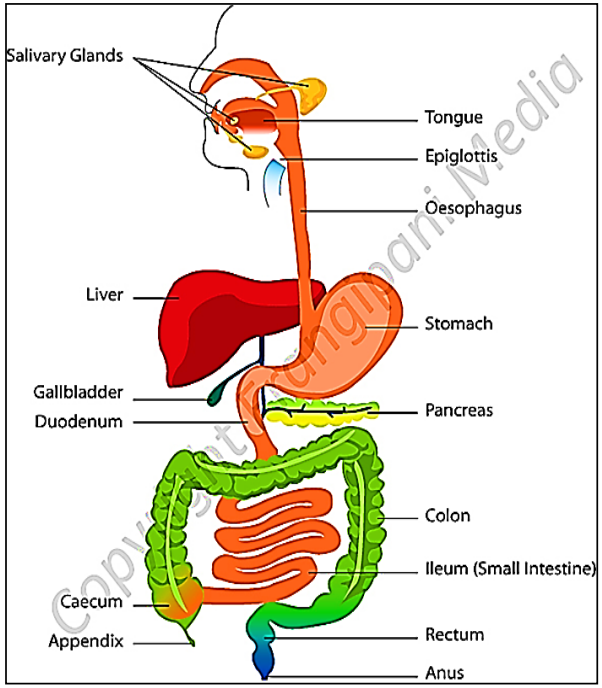
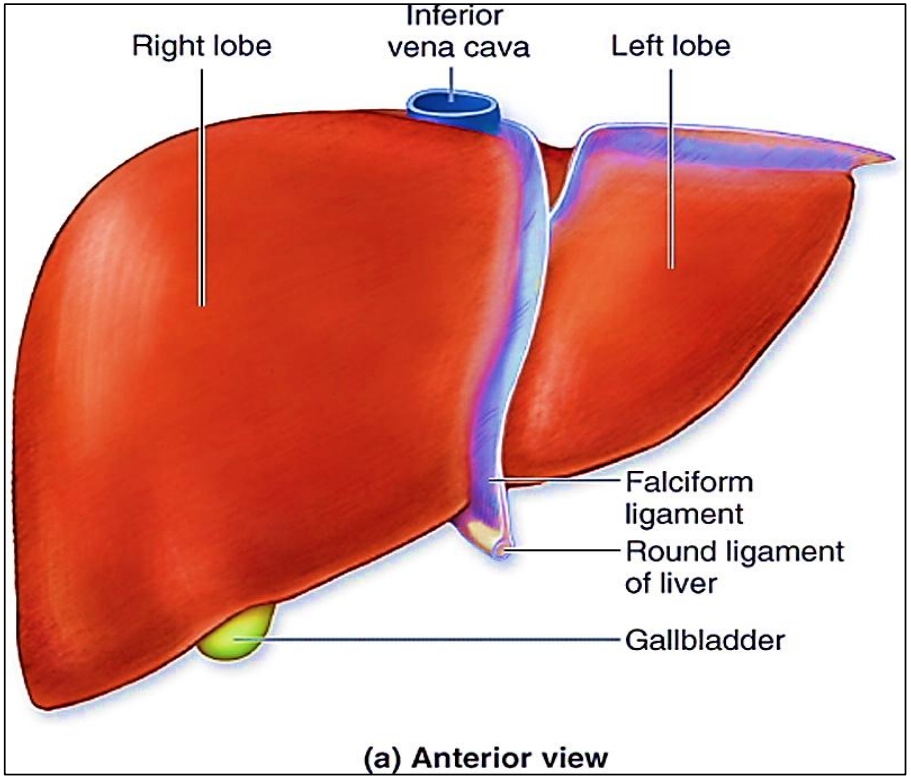
The digestive system IV

Organs associated with digestive tract

- Liver
- Pancreas
- Gall bladder



Liver


Right lobe
Inferior vena cava
Left lobe
Falciform ligament
Round ligament of liver
Gallbladder
(a) Anterior view

Liver

The Liver is the largest gland in the body (1.5 Kg)

Mixed endocrine & exocrine gland

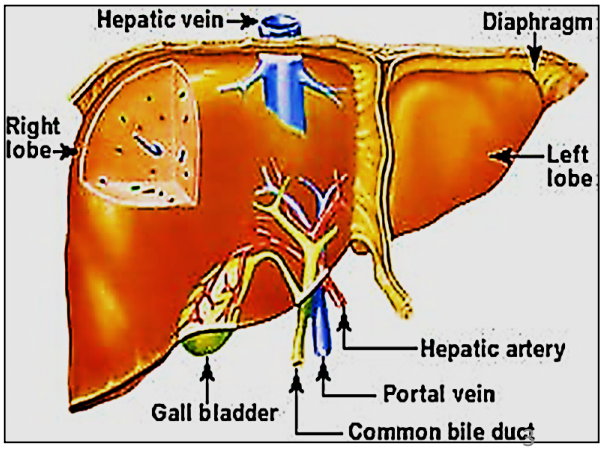
1. Processing & metabolism of nutrients

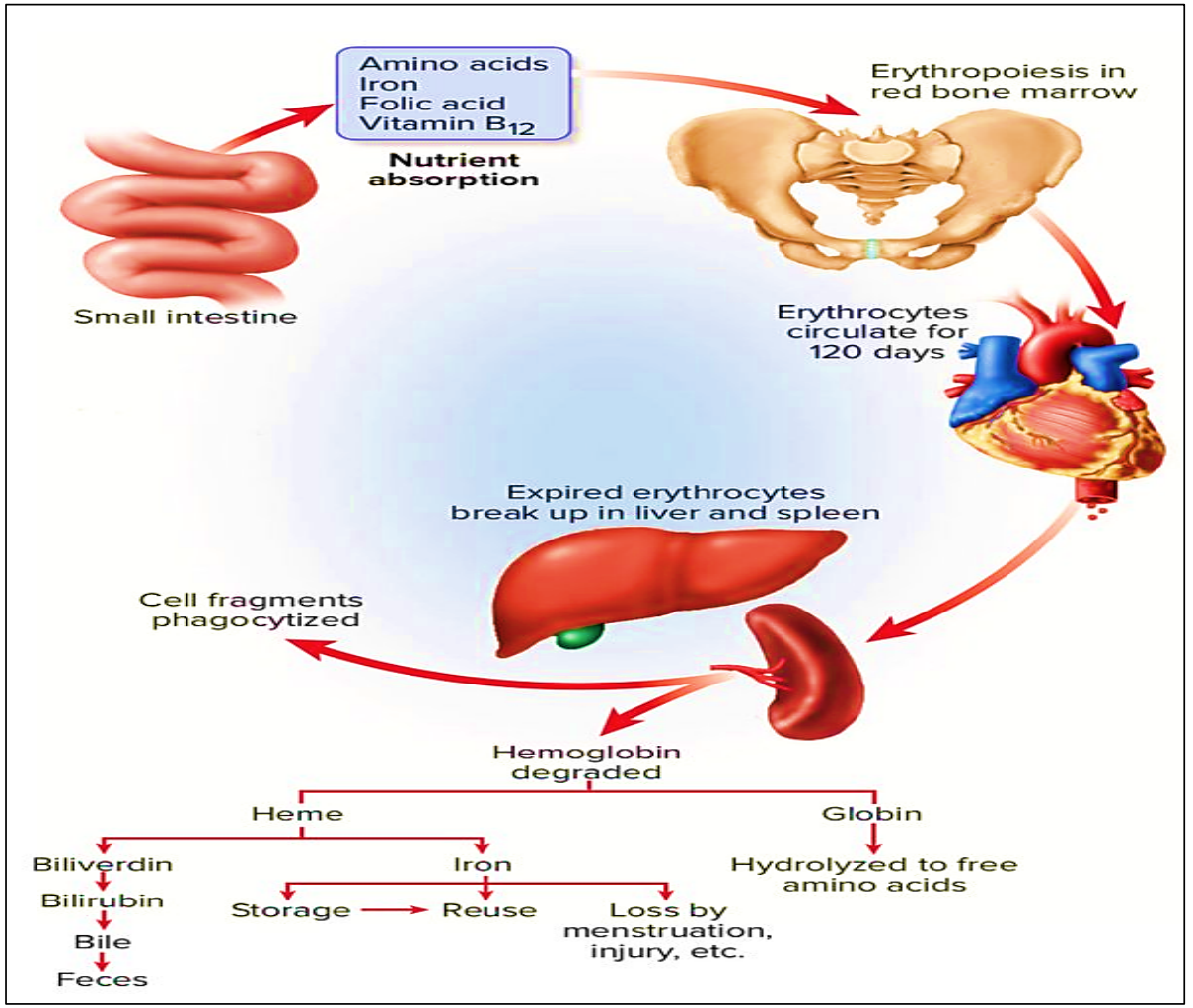
2. Detoxification: modifying potentially dangerous chemicals & removal of old RBCs

3. Endocrine : synthesize and secrete plasma proteins (albumin, prothrombin, fibrinogen), glucose &lipids into blood via blood sinusoids

4. Exocrine: synthesize and secretion of **bile**

5- Storage of: glucose, fat , vit. A, B, D, K




Amino acids
Iron
Folic acid
Vitamin B_{12}
Nutrient absorption
Small intestine
Erythropoiesis in red bone marrow
Erythrocytes circulate for 120 days
Expired erythrocytes break up in liver and spleen
Cell fragments phagocytized
Hemoglobin degraded
Heme
Globin
Biliverdin
Bilirubin
Bile
Feces
Iron
Storage
Reuse
Loss by menstruation, injury, etc.
Hydrolyzed to free amino acids

Blood supply of liver

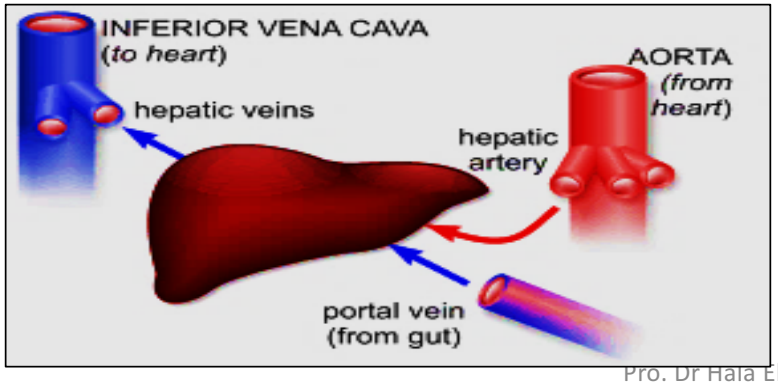
1- Portal vein: 70 - 80%

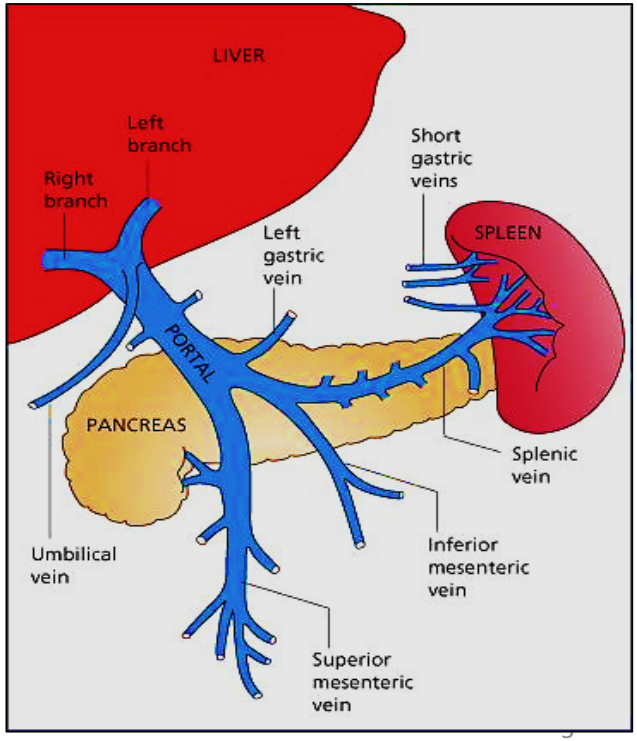
- Main drainage of blood from GIT, spleen, pancreas
- Brings **nutrient rich**, **toxin loaded**, **oxygen poor** blood

