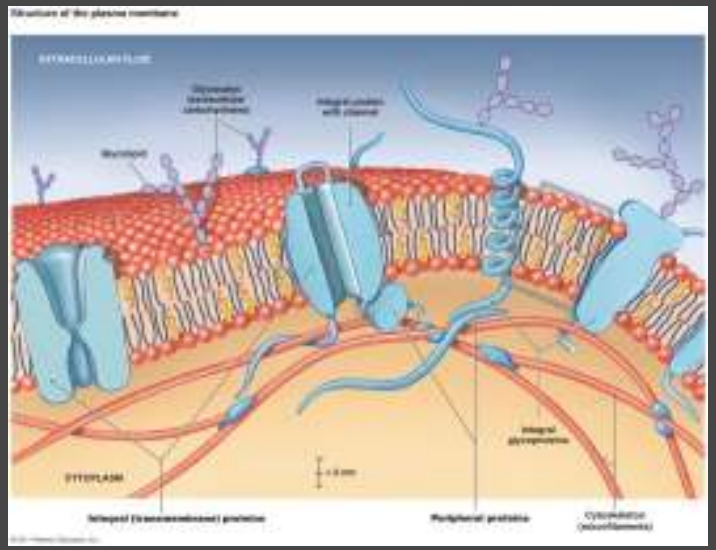
PLASMA MEMBRANE



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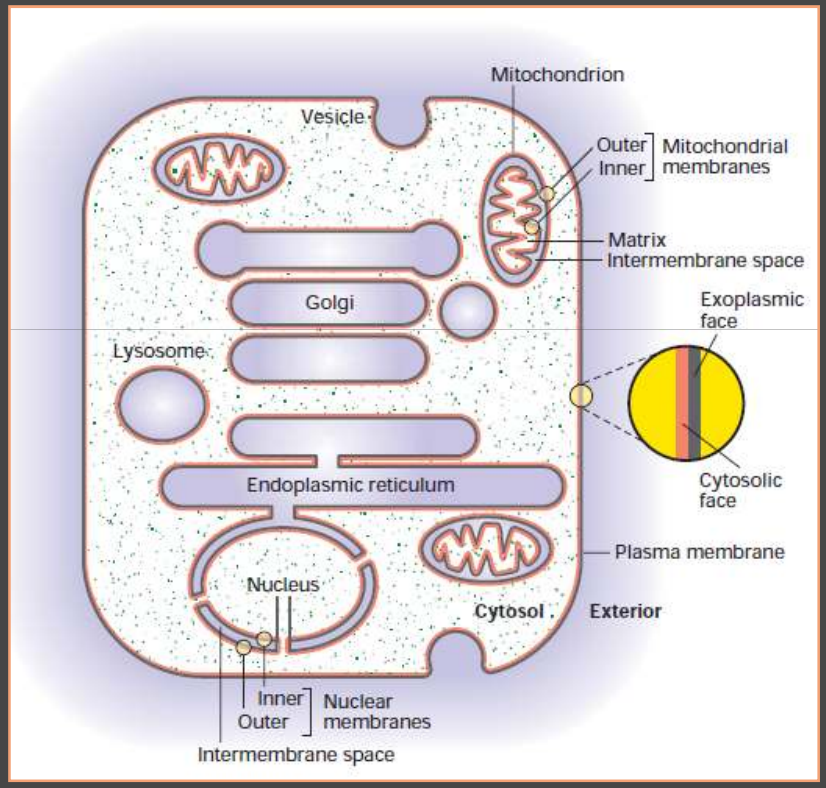
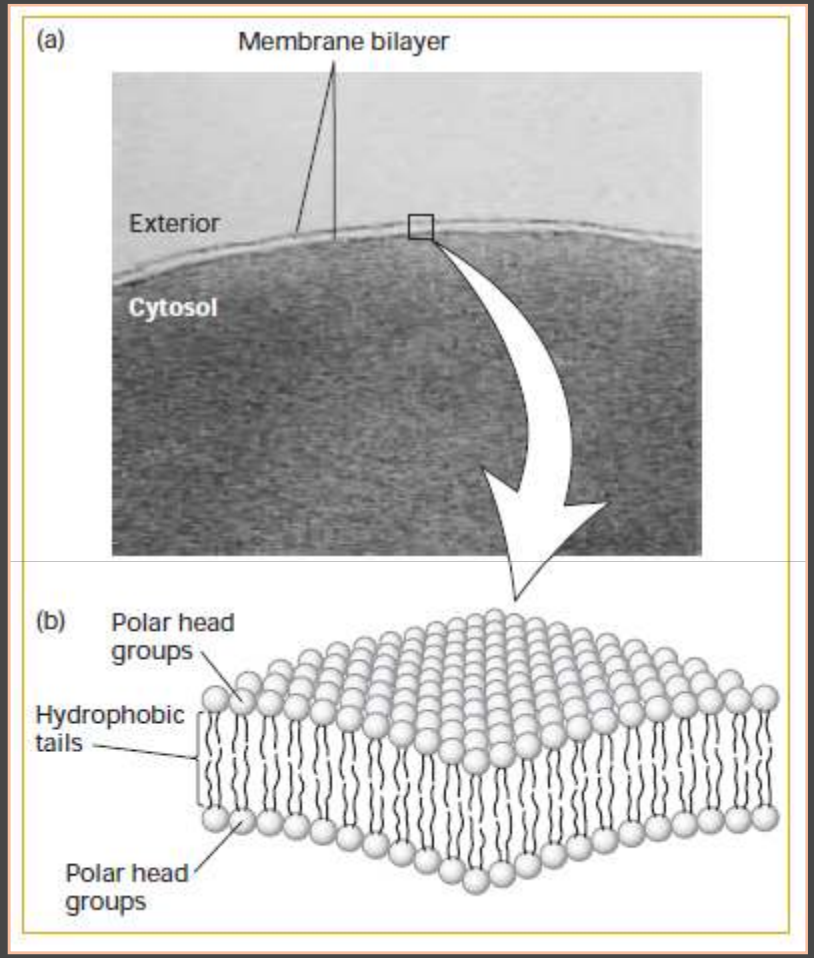
INTRODUCTION

