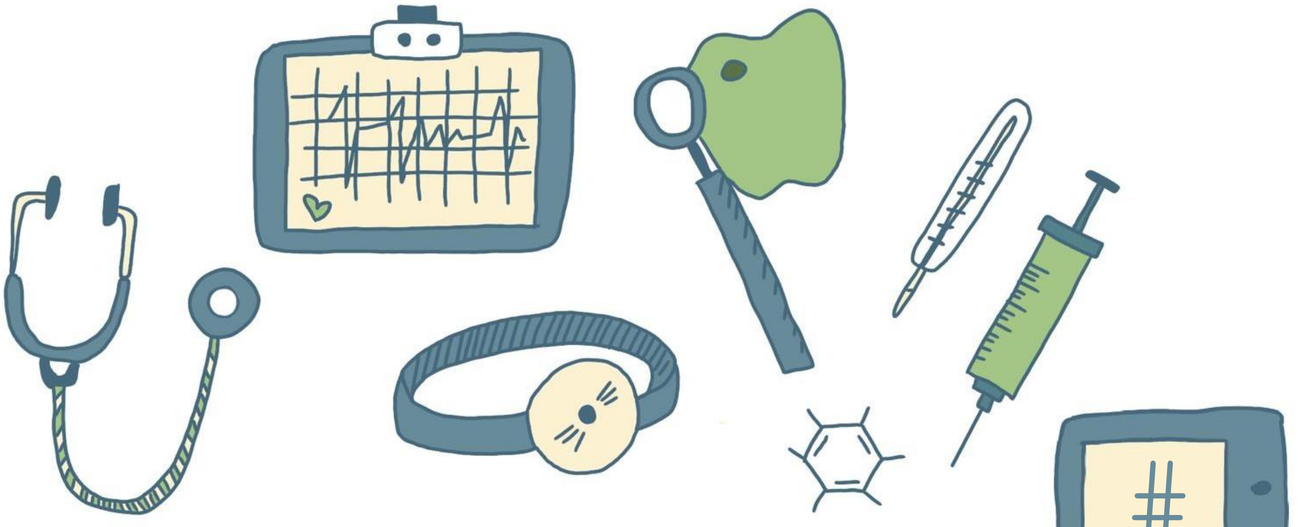


BioChem

Writer: Hana Arikat & Ahmad Qatawneh

Science: Baker Shiha

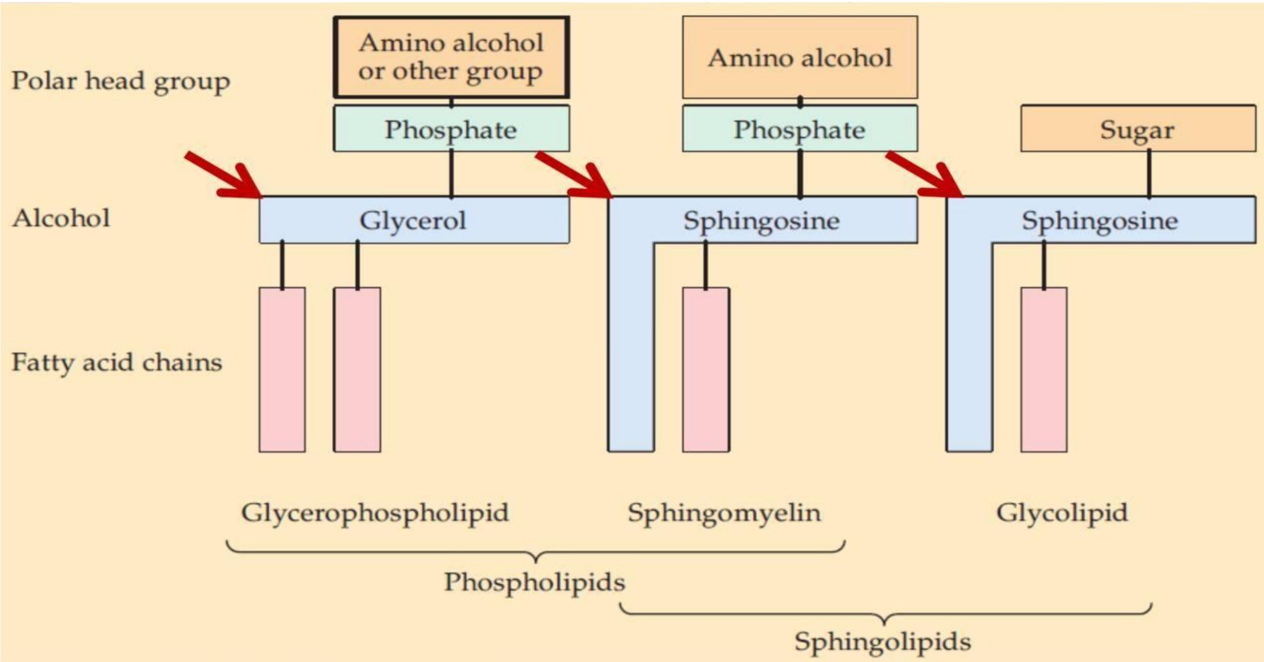
Grammar: Baker Shiha

Doctor: Diala Abu Hassan

Membrane Lipids

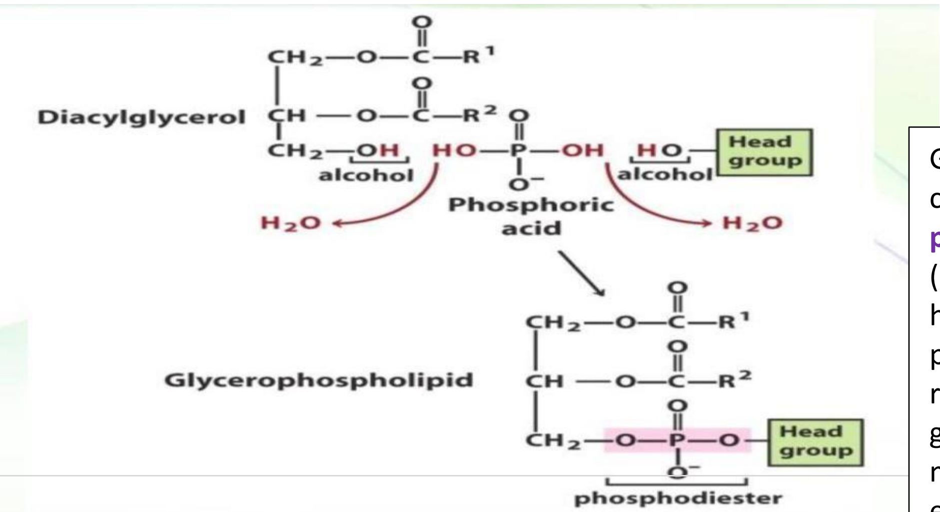
- Membrane lipids are classified into two major types :
- Phospholipids (contain phosphate group): Contain two subgroups : glycerophospholipid and sphingomyelin.
- Sphingolipids (contain sphingosine backbone): Contain two subgroups: glycolipid and sphingomyelin, they differ in the functional group connected to C1.

- Both of these two types have a hydrophilic head and two hydrophobic tails.



Phospholipids (phosphoacylglycerols)

Basically, they are made of glycerol molecule (that has 3 OH groups). The first two carbons are connected to fatty acids and the third carbon is attached to a phosphate group.



Glycerophospholipids contain a **phosphodiester bond** (when exactly two hydroxyl groups in a phosphate group react with hydroxyl groups on other molecules to form 2 ester bonds)

- Different head groups are linked to the phosphate group to make different types of phosphoacylglycerols.

Phosphatidic acid	—	$-H$
Phosphatidylethanolamine	**Ethanolamine**	$-CH_2-CH_2-\overset{+}{N}H_3$
Phosphatidylcholine	**Choline**	$-CH_2-CH_2-\overset{+}{N}(CH_3)_3$
Phosphatidylserine	**Serine**	$-CH_2-\underset{COO^-}{\underset{\vert}{C}H}-\overset{+}{N}H_3$
Phosphatidylinositol	**Inositol**	**Sugar Alcohol**

Notice that all groups are polar (except for H; however, phosphate is polar), thus molecules have a polar head.

Notice that regarding to the negative charged phosphate group and the positive charged head group, you may say that the net charge is zero and that's correct but even if the net charge is zero look at it as two different charged regions within the polar head.

** Phosphatidic acid is the simplest and smallest type.

➢ Classification of Glycerophospholipids :

- **Phosphatidic acids**
- **Phosphatidylcholine (Lecithins)**
  Most abundant membrane lipid.
- **Cephalins :** phosphatidylethanolamine & phosphatidylserine
  Abundant in brain.
- **Phosphatidylinositol** (inositol is a modified sugar molecule)
  Sends messages across cell membranes because it is a signaling molecule that exists inside the cell.
- **Cardiolipin**
- **Plasmalogens**

➢ Lecithins

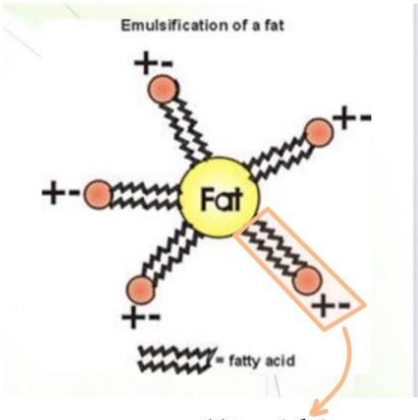
Phosphatidylcholine **Choline** $—CH_2—CH_2—\overset{+}{N}(CH_3)_3$

Lecithin is an important molecule in our system and exists a lot in the plasma membrane of RBCs. Snake venom contain lecithinase, which hydrolyzes polyunsaturated fatty acids and converting lecithin into lysolecithin.
So, these blood cells will be ruptured (hemolysis of RBCs).

Emulsification

Phosphatidylcholine is important for a process known as emulsification. Because of their amphipathic nature, they act as emulsifying agents, that is substances that can surround nonpolar molecules and keep them in suspension in water. In other words, it assists in mixing hydrophobic and hydrophilic substances.

**So that we get products with better quality.

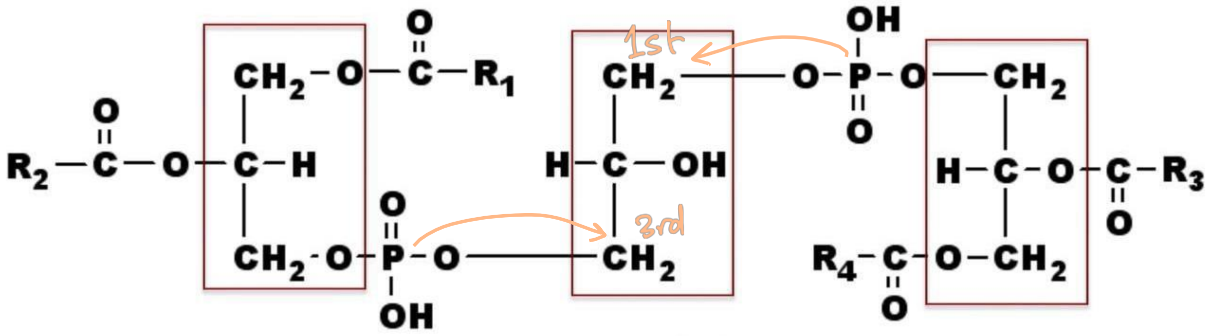


**Lecithin

➢ Cardiolipins

It's a large complicated type of glycerophospholipids. It is composed of a glycerol molecule connecting two glycerophospholipids. The polar head of the first glycerophospholipid is attached to the first carbon, while the polar head of the second glycerophospholipid is attached to the third carbon, leaving the second carbon connected to OH group.

- Found in the inner mitochondrial membrane.
- Initially isolated from heart muscle (cardio).
- Structure: 3 molecules of glycerol, 4 fatty acids & 2 phosphate groups (Large molecule).