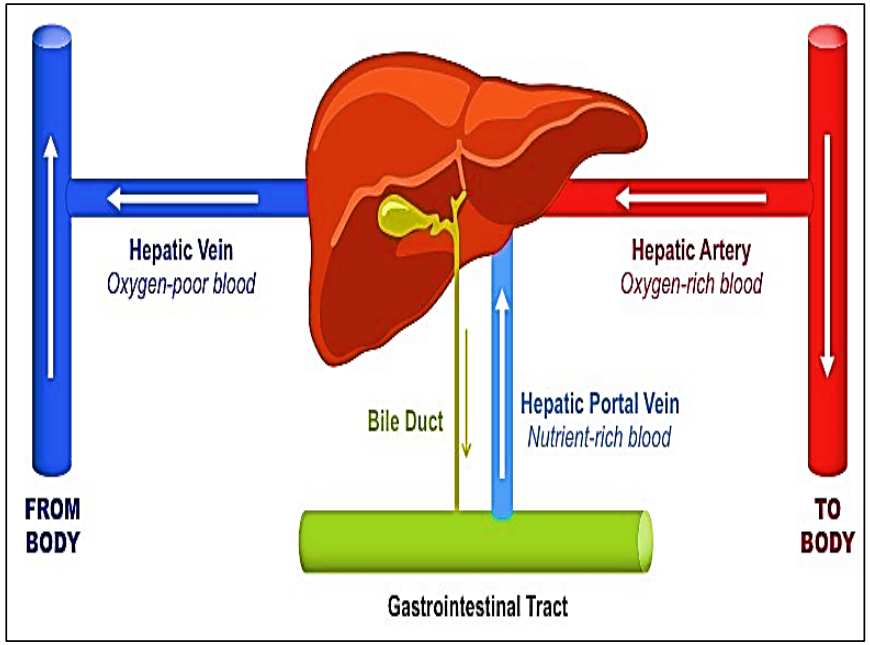
2- Hepatic artery: 30 – 20%

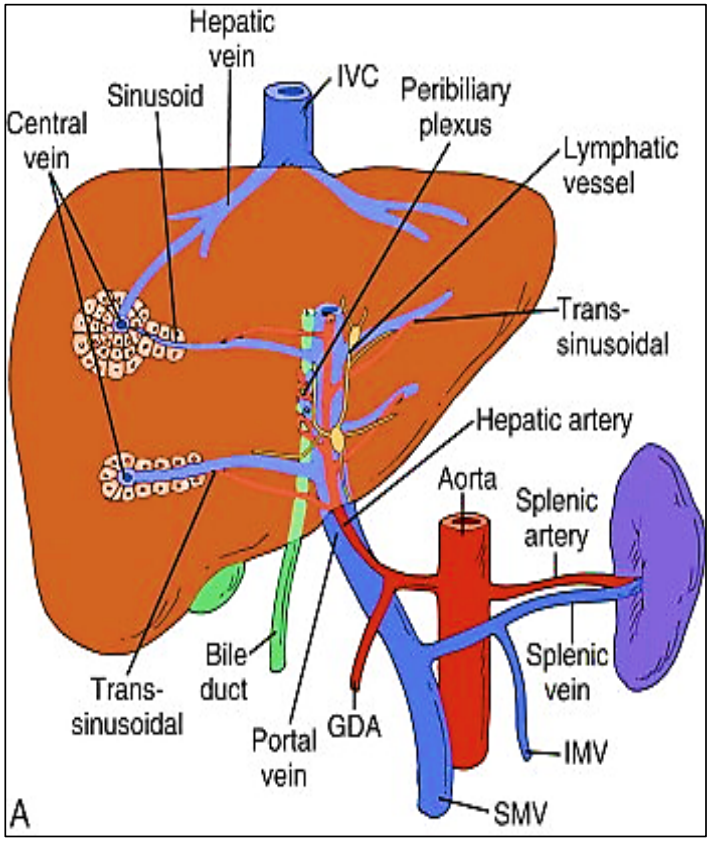
Aorta→ hepatic artery

- Brings **oxygen rich** blood to liver





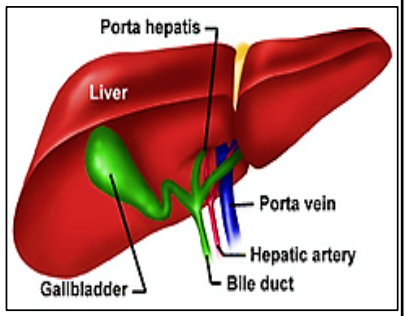




Blood supply of the liver

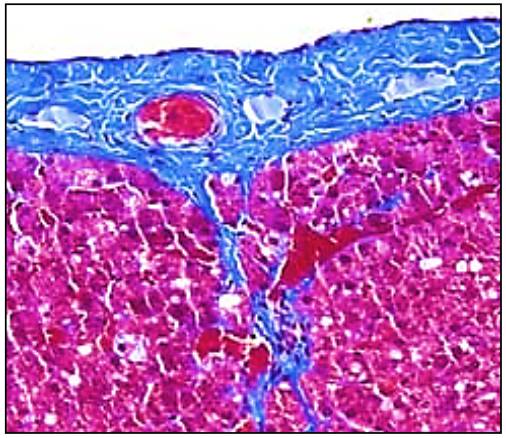
Structure of liver

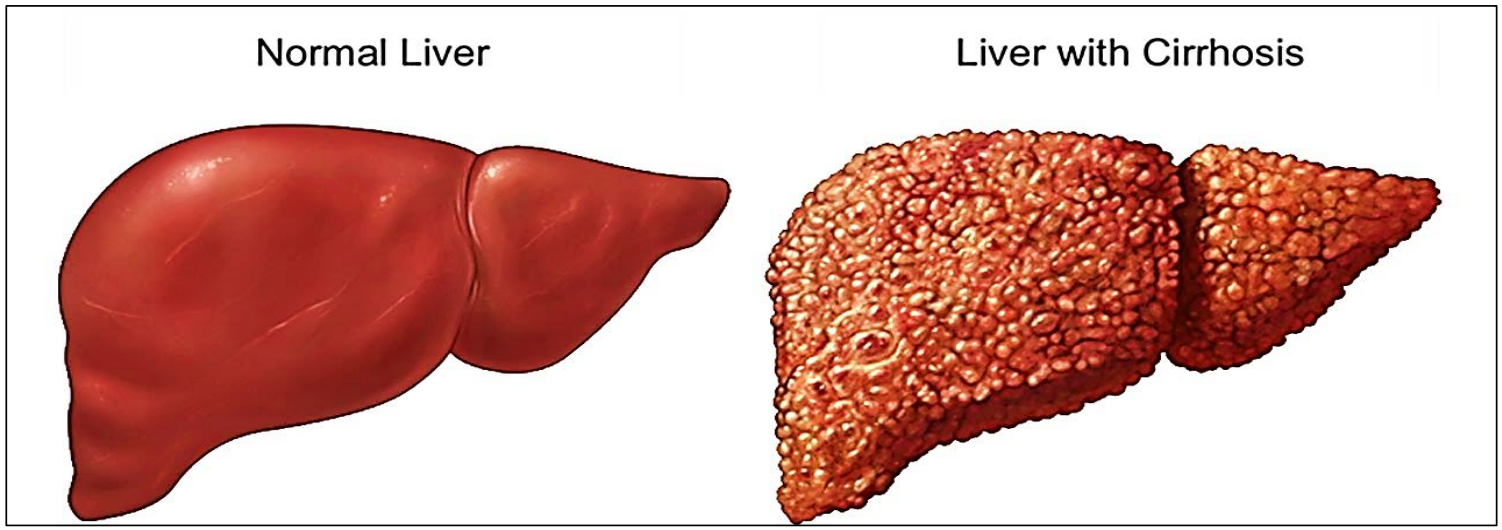
Stroma & parenchyma

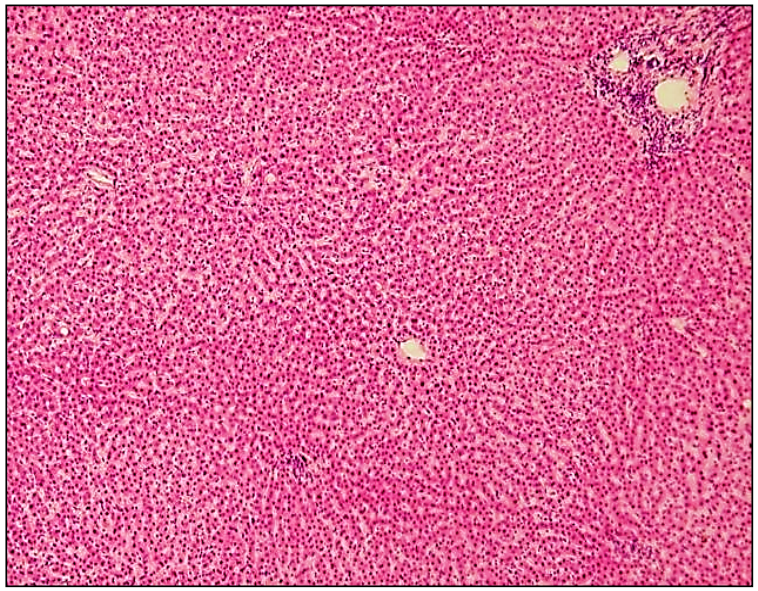


A) Stroma: capsule → septa → reticular fibers

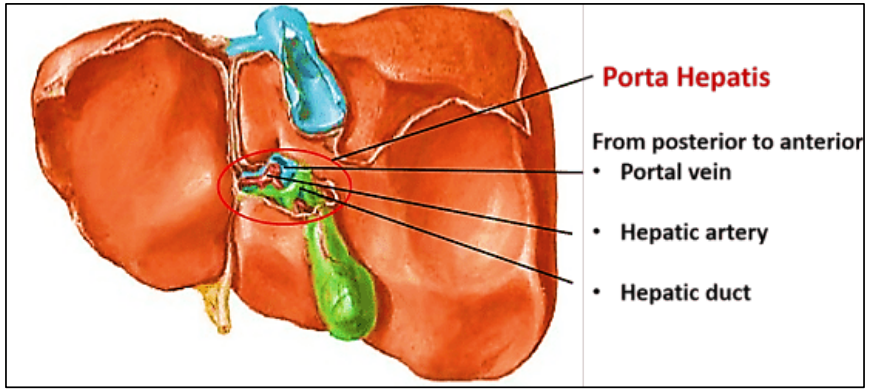
- **Capsule of Glisson:** thin fibrous C.T. sheet, covers the liver. Thick at hilum to form **prota hepatis** which gives rise to C.T. septa divide the liver into lobes and lobules
- **septa**: surround lobules. **Thick and easy to identify in pig's liver.. Lobulation are not clear in humans unless??**
- **Portal tracts**: triangular masses of C.T. at angles between hepatic lobules
- **Reticular fibers**: delicate network surround and support liver cells

