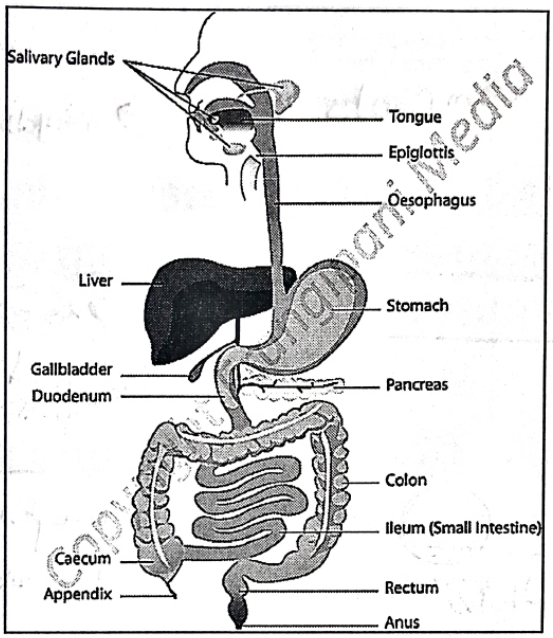
digestive system III

Organs associated with digestive tract

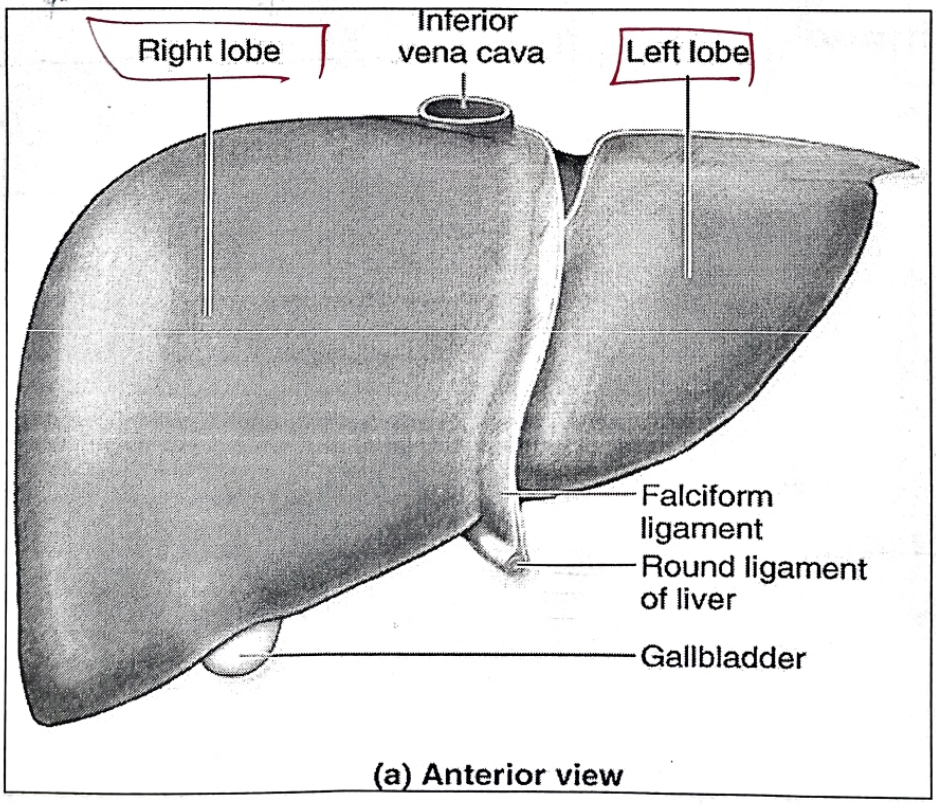
- Liver
- Pancreas
- Gall bladder

upper right quadrant
Intra Abdominal organ



Anatomically

Liver



(a) Anterior view

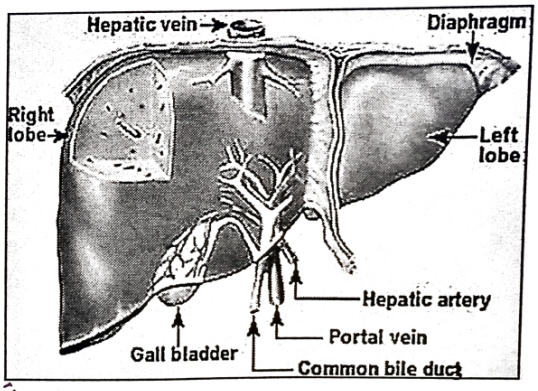
* Caudate lobe
between right and left lobe

* quadrate lobe
related to right lobe on inferior surface of it

Liver

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

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



Blood supply of liver

emulsification of fat so proper digest for food.

تخزين الجلوكوز على صيغة glycogen

Blood supply of liver

Portal vein: 70 - 80%

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

جايب nutrient / بكتيريا / سموم / medications

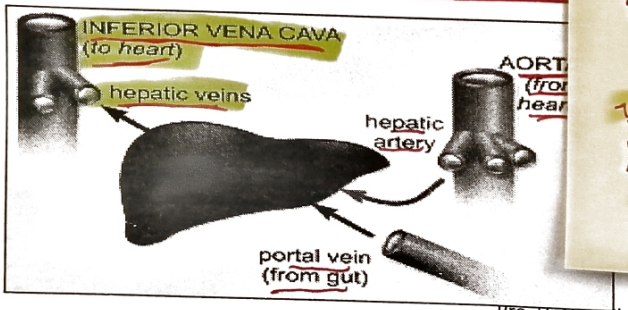
جايب remnants RBC

جايب الانسولين glucagon and many others hormons

Hepatic artery: 30 – 20%

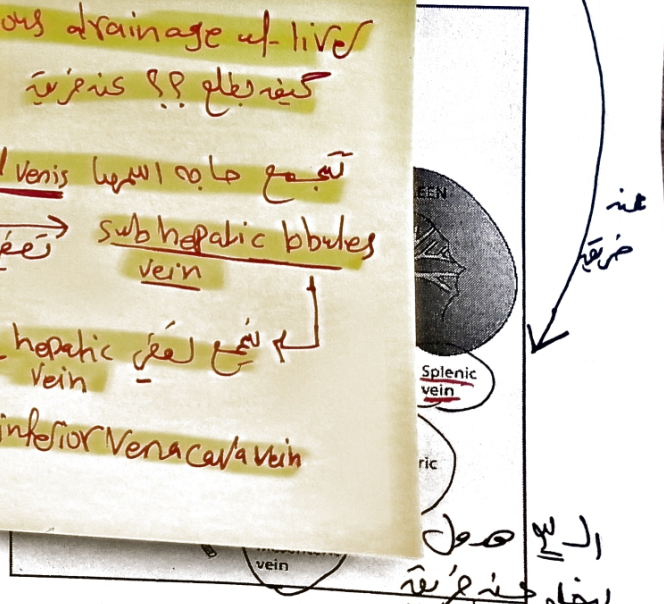
Aorta → hepatic artery

- Brings **oxygen rich** blood



Venous drainage of liver
كيف بطلع ؟؟ شرايين

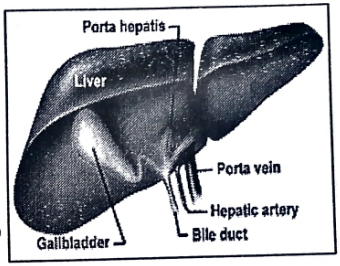
Central veins تجمع جايب الدم
تصفى في
sub hepatic bbules vein
تجمع تصفى
hepatic vein
in inferior Vena cava vein



الي وصل بيطلع شرايين
Portal vein to liver

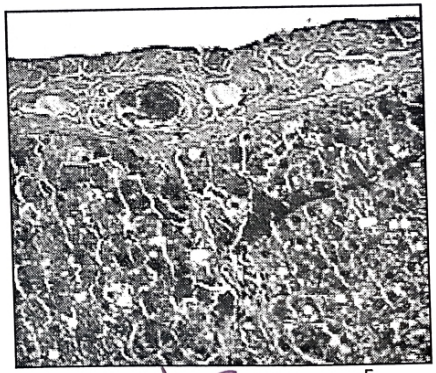
Structure of liver

Stroma & parenchyma



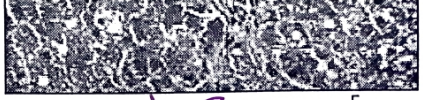
A) Stroma: capsule → septa → reticular fibers

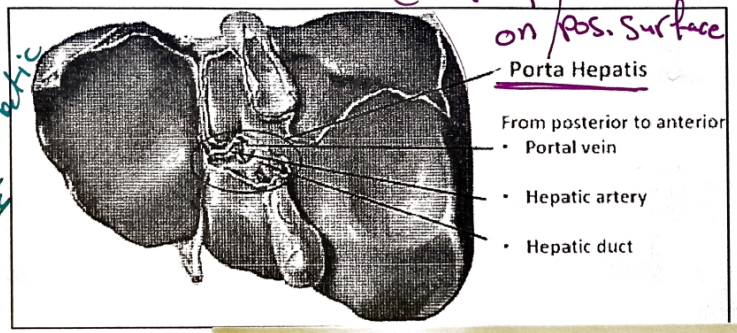
- **Capsule of Glisson:** thin fibrous C.T. sheet, covers the liver. Thick at hilum to form **prota hepatis** which gives rise to C.T. septa divide the liver into lobes and lobules
- **septa:** surround lobules. **Thick and easy to identify in pig's liver.. Lobulation are not clear in humans unless??**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

