# Topic 1.1

# Why are cells important?

## Key Concepts

- Studying cells helps us understand how organisms function.
- Cellular organelles work together to carry out life functions.
- Cellular processes enable organisms to meet their basic needs.

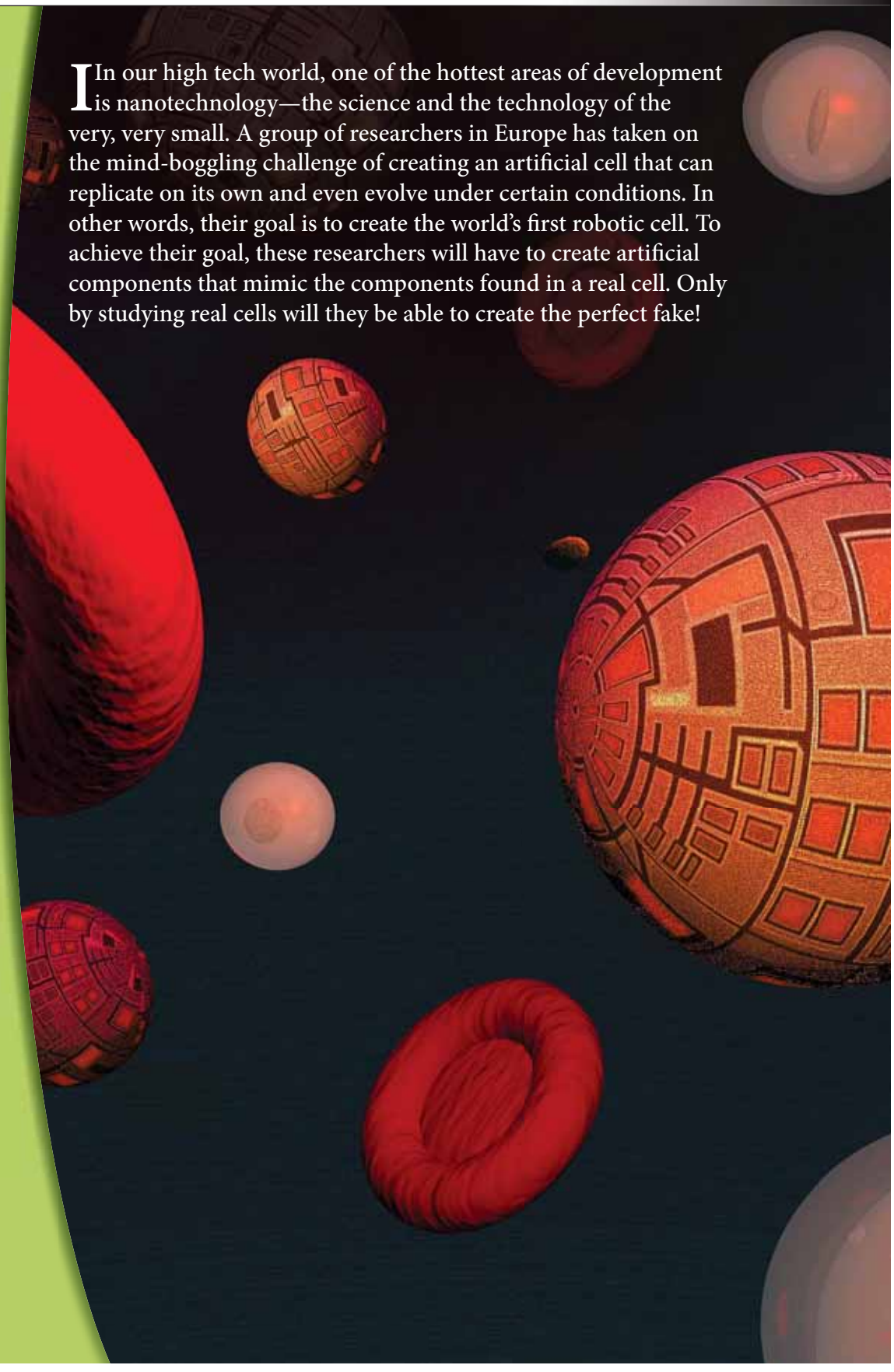
## Key Skills

- Inquiry
- Literacy

## Key Terms

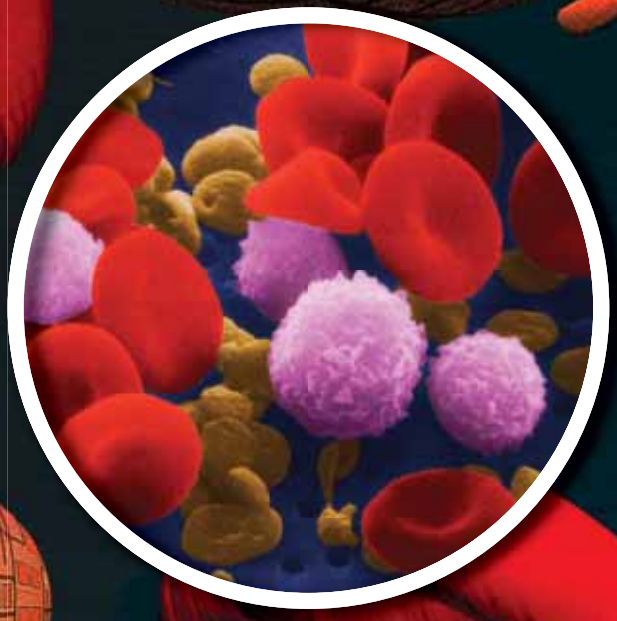
organelle
diffusion
concentration
osmosis

In our high tech world, one of the hottest areas of development is nanotechnology—the science and the technology of the very, very small. A group of researchers in Europe has taken on the mind-boggling challenge of creating an artificial cell that can replicate on its own and even evolve under certain conditions. In other words, their goal is to create the world's first robotic cell. To achieve their goal, these researchers will have to create artificial components that mimic the components found in a real cell. Only by studying real cells will they be able to create the perfect fake!



## Starting Point Activity

1. The large picture here shows how an artist imagines robotic cells mingling with real cells in a body. The disk-shaped cells are red blood cells. You may have learned about them in an earlier grade. What do you know or recall about the function of red blood cells in the body?
2. Write down as many details about cell components as you can recall from your study of cells in earlier grades.



This photo shows real red blood cells, as well as other cells that are part of blood: white blood cells, which help fight infection, and platelets, which help heal over wounds.

# Studying cells helps us understand how organisms function.

Much of this unit focuses on how cells function, divide, and work together. But before you read any further, take a moment to think about one very important question:

**Why should we learn about cells?**

The answer is that studying cells helps us understand how organisms, including humans, function. After all, our bodies are made up of trillions of cells. By learning about cells, we come to understand how we can

- protect cells to prevent infection and other harmful effects
- observe cells to diagnose disease
- treat cells to heal illnesses
- stop harming cells through our choices and actions

Consider the medical advances shown in the four pictures on these two pages. None of these advances would have been possible without an understanding of how different cells work.

Malaria is a deadly disease. It is transmitted by mosquitoes in tropical parts of the world. Scientists have recently developed a vaccine that can protect human cells from malaria infection. To develop this vaccine, scientists needed to learn about cells in both humans and mosquitoes. They also needed to understand the single-celled organism that causes malaria.

A person with severe burns is often treated with skin grafts taken from another region of their body. However, sometimes there is little healthy skin left on the body. In such cases, doctors place an artificial skin substitute over the burns. This nylon-based material contains a substance that works with the blood to heal the wound. Knowledge of how both skin and blood cells function has made this technology possible.

Literacy Focus

## Activity 1.1

### WHY STUDY CELLS?

1. Look through the resources provided by your teacher to find an article about a new medical breakthrough, discovery, or technology.
2. Describe the breakthrough in your own words.
3. Explain how this research relates to cells.
4. Explain how this research helps you, your family, or society.

