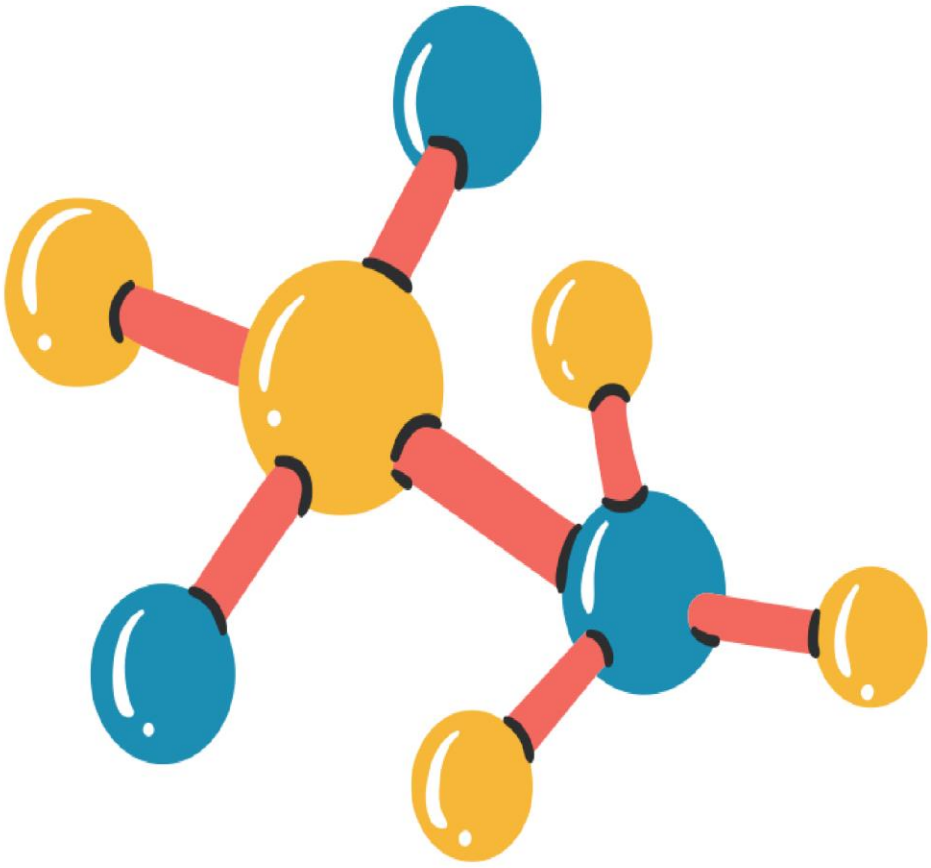
Sheet no.13

Biochemistry



Writer: Areen hatamleh & yara
Corrector: Corrector team
Doctor : Diala abu hassan

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Membrane Lipids

Membrane lipids have 2 main types :

1. phospholipids (they contain phosphate group)
2. sphingolipids (they contain sphingosine)

Note: Both of these membrane lipid types have one polar head and two hydrophobic tails .

-Sub groups of phospholipids (phosphoacyglylycerols):

1-**glycerophospholipid**

It's glycerols first and second carbons interact with fatty acid chains making the hydrophobic tail of the phospholipid, while its third carbon is connected to a phosphate group (that's why it is considered a phospholipid) .

Note: There is an extra group attached to the phosphate , this extra group makes Phosphates have different types.

2-Sphingomyelin

In this type we only have one fatty acid chain (it forms one tail) , while the other tail is made from the sphingosine structure itself .

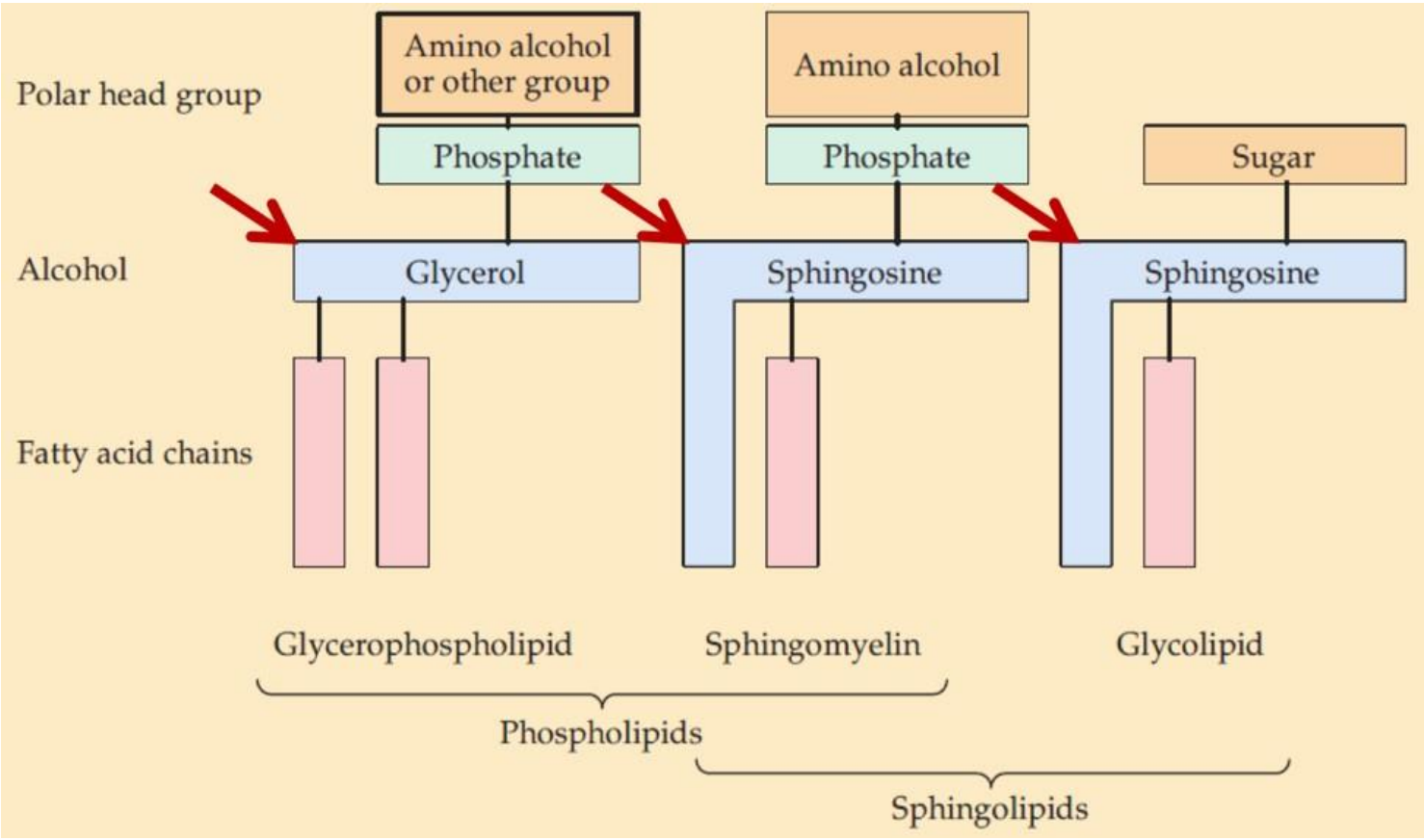
Note: Sphingosine is much larger than glycerol so it has the ability to form a tail , it also acts as a connecting region between the Hydrophobic tail and the polar head. (An amino alcohol is also attached to the phosphate group).

