Biochemistry
Lipids 2

2nd year Biology

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Prostaglandins

Prostaglandins are derived from the fatty acid “arachidonic acid”

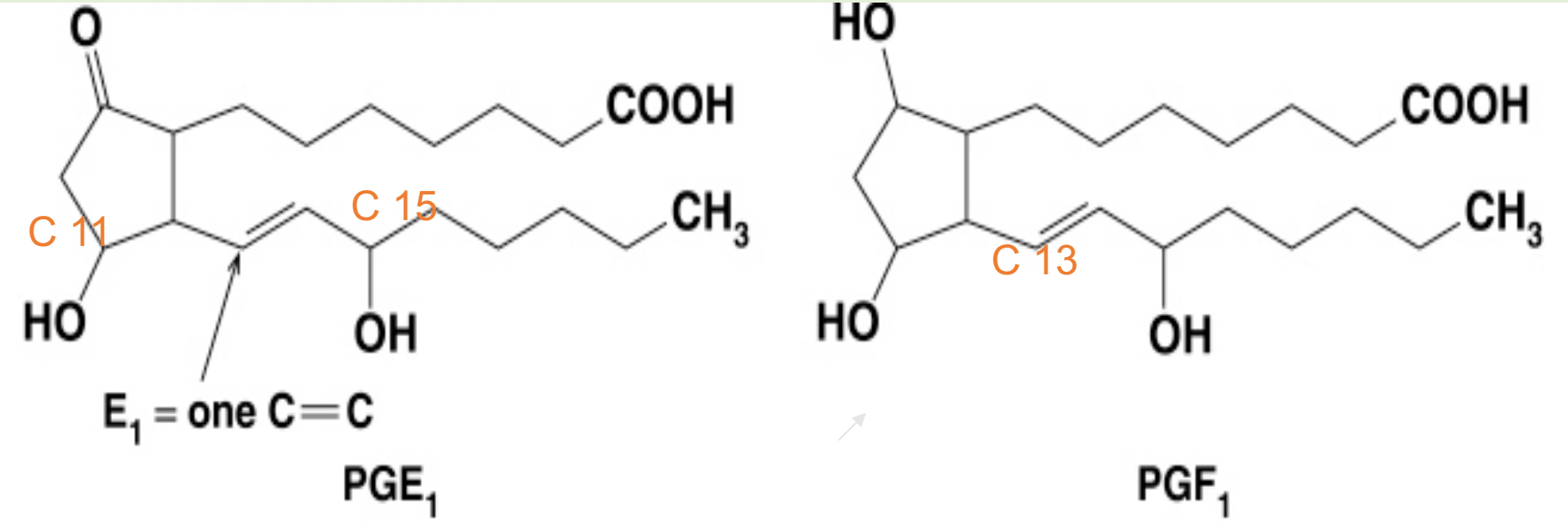
The Prostaglandins group is one of hormone-like substances that participate in a wide range of body functions such as:

- the contraction and relaxation of smooth muscle,
- the dilation and constriction of blood vessels,
- control of blood pressure,
- modulation of inflammation.

Prostaglandins

Prostaglandins have

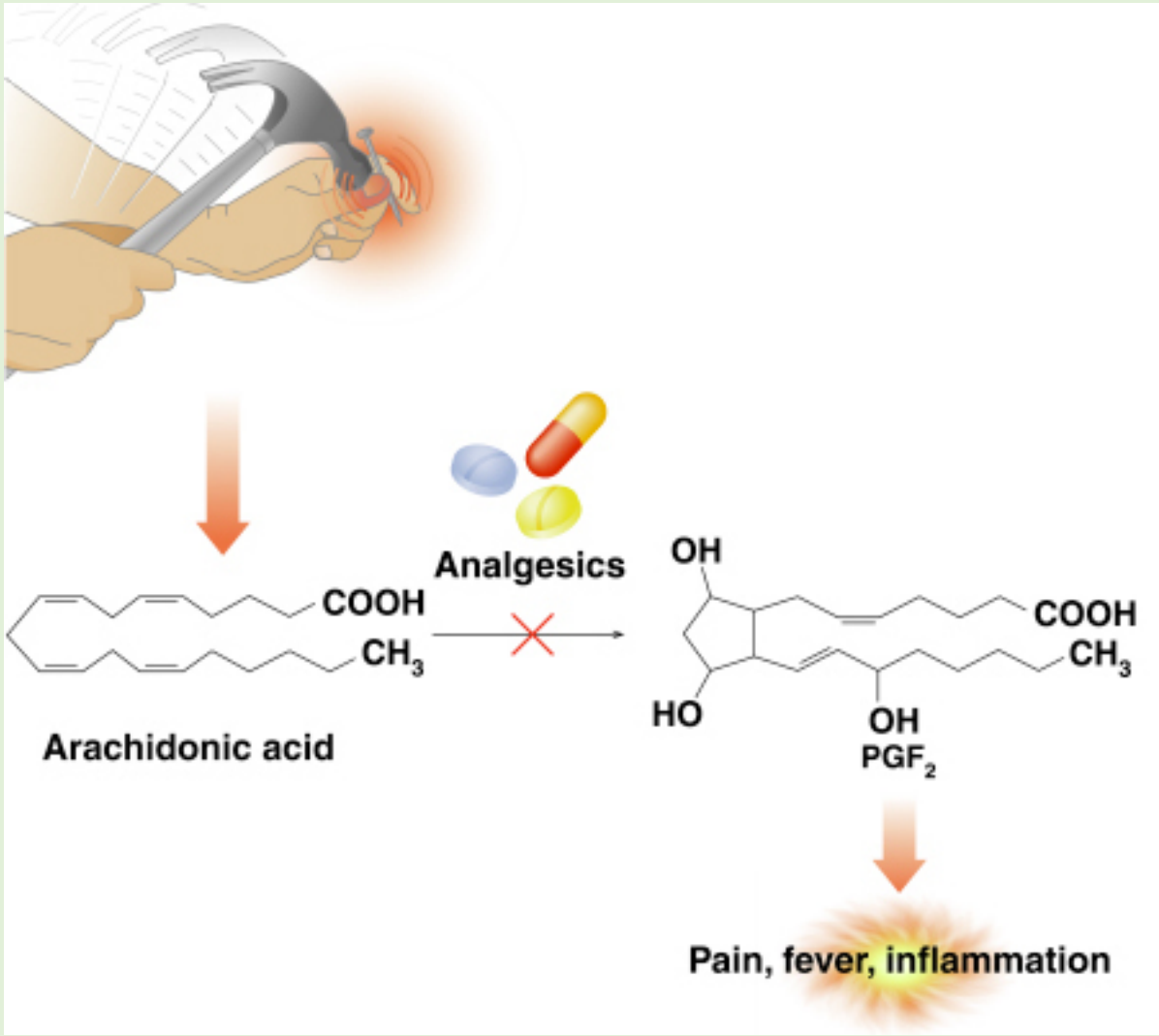
- 20 carbon atoms in their fatty acid chains.
- An OH on carbon 11 and 15.
- A trans double bond at carbon 13.