## LEARNING CHECK

1. Why bother learning about cells?
2. What types of cells would you have to study to develop a malaria vaccine?
3. How would knowledge of cells help doctors create an artificial skin substitute?
4. What type of technology might an understanding of nerve cell function help researchers create?

Medical doctors have discovered that reducing body temperature can help a person survive a heart attack. Cold temperatures reduce the harm to heart and brain cells after a heart attack. By studying cells, doctors have been able to develop this new life-saving treatment.

A human heart

Did you know that artificial sweeteners can make us gain weight? Scientists have discovered that consuming artificially sweetened foods and beverages "disappoints" brain cells that were expecting sugar, based on the taste. As a result, our brain tells us to keep eating, hoping to get the sugar it was promised. Such knowledge about cells can help us make healthier choices in the foods and beverages we consume.

# Cellular organelles work together to carry out life functions.

The flies on this page have a lot in common with the Venus's-flytrap. As well as providing the Venus's-flytrap with nutrients, the flies are composed of the same basic units of life that make up the plant—cells. Plants, flies, people, and all other living things are made up of one or more cells. Each cell, in turn, is made up of smaller components. These smaller components are called organelles.

**organelle:** a structure within a cell that carries out specific functions to support the life of the cell

An **organelle** is a structure within a cell. Organelles work together to carry out specific functions that support the life of the cell. These functions include

- bringing in nutrients
- removing wastes
- generating and releasing energy for the cell to use
- making substances that the cell needs
- reproducing

Inquiry Focus

## Activity 1.2

### ORGANELLES ON STRIKE

This activity is designed to help you determine what you remember about cells and cell parts from earlier grades. If you need any reminders, you can turn to the next page, where this information is reviewed.

The organelles and cell parts that are involved with the following functions have gone on strike:

- transporting substances such as water and salt into the cell
- transporting waste substances such as carbon dioxide out of the cell
- reproducing to make two identical copies of the cell

Use what you know or remember to identify the organelles that are important for each of these functions.


## LEARNING CHECK

1. What is the basic unit of life?
2. What is an organelle?
3. Describe three ways that organelles support the life of a cell.
4. What would happen to the cells of your body if they didn't have organelles to control the materials entering and leaving the cells?

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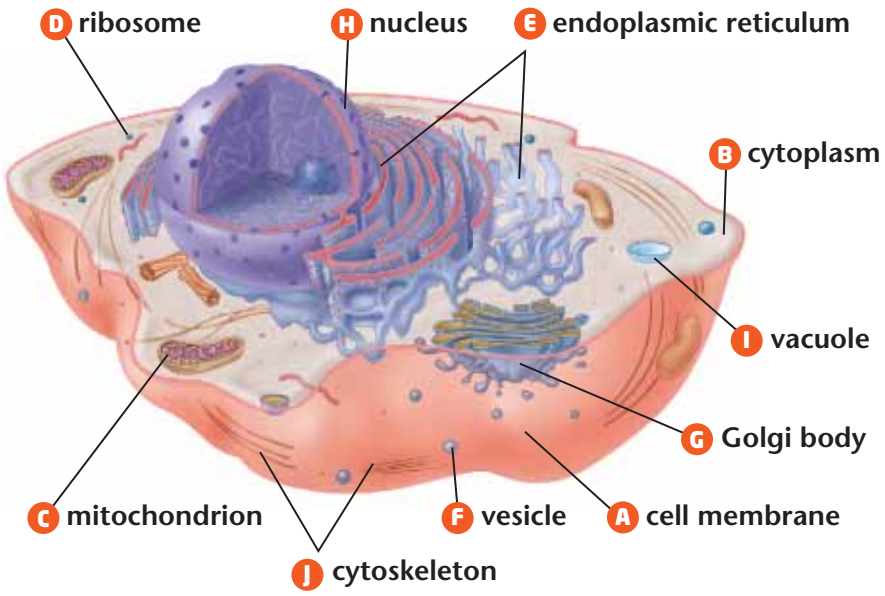
## Organelles and other structures in cells have different tasks.