- All internal and external membrane of cell are called cell membrane or biomembranes.
- It also cover several organelles like Nucleolus, Mitochondria, Golgi Bodies, Plastids, Lysosome, Peroxisome etc.
- It made up of Lipid protein lipid, so called as Lipoprotein Layer.



Membrane Lipids

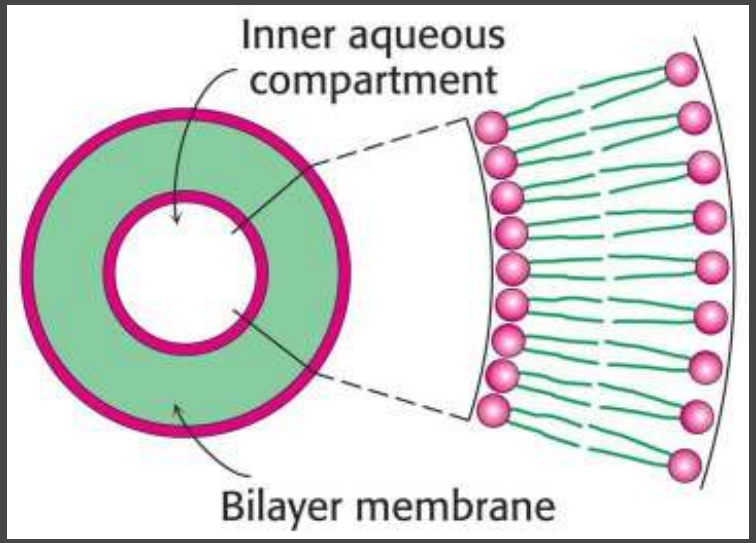
- Lipid constitute about 50% mass of Cell Membrane.
- Phospholipids, Glycolipids and Cholesterol consist to membrane of cells.

