OHIO SCIENCE

A CLOSER LOOK

Macmillan/McGraw-Hill

OHIO

SCIENCE

A CLOSER LOOK

Macmillan McGraw-Hill

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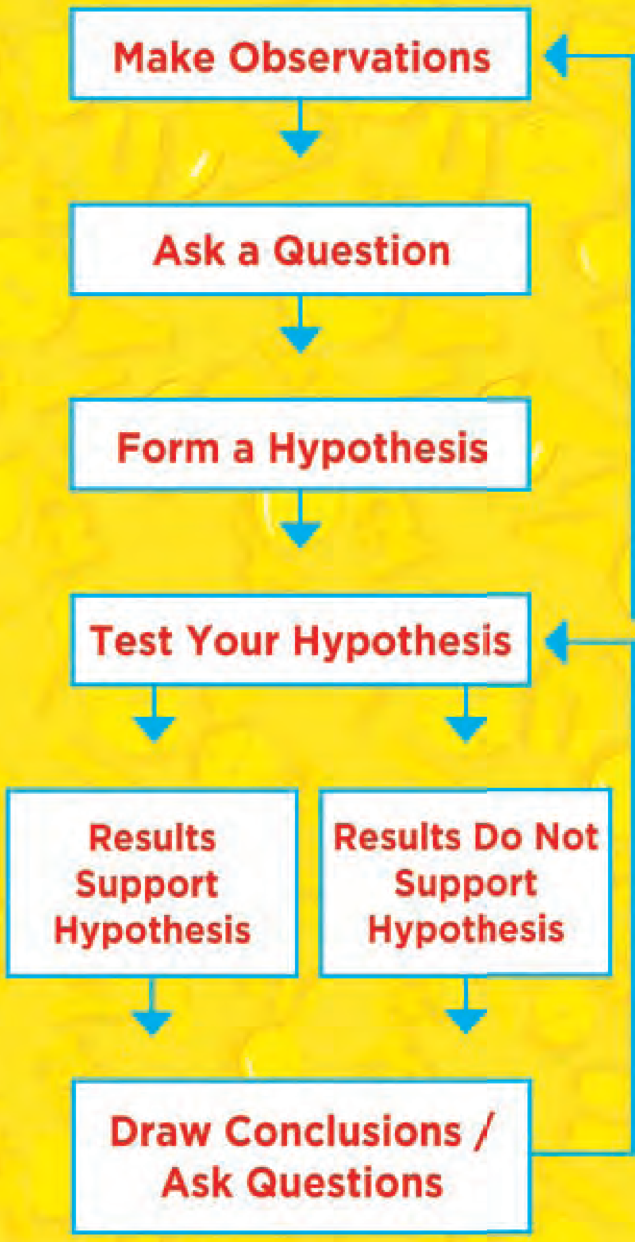
American Museum & Natural History
The American Museum of Natural History in New York City is one of the world's preeminent scientific, educational, and cultural institutions, with a global mission to explore and interpret human cultures and the natural world through scientific research, education, and exhibitions. Each year the Museum welcomes around four million visitors, including 500,000 schoolchildren in organized field trips. It provides professional development activities for thousands of teachers; hundreds of public programs that serve audiences ranging from preschoolers to seniors; and an array of learning and teaching resources for use in homes, schools, and community-based settings. Visit www.amnh.org for online resources.

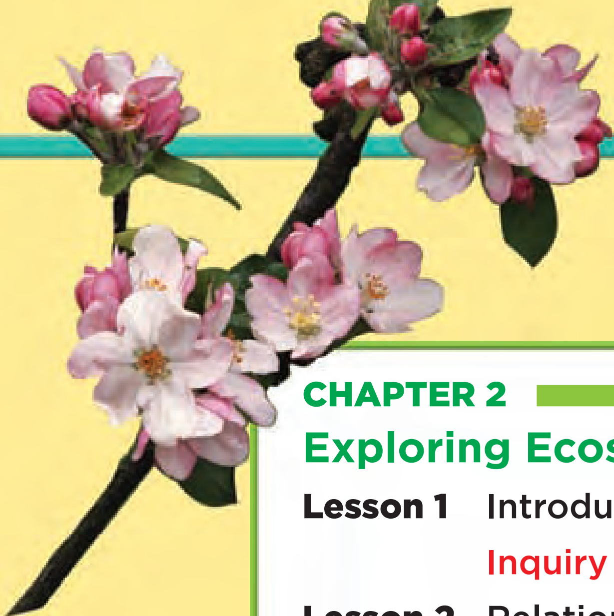
Be a Scientist

◀ Making a model can help you understand how something works.

Scientific Method



Life Sciences



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Exploring Ecosystems 80

Earth and Space Sciences

CHAPTER 4

Physical Sciences

Activities and Investigations

Life Sciences

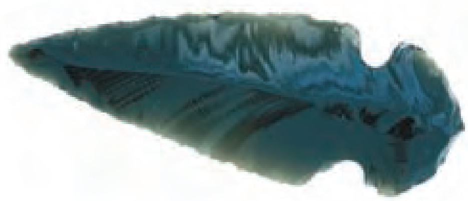
Earth and Space Sciences

CHAPTER 3

Explore Activities

Quick Labs

Inquiry Skills and Investigations



CHAPTER 4

Explore Activities

Quick Labs

Inquiry Skills and Investigations

Activities and Investigations

Physical Sciences

CHAPTER 5

Explore Activities

Quick Labs

Inquiry Skills and Investigations

CHAPTER 6

Explore Activities

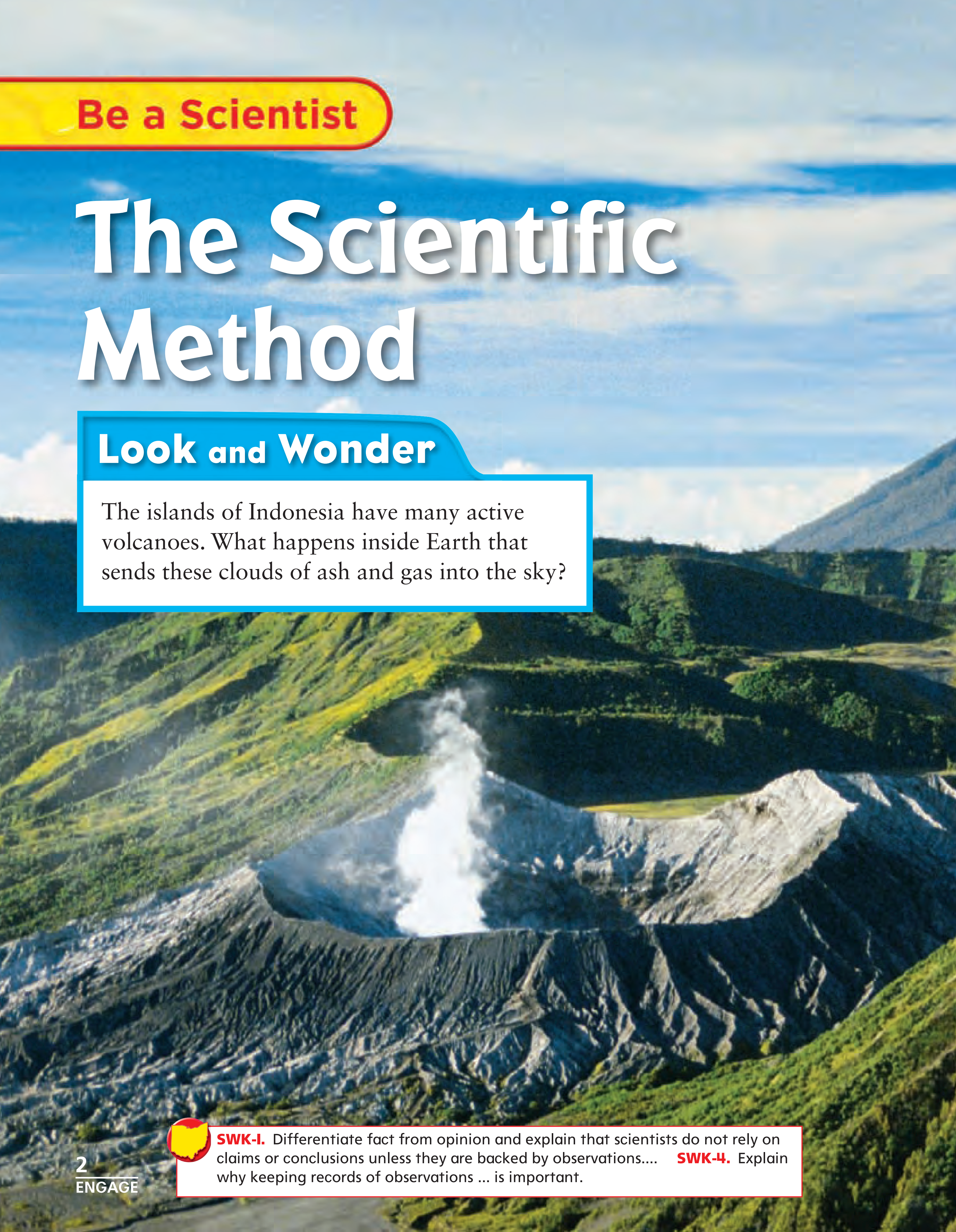
Quick Labs

Inquiry Skills and Investigations

Be a Scientist

Mount Etna is the largest active volcano in Europe.

Mount Etna, Italy



Be a Scientist

The Scientific Method

Look and Wonder

The islands of Indonesia have many active volcanoes. What happens inside Earth that sends these clouds of ash and gas into the sky?

SWK-I. Differentiate fact from opinion and explain that scientists do not rely on claims or conclusions unless they are backed by observations.... **SWK-4.** Explain why keeping records of observations ... is important.

Francesca studies volcanoes in their natural settings.

Jim studies volcanoes in the laboratory.

Explore

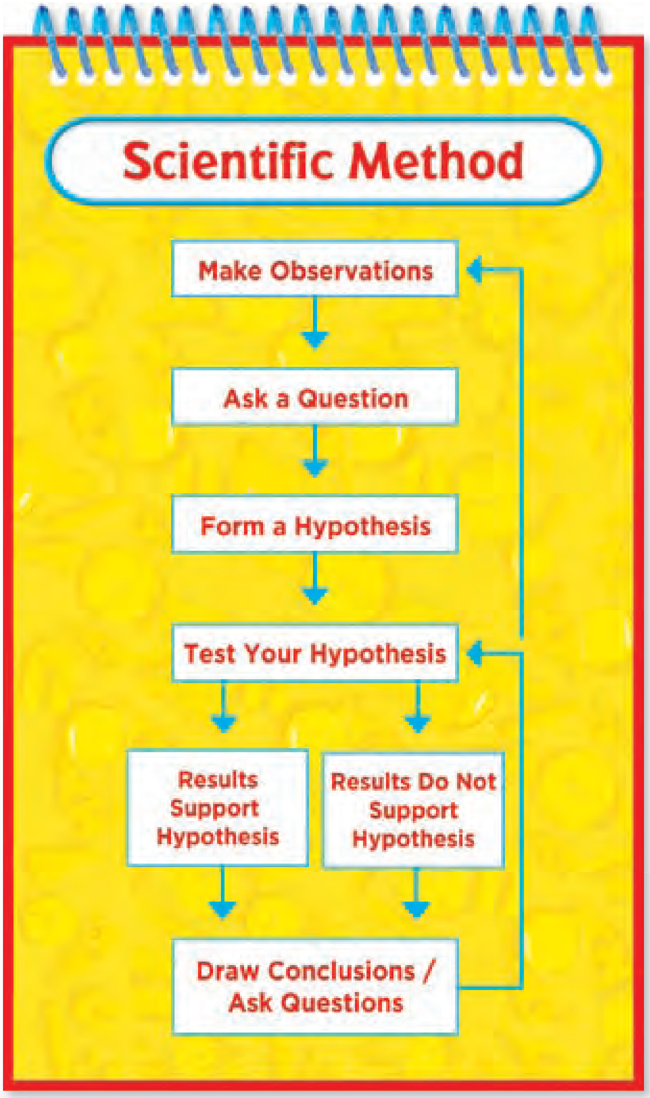
What do you know about volcanoes?

- Why are some mountains volcanoes?
- What happens when a volcano erupts?
- Why do some volcanoes explode more violently than others?

How do scientists find answers to these questions?

Jim Webster and Francesca Sintoni are geologists (jee•OL•uh•jists). They work at the American Museum of Natural History in New York City. Geologists are scientists who study what goes on inside and outside Earth. Jim and Francesca are curious about volcanoes. They want to understand more about why volcanoes erupt.

SI-4. Explain the importance of keeping conditions the same in an experiment.



What do scientists do?

More than a million people live in the city of Naples, Italy. This city lies in the shadow of an active volcano named Mount Vesuvius (vuh•SEW•vee•uhs). It has erupted explosively many times over the past 2,000 years. "It's very dangerous," says Francesca, who lives in Italy. She studies Mount Vesuvius.

The Scientific Method

Francesca and Jim want to know what causes volcanoes like Mount Vesuvius to erupt. To find out, they use the scientific (sy•uhn•TIF•ik) method. The **scientific method** is a process that scientists use to answer questions. This method helps them explain the natural world. The steps in the scientific method guide their investigations. Not every step needs to be followed in order every time.

From Naples you can see Mount Vesuvius. It last erupted in 1944.

Asking Questions

Volcanoes are filled with melted rock called *magma*. Magma is found deep inside Earth. Sometimes a gas is present in the magma. The gas may have water vapor, chlorine, or other substances in it.

When magma erupts from a volcano, lavas (LAH•vuhz) form. Many lavas are filled with small holes. These holes were once bubbles of gas in the hot magma.

Jim and Francesca ask why some volcanic eruptions are more explosive than others. They already know that water vapor affects how volcanoes erupt. Based on what they know, Jim and Francesca make a prediction. They predict that other substances will also affect volcanic eruptions. One variable (VAYR•ee•uh•buhl) they want to test is a substance called chlorine. A **variable** is something that changes, or varies.

Forming a Hypothesis

1. Ask lots of "why" questions.
2. Look for connections between important variables.
3. Suggest possible explanations for those connections.

▶ **Make sure the explanations can be tested.**

Forming a Hypothesis

Jim and Francesca form a hypothesis (hye•PAH•thuh•sis). A **hypothesis** is a statement that can be tested to answer a question. Their hypothesis states that if magma has chlorine, then a volcano will have a larger explosion.

Francesca and Jim want to know why volcanoes erupt the way they do.

How do scientists test their hypothesis?

Can Jim and Francesca do research inside a volcano? No! Instead they use a laboratory, or lab for short. An instrument in Jim's lab models the heat and pressure deep inside a volcano. "We're trying to imitate the temperature and pressure inside Earth's crust," Jim explains.

Selecting a Strategy

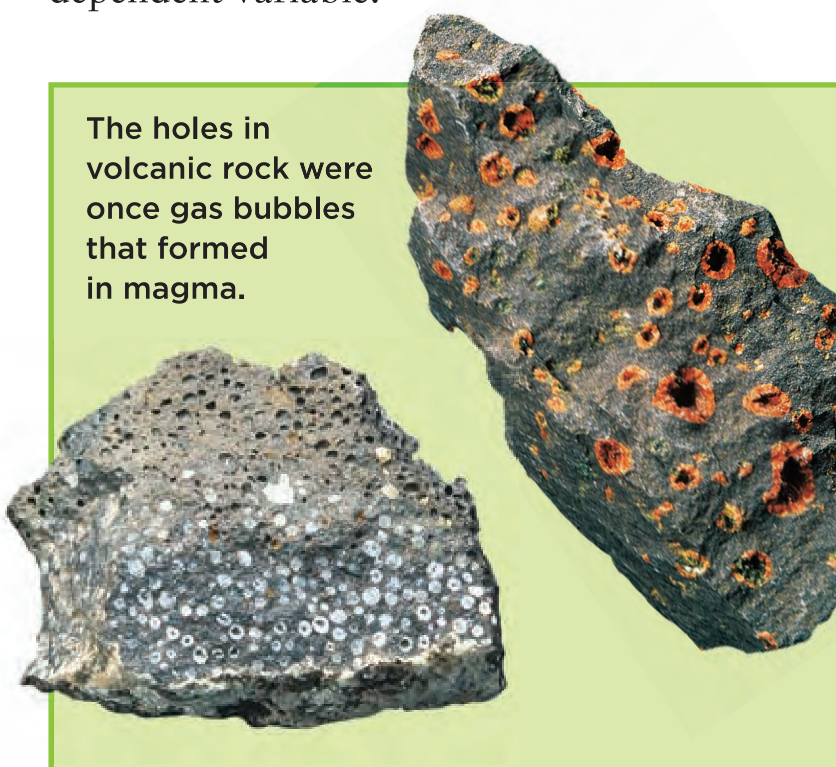
To test their hypothesis, Jim and Francesca need to collect evidence. They decide to perform a set of experiments. An **experiment** is a scientific test that can be used to support or disprove a hypothesis. The pair design a set of experiments to test the effects of chlorine.

Planning a Procedure

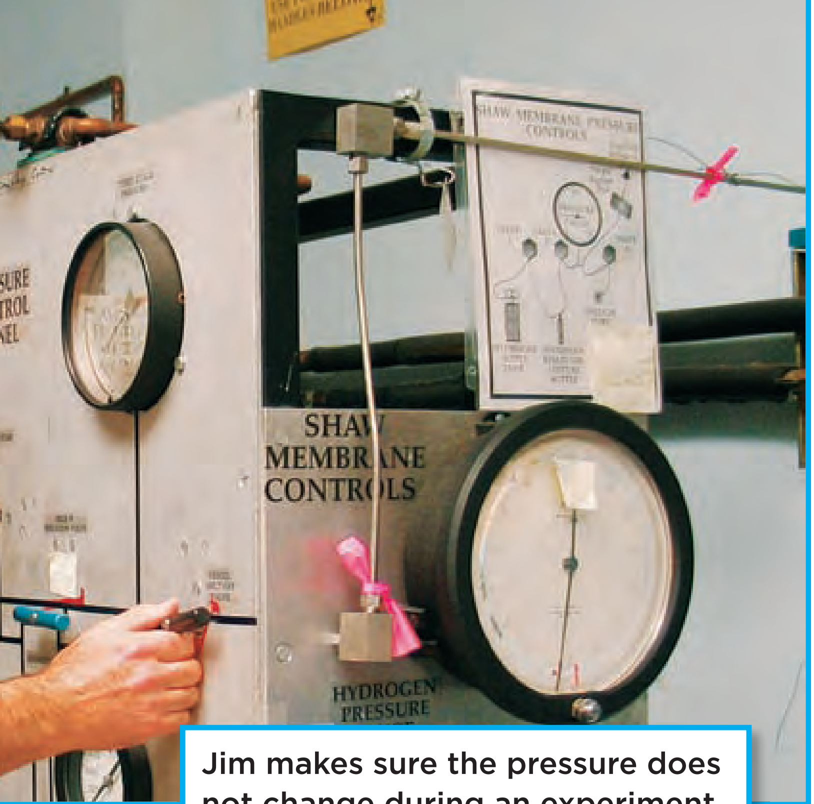
Jim and Francesca write the steps of their procedure clearly. That way, they and others can repeat their experiments. Why? Good experiments are done again and again. If the results are similar, the evidence is stronger.

The plan is to add known amounts of chlorine to volcanic rock samples. Chlorine is the only variable they will change. The variable that changes in an experiment is the *independent variable*. Most experiments test only one independent variable at a time.

A good experiment also has *controlled variables* that are kept the same. Here, the scientists plan to control the mass, pressure, and temperature of each sample. How will they know if chlorine has any effect? They will count the number of holes in each rock—their dependent variable.



The holes in volcanic rock were once gas bubbles that formed in magma.



Jim makes sure the pressure does not change during an experiment.

Testing a Hypothesis

1. Think about the different kinds of evidence needed to test the hypothesis.
2. Choose the best strategy to collect this data.
   - **perform an experiment** (in the lab)
   - **observe the natural world** (in the field)
   - **make a model** (on a computer)
3. Plan a procedure and gather data.

▶ **Make sure the procedure can be repeated.**

Collecting Data

Jim and Francesca follow their plan. They pour crushed rock and water into tiny metal capsules. They add different amounts of chlorine. One capsule has no chlorine.

Francesca puts the sealed capsules inside a strong steel cylinder. Then Jim increases the pressure inside the cylinder. The high pressure makes the temperature about ten times hotter than a pizza oven!

After one week, it is time to cool the cylinder and open it. Jim and Francesca open the capsules. They observe the cooled rocks under a microscope. They count and record the number of holes. Later, they repeat the experiment exactly. They make sure the data are dependable.

The rock is crushed into small particles.

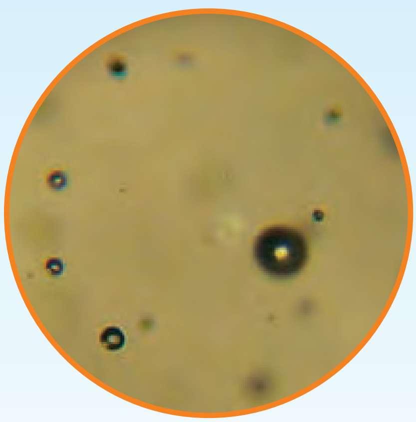
How do scientists analyze data?

When Jim and Francesca collect data, they keep careful records of their observations. They record how much chlorine went into each capsule. They carefully describe each tiny piece of cooled rock. They record the number of holes. Then they organize all this data in a way that makes sense.

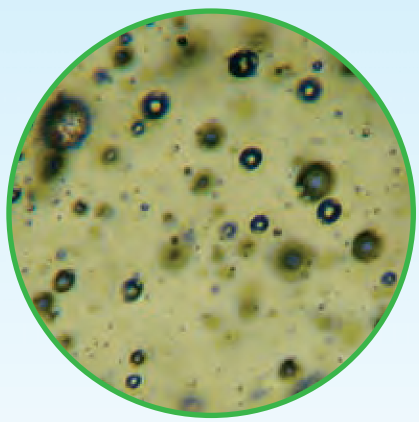
A lab assistant looks at each sample with an electron microscope. ▼

Comparing Samples

sample 1



sample 2



sample 3

Data Chart				
Run	Temperature	Pressure	Chlorine	Bubble
1	920°C	**200 MPa**	0%	none
2	920°C	**200 MPa**	0.8%	some
3	920°C	**200 MPa**	0.9%	many

Looking for Patterns

The table above has some of the results from Jim and Francesca's study. In total, they ran about 50 experiments. Each one took about a week to complete. That means it took almost a year to collect their data!

After Jim and Francesca organize all their data, they look for patterns. What do their data show? When a sample has more chlorine, the cooled rock has more holes. The control sample, without chlorine, has no holes at all.

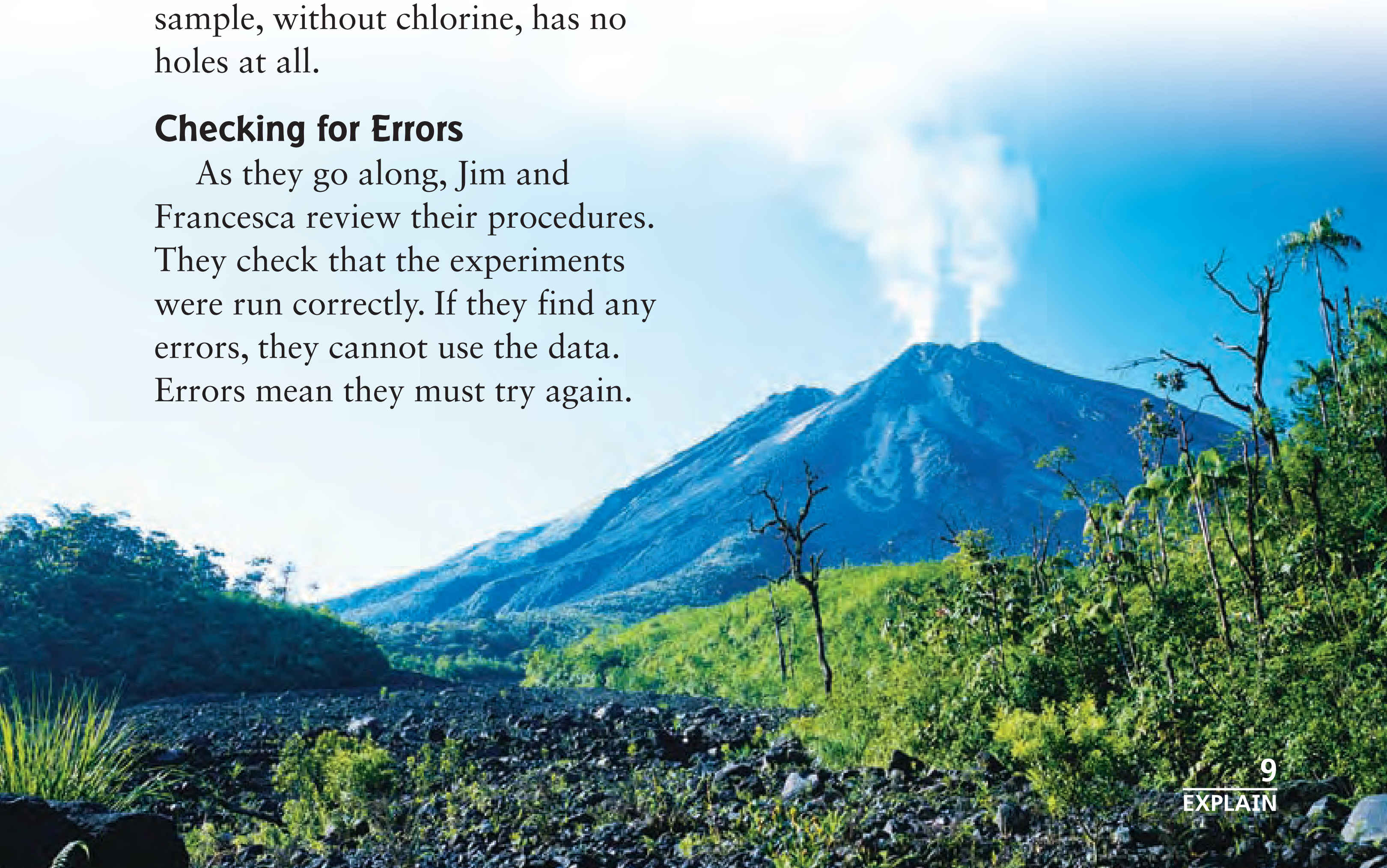
Checking for Errors

As they go along, Jim and Francesca review their procedures. They check that the experiments were run correctly. If they find any errors, they cannot use the data. Errors mean they must try again.

Analyzing the Data

1. Organize the data as a table, graph, diagram, map, or group of pictures.
2. Look for patterns in the data that show connections between important variables in the hypothesis being tested.

▶ **Make sure to check the data by comparing it to data from other sources.**



How do scientists draw conclusions?

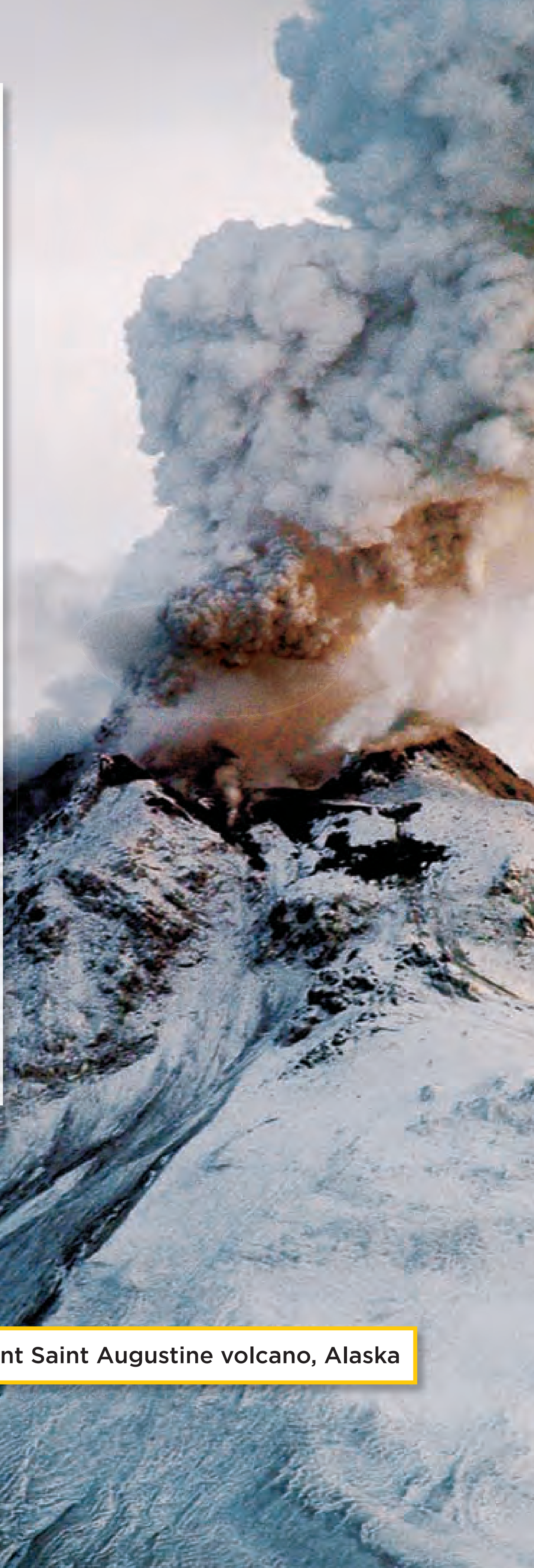
Now Jim and Francesca must decide if their data support their hypothesis. They compare their results with lavas from Mount Vesuvius and other explosive volcanoes. This comparison allows them to draw their conclusion.

Does more chlorine in the magma cause a bigger explosion? “Yes, it does!” Francesca exclaims.

The results of an experiment do not always support the tested hypothesis. This can be a useful outcome. When a hypothesis is not supported, scientists ask why. They may decide to test the hypothesis with new experiments using different methods.

Sometimes scientists conclude that a hypothesis is incorrect. When this happens, they often form a new hypothesis. Then they follow the steps of the scientific method once again!

Pumice is a lava from explosive volcanoes.



Mount Saint Augustine volcano, Alaska

Communicating

Jim and Francesca report their conclusions. This way, other scientists can do the same experiment and compare their results. Many scientists share their results so people can learn from their work.

Asking New Questions

A scientist's results may lead to new questions. Jim wants to know if chlorine affects eruptions at other volcanoes, too. What other gases affect the size of eruptions? What else happens when a volcano erupts?

Today Jim studies Mount Saint Augustine volcano in Alaska. Like Mount Vesuvius, Mount Saint Augustine is an active volcano. It makes up its own island in Alaska's Cook Inlet!

Drawing Conclusions

1. Decide if the data clearly support or do not support the hypothesis.
2. If the results are not clear, rethink the procedure.
3. Write up the results to share with others.

▶ **Make sure to ask new questions.**

Think, Talk, and Write

1. Why is the scientific method useful to scientists?
2. What other questions about volcanoes can you think of? Choose one. Form a hypothesis that could be tested.
3. What could scientists do if their data disproved their hypothesis?

Jim visits Mount Saint Augustine with other scientists. Together, they make new observations.

Focus on Skills

▲ What observations can you make about the squirrel in this photograph?

Scientists use many skills as they apply the scientific method. Inquiry (IN•kwuh•ree) skills help you gather information and answer questions about the world around you. Here are some important inquiry skills that all scientists use:

Observe Use your senses to learn about an object or event.

Form a Hypothesis Make a statement that can be tested to answer a question.

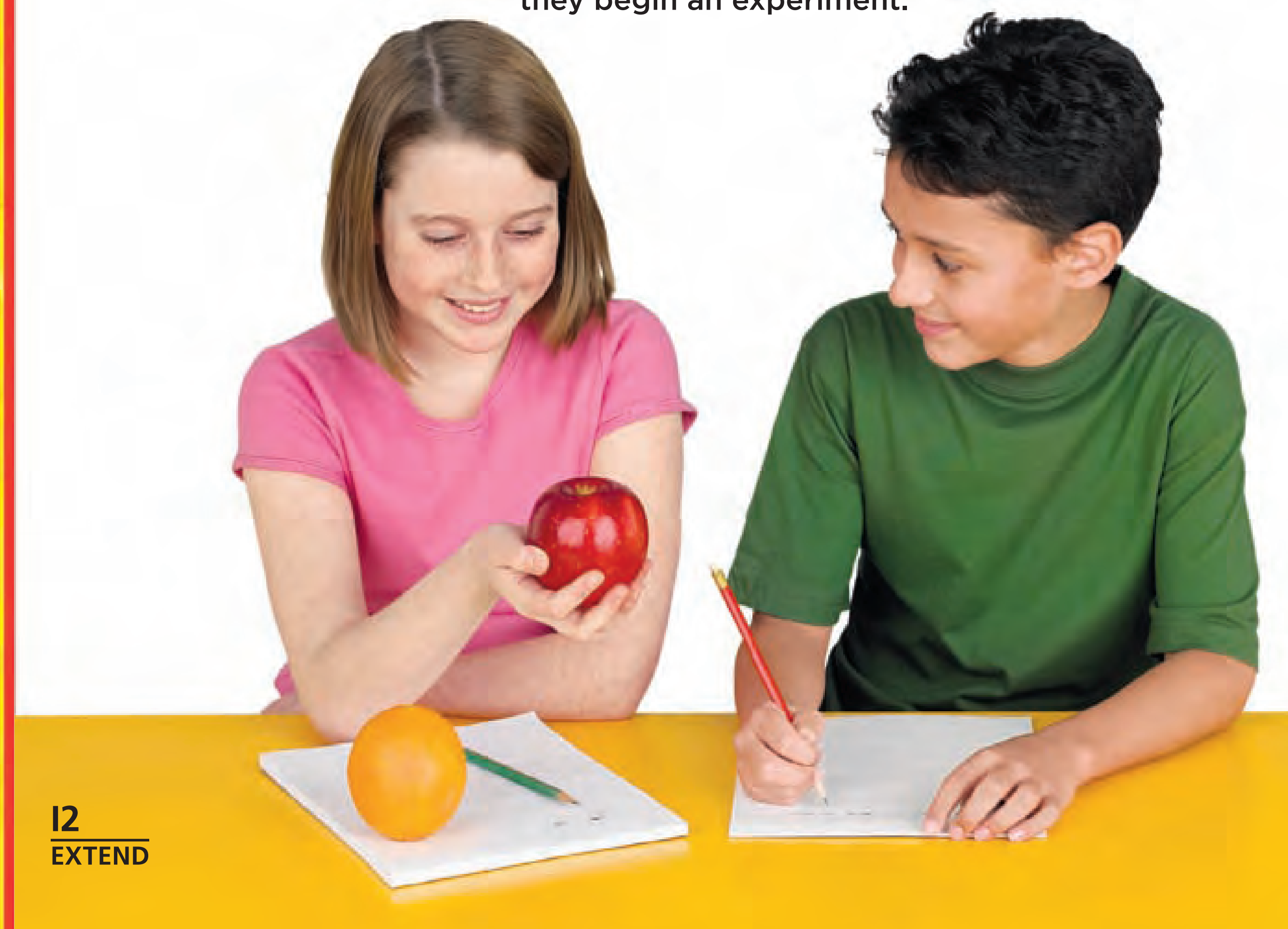
Communicate Share information with others.

Classify Place things with similar properties into groups.

Use Numbers Order, count, add, subtract, multiply, or divide.

Make a Model Assemble something that represents an object, a system, or a process.

Scientists form a hypothesis before they begin an experiment.



Carton A	
Prediction	
Day	Observations
1	
2	
7	
10	

A data table is a good way to organize information. ▶

Use Variables Identify things that can control or change the outcome of an experiment.

Interpret Data Use information that has been gathered to answer questions, solve problems, or compare results.

Measure Find the size, distance, time, volume, area, mass, weight, or temperature of something.

Predict State a likely result of an event or experiment based on facts or observations.

Infer Form an idea or opinion from facts or observations.

Experiment Perform a test to support or disprove a hypothesis.

It's important for a scientist to use variables during an experiment. ▶

Inquiry Skill Builder

In each chapter of this book, you will find an Inquiry Skill Builder. These features will help you practice the skills that scientists use every day.

Focus on Skills

Science and Technology:
The Design Process

When scientists have a problem, they must design a solution. Sometimes scientists must invent a brand new solution. Other times they might change an existing design.

▶ Learn It

How could you design a bridge? Use the **design process** to help you design a solution.

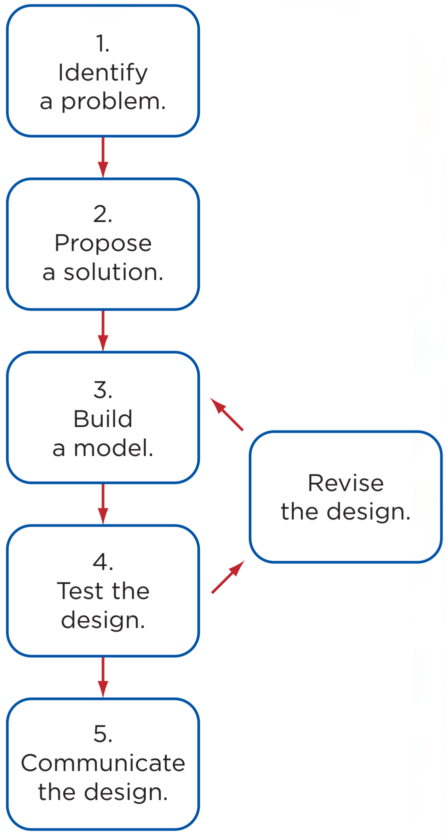
1. **Identify and describe the problem.**
   In order to solve the problem, you must understand it. How much distance must the bridge span? How much weight must it hold?
2. **Propose a solution.**
   Your solution should include the information needed to solve the problem. Consider the materials needed and how much time you have to solve the problem.
3. **Build a model.**
   A model is a small-scale or full-size replica of an object. Architects and engineers use models to test their designs.
4. **Test and revise the design.**
   When evaluating a design, ask the following questions
   a. Does it work?
   b. Will changes improve the solution?
5. **Explain the solution.**
   Finally communicate how you solved or did not solve the problem. Most designs are not perfect when they are first made. Present your design in a group discussion or a written report. Include pictures, diagrams, or photos.

ST-1. Explain how technology from different areas (e.g., transportation, communication, nutrition ... and manufacturing) has improved human lives.

▶ Try It

Materials **tape, straws, paper clips, construction paper, rubber bands, pennies, plastic cup**

1. Use the **design process** to construct a bridge from common classroom materials. Build the bridge between two level desks or stacks of books. Place the books or desks 0.5 meters (about 1.5 feet) apart. The bridge must support a plastic cup containing 20 pennies.
2. Illustrate what the bridge will look like before beginning. Label your illustration and list the materials.
3. Build your design.
4. Test your design. *Does it hold the cup with 20 pennies?*
5. If the bridge fails the 20-penny test, change your design. Then retest the design.
6. Explain your solution to the class.



Communication is the last step in the design process.

▶ Apply It

1. How could you improve the design of your bridge to support a cup with 40 pennies?
2. Compare any problems you and others in your class might have faced. Were there any common problems?
3. If you were designing a real bridge, why would it be important to build a model?
4. How could you use the design process to solve a real-life problem?
5. Research bridges built long ago. How has bridge design changed? How do bridges improve human lives?

ST-2. Investigate how technology and inventions change.... **ST-3.** Describe, illustrate and evaluate the design process used to solve a problem.

Safety Tips

In the Classroom

- Read all of the directions. Make sure you understand them. When you see "⚠ **Be Careful,**" follow the safety rules.
- Listen to your teacher for special safety directions. If you do not understand something, ask for help.

- Wash your hands with soap and water before an activity.
- Be careful around a hot plate. Know when it is on and when it is off. Remember that the plate stays hot for a few minutes after it is turned off.
- Wear a safety apron if you work with anything messy or anything that might spill.

- Clean up a spill right away, or ask your teacher for help.
- Dispose of things the way your teacher tells you to.
- Tell your teacher if something breaks. If glass breaks do not clean it up yourself.

- Wear safety goggles when your teacher tells you to wear them. Wear them when working with anything that can fly into your eyes or when working with liquids.
- Keep your hair and clothes away from open flames. Tie back long hair, and roll up long sleeves.
- Keep your hands dry around electrical equipment.
- Do not eat or drink anything during an experiment.
- Put equipment back the way your teacher tells you to.
- Clean up your work area after an activity, and wash your hands with soap and water.

In the Field

- Go with a trusted adult, such as your teacher, or a parent or guardian.
- Do not touch animals or plants without an adult's approval. The animal might bite. The plant might be poison ivy or another dangerous plant.

Responsibility

Treat living things, the environment, and one another with respect.

Ohio

Life Sciences

Most modern ferns are small, but ancient ferns once grew as tall as trees.

Conkle's Hollow Nature Preserve, Logan, Ohio

fossils from Fossil Park

trilobite

Fossil Park

Finding Fossils

Visiting Fossil Park near Toledo gives you the chance to be a paleontologist (pay•lee•on•TAH•lu•just). A paleontologist studies fossils to learn about Earth's past.

Workers at a nearby quarry, or rock mine, dig up piles of rocks. They put the rocks in Fossil Park for people to look through. If you find any fossils, you can take them home! You might find a trilobite (TRIGH•loh•bight) fossil at the park. *Trilobites* were common ocean animals hundreds of millions of years ago.

Ohio's Past

Fossils formed long ago when ancient organisms died. They were buried by layers of sediment. When the sediment became rock, their shapes were preserved.

Fossils provide clues to what Earth was like in the past. For example coal deposits in Ohio, Pennsylvania, and West Virginia contain fossils of ferns. Modern ferns similar to the type found there grow in warm, moist areas such as tropical rain forests. Because of this, we can infer that southeastern Ohio had a tropical climate a long time ago.

Think, Talk, and Write

Critical Thinking Why do we find fossils of ocean animals in Ohio?

LS-4. Observe and explore that fossils provide evidence about plants that lived long ago and the nature of the environment at that time.

Ohio

A CLOSER LOOK

Main Idea

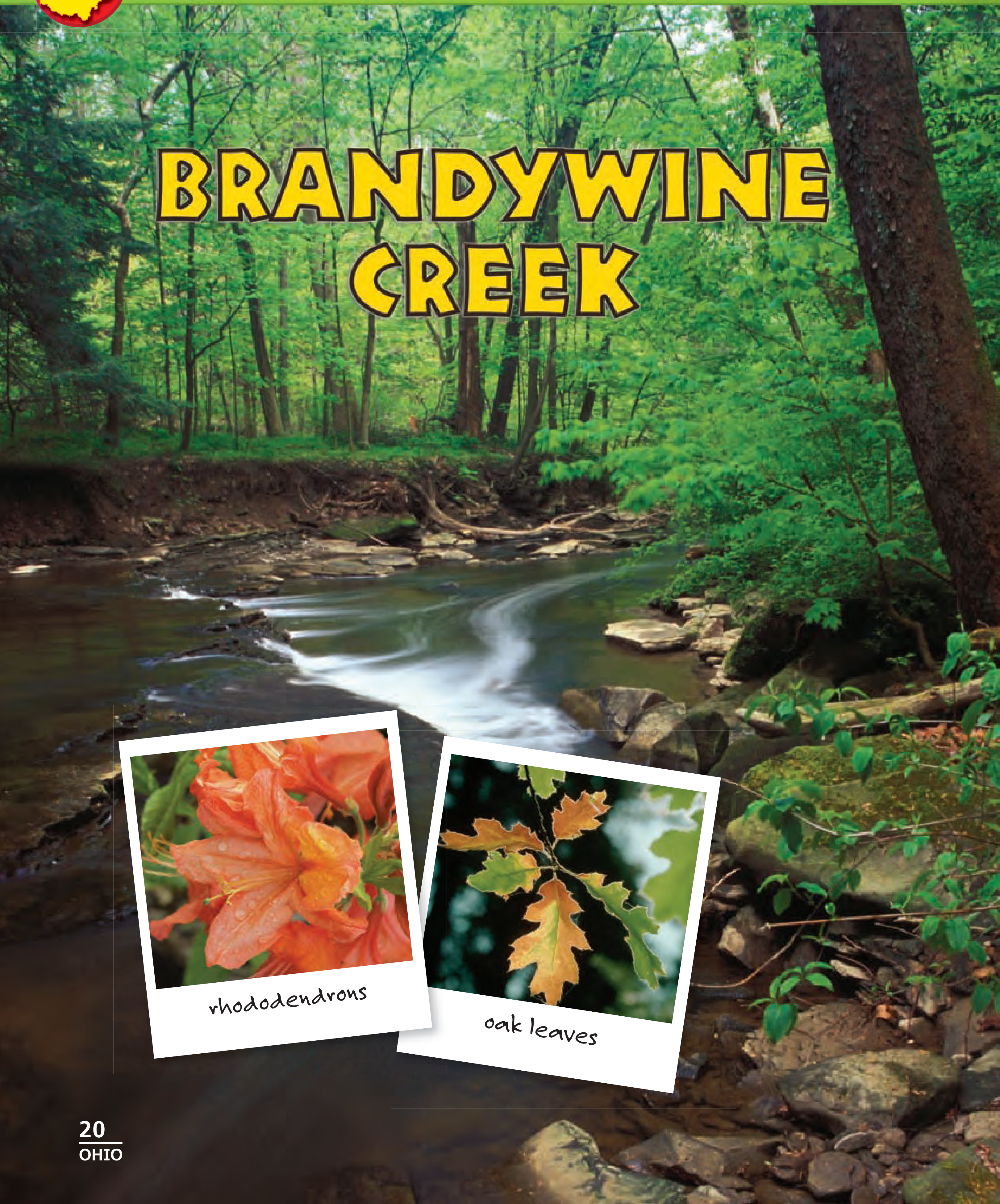
Fossils are the remains of organisms that lived long ago. They can look similar to, or different from, plants and animals alive today.

Activity

Classify Look at pictures of different plant and animal fossils. Conduct research to find out where they live.

- Which fossils look like plants or animals that are alive today?
- Compare fossils to living organisms. What can fossils tell you about past environments?

BRANDYWINE CREEK



rhododendrons

oak leaves

Cuyahoga Valley National Park

No matter what season it is, Brandywine Creek is always a beautiful sight to see. During autumn you can watch the brightly colored leaves fall in the creek and float downstream. During winter look for large icicles instead of flowing water.

Brandywine Creek is located in Cuyahoga Valley National Park in northeastern Ohio. The park surrounds the Cuyahoga River and covers 33,000 acres of land! Many habitats are found within the park, such as forests, wetlands, fields, and bodies of water.

Plants in the Park

Cuyahoga Valley National Park is home to more than 900 plant species. You can find oak, hickory, and pine forests in the park.

Plants are classified by their structures. For example oak trees have lobed leaves and produce seeds called *acorns*. Other plants such as ferns do not produce seeds at all. Ferns reproduce with *spores*.

Spring features blooming wildflowers in the park. Many shrubs and trees have flowers as well. Flowers can be used to classify trees and other plants.

Think, Talk, and Write

Critical Thinking You see a plant while walking through the park. How would you begin to classify the plant?

LS-3 Classify common plants according to their characteristics (e.g., tree leaves, flowers, seeds, roots and stems).

Ohio

A CLOSER LOOK

Main Idea

Plants can be classified by their characteristics.

Activity

Classify Research the different shapes of tree leaves. Some examples are palmate, smooth, lobed, pinnate, and toothed.

- Collect leaves from trees in your local area.
- Classify the leaves according to their characteristics.
- Can you identify the tree by its leaves? What other characteristics can help you identify trees?

CHAPTER 1

Kingdoms of Life

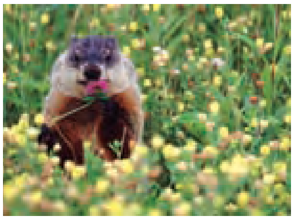
The Big Idea

What are living things and how are they classified?

Coral reef in Indo-Pacific Ocean, Indonesia

Key Vocabulary

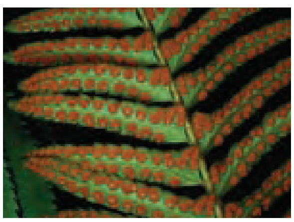
cell
the smallest unit of living matter (p. 26)



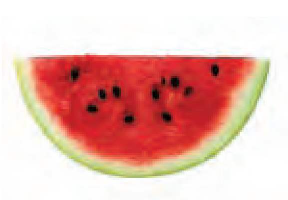
organism
a living thing that carries out five basic life functions on its own (p. 26)

trait
a characteristic of a living thing (p. 38)

photosynthesis
a process in plants that uses energy from sunlight to make food from water and carbon dioxide (p. 54)



spore
one of the cells in a seedless plant that grows into a new organism (p. 56)



seed
an undeveloped plant with stored food sealed in a protective covering (p. 64)

More Vocabulary

oxygen, p. 26
tissue, p. 31
organ, p. 31
organ system, p. 31
kingdom, p. 39
root, p. 53
root hair, p. 53
stem, p. 53
stomata, p. 55
transpiration, p. 55
respiration, p. 55
reproduction, p. 66
ovary, p. 66
pollination, p. 67
fertilization, p. 67
germination, p. 68
life cycle, p. 69

LS-A. Differentiate between the life cycles of different plants and animals.
LS-B. Analyze plant and animal structures and functions needed for survival....

Lesson 1

Cells

Look and Wonder

What do you see in this picture? Is it something you have seen before? Each one of these boxes is so tiny, you can only see it through a microscope.

Building block lesson for LS-2. Relate plant structures to their specific functions (e.g., growth, survival and reproduction).

Explore

Inquiry Activity

What are living things made of?

Purpose

Use different ways of observing to explore the parts of plants.

Procedure

1. **Infer** Draw an onion plant. Label its parts. How might each part help the plant to live?
2. Ask your teacher to cut the plant lengthwise. Draw and label what you see in a data table.
3. **Observe** Look at the onion skin and the leaf with a hand lens. Draw what you see in your data table.
4. Ask your teacher for the prepared slides. One has onion skin. The other has a leaf. Look at the slides under a microscope. Draw them in your data table. Use high and low power.

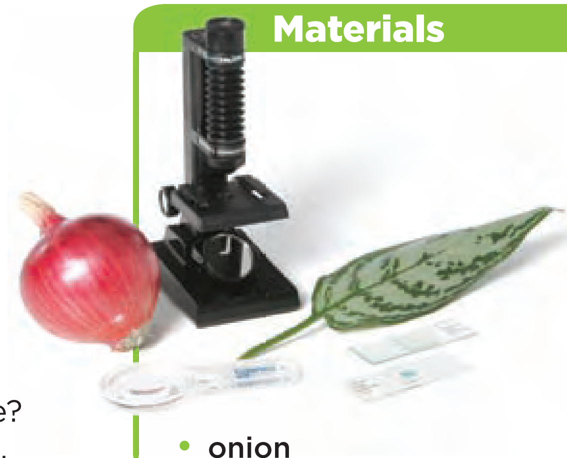
Draw Conclusions

5. **Communicate** How did your observations change as you looked more closely?
6. **Interpret Data** What do both the onion skin and the leaf seem to be made of?

Explore More

What might you see if you looked at the onion's roots? Make a plan to test your idea. Then try it!

Materials



- onion
- leaf
- hand lens
- prepared slides of onion skin and leaf
- microscope

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Read and Learn

Main Idea LS-2

Cells are the basic building blocks of all living things.

Vocabulary

cell, p. 26

oxygen, p. 26

organism, p. 26

tissue, p. 31

organ, p. 31

organ system, p. 31

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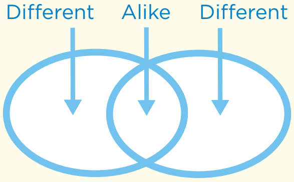
Reading Skill

Compare and Contrast



What are living things?

You know that plants and animals are living things. How do you know? For one thing, plants and animals have cells (SELZ). A **cell** is the smallest unit of living matter. Ants and onion plants are made of cells. You are, too!

Living Things Have Needs

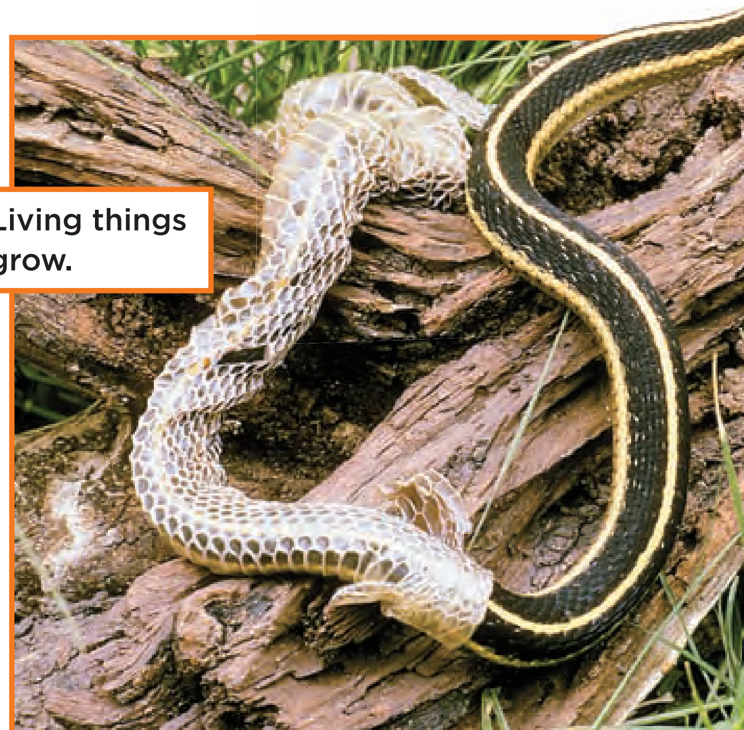
A living thing may have millions of cells. It may only have one cell. In any case, all living things have needs. They need water, food, and a place to live. They also need **oxygen** (OK•suh•juhn)—a gas in air and water.

Living Things Reproduce

Scientists use the word *organism* in place of *living thing*. An **organism** is a living thing that carries out five basic jobs, or *life functions*.

One life function is for organisms to make more of their own kind. The birds below are albatross. The chick is their offspring. *Offspring* is a term we use for the young of living things. To make more of one's own kind is to *reproduce*.

Living things reproduce.



Living things grow.

Other Life Functions

As a snake grows bigger, it sheds its skin. Not all organisms shed their skin. But they all grow and develop.

How do organisms get energy for growing? They use food! Woodchucks eat flowers. Plants make their own food. After they eat, organisms must get rid of wastes. Owl pellets show what food an owl ate.

Lastly, all organisms react to changes in their environment. Why are all the sunflowers in the photo facing the same way? Like all plants, they grow toward the light.

Is It a Living Thing?

Life Function	Lizard	Rock	Car
Does it grow?	✔	✘	✘
Does it use food to get energy?	✔	✘	✔
Does it get rid of wastes?	✔	✘	✔
Does it reproduce?	✔	✘	✘
Does it react to changes in its environment?	✔	✘	✘

Read a Table

How can you tell if a car is a living thing?

Clue: See if it performs all five life functions.

Quick Check

Compare and Contrast How are plants different from computers?

Critical Thinking What makes you a living thing?

Living things get rid of wastes.

Living things use food for energy.

Living things react to changes.

How do plant and animal cells compare?

All cells have smaller parts that help them stay alive. But all cells are not the same. Plants and animals share some of the same cell parts. Plant cells also have some things that animal cells do not have.

Plant Cells Have Chlorophyll

Most plant cells have green parts called *chloroplasts* (KLAWR•uh•plasts). They are filled with a green substance called *chlorophyll* (KLAWR•uh•fil). This substance helps plants make food using the Sun's energy. Animal cells do not have chloroplasts or chlorophyll.

Plant Cells Have Cell Walls

Plant cells also have sturdy *cell walls*. Cell walls give the cell a shape like a box. Animal cells have a cell membrane, but not a cell wall. Animal cells tend to have a round shape.

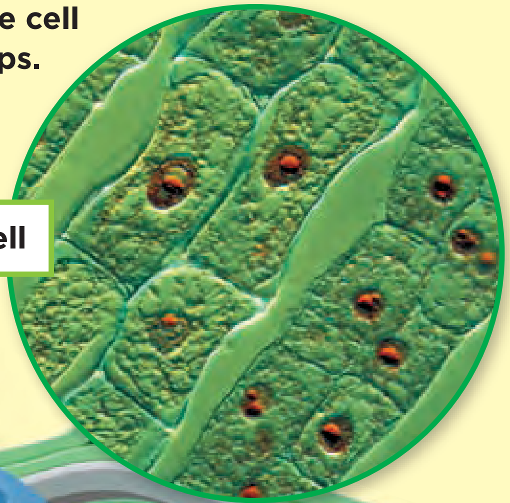
1 **cell wall**
This stiff structure protects and supports the plant cell.

2 **mitochondrion**
(my•tuh•KON•dree•uhn)
Food is burned here to give the cell energy.

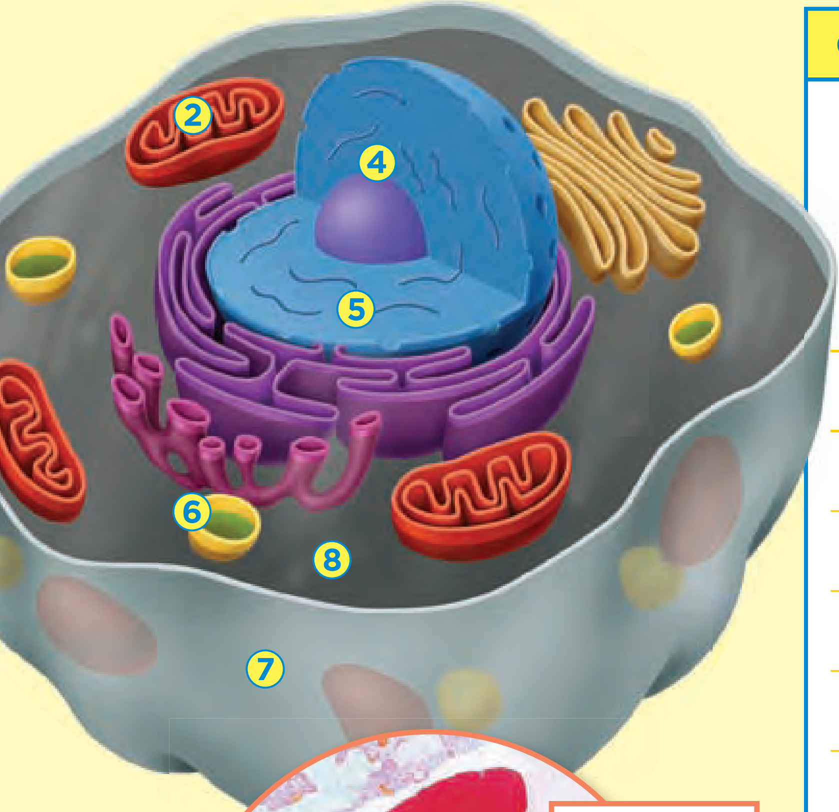
3 **chloroplast**
The plant cell's food factory has chlorophyll.

4 **nucleus** (NEW•klee•uhs)
This controls all cell activities.

5 **chromosome**
(KROH•muh•sohm)
These control how the cell develops.



plant cell

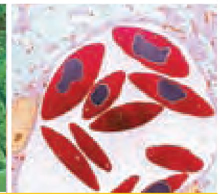


⑥ **vacuole** (VAK•yew•ohl)
This structure stores the cell's food, water, and wastes. Plant cells have one or two vacuoles. Animal cells have many.

⑦ **cell membrane**
This thin covering is found outside the cell. In plants, it is inside the cell wall.

⑧ **cytoplasm** (SY•tuh•plaz•uhm)
Filling the cell is a substance that is like jelly. It is mostly water. It also has important chemicals.

Cell Parts

	Plant Cells 	Animal Cells 
cell wall	✔	✘
mitochondria	✔	✔
chloroplasts	✔	✘
nucleus	✔	✔
chromosomes	✔	✔
vacuole	large	small
cell membrane	✔	✔
cytoplasm	✔	✔

Read a Table

How are a plant cell and an animal cell alike? How are they different?

Clue: Read down the list of cell parts. Compare the plant cell side by side with the animal cell.

Quick Check

Compare and Contrast How is a cell wall different from a cell membrane?

Critical Thinking Could an animal cell be green? Why or why not?

How are cells grouped?

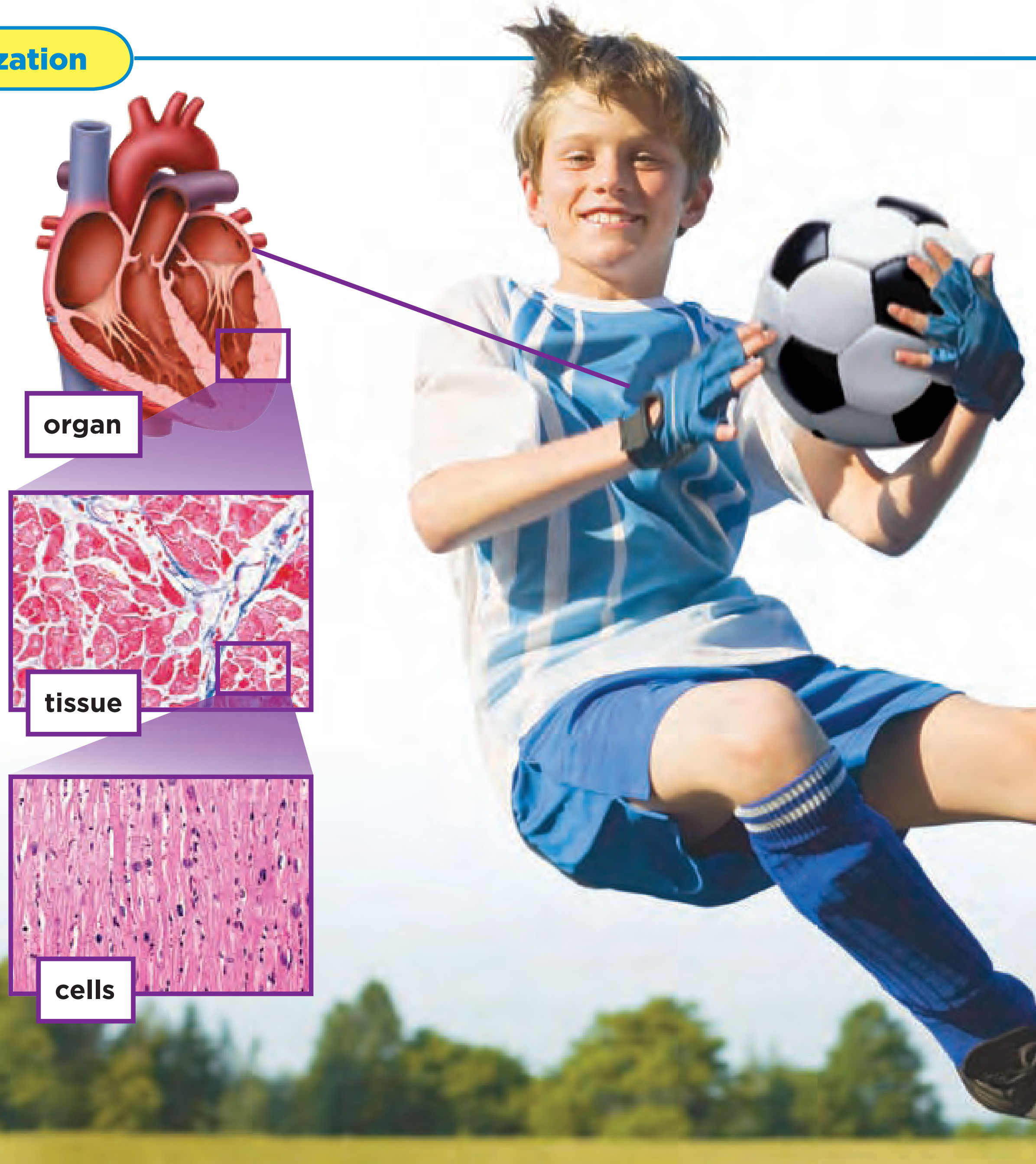
What makes your heart different from your skin? The cells are different! When an organism has many cells, its cells tend to do different jobs.

For instance, many plants have root cells. Their job is to take in water and nutrients. Root cells do not make food, so they have no chloroplasts. Other cells in the plant make food.

Animals take in substances from red blood cells. Red blood cells look like soccer balls without any air inside. They have the important job of carrying oxygen and other matter through the body.

Nerve cells carry messages from one part of an animal's body to another. When you want to walk, nerve cells carry the message from your brain to your leg. Then your muscle cells help move your leg.

Levels of Organization



The heart is an organ that pumps blood.

The heart is made of different kinds of tissues.

Muscle cells make up muscle tissue.

Cells Make Up Tissues

In organisms with many cells, the ones that do the same job all group together. These cell groups form tissues (TISH•ewz). A **tissue** is a solid wall of cells that are alike. It is much like a wall made of bricks.

Tissues Make Up Organs

Tissues can also group together. When they do, they form an **organ**. The tissues in an organ work together to carry out a job. For instance, your heart pumps blood.

Organs Make Up Organ Systems

Organs work together in an **organ system** to perform a life function. Your heart is part of the circulatory system. It moves blood throughout your body.

Quick Check

Compare and Contrast How is an organ different from a tissue?

Critical Thinking Why do different living things need different organs?

Quick Lab

Cells, Tissues, and Organs

1. One by one, each student calls out a cell name—blood, nerve, or muscle—in that order. Each student writes the name of the cell on a card.
2. **Make a Model** The "cells" students model tissues by pairing up in groups of two. For example, two nerve cells standing together represent nerve tissue.
3. The "tissues" students model organs by forming groups of three different tissues.
4. Find a way to model an organ system.

How can you see cells?

Some things are too small to see with your eyes alone. Most cells are that tiny. Bacteria (bak•TEER•ee•uh) are the smallest cells of all!

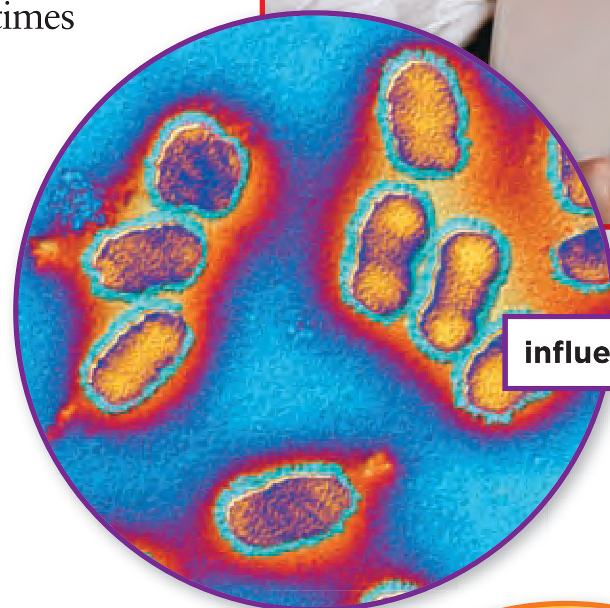
Microscopes

To see most cells, you need to use a microscope (MY•kruh•skohp). A microscope works like a hand lens. It makes small things look much bigger.

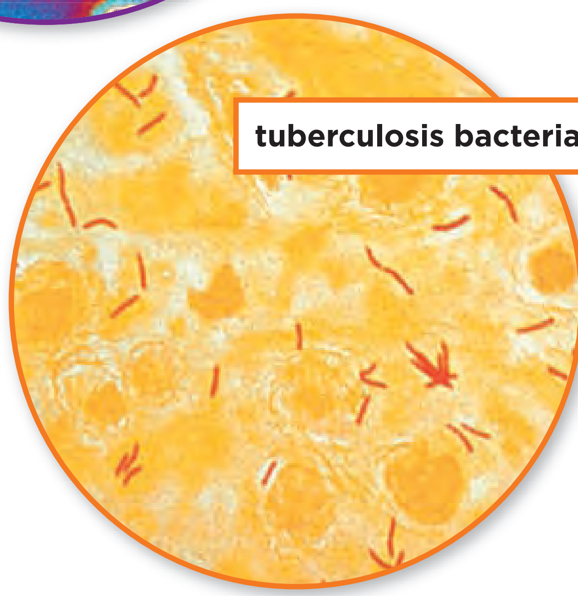
The microscopes scientists use are a lot more powerful than the ones you use. Some can make a cell look hundreds of thousands of times larger!

Microscopes are also used to study viruses. *Viruses* are even smaller than cells. Viruses cannot reproduce on their own. Instead, they force living cells to make new copies of the virus.

Scientists use microscopes to see bacteria and viruses.



influenza virus



tuberculosis bacteria

Quick Check

Compare and Contrast How is a hand lens like a microscope? How is it different?

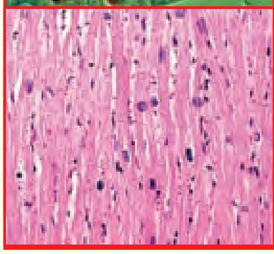
Critical Thinking Is a virus a living organism? Explain.

Lesson Review

Visual Summary

Living things are made of cells. Cells help organisms perform five basic life functions.

Plant cells and animal cells share several basic parts. Plant cells have some parts that animal cells do not.



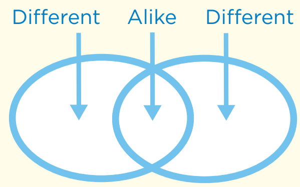
Organisms can exist as single cells. Cells can be organized into **tissues, organs, and organ systems**.

Make a FOLDABLES Study Guide

Make a Trifold Book. Use it to summarize what you read about living things.

Think, Talk, and Write

1. **Main Idea** What are the five basic life functions?
2. **Vocabulary** The ________ controls the activities of the cell.
3. **Compare and Contrast** How are plant and animal cells alike? How are they different?



4. **Critical Thinking** Can one cell be a living thing? Explain why or why not.
5. **Test Prep** **Which of these parts is only in plant cells?**
   - **A** mitochondrion
   - **B** chloroplast
   - **C** cell membrane
   - **D** chromosome
6. **Test Prep** **All cells in a plant**
   - **A** are shaped like boxes.
   - **B** have tiny vacuoles.
   - **C** do the same job.
   - **D** are round.

Writing Link

Write a Story
Write a story that starts by looking at an organism from far away. Describe it as you move closer and closer, until the cells are visible. What would you see each time you get closer?

Math Link

Estimate
Professor Bubica sees 38 cells in her microscope. If she uses a less powerful microscope, she will see five times as many. How many cells will she see in the second microscope?

Focus on Skills

Inquiry Skill: Observe

You have read about the organ systems of plants. An organ system performs a job. Plants have an organ system to move water from the ground into the plant's cells. How do scientists know this? They **observe** plants.

▶ Learn It

When you **observe**, you use one or more of your senses to learn about the world around you. Even though scientists know a lot about plants, they continue to observe them. Scientists are always learning new things about plants. They record their observations so they can share information with others. They use their observations to try to understand things in our world. You can, too!

▶ Try It

In this activity you will **observe** how water moves through a plant. Remember to record your observations.

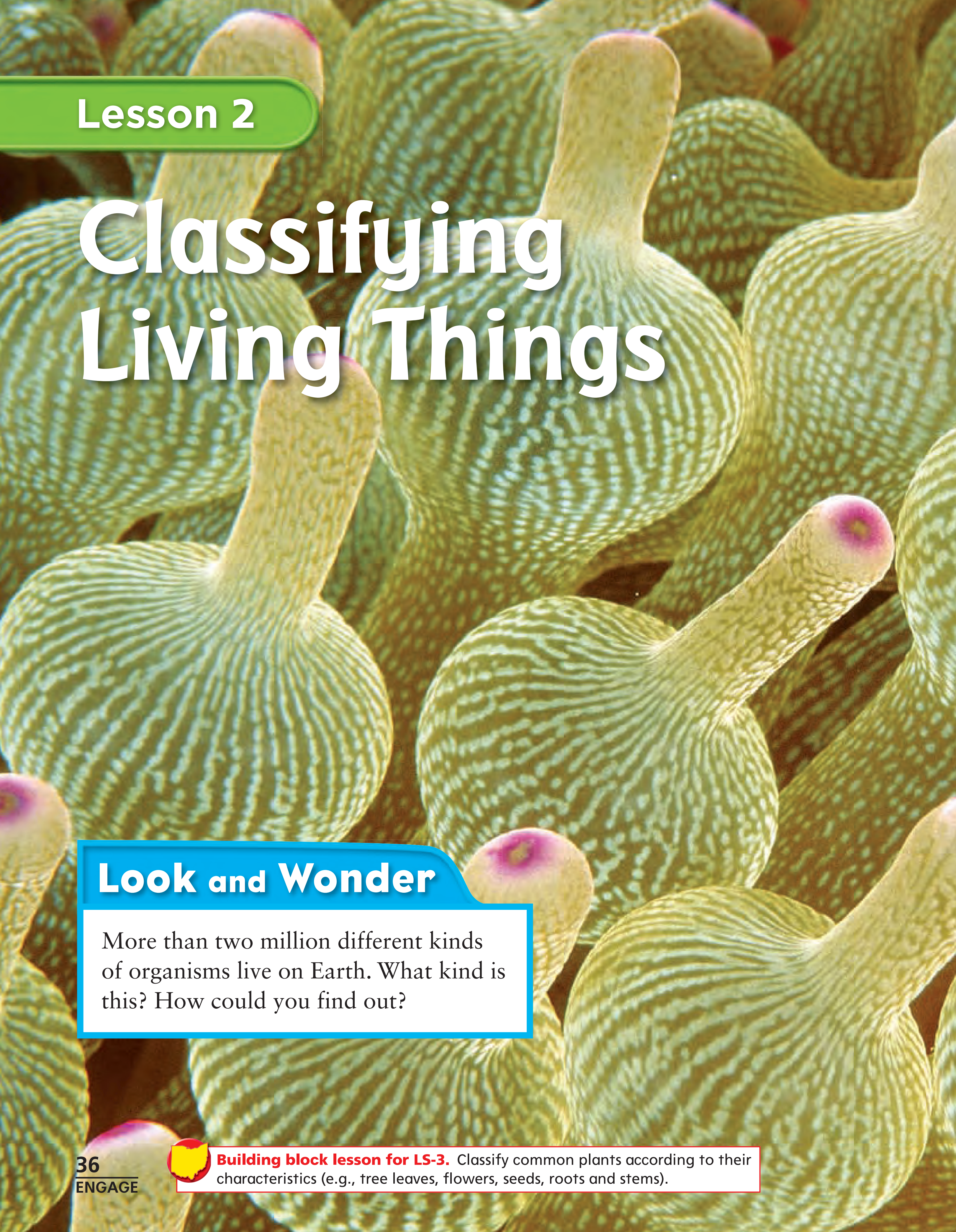
Materials **water, jar, blue food coloring, spoon, celery stalk, scissors**

1. Pour 100 mL of water into a jar. Add a few drops of blue food coloring to the jar. Stir the contents with a spoon.
2. Use scissors to cut about 3 cm off the bottom of a fresh celery stalk. Put the stalk in the jar of water. Record the time when you do this.
3. Observe the celery for 30 minutes. Record your observations. Use your observations to describe how water moves through a plant.

▶ Apply It

Now **observe** how water travels through other plants. Repeat your inquiry using a white flower, such as a carnation. Record your observations. Then share them with your classmates.

SWK-2. Record the results and data from an investigation and make a reasonable explanation.



Lesson 2

Classifying Living Things

Look and Wonder

More than two million different kinds of organisms live on Earth. What kind is this? How could you find out?

Building block lesson for LS-3. Classify common plants according to their characteristics (e.g., tree leaves, flowers, seeds, roots and stems).

Explore

Inquiry Activity

How are organisms classified?

Purpose

Explore how to sort animals and plants into groups using different characteristics.

Procedure

1. Choose ten different animals and plants. You may pick organisms that you see in your neighborhood. You may also use some of the organisms shown here. Make a card for each organism you choose.
2. **Observe** How are the organisms alike? How are they different? Do the animals have wings, beaks, or tails? Do the plants have seeds or flowers? Make a data table. Record each organism's characteristics.
3. **Classify** Sort your cards into groups that have similar characteristics. This is one way scientists classify animals and plants.

Draw Conclusions

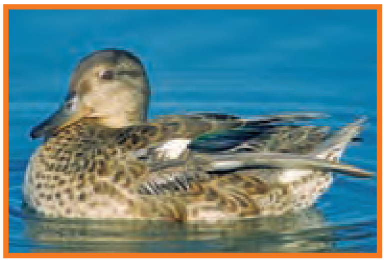
4. **Observe** What are the characteristics of the organisms in each group? Make a list.
5. **Predict** Will your classification work for other organisms? Think of other animals or plants that could be placed into each group.

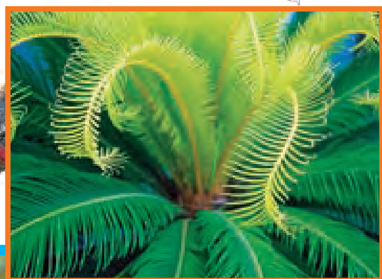
Explore More

Find out how other students sorted their organisms. Are their groups the same as yours? Which characteristics did other students use? Compare them to the characteristics of your organisms.

Materials

- paper
- scissors
- colored markers





SWK-4. Explain why keeping records of observations and investigations is important.

Read and Learn

Main Idea LS-3

Living things can be divided into six kingdoms. Members of each kingdom can be grouped into phylum, class, order, family, genus, and species.

Vocabulary

trait, p. 38

kingdom, p. 39

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Reading Skill

Classify

Technology SCIENCE QUEST

Explore classification on Science Island.

How are living things classified?

Have you ever tried to sort laundry? How do you do it? You might not have known it, but sorting laundry is a way to classify items. When you *classify*, you place things that share properties together in groups.

To classify, you have to decide what characteristics to use to define the groups. For example, you can sort laundry by color. Living things can be organized into groups, too.

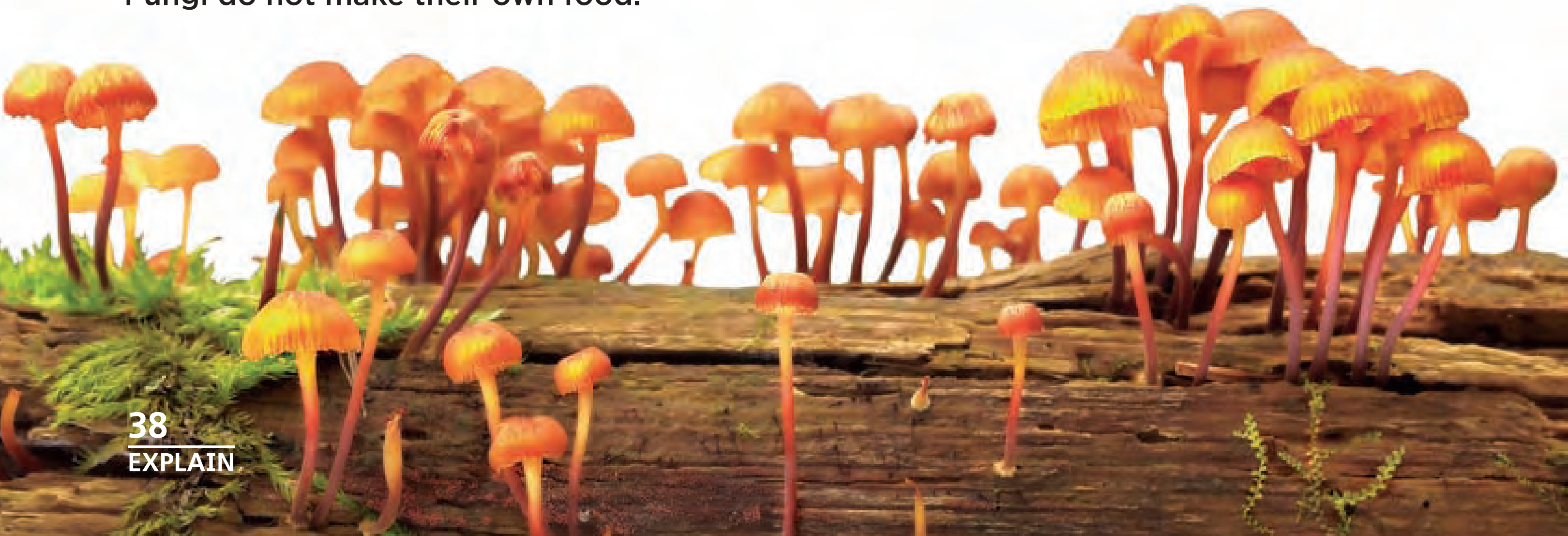
Traits

To classify organisms into large groups, scientists study many traits. A **trait** is a characteristic of a living thing.

Scientists look at body form and how an organism gets food. They observe if it moves from place to place. They also study the number of cells, if the cell has a nucleus, and cell parts.

For many years, scientists could not agree on a way to classify living things. People often used different names to describe the same organism. Over time, a system of classification came about.

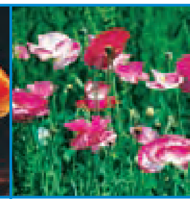
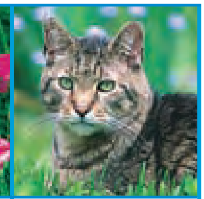
Mushrooms are fungi, not plants. Fungi do not make their own food.



Classifying Organisms





Kingdom	ancient bacteria	bacteria	protists	fungi	plants	animals
Number of Cells	one	one	one or many	one or many	many	many
Nucleus	no	no	yes	yes	yes	yes
Food	make their own or get food from other organisms	make their own or get food from other organisms	make their own or get food from other organisms	get food from other organisms	make their own food	get food from other organisms
Move from Place to Place	yes	yes	yes	no	no	yes

Six Kingdoms

Scientists divide living things into six kingdoms. A **kingdom** is the largest group into which organisms can be classified. All the members of a kingdom share the same basic traits.

Plants have their own kingdom. So do animals. There are so many kinds of bacteria, they get two kingdoms! There is also a kingdom for *protists* (PROH•tists) and one for *fungi* (FUN•jye). The chart shows which traits the organisms in each kingdom share.

Read a Chart

How are the two kingdoms of bacteria different from the other four kingdoms?

Clue: Find the columns for both kingdoms of bacteria. Compare the data side by side with other columns.

Quick Check

Classify Into which kingdom would you classify an organism that has many cells, does not make its own food, and moves?

Critical Thinking Some bacteria make their own food. Why are they not classified as plants?

How are organisms grouped within a kingdom?

Squirrels and lizards belong to the animal kingdom even though they are very different. To further classify animals, scientists divide them into smaller groups.

The next group down is a *phylum* (FY•luhm). Members of a phylum have at least one major trait in common, such as having a backbone.

A phylum is broken down into smaller groups called *classes*. Each class has even smaller groups of *orders*. Orders have *families*.

The chart shows these groups from largest to smallest. Each grouping has fewer and fewer members. The smaller the group, the more similar the organisms in it are to each other. The smallest are *genus* (JEE•nuhs) and *species* (SPEE•seez).

The Eastern red squirrel is a member of the animal kingdom.

Kingdom

Members of the animal kingdom move, eat food, and reproduce.

Phylum

Members of this phylum share at least one major characteristic, such as having a backbone.

Class

Members of this class produce milk for their young.

Order

Members of this order have long and sharp front teeth.

Family

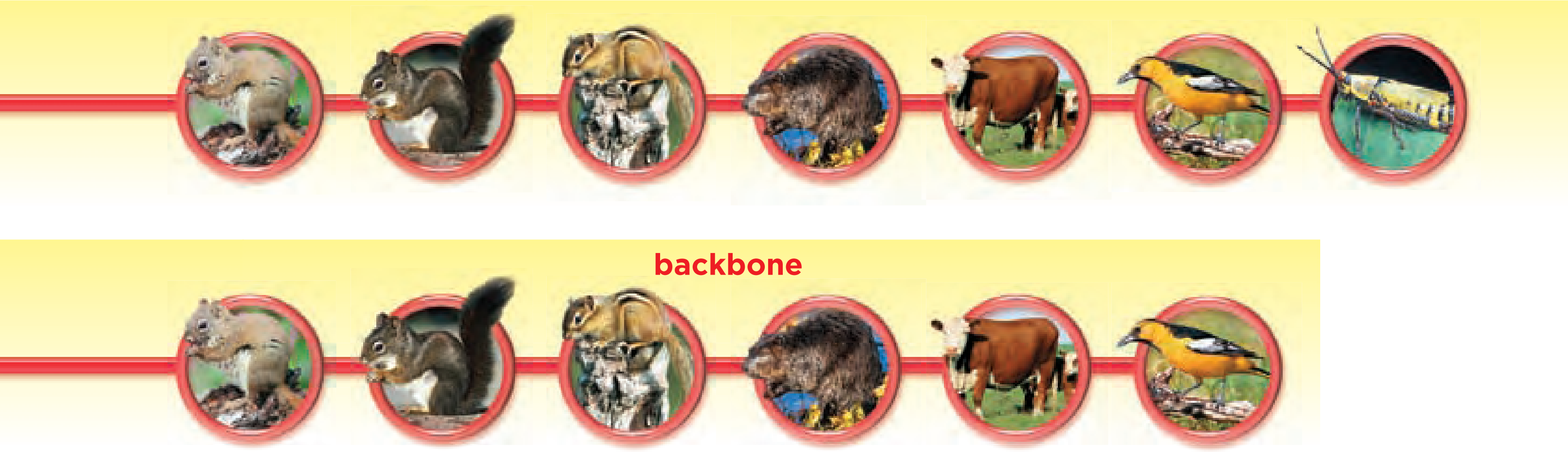
Members of this family have a bushy tail.

