Lecture Three: Plasma Membrane Functions

The plasma membrane keeps a **cell intact**. It allows only certain molecules and ions to enter and exit the cytoplasm freely. Therefore, the plasma membrane is said to be **selectively permeable** (Figure 1). Small, lipid-soluble molecules, such as oxygen and carbon dioxide, can pass through the membrane easily. The small size of water molecules allows them to freely cross the membrane by using protein channels called **aquaporins**.

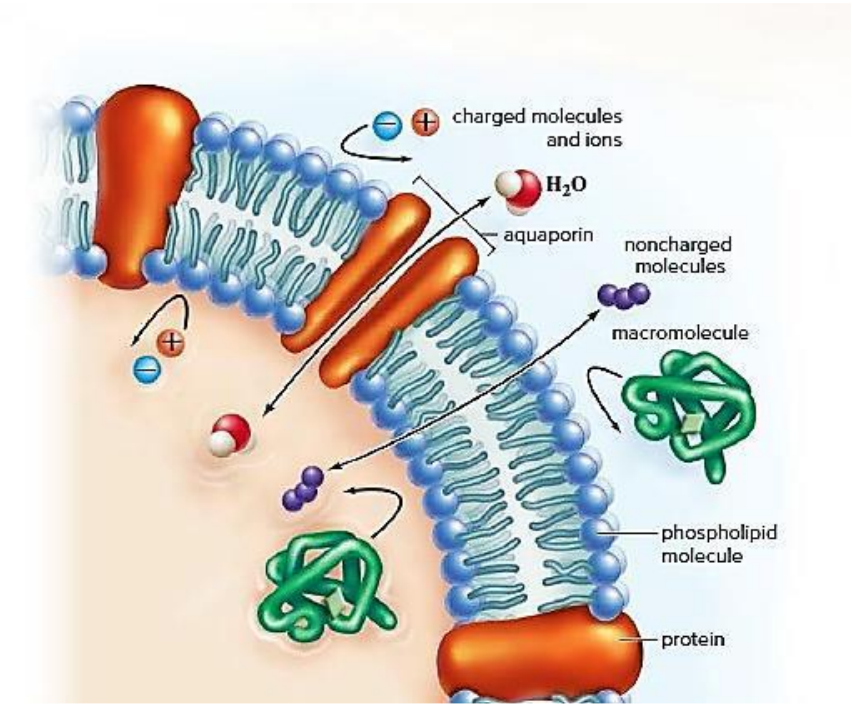


Figure 1: Selective permeability of the plasma membrane

Plasma membrane contributes in different activities:

1-Diffusion

Diffusion is the random movement of molecules from an area of higher concentration to an area of lower concentration, until they are equally distributed. Diffusion is a passive way with no cellular energy is needed (Figure 2). Oxygen diffuses across the plasma membrane, and the net movement is toward the inside of the cell. This is because a cell uses oxygen when it produces ATP molecules for energy purposes.

2-Osmosis

Osmosis is the net movement of water across a semipermeable membrane, from an area of higher concentration to an area of lower concentration. The membrane separates the two areas, and solute is unable to pass through the membrane. Water will tend to flow from the area that has less solute (and therefore more water) to the area with more solute (and therefore less water). Tonicity refers to the osmotic characteristics of a solution across a particular membrane, such as a red blood cell membrane. Normally, body fluids are isotonic to cells.

There is the same concentration of non-diffusible solutes and water on both sides of the plasma membrane. Therefore, cells maintain their normal size and shape. Intravenous solutions given in medical situations are usually isotonic. Solutions that cause cells to swell or even to burst due to an intake of water are said to be hypotonic. A hypotonic solution has a lower concentration of solute and higher concentration of water than the cells. If red blood cells are placed in a hypotonic solution, water enters the cells. They swell to bursting. Lysis is used to refer to the process of bursting cells. Bursting of red blood cells is termed hemolysis. Solutions that cause cells to shrink or shrivel due to loss of water are said to be hypertonic. A hypertonic solution has a higher concentration of solute and lower concentration of water than do the cells. If red blood cells are placed in a hypertonic solution, water leaves the cells; they shrink. These changes have occurred due to osmotic pressure which control water movement in our bodies. For example, in the small and large intestines, osmotic pressure allows us to

absorb the water in food and drink. In the kidneys, osmotic pressure controls water absorption as well.

Osmosis and Diffusion Similarities

Osmosis and diffusion are related processes that display similarities:

- Both osmosis and diffusion equalize the concentration of two solutions.
- Both diffusion and osmosis are passive transport processes, which means they do not require any input of extra energy to occur. In both diffusion and osmosis, particles move from an area of higher concentration to one of lower concentration.