Cardiolipin

➢ Plasmalogens

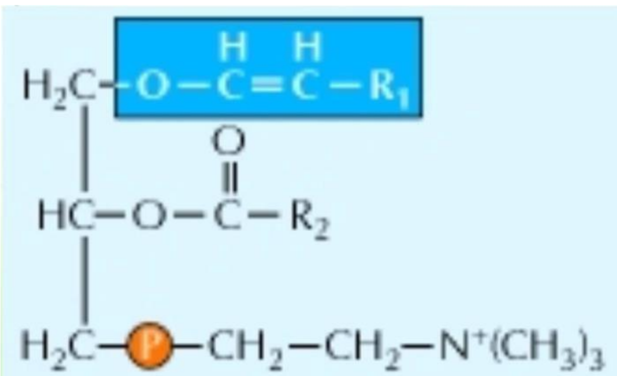
- They are found in the cell membrane phospholipids fraction of brain & muscle, liver, and semen.
- They have a protective role against reactive oxygen species.

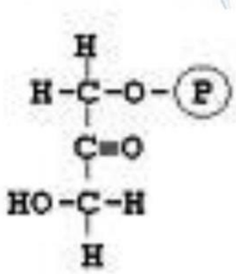
> Reactive oxygen species : highly reactive chemicals that contain oxygen with extra electrons. And they are very harmful so we need get rid of them.

Structure:

**** its structure is a bit different.**

- Precursor of the backbone:
  Dihydroxyacetone phosphate (the simplest ketose sugar with a phosphate group).
- At C1; Unsaturated fatty alcohol connected by ether bond, not ester bond.
- At C2; Fatty acid connected by ester bond.
- In mammals: at C3; phosphate + ethanolamine or choline.





Dihydroxyacetone phosphate

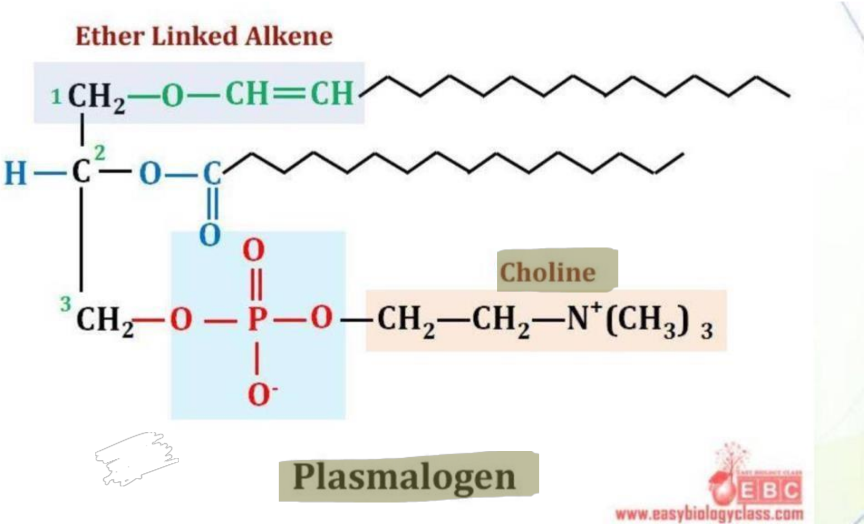
- **Major classes of plasmalogens**

Depending on what's linked to the phosphate we have :

1. Ethanolamine plasmalogen (myelin-nervous tissues).
2. Choline plasmalogen (cardiac tissue).

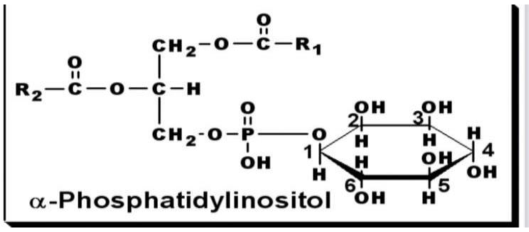
-Platelet activating factor.

3. Serine plasmalogens.



➢ Inositides

- Phosphatidyl inositol
- Nitrogenous base: cyclic sugar alcohol (inositol).
- Structure: glycerol, saturated FA, unsaturated FA, phosphoric acid & inositol.
- Source: Brain tissues.



- **Functions :**

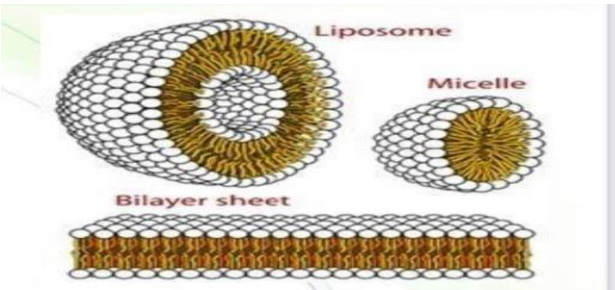
1. Major component of cell membrane. It's exposed to the cytoplasmic side so when signals reach the membrane , it gets released and it can interact with other molecules to send signals.
2. Second messenger during signal transduction, on hydrolysis by phospholipase C, phosphatidyl-inositol-4,5- diphosphate (PIP2) produces diacyl-glycerol (DAG) & inositol- triphosphate (IP3).

** IP3 can bind to Ca++ channels on the SER membrane, liberating calcium ions from the SER. So, it facilitates the completion of signal transduction.

The different structures of phospholipids

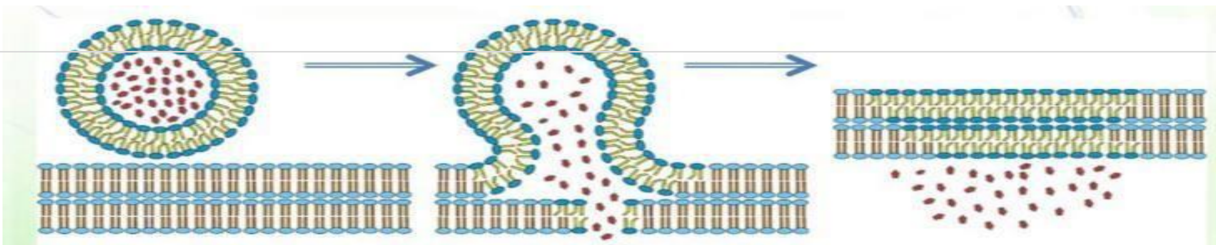
Different types of lipid molecules will accumulate and form a bilayer sheet, because aqueous solution is surrounding molecules from both sides; however, bilayer sheet is still not stable when aqueous environment surrounds molecules from all sides (like in cells), thus lipid molecules will form a liposome structure.

The difference between the micelle structure and the liposome is that the micelle is made only of one layer of amphipathic molecule with the core being hydrophobic (fatty acids) and the outer surface is polar. While the liposome has a hydrophilic core and can be formed from a lipid bilayer.



- Liposome can be used for delivering hydrophilic molecules to cells (delivery of drugs, DNA,.. etc.)

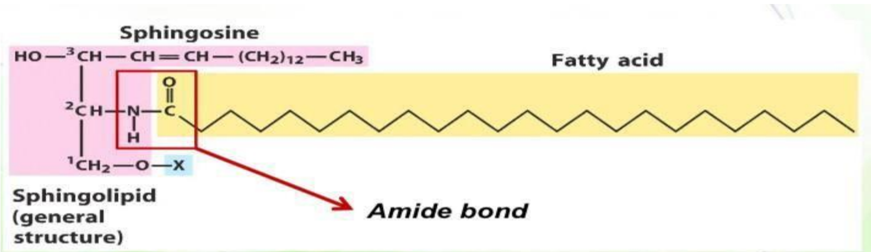
Drugs are loaded inside the liposomeCertain proteins are inserted in between phospholipids and they specifically bind to a receptor or a molecule on the target cell. This will allow the fusion of the liposomalbilayer and the delivery of the hydrophilic molecules.



Sphingolipids

- They are less abundant than phospholipids and found in the plasma membranes of all eukaryotic cells and is highest in the cells of the central nervous system.
- The core of sphingolipids is the long-chain amino alcohol, sphingosine.

** Sphingolipids consist of one fatty acid, whereas the bent structure of the sphingosine, a long-chain (18c) amino alcohol with a double bound, acts as the second tail. Sphingosine acts also as a connecting region joining hydrophobic tails with X group.

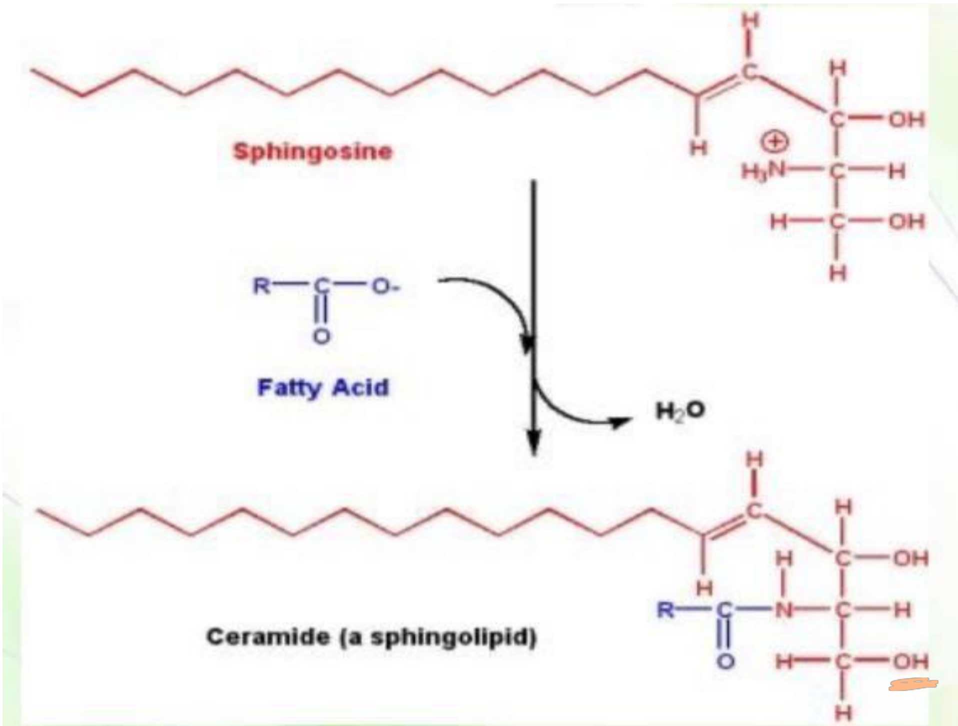


-The OH group of sphingosine interacts with (X) to make different types of sphingolipids.

-The fatty acid interacts with the amino group on C2 to form an Amide linkage.

- Usually, the part of sphingosine that makes the tail has a double bond which introducesa kink in the structure.

- **Ceramide**



Ceramide (which results from the reaction of sphingosine & a fatty acid) is the simplest sphingolipid & the precursor of all other sphingolipids. (Just like phosphatidic acid to other glycerophospholipids

Notice that there is no (X) group attached to the OH.

Types of sphingolipids:

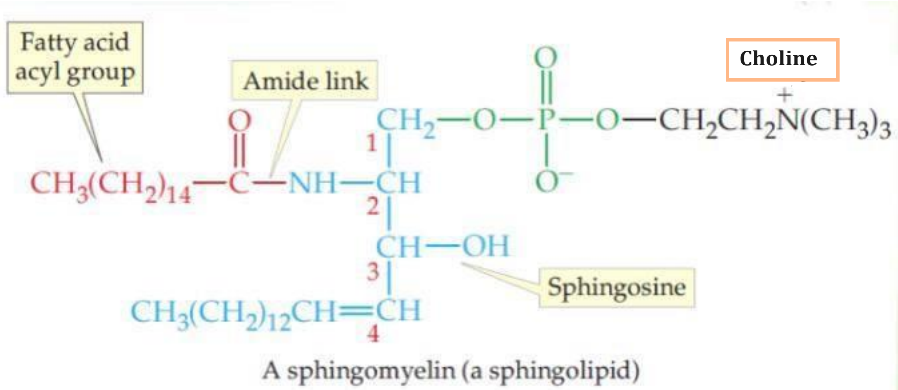
As we mentioned before sphingolipids are divided into two subcategories:

1- Sphingomyelins (considered as Sphingolipids & phospholipids)
2- Glycosphingolipid (or glycolipids)

➢ Sphingomyelin

Is a sphinglolipid that is a major component of the coating around nerve fibers (myelin sheath).

