



GIS 10

ANATOMY



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This lecture will be about the liver and the gallbladder. Enjoy

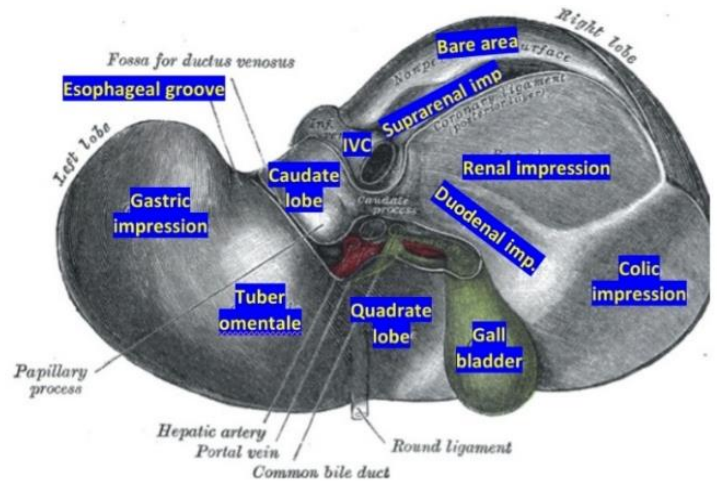
Anything underlined in this sheet is in the slides and was not mentioned by the professor.

♣ The surfaces of the liver ♣

- 1) Postero - inferior surface= visceral surface (explained in the previous lecture)
- 2) Anterior surface
- 3) Posterior surface
- 4) Superior surface = Diaphragmatic surface
- 5) Right surface

《1》 **Visceral surface** let's go over the relations of this surface quickly

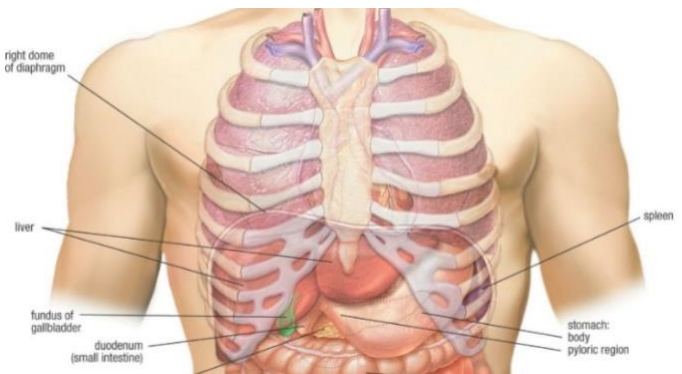
- Inferior vena cava (I.V.C)
- The gallbladder
- Esophagus → with esophageal groove of liver
- Stomach → with gastric impression
- Duodenum → Duodenal impression (near the neck of the gallbladder)
- Right colic flexure → Colic impression
- Right kidney → Renal impression
- Right suprarenal gland → Suprarenal impression
- Porta hepatis (bile duct, hepatic artery, portal vein, lymph nodes, ANS fibers)
- Ligamentum venosum & lesser omentum → there is a fissure for both
- Ligamentum teres
- Tubular omentum (tuber omentale related to pancreas)



《2》 **Anterior surface**

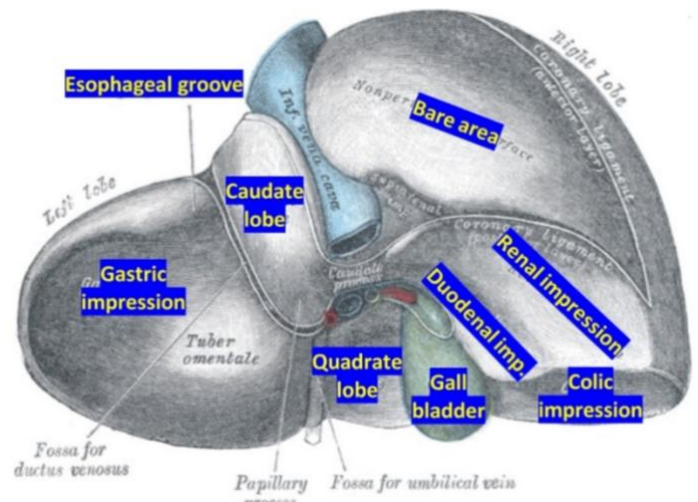
Relations of the liver anteriorly:

- Diaphragm (it extends to cover part of the anterior surface of the liver)
- Right & left pleura and lungs (the diaphragm separates between them and the liver)
- Costal cartilage
- Xiphoid process
- Anterior abdominal wall



