CELL MEMBRANE

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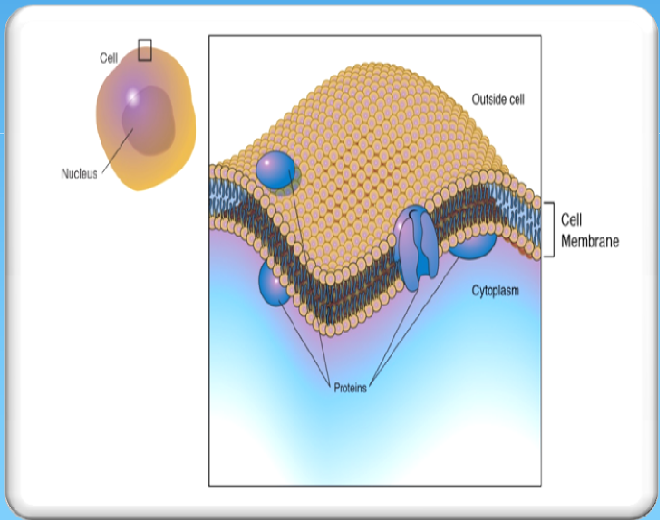

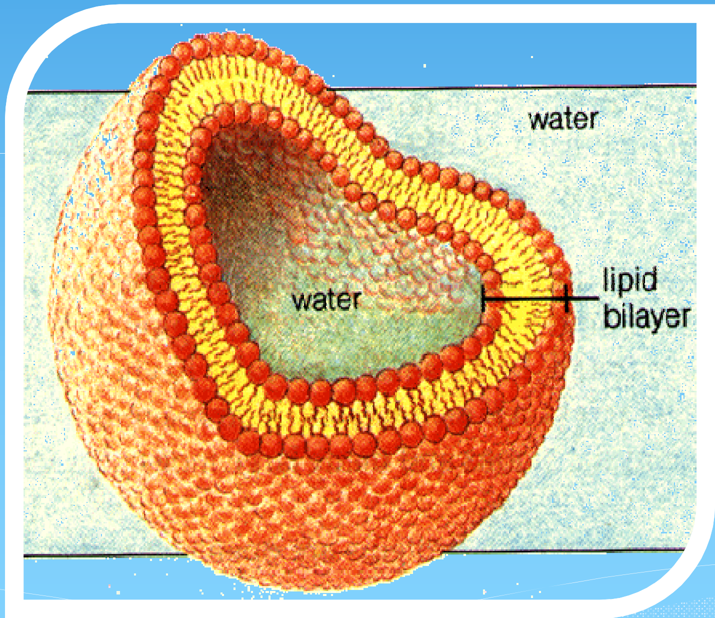

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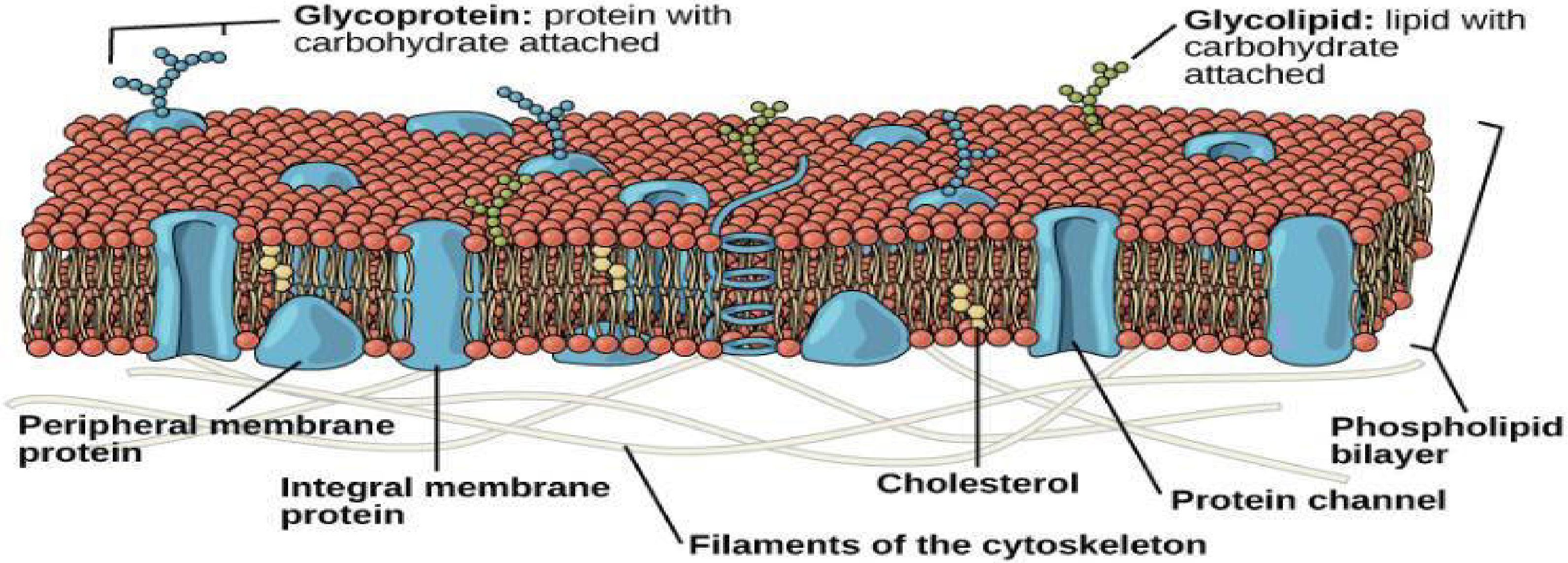
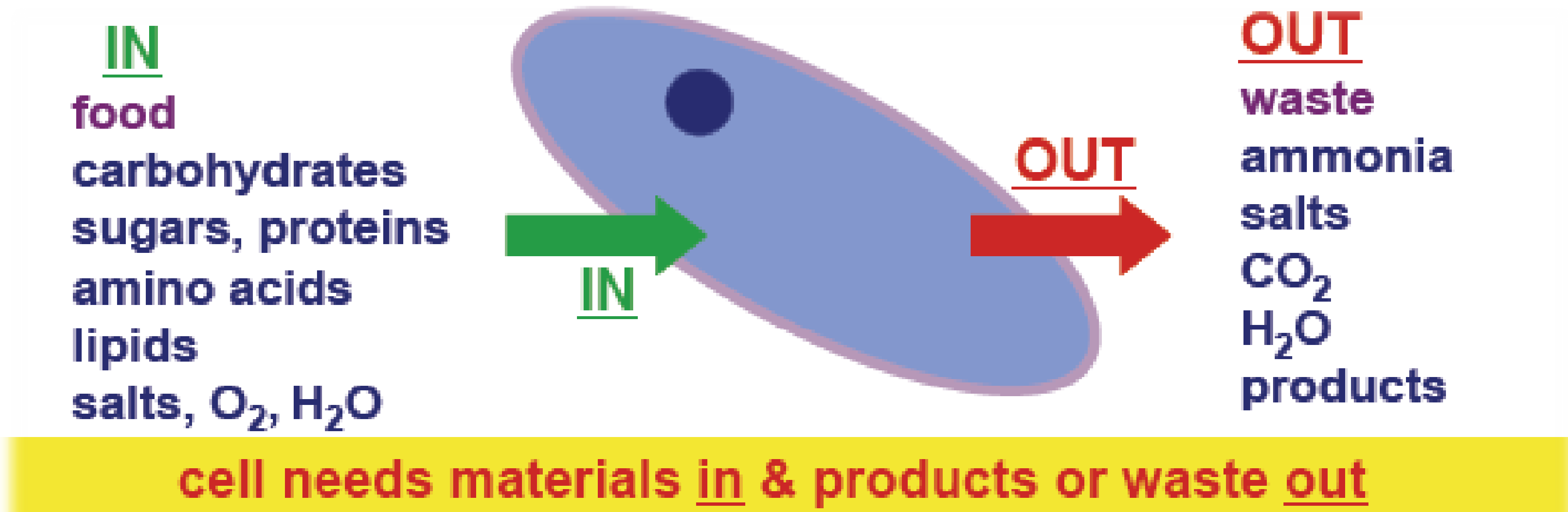
Plasma membrane, also called the **cell membrane**, is the membrane found in all cells that separates the interior of the cell from the outside environment. In bacterial and plant cells, a cell wall is attached to the plasma membrane on its outside surface. The plasma membrane consists of a lipid bilayer that is **semipermeable**. The plasma membrane regulates the transport of materials entering and exiting the cell.



