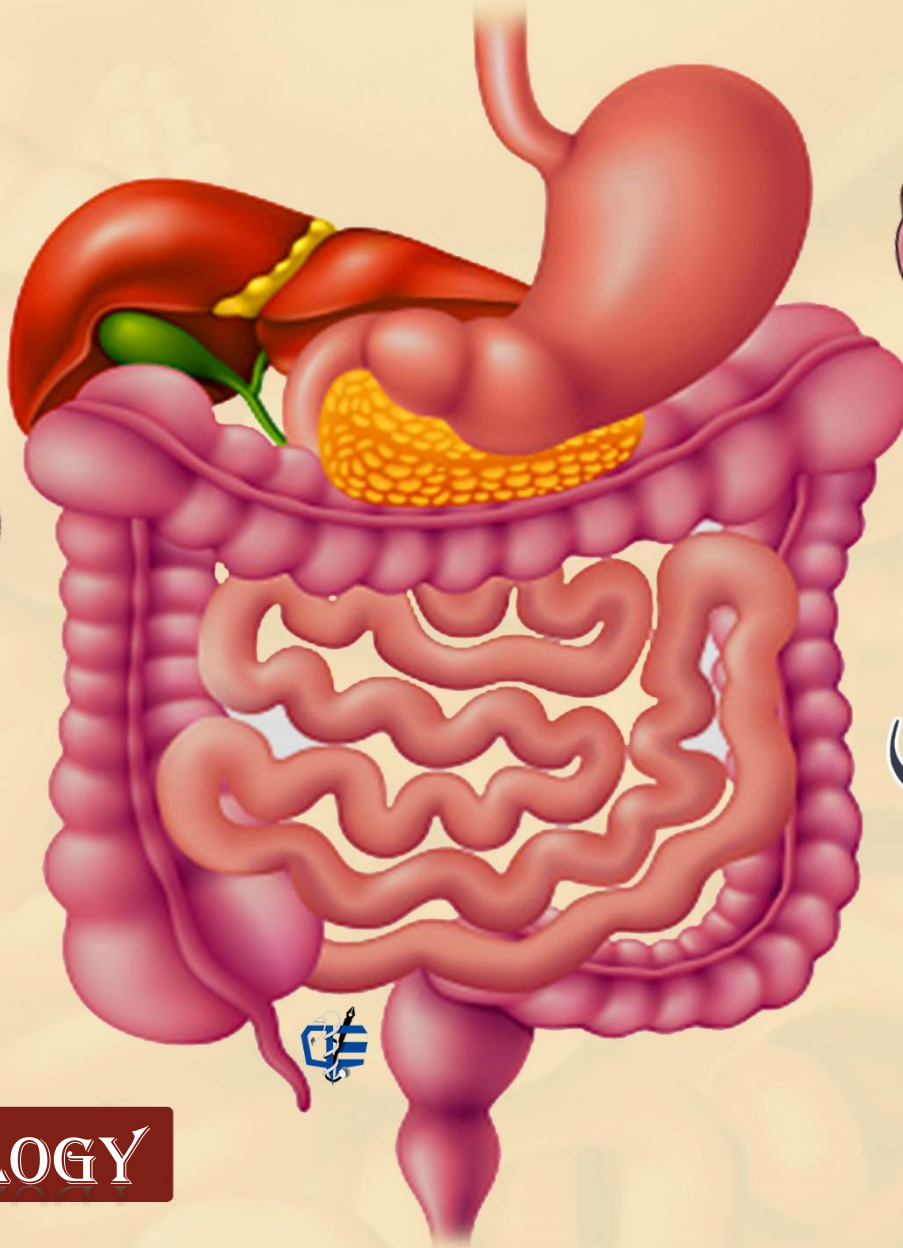


# GastroIntestinal System



## HISTOLOGY

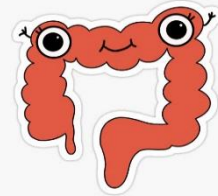
Doctor: Dr. Mohammad Al-mohaseb .

Done by: Suhaib Shabatat 019 batch.

Edited by: Deema Sayeh.



# Large intestine



★ Large intestine has 4 main layers as small intestine which are mucosa, submucosa, muscularis externa and serosa (or adventitia).

\*\*you all know that large intestine is consist of cecum, ascending colon, transverse colon, descending colon, sigmoid colon and rectum.

=> they all have the same structure.

★ The main function of it is absorption of water, formation of feces and production of mucus.

★ The epithelium here is simple columnar epithelium with goblet cells (goblet cells are **numerous** in large intestine).

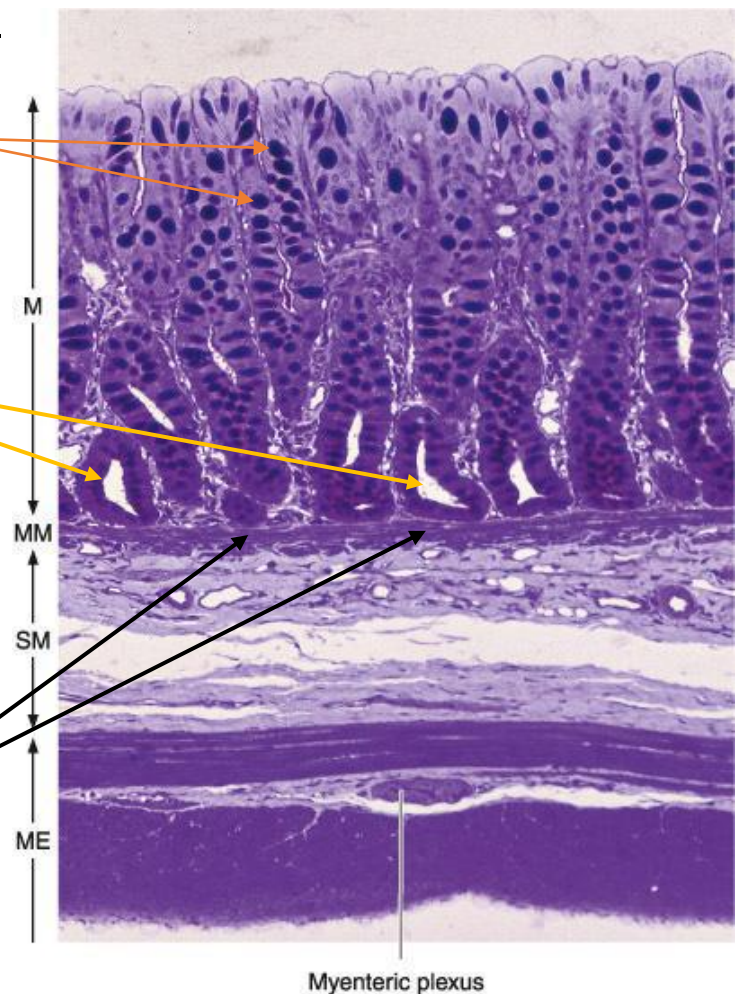
☯ No villi are present in it.

☯ The intestinal glands are found in the lamina propria (but here there's NO Paneth cells) it has neuroendocrine cells, stem cells and mucus secreting cells.

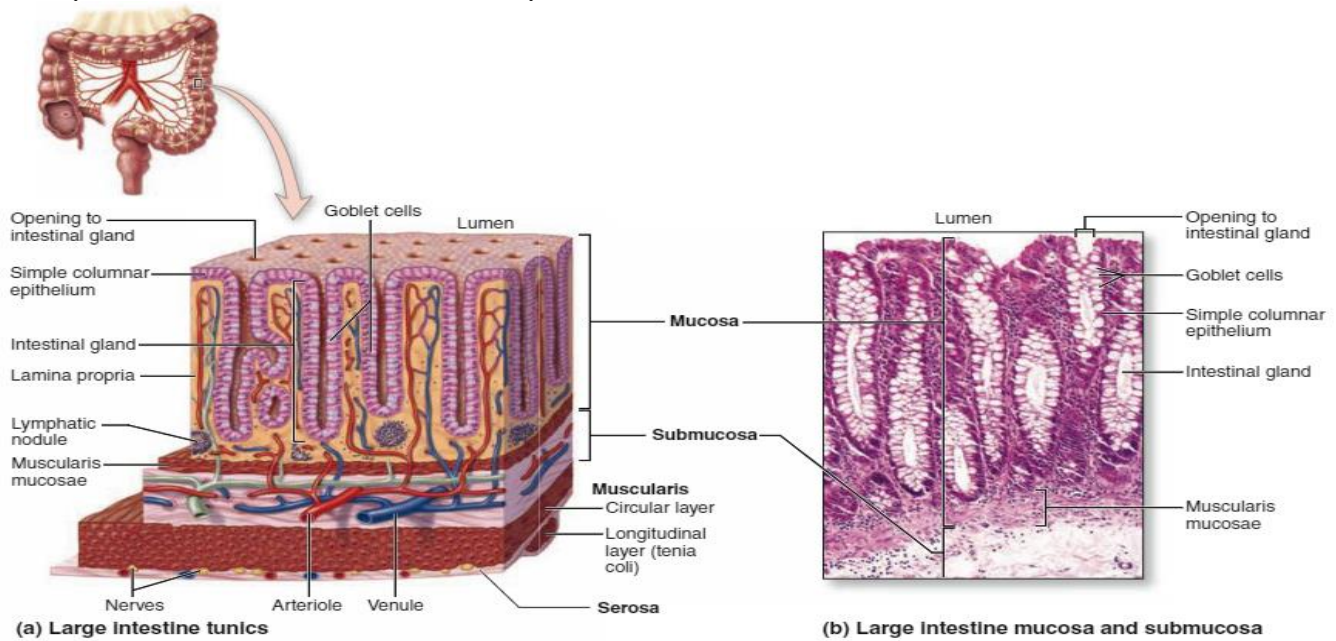
☯ There're also absorptive cells which are columnar and have short, irregular microvilli.

