

Course Name- Cell Biology

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Unit: Structure and Functions of the Cell Membranes

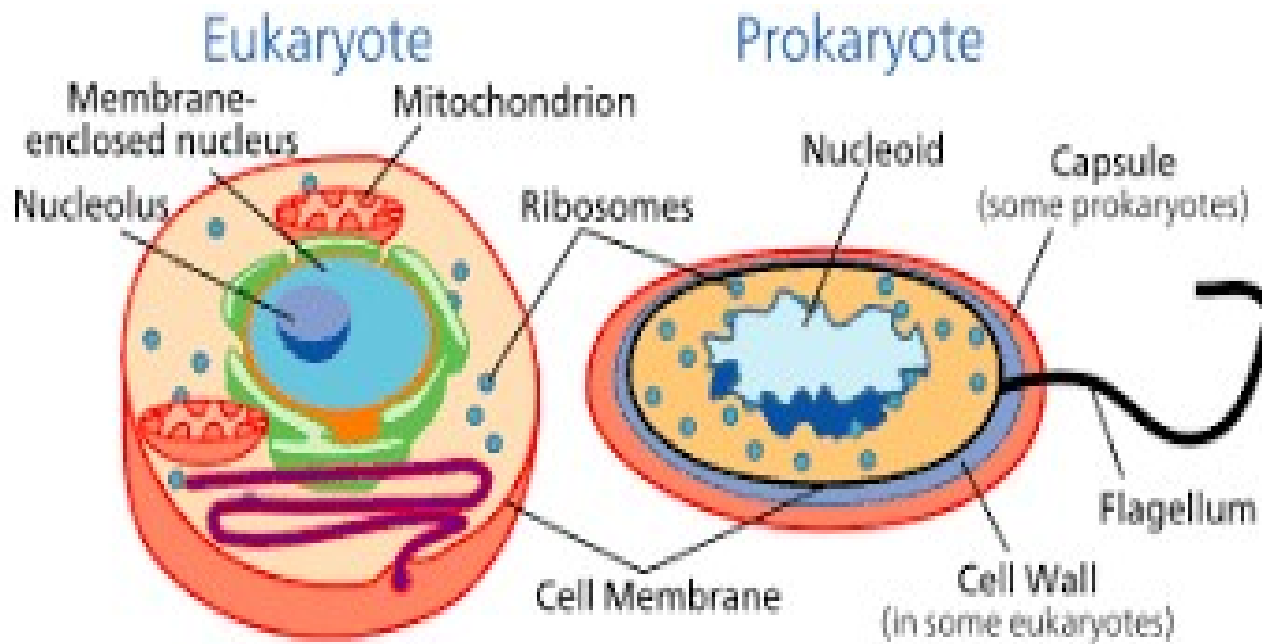
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Cell Membrane

Introduction:

- The cell membrane (also known as the plasma membrane (PM) or cytoplasmic membrane, and historically referred to as the plasmalemma) is a biological membrane that separates the interior of all cells from the outside environment (the extracellular space) which protects the cell from its environment.
- The cell membrane consists of a lipid bilayer, including cholesterol (a lipid component) that sit between phospholipids to maintain their fluidity at various temperatures.

- The membrane also contains membrane proteins, including integral proteins that go across the membrane serving as membrane transporters, and peripheral proteins that loosely attach to the outer (peripheral) side of the cell membrane, acting as enzymes shaping the cell.
- The cell membrane controls the movement of substances in and out of cells and organelles. In this way, it is selectively permeable to ions and organic molecules.
- In addition, cell membranes are involved in a variety of cellular processes such as cell adhesion, ion conductivity and cell signalling and serve as the attachment surface for several extracellular structures, including the cell wall, the carbohydrate layer called the glycocalyx and the intracellular network of protein fibers called the cytoskeleton.



Chemical composition

- The cell membrane is composed mainly of protein, lipid, and a small percentage of oligosaccharides that may be attached to either the lipids(glycolipids) or the proteins (glycoproteins).
- There is a wide variation in the lipid-protein ratio between different cell membranes.
- **Lipid Fraction of Cell Membranes-**
 - The cell membrane contains about 20 to 79% of lipid.
 - The main lipid constituents of cell membrane are phospholipids, cholesterol and galactolipids; their proportions varies in different cell membranes.