Note: Sphingomyeline is also considered a sphingolipid because it Contains sphingosine.

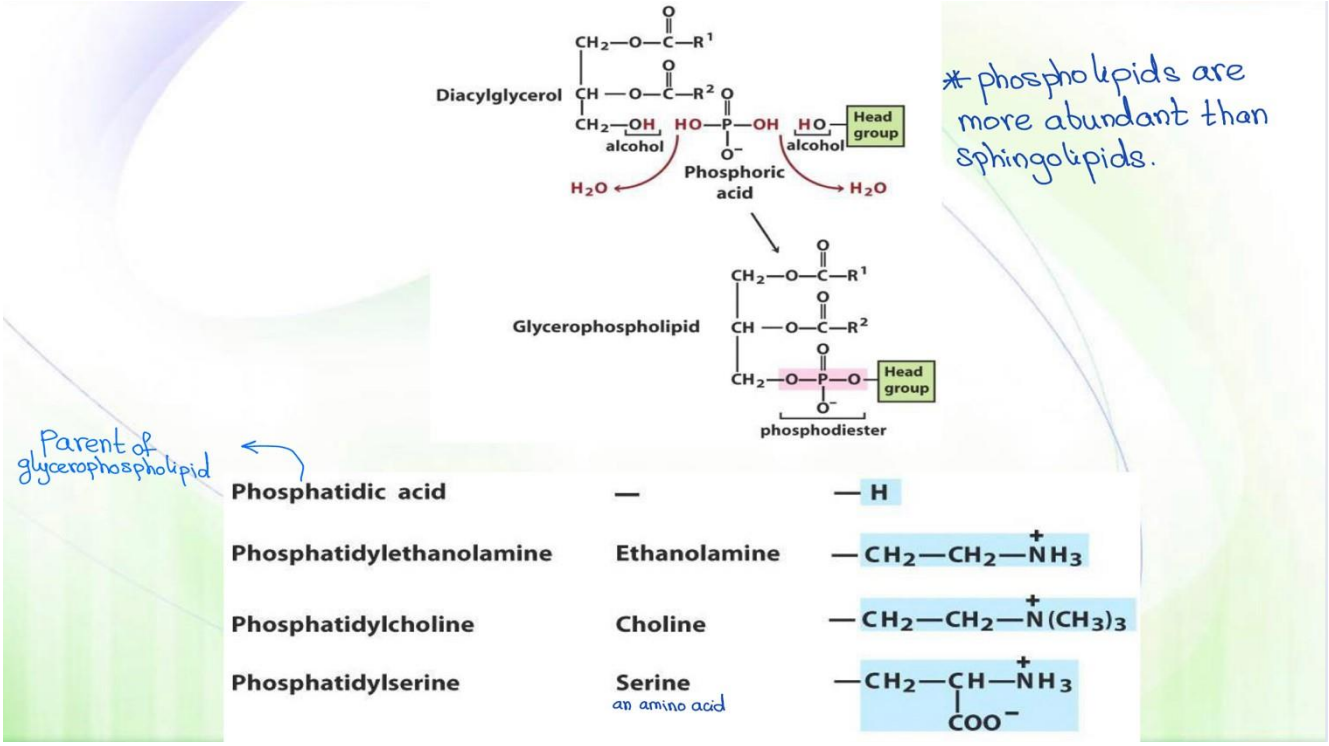
-Sub groups of sphingolipids:

1-sphingomyeline: (it is a subtype of both : phospholipids & sphingolipids)

2-glycolipid : (glycol means it contains sugars) , it contains sphingosine Making the connecting region between the polar head and the hydrophobic tails .
(sphingosine acts as one of the tails) , the head group is made of sugar (the sugar can be monosaccharide , disaccharide or oligosaccharide) .



Note: The most common membrane lipids are glycerophospholipids.



Note: Phosphatidic acid is the simplest and smallest type of glycerophospholipids.

Classification of Glycerophospholipids:

1.Phosphatidic acids

2.Phosphatidylcholine (lecithins) :

Most abundant membrane lipid , which acts as an emulsifier (مستحلب)
Which helps mixing hydropobic and hydrophilic ingredients.

3.cephalins (cepha = brain):

- Phosphatidylethanolamine
- Phosphatidylserine (abundant in brain).

4.phosphatidlinositol

Is a sugar like structure that can be connected to the phosphate group , it sends messages across cell membrane .

5.cardiolipin

6.plasmalogens

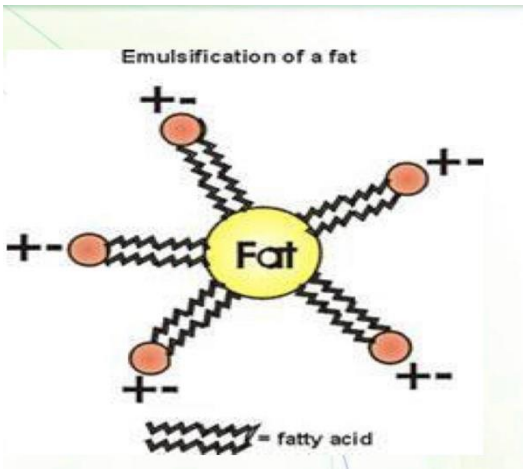
Glycerophospholipids (lecithins) :

Phosphatidylcholine Choline $-CH_2-CH_2-\overset{+}{N}(CH_3)_3$

Snake venom contains “lecithinase” (which breaks lecithin) , which hydrolyses polyunsaturated fatty acids and converting lecithin into lysolecithin , and eventually causes hemolysis of RBCs .

