CELL AND MOLECULAR BIOLOGY
UNIT II
PLASMA MEMBRANE –
STRUCTURE, CHEMICAL COMPOSITION AND MODELS

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CYTOPLASM

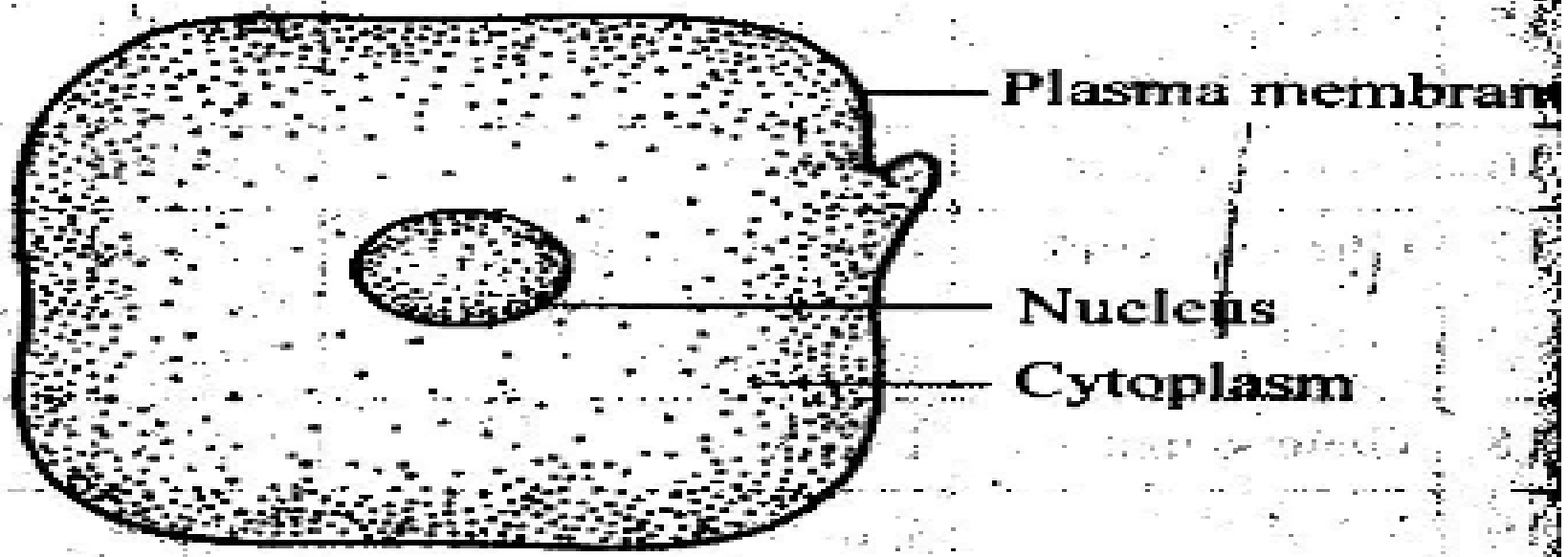
- Cytoplasm, the semifluid substance of a cell that is external to the nuclear membrane and internal to the cellular membrane, sometimes described as the nonnuclear content of protoplasm.
- In eukaryotes (i.e., cells having a nucleus), the cytoplasm contains all of the organelles.
- Among such organelles are the mitochondria, which are the sites of energy production through ATP (adenosine triphosphate) synthesis;
- the endoplasmic reticulum, the site of lipid and protein synthesis;
- the Golgi apparatus, the site where proteins are modified, packaged, and sorted in preparation for transport to their cellular destinations;
- lysosomes and peroxisomes, sacs of digestive enzymes that carry out the intracellular digestion of macromolecules such as lipids and proteins;
- the cytoskeleton, a network of protein fibres that give shape and support to the cell; a
- and cytosol, the fluid mass that surrounds the various organelles.