- All living cells have cell membranes (plasma membrane).
- Not the same thing as a cell wall
- Separates the inside of the cell from the outside of the cell
- Controls the flow of things in and out of the cell (ions, nutrients, wastes, water, secretory products….)



The **phospholipid bilayer** is the basic structure of membranes.

The **lipid bilayer** consists of two (bi) layers of phospholipids.

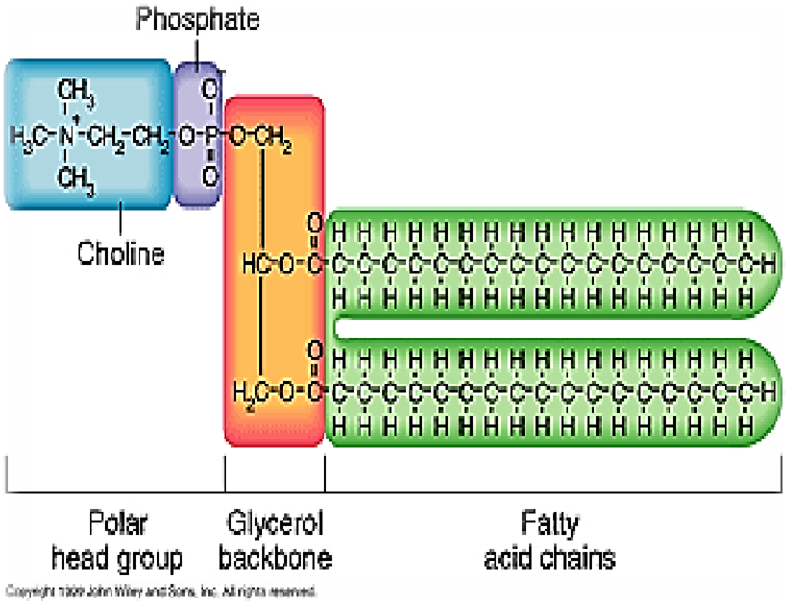
Plasma membranes are **selectively permeable** that separate the interior of the cell from the environment. Structure allows some substances to pass through easily while other things can not

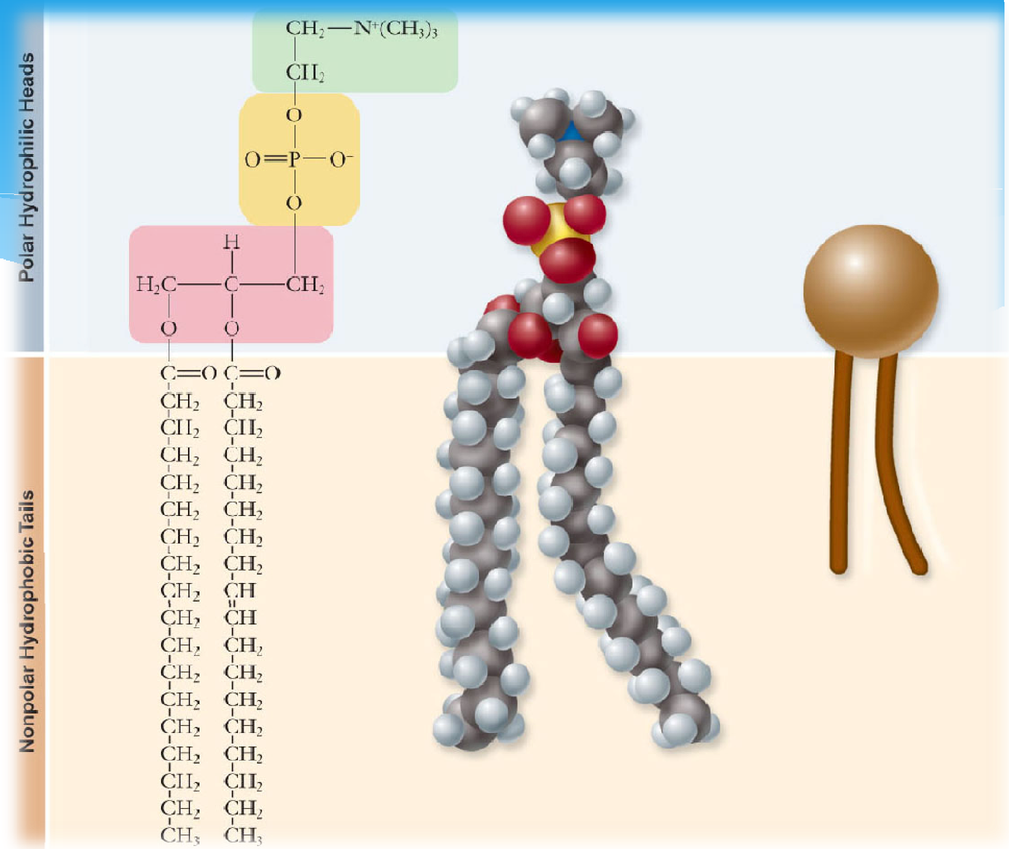
Cell membranes contain lipids and proteins that form their structure and facilitate cellular function (**cell adhesion** and **cell signaling** are cellular processes initiated by the plasma membrane.

