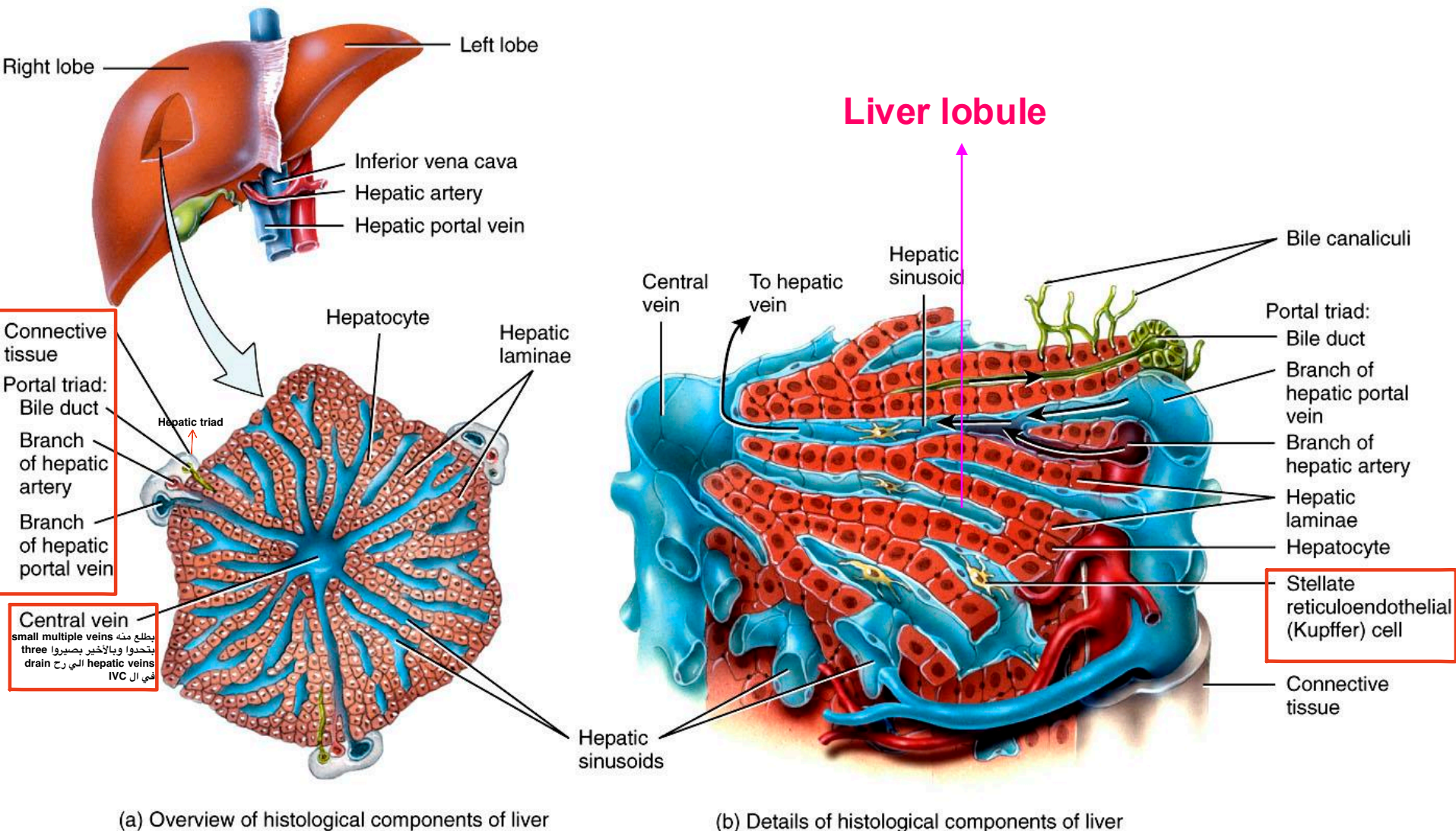


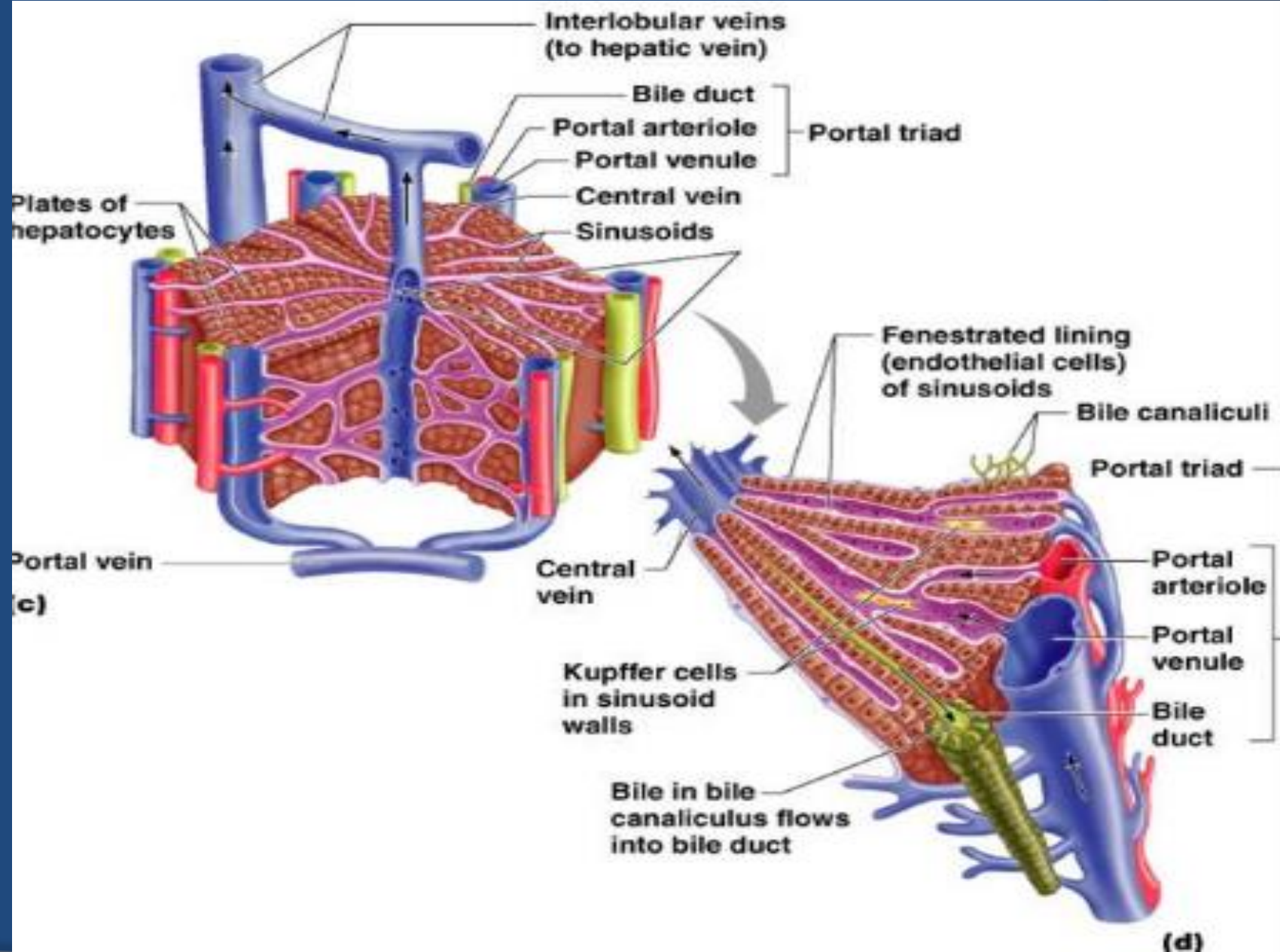
6-Secretion of Bile by the Liver

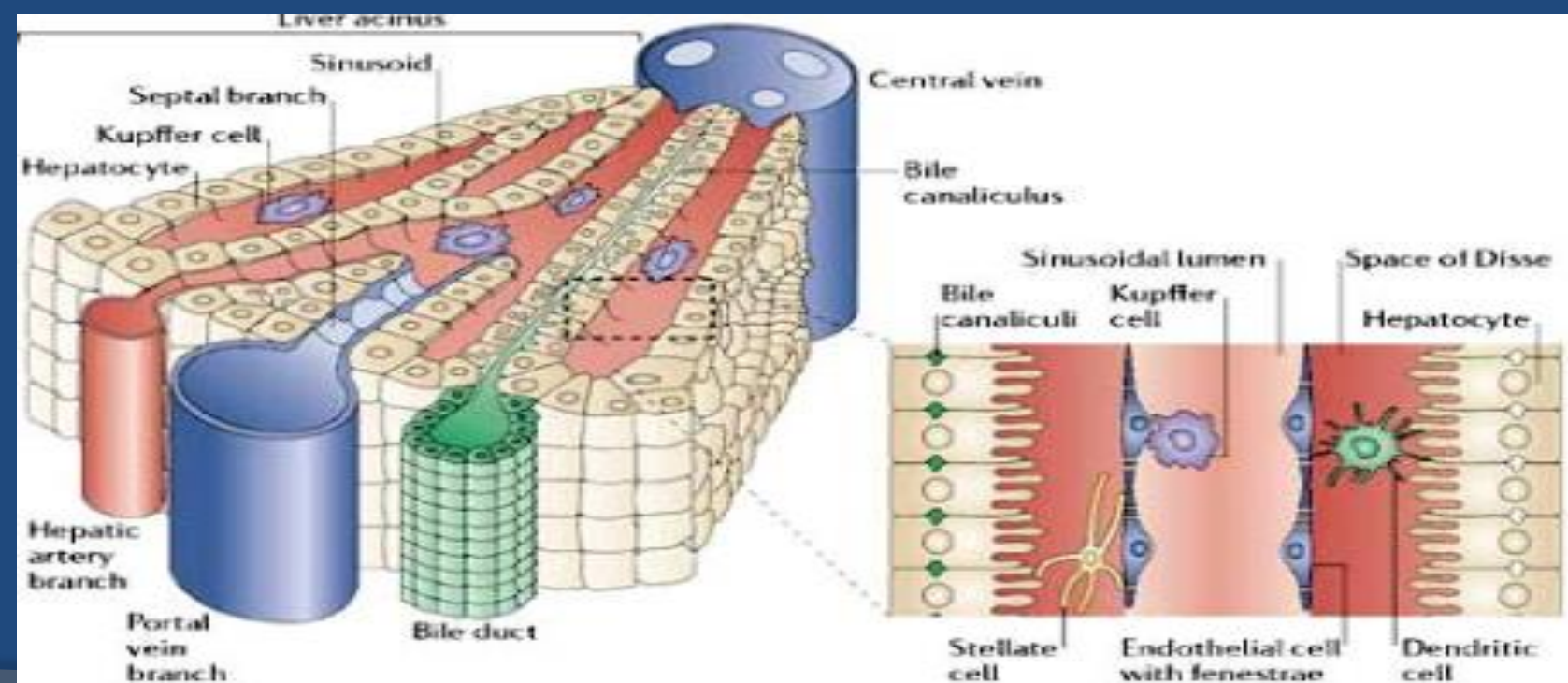
Functions of the Biliary Tree

- liver is the largest gland in the body (1.5 Kg), essential for life. 1kg-2.5kg
- The functional unit is the *liver lobule* (hepatocytes around a central vein separated by blood sinusoids). liver lobules ال liver عبارة عن two layer أو layer يتكون