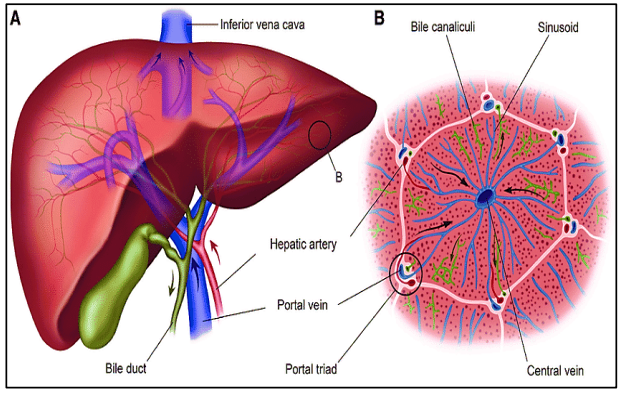


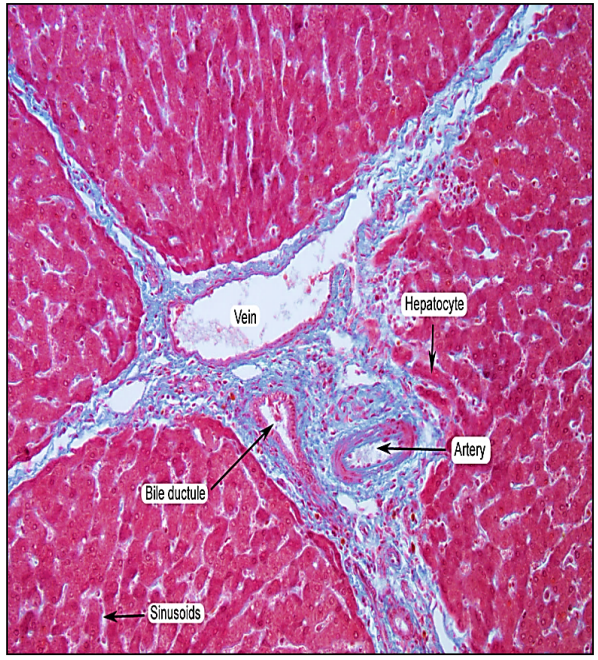

Normal Liver
Liver with Cirrhosis




HUG

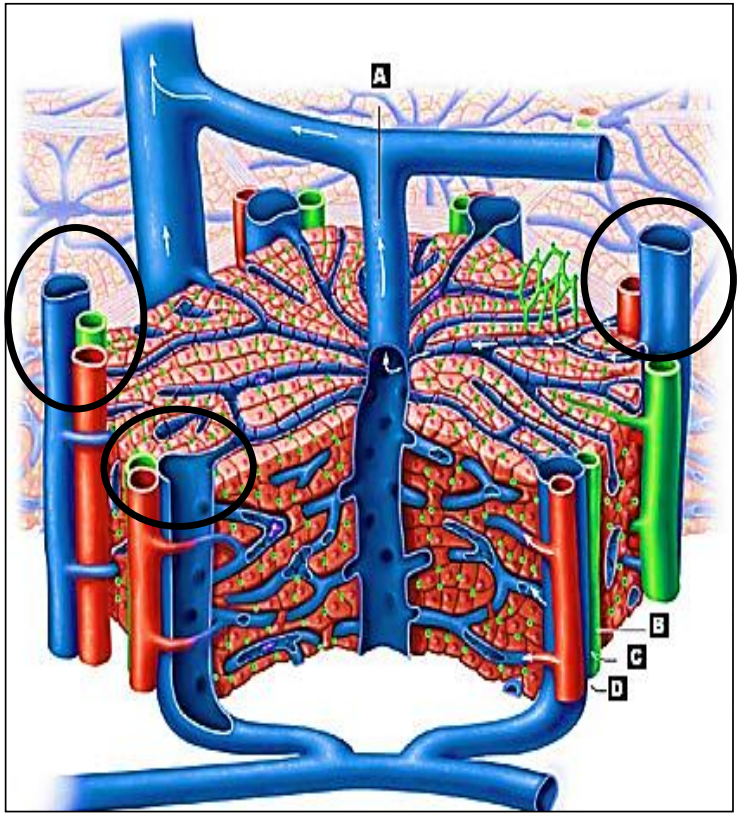


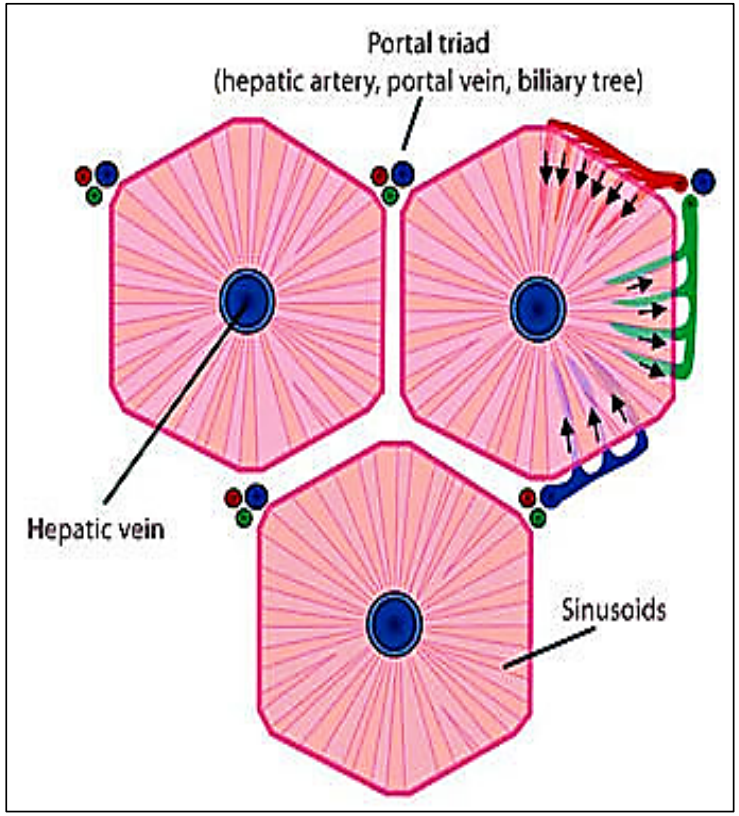




Septa are thick & the lobulation is clear in pig's liver (similar lobulation only seen in human's in liver cirrhosis)

Portal tracts of the liver

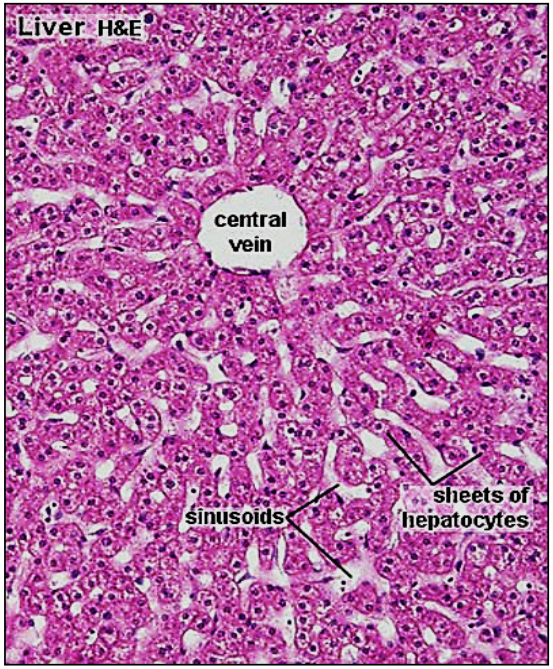


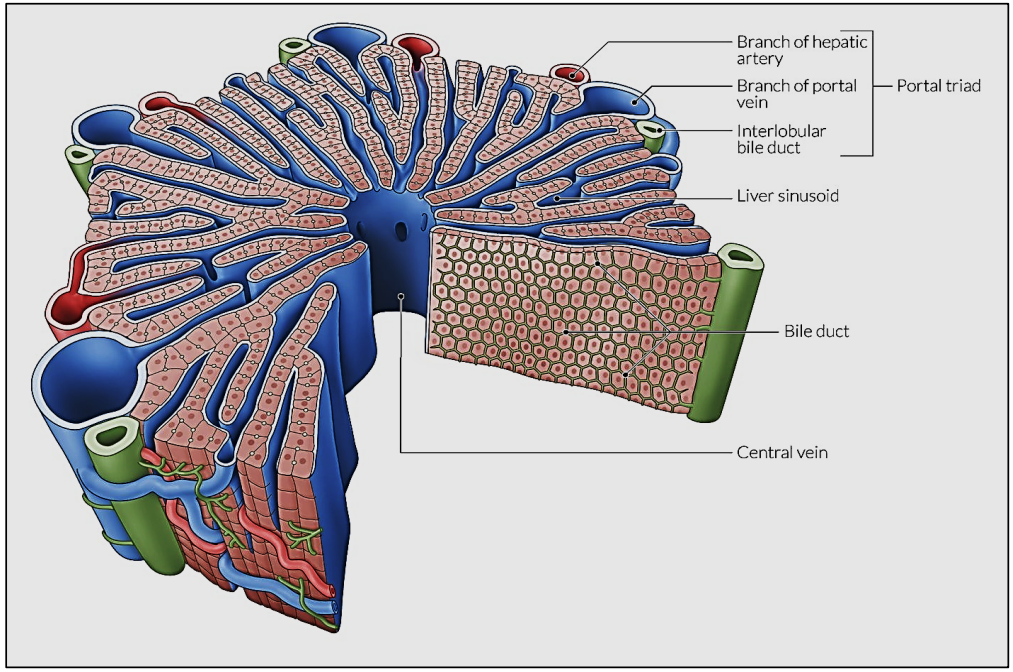


B) Parenchyma : Within each lobule the liver cells arranged in **interconnected plates** (cords) around the central vein

- The plates are two or more rows of cells width

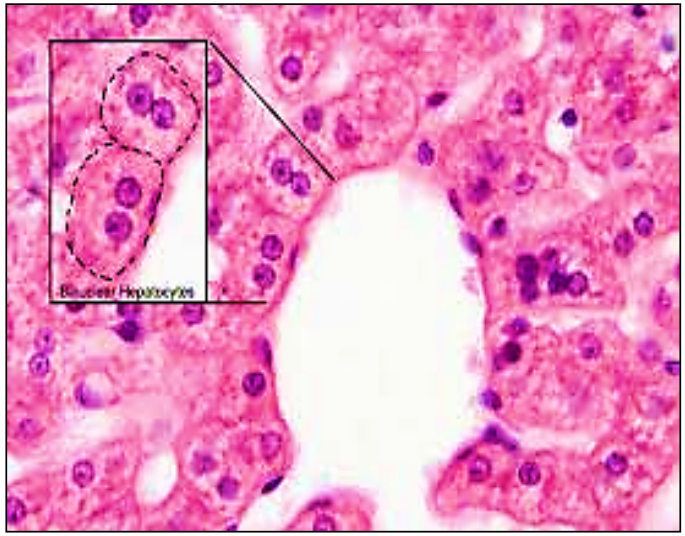
- The spaces between the plates called **liver sinusoids**. They drain **blood** into central vein

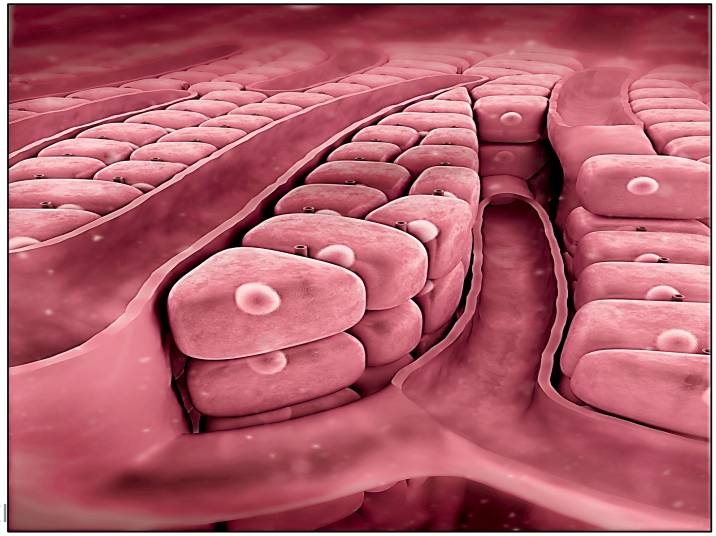




Hepatocytes

- **LM:** large polygonal cells with 1 or 2 nuclei (bi-nucleated) so that they can more efficiently do all the required jobs. (The muscle cells have multiple nuclei)
- Nuclei: central, rounded, e prominent nucleoli
- Acidophilic cytoplasm (↑↑in mitochondria & SER), it also appear vacuolated due to dissolved glycogen and fat





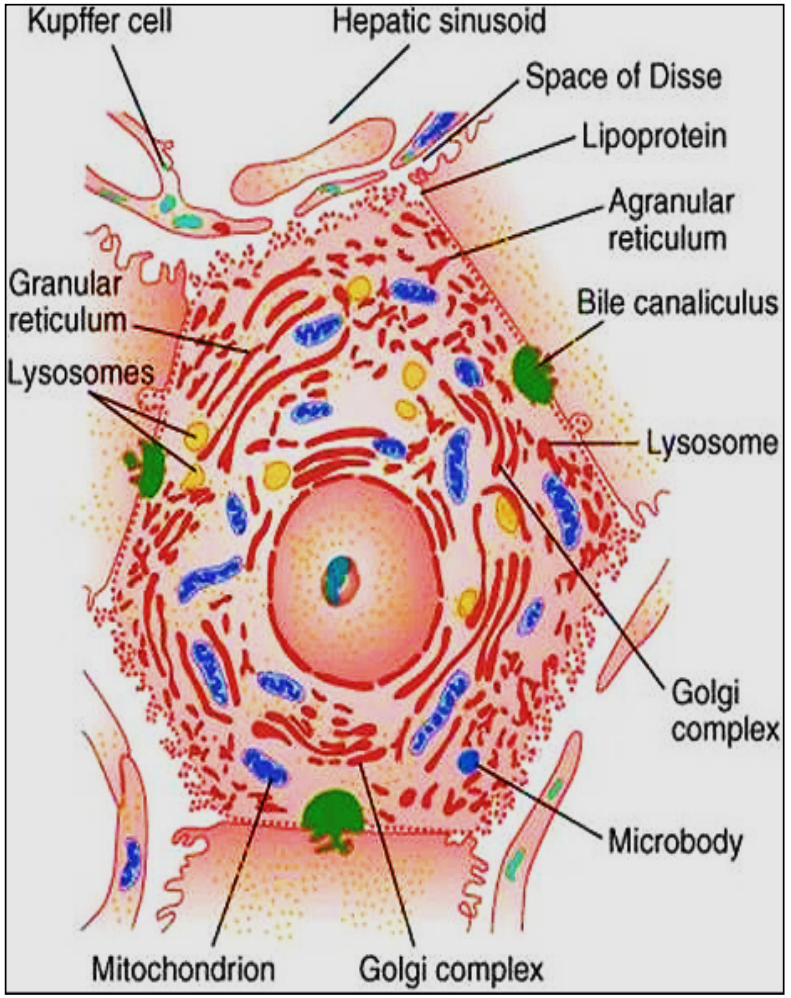
E/M:

Cytoplasm is very rich in organelles & inclusions

- Organelles:
  mitochondria, rER, ribosome, sER (detoxification, bile, glycogen), Golgi complex, lysosomes & peroxisomes.

