



Derived lipids-1

By lecturer:

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M.sc in Biochemistry and Molecular Biology

LECTURE OUTLINES

- **By the end of this lecture, you should be able to identify :**
- **The structure & functions of all lipoproteins.**
- **Steroid compounds structure, properties & their compounds**
- **Structure and function of cholesterol as most abundant sterol in the body.**
- **Precursors for vitamin D2 & D3 synthesis.**
- **Bile acids & salts, ketone bodies structure & functions.**

Complex lipids

Plasma lipoproteins

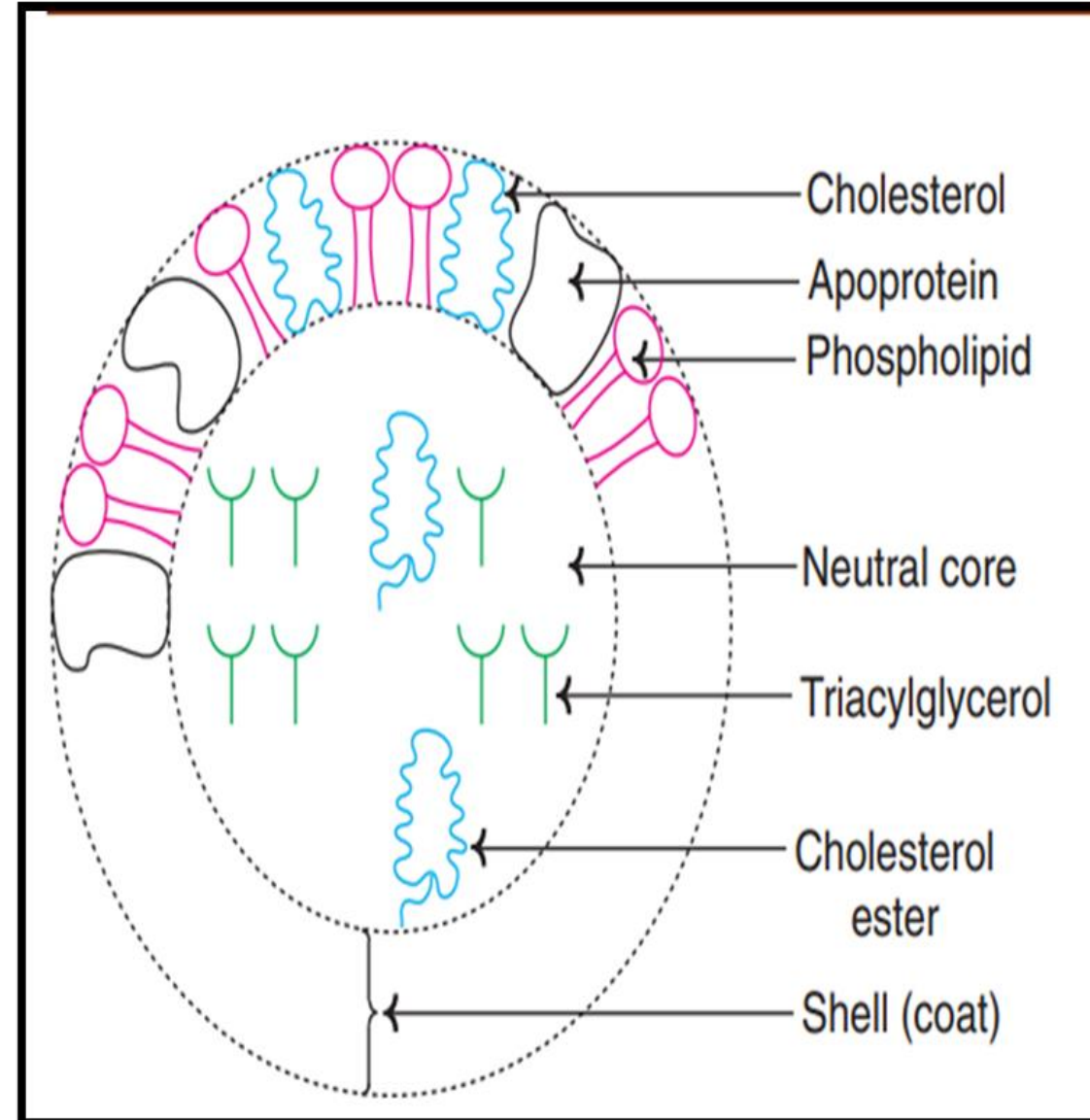
Lipoproteins: are complex lipids formed of lipids conjugated with protein

- **Function:** water-soluble molecules, transport lipids in blood plasma to various tissues for utilization.

Lipoproteins structure

Lipoproteins consisting of:

- 1. A neutral lipid core (triacylglycerol ,cholesteryl ester)**
- 2. Surrounded by phospholipids**
- 3. Apoproteins**
- 4. Cholesterol**



Classification of lipoproteins

- **Four major classes of lipoproteins according to their relative density are identified in human plasma :**

- 1. Chylomicrons (CM)**
- 2. Very low-density lipoproteins (VLDL)**
- 3. Low density lipoproteins (LDL)**
- 4. High density lipoproteins (HDL)**

1. Chylomicrons

Function: transport exogenous (dietary) triacylglycerol (contains also cholesterol, phospholipids and fat-soluble vitamins) from the intestine to peripheral tissues.

2. Very low-density lipoproteins (VLDL)

- **Function** : transport endogenously synthesized triacylglycerols from liver to peripheral tissues

3. Low density lipoproteins (LDL) (Bad cholesterol)

Function: transport cholesterol from liver to peripheral tissues

4. High density lipoproteins (HDL) (Good cholesterol)

Function: transports excess cholesterol from peripheral tissues to liver

- HDL prevents accumulation of cholesterol in peripheral tissues.

