

Lipids

Tishk International University,
Education Faculty, Biology Dept,
Biochemistry, 1st Semester

Lipids

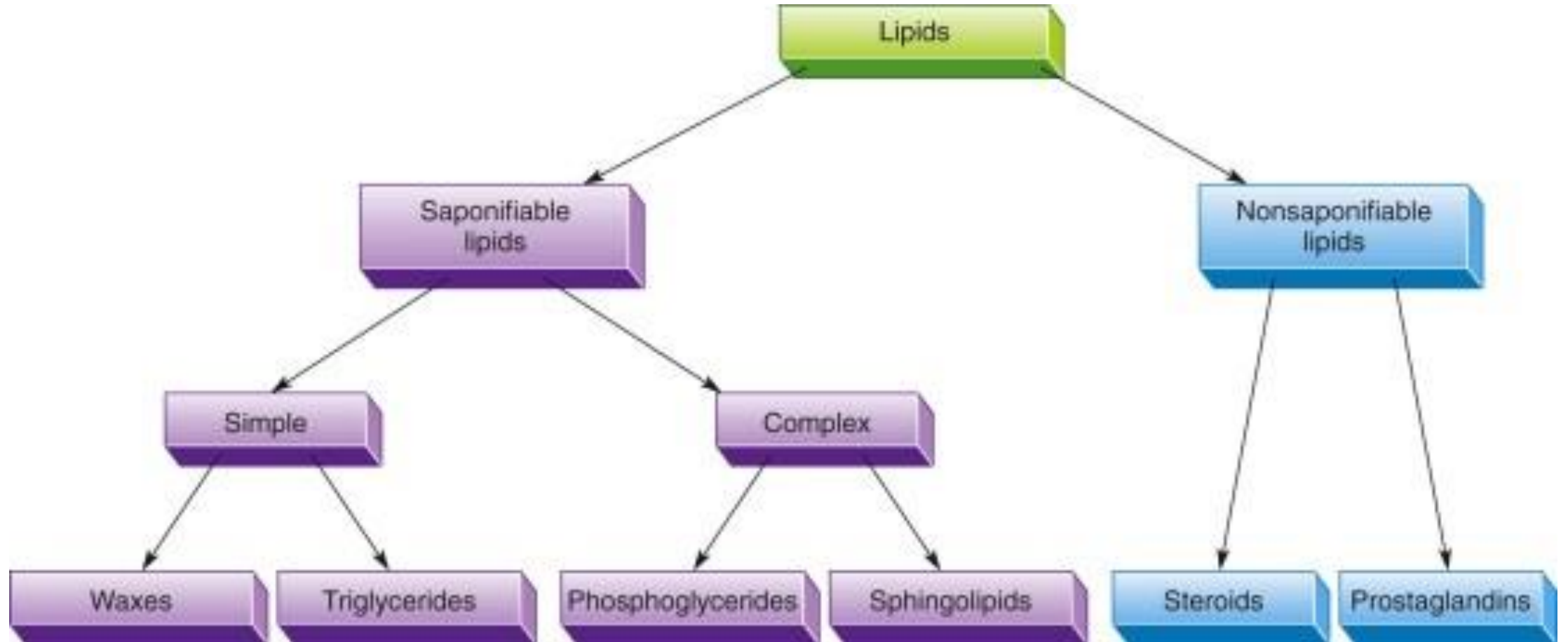
- **Lipids** are biological molecules that are insoluble in water but soluble in nonpolar solvents.
 - Lipids have a wider spectrum of compositions and structures because they are defined in terms of their physical properties (water solubility).
- Lipids are the waxy, greasy, or oily compounds found in plants and animals.
 - wax coating that protects plants
 - used as energy storage
 - structural components (cell membranes)
 - insulation against cold



Classification of Lipids

- Lipids are divided into:
 - Saponifiable lipids** — contain esters, which can undergo saponification (hydrolysis under basic conditions) (waxes, triglycerides, phospho- glycerides, sphingolipids)
 - Nonsaponifiable lipids** — do not contain ester groups, and cannot be saponified (steroids, prostaglandins)
- Saponifiable lipids can also be divided into groups:
 - Simple lipids** — contain two types of components (a fatty acid and an alcohol)
 - Complex lipids** — contain more than two components (fatty acids, an alcohol, and other components)

