

You don't need to refer to the slides, we included everything here ..

In this lecture we will talk about Liver & Gallbladder...

Liver

The liver is the largest gland in the body and has a wide variety of functions.

- It's an accessory organ of GIT

Accounting for

- **1/50 of body weight in adult** >> for example a person whose weight is 50 kg, his liver weight's $(1/50)*50 = 1$ kg
- **1/20 of body weight in infant** >> so it's heavier in infants reflecting the importance of its function at that age and higher activity

It is an:

- **Exocrine organ** >> because it secretes bile and bile salts.
- **Endocrine organ** >> because it secretes albumin, prothrombin, fibrinogen and globulin
It secretes enzymes and hormones...

Functions of the liver:

- secretion of bile and bile salts.
- metabolism of carbohydrates, fat & proteins.
- formation of enzymes, heparin & anticoagulant substances.
- formation of coagulant substances .
- storage of glycogen & vitamins.
- activation of vitamin D.
- detoxication also kidney has this function as well .

Heparin is a very important anticoagulant; it's given to people who have thrombus or embolism in their blood vessels.

Detoxication is the most important function.

drugs we use have toxic materials, so they are detoxicated by the liver.

morphine " which is a painkiller" is given to reduce sever pain in

many clinical cases "as cancer" >> It is detoxified in the liver.

- Before giving morphine >> a liver function test is done to indicate the activity of hepatocytes. (if it works or not)
- in cases of "cancer" with metastasis to liver we shouldn't give morphine because liver here is damaged.
- What is interesting in the liver that is only 1/8 of its tissue mass can perform the entire functions of the liver .

Location:

Occupies right hypochondriac region and reaches the epigastrium, the left lobe may reach the left hypochondriac region.

Surface anatomy:

- The greater part of the liver is situated under cover of the right costal margin.

- Diaphragm separate it from the pleura, lungs, pericardium & heart.
- Heart & pericardium above the epigastric region “central part” so it’s above left lobe of live !!!
- Liver is located below the right copula of diaphragm separate it from right pleura and right lung.
- The diaphragm covers the liver superiorly , anteriorly ,posteriorly and from the right side.
- The upper surface of the liver can reach the level of 5th intercostal space from the right side , it descends down in deep inspiration.
- The lower border of the liver is related to the right 9th costal cartilage.
- The fundus of the gallbladder projects below the lower border of the liver at the level of the right 9th costal cartilage
- The lower border of the liver is sharp , we can feel it putting our index deep under the right costal cartilages during deep inspiration and also it can be felt in the clinical examination of enlargement of the liver (hepatomegaly).

The doctor said here an important question:

If we insert a needle in the 9th intercostal space of the right side what are the things that will be penetrated ?!!

The answer is : diaphragm, pleura, liver; but it doesn’t penetrate the lung because it reaches the 8th intercostal space not 9th.

Surfaces of the liver, their relations & impressions:

(we have 5 surfaces; postero-inferior (visceral surface), superior, anterior & right surfaces)...

Relations of liver anteriorly:

- Diaphragm
- Rt & Lt pleura & lung
- Costal cartilage
- Xiphoid process
- Ant. Abdominal wall

Relations of liver superiorly:

- Diaphragm
- Pleura & lung
- Pericardium & heart

Notice:

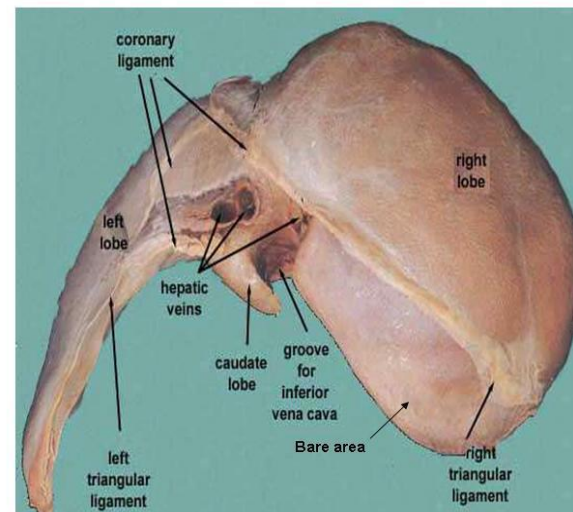
✓The bare area of liver “where there is no peritoneum covering the liver”.