- The sinusoids are wide fenestrated, contain large Kupffer cells. killer cells (phagocytic cell) عبارة عن
- **Hepatic vascular system:**
 - 1.5 L/minute (27% of CO), 1L from portal vein, 500ml from hepatic artery. 6L لو ال CO كان 27%-30% Cardiac output
دم مليان nutrients and toxic materials ال nutrients، بالذات amino acids و glucose، لأنه ال Fat جزء منه بروح عن طريق ال Lacteals وفي شوية Fat (medium chain triglyceride) ال liver يتروح على
 - Rich lymphatic drainage.
- liver sinusoids بصير فيها Mix ل 70% portal vein blood و hepatic artery 30%

Histology of the Liver







Liver: Blood Supply

Two sources

■ Hepatic artery - oxygenated blood from aorta.

■ Hepatic portal vein - deoxygenated blood:

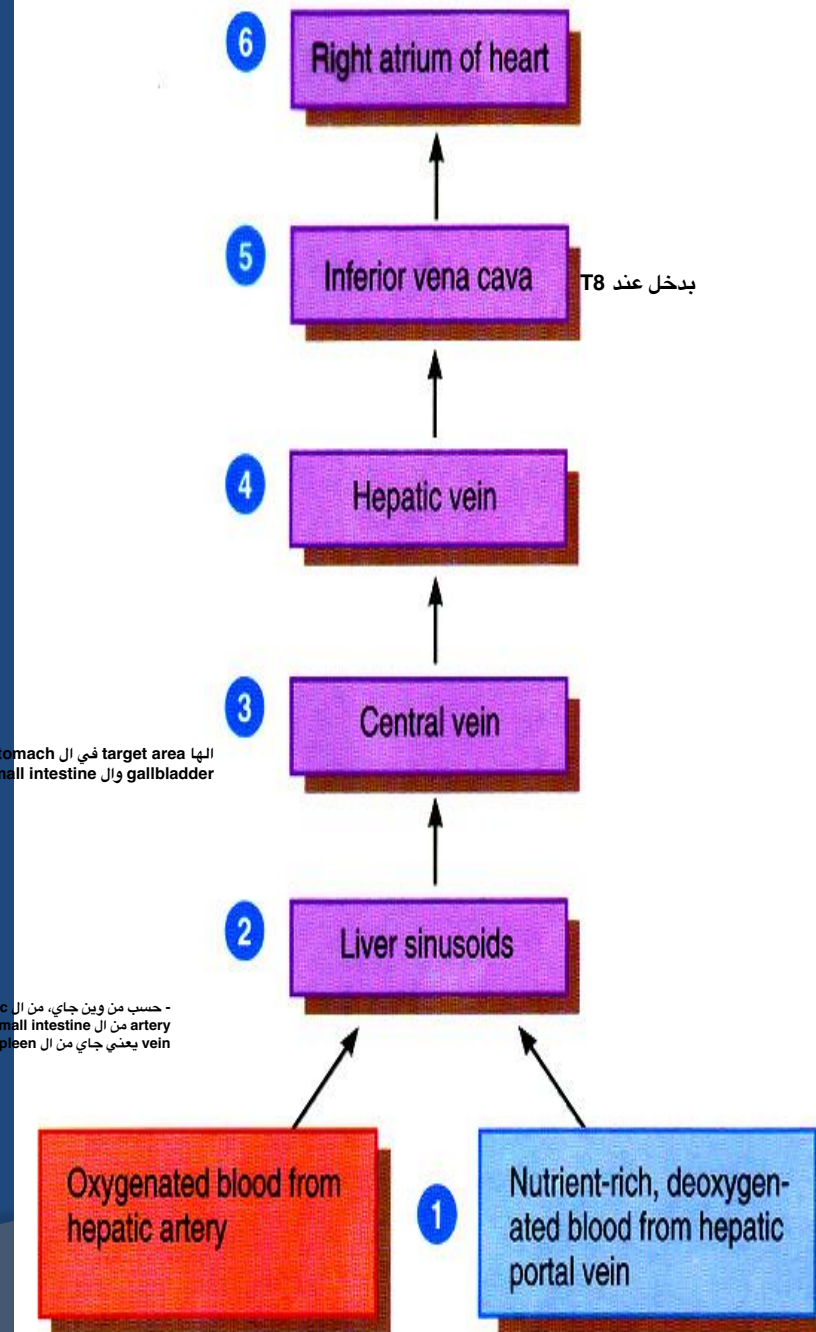
■ Absorbed nutrients and toxins from the stomach and intestines.