**The group attached to C1 is a phosphocholine.

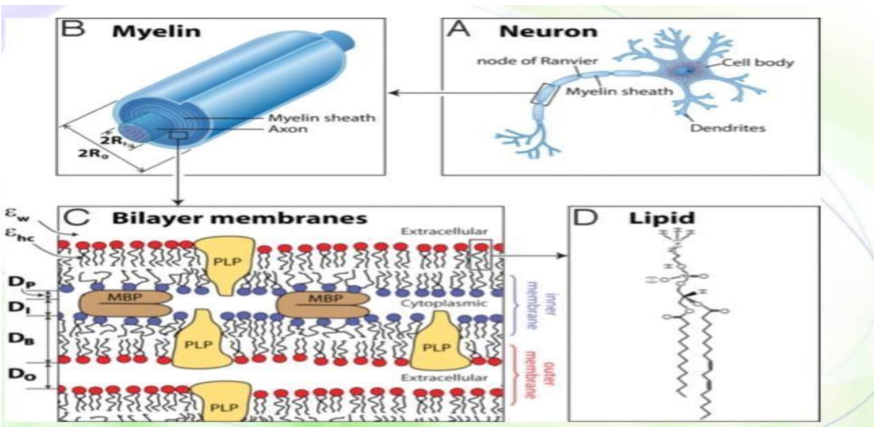


A sphingomyelin (a sphingolipid)

➢ Zooming into the myelin

Myelin sheath is a layer that is mostly made of sphingomyelin together with proteins and other molecules but the major component is sphingomyelin.

It acts as an insulator around nerve axons and increases conduction velocity. Myelinated nerves exhibit saltatory conduction because action potentials can be generated only at the nodes of Ranvier, where there are gaps in the myelin sheath.

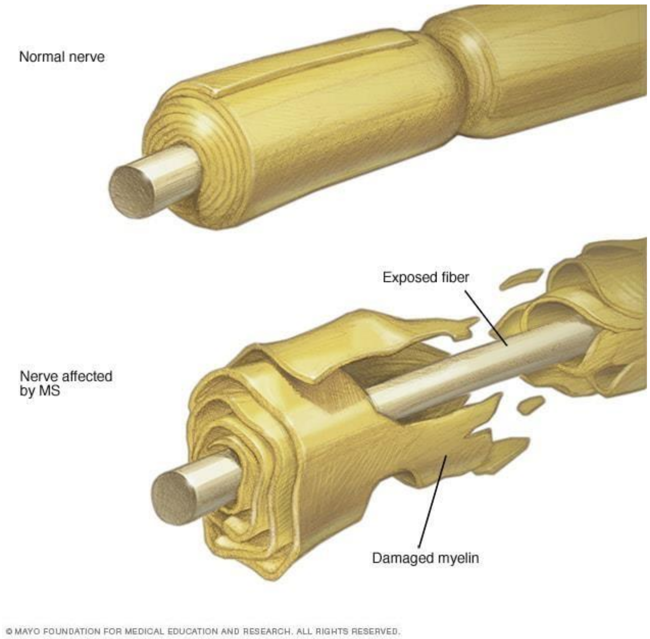


➢ **Medical Application**

Multiple Sclerosis (التصلب اللوحي): in this disease there is a problem in the sphingomyelin structure so there will be a distortion in the myelin sheath and the transmission of action potential will be delayed. There are different types of neurons that can be affected resulting in different symptoms in the patient.

This disease usually affects young females. The reason behind it and the final treatment are unknown. The family history plays a role in having the disease.

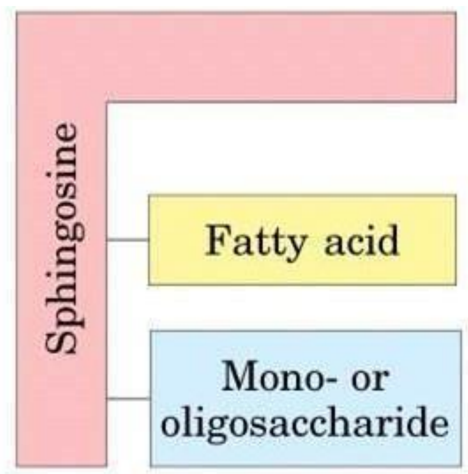
If the affected neuron is related to vision there will be an effect on vision and so on.



To know more!

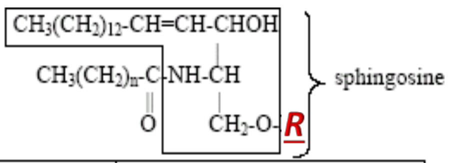
• Glycosphingolipids (Glycolipids)

Glycosphingolipid (**Glyco**: attached sugar, **Sphingo**: Sphingosine backbone **lipid**) is a membrane sphingolipid in which Carbon number (1) is connected to a carbohydrate molecule as a head group (rather than a phosphate group in the case of Sphingomyelin).



- Glycolipids are present on cell membranes and act as cell surface receptors that can function in **immune and cell recognition** (e.g., pathogens, ABO blood groups) and as **chemical messengers**.

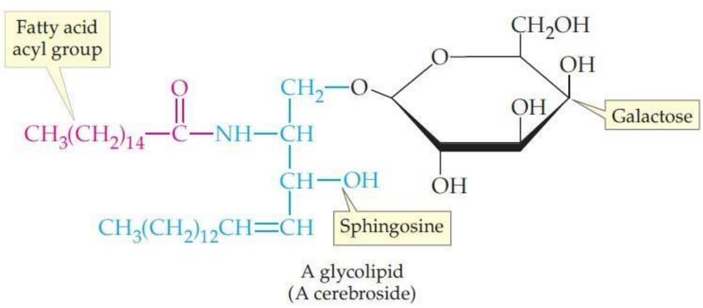
- There are three types of glycolipids according to the type of sugar attached:-
  1. **Cerebrosides**
  2. **Globosides**
  3. **Gangliosides**

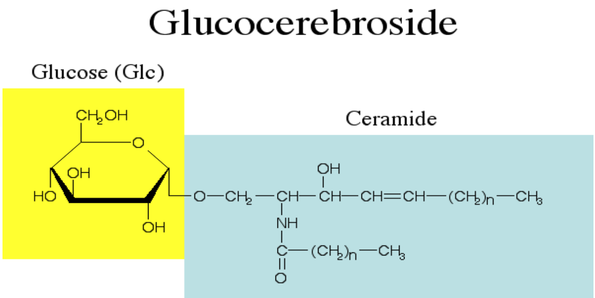


glycolipids

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

1. **Cerebrosides:-** the simplest type of glycolipids containing an **Aldohexose monosaccharide** (**Glucose or Galactose) as a head (R) group**.

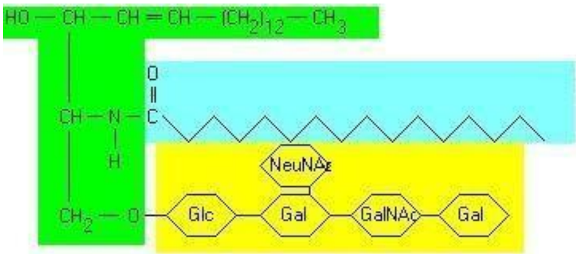




Galactocerebroside **Glucocerebroside**

2. **Globosides:-** A more complex glycolipids containing either a **disaccharide or an oligosaccharide as a head (R) group**.

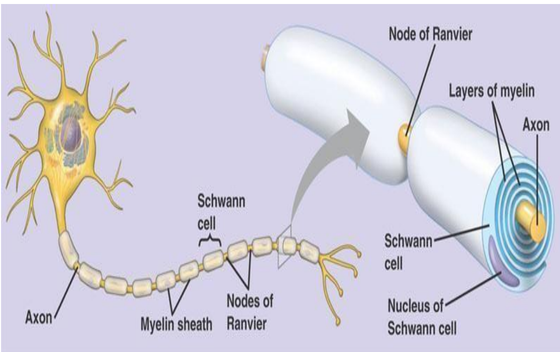
3. **Gangliosides:-** A complex type of glycolipids containing an **oligosaccharide as a head (R) group that must contain at least one sialic acid** (Mandatory). The figure below represents a Ganglioside that contains a **sialic acid molecule (NueNac)**

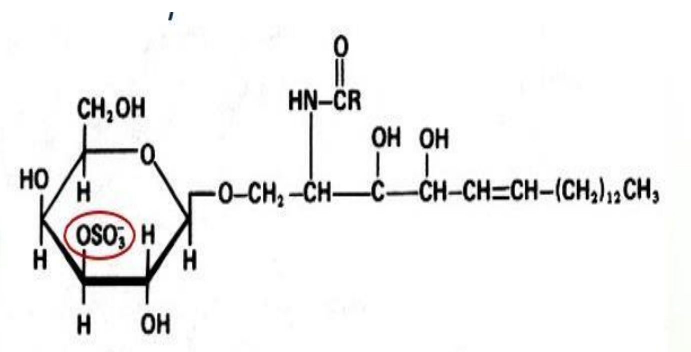


- **Gangliosides** are abundant in **ganglia** as indicated by their names and subsequently , they are involved in the nervous system activities.
- **Gangliosides** are targeted by **The Cholera toxin** in the intestine, that's why cholera illness leads to disturbance in the activity of the nervous system.

Remember:- A key difference between Globosides and gangliosides is the mandatory presence of N-Acetyl Nueroaminate (Also known as sialic acid) in Gangliosides in addition to only being attached to Oligosaccharides meanwhile Globosides can be attached to Disaccharides or Oligosaccharides.

➤ **Sulfatides:** Cerebroside-derived molecules, specifically derived from Galactocerebroside





-Notice that Galactose sugar is modified via the addition of a sulfate group (OSO3-) On **carbon (3).** This modification changes the whole molecule from a Galactocerebroside into a sulfatide.

-Abundant in **brain** myelin

➢ Sphingolipids and blood groups (ABO-system)

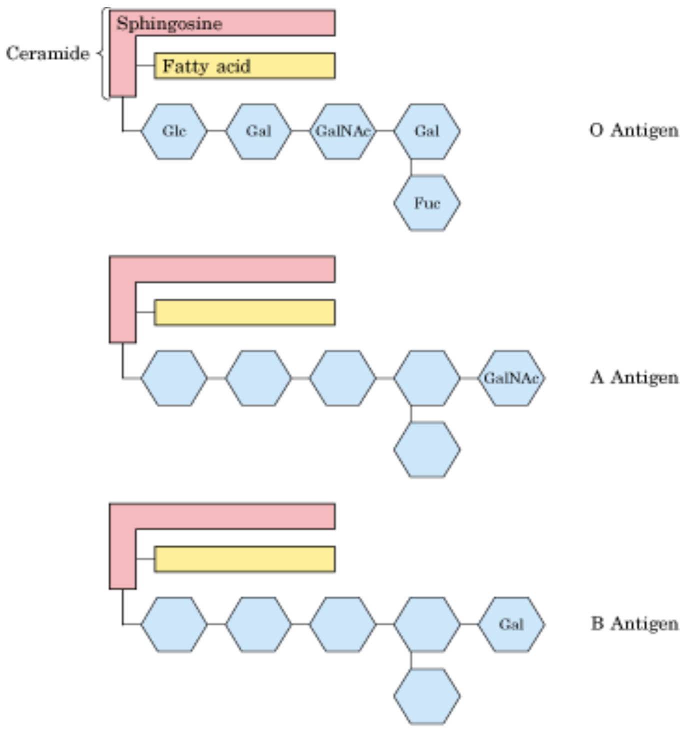
As we mentioned previously, Sphingolipids are involved in the (ABO) blood grouping system in which **different blood types differ only in the types of sugars attached** to the glycolipids (Sphingolipids) on the surface of RBCs.