- The phospholipids components of cell membrane are of two kinds-

- i) neutral phospholipids and

- ii) acidic phospholipids

Neutral phospholipids such as phosphatidylcholine, phosphatidylethanolamine and sphingomyelin have no net charge at neutral pH and they tend to pack tightly in the bilayer.

Acidic phospholipids such as phosphatidylinositol, phosphatidylserine, cardiolipin, phosphatidylglycerol, sulpholipids are negatively charged and in the membrane are associated principally with proteins by way of lipid-protein interactions.

➤ Carbohydrate Fraction of Cell Membrane-

- 1962 Bell has suggested the cell membrane of carbohydrates in the plasma membrane.
- The most common oligosaccharides of cell membrane of mammalian erythrocytes and liver cells are hexose, hexosamine, fucose and sialic acid.
- Sialic acid is sensitive to neuraminidase and is attached to proteins by N-acetylgalactosamine on the outer surface of the membrane
- A small amount of sialic acid exists in the form of gangliosides (i.e., glycolipids) in the plasma membrane of liver cells

- They play an important role, not only in the mechanical structure of the membrane, but also as carriers or channels, serving for transport.

➤ Protein Fraction of Cell Membranes

- Proteins represent main and one of the most significant fractions of cell membranes. They play an important role, not only in the mechanical structure of the membrane, but also as carriers or channels, serving for transport, they may also be involved in regulatory or ligand-recognition properties.
- Besides the structural proteins, there occur enzymatic proteins, and also the antigens and various kinds of receptor molecules, in the plasma membrane.

➤ Enzymes of Cell Membrane

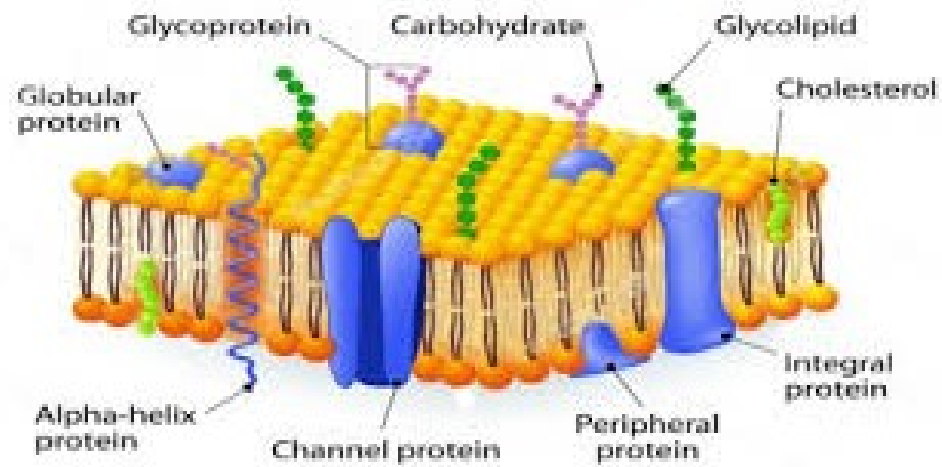
- In any cell in which active transport occurs, it is likely that enzyme occur in the surface of the cell.
- The structural protein of a cell membrane is enzymatic protein (Chambers and Chambers,1961).
- About 30 enzyme have been reported from the isolated cell membranes.
- Most constantly found are 5- nucleotidaes, Mg^{2+} ATPase, Na^{+} - K^{+} activated- Mg^{+} Atpase, alkaline phosphatase, adenyl cyclase, acid phosphomonoesterase and RNase.
- The enzyme Na^{+} - K^{+} activated- Mg^{+} ATPase is one of the most important enzyme of plasma membrane because of its role in ion transfer across the plasma membrane.

