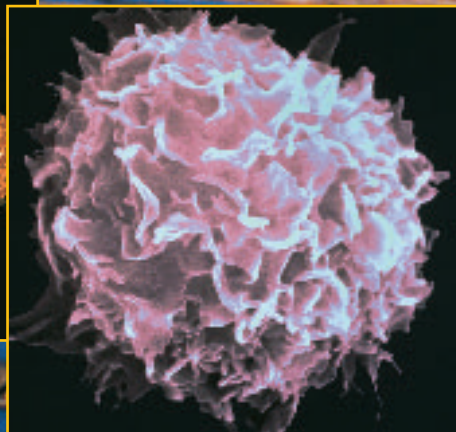
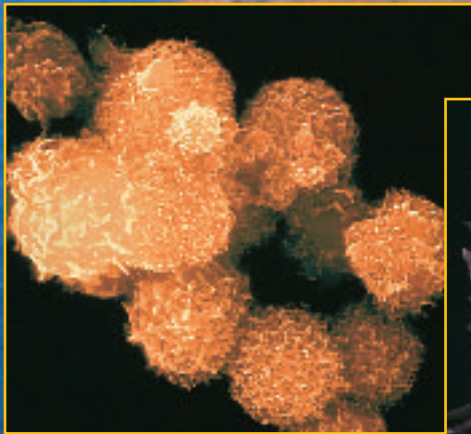


How Are Cargo Ships & Cancer Cells Connected?



Below, a present-day cargo ship glides through a harbor in New Jersey. In 1943, during World War II, another cargo ship floated in an Italian harbor. The ship carried a certain type of chemical. When a bomb struck the ship, the chemical accidentally was released. Later, when doctors examined the sailors who were exposed to the chemical, they noticed that the sailors had low numbers of white blood cells. The chemical had interfered with the genetic material in certain cells, preventing the cells from reproducing. Since cancer cells (like the ones at lower left) are cells that reproduce without control, scientists wondered whether this chemical could be used to fight cancer. A compound related to the chemical became the first drug developed to fight cancer. Since then, many other cancer-fighting drugs have been developed.

unit projects

Visit green.msscience.com/unit_project to find project ideas and resources.

Projects include:

- **History** Create a Moment in History to present the lives of the two famous scientists credited with discovering the structure of DNA.
- **Technology** Using online resources, research the adaptations of a species and design a flow chart showing four changes through time.
- **Model** Using a penny and a three-generation family tree, determine the genotype and phenotype of each generation.



New Research on Cells provides an opportunity to explore current research on cells, and how different cells work in the human body.

CONTENTS

Doug Wilson/CORBIS



Life's Structure and Classification

chapter preview

sections

- 1 Living Things
 - 2 How are living things classified?
 - 3 Cell Structure
Lab Comparing Cells
 - 4 Viruses
Lab Comparing Light Microscopes
-  **Virtual Lab** How are living things classified into groups?

Surrounded by Life!

This scientist is getting a chance to see many different living things and to study how they interact. Living things have some common characteristics. These characteristics are what scientists use to classify life. By classifying life, scientists can determine how all living things, including humans, relate to each other.

Science Journal Make a list of the living things you see in this photo.

Start-Up Activities



Classifying Life

Life scientists discover, describe, and name hundreds of organisms every year. What methods do they use to decide if an insect is more like a grasshopper or a beetle?



1. Observe an insect collection or a collection of other organisms.
2. Decide which feature could be used to separate

the organisms into two groups, then sort the organisms into the two groups.

3. Continue to make new groups using different features until each organism is in a category by itself.
4. **Think Critically** List the features you would use to classify the living thing in the photo above. How do you think scientists classify living things?

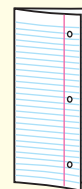


Preview this chapter's content and activities at green.msscience.com

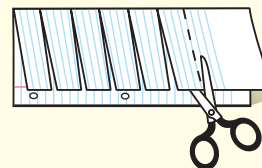
FOLDABLES™ Study Organizer

Life's Structure and Classification Make the following Foldable to help you understand the vocabulary terms in this chapter. Use this Foldable to review for the chapter test.

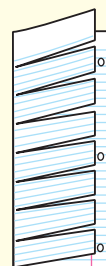
- STEP 1** Fold a sheet of notebook paper in half lengthwise.



- STEP 2** Cut along every third line of only the top layer to form tabs.



- STEP 3** Turn vertically and label each tab as described below.



Build Vocabulary As you read the chapter, list the vocabulary words about the classification and structure of life on the tabs. As you learn the definitions, write them under the tab for each vocabulary word.



Living Things

as you read

What You'll Learn

- **Distinguish** between living and nonliving things.
- **Identify** what living things need to survive.

Why It's Important

All living things, including you, have many of the same traits.



Review Vocabulary

trait: a feature of a living thing

New Vocabulary

- organism
- cell
- homeostasis

What are living things like?

What does it mean to be alive? If you walked down your street after a thunderstorm, you'd probably see birds flying and clouds moving across the sky. You'd see living and nonliving things that are alike in some ways. For example, birds and clouds move. Yet clouds are nonliving things, and birds are living things. Any living thing is called an **organism**.

Organisms vary in size—from the microscopic bacteria in mud puddles to gigantic oak trees—and are found just about everywhere. They have different behaviors and food requirements. In spite of these differences, all organisms have similar traits. These traits determine what it means to be alive.

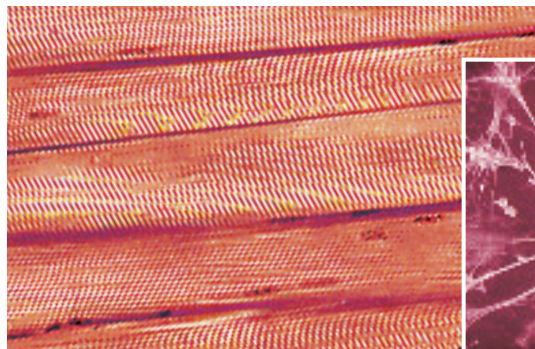
Living Things Are Organized Imagine looking at almost any part of an organism, such as a plant leaf or your skin, under a microscope. You would see that it is made up of small units called cells, such as the ones pictured in **Figure 1**. A **cell** is the smallest unit of an organism that carries on the functions of life. Cells take in materials from their surroundings and use them in complex ways. Some organisms are composed of just one cell while others are composed of many cells. Each cell has an orderly structure and contains the instructions for cellular organization and function in its hereditary material. All the things an organism can do are possible because of what their cells can do.



Reading Check

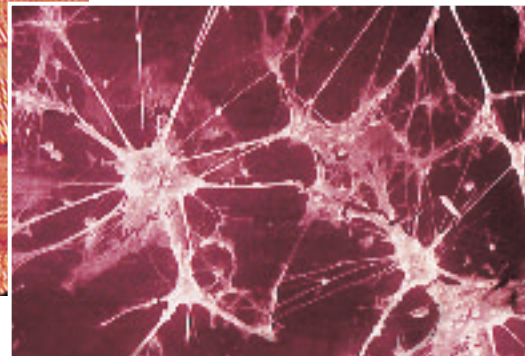
How are living things organized?

Color-enhanced LM Magnification: 106×



Muscle cells

Color-enhanced SEM Magnification: 2500×



Nerve cells

Figure 1 The human body is organized into many different types of cells. Two types are shown to the right.



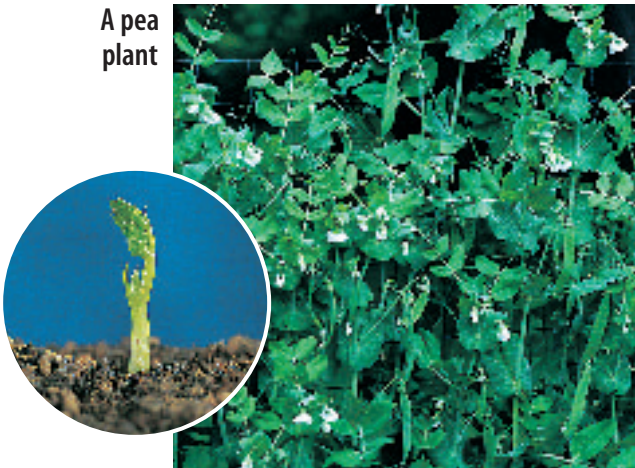
A dog



A human



A pea plant



A butterfly



Living Things Grow and Develop When a puppy is born, it might be small enough to hold in one hand. After the same dog is fully grown, you might not be able to hold it at all. How does this happen? Growth of a many-celled organism, such as a puppy, is mostly due to an increase in the number of cells. In one-celled organisms, growth is due to an increase in the size of the cell.

Organisms change as they grow. Puppies can't see or walk when they are born. In eight or nine days, their eyes open, and their legs become strong enough to hold them up. All of the changes that take place during the life of an organism are called development. **Figure 2** shows how four different organisms changed as they grew.

The length of time an organism is expected to live is its life span. Some dogs can live for 20 years. Other organisms have a short life span. For example, mayflies live only one day. Yet, others have a much longer life span. A land tortoise can live for more than 180 years, and some bristlecone pine trees have been alive for more than 4,600 years! A human's life span is about 80 years.

Figure 2 Complete development of an organism can take a few days or several years.

INTEGRATE Health

Human Stages of Development Human infants can't take care of themselves at birth. Research to find out what human infants can do at different stages of development. Make a chart that shows changes from birth to one year of age.



Topic: Homeostasis

Visit green.msscience.com for Web links to information about homeostasis.

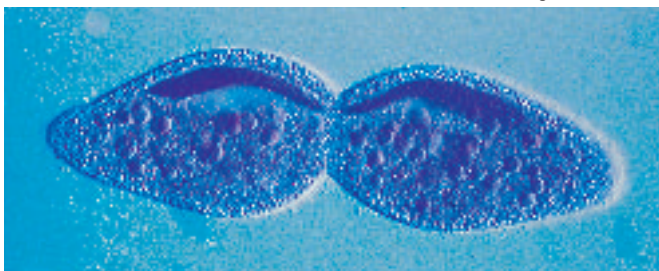
Activity Choose two living things and describe a method each uses to maintain homeostasis.

Figure 3 Living things reproduce themselves in many different ways.



Beetles, like most insects, reproduce by laying eggs.

Color-enhanced LM Magnification: 400×



Paramecium species reproduce by dividing into two.

Living Things Respond Living things must interact with their surroundings. Anything that causes some change in an organism is a stimulus (plural, *stimuli*). The reaction to a stimulus is a response. Often, that response results in movement. An organism must respond to stimuli to carry on its daily activity and to survive.

Living Things Maintain Homeostasis Living things also must respond to stimuli that occur inside them. For example, water or food levels in an organism's cells can increase or decrease. The organism then makes internal changes to maintain the right amounts of water and food in its cells. The regulation of an organism's internal, life-maintaining condition despite changes in its environment is called **homeostasis**. Homeostasis is a trait of all living things.



Reading Check

What is homeostasis?

