

# The structure and function of the plasma membrane

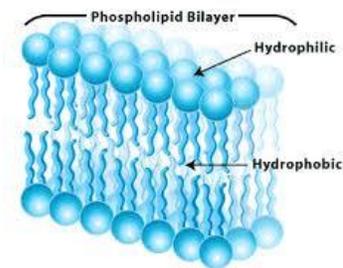
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Our current view of membrane structure is based on the fluid mosaic model. This model proposes that membranes are not rigid, with molecules locked into place. Instead, membranes consist of lipid molecules in which proteins are embedded and float freely.

The **plasma membrane**, the outermost part of the cell, is a thin layer of lipids, proteins and a small amount of carbohydrates that control what goes in and what goes out of the cell.

## THE ROLE OF PHOSPHOLIPIDS

Most of the lipids in the cell membrane are **phospholipids**. Phospholipids form a lollipop-shaped molecule with a *polar* (charged) head and a *nonpolar* (uncharged) tail. These phospholipids molecules found in the cell membrane are arranged in a double layer (or bilayer). The polar heads of the outer layer of phospholipid molecules face the watery extracellular fluid, and the polar heads of the inner layer molecules are directed inward toward the watery cytoplasm.



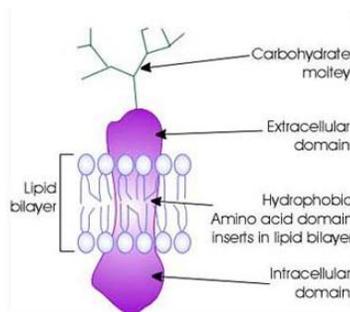
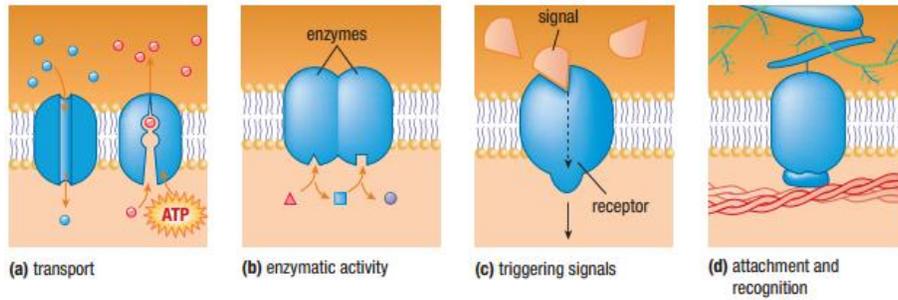
## THE ROLE OF MEMBRANE PROTEINS

Interspersed in the lipid bilayer of human cells are large protein molecules known as **integral proteins**. The integral proteins of the plasma membrane are globular structures that float freely like giant icebergs in their sea of lipid.

- **Integral membrane protein** – is a protein that is embedded in the liquid bilayer.
- **Peripheral membrane protein** – is a protein on the surface of the membrane.

The array of proteins found in the plasma membrane, determines its function and its uniqueness. When several proteins are joined together they form **pores** (channels) that permit movement of molecules in and out of the cell. Other proteins attach to the underlying cytoskeleton anchoring the plasma membrane in place. There are four functional categories of proteins;

- a) **Transport:** certain substances are unable to diffuse through the membrane, therefore they must pass through hydrophilic protein channels.
- b) **Enzymatic Signals:** proteins associated with respiration and photosynthesis, are enzymes.
- c) **Triggering Signals:** Membrane proteins can bind to hormone signals, which can cause changing events in the cell.
- d) **Attachment and Recognition:** These proteins are found on both the internal and external surfaces. One example would be the recognition of invading microbes and stimulation an immune response.



Plasma membranes contain small but significant amounts of **carbohydrates**. These segments attach to the integral proteins that protrude into the extracellular fluid. A protein combined with a carbohydrate is a **glycoprotein**. Similarly, a lipid bound to a carbohydrate is a **glycolipid**.

**Cholesterol** molecules, known as membrane stabilizers, are found in the plasma membrane, wedged between the phospholipid molecules at lower temperatures. Although their function is not well understood, they appear to make the membrane more elastic at high temperatures and help restrain the movement of the phospholipids in the bilayer.

## FUNCTION OF THE CELL MEMBRANE

The plasma membrane regulates the flow of molecules in and out of the cell. This helps maintain the chemical concentrations inside and outside the cell.

Because the cell membrane regulates the molecular traffic, it is said to be selectively permeable. In other words, it decides what enters and what leaves the cell.

# Transport Across Membranes

## 1) PASSIVE MEMBRANE TRANSPORT

**Passive transport** – is the movement of a substance across a membrane without expending energy.

**Dynamic equilibrium** – is the state in which continuous action results in balanced conditions.

This passive motion occurs because molecules are always in constant motion, and in a closed environment become uniformly distributed.