Classification of Lipids

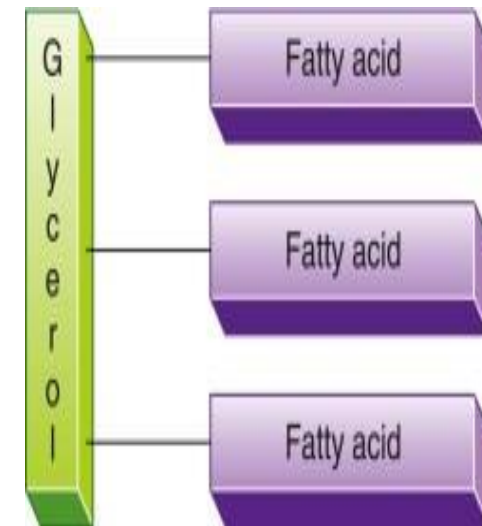
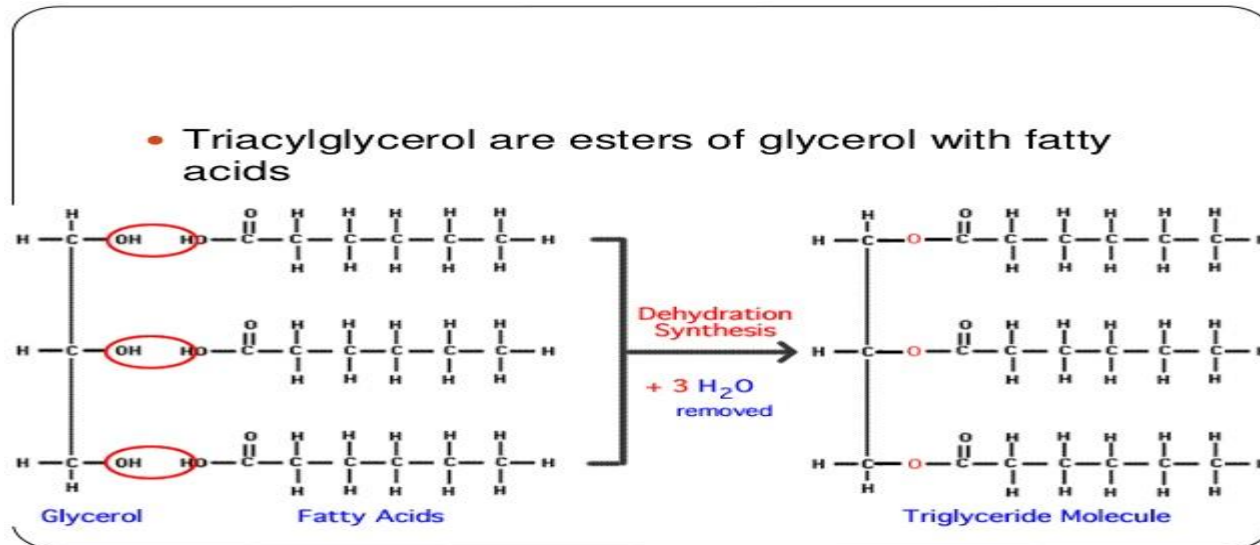


I. Hydrolysable (saponifiable) lipids

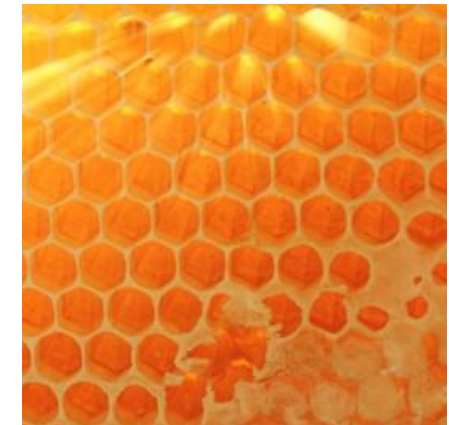
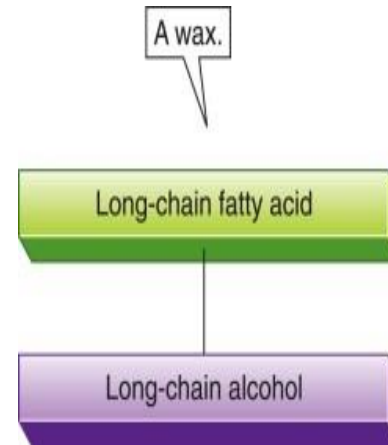
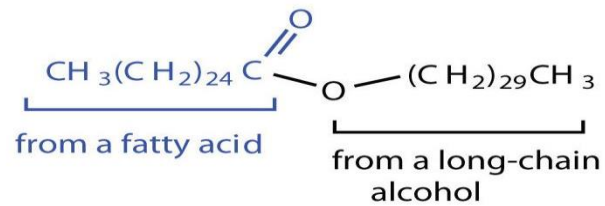
- **Simple Lipids** – consist from only two components:

a) Triglycerides (neutral fats and oils – storage lipids):

Animal fats and vegetable oils are esters composed of three molecules of a fatty acid connected to a glycerol molecule, producing a structure called a **triglyceride** or a **triacylglycerol**:



- **b) Waxes:** Composed of esters of fatty acids with alcohol other than glycerol;
- Waxes are insoluble in water, and not as easily hydrolyzed as fats and oils.
- They often occur in nature as protective coatings on feathers, fur, skin, leaves, and fruits.



Fatty acids

Fatty acids are present in all organisms as components of storage and membrane lipids.

The naturally occurring **fatty acids** are carboxylic acids with unbranched hydrocarbon chains of 12–24 carbon atoms.