Go to **scienceontario** to find out more

Each organelle and cell part has a specific role within a cell. This role is important to the proper functioning of both the cell and the organism. Some cells have more of one type of organelle and less of another. This is because different cells also perform different roles in an organism. For example, a muscle cell requires a lot of energy. As a result, it may have many organelles that make energy available to the cell. These organelles are called mitochondria. **Figures 1.1** and **1.2** show the organelles that are found in a typical animal cell and a typical plant cell.




▶ **Figure 1.1** This diagram shows a typical animal cell. As you will learn on the next few pages, animal cells vary greatly within an organism. The organelles they contain also vary according to the role of each cell.

**A cell membrane** separates the inside of the cell from the external environment; controls the flow of materials into and out of the cell

**B cytoplasm** includes the organelles, and other life-supporting materials, such as sugar and water, all contained by the cell membrane

**C mitochondria** (singular: mitochondrion) where energy is released from glucose to fuel cell activities

**D ribosomes** help to produce proteins, which make up much of a cell's structure and are required for activities necessary for the cell's survival; some ribosomes float in the cytoplasm, and others are attached to the endoplasmic reticulum

**E endoplasmic reticulum** a network of membrane-covered channels that transport materials made in the cell; is connected to the nucleus

**F vesicles** membrane-covered sacs that transport and/or store materials inside the cell and sometimes help these materials cross the cell membrane to enter or exit the cell

**G Golgi body** sorts and packages proteins and other molecules for transport out of the cell

**H nucleus** controls all cell activities

Literacy Focus

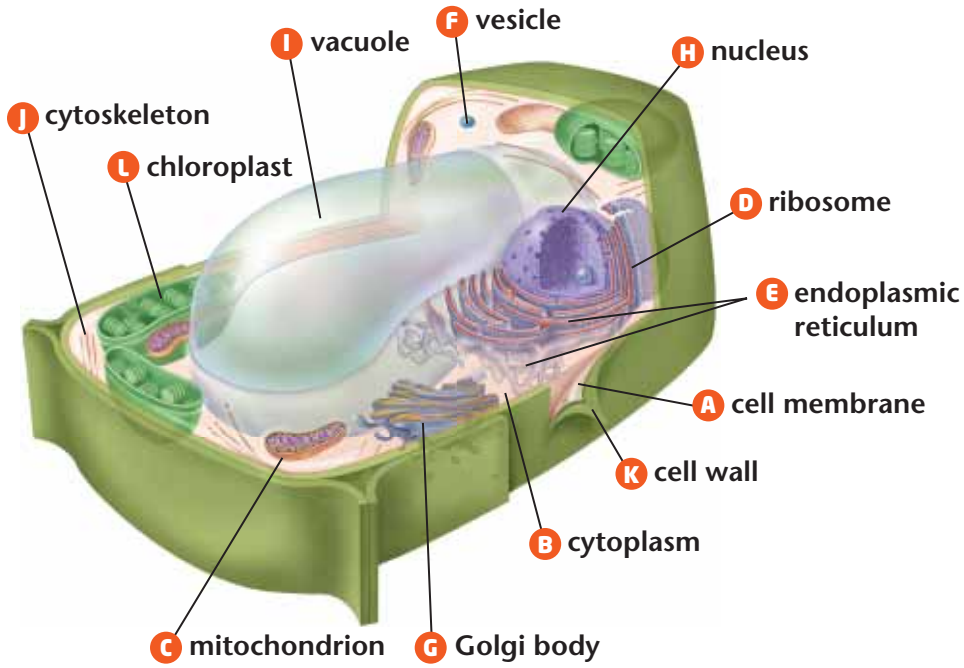
## Activity 1.3

### ORGANELLE BINGO

Create a game that will help other students learn about cellular organelles and their functions. Develop rules for organelle bingo, cell function Jeopardy!, or another game of your choice.


## LEARNING CHECK

1. Why do some cells have more of one type of organelle?
2. Identify three differences between an animal cell and a plant cell.
3. Muscle cells have a lot of mitochondria. What do you think might happen if a person got a disease that destroyed all the mitochondria in muscle cells?




