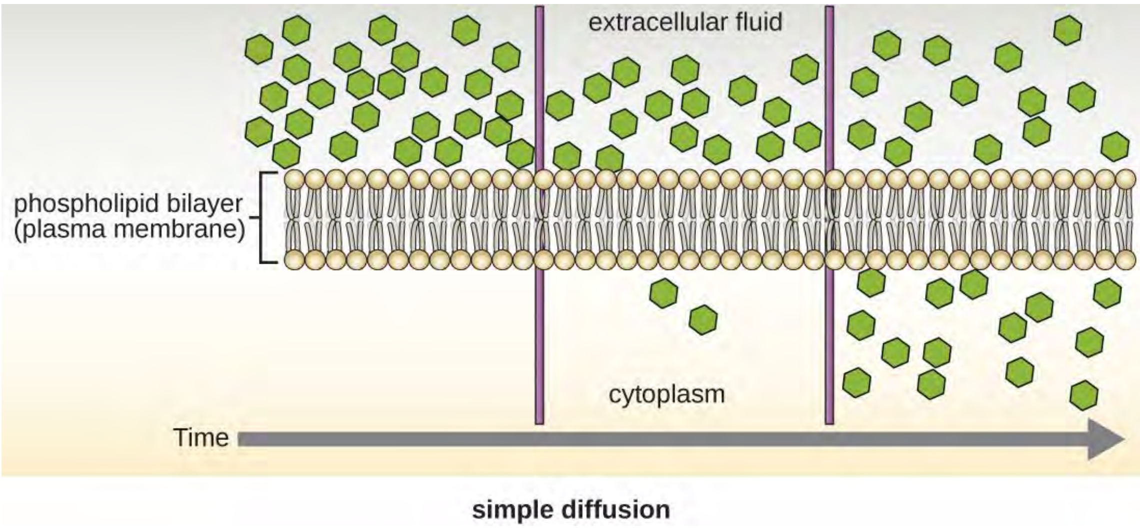

Figure 5.7 Diffusion of molecules through a permeable membrane. (credit: modification of work by Mariana Ruiz Villareal / Microbiology OpenStax)

Each separate substance in an environment has its own concentration gradient, independent of the concentration gradients of other materials in that same environment. Each material will diffuse according to its own gradient. In Figure 5.8, the molecules represented by the green circles are more concentrated within the cell, whereas the molecules represented by the blue hexagons are more concentrated outside of the cell. Each molecule will diffuse independently of one another down their respective concentration gradients until equilibrium is met. The blue hexagons will diffuse into the cell while the green circles diffuse out of the cell.

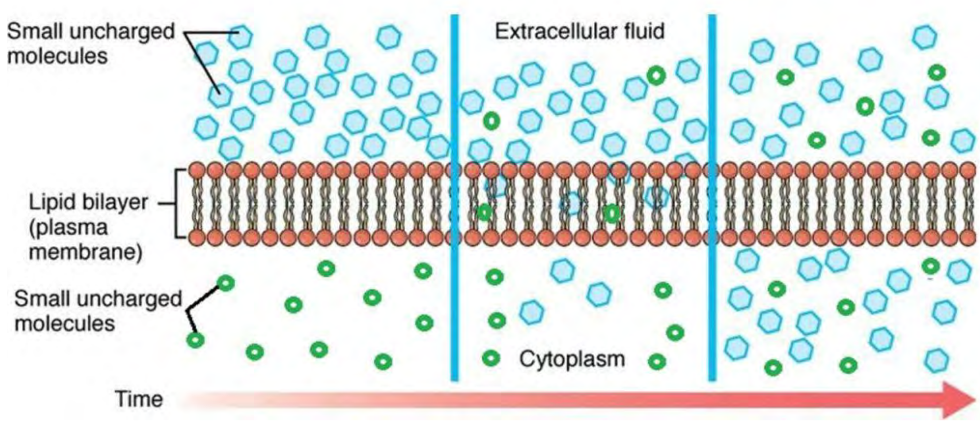

Figure 5.8 Diffusion of two different molecules through a permeable membrane in different directions. (credit: Modified by Elizabeth O'Grady original work of Mariana Ruiz Villareal / Biology 2E OpenStax)

Several factors affect the rate of diffusion.

- The extent of the concentration gradient: The more significant the difference in concentration between two points, the more quickly the substance will diffuse. The closer the substance gets to being at equilibrium, the slower the rate of diffusion.
- Mass of the molecules diffusing: Large molecules move more slowly. It is more difficult for them to move between the molecules of the substance they are diffusing through. As a result, they diffuse more slowly.
- Temperature: Higher temperatures increase the movement of the molecules, which increases the rate of diffusion.
- Solvent density: As the density of the solvent increases, the rate of diffusion decreases. The molecules slow down because they have a more difficult time getting through the denser solvent.

CONCEPTS IN ACTION - For an animation of the diffusion process in action, view this short video on cell membrane transport.

Facilitated transport

In facilitated transport, also called **facilitated diffusion**, material moves across the plasma membrane with the help of transport proteins. In facilitated diffusion, materials still move down a concentration gradient from high to low concentration without investing any energy (Figure 5.9). Without the help of a transport protein however, the substances that undergo facilitated transport could not diffuse easily or quickly across the plasma membrane.