Plasma membranes also serve as attachment points for intracellular **cytoskeletal** proteins.

Phospholipids are **Amphipathic**: molecule has both a **hydrophilic ("water-loving")** region and a **hydrophobic ("water-fearing")** region.

Phospholipids will form an artificial membrane on the surface of water with only the hydrophilic heads immersed in water.





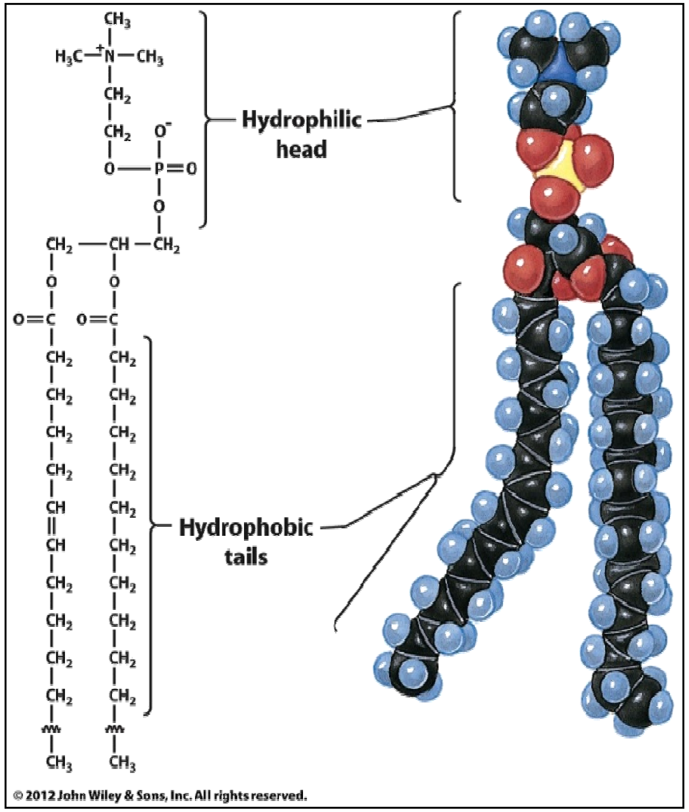
The polar (hydrophilic) heads of phospholipids are oriented towards the protein layers forming a hydrophilic zone.

The nonpolar (hydrophobic) tails of phospholipids are oriented in between polar heads forming a hydrophobic zone.

Not all membranes are identical or symmetrical (***asymmetrical***)

Membranes with different functions also differ in chemical composition and structure.

Membranes are ***bifacial*** with distinct inside and outside faces.



FLUID-MOSAIC MODEL

It was proposed by **Singer & Nicolson (1972).**

It is the model that is currently accepted.

Fluid = pliable/easily : moved because individual phospholipids and proteins can move around freely within the layer, like it's a liquid

Mosaic = made of many different molecules (lipids, proteins, carbohydrates

Lipids

Three types of lipids are found in cell membranes: **Phospholipids**, **Cholesterol**, and **Glycolipids**.

1. Phospholipids

The most abundant of the membrane lipids.

They are polar, ionic compounds that are **Amphipathic** in nature. That is, each has a **hydrophilic head**, which is the phosphate group plus whatever alcohol is attached to it (for example, serine, ethanolamine, and choline) and a long, **hydrophobic tail** containing fatty acids.

