جامـــــعة المـــــستـقبـل
AL MUSTAQBAL UNIVERSITY

كلية العلـــوم

قـســـــــم الادلة الجنائية

المحاضرة الثالثة

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المادة : الخلية The Cell

المرحلة : الأولى

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Structure and function of cell membrane and cell wall

Every cell, prokaryotic or eukaryotic, is surrounded by a thin and elastic of phospholipid bilayer, 7.5 -10nm, called the plasma membrane or cell membrane or plasma - lemma. In plant cells plasma lemma is further covered by cellulosic cell wall. It maintains the internal environment of the cell from its external environment by controlling the entrance and exit of the molecules and ions. It regulates the passage of substances as **Endocytosis** (entrance of materials inside the cell) and **Exocytosis** (release of toxic metabolic by-products of the cell). Thus, it functions as semi-permeable or selectively permeable membrane. It possesses devices for attachment to other cells for cell-to-cell communications, ion pumps, receptors for hormones, etc. Finally, its link adjacent cells together via membrane junction and cell adhesion molecules.

The chemical composition of plasma membrane

Plasma membrane is consisting of:

- 55% protein
- 25% phospholipid
- 13% cholesterol
- 4% lipids
- 3% carbohydrates

Proteins

Proteins are the main component of plasma membrane. According to type of the cell, percentage of protein is varied. For example:

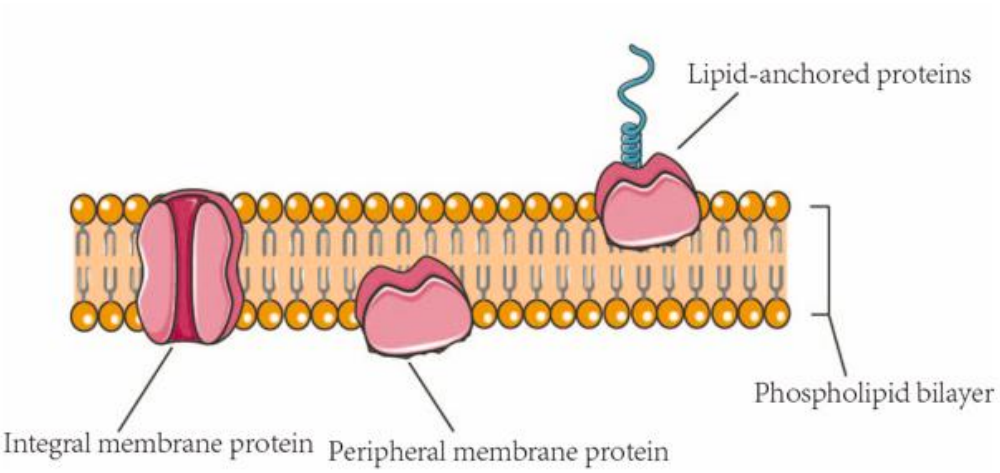
Myelin sheath (membrane surrounding some nerve axons) is composed of 20% protein.

Eukaryotes membrane, which serves as permeability barriers possesses about 50% proteins. Plasma membrane that are actively involved in energy transfer, such as inner membrane of mitochondria, chloroplasts have large amounts of proteins about 75%. Proteins are not only provided mechanical support but also act as carriers or channels, serving for transport.

Membrane proteins are classified as integral (intrinsic) or peripheral (extrinsic) according to the degree of their association with the membrane.

- **Integral or Intrinsic Proteins:** These proteins penetrate the plasma membrane wholly or partially and represent more than 70% of the two protein types. Structurally, the integral protein contains residues with hydrophobic side chains that anchored the protein to the membrane. **The main function of integral proteins is** forming receptors, ion channels, pumps and carries.

