

[lecture 6]

# Biochemical Aspects of Bile Acids and Salts



## The Objectives

- Structure of primary bile acids and salts
- Structure of secondary bile acids and salts
- Functions of bile salts
- Enterohepatic circulation
- Malabsorption syndrome
- Cholelithiasis

Red =  
Important

Blue =  
explain

Green =  
addition  
notes



# Mind Map

Cholesterol

Primary Bile Acids and salts

Hormonal Control of Bile Secretion

Functions of Bile Salts

Enterohepatic circulation

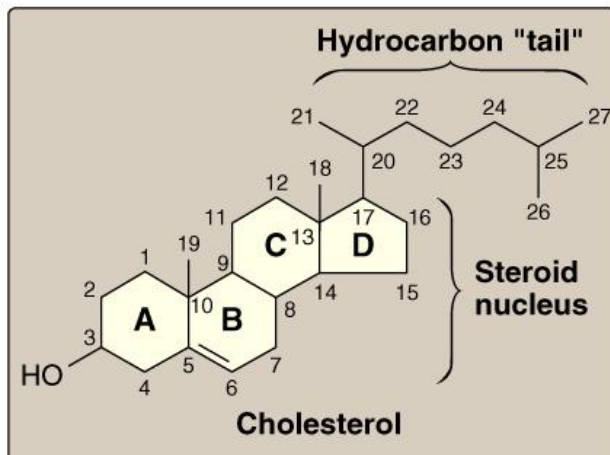
Malabsorption syndrome

Cholelithiasis

# Cholesterol

Cholesterol (27 C) is the:

- ❖ Parent steroid compound
- ❖ Precursor of bile acids and salts  
(One of major excretion of cholesterol is bile acid)



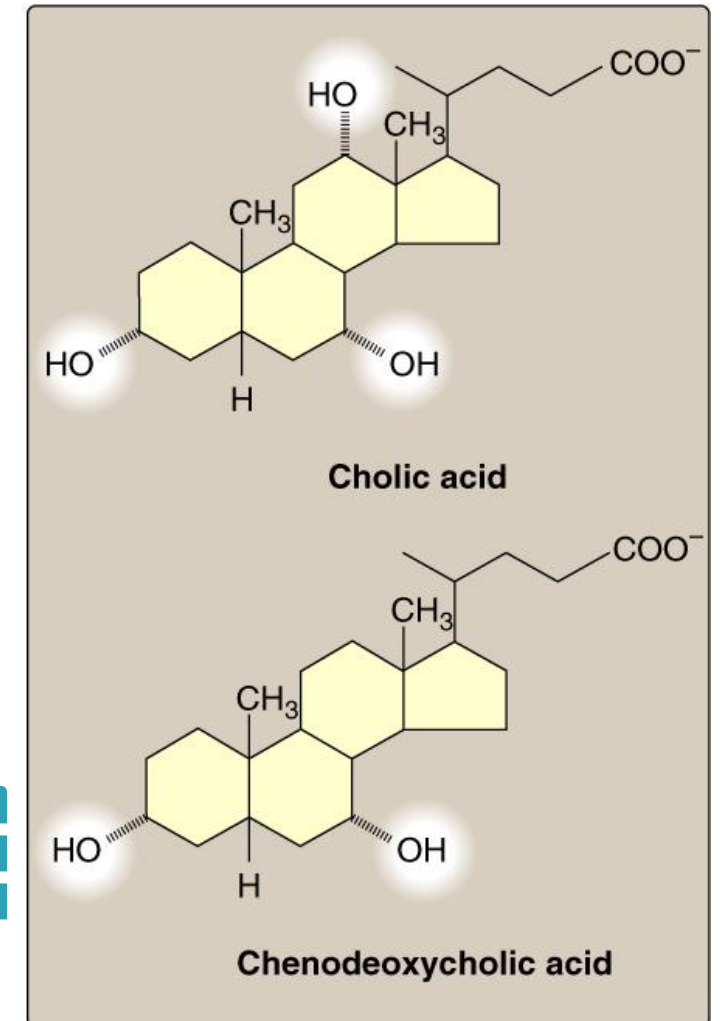
It is the parent for steroid hormones, vitamin D, bile salts and the bile