PLASMA MEMBRANE

- 1. STRUCTURE
- 2. MODELS
- 3. CHEMICAL COMPOSITION

The plasma membrane may be defined as ***the thin elastic semipermeable living membrane that serves as boundary for the cytoplasm.*** The term "plasma membrane" was coined by *Nageli* in 1855. Plasma membrane is otherwise called ***cell membrane*** or ***plasmalemma.***

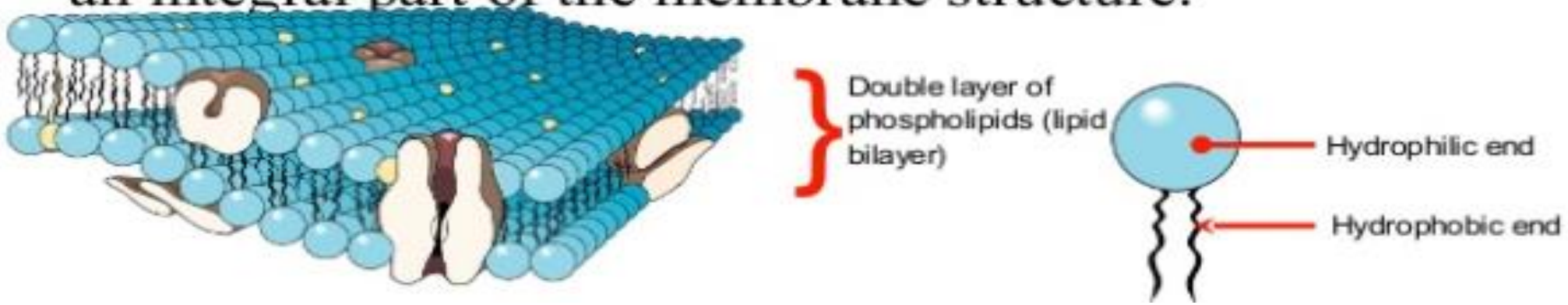
Plasma membrane is the outer limiting membrane in all animal cells. But in plant cells and bacterial cells, it is present inner to the cell wall.



Plasma membrane.

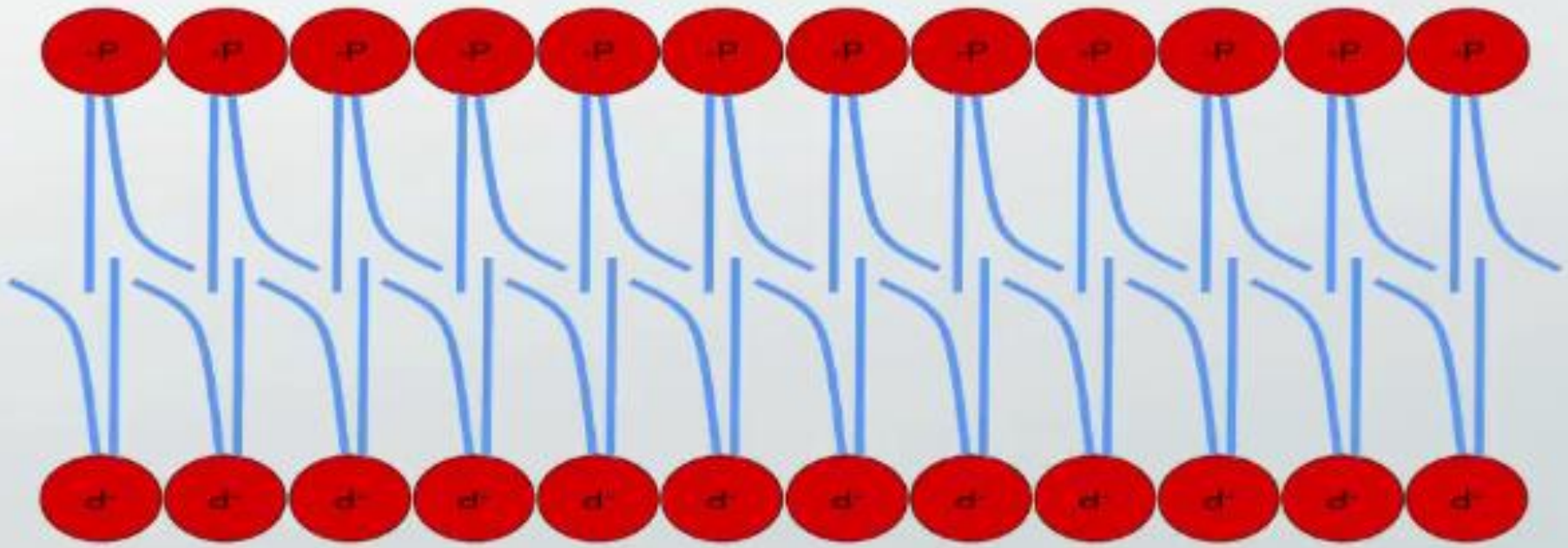
Membrane Structure

- The currently accepted model for the structure of the **plasma membrane** (and cellular membranes generally) is the **fluid mosaic model**.
  - In this model there is a double layer of **phospholipids** (fats), which are arranged with their **hydrophobic tails** facing inwards.(repel water)
  - The **hydrophilic head** (phosphate) is attracted to water-both inside and outside cell-cell is in a watery environment
  - The double layer of lipids is quite **fluid**, with **proteins** floating within it.
  - Glycoproteins, glycolipids, and cholesterol are also an integral part of the membrane structure.

