GI
HISTOLOGY

 # 1

WRITER:
Tasneem
Alremawi

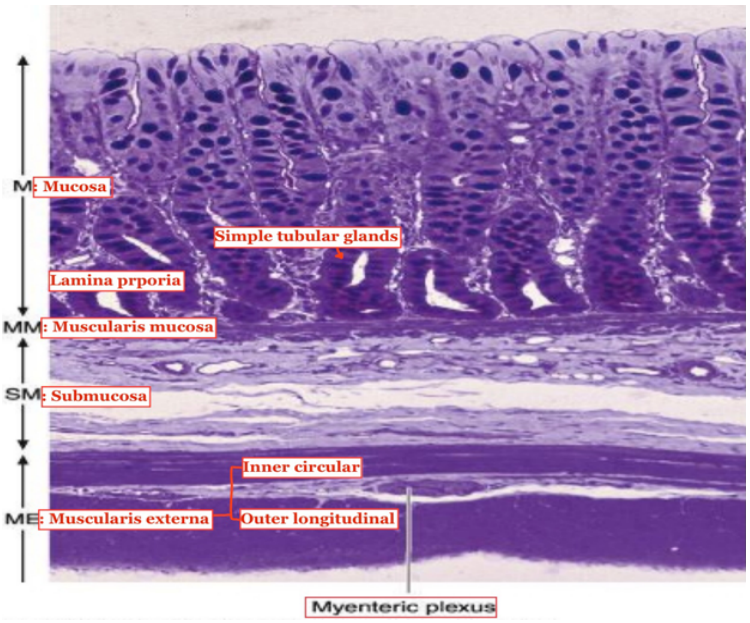
CORRECTOR:

DOCTOR:
Almuhtaseb

This is an easy one that won't take much of your time ♡
Notes in the slides that the doctor didn't mention in the lecture are going to be in this color, you will find a lot of those :)

LARGE INTESTINE

The picture to the right shows a section taken from the colon (which involves: the ascending, transverse, descending and sigmoid colon; they all have the same histology). It has 4 main layers as small intestine: mucosa, submucosa, muscularis externa with the myenteric plexus between the inner circular and the outer longitudinal layer.



• **No villi (smooth surface) are present in this portion of the intestine.**

• **The large intestine is lined with simple columnar epithelium with NUMEROUS (abundant) goblet cells** (numerous because the large intestine's function requires lubrication).

• **The intestinal glands (crypts of Lieberkühn, simple tubular glands) are long and characterized by a great abundance of goblet and absorptive cells and a small number of enteroendocrine cells ,and have NO paneth cells.**

• **The muscularis mucosa** is ill-defined and **comprises longitudinal and circular strands.**

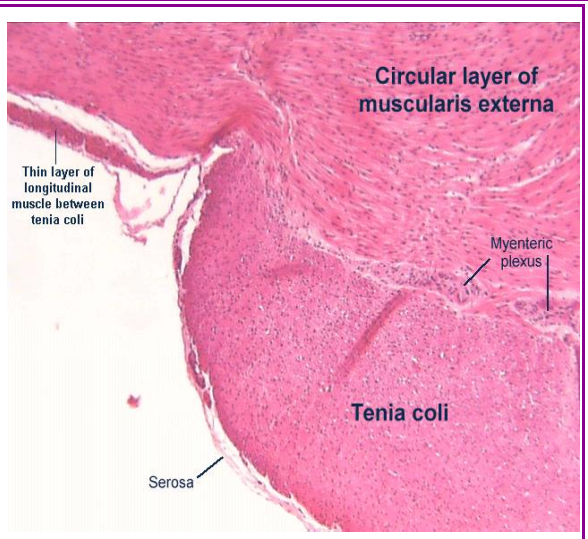
• The large intestine consists of a mucosal membrane with no folds except in its distal (rectal) portion. The absorptive cells are columnar and have short, irregular microvilli.

• **The large intestine is well suited to its main functions: absorption of water, formation of the fecal mass, and production of mucus.**

• **Goblet cells have a foamy appearance** caused by the preparation steps it went through and it secrete **mucus which is a highly hydrated gel** (for its function) **that not only lubricates the intestinal surface but also covers bacteria and particulate matter.**

• **The absorption of water is passive (doesn't need energy)**, following the active transport of sodium out of the basal surfaces of the epithelial cells.

• The lamina propria is rich in lymphoid cells and in nodules that frequently extend into the submucosa.This richness in lymphoid tissue (GALT) is related to the abundant bacterial population of the large intestine.



• **This layer differs from that of the small intestine, because fibers of the outer longitudinal layer congregate (تتجمع) in three thick longitudinal bands called teniae coli,** and have **appendices epiploicae** (tags of fat)**.**

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

THE DIFFERENCES BETWEEN THE SMALL AND LARGE INTESTINE:

• **Mucosa is thicker and contains crypts but NO Vili.**

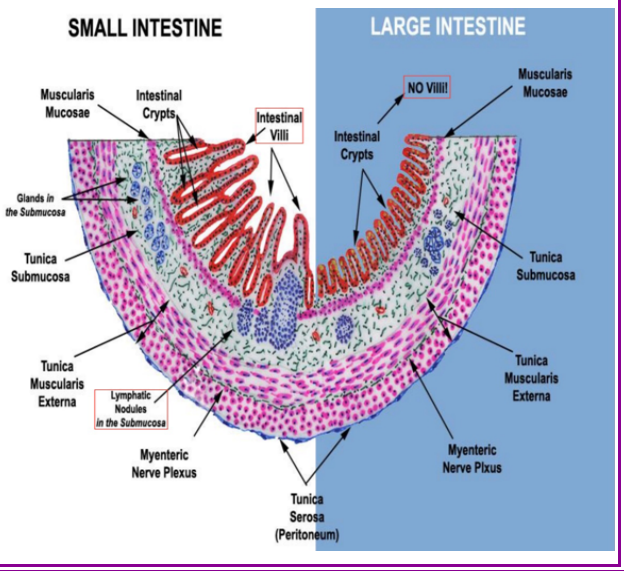
• **Simple columnar epithelium with an abundance of goblet cells.**

• **Crypts of Lieberkühn are longer , more closely packed and there is no paneth cells.**