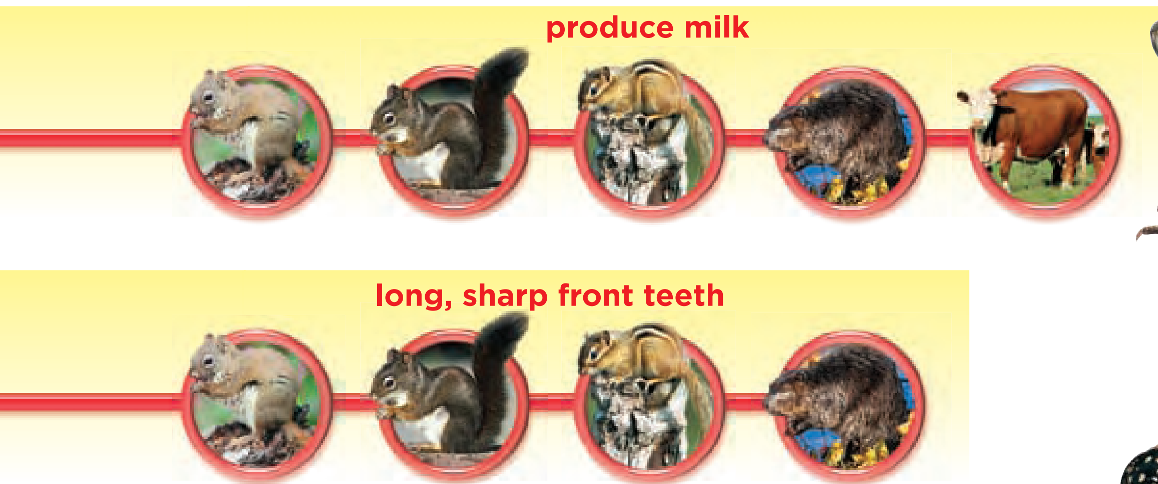
Genus

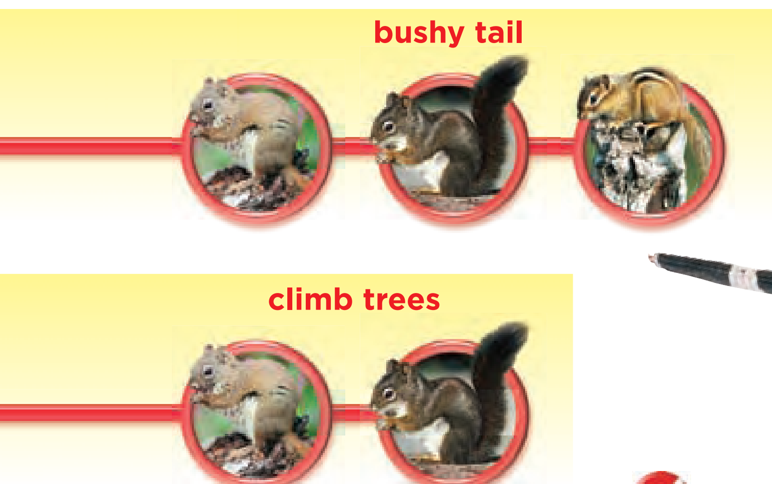
Members of this genus climb trees.

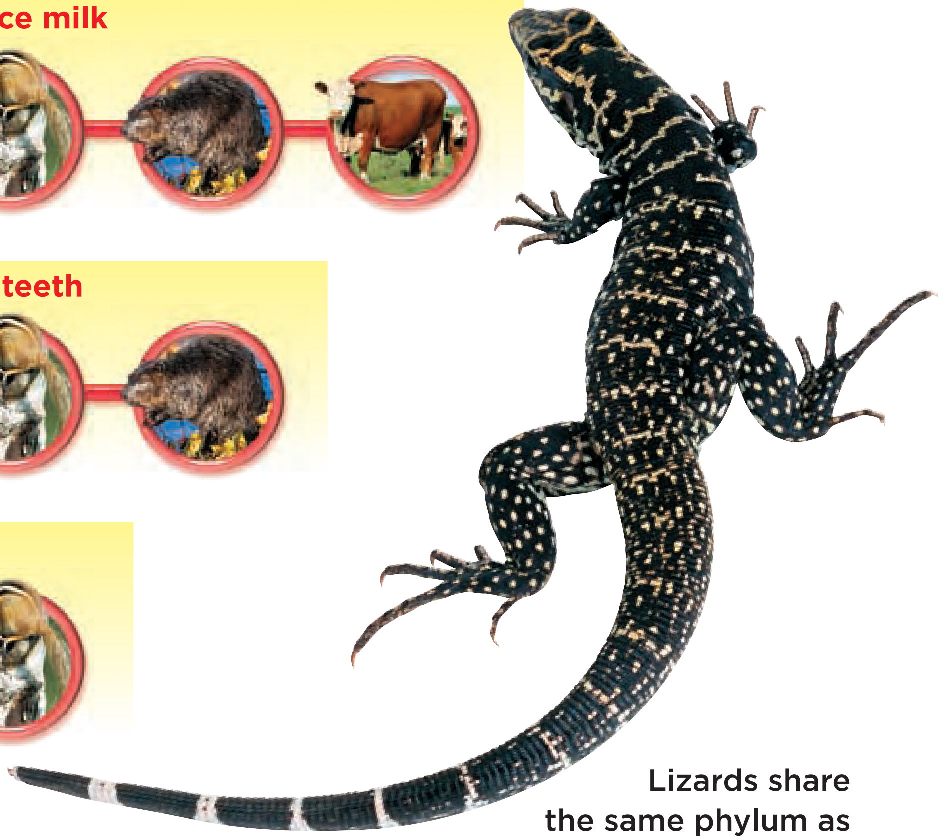
Species

A species is made up of only one type of organism.







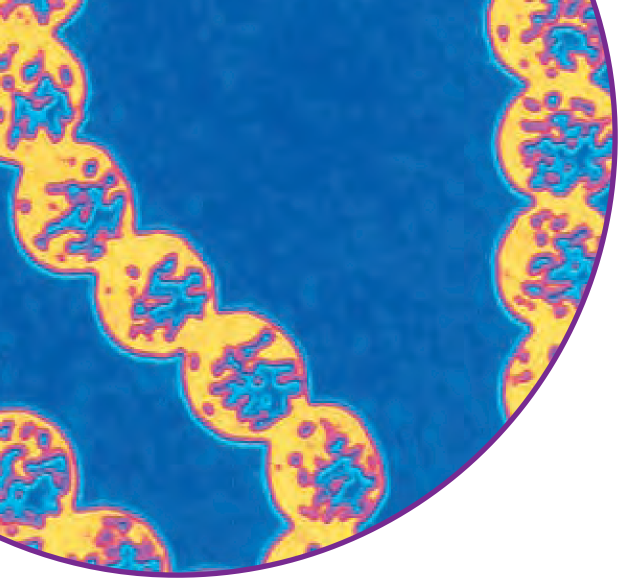


Lizards share the same phylum as squirrels. They both have backbones.

Quick Check

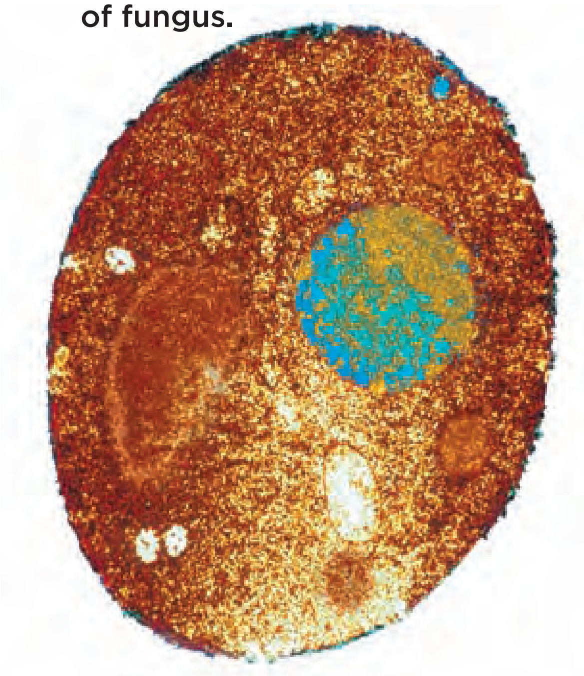
Classify Why does a phylum have more members than an order? Explain.

Critical Thinking Can organisms that belong to different kingdoms be in the same phylum? Explain why or why not.



Streptococcus bacteria can cause infections like "strep" throat.

Yeast is a kind of fungus.



What kinds of organisms have only one cell?

You cannot see them, but there are tiny living things everywhere. They are on the food you eat. They are on the book you hold. They are inside and outside your body. You will find them in lakes, oceans, ponds, and rivers.

What are these tiny organisms? They are microorganisms (MY•kroh•AWR•guh•niz•uhmz). *Microorganisms* are living things too small to be seen with just our eyes. Most microorganisms are made of only one cell.

Bacteria

Bacteria are the smallest and simplest microorganisms. They are the only living things that have no cell nucleus. Some bacteria break down dead plant matter for food. Others make their own food.

You probably know that bacteria can cause infections and diseases. Some bacteria are helpful. You have bacteria in your digestive system to help break down your food.

Fungi

Fungi are microorganisms that have some traits of plants. The cells have a cell wall. Because they do not have chloroplasts, fungi cannot make their own food.

Yeast is a fungus that is commonly used to make bread. It makes the dough rise. Yeast has only one cell. Some fungi have many cells.

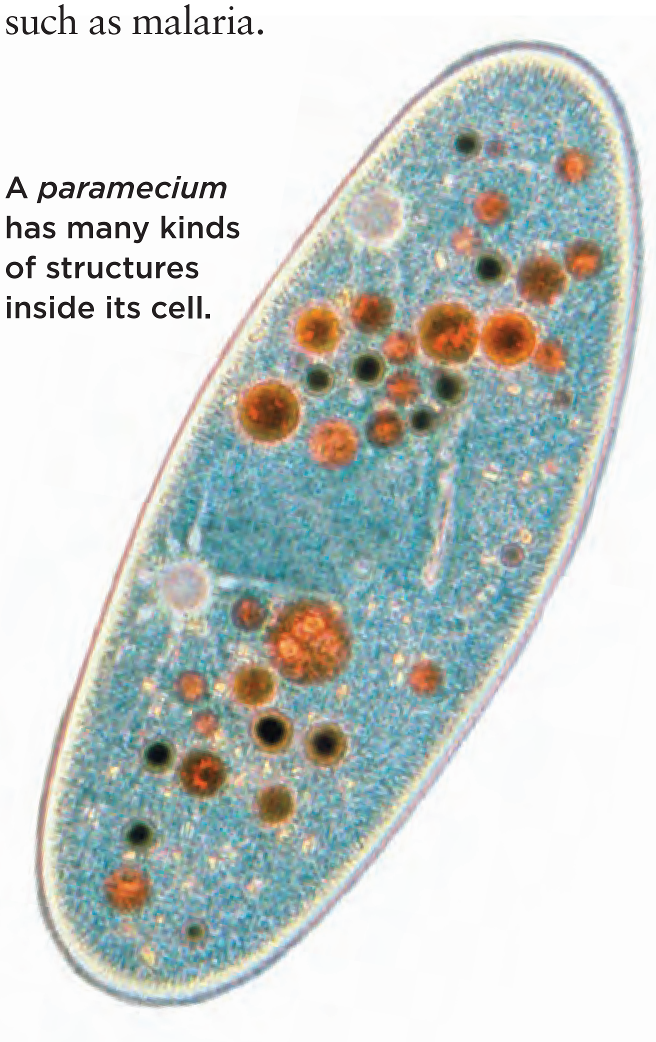
FACT Not all bacteria cause disease.

Protists

Members of the protist kingdom have a cell nucleus. They also have different parts inside their cell to perform different jobs. A *paramecium* (par•uh•MEE•see•uhm) has a structure that pumps out extra water from inside the cell.

Some protists, such as algae (AL•jee), make their own food. Others get food by eating other organisms.

Like bacteria and fungi, most protists are harmless. Many are even helpful. Protists are a food source for other organisms. However, some protists can cause serious diseases, such as malaria.



A *paramecium* has many kinds of structures inside its cell.

Quick Lab

Observe a One-Celled Organism

1. **Observe** Using a microscope, look carefully at the organism on your slide.
2. **Classify** Is your organism made of one cell or many cells? How can you tell?
3. The microscope you are using is not strong enough to view individual bacteria. What kind of organisms are you observing?

Quick Check

Classify How can you tell the difference between protists and bacteria?

Critical Thinking How can observing cells under a microscope be useful in identifying organisms?

How are organisms named?

Scientists use a naming system to classify living things. Each kind of organism has its own name. The first part of the organism's name is its genus. The second part is its species. By using these names, scientists can identify and study specific organisms.

Scientists have named about 1.7 million species on Earth. Countless more have yet to be named!

Genus and Species

Wolves and coyotes belong in the genus *Canis* (KAY•nis). Dogs belong in this genus, too. Members of the genus *Canis* look similar. They all eat meat. However, the species in this genus have different traits. One trait is color. Red wolves are *Canis rufus*. Gray wolves, *Canis lupus*. Coyotes are *Canis latrans*.

Quick Check

Classify How do scientists use names to classify organisms?

Critical Thinking How would a scientist name an organism that has just been discovered?

Naming Organisms

Genus *Canis*

gray wolf
(Canis lupus)

coyote
(Canis latrans)

Read a Diagram

Does the term *lupus* refer to a genus or a species?

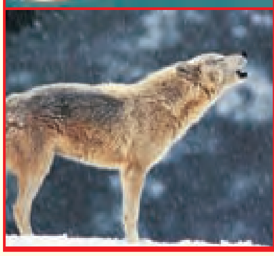
Clue: A species is the smallest classification group.

Lesson Review

Visual Summary

Organisms **can be grouped** by **kingdom**, phylum, class, order, family, genus, and species.

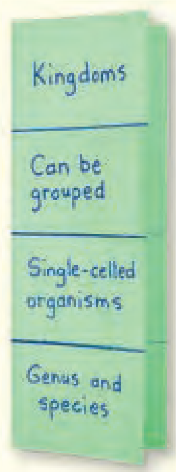
Bacteria, protists, and fungi belong to kingdoms that include **single-celled organisms**.



Genus and species are used for scientific names of organisms.

Make a FOLDABLES™ Study Guide

Make a Four-Tab Book. Use it to summarize what you learned about classifying living things.



Think, Talk, and Write

1. **Main Idea** What are the six kingdoms into which organisms are classified?
2. **Vocabulary** Plants, animals, fungi, and ________ are the four kingdoms of organisms with many cells.
3. **Classify** Many birds eat the seeds of the rose plant, *Rosa rugosa.* What is this plant's genus and species?
4. **Critical Thinking** How can classification of a poisonous organism help save someone's life?
5. **Test Prep** **Which of these statements about the number of species is true?**
   - **A** Kingdoms contain the most.
   - **B** A phylum contains the most.
   - **C** Orders have the fewest.
   - **D** Kingdoms have the fewest.
6. **Test Prep** **All the organisms in this kingdom make their own food.**
   - **A** fungi
   - **B** protists
   - **C** bacteria
   - **D** plants

Writing Link

Write an Essay
Think about the common traits of cats. Write an essay that tells how a cat is different from a dog.

Math Link

Solve a Problem
A family of plants contains four different *genera* (the plural of genus). Each genus has three species. How many plants are in this family?

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Red Tide

A Bad Bloom at the Beach

You're ready for some fun in the sun. But when you get to the beach, it's closed. Then you notice that the water is a strange color. You can put your swimsuit away. Your beach is a victim of red tide!

Red tide isn't actually a tide. It is ocean water that is blooming with a harmful kind of algae. These one-celled organisms are poisonous to the sea creatures that eat them. The water isn't always red, either. Sometimes it's orange, brown, or green.

a bloom of red tide

American Museum of Natural History

An outbreak of red tide can do a lot of damage. On the coast of Florida, one killed tens of thousands of fish, crabs, birds, and other small animals within a few months. It also killed large animals like manatees, dolphins, and sea turtles. Red tides can also make people sick if they eat infected shellfish.

Scientists are working to predict where and when red tides occur. They measure the amount of algae along coastlines. They use data collected from satellites to study wind speed and direction. This information helps scientists predict where blooms may develop. With their predictions, scientists help warn local agencies about future red tides.

▲ Scientists collect water to look for harmful algae.

Infer

- Use information that you already know.
- List the details in the text that support your inference.

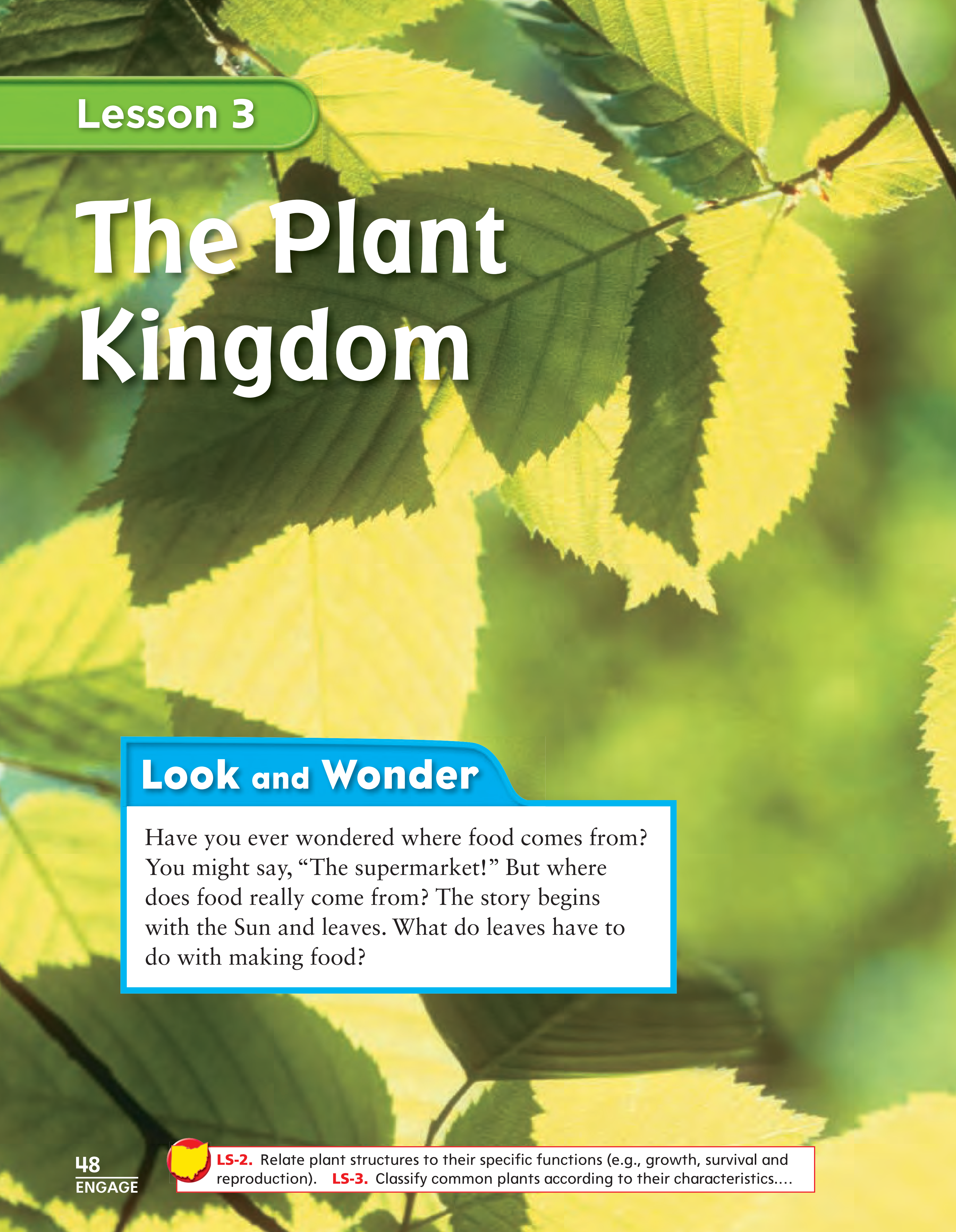
Write About It

Infer

1. What could you infer about a closed beach with reddish-colored water?
2. How could the prediction of red tides be helpful to people?

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

ELA RP-5. Make inferences or draw conclusions about what has been read and support those conclusions with textual evidence.



Lesson 3

The Plant Kingdom

Look and Wonder

Have you ever wondered where food comes from? You might say, “The supermarket!” But where does food really come from? The story begins with the Sun and leaves. What do leaves have to do with making food?

LS-2. Relate plant structures to their specific functions (e.g., growth, survival and reproduction). **LS-3.** Classify common plants according to their characteristics....

Explore

Inquiry Activity

How are leaves different from each other?

Make a Prediction

How do leaves from different plants differ from each other? Write a prediction.

Test Your Prediction

1. **Observe** Use the hand lens to observe both leaves carefully. What do you notice?
2. **Communicate** Record your observations in a chart like the one shown. How are the leaves different?

Leaf Trait	Leaf A	Leaf B
Texture		
Color		
Size		
Shape		

Draw Conclusions

3. **Infer** Tell what each leaf trait on the chart is for. For example, you might infer that fuzzy leaves are for catching rain. Colored leaves might be for attracting insects. Record your ideas.

Explore More

What leaf traits do both leaves have in common? Tell what each shared trait is for. Make a plan to test your idea.

Materials

- leaves from two plants
- hand lens

Step 1

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea LS-2, LS-3

The roots, stems, and leaves of a plant help it get water, support itself, and make food.

Vocabulary

root, p. 53

root hair, p. 53

stem, p. 53

photosynthesis, p. 54

stomata, p. 55

transpiration, p. 55

respiration, p. 55

spore, p. 56

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Reading Skill

Infer

Clues	What I Know	What I Infer

How do we classify plants?

Plants come in all sizes, shapes, and colors. Some are so small you can barely see them. Others can be as tall as skyscrapers. In all, there are about 400,000 different kinds of plants.

Classifying by Structures

One way to classify plants is by their parts, or structures. Scientists look at the shapes of leaves, the kinds of stems, and the shapes of roots. Some plants do not have these structures. We can use this fact to sort plants into two groups. One group has plants with roots, stems, and leaves. The other group has no roots, stems, or leaves.

All plants need to move water from the ground to their cells. Plants with roots, stems, and leaves have a system of tubes for this. Mosses and other plants that lack such structures grow close to the ground. They don't need a tube system. They take in water directly from the soil.

Wort plants do not have roots, stems, or leaves.

Classifying by Seeds

What do you find when you bite into an apple? At the apple's core are seeds. If you plant these seeds, they grow into apple trees. Then those trees make more apples and more seeds.

We can classify plants by whether or not they have seeds. Most plants that you are familiar with have seeds. In fact, most of the plants that have roots, stems, and leaves also have seeds and fruit!

Horsetail plants grow about a meter tall. They have stems that look like horses' tails. They also have roots and leaves. But horsetails have no seeds, flowers, or fruit. How do they reproduce? Horsetails produce offspring from spores. Other plants with roots, stems, and leaves use spores as well.

The viola plant has roots, stems, and leaves. Its offspring grow from seeds.

Quick Check

Infer You find a plant without roots, stems, or leaves growing close to the ground. Do you think it has seeds? Explain.

Critical Thinking Think of your favorite plant. How would you classify it based on what you have read?

The horsetail plant has roots, stems, and leaves, but no seeds.

How do plants get what they need?

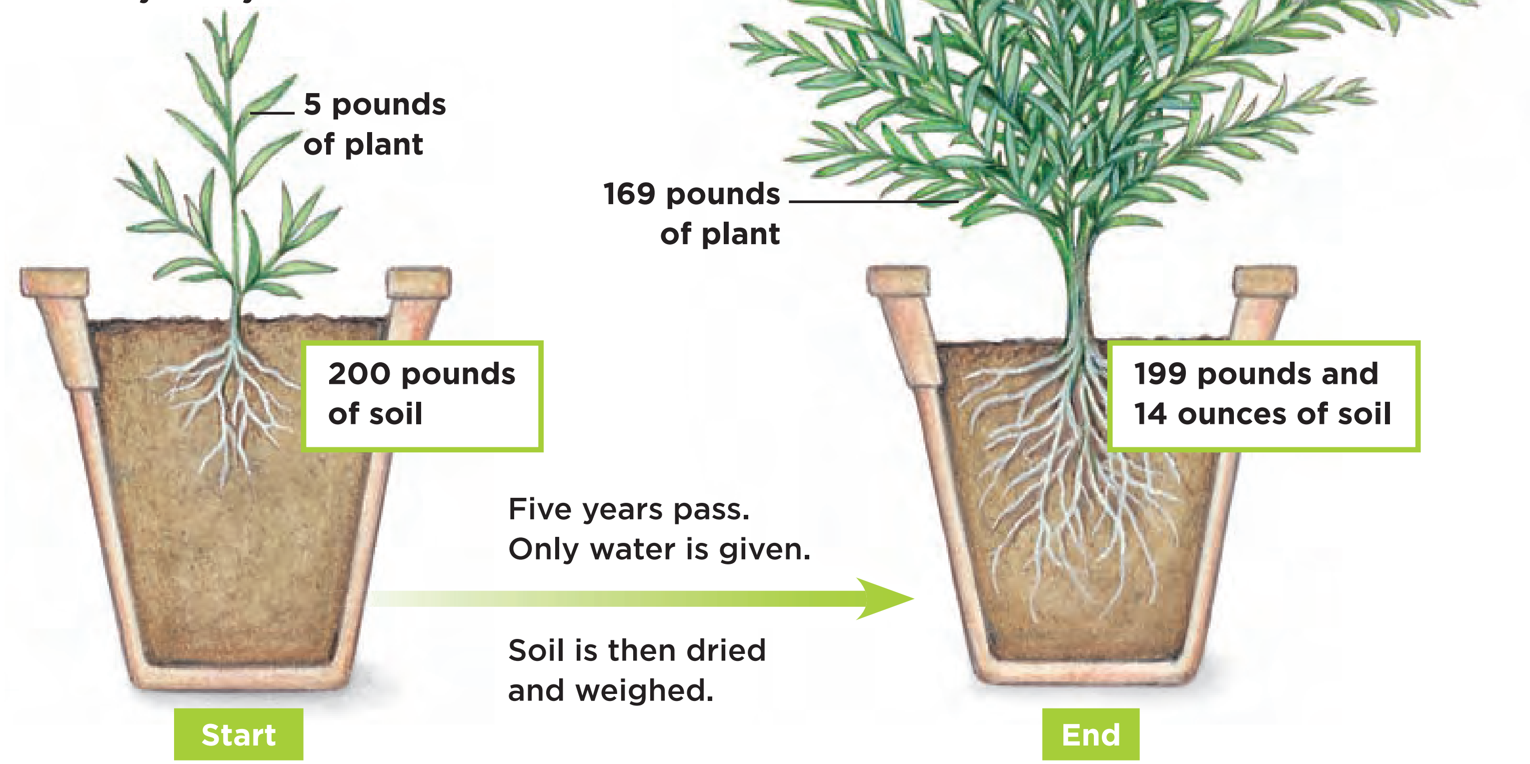
About 400 years ago, a Dutch scientist named Jan van Helmont wanted to know how plants meet their needs. He planted a seedling in a pot of soil. He watered it regularly. After five years, the seedling became a small tree. Only a tiny amount of soil was missing from the pot. Where did the plant get the material to grow?

Van Helmont concluded that most of the material came from the water. He was partly correct. Almost 100 years later, scientists found that the rest of the material comes from *carbon dioxide*, a common gas in the air.

We now know that trees and other green plants use the energy from sunlight to make their own food. The key ingredients are water and carbon dioxide.

van Helmont's Experiment

In his experiment, Jan van Helmont discovered that growing plants use only a very small amount of soil.

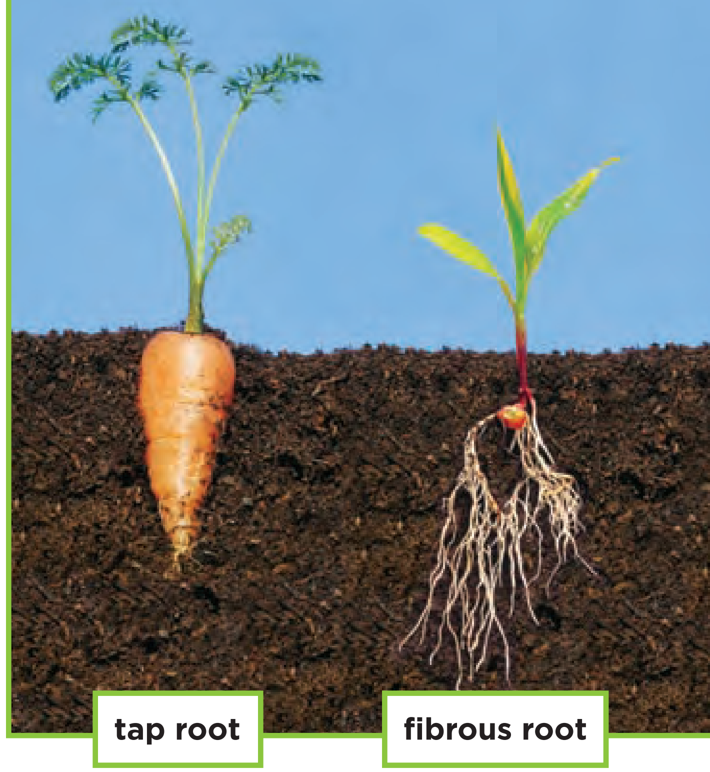


The Role of Roots

Roots take up water and nutrients from the ground. They also keep plants firmly in the soil. Some roots even store food.

Roots are covered with **root hairs**. These are thin cells that look like thread. Root hairs take in the water and nutrients that plants need.

All roots do the same jobs, but different plants have different kinds of roots. Carrots and dandelions have one large root called a *taproot*. Grasses have *fibrous* (FY•bruhs) roots that spread out into the soil.



The Role of Stems

A plant's stem grows above the ground. The **stem** moves food, water, and nutrients throughout the plant. Stems also hold the plant upright so it does not fall over.

There are two kinds of stems. Most trees and shrubs have woody stems. Woody stems protect the plant and give it extra support. Smaller plants have stems that are soft, green, and bendable. They rely on the pressure of watery sap for support.

Woody stems are strong. They cannot bend.

Nonwoody stems are soft and bendable.

Quick Check

Infer Why do most trees have woody stems instead of nonwoody stems?

Critical Thinking Why is it important that a plant's roots allow materials to move in only one direction?

Why are leaves important?

Like all living things, plants need energy. Animals eat food to get energy. Plants make their own food. Most plants use leaves to collect light from the Sun.

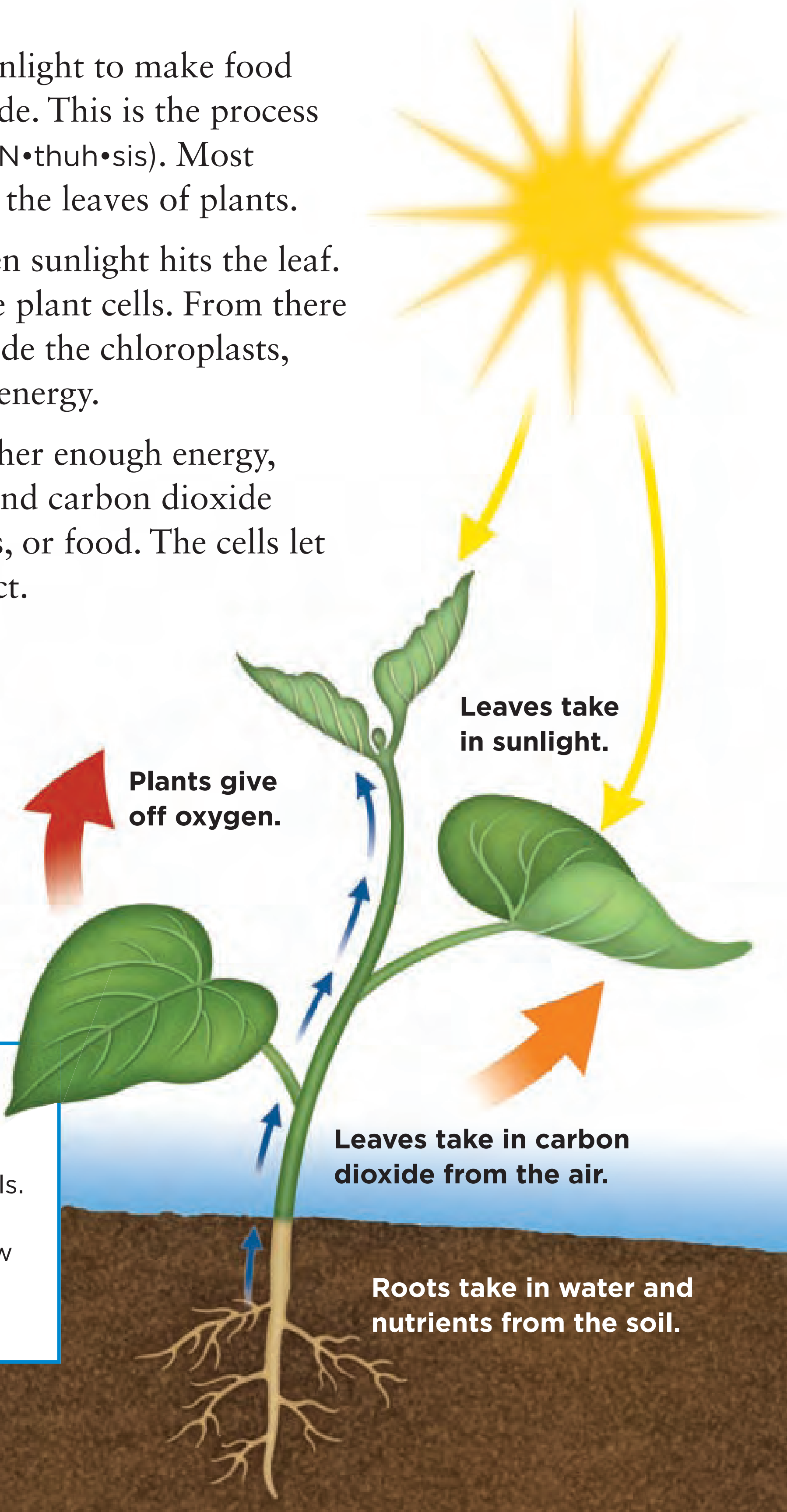
Photosynthesis

Plants use the energy in sunlight to make food from water and carbon dioxide. This is the process of **photosynthesis** (foh•toh•SIN•thuh•sis). Most photosynthesis takes place in the leaves of plants.

Photosynthesis begins when sunlight hits the leaf. The light energy goes into the plant cells. From there it enters the chloroplasts. Inside the chloroplasts, chlorophyll collects the light energy.

When the chloroplasts gather enough energy, a change takes place. Water and carbon dioxide combine to form plant sugars, or food. The cells let oxygen out as a waste product.

Photosynthesis



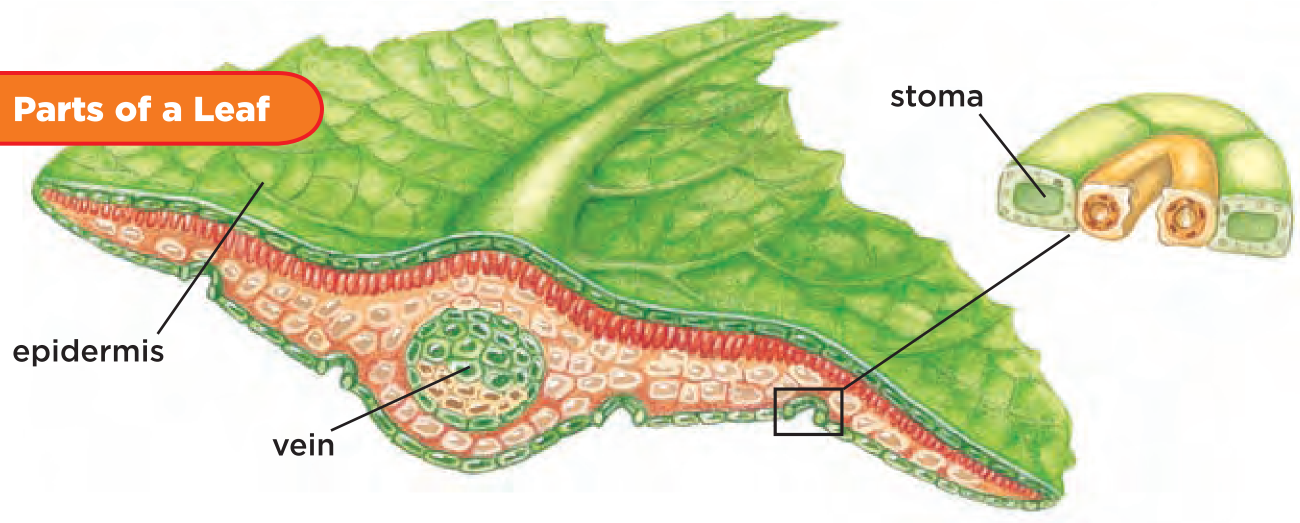
Read a Diagram

Which gas is made by the plant?

Clue: Follow the arrows pointing away from the plant. Read all labels.

LOG ON *Science in Motion* Watch how photosynthesis occurs at www.macmillanmh.com

Parts of a Leaf



Collecting Carbon Dioxide

Where do leaves get carbon dioxide gas for photosynthesis? Carbon dioxide enters through tiny holes on the bottom of leaves. The holes are called **stomata** (stoh•MAH•tuh). A single one is a *stoma* (STOH•muh).

Collecting Water

The roots of a plant take up water from soil. Small tubes called *veins* (VAYNZ) carry the water from the roots to the stem. Veins also move the water into each leaf.

Leaves have a thin covering to keep water in. This layer is called the *epidermis*. It protects leaves the way skin protects your body.

Transpiration

If a plant has too much water, its stomata stay open. The extra water escapes. This process is called **transpiration**. If a plant has too little water, it closes its stomata. The water stays inside the leaf.

Respiration

Like all living things, plants need energy. They get it from the sugars made during photosynthesis. The sugars provide plants with food.

Veins carry the sugars from the leaves to the rest of the plant. Inside the cell, mitochondria break down the sugars. The energy stored inside the sugars is released. This process is called **respiration**. During respiration, cells take in oxygen and give off carbon dioxide.

Photosynthesis takes place only in the light. Respiration happens both day *and* night. It takes place in all living cells, not just plant cells.

Quick Check

Infer Why does a plant need both photosynthesis and respiration to survive?

Critical Thinking Desert plants often keep their stomata closed during the day. Why?

Mosses use spores to make new plants.

What are mosses and ferns?

In the cool forests of North America, the ground is a moist, green carpet. When you walk on this carpet, it feels spongy. If you look closely, you will see small structures in the carpet. They are mosses. Look around the forest and you will find the delicate leaves of ferns.

Spores

Both ferns and mosses are seedless plants. Instead of using seeds to make new plants, they make spores. A **spore** is a cell in a seedless plant that can grow into a new plant.

How Spores Grow

Spores grow inside tough spore cases. The cases protect the spores from too much heat or too little water. When the spore cases open, the spores are released. They drift through the air and then settle.

Spores that land on damp ground can grow into new moss or fern plants. Like all plants, spores need light, nutrients, and water to grow. If their needs are met, the cycle of life starts all over again.

You can see the spore cases on the underside of fern leaves.

Quick Lab

How Do Mosses Get Water?

1. Cut a sponge into strips of different lengths.

2. Pour water into several paper cups. Place the short end of each sponge into a cup of water. Some sponges will stand taller than others.
3. **Observe** What happens to the water?
4. Which sponge got completely wet first? Which took longest to become wet?
5. **Infer** Why do you think mosses are so small?

Quick Check

Infer How are mosses and ferns alike? How are they different?

Critical Thinking Can a spore grow into a new plant if it is buried below the soil? Explain.

How do we use plants?

Plants do much more than just add beauty to our world. Plants give us the food we eat and are useful in many other ways.

Plants as Food

Lettuce and spinach are the leaves of plants. If you eat carrots or beets, you are eating roots. Celery and asparagus are stems. Broccoli and cauliflower are flowers. Rice and beans are seeds. You may think all fruits are sweet, but tomatoes and cucumbers are fruits, too.

Medicines and More

People have used certain plants as herbs or medicines for a long time. Today, we are finding more medicines that come from plants. We use trees to build things like furniture and toys. Plants can be burned as fuel for heating or cooking. Plants are used for clothing, too. Woven shirts and denim come from the cotton plant.

Quick Check

Infer Why are cucumbers fruits and not vegetables?

Critical Thinking Are there plant parts that people do not use? Explain.

Plants That People Eat

Read a Photo

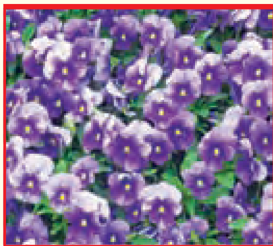
Which plants are fruits? Which are stems?

Clue: Classify each as having seeds or growing in soil.

FACT Vegetables do not have seeds.

Lesson Review

Visual Summary



Plants are classified by the presence of **roots, stems, and leaves,** or by whether they have seeds.

Photosynthesis is the process of making food in the presence of sunlight. Respiration turns food into energy.

Mosses and ferns have spores instead of seeds. People **use plant parts** for food, medicine, and clothing.

Make a FOLDABLES™ Study Guide

Make a Layered-Look Book. Use it to summarize what you learned about the plant kingdom.

Think, Talk, and Write

1. **Main Idea** What four things does a plant need to grow and stay healthy?
2. **Vocabulary** Mosses and ferns use ________ to make new plants.
3. **Infer** A scientist compared transpiration in a water lily and a desert cactus. Which plant would you expect to have a higher rate of transpiration? Why?

Clues	What I Know	What I Infer

4. **Critical Thinking** Why do mosses grow so close to the ground?
5. **Test Prep** **In which part of a plant does most photosynthesis take place?**
   - **A** woody stems
   - **B** leaves
   - **C** roots
   - **D** root hairs
6. **Test Prep** **Photosynthesis requires all of the following EXCEPT**
   - **A** light.
   - **B** carbon dioxide.
   - **C** water.
   - **D** oxygen.

Writing Link

Plants for Dinner
Plan a dinner that includes at least four different parts of a plant. Describe each dish. If you can, write a recipe for one of the dishes.

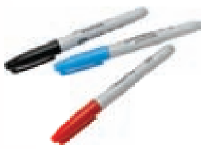
Art Link

Photosynthesis Art
Make a poster showing the steps in photosynthesis and respiration. Include how water, carbon dioxide, oxygen, and sunlight are involved.

Be a Scientist

Materials

microscope and prepared slide of root

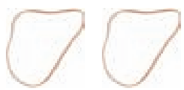


marker

water

2 plastic jars

plastic wrap



2 rubber bands

scissors

onion plants with roots

Structured Inquiry

How do root hairs affect the amount of water a plant can absorb?

Form a Hypothesis

Root hairs are found on the roots of most plants. They help plants to take in water and nutrients. Does the number of root hairs affect the amount of water a plant can absorb? Write your answer as a hypothesis in the form, "If a plant has more root hairs, then . . ."

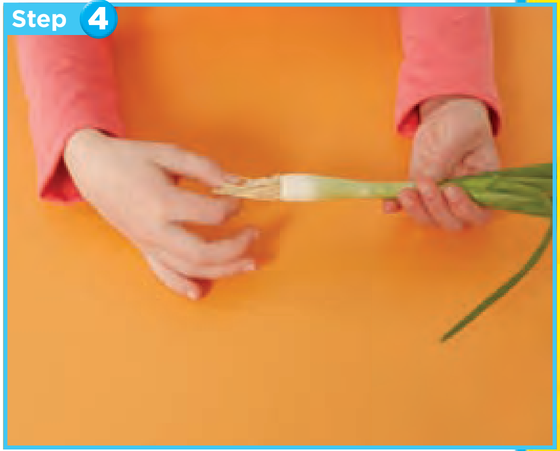
Test Your Hypothesis

1. **Observe** Look at the root slide with a microscope. Draw and describe the root and root hairs.
2. **Measure** Pour 100 mL of water into two jars. Mark the water level with a marker. Cover each jar with plastic wrap. Secure the plastic wrap with a rubber band.
3. Poke a small hole in the plastic wrap of one jar. Push one onion plant bulb through the hole. The bulb and roots should be under the water. Cut 3 cm off the ends of the leaves.
4. Take another onion plant bulb. Rub the root hairs off the roots using your fingernails. Repeat step 3 with the second jar.
5. **Observe** Check the jars every hour. Record your observations. Note any changes to the plants or the water level in the jars.

Draw Conclusions

6. **Communicate** Did your results support your hypothesis? Why or why not?
7. What did you observe when you looked at the slide of the root?
8. **Interpret Data** What happened to the water level in each jar during the activity? Why do you think this happened?
9. **Infer** What would happen to a plant if the root hairs were damaged by insects?

Step 4



Guided Inquiry

How do taproots and fibrous roots differ?

Form a Hypothesis

How does the type of root affect the amount of water a plant can absorb? Do fibrous roots absorb more water than taproots? Write a hypothesis.

Test Your Hypothesis

Design a model to illustrate how the type of root affects the amount of water a plant can absorb. Use classroom materials in your model. Write out the materials you need and the steps you will follow. Record your results and observations.

Draw Conclusions

Did your results support your hypothesis? Why or why not?

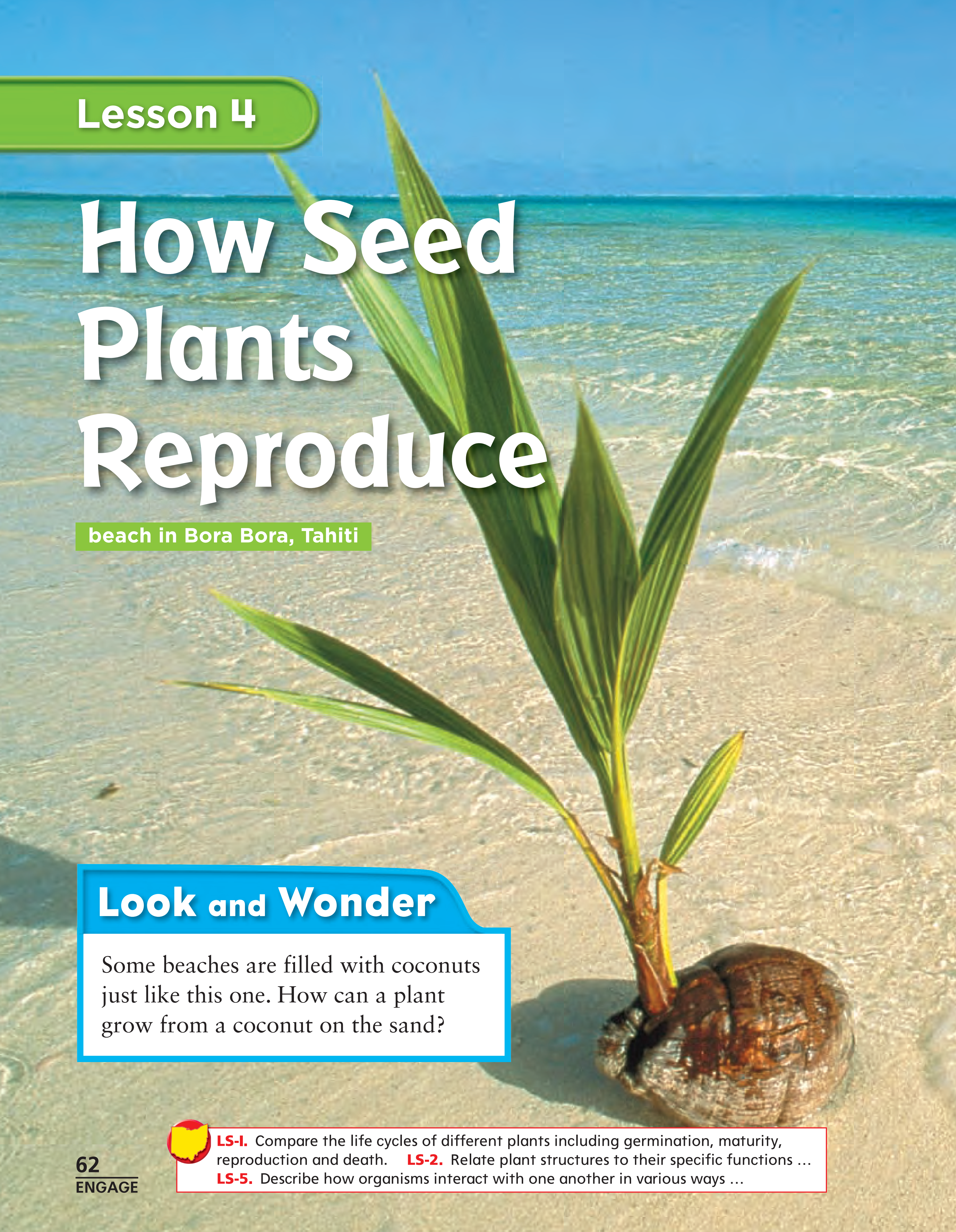
Open Inquiry

What else would you like to learn about roots? Write a hypothesis. Then design an experiment to answer your question.

Remember to follow the steps of the scientific process.

Ask a Question → Form a Hypothesis → Test Your Hypothesis → Draw Conclusions

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.



Lesson 4

How Seed Plants Reproduce

beach in Bora Bora, Tahiti

Look and Wonder

Some beaches are filled with coconuts just like this one. How can a plant grow from a coconut on the sand?

LS-1. Compare the life cycles of different plants including germination, maturity, reproduction and death. **LS-2.** Relate plant structures to their specific functions ... **LS-5.** Describe how organisms interact with one another in various ways ...

Explore

Inquiry Activity

Does a seed need water to grow?

Make a Prediction

What happens to a seed that does not get any water? Write a prediction.

Test Your Prediction

1. Line each cup with a folded paper towel. Crumple two more paper towels. Place one in each cup to hold the lining in place. Label one cup *water* and the other *no water*.
2. Place one bean about two centimeters from the bottom of each cup. Place it between the paper towel lining and the side of the cup.
3. **Use Variables** Fill the graduated cylinder with water. Drip the water into the cup labeled *water*. Add just enough water to wet the paper towels. Do not wet the paper towels in the other cup.
4. **Observe** Place both cups in a sunny spot. Keep the lining of the cup labeled *water* moist. Observe the beans every day for ten days. Record your observations in a table.

Draw Conclusions

5. Compare your results with those of your classmates. How are they alike? Different?
6. **Infer** Was your prediction correct? Does a seed need water to grow?

Explore More

Does a seed need sunlight to grow? Write a hypothesis. Plan an experiment to test it.

Materials

- 2 plastic cups
- paper towels
- marker
- lima beans
- small graduated cylinder
- water

Step 3

Step 4

My Prediction	What Happens

SWK-2. Record the results and data from an investigation and make a reasonable explanation. SI-3. Develop, design and conduct safe, simple investigations ...

Read and Learn

Main Idea LS-1, LS-2, LS-5

Seed plants make and store seeds in flowers and fruits or cones. The seeds can produce new plants.

Vocabulary

seed, p. 64

reproduction, p. 66

ovary, p. 66

pollination, p. 67

fertilization, p. 67

germination, p. 68

life cycle, p. 69

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Reading Skill

Predict

My Prediction	What Happens

How do we classify seed plants?

What are some of the plants you see every day? Chances are, they are seed plants.

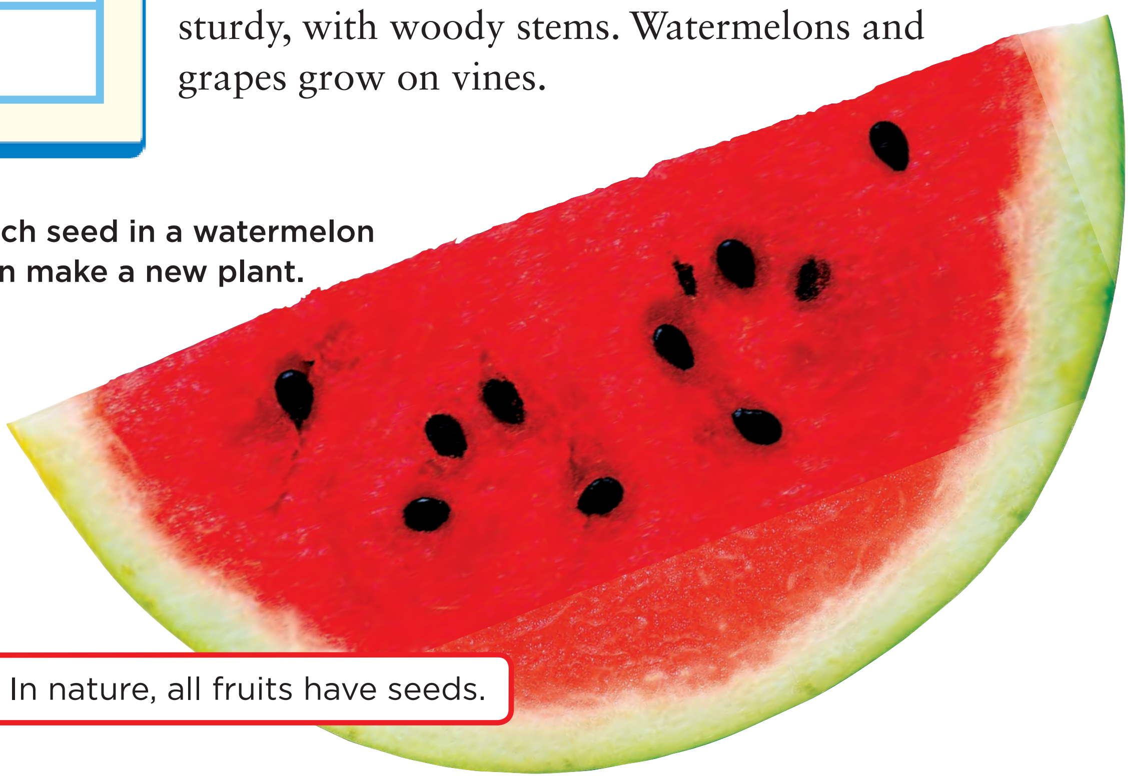
Grasses, trees, and other seed plants grow from seeds. A **seed** is a plant that is not fully formed. The coating of a seed protects the plant inside.

There are about 250,000 species of seed plants. How could you classify all of them? What would you look for?

Comparing Seeds and Structures

Seeds come in all shapes and sizes. You can use those differences to classify seed plants. A watermelon has many flat, slippery seeds. A peach has just one seed, or pit, that is hard and round. A cherry seed is smaller and smoother.

Plants that make seeds also have roots, stems, and leaves. These parts can be very different among plants. They can also help you classify seed plants. Coconuts are giant seeds that come from certain palm trees. The trees are tall and sturdy, with woody stems. Watermelons and grapes grow on vines.



Each seed in a watermelon can make a new plant.

FACT In nature, all fruits have seeds.

Flowers and Cones

We can also classify seed plants by where they store seeds. Most seed plants have flowers that bear fruit. The fleshy tissue of the fruit protects the seeds inside.

Have you ever seen a pinecone? Pinecones come from conifers (KON•uh•furz). A *conifer* is a seed plant that has no flowers or fruit.

If they have no fruit, where do conifers store their seeds? Pine trees and other conifers bear seeds on the surface of cones. Every conifer has male and female cones. The male cones are smaller than the females.

The male cones produce a yellow powder called *pollen*. A gust of wind can blow pollen grains from a male cone to a female. If the pollen lands on a female cone, the seeds develop there.

Conifer Seeds

Read a Photo

Which pinecone is the female? Which is the male?

Clue: Smaller male pinecones produce pollen.

Quick Check

Predict A friend gives you a seed from a plant with no fruit or flowers. What kind of plant is it likely to grow?

Critical Thinking Are there male conifer trees and female conifer trees?

Conifers grow well in cold climates.

How do seeds form?

Think about a delicate red rose or a colorful tulip. Flowers may look pretty or smell nice, yet they do not make food for a plant. What is the job of a flower?

Reproduction

You know that all living things can make more of their kind. **Reproduction** (ree•pruh•DUK•shuhn) is how living things make offspring.

Flowering plants use flowers to reproduce. Like cones, flowers have male and female parts. The male part is the *stamen*, which includes the anther. The *anther* makes pollen that has male sex cells. The female part of a flower is the pistil, which includes the ovary (OH•vuh•ree). The *pistil* makes female sex cells, or eggs. The **ovary** stores the eggs. To reproduce, flowering plants combine male and female sex cells. How do those cells join together?

The bright colors and sweet smells of flowers attract bees.

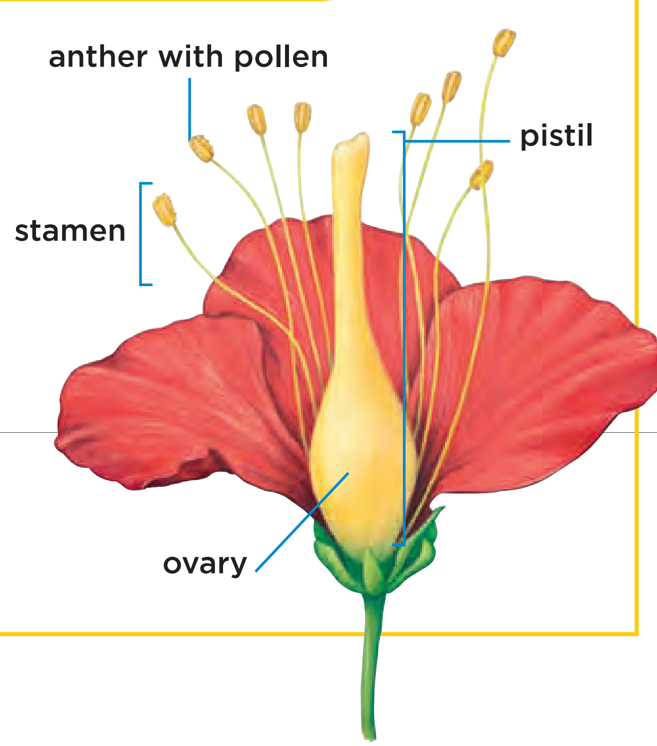
Pollination

A gust of wind can blow pollen from an anther to a pistil. More often, plants rely on birds, insects, or other pollinators. *Pollinators* are animals that carry pollen from one flower to another. For instance, bees suck up *nectar*—a sugary liquid inside a flower. If the bee touches an anther, pollen sticks to its body and legs. At the next flower, the pollen falls from the bee to the pistil. The process of moving pollen is called **pollination**.

Fertilization

The next step in seed formation is to move pollen to the ovary. The pistil grows a long tube for the pollen to travel. Inside the ovary, the male sex cell combines with an egg. **Fertilization** occurs when the male sex cell joins with the female sex cell. Fertilization is the process that forms a seed.

Parts of a Flower



Quick Check

Predict What happens to a plant if a pollinator does not bring pollen to it?

Critical Thinking How does nectar help both the plant and the pollinator?

Quick Lab

Make a Seed Model

1. Design a "seed" that could be dropped from a tree. Your goal is to make the seed fall the farthest from where you drop it.
2. **Make a Model** Build your seed. Make sure it includes a weight, such as a paper clip.
3. **Measure** Drop your model from the same height several times. Each time, measure and record the distance that the seed travels.
4. Compare your results with those of your classmates. Which design worked best? Why?

How do seeds grow?

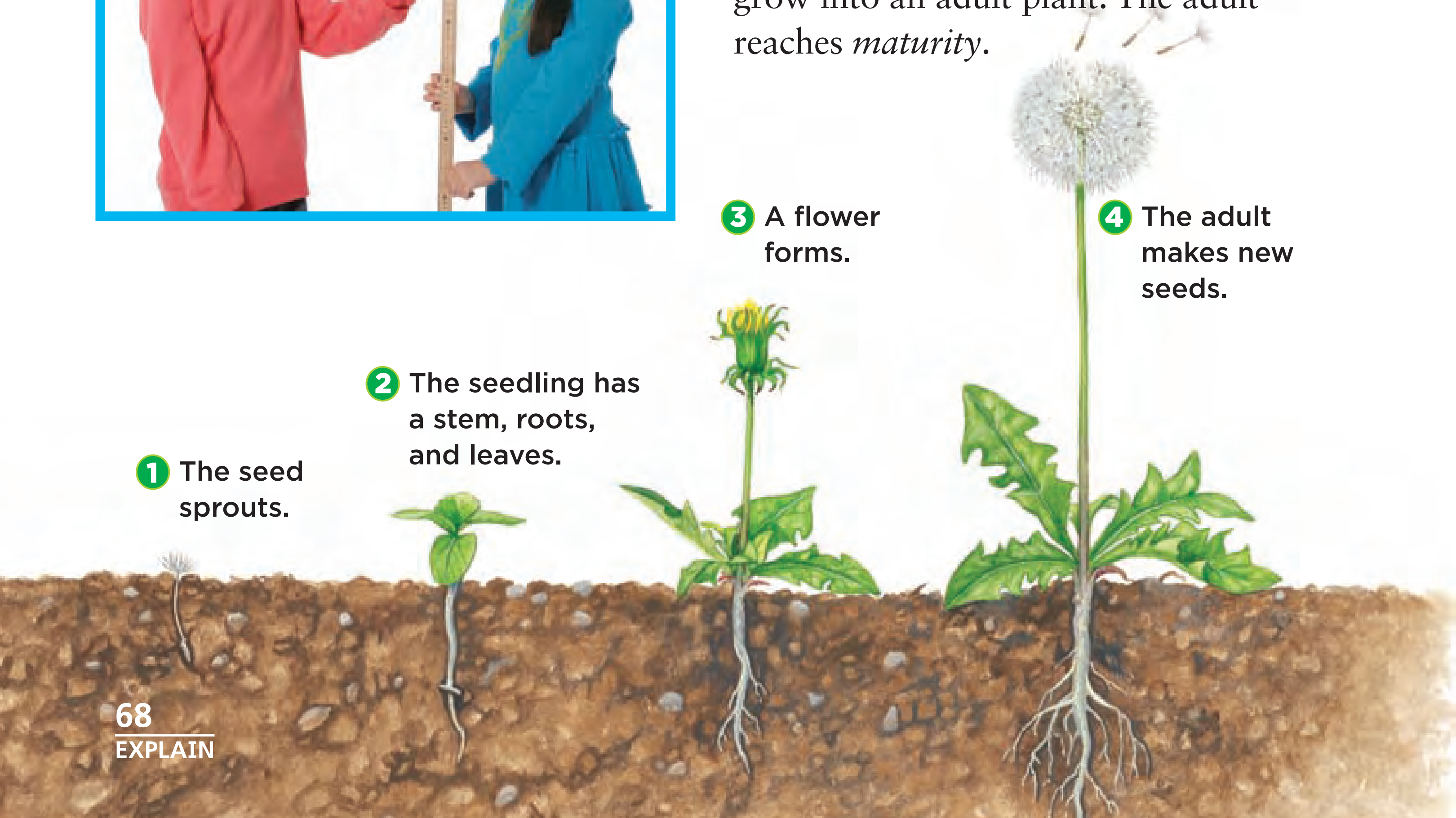
Inside each seed is an unformed plant and a food source. A layer called the *seed coat* surrounds and protects them.

Germination

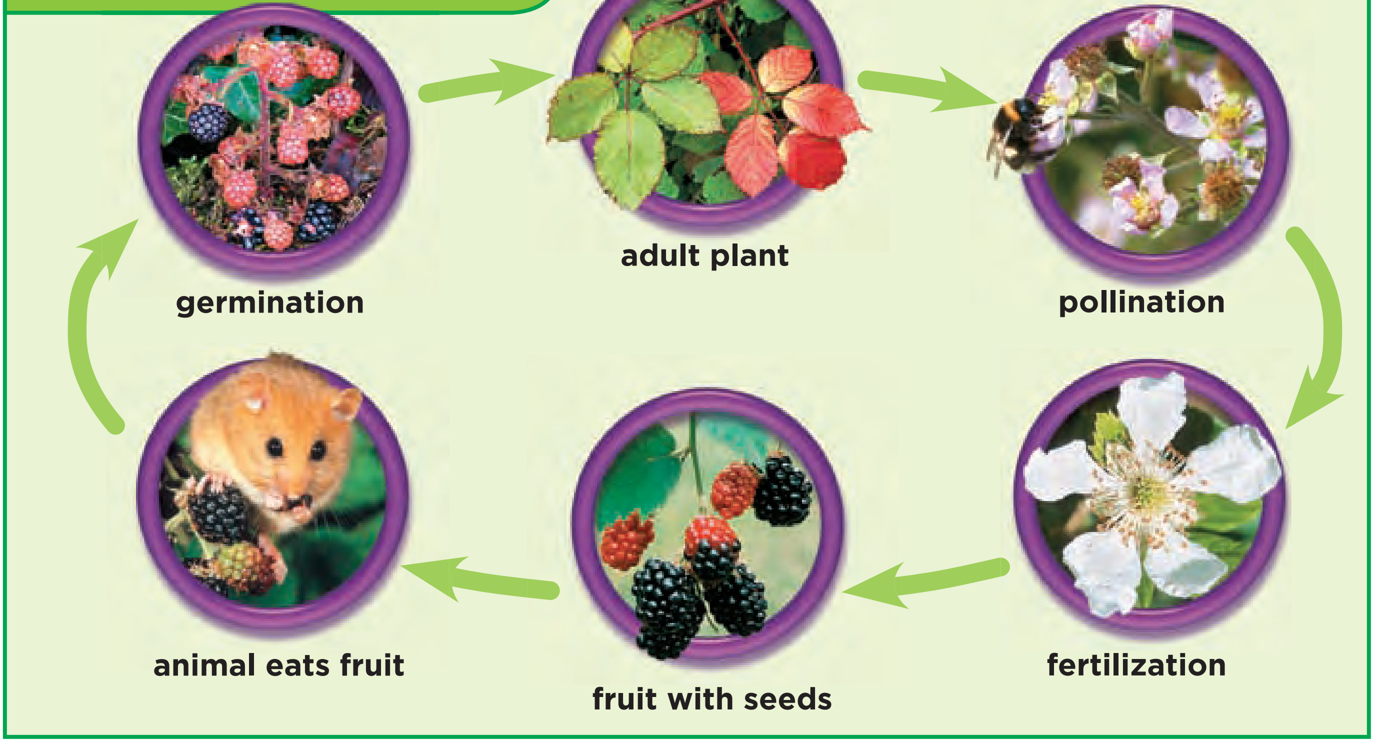
Under the right conditions, the seed will sprout. First, the seed coat splits open. A root pushes through the crack. Then, a tiny stem grows upward. One or two leaves appear on the stem. All seeds develop this way. The process is called **germination** (jur•muh•NAY•shuhn).

Seedlings

A *seedling* is the young plant that grows from a seed. Seedlings need water, light, and nutrients to grow. If its needs are met, the seedling will grow into an adult plant. The adult reaches *maturity*.



Life Cycle of a Seed Plant



Life Cycles

For some plants, it takes only days for the seed to reach maturity. For others, it takes years. No matter how long it takes, all seed plants go through the same stages.

Look at the diagram above. It shows the life cycle of a berry plant. A **life cycle** includes the stages of germination, maturity, reproduction, and death. *Death* marks the end of a plant's life. Some plants grow, reproduce, and die in a single season. Others, like some conifers, can live more than 5,000 years.

When a plant dies, its life ends but its life cycle does not. Seed plants make new seeds. The life cycle continues.

Seeds on the Move

Seeds need space to grow, but they cannot move on their own. Some, like dandelion seeds, are easily carried by wind. Others have prickly surfaces that can be caught on animal fur.

Many seed plants bear fruits. When an animal eats the fruit, the seeds pass through the animal's body. Then, the seeds can germinate.

Quick Check

Predict What might happen to seed plants if there were no animals?

Critical Thinking Squirrels often bury seeds in the ground to store them for winter. How does this help make new plants?

How are plants alike and different from their parents?

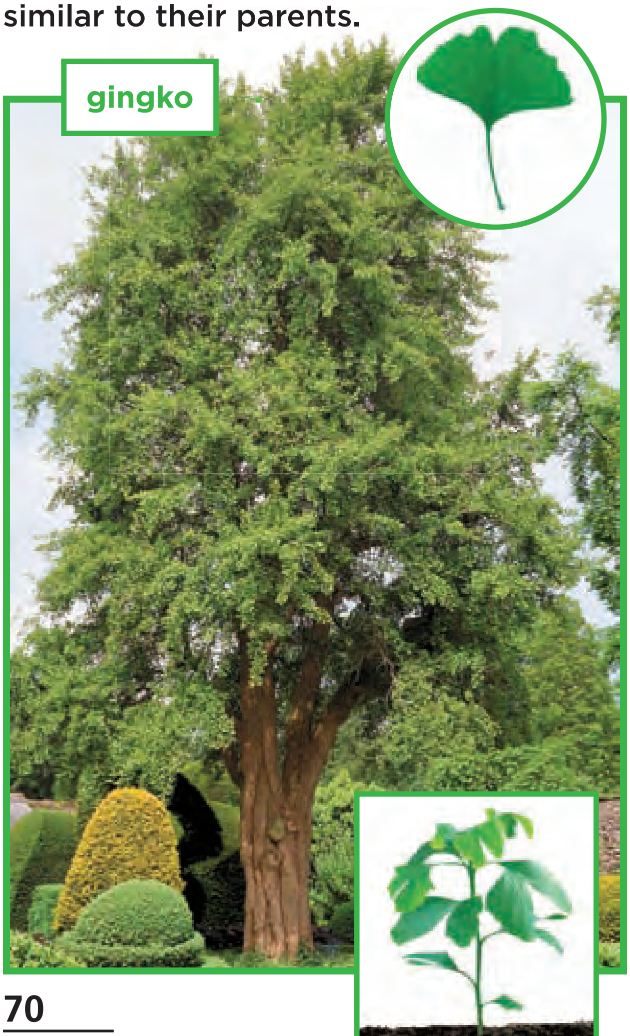
Seeds grow into plants that look similar to their parent plants. For example, all foxglove plants have tall stems and flowers shaped like trumpets. However, offspring plants are not an exact copy of their parents. The color of their flowers may be different. Some may be taller.

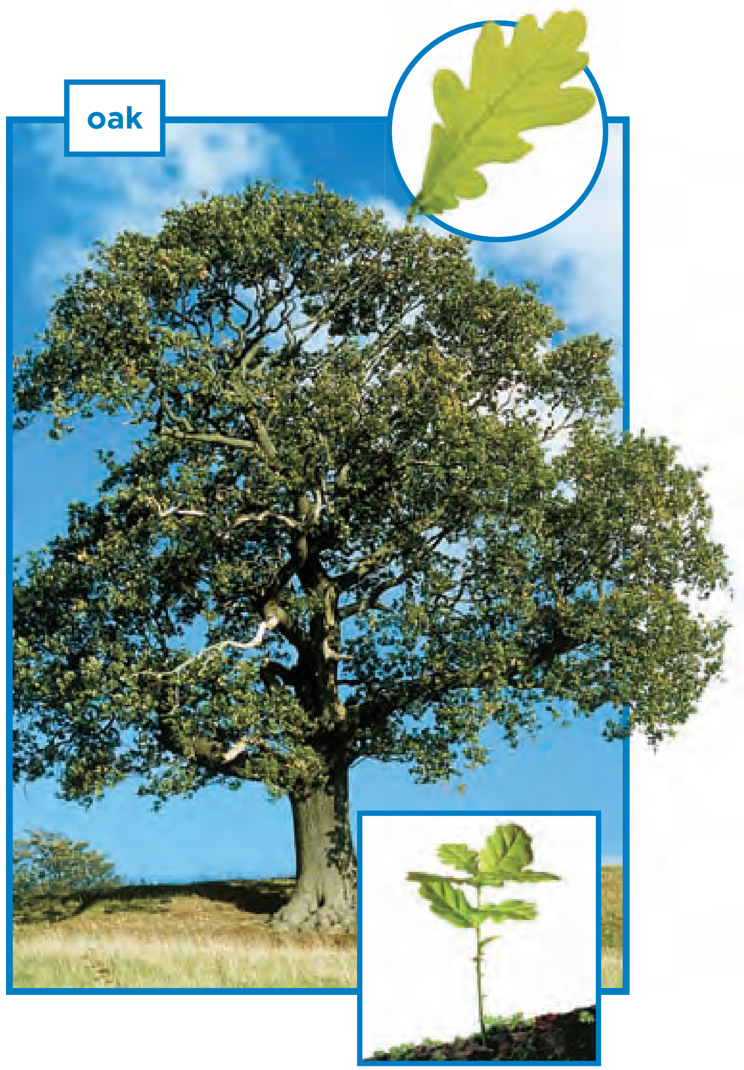
The flowers of a foxglove plant may have different colors.

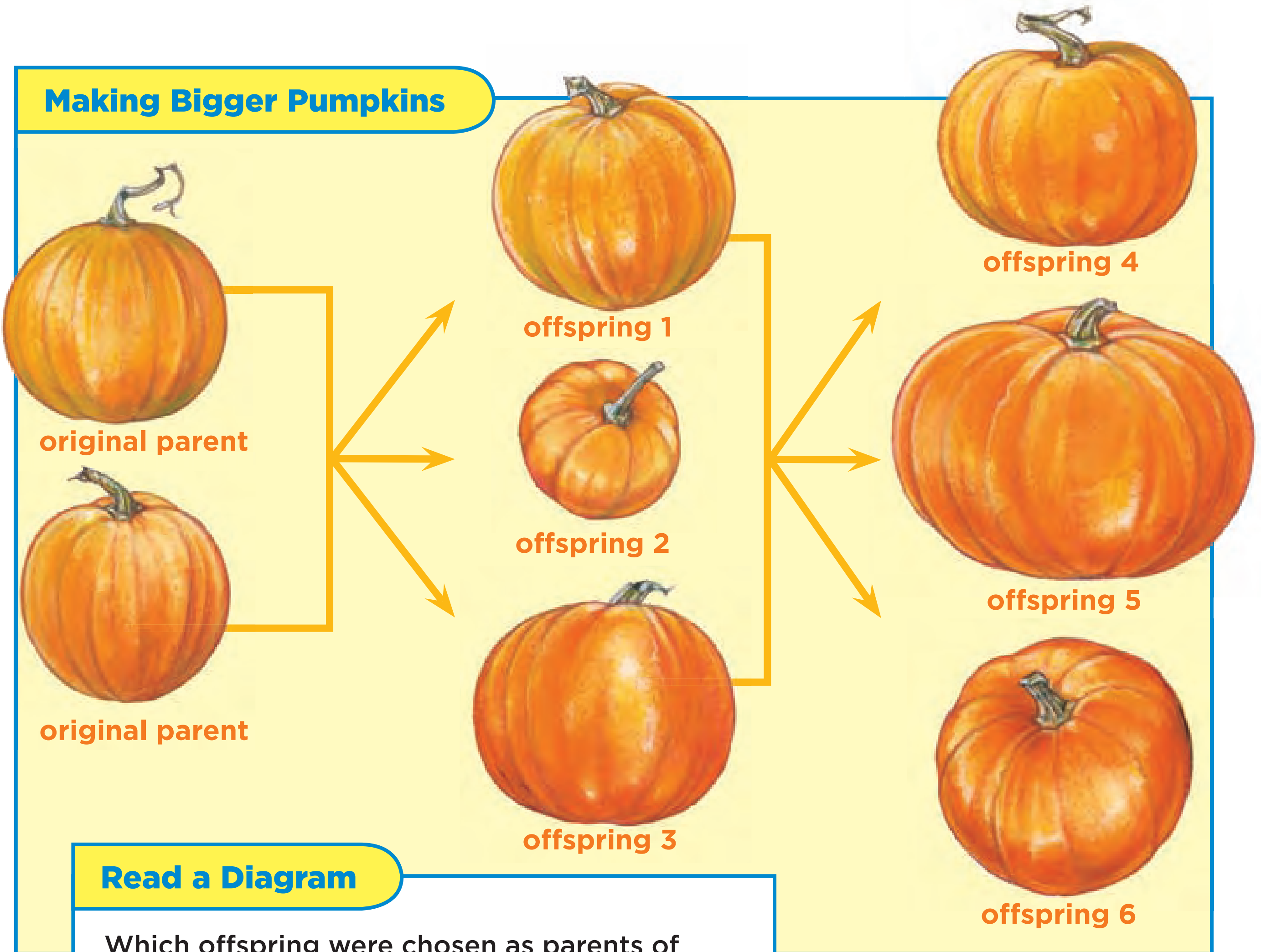
Inherited Traits

Color, size, and shape are inherited (in•HER•uh•tid) traits. *Inherited traits* are characteristics passed from parent to offspring. When traits from two parents combine, the offspring may end up with different traits than their parents. For example, the offspring may be larger or smaller than its parents.

The offspring of these trees look similar to their parents.







Read a Diagram

Which offspring were chosen as parents of offspring 4, 5, and 6?

Clue: Trace the direction of the lines and arrows.

Choosing Traits

Farmers can put inherited traits to good use. Suppose you wanted to grow a giant pumpkin. You might start by choosing two adult plants that produced the largest pumpkins in the crop. Then you could be a pollinator and move pollen from one plant to the other. What happens if you then choose two offspring with the biggest pumpkins and pollinate again? Each time, you get bigger and bigger pumpkins.

Many fruit and vegetable growers pollinate their plants. That way, growers produce plants with traits that people prefer. Seedless watermelons are a good example.

Quick Check

Predict What kind of offspring might result from a tall parent and a short parent?

Critical Thinking If you were a farmer, how would you make a seedless watermelon?

What are other ways plants can reproduce?

Runners

Not all plants reproduce using flowers, cones, or spores. Some plants, such as strawberries, use runners. A *runner* is a stem that grows along the ground and can make new plants.

Cuttings

A *cutting* is a part of a plant that has been clipped and can produce a new plant. Usually, a cutting is a leaf or a stem. When cuttings from some plants are put into water, roots grow. A whole new plant can grow from the cutting.

Bulbs and Tubers

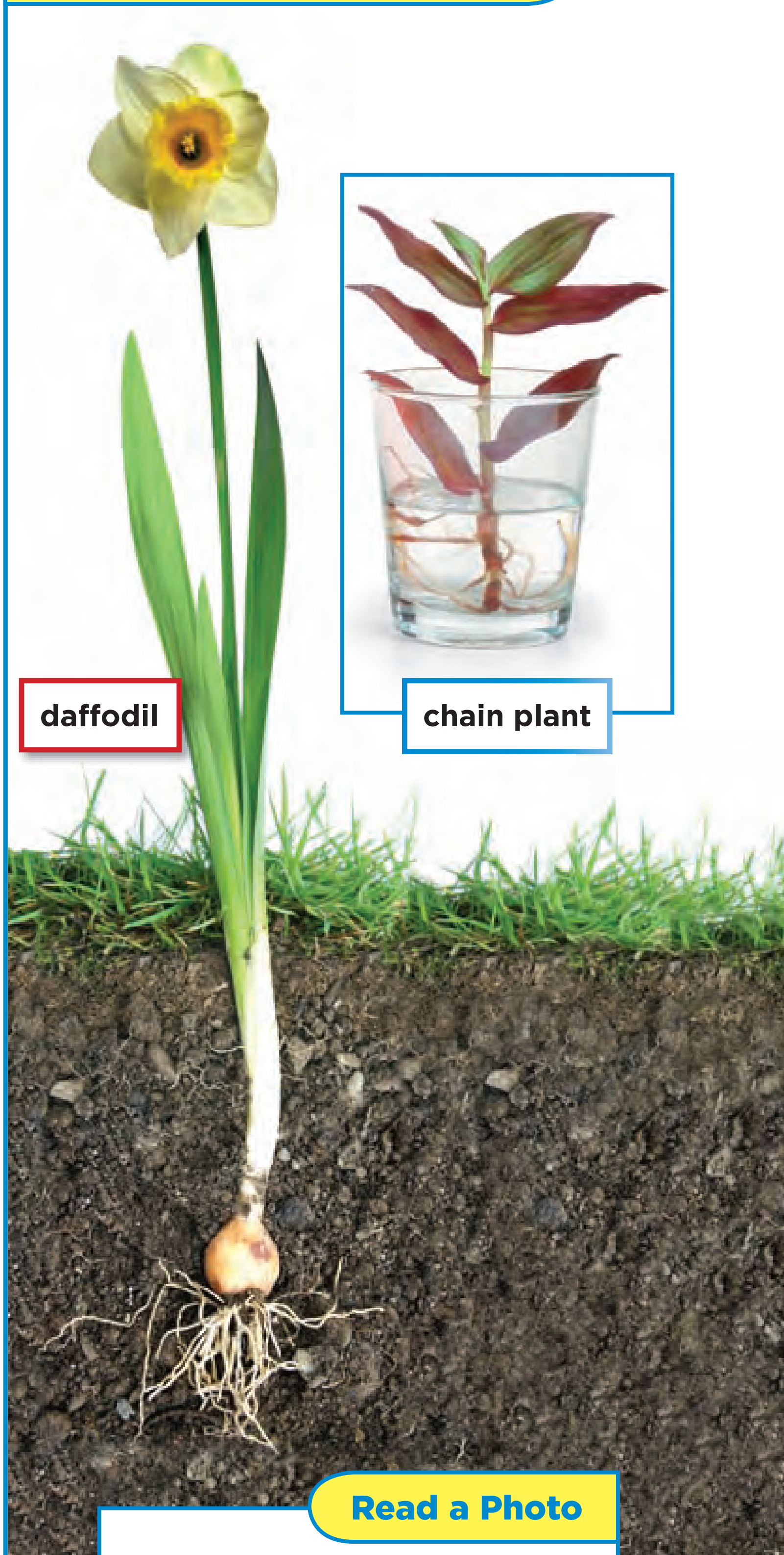
A *bulb* is a stem that grows under the ground. Tulips and onions grow from bulbs. A *tuber* is a storage part of a plant. Potatoes are tubers. If you plant a potato by itself, more potatoes will grow.

Quick Check

Predict If you bury a potato in soil, what might happen in a few weeks?

Critical Thinking Suppose you want to start a strawberry patch. You do not have any seeds. How could you grow strawberries?

Reproduction Without Seeds



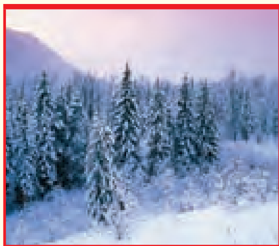
Read a Photo

Which kinds of plant reproduction are shown here?

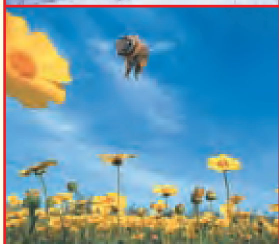
Clue: Look closely at how the plants are growing.

Lesson Review

Visual Summary



There are different ways to **classify seed plants**. The two main groups are flowering plants and conifers.



The **life cycle of a seed plant** includes pollination, fertilization, and germination.

The offspring of seed plants **inherit traits** from their parents. Not all plants have **flowers, cones, or spores**.

Make a FOLDABLES™ Study Guide

Make a Folded Book. Use it to summarize what you learned about reproduction in seed plants.

Think, Talk, and Write

1. **Main Idea** How do seed plants reproduce?
2. **Vocabulary** The movement of pollen from the anther to the pistil is called _________ .
3. **Predict** What might happen to flowering plants if there were no more animal pollinators?

My Prediction	What Happens

4. **Critical Thinking** Conifers do not produce fruit. How might this affect the way conifers grow in an area?
5. **Test Prep** **Where does fertilization take place in a plant?**
   - **A** in the ovary
   - **B** in the anther
   - **C** in the stamen
   - **D** in the pistil
6. **Test Prep** **Where is pollen made?**
   - **A** in the ovary
   - **B** in the anther
   - **C** in the pistil
   - **D** in the seed

Writing Link

Describe Plants
Choose two different kinds of seed plants. Find out more about them. Write a paragraph about how you can tell them apart.