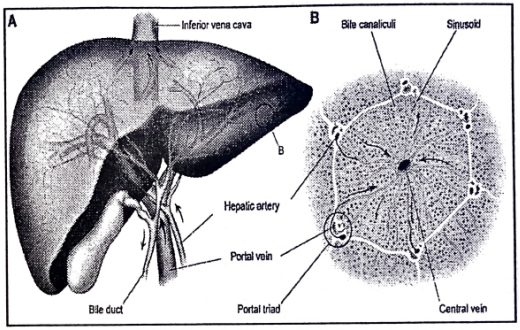


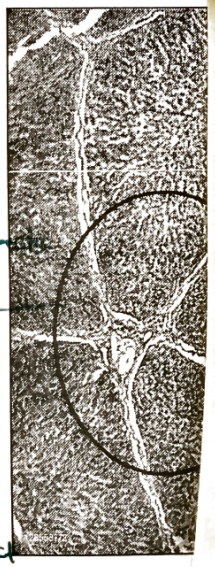
surround and support liver cells

Pro. Dr Hala El- mazar

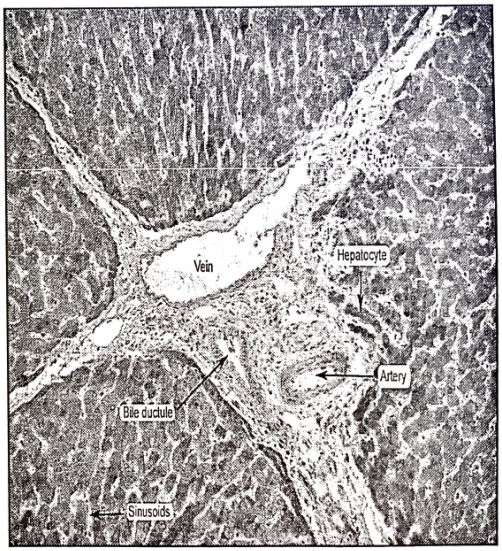






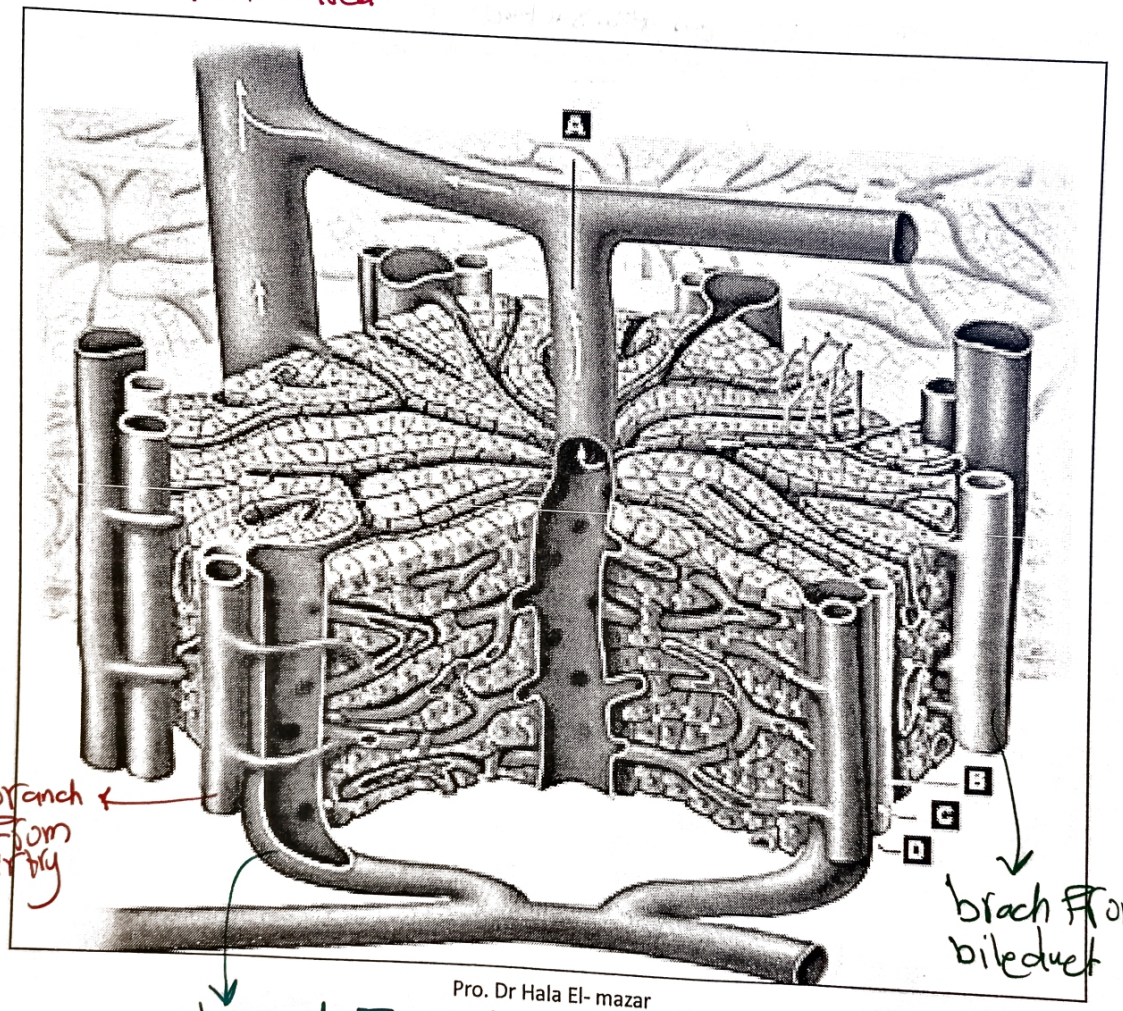


portal tracts : blood vessels
portal vein/hepatic artery
break/divide into
branches inside liver
Connect ← hepatic lobule
* branch from vein
* branch from artery
* branch from bile duct



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

Portal area



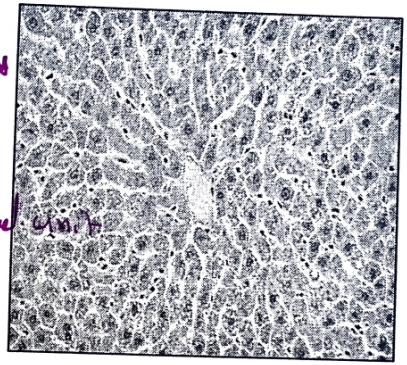
ILE branch From lymphatic vessels

branch From artery

branch From vein

branch From bile duct

B) Parenchyma: liver cells (hepatocytes)

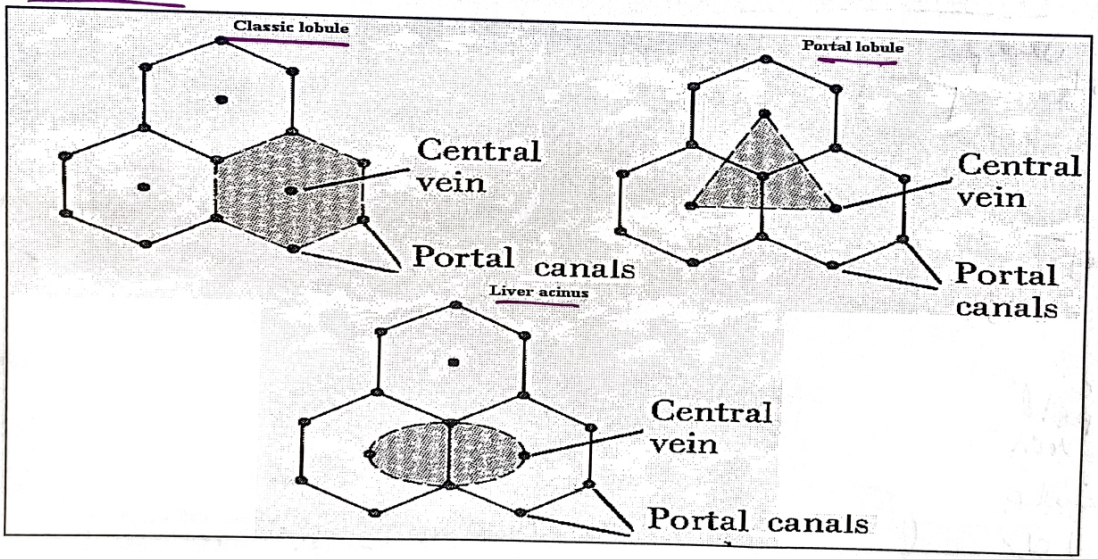


They are arranged to form either :

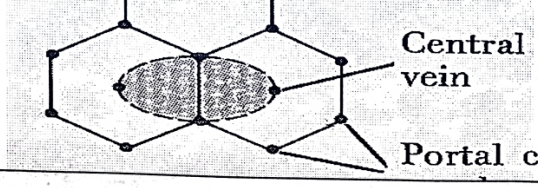
1- Classic hepatic lobules — Anatomical / Functional