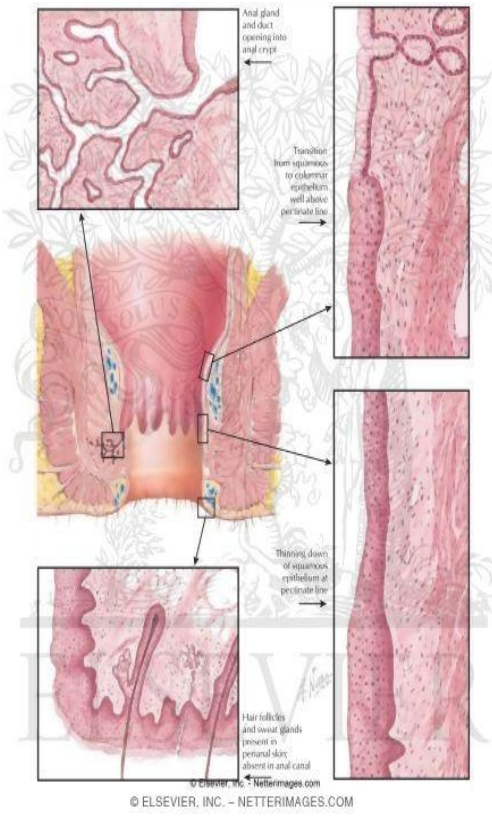
• **Lamina propria is reduced, and it contains solitary lymph nodes (only one lymph nodule and it's found in the lamina propria till the submucosa).**

• **The muscularis externa layer is well developed.**

	Large intestine	Small intestine
Mucosal lining	Simple columnar epithelium with numerous goblet cells	Simple columnar epithelium with goblet cells and microvilli
Intestinal glands' lining	Simple tubular glands	Simple branched tubular glands
Lymphatic nodules	Solitary nodules found in the lamina propria till the submucosa	
Villi & paneth cells	✗	✓
Appendices epiploicae & 3 teniae coli	✓	✗



THE ANAL REGION



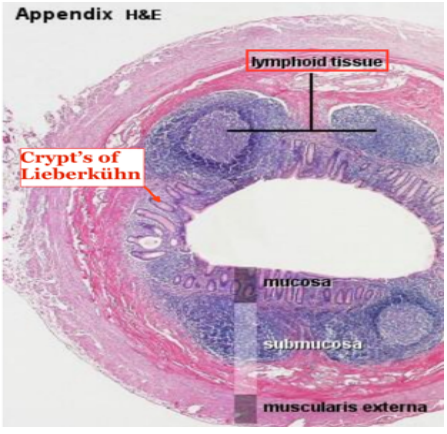
• **The mucous membrane forms a series of longitudinal folds, the rectal columns of Morgagni** (which reaches the pectinate line) **These columns connects to the anal orifice to form the anal valves and sinuses.**

• **the epithelium of the rectum and upper half of anal canal is simple columnar epithelium.** And the lower half of the anal canal (2cm) is divided into upper and lower cm the upper cm. **The upper cm from the lower half of anal canal is non-keratinized stratified squamous epithelium and the lower cm is keratinized stratified squamous epithelium with hair follicles and sebaceous glands.**

• About 2 cm above the anal opening, the intestinal mucosa is replaced by stratified squamous epithelium. In this region, the lamina propria contains a plexus of large veins that, when excessively dilated and varicose, produces hemorrhoids. The muscularis layer gives rise to the anal sphincter. The adventitia layer connects the anal canal to the surrounding structures.

APPENDIX

• The appendix is an evagination of the cecum. And it's Covered entirely by serosa (mesoappendix).



• **The mucosa is lined with simple columnar with few goblet cells. Its lamina propria has few crypt's of Lieberkühn.**

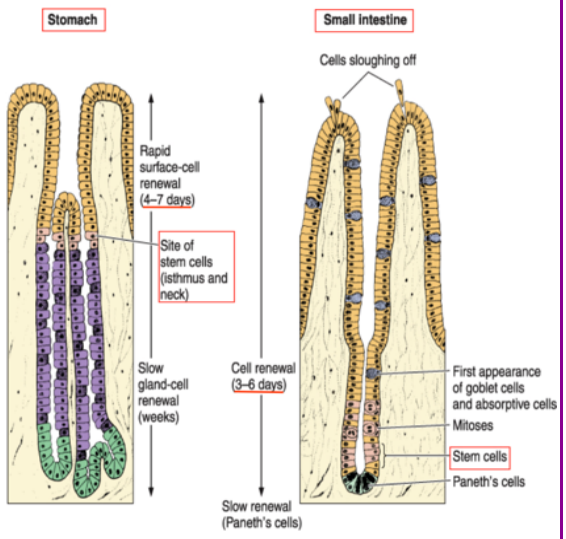
• **is characterized by a relatively small, narrow, and irregular lumen. It's lumen is very narrow,** so in cases of appendicitis, the lumen can get obstructed which can rupture the appendix, that's is why the only solution for it is appendectomy.

• **caused by the presence of ABUNDANT lymphoid follicles in its wall, that form a circular layer in the mucosa and may infiltrate the submucosa and lamina propria. The appendix is a lymphoid organ, it has lymphatic nodules, which fill the lamina propria and the submucosa.**

• **Although its general structure is similar to that of the large intestine (same epithelium:** mucosa, submucosa, muscularis externa and adventitia**), it contains fewer and shorter intestinal glands and has no teniae coli.**

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.**

- **Stem cells in stomach**: present in the **neck and isthmus of the glands,** between the surface and the root; new cells can go **upwards or downwards,** takes **4-7 days** for renewal.
- **Stem cells in small intestine**: **basal cells**, new cells go **upwards** to the surface; to replace the surface cells that get sloughed (تُكشط), takes **3-6 days** for renewal.

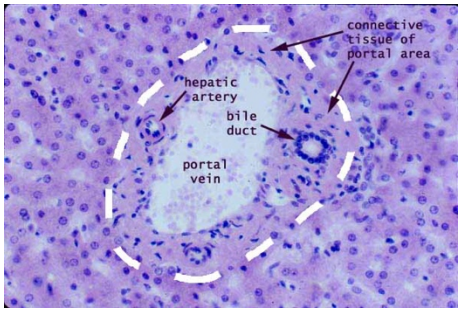
LIVER

You can watch this short video to have a general idea about what is next : https://youtu.be/6kshGRIn2BU

• **The liver is the second-largest organ of the body (the largest is the skin) and the largest gland, weighing about 1.5 kg. It is a mixed gland with both exocrine and endocrine functions; it produces (bile and bile salts) and (plasma proteins, such as albumin and other carrier proteins, coagulation factors, growth factors, globulin, prothrombin, immunoglobulins…).**

• The position of the liver in the circulatory system is optimal for gathering, transforming, and accumulating metabolites and for neutralizing and eliminating toxic substances.