# Primary Bile Acids

Primary bile acids (24 C):

- ❖ **Amphipathic** (molecule having hydrophobic and hydrophilic regions)
- ❖ **-COOH at side chain**
- ❖ **Cholic acid: 3 OH** ( more hydrophilic than chenodeoxycholic because it has 3 OH )
- ❖ **Chenodeoxycholic: 2 OH**

To form the bile acids we increase OH and decrease the carbon atoms in comparison to the cholesterol





## Hepatic Synthesis of Bile Acids

The rate-limiting step is catalyzed by:

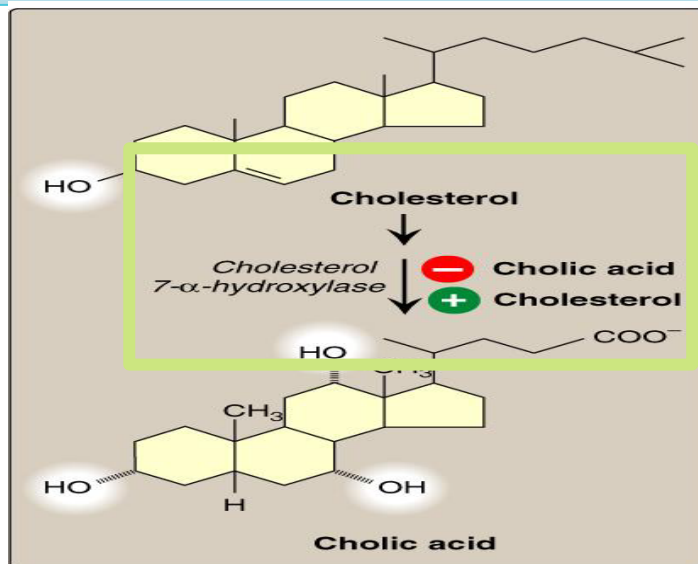
**Cholesterol 7- $\alpha$ -hydroxylase**

Regulation: happens at the gene level

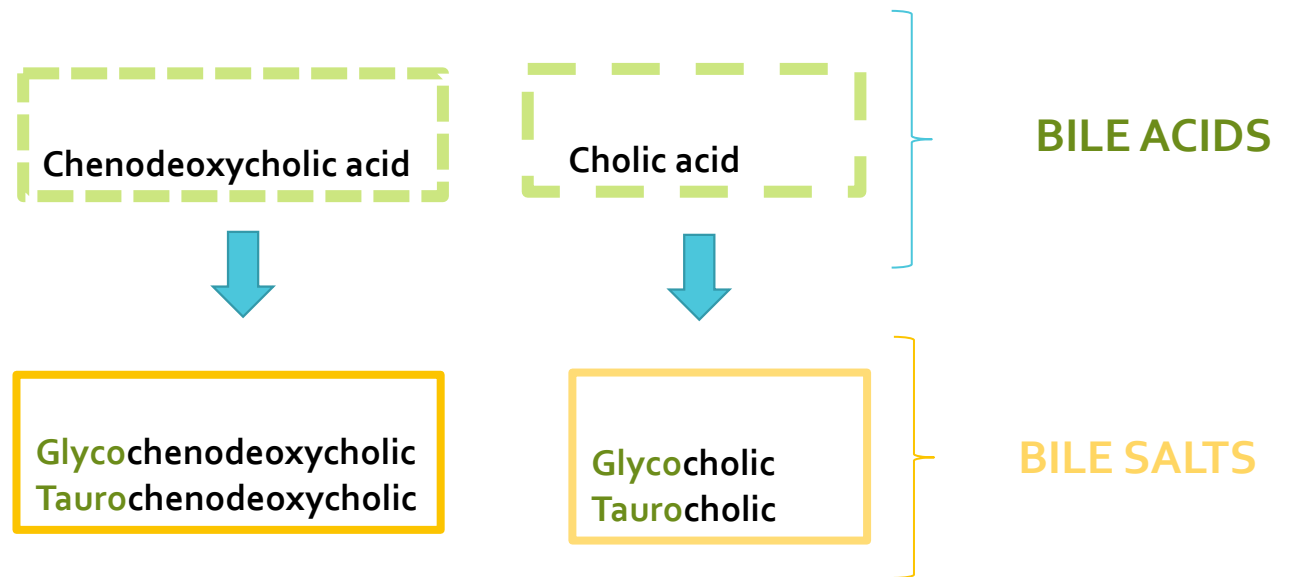
❖ Down-regulated by end products (bile acids)