Math Link

Solve a Problem
A tree produces 3,000 seeds. Squirrels bury half of the seeds. In winter, the squirrels find and eat half of the seeds they buried. How many seeds are left in the ground?

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Writing in Science

Dandelions and Me

When I was eight, Dad and I drove away from the city to look for a new house. We waited outside the real estate agent's office. I began to pick the dandelions growing along the edge of the steps. I was so sad about leaving our home, I started crying.

"Bet I can make you laugh," said Dad. He was holding a puffball—a dandelion turned to seed. "What did the wolf do in *The Three Little Pigs*?"

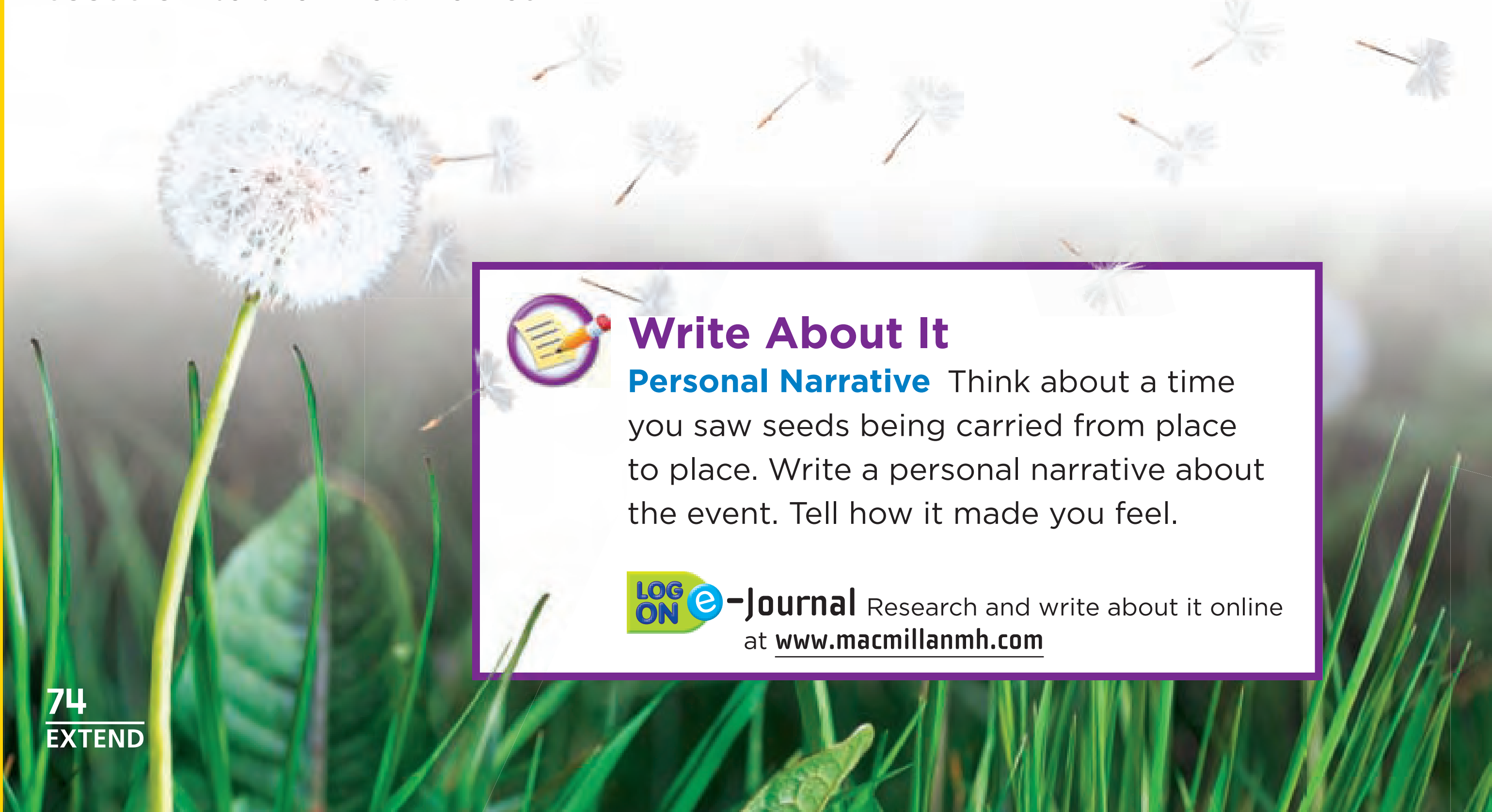
"Well, he huffed and he puffed ... " As I said that, Dad took a deep breath and blew it out. Pieces of the puffball floated off like little white umbrellas. Some got carried away by the wind. "Look at that!" I laughed. "They're going to a new place, too."

"And just like us, they'll be fine," Dad added. So I took a deep breath, blew, and sent more dandelion seeds off to their new homes.

Personal Narrative

A personal narrative

- **tells a story about a personal experience**
- **uses the first-person point of view ("I") to tell the writer's feelings**
- **tells the events in a sequence that makes sense**



Write About It

Personal Narrative Think about a time you saw seeds being carried from place to place. Write a personal narrative about the event. Tell how it made you feel.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

Math in Science

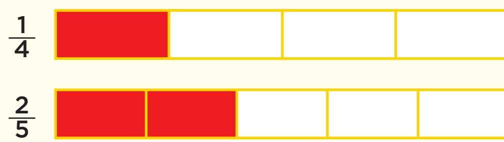
Parts of a Whole

Not every seed becomes a new plant. Of all the seeds a plant makes, only a fraction of them will grow. A fraction is a part of a whole.

The number of seeds that do grow may differ for different plants. Suppose a sunflower plant and a thistle plant each make 100 seeds. One fourth ($\frac{1}{4}$) of the sunflower's seeds grow into new plants. Two fifths ($\frac{2}{5}$) of the thistle's seeds grow into new plants. Which plant makes the most new plants from 100 seeds? Use fraction strips to find out.

Fractions

Fraction strips can show how fractions are related.



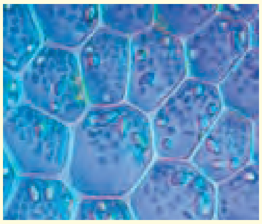
▲ **This fraction strip shows that $\frac{2}{5}$ is greater than $\frac{1}{4}$.**

Solve It

A tomato and a pepper each have 100 seeds. Two thirds ($\frac{2}{3}$) of the tomato seeds grow into new plants. Two fifths ($\frac{2}{5}$) of the pepper seeds grow into new plants. Which grows more plants?

CHAPTER 1 Review

Visual Summary



Lesson 1 Cells are the basic building blocks of all living things.

Lesson 2 Living things are classified by kingdom, phylum, class, order, family, genus, and species.

Lesson 3 The roots, stems, and leaves of a plant help it get water and nutrients, support itself, and make food.

Lesson 4 Seed plants use flowers, fruits, and cones to make seeds that will produce new plants.

Make a FOLDABLES™ Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.

Vocabulary

Fill each blank with the best term from the list.

cell, p. 26	**reproduction**, p. 66
kingdom, p. 39	**stem**, p. 53
life cycle, p. 69	**trait**, p. 38
photosynthesis, p. 54	**tissue**, p. 31

1. The smallest unit of living matter is a ________.
LS-B

2. All living things make offspring through ________.
LS-I

3. A plant's ________ moves food, water, and nutrients throughout the plant.
LS-2

4. The largest group into which an organism can be classified is a ________.
LS-3

5. The stages of growth a plant goes through is its ________.
LS-I

6. A group of similar cells that do a job together is called ________.
LS-B

7. The ability to make their own food is a ________ that all plants share.
LS-3

8. A plant makes food from sunlight, carbon dioxide, and water during ________.
LS-B

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Skills and Concepts

Answer each of the following in complete sentences.

9. **Classify** What are some ways that plants can be classified?
LS-3

10. **Observe** Find a plant in or around your school or home. Describe the plant. Include details about its appearance. List the functions of each plant part that you observe.
LS-2

11. **Critical Thinking** What could you infer if you looked into a microscope and saw a cell with cell walls? Explain your answer.
LS-2

12. **Descriptive Writing** Describe three ways that plants are important in your life.
LS-5, LS-B

The Big Idea

13. What are living things and how are they classified?
LS-A, LS-B

Performance Assessment

Make a Cell Model

1. Make a model of a plant leaf cell using things you can eat. Use different food items for each part of the cell. Include the cell wall, cell membrane, cytoplasm, nucleus, chloroplast, mitochondria, and vacuole.

2. Make sure that your model has the traits of a plant leaf cell—that it is shaped like a box and green. Label each part of the cell.

3. Write a short paragraph explaining the job of each cell part.

Ohio Activity

You will find many different kinds of plants in Ohio. How can you identify them? In trees, leaf shape can help you. Flowering plants have flowers with different shapes and colors. Make a plant field guide for your local area. A field guide is a book that shows how to identify organisms and objects in the environment. It can also include interesting information, such as where the organism lives.

Ohio Benchmark Practice

1 **Which is *not* true of mosses and ferns?**

A They have chlorophyll.

B They need water.

C They need energy.

D They make seeds.

LS-A, LS-B

2 **What is the correct order for a growing plant?**

A spore, seed, seedling

B seed, spore, seedling

C seed, seedling, adult plant

D seedling, seed, adult plant

LS-B

3 **A student classified some plants in the chart below.**

Group A	Group B
asparagus	apples
carrots	cucumbers
lettuce	pears
potatoes	tomatoes

Which of the following categories did the student most likely use to classify these plants?

A vegetable or fruit

B root or flower

C skin or peel

D stem or leaf

LS-B, SWK-B

4 **Which would be the simplest way to tell whether a plant stem comes from a tree?**

A Send it to a lab to analyze its cell structure.

B Try to bend it. Trees have woody stems that cannot bend.

C Compare the stem to pictures in a plant encyclopedia.

D Plant it in the ground. See if it grows into a tree.

SI-C

5 **Which is the *best* description of fertilization as it occurs in a flowering plant?**

A Pollen is carried from one flower to another.

B Seeds are eaten by small animals and left behind to grow.

C Pollen unites with an egg cell to form a seed.

D The stamen produces pollen grains, and the pistil produces egg cells.

LS-A, LS-B

6 **Organisms can interact with one another in various ways.**

In your *Answer Document*, explain how an animal can help a plant reproduce.

Then, draw or describe an example.

Be sure to label any drawings. (2 points)

LS-A, LS-B

7 **A conifer reproduces using cones. What does a strawberry plant use?**

A runners

B fruit

C flowers

D spores

LS-A, LS-I

8 **A farmer is trying to grow bigger pumpkins by pollinating adult plants. Which inherited trait should he measure in the offspring?**

A length of the plant stem

B weight of the pumpkin

C color of the pumpkin flesh

D volume of the pumpkin seeds

SI-B, LS-B

9 **A blossoming apple tree is growing in a glass building that has no bees, ants, or birds. Which is most likely to happen?**

A Many apples will grow.

B Some apples will grow.

C A few apples will grow.

D No apples will grow.

LS-A

10 **A doctor examines a microorganism on a slide under a microscope. She observes that it has one cell and no cell nucleus.**

In your Answer Document, explain what type of microorganism it is.

Then, identify how this information could be important to the doctor. (2 points)

SWK-B, SWK-C

11 **What is a seedling?**

A a young plant

B a plant structure that makes seeds

C an underground stem

D a structure that holds seeds

LS-A

12 **A tiny fern is growing in a forest, miles away from any other fern. Which of these could you infer?**

A A squirrel dropped a fern bulb in the soil.

B A bird carried seeds from another fern.

C A root of a fern got enough water to start growing.

D A fern spore was blown by the wind onto damp soil.

LS-A, LS-B

CHAPTER 2

Exploring Ecosystems

The Big Idea

What happens when changes occur in ecosystems?

Antarctic fur seals in tussock grass, South Georgia

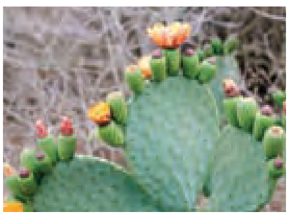
Key Vocabulary

ecosystem
the living and nonliving things in an environment, and all their interactions (p. 85)

habitat
the home of an organism (p. 85)

producer
an organism, such as a plant, that makes food (p. 92)

energy pyramid
a diagram that shows how energy is used in an ecosystem (p. 98)



adaptation
a trait or response that helps a living thing survive in its environment (p. 106)

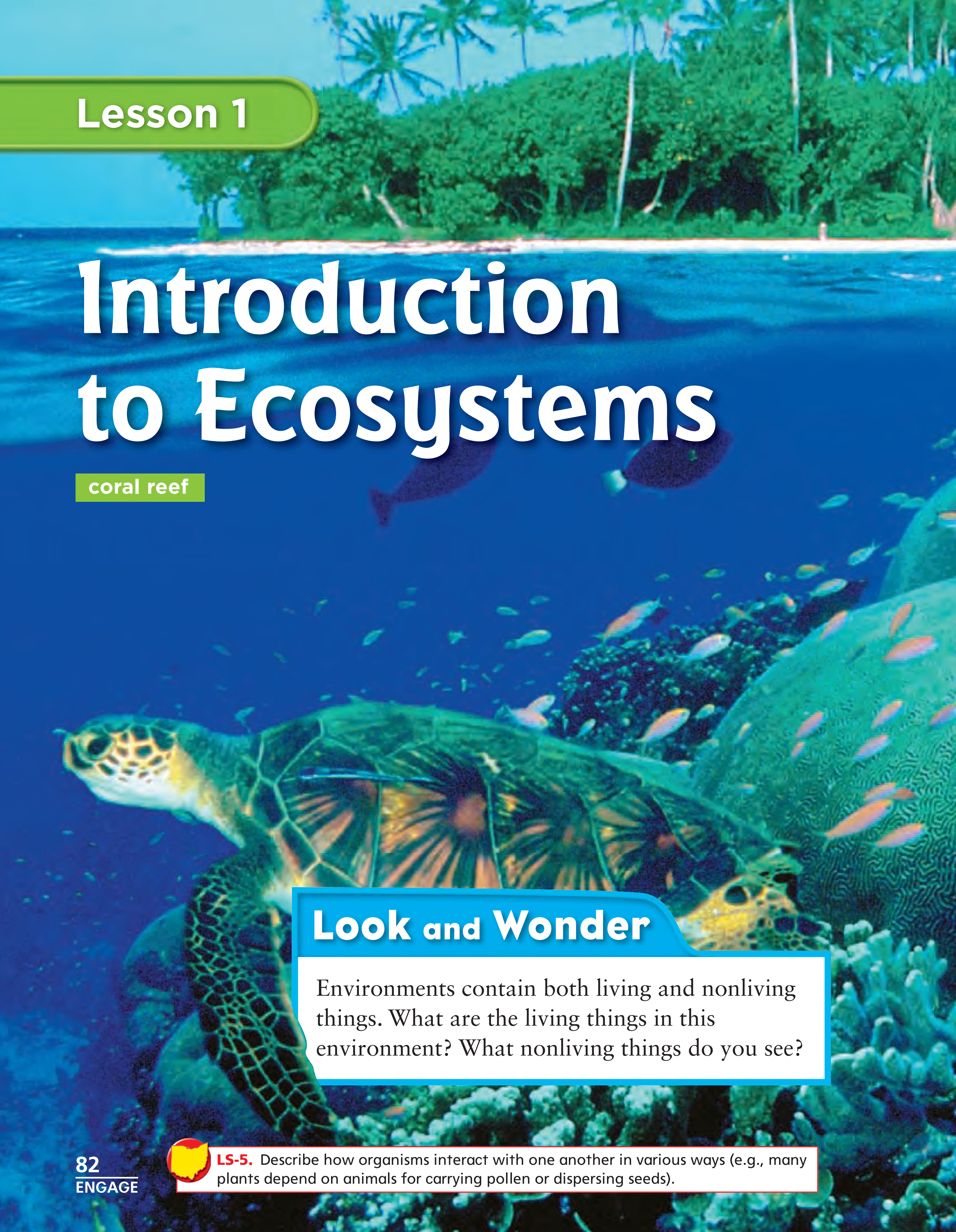
extinct
a kind of organism that is no longer alive on Earth (p. 118)

More Vocabulary

LS-B. Analyze plant and animal structures and functions needed for survival and describe the flow of energy through a system that all organisms use to survive. **LS-C.** Compare changes in an organism's ecosystem/habitat that affect its survival.

Lesson 1

Introduction to Ecosystems



coral reef

Look and Wonder

Environments contain both living and nonliving things. What are the living things in this environment? What nonliving things do you see?

LS-5. Describe how organisms interact with one another in various ways (e.g., many plants depend on animals for carrying pollen or dispersing seeds).

Explore

Inquiry Activity

What can you find in an environment?

Make a Prediction

What living and nonliving things might you find in your environment? Write a prediction.

Test Your Prediction

1. **Measure** Mark off an area of ground that is about one meter square. Push a clothespin in the ground at each corner. Wrap yarn around the tops of the four clothespins as a border.
2. **Observe** Using your hand lens, look at the living and nonliving things inside the square.
3. Make a data table to record what you see. Label each object as living or nonliving.
4. **Communicate** Share your findings with a classmate. Compare what was in the environments each of you observed.

Draw Conclusions

5. **Classify** How many different kinds of living and nonliving things were in your environment? Which did you see more of?
6. Does your data match your prediction? How?
7. How did your data differ from your classmate's? How were the data similar?

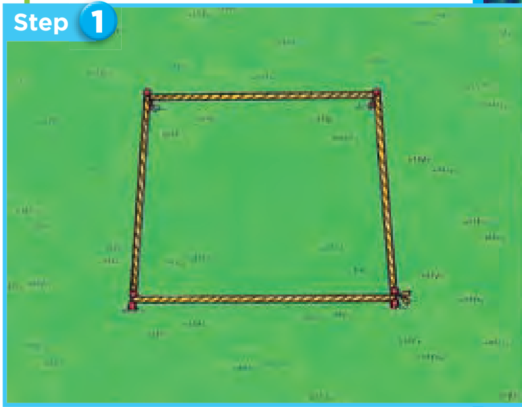
Explore More

Would you get the same results if you looked at a different square meter in the same environment? Write detailed instructions, then try them. Communicate your data to the class.

Materials

- tape measure
- 4 clothespins
- ball of yarn
- hand lens

Step 1



Step 2

SI-6. Formulate instructions and communicate data in a manner that allows others to understand and repeat an investigation or experiment.

Read and Learn

Main Idea LS-5

Living and nonliving things interact in an ecosystem.

Vocabulary

biotic factor, p. 84

abiotic factor, p. 84

ecosystem, p. 85

habitat, p. 85

population, p. 86

community, p. 86

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Reading Skill

Fact and Opinion

Fact	Opinion

What is an ecosystem?

Who or what is around you right now? You probably see classmates or your teacher. Perhaps there are books. You might be at a desk.

Biotic Factors

Scientists call the living things in an environment **biotic** (bye•AH•tik) **factors**. Plants, animals, and bacteria are all biotic factors. You are a biotic factor, too!

Abiotic Factors

Your desk, pen, pencil, and textbook are abiotic (ay•bye•AH•tik) factors. **Abiotic factors** are all the nonliving things in an environment. Other abiotic factors are water, rocks, soil, and light. Climate (KLYE•mit) is another. *Climate* refers to the typical weather pattern in an environment. Can you name other abiotic factors in your environment?

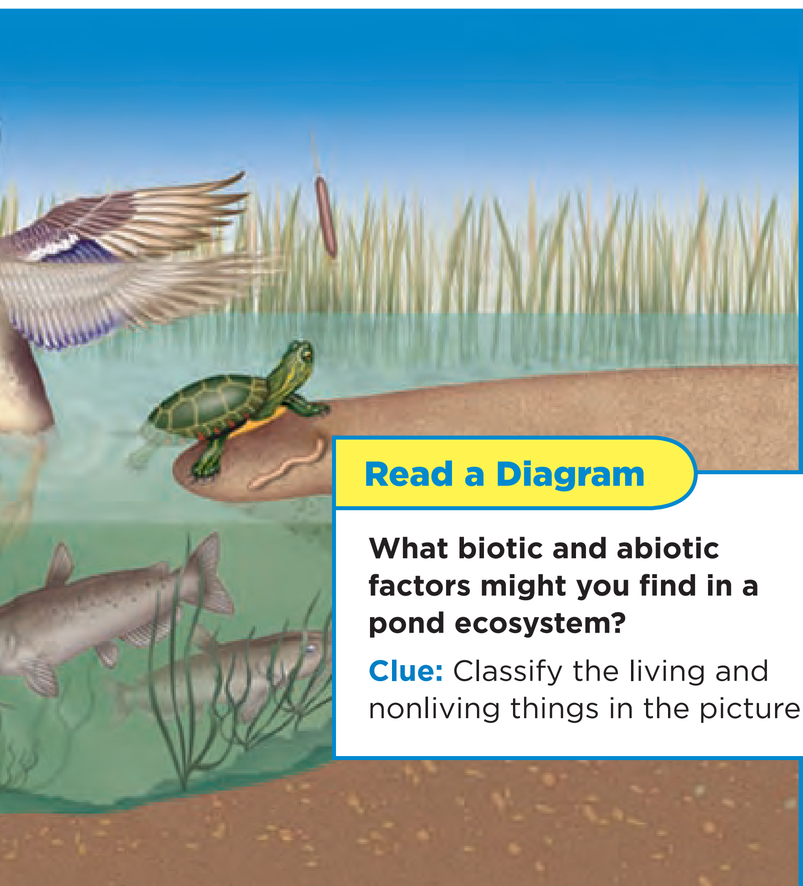
A Pond Ecosystem

Depending on Each Other

The biotic and abiotic factors of an environment make up an **ecosystem** (EE•koh•sis•tuhm). An ecosystem can be small, like a single log, or very large, like a desert.

Each organism in an ecosystem has its own place to live, or **habitat**. Different ecosystems provide very different habitats. A rainforest plant could not find a habitat to meet its needs in a hot, dry desert! Likewise, a cactus would not be able to survive in a rainforest.

Living things in an ecosystem depend on other living things to survive. For example apple trees depend on bees for pollination. Many other food crops in Ohio rely on bees for pollination as well.



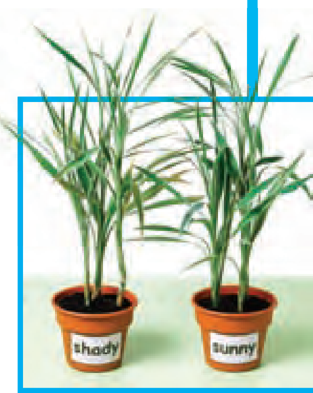
Read a Diagram

What biotic and abiotic factors might you find in a pond ecosystem?

Clue: Classify the living and nonliving things in the picture.

Quick Lab

Sun and Shade

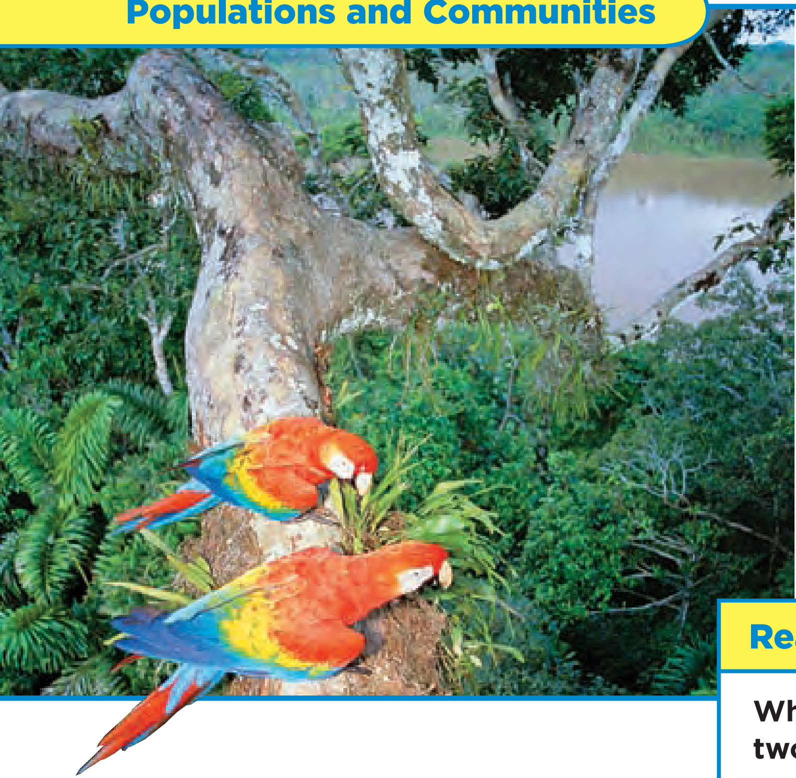


1. Obtain two plants of the same type that are of similar size. Label one pot *shady* and the other *sunny*.
2. **Use Variables** Put the plant labeled *sunny* in bright sunlight. Place the other plant in a dark or shady location.
3. Keep the soil in both plants moist using the same amounts of water.
4. Observe each plant every day for two weeks. Record your observations in a data table.
5. **Interpret Data** Which variables did you control? What can you conclude about how well each ecosystem supplied the needs of each plant?

Quick Check

Fact and Opinion Is the following statement a fact or an opinion? *A small ecosystem can have many kinds of living and nonliving things.* Explain.

Critical Thinking What kinds of biotic and abiotic factors do you depend on?



Read a Photo

What populations are visible in these two ecosystem?

Clue: Try to name the plants and animals in the photographs.

What are populations and communities?

Like all habitats, a pond is home to many different organisms. Each kind of organism is a member of a different species. A **population** is all the members of a species that live in an ecosystem. For example, the bullfrogs in a pond make up one population. Water lilies are another.

All of the populations in an ecosystem make up a **community**. A pond community may have populations of bullfrogs, fish, water lilies, and dragonflies. The size of a community depends on factors such as food, shelter, and light. Communities in warm, moist ecosystems tend to outnumber those in cold or dry places.

Studying Ecosystems

Scientists study populations and communities to learn about ecosystems. A change in a population can affect the community. For example, if bees die off, flowering plants cannot reproduce.

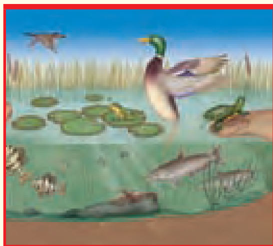
Quick Check

Fact and Opinion *The algae population is more important than the beetle population in a pond.* Is this a fact or an opinion? Explain.

Critical Thinking How can a change in one population affect the entire community in an ecosystem?

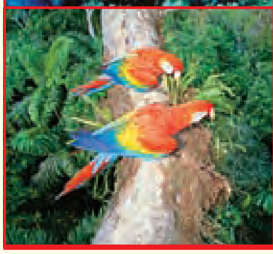
Lesson Review

Visual Summary



An ecosystem includes both **biotic and abiotic factors**.

Each biotic factor in an ecosystem has its own **habitat**.



All of the populations in an ecosystem form a **community**.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you have read about ecosystems.

Think, Talk, and Write

1. **Main Idea** Describe the factors that make up an ecosystem.

2. **Vocabulary** How are populations different from communities?

3. **Fact and Opinion** *An entire ecosystem can exist under a single rock.* Is this a fact or an opinion? Explain.

Fact	Opinion

4. **Critical Thinking** How do light and temperature affect the ability of an ecosystem to support life?

5. **Test Prep** **Which are abiotic factors?**
   - **A** snow, wind, rain
   - **B** air, bacteria, temperature
   - **C** plants, birds, insects
   - **D** rain, wind, flowers

6. **Test Prep** **All of the populations in an ecosystem make up a(n)**
   - **A** habitat.
   - **B** abiotic factor.
   - **C** community.
   - **D** pond.

Math Link

Solve an Equation
An elephant eats about 155 pounds of food every day. How many pounds of food would a population of nine elephants eat in one day?

Art Link

Picture an Ecosystem
Draw a picture of your favorite ecosystem. Include all the biotic and abiotic factors that you can think of. Label the different factors.

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Focus on Skills

Inquiry Skill: Predict

Scientists use what they know about a subject to plan their experiments. You know that plants depend on air, soil, light, and water. Knowing this information, you can investigate plants and their needs. You can **predict** what might happen in an experiment.

▶ Learn It

When you **predict**, you state the possible results of an event or experiment. You base your statement on what you already know. First, you tell what you think will happen. Then, you conduct your experiment. Finally, you analyze your results to determine if your prediction was correct.

▶ Try It

How well do you **predict** a seed will grow in polluted soil? Use what you have learned about plants and ecosystems to make your prediction. Write your prediction. Then, experiment to see if your prediction was correct.

Materials **2 milk cartons, measuring cup, soil, 10 bean seeds, water, safety goggles, graduated cylinder, vinegar, red food coloring**

1. Label one milk carton *A* and the other one *B*. Place one cup of soil in each carton. Push 5 bean seeds just below the surface of the soil in each carton. Water the soil just until it is moist.

2. ⚠ **Be Careful.** Wear safety goggles. Measure 80 mL of vinegar into the measuring cup. Place 5 drops of red food coloring in the vinegar. Carefully pour the liquid into carton B.

3. Place the cartons near a sunny window. Add equal amounts of water to each carton every 2–3 days. Observe both cartons after 2 days, 7 days, and 10 days. Write your observations in a chart like the one shown.

Carton A	
Prediction	
Day	Observations
1	
2	
7	
10	

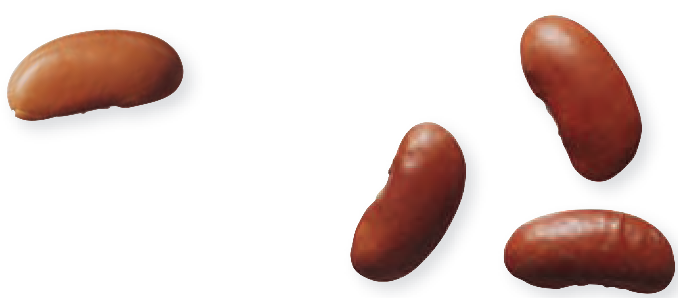
Carton B	
Prediction	
Day	Observations
1	
2	
7	
10	

4. In which carton did the seeds grow better? Compare your results to your prediction. Was your prediction correct?

5. Carton B models polluted soil. Use a spoon to dig up the soil in carton B. Can you still see the food coloring? What does this tell you about pollution?

▶ Apply It

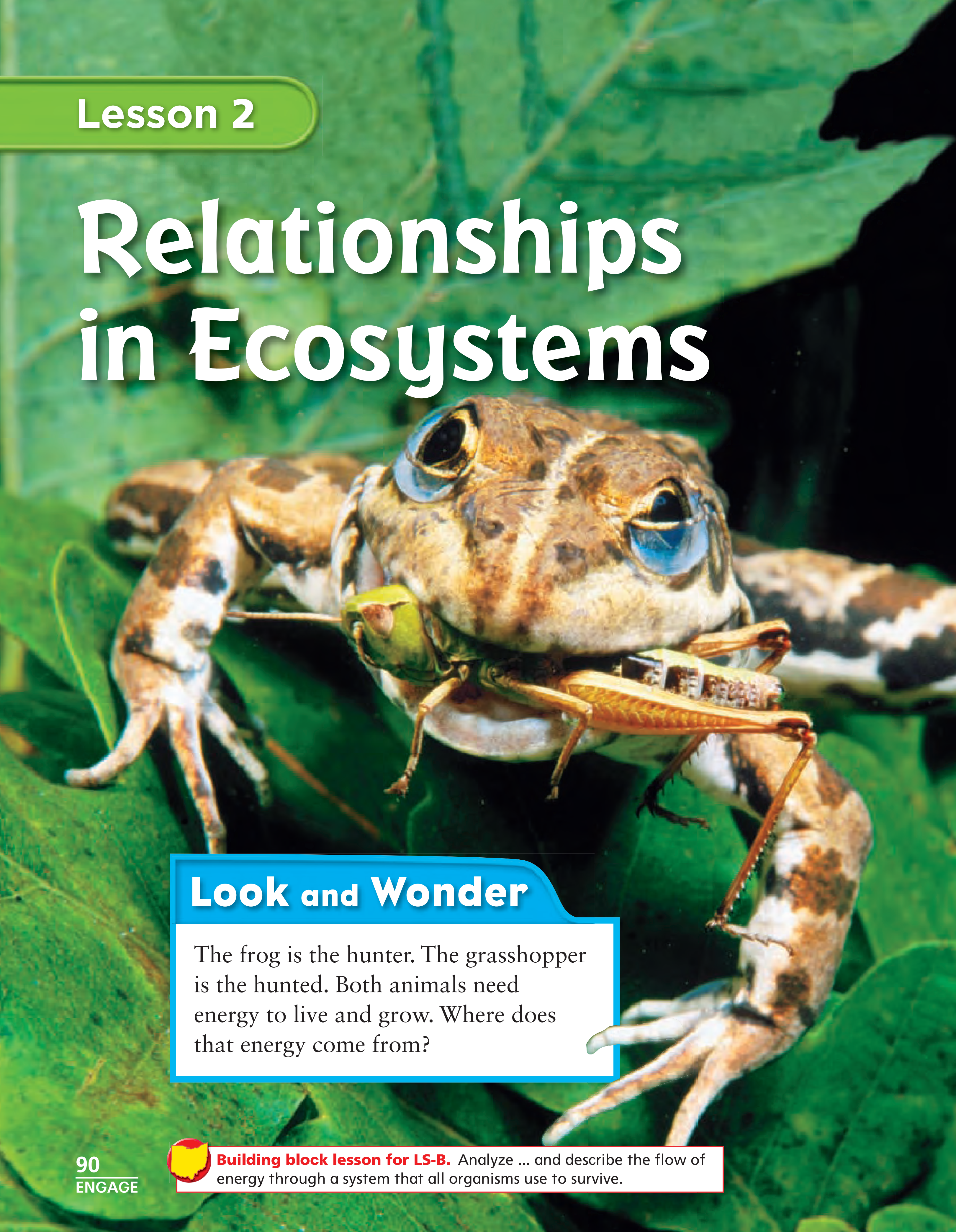
Now that you have learned to think like a scientist, make another prediction. How do you **predict** different amounts of water will affect a plant's growth? Plan an experiment to find out if your prediction is correct.



SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Lesson 2

Relationships in Ecosystems



Look and Wonder

The frog is the hunter. The grasshopper is the hunted. Both animals need energy to live and grow. Where does that energy come from?

Building block lesson for LS-B. Analyze ... and describe the flow of energy through a system that all organisms use to survive.

Explore

Inquiry Activity

How much energy do living things use?

Purpose

Model how energy passes from one organism to another in an ecosystem.

Procedure

1. Work in groups of four. Make labels for *Sun*, *plant*, *plant eater*, and *meat eater*.
2. **Measure** Cut a 1-m strip of butcher paper. This represents energy that living things can use. Make a mark every 10 cm along the strip.
3. **Make a Model** Each student takes a label. *Sun* begins by passing the energy strip to *plant*.
4. *Plant* cuts off 10 cm from the strip. *Plant* holds the larger section and passes the smaller section to *plant eater*.
5. *Plant eater* cuts off 1 cm and passes the smaller section to *meat eater*.

Draw Conclusions

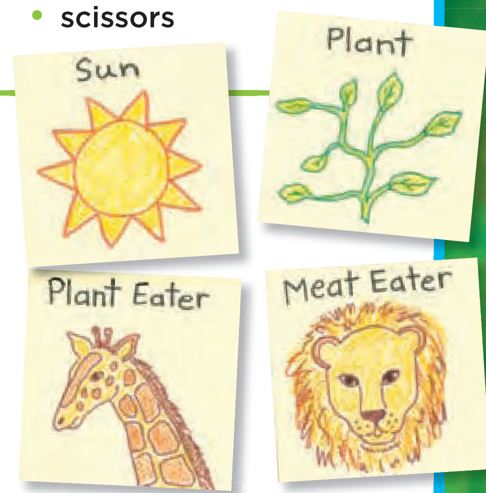
6. **Infer** Why do you think the energy strip gets cut before it gets passed on?
7. **Use Numbers** How much energy is available to the meat eater compared to the plant? Compared to the plant eater?

Explore More

What might happen if the plant could not make its own food energy? Design a test to find out.

Materials

- markers
- label paper
- butcher paper
- meter stick
- scissors



Step 4

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea LS-B

Energy is passed from producers to consumers to decomposers in an ecosystem.

Vocabulary

producer, p. 92

consumer, p. 93

decomposer, p. 93

food chain, p. 94

food web, p. 96

competition, p. 97

energy pyramid, p. 98

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Draw Conclusions

Text Clues	Conclusions

Technology SCIENCE QUEST

Explore relationships in ecosystems on Science Island.

How do organisms depend on one another?

To understand an ecosystem, scientists look at the relationships and roles of organisms within a community.

Producers

Every organism in an ecosystem relies on producers. **Producers** are organisms that make their own food using the energy in sunlight. Producers on land include green plants, such as grasses and trees. In lakes and oceans, the main producers are algae. Many other protists are producers, too.

Roles in an Ecosystem

Producers make food using sunlight.

Consumers eat producers.

Decomposers break down dead and decaying organisms.

Consumers

Organisms who cannot make their own food are called **consumers**. Birds, mammals, and other consumers get energy from the food made by other organisms.

We can classify consumers by the kinds of food they eat. *Herbivores* (UR•buh•vorz) eat only producers. Porcupines and most other rodents are herbivores. So are rabbits and deer.

Some animals eat producers and consumers. These are *omnivores* (OM•nuh•vorz). Opossums, raccoons, and bears are all omnivores. *Carnivores* (KAHR•nuh•vorz) are animals that eat herbivores and omnivores. Ospreys and other birds of prey are carnivores. So are cats, tigers, and lions. Sharks are carnivores, too.

Decomposers

Some organisms break down dead and decaying matter into wastes and simpler substances. These organisms are **decomposers**. Worms, bacteria, fungi, and other decomposers get energy this way. They return the substances to the ecosystem as nutrients. In other words, decomposers are recyclers.

Quick Check

Draw Conclusions What would happen if producers disappeared?

Critical Thinking Do consumers get energy from the Sun? Explain.

Quick Lab

Observe a Decomposer

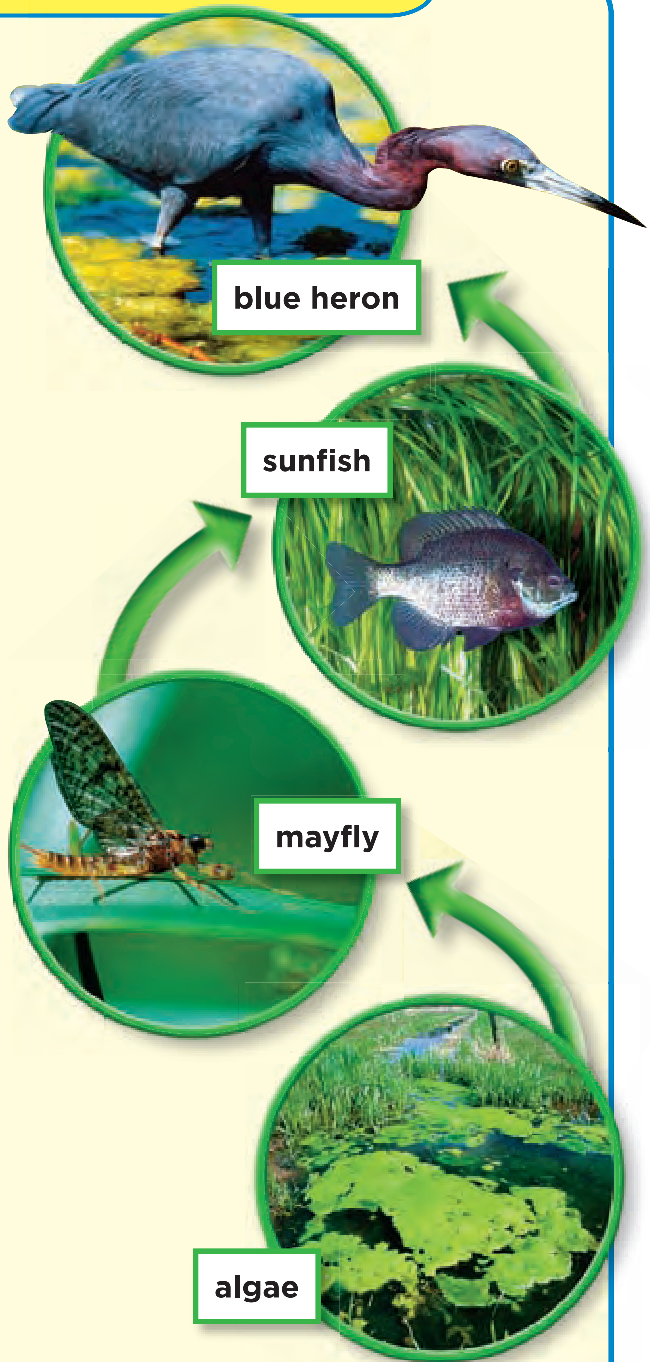
1. Moisten four food samples. Place each one in a plastic bag.

2. Seal the bags. Put them in a warm, dark place.

Be Careful! Do not open the bags after you seal them.

3. **Observe** Check the bags each day. Record your observations.
4. **Communicate** How did the foods change? Why did this happen?

Pond Food Chain



Read a Diagram

How does food travel in a pond?

Clue: The arrows in a food chain point to the next consumer.

LOG ON *Science in Motion* Watch decomposers in action at www.macmillanmh.com

What is a food chain?

Every organism needs energy to live and grow. The energy in an ecosystem comes from the Sun.

Look at the animals shown on these pages. None of them can use the Sun's energy directly. The energy of the Sun is stored in food. That energy passes from one organism to another in a **food chain**. The energy in a food chain moves from producers to consumers to decomposers.

A Pond Food Chain

Algae and green plants are first in the pond food chain. Algae capture the Sun's energy during photosynthesis. They store it in their cells as sugars.

What happens when a plant eater, such as a mayfly, eats the algae? The insect uses oxygen to release the energy stored in the algae it ate. It uses some of that energy to move, grow, eat, and reproduce. It stores some of the energy in its tissues.

A meat eater like the sunfish might snap up the mayfly. A blue heron may then eat the sunfish. As you can see, even the heron gets some of the Sun's energy that was passed along the chain.

All the plants and animals in the pond become food for decomposers after they die. Bacteria and other decomposers break down the dead tissues into simple nutrients that other living things can use.

A Land Food Chain

A food chain on land is similar to a pond food chain. On land the food chain usually starts with grasses, trees, and other green plants.

In the example on the right, the spear thistle is the producer. The painted lady caterpillar is the herbivore that munches on its leaves. The Chinese mantis, skink, and barred owl are the other consumers, in that order.

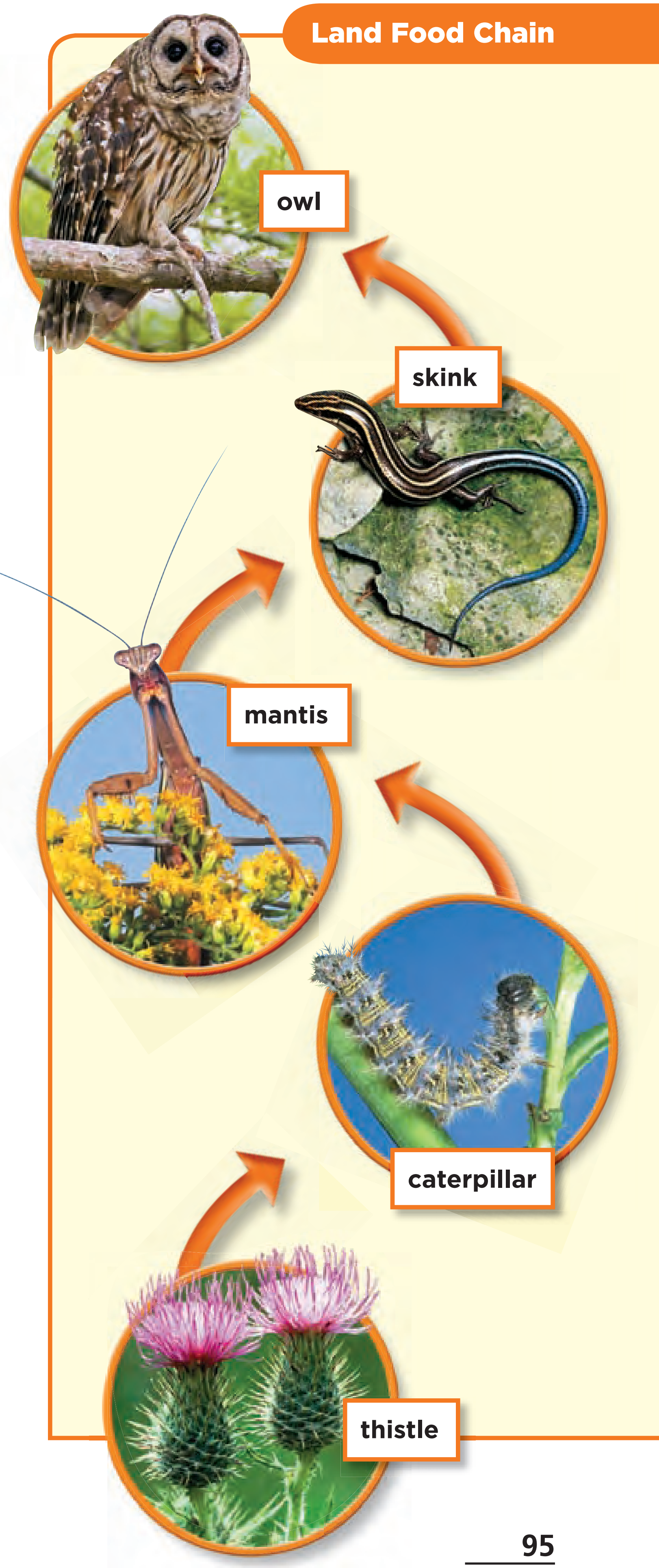
Where are the decomposers in both food chains? Decomposers are often left out of food chain diagrams. This is because they take part in every step of every food chain. Every time you see a food chain, remember the importance of decomposers.

Notice the arrows shown in the diagrams. The direction of the arrows is important. Each arrow in a food chain points away from the organism that is eaten. The arrow always points to the organism that eats it.

Quick Check

Draw Conclusions How is a food chain a good example of recycling in an ecosystem?

Critical Thinking Why is the term *food chain* a good descriptor of the relationships shown on these pages?

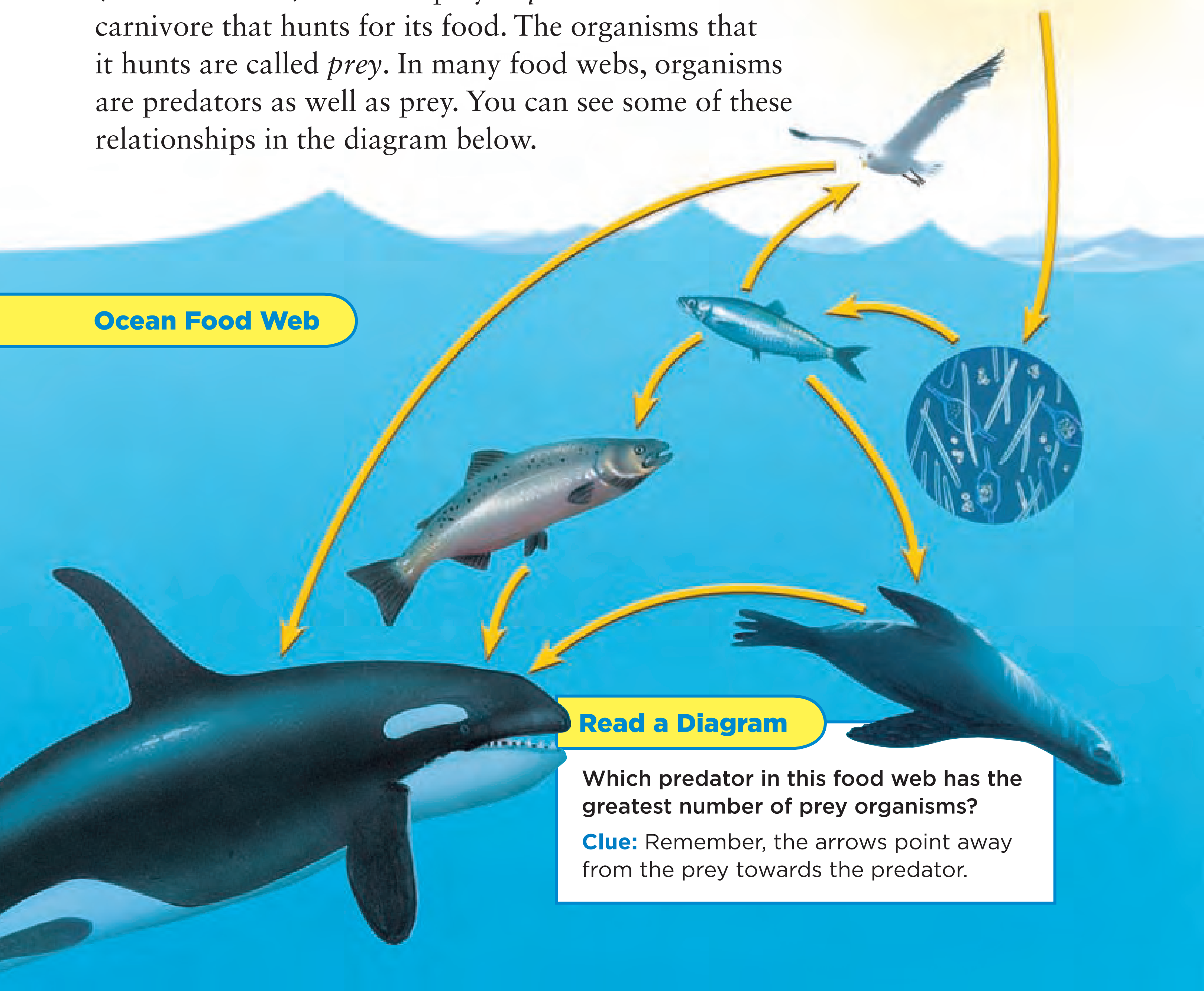


What is a food web?

A food chain is a good model of how energy travels in the form of food. However, it only shows one path. Most ecosystems have many different food chains that link together. A **food web** shows how all the food chains in an ecosystem are connected.

Predator and Prey

Food webs show relationships between predators (PRED•uh•tuhrz) and their prey. A *predator* is a carnivore that hunts for its food. The organisms that it hunts are called *prey*. In many food webs, organisms are predators as well as prey. You can see some of these relationships in the diagram below.



Ocean Food Web

Read a Diagram

Which predator in this food web has the greatest number of prey organisms?

Clue: Remember, the arrows point away from the prey towards the predator.

Competition

A food web shows that a single organism can take part in more than one food chain. When this happens, competition can result. **Competition** is the struggle between organisms for food, water, and other needs.

Look at the land food web. It has different herbivores, such as deer, small birds, and mice. What if they all ate the same plants? The three populations would compete for the food. One population might win out. The other populations would die unless they found a different food or moved to a different place.

Competition is not limited to animals. In the forest, small plants and flowers compete with tall trees for sunlight and nutrients.

Individuals in a population also compete with each other. You may have watched squirrels in a park compete for nuts. With all this competition, all living things on Earth can be considered part of one giant food web.

Quick Check

Draw Conclusions In the ocean food web, what animal competes with the killer whale for fish?

Critical Thinking List four different food chains in the land food web at the right.

Land Food Web

What is an energy pyramid?

Plants capture energy from the Sun. When you eat a plant, how much of that energy do you get?

An **energy pyramid** is a model that shows the amount of energy at each level of a food web. Producers are always at the bottom, or base, of the pyramid. They use about $\frac{9}{10}$ of all the energy they produce. They store the other tenth in their cells.

When an herbivore eats a producer, it gets the plant's stored energy. But that amount is only $\frac{1}{10}$ of the original energy from the Sun.

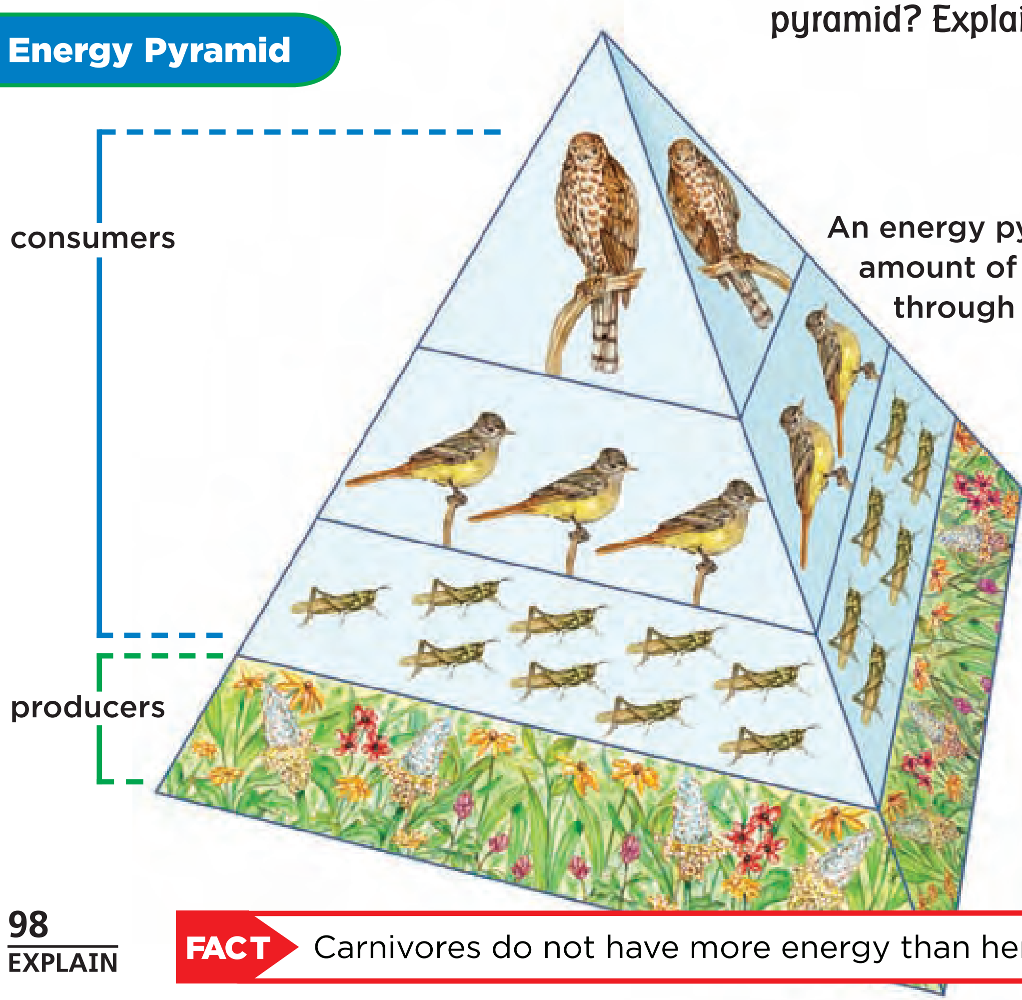
There are fewer and fewer organisms at each level of an energy pyramid. The organisms at each level use $\frac{9}{10}$ of the available food energy. Only $\frac{1}{10}$ of the energy gets passed to the next level. With only $\frac{1}{10}$ of the energy available to them, fewer organisms are able to survive on the level above. The animals at the top get just a tiny fraction of the original energy.

Quick Check

Draw Conclusions Why do food webs have more producers than consumers?

Critical Thinking Is it possible to have an upside-down energy pyramid? Explain.

Energy Pyramid



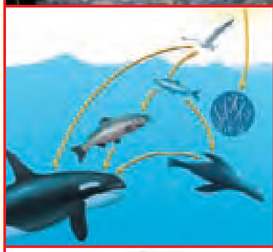
An energy pyramid models the amount of energy moving through a food web.

FACT Carnivores do not have more energy than herbivores.

Lesson Review

Visual Summary

In an ecosystem, food is made by **producers**, eaten by **consumers**, and broken down by **decomposers**.



Food chains and **food webs** show the relationships between organisms in an ecosystem.

Energy pyramids show how food energy moves through an ecosystem.

Make a FOLDABLES™ Study Guide

Make a Four-Tab Book. Use it to summarize what you read about relationships in ecosystems.

Think, Talk, and Write

1. **Main Idea** What roles do producers, consumers, and decomposers have in an ecosystem?
2. **Vocabulary** What is an omnivore? Give three examples.
3. **Draw Conclusions** Scientists are doing a survey of an ecosystem. So far, they have counted more carnivores than herbivores. Is the survey complete? Why or why not?

Text Clues	Conclusions

4. **Critical Thinking** Why do carnivores usually have sharper teeth than herbivores?
5. **Test Prep** **Two food chains can combine to form a(n) ________**
   - **A** ecosystem.
   - **B** food web.
   - **C** energy pyramid.
   - **D** food chain.

Math Link

Figure the Number of Carnivores
A normal ecosystem has 10 times as many herbivores as carnivores. How many carnivores would you expect to find if there are 4,250 herbivores?

Art Link

Show a Food Web
Find out about the organisms in your local environment. Make a poster showing each organism and the food web that connects them.

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

The Moth That Needed the Tree

The yucca moth of the Mojave Desert spreads the pollen of yucca trees. It also does something very unusual. When the moth visits a flower on the yucca tree, it pokes a hole in the flower's ovary. Then it places its own eggs in the flower! The moth leaves pollen on the flower as well. This helps the plant reproduce.

The moth's eggs and the tree's seeds grow at the same time. The seeds become food for the moth's offspring. All of this happens inside the flower! The young moths get the food they need. They also stay safe from predators. The yucca moth and yucca tree depend on each other.

yucca flower

Expository Writing

Good expository writing

- supports the main idea with facts and details
- organizes facts and details to show causes and effects
- draws a conclusion based on the information presented

Write About It

Expository Writing Research another example of how insects and plants depend on each other. Write a report with facts and details from your research.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

LS-5. Describe how organisms interact with one another in various ways (e.g., many plants depend on animals for carrying pollen or dispersing seeds).

Math in Science

How Many Monarchs?

Each winter, about 180 to 280 million Monarch butterflies travel from the north toward Mexico. There the climate is warmer and the butterflies can survive.

The milkweed plant is the Monarch's main source of food. Today, people are building in places where milkweed grows. Monarchs are having trouble finding enough food for their journey south. This change in the food chain means that fewer butterflies make the trip each year. Their numbers have been reduced by many millions.

Place Value

A place-value chart can help you understand the values of large whole numbers.

hundred millions	ten millions	millions	hundred thousands	ten thousands	thousands	hundreds	tens	ones
1	0	5,	8	3	7,	5	0	9

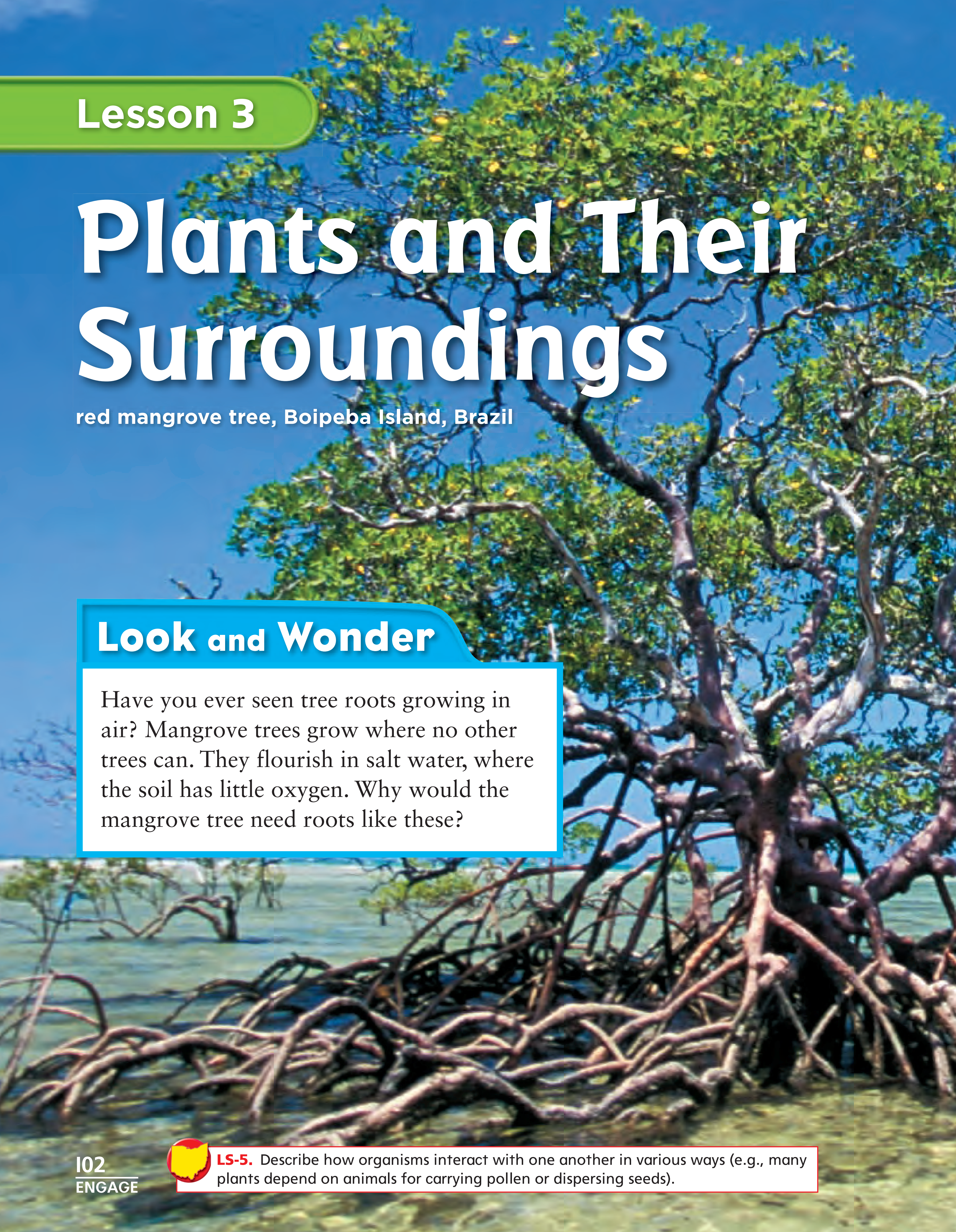
▲ **Read this number as one hundred five million, eight hundred thirty-seven thousand, five hundred nine.**

Solve It

An average population of Monarch butterflies is one million, nine hundred fifty-eight thousand, thirty-three. Write this number in a place-value chart.

Lesson 3

Plants and Their Surroundings



red mangrove tree, Boipeba Island, Brazil

Look and Wonder

Have you ever seen tree roots growing in air? Mangrove trees grow where no other trees can. They flourish in salt water, where the soil has little oxygen. Why would the mangrove tree need roots like these?

LS-5. Describe how organisms interact with one another in various ways (e.g., many plants depend on animals for carrying pollen or dispersing seeds).

Explore

Inquiry Activity

How do plants respond to their environment?

Make a Prediction

Plants need sunlight to live. If the light is blocked, how will a plant respond? Write your prediction.

Test Your Prediction

1. ⚠ **Be Careful.** Handle scissors carefully. Cut an opening in one side of one end of a shoe box.
2. **Measure** Cut two dividers from the cardboard. Make them as tall as the shoe box but 3 cm narrower.
3. Place the dividers upright across the inside of the box. Tape the first divider to the same side as the opening you cut in step 1. Tape the other divider a few inches away on the opposite side, as shown. Put a plant in the end of the box opposite the opening. Put the lid on the box. Turn the opening toward bright sunlight.
4. **Observe** Every 3–4 days for several weeks, remove the lid to water your plant. Observe and measure its growth. Record your observations in a data table.

Materials

- shoe box
- scissors
- cardboard
- ruler
- tape
- potted plant

Step 3

Draw Conclusions

5. **Interpret Data** What happened to the plant? Why?
6. **Infer** How did the plant get sunlight? How does this model plants that live on the forest floor?

Explore More

Would a seed germinate in the box you made? Design an investigation to find out. Use several lima bean seeds placed in a damp paper towel.

SWK-3. Explain discrepancies in an investigation using evidence to support findings.
SI-2. Analyze a series of events ..., describe the patterns and infer the next likely occurrence.

Read and Learn

Main Idea LS-5

Plants have adaptations and can respond to their environments.

Vocabulary

stimulus, p. 104

tropism, p. 105

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Problem and Solution

Problem
↓
Steps to Solution
↓
Solution

How do plants respond to their environment?

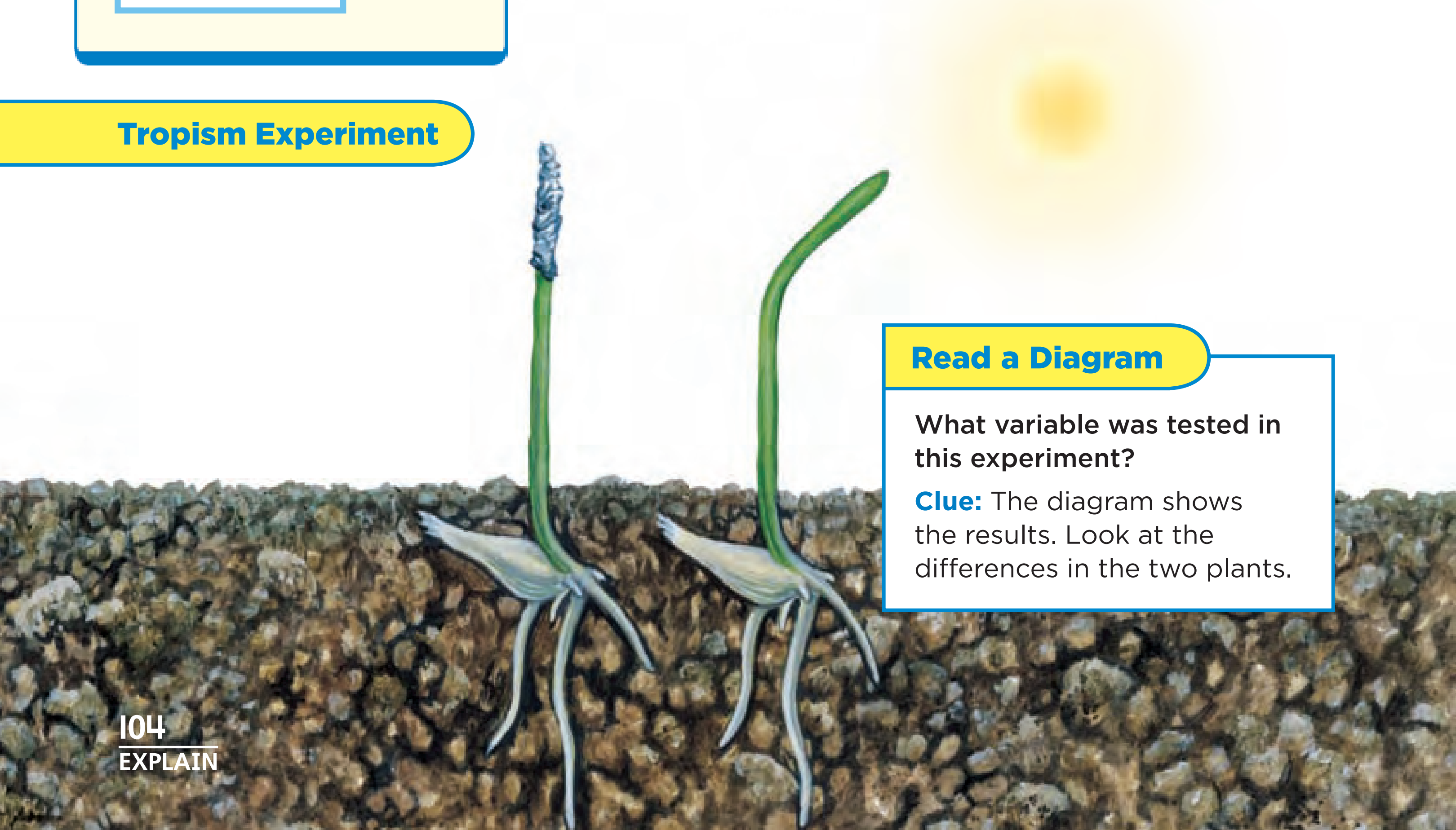
Plants cannot move around the way most animals can. Yet plants can react to changes in their environment. A **stimulus** (STI•myew•luhs) is something in an environment that causes a living thing to react.

Stimulus and Response

How does a plant react, or *respond*, to a stimulus? It changes its direction or pattern of growth. Light, water, and gravity can each be a plant stimulus.

Plants respond to light by growing toward the source of the light. Plants respond to water by growing their roots toward the water's source. The roots of most plants grow downward—the same direction as the pull of gravity. The stems of most plants grow upward, away from gravity.

Tropism Experiment



Read a Diagram

What variable was tested in this experiment?

Clue: The diagram shows the results. Look at the differences in the two plants.

Like most plants, the stems of water lilies grow toward the sunlight

Tropism

The responses of plants to light, water, and gravity are tropisms (TROH•pizmz). A **tropism** is the reaction of a plant to something in its environment. Plants also show tropisms to chemicals and heat.

What causes a tropism? The British scientist Charles Darwin did an experiment to find out. He took two growing plant shoots. He covered the tip of one shoot with a cap made of tin foil. He let the other shoot grow normally.

The results were clear. The shoot covered in foil did not bend toward the light. Darwin concluded that there was something in the tip that caused the shoot to bend. Later experiments showed that this "something" was a chemical that all plants have. Plants use this chemical to grow.

Quick Lab

Drying Time

1. Wet two paper towels. Roll one into the shape of a tube. Lay the other towel flat on a tray.
2. **Measure** Place both towels in bright sunlight or under a lamp. Record the time they take to dry.
3. Look at the maple leaf and the branch of pine needles. Which towel is like the maple leaf? Which is like a pine needle?

pine needles

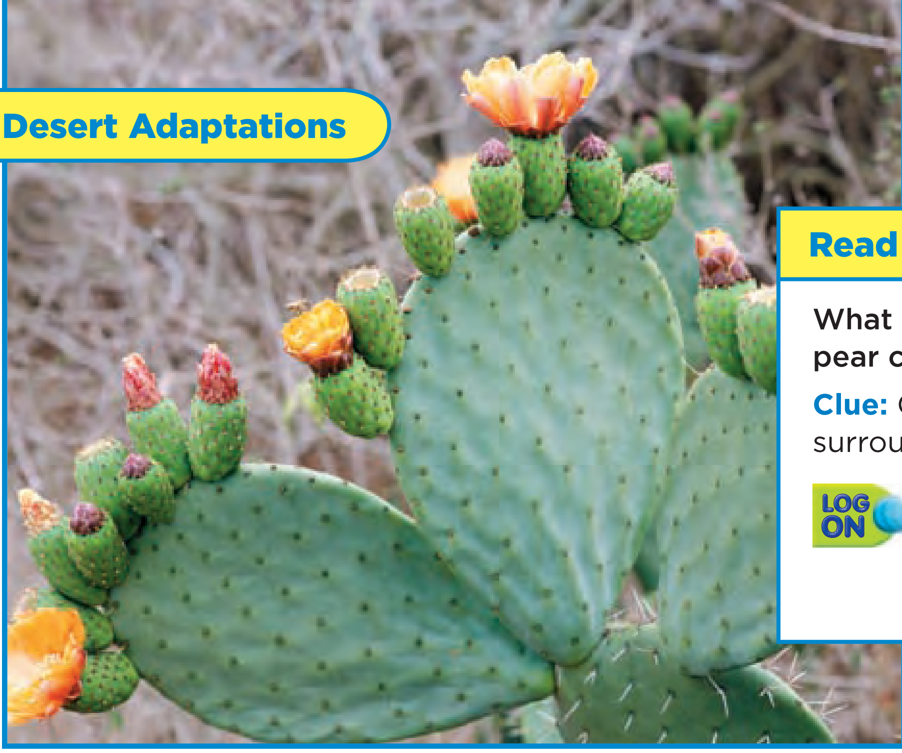
maple leaf

4. **Infer** Which can get more sunlight—a maple leaf or a pine needle? Which holds more moisture? How is each kind of leaf adapted to its environment?

Quick Check

Problem and Solution How could you test a plant's response to a chemical, such as vinegar?

Critical Thinking Some people think that plants respond to music. How could you test this hypothesis?



Desert Adaptations

Read a Photo

What adaptations help the prickly pear cactus live in the desert?

Clue: Compare the plant to its surroundings.

LOG ON *Science in Motion* See adaptations of other desert plants at www.macmillanmh.com

What are some plant adaptations?

Every ecosystem has its challenges. Plants can meet those challenges with the right kinds of adaptations. *Adaptations* are traits or behaviors that help living things survive in their environment. A cactus is a good example. It has soft tissue that holds water just like a sponge. It also has a thick, waxy cover to keep the water inside.

Plants outside of the desert have different adaptations. Cold winter air can harm the leaves of trees. That is why some trees lose their leaves in winter.

Some plants produce fruits. Many fruits attract animals with food. Some fruits can stick to fur. This can help the plant *disperse*, or move, its seeds.

The bright red color of the Peruvian lily is an adaptation that attracts pollinators.

Quick Check

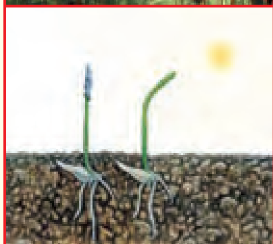
Problem and Solution How is it possible for plants to live in many different environments?

Critical Thinking What might happen if you brought a desert plant into a humid greenhouse?

Lesson Review

Visual Summary

Plants respond to **stimuli** by changing the way they grow.

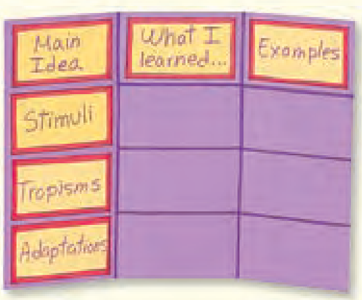


Plants have **tropisms** to light, water, gravity, heat, and chemicals.

Plants have **adaptations** that help them live in different environments.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you learned about how plants respond to their surroundings.



Think, Talk, and Write

1. **Main Idea** How do plants respond to their environments? Give at least three examples.

2. **Vocabulary** What is a stimulus?

3. **Problem and Solution** How could you show that plants respond to changing temperatures?

   Problem → Steps to Solution → Solution

4. **Critical Thinking** How are the adaptations of a desert plant different from those of a rain-forest plant?

5. **Test Prep** **Which word describes a plant's response to its environment?**

   A tropical
   B tropism
   C gravity
   D stimulus

Math Link

Solve a Problem
A plant is 6 cm tall. It grows 0.5 cm each day. How tall will the plant be after one week? After three weeks?

Art Link

Make a Poster
Use the Internet or reference books to learn more about plant adaptations. Make a poster of your findings.

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

A Field of Sun

There it was—a field of gold. There were hundreds, or maybe thousands, of tall sunflowers in full bloom. They seemed to stand in rows like soldiers, with their faces all pointed to the east.

A sunflower in full bloom is a beautiful sight. The head is made up of over 1,000 tiny flowers. These flowers later produce seeds. Golden petals circle the head. They look a bit like a tutu on a dancer, or a mane on a lion.

The sunflower's stem is tall and straight. It holds the head to the east. This protects the seeds from the hot rays of the Sun. Budding sunflowers follow the movement of the Sun. In the morning, they point east. In the late afternoon, they point west. At night, they point east again.

Descriptive Writing

Good descriptive writing

- includes details that tell how something looks, sounds, smells, tastes, or feels
- uses words that describe

Write About It

Descriptive Writing

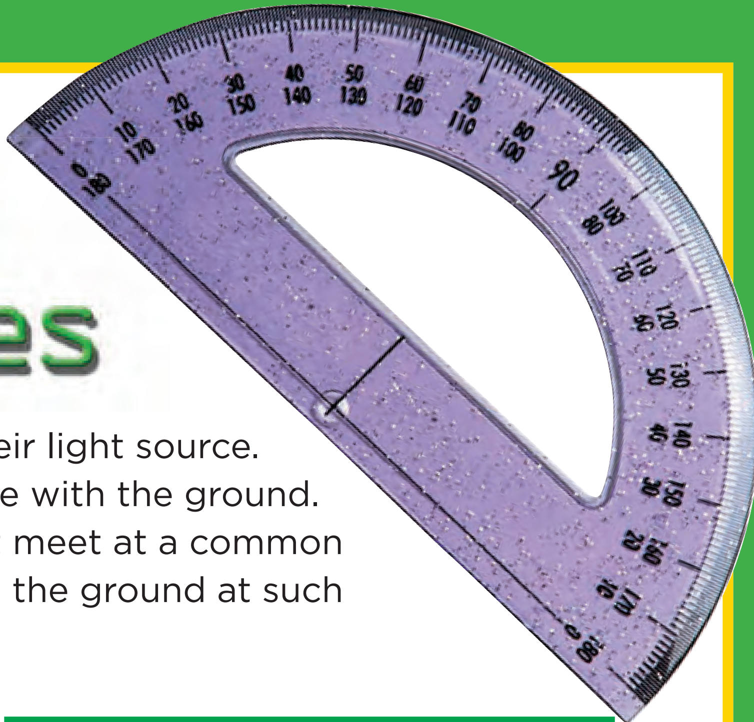
Do some research about another plant. Write a description of how this plant reacts to its environment.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

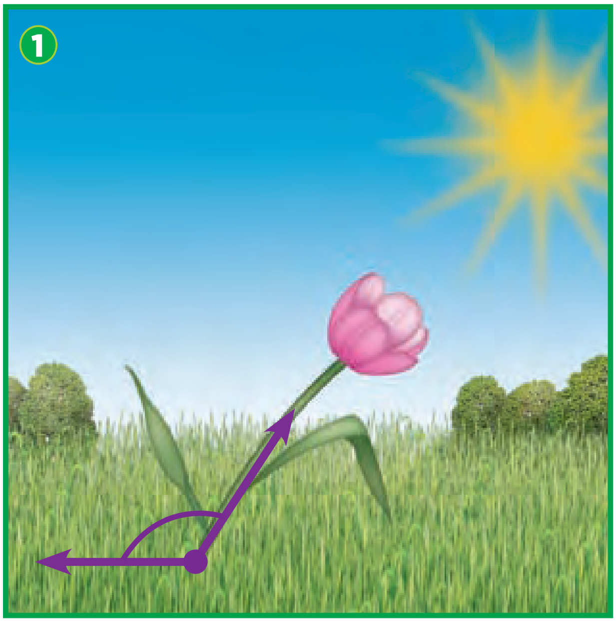
Sunflowers in full bloom face the east.

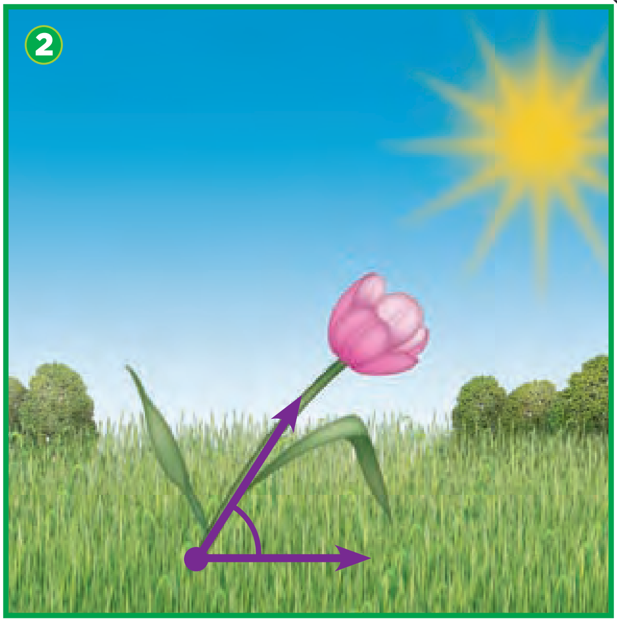
Math in Science

Comparing Plant Angles



Plants grow in the direction of their light source. This makes their stems form an angle with the ground. An angle is formed by two lines that meet at a common endpoint. The stem of a plant meets the ground at such an endpoint.





Solve It

1. Which diagram shows an acute angle? Which shows an obtuse angle?
2. Are there any right angles shown in the diagrams? How do you know?

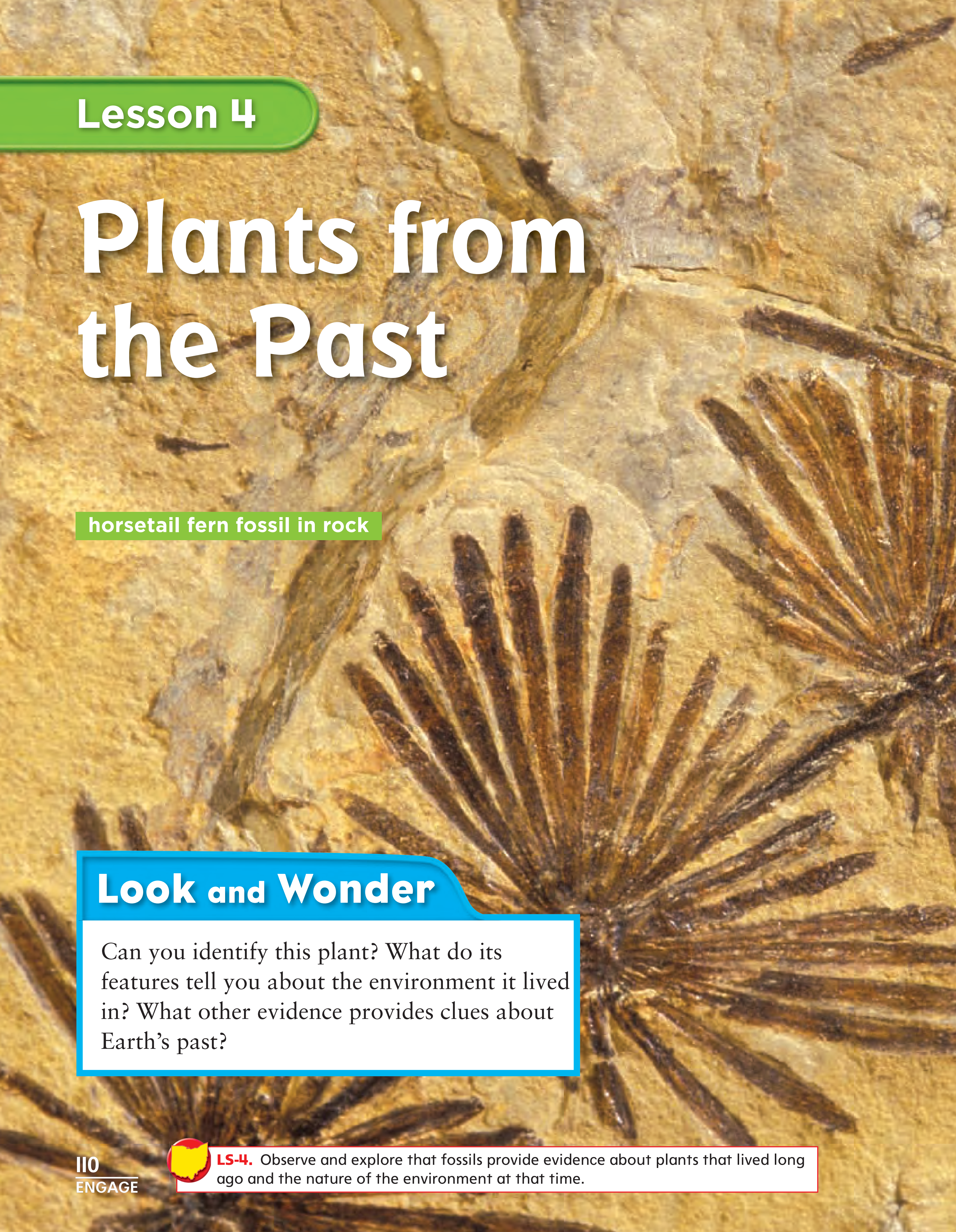
Classifying Angles

- A right angle has a square corner where the lines meet.
- An obtuse angle has a wider opening than a right angle.
- An acute angle has a smaller opening than a right angle.

M GSS-4. Identify and define triangles based on angle measures (equiangular, right and obtuse angles)....

Lesson 4

Plants from the Past



horsetail fern fossil in rock

Look and Wonder

Can you identify this plant? What do its features tell you about the environment it lived in? What other evidence provides clues about Earth's past?

LS-4. Observe and explore that fossils provide evidence about plants that lived long ago and the nature of the environment at that time.

Explore

Inquiry Activity

What can you learn from fossils?

Purpose

Make inferences from observations of model fossils.

