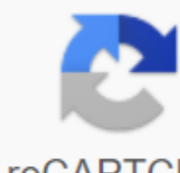


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' Recall that membranes have two major components: phospholipids arranged in a bilayer, and membrane proteins. Click here for a more elaborate picture of a cell membrane. One of the functions of the membrane is to control what passes into and out of the cell. In this module you will review mechanisms of membrane transport. There are several different types of membrane transport, depending on the characteristics of the substance being transported and the direction of transport. SIMPLE DIFFUSION In simple diffusion, small non-charged molecules or lipid-soluble molecules pass between phospholipids to enter or leave the cell, moving from high concentration areas to low concentration areas (they move down their concentration gradient). Oxygen and carbon dioxide and most lipids enter and leave cells through simple diffusion. Illustrations of simple diffusion. Note that the arrows indicate that the substance moves from where there is more of that substance to where there is less of it, and that the substances pass between phospholipids in the membrane. OSMOSIS OSMOSIS is a type of simple diffusion in which water molecules spread through a selectively permeable membrane from areas with high water concentration to areas with lower water concentration. (Note that the more particles that are dissolved in a solution, the less water there is in it, so osmosis is sometimes described as diffusion of water from areas with low sunless concentration to areas with high sunless concentration). Illustration by Osmos. Suppose the membrane is permeable for water, but not for sucrose (represented by the small black boxes). The sucrose molecules will not leave the cell because they cannot pass through the membrane. But since there is less water on the side with sucrose, water enters the cell through osmosis. Another way to describe the two solutions in the example above is to use the terms hypertonic and hypotonic. A hypertonic solution has more solutes and less water than a hypotonic solution. So, in the example above, the solution inside the cell is the hypertonic to the solution outside the cell. During osmosis, water moves from the hypotonic solution (more water, less solutes) to hypertensive solution (less water, more solutes). In each of the examples shown below, which of the solutions is hypertonic? Response FACILITATED DIFFUSION In facilitated diffusion, substances in or out of cells move into or out of cells down their concentration gradient through protein channels in the cell membrane. Simple diffusion and facilitated diffusion are similar in that both involve movement down the concentration gradient. The difference is how the substance gets through the cell membrane. In simple diffusion, the substance passes between the phospholipids; in facilitated diffusion there is a specialized membrane channels. Charged or polar molecules that cannot fit phospholipids generally enter and leave cells through facilitated diffusion. Illustrations of facilitated diffusion. Note that the substance moves down its concentration gradient through a membrane protein (not between phospholipids) ACTIVE TRANSPORT The types of membrane transport discussed so far always mean that substances move down their concentration gradient. It is also possible to move substances across membranes towards their concentration gradient (from low concentration areas to high concentration areas). Since this is an energetically unfavorable reaction, energy is needed for this movement. The energy source is the breakdown of ATP. If the energy of ATP is directly used to pump molecules against their concentration gradient, the transport is called primary active transport. Illustration of primary active transport. Note that the substance (indicated by the triangles) is transported from the side of the membrane with a little of the substance to the side of the membrane with much of the substance through a membrane protein, and that ATP is broken down to ADP. In some cases, the use of ATP may be indirect. For example, if a cell uses ATP to pump out Na<sup>+</sup> and then uses the Na<sup>+</sup> concentration gradient to get glucose in, the transport of glucose would be an example of secondary active transport. On the left side of the image below, a substance (represented by an X) is transported from the inside of the cell to the outside, even though there is more of that substance on the outside (indicated by the letter X that is larger on the outside of the cell. This is primary active transport. In the picture on the right side, substance S, already at higher concentration in the cell, is brought into the cell with substance X. Since S is transported without direct use of ATP, the transport of S is an example of secondary active transport. For topic X primary active transport of X occurs. The high concentration of X outside the cell is used to insert substance S against its concentration gradient. ENDOCYTOSIS AND EXOCYTOSIS: MOVEMENT OF LARGE PARTICLES It is possible for large molecules to enter a cell through a process called endocytosis, in which a small piece of the cell membrane wraps around the particle and is in the cell. If the particle is fixed, endocytosis is also called phagocytosis. If liquid drops are taken in, the processes are called pinocytosis. Illustration of endocytosis. Note that the particle entered the cell surrounded by a piece of cell membrane. The opposite of endocytosis is exocytosis. Cells use exocytosis to secrete molecules too large to pass through the cell membrane of any other mechanism. Other Links and animations: For an animation of active transport, exocytosis, see: For more information on secondary active transport, check out: DICHOTOMOUS KEY FOR CELL TRANSPORT Click the button above to open a problem solver to help you practice your understanding of membrane transport with the following example: 1. A white blood cell engulfs a bacterium when you are battling an infection. 2. Carbon dioxide (a small uncharged gas molecule) enters the lungs (where it is less concentrated) from the blood (where it is more concentrated). 3. Cells in the stomach wall transport hydrogen ions through an ATP-dependent membrane protein to the inside of the stomach, giving a pH of 1.5. The PH value of the cytosun (fluid inside the cells) in the wall cells of the stomach is about 7. (Remember that a low pH means high hydrogen ion concentrations). 4. The lung cells of a victim who drowned in fresh water are swollen due to water entering the cells. 5. Salivary gland cells produce the enzyme salivary amylase and secrete it into the salivary channels to be delivered to the mouth. 6. A Paramecium (a single cell organism) swims into an area of salt water.. Paramecium shrivels up as it loses water through its cell membrane. 7. Some bacteria use the energy of ATP to pump H<sup>+</sup> out of their cells. They use the H<sup>+</sup> concentration gradient to drive the transport of sugar into the cell against their concentration gradients. Which transport mechanism best describes how sugar gets into bacterial cells? 8. Some cells engulf drops of extracellular fluid. What transport mechanism would this be? Answer Thank you for your participation! ' Recall that membranes have two major components: phospholipids arranged in a bilayer, and membrane proteins. Click here for a more elaborate picture of a cell membrane. One of the functions of the membrane is to control what passes into and out of the cell. 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