“Enzyme repression”

❖ Up-regulated by cholesterol “Enzyme induction”



## Primary Bile Acids and Salts



Bile salts (Conjugated bile acids):

❖ amide-linked with **glycine** or **taurine**

❖ The ratio of glycine to taurine forms in the bile is **3:1** (that means the ratio of glycocholic to taurocholic is 3:1 also)

In the bile you find **bile salt** only because the bile acid convert to bile salts in liver before go to bile

The conjugation happens in the liver

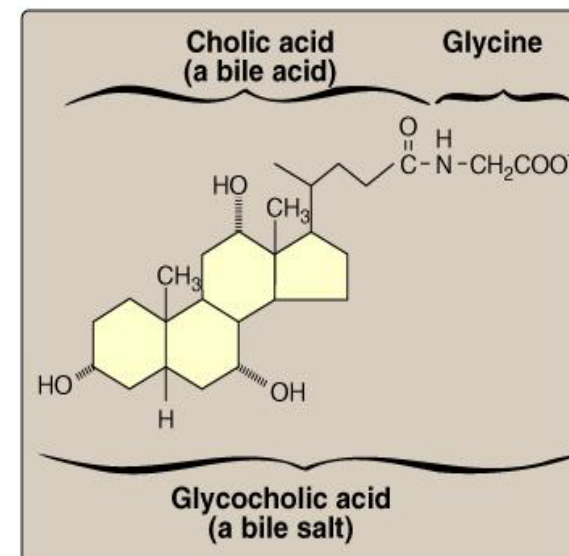


## Bile Salts

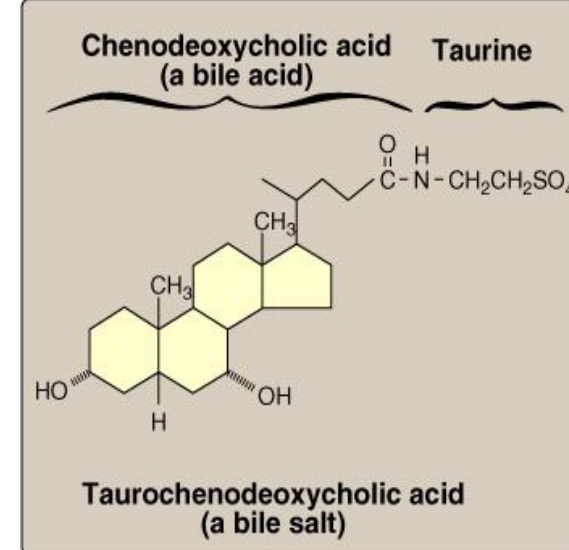
- ❖ Addition of glycine or taurine results in the presence of fully **ionized** groups at pH 7.0:
  - -COOH- of glycine &
  - -SO<sub>3</sub><sup>-</sup> of taurine
  - (hence, its name as bile salts e.g., Sodium or potassium glycocholate)
- ❖ More effective detergent than bile acids
- ❖ Only bile salts, but not acids, found in bile

- Bile acid more hydrophilic than cholesterol
- Bile salts (**fully ionized**) more hydrophilic than bile acid (**partially ionized**)

Na or K Glycocholate



Na or K Taurochenodeoxycholate





## Functions of Bile Salts:

Cholesterol Digestion, Absorption, and Excretion.



1. Contain emulsifying factors.
2. Cofactor for Pancreatic Lipase and Phospholipase A<sub>2</sub>.



Facilitate absorption by forming mixed micelles .



1. Contain the metabolic end products of Cholesterol.
2. Solubilize the Cholesterol that is present in the bile as such.

## Hormonal Control of Bile Secretion

**Stimulus:**

Undigested lipids and partially digested proteins in duodenum

**Hormone from gut cells:**

Cholecystokinin (CCK)

**Responses:**

1. Secretion of pancreatic enzymes
2. Bile secretion
3. Slow release of gastric contents



### Emulsification:

It is a prerequisite for lipid digestion.

