Human Histology session

1st stage

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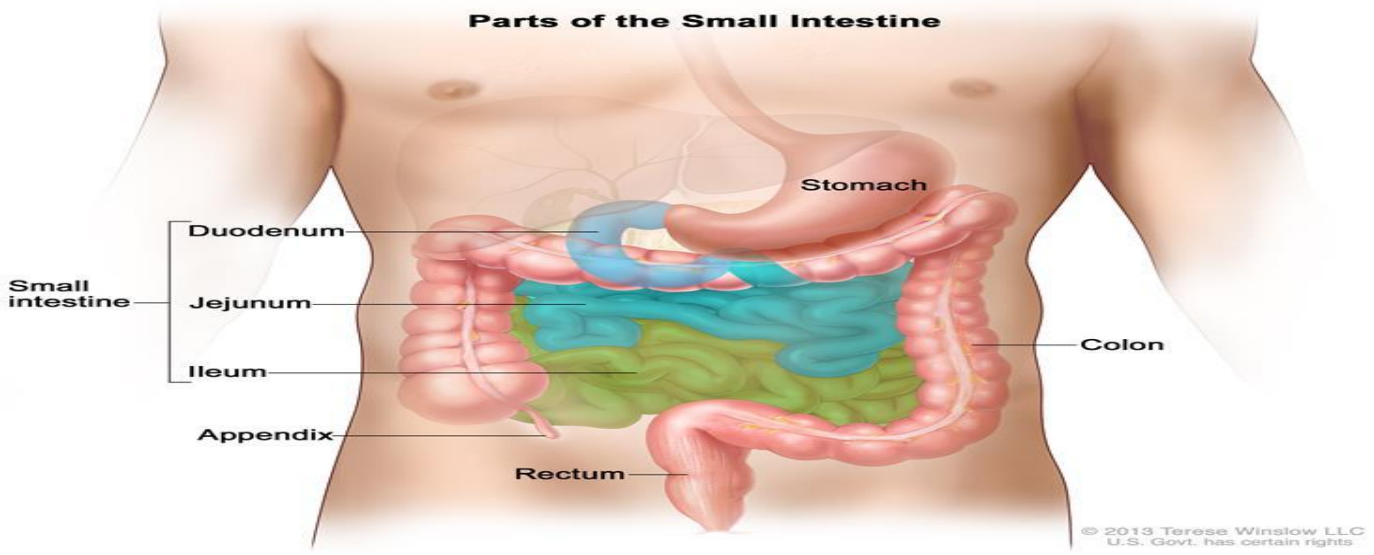
Histology of Digestive system

Part 2

Small intestine

The small intestine is an organ located in the gastrointestinal tract, between the stomach and the large intestine. It is, on average, 23ft long and is comprised of three structural parts; the duodenum, jejunum and ileum.

Functionally, the small intestine is chiefly involved in the digestion and absorption of nutrients. It receives pancreatic secretions and bile through the hepatopancreatic duct which aid with its functions.



Histological structure of the small intestine

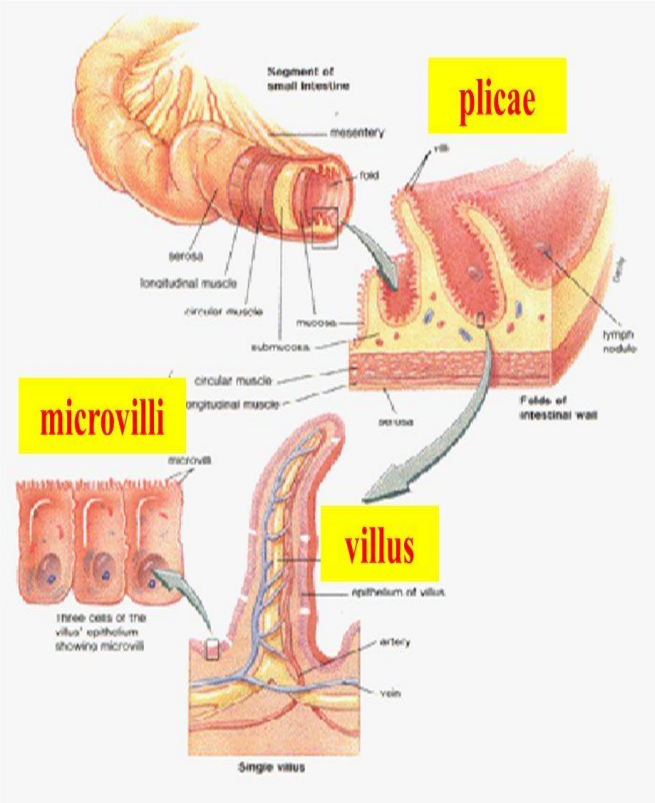
* The histological structure of the small intestine is similar to the other organs in the digestive tract. There are four main layers:
* Mucosa (Innermost layer) – Contains the epithelium, lamina propria and muscularis mucosae.
* The mucosa is highly folded.