To move polar substances and other large or charged substances across the plasma membrane, there must be integral proteins that span the membrane. The material being transported is first attached to a protein or glycoprotein receptor on the exterior surface of the plasma membrane. This allows the material that is needed by the cell to be removed from the extracellular fluid or cytoplasm. The substances are then passed to specific integral proteins that facilitate their passage. Integral proteins form channels or pores that allow certain materials to pass through the membrane. The integral proteins involved in facilitated transport are collectively referred to as transport proteins.

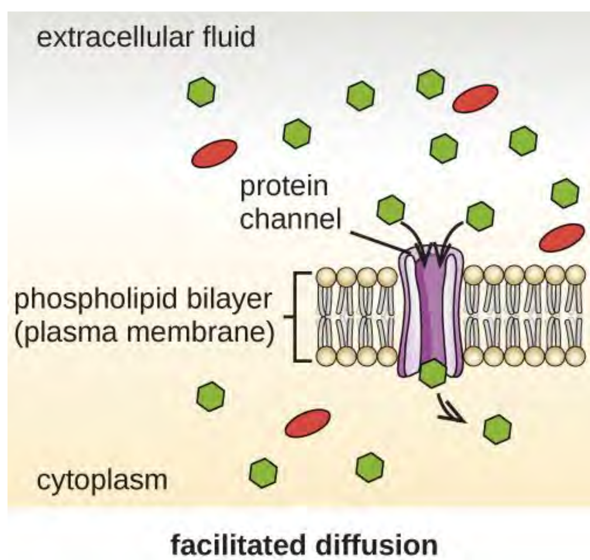

Figure 5.9 Facilitated diffusion of substances across the cell membrane takes place with the help of transport proteins. (credit: Parker et al./ Microbiology OpenStax)

Osmosis

Osmosis is a form of passive transport that involves transporting *only* water across a membrane. **Osmosis** can be defined as the movement of water from an area of low solute concentration to high solute concentration until equilibrium is met. Water can move freely across the cell membrane of all cells, either through protein channels called aquaporins or by slipping between the lipid tails of the membrane itself. Water, like other substances, moves from an area of higher water concentration to an area of lower water concentration. Water movement is also dependent on solute concentration.

Imagine a beaker with a semipermeable membrane separating the two sides or halves (Figure 5.10). On both sides of the membrane, the amount of water molecules is the same, but there are different concentrations of a dissolved substance, or solute, on each side. For example, on one side of the beaker, there is a single teaspoon of sugar dissolved in the water; whereas, on the other side of the beaker 1/4 cup of sugar has been dissolved. The sugar cannot cross the membrane. The sugar is kept dissolved in solution due to its chemical interactions with water. The more sugar molecules that are present, the more water molecules that are needed to keep the sugar dissolved in the solution. In Figure 5.10, there is a higher concentration of sugar on the right side and, therefore, a lower concentration of free water on that side because of the chemical interactions between the sugar and the water. On the left side, there is a low concentration of sugar; therefore, a higher concentration of free water. Water will move from an area with low solute concentration, right side, to an area of high solute concentration, left side, until equilibrium is met (Figure 5.10). This can also be stated as water will move from an area of high free water concentration to an area of low free water concentration until equilibrium is met.

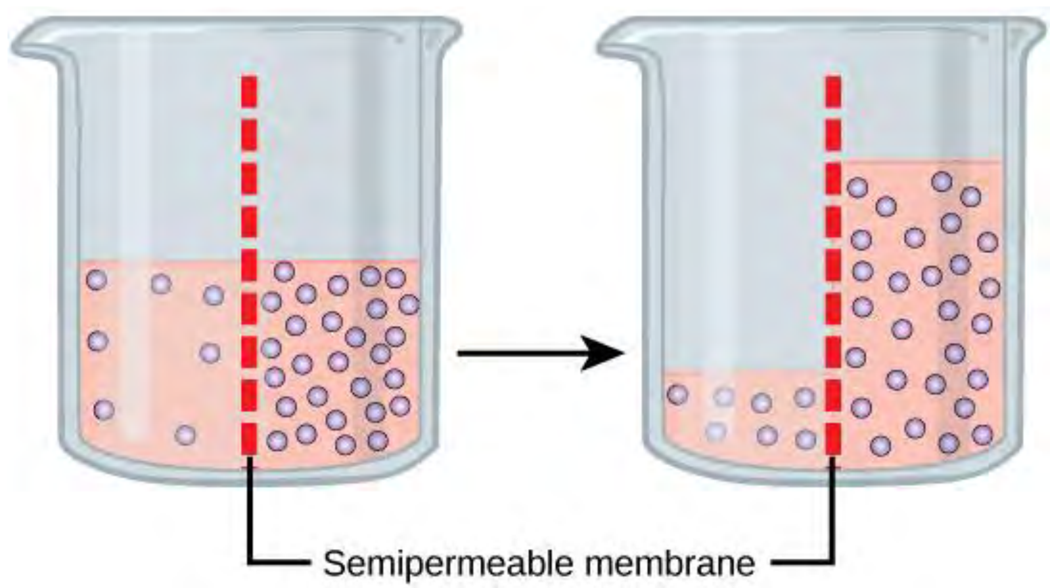

Figure 5.10 In osmosis water always moves through a semipermeable membrane from an area of low solute concentration to an area of higher solute concentration. (credit: Fowler et al. / Concepts of Biology OpenStax)