

Plasma Membrane

Structure and Function

Dr. S.D. Saraswathy

Assistant Professor

Department of Biomedical Science

Bharathidasan University, Tiruchirappalli

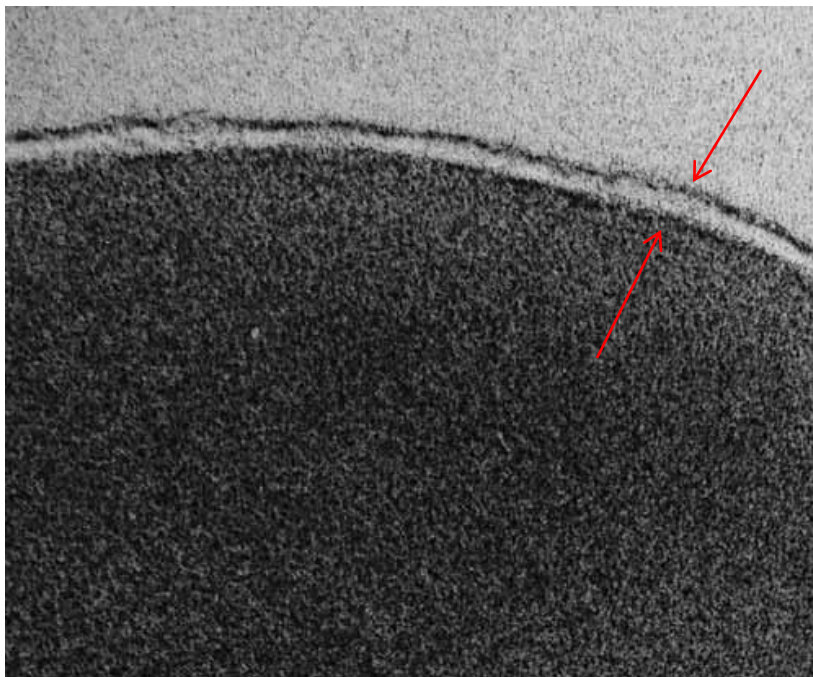
Introduction

- The **plasma membrane** (or **cytoplasmic membrane**) separates the interior contents from the outside environment.
- Protective outer boundary of a living cell.
- Thin, fragile structures of **5 to 10 nm wide**.
- Ultrastructures could be examined only through the **electron microscope**.
- All membranes taken from various organisms (plants, animals, or microorganisms) have the same ultrastructure.

Plasma membrane

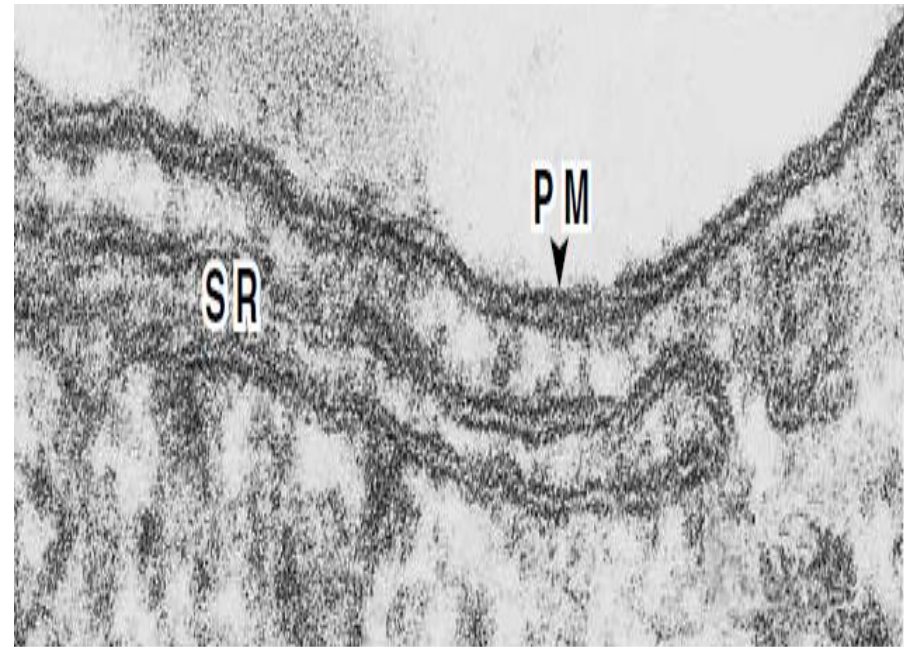
- The early electron micrographs portrayed the plasma membrane as a three-layered structure.

