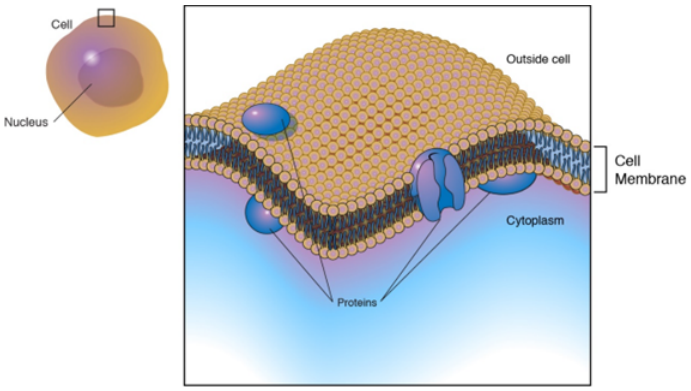
6.8: Cell membrane

Learning Objectives

- Define and understand the composition of the cell membrane and how the composition adjusts the fluidity fo the membrane.
- Understand three modes of transport through the cell membrane: diffusion, facilitated transport, and active transport.

What is a cell membrane?

The cell membrane, also known as the plasma membrane, cytoplasmic membrane, and plasmalemma, is a lipid bilayer with proteins dispersed in it that separates the cell interior from the extracellular space, as illustrated in the figure on the right (*Copyright; National Human Genome Research Institute, Public domain*).



Composition of the cell membrane

A cell membrane is a complex structure with several components, as shown in Figure 6.8.1. and described here.

- Phospholipid bilayer that has polar heads on the outside in contact with water and nonpolar tails inside the bilayer. Unsaturated fatty acids in the lipid hydrophobic tails increase the membrane fluidity -the more proportion of unsaturated fatty acids, the higher the fluidity.
- Cholesterol interspersed between phospholipids controls the rigidity of the membrane -the more the proportion of cholesterol, the more rigid the membrane.
- Two types of proteins: integral proteins that span the membrane and serve as transporters of species, and peripheral proteins that are loosely attached to the outer side of the membrane that act as enzymes to facilitate the interaction with the cell's environment.
- Glycoproteins and glycolipids have carbohydrate oligomers attached to the outer lipid layer and serve the purpose of cell-to-cell recognition.

The cell membrane controls the movement of substances in and out of the cells and organelles. It is selectively permeable to ions and organic molecules. It plays a role in cell adhesion, cell signaling, and attachment surface for the cytoskeleton to shape the cells and attach to the extracellular matrix to hold them together in tissues.

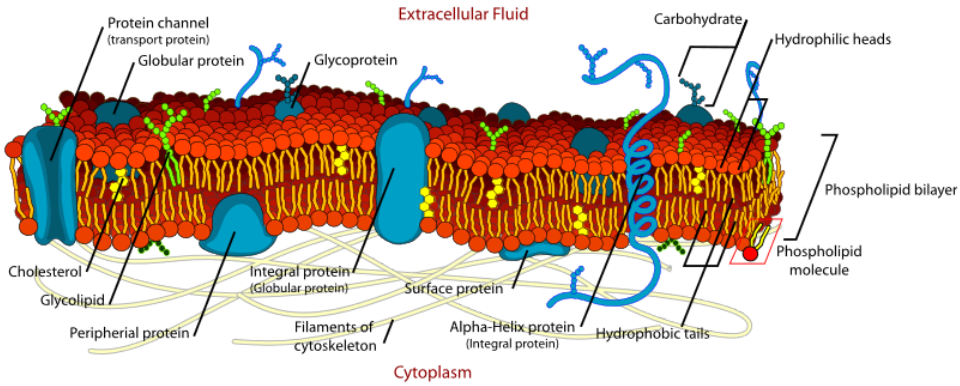


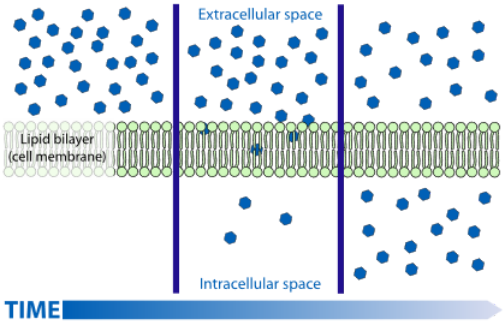
Figure 6.8.1: A detailed cell membrane structure. (Copyright; LadyofHats, Public domain, via Wikimedia Commons)

Transport through the cell membrane

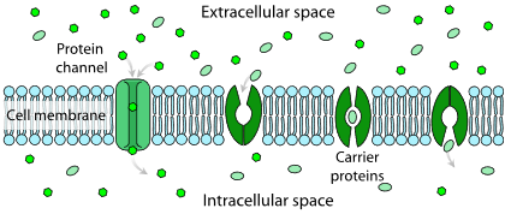
The cell membrane is a partition between intracellular and extracellular spaces. Still, some substances needed by the cell need to enter, and some products or wastes need to exit the cell. The cell membrane allows a selective movement of substances in and out of the cell in several ways.