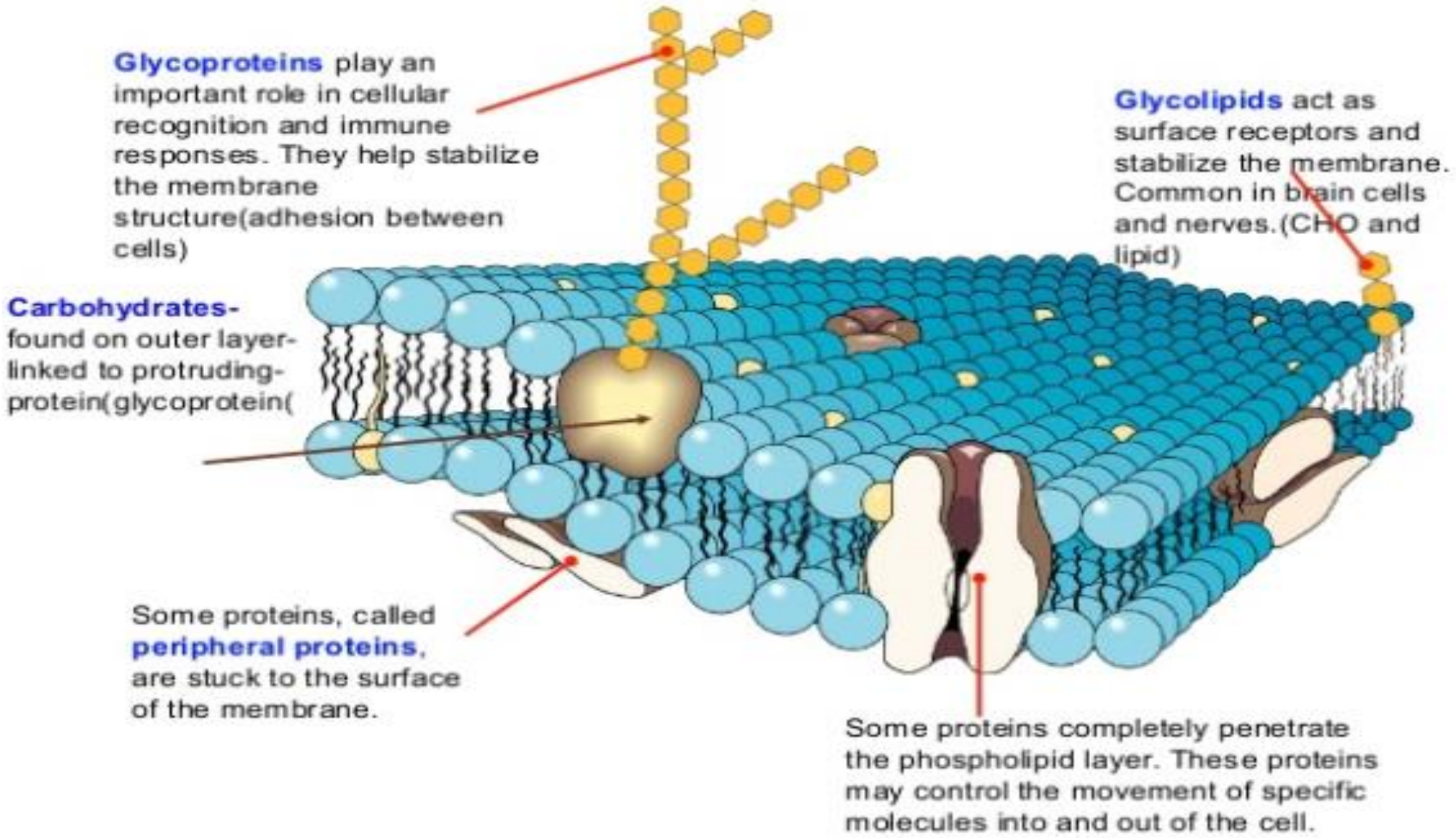


Phospholipid Bilayer

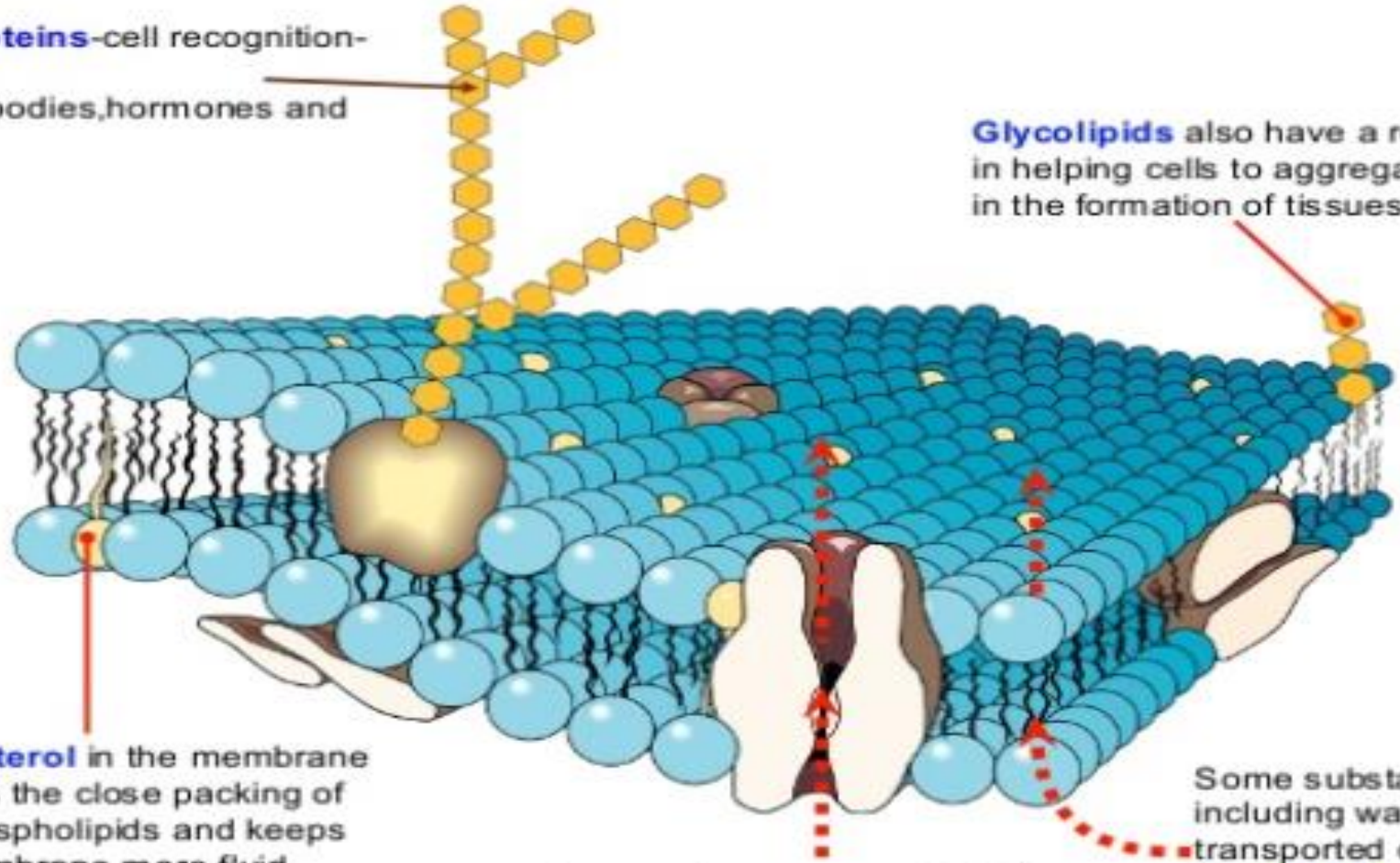
two layers of phospholipids back to back



Membrane Structure



Membrane Structure



Glycoproteins-cell recognition-between cells,antibodies,hormones and viruses

Glycolipids also have a role in helping cells to aggregate in the formation of tissues.

Cholesterol in the membrane disturbs the close packing of the phospholipids and keeps the membrane more fluid. Provides rigidity and water resistance. Membranes would break down without it. Plants have phytosterol.