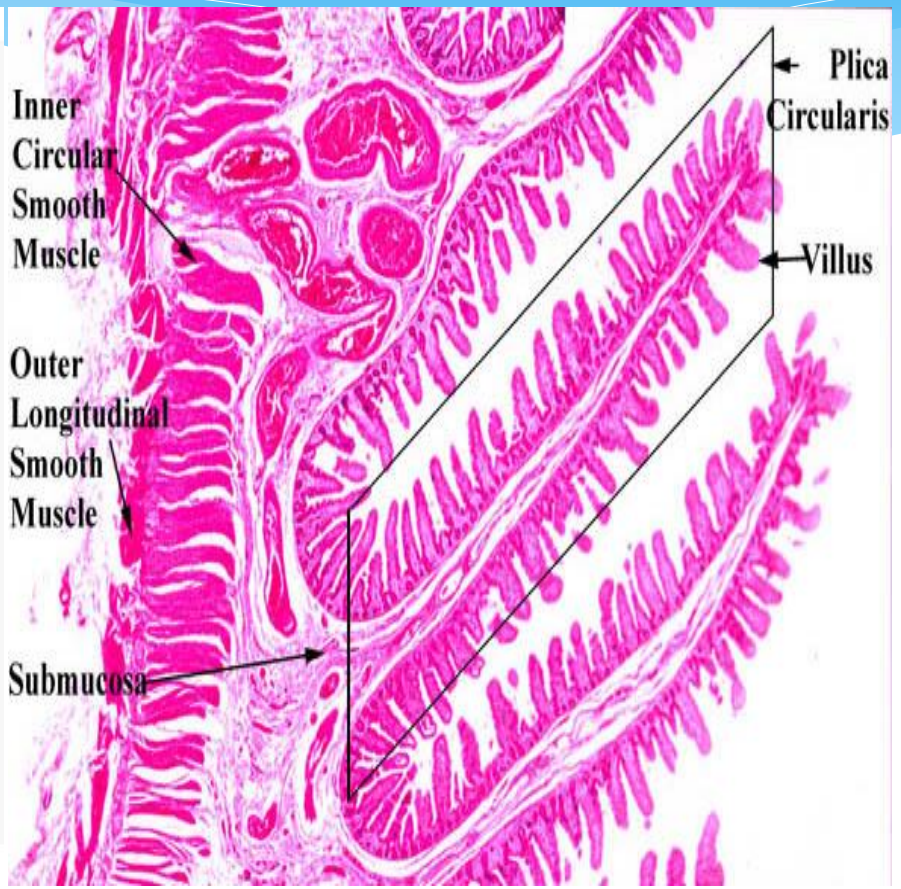
1-large circular folds called plicae circulares (shown in the diagram belloew), most numerous in the upper part of the small intestine

2-smaller folds called villi, which are finger like mucosal projections, about 1mm long.

3-the lining columnar epithelial cells have fine projections on their apical surfaces called microvilli.

Histological structure of the small intestine





Histological structure of the small intestine

* Submucosa – Connective tissue layer, which contains blood vessels, lymphatics and the submucosal plexus
* Lymphoid aggregations are commonly found in the sub-mucosa of the small intestine, an you can see one here. The larger aggregations of lymphoid tissue are known as Peyer's Patches.
* Muscularis externa – Consists of two smooth muscle layers; the outer longitudinal layer and inner circular layer. The myenteric plexus lies between them.
* Adventitia (Outermost layer) – Comprised of loosely arranged fibroblasts and collagen, with the vessels and nerves passing through it. The majority of the small intestine adventitia is covered by mesothelium and is commonly called the serosa.

Histological structure of the small intestine

* The small intestine is the major absorptive site in the gastrointestinal tract, and therefore has a number of modifications to aid its function. The mucosa and submucosa form large numbers of folds (or **plicae**) arranged in a circular fashion in the lumen (therefore called plicae circulares). Additionally, the plicae contain microvilli to further increase the surface area, which increases absorption.