Materials

- modeling clay
- small common objects, such as pencil, shell, eraser, coin, paper clip

Procedure

1. **Make a Model** Flatten some modeling clay. Make model fossils by pressing small objects into the clay.
2. **Communicate** Tell classmates about your fossils. What did the organisms look like? Where did they live? What other plants and animals lived there?
3. **Infer** What plant or animal parts would make the best fossils?

Step 1

Draw Conclusions

4. What can impressions in clay reveal about the objects that made them?
5. **Interpret Data** What can a plant or animal fossil tell us about the environment in which it lived?
6. What do you think scientists can infer from fossil plant and animal parts made long ago?

Explore More

What can plant and animal fossils tell us about how environments have changed? Do some research and make observations. Then share your findings with the class.

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea LS-4

Fossils provide clues about organisms and environments in Earth's past.

Vocabulary

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Draw Conclusions

Text Clues	Conclusions

What are fossils?

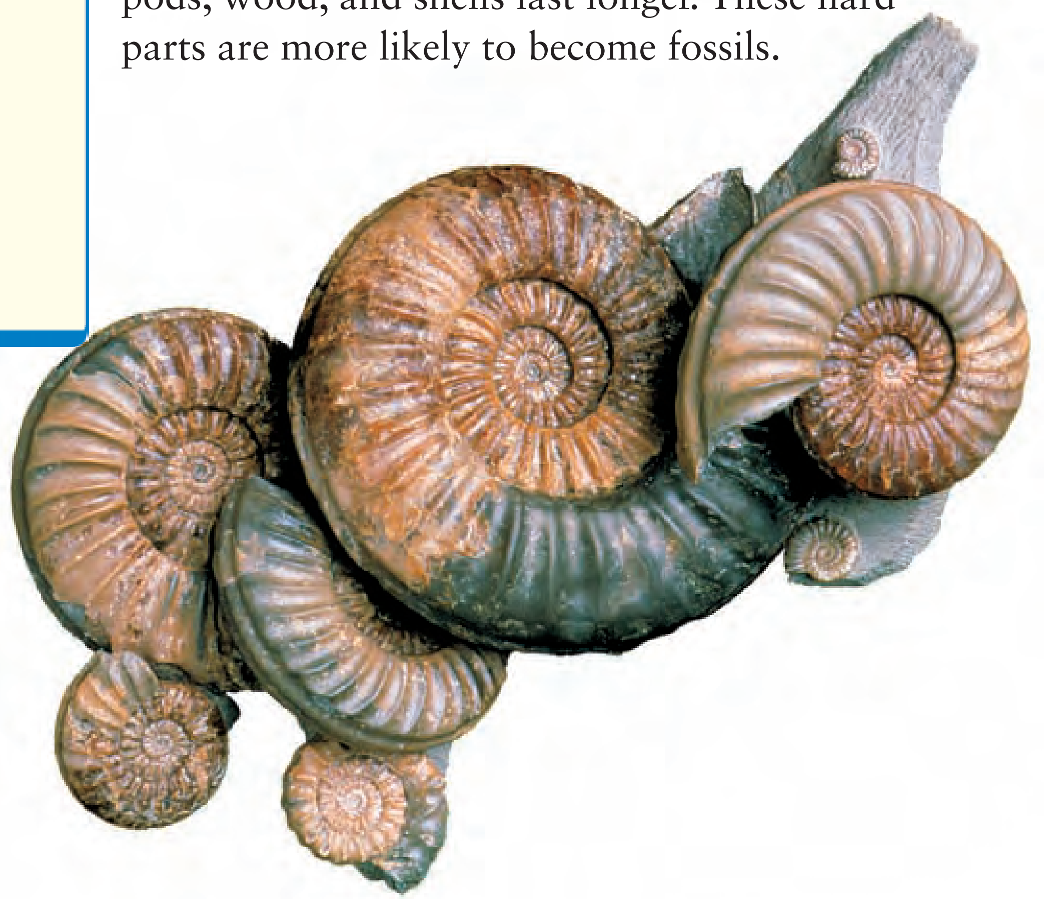
Scientists use clues from fossils to learn about Earth's past. A **fossil** (FAH sul) is evidence of an organism that lived long ago. For instance scientists have found dinosaur tracks and bones. Scientists have also found fossils of shells from marine organisms. A *marine organism* is a living thing from an ocean environment.

Many types of marine-organism fossils have been found in Ohio. What does this tell you about a past environment in Ohio?

How Fossils Form

Most fossils form in layers of rocks. Sediments bury whatever remains from a plant or animal that once lived. As the sediments turn to rock, the buried remains can become fossils.

When a plant or animal dies, the soft parts quickly decay or are eaten. Bones, teeth, seed pods, wood, and shells last longer. These hard parts are more likely to become fossils.

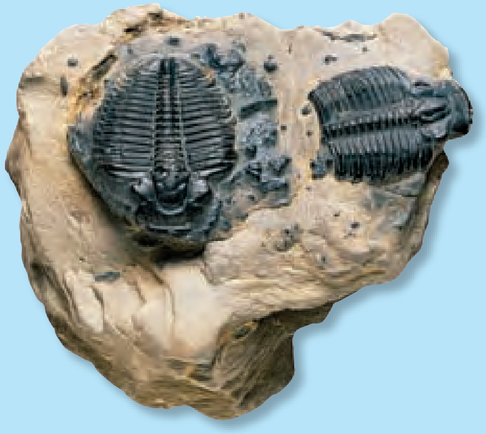


Ammonites lived in water. These fossil ammonites were found on land. ▶

Kinds of Fossils

leaf imprint

trilobite cast



petrified wood

Molds and Casts

Shells often leave behind fossils known as molds. A **mold** is a hollow form with a certain shape. How does a mold form? Water can seep into the spaces in the rock where an organism is buried. Slowly the water washes away the shell. It leaves a hollow space, or mold, where the shell was.

If minerals build up inside a mold, another kind of fossil may form. A **cast** is a fossil that is formed or shaped in a mold. Have you ever poured gelatin into a shaped cup? The cup was a mold. The hardened gelatin was a cast.

▲ *Isotelus* is Ohio's state fossil.

Imprints

Sometimes a shallow print is the only fossil evidence we have. Tracks, body outlines, and leaf prints are called imprint fossils. An **imprint** is a mark made by pressing.

Stony Fossils

Wood and bones can become *petrified,* or turned to stone. As minerals slowly seep inside a dead tree or animal, they replace its insides. The organism becomes a solid rock fossil!

Quick Check

Draw Conclusions How do we know that Ohio was once covered by water?

Critical Thinking How could you model a cast fossil and its mold?

What do fossils tell us?

Scientists use powerful computers and microscopes to learn about ancient life. When a new fossil is discovered, scientists compare it to similar living organisms. In doing so scientists must consider that organisms change over time.

Sometime a fossil's location is more puzzling than the fossil itself. For example fossils of ferns have been found in icy Antarctica. Antarctica is a polar environment. It is much too cold for ferns to grow!

Geologic Time

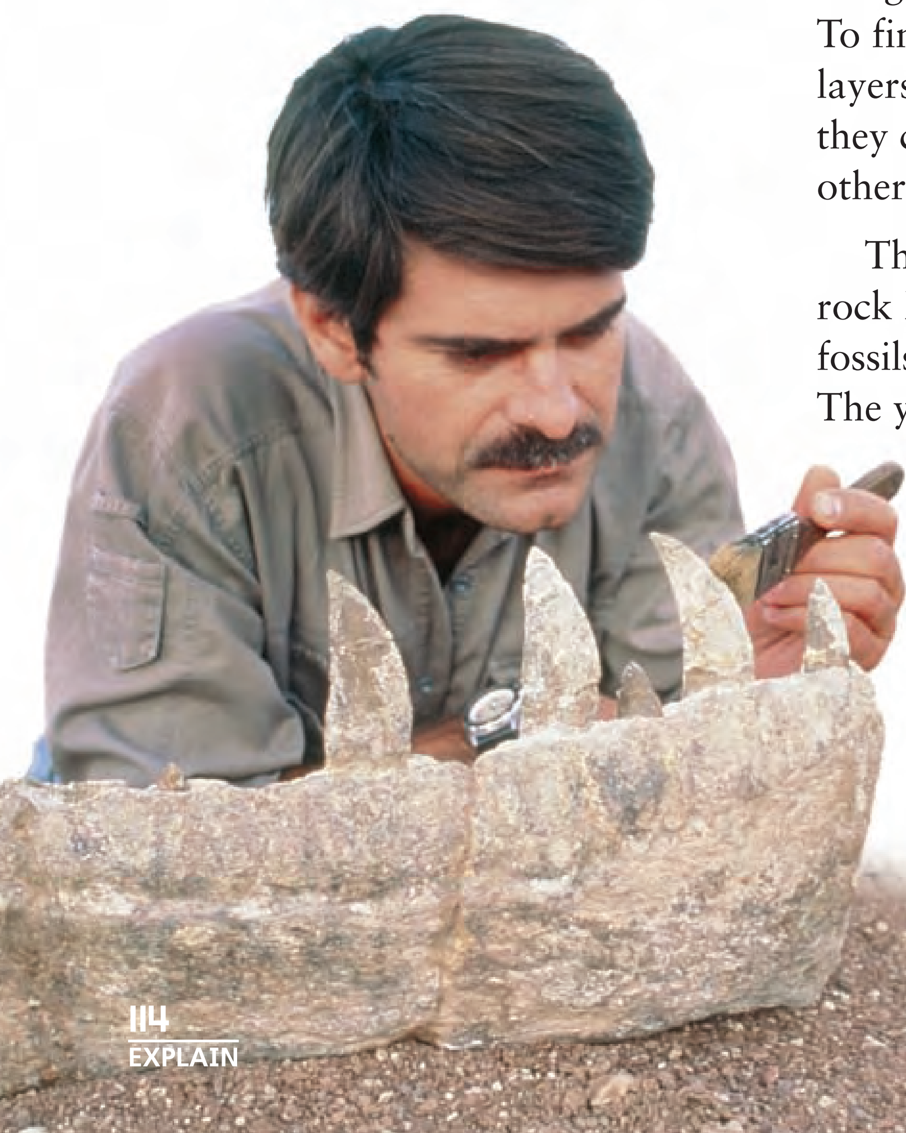
Organisms are not the only things that change over time. Earth's land and climate have also changed. You are familiar with fast changes like hurricanes and landslides. However, most of Earth's changes are very, very slow.

Scientists measure Earth's history in millions—even billions—of years. We call such long spans *geologic time*. When scientists study fossils, they are also studying geologic time.

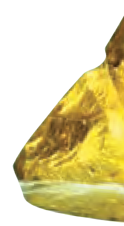
Examining Rock Layers

How have Earth's land and living things changed over geologic time? To find out scientists examine rock layers. They look for fossils. Then they compare those fossils with other fossils in the same rock.

The oldest fossils are in the oldest rock layers at the bottom. Younger fossils are found in upper rock layers. The younger layers formed later.

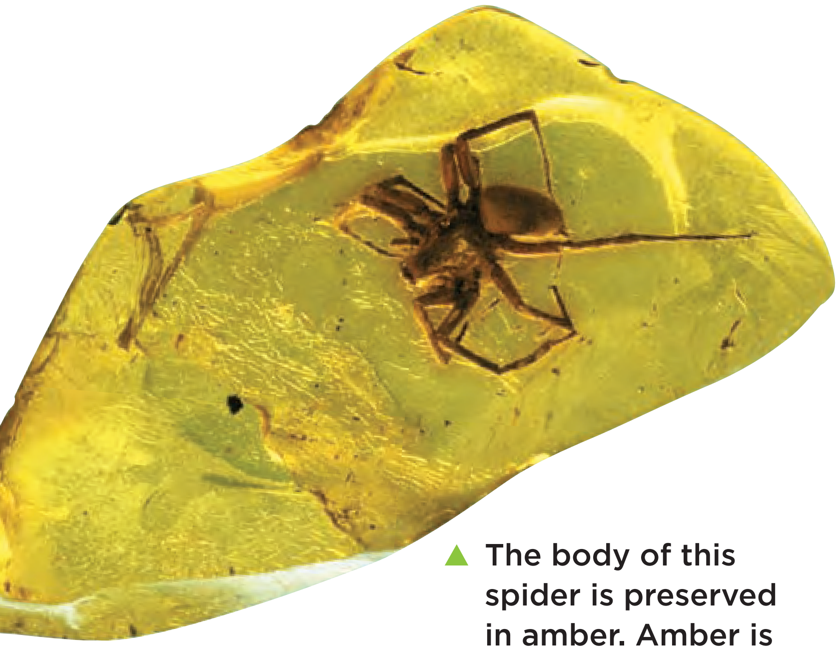


Scientists must work carefully to clean and prepare fossils for study.



Fossil Evidence

Rock layers and fossils are evidence of Earth's changes over time. In the past Earth's climate was warmer than it is now. At other times in the past, it was cooler. If you find a fish fossil on land, you know that water once covered that land.



▲ The body of this spider is preserved in amber. Amber is hardened tree sap.

▼ This fossil fern was found where it is too cold for ferns to grow!

Quick Lab

Older and Younger

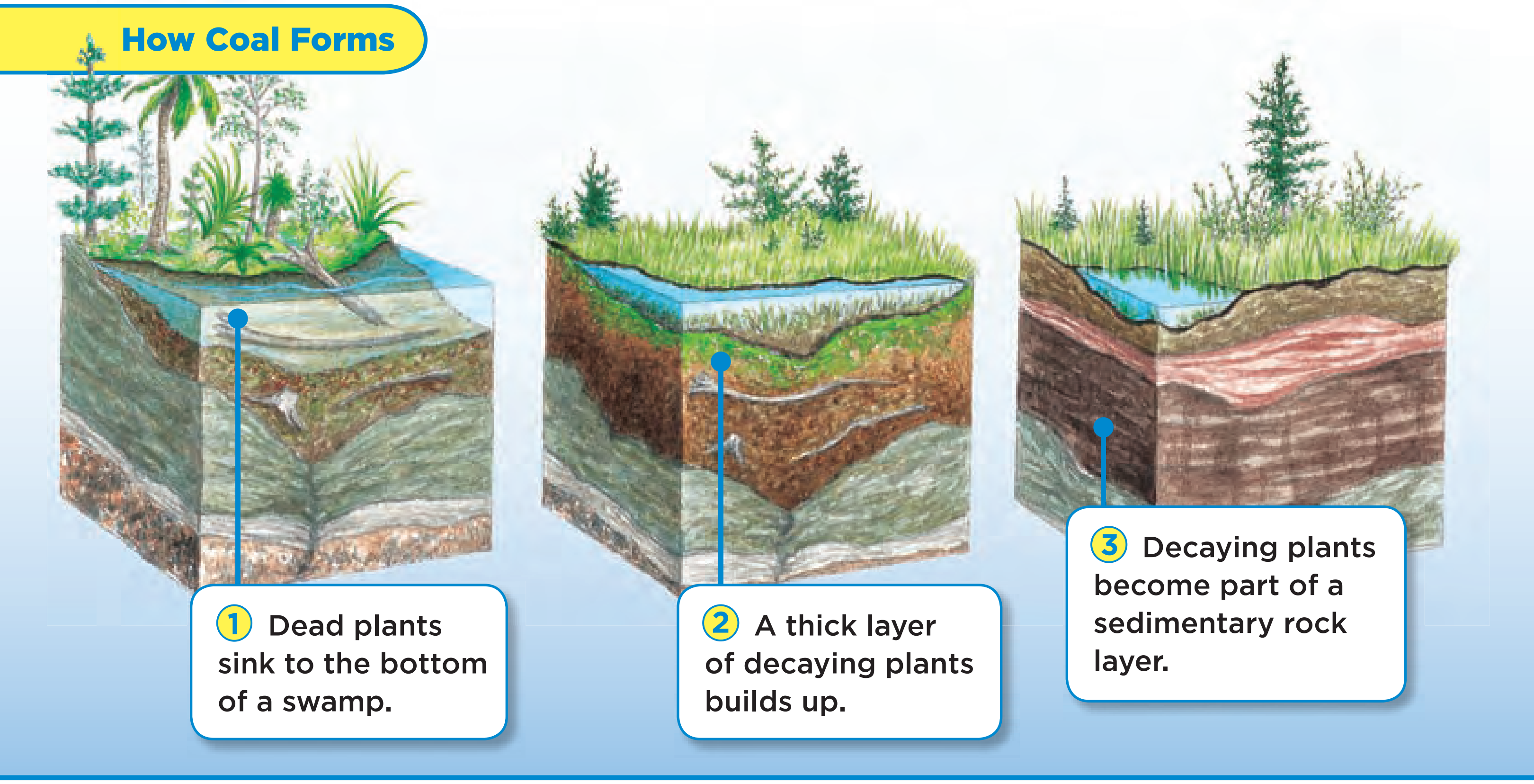
1. Cut a piece of paper into four pieces. Draw a "fossil" on each.
2. **Make a Model** Have a partner place each fossil inside the front cover of four different books. The stack models Earth's rock layers.
3. Find the fossils. Arrange them from "oldest" to "youngest."
4. **Communicate** How did you decide which fossil is oldest and which is youngest? Explain this to your partner.

Quick Check

Draw Conclusions How could ferns have lived on Antarctica?

Critical Thinking Scientists are certain that dinosaurs and mammals once lived together. How can they know this?

How Coal Forms



What are fossil fuels?

Where do people get energy to make electricity and drive vehicles? Much of it comes from fossil fuels, such as coal, oil, and natural gas. A **fossil fuel** is an energy source that formed millions of years ago. Fossil fuels form from the remains of buried plants and animals.

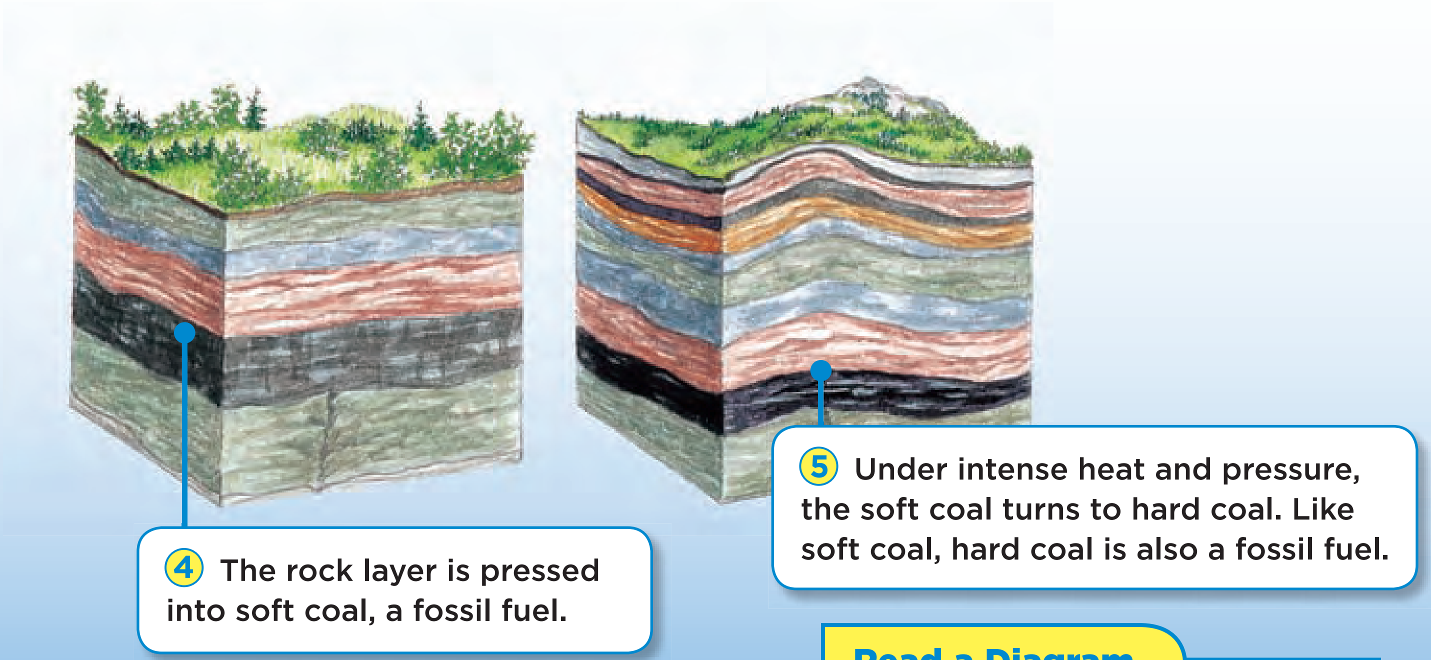
Fossil fuels are nonrenewable resources (NON•ri•NEW•i•buhl REE•sor•sez). A **nonrenewable resource** is a useful material that cannot be replaced easily. Once it is used up, it is gone forever. To release the energy stored in fossil fuels, we have to burn them. When we burn the fuels, we destroy the resource.

A Changing Environment

Coal formed from a process that began around 300 million years ago. At the time large swamps covered much of North America. The most common plants in these swamps were ferns. These ferns grew as tall as 25 meters (82 feet)!

Other tree fossils are found in coal deposits from the same period. These trees had hollow, jointed trunks, much like bamboo. These fossil plants are called calamites.

As the climate changed, the swamps dried up and most of the plants and animals died off. The fossils and fossil fuels that remain give an idea of what Earth was like.



Read a Diagram

How can dead plants or animals become a fossil fuel?

Clue: Follow the steps in the diagram.

Alternative Energy

Searching for fossil fuels can be expensive. Burning fossil fuels causes air pollution. No one knows how long our fossil fuel supply will last. Scientists are always looking for other ways to produce energy. These are called *alternative energy sources*. Can you think of some?

Quick Check

Draw Conclusions Why should we conserve fossil fuels?

Critical Thinking How do you and your family rely on fossil fuels?

Modern horsetails resemble fossil calamites.

The passenger pigeon was hunted into extinction in 1914.

The Tasmanian tiger was declared extinct in 1936. This was the last known individual.

Extinction

Some living things cannot adapt to an ecosystem change. If an organism does not meet its needs after a change, it will die. Sometimes an entire species can slowly disappear.

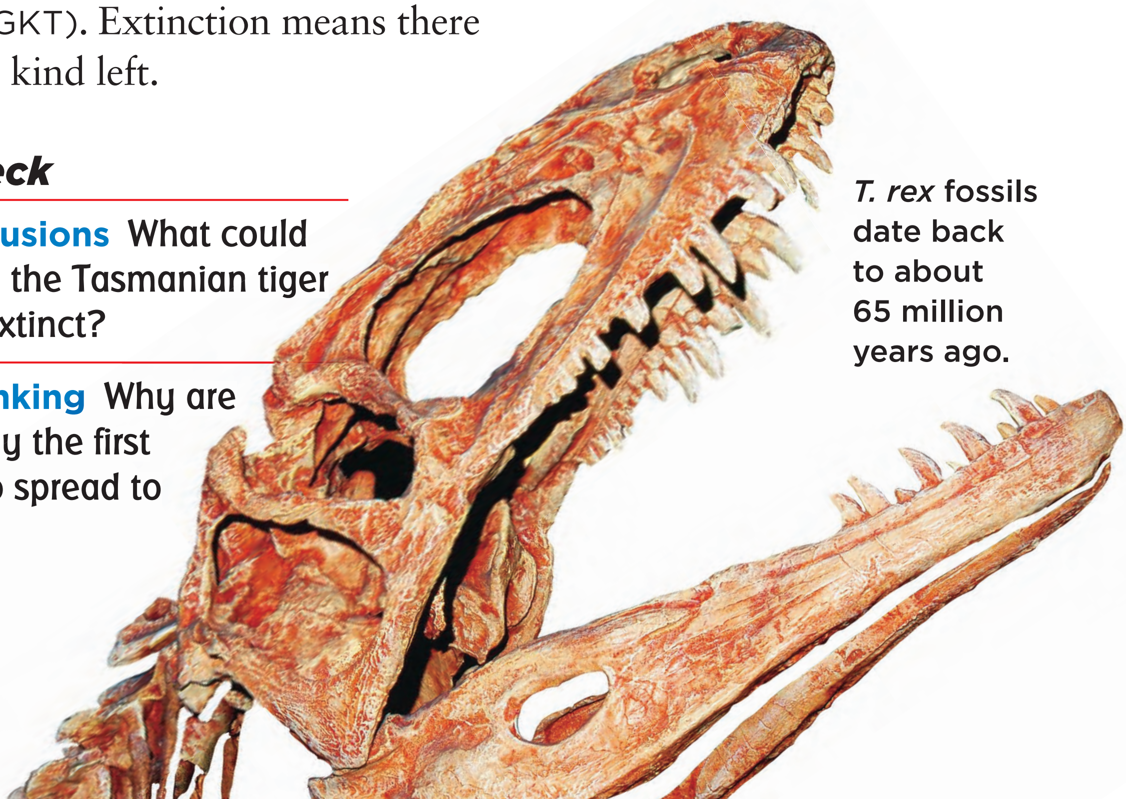
A living thing that has few of its kind left is **endangered** (en•DAYN•juhrd). Some endangered plants and animals can become **extinct** (ek•STINGKT). Extinction means there are none of their kind left.

Seed ferns became extinct millions of years ago.

Quick Check

Draw Conclusions What could have caused the Tasmanian tiger to become extinct?

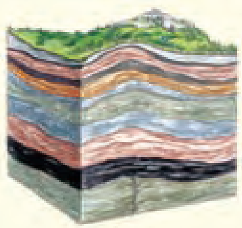
Critical Thinking Why are plants usually the first organisms to spread to a new area?



T. rex fossils date back to about 65 million years ago.

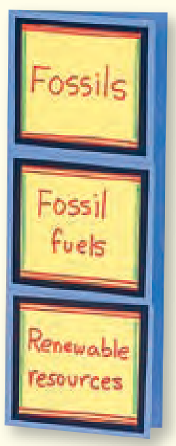
Lesson Review

Summarize the Main Idea

	**Fossils** provide clues about what Earth was like in the past. There are different kinds of fossils.
	**Fossil fuels,** such as coal, are nonrenewable resources. They cannot be replaced quickly.
	When environments change, organisms can become **extinct.**

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you read about fossils and fossil fuels.



Think, Talk, and Write

1. **Main Idea** Describe how fossils form. Name some different types of fossils.
2. **Vocabulary** When a species no longer exists, it is ________.
3. **Draw Conclusions** What can fossils tell you about past environments?

Text Clues	Conclusions

4. **Critical Thinking** How do the fossils displayed in museums compare with those in the ground?
5. **Test Prep** **Which resource is nonrenewable?**
   - **A** wind
   - **B** water
   - **C** wood
   - **D** coal

Writing Link

Write a Short Story
Write a story in which a fossil plays an important role. Describe the organism that left the fossil. Tell about the people who find or study the fossil.

Social Studies Link

Write a Report
What is the price of gasoline in your community? Ask adults what they think about energy costs. How do these costs affect them? Write a report about what you learned.

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Materials

model of fossil
T. rex tooth

model of fossil
Edmontosaurus tooth

model of fossil
shark tooth

horse tooth

colored pencils

Structured Inquiry

How do scientists learn about dinosaurs?

Form a Hypothesis

Scientists use fossils to infer things about dinosaurs. For example, scientists look at fossil teeth to infer what a dinosaur would have eaten. What can you learn from teeth? Write your answer as a hypothesis in the form, "If a dinosaur's tooth is flat, the dinosaur would have eaten …"

Test Your Hypothesis

1. Create a data table that includes rows for length and width. Make a place in your data table for drawings.
2. **Observe** Look closely at each model tooth. Draw its picture in your table.
3. **Measure** Find the length and width of each tooth. Record each measurement in your table.

Draw Conclusions

4. **Interpret Data** Compare and contrast the teeth you examined. Which dinosaur tooth is more like the horse tooth? Which dinosaur tooth is more like the shark tooth? Explain your answers.
5. The diet of modern horses includes grasses, hay, and wheat. Modern sharks eat fish and other animals. Based on your results, what do you think *Edmontosaurus* ate? Why?
6. **Infer** What did *T. rex* eat? How do you know?
7. Was your hypothesis correct? Explain.

Guided Inquiry

What else can you learn from fossil teeth?

Form a Hypothesis

What other information can scientists infer from animal teeth? Write your answer as a hypothesis.

Test Your Hypothesis

Design an investigation to find out if tooth size can tell you the size of an animal. Write out the materials you need and the steps you will follow. Record your results and observations.

Draw Conclusions

Did your results support your hypothesis? Why or why not? Form a new hypothesis if yours was not supported.

Open Inquiry

What else would you like to learn about dinosaur fossils? Design an investigation to answer your question.

Remember to follow the steps of the scientific process.

Ask a Question
↓
Form a Hypothesis
↓
Test Your Hypothesis
↓
Draw Conclusions

LS-C. Compare changes in an organism's ecosystem/habitat that affect its survival. **SI-3.** Develop, design and conduct safe, simple investigations ...

CHAPTER 2 Review

Visual Summary

Lesson 1 The living things in an ecosystem interact with each other. They depend on the nonliving things.

Lesson 2 Energy is passed from one organism to another in an ecosystem.

Lesson 3 Plants have adaptations and can respond to their surroundings.

Lesson 4 Fossils give clues about plants and animals that lived long ago.

Make a FOLDABLES™ Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned.

Vocabulary

Fill each blank with the best term from the list.

adaptation, p. 106

consumer, p. 93

ecosystem, p. 85

extinct, p. 118

food web, p. 96

habitat, p. 85

producer, p. 92

stimulus, p. 104

1. Two or more food chains that share links make up a(n) ________.
LS-5

2. A plant's long, deep roots is a(n) ________.
LS-2

3. An organism that cannot make its own food is called a(n) ________.
LS-5

4. The place where an organism lives is its ________.
LS-C

5. An organism that uses the energy in sunlight to make food is a(n) ________.
LS-2

6. The biotic and abiotic factors of an environment make up a(n) ________.
LS-B

7. When all the individuals of a species die, the species is ________.
LS-4

8. Something in the environment that causes an organism to respond is called a(n) ________.
LS-B

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Skills and Concepts

Answer each of the following in complete sentences.

9. **Fact and Opinion** *A scientist finds a fossil plant that resembles kelp, a sea plant, and says the fossil plant once lived in the sea.* Is this a fact or an opinion? Explain.
LS-4

10. **Expository Writing** Explain why abiotic factors are important to an ecosystem. Use details to support your explanation.
LS-B

11. **Critical Thinking** Suppose scientists discover a new species of plant living in the desert. What adaptations might this plant have?
LS-2

12. **Interpret Data** Which organisms in the food pyramid are consumers? Which are producers?
LS-B

The Big Idea

13. What happens when changes occur in ecosystems?
LS-B, LS-C

Performance Assessment

Kitchen Garden

Learn more about the produce that you could grow at home.

What to do

1. Use books or the Internet to research at least 6 different fruits or vegatables that will grow in your climate. Copy the chart below. Use your copy to record the plant spacing and yield.

Plants	Spacing	Yield
1		
2		
3		
4		
5		
6		

2. Design a garden to grow the six plants you selected.

Predict your results

How much produce do you expect to harvest from the garden?

Ohio Activity

Did you know Ohio has a state fossil? Research Ohio's state fossil. Name it and describe it. Include facts about how long ago the organism lived. Describe the environment at that time. Give details about other organisms that lived at that time as well. Tell where you can go to find and collect samples of this fossil.

Ohio Benchmark Practice

1 **A student observes the ecosystem of his backyard. How can he classify the grass?**

A as a biotic factor

B as an abiotic factor

C as a climate pattern

D as a desert element

LS-B, SWK-B

2 **After a drought lasting several years, many underground water pipes were found to have tree roots growing around them. This is an example of**

A a stimulus.

B a succession.

C an adaptation.

D a tropism.

LS-B, SI-C

3 **A student asks, "How do plants respond to sugar?" The student hypothesizes that sugar water will make plants grow faster.**

In your Answer Document, describe or draw a safe, simple investigation or experiment to answer the student's question.

Identify the variables, the way data will be collected, and how the student will know if the hypothesis was correct. (4 points)

SWK-B

4 **Which describes an animal adaptation?**

A the prickly surface of a seed that catches on an animal's fur

B the pollen that catches on a bee's leg

C the bright red color of the Peruvian lily

D the camouflage of a prey organism in the desert

LS-B

5 **A student made this table for her science class.**

gypsy moths stripping trees of leaves	planting trees
birds spreading seeds	building houses
beavers making new lakes	building dams

What would be a good heading for this table?

A Destroying Ecosystems

B How Living Things Change Ecosystems

C Common Problems in Ecosystems

D Building New Ecosystems

LS-C, SI-C

6 **If many plants begin to grow in an environment, what will likely happen next?**

A Animals will avoid the environment.

B Animals will move to the environment.

C Smaller plants will block sunlight from larger plants.

D Animals and plants will compete for sunlight.

LS-C

7 **Which is needed to test a plant's response to varying degrees of thermal energy?**

A a thermometer

B a compass

C a shovel

D a scale

SI-A

8 **A marine plant fossil is found at a local park. What does this most likely imply?**

A The fossil was lost by someone in the park long ago.

B The park was once under water in the past.

C Plants can no longer grow at the park.

D Fossils are not easily found.

SWK-A, LS-C

9 **A student examines a sample of petrified wood and concludes that trees must have been as hard as stone in the past. What fact would correct the student's reasoning?**

A Wood is harder than stone.

B Minerals seeped inside the tree and turned it to stone.

C Wood had a higher mineral content in the past.

D Tree wood is more likely to be petrified than stone.

LS-C

10 **Fossils can provide evidence about organisms that lived long ago.**

In your Answer Document, describe or draw a fossil of an ancient animal.

Then, indicate one structure, or feature, of the animal that helped it survive in its environment. (2 points)

LS-C

Literature

National Wildlife Federation

Ranger Rick

Magazine Article

Sea Otters

Key to the Kelp Forest

Sea otters dive deep underwater to catch food. Then they float on top of the water to eat.

from *Ranger Rick*

Sea otters are completely at home in the water. Look how relaxed this one is! Staying warm in the cold ocean can be a challenge, though. Whales, seals, and most other sea mammals have a thick layer of blubber to keep them warm. Sea otters do not have this layer of blubber. But they do have very thick fur to keep them warm—around 700,000 hairs per square inch. That is more hair than you have on your whole head! They also eat a lot of food for energy to stay warm.

Sea otters eat food such as clams, mussels, and their favorite, the purple sea urchin. Sea otters hunt in underwater forests of giant seaweed called kelp. A kelp forest is home to many animals. It is like a tall apartment building with different animals living on every floor.

Every animal in a kelp forest depends on sea otters. Why? On the bottom of the kelp forest, sea urchins eat loose bits of kelp. Sea otters dive down to catch and eat the urchins. All is well if there are enough sea otters around. If not, the number of urchins gets out of balance. The hungry urchins start to gnaw on the growing kelp plants. This causes the plants to break off and float away.

As the forest is destroyed, the animals lose their home. In many places, sea otters are threatened by oil spills, diseases caused by pollution, and other problems. The good news is that a lot of people are working to save them. That's important—not just for the sea otters, but also for the many animals that depend on them!

Write About It

Response to Literature Research another place where plants and animals depend on each other. Write a report describing how the plants and animals interact.

LOG ON e-Journal Write about it online at www.macmillanmh.com

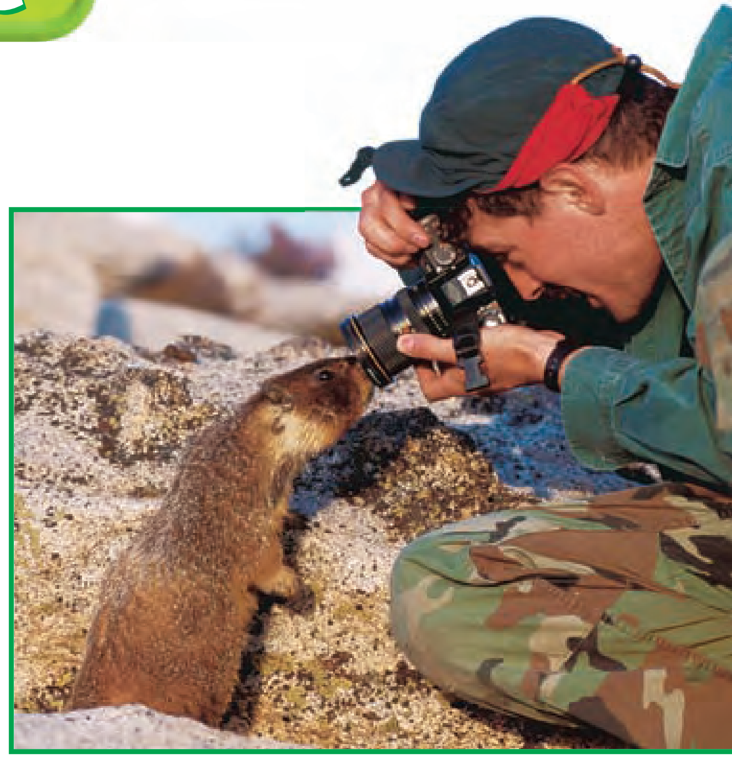
Careers in Science

Nature Photographer

Picture yourself deep in a forest or below the ocean's surface. There is no one else around. You are ready to capture a special moment on film.

To be a nature photographer, you need to take classes in art and photography. You should also enjoy being outdoors.

A nature photographer needs patience. A single shot might take days or even weeks to get. You may face harsh conditions, like swarms of insects or cold rains. But when you finally capture that perfect photo, it is all worthwhile!



▲ A nature photographer must know about living things and their habitats.

Forester

Do you love the outdoors? You should think about a career as a forester. A forester manages forests or wilderness areas. Their job is to help protect the land and make the best use of it.

To become a forester, you need a college degree in life science. Your studies will help you decide if land is safe for hiking, camping, or hunting. You will learn to care for seedlings. You might teach others how to care for the land.

▲ A forester teaches people about forest ecosystems.

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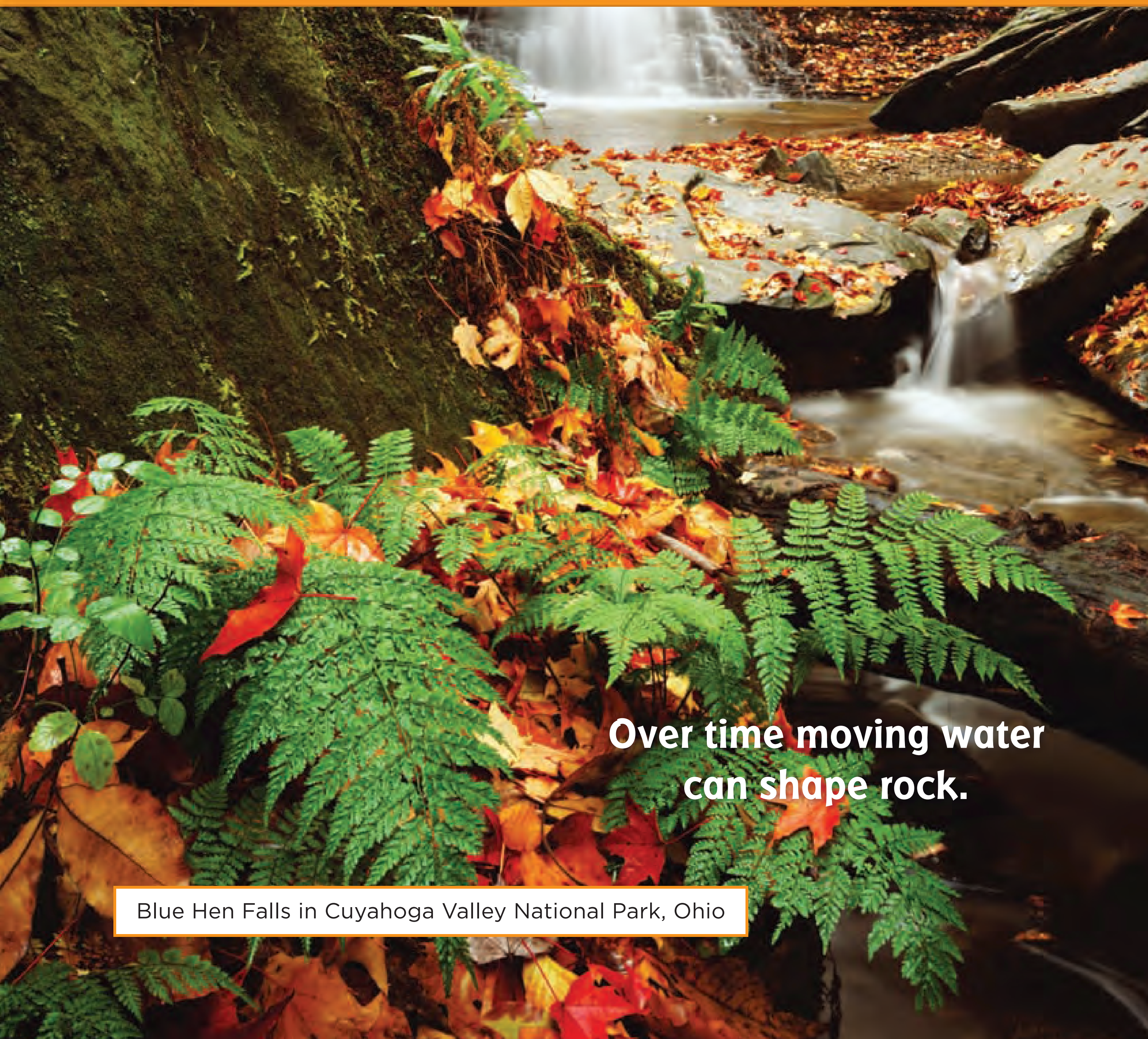
Ohio

Earth and Space Sciences



Over time moving water can shape rock.

Blue Hen Falls in Cuyahoga Valley National Park, Ohio

WINTER IN NORTHEAST OHIO

man shoveling snow

Winter in Ohio

Winter in Ohio usually brings snow. In some parts of the state, however, winter brings lots and lots of snow! People who live along the coast of Lake Erie are used to receiving between 150 and 280 centimeters (59–110 inches) of snow each winter season.

The counties along the lake—from Cleveland to Ashtabula—and the counties immediately to the south form a region called the Snow Belt.

The Lake Effect

Why does Cleveland get more snow than Cincinnati? The answer is in the arctic air from Canada that blows across Lake Erie. During winter, the water in the lake is warmer than the air that blows across it. As the cold air blows over the warm water from west to east, it warms up. As it warms, it picks up moisture. The air rises and blows over the land along the lake. The air cools and the moisture turns into snow. The result is called lake-effect snow. Lake-effect snow only happens where there is a large body of relatively warm water that has cool air blowing over it.

Think, Talk, and Write

Critical Thinking Where else might lake-effect snow occur? Explain your reasoning.

Ohio

A CLOSER LOOK

Main Idea

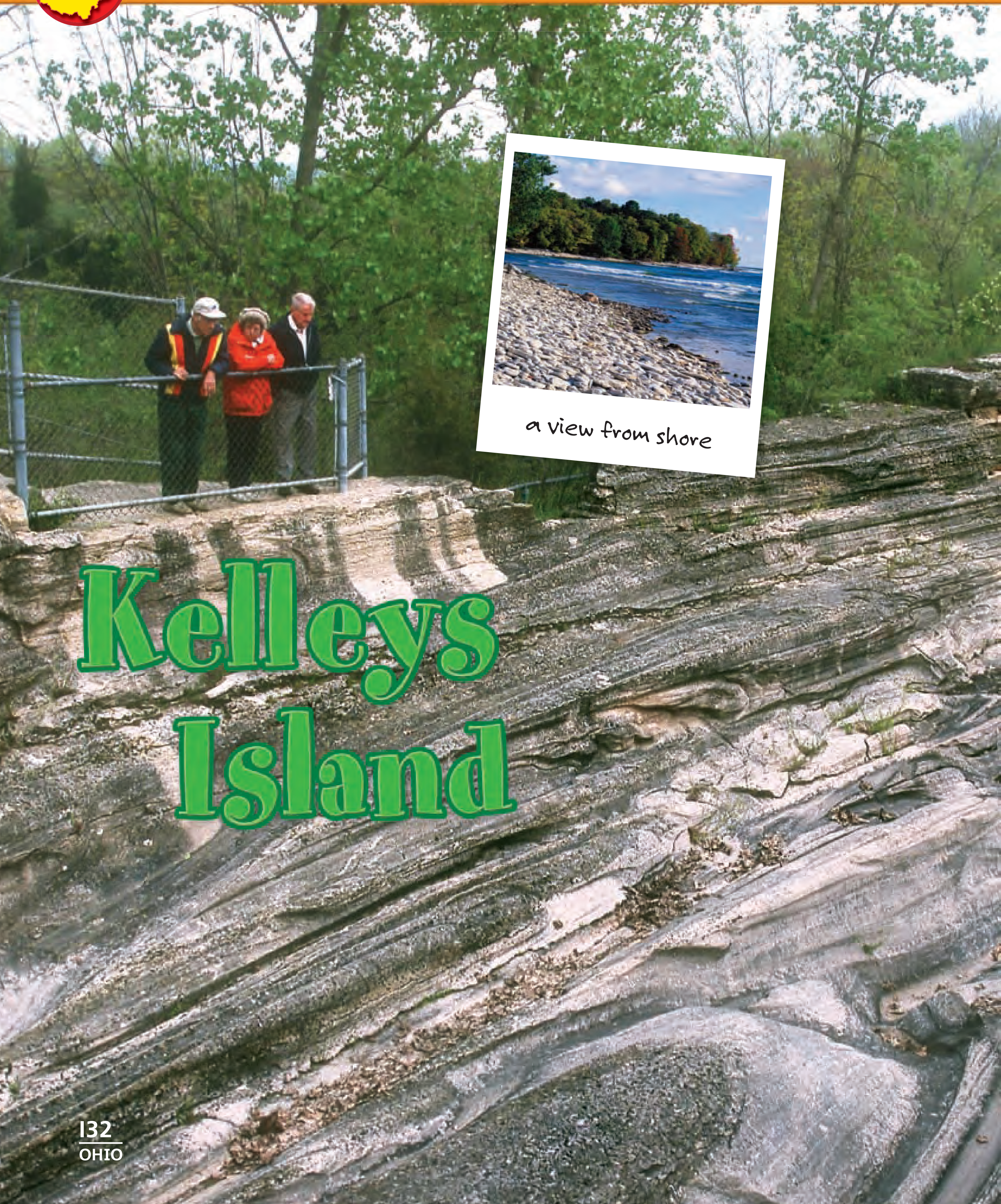
As cold air moves over a large body of relatively warm water, lake-effect snow can result.

Activity

Record Data Research the annual snowfall in several Ohio cities.

- Make a data table that lists the amount of snow in the different cities.
- Make a bar graph showing your data. Include a key, or legend, for your graph.

ESS-2. Identify how water exists in the air in different forms (e.g., in clouds, fog, rain, snow and hail). **ESS-3.** Investigate how water changes from one state to another (e.g., freezing, melting, condensation and evaporation).



Kelleys Island

a view from shore

Carving Earth

Kelleys Island is located 4 miles north of Marblehead, Ohio, in the western part of Lake Erie. The island was formed during the last ice age when enormous ice sheets slowly entered Ohio and then melted.

When the glaciers moved into Ohio, Lake Erie was a low spot with a river flowing through it. Kelleys Island was a high spot made of limestone. The glaciers acted like giant bulldozers on softer shale bedrock but had a more difficult time crossing over the harder limestone bedrock. *Bedrock* is solid rock below the soil. The glaciers scoured the softer bedrock, and the melting ice created the Great Lakes and their islands.

Glacial Grooves

As glaciers move they loosen and scrape away pieces of rock. The rock debris is picked up by the glacier and grinds away the bedrock below. The unusual giant glacial grooves on Kelleys Island are evidence the glaciers covered Ohio. The grooves formed almost 18,000 years ago from moving glaciers and water flowing underneath the massive ice sheets.

Think, Talk, and Write

Critical Thinking How were the glacial grooves on Kelleys Island formed?

ESS-8. Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas and glacial moraines).

Ohio

A CLOSER LOOK

Main Idea

Glaciers have reshaped some of Earth's surface including much of Ohio.

Activity

Draw Conclusions Glaciers covered two thirds of Ohio but not the southeastern portion of the state.

- Research the landforms that occur in Ohio. Examples of Ohio landforms include lakes, rivers, hills, and glacial moraines. Plot the landforms on an Ohio map.
- Compare the landforms in the regions and draw your own conclusions how glaciers contributed to the features of the land.
- Check your conclusions against research materials. Were your conclusions correct? Explain.

CHAPTER 3

Shaping Earth

The Big Idea What causes Earth's surface to change?

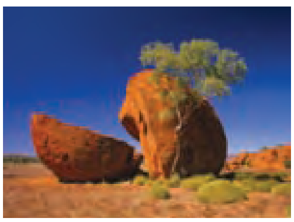
Dead Horse Point State Park, Utah

Key Vocabulary

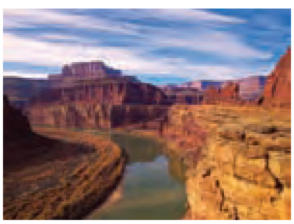
crust
solid rock that makes up the Moon's and Earth's outermost layers (p. 142)

earthquake
a sudden shaking of the rock that makes up Earth's crust (p. 150)

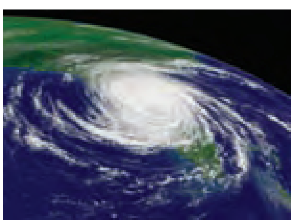
seismograph
a tool that graphs seismic waves as wavy lines and helps scientists detect earthquakes (p. 152)



weathering
a process that breaks rocks into smaller pieces (p. 160)



erosion
the removing of weathered rock (p. 162)

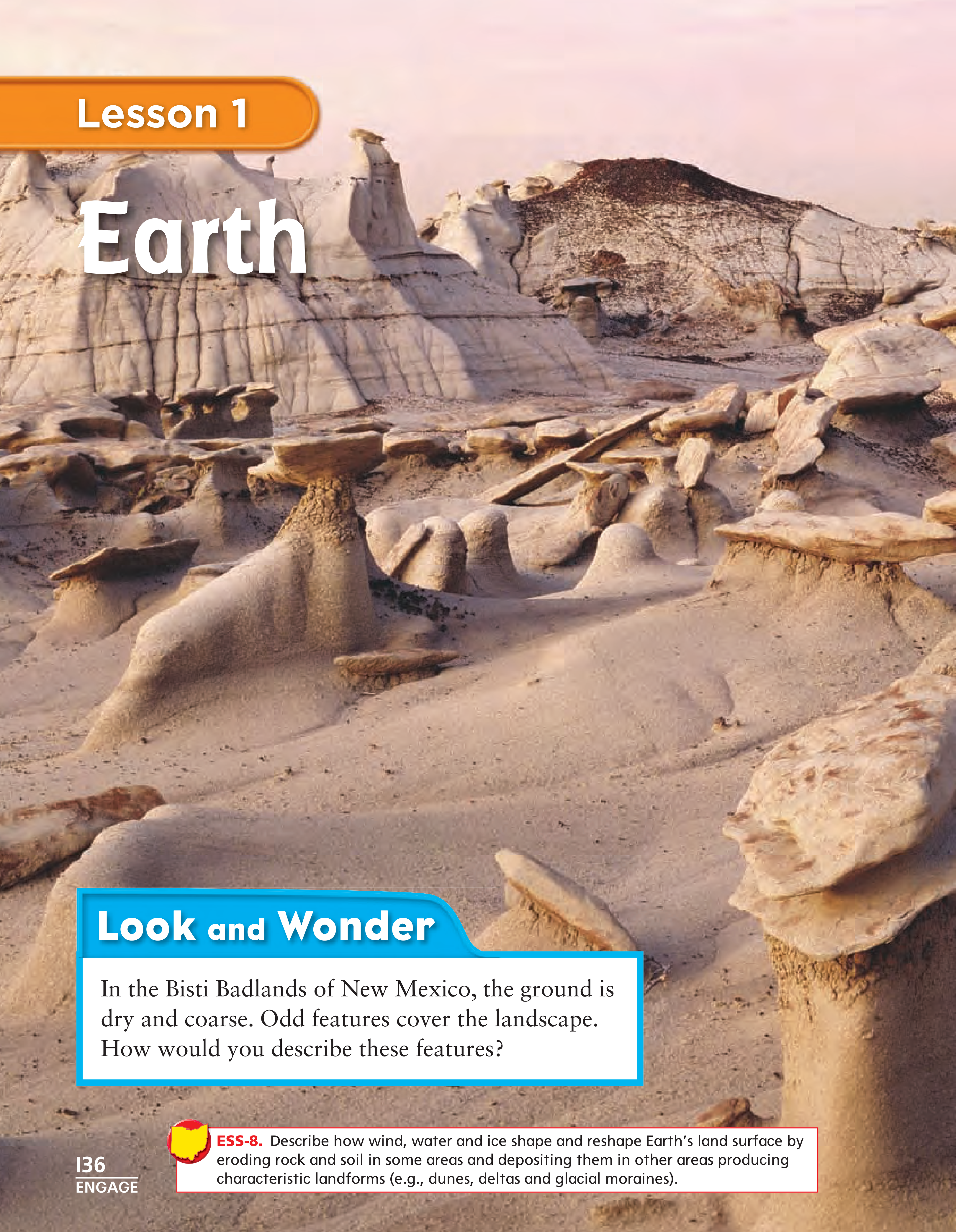


hurricane
a violent, swirling storm with strong winds and heavy rains (p. 174)

More Vocabulary

mantle, p. 142
outer core, p. 142
inner core, p. 142
fault, p. 149
plateau, p. 149
fold, p. 149
mountain, p. 149
seismic wave, p. 152
volcano, p. 154
deposition, p. 163
terminus, p. 165
moraine, p. 165
flood, p. 172
tornado, p. 174
landslide, p. 176
avalanche, p. 176

ESS–B. Summarize the processes that shape Earth's surface and describe evidence of those processes.



Lesson 1

Earth

Look and Wonder

In the Bisti Badlands of New Mexico, the ground is dry and coarse. Odd features cover the landscape. How would you describe these features?

ESS-8. Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas and glacial moraines).

Explore

Inquiry Activity

What shapes can the land take?

Purpose

Explore some of the features on Earth's surface.

Procedure

1. **Observe** Draw some different shapes that you have seen on Earth's surface. Think about places you have visited. Recall places you have seen in magazines, movies, on television, or the Internet. You can also look for pictures in this chapter.
2. **Make a Model** Choose one of these land shapes. Mold some modeling clay to show how the land looks. Add as many details as you can.
3. **Communicate** Discuss your model with a partner. How are your models alike? How are they different?

Draw Conclusions

4. **Classify** Do you recognize any of the land shapes? Name them if you can.
5. Do you think the land always had these shapes? If not, how did they come about?

Explore More

Describe the shape of the land where you live. Are any of the models like that land? If not, make a new model to show what the land looks like near you.

Materials

- modeling clay

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea ESS-8

Different features cover Earth's continents and the ocean floor. Earth's rocky material is composed of layers.

Vocabulary

crust, p. 142

mantle, p. 142

outer core, p. 142

inner core, p. 142

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Reading Skill

Draw Conclusions

Text Clues	Conclusions

What does Earth's land look like?

Viewed from space, Earth's land might seem flat. From close up, you can see many natural features on Earth's surface. These features are called *landforms*.

Tallest and Flattest

The tallest and most visible landforms are *mountains*. Most rise steeply to a peak at the top. Others have a gentle slope. Some are *volcanoes* formed by melted rock.

A *plain* is the flattest kind of landform. Plains are vast areas of land without hills or mountains.

Landforms Shaped by Water

Flowing water can shape the land. Streams and rivers can cut small *channels* or larger *gullies* where they flow. Strong flows can create deep *valleys*. In some places, rivers form narrow, V-shaped valleys called *canyons*. The Grand Canyon is more than one kilometer deep!

Waves wear away land, too. Waves can make a beach flat and smooth or sharp and rocky.

Landforms Shaped by Wind

Gusts of wind can pile sand into large mounds in deserts and on beaches. These mounds are called *sand dunes*. Wind can also combine with water to make mountains steeper and valleys deeper.

The Continental United States

Read a Map

Describe landforms you might see on a trip across the United States.

Clue: Trace a line on the map to connect the numbers and pictures.

Quick Check

Draw Conclusions What can landforms teach us about Earth's history?

Critical Thinking Compare how wind and water shape the land.

What does it look like where water meets land?

Water always flows downhill. What happens when it gets to the bottom of a landform?

River Deltas

As the land gets flatter, the flow of a river slows. If the river empties into an ocean, the water moves even slower. It drops off bits of sand and soil it carried. The bits form a *delta*—a landform shaped like a triangle.

Drainage Basins

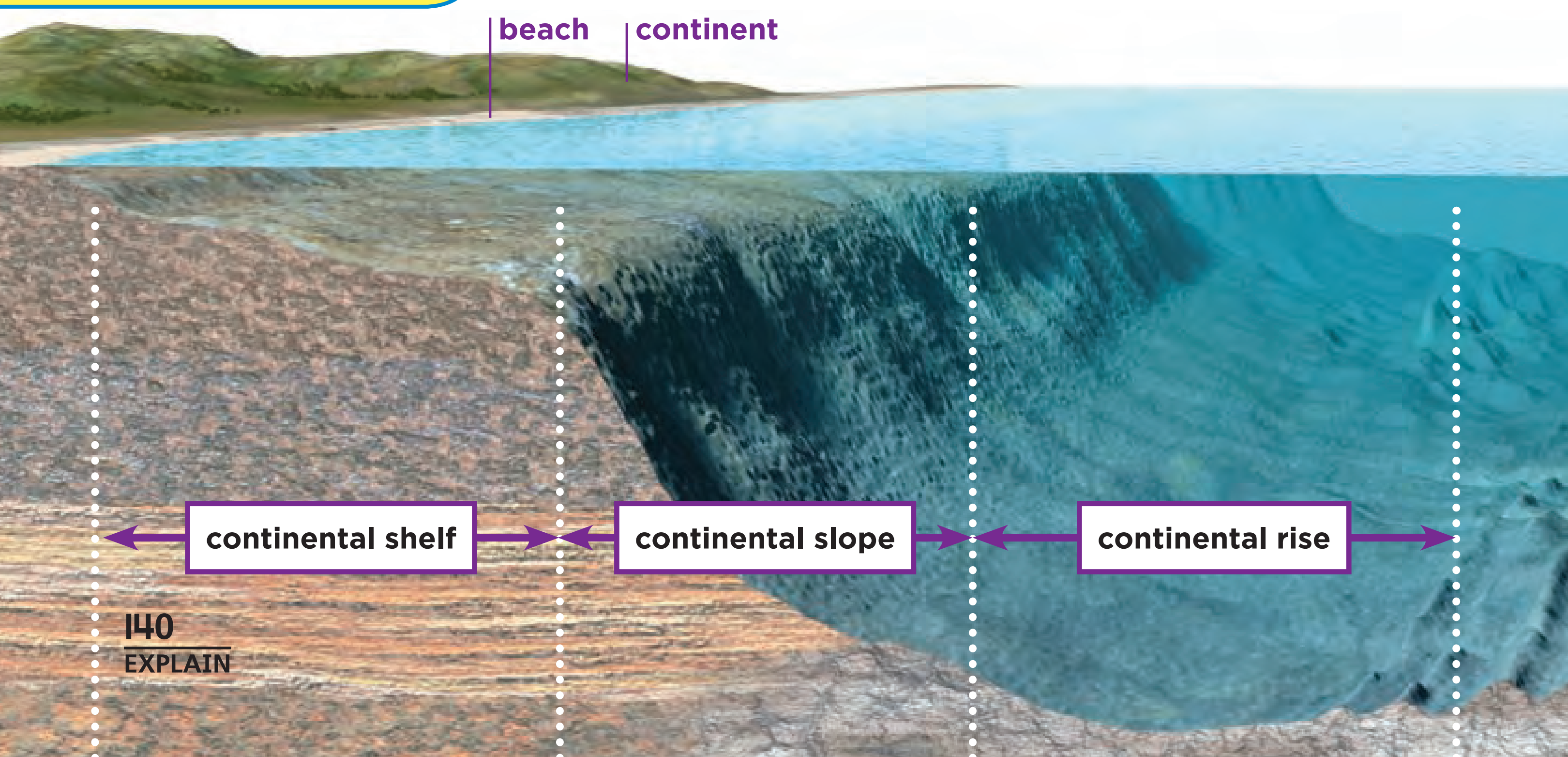
Some rivers empty into channels. A channel that carries water is called a drainage (DRAY-nihj). A *drainage basin* is the area of land drained by flowing water. Much of central North America, for example, is a drainage basin for the Mississippi River.

This delta formed where the Copper River meets Prince William Sound in Alaska.

Continental Shelves

It's a sunny day at the beach. You want to swim with your friends. You move farther and farther from shore, but the water is still too shallow. Where are you? You are on a continental shelf. The *continental shelf* is the land connecting shore to sea. It can stretch seaward for miles.

From Land to Sea



Beyond the Continent

Beyond the continental shelf is an area of land called the *continental slope*. This land is the steeper part of the continent that slopes down toward the ocean floor. Underwater canyons can form on the slope.

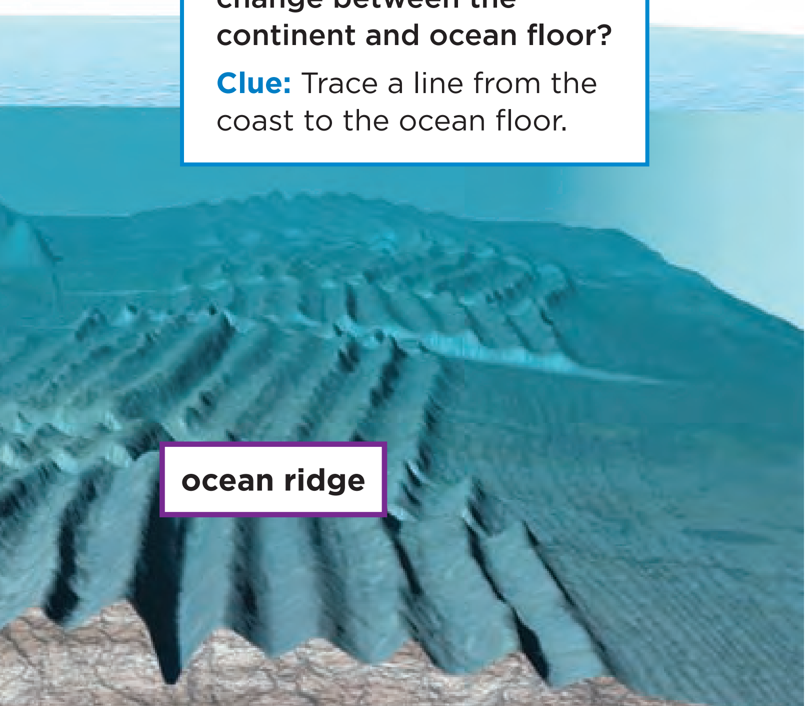
At the base of the slope lies the *continental rise*. The rise connects the continent and ocean floor.

Most of the ocean floor is flat and without features. Long mountain ranges, though, stretch through the middles of some oceans. These are *ocean ridges*. The ocean floor is spotted with undersea volcanoes, too. Deep trenches can cut far into the ocean floor.

Read a Diagram

How does Earth's surface change between the continent and ocean floor?

Clue: Trace a line from the coast to the ocean floor.



Quick Lab

Drain Away

1. **Make a Model** Place some modeling clay in a plastic or metal container. Shape it into landforms. Include at least one mountain, valley, and plain. Draw a map of your model.
2. Spray water onto the top of the model mountain and along its sides. Repeat until you see water collecting in the container.
3. **Observe** How did the water flow over the model? Where did the water collect?
4. Use your map to describe the drainage basin in your model.

Quick Check

Draw Conclusions Are oceans drainage basins? Explain.

Critical Thinking How do features of the ocean floor compare to those on land?

What is below Earth's surface?

You have read about some of the features on Earth's surface. What is Earth like beneath those features?

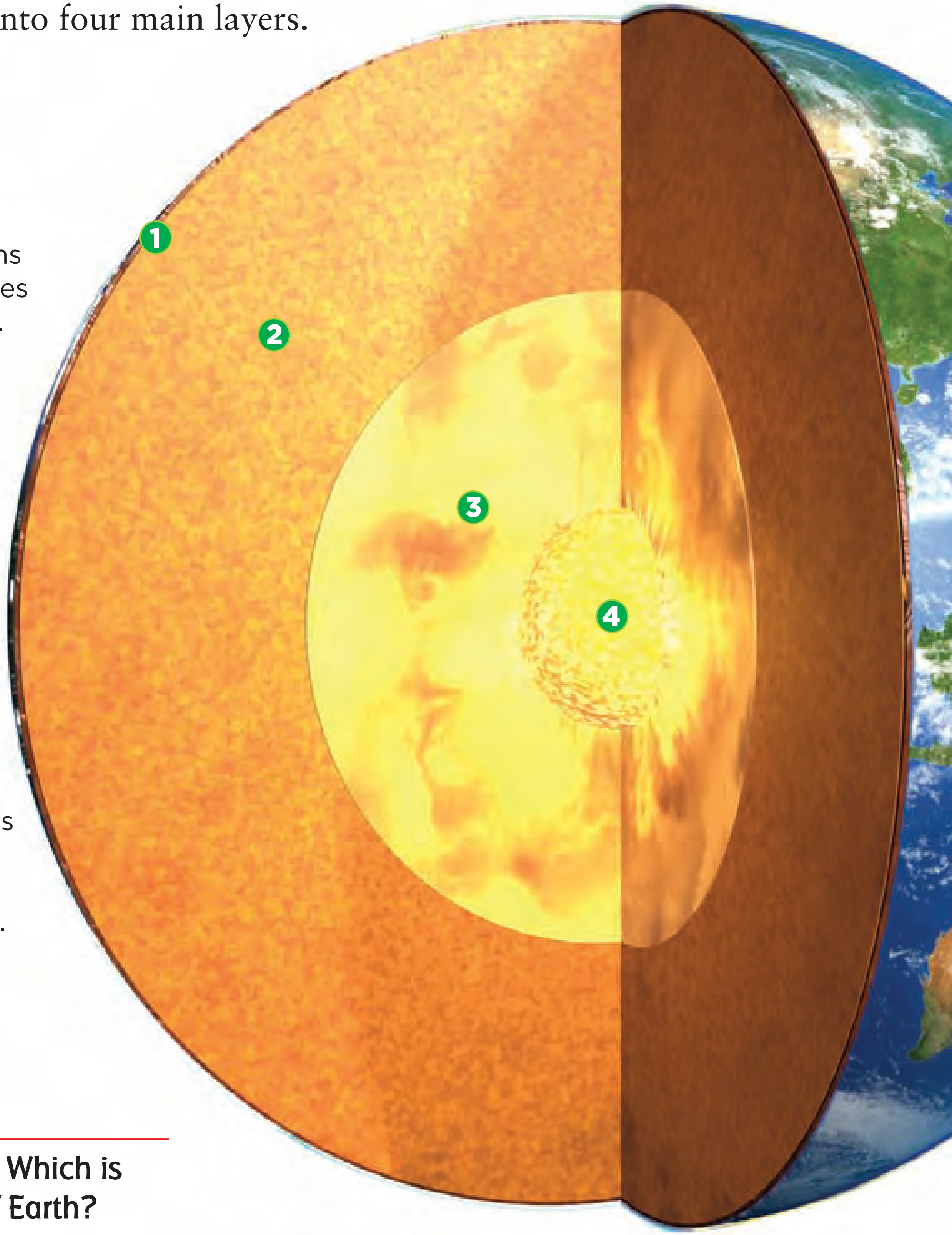
Look at the diagram. It shows the interior of Earth. Scientists divide Earth into four main layers.

1 **Crust** Solid rock that makes up Earth's outermost layer. It is brittle and can crack easily. Earth's landforms and underwater features are found on the crust.

2 **Mantle** Layer of rock below the crust. It is solid, but some of the rock can move or change shape at high pressures and temperatures.

3 **Outer Core** Liquid layer below the mantle. It is made mostly of melted iron.

4 **Inner Core** Sphere of solid material at Earth's center. It is the hottest part of Earth. It is probably made of iron.



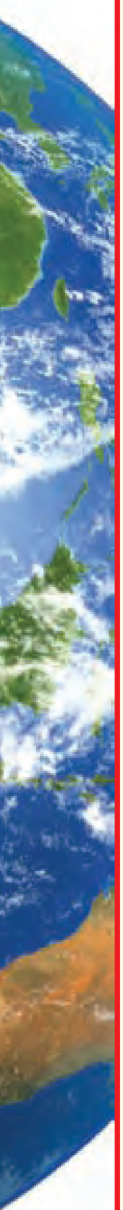
Quick Check

Draw Conclusions Which is the thinnest layer of Earth?

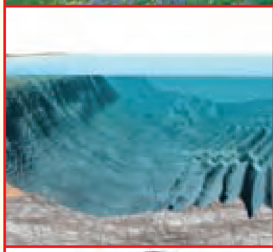
Critical Thinking How can scientists study Earth's core?

Lesson Review

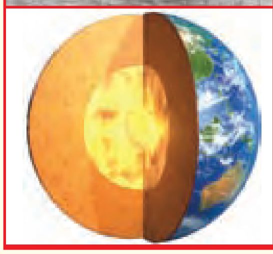
Visual Summary



Earth's many **landforms** include mountains, plains, canyons, and other features formed by water and wind.



Earth's water drains into rivers, channels, drainage basins, and oceans. The ocean has features similar to land.



Earth has four main **layers**. They are the crust, mantle, outer core, and inner core.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you read about Earth's features.

Think, Talk, and Write

1. **Main Idea** Name and describe four different landforms.
2. **Vocabulary** The first layer of Earth beneath the crust is the ________.
3. **Draw Conclusions** Where would you go to find a delta?

Text Clues	Conclusions

4. **Critical Thinking** How could you use an apple to model Earth's interior?
5. **Test Prep** **A wide, flat landform is called a ________**
   - **A** plain.
   - **B** valley.
   - **C** canyon.
   - **D** trench.
6. **Test Prep** **What is Earth's outermost layer?**
   - **A** inner core
   - **B** outer core
   - **C** mantle
   - **D** crust

Writing Link

Write an Essay
Write an essay about the different landforms that you would visit on a trip across the United States. You may also research and write about specific places, such as the Great Lakes or Grand Canyon.

Math Link

Writing Fractions
Oceans cover about 70 percent of Earth's surface. How can you show 70 percent as a fraction? Express the fraction in simplest form. How could you model this fraction?

Focus on Skills

Inquiry Skill: Experiment

A mountain takes hundreds or even thousands of years to form. Yet it can change in a day. Landslides are one way a mountain or hill can change quickly. Soil, rocks, and trees suddenly slide downhill. Houses may be carried away. To study landslides, scientists do **experiments**. Then they draw conclusions from their results.

▶ Learn It

When you **experiment**, you make and follow a procedure to test a hypothesis. A procedure is a set of numbered steps that tell what to do first, next, and last. It is important to record your observations while you follow your procedure. Your observations can help you draw a conclusion from your results. It's always good to run your test several times. That way, you know if your results are true.

▶ Try It

Do you think there is a way to lessen the damage from landslides? Write your idea in the form of a hypothesis. Then **experiment** to test your hypothesis.

Materials **soil, planter box, rocks, twigs, wooden blocks, water, watering can, plastic tablecloth, 2 or 3 books, cookie tray**

1. Spread dry soil in the bottom of a long planter box. Push rocks and twigs into the soil. Place small, wooden blocks as houses. Sprinkle the soil with water until it is damp.
2. Cover a table with a plastic tablecloth. Set the box on it. Prop up one end of the box with two or three large books. Place a cookie tray under the other end of the box.

3. Predict what would happen to the soil in a heavy rainstorm. Record your prediction in a chart like the one below.

Step	Predictions	What I Observed
step 3 no wall or barrier		
step 5 wall near top		
step 6 barrier near bottom		

4. Use a watering can to pour water at the high end of the box. Record what happens.
5. Repeat steps 1 and 2. This time, bury a block in the soil near the top of the box to make a wall. Then repeat steps 3 and 4.
6. Repeat steps 1 and 2. This time, make a fence, or barrier. Put a piece of wood as wide as the box into the low end of the box. Then repeat steps 3 and 4. If you have time, rerun the entire experiment from step 1 through step 5.
7. Review your results. Do they support your hypothesis? Explain.
8. Can anything be done to prevent or ease the damage caused by landslides? Use your results to explain your answer.

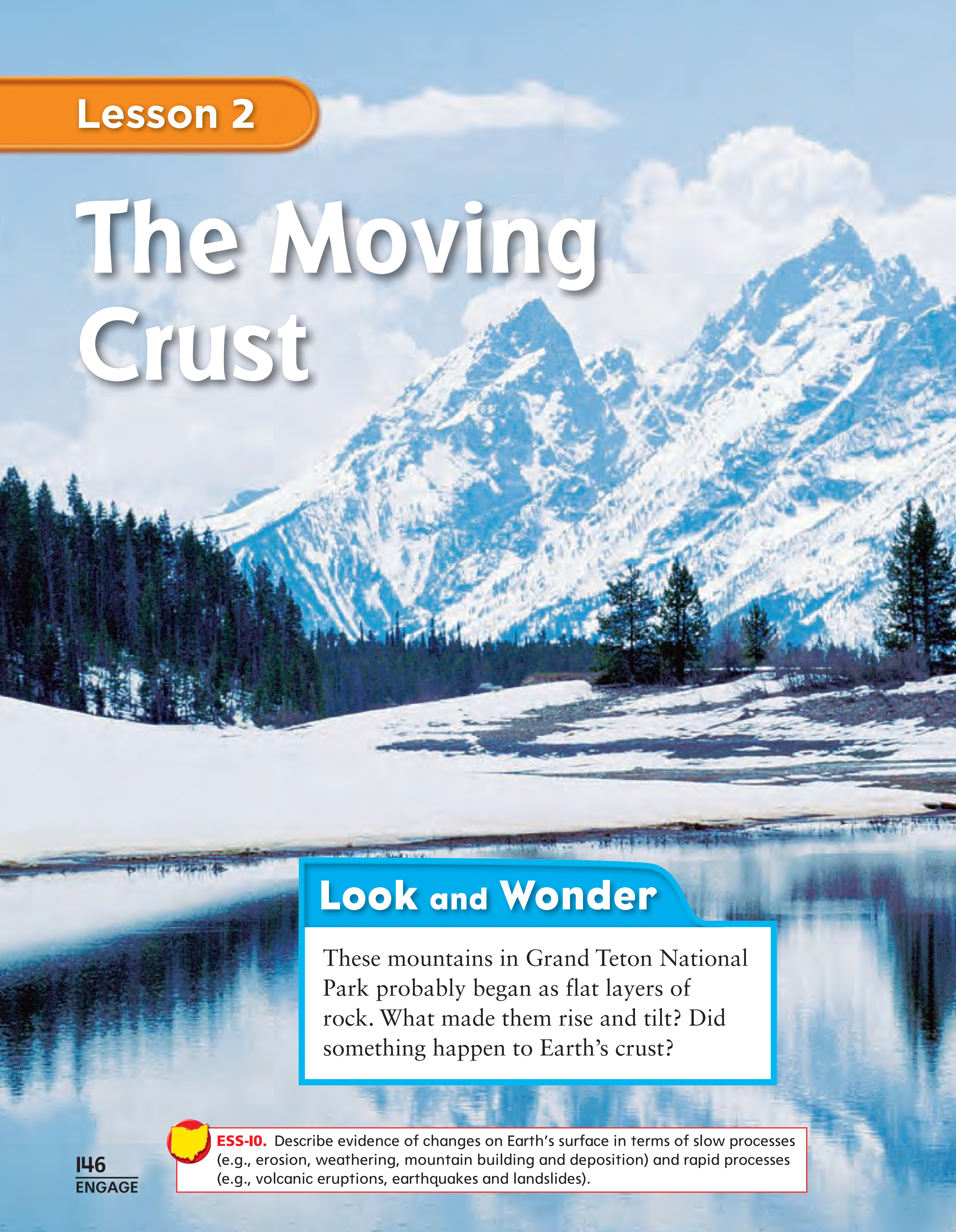
▶ Apply It

1. What do you think would happen if you placed the barrier near the top of the hill? What if one barrier were at the top and one were at the bottom? What if every house had a fence around it? Write a hypothesis for one of these ideas or form your own.
2. Design an **experiment** to test your hypothesis. Remember to record your observations, run several tests, and draw conclusions from your results.

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Lesson 2

The Moving Crust



Look and Wonder

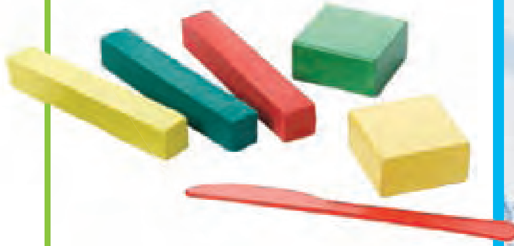
These mountains in Grand Teton National Park probably began as flat layers of rock. What made them rise and tilt? Did something happen to Earth's crust?

ESS-10. Describe evidence of changes on Earth's surface in terms of slow processes (e.g., erosion, weathering, mountain building and deposition) and rapid processes (e.g., volcanic eruptions, earthquakes and landslides).

Explore

Inquiry Activity

How can Earth's crust change shape?



Materials

- modeling clay (3 colors)
- plastic knife
- 2 wooden blocks

Make a Prediction

Predict how flat rock layers will react to pressure.

Test Your Prediction

1. Flatten three pieces of colored clay into thin layers. Press the layers on top of each other, like a sandwich.
2. **Make a Model** Use the plastic knife to cut the stack of clay in half. You will have two squares. These are your models of rock layers.
3. Press two wooden blocks flat against opposite sides of one clay square. Move the blocks slowly and firmly toward each other. Record your observations.
4. Cut a slice at an angle from the top to the bottom of the second clay square. Repeat step 3 on this new model. Record your observations.

Draw Conclusions

5. How did squeezing change the clay layers? What landforms do the models now resemble?
6. **Interpret Data** Did slicing the layers make a difference in how the clay reacted to squeezing? Explain.
7. **Infer** Using your model, explain how rock layers can be folded or lifted.

Explore More

Compare how the clay model reacts to slow steady pressure and strong sudden pressure. Make new models and test them.

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea ESS-10

Earth's crust and upper mantle are divided into plates. The slow movements of these plates change Earth's crust.

Vocabulary

fault, p. 149

plateau, p. 149

fold, p. 149

mountain, p. 149

earthquake, p. 150

seismic wave, p. 152

seismograph, p. 152

volcano, p. 154

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Reading Skill

Cause and Effect

Cause → Effect
→
→
→
→

How does Earth's crust move?

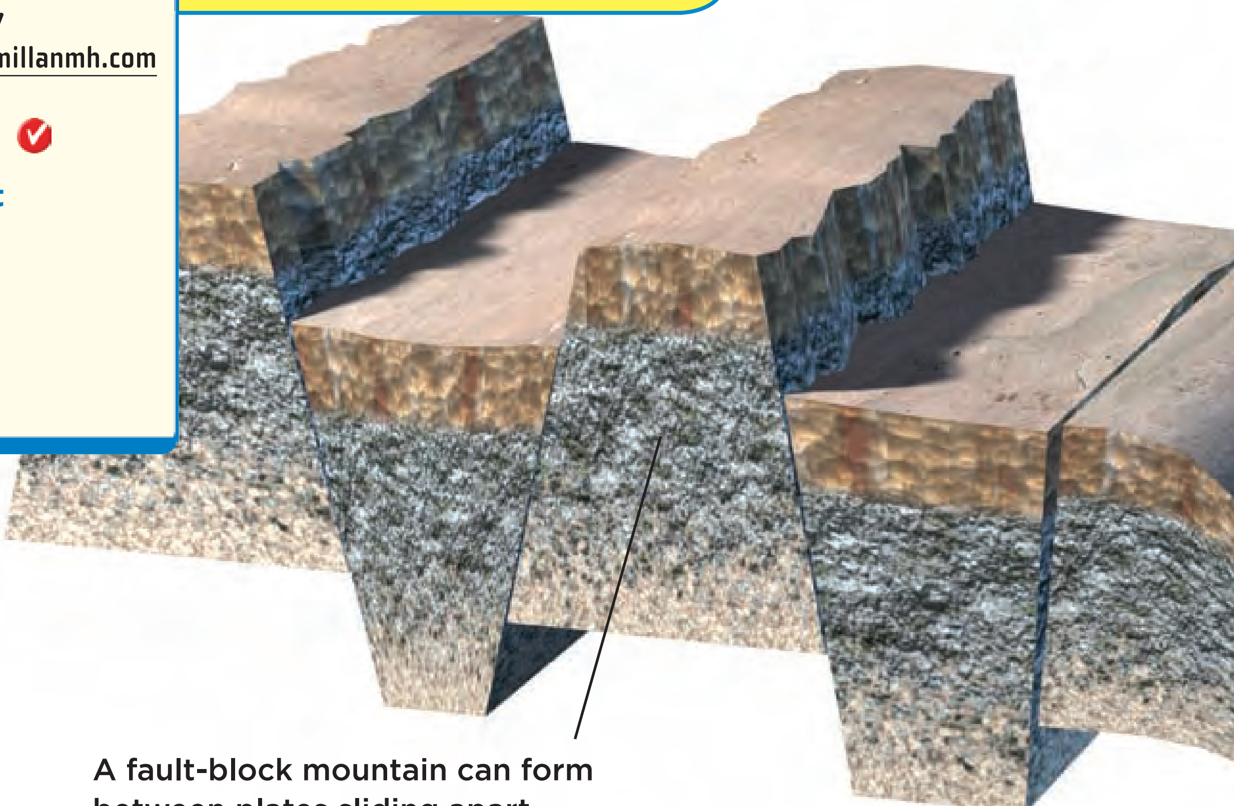
You have learned that Earth is made up of layers. The crust is the thin outer layer. The mantle lies beneath the crust.

Plates

Earth's surface is broken into several huge plates of rock. *Plates* are made of crust. The crust is solid. The upper mantle can flow. When the mantle flows, Earth's plates move.

Earth's plates move about as slowly as your fingernails grow. The edges of plates are where changes to the crust happen. You cannot see or feel most of the changes. Others you cannot miss!

Mountains in the Making



A fault-block mountain can form between plates sliding apart.

Faults

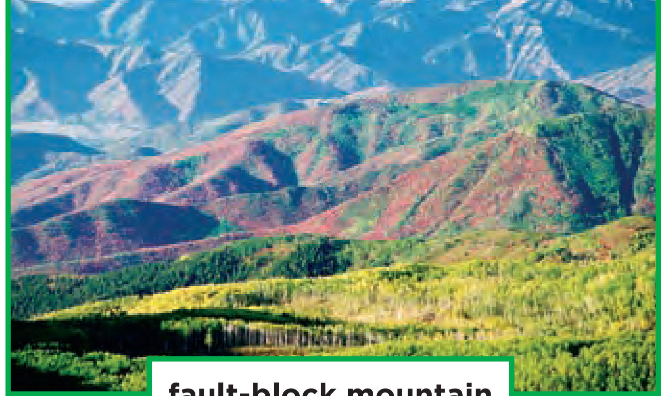
Some plates slide past each other from side to side. The place where they rub is called a fault. A **fault** is a long, narrow crack in the crust.

A plate on one side of a fault can slide up while the other slips down. Rising plates can form *fault-block mountains*. If the lifting is spread over a wide area, a plateau (pla•TOH) may form. A **plateau** is a high landform with a flat top.

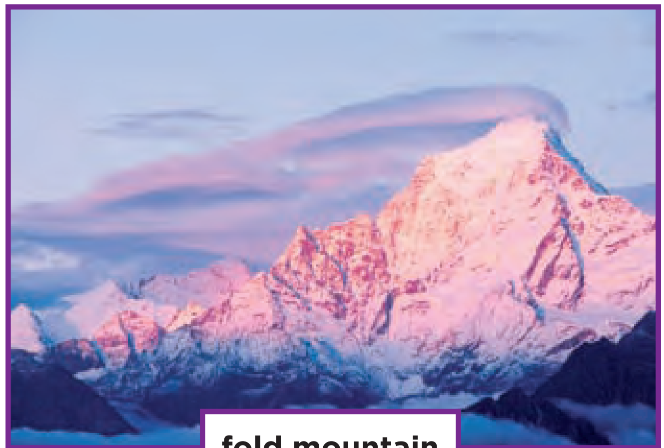
Folds

Some plates meet at the edges of continents. If the land scrunches up between them, a fold forms. A **fold** is a bend in the rock layers.