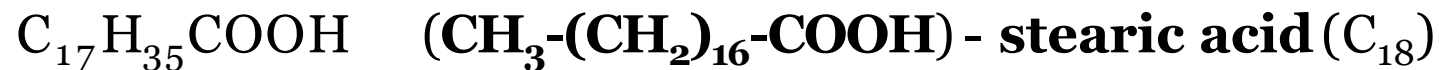
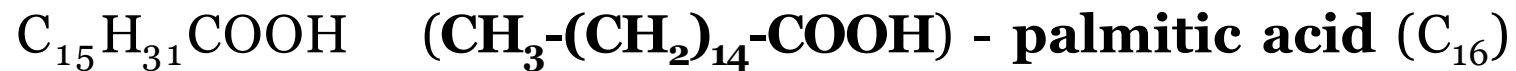
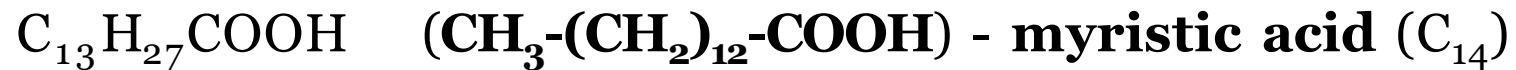
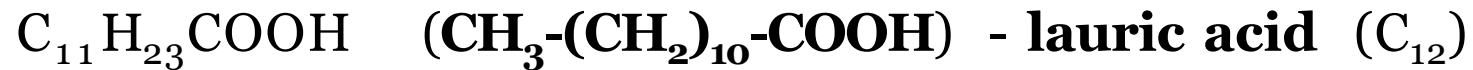


Most naturally occurring fatty acids have an **even number** of carbon atoms.

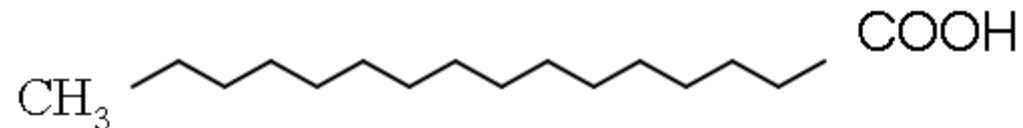
Some fatty acids contain one or more *double bonds*, and are therefore **“unsaturated.”** Double bonds in fatty acids usually have the **cis** configuration.

Some naturally occurring fatty acids.

1. **Saturated fatty acids:** general formula $C_nH_{2n+1}COOH$; have no double bonds in the chain.



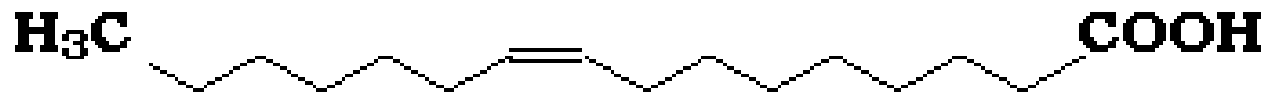
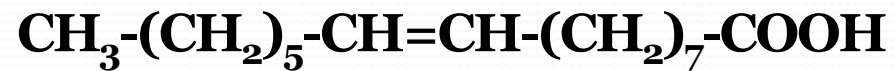
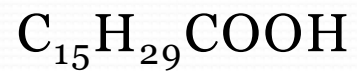
The conformation of carbon chain is a zigzag. For example- palmitic acid:



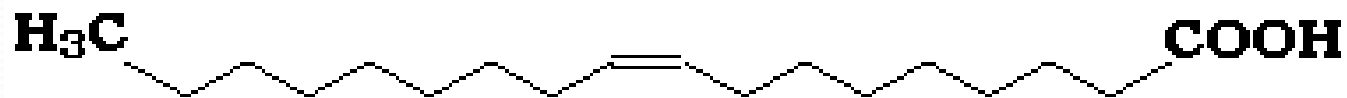
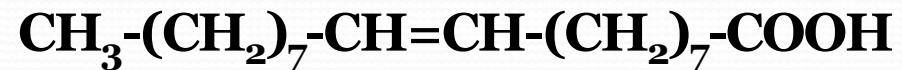
2. The unsaturated fatty acids

with one double bond (monounsaturated acids) - $C_nH_{2n-1}-COOH$:

palmitoleic acid $C_{16}:\Delta^9$



oleic acid $C_{18}:\Delta^9$

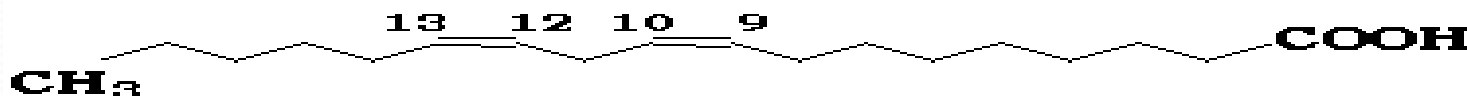
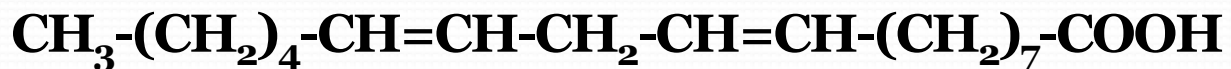