Peripheral or extrinsic Proteins: They are associated with membrane surface. Most of peripheral proteins are hydrophilic, so they are either attached to integral membrane proteins or can bound directly to polar head group of the bilayer. These can be separated by addition of salts, soluble in aqueous solutions and usually free of lipids. Common examples are cytochrome-C found in mitochondria, and spectrin found in erythrocytes

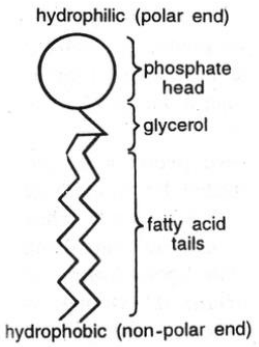


Classification of membrane protein

Phospholipids

Phospholipids are amphipathic molecules. They consist of both a hydrophobic and hydrophilic. The hydrophobic (2 unsaturated fatty acid chains) and hydrophilic (phosphorylated glycerol head).

Polar head groups have affinity for water, whereas their hydrocarbons tails avoid water. This can be accomplished by forming a micelle, in which polar head groups are on the surface and hydrocarbon tails are directed inside.



1. Cholesterol

It is a fluidity buffer present in eukaryotes but not in prokaryotes. Plasma membrane of cells such as erythrocyte, liver cells and myelinated nerve cells are rich in cholesterol. Its function as diminishes lateral membrane mobility, reduces permeability to small water-soluble molecules.

2. Carbohydrates

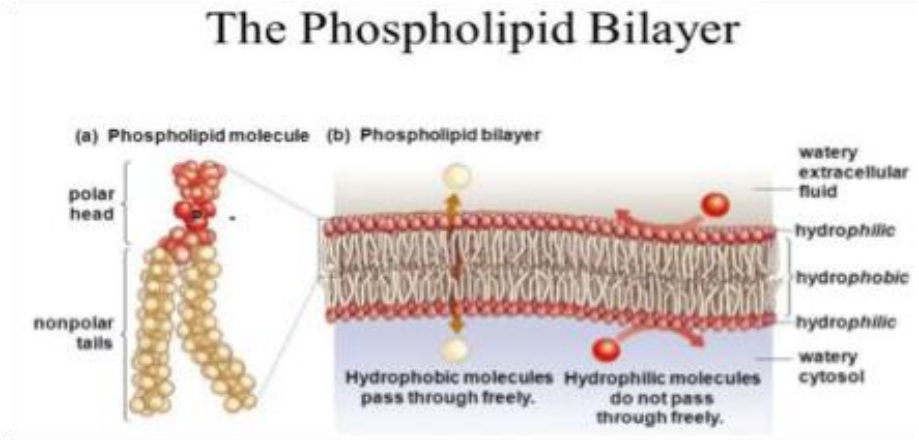
The membranes of eukaryotic cells usually contain 2% to 10% carbohydrates in the form of glycolipids and glycoproteins. Hexose, hexosamine, fucose and sialic acid are the commonest carbohydrates found in the membrane. Plasma membranes of neuronal surface contain gangliosides and are probably involved in the ion transfers.

Model of cell membrane structure

1. **Lipid and Lipid Bilayer Model:**

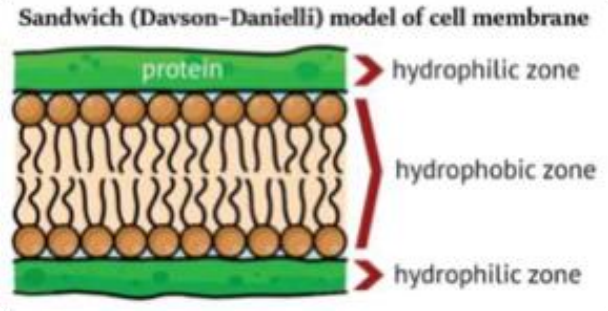
   In 1902, Overton observed that substances soluble in lipid could selectively pass through the membranes. On this basis he stated that plasma membrane is composed of a thin layer of lipid.

Gorter and Grendel (1925) were the first to suggest a possible structure of the cell membrane. Where they thought that the membrane consisted of double layers of lipid molecules, the polar hydrophilic groups of the molecules being situated on the outside and hydrophobic ends standing at right angles to the surface are oriented inwardly. These models of Gorter and Grendel could not explain the proper structure of plasma membrane, but they put the foundation of future models of membrane structure.