Phospholipids that present in the plasma membrane:

A. Glycerol PL

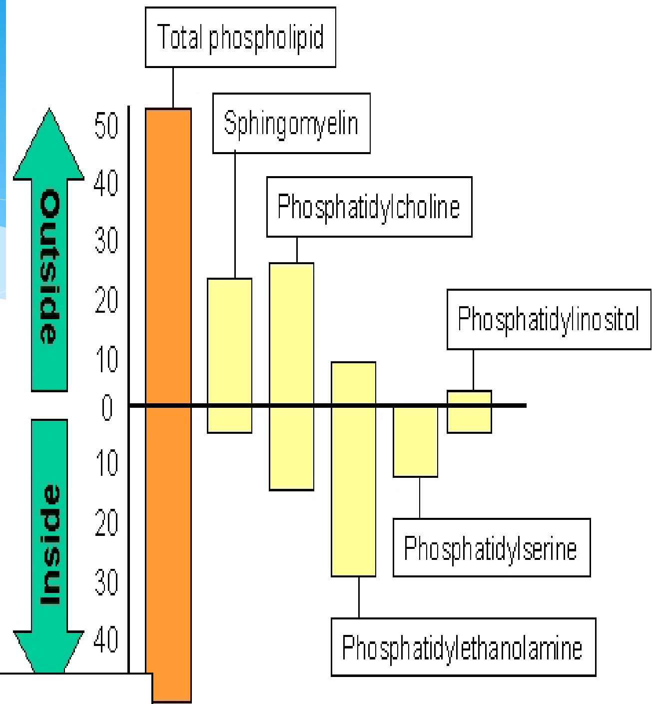
Phospholipids contain **Glycerol**:

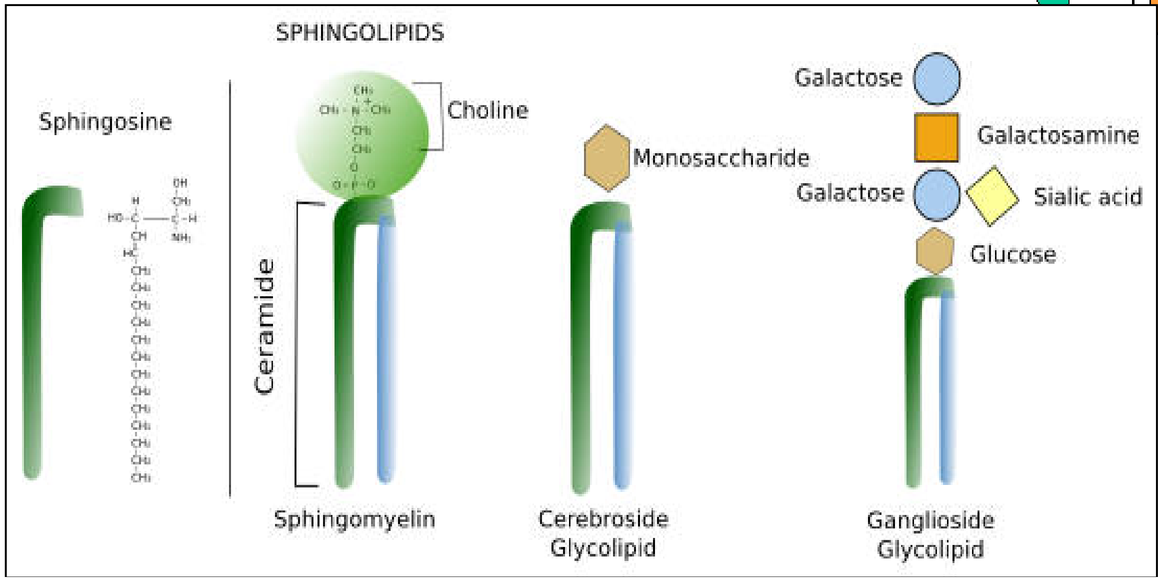
Phosphatidylserine, **Phosphatidylethanolamine**, **Phosphatidylinositol**, and **Phosphatidylcholine**.