Prostaglandins in the Body

Prostaglandins are

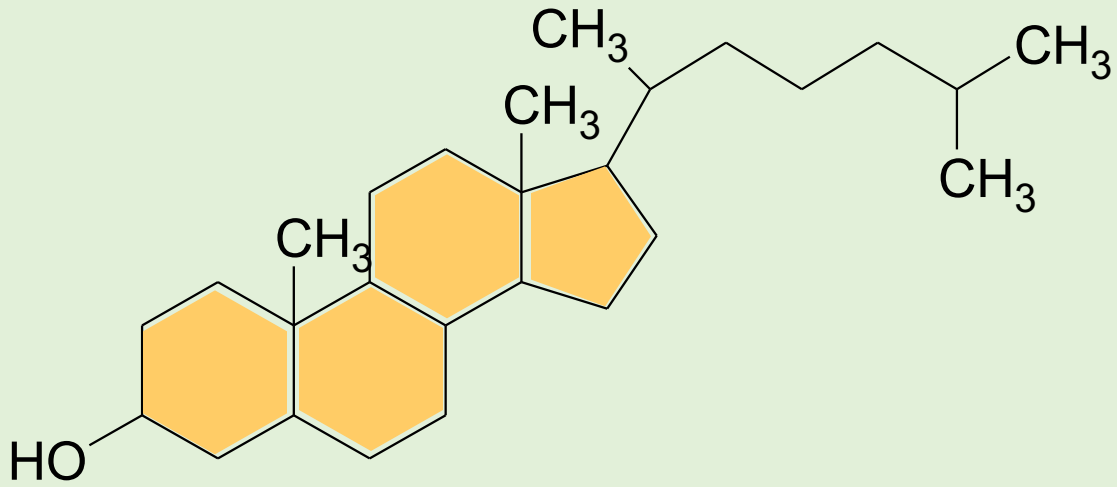
- Produced by injured tissues.
- Involved in pain, fever, and inflammation.
- Not produced when using anti-inflammatory drugs, such as aspirin inhibit their synthesis.



LIPIDS

Steroids:

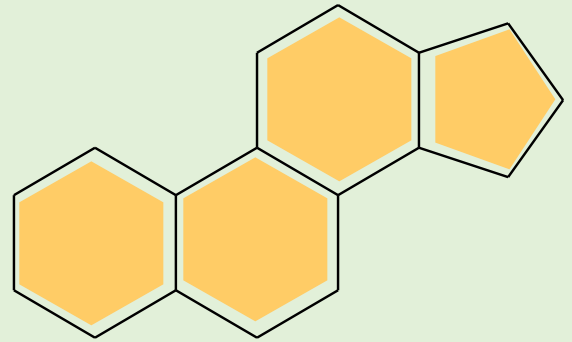
Cholesterol, Bile Salts, and Steroid Hormones



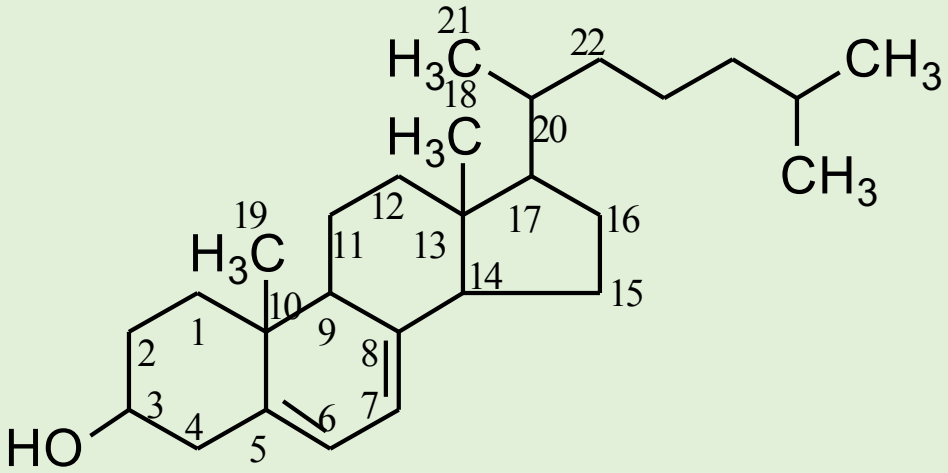
Steroid Nucleus

A steroid nucleus consists of

- 3 cyclohexane rings.
- 1 cyclopentane ring.
- No fatty acids.