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



• 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.

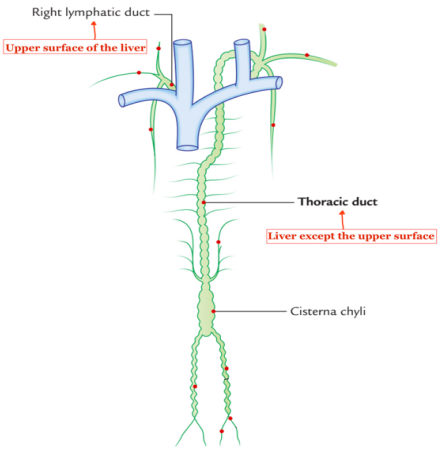
❖ **Blood supply:** the liver receives deoxygenated and oxygenated blood vessels:

1. **Portal vein (70-80%, Most of its blood) arising from the stomach, intestines, and spleen,** gives branches called venules.
2. **Hepatic artery (20-30%, smaller percentage)** gives branches called arterioles.

❖ **Venous drainage:** the waste product of the liver & Co2 leave the liver by the **central veins → hepatic veins → IVC.**

❖ **Lymphatic drainage** of the liver is split into two drainage systems:

1. **Lipids (chylomicrons) are absorbed by hepatic lymph vessels in the liver** (most the liver is drained this way except the upper surface) → **the hepatic lymph** nodes in the lesser omentum → **celiac lymph nodes → Cisterna chyli → thoracic duct.**
2. Lymphatic drainage of **the upper surface of the liver → right thoracic duct** (right lymphatic duct).

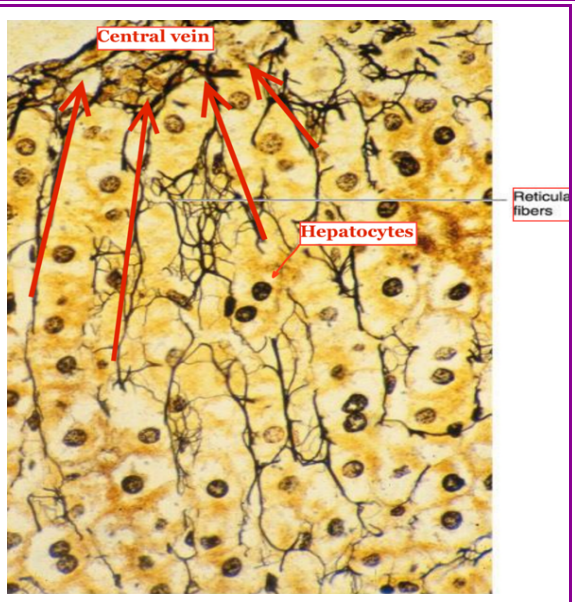


❖ **Bile execration: Elimination occurs in the bile, an exocrine secretion of the liver that is important for lipid digestion.**

Formed bile is transported via bile ducts in the liver → forming **two hepatic ducts** which then **join the cystic duct** → forming the **common bile duct** which open into the 2nd part of duodenum.

- Keep in mind that **the hepatic artery and the portal vein** enter the liver, while **hepatic veins,** lymph of the liver and bile exit.

This section shows the stroma of the liver 👉🏼



- Notice how hepatocytes are arranged radially in rows from the periphery to the central vein.

• The liver is covered by a thin connective tissue capsule (Glisson's capsule), which divides the liver into lobes and hexagonal lobules.

• Connective tissue becomes thicker at the hilum (porta hepatis), where the portal vein and the hepatic artery enter the organ and where the right and left hepatic ducts and lymphatics exit.

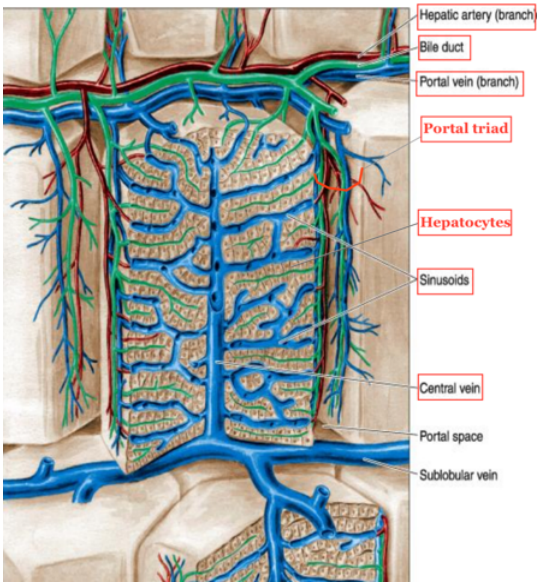
• These vessels and ducts are surrounded by connective tissue all the way to their termination (or origin) in the portal spaces between the liver lobules. The liver is characterized by having a lot of reticular fibers (supportive tissue) between cells especially around blood sinusoids, the portal triad and the central vein.

• At this point (central vein)**, a delicate reticular fiber network that supports the hepatocytes and sinusoidal endothelial cells of the liver lobules is formed.**

THE LIVER LOBULE

• The basic structural component of the liver is the liver cell, or hepatocyte, it is hexagonal in shape and on every angle there is a portal triad (bile duct, a branch of the hepatic artery and a branch of the portal vein, filled with reticular fibers).

- Notice that a hepatocyte row is surrounded by two spaces: a **sinusoid**, which is a bigger space with blood in it, and a smaller space with **bile** in it.