Some substances, particularly ions and carbohydrates, are transported across the membrane via the proteins.

Some substances, including water, are transported directly through the **phospholipid bilayer**. **But mostly impermeable to water soluble(polar) molecules-most movement via proteins.**

Plasma membrane is about 75A° in thick. It thickness is almost constant in all plant cells, animal cells and bacteria cells (A°; One Angstrom unit = 10^{-8} cm (1/100000000cm) But the blood cells show variations. Even in the same cell it thickness varies at different points.

Plasma membrane is formed of proteins and lipids. These molecules are arranged in a definite pattern. The following models are proposed to explain the structure of plasma membrane:

1. *Trilaminar model*
2. *Bimolecular leaflet model*
3. *Lattice model*
4. *Fluid mosaic model and*
5. *Micellar model*

1. Trilaminar model

This model was proposed by ***Robertson.*** According to this model, the plasma membrane is formed of three layers. The three layers are an ***outer protein layer,*** a ***middle lipid layer*** and an ***inner protein layer.*** The middle layer is 35A° thick and the inner and outer layers are 20 A° each. Such a trilaminar membrane is called a ***unit membrane.***

According to ***Robertson,*** all biological membranes are unit membranes and this concept is called ***unit membrane hypothesis.***

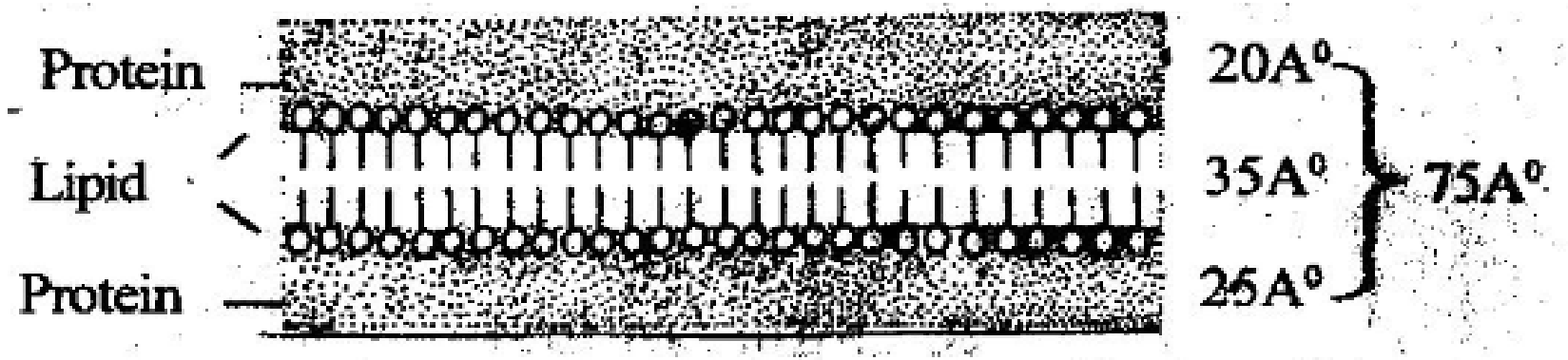


Fig. 5.2: Unit membrane model.

Unit Membrane Concept.

All biological membranes have a ***trilaminar*** structure. Because of the ***unity in structure*** of all membranes of bacteria, plants and animals, it is called an ***unit membrane.*** This concept is called ***unit membrane concept.***