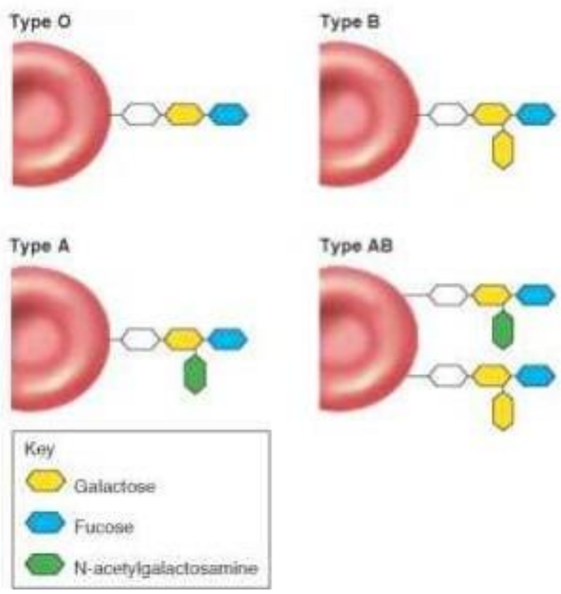
❖ **All blood groups (A,B , AB, or O)** share a common part within the oligosaccharide chain attached to C1.This Oligosaccharide has the following ordered structure: **Glucose - Galactose - N-AcetylGalactosamine -Galactose – Fucose** as shown below.

❖ Conversely, these blood groups differ in the presence of terminal sugar residues effectively producing different Blood types :-

1. **Blood type (A)**: The presence of a **terminal N-AcetylGalactosamine.**
2. **Blood type (B):** The presence of a **terminal galactose.**
3. **Blood type (AB): Both terminal sugars are present together**. In other words, all possible Antigens are present in the AB type making it a **general acceptor of blood**.
4. **Blood type (O)**: **Both terminal sugars are absent**. In other words, having only the common sequence of sugars mentioned above (Familiar for all blood groups) making the O blood group a **general donor of blood**.

Fucose:- a modified (reduced) form of Galactose missing an OH- Group on C6.

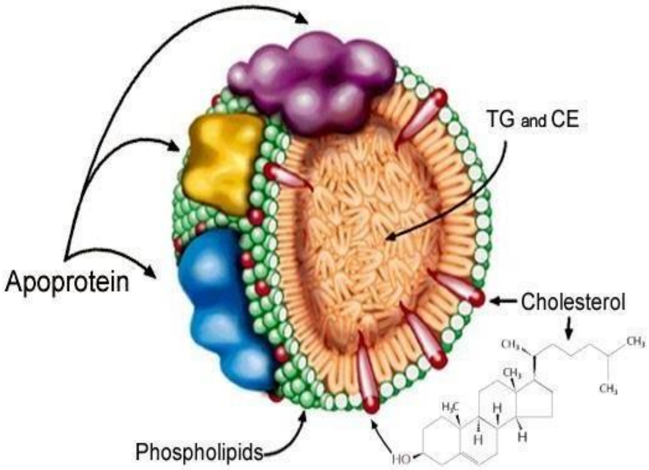




• Lipoproteins

Lipoproteins are a sub-group of lipid molecules in which they contain high amounts of proteins along with different types of lipids being a component of this structure.

❖ **Lipoproteins are used for the transport of different types of lipids** (Cholesterol C, Cholesterol esters CE ,phospholipids and triaclyglycerides) in the circulating blood plasma.



❖ The transport-absorption of lipids cannot occur without the formation of Lipoprotein structures due to blood plasma being Hydrophilic,thus an unsuitable environment for the movement of these relatively **hydrophobic substances**.

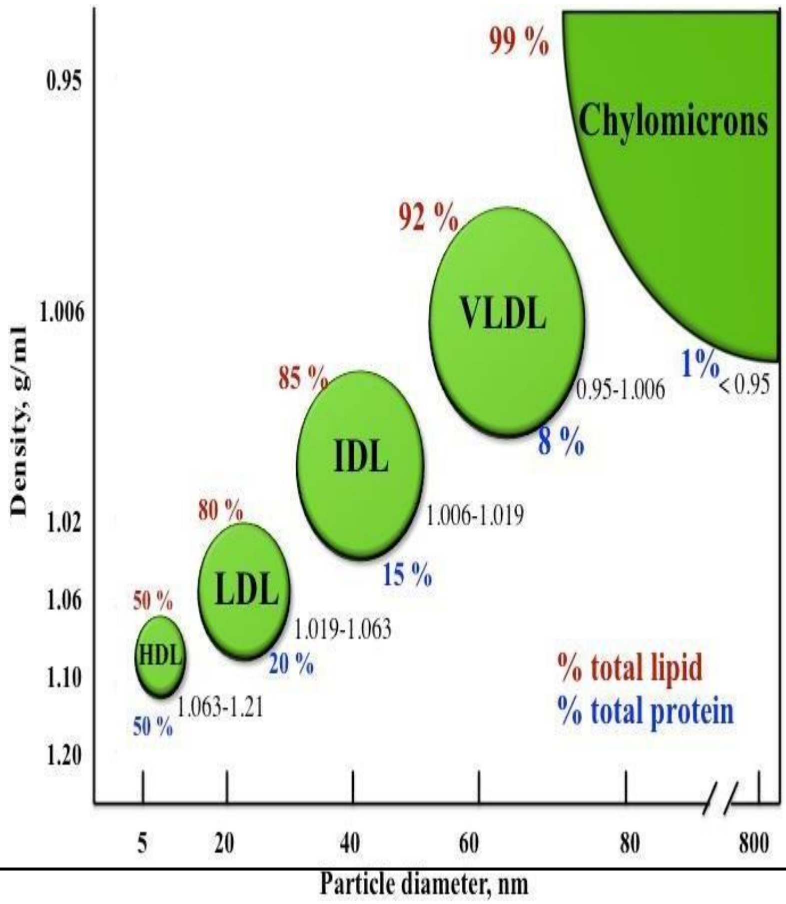
❖ Different types of lipoproteins are present in our body, for example: **HDL** (high density Lipoprotein), **LDL** (low DL), **IDL** (intermediate DL), **VLDL** (very low DL), **chylomicrons**.

❖ Notice the differences in size, HDL is the smallest, while chylomicron is the largest. Also, it is obvious that density is inversely proportional to size.

❖ **As lipid content increases ,the Lipid/Protein ratio increases and the density (density of proteins) decreases in a given volume**, leading to more harmful lipoproteins as shown in the figure below .

- The larger lipoproteins including Chylomicrons will have larger sizes and less protein content, thus a smaller density and a high Ratio of Lipids/Proteins.

- Smaller lipoproteins including HDL (Commonly known as good cholesterol) will have the largest protein content relative to their small size, a higher Density, and a smaller lipid/protein ratio relative to the previously mentioned large ones.



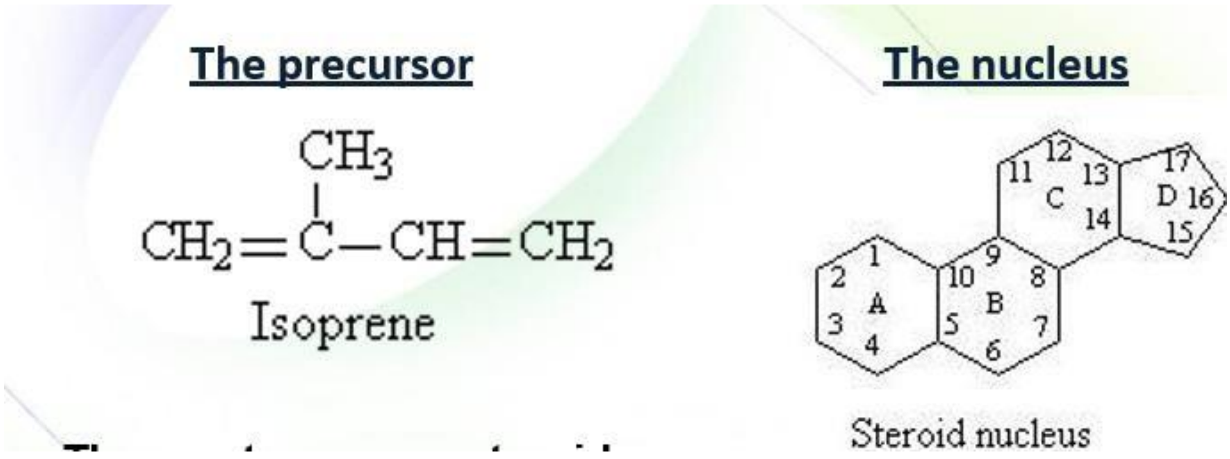
- The movement and the direction (route) of transport differs according to the type of these lipoproteins

- **High density lipoproteins (HDLs)** transport lipid molecules to where they are reduced (consumed), more specifically to the Liver to produce important substances such as Vitamin D and Bile acids, which is why it is commonly known as **Good Cholesterol**. Conversely, **Low density lipoproteins (LDLs)** transport lipid molecules to cells where they are usually stored rather than being consumed leading to accumulation of these fat molecules (Obesity and other health problems) and for that reason, they are known as **Bad Cholesterol**.

- ***Chylomicron*** is important forabsorbing lipid molecules through the Intestinal tract

Steroids

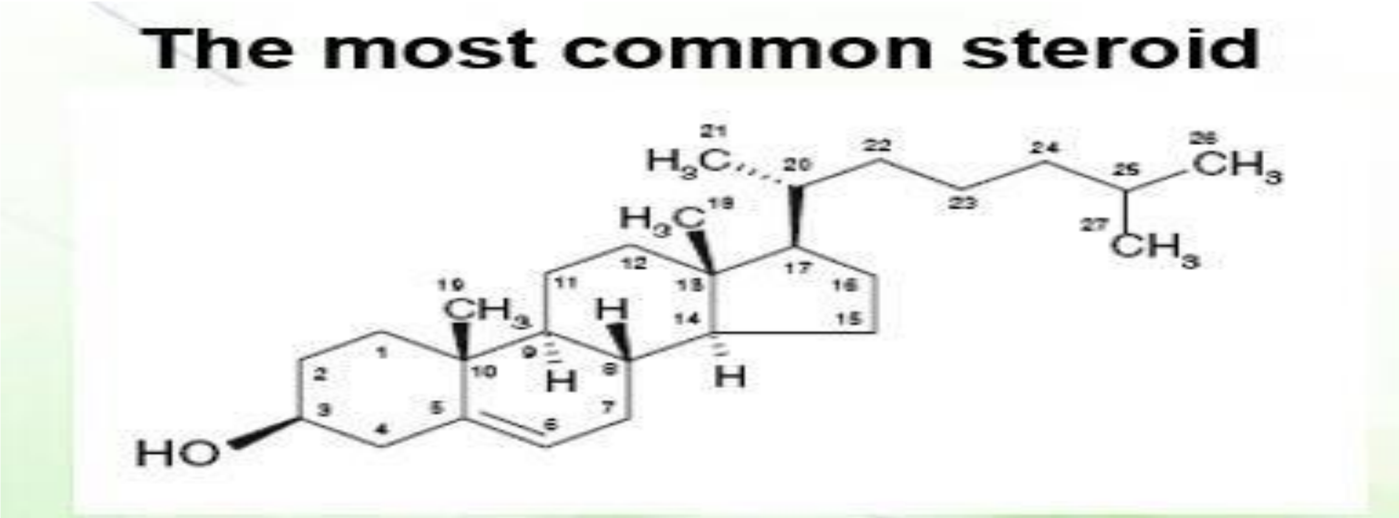
Steroids are another class of lipid molecules that share the presence of a structure known as **Steroid Nucleus** , which has 3 six-membered rings (A,B,C) fused together along with a five-membered ring (D).The steroid nucleus is originally derived from a precursor molecule known as **Isoprene** (A five carbon unit with 2 double bonds and 1 branching that enters a complex pathway repeated several times effectively producing steroids such as Cholesterol.