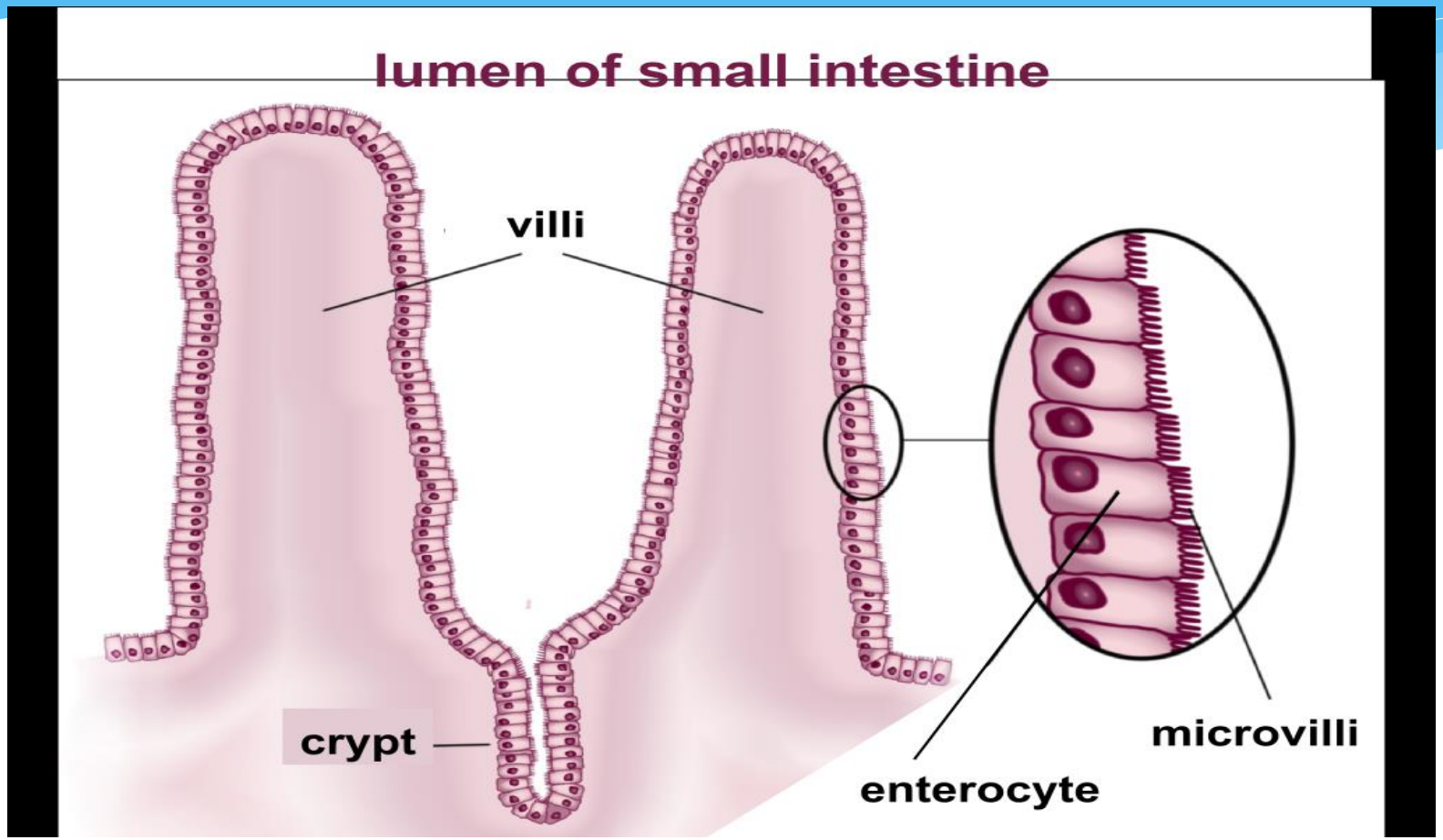
Cells of the Epithelium

* The epithelium of the small intestine lines the luminal surface. There are a number of components to the epithelium:
* **Enterocytes** – Tall columnar cells, which have an absorptive function. They contain brush border enzymes on the surface which have an important digestive function.
* **Goblet cells** – which secrete mucin.
* **Crypts of Lieberkuhn**
* The Crypts of Lieberkuhn are glands found in the epithelial lining. They contain numerous cells such as stem cells to produce new cells to replenish the cells lost due to abrasion, as well as **enteroendocrine cells** to synthesis and secrete hormones.

