

5.3

Osmosis: An Important Type of Diffusion



Figure 1 The human body is made up of approximately 60–70 % water.

osmosis: the diffusion of water across a selectively permeable membrane from an area of higher water concentration (or low solute concentration) to an area of lower water concentration (or high solute concentration)

Water is vital to life. Plants and animals (including humans) use water to carry out essential life processes (Figure 1). Water particles are small enough to cross the cell membrane by diffusion. Normally, there is a constant diffusion of water across the cell membrane in both directions (into and out of a cell). This means that the concentration of water is equal on both sides of the cell membrane. The cell maintains its size.

Sometimes water is more concentrated either inside or outside of the cell. The direction in which water moves across the cell membrane adjusts to this imbalance. This means that more water will move in one direction than in the other. Water moves across the cell membrane from an area of higher water concentration to an area of lower water concentration (down its gradient) by **osmosis** (Figure 2).

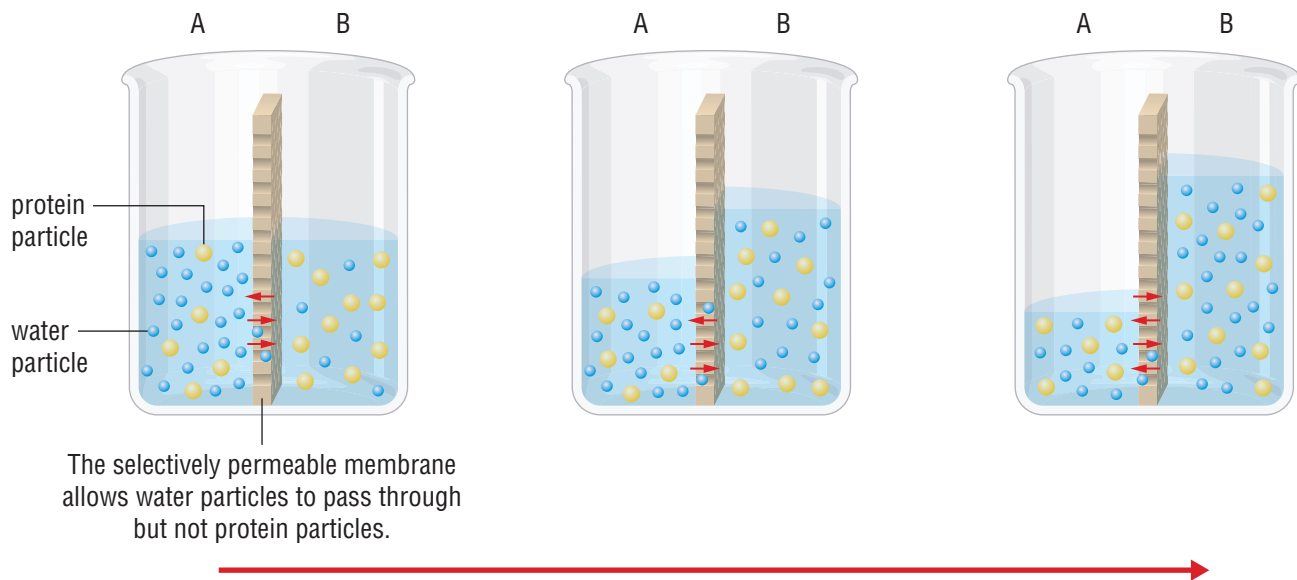


Figure 2 Osmosis. Water moves from an area of higher water concentration (side A) to an area of lower water concentration (side B).

Osmosis is a type of diffusion because it is driven by a concentration gradient. When the concentration of solutes is higher inside or outside of a cell, a concentration gradient exists. When this happens water will move from the area with higher water (or lower solute) concentration to the area with lower water (or higher solute) concentration. Osmosis continues until the concentration of water (and solute particles) is equal on both sides of the membrane. Once the concentrations are equal on both sides of the membrane, osmosis comes to an end. Water continues to pass through the cell membrane in both directions at an equal rate.

To watch an animation of osmosis,

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Cells in Solution

Sugars, salts, and proteins are common solutes in cells. Water acts as the solvent. Cells need to maintain solute concentrations at certain levels to stay alive and healthy. The movement of water into and out of a cell determines the solute concentration inside the cell.

When water enters and exits a cell at the same rate, the cell maintains its size and shape (Figure 3(a)). When there is a lower concentration of water inside the cell than outside the cell (higher concentration of solutes inside), water moves into the cell by osmosis faster than it moves out of the cell. This causes the cell to increase in size. If too much water enters the cell, it may burst and die (Figure 3(b)). On the other hand, if there is a higher concentration of water inside the cell than outside the cell (lower concentration of solutes inside), water moves out of the cell by osmosis faster than it moves into the cell. The cell shrinks in size. If too much water leaves the cell, it may die (Figure 3(c)).