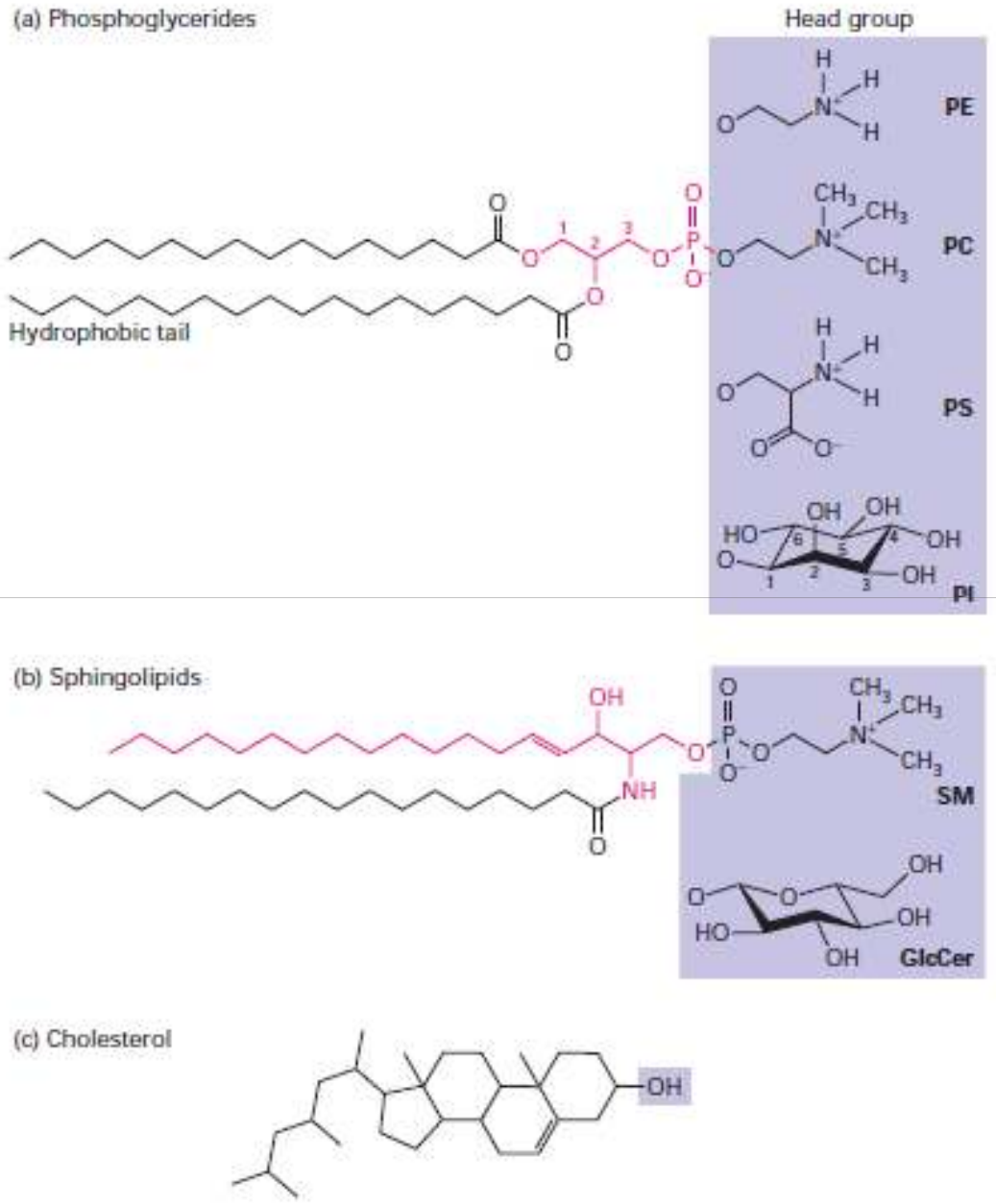


Membrane Lipids

- The lipid bilayer has two important properties. First, the hydrophobic core is an impermeable barrier that prevents the diffusion of water- soluble **(hydrophilic) solutes across the** membrane.

- The second property of the bilayer is its stability. The bilayer structure is maintained by hydrophobic and van der Waals interactions between the lipid chains.





◀ FIGURE 5-5 Three classes of membrane lipids. (a) Most phosphoglycerides are derivatives of glycerol 3-phosphate (red) containing two esterified fatty acyl chains, constituting the hydrophobic "tail" and a polar "head group" esterified to the phosphate. The fatty acids can vary in length and be saturated (no double bonds) or unsaturated (one, two, or three double bonds). In phosphatidylcholine (PC), the head group is choline. Also shown are the molecules attached to the phosphate group in three other common phosphoglycerides: phosphatidylethanolamine (PE), phosphatidylserine (PS), and phosphatidylinositol (PI). (b) Sphingolipids are derivatives of sphingosine (red), an amino alcohol with a long hydrocarbon chain. Various fatty acyl chains are connected to sphingosine by an amide bond. The sphingomyelins (SM), which contain a phosphocholine head group, are phospholipids. Other sphingolipids are glycolipids in which a single sugar residue or branched oligosaccharide is attached to the sphingosine backbone. For instance, the simple glycolipid glucosylcerebroside (GlcCer) has a glucose head group. (c) Like other membrane lipids, the steroid cholesterol is amphipathic. Its single hydroxyl group is equivalent to the polar head group in other lipids; the conjugated ring and short hydrocarbon chain form the hydrophobic tail. [See H. Sprong et al., 2001, *Nature Rev. Mol. Cell Biol.* **2**:504.]