2- Portal lobules — Pathological / Functional

3- Liver acini

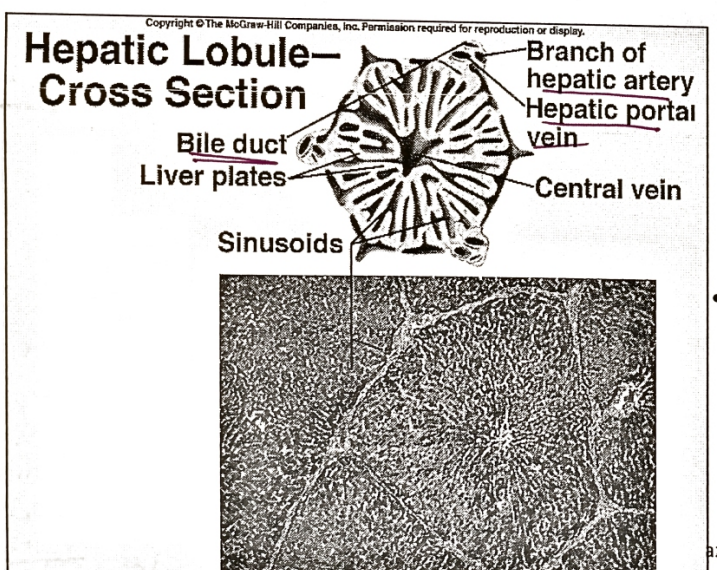


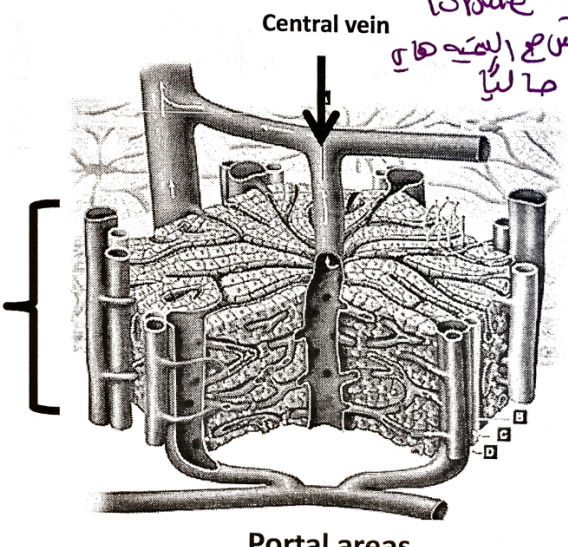
1- Classic hepatic lobule



1- Classic hepatic lobule

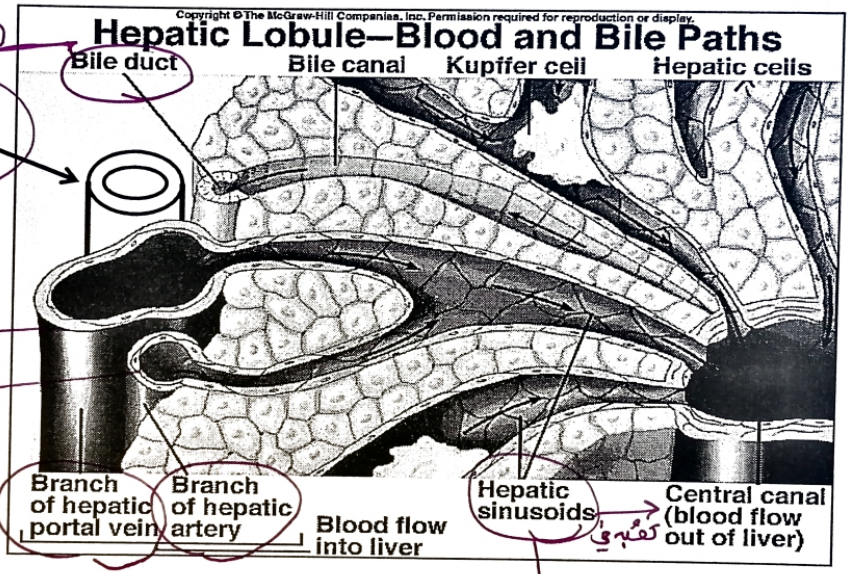
- Hexagonal or polygonal in shape (cross section)
- Surrounded with thick C.T. septa in pig's liver
- Each lobule has 3-6 portal areas (**portal triads**) at its periphery, and **central vein** (CV) at its center





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



- 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

Central vein

[Centrifugal] [Centripetal]

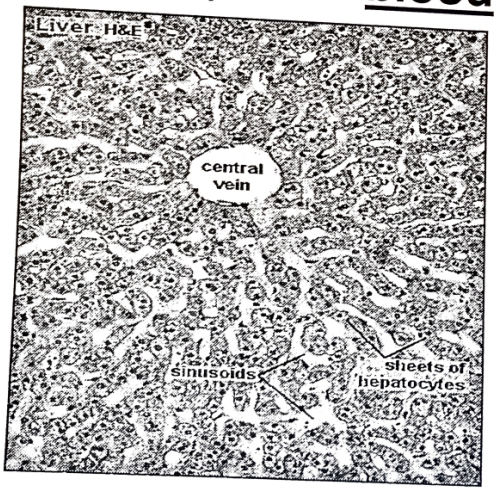
portal vein artery Blood flow into liver sinusoids Central canal (blood flow out of liver)

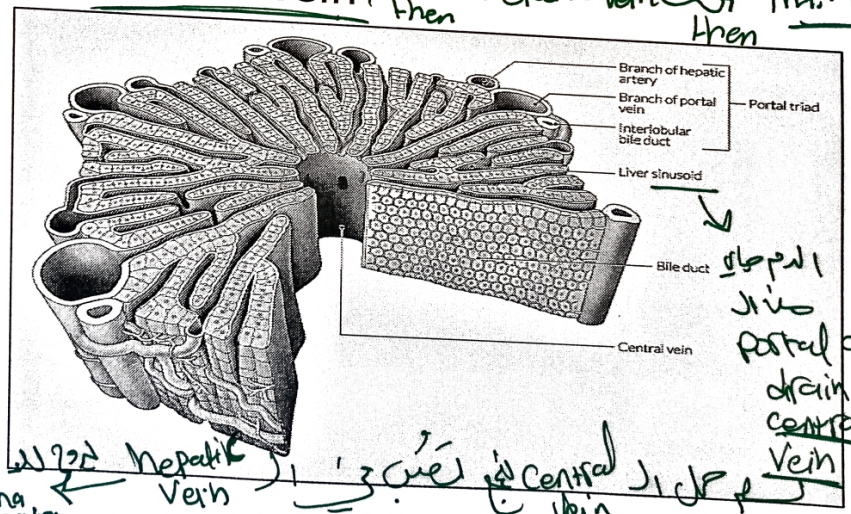
mixed blood From hepatic artery and portal vein

rich in O2

- 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

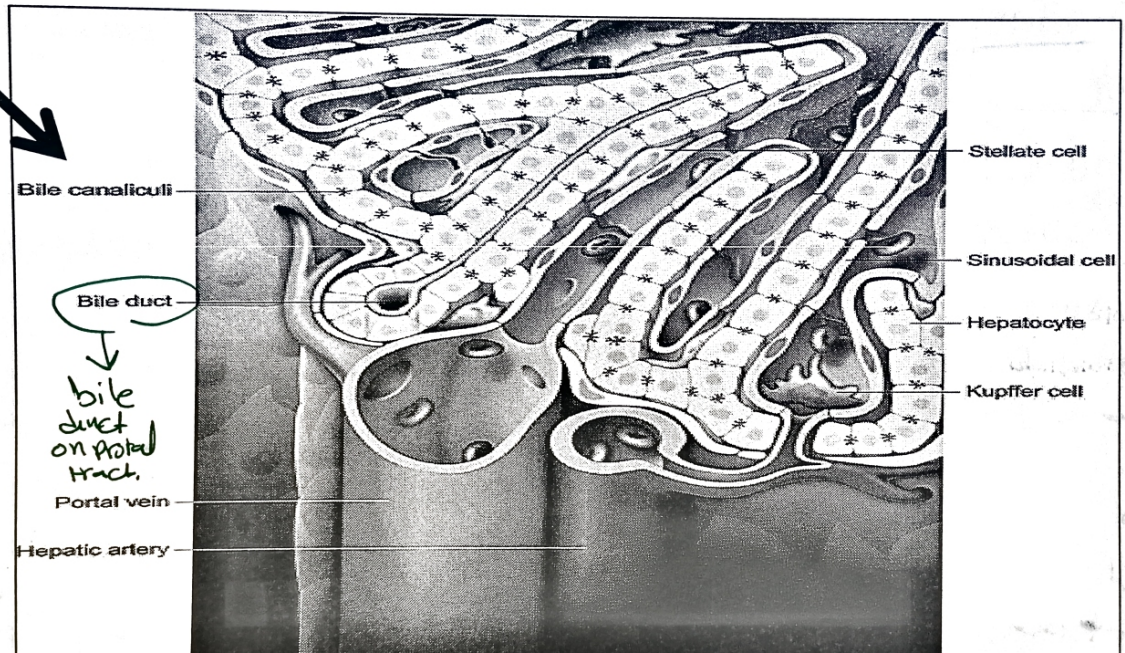




then hepatic vein then inf. vena cava

hepatic vein central vein Inf. vena cava

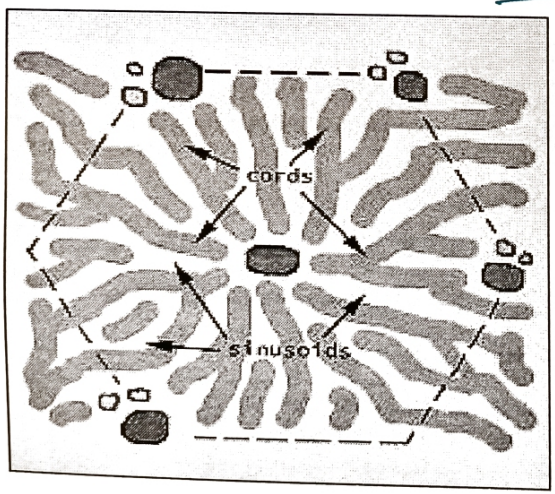
- **Bile canaliculi** present within the plates in-between adjacent hepatocytes, they drain **bile** into the bile ducts in portal areas

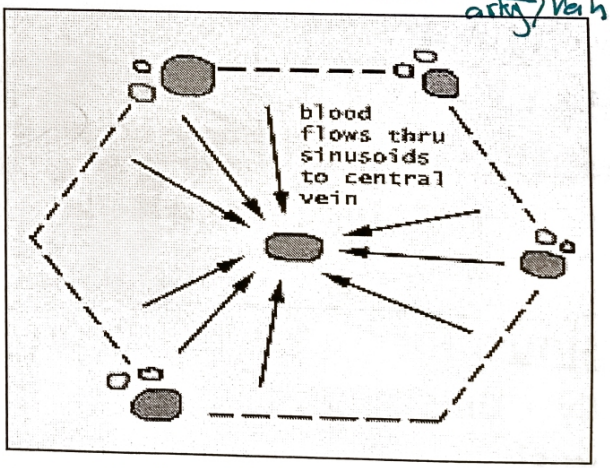


Liver sinusoids and space of Disse

A- Liver sinusoids

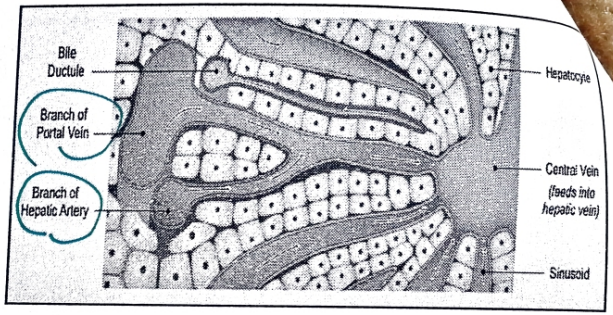
- Minute blood channels present **between** plates /cords of liver cells
- Transport blood from branches of portal vein & hepatic artery in portal area toward central veins (mixed blood)