Living Things Use Energy Staying organized and carrying on activities like finding food requires energy. The energy used by most organisms comes either directly or indirectly from the Sun. Plants and some other organisms can use the energy in sunlight, carbon dioxide, and water to make food. You and many other organisms can't use the energy in sunlight directly. Instead, you take in and use food as a source of energy. In order to release the energy in food, you and many other organisms must take in oxygen.

Some bacteria live at the bottom of the oceans and in other areas where sunlight cannot reach. They can't use the Sun's energy to produce food; instead, the bacteria use energy stored in some chemical compounds and carbon dioxide to make food. Unlike many other organisms, most of these bacteria do not need oxygen to release the energy that is found in their food.

Living Things Reproduce All living things eventually reproduce, to make more of their own kind. Some bacteria reproduce every 20 minutes, while it might take a pine tree two years to produce seeds. **Figure 3** shows some ways organisms reproduce.

Without reproduction, living things would not exist to replace those individuals that die. An individual cat can live its entire life without reproducing. However, if cats never reproduced, all cats soon would disappear.



What do living things need?

Do you have any needs that are different from those of other living things? All living things need a place to live, water, and food source to survive.

A Place to Live All organisms need a place to live that is suited to their unique needs. Could a cactus survive in Antarctica, or a penguin in the Sahara? A place to live also provides enough space for the organism. When weeds grow in a flower bed, they crowd out the flowers, taking up the space that the flowers need to grow. The flower bed is no longer a suitable place for the flower to live.

Water Water is important for all living things. All organisms take in water from their surroundings, as shown in **Figure 4**. Most organisms are composed of more than 50 percent water. You are made up of 60 to 70 percent water. Water performs many functions, such as transporting materials within a cell and between cells. Organisms also give off large amounts of water each day. Homeostasis balances the amount of water exchanged.

Food Sources Living things are made up of substances such as proteins, fats, and sugars. Animals take in these substances as part of the foods that they eat. Plants and some bacteria make their own food. When organisms die, substances in their bodies are broken down and released into the environment. The substances can then be used again by other living organisms. Some of the substances in your body might once have been part of a butterfly or an apple tree!



Figure 4 Most animals, including humans, drink water. They also take in water through the foods they eat, such as corn.

Infer how a corn plant takes in water.

section 1 review

Summary

What are living things like?

- An organism is any living thing.
- All living things are organized into cells, which are the smallest units that carry on the functions of life.
- Living things also grow and develop, respond to stimuli, maintain homeostasis, reproduce, and use energy.

What do living things need?

- All living things need a place to live, a food source, and water to survive.

Self Check

1. **Identify** the main source of energy used by most organisms.
2. **Infer** why you would expect to see cells if you looked at a section of a mushroom cap under a microscope.
3. **Think Critically** Why is homeostasis important to organisms?

Applying Skills

4. **Compare and contrast** the similarities and differences between a goldfish and the flame of a burning candle.



How are living things classified?

as you read

What You'll Learn

- **Describe** how early scientists classified living things.
- **Explain** the system of binomial nomenclature.
- **Demonstrate** how to use a dichotomous key.

Why It's Important

Knowing how living things are classified will help you understand the relationships that exist between all living things.



Review Vocabulary

hereditary: relating to the passing of traits from parent to offspring

New Vocabulary

- binomial nomenclature
- genus
- phylogeny
- kingdom

Classification

People have grouped together similar organisms, or classified them, for thousands of years. Many different systems were used until the late eighteenth century. Carolus Linnaeus, a Swedish naturalist, developed a new system of grouping organisms that was accepted and used by most scientists. His classification system was based on looking for organisms with similar structures. For example, plants that had a similar flower structure were grouped together. Linnaeus also developed a scientific naming system that still is used today.

Binomial Nomenclature The two-word naming system that Linnaeus used to name various organisms is called **binomial nomenclature** (bi NOH mee ul • NOH mun klay chur). This two-word name is an organism's species. Organisms that can mate and produce fertile offspring belong to the same species.

The first word of the two-word name identifies the genus of the organism. A **genus** is a group of similar species. For example, a salamander's genus is *Ambystoma*. The second word of the name usually describes a feature. The Eastern tiger salamander is *Ambystoma tigrinum*, shown in **Figure 5**. Latin is the language used for scientific names.

Figure 5 An eastern tiger salamander's scientific name is *Ambystoma tigrinum*.

Infer which trait is described in this animal's scientific name.





Kingdom ————— Animalia

Phylum ————— Chordata

Class ————— Mammalia

Order ————— Cetacea

Family ————— Delphinidae

Genus ————— *Tursiops*

Species — *Tursiops truncatus*

Figure 6 The classification of the bottle-nosed dolphin shows that it is in the order Cetacea. This order includes whales and porpoises.

Uses of Scientific Names Why use scientific names at all? Scientific names are used for four reasons. First, they help avoid mistakes. Often, common names for two different organisms are the same, or one organism has many different common names. Scientific names help distinguish between those organisms. Second, organisms with similar evolutionary histories are classified together. Because of this, you know that organisms in the same genus are related. Third, scientific names give descriptive information about the species, like the salamander mentioned earlier. Fourth, scientific names allow information about organisms to be organized easily and efficiently. Such information may be found in a book or a pamphlet that lists related organisms and gives their scientific names.

 **Reading Check** *What are the functions of scientific names?*

Modern Classification Like Linnaeus, modern scientists use similarities in structure to classify organisms. They also study fossils, hereditary information, and early stages of development. Scientists use all of this information to determine an organism's phylogeny. **Phylogeny** (fi LAH juh nee) is the evolutionary history of an organism, that is, how the organism has changed over time. Today, it is the basis for the classification of many organisms.

In the classification system used today, the smallest group is a species. There are broader groups preceding species, the largest of which is a **kingdom**. To understand how an organism is classified, look at the classification of the bottle-nosed dolphin in **Figure 6**. Some scientists have proposed that before organisms are grouped into kingdoms, they should be placed in larger groups called domains. One proposed system groups all organisms into three domains.



Communicating Ideas

Procedure

1. Find a **magazine picture of a piece of furniture** that can be used as a place to sit and to lie down.
2. Show the picture to ten people and ask them to tell you what word they use for this piece of furniture.
3. Keep a record of the answers in your **Science Journal**.

Analysis

1. In your Science Journal, infer how using common names can be confusing.
2. How do scientific names make communication among scientists easier?





Tools for Identifying Organisms

Scientists use field guides and dichotomous (di KAH tuh mus) keys to identify organisms. Many different field guides are available. Most have descriptions and illustrations of organisms and information about where each organism lives.

A dichotomous key is a detailed list of identifying characteristics that includes scientific names. You can use **Table 1** to find out what type of mouse is pictured to the left. Choose between the pair of descriptions at each step. What is the name of this mouse according to the key?



Table 1 Mice of North America

1. Tail hair	a. no tail hair; scales show plainly; house mouse, <i>Mus musculus</i> b. hair on tail, go to 2
2. Ear size	a. ears small and nearly hidden in fur, go to 3 b. ears large and not hidden in fur, go to 4
3. Tail length	a. less than 25 mm; woodland vole, <i>Microtus pinetorum</i> b. more than 25 mm; prairie vole, <i>Microtus ochrogaster</i>
4. Tail coloration	a. sharply dark above; deer mouse, <i>Peromyscus maniculatus</i> b. slightly dark above; white-footed mouse, <i>Peromyscus leucopus</i>

section 2 review

Summary

Classification

- Linnaeus developed the first widely accepted method of classification based on similar structures.
- Binomial nomenclature is the two-name system that scientists use today. It consists of the genus name and another identifying name.
- Scientists study fossils, hereditary information, and early stages of development to determine classification.
- Scientists use field guides and dichotomous keys to identify organisms.

Self Check

- Explain** the purpose of classification.
- Identify** what information a scientist would use to determine an organism's phylogeny.
- Think Critically** Why would a field guide have common names as well as scientific names?

Applying Skills

- Classify** Create a dichotomous key that identifies types of cars.
- Communicate** Select a field guide for trees, insects, or mammals. Select two organisms in the field guide that closely resemble each other. Use labeled diagrams to show how they are different.

Cell Structure

Viewing Cells

Four hundred years ago, scientists did not know what cells looked like, or that they even existed. That changed in the late 1500s, when the first microscope was made by a Dutch optometrist. He put two magnifying lenses together in a tube and got an image that was larger than the image that was made by either lens alone. In the mid 1600s, Antonie van Leeuwenhoek, a Dutch fabric merchant, made a simple microscope with a tiny glass bead for a lens, as shown in **Figure 7** on the next page. These microscopes eventually led to the types of microscopes that scientists use today.

Development of the Cell Theory

In the seventeenth century the microscope was improved, which led to the discovery of cells. In 1665, Robert Hooke cut a thin slice of cork and looked at it under his microscope. To Hooke, the cork seemed to be made up of empty little boxes, which he named cells.

In the 1830s, Matthias Schleiden used a microscope to study plant parts. He concluded that all plants are made of cells. Theodor Schwann, after observing many different animal cells, concluded that all animals also are made up of cells. Eventually, they combined their ideas and became convinced that all living things are made of cells.

Several years later, Rudolf Virchow hypothesized that cells divide to form new cells. Virchow proposed that every cell came from a cell that already existed. His observations and conclusions and those of others are summarized in the **cell theory**, as described in **Table 2**.

as you read

What You'll Learn

- **Describe** the development of the cell theory.
- **Identify** names and functions of each part of a cell.
- **Explain** how important a nucleus is in a cell.
- **Compare** tissues, organs, and organ systems.

Why It's Important

Humans are like other living things because we are made of cells.

Review Vocabulary

theory: an explanation of events or circumstances based on scientific knowledge resulting from repeated observations and tests

New Vocabulary

- cell theory
- cell wall
- cell membrane
- cytoplasm
- ribosome
- organelle
- nucleus
- chloroplast
- mitochondrion
- endoplasmic reticulum
- Golgi body
- tissue
- organ
- organ system

Table 2 The Cell Theory

All organisms are made up of one or more cells.	An organism can be one cell or many cells like most plants and animals.
The cell is the basic unit of organization in organisms.	Even in complex organisms, the cell is the basic unit of structure and function.
All cells come from cells.	Most cells can divide to form two new, identical cells.



Figure 7

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 2,000×** **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.



