2. 14: Facilitated Diffusion

Can you help me move?

What is one of the questions no one likes to be asked? Sometimes the cell needs help moving things as well, or facilitating the diffusion process. And this would be the job of a special type of protein.

Facilitated Diffusion

What happens if a substance needs assistance to move across or through the plasma membrane? Facilitated diffusion is the diffusion of solutes through transport proteins in the plasma membrane. Facilitated diffusion is a type of passive transport. Even though facilitated diffusion involves transport proteins, it is still passive transport because the
solute is moving down the concentration gradient.

Small nonpolar molecules can easily diffuse across the cell membrane. However, due to the hydrophobic nature of the lipids that make up cell membranes, polar molecules (such as water) and ions cannot do so. Instead, they diffuse across the membrane through transport proteins. A transport protein completely spans the membrane, and allows certain molecules or ions to diffuse across the membrane. Channel proteins, gated channel proteins, and carrier proteins are three types of transport proteins that are involved in facilitated diffusion.

A channel protein, a type of transport protein, acts like a pore in the membrane that lets water molecules or small ions through quickly. Water channel proteins (aquaporins) allow water to diffuse across the membrane at a very fast rate. Ion channel proteins allow ions to diffuse across the membrane.

A gated channel protein is a transport protein that opens a "gate," allowing a molecule to pass through the membrane. Gated channels have a binding site that is specific for a given molecule or ion. A stimulus causes the "gate" to open or shut. The stimulus may be chemical or electrical signals, temperature, or mechanical force, depending on the type of gated channel. For example, the sodium gated channels of a nerve cell are stimulated by a chemical signal which causes them to open and allow sodium ions into the cell. Glucose molecules are too big to diffuse through the plasma membrane easily, so they are moved across the membrane through gated channels. In this way glucose diffuses very quickly across a cell membrane, which is important because many cells depend on glucose for energy.

A carrier protein is a transport protein that is specific for an ion, molecule, or group of substances. Carrier proteins "carry" the ion or molecule across the membrane by changing shape after the binding of the ion or molecule. Carrier proteins are involved in passive and active transport. A model of a channel protein and carrier proteins is shown in Figure below.

Facilitated diffusion through the cell membrane. Channel proteins and carrier proteins are shown (but not a gated-channel protein). Water molecules and ions move through channel proteins. Other ions or molecules are also carried across the cell membrane by carrier proteins. The ion or molecule binds to the active site of a carrier protein. The carrier protein changes shape, and releases the ion or molecule on the other side of the membrane. The carrier protein then returns to its original shape.

An animation depicting facilitated diffusion can be viewed at http://www.youtube.com/watch?v=OV4PgZDRTQw (1:36).
Ion Channels

Ions such as sodium ($\text{Na}^+$), potassium ($\text{K}^+$), calcium ($\text{Ca}^{2+}$), and chloride ($\text{Cl}^-$), are important for many cell functions. Because they are charged (polar), these ions do not diffuse through the membrane. Instead they move through ion channel proteins where they are protected from the hydrophobic interior of the membrane. Ion channels allow the formation of a concentration gradient between the extracellular fluid and the cytosol. Ion channels are very specific, as they allow only certain ions through the cell membrane. Some ion channels are always open, others are "gated" and can be opened or closed. Gated ion channels can open or close in response to different types of stimuli, such as electrical or chemical signals.

Summary

- Facilitated diffusion is the diffusion of solutes through transport proteins in the plasma membrane. Channel proteins, gated channel proteins, and carrier proteins are three types of transport proteins that are involved in facilitated diffusion.

Explore More

Explore More I

Use this resource to answer the questions that follow.


1. Define facilitative diffusion.
2. Describe the alternating access model.
3. What is meant by the occluded state?
4. What occurs after the occluded state?

Explore More II

Review

1. What is facilitated diffusion?
2. What is a transport protein? Give three examples.
3. Assume a molecule must cross the plasma membrane into a cell. The molecule is very large. How will it be transported into the cell?
4. Explain how carrier proteins function?
5. Explain the role of ion channels. Why are ion channels necessary?