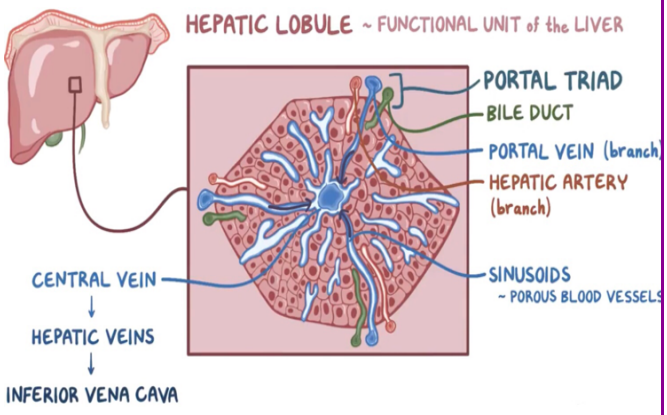


- The narrow space between two adjacent rows of hepatocytes where bile secretion and collection starts is called **bile canaliculus.**
- The space between two adjacent rows of hepatocytes where bile collection ends is called **herring duct.**
- Bile is then transported in the portal triad via **bile duct** tho the hepatic duct.

- Bile canaliculus → herring duct → bile duct.

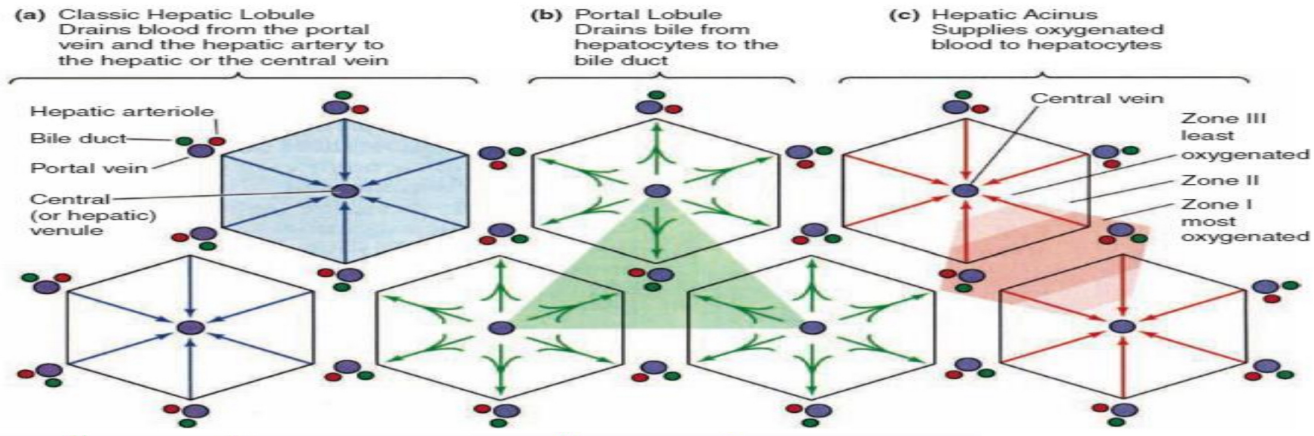
- **Blood sinusoids** are lined with **<u>fenestrated endothelium</u>** and contain blood from <u>the hepatic artery and the portal vein</u> get mixed, allowing the hepatocytes to get their oxygen and nutrients from the arterial blood and release CO2 into the venous blood.

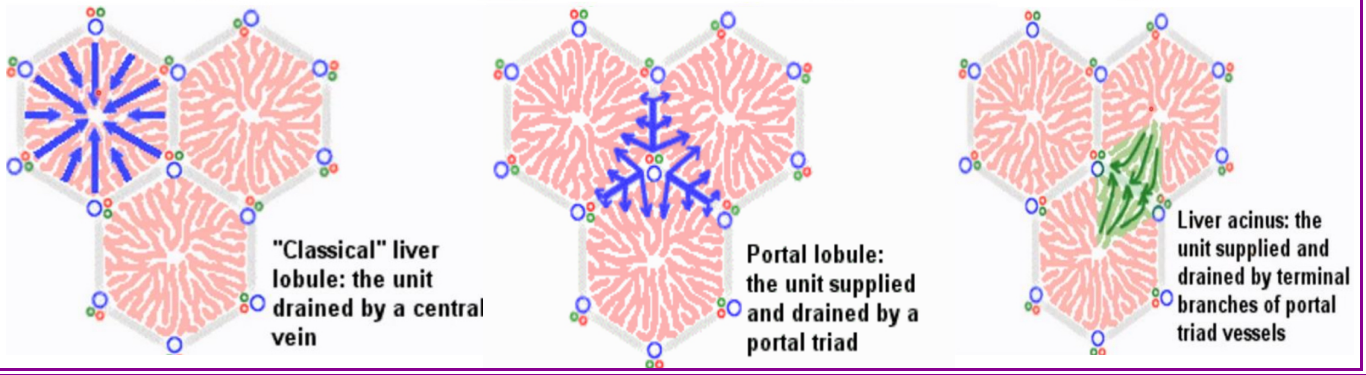
• Hepatocytes are grouped in interconnected plates and constitute two-thirds of the mass of the liver. In light-microscope sections, structural units called liver lobules can be seen. The liver lobule is formed of a polygonal mass of tissue about 0.7x2 mm in size. with portal spaces at the periphery and a vein, called the central or centrolobular vein, in the center.



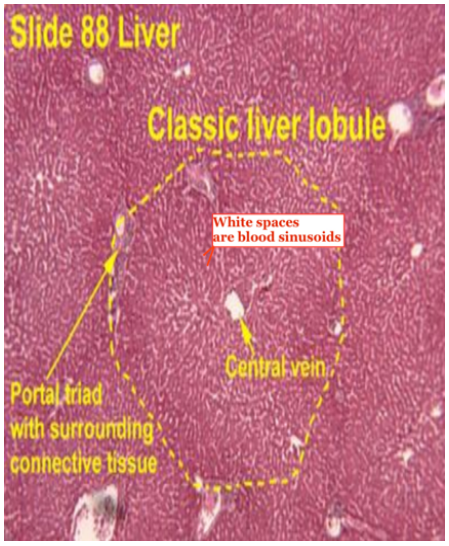
- From a functional point of view, there are three possible ways of describing liver lobules:

1. **Classical** ⬡: hexagonal in shape with **central vein in the centre and portal triad on each angle.**
2. **Portal** △: triangular in shape with **portal triad in the center and central vein on each angle.**
3. **Acinus** ◊: diamond in shape and its **between two central veins and two portal triads.** (Classified according to the level of oxygen supply, which is more in the axis between the two portal triads because the have arterial blood).