=muscularis mucosa is well-defined in large intestine.

=submucosa has lymphatic vessels and nodules (solitary lymphatic nodules in SM and lamina propria) and blood vessels.



☯ The large intestine consists of a mucosal membrane with no folds except in its distal (rectal) portion.



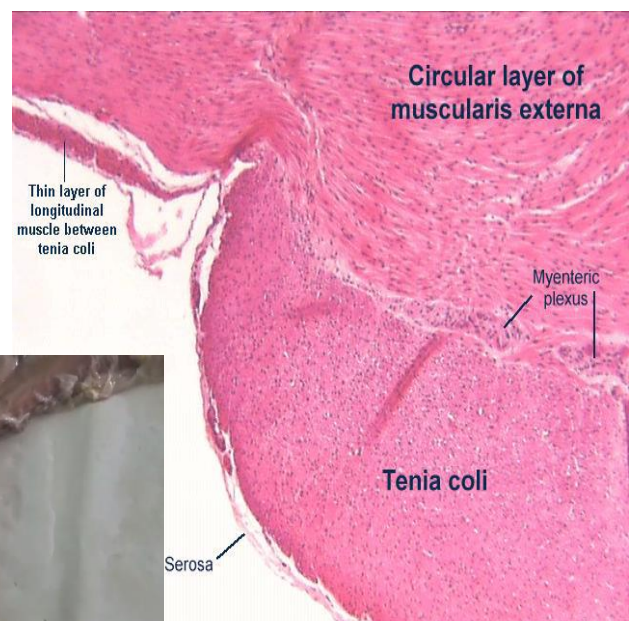
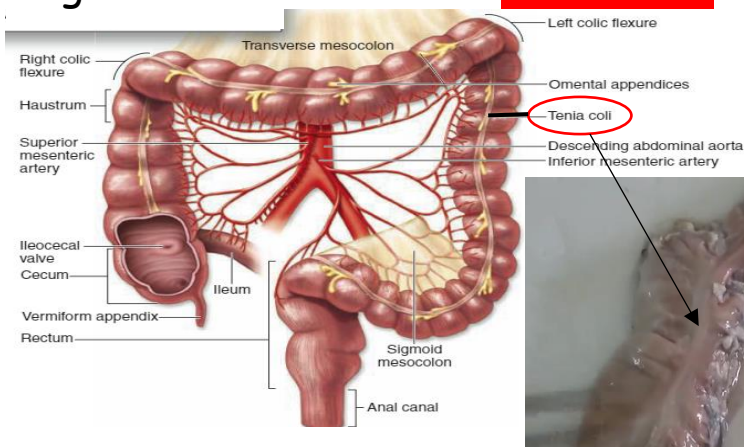
★ Mucus is a highly hydrated gel that not only **lubricates** the intestinal surface but also **covers** bacteria and particulate matter.

★ The absorption of water is passive, following the active transport of sodium out of the basal surfaces of the epithelial cells.

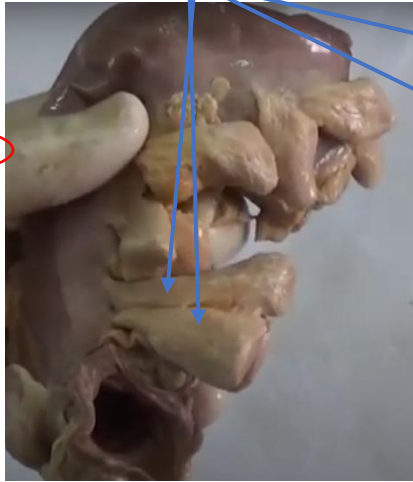
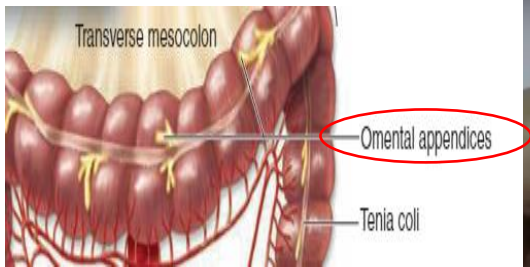
★ The richness in lymphoid tissue (GALT) is related to the abundant bacterial population of the large intestine.

★ The muscularis comprises longitudinal and circular strands.

★ Fibres of the outer longitudinal layer congregate in three thick longitudinal bands called **teniae coli**.

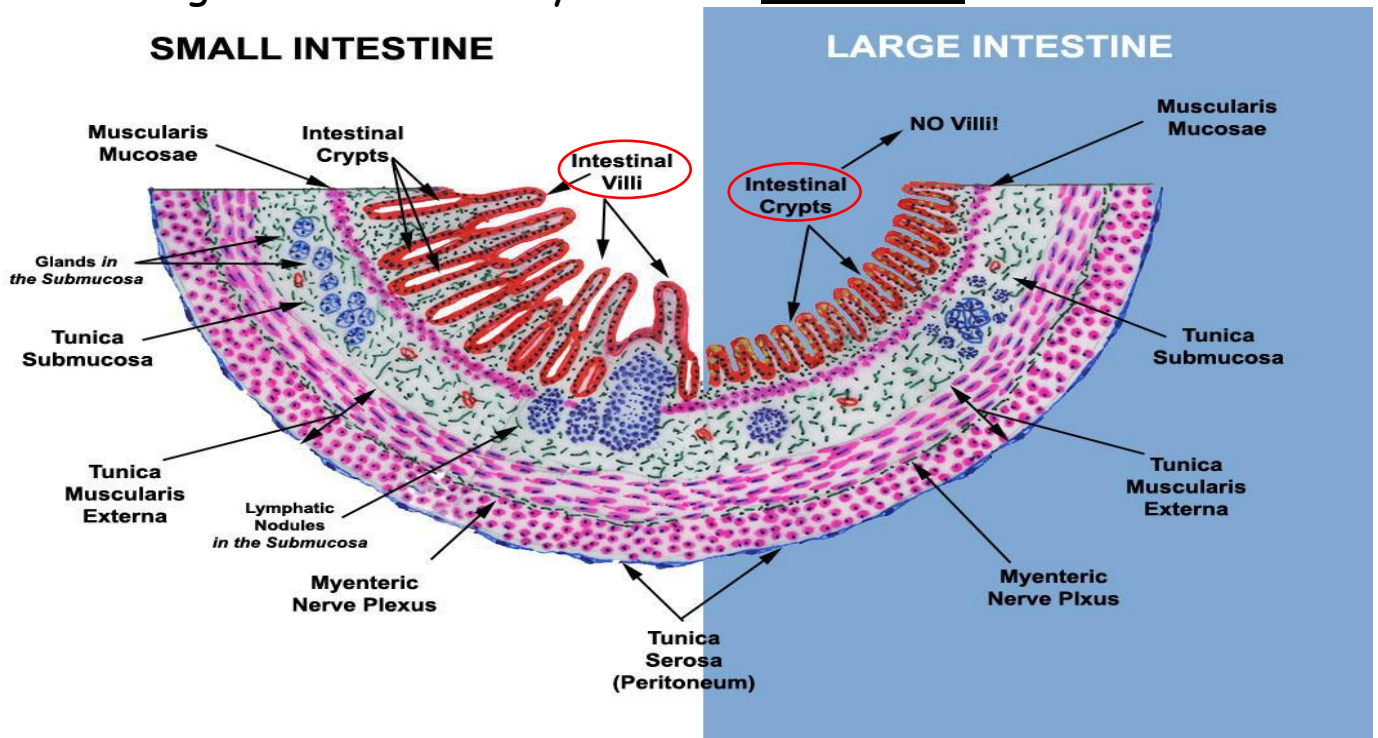


★ In the intraperitoneal portions of the colon, the serous layer is characterized by small, pendulous protuberances composed of adipose tissue—the **appendices epiploicae**.



★ So, the differences between the small and large intestine are:

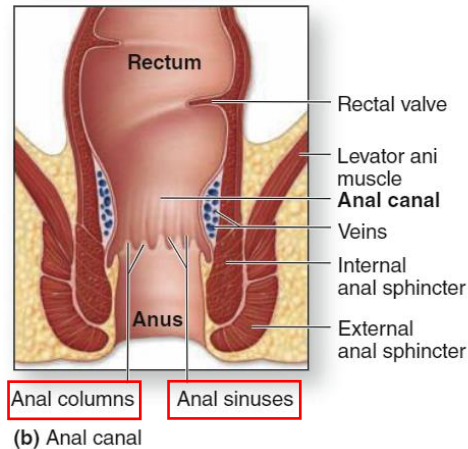
- Mucosa is thicker and contains crypts but no Villi.
- Simple columnar epithelium with an abundance of goblet cells.
- Crypts are longer, more closely packed and there are no Paneth cells.
- Lamina propria is reduced, and it contains solitary lymph nodes.
- The muscularis layer is well developed.
- Outer longitudinal muscle layer forms tineae coli.



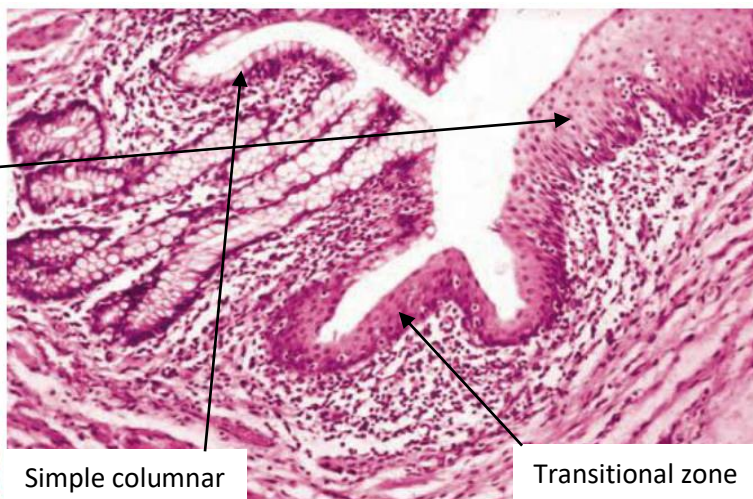
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In the anal region, the mucous membrane forms a series of longitudinal folds start at the end of the rectum and reach the anal canal, called the **rectal columns of Morgagni** or **anal column**.