✓The superior & inferior parts of coronary ligament “reflection of peritoneum around the bare area”.

✓The left & right triangular ligament.

✓Groove for IVC & hepatic veins “*IVC receives the hepatic veins*”.

✓Caudate lobe of the liver more or less wrapping around the groove of IVC.



Relations of Postero-inferior surface = "visceral surface" :

- IVC
- Esophagus
- Stomach (mainly the pylorus)
- Duodenum
- Right colic flexure
- Right kidney
- Right suprarenal gland
- Gall bladder
- Porta hepatic (bile duct, hepatic artery& portal vein)
- Fissure for ligamentum venosum & lesser omentum
- Tubular omentum
- Ligamentum teres

- Left lobe is related to esophagus & stomach >> esophageal & gastric areas or impressions.
- right lobe is related to the right kidney & suprarenal >> renal & suprarenal areas.
- gallbladder has its own impression on the visceral surface of the liver and its neck is related to the pylorus and duodenum , and its fundus is related to the transverse colon.
- So fundus of gallbladder has an impression on the visceral surface which will take blood supply directly from the liver and this will prevent the gangrene in appendix! (that is what the doctor said exactly; but I guess its gallbladder not appendix!!
- The fundus of gall bladder is on the tip of right 9th costal cartilage with linea semilunaris and trans pyloric line "at the level of L1"!

Relations of liver posteriorly:

- Diaphragm
- Right kidney
- Suprarenal gland
- Transverse colon (hepatic flexure)
- Duodenum
- Gallbladder
- IVC
- Esophagus
- Fundus of stomach

Lobes of liver: " 4 lobes"

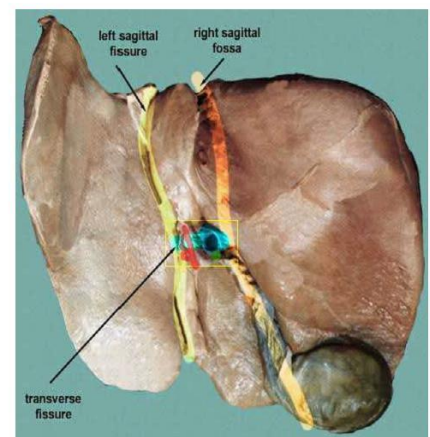
- 1- Right lobe
- 2- Left lobe
- 3- Caudate lobe
- 4- Quadrate lobe (the duodenum will cross it and the will cross the neck of gall bladder)

Separation of the 4 lobes of the liver:

✓ **Right sagittal fossa** -groove for inferior vena cava and gall bladder.

✓ **left sagittal fissure** - contains the Ligamentum Venosum and round ligament of liver.

✓ **Transverse fissure** (also porta hepatis) -bile ducts, portal vein, hepatic arteries.



Right lobe:

- largest lobe
- occupies the right hypochondrium
- divided into anterior & posterior sections by the right hepatic vein.
- Reidel's lobe extend as far caudally as the iliac crest.

Riedel's lobe is an extended, tongue-like, right lobe of the liver. It is not pathological; it is a normal anatomical variant and may extend into the pelvis. It is often mistaken for a distended gall bladder or liver tumor. "Wikipedia"

Left lobe:

- Varied in size
- Lies in the epigastric & left hypochondriac region.
- Divided into lateral & medial segments by left hepatic vein.

Right & left lobes are separated by:

- Falciform ligament (separate them anteriorly & it's 2 layers of peritoneum which connect the anterior surface of liver with diaphragm and anterior abdominal wall).
- Ligamentum venosum & Ligamentum teres >> on the visceral surface.

Note that ligamentum teres (Also known as: round ligament), is an obliterated umbilical vein, lies in the free edge of falciform ligament!

