Cell membrane
L1

Objectives

- ✓ Define biological membrane
- ✓List the components of the membrane
- ✓Describe the clinical importance

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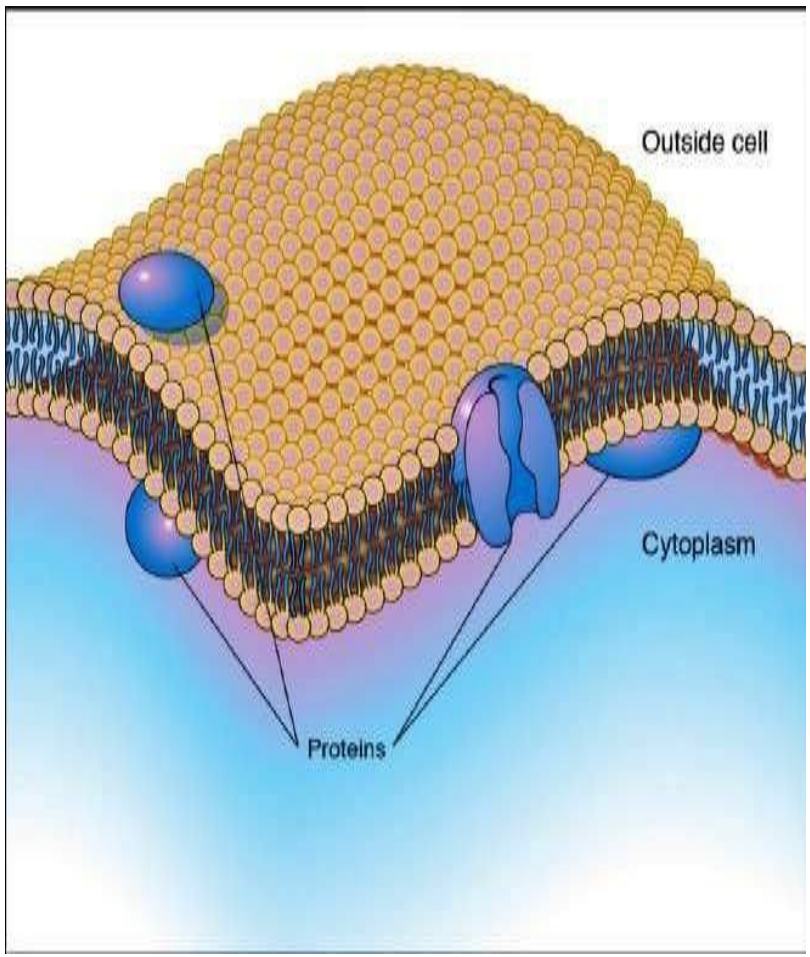


Cell membrane

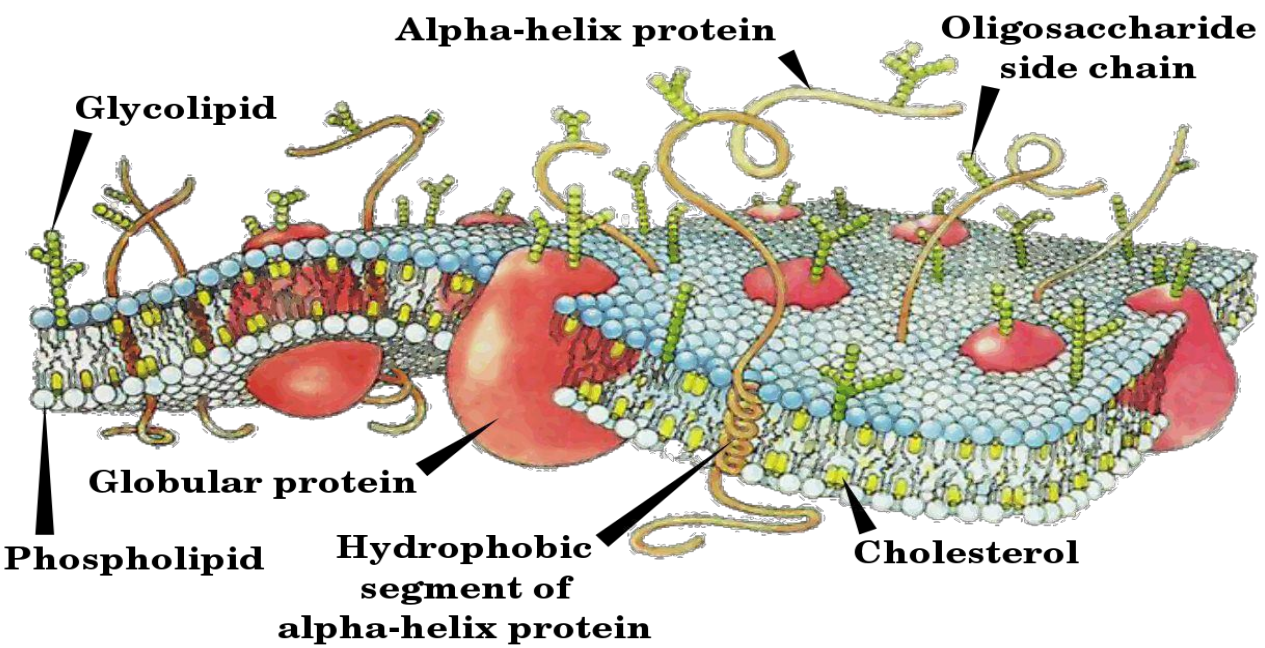
Cell membrane or **cytoplasmic membrane,** and historically referred to as the **plasmalemma**) is a biological membrane that separates the interior of all cells from the outside environment (the extracellular space) which protects the cell from its environment.