Derived lipids

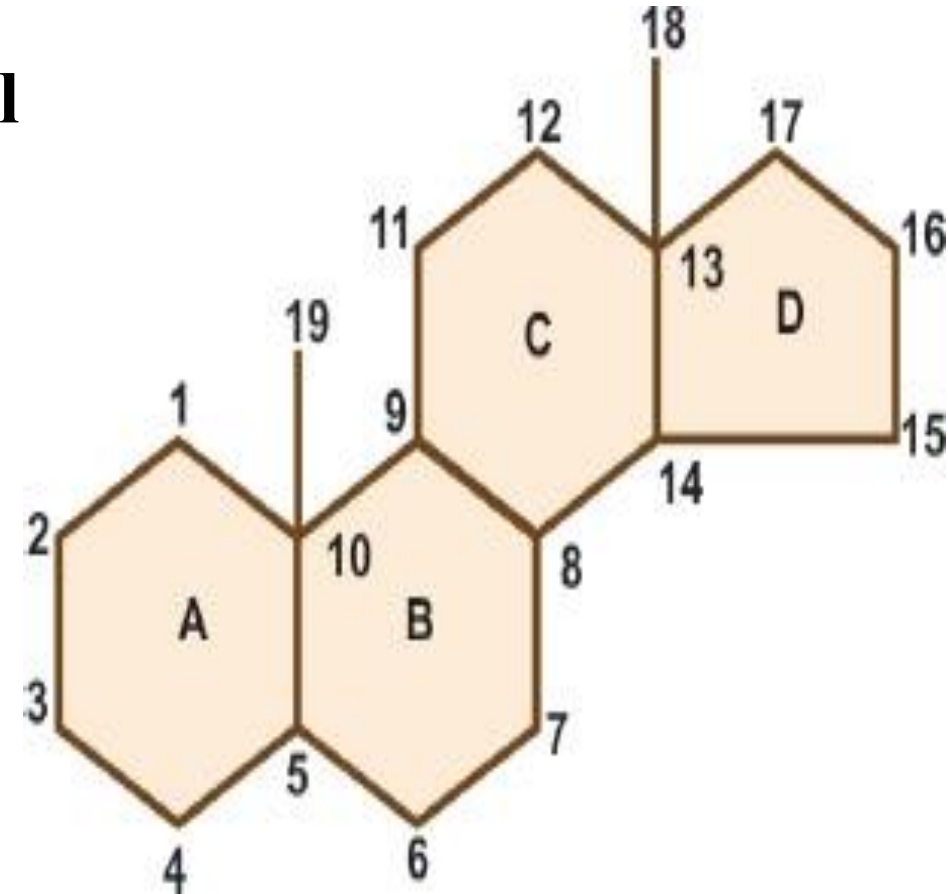
- **Are lipids result from the chemical breakdown (hydrolysis) of simple and complex lipids or through other modifications.**

Derived lipids include:

- **Fatty acids, glycerol.**
- **Steroids: cholesterol & hormones (estrogen, testosterone, progesterone), prostaglandins.**
- **Fat-soluble vitamins.**
- **Bile acids and salts**

What is a steroid compound?

- It is a compound that is based on a core structure consisting of three 6-membered rings A, B, C & one 5-membered ring D, all fused together.
- This arrangement is highly rigid giving steroids their characteristic stability and shape
- It is called a **steroid nucleus**



Steroid compounds structure

The ring is characterized by the presence of the following atoms or groups:

1. At C3: oxygen In the form of hydroxy (-OH) or ketone (=O) group.

2. At C17: Side chain.

3. At C10 and C13: Methyl groups.

➤ Steroids and sterols differ from each other in the nature of side chain (at C17).

Steroid compounds properties

- Steroids are **lipophilic** due to their four-ring structure which is hydrophobic.
- Steroids are **amphipathic**; (polar –OH group and Hydrophobic tail).
- Steroids are **chiral molecules** as they have specific 3-D orientations around their carbon rings  stereoisomers.

Types of steroid compounds

- **Cholesterol (animal origin).**
- **Ergosterol (plant origin).**
- **Steroid hormones (adrenocortical & sex hormones)**
- **Bile acids and salts**
- **Vitamin D group**

Cholesterol

- Cholesterol is the major steroid in human body.

2/3 of blood cholesterol existed as esterified; **cholesterol ester (cholesterol + F.A), 1/3 is **free** form.**

- Cholesterol is transported in the blood by lipoproteins.
- Cholesterol is rarely found in plants, never in bacteria

Cholesterol in the Body

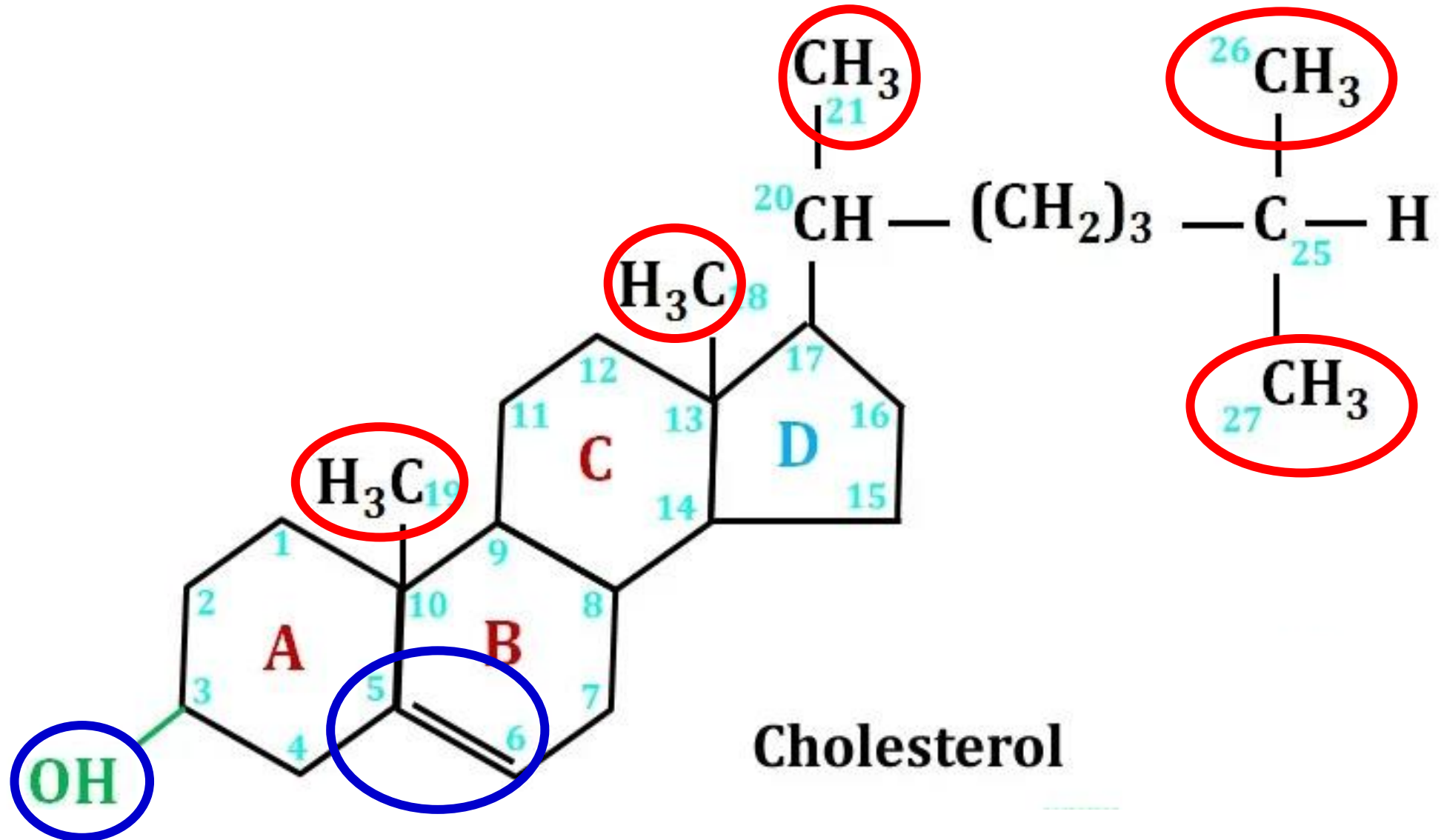
- Dietary sources: (animal sources) meats, milk, and eggs → **exogenous cholesterol**
- Is synthesized in the liver → **endogenous cholesterol**
- Clogs arteries when high levels form plaque.
- Normal level in plasma is **Less than 200 mg/dl.**
(5.2 mmol/ml)