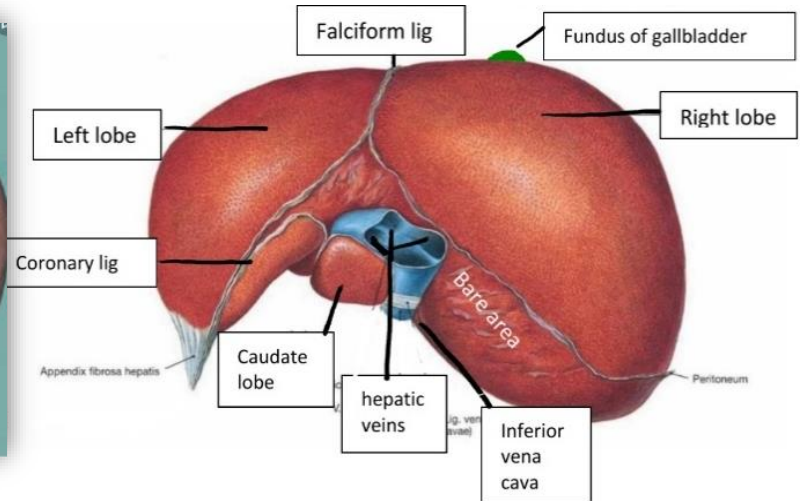
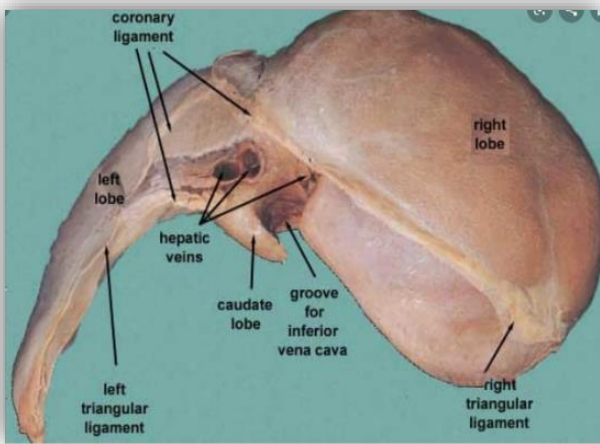
《3》 **Posterior surface**

- Diaphragm
- Right kidney and the supra-renal gland
- Transverse colon (right colic flexure)
- Duodenum
- Gall bladder
- I.V.C
- Esophagus
- Fundus(base) of stomach



《4》 Superior surface

- Diaphragm
 - Cut edge of the falciform ligament
 - The left and right triangular ligaments
 - The cut edges of the superior and inferior parts of the coronary ligament
 - I.V.C and the 3 hepatic veins (right, left & middle) → passing through a groove
- ⇒ The 3 hepatic veins drain into I.V.C
 ⇒ The caudate lobe of the liver more or less is wrapping around the groove of the IVC
 ⇒ Right & left liver lobes and the bare area of the liver can be seen from the superior view.



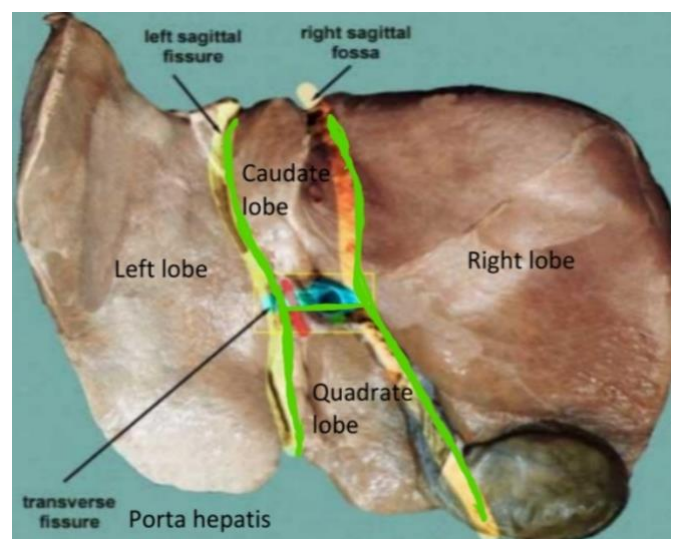
Notice how the diaphragm (which separates the pleura, the lung, the pericardium & the heart from the liver) covers parts of **all** surfaces of the liver *except* the **visceral** surface.

♣ Lobes of the liver ♣

4 lobes: Right, left, quadrate and caudate lobes.

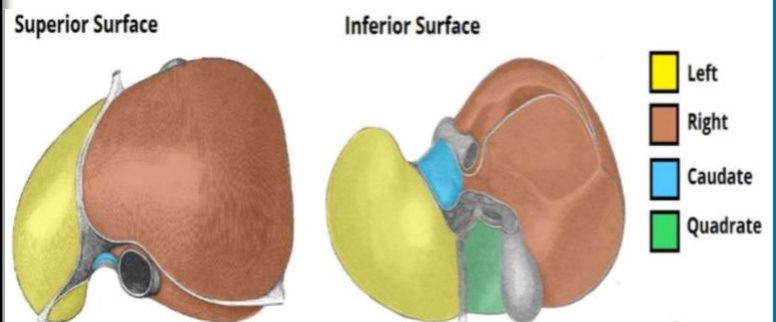
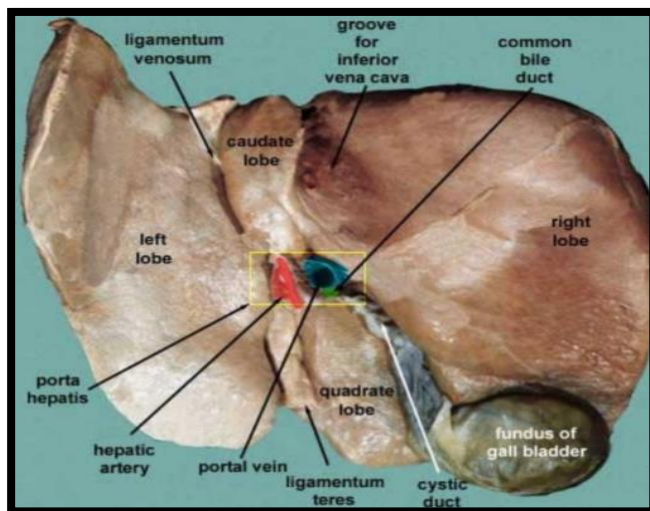
The following structures forming an “H shape”, divide the liver into the previously mentioned 4 lobes