three-layered (trilaminar) structure of the plasma membrane of an erythrocyte :



50 nm

trilaminar structure of both the plasma membrane (PM) and the membrane of the sarcoplasmic reticulum (SR), a calcium-storing compartment of the cytoplasm.



0.1 μm

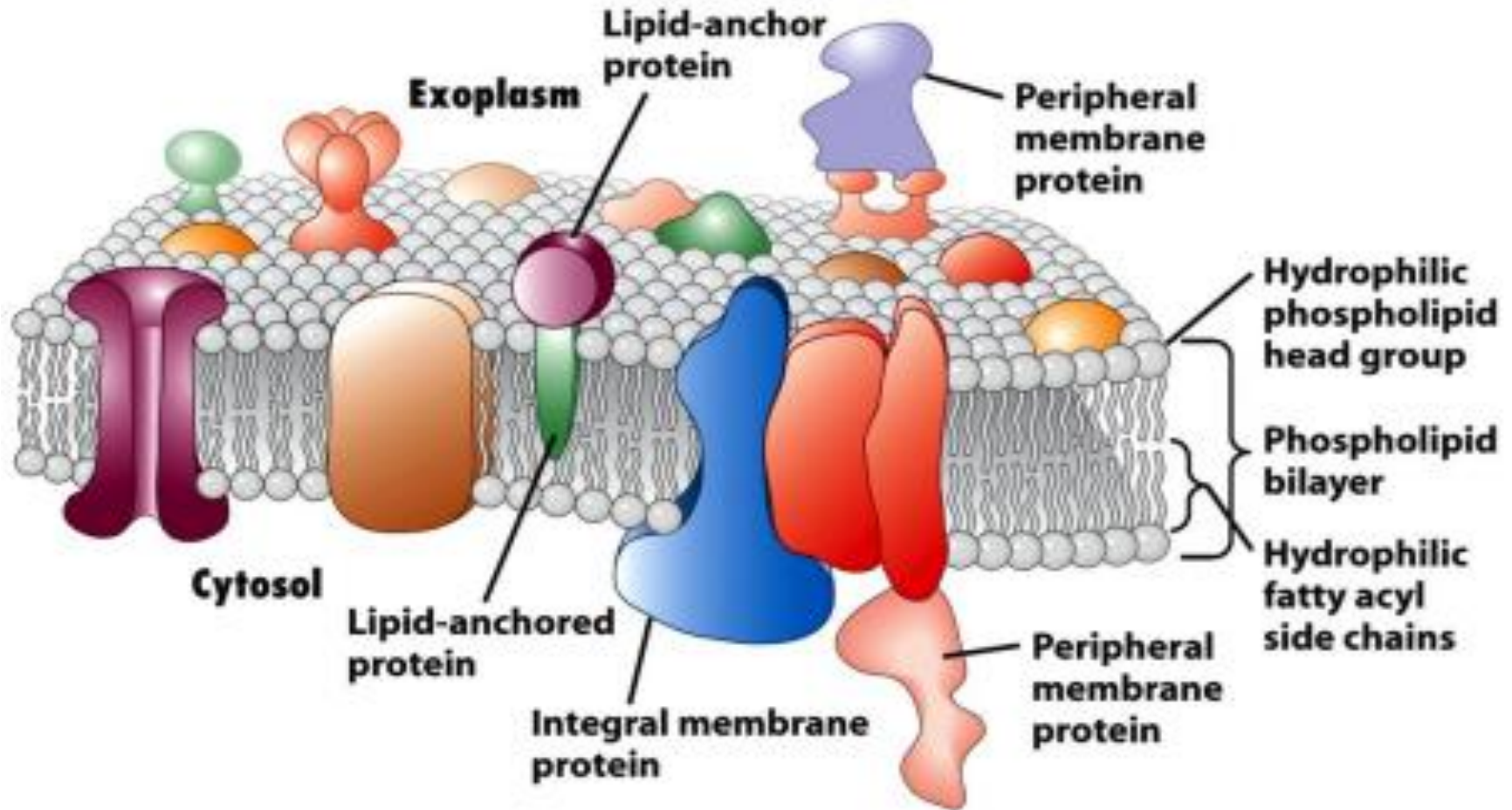
Plasma membrane - Functions

- **Compartmentalization:**
 - The plasma membrane encloses the contents of the entire cell whereas various membrane-bound compartments of a cell enclose diverse contents.
- **Providing a selectively permeable barrier:**
 - Serve as a general barrier, have selected entry of molecules from one side to the other.
- **Scaffold for biochemical activities:**
 - Membranes provide the cell with an extensive framework (scaffolding) within which molecules can be interacted effectively.

Plasma membrane - Functions

- **Transportation:**
