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Study of Physical and Chemical Models of Membranes

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Abstract: The work considers the formation of structures and certain functions of the biological membrane. From the construction of the biomembrane and the study of its properties, physicochemical models of the membrane were studied - monolayers of phospholipids, liposomes and biolipid (biolayer lipid) membrane. The scheme of the cell structure was carefully studied.

Key words: membrane, formation, structure, cell, model, monoayer, liposome, bio-pid , liquid, solid, molecule, ion.

An important part of the cell are biological membranes. They limit the cell from the environment, protect it from harmful external influences, control the metabolism between the cell and its environment, facilitate the generation of electrical potentials, participate in the synthesis of universal energy accumulators ATP-adenosine triphosphorus in mitochondria, etc.

Essentially, membranes form the structure of the cell and perform its functions. Many diseases (atherosclerosis, poisoning, etc.) are associated with disruption of the structure and function of membranes.

Membranes surround all cells (plasma and outer cell membranes). Without a membrane, the contents of the cell would simply spread out, diffusion would lead to thermodynamic equilibrium, which means no life. We can say that the first cell appeared when it separated itself from the environment with a membrane.

Intracellular membranes divide the cell into a number of closed compartments, each of which performs a specific function. The basis of the structure of any membrane is a double lipid layer (largely phospholipids). The double lipid layer is formed from two monolayers of lipids so that the hydrophobic "tails" of both layers are directed inward.

This ensures the least contact of the hydrophobic parts of the molecules with water. This idea of the membrane structure did not provide answers to many questions.

Later, a model was proposed based on the same lipid biolayer membrane.

This phospholipid base is like a two-dimensional solvent in which more or less immersed proteins float. Due to these proteins, specific membrane functions are fully or partially carried out - permeability, generation of electrical potential, etc.

Membranes are not static, still structures.

Lipids and proteins exchange membranes and move both along the plane of the membrane - lateral diffusion, and across it - the so-called flip -flop.

Lateral diffusion corresponds to high lipid mobility, while flip -flop corresponds to low mobility, i.e. the exchange of lipids located on different sides of the membrane is a rare process.

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Clarification of the structure of the biomembrane and study of its properties turned out to be possible with the use of physicochemical models of the membrane (artificial membranes).

Three of these models are the most widespread.

The first model is monolayers of phospholipids at the water-air or water-oil interface. At such interfaces, the phospholipid molecules are arranged so that the hydrophilic heads are in the water, and the hydrophilic "tails" are in the air or oil. If you gradually reduce the area occupied by the monolayer , you will eventually get a monolayer in which the molecules are densely located.

The second widely used model of biomembrane is liposomes , which are like a biological membrane, completely devoid of protein molecules, these are tiny bubbles (vesicles) consisting of a biolipid membrane and obtained by treating a mixture of water and phospholipids with ultrasound.

The third model, which made it possible to study some properties of biomembranes using direct methods, is the biolipid (biolayer lipid) membrane (BLM).

Membranes perform two important functions: matrix (i.e. they are a matrix, a basis for holding proteins that perform different functions) and barrier (they protect the cell and individual compartments from the penetration of unwanted particles). If these membrane functions are disrupted, then the normal functioning of the cells changes and, as a result, the body becomes ill.

Physical properties and parameters of membranes: Measurement of the mobility of membrane molecules and the diffusion of particles through the membrane indicate that the lipid bilayer behaves like a liquid.

However, the membrane is an ordered structure. These two facts suggest that the phospholipids in the membrane during its natural functioning are in a liquid crystalline state.

When the temperature changes in the membrane, phase transitions can be observed: melting of lipids when heated and crystallization when cooled.

The liquid crystalline state of the biolayer has a lower viscosity and a higher solubility of various substances than the solid state. The thickness of the liquid crystalline biolayer is less than that of the solid.

The structure of molecules in liquid and solid states is different. In the liquid phase, phospholipid molecules can form cavities (kinks) into which molecules of the differentiating substance can be introduced. The movement of the kink in this case will lead to diffusion of the molecule across the membrane.

Transfer of molecules (atoms) through membranes : An important element of membrane functioning is their ability to pass or not pass molecules (atoms) and ions. The probability of such penetration of particles depends both on the direction of their movement (for example, into or out of the cell) and on the type of molecules and ions.