1. Right sagittal fossa - groove for inferior vena cava superiorly and gall bladder inferiorly
2. Left sagittal fissure - contains the ligamentum venosum superiorly and round ligament of liver (lig. Teres) inferiorly
3. Transverse fissure (porta hepatis)



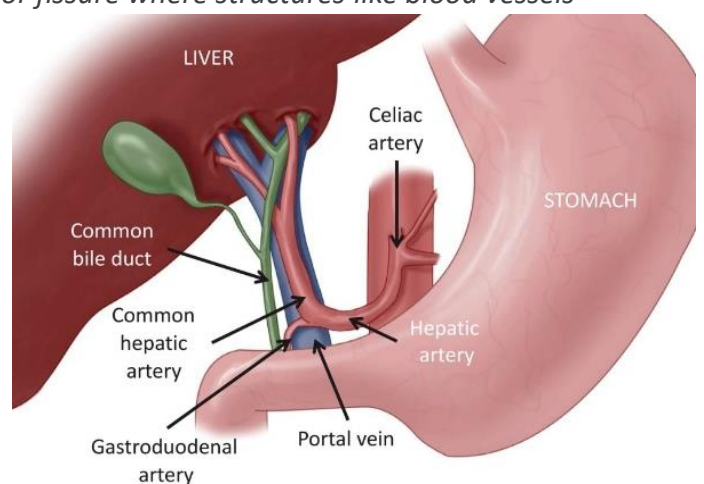
The following table includes some information about the lobes of the liver (check the pictures)

Right lobe	Left lobe	Caudate lobe	Quadrate lobe
<ul style="list-style-type: none"> - Largest lobe - Occupies the right hypochondrium - Divided into anterior and posterior sections by the right hepatic vein - Reidel's Lobe: is an extension of the right lobe caudally as far as the iliac crest (in some people). 	<ul style="list-style-type: none"> - Varied in size - Lies in the epigastric and left hypochondriac regions - Divided into lateral and medial segments by the left hepatic vein <p>☆ Right & left lobes are separated by</p> <ul style="list-style-type: none"> • Falciform ligament • Ligamentum Venosum • Ligamentum teres 	<ul style="list-style-type: none"> - Present on the posterior surface of the right lobe - Two processes <ol style="list-style-type: none"> 1- Caudate process 2- papillary process - Relations of caudate lobe <ul style="list-style-type: none"> ▪ Inferiorly: the porta hepatis ▪ On the right: the fossa for the IVC ▪ On the left: the fossa for ligamentum venosum. 	<ul style="list-style-type: none"> - Present on the inferior surface of the right lobe - Relations <ul style="list-style-type: none"> ▪ <u>Anteriorly: anterior margin of the liver</u> ▪ Superiorly: porta hepatis ▪ On the right: fossa for the gallbladder ▪ On the left: fossa for ligamentum teres.



♣ Porta hepatis ♣

- It's the **hilum** of the liver (*a hilum is a depression or fissure where structures like blood vessels enter/leave an organ*).
- It's located **outside** the peritoneum (it's just **surrounded** by it)
- Found on the postero-inferior surface of liver between the caudate and quadrate lobes
- The gallbladder is located anteriorly to porta hepatis.



More about porta hepatis in the next page

- As mentioned earlier, porta hepatis contents include:
 - Portal vein** → divides into right & left portal veins
 - Proper hepatic artery** → with its right and left hepatic branches
 - Common hepatic duct** → it joins the cystic duct to form the **common bile duct**
 - 1) Sympathetic and parasympathetic fibers → though the **celiac plexus of nerves**
 - 2) **Hepatic lymph nodes**
 - 3) ⇒ **Proper hepatic artery, nerve fibers and lymphatic node are in the middle.**
 - 4) **Portal vein is located posteriorly**
 - 5) The **bile duct is located anteriorly**
- Lesser omentum is attached to its margin → so the lesser omentum also contains in its free edge the proper hepatic artery, the portal vein, the common bile duct, lymphatics, and the hepatic plexus of nerves which is an offset of the celiac plexus.

♣ Peritoneum of the liver ♣

- The liver is covered by peritoneum (intraperitoneal organ) except at bare area → so can be considered “Interperitoneal”
- Inferior surface of the liver is covered with peritoneum of greater sac, except porta hepatis, gallbladder and ligamentum teres fissure
- Right lateral surface is also covered by peritoneum and is related to the diaphragm ⇒ the diaphragm extends along ribs 6-11 and part of it embryologically originates from septum transversum {The professor said that the diaphragm reaches until the 5th costal cartilage}

♣ Ligaments of the liver ♣

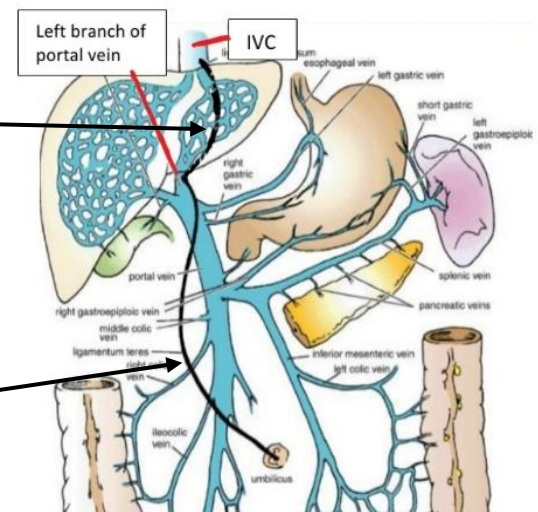
We've already talked about them in the 6th lecture, you can refer to that sheet, but let's go over some important notes.