■ Hormones from the pancreas. Like CCK and secretin
الها target area في ال stomach وال
small intestine وال gallbladder

■ Breakdown products of RBCs from the spleen.

● Blood mixes in the sinusoids حسب من وين جاي، من ال superior mesenteric
artery من ال small intestine، من ال splenic
vein يعني جاي من ال spleen

● Hepatocytes (liver cells) modify and exchange molecules with the blood.



Liver functions

1. Vascular Function:

- Blood storage: 10% of total blood volume 450ml.
- Blood filtration: 99% of bacteria that enter the portal blood from the intestine, small blood clots by are phagocytosed by Kupffer cells that line hepatic sinusoids.
- Removal of old red blood cells by Kupffer cells. RBCs 120 day, platelets 6-10 days
Neutrophils 6h

عشان هيك لما واحد بياخد aspirin بخرّب ال platelets فعشان
يكون ال platelets يكونوا فرش بنقله وقف ال aspirin لأسبوع

2. Secretory function (Bile formation):

Synthesis & secretion of bile salts & bile pigments.

نتيجة تكسر ال RBCs

3. Metabolic functions:

1. **Carbohydrate metabolism:** gluconeogenesis, glycogenolysis ,.
2. **Protein metabolism:** Deamination of amino acids
→ ketoacids.

Conversion of ammonia to urea.

Formation of uric acid.

Synthesis of non essential amino acids.

3. Fat metabolism:

1. Oxidation of fatty acids to supply energy
2. Synthesis of cholesterol, lipoproteins & phospholipids.
3. Lipogenesis.

1 g of fat = 9 كيلو كالوري
1 g of glucose = 4 كيلو كالوري
1 g of protein = 4 كيلو كالوري

4. **Synthesis of** 25 hydroxy-cholecalciferol, plasma proteins (except y globulin), clotting factors.

= vitmaine D

gama globulin

يعني لو واحد شلته معدته كلها وفش ال intrinsic factor المهم لل B12 absorption (ال intrinsic factor يعمل مع ال B12 وبصيرلهم absorption في ال liver هيكفيه سنه بعديها هتظهر أعراض نقص ال B12، ولو واحد Crohn's disease وال terminal ileum خربان وفش absorption لهاد ال complex، برضو بعد سنة بتبين الأعراض

