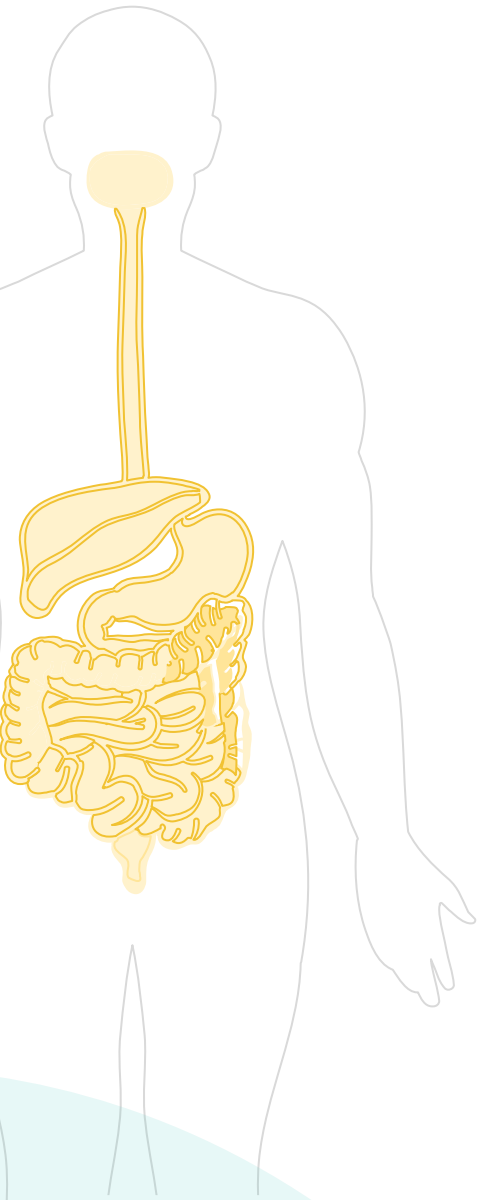
L8



# Physiology of Bile Salts & Enterohepatic Circulation

GNT Physiology

**Color Index:**

- Main text
- Important
- Female Slides
- Male Slides
- Notes
- Extra

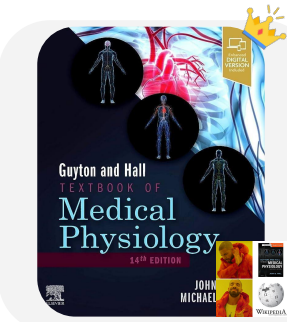
Editing File

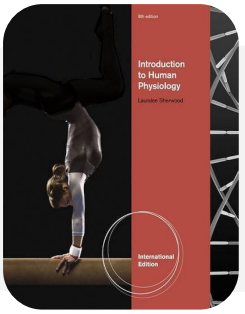
# Objectives

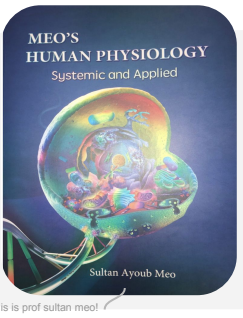
1. Liver Digestive Functions.
2. Physiologic Anatomy of Biliary Secretion
3. The Components of Bile
4. What is the bile acid ? What are the types of the bile acid?
5. Storing and Concentrating Bile in the Gallbladder
6. Function of Bile Salts in Fat Digestion and Absorption
7. Enterohepatic Circulation of Bile Salts
8. The mechanisms of bile reabsorption back into hepatocytes
9. Functions of the bile and stages of its secretion
10. Characteristics & main constituents of bile.
11. Functions of gall bladder.
12. Control of biliary system.
13. Enterohepatic circulation of bile salts.
14. Absorption, uptake & functions of bile acids.

## Resources

Only GI chapters included




This is prof sultan meo!

وَلَقَدْ خَلَقْنَا الْإِنسَانَ وَنَعْلَمُ مَا تُوَسْوِسُ بِهِ نَفْسُهُ ۖ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ (16)

يخبر تعالى، أنه المتفرد بخلق جنس الإنسان، ذكورهم وإناثهم، وأنه يعلم أحواله، وما يسره، ويوسوس في صدره وأنه أقرب إليه من حبل الوريد، الذي هو أقرب شيء إلى الإنسان، وهو العرق المكتنف لثغرة النحر، وهذا مما يدعو الإنسان إلى مراقبة خالقه، المطلع على ضميره وباطنه، القريب منه في جميع أحواله، فيستحي منه أن يراه، حيث نهاه، أو يفقده، حيث أمره، وكذلك ينبغي له أن يجعل الملائكة الكرام الكاتبين منه على بال، فيجلهم ويوقرهم، ويحذر أن يفعل أو يقول ما يكتب عنه، مما لا يرضي رب العالمين.

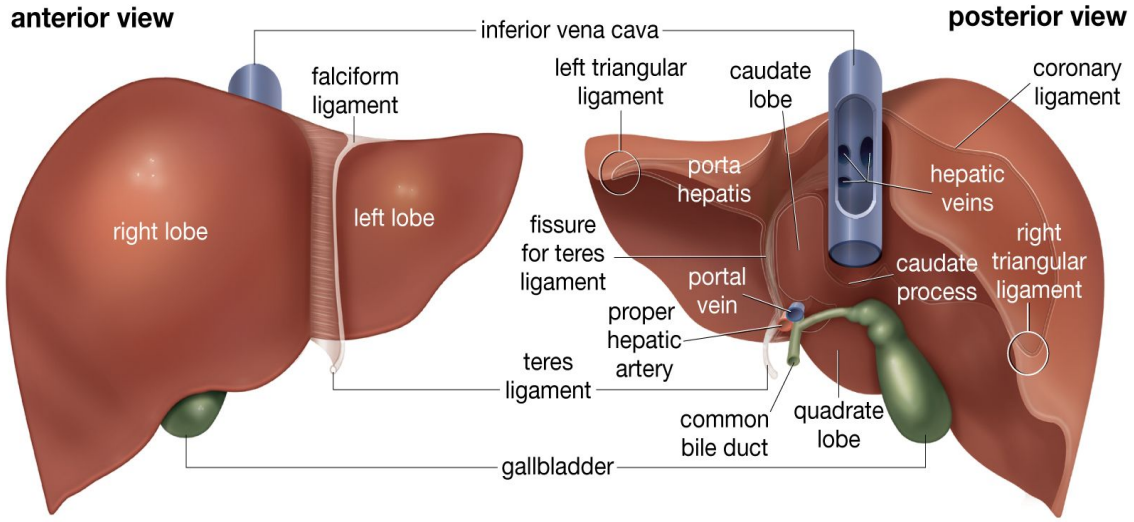
-تفسير السعدي

# The Liver

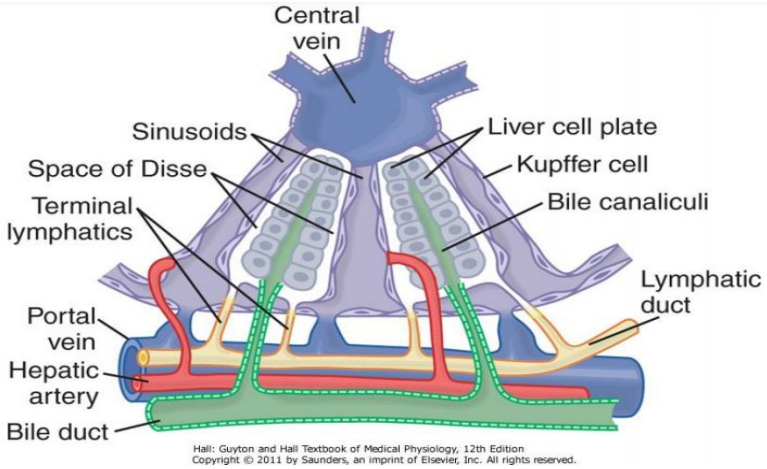
## Introduction:

- The liver is the largest internal organ in the body, constituting about 2.5% of an adult's body weight.
- Receives 25% of the cardiac output via the hepatic portal vein and hepatic artery.
- Takes up, stores, and distributes nutrients and vitamins.
- Plays an important role in maintaining blood glucose levels.
- Regulates the circulating blood lipids by the amount of very low–density lipoproteins (LDL) it secretes. Synthesizes many of the circulating plasma proteins.
- Takes up numerous toxic compounds and drugs from the portal circulation.
- Performs important endocrine functions.
- Serves as an excretory organ for bile pigments, cholesterol, and drugs.
- The main digestive function of the liver is the secretion of bile

## Anatomy of the liver:




## Bile Canaliculi & Ducts:





**Normal flow**:

Portal vein → hepatocyte→ some drains to lymphatic system

# The main digestive function of the liver

The main digestive function of the liver is the secretion of bile (normally 600-1000 ml/day).

**Bile serves two important functions:**

**It plays an important role in fat digestion and absorption by its content of bile or by the following:;**

- **They aid in absorption of the digested fat end products through the intestinal mucosal membrane, via micelles formation.**
- **Emulsifying the large fat particles of the food into minute particles.**

**bile serves as a means for excretion of waste products from the blood. These include especially bilirubin.**
***An End product of hemoglobin destruction***

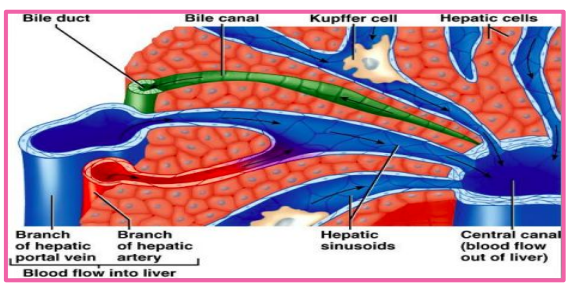
Bile is considered **secretion** and **excretion**:
I/ secretion : secret variable substance which have important physiological function.
Bile acid and bile salt are important for fat digestion and absorption.
2/ excretion.

## Gallbladder Bile Differs From Hepatic Bile

### Bile is secreted in two stages:

#### *First stage*

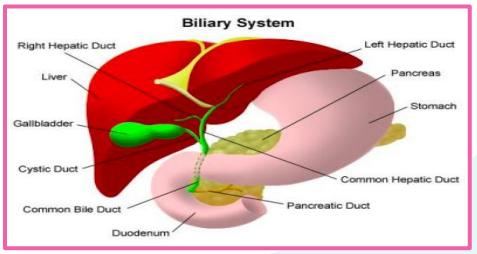
1. **The initial portion is continually secreted by the hepatocytes.**
2. **It is secreted into bile canaliculi that originate between the hepatic cells.**
3. **Hepatic Bile: Isotonic secretion, with high Na+, Cl- and HCO3-and low K+ and Ca2+.**
4. **The bile flows in the canaliculi toward the hepatic duct and common bile duct.**




#### *Second stage*

5. **From these the bile either empties directly into the duodenum or is diverted for minutes up to several hours through the cystic duct into the gallbladder, (the gallbladder is the second portion of liver secretion which is added to the initial bile).**
In between meal, when there is no need for bile, bile is diverted and stored in the gallbladder.

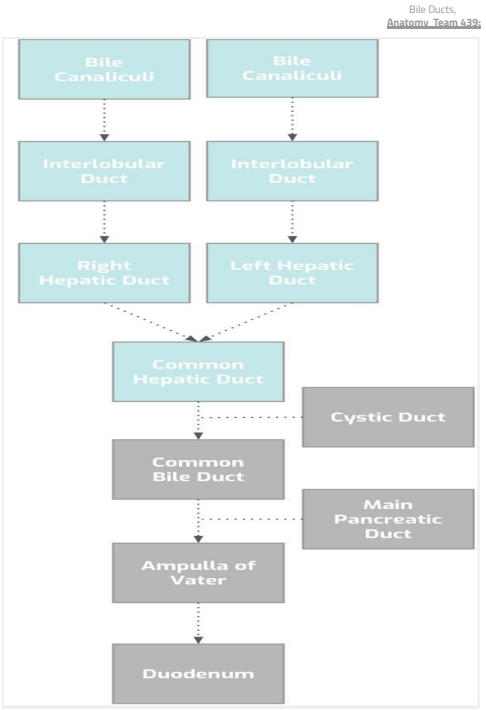
**Gallbladder bile: high Bile acid anion and Ca2+ ; but low Na+ , Cl- , HCO3 and H2O.**

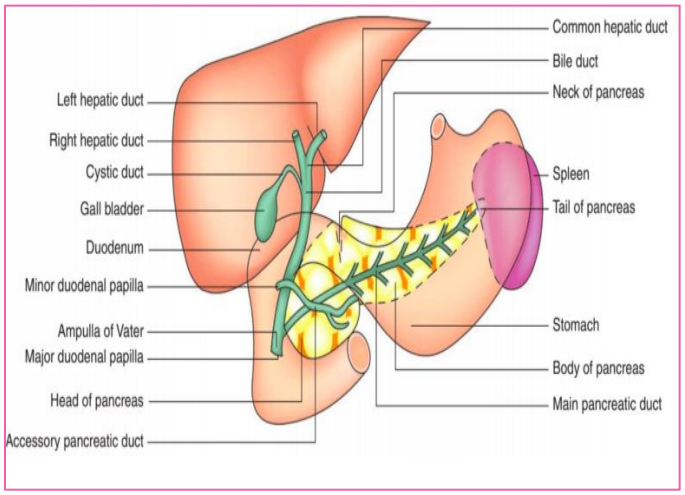


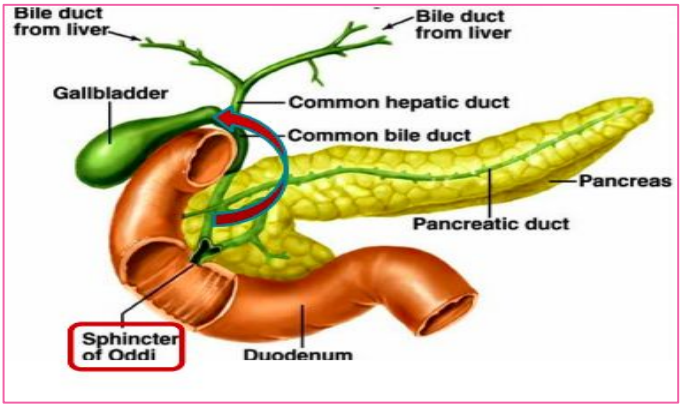
# Where The Common Bile Duct Opens

Female slides

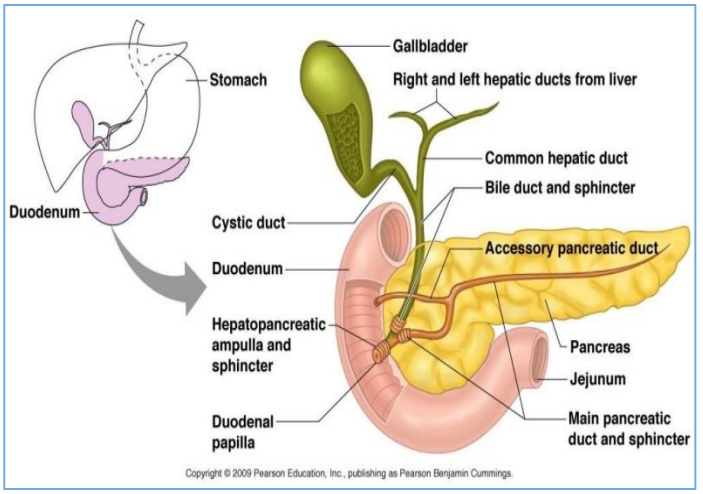
**The common bile duct open into the duodenum in company with the pancreatic duct at the ampulla of vater.**
**This opening is guarded by the sphincter of Oddi (choledochoduodenal sphincter).**




