TOPIC: PLASMA MEMBRANE AND INTRODUCTION TO MITOCHONDRIA

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Fluid Mosaic Model of plasma membrane:-

It was proposed by **Singer and Nicholson (1972**). The lipids are thought to be arranged primarily in a bilayer in which proteins are embedded to varying degrees. Singer classifies membrane protein s as peripheral or integral. The proteins varied in size and dissolved to varying degrees in the lipid matrix are able to diffuse later ally in the plane of membrane, and the entire structure is hence dynamic. In this model, lipid molecules may exhibit intra molecular move ment or may rotate about their axis or ma y display flip-flop movement including transfer from one side of bilayer to the other.

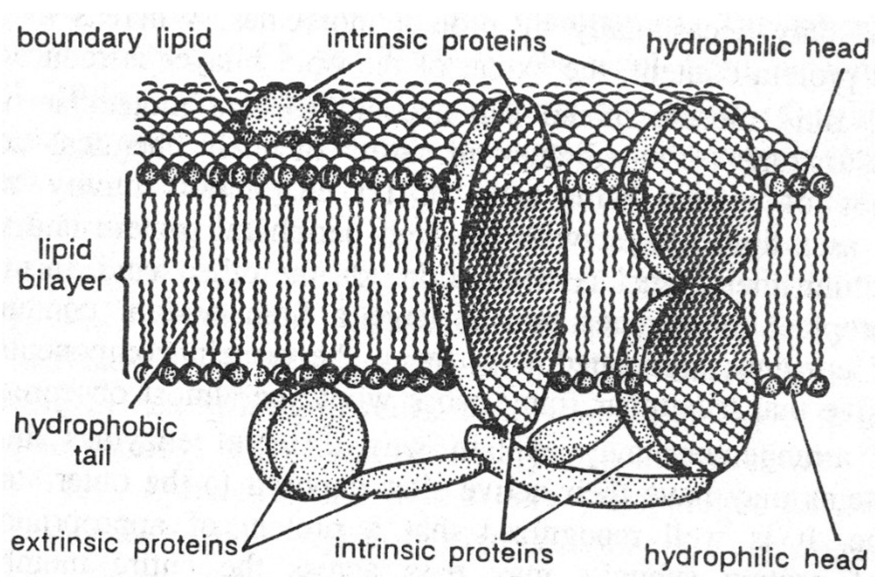

Fig. 2.8: Plasma membrane based upon Fluid-mosaic model

The lipids, glycoprotein and many of the intrinsic proteins of the membranes are amphipathic molecules. These amphipathic molecules constitute liquid crystalline aggregates in which the polar groups are directed toward the water phase and the n on-polar groups are situated inside the bilayer. The lipid bilayer forms the structural matrix which serves as the permeability barrier of the membrane. In membranes with high lipid content, lipid bilayer is extensive and interrupted only occasionally by protein molecules, whereas in membranes with high protein content, the extent of lipid bilayer is reduced. Thus, fluid mosaic model may describe the chemical composition of the molecular organization and ultrastructure of plasma membranes. This arrangement allows various enzymes and antigenic glycoprotein to have their active sites exposed to the outer surface of the membrane. The fluidity of membrane also implies that both the lipid and the protein have considerable freedom of movement within the bilayer. The fluidity of the lipid depends on the degree of saturation of the hydrocarbon chains and on the ambient temperature. A considerable proportion of the lipids in the membrane are unsaturated, so that melting point of the bilayer is below body temperature.

Functions of Plasma Membrane:-

The plasma membrane serves many functions such as:

It maintains the individuality and form of the cell.

It keeps the cell contents in place and distinct from the environmental materials. It protects the cell from injury.

It regulates the flow of materials into and out of the cell to maintain the concentration and kinds of molecules and ions in the cell. A cell remains alive as long as the cell membrane is able to determine which materials should enter or leave the cell.

It forms organelles within the cytoplasm. Its junctions keep the cells together.

It’s infolds help in the intake of materials by endocytosis (pinocytosis and phagocytosis).

It’s out folds (microvilli) increase the surface area for absorption of nutrients. The out folds also form protective sheaths around cilia and flagella.

Its receptor molecules permit flow of information into the cell. Its oligosaccharide molecule helps in recognizing self from non-self.

By controlling flow of material and information into the cell, the plasma membrane makes metabolism possible.

It permits exit of secretions and wastes by exocytosis.

It controls cellular interactions necessary for tissue formation and defense against microbes.

It helps certain cells in movement by forming pseudopodia as in Amoeba and leucocytes.