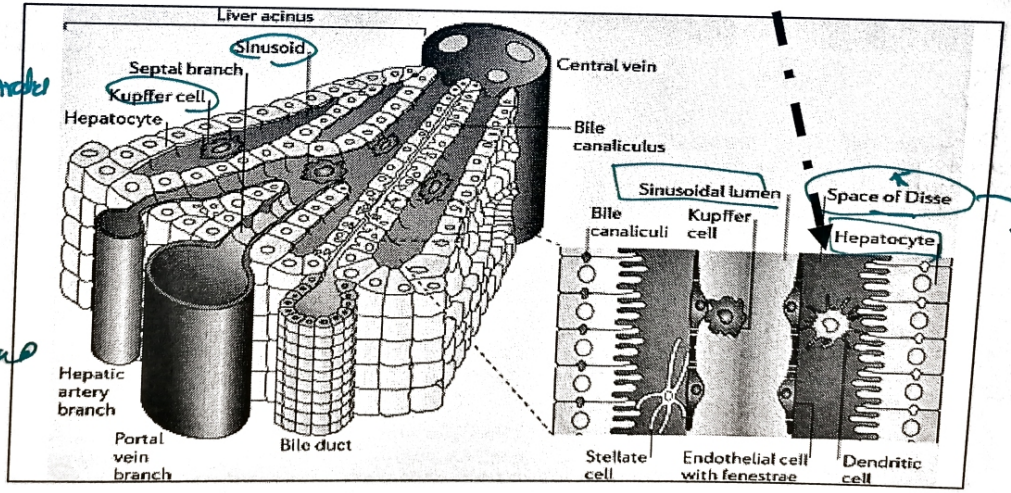


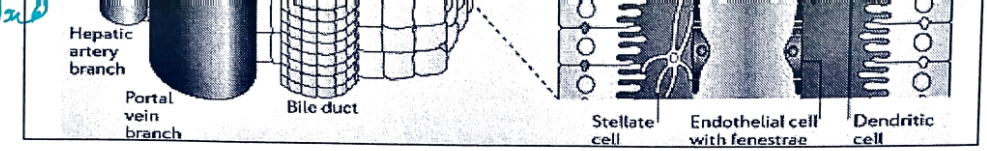


The flow of blood is centripetal

- **Lining of blood sinusoids consists of:**
  - ✓ fenestrated endothelial cells
  - ✓ Discontinuous basal lamina
  - ✓ Kupffer cells
  - ✓ Pit cells
- The wall of the sinusoids is separated from the hepatocytes by a space called **space of Disse**

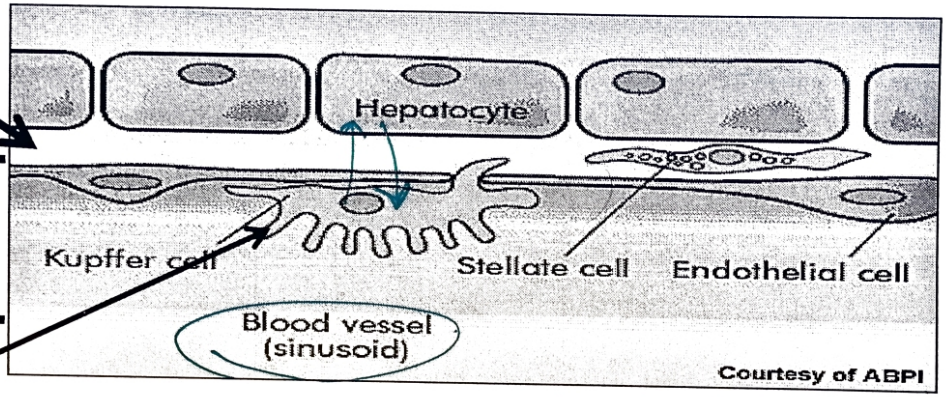






Endothelial cells lining of liver sinusoids:

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

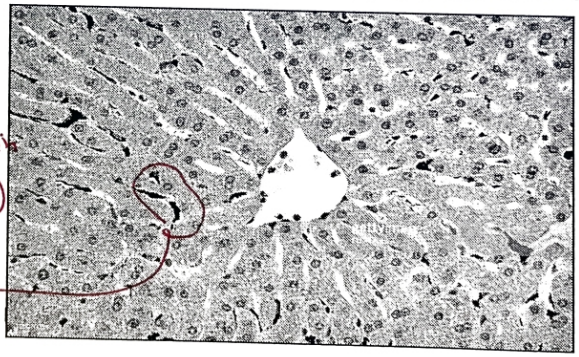


Kupffer cells:

- 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.

- **Pit cells:** are liver-specific natural killer (NK) cells and belong to the group of sinusoidal cells. They are morphologically and functionally modified form of peripheral blood NK cells. 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

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



Pro.

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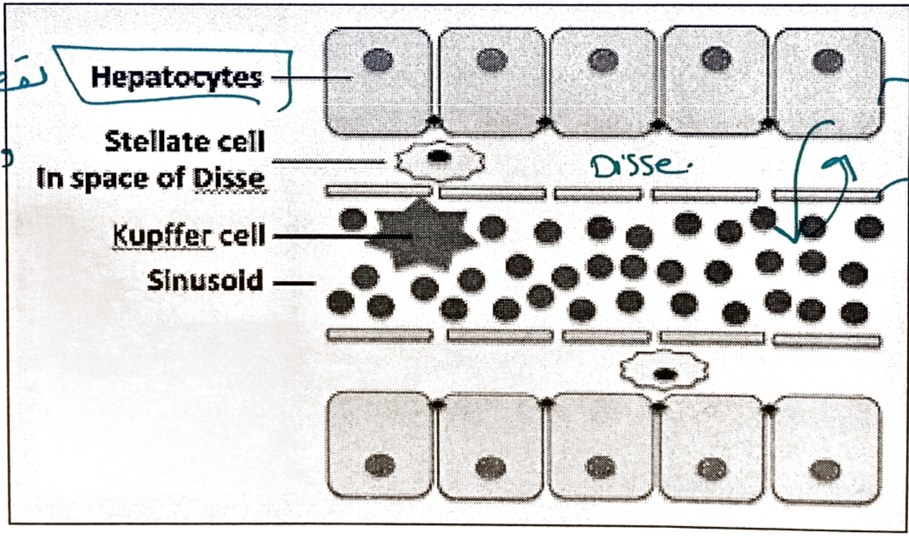
Space of Disse

- **EM**: space separate between the endothelial cells lining

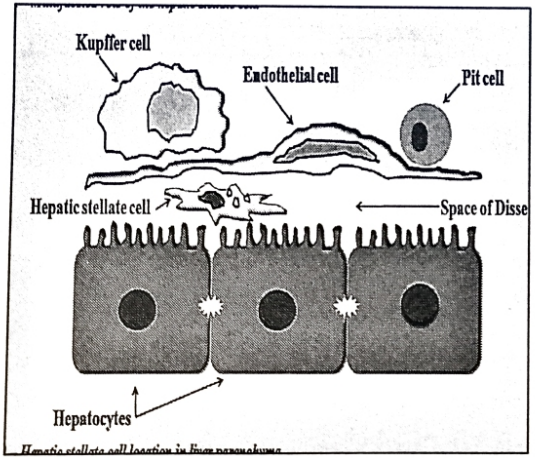
Space of Disse

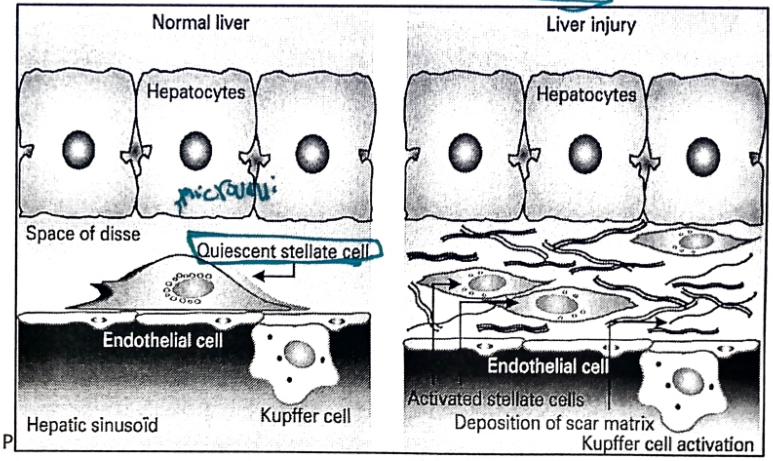
- **EM**: space separate between the endothelial cells lining of the sinusoids and hepatocytes
- Through out the space exchange of metabolites between blood and hepatocytes takes place



Space of Disse contains:

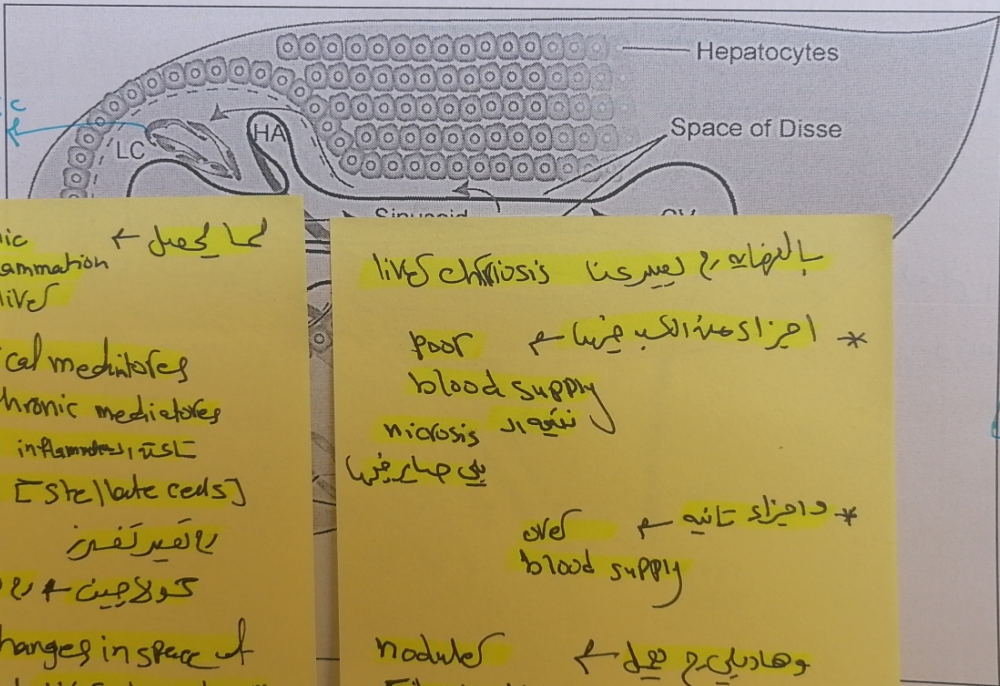
- Fat storing cells **(Ito cells, stellate cells).** They store Vit. A in small lipid droplets in their cytoplasm, and maintain the extracellular matrix of the space
- Long microvilli of hepatocytes project in the space (↑)
- Blood plasma
- Reticular fibers that support the wall of the sinusoids





- The peri-sinusoidal spaces of Disse is the beginning

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



lymphatic capillary

الكميات اللي ما تروح للدم ولا ترجع لل hepatocyte ما رح تظل بال Disse لأنو رح يصرفها drain of lymphatic

لما يحصل ← chronic inflammation in liver ← وتيجي

→ chemical mediators or chronic mediators

تظل تحتك بال inflammation

→ Ito cell [Stellate cells]

aggressive cell → رح تصير تفرز

Fibrosis كولاجين ← رح يصير

→ so changes in space of disse → رح يتغير + liver sinusoid will shrunk

بالنهاية رح يصير عنا liver cirrhosis

* أجزاء من الكبد عندها ← poor blood supply

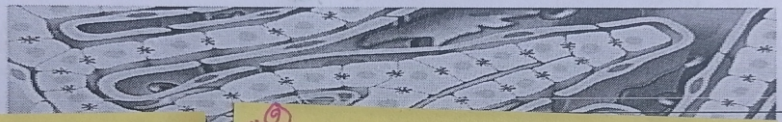
nicrosis تتموت في منطقة

* وأجزاء ثانية ← over blood supply

وهادول رح يصير ← nodules Fibrotic liver [Fibrosis]

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



① مرتبط ع ليضا عن hepatocyte الـ
↳ tight junctions
↳ مايخلي حاجه تعدي مثل مكانا العزوفيه تعدي من
لما تتكسر RBC ← تنكسر وتنتج عنا
heme + globen
↓ ينقسم الى
[iron + biliverdin] ↳ recycling يعيد
(amino Acids) ويعطي

② ✱ Iron → go to bone marrow يروح by transferrin
عشان يعيد يعمل recycle يعمل another RBC
✱ biliverdin → blood sinusoid يخرج من
space of Disse يدخل في
upper surface of hepatocyte يقابله
↳ transporter موجود حاجات proteins
بالي تتحرك يدخل فيها cells

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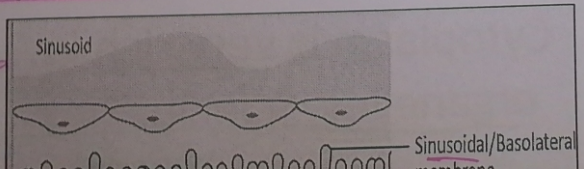
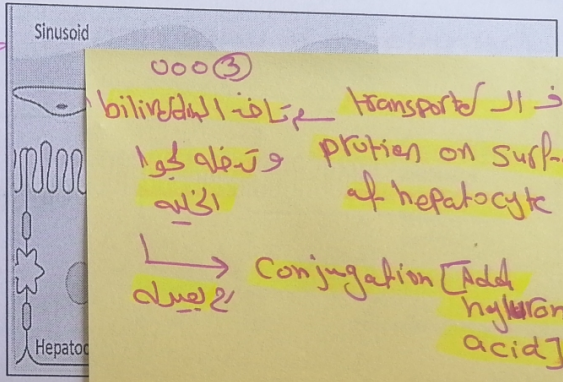
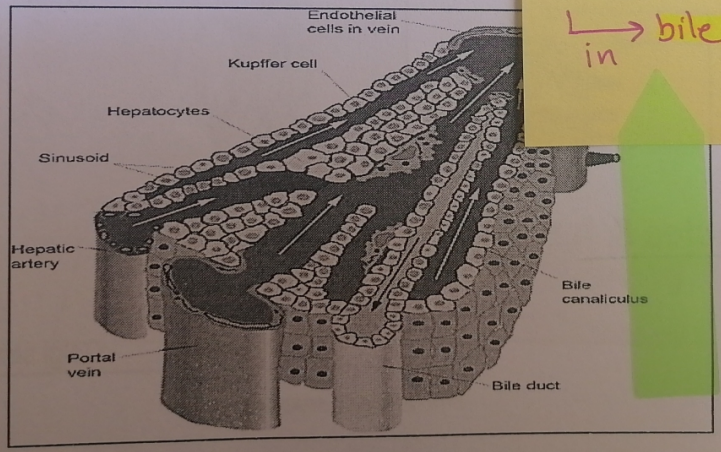
- Small microvilli project from hepatocytes into the canaliculi and tight junctions hold the cell membranes of



- 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)

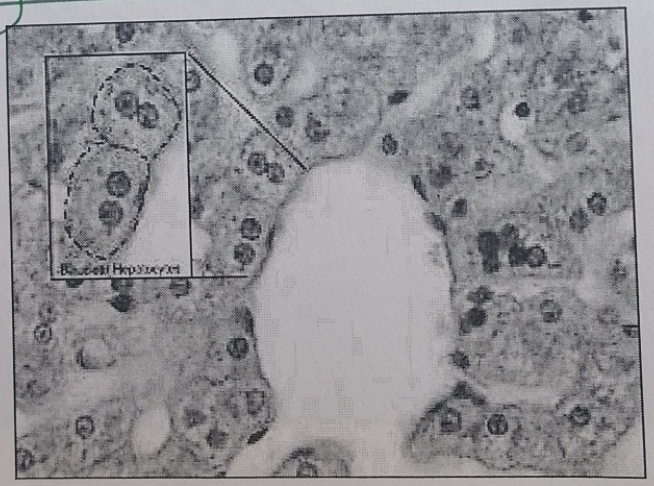


- Bile secreted by hepatocytes drains

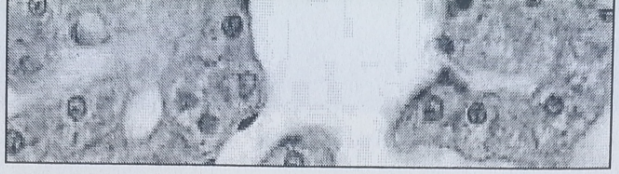


Hepatocytes

- **LM:** large polygonal cells with 1 or 2 nuclei (bi-nucleated)
- Nuclei: central, rounded, e prominent nucleoli
- Acidophilic cytoplasm (rich in mitochondria& SER), it also appear vacuolated due to dissolved glycogen and fat



E/M:



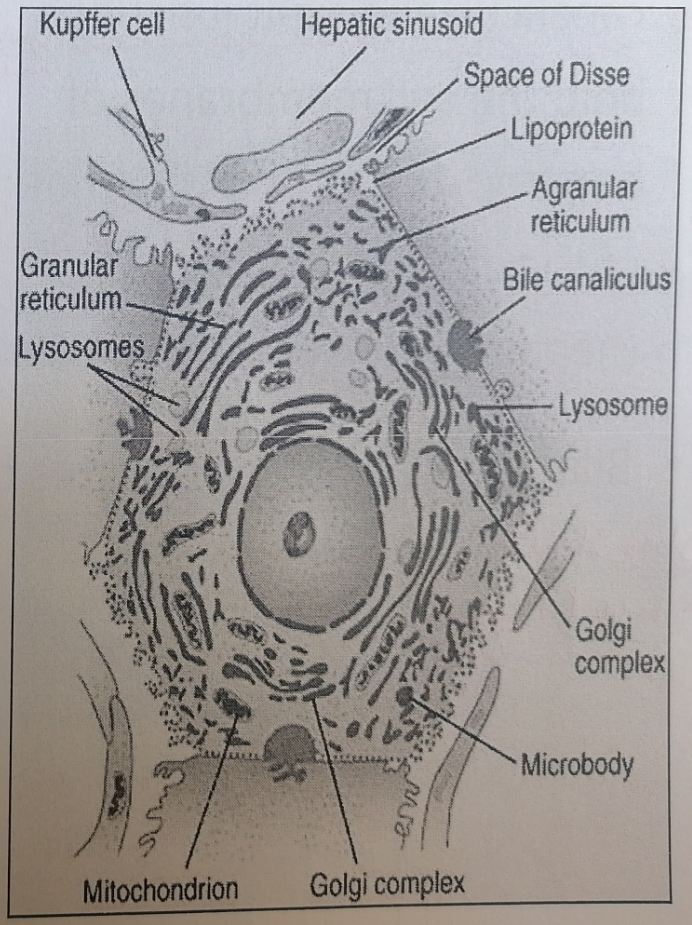
E/M:

Cytoplasm is very rich in organelles & inclusions

glycogen + Fat droplets.