Membrane Lipids

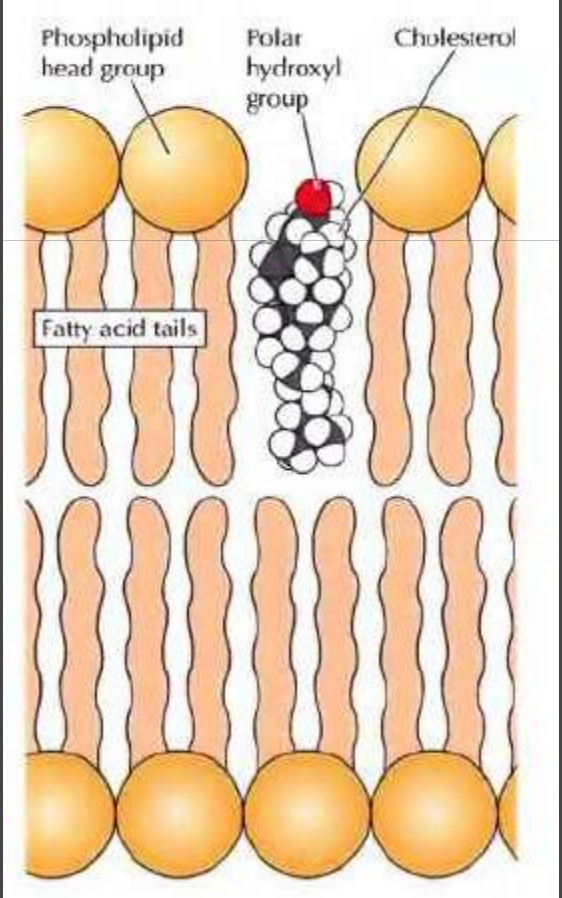
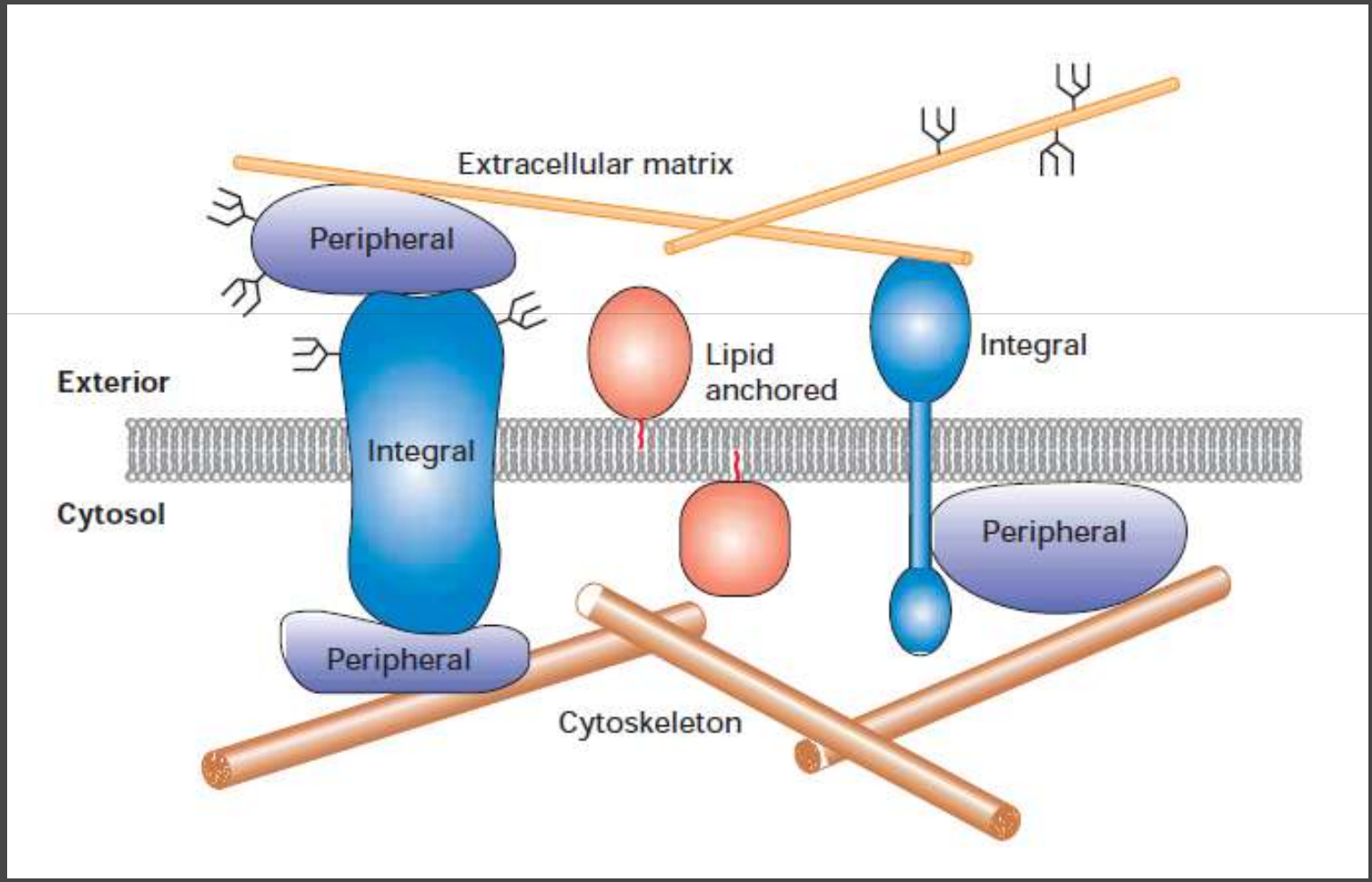