Cholesterol Structure

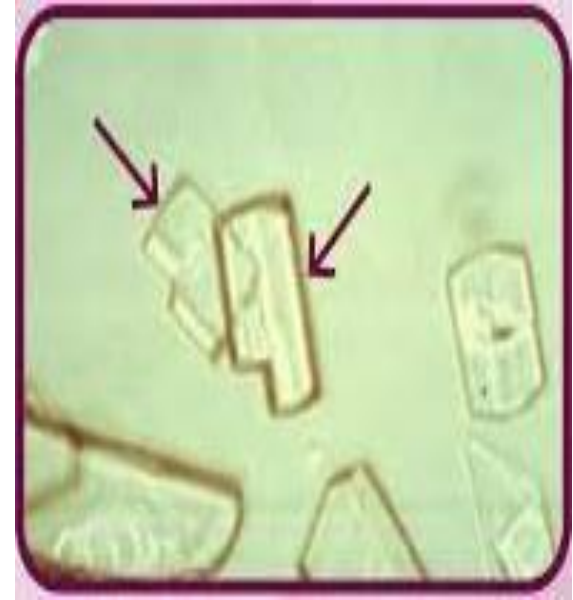
- Cholesterol is a **sterol**: steroid alcohols (-OH group in C-3) and one or more double bonds.
- **Consist of 27 carbon atoms and contains:**
 - -OH group at C3
 - Double bond between C5 and C6.
 - 8 carbon aliphatic side chain attached to C17.
 - 5 methyl groups

Cholesterol Structure



Cholesterol properties

- It Is present only in animals and not in plants.
- Amphipathic **why??**
- Forms characteristic crystals with broken corner.
- Gives positive Lieberman's test, which runs as follows:



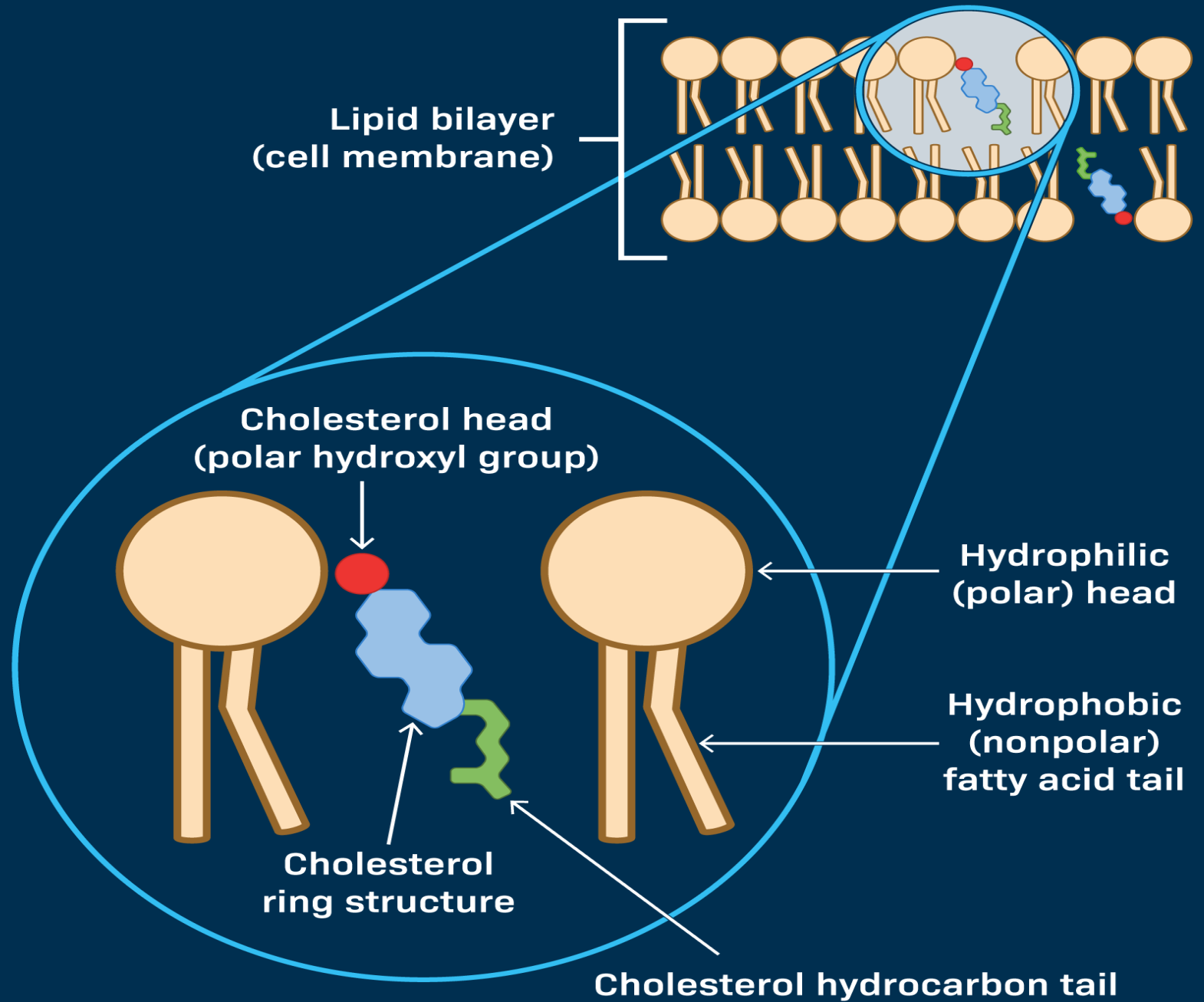
Cholesterol + Acetic acid + conc. sulphuric acid $\longrightarrow$ Bluish green color.

Functions of Cholesterol

❖ Cholesterol play importance roles in the human body which are

1. present in every body cell (cell membrane) & plasma lipoproteins.
2. Synthesis of **Vitamin D3**.
3. Precursor of **steroid hormones**.
4. Synthesis of **bile acids**.

