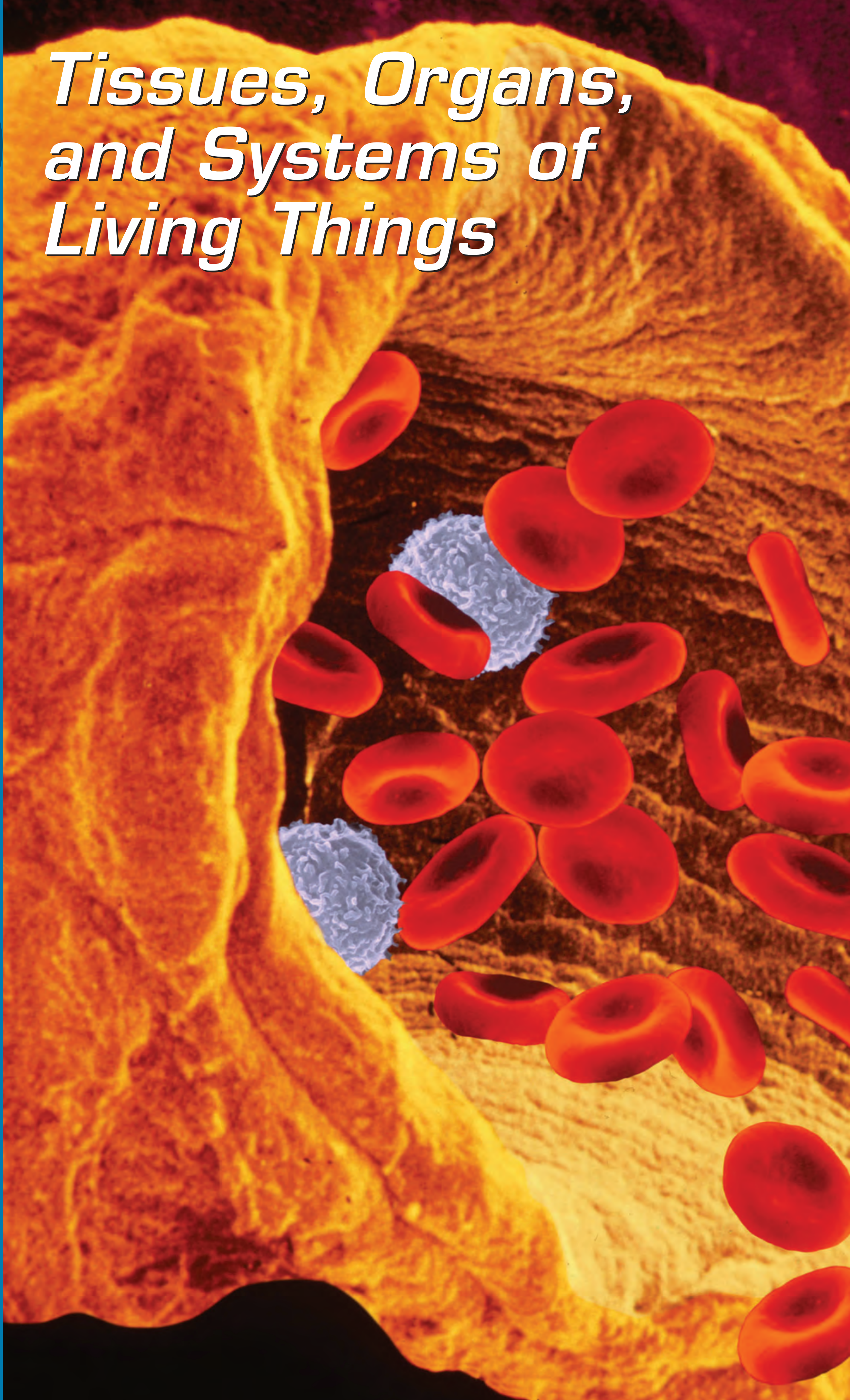
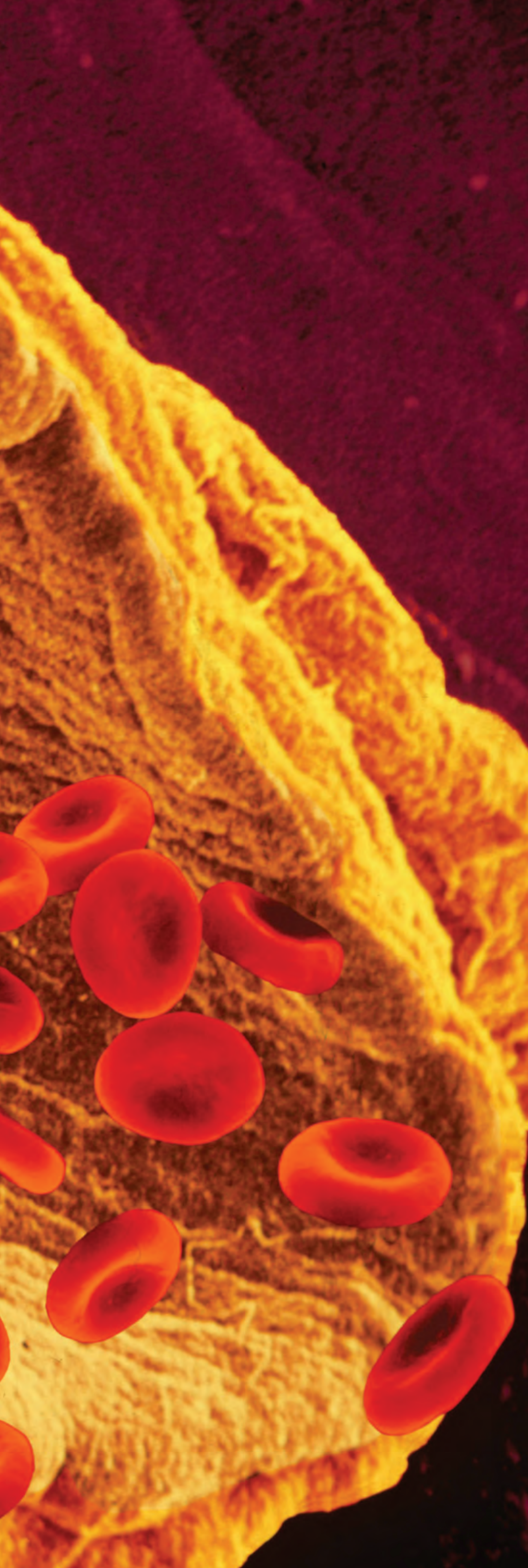
UNIT A

Tissues, Organs, and Systems of Living Things



Scanning electron micrograph of red and white blood cells flowing through a vein in a human leg (magnification 4000×)



Contents

Unit Task

Advancements in systems biology have affected society both in good ways and in bad ways. Your task is to present an opinion on how these advances have affected society. You may also discuss the controversies surrounding the advancements as well as the next step in development that may occur. Your presentation should be in the form of a collage, comic, video, PowerPoint presentation, monologue, written report, or brochure.

Essential Question

How have advancements in systems biology affected individuals and society?

Exploring

To protect themselves from the Spanish flu pandemic, people were encouraged to wear cloth masks.

Reviving a Killer

In 1918, one of the deadliest diseases was unleashed on the world. In early March of that year, medical authorities in the United States reported the first case of a deadly influenza. The symptoms — the skin turned blue, the feet turned black, and the lungs filled with blood — were unlike any symptoms previously seen. Victims, who were mostly young men and women, became ill and died within hours. At a time when hundreds of young adults were being killed while fighting in a world war, thousands more were being killed at home by the influenza virus. Within months of the first case, there were reports of widespread outbreaks in many parts of the world. Because the influenza infected people around the world, it was known as a pandemic. This influenza became known as the Spanish flu because it was first widely reported in Spanish newspapers. During the first six months of this pandemic, millions of people died. The Spanish flu was responsible for the deaths of between 25 million and 50 million people died from the Spanish flu.

Between 25 million and 50 million people died from the Spanish flu.

At the time, doctors believed that the spread of influenza could be controlled by limiting contact with the source of disease. People were told to wear masks when they were out in public, to cover the nose and mouth when coughing, and not to shake hands. Some people were put in quarantine, a situation in which an ill person or a suspected ill person was kept away from other people.

Lessons Learned

Scientists learned valuable lessons from the 1918–1919 Spanish flu pandemic and were better prepared for the Asian influenza pandemic that occurred in 1957–1958 and the Hong Kong influenza pandemic in 1968. Governments and organizations, such as the World Health Organization, developed plans to handle future influenza pandemics.

One strategy involved studying and researching the Spanish flu virus itself. In 1997, a team of researchers led by Canadian Dr. Kirsty Duncan dug up bodies of 1918 influenza victims buried in a Norwegian cemetery and attempted to "revive" the virus. Although researchers believed that the virus would still be capable of reproducing, this was not true. However, in 2005, American researchers were able to restore the virus using pieces of the virus obtained from various sources. Researchers in Canada and the U.S. are currently working with the restored virus to understand what made it so deadly.

In 2008, scientists gained permission to study the corpse of a 39-year-old British diplomat who had died in 1918 from influenza. Because the body is in a lead-lined casket, researchers believe the body will be very well preserved and they will be able to obtain samples that will reveal information about the virus. By reviving and studying a killer virus, scientists hope to prevent future deaths from the virus.

A scientist works with the resurrected 1918 influenza virus in a special airflow cabinet. Air is sucked into the cabinet and filtered before it is recirculated in a sealed laboratory.

A1 STSE *Science, Technology, Society, and the Environment*

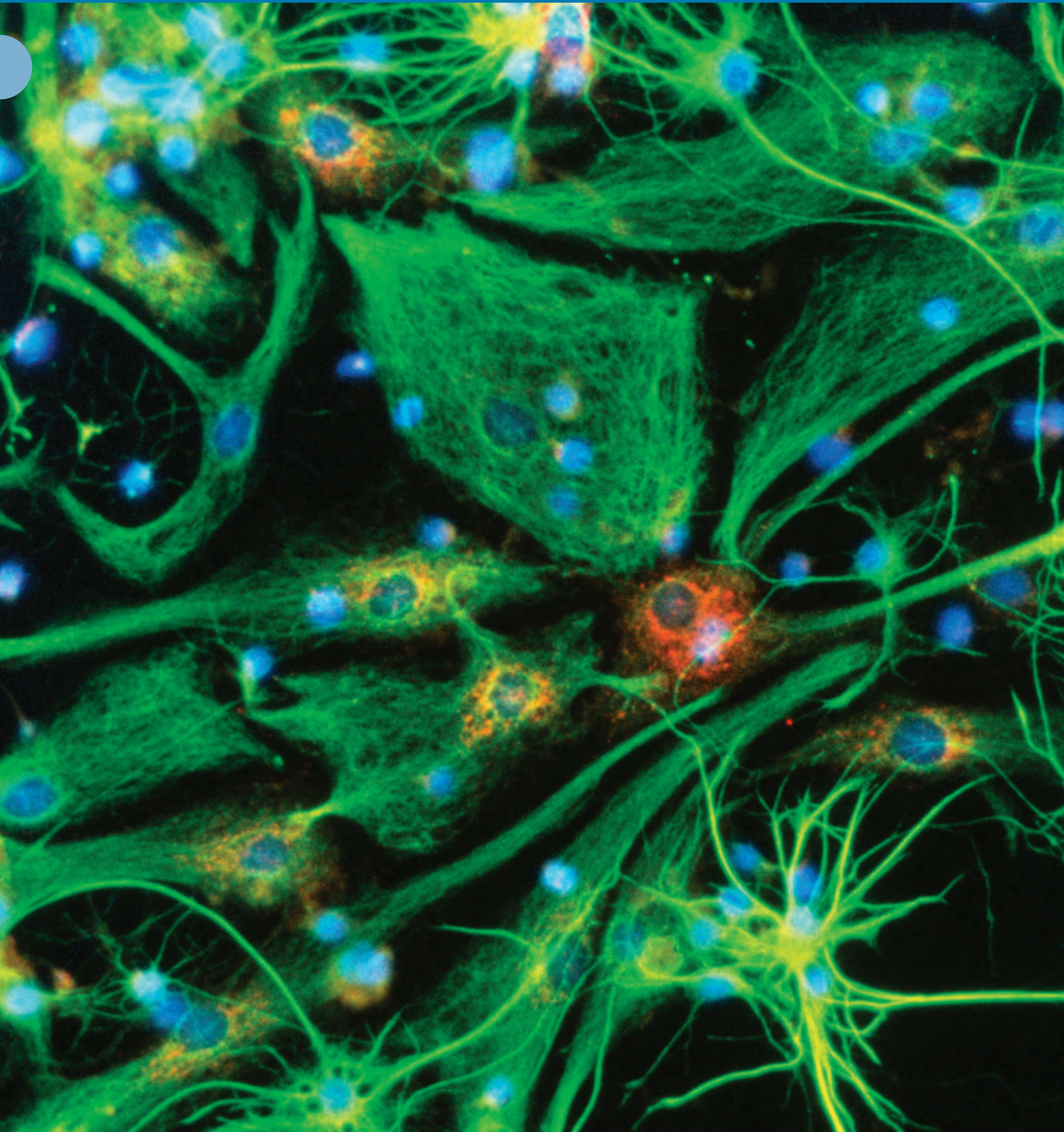
Questions about Quarantine

During the Spanish flu pandemic, health officials attempted to prevent the spread of the disease by placing sick people in quarantine. Quarantine restricted the actions of individuals who appeared to have the illness and kept them away from healthy people. An individual would be kept in quarantine until symptoms of the illness were gone. In some situations, signs would be posted on the front door of houses to indicate the presence of a quarantine. Today, public health officials may impose quarantine to stop the spread of disease.

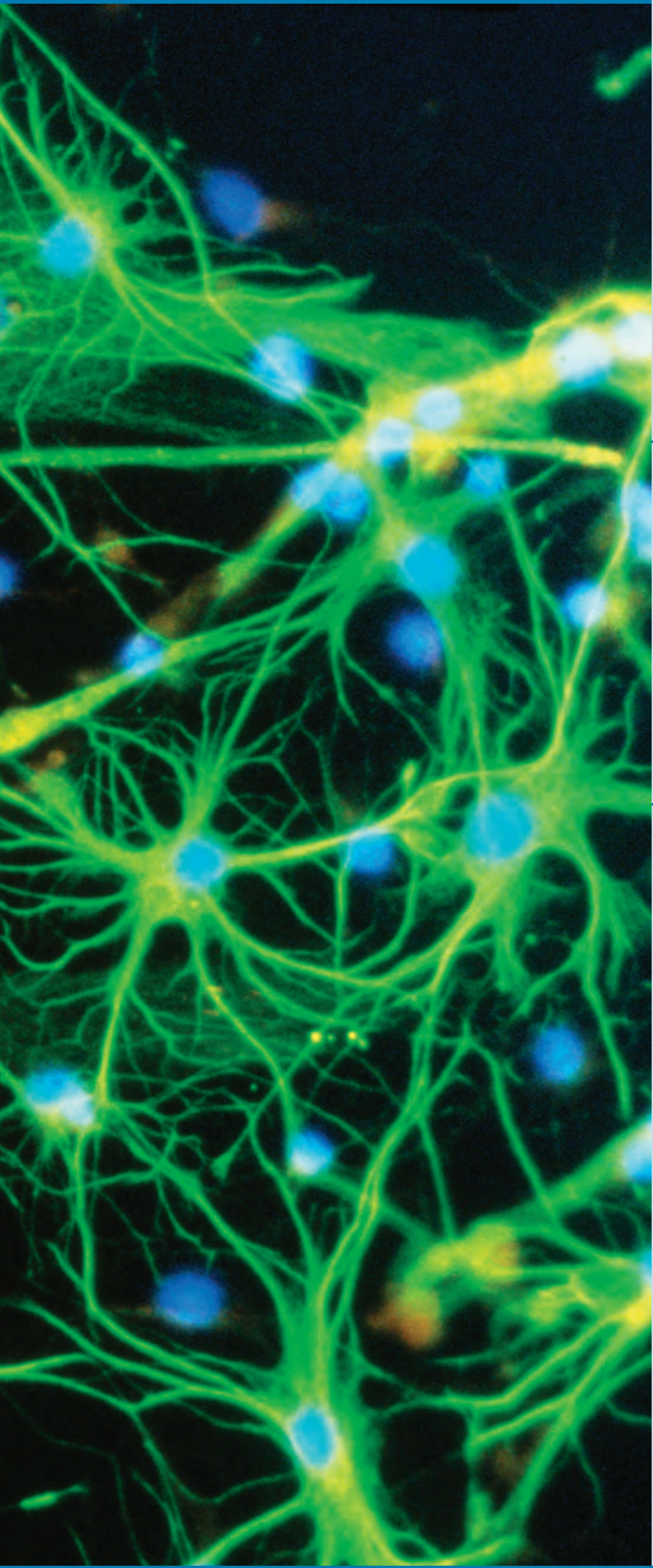
You will consider some of the political, economic, social, and ethical issues associated with using quarantine to prevent the spread of infectious diseases.

1. As a class, discuss the term "quarantine" and give examples of the use of quarantine in society.
2. Work with a partner and think about the implications of living in your house under an imposed quarantine for two weeks.
3. Repeat step 2, but assume that you are in need of medical care and that the local hospital is under quarantine.
4. Should governments have the right to impose a quarantine on individuals? Explain your answer.
5. What economic problems could be associated with the imposition of quarantine ?
6. Explain some of the social problems that could be associated with the imposition of quarantine.
7. Explain some of the ethical issues associated with the imposition of quarantine.
8. Do you think that placing sick people in quarantine prevents the spread of disease? Explain your answer.

1 Cells are the basic unit of life and often combine with other cells to form tissues.



Astrocytes (light green) are star-shaped cells in the brain and spinal cord.



Skills You Will Use

In this chapter, you will:

- examine cells under a microscope to identify the various stages of mitosis in plants and animals
- examine different plant and animal cells under a microscope, and draw labelled biological diagrams to show how the cells' organelles differ
- investigate, using a microscope, specialized cells in the human body or in plants, focussing on different types of cells, and draw labelled biological diagrams to show the cells' structural differences
- investigate the rate of cell division in cancerous and non-cancerous cells using pictures or images, and predict the impact of this rate of cell division on an organism

Concepts You Will Learn

In this chapter, you will:

- describe the cell cycle in plants and animals, and explain the importance of mitosis for the growth of cells and repair of tissues
- explain the importance of cell division and cell specialization in generating new tissues
- explain the links between specialized cells and tissues in plants and animals

Why It Is Important

An important step in understanding how your body works is understanding the cell. Your body is made of trillions of cells.

Before Reading

Thinking Literacy

Set a Goal to Understand New Vocabulary

To understand the content of this chapter, you will need to understand many new terms. How many words in the following list of key terms do you recognize? Preview section 1.1, and note the terms in bold print. Make a two-column chart, recording new terms in the first column. Add definitions or explanations in the second column as you read.

Key Terms

• anaphase • cell • concentration • differentiation • diffusion • meristematic cells • meristematic tissue • mesophyll • mitosis • organelle • phloem • prophase • red blood cells • regeneration • stomate • tissue • xylem

1.1 Plant and Animal Cells

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

- Cells have special structures that enable them to perform important life functions.
- Scientists use technology, such as the microscope, to understand the cell.

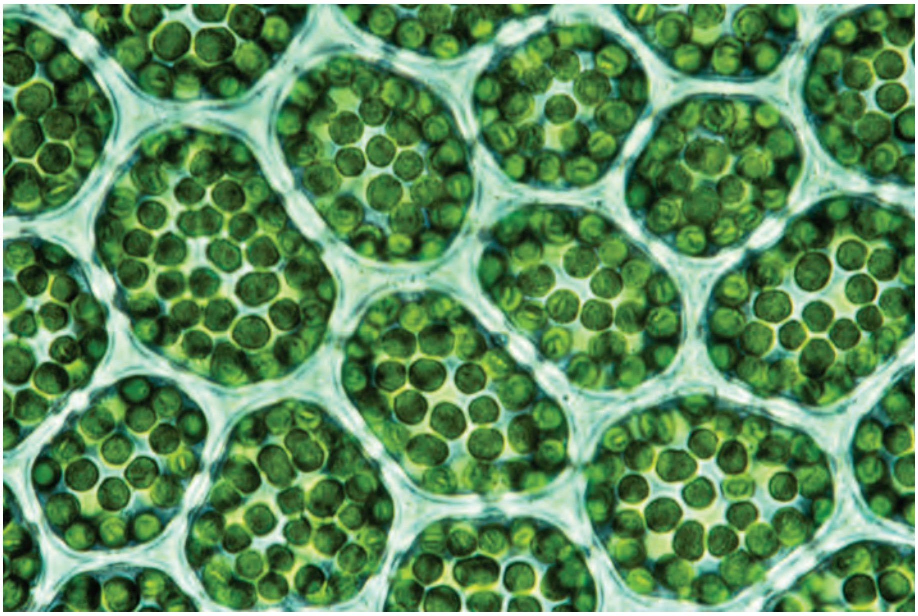


Figure 1.1 A piece of moss, as seen through a microscope, shows many cells filled with chloroplasts, an organelle involved in photosynthesis. The cells are shown at a magnification of 500×.

The Discovery of the Cell

When the microscope was invented in the mid-1600s, it became possible for scientists to look at the previously invisible world of the cell. Imagine the strange and beautiful structures that appeared before the eyes of these scientists. Today, we use sophisticated electron microscopes that allow us to not only see the cell in detail but also to get a glimpse of some amazing sights (Figure 1.1).

Robert Hooke was the first to describe cells in 1663 (Figure 1.2). He thought that the cells were the passages for fluids in a plant. Today, we understand that a cell is the basic building block of life. Every living organism is made of cells. A cell takes in nutrients from its environment and releases waste products into its environment. A cell can also divide to make copies of itself. A cell contains everything that it needs to live and grow.

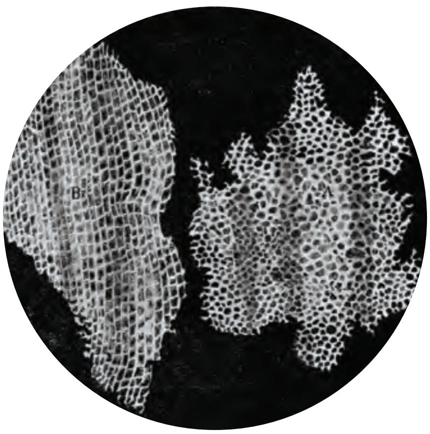


Figure 1.2 Robert Hooke's drawing of cork cells, as seen under a microscope. He used the term "cells" based on what he saw.

Using Technology to Study the Cell

In the early days of cell biology, scientists used simple light microscopes to view sliced sections of living cells. These microscopes helped scientists see and study the external structure of a cell but revealed few details about the tiny specialized working parts within the cell.

Advances in technology, such as the development of the electron microscope (Figure 1.3), have allowed biologists to learn detailed information about different cell parts and their functions. Technology has also made the process of learning about the cell easier. For example, the electron microscope can produce images that are 1000 times more detailed than the light microscope (Figure 1.4).

The discovery of the cell is an example of how scientific knowledge depends on technology. As our technology continues to improve, our knowledge and understanding of the cell will continue to expand.

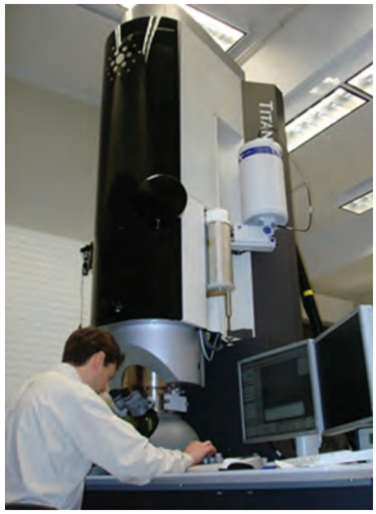


Figure 1.3 The world's most powerful electron microscope, the Titan 80-300 Cubed, was installed at McMaster University in Hamilton, Ontario, in October 2008.

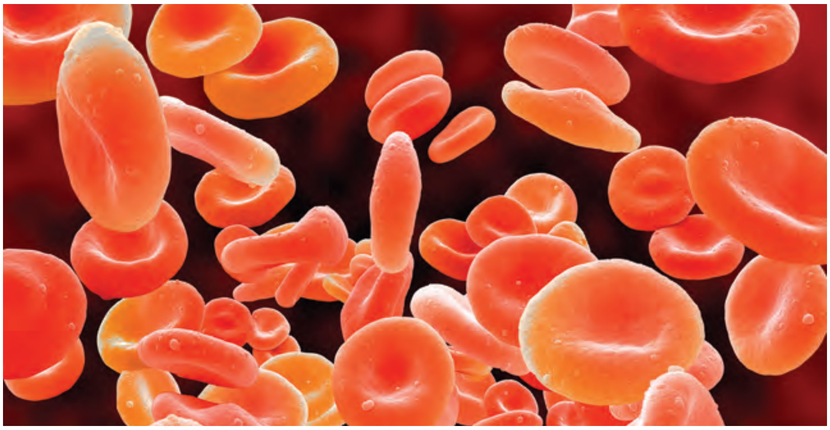


Figure 1.4 Red blood cells viewed through a scanning electron microscope (magnification 3700×)

A2 *Quick Lab*

What We Remember about the Cell

Cells come in a variety of shapes and sizes. However, there are some structures that are common to cells. There are also some differences. This activity will give you an opportunity to review the information that you know about the cell.

Purpose

To create a graphic organizer that shows what you remember about the cell

Procedure

1. Work in a small group of 2–4 students.
2. Brainstorm for two minutes with your group about what you remember about the cell. You may wish to use words, pictures, or phrases. Think about the different parts of the cell, the functions of these parts, or different examples of cells.
3. Create a graphic organizer using the words, pictures, or phrases that you came up with in step 2.

Questions

4. Sometimes, we remember things better if we can visualize an example or illustration. What type of cell did you visualize when you were brainstorming about the cell?
5. There are many parts in a cell. Sometimes, it is easier to remember the functions of the different cell parts by using analogies to everyday things. For example, we may say that the cell has a part that acts like a brain. Use an analogy to describe one specific part of the cell that you placed in your graphic organizer.
6. Did your group find that it was easier to remember the parts of the cell, functions of the cell, or examples of cells? Explain.

WORDS MATTER

The word "cell" is derived from the Latin word *cellula*, meaning small compartment. The word "cyto," as in cytoplasm, is from the Greek root meaning cell.

Cell Parts and Their Functions

All living things are made of cells. Our bodies are made up of between 10 trillion (10^{13}) and 100 trillion (10^{14}) cells. A **cell** is the basic unit of life. Each cell contains smaller parts called **organelles**. These organelles have special functions that maintain all the life processes of the cell, including:

- intake of nutrients
- movement
- growth
- response to stimuli
- exchange of gases
- waste removal
- reproduction

There are two types of cells: plant cells and animal cells (Figures 1.5 and 1.6).

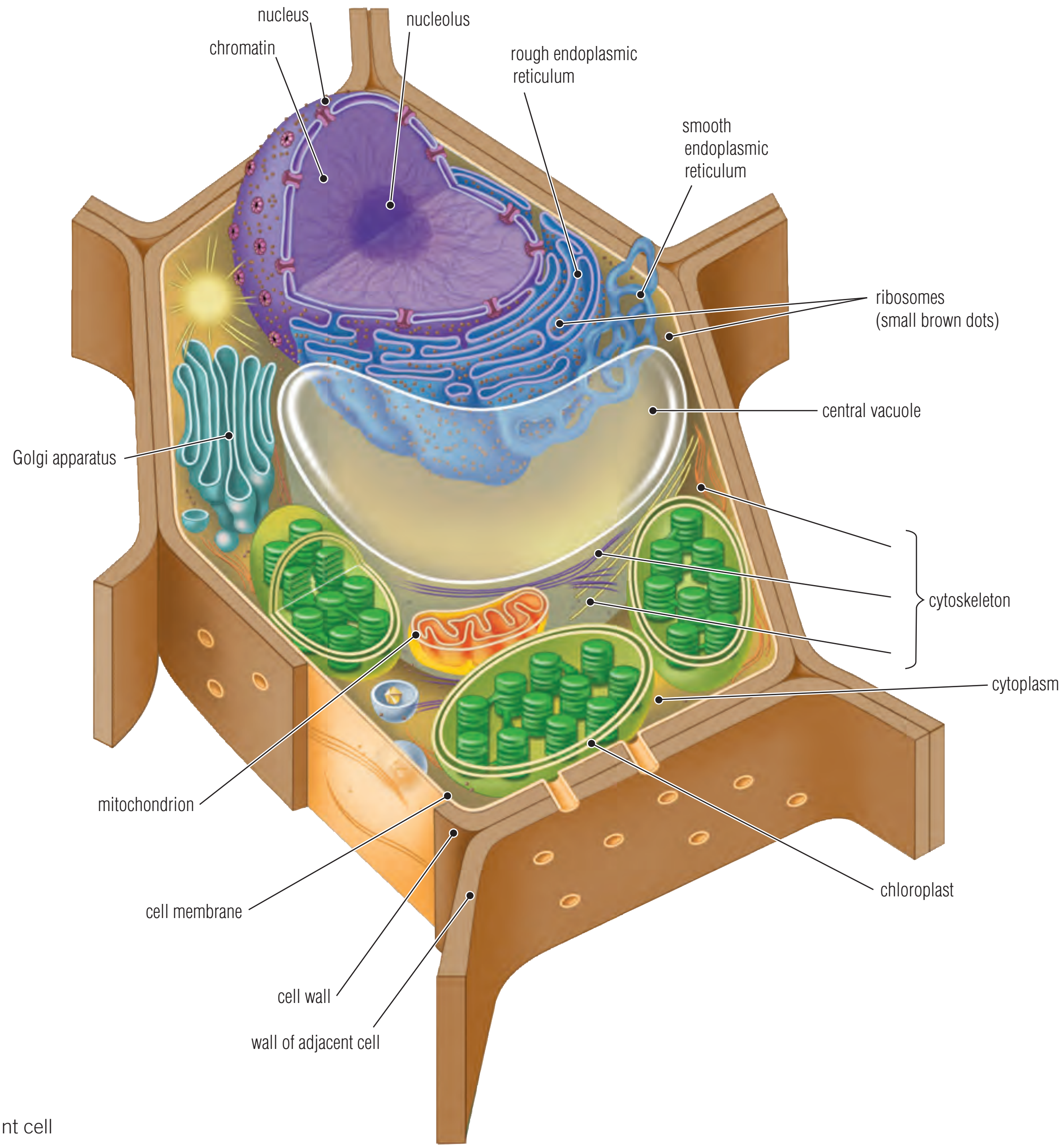


Figure 1.5 A plant cell

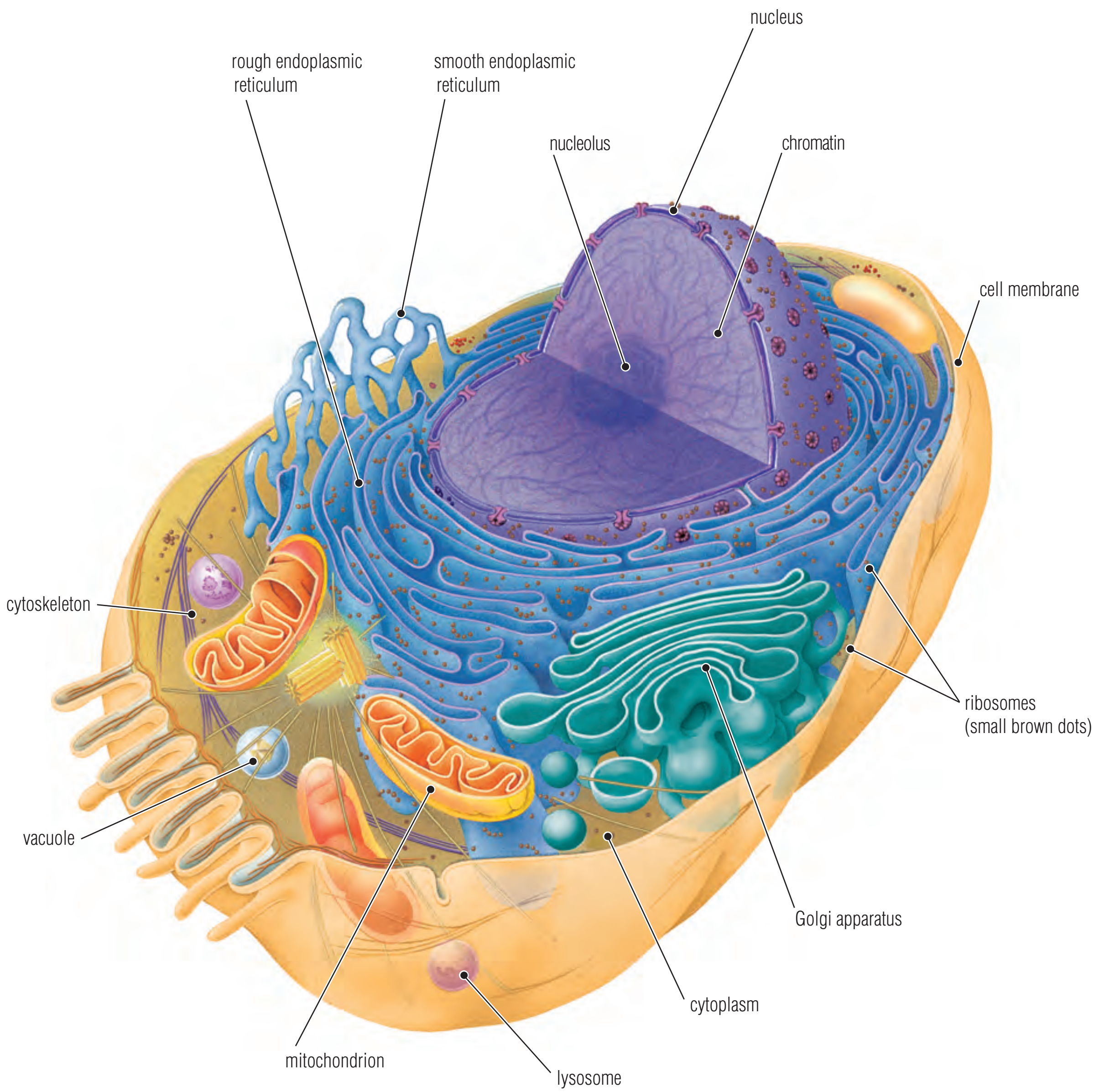


Figure 1.6 An animal cell

Structures and Organelles in Cells

A cell contains structures and organelles that carry out various functions. Although all cells must perform the tasks that maintain life, not all cells are identical. Therefore, some structures and organelles are the same in both plant and animal cells while other structures and organelles differ between plant and animal cells.

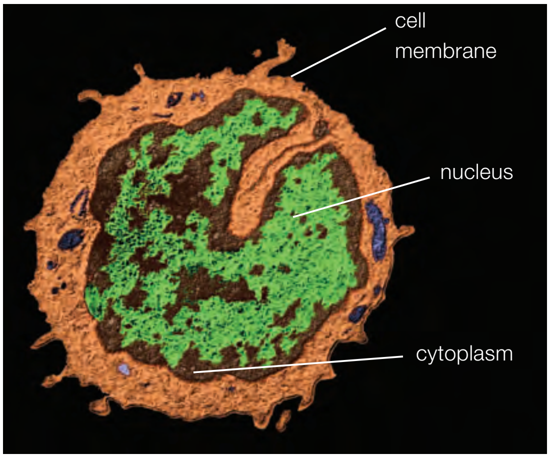


Figure 1.7 A cell showing the cell membrane, cytoplasm, and large nucleus (magnification 6000×)

Cell Membrane

Every cell has a **cell membrane** that forms a protective barrier around the cell (Figure 1.7). The cell membrane is made of a double layer of lipids. A lipid is a fat-like molecule that does not dissolve in water. The cell membrane is designed to allow different substances to move through it.

One process for moving substances across the cell membrane is called **diffusion**. Diffusion depends on the concentration of the substance on both sides of membrane. The amount of dissolved particles, called solutes, in a solution is the **concentration**. When a substance is present in different concentrations on either side of the cell membrane, the particles will diffuse, or move, from an area of high concentration to an area of lower concentration (Figure 1.8).

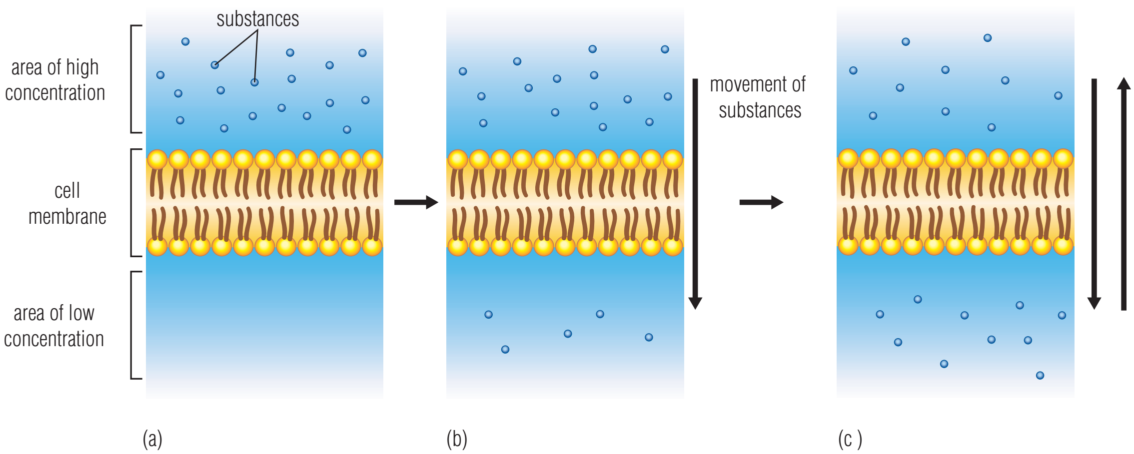


Figure 1.8 (a) There is a higher concentration of substances on one side of the cell membrane. (b) The substances move to the side that has a lower concentration until a balanced state, called equilibrium, is attained. (c) When equilibrium is reached, the substances diffuse across the cell membrane in both directions.

Cytoplasm

All cells contain **cytoplasm**, a jelly-like substance that fills the cell and surrounds the organelles (Figure 1.7). Cytoplasm contains the nutrients required by the cell to carry on its life processes. The organelles are suspended in the cytoplasm. The physical nature of the cytoplasm allows the nutrients and organelles to move within the cell.

Nucleus

The **nucleus** is the control centre organelle of the cell (Figure 1.7). It controls all the activities in a cell, including growth and reproduction. The nucleus is surrounded by the nuclear envelope, which contains pores to allow the transport of materials. Most nuclei also contain a small dense area called the nucleolus.

The nucleus contains nearly all of the cell's DNA. DNA stands for deoxyribonucleic acid. Most of the time, the DNA is bound to proteins and appears as a granular substance known as chromatin (Figure 1.9). However, when a cell divides, the chromatin condenses to form chromosomes.

DNA is very important to the cell because it contains the coded information for making proteins and other molecules. Proteins serve many purposes and are found in various locations in the cell.

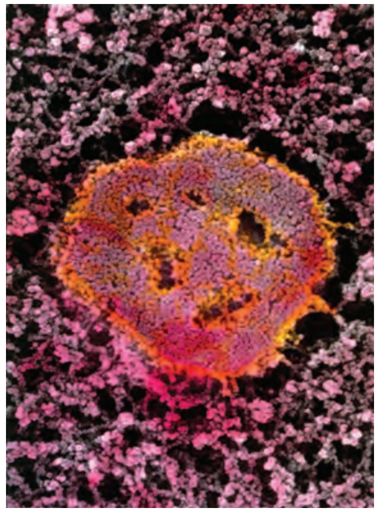


Figure 1.9 The nucleolus and chromatin in a human cell, as seen through an electron microscope

Vacuoles and Vesicles

Vacuoles and **vesicles** are membrane-bound organelles that store nutrients, wastes, and other substances used by the cell (Figure 1.10). In plant cells, the central vacuole stores water for the cell. When water enters the cell, the central vacuole swells, causing the plant cell to become firm. Vesicles transport substances throughout the cell.

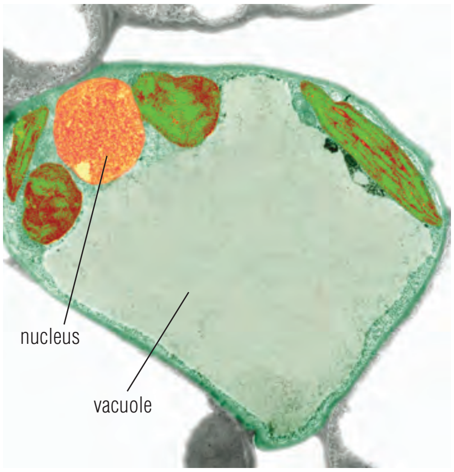


Figure 1.10 A leaf cell showing a large vacuole (pale green) and nucleus (orange) (magnification 11 000×)

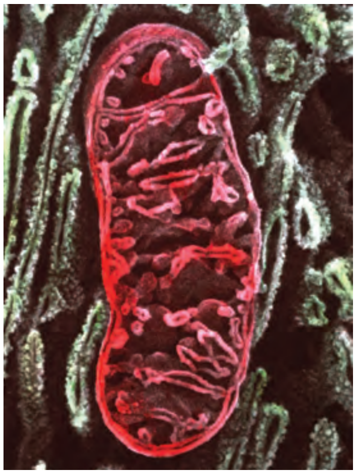


Figure 1.11 A mitochondrion, as seen through an electron microscope (magnification 80 000×)

Mitochondria

All cells require a source of energy: the organelles known as **mitochondria** supply that energy. Mitochondria are the powerhouses of the cell. Reactions occur in these organelles to convert the chemical energy in sugar into energy that the cell can use. Figure 1.11 shows a single mitochondrion.

Lysosomes

Lysosomes are organelles where digestion takes place. They are small organelles that are filled with enzymes. An enzyme is a protein that can speed up chemical reactions in the cell. Lysosomes also break down invading bacteria and damaged cell organelles. Essentially, they work as the clean-up system in the cell. Figure 1.12 shows a lysosome.

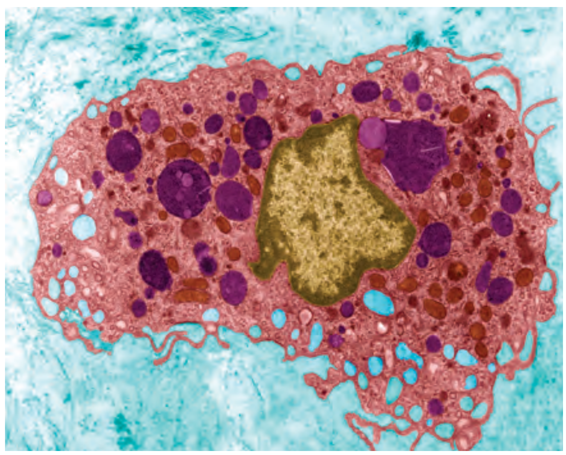


Figure 1.12 Lysosomes (purple) in a white blood cell. The cell's nucleus is light brown.

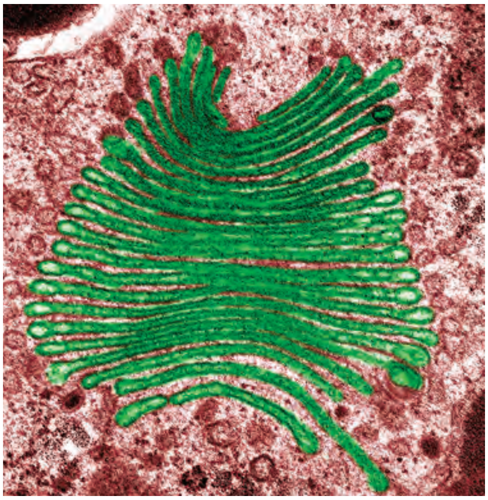


Figure 1.13 The Golgi apparatus is named after Camilio Golgi, who first identified it in 1898.

Golgi Apparatus

The **Golgi apparatus** receives proteins from the endoplasmic reticulum. The function of the Golgi apparatus is to modify, sort, and package these proteins for delivery throughout the cell or outside of the cell. The Golgi apparatus looks like a stack of flattened membranes (Figure 1.13).

Endoplasmic Reticulum

The endoplasmic reticulum is an organelle that is made of a series of interconnected small tubes that carry materials through the cell. **Rough endoplasmic reticulum** is associated with making proteins (Figure 1.14). **Ribosomes** are small, dense-looking organelles that may be attached to the rough endoplasmic reticulum or free in the cytoplasm. Ribosomes are the sites where proteins are assembled. **Smooth endoplasmic reticulum** is associated with the production of fats and oils (Figure 1.15). Smooth endoplasmic reticulum does not have ribosomes.

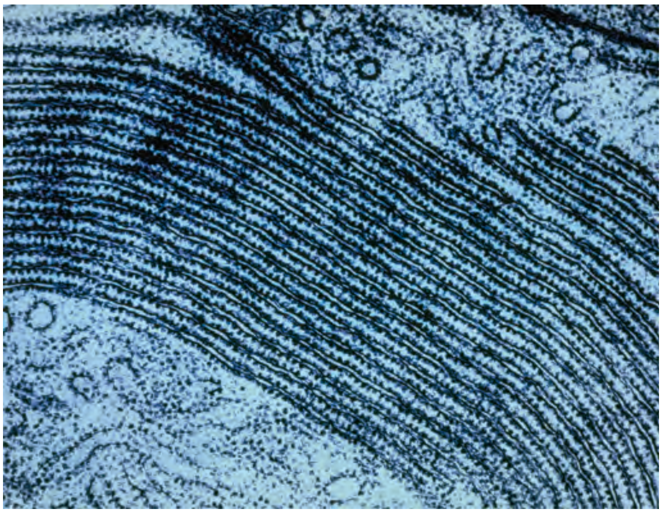


Figure 1.14 Rough endoplasmic reticulum and ribosomes

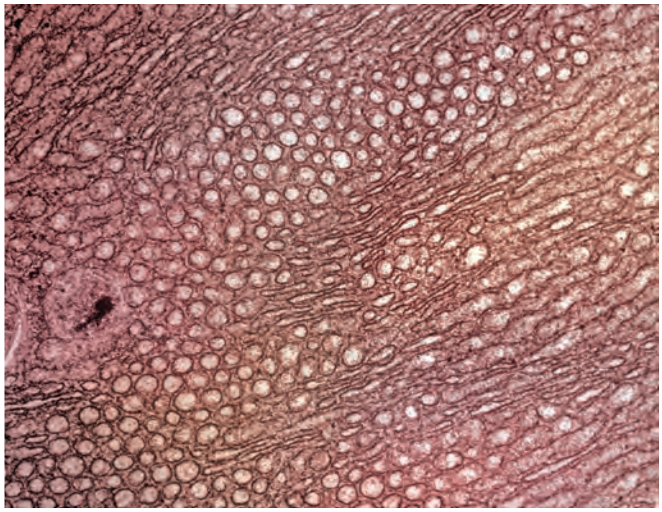


Figure 1.15 Smooth endoplasmic reticulum

Cytoskeleton

All cells have an internal network of fibres, called the **cytoskeleton**. The cytoskeleton is made up of protein filaments. It helps maintain the cell's shape.

Organelles in Plant Cells

Some organelles are found only in plant cells.

Cell Wall

Only plant cells, bacteria, fungi, and some algae have a cell wall. The **cell wall** is a rigid frame around the cell that provides strength, protection, and support (Figure 1.16).

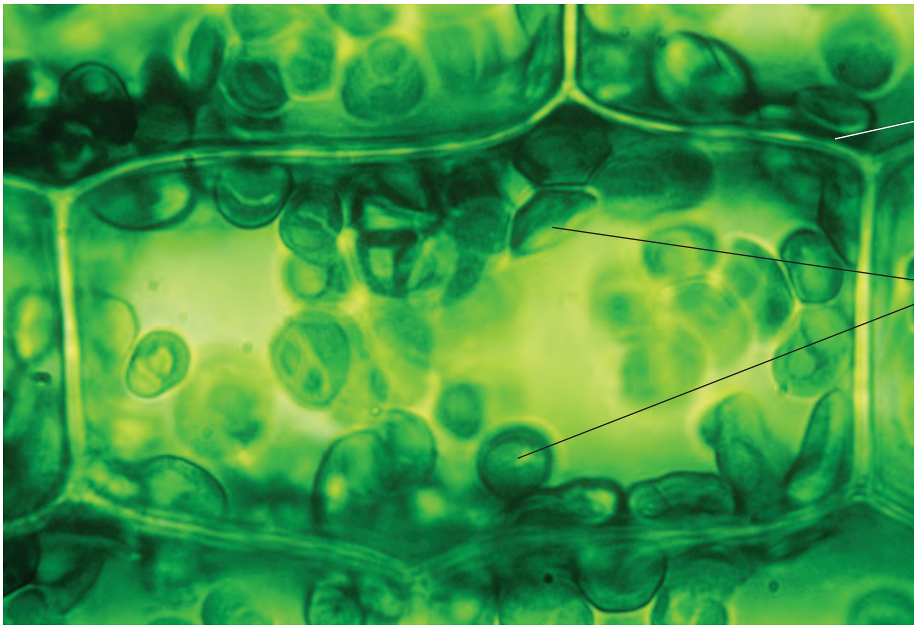


Figure 1.16 A leaf cell showing the cell wall and many chloroplasts (magnification 1000×)

Chloroplasts

Chloroplasts are found only in plant cells and some algae. These organelles contain a green substance called chlorophyll. Chlorophyll uses energy from the Sun to convert carbon dioxide and water into sugar and oxygen in a process called photosynthesis. Figure 1.17 shows the internal structure of a chloroplast. The chloroplast is made up of little sacs known as **thylakoids**. Thylakoids are stacked together in a way that resembles a stack of coins. They are surrounded by a thick fluid called stroma. A stack of thylakoids is called a **granum**; chloroplasts may have many grana. You can think of the thylakoids as being "solar collectors." They collect light energy from the Sun, which is used during the process of photosynthesis to produce carbohydrates. The carbohydrates are used for the growth of the plant.

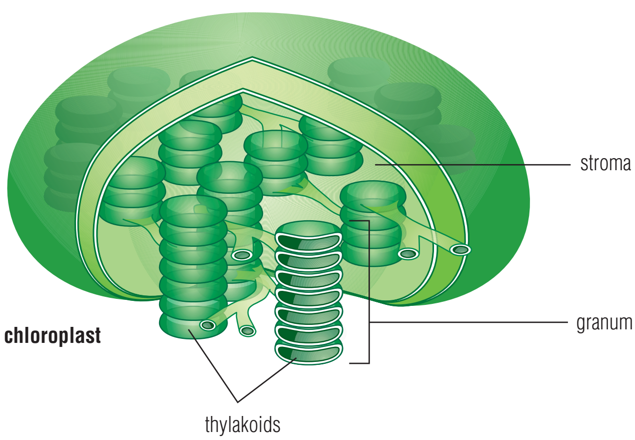


Figure 1.17 Photosynthesis takes place in the chloroplast in a plant cell.

During Reading — Thinking Literacy

One Word Connects to Another Word

In the passage on chloroplasts, note the way in which each term is connected to another term. Create a concept map to show the connections. Begin with a top bubble with the term "chloroplast," and then connect the other terms as you read the paragraph. Try this strategy with another paragraph that contains new terms.

Suggested Activities

- A6 Inquiry Activity on page 24
- A3 Quick Lab on page 21
- A4 Quick Lab on page 21

Differences between Plant and Animal Cells

Cell walls and chloroplasts are only found in plant cells. However, there are other differences between plant and animal cells:

- Plant cells contain a specialized chemical compound called chlorophyll, a pigment that makes photosynthesis possible.
- Plant cells have a large central vacuole. Vacuoles in animal cells tend to be small.
- Some plant cells store energy in the form of starch or oils, such as cornstarch and canola oil. Animal cells store energy in the form of glycogen, a carbohydrate, or as lipids in the form of fats.
- Some animal cells have specialized compounds: for example, hemoglobin in red blood cells and cholesterol in other cells.
- Animal cells have **centrioles**, which are paired structures that are involved in cell division. Plant cells do not have centrioles.

Learning Checkpoint

1. What is an organelle?
2. What is the function of vacuoles and vesicles?
3. Describe the relationship between the functions of the endoplasmic reticulum and the Golgi apparatus.
4. Explain the role of the thylakoids in the process of photosynthesis.
5. State two similarities and two differences between plant and animal cells.

The Microscope as a Tool for Cell Research

The cell is very small — too small to be seen with the unaided eye. Once the microscope was developed, scientists were able to see and study the cell. Today, biologists use different types of microscopes to explore cell structure and function. This knowledge is useful in assessing our health because cells can be viewed under a microscope to look for abnormalities.

Compound Light Microscope

A compound light microscope uses light focussed through different lenses to form a magnified image of a specimen or object. Figure 1.18 shows a compound light microscope.

Table 1.1 Parts of a Microscope

Part		Function
1.	Tube	Separates the ocular lens from the objective lens
2.	Revolving nosepiece	Holds the objective lenses
3.	Objective lenses	Magnify specimen; three lenses are usually 4×, 10×, and 40×
4.	Stage	Supports the slide for observation
5.	Diaphragm	Allows light to pass through the specimen
6.	Condenser lens	Focusses light onto the specimen
7.	Lamp	Supplies the light that passes through the specimen
8.	Base	Provides a stable platform for the microscope
9.	Fine adjustment knob	Sharpens an image
10.	Coarse adjustment knob	Moves the stage up or down to focus on the specimen
11.	Stage clips	Hold the slide in position on the stage
12.	Arm	Holds the tube in place and is used to carry the microscope
13.	Eyepiece or ocular lens	Magnifies the specimen, usually by 10×; single lens

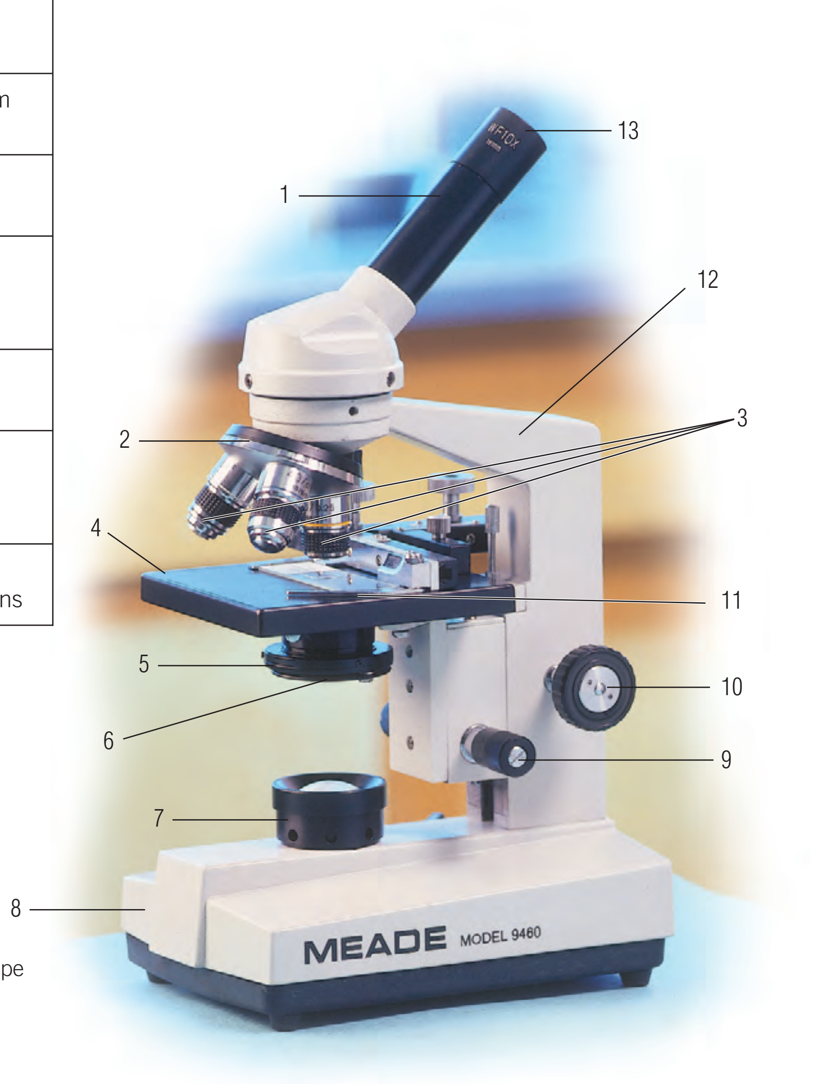


Figure 1.18 This compound light microscope is commonly found in science classrooms.

Magnification

The first microscope had a magnification of 20×, which meant that it produced an image that was enlarged by about 20 times. A compound light microscope has a series of lenses, which permits a higher level of magnification. For example, the compound light microscope has a maximum magnification of 1000× to 2000×; this means that the image is 1000 to 2000 times bigger than the actual object. To find the total magnification, you multiply the power of the objective lens by the power of the ocular lens (eyepiece).

A photo taken through a microscope is called a micrograph. A micrograph shows the magnified image of a specimen. To produce a micrograph, either a camera is attached to a microscope in place of the eyepiece or a special microscope that has a camera and an eyepiece is used.

Suggested Activity •
A5 Inquiry Activity on page 22

Example Problem 1.1

Determine the total magnification of a microscope if the magnification of the objective lens is 10× and the magnification of the ocular lens is 10×.

Given
Magnification of objective lens = 10×
Magnification of ocular lens = 10×

Required
Total magnification = ?

Analysis and Solution
Multiply the magnification of the objective lens by the magnification of the ocular lens to get the total magnification.
(10×)(10×) = 100×

Paraphrase
Therefore, the total magnification is 100×.

Practice Problems

1. Determine the total magnification of a microscope with an objective lens of 100× and an ocular lens of 10×.
2. Determine the total magnification of a microscope with an objective lens of 4× and an ocular lens of 10×.
3. Determine the total magnification of a microscope with an objective lens of 40× and an ocular lens of 10×.

Resolution

Regardless of the magnification, being able to see clear detail in an image depends on the resolution, or resolving power, of the microscope. Resolution is the ability to distinguish between two objects that are very close together. For example, look at Figure 1.19. You may be able to see the individual dots in A and B, but it is hard to see the dots in D. This is because most people can only see dots that are 0.1 mm or larger. Using a compound light microscope, we can see individual objects that are closer together than 0.1 mm.

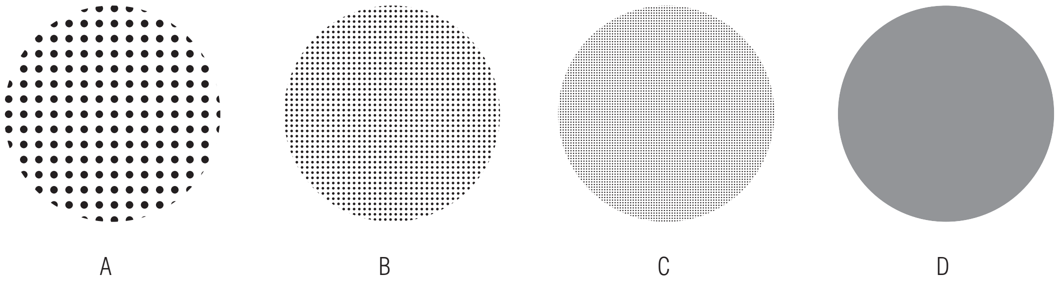


Figure 1.19 Can you see the individual dots that make up the circles in A, B, C, and D?

Contrast

It can be difficult to see the cell parts because both the cell and its background may be pale or transparent. Scientists use stains to improve the contrast between a cell's structures and the background and to produce better images. Two common stains are methylene blue and iodine. In fluorescence microscopy, fluorescent substances are added to the cells. When the cells are placed in ultraviolet light, the fluorescent substances glow (Figure 1.20).

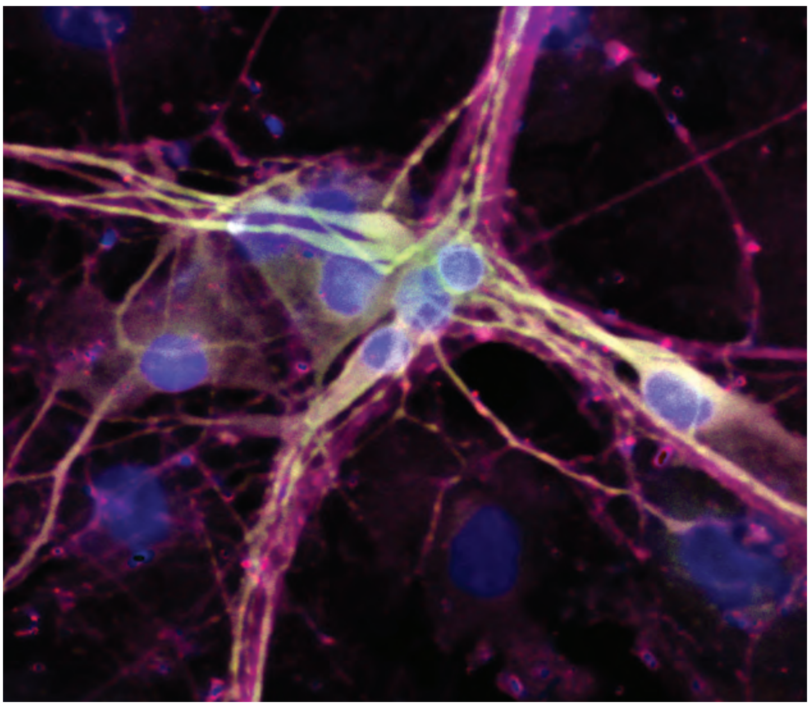


Figure 1.20 A micrograph showing nerve cells that have been stained with a fluorescent stain.

Electron Microscopes

An electron microscope uses a beam of electrons instead of light. The transmission electron microscope (TEM) is capable of magnifications of up to 1 500 000× (Figure 1.21). Since a beam of electrons can pass through thin slices, only thin sections of cells can be examined. This means that an electron microscope cannot be used to look at living cells — only dead cells can be observed.

A scanning electron microscope (SEM) provides information about the surface features of a specimen (Figure 1.22). The SEM operates up to a magnification of 300 000× and produces three-dimensional images of cells.

A photograph taken through either a TEM or an SEM is called an electron micrograph. An electron micrograph provides detailed information about the surface and texture of a cell, the shape and size of the particles in the cell, and the arrangement of the materials in a cell.

As a result of new technology, research on cells has led to major breakthroughs in medicine and industry. For example, the scanning tunnelling microscope (STM) and the atomic force microscope (AFM) produce images of molecules within cells, which help scientists understand the structure and function of molecules within the cell.

Take It **Further**

Take a closer look at either the mitochondrion or the lysosome. Briefly describe the function of the organelle. Find out how the electron microscope has improved the understanding of the structure and function of this organelle. Use a graphic organizer to record your thoughts and your sources. Begin your research at ***ScienceSource***.

Figure 1.21 In a transmission electron microscope, the electrons travel down the microscope column and pass through the specimen. An image forms on a fluorescent screen at the bottom of the column.

Figure 1.22 A researcher using a scanning electron microscope

A3 Quick Lab

Cells on Display

Purpose

To create a model of a plant or an animal cell

Materials & Equipment

- coloured modelling clay

Procedure

1. Select the type of cell — plant or animal — that you will model.
2. You will work in partners. Decide which of the cell parts you will include in your model. For each cell part, decide on the shape, size, and texture.
3. Create your model using the modelling clay, and share it with the class.

Questions

4. How do you think that the shape and structure of a specific cell part relates to its function? Explain your answer.
5. In this activity, you created a scientific model of the cell. What are some limitations of your model?

A4 Quick Lab

Practice Makes Perfect!

It is useful to record your observations when using a microscope. A sketch is a basic drawing that provides little detail but is accurate in scale and in proportion (Figure 1.23).

Purpose

To practise drawing sketches of cells

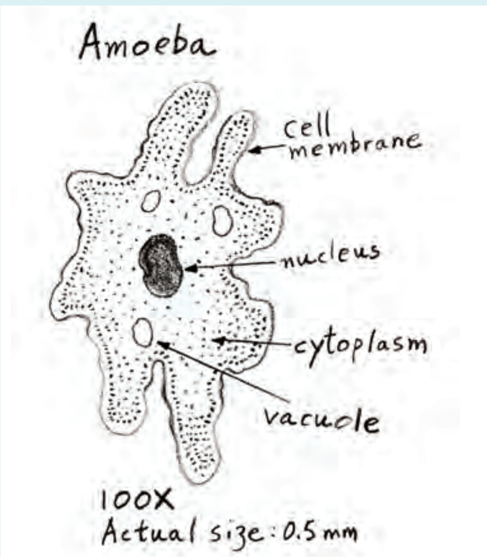


Figure 1.23 A labelled sketch of an amoeba

Materials & Equipment

- LCD projector
- prepared slides
- paper
- pen and/or pencil
- transparent ruler

Procedure

1. Your teacher will display a prepared slide on an LCD projector. Study the cell carefully.
2. Draw a sketch of the cell showing the external structures. Make sure that your sketch reflects accurate scale and proportion.
3. Repeat step 2 for the other slides. Be sure to include a title for each sketch.

Questions

4. What aspects of sketching did you find easy? What aspects did you find difficult?
5. What could you do to improve your sketches?

A5 *Inquiry Activity*

Skills References 2, 6, 10

SKILLS YOU WILL USE

- Using equipment, materials, and technology accurately and safely
- Communicating ideas, procedures, and results in a variety of forms

Creating Biological Diagrams of Plant and Animal Cells

A compound light microscope magnifies the image of a specimen. The magnification depends on the combination of lenses used. While it is interesting and informative to view objects under a microscope, it is difficult to know the actual size of the object being observed. To learn how to estimate the size of an object, you will compare it with something you already know — the diameter of the field of view, which is the entire area that you see when you look through the ocular lens. You will then estimate the size of plant and animal cells. You will record your observations in the form of a labelled biological diagram.

Question

How can a compound light microscope be used to estimate the size of a plant or animal cell?

Materials & Equipment

- compound light microscope
- pen and/or pencil
- paper
- transparent metric ruler
- prepared slides of plant and animal cells

CAUTION: Practise proper techniques in handling the microscope and slides.

Procedure

Part 1 — Determining the Size of the Field of View

1. Review the proper handling and use of the microscope in Skills Reference 10.
2. Copy Table 1.2 in your notebook. Record the magnification for each power.

Table 1.2 Microscope Magnification and Field Diameter

Field	Magnification	Field Diameter (mm)	Field Diameter (µm)
low power			
high power			

3. Set up your microscope and place a transparent metric ruler on the stage, so that it covers about half of the stage, as shown in Figure 1.24.
4. Observe the ruler under low power. Move the ruler so that you are measuring the diameter (width) of the low-power field of view from left to right. Set one of the millimetre divisions at the edge of the field of view, as shown in Figure 1.25.

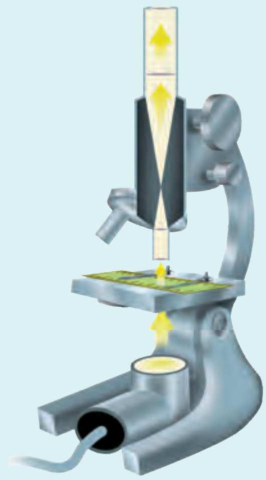


Figure 1.24 Set-up for measuring the diameter of the field of view

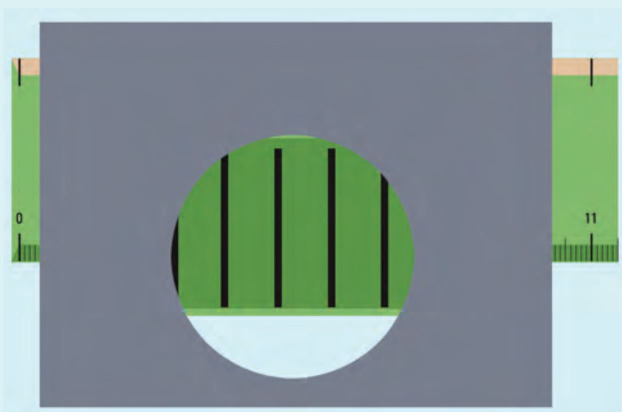


Figure 1.25 Move the ruler so that you can measure the diameter of the field of view. Line up a millimetre mark at the edge of the circle.

5. Measure the diameter of the low-power field of view to the nearest tenth of a millimetre. Record this measurement in your table. Convert the diameter from millimetres to micrometres, and record the measurement in your table. Remember that 1 mm = 1000 µm.
6. You cannot measure the diameter of the high-power (HP) field of view because it is less than 1 mm. However, you can use the following ratio to calculate the field diameter under high power.

$$\frac{\text{high-power field diameter}}{\text{low-power field diameter}} = \frac{\text{low-power magnification}}{\text{high-power magnification}}$$

   Show your work. Record the high-power field diameter both in millimetres and micrometres in your table.

Part 2 — Estimating Cell Size

7. Examine a prepared slide of a plant cell through the low- and high-power objective lenses.
8. Draw what you see in the field of view on low power. Calculate the scale of your drawing by comparing the diameter of the circle in your drawing with the field diameter that you obtained in step 5. For example, if the field diameter of the low-power objective was 3 mm and the diameter of the circle on your drawing was 3 cm (30 mm), the scale of the drawing would be 10:1.
9. Estimate the size of the cells that you view under the microscope by comparing them with the diameter of the field of view. For example, a cell that takes up $\frac{1}{5}$ of a field of view that is 500 µm has a size of about $\frac{1}{5}$ of 500 µm, or 100 µm, while a cell that takes up $\frac{1}{2}$ of a field of view that is 500 µm in diameter has a size of about $\frac{1}{2}$ of 500 µm, or 250 µm.
10. Examine a prepared slide of an animal cell through the low- and high-power objective lenses. Repeat steps 8 and 9.
11. Clean up your work area. Make sure to follow your teacher's directions for safe disposal of materials. Wash your hands thoroughly.

Analyzing and Interpreting

12. How many times is the magnification increased when you change from the low-power to the high-power lens?
13. State two observable characteristics that you can use to distinguish an animal cell from a plant cell based on what you saw using the compound light microscope.

Skill Practice

14. When using a microscope to view living cells, it is sometimes difficult to obtain a good image of the object. What two things can you do to ensure optimal viewing of the image?

Forming Conclusions

15. How can you use a compound light microscope to estimate the size of a plant or animal cell?
16. If an object under low power had an actual cell length of 30 µm, what would the cell length be under high power?
17. When you changed from low to high power, the image also changed. State three ways in which the image changed as the magnification was increased.
18. How would you estimate the size of an object viewed under the high-power objective lens (40×) if you were given the size of the field diameter when using the low-power objective lens (4×)?

AG6 *Inquiry Activity* Skills References 2, 6, 10

SKILLS YOU WILL USE
- Conducting inquiries safely
- Observing, and recording observations

Examining Plant and Animal Cells

There are some similarities and some differences between plant cells and animal cells that can be seen using a compound light microscope. You will look at cells from the human body and from an onion to see the similarities and the differences.

Question

What similarities and differences between plant and animal cells can be seen using a microscope?

Materials & Equipment

- clear adhesive tape
- compound light microscope
- methylene blue stain
- microscope slides and cover slips
- onion epidermis
- iodine stain
- paper
- paper towel
- pen and/or pencil
- tweezers

CAUTION: Practise proper techniques in handling the microscope and slides. Use care when staining. Cover your staining work area with a paper towel.

Procedure

Part 1 — Examining Animal Cells

1. Review the proper handling and use of the microscope in Skills Reference 10. Set up your microscope.
2. Take a small piece of clear adhesive tape, and stick it on the inside of your wrist. Remove the tape, and place it sticky side up on the slide.
3. Verify that cells are present by looking at your slide at low power and medium power.
4. Make a wet mount of your cells. Add a drop of methylene blue stain to the slide at one edge of the cover slip.
5. Place a piece of torn paper towel against the edge of the cover slip on the side opposite that of the stain. The stain should move under the cover slip toward the paper towel. When all of the cells are stained, remove the paper towel.
6. Place the slide on the microscope, and observe the cells.
7. Create a labelled diagram of your skin cells. Include the magnification and scale.

Part 2 — Examining Plant Cells

8. Obtain a small section of onion. Use the tweezers to pull off a thin transparent layer of cells.
9. Prepare a wet mount of the onion cells. Add a drop of iodine stain, and follow the staining procedure in step 5.
10. Place the slide on the microscope, and observe the cells.
11. Create a labelled diagram of the onion cells. Include the magnification and scale.
12. Clean up your work area. Make sure to follow your teacher's directions for safe disposal of materials. Wash your hands thoroughly.

Analyzing and Interpreting

13. Both the plant and animal cells used in this activity are specialized cells that form the outer layer of the organism. Describe how the appearance and shape of the cells enable them to accomplish their task of covering and protection.
14. Explain how the cells appeared to be different when viewed at different magnifications.
15. Explain why it is necessary to use onion membrane that is only one cell in thickness.

Skill Practice

16. Explain how the use of contrast (light levels and use of stain) improved your understanding of the cells that you were viewing.

Forming Conclusions

17. Describe the similarities and differences that you observed between the plant and animal cells.

1.1 CHECK and REFLECT

Key Concept Review

1. What five life processes do cells perform?
2. List the five organelles that are common to plant and animal cells. What are their functions?
3. What are three differences between plant and animal cells?
4. Why can the granum and thylakoid structures be described as "solar collectors"?
5. Prepare a table that summarizes the organelles and structures found in plant and animal cells.
6. Explain how fluorescence microscopy works.
7. Name two types of electron microscopes that are used by cell biologists.
8. What is the name of the image created by an electron microscope?
9. Explain why the cell can be considered to be the "building block" of life.
10. Explain the importance of contrast in microscopy.
11. What two things can you do to create contrast when you use a compound light microscope to study a specimen?

Connect Your Understanding

12. Explain why a cell biologist would choose to use an electron microscope rather than a light microscope. When would a light microscope be preferred?
13. What details of a microscope would you need to know to determine the total magnification of the system?
14. Explain why you would expect the cells of a desert plant, such as a cactus, to have thickened cell walls.
15. Think about the function of the mitochondria. You have been asked to view cells taken from the leg muscle of an athlete and cells taken from the skin of an elderly individual. What differences in the number of mitochondria would you see in the two samples? Explain your thinking.
16. Explain how a microscope may be used to assess human health.
17. Write a short paragraph that compares and contrasts plant and animal cells by considering structures, presence of specialized compounds, and forms of energy storage.
18. The scientist shown below is looking at cells through a fluorescent microscope. How has the development of technology aided our understanding of cells?

Question 18

Reflection

19. Describe three things about plant and animal cells that you did not know before you started working on this section.

For more questions, go to ***ScienceSource***.

1.2 The Cell Cycle and Mitosis

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

- The life cycle of a cell has four phases.
- Growth and repair of cells is accomplished by mitosis.
- Cancer cells have an abnormal rate of cell division.

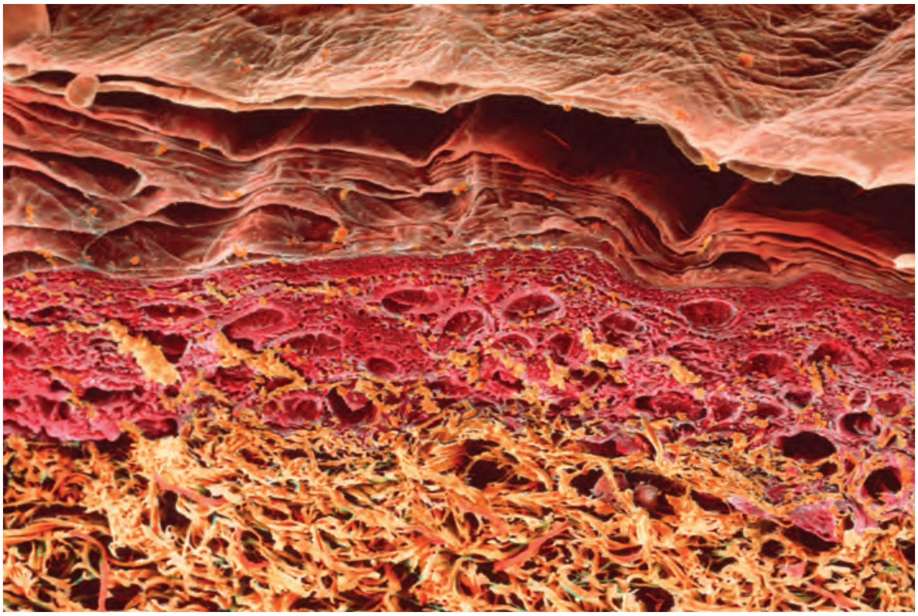


Figure 1.26 An electron micrograph of the skin shows the different layers of cells.

The Life and Death of Skin Cells

Stare at your face in the mirror. Your eyes are bright and alive, and your skin looks . . . dead? Actually, when we look at our skin, we are viewing dead cells. You lose about 30 000 to 40 000 skin cells every minute. If you collected all the dead cells that you shed over a day, you would collect 0.5 g of dead cells. If you collected those cells over a year, you would have about 3 kg of skin cells.

Since we lose so many skin cells every day, it is surprising that our skin does not simply wear away. However, our skin is made of different layers of cells (Figure 1.26). Skin cells are produced in the deeper layers of the skin and, in young people, mature over a period of about four weeks. During this time, the cells travel to the surface, where they are eventually sloughed off, leaving younger cells behind.

The cells on the surface are old, dead cells that have become toughened and flattened. This change in structure enables them to form a good protective layer for your body. These surface cells are continuously being replaced by cells from the layer below.

The time taken for the process of cell renewal changes as individuals age, or with changes in hormone or vitamin levels. For example, in older people, surface cells are held in the skin for up to 75 days, resulting in skin that is thicker and duller in appearance.

People apply products to their skin to keep it healthy, attractive, and young looking (Figure 1.27). The best way to keep skin healthy is to stay out of the Sun. Exposure to the Sun is responsible for damaging skin cells. Much of the damage is associated with premature skin aging, including the appearance of wrinkles and discoloured areas. Excessive exposure to the ultraviolet (UV) radiation in sunlight can also cause skin cancer: each year, about 30 000 Ontarians are diagnosed with skin cancer. The UV radiation changes the genetic information that is coded in the skin cells' DNA. This affects the functions of the cell, including the ability to reproduce and to repair itself. You can protect your skin from UV damage by wearing protective clothing (long-sleeved shirts and hats) and sunglasses, limiting your time in the Sun, and applying sunscreen to exposed skin.

Figure 1.27 People use skin creams to keep their skin looking healthy.

A7 STSE *Quick Lab*

Taking Protective Actions

The Sun is necessary for all life on Earth, but it is also the source of ultraviolet (UV) radiation, which is harmful to skin cells. There are things that you can do to protect your skin.

Purpose

To survey your class about Sun protection behaviours and to compare the class data with national data

Procedure

1. Think about your typical Sun protection behaviours during the summer.
2. Create a table in your notebook in which to record the results of your survey. Your table should indicate the total number of students responding to the survey and the total number of "yes" and "no" responses.
3. Participate in a survey of three questions of your class members.
   - Do you regularly practise Sun protection behaviours in the summer?
   - Have you suffered at least one major sunburn in the summer?
   - How many hours per day do you spend in the Sun during the summer?
4. Use the number of positive responses and the total number of students surveyed to calculate the percentage of students who practise Sun protection behaviours during the summertime.

Questions

5. Do your data suggest that youth are practising Sun protection behaviours?
6. How do your class data compare with the data in Table 1.3?

Table 1.3 National Sun Survey 2006

Percent of Canadians who:	16–24 years old	
	Male	Female
• spent at least 2 h in the Sun daily	47%	32%
• practised Sun protection behaviours	42%	58%
• acquired a tan from the Sun	28%	49%

7. What is one action that you could take to encourage your friends and family to practise Sun protection behaviours?
8. What Sun protection behaviours should people who work outside every day practise?

The Cell Cycle

Every hour, about one billion (10^9) cells die and one billion cells are made in your body. Through careful observation, scientists have identified a repeating cycle of events in the life of a cell. This cycle of events is called the **cell cycle**. During much of the cell cycle, the cell grows and prepares for cell division. In fact, although the main goal of the cell cycle is division, the cell spends most of its time preparing for division. The cell is in **interphase** when it is preparing for cell division. Cell division involves packaging the genetic information in the nucleus into two equal portions; this process is called **mitosis**. Then, the cytoplasm is split into two portions so that the original parent cell divides to form two new "daughter cells." Cells use mitosis in the processes of growth and repair.

We can visualize the cell cycle by considering Figure 1.28. There are four phases in the cell cycle: first growth phase (G_1), synthesis phase (S), second growth phase (G_2), and mitosis (M).

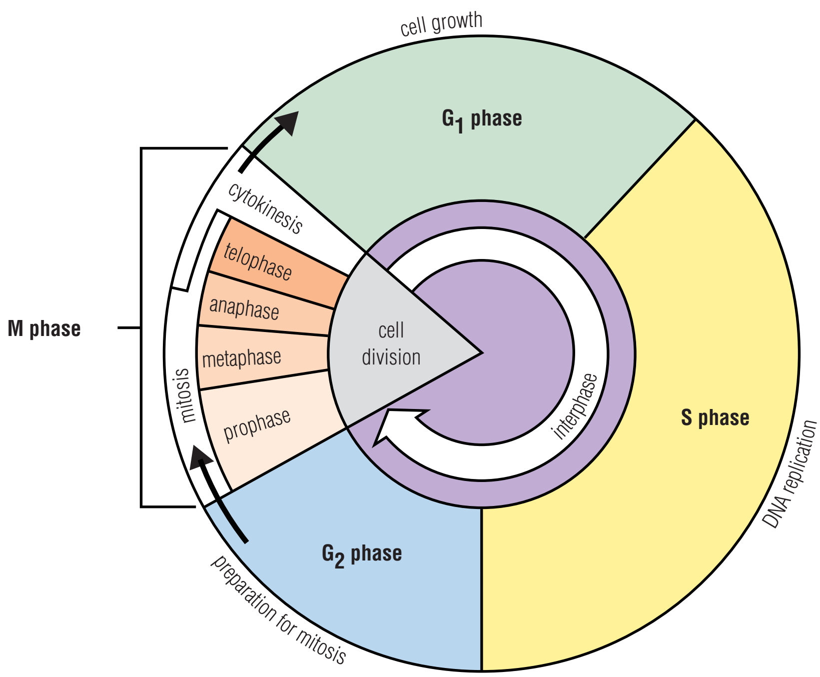


Figure 1.28 The cell cycle has four phases. During most of the cell cycle, the cell is growing, replicating its DNA, and preparing for cell division.

Chromosomes

Every cell contains chromosomes. Each **chromosome** is a long piece of coiled DNA and proteins. The number of chromosomes in each cell differs between organisms. For example, a horse has 64 chromosomes, while a hermit crab has 254 chromosomes. The typical human cell has 46 chromosomes — 23 matching pairs of chromosomes.

Chromosomes are visible only when the cell is dividing. When the cell is not dividing, the DNA and proteins that make up the chromosomes are spread throughout the cell in the form of chromatin. At the beginning of cell division, the chromosomes condense into visible structures. Before cell division can occur, each chromosome is copied. As shown in Figure 1.29, the chromosome consists of two identical copies, called **sister chromatids**. When the cell divides, one chromatid goes to each of the new cells.

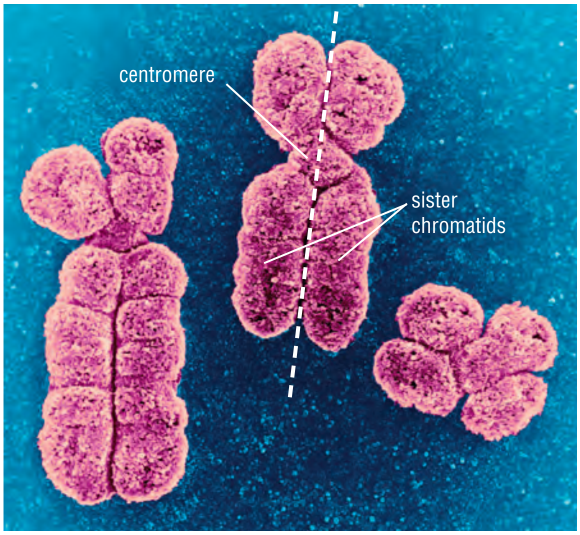


Figure 1.29 Each chromosome consists of two identical sister chromatids (shown magnified 8,300×).

A Closer Look at Interphase

A cell spends about 90 percent of its time in interphase. During interphase, the cell is growing. However, there is a limit to how big a cell can become. As a cell increases in size, the relationship of the surface area of the cell membrane to the amount of volume of cytoplasm changes. The volume of a cell's cytoplasm increases faster than the surface area of a cell's membrane. This affects how well a cell can absorb substances from its environment or expel wastes into its environment. When a cell reaches a certain size, it is healthier for the cell to undergo division. On average, the cells of an adult human are the same size as the cells in a child — however, there are more cells in an adult.

During interphase, the cell takes in nutrients, grows, and conducts other normal cell functions. There are three phases of interphase.

First Growth Phase (G_1)

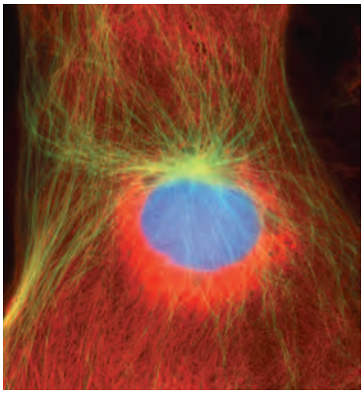
This phase is a period of growth for the cell. During this phase, the cell also produces new proteins and organelles. If the cell is healthy and conditions are favourable, the cell moves into the next phase.

Synthesis Phase (S)

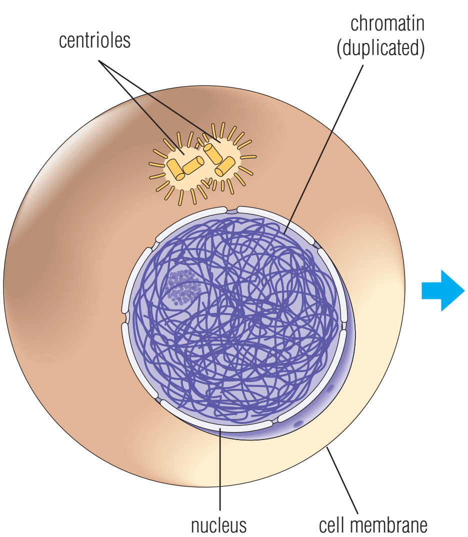
During this phase, the cell makes (synthesizes) an entire copy of the DNA of the cell. Key proteins that are associated with chromosomes are also produced during this phase.

Second Growth Phase (G_2)

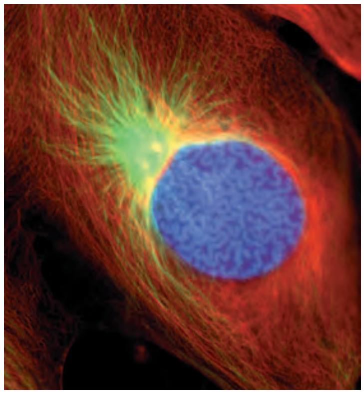
Once the DNA has been copied, the cell moves into the second growth phase. During this phase, the cell produces the organelles and structures needed for cell division. This phase is the shortest of the phases of interphase.



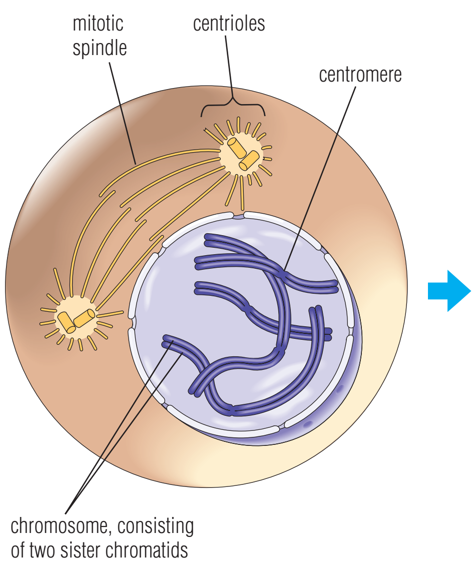
interphase



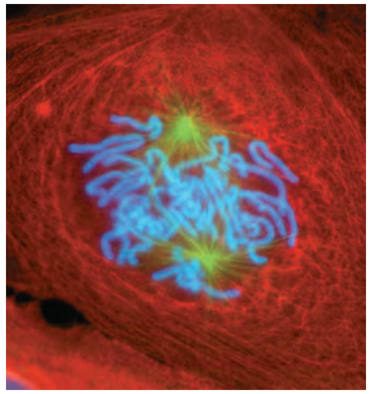
DNA has been duplicated in the S phase and appears as threads in the nucleus.



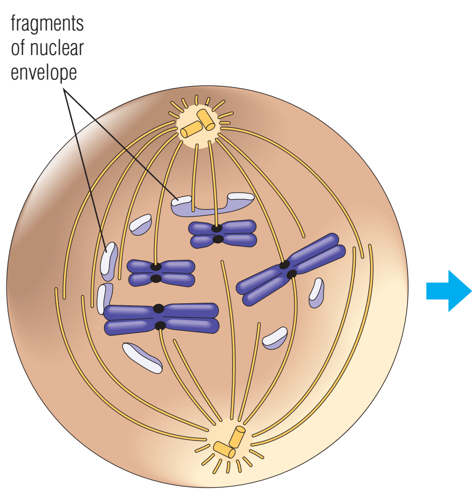
early prophase



The chromatin condenses to form chromosomes. The centrioles move toward the poles. Spindle fibres form.



late prophase



The nuclear envelope breaks down. Each chromosome is connected to a spindle fibre at its centromere.

WORDS MATTER

Many of the words associated with cells come from Greek words. "Mitosis" comes from the Greek word *mitos*, meaning thread. The words "meta," "ana," and "telo" come from the Greek words for between, renewal, and end.

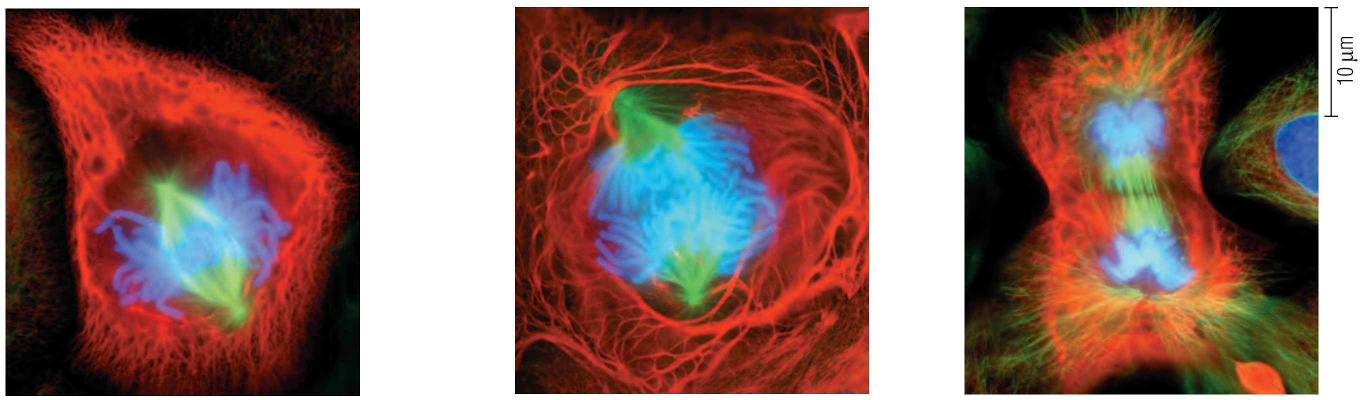
Suggested Activity •

A8 Inquiry Activity on page 35

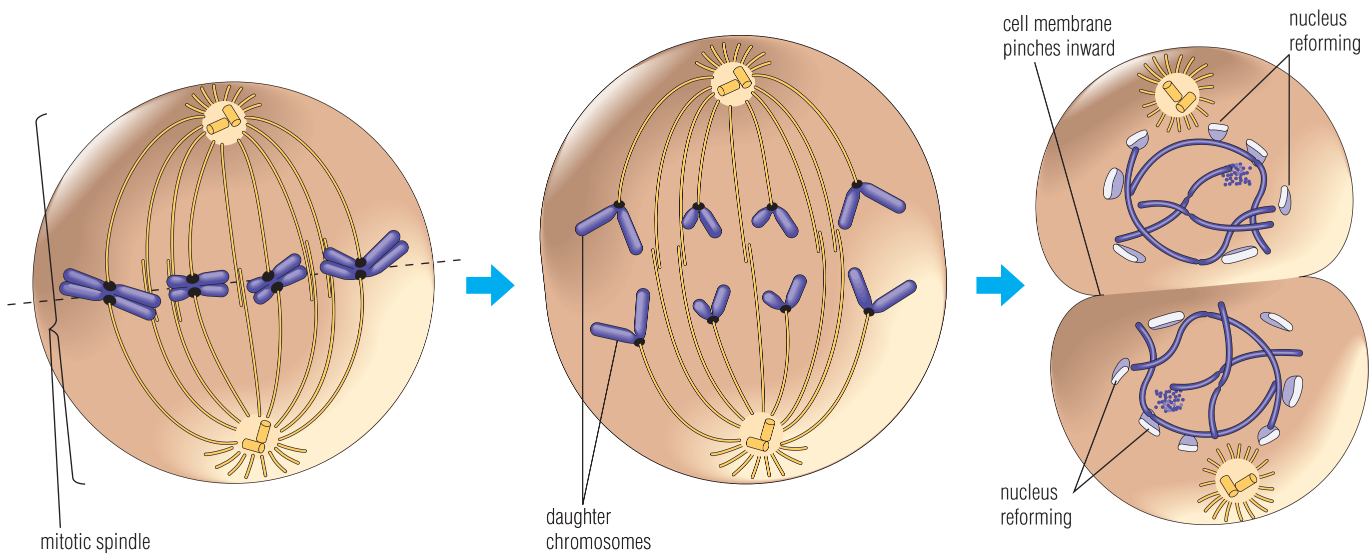
A Closer Look at Mitosis

During most of the cell cycle, the cell is in interphase — it is growing, synthesizing DNA, and repairing itself. Once the cell is ready to divide and make two new identical cells, it enters mitosis (M phase). Before cell division can be accomplished, the cell must undergo great change. Therefore, during the M phase, the cell's energy must be entirely devoted to the process of cell division.

There are four phases in mitosis: prophase, metaphase, anaphase, and telophase. At the end of telophase, two daughter cells, each containing identical genetic information, are formed.



metaphase | **anaphase** | **telophase and cytokinesis**



The chromosomes line up at the centre of the cell.

The sister chromatids separate into individual chromosomes and move to opposite poles.

The mitotic spindle breaks down, and two new nuclei form. The chromosomes lose their distinct shape. The cytoplasm and the cell membrane pinch in half to form two new daughter cells.

Prophase

During the first phase of mitosis, called **prophase**, the chromatin (DNA and proteins) that makes up the chromosomes condenses. At this stage, the chromosome is actually two identical copies called sister chromatids attached together at a centromere. These sister chromatids will eventually separate and move to opposite sides of the cell. To enable the movement of the chromatids within the cell, the nuclear structures and nuclear envelope disintegrate. In addition, a framework called the mitotic spindle forms to move the chromatids around in the cell. Chromatids are attached to the spindle at their centromeres. In animal cells, a pair of organelles called centrioles moves to each end of the cell, forming the poles of the mitotic spindle.

Metaphase

As the cell moves into the second stage of mitosis, called **metaphase**, each chromosome becomes completely condensed. The chromosomes move toward the centre of the cell and line up at the middle of the cell. The mitotic spindle is complete and is made of tiny tubes that extend from each pole to the middle of the cell. These tubes connect the centromere of each chromosome to the two poles.

Anaphase

During **anaphase**, the sister chromatids separate at the centromere. Each chromatid is now a complete chromosome. The separated chromosomes are pulled to opposite ends of the cell.

Telophase and Cytokinesis

During the last phase of mitosis, known as **telophase**, the cell divides the cytoplasm into two portions. The process of splitting the cytoplasm is known as **cytokinesis.** In animal cells, the cell membrane pinches inward, eventually splitting the one cell into two cells. In plant cells, the cell plate forms the cell wall and inner plasma membrane in each of the new cells. At the end of cytokinesis, the two new cells return to interphase conditions. Two nuclei form where each pole of the parent cell was. The mitotic spindle disappears. Each of the new cells enters the G_1 phase of the cell cycle, and the cell cycle is repeated.

During Reading — Thinking Literacy

Match the Story to the Picture

You may read paragraphs where there are so many new terms that you cannot understand all of them. Do not forget to check the diagrams and other pictures included in the text. Reread the text, matching the words you are reading to the pictures to get a better understanding of the ideas.

Learning Checkpoint

1. What is the purpose of the cell cycle?
2. Define the term "interphase" and describe its purpose.
3. (a) What is mitosis?

   (b) Why is mitosis important to the cell?
4. Define and distinguish between the following terms: chromosome, centromere, and sister chromatids.
5. Explain the meaning and importance of the term "cytokinesis."

Cell Growth and Repair

Multicellular organisms are made up of many different cells. These different cells all undergo cell growth and cell division at different rates. For example, in the human body, nerve cells do not undergo mitosis once they mature. Other cells, such as skin cells and cells in the digestive tract, undergo cell division regularly. Cell division provides new cells to replace cells that wear out or break down. After observing rates of cell division, scientists concluded that differences in rates of cell division reflect the internal control systems of the cell cycle.

In a growing organism, there is rapid mitosis of cells in areas of growth. Cells that are likely to be damaged or injured as they function also have high rates of mitosis. For example, your intestinal cells divide every three days and are then broken down by the digestive process, whereas your red blood cells may last for four months. In plants, growth occurs in the meristem region (Figure 1.30). The cells in the meristem region of a root tip appear to divide every 12 to 36 h.

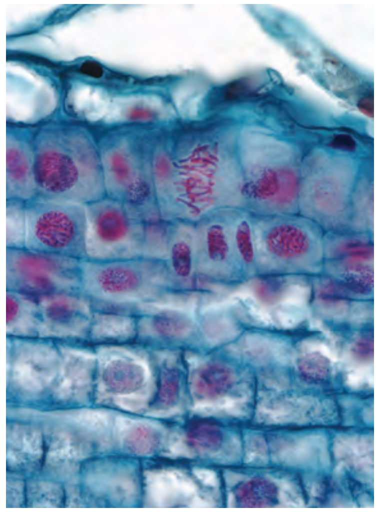


Figure 1.30 Cells in the meristem region in an onion root tip undergoing mitosis (magnification 350×)

Factors That Affect Mitosis

The environment impacts the rate of mitosis. For example, if you travelled to a part of the world where you were exposed to a change in environmental conditions, such as a change in altitude, the rate of mitosis in your blood cells would increase. Plants may also respond to environmental changes by altering their rates of mitosis: a plant will bend toward the light because the cells in the stem opposite the light grow more rapidly than those facing the light (Figure 1.31).

Figure 1.31 A field of sunflowers in Ontario

Antibiotics can also affect the rate of mitosis of a cell. Antibiotics are drugs given to combat bacterial infections. Some antibiotics, called bacteriostatic drugs, temporarily stop bacteria from growing by interfering with mitosis. Some bacteriostatic drugs inhibit the replication of DNA. Other drugs, called cytostatic drugs, also interfere with mitosis and are used in chemotherapy.

Will Cells Live Forever?

The cell cycle regulates how long a cell lives. Sometimes, cells die because they have suffered injury or damage that cannot be repaired. For example, cells that are exposed to a poison may absorb the poison and die. This type of death is known as cell necrosis.

A cell also dies as a normal part of the functioning of healthy multicellular organisms. This regulated, or controlled, cell death is known as **apoptosis**. Apoptosis is the death of cells that are no longer useful (Figure 1.32). For example, when your body fights a viral infection, your body produces many cells to fight that infection. When the virus has been removed from your body, these cells are no longer needed and they are removed by apoptosis. Apoptosis also removes cells that have lost their ability to perform efficiently.

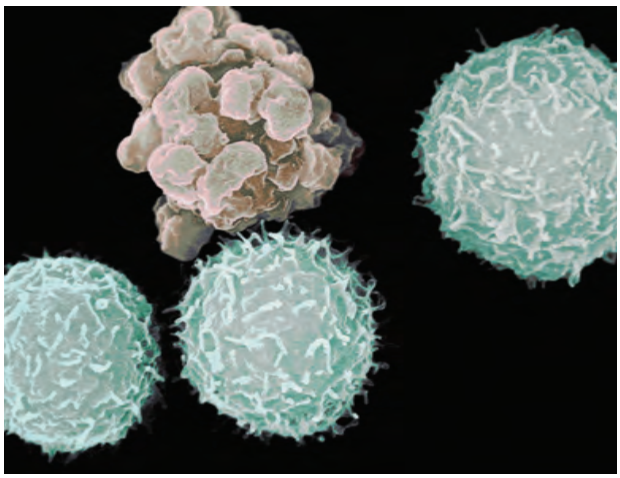


Figure 1.32 Scanning electron micrograph showing normal cells surrounding a cell undergoing apoptosis (magnification 3000×)

Cancer Cells

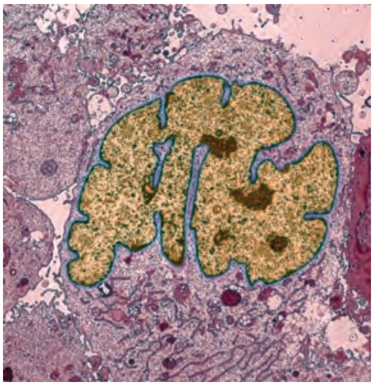


Figure 1.33 A transmission electron micrograph of a lung cancer cell. The nucleus (beige) is enlarged and irregularly shaped (magnification 1000×).

A cell that divides uncontrollably is called a **cancer cell** (Figure 1.33). Cancer cells develop when a change occurs in the cell that affects how that cell divides. When a cell's DNA is changed, it is known as a mutation. Some viruses and environmental agents, such as ultraviolet radiation or cigarette smoke, can cause cell mutations. Some cancer-causing mutations are inherited.

A cancer cell divides differently from a normal cell. For example, while normal cells usually live for about 50 to 60 cell divisions, cancer cells can seem to be "immortal" because they do not stop dividing. A normal cell will undergo apoptosis if it is damaged genetically, whereas a cancer cell will continue to divide (Figure 1.34). Table 1.4 compares the characteristics of a normal cell with a cancer cell.

Suggested Activity •
A9 Quick Lab on page 36

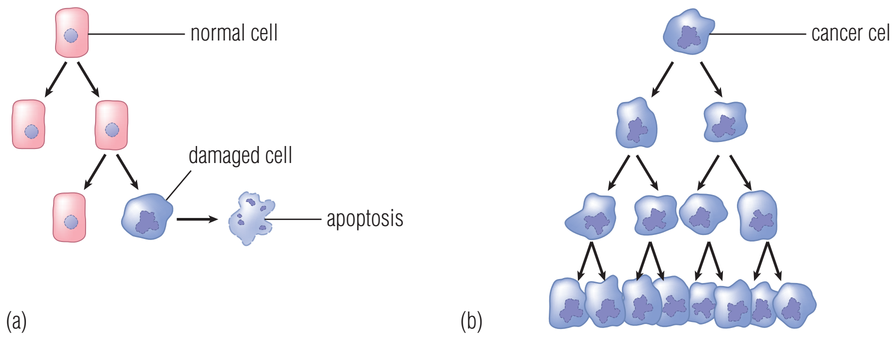


Figure 1.34 (a) Cell division and cell death in normal cells. (b) Cell division in cancer cells

Table 1.4 Comparing Normal Cells with Cancer Cells

Normal Cells	Cancer Cells
• make exact copies of themselves through mitosis	• make exact copies of themselves through mitosis
• reproduce for about 50–60 cell divisions	• do not stop reproducing
• stick together to form masses of cells as appropriate	• do not stick to other cells • behave independently
• self-destruct when too old or too damaged	• may move to another location of the body

Take It **Further**

HeLa cells have been used in cancer research for over 50 years. Research the history of HeLa cells. Be prepared to report on your findings. Begin your research at ***ScienceSource***.

DI Key Activity

A8 *Inquiry Activity*

Skills References 2, 6, 10

SKILLS YOU WILL USE

- Observing, and recording observations
- Interpreting data/information to identify patterns or relationships

Identifying the Stages of Mitosis in Plant and Animal Cells

To understand and identify the different stages of mitosis, you need to examine plant and animal cells undergoing mitosis.

Question

What similarities and differences between plant and animal cell mitosis can you see using a microscope?

Materials & Equipment

- compound light microscope
- pen and/or pencil
- paper
- prepared slides of plant and animal cells in mitosis

CAUTION: Practise proper techniques in handling the microscope and slides.

Procedure

Part 1 — Examining Plant Cell Mitosis

1. Review the proper handling and use of the microscope in Skills Reference 10. Set up your microscope.
2. Place a prepared slide of plant cells on your microscope.
3. View this slide and scan to see its contents using low power. Adjust the light so that you can see the cell contents clearly.
4. Find the section of small cells near the top of the root cap. Move the slide so that these cells are in the centre of your field of view.
5. Look at the cells using the low-, medium-, and high-power lenses. Identify cells that are in each phase of mitosis.
6. Make sketches of cells in each phase of mitosis. Count the number of cells that are in each phase in one field of view.
7. Remove the plant cell microscope slide, and return the microscope to low power.

Part 2 — Examining Animal Cell Mitosis

8. Place a prepared slide of animal cells on your microscope.
9. View this slide and scan to see its contents using low power. Adjust the light so that you can see the cell contents clearly.
10. Find a section of cells that appear to be in mitosis. Look at the cells using the low-, medium-, and high-power lenses. Identify cells that are in each phase of mitosis.
11. Make sketches of cells in each phase of mitosis. Count the number of cells that are in each phase in one field of view.
12. Clean up your work area. Make sure to follow your teacher's directions for safe disposal of materials. Wash your hands thoroughly.

Analyzing and Interpreting

13. Was there a difference in the frequency of cells in the various stages of mitosis? If so, what stage of mitosis did you find most frequently?
14. Based on your observations, which phase do you think takes the longest? Why?

Skill Practice

15. Explain how the use of contrast (light levels and use of stain) improved your understanding of the cells that you were viewing.

Forming Conclusions

16. What similarities and differences did you observe between the plant cells and the animal cells undergoing mitosis?

A9 *Quick Lab*

Comparing Cancer Cells and Normal Cells

The main difficulty in detecting cancer is that the appearance of symptoms depends on how fast the cancer cells are dividing. The rate of cancer growth is measured in doubling times. One doubling time is the length of time it takes for the cancer cells to double in number. Doubling times for different types of cancer cells vary from 10 days to several years. The average doubling time for a cancer cell is four months.

Purpose

To compare the rate of cell division in cancerous cells and non-cancerous cells

Procedure

1. Identify which diagram in Figure 1.35 represents cancerous cells.
2. It takes about 30 doubling times for a cancer cell to form a tumour that is large enough to be felt through the skin with hands. Calculate how many months it would take for the cells in Figure 1.36 to form a tumour that could be felt if the doubling rate is two months.

Questions

3. Explain how you know which diagram in Figure 1.35 shows cancerous cells.
4. What do you think is happening in Figure 1.36?
5. If the cancerous cells were left untreated, what do you predict would happen?
6. What are the limitations of visual inspection as a diagnostic tool for cancer?

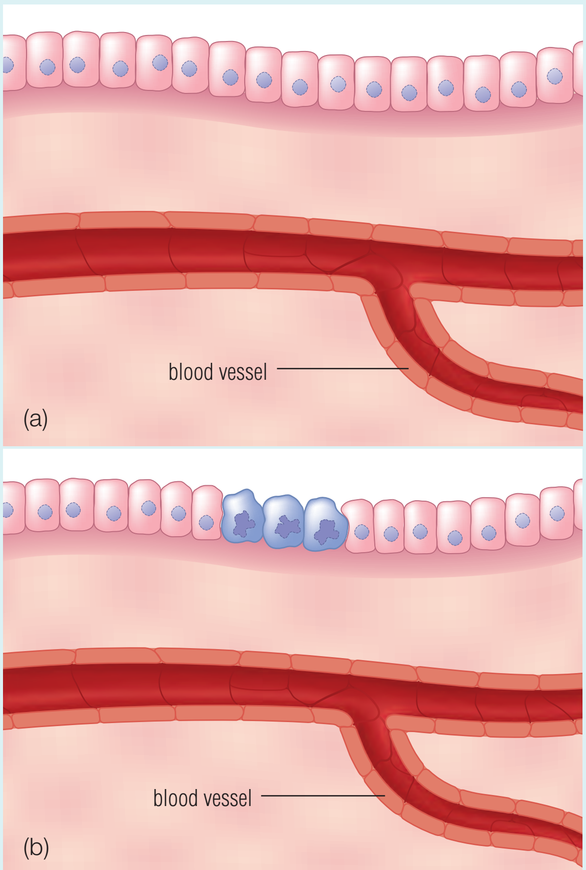


Figure 1.35

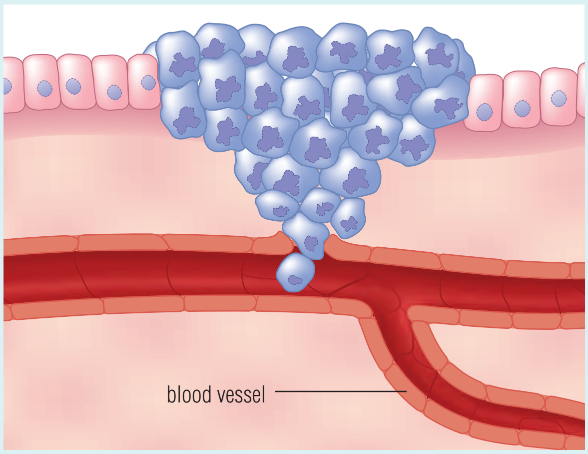


Figure 1.36

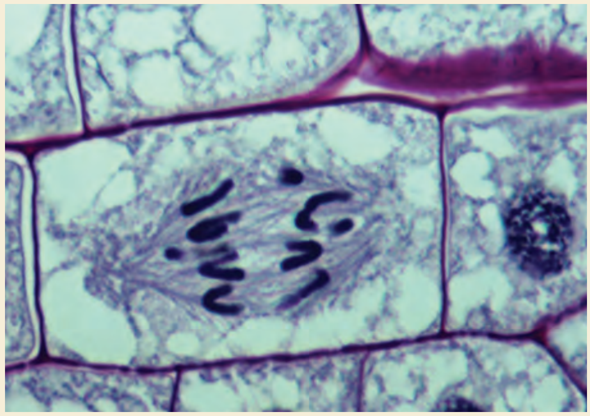
1.2 CHECK and REFLECT

Key Concept Review

1. Describe the events in the cell cycle.
2. Compare mitosis in plant and animal cells.
3. Describe the meaning of the term “apoptosis,” and state its importance.
4. State one similarity and one difference between plant and animal mitosis.
5. What is a cancer cell?
6. Explain how mitosis ensures genetic continuity.
7. How does mitosis make the growth and repair of cells possible in an organism?
8. Why would you expect cells to spend the greatest percentage of their cycle in interphase?
9. What happens to the chromosomes as a cell prepares to divide?
10. How is a cancer cell different from a normal cell? Give three differences.

Connect Your Understanding

11. Describe the differences between mitosis in an animal cell and a plant cell.
12. Why must cell division be controlled or regulated for cells to remain healthy? Explain your answer.
13. A certain antibiotic affects cells by preventing the formation of spindle fibres. Explain how this drug would affect mitosis in cells.
14. A drug used in chemotherapy causes chromosomes to move incorrectly during mitosis. As a result, the daughter cells that are produced have either too much or too little genetic information. Predict why this treatment causes the cancer cells to die.
15. Identify the stage of mitosis shown in the photo below. Explain your thinking.



Question 15

16. The nerve cells in our bodies rarely undergo mitosis. Use this information to explain why complete recovery from injuries to our nervous system may not occur.
17. Sunscreens protect your skin by blocking types of ultraviolet radiation. Explain why the Canadian Cancer Society advises Canadians to apply sunscreen.
18. Suggest reasons why cancer researchers may be interested in using their learning about the processes of cell division to develop new forms of cancer prevention and treatment.
19. Three samples of cells from three different patients were unlabelled. One sample was from an 85-year-old man, one was from a 5-year-old boy, and one was from a person with skin cancer. How could you determine to which patient they belonged?

Reflection

20. How did your understanding of cell division change after you viewed cells under a compound light microscope?

For more questions, go to ***ScienceSource***.

1.3 Specialized Plant and Animal Cells

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

- Unspecialized cells can become specialized through interactions with their environments.
- Specialized cells group together to function as a tissue.
- Specialization of cells allows for diversity of function in multicellular organisms.
- Current research is focussed on the function and use of unspecialized cells, known as stem cells, in treating disease.

Figure 1.37 The axoloti is a type of salamander that has an amazing ability to regenerate missing limbs.

Figure 1.38 The regeneration of a newt's limb over 6 to 8 weeks. The newt is a type of salamander. The lighter colour represents the newly formed forelimb.

Regeneration

In scientific laboratories around North America, scientists study the superstar of regeneration — the salamander (Figure 1.37). **Regeneration** is the process whereby a body part is replaced or regrown. The salamander has the unique ability to regrow not only limbs that have been amputated but also tails, lenses in eyes, and parts of the heart (Figure 1.38). In the salamander, the process of mitosis is responsible for regenerating the cells that will eventually specialize and create a newly formed limb.

Although regeneration has been studied in organisms such as the salamander, it is not often thought to occur in humans. However, examples of regeneration in humans do exist. The human liver is the only human organ that has an ability to naturally regenerate. Additionally, human fingertips have a limited ability to regenerate. In young children, an amputated fingertip that is cleaned and covered with a simple dressing can regenerate. The new fingertip has the same fingerprint pattern and sensations of the original fingertip.

Research into Regeneration

In 2008, scientists reported some astonishing progress in the field of regeneration. A powder stimulated a human adult fingertip that had been severed to regrow. The powder, made from pigs' bladders, is called an extracellular matrix. Although regenerating a fingertip is not the same as regenerating a limb, scientists hope that the knowledge they gain from researching the extracellular matrix will lead to further developments.

Another development in the field of regeneration is the creation of body parts in the lab. In one example, a patient's bladder cells were isolated and grown on a prepared surface called a scaffold. In two months, the cells had formed a functioning bladder that was implanted into the patient (Figure 1.39). This technology has also been used to create functioning blood vessels and heart valves. In the future, scientists believe it may be possible to grow a functioning human heart.

Scientists do not fully understand why a salamander can regenerate certain body parts but not others, even though all salamander cells contain the same DNA. With the success in developing technologies to regenerate human bladders or blood vessels, it may be possible to grow all body parts through regeneration in the future.

Figure 1.39 An artificial bladder held by gloved hands. The bladder was grown from cultured bladder cells.

A10 STSE *Quick Lab*

Tailor-Made Body Parts

In 2008, Dr. Anthony Atala, from Wake Forest University, North Carolina, reported that he and his team had successfully grown 18 different tissues outside of the body using the techniques of regeneration. One particularly successful experiment involved the creation of a human bladder that was grown in the lab from the patient's own bladder cells and then transplanted into the patient. Growing replacement organs in the lab would meet the needs for replacement organs. Some businesses have recognized the opportunities that this new technology provides. For example, in the future, if you were in need of a replacement organ, you could simply order a tailor-made replacement body part made using your own cells.

Purpose

To consider the social and ethical issues connected with using technology to make human body parts

Procedure

1. Work with a partner. Prepare a T-chart with the headings "Social Issues" and "Ethical Issues."
2. Brainstorm about how the production of human body parts using regenerative technologies could affect society. Think about both the positive and negative ways. List your ideas in the T-chart under the heading "Social Issues."
3. Continue to brainstorm about the ethical issues related to the production of body parts using regenerative technologies. List your ideas in the T-chart under the heading "Ethical Issues."

Questions

4. With the development of regenerative technologies, there has been interest in the mass production and commercialization of human organs. Discuss two positive outcomes and two negative outcomes of this action.
5. Why do you think this technology would be of interest to the military?

Figure 1.40 Meerkats have different specialized jobs. The sentinel meerkat looks for any dangers to the clan.

The Process of Cell Specialization

Meerkats are small mammals that live in the desert regions of southern Africa. Meerkats live in groups, called clans or mobs, of 5 to 20 animals. Members of the clan work together to find food, care for the young, and defend themselves against predators. Scientists have observed that there are certain specialized roles that meerkats may play within in the clan. In each clan, there is a dominant, or alpha, pair of animals that lead the group. The other adult meerkats are subservient to the alpha meerkats and leave the clan when they are three years old. During the day, there is always at least one adult meerkat acting as a sentinel, or lookout, and watching for predators while the rest of the clan plays or searches for food (Figure 1.40). Using a bark, the sentinel signals to the rest of the clan when danger approaches. Other meerkats serve as babysitters for the young. The success of the meerkat clan depends on each meerkat doing his or her specialized job.

Much like a meerkat clan is a collection of different meerkats doing specialized jobs, a multicellular organism is a collection of different types of cells doing specialized jobs. Although all cells have the same DNA information, they are not all alike. Cells develop in different ways to perform particular functions in a process called **cell specialization.** For example, animal cells may become specialized to form lung cells, skin cells, or brain cells. Plant cells become specialized to form a variety of specialized cells including xylem or phloem in the root, stem, or leaf.

During Reading Thinking Literacy

Sketch to Stretch Your Understanding

When reading comprehension gets difficult because of unfamiliar terminology, good readers find it helpful to visualize ideas, and they may even draw or sketch as they read to try and understand the text. Choose one paragraph and sketch as you read, then check your understanding. Did the sketches help you to make sense of what you were reading?

Stem Cells

Every cell in your body originally came from a small group of stem cells. A **stem cell** is an unspecialized cell. Stem cells can form specialized cells when exposed to the proper environmental conditions, or they can remain unspecialized and actively dividing for long periods.

Scientists are studying stem cells in animals and plants so that they can understand the process of cell specialization. They believe that stem cells may be used to treat injuries and diseases by regenerating organs. Figure 1.41 shows how stem cells are produced in the lab for stem cell research. These stem cells are capable of becoming any cell — including nerve cells, blood cells, or muscle cells — in the human body.

Embryonic and Adult Stem Cells

There are two types of stem cells: embryonic stem cells and adult stem cells. As the name suggests, embryonic stem cells are found in embryos. Embryonic stem cells are able to undergo **differentiation**, which means that the cells look different from one another and perform different functions. Embryonic stem cells differentiate into other cell types. As these cells divide, further specialization occurs, leaving cells with a limited ability to create a variety of cell types. These cells are called adult stem cells.

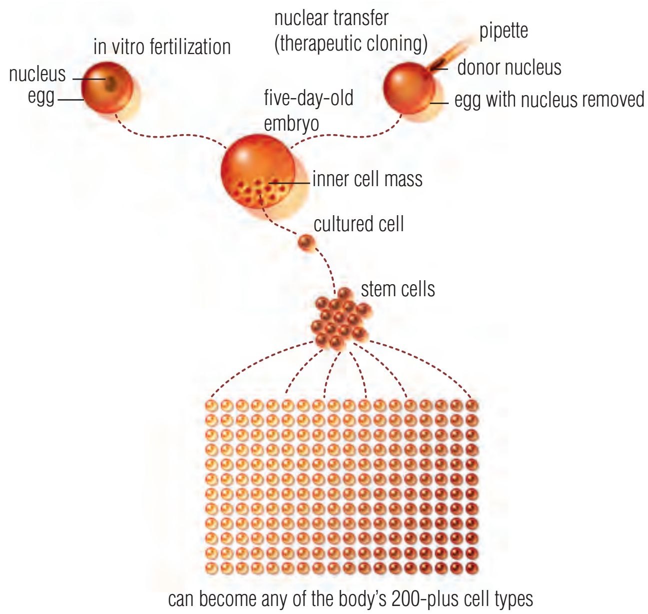


Figure 1.41 Most stem cells used for research are taken from embryos created by in vitro fertilization. The process occurs when the egg is fertilized under laboratory conditions. Scientists are also working on getting cells from embryos produced by therapeutic cloning, in which the nucleus of a skin cell, for example, is inserted into an egg whose nucleus has been removed. Either way, after five days scientists transfer the embryo's inner cell mass — with its 40 or so stem cells — to a lab dish where the cells can reproduce. After many months, the original stem cells have grown into millions of healthy cells without beginning to differentiate into specialized cells.

As an organism matures, stem cells become specialized. In adult organisms, therefore, there are few examples of stem cells; most adult stem cells are involved in the replacement of damaged tissue. For example, adult stem cells are found in skin, blood, and neural tissue. Recent studies have found that adult stem cells from the tissue of one organ can regenerate tissue in another organ. For example, adult blood stem cells have regenerated liver, kidney, and brain cells.

Current research involves the use of stem cells in the treatment of such diseases as cancer, Parkinson's disease, Alzheimer's disease, stroke, heart disease, diabetes, and rheumatoid arthritis. There is much public debate about the use of embryonic stem cells. It is possible to harvest a few embryonic stem cells from the umbilical cord or placenta, but to collect larger amounts of embryonic stem cells, it is necessary to destroy the embryo.

Meristematic Cells

Stem cells are also found in plants. Plant stem cells are called **meristematic cells**. They are found in the growing tips of roots (Figure 1.42) and stems and also in a layer in the stem known as the cambium. Plant meristematic cells are active throughout the life of a plant, which means that they continually produce new cells of various types.

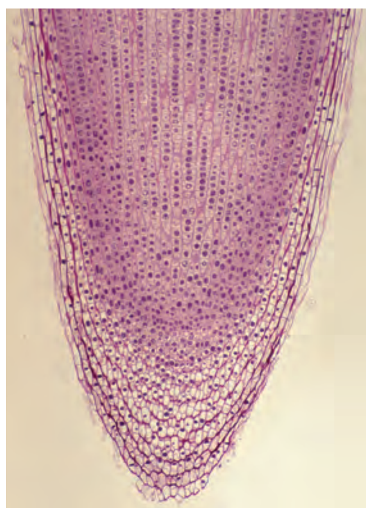


Figure 1.42 Meristematic cells in an onion root tip (magnification 25×)

Learning Checkpoint

1. Define the term "stem cell."
2. Explain how stem cells can become specialized.
3. Compare and contrast embryonic stem cells and adult stem cells.
4. State one practical use of stem cell research.
5. What are meristematic cells?

Specialized Cells and Tissues

Imagine being stranded on a deserted island with a group of your family and friends. You could look out only for yourself and be responsible for all of your own needs, including food and shelter. Or you could work with the other people on the island and form teams: one team may be responsible for building the shelter, while another team would look for food. In the second scenario, each team works for the good of the whole group: everything does not depend on one person.

We can use this analogy to understand how a multicellular organism accomplishes its life processes. A multicellular organism is made of many cells. Since it would be difficult for each cell in a multicellular organism to perform all of the necessary life processes independently, cells group together and become specialized. Just as it makes sense for you to work together as a team on the deserted island, it makes sense for groups of cells to function together. Groups of cells that function together to perform specialized tasks are called **tissues**.

Animal Tissues

In animals, cells specialize to form four types of tissues (Table 1.5). The cells in each tissue work together to accomplish important tasks.

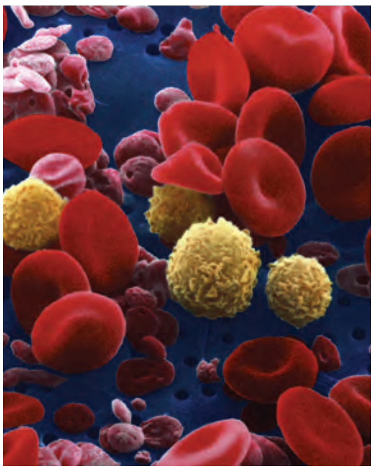


Figure 1.43 Scanning electron micrograph showing human red blood cells, white blood cells (yellow), and platelets (pink)

Epithelial and Connective Tissue

Epithelial tissue is made of cells that are tightly packed together to form a protective barrier. Epithelial tissue may be one cell thick or consist of several layers of cells.

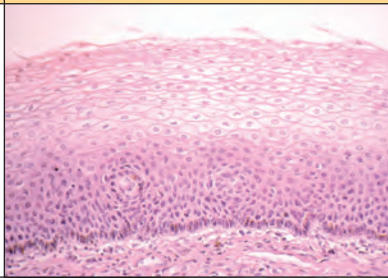
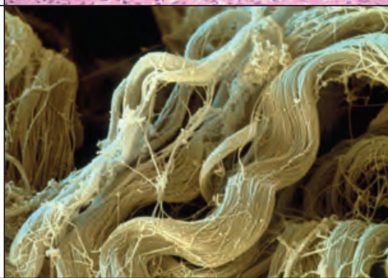
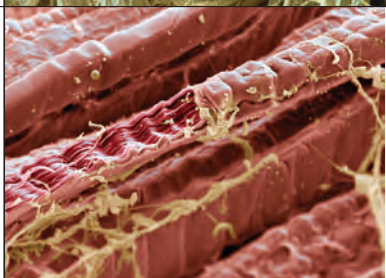
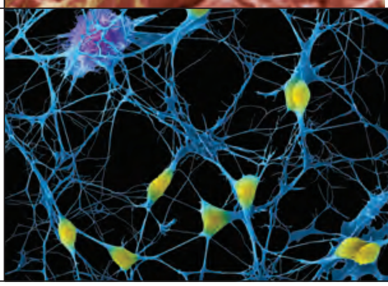
The main function of connective tissue is to join other tissues together. There are different types of connective tissue including tendons and ligaments, bones, cartilage, and blood. Tendons connect muscles to bones, and, ligaments connect bones to bones. Blood is made of plasma, red blood cells, white blood cells, and platelets (Figure 1.43). **Red blood cells** contain hemoglobin, a protein that can absorb and release oxygen. White blood cells protect the body from bacteria and viruses and fight infection. Platelets are cells that help in the process of blood clotting.

Muscle and Nervous Tissue

There are three types of muscle tissue: skeletal, smooth, and cardiac. When you move your arm or leg, you are using skeletal muscle. Smooth muscle occurs in blood vessels, the stomach, and other organs. Cardiac muscle is only found in the heart. Skeletal muscle is voluntary, which means that it is controlled by will. Smooth muscle and cardiac muscle are involuntary, which means they move without conscious control.

Nervous tissue is made of nerve cells which are capable of creating messages, called impulses, and transmitting them throughout the body. Nerve cells receive information from inside and outside the body.

Table 1.5 Animal Tissues and Their Functions

Tissue Type	Micrograph	Major Function(s)
epithelial tissue		• lines body cavities and outer surface of body • protects structures • forms glands that produce hormones, enzymes, and sweat
connective tissue		• supports and protects structures • forms blood • stores fat • fills empty space
muscle tissue		• allows for movement
nervous tissue		• responds to stimuli • transmits and stores information

Plant Tissues

There are four types of tissues in plants: epidermal tissue, vascular tissue, ground tissue, and meristematic tissue (Figure 1.44). All plant tissues are formed from groups of meristematic cells known as **meristematic tissue**. Table 1.6 (on the next page) describes and illustrates the different types of plant tissues.

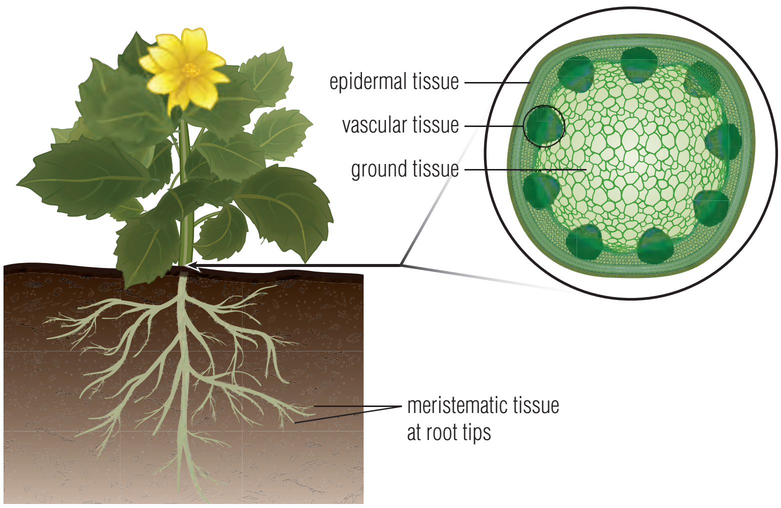
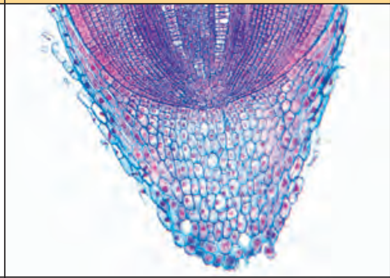
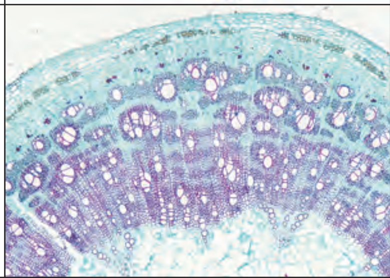
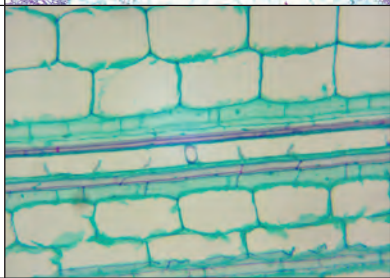
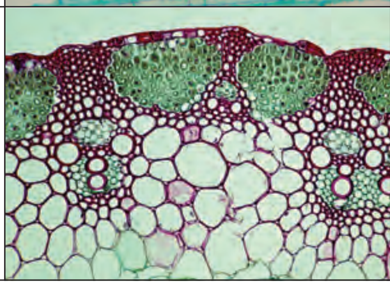


Figure 1.44 Location of plant tissues

Table 1.6 Plant Tissues and Their Functions

Tissue Type	Micrograph	Major Function(s)
meristematic tissue		• unspecialized tissue capable of dividing by mitosis • found in several locations in the plant • responsible for growing new parts of the plant
epidermal tissue* * The micrograph shows both epidermal and vascular tissues.		• forms the protective outer covering • allows the exchange of materials and gases into and out of the plant
ground tissue		• in the stem: provides strength and support • in the roots: stores food and water • in the leaves: where photosynthesis occurs
vascular tissue		• moves substances from the roots to the leaves • transports sugars from the leaves to other parts of the plant

Suggested Activity •
A12 Inquiry Activity on page 46

Epidermal and Ground Tissue

The epidermal tissue on both the top and underside of the leaf is clear and very thin. Specialized guard cells form a tiny opening, or pore, called a **stomate**, that allows carbon dioxide, water vapour, and oxygen to move into or out of the leaf easily. Most stomata are found on the underside of the leaf.

Most of the plant is made of ground tissue. The function of the ground tissue depends on where it is found in the plant. For example, in the roots, ground tissue is involved in food and water storage. In the leaves, photosynthesis and gas exchange occurs in specialized ground tissues called **mesophyll**. During photosynthesis, carbon dioxide and water are converted into sugar and oxygen.

Vascular Tissue

Vascular tissue plays an important role in transporting water and nutrients throughout the plant. There are two types of vascular tissue in the plant: xylem and phloem. **Xylem** is responsible for the movement of water and minerals from the roots up the stem to the leaves, where these substances are used in photosynthesis. **Phloem** transports the sugar produced during photosynthesis from the leaves to other parts of the plant, where it is used to provide energy for all cellular processes.

WORDS MATTER

"Xylem" comes from the Greek root *xyl*, meaning wood. Phloem comes from the Green root *phloe*,meaning bark.

Learning Checkpoint

1. Define the term "tissue."
2. What is the link between specialized cells and tissues?
3. Compare the structure and functions of epithelial tissue and epidermal tissue.
4. What are four types of animal tissues?
5. What are four types of plant tissues?

Take It Further

Find out how stem cells are used in the treatment of a disease such as diabetes or Parkinson's disease. Create a concept map to show the details of your findings. Begin your research at ***ScienceSource***.

A11 STSE *Science, Technology, Society, and the Environment*

Receiving Mixed Messages

We have an almost unlimited access to various sources of information. The Internet gives us the opportunity to interact with others and exchange information on a global scale. Scientific inquiry is now a collaborative international process. The ability to communicate electronically over the Internet using text, sound, and pictures is a powerful tool for the scientist. However, effective and accurate communication of information is important to the success of the process of scientific inquiry.

We have the opportunity to receive scientific information in various forms of media including journals, newspapers, TV shows, movies, books, lectures, and interviews. Recent scientific advancements are commonly used in the story lines of television programs and movies. The problem is that sometimes these messages about science are not entirely correct. For example, some movies have plots based on a scientific theme but may not be scientifically accurate. Although media with science-based themes may increase the level of public awareness of an issue, it is also possible that they could misinform the public. In addition, it is also possible that some messages are delivered in a manner that reflects the bias of a particular interest group or corporate sponsor.

In this activity, you will discuss examples in which you received media messages about cell biology.

1. With a partner, make a list of situations where you have received media messages about cells. Remember to consider different types of media including radio, advertisements, newspapers, TV, magazines, websites, blogs, wikis, music, videos, and movies.
2. Share your responses with the whole class and compile a class list.
3. As a class, identify any trends that emerge.
4. As a class, predict how corporate sponsorship of scientific research may affect the nature of the scientific messages that are delivered in the media.

A12 *Inquiry Activity* Skills References 2, 6, 10

SKILLS YOU WILL USE
- Justifying conclusions
- Communicating ideas, procedures, and results in a variety of forms

Examining Plant and Animal Tissues

If you offered to shovel snow for a neighbour, you would be sure to use the proper equipment. You would not use a dustpan or a mop but rather a snow shovel. You would also be sure to be dressed in the appropriate clothing so that you would stay warm and dry while on the job. Groups of cells must also have the proper equipment if they are to perform efficiently as tissues. In this activity, you will observe groups of cells and infer how their structures allow them to perform their specialized tasks.

Question

How do cell structures enable the tissue to accomplish its function?

Materials & Equipment

- prepared slides of plant tissue (epidermal tissue, ground tissue, vascular tissue)
- pencil or pen
- ruler
- prepared slides of animal tissue (epithelial tissue, nervous tissue, muscle tissue)
- paper
- compound light microscope

CAUTION: Practise proper techniques in handling the microscope and slides.

Procedure

Part 1 — Examining Plant Tissue

1. Review the proper handling and use of the microscope in Skills Reference 10.
2. Set up your microscope, and place a prepared slide of plant tissue on your microscope.
3. View the slide under low power, and scan to see its contents. Adjust the light using the diaphragm so that you can see the cell contents clearly.
4. Find the section of the slide of cells that you wish to examine.
5. Use the low-, medium-, and high-power lenses to study the cells.
6. Draw a labelled diagram of the plant tissue. Remember to include the magnification and scale in your drawing.

Part 2 — Examining Animal Tissue

7. Repeat steps 2 to 6 using a prepared slide of animal tissue.
8. Clean up your work area. Make sure to follow your teacher's directions for safe disposal of materials. Wash your hands thoroughly.

Analyzing and Interpreting

9. Describe the structure of the cells in the plant tissue that you examined. How does the structure relate to its function?
10. Describe the structure of the cells in the animal tissue that you examined. How does the structure relate to its function?
11. What information about the tissues could be found through examination using a compound light microscope?

Skill Practice

12. Was the section of the slide that you chose to examine a good representation of the entire tissue?

Forming Conclusions

13. Would you expect plant and animal tissues with similar functions to share some common structural features? Support your answer with evidence from your observations.

1.3 CHECK and REFLECT

Key Concept Review

1. What are two characteristics of stem cells?
2. What are stem cells called in plants?
3. Name the four types of specialized animal tissues, and state the general function of each tissue.
4. Name three types of specialized plant tissues, and state the general function of each tissue.
5. Specialized tissues in the cactus, shown below, help it to survive in the harsh desert climate. Why are epidermal tissues so important to plant survival?

Question 5

6. Explain the location and function of ground tissue.
7. Describe the function and importance of mesophyllic tissue.
8. Define the term "regeneration," and give an example of regeneration in animals.

Connect Your Understanding

9. In this section, you learned about organ regeneration. Predict two social, political, or economic implications that would result if organ regeneration were possible for every organ in your body.
10. What are some advantages and disadvantages of cell specialization?
11. What is the relationship between specialized cells and tissues in animals?
12. The muscles in the heart are said to be "involuntary." Explain the meaning of this term, and then state why this characteristic of heart muscle is necessary.
13. Explain how the different types of plant tissues are involved in photosynthesis.
14. (a) Define the term "xylem."
    (b) Describe how the xylem and phloem work together as a transport system.
15. Plants are often called "nature's air purifiers." Explain the meaning of this term.
16. A cross section of a tree trunk reveals rings. These annual rings are made of xylem tissue. Scientists use the size of the tree rings to infer the climate of the year in which the tree grew. Use your knowledge of the function of xylem tissue to explain why wide rings could indicate that the tree grew in an environment with plenty of moisture while narrow rings could indicate that the tree grew in an environment that was unusually dry.
17. Compare animal tissues and plant tissues that have similar functions.

Reflection

18. Explain why you think that it is important for you to learn about stem cells and stem cell research.

For more questions, go to ***ScienceSource***.

Great CANADIANS in Science Sheela Basrur

Figure 1.45 Dr. Basrur calms the fears of the public during the SARS outbreak.

In March 2003, a 44-year-old man went to the emergency room (ER) at Scarborough Hospital with an unknown respiratory illness. During the time he was in the ER, he transmitted the illness to two other patients and sparked a chain of infection that ultimately killed 44 people and sickened 330. Although no one knew it at the time, he had severe acute respiratory syndrome, or SARS.

SARS is a severe pneumonia-like respiratory disease that was first seen in Southeast Asia in late February 2003. By the time the disease had run its course, over 8000 people around the world were sick and 800 had died.

During the SARS epidemic, Dr. Sheela Basrur provided skilled leadership that earned her the respect of the people of Toronto as well as the rest of Canada (Figure 1.45). Dr. Basrur was Toronto's Chief Medical Officer of Health. Dr. Basrur and other medical officials put various procedures in place to control the epidemic. Rigid infection-control procedures were installed in 22 hospitals in Toronto: people who were exposed to SARS were put in quarantine, and people who had the disease were isolated. Dr. Basrur ultimately showed that the epidemic was under control.

In addition to calming a nation's fears about SARS, Dr. Basrur helped develop anti-pesticide and anti-smoking laws. After she showed leadership during the SARS crisis, she was appointed Ontario's Chief Medical Officer of Health and Assistant Deputy Minister of Public Health in 2004. She helped develop a post-SARS action plan for Ontario, which included stockpiling 55 million respirator masks for health-care workers and hiring 10 disease-tracking experts at public health labs. She resigned in 2006 to undergo treatment for cancer. In April 2008, Dr. Basrur received the Order of Ontario (Figure 1.46). On June 2, 2008, Dr. Basrur died; she was 51 years old. The headquarters for the newly formed Ontario Agency for Health Protection has been named in Dr. Sheela Basrur's honour.

Questions

1. Describe the role that Dr. Basrur played in controlling the SARS epidemic of 2003.
2. *ScienceSource* Research to learn how Ontario prepared itself for any future pandemic or epidemic.

Figure 1.46 Dr. Basrur admires the Order of Ontario that she received for her work during the SARS crisis.

Science in My FUTURE Medical Laboratory Technologist

Figure 1.47 A medical technologist draws blood from a patient's arm for testing.

Having the technology to diagnose and treat diseases is useful only if there are people qualified to use the technology. A medical laboratory technologist works individually or as part of a team in a laboratory to analyze specimens taken from a body. Common specimens sampled include blood, urine, fetal tissue, amniotic fluid, bone marrow, and tumours (Figure 1.47). A technologist uses sophisticated techniques and instruments to obtain necessary information about these specimens that will help doctors make medical decisions.

Since technology is constantly changing, a technologist must be capable of learning new information and techniques. Technologists need to be detail oriented and must demonstrate strong critical and creative thinking skills. Technologists must also possess strong motor skills and eye-hand coordination. They must know how to use a great variety of lab instruments and techniques and when to use each appropriately (Figure 1.48).

However, technical skill is not sufficient in itself. Analyzing lab specimens and recording lab results must be done accurately so that the decisions based upon the laboratory work are valid. The technologist must also remember that lab information will affect the present and future medical care of the patient.

Usually, technologist training requires two years at a post-secondary institution. In Ontario, the Michener Institute offers a great variety of specialty courses in medical laboratory technology. Some specialty areas require additional preparation at the university level.

Questions

1. Describe some of the skills needed to be a successful medical laboratory technologist.
2. ***ScienceSource*** Research three of the different areas in which medical laboratory technologists can work.

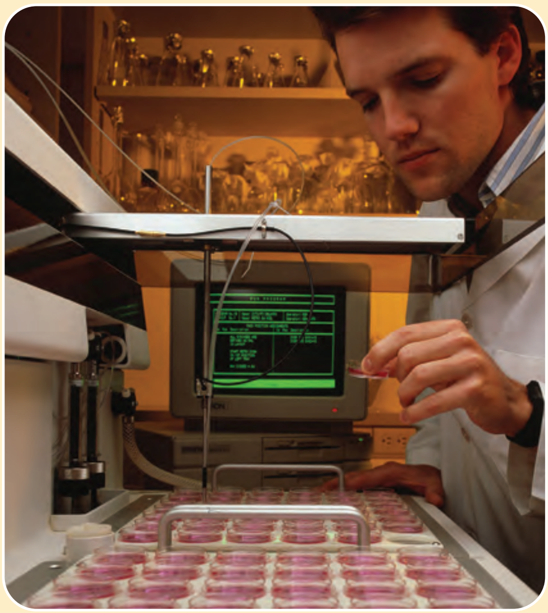


Figure 1.48 A technologist works with petri dish cultures of amniotic cells. Tests done on the cells will determine if the developing fetus has genetic disorders, such as Down syndrome or cystic fibrosis.

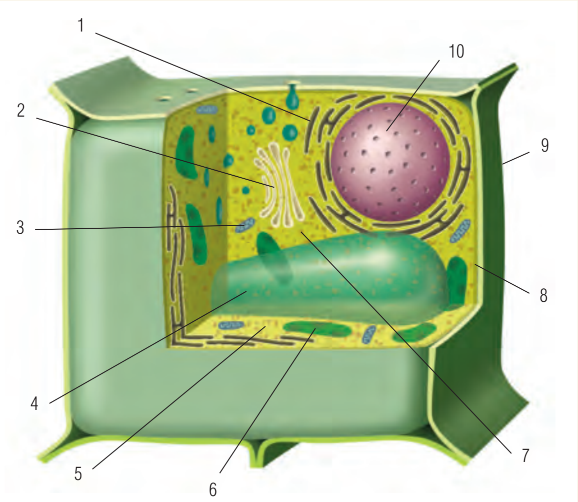
1 CHAPTER REVIEW

ACHIEVEMENT CHART CATEGORIES

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

Key Concept Review

1. (a) Identify the type of cell shown below. k
   (b) Name all the numbered parts. k
   (c) Describe the function of parts 2, 3, 6, and 10. k



Question 1

2. Describe the cell cycle in plant and animal cells. t

3. What significant events occur during interphase? k

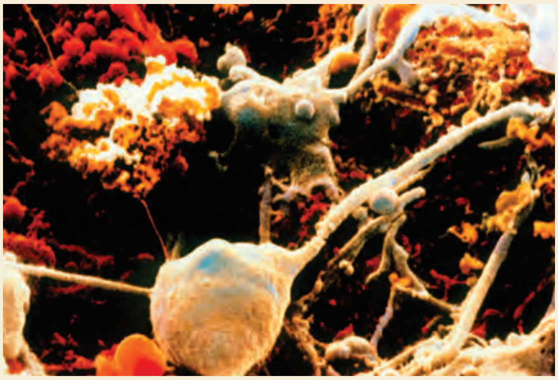
4. Describe the phases of mitosis using sketches and words. t

5. Describe some factors that affect the rate of mitosis in plants and in animals. k

6. Define the term "apoptosis." k

7. Distinguish between embryonic stem cells and adult stem cells. k

8. Explain why cells, such as the brain cells shown below, undergo specialization. t



Question 8

9. How do cancer cells differ from normal cells? k

10. List the four types of animal tissues. k

11. What is the function of meristematic tissue in plants? k

Connect Your Understanding

12. Explain the role that magnification, resolution, and contrast play when using a microscope to find out about cell structure and function. a

13. Why do plant and animal cells have some of the same organelles? Describe these organelles. t

14. Why do plant cells have different organelles than those found in animal cells? Describe these organelles, and explain their functions. t

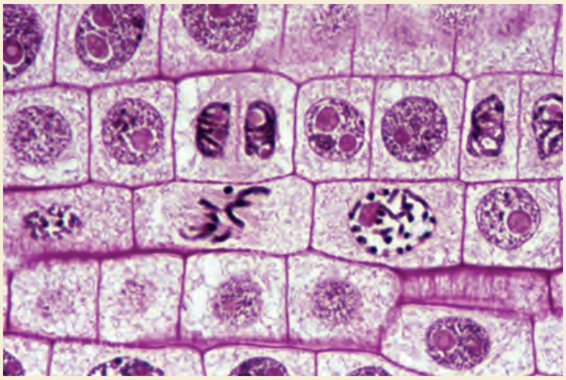
15. Write a short paragraph that defines the words and shows the relationships among the following terms: cell membrane, concentration, water, and solutes. c

16. Explain how the development of microscopy has led to an understanding of the cell. a

17. For a cell to be able to perform the life processes, it must be able to move materials in and out of the cell. Explain how substances tend to move across the cell membrane. t

18. Select one of the life processes of the cell and explain how cell organelles are used to accomplish the process. t

19. What stages of mitosis do you see in the following photo? Explain your thinking. t

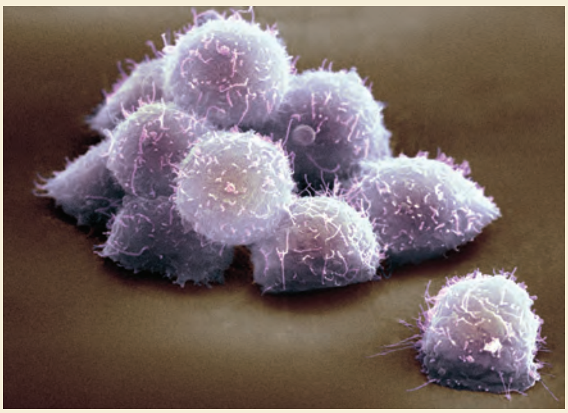


Question 19

20. Explain the role of mitosis in the growth and repair of tissues in plants and animals. t

21. Explain the role of cell specialization in the development of tissues. t

22. What is a stem cell (shown below)? Explain why these cells are of great interest to researchers. a



Question 22

23. Explain the link between the regeneration of tissues and stem cells. t

24. Write a short paragraph that shows the relationship between the following terms: embryonic stem cells, adult stem cells, differentiation, and cell specialization. c

25. Choose two advances in imaging technology, and explain how they have led directly to a new understanding of cell structure and function. a

26. How are adult stem cells used in the process of tissue regeneration? Give examples in your answer. a

27. What type of tissue would you expect to find in the stem of a plant? Explain your answer. t

Reflection

28. Reflect on what you learned in this chapter. What interested you most about cells, the cell cycle, and tissues? Explain why this topic interested you. c

After Reading

Thinking Literacy

Reflect and Evaluate

List the reading strategies recommended in this chapter. Two of them involved using a graphic organizer, and two used pictures or graphics in some way. Rate the helpfulness of each strategy from 1 to 4. Which was most helpful in learning new ideas and terms? Compare your ratings with a partner's, and explain your reasons for the ratings.

Unit Task Link

Review your notes to find information about how the following aspects of cell biology have affected society: cell cycle, cancer cells, and stem cells. You may wish to record your ideas and classify them under the headings "Plus," "Minus," and "Interesting."