Emulsification:

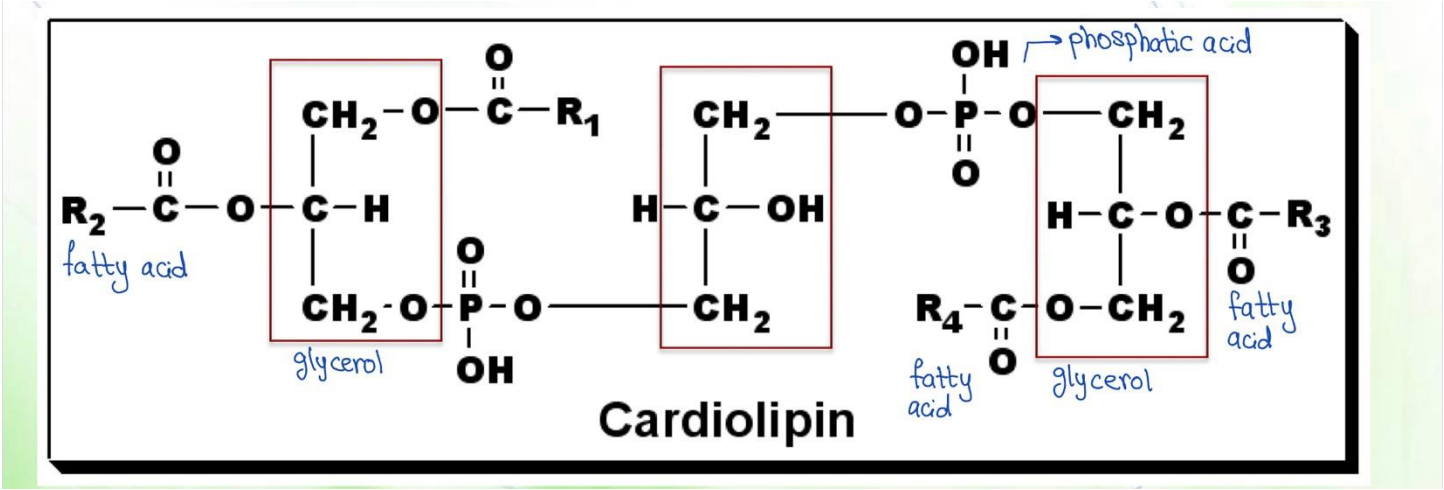
Another application related to phosphotidylcholine , is that it is used as an Emulsifier , because it is amphipathic and can surround nonpolar molecules , (so if you take chocolate bars , for example , and read the ingredients you will find an emulsifier or lecithin , they are there to help mixing the different components – like water and oil – of these products , because some are hydrophobic and others are hydrophilic so if you mix them together they will not , so the emulsifier will facilitate the mixing) .



Cardiolipin:

It is large and complicated (seems like two molecules attached together) :

- Diphosphatidyl glycerol.
- Structure: 3 molecules of glycerol , 4 fatty acids and 2 phosphate groups .



Note: Cardiolipins are first discovered in cardiac tissue , that's why it is called cardio (cardio=heart) , they are important and specific for the inner membrane of the mitochondria.

Plasmalogens:

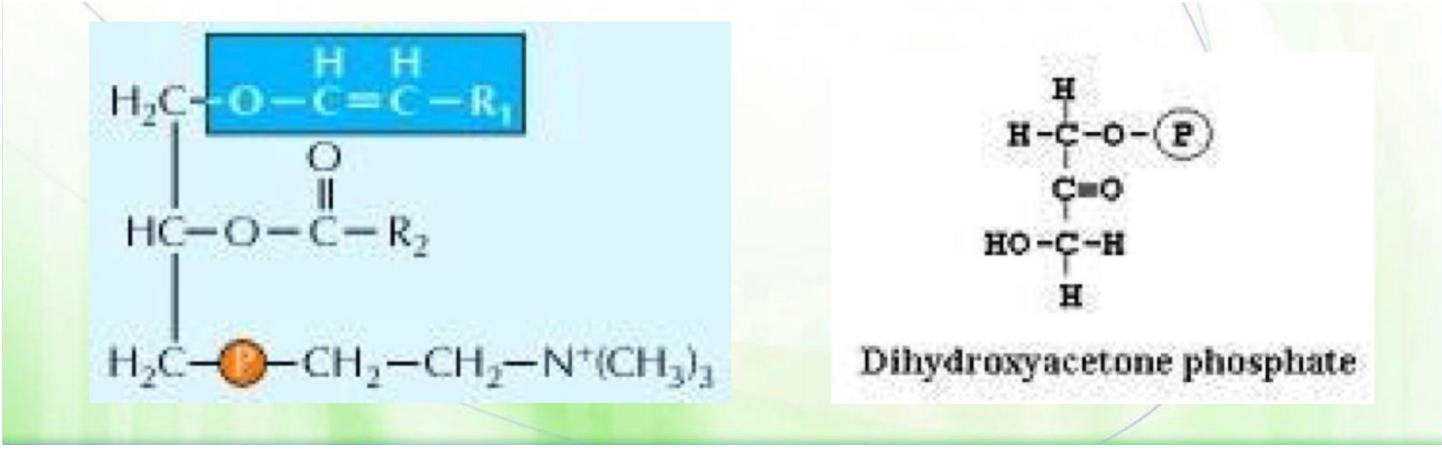
- They are found in the cell membrane phospholipids fraction of brain ,muscle, liver(hepatic) and semen.
- They have a protective role against the reactive oxygen species (oxygen has extra electrons that are very harmful on health) .

- Its Structure:

  1-precrusor: dihydroxyacetone phosphate .

  2-unsaturated fatty alcohol at C1 connected by ether bond .

  3- in mammals: at C3;phosphate + ethanolamine or choline .



Note: C1:ether linkage C2: ester Linkage C3:ester linkage

-Major classes of plasmalogens :

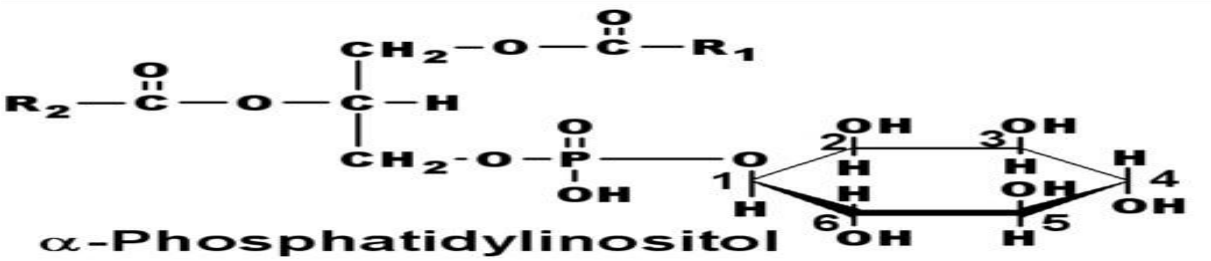
1.eathanolamine plasmalogen (myelin-nervous tissues) .
2.choline plasmalogen (cardiac tissue) , Platelet activating factor .
3.serine plasmalogens .

Inositides (Phosphatidylinositol)

1.nitrogenous base : cyclic sugar alcohol (inositol)
2.structure: glycerol , saturated FA , unsaturated FA , phosphoric acid and inositol.
3.source: brain tissues
4.functions ;
a. Major component of cell membrane.
b. Second messenger during signal transduction..

c. On hydrolysis by phospholipase , Phosphatidyl-inositol-4,5-diphosphate produces diacyl-glycerol (DAG) & inositol-triphosphate (IP3); which liberates calcium.

Note: its structure is so similar to sugar.