- The **falciform ligament** of liver (sickle shaped, between right and left liver lobes & is attached to the anterior abdominal wall)
 - Ligamentum teres**
 - The **hepatogastric ligament** and the **hepatoduodenal ligament** (edge of lesser omentum)
 - The **coronary ligament** that forms the **right** and **left triangular ligaments**
- ⇒ The coronary ligament has superior and inferior parts, between those, the bare area is located. But how do we grossly differentiate between an area covered with peritoneum and an area that is not? The intraperitoneal part looks **glistening and smooth**, while the bare area looks **dull**

♣ The ligamentum venosum ♣

It is a fibrous band that is the remains of the ductus venosus that was present in the embryo. It is attached to the **left branch of the portal vein** and ascends in a fissure on the visceral surface of the liver to be attached above to the **inferior vena cava**

- Also notice **ligamentum teres**, which is an obliterated umbilical vein extending from the umbilicus to **the left portal vein**.

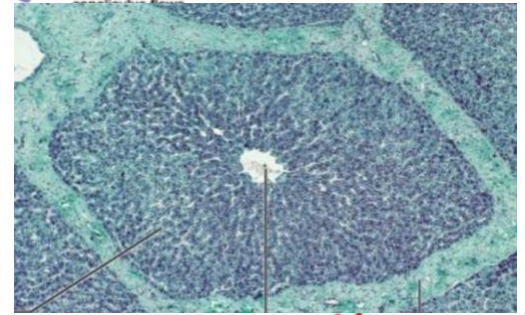
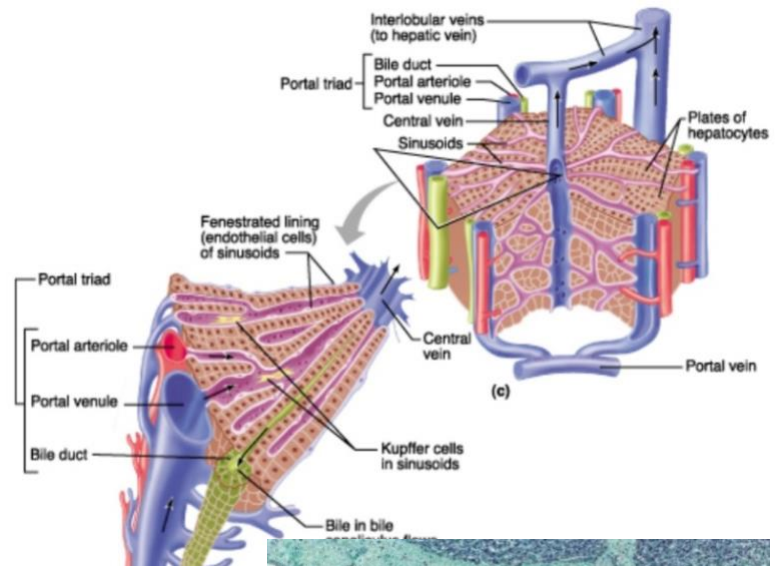


🌿 Histology of the liver 🌿

The liver, just like any other gland, is surrounded by a connective tissue capsule. In the liver, it's called **Glisson's capsule**. This capsule sends septa into the liver to divide the liver parenchyma into lobes and lobules.

Liver lobules are roughly **hexagonal** structures consisting of hepatocytes. These hepatocytes are arranged **radially** from the edge of the hexagonal shaped lobule to the **central vein** in the center which is responsible for the drainage of the hepatocytes in the lobule. This vein then drains into **the hepatic vein** (remember we have 3 hepatic veins right, left and middle) which then drains into **inferior vena cava**.