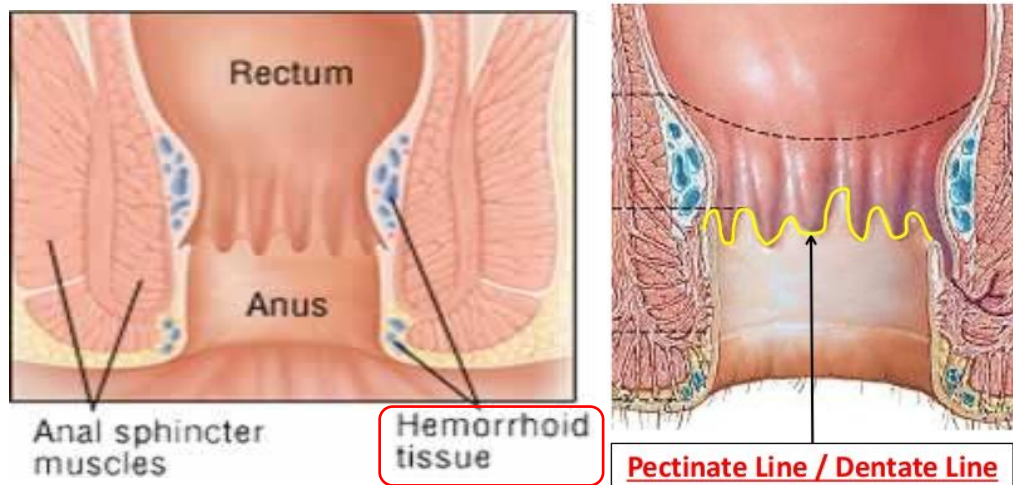
These columns connect to the anal orifice to form the anal valves and sinuses.



\*\*About 2 cm above the anal opening, the intestinal mucosa is replaced by **stratified squamous epithelium** (and the number of **goblet cells decreases**) and in the orifice it becomes **stratified squamous keratinized** (has hair follicle).



\*\*In this region, the lamina propria contains a plexus of large veins that, when excessively dilated and varicose, produces haemorrhoids (we have internal and external haemorrhoids separated by pectineal line).



Extra info:

Haemorrhoids

هي البواسير بالعربي وهي انتفاخ بهاي الأوردة زي فكرة الدوالي

The muscularis layer gives rise to the anal sphincter.

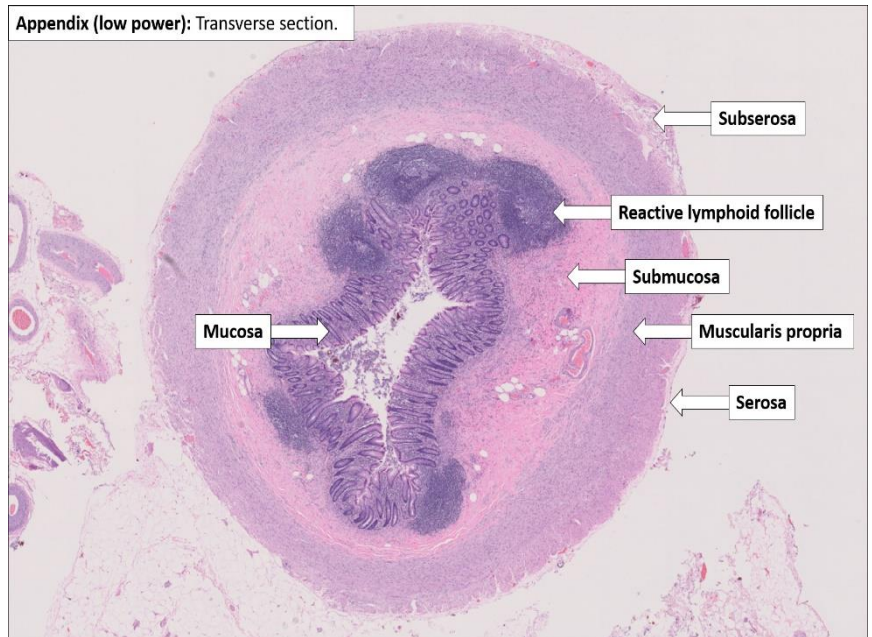
The adventitia layer connects the anal canal to the surrounding structures.

Appendix, however its in GIT but its lymphoid structure, so it has narrow irregular lumen, the lining epithelium is simple columnar with few goblet cells (because it doesn't have function here), and the lamina propria has few gland (it's prominent structure is **lymphoid tissue**).

\*\*the lymphoid tissue here is circular and extend to submucosa.

\*doesn't have tinea coli.

\*Covered entirely by serosa (**mesoappendix**, which is two layers of peritoneum, has fats, blood vessels, lymphatics and lymphatic nodules).



∴ Anal canal can be divided into  
 → upper half: simple columnar epithelium with goblet cells → has an **ENDODERMAL** origin  
 → lower half: stratified squamous epithelium Non-keratinized  
 → Orifice: keratinized stratified squamous epithelium. → has an **ECTODERMAL** origin.

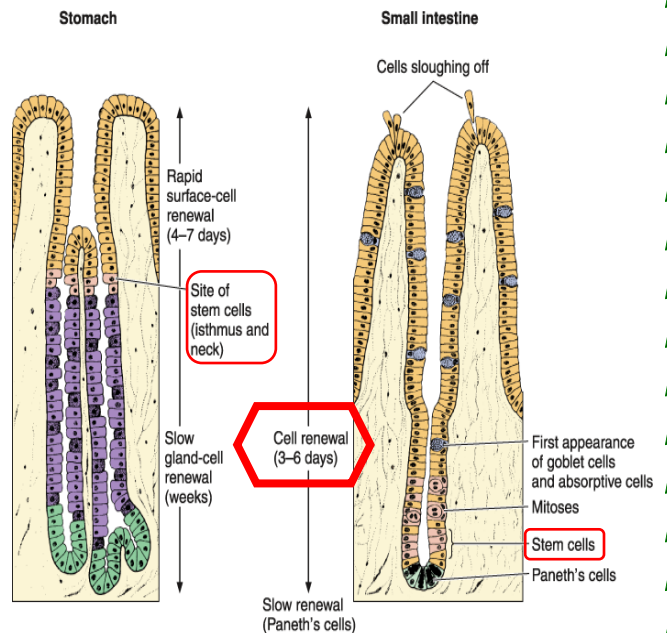
## Cell Renewal in the Gastrointestinal Tract:

\*The epithelial cells of the entire gastrointestinal tract are constantly being cast off and replaced with new ones formed through mitosis of stem cells.

\*These stem cells are located in the **basal layer of the esophageal** epithelium, the **neck of gastric** glands, the **lower half of the intestinal** glands and the **bottom third of the crypts of the large intestine**

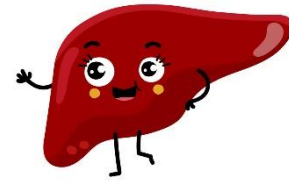
\*From this proliferative zone in each region, cells move to the maturation area, where they undergo structural and enzymatic maturation, providing the functional cell population of each region

\*In the small intestine the cells die by apoptosis in the tip of the villi or are sloughed off by mechanical action during function.



4

# Liver



☀ The liver is the second-largest organ of the body (the largest is the skin) and the **largest gland**, weighing about **1.5 kg**.

☯ Its located in the right hypochondriac region and extend to the epigastric and sometimes to the left hypochondriac regions.

\*\*The liver is the organ in which nutrients absorbed in the digestive tract are processed and stored for use by other parts of the body.

☯ the liver is considered endocrine and exocrine; because it secrets bile and bile salt {exocrine} and also secrets albumin, globulin, antibodies, coagulant material and heparin {endocrine}.

\*\*It is thus an interface between the digestive system and the blood.

☯ Most of its blood (70-80%) comes from the **portal vein**, arising from the stomach, intestines, and spleen; the smaller percentage (20-30%) is supplied by the **hepatic artery**.

\*\* All the materials absorbed via the intestines reach the liver through the portal vein, except the complex lipids (**chylomicrons**), which are transported mainly by lymph vessels.

☀ The position of the liver in the circulatory system is optimal for gathering, transforming, and accumulating metabolites and for neutralizing and eliminating toxic substances, because the function of the liver is the metabolism of carbohydrates, fats and proteins.

☯ Its also important in detoxification and coagulation.

