AL- MUSTAQBAL UNIVERSITY
College Of Health And Medical Techniques
Prosthetic Dental Techniques Department
Second Grade
Second Semester

Advanced chemistry

Lecture 19 (The theoretical part)

(Lipids)

By:
Prof.Dr. Hussein Kadhem AL-Hakeim

Giving the lecture

Assist.Prof.Dr.Ahmed A. AL-Khafagi

Lecture 19

Lipids: Biological molecules that are insoluble in aqueous solutions and soluble in organic solvents are classified as lipids.

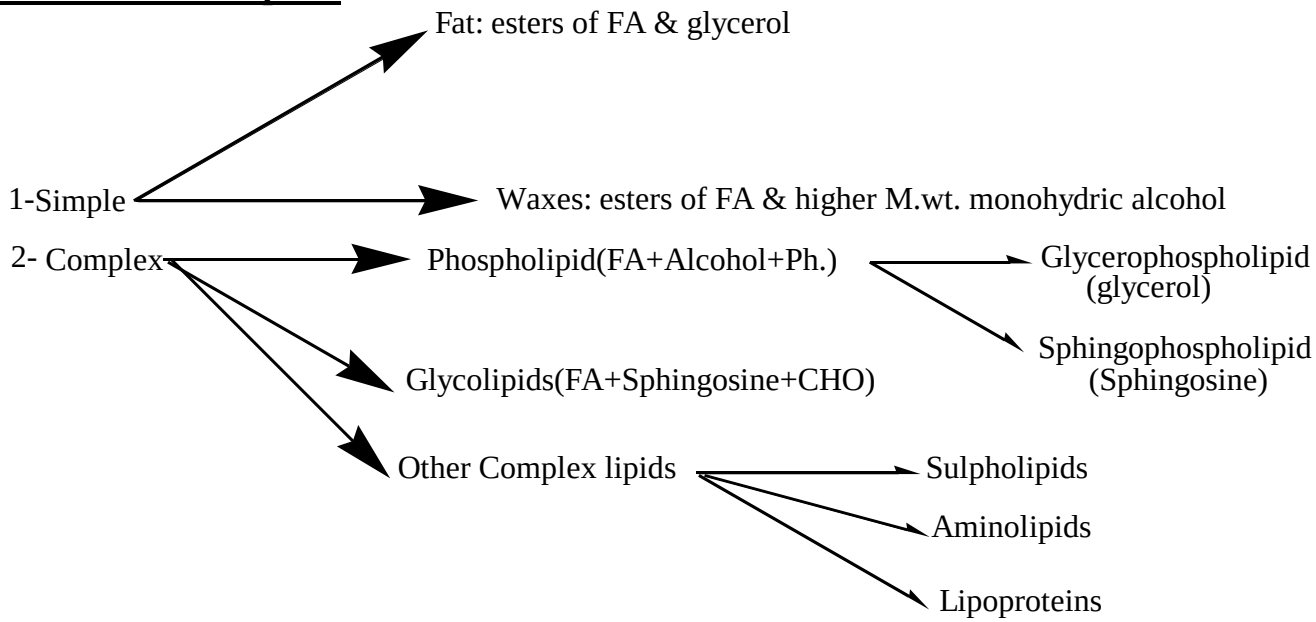
***-**Neutral lipids(e.g. cholesterol esters, triglyceride..) are uncharged molecules.

Major Roles of Biological of Lipids:

The lipids of physiological importance for humans have four major functions:

1. They serve as structural components of biological membranes.
2. They provide energy reserves, predominantly in the form of triacylglycerols.
3. Both lipids and lipid derivatives serve as vitamins and hormones.
4. Lipophilic bile acids aid in lipid solubilization.
5. Serve as thermal and electrical insulator.

Classification of Lipids:



3-Precursors and derived lipids: FA,Steroids, Ketone bodies, Some hormones, lipid soluble vitamines.

1-Fatty Acids:

Fatty acids are long-chain hydrocarbon molecules containing a carboxylic acid moiety at one end.