The unsaturated acid with two double bounds –

$C_nH_{2n-3}-COOH$:

linoleic acid $C_{18}:\Delta^{9,12}$

$C_{17}H_{31}COOH$



The unsaturated acids with three double bounds –

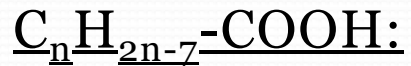
$C_nH_{2n-5}-COOH$:

linolenic acid $C_{18}:\Delta^{9,12,15}$

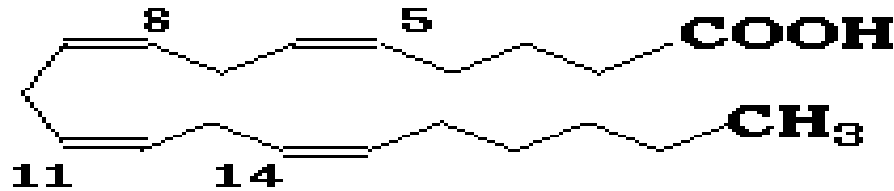
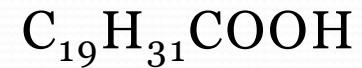
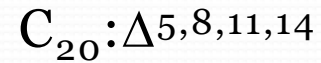
$C_{17}H_{29}COOH$



The unsaturated acids with four double bounds



arachidonic acid

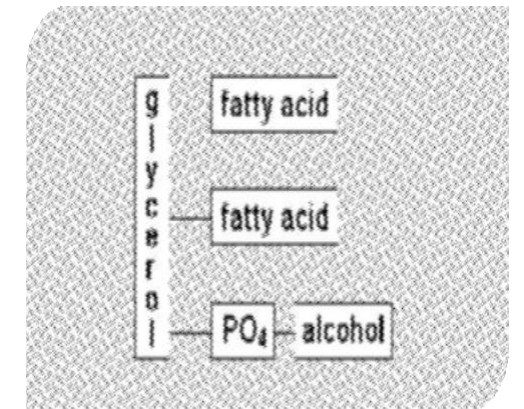
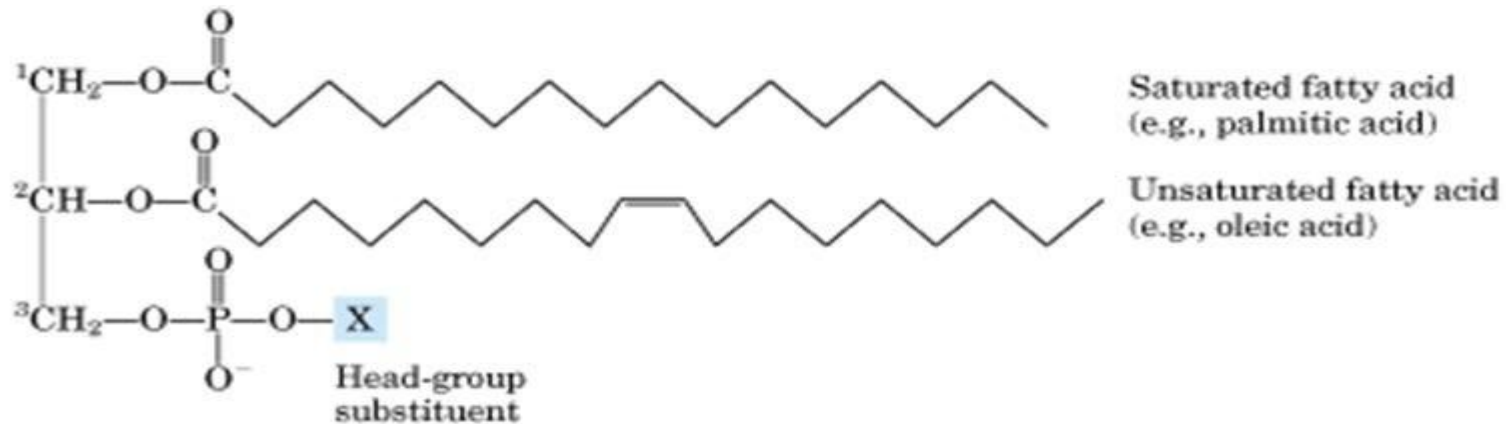


All polyunsaturated fatty acids: *arachidonic*, *linoleic* and *linolenic acid* are essential fatty acids - they are not produced in human organism and have to be supplied in the diet. They are indispensable components of nutrition.