If the land keeps scrunching, a fold becomes a mountain. A **mountain** is a tall landform that rises to a peak. As time passes, wind and rain can break off bits and pieces.



fault-block mountain

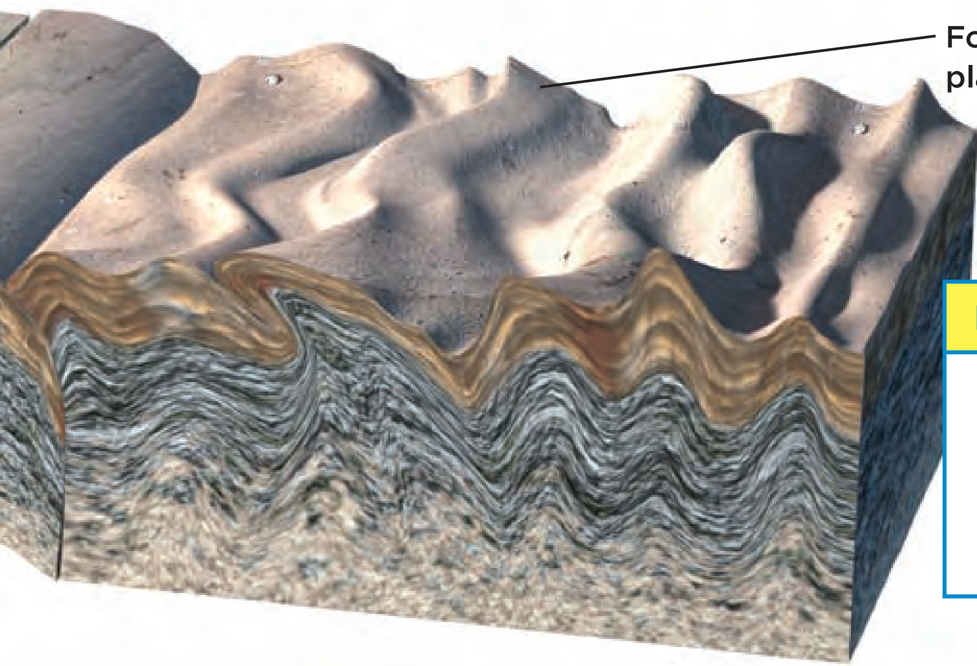


fold mountain

Quick Check

Cause and Effect What are two ways that mountains can form?

Critical Thinking Why do mountains form at only some places on Earth?



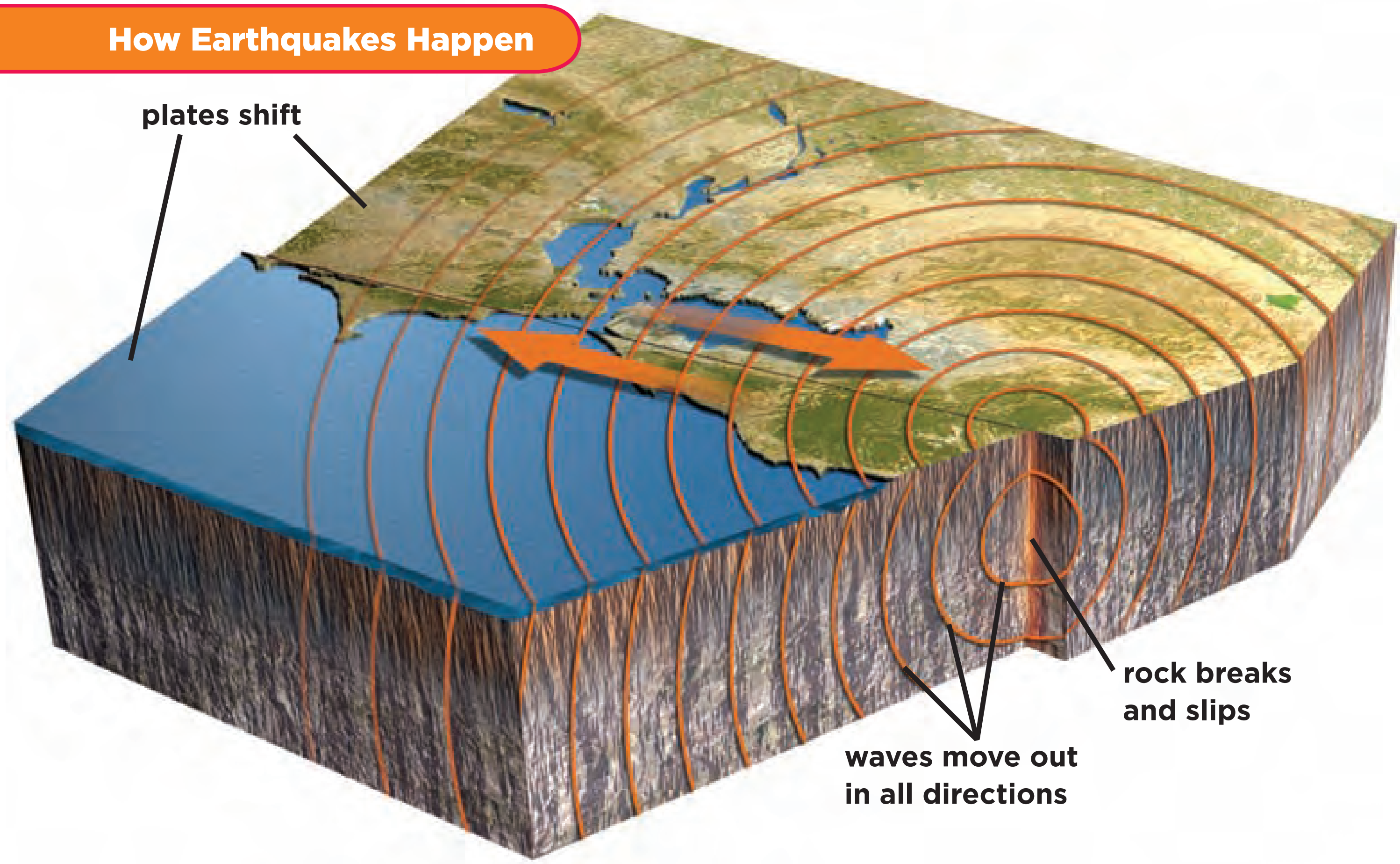
Fold mountains can form where plates slide toward each other.

Read a Diagram

Compare how fold mountains and fault-block mountains form.

Clue: Look for the differences between the two kinds of mountains in the diagram.

How Earthquakes Happen



What causes earthquakes?

An **earthquake** is a sudden shaking of Earth's crust. It is caused by plates moving along a fault. When the plates slide against each other, energy builds up in the rock. Rocks may store this energy for many years in Earth's crust. Then suddenly, they break apart! Earthquakes are common in places with active faults, like parts of Alaska and California.

How Earthquakes Travel

An earthquake begins below the ground. The energy released by a sudden plate motion shakes the crust. Vibrations, or waves, move through the crust in all directions.

Did you ever drop a pebble in water? The waves of an earthquake travel like the ripples of water. As they move away from the center of the earthquake, the waves weaken. Even so, you may feel them at the surface hundreds of miles away!

FACT No scientist has ever predicted a major earthquake.

Earthquake Safety

Most earthquakes are too weak to notice. Others can cause extreme damage. During a major earthquake, buildings and roads may break apart. Bridges might collapse.

Do you know what to do if the ground below you starts to shake? You can stay safe in an earthquake by following a few simple rules. If you are indoors, duck under a table or doorway. Keep away from walls and windows. If you are outdoors, stay away from trees, power lines, and anything that might fall down.

Earthquakes in the Ocean

Some earthquakes strike below the ocean. If an earthquake is strong enough, it can cause the ocean crust to lift suddenly. When this happens, look out! A giant ocean wave, or *tsunami* (soo•NAH•mee), might hit the shore. Tsunamis cause the most damage along coastlines. They can destroy everything in their path.

Quick Check

Cause and Effect How can an earthquake cause a tsunami?

Critical Thinking How can you stay safe if a tsunami is coming?

▼ Modern buildings can stand up to most earthquakes. This older building in San Francisco was damaged by an earthquake.

How do scientists study earthquakes?

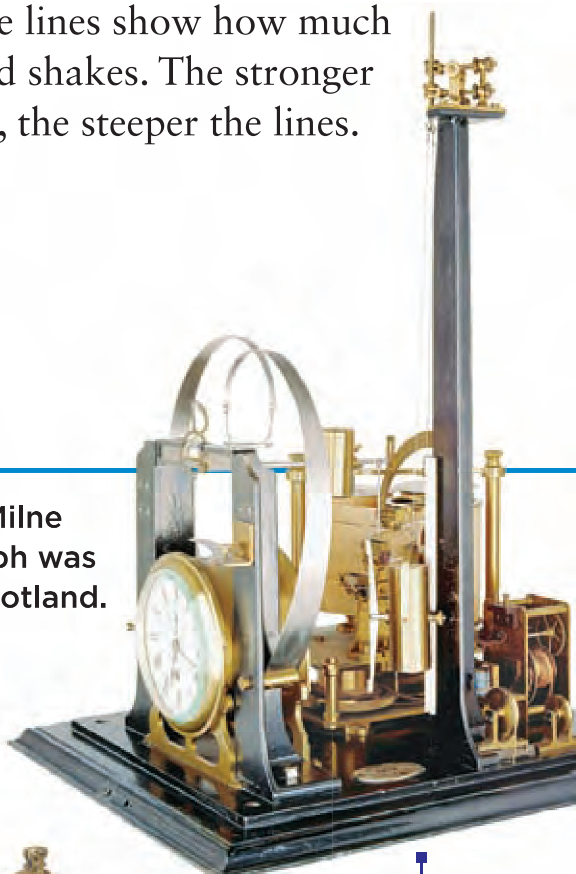
Any movement can cause a vibration. **Seismic waves** are the vibrations caused by earthquakes.

When an earthquake strikes, seismic waves travel out from the source in all directions. The waves move at different speeds. Some of the waves travel along or near Earth's surface. Others travel through Earth's interior.

Measuring Seismic Waves

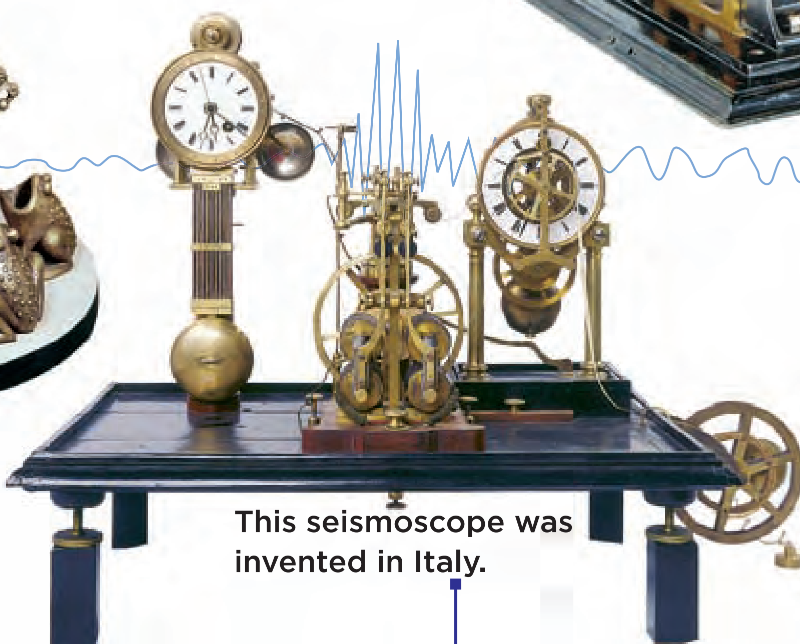
Scientists measure seismic waves with an instrument called a seismograph (SIZE•muh•graf). A **seismograph** detects and records earthquakes. It shows seismic waves as curvy lines along a graph. The lines show how much the ground shakes. The stronger the quake, the steeper the lines.

Time Line of Seismic Study



The Gray-Milne seismograph was made in Scotland.

Chang Hêng's seismoscope was invented in China.



This seismoscope was invented in Italy.

A.D. 132 — 1856 — 1885

Seismic Networks

When an earthquake hits, one of the first questions is "Where was it?" Earthquake scientists have a network of seismographs around the world. They collect data from each seismic station. Then they calculate the location and depth of the quake.

Quick Check

Cause and Effect What causes seismic waves?

Critical Thinking Why do the seismic wave readings shown below have different heights?

Quick Lab

Hearing Clues

1. Your teacher will give you containers. Make a plan to find out what they hold without opening the containers.
2. **Observe** Carry out your plan. Be sure not to damage the containers! Record your observations.
3. **Interpret Data** Study your data. What clues do they provide?
4. What do you think is inside each container? Make a diagram to help explain your ideas.

Ocean Bottom Seismographs were invented in the United States.

Wiechert's seismograph was invented in Germany.

1899

1937

Read a Diagram

How have seismographs changed over time?

Clue: Follow the time line from left to right.

What is a volcano?

A **volcano** is a mountain that builds up around an opening in Earth's crust. Sometimes a volcano will force materials from Earth's interior out of its opening. Scientists call this event an *eruption*.

A volcanic eruption can send out melted rock, gases, ash, or small rocks into the air. Melted rock is called *magma*. Once magma reaches Earth's surface, it is called *lava*. By erupting often, a volcano can build a large mountain. Each eruption adds a layer of lava and ash. The lava and ash cool and harden into rock.

Some volcanoes rest quietly for many years until they erupt suddenly. Others erupted often in the past, but will never erupt again.

Where Volcanoes Form

Most volcanoes occur at the edges of plates. When two plates meet up, one can sink below the other. As it sinks, the plate gets hotter. The rock melts into magma. The magma rises and forms a volcano.

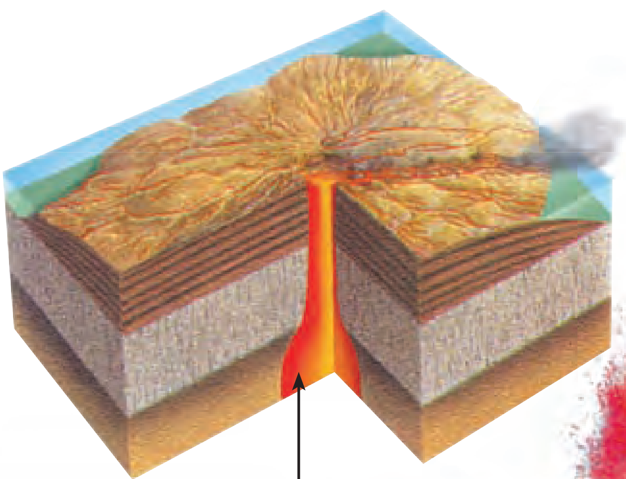
Volcanoes also form where Earth's plates move apart. The space between the moving plates allows magma to rise to the surface.

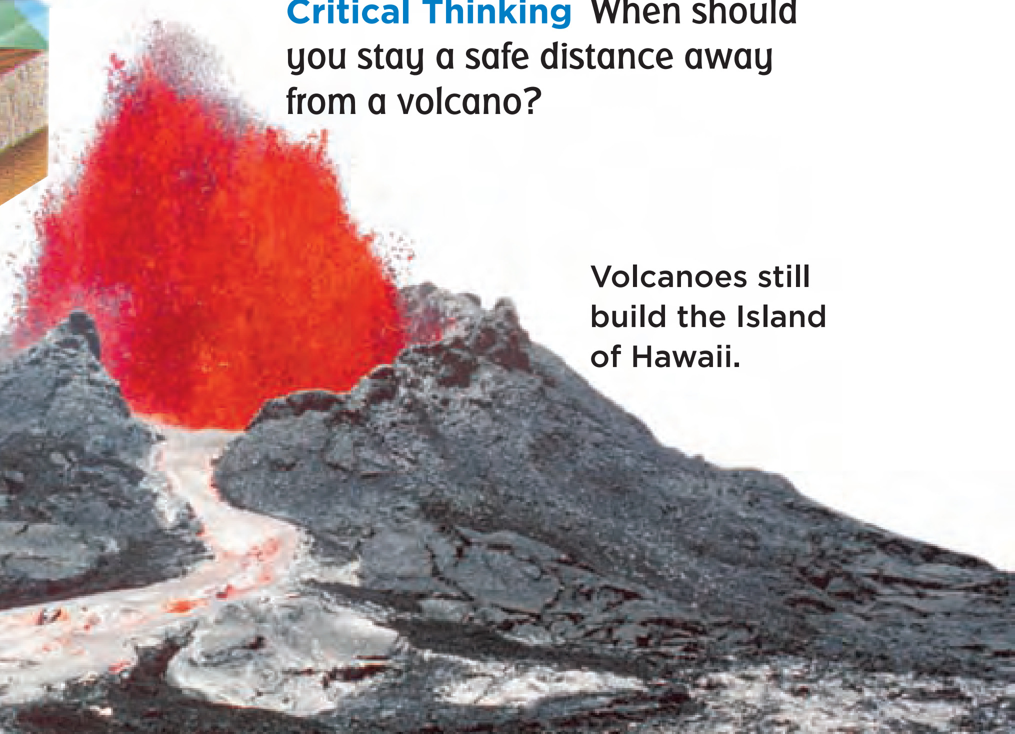
Some volcanoes form far away from plate edges. These *hot spots* are places where Earth's crust is very thin. Magma can easily break through to the surface. The islands of Hawaii formed over a hot spot in the Pacific Ocean. The islands are the tops of huge volcanoes that rose from the ocean floor.

Quick Check

Cause and Effect How can volcanic eruptions build mountains?

Critical Thinking When should you stay a safe distance away from a volcano?



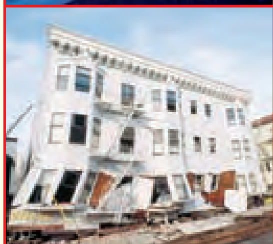


Volcanoes still build the Island of Hawaii.

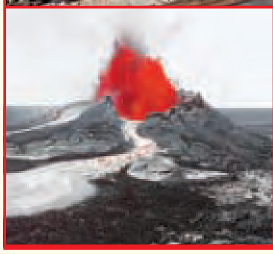
Lesson Review

Visual Summary

Earth's crust and upper mantle are divided into slow-moving **plates**. **Mountains** may form where plates meet.



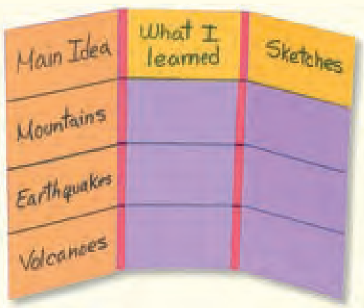
An **earthquake** is a sudden shaking of Earth's crust. It begins along a **fault**, releasing **seismic waves**.



A **volcano** is an opening in Earth's crust to the hot layers below. Volcanoes can build mountains.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you read about Earth's moving crust.

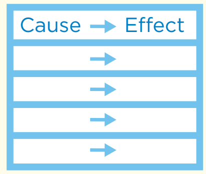


Think, Talk, and Write

1. **Main Idea** Describe how Earth's plates can cause the crust to change.

2. **Vocabulary** What do we call the vibrations from an earthquake?

3. **Cause and Effect** What are three ways that mountains are built?



4. **Critical Thinking** Earth's plates move slowly. Why do earthquakes happen suddenly?

5. **Test Prep** **Which instrument measures earthquakes?**

   A scientist
   B seismic wave
   C seismology
   D seismograph

Math Link

Measuring Distance
One kind of seismic wave moves through rock at 7 kilometers per second. How long would it take such a wave to travel from San Francisco to New York—a distance of 4,100 kilometers?

Social Studies Link

Research and Report
In the year A.D. 79, Mount Vesuvius erupted in Italy. Ash quickly covered the city of Pompeii. Research and report on this event. Describe the effect of the eruption.

Meet Ro Kinzler

Ro Kinzler is fascinated by volcanoes and volcanic rocks. She would go just about anywhere to find out more about them. Ro is a scientist at the American Museum of Natural History.

Ro travels to the Cascades in Northern California to collect lava samples from active volcanoes like Mount Shasta and Medicine Lake. She wants to study how magma moves through Earth. Back in the lab, Ro does experiments. She heats and squeezes the lava samples to find out how they formed deep in Earth.

Ro's favorite place to collect lava samples is Kilauea volcano in Hawaii.

Lava is melted rock that cools at Earth's surface.

SWK-D. Explain that men and women of diverse countries and cultures participate in careers in all fields of science.

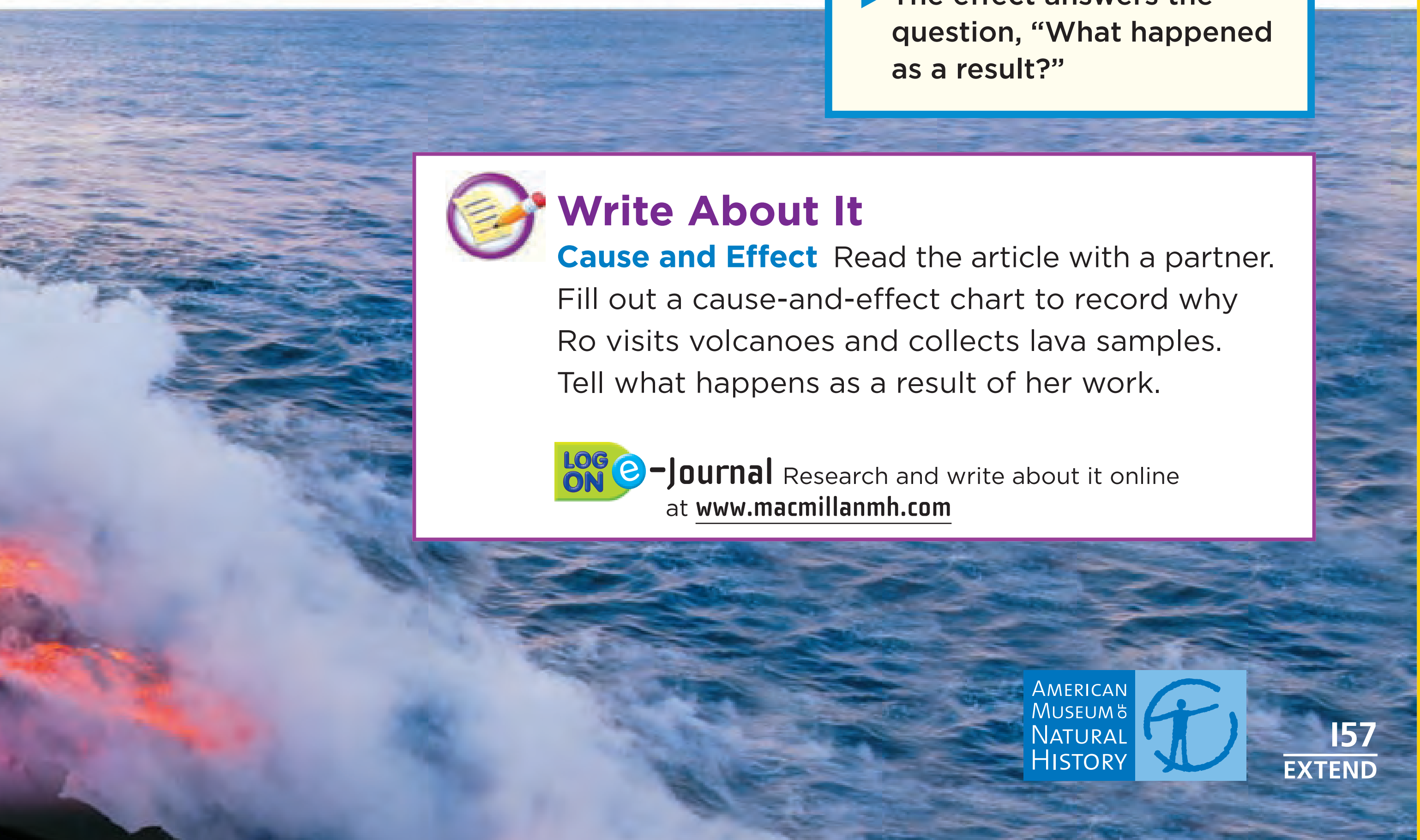
You don't only find volcanoes on land. There are lots of them on the ocean floor. Ro and other scientists have gone to the bottom of the ocean to study volcanoes. They use small underwater vehicles called submersibles.

The scientists visited the Mid-Atlantic Ridge, part of the longest volcano chain in the world. Ro is one of the few people to have ever seen it. She peered out the portholes of the submersible *Alvin* with other scientists. They made careful observations. They used these observations to make maps of the ocean floor.

▲ *Alvin* is a submersible that can take scientists to the ocean floor.

Cause and Effect

- The cause answers the question, "Why did something happen?"
- The effect answers the question, "What happened as a result?"



Write About It

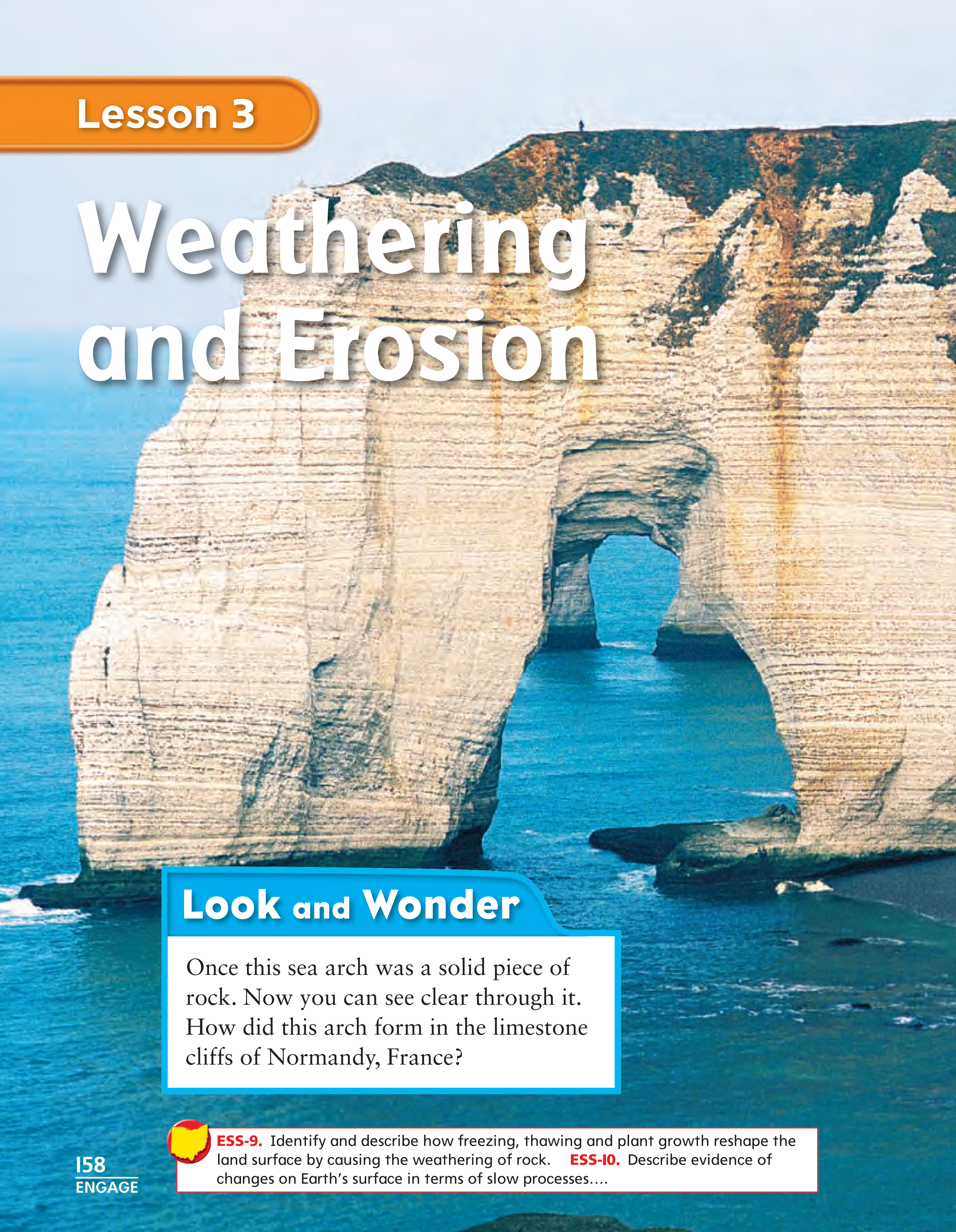
Cause and Effect Read the article with a partner. Fill out a cause-and-effect chart to record why Ro visits volcanoes and collects lava samples. Tell what happens as a result of her work.

LOG ON **e-Journal** Research and write about it online at www.macmillanmh.com

American Museum of Natural History

Lesson 3

Weathering and Erosion



Look and Wonder

Once this sea arch was a solid piece of rock. Now you can see clear through it. How did this arch form in the limestone cliffs of Normandy, France?

ESS-9. Identify and describe how freezing, thawing and plant growth reshape the land surface by causing the weathering of rock. **ESS-10.** Describe evidence of changes on Earth's surface in terms of slow processes….

Explore

Inquiry Activity

How can rain shape the land?

Make a Prediction

Water always moves down a slope. What happens when it rains? Write a prediction that tells how rainfall shapes the land.

Test Your Prediction

1. **Make a Model** Pile a mixture of potting soil, sand, and pebbles at one end of a pan. Shape the mixture into a sloping hillside.
2. Use a spray bottle to simulate rain. Spray at an even rate until the hillside is soaked.
3. **Observe** Continue the “rain” at the same rate. Observe what happens to the hillside. Record your observations.

Draw Conclusions

4. **Communicate** Did your results match your prediction? Explain what happened to the model land.
5. **Infer** How is your model like the real world? Use evidence from your observations.

Explore More

Does the rate of rainfall affect the amount of land that moves downhill? What variables must you control to test a hypothesis? What variable would you change? Try it. Report your results.

Materials

- potting soil
- sand
- pebbles
- shallow pan
- spray bottle with water

SI–4. Explain the importance of keeping conditions the same in an experiment.

Read and Learn

Main Idea ESS-9, ESS-10

Weathering, erosion, and deposition are the main processes that shape the land.

Vocabulary

weathering, p. 160

erosion, p. 162

deposition, p. 163

terminus, p. 165

moraine, p. 165

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Reading Skill

Classify

Technology

SCIENCE QUEST

Explore weathering and erosion on Science Island.

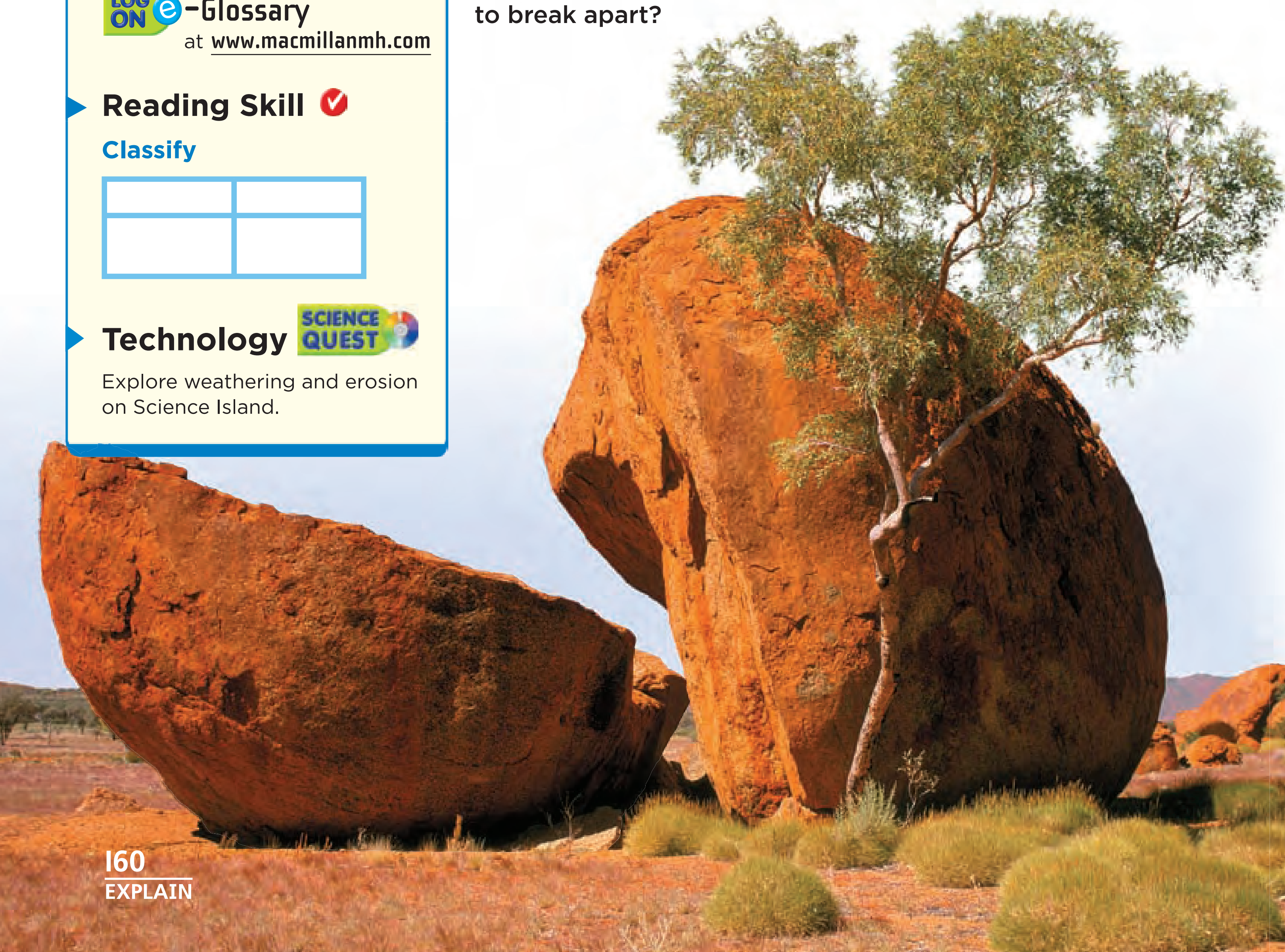
What is weathering?

Every day, rocks move and change shape as the wind blows and rain falls. Look at the rock below. What happened to it?

Even the largest boulder can break apart over time. **Weathering** is the slow process that breaks rocks down into smaller pieces. Flowing water, rain, and wind are some causes of weathering.

In the distant future, the rock below will probably look very different. It may break into pieces the size of pebbles, or even smaller!

What caused this boulder to break apart?



▲ Chemical weathering can form limestone caves like this one in Brazil.

Physical Weathering

Rocks can change size and shape without changing their chemical makeup. This process is called *physical weathering*.

Flowing water from streams and rivers can make sharp rocks smooth. Waves crashing onto a cliff can break off small pieces of land. Rainfall may seep through small cracks in a rock. Cycles of freezing and melting can widen the cracks.

Living things also cause physical weathering. Plant roots can force their way through cracks in a rock. As the plant grows, its roots get stronger. The strong roots can break the rock apart.

Chemical Weathering

Chemical weathering changes the minerals that make up rocks. Oxygen, acids, and carbon dioxide all cause chemical weathering. They change minerals into new substances.

Have you ever seen an iron chain get rusty? Water and air change iron into rust. Rocks that have iron in them can rust too. Water and carbon dioxide can form limestone caves. Even living things, such as lichens, can soften the rocks they grow on.

✓ Quick Check

Classify What are the two kinds of weathering?

Critical Thinking Where might you find examples of weathering?

What is erosion?

Have you ever built a sand castle at the beach? Did waves wash it away? Waves crash against the shores of oceans and lakes all the time. They pick up beach sand and small rocks. Then they carry the pieces away.

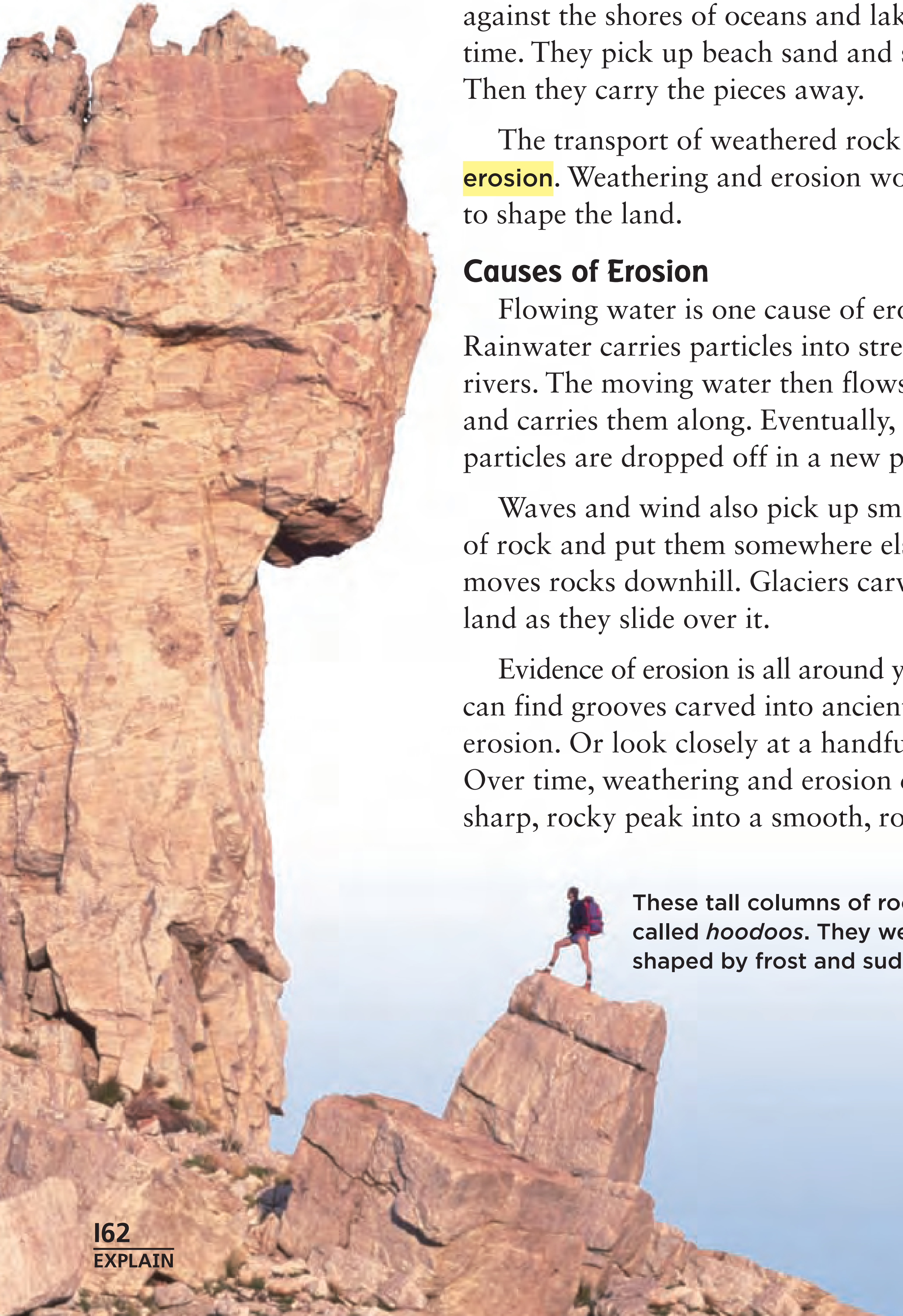
The transport of weathered rock is called **erosion**. Weathering and erosion work together to shape the land.

Causes of Erosion

Flowing water is one cause of erosion. Rainwater carries particles into streams and rivers. The moving water then flows downhill and carries them along. Eventually, the particles are dropped off in a new place.

Waves and wind also pick up small pieces of rock and put them somewhere else. Gravity moves rocks downhill. Glaciers carve through land as they slide over it.

Evidence of erosion is all around you. You can find grooves carved into ancient rocks by erosion. Or look closely at a handful of sand. Over time, weathering and erosion can turn a sharp, rocky peak into a smooth, round one.



These tall columns of rock are called *hoodoos*. They were shaped by frost and sudden rain.

Rivers Erode the Land

The Grand Canyon in Arizona shows how powerful a river can be. The canyon is 446 km (277 mi) long. It has an average depth of 1.6 km (1 mi). This huge space was carved over thousands of years by the Colorado River.

Rivers and streams pick up bits of rock and soil as they flow over land. Some of the pieces get deposited, or dropped off, on the banks. Others get carried to the mouth of the river.

Deposition

Deposition is the dropping off of weathered rock. Deposition by water builds up deltas, riverbanks, and beaches. Deposition by wind forms sand dunes.

Quick Check

Classify What processes erode land? What processes deposit it?

Critical Thinking How do rivers cause weathering and erosion?

Rivers Shape the Land

Read a Photo

In your own words, describe how this canyon in Utah probably formed.

Clue: Observe the sides of the canyon. Look where the water is located.

LOG ON *Science in Motion* Watch how a river shapes the land at www.macmillanmh.com

How do glaciers shape the land?

In very cold places, thick sheets of ice called *glaciers* (GLAY•shuhrz) creep over the land. About a million years ago, glaciers began to cover much of Earth. Few places are cold enough for glaciers today.

Glaciers form where snow collects quickly and melts slowly. Year after year, the snow builds higher. The weight on top of the mound puts pressure on the snow below. The bottom of the glacier slowly turns to ice. Near the ground, some ice melts.

Carving the Land

Melting makes the bottom of the glacier slippery. It begins to flow downhill. The bottom and sides freeze onto rocks. As the glacier continues to move, it tears rocks from the ground. It scratches, flattens, breaks, or carries away the things in its path. A glacier can make a valley wider and steeper.

A glacier carved this valley in Alaska. ▼

A Glacier Deposits Land

What Glaciers Leave Behind

You have read how glaciers erode the land. Glaciers also deposit land. As glaciers melt, they leave behind the rocks they carried. The leftover rocks are called *glacial debris* (GLAY•shuhl duh•BREE).

Glacial debris can be made of large boulders or small rocks. They can have bits of gravel, sand, soil, and clay. The glacier drops most of this debris at its downhill end, or **terminus**.

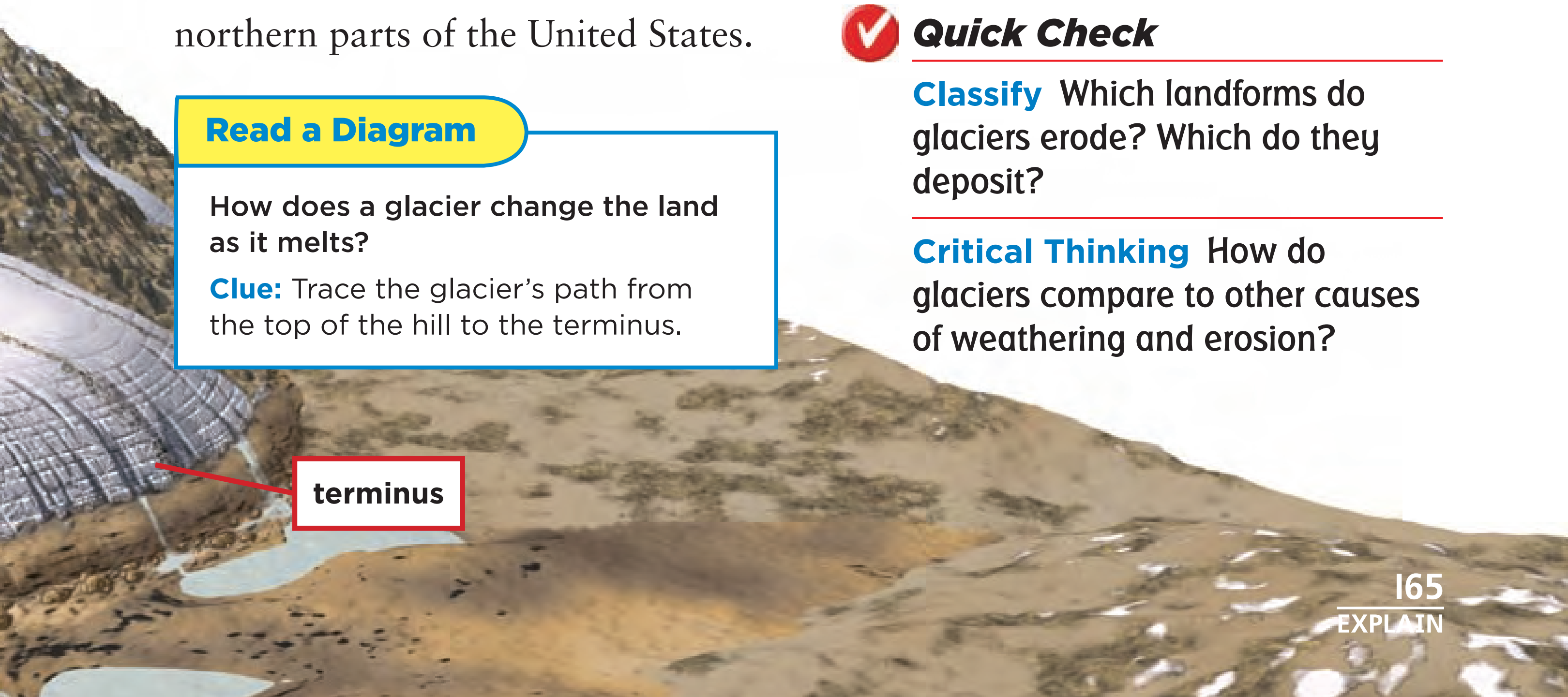
Have you ever seen a giant boulder all by itself in a valley? It was probably glacial debris. More often, glacial debris is a mix of gravel, small rocks, sand, and clay. The mixture is called *glacial till*.

Materials that a glacier picks up or pushes can forms mounds. These mounds are called **moraines**. Today, you can find glacial till and moraines across Canada and northern parts of the United States.

Read a Diagram

How does a glacier change the land as it melts?

Clue: Trace the glacier's path from the top of the hill to the terminus.



Quick Lab

Scratch, Scratch

1. Compare two ice cubes—a plain one and one with sand or gravel.
2. Rub each cube over a material, such as waxed paper or aluminum foil. Compare the effects of each material on each ice cube.
3. **Observe** Place the ice cubes in separate dishes. Allow them to melt. Observe what happens.
4. **Infer** How do the two ice cubes act like glaciers?

Quick Check

Classify Which landforms do glaciers erode? Which do they deposit?

Critical Thinking How do glaciers compare to other causes of weathering and erosion?

How do people shape the land?

Most processes in nature change Earth's land very slowly. People can make faster changes.

Mining

One way people change the land is by mining it. *Mining* is digging into the land for useful resources like minerals, metals, or fuel.

Landfills

Landfills are places where people pile trash. Some form large mounds or hills. Some are covered with soil and plants to blend in with the land.

Forests

People need land to build farms, homes, resorts, and factories. Often, people cut down or burn forests to clear the land. The trees are used to make products. Scientists are concerned about losing our forests.

You can help the land by planting and caring for trees.

Quick Check

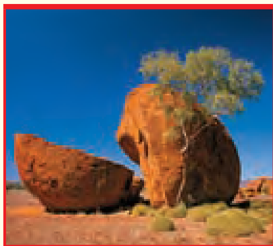
Classify List some of the ways people shape the land. Are these helpful or harmful to the land?

Critical Thinking Think of other helpful ways that people shape the land.

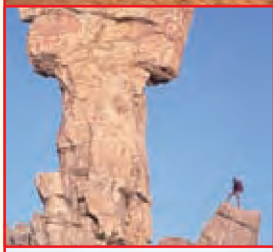
Part of this evergreen forest has been cut down.

Lesson Review

Visual Summary



Weathering is the breaking down of rock into smaller pieces. Two kinds of weathering are physical and chemical.

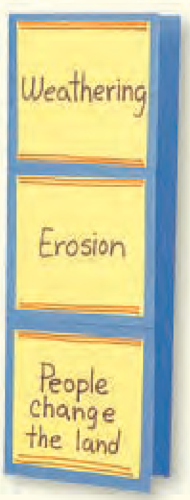


Erosion is the transport of weathered rock. Deposition is the dropping off of eroded rock.

People change the land in many ways. These changes can be helpful and harmful to the land.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you read about weathering and erosion.



Think, Talk, and Write

1. **Main Idea** Describe three causes of weathering and three kinds of erosion.

2. **Vocabulary** A moraine can form at the ________ of a glacier.

3. **Classify** List examples of physical weathering and examples of chemical weathering.

4. **Critical Thinking** Compare natural weathering and erosion to changes that people make to the land.

5. **Test Prep** **Which of the following is likely to carve a canyon into Earth's crust?**
   - **A** chemical weathering
   - **B** erosion caused by wind
   - **C** erosion caused by water
   - **D** physical weathering

6. **Test Prep** **Which is made of deposited materials?**
   - **A** a moraine
   - **B** a mountain
   - **C** a valley
   - **D** a river

Math Link

Measuring Distances
A glacier advances 6 meters every year. How long will it take for the glacier to move a distance of 1,000 meters?

Social Studies Link

Study a Map
Study a road map of Colorado, Utah, Montana, or another state that has mountains. Compare the roads and cities to the paths of rivers.

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

Land Over Time

Mountains may seem like mighty giants. But are they? Weathering can break down even the strongest mountains. How does this happen?

Wind carries the seeds of plants from place to place. A seed can land on a patch of soil on rock. There the seed sprouts. The roots find small cracks in the rock.

As the roots grow, rainwater fills the cracks in the rock. If it gets cold enough, the water freezes into ice. The ice expands. The cracks widen. All this time, the roots grow bigger.

At some point, the cracks widen so much that pieces of rock break off. In time, these pieces get smaller. Over millions of years, weathering can break down an entire mountain!

Write About It

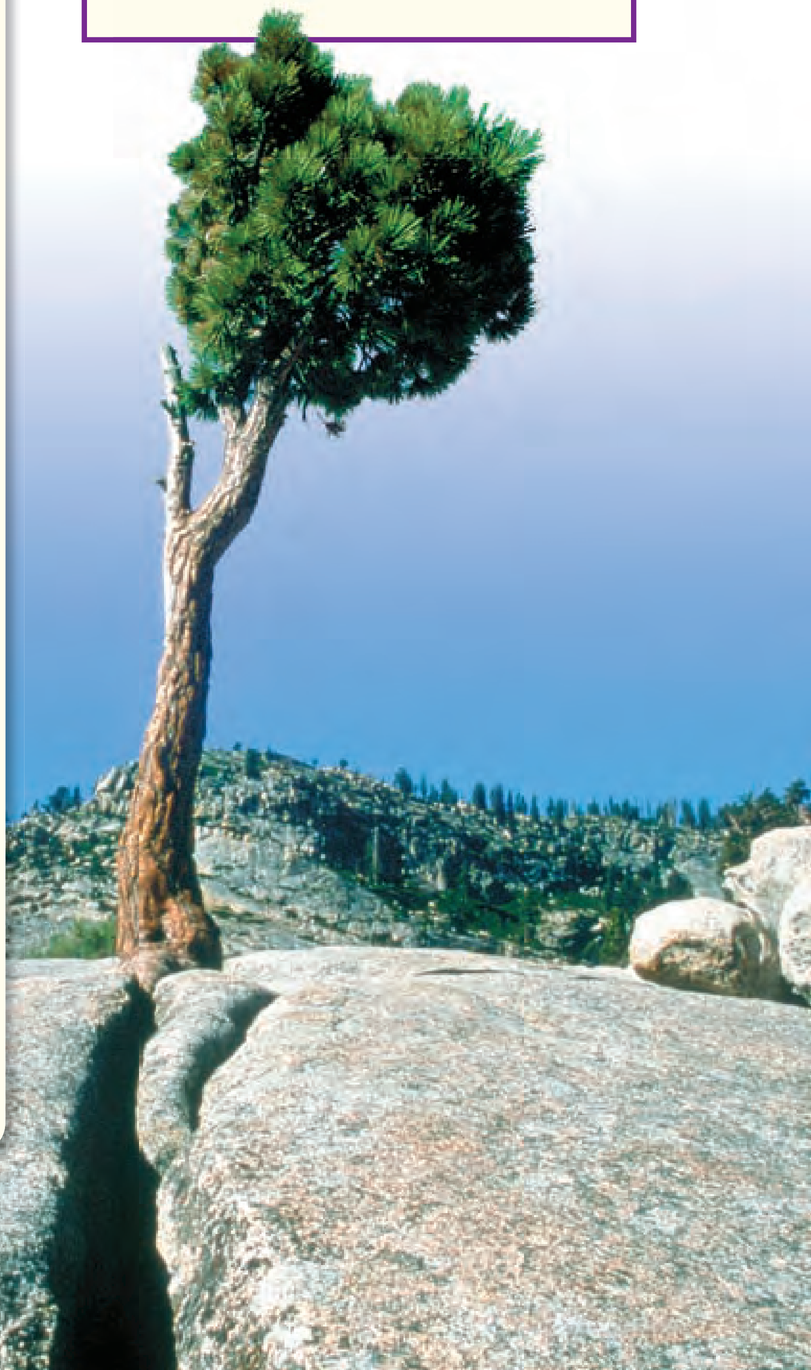
Expository Writing Write a paragraph that summarizes "Land Over Time." Include the main idea and the most important details.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

Expository Writing

Good expository writing

- presents the main idea in a topic sentence
- supports the main idea with facts and details



Math in Science

DISAPPEARING MOUNTAINS


Mount McKinley


Mount Whitney


Mount Shasta


Wheeler Peak

This table shows the heights of some mountain peaks in the United States.

Heights of Mountain Peaks

Mountain	State	Height in Meters	Height in Feet
Mount McKinley	Alaska	6,194	20,320
Mount Whitney	California	4,417	14,491
Mount Shasta	California	4,317	14,162
Wheeler Peak	Nevada	3,982	13,065

Mountains erode by small amounts. Suppose Mount McKinley erodes 2 meters each year. How many years would it take for the mountain to be 6,174 meters tall?

Problem Solving

- **To find the number of years, you can count backward by 2 from 6,194 m to 6,174 m.**

  6,194 6,192 6,190
  6,188 6,186 6,184
  6,182 6,180 6,178
  6,176 6,174

  It would take 10 years.

- **Another way is to find the number of meters lost. Then you can divide the difference of meters by 2.**

  6,194 m – 6,174 m = 20 m
  20 ÷ 2 = 10
  It would take 10 years.

Solve It

If the erosion rate is 1 meter each year, what will be the height of:

1. Mount Shasta in 20 years?

2. Mount Whitney in 15 years?

3. Wheeler Peak in 80 years?

M MP-B. Use an organized approach and appropriate strategies to solve multi-step problems.

Lesson 4

Changes Caused by the Weather

Look and Wonder

This house in Washington State is in a strange position. How did it get that way? What caused the damage?

ESS-10. Describe evidence of changes on Earth's surface in terms of slow processes … and rapid processes (e.g., volcanic eruptions, earthquakes and landslides).

Explore

Inquiry Activity

How does steepness of slope affect the movement of Earth's materials?

Form a Hypothesis

We sometimes see evidence of sliding rocks and soil at the bottom of a hill. How does the steepness of a slope affect the downhill movement of rocks and soil? Write a hypothesis.

Test Your Hypothesis

1. Stir equal amounts of soil, gravel, and sand in the pan. Pat the mixture into a flat layer.
2. **Predict** What will happen when you raise one end of the pan? Record your prediction.
3. **Observe** Raise one end of the pan 4 cm. Record what happens. Continue raising that end by 4 cm at a time until the pan is nearly upright. Record your observations each time.

Draw Conclusions

4. **Interpret Data** How did raising the end of the pan affect your results?
5. What is the relationship between steepness of slope and the movement of soil and rocks?

Explore More

How do sudden downpours of rain affect very steep slopes? How could you test this? What variable would you control? What variable would you change? Try it. Report your results.

Materials

- deep aluminum pan
- measuring cup
- potting soil
- gravel
- sand
- metric ruler

Step 1

Step 3

SI-5. Describe how comparisons may not be fair when some conditions are not kept the same between experiments.

Read and Learn

Main Idea ESS-10

Floods, fires, storms, and other weather events can change the land quickly.

Vocabulary

flood, p. 172

tornado, p. 174

hurricane, p. 174

landslide, p. 176

avalanche, p. 176

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Infer

Clues	What I Know	What I Infer

Technology SCIENCE QUEST

Explore fast changes to land on Science Island.

How do floods and fires change the land?

You have learned how erosion and deposition change the land slowly. What causes Earth's surface to change quickly?

Floods

Heavy rain or quickly melting snow can cause water to flow over the land. The water may not soak into the ground completely. It runs on top of the land. It flows into streams and rivers. The extra water may spill over the sides, or banks, of streams and rivers. Then it floods (FLUHDZ) the nearby land. A **flood** is an overflow of water onto land that is normally dry.

Cities flood when water drains cannot carry water away fast enough. The drains overflow. The streets become flooded.

Floods can carry mud into homes and streets. The mud and water cause damage. Floodwaters erode the soil quickly. They can wash away trees and anything else in their path.

Floods also serve a purpose in nature. After a flood, new soil is deposited on the land. The nutrients in this soil help plants grow.

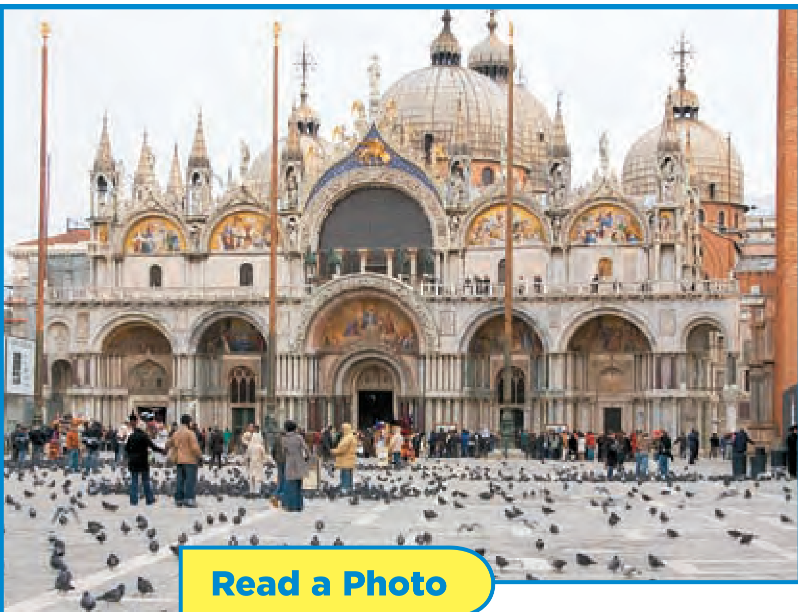
Fires

When there is too little rain, fires are likely. Many are caused by lightning. A fire can quickly change a forest into a field of charred tree trunks. Forest animals lose their habitats. Grassland fires are fueled by dry plants and spread by winds. Most places recover from natural fires.

FACT Some forests depend on fires to help plants grow.

Before and After






Read a Photo

How can floods and fires change the land?

Clue: Compare the two photos of floods and the two photos of fire.

Fire Safety

Carelessness also causes fires. People can prevent wildfires by being safe around campfires and cookouts. Do not light fires in dry areas. Never play with matches.

Quick Check

Infer What kinds of weather cause floods and fires?

Critical Thinking How can people prevent forest fires?

How do storms change the land?

Have you ever heard the saying "When it rains, it pours"? A light shower might form a few puddles here and there. A severe storm can change the land.

Tornadoes

A thunderstorm can spin off a violent storm called a tornado (tor-NAY-doh). **Tornadoes** are columns of spinning wind. They move across the ground in a narrow path. As they move, tornadoes whip up or destroy everything in their path.

Tornadoes are common in the Great Plains region of the United States. In fact, a certain path through that region is known as "Tornado Alley."

Hurricanes

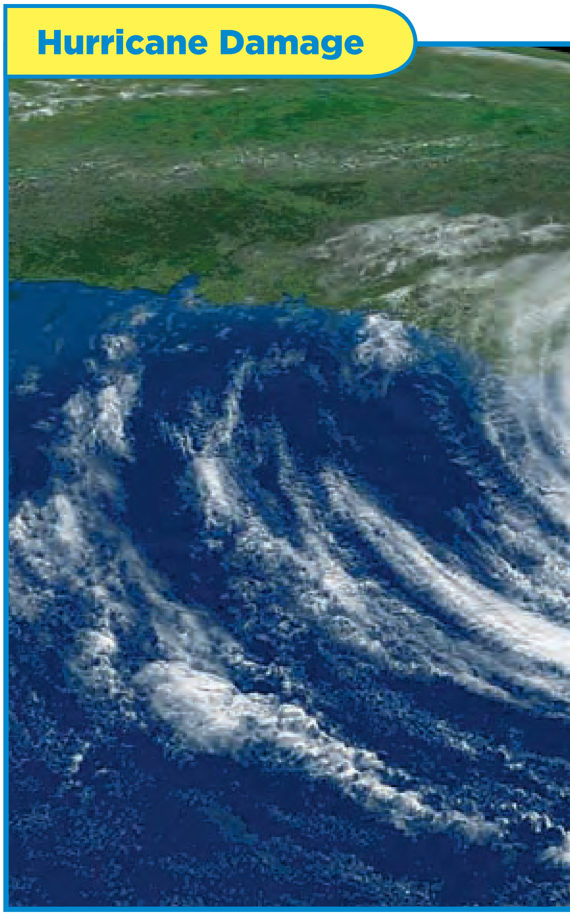
If you live near an ocean or the Gulf Coast, you may have experienced a hurricane. A **hurricane** is a very large, swirling storm. At its center, or eye, is an area of very low pressure. Strong winds, walls of clouds, and pounding rains surround the eye.

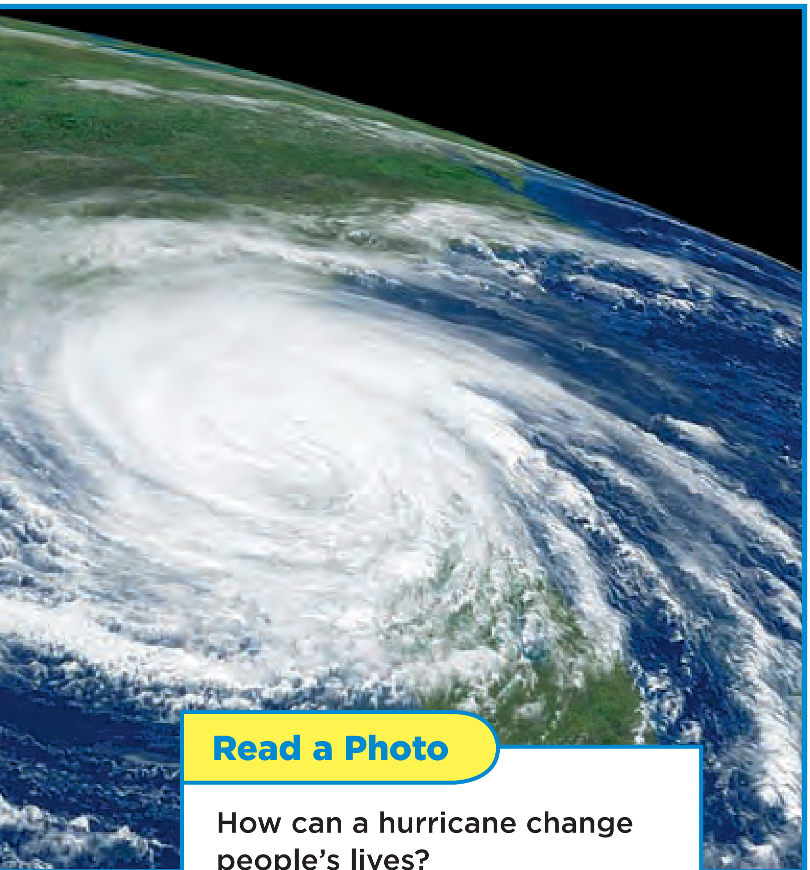
A hurricane is much bigger than a tornado. It can span hundreds of kilometers. It also lasts longer.

Hurricanes form over warm oceans near the equator. They whip up large waves as they travel. When a hurricane moves toward a coast, winds and waves can force water onshore. Massive floods can occur. Heavy rains add to the flooding. The damage does not stop there. Once it is over land, a hurricane can uproot trees and flatten buildings. It can change an entire ecosystem in one day.

Hurricanes are becoming more and more common in some places. Scientists are finding that higher temperatures are a factor.

Hurricane Damage





Read a Photo

How can a hurricane change people's lives?

Clue: Think about the people who live or work in the place shown below.

Quick Lab

Storms at the Beach

1. **Make a Model** Pour and press sand into one end of a long pan. This is your beach. Add water to the other end. The water should come up to the lower edge of the beach.

2. Make waves by moving a ruler back and forth in the water. Observe how the beach changes. Continue observing as you move the ruler more quickly, making taller waves.

3. **Infer** Storms bring taller, stronger waves. How do storms and waves affect beach erosion?

Quick Check

Infer Why is it useful to predict storms?

Critical Thinking How are tornadoes similar to hurricanes? How are they different?

How do landslides change the land?

Have you ever seen a pile of rocks at the bottom of a slope? How did they get there? Part of the answer is gravity. *Gravity* pulls rocks and other objects from high places to low places.

Heavy rains can cause loose rock and soil to move quickly down a slope. A **landslide** is the sudden downhill movement of these materials in large amounts.

An avalanche (AV•uh•lanch) is similar to a landslide. In an **avalanche**, tons of ice and snow rush down a mountain.

Scientists work to predict when and where landslides and avalanches happen. They never know when one will strike. It pays to be extra careful when you are near mountains.

Quick Check

Infer Near what landforms would landslides most likely take place?

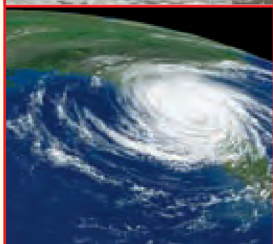
Critical Thinking Why might it be risky to build a town on a soft hillside?

An avalanche like this one can shift the snowy landscape. These people are in trouble!

Lesson Review

Visual Summary

Too much rain can cause **floods**. Too little rain can lead to fires. Both can change the land quickly.

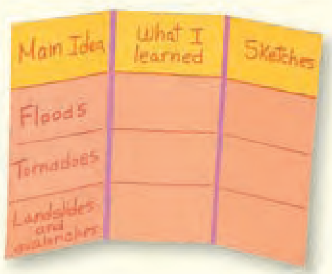


Tornadoes and hurricanes are powerful storms that shape the land quickly.

In **landslides and avalanches**, large amounts of land, ice, or snow slide downhill suddenly.

Make a FOLDABLES Study Guide

Make a Trifold Book. Use it to summarize what you learned about changes caused by the weather.



Think, Talk, and Write

1. **Main Idea** What are three ways that weather can change the land quickly?

2. **Vocabulary** What word describes a large, sudden movement of ice or snow downhill?

3. **Infer** A photograph shows fallen palm trees along a beach. The beach is in the southeast United States. What kind of event most likely caused this result? Fill in the graphic organizer to show your thinking.

Clues	What I Know	What I Infer

4. **Critical Thinking** Some radios are powered by batteries. How could such a radio help you prepare for a severe storm?

5. **Test Prep** **Which of these events can help plants grow?**

   A hurricanes
   B tornadoes
   C forest fires
   D landslides

Writing Link

Write a Newspaper Report
Research a recent hurricane or tornado. Write a newspaper report describing the storm. Include facts and details. Support your report with comments from witnesses.

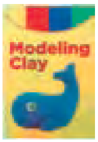
Social Studies Link

Research an Event
New Hampshire was once home to a rock formation called "Old Man of the Mountain." Find out what happened to the "Old Man." Describe the event that changed it.

Be a Scientist

Materials

aluminum pan



modeling clay

water

colored pencils

paper

soil and gravel

plastic cup

Structured Inquiry

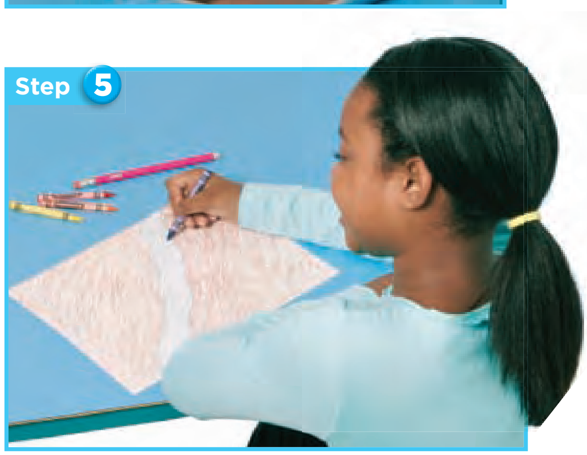
What happens to the environment when a river floods?

Form a Hypothesis

Rivers can move large amounts of materials from one place to another. These materials include minerals and bits of rock. When a flood erodes the sides of a river, where do the materials go? Write your hypothesis in the form, "If a river floods, the materials in the water will be deposited..."

Test Your Hypothesis

1. **Make a Model** Construct a model river and surrounding land. Mold clay inside an aluminum pan to form a flat river bottom. Flatten the land as well.
2. Pour just enough water into the river to fill it. Draw your model.
3. Make "floodwater" by mixing soil and gravel in a cup of water.
4. Pour the floodwater into the river. Where does the water go? Draw the flooded river area on a sheet of paper.
5. **Observe** Let your flooded land dry overnight. Observe and record any changes the next day. Draw your river area again.
6. **Communicate** Describe the materials that were deposited on the land.



Draw Conclusions

7. What happened to your landscape when the river overflowed?

8. **Infer** How might floods help plants, animals, or farmers on the land surrounding a river?

Guided Inquiry

How does the amount of water affect damage?

Form a Hypothesis

How can the amount of water in a flood affect the amount of damage to the land? Write your hypothesis in the form, "As the amount of floodwater increases, the amount of material carried away by the water..."

Test Your Hypothesis

Design an investigation to test your hypothesis. Write out the materials you need and the steps you will follow. Record your observations and results.

Draw Conclusions

Did your results support your hypothesis? Why or why not? Explain how you set up the experiment to test for just one variable.

Open Inquiry

What can you learn about floods? For example, what types of soil are most likely to wash away during a flood? Design an investigation to answer your question. Test one variable at a time. Write your procedure so that another group can repeat the investigation by following your instructions.

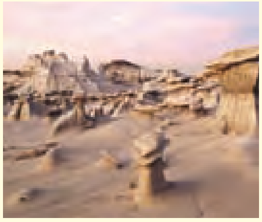
Remember to follow the steps of the scientific process.

Ask a Question → Form a Hypothesis → Test Your Hypothesis → Draw Conclusions

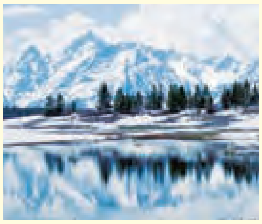
SI-6. Formulate instructions and communicate data in a manner that allows others to understand and repeat an investigation or experiment.

CHAPTER 3 Review

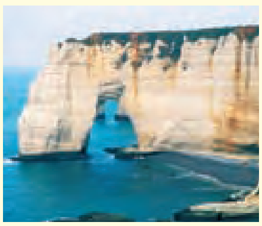
Visual Summary



Lesson 1 Landforms such as mountains and valleys cover Earth's crust. Earth's interior is made up of layers.



Lesson 2 Earth's surface is broken into large plates. The plates move slowly. Many landforms form at the plate edges.



Lesson 3 Weathering, erosion, and deposition are slow processes that shape the land.

Lesson 4 Floods, fires, storms, volcanoes, and landslides can change the land quickly.

Make a FOLDABLES Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.

Vocabulary

Fill in each blank with the best term from the list.

crust, p. 142
erosion, p. 162
fault, p. 149
flood, p. 172
hurricane, p. 174
inner core, p. 142
volcano, p. 154
weathering, p. 160

1. A crack in Earth's crust is called a(n) _________.
ESS-10
2. Physical _________ is a process that changes only the size or shape of rock.
ESS-8, ESS-9
3. The sphere of solid material at the center of Earth is the _________.
ESS-B
4. Heavy rainfall can cause a(n) _________.
ESS-8
5. Earth's landforms are found on the _________.
ESS-8
6. A large, swirling storm with strong winds and heavy rain is called a(n) _________.
ESS-8
7. When gravity, waves, wind, and glaciers transport rock, _________ happens.
ESS-10
8. When a(n) _________ erupts, magma, ash, and gases are sent into the air.
ESS-B

Skills and Concepts

Answer each of the following in complete sentences.

9. **Infer** Why do volcanoes often appear near the edges of plates rather than at the center of plates?
ESS-10
10. **Make a Model** Design a way to show how wind causes erosion. Use sand, a flat container, and a straw as your materials. Based on your results, how does wind move sand?
ESS-8
11. **Critical Thinking** How do scientists get information about Earth's layers?
ESS-B
12. **Expository Writing** Explain how snow can cause weathering and erosion.
ESS-9

The Big Idea

13. What causes Earth's surface to change?
ESS-B

Performance Assessment

Make a Tornado

1. Place rock, soil, and other heavy materials in the bottom of a bucket. Fill the bucket with water.
2. Place a large spoon or stick in the bucket. Swirl it around rapidly to model a tornado in the water.
3. Describe what happens to the materials you placed in the bottom of the bucket.

Analyze Your Results

Explain how the objects in the water reacted to the model tornado. Were there any differences between the materials? How does the tornado you made compare to an actual tornado?
ESS-8

Ohio Activity

As you travel Ohio, you will see many landforms. Many of these landforms were made or changed by glaciers. During the Ice Age, glaciers covered two-thirds of the state. Research the landforms created by the glaciers in Ohio. How did they form? Where are these landforms located? Prepare a report to share with your class.

Ohio Benchmark Practice

1 **All of the following shape Earth's surface except**

A glaciers.

B rivers.

C clouds.

D wind.

ESS-B

2 **Scientists measure the heights of waves resulting from an underwater earthquake in locations 10, 100, 500, 1,000, and 2,000 kilometers away from the epicenter. What question are they trying to answer?**

A How quickly do tsunamis travel?

B How many tsunamis result from an earthquake?

C How far do tsunamis travel?

D How are tsunamis caused?

SI-C

3 **Which of the following is responsible for the development of deltas?**

A physical weathering

B erosion

C deposition

D chemical weathering

ESS-B, ESS-8

4 **What is a moraine?**

A a mound formed by materials that a glacier picks up or pushes

B a mixture of sand, gravel, rocks, and clay dropped by glaciers

C the starting point of a glacier

D the deep valley carved by a glacier

ESS-B, ESS-8

5 **An experiment shows that the action of waves erodes beaches. What conclusion can you draw from this observation?**

A Sand dissolves in water.

B Salt water results in a higher rate of erosion.

C Over time beaches change shape.

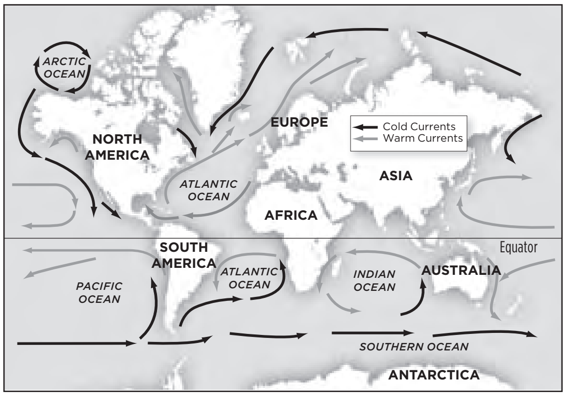
D All beaches erode at the same rate.

SWK-B

6 **Floods are a naturally occurring event. In your Answer Document, explain how floods can be beneficial and harmful.** (2 points)

SWK-4

7 The map below shows the world's ocean currents.



If an oil tanker capsized and spilled its cargo off the western coast of Australia, which conclusion might be valid?

A Marine life near the southeastern African coast could be affected.

B The eastern coast of Australia would experience the effects of the oil spill.

C The Gulf Stream would carry the oil to the Northern Hemisphere.

D Only the western coast of Australia would be affected.

SWK-B

8 What can cause a flood?

A a forest fire

B quickly melting snow

C a long drought

D freezing temperatures

ESS-B, ESS-I0

9 Much of the sand on a beach is piled into hill-like landforms called dunes. A year later the dunes have changed position. In your **Answer Document**, explain how they could have moved. (2 points)

ESS-B, ESS-I0

10 Scientists studied a section of shoreline for five years. They found that during this time period, the water level rose significantly, and the shoreline moved inland. What conclusion can you draw from these observations?

A There is no relationship between beach erosion and higher water levels.

B Beach erosion slows as the water level rises.

C High water levels lead to greater beach erosion.

D Beach erosion leads to higher water levels.

SWK-2

11 What is true of most sand on continental beaches?

A It is made of sediment from rivers.

B It eroded from cliff rock.

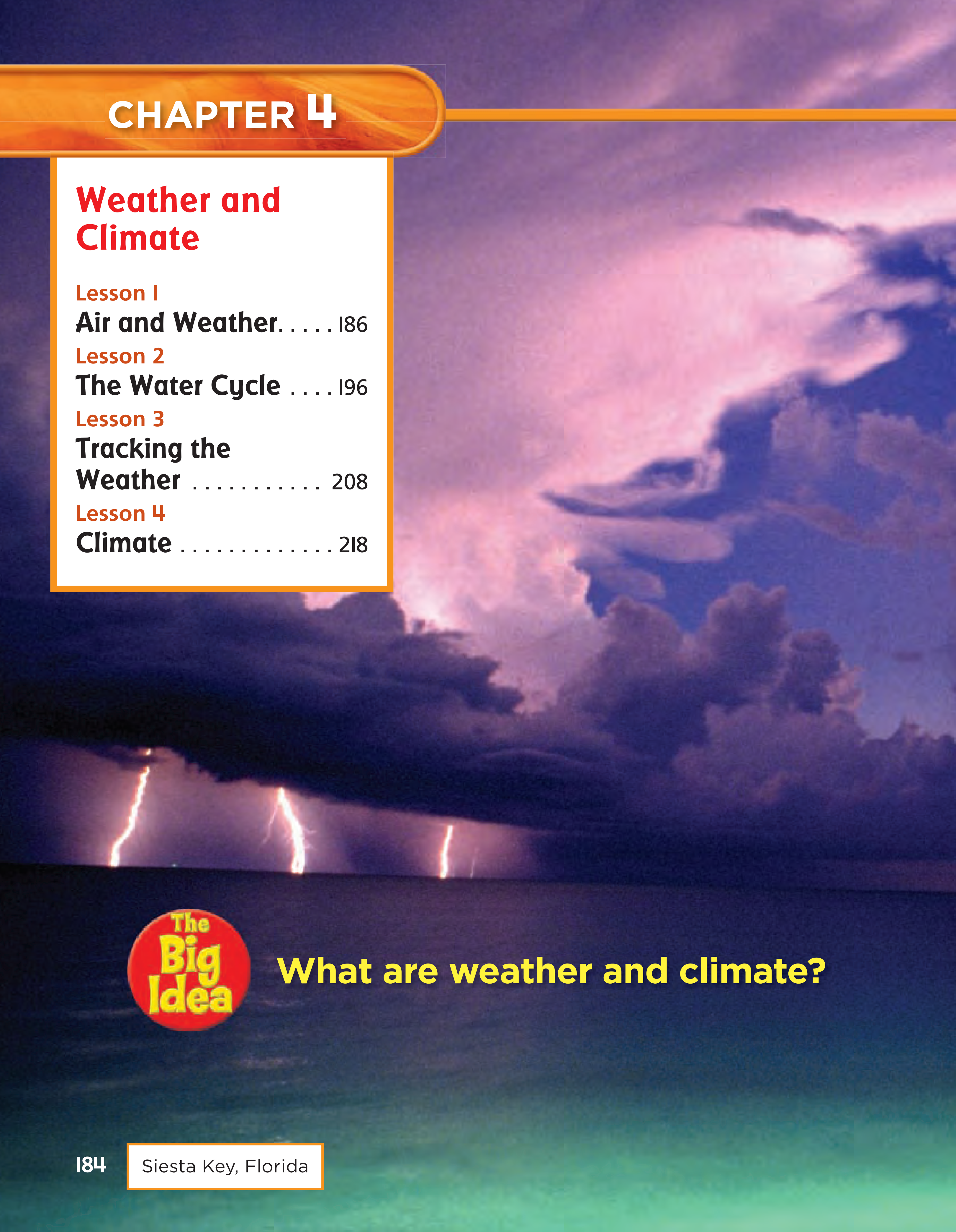
C It is made of remains of marine creatures.

D It washed onshore from barrier islands.

ESS-B, ESS-I0

CHAPTER 4

Weather and Climate

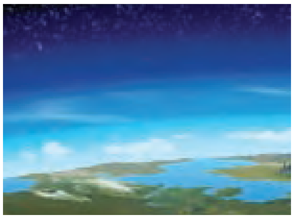


The Big Idea

What are weather and climate?

Siesta Key, Florida

Key Vocabulary



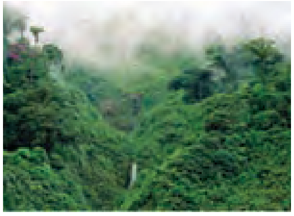
atmosphere
the blanket of gases that surrounds Earth (p. 188)

condensation
the process of a gas changing into a liquid (p. 199)

cloud
a collection of tiny water droplets or ice crystals that hangs in the air (p. 199)

air mass
a large region of the atmosphere where the air has similar properties throughout (p. 210)

front
a boundary between air masses with different temperatures (p. 211)



climate
the average weather pattern of a region over time (p. 220)

More Vocabulary

temperature, p. 190
humidity, p. 190
air pressure, p. 191
thermometer, p. 192
barometer, p. 192
wind vane, p. 192
rain gauge, p. 192
evaporation, p. 198
water vapor, p. 198
freeze, p. 199
precipitation, p. 199
water cycle, p. 200
melt, p. 204
warm front, p. 211
cold front, p. 211
stationary front, p. 211
forecast, p. 213
current, p. 222

ESS-D. Analyze weather and changes that occur over a period of time.

Lesson 1

Air and Weather

Look and Wonder

Pinwheels spin wildly in a strong wind. What makes the wind blow strongly? Why does it blow from different directions?

ESS-I. Explain that air surrounds us, takes up space, moves around us as wind, and may be measured using barometric pressure.

Explore

Inquiry Activity

How does the wind move?

Make a Prediction

Air can move from place to place. When you open a sealed bottle of liquid that is under pressure, air moves. Does the air move into or out of the bottle? Why? Write your prediction.

Test Your Prediction

1. **Make a Model** Fill an empty plastic bottle halfway with very warm water from a faucet.
2. ⚠ **Be Careful.** Pour warm liquids carefully. Place the cap on the bottle. Shake the bottle several times. Pour the water out. Replace the cap and set the bottle on a table. Observe it for several minutes.
3. **Observe** Hold the bottle near your ear. Remove the cap slowly. Listen carefully.

Draw Conclusions

4. Did air move into or out of the bottle? What happened to the pressure inside the bottle before the cap came off? After it came off?
5. **Infer** How might air pressure affect the direction from which winds blow? Use evidence from your model in your answer.

Explore More

Suppose you warm the air inside a capped bottle. What will happen to the air pressure inside the bottle? Write a prediction. Try it!

Materials

- bottle with cap
- funnel
- very warm water

Step 1

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea ESS-I

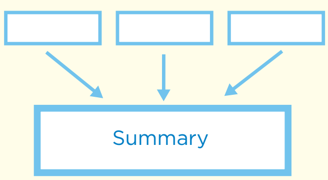
Earth's atmosphere has properties that we can measure to describe weather.

Vocabulary

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Summarize



What is in the air?

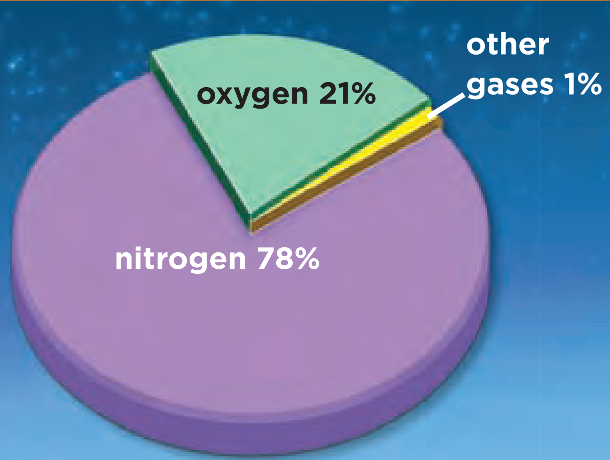
When you think of wind, what comes to mind? Wind is really just air in motion. In fact, air surrounds Earth like a thin blanket. This blanket of air is the **atmosphere** (AT•muhs•feer).

Gases

The atmosphere is a mix of different gases. You can tell from the pie chart that most of the atmosphere is made of nitrogen (NYE•truh•juhn) and oxygen. Without these gases, life could not exist on Earth!