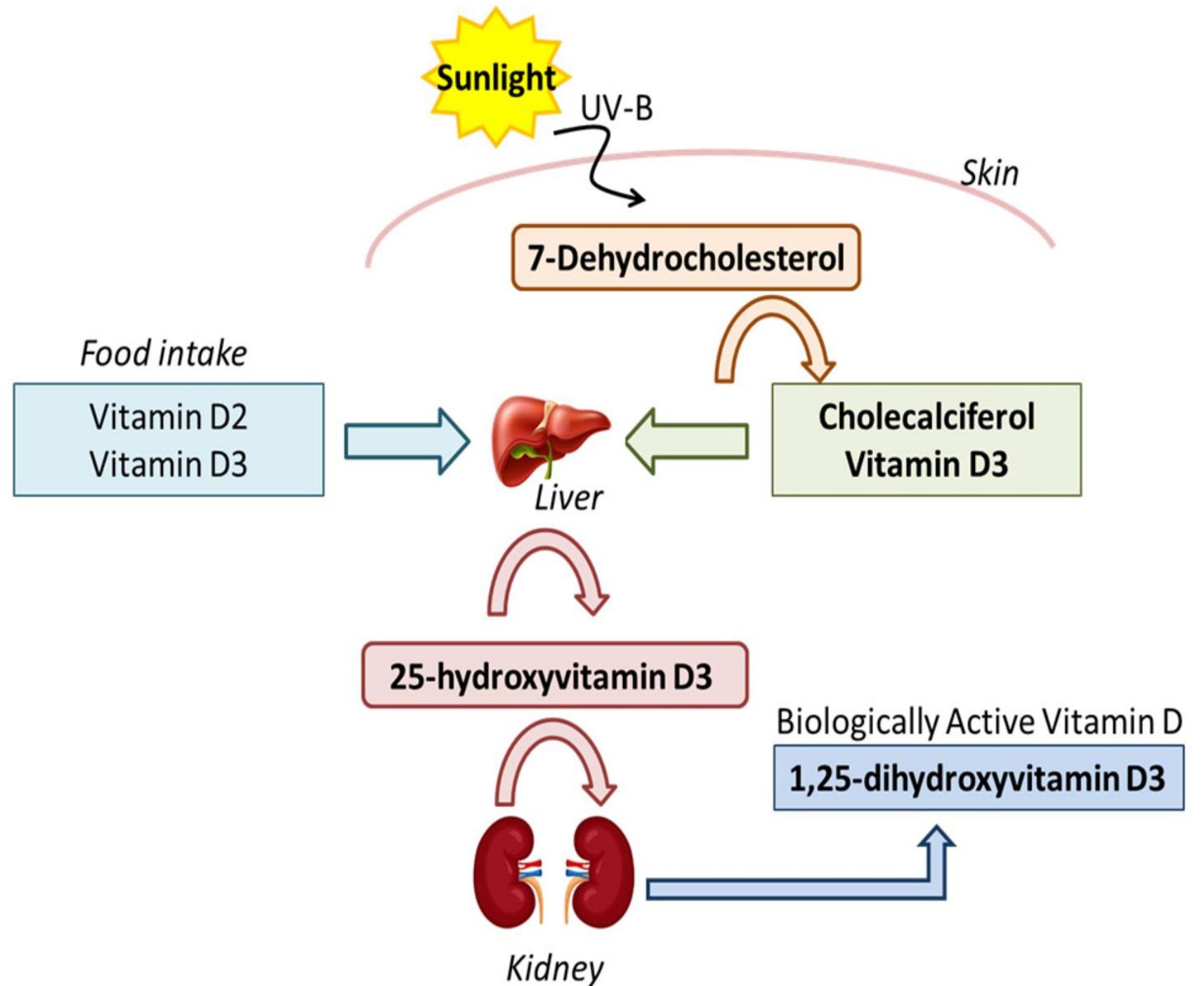
Cholesterol function in the cell membrane



Vitamin D synthesis

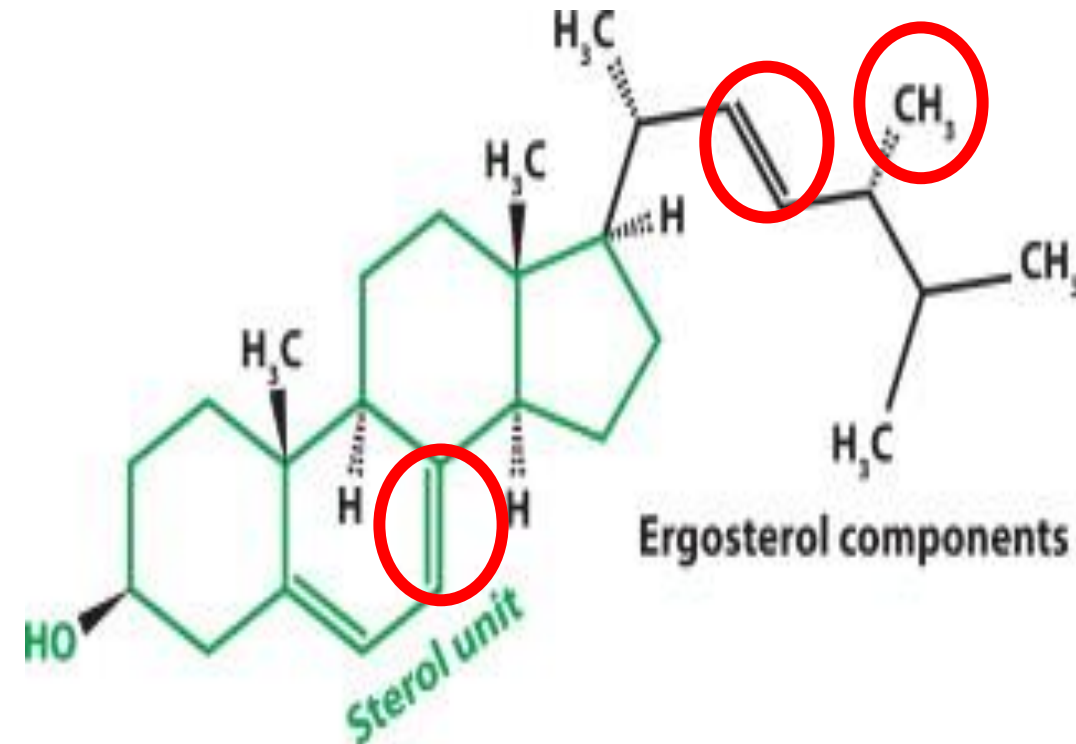
Structure: Vitamin D is derived from 7-dehydrocholesterol (skin) by the rupture of second ring by ultraviolet rays.