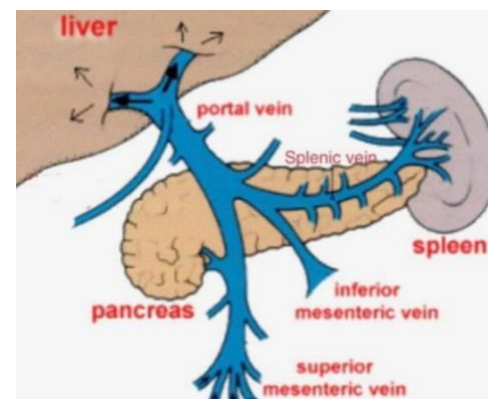
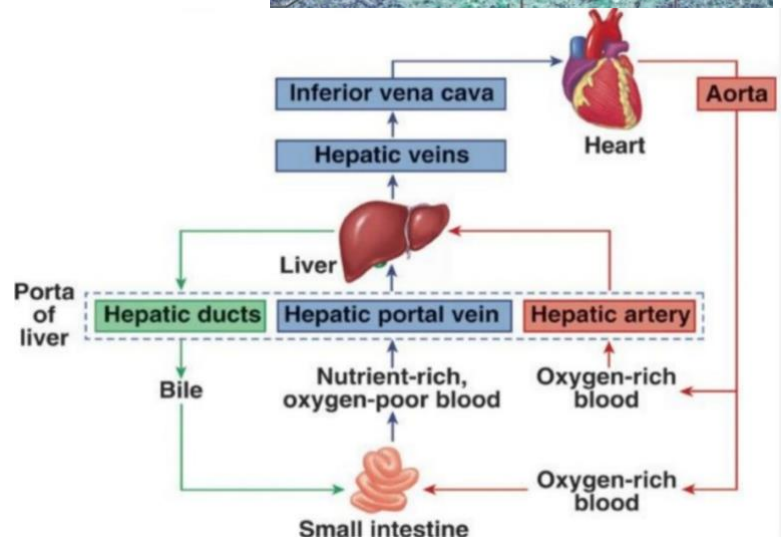
However, the portal triad [**the portal arteriole**, **portal venule**, **bile duct**] is located at the **angles** of the hexagonal lobules.
 ⇒ Bile is synthesized in hepatocytes then is transported through **the hepatic bile duct** to **the common bile duct** that opens into the **2nd** part of the duodenum.



🌿 Blood supply of the liver 🌿

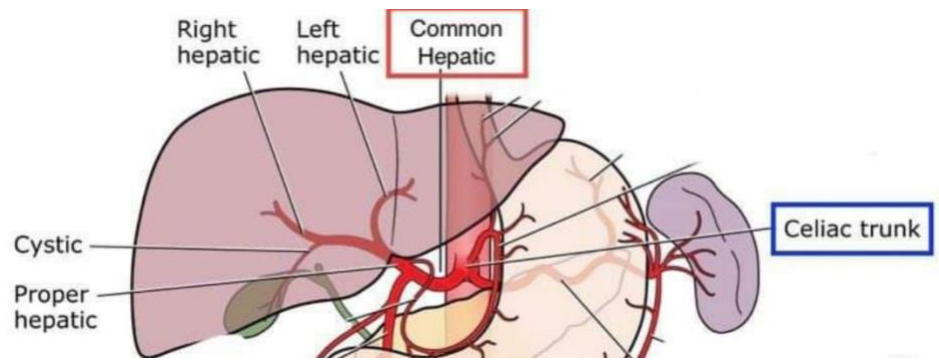
Liver blood sinusoids located between hepatocytes in liver lobules are branches from **portal vein** (then venule) and **hepatic artery** (then arteriole). These sinusoids contain blood that supplies hepatocytes with oxygen and nutrients. How?

☆ **Hepatic portal vein** formed by the union of **the superior mesenteric** and **the splenic vein** behind the neck of the pancreas carries **nutrient rich** blood (*the products of digestion, which have been absorbed from the gastrointestinal tract*). It enters the liver and divides into right and left portal veins that then give off branches that provide hepatocytes with nutrients → 75-80% of blood entering the liver (The **cystic vein** coming from the gallbladder ends in the **right branch of the portal vein**)



More in the next page

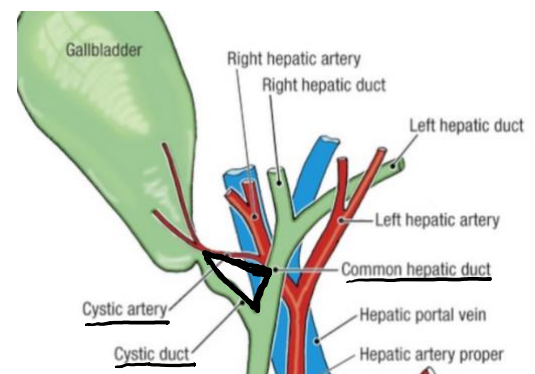
☆ **The hepatic artery**, a branch from the **celiac trunk** divides into **right and left hepatic arteries** as it enters the liver carrying oxygenated blood. These give off branches that supply hepatocytes with oxygen → 20-25% of blood entering the liver (The **right hepatic artery** usually gives off **the cystic artery**, which runs to the neck of the gallbladder)



⇒ After hepatocytes perform their functions, blood carrying waste products travels along the sinusoids and exits through **the central vein** in each lobule which drains into the **hepatic veins** that drain posteriorly into the **I.V.C** then into the right atrium of the heart

♣ Calot's triangle ♣

- Margins: **cystic duct**, **common hepatic duct** and **cystic vessels**.
- Important surgically in cholecystectomy: cutting and ligation (to prevent bleeding) of blood vessels and the cystic duct → now the gallbladder is free and can be removed
- ⇒ Need to take the location of the cystic vessels into consideration: in 80% of cases, the blood vessels are located **posteriorly** to the common hepatic duct but in 20% of the cases → **anteriorly** to the duct