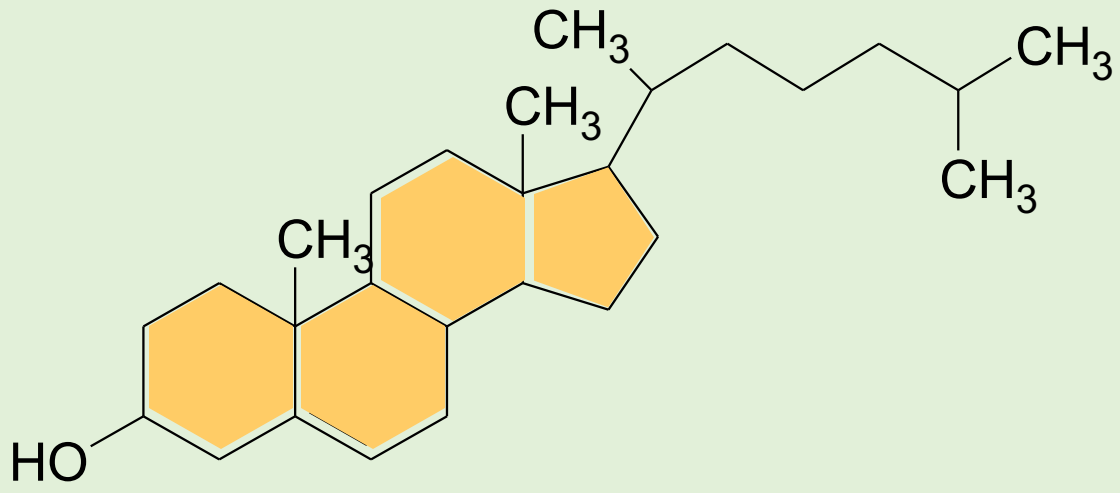
steroid nucleus



Cholesterol

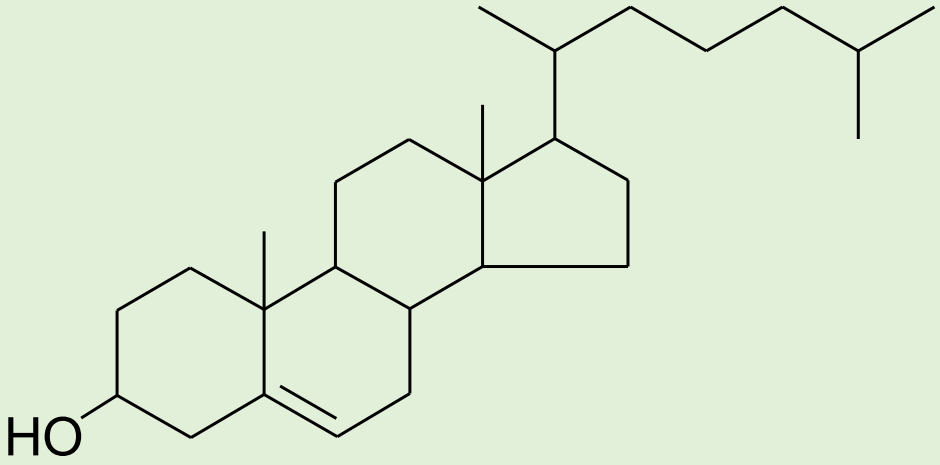
Cholesterol

- Is the most abundant steroid in the body.
- Has methyl CH_3- groups, alkyl chain, and -OH attached to the steroid nucleus.



Cholesterol,

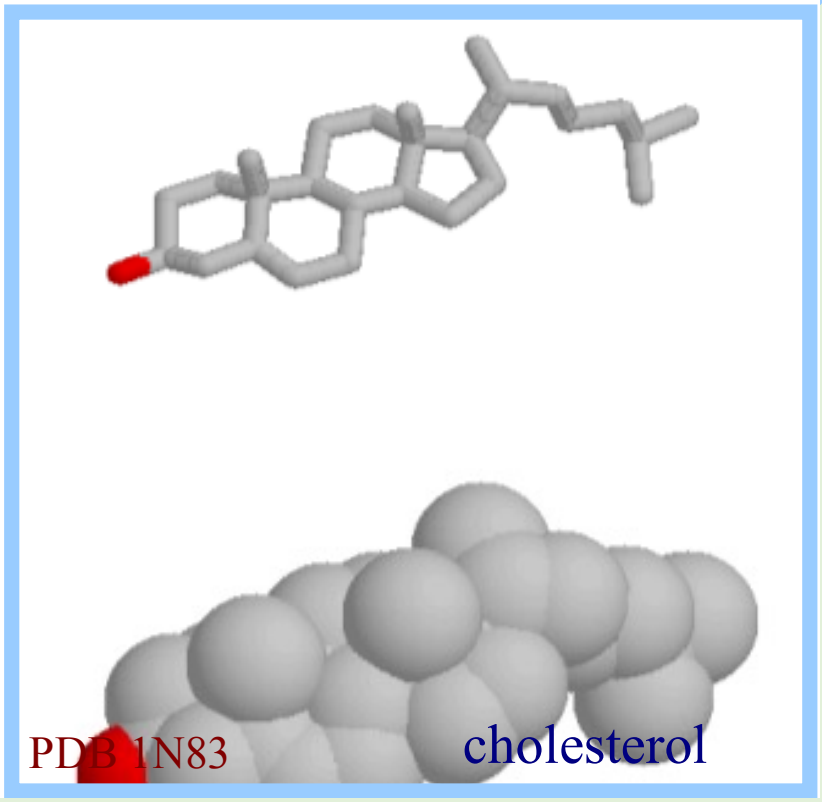
An important constituent of cell membranes, has a rigid ring system and a short branched hydrocarbon tail.

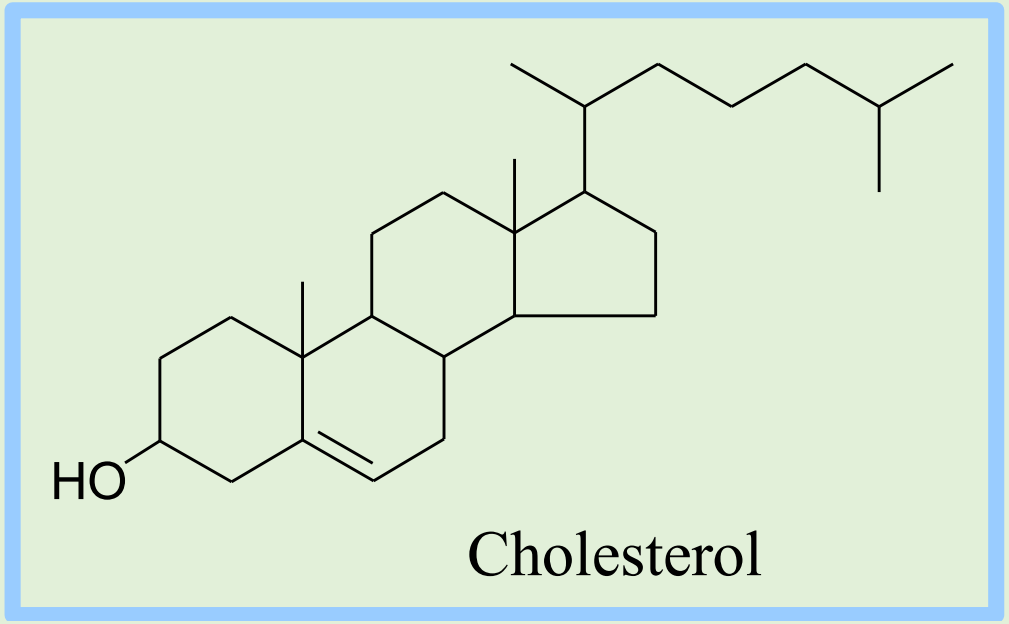


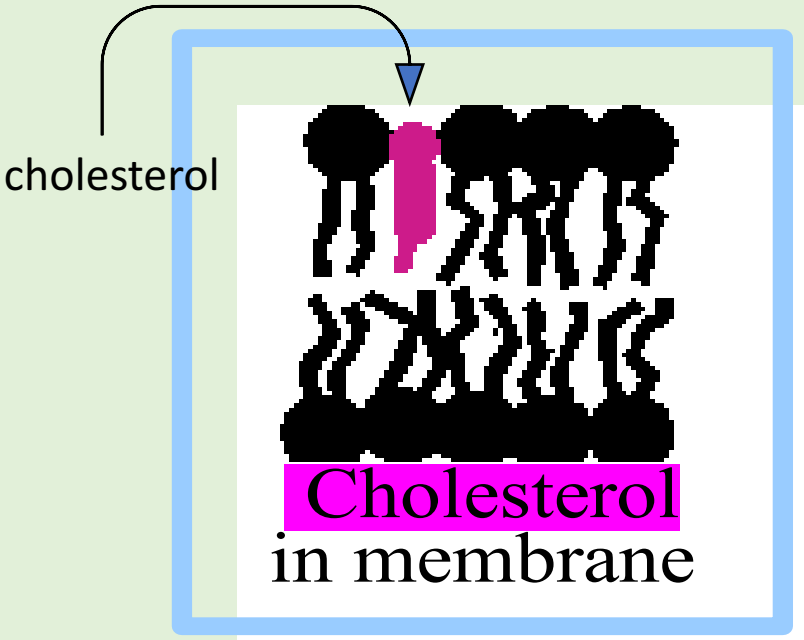
Cholesterol

Cholesterol is largely **hydrophobic**.