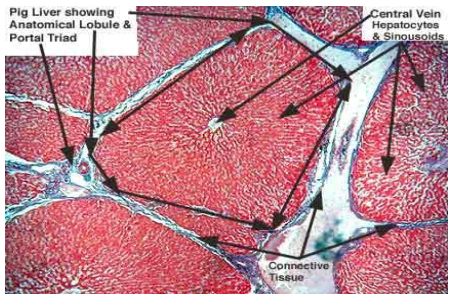




➢ CLASSICAL LIVER LOBULE

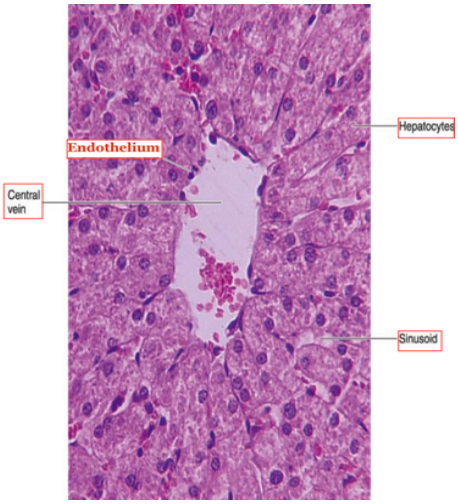


- A hexagonal structure with **portal spaces, regions located in the corners of the lobules, contain connective tissue, bile ducts, lymphatics, nerves, and blood vessels.**
- **The human liver contains three to six portal spaces per lobule** (one on every angle)**, each with a venule (a branch of the portal vein), an arteriole (a branch of the hepatic artery), a duct (part of the bile duct system), and lymphatic vessels.**
- **The venule contains blood coming from** the portal vein from **the superior and inferior mesenteric and splenic veins, and it's the largest structure.**
- **The arteriole contains oxygen-rich blood coming from** hepatic artery 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.**



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

• The hepatocytes in the liver lobule are radially disposed and are arranged like the bricks of a wall.



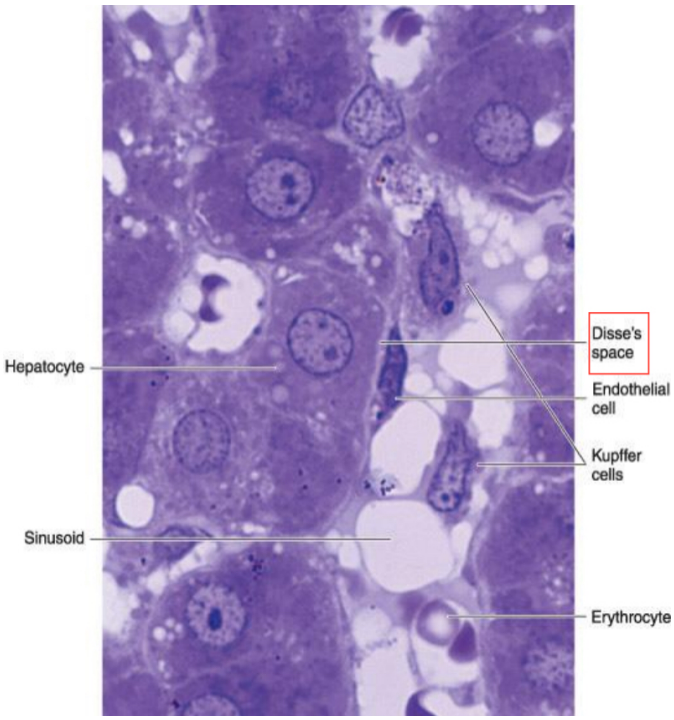
• These cellular plates are directed from the periphery of the lobule to its center and anastomose freely, forming a labyrinthine and spongelike structure. The space between these plates contains capillaries, the liver sinusoids. sinusoidal capillaries are irregularly dilated vessels composed solely of a discontinuous layer of fenestrated endothelial cells.

• The fenestrae are about 100 nm in diameter, have no diaphragm (spaces extend to the basal lamina, which helps in transporting materials from blood sinusoids to the hepatocytes)**, and are grouped in clusters.**

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

SPACE OF DISSE

• A subendothelial space known as the space of Disse separates the endothelial cells (of blood sinusoids) from the hepatocytes.



• The fenestrae and discontinuity of the endothelium allow the free flow of plasma and other small molecules, but NOT of cellular or other blood elements into the space of Disse.

There is no direct contact between the blood sinusoids and hepatocytes through the space of disse.(مهم)

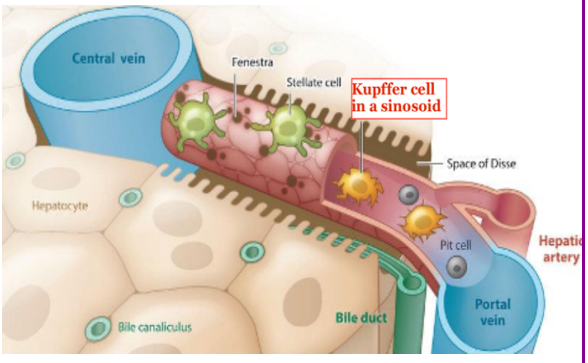
• Thus permitting an easy exchange of molecules (including macromolecules) from the sinusoidal lumen to the hepatocytes and vice versa. Which allows the release of the large number of macromolecules (eg. lipoproteins, albumin, fibrinogen) secreted into the blood by hepatocyte sand also it enables the liver takes up and catabolizes many of these large molecules.

- **Exchange of materials between sinusoids and hepatocytes is easy, but exchange between the space of disse and hepatocytes isn't.**

• The basolateral side of the hepatocyte, which lines the space of Disse, contains many microvilli and demonstrates endocytic and pinocytic activity The sinusoid is surrounded and supported by a delicate sheath of reticular fibers.

KUPFFER CELLS:

• In addition to the endothelial cells, the sinusoids' wall contain dark macrophages known as Kupffer cells which engulf foreign bodies also it uptakes iron from broken hemoglobin, and it destroys bacteria by forming immunoglobulins.