► **Up to 250×**

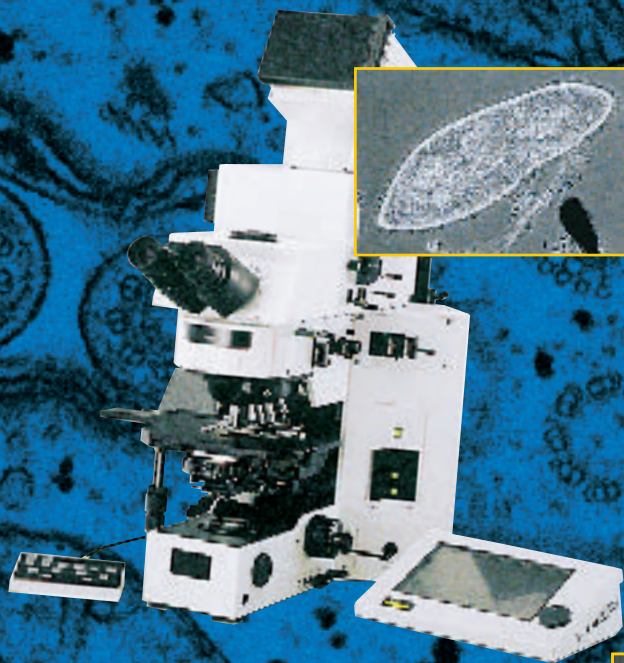
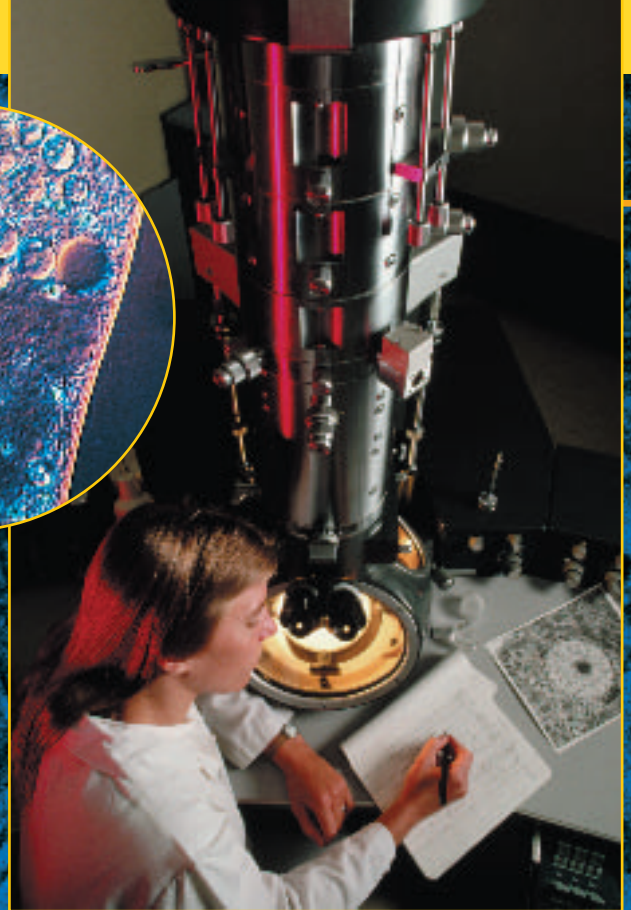
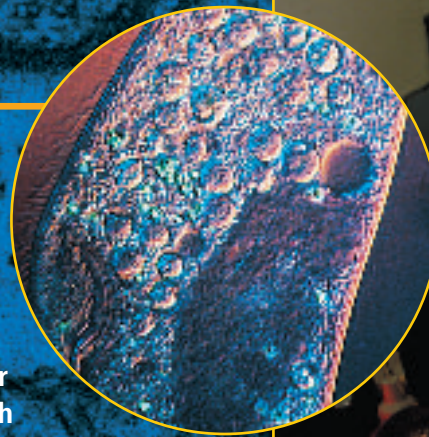
LEEUVENHOEK MICROSCOPE Held by a modern researcher, this historic microscope allowed Leeuwenhoek to see clear images of tiny freshwater organisms that he called “beasties.”



▲ **Up to 1,500×**

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 1,500×** **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.



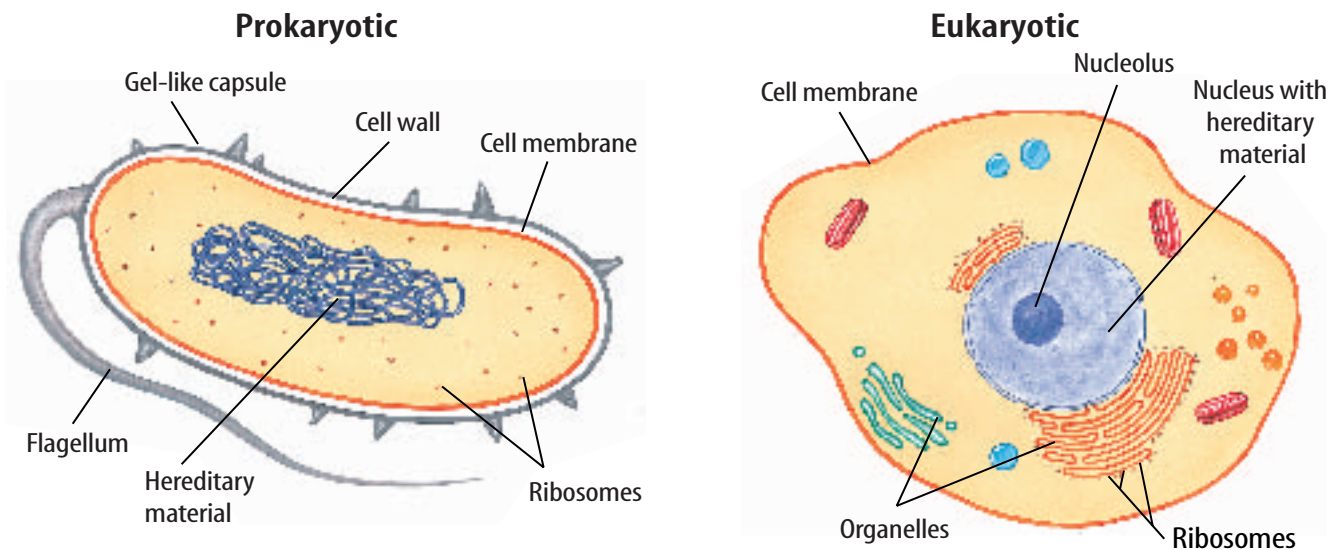


Figure 8 Examine these drawings of cells. Prokaryotic cells only are found in one-celled organisms, such as bacteria. Protists, fungi, plants and animals are made of eukaryotic cells.

Describe the differences between these cells.

Cellular Organization

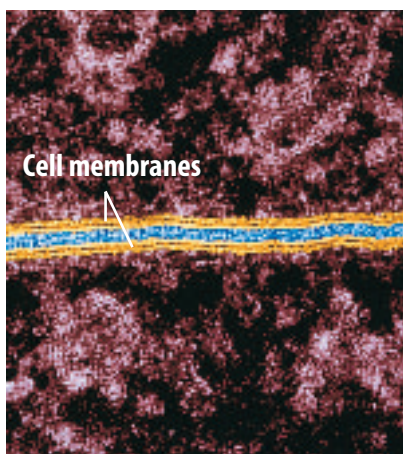
Scientists have found that cells can be separated into two groups. One group has membrane-bound structures inside the cell and the other group does not, as shown in **Figure 8**. Cells without membrane-bound structures are called prokaryotic (proh kayr ee AH tihk) cells. Cells with membrane-bound structures are called eukaryotic (yew kayr ee AH tihk) cells. Each cell performs specific functions; however, all cells must constantly take in nutrients, store, produce, and breakdown substances, and take in and use energy.

Cell Wall The cells of plants, algae, fungi, and most bacteria are enclosed in a cell wall. **Cell walls** are tough, rigid outer coverings that protect cells and give them shape.

A plant cell wall mostly is made up of a carbohydrate called cellulose. The long, threadlike fibers of cellulose form a thick mesh that allows water and dissolved materials to pass through. Plant cell walls also may contain pectin and lignin. Pectin aids in cell growth, development, defense, and strength, among other functions. It is also what makes jams and jellies have a thick texture. Lignin is a compound that makes cell walls rigid. Plant cells responsible for support have more lignin in their walls than other plant cells.

Cell Membrane The protective layer surrounding every cell is the **cell membrane**, as shown in **Figure 9**. The cell membrane is the outermost covering of a cell unless a cell wall is present. The cell membrane regulates interactions between the cell and its environment. The cell membrane allows nutrients to move into the cell, while waste products leave.

Figure 9 The cell membrane is made up of a double layer of fat-like molecules.



Color-enhanced TEM Magnification: 125,000×



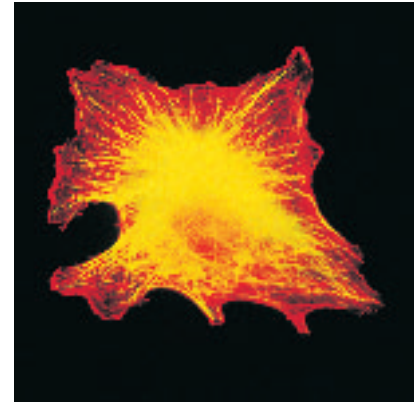
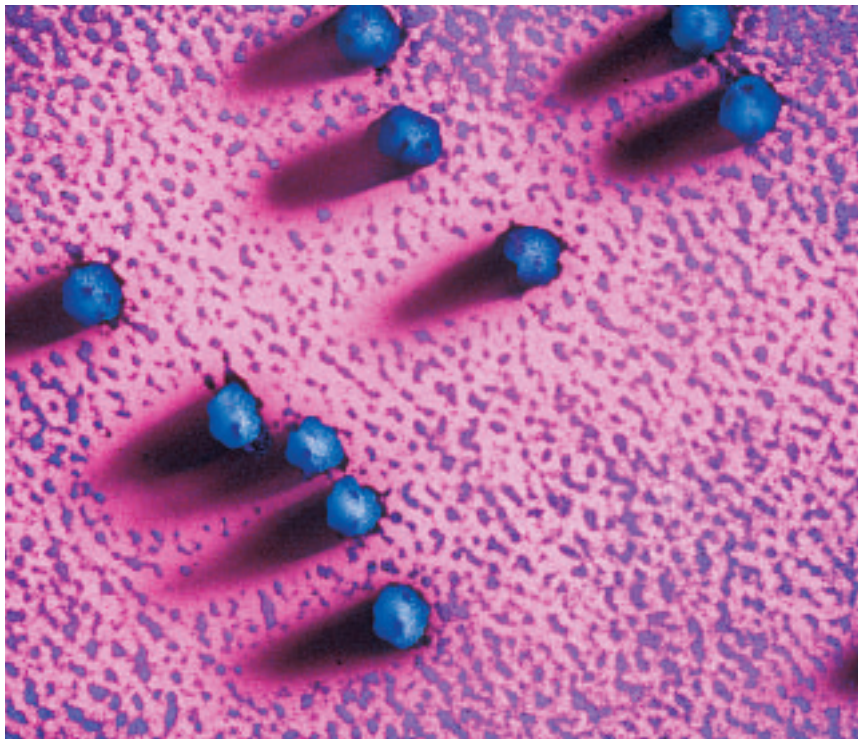
Cytoplasm Cells are filled with a gelatinlike substance called **cytoplasm** (SI toh pla zuhm) that constantly flows inside the cell membrane. Most of a cell's life processes occur in the cytoplasm. In prokaryotic cells, the hereditary material is found here. Throughout the cytoplasm is a framework called the cytoskeleton, shown in **Figure 10**, which helps the cell maintain or change its shape and enables some cells to move. The cytoskeleton is made up of thin, hollow tubes of protein and thin, solid protein fibers. Proteins are organic molecules made up of amino acids.

Reading Check

How might an amoeba move using its cytoskeleton?