The atmosphere also has a few other gases, including carbon dioxide and water vapor. These gases are important to Earth's water cycle.

Layers of Earth's Atmosphere



Most of the air we breathe in the troposphere is oxygen and nitrogen.

The Troposphere

Earth's atmosphere is made up of layers. The layer closest to Earth's surface is the *troposphere* (TROHP•uh•sfeer). Compared to the rest of the atmosphere, the troposphere is very thin. Yet all of Earth's life exists here.

The troposphere is also where all of Earth's weather takes place. Here the air is always on the move. Air that moves from place to place is called *wind*. Wind can be as gentle as a light breeze. It can be as fierce as a tornado. Any change in the wind brings a change in the weather.

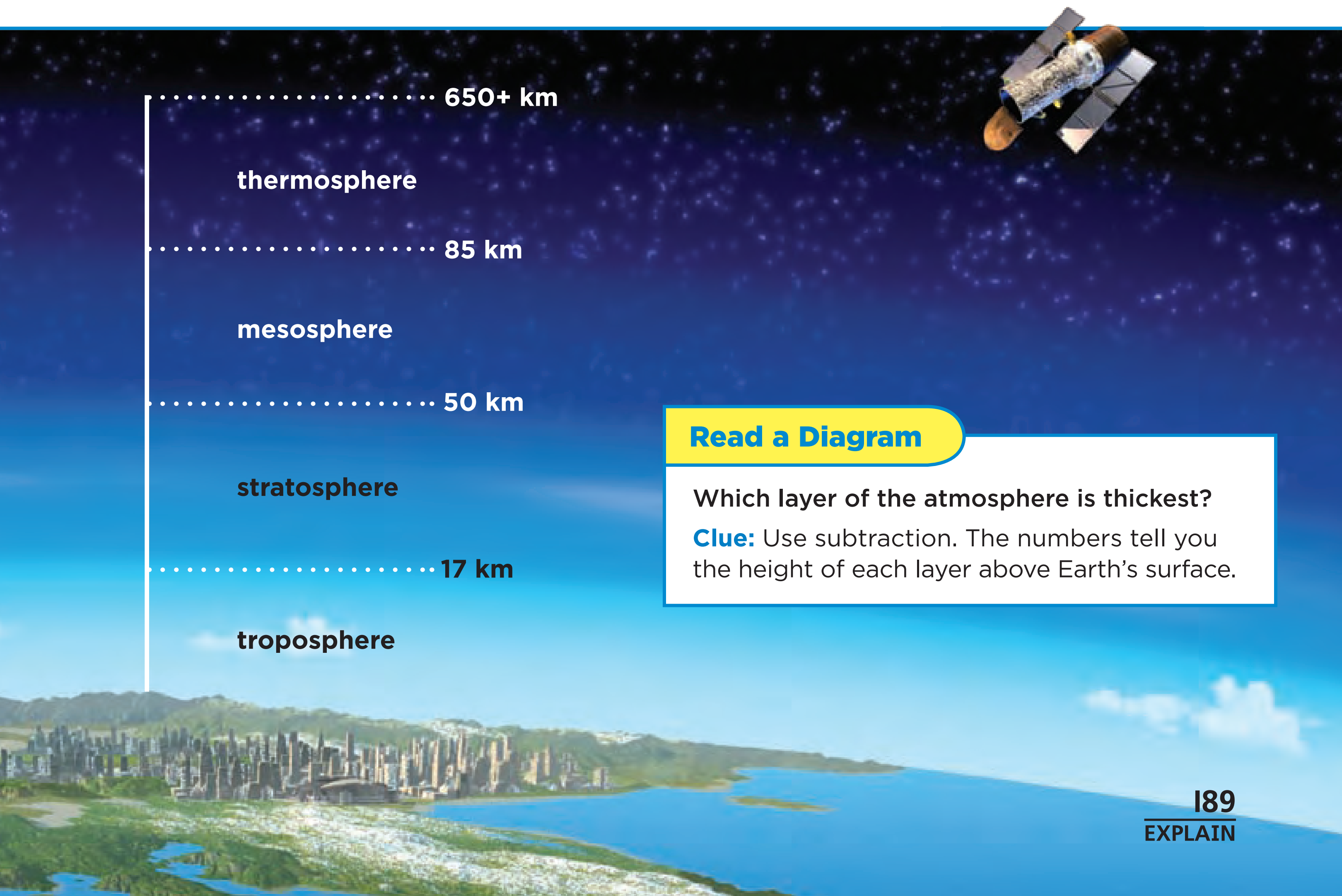
Other Layers of the Atmosphere

The diagram shows three other layers of Earth's atmosphere. The stratosphere (STRAT•uhs•feer) is the layer above the troposphere. There, temperatures get warmer as you go higher. Temperatures get colder in the mesosphere (MEZ•uh•sfeer) and thermosphere (THURM•uh•sfeer).

Quick Check

Summarize How are the troposphere and the atmosphere related?

Critical Thinking In what way is Earth's atmosphere like an orange peel? How is it different?



Read a Diagram

Which layer of the atmosphere is thickest?

Clue: Use subtraction. The numbers tell you the height of each layer above Earth's surface.

What are some properties of weather?

Wind is an important part of Earth's weather. *Weather* is the condition of the atmosphere at a given time and place.

Air Temperature

Temperature (TEM•puhr•uh•chuhr) describes how hot or cold something is. When the Sun's energy heats Earth's surface, the surface warms the air above it. The temperature of the air rises. If the air temperature changes, the air moves. Winds start to blow. Temperature affects wind speed and wind direction.

Humidity

If the air around us feels damp and sticky, we call the weather humid (HYEW•mid). **Humidity** (hyew•MID•i•tee) is a measure of how much water vapor is in the air. Deserts usually have very low humidity. Rain forests have very high humidity.

Air always has some amount of water vapor. Most of it comes from ocean water that evaporates from a liquid to a gas. This is why the air over oceans and lakes is humid.

Read a Photo

What can you infer about the weather in a tropical rain forest?

Clue: Look for clues that show humidity and air temperature.

Humidity in a Rain Forest

Mountain climbers use special equipment to deal with low temperature and low air pressure.

Air Pressure

We live at the bottom of the troposphere. Here, the weight of the entire atmosphere pushes down on us. The force of air pushing on an area is called **air pressure**.

Particles of cool air are closer together than particles of warm air. In the same amount of space, cool air weighs more than warm air. Air that weighs more has greater air pressure. Therefore, cool air has higher air pressure than warm air.

Precipitation

Any form of water that falls from clouds is *precipitation* (pree•sip•uh•TAY•shuhn). The term includes rain, snow, sleet, and hail. The amount of precipitation is an important property of weather.

Quick Lab

Humidity in a Cup

1. Pour 5 mL of water in each of two cups. Cover each cup with plastic wrap.

2. Place one cup in the refrigerator for ten minutes. Keep the other cup on a flat surface.
3. **Observe** Remove the cup from the refrigerator. Set it beside the other cup. Observe and compare the water in both cups. What differences do you notice?
4. **Infer** Which cup do you think has greater humidity—the warm cup or the cold cup? How do you know?

Quick Check

Summarize What properties can you use to describe the weather?

Critical Thinking What role does the Sun play in Earth's weather?

FACT Humidity on Earth's surface never reaches zero.

How can you measure weather?

Weather scientists often collect data from a place called a weather station. You can set up your own weather station! All you need are a few of the tools shown on this page.

A *hygrometer* (hye•GROM•i•tuhr) measures humidity. ▲

◀ A **thermometer** measures air temperature in degrees Celsius (°C) or degrees Fahrenheit (°F).

A **wind vane** points in the direction from which the wind is blowing. ▶

A **barometer** measures air pressure. ▶

An *anemometer* (an•uh•MOM•i•tuhr) measures wind speed. The faster the wind blows, the faster the cups spin. ▼

◀ A **rain gauge** (GAYJ) is a tube that collects water. It shows the amount of rainfall.

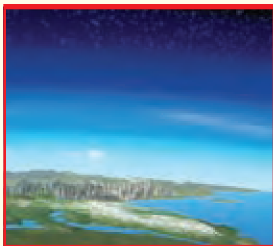
Quick Check

Summarize What tools could you use to measure the weather?

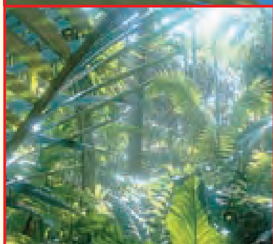
Critical Thinking Why do scientists use different tools to measure weather?

Lesson Review

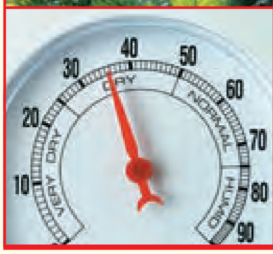
Visual Summary



Earth's atmosphere is made of gases. It has several layers. The troposphere is the layer where weather forms.



We can describe the **properties of weather** using air temperature, humidity, air pressure, precipitation, and wind.



Scientists use many different **tools to measure weather**, such as hygrometers and thermometers.

Make a FOLDABLES™ Study Guide

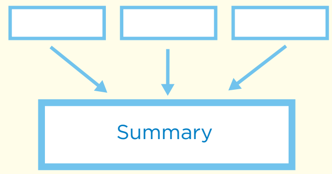
Make a Three-Tab Book. Use it to summarize what you read about air and weather.

Think, Talk, and Write

1. **Main Idea** What properties describe the weather? How can you measure them?

2. **Vocabulary** A(n) ________ measures the speed of the wind.

3. **Summarize** What are the different parts of Earth's atmosphere?



4. **Critical Thinking** Compare and contrast two examples of weather that you have experienced. Your comparison should include the vocabulary terms from this lesson.

5. **Test Prep** **In which layer of the atmosphere do we experience weather?**

   A the thermosphere
   B the stratosphere
   C the mesosphere
   D the troposphere

Math Link

Find the Average Rainfall
It rains 4 cm on Monday, 8 cm on Tuesday, and 6 cm on Wednesday. What is the average rainfall for the three days?

Health Link

Report on Staying Healthy
How do people stay healthy when the air temperature is very cold or very hot? Research the answers. Report on your findings.

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

WATCHING SPRING WEATHER

Spring weather can be very different from day to day. Last week, we had a stretch of sunny and mild spring weather. Temperatures were in the seventies. At night, they dropped to the mid-sixties. The air was pretty still, with a gentle breeze moving in every now and then.

Then the barometer started to fall rapidly. This signaled an approaching storm.

Yesterday strong winds swept in from the northwest. A heavy rain began to fall. The temperature was 41°F at noon. At night, it fell to the low thirties.

Today it is cloudy and overcast. The temperatures are in the high forties. The wind speed is 23 miles per hour.

Don't put away your winter coat yet. The weather forecasters predict more cold weather to come. We might have a light snowfall tonight.

Expository Writing

Good expository writing

- develops the main idea with facts and details
- uses transition words to connect ideas
- draws a conclusion based on the information

Write About It

Expository Writing Observe the weather in your area every day for two weeks. Record the temperature, air pressure, precipitation, clouds, and wind speed. Write a newspaper article about the changes you observed.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

ESS-5. Record local weather information on a calendar or map and describe changes over a period of time....

Math in Science

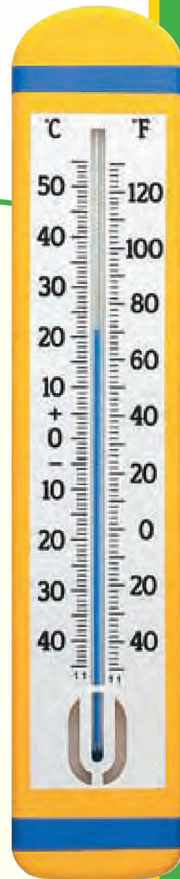
Graphing Weather Changes

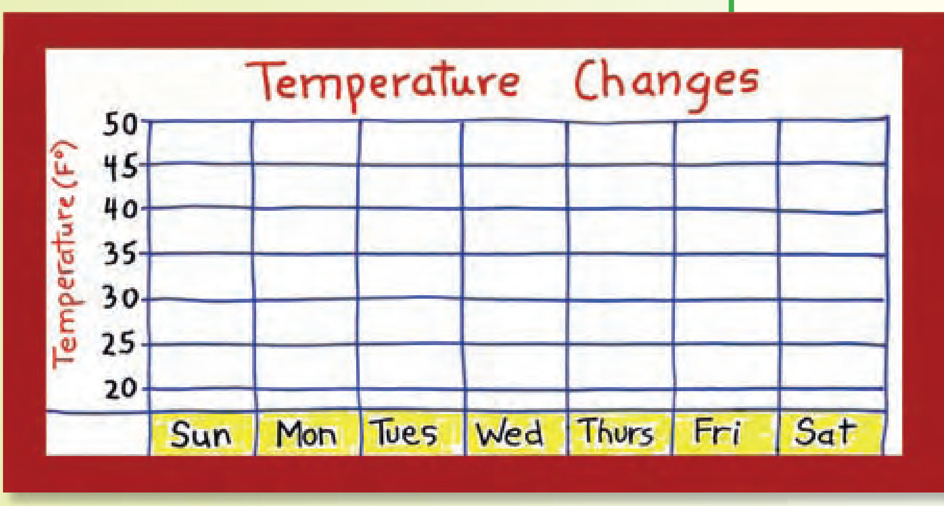
You can use line graphs to show how things change over time. Record the high and low temperatures in your area every day for seven days. Use the Internet, newspapers, television, or radio broadcasts to collect your data. Then plot the data on a line graph.

First, title your graph *Temperature Changes*. Label the bottom and left side as shown below. Start the temperature scale with a lower number than the lowest temperature you recorded. Then, mark off equal spaces in intervals of 5. Write the days of the week across the bottom.

Plotting Points on a Line Graph

- Use two different colors for high and low temperatures.
- Find the high temperature for your first day. If it is between two markings, make an estimate. Slide your finger over to the day. Mark that spot with a point.
- Continue plotting all the high and low temperatures. Use straight lines to connect all of the highs. Use another line to connect all of the lows.

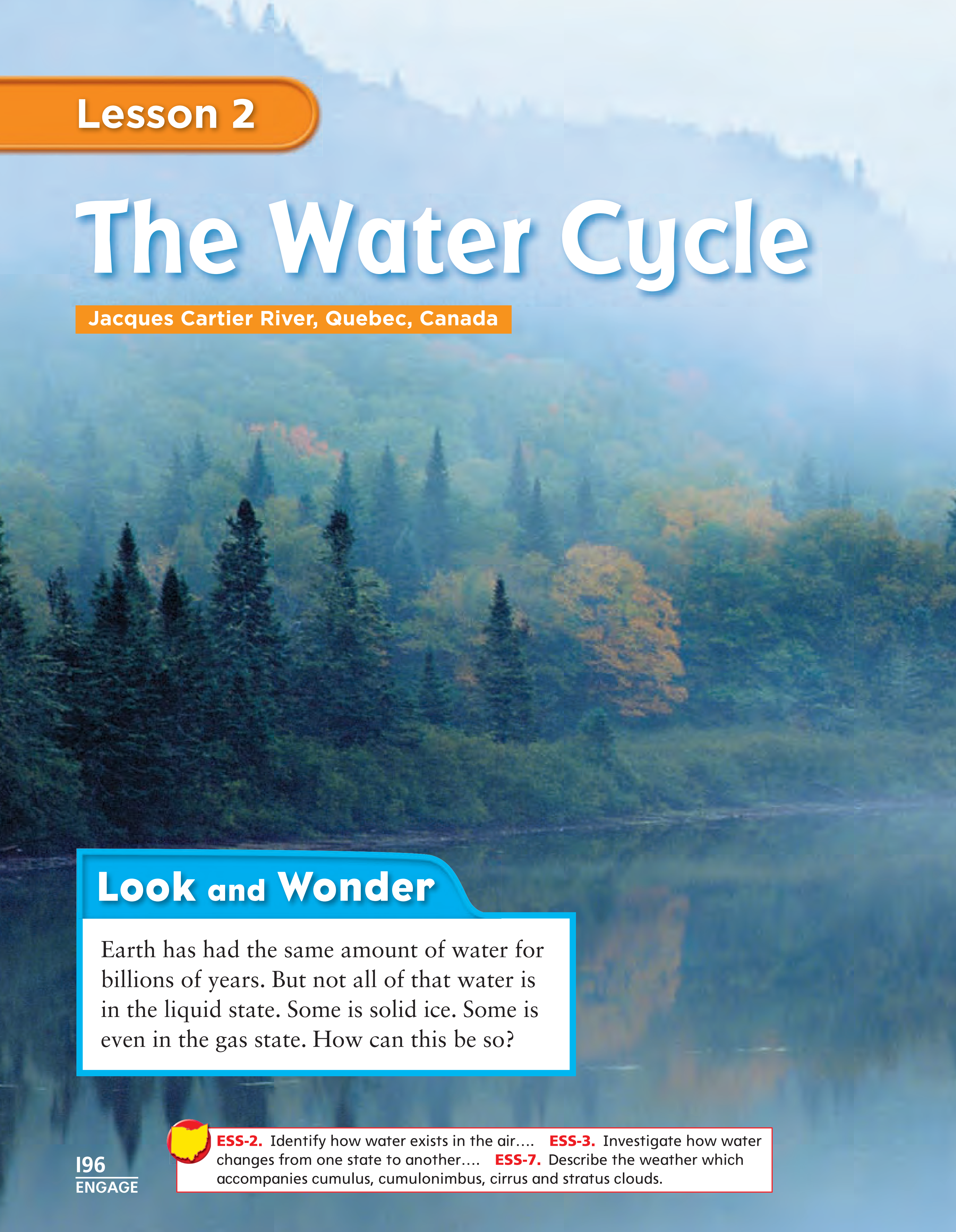




Solve It

Plot your data on the graph you made. Describe the temperature pattern shown on your graph.

M GSS-6. Specify locations and plot ordered pairs on a coordinate plane, using first quadrant points.



Lesson 2

The Water Cycle

Jacques Cartier River, Quebec, Canada

Look and Wonder

Earth has had the same amount of water for billions of years. But not all of that water is in the liquid state. Some is solid ice. Some is even in the gas state. How can this be so?

ESS-2. Identify how water exists in the air.... **ESS-3.** Investigate how water changes from one state to another.... **ESS-7.** Describe the weather which accompanies cumulus, cumulonimbus, cirrus and stratus clouds.

Explore

Inquiry Activity

How does water change from a liquid to a gas?

Form a Hypothesis

What variables affect how water changes from a liquid to a gas? Write a hypothesis.

Test Your Hypothesis

1. **Communicate** Work in a small group. Discuss examples of water changing from a liquid to a gas. What might affect how fast this change occurs? Consider temperature, wind, area, and volume of water.
2. **Use Variables** Using the materials, design an experiment to test one of the variables you discussed. Use two water samples. One will test the independent variable. The other water sample is your control.
3. **Experiment** Conduct your experiment. Record your observations at each step.

Draw Conclusions

4. Was your hypothesis correct? Does the variable you tested affect how water changes from a liquid to a gas? Give evidence to support your conclusion.
5. **Classify** Share your results as a class. Classify the variables you tested into those that affect the change and those that do not.

Explore More

Choose a different variable that might affect how liquid water changes to a gas. Form a new hypothesis. Design an experiment to test it. Then conduct your experiment. Share your findings with the class.

Materials

- water
- 2 plastic containers with lids
- spoon
- salt

Step 4

SI-5. Describe how comparisons may not be fair when some conditions are not kept the same between experiments.

Read and Learn

Main Idea ESS-2, ESS-3, ESS-7

In the water cycle, water changes state as it moves between Earth's surface and atmosphere.

Vocabulary

evaporation, p. 198

water vapor, p. 198

condensation, p. 199

cloud, p. 199

freeze, p. 199

precipitation, p. 199

water cycle, p. 200

melt, p. 204

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Sequence

First

↓

Next

↓

Last

Why does water change state?

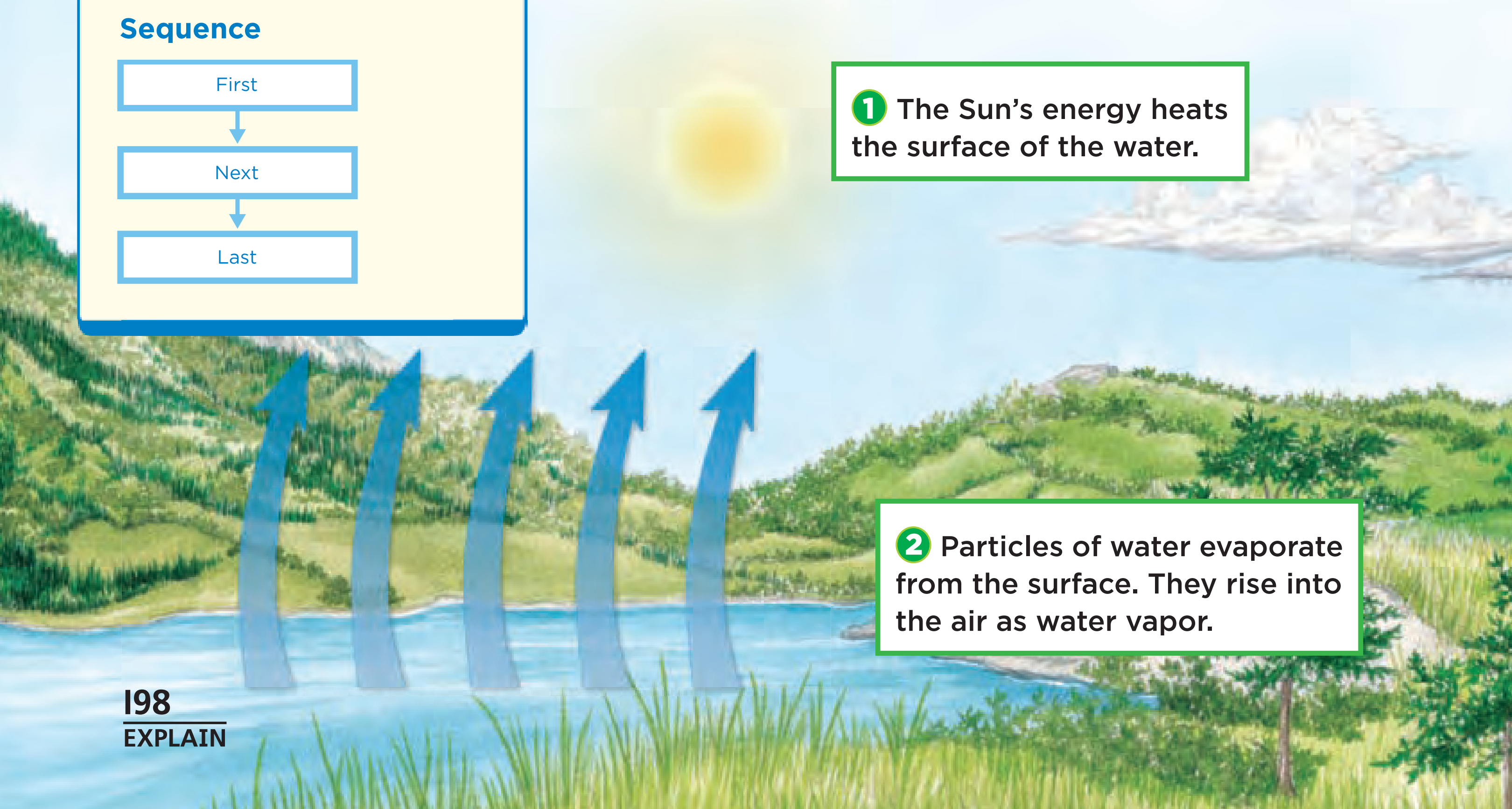
Water moves from Earth's surface into the atmosphere. Then it moves back to the surface. Water changes state as it moves.

Evaporation

Water seems to disappear when it evaporates (ee•VAP•uh•rayts). **Evaporation** is the term for a liquid changing slowly to a gas. Liquid water doesn't really disappear. It just changes to a gas.

Water vapor is water in the gas state. You cannot see water vapor, but it is part of the air around you.

Water is always evaporating from oceans, streams, lakes, rivers, and ponds. The Sun's heat causes particles of water at the surface to move rapidly. The more heat energy they take in, the faster and farther apart they move. Some of the particles rise into the air as a gas—water vapor.

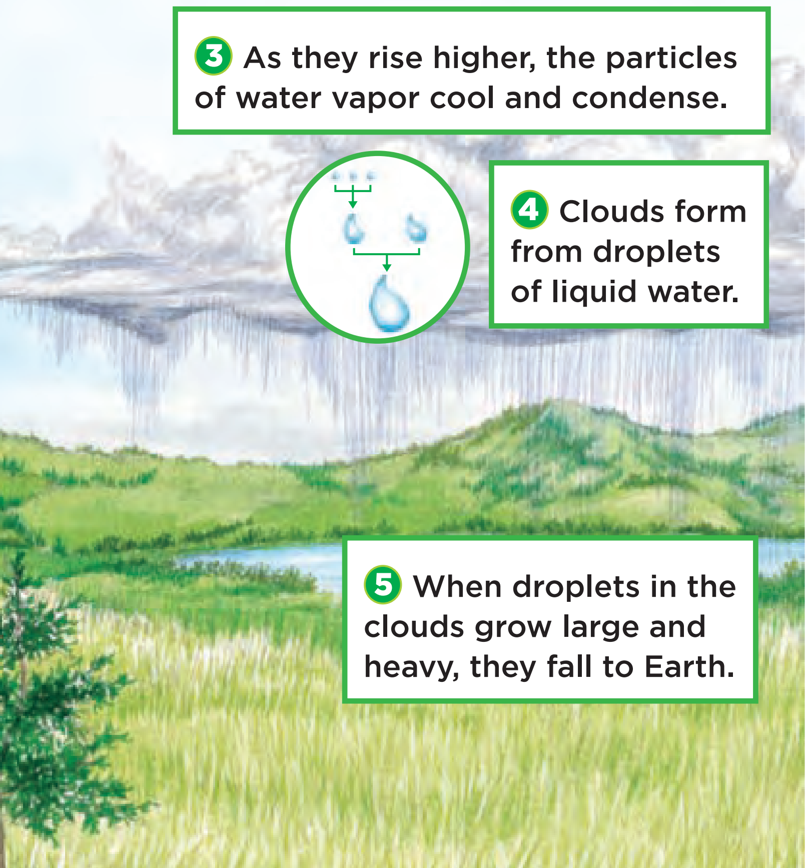


Condensation

As particles of water vapor rise into the air, they cool. The particles lose energy. They move more slowly. High in the atmosphere, the water vapor *condenses* (kuhn•DEN•sez) to liquid water. **Condensation** is when a gas changes to a liquid.

Dew is a familiar kind of condensation. Dew forms when water vapor cools and condenses onto a surface. Have you ever seen drops of water cover the grass on a cool morning? Those drops are dew.

Water vapor can also condense onto dust particles in the air. The tiny drops, or *droplets*, form clouds. A **cloud** is a group of water droplets in the atmosphere. The droplets are pure water in liquid form.



Dew can form on spiderwebs in the early morning.

Precipitation

Inside a cloud, small water droplets may join together and form larger ones. If it is very cold, some droplets freeze into ice. To **freeze** is to change from a liquid to a solid.

The droplets and bits of ice grow larger and heavier. When they are too heavy, they fall to Earth's surface. **Precipitation** (pri•sip•i•TAY•shuhn) is the term for water that falls from clouds down to Earth.

Quick Check

Sequence Explain the steps in evaporation and condensation.

Critical Thinking What happens to a puddle of water on a sunny day? Why?

Where does water go?

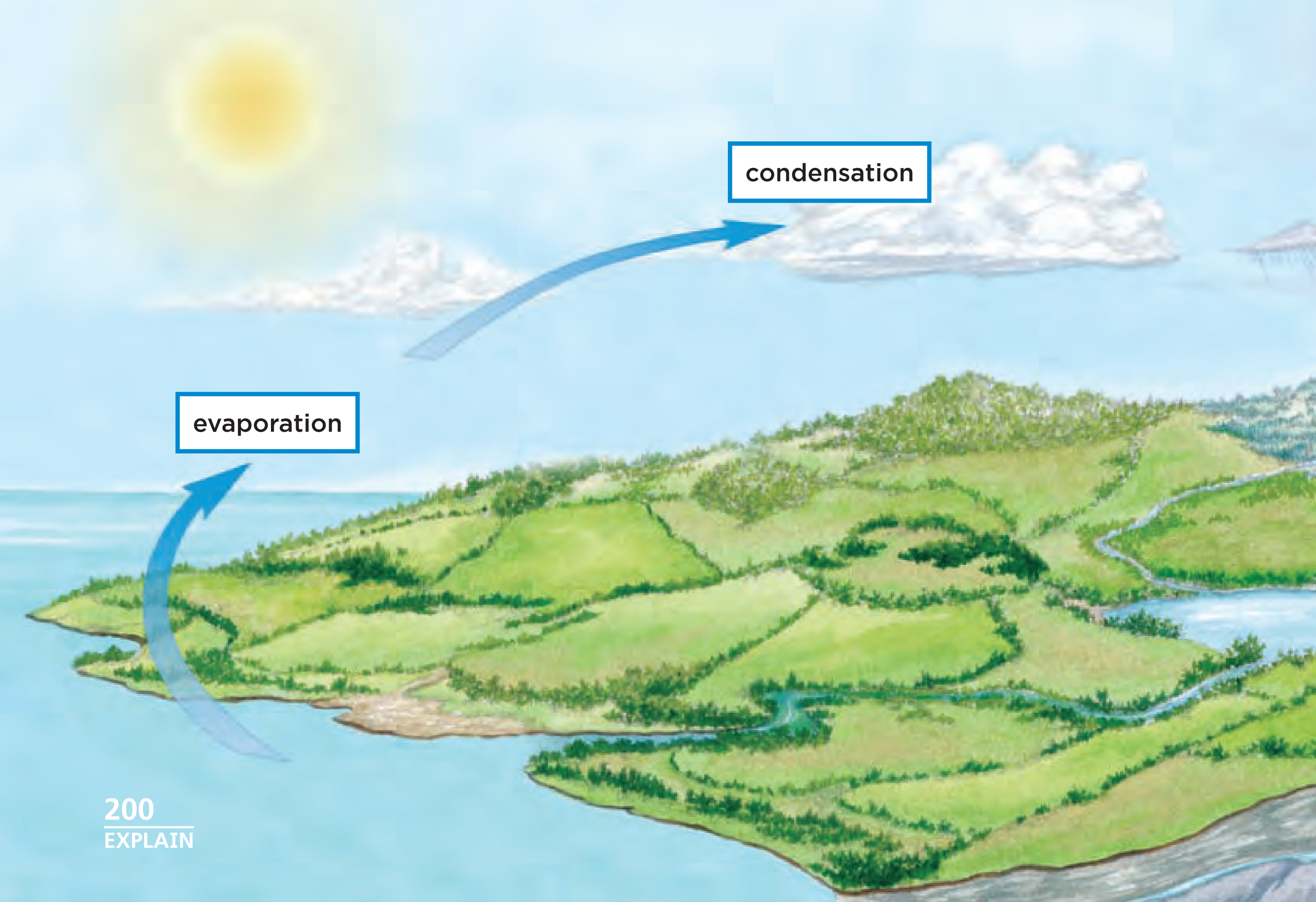
By now you know a lot about water. You know that water can be found in many places. You know it has three different states.

Water is always moving from place to place, in one form or another. The **water cycle** is the movement of water between Earth's surface and the air. Evaporation, condensation, and precipitation help water move through the cycle. The diagram shows you how.

In the Air

In the water cycle, water changes state between liquid, gas, and solid. The Sun is the energy source for this cycle. The Sun's energy causes water to evaporate from lakes, oceans, and other bodies of water. Water also evaporates from the leaves of plants. This is called *transpiration* (trans•puh•RAY•shuhn). As it rises in the air, the water vapor condenses. Clouds form. During precipitation, water falls from the clouds over land and water.

The Water Cycle



On and Below the Ground

Precipitation can fall as rain, snow, sleet, or hail. When it rains, water flows over Earth's surface as *runoff*. Runoff gathers in lakes, oceans, rivers, and streams. Over time, water collects in glaciers and ice caps.

Rainwater also soaks into the ground. Plants take up some of the water from soil. The rest collects in small cracks and spaces below the ground. This groundwater can stay above the bedrock, flow, or slowly evaporate.

Quick Check

Sequence How does water enter and leave the atmosphere?

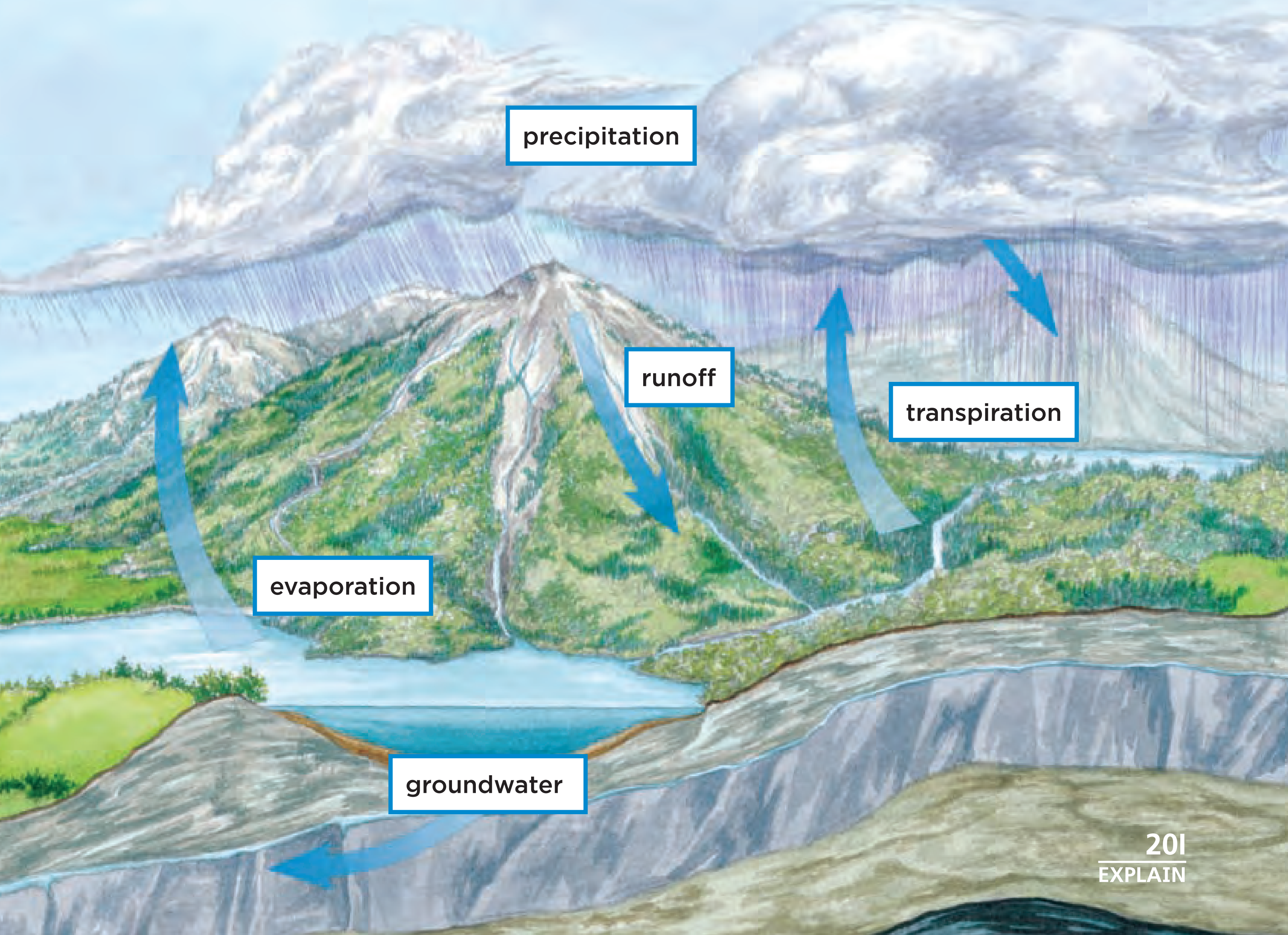
Critical Thinking How does the Sun's energy affect Earth's weather?

Read a Diagram

Describe one path through the water cycle.

Clue: Follow the arrows.

LOG ON *Science in Motion* Watch how the water cycle works at www.macmillanmh.com



Quick Lab

Cloud in a Jar

1. Pour very warm water into a jar so that it is about 1 cm deep. Seal the jar tightly. Then shake it several times.
2. Open the jar and quickly place a plastic sandwich bag inside it. Using a rubber band, seal the bag tightly around the mouth of the jar.
3. **Observe** Reach into the bag. Gently pull it up. Then release the bag. Observe and describe what happens in the jar. Repeat this step several times.
4. **Interpret Data** When does the cloud form? When does it disappear? Why do you think this happens?

What are some types of clouds?

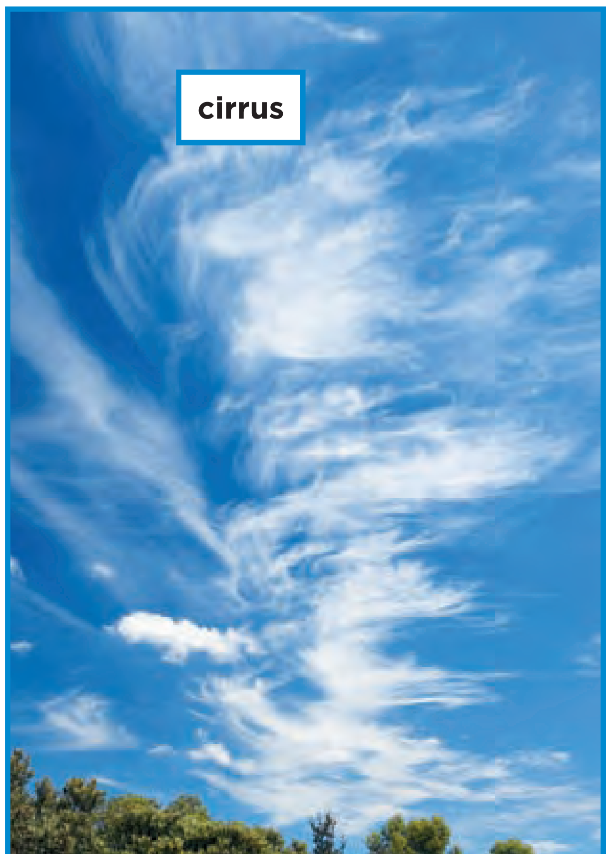
Scientists classify clouds into three main types based on how and where they form. Clouds give clues about the weather you can expect.

Cumulus

Cumulus (KYEW•myuh•luhs) clouds are puffy, white clouds that look like cotton balls. They often appear in fair weather.

You may have seen clouds grow dark before a rainstorm. If a cumulus cloud becomes dark and thick, it is called a *cumulonimbus* (kyew•myuh•loh•NIM•buhs) cloud. This kind of cloud causes precipitation.

Cloud Types



Stratus

Stratus (STRAT•uhs) clouds form in layers. The layers look like sheets or blankets. Stratus clouds are often the lowest clouds in the sky. Dark stratus clouds can produce precipitation.

Cirrus

Cirrus (SIR•uhs) clouds look thin, wispy, or feathery. Cirrus clouds are usually found very high in the sky. They indicate changes in the weather.

Observing Clouds

In the diagram to the right, you can see some other cloud types. Often, you can observe more than one cloud type in the sky at one time.

Quick Check

Sequence How might clouds change as a morning rain shower turns into a sunny day?

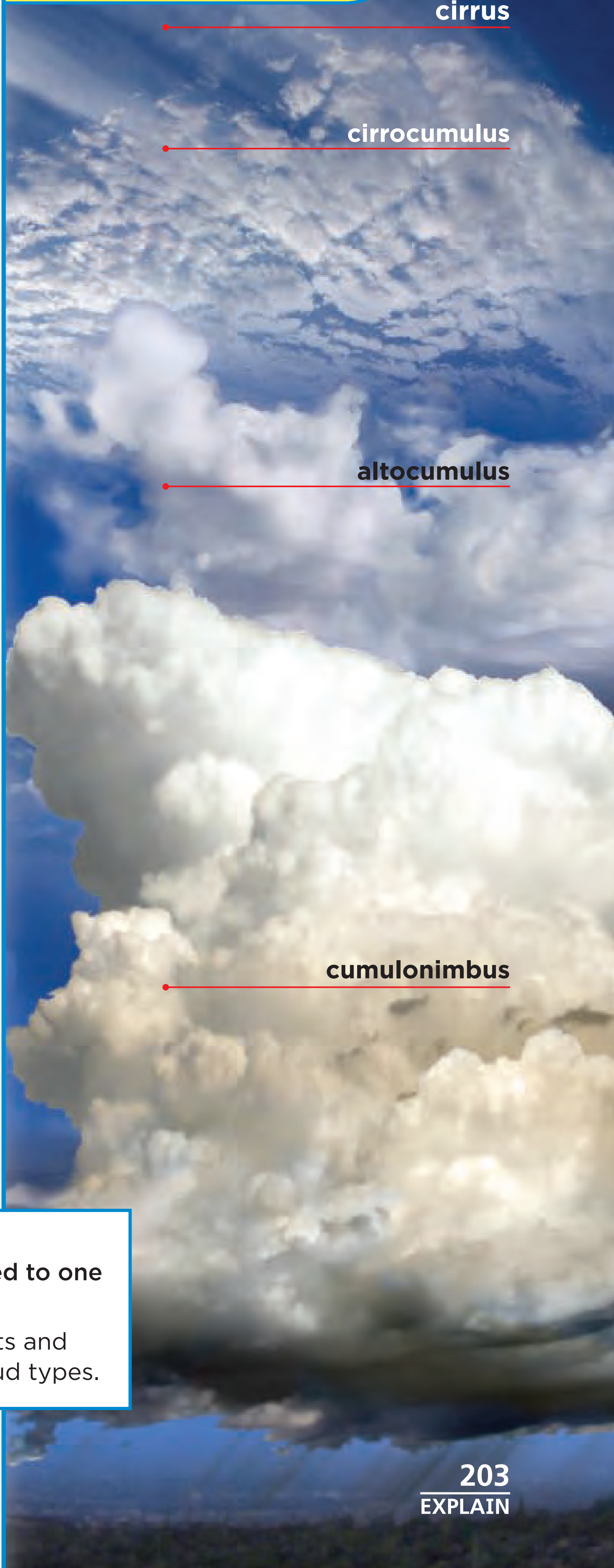
Critical Thinking Classify the types of clouds you see in the sky today.

Read a Diagram

Which cloud types are related to one another?

Clue: Compare the word parts and pictures for the different cloud types.

Many Kinds of Clouds



What are other forms of precipitation?

Rain is just one form of precipitation. Water can change state as it moves through the air. When this happens, other kinds of precipitation may fall.

Snow

When water reaches a temperature below 0°C (32°F), it freezes into ice. Remember, to freeze is to change from a liquid to a solid. Bits of ice can collect in a cloud. If they get too heavy, they fall as snow.

Snow may melt as it falls to the ground. To **melt** is to change from a solid to a liquid. Melting happens when sunshine or warm air heats the icy snowflakes. The heat makes the snow change to rain.

Sleet and Hail

Sometimes rain falls from clouds as a liquid but freezes along the way. The rain turns into small chunks of ice. The ice that falls to the ground is called *sleet*.

Hail is made of ice, too. The ice chunks are much larger than sleet. Hail forms inside the tall clouds of a thunderstorm. Most hailstones are the size of peas. However, some are bigger than baseballs!

Quick Check

Sequence How does snow form?

Critical Thinking Do all pieces of ice that fall to the ground come from icy clouds? Explain.

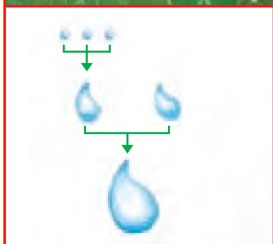
Most hailstones are small. Large ones can be dangerous! How wide is the hailstone on the left?

FACT Hail can fall in spring and summer.

Lesson Review

Visual Summary

Water changes from a liquid to a gas through **evaporation**. It changes from a gas to a liquid through **condensation**.

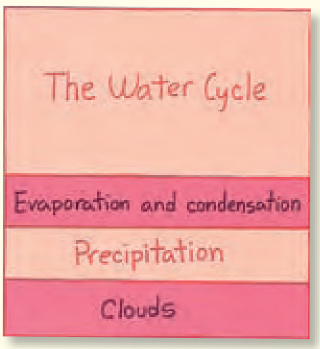


In the **water cycle**, water travels by runoff, evaporation, condensation, and **precipitation**.

Clouds form at different heights above Earth's surface. They are classified by how and where they form.

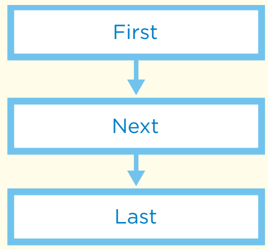
Make a FOLDABLES™ Study Guide

Make a Layered-Look Book. Use it to summarize what you read about the water cycle.



Think, Talk, and Write

1. **Main Idea** How does water travel through the water cycle?
2. **Vocabulary** Water vapor becomes liquid water through ________.
3. **Sequence** Describe the path of water from the ocean to a raindrop.



4. **Critical Thinking** How are hail and sleet alike? How are they different?
5. **Test Prep** **Clouds form when water vapor**
   - **A** evaporates.
   - **B** condenses.
   - **C** precipitates.
   - **D** transpires.
6. **Test Prep** **Puffy, white clouds that look like cotton balls are**
   - **A** cumulus clouds.
   - **B** cirrus clouds.
   - **C** stratus clouds.
   - **D** cirrostratus clouds.

Writing Link

Write a Cloud Poem
Write a poem about clouds. Choose ones you have seen or ones you would like to see. Include several different cloud types in your poem.

Art Link

Water Cycle Diorama
Make a diorama that shows how the water cycle works. Label the places where water goes. Write captions to describe how water changes state.

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Focus on Skills

Inquiry Skill: Make a Model

You've seen water collect in puddles during a heavy rainstorm. You've learned that evaporation causes puddles to dry up. Does the size of a puddle affect how fast it evaporates? To answer this question and still stay dry, you can **make a model**.

▶ Learn It

When you **make a model**, you build something to represent an object or event. A model helps you learn more about the real object or event you are investigating. It is important to record your observations about your model. Then you can make inferences about the real thing.

▶ Try It

Make a model to study how the size of a puddle affects evaporation.

Materials **whole kitchen sponge, half kitchen sponge, two-pan balance, paper clips, water, measuring cup, lamp**

1. Place the whole sponge in one balance pan and the half sponge in the other. The sponges represent puddles.
2. Add paper clips to the pan with the half sponge until both sides of the balance are equal in mass.
3. Add equal amounts of water to each sponge.
4. Place the lamp so it will shine on both "puddles." Turn on the lamp. This models the Sun.
5. Observe the sponges after 5 minutes. Read the measurement on the balance. Record your observations in a data table like the one shown.

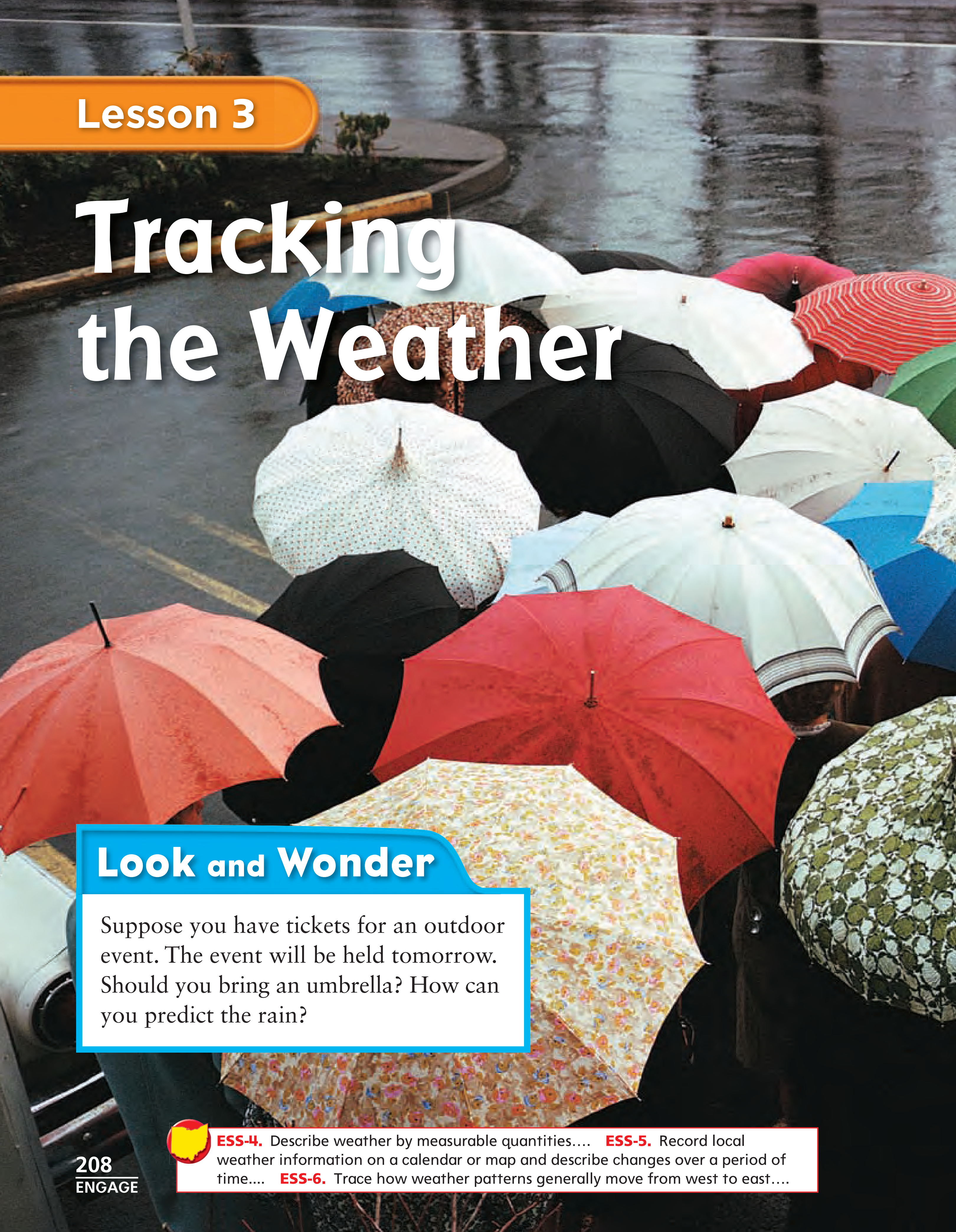
6. Continue to read the balance every 5 minutes for 15 minutes. Record your observations.
7. Look at your results. Which sponge became lighter first? Why do you think it did?
8. How are your model puddles like real rain puddles? How are they different?

▶ Apply It

Now **make a model** to test the effect of wind on evaporation. Use two rectangular plastic containers.

1. Pour the same amount of water into each container. Place a fan so that it will blow across the surface of only one container. Turn the fan on. Use a low setting.
2. Wait 10–15 minutes. Then measure the amount of water in each container.
3. How much water evaporated from each container? What does this tell you about wind and evaporation?

ESS-3. Investigate how water changes from one state to another (e.g., freezing, melting, condensation and evaporation).



Lesson 3

Tracking the Weather

Look and Wonder

Suppose you have tickets for an outdoor event. The event will be held tomorrow. Should you bring an umbrella? How can you predict the rain?

ESS-4. Describe weather by measurable quantities.... **ESS-5.** Record local weather information on a calendar or map and describe changes over a period of time.... **ESS-6.** Trace how weather patterns generally move from west to east....

Explore

Inquiry Activity

How do raindrops form?

Form a Hypothesis

How do changes in air temperature affect water in the liquid and gas states? Write a hypothesis.

Test Your Hypothesis

1. Pour just enough water into each jar to cover the bottom of the jars.
2. **Use Variables** Place one lid upside down on one jar. Put three or four ice cubes in that lid. Place the other lid upside down on the second jar. Do not add ice cubes to that lid.
3. **Observe** Wait two minutes. Then look closely at the parts of the lids inside the jars. Record your observations every two minutes over the next ten minutes.
4. Draw a diagram that shows what happened to the water inside the jars. Add labels and arrows to explain how the water changed.

Draw Conclusions

5. Why did water droplets form mostly underneath the lid? Why didn't they form inside the jar or on the upside-down lid?
6. **Predict** What if you shined a heat lamp on the water in the jars before step 3? Predict how your results would change.

Explore More

What would happen if you used ice instead of water in step 1? Make a prediction. Then repeat the activity with the ice. Explain your results.

Materials

- 2 jars with lids
- water
- ice cubes

Step 2

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Read and Learn

Main Idea ESS-4, ESS-5, ESS-6

Air masses and fronts cause weather patterns to form and change.

Vocabulary

air mass, p. 210

front, p. 211

warm front, p. 211

cold front, p. 211

stationary front, p. 211

forecast, p. 213

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Reading Skill

Predict

My Prediction	What Happens

What are air masses and fronts?

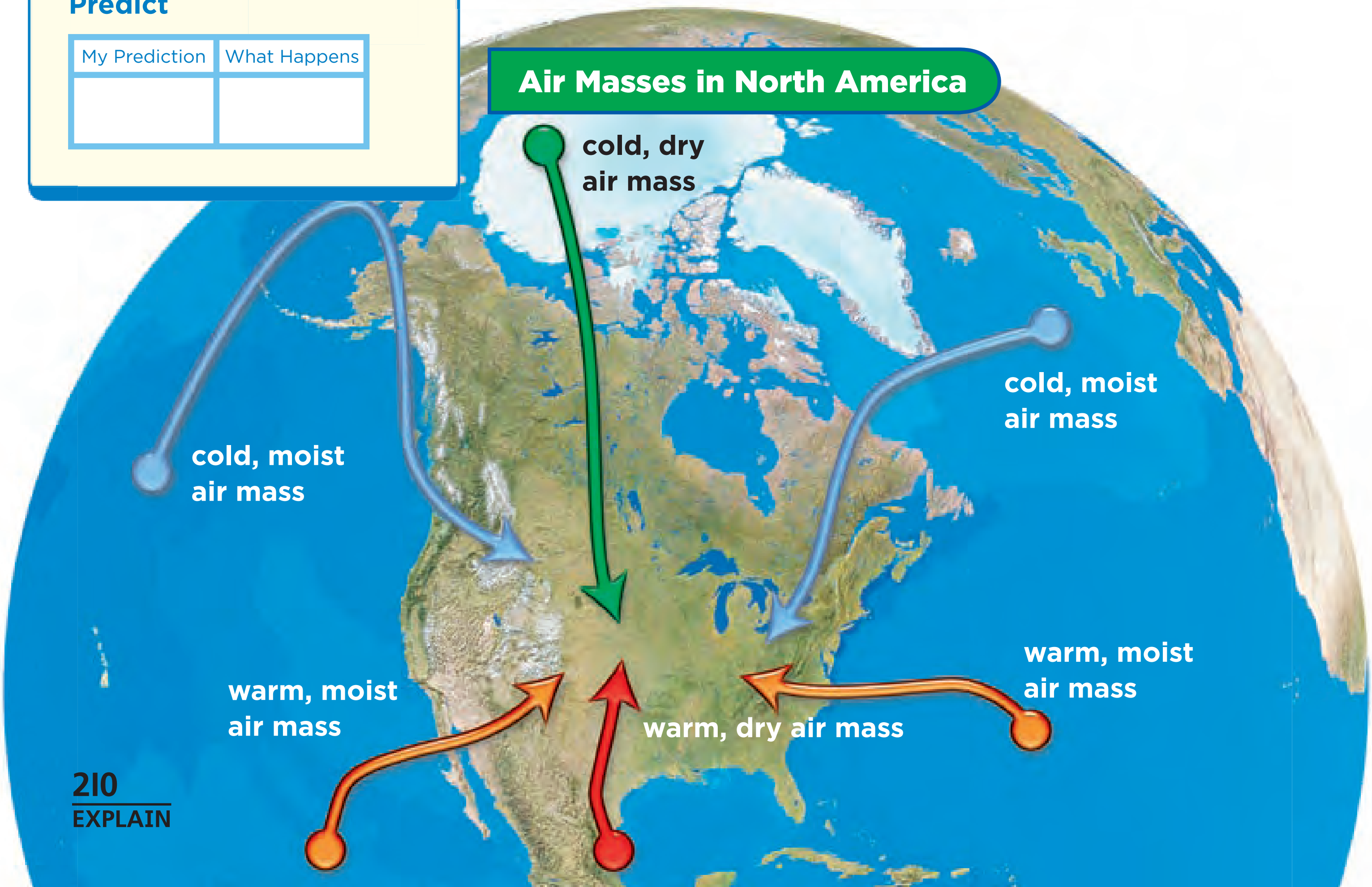
The wettest place on Earth is in the state of Hawaii. Rain falls over one of the islands about 350 days of the year. One of the driest places in the world is a desert in South America. Some parts have not seen rain for centuries! Why is it so rainy in some places and dry in others?

Air Masses

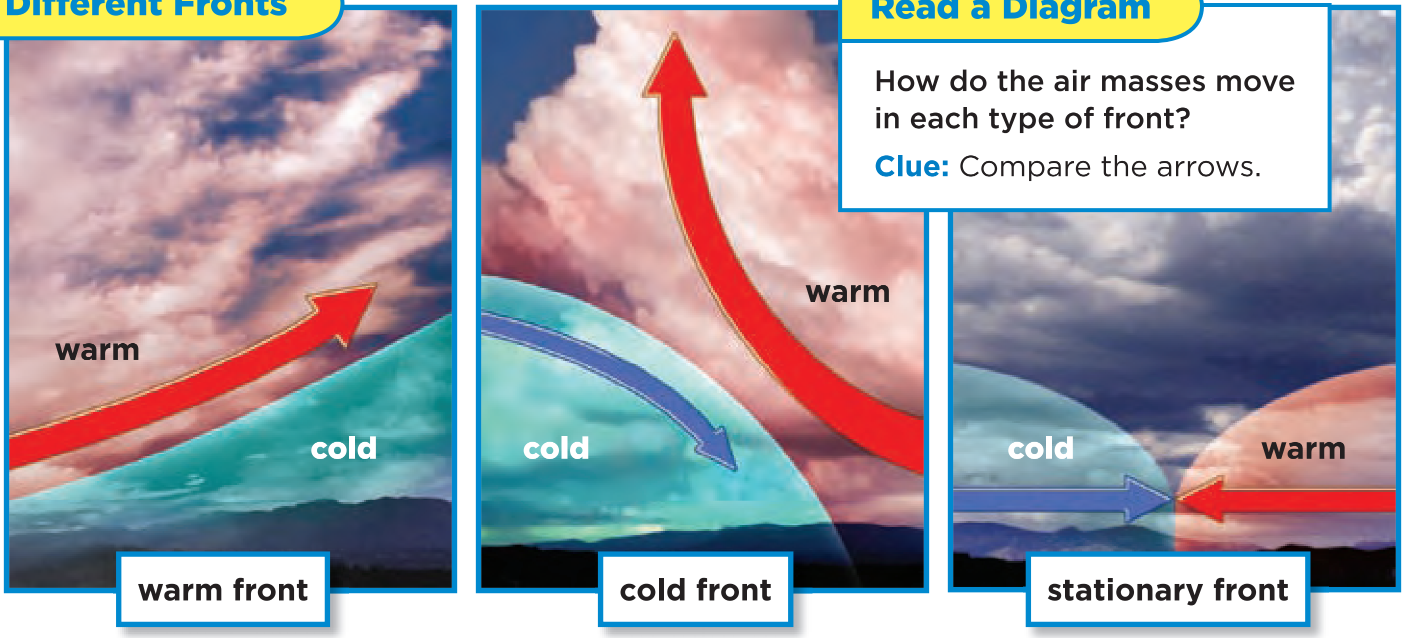
The properties of the air in different places on Earth vary. Large areas of air have nearly the same properties. These regions are called **air masses**. Weather in one part of an air mass is like the weather throughout the rest of the air mass.

Air masses form all the time, usually near the poles or the equator. They move across Earth, covering it like an ever-changing blanket. The map shows some of the common paths they take.

Air Masses in North America



Different Fronts



Read a Diagram

How do the air masses move in each type of front?

Clue: Compare the arrows.

Fronts

As an air mass moves, it brings weather with it. What happens when different air masses meet? Like two cars in a crash, the air masses slam into each other. The area where they meet is called a front.

A **front** is the boundary between two air masses that have different temperatures. Fronts usually cause a change in the weather.

Warm Fronts

When a warm air mass pushes into a cold air mass, a **warm front** forms. As the diagram shows, the warm air mass slides up and over the cold air mass. Layers of clouds form. The cold air retreats.

A warm front often brings light, steady rain. After the front passes, the air temperature rises.

Cold Fronts

A **cold front** forms when a cold air mass pushes under a warm air mass. The cold air mass forces the warm air mass upward quickly. Thick clouds form as the warm air rises and cools. Cold fronts often bring stormy weather.

Stationary Fronts

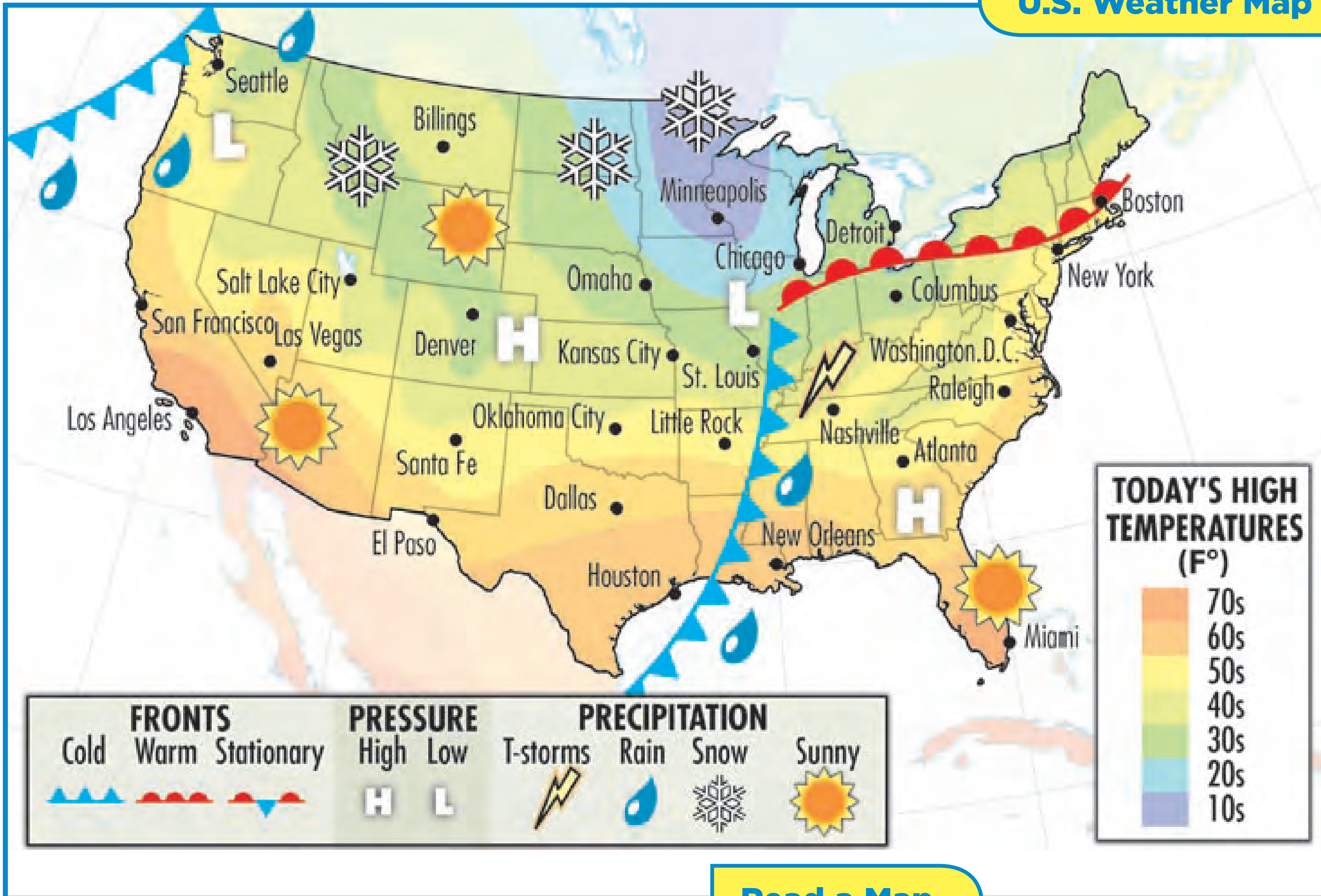
Sometimes rainy weather lasts for days. This can be caused by a stationary front. A **stationary front** is a boundary between air masses that are not moving.

Quick Check

Predict What will happen if a cold air mass pushes into a warm air mass?

Critical Thinking How do warm fronts differ from cold fronts?

U.S. Weather Map



What does a weather map show?

Every day, scientists make and share weather maps like the one above. Weather maps show weather conditions at a certain time and place. They tell about air temperature, pressure, precipitation, and winds.

Weather maps may also show the locations of fronts. The fronts appear as a line of triangles or half circles. In the map above, rain and thunderstorms have formed along the two cold fronts.

Read a Map

What does this map show about the weather in Nashville?

Clue: Use the legends to find the meanings of the colors and symbols.

Forecasting

Maps can help us answer questions. Scientists use weather maps to make forecasts. To **forecast** is to predict weather conditions.

Temperature, air pressure, and the direction of moving fronts give important clues for forecasts. Look at the map again. Do you see the cold front from St. Louis to Houston? The triangles point toward the east. Like most fronts in the United States, this one is moving from west to east. A forecast based on this map may predict a chance of rainy weather for New Orleans.

Scientists use many technologies in forecasting. Satellites in orbit around Earth take pictures of the atmosphere. Computers help scientists analyze weather data and produce better weather maps.

Quick Lab

Weather Forecast

1. Study a weather map from today's newspaper or the Internet. Compare it to maps from yesterday and the day before, if they are available.
2. **Communicate** Describe today's weather in your region and in surrounding regions.
3. **Predict** Use the weather map to predict tomorrow's weather. Explain your prediction.
4. Study the weather map tomorrow. Compare it to your prediction. How close was your forecast to the actual weather?

Quick Check

Predict How can weather maps be used to predict the weather?

Critical Thinking How likely are you to see the same cold front for several days in one place? Why?

Strong winds and lightning can make a storm dangerous!

What are the signs of severe weather?

Have you ever heard a loud clap of thunder just before a storm? Thunder is the booming sound made when lightning heats the air around it quickly. Thunder tells you that a storm is very near.

If you see a tall, swirling mass of air shaped like a funnel, take cover! It could be a tornado. A *tornado* is a rotating column of air that touches the ground during a thunderstorm. Tornadoes can reach speeds of 400 km (250 mi) per hour or more!

A *hurricane* is a very wide storm. A typical one spans about 480 km (300 mi) across. Hurricanes form over warm water in the ocean. They bring very heavy rains and strong winds. If a hurricane moves across land, it can cause severe damage.

Storm Safety

Scientists pay close attention to signs that severe storms are forming. If one appears in their forecast, they alert the government and the public.

Do you know how to stay safe in severe weather? If thunderstorms are predicted, stay away from water and trees. When tornadoes are predicted, head for a sturdy shelter, such as a basement. To avoid a hurricane, you may need to move inland.

In any storm, always listen for directions. Seek out a trusted adult if a severe storm strikes. Be sure to follow warnings on the radio and television.

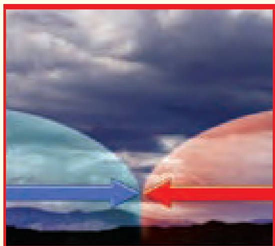
Quick Check

Predict What might happen if a hurricane strikes the land?

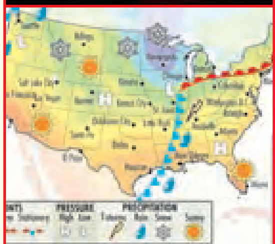
Critical Thinking Why should you stay inside during a storm?

Lesson Review

Visual Summary



When two **air masses** meet, a **front** forms between them. Fronts usually bring a change in the weather.



Scientists use weather maps to make **forecasts** about the weather to come.

It is important to know about **severe storms** so you can stay safe.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you read about tracking the weather.

Think, Talk, and Write

1. **Main Idea** How do air masses affect the weather?
2. **Vocabulary** To ________ is to predict the weather.
3. **Predict** Study today's weather map. Forecast the weather for tomorrow.

My Prediction	What Happens

4. **Critical Thinking** How can a battery-powered radio help you stay safe during a storm?
5. **Test Prep** **A storm usually forms**
   - **A** inside an air mass.
   - **B** along a front.
   - **C** over tall buildings.
   - **D** over a river.
6. **Test Prep** **Which term describes a very tall, gray, funnel shape?**
   - **A** a hurricane
   - **B** a tornado
   - **C** a cold front
   - **D** a thunderhead

Writing Link

Write a Short Essay
Write an essay about a storm that you experienced. Or ask an adult to tell you about a storm he or she remembers. Include facts about the storm and how it affected people.

Social Studies Link

History Report
Research and write a report on a severe weather event in history. If possible, write about an event in your area. Include information about how people solved problems caused by the event.

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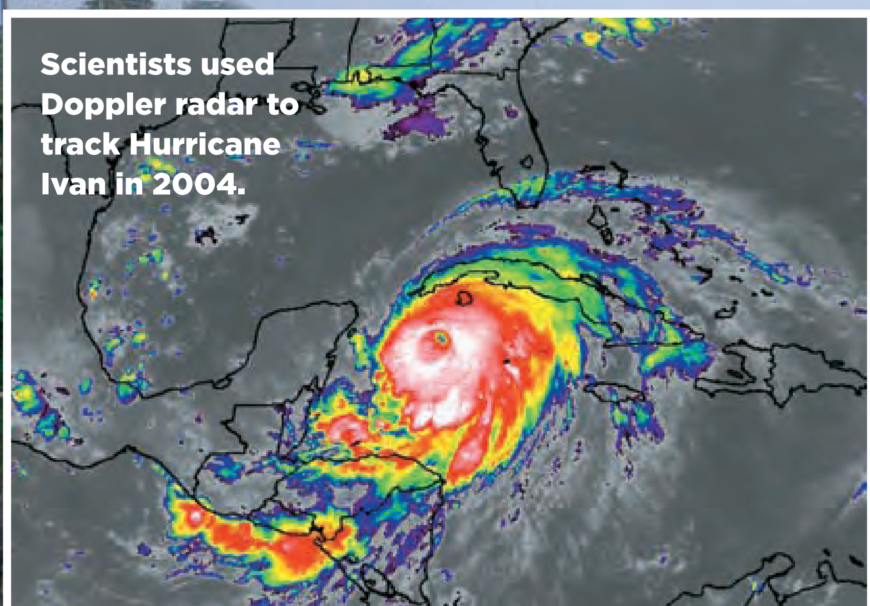
Real World Reading in Science

Hurricane Season

June is the beginning of a busy time for the National Hurricane Center in Miami, Florida. That's when hurricane season begins, and the scientists at the center are ready for action.

Hurricanes develop at sea under particular conditions. These include warm ocean water, low pressure, moist air, and light winds. They usually happen in the Atlantic and northeast Pacific Oceans from June through November. When a hurricane forms, it can bring violent winds, large waves, floods, and lots of damage.

To study a hurricane, scientists gather large amounts of data. Satellites that orbit Earth collect information about cloud patterns. They record temperatures on top of clouds and at the sea surface. Satellites also measure the direction and speed of winds above the ocean. This information helps scientists track the size, path, and intensity of a storm.

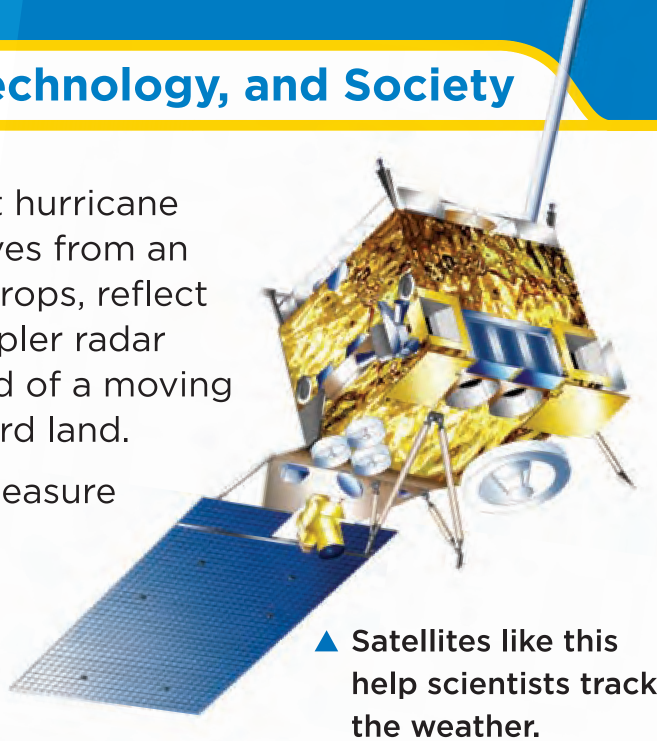


Scientists used Doppler radar to track Hurricane Ivan in 2004.

SWK-I. Differentiate fact from opinion and explain that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.

Science, Technology, and Society

Doppler radar is another tool that hurricane scientists use. It sends out radio waves from an antenna. Objects in the air, like raindrops, reflect the waves back to the antenna. Doppler radar can measure the direction and speed of a moving object, like a hurricane moving toward land.



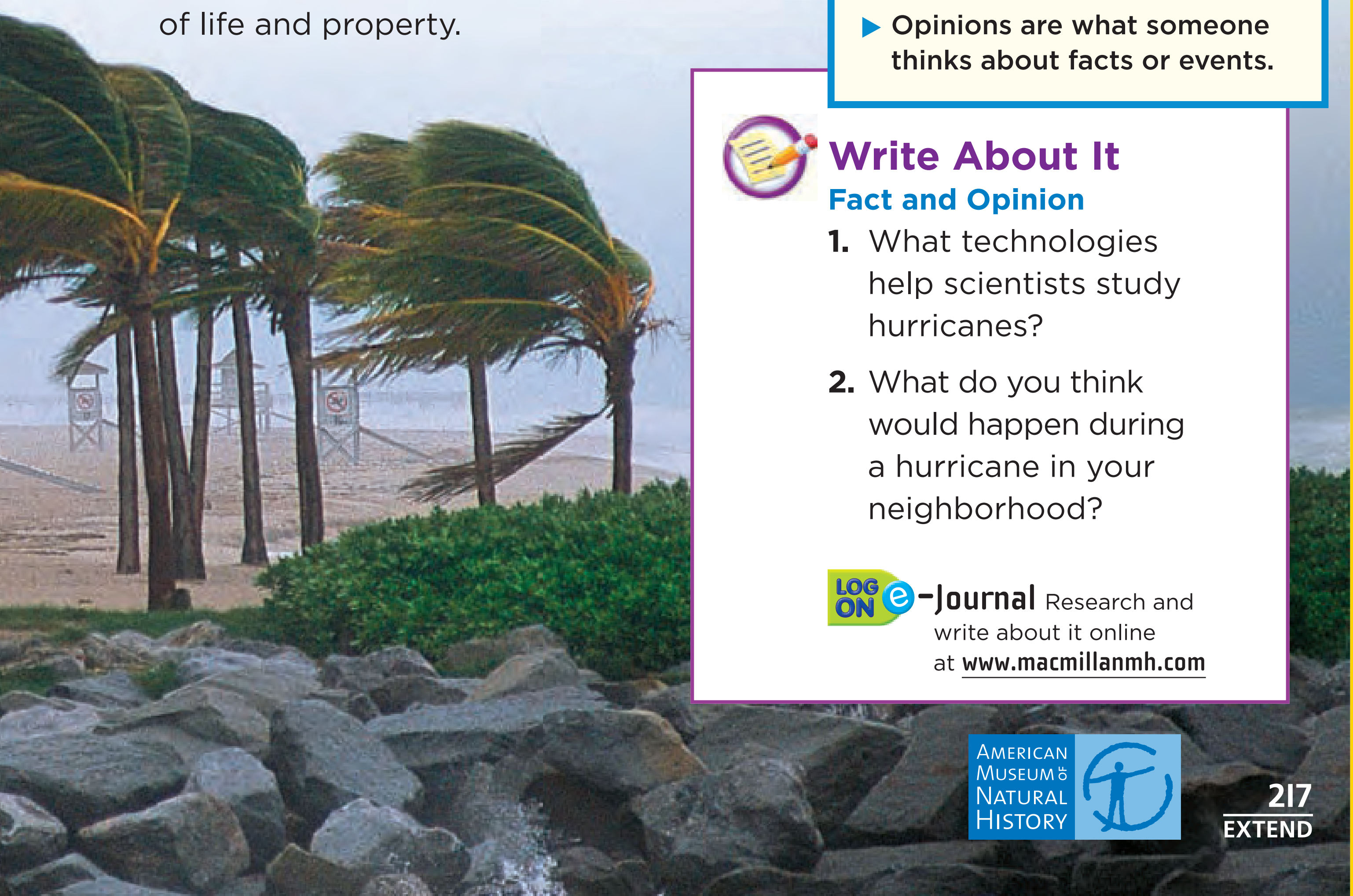
▲ Satellites like this help scientists track the weather.

Buoys spread across the ocean measure conditions like surface wind, waves, temperature, and fog. Planes fly to the center of a hurricane to gather data about wind, pressure, temperature, and humidity.

Scientists enter all of this data into supercomputers to create a model of the hurricane. This model helps them predict the wind speed, size, and direction of the hurricane, and where and when it might hit land. Accurate predictions of a hurricane's path can reduce the loss of life and property.

Fact and Opinion

- Facts tell you about something that has really happened.
- Opinions are what someone thinks about facts or events.



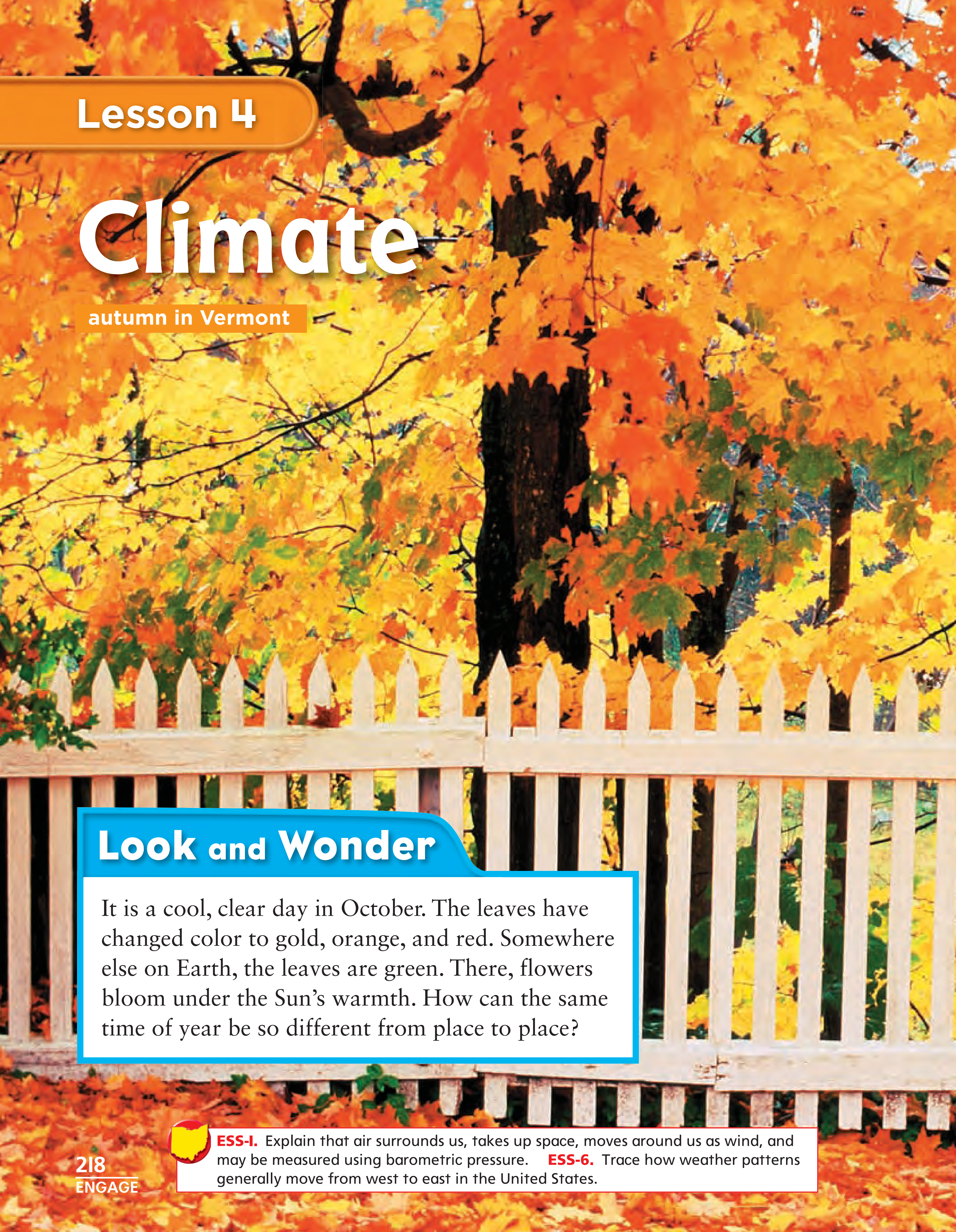
Write About It

Fact and Opinion

1. What technologies help scientists study hurricanes?
2. What do you think would happen during a hurricane in your neighborhood?

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

American Museum of Natural History



Lesson 4

Climate

autumn in Vermont

Look and Wonder

It is a cool, clear day in October. The leaves have changed color to gold, orange, and red. Somewhere else on Earth, the leaves are green. There, flowers bloom under the Sun's warmth. How can the same time of year be so different from place to place?

ESS-1. Explain that air surrounds us, takes up space, moves around us as wind, and may be measured using barometric pressure. **ESS-6.** Trace how weather patterns generally move from west to east in the United States.

Explore

Inquiry Activity

What affects weather patterns?

Purpose

Explore the factors that determine the weather patterns in different places.

Procedure

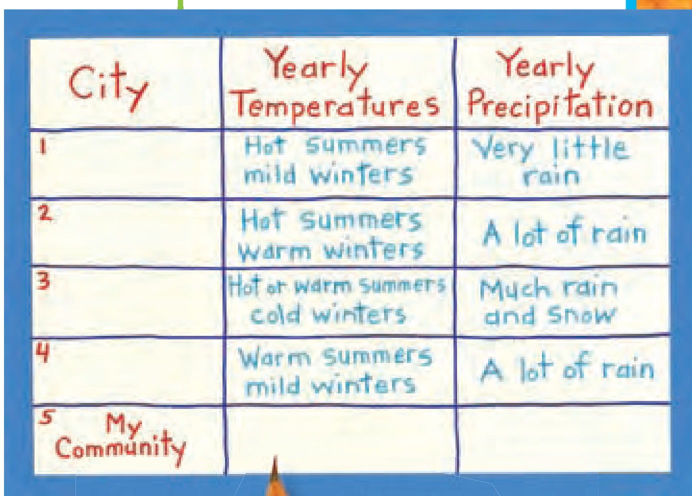
1. Locate the cities of Chicago, Miami, Phoenix, and Seattle on a map.
2. **Predict** The data table shows the yearly temperature and precipitation for these four cities. Predict where each belongs in the table.
3. **Classify** Copy the table. Research the weather patterns of the four cities. Fill in the cities where they belong.
4. Find out the yearly temperature and precipitation for the place where you live. Add this data to your table.

Draw Conclusions

5. Compare the table to your prediction in step 2. How does it compare?
6. **Interpret Data** Which cities are near oceans? How does their data compare to the other cities? Which cities are farthest south? How do they compare to the northern cities?

Materials

- paper
- markers



City	Yearly Temperatures	Yearly Precipitation
1	Hot summers mild winters	Very little rain
2	Hot summers Warm winters	A lot of rain
3	Hot or warm summers cold winters	Much rain and snow
4	Warm summers mild winters	A lot of rain
5 My Community		

Explore More

Look at today's weather map. Compare the weather in each of the four cities with your data table. Is today's weather similar to or different from yearly patterns? Can you explain any differences?

SI-6. Formulate instructions and communicate data in a manner that allows others to understand and repeat an investigation or experiment.

Read and Learn

Main Idea ESS-I, ESS-6

Climate is the weather pattern of an area. Many factors affect the different climate regions of the world.