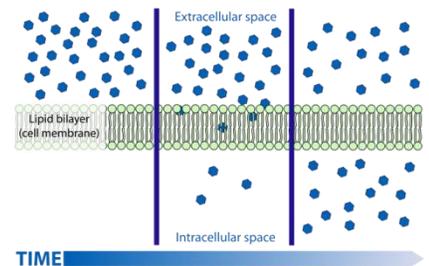
If molecules are more concentrated on one side of a membrane, these molecules will eventually travel across the membrane creating a dynamic equilibrium. The rate of diffusion is controlled by the concentration gradient that exists between the two sides or across the membrane. The larger the concentration gradient the faster the rate of diffusion occurs.

Membranes are selectively permeable, which means that some substance can pass through freely while others cannot or require assistance. The size and charge of the molecules determines whether or not a molecule will pass across the membrane. The two types of passive transport are simple diffusion and facilitated diffusion.

### SIMPLE DIFFUSION:

**Lipid-soluble** substances pass directly through the membrane via diffusion.

**Diffusion** refers to any unassisted movement of molecules or ions from high concentration to low concentration. Steroid hormones, oxygen, carbon dioxide are all lipid soluble therefore they can pass directly through the lipid bilayer. **Water soluble** materials cannot pass through the lipid bilayer and must travel via other routes.



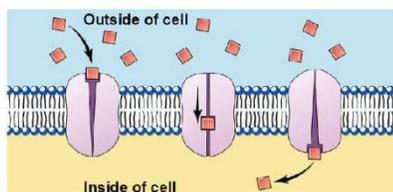
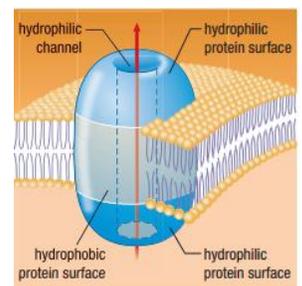
### FACILITATED DIFFUSION

Many polar and charged molecules, such as water, amino acids and sugars diffuse across the membrane with the help of protein complexes that span the membrane based on a concentration gradient from regions of high concentration to regions of low concentration.

These transport proteins that extend throughout the membrane fall into two types of proteins:

**Channel Proteins** and **Carrier Proteins**.

**Channel Proteins** form hydrophilic pathways in the membrane in which water and certain ions can pass through. Other channel proteins will facilitate the transport of ions ( $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^+$ ,  $\text{Cl}^-$ ).