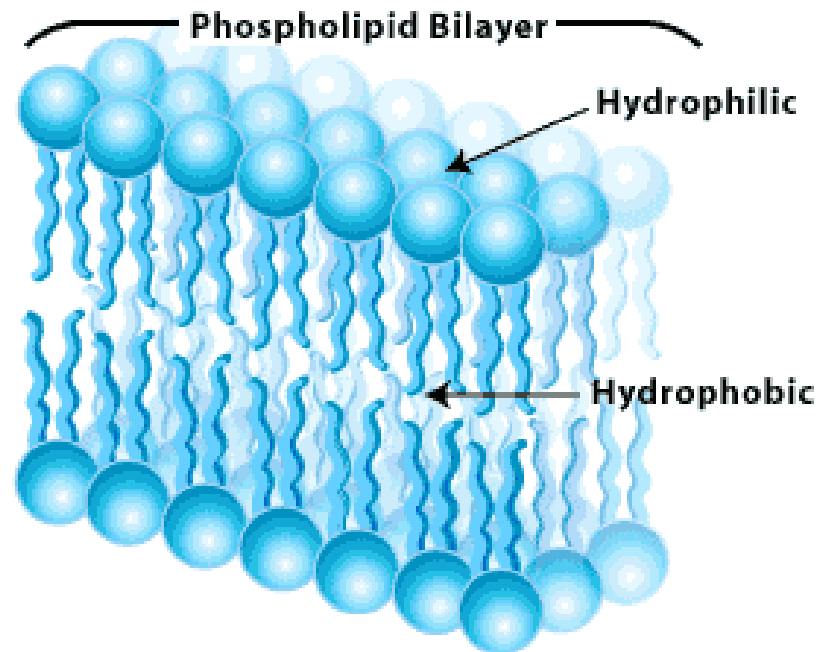
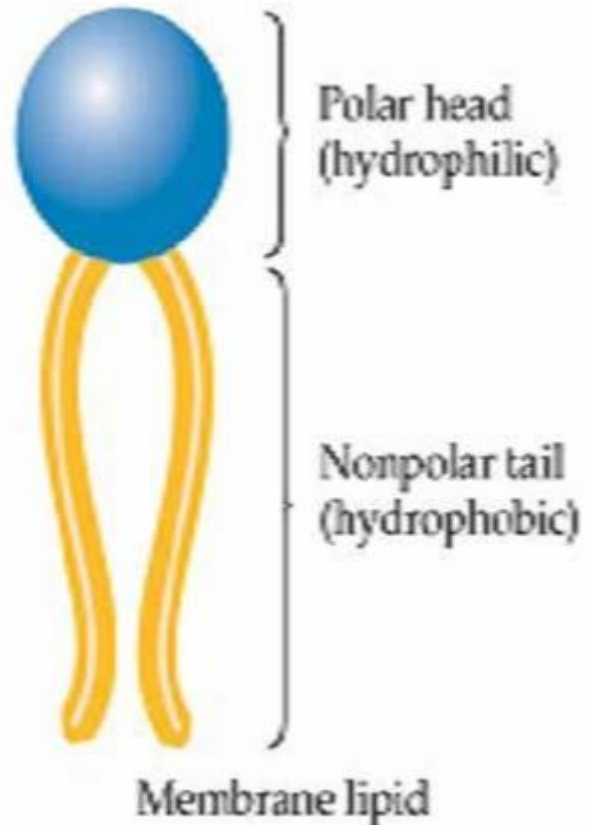
Saponifiable Lipids

- 2) complex lipids
- Phosphoglycerides:

- are common constituents of cellular membranes. They are composed of glycerol, fatty acids and phosphoric acid bound to a polar head group – an alcohol (X):

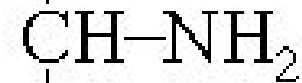
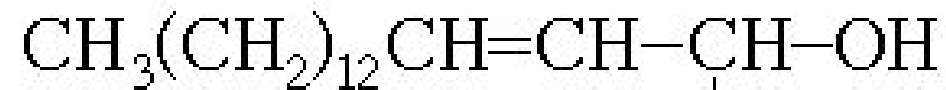
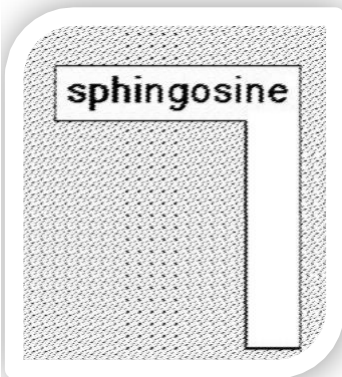


Glycerophospholipids are amphipathic - they have **hydrophilic (polar)** and **hydrophobic (nonpolar)** portions located at separate parts of each molecule. As a result, the lipid components are arranged in a continuous **bimolecular bilayer**. The polar portions of the constituent molecules lie in the two bilayer faces, while the nonpolar portions constitute the interior of the bilayer.