## The Gallbladder




# Characteristics of Bile

Female slides

| | |
|---|---|
| Bile is | A viscous golden yellow or greenish fluid |
| PH | Isotonic with plasma and slightly alkaline (due to NaHCO3). It participates in neutralization of acid chyme delivered from stomach.3 alkaline GI secretions ? Intestinal, pancreatic and bile. All these secretion participate in neutralization of the acid chyme from stomach. |
| Volume | The liver produces about 5 L /day, but only 600-1000 ml/day are poured into the duodenum. why? Stored and concentrated on the gallbladder. |

# What Are The Components of Bile?

Classification is based on girls slides

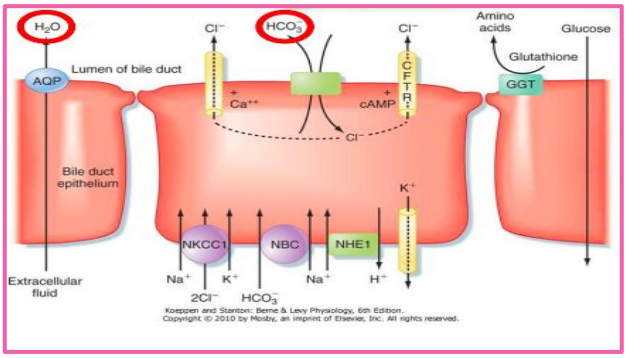
## From hepatocytes:

1. Bile acids (bile salts) (65% of dry weight of bile)
2. Phospholipids (Lecithin, 20%), phosphatidylcholine
3. Cholesterol (4%) bile is the major route for cholesterol excretion
4. Bile pigments (as bilirubin, 0.3%)
5. Ions and water
6. Proteins (5%)

## From bile ducts epithelial cells

*Female slides*

- Electrolytes mainly $HCO3^-$, in addition to H2O
- These contribute to the volume of hepatic bile.
- $HCO3^-$ aids in neutralization of acid chyme.




While passing through the duct, electrolytes and water will be added. So increase the volume.

*Female slides*

## Composition of Bile

اعادة للكلام اللي فوق:)

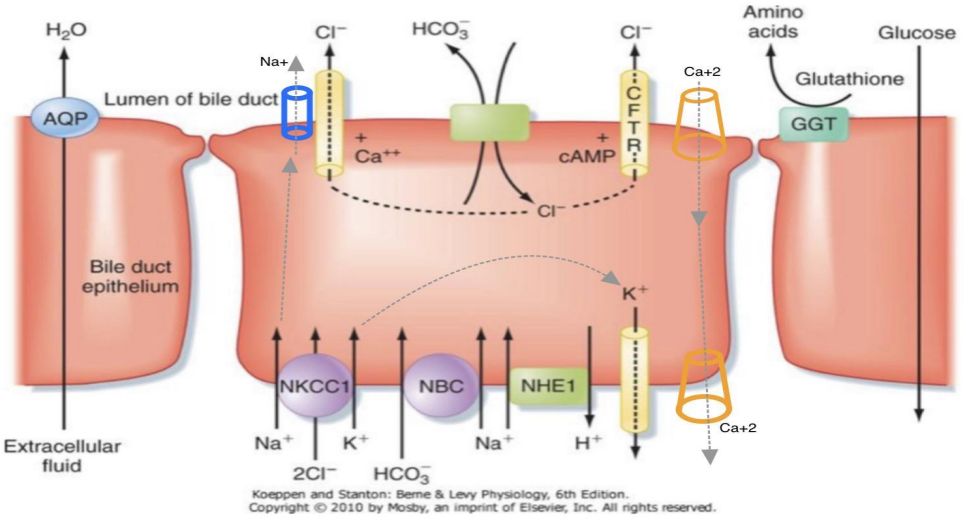
### From hepatocytes (organic constituents)

- **Bile salts(65%)**
- **Phospholipids (Lecithin, phosphatidylcholine) (20%)**
- **Proteins (5%)**
- **Cholesterol (4%)**
- **Bilirubin (0.3%)** mostly excreted out to prevent jaundice

### From ducts

- **Aqueous alkaline Solution (NaHCO3)**

# The major transport processes of <u>cholangiocytes</u> that secrete an alkaline-rich fluid




<u>Want to see Dr explanation? Click on me</u>

- **Active reabsorption of Glucose and A.A. to prevent bacterial growth.**
- **Hepatic Bile: Isotonic secretion, with high Na+, Cl- and HCO3 and low K+ and Ca2+.**

# Storing and Concentrating Bile in the Gallbladder

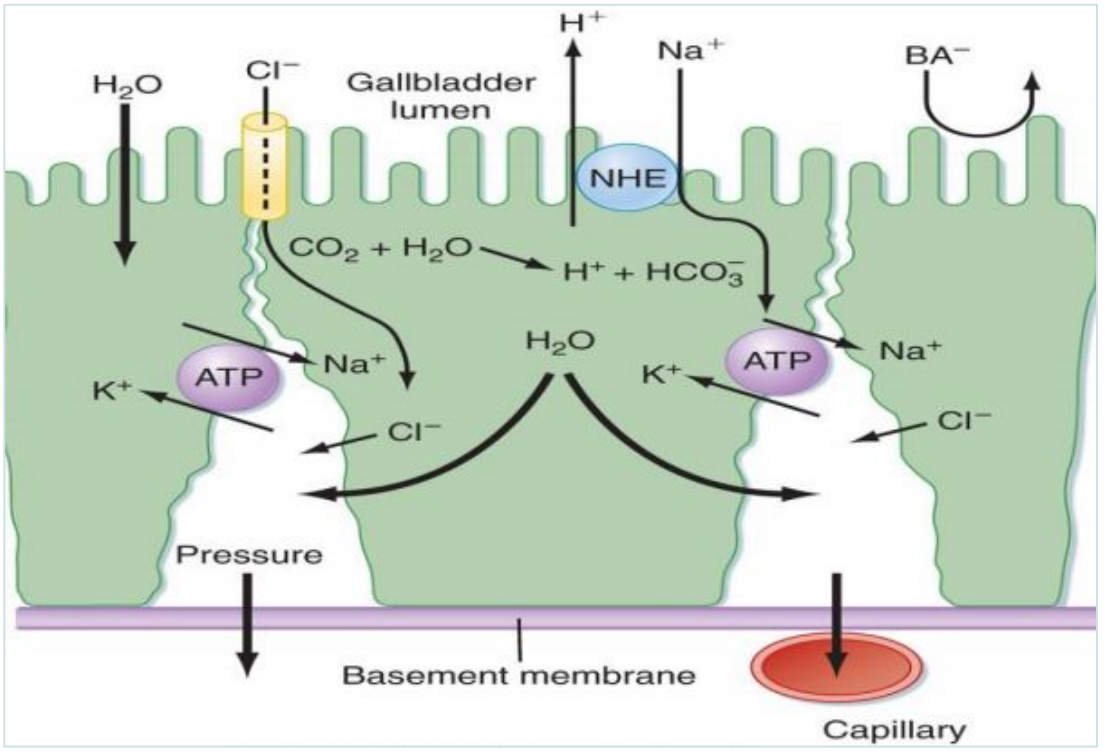
Ion Conc. in the gallbladder is almost opposite to to that of the hepatic ducts