Manufacturing Proteins One substance that takes part in nearly every cell activity is protein. Proteins are part of cell membranes and are needed for chemical reactions that take place in the cytoplasm. Cells make their own proteins on small structures called **ribosomes**. All ribosomes in prokaryotic cells, and some in eukaryotic cells, are made and float freely in the cytoplasm, like the ribosomes in **Figure 11**. Ribosomes receive directions from the hereditary material on how, when, and in what order to make specific proteins.

Figure 11 Some ribosomes, like these in this electron microscope image, float freely in the cytoplasm.



Stained LM Magnification: 700×

Figure 10 Cytoskeleton, a network of fibers in the cytoplasm, gives cells structure and helps them maintain shape.

Describe what the cytoskeleton is made of.

Mini LAB

Modeling Cytoplasm

Procedure

1. Add 100 mL water to a clear container.
2. Add unflavored gelatin and stir.
3. Shine a flashlight through the solution.

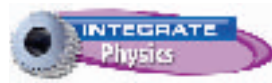
Analysis

1. Describe what you see.
2. How does a model help you understand what cytoplasm might be like?



Membrane-Bound Organelles Within the cytoplasm of eukaryotic cells are structures called **organelles**, the largest of which is usually the nucleus. Some organelles process energy and others manufacture substances needed by the cell or other cells. Certain organelles move materials, while others act as storage sites. Most organelles are surrounded by a membrane. Ribosomes are considered organelles, but are not membrane-bound.

Nucleus All cellular activities are directed by the **nucleus**. Materials enter and leave the nucleus through openings in its membrane. The nucleus contains long, threadlike, hereditary material made of DNA. DNA is the chemical that contains the code for the cell's structure and activities. A structure called a nucleolus also is found in the nucleus, and is where most ribosomes are made in a eukaryotic cell.

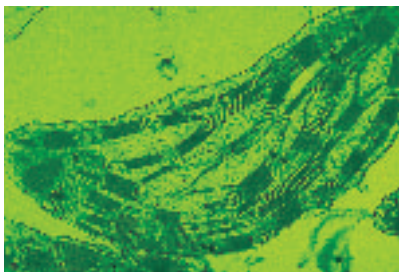


Organelles That Process Energy Cells require a continuous supply of energy to process food, make new substances, eliminate wastes, and communicate with each other. In plant cells, food is made in green organelles in the cytoplasm called **chloroplasts** (KLOR uh plasts), shown in **Figure 12**. Chloroplasts contain the green pigment chlorophyll, which gives many leaves and stems their color. Chlorophyll captures light energy that is used to make a sugar called glucose. This light energy is changed and stored in glucose as chemical energy. Many cells do not have chloroplasts for making food and must get food from their environment.

The energy in food usually is released by mitochondria. **Mitochondria** (mi tuh KAHN dree uh) (singular, *mitochondrion*), also shown in **Figure 12**, are organelles where energy is released when food is broken down into carbon dioxide and water. Some types of cells, such as muscle cells, are more active than other cells and have larger numbers of mitochondria. Both chloroplasts and mitochondria contain ribosomes and hereditary material. Both plant and animal cell structures can be found in **Figure 13**.

Figure 12 These organelles transform energy for the cell.

Compare and contrast
chloroplasts and mitochondria.



Color-enhanced TEM Magnification: 37,000×

Chloroplasts are organelles in organisms, such as plants, that use light to make sugar from carbon dioxide and water.

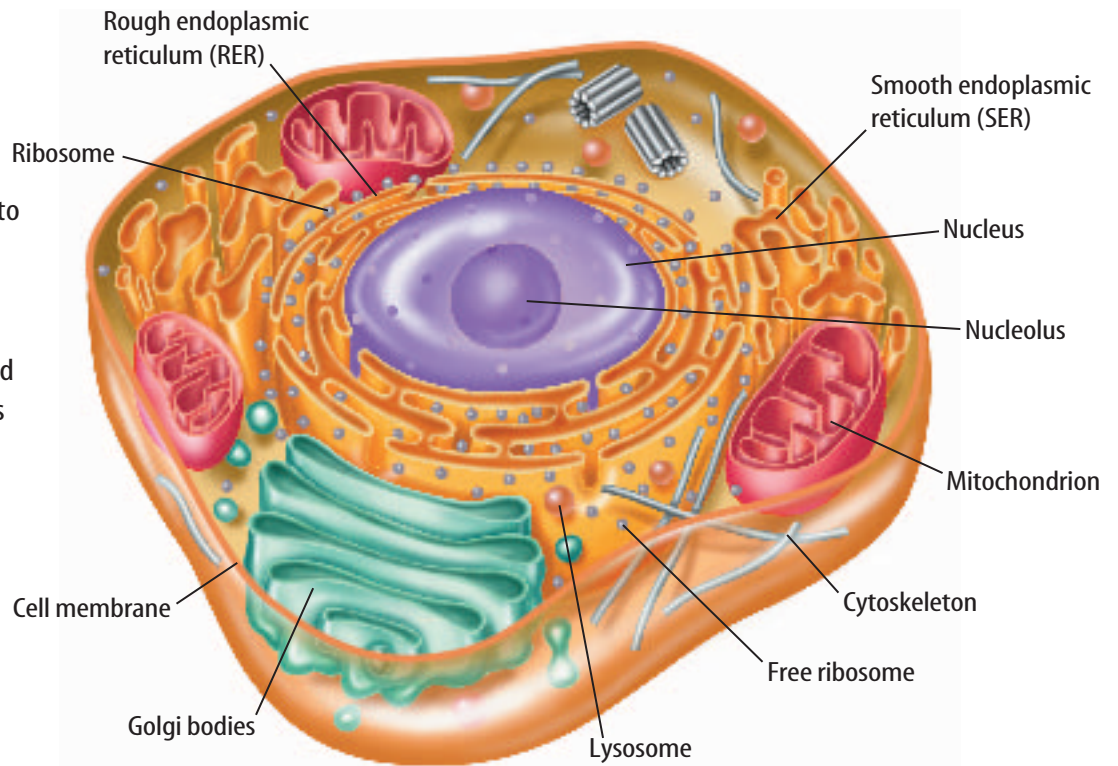


Color-enhanced SEM Magnification: 48,000×

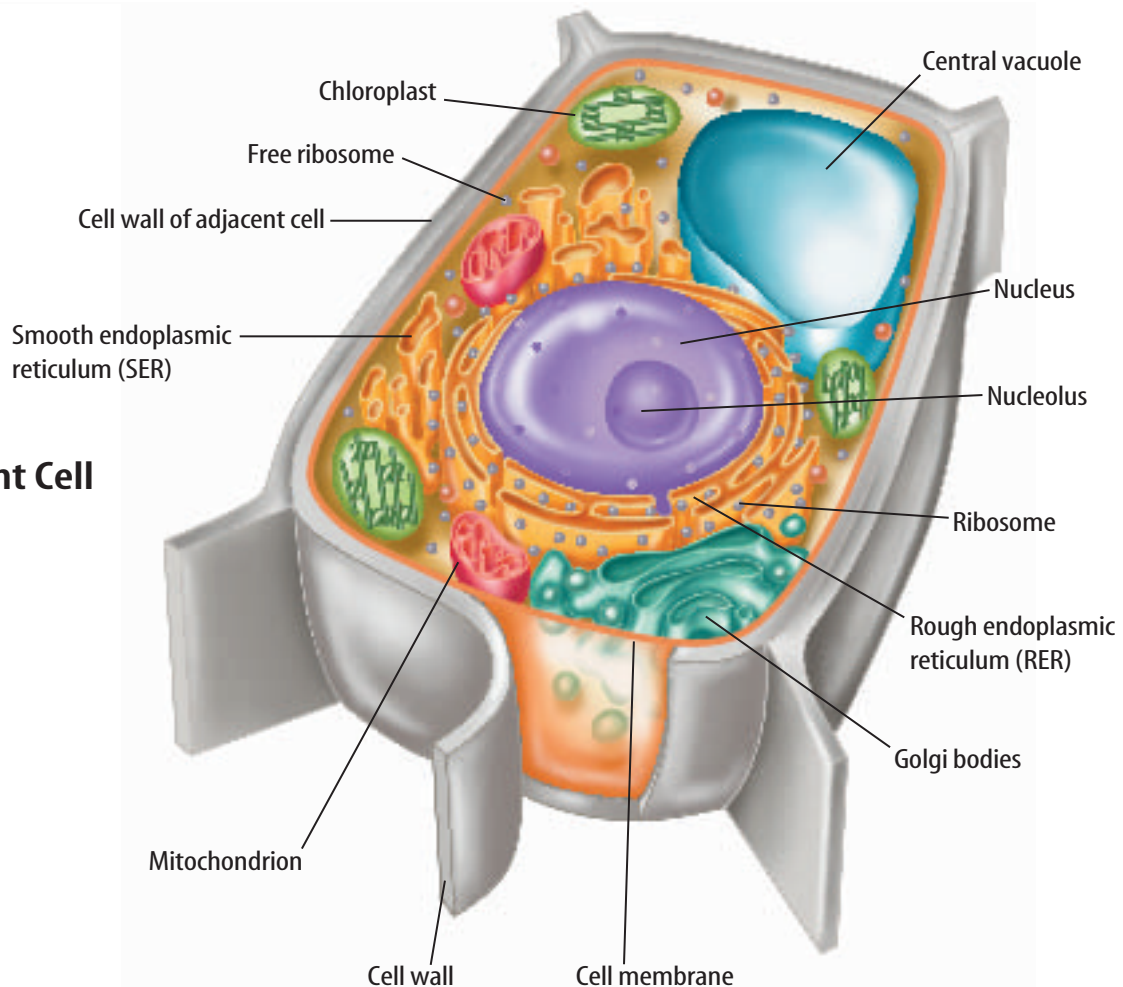
Mitochondria are known as the powerhouses of the cell because they release energy that is needed by the cell.

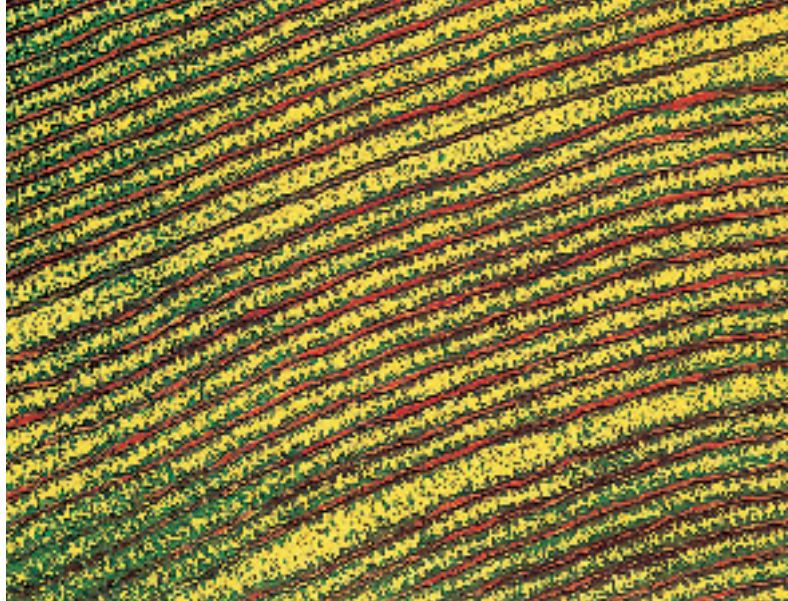
Animal Cell

Figure 13 Refer to these diagrams of a typical animal cell (top) and plant cell (bottom) as you read about cell structures and their functions.