VitaminD3

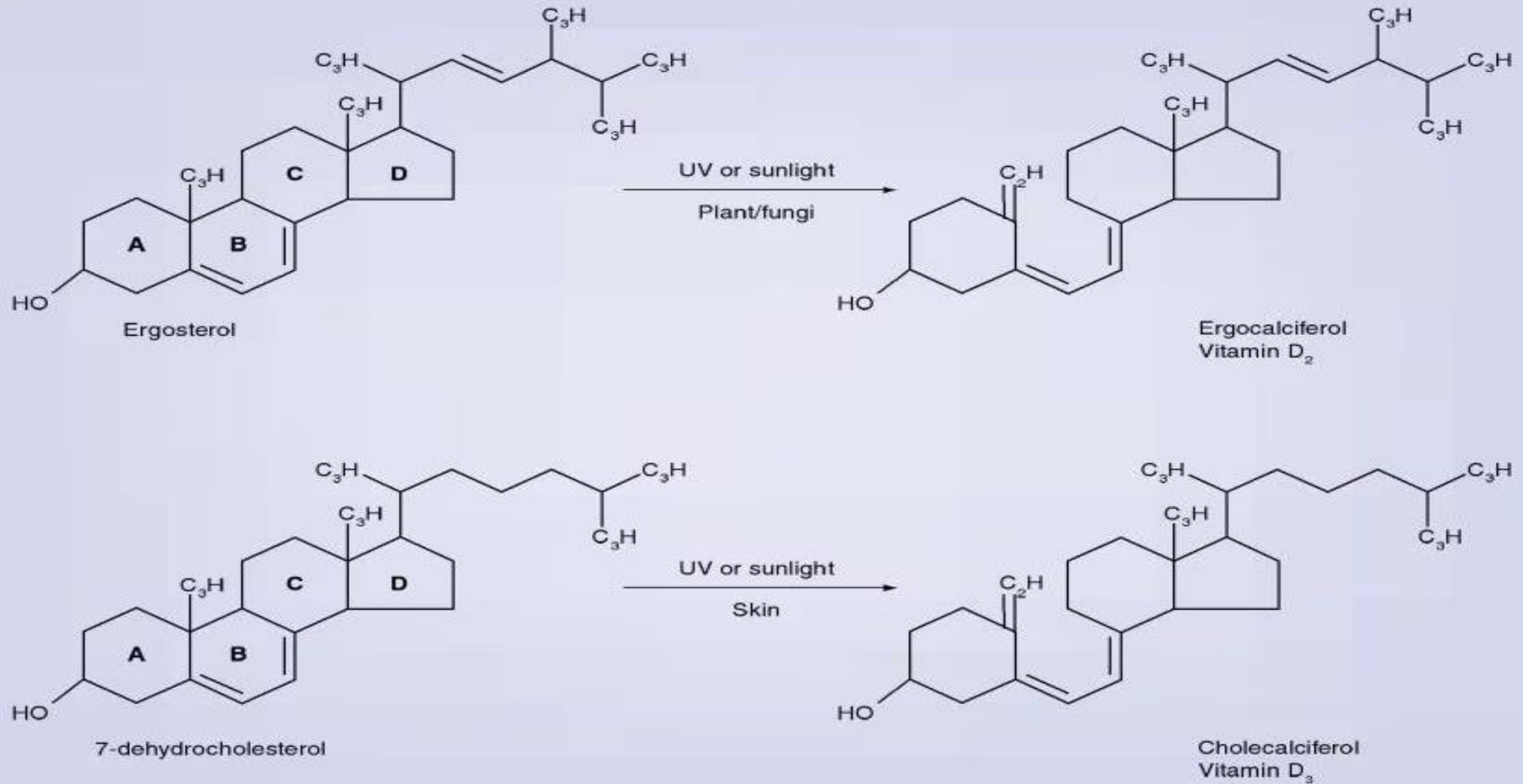


Ergosterol

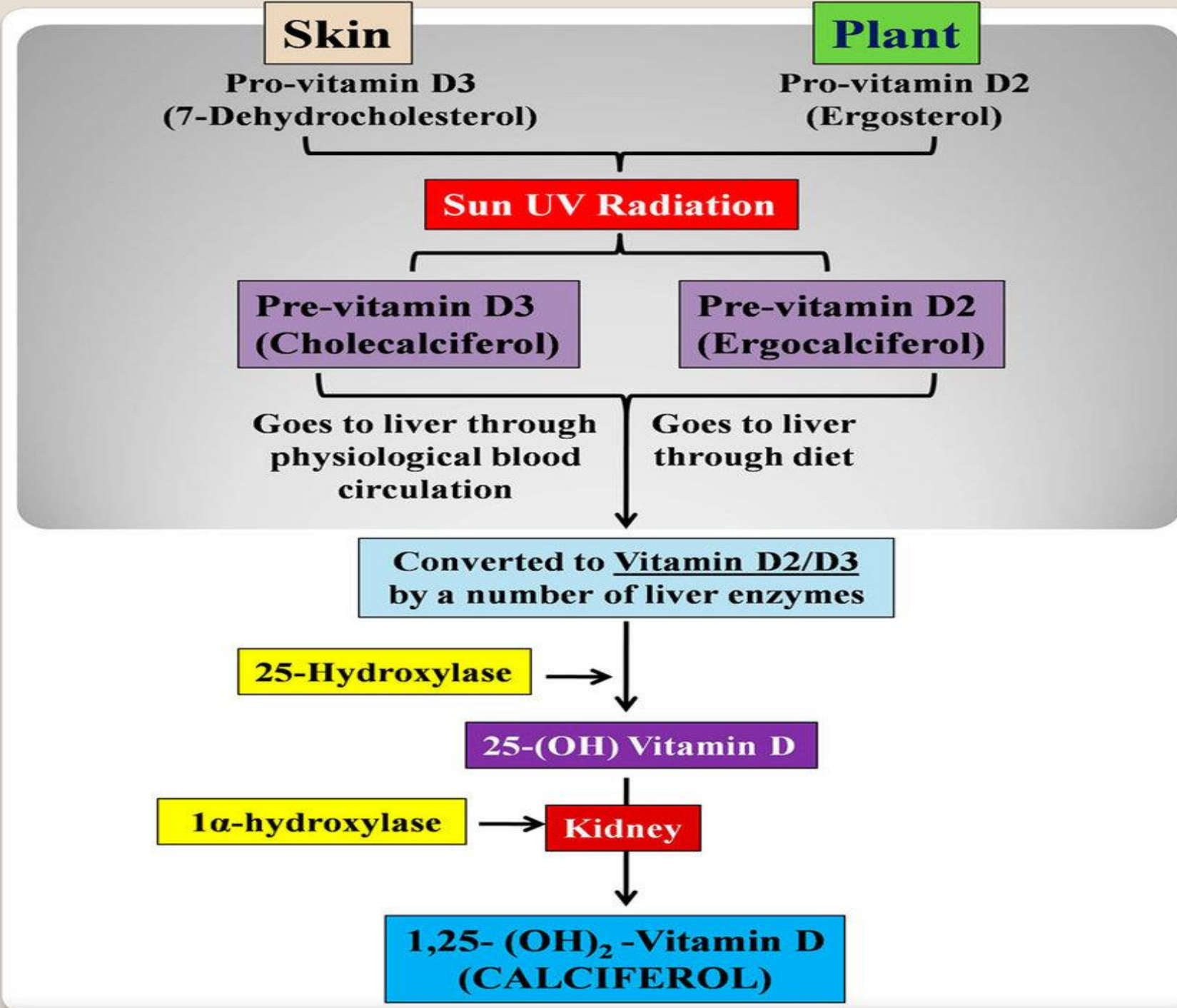
- It is a **plant sterol** (structural constituent of membranes in yeast, fungi and protozoa), poorly absorbed from small intestine.
- **Structure:** Similar to cholesterol but **differs** in:
 - **Extra double bond** between C7- C8.
 - The side chain is unsaturated and has **extra methyl group**.
- **Functions:** precursor for vitamin **D2** (ergocalciferol).