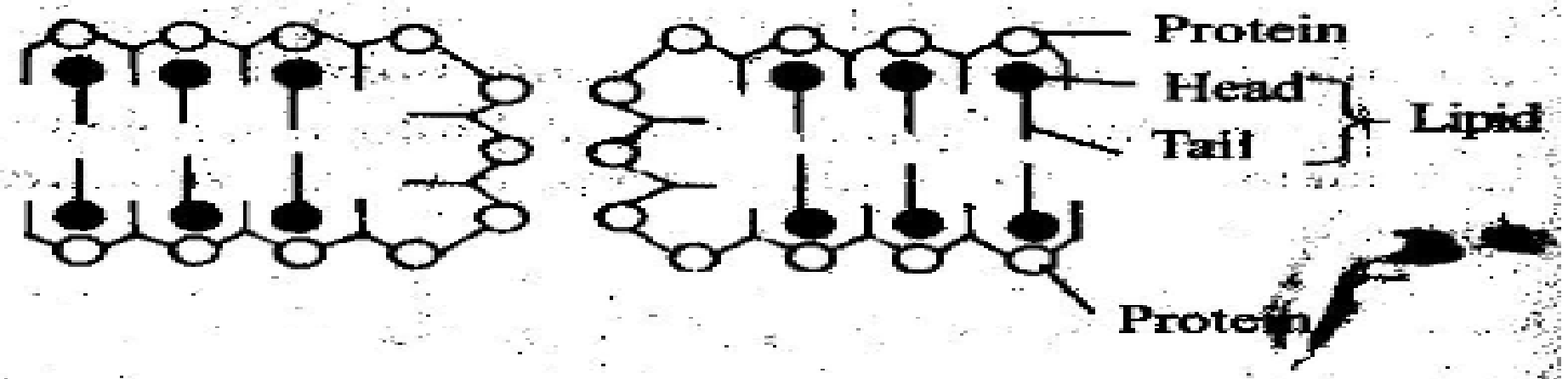
The unit membrane concept was proposed by ***Robertson*** in 1959. According to this concept, the plasma membrane is formed of three layers, namely an outer ***protein layer,*** a middle ***lipid layer*** and an inner ***protein layer.*** This trilaminar membrane is called unit membrane.

Robertson believed that all biological membranes are unit membranes. The plasma membranes of prokaryotes and

eukaryotes are unit membranes. Again the membranes of endoplasmic reticulum, Golgi bodies, mitochondria, lysosomes, plastids and nucleus are unit membranes.

2. Bimolecular leaflet model

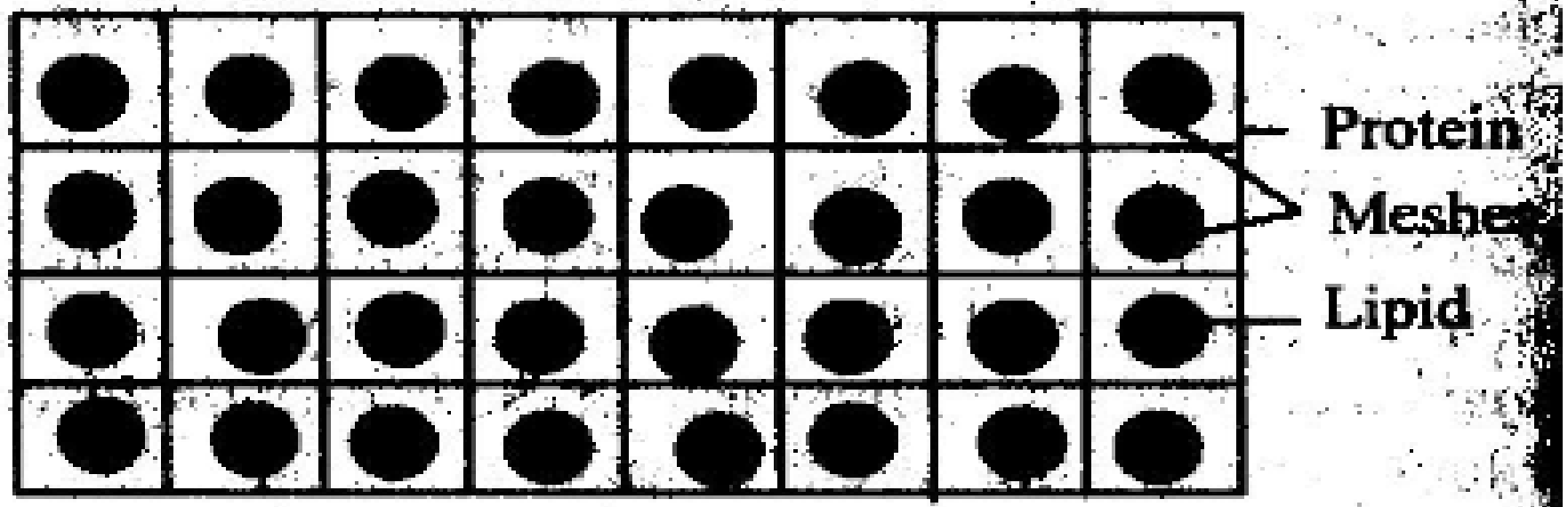
This model was proposed by ***Danielli and Davson*** in 1934. According to this model, the plasma membrane is formed of two layers of lipid molecules coated with protein. Each lipid molecule has a ***hydrophobic tail*** and a ***hydrophilic head***. The hydrophilic heads face outwards and the hydrophobic tails of the two layers face each other.