B. Sphingo PL

Phospholipids contain **Sphingosine** :

sphingomyelin.Cerebroside and **Ganglioside** glycolipids



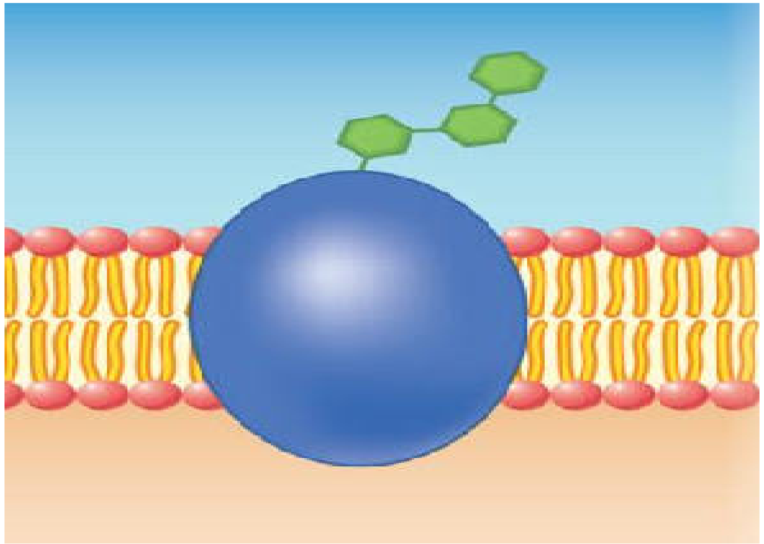


2. Cholesterol

An **amphipathic** molecule, cholesterol contains a polar hydroxyl group as well as a hydrophobic steroid ring and attached hydrocarbon.

It is dispersed throughout cell membranes, intercalating between phospholipids.

Its polar hydroxyl group is near the polar head groups of the phospholipids while the steroid ring and hydrocarbon tails of cholesterol are oriented parallel to those of the phospholipids.



3. Glycolipids

Lipids with attached **carbohydrate** (sugars), glycolipids are found in cell membranes in lower concentration than phospholipids and cholesterol.

The carbohydrate portion is always oriented **toward the outside of the cell,** projecting into the environment.

Glycolipids help to form **the carbohydrate coat** observed on cells and are involved in cell-to-cell interactions

PROTEINS

Largely responsible for many **biological functions** of the membrane. For example, some membrane proteins function in **transport** of materials into and out of cells. Others serve as **receptors** for hormones.

The types of proteins within a plasma membrane vary depending on the cell type. However, all membrane proteins are associated with membrane in one of three main ways.

1- **Transmembrane** (**Intrinsic**) with **hydrophobic midsections** between hydrophilic ends exposed on both sides.

These proteins are oriented with their **hydrophilic portions** in contact with the aqueous exterior environment and with the cytosol and their **hydrophobic portions** in contact with the fatty acid tails of the phospholipids.

Integral proteins are **difficult to remove from membrane**, You must use **detergents** to dissolve it away (A, B)

2- Peripheral proteins (Extrinsic)

They are not **embedded** but attached to the membrane's surface.

May be attached to integral proteins (C,F)

On cytoplasmic side, may be held **by filaments of cytoskeleton**.

They are easy to remove from membrane when treated with high salt and the membrane is not destroyed

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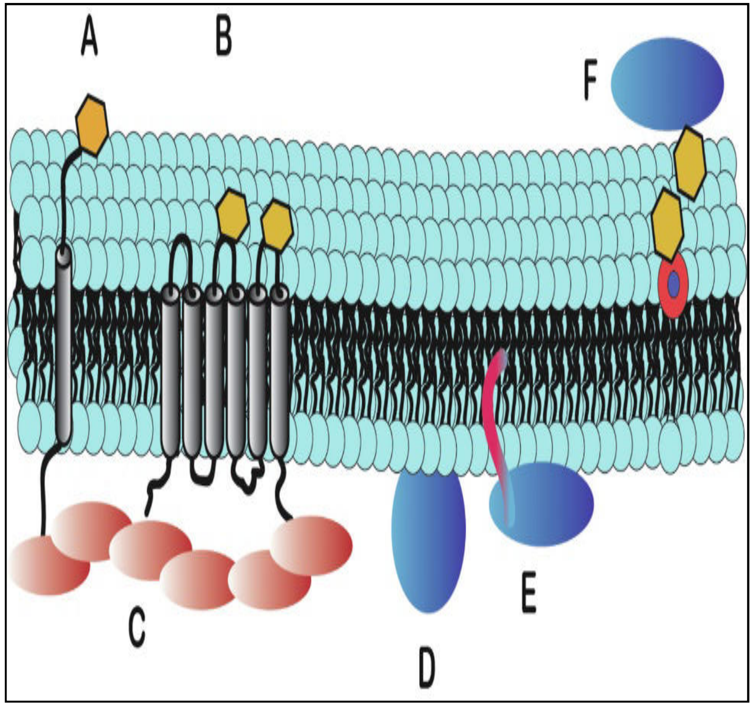
3- Lipid-anchored proteins