**Bile is secreted continually by the liver cells and then normally stored in the gallbladder until needed in the duodenum (gallbladder can hold 30 to 60 mL <u>at once</u>).**

**Gallbladder concentrates the bile, which has the bile salts, cholesterol, lecithin, and bilirubin during every 12 hours of bile secretion (usually about 450 mL) because water, Na, Cl, and most other small electrolytes are continually absorbed through the gallbladder mucosa by active transport of sodium, and this is followed by secondary absorption of chloride ions, water, and most other diffusible constituents.**
**Na+ is actively transport through the gallbladder mucosa. Then, followed by secondary absorption of Cl-, water, and most other diffusible constituents.**

**Bile is normally concentrated in this way about 5-fold, but it can be concentrated up to a maximum of 20-fold.**

# Concentration of Bile During Storage in The Gallbladder




**Want to see Dr explanation? Click on me**

**The tight junctions have low permeability, they resist the passage of Bile Acid anions (BA) out of the lumen.**

**CFTR: Cystic fibrosis transmembrane conductance regulator (chloride channel).** Doctor: just know that it is a chloride channel

**Gallbladder bile: high Bile acid anion and Ca2+; but low Na+, Cl-,HCO3 and H2O.**

The function of gallbladder is to store and concentrate bile. To store the amount that is continuously secreted by the liver, it must be concentrated, why? Gallbladder capacity is only 30-60 ml, and can store about half liter or 450ml by concentrate the bile, how? By removing water, and to remove water, $Na^+$ must be transported from the lumen into the gallbladder epithelial cells by active transport, then to capillary circulation. This is followed by $Cl^-$ and $HCO_3^-$ absorption. So, due to increase osmolarity (osmotic pressure) water will move from low to high osmotic gradient.
This cause absorption of $Na^+$, $Cl^-$, $HCO_3^-$ and water.

# Differences Between Hepatic and Gallbladder Bile

*Female slides*

| | | Hepatic Bile | Gallbladder Bile |
|---|---|---|---|
| Organic | Water % | 98 | 89 |
| | Total solids % | 2-4 | 11 |
| | **Bile salts %** most important | 26 | 145 |
| | Bilirubin % | 0.7 | 5 |
| | Cholesterol % | 0.5 | 4 |
| | Phospholipids | 0.5 | 4 |
| Inorganic ( electrolytes) | Na+ | 145 | 130 |
| | Cl- | 100 | 25 |
| | HCO3- | 28 | 10 |
| | Ca++ | 5 | 23 |
| | K+ | 5 | 12 |
| | pH | 8.3 bcs of HCO3 | 7.5 |

مش مطلوب حفظ التركيز لكل المكونات. لكن مهم تعرفون هذه النقاط:

1/ all the constituents are concentrated in gallbladder bile in compare to hepatic bile **except** ( $Na^+$, $Cl^-$, $HCO_3^-$ and water ).

2/ ($Na^+$, $Cl^-$, $HCO_3^-$ and water) are low conc. in compare to hepatic bile? Due to absorption.

3/ pH of gallbladder is lower than pH of hepatic, but both are alkaline, which is **important physiologically**, because all the constituents are concentrated, it may cause $Ca^{++}$ stones. But since the pH is lower, $Ca^{++}$ solubility is more in acidic medium. So, lower pH "as compared to that of hepatic bile" prevent precipitation of $Ca^{++}$ , and guard against $Ca^{++}$ stones.

# Regulation of Bile Secretion

**Bile secretion is primarily regulated by a feedback mechanism, with secondary hormonal and neural controls.**

## Feedback Control - Most important

**The maior determinant of bile acid synthesis is its concentration in hepatic portal blood (feedback control).**

Bile acids after secretion, when they reach the duodenum and terminal ileum they are reabsorbed again into the liver through the portal circulation, which is essential to stimulate bile secretion more and more.

كأنها تعمل تحفيز ذاتي لنفسها

## Hormonal Control

**CCK,Secretin, and estrogen (Hormonal control)** stimulate bile secretion

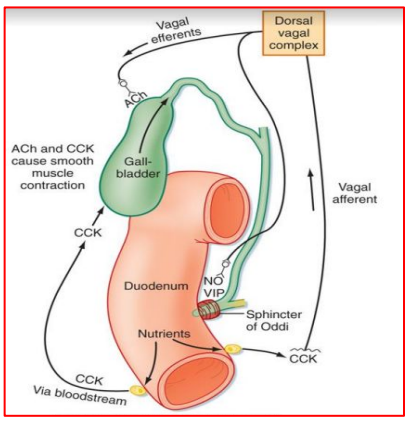
## Neural Control

**-Parasympathetic and sympathetic nerves supply the biliary system. Parasympathetic (vagal) stimulation results in contraction of the gallbladder and relaxation of the sphincter of Oddi, as well as increased bile formation.**

**-Bilateral vagotomy** (cutting of vagus nerve in left and right side) **results in reduced bile secretion after a meal, suggesting that the parasympathetic nervous system plays a role in mediating bile secretion.**

**-By contrast, sympathetic stimulation results in reduced bile secretion and relaxation of the gallbladder.** + contract the sphincter.