: *Bi-molecular model.*

3. *Lattice model*

This model was proposed by ***Wolpers*** in 194
According to this model, in the plasma membrane lipids a
proteins are arranged as a ***lattice*** or ***network.*** Proteins fo
a kind of mechanical frame work. The lipid component
distributed in the meshes of the protein frame.



Lattice model.

4. Fluid mosaic model

This model was proposed by *Singer* and *Nicolson* in 1972. According to this model the plasma membrane consists of two layers of ***Lipids*** and the ***protein*** molecules are embedded among the lipid molecules.

The two layers of lipids are an ***outer lipid layer*** and an ***inner lipid layer.*** Each lipid molecule has a ***hydrophobic tail*** and a ***hydrophilic head.*** The hydrophilic heads face outwards and the hydrophobic tails of the two layers face each other.

The protein molecules are globular and are of two types, namely ***peripheral*** or ***extrinsic proteins*** and ***integral*** or ***intrinsic proteins.*** The peripheral proteins are arranged on the surface and are loosely bound to the lipid. The integral proteins are deeply embedded and are tightly bound to the lipid molecules.

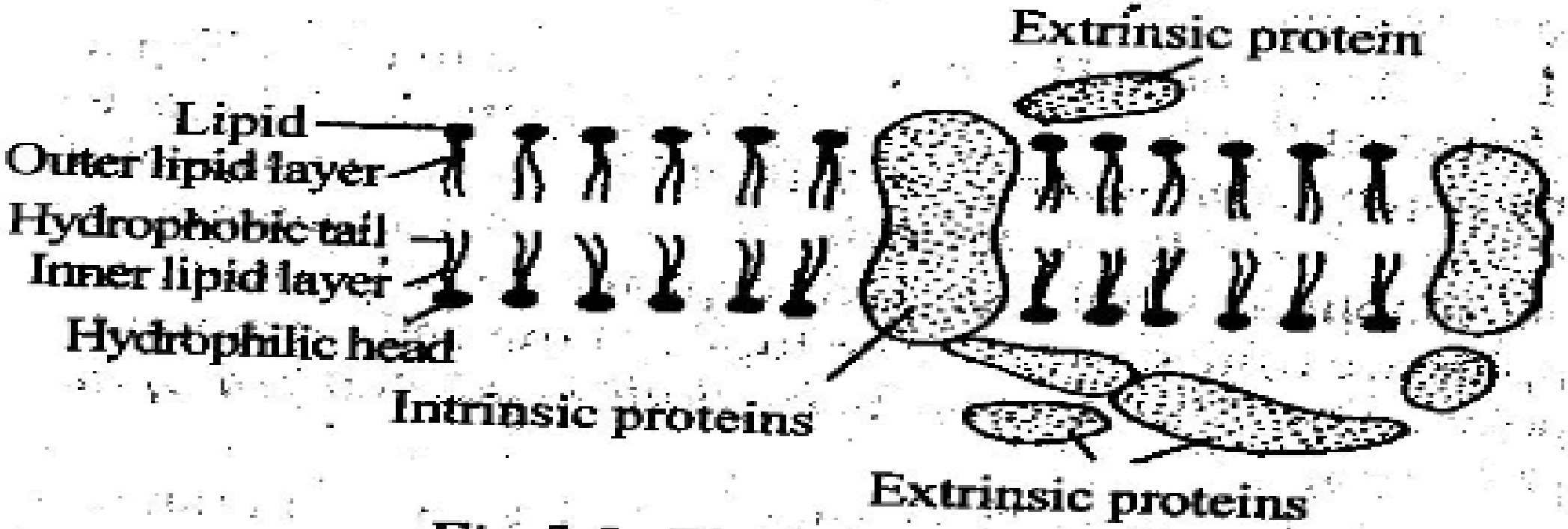


Fig. 5.5: Fluid mosaic model.

5. Micellar model

This model was proposed by ***Hillier*** and ***Hoffman*** in 1953. According to this model, the molecules in the plasma membrane are arranged in the form of globular sub-units called ***micelles.*** The lipid micelles are the building blocks of the membrane and the protein globules are arranged on either side.