 - The transporting machinery of the membrane allows solutes, energy metabolites and specific ions from one side of the membrane to another by active and passive transport mechanisms.
- **Responding to external signals:**
 - Different receptors present in the membrane are capable of recognizing and responding to different external stimuli and ligands (Signal transduction).
- **Intercellular interaction:**
 - Allows cells to recognize one another and adhere, when exchange of material and information occurs.

Structure of Plasma Membrane



Biomembrane - Composition

- **Biomembrane:** Plasma membrane or internal membranes (e.g. endoplasmic reticulum, Golgi apparatus) that are present in all cells.
- All membranes consist of 3 main molecules:
 - **Lipids**
 - **Proteins**
 - **Carbohydrates (Glycoproteins, Glycolipids)**
- The ratio between lipid and proteins depends on the function of the cell.

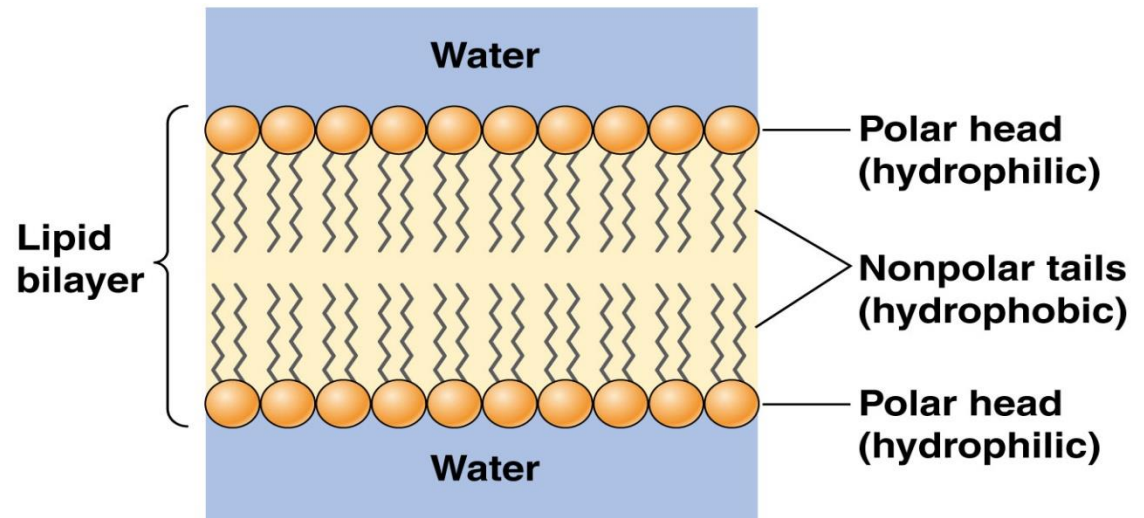
Composition of the cell membrane

Different cell membranes possess different compositions.