♣ Lymphatic drainage of the liver ♣

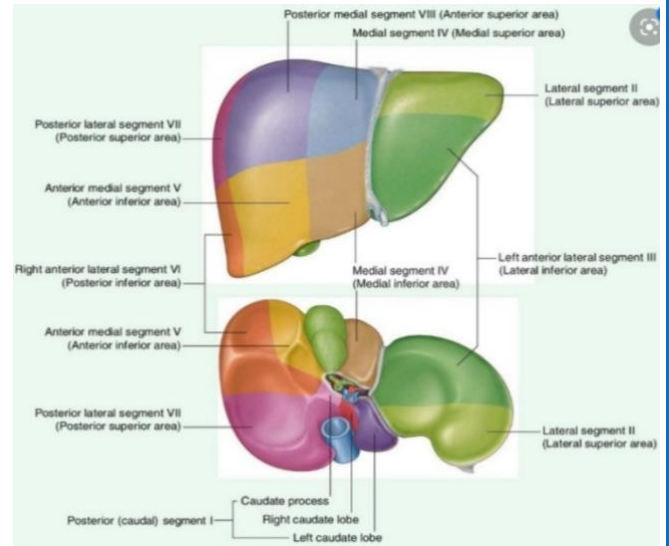
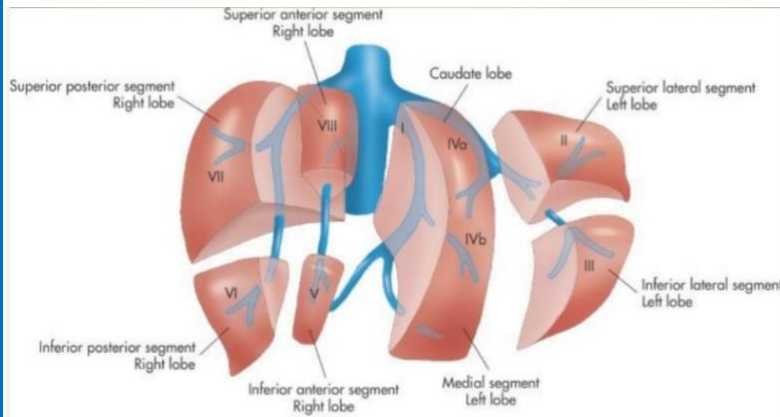
- Liver produces large amount of lymph, about one third – one half of total body lymph
- Lymph leaves the liver and enters several **hepatic lymph nodes** in porta hepatis → then efferent vessels pass to **celiac nodes**
 - A few lymph vessels pass from the bare area of the liver through the diaphragm to the **posterior mediastinal lymph nodes** then to the **right thoracic (lymphatic) duct**.

♣ Nerve supply ♣

- The **liver** is innervated by **the hepatic plexus**, which contains **sympathetic (from celiac plexus)** and **parasympathetic (vagus nerve-anterior part)** nerve fibres.
- The anterior vagal trunk also gives rise to a large hepatic branch, which passes directly to the liver
 - Generally: Sympathetic and parasympathetic nerves form the celiac plexus.
 - ⇒ **The celiac plexus: from celiac ganglia** (more about it in a future lecture)

♣ Segmental anatomy of the liver ♣

Right and left lobes are separated by ligaments (anatomic separation) and are of no morphological significance. True morphological and physiological division is by a line that extends from fossa of gallbladder to fossa of I.V.C. Divisions are further divided into 8 segments based on hepatic and portal venous segments. Each segment also has arterial supply and lymph drainage and there is no anastomosis between divisions.



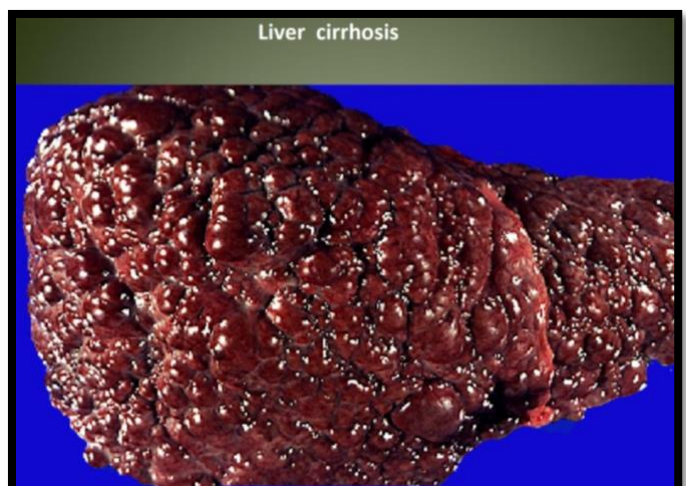
The professor didn't go much into detail about the segments' names and location

Note the professor mentioned that the **caudate** and **quadrate lobes** are *physiologically* and *functionally* related to the **left liver lobe** due to their common blood supply, but upon searching, I found that the **caudate lobe** is functionally part of both **right and left lobes**, because it receives its blood supply from both **right and left hepatic arteries**. The quadrate lobe receives its blood supply from the **left hepatic artery** and is therefore considered functionally part of **the left lobe**.

Liver transplantation: it is important to recall that just one segment with its blood supply is used in transplantation & not the entire liver. Interestingly, stem cells that differentiate into hepatocytes upon stimulation by certain proteins have also been recently used

♣ Liver cirrhosis and fibrosis ♣

- 1/8 of the liver is enough for proper function.
- Spread of cirrhosis/fibrosis along the liver is fast and extensive ☹️
- Bilharzia can cause liver fibrosis.



❖ The gallbladder

- It is a green muscular pear-shaped hollow organ
- Anatomical position of the gallbladder

In the Epigastric - **Right hypochondrium region**

At the tip of the 9th right costal cartilage (the fundus).

On inferior surface of liver.

Between quadrate and right lobes.