Definition: The outer limiting membrane that surrounds the cell and regulates the passage of materials into or out of the cell. It is then elastic semipermeable structure.

Thickness: 9-10 nm.

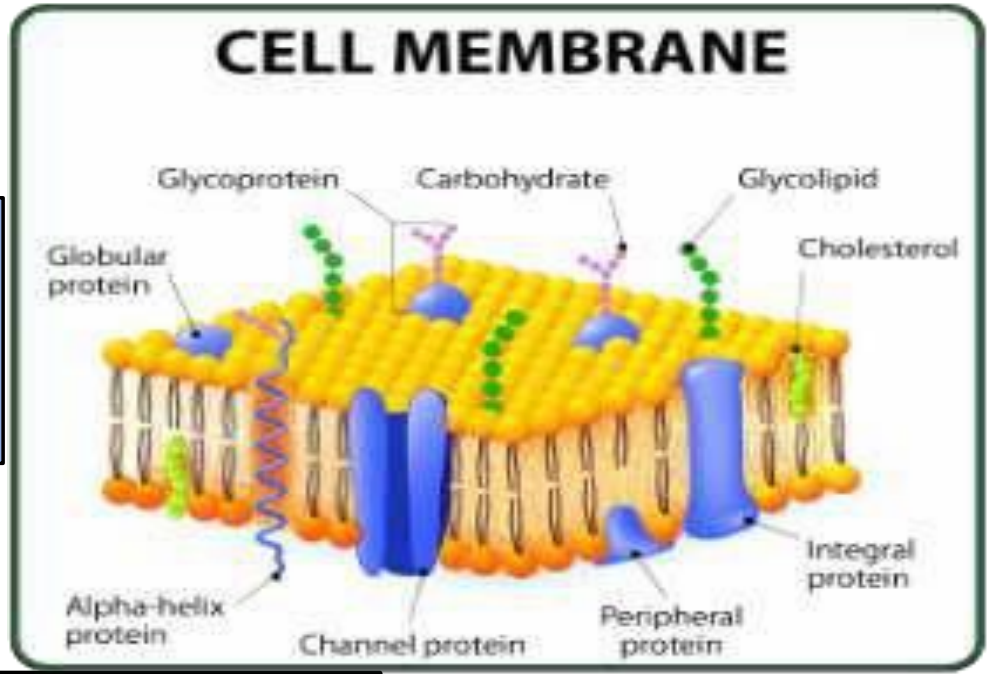
Chemical structure

- Lipid 42%
- Proteins 55%
- Carbohydrates 3%:
- Arranged in a special manner in the cell membrane.