Vocabulary

climate, p. 220

current, p. 222

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Reading Skill

Fact and Opinion

Fact	Opinion

What is climate?

The weather where you live may change from day to day. Yet you can predict what the weather will be like each season. The pattern of seasonal weather that happens year after year is called **climate** (KLYE•mit).

Climate is not the same everywhere on Earth. The city of Phoenix is in the southwest United States. The climate there is warm and dry all year. Snow and rain rarely fall. Seattle is in the northwest United States. There the climate is cool and wet.

Farmers depend on climate to grow their crops. Some crops grow well in cool climates with steady rain. Other crops need dry climates. Still others need warm, humid climates.


Canada

temperate


Antarctica

polar

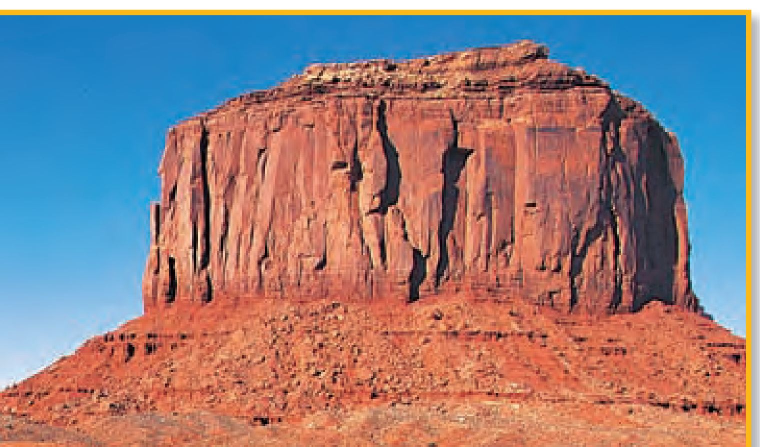

Arizona

dry

Climate Regions

Think of climate as the average weather in a certain place for a long period of time. It has similar patterns of temperature, humidity, precipitation, and wind. We can call such an area a *climate region*.

Polar regions have cold climates with low precipitation. Tropical regions are near the equator. There, the climate is warm, humid, and rainy. *Temperate* regions lie between polar and tropical regions. Temperate climates often have four seasons. Some have just two seasons—a dry one and a rainy one. Still other regions are dry or cool.



Quick Check

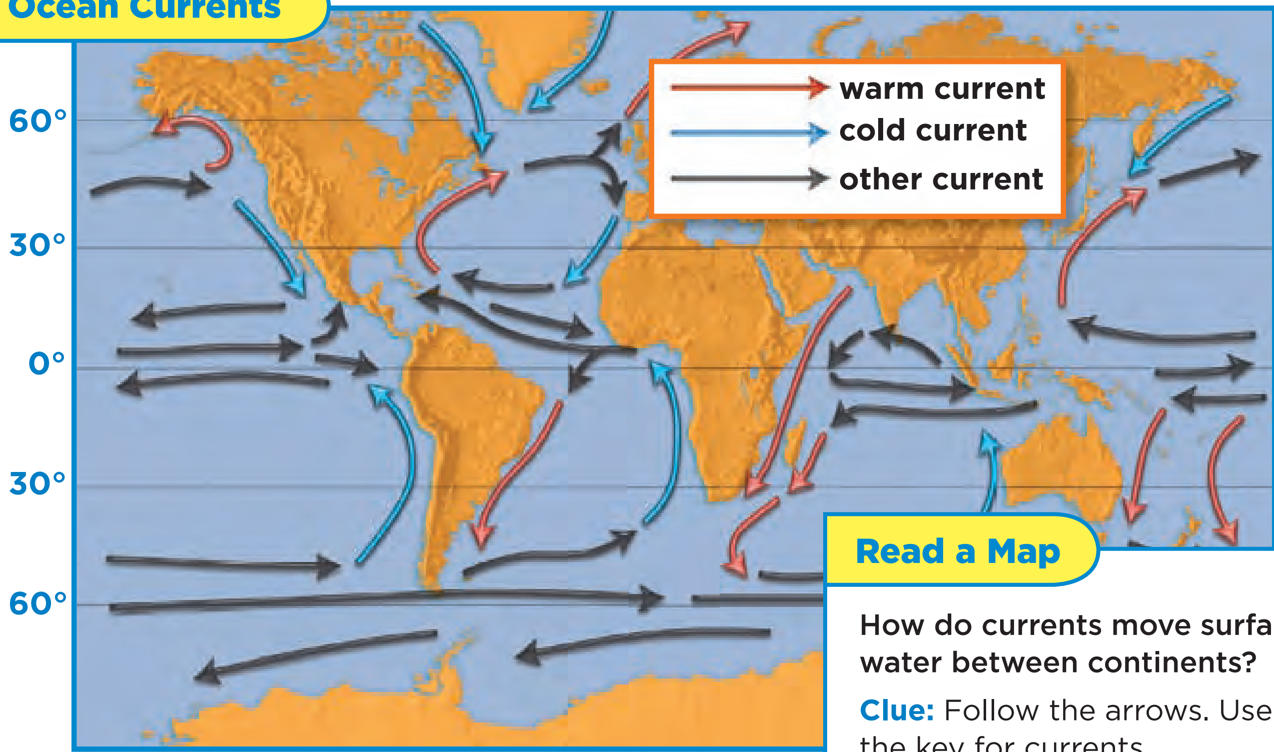
Fact and Opinion *Cool climate regions are best.* Is this statement a fact or an opinion? Explain.

Critical Thinking Describe the climate of your region.

tropical

cool

Ocean Currents



Read a Map

How do currents move surface water between continents?

Clue: Follow the arrows. Use the key for currents.

What determines climate?

Several things affect a climate region over time. These include latitude, winds, and currents.

Latitude

The thin lines that run east and west across some maps are lines of latitude. *Latitude* is a measure of how far a place is from the equator. The equator's latitude is set at zero degrees. Latitude increases as you move north or south from there. The highest latitude is at the North and South Poles. Both are 90 degrees.

Climates near the equator are warm and rainy. Between the equator and the poles, the climate is mild or temperate. Near the poles, the climate is cold all year.

Global Winds

Temperature differences between latitudes cause *global winds*. These are winds that move air between the equator and poles. Warm air near the equator rises and moves toward the poles. Cold air near the poles sinks and moves toward the equator.

Ocean Currents

A **current** is a directed flow of a gas or a liquid. Some ocean currents move warm water from the equator to the poles. Others move cold water from the poles toward the equator. There are also currents that move along lines of latitude. Together, these currents form circular patterns in the oceans.

Distance from Water

Do you like to swim at the beach in summer? You may have noticed that the water stays cool even on the hottest days. That is because water heats up more slowly than land does. Water cools more slowly, too.

Remember that more than 70 percent of Earth's surface is covered by water. Land and water heat and cool at different rates. These differences affect the air temperature and precipitation nearby.

Climates near lakes and oceans are cloudier and rainier than regions farther inland. Summers are cooler. Winters are warmer. Nearness to water reduces temperature extremes. It also increases moisture in the air.

Quick Lab

Climate in Two Cities

1. Study the data table. It shows climate information for Seattle, WA, and Fargo, ND. Locate these two cities on a map.
2. **Communicate** Describe the climates of the two cities. How do the climates compare?
3. **Infer** What factor best explains the differences between the two climates? Why do you think so?

Month	Property	Seattle	Fargo
July	high temperature	75°F	83°F
July	precipitation	19 mm	69 mm
December	high temperature	45°F	20°F
December	precipitation	150 mm	17 mm

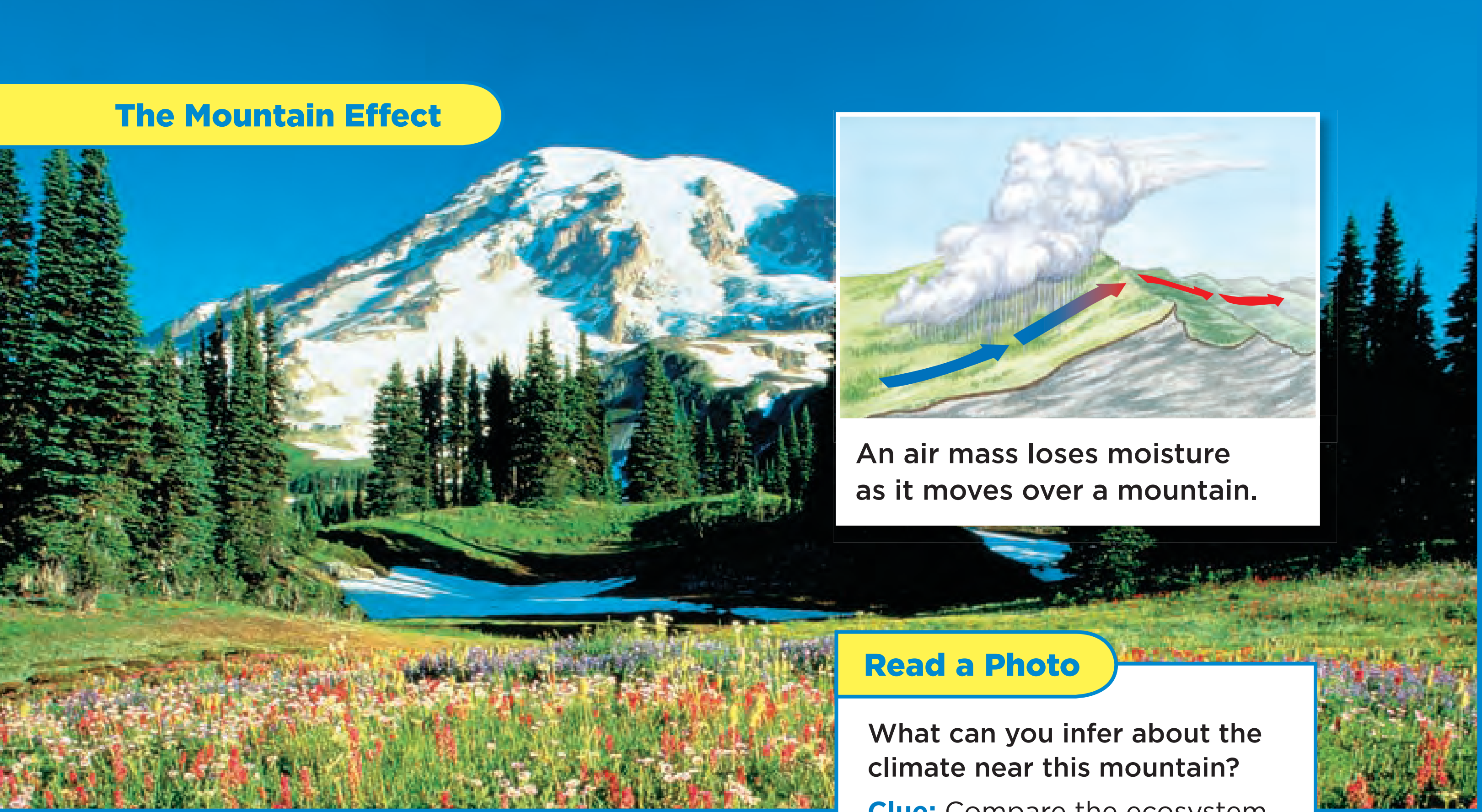
Quick Check

Fact and Opinion *The equator has a warm climate.* Is this statement a fact or an opinion? Explain.

Critical Thinking What kinds of evidence might sailors in the past have used to learn about currents?

Indiana is an inland state. Winters there are cold and snowy.

The Mountain Effect



An air mass loses moisture as it moves over a mountain.

Read a Photo

What can you infer about the climate near this mountain?

Clue: Compare the ecosystem at the base of the mountain to its peak.

How do mountains affect climate?

Latitude, water,and winds are not the only factors that affect climate. Mountains also have an effect.

Altitude

Climate at the base of a mountain is always warmer than at its peak. The higher the altitude, the lower the air temperature. *Altitude* is a measure of the height of a place above sea level.

What happens when an air mass meets a mountain? The air rises up the side of the mountain. As the altitude gets higher, temperature gets cooler. Water vapor in the air condenses into clouds.

Clouds and Precipitation

As a cloud moves up a mountain, its water droplets get heavy. Precipitation falls. By the time the air mass passes over the mountain, the air is dry. For this reason, the climate on one side of a mountain tends to be wet. The climate on the other side is often dry.

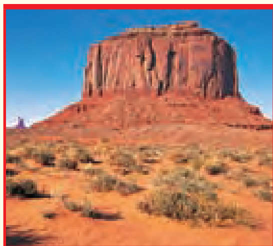
Quick Check

Fact and Opinion State one fact and one opinion about mountains and climate.

Critical Thinking How can a mountain "dry out" the air?

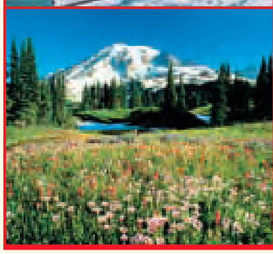
Lesson Review

Visual Summary



Climate regions have regular patterns of air temperature, humidity, precipitation, and wind.

Factors that affect climate are latitude, global winds, ocean currents, and distance from oceans and lakes.



Altitude affects **mountain climates**. The air temperature gets lower as you move up a mountain.

Make a FOLDABLES™ Study Guide

Make a Trifold Chart. Use it to summarize what you read about climate.

Think, Talk, and Write

1. **Main Idea** What factors affect the climate of a region?

2. **Vocabulary** Ocean ________ move heat from one place to another.

3. **Fact and Opinion** Choose a climate. Why would you enjoy living in this climate? Why would you not enjoy this climate? Include facts from this lesson.

Fact	Opinion

4. **Critical Thinking** How is climate different from weather?

5. **Test Prep** **Latitude is a measure of distance from ________**
   - **A** an air mass.
   - **B** an ocean current.
   - **C** a mountain.
   - **D** the equator.

6. **Test Prep** **Where is altitude highest?**
   - **A** on a mountaintop
   - **B** at the base of a mountain
   - **C** at sea level
   - **D** in a valley

Math Link

Find the Average Temperature
For five years, a weather station recorded high temperatures of 86°F, 89°F, 90°F, 92°F, and 88°F for the same date. What was the average for that date over the five years?

Social Studies Link

Learn About Climate
Choose another country or region. Research and report on its climate. Show how climate affects the people who live there. Find out about the crops they grow.

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Be a Scientist

Materials

paper

scissors

string

heat source

Structured Inquiry

How does warmed air affect the weather?

Form a Hypothesis

Large masses of warm air can affect the climate of a region. You can model how warm air moves. What do you think will happen if you hold a spiral of paper over a heat source? Write your hypothesis in the form "If the air warms, then the paper spiral will ..."

Test Your Hypothesis

1. ⚠ **Be Careful.** Cut a circle of paper to form a spiral.
2. Tie a piece of string to one end of the paper.
3. Have your teacher turn on a heat source, such as a lamp. Carefully hold or hang the spiral about 15 centimeters above the heat source.
4. **Observe** Describe what the spiral does.
5. While holding the spiral above the heat source, turn the heat off. Describe what happens to the spiral.

Step 1

Step 2

Draw Conclusions

6. Was your hypothesis correct? How did the paper spiral move when it was heated?
7. **Communicate** What happened to the paper spiral when you turned the heat off? How can you explain this?
8. **Infer** What happens to air over ground that is warmed throughout the day?

Guided Inquiry

Which type of land changes temperature fastest?

Form a Hypothesis

Air is warmed by heat released from the land or water. Of soil, sand, or rock, which type of land holds heat longest? Write your answer in the form of a hypothesis.

Test Your Hypothesis

Design an investigation to find out which type of land holds heat longest. Write out the materials you will need and the steps you will follow. Record your results and observations.

Draw Conclusions

Did your results support your hypothesis? Why or why not?

Open Inquiry

What else would you like to learn about air, heat, and climate? Design an investigation to answer your question. Your investigation must be written so that another group can repeat the investigation by following your instructions.

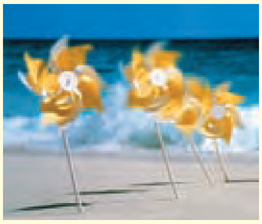
Remember to follow the steps of the scientific process.

Ask a Question
↓
Form a Hypothesis
↓
Test Your Hypothesis
↓
Draw Conclusions

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

CHAPTER 4 Review

Visual Summary



Lesson 1 Scientists measure the properties of Earth's atmosphere to describe weather.

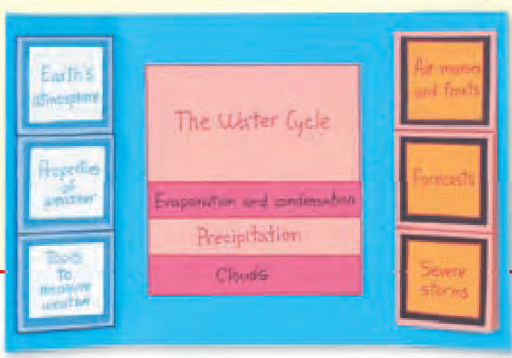
Lesson 2 Water changes state as it moves between Earth's surface and atmosphere.

Lesson 3 We can predict the weather by observing air masses and fronts.

Lesson 4 Climate is the pattern of seasonal weather in a region. Latitude and other factors affect climate.

Make a FOLDABLES™ Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.



Vocabulary

Fill each blank with the best term from the list.

air mass, p. 210

atmosphere, p. 188

climate, p. 220

condensation, p. 199

current, p. 222

evaporation, p. 198

front, p. 211

humidity, p. 190

1. During the process of ________, a liquid changes slowly into a gas.
ESS-3

2. A large region of air with nearly the same temperature and water vapor throughout is called a(n) ________.
ESS-I

3. The blanket of air surrounding Earth is called the ________.
ESS-I

4. The pattern of seasonal weather in a region over many years is called ________.
ESS-D

5. A measurement of the amount of water vapor in the air is ________.
ESS-4

6. A directed flow of a gas or liquid is called a(n) ________.
ESS-6

7. A boundary between two air masses that have different temperatures is called a(n) ________.
ESS-D

8. A gas changes to a liquid during ________.
ESS-3

Skills and Concepts

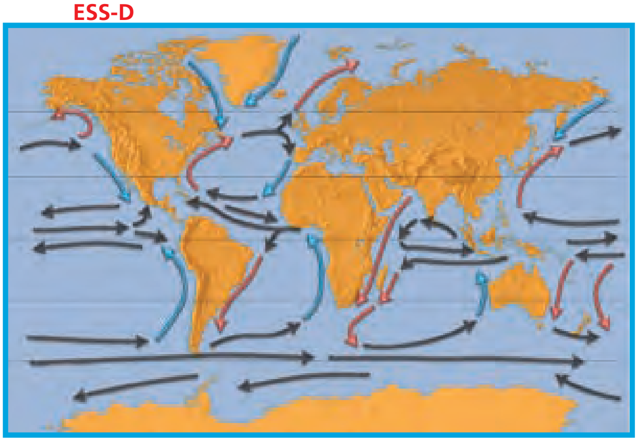
Answer each of the following in complete sentences.

9. **Summarize** Describe the different kinds of fronts.
ESS-D

10. **Make a Model** Construct a simple rain gauge. On an index card, write a short explanation of how it works.
ESS-4

11. **Critical Thinking** A mountain climber goes up a tall peak. At what point in the climb would you expect the air pressure to be the strongest?
ESS-I

12. **Expository Writing** Write a paragraph describing the impact of oceans on climate.
ESS-D



13. **Sequence** What happens to water in a lake during the year?
ESS-3

The Big Idea

14. What are weather and climate?
ESS-D

Performance Assessment

Weather Words

1. Observe the weather at three different points during the day—morning, afternoon, and evening. Write a description of what you observe at each time of the day.

2. Look at a weather report on the Internet or on television later that evening. Create a chart comparing your weather observations to those of weather forecasters.

Analyze Your Results

Write a paragraph analyzing your results. How well did your weather observations compare to published reports? How would you explain any differences?

Ohio Activity

In Ohio tornadoes have caused great damage. Write a personal narrative describing how you and your family would respond to a tornado warning. Where in your home would you go? Would you need any special supplies?

Ohio Benchmark Practice

1 **Which instrument measures wind speed?**

A a wind vane

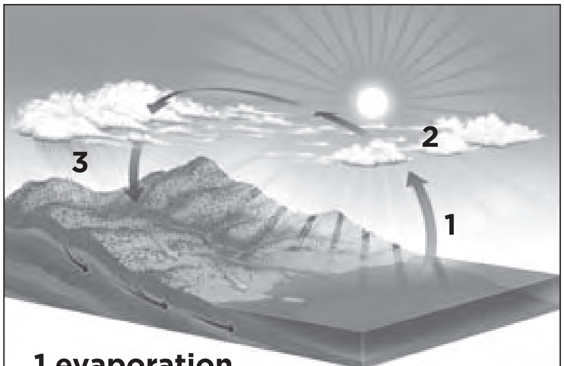
B a barometer

C a hygrometer

D an anemometer

ESS-D, ESS-I

2 **The picture shows the processes involved in the water cycle.**



1 evaporation

2 condensation

3 precipitation

What happens after water condenses in the atmosphere?

A It turns to gas.

B It falls to Earth as precipitation.

C It flows to the sea as runoff.

D It evaporates in the atmosphere.

ESS-D, ESS-3

3 **In your Answer Document, describe or draw two factors that influence the climate of a region.**

Be sure to label any drawings. (2 points)

SI-5

4 **What determines whether a storm is a hurricane?**

A amount of precipitation

B wind direction

C wind speed

D location of origin

ESS-D, ESS-4

5 **What the air is like at a certain time and place describes**

A air pressure.

B atmosphere.

C weather.

D temperature.

ESS-D

6 **If you could tell your friend the average temperature and precipitation of your city or town, what are you talking about?**

A the weather

B the seasons

C the Sun's rays

D the climate

ESS-D

7 This table summarizes the weather in an Ohio city during a week in May.

Monday	steady rain/high 76°F
Tuesday	light showers/high 81°F
Wednesday	clear skies/high 82°F
Thursday	severe storms/ early high 79°F
Friday	clear skies/high 64°F

Based on the table, on which day did a cold front move in?

A Monday

B Wednesday

C Thursday

D Friday

SWK-B

8 In April, a hygrometer measured 31 percent. In August, it measured 78 percent. What change does this indicate?

A an increase in humidity

B an increase in temperature

C a decrease in wind speed

D a decrease in air pressure

ESS-D, ESS-5

9 If sleet falls, what can you infer?

A The air outside the cloud is freezing.

B A thunderstorm is occurring.

C The ice in a cloud became too heavy and fell.

D Air temperatures are above freezing.

ESS-D

10 A barometer measures

A temperature.

B wind speed.

C humidity.

D air pressure.

ESS-D

11 Condensation of water vapor onto dust particles in the atmosphere forms

A dew.

B runoff.

C clouds.

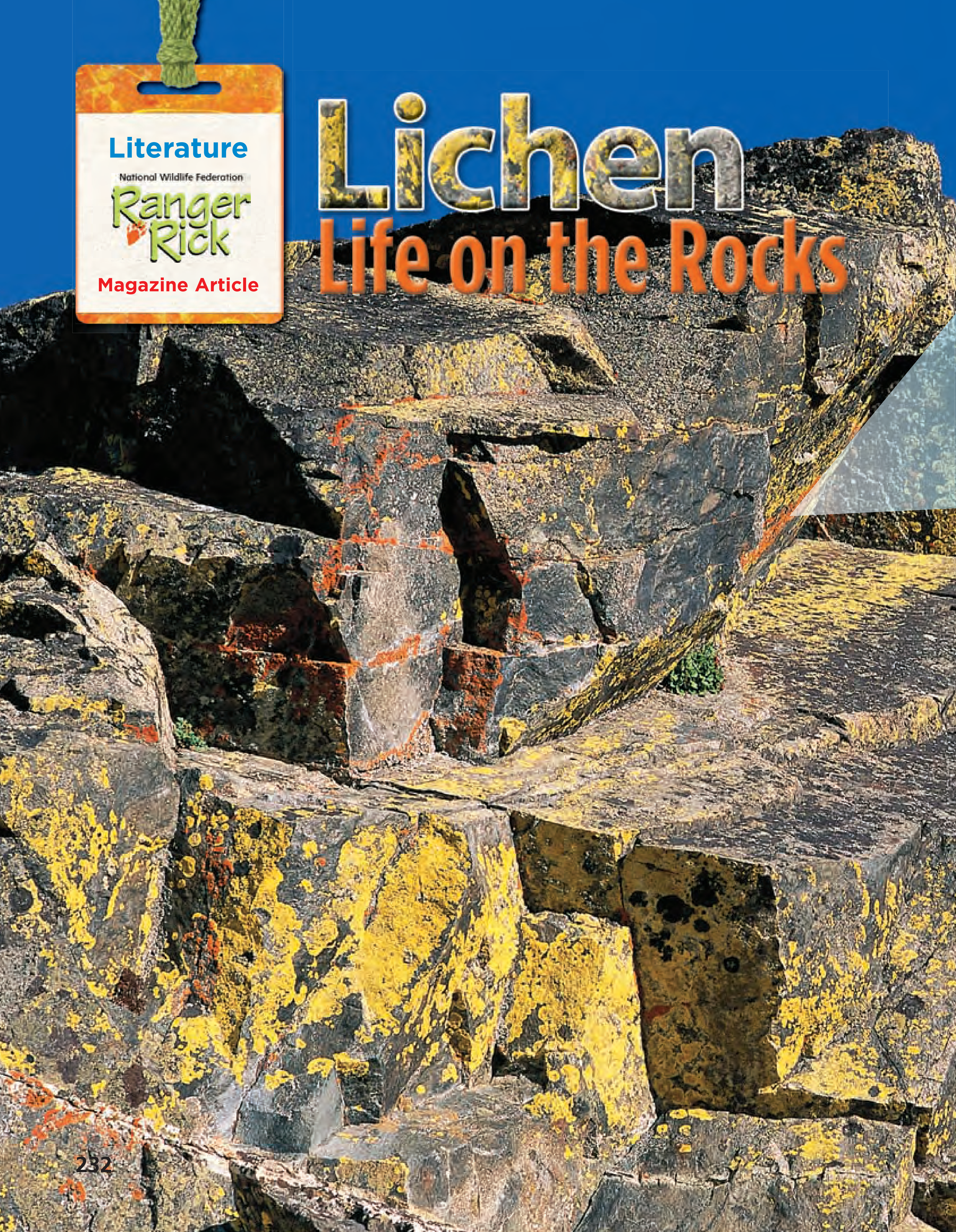
D hail.

ESS-D, ESS-2

12 There are three main cloud types.

In your **Answer Document**, name one cloud type and identify the weather that accompanies it. (2 points)

ESS-D, ESS-7



Literature

National Wildlife Federation

Ranger Rick

Magazine Article

Lichen
Life on the Rocks

Lichen (LY•kuhn) is not one thing but two. It is a team effort. Half the team is an alga. Algae are tiny green protists. They use sunlight to make their own food. The other team member is a fungus. Fungi are living things that often grow and feed on dead things. They help to break down dead things and recycle them. Mushrooms are one type of fungus.

Some lichen are crusty and flat and grow on a rock's surface. Others are leafy and often grow on tree bark. Still other lichens are thick branching ones, such as reindeer moss, that grow in clumps on the ground.

In a lichen, each partner helps out the other. The alga makes food for both of them. The fungus provides a "house" that protects the alga from drying out in sunlight. Lichens are able to live in places where few other living things can. Lichens, for example, are often the first things to grow on bare rock.

The lichen forms a crust on the rock. It grows very slowly and begins to break down the rock. Acids it gives off form tiny cracks in the rock. Water fills the tiny cracks and, when the water freezes, causes the cracks to widen. Over time, blowing bits of soil get caught in the lichen. Plant seeds may take root. After many years, the rock is covered with soil and plants. This all starts with fungi and algae!

Write About It

Response to Literature This article tells you that lichen is not one thing but two. What are the two parts of a lichen? How can a lichen change rocks? Write a summary. Use your own words to explain what this article is about.

LOG ON e-Journal Write about it online at www.macmillanmh.com

Survey Technician

How can you find out exactly where your front yard ends and your neighbor's begins? You need the help of a survey technician! Survey technicians use certain instruments to find the borders of lands. They help plan where new roads, bridges, and homes are built.

To join a surveying crew, you will probably need a technical degree in surveying. You will also need a steady hand and strong math skills. Computer skills are especially useful.

▲ Surveyors use high-tech tools to measure land area.

Geologist

If you are curious about planet Earth, you may want to become a geologist. Geologists are also called Earth scientists.

Not all geologists study rocks. Some work with businesses to locate oil or other resources in the ground. Others study earthquakes or volcanoes. Geologists also look at how Earth has changed over time. They make predictions about the future.

To be a geologist, you need a college degree. Most geologists go to school for several more years after college. If you want to be a real "rock hound," you'd better bone up on science!

▲ Geologists who study volcanoes wear thermal suits for protection.

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Ohio

Physical Sciences

Heat can change sand and minerals into glass!

worker making glass in a factory

Riverfest Labor Day Festival

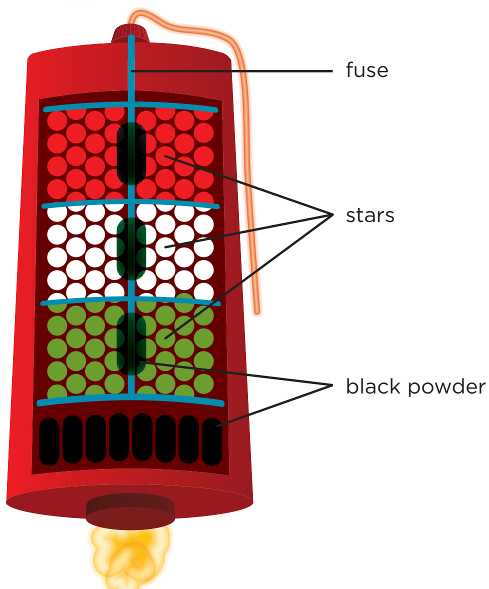
the Cincinnati skyline

Oohs, Ahhhs, and Booms

Every Labor Day weekend the city of Cincinnati hosts Riverfest. The highlight of this festival is the fireworks show, one of the largest pyrotechnics (pigh•roh•TEK•niks) displays in the United States. Pyrotechnics refers to the science and technology of fireworks.

Pyrotechnics

The fireworks we see at events like Riverfest are called *aerial* (AYR•ee•ool) *shells*. Aerial shells contain black powder that reacts explosively like gunpowder. The explosion propels the aerial shell upward.



an aerial shell

Ohio

A CLOSER LOOK

Main Idea

The colors in aerial shell fireworks come from the burning of different types of metals.

Activity

Communicate Conduct research about the history of fireworks.

- Where and when were fireworks first used?
- How have modern fireworks changed since then?
- Communicate your findings to your classmates.

Aerial shells also contain small pellets of metal-containing chemicals called *stars*. The metal in a star determines the color it burns. For example strontium makes a red flame. Copper produces a blue flame. Magnesium burns white.

Fireworks experts, called pyrotechnicians, make aerial shells. They determine the size, number, and type of stars and how much black powder to use. They also select the exact length of fuse needed so the stars will burst at different heights.

Think, Talk, and Write

Critical Thinking What metals are in the aerial shell diagram? Explain.

PS-2. Identify characteristics of a simple chemical change. When a new material is made by combining two or more materials, it has chemical properties that are different from the original materials (e.g., burning paper, vinegar and baking soda).

Ohio Challenge Festival

hot air balloon inflating

balloon glow at night

Hot Air Balloons

In southwest Ohio, Middletown is home to the Ohio Challenge Hot Air Balloon Festival. The festival is a weekend event full of things to see and do. The main attraction of the festival is the hot air balloons.

The best hot air balloon pilots come to compete at this festival. Pilots show their skills by trying to land their balloons on targets. In the evening the balloons stay on the ground. The pilots turn on their burners, sending flames up into the balloons. This makes the colorful balloons light up. This is called a balloon glow.

Floating in the Sky

A hot air balloon consists of a balloon, a burner, and a basket. The pilot rides in the basket and controls the burner.

The flames from the burner heat the air inside the balloon. This causes the air inside the balloon to be warmer than the surrounding air. The warm air expands. This makes the air inside the balloon less dense than the air outside the balloon. This means the air particles inside the balloon are spaced farther apart than the outside air particles. The balloon begins to rise.

Think, Talk, and Write

Critical Thinking What makes a hot air balloon rise?

PS-4 Explain that matter has different states (e.g., solid, liquid and gas) and that each state has distinct physical properties.

Ohio

A CLOSER LOOK

Main Idea

As air is heated it becomes less dense than the air around it. This causes the air to rise.

Activity

Form a Hypothesis How do pilots get their balloons to land?

- What direction will the balloon move if the burner is on?
- What direction will the balloon move if the burner is left off?

CHAPTER 5

Properties of Matter

The Big Idea

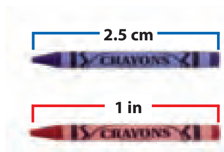
What is matter and how is it classified?

Beads in a Paris flea market

Key Vocabulary

matter
anything that has mass and takes up space (p. 244)

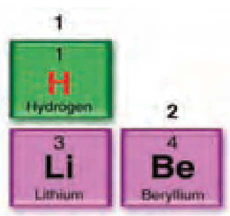
mass
the amount of matter making up an object (p. 244)



length
the number of units that fit along one edge of an object (p. 255)

element
a substance that is made up of only one type of matter (p. 264)

metal
any of a group of elements found in the ground that conducts heat and electricity (p. 265)



periodic table
a chart that shows the elements classified by properties (p. 266)

More Vocabulary

property, p. 244

volume, p. 245

buoyancy, p. 245

solid, p. 246

liquid, p. 246

gas, p. 247

metric system, p. 254

area, p. 255

density, p. 256

weight, p. 258

gravity, p. 258

atom, p. 264

PS-B. Identify and describe the physical properties of matter in its various states.

Lesson 1

Describing Matter

frozen water on holly berries

Look and Wonder

In winter, rain can freeze to ice. The warmth of spring melts the ice. How can you tell the difference between rainwater and ice?

Building block lesson for PS-B. Identify and describe the physical properties of matter in its various states. **PS-3.** Describe objects by the properties of the materials from which they are made.... **PS-4.** Explain that matter has different states....

Explore

Inquiry Activity

How can you tell if something is a solid or a liquid?

Make a Prediction

What is a solid? A liquid? Write a definition of each. If you mix cornstarch and water, will you have a solid or a liquid? Record your prediction.

Test Your Prediction

1. Pour the cornstarch and water into the bowl.
2. Use your fingers to mix the cornstarch and water together.
3. **Observe** Use your senses to observe the new substance. How does it feel? What does it look like? Record your description.
4. Tap the surface of the substance with your finger. Does it splash out of the bowl?
5. Place a small object such as a penny on the surface. Does it stay on top or sink?

Draw Conclusions

6. **Interpret Data** Compare your observations to your definitions. How is the new substance like a solid? How is it like a liquid?
7. **Infer** Is the mixture of cornstarch and water a solid or a liquid? Explain.
8. Do your results support your prediction? Why or why not?

Explore More

What would happen to this substance if you added more water? What if you let it dry out overnight? Make a prediction. Try it! Then report your results.

Materials

- 250 g cornstarch
- 200 mL water
- bowl
- penny
- paper towels

Step 3

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea PS-B, PS-3, PS-4

Matter can be described by its properties, including mass, volume, and state.

Vocabulary

matter, p. 244
property, p. 244
mass, p. 244
volume, p. 245
buoyancy, p. 245
solid, p. 246
liquid, p. 246
gas, p. 247

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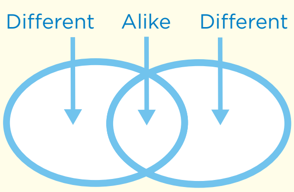
Reading Skill

Compare and Contrast



What is matter?

When you mix cornstarch and water, you get a thick gooey substance. You can see and touch it. It takes up space in the container. Like many things, this substance is matter. **Matter** is anything that has mass and takes up space.

Most things are made of matter. The air you breathe and the book you are reading are made of matter. Light and heat are not matter, however. They do not take up space.

One way to describe matter is by its properties (PROP•uhr•teez). A **property** is a characteristic that you can observe. Color, shape, and size are some properties of matter.

Matter Has Mass

One very important property of matter is mass. **Mass** is the amount of matter making up an object. Mass is often measured in units called *grams* (g) or *kilograms* (kg). To measure mass, you use a tool called a *balance* (BAL•uhns).

Comparing Masses

Read a Photo

Which has more mass—the rock or the feather? How can you tell?

Clue: Which side of the balance is lower?

Matter Has Volume

Another property of matter is volume (VOL•yewm). **Volume** is how much space an object takes up. We measure volume by counting the number of cubes that can fit in an object. We can also measure volume with tools like graduated cylinders.

Some Properties Are Unseen

Properties that cannot be seen can still be measured. Take magnetism, for example. This is the ability of matter to attract certain metal objects.

Another unseen property is the ability of matter to dissolve in a liquid. When a substance *dissolves*, it blends in and seems to disappear. Sugar and salt will dissolve in water. Sand will not.

Useful Properties

Properties help people choose the right kinds of matter for different jobs. When strength is needed, iron is a good choice. Wood is better when you need a light material that can easily be shaped.

Buoyancy (BOY•uhn•see) is a property that helps us build boats. **Buoyancy** is the upward force of a liquid or gas on an object. All objects are buoyant. Some objects are so buoyant that they float.

Magnetism is a property of matter. ▶

▲ Salt dissolves in water.

Sand does not dissolve in water. ▼

◀ Some objects can float in water. Other objects sink.

Quick Check

Compare and Contrast How are mass and volume alike? How are they different?

Critical Thinking How do you know that your desk is matter?

What are the states of matter?

Matter is found in many forms. We call these forms *states*. Solid, liquid, and gas are the three common states of matter on Earth.

Solids

A **solid** has a definite shape and takes up a definite amount of space. The particles of matter in a solid are packed together tightly. Often the particles are packed in a regular pattern. This textbook and your desk are solids. What other solids can you name?

This musical instrument is a solid. Its particles are packed closely together.

Juice is a liquid. Its particles are less tightly packed as those in a solid. They can move past one another.

Liquids

Orange juice is a liquid. Unlike a solid, a **liquid** does not have a definite shape. It takes the shape of its container. However, a liquid does take up a definite amount of space.

Consider a glass of juice. The juice has the same volume whether it is in a glass or a graduated cylinder. If the juice spills, it will spread out. Its volume stays the same.

In a liquid, the particles of matter can move more than they do in a solid. The particles can change place and slide past one another. They are farther apart than in a solid.

Water, milk, and oil are all liquids. What other liquids can you name?

Gases

Helium (HEE•lee•uhm) is an example of a gas. A **gas** does not have a definite shape. In that way it is like a liquid.

Unlike a liquid, a gas does not take up a definite amount of space. It fills the shape and space of its container. The helium in a balloon takes the shape of the balloon. If the balloon bursts, the helium will spread out into the air.

In a gas, the particles of matter move about freely. The particles move farther apart from one another to fill the space around them. If there is less space to fill, the particles are closer together. A gas always spreads out to fill its container.

Quick Lab

States of Matter

1. Place several ice cubes in a pan. What state do they represent?

2. **Observe** Look at the ice cubes after 30 minutes. Now what states are represented?
3. Have your teacher heat the pan.
4. **Observe** What states do you see after the pan is heated?

Inside these balloons is a gas. Gas particles move about freely and spread far apart.

Quick Check

Compare and Contrast How are solids, liquids, and gases the same? How are they different?

Critical Thinking A cornstarch and water mixture has both liquid and solid properties. How would you classify it?

FACT The particles that make up solids do move.

Uses of Matter

Objects Made by People

Objects in Nature

Read a Photo

How are these objects classified? How else could you sort them?

Clue: Think of the properties of each object.

What happens to the matter we use?

You use matter all the time. The food you eat is matter. Your chair is matter. You even breathe matter!

Some matter, like air, can be used again and again. Other forms of matter get thrown away. Too often, matter becomes trash. It goes into landfills or oceans.

Many people choose to *reuse* matter. This is when you use something again instead of throwing it away. An egg carton can be used to plant seeds. Are there other uses for things you throw away?

Matter can also be *recycled*, or made into something else. Cans, paper, plastic, and glass can all be recycled. What else can you recycle?

Quick Check

Compare and Contrast What is the difference between using matter and reusing matter?

Critical Thinking How many uses can you think of for a milk carton? List them.

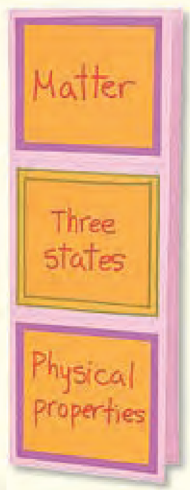
Lesson Review

Visual Summary

	All **matter** has mass. Other properties of matter include volume, magnetism, and buoyancy.
	The **three states** of matter are solid, liquid, and gas. Each has particles with different **physical properties**.
	People use matter in many different ways. People can also reuse matter.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you learned about describing matter.

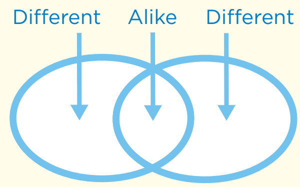


Think, Talk, and Write

1. **Main Idea** What are some properties of matter?

2. **Vocabulary** Solid, liquid, and gas are three ________ of matter.

3. **Compare and Contrast** Choose two states of matter. How are they alike? How are they different?



4. **Critical Thinking** Look around your school or classroom. List examples of solids, liquids, and gases.

5. **Test Prep** **Which of the following is matter?**

   A heat
   B sound
   C air
   D light

Writing Link

Write a Paragraph
Choose an object from around your classroom or home. Make a list of its properties. Write a short paragraph describing those properties. How do they make the object useful?

Math Link

Measure Water
Joel wants to empty a gallon of water into jars. He has jars that hold one quart and jars that hold two quarts. What combinations of jars can he use to empty all four quarts of the gallon?

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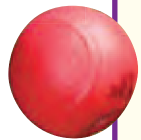
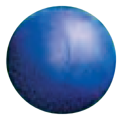
Juggling Matter



You've seen jugglers throwing balls into the air and catching them. Usually, the balls weigh about six ounces. They range in size from two to three inches in diameter. Most of the balls fit in the palm of your hand. They may be soft so they do not cause any harm. Most juggling balls bounce. They are often brightly colored so that the audience can see them.



Some jugglers use bowling balls. Bowling balls are larger than juggling balls. They're also a lot heavier. A bowling ball can weigh up to sixteen pounds! Most are about eight or nine inches in diameter. Only professional jugglers should ever juggle bowling balls!

Descriptive Writing

Good descriptive writing

- tells how things look, sound, smell, taste, and feel
- uses details to compare and contrast

Write About It

Descriptive Writing

Choose three or four objects to describe. For example, you might choose a child's toy, your pet's toy, and a backpack. Write a paragraph describing them. Include the properties that make these objects useful to you.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

Math in Science

Taking Up Space

Volume is the amount of space that something takes up. Tools like measuring cups and beakers make it easy to find the volume of a liquid. You probably use measuring cups at home to add milk or water to a recipe. How can you find the volume of a solid?

To find the volume of a solid, you first take its measurements. Then, you make a calculation. For a rectangular solid, you measure its length, width, and height. Then, you multiply those numbers together.

Let's look at an example. A box measures 30 cm in length, 20 cm in width, and 10 cm in height. To find its volume, just multiply the numbers.

Calculating Volume

- **The volume (V) of a rectangular object is the product of its length (l), width (w), and height (h). Another way of stating this relationship is: $V = l \times w \times h$**
- **In the example, $V = 30 \text{ cm} \times 20 \text{ cm} \times 10 \text{ cm}$, so $V = 6{,}000 \text{ cm}^3$**
- **What is a cm^3? It is a unit of volume called a cubic centimeter. One cm^3 is a cube with sides that are each 1 cm long. Six thousand of them would fit in a box with the measurements above.**

1


2


3


Solve It

Calculate the volumes of the objects shown.

1. length = 6 cm, width = 4 cm, height = 2 cm

2. length = 31 cm, width = 18 cm, height = 11 cm

3. length = 5 cm, width = 25 cm, height = 38 cm

M M-3. Identify and select appropriate units to measure ... volume–cubes (cubic inches or cubic centimeters).

Lesson 2

Measurement

Look and Wonder

Building a house is no simple task. It takes planning. Every material that is used for the house must be measured. How does a builder make all those measurements?

SI-I. Select the appropriate tools ... to measure and record length, weight, volume, temperature and area in metric and English units. **PS-3.** Describe objects by the properties of the materials from which they are made....

Explore

Inquiry Activity

How can you compare matter?

Make a Prediction

Look at shapes *A*, *B*, and *C*. Predict how you can use the ruler to determine the largest and smallest shapes. Record your prediction.

Test Your Prediction

1. **Measure** Use the ruler to draw one-inch squares on shapes *A* and *B*. Draw as many as you can fit. If you reach the edge, make a partial square.
2. **Use Numbers** Look at shapes *A* and *B*. How will you use the squares you drew to determine which shape is largest? Smallest?
3. **Observe** Repeat step 1 on shape *C*. Compare the three shapes again. Record your observations.

Draw Conclusions

4. Which shape is the largest? Smallest?
5. **Communicate** How did you use the one-inch squares to compare the shapes?
6. Was your prediction correct? Explain.

Explore More

Can you use a different measuring tool to compare shapes *A*, *B*, and *C*? Make a prediction. Then try it.

Materials

- 3 shapes labeled *A*, *B*, and *C*
- ruler
- pencil

Step 1

Step 3

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Read and Learn

Main Idea SI-I, PS-3

Matter can be measured in standard units of length, area, volume, mass, density, and weight.

Vocabulary

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Problem and Solution

Problem
↓
Steps to Solution
↓
Solution

How do we measure matter?

Measuring and counting squares is one way to compare size. When we measure, we use *standard units*. A standard unit is a measurement on which people agree. Many people in the United States use standard units in the English system. The inch (in.), pound (lb), and ounce (oz) are standard units in that system.

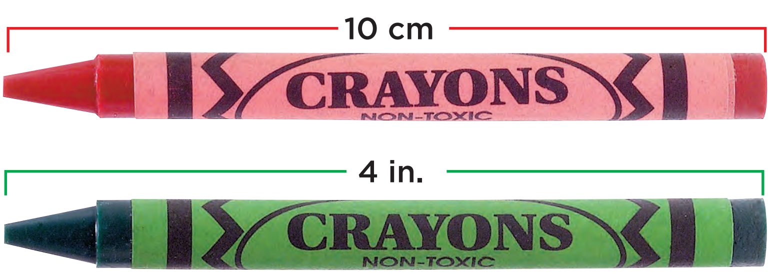
Scientists use standard metric units. The **metric system** is based on units of ten. It uses prefixes such as *kilo-*, *centi-*, and *milli-* to define the size of measurements. For example, 1 meter (m) is divided into 100 centimeters (cm). There are 1,000 meters in a kilometer (km).

Metric Units	Amount	Estimated Length
1 centimeter (cm)	$\frac{1}{100}$ of a meter	the width of your thumbnail
1 decimeter (dm)	10 cm $\frac{1}{10}$ of a meter	the length of a crayon
1 meter (m)	10 dm 100 cm	the length of a baseball bat
1 kilometer (km)	1,000 m 100,000 cm	the distance you walk in 10 to 15 minutes

Read a Table

How many centimeters are in a meter? In a kilometer?

Clue: Find each unit in the first column then look across the row.



You can measure length in centimeters or inches.

Length and Width

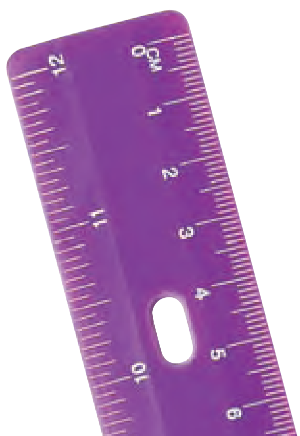
An object's **length** is the number of units that fit from one end to the other. *Width* is the number of units that fit across. How wide is this page? How long is it?

Area

Area (AYR•ee•uh) describes the number of unit squares that cover a surface. An easy way to find the area of a rectangular shape is to multiply its length by its width. The area of this page, for example, is 27 cm × 20 cm, or 540 square cm (cm^2).

What if a shape is not rectangular? Divide it into smaller squares. Find the area of each smaller shape. You might need to estimate parts of some shapes. Then add the area of each smaller shape to find the total area.

A baker may measure volume in cups or pints.



Kitchen tools measure volume in teaspoons or tablespoons.

Volume

Volume describes the number of cubes that fit inside an object. To find the volume of a rectangular solid, just multiply its length by its width and height.

If a solid is not rectangular, you can use water. First, measure the amount of water in a container. Then, submerge the entire object below the water. Subtract the original water level from the new water level. The result is the volume of the object.

To find the volume of a liquid, pour it into a measuring cup, spoon, beaker, or graduated cylinder. Then read the markings on the container.

Quick Check

Problem and Solution How can you measure the area and volume of your room?

Critical Thinking How can you find the area of a triangle?

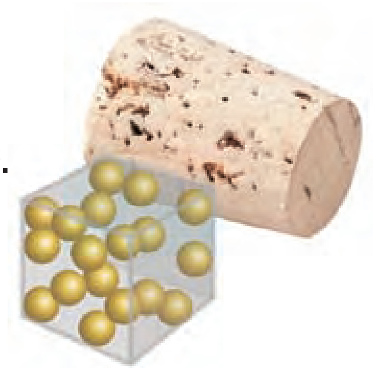
What is density?

A plastic ball floats on water. If you fill the ball with sand, it will sink. Why? The volume of the ball is the same, but you changed its mass. Sand has more mass than air.

Mass Divided By Volume

The relationship between mass and volume is called density (DEN•si•tee). **Density** is the amount of matter in a given space. Scientists define density as the amount of mass in a unit of volume.

Density describes how tightly matter is packed together. To find the density of an object, divide its mass by its volume. If the mass is in grams and the volume in cubic centimeters, then the result will have units in grams per cubic centimeter (g/cm^3).



The density of cork is $0.24\ g/cm^3$. The particles are loosely packed.

The density of marble is between 2.4 and $2.7\ g/cm^3$.

The density of brass is $8.5\ g/cm^3$. The particles are tightly packed.

Real-World Density

Density and Buoyancy

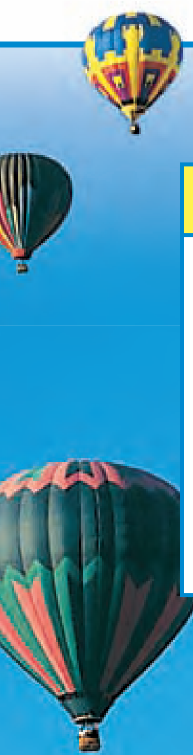
The density of an object also affects its buoyancy. Remember, buoyancy is the upward force of a liquid or gas on another object.

Float or Sink?

Consider cork and water. The density of water is 1 g/cm³. The density of cork is 0.24 g/cm³. Does cork float or sink?

An object floats when its density is less than the density of the liquid or gas in which it is placed. The density of cork is less than the density of water. So cork floats on water. Liquids can float on top of water, too.

Can you change the density of matter? If you add heat to air, the air particles move more quickly. They spread out more. The heated air is less dense. It rises and floats over the cooler, denser air.



Read a Diagram

Why does a hot-air balloon float?

Clue: Compare the density of the air inside the balloon with the density of the air outside.

LOG ON *Science in Motion* Watch density affect balloons at **www.macmillanmh.com**

Quick Lab

Comparing Densities

1. **Predict** Water, oil, and syrup have different densities. What will happen if you pour them into the same container?
2. **Measure** Pour 100 mL of water into a cup. Then pour 100 mL of oil into the cup. Last, slowly add 100 mL of syrup.
3. What happened when you added each liquid to the cup? Was your prediction correct?
4. Drop a craft stick, a piece of pasta, and a crayon into the cup. Where does each float? Why? What can you say about the density of the liquids and solids?

Quick Check

Problem and Solution What is the density of a cube with a mass of 8 g and volume of 1 cm³?

Critical Thinking What should a hot-air balloonist do to go higher? Explain.

What is weight?

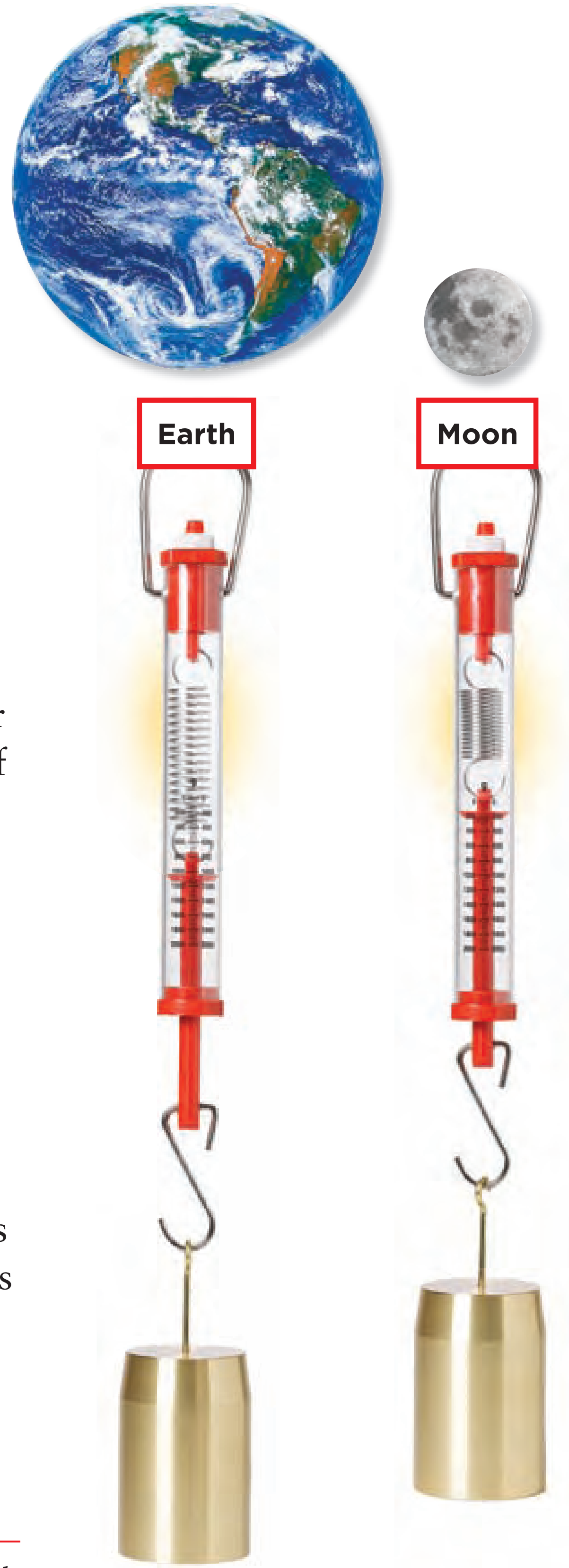
Do you know your weight (WAYT)? Weight is another way to measure matter. Weight and mass may seem similar, but they are not the same.

Mass is the amount of matter in an object. **Weight** measures the amount of gravity between an object and a planet, such as Earth. **Gravity** is a force, or pull, between all objects.

How are weight and mass related? The force of gravity depends, in part, on an object's mass. The more mass, the stronger the pull of gravity. The stronger the pull of gravity, the more an object weighs.

Unlike mass, an object's weight is different on other planets and on the Moon. The pull of gravity on the Moon is about $\frac{1}{6}$ as strong as on Earth. So an object's weight on the Moon is only $\frac{1}{6}$ of its weight on Earth.

Do you weigh yourself with a scale? Mass is measured with a balance. Weight is measured with a scale. Ounces and pounds are the English units for weight. The metric unit for weight is the *newton* (N).



An object with a mass of 1 kg weighs 9.8 newtons on Earth. On the Moon, the same object weighs just 1.6 newtons.

Quick Check

Problem and Solution How would you measure a rock's mass on the Moon?

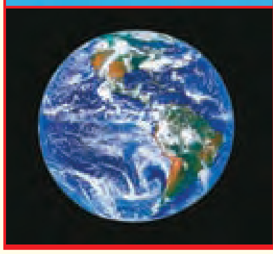
Critical Thinking What is the difference between a balance and a scale?

Lesson Review

Visual Summary

We use **standard units** to measure the length, width, area, and volume of an object.

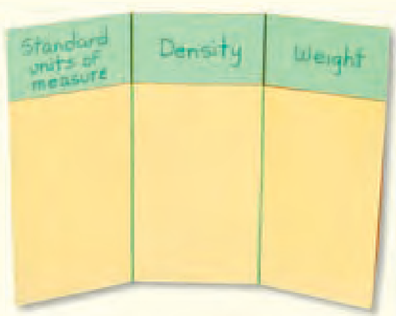
We calculate **density** by dividing the mass of an object by its volume.



Weight is a measure of the pull of gravity. We measure weight with an instrument called a scale.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you learned about measurement.



Think, Talk, and Write

1. **Main Idea** What are six ways you can measure matter?
2. **Vocabulary** The number of unit squares that covers a surface describes its ________.
3. **Problem and Solution** Describe how to find the volume of air in your classroom.

   Problem → Steps to Solution → Solution

4. **Critical Thinking** Why does one kilogram of foam take up more space than one kilogram of rock?
5. **Test Prep** **This property of matter changes depending on the pull of gravity.**

   A density
   B length
   C mass
   D weight

Writing Link

Scientific Writing
You are classifying several different objects. Write a report telling how you will determine the properties of each object.

Math Link

Calculate Area and Volume
Measure the length, width, and height of your desk. What is its area? What is its volume?

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Focus on Skills

Inquiry Skill: Measure

You know that there are many kinds of rocks and minerals. Scientists can describe a particular rock by its properties. Two properties that you can use to describe rock are mass and length. You **measure** to find an object's mass and length.

▶ Learn It

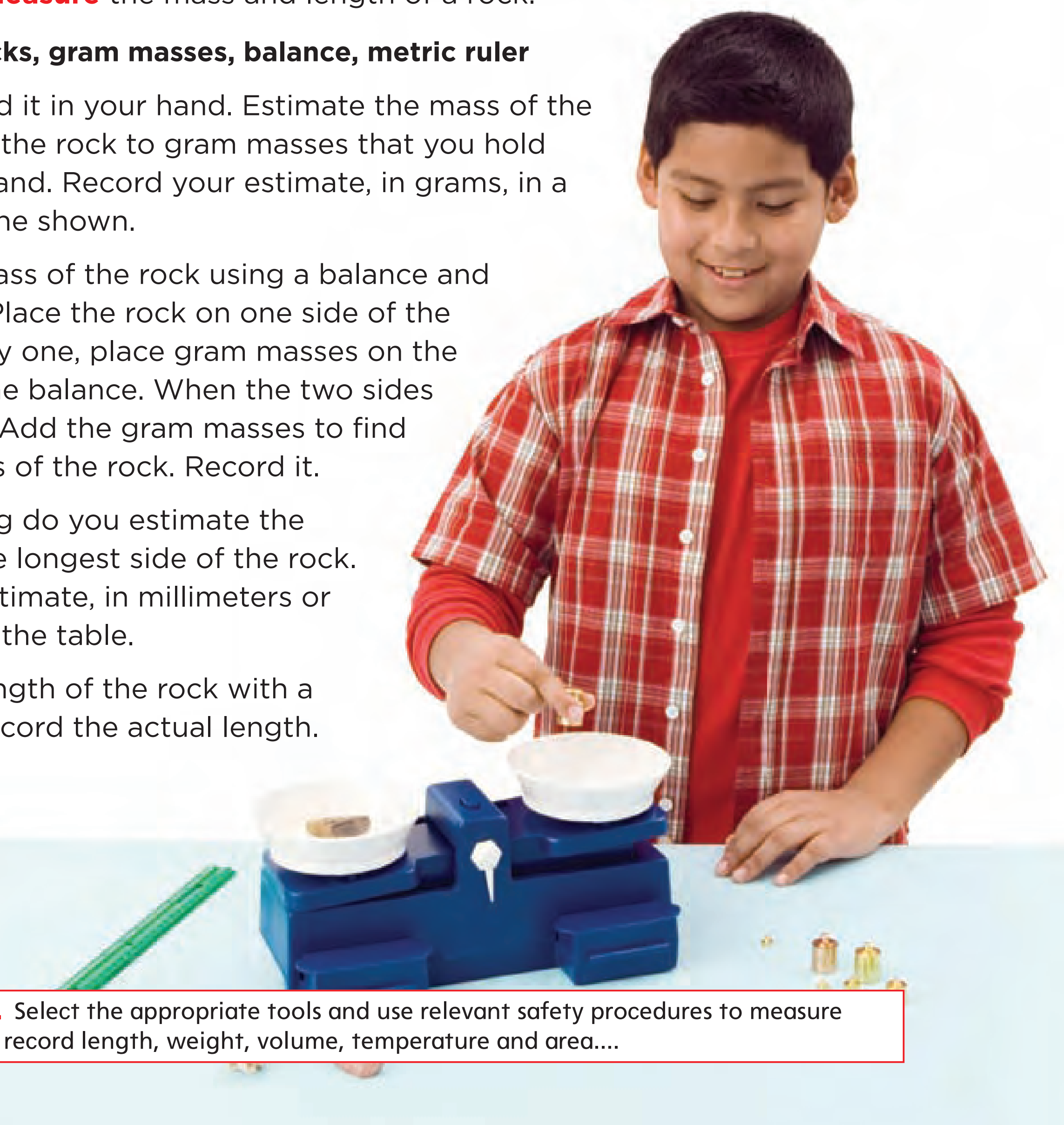
When you **measure**, you find the length, volume, area, mass, or temperature of an object. You can use tools to measure these properties. When you measure, it's a good idea to record your measurements on a table or chart. It helps you stay organized.

▶ Try It

Estimate and **measure** the mass and length of a rock.

Materials **3 rocks, gram masses, balance, metric ruler**

1. Get a rock. Hold it in your hand. Estimate the mass of the rock. Compare the rock to gram masses that you hold in your other hand. Record your estimate, in grams, in a table like the one shown.
2. Measure the mass of the rock using a balance and gram masses. Place the rock on one side of the balance. One by one, place gram masses on the other side of the balance. When the two sides are even, stop. Add the gram masses to find the actual mass of the rock. Record it.
3. About how long do you estimate the rock is? Use the longest side of the rock. Record your estimate, in millimeters or centimeters, in the table.
4. Measure the length of the rock with a metric ruler. Record the actual length.



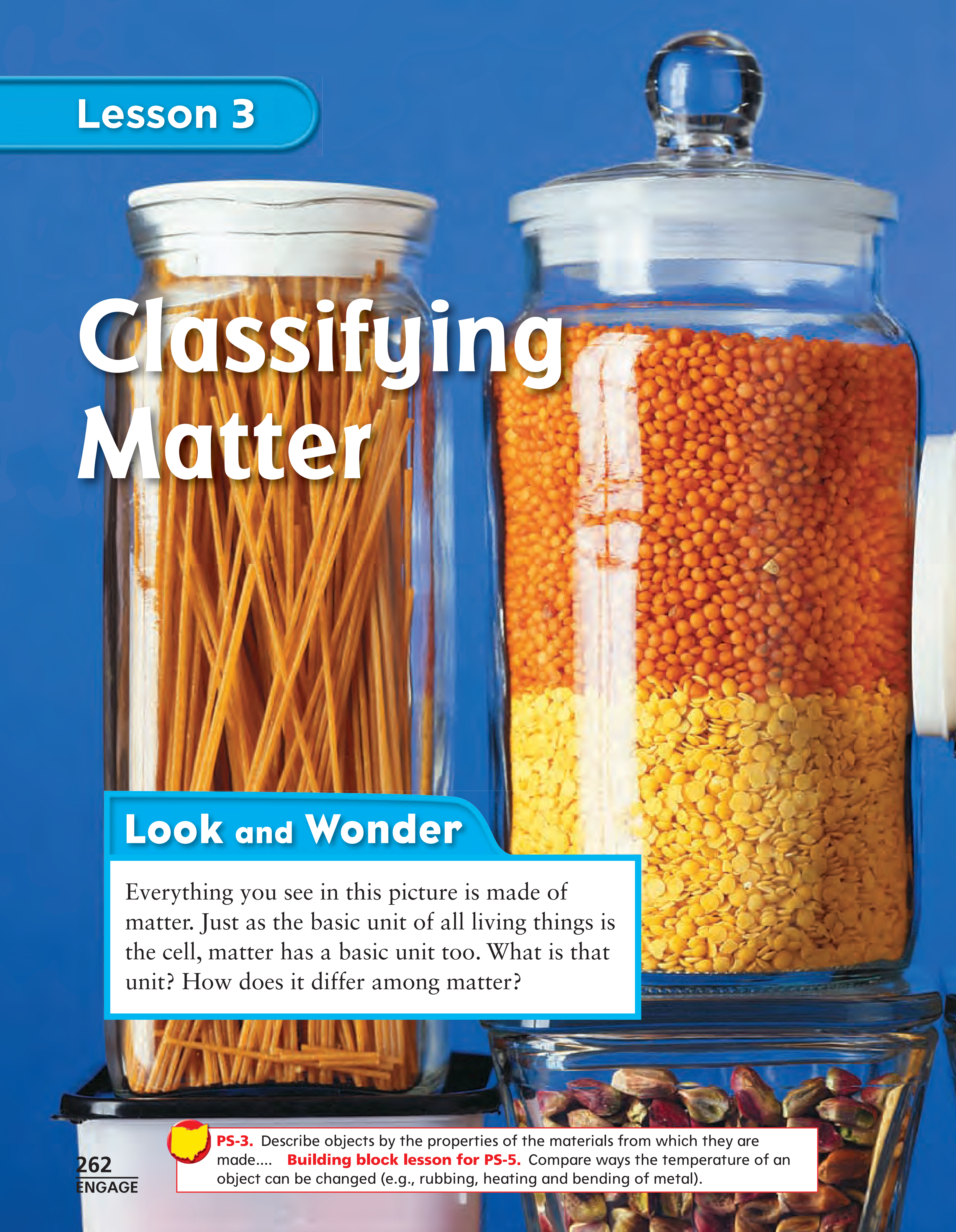
SI-I. Select the appropriate tools and use relevant safety procedures to measure and record length, weight, volume, temperature and area....

▶ Apply It

Estimate and **measure** the mass and length of two more rocks. Record this data in your table.

1. Look at your data. Did you closely estimate the mass of each rock? Did you closely estimate the lengths? Which was easier for you to estimate—mass or length? Why?
2. With practice, you can become better at estimating mass and length. Repeat the activity using different rocks. Record your estimates and actual measurements again in a table.
3. Were your estimates closer to your actual measurements this time?
4. Do you think you can now estimate the mass of a rock before you pick it up? Try it for several rocks. Then use the balance to measure the actual mass. What property or properties do some rocks have that might throw off your estimate?

Rocks	1	2	3
Estimated Mass			
Actual Mass			
Estimated Length			
Actual Length			



Lesson 3

Classifying Matter

Look and Wonder

Everything you see in this picture is made of matter. Just as the basic unit of all living things is the cell, matter has a basic unit too. What is that unit? How does it differ among matter?

PS-3. Describe objects by the properties of the materials from which they are made.... **Building block lesson for PS-5.** Compare ways the temperature of an object can be changed (e.g., rubbing, heating and bending of metal).

Explore

Inquiry Activity

How can you identify a metal?

Purpose

Test the properties of some materials to find out which are metals.

Procedure

1 Obtain three unknown materials from your teacher. Make a table like the one shown.

Property	Test
luster	Is the material shiny?
can bend	Can the material be bent into a shape?
carries heat	Does the material carry heat well?

2 **Observe** Examine each material. Is it shiny? Can it be bent? Answer yes or no in your chart.

3 Fill a beaker with ice water. For each material, place one end in the water. Does the end you are holding get cold? Record your answers.

Draw Conclusions

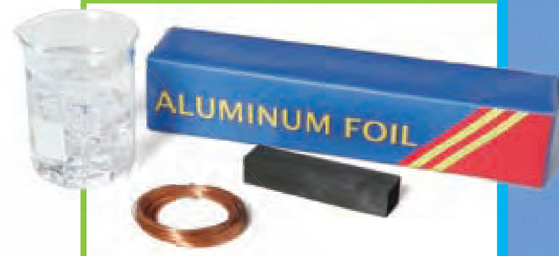
4 **Interpret Data** How do the three materials compare? Is one more like another?

5 **Classify** Metals are shiny, can bend, and carry heat well. Which of the materials you tested are metals?

Explore More

Collect some materials from around your classroom or home. Test their properties using the same procedure. Record your findings in a table. Then classify the materials as metals or nonmetals.

Materials



- 3 unknown materials
- beaker
- ice water

SWK-2. Record the results and data from an investigation and make a reasonable explanation. **SI-3.** Develop, design and conduct safe, simple investigations or experiments to answer questions.

Read and Learn

Main Idea PS-3, PS-5

All matter is made up of elements that can be classified according to their properties.

Vocabulary

element, p. 264

atom, p. 264

metal, p. 265

periodic table, p. 266

LOG ON e-Glossary at www.macmillanmh.com

Reading Skill

Classify

What are elements?

People once thought that all matter was made up of earth, air, fire, and water. We now know that all matter is made of elements (EL•uh•muhnts). An **element** is a substance that is made up of only one type of matter.

Scientists call elements "the building blocks of matter." That is because an element cannot be broken down into a simpler form. Hydrogen and oxygen are elements. So are gold and silver.

Atoms

Elements are made up of atoms (AT•uhmz). An **atom** is the smallest part of an element. You can think of atoms as tiny particles—so tiny that you cannot see them!

All atoms in an element are alike. For instance, all the atoms in copper are copper atoms. They have different properties from the atoms of any other element.

Neon is a gas. In a tube, neon glows if electricity is added.

FACT Fire is not an element.

▲ Aluminum is strong and light in weight.

Metals and Nonmetals

How do we classify elements? One way is to decide if they are metal (MET•uhl) or nonmetal. A **metal** is shiny. It can be bent or hammered into a shape. Some metals are iron, aluminum (uh•LEW•muh•nuhm), and copper.

Metals let heat and electricity pass through them easily. A metal pan over a flame or a heated burner gets hot very quickly.

Metalloids (MET•uh•loydz), such as silicon, have some but not all of the properties of metals. Oxygen and nitrogen are *nonmetals*. They have none of the properties of metals. They are gases.

▼ pure copper

Symbols for Elements

Scientists use symbols to stand for each element. Often, a symbol is the first letter of the element's name. For example, *C* is the symbol for carbon. Some elements take their symbols from their Latin names. The Latin word for gold is *aurum* (AW•ruhm). Gold's symbol is Au. The first letter in a chemical symbol is always capitalized.

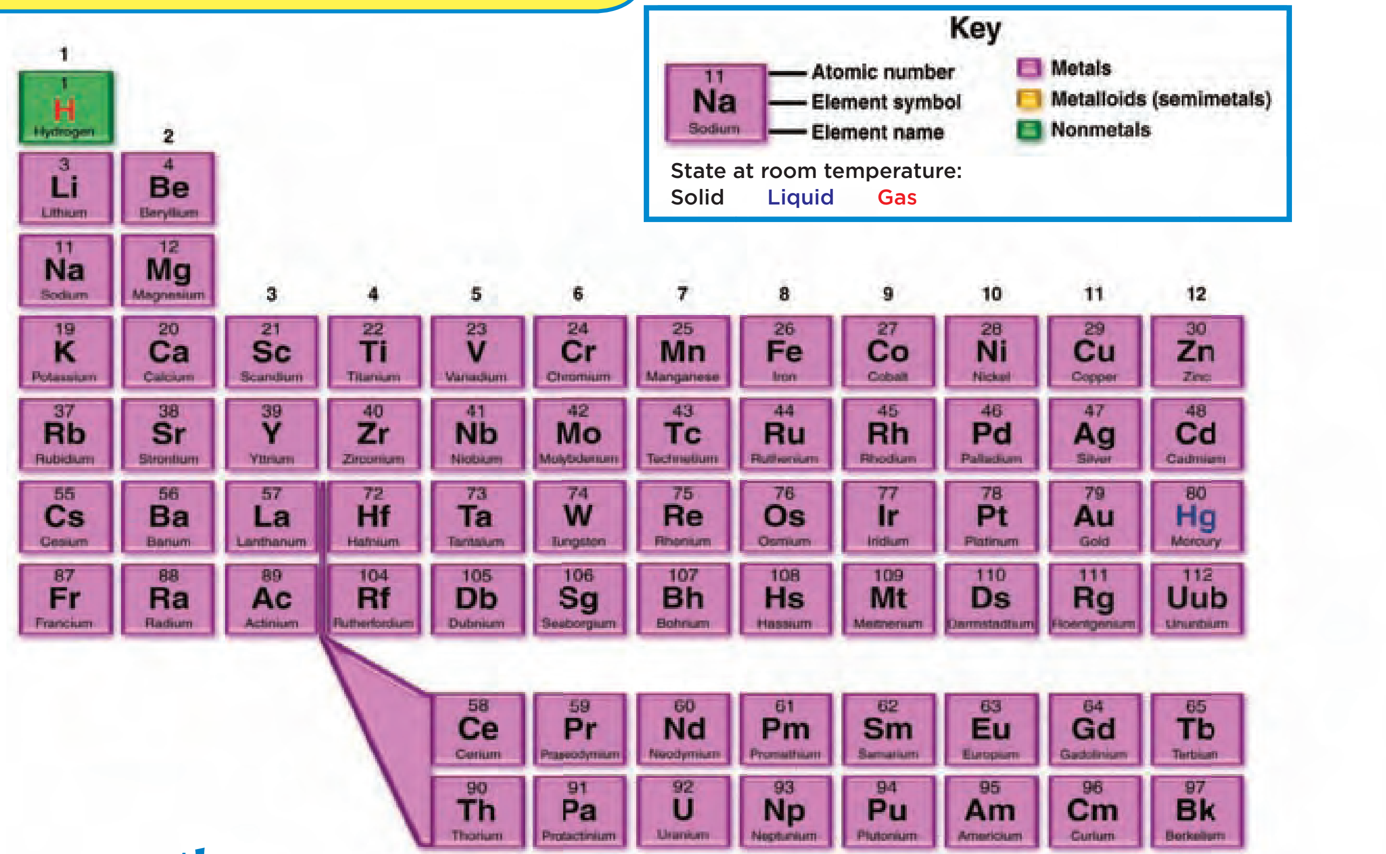
▲ Artists use copper to make jewelry.

Quick Check

Classify Name two elements that are gases. Name two elements that are metals.

Critical Thinking Table salt is made of two elements—sodium and chlorine. Is table salt an element? Why or why not?

Periodic Table of the Elements



How are the elements organized?

Nearly 150 years ago, a Russian scientist named Mendeleev (men•duh•LAY•uhf) made a table of the elements. He based his table on the known properties of elements. It is the **periodic** (peer•ee•OD•ik) **table**.

Atomic Number

As new elements were found, they were added to the table. The modern table is shown above. The three main groups are metals, metalloids, and nonmetals. You can see that the elements are arranged by their atomic numbers. The *atomic number* is related to the mass of each element.

Columns and Rows

So far, scientists have named 112 elements. The periodic table shows how they are similar and how they are different. Elements in the same column have similar properties. For example, all the elements in column 17 combine easily with other elements. They often form new substances. The elements in column 18 hardly ever react.

The rows of the table are called *periods*. They also group similar elements. Iron, cobalt, and nickel are magnetic. They are next to each other in the table.

13	14	15	16	17	18
					2 He Helium
5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon

66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Read a Table

What is the atomic number for fluorine (F)? Is it a metal? What state is it at room temperature?

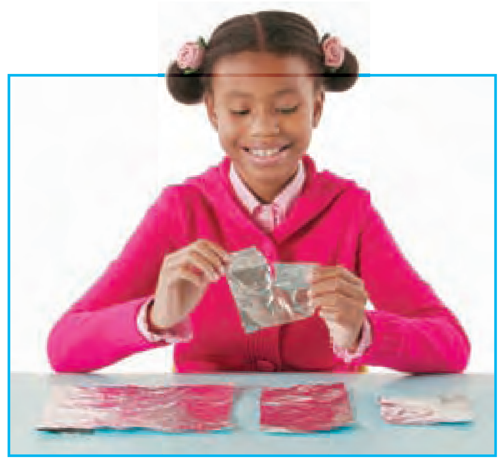
Clue: Look at the key at the top of page 266.

Diamonds, coal, and the graphite in pencils are all made of carbon.

Quick Lab

Properties of an Element

1. **Observe** Look carefully at a sheet of aluminum foil. List the properties you can see and touch.
2. Tear the foil in half, then in half again. Tear each piece in half once more. You will have eight small pieces of foil.



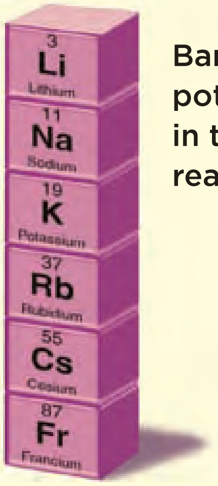
3. What properties do the pieces of foil have? Make a new list. Compare it to the properties you listed for the whole sheet of foil.
4. **Interpret Data** Are the pieces of aluminum foil still aluminum? How are the pieces of foil similar to the atoms of an element?

Quick Check

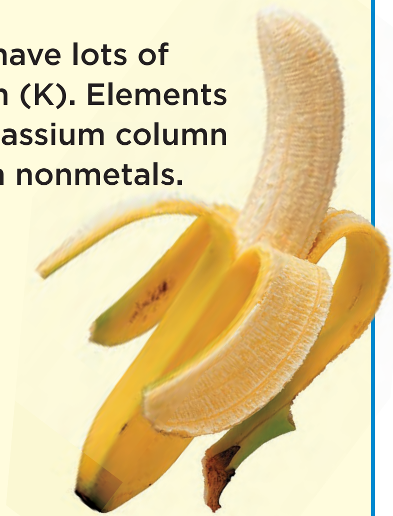
Classify Describe how the periodic table is organized.

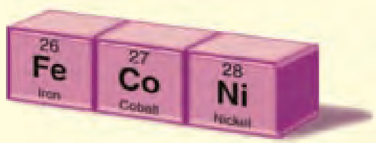
Critical Thinking How are coal and diamonds similar? Different?

Comparing Properties of Elements

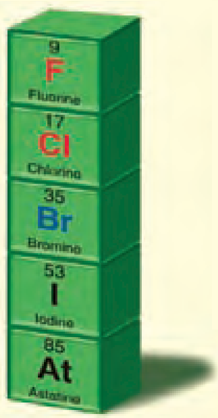


Bananas have lots of potassium (K). Elements in the potassium column react with nonmetals.





Many nails are made of iron (Fe), cobalt (Co), or nickel (Ni). These elements are all magnetic.



This is a sample of fluorite. All the elements in the flourine column form salts with elements in column 1.

Read a Diagram

Which elements are magnetic? Which elements form salts?

Clue: Notice the symbols in each box.

How do scientists use the periodic table?

When Mendeleev arranged the elements in a table, he saw a pattern. Elements with similar properties were grouped near one another.

Scientists use these patterns to predict how an element behaves. Hydrogen (H), for instance, reacts easily with other substances. The elements that share its column in the periodic table also react easily.

Elements that share the same row often have similar properties, too. Iron (Fe) is magnetic. Can you find it in the table? The two elements next to iron are magnetic too.

Turn back to the periodic table on the previous page. You can see that some parts of the table are not filled in all the way. Why not? Scientists have not yet found all the elements they have predicted!

Quick Check

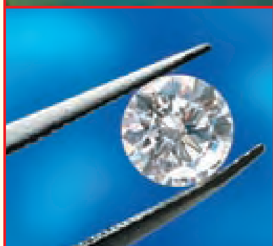
Classify How do scientists use properties to classify elements?

Critical Thinking Why might a scientist want to make a prediction about an element?

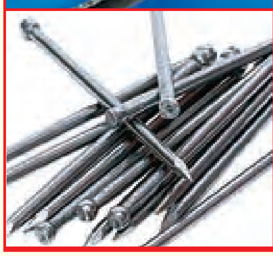
Lesson Review

Visual Summary

An atom is the building block of elements. Matter is made of atoms.



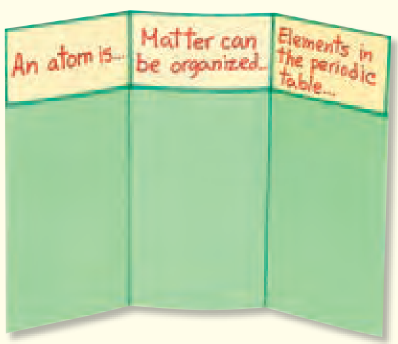
Matter can be organized by its properties.



Elements in the periodic table are grouped by similar properties.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you learned about classifying matter.



Think, Talk, and Write

1. **Main Idea** How can you classify matter?

2. **Vocabulary** A substance that is made up of only one type of matter is called a(n) ________.

3. **Classify** List all the elements mentioned in this lesson. Use the periodic table to classify each one as metal, nonmetal, or metalloid. Write the classification in your chart.

4. **Critical Thinking** Why are elements called "the building blocks of matter"?

5. **Test Prep** **Nitrogen is listed in the periodic table. Therefore, nitrogen is a(n) ________**

   A atom.
   B element.
   C metal.
   D liquid.

Writing Link

Explanatory Writing
Write a brief paragraph explaining some of the ways you use elements in daily life.

Math Link

Compare and Order Numbers
Compare the number of solids, liquids, and gases in the periodic table. Place them in order from greatest to least in number.

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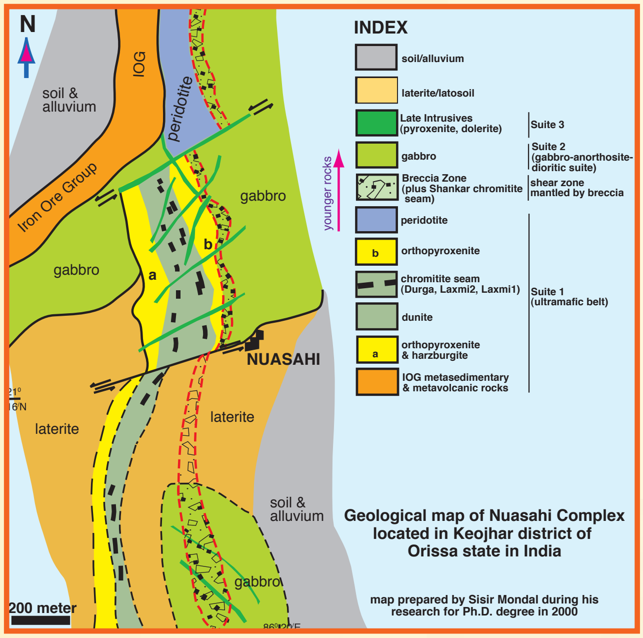
Reading in Science

Real World

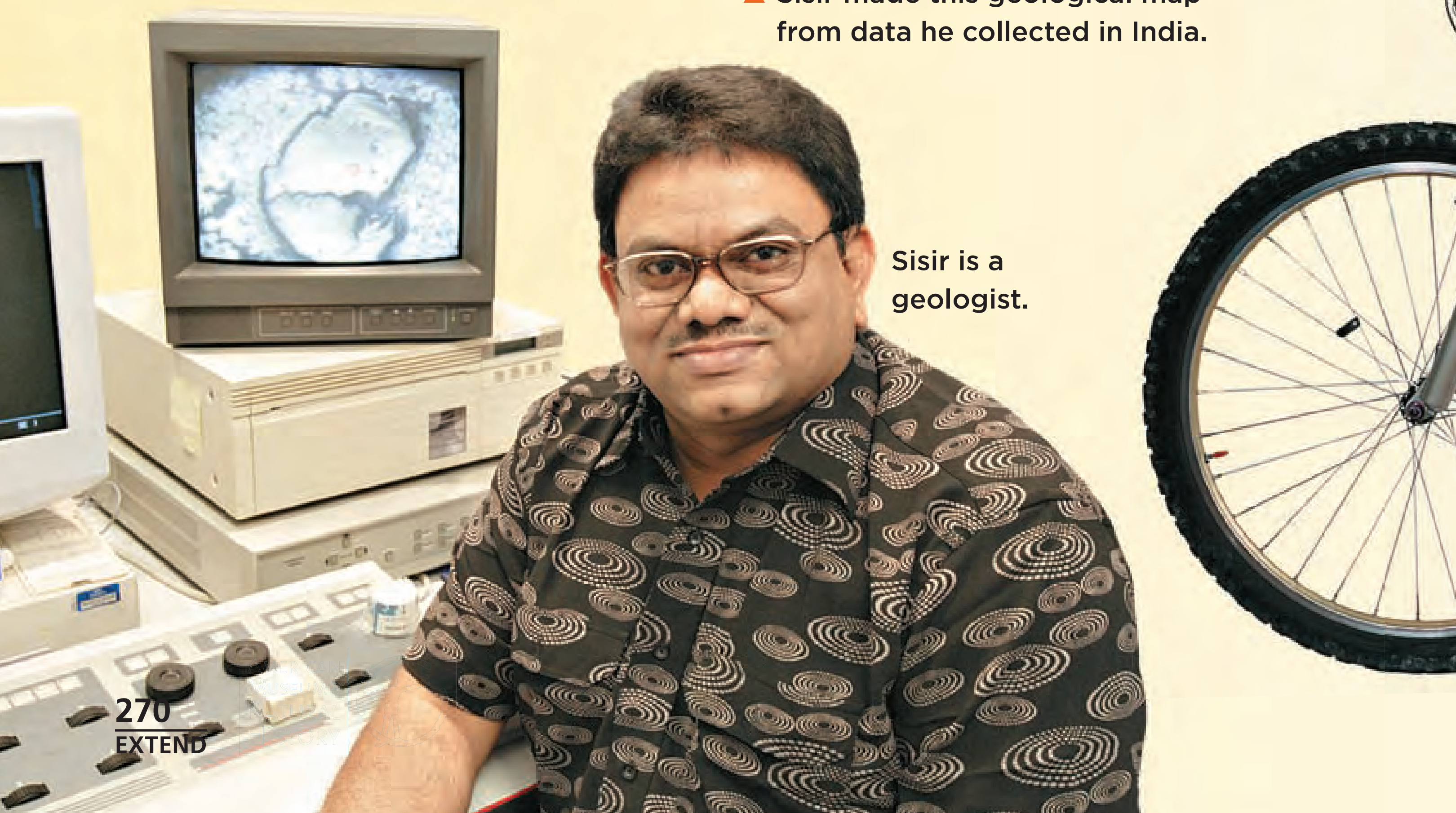
Meet Sisir Mondal

Every year, for about a month, Sisir Mondal travels across the globe to places like India and South Africa. Sisir travels to those places to study rocks.