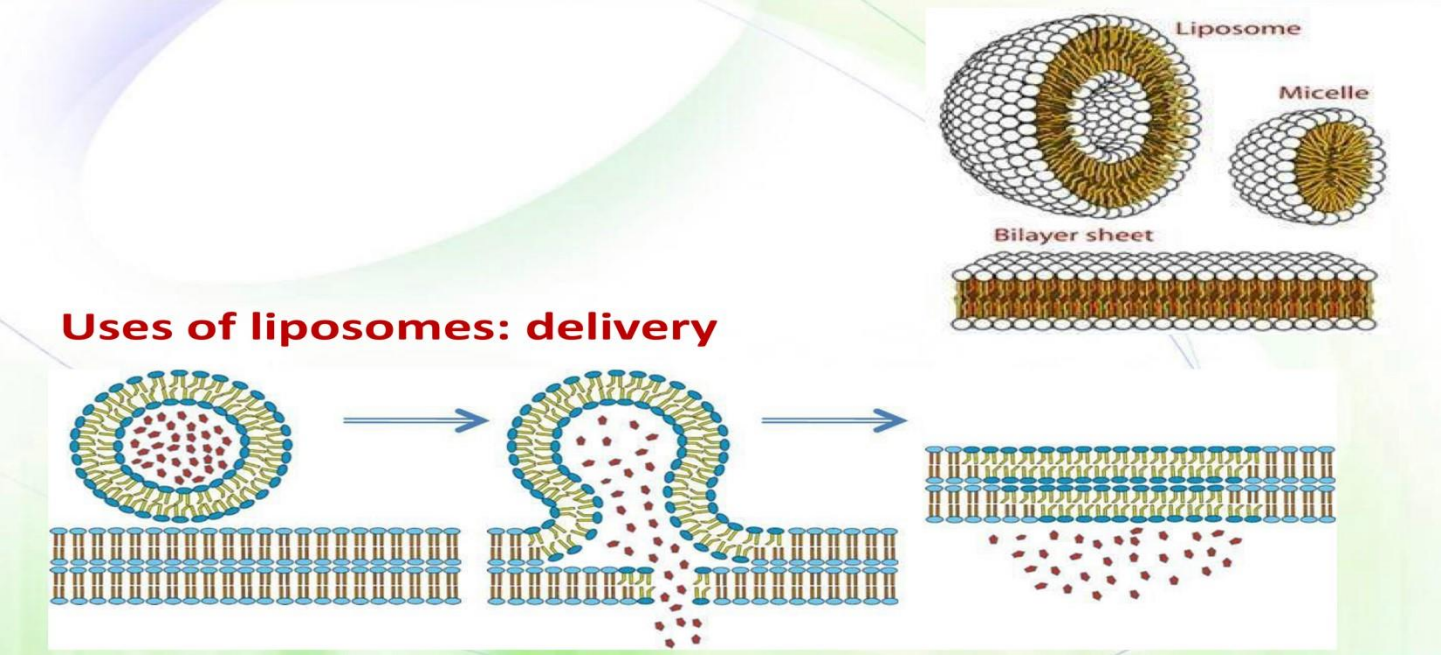


Liposomes

In membrane we have a bilayer of phospholipids and sphingolipids (phospholipids are more abundant), and because of the hydrophobic tails region and hydrophilic polar head , it doesn't exist as one layer.
The aqueous environment surround it from outside so the layers line in opposite directions so that the hydrophobic region avoid aqueus environment.
The membrane can't exist as a sheet , because the sides will be exposed to the aqueous environment and it will be unstable, so it forms into a more stable ball like structure, this structure is called liposome.

Note: the liposomal structure is different than the micelle . the micelle is made of only one layer while the liposome is made of two.

Note: we use the liposome idea for delivery of drugs. For example, you can load your drug inside the liposome and in between the phospholipids we insert some proteins that specially bind to a receptor on target cell, and this will allow fusion of liposomal membrane with target cell membrane and hence releasing the content inside the target cells.