Membrane	% By weight		
	Protein	Lipid	Carbohydrate
Myelin	18	79	3
Human erythrocyte plasma membrane	49	43	8
Mouse liver	44	52	4
Amoeba plasma membrane	54	42	4
Chloroplast spinach lamellae	70	30	0
<i>Halobacterium</i> purple membrane	75	25	0
Mitochondrial inner membrane	76	24	0

Basic structure

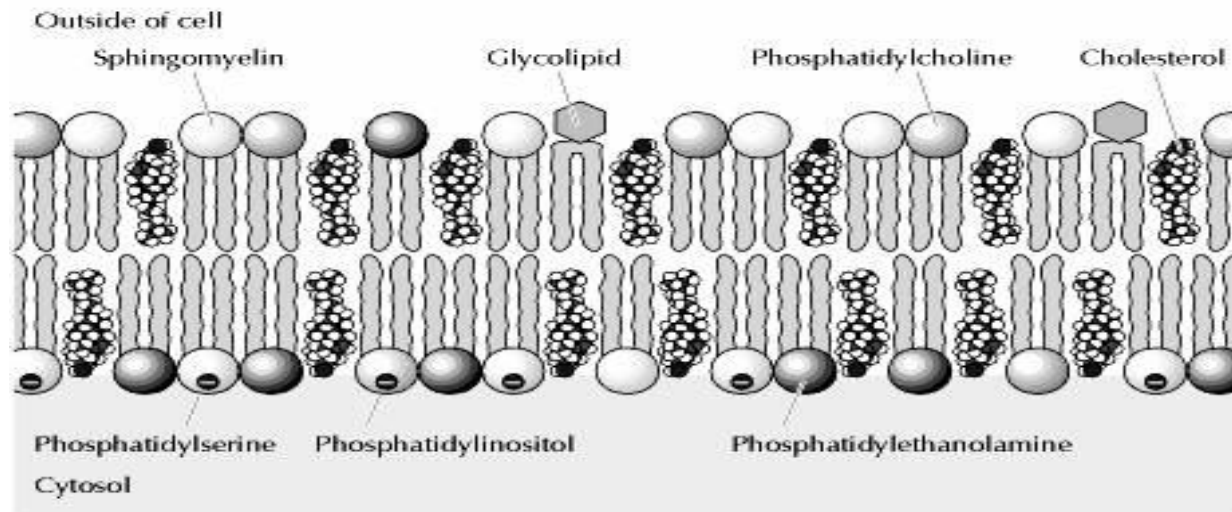
- **Lipid bilayer:** The basic structural unit of cell membranes.
- Composed of two parallel sheets of phospholipid molecules arranged tail to tail (hydrophobic).
- Hydrophilic heads at the surface on either side membrane



© 2012 Pearson Education, Inc.

Lipids of plasma membrane

- In addition to phospholipids, **glycolipids** and **cholesterol** are also found in plasma membrane.
- **Glycolipids** - Lipid molecule, attached to a variety of sugars (straight or branched chain).
- **Cholesterol** - Reduces membrane fluidity and permeability to some solutes.