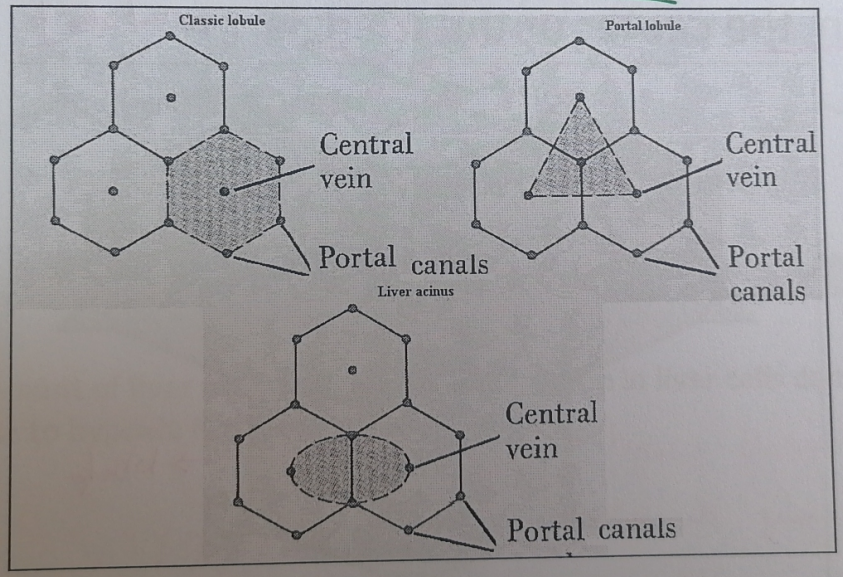
- Organelles:
  mitochondria, rER, ribosome, sER, Golgi complex, lysosomes & peroxisomes.

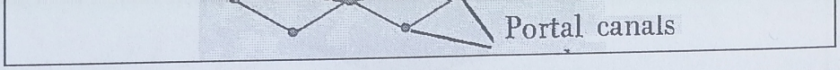
- Inclusions:
  glycogen granules & fat droplets



Organization of liver parenchyma/function:

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

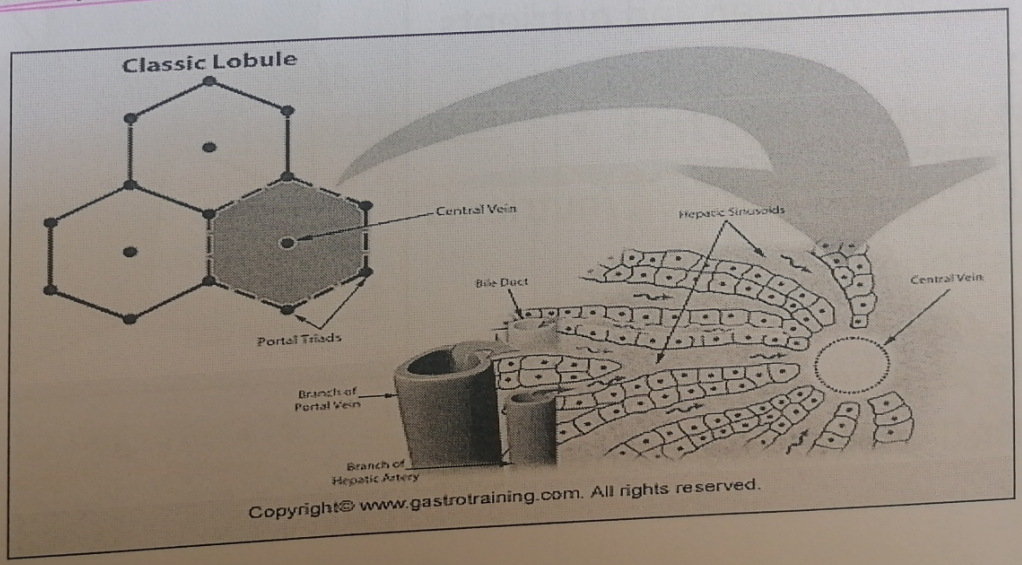




Classic hepatic lobule: endocrine Function,

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

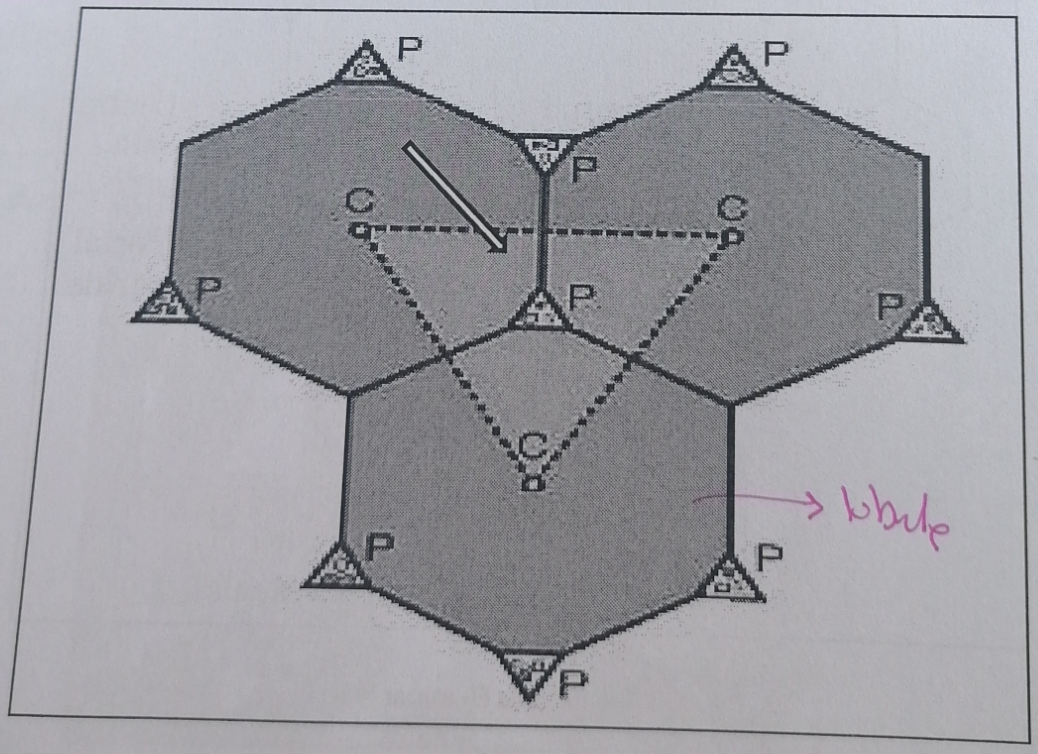
Proteins, glucose secreted by liver cells released directedly into blood sinusoids → to central vein.



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 [portal area]



→ lobule

→ 2 hepatic lobule So 2 central veins + 2 portal area

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

Diamond shaped mass of liver cells surrounding a central vascular

→ 2 hepatic lobule So 2 central veins + 2 portal tracts

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: portal vein / hepatic artery

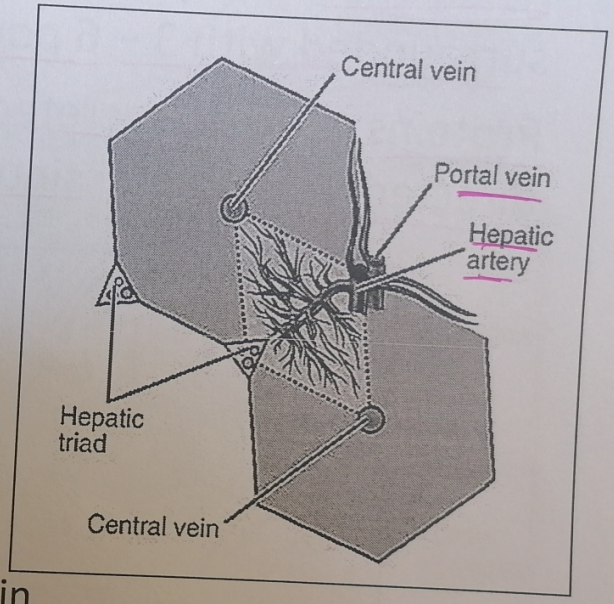
- Close to the vascular core
- Get the most oxygen and nutrients

Zone 2:

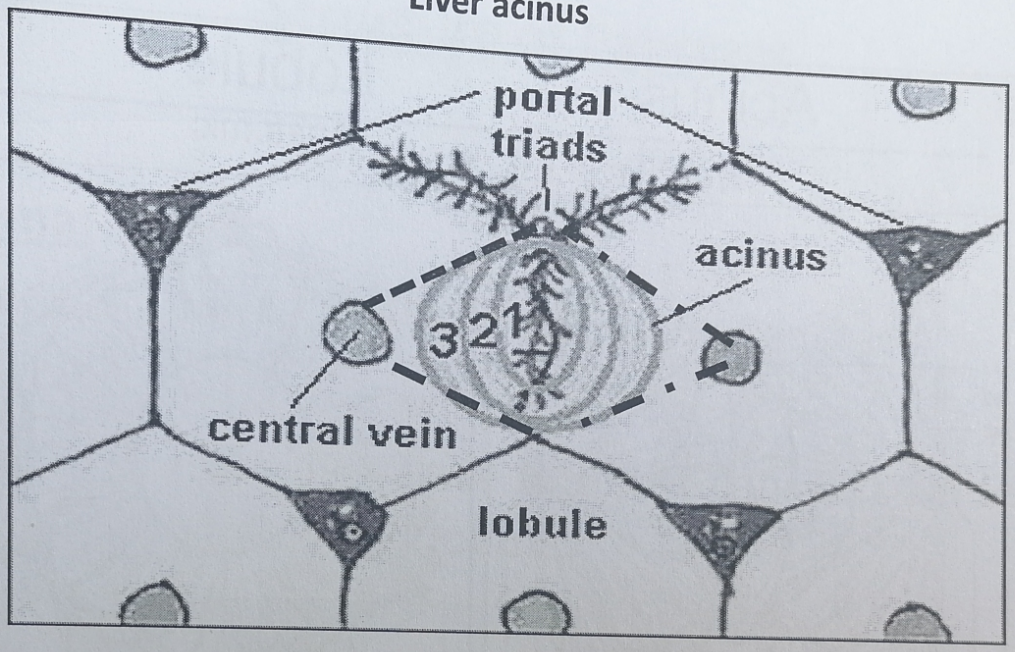
- Surrounds zone 1
- Get intermediate oxygen /nutrients