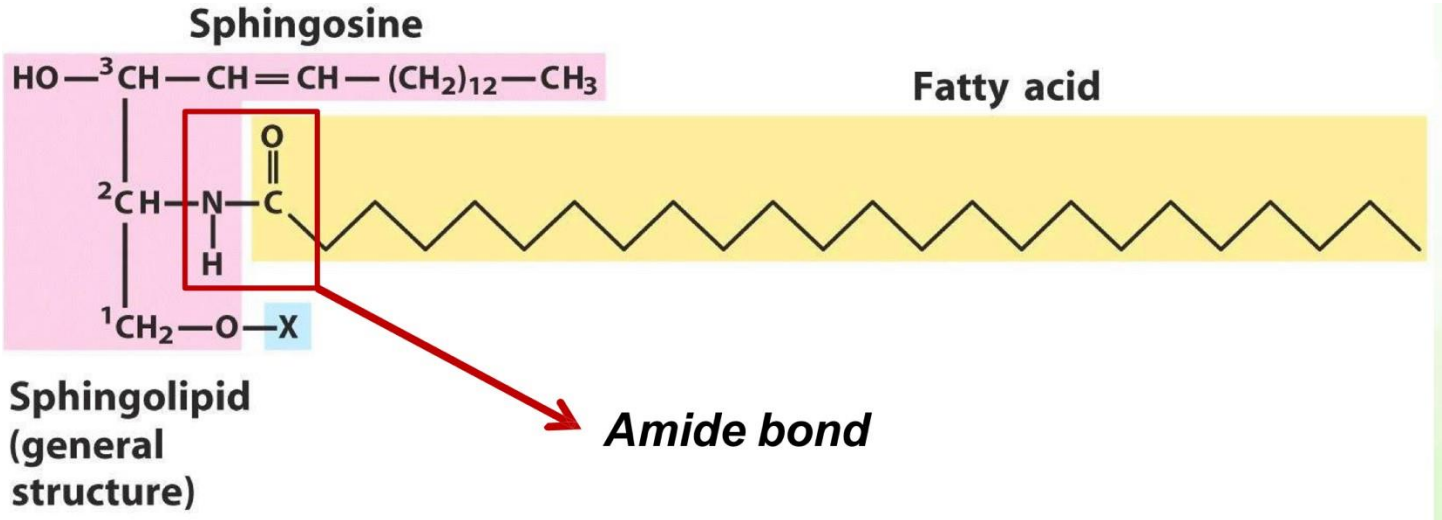


Sphingolipids

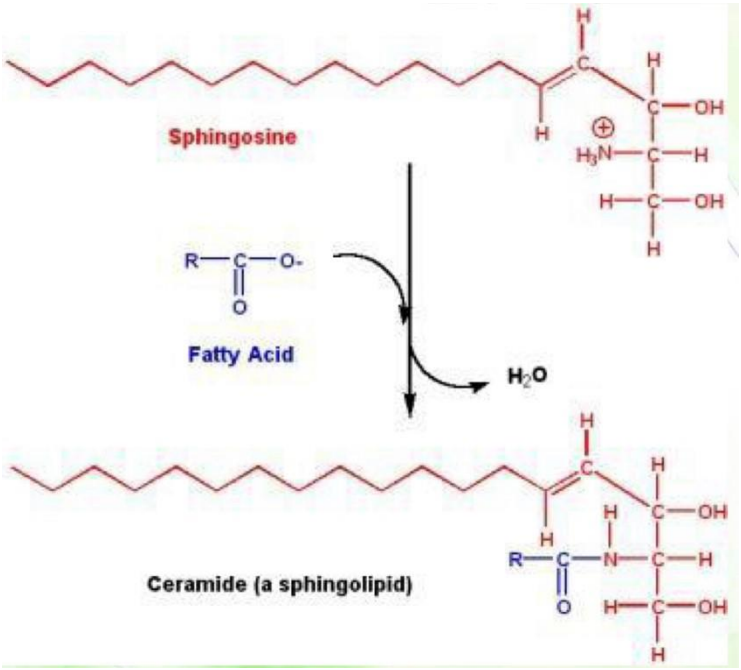
Sphingolipids are less abundant that phospholipids, they are found in the plasma membranes of all eukaryotic cells and is highest in the cells of the CNS.

Structure: the core of it is a long-chain amino alcohol, sphingosine.

Note: it is an 18 carbon molecule.



Ceramide: Is the parent molecule of sphingolipids , a shingosine structure , to the N of which is attached a fatty acid forming an amide bond.



Types of sphingolipids

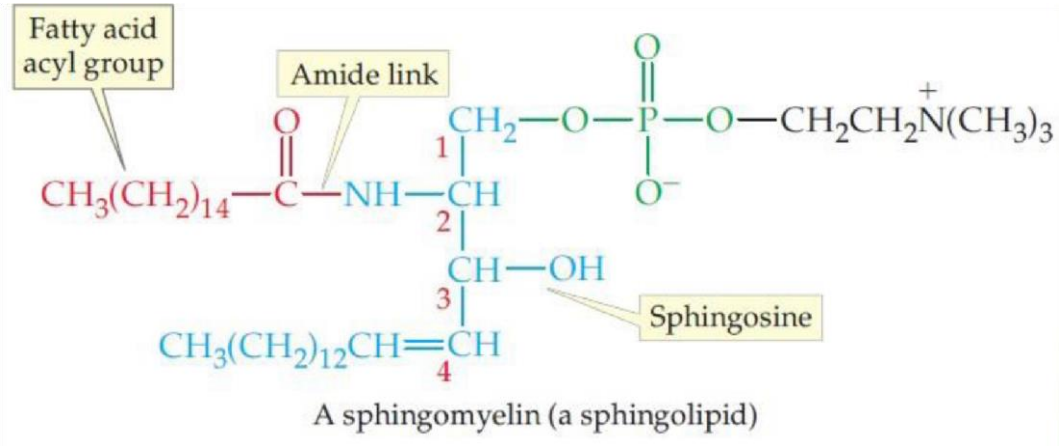
The are divided into two categories :

1.sphingomyelins 2.glycosphinolipids (glycolipids)

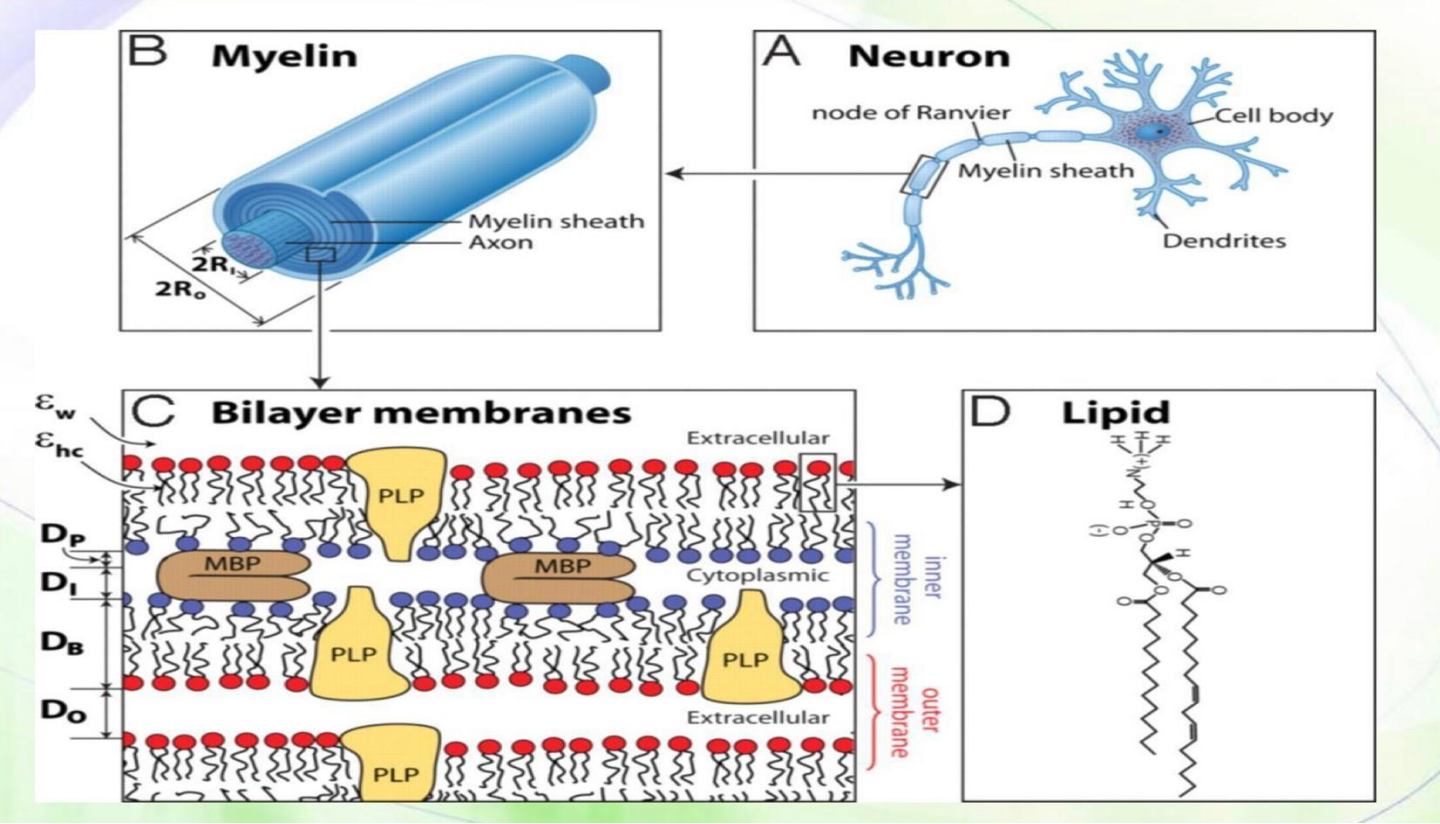
Sphingomyelin

Is a sphinglolipid that is a major component of the coating around nerve fibers.