- The addition of different functional groups to their terminal five-membered ring will create several different steroid molecules, for example: Cholesterol

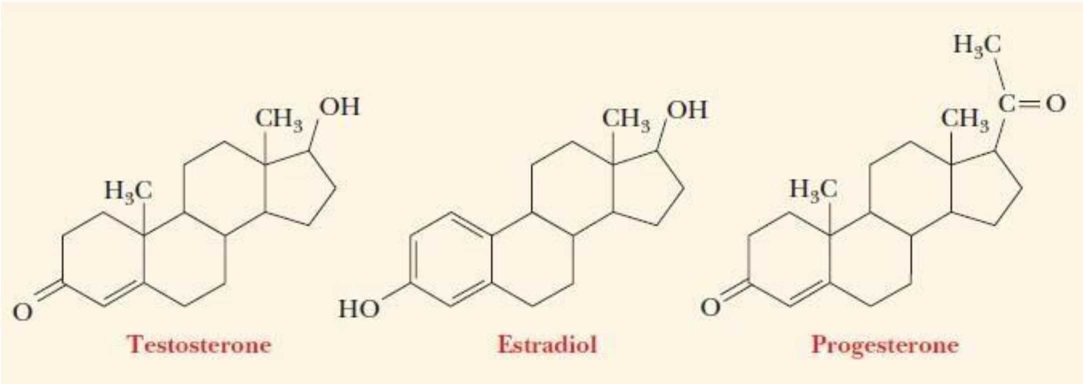
• Cholesterol and its products

Cholesterol (a sterol) is the most common type of steroids in animal cells, in which there is **a hydrocarbon side chain** attached to the last ring as well as an **OH- group** attached to carbon (3) of the first six-membered ring making the molecule **Amphipathic** (due to the polarity of OH- group).

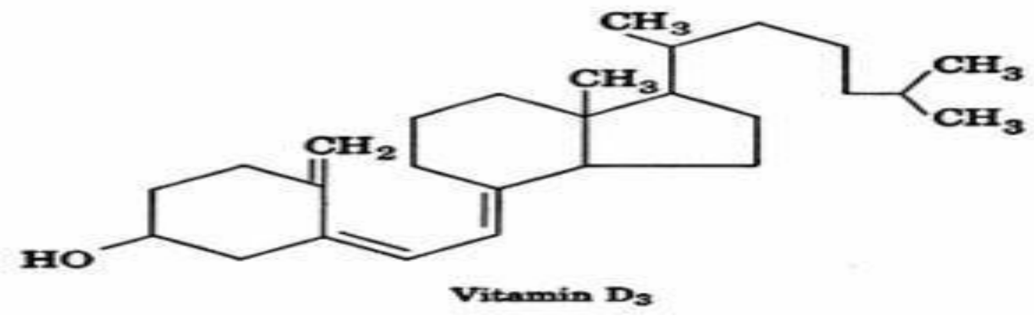


❖ Cholesterol itself is an essential component in cell membranes; moreover, cholesterol is important for synthesizing other molecules

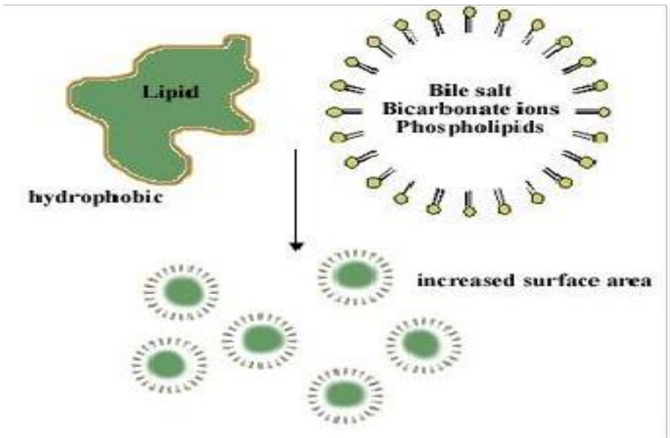
1- Hormones: such as androgen, estrogens, progestins. Etc.

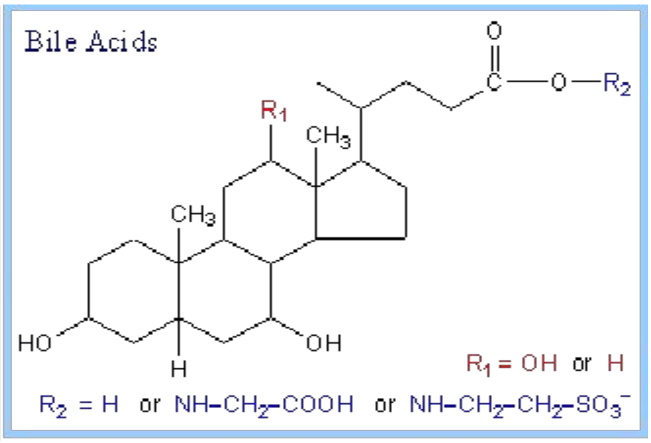


2- **Some vitamins such as vitamin D: Recall** that Vitamins A,D,E and K are made from isoprenoids.



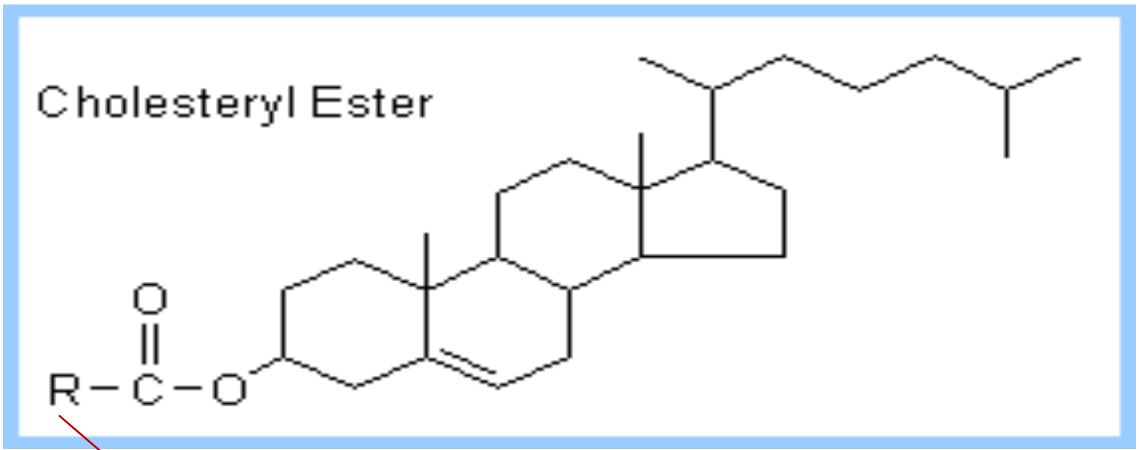
3- **Bile (steroid) acids:** They facilitate the action of enzymes of the Intestinal tract on lipid molecules, leading to **intestinal absorption of fats**, by acting as emulsifiers.



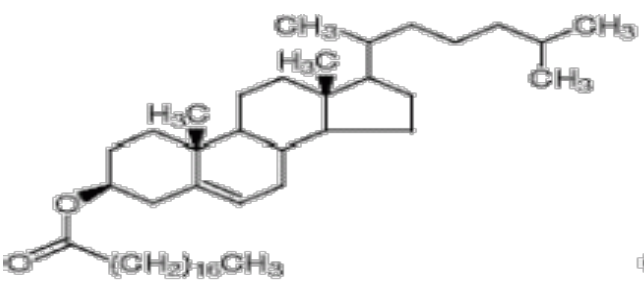


• Cholesterol esters

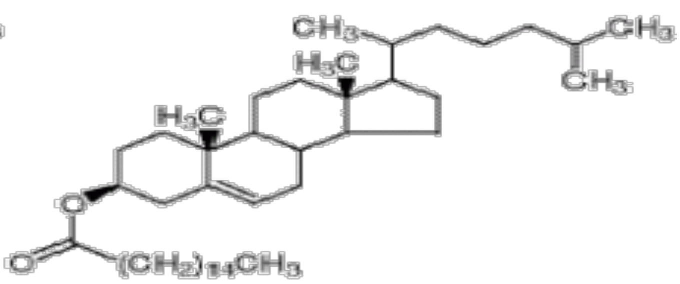
Cholesterol esters (CE) are compounds in which a fatty acid is attached at the (OH-) group of Carbon 3 (modified esters). CE represent an inactive form of Cholesterol and thus are usedto transport Cholesterol within lipoproteins ,specifically in HDLs.



Different R groups here result different types of cholesterol esters



Cholesteryl linoleate



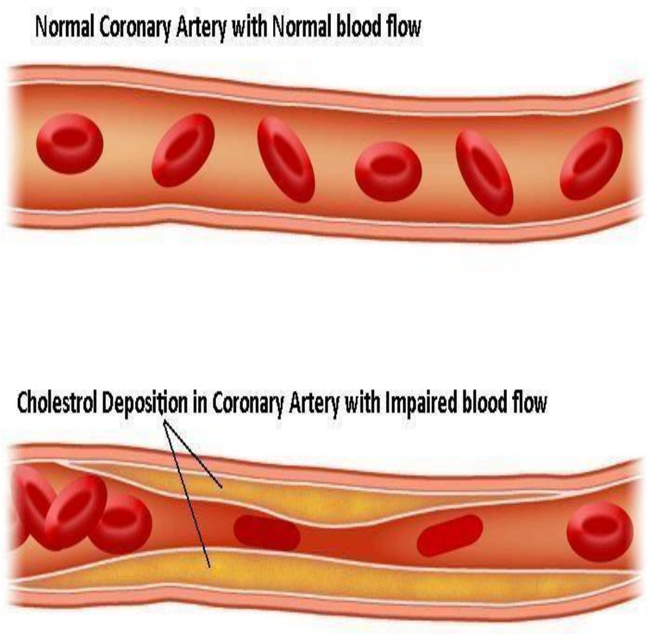
Cholesterol Palmatite

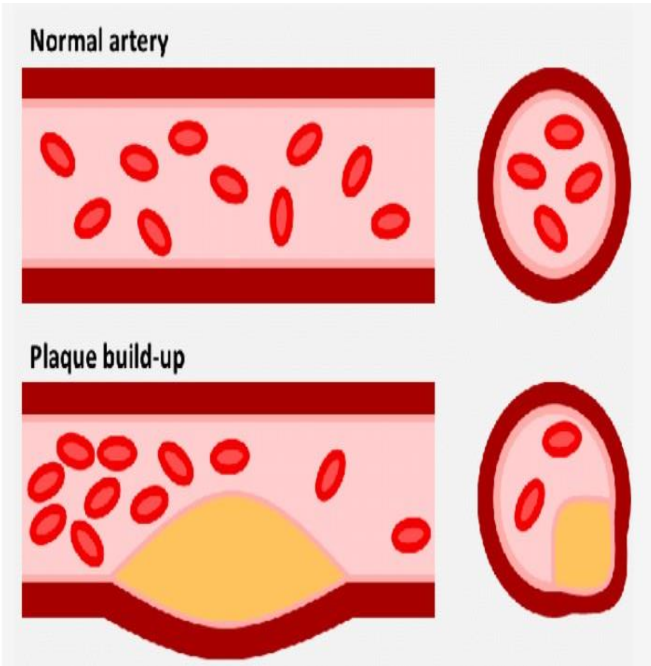
- The reason why **HDLS are commonly used to transport C and CE** is that **HDLS** are smaller in size (Larger in density) as well as not containing large amounts of lipids relatively, thus being able to transport as much cholesterol as possible while avoiding spending much energy in putting these Cholesterol molecules in the HDL against the Concentration gradient. **However**, if adding cholesterol keeps on , the concentration gradient is going to be so high preventing any further intake of cholesterol.