**Location:** Duodenum

**Mechanisms:**

- Mechanical mixing (Peristalsis)
- Detergent effect of bile salts which interact with lipids and hydrophilic duodenal contents to make smaller particles.

**Function:** Prevents the particles from coalescing (sticking together) and increases the surface area of lipid droplets so that enzymes can effectively act.

Old info.

**Mixed Micelles:**

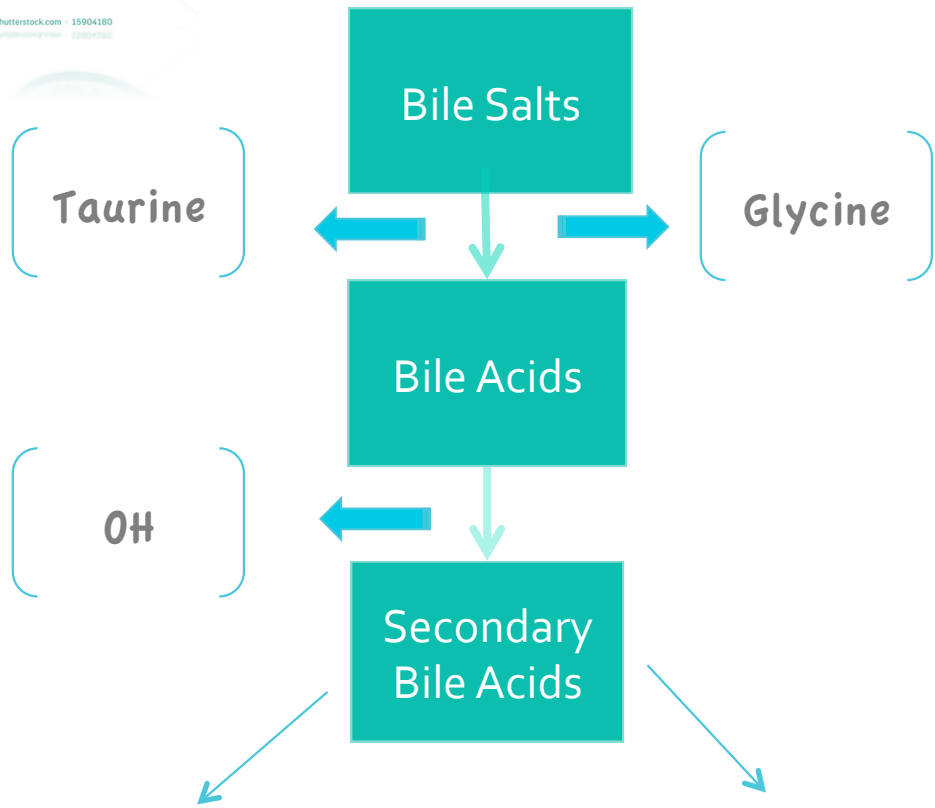
Clusters of amphipathic lipids arranged with their hydrophobic end on the inside and hydrophilic end on the outside.

**Components:**

1. Products of lipid digestion ((except short and medium-length fatty acids which do not require mixed micelles for absorption)
2. Bile salts
3. Fat-soluble vitamins



Bile salts are converted into primary bile acids and then secondary bile acids by intestinal bacteria.