Plant Cell





Color-enhanced TEM Magnification: 65,000×

Figure 14 Endoplasmic reticulum (ER) is a complex series of membranes in the cytoplasm of the cell.

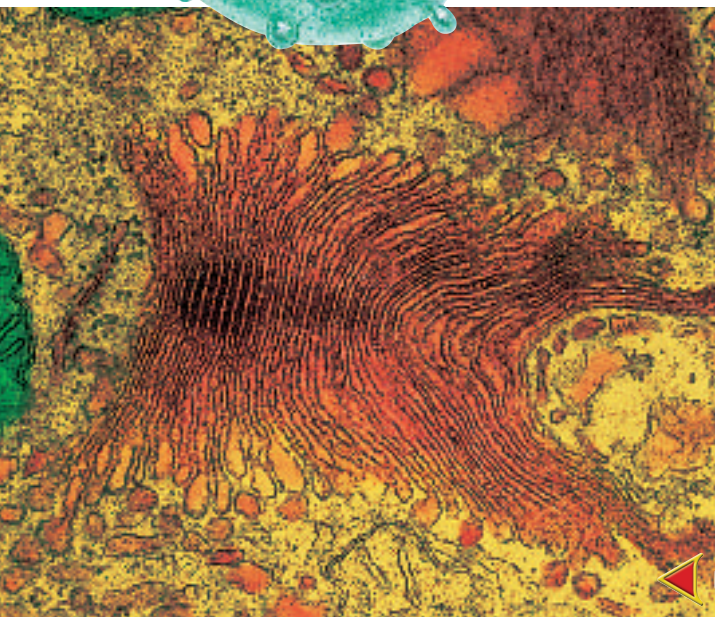
Describe smooth ER.



(t)Don Fawcett/Photo Researchers, (b)Biophoto Associates/Photo Researchers

Figure 15 Golgi bodies package materials.

Infer why some materials are removed from the cell.



Color-enhanced TEM Magnification: 28,000×

Organelles That Process, Transport, and Store

Figure 14 shows the endoplasmic reticulum (en duh PLAZ mihk • rih TIHK yuh lum), also called the ER. The **endoplasmic reticulum** is a series of folded membranes in which materials can be processed and moved around inside of the cell. It extends from the nucleus to the cell membrane and takes up a considerable amount of space in some cells.

The ER may be “rough” or “smooth.” Ribosomes are attached to areas on the rough ER. There they carry out their job of making proteins that are moved out of the cell or used within the cell. ER that does not have attached ribosomes is called smooth ER. This type of ER processes cellular substances such as lipids that store energy.



Reading Check

What is the difference between rough ER and smooth ER?

After proteins are made in a cell, they are transferred to another type of cell organelle called the Golgi (GAWL jee) bodies. The **Golgi bodies**, shown in **Figure 15**, are stacked, flattened membranes. The Golgi bodies sort proteins and other cellular substances and package them into membrane-bound structures called vesicles. The vesicles deliver cellular substances to areas inside the cell, and carry cellular substances to the cell membrane where they are released to the outside of the cell.

Cells also have membrane-bound spaces called vacuoles for the temporary storage of materials. A vacuole can store water, waste products, food, and other cellular materials. In plant cells, the vacuole may make up most of the cell's volume.



Organelles That Recycle Active cells break down and recycle substances. Organelles called lysosomes (LI suh sohms) contain digestive chemicals that help break down food molecules, cell wastes, worn-out cell parts, and viruses and bacteria that enter a cell. Chemicals can be released into vacuoles when needed to break down its contents. The lysosome's membrane prevents the digestive chemicals inside from leaking into the cytoplasm and destroying the cell.

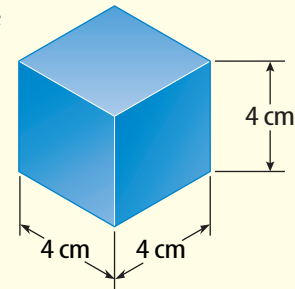
When a cell dies, the lysosome's membrane disintegrates, releasing digestive chemicals that allow the quick breakdown of the cell's contents. This is what happens when a frog tadpole becomes an adult. The lysosomes digest the cells in the tadpole's tail. These cellular molecules then are used to make other cells, such as those in the legs of the frog.



Recycle Just like a cell, you can recycle materials. Paper, plastic, aluminum, and glass can be recycled into usable items. Many other countries require recycling because of a lack of space for landfills. Research recycling in other countries and make a bar graph that compares recycling rates in other countries to the rate in the United States.

Applying Math Find a Ratio

CELL SURFACE AREA AND VOLUME You can find the surface area and volume of a cell in the same way you find the surface area and volume of a cube, if you assume that a cell is like a cube with six equal sides. Find the ratio of surface area to volume for a cell that is 4 cm high.



Solution

- 1 *This is what you know:* A cell has six equal sides of $4\text{ cm} \times 4\text{ cm}$
- 2 *This is what you want to find out:* What is the ratio (R) of surface area to volume for each cell?
- 3 *This is the procedure you need to use:*
 - Use the following equations:
 $\text{surface area (A)} = \text{width} \times \text{length} \times 6$
 $\text{volume (V)} = \text{length} \times \text{width} \times \text{height}$
 $R = A/V$
 - Substitute in known values and solve.
 $A = 4\text{ cm} \times 4\text{ cm} \times 6 = 96\text{ cm}^2$
 $V = 4\text{ cm} \times 4\text{ cm} \times 4\text{ cm} = 64\text{ cm}^3$
 $R = 96\text{ cm}^2/64\text{ cm}^3 = 1.5\text{ cm}^2/\text{cm}^3$
- 4 *Check your answer:* Multiply $1.5\text{ cm}^2/\text{cm}^3 \times 64\text{ cm}^3$. You should get 96 cm^2 .

Practice Problems

1. Calculate the ratio of surface area to volume for a cell that is 2 cm high. What happens to this ratio as the size of the cell decreases?
2. If a 4-cm cell doubled just one of its dimensions—length, width, or height—what would happen to the ratio of surface area to volume?



For more practice, visit
green.msscience.com/math_practice

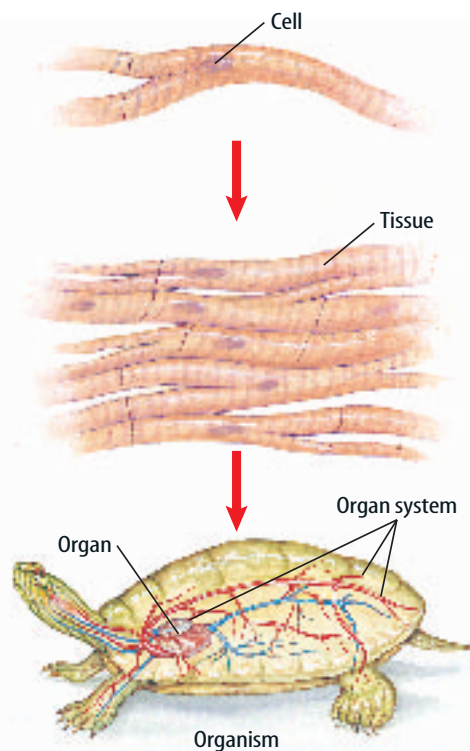


Figure 16 In a many-celled organism, cells are organized into tissues, tissues into organs, organs into systems, and systems into an organism.

Many-Celled Organisms

Cells in a many-celled organism do not work alone. Each cell carries on its own life functions while depending in some way on other cells in the organism. Many one-celled organisms, however, perform all life functions on their own.

In **Figure 16**, you can see cardiac muscle cells grouped together to form a tissue. A **tissue** is a group of similar cells that work together to do one job. Each cell in a tissue does its part to keep the tissue alive.

Tissues are organized into organs. An **organ** is a structure made up of two or more different types of tissues that work together. Your heart is an organ made up of nerve, blood, and cardiac muscle tissues. The cardiac muscle tissue contracts, making the heart pump. The nerve tissue brings messages that tell the heart how fast to beat. The blood tissue is carried from the heart to other organs of the body.

A group of organs working together to perform a certain function is an **organ system**. Your heart, arteries, veins, and capillaries make up your cardiovascular system. Organ systems work together to make up a many-celled organism.

section 3 review

Summary

Viewing Cells and the Cell Theory

- Cells could be seen after the invention of the microscope by van Leeuwenhoek.
- The cell theory states that all organisms are made up of cells, the cell is the basic unit of organization, and all cells come from other cells.

Cellular Organization

- Cells are prokaryotic or eukaryotic.
- All cells have a cell membrane, cytoplasm, and ribosomes. Some have a cell wall.
- All eukaryotic cells have membrane-bound organelles to carry out life processes.

Many-Celled Organisms

- Cells in many-celled organisms cannot function alone. Cells group together to form tissues, tissues form organs, organs form organ systems, and organ systems form an organism.

Self Check

- Describe** the events leading to the discovery of the cell theory.
- Identify** the role of the nucleus in the life of a cell.
- Compare and contrast** the differences between plant and animal cells.
- Explain** how a cell is like your school or town. What is the nucleus of your town? The mitochondria?
- Think Critically** How is the cell of a one-celled organism different from the cells in many-celled organisms?

Applying Math

- Solve One-Step Equations** The magnification of a light microscope can be found by multiplying the power of the eyepiece by the power of the objective lens. Calculate the magnifications of a microscope that has an $8\times$ eyepiece, and $10\times$ and $40\times$ objectives.

Comparing Cells

Real-World Question

If you compared a goldfish to a rose, you would find them unlike each other. Are their individual cells also different? Try this lab to compare plant and animal cells. How do human cheek cells and plant cells compare?

Goals

- **Compare and contrast** an animal and a plant cell.

Materials

microscope	dropper
microscope slide	<i>Elodea</i> plant
coverslip	prepared slide of human
forceps	cheek cells
tap water	

Safety Precautions



Procedure

1. Copy the data table in your Science Journal. Check off the cell parts as you observe them.

Cell Observations

Cell Part	Cheek	<i>Elodea</i>
Cytoplasm		
Nucleus	Do not write in this book.	
Chloroplasts		
Cell wall		
Cell membrane		

2. Using forceps, make a wet-mount slide of a young leaf from the tip of an *Elodea* plant.

3. Observe the leaf on low power. Focus on the top layer of cells.
4. Switch to high power and focus on one cell. In the center of the cell is a membrane-bound organelle called the central vacuole. Observe the chloroplasts—the green, disk-shaped objects moving around the central vacuole. Try to find the cell nucleus. It looks like a clear ball.
5. Draw the *Elodea* cell. Label the cell wall, cytoplasm, chloroplasts, central vacuole, and nucleus. Return to low power and remove the slide. Properly dispose of the slide.
6. Observe the prepared slide of cheek cells under low power.
7. Switch to high power and observe the cell nucleus. Draw and label the cell membrane, cytoplasm, and nucleus. Return to low power and remove the slide. Properly dispose of the slide.