The group attached to C1 is a phosphocholine.



A sphingomyelin (a sphingolipid)



The sphingomyelin is abundant in the myelin sheath , these types of molecules cover the axons of neurons, so if any problem happened to sphingomyelin it will cause a delay in action potential, a disease that can be caused because of this is called multiple sclerosis (التصلب اللويحي).

Glycolipids :

- Sphinogolipids can also contain carbohydrates attached at . C1 and these are known as glycolipids.
- Glycolipids are present in cell membranes and act as cell surface receptors that can function in cell recognition (ex:pathogens) and chemical messengers.

- **There are 3 types of glycolipids :**

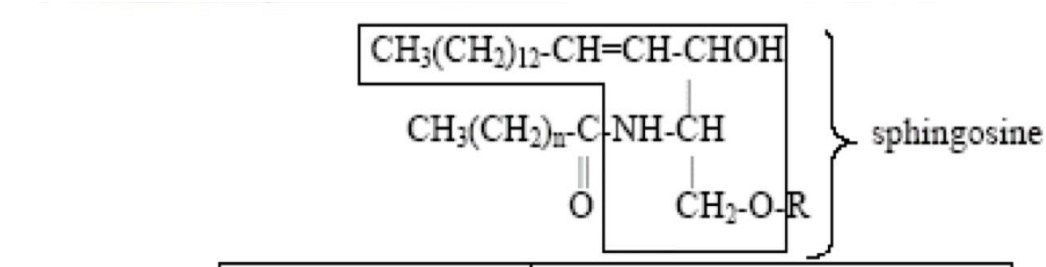
1.cerebrosides 2.globosides 3.gangliosides

Note: cerebrosides have monosaccharides while the other 2 have more than one building block of sugar.

Glycolipids subtypes:

1-cerebrosides: the simplist glycolipids, contains single heroes (galactose or glucose).

2-globosides and gangliosides: are more complex glycolipids, both contain glucose, galactose and N-acetylgalactoseamine, but gangliosides must also contain sialic acid. (gangliosides are abundant in ganglia)



Sphingolipid type	R group
Ceramide	H
Sphingomyelin	phosphocholine
Cerebroside	monosaccharide (galactose or glucose)
Globoside	two or more sugars (galactose, glucose, N-acetylglucosamine
Ganglioside	three or more sugars including at least one sialic acid

glycolipids

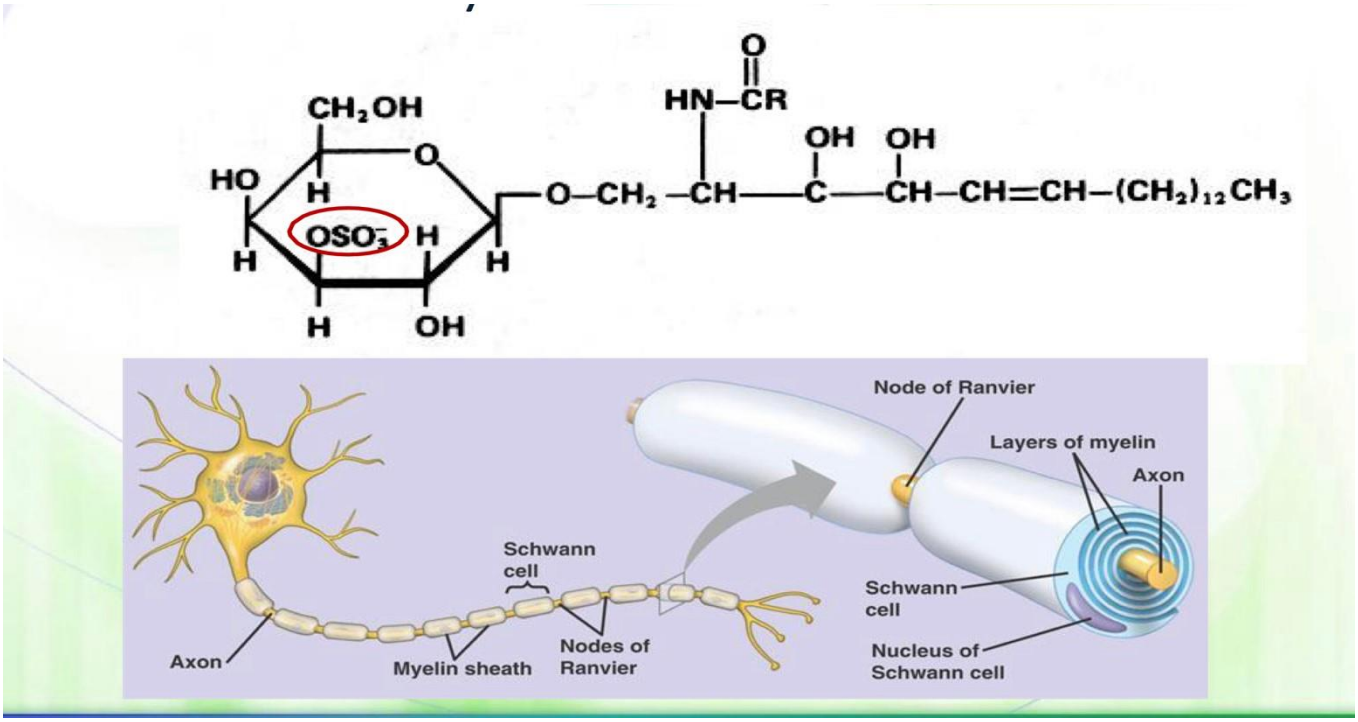
Glucocerebroside

Note: gangliosides are a target for cholera toxins in the human intestine, people affected with cholira will have their gangliosides affected and this will interfere with the function of the nervous system.

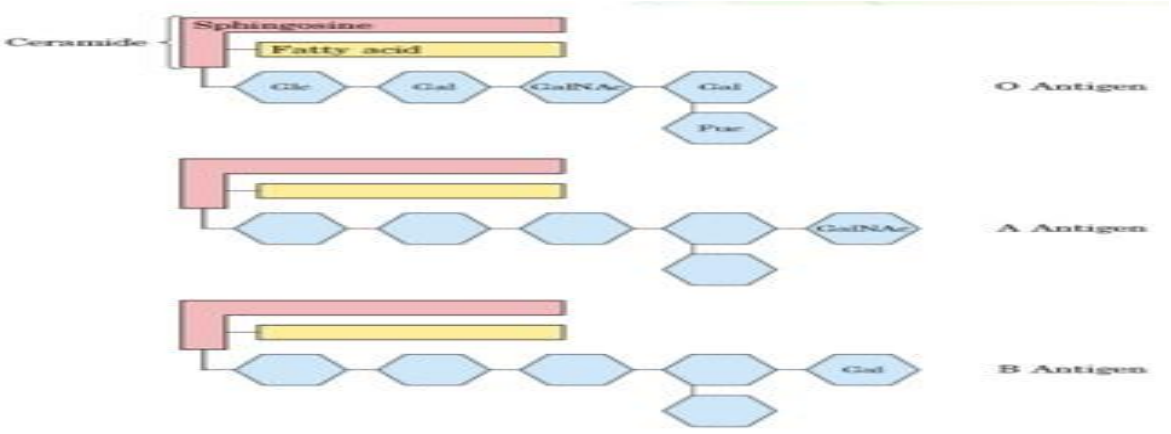
Sulphatides

Are another type of sphingolipids that is derived from galactocerebriosides Abundant in brain myelin.