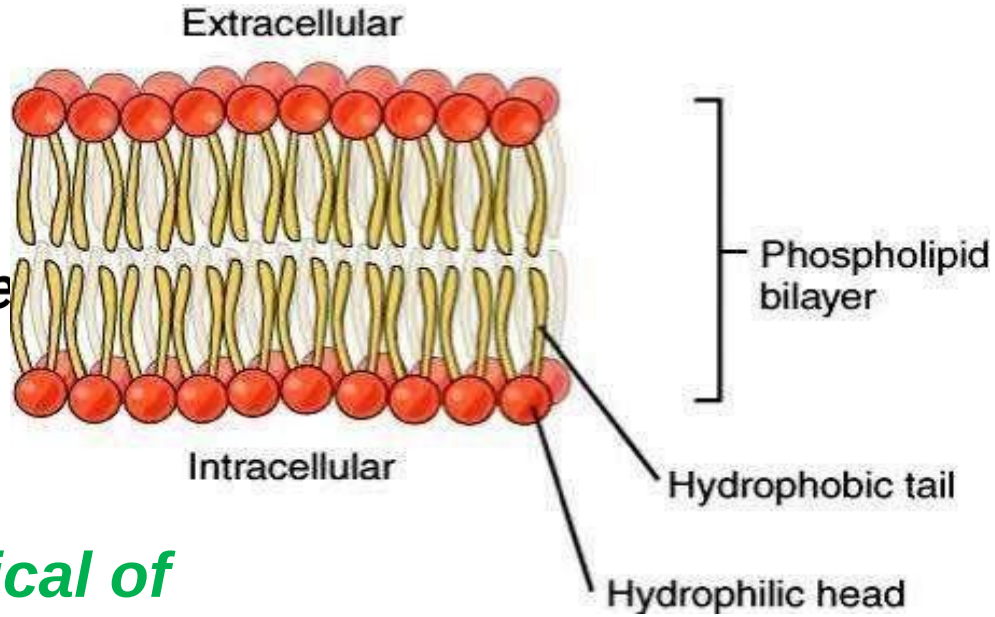
Structure :

Cell Membrane is composed of



- Lipids 42%
- Proteins 55%
- Carbohydrates 3%

1- Lipid bilayer (42%):



Thin, double layered film of lipids.

It is continuous over the whole surface

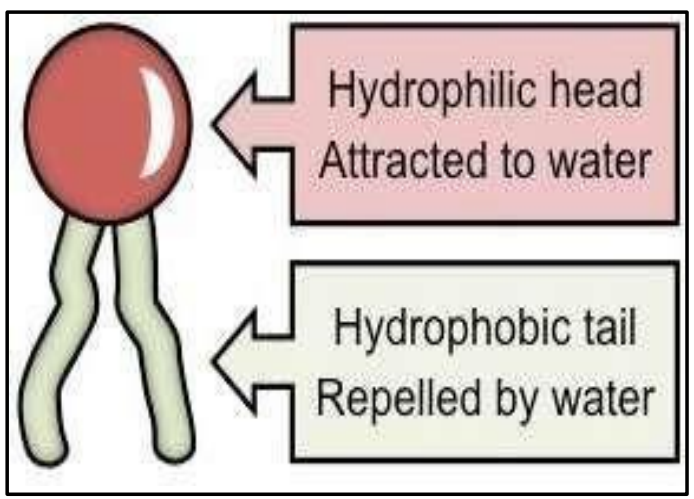
Each layer is formed of:

Head: ***Contains phosphate radical of phospholipid which is hydrophilic thus it is exposed to water present outside the cell (E.C.F) or inside the cell(I.C.F).***

Tail: Contains free fatty acid radical of phospholipid which is hydrophobic thus it is present in the inner parts of the membrane.

Lipid bilayer 42%

> It is consisted of



Head	Tail
Contain phosphate radical of phospholipids	Contain free fatty acid (FFA) radical of phospholipids
Water soluble (hydrophilic)	Water insoluble (hydrophobic)
It is exposed to water present inside or outside the cell	It presents in the water poor interior of the membrane

