MEMBRANE TRANSPORT

(Reader 1)

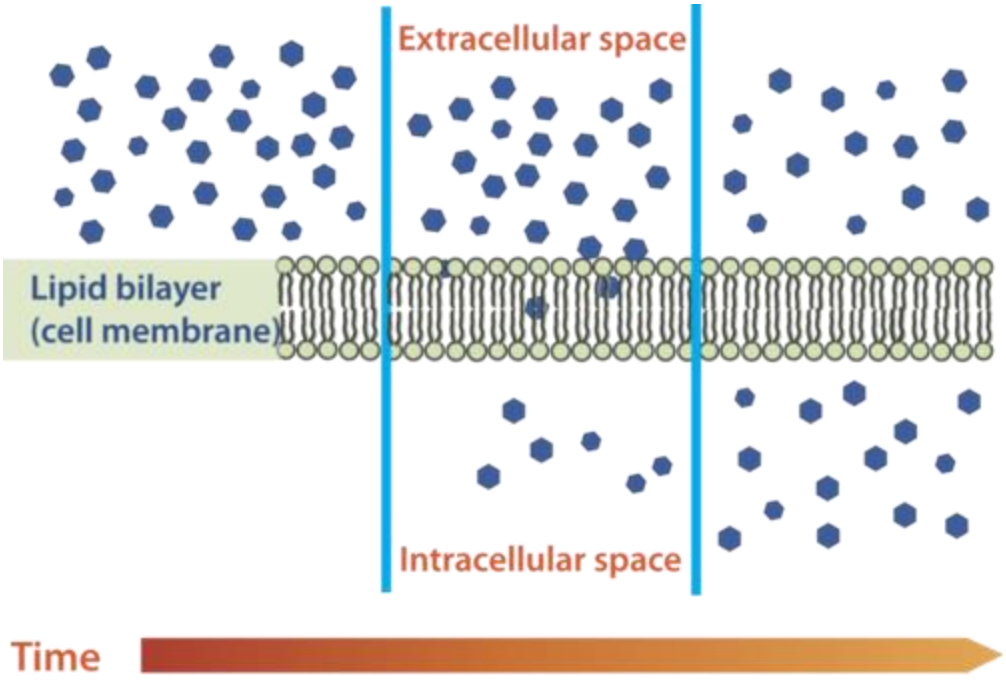
Passive Transport

Passive transport occurs when a substance passes through the cell membrane without needing any energy to pass through. This happens when a substance moves from an area where it is more concentrated to an area where it is less concentrated. **Concentration** is the number of particles of a substance in a given volume. Let's say you dissolve a teaspoon of salt in a cup of water. Then you dissolve two teaspoons of salt in another cup of water. The second solution will have a higher concentration of salt.

Why does passive transport require no energy? A substance naturally moves from an area of higher to lower concentration. This is known as moving down the concentration gradient. The process is called **diffusion**. It's a little like a ball rolling down a hill. The ball naturally rolls from a higher to lower position without any added energy. You can see diffusion if you place a few drops of food coloring in a pan of water. Even without shaking or stirring, the food coloring gradually spreads throughout the water in the pan. Some substances can also diffuse through a cell membrane. This can occur in two ways: simple diffusion or facilitated diffusion.

Simple Diffusion

Simple diffusion occurs when a substance diffuses through a cell membrane without any help from other molecules. The substance simply passes through tiny spaces in the membrane. It moves from the side of the membrane where it is more concentrated to the side where it is less concentrated. You can see how this happens in **Figure** below.



Simple diffusion of molecules (blue) from outside to inside a cell membrane

Substances that cross cell membranes by simple diffusion must squeeze between the lipid molecules in the membrane. As a result, the diffusing molecules must be very small. Oxygen (O_2) and carbon dioxide (CO_2) are examples of molecules that can cross cell membranes this way.