Note: the first tail is made of sphingosine , the second tail is made of fatty acid.



Sphingolipids are important in blood grouping :



Lipoproteins

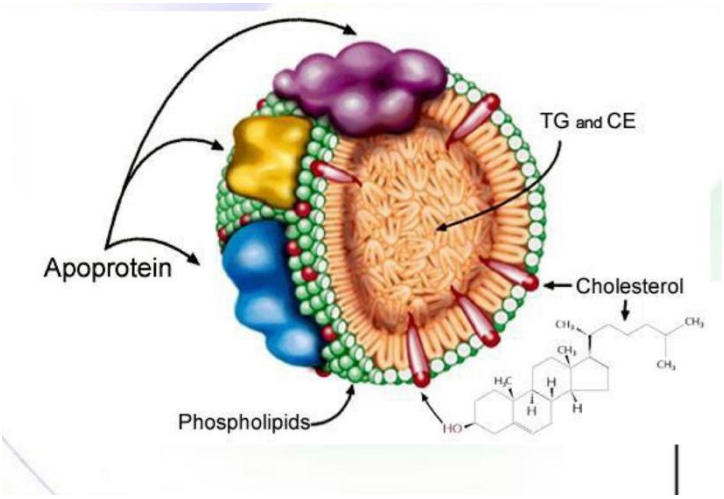
Function: transport of different types of lipids (cholesterol, cholesterol esters ,phospholipids and triacyglycerols) in blood plasma.

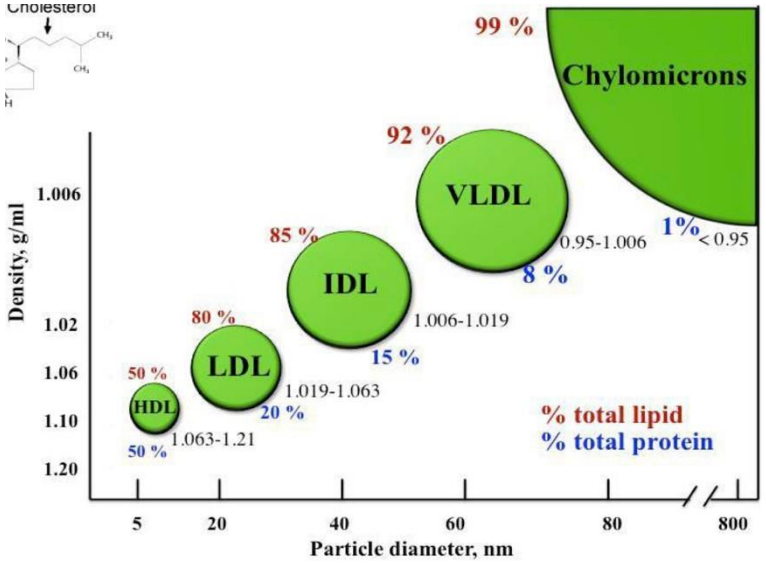
Lipoproteins are subtype of lipid molecules , they contains lipid and protein, the lipid constitutes a large part while protein smaller. They transport liquid to different cells.

Types of lipoproteins:

1.chylomicrons
2.VLDL
3.IDL
4.LDL(the bad one)
5.HDL (the good one)

Note: they differin the percentages of lipids to proteins
Note: the density of the protein is lower than the density of lipids, that why when the amount of lipids increase the size increases.





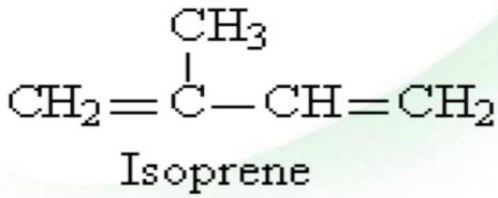
Try to understand the picture on the right !

Steroids

They are another class of lipid molecules , they share the presence of steroid nucleus that has 3 six-membered rings fusedtogether ,in addition to a 5 membered ring.

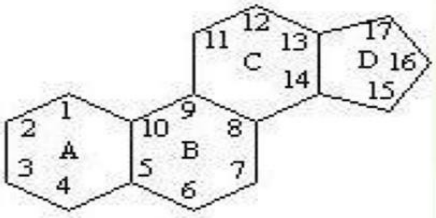
Note:the most common steroid is cholesterol.
Cholesterol moleculesis amphipathic, because it has a polar side and the rest of the molecule is nonpolar .

The precursor



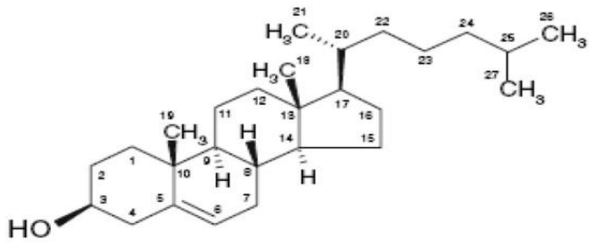
Isoprene

The nucleus



Steroid nucleus

The most common steroid



The products of cholesterol:

1.hormones

- Sex hormones (androgens , estrogens, progestins)

2.some vitamins such as vitamin D

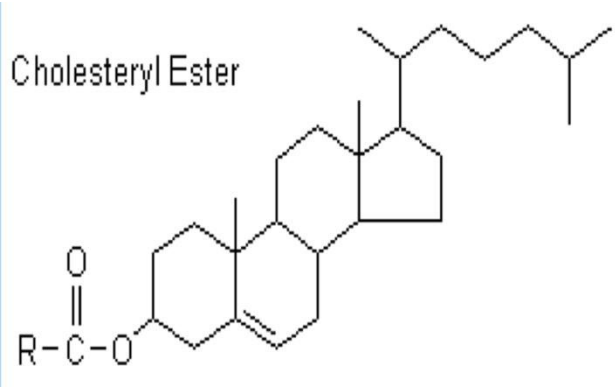
- Vitamins A,D,Eand K are made from isoprenoids