- Inclusions:
  glycogen granules & fat droplets

- Lipofuscin pigment (aged cells e.g cardiac ms. cells & nerve cells)



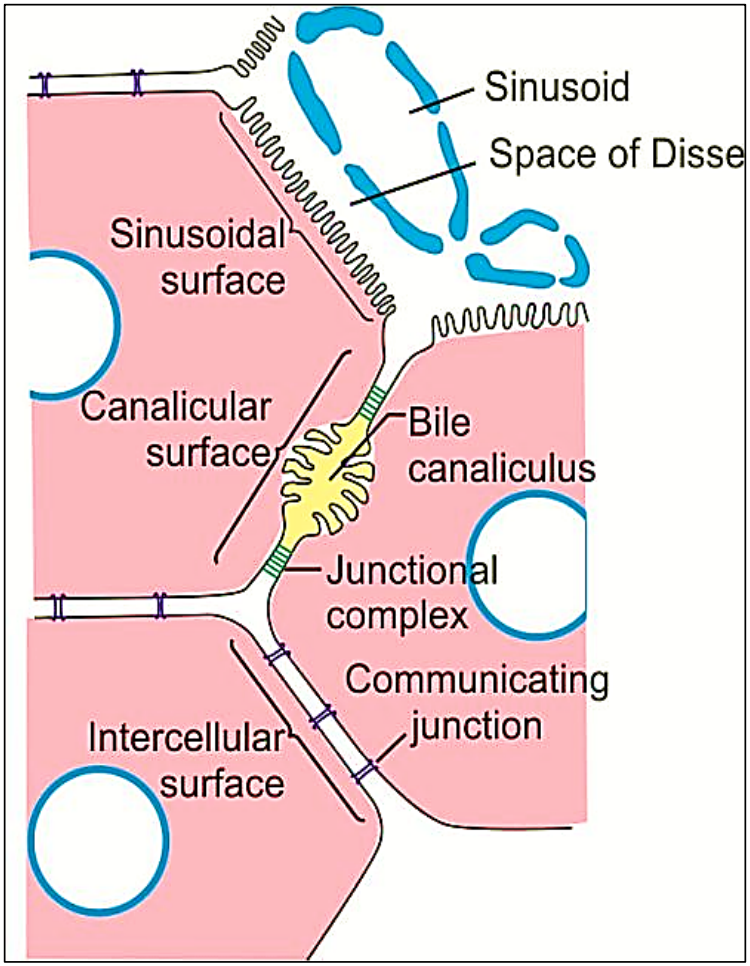
The hepatocytes has two functional surfaces:

1- the vascular side:

Has long microvilli and faces the perisinusoidal space (space of Disse)

2- The intercellular side:

Has short microvilli projecting into the bile canaliculi and is bounded by tight junctions and desmosomes

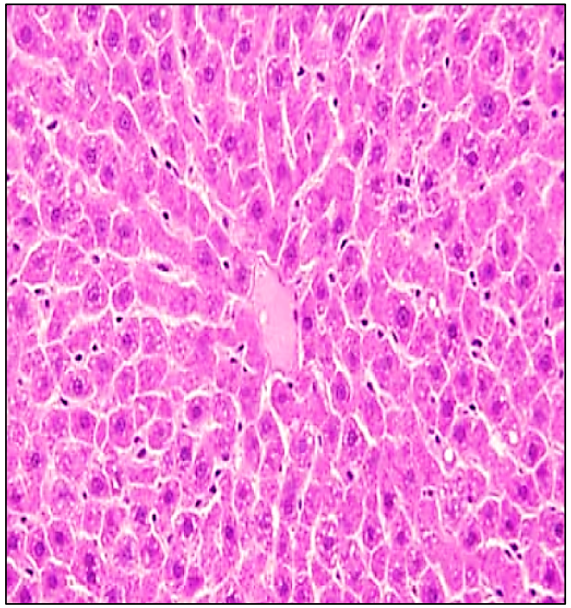


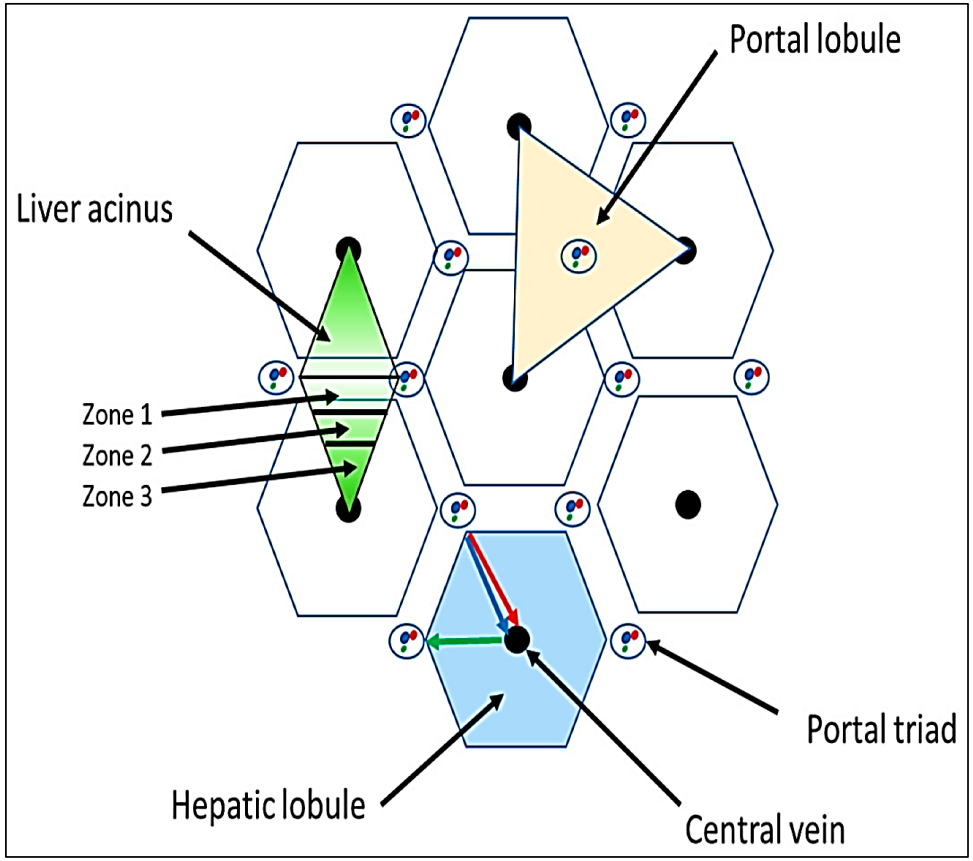
Liver cells (hepatocytes) up to the Function they perform are arranged into either :

1- Classic hepatic lobule

2- Portal lobule

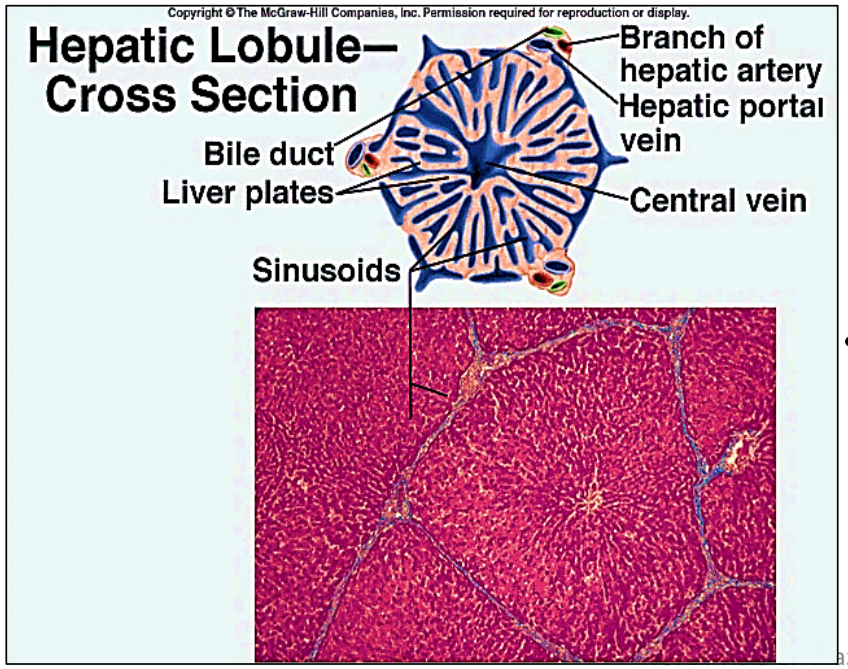
3- Liver acinus

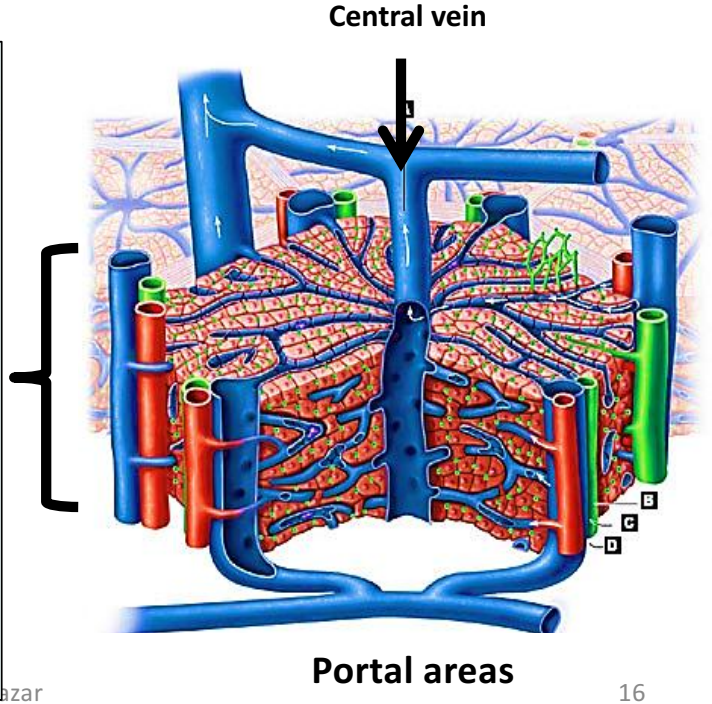




1- Classic hepatic lobule

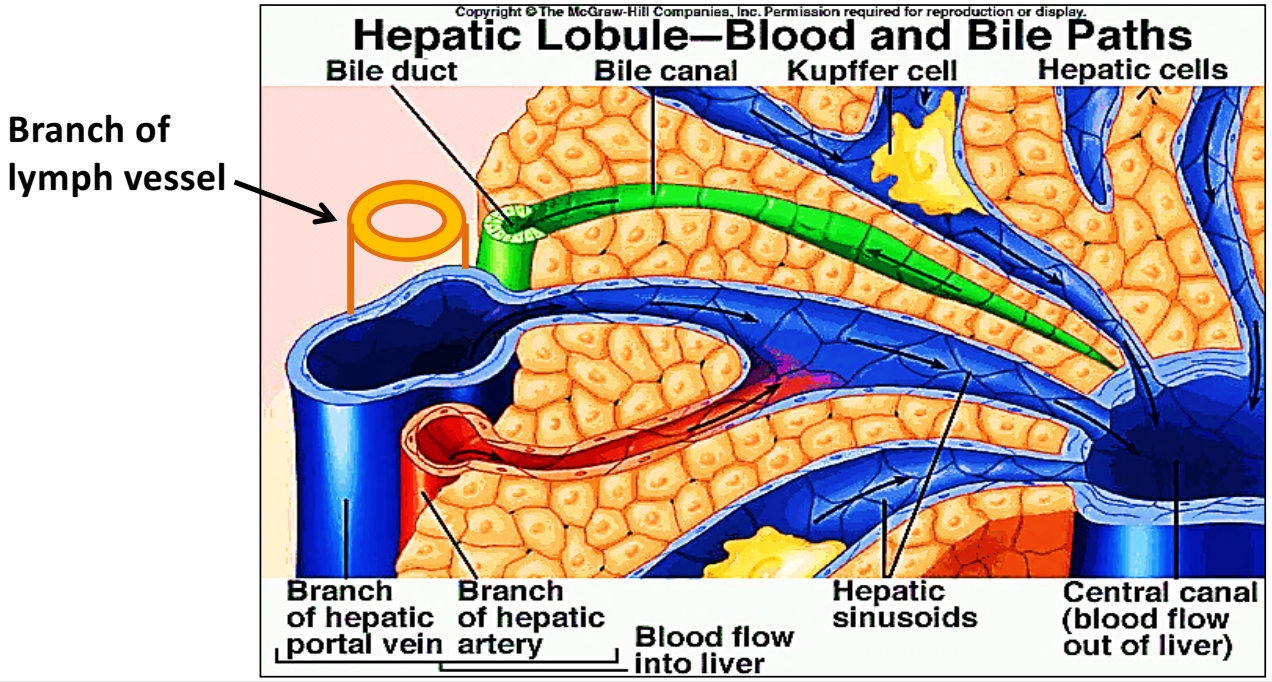
- Hexagonal or polygonal in shape (cross section)
- Surrounded with thick C.T. septa in pig's liver
- Each lobule has 3-6 portal areas (**portal triads**) at its periphery, and **central vein** (CV) at its center



