Teacher Tune-up

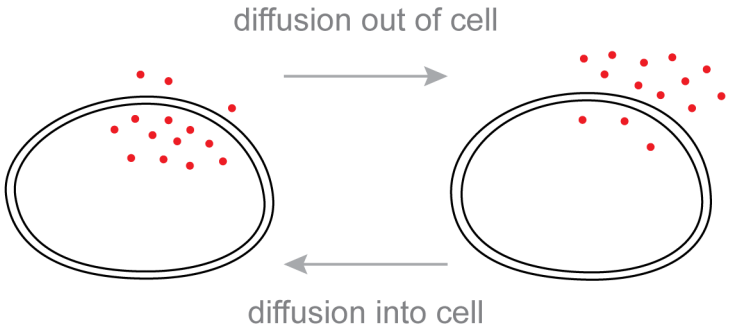
Quick Content Refresher for Busy Professionals

How do substances pass through the cell membrane on their own?

Diffusion

All cells are surrounded by a membrane that provides them support and protection. Membranes are fluid structures in which proteins are embedded that help regulate what enters and exits the cell. Most large molecules, as well as small ones that are electrically charged, can't enter the cell without the help of these proteins. Some small molecules, like oxygen, carbon dioxide, and water, can pass right through the membrane on their own. This process is known as diffusion.

Diffusion occurs when the concentration of molecules in one area is different from another. A common example occurs when you spray perfume in the air. Right at the spot where the perfume exits the bottle, there is a high concentration of perfume molecules. Across the room, the concentration is very low. As time passes, the perfume molecules will slowly travel across the room until these concentrations are balanced, and everyone in the room gets an equally weak whiff of the smell.



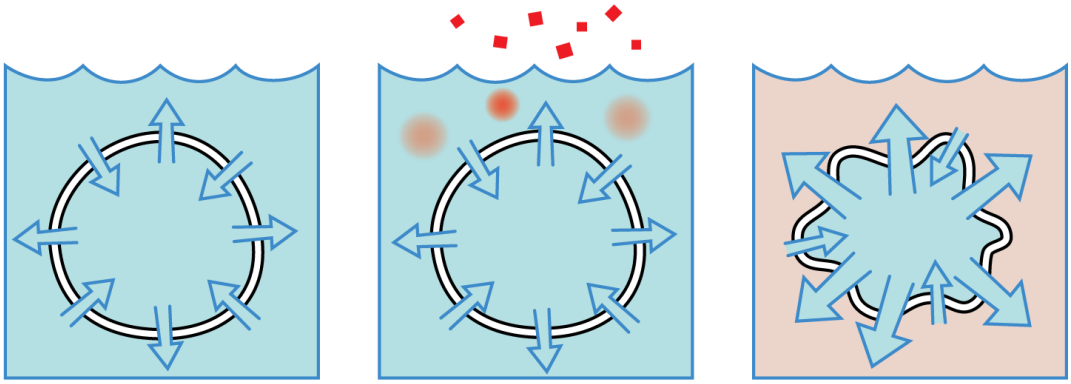
Molecules pass through cell membranes in the same way. Oxygen molecules are constantly passing across the membrane in both directions, into and out of the cell; but if the concentration of oxygen on one side of the membrane is higher than the other, a greater number of molecules cross over to the less concentrated side until the concentrations are in equilibrium. This process happens in the lungs with each breath of air that you inhale. The new gas in your lungs has a higher concentration of oxygen than is found inside of your red blood cells. Since the net motion of molecules goes from high concentration to low, the oxygen in your lungs diffuses across the cell membranes into these waiting blood cells, which can now transport the oxygen to the rest of the body. Meanwhile, blood cells returning from the body contain a high concentration of carbon dioxide. When they flow to the lungs and encounter surroundings with low carbon dioxide, the molecules diffuse back across the cell membrane into the sacs of the lungs, where they can be pushed out of the body with the next breath. Movement of molecules along these concentration gradients is the key to cells being able to function, taking in what they need and getting rid of their waste.

Osmosis

Another substance that passes through the cell membrane with ease is water. If you look at the inside or outside of a cell, water is everywhere. In fact, it comprises about 60% of your body. This water isn't pure; it contains many salts and other particles (i.e. the water is a solvent with many solutes in it, all of which constitutes a solution). If the water is particularly salty on one side of a cell, that solution could also be

considered less watery; that is, a higher salt concentration means a lower concentration of water. Substances move from areas of high concentration to those of low concentration, and water is no exception. If a cell is saltier on the inside, or less watery, water will come in from outside to balance the concentrations. If the space outside the cell is the salty side, water will exit the cell. Cells would not be able to function if things were too watery, or too salty, so this process of diffusion of water, known as osmosis, is critical to cell survival.

Osmosis *drawing water out of a cell*



Water diffusion in equilibrium

Salt added to water

More water leaves cell than enters

Imagine that you are stranded on a deserted island in the middle of the ocean, surrounded by a sea of salty water. Why can't you drink it? The reason all comes down to osmosis. Drinking salty water would make the environment around your cells very salty, and thus less watery. Since water moves from areas of high to low concentration, water inside your cells would diffuse across the membrane to the outside, balancing the concentration of water. You may be thirsty on your island, but drinking salt water won't help. In fact, it would actually make your cells lose water, and you'd become more dehydrated.

On the other hand, drinking extreme amounts of pure water in short period of time is equally damaging to your body. If you flood the body with pure water, the environment outside your cells will have a very high concentration of water compared to inside your cells. Water will then diffuse into your cells, causing them to swell. Sadly, hazing rituals or extreme water drinking contests have actually led to instances of death due to cells swelling. Even though water is essential to the body, like all substances, it becomes toxic if you consume too much.

Marathon runners can also suffer from water intoxication. Extreme exercise can cause the body to lose lots of salts through sweat, causing the extracellular environment to become more watery (less salty) than inside cells. This imbalance in concentration causes water to flow into cells by osmosis, which causes the cells to swell up in size. When cells in the brain swell, this causes multiple health problems and can even be fatal.