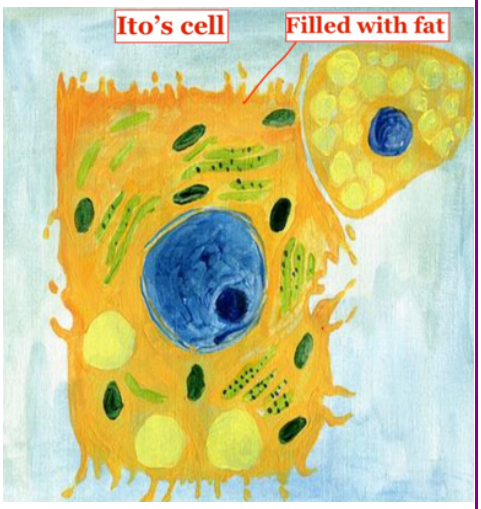


• **These cells are found on the luminal surface of the endothelial cells, within the sinusoids.**

• **Their main functions are to metabolize aged erythrocytes** (they uptake iron from broken hemoglobin)**, digest hemoglobin, secrete proteins related to immunological processes, and destroy bacteria** (by forming immunoglobulins) **that eventually enter the portal blood through the large intestine.**

• **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.**

ITO'S CELLS:



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

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

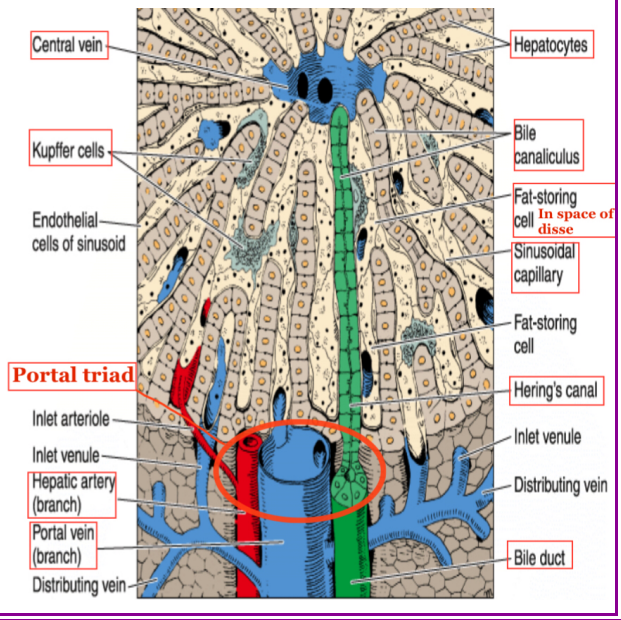
1. Uptake, storage, and release of retinoids.
2. Synthesis and secretion of several extracellular matrix proteins and proteoglycans.
3. Secretion of growth factors and cytokines, and the regulation of the sinusoidal lumen diameter in response to different regulators (eg. prostaglandins, thromboxane A2).

- Sinusoids' wall contain Kupffer cells (macrophages).
- Space of disse contain Ito's or stellate or fat storing cells & reticular fibers.

THE HEPATOCYTE

• **Hepatocytes are polyhedral, with six or more surfaces, and have a diameter of 20-30 um.**

• **the cytoplasm of the hepatocyte is eosinophilic** (acidophilic)**, mainly because of the large number of mitochondria and some smooth endoplasmic reticulum,** basally it has basal bodies, it can be binucleated due to its activity.

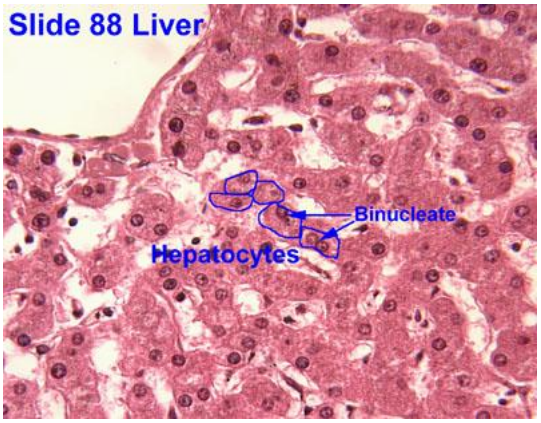


• Hepatocytes located at different distances from the portal spaces show differences in structural, histochemical, and biochemical characteristics.
• The surface of each hepatocyte is in contact with the wall of the sinusoids, through the space of Disse, and with the surfaces of other hepatocytes. Wherever two hepatocytes abut, they delimit a tubular space between them known as the bile canaliculus. At the periphery, bile enters the bile ductules, or Hering's canals composed of cuboidal cells.

• 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, ie. from the center of the lobule to its periphery.
• 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.

• The hepatocyte has one or two rounded central **nuclei** (can be **binucleated**) **with one or two nucleoli.**



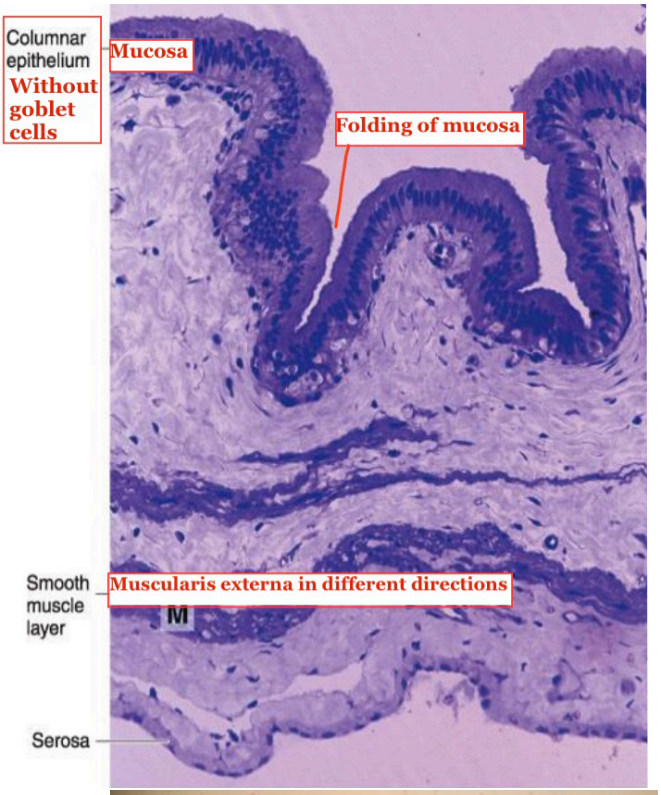
• Some of the nuclei are polyploid.

• In the hepatocyte, the rough endoplasmic reticulum forms aggregates dispersed in the cytoplasm; these are often called basophilic bodies in the base.