4. Storage function:

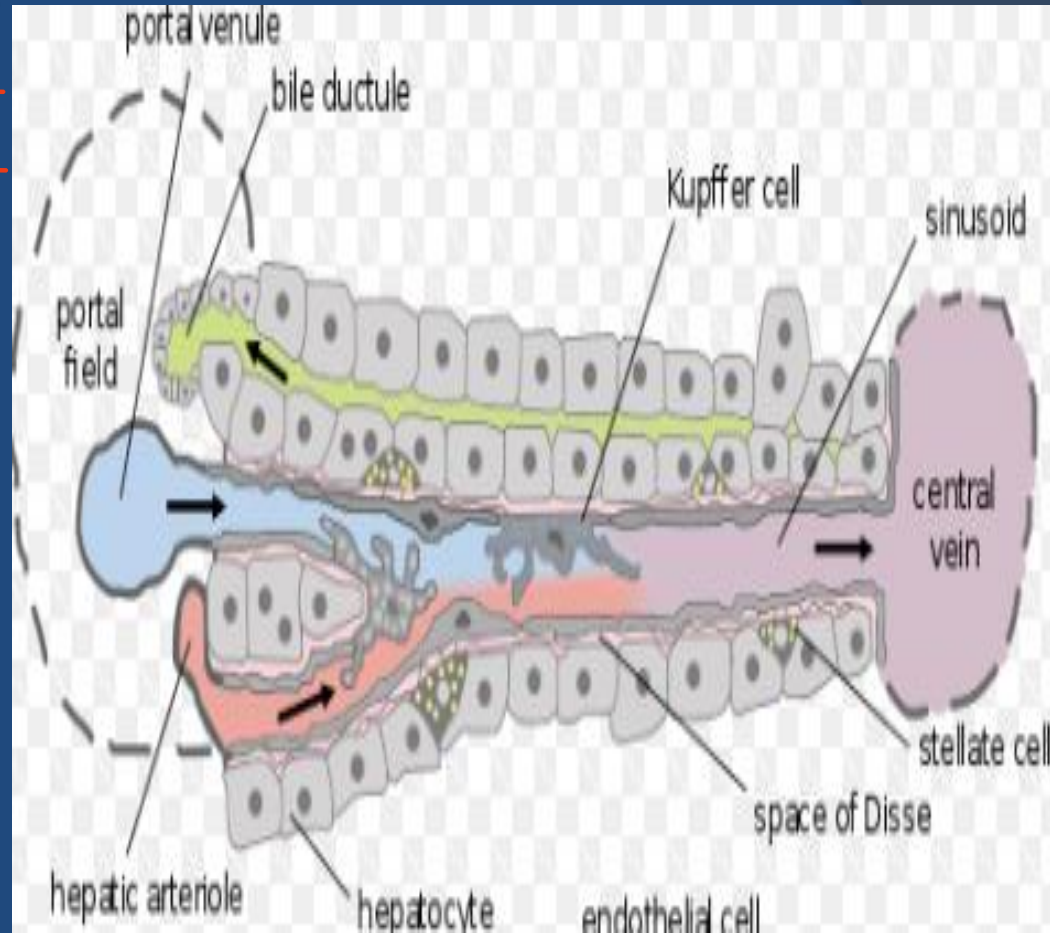
ال liver فيه supply لل Vitamine A لعشر شهور

Glycogen, Vitamin A
(ten months), D (3-4
months), B12 (12
months), Iron as
ferritin.

5. Excretory function ;bile
pigments, cholesterol.

6. Detoxification of drugs
& hormones (thyroxin,
steroid).

7. Immunity:Kupffer
cells.



Bile

- Bile is an important digestive juice that is secreted by the liver and stored into the gall bladder.

زَي مَا قَلْنَا ال primary secretion الي بصير في ال salivary acini

- **Initial secretion** The liver forms and secretes 600-1200 ml of bile/ day by the liver hepatocytes into the biliary canaliculi rich in bile acids, cholesterol, lecithin to reach the hepatic duct.
بتجمعوا ويعملوا R&L hepatic duct

زَي مَا قَلْنَا ال secondary secretion الي بصير في ال salivary ducts

- **Second secretion** by hepatic ducts rich in Na&Hco3 then the bile empties into the duodenum or through the cystic duct into the gall bladder.

Composition:

Volume: 600-1200 ml/day.

pH: 7.8- 8.6.