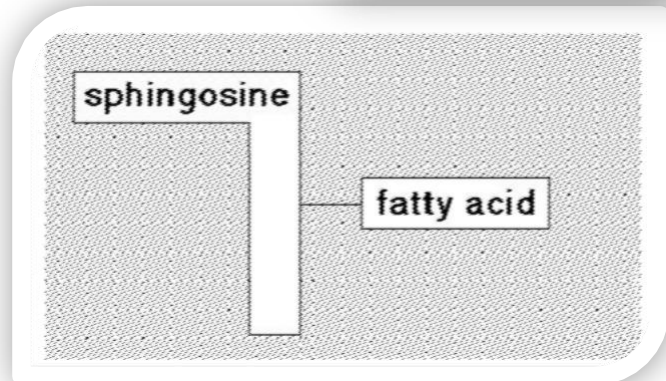
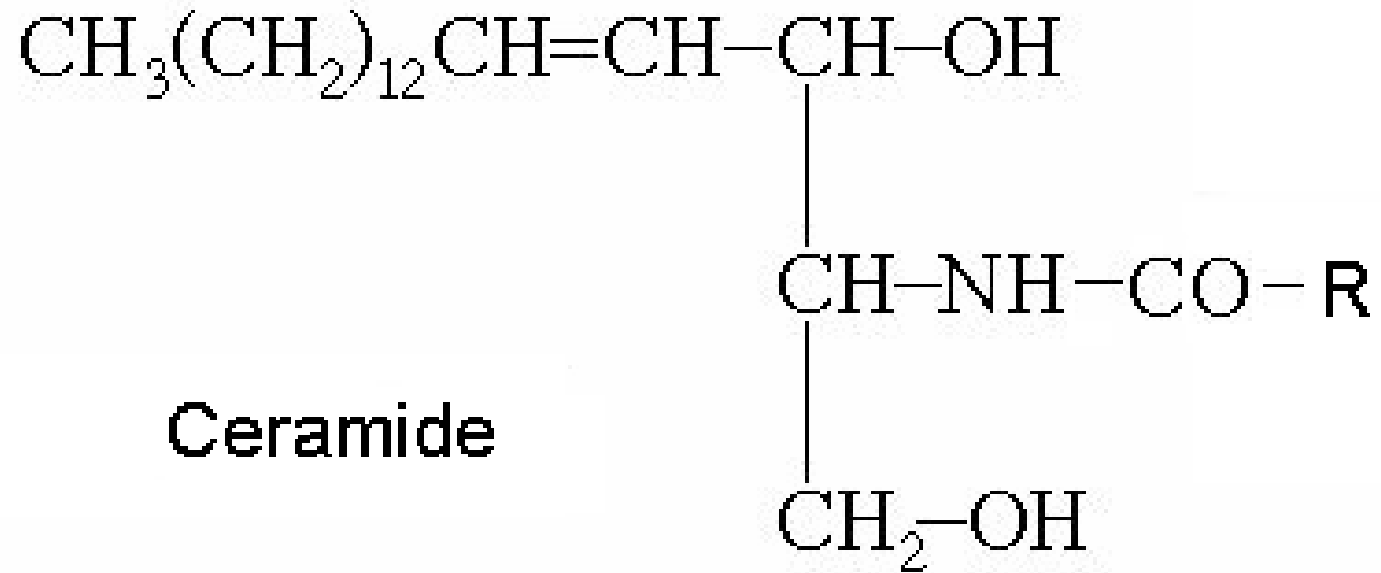
Sphingolipids

- - sphingophospholipids (sphingomyelins) and glycolipids - are the second large class of membrane lipids, also have a polar head and two nonpolar tails, but unlike glycerophospholipids they contain no glycerol.
- All sphingolipids contain one molecule of the long-chain unsaturated amino alcohol sphingosine.



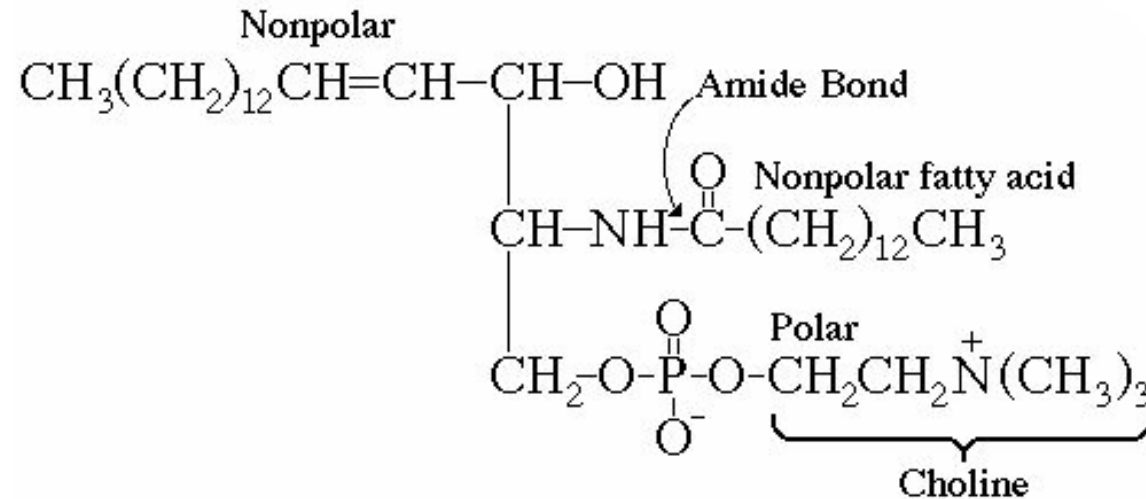
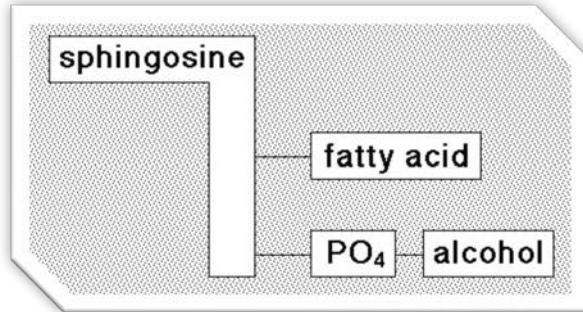
Sphingosine

In all sphingolipids sphingosine is bound by an amide bond to a fatty acid and forms a ceramide:



Sphingolipids Are Derivatives of Sphingosine

Sphingophospholipids (Sphingomyelins) contain phosphocholine or phosphoethanolamine as their polar head group, and are therefore classified as phospholipids.