Osmosis and Diffusion Differences

- Diffusion can occur in any mixture, including one that includes a semipermeable membrane, while osmosis always occurs across a semipermeable membrane.
- Osmosis in biology, it always refers to the movement of water. In chemistry, it's possible for other solvents to be involved. In biology, this is a difference between the two processes.
- One big difference between osmosis and diffusion is that both solvent and solute particles are free to move in diffusion, but when we talk about osmosis, only the solvent molecules (water molecules) cross the membrane.

3-Facilitated Transport

Many solutes do not simply diffuse across a plasma membrane. They are transported by means of protein carriers within the membrane. During facilitated transport, a molecule is transported across the plasma membrane from the side of higher concentration to the side of lower

concentration (Figure 3). This is a passive means of transport because the cell does not need to expend energy to move a substance down its concentration gradient. Each protein carrier, sometimes called a transporter, binds only to a particular molecule, such as glucose.

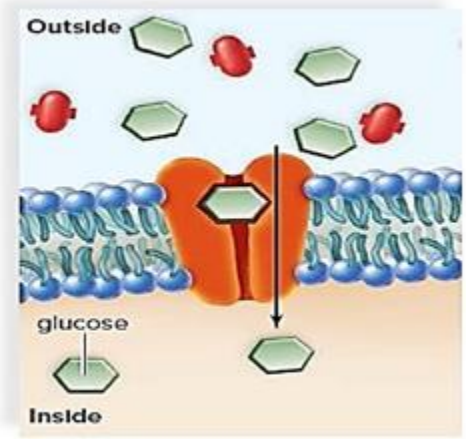


Figure 3: Plasma membrane facilitated transport

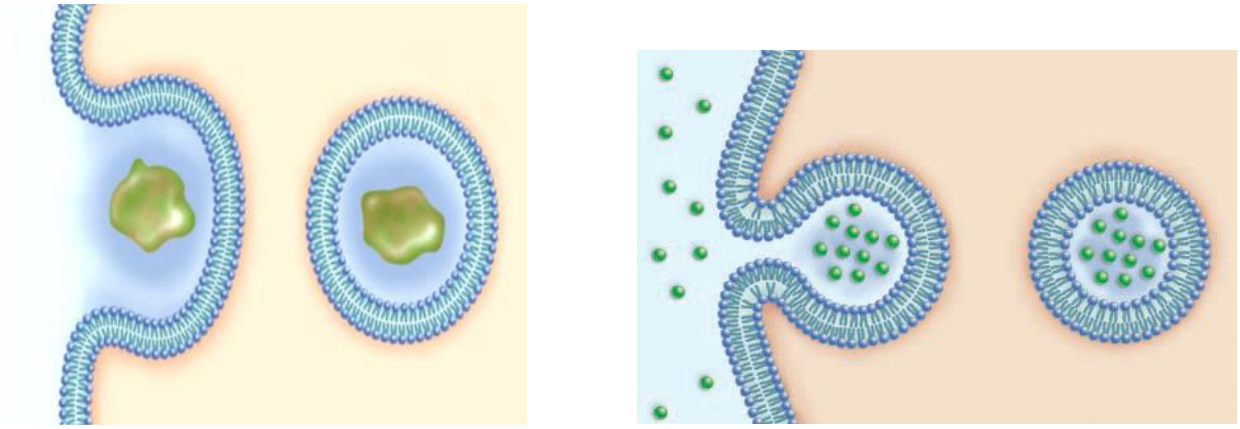
4- Active Transport

During active transport, a molecule is moving from a lower to higher concentration. One example is the digestive tract; sugar is completely absorbed from the gut by cells that line the intestines. Active transport requires a protein carrier and the use of cellular energy obtained from the breakdown of ATP. When ATP is broken down, energy is released. In this case, the energy is used to carry out active transport. Proteins involved in active transport often are called pumps. Just as a water pump uses energy to move water against the force of gravity, energy is used to move substances against their concentration gradients.

5-Endocytosis and Exocytosis

During endocytosis, a portion of the plasma membrane invaginates, or forms a pouch, to envelop a substance and fluid. Then the membrane pinches off to form an endocytic vesicle inside the cell (Figure 4). Some

white blood cells are able to take up pathogens (disease-causing agents) by endocytosis. Here the process is given a special name: phagocytosis. Usually, cells take up molecules and fluid, and then the process is called pinocytosis. During exocytosis, a vesicle fuses with the plasma membrane as secretion occurs. This is the way that signaling molecules, called neurotransmitters, leave one nerve cell to excite the next nerve cell or a muscle cell.



A. Endocytosis (Phagocytosis) **B. Pinocytosis**

Figure 4: Movement of large molecules across the membrane