Cells of the Epithelium

* Paneth cells
* To protect from pathogens, there are Paneth cells which secrete protective agents (such as defensins and lyzozymes) and Peyer's patches which are only found in the ileum. Peyer's patches contain mucosal-associated lymphatic tissue (MALT) which house white blood cells and lymphocytes. These cells can produce antibodies to further protect the small intestine from infection.

Cells of the Epithelium



Duodenum

* The first part of the small intestine is the **duodenum**, and its structure is similar to that seen elsewhere in the small intestine, with some differences. The villi are broader, Peyers Patches are less common, and it has one unique feature: **Brunner's glands**, which are found in the sub-mucosa.
* Both Brunner's glands, and the goblet cells in the duodenum secrete mucus. The mucus secreted by Brunner's glands is **alkaline**, and helps to neutralize the acid chyme produced by the stomach, to produce chyme with a pH suitable for the digestive enzymes of the small intestine.

Jejunum

* The jejunum is the middle of the three parts of the small intestine between the duodenum and ileum.
* Jejunum wall structure

1-Mucosa - simple columnar epithelium; contains crypts of Lieberkuhn and intestinal villi
2-Submucosa - loose connective tissue containing neurovasculature(which lacks Brunner's glands and Peyer's patches)
3-Tunica muscularis - an inner circular and outer longitudinal smooth muscle layer
4-Tunica serosa - simple squamous epithelium

Histology of the ileum

* The ileum is the last of the three parts of the small intestine.
* Histologically, the ileum has the same basic structure as the jejunum.
* The mucosa is lined by simple columnar epithelium comprising enterocytes and goblet cells. Underneath lies a connective tissue layer (lamina propria) and a muscle layer (lamina muscularis mucosae). Compared to the rest of the small intestine the circular folds are rather flat and the villi relatively short. The submucosa contains blood vessels, lymph nodes. The muscularis consists of an inner circular and outer longitudinal muscle layer. The ileum is entirely covered by serosa from the outside.
* A characteristic feature of the ileum is the Peyer's patches lying in the mucosa.

Large intestine

The large intestine, or large bowel, is the last part of the digestive system in vertebrate animals. Its function is to absorb water from the remaining indigestible food matter, and then to pass the useless waste material from the body. The large intestine consists of the cecum, colon, rectum, and anal canal.

Histology of large intestine

* Colon
* Histologically, the large intestines can be distinguished from the small intestines by the absence of villi, plicae circularis, and Paneth cells (in adults). Simple columnar epithelium lines its mucosa. The crypts of Lieberkühn are deeper in the colon and goblet cells become more abundant.
* The enteroendocrine cells are dispersed throughout the mucosa and the surface epithelium is equipped with brush borders. The double layered muscularis mucosae that is typical of the GIT is also present.

Histology of large intestine

The neurovascular and lymphatic arrangement of the submucosa of the large intestine is also consistent with the rest of the GIT.

The muscularis externa has
its longitudinal and circular layers present. However, the longitudinal layers concentrate into three muscular bands that course along the length of the colon called the taeniae coli muscles.

Histology of large intestine

* Appendix
* The vermiform appendix has a similar histological appearance to the colon with the following exceptions:
* The taeniae coli are absent in the appendix;
* The lamina propria and submucosa contain joining lymphatic nodules along its length;

Histology of large intestine

* Rectum and anus
* The epithelium of the colon is continuous with that of the proximal rectum. Similar to the colon, longer, narrower crypts of Lieberkühn with numerous goblet cells, adipocytes and lymphatic aggregates are also observed in the lamina propria of the rectum.

Accessory digestive organs

* The **accessory organs** are the teeth, tongue, and glandular **organs** such as salivary glands, liver, gallbladder, and pancreas. The **digestive system** functions to provide mechanical processing, **digestion**, absorption of food, secretion of water, acids, enzymes, buffer, salt, and excretion of waste products.

Salivary glands

Humans possess three pairs of major salivary glands and approximately 600 to 1000 minor glands. The major salivary glands are the submandibular gland (SMG), sublingual gland (SLG), and the parotid gland (PG). Of these, the parotid gland is the largest and most important in terms of salivary production, providing approximately 50% of the total saliva volume. Collectively, all the major salivary glands function to secrete saliva, which contains a host of electrolytes, such as bicarbonate, and enzymes, such as salivary amylase, which break down carbohydrates in the oral cavity.