*Fatty acids fill two major roles in the body:

1. As the components of more complex membrane lipids.
2. As the major components of stored fat in the form of triacylglycerols.

* **Saturated fatty acids:** Fatty acids that contain no carbon-carbon double bonds.
* **Unsaturated fatty acids:** Fatty acids that contain double bonds.

Fatty acids may be further subdivided as follows:

(1) **Monounsaturated** (monoethenoid, monoenoic) acids, containing one double bond.
(2) **Polyunsaturated** (polyethenoid, polyenoic) acids, containing two or more double bonds.
(3) **Eicosanoids:** These compounds, derived from eicosa- (20-carbon) polyenoic fatty acids, comprise the **prostanoids, leukotrienes (LTs),** and **lipoxins (LXs).** Prostanoids include **prostaglandins (PGs), prostacyclins (PGIs),** and **thromboxanes (TXs).**

#The site of unsaturation in a fatty acid is indicated by the symbol **Δ** and the number of the first carbon of the double bond (e.g. palmitoleic acid is a 16-carbon fatty acid with one site of unsaturation between carbons 9 and 10, and is designated by $16:1^{\Delta 9}$).

@ Naturally occurred unsaturated FA occurs in cis-form.

@ Body can biosynthesize lipids and can supply the body with all the various fatty acid structures needed except the essential FA.

*Essential fatty acids; must be provided in the diet (the highly unsaturated fatty acids: **linoleic acid** and **linolenic acid**) because they containing unsaturation sites beyond carbons 9 and 10.

Physiologically Relevant Fatty Acids:

Numerical Symbol	Common Name	Structure	Comments
14:0	Myristic acid	$CH_3(CH_2)_{12}COOH$	
16:0	Palmitic acid	$CH_3(CH_2)_{14}COOH$	End product of mammalian F.A. synthesis
$16:1^{\Delta 9}$	Palmitoleic acid	$CH_3(CH_2)_5C{=}C(CH_2)_7COOH$	
18:0	Stearic acid	$CH_3(CH_2)_{16}COOH$	
$18:1^{\Delta 9}$	Oleic acid	$CH_3(CH_2)_7C{=}C(CH_2)_7COOH$	
$18:2^{\Delta 9,12}$	Linoleic acid	$CH_3(CH_2)_4C{=}CCH_2C{=}C(CH_2)_7COOH$	**Essential fatty acid**
$18:3^{\Delta 9,12,15}$	Linolenic acid	$CH_3CH_2C{=}CCH_2C{=}CCH_2C{=}C(CH_2)_7COOH$	**Essential fatty acid**
$20:4^{\Delta 5,8,11,14}$	Arachidonic acid	$CH_3(CH_2)_3(CH_2C{=}C)_4(CH_2)_3COOH$	**Precursor for eicosanoid synthesis**

&&Prostaglandines:

Synthesized *in vivo* by cyclation of the center of the (20C-atoms unsaturated FA that called Eicosanoic acid) to form cyclopentane cycle. Examples of prostaglandins: thromboxane, prostaglandine 2 (PGE2)

Figure : PEG2

2-Basic Structure of Triacylglycerides

Triacylglycerides (TG) are composed of a glycerol backbone to which 3 fatty acids are esterified. TG are the stored lipids in the body tissues.

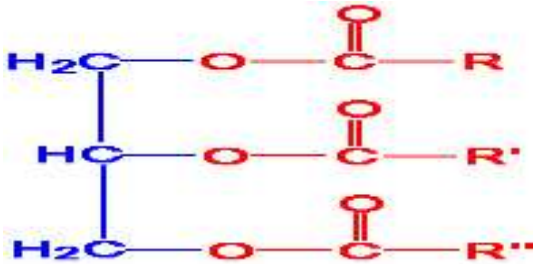


Figure: Basic composition of a triacylglyceride

3-Basic Structure of Phospholipids

The basic structure of phospolipids is very similar to that of the triacylglycerides except that C-3 of the glycerol backbone is esterified to phosphoric acid.