TABLE 2.1 Lipid Composition of Cell Membranes[a]

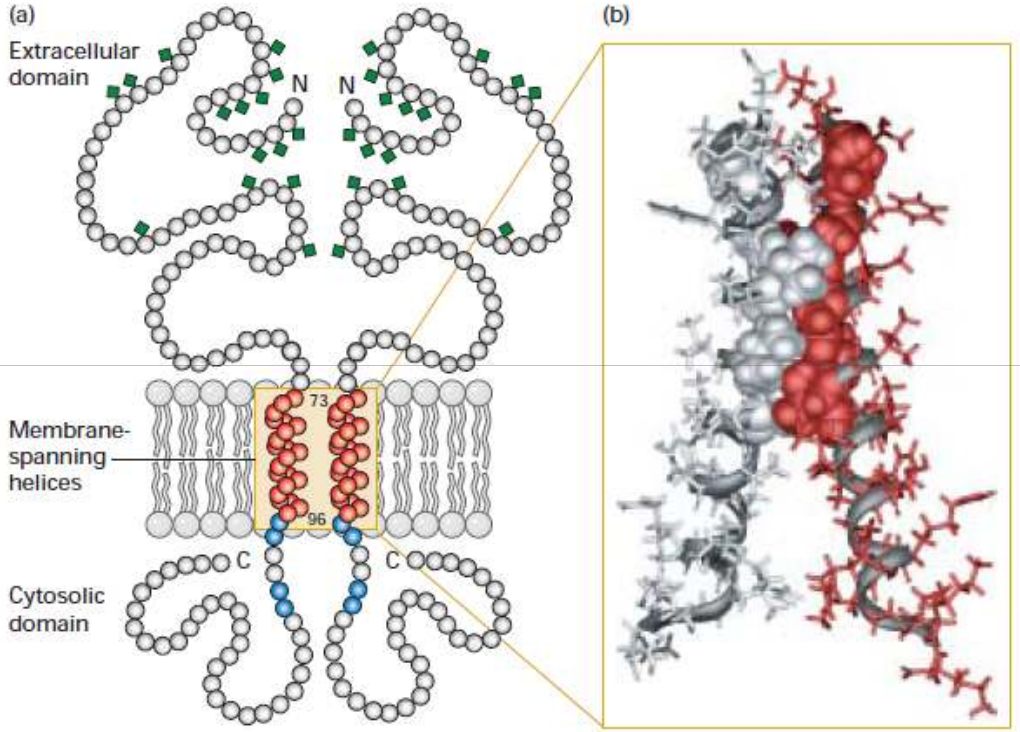
Lipid	Plasma membrane		Rough endoplasmic reticulum	Outer mitochondrial membranes
	E. coli	Erythrocyte		
Phosphatidylcholine	0	17	55	50
Phosphatidylserine	0	6	3	2
Phosphatidyl-ethanolamine	80	16	16	23
Sphingomyelin	0	17	3	5
Glycolipids	0	2	0	0
Cholesterol	0	45	6	<5

Source: Data from P. L. Yeagle, 1993. *The Membranes of Cells*, 2nd ed. San Diego, CA: Academic Press.
[a] Membrane compositions are indicated as the mole percentages of major lipid constituents.

