5.2 Fluid Movement in Cells: Diffusion

Have you ever wondered how the smell of a home-cooked meal or of a freshly baked pie can travel through the house? What about air fresheners that work to keep rooms smelling clean?

In Grade 7, you learned about the particle theory, which states that all particles of matter are in constant motion. This can explain how the scent of an air freshener is able to fill a room. When you release air freshener into a room, the scent particles from inside the air freshener are released into the air. Since particles are in constant motion, the scent particles begin to collide with air particles in the room. Though you may not be able to see the particles of air or of freshener, both are in constant motion. These movements cause the scent particles to move through the room until they are evenly dispersed among the air particles. This fills the room with a pleasant scent (Figure 1).

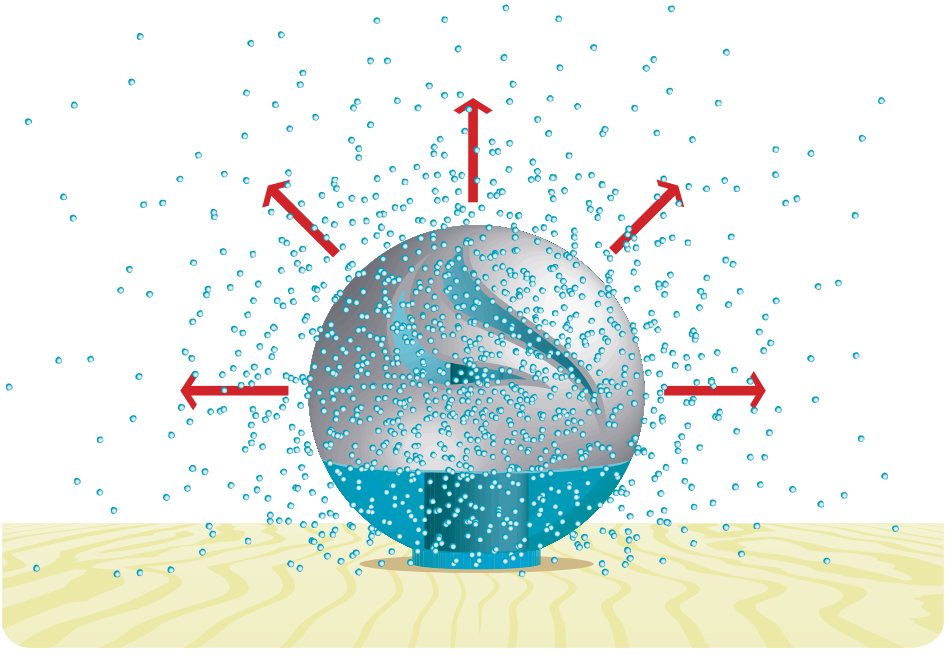

Figure 1 Particles from the air freshener move through the air in the room, filling it with a pleasant scent.

In Figure 1, the scent particles of the air freshener are highly concentrated only around the bottle (and likely have quite a strong scent). When the bottle is opened, they slowly spread to parts of the room where they are less concentrated. This continues until there is an equal concentration of scent particles and air particles in the room. Recall from Grade 7 that concentration is a measure of the amount of a substance that is mixed in with another substance. This movement of particles from an area of higher concentration to an area of lower concentration is known as **diffusion**.

diffusion: the movement of particles from an area of higher concentration to an area of lower concentration

To watch an animation of how perfume particles diffuse through the air, Go to Nelson Science

concentration gradient: a difference in concentration of a substance between two areas

We refer to a difference in concentration between two areas as a **concentration gradient**. This difference in concentration determines the direction of particle movement between the two areas. Diffusion is a natural process that always occurs down a concentration gradient. This means that the particles move from an area where they are more concentrated to an area where they are less concentrated. As this continues, the concentration gradient decreases until the concentrations are equal (Figure 2).

To watch an animation of how diffusion occurs, Go to Nelson Science

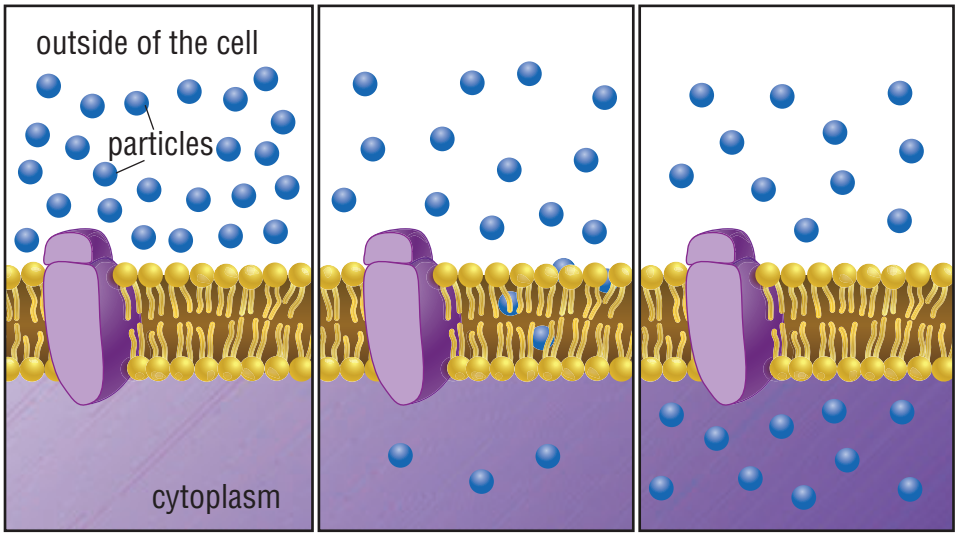

Figure 2 In a cell, diffusion of particles occurs across the selectively permeable membrane.