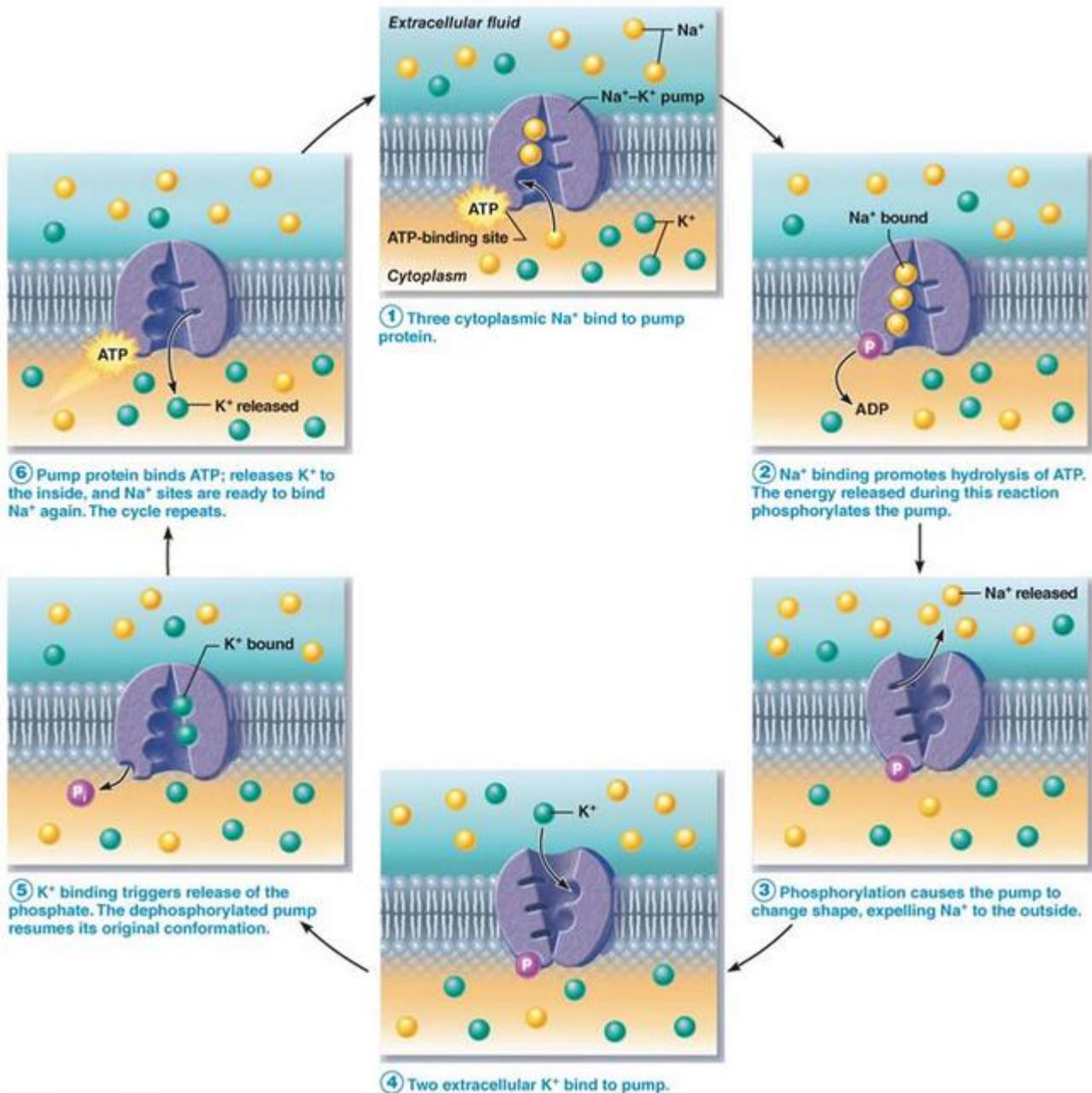


**Carrier Proteins** bind to a specific solute, such as a glucose molecule or a particular amino acid and transports it across the lipid bilayer by changing shape, allow the solute to move from one side to the other. Many proteins are very selective about which solute they will carry which allows for tight control of what gets in and out of the cells.

## 2) ACTIVE MEMBRANE TRANSPORT

Active transport is the movement of molecules across the cell membrane with the aid of protein carrier molecules in the plasma membrane and with energy supplied by a special molecule called ATP.

During primary active transport, positively charge ions are transported from regions of low concentrations to regions of high concentrations. This is called "*against the concentration gradient*". When the cell needs energy to move molecules across its membrane, ATP splits off a phosphate, forming ADP and energy.

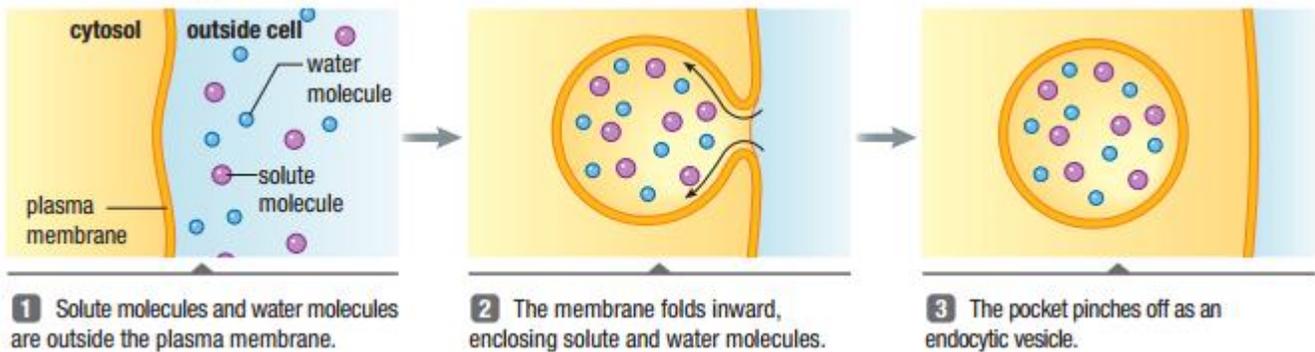


## ENDOCYTOSIS AND EXOCYTOSIS

Large molecules that are unable to pass across the membrane by either passive or active transport, but are still required by the cell, must have a method of entering the cell. Exocytosis is the movement of large molecules out of the cell, and Endocytosis is the movement of molecules into the cell. These processes actually require the membrane to form around materials entering and the membrane reattaching as material leaves.

### 1) ENDOCYTOSIS

In endocytosis, proteins and other substances are trapped in pit-like depressions that bulge inward from the plasma membrane. The depression then pinches off as an endocytic vesicle.



### 2) EXOCYTOSIS

This is essentially the reverse of endocytosis. Proteins and hormones are packaged in membrane bound vesicles. These vesicles migrate to the plasma membrane and fuse with them. At the point of fusion, the membrane breaks down, and the proteins or hormone is release in the extracellular fluid.