Membrane Protein



Membrane Protein

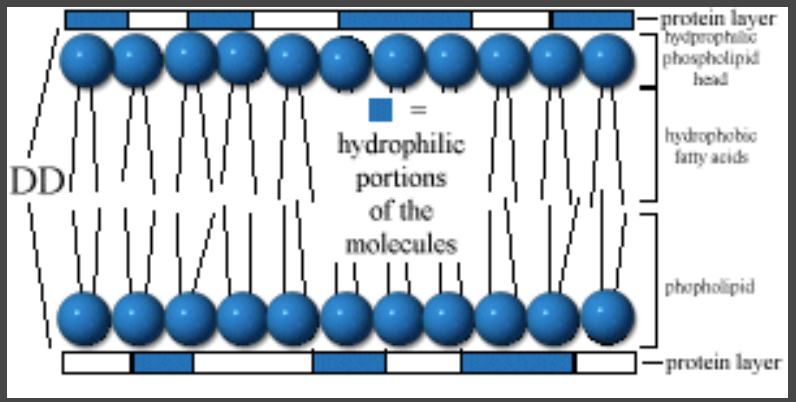


▲ **FIGURE 5-12 Structure of glycophorin A, a typical single-pass transmembrane protein.** (a) Diagram of dimeric glycophorin showing major sequence features and its relation to the membrane. The single 23-residue membrane-spanning α helix in each monomer is composed of amino acids with hydrophobic (uncharged) side chains (red spheres). By binding negatively charged phospholipid head groups, the positively charged arginine and lysine residues (blue spheres) near the cytosolic side of the helix help anchor glycophorin in the membrane. Both the extracellular and the cytosolic domains are rich in charged residues and polar uncharged residues; the extracellular domain is heavily glycosylated, with the carbohydrate side chains (green diamonds) attached to specific serine, threonine, and asparagine residues. (b) Molecular model of the transmembrane domain of dimeric glycophorin corresponding to residues 73–96. The side chains of the α helix in one monomer are shown in red; those in the other monomer, in gray. Residues depicted as space-filling structures participate in intermonomer van der Waals interactions that stabilize the coiled-coil dimer. [Part (b) adapted from K. R. MacKenzie et al., 1997, *Science* **276**:131.]

Models of Plasma Membrane

Bilayer Model

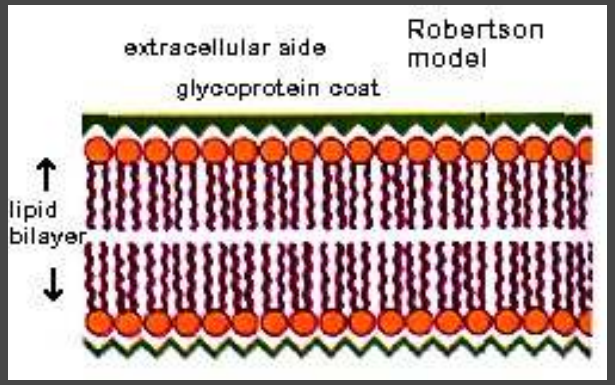
- In 1935, Hugh Davson and James Danielli proposed a model of the cell membrane in which the phospholipid bilayer lay between two layers of globular protein.



Models of Plasma Membrane

Unit Membrane Concept

- In the year 1959 David Robertson based on the electron microscopic studies, proposed the idea of unit membrane.
- He noticed a three-layered (dark-light-dark) arrangement for all the membranes that he studied.
- This idea holds that a membrane consists of a phospholipid bilayer sandwiched between two protein monolayers and that various membranes in a cell are unit membranes.