Salivary glands structure

* The major salivary glands have essentially the same structure: secretory end-pieces termed acini that produce saliva, which flows into arborized ducts that open into the oral cavity. All salivary glands are encapsulated and divided into divisions called lobes, which further subdivide into lobules, each of which is separated by a connective tissue septum. Each salivary gland is made up of two separate parts: a serous portion, responsible for secreting watery saliva, and a mucous portion, responsible for a more viscous fluid. The three major salivary glands are all composed of a mixture of these two types of cells. The parotid gland is composed primarily of serous acini and produces watery saliva, which lubricates the oral cavity and helps with swallowing, talking, and maintaining homeostasis. The submandibular gland has a predominance of serous cells with some mucous cells. The sublingual gland is composed of mostly mucous acini and thus produces the thickest and most viscous saliva.

Salivary glands histology

* The salivary glands are made of secretory units called acini, which are made up of acinar cells which could be serous or mucous. The serous cells are pyramidal or triangular in shape while the mucous cells are columnar in shape. The serous cells are occasionally seen capped by structures called demilunes. The acini cells are surrounded by contractile cells called as myoepithelial cells/basket cells, which are responsible for the flow of secretions of saliva by contraction of the cell. The acini of salivary glands are connected to hollow tubular structures which are called salivary ducts. The lining of the duct changes with the type of duct and its location within the salivary gland.

Salivary gland ducts

S. no	Duct	Description	Epithelium
1.	Intercalated duct	Connect the terminal secretory unit with the next system of ducts	Single layer of low cuboidal cells
2.	Striated duct	Intercalated ducts drain into striated duct	Tall columnar epithelial cells with centrally placed nucleus. Cells are partitioned by deep sheet like foldings of membrane, which appear as striations under light microscope
3.	Interlobular duct/excretory duct	Formed by joining of striated ducts	Pseudo-stratified columnar epithelial cells with outer connective tissue adventitia

Liver and gallbladder

The liver is the largest internal organ of the human body, weighing approximately 1.5 kg. Anatomically the liver consists of four lobes: two larger ones (right and left) and two smaller ones.

* Histological components
* The liver consists of the following major histological components:
* Parenchyma, which is represented by hepatocytes and sinusoids contain a specific cell type called Kupffer cell, containing ovoid nuclei. These monocyte derivatives of the mononuclear phagocytic system are part of the sinusoid lining from which they extend processes into the lumen. Therefore, Kupffer cells continuously sample the blood travelling through the sinusoids, phagocytosing antigens, microorganisms, and damaged red blood cells.
* Stroma, which is a continuation of the surrounding capsule . It consists of connective tissue and contains the vessels. The capsule is also covered by a layer of mesothelium, arising from the peritoneum covering the liver.