They are attached **covalently to a portion of a lipid** without entering the core portion of the bilayer of the membrane (E)



(A) **Single-pass** glycosylated integral membrane protein (note that a single **α-helical segment** of the protein crosses the bilayer);

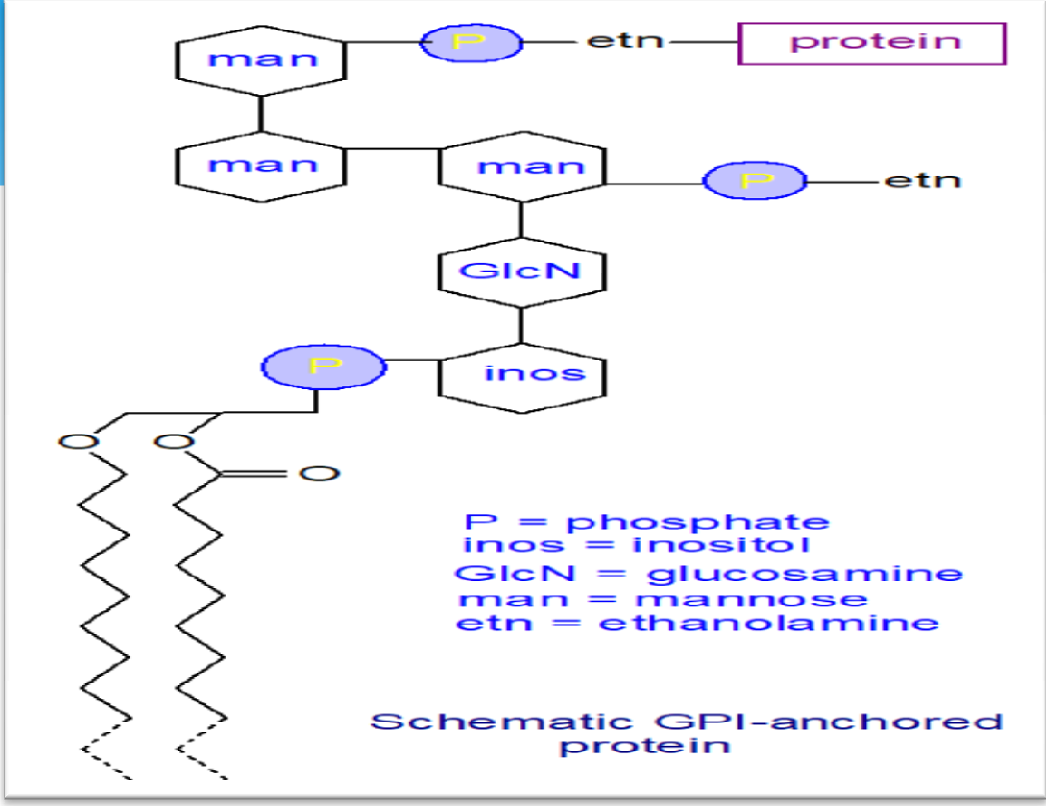
(B) **Multipass** glycosylated integral membrane protein (this structure is found in transporters and membrane channels);

(C) Membrane proteins can interact with membrane **skeleton protein** structures to stabilize the membrane;

(D) Peripheral membrane protein associated with the **polar head groups of phospholipids** by an ionic interaction;

(E) Membrane protein for which the protein itself does not enter the bilayer but instead is **covalently linked to a fatty acid tail**;

(F) A membrane protein for which the protein itself does not enter the bilayer but instead is **covalently linked by sugars to phosphatidylinositol (glycosylphosphatidylinositol(GPI)-anchored proteins)**



Both **transmembrane** and **lipid-anchored proteins are integral membrane proteins** since they can only be removed from a membrane by **disrupting the entire membrane structure.**

Carbohydrates

Found only on the **outer side** of the bilayer.

Glycolipids are differentially arranged as well and are always on **the outer leaflet** with their attached carbohydrate projecting away from the cell.

Glycoproteins are similarly oriented on the outer leaflet with carbohydrates projecting into the environment.