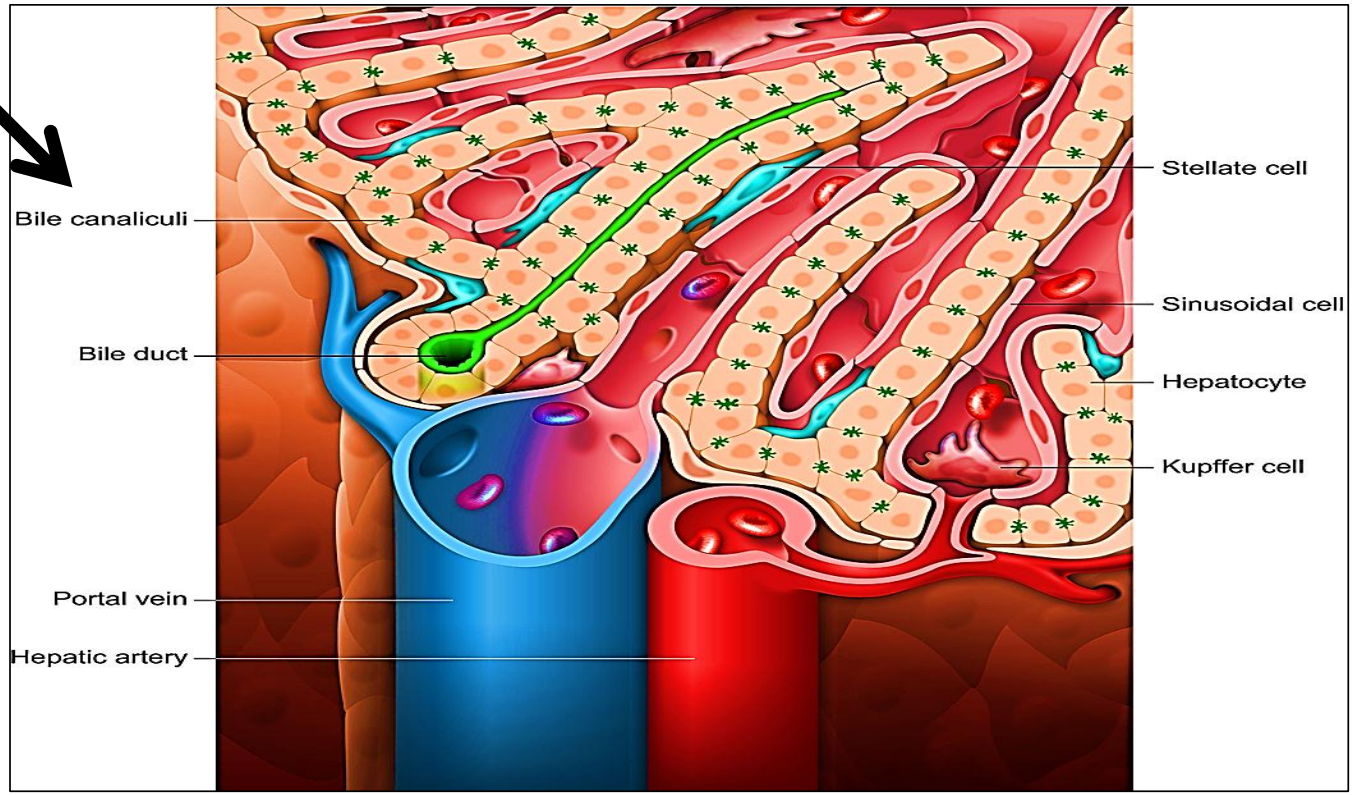


Portal areas (tracts): Each contains :

1. A branch of portal vein: widest with thin wall
2. A branch of hepatic artery: rounded with narrow lumen
3. A branch of bile duct: lined with cubical epithelium
4. Lymph vessel



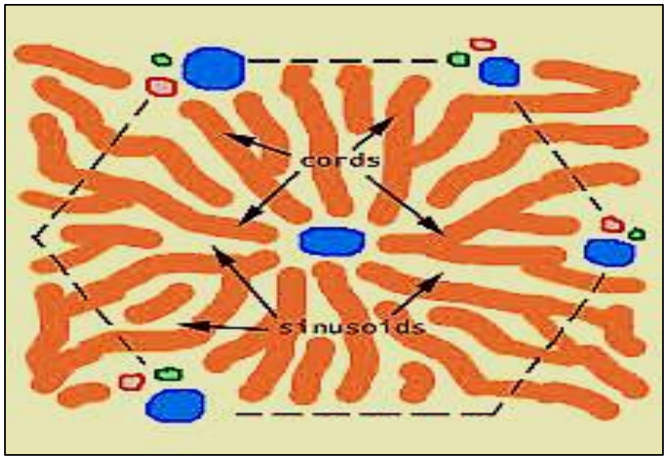
- **Bile canaliculi** present within the plates in-between adjacent hepatocytes, they drain **bile** into the bile ducts in portal areas

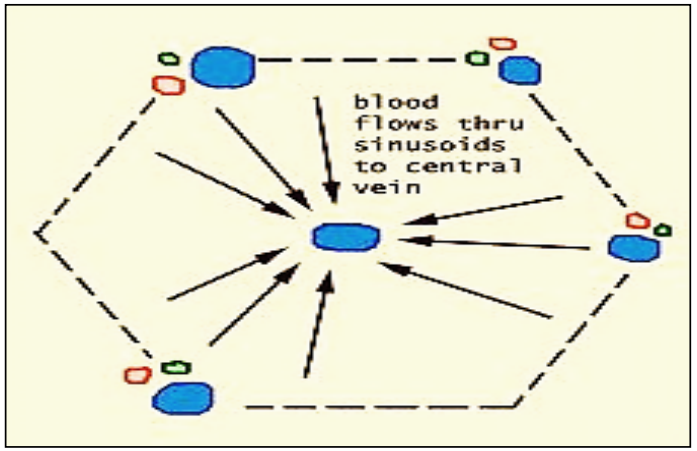


Liver sinusoids and space of Disse

A- Liver sinusoids

- Minute blood channels present **between** plates /cords of liver cells (hepatocytes never exposed to fully oxygenated blood)
- Transport blood from branches of portal vein & hepatic artery in portal area toward central veins (mixed blood)

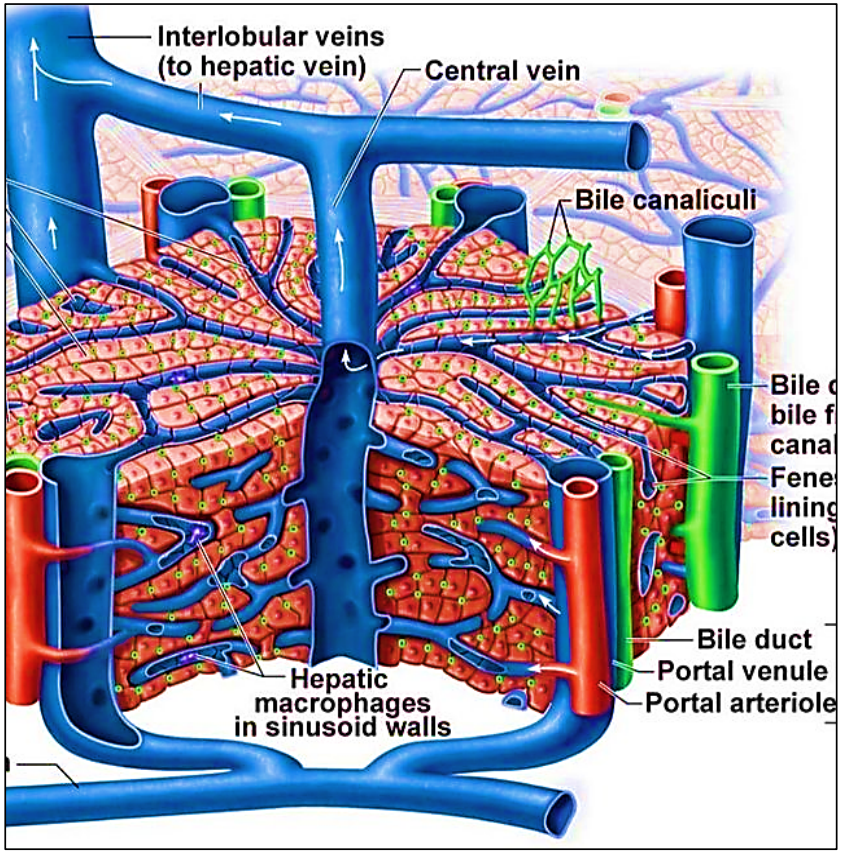




The flow of blood is centripetal

Drainage of liver sinusoids

- Liver sinusoids
  ↓
- Central vein
  ↓
- Hepatic vein
  ↓
- Inferior vena cava
  ↓
- Right atrium of heart



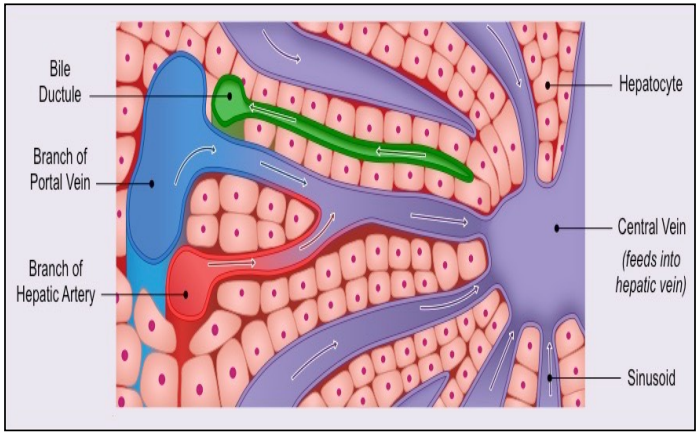
- Lining of blood sinusoids consists of:

✓ fenestrated endothelial cells has no diaphragm

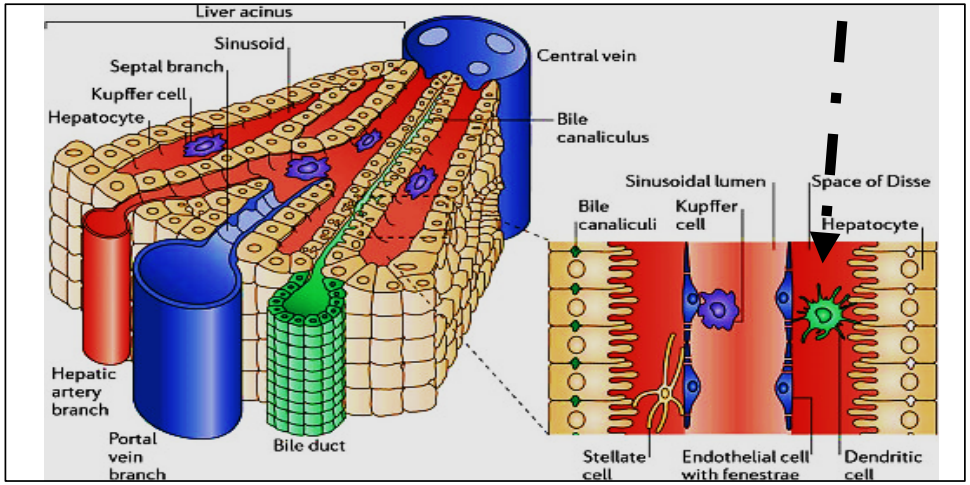
✓ Discontinuous basal lamina

✓ Kupffer cells

✓ Pit cells

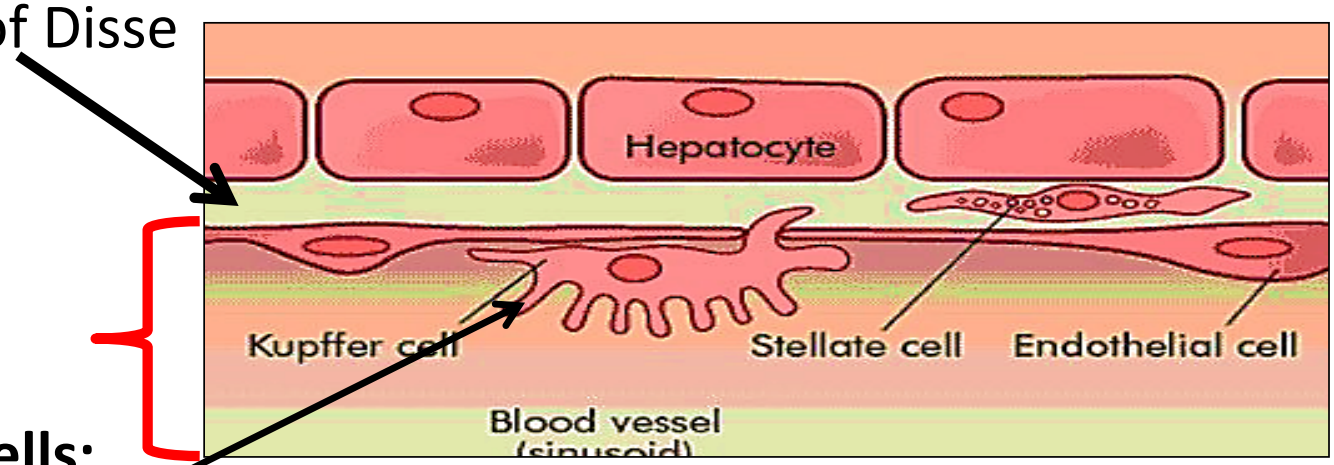


- The wall of the sinusoids is separated from the hepatocytes by a space called **space of Disse**