- **To resolve this**, the body introduces Cholesterol esters that **have their own gradient in addition to being more hydrophobic in comparison to normal cholesterol-** (Thus, being able to enter the hydrophobic interior of the lipoprotein easily).All of this facilitates the transport of more Cholesterol (in the form of cholesterol esters) to tissues where it is used after the removal of the fatty acid **resulting a decrease in cholesterol levels in the blood.**

• Atherosclerosis

A medical condition whereby the accumulation of different types of lipid molecules within **LDL-lipoproteins** in blood vessels (i.e., high concentration of blood LDLs) **leads to the production of** plaques (which is a buildup of fats and different lipid molecules on the walls of blood vessels), thus rigidifying blood vessels and making them less elastic; moreover, narrowing the blood vessels which interferes with the movement of RBCs within the bloodstream and subsequently, cutting off the blood supply to the tissues supplied by the blocked arteries.

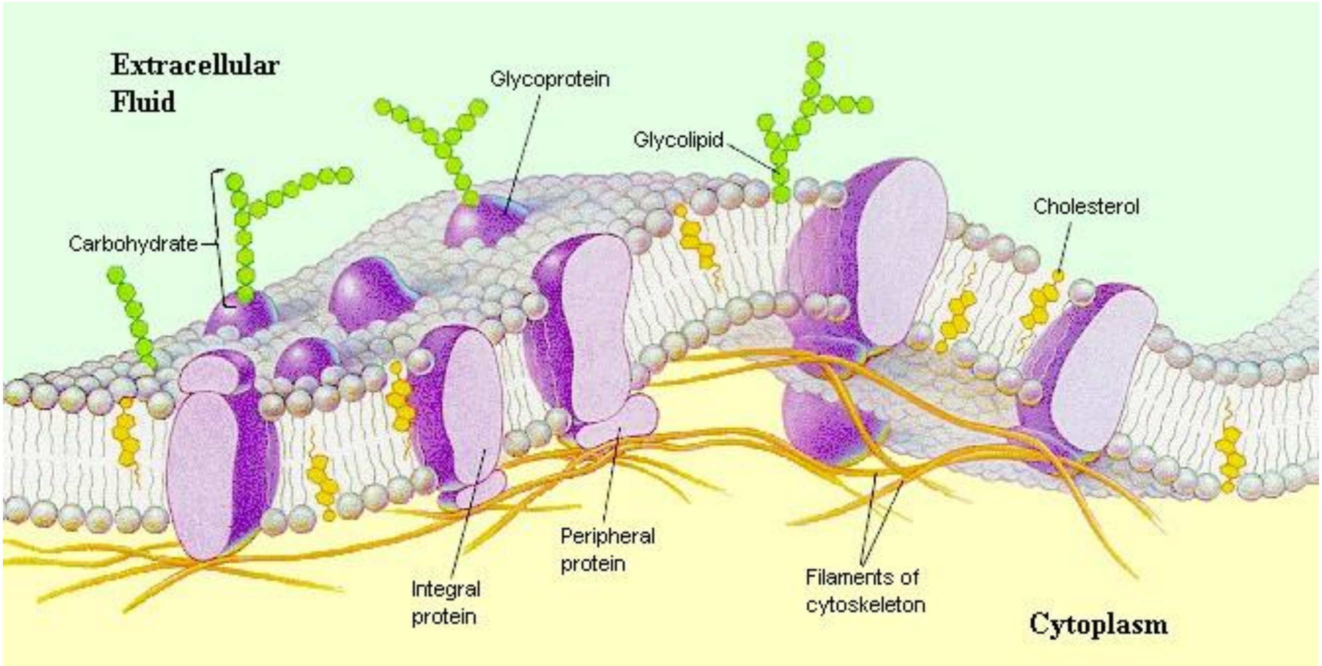




• Cell membranes

Recall that the plasma membrane is a **phospholipid bilayer** composed of two different leaflets : an outer leaflet and an inner leaflet , each with its unique chemical composition of **lipids, proteins and carbohydrates that are associated with several types of glycoproteins as well as glycolipids**.

- The Plasma membrane is hypothesized in a model known as the **fluid mosaic model**
  Fluid: all the components of the membrane in a constant state of flux and movement
  Mosaic: a variety different types of molecules making the composition of the membrane.
- **Components**: **45% lipid, 45% protein and 10% carbohydrate**. They exist side by side without forming some other substance of intermediate nature.



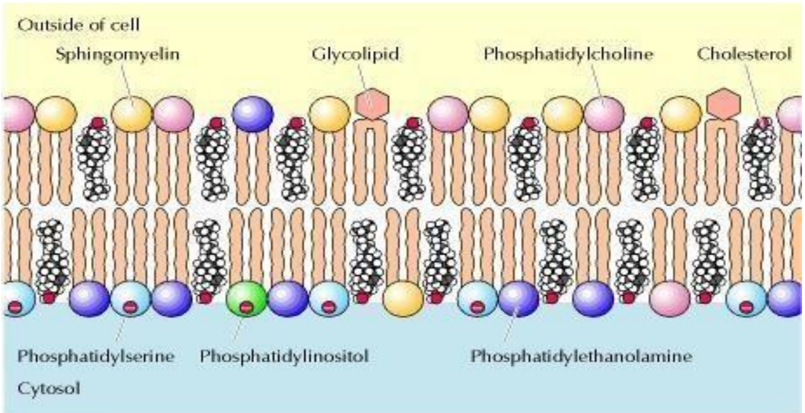
Notice from the figure above the following:-

1. Some membrane proteins can penetrate the lipid bilayer either completely or partially and these are known as **Integral membrane proteins.**
2. Other proteins are attached to the lipid bilayer without penetrating it and these are known as **peripheral membrane proteins**.
3. **Glycolipids and glycoproteins** are found exclusively in **the outer leaflet of the plasma membrane**, with their carbohydrate portions exposed on the cell surface.
4. Cholesterol molecules are embedded between the membrane phospholipids and sphingolipids.

Lipid molecules (glycerophospholipids & sphingolipids) are distributed in different proportions across the leaflets.

- **The contents of the Plasma membrane are distributed as the following**:-
  - **The outer leaflet contains:**
    1. **Phosphatidylcholine**
    2. **Sphingomyelin**
    3. **Glycolipids** (The sugar component is essential for **recognizing cell-types**)
    4. **Cholesterol**
  - **The inner leaflet contains**:
    1. **Phosphatidylethanolamine**
    2. **phosphatidylserine**
    3. **phosphatidylinositol** **(signaling)**
    4. **Cholesterol**

-Notice that Cholesterol Is evenly distributed between the leaflets (1:1 Ratio).
-Distribution of lipids differs among organisms, (animals, plants, prokaryotes, etc.) depending on cellular membrane functions



-Several factors affect the membrane fluidity, including cholesterol, fatty acids & temperature,

• membrane fluidity and Fatty acids

Recall from previous lectures that glycerophospholipids mainly composed of the 2 fatty acid chains that can be either saturated or unsaturated (thus introducing cis kinks in the structure of the molecule). Regarding membrane fluidity , there are two different scenarios :-

1. **Saturated fatty acyl chains**:- These have straight chains without kinks. According to this, fatty acids are densely aligned next to each other, thus their whole surface area is available for non-covalent interactions such as Van der Waals and hydrophobic interactions causing the membrane to be more rigid in structure.

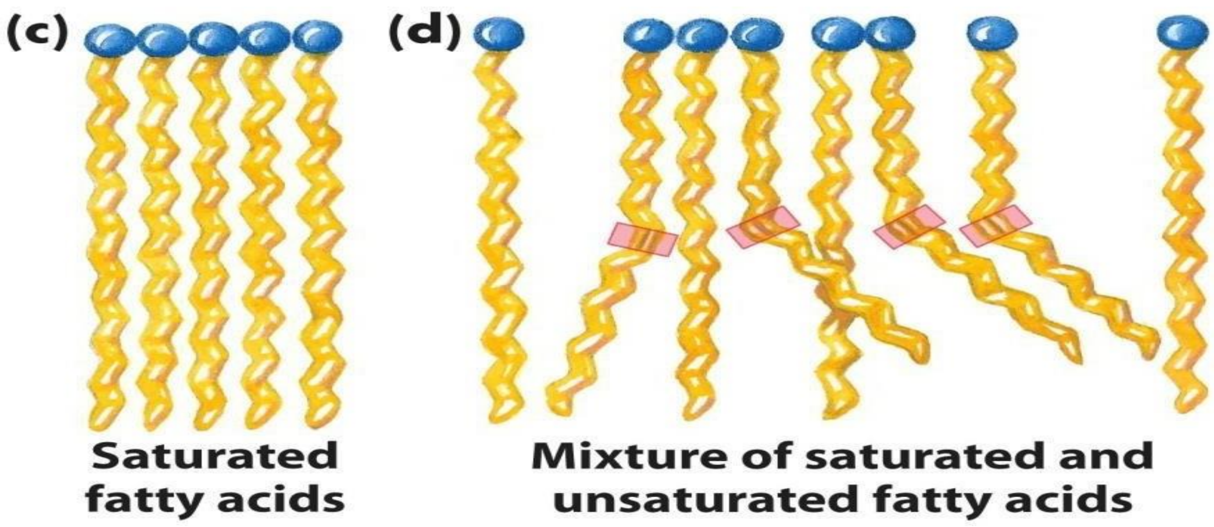
2. **Unsaturated fatty acyl chains**: These chains contain unsaturated double bonds mostly in cis configuration that introduces kinks in the structure of the molecule pushing and increasing the space between lipid molecules leading to less non-covalent interactions and subsequently, a less rigid structure.

Note:- different regions within the plasma membrane can have different fluidities due to their different composition of fatty acids whether saturated or unsaturated.

