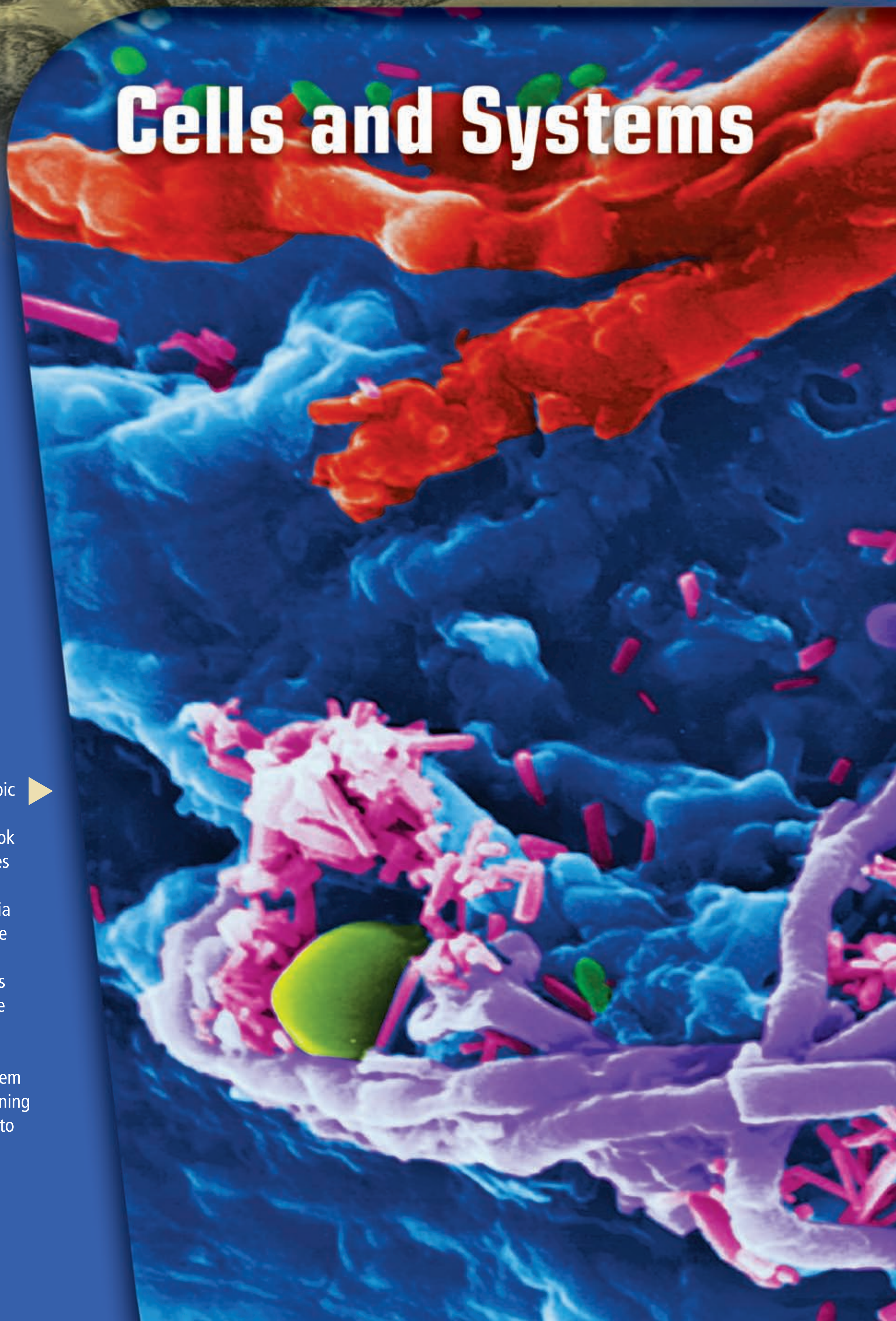
UNIT 1

Cells and Systems



Welcome to the microscopic world of a kitchen sponge greatly enlarged. If you look closely, you can see masses of small, pink rod shapes. These are bacteria. Bacteria are tough, single-celled life forms that can affect how our cells and body systems function. They are also one of the oldest life forms on Earth. Scientists rely on powerful tools to study them up close, such as the scanning electron microscope used to take this photograph.

Key Ideas

1 The cell is the basic unit of life.

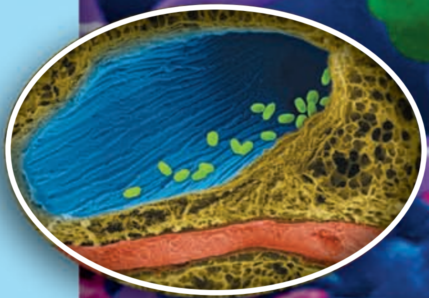
1.1 Observing Living Things
1.2 Cells
1.3 Diffusion, Osmosis, and the Cell Membrane

2 Human body systems work independently and together.

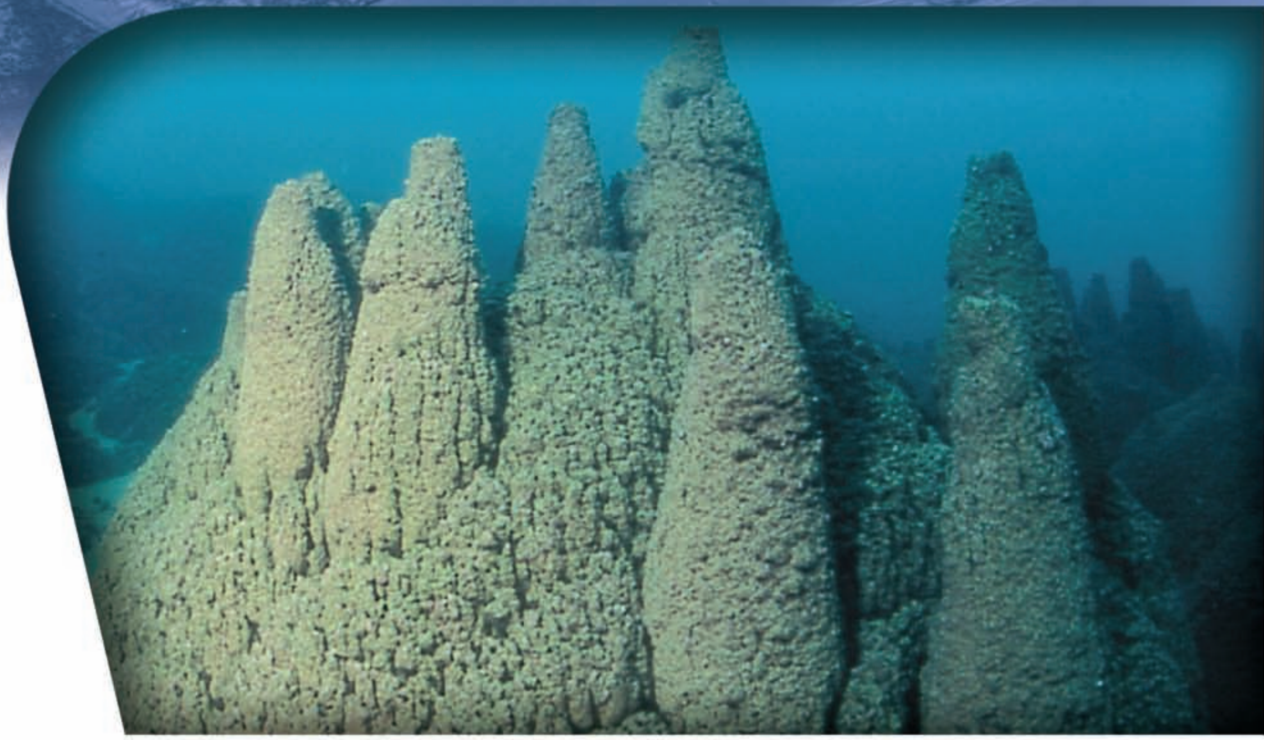
2.1 Body Systems
2.2 The Digestive and Excretory Systems
2.3 The Circulatory and Respiratory Systems

3 The immune system protects the human body.

3.1 The Immune System
3.2 Factors Affecting the Immune System



Getting Started



The structures in Pavilion Lake

Pavilion Lake is located in southwestern British Columbia.

In southwestern British Columbia, there is a unique place called Pavilion Lake. This clear, blue lake is part of the traditional territory of the Ts'kw'aylaxw people and the Pavilion First Nations Indian Band. The Ts'kw'aylaxw people consider this area to be an important part of their culture and maintain a strong spiritual connection to it.

Besides its beauty and spiritual importance, Pavilion Lake contains other unique features. Under its waters lie structures (see above) similar to the coral reefs you would find in much warmer oceans. Researchers have determined that the structures in Pavilion Lake are at least 11 000 years old and are made up of both living and non-living things. Tiny living things called microbes cover the surface of each mound. Certain kinds of ancient bacteria and algae make up this microbe community. When the microbes die, they harden to form the non-living part of the structure. This non-living layer provides a place for new microbes to grow. Over time, this layer-producing process is repeated, and eventually, a structure like the one in this photograph forms.

The structures in Pavilion Lake have caught the attention of astrobiologists—scientists who look for life on other planets. They think the microbes growing on these mounds are similar to the first living things on Earth. If robots investigating Mars record similar mound-like structures, they might be clues that living things once populated that planet.

Scientists are working together to find out how Pavilion Lake's microbes survive. They are also consulting with the Ts'kw'aylaxw people to learn more about the history of the lake and the surrounding area. By collecting as much information as they can, scientists may be able to answer questions such as what food do the microbes need for survival, and how can they live in such cold, fresh water? A better understanding of the living and non-living things in Pavilion Lake may someday yield a better understanding of life on Earth and possibly on distant planets.

Word Connect

The word "microbe" comes from a Greek word that means small life.

Living or Non-living?

Find Out ACTIVITY

Living things have unique needs that must be met so that they can survive in their environment. You may already know what some of these needs are. In this activity, you will use this knowledge to help you find out whether two similar-looking things are living or non-living.

Materials

- 2 samples in separate containers
- magnifying glass
- ruler
- 2 bowls
- warm sugar water

What to Do

1. Your teacher will give you two containers of similar-looking samples. Your task is to determine which characteristics these samples have in common and which characteristics they do not have in common. Then you will decide if one or both of these samples is a living thing.
2. Examine both substances using the magnifying glass. Use any other equipment available to help you add to your observations. Record your observations in a chart.

Science Skills

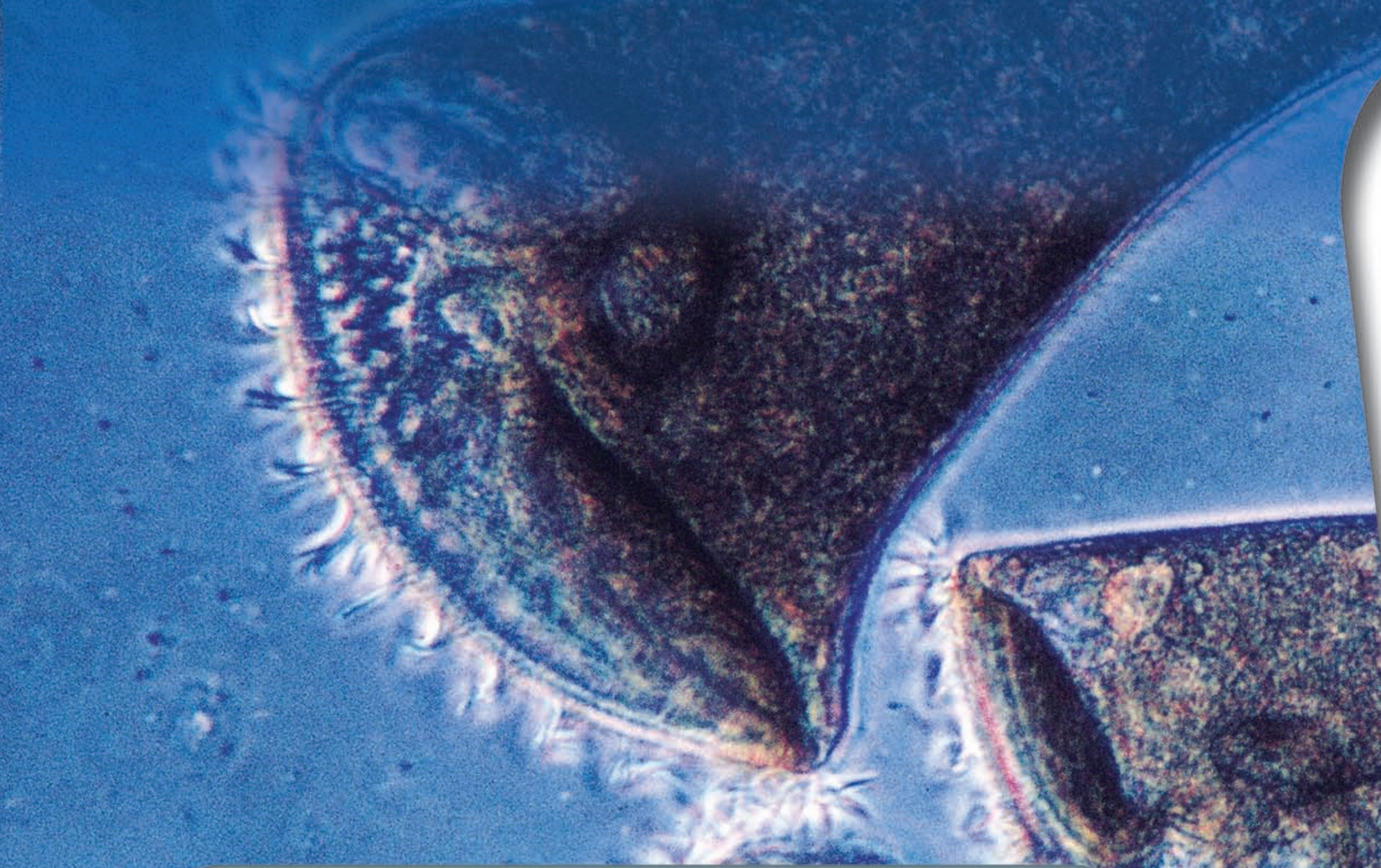
Go to Science Skill 2 for information about conducting a fair test.

3. Place a small amount of each sample in separate bowls. Add equal amounts of warm sugar water to both bowls. Observe and record any changes.
4. Perform one more test you think will provide evidence that one of these samples is living. Record your observations.
5. Clean up and put away the equipment you have used.

What Did You Find Out?

1. Discuss your results with your class.
2. Decide which observations suggest that one or both of the samples is living. Record these observations in a list.
3. Based on your evidence, what can you conclude about the two samples?

The cell is the basic unit of life.



The stentor, which is about 2 mm in length, lives in many freshwater ponds, ditches, and lakes throughout British Columbia. Take a close look at the cup-shaped head and long, narrow neck. Do you see the tiny little hairs around the top of the head? These hairs all wave together to create a small water current that pulls food into the bottom of the head where the mouth is located. The long neck can slowly move up in search of food and snap back down if danger approaches.

You might be surprised to learn that a stentor is a living thing composed of only one **cell**. All the life processes that keep the stentor alive take place inside this single cell. This is why the cell is called the basic unit of life. Scientists refer to single-celled living things as **unicellular**. An animal, such as a human, is made up of many cells and is called **multicellular**. Both unicellular and multicellular living things are called **organisms**.

FOLDABLES™
Reading & Study Skills

What You Will Learn

In this chapter, you will
- **identify** the characteristics of living and non-living things
- **demonstrate** an understanding of cells
- **explain** the processes of diffusion and osmosis

Why It Is Important

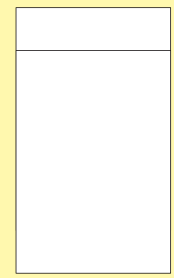
Understanding how cells function can help you understand how your body functions.

Skills You Will Use

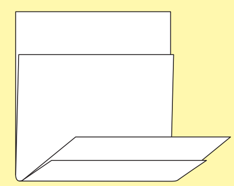
In this chapter, you will
- **observe** living things using a microscope
- **model** the structures and functions of a cell
- **work** co-operatively to design an investigation
- **communicate** your understanding of how particles move through the cell membrane

Make the following Foldable to take notes on what you will learn in Chapter 1.

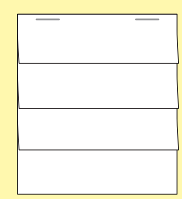
STEP 1 **Collect** 2 sheets of paper and layer them about 2.5 cm apart vertically. (Hint: from the tip of your index finger to your first knuckle is about 2.5 cm.) Keep the edges level.



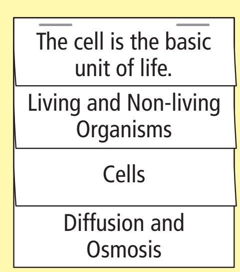
STEP 2 **Fold** up the bottom edges of the paper to form 4 tabs.



STEP 3 **Fold** the papers and crease well to hold the tabs in place. **Staple** along the fold.



STEP 4 **Label** the tabs as shown. (Note: the first tab will be larger than shown here.)



Summarize As you read the chapter, summarize what you learn under the appropriate tabs.

1.1 Observing Living Things

Living things survive in many different environments. All living things have five main characteristics that demonstrate they are alive. They respond to their environment, they need energy, they grow, they reproduce, and they get rid of wastes. Some living things are very small and can be observed only with a microscope. To study such organisms on prepared or wet mount slides, you must handle a compound light microscope carefully and learn how to operate it correctly.

Key Terms

compound light microscope
electron micrograph
magnification power
resolving power
scanning electron microscope

Living things can survive in almost any type of type of environment on Earth—from very wet and warm to very cold and dry. Scientists have discovered multicellular organisms, such as the red tube worm, in the depths of the ocean. They have also found bacteria, unicellular organisms, and tiny worms called nematodes in the ice and snow of Antarctica.

Amazing Survival Stories

All living things have special features that help them survive. For example, the feathers on a duck are oily so they do not absorb water. This waterproof coat helps keep the duck dry and warm. Other living things have more out-of-the-ordinary features that help them cope with their environments. A single honey mushroom, which lives in the Blue Mountains of eastern Oregon, is thought to be the largest living thing on Earth (see Figure 1.1). It spreads out over 890 hectares. Scientists estimate that this enormous mushroom is about 2400 years old. What makes this living thing such a survivor? It has a huge network of thread-like structures that draw water and food out of the trees it grows around.

The strongest living thing on Earth is the rhinoceros beetle (see Figure 1.2 on the next page). As beetles go, the rhinoceros beetle is pretty big, but compared to an elephant, it is tiny. However, this amazing beetle can lift 850 times its own weight. An elephant can lift only up to one quarter of its weight. Although an elephant may be able to lift a heavier object, relative to its weight the rhinoceros beetle is the lifting champion. This strength helps the beetle survive on the jungle floor. Since the jungle floor is covered with dead plants, leaves, and other debris, the beetle uses its strength to clear a path.

Figure 1.1 You will not see a giant organism if you go looking for the honey mushroom. Most of it is growing underground. In the fall, it sends up groups of mushrooms like these.

To survive on the vast, open plains of southern and eastern Africa, animals like the cheetah must be fast and alert (see Figure 1.3). The cheetah holds the speed record for land animals and has been clocked running at about 100 km/h for short periods of time. These short bursts of speed help the cheetah catch fast-moving prey like the antelope, which it depends on for food.

Regardless of where they live, all living things have needs that must be met if they are to survive in their environment.

Did You Know?

Bacteria have been found to live in water temperatures of 90°C and in water as acidic as vinegar.

Figure 1.2 To match the lifting ability of a rhinoceros beetle, a 100 kg human would have to lift 85 000 kg. That is approximately the mass of an empty space shuttle!

Figure 1.3 The cheetah can reach its top speed in just a few seconds.

1-1 What Do Living Things Need for Survival?

Find Out ACTIVITY

All living things require certain living conditions and have particular needs that must be met if they are to survive. In this activity, you will develop your own list of what living things need for survival.

What to Do

1. Work with a partner or a small group of classmates. On a piece of chart paper, brainstorm a list of what you think a living thing needs for survival.
2. When you are finished, half of your group will join half of another group to see what they have done. The remaining half will explain your work to the classmates who have joined your group.
3. Get back together in your original group. Decide if you will add, change, or remove any of the points on your chart paper.
4. Join another group. Use the ideas from both sheets of chart paper to make a new list that shows what the new group thinks a living thing needs for survival.
5. Post your list on the wall.

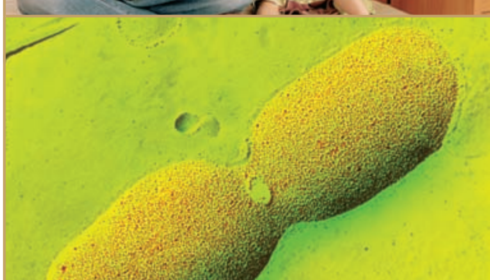
What Did You Find Out?

1. Go around to the different lists. As you are looking at your classmates' work, record your own list of what living things need for survival.
2. As a class, discuss your ideas. List which ideas your class believes all living things need to survive in their environment.

Characteristics of Living Things

Sometimes it is clear whether something is living or non-living. You and your friends are living; a pencil or book is non-living. What about a lighted match? The flame of the match can grow. It can produce more flames and it can move. But is it living or non-living? A living thing must have at least the five characteristics listed in Table 1.1 to be considered alive.

Table 1.1 Five Characteristics of Living Things

	**Living things respond to their environment** A cat may hiss when it feels threatened by something in its external environment. Hissing is the cat's response to a **stimulus**. A stimulus (plural: stimuli) is anything that causes a living thing to respond. Living things also respond to stimuli that occur in their internal environment. Think of the last time you were hungry or thirsty. Hunger and thirst are stimuli that cause you to respond by eating or drinking.
	**Living things need energy** Responding to the environment and carrying out activities necessary for survival require energy. You get your energy from the food you eat. Other living things have different ways of getting energy. Plants, for example, combine carbon dioxide, water, and sunlight to produce sugar or food.
	**Living things grow** As you continue to grow as a teenager, you get taller and your clothes probably do not fit for long. Your growth is the result of the cells in your body increasing in number. Even when you stop growing, your body will continue to replace cells as they wear out and die.
	**Living things reproduce** Reproduction provides a way for living things to replace older individuals that die. Some living things, such as bacteria, reproduce every 20 minutes. Some types of salmon will spend about four years in the ocean before returning to the freshwater stream where they hatched. Once they have returned, they will lay eggs and die.
	**Living things must get rid of wastes** Animals produce wastes such as carbon dioxide, urine, and feces. To survive, they must have ways of getting rid of these wastes. For example, when a whale uses the food it eats to make energy, carbon dioxide gas is produced. Exhaling is the way the whale's body gets rid of this waste gas.

Examining Very Small Living Things

When you look around your environment, how many living things do you see? It might surprise you to know that there are many more living things that you cannot see with the unaided eye than ones you can. Figure 1.4 is an example of tiny organisms you can see only with a microscope.

One tool that scientists use to see very small unicellular and multicellular living things is the microscope. There are many different types of microscopes, some of which you may already know about. For example, a magnifying lens is a simple microscope you may have used to look at a leaf or an ant. A compound light microscope is one that you will use in this unit to investigate living things. Electron microscopes are more powerful microscopes that scientists use for scientific research. They can be used to make images called **electron micrographs**. Scientists used a **scanning electron microscope**, or SEM, to study the bacteria they found in Pavilion Lake (see page 4). The SEM allowed them to see a great deal of detail on the surface of the tiny organisms. All of these microscopes help us learn more about small living things.

Figure 1.4 Daphnia, or water fleas, are microscopic organisms that live in lakes and ponds throughout the world.

Reading Check

1. What is the difference between unicellular and multicellular living things?
2. Define stimulus and provide an example.
3. Where do animals get their energy?
4. What are three wastes produced by animals?
5. Describe the five characteristics of living things.

Early Microscopes

Early microscopes were built in the late 1600s and early 1700s. These microscopes were more like magnifying glasses, but they were an important first step in the development of better instruments. Anton van Leeuwenhoek was one of the first people to build a microscope. Leeuwenhoek was very good at making optical lenses. He used this skill to make a microscope (see Figure 1.5) that could magnify about 250 times (250×). With it, he peered into a drop of pond water to observe microscopic living things. After this first look into the microscopic world, Leeuwenhoek is said to have exclaimed, “No more pleasant sight has met my eye than this of so many thousands of living creatures in one small drop of water...”

Observing new living things when looking through a microscope is one of science’s most exciting and rewarding experiences. The next time you look through a microscope at living things, you may be the first person to see a new organism.

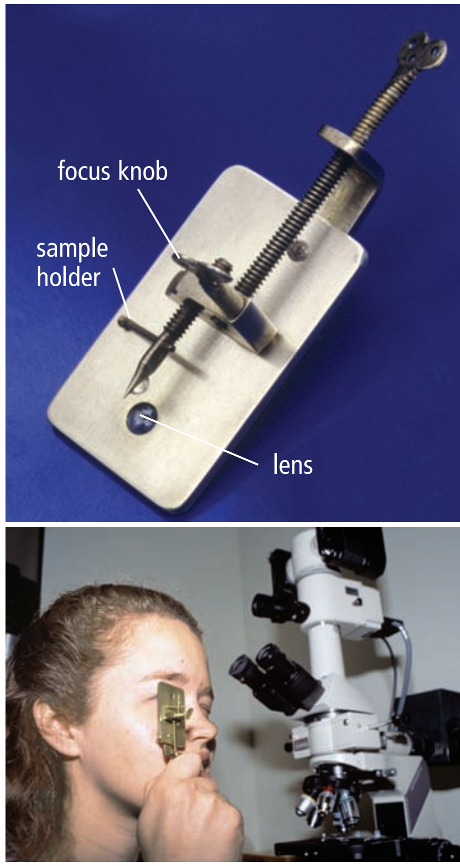


Figure 1.5 One of Leeuwenhoek’s microscopes (above) and how it is held (below)

The Compound Light Microscope

Figure 1.6 shows a **compound light microscope**. This is the microscope usually used in science classes and medical laboratories. Table 1.2 lists the parts of the compound microscope and their functions. Figure 1.7 shows the correct way to carry it.

Figure 1.6 A compound light microscope

Figure 1.7 Always carry a microscope with one hand on the arm and one hand on the base.

Table 1.2 The Parts of a Compound Light Microscope

Part	Function
Eyepiece	Is used for viewing and contains a lens that magnifies.
Arm	Supports the eyepiece.
Coarse focus knob	Brings an object into focus at low or medium power.
Fine focus knob	Brings an object into focus at high power.
Objective lenses	Magnify the image. Most microscopes have three or four lenses.
Revolving nosepiece	Holds the three objective lenses.
Stage	Supports the slide. Some microscopes have stage clips to hold the slide in place.
Light source	Supplies the light needed to view the slide.
Base	Supports the entire microscope.

Connection

Section 6.2 has more information about how a compound light microscope works.

How a compound light microscope works

A compound light microscope has two sets of lenses. These lenses work together to magnify and focus an image. When you look through this microscope, you will observe an image that is magnified, inverted, and reversed (see Figure 1.8).

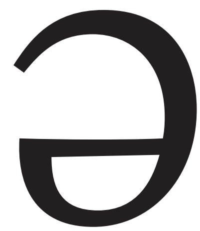


Figure 1.8 The letter "e" seen through the lens of a microscope will appear like this.

Magnification

Each of the objective lenses on a compound light microscope has a different **magnification power**. You can find the power of magnification as a number on each objective lens (see Figure 1.9). The objective lenses on most compound light microscopes used in schools today have these powers of magnification:

- low-power objective lens (4×)
- medium-power objective lens (10×)
- high-power objective lens (40×)

Usually, the lens in the eyepiece has a magnification power of 10×. To determine the total magnification of the microscope when using each objective lens, you multiply the power of the objective lens by the power of the eyepiece. For example:

$$\text{low-power objective lens} \times \text{eyepiece lens}$$
$$=$$
$$\text{total magnification of microscope}$$
$$\text{or}$$
$$4 \times 10 = 40$$

The total magnification of a medium-power lens is 100× and a high-power lens is 400×.

Suggested Activities

Find Out Activity 1-2 on page 15

Conduct an Investigation 1-3 on page 16

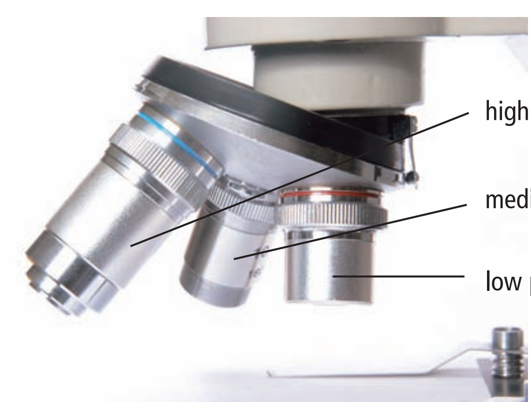


Figure 1.9 Magnification power of the three objective lenses

Look at Figure 1.10 to get a sense of what you can see when using the medium-power and high-power objective lenses.

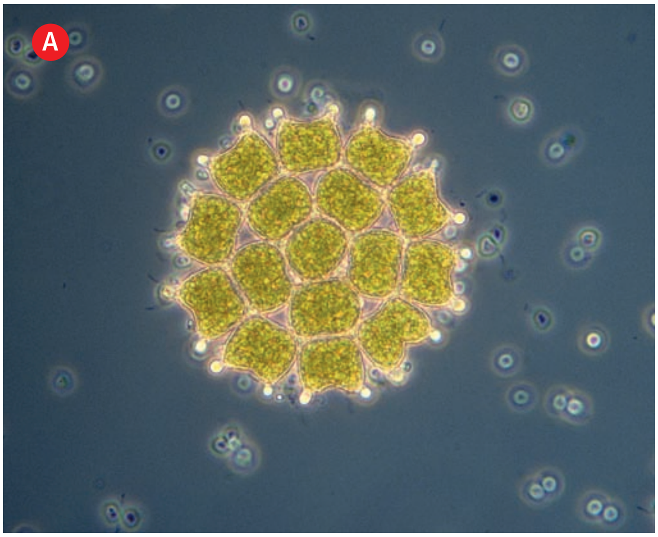


Figure 1.10A Green algae under the medium-power objective lens (total magnification of 100×)

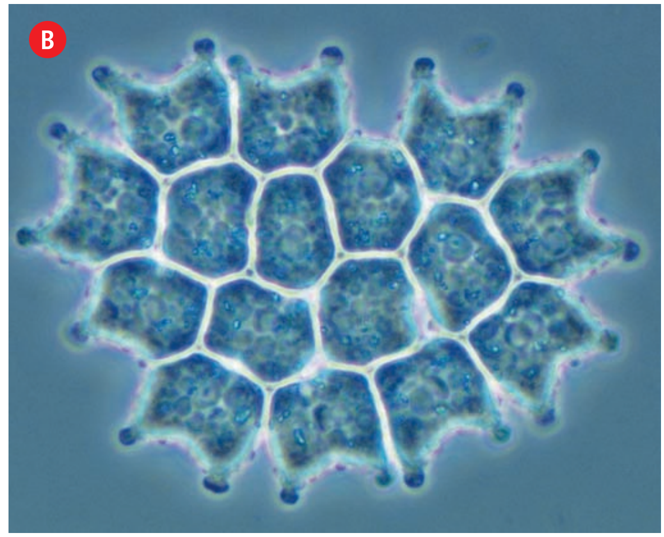


Figure 1.10B Green algae under the high-power objective lens (total magnification of 400×)

Resolving power

Look closely at the four images in Figure 1.11. All the dots in picture A are 1 mm in diameter. They are also 1 mm apart. Now look at pictures B, C, and D. Can you see the dots clearly in each picture?

Most people cannot see the dots in picture D. This is normal. Average human eyesight means people can see only dots that are separated by a distance of 0.1 mm or more. The microscope extends human vision by allowing you to view objects that are smaller and closer together. The ability to distinguish between two dots or objects that are very close together is called **resolving power**. The resolving power of a compound light microscope is about 0.2 microns (μm), which means that the microscope cannot separate two images that are less that 0.2 μm apart. A micron is a millionth of a metre. If you were to observe a living thing that was a micron in size, you could fit one million of them side by side on a metre stick.

Explore More

Microscope technology continues to improve. Using print and electronic resources find a description of the most powerful microscope in use today and research its various uses. Begin your research at **www.bcscience8.ca.**

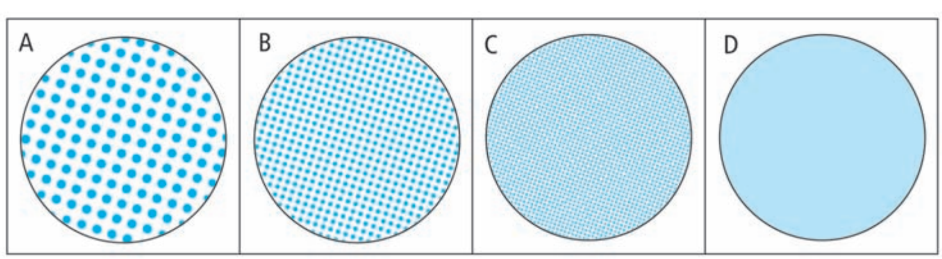


Figure 1.11 In which picture are you unable to make out individual dots?

Reading Check

1. What was the approximate magnification of Leeuwenhoek's first microscopes?
2. You are viewing a microscope slide. You move the slide to the right, but which way does it appear to move? Explain.
3. Draw how the letter "G" would appear when viewed through a compound light microscope.
4. What is the total magnification for the medium-power objective lens?
5. Define resolving power.

1-2 Observing Organisms in Pond Water

Find Out ACTIVITY

Leeuwenhoek was amazed when he first looked at a drop of pond water with his microscope. In this activity, you will use a compound light microscope to observe a variety of organisms that live in pond water. As you are looking at these organisms, try to determine how each one demonstrates the characteristics of living things. For example, observe the different ways they eat or respond to stimuli.

Materials

- microscope
- microscope slide
- cover slips
- medicine dropper
- tweezers
- pond water

Safety

- Microscopes, slides, and cover slips can break, especially when using the high-power objective lens. Handle with care.
- Be careful when using sharp objects such as tweezers.
- Wash your hands thoroughly after doing this activity.

What to Do

1. Obtain a sample of pond water from your teacher. Make a wet mount slide with this sample. (See Conduct an Investigation 1-3 on page 16.)

Science Skills

Go to Science Skill 9 for information about using microscopes and making scale drawings.

2. Examine the slide under low and medium power, looking for different organisms in the pond water.
3. Draw what you see for at least two different organisms. Include as much detail as possible.
4. For each organism, record which characteristics of living things you observe.
5. Clean up and put away the equipment you have used.

What Did You Find Out?

1. Summarize the evidence you collected that demonstrates the organisms you observed were living. Use a chart or write a paragraph to help organize your summary.

1-3 Focussing on the Microscopic World

Skill Check

- Observing
- Measuring
- Communicating
- Working co-operatively

Safety

- Microscopes, slides, and cover slips can break, especially when using the high-power objective lens. Handle with care.
- Be careful when using sharp objects such as tweezers.
- Wash your hands thoroughly after doing this investigation.

Materials

- microscope
- prepared microscope slides
- see-through plastic ruler
- lens paper
- microscope slides
- cover slips
- medicine droppers
- tweezers
- water
- live specimens

Science Skills

Go to Science Skill 9 for more information about using microscopes and making scale drawings.

Using a microscope can open up an exciting new world of discovery. You can see things with it that you may not have thought possible. In this activity, you will practise using a compound light microscope carefully and accurately. You will also examine some living and non-living things and learn how to prepare your own slides.

Procedure

Part 1 Focus the Image

1. Pick up your microscope and bring it back to your work table. Check that it is set to the low-power objective lens.
2. Select a prepared slide from the ones provided by your teacher. Place the slide on the stage of the microscope. If your microscope has stage clips, use them to hold your slide in place.
3. Turn the coarse focus knob carefully to bring your image into focus. Draw and label what you observe.
4. Move your slide to the right. Which way does the image move?
5. Move your slide up. Which way does the image move?
6. Change the lens to medium power and focus the image. You may need to turn the fine focus knob to make minor adjustments so that you can bring the image into focus. Draw and label what you observe.
7. **Optional:** Check with your teacher before you do this step. Change the lens to high power and focus the image. Use only the fine focus knob for making any adjustments to make the image clear. Draw and label what you observe.

Part 2 Determine the Field of View

8. Place a see-through ruler on the stage and focus on the ruler at low power.
9. Record the length of the ruler you can see at low power. This is called the **field of view**.
10. Repeat Procedure step 2 at medium power and at high power if your teacher approves.
11. You can use the field of view to determine the approximate size of an object you are viewing. For example, the field of view at low power is usually 4.2 mm. If an object takes up half the field of view at low power, this would mean that its approximate size would be 2.1 mm. Or stated mathematically:

$$\text{approximate size} = \text{field of view} \times \text{fraction of field taken up}$$

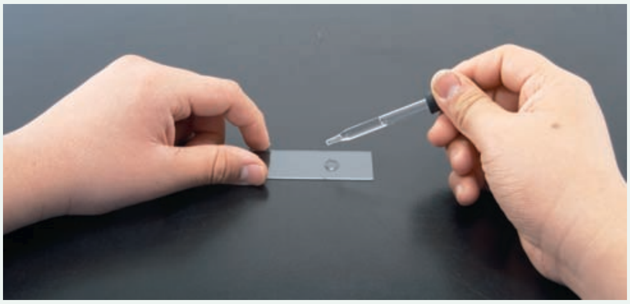
or

$$2.1 \text{ mm} = 4.2 \text{ mm} \times 0.5$$

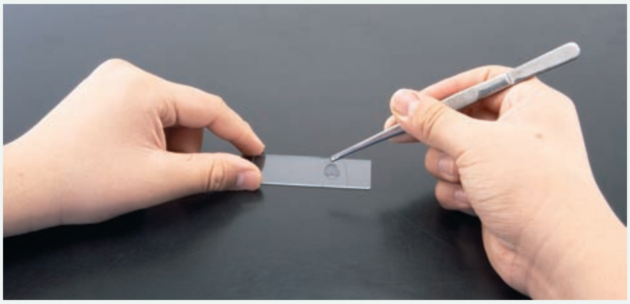
12. Select another prepared slide and determine the approximate size of an object at both low and medium power. Record your answers.

Part 3 Make a Wet Mount Slide

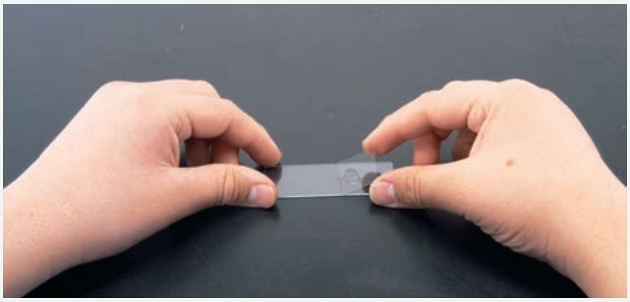
13. You can make your own slide rather than use a prepared one. This type of slide is called a **wet mount slide**. To prepare a wet mount slide, follow the instructions below. (Make sure your slide is clean before you begin. If it is not, use lens paper to wipe it off.)



Place a drop of water on the slide.



Use tweezers to place your specimen in the drop of water.



Hold the cover slip at a 45° angle and gently lower it onto the slide. There should be no air bubbles under the cover slip. If there is any excess water on the slide, dab a piece of tissue paper on the slide.

14. Prepare a wet mount slide of a strand of hair. Place the slide on the stage of the microscope. Observe and draw the hair at two different powers. Label your drawings.
15. Your teacher will provide you with a live specimen to observe. Prepare a wet mount slide. After placing the slide on the stage, determine which power would be best for observing it. Make your observations, then draw the specimen and label your drawing.
16. When you have completed Procedure steps 13–15, make sure your microscope is set at low power.
17. Clean up and put away the equipment you have used.

Analyze

1. Compare the drawings you made in this activity. Describe how your images changed when you increased the power of magnification. For example, did you see more or less of an image, or was it easier or harder to focus on the whole image?
2. Making clear, well-labelled drawings is an important skill when using a microscope. What are three things a drawing should have to ensure it is done properly?
3. A small, multicellular organism takes up a quarter of the field of view under a compound light microscope at medium power. What is the approximate size of this organism? Show your calculations.
4. You are looking at an image at low power. You see a round object in the top left corner of the image that you would like to see more clearly. You switch to medium power. List the steps you would have to take to get the round object in the middle of your view.

Conclude and Apply

1. A classmate has missed this lab activity and has asked you to help him learn how to use a microscope properly. Write a step-by-step set of directions. Include labelled diagrams where needed.

NATIONAL GEOGRAPHIC

VISUALIZING MICROSCOPES

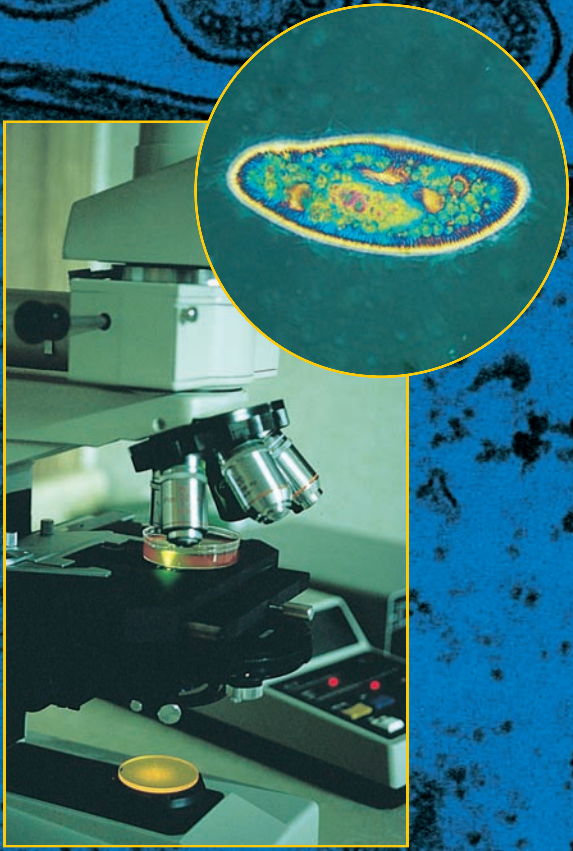
Microscopes give us a glimpse into a previously invisible world. Improvements have vastly increased their range of visibility, allowing researchers to study life at the molecular level. A selection of these powerful tools—and their magnification power—is shown here.

Up to 250× **LEEUWENHOEK MICROSCOPE** Held by a modern researcher, this historic microscope allowed Leeuwenhoek to see clear images of tiny freshwater organisms that he called "beasties."

Up to 2000× **BRIGHTFIELD / DARKFIELD MICROSCOPE** The light microscope is often called the brightfield microscope because the image is viewed against a bright background. A brightfield microscope is the tool most often used in laboratories to study cells. Placing a thin metal disc beneath the stage, between the light source and the objective lenses, converts a brightfield microscope to a darkfield microscope. The image seen using a darkfield microscope is bright against a dark background. This makes details more visible than with a brightfield microscope. Below are images of a paramecium as seen using both processes.

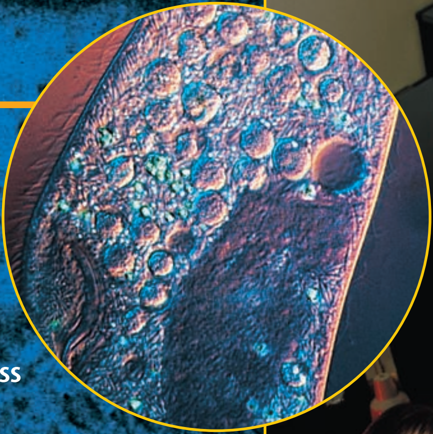
darkfield

brightfield

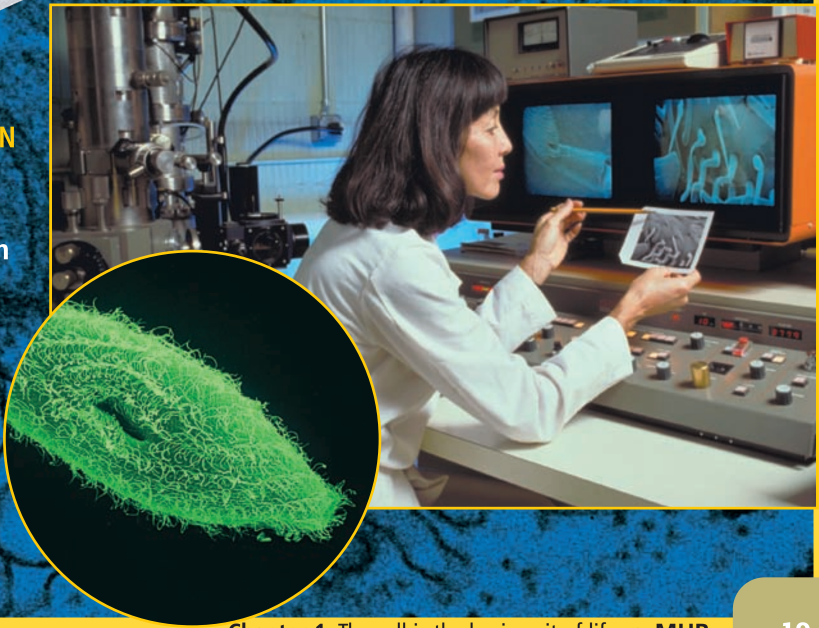


Up to 1500× **FLUORESCENCE MICROSCOPE** This type of microscope requires that the specimen be treated with special fluorescent stains. When viewed through this microscope, certain cell structures or types of substances glow, as seen in the image of a paramecium above.

Up to 1 000 000× **TRANSMISSION ELECTRON MICROSCOPE** A TEM aims a beam of electrons through a specimen. Denser portions of the specimen allow fewer electrons to pass through and appear darker in the image. Organisms, such as the paramecium at right, can only be seen when the image is photographed or shown on a monitor. A TEM can magnify hundreds of thousands of times.



Up to 1500× **PHASE-CONTRAST MICROSCOPE** A phase-contrast microscope emphasizes slight differences in a specimen's capacity to bend light waves, thereby enhancing light and dark regions without the use of stains. This type of microscope is especially good for viewing living cells, like the paramecium above left. The images from a phase-contrast microscope can only be seen when the specimen is photographed or shown on a monitor.



Up to 200 000× **SCANNING ELECTRON MICROSCOPE** An SEM sweeps a beam of electrons over a specimen's surface, causing other electrons to be emitted from the specimen. SEMs produce realistic, three-dimensional images, which can only be viewed as photographs or on a monitor, as in the image of the paramecium at right. Here a researcher compares an SEM picture to a computer monitor showing an enhanced image.

Science Math connect

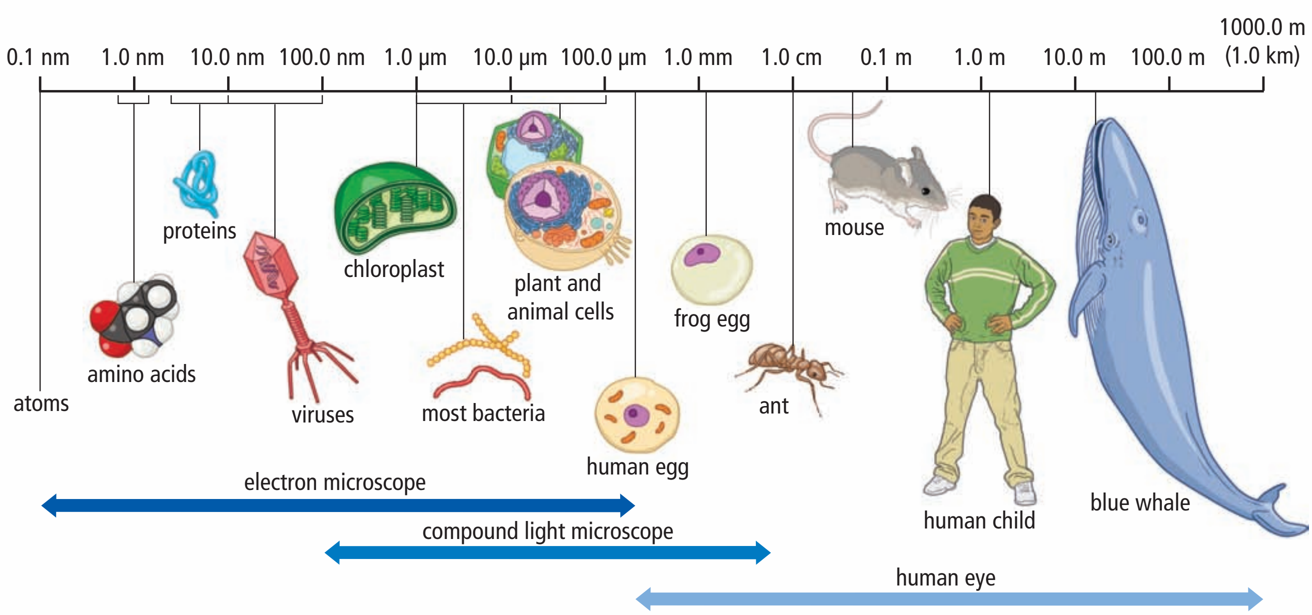
Nano, Micro, Milli

The table below summarizes some of the units of measurement you will use in this textbook and future science courses. The table includes the prefix (with its definition), the symbol, and the mathematical measurement. You can use a prefix to describe a unit of measurement. For example, you have probably seen highway signs that state the speed limit as 80 km/h. The km refers to kilometres. Since the prefix "kilo" means one thousand, you can figure out from the prefix and the unit that a kilometre is 1000 metres.

Prefix	Symbol	Mathematical Measurement
nano (Greek for dwarf)	*n*	10^{-9} (billionth)
micro (Greek for small)	*μ*	10^{-6} (millionth)
milli (Latin for thousand)	*m*	10^{-3} (thousandth)
kilo (Greek for thousand)	*k*	10^{3} (thousand)
mega (Greek for big)	M	10^{6} (million)

Questions

1. If the thickness of one sheet of paper in this textbook is 0.2 mm, how high would a pile of paper be for:
   (a) 1000 sheets (thousand)
   (b) 100 000 sheets (hundred thousand)
   (c) 1 000 000 sheets (million)
   (d) 1 000 000 000 sheets (billion)
2. For each calculation, convert your answer into another unit. For example, 100 m could be written as 0.1 km or 10 000 cm.

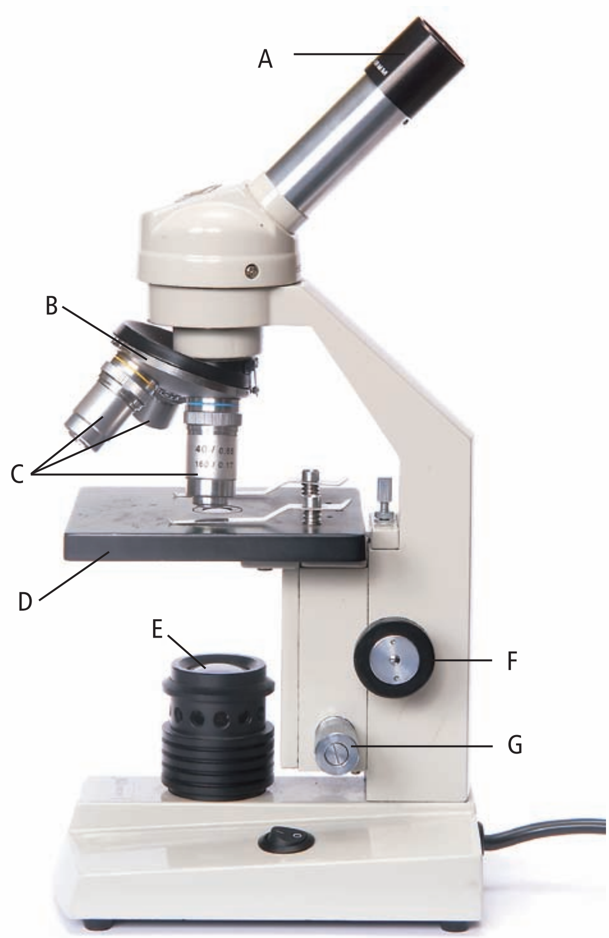


The scale in this diagram increases by a factor, or power, of 10. Using this type of scale makes it mathematically easier to work with very small and very large numbers.

Check Your Understanding

Checking Concepts

1. List the five characteristics of living things. Provide an example for each characteristic.
2. Non-living things sometimes seem to have one or more characteristics of living things, but they can never have all the characteristics of living things. Which characteristic of living things does each of the following non-living things appear to have?
   (a) portable music player
   (b) birthday candle
   (c) sprinkler
3. What is the proper way to carry a microscope?
4. Name each part identified with a letter in the photograph of the compound light microscope below.



5. Why do you start with the low-power objective lens when focussing an image?
6. Explain the steps you must follow to make a wet mount slide.
7. If an objective lens of a compound light microscope has a magnification power of 40×, why is the image magnified 400×?
8. A tiny unicellular living thing from a local pond takes up a quarter of the field of view of a microscope on low power. What is the actual size of the living thing you are viewing?

Understanding Key Ideas

9. You are exploring a remote region in the interior of British Columbia. You unexpectedly discover what may be a new microscopic life form in a sample of pond water. How could you determine if this sample is living or non-living?
10. You observe several bald eagles at a stream eating salmon that have died after spawning. How do the eagles demonstrate the characteristics of living things? Do the eagles show all the characteristics of living things discussed in this chapter? If they do not, can you still say they are alive? Explain your answer.
11. You find a cracked microscope slide on the stage of a microscope. The objective lens is on high power. Describe a possible reason why the slide is broken.

Pause and Reflect

Think back to the characteristics of living things and the various environments they live in. Are there other characteristics of living things you could add to the five listed in Table 1.1 on page 10?