Models of Plasma Membrane

Fluid Mosaic Model

Singer and Nicolson 1972

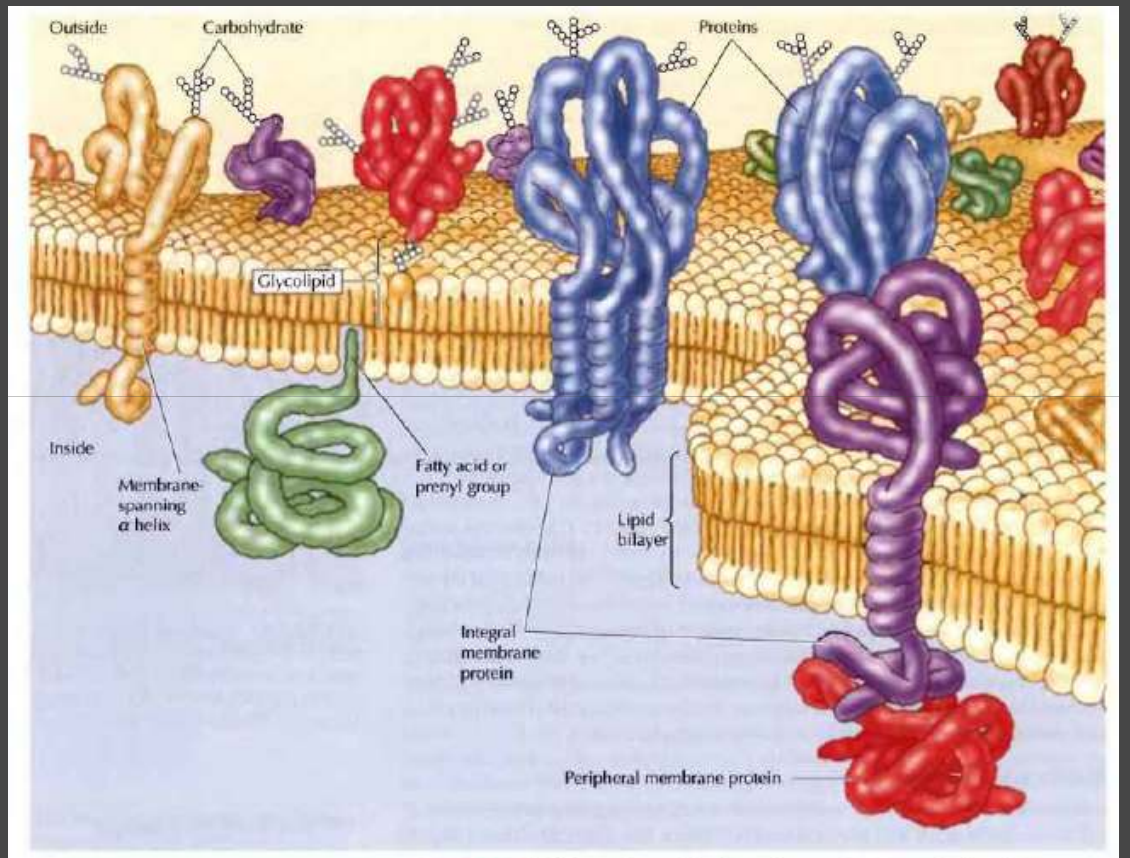


FIGURE 2.25 Fluid mosaic model of membrane structure Biological membranes consist of proteins inserted into a lipid bilayer. Integral membrane proteins are embedded in the membrane, usually via α-helical regions of 20 to 25 hydrophobic amino acids. Some transmembrane proteins span the membrane only once; others have multiple membrane-spanning regions. In addition, some proteins are anchored in the membrane by lipids that are covalently attached to the polypeptide chain. These proteins can be anchored to the extracellular face of the plasma membrane by glycolipids and to the cytosolic face by fatty acids or prenyl groups (see Chapter 8 for structures). Peripheral membrane proteins are not inserted in the membrane but are attached via interactions with integral membrane proteins.

- Each phospholipid molecule has a head that is attracted to water (hydrophilic: hydro = water; philic = loving) and a tail that repels water (hydrophobic: hydro = water; phobic = fearing).
- Both layers of the plasma membrane have the hydrophilic heads pointing toward the outside; the hydrophobic tails form the inside of the bilayer.
- Because cells reside in a watery solution (extracellular fluid), and they contain a watery solution inside of them (cytoplasm), the plasma membrane forms a circle around each cell so that the water-loving heads are in contact with the fluid, and the water-fearing tails are protected on the inside.

Integral proteins or transmembrane proteins	Span the membrane and have a hydrophilic cytosolic domain, which interacts with internal molecules, a hydrophobic membrane-spanning domain that anchors it within the cell membrane, and a hydrophilic extracellular domain that interacts with external molecules. The hydrophobic domain consists of one, multiple, or a combination of α-helices and β sheet protein motifs.	Ion channels,proton pumps,G protein-coupled receptor
Lipid anchored proteins	Covalently bound to single or multiple lipid molecules; hydrophobically insert into the cell membrane and anchor the protein. The protein itself is not in contact with the membrane.	G proteins
Peripheral proteins	Attached to integral membrane proteins, or associated with peripheral regions of the lipid bilayer. These proteins tend to have only temporary interactions with biological membranes, and once reacted, the molecule dissociates to carry on its work in the cytoplasm.	Some enzymes,some hormones