Structure of the Cell Membrane

- Phospholipids are a main component of the cell membrane. These are lipid molecules made up of a phosphate group head and two fatty acid tails.
- The properties of phospholipid molecules allow them to spontaneously form a double-layered membrane. When in water or an aqueous solution, which includes the inside of the body, the hydrophilic heads of phospholipids will orient themselves to be on the outside, while the hydrophobic tails will be on the inside.
- The technical term for this double layer of phospholipids that forms the cell membrane is a phospholipid bilayer. Eukaryotic cells, which make up the bodies of all organisms except for bacteria and archaea, also have a nucleus that is surrounded by a phospholipid bilayer membrane.

- In addition, the cell membrane contains glycolipids and sterols.
- One important sterol is cholesterol, which regulates the fluidity of the cell membrane in animal cells. When there is less cholesterol, membranes become more fluid, but also more permeable to molecules.
- The amount of cholesterol in the membrane helps maintain its permeability so that the right amount of molecules can enter the cell at a time, not too many or too few.

Cell Membrane



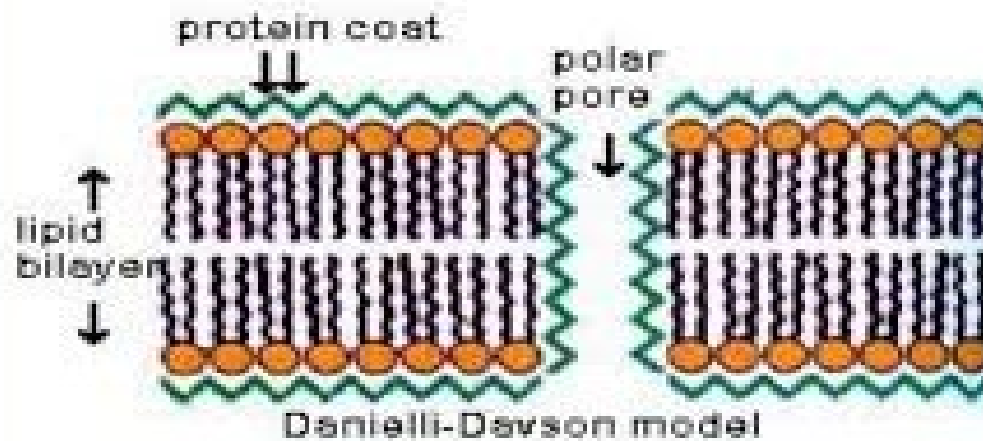
- The cell membrane also contains many different proteins.
- Proteins make up about half of the cell membrane.
- Many of these proteins are transmembrane proteins, which are embedded in the membrane but stick out on both sides.
- Some of these proteins are receptors which bind to signal molecules, while others are ion channels which are the only means of allowing ions into or out of the cell.
- Scientists use the fluid mosaic model to describe the structure of the cell membrane.

Models of Plasma Membrane

Danielli and Davson Model:

- In 1935 , Danielli and Davson studied triglyceride lipid bilayers over a water surface
- In their model, Danielli and Davson proposed that the plasma membrane consists of two layers of lipid (phospholipid) molecules.
- They found that they arranged themselves with the polar heads facing outward
- It always formed droplets (oil in water) and the surface tension was much higher than that of cells

DANIELLI AND DAVSON MODEL



Robertson's Model:

- In 1965, Robertson noted the structure of membranes seen in the electron micrographs
- He saw no spaces for pores in the electron micrographs
- He hypothesized that the railroad track appearance came from the binding of osmium tetroxide to proteins and polar groups of lipids
- Proposed unit membrane hypothesis