**Imp pic**



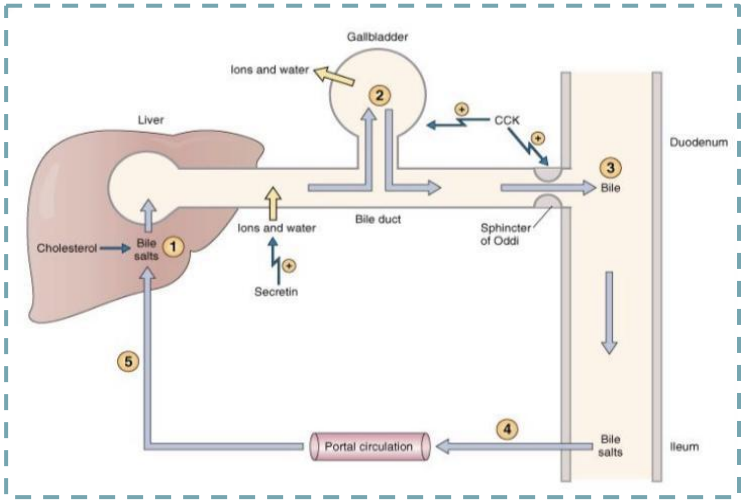

Neurohumoral control of gallbladder contraction and biliary secretion

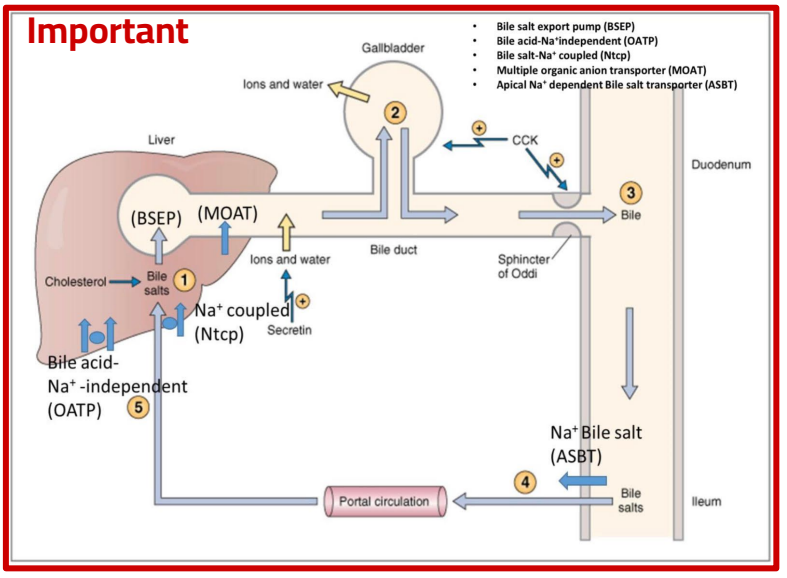
Summary: Regulators:
1- Feedback
2- Nutrients stimulate I cells to secrete CCK, which contracts the bladder and relaxes the sphincter of Oddi. CCK also stimulates dorsal vagal complex in the brainstem via the **vagal afferents, which gives commands to the vagal efferents to stimulate the gallbladder by ACh, and also it relaxes the sphincter of Oddi by NO and VIP**
CCK and vagal stimulation have the same effect

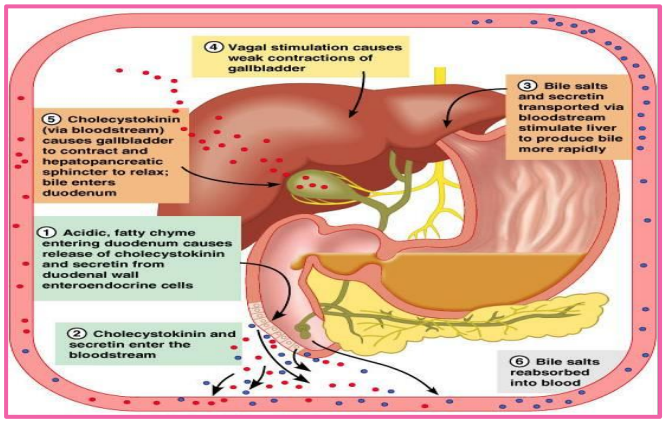
# Feedback Control of Bile Secretion through Enterohepatic Circulation of Bile Salts

The topic was found in boys and girls slides but the text was found in boys slides only. Pictures were in both.
Text from I to 5 from Male dr pic, but female dr explained the concept and the pic

| | |
|---|---|
| I | The hepatocytes of the liver continuously synthesize and secrete the constituents of bile actively by BSEP and also by MOAT (Step I) |
| 2 | The components of bile are the bile salts, cholesterol, phospholipids, bile pigments, ions, and water. secretion of these ions by cholangiocytes is stimulated by secretin, because you know that secretin hates acidity, and these secretions contains bicarbonate. Bile flows out of the liver through the bile ducts and fills the gallbladder, where it is stored (Step 2) (Some bile goes directly to the intestine without entering the gallbladder)<br>The gallbladder then concentrates the bile salts by absorption of water and ions. |
| 3 | When chyme reaches the small intestine, CCK is secreted. CCK has two separate but coordinated actions on the biliary system: It stimulates contraction of the gallbladder and relaxation of the sphincter of Oddi, causing stored bile to flow from the gallbladder into the lumen of the duodenum (Step3). In the small intestine, the bile salts emulsify and solubilize dietary lipids. |
| 4 | When lipid absorption is complete, the bile salts are recirculated to the liver via the enterohepatic circulation, mediated by the active transporter ASBT (Step 4) |
| 5 | The steps involved in the enterohepatic circulation include absorption of bile salts from the ileum into the portal circulation, delivery back to the liver mediated by two active transporters; OATP and Ntcp, and extraction of bile salts from the portal blood by the hepatocytes. (Step 5) |




Regulation of Bile secretion

Secretin directly stimulate hepatocytes to increase $HCO_3^-$ in the bile (as in pancreatic secretion)

**VERY important pic male.dr really focus on it. and read the receptors name you will need them in the next lectures.**

**Note; DR take the pic from guyton and ADD the names.**

2+I. Bile secreted "including bile salt" from liver and Gallbladder.
4. when bile reach terminal ileum, most of Bile reabsorbed again.
5. When Bile reach the to the liver, it stimulate the liver for synthesis of more Bile and bile salts

# Bile acids & salts

## What is the bile acid ?
## What are the types of the bile acid?

- Bile acids are formed in the liver from **cholesterol** (Doctor: we asked about this in previous exams). During the conversion, hydroxyl groups and a carboxyl group are added to the steroid nucleus.
- Bile acids are steroid acids, synthesized in the liver from cholesterol by the **enzyme cholesterol 7 α-hydroxylase.**

**Bile acids are classified as:**

### Primary

- hepatocytes synthesize the primary bile acids (**by 7 o-hydroxylase**), which includes:
- **cholic acid**
- **chenodeoxycholic acid**

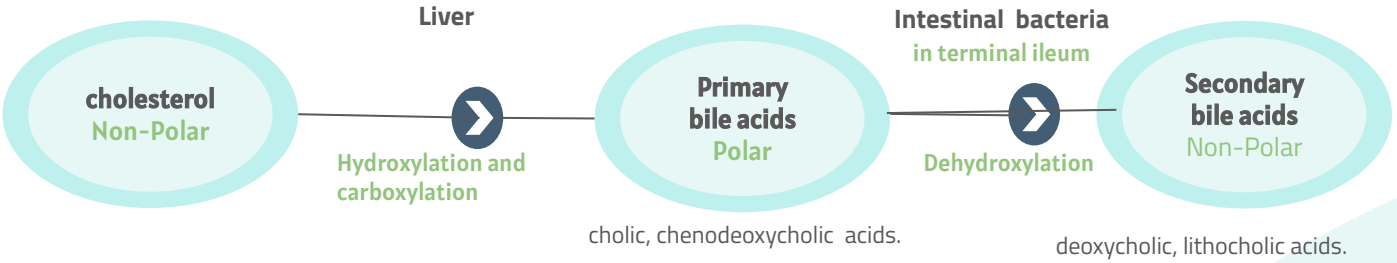
### Secondary

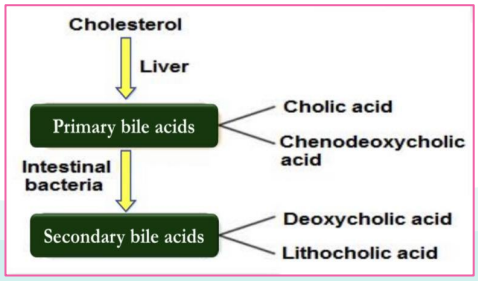
- **deoxycholic acid**
- **lithocholic acid**

In intestine by bacterial flora, they convert primary bile acids to secondary bile acids.