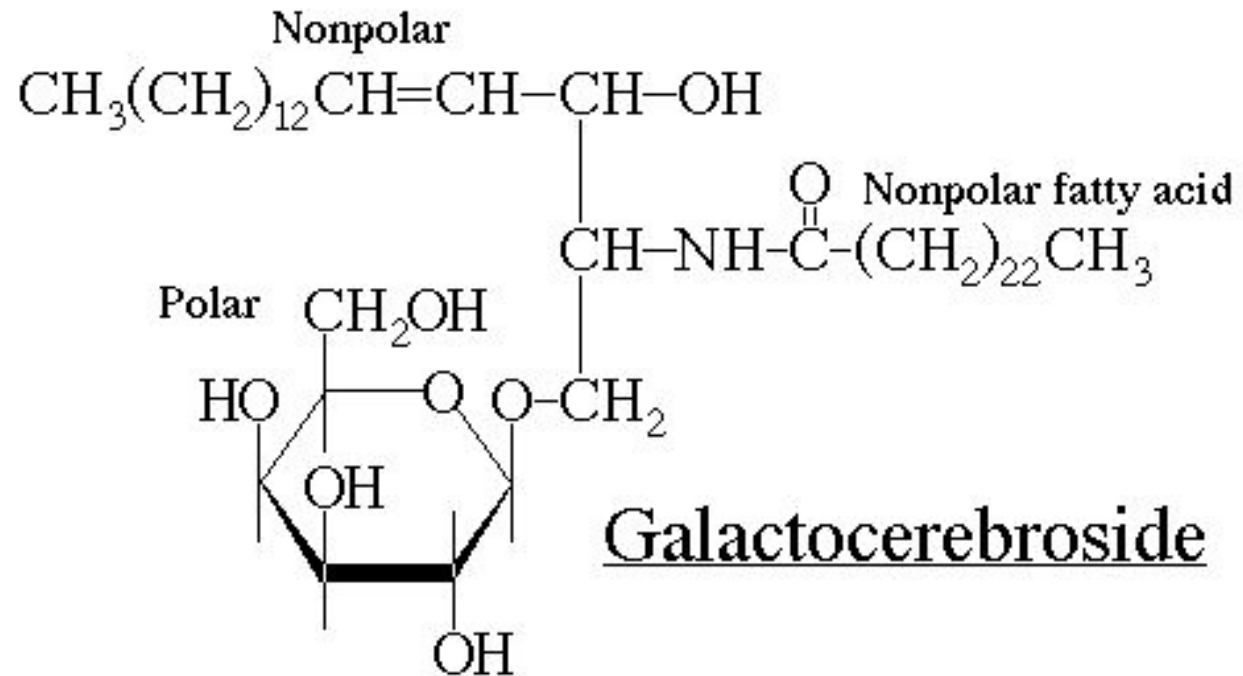
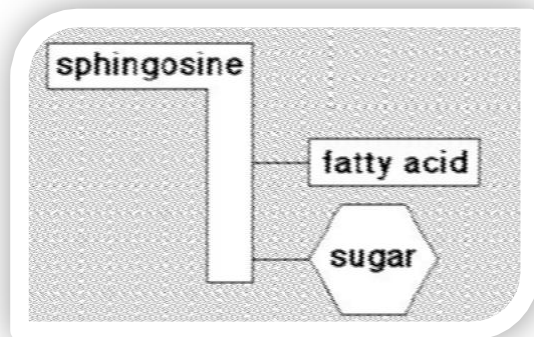


Sphingomyelins are present in plasma membranes of animal cells; the myelin sheath which surrounds and insulates the axons of myelinated neurons is a good source of sphingomyelins, and gives them their name.

Glycolipids

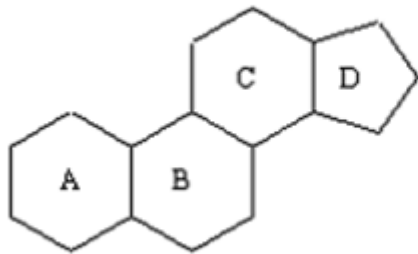
Glycolipids (sphingoglycolipids) occur largely in the outer surface of the plasma membrane.

- **Cerebrosides** have a single sugar (glucose or galactose) linked to ceramide:

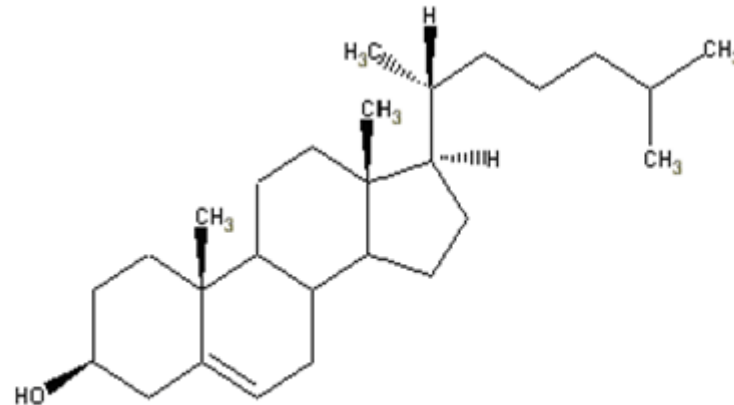


Nonsaponifiable Lipids

- *Steroids, Steroid Hormones and Prostaglandins*
- **Steroids** are classified as lipids because they are soluble in nonpolar solvents, but they are nonsaponifiable because the components are not held together by ester linkages.
- **Cholesterol, bile salt**
- The basic steroid structure contains four fused rings:



a) Backbone of steroid molecule

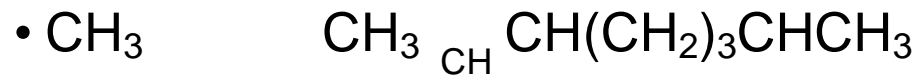


b) Structure of cholesterol

- *Cholesterol*

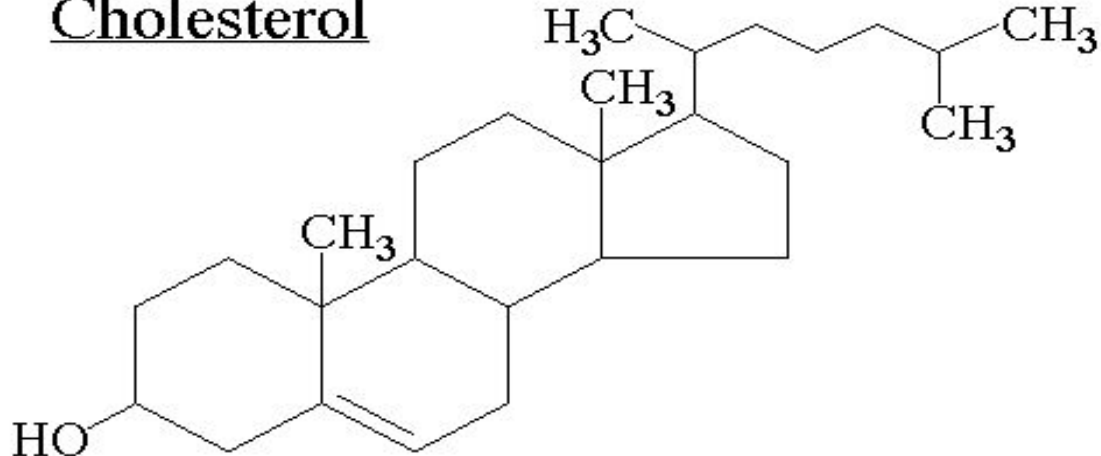
- **Cholesterol** is the most abundant steroid in the body. It is an essential component of cell membranes, and is a precursor for other steroids, such as the bile salts, sex hormones, vitamin D, and the adrenocorticoid hormones.

- There is apparently a correlation between high levels of cholesterol in the blood and atherosclerosis.



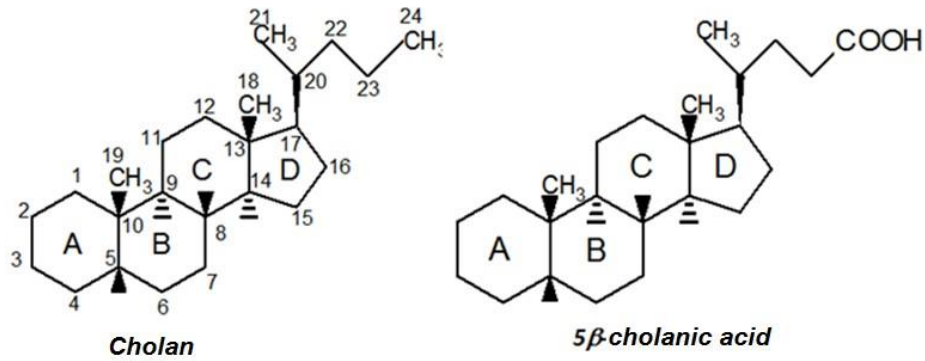
3

Cholesterol



- *Bile Salts*

- **Bile** is a yellowish brown or green fluid produced in the liver and stored in the gall bladder.
- Bile salts act like soaps and other emulsifiers: they contain both polar and nonpolar regions, helping to break fats in foods into smaller pieces, allowing them to be hydrolyzed more easily.



Steroid Hormones and Prostaglandins

- There are **four groups of steroid hormones**:
 - **gestagens - progesterone** (corpus luteum hormone),
 - **corticosteroids-adrenocorticoids** (adrenal cortex hormones),
 - **androgens** (male sex hormones),
 - **estrogens** (female sex hormones).

- *Adrenocorticoid Hormones*

- **Hormones** are chemicals released by cells or glands in one part of the body that send out messages that affect cells in other parts of the body. Many hormones are based on steroids.

- The **adrenocorticoid hormones** are produced in the adrenal glands (located on the top of the kidney).

- Glucocorticoids such as **cortisol** affect the metabolism of carbohydrates. Cortisol and its derivatives, cortisone and prednisolone (synthetic) are powerful **anti-inflammatory drugs** used to treat **arthritis** and **asthma**.

• *Prostaglandins*

- Prostaglandins are cyclic compounds synthesized from arachidonic acid.
- Like hormones, they are involved in a host of body processes, including reproduction, blood clotting, inflammation, and fever. (Aspirin works by inhibiting prostaglandin production, alleviating inflammation and fever.)