ROBERTSON'S MODEL

extracellular side
glycoprotein coat

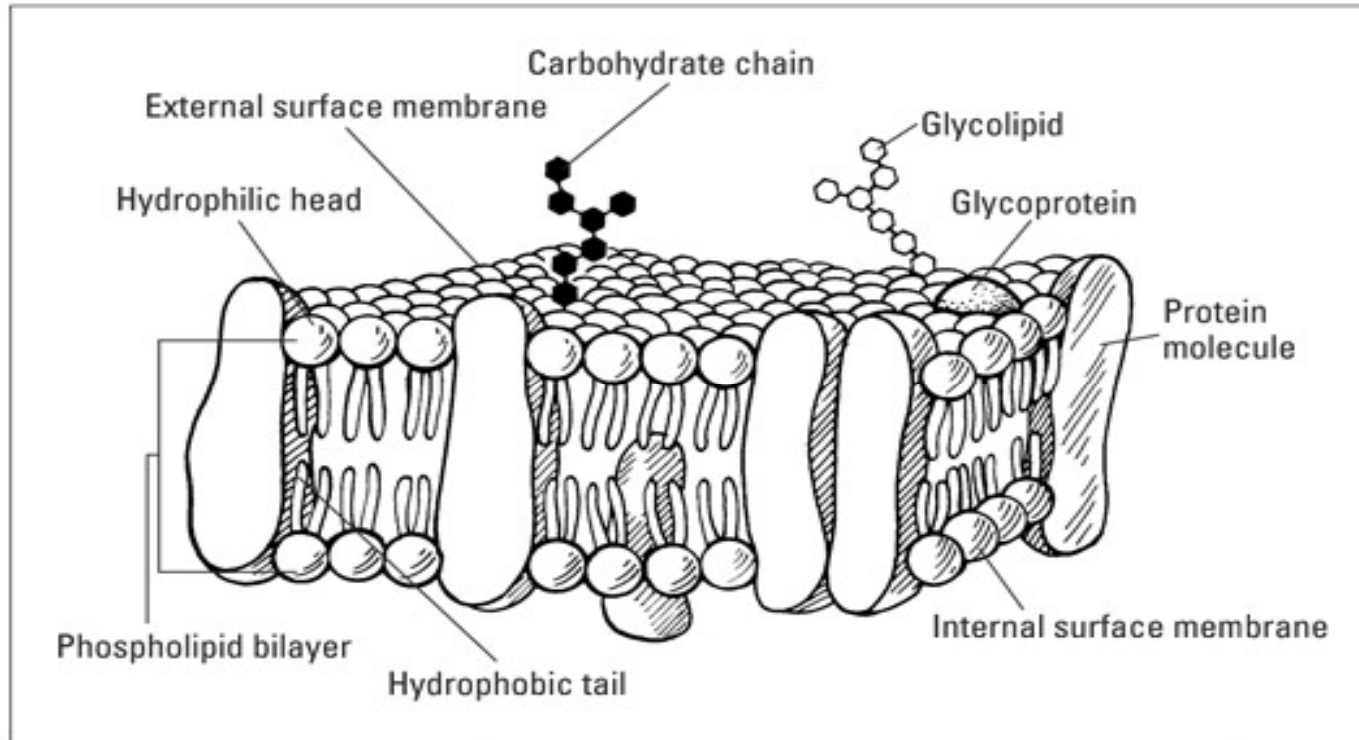
Robertson
model



Fluid Mosaic Model:

- According to S.J.Singer and G.L.Nicolson 1972, the biological membranes can be considered as a two dimensional liquid where all lipid and protein molecules diffuse more or less freely.
- Singer studied phospholipid bilayers and found that they can form a flattened surface on water, with no requirement for a protein coat.
- It occur in form of globular protein.
- Widely accepted modal.