To summarize :-

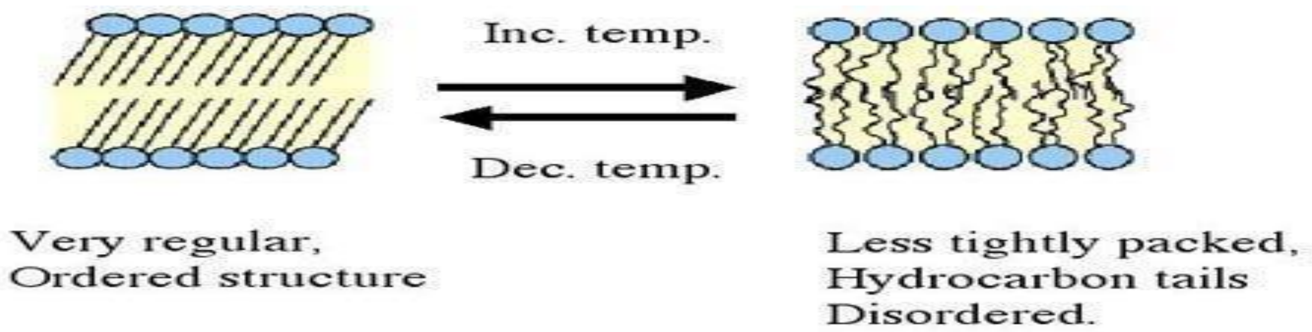
Saturated → linear and exposed surface → more non-covalent interactions → more rigidity

Unsaturated → kinked structure-less space → less non-covalent interactions → more fluidity

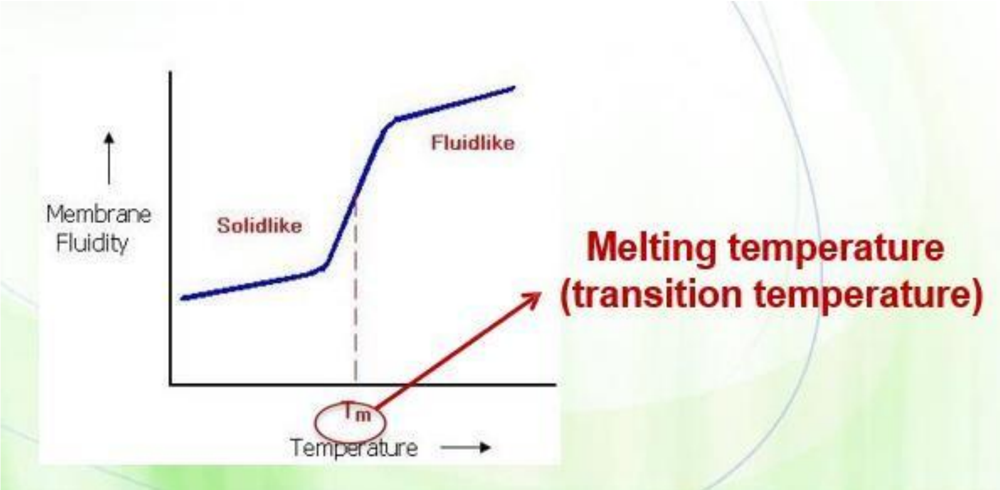


• Membrane fluidity and temperature

Changes in temperature above or below the normal physiological temperature could lead to different effects on membrane fluidity. **When there is an increase in temperature**, Phospholipid molecules gain more kinetic energy causing a disruption in their interactions as they move faster and away from each other, leading to a decrease in membrane rigidity and vice versa. (**When we revert the temperature back to normal, the membrane goes back to the normal rigid state**)

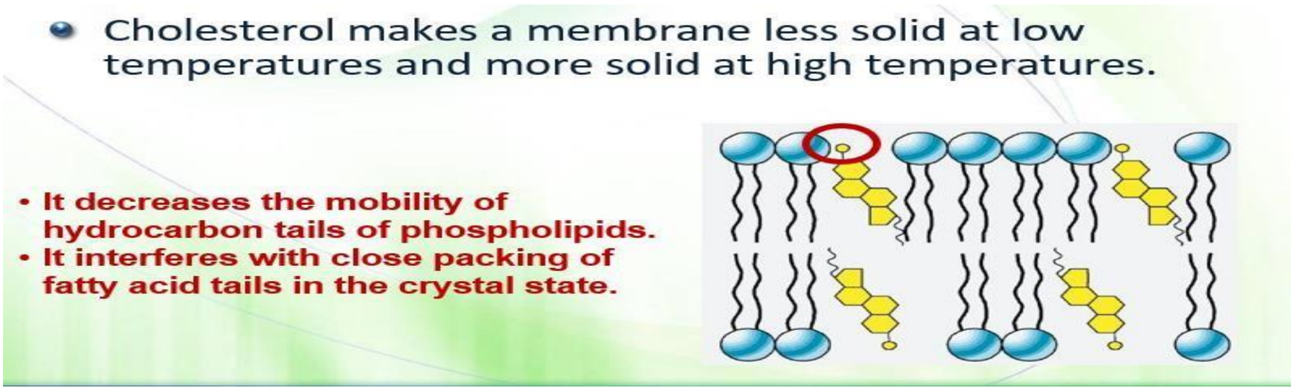


- The term **Transition temperature or Melting temperature** refers to the **temperature required to induce a change in the lipid physical state from the ordered gel phase**, (where the hydrocarbon chains are fully extended and closely packed) **to the disordered liquid crystalline phase** (where the hydrocarbon chains are randomly oriented and fluid) and vice versa.



• Membrane fluidity and Cholesterol

Notice that the rigid steroid-ring structure of cholesterol is embedded between membrane phospholipids (leaving the polar OH group near the polar heads). A large number of van der Waals interactions form between the rigid steroid-ring structure and fatty acids, due the presence of large number of atoms in the rigid structure of cholesterol, these interactions stabilizes the extended straight-chain arrangement of saturated fatty acids. Furthermore, **Cholesterol acts as a fluidity buffer** resisting changes in membrane fluidity by intercalating in between and preventing the close packing of fatty acid tails in the crystal state **at low temperatures** and conversely, it decreases the mobility of the hydrocarbon tails **at high temperatures** effectively increasing the melting temperature for that membrane.



In summary, **Cholesterol functions as a buffer,** preventing lower temperatures from inhibiting fluidity and preventing higher temperatures from increasing fluidity.

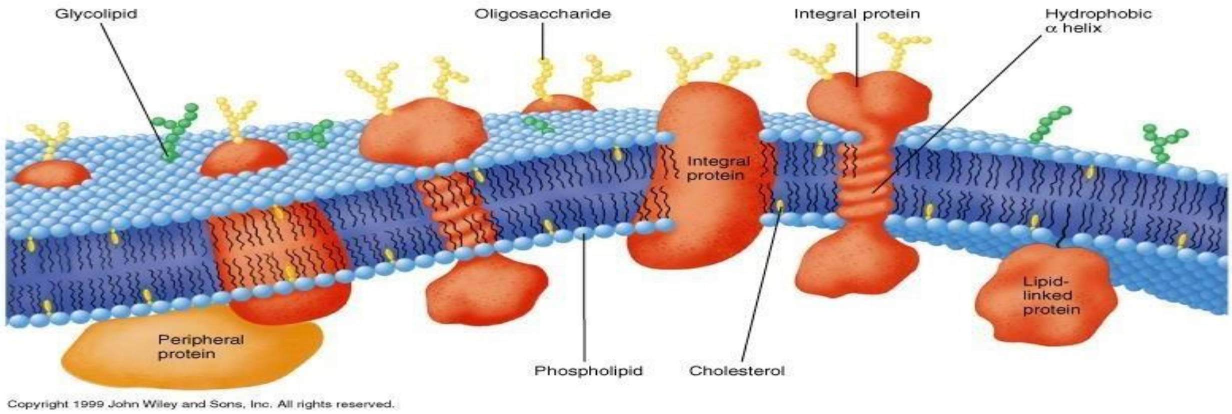
• Membrane Proteins

We mentioned previously that one of the major contents of the plasma membrane is proteins , which can be classified into 3 types:

1. **Integral membrane proteins**: **(Anchored into membrane via Hydrophobic regions).**

2. **Peripheral membrane proteins:** **(Associated with the exterior of membranes via weak non-covalent interactions).**

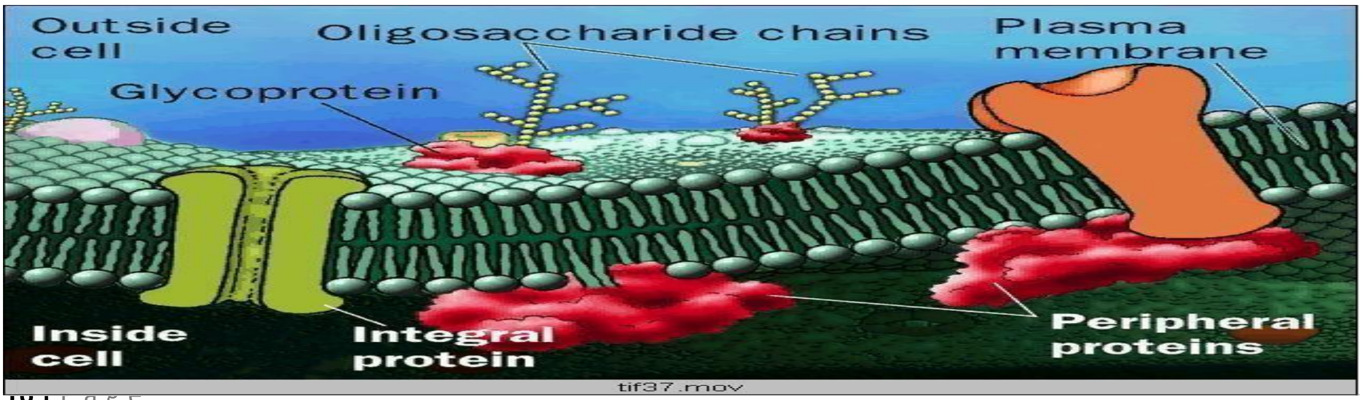
3. **Lipid-anchored proteins**: **(Associated with the membrane via a lipid group through covalent bonds).**



• Peripheral membrane proteins

- These proteins are attached to membranes but do not penetrate the hydrophobic core of the bilayer, which means that they lack the presence of hydrophobic amino acids on their surface. Instead, they associate with the plasma membrane either **directly** by interacting with the lipid polar heads or **indirectly** by interacting with other integral membrane proteins (**Often associated with integral membrane proteins**).

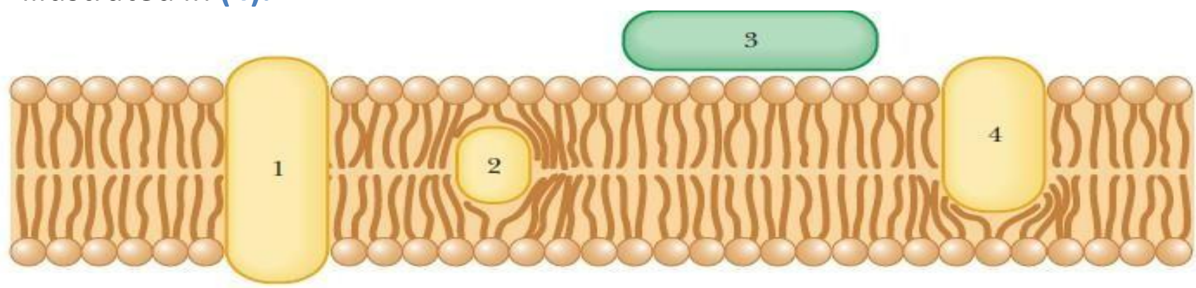
- They are weakly bound to the membrane via **non-covalent interactions** that can be easily broken effectively removing them without disrupting the structure of the membrane (Example : **Treatment with mild detergents**).