But it has one polar group, a **hydroxyl**, making it **amphipathic**.







Cholesterol inserts into bilayer membranes with its hydroxyl group oriented toward the aqueous phase, but the hydrophobic rings are adjacent to fatty acid chains of phospholipids.

The **OH** group of cholesterol forms hydrogen bonds with polar phospholipid head groups.

Cholesterol in the Body

- Cellular membranes
- Myelin sheath (CNS), brain, and nerve tissue
- Bile salts
- Hormones
- Vitamin D

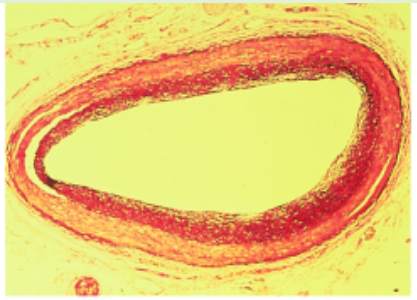
Cholesterol sources

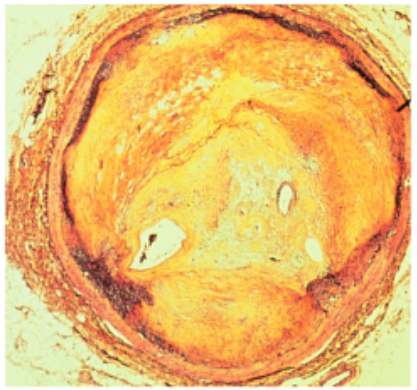
- Meats, milk, and eggs.
- Is synthesized in the liver.

- High levels of cholesterol form plaque in the arteries.

- Normal value ~ 150-200 mg/dL.

A normal, open artery.





An artery clogged by cholesterol plaque

Cholesterol in Foods

1 cup= 8 oz (ounce)

Table 18.4 Cholesterol Content of Some Foods

Food	Serving Size	Cholesterol (mg)
Liver (beef)	3 oz	370
Egg	1	250
Lobster	3 oz	175
Fried chicken	3½ oz	130
Hamburger	3 oz	85
Chicken (no skin)	3 oz	75
Fish (salmon)	3 oz	40
Butter	1 tablespoon	30
Whole milk	1 cup	35
Skim milk	1 cup	5
Margarine	1 tablespoon	0

Bile Salts

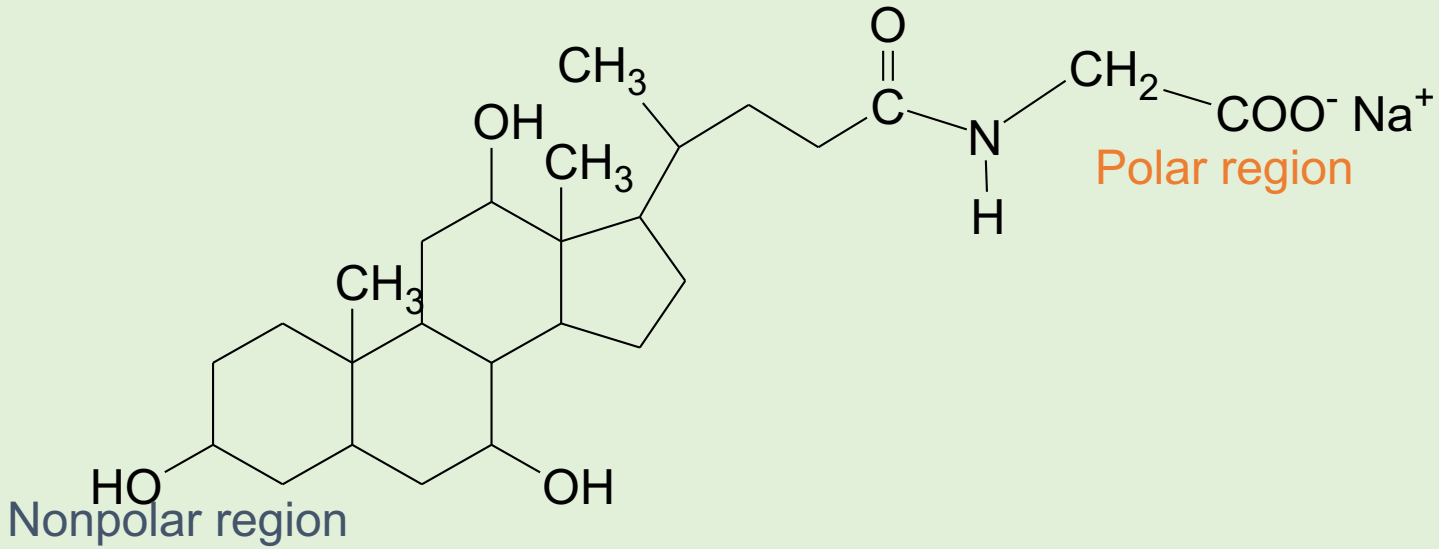
Bile salts

- Are synthesized in the liver from cholesterol.
- Are stored in the gallbladder.
- Are secreted into the small intestine.
- Have a polar and a nonpolar region
- Mix with fats to break them part.
- Emulsify fat particles to provide large surface area.