*The building block of the phospholipids is **phosphatidic acid** (X= hydrogen atom).

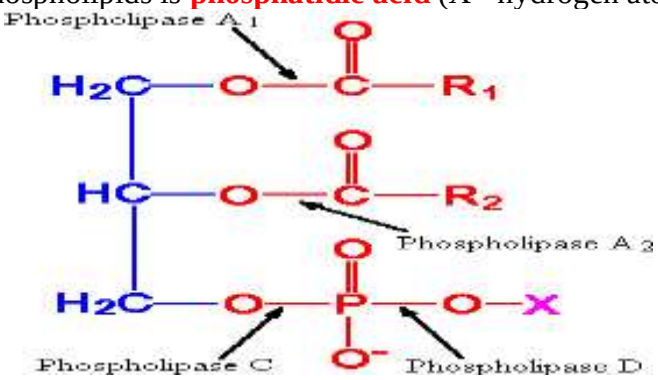
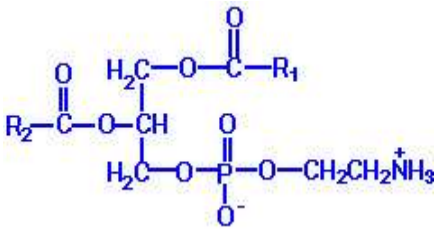
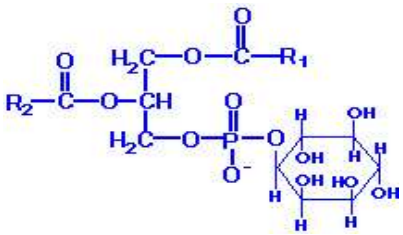


Figure: Basic composition of a phospholipid. X can be a number of different substituents.

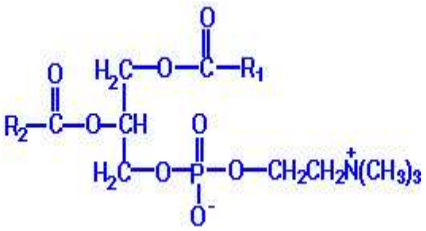
*Substitutions include ethanolamine (**phosphatidylethanolamine**), choline (**phosphatidylcholine**, also called **lecithins**), serine (**phosphatidylserine**), glycerol (**phosphatidylglycerol**), *myo*-inositol (**phosphatidylinositol**,, and phosphatidylglycerol (**diphosphatidylglycerol** more commonly known as **cardiolipins**).



Phosphatidylethanolamine



Phosphatidylinositol



Phosphatidylcholine (lecithins)

4-Basic Structure of Plasmalogens

Plasmalogens are phospholipids substituted at C-1 (*sn*1) of glycerol contain either an *O*-alkyl or *O*-alkenyl ether species. One of the most potent biological molecules is **platelet activating factor**.

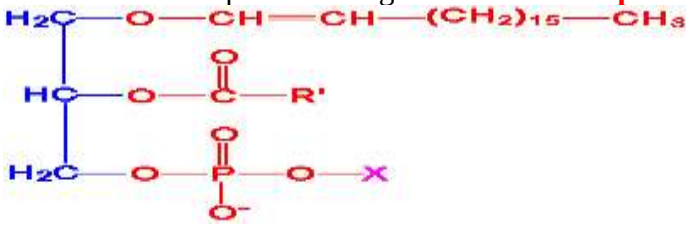


Figure: basic composition of *O*-alkenyl plasmalogens.

5-Basic Structure of Sphingolipids

*Sphingolipids are composed of a backbone of sphingosine which is derived itself from glycerol.

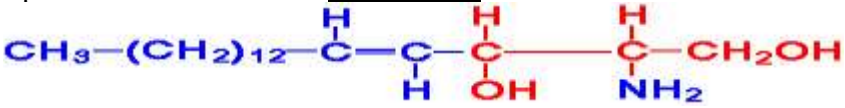


Figure: Sphingosine

* **Ceramides:** A family of molecules composed of sphingosine when N-acetylated by a variety of fatty acids. Sphingolipids predominate in the myelin sheath of nerve fibers.