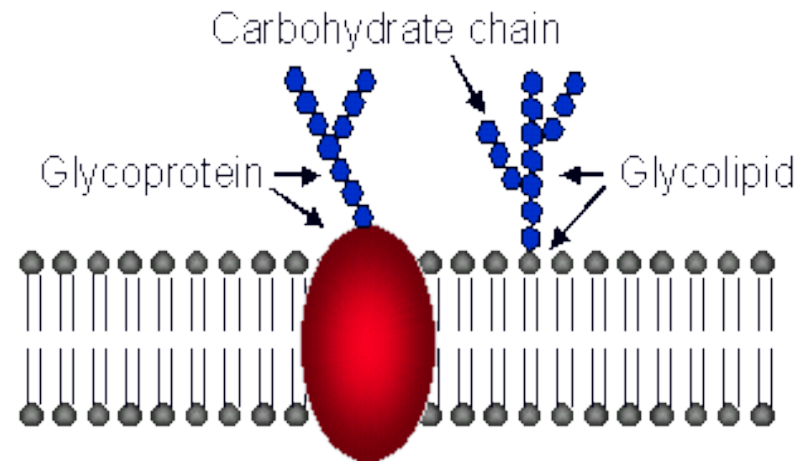
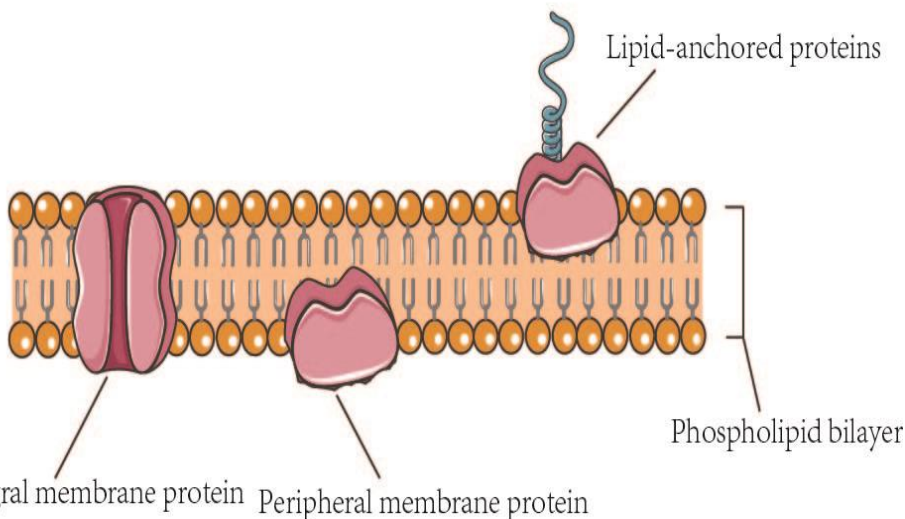


Lipid Composition of Cell Membrane

Lipid (Mole %)	Plasma membrane		Rough Endoplasmic reticulum	Outer mitochondrial membranes
	<i>E. coli</i>	Erythrocyte		
Phosphatidylcholine	0	17	55	50
Phosphatidylserine	0	6	3	2
Phosphatidylethanolamine	80	16	16	2
Sphingomyelin	0	17	3	5
Glycolipids	0	2	0	0
Cholesterol	0	45	6	< 5

Proteins of plasma membrane

- **20%** or more of the weight of a membrane consists of **protein** molecules, mainly **glycoproteins**.
- **Peripheral** proteins (PP) and **Integral** proteins (IP) are the 2 major proteins associated with lipid bilayer.



<https://animalcellbiology.wordpress.com/category/carbohydrates/>

Proteins of plasma membrane

- **PPs** occur either on the outside or the inside surface of the membrane anchored by **covalent** and **non-covalent interactions**.
- **IPs** extend completely through the cell membrane and may twist in and out of the membrane many times.
- Hydrophobic regions of the **IP** pass across the membrane and hydrophilic regions protrude from both surfaces of the bilayer.
- Many **IPs** are **glycoproteins**, have a short carbohydrate chain which project externally.

Membrane proteins: Functions

- **Performs various functions:**
 - ✓ Act as a carriers/channel to transport specific molecules across the membrane.
 - ✓ Some act as a receptors, performs enzymatic action and also serves as structural links.
 - ✓ Glycoproteins and glycolipids often help to stabilize the membrane structure.
 - ✓ Glycoproteins help to identify, adhere to and communicate with the cell.
 - ✓ Glycolipids serves as recognition sites for cell-cell interactions.
 - ✓ IPs largely determine a membrane's specific functions.

Properties of Plasma Membrane

Membrane fluidity

- All cell membranes are dynamic and fluid structures.
- Fluidity is essential for the functioning of some enzymes which become inactive when the membrane solidifies.
- Cholesterol scattered in the lipid bilayer helps to maintain the membrane fluid consistent.
- Also, greater the concentration of unsaturated fatty acid residues (in hydrophobic tail region), the more fluid is the bilayer.
- In general the proteins are free to drift laterally in the fluid lipid bilayer.

The Mosaic Quality of the membrane

- Cell membranes have their own unique **collections of proteins.**
- Membranes have a mosaic pattern, depending on the types and quantity of proteins.
- The Plasma membrane of a RBC contain over **50 different types of proteins.**
- The proteins form different patterns and also they differ in composition within the same membrane i.e why the membrane is said to be a **mosaic.**

Fluid-mosaic model

- The overall structure of the cell membrane is represented by the **fluid-mosaic model**.