To watch an animation showing cells in solution,

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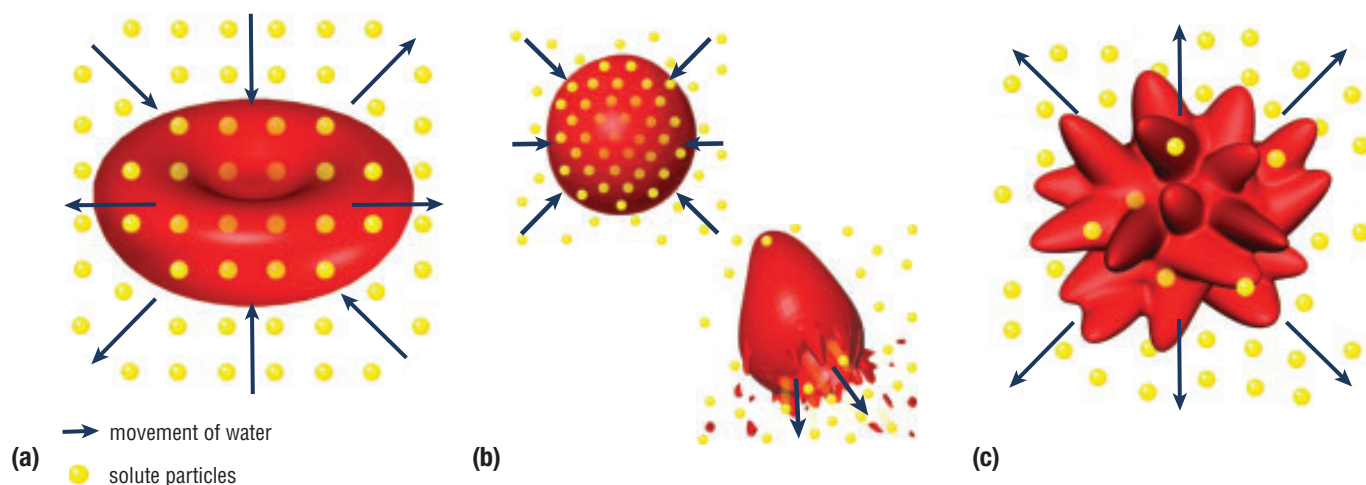


Figure 3 (a) When osmosis occurs at an equal rate, the size of the cell is maintained. (b) When the concentration of solutes inside the cell is higher than the concentration of solutes outside of the cell, water moves into the cell by osmosis, causing it to expand in size. If too much water moves into the cell, it may burst. (c) Water moves out of the cell when the concentration of solutes inside the cell is lower than the concentration of solutes outside the cell.

Turgor Pressure: Osmosis in Action

Plant cells have a large, central vacuole which is filled with water. This vacuole takes up most of the cell's interior space. Plant roots absorb water from the soil surrounding the plant and transport it to cells in the plant. This water is stored in vacuoles. When a cell needs water for cellular processes, water moves from the vacuole to the parts of the cell where it is needed. This causes a decrease in the concentration of water in the cell's cytoplasm, and, therefore, an increase in the concentration of solutes. If the solute concentration inside the plant cell becomes higher than the solute concentration outside the plant cell, water moves into the cell by osmosis.

turgor pressure: the outward pressure that is exerted on a plant cell wall by the cell contents when water is taken in by osmosis

When plant roots absorb water, the sudden influx of water fills the central vacuole and cytoplasm. This exerts pressure against the cell wall and causes the cell to swell. This outward pressure on the cell wall of a plant cell is called **turgor pressure**. A plant cell that is swollen with water is said to be “turgid.”

When the cells in a plant’s stem and leaves take in water by osmosis, they become turgid and press against each other. This causes the stems and leaves to stiffen and stay upright (Figure 4(a)). When the cells in a plant’s stem and leaves lose water by osmosis, the cells become less turgid. The plant wilts (Figure 4(b)).

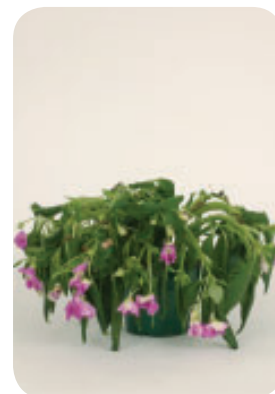
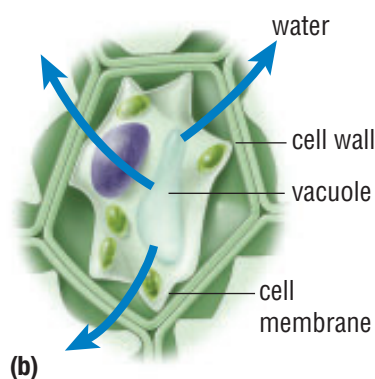
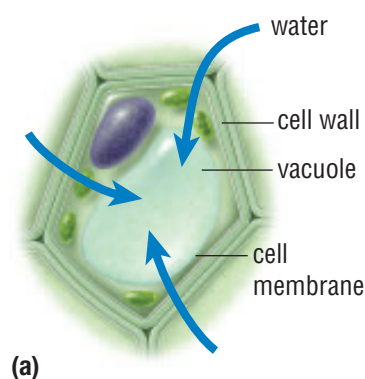


Figure 4 (a) The stems and leaves of this plant are stiff and upright because the plant’s cells are turgid; water has moved into the plant’s cells by osmosis. (b) When water moves out of the plant’s cells by osmosis, the stems and leaves of the plant lose their turgidity and become wilted.

Problems can arise when plants lose too much water. For example, fertilizers contain nutrients that can help plants grow. However, these nutrients become dissolved in water in the soil. This increases the concentration of solutes and lowers the concentration of water in the soil, compared to the concentration inside the plant roots. Water moves from cells in the plant’s roots (higher water concentration) into the soil by osmosis. To minimize crop damage, fertilizers must be applied in small amounts. Understanding osmosis in plants is important in industries such as farming and horticulture.

CHECK YOUR LEARNING

1. (a) Describe an idea in the reading that you found to be particularly important.
(b) Why do you think this idea is important?
2. Explain the process of diffusion in your own words. Use a diagram with your explanation.
3. Explain the process of osmosis in your own words. Use a diagram with your explanation.
4. Explain how osmosis creates turgor pressure in plants.
5. What cell organelle makes turgor pressure in a plant cell possible? Describe the role of this organelle in this process.