Conclude and Apply

1. **Compare and contrast** the shapes of the cheek cell and the *Elodea* cell.
2. What can you conclude about the differences between plant and animal cells?

Communicating Your Data

Draw the two kinds of cells on one sheet of paper. Use a green pencil to label the organelles found only in plants, a red pencil to label the organelles found only in animals, and a blue pencil to label the organelles found in both.



Viruses

as you read

What You'll Learn

- **Explain** how a virus makes copies of itself.
- **Identify** the benefits of vaccines.
- **Investigate** some uses of viruses.

Why It's Important

Viruses can infect nearly all organisms, including humans.



Review Vocabulary

bacteria: a prokaryotic, one-celled organism

New Vocabulary

- virus
- host cell

What are viruses?

Cold sores, measles, chicken pox, colds, the flu, and AIDS are diseases caused by nonliving particles called viruses. A **virus** is a strand of hereditary material surrounded by a protein coating. A virus multiplies by making copies of itself with the help of a living cell called a **host cell**. Viruses don't have a nucleus, other organelles, or a cell membrane. They have a variety of shapes and are too small to be seen with a light microscope. They were discovered only after the electron microscope was invented. Before that time, scientists only hypothesized about viruses.

Active Viruses When a virus enters a cell and is active, it causes the host cell to make new viruses. This process destroys the host cell. Follow the steps in **Figure 17** to see one way that an active virus functions inside a cell.

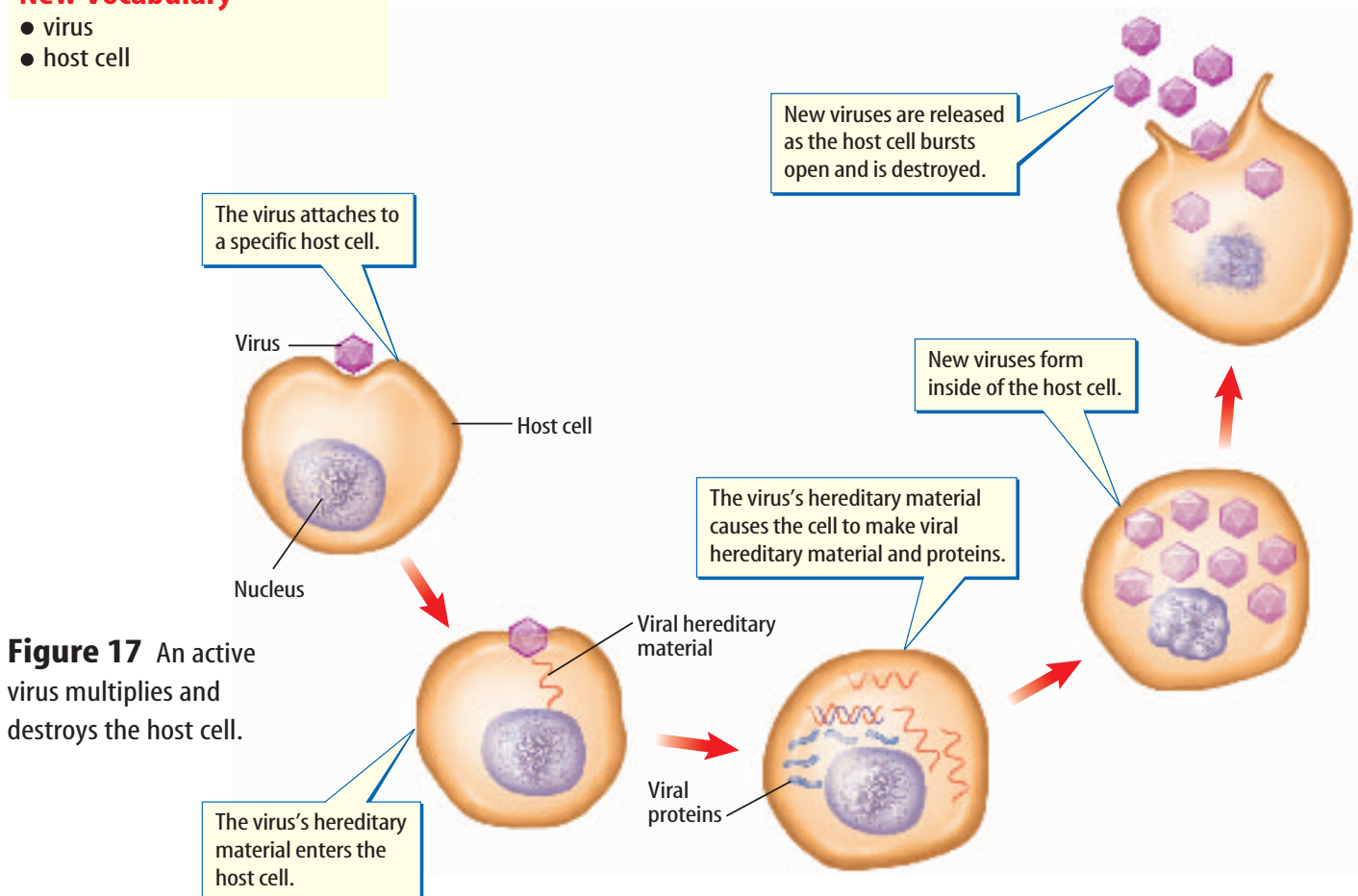


Figure 17 An active virus multiplies and destroys the host cell.



Latent Viruses Some viruses can be inactive, and are called latent. This means that after the virus enters a cell, its hereditary material becomes part of the cell's hereditary material. It does not immediately make new viruses or destroy the cell. As the host cell reproduces, the hereditary material of the virus is copied. A virus can be latent for many years. Then, at any time, certain conditions, either inside or outside the body, can activate the virus.

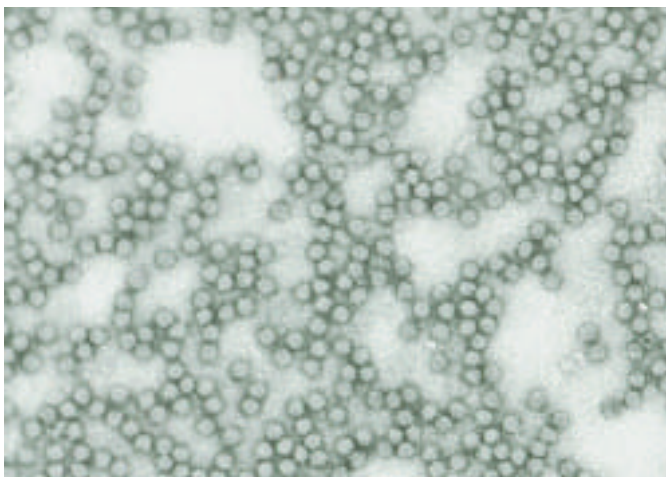
If you have had a cold sore on your lip, a latent virus in your body has become active. The cold sore is a sign that the virus is active and destroying cells in your lip. When the cold sore disappears, the virus has become latent again. The virus, however, is still in your body's cells.

How do viruses affect organisms?

Viruses can infect animals, plants, fungi, protists, and all bacteria. Most viruses can infect only specific kinds of cells. For instance, many viruses, such as the potato leafroll virus in **Figure 18**, are limited to one host species or to one type of tissue within a species. A few viruses affect a broad range of hosts. An example of this is the rabies virus. Rabies can infect humans and many other animal hosts.

A virus cannot move by itself, but it can reach a host's body in several ways. For example, it can be carried onto a plant's surface by the wind or it can be inhaled by an animal. In a viral infection, the virus first attaches to the surface of the host cell. The virus and the place where it attaches must fit together exactly, also shown in **Figure 18**, which is why most viruses attack only one kind of host cell. Viruses that infect bacteria are called bacteriophages (bak TIHR ee uh fay juhzh).

The potato leafroll virus, PLRV, damages potato crops worldwide, and is specific to only potatoes.



Magnification: unknown

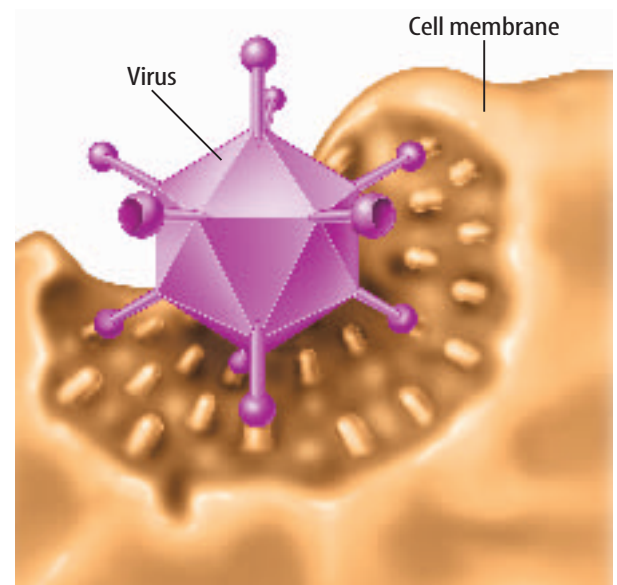


Figure 18 Viruses and the attachment sites of the host cell must match exactly, like a puzzle. That's why most viruses infect only one kind of host cell.



Topic: Latent Viruses

Visit green.msscience.com for Web links to information about viruses.

Activity Name three environmental stimuli that may activate a latent virus.



Treating and Preventing Viral Diseases

Antibiotics are used to treat bacterial infections, but they do not work against viral diseases. Antiviral drugs can be given to infected patients to help fight a virus; however, they are not widely used because of adverse side effects. Prevention is the best way to fight the diseases, because treatment is very difficult.

Public health measures for preventing viral diseases include vaccinating people, improving sanitary conditions, separating patients with diseases, and controlling animals that spread the disease. Yellow fever was wiped out completely in the United States through mosquito-control programs. Annual rabies vaccinations protect humans by keeping pets and farm animals free from infection.



Reading Check

What are some methods used to prevent viral infections?

Natural Immunity One way your body can stop viral infections is by making interferons. Interferons are proteins that protect cells from viruses. These proteins are produced rapidly by infected cells and move to noninfected cells in the host. They cause the noninfected cells to produce protective substances.

Vaccines Vaccinations, like the one the child is receiving in **Figure 19**, are used to prevent disease. A vaccine is made from weakened virus particles that cause your body to produce interferons to fight the infection. Vaccines have been made to prevent

many diseases, including measles, mumps, smallpox, chicken pox, polio, and rabies. Edward Jenner is credited with developing the first vaccine in 1796. He injected a weakened form of the cowpox virus into healthy people, which protected them from smallpox. Jenner did not know how his virus worked, or that smallpox and cowpox were related viruses.

Figure 19 A child is getting vaccinated before entering school.

Describe how a vaccine works.



Research with Viruses

You might think viruses are always harmful. However, scientists are discovering helpful uses for some viruses through research. One use, called gene therapy, is being tried on cells with defective hereditary material. Normal hereditary material is enclosed in viruses. The viruses then “infect” defective cells, taking the new hereditary material into the cells to replace the defective material. Using gene therapy, scientists hope to help people with genetic disorders and find a cure for cancer.

