

AP® Biology Laboratory 1

Diffusion and Osmosis

Objectives

- Use dialysis tubing to model diffusion across the cell membrane.
- Investigate the influence of solute concentration on osmosis.
- Investigate the concept of water potential in relation to water movement into or out of plant cells.

Background to Activities A and B

The cell membrane is a cell's interface with its surroundings. In one sense, this membrane must function as a barrier: it must keep together in one bundle the enzymes, DNA, and metabolic pathways that make life possible. The cell membrane must also function as a gateway: waste products must be discharged, through it and essential materials (oxygen, water, etc.) must enter through it. A membrane that allows some molecules to pass through while blocking the passage of others is said to be **semipermeable**. Molecules pass through the cell membrane either through processes that require the cell to expend energy (active transport), or through processes driven by the kinetic (thermal) energy of molecules (passive transport).

In these lab activities, you will investigate the passage of materials through a semipermeable membrane by passive transport. The membrane you will use, dialysis tubing, is semipermeable because it has submicroscopic holes through it. Molecules are in constant random motion. By chance, a molecule's motion may move it toward the membrane (Figure 1). If it collides with the membrane wall, it rebounds. If its motion takes it toward a pore, it may either pass through the pore, or it may rebound, depending upon the size of the molecule relative to the diameter of the pore. Molecules that are small enough to pass through the pores can pass through in either direction. Notice that on one side of the membrane solute molecules have displaced some of the water molecules. Thus, there is a higher concentration of water molecules on the opposite side of the membrane. More water molecules are available to collide with the membrane on the side having the higher concentration of water. Thus, although water molecules will move in both directions across the membrane, more will move from the side having the higher concentration to the side having the lower concentration. The movement of molecules from areas of higher concentration to areas of lower concentration is called **diffusion**.

The diffusion of water molecules across a semipermeable membrane is termed **osmosis**. A process that depends upon random motion might seem inefficient, but so many water molecules are involved and they move so fast, that it is estimated that a red blood cell floating in blood plasma gains an amount of water equal to 125 times its own volume every second. It also loses the same amount of water each second, all by osmosis. This occurs because the concentration of solutes in the blood plasma is the same as the concentration of solutes in red blood cells. Solutions that have the same solute concentrations are **isotonic**. If we took a sample of whole blood and added salt to the plasma, increasing its solute concentration, the plasma becomes **hypertonic** to the solution in the red blood cells, and the cells lose water and shrink. If we add water to the blood plasma, decreasing its solute concentration, the plasma becomes **hypotonic** to the solution in the red blood cells. The cells gain water, swell, and may even burst.

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M Carnoy



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