Osmosis: Diffusion of Water

Although the plasma membrane of a cell can act as a dam or pump for water-soluble molecules that cannot pass freely through the membrane, it does not limit the diffusion of water. Recall that diffusion is the movement of particles from an area of higher concentration to an area of lower concentration. In a cell, water always moves to reach an equal concentration on both sides of the membrane. The diffusion of water across a selectively permeable membrane is called **osmosis** (ahs MOH sus). Regulating the water flow through the plasma membrane is an important factor in maintaining homeostasis within the cell.

Word Origin

osmosis from the Greek word *osmos,* meaning "pushing"; Osmosis can push out a cell's plasma membrane.

What controls osmosis?

If you add sugar to water, the water becomes sweeter as you add more sugar. If a strong sugar solution and a weak sugar solution are placed in direct contact, water molecules diffuse in one direction and sugar molecules diffuse in the other direction until all molecules are evenly distributed throughout.

If the two solutions are separated by a selectively permeable membrane that allows only water to diffuse across it, water flows to the side of the membrane where the water concentration is lower. The water continues to diffuse until it is in equal concentration on both sides of the membrane, as shown in ***Figure 8.1.*** Therefore, we know that unequal distribution of particles, called a concentration gradient, is one factor that controls osmosis.

Cells in an isotonic solution

It is important to understand how osmosis affects cells. Most cells, whether in multicellular or unicellular organisms, are subject to osmosis because they are surrounded by water solutions. In an **isotonic solution,** the concentration of dissolved substances in the solution is the same as the concentration of dissolved substances inside the cell. Likewise, the concentration of water in the solution is the same as the concentration of water inside the cell.

Cells in an isotonic solution do experience osmosis, but because water diffuses into and out of the cells at the same rate, the cells retain their normal shape, as shown in ***Figure 8.2.***

Word Origin

iso-, hypo-, hyper- from the Greek words *isos,* meaning "equal," *hypo,* meaning "under," and *hyper,* meaning "over," respectively.

Cells in a hypotonic solution

In the **hypotonic solution** in ***Figure 8.3A,*** the concentration of dissolved substances is lower in the solution outside the cell than the concentration inside the cell. Therefore, there is more water outside the cell than inside. Cells in a hypotonic solution experience osmosis. Water moves through the plasma membrane into the cell. The cell swells and its internal pressure increases.

As the pressure increases inside animal cells, the plasma membrane swells, like the red blood cells shown in ***Figure 8.3B.*** If the solution is extremely hypotonic, the plasma membrane may be unable to withstand this pressure and may burst.

Because plant cells contain a rigid cell wall that supports the cell, they do not burst when in a hypotonic solution. As the pressure increases inside the cell, the plasma membrane is pressed against the cell wall, as shown in ***Figure 8.3C.*** Instead of bursting, the plant cell becomes more firm. Grocers keep produce looking fresh by misting the fruits and vegetables with water.

Cells in a hypertonic solution

In a **hypertonic solution,** the concentration of dissolved substances outside the cell is higher than the concentration inside the cell. Cells in a hypertonic solution experience osmosis that causes water to flow out.

Animal cells in a hypertonic solution shrivel because of decreased pressure in the cells.

Plant cells in a hypertonic environment lose water, mainly from the central vacuole. The plasma membrane and cytoplasm shrink away from the cell wall, as shown in ***Figure 8.4C.*** Loss of water in a plant cell results in a drop in pressure and explains why plants wilt.