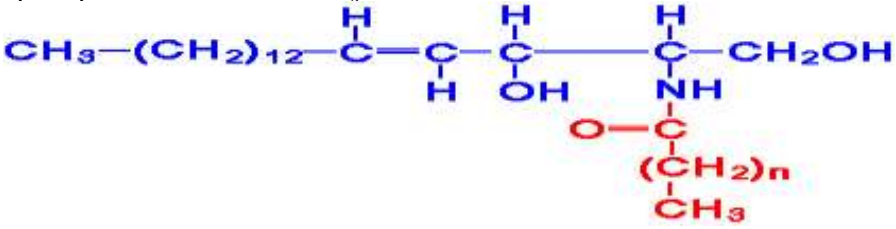


Figure: Ceramide

***Sphingomyelin** is an abundant sphingolipid generated by transfer of the phosphocholine moiety of phosphatidylcholine to a ceramide, thus sphingomyelin is a unique form of a phospholipid.

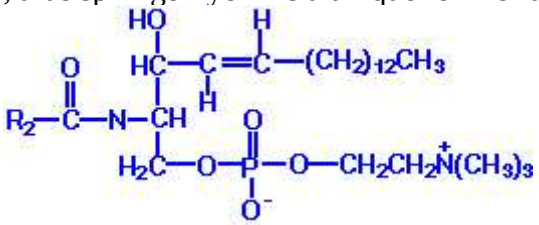


Figure: Sphingomyelin

The other major class of sphingolipids (besides the sphingomyelins) are the **glycosphingolipids** generated by substitution of carbohydrates to the *sn1* carbon of the glycerol backbone of a ceramide. There are 4 major classes of glycosphingolipids:

Cerebrosides: contain a single moiety, principally galactose.

Sulfatides: sulfuric acid esters of galactocerebrosides.

Globosides: contain 2 or more sugars.

Gangliosides: similar to globosides except also contain sialic acid.

6- Steroids:

Steroids are lipids derived from the cyclopentanophenanethrine.

Cholesterol is an extremely important biological steroids: 1-Constituent of plasma membrane and lipoproteins 2- precursor for the synthesis of the steroid hormones, sex hormones, vitamine D, and bile acids. @@ Both dietary cholesterol and that synthesized *de novo* are transported through the circulation in lipoprotein particles. The same is true of cholesteryl esters, the form in which cholesterol is stored in cells.

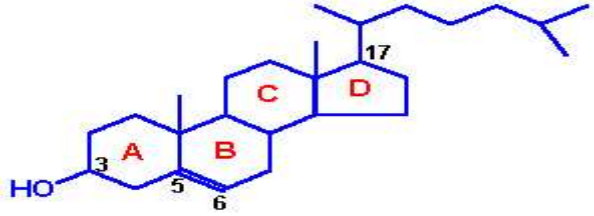


Figure: Cholesterol

Lipid Peroxidation:

It is a chain reaction providing continuous supply of free radicals ($ROO^{\cdot}$, $RO^{\cdot}$, and $OH^{\cdot}$) that initiates further peroxidation.

This process causes different disorders: rancidity (auto oxidation of lipids by oxygen), aging, cancer, atherosclerosis, inflammation, damage to tissue in vivo.

Notes:

@Amphipathic molecule: Part of the molecule is hydrophilic (polar) and the other is hydrophobic (non-polar). Polar group faces the water phase and the non-polar faces the hydrophobic phases (oil); this is the main feature of plasma membrane.

@ Micelles: Critical concentration of polar lipids in aqueous medium.

@ Liposome: Consist of spheres of lipid layers that enclose part of water.

@ Emulsion: Larger particles formed by non-polar lipids in an aqueous medium.

#-Aggregation of bile salts into micelles and liposomes with th product of fat digestion are important in facilitating absorption of lipids from intestine.