The bio-membranes around the organelles help the latter to:

Maintain their identity and functional individuality.

Receive and turn out required material.

SUMMARY

The plasma membrane constitutes the outermost boundary of the cell and it is remarkably complex in its molecular organization. It is composed of almost equal parts of proteins and lipids. It allows only selected ions and macromolecules to enter or leave the cell, thus it functions as a semi permeable membrane.

Ultra structure of plasma membrane may be of symmetrical or asymmetrical molecular structure in nature. Plasma membrane is a tripartite structure in both of the above types, the difference lies in the thickness of the three layers. In symmetrical molecular structure all the three layers, the outer and inner adielectronic along with the middle di-electronic layer are of 25Å thickness each having total thickness of 75Å. While in asymmetrical structure the inner adielectronic component is of 35Å to 40Å thickness, the outer dielectronic component is of 25Å thick and the central dielectronic layer is 30Å wide, thus total thickness becomes 90-95Å.

Plasma membrane is primarily composed of proteins and lipids, although carbohydrate is often present in association with proteins (as glycoproteins) or lipids (as glycolipids). However, the relative proportions of proteins and lipids vary considerably in membranes. Enzymes are also found in plasma membranes which play an important role in ionic exchange. Besides, salt and water are also present. The arrangement of lipids and proteins molecules is explained through various theories.

Lamella model of plasma membrane is consisted of a double layer of lipid molecules arranged radially with their hydrophobic hydrocarbon chains towards each other and with their respective polar groups arranged outwardly and inwardly. The double layer of lipids is sandwiched between two continuous layers of proteins. According to miceller theory, plasma membrane consists of a mosaic of globular subunits or micelles. These micelles are closely packed together having the lipid molecules in the central core. Protein components form a monolayer on the entire surface of the lipid micelles forming a globule. The widely accepted theory is fluid mosaic models of membrane as it can be used to describe the structure of different membranes. In this model the lipids are arranged in a bilayer in which proteins are embedded as peripheral or integral. The proteins varied in size and dissolved to varying degrees in the lipid matrix, diffuse laterally in the plane of membranes and the entire structure is hence dynamic.

Plasma membrane performs variety of functions as they impart shape to the cell and protects the cell contents. It regulates the cellular semi permeability, resorption, excretion and secretion. It contributes to the formation of various cell organelles within the cell. Its junctions keep the cells together.

GLOSSARY:-

Plasma membrane - A microscopic membrane made up of lipids and proteins which forms the external boundary of the cytoplasm of a cell or encloses a vacuole, and regulates the passage of molecules in and out of the cytoplasm.

Permeability- The ability of a barrier to let any substance pass through it.

Ions- An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

Semi permeable- Allowing certain substances especially small molecules or ions to pass through it but not others, especially allowing the passage of a solvent but not of certain solutes.

Receptor- A receptor is a protein molecule in a cell or on the surface of a cell to which a substance such as a hormone, a drug, or an antigen can bind, causing a change in the activity of the cell.

Dielectric- Having the property of transmitting electric force without conduction.

Hydrophobic- The substances that have an affinity for water due to the formation of hydrogen bonds.

Hydrophilic- Hydrophilic molecules typically have polar groups enabling them to readily absorb or dissolve in water as well as in other polar solvents.

Micelles- It is an aggregate of molecules in a colloidal solution, such as those formed by detergents.

Peripheral proteins/extrinsic proteins- Peripheral membrane proteins are proteins that adhere only temporarily to the biological membrane with which they are associated. These molecules attach to integral membrane proteins, or penetrate the peripheral regions of the lipid bilayer.

Integral proteins/intrinsic proteins- An integral membrane protein (IMP) is a type of membrane protein that is permanently attached to the biological membrane. All trans membrane proteins are IMPs, but not all IMPs are trans membrane proteins.

Amphipathy- It is the property of a molecule having both polar (water-soluble) and non polar (not water-soluble) affinities in its structure.

Enzyme- The proteins which acts as catalysts within living cells and increases the rate of biochemical reactions.

MITOCHONDRIA

Objectives:-

After reading this unit the readers will be able to:

Define mitochondria

Illustrate the morphology and ultra structure of mitochondria Describe the biogenesis of mitochondria

Explain the functions of mitochondria

Elucidate the respiratory chain complex and electron transport mechanism.