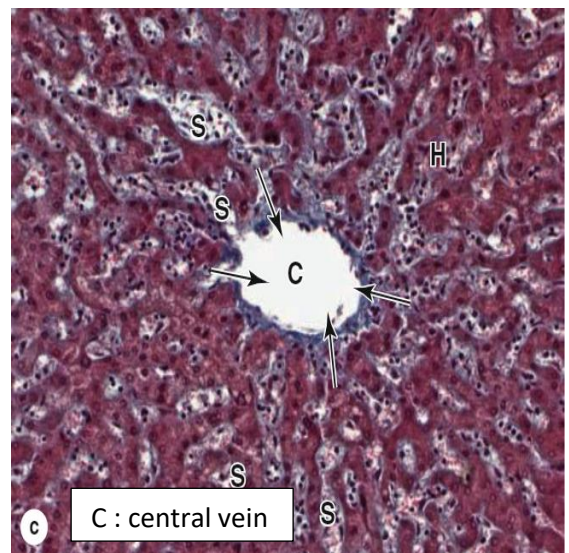
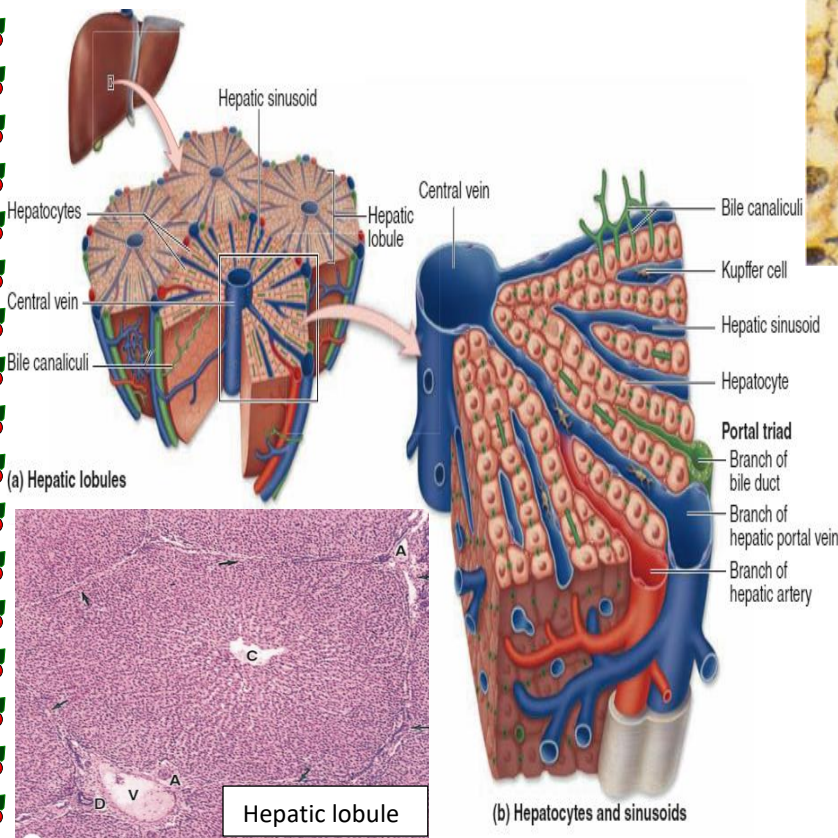
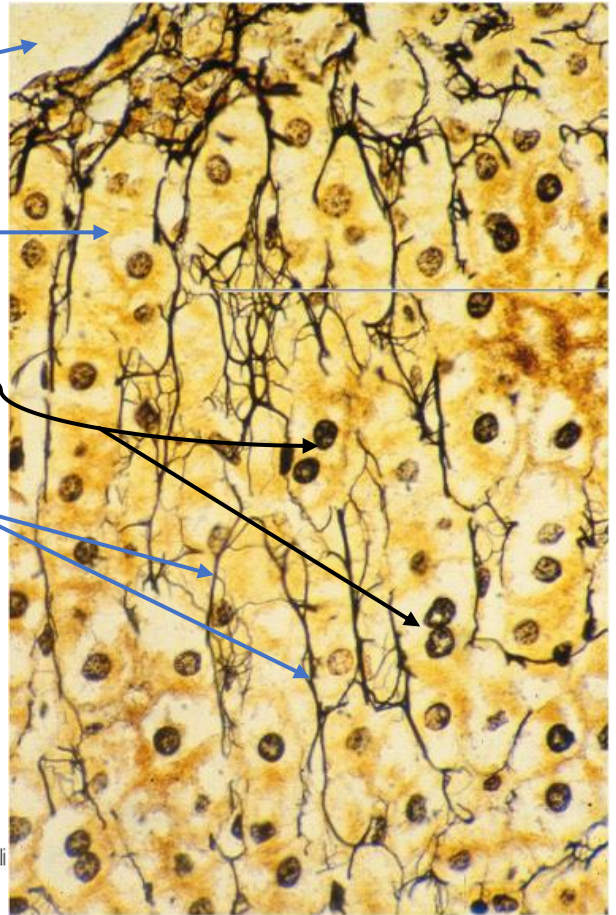
\*\*Elimination occurs in the bile, an exocrine secretion of the liver that is important for lipid digestion.

If we take a section through the liver, we find that it consists of lobes and lobules and they are covered by a thin connective tissue capsule (**Glisson's capsule**).

the capsule becomes thicker in the **hilum** (or porta hepatis) which is the entrance of blood vessels and the exit way for bile duct, there's also some nerves and lymphatic vessels and lymph nodes.

The liver consists of hexagonal lobule with central vein in the middle. = hepatocyte (liver cells) has central rounded nuclei and sometimes the cell could be binucleated, these cells are arranged radially from the periphery to the central vein.

\*\*liver has large amount of reticular fibres appear with special stain called silver nitrate.





Now this is the hexagonal lobule with central vein and sinusoids between hepatocytes (it has mixed blood from the artery and the vein goes to the hepatocytes to do their job)

\*in green is bile duct (hepatic duct)  
 \*the corners of hexagonal are called portal triad (or portal spaces) it has artery (from hepatic artery), vein (from portal vein) and bile to form The bile duct,, also we could find reticular fibres and lymph vessels.

These hepatic cells are grouped in interconnected plates and constitute two-thirds of the mass of the liver.

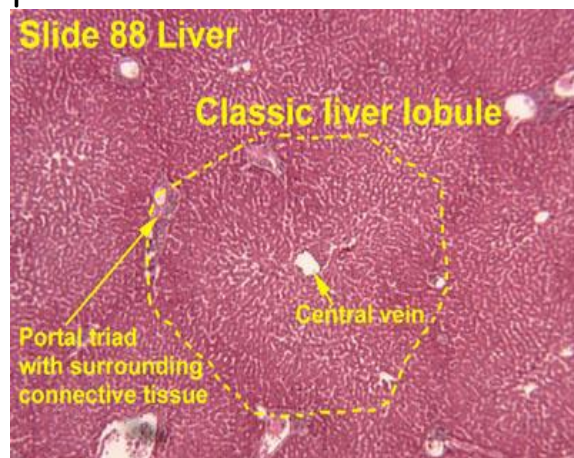
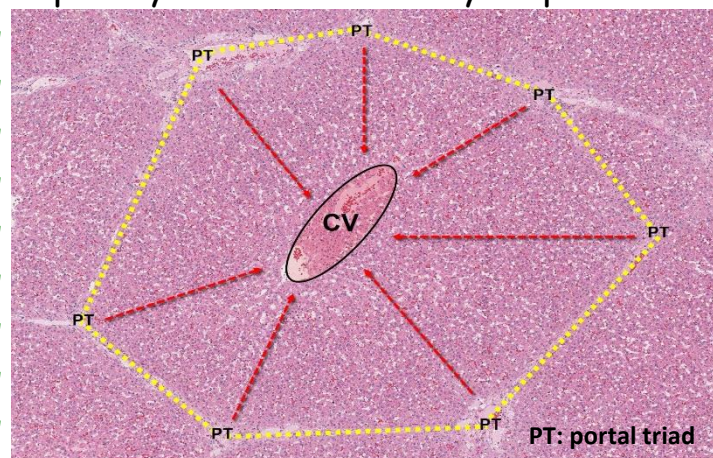
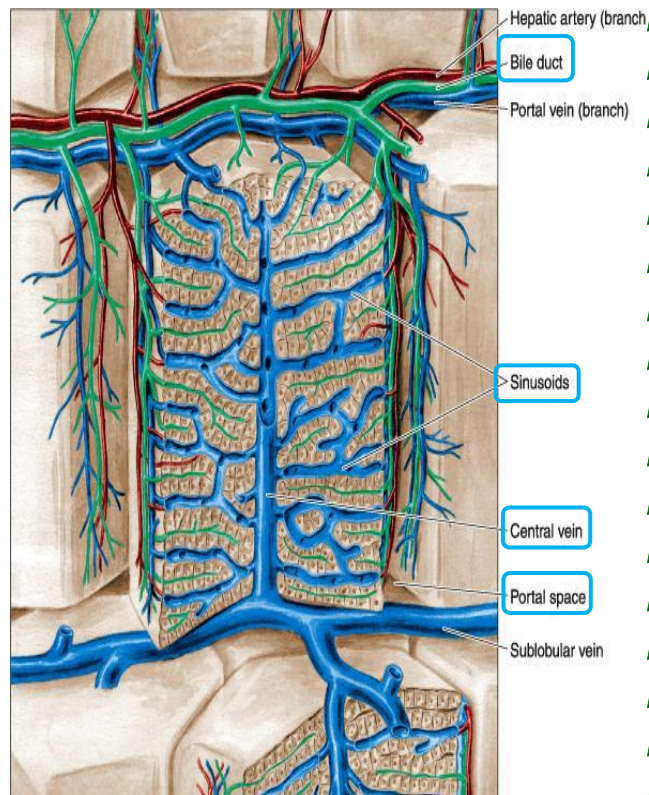
\*The liver lobule is formed of a polygonal mass of tissue about 0.7 x 2 mm in size.

Portal spaces located in the corners of the lobules, and they are 3-6 in each lobule.

\*\*The venule contains blood coming from the superior and inferior mesenteric and splenic veins, and it's the largest structure.

