How does stuff get into and out of a living cell?

Introduction

Imagine living in a house that has walls without any windows or doors. Nothing could enter or leave the house. Now imagine living in a house with holes in the walls instead of windows and doors. Things could enter or leave the house, but you wouldn't be able to control what came in or went out. Only if a house has walls with windows and doors that can be opened or closed can you control what enters or leaves. For example, windows and doors allow you to let the dog in and keep the bugs out.

Transport Across Membranes

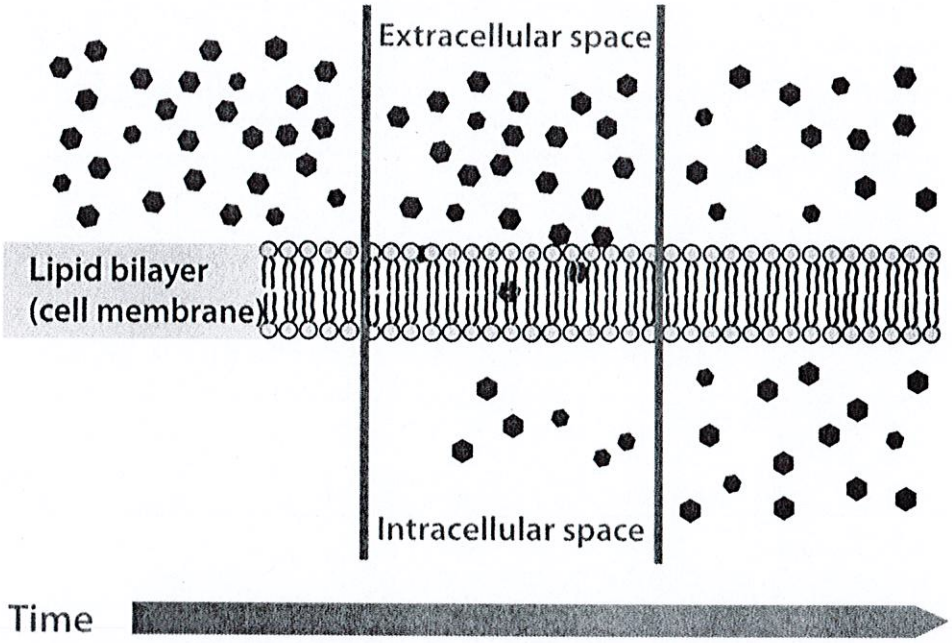
If a cell were a house, the cell membrane would be walls with windows and doors. Moving things in and out of the cell is an important role of the cell membrane. It controls everything that enters and leaves the cell. There are two basic ways that substances can cross the cell membrane: passive transport and active transport.

I. Passive Transport

Passive transport occurs when substances cross the cell membrane without the cell having to use energy. No energy is needed because the substances are moving from an area where they have a higher concentration to an area where they have a lower concentration. A substance always moves from an area where it is more concentrated to an area where it is less concentrated. It's a little like a ball rolling down a hill. It goes by itself without any input of extra energy.

There are several different types of passive transport, including simple diffusion, osmosis, and facilitated diffusion.

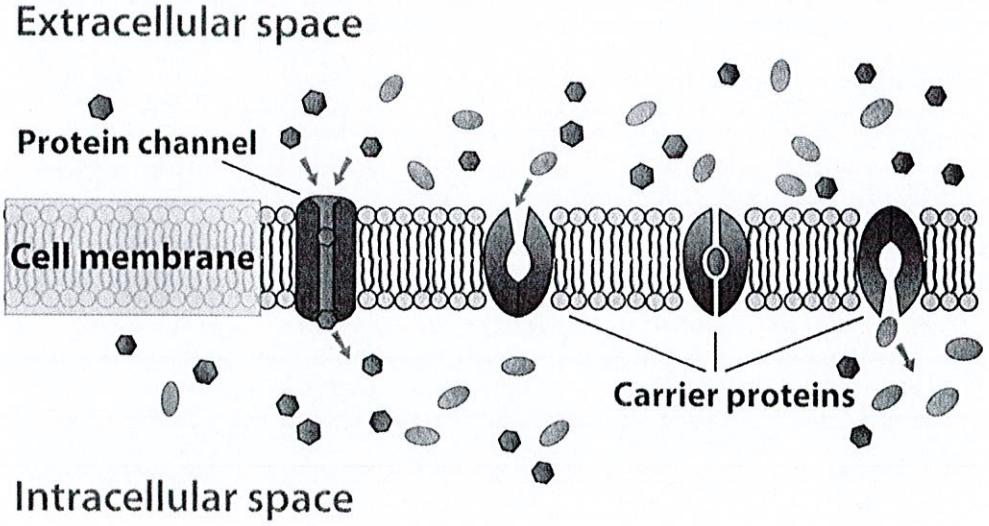
- **Diffusion** is the movement of a substance across a membrane, due to a difference in concentration, without any help from other molecules. The substance simply moves from the side of the membrane where it is more concentrated to the side where it is less concentrated. Molecules like oxygen and carbon dioxide can squeeze through the membrane to get in or out.