## Bile acids conversion

- The principal primary bile acids conjugate with glycine or taurine to form glycin and taurocholic bile acids. Bile acids are secreted as conjugates of taurine or glycine.
- When bile enters the GI tract, bacteria present in the lumen act on the primary bile acids and convert them to secondary bile acids by dehydroxylation.
  **1-Cholic acid is converted to deoxycholic acid.**
  **2-Chenodeoxycholic acid to lithocholic acid.**
  Which is cytotoxic and can be sulfated by the liver if it presents in high concentration(most of it are excreted into the feces).
- Primary bile acids are more effective than secondary bile acids for solubilizing lipid



# Properties of Bile acids & salts

1

**At a neutral pH, the conjugated bile acids are mostly ionized, more water soluble, and are referred to as bile salts. Conjugated bile acids ionize more readily than the unconjugated bile acids and, thus, usually exist as salts of various cations (mostly Na+) e.g., sodium glycocholate and are called bile salts.** Bile salt are more polar and more water soluble. So, they cross the cell membrane of intestinal epithelium poorly ( cross the membrane at slower rate than Bile Acid). So, they remain for a sufficient time in the small intestine until most of the fat and fat soluble vitamin are Absorbed
(we need Bile acids to form micelles to help fat Absorption)

2

**The conjugation biochemical reaction decreases the pKa(more easy to become salt)of the compound and make it more ionized.**

3

**Bile salts are much more polar than bile acids and have greater difficulty penetrating cell membranes. Consequently, the small intestine absorbs bile salts much more poorly than bile acids. This property of bile salts is important because they play an integral role in the intestinal absorption of lipid. Therefore, it is important that the small intestine absorb bile salts only after all of the lipid has been absorbed.** More polar means it will help in emulsification , and last to be absorbed after all lipids

4

**Bile acids are amphipathic that is having both hydrophilic & hydrophobic domains and tend to form molecular arrangement called micelles. In bile acid micelle, the hydrophobic side of bile acid faces inside & away from water. The hydrophilic surface faces outward towards the water.**
**Bile acid micelles form when the conc. of bile acids exceed a certain limit (critical micelle conc.). Above this conc., any additional bile acid will join the micelle. Normally bile acid conc. in bile is much greater than critical micelle conc.**
معناها انهم دائمًا موجودين في حالة ال micelles للمساعدة في fat absorption.
Also, make the cholesterol in the bile globule form > prevent formation of cholesterol stones.

*Male slides*

## Functions of Bile salts in Fat Digestion and absorption

**Figure 26.13: Bile acids are formed from cholesterol *in the liver.***
**Bile acids are conjugated with the amino acid, glycine, and taurine (which is an organic compound available in animal tissue) in the liver.**

**At neutral pH, the bile acids are mostly ionized and referred to as bile salts.**

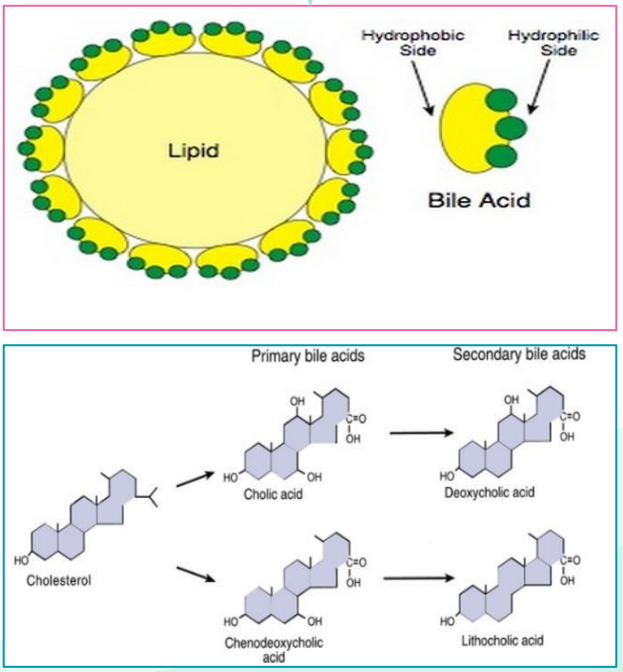


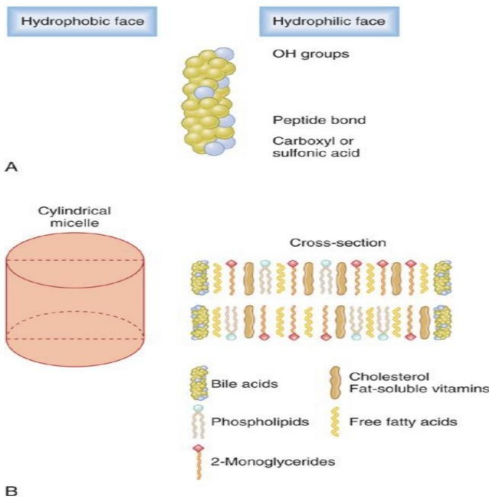

Figure 26.13

# Role of Bile Salts to Accelerate Fat Digestion
# Formation of Micelles

*Male slides*

- Bile salts have the ability to form **micelles**, (each bile salt molecule is composed of a sterol nucleus that is fat-soluble and a polar group that is water-soluble.
- **Micelles** are small spherical, cylindrical globules 3 to 6 nm in diameter composed of 20 to 40 molecules of bile salt.
- The polar groups are (-) charged, they allow the entire micelle globule to dissolve in the water of the digestive fluids and to remain in stable solution.
- **The micelles act as a transport medium to carry the monoglycerides and free fatty acids to the brush borders of the intestinal epithelial cells.**

*Micelles Formation*



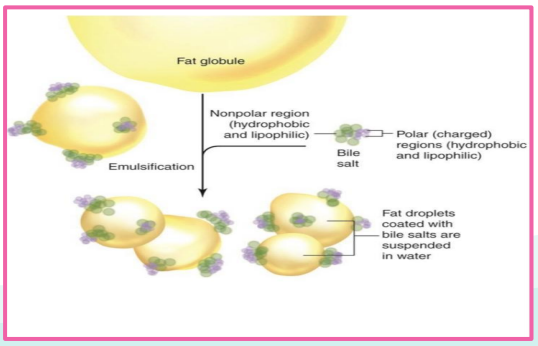

# Functions of Bile Salts/ acids

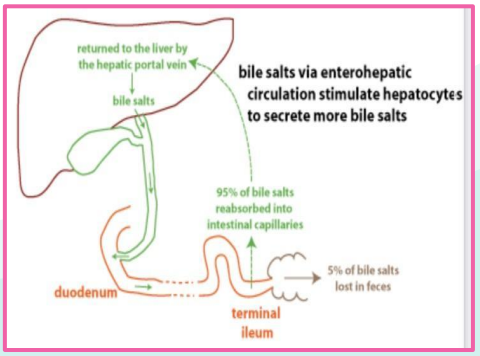
**1** (Digestion of fat):They have a detergent action (emulsifying) on the fat particles in the food which decreases the surface tension of the particles./ Bile salts have a detergent action that help fat digestion by decreasing fat surface tension resulting in emulsification of fats into small particles. This increase the surface area upon which the digestive enzymes will act.

**2** (Absorption of fats):- • Bile salts combine with fats to form micelles (water soluble compounds) /They help in the absorption of fatty acids, monoglycerides, cholesterol, and other lipids from the intestinal tract. Without the presence of bile salts in intestinal tract up to 40% of lipids are lost into the stools (steatorrhea).

**3** **Bile salts are essential for absorption of fat soluble vitamins (A, D, E and K).** (KADE=كادي )

**4** In the liver, bile salts are important for stimulating bile secretion and flow (choleretic action). They also take part in the formation of micelles which render cholesterol molecules soluble in bile.



# Enterohepatic Circulation (Portal circulation) of Bile Salts/ Enterohepatic Circulation of Bile Acids

**Enterohepatic Circulation of Bile Salts:**

is the recycling of bile salts between the small intestine and the liver.

**Total Bile Acid Pool**

Is The total amount of bile acids in the body, primary or secondary, conjugated or free, at any time.