Reading Check *How does gene therapy work?*

An active area of viral research is HIV/AIDS research. HIV stands for human immuno-deficiency virus, a virus that attacks the immune system. The immune system is the system that protects your body from disease. Eventually, this virus leads to Acquired Immune Deficiency Syndrome, or AIDS. A weak immune system allows the body to be attacked by other diseases and infections, like pneumonia and certain types of cancer. AIDS occurs worldwide, with 95 percent of the cases in developing countries. **Table 3** shows some recent calculations of infected individuals. Currently, there is no known cure for AIDS. The research will hopefully lead to better treatments, a vaccine, and eventually a cure.

Table 3 HIV/AIDS in the World

Adults age 15–49 with HIV/AIDS, 2001	37,100,000
New HIV infections, 2001	5,000,000
Adult HIV prevalence (%), 2001	1.20
Women age 15–49 with HIV/AIDS, 2001	18,500,000
Children with HIV/AIDS, 2001	3,000,000
AIDS deaths, 2001	3,000,000

Source: UNAIDS

section 4 review

Summary

What are viruses?

- A virus is a strand of hereditary material surrounded by a protein coating, which multiplies by making copies of itself using a host cell.
- Almost every living thing can be infected by a virus.

Fighting Viruses

- Viruses can be prevented by vaccines, antiviral drugs, improving sanitary conditions, separating infected patients, and controlling animals that spread disease.
- Your body produces interferons to naturally protect itself.

Self Check

1. **List** the steps an active virus follows when attacking a cell.
2. **Compare and contrast** a latent virus and an active virus. Give an example of each.
3. **Explain** how vaccines prevent infection.
4. **Infer** how some viruses might be helpful.
5. **Think Critically** Explain why a doctor might not give you any medication if you have a viral disease.

Applying Skills

6. **Interpret Scientific Illustrations** Using **Figure 18**, explain why most viruses infect one species.
7. **Research Information** Find one precaution your community uses to prevent viral disease.

Comparing Light Microscopes

Goals

- **Learn** how to correctly use a stereomicroscope and a compound light microscope.
- **Compare** the uses of the stereomicroscope and compound light microscope.

Possible Materials

compound light microscope
stereomicroscope
items from the classroom—include some living or once-living items (8)
microscope slides and coverslips
plastic petri dishes
distilled water
dropper

Safety Precautions



Real-World Question

You're a technician in a police forensic laboratory. You use a stereomicroscope, which uses two eyepieces to see larger objects in three dimensions, and a compound light microscope to see a smaller specimen. A detective just returned from a crime scene with bags of evidence. You must examine each piece of evidence under a microscope. How do you decide which microscope is the best tool to use? Will all of the evidence that you've collected be viewable through both microscopes?



Form a Hypothesis

Form a hypothesis to predict which items in an actual police laboratory, such as blood and dirt samples, would be viewed under a compound light microscope. A stereomicroscope? What qualifications would the technician use to decide?



Test Your Hypothesis

Make a Plan

1. As a group, decide how you will test your hypothesis.
2. **Describe** how you will carry out this experiment using a series of specific steps. Make sure the steps are in a logical order. Remember that you must place an item in the bottom of a plastic petri dish to examine it under the stereomicroscope, and you must make a wet mount of any item to be examined under the compound light microscope. For more help, see the Reference Handbook.
3. If you need a data table or an observation table, design one in your Science Journal.

Follow Your Plan

1. Make sure your teacher approves the objects you'll examine, your plan, and your data table before you start.
2. Carry out the experiment.
3. While doing the experiment, record your observations and complete the data table.

Analyze Your Data

1. **Compare** the items you examined with those of your classmates.
2. Based on this experiment, classify the eight items you observed.

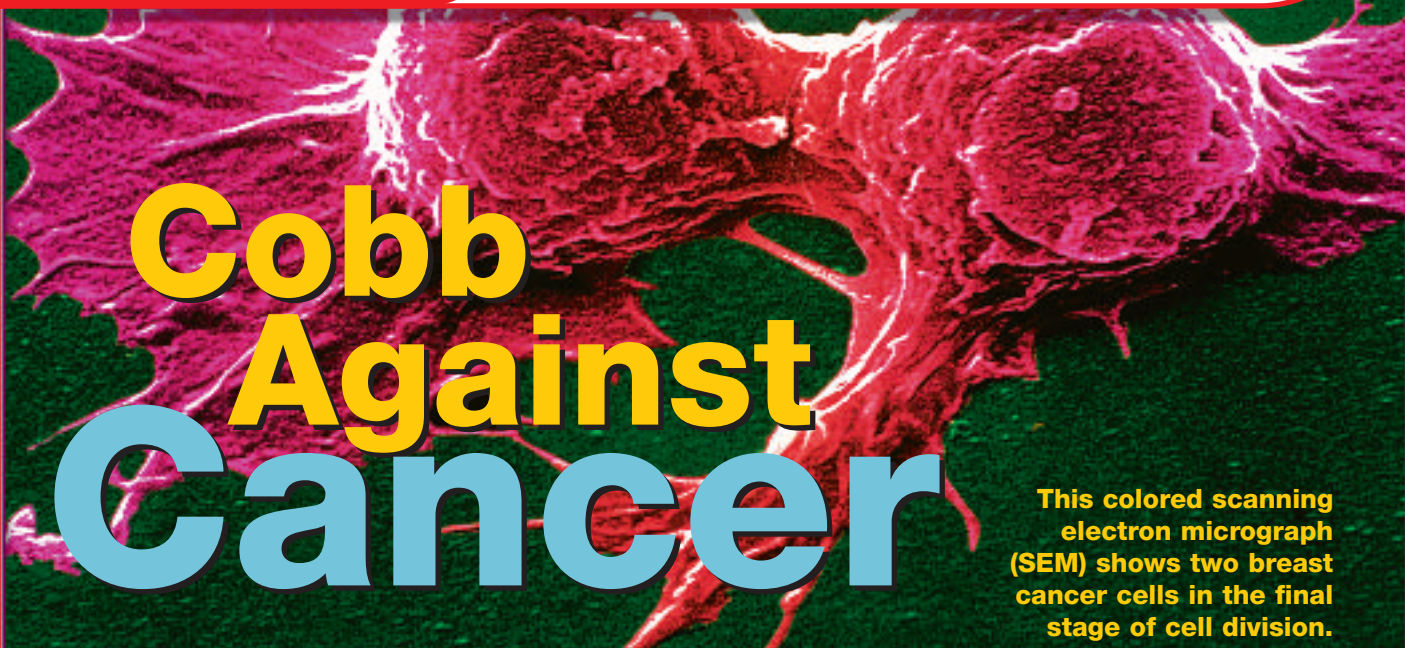
Conclude and Apply

1. Were you correct in your original hypothesis about the correct microscope to use? For which objects would you reconsider the microscope used?
2. **Infer** which microscope a scientist might use to examine a blood sample, fibers, and live snails.
3. **List** five careers that require people to use a stereomicroscope. List five careers that require people to use a compound light microscope. Enter the lists in your Science Journal.
4. **Describe** If you examined an item under a compound light microscope and a stereomicroscope, how would the images differ?
5. **Name** the microscope that was better for looking at large or possibly live items.



Communicating Your Data

In your Science Journal, write a short description of an imaginary crime scene and the evidence found there. Sort the evidence into two lists—items to be examined under a stereomicroscope and items to be examined under a compound light microscope.



Cobb Against Cancer

This colored scanning electron micrograph (SEM) shows two breast cancer cells in the final stage of cell division.

Jewel Plummer Cobb is a cell biologist who did important background research on the use of drugs against cancer. She removed cells from cancerous tumors and cultured them in the lab. Then, in a controlled study, she tried a series of different drugs against batches of the same cells. Her goal was to find the right drug to

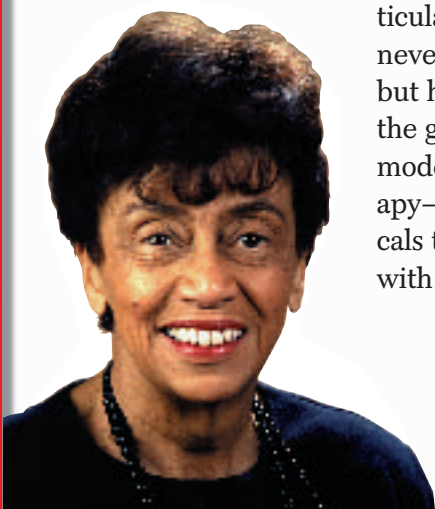
cure each patient's particular cancer. Cobb never met that goal, but her research laid the groundwork for modern chemotherapy—the use of chemicals to treat people with cancer.

Jewel Plummer Cobb also has influenced sciences as dean or

president of several universities. She was able to promote equal opportunity for students of all backgrounds, especially in the sciences. She retired in 1990 from her post as president of California State University at Fullerton, and continues to be active in the sciences.

Light Up a Cure

Building on Cobb's work, Professor Julia Levy and her research team at the University of British Columbia actually go inside cells, and even organelles, to work against cancer. One technique they are pioneering is the use of light to guide cancer drugs to the right cells. First, the patient is given a chemotherapy drug that reacts to light. Next, a fiber optic tube is inserted into the tumor. Finally, laser light is passed through the tube. The light activates the light-sensitive drug—but only in the tumor itself. This technique keeps healthy cells healthy while killing sick cells.



Write Report on Cobb's experiments on cancer cells. What were her dependent and independent variables? What would she have used as a control? What sources of error did she have to guard against? Answer the same questions about Levy's work.

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Reviewing Main Ideas

Section 1 Living Things

1. Organisms are made of cells, use energy, reproduce, respond, maintain homeostasis, grow, and develop.
2. Organisms need a food source, water, and a place to live.

Section 2 How are living things classified?

1. Scientists today use phylogeny to group organisms into six kingdoms.
2. All organisms are given a two-word scientific name using a system called binomial nomenclature.