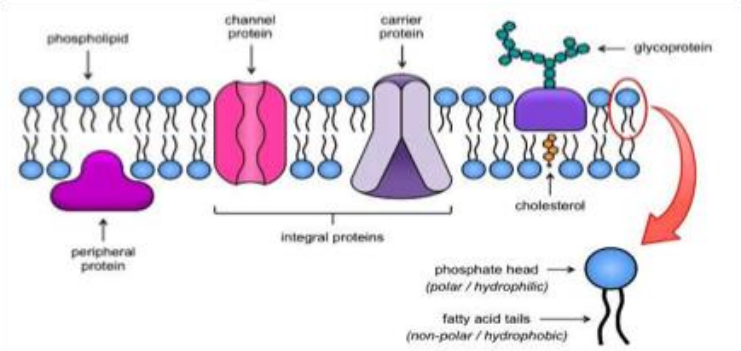
1. Lamella-model of plasma membrane (Danielli-Davson model)

Danielli-Davson model (1934) suggested that the plasma membrane consists of two layers of lipid molecules in which phospholipid molecules are arranged in such a way that hydrophilic heads of the phospholipid molecules face outside, and hydrophobic non-polar lipid chains are associated in the inner region. Also, the hypothesis suggest that the polar ends of the lipid molecules are associated with a monomolecular layer of polar globular protein molecule. The entire structure thus consisted of double layer of lipid molecule sandwiched between two continuous layers of protein. The lipid molecules are set at right angles to the surface and are so arranged in two layers that their non-polar hydrophobic fatty acid tails face each other and their polar hydrophilic phosphate heads face the protein layer. The proteins involved were thought to be globular. Moreover, lamellar theory assumed the cell membrane to be a stable structure with little functional specificity and variability.



2. Fluid Mosaic Model of plasma membrane:-

It was proposed by Singer and Nicholson (1972). The fluid mosaic model describes the structure of the plasma membrane as a mosaic of components including phospholipids, cholesterol, proteins, and carbohydrates that gives the membrane a fluid character. The lipids are thought to be arranged primarily in a bilayer in which proteins are embedded to varying degrees. Singer classifies membrane proteins as peripheral or integral. In this model, lipid molecules may exhibit intra molecular movement or may rotate about their axis or may display flip-flop movement including transfer from one side of bilayer to the other.



CELL WALL

The plant cell is always surrounded by a cell wall and this feature distinguishes them from animal cells. The cell wall is a non-living structure which is formed by the living protoplast (A plant cell without its cell wall is called a **protoplast**). In most of the plant cells, the cell wall is made up of :

- Cellulose
- Hemicellulose
- pectin
- protein
- mineral deposit

In many fungi, the cell wall is formed of chitin and in bacteria; the cell wall contains protein-lipid-polysaccharide complexes. Thus, the cell wall is a rigid and protective layer around the plasma membrane which provides the mechanical support to the cell and determines the shape of plant cells.

Structure of cell wall

The cell wall is complex in nature and is differentiated in the following layers:

(i) Primary cell wall.
(ii) Secondary cell wall.
(iii) Tertiary cell wall.

(i) Primary cell wall. The first formed cell wall is known as primary cell wall. It is the outermost layer of the cell and in the immature meristematic and parenchymal cells it forms the only cell wall. The primary cell is comparatively thin and permeable.

Certain epidermal cells of the leaf and the stem also possess the cutin and waxes which make the primary cell wall impermeable.

(ii) Secondary cell wall. The secondary cell wall is thick, permeable and lies near the plasma membrane of the tertiary cell wall, if the latter occurs. It is composed of three concentric layers (S1, S2 and S3) which occur one after another.

(iii) Tertiary cell wall. The tertiary cell wall differs from the primary and secondary cell wall in its morphology, chemistry and staining properties. Besides the cellulose, the tertiary cell wall consists of another chemical substance known as the xylan.

Functions of Cell Wall

1. Protecting the cell against physical damage and invading pathogens.
2. Cell wall controls and regulates the direction of cell growth.
3. Providing the strength, structural support and maintaining the shape of the cell.
4. Functions as a storage unit by storing carbohydrates for use in plant growth, especially in seeds.