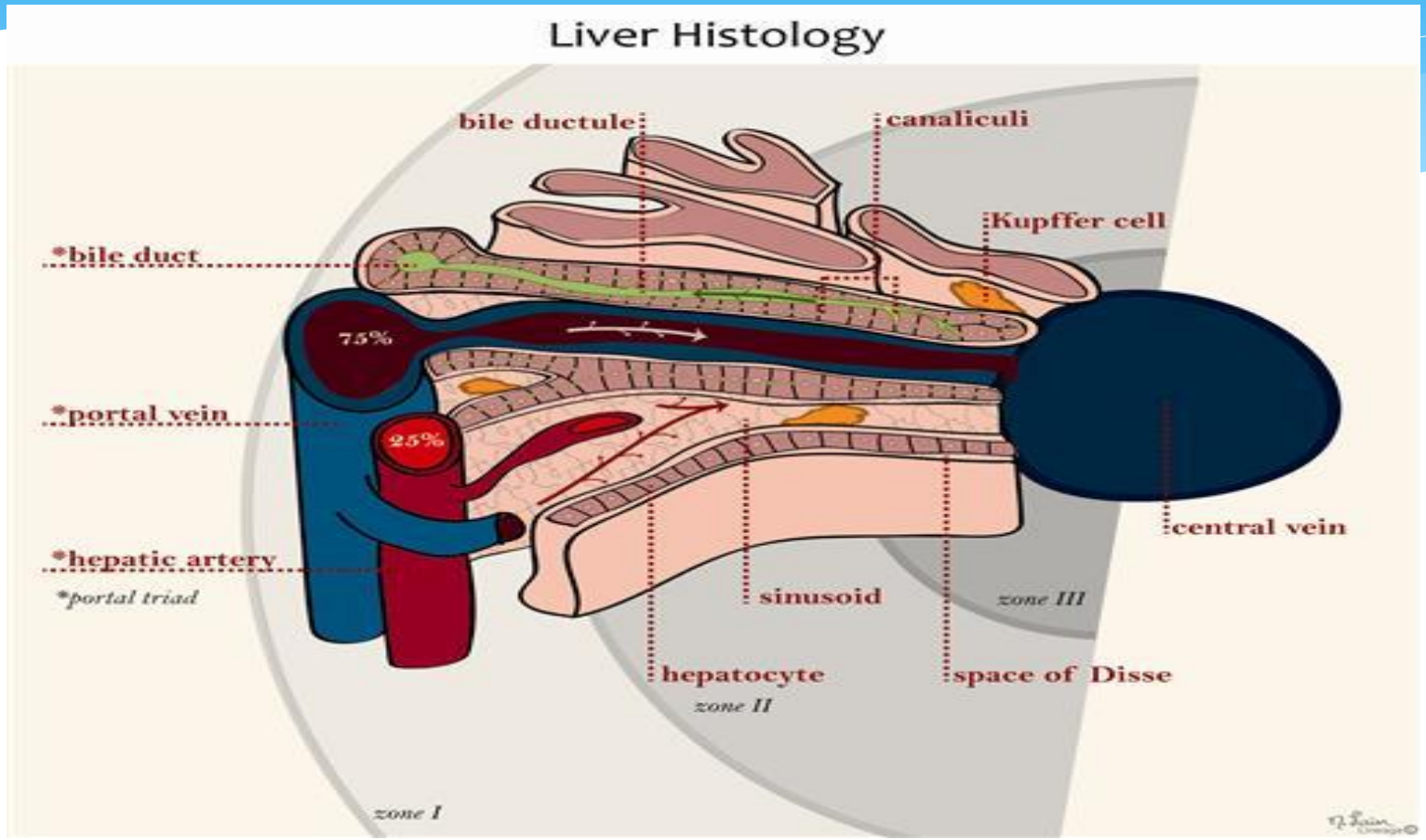
Liver histological components

* Stroma, which is a continuation of the surrounding capsule . It consists of connective tissue and contains the vessels.
* Sinusoids, which are capillaries travelling between hepatocytes
* The hepatic sinusoids have a discontinuous epithelium due to the presence of fenestrae and gaps between endothelial cells .
* Spaces of Disse (perisinusoidal spaces), which are located between the hepatocytes and the sinusoids.

Liver Vasculature

* The liver, as an organ, receives blood from two different sources. The major one is via the hepatic portal vein (75%), which carries venous blood from the intestines, pancreas and spleen. Despite the lack of oxygen, this blood contains high amount of nutrients, endocrine secretions, broken down erythrocytes, but also ingested toxins. The second major source is via the hepatic artery (25%), which brings oxygenated blood to the liver.
* Those structures supply blood to the sinusoids and the hepatocytes, subsequently draining into the central vein followed by the sublobular veins. The second drainage pattern is via the hepatic veins, which end up in the inferior vena cava.