◀ **Figure 1.2** This diagram shows a typical plant cell. Like animal cells, plant cells vary according to their role.

**I** **vacuoles** contain water and other materials and are used to store or transport small molecules; plant cells tend to have one large vacuole; animal cells may have several smaller vacuoles

**J** **cytoskeleton** filaments and tubules that provide a framework for the cell, helping it maintain its structure and providing "tracks" along which vesicles and organelles can move

**K** **cell wall** a tough, rigid structure lying just outside a plant cell's membrane; provides support for the cell; not found in animal cells

**L** **chloroplasts** found only in plant cells; trap energy from the Sun to make glucose, which is broken down in the mitochondria to power cell activities (animals must get glucose from the food they eat)

# Cellular processes enable organisms to meet their basic needs.

Cellular processes are the activities that organelles perform to carry out the cell's life functions. Two of the most important cellular processes are diffusion and osmosis.

**diffusion:** the movement of molecules (or other particles) from an area of high concentration to an area of low concentration until they are evenly distributed

**concentration:** the number of molecules of a substance in a given volume

## How Diffusion Works

Figure 1.3 shows ink particles spreading through water. The ink particles move from an area where there is a lot of ink to an area where there is little or no ink. This process is called diffusion. **Diffusion** is the movement of particles of a substance from an area of high **concentration** to an area of low concentration until all the particles are evenly distributed.

▶ **Figure 1.3** As ink diffuses in water, the ink particles spread through the water from where there is lots of ink (high concentration) to where there is little or no ink (low concentration).

Diffusion is an essential cellular process. Without it, life as we know it would not be possible. Diffusion occurs:

- within a cell

  Example: Substances that are produced by one organelle may travel to another organelle or the cell membrane by diffusing through the cytoplasm.

- across the cell membrane

  Example: Each time you breathe in, your blood picks up oxygen. Your blood then transports this oxygen to your cells. The concentration of oxygen molecules is at first greater outside the cell than inside the cell. As a result, the oxygen molecules pass through the cell membrane into the cytoplasm. They continue to do so until there is an equal concentration of oxygen inside and outside the cell.

- outside a cell in body fluids

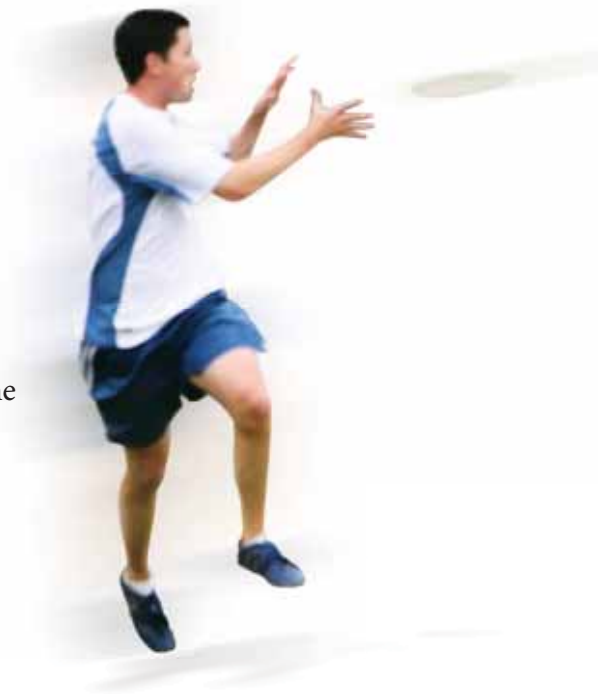
  Example: Nerve cells release chemicals to communicate with each other. These chemicals diffuse through the fluid in the space between nerve cells.

