JOINT CSIR-UGC- NET/SET/JRF-JUNE 2020

PAPER- II

LIFE SCIENCES

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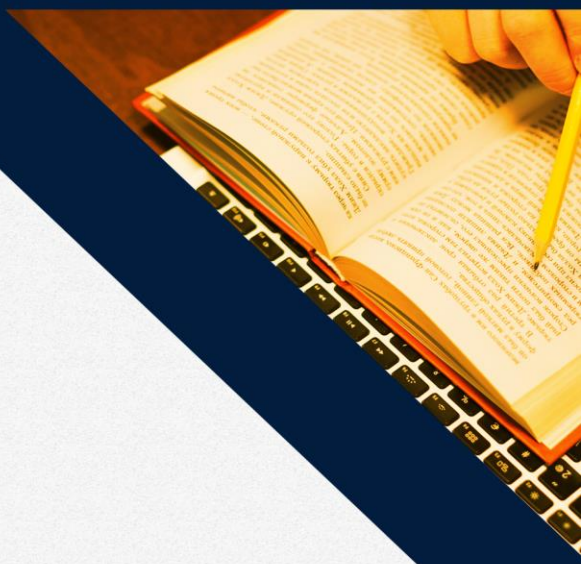

LIPID BILAYER:

Lipid molecules constitute the bulk and thick components of cell membrane, lipid bilayer. There are about 10^9 lipid molecules in the cell membrane of a single animal cell. All the lipid molecules in the plasma membrane are **amphiphilic** in nature that is they have a **hydrophilic** (water loving) or polar end and a **hydrophobic** (water fearing) or non polar end.

PHOSPHOLIPIDS- Phospholipids are composed of one primary alcohol, phosphate group, one secondary alcohol, two fatty acid chain. Depending upon the primary alcohol phospholipids can be of two types- glycerophospholipids (glycerol), sphingolipids (sphingosine).

The main phospholipids in most animal cell membrane are phosphoglycerides. Phosphoglycerides contain a three-carbon glycerol. Two long chain fatty acids are linked through esters bond with two adjacent carbon atoms of glycerol. These structures form the hydrophobic tail part of the phospholipids as it is non-polar so can not dissolve in water. This hydrophobic part is dissolved in organic solution. The third carbon atom of the glycerol is attached to the phosphate group (with one negative charge) which in turn attached with another group, the secondary alcohol (serine, choline, ethanolamine) with a positive charge or neutral. These form the head part of phospholipids which is polar, dissolve in water, i.e., hydrophilic in nature.

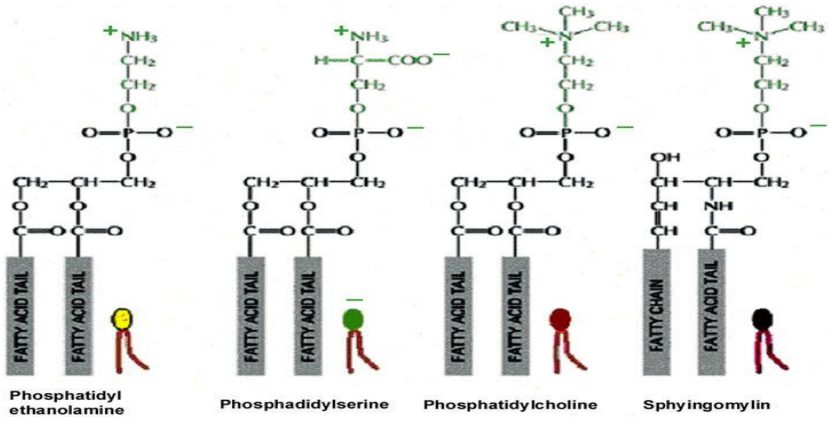

Figure- Phospholipids of cell membrane

MEMBRANE ASYMMETRY OF LIPIDS:

The lipid composition is different in the cytosolic leaflet and non-cytosolic or exoplasmic leaflet of the phospholipid bilayer. In plasma membrane of human erythrocyte cells sphingomyelin and phosphatidylcholine found more in number in the exoplasmic side of phospholipid bilayer, whereas phosphatidylserine, phosphatidylethanolamine and phosphatidylinositol are preferentially located in the cytosolic side of the phospholipid bilayer. Although these phospholipids molecules are generated in the ER they oriented in preferential manner in the phospholipid bilayer with the involvement of three enzymes **flippase, floppase and scramblase.** After synthesis phospholipid molecules are equally distributed in two phospholipid monolayers, and this is mediated by **scramblase,** a phospholipid translocator protein. Thereafter **flippase,** a P-type active transporter protein transport phospholipids (phosphatidyleserine, phosphatidyleethanolamine, phosphatidyleionositol) from **outside to inside.** On the other hand another **floppase,** another active transporter protein transport phospholipid molecules (phosphatidylecholine, sphingolipids) from **inside to outside. Scramblase** is a ATP independent transporter protein.

FLIPPASE	FLOPPASE	SCRAMBLASE
P-type	ABC type	
ATP dependent	ATP dependent	ATP independent
Outside to inside	Inside to outside	Both direction and lateral direction

However there is a significant differences is available in lipid asymmetry between apoptotic or cancer cell and normal cell. In apoptotic cell or cancer cell phosphatidylecholine found more in cytosolic end and phosphatidyleserine found more in exoplasmic cell. This is a very useful difference between cancer cell and normal cell.

MEMBRANE FLUIDITY: Cell membrane has a quasi-fluid structure. Cell membrane maintains a critical fluidity so as to maintain its semi-permeability. Fluidity is essential to transport gasses, nutrients, signalling molecules, and also for movement of phospholipids molecule along the membrane plane. For example human live in different climatic region. But there a lot of differences between cell membrane compositions among people live in colder region and temperate region. The cell membrane fluidity is controlled by various factors,

1) **Temperature:** As the temperature increases the fluidity of the membrane increases. Increasing in temperature increase the kinetic energy of phospholipids molecules and also decrease the interaction between lipid molecules thus increase the fluidity. Decrease in temperature in turn decrease the membrane fluidity and make the cell membrane more rigid in nature. The temperature at which membrane behaves like 50% fluid and 50% gel like structure is known as transition melting point **(T_m).**
2) **Fatty Acid Chain Length:** Long saturated fatty acid chains have more tendency to aggregate and packed tightly by van der walls interaction and hydrophobic interactions, thus make the membrane more gel like state or increase the rigidity and decrease the membrane fluidity. Meanwhile presence of short fatty acid chains increase the membrane fluidity as there is less surface area available for van der walls interaction and hydrophobic interaction.
3) **Degree of Saturation:** Phospholipids with unsaturated fatty acid chains that is fatty acid chains having double bond or triple bond structure, increase the membrane fluidity. Unsaturation that is presence of double bond structure in the fatty acid chain form kink structure and increase the distance between adjacent fatty acid chains of neighbouring phospholipid molecules. This in turn reduces the tendency to interact with other phospholipid molecules. So more the unsaturation more will be the membrane fluidity.

Sterol: There is another molecule sterol, is also responsible for maintaining the cell membrane fluidity. Sterols are lipid soluble molecules and these are amphipathic in nature. These are mainly responsible for maintaining of membrane rigidity. In case of animal cell the sterol present is known as **cholesterol,** in case of plant the sterol present is known as **phytosterol.** Most common phytosterol are **brassicasterol, campesterol, sitosterol, stigmasterol, avenasterol.** In case of fungi the sterol present is known as **ergosterol.** Bacteria contain **hopanoids** instead of sterol. In animal cells Cholesterols mainly interact with phospholipids present in the cell membrane. Cholesterol present in between lipid molecules and interacts with phospholipids by the means of hydrophilic interaction and hydrophobic interaction as cholesterol shows amphipathic character. Basically in cold temperature cholesterol concentration increases so as to prevent possibilities to be more rigid as it prevent phospholipid molecules to came more closer. Whereas in high temperature cholesterol also prevent lipid molecules from being separated out from each other by means of hydrophobic interaction with fatty acid chains. So the main role of cholesterol in the plasma membrane to maintain membrane fluidity.