The umbilical vein is a vein present during fetal development that carries oxygenated blood from the placenta to the growing fetus. Within a week of birth, the infant's umbilical vein is completely obliterated and is replaced by a fibrous cord called the round ligament of the liver. "Wikipedia"

Caudate lobe:

- Present in the posterior surface from the right lobe
- 2 processes:
 - 1) c-process
 - 2) papillary process
- It's relations:
 - 1) Inf. >> the porta hepatic
 - 2) On the right >> fossa for IVC
 - 3) On the left >> fossa for ligamentum venosum

Quadrate lobe:

- Present on the inferior surface from the right lobe
- It's relations:
 - 1) Ant. >> anterior margin of liver
 - 2) Sup. >> porta hepatis
 - 3) On the right >> fossa for gall bladder
 - 4) On the left >> fossa for ligamentum teres

The caudate lobe is related to IVC , whereas the quadrate lobe is related to gallbladder.

Anatomically; caudate & quadrate lobes belong to the right lobe BUT physiologically & functionally; they belong to the left lobe. and this is due to the following reasons :

- 1) They are supplied by the left hepatic artery*. (whereas the right hepatic artery supplies the right lobe & gives the cystic artery to the gallbladder)
- 2) Their venous drainage is in the left hepatic vein.
- 3) Their bile secretion is to the left hepatic duct. (right hepatic duct for right lobe)

* left hepatic artery & right hepatic artery are branches from hepatic artery.

Porta Hepatis:

- It is the hilum of the liver.
- It's found on the postero-inferior surface.
- Lies between the caudate & quadrate lobes.
- Lesser omentum attached to its margin (lesser omentum between porta hepatic & lesser curvature of stomach)
- It has no peritoneum
- Contents:
 - 1) Ant. >> gallbladder (It should be common bile duct but in the slide it's gallbladder!!)
 - 2) Middle >> hepatic artery, nerves & lymphatic nodes
 - 3) Post. >> portal vein

Remember that

- the free edge of lesser omentum contain the portal vein, the hepatic artery, and the common bile duct
- common bile duct is formed by the union of the common hepatic duct (formed by right hepatic duct from right lobe & left hepatic duct from left lobe) and the cystic duct (from the gall bladder). It is later joined by the pancreatic duct to form the ampulla of Vater. There, the two ducts are surrounded by the muscular sphincter of Oddi. "Wikipedia"
- nerves are sympathetic & parasympathetic (parasympathetic through the vagus nerve, remember the anterior vagal trunk that give the hepatic branch).
- Hepatic artery (branch from celiac artery) gives:
 - 1) right hepatic artery >> supplies the right lobe
 - 2) left hepatic artery >> supplies the left, caudate & quadrate lobes.

Peritoneum of liver:

- The liver is covered by peritoneum (Intraperitoneal organ) except the bare area (its origin from septum transversum)
- Inferior surface covered with peritoneum of greater sac except porta hepatic, gallbladder & ligamentum teres fissure.
- Right lateral surface covered by peritoneum, related to diaphragm which separate it from right pleura, lung & right ribs (6-11).

Ligaments of liver:

1- The Falciform ligament

- Consist of double peritoneal layer
- Sickle shaped
- Extend from anterior abdominal wall (umbilicus) to liver
- Free border of the ligament contains the Ligamentum teres (obliterated umbilical vein).
- Separate the right & left lobes.
- Makes right and left sub-diaphragmatic spaces

2- The Ligamentum teres hepatis

- Also known as: round ligament
- It is an obliterated umbilical vein
- Extend in the free edge of falciform ligament
- Connects with the left portal vein; so anatomically, it divides the left part of the liver into medial and lateral sections.

3- The Coronary ligament

- The area between upper & lower layers of the coronary ligament is the bare area of the liver which contract with the diaphragm.

- 4- The right triangular ligament
- 5- The Left triangular ligament
- Left & right coronary ligaments formed by left & right extremity of coronary ligament.

- 6- The Hepatogastric ligament
- Thickening of peritoneum between liver & stomach (lesser curvature).

- 7- The Hepatoduodenal ligament
- Thickening of peritoneum between liver & duodenum (especially 1st inch).