Section 3 Cell Structure

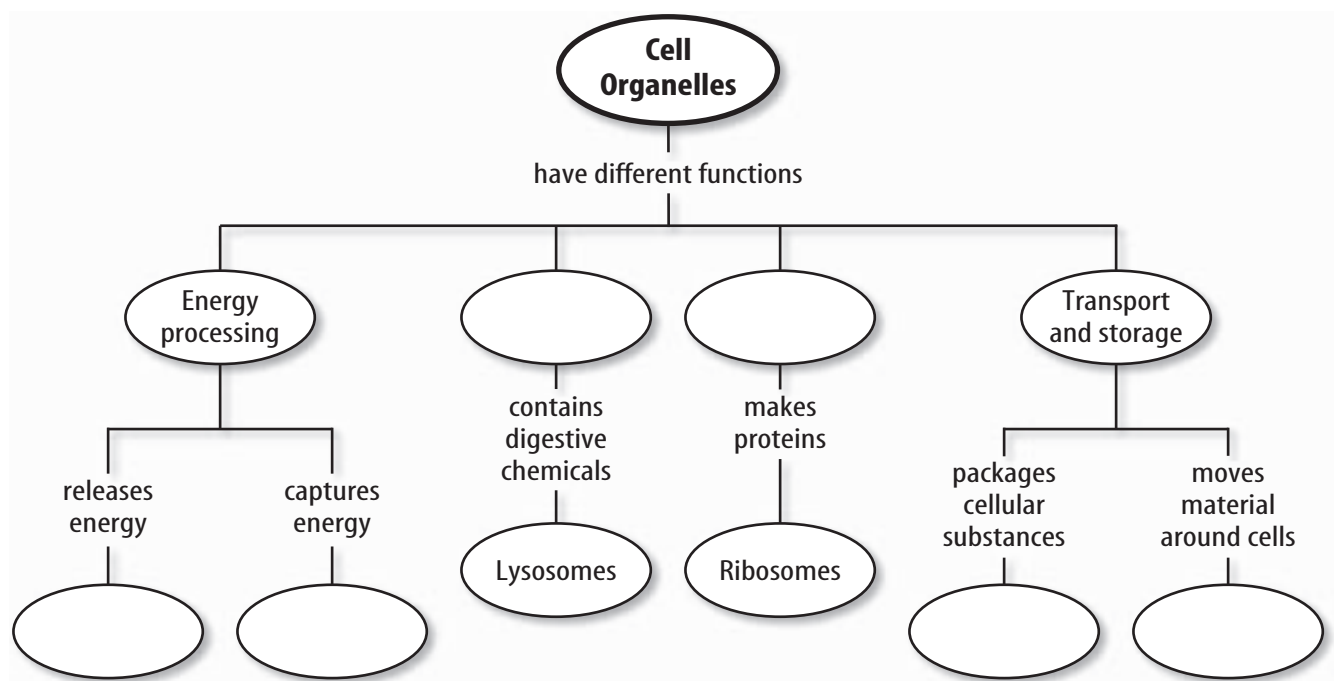
1. The invention of the microscope led to the cell theory.
2. Cells without membrane-bound structures are prokaryotic cells. Cells with membrane-bound structures are eukaryotic cells.
3. Most many-celled organisms are organized into tissues, organs, and organ systems.

Section 4 Viruses

1. A virus is a nonliving structure containing hereditary material surrounded by a protein coating. It can only make copies of itself when inside a living host cell.
2. Viruses cause diseases in organisms.

Visualizing Main Ideas

Copy and complete the following concept map of the basic units of life.



Using Vocabulary

binomial nomenclature p. 218	host cell p. 232
cell p. 214	kingdom p. 219
cell membrane p. 224	mitochondrion p. 226
cell theory p. 221	nucleus p. 226
cell wall p. 224	organ p. 230
chloroplast p. 226	organelle p. 226
cytoplasm p. 225	organism p. 214
endoplasmic reticulum p. 228	organ system p. 230
genus p. 218	phylogeny p. 219
Golgi body p. 228	ribosome p. 225
homeostasis p. 216	tissue p. 230
	virus p. 232

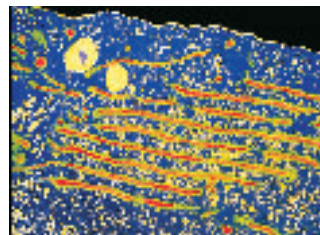
Write the correct vocabulary word for each phrase.

- the smallest unit of life
- maintaining proper internal conditions
- similar structures
- Homo sapiens*
- directs all cell activities
- plant-cell organelle that processes energy
- powerhouse of a cell
- a structure that surrounds every cell
- made up of cells
- contains only hereditary material

Checking Concepts

Choose the word or phrase that best answers the question.

- What category of organisms can mate and produce fertile offspring?
A) family C) genus
B) class D) species
- What is the closest relative of *Canis lupus*?
A) *Quercus alba* C) *Felis tigris*
B) *Equus zebra* D) *Canis familiaris*
- What is the source of energy for plants?
A) the Sun C) water
B) carbon dioxide D) oxygen
- What is the length of time an organism is expected to live?
A) life span C) homeostasis
B) stimulus D) theory
- What is the first word in a two-word name of an organism?
A) kingdom C) phylum
B) species D) genus
- Identify the folded membranes that move materials around the cell, pictured above.
A) nucleus
B) cytoplasm
C) Golgi body
D) endoplasmic reticulum
- What are the structures in the cytoplasm of a eukaryotic cell called?
A) organs C) organ systems
B) organelles D) tissues
- Groups of different organ systems form which of the following?
A) organ C) organ system
B) organelle D) organism
- According to the cell theory, what is the basic unit of life?
A) the Sun C) a cell
B) a tissue D) a chloroplast
- Where does a virus multiply?
A) in the ground C) a host cell
B) in water D) in the air



Thinking Critically

- 21. Draw Conclusions** Using a bird as an example, explain how it has the traits of living things.
- 22. Explain** what binomial nomenclature is and why it is important.
- 23. Infer** what *Lathyrus odoratus*, the name for a sweet pea, tells you about one of its characteristics.
- 24. Determine** why it is difficult to treat a viral disease.
- 25. Predict** what would happen to a plant cell that suddenly lost its chloroplasts.
- 26. Concept Map** Make an events-chain concept map of the following from simple to complex: *small intestine, circular muscle cell, human, and digestive system*.
- 27. Interpret Scientific Illustrations** Use the illustrations in **Figure 1** to describe how the shape of a cell is related to its function.
- 28. Compare and Contrast** Copy and complete the following table to compare and contrast the structures of a prokaryotic cell to those of a eukaryotic cell.

Cell Structure		
Structure	Prokaryotic Cell	Eukaryotic Cell
Cell Membrane		Yes
Cytoplasm	Yes	
Nucleus		Yes
Endoplasmic Reticulum		
Golgi Bodies		

- 29. Describe** how you would decide if a cell was animal, plant, or prokaryotic.

Performance Activities

- 30. Make a Time Line** Make and illustrate a time line to show the development of the cell theory. Begin with the development of the microscope and end with Virchow. Include the contributions of Leeuwenhoek, Hooke, Schleiden, and Schwann.
- 31. Make a Model** Use materials that resemble cell parts or that represent their functions to make a model of a plant cell or an animal cell. Make a key to the cell parts to explain your model.
- 32. Make a Brochure** Research the types of vaccinations required in your community and at what ages they are usually administered. Contact your local Health Department for current information. Prepare a brochure for new mothers.

Applying Math

Use the table below to answer questions 33 and 34.

Temperature v. Number of Viruses

Temperature	Number of Viruses
37°C	1.0 million
37.5°C	0.5 million
37.8°C	0.25 million
38.3°C	0.1 million
38.9°C	0.05 million

- 33. Temperature Dependence** Use a computer to make a line graph of the above data.
- 34. Number of Viruses** From the line graph you have just made, determine the number of viruses at 37.3°C

Part 1 Multiple Choice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Use the photo below to answer question 1.



- The puffball above is releasing millions of spores. What characteristic of living things is represented by this picture?
 A. reproduction C. organization
 B. development D. use of energy
- Which of the following is the best example of homeostasis?
 A. the ability of plants to use the Sun's energy, carbon dioxide and water to make food
 B. the movement of a cat toward food
 C. the ability of some organisms to keep their temperature within a certain range
 D. the production of eggs by most insects
- What plant cell structure is made up mostly of cellulose?
 A. cell wall C. cell membrane
 B. chloroplast D. mitochondrion

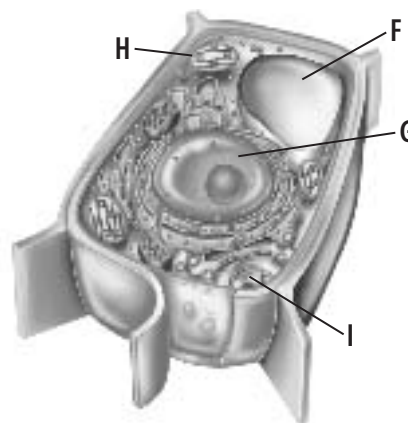
Test-Taking Tip

Read Carefully Read each question carefully for full understanding.

Question 2 Reread this question so that you thoroughly understand it. Also, read all of the choices before deciding which one is the best answer to the question.

- Which one of the following structures is found in prokaryotic cells?
 A. chloroplast C. mitochondrion
 B. Golgi bodies D. ribosomes
- Which of the following is the evolutionary history of an organism?
 A. phylogeny C. nomenclature
 B. classification D. dichotomy
- What is the two-word system used to name various species?
 A. binomial species
 B. binomial nomenclature
 C. dichotomous key
 D. modern classification

Use the illustration below to answer questions 7 and 8.



- Which letter corresponds to the nucleus?
 A. F C. H
 B. G D. I
- Which part is used by plant cells to make food?
 A. F C. H
 B. G D. I
- What are the smallest units that make up your body called?
 A. cells C. organisms
 B. tissues D. organs

Part 2 Short Response/Grid In

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

- 10.** Explain why your heart would be called an organ and not a tissue.

Use the illustration below to answer questions 11 and 12.



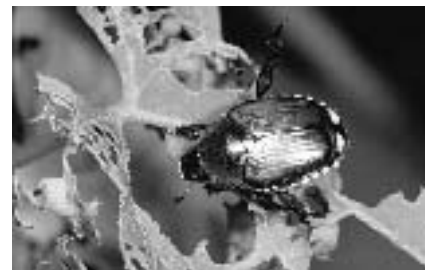
- 11.** A scientist is studying living cells. Above is an image of one of the cells that is being studied. If the pointer shown above with the cell is 10 micrometers in length, then about how wide is this cell?
- 12.** What tool was the scientist probably using to view the living cell?
- 13.** List three different organisms whose cells are enclosed in cell walls.
- 14.** Explain why water is important to living things.
- 15.** A scientist observes a cell under a microscope and notices that the cell's cytoplasm is almost completely full of rough endoplasmic reticulum. What would you hypothesize these cells are making in large amounts? Explain your answer.
- 16.** What is the smallest classification category?
- 17.** What are four reasons scientific names are used to describe organisms rather than common names?

Part 3 Open Ended

Record your answers on a sheet of paper.

- 18.** Explain stimulus and response. How is response to a stimulus related to homeostasis? Give an example using the stimulus of heat.
- 19.** Draw diagrams of a prokaryotic cell and of a eukaryotic cell. Label the parts to show the differences between the two cell types.
- 20.** How might you go about writing a field guide to use to identify plants that might grow in a garden? What would you need to do if you wanted to include a dichotomous key in the field guide?
- 21.** Explain how DNA is related to the chromosomes found in the nucleus of a cell. What is the importance of DNA in the nucleus?
- 22.** The nucleus of a cell directs all the activities of a cell. But bacteria, which are prokaryotic cells, do not have nuclei. Explain how bacterial cells can function without a nucleus.

Use the photo below to answer questions 23 and 24.



- 23.** Both of these organisms use energy. Describe the difference between their sources of energy. What are the common ways that these organisms use energy?
- 24.** How are the needs of the two organisms alike? Explain why the plant fulfills a need for the beetle. When the beetle dies, how could it fill a need for the plant?