TRY THIS: Modelling Diffusion at Home

SKILLS MENU: predicting, performing, observing, analyzing, evaluating, communicating

SKILLS HANDBOOK 2.B.3., 2.B.6.

A simple model of diffusion can be observed by making a cup of tea. Brewing tea involves the diffusion of tea particles into the surrounding water (Figure 3).

Figure 3

Equipment and Materials: 2 beakers (250 mL); pencil; paper; room-temperature water; hot water; 2 tea bags

1. Fill one beaker with 200 mL of room-temperature water. Fill the other beaker with 200 mL of hot water.
2. Gently place a tea bag into each of the beakers and observe what happens. Draw what you see in your notebook.
3. Wait 2 min and observe the water again. Draw what you see and write a statement that summarizes your observations.

A. How does the tea bag act as a selectively permeable membrane? Use a diagram to show the movement of the tea solutes and the water over the 2 min period.

B. What do you think would happen if the water was cold? Use your knowledge of the particle theory to make a prediction about the movement of particles.

C. Repeat the procedure using cold water and compare your observations to the prediction you made in B. Was your prediction supported by your observations? Evaluate your prediction and make a conclusion about the effect of temperature on diffusion.

D. Describe two other situations from your everyday experience where diffusion occurs.

Diffusion plays an important role in how living things obtain energy and get rid of wastes. In living things, the intake of nutrients from food and the removal of wastes occur at the cellular level. This requires that particles cross the cell membrane. In your body, for example, tiny blood vessels in your muscles (capillaries) carry oxygen-rich blood cells to individual muscle cells. Oxygen diffuses from the blood cells in the capillaries, where it is highly concentrated, into the muscle cells, where the oxygen is less concentrated (Figure 4). Once inside the muscle cell, oxygen is used up to make energy. This keeps the concentration of oxygen in the muscle cell lower than the concentration of oxygen outside the cell. This allows diffusion to continue.

At the same time, wastes, such as carbon dioxide, are produced inside the muscle cells. The wastes accumulate inside the cell to higher concentrations than outside of the cell. These particles diffuse from the muscle cells, where they are highly concentrated, into the blood. The exchange of oxygen and carbon dioxide happens continuously. This makes it necessary for you to have a constant supply of oxygen-rich blood.

LINKING TO LITERACY

Summarizing

After reading, good readers summarize by thinking about the most important details. Ask yourself, "What are the main ideas? What were some of the text features and clues that helped me identify the important ideas?"

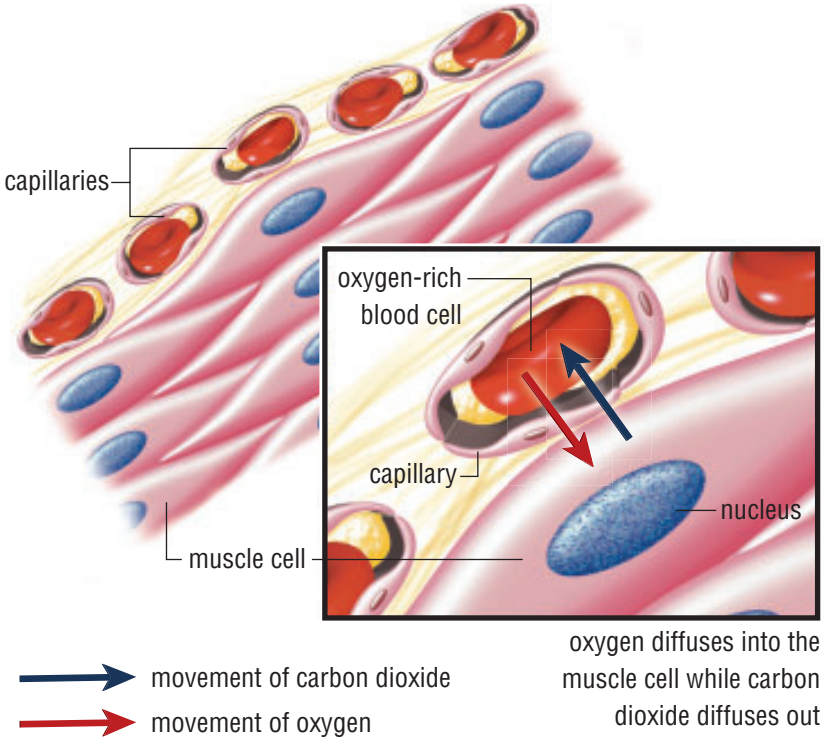

Figure 4 Oxygen and carbon dioxide are exchanged across the membranes of blood cells and muscle cells by diffusion. This exchange of gases is necessary for life.

CHECK YOUR LEARNING

1. How have the concepts in this reading added to your understanding of cells?
2. Describe the process of diffusion in your own words. Use the particle theory in your explanation.
3. What does the term "concentration gradient" mean?
4. How is the movement of particles in diffusion determined?
5. Give two examples in your everyday experience where diffusion occurs. Can you think of a situation where this might be harmful?