Liver Histology



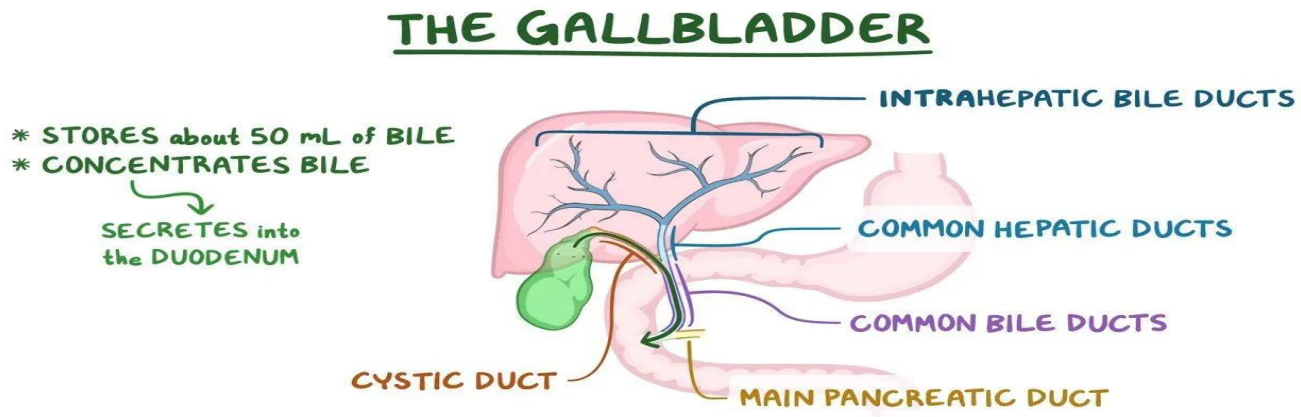
Biliary tree

* This is a system consisting of channels that carries bile from the source, this being the hepatocytes, all the way to the gallbladder and intestines. The epithelial cells lining this system are called cholangiocytes. They range in shape from cuboidal in small ductules, to columnar in large ductules. Cholangiocytes have several histological features, such as:
* Few organelles
* Presence of tight junctions between the cells
* Microvilli on their apical domains
* The hepatocytes secrete bile into the bile canaliculi, which are the smallest channels of the biliary tree.

Gall bladder

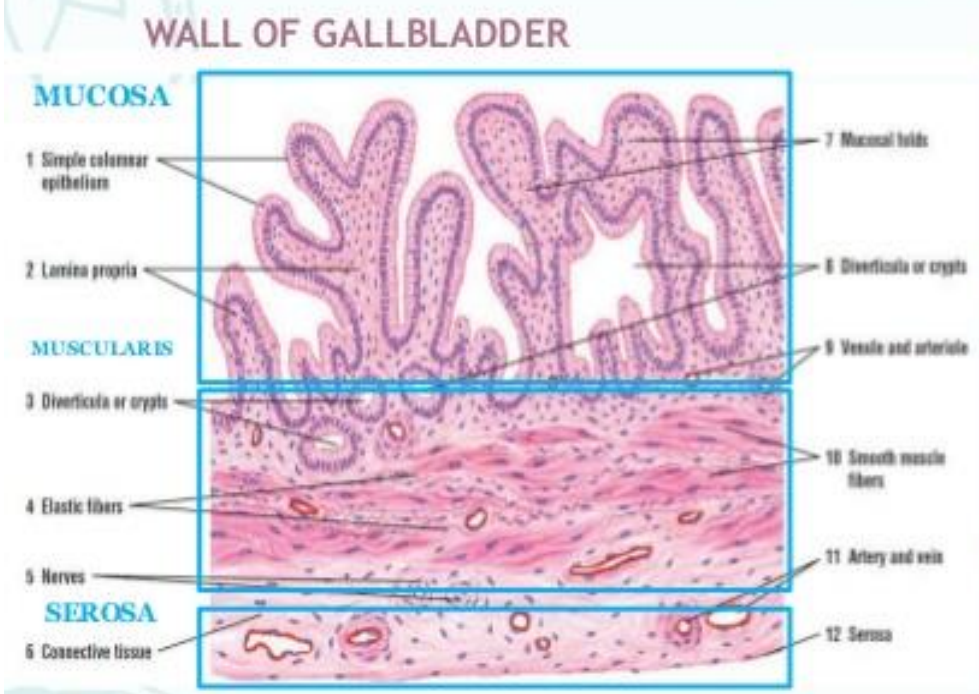
* This is a sac-like structure adhering to the liver which has duct that lead directly into the common bile duct.

During periods of time when bile is not flowing into the intestine, it is diverted into the gall bladder, where it is dehydrated and stored until needed.