Alkaline, to neutralise the acidity of the gastric secretion in the duodenum

بتعمل acidification of bile، فال
bicarbonate بتقل في ال liver

Gallbladder Bile

يعمل concentration و storage
لل bile، فبيدهي المي هتقل

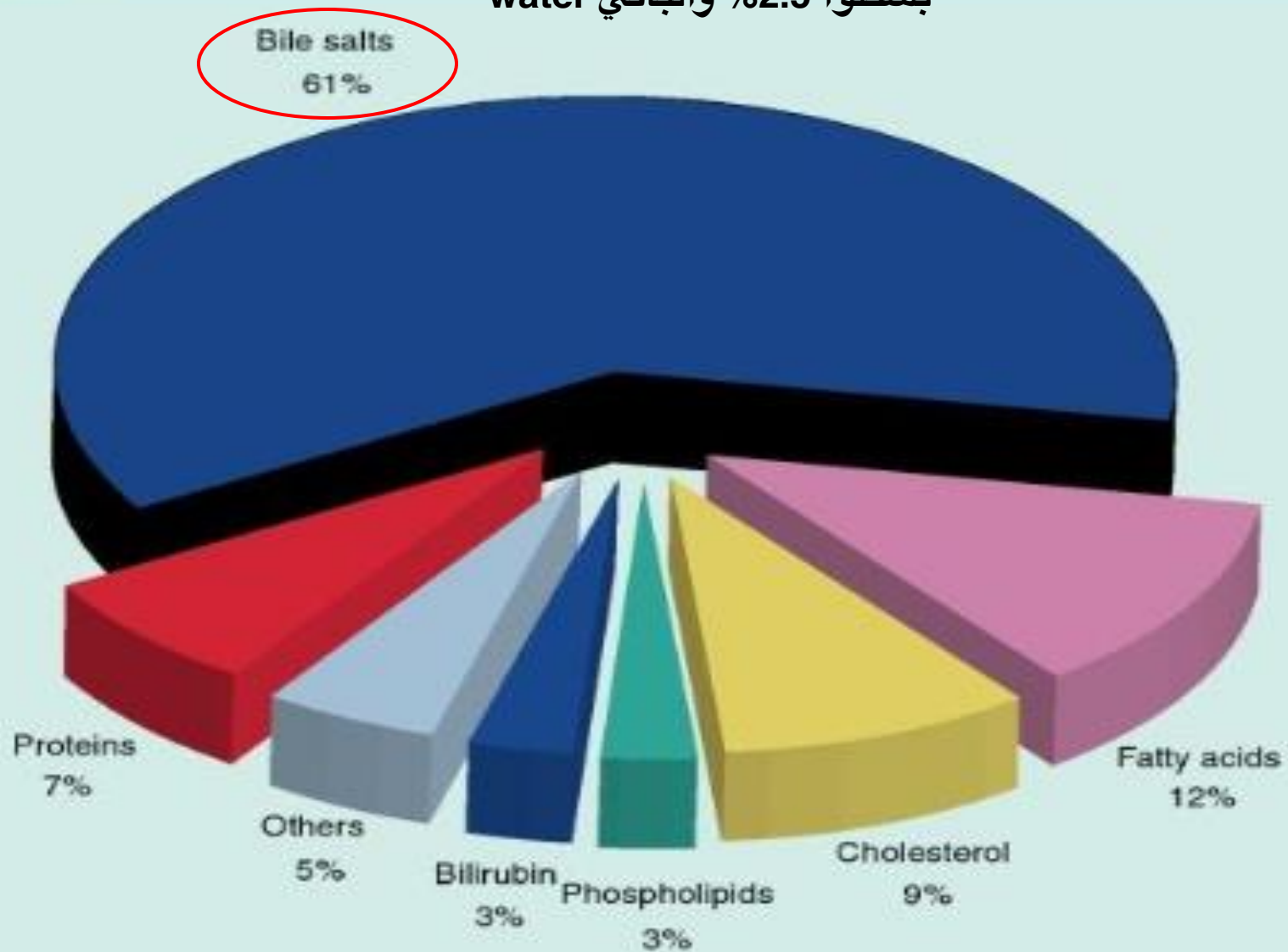
Liver Bile

المي بتكون فيه كثير

Water	97.5 g/dl	92 g/dl
Bile salts	1.1 g/dl	6 g/dl
Bilirubin	0.04 g/dl	0.3 g/dl
Cholesterol	0.1 g/dl	0.3 to 0.9 g/dl
Fatty acids	0.12 g/dl	0.3 to 1.2 g/dl
Lecithin	0.04 g/dl	0.3 g/dl
Na ⁺ reabsorption of Na بصير	145.04 mEq/L	130 mEq/L
K ⁺ secretion of K بصير	5 mEq/L	12 mEq/L
Ca ⁺⁺	5 mEq/L	23 mEq/L
Cl ⁻	100 mEq/L	25 mEq/L
HCO ₃ ⁻	28 mEq/L	10 mEq/L

Organic composition of bile

بشكلوا 2.5% والباقي water



Constituents:

1-Aqueous constituents (alkaline fluid, 97.5%);

- Secreted by Duct cells.
- H₂O, Inorganic salts 0.5% (Na⁺, K⁺, Ca²⁺, Cl⁻, HCO₃⁻).

2-Organic constituents (2.5%):

- Secreted by Hepatocytes.
- (Bile salts, bile pigments, fatty acids, cholesterol, lecithin).

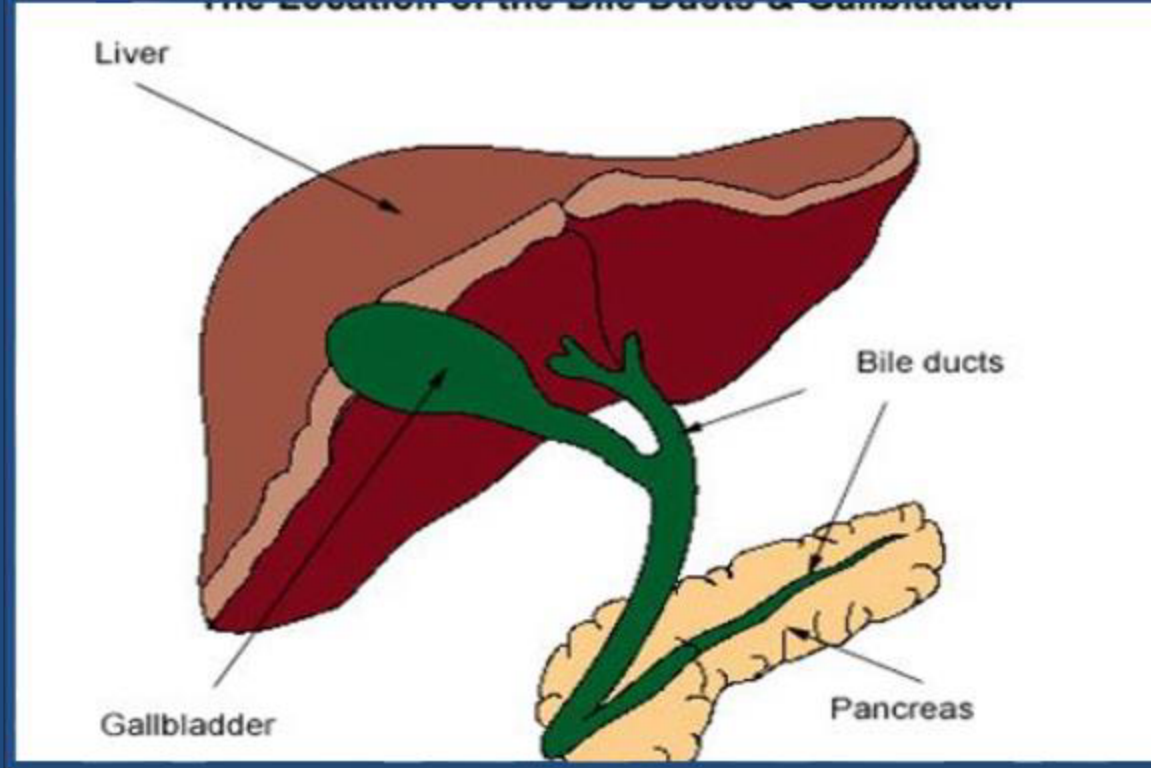
3-Alkaline phosphatase enzyme. Biliary ducts ال بنفرز من ال