Bile Salts

cholic acid, a bile acid

glycine, an amino acid

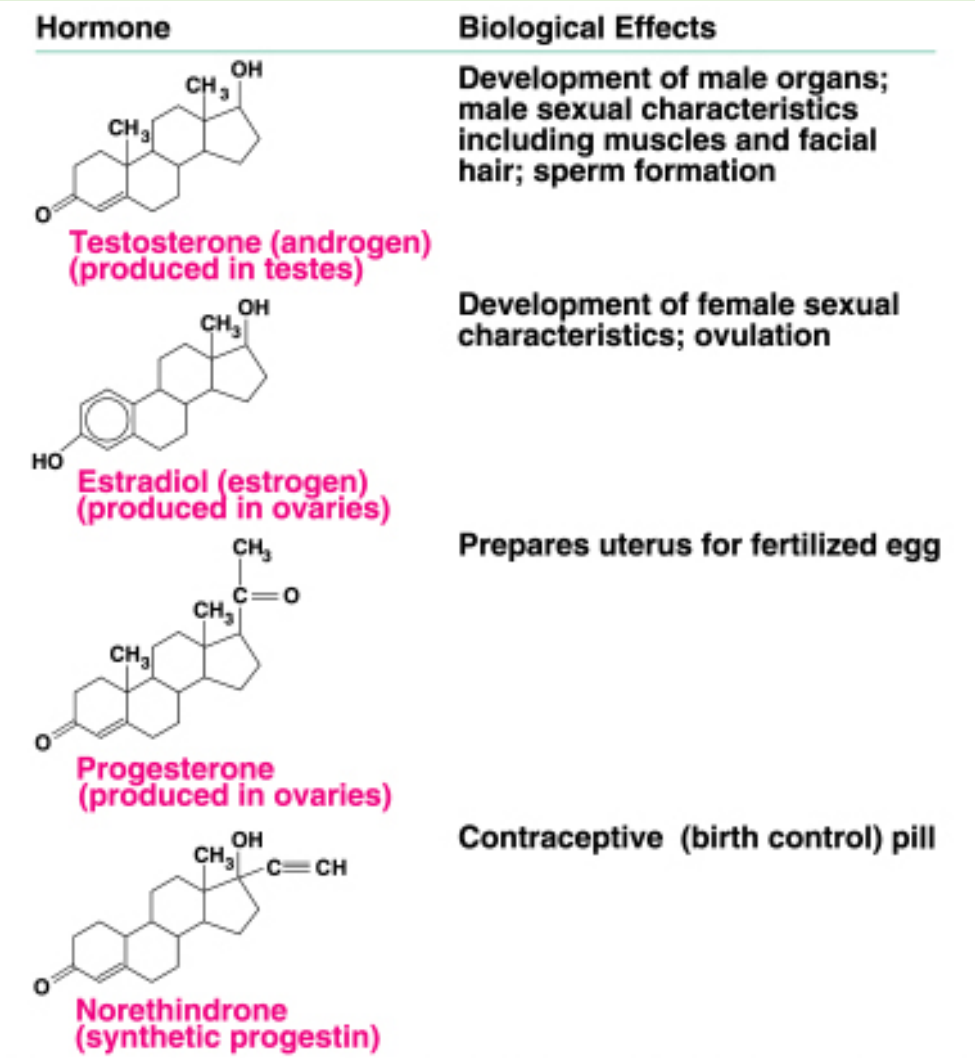


sodium glycocholate, a bile salt

Steroid Hormones

Steroid hormones

- Are chemical messengers in cells.
- Are produced from cholesterol.
- Include sex hormones such as androgens (testosterone) in males and estrogens (estradiol) in females.



Learning Check

Identify each as a

1. fatty acid 2. steroid 3. triacylglycerol
4. phospholipid 5. sphingolipid

A. cholesterol
B. glycerol, 2 fatty acids, phosphate, and choline
C. glyceryl tristearate
D. sphingosine, fatty acid, phosphate, and choline
E. estradiol
F. bile salts
G. lipids in plasma membranes

Solution

A. cholesterol 2 steroid
B. glycerol, 2 fatty acids, phosphate, and choline
4 phospholipid
C. glyceryl tristearate 3 triacylglycerol
D. sphingosine, fatty acid, phosphate, and choline
5 sphingolipid
E. estradiol 2 steroid
F. bile salts 2 steroid
G. lipids in plasma membranes
4 phospholipid, 5 sphingolipid

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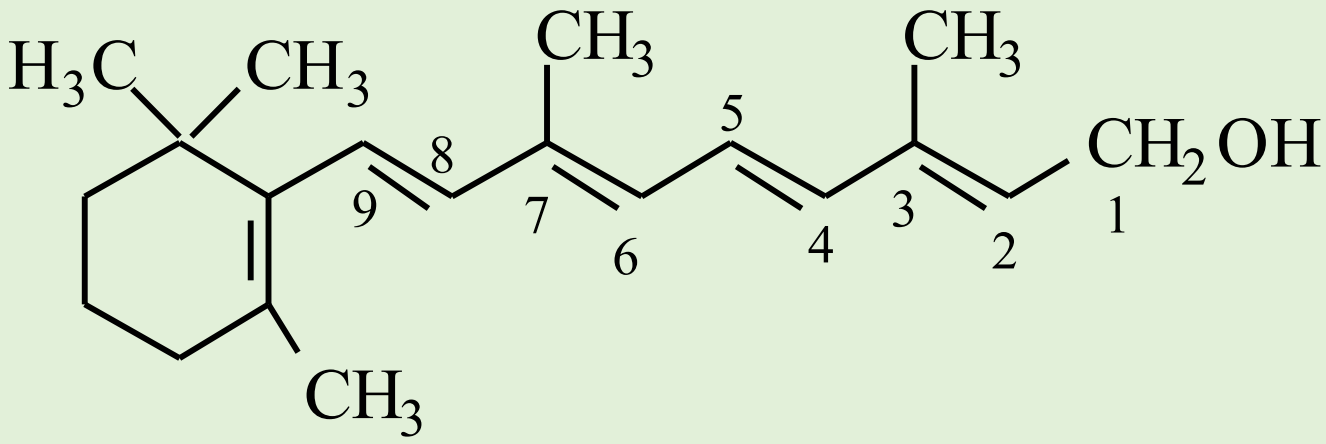
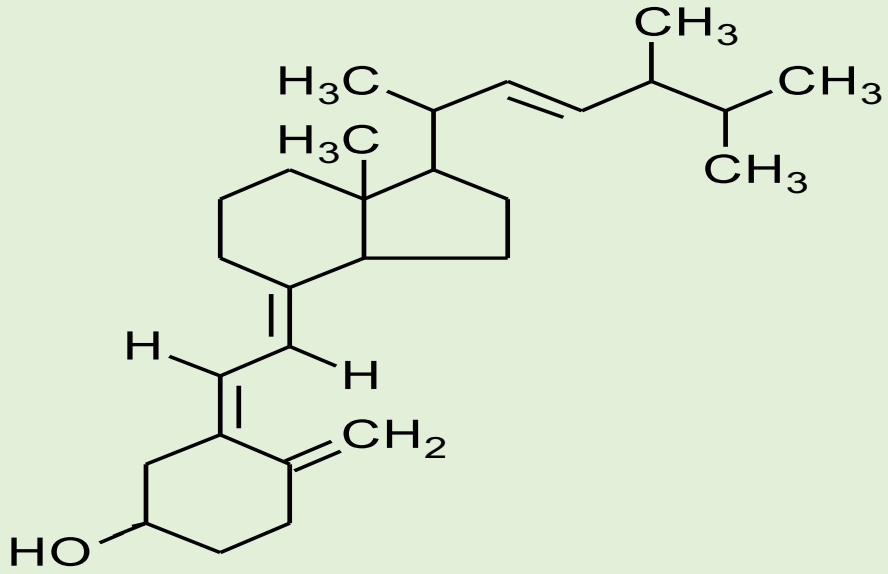
Fat soluble vitamins