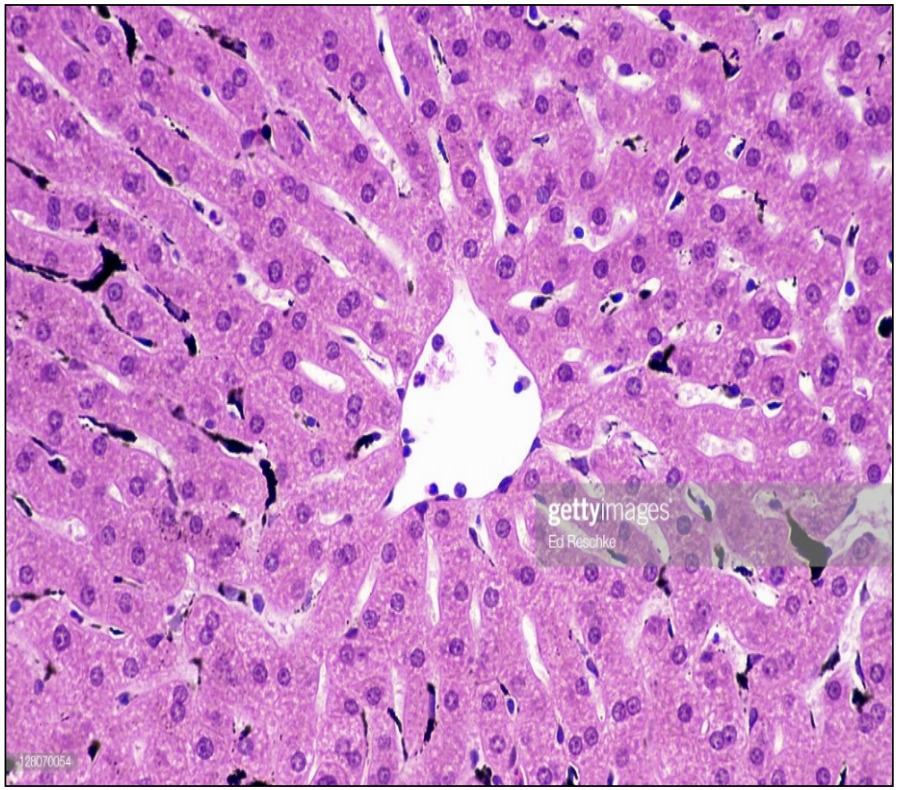
Endothelial cells lining of liver sinusoids:

- Flat cells, contain many holes (fenestrae) to allow free passage of molecules between blood and peri-sinusoidal space of Disse



Kupffer cells:

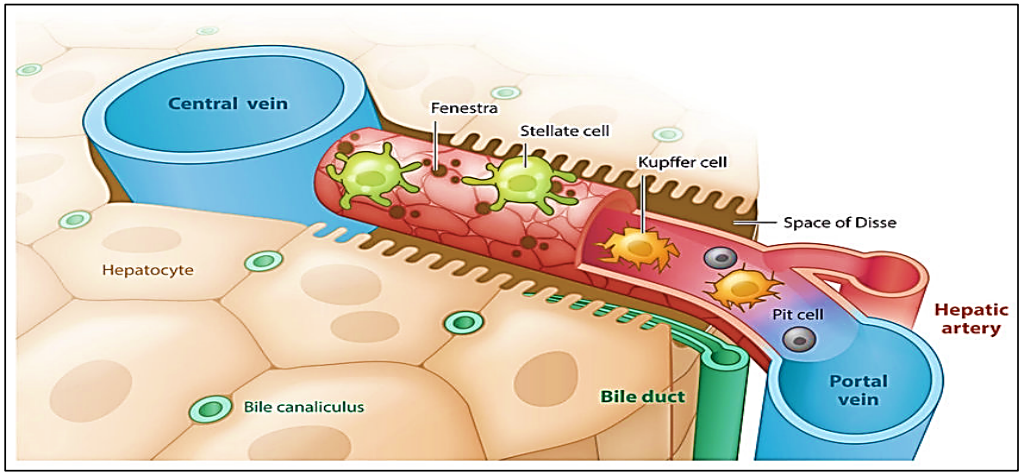
- Macrophages (Fixed) , large cells with large oval nucleus and numerous cytoplasmic processes. Seen in **the blood sinusoids** and in between endothelial cells. Their cytoplasm contain lysosomes, pinocytotic and phagocytic vesicles.



Kupffer cells seen in liver lobules as black cells with special stains (India ink).
Found more near <u>portal areas</u>

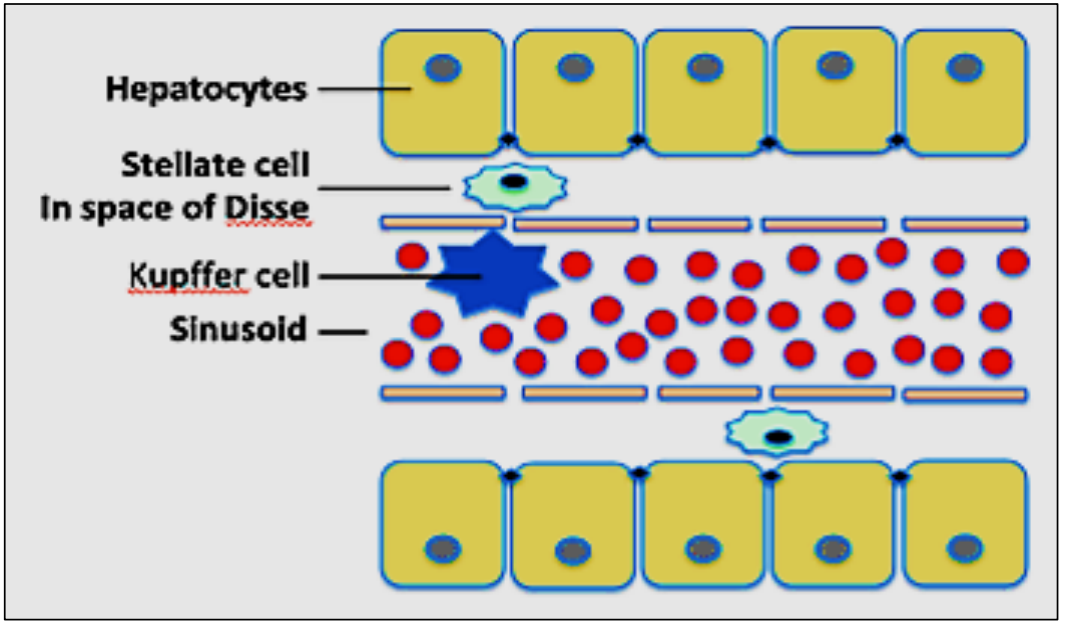
- **<u>Pit cells:</u>** are liver-specific, short lived natural killer (NK) cells also called large granular lymphocytes (LGL). localized inside the lumen of the sinusoid, closely adhering to the endothelial cells and Kupffer cells, and often extending well-developed pseudopodia suggestive of migration along the sinusoidal wall. Multivesicular dense granules are frequently found in the cytoplasm of pit cells which exert antitumor functions by exocytosis of perforin/granzyme-containing granules, which cause death of target cells through receptor-mediated apoptosis , and production of various cytokines that augment the activities of other immune cells.

Safeguard liver cells against hepatitis virus infection or malignancy transformation



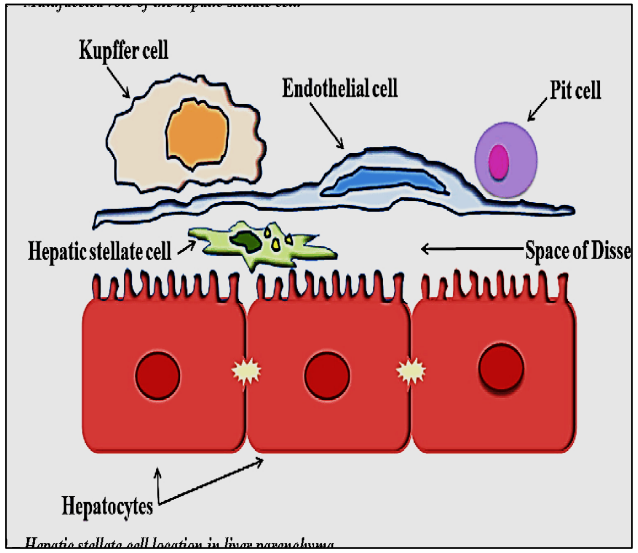
Space of Disse

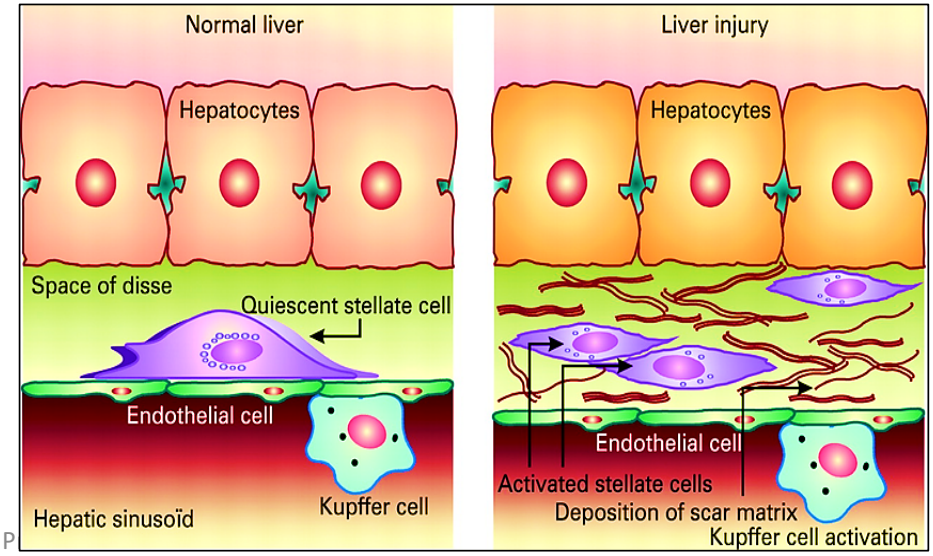
- **EM**: Narrow space separate between the endothelial cells lining of the sinusoids and hepatocytes
- Through out the space exchange of metabolites between blood and hepatocytes takes place



Space of Disse contains:

- Fat storing cells **(Ito cells, stellate cells).** They store Vit. A in small lipid droplets in their cytoplasm, and maintain the extracellular matrix of the space
- Long microvilli of hepatocytes project in the space (↑)
- Blood plasma
- Reticular fibers that support the wall of the sinusoids

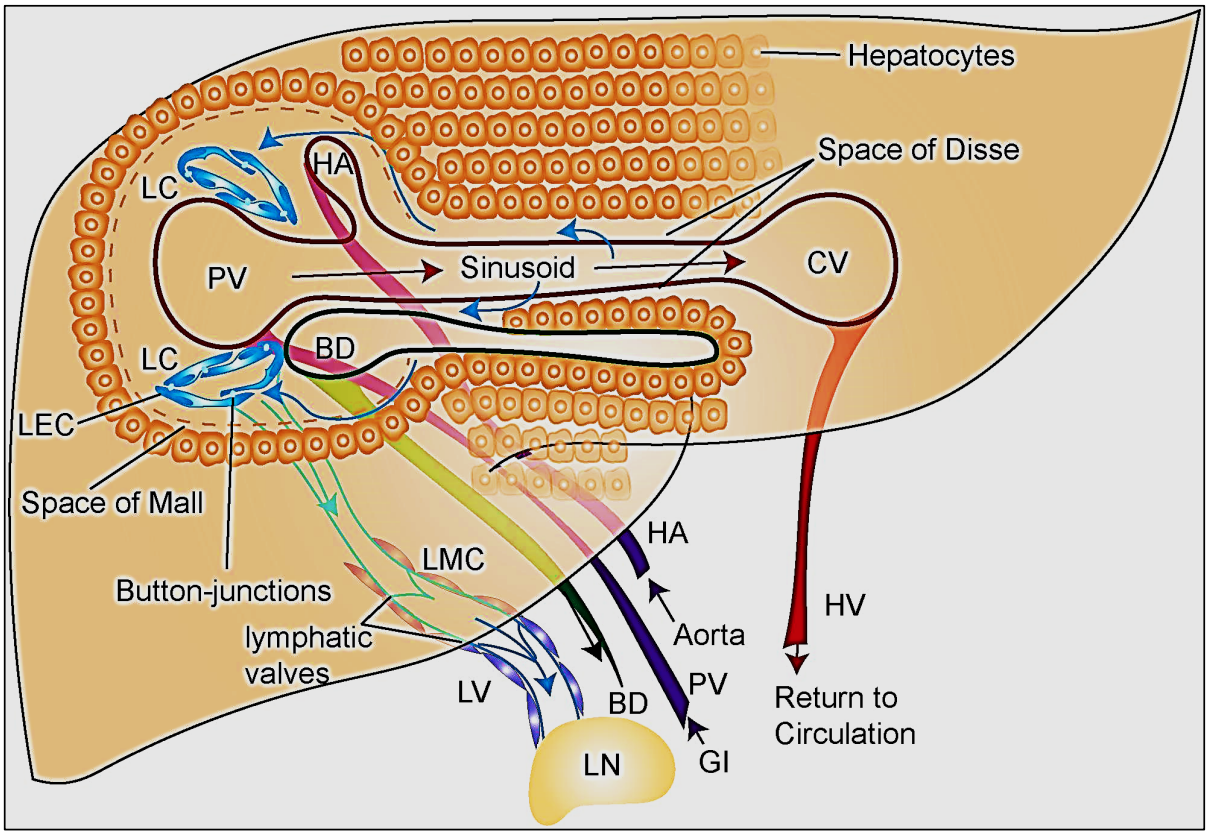




Ito cells:

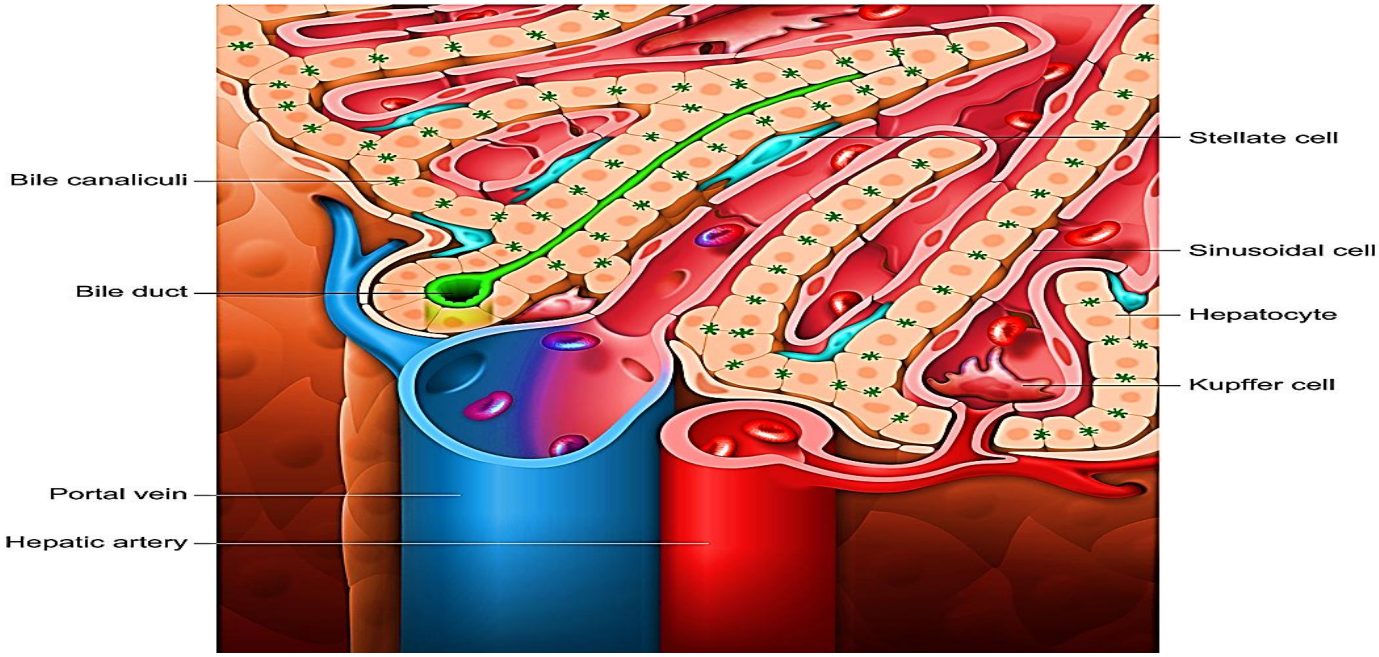
- Ito cells (perisinusoidal fat-storing cells, stellate cells, lipocytes) of the liver are located in the space of Disse.
- They are the main place of vitamin A storage in characteristic lipid droplets.
- In chronic inflammation of the liver on (e.g. viral hepatitis & Bilharziasis) they differentiates into myofibroblasts and deposit large amounts of collagen in the space of Disse causing liver fibrosis → ↑ portal hypertension → esophageal varices (famous singer death)

- The peri-sinusoidal spaces of Disse is the beginning of the lymphatic system of the liver

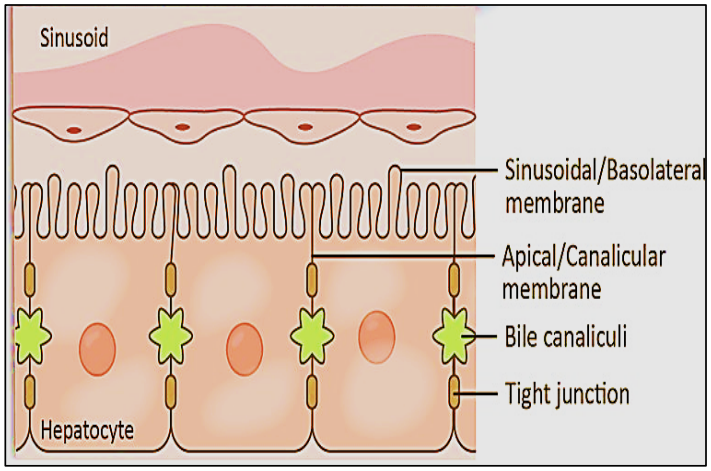


Bile canaliculi and bile ducts

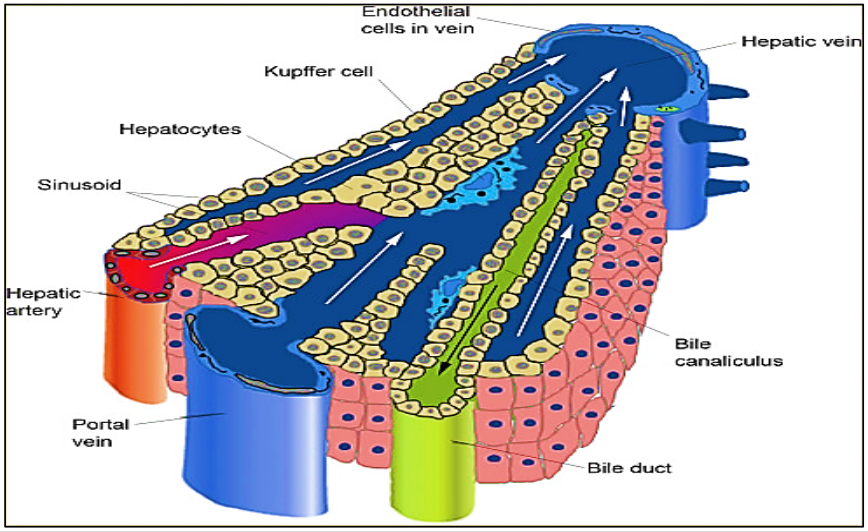
- Minute canals present **within** hepatic plates, in-between adjacent hepatocytes.
- They are bounded by the cell membrane of adjacent hepatocytes



- Small microvilli project from hepatocytes into the canaliculi and tight junctions hold the cell membranes of hepatocytes around the lumen of the canaliculus (hepatocyte polarization)

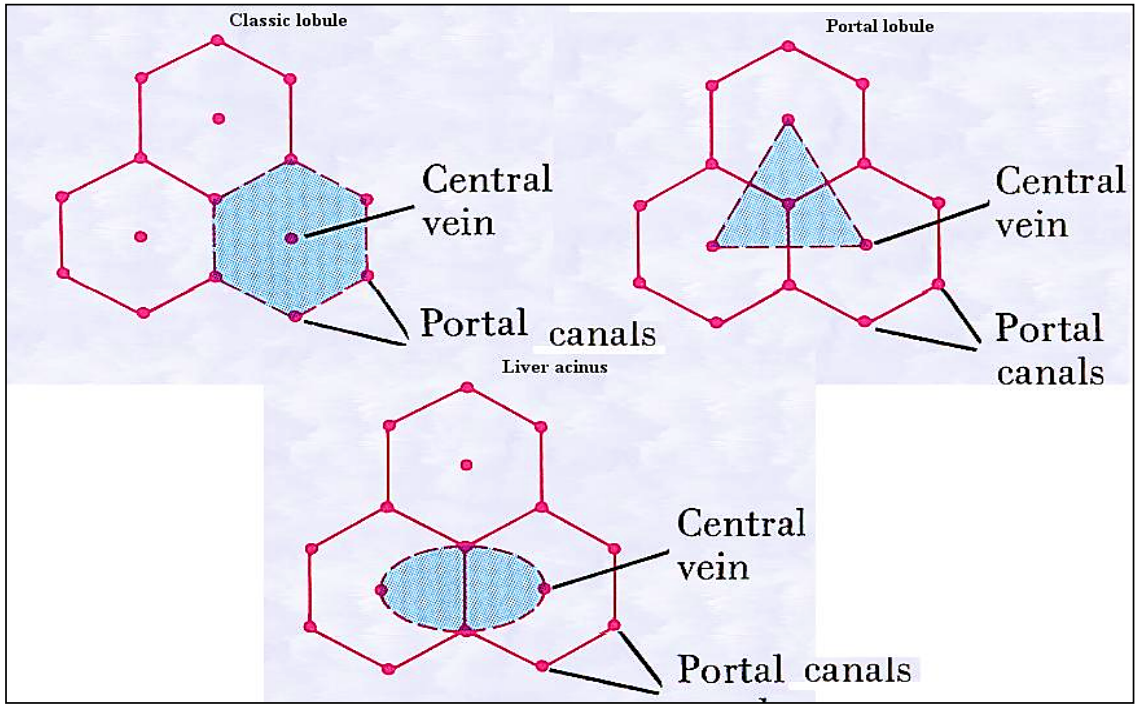


- Bile secreted by hepatocytes drains **out** of the lobule.



Organization of liver parenchyma/function:

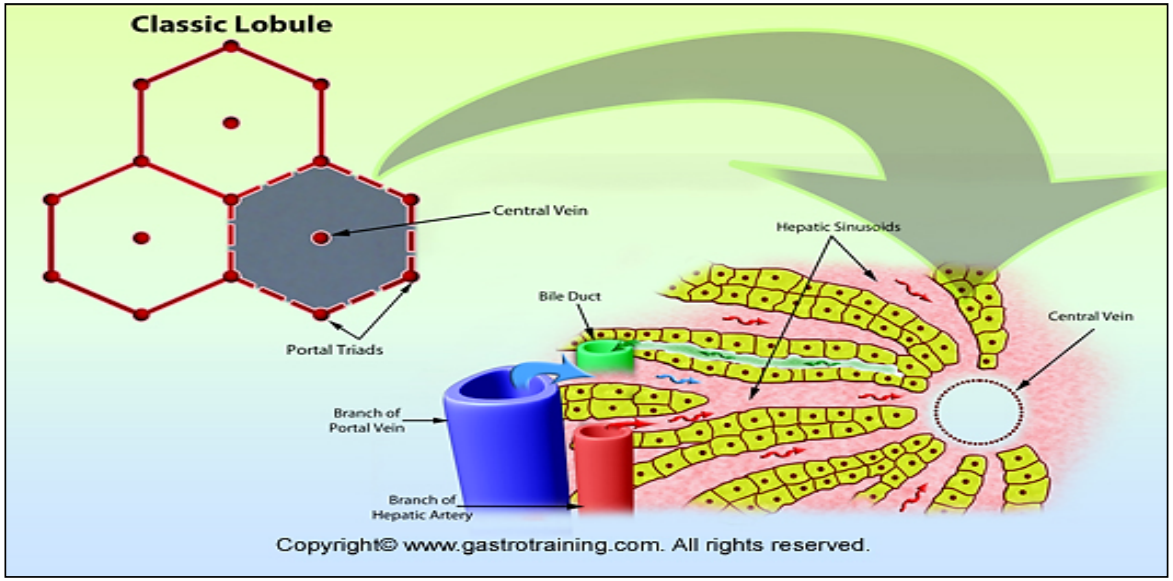
- Classic hepatic lobule → endocrine function
- Portal lobule → exocrine function
- Liver acinus → oxygen/ nutrients supply



Classic hepatic lobule:

Hexagonal in shape with **central vein** in the center, surrounded with 3 – 6 portal tracts at the its corners

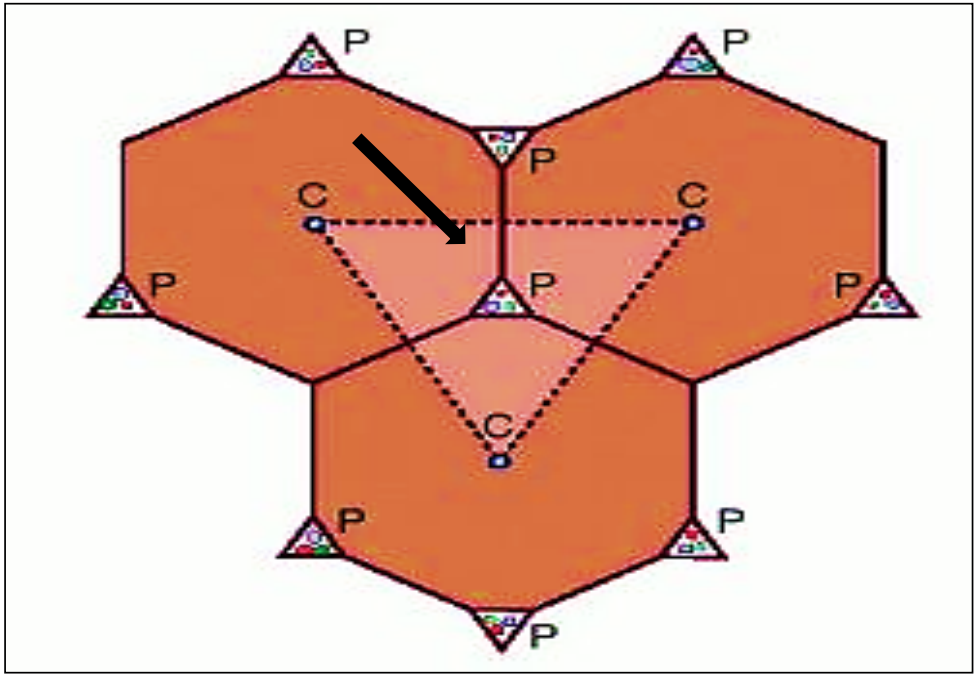
Proteins, glucose secreted by liver cells released directedly into blood sinusoids



Portal lobule:

- Triangular in shape, centered on **portal area (tract)** apices of the triangle are formed by 3 central veins.