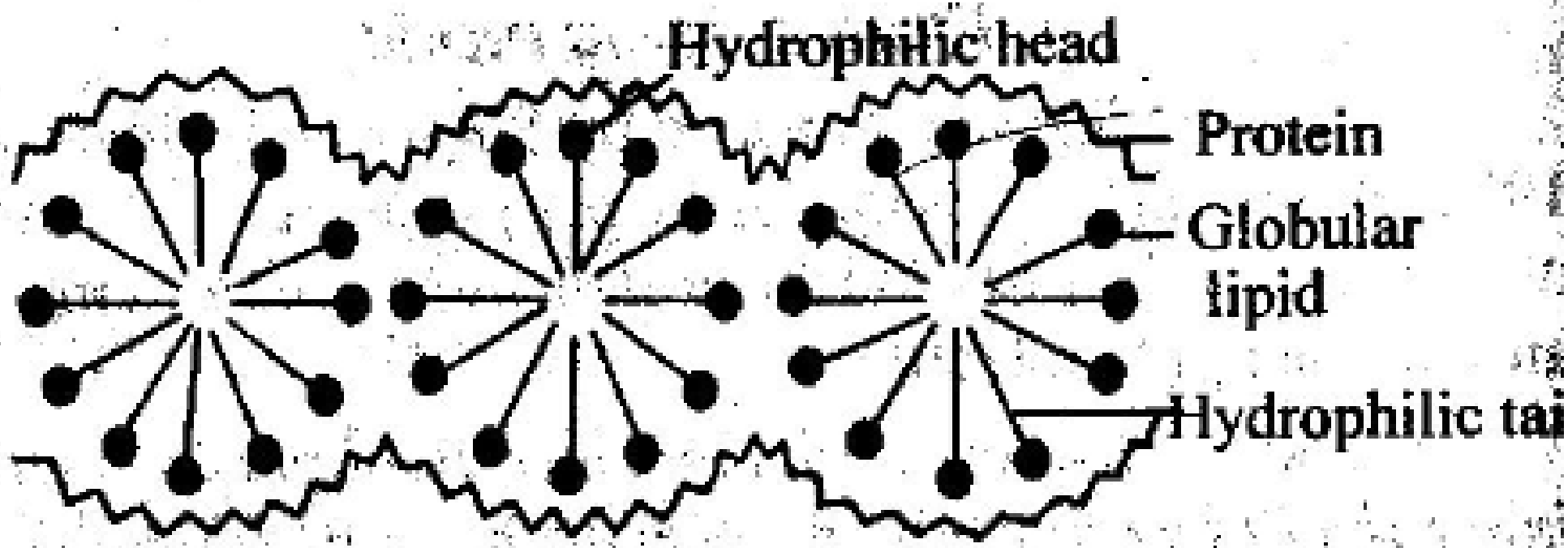


Fig.5.6: Micellar model.

In a lipid micelle the lipid molecules are arranged
the form of a circle. Each ***lipid molecule*** has a ***head*** and
tail. The head is ***hydrophilic*** and the tail is ***hydrophobic.*** Th
tail is directed inwards.

Chemical Composition

Plasma membrane is formed of the following chemic components:

1. Lipids: The main bulk of plasma membrane i formed of lipids. The main lipid component of the plasm membrane is *phospholipid.* About 5 important phospholipid are seen. Of these *lecithin* is the most abundantly see phospholipid. Cholesterol and cephalin are also found. Som lipids are triglycerides. The lipids of the cell membrane a polar lipids. They contain *hydrophilic heads* and *hydrophob tails.* (Fig.5.5)

2. Proteins: The proteins of plasma membrane hav high molecular weight. Three different classes of protein occur in the plasma membrane. They are *structural proteins carrier proteins* and *enzymes.* The structural proteins for the 'back bone' of the cell membrane. The carrier protei are involved in active transport. The enzymes include *ase, phosphatase, hexokinase, RNA ase* and *esterase.*

3. Carbohydrates: They form a cell coat around plasma membrane. Hexose, hexosamine, fucose and si

acid are the important carbohydrates found in the plasma membrane of R.B.C. Plasma membrane of ***Amoeba proteus*** contains a large amount of polysaccharides.

4. Nucleic Acids: The plasma membrane of ***Arbacia egg*** contains nucleic acids.

5. Salts: Salts are generally present in the cell membrane. Some of them are present in higher concentrations.

6. Water: The cell membrane also contains water.