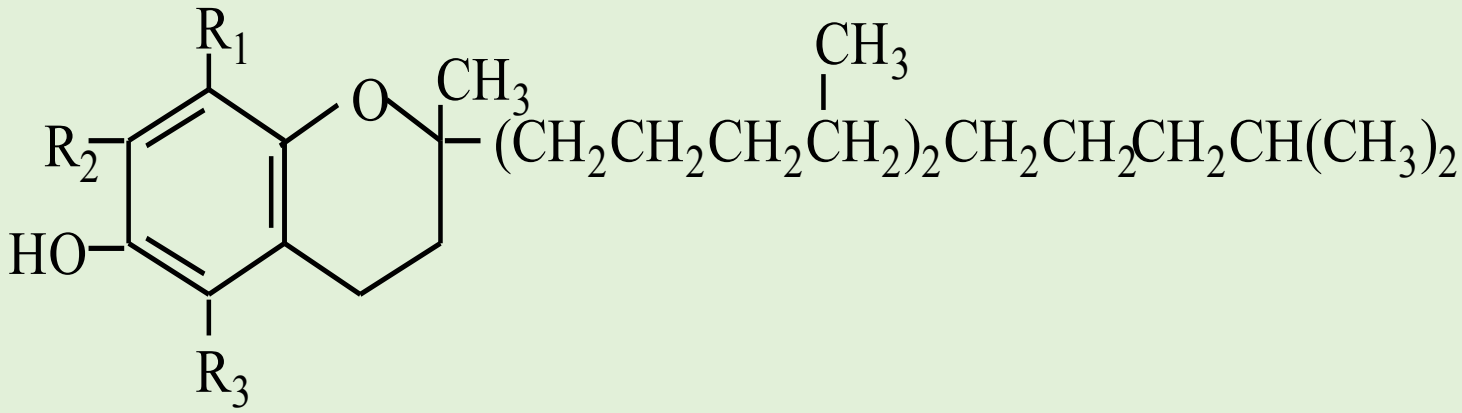
Vitamin A:



Vitamin D2:



Vitamin E:



Chemical reactions of lipids

- Hydrogenation: double bonds in unsaturated fatty acids react with H_2 in the presence of a Ni or Pt catalyst and become a single bond.

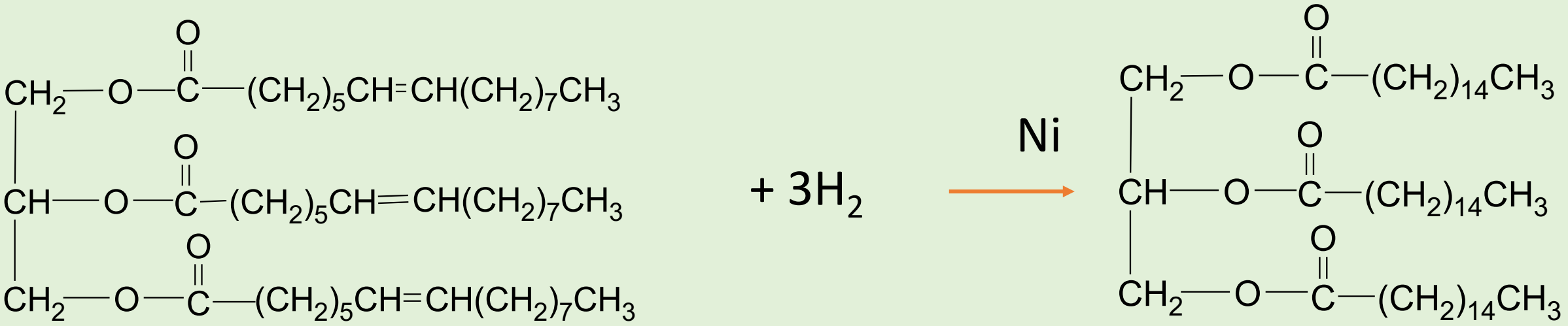
- Hydrolysis: ester bonds of TG are split by water in the presence of an acid, a base, or an enzyme.

1- Hydrogenation of Oils

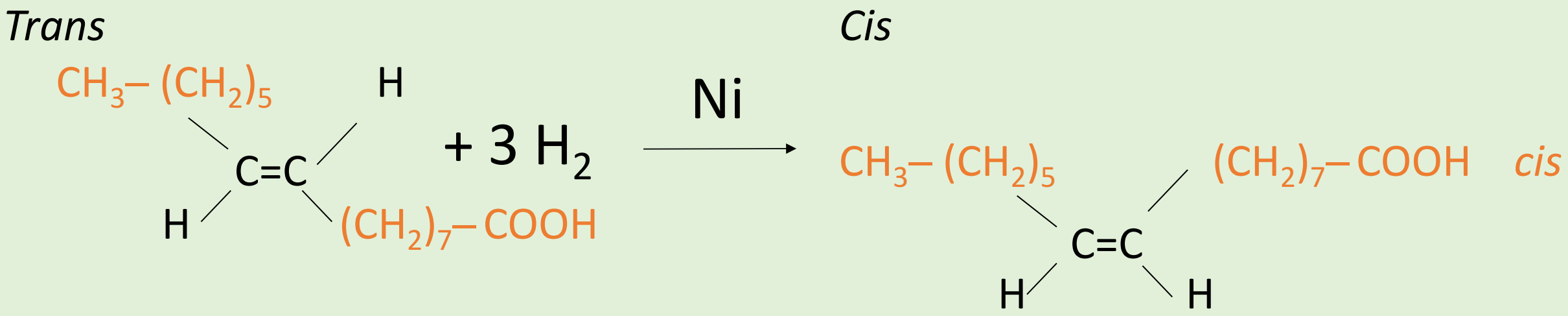
The hydrogenation of oils

- Adds hydrogen (H_2) to the double bonds of fatty acids
- Converts double bonds to single bonds.
- Increases the melting point.
- Converts oils into fat (solids), such as margarine.
- Converts Trans unsaturated fatty acids into cis unsaturated fatty acid.

Hydrogenation of oils



Hydrogenation of oils



Trans fatty acids are

- estimated to make up 2-4% of our total Calories.
- reported to raise LDL-cholesterol (bad cholesterol) and lower HDL-cholesterol.