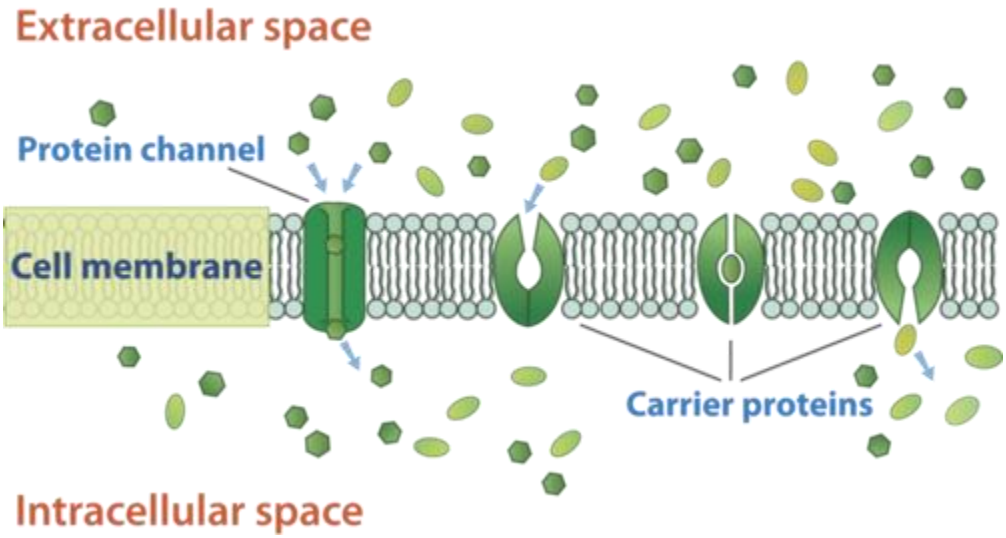
- When you breathe in, oxygen is more concentrated in the air in your lungs than it is in your blood. So oxygen diffuses from your lungs to your blood.
- The reverse happens with carbon dioxide. Carbon dioxide is more concentrated in your blood than it is in the air in your lungs. So carbon dioxide diffuses out of your blood to your lungs.

Facilitated Diffusion

Hydrophilic molecules and very large molecules can't pass through the cell membrane by simple diffusion. They need help to pass through the membrane. The help is provided by proteins called **transport proteins**. This process is known as **facilitated diffusion**.

There are two types of transport proteins: channel proteins and carrier proteins. They work in different ways. You can see how they work in **Figure** below.

- A channel protein forms a tiny hole called a pore in the cell membrane. This allows water or hydrophilic molecules to bypass the hydrophobic interior of the membrane.
- A carrier protein binds with a diffusing molecule. This causes the carrier protein to change shape. As it does, it carries the molecule across the membrane. This allows large molecules to pass through the cell membrane.



Transport proteins

Osmosis

Osmosis is the special case of the diffusion of water. It's an important means of transport in cells because the fluid inside and outside cells is mostly water. Water can pass through the cell

membrane by simple diffusion, but it can happen more quickly with the help of channel proteins. Water moves in or out of a cell by osmosis until its concentration is the same on both sides of the cell membrane.

(Reader 2)

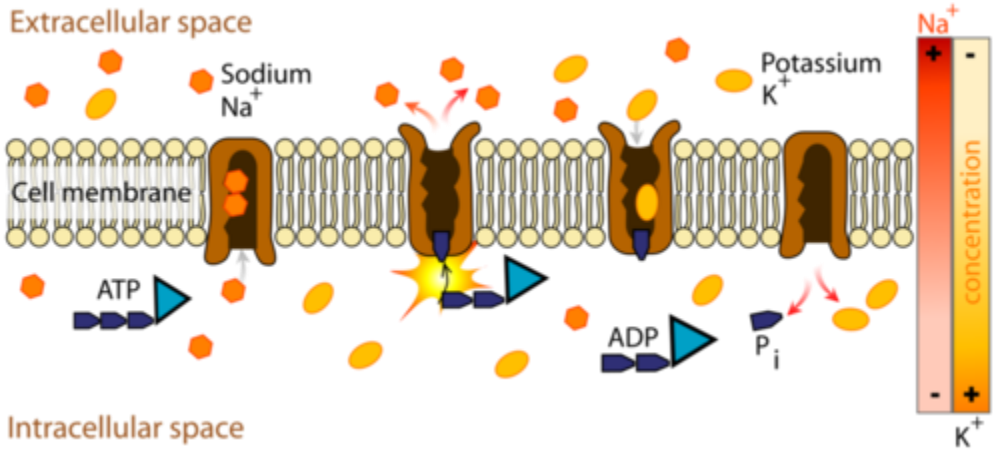
Active Transport

Active transport occurs when a substance passes through the cell membrane with the help of extra energy. This happens when a substance moves from an area where it is less concentrated to an area where it is more concentrated. This is the opposite of diffusion. The substance moves up, instead of down, the concentration gradient. Like rolling a ball uphill, this requires an input of energy. The energy comes from the molecule named ATP (adenosine triphosphate). The energy allows special transport proteins called pumps to move substances to areas of higher concentration. An example is the sodium-potassium pump.