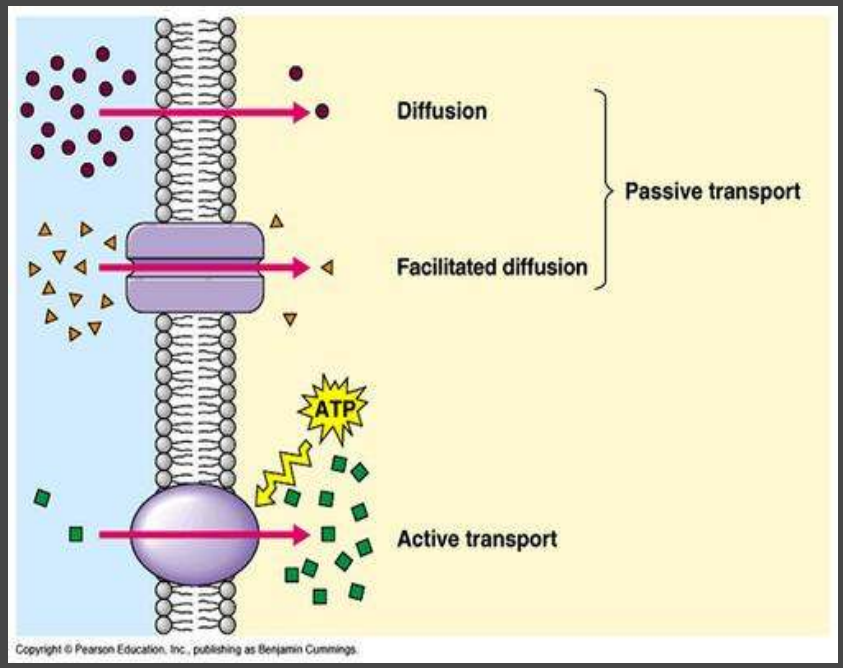
Functions of the Cell Membrane

1.	**Mechanical Structure** (a) Defines/encloses the Cell	A cell membrane encloses and defines the cell. There are different ways to express this, e.g. • The cell membrane **maintains the physical integrity of the cell**. It's most obvious in the cases of animal cells (because they don't have cell walls) that the cell membrane holds the cell together **by enclosing the cytoplasm and organelles** within it. • The cell membrane **forms a barrier between the inside of the cell and the environment outside the cell** - enclosing cytoplasm and any organelles within the cell, and enabling different chemical environments to exist on each side of the cell membrane. • The cell membrane **physically separates the intracellular components** (e.g. organelles in eukaryotic cells) **from the extracellular environment**. The 3 points listed above say much the same thing.
	(b) Re. Cytoskeleton	In many cases the cell membrane also helps to hold the cytoskeleton (which is within the cell) in place. This is is achieved by some proteins in the cell membrane attaching to some cytoskeletal fibres and helps to define and maintain the shape of the cell.
	(c) Extracellular Matrix	In many cases (but not all, e.g. not in the case of single celled-organisms) the cell membrane interacts with the cell membrane of adjacent cells e.g. to form plant and animal tissues.
	(c) Protection	The cell membrane protects the cell from some harmful chemicals in its external environmemt. It also protects the cell from loss of useful biological macromolecules held within the cell by its plasma membrane.
2.	**Selective Permeability**	The cell membranes that enclose cells (inside the cell wall in the cases of plant cells and prokaryotic cells) are **selectively permeable**. That is, the structure of these membranes is such that they allow certain particles, incl. e.g. molecules, - but not others - to pass through the membrane, hence into or out of the cell. (*This cell membrane function is one of several functions that facilitate the transport of materials needed for survival of the cell, others include "active transport", "exocytosis" and "endocytosis".*)
3.	**Active Transport**	Cell membranes, also known as "plasma membranes", can allow active transport of specific molecules across the cell membrane in either direction, i.e. either into or out of the cell. That is - cell membranes **can allow some particular molecules to move against a concentration gradient e.g. from a lower concentration outside the cell to a higher concentration inside the cell, or vice-versa**. Active transport (movement against the concentration gradient) requires, that is it uses, energy.

4.	**Bulk Transport**: **Exocytosis** and **Endocytosis**	**Exocytosis** is the process by which a cell moves the contents of secretory vesicles out of the cell via the cell membrane. **Endocytosis** is the opposite process by which the contents of secretory vesicles are moved into the cell via the cell membrane.
5.	**Markers & Signalling** (for communication with other cells & the external environment)	Proteins called **surface protein markers** embedded in the cell membrane identify the cell, enabling nearby cells to communicate with each other. Cell membranes often include receptor sites for interaction with specific biochemicals such as certain hormones, neurotransmitters and immune proteins. In this way the cell can recognize and process some signals received from the extracellular environment.
6.	**Metabolic Activities**	Plasma membranes include as part of their structures certain proteins and enzymes that are involved in some of the metabolic processes of the cell.

TRANSPORT ACROSS MEMBRANE

Diffusion	Passive movement of any substance from an area of high concentration to an area of low concentration.
Osmosis	Passive diffusion of water through a semiper-meable membrane.
Facilitated transport	Accomplished by proteins in the membrane that allow the passage of otherwise restricted molecules.
Active transport	The process of using energy (ATP) to "pump" molecules across the membrane against the concentration gradient.
Endocytosis **Phagocytosis** **Pinocytosis**	Processes that bring material into the cell. Cell membrane engulfs a foreign substance or body. Membrane engulfs small droplets of water.
Exocytosis	Release of molecules from the cell.



Thankyou