Vitamin D2/ D3

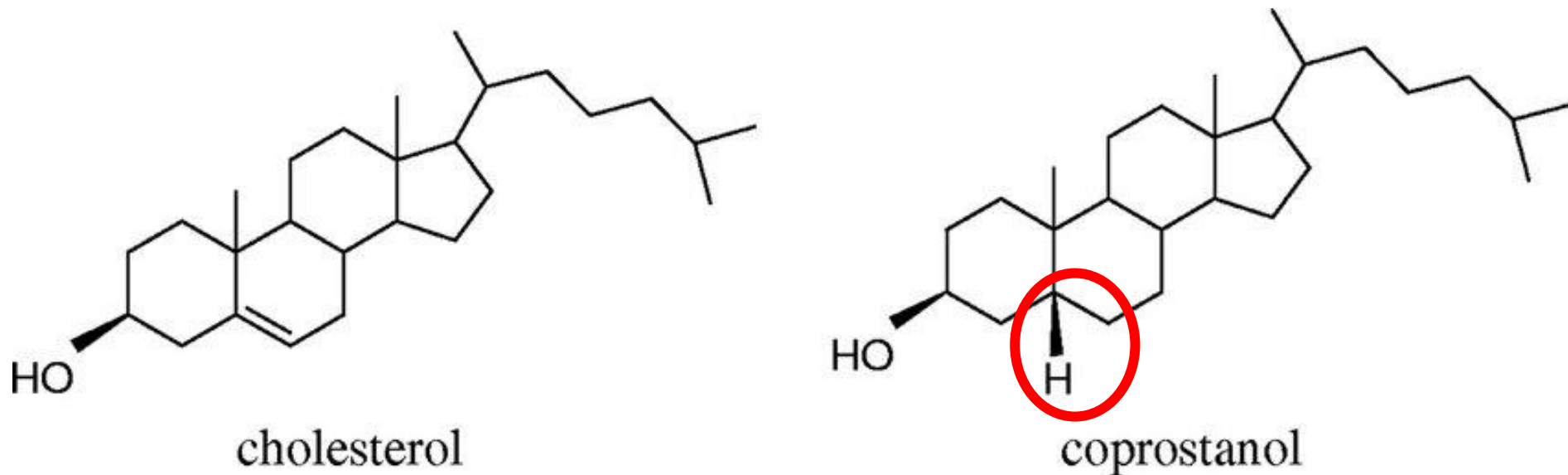


Vitamin D2/ D3



Coprastanol

- **Result from reduction of cholesterol double bond (C5 - C6) by intestinal bacteria before excretion.**



Bile acids and salts

- **Bile acids are found in the bile & synthesized from cholesterol in the liver**
- **They act as emulsifying agents in the intestine.**

Types of bile acids:

- 1. Primary bile acids**
- 2. Secondary bile acids**

Types of bile acids

1. Primary bile acids: formed in the liver from oxidation of cholesterol.

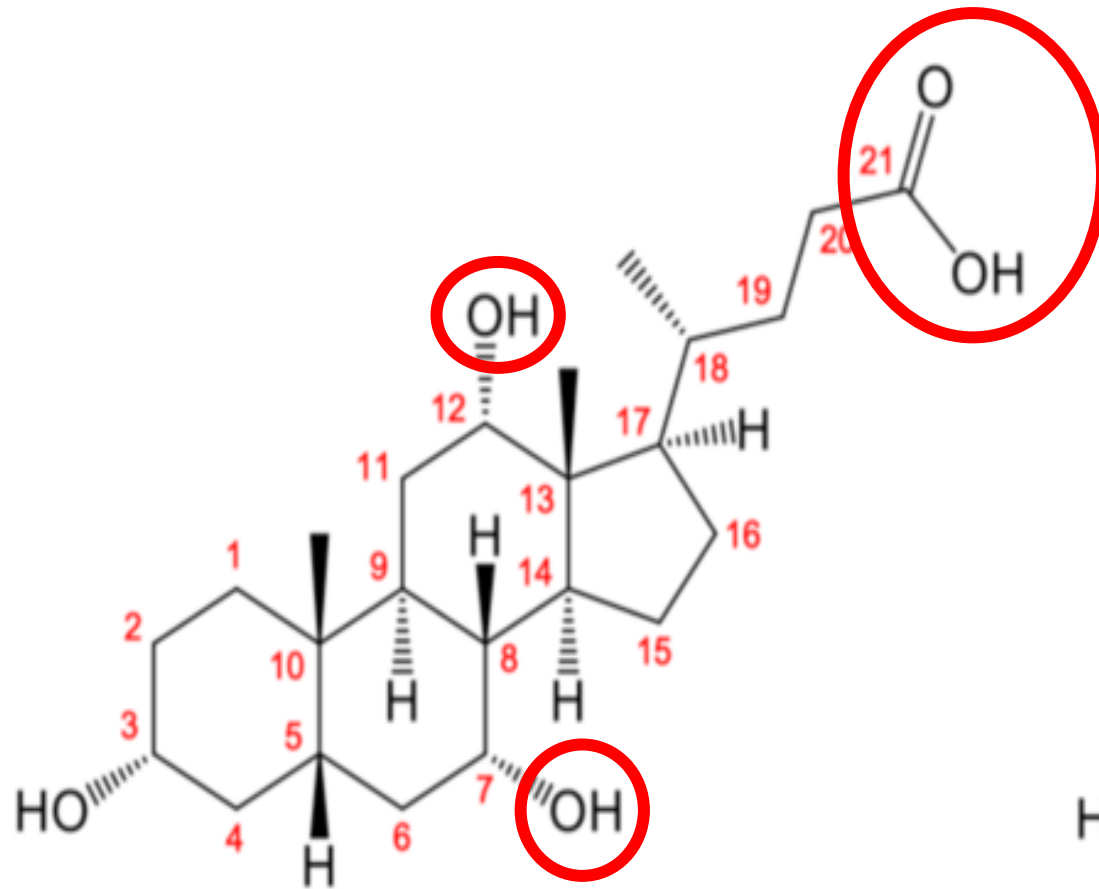
- **Cholic acid** (3, 7,12 trihydroxy cholanic acid)
- **Chenodeoxy cholic acid** (3, 7 dihydroxy cholanic acid).

2. Secondary bile acids (no -OH at C7):

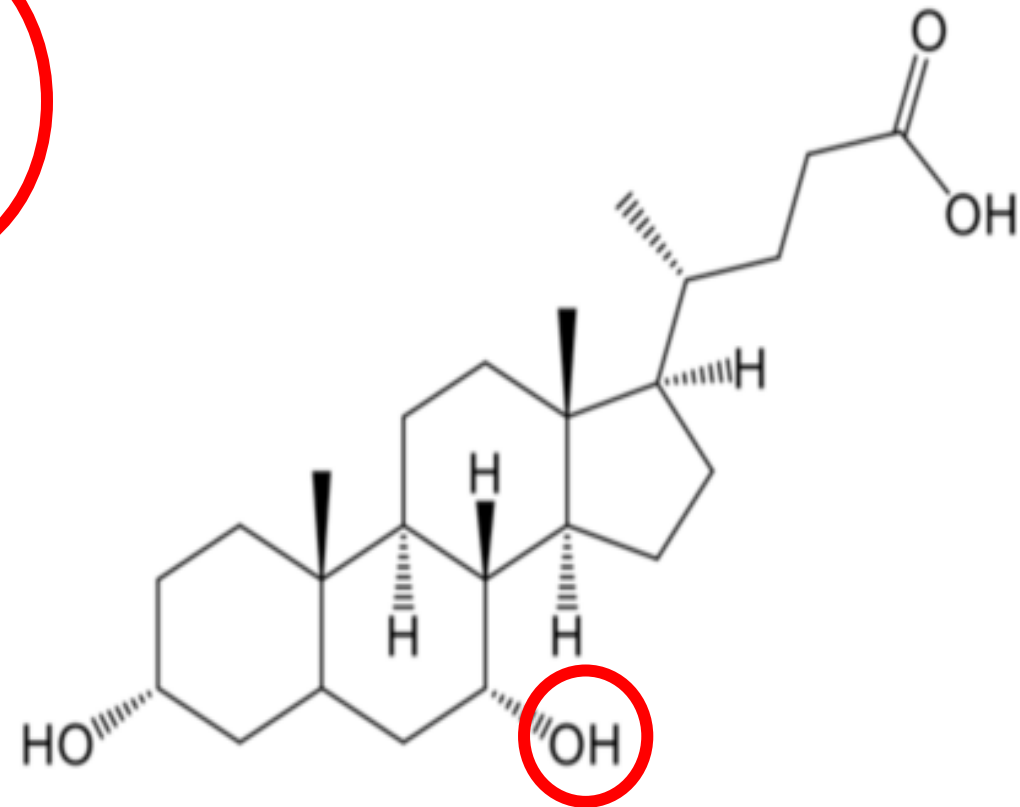
Formed by the action of intestinal bacteria (7, α - dehydroxylase)

- **Deoxycholic acid** (3,12 dihydroxy cholanic acid) and
- **Lithocholic acid** (3 monohydroxy cholanic acid}.