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	zone 3
Cells close to the distributing vessels	Cells far from the distributing vessels

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** due to circulatory impairment
- **first** to **regenerate**

zone 3

Cells far from the distributing vessels

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

Pancreas

Mixed exocrine + endocrine gland produce both digestive enzymes and hormones

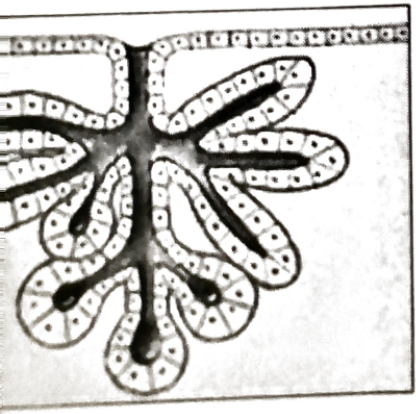
The exocrine part: compound tubulo-alveolar gland

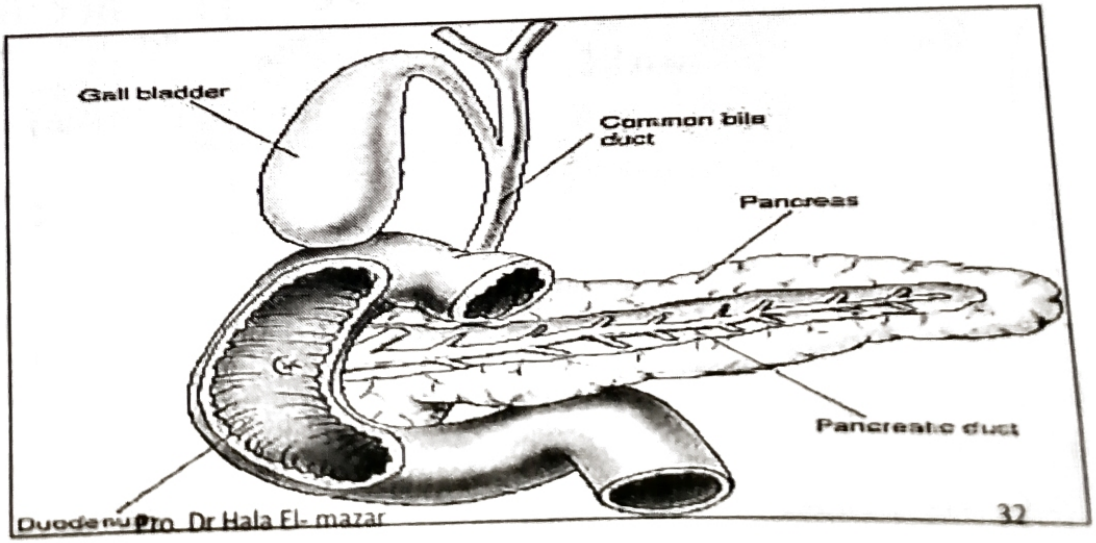
- secretes pancreatic enzymes & bicarbonate

The endocrine part: Islets of Langerhans secrete hormones: insulin, glucagon, somatostatin..etc

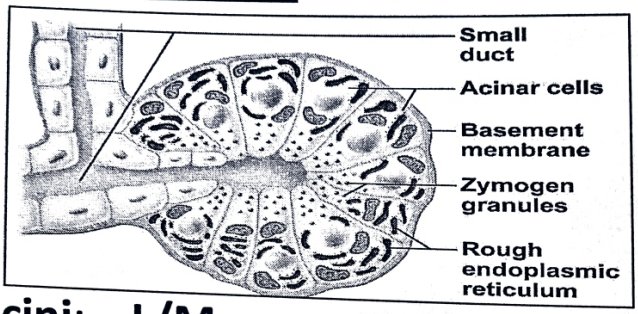
يفرز إلى 2nd part duodenum so will neutralize acidic that come from stomach.

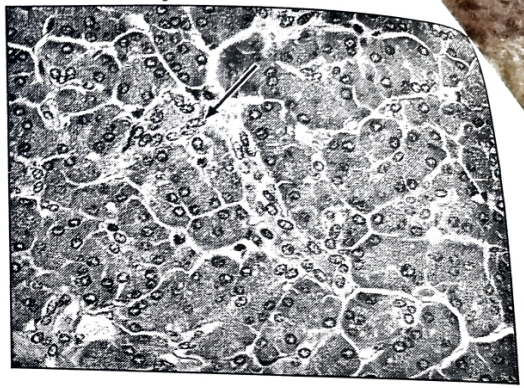
bulo-alveolar gland





A- **Exocrine part:** formed of acini & duct system





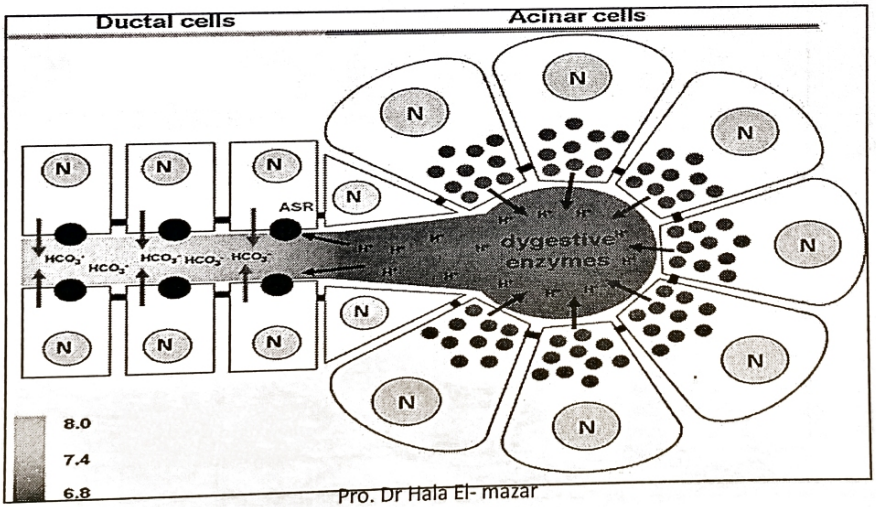
Acini: L/M

- Composed of serous producing cells (enzymes)
- The pancreatic acini has very small lumen
- Cells are pyramidal with rounded basal nuclei
- Cells are protein secreting cells → (exocytosis)
- Cytoplasm shows basal basophilia (rER) & apical acidophilia (zymogen granules)

- Cytoplasm shows basal basophilia (rER) & apical acidophilia (zymogen granules)

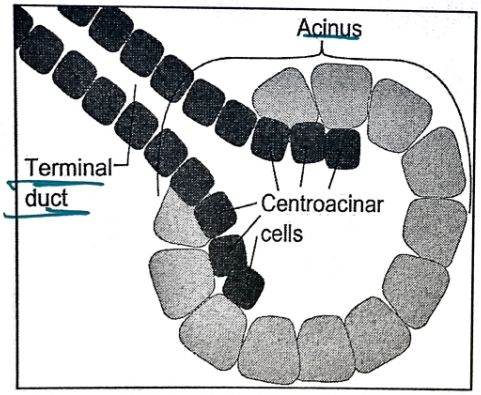
Pancreatic exocrine secretion is controlled by hormones from the endocrine cells of GIT (stomach & duodenum):

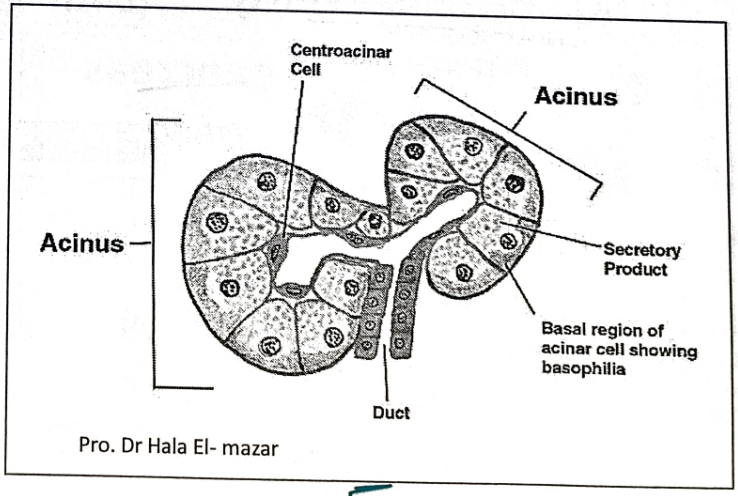
1. **Cholecytokinin**: ++ acinar cells to secrete **pancreatic enzymes.**
2. **Secretin**: ++ **intercalated duct cells** to secrete **alkaline fluid** to neutralize acidic chyme in duodenum.