Diffusion Across a Cell Membrane. Molecules diffuse across a membrane from an area of higher concentration to an area of lower concentration until the concentration is the same on both sides of the membrane.

- **Osmosis** is a special type of diffusion — the diffusion of water molecules across a membrane. Like other molecules, water moves from an area of higher concentration to an area of lower concentration. Water moves in or out of a cell until its concentration is the same on both sides of the cell membrane.

- **Facilitated Diffusion** Water and many other substances cannot simply diffuse across a membrane. Glucose, water, and other large molecules need help getting through the cell membrane. Diffusion with the help of transport proteins is called **facilitated diffusion**. There are several types of transport proteins, including channel proteins and carrier proteins. Both are shown in **Figure** below.
    - *Channel proteins* form pores, or tiny holes, in the membrane. This allows water molecules and small ions to pass through the membrane without coming into contact with the hydrophobic tails of the lipid molecules in the interior of the membrane.
    - *Carrier proteins* bind with specific ions or molecules, and in doing so, they change shape. As carrier proteins change shape, they carry the ions or molecules across the membrane.

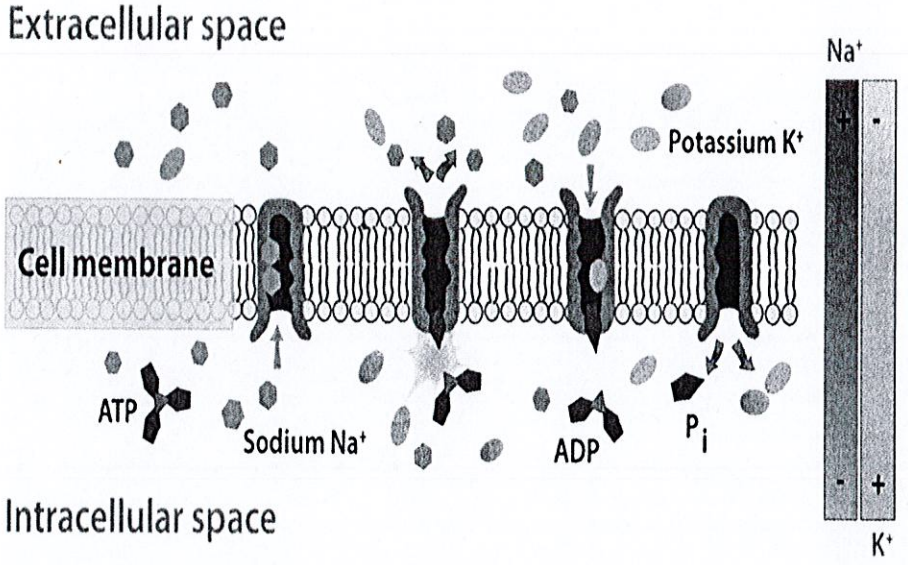


Facilitated Diffusion Across a Cell Membrane. Channel proteins and carrier proteins help substances diffuse across a cell membrane. In this diagram, the channel and carrier proteins are helping substances move into the cell (from the extracellular space to the intracellular space).

II. Active Transport

Active transport occurs when energy is needed for a substance to move across a plasma membrane. Energy is needed because the substance is moving from an area of lower concentration to an area of higher concentration. This is a little like moving a ball uphill; it can't be done without adding energy. The energy for active transport comes from the energy-carrying molecule called ATP. Like passive transport, active transport may also involve transport proteins. You can watch an animation of active transport at the link below.

- **Sodium-Potassium Pump** An example of active transport is the **sodium-potassium pump**. When this pump is in operation, sodium ions (salt) are pumped out of the cell, and potassium ions are pumped into the cell. Both ions move from areas of lower to higher concentration, so ATP is needed to provide energy for this "uphill" process. **Figure** below explains in more detail how this type of active transport occurs.



The sodium-potassium pump. The sodium-potassium pump moves sodium ions (Na+) out of the cell and potassium ions (K+) into the cell. First, three sodium ions bind with a carrier protein in the cell membrane. Then, the carrier protein receives a phosphate group from ATP. When ATP loses a phosphate group, energy is released. The carrier protein changes shape, and as it does, it pumps the three sodium ions out of the cell. At that point, two potassium ions bind to the carrier protein. The process is reversed, and the potassium ions are pumped into the cell.

- **Vesicle Transport** Some molecules, such as proteins, are too large to pass through the plasma membrane, regardless of their concentration inside and outside the cell. Very large molecules cross the plasma membrane with a different sort of help, called **vesicle transport**. Vesicle transport requires energy, so it is also a form of active transport. There are two types of vesicle transport: endocytosis and exocytosis.

III. Homeostasis

The purposes of active and passive transport are to keep a balance of water, sodium, and nutrients in each of the cells. The process of keeping a balance of importance factors in a living organism is called **homeostasis**. If homeostasis is not kept under control, the cell begins to weaken and may quickly die which may affect the ability of other cells to do their jobs. Other factors that may affect homeostasis are temperature, amount of waste, and amount of chemicals like drugs and hormones.