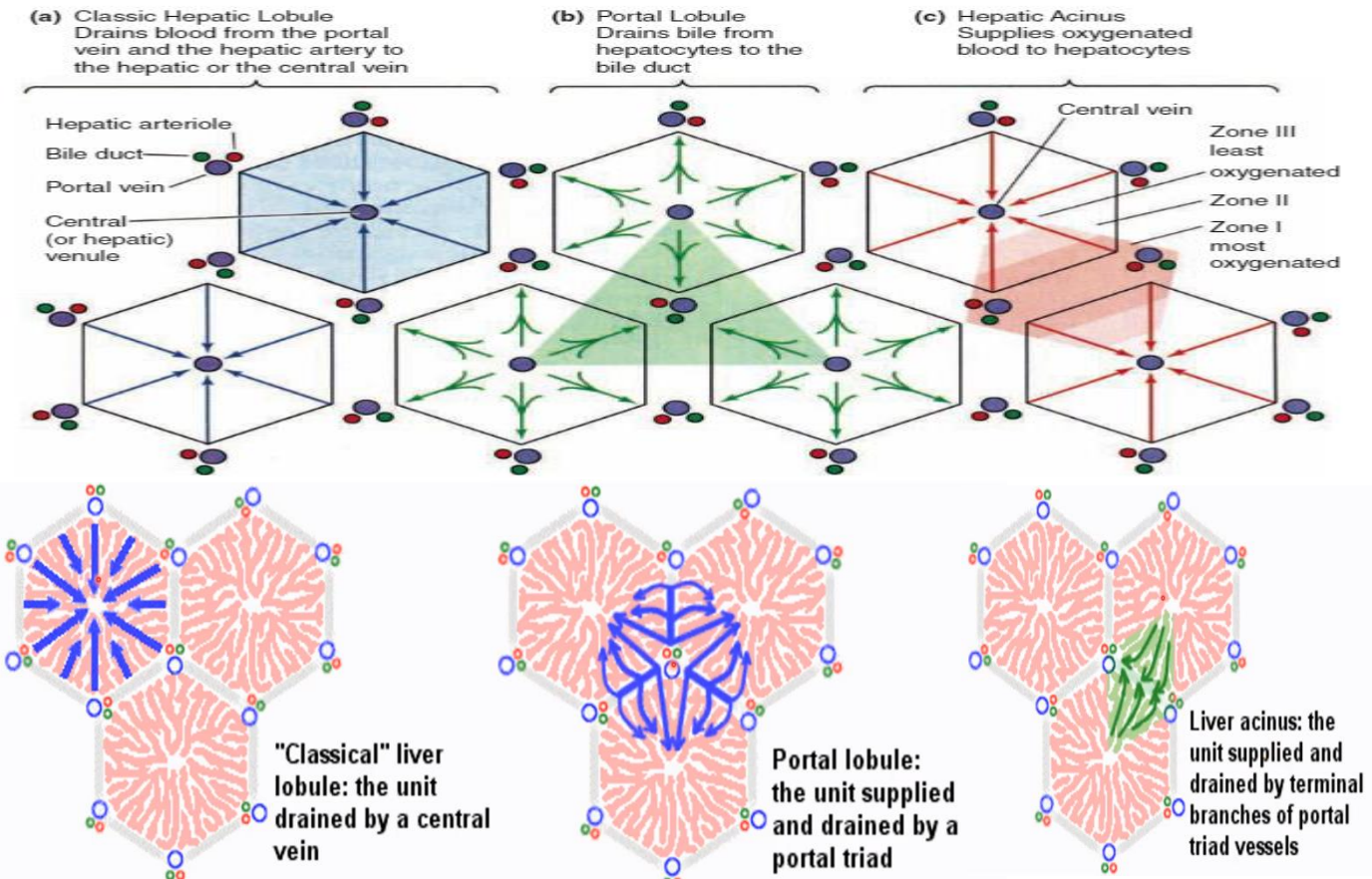
\*\*The arteriole contains oxygen-rich blood coming from the celiac trunk of the abdominal aorta.

\*\*The duct, lined by cuboidal epithelium, carries bile synthesized by the hepatocytes and eventually empties into the hepatic duct.

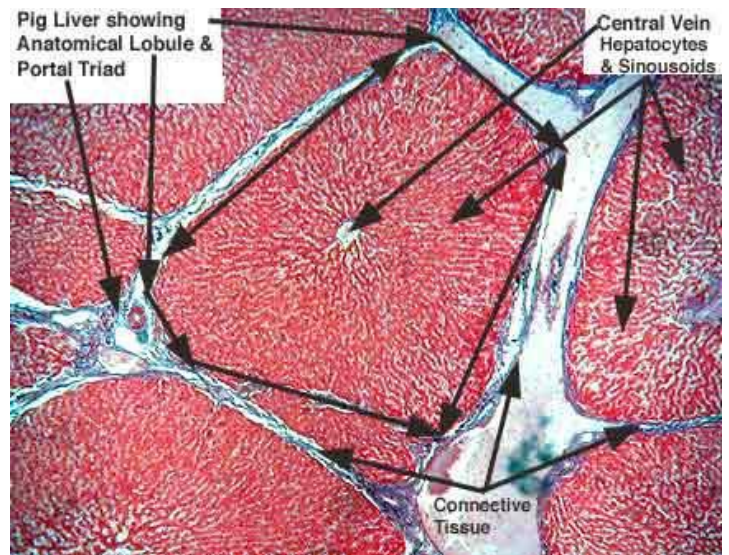


♥ Types of hexagonal lobules:

- 1) **The classical lobule**: which has **central vein**.
- 2) **Portal lobule**: found between hexagonal lobule and has **portal triad in the centre** (with its arteriole, venule and bile duct).
- 3) **Liver acinus**: diamond in shape and its **between two central veins and two portal triads**.



☯ In certain animals (eg, pigs), the lobules are separated by a layer of connective tissue. This is not the case in humans, where the lobules are in close contact along most of their length, making it difficult to establish the exact limits between different lobules.

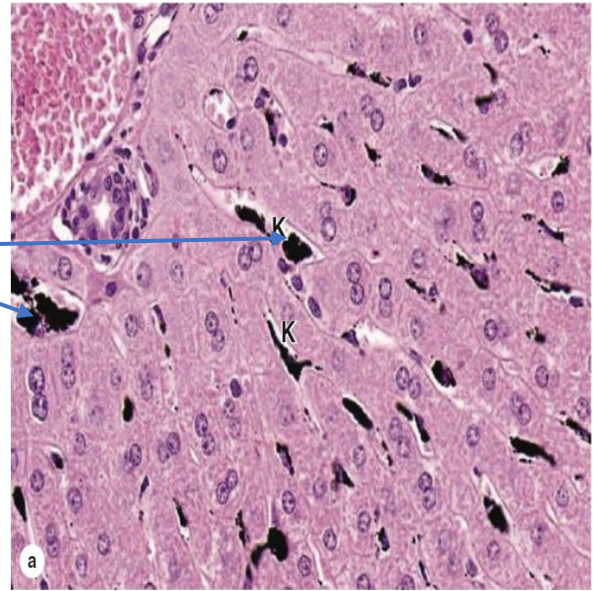


♥ The lining of the central vein is **simple squamous epithelium**.

☯ for each two lines of hepatocytes there's one line of sinusoids and these sinusoids lined by **endothelial cells**.

☯ the darkly stained cells are Kupffer cells which are macrophages.

☯ sinusoidal capillaries are irregularly dilated vessels composed solely of a discontinuous layer of fenestrated endothelial cells.



\*\*The fenestrae are about 100 nm in diameter, have no diaphragm, and are grouped in clusters.

☯ There are also spaces between the endothelial cells, which, together with the cellular fenestrae and a discontinuous basal lamina (depending on the species), give these vessels great permeability.

\*\*The cellular plates are directed from the periphery of the lobule to its centre and anastomose freely, forming a labyrinthine and sponge like structure.

★ A subendothelial space known as the **space of Disse** separates the endothelial cells from the hepatocytes and has NO direct blood nor mixed blood.

☯ The fenestrae and discontinuity of the endothelium allow the free flow of plasma but not of cellular elements into the space of Disse, thus permitting an easy exchange of molecules (including macromolecules) from the sinusoidal lumen to the hepatocytes and vice versa, Which allows the release of the large number of macromolecules (eg, lipoproteins, albumin, fibrinogen) secreted into the blood by hepatocytes and also it enables the liver takes up and catabolizes many of these large molecules.

☯ The basolateral side of the hepatocyte, which lines the space of Disse, contains many microvilli and demonstrates endocytic and pinocytic activity.

\*In addition to the endothelial cells, the sinusoids contain macrophages known as **Kupffer cells**.

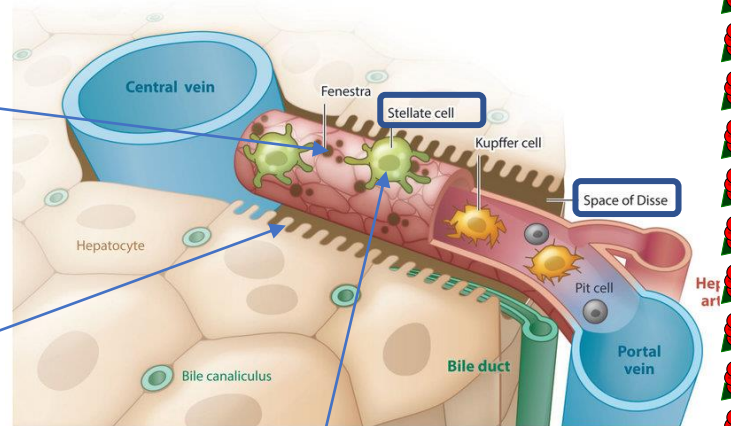
=Kupffer cells are absent in space of Disse.

☉Kupffer cells account for 15% of the liver cell population. Most of them are located in the periportal region of the liver lobule, where they are very active in phagocytosis

=Their main functions are to metabolize aged erythrocytes, digest haemoglobin, secrete proteins related to immunological processes, and destroy bacteria that eventually enter the portal blood through the large intestine.