8- The Ligamentum venosum

- Fibrous band that is the remains of ductus venosum of the fetal circulation.
- It is attached to the left branch of the portal vein & ascends in the fissure on the visceral surface of the liver to be attached above to IVC.
- It is invested by the peritoneal folds of the lesser omentum within a fissure (fissure of Ligamentum venosum) on the inferior surface of the liver between the caudate and main parts of the left lobe.

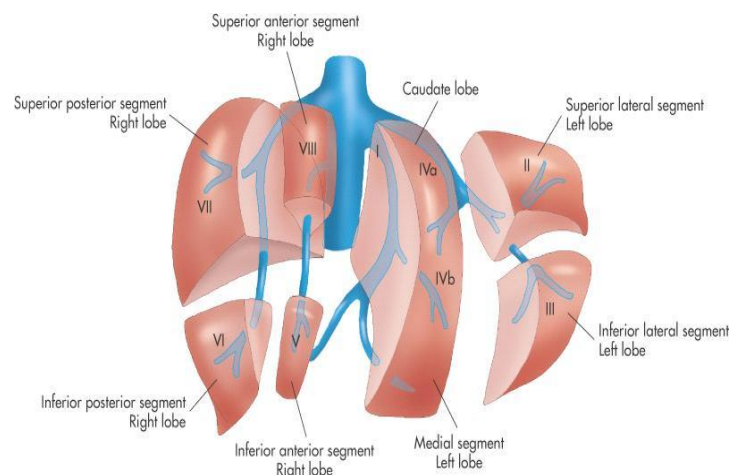
- The ductus venosus shunts approximately half of the blood flow of the umbilical vein through the liver directly to IVC. Thus, it allows oxygenated blood from the placenta to bypass the liver.
- ☑ The ductus venosus is open at the time of the birth and is the reason why umbilical vein catheterization works. Ductus venosus naturally closes during the first week of life in most full-term neonates; however, it may take much longer to close in pre-term neonates. Functional closure occurs within minutes of birth. Structural closure in term babies occurs within 3 to 7 days.
- After it closes, the remnant is known as ligamentum venosum. "Wikipedia"

Histology of liver:

- Lobules >> roughly hexagonal structures consisting of hepatocytes. Radiate outward from a central vein.
- Central veins will union to form three hepatic veins which will drain into IVC...
- At each of the six corners of a lobule is a portal triad (it's a porta hepatis having hepatic artery, portal vein and IVC).
- Between the hepatocytes are the liver sinusoids (mixed blood)
- Liver surrounded by a thin capsule at portahepatic (it is thick) Glisson's capsule invests the liver and send septa into liver subset subdivide the parenchyma into lobules (hexagonal lobules).

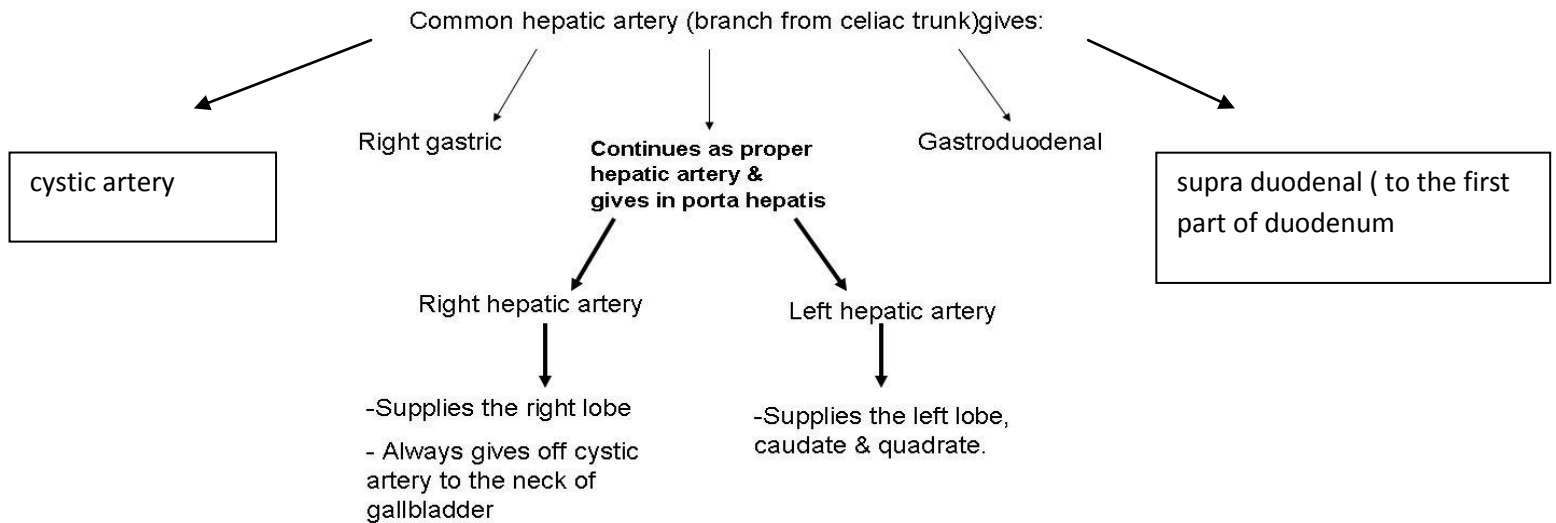
Segmental anatomy of the liver:

- It's very important in liver transplantation nowadays .
- Right & Left lobes anatomically no morphological significance. Separation by ligaments (Falciform, ligamentum Venosum & Ligamentum teres).
- True morphological and physiological division by a line extend from fossa of Gall bladder to fossa of I.V.C each has its own arterial blood supply, venous drainage and biliary drainage.
- No anastomosis between divisions.
- 3 major hepatic veins: Right, Left & central.
- 8 segments based on hepatic and portal venous segments, but with (4a, 4b) the total segments are 10.
- Liver segments are based on the portal and hepatic venous segments.



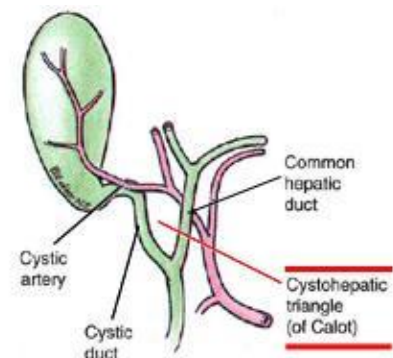
Blood supply of liver:

- blood vessels conveying blood to the liver are the hepatic artery (30%) and portal vein (70%).
- The hepatic artery brings oxygenated blood to the liver, and the portal vein brings venous blood rich in the products of digestion, which have been absorbed from the gastrointestinal tract.
- The arterial and venous blood is conducted to the central vein of each liver lobule by the liver sinusoids.
- The central veins drain into the right and left hepatic veins, and these leave the posterior surface of the liver and open directly into the inferior vena cava.



Calot's triangle (also known as hepatobiliary triangle):

- is an anatomic space bordered by the common hepatic duct medially, the cystic duct laterally and the cystic artery superiorly.
- It's above the liver and below cystic artery and duct .



- Its significance appears in the cholecystectomy procedure, they ligate the cystic artery which is part of the triangle & usually crosses posteriorly to the bile duct (this is the normal as found in 70% of people); sometimes it crosses anteriorly (this is abnormal)!

Venous drainage of the liver:

- The hepatic veins (three or more) emerge from the posterior surface of the liver and drain into the inferior vena cava.
- right lobe --> right hepatic vein ; left lobe --> left hepatic vein and caudate and quadrate lobes to middle hepatic veins
- The portal vein divides into right and left terminal branches that enter the porta hepatis behind the arteries.