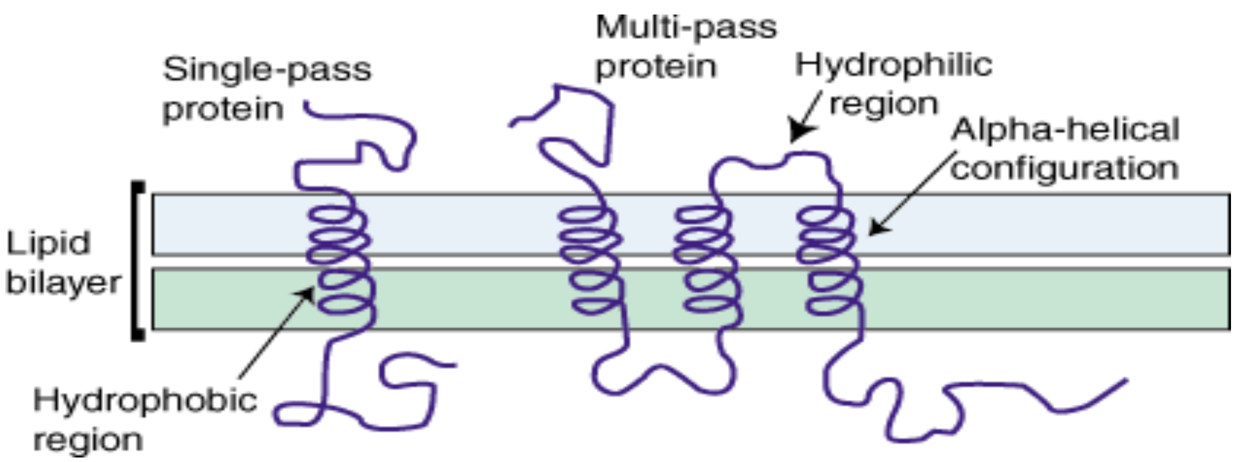


- ## Integral membrane proteins

Proteins inserted into the two leaflets of membrane. Integral membrane proteins are **amphipathic molecules** that can be associated with the lipid bilayer in several ways ,in which the **Hydrophilic regions** protrude outside facing the aqueous surrounding environment while the **Hydrophobic regions** (**non- polar amino acids**) anchor the protein within the bilayer by forming non-covalent interactions (this is why detaching these proteins is harder compared to peripheral proteins)

1. They could fully penetrate the lipid bilayer thus being exposed to both sides, we refer to such proteins as **Transmembrane integral proteins (1)**.
2. They could be embedded within the lipid bilayer without being exposed to any of the sides as illustrated in **(2).**
3. They could partially penetrate the lipid bilayer thus being exposed to one side as illustrated in **(4).**





- Notice from the figure above that the membrane integral domains can be :
    1. **Single or multiple:** Some membrane proteins are composed of multiple helices inserted in the bilayer or a single helix in other cases.
    2. **a-helix or b-sheet:** Most integral proteins are made from **alpha helices**; however, there are some examples where **beta sheets** are inserted into the membrane.

       - Alpha helices can be organized to form channels that transport several ions (K+ ,Na+ ,Ca++)

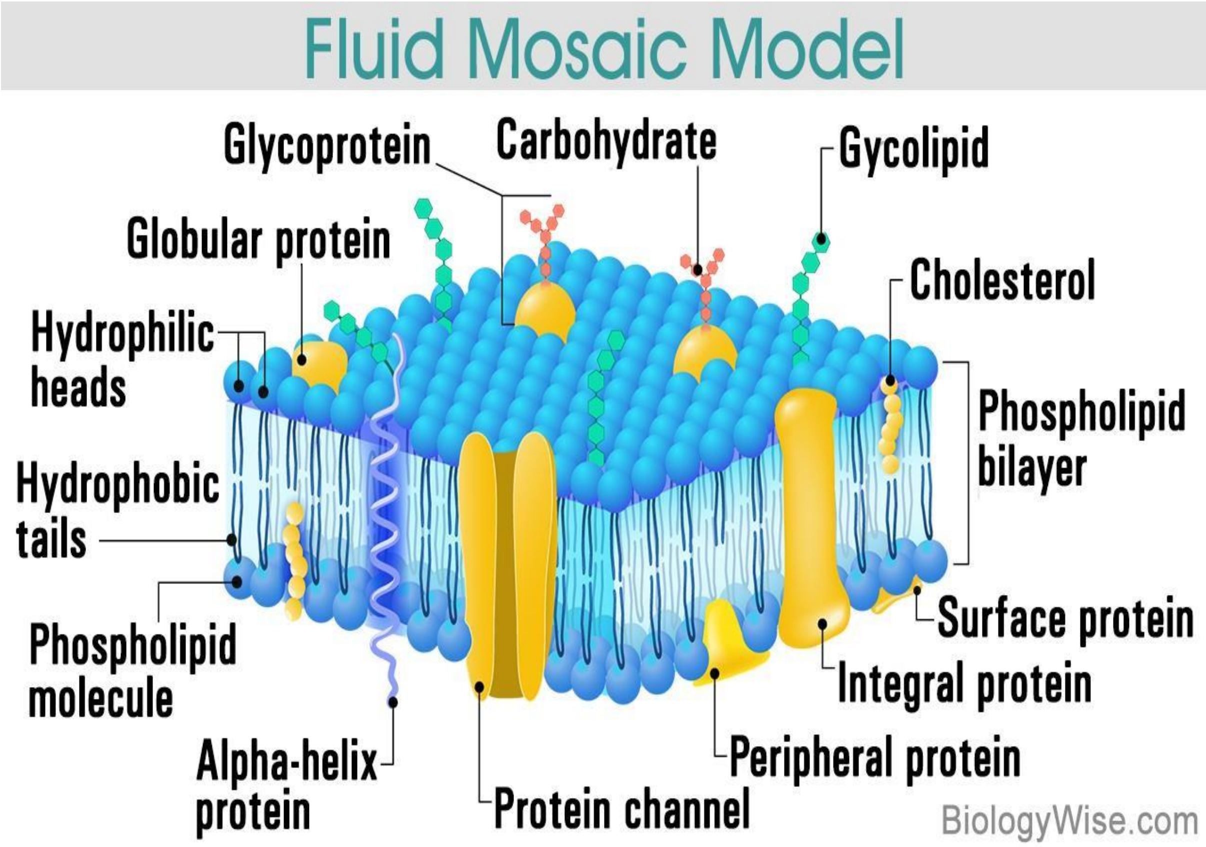
       -beta sheets organize themselves into beta barrels forming pores such as **Aquaporins**.(Proteins responsible for the transport of water across the bilayer)

• Structure-Function of Membranes

❖ Transport: **Cellular membranes are impermeable barriers** , that is they permit the passing of certain (Hydrophobic-water insoluble) molecules while permitting the passing of large hydrophilic substances**.** Therefore**, integral membrane proteins come to the rescue by acting as carriers (transporters) or channels** that facilitate the crossing of many materials that cannot cross the lipid bilayer (Ions for instance).

❖ Signaling**: Protein receptors and small molecules (some can be lipids themselves).**

❖ Catalysis **(speeding chemical reactions): Enzyme linked receptors** which can be integral or peripheral membrane proteins.



The End

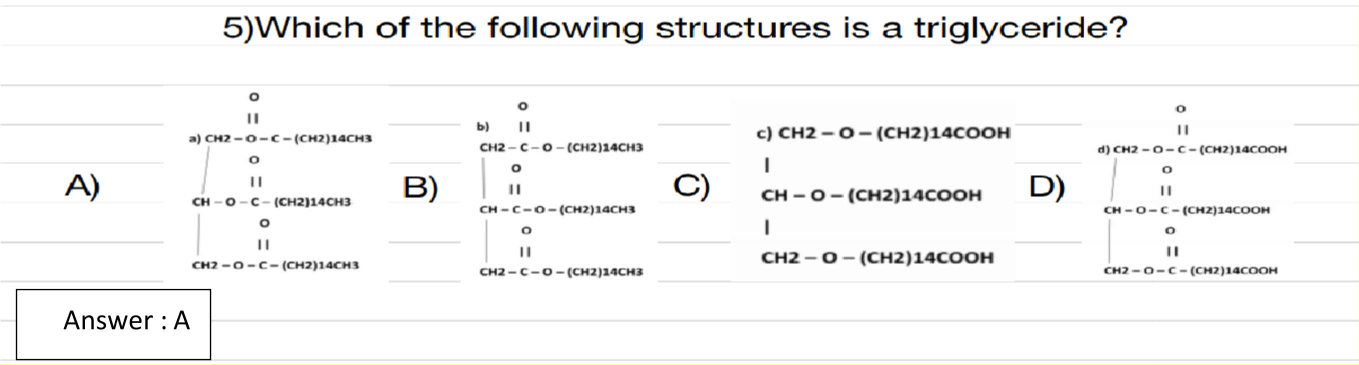
Self-assessment Questions

1. Fatty acids are a component of A) carotenes.
   A. cerebrosides.
   B. sterols.
   C. vitamin D.
   D. vitamin K.

2. Which of the following is true of sphingolipids?
   A. Cerebrosides and gangliosides are sphingolipids.
   B. Phosphatidylcholine is a typical sphingolipid.
   C. They always contain glycerol and fatty acids.
   D. They contain two esterified fatty acids.
   E. They may be charged but are never amphipathic.

3. A compound containing N-acetylneuraminic acid (sialic acid) is:
   A. cardiolipin.
   B. ganglioside GM2.
   C. phosphatidylcholine.
   D. platelet-activating factor.
   E. sphingomyelin.

4.



5. Which of the following is a characteristic of both triacylglycerols and glycerophospholipids?
   a) Both contain carboxyl groups and are amphipathic
   b) Both contain fatty acids and are saponifiable.
   c) Both contain glycerol and ether bonds.
   d) Both can be negatively charged at cellular

6. Which is a characteristic of sphingolipids?

A. They all contain a fatty acid joined to glycerol.
B. They all contain a long-chain alcohol joined to isoprene.
C. They all contain ceramide joined to a polar group.

D. They all contain a carbohydrate joined to a phosphate group

7. Which is a characteristic of all the fatty acid components in this lipid?
A. They all contain an unbranched carbon chain.
B. They all contain unconjugated cis double bonds.
C. They all are joined to glycerol through an ester bond.
D. They all are hydrophilic because they contain oxygen.

8. Which type of membrane lipid contains an acidic oligosaccharide?
A. phosphatidylinositol
B. cerebroside
C. ganglioside
D. globoside

9. Which component is found in all sphingolipids?
A. carbohydrate
B. a negative charge
C. a phosphate group
D. an amino alcohol

10. Which characteristic is most likely shared by a cell membrane and a lipoprotein?
a) Both are composed of a lipid bilayer.
b) Both contain a high amount of triacylglycerols.
c) Both contain hydroxyl groups on the surface.
d) Both contain proteins in the interior

11. Which type of membrane lipid could contain serine?
A. a globoside
B. a cerebroside c
C. glycerophospholipid
D. a ganglioside

12. Which of the following best describes the cholesterol molecule?

A) Amphipathic
B) Nonpolar, charged
C) Nonpolar, uncharged
D) Polar, charged
E) Polar, uncharged 2)

13. Which of the following contains an ether-linked alkyl group?

A) Cerebrosides

B) Gangliosides

C) Phosphatidyl serine

D) Platelet-activating factor

E) Sphingomyelin

14. Which of the following is not a fat-soluble vitamin?

A) A
B) C
C) D
D) E
E) K

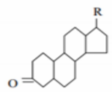
15. Which vitamin is derived from cholesterol?

A) A
B) B12
C) D
D) E
E) K

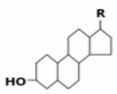
16.

5) Which of the following structures is a sterol?

a)



b)



A or B

Answer : B

17. Which is a characteristic of the lipids in a biological membrane?

a) Specific glycerophospholipids are distributed equally on the two membrane surfaces.

b) Lipid molecules are held in fixed positions by non-covalent bonds with proteins.

c) The fluidity of the membrane decreases with lower levels of saturated fatty acids.

d) The fatty acids of lipid molecules are found in the interior of the membrane

18. Which is a property of integral membrane proteins?

a) All integral membrane proteins contain hydrophilic regions.

b) All integral membrane proteins span the entire membrane.

c) All integral membrane proteins contain carbohydrate groups within the membrane.

d) All integral membrane proteins transport non-polar molecules through the membrane.

19. Which will be a characteristic of a steroid that is part of a cell membrane?

A. It will contain a hydroxyl group.
B. It will contain four aromatic rings.
C. It will contain choline.
D. It will contain an amide bond.

20. Which characteristic is shared by a cell membrane and a chylomicron?

a) Both contain specific proteins.

b) Both have a bilayer structure.

c) Both contain a high proportion of triglycerides.

d) Both contain a high proportion of sterols.