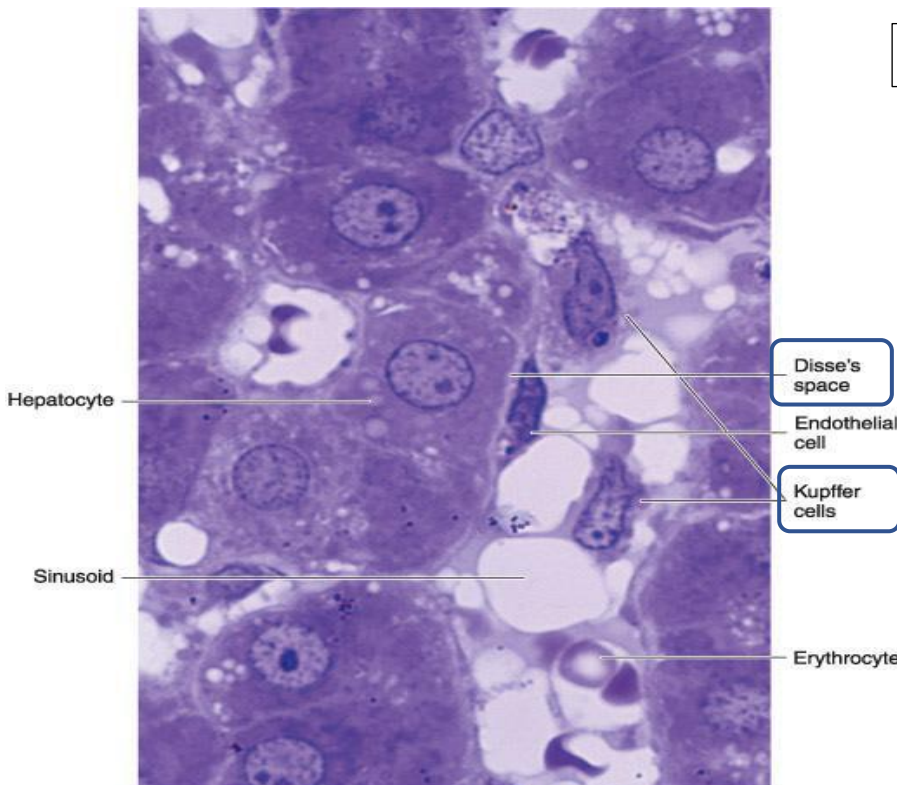
Fenestra means places within the sinusoids that aren't covered with endothelium

Notice the microvilli facing the space



Fat storing cells

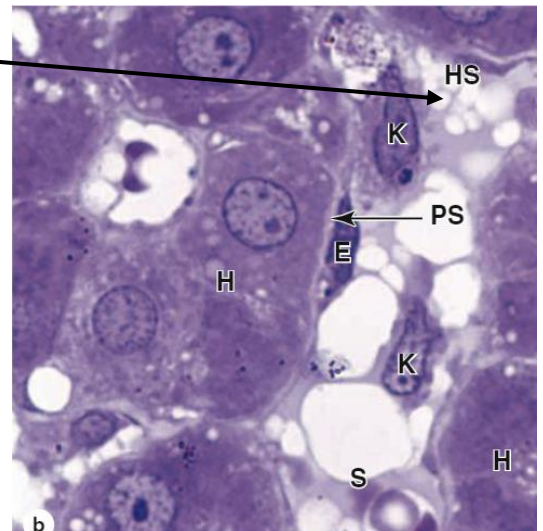
Discussed  
In the next page



In the space of Disse (perisinusoidal space), **fat-storing cells**, also called **stellate** or **Ito's cells**, contain vitamin A rich lipid inclusions supported by reticular fibres.

In the healthy liver, these cells have several functions, such as:

- 1) uptake, storage, and release of retinoids.
- 2) synthesis and secretion of several extracellular matrix proteins and proteoglycans.
- 3) secretion of growth factors and cytokines, and the regulation of the sinusoidal lumen diameter in response to different regulators (eg, prostaglandins, thromboxane A2).



The beginning of bile way is called **bile canaliculi**, then **bile ductulus**, its end called **Hering's canal** and in the portal triad is called **bile duct**.  
-This duct is consists of simple cuboidal cells.

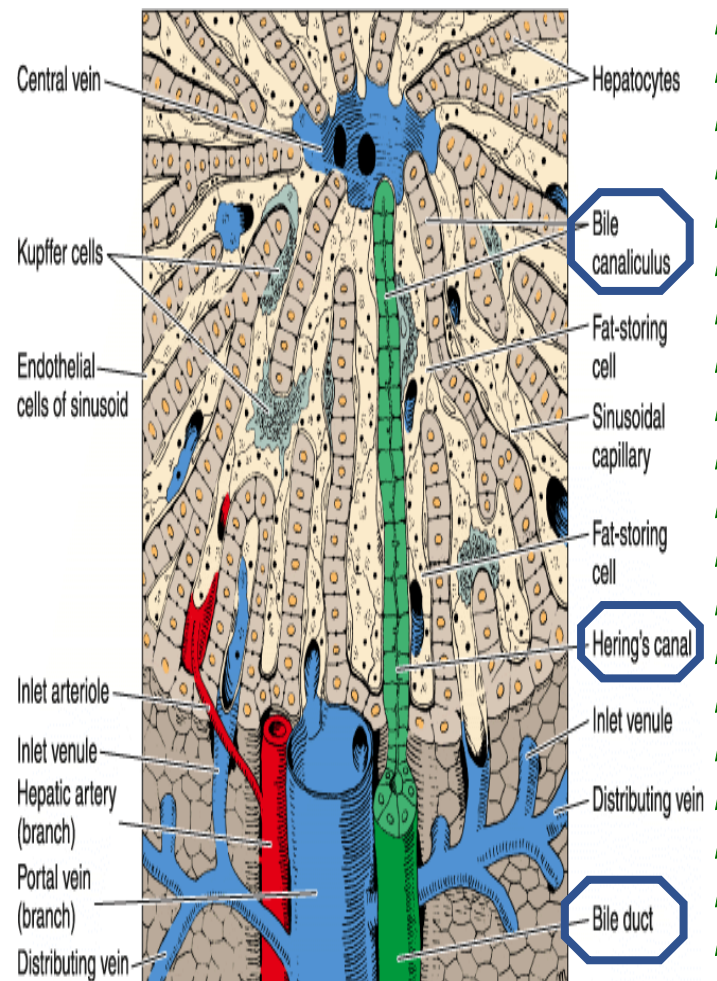
Notes from the slides:

\*Hepatocytes are polyhedral, with six or more surfaces, and have a diameter of 20-30  $\mu\text{m}$ .

\*the cytoplasm of the hepatocyte is eosinophilic, mainly because of the large number of mitochondria and some smooth endoplasmic reticulum.

\*Hepatocytes located at different distances from the portal spaces show differences in structural, histochemical, and biochemical characteristics.

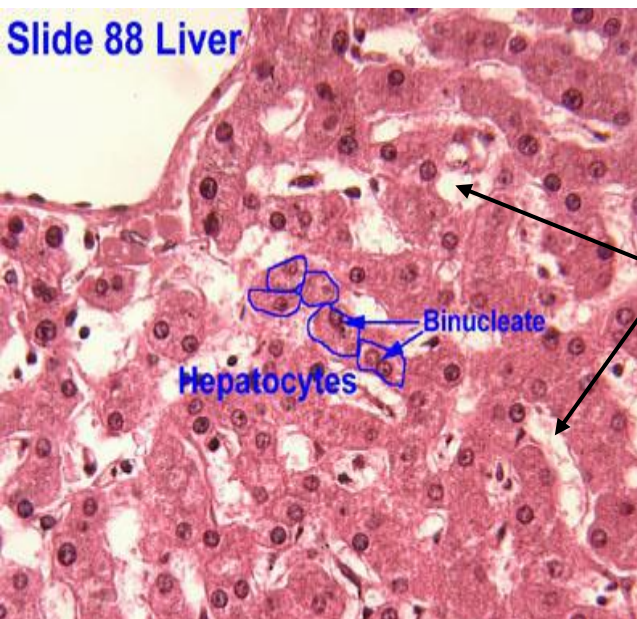
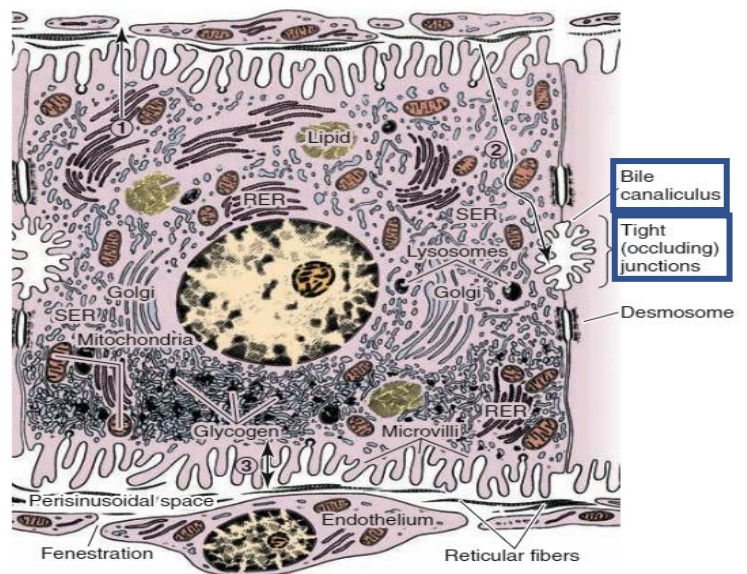
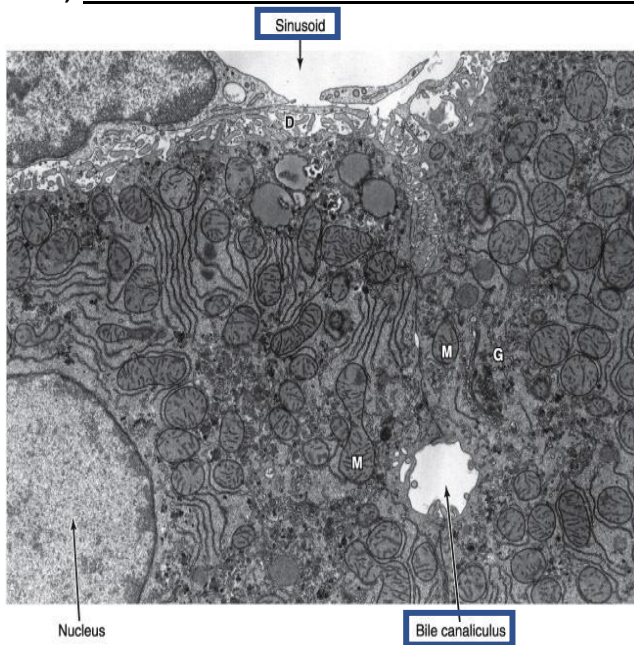
\*The surface of each hepatocyte is in contact with the wall of the sinusoids, through the space of Disse, and with the surfaces of other hepatocytes.