- So the venous drainage of liver is the hepatic vein NOT the portal vein which gives blood to hepatocytes.
- Portal vein found in the free edge of lesser omentum but when it reaches the porta hepatis it divides into:
 - 1- Right portal : which receives the cystic vein opposite the cystic artery
 - 2- Left portal.
- Right & left enter the porta hepatis

Lymphatic drainage of the liver:

- Liver produce large amount of lymph~ one third – one half of total body lymph
- lymph leaves the liver and enters several lymph nodes in porta hepatis >> Goes to celiac lymph nodes through efferent vessels >> then to cisterna chyli in the opening of abdominal aorta & from which the thoracic duct arise >> So thoracic duct is the main lymphatic duct that the liver drains into it except the bare area.
- A few vessels pass from the bare area of the liver through the diaphragm to the posterior Mediastina lymph nodes.
- bare area have right lymphatic duct which drains into the junction between internal jugular vein & subclavian vein brachiocephalic vein on the right side and to blood circulation .

Nerve supply:

- Parasympathetic vagus nerve(anterior part).
- Sympathetic hepatic plexus>>> celiac plexuses thoracic ganglion chain T1-T12 (thoracic sympathetic chains)
- Sympathetic and parasympathetic nerves form the celiac plexus and found in lesser omentum .
- The anterior vagal trunk gives rise to a large hepatic branch, which passes directly to the liver.

ERCP (Endoscopic retrograde cholangiopancreatography) :

- Just to clarify its name : from oral cavity till duodenum then return back to common bile duct & pancreatic duct.
 - Anterograde
 - Retrograde
 - Cholangiopancreatography : biliary system and pancreas

-It is a technique that combines the use of endoscopy and fluoroscopy to diagnose and treat certain problems of the biliary or pancreatic ductal systems. Through the endoscope, the physician can see the inside of the stomach and duodenum, and inject dyes into the ducts in the biliary tree and pancreas so they can be seen on X-rays.

-ERCP is used primarily to diagnose and treat conditions of the bile ducts, including gallstones, inflammatory strictures (scars), leaks (from trauma and surgery), and cancer.

this technique are used in 2 conditions:

1- In the past, they used to remove common bile duct and gallbladder in order to remove the stone. Nowadays by using this technique they insert an endoscope from mouth down the esophagus, through the stomach, and into the duodenum till reaching the sphincter of oddi and there they make a small cut then insert a basket finally they leave the stone in duodenum which will leave the body with stool!

2- Some people have jaundice (bile increase in blood so there will be itching) because of mud in common bile duct & main pancreatic duct; so here we make irrigation by saline.

Here, the doctor talked about 2 pathological conditions of the liver: fibrosis & cirrhosis...

- Fibrosis: results from bilharziasis “ very common in Egypt”
- Cirrhosis: is a consequence of chronic liver disease characterized by replacement of liver tissue by fibrosis, scar tissue and regenerative nodules leading to complete loss of liver function (all cells are damaged & it's very dangerous because its asymptomatic), it is most commonly caused by alcoholism...

- Note : during fast there will be stasis of secretion due to dehydration .. complaining from renal colic , pancreatitis ... so due to stasis the bacteria will grow and cause growth (treated by irrigation by saline)

GallBladder

Anatomical position:

- Epigastric - Right hypochondriac region
 - Its fundus at the tip of the 9th right costal cartilage
 - It meets at trans pyloric line with linea semilunaris (edge of rectus abdominus muscle).
- Green muscular organ
 - Pear-shaped, hollow structure
 - On inferior surface of liver (the visceral surface)
 - Between quadrate and right lobes
 - **Has a short mesentery** so its intraperitoneal , or may not have mesentery and have an impression on liver “ interperitoneal “ so the posterior surface with liver and not damaged
 - Capacity 40- 60 cc
 - Body and neck Directed toward porta hepatis.