In healthy people, the bile acid pool ranges from 2 to 4 g.

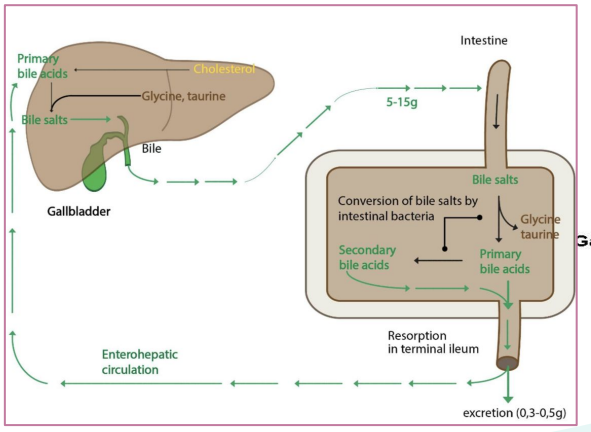
The enterohepatic circulation of bile acids in this pool is physiologically extremely important. By cycling several times during a meal, a relatively small bile acid pool can provide the body with sufficient amounts of bile salts to promote lipid absorption. In a light eater (little fat in the diet), the bile acid pool may circulate three to five (3-5) times a day; in a heavy eater (high fat in the diet), it may circulate 14 to 16 times a day. So, enterohepatic circulation depend on the diet.

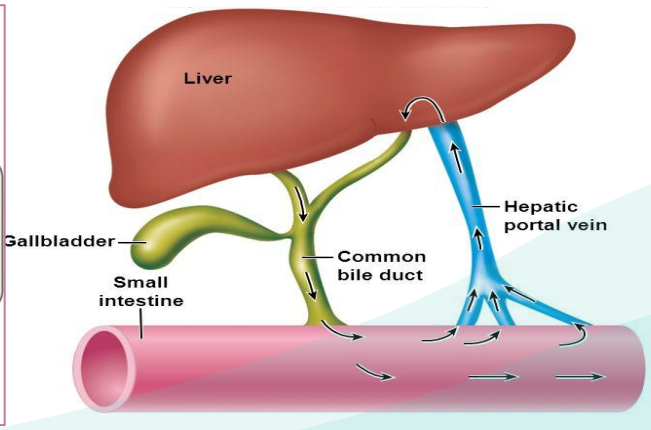
The intestine is normally extremely efficient in absorbing the bile salts by carriers located in the distal ileum. Inflammation of the ileum can lead to their malabsorption and result in the loss of large quantities of bile salts in the feces e.g., inflammatory bowel diseases (Crohn's disease and Ulcerative Colitis).

If enterohepatic circulation is interrupted (e.g. due to obstruction or surgical removal or inflammation of the terminal ileum , bile flow is markedly reduced and Large quantities of bile salts enter the colon (diarrhea) and lost in the feces.

Depending on the severity of illness, malabsorption of fat may result in steatorrhea (fat in stool) because bile salt pool was depleted following the ileal inflammation or resectioning. Presence of bile salt in the colonic lumen will activate Cl secretion, Na and water will follow Cl into the intestinal lumen, producing **secretory diarrhea.**

Steatorrhea is Due to :
- deficiency of bile.
- insufficiency of pancreatic lipase.
-Malabsorption and maldigestion.

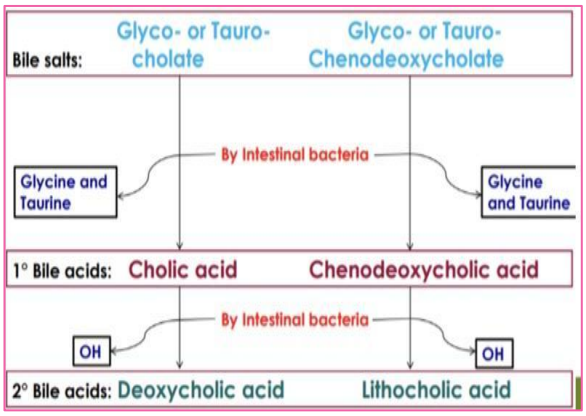


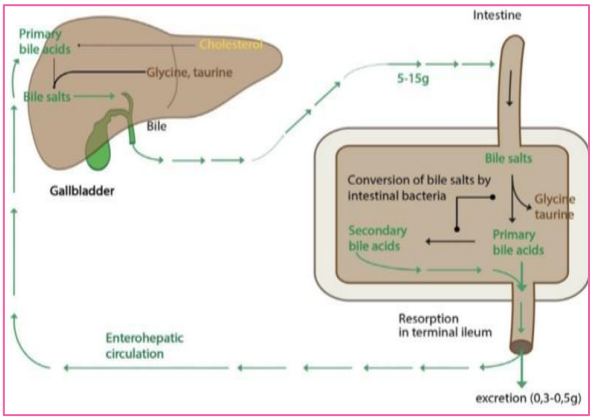



## Enterohepatic Circulation (Portal circulation) of Bile Salts/
## Enterohepatic Circulation of Bile Acids

*Female slides*

- About 5-15 g of bile acids are poured into the duodenum/day.
- In the intestine, some of bile acids are deconjugated and dehydroxylated in the 7 α position by intestinal bacteria that normally colonize in the digestive tract.
- Dehydroxylation results in the production of <u>secondary bile acids:</u>
  1-Cholic acid is converted to deoxycholic acid
  2-chenodeoxycholic acid to lithocholic acid.
- On reaching the terminal ileum, about 95% of bile acids are absorbed and reach the liver through the portal vein. Stimulate more bile secretion ( feedback control ).
- About 0.3-0.5 g of bile acids are lost in feces daily (15-35% of total bile acid pool). These are replaced by new synthesis in liver. So, total bile acids remain constant. Feedback regulation will stimulate liver to synthesis the same amounts of BA that is secreted out with feces.




What is the difference between primary and secondary ?
Primary bile acids contain hydroxyl group and conjugate with amino acids ( glycine and taurine ).
So, it converts to secondary by deconjugation and dehydroxylation ( in intestine by intestinal flora ).

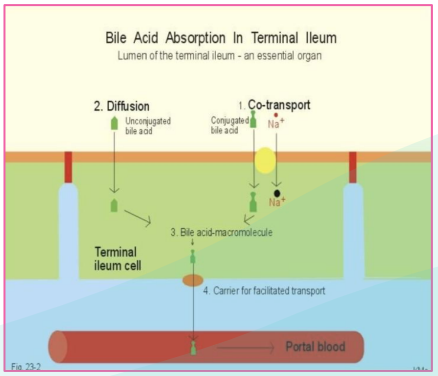
## Absorption of Bile Acids in The Small intestines

*Female slides*

**Bile acids are absorbed largely in the <u>terminal part of the ileum.</u> They cross the brush border plasma membrane by two routes:**

**Unconjugated bile acids are better absorbed by <u>simple diffusion</u>. (They are less polar).**

**Conjugated bile acids are <u>2ry active transported</u> (Sodium dependent ) powered by the Na+ gradient across the brush border membrane.The same as amino acids, glucose and galactose**

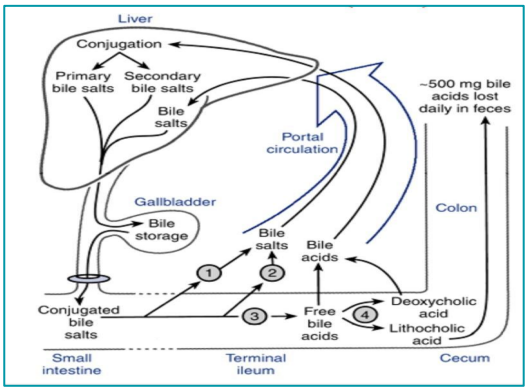


# Absorption of Bile Acids into portal circulation

**IMPORTANT**

**Bile salts or bile acids in the intestine lumen are absorbed via four pathways into portal circulation (enterohepatic circulation):**