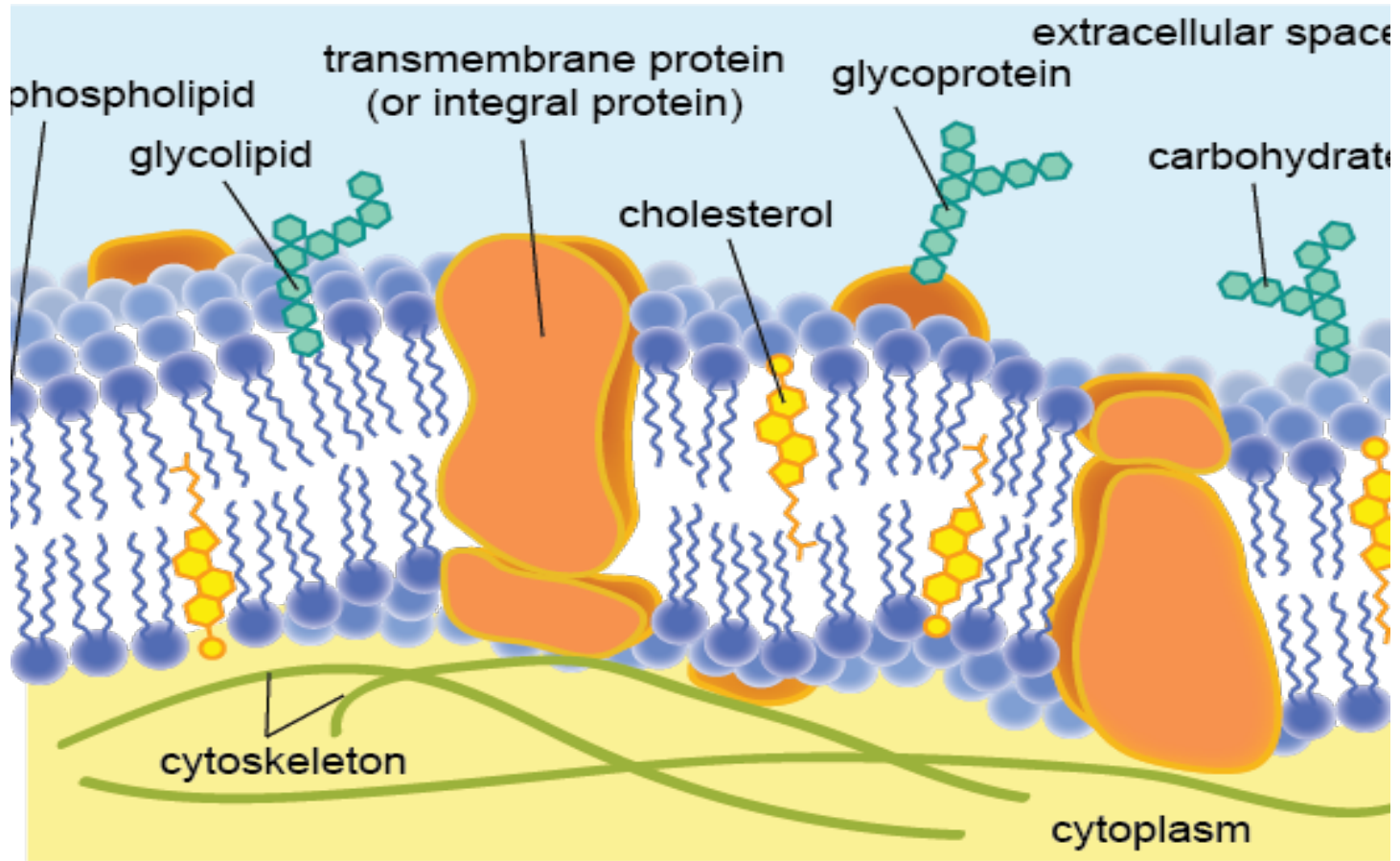
Fluid Mosaic Model



Function of the Cell Membrane

- The cell membrane is the cell's flexible outer limiting barrier that separates the cell's internal environment from the external (extracellular) environment.
- It present in prokaryotes and eukaryotes.
- Oxygen, which cells need in order to carry out metabolic functions such as cellular respiration, and carbon dioxide, a byproduct of these functions, can easily enter and exit through the membrane.
- Water can also freely cross the membrane, although it does so at a slower rate. However, highly charged molecules, like ions, cannot directly pass through, nor can large macromolecules like carbohydrates or amino acids.

- During exocytosis, vesicles come to the surface of the cell membrane, merge with it, and release their contents to the outside of the cell.
- Exocytosis removes the cell's waste products— parts of molecules that are not used by the cell.
- The cell membrane also plays a role in cell signaling and communication.
- Receptor proteins on the cell membrane can bind to molecules of substances produced by other areas of the body, such as hormones.



Cell Membrane: Functions

- When a molecule binds to its target receptor on the membrane, it initiates a signal transduction pathway inside the cell that transmits the signal to the appropriate molecules.
- Then, the cell can perform the action specified by the signal molecule, such as making or stopping production of a certain protein.
- Cell membrane provide a binding site for enzyme.

THANK

YOU