في منه خمسة، واحد بطلع من ال bone، واحد من ال liver (أهم اثنين)

وفي بطلعوا من ال brain وال placenta

- فلو واحد عنده ال Alkaline phosphatase عالي في جسمه، يا يكون في مشكلة في

ال bone، يا مشكلة في ال liver



Liver continuously synthesizes & secretes bile. Between meals, **sphincter of Oddi** is closed so secreted bile is moved into the gall bladder to be stored and concentrated. During meal, bile is secreted from the gall bladder & liver .

Functions of bile

مثّل لحالته، يرضو في ال pancreatic secretions الي
تعتبر more alkaline than liver bile

- **Neutralization of HCl :** Share in HCl neutralization in the duodenum due to its high bicarbonate content. Its mucus content protect duodenal mucosa.

ال bile acids مع ال Na أو مع
ال K بصير اسمهم bile salts

- **Digestive function:** Bile contains bile acids & salts , which are critical for digestion and absorption of fats and fat-soluble vitamins in the small intestine.

- يساعد في هضم الدهون، لكن فش فيه enzymes للهضم

Destruction of the old RBCs

- **Excretory function:** Many waste products (bilirubin & cholesterol) , are eliminated from the body by secretion into bile and elimination in feces.

cholesterol لو زاد كثير ممكن يعمل
stones in the gallbladder

Free cholesterol is not soluble in aqueous solutions, but in bile, it is made soluble by bile acids and lipids like lecithin.

- Bile salts are important for cholesterol homeostasis,
- Hepatic synthesis of bile acids accounts for the majority of cholesterol breakdown in the body. In humans, roughly 1-2g of cholesterol are converted to bile acids and eliminated in bile every day.

Bile salts

- Bile acids (600 mg daily) are synthesized in the hepatocytes from cholesterol.
- Cholesterol is converted into the (primary), bile acids cholic and chenodeoxycholic acids which are then conjugated to an amino acid (glycine or taurine) to yield the conjugated form that is actively secreted into canaliculi.
بعد هيك لو ارتبطوا في Na أو K بصير bile salts
- Bile acids contain both hydrophobic (lipid soluble) and polar (hydrophilic) faces. 2ry bile acids deoxycholic , lithocholic acids are formed by bacterial action in colon.
بصيرله reabsorption
Lost in the stool
تقريباً هو المسؤول عن لون ال stool
- Tertiary(ursodeoxycholic,sulpholithocholic.

بنستخدمهم مرات في الي عندهم
jaundice عشان نقلل الحكة

3- من الأربعة بصيرلهم reabsorption
والرابع بروج في ال stool

Functions of bile salts: زي ما تحكي bile acids برضو

1. They help fat digestion by decreasing surface tension of fat globules $\rightarrow$ يعني ال الكبير بنحوه لصغير fat emulsification (detergent function) to small droplets.

2. They are essential for absorption of

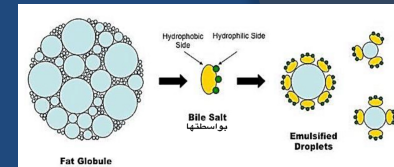
◆ Fatty acids

◆ Monoglycerides

◆ Cholesterol.

◆ Other lipids from the intestinal tract. & fat soluble vitamins (A,D,E, K).