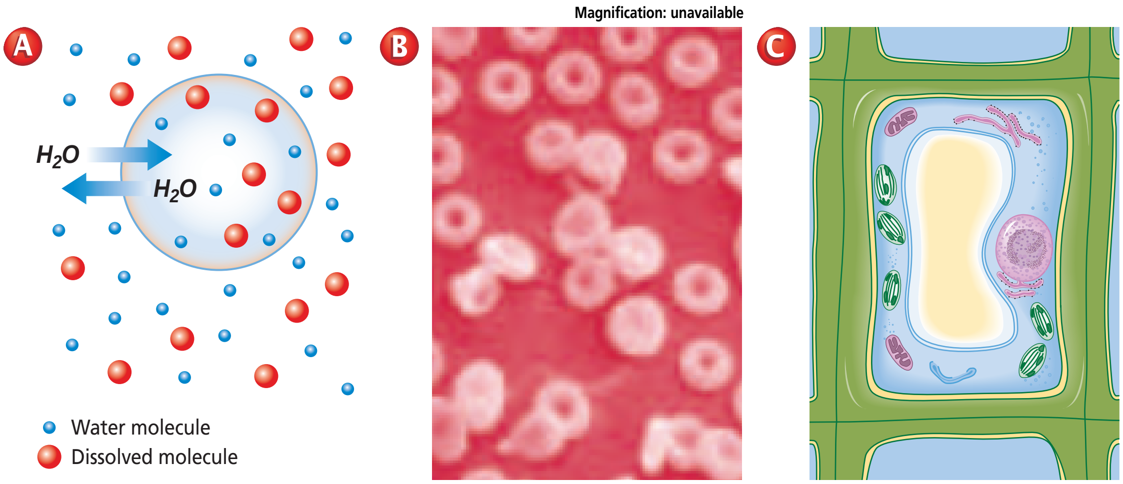

Figure 8.2
In an isotonic solution, water molecules move into and out of the cell at the same rate, and cells retain their normal shape **(A).** Notice the concave disc shape of a red blood cell **(B).** A plant cell has its normal shape and pressure in an isotonic solution **(C).**

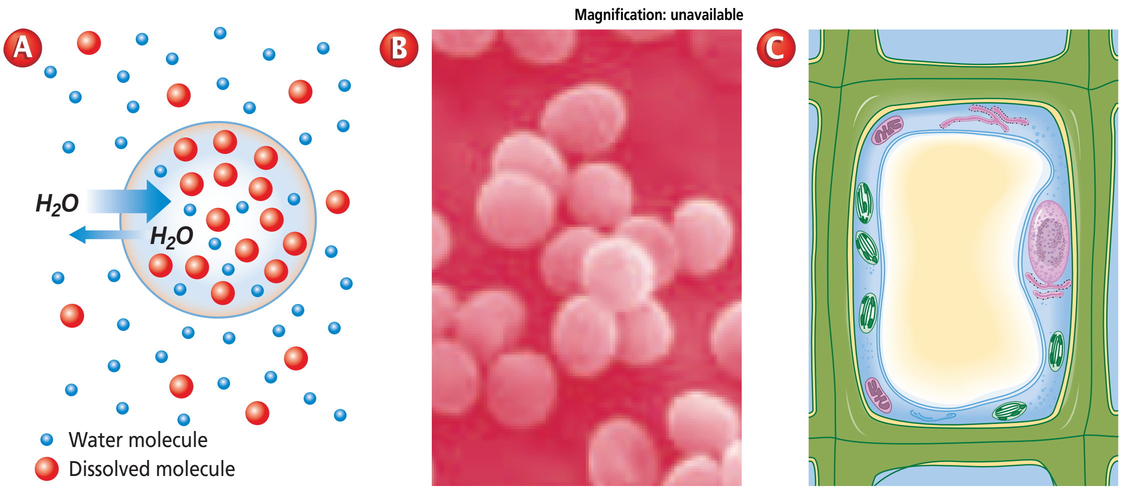

Figure 8.3
In a hypotonic solution, water enters a cell by osmosis, causing the cell to swell **(A).** Animal cells, like these red blood cells, may continue to swell until they burst **(B).** Plant cells swell beyond their normal size as pressure increases **(C).**

Figure 8.4
In a hypertonic solution, water leaves a cell by osmosis, causing the cell to shrink **(A).** Animal cells like these red blood cells shrivel up as they lose water **(B).** Plant cells lose pressure as the plasma membrane shrinks away from the cell wall **(C).**