◆ In this TEM below we can see bile canaliculus and sinusoids.

🌀 notes from the slides:

- \*The canaliculi, the first portions of the bile duct system, are tubular spaces 12 um in diameter.
- \*They are limited only by the plasma membranes of two hepatocytes and have a small number of microvilli in their interiors.
- \*The cell membranes near these canaliculi are firmly joined by tight junctions.
- \*Gap junctions are frequent between hepatocytes and are sites of intercellular communication.
- \*The bile flow therefore progresses in a direction opposite to that of the blood, i.e., from the centre of the lobule to its periphery.



🌀 Here is another section for hepatocytes, remember some of them are binucleated.

\*some of the nuclei are polyploid.

\*these white spaces are sinusoids.

-hepatocytes have many mitochondria and rough ER that form aggregates dispersed in the cytoplasm and are called **basophilic bodies.**

\*notes from slides:

-The surface of the hepatocyte that faces the space of Disse contains many microvilli that protrude into that space, but there is always a space between them and the cells of the sinusoidal wall.

-again its function is synthesis of several proteins (albumin, fibrinogen) on polyribosomes, and also oxidation, methylation and conjugation (for inactivation or detoxification) of various substances before their excretion from the body.

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5

## Gallbladder



☀ The gallbladder is hollow, pear shaped organ attached to the lower surface of the liver.

=Its main function is storage of 30-50 ml and concentration of bile by absorbing its water up to 20 times (so it secretes 2 ml of concentrated bile to digest fats instead of secretion of 20 L of diluted bile).

☉ The wall of the gallbladder consists of a mucosa composed of **simple columnar epithelium** without goblet cells and this epithelium has **folding** and this gives it honeycomb appearance and it's rich with mitochondria.

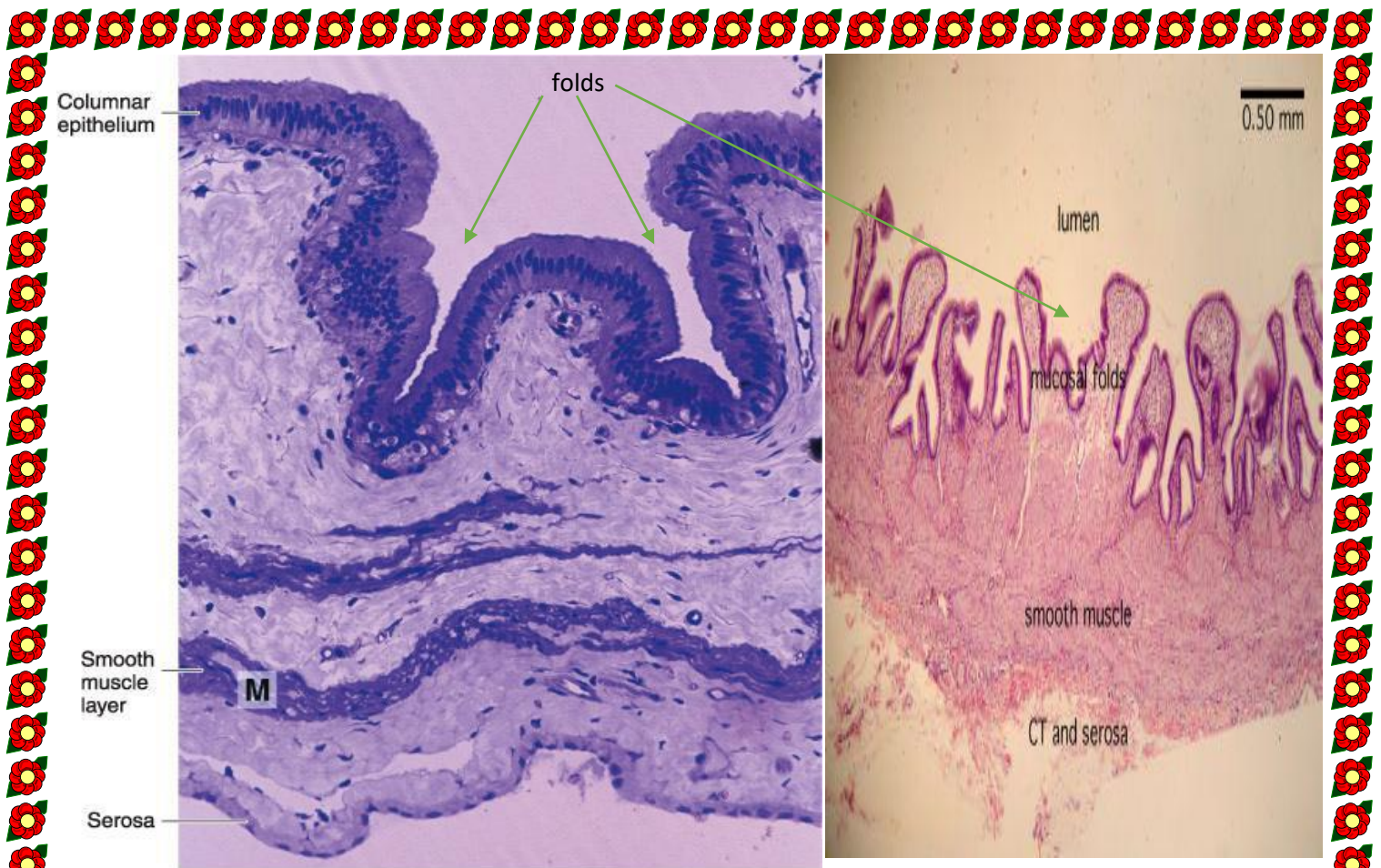
\*it could have mucus gland (tubuloacinar) near its neck for secretion of mucus.

☉ The lamina propria is ill-defined and doesn't have glands.

☉ There's NO muscularis mucosa nor submucosa.

☉ Muscularis externa is patches of smooth muscles one layer (there's no inner circular and outer longitudinal).

☉ The serosa is on its anterior surface, however, the embedded surface in the liver is connective tissue.



☯ Contraction of the smooth muscle of the gallbladder is induced by **cholecystikin**, a hormone produced by enteroendocrine cells located in the epithelial lining of the small intestine.

\*Release of cholecystikin is, in turn, stimulated by the presence of dietary fats in the small intestine.

-no peristaltic movement.



6

# Pancreas



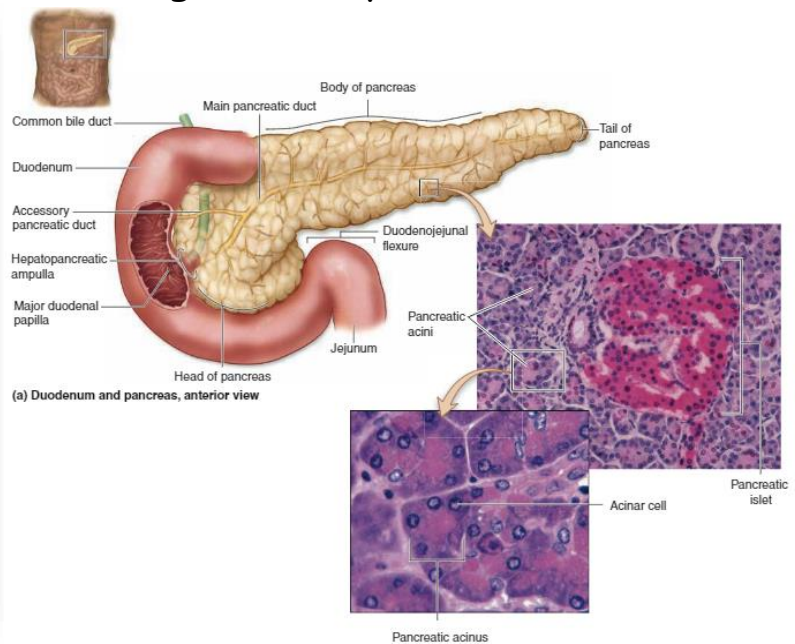
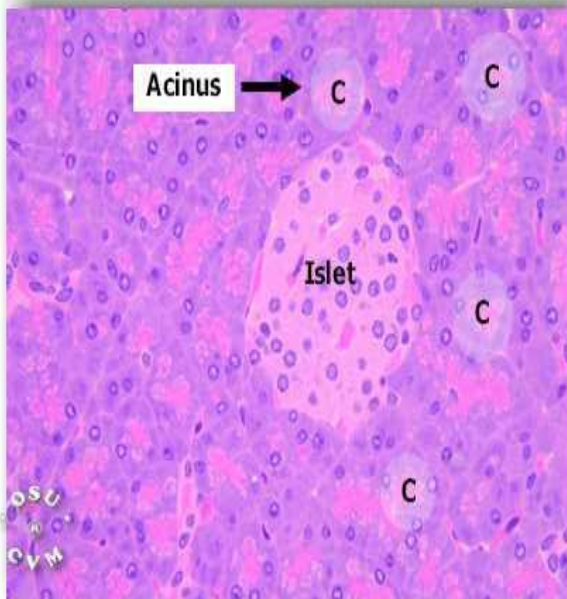
😊 The pancreas is a mixed exocrine-endocrine gland that produces digestive enzymes and hormones.