Centroacinar cells:

- Flat squamous cells found lining the lumen of the acini
- They represent the beginning of the cells o intercalated duct into
- They secrete **bicarbonate rich fluid** in response to secretin





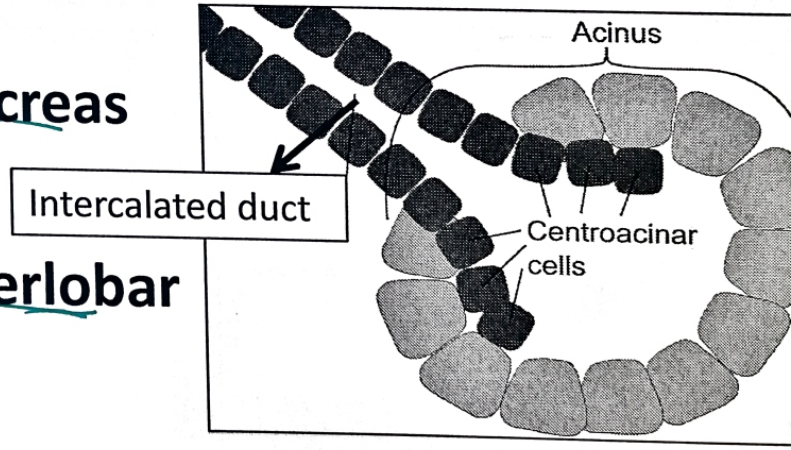
Duct system

Intercalated ducts:

- Thin ducts arise from within the acini
- Lined with simple squamous cells.
- The initial cells called centroacinar cells (secrete HCO3 rich fluid which hydrate and alkalinizes the enzymatic secretion of acinar cells)

Alkaline.

No striated ducts in the pancreas



There are interlobular & interlobar ducts

B- Endocrine part:

Islets of Langerhans

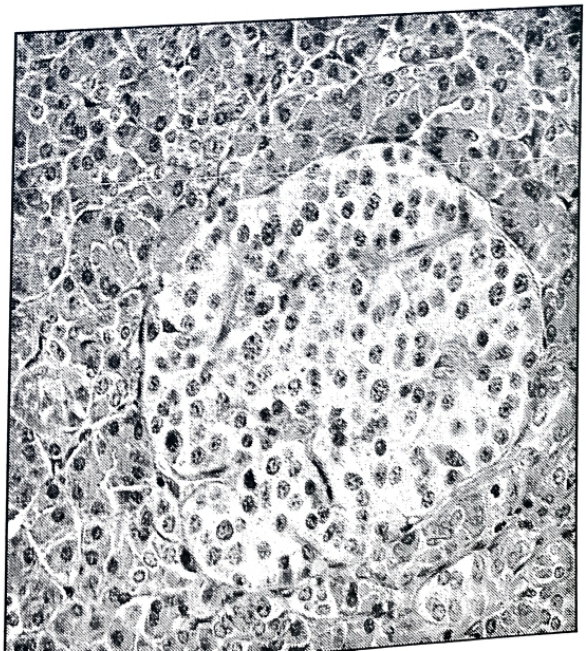
Masses of pale staining cells scattered between the pancreatic acini

between exocrine pancreas

They are more in the tail than head of pancreas

The cells are separated by fenestrated capillaries (highly vascularized)

Nerve supply autonomic nerve fibers

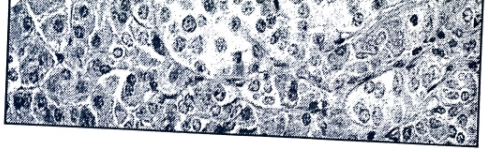


- Cells of islets of Langerhans are
  Beta, Delta, Ganglion, PPcells

Alpha, Beta, Delta, Ganglion, PPcells

Pan creatic polypeptide

Pro. Dr Hala El- mazar



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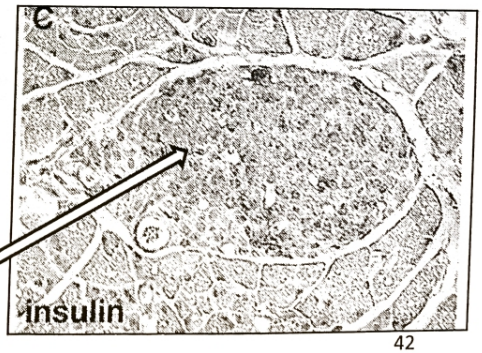
Beta (B) cells (70%):

- Produce **insulin** which **lower** blood sugar
- Cells are small in size, most numerous cell type, central in location in the islets
- Stain **blue**
- EM: appear in two functional stages active & resting
- When active synthesize insulin. When resting packed with granules storing insulin
- Cells divide at very slow rate

damage → diabets.



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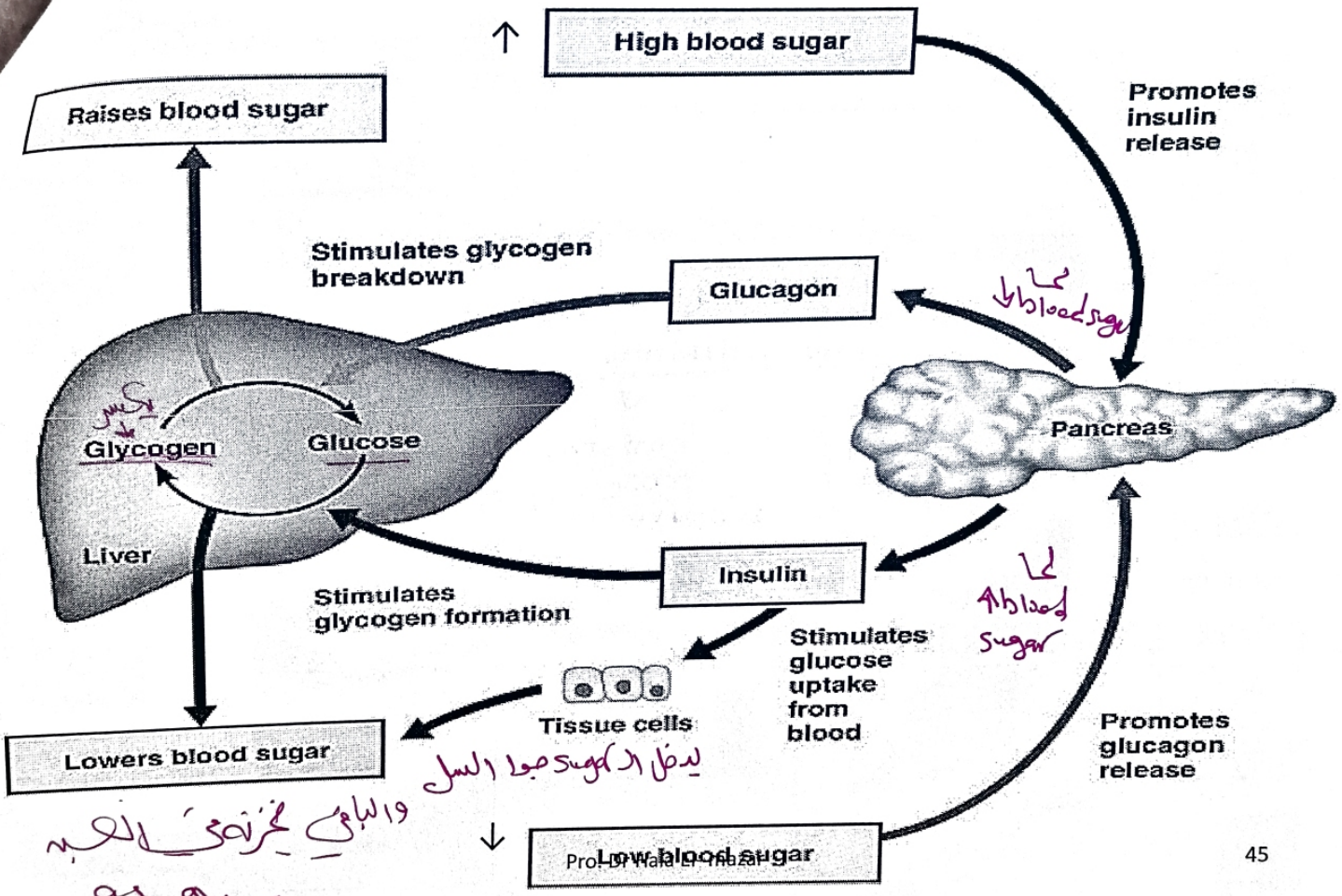
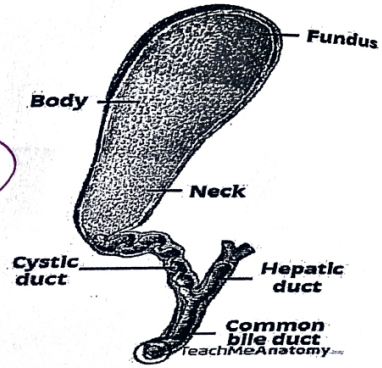
Regulation of blood glucose level



Pancreas vs. Parotid

Gall bladder & biliary tract

- Hollow pear shaped organ
- Attach to the lower surface of liver
- It stores and concentrate bile secreted by liver
- Wall of gall bladder consists of:



Mucosa: (highly folded)

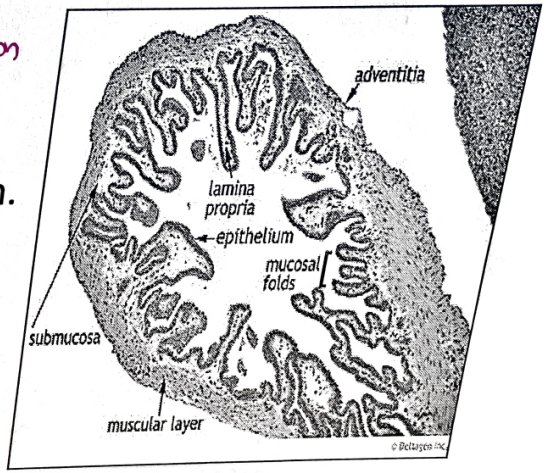
epithelium: simple columnar with microvilli

No muscularis mucosa

Musculosa

Bundles of irregularly arranged smooth m.

Fibers , elastic & collagenous fibers



Serosa