- **Passive diffusion**
- **An active carrier-mediated process(Apical Na+ dependent Bile salt transporter (ASBT).**
- **De-conjugation and/or transforming of bile salts to bile acids (by bacteria)**
- **Transforming the primary bile acids to secondary bile acids (by bacteria)**



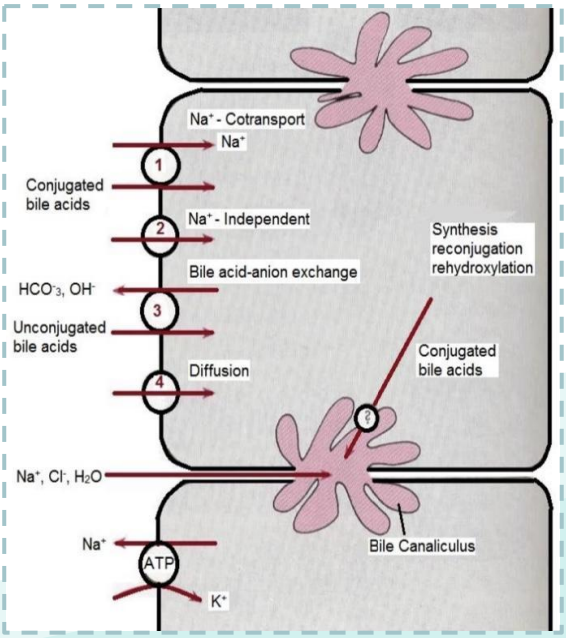

The Enterohepatic Circulation recycles bile salts between the small intestine and the liver

**IMPORTANT**

## Absorption of bile acids or bile salt back into hepatocytes

- **Multiple transport mechanisms are located in the hepatocyte plasma membrane for uptake of bile acids from sinusoidal blood.**
- **Bile salts or bile acids in the portal circulation are absorbed via four pathways into hepatocytes:**

1. **An active carrier-mediated process.**
   **conjugated bile acids-Na co-transport (Bile salt-Na+ coupled (Ntcp).**
2. **Na-independent pathway (Bile acid-Na+ independent (OATP).**
   **Facilitated diffusion** (Sodium independent)
3. **Bile acid-HCO3 or Bile acid-OH exchange.**
   - $OH^-$ and $HCO_3^-$ = reabsorbed or leave the cell.
   - unconjugated bile acid - enter into the cell.
4. **Passive diffusion (very little).**



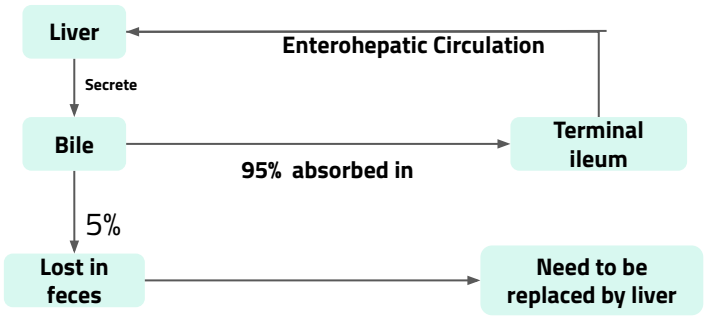
## Absorption of bile acids or bile salt back into hepatocytes

1. Hepatocytes extract bile acids, essentially clearing the bile acids from the blood in a single pass through the liver.
2. In the hepatocytes, most deconjugated bile acids are reconjugated & some 2ry bile acids are rehydroxylated.
3. The reprocessed bile acids, together with newly synthesized bile acids, are secreted into bile.

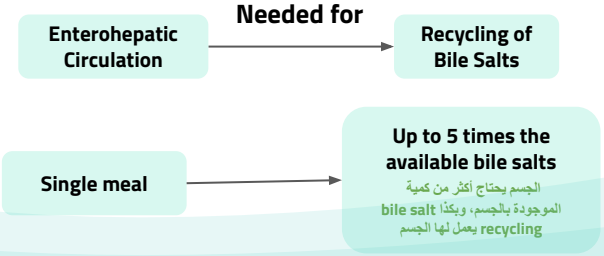
## Importance of Enterohepatic Circulation of Bile Acids

Female slides

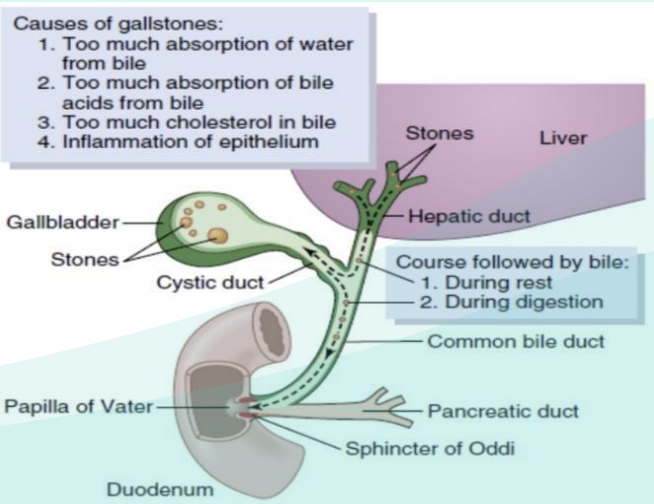
1. It is essential for stimulating & maintaining the secretion of bile by hepatocytes.
2. **The greater the quantity of bile salts in the enterohepatic circulation, the greater the rate of bile secretion.** the greater bile is absorbed the greater will be secreted when there is food and need it ,and less synthesis
3. By cycling several times, a relatively small bile acid pool can provide the body with sufficient amounts of bile salts to promote lipid absorption.




## Why Recycling Bile salts is needed?




## Gallstones



# TEST YOURSELF !

## MCQ:

**Q1) Hepatic bile secretion is containing:**

A) High Bile acid anion and Ca2+

B) Low Na+ , Cl- , HCO3 and H2O

C) Low K+ and Ca2+

D)B + C

**Q2) Which of the following is the action of bile salt on the digestion of fat:**

A) Break triglycerides to FFA

B) Emulsify fat to small particles

C) Increase fat surface tension

D) Reduce cholesteryl ester

**Q3) Chenodeoxycholic acid is converted to lithocholic acid by:**

A) Liver enzymes

B) Intestinal mucosa

C) Intestinal bacteria

D) Micelles

**Q4) The absorption of bile salts occur in:**

A) 3rd part of the duodenum

B) Jejunum

C) Ileum

D) Colon

Answers: Q1:C | Q2:B | Q3:C | Q4:C

## SAQ:

**Q1) Name 4 pathways for absorption of bile acids into the portal circulation ?**

- 1-passive diffusion.
- 2-active carrier-mediated process.
- 3-Transforming bile salts to bile Acids.
- 4-Transforming primary bile acids to secondary bile acids.

**Q2) Mention FOUR functions of bile acids?**

1-essential for absorption of fat soluble vitamins (A, D, E and K).
2-Emulsify fat to small Particles.
3-They help in the absorption of fatty acids.
4-stimulate bile secretion and flow (choleretic action).

PHYSIOLOGY

GNT Block

Team 443

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