Introduction:-

Mitochondria (Gr., *mito*, thread; *chondrion*, granule) are thread like or granular structures of eukaryotic cells. These may assume rod-like shape called chondriosomes which may enlarge or aggregate to form massive spheroidal bodies called chondriospheres. These are not present in bacterial cells. Mitochondria are the '**power plants**' which by oxidation release the energy contained in the fuel molecules or nutrients and make other forms of chemical energy. The main function of mitochondria is oxidative phosphorylation, which is an exergonic reaction, meaning that it releases energy. In prokaryotes, oxidation of organic material is carried out by plasma membrane enzymes.

History :-

Kölliker (1880) was the first who observed the mitochondria in insects muscle cells. He called them as 'sarcosomes'. **Flemming** (1882) named the mitochondria as 'fila'. **Altmann** in 1894 observed them and named them Altmann's granules or bioblasts.

The term '**mitochondria**' was applied by **Benda** (1897-98). They were recognized as the sites of respiration by Hogeboom and his coworkers in 1948. **Lehninger and Kennedy** (1948) reported that the mitochondria catalyze all the reactions of the citric acid cycle, fatty acid oxidation and coupled phosphorylation.

Structure of Mitochondria

Morphology of Mitochondria:-

Morphologically mitochondria may be in the form of filaments or small granules. These may assume rod-like shape called **chondriosomes** which may enlarge or aggregate to form massive spheroid bodies called **chondriospheres**.

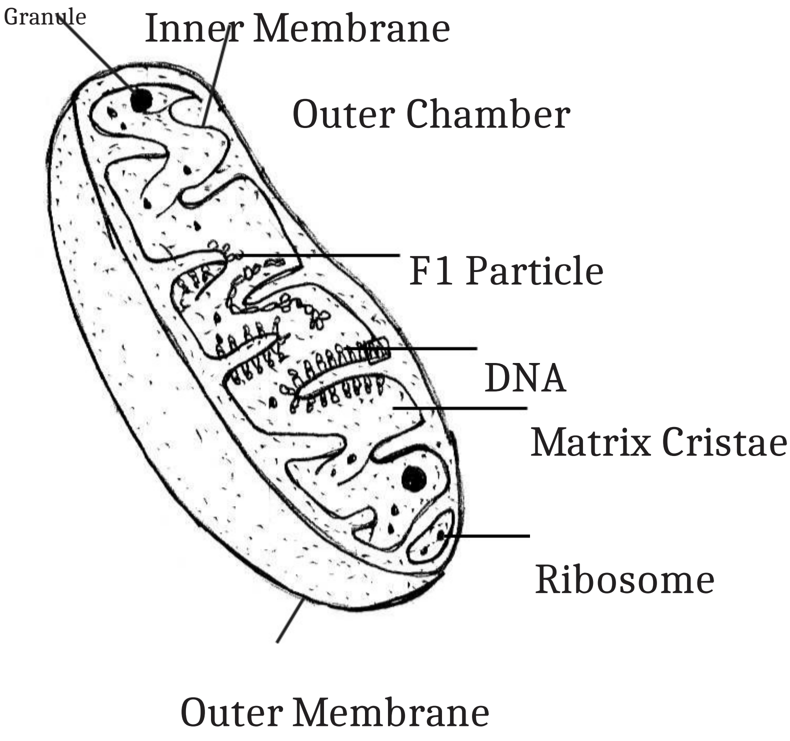

Fig. 3.1: Structure of a Mitochondrion

Position- Mitochondria lie freely in cytoplasm, possessing power of independent movement and may take the form of filaments. In some cells they can move freely, carrying ATP where needed, but in others they are located permanently near the region of the cell where more energy is needed. E.g., in the rod and cone cells of retina mitochondria are located in the inner segment, in cells of kidney tubules they occur in the folds of basal regions near plasma membrane, in neurons they are located in the transmitting region of impulse, in certain muscle cells (e.g. diaphragm), mitochondria are grouped like rings or bracers around the I-band of myofibril. During cell division they get concentrated around the spindle.

Number- The number of mitochondria varies a good deal from cell to cell and from species to species. A few algae and some protozoan have only single mitochondria. Their number is related to the activity, age and type of the cell. Growing, dividing and actively synthesizing cells contain more mitochondria than the other cells. In Amoeba (***Chaos chaos),*** there may be as many as 50,000 mitochondria. In rat liver cells, these are few in number, about 1000 to 1600. Some Oocytes contain as many as 3, 00,000 mitochondria.

Size- The average size of mitochondria is 0.5-1.0μ in diameter and about 2-8 μ in length. In exocrine cells of mammalian pancreas they are about 10 μ long and in oocytes of amphibian ***Rana pipiens*** are 20-40μ long. Yeast cells have the smallest mitochondria.

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