• Several proteins (eg. blood albumin, fibrinogen) are synthesized on polyribosomes in these structures. The smooth endoplasmic reticulum is responsible for the processes of oxidation, methylation, and conjugation required for inactivation or detoxification of various substances before their excretion from the body.

You can watch this video for more clarification (it has some extra info that wasn't mentioned in the lecture)
https://youtu.be/Z2_nXBl3sUQ

GALLBLADDER



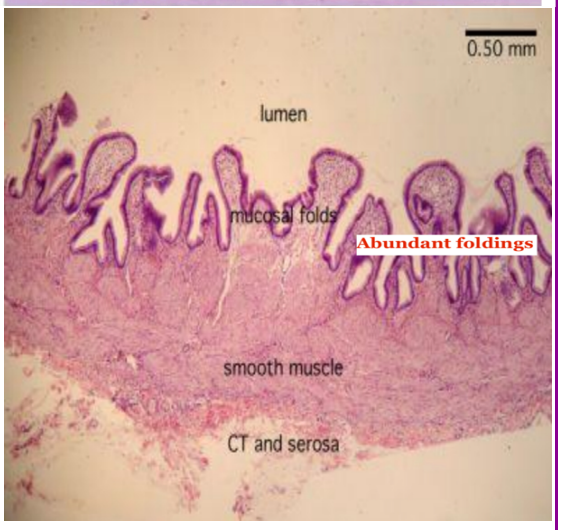
• The gallbladder is a hollow, pear-shaped organ attached to the lower surface of the liver. The epithelial cells are rich in mitochondria.

• **It can store 30-50 mL of bile.**

• **The wall of the gallbladder consists of a mucosa composed of folded simple columnar epithelium** without goblet cells **and** ill-defined **lamina propria, no submucosa, irregular muscularis externa (not well defined),** a layer of smooth muscle, a perimuscular connective tissue layer, and a serous membrane. It has no peristaltic movements.

Gallbladder properties: (مهم)

1. **Abundant folding in the mucosa.**
2. **No goblet cells.**
3. **Ill-defined lamina propria.**
4. **No submucosa.**
5. **Irregular (oblique) muscularis externa.**



• **The mucosa has ABUNDANT folds that are particularly evident when the gallbladder is empty. Which is called honeycomb appearance.**

• **All these cells are capable of secreting small amounts of mucus. Tubuloacinar mucous glands** (around the neck) **near the cystic duct are responsible for the production of most of the mucus present in bile (no goblet cells).**

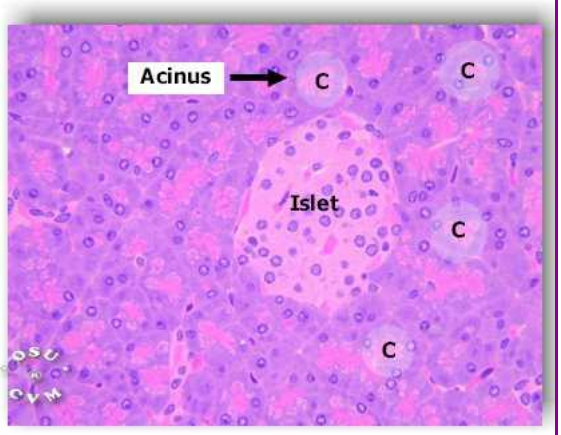
• **The main function of the gallbladder is to store bile, concentrate it** (about 20 times) **by absorbing its water, and release it when necessary into the digestive tract.**

• **Contraction of the smooth muscle of the gallbladder is induced by cholecystokinin, a hormone produced by enteroendocrine cells located in the epithelial lining of the small intestine. Release of cholecystokinin is, in turn, stimulated by the presence of dietary fats in the small intestine.** When the gallbladder contracts, sphincter of oddi relaxes.

- **No muscularis mucosa or submucosa.**
- **The muscularis externa is composed of irregular (oblique) smooth muscles with collagen and elastic fibers in between.**

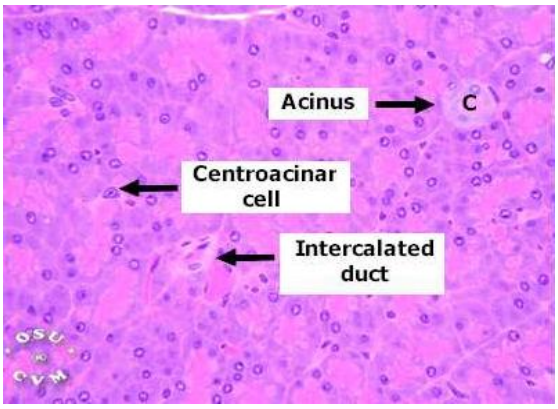
PANCREAS

- **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** serous **acini.** (Its secretions concentrate at the apex giving it its polar shape, it is also present in the parotid gland)
  - **The hormones are synthesized in clusters of endocrine epithelial cells known as islets of Langerhans.** (They appear lighter in histology, have 4 types of cells: alpha, beta, delta and gamma)
- **exocrine portion of the pancreas is a compound acinar gland, similar in structure to the parotid gland.**