Gall bladder structure

GALLBLADDER



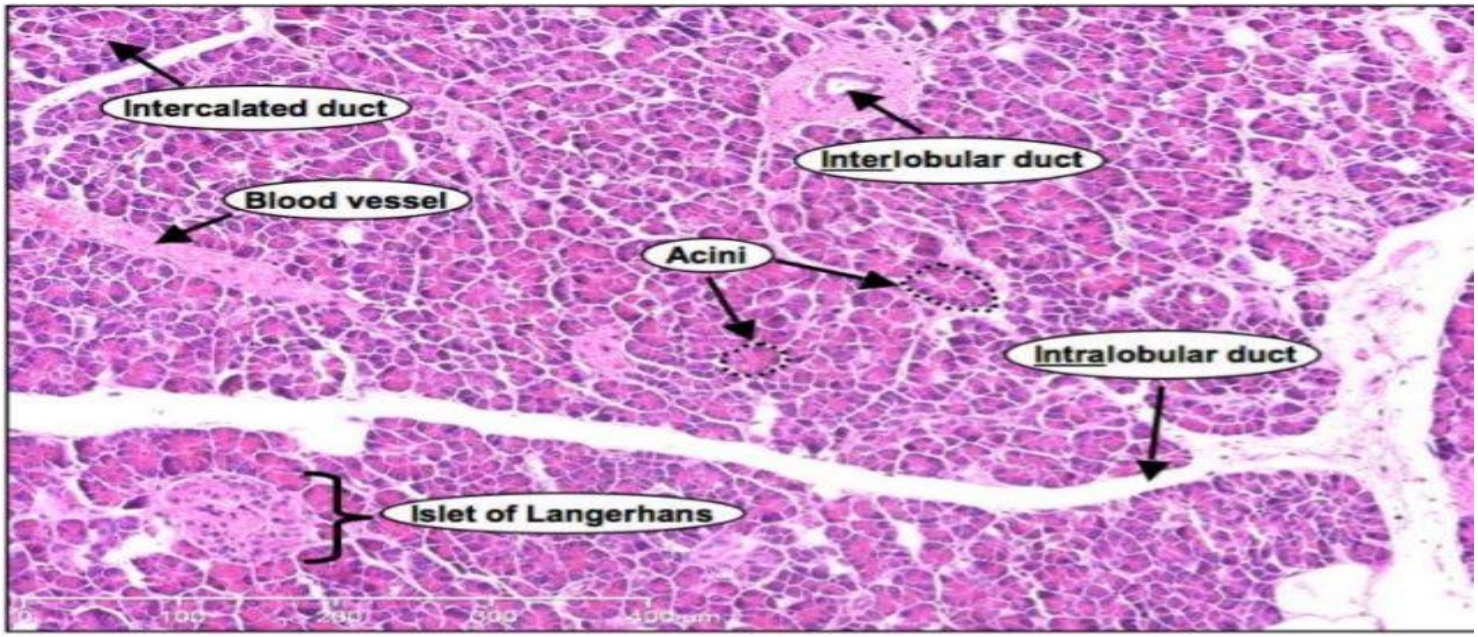
1. **Mucosa**
   - ✓ Simple Columnar Epithelium
   - ✓ Lamina propria
     - loose connective tissue
     - diffuse lymphatic tissue
     - venule and arteriole
2. **Muscularis**
   - ✓ smooth muscle fibers
   - ✓ Connective tissue layer
     - large blood vessels, artery and veins
     - lymphatics
     - nerves
3. **Adventitia or serosa**
   - ✓ covers the entire unattached gallbladder surface

Pancreas

* The pancreas is both an exocrine accessory digestive organ and a hormone secreting endocrine gland. The bulk of the pancreatic tissue is formed by the **exocrine component**, which consists of many serous pancreatic acini cells. These acini synthesize and secrete a variety of enzymes essential to successfully
* Digestion.
* The **endocrine component** is a much smaller, but equally important, portion of the pancreas. It is composed of pancreatic islets, which appear as islands of cells dispersed between the pancreatic acini. These islet cells produce and secrete hormones that regulate glucose, lipid and protein metabolism.

Pancreas Structure

* The pancreas is covered by a thin capsule made of loose connective tissue. The parenchyma consists of pancreatic acini and sparsely scattered pancreatic islets surrounded by stroma of loose connective tissue. Interlobular connective tissue septa project from the capsule into the pancreatic parenchyma, organising it into lobules.



Exocrine pancreas

* The exocrine component of the pancreas makes up about 98% of the pancreatic tissue. It is comprised of densely packed serous acinar (tubuloacinar) glands. These glands are called pancreatic acini, which represent the secretory units of the pancreas. They are formed out of simple epithelium. Each pancreatic acinus consists of pyramidal-shaped acinar cells, which have a broad basal portion and a narrow apical surface that surround a small central lumen.

Duct system

* Once synthesized, the pancreatic secretions leave the acini via the intercalated ducts. The latter are short ducts with a small lumen that start within the acini. The initial, intra-acinar portion of the intercalated duct is lined by simple squamous epithelial cells called centroacinar cells, which signify the beginning of the ductal system of the exocrine pancreas. Centroacinar cells are continued by simple, low cuboidal ductal cells that line the extra-acinar portion of the intercalated ducts which extends outside the acinus. Intercalated ducts drain into intralobular ducts, which are lined by simple, low columnar epithelium.

Endocrine pancreas

* The endocrine component makes up about 2% of the pancreas, which is represented by about 1-2 million pancreatic islets (of Langerhans). They are dispersed throughout the exocrine component of the pancreas, most of them being located in the tail region. Pancreatic islets are permeated by many fenestrated capillaries, which allow quick entry of pancreatic hormones into the blood.

End

* Thanks a lot for attention

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