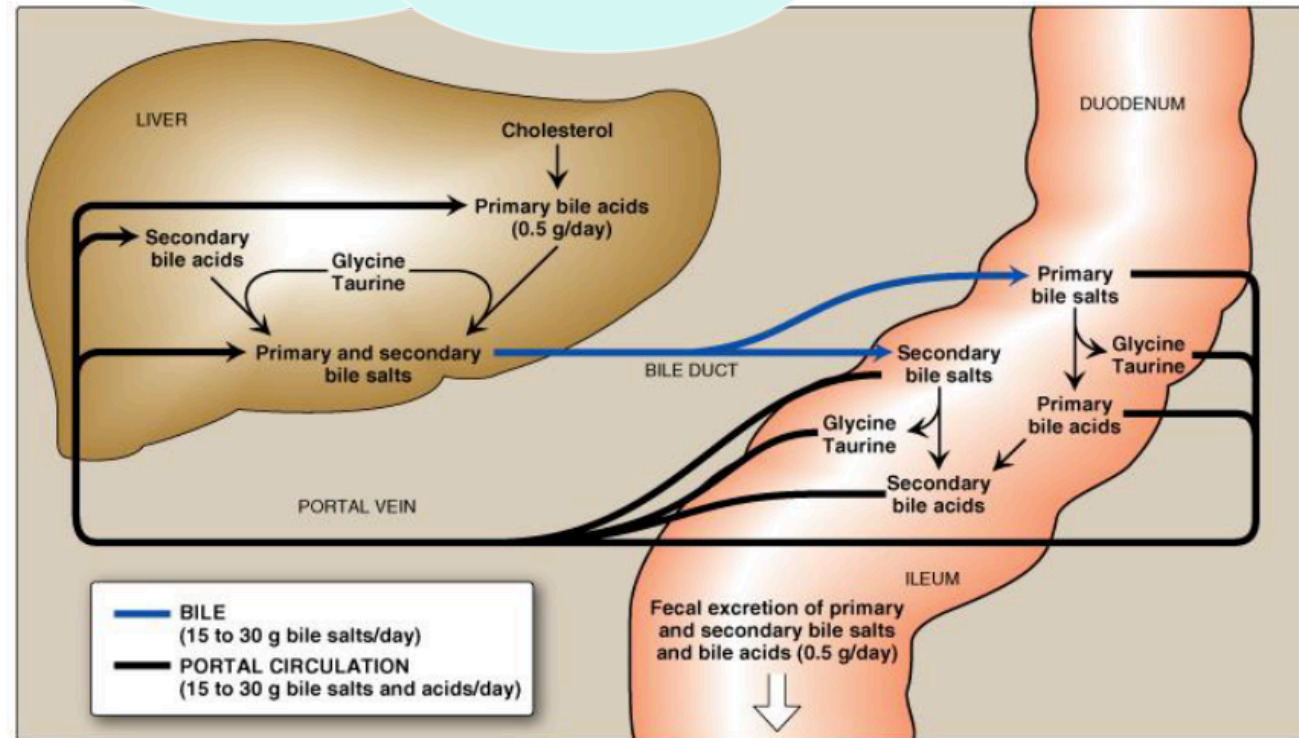


Deoxycholic acid  
from:  
Glyco- or Tauro-  
cholate

Lithocholic acid  
from:  
Chenodeoxycholate

### Enterohepatic circulation:

Synthesis of bile salts is equal to the amount excreted. Most of the synthesized bile is reused, both primary and secondary bile salts are carried by serum albumin to the liver where they are recycled.







## Decreased bile secretion

From the gallbladder

Gall stones

From the liver

Hepatitis or cirrhosis

Malabsorption/Maldigestion of lipids

## Decreased bile salts in bile

Decreased synthesis

Hepatic dysfunction

Interference with enterohepatic circulation

Obstruction

Increased biliary cholesterol secretion

Cholelithiasis

Treated by surgery or bile acid replacement therapy



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Team



# Summary

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- ✓ Bile salts secreted into the intestine are reabsorbed (greater than 95%) .
- ✓ The liver converts both primary and secondary bile acids into bile salts by conjugation with glycine or taurine, and secretes them into the bile.
- ✓ The mixture of bile acids and **bile salts is absorbed primarily in the ileum** into the portal blood carried by serum albumin.

## Test your knowledge ...!

1. Which one of the following is considered a constituent of the bile ?

- A. Bile Acids
- B. Bile Salts
- C. Mixed Micelles
- D. Hormones

2. Primary bile salt found in the body associated with ?

- A. Cl
- B. Na
- C. K
- D. B & C

3. What is the function of the hormone CCK ?

- A. Contraction of the smooth muscles in the intestine
- B. Decreases the absorption of lipids
- C. Stimulates gastric emptying
- D. Contracts the gallbladder

4. Cholelithiasis is caused by ?

- A. Decreased bile salts in the bile
- B. Pancreatic insufficiency
- C. Increased lipid absorption
- D. Decreased motility of the intestine

Answers

1) B

2) D

3) D

4) A



Biochemistry  
Team

If you find any mistake, please contact us:  
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Thank you