Diffusion (passive) transport

The molecules in the lipid bilayer are vibrating due to thermal energy. Therefore, some molecules, such as O_2, CO_2, urea, water, etc., can move across the membrane from a higher concentration region to a lower concentration region through the process of diffusion, as illustrated in Figure $6.8.2$ left.



Diffusion or passive transport



Facilitated transport through protein channels or carrier protein

Figure 6.8.2: Illustration of diffusion and facilitated transport across the cell membrane. (Copyright; LadyofHats, Public domain, via Wikimedia Commons)

Facilitated transport

Integral proteins form channels through which certain substances can diffuse more rapidly than by simple diffusion. The proteins have a channel size that matches the substance's size or changes the shape to adjust to the size of the substance that needs to be selectively transported through the facilitated transport, as illustrated in Figure $6.8.2$ right. Particularly, water-soluble substances such as chloride ion (Cl^-), bicarbonate ion HCO_3^-, and glucose molecules do not move fast enough through simple diffusion and are transported by the facilitate transport process to meet the need of the cells.

Active transport

Sometimes substances need to be moved against the concentration gradient. It takes place at the expense of energy in the form of ATP, just like pumping substances at the cost of electricity in everyday life. For example, K^+ concentration is greater inside the cell, and that of Na^+ is greater outside the cell. In the conduction of nerve impulses and contraction of muscles, K^+ moves into the cell, and Na^+ moves out of the cell by active transport process, as illustrated in Figure $6.8.3$.

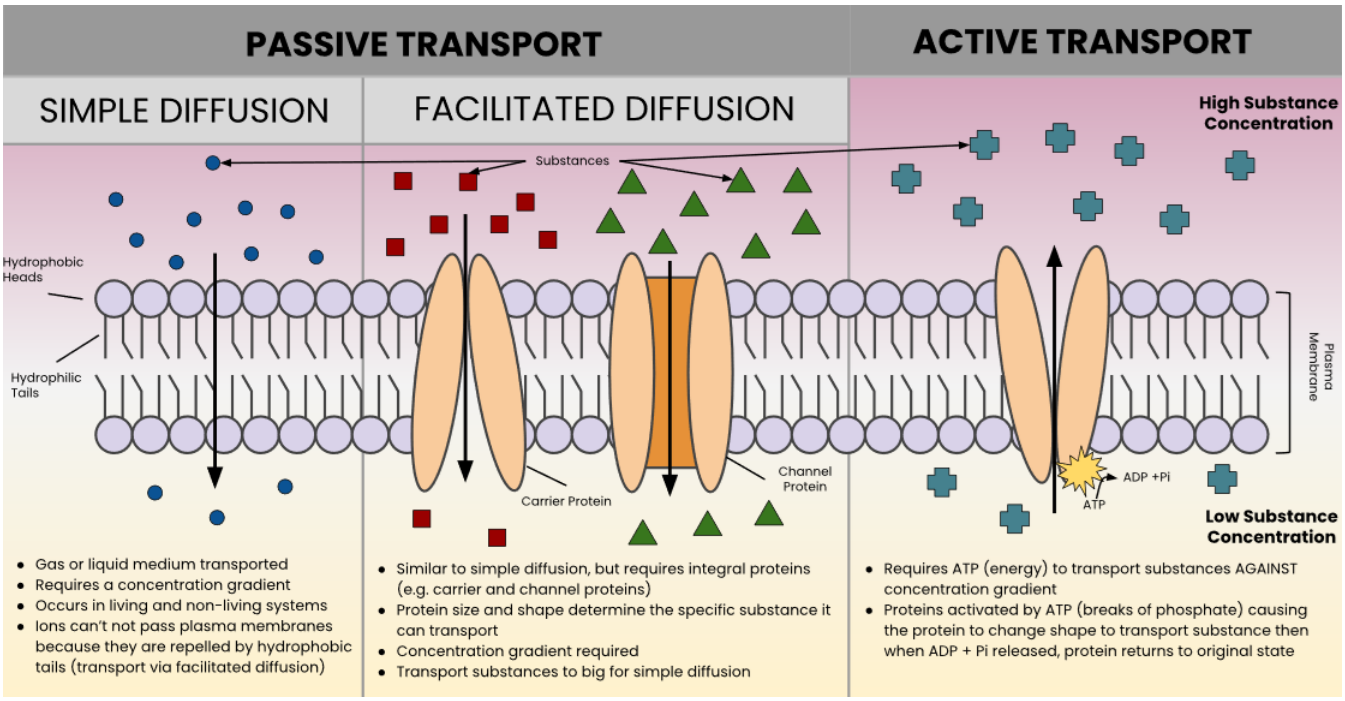


Figure 6.8.3: Comparison of membrane transport methods: passive transport, which includes simple and facilitated diffusion, and active transport, which takes place at the expense of energy. (Copyright; LSumi, CC BY-SA 4.0, via Wikimedia Commons)