Structure of GB:

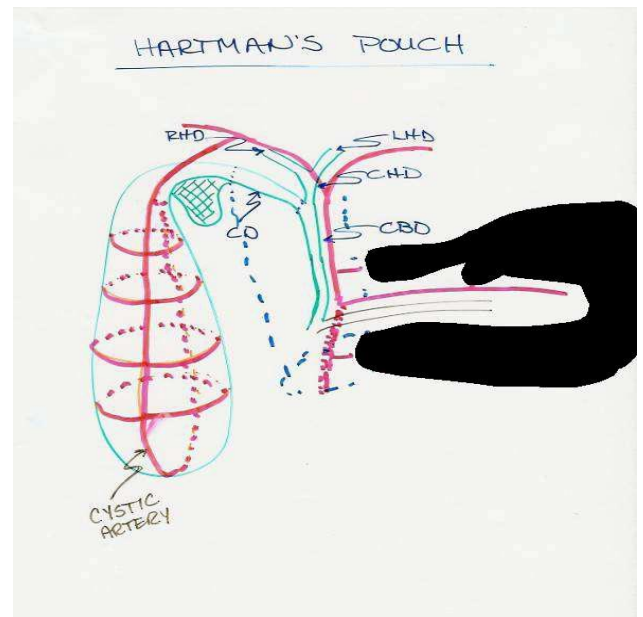
- Fundus:
 - Anterior: anterior abdominal wall
 - Postero-inferior: transverse colon
- Body:
 - superior: liver
 - Postero-inferior: Transverse colon. End of 1st part of duodenum, beginning of 2nd part of duodenum
- Neck:
 - Form the cystic duct.

just remember : common bile duct is (8-10 cm) divides into:

- suprapancreatic in the free edge of lesser omentum.
- retroduodenal between the pancreas and first part of deudenum.
- retropancreatic behind neck of pancreas and open in the medial side.

Hartmann’s Pouch:

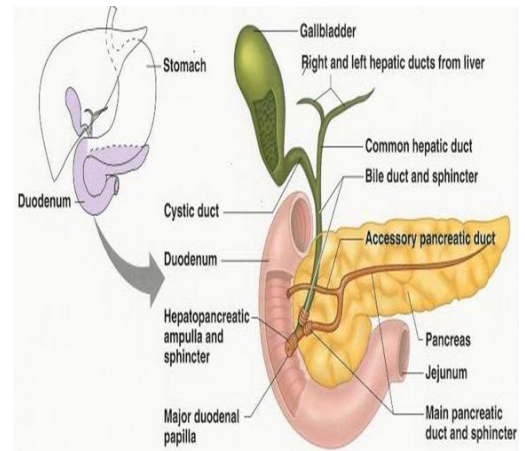
- Lies between body and neck of gallbladder
- A normal variation
- May obscure cystic duct
- If very large, may see cystic duct arising from pouch



- Its importance is that usually when the gall stone lodges in this area, it forms **single gall stone** producing severe pain. The single gall stone is formed here due to the susceptible nature of this region as it is pouch, so stasis occurs to the bile and with the extensive absorption of water. All of this will lead to the formation of this single stone.
- Rule: if there was a stone in the gall bladder you should do cholecystectomy; because it might convert to malignancy or tumor.

Cystic duct:

- Its 4 cm in length comes from the neck & joins the common hepatic duct (also 4 cm in length) to Form the common bile duct.
- it was blocked it will obstruct the duct so all the bile will go back to blood (Jaundice will occur) ; treated by ERCP .



Arterial supply:

- Cystic artery branch of Rt. Hepatic artery.

Venous drainage :

- Cystic vein end in right portal vein.

Small branches (arteries and veins run between liver and gall bladder).

Lymphatic drainage :

1. Terminate at celiac nodes
2. Cystic node at neck of GB
 - a. Actually a hepatic node
 - b. Lies at junction of cystic & common hepatic ducts
3. Other lymph vessels also drain into hepatic nodes

What the doctor said here: drain into porta hepatic lymph nodes then to celiac lymph nodes around the origin of celiac artery .

Nerve supply :

- Sympathetic and parasympathetic from celiac plexus
- Parasympathetic ---- vagus nerve
- Hormone -> cholecystokinin -> duodenum ((this point is written in the slides but the doctor didn't mention it)).

Sphincter of oddi: is a muscular valve that controls the flow of digestive juices (bile and pancreatic juice) through the ampulla of Vater into the second part of the duodenum.

Ampulla of vater: major duodenal papilla inside the duodenum.

Hepatopancreatic ampulla: when the pancreatic duct & the common bile duct join each other before the medial wall of duodenum.