Learning Check

(1) True or (2) False

A. There are more unsaturated fats in vegetable oils.

B. Vegetable oils have higher melting points than fats.

C. Hydrogenation of oils converts some *cis*-double bonds *to trans*- double bonds.

D. Animal fats have more saturated fats.

Solution

(1) True or (2) False

A. **T** There are more unsaturated fats in vegetable oils.

B. **F** Vegetable oils have higher melting points than fats.

C. **T** Hydrogenation of oils converts some *cis*-double

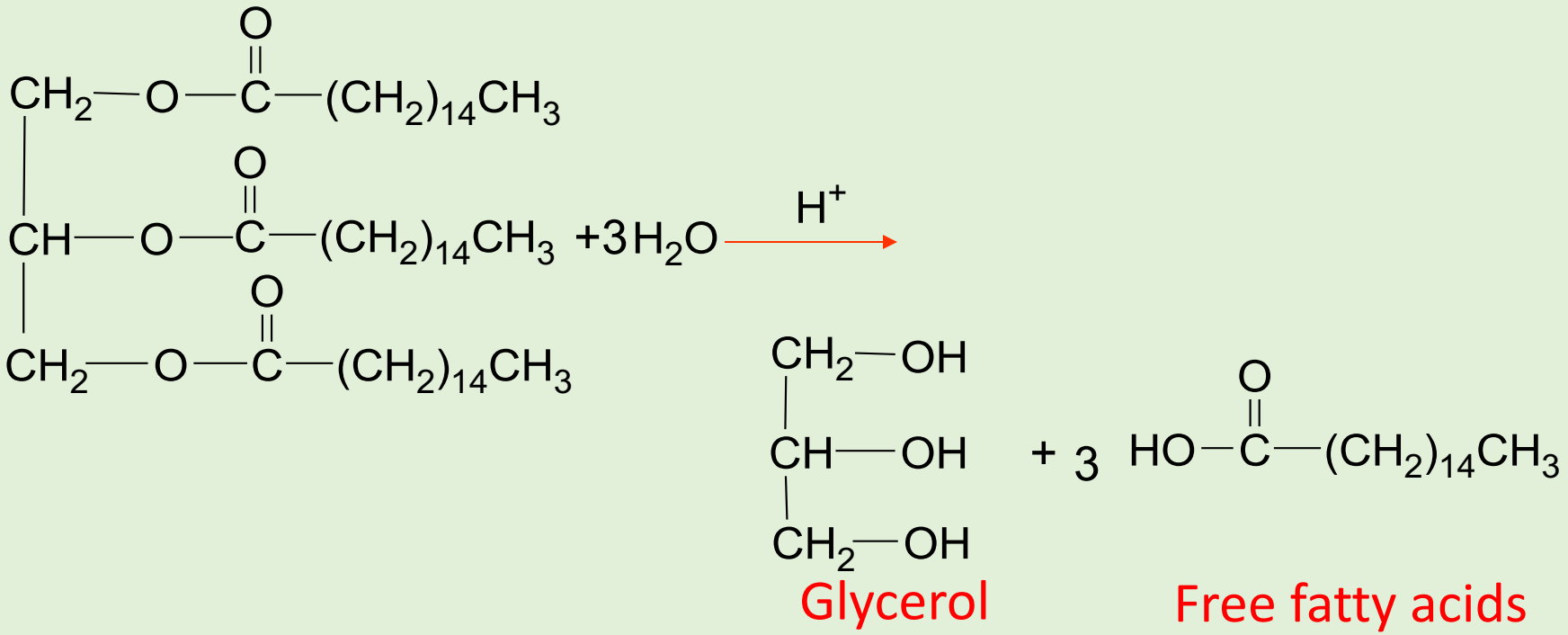
bonds *to trans*- double bonds.

D. **T** Animal fats have more saturated fats.

2- Hydrolysis

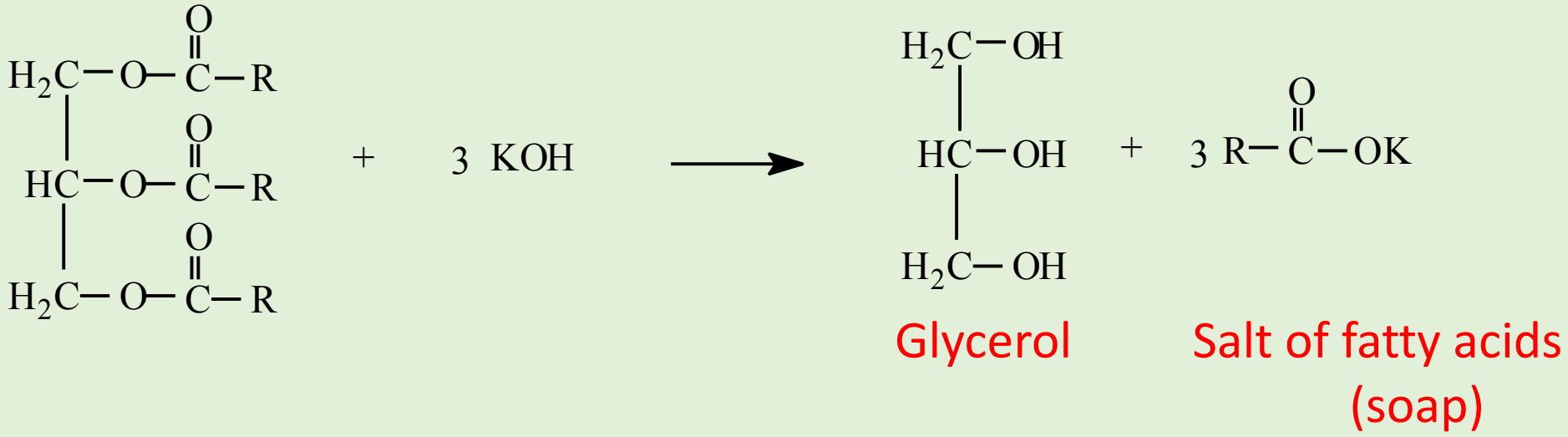
In hydrolysis,

- Triacylglycerols split into glycerol and three fatty acids.
- An acid or enzyme catalyst is required.