Primary bile acids

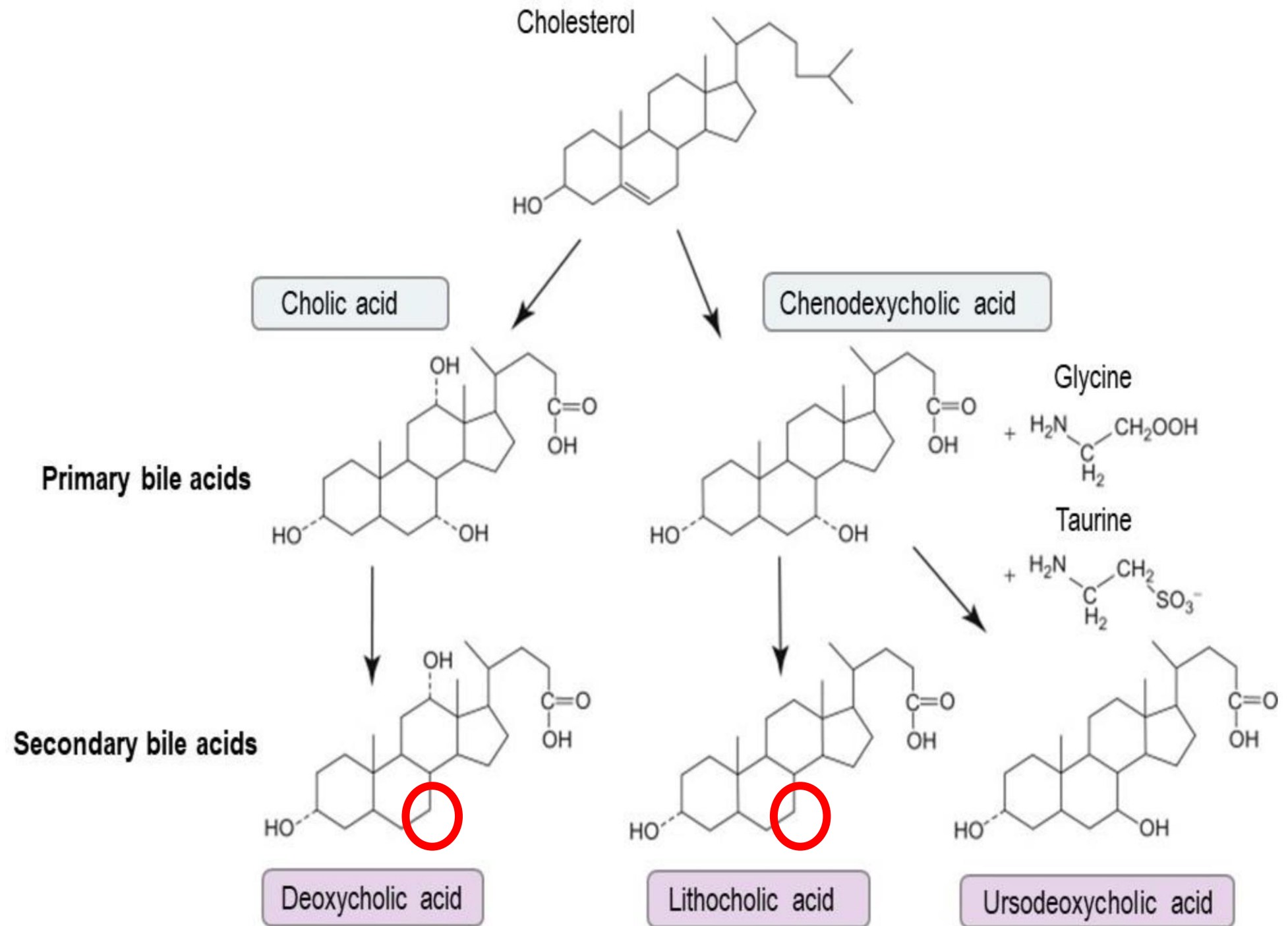


CHOLIC ACID



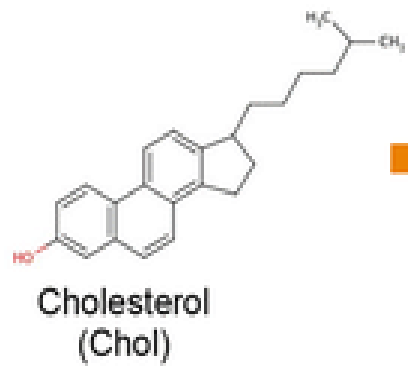
CHENODEOXYCHOLIC ACID

Secondary bile acids



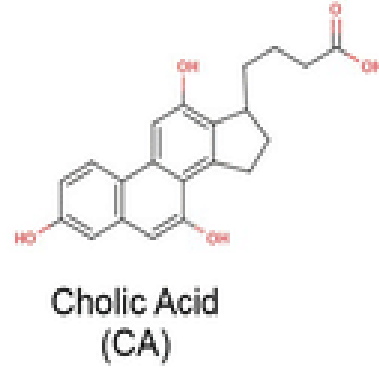
Bile salts

- Are bile acids **conjugated** with **glycine** (80%) or **taurine** (20%) → glycocholic acid, taurocholic acid + **sodium** or **potassium** → Sodium (glycocholate, taurocholate) in the liver.
- Bile salts (bile) → intestine reabsorbed → liver excreted → bile (enterohepatic circulation)



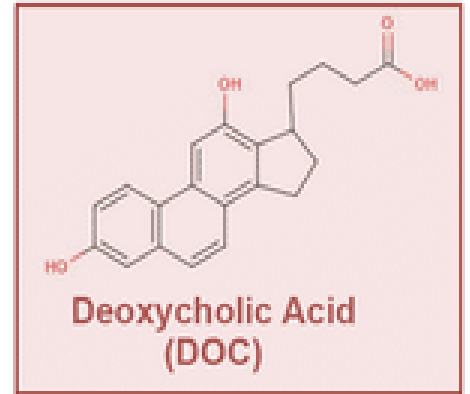
Oxidation

Primary Bile Acid



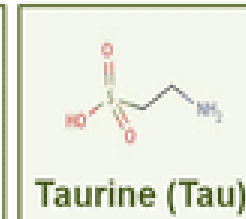
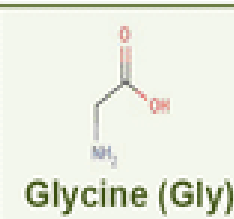
Dehydroxylation by
microbiota

Secondary Bile Acid



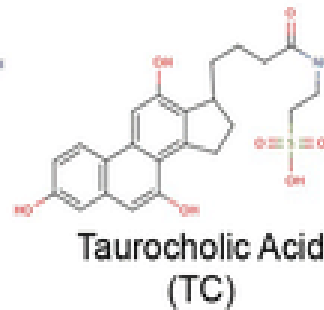
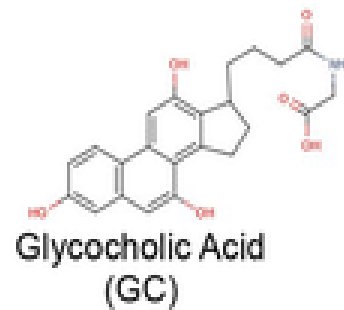
Deconjugation by
microbiota

Conjugation

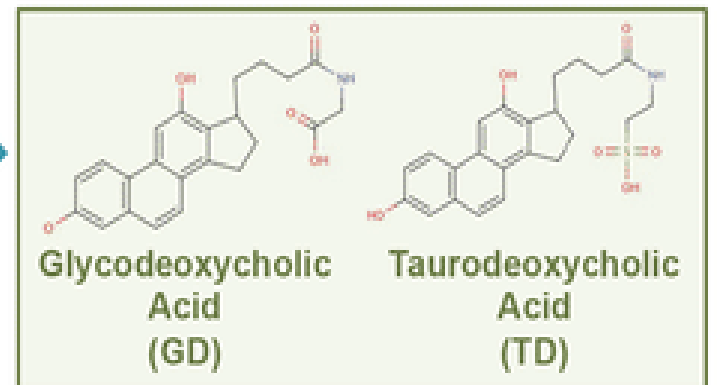


Conjugation

Deconjugation by
microbiota



Dehydroxylation by
microbiota



Location:

■ Intestine

■ Liver

Effect on T6SS function:

■ Enhancing

■ Inhibiting

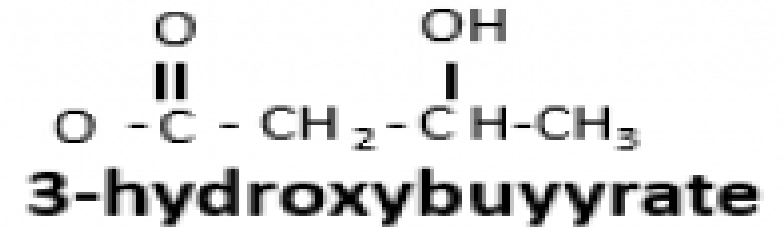
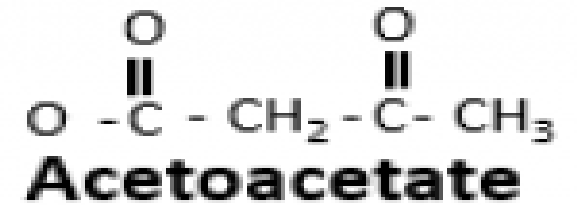
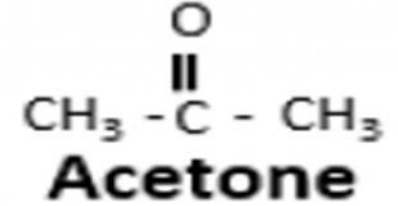
Functions of Bile salts

- Digestion and absorption of lipids **by:**
- **Emulsification** of fat in the intestine and activation of lipase enzyme.
- Absorption of lipids: by **forming micelles**.
- Excretion of cholesterol converted  bile salts.

Ketone bodies

There are three types:

- Acetone.
- Acetoacetate.
- β -hydroxybutyrate.
- There are synthesized in the liver from fatty acids
- **Function:** used as a source of energy by extra-hepatic tissues such as *muscles, kidney and brain during starvation only.*



THE END