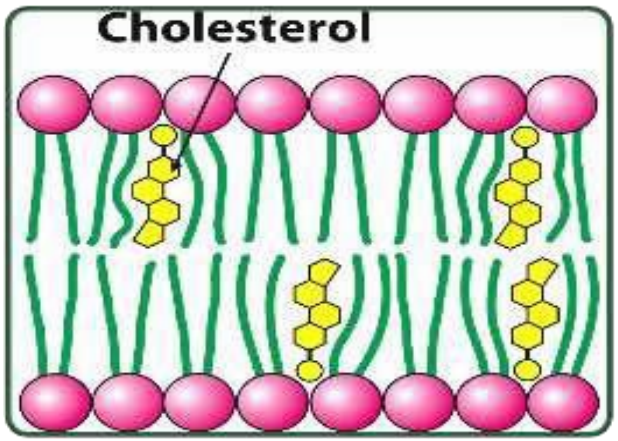
Characteristic of phospholipid layer

1. The entire membrane is held together via non-covalent interaction of hydrophobic tails, however the structure is quite fluid and not fixed rigidly in place.
2. Under physiological conditions phospholipid molecules in the cell membrane are in the liquid crystalline state. It means the lipid molecules are free to diffuse and exhibit rapid lateral diffusion along the layer in which they are present.
3. The exchange of phospholipid molecules between intracellular and extracellular leaflets of the bilayer is a very slow process .
4. Also, a fraction of the lipid in direct contact with integral membrane proteins, which is tightly bound to the protein surface is called annular lipid shell; it behaves as a part of protein complex.

B-Cholesterol 13%

Definition

It is dissolved in the phospholipid bilayer



Function

1-It determine the permeability of the lipid layer

It determine the fluidity of the cell membrane

Characteristic of Cholesterol

Represent 13% of the lipid in the cell membrane.

Determines the permeability and fluidity of the cell membrane.

It is dissolved in the phospholipid bilayer.

Phospholipid bilayer is the major lipid in the cell membrane.

Cholesterol in the membrane

In animal cells cholesterol is normally found dispersed in varying degrees throughout cell membranes, in the irregular spaces between the hydrophobic tails of the membrane lipids, where it confers a stiffening and strengthening effect on the membrane. Additionally, the amount of cholesterol in biological membranes varies between organisms, cell types, and even in individual cells.

1. Cholesterol, a major component of animal plasma membranes, regulates the fluidity of the overall membrane, meaning that cholesterol controls the amount of movement of the various cell membrane components based on its concentrations.
2. In high temperatures, cholesterol inhibits the movement of phospholipid fatty acid chains, causing a reduced permeability to small molecules and reduced membrane fluidity. The opposite is true for the role of cholesterol in cooler temperatures.

3. Cholesterol production, and thus concentration, is up-regulate, (increased) in response to cold temperature.

4. At cold temperatures, cholesterol interferes with fatty acid chain interactions. Acting as antifreeze, cholesterol maintains the fluidity of the membrane .

4. Cholesterol is more abundant in cold-weather animals than warm-weather animals.

5.In plants, which lack cholesterol, related compounds called sterols perform the same function as cholesterol.

Proteins

- The cell membrane has large content of proteins, typically around 55% of membrane volume.
- These proteins are important for the cell because they are responsible for various biological activities.
- Integral proteins are amphipathic trans membrane proteins.
- Examples of integral proteins include ion channels, proton pumps, and g-protein coupled receptors.
- Ion channels allow inorganic ions such as sodium, potassium, calcium, or chlorine to diffuse down their electrochemical gradient across the lipid bilayer through hydrophilic pores across the membrane.
- The electrical behavior of cells (i.e. nerve cells) are controlled by ion channels.

2-proteins 55%

Definition

They don't form a continuous layer as lipids, but they exist as masses floating in the lipid layer.

Types

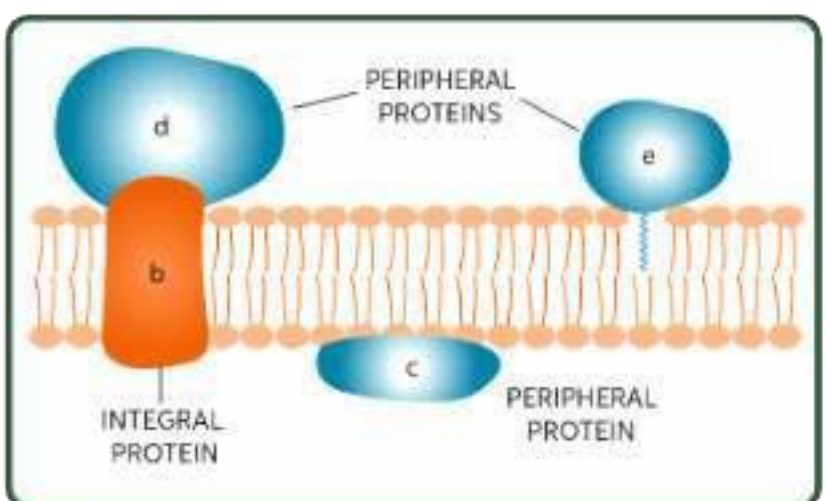
A- Integral proteins

B- Peripheral proteins

- **Peripheral proteins** (on the surface, polar, very water soluble)
- **Integral proteins** (can be released only by disrupting the lipid bilayer and interfering with the hydrophobic interactions between protein and lipids).
- **Peripheral proteins** are usually bound to the membrane by non-covalent, ionic, and hydrogen complementary amine residues in integral proteins that are exposed on the membrane surface.

A- Integral proteins

> Extends through the whole thickness of the membrane.



Function

1- Ion Channels for passage of ions.

2-Carriers for transport of substances as glucose & amino acids.

3- Receptors for actions of substances as hormones.

4-Enzymes

B- peripheral proteins

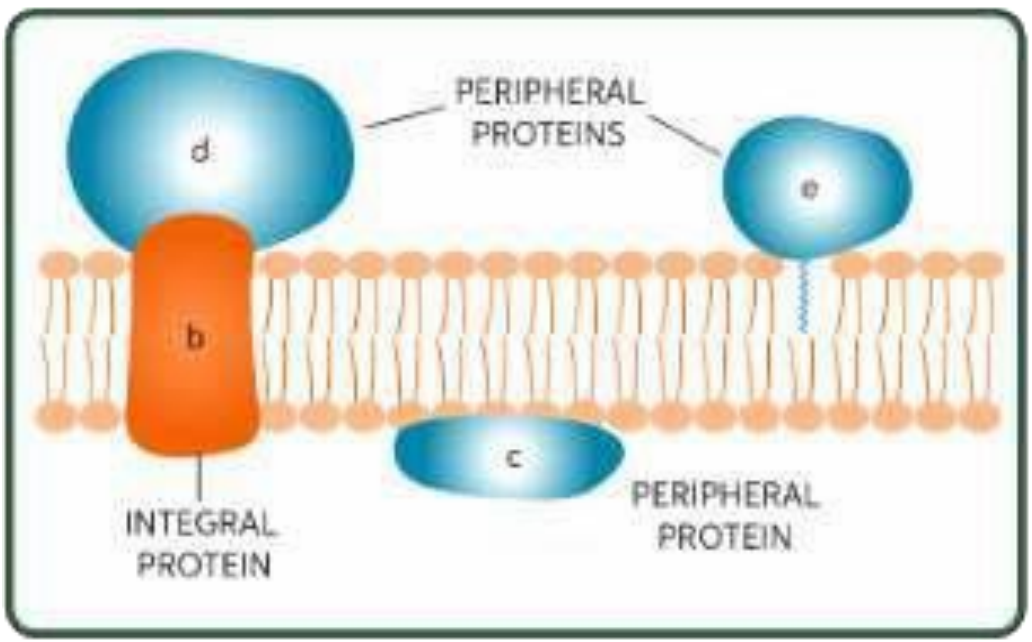
> They are attached to cell membrane either from outside or more commonly fron inside

> Not extend through the whole thickness of the membrane.

> They are often attached to one of the integral proteins.

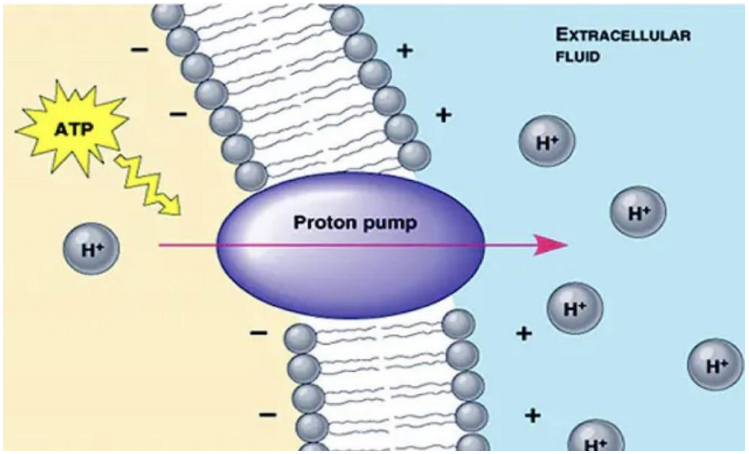
Function

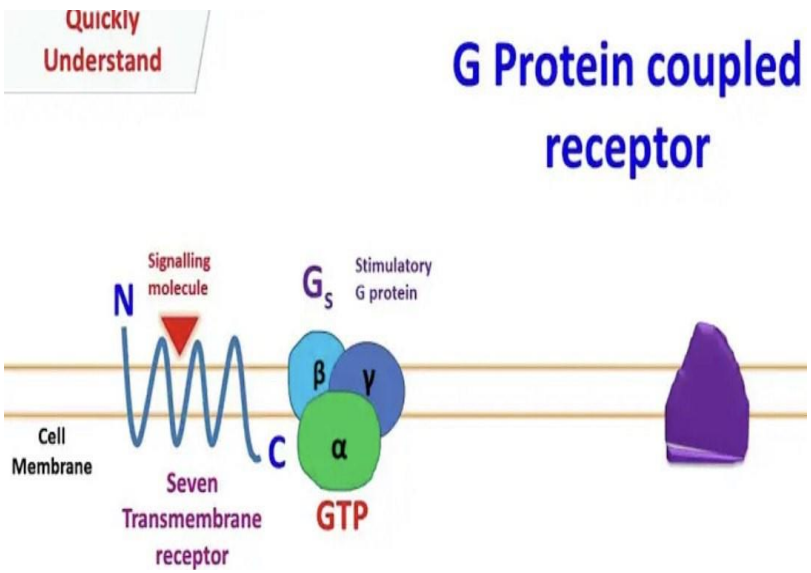
They act mainly as Enzymes



Characteristic of Proteins

1. **Proton pumps** are protein pumps that are embedded in the lipid bilayer that allow protons to travel through the membrane by transferring from one amino acid side chain to another.
2. Processes such as electron transport and generating ATP use **proton pumps**
3. **A G-protein coupled receptor** (integral membrane proteins) is a single polypeptide chain that crosses the lipid bilayer seven times responding to signal molecules (i.e. hormones and neurotransmitters).(also known as 7-Transmembrane receptors).





5. Functions of membrane proteins can also include cell–cell contact, surface recognition, cytoskeleton contact, signaling, enzymatic activity, or transporting substances across the membrane.

6. **Most membrane proteins** must be inserted in some way into the membrane. For this to occur, an N-terminus "signal sequence" of amino acids directs proteins to the endoplasmic reticulum, which inserts the proteins into a lipid bilayer and it serves as a start-transfer signal.

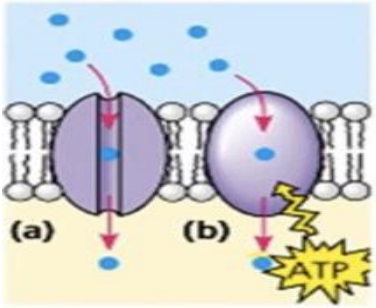
7-The cell membrane, being exposed to the outside environment, is an important site of cell–cell communication. Large variety of protein receptors and identification proteins, such as antigens, are present on the surface of the membrane.

Functions of membrane proteins can also include

1-Cell–cell contact. 2-Surface recognition.

3-Cytoskeleton contact.4-Signaling, enzymatic activity, or transporting substances across the membrane.

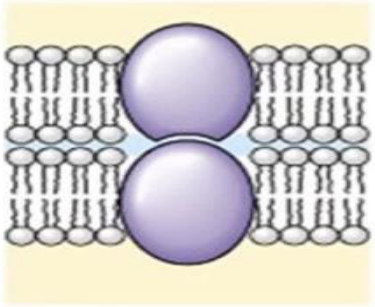
Protein Functions



Transport

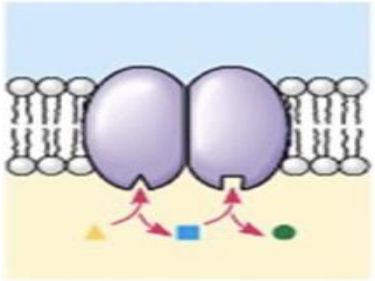
-Passive // Channel Proteins

-Active // Protein Pumps



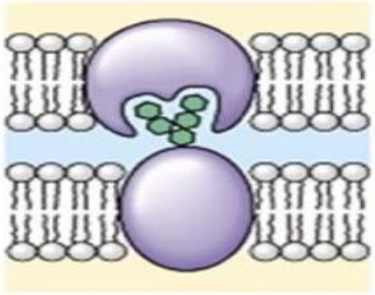
Intercellular joining

Intercellular junctions



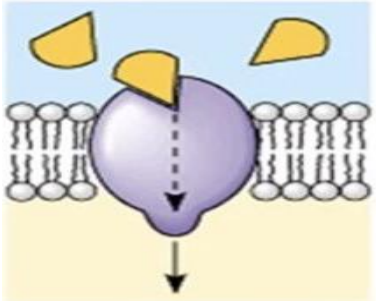
Enzymatic activity

Membrane enzymes produce a variety of substances essential for cell function



Cell-cell recognition (Cell surface identity Marker)

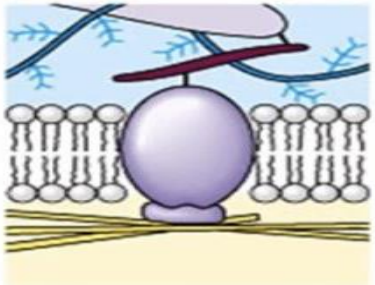
Some glycoproteins serve as identification tags that are specifically recognized by other cells



Signal transduction (Cell surface Receptor)

Extracellular signaling molecule activates a membrane receptor

creating intracellular response



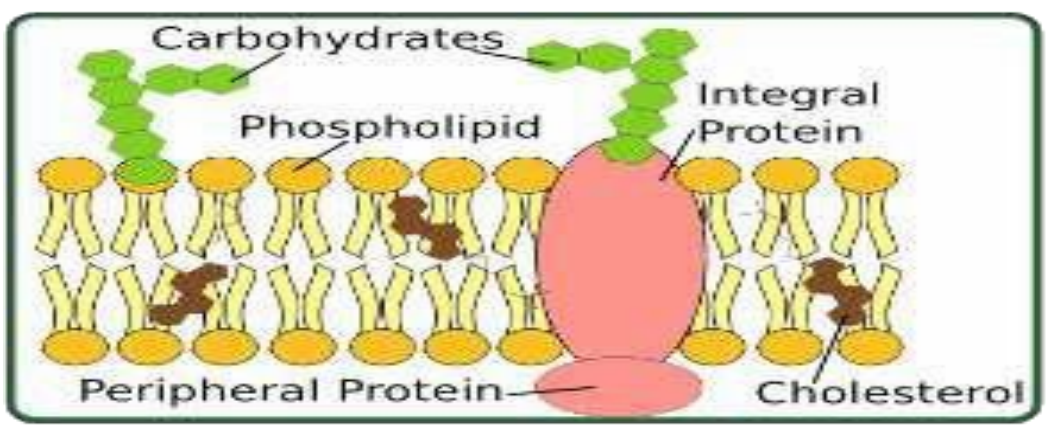
Attachment to the cytoskeleton and extracellular matrix

Microfilaments or other elements bonded to membrane proteins, maintain cell shape and stabilizes the location of certain membrane proteins

3 – Carbohydrates (3 %)

Present on the outer surface of the cell membrane

Cell (Glycocalyx):
They may be combined with proteins(glycoproteins) or lipids (glycolipids).



Functions

1- Many of them are negatively charged thus give most cell overall negative charge.

2- Attach cells to each other.

3- Act as receptor.

4- Some has a role in immune response

Carbohydrates

Plasma membranes also contain carbohydrates, predominantly glycoproteins, but with some glycolipids (cerebrosides and gangliosides).

Carbohydrates are important in the role of cell-cell recognition in eukaryotes; they are located on the surface of the cell where they recognize host cells and share information, viruses that bind to cells using these receptors cause an infection .

Glycolipids appear only in the membrane layer that faces the extracellular fluid.