Sodium-Potassium Pump

Sodium and potassium are two of the most important elements in living things. They are present mainly as positively charged ions dissolved in water. The sodium-potassium pump moves sodium ions (Na^+) out of the cell and potassium ions (K^+) into the cell. In both cases, the ions are moving from an area of lower to higher concentration. Energy in ATP is needed for this "uphill" process. **Figure** below shows how this pump works. Trace these steps from left to right in the figure:

1. Three sodium ions inside the cell bind with a carrier protein in the cell membrane.
2. The carrier protein receives a phosphate from ATP. This forms ADP (adenosine diphosphate) and releases energy.
3. The energy causes the carrier protein to change shape. As it does, it pumps the three sodium ions out of the cell.
4. Two potassium ions outside the cell next bind with the carrier protein. Then the process reverses, and the two potassium ions are pumped into the cell.



Sodium-potassium pump

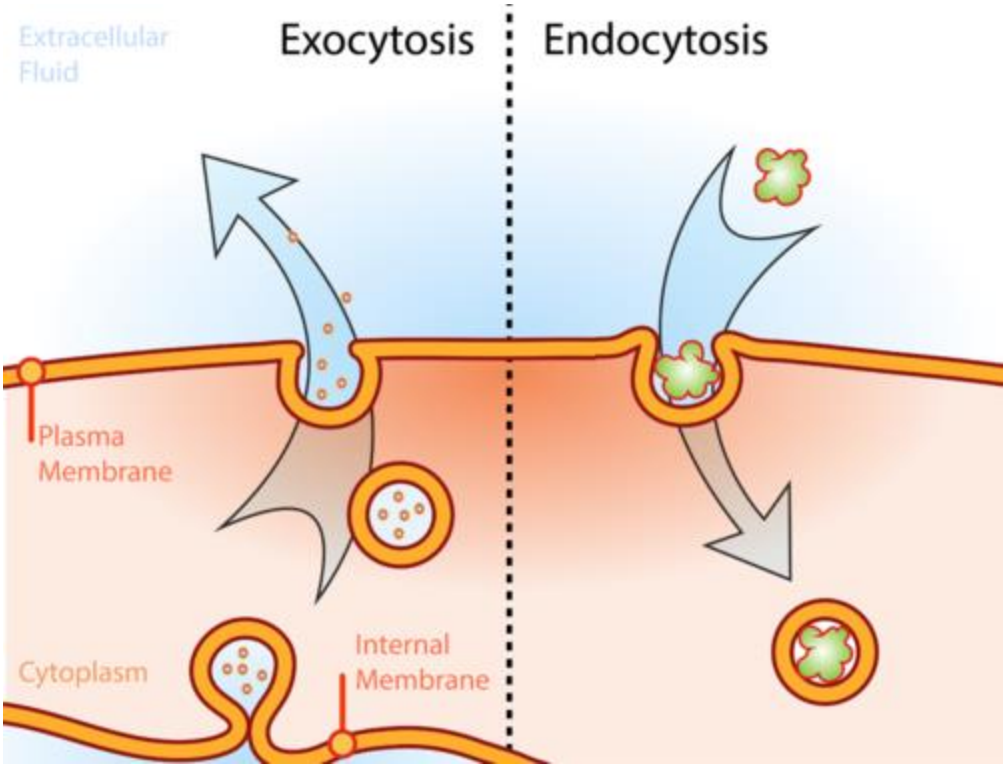
Vesicle Transport

Some substances are too big to be pumped across the cell membrane. They may enter or leave the cell by **vesicle transport**. This takes energy, so it's another form of active transport. You can see how vesicle transport occurs in **Figure** below.

- Vesicle transport out of the cell is called exocytosis. A vesicle containing the substance moves through the cytoplasm to the cell membrane. Then the vesicle fuses with the cell membrane and releases the substance outside the cell. You can watch this happening in this very short animation:

http://www.youtube.com/watch?v=V2FrQB6rX34

- Vesicle transport into the cell is called endocytosis. The cell membrane engulfs the substance. Then a vesicle pinches off from the membrane and carries the substance into the cell.



Vesicle transport

Lesson Summary

- The cell membrane consists of two layers of phospholipids. Transport proteins are embedded in the layers. The movement of substances across the cell membrane may be by passive or active transport.
- Passive transport requires no energy because it moves substances by diffusion, from an area of higher to lower concentration. This happen by simple diffusion or by facilitated diffusion, which requires the help of transport proteins.
- Active transport requires energy because it moves substances from an area of lower to higher concentration. An example is the sodium-potassium pump. Another form of active transport is vesicle transport, which is needed for very large molecules.