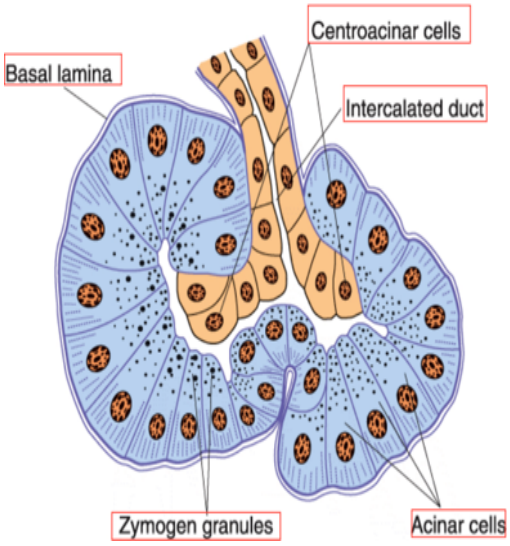
DIFFERENCES BETWEEN THE PAROTID AND THE PANCREAS



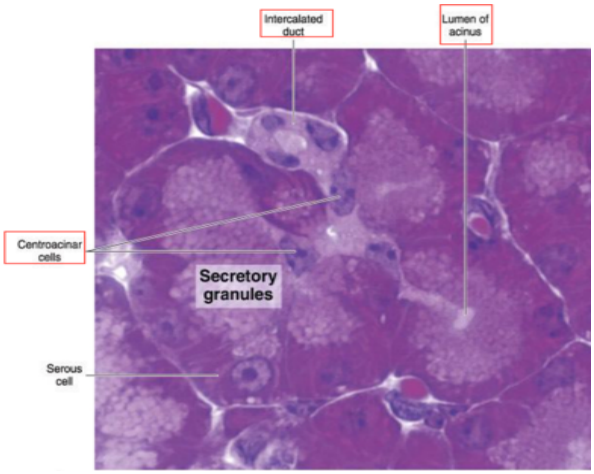
- **In histological sections, a distinction between the two glands can be made based on the absence of striated ducts and the presence of the islets of Langerhans also the presence of centroacinar cells** (large cuboidal cells in the lumen) **in the intercalated ducts in the pancreas.**
- Another characteristic detail is that in the pancreas the initial portions of intercalated ducts penetrate the lumens of the acini. Nuclei, surrounded by a pale cytoplasm, belong to centroacinar cells that constitute the intraacinar portion of the intercalated duct. These cells are found only in pancreatic acini. 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.

This vid explains the difference between the parotid and the pancreas: https://youtu.be/eliH0UUH_1k

• **There are no striated ducts in the pancreatic duct system.**
• **The exocrine pancreatic acinus is composed of several serous cells surrounding a lumen.**
• **These cells are highly polarized, with a spherical nucleus, and are typical protein-secreting cells.**
• **The number of zymogen granules** (dark granules at the apex making the pancreatic cells polar) **present in each cell varies according to the digestive phase and attains its maximum in animals that have fasted.**



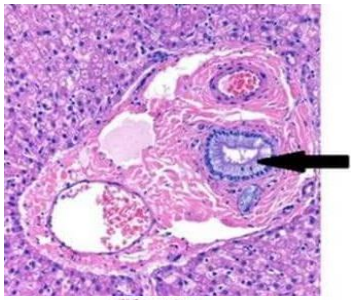
• **Intercalated ducts** (simple cuboidal 4 or 5 cells) starts from the lumen (which have centroacinar cells in it) ➞ continues as **interlobular duct** (between lobules, which can be stratified cuboidal or stratified columner) ➞ becomes **the main pancreatic duct** (stratified squamous non-keratinized).



• **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 fibers.**
• The pancreas also has a rich capillary network, essential for the secretory process. 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. Pancreatic secretion is controlled mainly through two hormones. secretin and cholecystokinin that are produced by enteroendocrine cells of the intestinal mucosa (duodenum and jejunum).

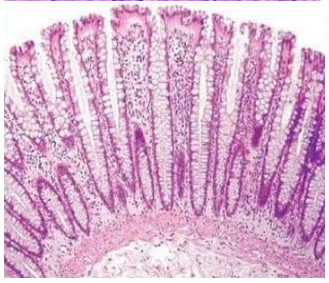
PAST PAPERS

1.Identify the pointed structure:



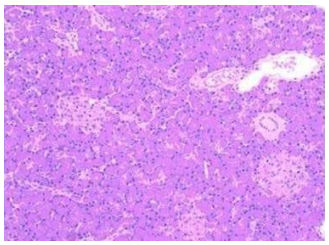
A. Portal Vein.
B. Hepatic Artery.
C. Porta hepatis.
D. Blood Sinusoids.
E. Bile Duct.

2.Identify this section:



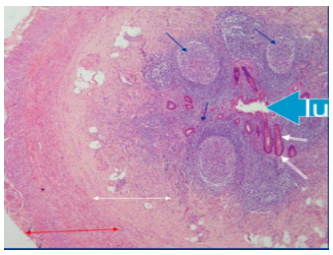
A. Appendix.
B. Colon.
C. Gallbladder.
D. Duodenum.
E. Jejunum.

3.Identify this section:

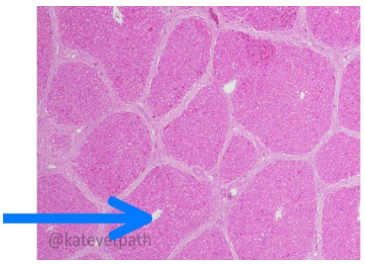


A. Parotid gland.
B. Sublingual gland.
C. Pancreas.
D. Liver.
E. Submandibular gland.

4.The following histological section represents:

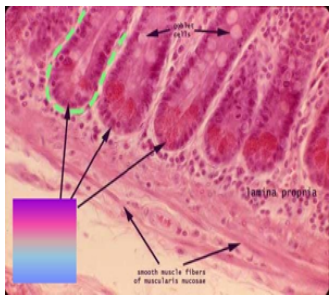


5.Identify the pointed structure in this section:



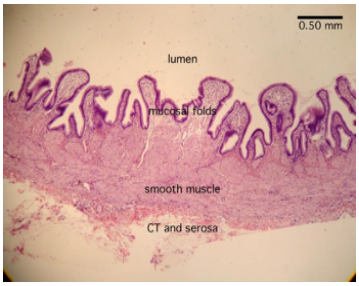
A. Branch from portal vein.
B. Bile duct.
C. Central vein.
D. Branch from hepatic artery.
E. Blood sinusoids.

6.Identify the pointed structures in this section:



A. Intestinal gland.
B. Brunner's gland.
C. Gastric gland.
D. Von Ebner's gland.
E. Esophageal gland.

7.Identify this section:



A. Esophagus.
B. Duodenum.
C. Colon.
D. Appendix.
E. Gallbladder.

8.Wrong about colon histology?

Answer: Presence of Peyer's patches

ANSWERS

1.E (this section shows a portal triad which contains hepatic artery, portal vein and bile duct, and you can see that the other two vessels contain blood)
2.B (smooth mucosa)
3.C (notice the pale islets of langerhans)
4.Appendix (notice narrow lumen and the circular lymphoid tissue)
5.C
6.A
7.E (notice the abundant foldings)

V2

In page 6 the last sentence in this color.

V3

In page 4 the lining of the lower half of the anal canal is stratified squamous not simple columnar.

V4

In page 13 the first pic (the gallbladder doesn’t have submucosa).

V5

In page 3 the in the table, the mucosal lining for the large and small intestine were flipped.

This color in the last page.