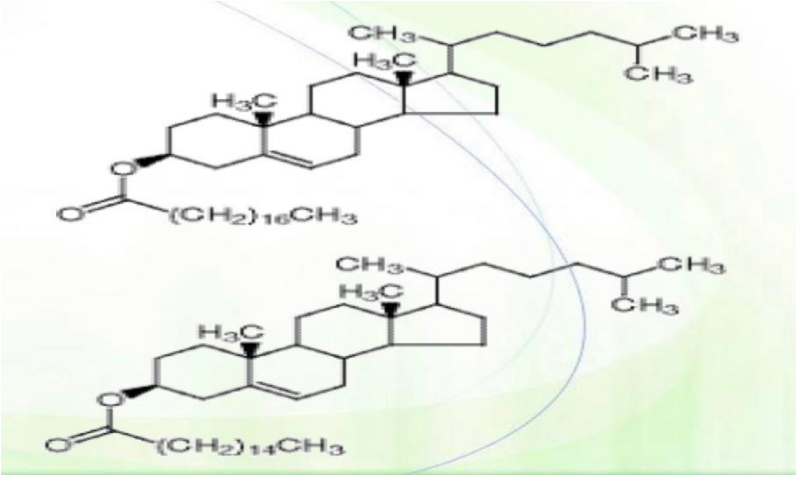
3.bile acids (intestinal absorption of fat)

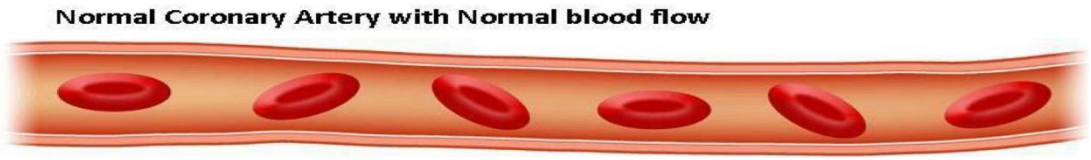
Cholesterol esters :

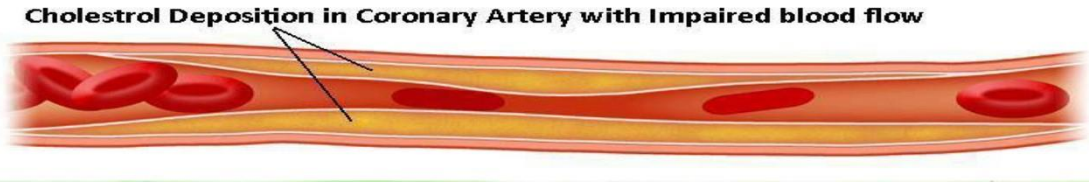
A cholesterol with A fatty acid attached AT (OH-) of C3 .

- Cholesterol can be modified to form cholesterol ester,which happen through The hydroxyl group because its an alcohol it can interact with a fatty acid which is a carboxylic acid forming ester.









Artherosclerosis

- The accumulation of different types of lipid molecules in our blood vessel

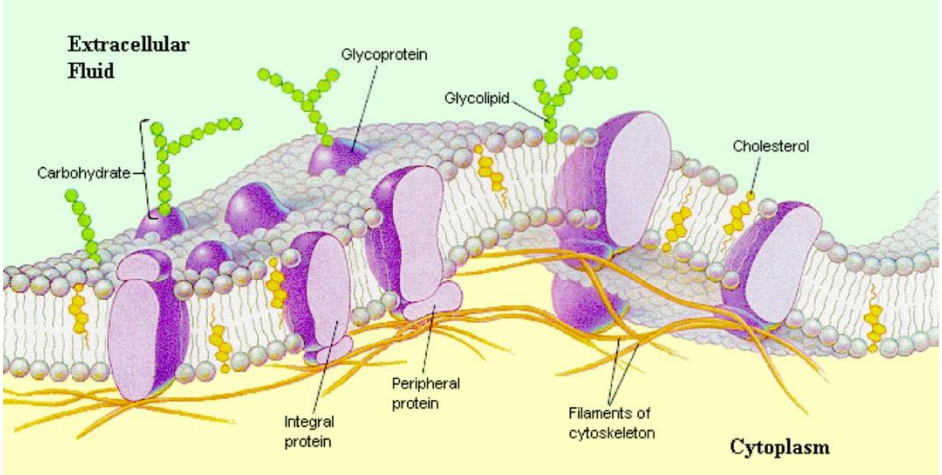
- They will be making plaques that result in narrowing of blood vessels which interfere with the transport of the RBCs within the blood strea
- The hemoglobin inside them has oxygen which is important for cellular respiration which is important for the activities of the cells.
- The narrowing will cut the blood supply to the same tissue which is a result of thickening of the walls of the blood vessels.

Cell membranes

-The membrane is hypothesized in a model known as the fluid mosaic model.

Components: 45% lipid, 45% protein and 10% carbohydrate.

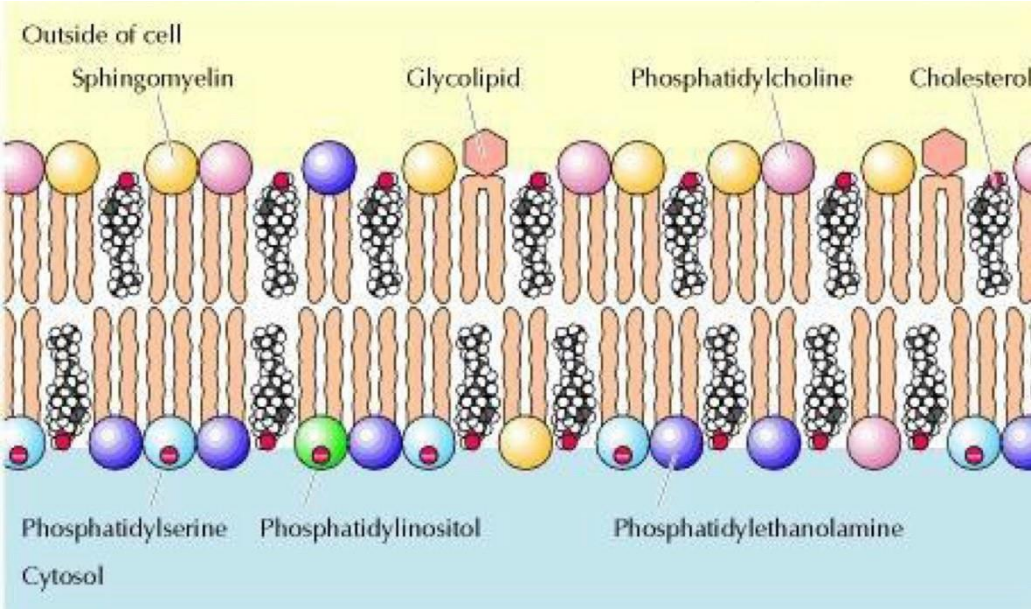
-They exist side by side without forming some other substance of the Intermediate nature.



Phospholipids

The outer: phosphatidylcholine , sphingomyelin , and glycolipids (cell recognition).

The inner: phosphatidylethanolamine , phosphatidylserine , and phosphatidyylinositol (signaling).



Note: cholesterol influences the fluidity of the membrane (it act as fluid buffer) , as it decreases the fluidity at high temperature and vice versa.
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