



CELL MEMBRANE & ITS FUNCTION

Learning objectives

At the end of lecture the students should be able to:

- Identify the structure of Cell membrane
- Recognize the Phospholipid bilayer and its composition
- Differentiate between different types of Cell membrane proteins.
- Recognize the function of cell membrane proteins and carbohydrates.

The Cell membrane

- What are the basic components of a cell?

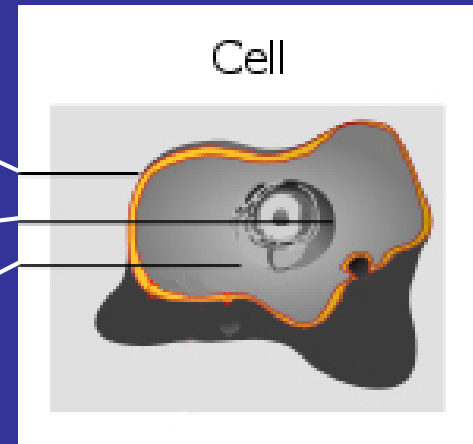
- cell membrane

- nucleus

- cytoplasm

- cytosol

- organelles



The cell membrane

- also called the *plasma membrane*, which envelops the cell, is a thin, pliable, elastic structure.
- only 7.5 to 10 nanometers thick.
- It is composed almost entirely of proteins and lipids.
- Is semipermeable, allowing some substances to pass through it & excluding others due to presence of numerous regulated **ion channels** & other transport proteins.

The **nucleus** is also surrounded by a membrane of this type

The different **organelles** like Mitochondria present with in cytoplasm are also surrounded by a membrane

Chemical structure of membranes & their properties vary considerably from one location to another.

The Cell Membrane

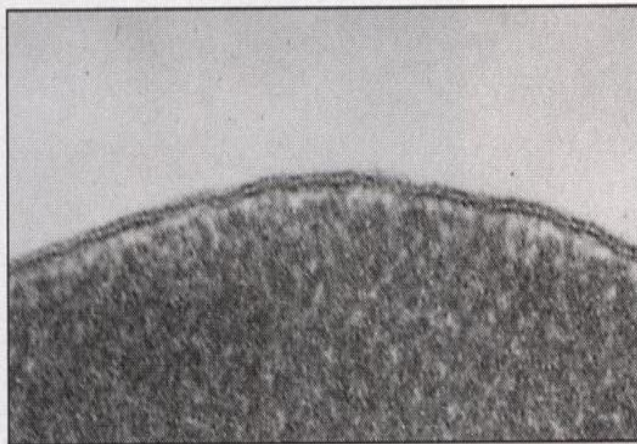
- What does the cell membrane do?
 - Creates separation between ECF vs. ICF
 - Creates fluid compartments
 - Regulates ECF – ICF exchange
 - Allows for communication
 - Provides structural support for cell and tissues

Functions Of Cell Membrane

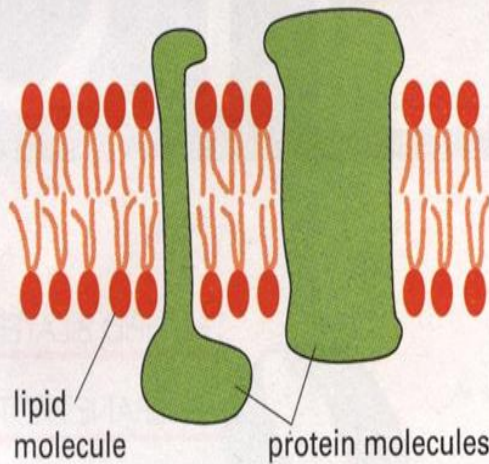
- **Protective function:** Cell membrane protects the cytoplasm and the organelles present in the cytoplasm.
- **Selective permeability:** Cell membrane acts as a semi permeable membrane, which allows only some substances to pass through it and acts as a barrier for other substances.
- **Absorptive function:** Nutrients are absorbed into the cell through the cell membrane.
- **Excretory function:** Metabolites and other waste products from the cell are excreted out through the cell membrane
- **Exchange of gases:** Oxygen enters the cell from the blood and carbon dioxide leaves the cell and enters the blood through the cell membrane
- **Maintenance of shape and size of the cell:** Cell membrane is responsible for the maintenance of shape & size of the cell.

The cell membrane

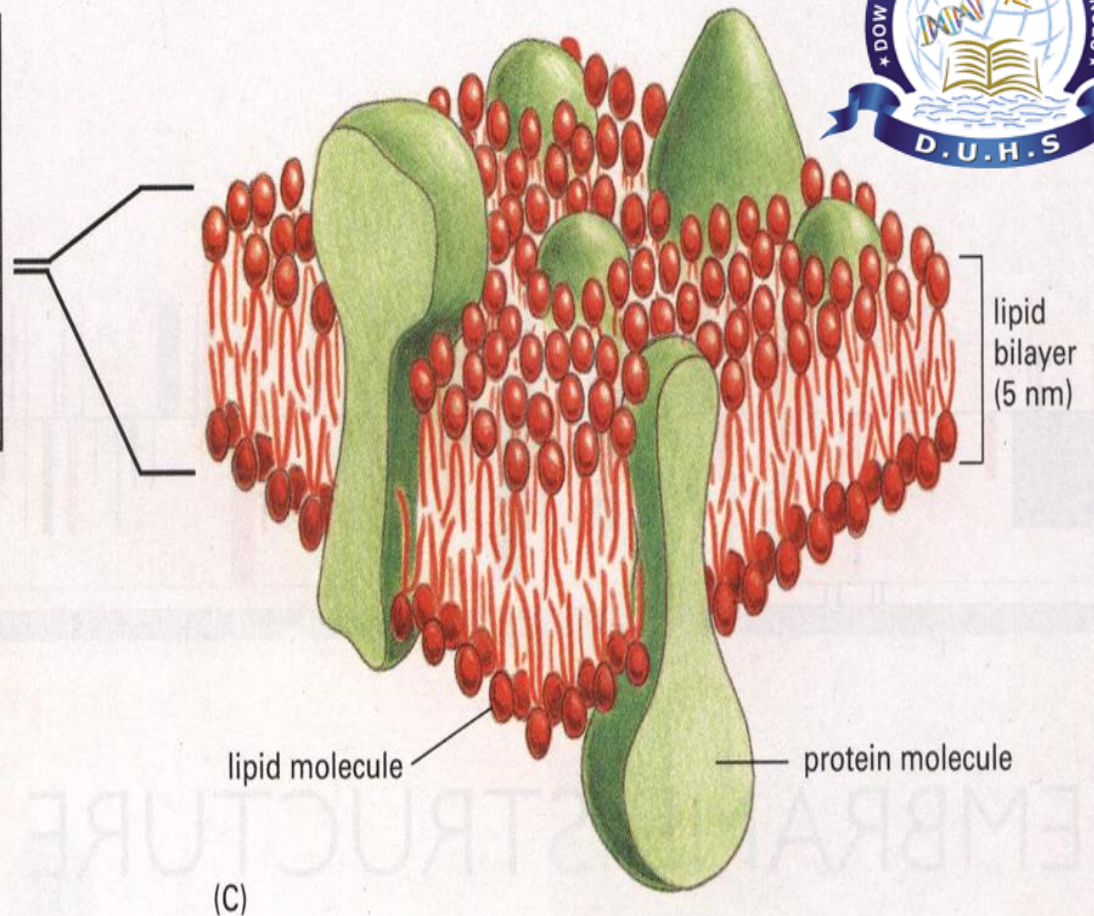
- The approximate composition is:
- Proteins, 55 %
- Phospholipids, 25 %
- Cholesterol, 13 %
- other lipids, 4 % and
- Carbohydrates, 3 %



(A)



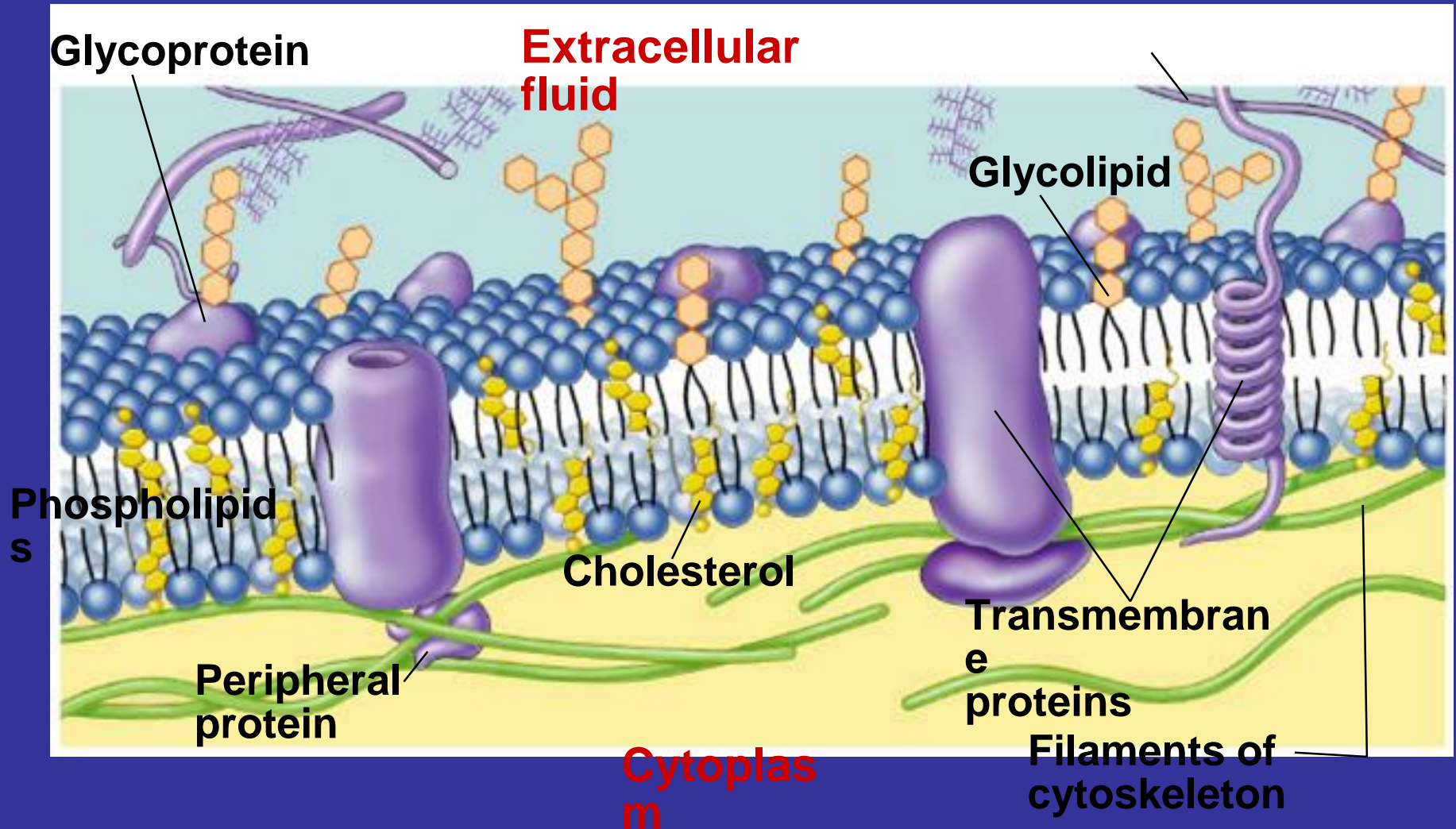
(B)



(C)

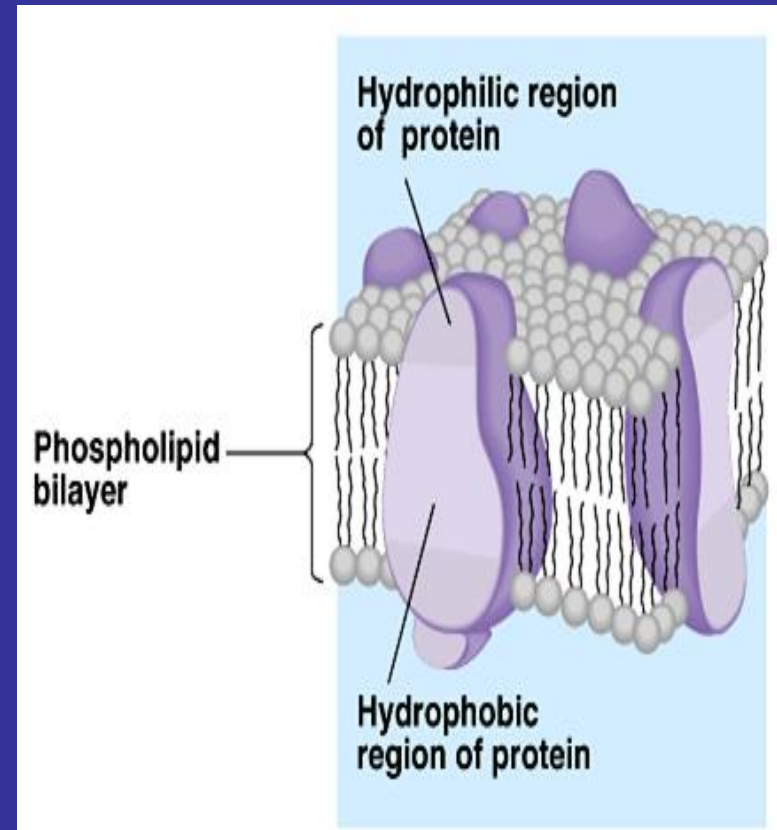
Figure 10-1 Three views of a cell membrane. (A) An electron micrograph of a plasma membrane (of a human red blood cell) seen in cross section. (B and C) These drawings show two-dimensional and three-dimensional views of a cell membrane. (A, courtesy of Daniel S. Friend.)

Membrane is a collage of proteins & other molecules embedded in the fluid matrix of the lipid bilayer



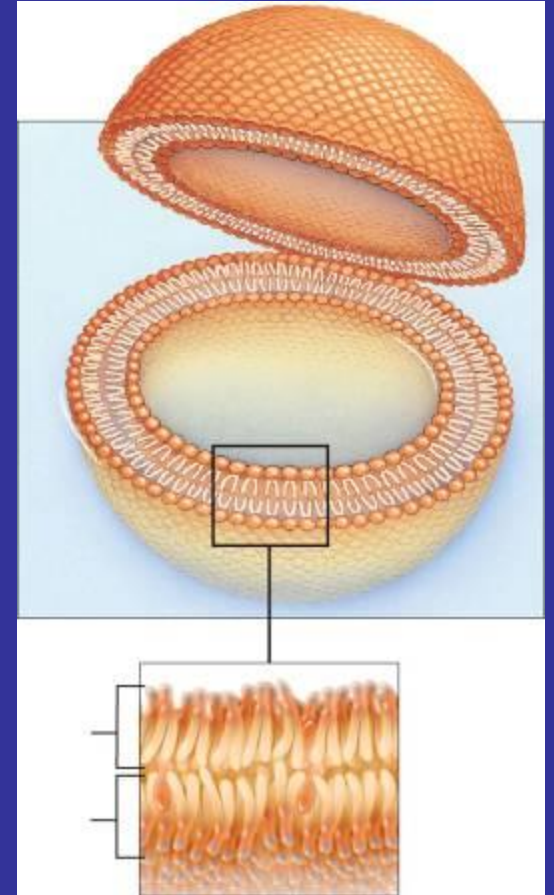
Fluid Mosaic Model

- Membrane is a mosaic of
 - Phospholipids
 - Glycolipids
 - Sterols
 - Proteins
- In 1972, S.J. Singer & GL. Nicolson proposed 'The Fluid Mosaic Model' According to them, the membrane is a fluid with mosaic of proteins. This model is accepted by the scientists till now.
- In this model, the proteins are found to float in the lipid layer instead of forming the layers of the sandwich-type model.



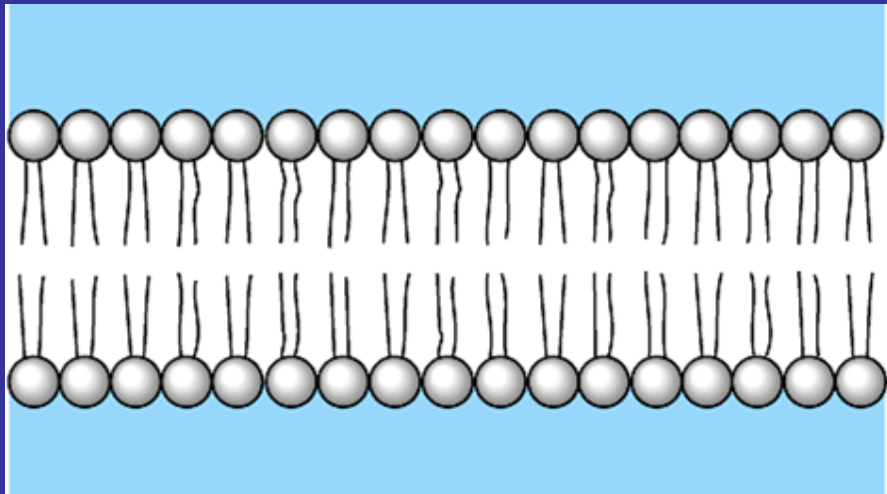
Lipid Bilayer

- Main component of cell membranes
- Gives the membrane its fluid properties
- Two layers of phospholipids

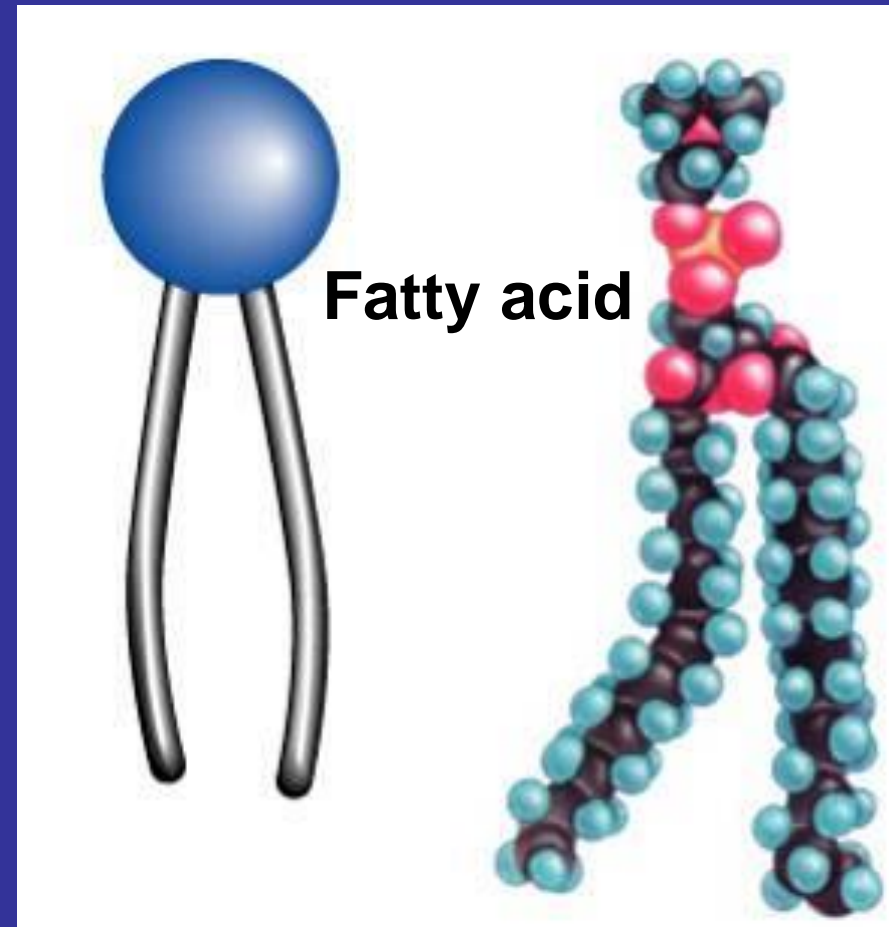


Phospholipids

- Fatty acid tails
 - hydrophobic
- Phosphate group head
 - hydrophilic
- Arranged as a bilayer



Phosphate

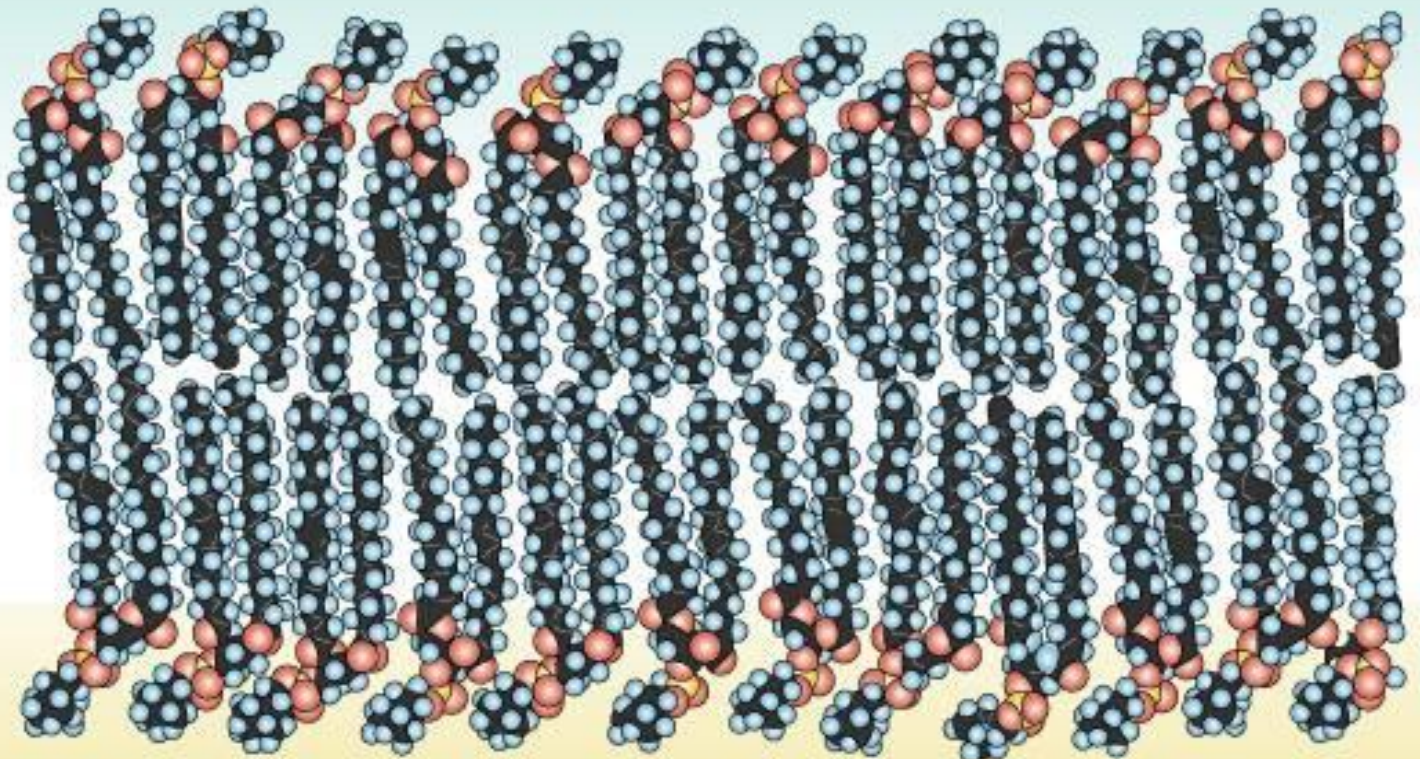


Phospholipid bilayer

polar
hydrophilic
heads

nonpolar
hydrophobic
tails

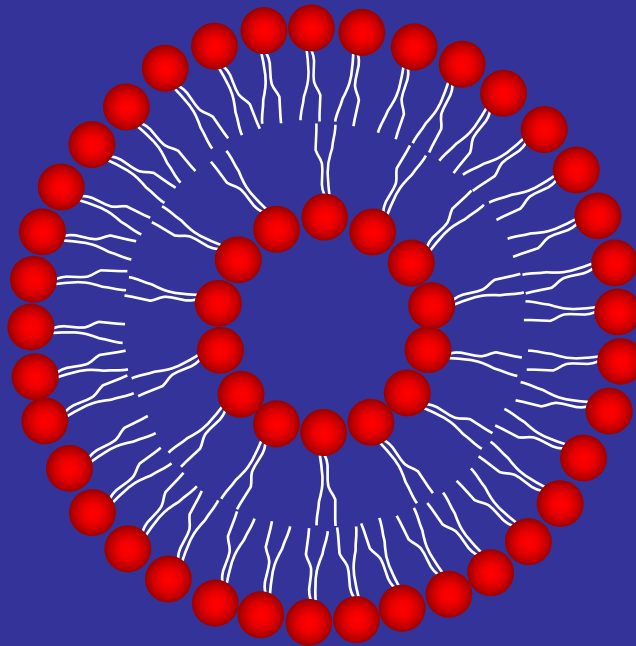
polar
hydrophilic
heads



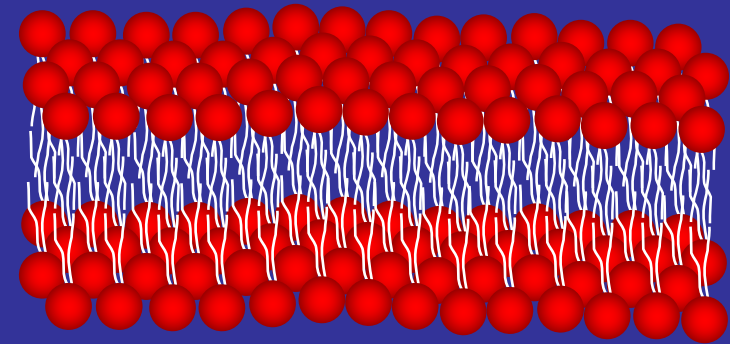
The Cell Membrane

- The physical barrier
 - Formed by the tail to tail arrangement of the phospholipid molecules
- Self assembles into

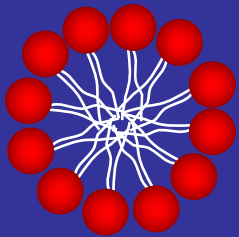
liposomes



bi-layer membranes

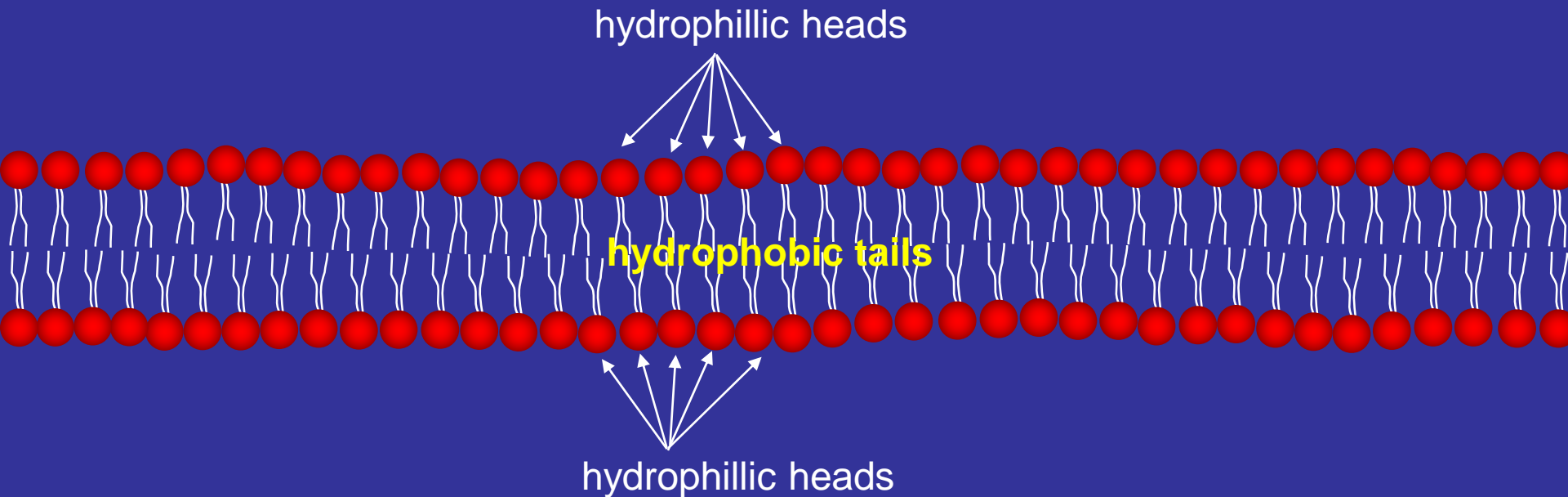


miceles





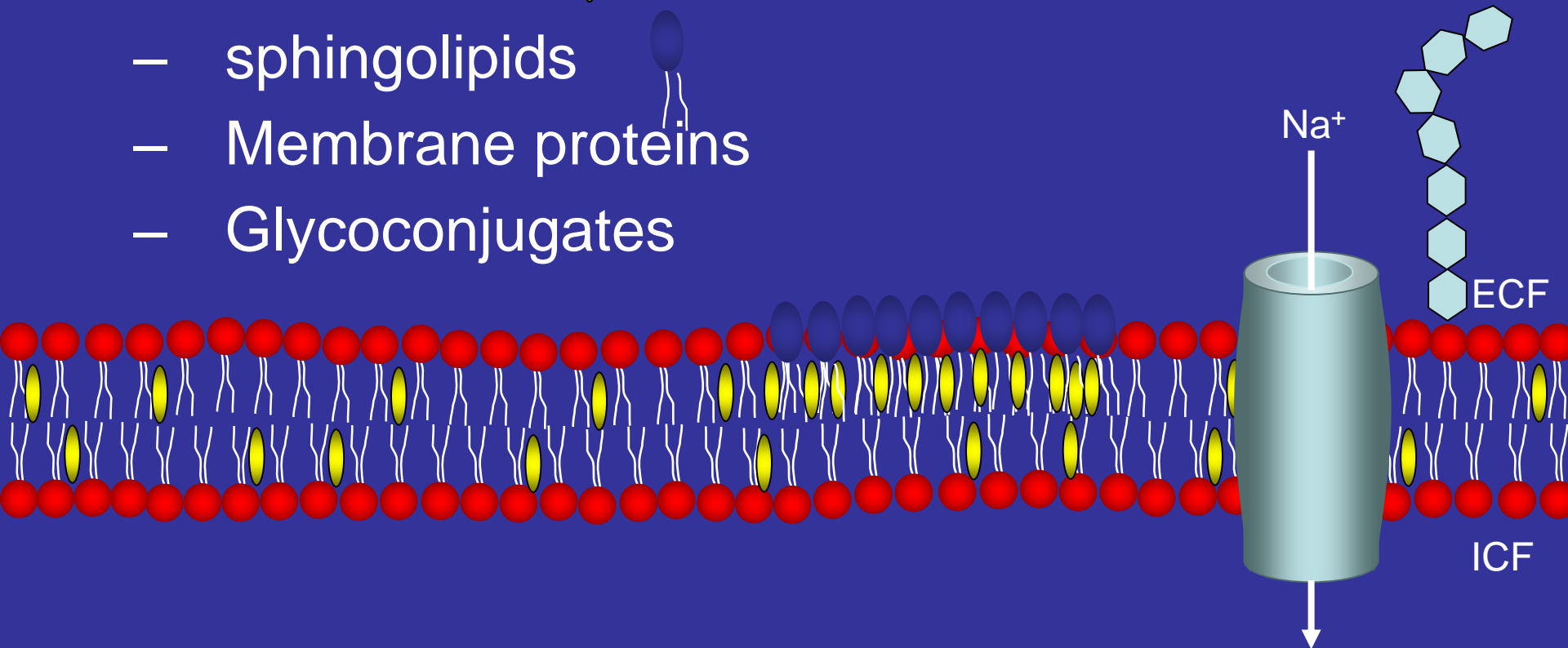
The Cell Membrane

- How does a barrier become a regulator?
 1. By being having a polar surface
 2. By specialized membrane components



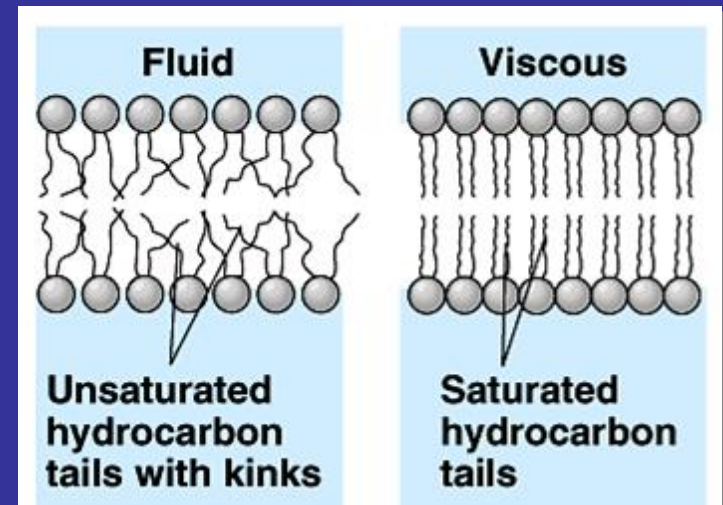
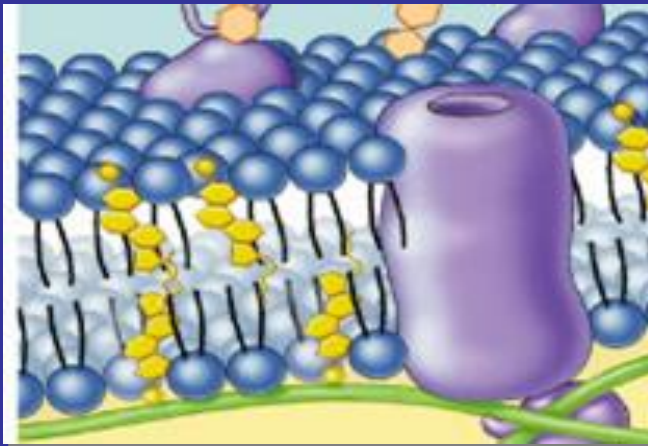
The Cell Membrane

- Other phospholipid bilayer membrane components
 - cholesterol 
 - sphingolipids 
 - Membrane proteins
 - Glycoconjugates



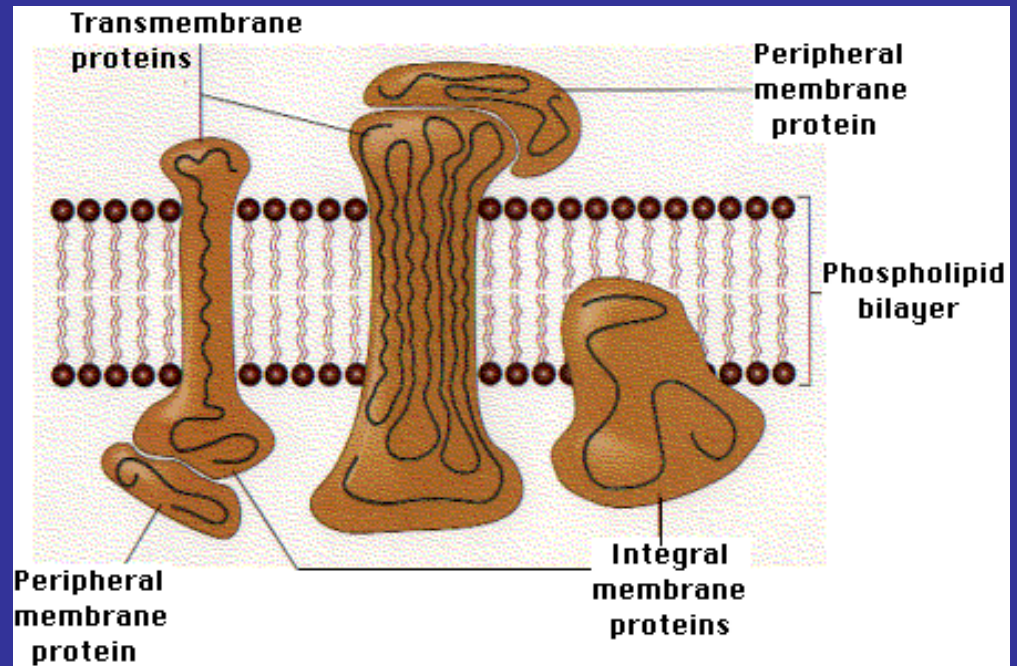
Membrane fat composition varies

- Fat composition affects flexibility
 - membrane must be fluid & flexible
 - about as fluid as thick salad oil
- % unsaturated fatty acids in phospholipids
 - keep membrane less viscous



Membrane Proteins

- They are present in the form of irregularly rounded masses.
- Most of them are “Peripheral proteins.”
- Some of them are “Integral or Transmembrane proteins.”



Membrane Proteins

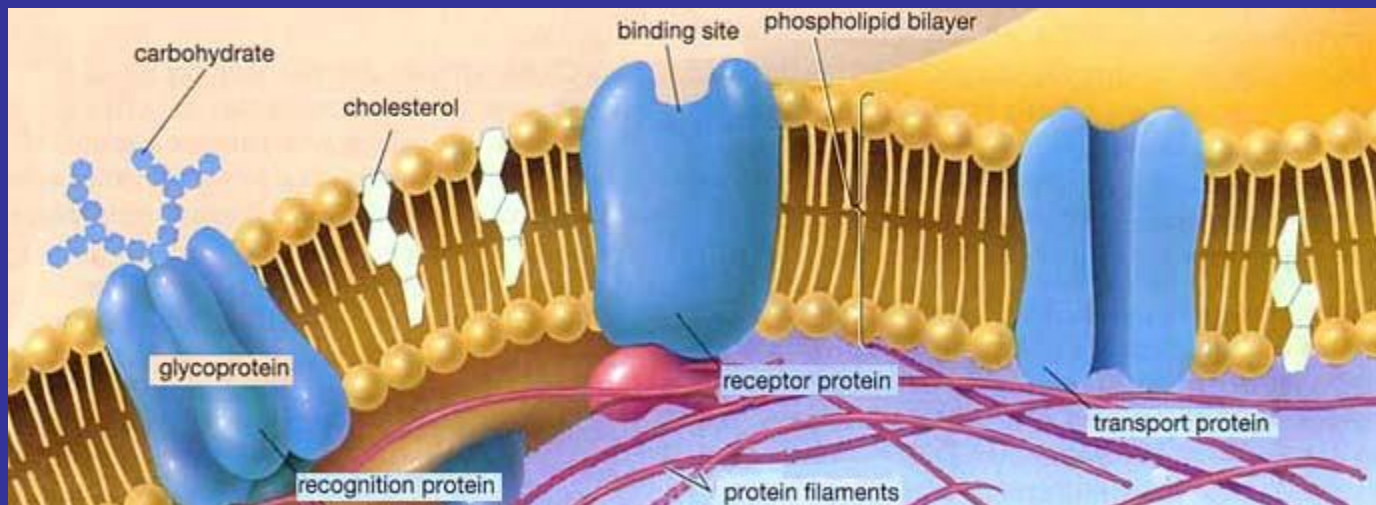
Membrane proteins:

- Peripheral proteins

- loosely bound to surface of membrane
- cell surface identity marker (antigens)

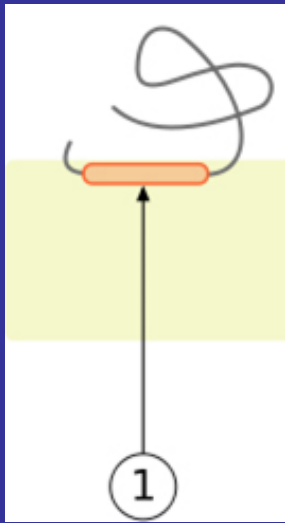
- Integral proteins

- penetrate lipid bilayer, usually across whole membrane
- transmembrane protein
- transport proteins
 - channels, permeases (pumps)

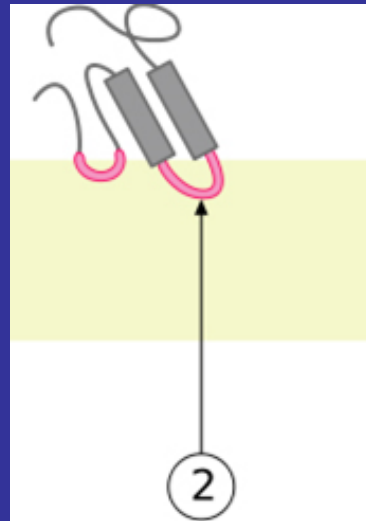


The Cell Membrane

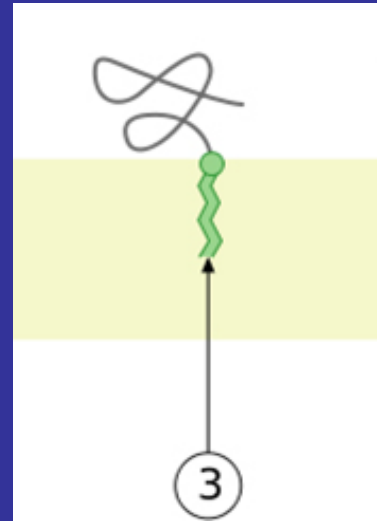
- Peripheral Proteins –
 - attachments to the phospholipid bi-layer



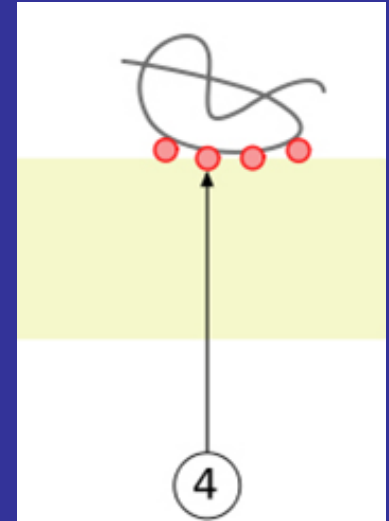
interaction with
alpha helix in
transmembrane
protein (not shown)



interaction by
a hydrophobic
loop



a covalently
bound
membrane
lipid (*forms
many
sphingolipids*)



electrostatic or
ionic
interactions
with membrane
lipids

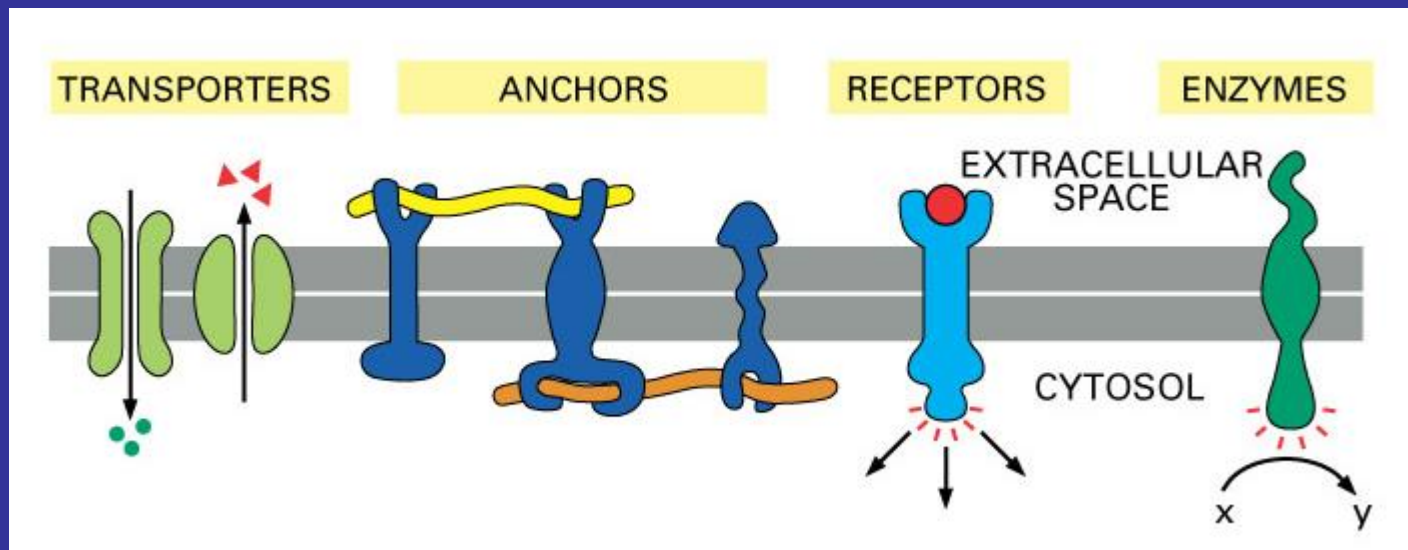
Functions Of Proteins

- **Integral proteins** provide the structural integrity of the cell membrane.
- Channel proteins help in the diffusion of water soluble substances like glucose and electrolytes.
- Carrier or transport proteins help in the transport of substances across the cell membrane by means of active or passive transport.
- **Pump:** Some carrier proteins act as pumps, by which ions are transported actively across the cell membrane
- Receptor proteins serve as the receptor sites for hormones and neurotransmitters.
- **Enzymes:** Some of the protein molecules form the enzymes and control chemical (metabolic) reactions within the cell membrane
- **Antigens:** Some proteins act as antigens and induce the process of antibody formation
- Cell adhesion molecules or the integral proteins are responsible for attachment of cells to their neighbors or to basal lamina.

Functions of protein

- **Significance of proteins:-**

1. Some proteins play vital role in transport across the membrane, and act as pump. Ions get attached to the protein on one surface and move with protein to the other surface.
2. Some proteins form passive channels through which substances can diffuse through the membrane.
3. Some proteins act as receptors for specific neurotransmitters or hormones.
4. Some proteins act as enzymes.



The Cell Membrane

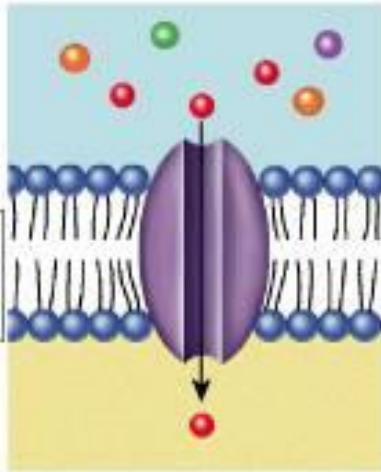
- **Peripheral Protein Functions**
 - Enzyme function
 - Mediate chemical reactions
 - Structural
 - Mediate attachment
 - Transporters
 - Between/among cell membrane proteins
 - Electron carriers
 - In electron transport chain
 - Regulators
 - Such as apoptosis

Many Functions of Membrane Proteins

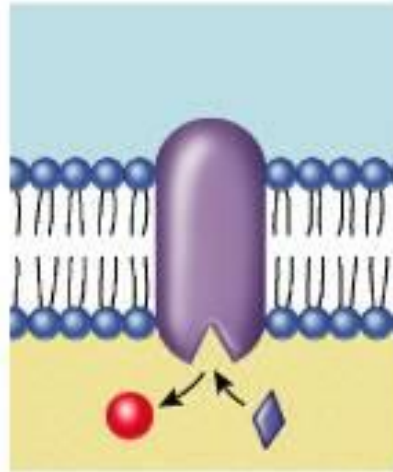
Outside

Plasma
membran
e

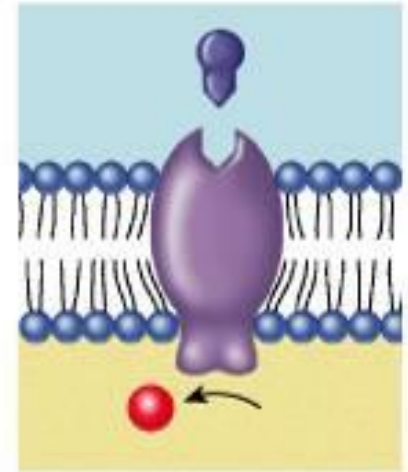
Inside



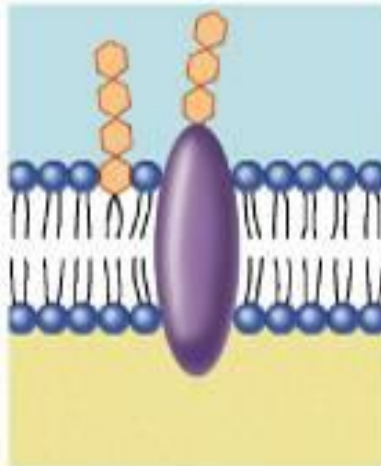
Transporter



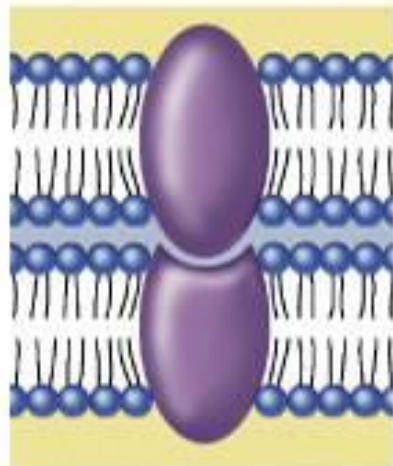
**Enzyme
activity**



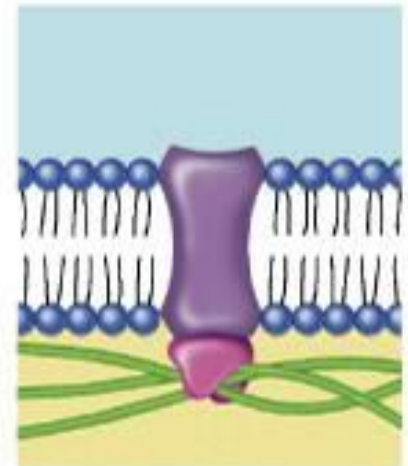
**Cell surface
receptor**



**Cell surface
identity marker**

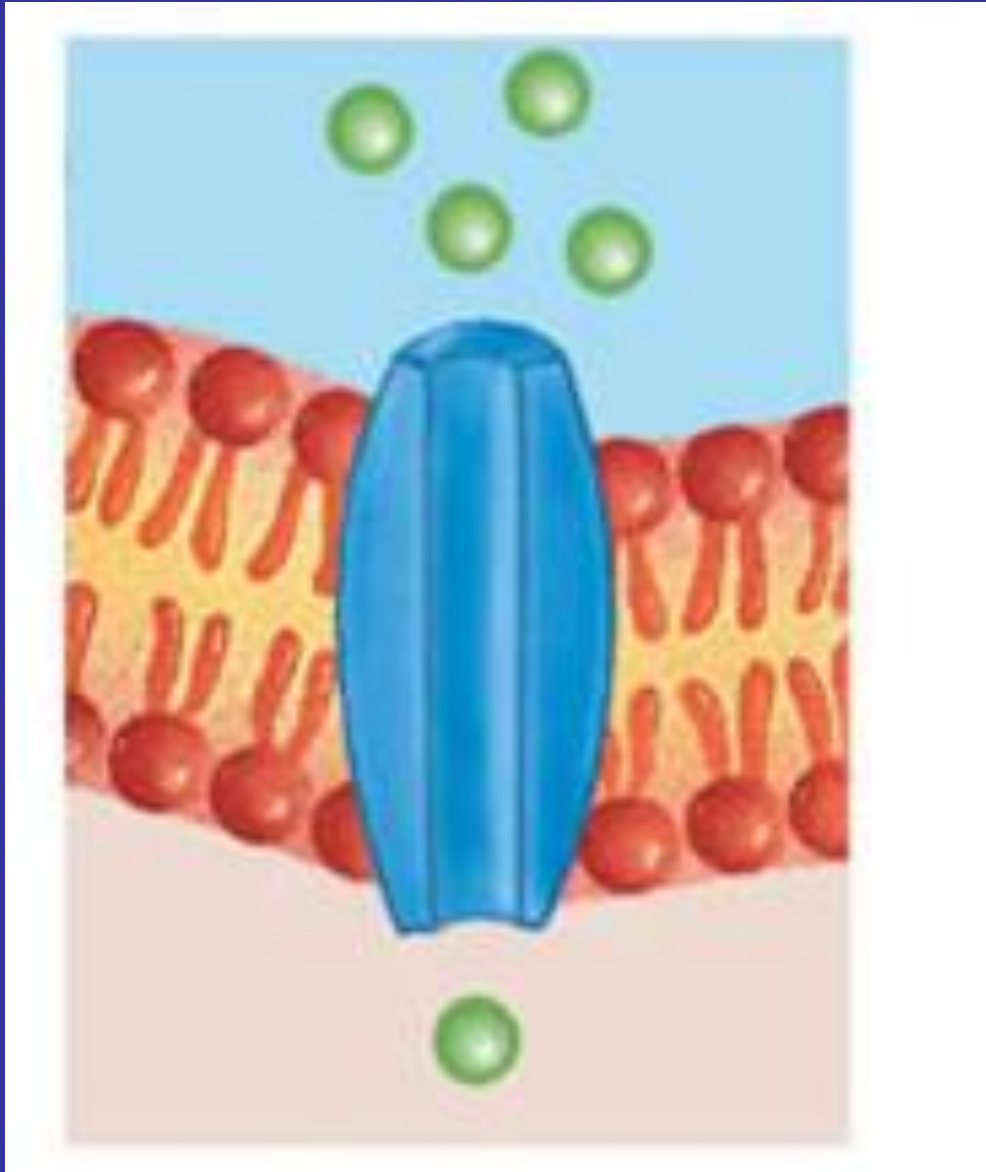


Cell adhesion

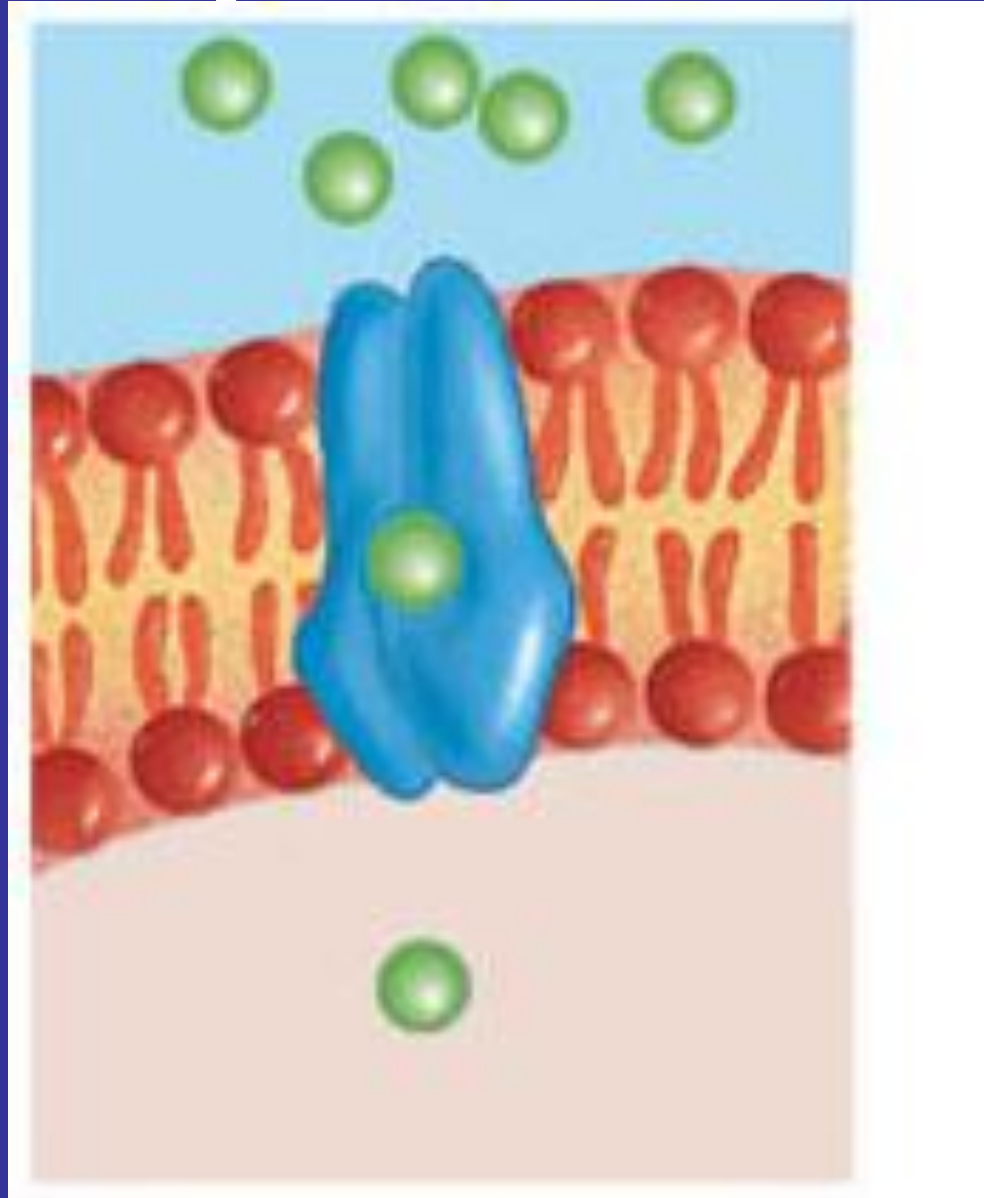


**Attachment to the
cytoskeleton**

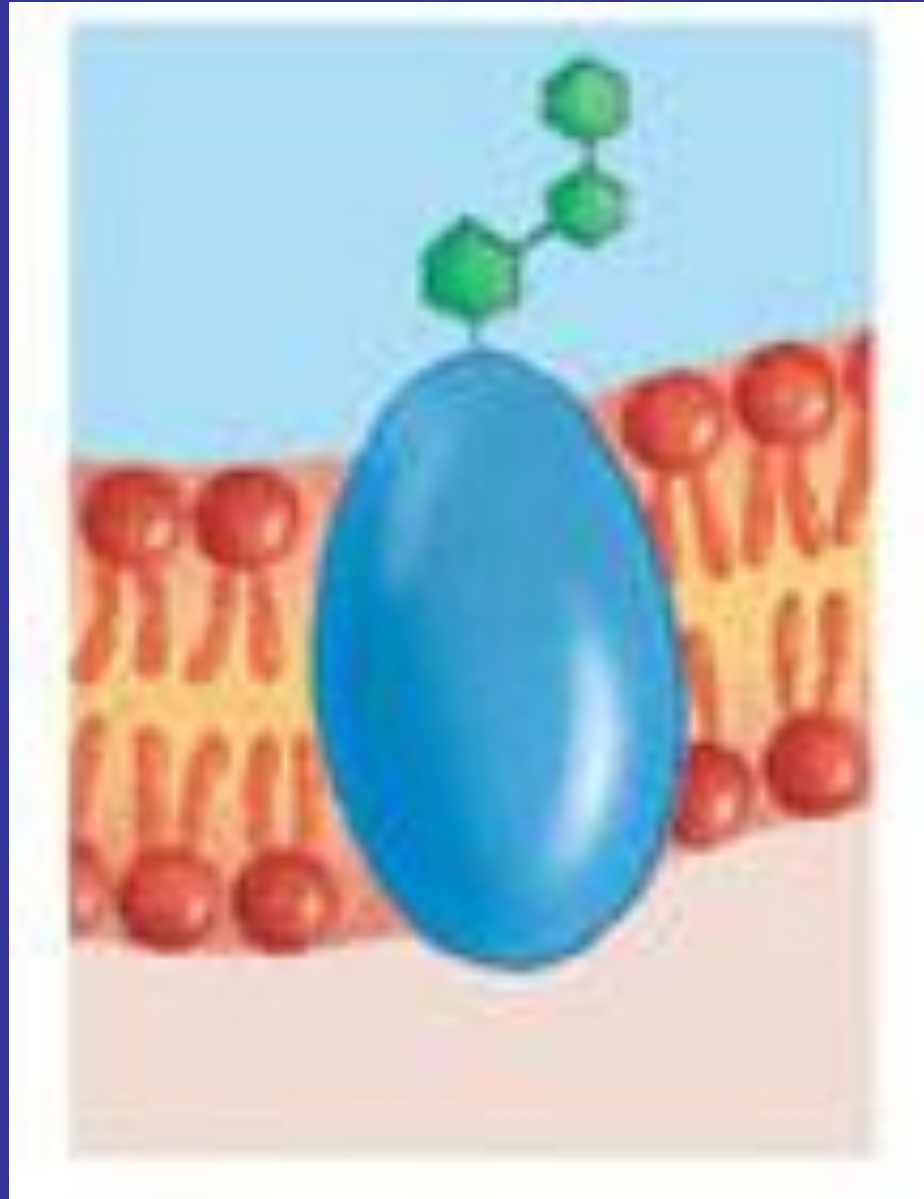
Channel protein



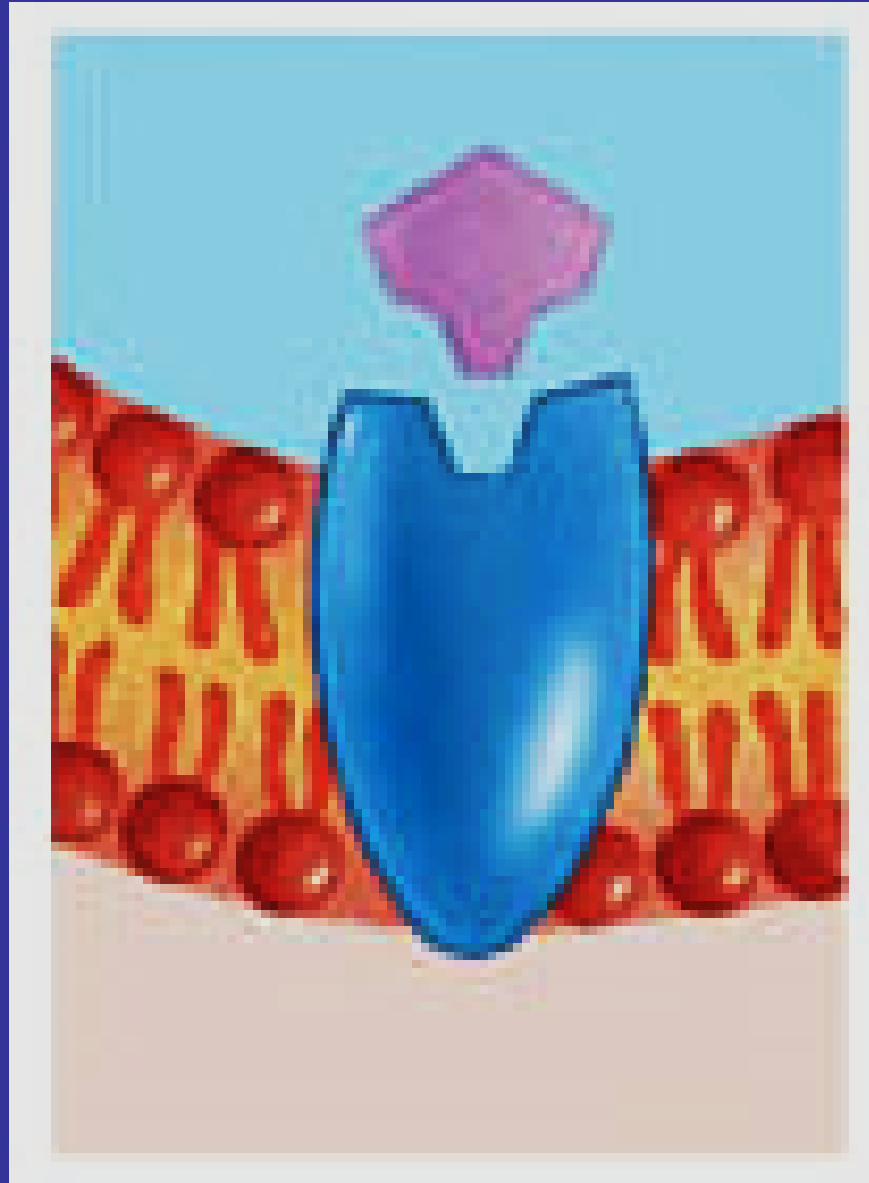
Carrier protein



Cell recognition protein

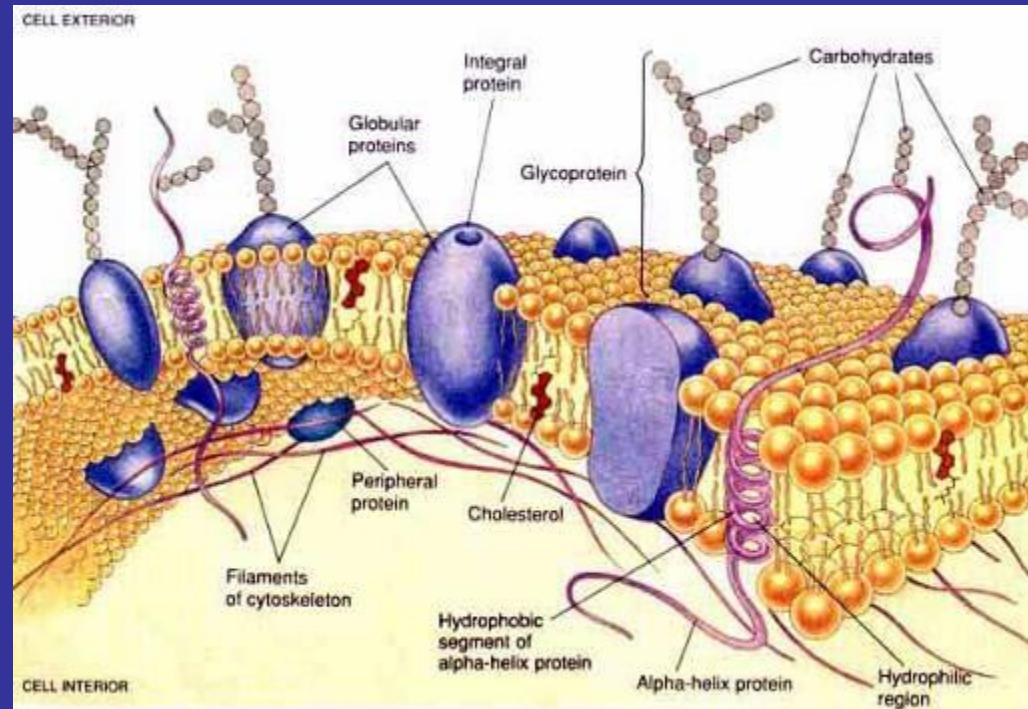


Receptor protein



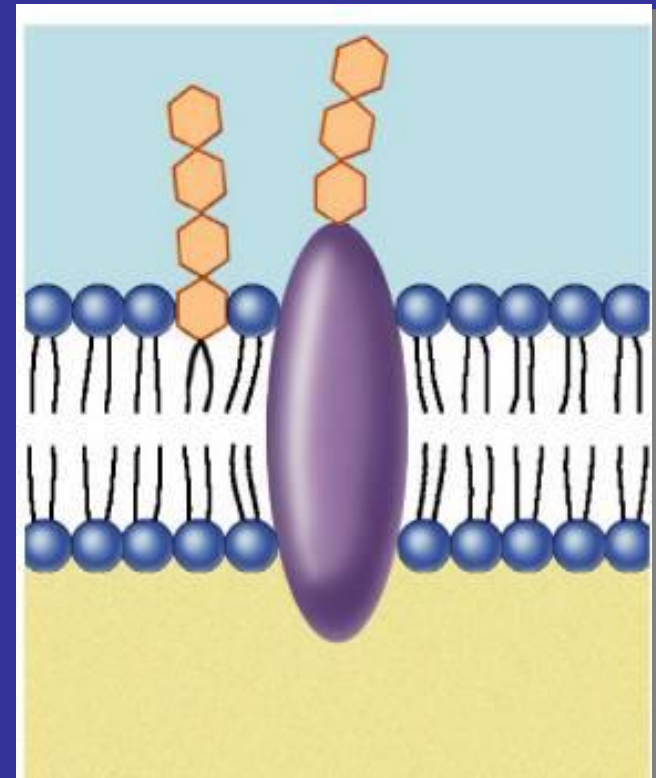
Carbohydrates

- They are present at the surface of cell membrane.
- They are attached either to the proteins (forming glycoproteins), or to the lipids (forming glycolipids).
- Carbohydrate molecules form a thin and loose covering over the entire surface of the cell membrane called glycocalyx. Its thickness vary from 2 to 20 nm.



Function of membrane carbohydrates

- Play a key role in cell-cell recognition
 - ability of a cell to distinguish one cell from another
 - antigens
 - important in organ & tissue development
 - basis for rejection of foreign cells by immune system



The Cell Membrane

- Functions of **glycocalyx**:
 - Protection
 - Cushions the plasma membrane and protects it from chemical injury
 - Immunity to infection
 - Enables the immune system to recognize and selectively attack foreign organisms
 - Defense against cancer
 - Changes in the **glycocalyx** of cancerous cells enable the immune system to recognize and destroy them
 - Transplant compatibility
 - Forms the basis for compatibility of blood transfusions, tissue grafts, and organ transplants

The Cell Membrane

- Cell adhesion
 - Binds cells together so that tissues do not fall apart
- Inflammation regulation
 - Glycocalyx coating on endothelial walls in blood vessels prevents leukocytes from rolling/binding in healthy states .
- Fertilization
 - Enables sperm to recognize and bind to eggs
- Embryonic development
 - Guides embryonic cells to their destinations in the body .

IMPORTANT RELATED Qs

- Composition of cell membrane
- What do u mean by Lipid bilayer
- What do u mean by Fluid mosaic model
- Significance of different layers of the cell membrane
- What are integral & peripheral proteins.

- Watch "Cell Membrane Structure & Functions || Membrane Lipids, Membrane Proteins and Carbohydrates" on YouTube
- <https://youtu.be/SsFqmYATM3k?si=wiGDW7WPBsM1rxX6>
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