UNIT A Cells

Unit Overview

Fundamental Concepts

In Science and Technology for grades 7 and 8, six fundamental concepts occur throughout. This unit addresses the following two:

- Systems and Interactions
- Structure and Function

Big Ideas

As you work through this unit, you will develop a deeper understanding of the following big ideas:

- Cells are the basis of life.
- Cells organize into tissues, tissues into organs, organs into organ systems, and organ systems into organisms.
- Healthy cells contribute to healthy organisms.
- Systems are interdependent.

Overall Expectations

By the end of this unit, you will be expected to:

1. assess the impact of cell biology on individuals, society, and the environment
2. investigate functions and processes of plant and animal cells
3. demonstrate an understanding of the basic structure and function of plant and animal cells and cell processes

Cindy Klassen's gold-medal efforts are a result of all her cells, tissues, and organs working together at peak efficiency.

Exploring

Mosquitoes feed on the blood of animals. They bite birds, cats, dogs, people, and other animals in their hunt for food to ensure their survival.

When you get a mosquito bite, you may get an itchy red bump where you were bitten. If you live in a country near the equator, you may develop malaria after the bite. If you live in North America, you may develop West Nile virus. If you get sick, you may have a fever or you may ache all over. We now know what is happening to our bodies during all these events. However, until doctors and scientists were able to examine human cells, they had no idea what was causing illnesses.

This unit is about cells, the tiny units that make up human tissues and organs. You will use a microscope to observe the basic structures of plant and animal cells. You will find out how cells function and interact and learn about processes inside cells. You will also assess the impact of technologies that change cellular structures and processes.

Mysterious Deaths

In 1999, there were reports in the northeastern United States of unusually high numbers of dead birds. Similar reports were released in southern Ontario in 2001.

Microbiologists, who study cells, examined the bird carcasses to find out what was happening. They studied blood and tissue samples under their microscopes, and they were able to see a virus in the birds' blood cells. They compared the virus they saw to other known viruses in North America and around the world. Modern technologies such as advanced microscopes, technologies for viewing cells, and electronic communication helped them identify the West Nile virus.

By 2002, people were diagnosed with the virus, and scientists were working to find out how they had become infected. While birds carried the virus, they were unlikely to pass it to humans unless people handled an infected bird carcass. Mosquitoes, which dine on both birds and humans and transfer saliva in the process, were identified as the organisms that transmitted the virus.

Before the development of the microscope and the study of cells, this illness would have been a mystery. People could avoid the carcasses of birds to protect themselves, but it would have taken much longer to realize that mosquitoes were the link.

Twenty percent of people infected with the virus will have a mild fever, a rash, and a headache. Two percent will have much more severe symptoms and, on rare occasions, they will die. The rest of those infected will experience no symptoms at all.

Canadian communities now protect themselves by monitoring mosquito populations, thanks to the knowledge gained from studies of cells under a microscope.

West Nile virus has killed crows, blue jays, chickadees, and robins. By 2007, over 150 bird species were identified as carriers of the virus.

Pools of standing water are ideal places for mosquitoes to lay their eggs.

...MORE TO EXPLORE

A1 Quick Lab

One Big Cell

Not all cells are microscopic. You have probably seen this cell in your kitchen at home. It is too big to view with a microscope.

Purpose

To examine a basic structure of a cell.

Procedure

1. Read the following description of an egg.

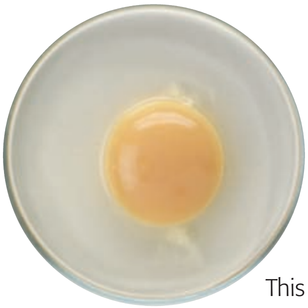
   The photograph here shows the contents of a single cell. It is a specialized cell for the reproduction of a chicken. The yellow part, called the yolk, is a food source for the developing chicken. The clear, milky part, called albumin, is mostly protein.

   These structures were in a protective covering made up of a hard, outer shell filled with tiny holes and two layers of thin, flexible membrane that also has tiny holes. The shell and the membranes allow air into the egg.

2. Answer the questions as a class.

Questions

1. Do you think the contents of the egg could survive without the protective coating?
2. Most cells are tiny. Do you think they have a protective coating? Explain your reasoning.



This chicken egg is a single cell.

A2 Thinking about Science, Technology, Society, and the Environment

Using an Insecticide

One of the ways to control the spread of the West Nile virus is to use insecticides to kill the mosquitoes. This can be done in a variety of ways. Spraying from the air will kill mature adults, or chemicals can be used earlier in the season to kill the eggs and larvae before they mature.

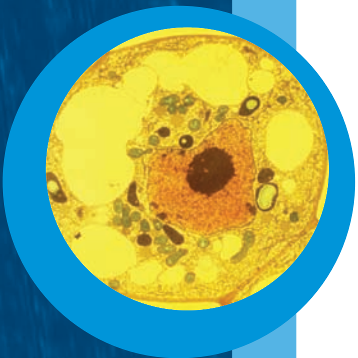
Consider This

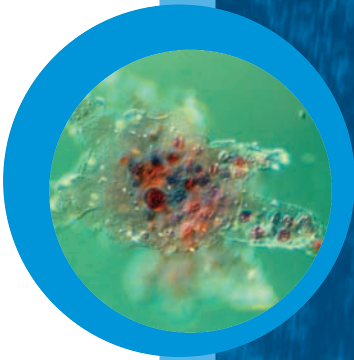
As a class, answer the following questions.

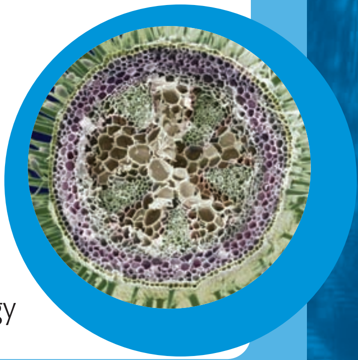
1. What would be the impact on society if insecticides eliminated West Nile virus?
2. What would happen in the environment if mosquitoes were eliminated through the use of insecticides?

UNIT A

Contents







Unit Task

The health of any organism — including you — depends on healthy cells. You are going to learn about cells, including their structure and how they function. Cells are the basic unit of life that few people understand. Your task will be to find an entertaining way to tell people about cells and their importance.

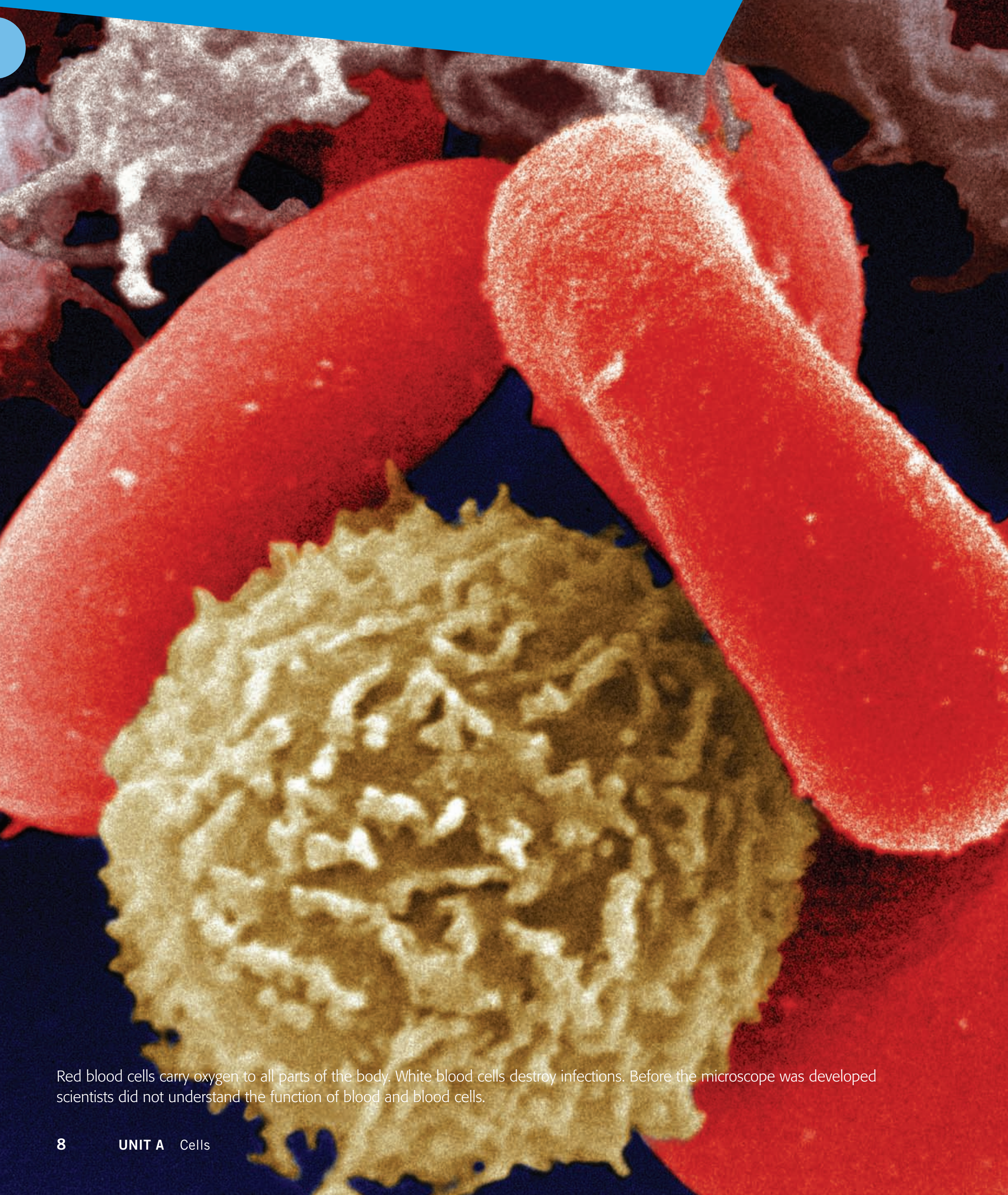
Essential Question
What should people know about their cells?

Getting Ready to Read

Thinking Literacy

Anticipation Guide
The statements in an anticipation guide can help you make sense of information by activating your prior knowledge. Before reading this unit, read each statement in the anticipation guide provided. Circle "Agree" or "Disagree" to indicate your position on each statement. You will revisit the statements in this anticipation guide when you have finished reading the unit to see whether your opinion has changed based on what you have learned.

1.0 Cells are the basic units of all living things.



Red blood cells carry oxygen to all parts of the body. White blood cells destroy infections. Before the microscope was developed scientists did not understand the function of blood and blood cells.

What You Will Learn

In this chapter, you will:

- explain why cells are considered to be the basic units of life
- identify key organelles in plant and animal cells and explain their functions
- distinguish between the processes of diffusion and osmosis

Skills You Will Use

In this chapter, you will:

- demonstrate the proper care and use of a microscope

Why This Is Important

Organisms are composed of cells. Healthy organisms have healthy cells. In order to ensure good health, it is essential to know more about cells, what they are made of, and how they function.

Before Reading

Thinking Literacy

Skimming and Scanning Text Features

Different reading tasks require different reading styles. "Skimming," or quickly looking across each line of text, gives an idea of the subject matter and if it will be useful. Skim the headings in chapter 1. Will it help you prepare microscope slides?

To find a specific word or piece of information, "scanning" by looking down or diagonally across the page will be more useful. Scan chapter 1 for new vocabulary words.

Key Terms

- cell theory
- eyepiece
- organelle
- selective permeability
- diffusion
- membrane
- osmosis
- stage

1.0 Getting Started

Figure 1.1 This painting, which shows an early anatomy lesson, was painted in 1632. In the Netherlands, in those days, one dissection each year was a public one, and spectators could pay a fee to watch the proceedings.

Figure 1.2 Smallpox was once a deadly disease that killed millions of people. After the microscope was developed, doctors were able to find out what was causing the disease and find a way to control it.

Living things need a suitable habitat that supplies their basic needs for oxygen, food, and water. They convert energy with these resources and carry out a variety of activities. Early doctors and scientists could only guess at how living things carried out these activities. They studied whole plants and animals, including humans, in an effort to find out. They were very curious about how living things worked. They also needed to know how organisms like the human body worked in order to treat diseases and injuries (Figure 1.2).

As early scientists continued their inquiries, they began to cut dead organisms into smaller parts in an effort to see what was inside. They looked at organ systems and individual organs such as hearts and lungs. They looked at muscles and brain tissue (Figure 1.1). Scientists began to develop new ideas about how living things worked, but until the first microscopes were built, they had no way of seeing the smallest unit of living things: the **cell**. The cell is the basic structural unit of an organism and the building block of life.

Microscopes gave scientists their first glimpses of cells. As microscopes improved, scientists saw that cells are made up of tiny structures. They now know that these structures cannot work independently. Cell structures must work as part of the cell unit to carry out activities.

The chicken egg cell you examined in Activity A1 was big, and ostrich eggs are even bigger, but most cells are incredibly small. Most are much smaller than 0.5 mm, which is about the size of the period at the end of this sentence. This is why microscope technology is essential for the study of cells.

Figure 1.3 There are a number of living and non-living things in this scene.

A3 *Quick Lab*

Defining Living Things

In grade 7 you learned that biotic elements — living things — need oxygen, food, water, energy, and a suitable habitat. You can expand this explanation by listing common characteristics of all forms of life.

Purpose

To develop definitions of living and non-living things

Procedure

1. With a partner, create a T-chart with the headings "Living" and "Non-living."
2. Together, think about things that are living, and list the characteristics or features that these things have. For example, you might say that living things grow.
3. List characteristics or features of non-living things on the other side of your T-chart.
4. With scissors, cut your chart in half. One partner will take the living list, and the other will take the non-living list.
5. Each partner will form a group with two other classmates who have the same half of the chart.
6. As a group, write a definition of a living or non-living thing.
7. As a class, combine group definitions of living and non-living things, and create a generally accepted definition of each.

Questions

8. The method used by you and your classmates to define a living thing is similar to the method used by scientists. They also created and collected ideas, and then discussed and edited them until they had an acceptable definition. Despite this, a simple definition of life does not exist in the scientific community. Not every scientist is happy with the accepted definition. Is there a portion of your class definition that you think could be explained better? How?
9. What do you think a scientist would need to do if he or she disagreed with a generally accepted definition?

1.1 Living Things and Cell Theory

Here is a summary of what you will learn in this section:

- Living things are made of cells.
- Scientists knew very little about cells before the microscope was developed.
- Cell theory is a way to describe the nature of cells.

Living things are all shapes and sizes. They can be plants or animals. They can live in a variety of habitats — from the tops of mountains to deep in the ocean. They have common basic needs, and they are all made up of cells.

In order to study these living things, scientists needed to be able to see them more clearly. There are written references to the use of some type of magnifier almost 2000 years ago. However, technological advances in both glass making and the grinding of lenses were required before magnification could be improved. Lenses for eyeglasses became available around the end of the 13th century. Lens makers became more skilled at grinding lenses as the demand for eyeglasses increased.

The earliest microscope was a tube with a single lens at one end and a plate for the object at the other. The magnification was 10 times the actual size of the object.

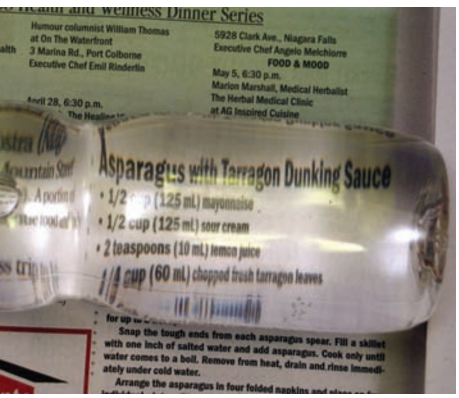


Figure 1.4 You can make a simple magnifier with a water-filled bottle.

A4 *Starting Point*

Skills A C

Make Your Own Magnifier

When light passes through a curved surface, it bends slightly. As a result, the image we see of the object beyond the curved surface seems larger than the actual object. This knowledge enabled people to magnify small objects. You can experiment to make your own magnifier.

1. Place a large drop of water on a microscope slide. Move the slide carefully to view the writing on a piece of newspaper.
2. Place a large drop of water on a clear overhead sheet. Move the sheet carefully over a piece of newspaper to view the writing on it.
3. Fill a test tube with water, and fit a stopper in it. Turn it sideways, and read through the test tube.
4. Fill a clear plastic bottle with water, and secure the cap. Turn it sideways, and read through the water-filled bottle (Figure 1.4).

Microscopes and Cell Theory

Since most cells are too small to see with the unaided eye, the existence and structure of cells remained unknown until the late 1600s. It was Antony van Leeuwenhoek (1632–1723) who built what is thought to be the first successful light microscope (Figure 1.5). Van Leeuwenhoek had taught himself how to grind and polish lenses in order to make his own magnifiers. Eventually, he made tiny lenses that could magnify an object up to 270 times. With this tool and a lot of curiosity, he uncovered the mysteries of the microscopic world. He was the first person to see bacteria cells, yeast cells, and blood cells. He also observed the variety of life in a drop of pond water.

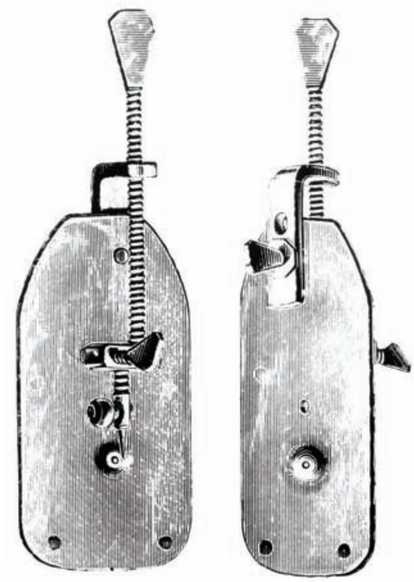


Figure 1.5 Antony van Leeuwenhoek built one of the first successful light microscopes.

The Basic Ideas of Cell Theory

The scientists who came after van Leeuwenhoek used increasingly effective microscopes. Over time, their discoveries led to the following key ideas of the **cell theory**.

1. The cell is the basic unit of life. In other words, the cell is the smallest living organism that shows the characteristics of living things.
2. An organism can be as simple as one cell (unicellular), like a paramecium, or it can be made up of trillions of cells (multicellular), like an elephant.
3. All cells are created from existing cells through a process called **cell division** by which a cell divides into two new cells.

WORDS MATTER

The prefix "micro-" comes from the ancient Greek word *mikros*, which means "small." The Greek word *skopos* means "watcher." The prefix "tele-" comes from the ancient Greek word for "far."

A5 *During Reading*

Thinking Literacy

Reading like a Writer

Textbook writers include a variety of text features to help the reader navigate the text more easily. As you read pages 13 and 14, record any scientific vocabulary you encounter. Compare the different ways scientific vocabulary is presented on these pages. Why might the writer have chosen different ways to highlight these specialized words? How does the "Words Matter" feature help you with the scientific vocabulary presented on these pages? What other text features do textbooks contain that help readers make sense of specialized vocabulary?

Take It Further

Before they developed cell theory, scientists believed in spontaneous generation. Find out more about this theory, and report back to your classmates. Begin your research at ScienceSource.

The Compound Light Microscope

A **compound light microscope** uses light focussed through several different lenses to form a magnified image of a specimen. A modern compound microscope, like the one shown in Figure 1.6 below, is a delicate and expensive instrument and needs to be handled with care.

1. **Eyepiece or ocular lens** This is the lens that magnifies the specimen, usually by 10 times (10x). This is the lens you look into.
2. **Coarse adjustment knob** This knob moves the stage up or down to focus on the specimen. This is the first knob you use to focus on a specimen.
3. **Fine adjustment knob** Use this lens to sharpen an image under low and medium power. It is the only adjustment knob needed with the high-power lens.
4. **Revolving nosepiece** This is where the objective lenses are mounted. Rotate the lens to select low-, medium-, or high-power lenses.
5. **Objective lenses** There are three lenses that magnify the specimen: low-power (4x), medium-power (10x) and high-power (40x). Keep the lenses free of dirt and fingerprints.
6. **Stage** This is where you place a slide for observation. Always keep the stage dry.
7. **Stage clips** These are used to hold a slide in position on the stage.
8. **Diaphragm** This has different-sized holes that let different amounts of light pass through the specimen on the stage.
9. **Lamp** The lamp supplies the light that passes through the specimen on the stage. Microscopes that do not have a lamp may have a mirror to collect and direct light.
10. **Arm** The arm holds the tube in place and is used to carry the microscope.
11. **Base** This provides a stable platform for the microscope. Always set it on a flat, dry, uncluttered surface.
12. **Tube** The tube separates the ocular lens from the objective lenses at a distance calculated for proper magnification.
13. **Condenser lens** This lens is under the stage. It helps focus light onto the specimen on top of the stage.

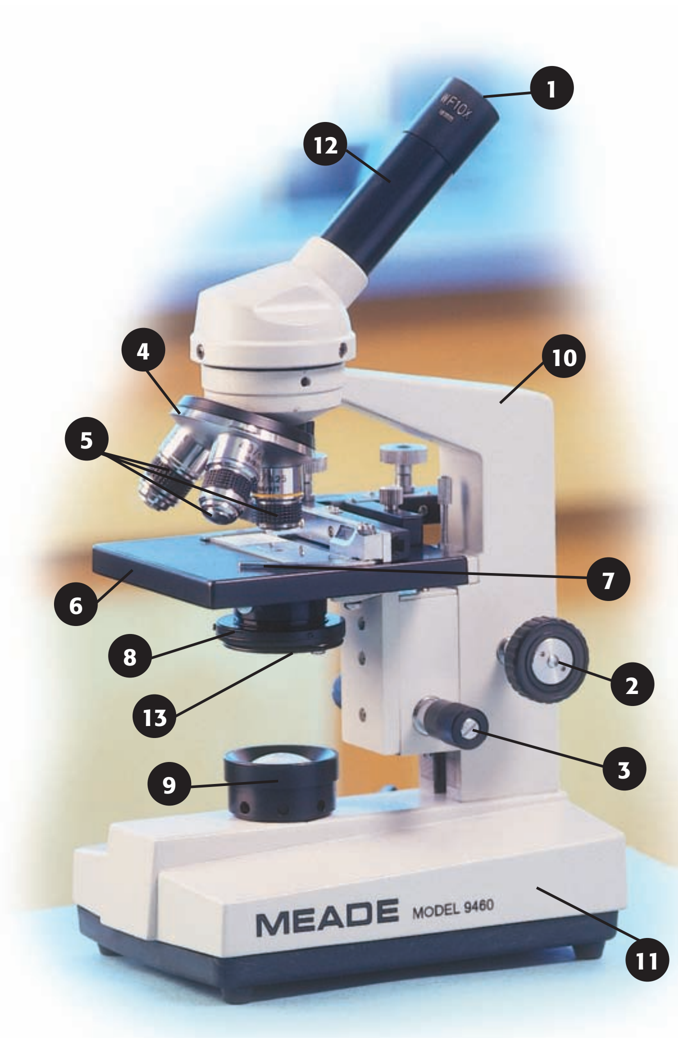


Figure 1.6 This compound light microscope is typical of the ones found in many science classrooms.

A6 *Quick Lab*

Care and Use of a Microscope

When used correctly, microscopes are powerful scientific tools. They are also expensive and delicate. Refer to Toolkit 9 before you follow the steps below to use them safely and effectively.

Purpose

To use a microscope correctly and follow safe laboratory procedures

Materials & Equipment

- compound light microscope
- lens paper
- prepared microscope slides

Procedure

1. Make sure you have a clear, clean, dry, flat work surface for the microscope. If the microscope has a plug, position the microscope so that it is close to the outlet.
2. Use two hands to carry the instrument — one hand on the base and the other on the arm.
3. Use lens paper to clean the lenses. *Never* touch the lenses with your fingers.
4. Rotate the revolving nosepiece until the low-power lens clicks into place.
5. View the microscope from the side. Turn the coarse adjustment knob until the low-power lens is about 1 cm from the stage. It will stop at the correct position. Do not force it.
6. Look through the ocular lens. Adjust the diaphragm until it is as bright as possible.
7. Place a prepared slide on the stage, and secure it with the stage clips. Check to make sure the object on the slide is centred over the hole in the stage.
8. Look through the ocular lens.
9. Slowly turn the coarse adjustment knob to bring the object into focus. The image should be very clear. If it is not, use the fine adjustment knob to make the image sharper.
10. Without adjusting the focus, rotate the revolving nosepiece until the medium-power lens clicks into place.
11. Use the fine adjustment knob to sharpen the image.
12. View an object and at the same time move the slide left, then right, then up, and then down. Describe what happens to the image.

Questions

13. Refer to Drawing Hints in Toolkit 9 to help you draw and label the images you see under the microscope. Draw sketches of two of the specimens you viewed. How are they the same? How are they different?

Figure 1.7 The coarse adjustment knob moves the stage up or down.

Figure 1.8 The fine adjustment knob brings the object into sharper focus.

1.1 CHECK and REFLECT

Key Concept Review

1. In your own words, restate the three key ideas about cell theory.
2. Create a chart listing the names of the parts of a microscope on the left-hand side and the functions of each part on the right-hand side. Your chart should have 13 rows.
3. In your own words, define a compound light microscope.

Connect Your Understanding

4. Your classmate is viewing a sample using high power and is about to refocus using the coarse adjustment knob. What would you recommend your classmate do and why?

Practise Your Skills

5. Write up the procedure for bringing a microscope from the storage area to your work space and setting it up.
6. The student in the photo below is using a microscope safely. Name three things she is doing correctly.

For more questions, go to ScienceSource.

A7 *Thinking about Science, Technology, and Society*

The Importance of Technology in Science

Most technologies are developed to answer a specific need, but they often lead to more questions, more studies, and whole new areas of knowledge. This is the case with the use of lenses to create microscopes.

What to Do

1. Compare the difference in the detail you observed while viewing the microscope slide with your unaided eye and viewing the slide under the microscope.

Consider This

With a classmate or as a whole class, discuss these questions.

2. Do you think it would have been possible to know that living things are made of cells if microscopes had not been developed? Explain your thinking.
3. Do you think that scientific discoveries always require the invention of new technologies? Explain your reasoning.

1.2 Comparing Plant and Animal Cells

Here is a summary of what you will learn in this section:

- Plant and animal cell structures are called organelles.
- Plant and animal cells perform some similar functions, such as converting energy and getting rid of wastes.
- Plant cells perform a unique function, which is using energy from the sun to convert carbon dioxide and water into food.

When you first learned to classify living things, the easiest ones to classify were likely the members of the plant kingdom and the members of the animal kingdom. Think of the main differences between plants and animals that you observed and that helped you decide which category the organism belonged to. Scientists decide which is which by dividing organisms into those that can make their own food (plants) (Figure 1.9) and those that must consume other living things in order to get the nutrients they need (animals).

This difference between plants and animals is reflected in the structure of their cells. Plant and animal cells have some similar specialized parts that do the same job. Plant cells also have some unique parts that allow them to transform the Sun's energy into food in the form of sugars.

Figure 1.9 Plants have cells with special parts that enable them to use energy from the Sun to produce food.

A8 *Starting Point*

Skills A C

What is the magnification?

The size of a red blood cell is about 0.007 mm. A liver cell is about 0.02 mm. The point of a ballpoint pen is about 0.2 mm. The head of a pin is about 1 mm.

What to Do

1. List which of the above items you could see with your unaided eyes.
2. Compare the actual size of a red blood cell with the image shown in Figure 1.10. Estimate how many times it has been magnified.

Consider This

3. When you are looking at a magnified image, is it important to know the magnification? Explain your answer.

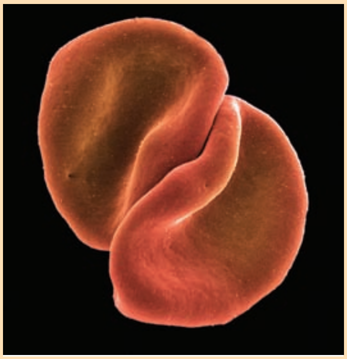
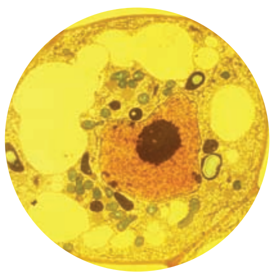


Figure 1.10 Red blood cells

Parts of Plant and Animal Cells

All plant and animal cells contain a jelly-like material called **cytoplasm** in which the parts of a cell float. To keep the cytoplasm together, cells possess a thin covering called a **cell membrane**. The cell membrane acts like a security guard, allowing only certain materials in or out. Floating in the cytoplasm are structures (parts) called organelles. **Organelles** are tiny parts within the cell that have special functions that help the cell survive, grow, and reproduce. Most organelles are contained inside a **membrane** of their own. Organelle membranes keep different parts of the cell separate from one another.

Figure 1.11 Photograph of a plant cell taken through a microscope. It shows chloroplasts (green), cytoplasm, vacuoles (large yellow areas), and the cell wall, among other structures.



Plant Cells

Figures 1.11 and 1.12 show various organelles and structures typical of plant cells.

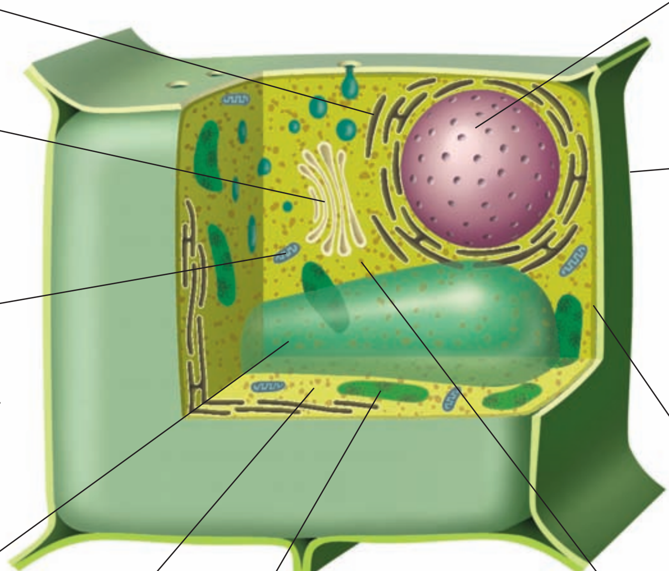


Figure 1.12 This is a representation of the key parts of a plant cell. It does not represent all plant cells.

Animal Cells

Figures 1.13 and 1.14 show that animal cells have many of the same organelles that plant cells have. Compare the two diagrams and note any similarities or differences.

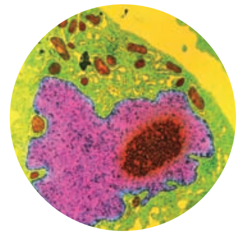
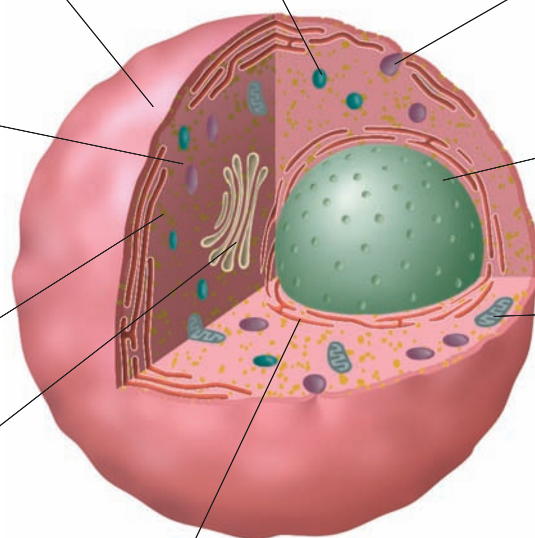


Figure 1.13 Photograph of an animal cell taken through a microscope. The nucleus (pink) takes up most of the cell. Outside the nucleus is the cell cytoplasm (green). The brown bodies at the top of the cell are mitochondria. The cell is surrounded by a cell membrane.



cell membrane The thin covering that surrounds the organelles inside the cell and controls the passage of materials in or out of the cell. The cell membrane is the outer boundary of an animal cell.

cytoplasm Jelly-like material that fills the cell and surrounds the organelles. Food and oxygen move through the cytoplasm to the organelles.

ribosomes Tiny organelles that help make proteins. There are many of these organelles in the cytoplasm.

Golgi apparatus A folded organelle that combines proteins made by the endoplasmic reticulum and delivers them to the rest of the cell and outside the cell.

lysosomes These organelles break down food and digest wastes.

endoplasmic reticulum A folded organelle that makes proteins.

vacuoles Sac-like organelles that store excess food, waste, and other substances. Animal cells have several small vacuoles.

nucleus A large organelle that is easy to see under magnification. It controls the activities of the cell, such as growth.

mitochondria The powerhouses of the cell. These organelles break down food particles and release their stored energy. The cell uses this energy to fuel all of its activities. The number of mitochondria varies according to the function of the cell.

Figure 1.14 This is a representation of the key parts of an animal cell. It does not represent all animal cells.

A9 *During Reading*

Thinking Literacy

Using Headings

Textbook headings are specifically organized to guide a reader's understanding of the information and indicate which topics are connected or related. As you read to the end of section 1.2, pay special attention to the headings and subheadings presented on these pages. In your notes, make a list of these headings as well as the different ways they are presented. Think about colour, type size, and other conventions used to highlight these headings. How does the visual presentation of the headings help you as a reader? Use the headings on these pages to explain the connections among these topics.

Special Technologies for Studying Plant and Animal Cells

When you first looked at cells under a microscope, you were likely looking at prepared slides, and the cells had been stained with a dye such as iodine. The cells and their organelles do not have much colouring, so light passes through them. Without colour or contrast, the organelles are difficult to see. Stains make some organelles visible (Figures 1.15 and 1.16). All of the cells shown in photographs in this text are micrographs of stained cells. **Micrographs** are photographs taken with a microscope.

The preparation of a specimen (sample) for viewing under the microscope involves a variety of steps that depend on the type of specimen. Typically, a very thin slice of the specimen is obtained without damaging the cells. Next, the specimen must be mounted on a slide.

Finally, the cells are stained. Researchers usually choose the type of stain best suited to the cell they are examining. For example, some stains are best for observing blood or bone marrow. Others are for distinguishing cells from surrounding tissues or to make carbohydrates visible.

Stains must be handled with care because some are toxic and others can damage the eyes. The most common stains for student purposes are:

- food colouring, which is non-toxic
- iodine, which is used to detect the presence of starch
- methylene blue, which is used on animal cells to make the nucleus visible

Take It **Further**

Biologists are not the only scientists who use microscopes. Earth scientists such as geologists also use them. Find out what a geologist uses a microscope for. Begin your research at ScienceSource.

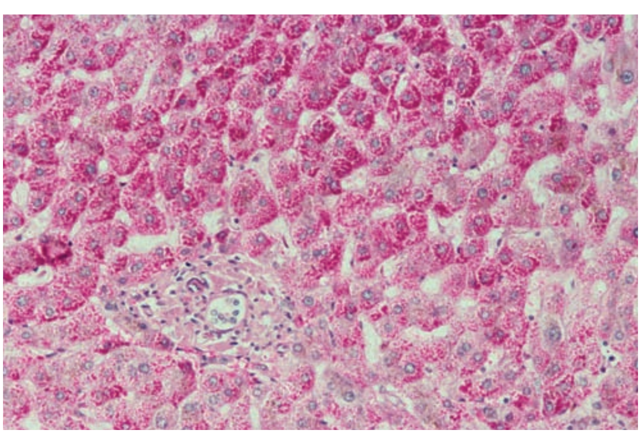


Figure 1.15 These liver cells were stained in order to reveal the organelles.

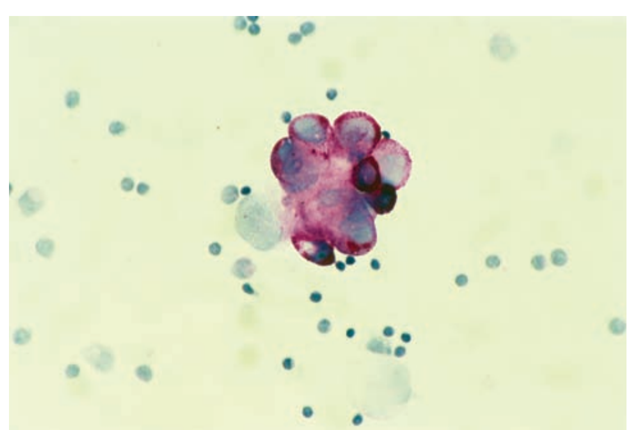


Figure 1.16 A stain was used in this sample to reveal the presence of cancer cells.

A10 *Quick Lab*

Building a Cell

Purpose

To design and construct a model of a plant or animal cell

Materials & Equipment

- building materials such as recycled objects OR
- food items such as pasta or breakfast cereal that resemble the organelles they are representing.

Procedure

1. Choose the type of cell you will construct.
2. List the organelles to be represented and the function of each one in a chart.
3. Consider options for materials that will best represent the organelle.
4. Select the best building materials and construct your model.

Questions

5. Add the material you used to represent each organelle to the chart you created in step 2.
6. Justify your choice of materials.
7. What part of your model best represents an organelle? Explain your reasoning.
8. If you had more time or different materials, what would you change in your model? How?

A11 *Quick Lab*

Preparing Dry Mount Slides

Purpose

To learn how to correctly prepare dry mount slides of a variety of non-living things

Materials & Equipment

- compound light microscope
- microscope slides and cover slips
- tweezers
- threads from different fabrics
- other samples (e.g., hair, salt)

Procedure

1. Choose a few strands of thread from the fabric samples provided.
2. Place the threads at the centre of a clean, dry slide.
3. Hold a cover slip very carefully by its edges, and gently place it over the threads.
4. View the threads under the microscope using the medium-power lens.
5. With your teacher's permission, make dry mount slides of other samples, such as hair or salt.

Questions

6. Draw and label a sketch of the threads you saw.
7. Challenge your lab partner to figure out what fabric sample the thread on your dry mount came from.
8. Repeat steps 6 and 7 for the other specimens.

DI Anchor Activity

A12 Quick Lab

Preparing Wet Mount Slides

Prepared microscope slides are convenient to use, but in order to view your choice of specimens, you need to prepare your own slides. In order to view living or moving objects, you must prepare a wet mount.

Purpose

To learn how to correctly prepare wet mount slides of a variety of objects

Materials & Equipment

- compound light microscope
- microscope slides
- cover slips
- tweezers
- medicine dropper
- water
- a newspaper
- homogenized milk
- skim milk (optional)
- other samples (e.g., pond water)

Procedure

1. Obtain a clean, dry microscope slide and cover slip. Place the slide in front of you.
2. Carefully cut a lowercase "e" from the newspaper.
3. Use the medicine dropper to place 1 or 2 drops of water in the middle of the microscope slide.
4. Use tweezers to place the "e" right side up on the drop of water.
5. Hold the cover slip very carefully by its edges, at an angle of about 45° to the surface of the slide. Gently lower the cover slip over the sample. If any air bubbles get trapped, carefully move the cover slip with your finger to free them.
6. View the sample under the microscope. Start with low power and then move to medium power.
7. Make a wet mount of homogenized milk, and view it under medium power.
8. Get permission from your teacher to make wet and dry mount slides of other samples, such as pond water.
9. Draw a sketch of the specimens you viewed. Give your sketch a name and a date.
10. Challenge your lab partner to figure out what your sketch represents.

Questions

11. There are many white blobs visible on the wet mount of homogenized milk. What might these be? Test your theory by making a wet mount slide of skim milk. Draw and label a sketch comparing both milk samples.
12. Why do you think it was important to get rid of any air bubbles?

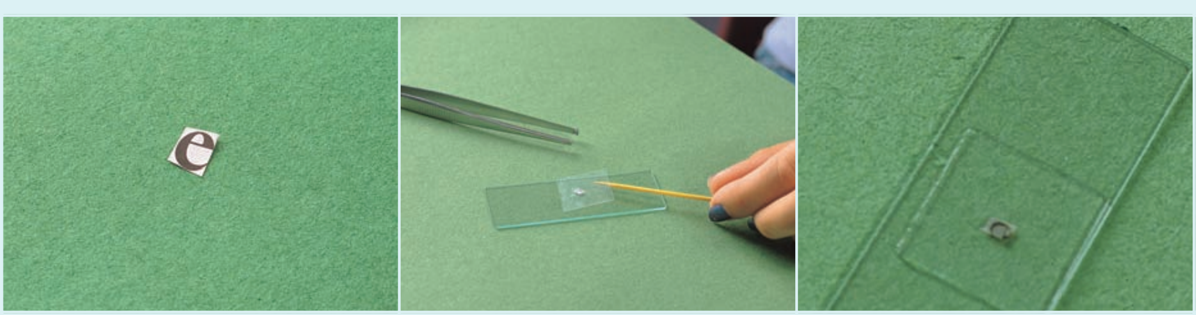


Figure 1.17

1.2 CHECK and REFLECT

Key Concept Review

1. Prepare a chart listing the organelles of a plant cell and their functions. Label the columns in your chart and give your chart a name.
2. Prepare a chart listing the organelles of an animal cell and their functions. Label the columns in your chart and give your chart a name.
3. When would you use a dry mount to view a specimen under a microscope? When would you use a wet mount?
4. What is a micrograph?

Connect Your Understanding

5. Plant and animal cells have some of the same types of organelles. List these organelles, and explain why you think this is the case.
6. Plant cells have some organelles that are different from those found in animal cells. List these organelles, and explain why you think these organelles are needed.

Practise Your Skills

7. You have obtained specimens of a piece of meteorite and water from the pond it landed in. Describe the procedure for preparing to view each of them under a microscope that has been set up.

For more questions, go to ScienceSource.

A13 *Thinking about Science, Technology, and Society*

"Perfecting" Plants

Farmers have saved seeds for crops almost since the beginning of agriculture. They have also experimented with breeding plants in the hope of developing better ones.

Scientists began to assist farmers, and in Canada, research studies led to the development of wheat that could grow in our climate. This success enabled Canadian farmers to become major producers of wheat, an important part of Canada's economy.

Scientists are now able to breed plants that resist insects or can grow better in more challenging conditions. Sometimes the seeds of those plants are engineered so that they cannot develop into new plants. This ensures that farmers will always buy seeds from the company that paid for the research.

Consider This

With a classmate or as a whole class, discuss these questions.

1. Companies are usually allowed to own the technology they invent. Should companies be able to own technologies that relate to living things? Explain your reasoning.
2. If scientists can change plant cells to improve the world's supply of food, should they be allowed to do so? Who should decide?

1.3 The Flow of Materials into and out of Cells

Here is a summary of what you will learn in this section:

- The cell membrane can control the substances that move into or out of a cell because the membrane is selectively permeable.
- Diffusion is a process where substances in areas of high concentration move to areas of low concentration.
- Osmosis is a special type of diffusion involving water and a selectively permeable membrane.

Figure 1.18 On a windy, rainy day only the right type of jacket will keep the wearer warm and dry.

When it is wet and windy outside, you need to wear a jacket that keeps the rain and cold air away from your body. A clothing designer must choose from the few fabrics that have the right properties for a wet-weather jacket. If the jacket is made of cotton, you will be wet and cold. Cotton is **permeable**, which means water and air can pass through it easily.

If the jacket is made of a plastic material, you may still be wet and perhaps cold. Plastic is **impermeable.** Although rain cannot pass through it, you will get hot and sweaty because the air heated by your body cannot escape through the plastic. Then the moisture in the heated air will condense on the inside of the jacket and conduct heat away from your body. The best jacket material keeps the rain out but lets some water vapour pass through. Such material is selectively permeable (Figure 1.18). **Selective permeability** refers to the property of a barrier that allows only certain substances to pass through it.

A14 *Starting Point*

Skills A C

Finding Buried Treasure

A sieve is an example of a selectively permeable membrane. It allows some items to pass through it while other items cannot.

If you lost your ring in a pail of sand, you could use a soil sieve or a kitchen sieve to retrieve it.

Consider This

1. If you were using a sieve to sift through sand to find your ring, what is the most important quality of the selectively permeable membrane you are using?

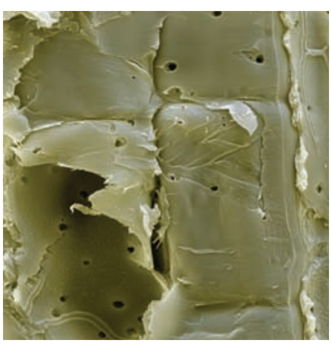
Cells and Permeability

The cell walls and membranes you see in Figures 1.19a and 1.19b below are selectively permeable. Each structure functions as a barrier that separates the inside of a cell from the outside environment and keeps the cell intact. In addition, these selectively permeable cell structures allow certain substances, such as water, oxygen, carbon dioxide, carbohydrates, and waste created within the cell, to pass through it. Large molecules that may harm the cell are blocked by the membrane or cell wall.

Without selective permeability, the cell would be sealed. It would be unable to access the supply of materials the organelles need to carry out cell activities, and the cell would be unable to get rid of the wastes generated by its activities. Instead, every cell in your body (and in every other organism) is bringing water, food, and gases in and removing wastes at every moment of the day.

This movement of substances into and out of a cell is called **cellular transport**. Cellular transport involves several different processes. Diffusion and osmosis are two types of cellular transport processes.

(a)



(b)

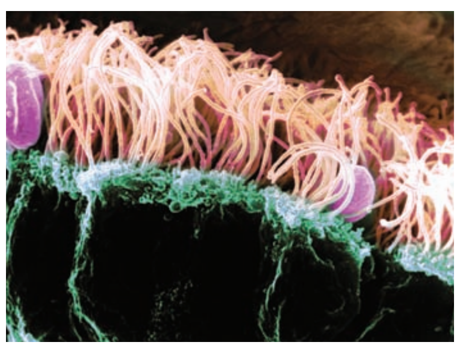


Figure 1.19 Both plant (a) and animal (b) cells have selectively permeable membranes and walls (in the case of plant cells). Substances such as air and water move into the cells and waste moves out of the cells.

A15 *Learning Checkpoint*

Build a Mind Map

A mind map is an excellent tool to help you remember what you are reading. In the information that follows, you will be introduced to two different forms of cellular transport — diffusion and osmosis. Create a mini-mind map to help you summarize their roles in ensuring the survival of a cell.

Begin by writing "cellular transport" in the centre of a piece of paper. Then build your understanding about the key ideas of diffusion and osmosis. Note definitions, functions, and examples of the two forms of transport as you read through the rest of this section.

Figure 1.20 The smoke from this fire moves through the air by diffusion, dispersing its particles evenly throughout the air.

Diffusion

Diffusion is the movement of particles from an area where there are many of them (a higher concentration) to an adjoining area where there are few of them (a lower concentration) (Figure 1.20). Diffusion continues until both areas have the same number (concentration) of particles (Figure 1.21).

Diffusion happens all around you. Diffusion occurs when you place a tea bag into boiling water to make tea. Diffusion is at work when you can smell the aroma of pizza coming from the kitchen. Everything you can smell is because of diffusion. Diffusion causes the fragrance of cologne or perfume to spread through a room. A classroom is usually not a good place to wear these products because of the effectiveness of diffusion in such a small space, and because some people are very sensitive to fragrances.

For a cell, diffusion is how resources such as oxygen are transported (moved) into it through its selectively permeable membrane. When the concentration of oxygen is lower inside a cell than it is outside the cell, oxygen diffuses into the cell, where it is used by the mitochondria. As the oxygen is used to produce energy, more will diffuse into the cell to keep the concentration almost the same inside and outside the cell.

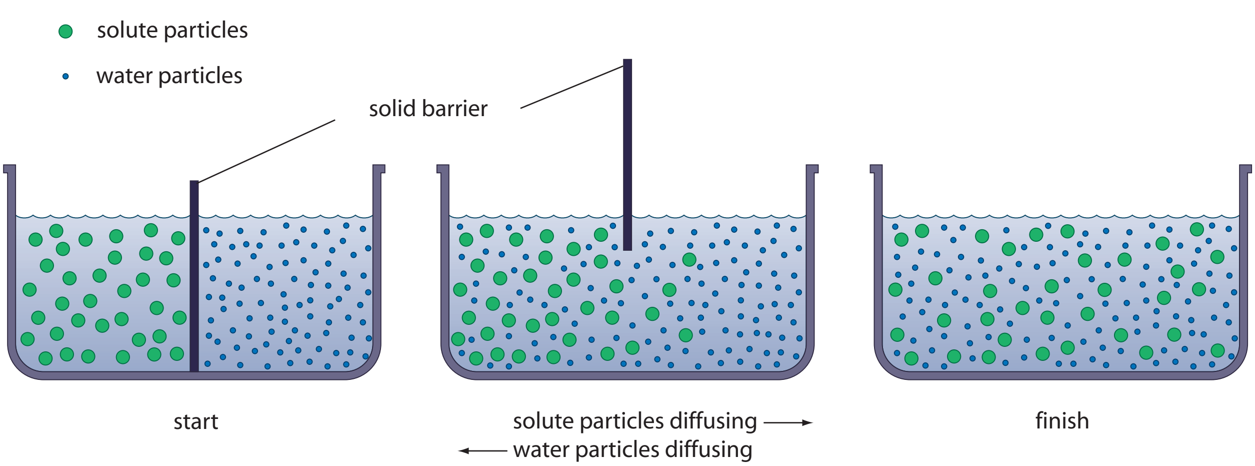


Figure 1.21 The process of diffusion

Osmosis

Osmosis is a special kind of diffusion that involves only the movement of water through a selectively permeable membrane (Figure 1.22). The concentration of water inside a cell must stay fairly constant, and therefore water diffuses into and out of cells continuously. Osmosis (this movement of water into and out of cells) is vital to the cells' survival.

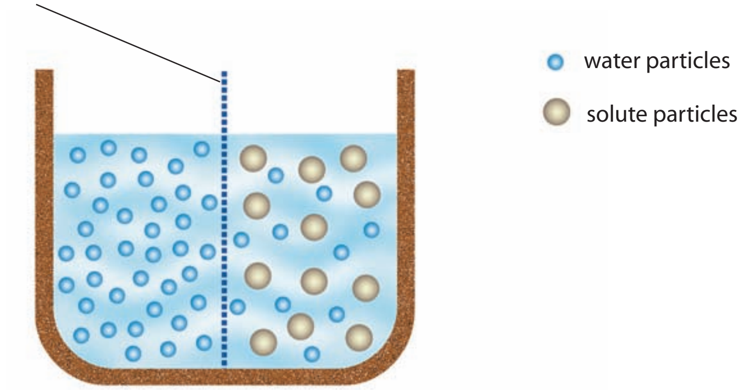


Figure 1.22 During osmosis, water moves from an area of higher concentration of water to an area of lower concentration of water through a selectively permeable membrane. In the diagram, the water particles move from left to right.

The process of osmosis also depends on the difference in the concentration of particles. In the case of cells, if the concentration of water particles inside the cell is higher than it is outside the cell, water will move out of the cell by osmosis. If the concentration of water particles outside the cell is higher, the water particles will move into the cell.

If you let the soil around the plant dry out, the plant would begin to droop as the concentration of water particles inside the cell dropped. With no water in the soil, there is no water to move into the cells. If you examined the cells in the stem, they would look shrunken. The cell walls would not be rigid, giving the plant a wilted appearance. This process is easiest to detect in plants (Figure 1.23).

If you were to look at one of the cells in the stem of a firm plant under the microscope, you would see that it has a very full shape. The cell has so much water in it that if the thick cell wall were removed, the cell would burst.

Take It **Further**

Bottled water is not pure water. It has dissolved substances in it. Find out more about these substances and how they may help your cells to function properly. Report back to your class. Begin your research at ScienceSource.

Figure 1.23 Osmosis is involved in giving plants the rigidity they need to reach up for sunlight. Compare the drawing of a cell in a wilted plant (left) to the one in the healthy plant.

A16 *Inquiry Activity*

Toolkit 2

SKILLS YOU WILL USE
- Evaluating procedures
- Drawing conclusions

Diffusion Detective

During diffusion, molecules move randomly as they shift from a high concentration to a low concentration. This activity will allow you to observe diffusion.

Question

Do all liquids diffuse in the same way?

Materials & Equipment

- 3 clean 400-mL beakers or clear glass containers
- water
- electric kettle
- food colouring
- vegetable oil
- tea bag
- medicine dropper

Figure 1.24 Get as close to the surface as possible (within 5 mm) before adding the substance to the water.

Procedure

1. Add approximately 300 mL of water to two of the containers.
2. Add approximately 300 mL of boiling water to the third container. Be careful with the hot water. It can scald you.
3. Carefully hold the food colouring container 5 mm above the surface of the water in the first container, and gently add 3 to 5 drops to the surface of the water.
4. Use the medicine dropper to carefully add 3 to 5 drops of vegetable oil to the surface of the water in the second container.
5. Carefully lower the tea bag into the third container.
6. Do not bump or move the containers or agitate, swirl, or stir the liquid inside them.
7. Observe what happens over a 5-min period.
8. Draw and label a series of diagrams that records what happened in each container.

Analyzing and Interpreting

9. Compare your observations with those of a classmate. In one sentence, describe the pattern of movement you observed for each of the substances added to the water.
10. Did you observe any differences in the way the substances moved in the water? Suggest an explanation.

Skill Builder

11. Do you think the activity was a fair test to compare the diffusion of different substances? Explain why or why not.
12. If necessary, suggest how the activity could be changed to make it a fair test.

Forming Conclusions

13. What factors, if any, do you think might affect diffusion?

SKILLS YOU WILL USE
- Predicting
- Observing and Recording

Food for Thought

Question

How will plain water and a saltwater solution affect plant cells?

Materials & Equipment

- two 400-mL beakers
- water
- 2 pieces of each food: carrot, celery stalk, raisin
- spoon
- salt
- plastic food wrap

Procedure

1. Fill each beaker with 300 mL of water.
2. Label one beaker A and the other beaker B.
3. Add salt to beaker B and stir. Continue to add salt until no more will dissolve (a small pile will remain on the bottom no matter how much you stir).

Figure 1.25

4. Create a chart to record your observations. In your chart, record the shape of each food item, what it feels like, and what it looks like. Add 1 carrot, 1 celery stick, and 1 raisin to each of your beakers.
5. Cover each beaker with a piece of plastic food wrap. Predict what will happen to each food item in each beaker. Create a chart to record your predictions.
6. Let the beakers sit for a day or less.
7. Record your observations in your chart.

Analyzing and Interpreting

8. How did the plain water and the saltwater solution affect the food items?

Skill Builder

9. Compare your predictions to your results. Discuss any differences.
10. Use words and pictures to show how osmosis occurred in this activity.

Forming Conclusions

11. Should you store plant-based foods in plain water or a saltwater solution? Explain your reasoning.

1.3 CHECK and REFLECT

Key Concept Review

1. Define the term "permeable" in your own words.
2. Use the term "concentration" in a sentence about liquids that conveys its meaning.
3. List three examples of a selectively permeable material or item. Explain where it is found or used and why a selectively permeable material is needed.

Connect Your Understanding

4. If you wrap fresh celery in foil, it will stay crunchy when you store it in the refrigerator. Explain why you think this happens.

Practise Your Skills

5. You need to put a new roof on your house. Describe how you would test possible materials for permeability. What would be the criteria for success?

For more questions, go to ScienceSource.

A18 *Thinking about Science, Technology, and Society*

The Artificial Kidney

Your kidneys help filter waste materials out of your blood. If they become damaged, you may need to have your blood filtered artificially. This process is called dialysis.

Dialysis works by using the principles of diffusion and osmosis. Tubing hooks the patient up to a machine, known as a dialyzer, and blood is pumped from one of the patient's arteries into the dialyzer (Figure 1.26). This blood is rich in waste materials.

The compartment in the dialyzer is divided by a selectively permeable membrane. A special dialysis fluid, called dialysate, flows through the dialyzer on the other side of the membrane.

This system can filter the waste materials from the patient's blood. The clean blood is returned to the body by being pumped into a vein.

Consider This

With a classmate or as a whole class, discuss the following questions.

1. A dialysis treatment can take from three to five hours and must be done three or four times a week. Every year, another 2000 Ontarians require dialysis. Should those who can afford it be asked to contribute to the cost? Explain your reasoning.
2. A kidney transplant is an alternative to dialysis. Should people be encouraged to donate their organs for transplant? Explain your reasoning.

Figure 1.26 Patients with damaged kidneys need regular dialysis treatment.

Solving the Mystery of Viruses

Figure 1.27 Transmission electron microscope

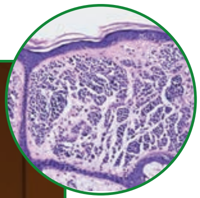


Figure 1.28 A skin cell seen under a compound light microscope

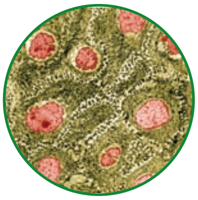


Figure 1.29 Skin cells seen under a scanning electron microscope

Viruses are extremely tiny agents that cause infection. They are smaller than bacteria, and they are unable to grow or reproduce on their own. Instead, they must invade a living cell. They use the resources of the cell to develop and multiply.

Researchers did not see viruses until after the electron microscope was developed in the late 1930s (Figure 1.27). Compound light microscopes are limited to magnifications of 500x or 1000x. This level of magnification did not allow researchers to see the details inside organelles such as the nucleus or mitochondria (Figure 1.28). Nor could they see tiny viruses. In order to see that level of detail, scientists needed microscopes that could magnify objects by 10 000x or more.

An electron microscope uses a focussed beam of electrons instead of light to create an image of a specimen. Magnetic lenses help contain and focus the beam. The interactions of the electrons and the specimen are transformed into an image (Figure 1.29).

Since the mid-1960s, when scanning electron microscopes became more widely available, there have been a number of breakthroughs in the study of viruses. In addition to solving the mystery of how West Nile virus is transmitted, researchers have studied everything from the common cold to the outbreak of SARS (severe acute respiratory syndrome).

Question

1. A compound light microscope costs hundreds of dollars, depending on the model. An electron microscope can cost hundreds of thousands of dollars, depending on the technology supplied with it. Should governments provide funds for researchers to acquire specialized electron microscopes? Explain your reasoning.

1.0 Chapter Review

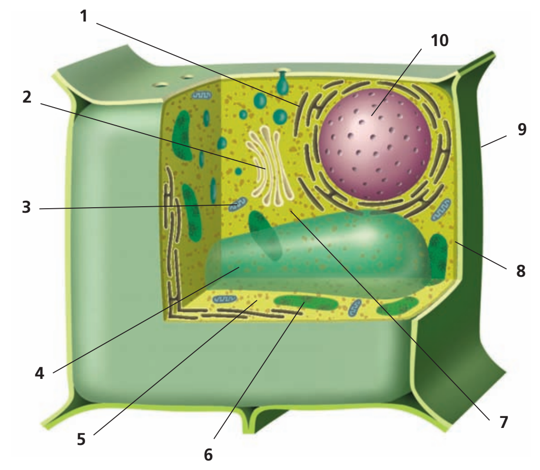
Assess Your Learning

Key Concept Review

1. Where is the diaphragm located on a microscope? Explain what it is used for. k

2. (a) Identify the type of cell in the diagram shown here, and name all numbered parts. k

   (b) Describe the function of the parts numbered 1, 3, 5, and 6. k



3. Compare and contrast the processes of osmosis and diffusion. Give an example of each. k

4. Your teacher has given you a sample of soil to examine. Would you use a dry mount or a wet mount to examine it? Explain your reasoning. t

5. If you were looking at a cell specimen through a microscope, how could you tell that the cells belonged to a plant? t

6. Use the term "selectively permeable" in a sentence that demonstrates its meaning. k

Connect Your Understanding

7. What would happen if cell membranes suddenly became permeable instead of selectively permeable? Could cells remain alive? Explain your thinking. a

After Reading *Thinking Literacy*

Reflect and Evaluate

Brain research indicates that the brain is a pattern seeker. As we read increasingly more complex text, the brain tries to draw on what it already knows about how the text works in order to understand new information.

With a partner, develop a chart to list the text features related to scientific vocabulary that you have encountered in chapter 1. What is the purpose of each of these text features? How does each feature help you as a reader? What other text features did you encounter in chapter 1? Include them in your chart.

ACHIEVEMENT CHART CATEGORIES

k Knowledge and understanding t Thinking and investigation c Communication a Application

8. What would be the impact on the environment if an artificial virus that attacked and destroyed chloroplasts in plant cells was accidently released by a research company? (a)
9. When you put the groceries away, you forgot to put the celery in the refrigerator. When you found it on the counter, it was soft and limp. How could osmosis help the celery? Explain what you would do and why it would work. (a)

Practise Your Skills

10. Describe the steps involved in preparing a wet mount of a specimen. (k)
11. You have mounted your specimen on the stage of the microscope. Describe the process of focussing the lens on the specimen. (k)
12. Describe the steps involved in making a drawing of what you see under a microscope. (k)
13. List three safety steps you must follow when carrying a microscope. (k)

Unit Task Link

Cells are the basic unit of life, and it is important to understand what they look like and how they function. Make a list of the key features of plant and animal cells and describe their function.

A19 *Thinking about Science, Technology, and Society*

STSE

Reverse Osmosis

During osmosis, water moves across a selectively permeable membrane from an area of high water concentration to an area of low water concentration. In other words, pure (100 percent) water will move across a selectively permeable membrane to water that has dissolved substances in it like salt.

During reverse osmosis, water particles are forced to move in the opposite direction — from a low concentration to a high one. High pressure is applied to the low water concentration (usually saltwater) side, and the water particles there are forced through the tiny holes of the selectively permeable membrane. They move to the high water concentration side, and the salt is left behind.

Consider This

With a classmate or as a whole class, discuss these questions.

1. How could this technology be used by shipwreck victims on an island in the ocean?
2. If viruses are smaller than salt molecules, is this filtering method 100 percent safe? Explain your reasoning.