Transfer phenomena are irreversible processes that result in spatial movement (transfer) of mass, momentum, charge or any other physical quantity in a physical system. Transfer phenomena include diffusion (transfer of mass of substance), viscosity (transfer of momentum), thermal conductivity (transfer of energy), and electrical conductivity (transfer of electrical charge).

There is a potential difference on the membrane, therefore, there is an electric field in the membrane. It affects the diffusion of charged particles (ions and electrons).

The transport of ions is determined by two factors: the unevenness of their distribution (i.e. the concentration gradient) and the effect of the electric field:

The study of the structure and functioning of biological membranes plays an important role in medicine, since many pathological processes in the cell are associated with disruption of membrane functions.

The total area of membranes in organs and tissues reaches enormous sizes.

Thanks to this, the cells have sufficient area for numerous processes to take place on the membranes that ensure human viability.

The membrane performs a wide variety of functions in the life activity of living cells.

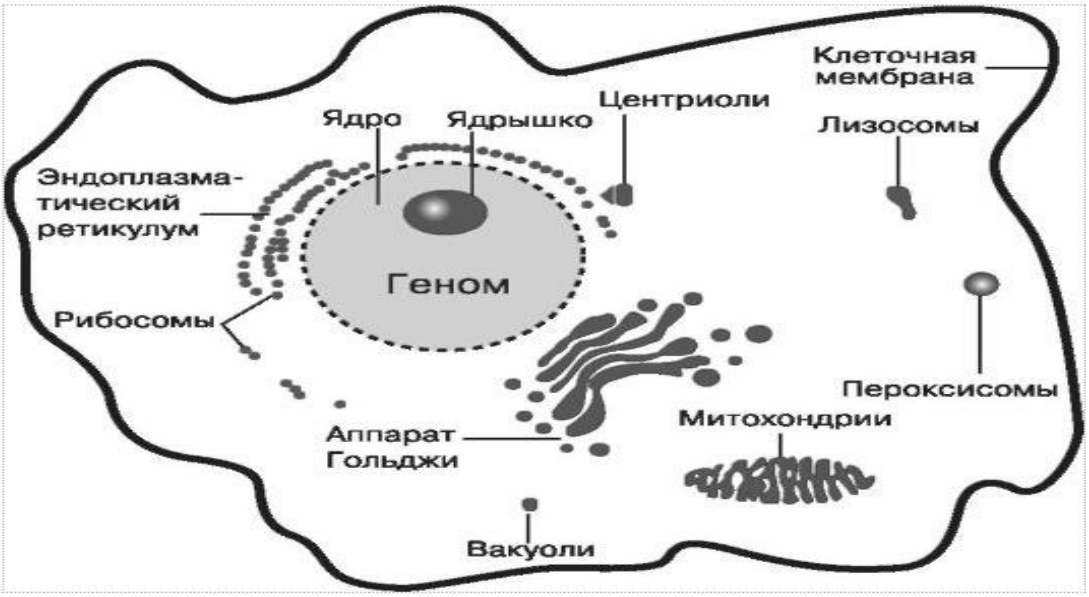

Figure. Diagram of the cell structure

Mechanical separation. A cell is an elementary living system. Each cell is surrounded by an outer cell plasma membrane, which encloses the contents of the cell.

On the other hand, fine regulation of intracellular processes is carried out on the basis of spatial separation of cell organelles (intracellular membranes). The membrane is the interface (dielectric boundary).

Transport function. The membrane is used to transport various substances, i.e. it takes an active part in the life of the cell.

Selective barrier. The membrane protects the cell from the penetration of unwanted particles and substances.

Reception. Recognition of other cells and substances occurs through the membrane.

Spread of nerve impulse. The main bioelectric processes are localized in the membrane. Generation of electrical potential is realized. Spread of nerve impulse occurs through the membrane.

The study of the structure and functioning of biological membranes is important for medicine, since many pathological processes in the cell are associated with the disruption of membrane functions. Their area is enormous. The area is sufficient to ensure numerous processes occurring on membranes that ensure human viability. The total area of membranes in human organs -is tens of thousands of square meters.

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