- Parts

- **Fundus.**

Relations: anteriorly - anterior abdominal wall
postero inferiorly - transverse colon

- **Body.**

Relations: superiorly - liver
postero inferiorly transverse colon, end of 1st part of duodenum to beginning of 2nd part of duodenum

- **Neck**

- Forms the **cystic duct** which is 4cm long

- Body and neck are directed towards porta hepatis

- **Hartmann's Pouch:** opposite to the neck of the gallbladder. It's usually filled with bile secretions but stasis of bile can occur resulting in gallstones (*usually a single stone*)

1. Lies between body and neck of gallbladder

2. A normal variation

3. May obscure cystic duct

4. If very large, may see cystic duct arising from pouch

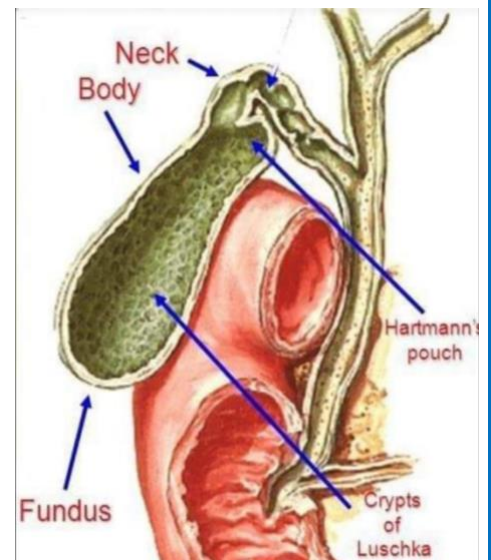
- It's sometimes completely covered by peritoneum and has short mesentery (intraperitoneal). Other times, it's just fixed from the anterior and sides to the liver and has a bare area (Interperitoneal)

- Capacity: 40- 60 cc (ml)

- Major function: **bile concentration** by increasing water absorption so that the concentration of bile increases **20 times**.

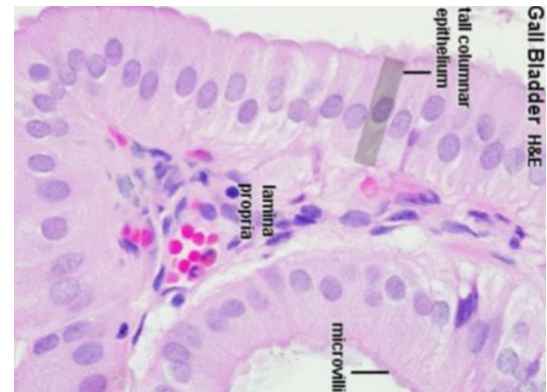
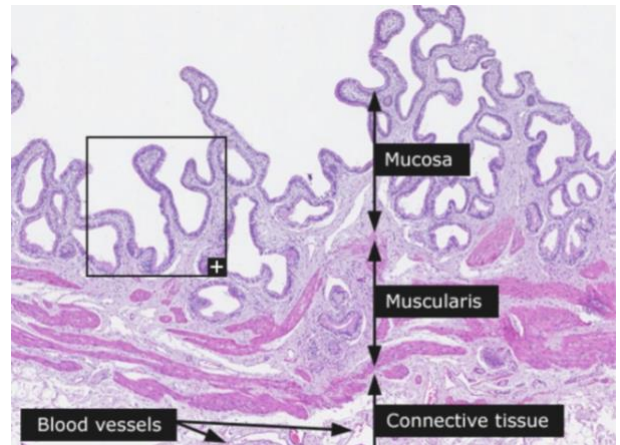
⇒ Explanation: Bile flows from the liver into **the hepatic** and **common bile ducts**. If food is present in the small intestine, the bile will continue directly into the duodenum. If the small intestine is empty, **the sphincter of Oddi** will be closed, and bile flowing down the common duct will accumulate and be forced back up the tube until it reaches the open **cystic duct**. The bile flows into the cystic duct and gallbladder, where it is stored and concentrated until needed. When food enters the duodenum, the common bile duct's sphincter opens, the gallbladder contracts, (*due to certain stimuli which include the release of cholecystinin (a hormone) into the duodenum*) and bile enters the duodenum to aid in the digestion of fats.

⇒ In **cholecystectomy**, the patient depends on the **diluted** bile released from the liver for the digestion of fat, so a large amount of bile flows into the duodenum since it's not concentrated → can cause **diarrhea**



🌀 Histology of gallbladder 🌀

The wall of the gallbladder is composed of mucosa, submucosa, muscularis and serosa/adventitia. **The mucosa** is made up of **branching folds** lined by a simple columnar epithelium **without** goblet cells. The abundant folds give the gallbladder mucosa a **honeycomb** appearance. **The muscularis** is made up of randomly distributed **irregular** smooth muscle fibres, & **not** outer longitudinal and inner circular layers. **The submucosa** is usually absent. Microvilli may be found on the surface of the epithelium.