## How Osmosis Works

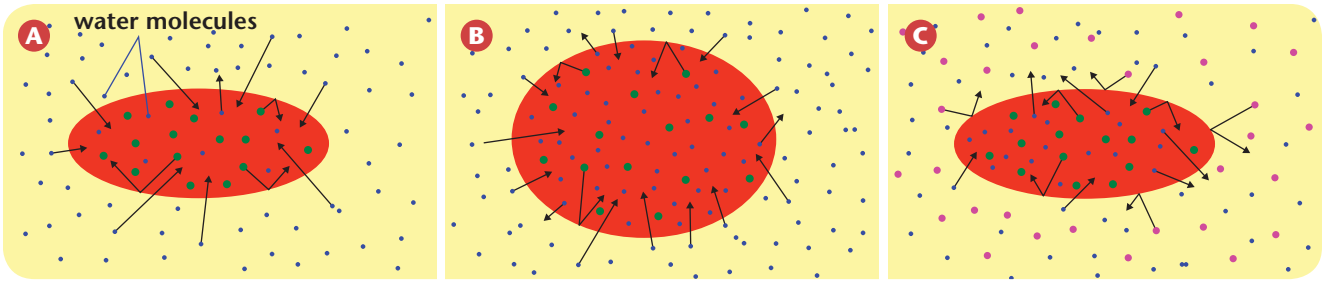
**osmosis:** the movement of water molecules across a membrane in response to concentration differences

After a fast-paced game of Ultimate Frisbee, the first thing you probably want is a big glass of cold water. Because your body loses nutrients such as sodium and potassium when you sweat, some people might recommend a glass of a sports drink, which has these nutrients in it. It's important that nutrients and other dissolved substances in your body stay in balance. But why? One answer involves a cellular process called **osmosis**.

Osmosis involves the diffusion of water through a *semi-permeable membrane*. A semi-permeable membrane lets water and some molecules diffuse across it but keeps molecules of other substances from penetrating it. You have read that cell membranes control the movement of substances into and out of cells. Cell membranes are semi-permeable. Water can penetrate the membrane, but molecules of many substances cannot. **Figure 1.4** shows what would happen to a cell if it was placed in pure water.



▼ **Figure 1.4** When a substance cannot penetrate a membrane, it cannot diffuse from an area of higher concentration to an area of lower concentration. Therefore, by osmosis, more water diffuses across the membrane to make up for the difference in concentration.




If you placed this cell in pure water, the concentration of green molecules would be zero outside the cell but high inside the cell. However, the green molecules cannot diffuse to the lower concentration, because they cannot penetrate the membrane. So, by osmosis, more water molecules diffuse into the cell to equalize the concentrations of water molecules inside and outside the cell.

Although some water molecules diffuse out of the cell, more water molecules will continue to diffuse in. But the concentration of the green molecules will never be equal on the two sides of the membrane. As a result, so much water will keep diffusing into the cell that it will eventually burst.

Fortunately, your body has many mechanisms to ensure that the concentrations of molecules are balanced on the two sides of cell membranes. Here, for instance, you see purple molecules outside the cell and green molecules inside the cell. Water diffuses in because of the green molecules, and water diffuses out because of the purple molecules. The diffusion of water is balanced.

### LEARNING CHECK

1. Use a Venn diagram to compare osmosis and diffusion.
2. Explain why your life would not be possible without the cellular process, diffusion.

**ACTIVITY LINK**
Activity 1.4, on page 18

Inquiry Focus

# Activity 1.4

## DIFFUSION IN ACTION

Observe and measure how long it takes for food colouring to diffuse through water.

### Safety

- Do not use your mouth with the pipette.

### What You Need

- 25 mL graduated cylinder
- warm tap water
- long pipette
- pipette filler
- undiluted blue or red food colouring
- watch or stopwatch
- graph paper

### What To Do

1. Copy the table below into your notebook. Give your table a title.

   **Title:** _____

| Volume | Time |
|---|---|
| 5 mL | |
| 10 mL | |
| 15 mL | |
| 20 mL | |

2. Fill the graduated cylinder with tap water. Gently tap the side of the cylinder to eliminate any air bubbles in the water.
3. Use a pipette to take a 1 mL sample of food colouring. Rinse the outside of the pipette with water. Carefully insert the pipette into the graduated cylinder until the tip reaches just above the bottom of the cylinder. Slowly release the food colouring into the water.
4. Time how long it takes for the colour to move up to the 5 mL mark on the cylinder.