The **glycocalyx** is a **polysaccharide**-based gel-like, highly hydrous cellular thin layer, covering present outside the cell. It acts as an interface between the **extracellular matrix** and **cellular membrane.** Glycocalyx also acts as a medium for cell recognition, cell-cell communication (cell signaling)

Membrane Fluidity

Most membrane lipids and some proteins can drift laterally within the membrane.

The fluidity of the membraneis influenced by:

phospholipids

chain length

saturation

Cholesterol content

Molecules rarely flip transversely across the membrane, because hydrophilic parts would have to cross the membrane's hydrophobic core.

Lipid Movements: motion of phospholipids within the lipid bilayer.

(A) The fatty acids tails undergo constant flexion as they interact with their neighbors.

(B) Phospholipids can rotate rapidly around a central axis.

(C) They are able to move in the plane of the bilayer at very fast rates.

(D) Lipids are capable of transbilayer movement (**flip-flop)**.

Phospholipids can drift laterally in the plane of the membrane

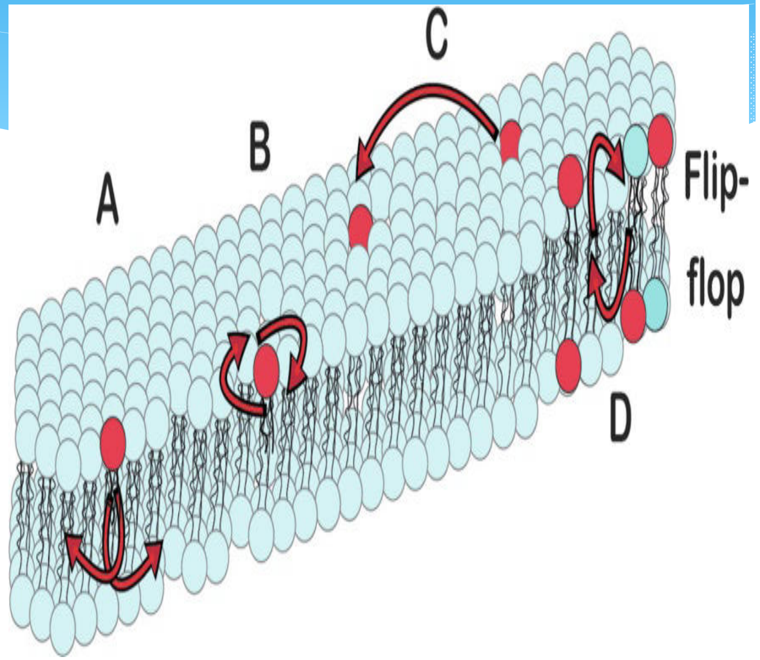
(an average lipid molecule can diffuse the length of a large

bacterial cells (~ 2 µm) in about 1 second) =

lateral movement (frequently)

Also, phospholipids can migrate from the monolayer

on one side to that on the other = **flipflop** (rarely).



Temperature

At low temperature, membrane is less fluid and because the phospholipids are more closely packed.

Membrane fluidity is influenced by the saturation of the phospholipid fatty acid tails

•**More saturation** = stiffer

•**Less saturation** = more fluid

Membranes rich in **unsaturated** fatty acids are; **more fluid** that those dominated by **saturated** fatty acids because the kinks in the unsaturated. fatty acid tails prevent tight packing

Steroid **cholesterol** which is wedged between phospholipids also effects membrane fluidity.

At warm **temperature**, it makes membrane less fluid by restraining the movement of phospholipid.

At **low** temperature, the membrane remains fluid because cholesterol hinders the close packing of the phospholipids

Membrane proteins drift more slowly than lipids

Membranes are Asymmetrical

Cholesterol can readily flip-flop or move from one leaflet to the other and is distributed on both sides of the membrane bilayer

Peripheral membrane proteins are attached only to the inner membrane leaflet, facing the cytoplasm. Therefore, the inner and outer membrane leaflets have different compositions and each can have functions distinct from those of the other.

The inner surface is supported by the cytoskeleton; some peripheral membrane proteins attach to the cytoskeleton.

The different types of phospholipids are distributed asymmetrically in the 2 phospholipid layers:

PC is usually in the outer layer and **PS, PI** and **PE** are in the inner bilayer.

During the process of programmed **cell death**, **phosphatidylserine** is transferred enzymatically from the inner leaflet to the outer leaflet of the membrane. The presence of phosphatidylserine on the outer leaflet then triggers **phagocytic** removal of the dying cells