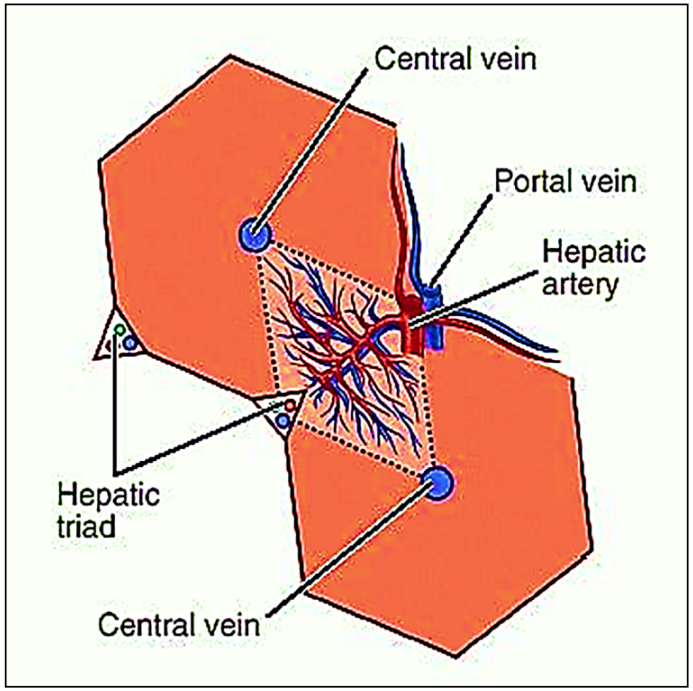
- Hepatocytes of this lobule drain their bile to a bile duct in the center of the triangle



Liver acinus: is the most **important classification**

Diamond shaped mass of liver cells surrounding a central vascular core

It is divided into 3 zones:



Zone 1:

- Close to the vascular core
- Get the most oxygen and nutrients

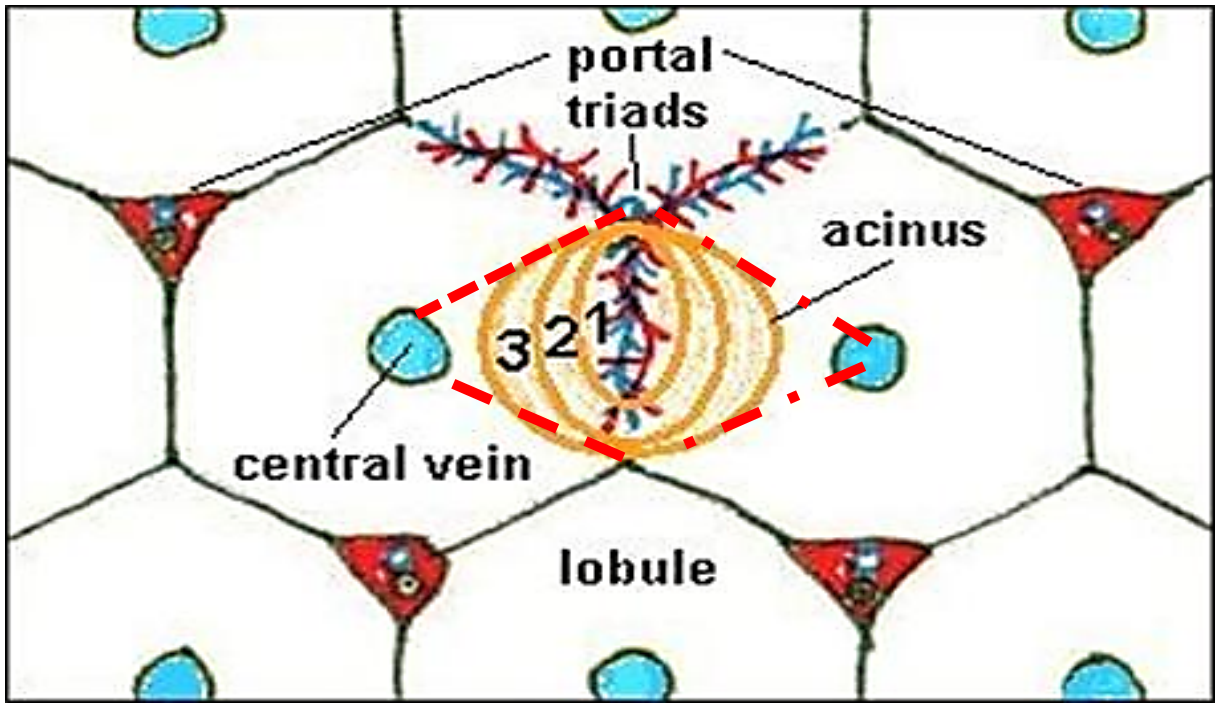
Zone 2:

- Surrounds zone 1
- Get intermediate oxygen /nutrients

Zone 3:

- At the periphery near the central vein
- Get the least oxygen/ nutrient supply

Liver acinus



Arrangement of liver acinus explains the variation in liver cells damage in response to hypoxia & toxins.

zone 1

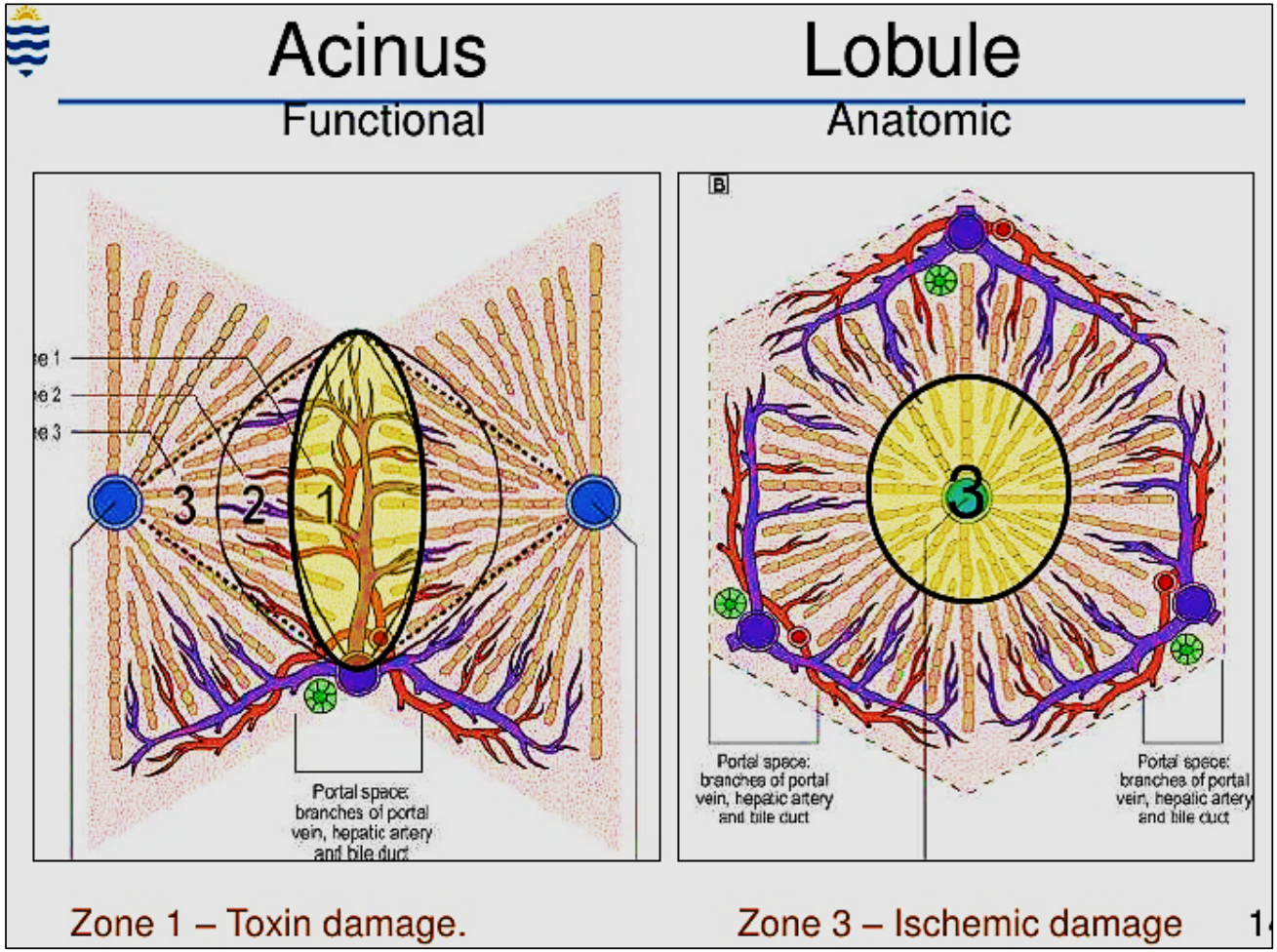
Cells close to the distributing vessels

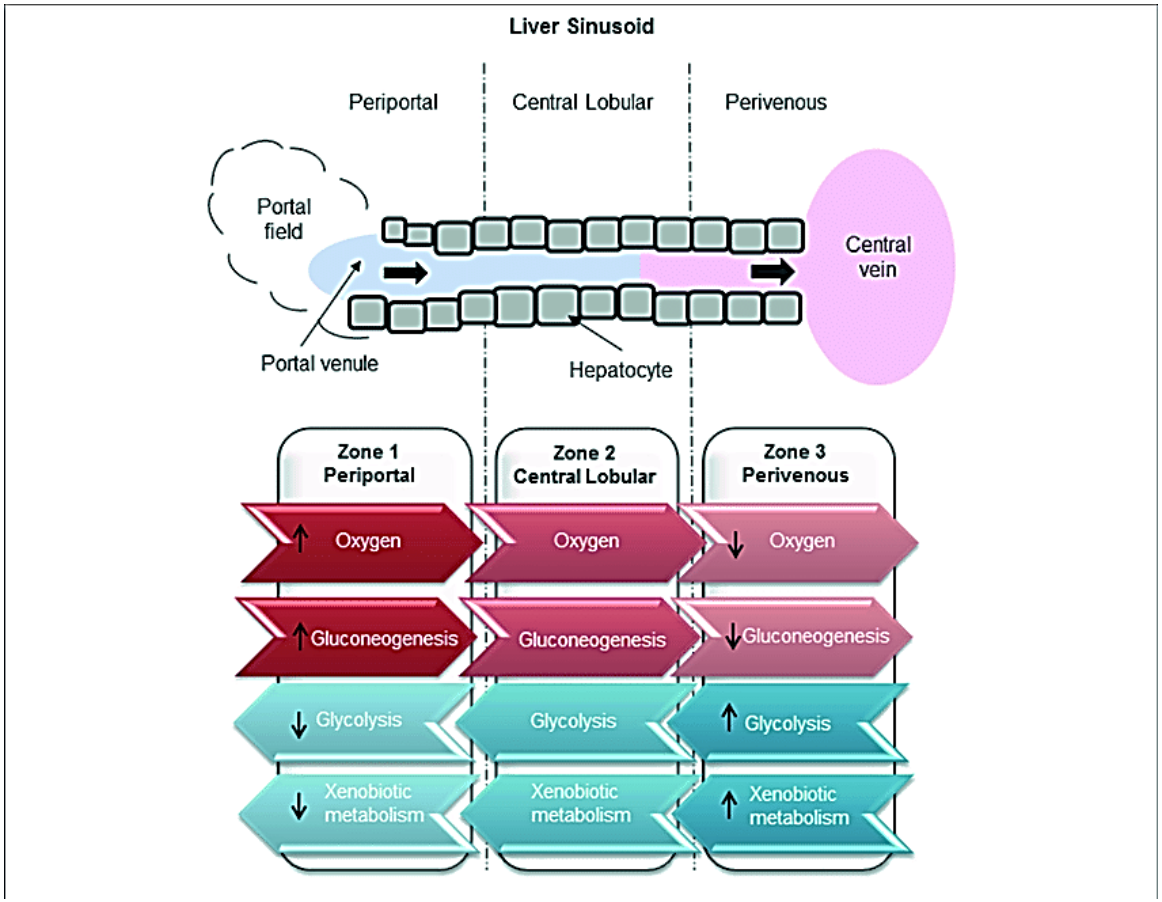
- **higher** in : oxygen, nutrient & toxin levels
- Least susceptible to ischemia
- **first** to show changes following bile duct occlusion
- **last** to **die** in case of circulatory impairment
- **first** to **regenerate**

zone 3

Cells far from the distributing vessels

- **first to show ischemic necrosis** (death due to impaired circulation (centri-lobular necrosis)
- **first cells to show fatty accumulation** (alcoholic liver disease) because these cells important for glycolysis
- **last to respond to toxins**


Acinus
Functional
Lobule
Anatomic
3
2
1
Portal space:
branches of portal
vein, hepatic artery
and bile duct
B
3
Portal space:
branches of portal
vein, hepatic artery
and bile duct
Portal space:
branches of portal
vein, hepatic artery
and bile duct
Zone 1 – Toxin damage.
Zone 3 – Ischemic damage



Zonation of liver metabolism. High oxygen exposure of hepatocytes in the periportal region compared to low exposure in the perivenous zone. Glucose production carried out through gluconeogenesis in the periportal zone. Glucose utilization carried out by glycolysis in the perivenous zone.

Thank you