🌀 The enzymes are stored and released by cells of the exocrine portion, arranged in acini.

🌀 The hormones are synthesized in clusters of endocrine epithelial cells known as **islets of Langerhans**.

🌀 exocrine portion of the pancreas is a compound acinar gland, similar in structure to the parotid gland.

\*In this picture we see the endocrine part, which is the islet of Langerhans, it has  $\alpha$  cells (secret glucagon) and  $\beta$  cells (secret insulin) as we see it looks pale patches surrounded by exocrine part which is pancreatic acini (release enzyme that go to the pancreatic duct)



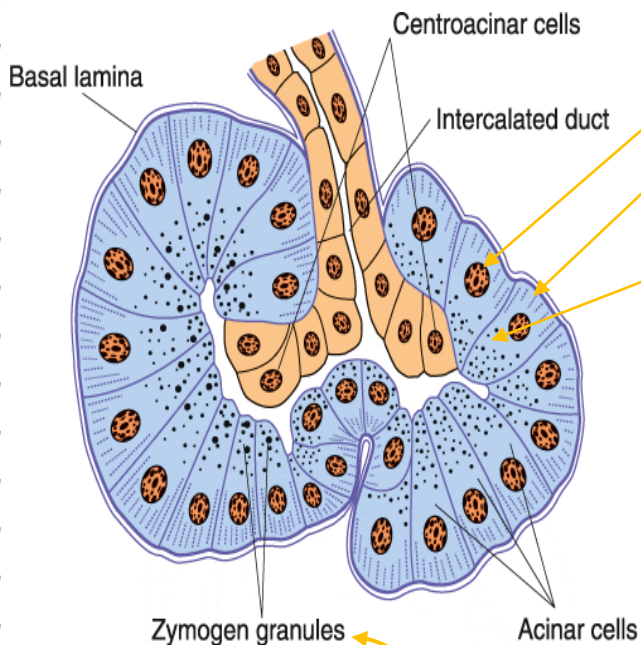
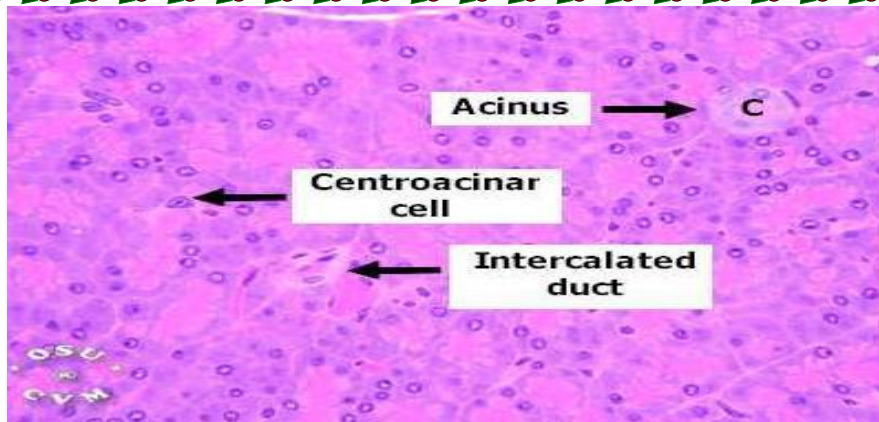
🌀 The differences between parotid and pancreas:

-No striated duct.

-in the lumen there's special type of cells called **Centro acinar** cells pale in colour.

-the duct in pancreas is intercalated duct (no striated ducts).

\*\*Intercalated ducts are tributaries of larger intralobular ducts that, in turn, form larger interlobular ducts lined by columnar epithelium, located within the connective tissue septa.



Here we can see acinar cells, it has basal and rounded nuclei.  
 -there's striation near basement membrane  
 =apex full of granules that has enzymes; so we have polarity (its base is basophilic)  
 \*intercalated duct are simple cuboidal cells opens in intralobular ducts then it forms pancreatic ducts.  
 \*pancreatic duct transforms from stratified columnar to stratified squamous epithelium when it opens in the duodenum.

Notes from slides:

- =The number of zymogen granules present in each cell varies according to the digestive phase and attains its maximum in animals that have fasted.
- =thin capsule of connective tissue covers the pancreas and sends septa into it, separating the pancreatic lobules.
- =The acini are surrounded by a basal lamina that is supported by a delicate sheath of reticular fibres.
- =The pancreas also has a rich capillary network, essential for the secretory process.

In the figure below we can see intercalated duct, lumen of pancreatic acinus, foamy appearance of secretory granules and basophilic base.

Pancreatic secretion is controlled mainly through two hormones **secretin** and **cholecystokinin** that are produced by enteroendocrine cells of the intestinal mucosa (duodenum and jejunum).

## Notes from slides:

\*The exocrine pancreas secretes 1500-3000 mL of isosmotic alkaline fluid per day containing water, ions, and several proteases:

=trypsinogens 1, 2, and 3,

=chymotrypsinogen,

=proelastases 1 and 2, protease E

=kallikreinogen.

=procarboxypeptidases A1, A2, B1, and B2),

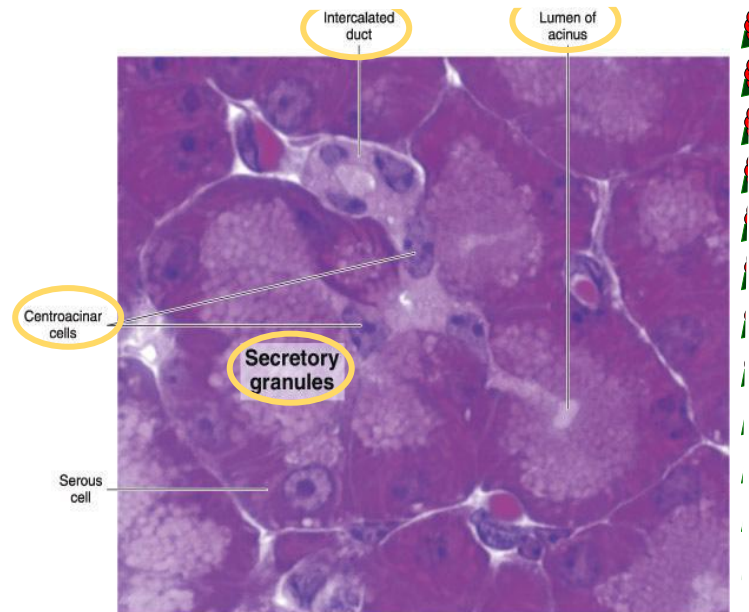
=amylase, lipases (triglyceride lipase, colipase, and carboxyl ester hydrolase),

=phospholipase A2,

=and nucleases (deoxyribonuclease and ribonuclease)

\*The majority of the enzymes are stored as proenzymes in the secretory granules of acinar cells, being activated in the lumen of the small intestine after secretion.

\*Enterokinase, an intestinal enzyme, cleaves trypsinogen to form trypsin, which then activates the other proteolytic enzymes in a cascade.



So as a quick recap we talked about the histology of six organs of the GI:

*They are not a part of the alimentary system! so we will not talk about mucosa/submucosa/muscularis...*

	large intestine	Anal canal	Appendix	Liver	Gall bladder	Pancreas
<b>lining epithelium</b>	simple columnar epithelium with numerous goblet cells.	upper half: simple columnar with goblet cells lower half: stratified squamous non-keratinized Orifices: stratified squamous keratinized	Simple columnar with <b>Few</b> goblet cells	✓ second largest organ of the body, largest gland. ✓ mixed gland endocrine: liver synthesizes hormones and proteins like growth factors and plasma proteins exocrine: hepatocytes synthesize bile and some enzymes	* it will release its contents into the 2nd part of the duodenum so you would notice a similar structure and histology to other alimentary organs.	✓ cells are highly folded.
<b>lamina Propria</b>	rich in lymphoid cells.	contain large veins that when excessively dilated produces hemorrhoids + lymph nodules	contain lymphoid follicles	Some hormones and proteins like growth factors and plasma proteins	✓ mucosa: simple columnar epithelium without goblet cells with abundant folds that give a honeycomb appearance.	✓ mixed gland: endocrine: islets of Langerhans exocrine: digestive enzymes are synthesized by acinar cells.
<b>Muscularis mucosa</b>	well developed.	No extra information added	Some sources state that <b>NO</b> muscularis mucosa in the appendix	✓ has a capsule called Glisson's capsule.	✓ NO submucosa nor muscularis mucosa.	Regarding the exocrine part it is similar to the parotid gland but it doesn't have striated ducts.
<b>submucosa</b>	lymphatic nodules + blood vessels.	contains lymphatic nodules	No extra info	✓ Gap junctions between hepatocytes are frequent to allow intercellular communication.	✓ muscularis externa is composed of oblique, irregular smooth muscles with collagen and elastic fibers in between.	
<b>Muscularis externa</b>	inner circular and outer longitudinal that concentrate in thick bands: Tenia coli	give rise to the anal sphincter	Normal: outer longitudinal, inner circular.	Types of lobules? ① Classical lobule: illustrates the endocrine function. ② Portal lobule: illustrates the exocrine function. ③ Hepatic acinus: illustrates the nature of blood supply to the hepatocytes	✓ NO peristaltic movements.	
<b>Serosa or adventitia.</b>	Some parts of the large intestine are intraperitoneal and have serosa while others are retroperitoneal and have adventitia. The intra-peritoneal parts have appendices epiploicae	Since it is retroperitoneal the adventitia connects the anal canal to the surrounding structures	<b>Serosa</b> , since it has a mesentery called mesoappendix		✓ lamina Propria is vascularized.	
<b>important info.</b>	* No villi in the mucosa * No Paneth cells in the crypts.	mucosa membrane forms a series of longitudinal folds called: rectal columns of Morgagni	* lumen is very narrow and can be obstructed * has NO villi * crypts are branched			Wish you all the best of luck.

go back to see how each one looks li