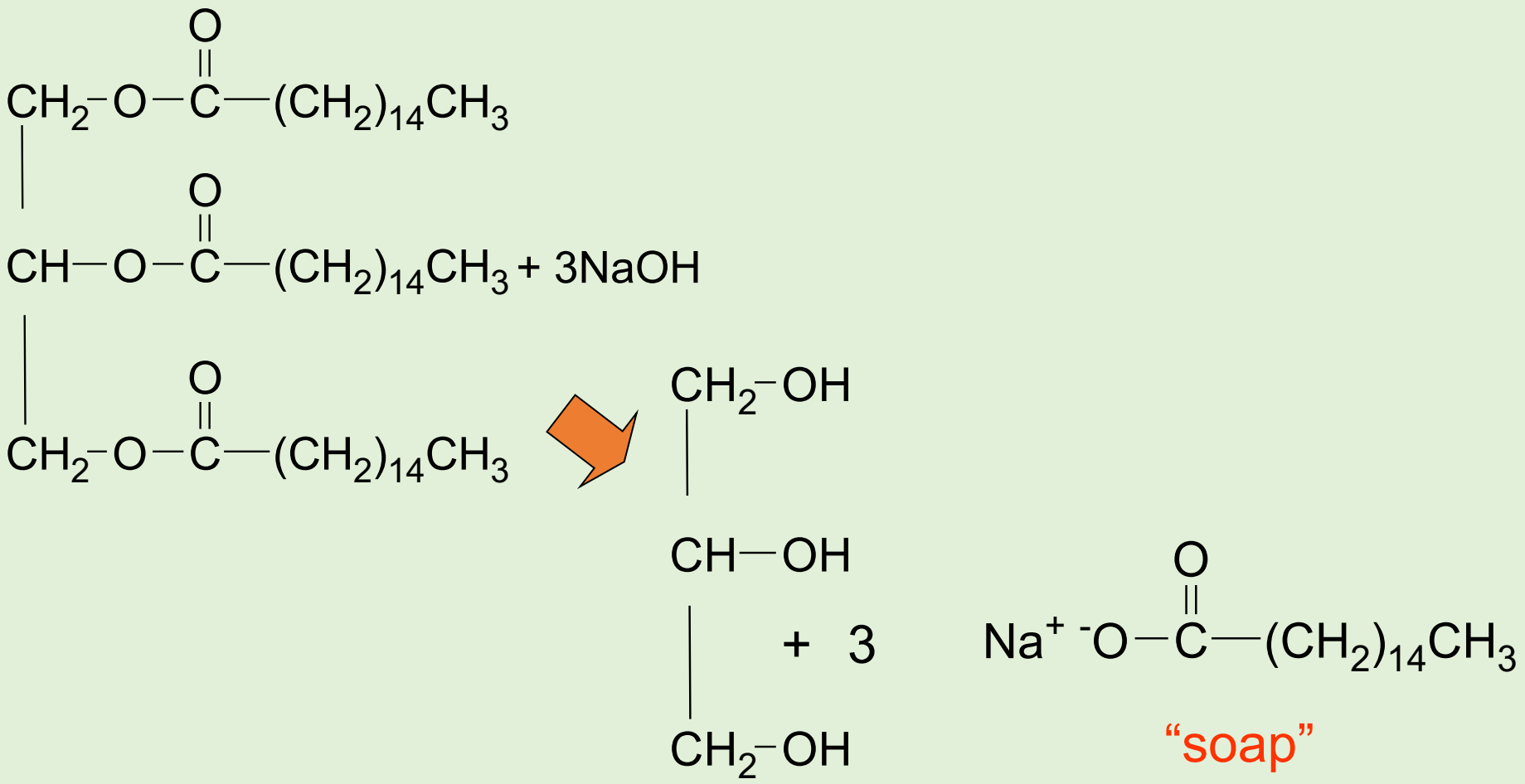


3- Saponification of lipids

- Saponification: a hydrolysis of TG under strong base to produce salt of fatty acids (soap) and glycerol.
- More base produce softer soap.



Saponification



Saponification Value of Fats and Oils

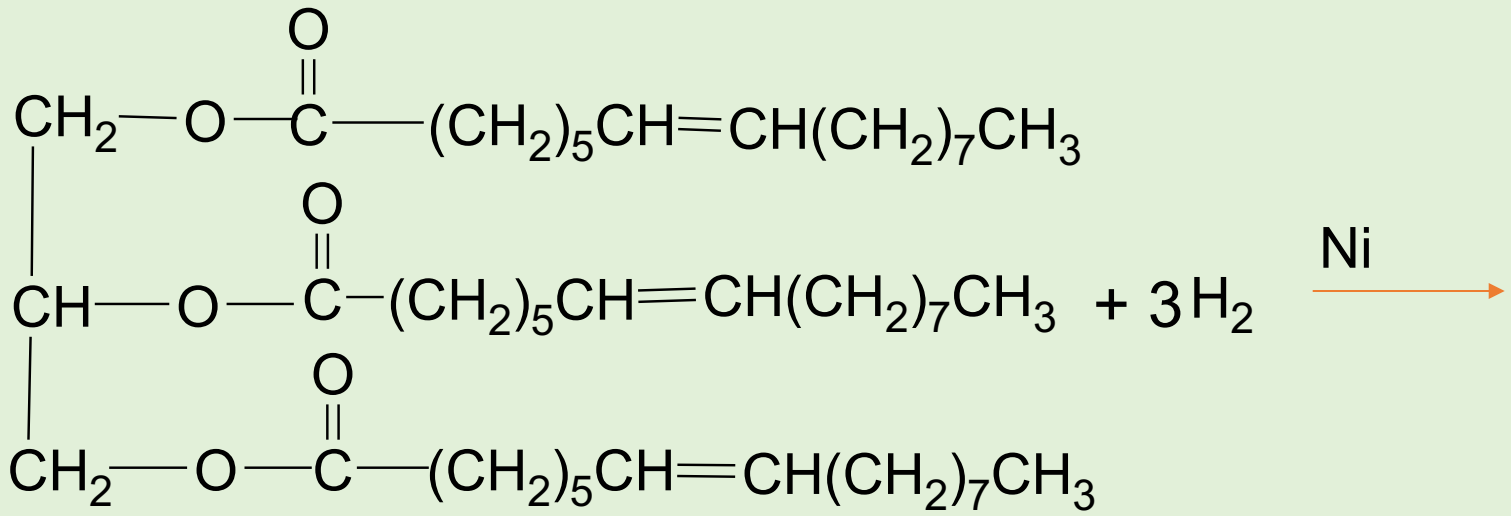
Fat	Saponification #
Milk Fat	210-233
Coconut Oil	250-264
Cotton Seed Oil	189-198
Soybean Oil	189-195
Lard	190-202

Learning Checks

1- What products are obtained from the complete hydrolysis of glyceryl trioleate?

Glycerol and 3 oleic acids, Glyceryl tristearate, Glycerol and 3 stearic acids.

2- Write the product of the following reaction:



Solutions

1- What products are obtained from the complete hydrolysis of glyceryl trioleate?

Glycerol and 3 oleic acids

2- Write the product of the following reaction: