Lesson 3

Exploring Life

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- How did microscopes change our ideas about living things?
- What are the types of microscopes, and how do they compare?

Vocabulary

light microscope
compound microscope
electron microscope

Multilingual eGlossary

inquiry Giant Insect?

Although this might look like a giant insect, it is a photo of a small tick taken with a high-powered microscope. This type of microscope can enlarge an image of an object up to 200,000 times. How can seeing an enlarged image of a living thing help you understand life?

Launch Lab

15 minutes

Can a water drop make objects appear bigger or smaller?

For centuries, people have been looking for ways to see objects in greater detail. How can something as simple as a drop of water make this possible?

1. Read and complete a lab safety form.
2. Lay a sheet of **newspaper** on your desk. Examine a line of text, noting the size and shape of each letter. Record your observations in your Science Journal.
3. Add a large drop of **water** to the center of a piece of **clear plastic.** Hold the plastic about 2 cm above the same line of text.
4. Look through the water at the line of text you viewed in step 2. Record your observations.

Think About This

1. Describe how the newsprint appeared through the drop of water.
2. **Key Concept** How might microscopes change your ideas about living things?

The Development of Microscopes

Have you ever used a magnifying lens to see details of an object? If so, then you have used a tool similar to the first microscope. The invention of microscopes enabled people to see details of living things that they could not see with the unaided eye. The microscope also enabled people to make many discoveries about living things.

In the late 1600s the Dutch merchant Anton van Leeuwenhoek (LAY vun hook) made one of the first microscopes. His microscope, similar to the one shown in **Figure 11,** had one lens and could magnify an image about 270 times its original size. Another inventor of microscopes was Robert Hooke. In the early 1700s Hooke made one of the most significant discoveries using a microscope. He observed and named cells. Before microscopes, people did not know that living things are made of cells.

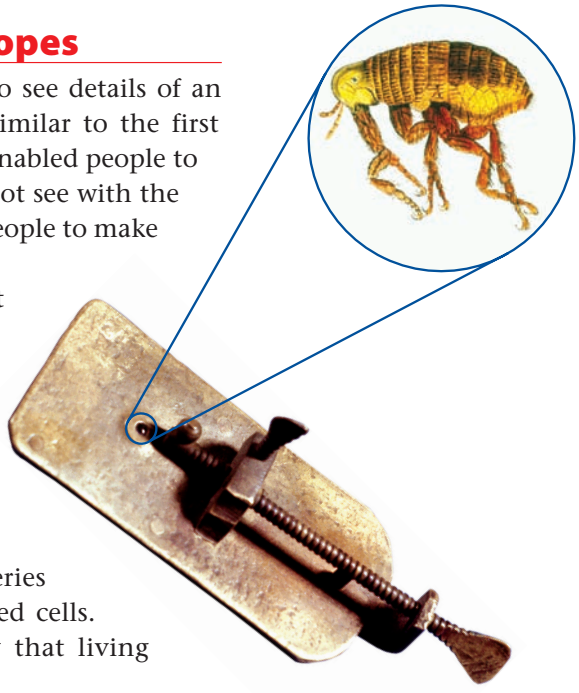


Figure 11 Anton van Leeuwenhoek observed pond water and insects using a microscope like the one shown above.

Key Concept Check How did microscopes change our ideas about living things?

Math Skills

Use Multiplication

The magnifying power of a lens is expressed by a number and a multiplication symbol (×). For example, a lens that makes an object look ten times larger has a power of 10×. To determine a microscope's magnification, multiply the power of the ocular lens by the power of the objective lens. A microscope with a 10× ocular lens and a 10× objective lens magnifies an object 10 × 10, or 100 times.

Practice

What is the magnification of a compound microscope with a 10× ocular lens and a 4× objective lens?

Review

- Math Practice
- Personal Tutor

Types of Microscopes

One characteristic of all microscopes is that they magnify objects. Magnification makes an object appear larger than it really is. Another characteristic of microscopes is resolution—how clearly the magnified object can be seen. The two main types of microscopes—light microscopes and electron microscopes—differ in magnification and resolution.

Light Microscopes

If you have used a microscope in school, then you have probably used a light microscope. **Light microscopes** *use light and lenses to enlarge an image of an object.* A simple light microscope has only one lens. *A light microscope that uses more than one lens to magnify an object is called a* **compound microscope.** A compound microscope magnifies an image first by one lens, called the objective lens. The image is then further magnified by another lens, called the ocular lens. The total magnification of the image is equal to the magnifications of the ocular lens and the objective lens multiplied together.

Light microscopes can enlarge images up to 1,500 times their original size. The resolution of a light microscope is about 0.2 micrometers (µm), or two-millionths of a meter. A resolution of 0.2 µm means you can clearly see points on an object that are at least 0.2 µm apart.

Light microscopes can be used to view living or nonliving objects. In some light microscopes, an object is placed directly under the microscope. For other light microscopes, an object must be mounted on a slide. In some cases, the object, such as the white blood cells in **Figure 12,** must be stained with a dye in order to see any details.

Reading Check What are some ways an object can be examined under a light microscope?

Compound Light Microscope

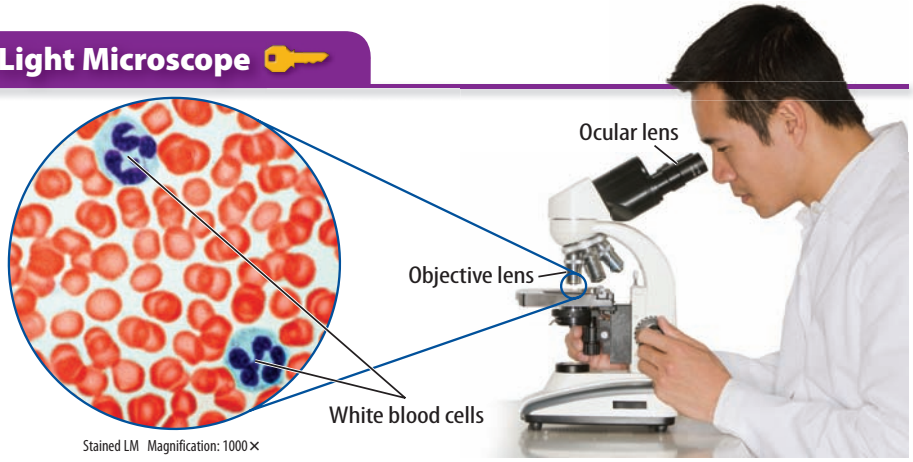


Figure 12 This is an image of a white blood cell as seen through a compound light microscope. The image has been magnified 1,000 times its original size.

Electron Microscopes

You might know that electrons are tiny particles inside **atoms.** **Electron microscopes** *use a magnetic field to focus a beam of electrons through an object or onto an object's surface.* An electron microscope can magnify an image up to 100,000 times or more. The resolution of an electron microscope can be as small as 0.2 nanometers (nm), or two-billionths of a meter. This resolution is up to 1,000 times greater than a light microscope. The two main types of electron microscopes are transmission electron microscopes (TEMs) and scanning electron microscopes (SEMs).

TEMs are usually used to study extremely small things such as cell structures. Because objects must be mounted in plastic and then very thinly sliced, only dead organisms can be viewed with a TEM. In a TEM, electrons pass through the object and a computer produces an image of the object. A TEM image of a white blood cell is shown in **Figure 13.**

SEMs are usually used to study an object's surface. In an SEM, electrons bounce off the object and a computer produces a three-dimensional image of the object. An image of a white blood cell from an SEM is shown in **Figure 13.** Note the difference in detail in this image compared to the image in **Figure 12** of a white blood cell from a light microscope.

Key Concept Check What are the types of microscopes, and how do they compare?

Review Vocabulary

atom
the building block of matter that is composed of protons, neutrons, and electrons

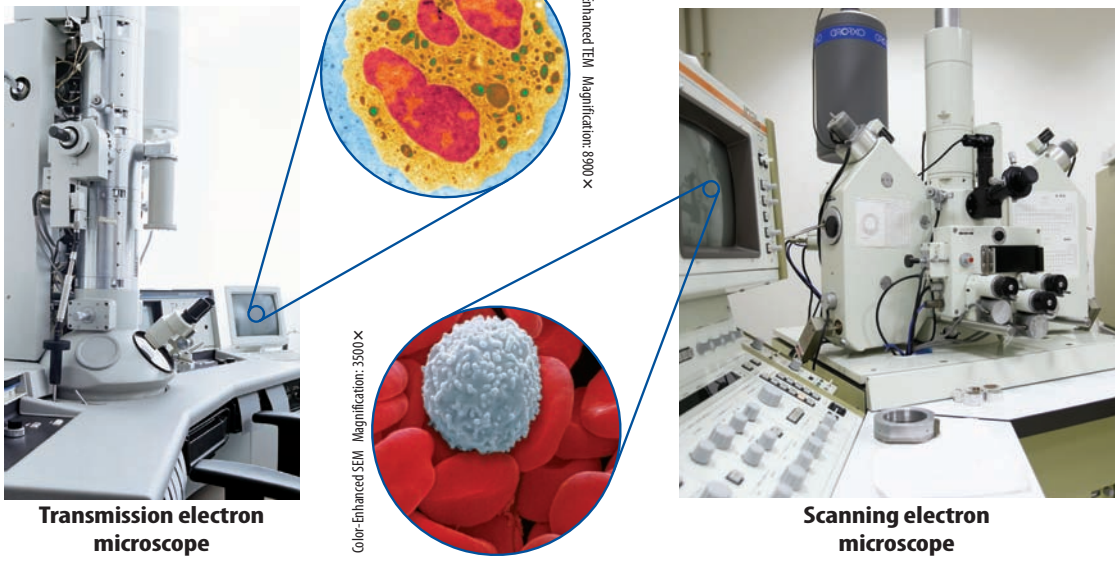
FOLDABLES®

Make a two-column folded chart. Label the front *Types of Microscopes,* and label the inside as shown. Use it to organize your notes about microscopes.

Figure 13 A TEM greatly magnifies thin slices of an object. An SEM is used to view a three-dimensional image of an object.

Electron Microscopes

Concepts in Motion Animation



Transmission electron microscope

Scanning electron microscope

Inquiry MiniLab — 20 minutes

How do microscopes help us compare living things?

A microscope enables scientists to study objects in greater detail than is possible with the unaided eye. Compare what objects look like with the unaided eye to those same objects observed using a microscope.

1. Read and complete a lab safety form.
2. Examine a **sea sponge,** a **leaf,** and **salt crystals.** Draw each object in your Science Journal.
3. Observe **microscope slides of each object** using a **microscope** on low power.
4. Draw each object as it appears under low power.

Analyze and Conclude

1. **Compare** your sketches of the objects observed with your unaided eye and observed with a microscope.
2. **Key Concept** Explain how studying an object under a microscope might help you understand it better.

Word Origin

microscope
from Latin *microscopium,* means "an instrument for viewing what is small"

Academic Vocabulary

identify
(verb) to determine the characteristics of a person or a thing

Using Microscopes

The **microscopes** used today are more advanced than the microscopes used by Leeuwenhoek and Hooke. The quality of today's light microscopes and the invention of electron microscopes have made the microscope a useful tool in many fields.

Health Care

People in health-care fields, such as doctors and laboratory technicians, often use microscopes. Microscopes are used in surgeries, such as cataract surgery and brain surgery. They enable doctors to view the surgical area in greater detail. The area being viewed under the microscope can also be displayed on a TV monitor so that other people can watch the procedure. Laboratory technicians use microscopes to analyze body fluids, such as blood and urine. They also use microscopes to determine whether tissue samples are healthy or diseased.

Other Uses

Health care is not the only field that uses microscopes. Have you ever wondered how police determine how and where a crime happened? Forensic scientists use microscopes to study evidence from crime scenes. The presence of different insects can help identify when and where a homicide happened. Microscopes might be used to **identify** the type and age of the insects.

People who study fossils might use microscopes. They might examine a fossil and other materials from where the fossil was found.

Some industries also use microscopes. The steel industry uses microscopes to examine steel for impurities. Microscopes are used to study jewels and identify stones. Stones have some markings and impurities that can be seen only by using a microscope.

Reading Check List some uses of microscopes.

Lesson 3 Review

Assessment Online Quiz

Visual Summary

Living organisms can be viewed with light microscopes.

A compound microscope is a type of light microscope that has more than one lens.

Living organisms cannot be viewed with a transmission electron microscope.

FOLDABLES®

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

What do you think NOW?

You first read the statements below at the beginning of the chapter.

5. Most cells are too small to be seen with the unaided eye.

6. Only scientists use microscopes.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. **Define** the term *light microscope* in your own words.
2. A(n) _____ focuses a beam of electrons through an object or onto an object's surface.

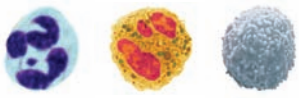
Understand Key Concepts

3. **Explain** how the discovery of microscopes has changed what we know about living things.
4. Which microscope would you use if you wanted to study the surface of an object?
   - **A.** compound microscope
   - **B.** light microscope
   - **C.** scanning electron microscope
   - **D.** transmission electron microscope

Interpret Graphics

5. **Identify** Copy and fill in the graphic organizer below to identify four uses of microscopes.

6. **Compare** the images of the white blood cells below. How do they differ?



Critical Thinking

7. **Develop** a list of guidelines for choosing a microscope to use.

Math Skills

Review Math Practice

8. A student observes a blood sample with a compound microscope that has a 10× ocular lens and a 40× objective lens. How much larger do the blood cells appear under the microscope?

inquiry **Lab** **45 minutes**

Materials

a collection of objects

Constructing a Dichotomous Key

A dichotomous key is a series of descriptions arranged in pairs. Each description leads you to the name of the object or to another set of choices until you have identified the organism. In this lab, you will create a dichotomous key to classify objects.

Question

How can you create a dichotomous key to identify objects?

Procedure

1. Read and complete a lab safety form.
2. Obtain a container of objects from your teacher.
3. Examine the objects, and then brainstorm a list of possible characteristics. You might look at each object's size, shape, color, odor, texture, or function.
4. Choose a characteristic that would separate the objects into two groups. Separate the objects based on whether or not they have this characteristic. This characteristic will be used to begin a dichotomous key, like the example below.

Dichotomous Key to Identify Office Supplies

The object is made of wood. Go to 1.	The object is not made of wood. Go to 2.
1. The object is longer than 20 cm. Go to 5.	3. The object is not longer than 20 cm. Go to 9.
2. The object is made of metal. Go to 6.	4. The object is not made of metal. Go to 10.