كيف؟؟ by forming the Micelles الي هو عبارة عن
الدهون الي هي mono glycerol و free fatty acid
محاطة ب bile salts عشان تصير water soluble



(forming Micelles which are water soluble complexes). If absent, 40-50% of fats will lost in feces. وهاد بصير عند الي عنده مشكلة في ال liver او ال pancreas

3. They are cholertics .i.e. stimulate bile flow. ال bile salts بتعمل feed back ويتساعد انه يصير إفراز لل bile كمان

4. Laxative action by stimulating intestinal peristalsis.

5. They are essential for keeping cholesterol dissolved in bile. بدون هيصير حصوات cholesterol

Liver Secretion Of Cholesterol And Gallstone Formation

- ❖ Bile acids are formed in the hepatic cells from cholesterol in the blood plasma.
- ❖ BS are conjugated in liver by amino acids glycine and taurine to glycocholic and taurocholic acids.
- ❖ Both form salts by binding to Na, K in alkaline bile
- ❖ In the process of secreting the bile salts about 1 to 2 grams of cholesterol are removed from the blood plasma and secreted into the bile each day.

Causes of gallstones:

1. Too much absorption of water from bile
2. Too much absorption of bile acids from bile
3. Too much cholesterol in bile
4. Inflammation of epithelium of the gallbladder

أهم واحد

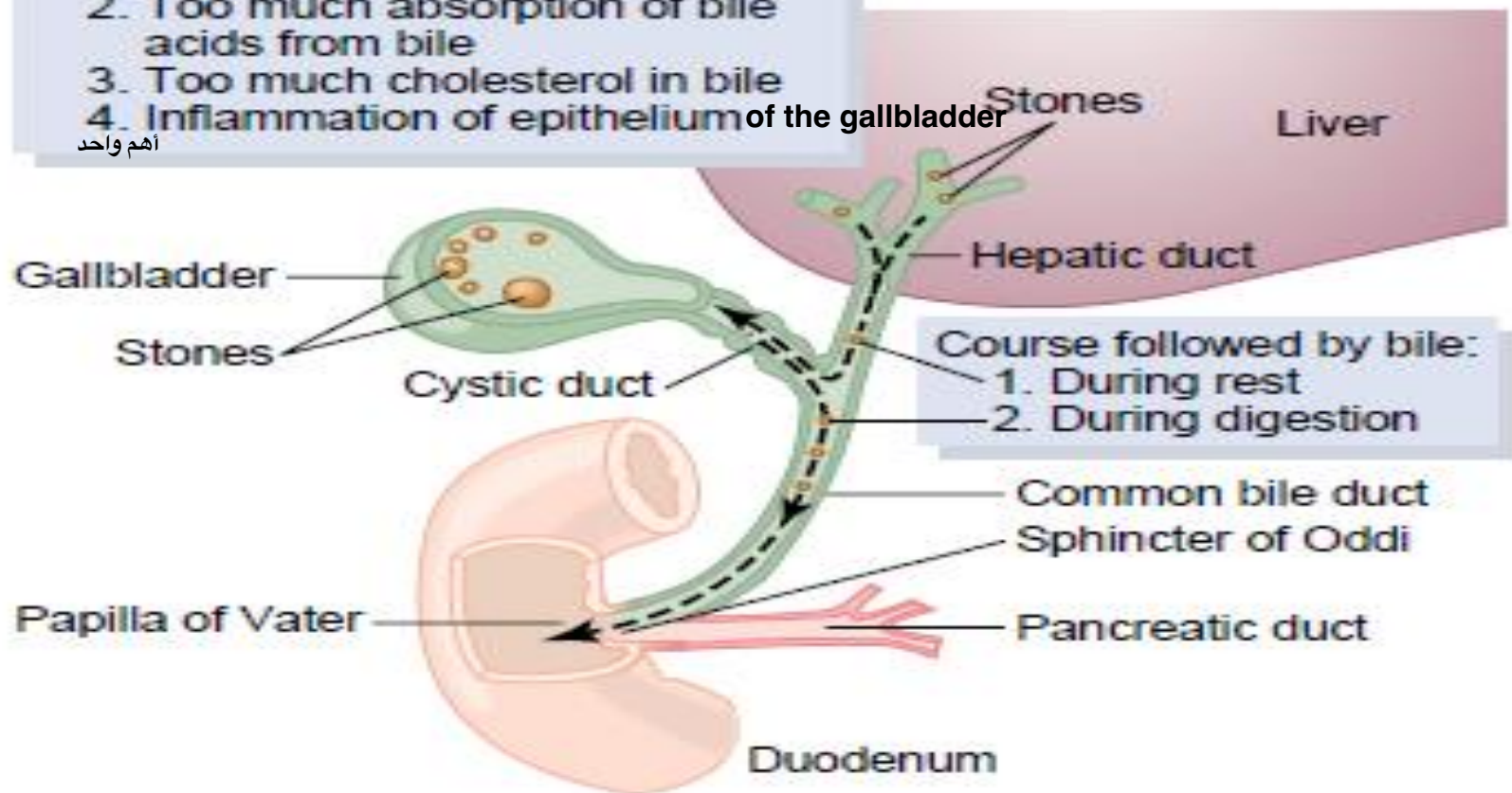


Figure 64-12

Formation of gallstones.

Digestion and Absorption

Large fat droplets enter small intestine after meal

Bile salts emulsify fats into smaller particles

Lipase breaks down fat into fatty acids and monoglycerides

Monoglycerides and fatty acids are absorbed through villi via micelles and then re-form into triglycerides