   Continue timing to find out how long it takes for the colour to move to the 10 mL, 15 mL, and 20 mL mark on the cylinder.
5. Record your observations.
6. Graph your results. Place time on the *x*-axis and volume on the *y*-axis of your graph.

### What Did You Find Out?

1. Identify the dependent variable and the independent variable.
2. Describe the results that are shown on your graph.
3. What conclusion can you make about the speed of diffusion and the distance that a substance diffuses?
4. Predict what your results would mean for very large cells. What would your results mean for very small cells? Explain your reasoning for each prediction.
   (**Hint:** Consider your answer to question 3.)

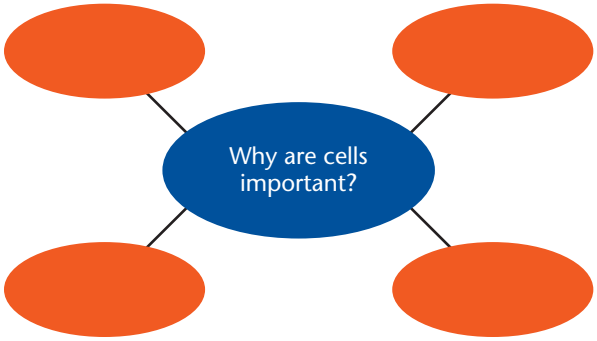
# Topic 1.1 Review

## Key Concept Summary

- Studying cells helps us understand how organisms function.
- Cellular components work together to carry out life functions.
- Cellular processes enable organisms to meet their basic needs.

## Review the Key Concepts

**1.** K/U Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.




**2.** K/U Describe three benefits that result from studying cells.

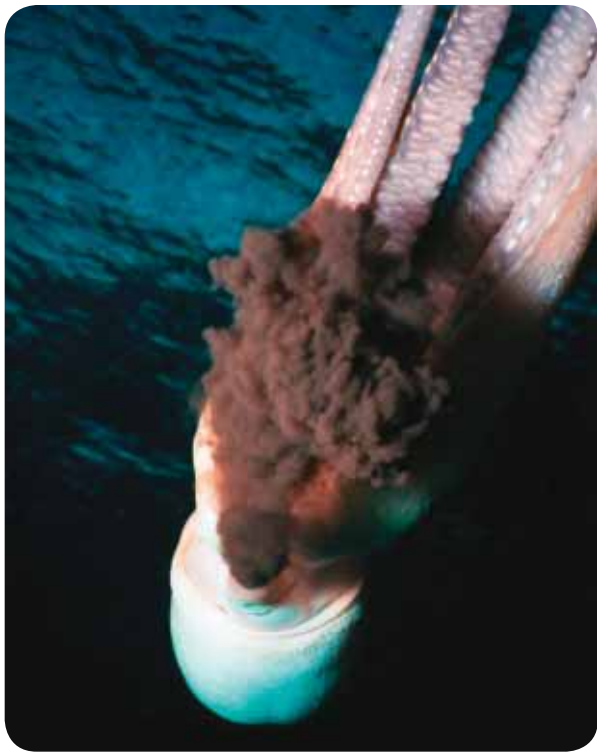
**3.** K/U Why is the cell considered the basic unit of life?

**4.** K/U Identify the function of each of the following cellular components.

| Organelle or Cell Part | Function |
|---|---|
| a) mitochondria | |
| b) cell membrane | |
| c) nucleus | |
| d) vacuole | |

**5.** A After painting your room and putting your brush into some clean water, you notice that the water is turning green. Explain why using scientific terminology.

**6.** A This squid is releasing ink from its body. The ink quickly diffuses in the water, enabling the animal to escape from a predator. Provide two other examples of diffusion in nature or in your own life.



**7.** C Organelles are structures within a cell that carry out specific roles. Create a rap, rhyme, or song that includes at least three organelles. Your lyrics must explain the role each organelle plays in carrying out one of the cell's life functions.