🌀 Blood supply of the gallbladder 🌀

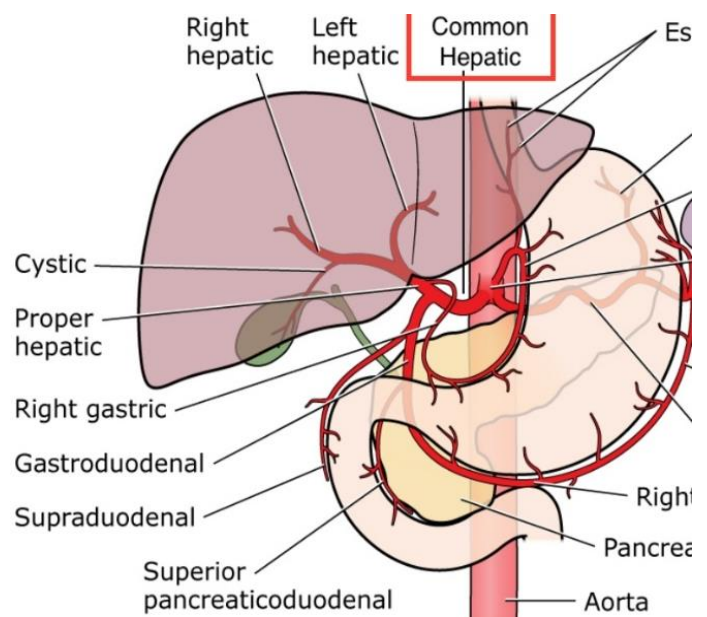
- **Cystic artery branch of right Hepatic artery** (from proper hepatic artery from common hepatic artery)
- **Cystic vein which ends in portal vein**
- Small branches (arteries and veins run between liver and gall bladder)

🌀 Lymphatic drainage of GB 🌀

Cystic lymph nodes at the neck of the gallbladder → **hepatic lymph nodes** → Terminate at **celiac lymph nodes**

🌀 Nerve supply of gallbladder 🌀

- Sympathetic and parasympathetic from **celiac plexus**
- Parasympathetic - vagus nerve
- Hormonal stimulation: the effect of cholecystokinin release into the duodenum



🌀 Common bile duct 🌀

- Common bile duct is 7-10cm long (3 inches)
- Descends in the free edge of lesser omentum
- Blood supply: Small arteries
 - a. Arise from cystic artery
 - b. Posterior branch of superior pancreaticoduodenal artery
- It can be divided into 3 parts: Supra-duodenal, retro-duodenal, retro-pancreatic.

More about the common bile duct in the next

1st part: Supra-duodenal: located above the duodenum
In right free margin of lesser omentum in front of the opening into the lesser sac (Epiploric opening).

Right to hepatic artery and portal vein

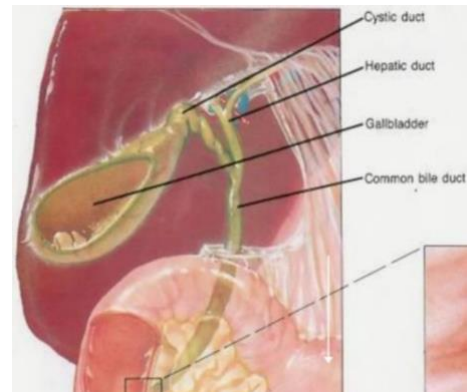
2nd part: Retro-duodenal: located behind the 1st part of the duodenum to the right of the gastroduodenal artery

3rd part: Retro-pancreatic: located behind the head of the pancreas

- Contact with main pancreatic duct

- Related to IVC, gastroduodenal artery, portal vein

- Ends in the half second part of duodenum at ampulla of Vater



♣ Bile ♣

- Bile composed of water, ions, bile acids, organic molecules (including **cholesterol**, phospholipids, bilirubin).
- **Acids and salts** emulsify fats for absorption across wall of small intestines into lacteal lymph capillaries
- Contains **waste products** from RBC breakdown and other metabolic processing (color of feces from bilirubin in bile)
- **Ions** buffer chyme from stomach
- **Cholelithiasis:** the presence of gallstones in gallbladder. They are mostly cholesterol. There are certain likely sites of stone formation/deposition
- Stone in common bile duct can cause jaundice & pancreatitis

♣ Gallbladder Diseases ♣

1- Cholelithiasis & Cholecystitis = inflammation of GB.

2- Obstructive jaundice: liver patterns

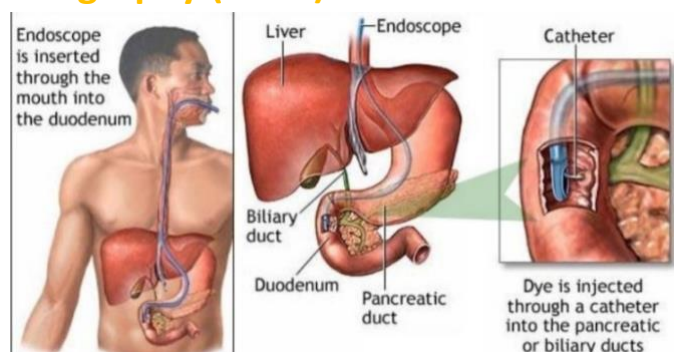
3- Gangrene of gall bladder rare due to the presence of 2 blood-supplying sources

4- Congenital defects

♣ Endoscopic retrograde cholangiopancreatography (ERCP) ♣

▪ It is a technique used instead of open surgeries that combines the use of endoscopy and fluoroscopy to diagnose and treat certain problems of the **biliary or pancreatic ductal** systems including gallstones, pancreatitis due to stasis in pancreatic secretions, inflammatory strictures (scars), leaks (from trauma and surgery), and cancer.

▪ Mechanism: Endoscope is inserted through the mouth into the duodenum (until the major duodenal papillae) → then dye is injected retrogradely into the common bile duct/the pancreatic duct so that they can be seen on X-rays.



GOOD LUCK♡