In the field, Sisir studies large layers of igneous rock. Sisir collects rock samples. He studies them closely to figure out their textures and what kinds of minerals the rocks contain. Based on his observations, he makes a geological map of the area.

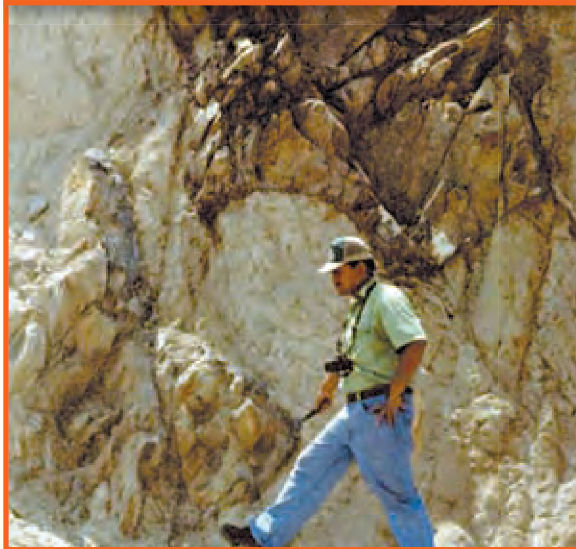


▲ Sisir made this geological map from data he collected in India.



Sisir is a geologist.

Sisir looks for rock samples.



Back in the museum, Sisir takes a much closer look at the rock samples he collected. He uses microscopes and other tools to see what stories the rocks tell. Sisir wants to know why certain minerals are found in the rocks. He's particularly interested in finding rocks that contain metallic elements like chromium and platinum. Why are those metals important? People use them every day. Chromium is used to make many things, including steel. Platinum is a precious metal, used in everything from jewelry to catalytic converters in cars.

◀ Chromium is used in making bicycle frames.

▲ These rings are made of platinum.

Classify

- ▶ List the properties that objects in the group share.
- ▶ Arrange ideas or objects into groups that have something in common.

Write About It

Classify Read the article again. What does Sisir look for in the rocks he studies? How do you think Sisir classifies the rocks?

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

ELA RP-C. Make meaning through asking and responding to a variety of questions related to text.

American Museum of Natural History

CHAPTER 5 Review

Visual Summary

Lesson 1 Matter can be described by its properties, such as mass, volume, and state.

Lesson 2 Matter can be measured using standard units of length, area, volume, mass, density, and weight.

Lesson 3 All matter is made up of elements that can be classified by their properties.

Make a FOLDABLES™ Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned in this chapter.

Vocabulary

Fill each blank with the best term from the list.

density, p. 256

element, p. 264

gravity, p. 258

matter, p. 244

metal, p. 265

periodic table, p. 266

property, p. 244

weight, p. 258

1. Anything that has mass and takes up space is ________.
PS-3

2. The measure of gravity's pull between an object and a planet is ________.
PS-B

3. A substance that cannot be broken down into a simpler form is a(n) ________.
PS-2

4. Color is an example of a(n) ________ of matter.
PS-3

5. To calculate an object's ________, you divide its mass by its volume.
PS-3

6. Gold, copper, and iron are examples of ________.
PS-3, PS-4

7. The pull between objects is called ________.
PS-C

8. Elements are classified by their properties in the ________.
PS-3

Skills and Concepts

Answer each of the following in complete sentences.

9. **Problem and Solution** How can you prevent the matter you use from becoming trash?
ST-I

10. **Measure** You want to know the area of a sheet of paper. What would you measure? How would you calculate the area?
SI-I

11. **Critical Thinking** How is hydrogen an example of an element?
PS-3

12. **Descriptive Writing** Describe the properties of copper.
PS-3

The Big Idea

13. What is matter and how is it classified?
PS-B

Performance Assessment

Elements Wanted

1. Choose an element from the periodic table.
2. Research properties of the element in the library or on the Internet.
3. Create a "wanted" poster for the element, describing three of its properties. Include illustrations. Be creative!

Ohio Activity

Each person in the United States produces about four pounds of waste every day. Some trash is taken to incinerators. There it is burned to ash. But some trash shouldn't be burned because it releases harmful chemicals into the air.

Most trash—including the ash from incinerators—is hauled to landfills. But there is so much trash that landfills fill up fast. And landfills have other problems. Rotting garbage gives off gases that pollute the air. Toxic chemicals from waste can seep into the ground. How can you help?

Research how your community disposes of trash. Prepare a report for your class. Include ideas about how your school can reduce, reuse, and recycle matter and create less trash.

Ohio Benchmark Practice

1 How would an object that is attracted to a magnet most likely be classified?

A glass

B plastic

C metal

D wood

PS-B

2 What form of matter is the helium in a balloon?

A gas

B solid

C liquid

D air

PS-C

3 Which tool can be used to measure volume?

A a thermometer

B a graduated cylinder

C a tape measure

D a protractor

SI-A

4 The amount of space something takes up is its

A volume.

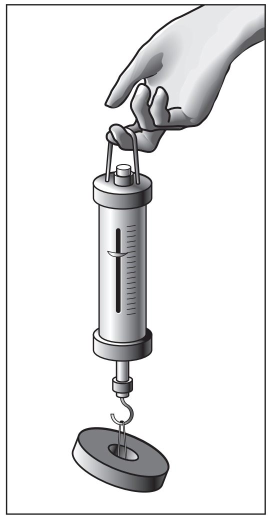
B length.

C weight.

D mass.

SWK-A

Use the following picture to answer questions 5–6.



5 What property of matter does the spring scale measure?

A mass

B weight

C volume

D magnetism

PS-C

6 The picture shows a spring scale measuring an object.

In your **Answer Document**, identify the name of the English units measured by the spring scale.

Then, describe how the measurement would change if it were taken on the Moon instead of Earth. (2 points)

PS-B

7 Which is **best** measured in liters?

A a wooden bowl

B a wooden block

C milk in a pitcher

D a plastic cup

SI-A

8 Matter is made up of tiny particles. The particles differ in how they are packed together in solids, liquids, and gases.

In your **Answer Document**, describe or draw how particles are packed together in solids, liquids, and gases.

Then, identify which has the **greatest** density and which has the **lowest** density. (2 points)

PS-B

9 What form of matter has a definite volume but no definite shape?

A gas

B solid

C liquid

D air

PS-C

10 A scientist performs the same experiment on two different elements.

Because the elements are in the same column in the periodic table, he predicts they will react

A similarly.

B differently.

C in exactly the same way.

D in completely the opposite way.

PS-B

11 Mrs. Camden fills a container with rocks and seals it. She drops it into a beaker of water and records the change in water level.

Then, she fills the container with flour, seals it, and drops it in the water. Again, she records the change in water level.

What question is she trying to answer?

A Does the mass of an object change its volume?

B Does the mass of an object change its weight?

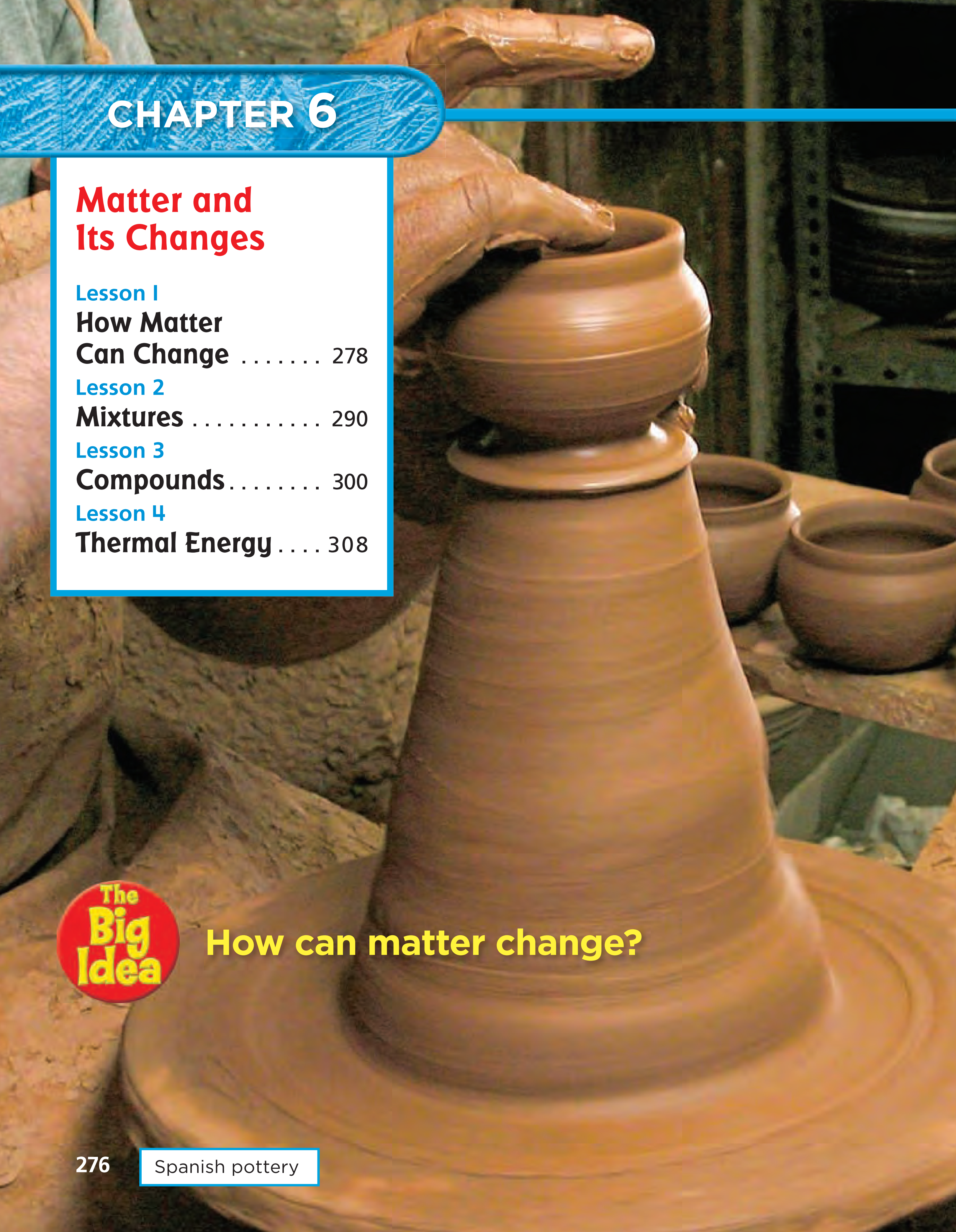
C Does water affect the volume of an object?

D Does temperature affect the volume of an object?

SWK-B

CHAPTER 6

Matter and Its Changes



The Big Idea

How can matter change?

Spanish pottery

Key Vocabulary

change of state
a physical change of matter from one state to another state because of a change in the energy of the substance (p. 282)

chemical change
a change that produces new matter with different properties from the original matter (p. 284)

mixture
two or more types of matter that are mixed together but keep their original properties (p. 292)

solution
a mixture in which one or more types of matter are mixed evenly in another kind of matter (p. 292)

compound
a substance made when two or more elements are joined together and lose their own properties (p. 302)

thermal energy
energy from moving particles (p. 310)

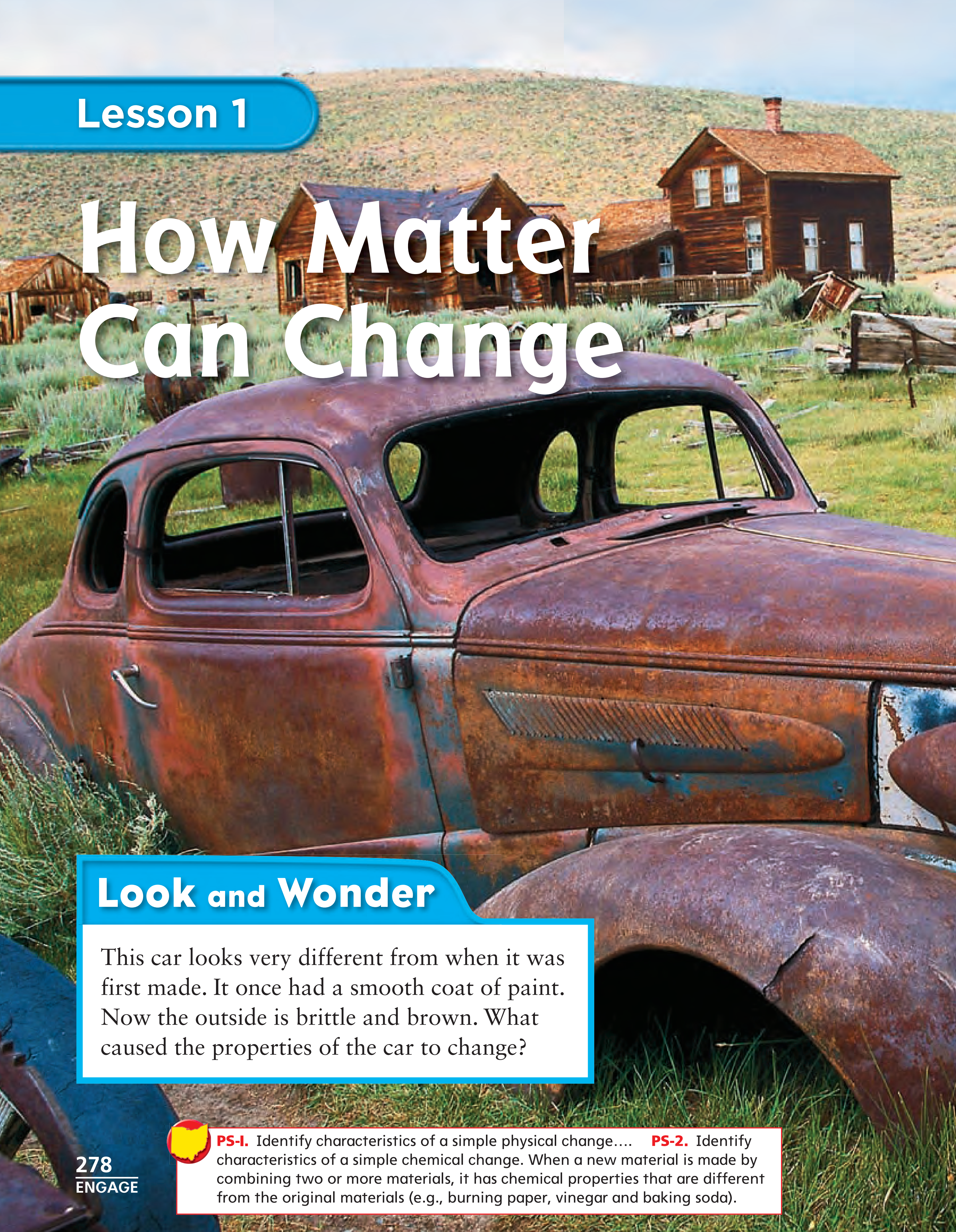
More Vocabulary

physical change, p. 280
evaporation, p. 283
rust, p. 284
tarnish, p. 284
alloy, p. 293
filter, p. 295
filtration, p. 295
distillation, p. 296
acid, p. 304
base, p. 304
conduction, p. 312
convection, p. 312
radiation, p. 313
insulator, p. 313
conductor, p. 313

PS-A. Compare the characteristics of simple physical and chemical changes.
PS-D. Summarize the way changes in temperature can be produced and thermal energy transferred.

Lesson 1

How Matter Can Change



Look and Wonder

This car looks very different from when it was first made. It once had a smooth coat of paint. Now the outside is brittle and brown. What caused the properties of the car to change?

PS-I. Identify characteristics of a simple physical change.... **PS-2.** Identify characteristics of a simple chemical change. When a new material is made by combining two or more materials, it has chemical properties that are different from the original materials (e.g., burning paper, vinegar and baking soda).

Explore

Inquiry Activity

Can you change the properties of a solid?

Make a Prediction

Will a piece of clay keep its original properties if you change its shape? What will happen to its mass and volume? Write your prediction.

Test Your Prediction

1. **Measure** Using a balance, measure the mass of a piece of clay. Measure its volume using a graduated cylinder and water. Record your observations in a table like the one shown.
2. Change the shape of the clay. For example, you might flatten it or cut it into pieces.
3. **Measure** With the balance and graduated cylinder, measure the mass and volume of the changed clay. Record your findings.
4. Change the shape of the clay in two or three other ways. Repeat step 3 each time.

Draw Conclusions

5. **Interpret Data** Did the mass change after you changed the shape of the clay? Did the volume change?
6. **Infer** What can you conclude about changing the properties of a solid?

Explore More

Will the mass or volume of the clay change if you let it dry out? Make a prediction. Try it!

Materials

- modeling clay
- balance
- graduated cylinder
- water
- plastic knife

Step 2

What I Observed

Mass before change	Volume before change	Shape change	Mass after change	Volume after change

SI-I. Select the appropriate tools and use relevant safety procedures to measure and record length, weight, volume, temperature....

Read and Learn

Main Idea PS-I, PS-2

Physical changes end with the same kind of matter. Chemical changes form new kinds of matter.

Vocabulary

physical change, p. 280

change of state, p. 282

evaporation, p. 283

rust, p. 284

chemical change, p. 284

tarnish, p. 284

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Reading Skill

Sequence

First
↓
Next
↓
Last

Technology

SCIENCE QUEST

Explore how matter changes on Science Island.

What are physical changes?

Knitting causes a physical change. The yarn changes shape.

When you flatten a piece of clay or cut it in half, you cause a physical (FIZ•i•kuhl) change. Even though the clay has a different shape, it is still clay. Its mass and volume do not change. A **physical change** begins and ends with the same type of matter.

Fold a piece of paper in half. You've caused a physical change. You can cut, crush, tear, bend, or stretch matter—all cause physical changes.

A physical change can also result from heating or cooling. When you heat the liquid in a thermometer, it expands. The liquid is still the same substance. It just takes up more space. When cooled, the liquid takes up less space.

Heating and cooling can also cause a change in state. An ice cube is solid water. If the ice cube cools, it melts. It is still water, just in its liquid state. If you pour that water into a kettle and heat it, you get steam. Steam is a sign that the liquid water turned to water vapor. Changes of state are physical changes, too.

Steam shows a change in state.

Folding paper is a physical change.

Real-World Changes

Physical changes happen all around you, all the time. The sidewalks in your town or city are made of concrete. When the concrete is new, it is one solid piece. In time, chips and cracks form. Small pieces of concrete break off. Wind and rain carry the pieces away. Cracking and breaking are physical changes in the sidewalks.

In winter, the surfaces of lakes and ponds can freeze. The surfaces become solid ice. Beneath the ice, the water is still a liquid. Not all liquids have this property. The physical changes of water allow living things to survive below the frozen surface.

Signs of a Physical Change

How can you tell if a physical change has taken place? It is not always as easy to identify as freezing ice. Look for a change in size, shape, texture, or state. Even a change in position can be a sign of a physical change.

Quick Check

Sequence What happens when ice turns to liquid water?

Critical Thinking Describe and explain some types of physical changes you can see every day.

Moving water can break apart even the hardest rocks.

How does matter change state?

You know that matter can exist in three states—solid, liquid, and gas. A pair of scissors is a solid. The air you breathe is a gas. Juice and water are liquids.

Some types of matter can exist in more than one state. You know that water can exist as a solid, a liquid, and a gas. Water changes its state easily. A **change of state** is a physical change in which one state of matter changes to another. After a change of state, the volume of a substance may change. Its mass stays the same.

Heating

If you add heat energy to a solid, its particles move faster. If the particles gain enough energy, the solid changes to a liquid. *Melting* is a change of state from a solid to a liquid.

If you add a lot of energy to a liquid, it can change to a gas. *Boiling* is a change of state from a liquid to a gas. Boiling is not the only way a liquid can become a gas.

Dew is water that changed state from a gas to a liquid.

How Water Changes State

Ice melts when energy is added. The particles move faster.

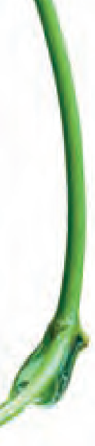
As energy is added to liquid water, the particles move faster. Some turn to gas.

Evaporation

Liquids everywhere go through evaporation (i•VAP•uh•RAY•shuhn) all the time. **Evaporation** is the slow change of a liquid to a gas without boiling. For instance, the Sun's energy constantly evaporates water in ponds, lakes, rivers, and oceans.

Cooling

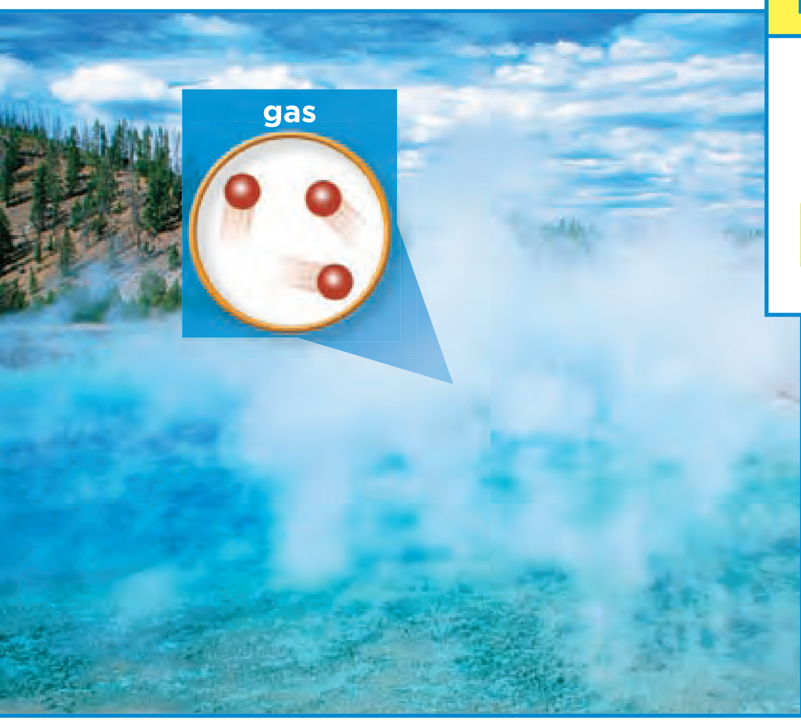
When you take away energy from any substance, its particles move slower. This is called *cooling*. As the particles cool, they move closer together. This is how a gas changes, or *condenses*, to a liquid. If enough energy is taken away, a gas or a liquid *freezes* into a solid. A solid's particles are close together.



Quick Lab

Heat and Evaporation

1. Pour an equal amount of water into two petri dishes.
2. **Predict** Place one petri dish under a lamp or in a sunny place. Put the other in a cooler or darker place. Predict which will evaporate first.
3. **Infer** Which dish of water evaporated first? Why?



Water vapor is a gas. Its particles move very fast.

Read a Diagram

What happens when energy is added to ice? To liquid water?

Clue: Compare the particles in each state.

LOG ON *Science in Motion* Watch matter change state at www.macmillanmh.com

Quick Check

Sequence What happens as water changes from a liquid to a gas? From a liquid to a solid?

Critical Thinking On a summer day, a puddle quickly disappears. What happened to the water?

What are chemical changes?

If you leave a bicycle outside for too long, it rusts. **Rust** is the result of a chemical (KEM•i•kuhl) reaction. Iron is a solid metal. It reacts with oxygen gas in the air. Over time, the iron changes from a smooth gray metal to brittle brown rust.

The change from iron to rust is a chemical change. A **chemical change** begins with one kind of matter and ends with another. The resulting matter has different properties from the original matter. Rust is very different from iron and oxygen.

All chemical changes either use energy or give off energy. This energy may be in the form of heat, light, or electricity.

Gas bubbles are evidence of a chemical change. ▼

▲ Fireworks release so much energy they can light up the sky!

Examples of Chemical Changes

When we cook food, we change its color, taste, and texture. Cooking and baking cause chemical changes in food.

Some chemical changes produce a gas. When vinegar is mixed with baking soda, carbon dioxide gas is released. You can tell by the bubbles that form. Burning paper is a chemical change too. This change also releases carbon dioxide.

Have you ever noticed a black substance on silver jewelry? That substance is **tarnish**. It forms when silver reacts with sulfur in the air.

Signs of a Chemical Change

If you know what to look for, you'll find evidence of chemical changes everywhere. The most visible sign is a change in color. Rust and tarnish are good examples.

A change in scent is another sign of a chemical change. Have you ever toasted marshmallows over a campfire? While your marshmallow is toasting, it gives off a pleasant aroma. If it burns, the odor is less appealing!

If you see bubbling or hear fizzing, a chemical change likely occurred. These signs indicate the release of a gas. For example, dropping antacid tablets into water will release lots of fizzy bubbles.

Many reactions cause the matter involved to become warm or hot. Others cause the matter to become cold. Some reactions even give off light. Fire is a chemical reaction which gives off light and heat.

Quick Check

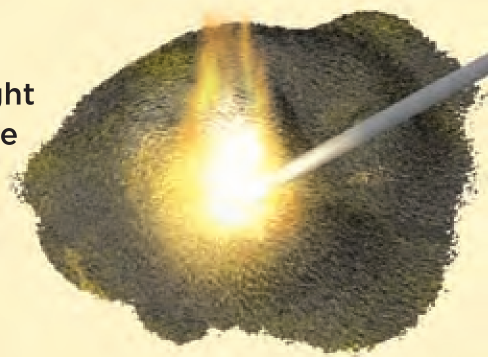
Sequence Explain how tarnish forms on silver. How is it removed?

Critical Thinking Over time, a copper statue will turn green. Is this a chemical change? Explain.

Reaction of Iron and Sulfur

① Iron and sulfur are mixed together. Iron is a silver metal. It is also magnetic. Sulfur is a yellow powder.

② A metal rod is heated to a high temperature.



③ The heated rod causes a chemical change. Light and heat are released.

④ The result is iron sulfide—a black, nonmagnetic material.

Read a Diagram

How is iron sulfide different from the iron and sulfur that formed it?

Clue: Compare the top picture with the bottom one. Read both captions.

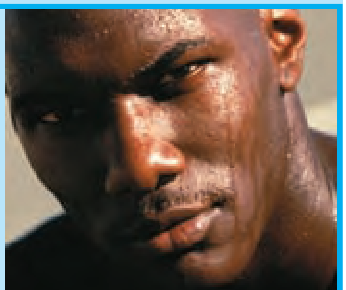
FACT Air and oxygen are not the same gas.

Physical Changes

As water vapor cools, it condenses into clouds. When enough drops condense in the cloud, they fall as rain or snow.

outside ▲

The particles of sweat carry away energy as they evaporate, leaving you cooler.



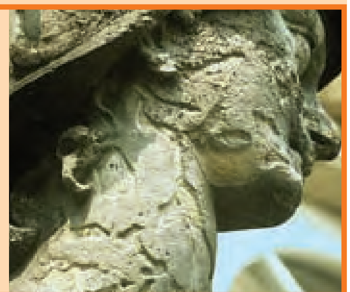
in your body ▲

Moist dough is easy to stretch. It can be pulled apart, braided, or shaped into rolls.

in the kitchen ▲

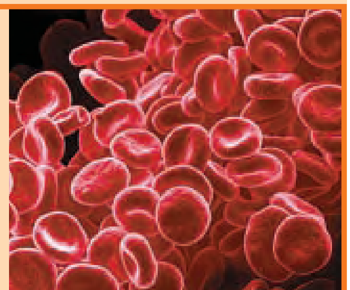
Chemical Changes

Some rain falls as acid rain. Acid rain reacts with limestone. It eats away at buildings and statues.



outside ▲

Blood carries oxygen to your cells. In the cell, the oxygen reacts with sugars. This releases energy for your body to use.



in your body ▲

In the presence of heat, the moist dough hardens. Baking changes it into crusty bread.

in the kitchen ▲

What are other real-world changes?

Changes take place all around you, all the time. What kinds of physical and chemical changes affect you and your environment? The chart shows some examples. Can you think of other cases of physical and chemical changes?

Quick Check

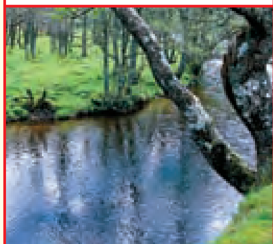
Sequence Describe the physical and chemical changes that happen when making bread.

Critical Thinking The flesh of a cut apple turns brown when left out in the air. Is this change physical or chemical? Explain.

Lesson Review

Visual Summary

A **physical change** begins and ends with the same type of matter. An example is folding paper.

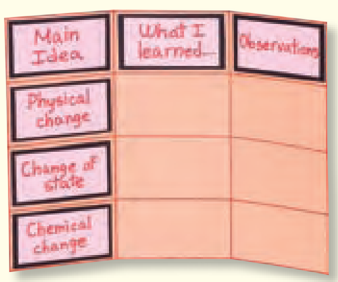


A **change of state** is a physical change from one state of matter to another.

A **chemical change** forms a new substance with different properties from the original ones.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you read about physical and chemical changes.



Think, Talk, and Write

1. **Main Idea** How is a physical change different from a chemical change? Give examples of each.

2. **Vocabulary** The slow change of a liquid into a gas is called ________ .

3. **Sequence** To build a campfire, wood must be gathered, dried, and cut into small pieces. Which changes are physical? Which are chemical?

First → Next → Last

4. **Critical Thinking** What change could you make to a sheet of paper to illustrate a physical change? A chemical change?

5. **Test Prep** **Which of the following is a chemical change?**

   A tarnish
   B popped corn
   C clouds
   D a change in state

Writing Link

Speechwriter
You have been asked to speak to a third-grade class. Your goal is to explain physical and chemical changes. Write a speech for the class. Use examples.

Health Link

Digestion Chart
When you eat, physical and chemical changes take place. Research how food changes in the digestive system. Make an illustrated chart of your findings.

LOG ON e-Review Summaries and quizzes online at www.macmillanmh.com

Real World **Reading in Science**

Lady Liberty

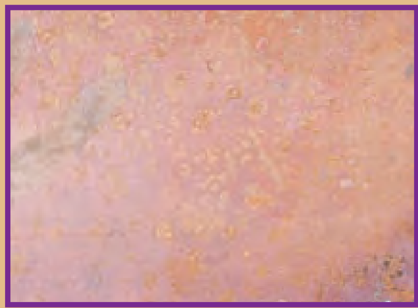
Did you know that the Statue of Liberty wasn't always green? When it was built, the statue was the color of a shiny new penny.

The Statue of Liberty is made of the metal copper. New copper has a reddish color. Twenty years after it was built, Lady Liberty was completely green. What caused this color change? A chemical reaction occurred!

Oxygen in the air reacts chemically with copper. The elements form a compound called copper oxide. This kind of change is called oxidation.

The Statue of Liberty was built in France in 1884. Two years later it came to America in 350 individual pieces.

▲ copper



▲ copper oxide

▲ copper hydroxide

The Statue of Liberty changed from red to dark brown—the color of copper oxide. That color didn't last long. Over time, rainwater and carbon dioxide in the air reacted with the copper oxide. This reaction formed a different compound called copper hydroxide. What color is copper hydroxide? It's green, of course!

The Statue of Liberty was originally the color of a shiny new penny.

The green layer on Lady Liberty is only as thick as a postcard. Still, it protects the copper underneath. If the layer were removed, the statue would shine like a new penny again—but only for a while!

Sequence

- Give events in order.
- Use time-order words such as *first*, *then*, and *next*.

Write About It

Sequence

1. Make a sequence chart showing how the color of the Statue of Liberty has changed over time.
2. Use your chart to write a summary of those changes.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

PS-2. Identify characteristics of a simple chemical change....

American Museum of Natural History

Lesson 2

Mixtures

leaves on a pond, Seattle, Washington

Look and Wonder

There are many different solids in this pond. Can you count them all? What happens when you mix solids with liquids?

PS-3. Describe objects by the properties of the materials from which they are made and that these properties can be used to separate or sort a group of objects....

Explore

Inquiry Activity

How do solids and water mix?

Make a Prediction

What will happen when you mix salt into water? What about sand and water? Sugar and water? Gelatin and water? Write your predictions.

Test Your Prediction

1. Label one cup *salt* and a second cup *sand*.
2. **Measure** Pour 100 mL of water into each cup. Add one spoonful of salt to the cup marked *salt*. Stir well. Add one spoonful of sand to the cup marked *sand*. Stir well.
3. **Observe** Observe the contents of both cups carefully. What happened to the salt? The sand? Record your observations.
4. Label a third cup *sugar* and the last cup *gelatin*. Repeat step 2 with both substances. After stirring, leave each cup alone for 20 minutes. What happened this time?

Draw Conclusions

5. **Communicate** Describe the similarities and differences you observed after the four solids were mixed with water. Were your predictions correct?

Explore More

Would you get the same results if the temperature of the water were higher or lower? Write a prediction that you could test.

Materials

- 4 clear cups
- marker
- measuring cup
- water
- 4 plastic spoons
- salt
- sand
- sugar
- gelatin

Step 2

SWK-3. Explain discrepancies in an investigation using evidence to support findings.

Read and Learn

Main Idea PS-3

Matter can be combined to form mixtures. Mixtures can be separated by their physical properties.

Vocabulary

mixture, p. 292

solution, p. 292

alloy, p. 293

filter, p. 295

filtration, p. 295

distillation, p. 296

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Reading Skill

Classify

Lemonade is a solution of water, lemon juice, and sugar.

Kinds of Mixtures

solids and solids

solids and gases

What is a mixture?

Did you ever make a salad? If you did, then you know how to make a mixture. A **mixture** is a combination of two or more kinds of matter. In a mixture, each kind of matter keeps its original chemical properties.

Everyday Mixtures

A salad is a mixture of lettuce, tomatoes, and other foods blended together. The foods that go into a salad look the same as they do on their own. They taste pretty much the same too.

You probably see mixtures every day. Some breakfast cereals are mixtures of solids. If you add milk, you get a mixture of solids and a liquid. Many creams and shampoos are mixtures. Even shoes and clothing can be mixtures.

Solutions Are Mixtures

Some solids mix easily with liquids. If you mix salt into water, the salt will break up. You cannot see it because salt water is a solution. A **solution** is a mixture in which two or more substances are blended completely.

liquids and liquids

solids and liquids

Read a Photo

What are four different ways to make a mixture?

Clue: Read the labels and identify the contents of each photograph.

Chemical Properties

You read that the substances in a mixture keep their own chemical properties. A solution may also have properties that the original substances do not have. Salt and water are both poor conductors of electricity. However, salt water is a very good conductor.

This brooch is made of bronze—a solution of copper and tin.

Alloys Are Solutions

Thousands of years ago, people discovered how to make bronze by mixing melted copper and tin. Bronze is a kind of solution called an alloy. An **alloy** is a mixture of two or more elements. At least one of the elements is a metal.

Alloys can be stronger, harder, or more flexible than the substances that formed them. Bronze is stronger than copper or tin. Steel is an alloy of iron and carbon. Iron is brittle and easily rusts. Steel is strong and resists rust.

Quick Check

Classify How are solutions, alloys, and mixtures related?

Critical Thinking A cook combines peas and carrots in a bowl. Is this a mixture or a solution? Explain.

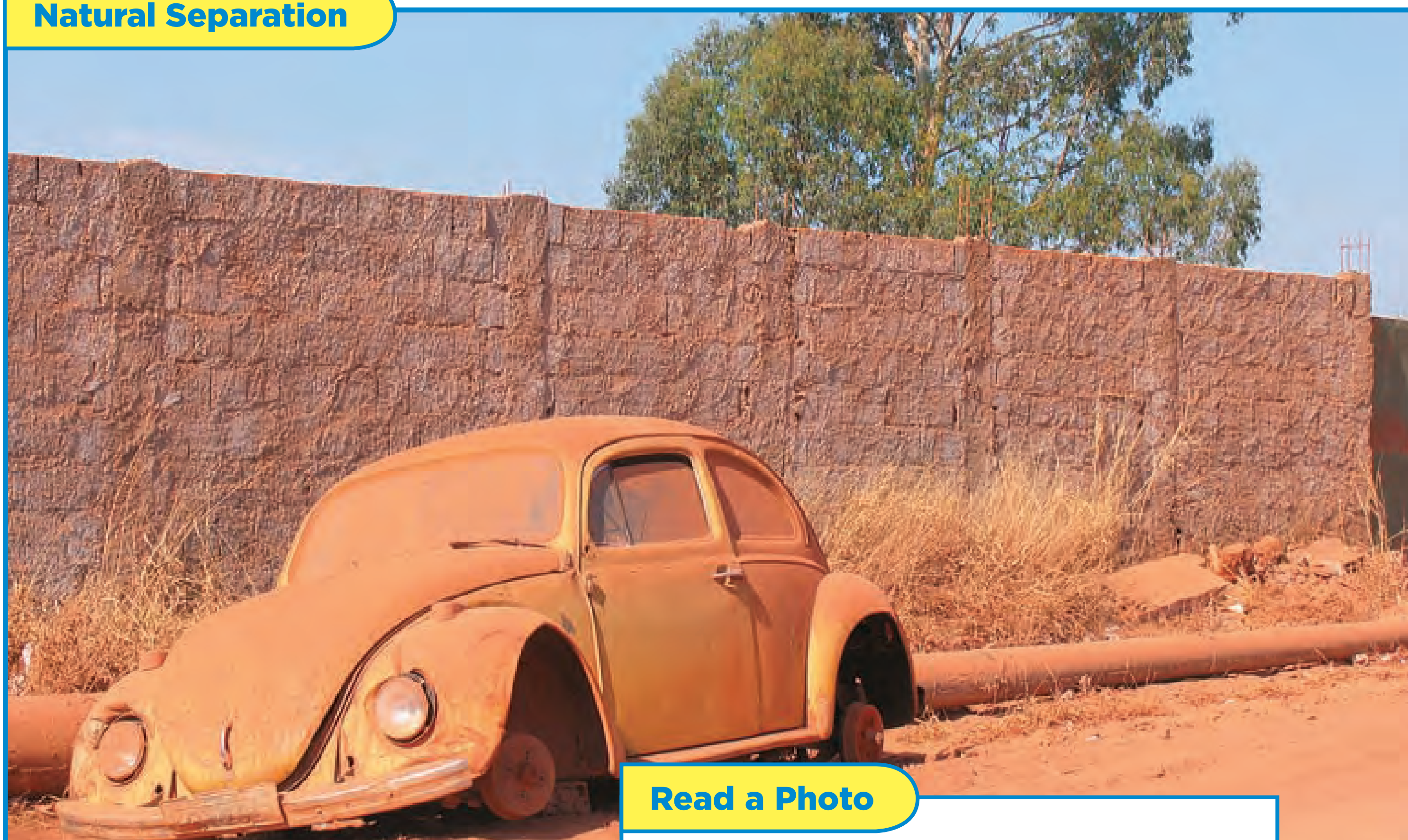
How can you separate the parts of a mixture?

We can use physical properties to separate a mixture. For example, you can separate a mixture of beads and coins by picking out different shapes and colors. You can also use properties like volume, size, state, and density.

Settling

One way to separate the parts of a mixture is by settling. *Settling* is when differences in densities cause the parts of a mixture to separate. For instance, mud is a mixture of soil and water. Over time, the soil in mud will sink to the bottom. The soil settles because it is denser than water.

Natural Separation



Read a Photo

How is this picture an example of settling?

Clue: Think about the kind of mixture that might be near the car.

A colander filters noodles from water.

Filtration

A **filter** separates things by size. Usually, the filter is a mesh, screen, net, or sieve (SIV). Materials that are smaller than the holes in a filter can pass through it. Larger materials stay behind.

Have you ever cooked noodles? You probably used a colander to drain the water out. People often use filters to separate a solid from a liquid. This process is called **filtration**.

Magnets

You can use a magnet to separate the parts of some mixtures. Magnets are often used to separate scrap metal from junkyards. A magnet pulls, or attracts, the elements iron, nickel, and cobalt. This property is called *magnetic attraction*.

Quick Lab

Separating a Mixture

1. Combine sand, paper clips, and small pebbles in a bowl.
2. **Observe** Move a magnet slowly over the mixture. What happens?
3. Filter the mixture with a colander. Use another bowl to collect what passes through the filter. Which items pass through the filter? Which do not pass through?
4. **Interpret Data** How can you use physical properties to separate the parts of a mixture?

Quick Check

Classify Which method would you use to separate a mixture of sand and water? Buttons and beads? Spaghetti and water?

Critical Thinking How can you separate salt from sand?

How can you separate the parts of a solution?

You have learned several ways to separate mixtures. How can you separate the parts of a solution like salt water? The tiny particles of salt can pass through most filters.

By Distillation

One way to separate a solution of liquid water and solid salt is distillation. In **distillation**, a solution is heated until the liquid becomes a gas. The solid is left behind.

The gas then passes through a *condenser*. This device cools the gas and collects it as a liquid. Distillation is used to make fuel. It separates gasoline from crude oil.

By Evaporation

Another way to separate the parts of a solution is evaporation. Recall that evaporation is the slow change of a liquid to a gas below the boiling point. When salt water evaporates, the water becomes a gas—water vapor. The solid salt is left behind. Evaporation only collects the solids in a solution. The liquids are lost to the air.

Quick Check

Classify List the methods you would use to separate the parts of a solution.

Critical Thinking To separate pure water from salt water, would you use evaporation or distillation? Explain.

In the Sahara Desert, salt pits are used to separate the salt from water.

Lesson Review

Visual Summary

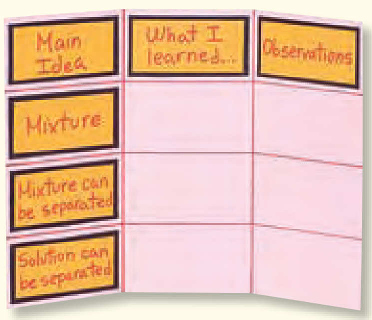
Mixtures are combinations of two or more types of matter. Solutions and alloys are types of mixtures.

Mixtures can be separated by their physical properties.

Solutions can be separated using evaporation and distillation.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use it to summarize what you read about mixtures.



Think, Talk, and Write

1. **Main Idea** What is a mixture? A solution? Give an example of each.

2. **Vocabulary** To collect the liquid from a solution of a solid and a liquid, you would use ________.

3. **Classify** Classify the following as mixtures or solutions—vegetable soup, salt water, bronze, smoke, apple juice and water, oil and water, trail mix.

4. **Critical Thinking** Blood is made of water, solids, and gases. Of these parts, the solids are densest. Is blood a mixture or a solution? How would you separate the solids from blood?

5. **Test Prep** **How would you separate salt from a saltwater solution?**

   A filtration
   B magnetism
   C evaporation
   D settling

Math Link

Gold Standards

Copper and gold form a hard alloy. The amount of gold in the alloy is measured in karats. Pure gold is 24 karats. Gold with half copper is 12 karats. How much copper is there in 6 karat gold alloy?

Art Link

Mix Colors

Red, blue, and yellow paint can be mixed to make other colors. What color does red and blue make? Red and yellow? Blue and yellow? What if you mix all three? Try it. Report your findings.

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Focus on Skills

Inquiry Skill: Use Variables

You know that water evaporates all the time. How would you find out if heat affects evaporation? When scientists plan an experiment to answer questions like this, they **use variables**. Variables are the factors in an experiment that are changed or unchanged. The factor you test is the *independent variable*. The factors you measure or count are *dependent variables*. The factors you keep the same are the *controlled variables*. By controlling variables, you know that only one thing affected your results—the independent variable.

▶ Learn It

When you **use variables** in an experiment, you identify what you are testing and what you are not testing. The best experiments test only one independent variable at a time. It's good practice to decide in advance how you will change the independent variable. It's important to keep careful records of those changes. Then you can easily see how the change affects the dependent variables.

▶ Try It

Use variables in your experiment to find out how heat affects evaporation.

Materials **3 air thermometers, graduated cylinder, water, 3 clear cups, 3 paper towels, 3 rubber bands, stopwatch**

1. As a class, select three locations that you think will have different air temperatures. Place a thermometer at each location.

2. Fill a graduated cylinder with 25 mL of water. Then prepare your cups. Stretch a paper towel across the top of each cup. Secure each towel with a rubber band. Label the cups *1*, *2*, and *3*.
3. Slowly pour 5 mL of water onto the center of each towel.
4. Place one cup at each of the three locations you chose in step 1. When you set each cup down, record the temperature and the time. Use a table like the one shown.

	Area 1	Area 2	Area 3
Temperature			
Start Time			
End Time			

5. Check the paper towels on the cups every minute. Record the time when each paper towel is dry.

▶ Apply It

1. How did you **use variables** in this experiment? List your independent variable, your dependent variable, and your controlled variables.
2. Explain how your dependent variables changed as you changed the independent variable. What does this tell you about the relationship between heat and evaporation?
3. If you wanted to show your results in a graph, where would you put the dependent variable? Where would you put the independent variable? Try it.

SI-5. Describe how comparisons may not be fair when some conditions are not kept the same between experiments.

Lesson 3

Compounds

Look and Wonder

Each July 4 we celebrate Independence Day. We gather with our families and our friends. At night, colorful fireworks light up the sky. What gives these fireworks their bright colors?

PS-2. Identify characteristics of a simple chemical change. When a new material is made by combining two or more materials, it has chemical properties that are different from the original materials (e.g., burning paper, vinegar and baking soda).

Explore

Inquiry Activity

How does iron react with air and moisture?

Make a Prediction

Steel wool has iron in it. What happens when you expose steel wool to air and moisture? Write a prediction.

Test Your Prediction

1. ⚠ **Be Careful.** Wear safety goggles. Take a small piece of steel wool. Soak it in vinegar for about one minute. Vinegar exposes the iron in the steel.
2. Fill a beaker slightly more than halfway with water. Using a pencil, push the steel wool into the bottom of an empty test tube. Place the tube upside down in the beaker of water.
3. **Observe** Put the beaker in a safe place. Observe it each day for four to five days. Record your observations. Add water to the beaker if the level gets low.

Draw Conclusions

4. **Communicate** Was your prediction correct? What happened to the steel wool? Describe any changes.
5. **Infer** Why do you think steel wool changes when it is exposed to moist air?

Explore More

Would you get the same results if the steel wool were completely underwater? Write a prediction that you can test. Design an experiment. Try it!

Materials

- safety goggles
- steel wool
- vinegar
- beaker
- water
- pencil
- test tube

Step 2

SI-2. Analyze a series of events and/or simple daily or seasonal cycles, describe the patterns and infer the next likely occurrence.

Read and Learn

Main Idea PS-2

Compounds are formed by chemical reactions between two or more elements.

Vocabulary

compound, p. 302

acid, p. 304

base, p. 304

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Reading Skill

Problem and Solution

Problem → Steps to Solution → Solution

What are compounds?

You have learned ways to separate the parts of a mixture. However, not all combinations of elements can be separated physically.

No amount of crushing, grinding, or sifting can separate the elements in table salt. That is because table salt is a compound. A **compound** forms when two or more elements combine chemically.

Chemical Properties

A compound can be separated only by chemical means, not by physical means. A substance's *chemical properties* can be observed when it changes chemically. A chemical property of iron is that it forms rust in the presence of oxygen.

Rust is a common compound. It is made of iron and oxygen. Iron is a gray metal. Oxygen is a clear gas. When these two elements combine, the result is iron oxide—rust. Rust is a brown solid. Rust is very different from both iron and oxygen!

Comparing Compounds and Mixtures

	Compound	Mixture
How are the parts combined?	two or more elements are combined chemically	two or more types of matter are mixed together
Do the parts keep their own properties?	no	yes
How can it be separated?	by chemical means	by physical means

Combining Elements

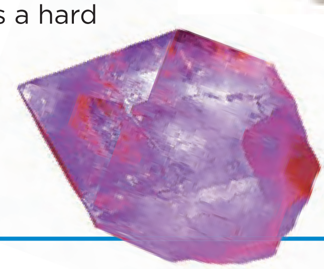
1 H Hydrogen — Hydrogen is a gas. + 8 O Oxygen — Oxygen is a gas. → Liquid water forms.

11 Na Sodium — Sodium is a metal. + 17 Cl Chlorine — Chlorine is a dangerous gas. → Table salt is a safe, nonmetal solid.

26 Fe Iron — Iron is a strong, gray metal. + 8 O Oxygen — Oxygen is a gas. → Rust is a weak, brown solid.

6 C Carbon — Carbon is a black solid. + 1 H Hydrogen — Hydrogen is a gas. + 8 O Oxygen — Oxygen is a gas. → Natural sugar is a brown solid.

14 Si Silicon — Silicon is a dark metalloid. + 8 O Oxygen — Oxygen is a gas. → Quartz is a hard mineral.



Read a Diagram

1. What do the plus signs stand for?
2. What do the arrows stand for?

Clue: Think of each combination as a math equation.

Quick Check

Problem and Solution How can you separate the elements in a compound?

Critical Thinking How are compounds different from mixtures?

Quick Lab

Acids and Bases

1. **Measure** In a large cup, mix 1 tsp of baking soda in 50 mL of water. Test this substance with both red and blue litmus paper. Record your observations in a chart.
2. ⚠ **Be Careful.** Wear goggles. Pour about 70 mL of vinegar in a different cup. Test it with litmus paper. Record your observations in your chart.
3. ⚠ **Be Careful.** Slowly pour the vinegar into the baking soda solution. Test the new solution with litmus paper. Record your observations.
4. **Interpret Data** Which were acids? Bases? How do you know?

Acids and Bases

Read a Diagram

Why does the water have both blue and red litmus paper below it?

Clue: What do the colors represent?

What are acids and bases?

Acids and bases are compounds that react easily with other substances. You can identify them using *litmus* (LIT•muhs) *paper*. Litmus is a dye that changes color when it touches acids or bases.

Acids

An **acid** is a substance that turns blue litmus paper red. A weak acid is what makes lemons sour. Some acids are quite strong. Acids can be harmful! Never touch or taste something to see if it is an acid. Many acids can burn your skin.

Bases

A **base** is a substance that turns red litmus paper blue. In foods, bases taste bitter. A strong base, such as drain cleaner, can also be harmful. Never touch or taste something to see if it is a base.

When an acid and a base combine, they react chemically. They form new a compound—a salt and water. Water does not change litmus paper. It is not an acid nor a base.

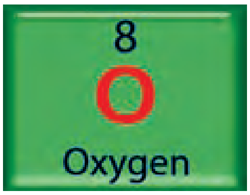
Quick Check

Problem and Solution How could you make a salt?

Critical Thinking Why should you never taste an acid or base?

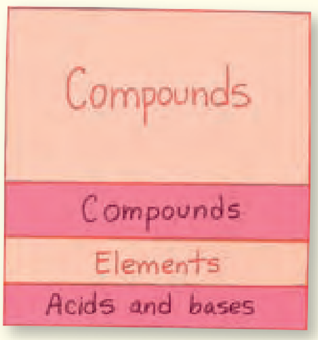
Lesson Review

Visual Summary

	**Compounds** form when two or more elements combine chemically. Rust is a common example.
	The properties of a compound are different from the properties of its original **elements**.
	You can use litmus paper to test for **acids and bases**.

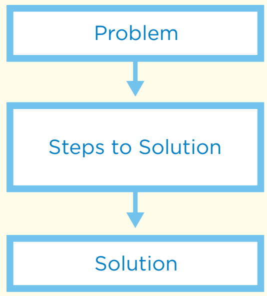
Make a FOLDABLES™ Study Guide

Make a Layered-Look Book. Use it to summarize what you read about compounds.



Think, Talk, and Write

1. **Main Idea** How are compounds formed?
2. **Vocabulary** Red litmus paper turns blue when you place it in a(n)________.
3. **Problem and Solution** You are looking for evidence of acid rain. What test or tests could you conduct?



4. **Critical Thinking** You breathe in oxygen from the air. You cannot breathe oxygen when it combines with hydrogen and forms water. Why not?
5. **Test Prep** **Which of the following is a compound?**
   - **A** oxygen
   - **B** sodium
   - **C** water
   - **D** iron

Writing Link

Explanatory Writing
How do you use compounds in your daily life? Write a brief paragraph explaining what they are and how you use them.

Art Link

Acid and Base Chart
Find pictures of different liquids you use every day. Establish if they are acids or bases. Arrange the pictures into a chart that shows how to classify the liquids.

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Be a Scientist

Materials

paper plates

markers

apple slices

toothpicks

lemon juice

water

Structured Inquiry

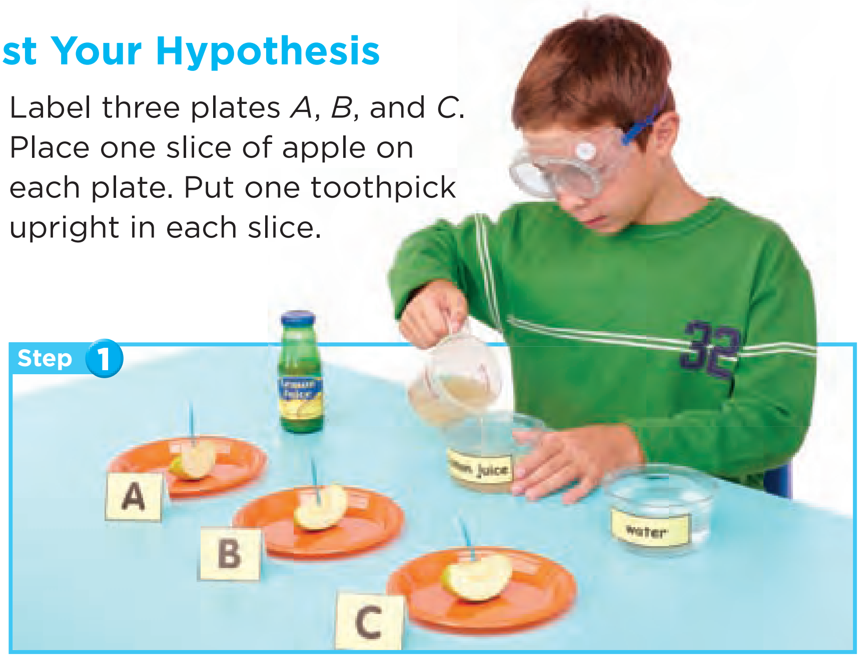
How can you change a chemical reaction?

Form a Hypothesis

Soon after an apple is cut, a chemical reaction takes place. Oxygen in the air turns the apple brown, just like iron turns to rust. Can you prevent this reaction? Use the materials in the list. Write your answer as a hypothesis in the form "A cut apple will not turn brown if ..."

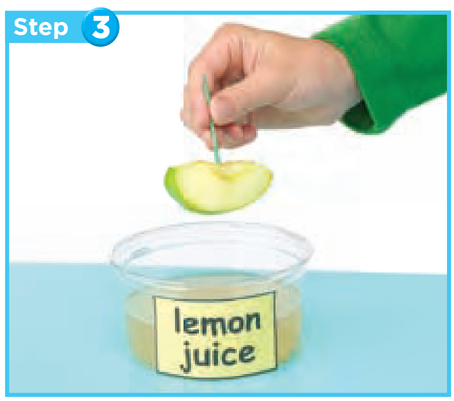
Test Your Hypothesis

1. Label three plates *A*, *B*, and *C*. Place one slice of apple on each plate. Put one toothpick upright in each slice.



2. **Communicate** In your journal, draw your setup. Describe the apple slices.

3. ⚠ **Be Careful.** Always wear safety goggles when using acids. Holding the toothpick, dip the entire apple slice from plate *A* in lemon juice. Then place the slice back on the plate. Dip the slice from plate *B* in water. Put it back on the plate. Leave the slice on plate *C* alone.



4 **Observe** After ten minutes, observe each apple slice. Record your observations.

Draw Conclusions

5 Was your hypothesis correct? Explain your answer.

6 **Interpret Data** How can you prevent a cut apple from turning brown? Why do you think this is so?

Guided Inquiry

How else can you stop oxygen from reacting chemically?

Form a Hypothesis

What other ways could you prevent fruit from turning brown? Write a hypothesis.

Test Your Hypothesis

Design an investigation to find out if other liquids stop fruit from turning brown. Write out the steps you will follow. Remember your safety tips. Record your results and observations in your journal.

Draw Conclusions

Did your results support your hypothesis? Why or why not? If you were making a fruit salad, what could you add to keep the fruit looking fresh?

Open Inquiry

What else would you like to learn about reactions between fruit and oxygen? For example, which fruits turn brown fastest? Design an investigation to answer your question. Another group should be able to complete the study by following your instructions.

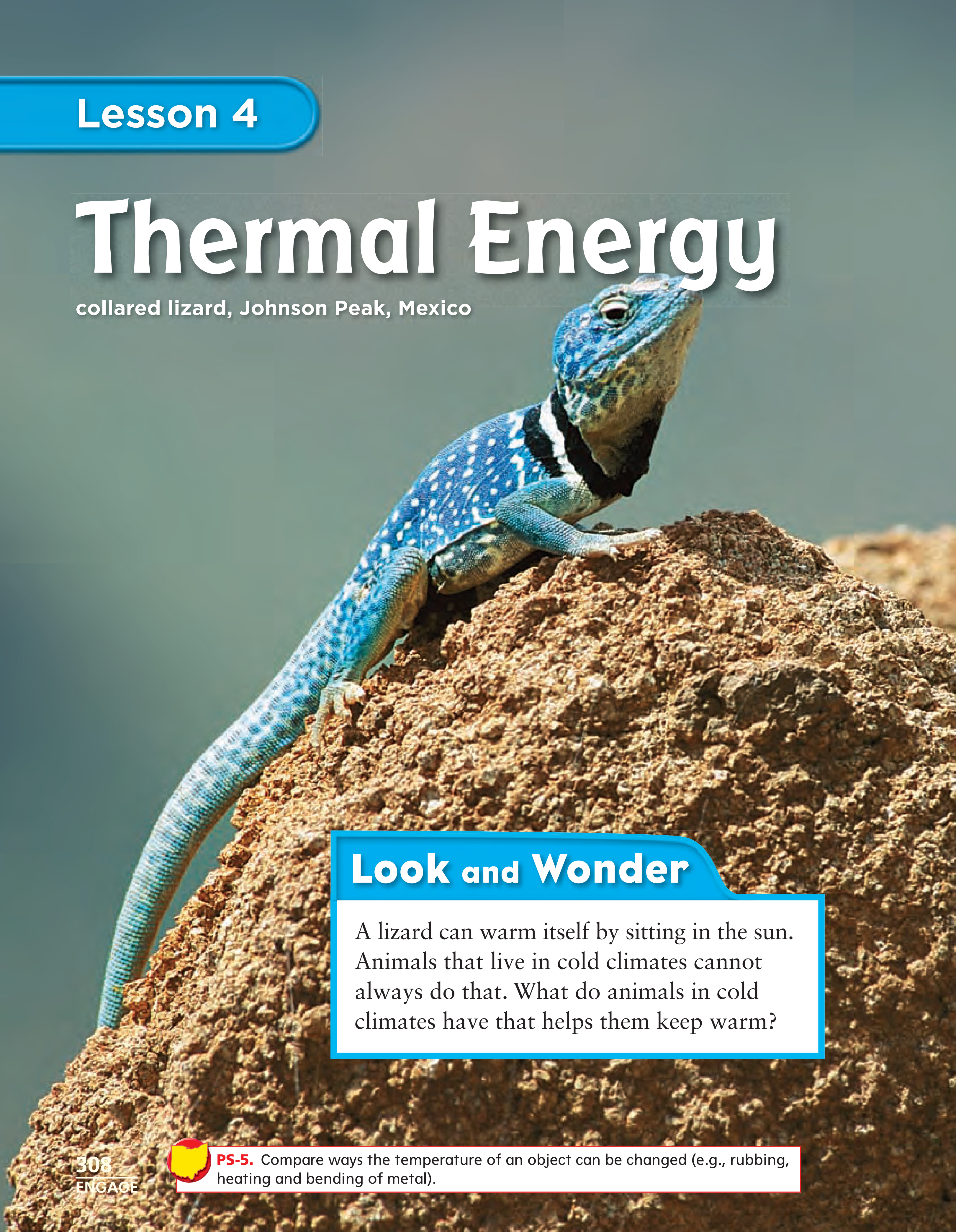
Remember to follow the steps of the scientific process.

Ask a Question
↓
Form a Hypothesis
↓
Test Your Hypothesis
↓
Draw Conclusions

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

Lesson 4

Thermal Energy



collared lizard, Johnson Peak, Mexico

Look and Wonder

A lizard can warm itself by sitting in the sun. Animals that live in cold climates cannot always do that. What do animals in cold climates have that helps them keep warm?

PS-5. Compare ways the temperature of an object can be changed (e.g., rubbing, heating and bending of metal).

Explore

Inquiry Activity

What keeps mammals warm in cold places?

Purpose

Explore how certain mammals—such as whales and seals—stay warm in cold water.

Procedure

1. Put on a latex glove. Have a partner time how long you can comfortably keep your hand in ice water. Record the time. ⚠ **Be Careful.** Remove your hand as soon as it feels chilled!
2. **Make a Model** Dry your hand and let it warm. Move your gloved hand around in the shortening to coat it. Get a thick layer over your entire hand and between your fingers.
3. How long can you keep your hand in the ice water now? Have your partner time you. Record the results.
4. **Use Numbers** Trade places and let your partner repeat the procedure. Compute the average of both sets of results.

Draw Conclusions

5. **Interpret Data** How long on average could you keep your hand in ice water in step 1? In step 3?
6. **Infer** The shortening represents fat. How might an extra layer of fat help you survive in a cold climate?

Materials

- latex gloves
- bucket of ice water
- stopwatch
- paper towels
- vegetable shortening

Step 1

Explore More

What other substances or materials can help mammals stay warm? List the ones you know. Then research some you don't know. Report your findings to the class.

SWK-2. Record the results and data from an investigation and make a reasonable explanation.

Read and Learn

Main Idea PS-5

Thermal energy flows from warmer objects to cooler objects. There are three main ways thermal energy is transferred.

Vocabulary

thermal energy, p. 310

conduction, p. 312

convection, p. 312

radiation, p. 313

insulator, p. 313

conductor, p. 313

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Reading Skill

Cause and Effect

Cause → Effect
→
→
→
→

What is thermal energy?

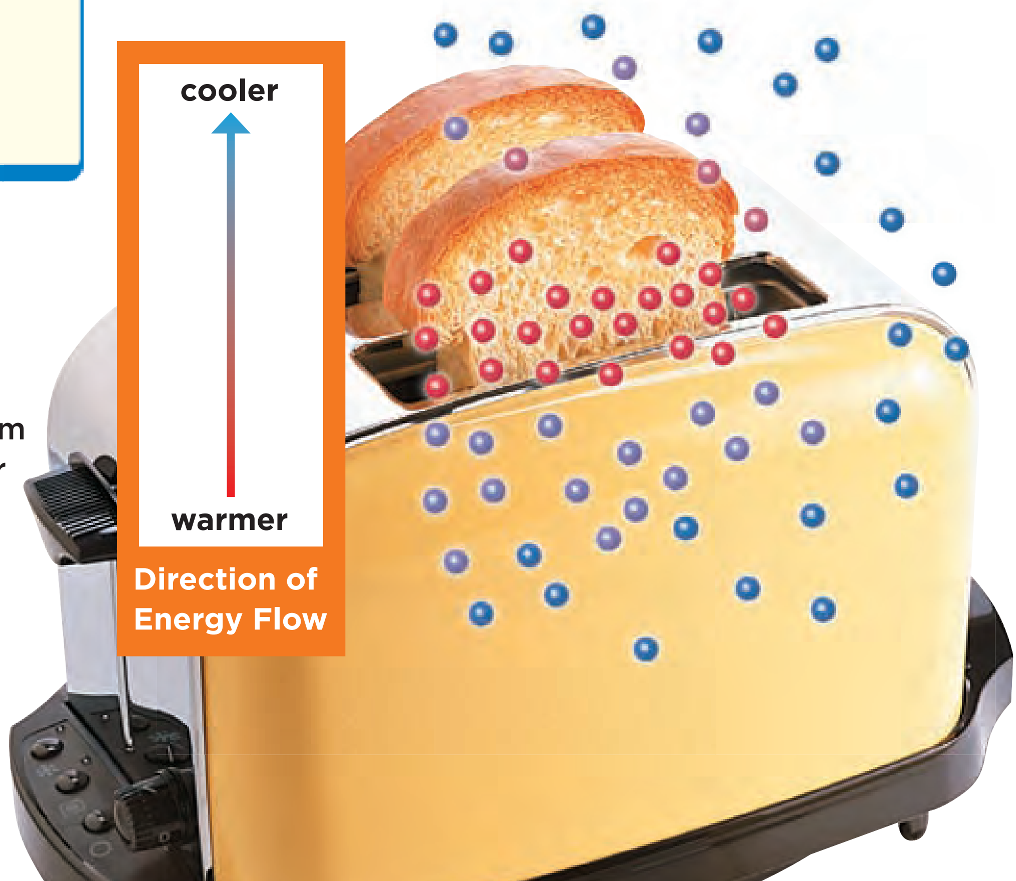
Energy is needed for animals to stay warm. Whether it's from the Sun or your body, thermal energy keeps you warm. **Thermal energy** is the energy of moving particles in matter. The more thermal energy, the faster the movement.

Heat is the flow of thermal energy from one object to another. Thermal energy always moves from warmer objects to cooler objects.

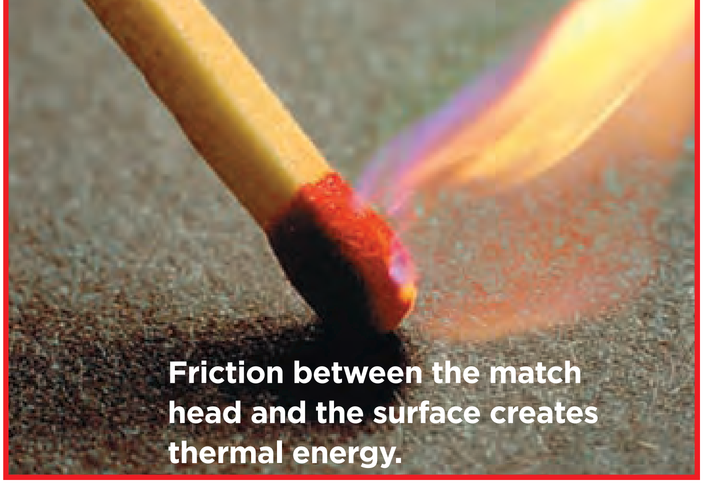
Transferring Thermal Energy

What happens when you use a toaster? Not only do you heat the bread, you also heat the air around it. Touch the warm toast, and that same thermal energy moves to your hand.

The hot particles of the toaster move quickly. They bump into cooler particles around them. The toaster particles slow as they transfer their thermal energy. The cooler particles speed up. In time, all the particles move at the same speed.



Thermal energy moves from the warm toaster to the cooler air around it.



Friction between the match head and the surface creates thermal energy.

Changing Temperature

Heating can change an object's temperature (TEM•puhr•uh•chuhr). *Temperature* measures the average energy of the particles in a substance.

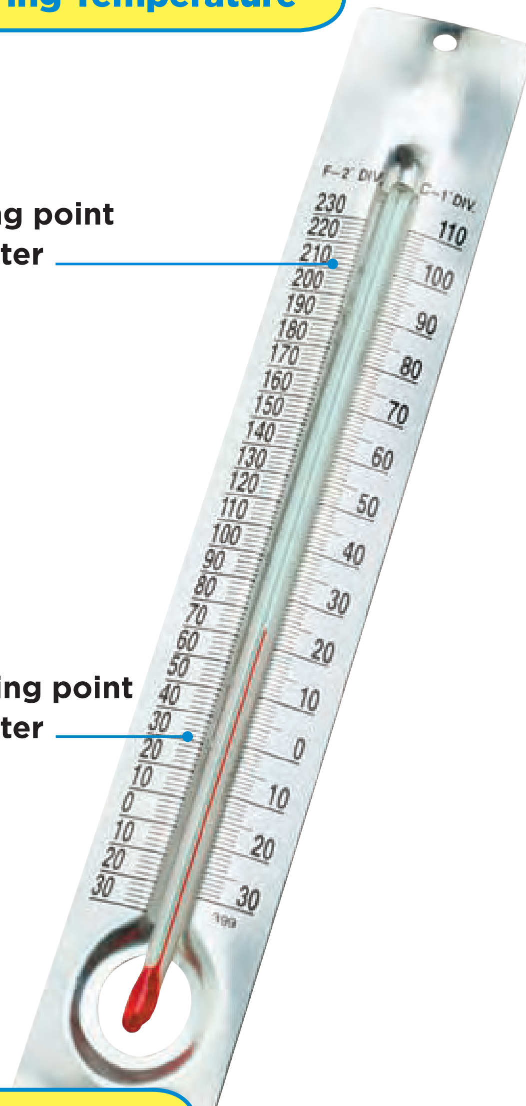
We measure temperature with a *thermometer* (thuhr•MOM•i•tuhr). Inside most thermometers is a liquid such as alcohol. As the thermometer warms, the particles of the liquid move faster and farther apart. This movement makes the liquid expand and rise inside the thermometer.

Measuring Temperature

Did you ever have a fever? You probably measured your temperature in degrees Fahrenheit, or F. Most scientists use the Celsius, or C, scale to measure temperature.

The thermometer on this page shows both scales. Water freezes at 32 degrees F. Can you locate that point on the thermometer? It is in the same place as 0 degrees C. Water boils at 212 degrees F. As you can see, that amount is 100 degrees C.

Measuring Temperature



Read a Photo

What is the temperature in Fahrenheit? In Celsius?

Clue: Find the marks near the top of the red line.

Quick Check

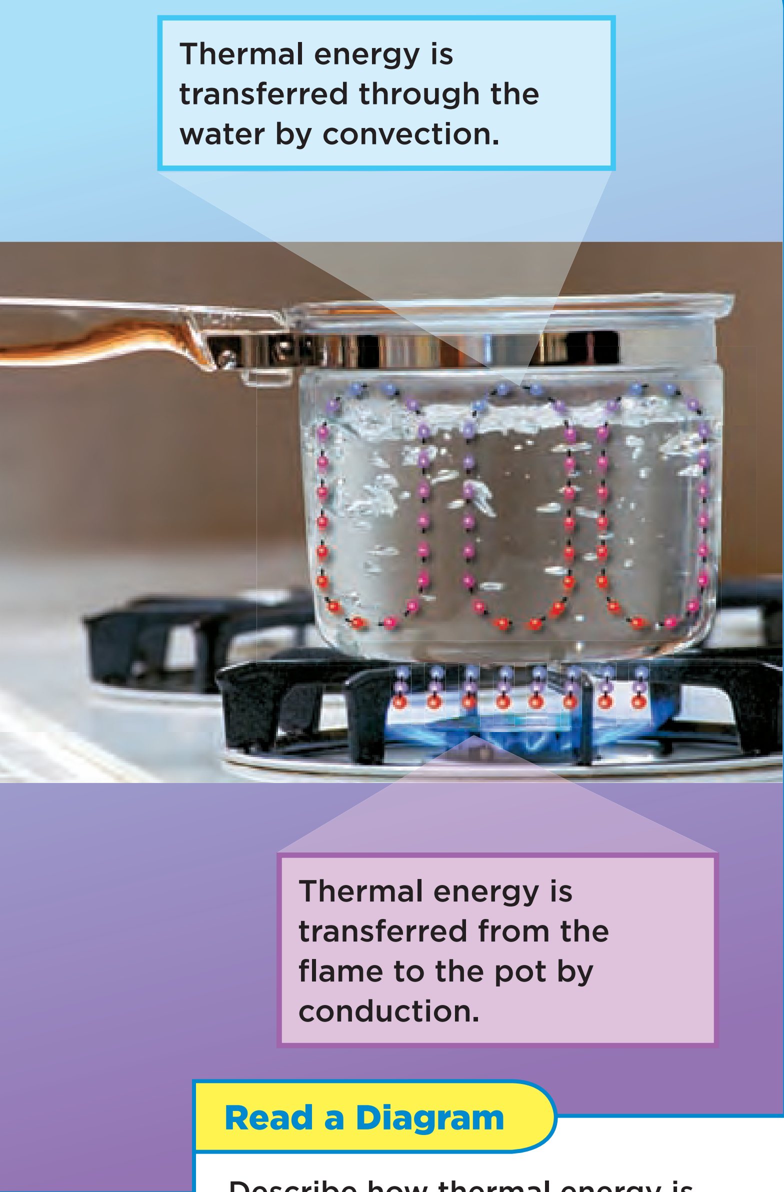
Cause and Effect What happens to the particles of an ice cube when placed in a glass of juice?

Critical Thinking How are thermal energy and temperature related?

How does thermal energy travel?

You have learned what happens when thermal energy is transferred. How does thermal energy transfer take place?

Thermal Energy Transfer



Read a Diagram

Describe how thermal energy is flowing in this pot of water.

Clue: The red circles are hot particles. The blue circles are cooler particles.

Conduction

Solids are heated mainly by conduction (kuhn•DUK•shuhn). **Conduction** occurs between two objects that are touching. Conduction can also occur within an object, such as a metal pot.

What happens when you heat a pan on a stove? The hot particles of the burner or flame hit the cooler particles of the pan. These collisions give the cooler particles more energy. Then, the particles of the pan start to collide with each other. Soon, the entire pan gets hot.

Convection

Another way to transfer thermal energy is by convection (kuhn•VEK•shuhn). **Convection** transfers thermal energy through liquids or gases.

If you want to boil water, you can heat it in a pot. As the pot heats, it transfers energy to the water. The water particles at the bottom of the pot heat first. They move faster and farther apart. As the particles get warmer they rise. The warm particles replace the cooler particles at the top. The cooler particles sink. When all particles of water move at the same rate, the liquid boils.

FACT Heat is not the same thing as temperature.

The Sun's energy is transferred through space by radiation.

Radiation

The third way to transfer thermal energy is by radiation (ray•dee•AY•shuhn). **Radiation** is the transfer of energy through space. Without radiation, energy from the Sun would not reach Earth. Matter does not need to be present for radiation to occur.

Quick Lab

Temperature and Air

1. **Predict** Place a deflated balloon over the mouth of an empty plastic bottle. What will happen if you put the bottle in hot water? In cold water?
2. **Observe** Place the bottle in a bucket of warm water. Wait five minutes. What happens to the balloon?
3. Now place the bottle in a bucket of ice water. What happens?
4. What do you think caused the balloon to inflate and deflate?

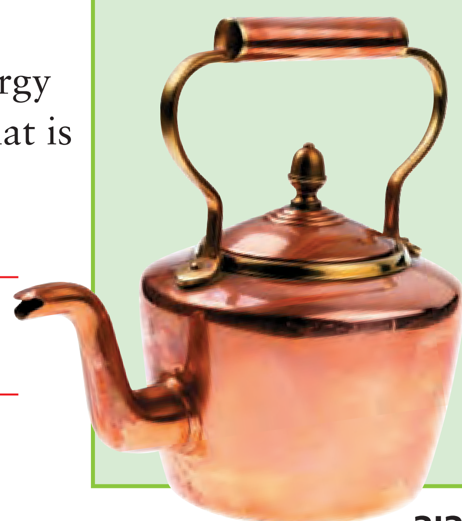
Insulators and Conductors

In winter, you might wear a fleece jacket to stay warm. Fleece is an insulator (IN•suh•lay•tuhr). **Insulators** do not transfer thermal energy very well. Fat is an insulator that mammals have in their bodies. It helps keep their body heat from escaping into the cold air.

Wool mittens are good insulators for your hands.

The opposite of an insulator is a conductor (kuhn•DUK•tuhr). **Conductors** transfer thermal energy easily. Metal, for instance, is a good conductor. That is why many pots and pans are made of metal.

A copper kettle is a good conductor for hot liquids. ▼



Quick Check

Cause and Effect A metal object feels cooler than a wood object at room temperature. Why?

Critical Thinking How is radiation different from conduction and convection?

How can thermal energy change matter?

The particles that make up matter are always moving. By adding energy to those particles, or taking energy away, you can change matter.

Physical Changes

If you add thermal energy, the particles of matter move faster and farther apart. The matter expands, taking up more space. The opposite happens if you take energy away. When cooled, most matter contracts (kuhn•TRAKTS), or shrinks. The particles move closer together.

Chemical Changes

Adding thermal energy can cause some matter to burn. Burning is a chemical change. When fuel burns, the energy stored inside it is released.

Changes of State

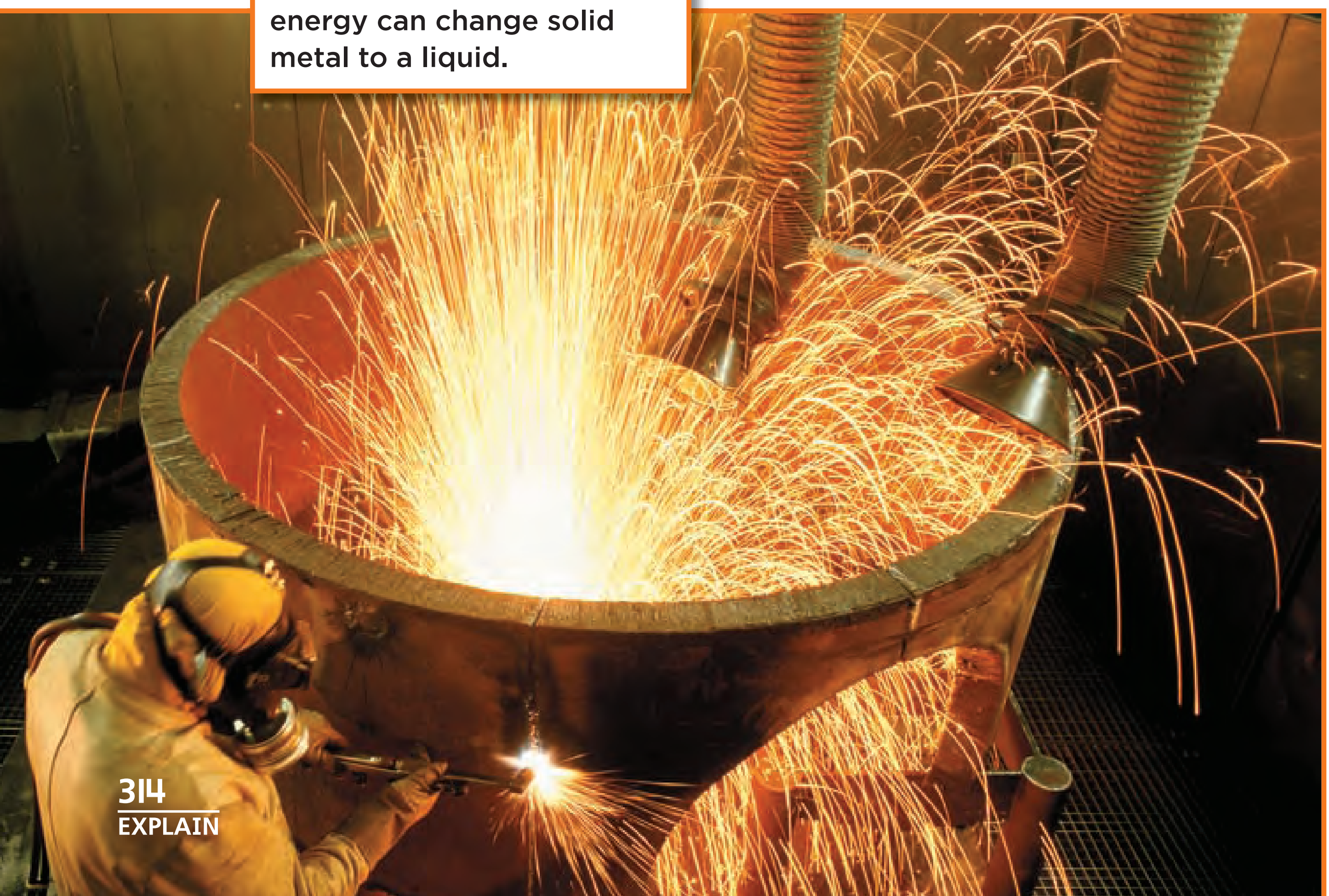
If enough energy is added, matter can change state. The welder below is using a torch to heat solid metal. The flame is hot enough to melt the metal. If more energy were added, the liquid metal would change to a gas.

Quick Check

Cause and Effect How does thermal energy affect matter?

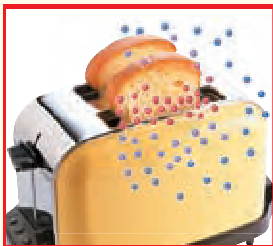
Critical Thinking Why do people burn coal and oil?

Increasing the thermal energy can change solid metal to a liquid.

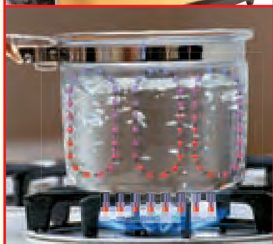


Lesson Review

Visual Summary



Heat is the flow of thermal energy from a warmer object to a cooler object.

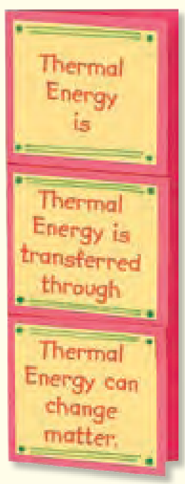


Thermal energy is transferred through conduction, convection, and radiation.

Thermal energy can cause matter to expand, contract, burn, or change state.

Make a FOLDABLES™ Study Guide

Make a Three-Tab Book. Use it to summarize what you learned about thermal energy.



Think, Talk, and Write

1. **Main Idea** Explain the three ways in which thermal energy is transferred.

2. **Vocabulary** The transfer of thermal energy through space is called ________.

3. **Cause and Effect** What happens when thermal energy is added to ice? To liquid water? To a balloon filled with air?

Cause → Effect
→
→
→
→

4. **Critical Thinking** Explain why thermal energy will not flow from an ice cube to a hot drink.

5. **Test Prep** **Many pots and pans are made of metal because metal is a good ________**

   A conductor.
   B insulator.
   C energy source.
   D radiator.

Writing Link

Compare and Contrast
Write a paragraph comparing a metal cup and a foam cup. Which would you choose for a hot drink? A cold drink? Explain your choices.

Art Link

Thermal Energy Transfer Picture
Draw a picture that shows examples of the three ways that thermal energy is transferred. Add labels and captions to your picture.

Focus on Skills

Inquiry Skill: Infer

You just read that insulators do not transfer thermal energy very well. One way to keep ice cubes from melting is to insulate them. Scientists experiment to find out which materials prevent the most energy transfer. After the experiment, they can **infer** which material will make the best insulator.

▶ Learn It

When you **infer**, you form an idea from facts or observations. It's easier to form an idea about a result when the information is organized. You can use charts, tables, or graphs to organize your data. That way you can quickly see differences and form an opinion about the results.

▶ Try It

Use different materials to insulate ice cubes. **Infer** which material is best for slowing the melting.

Materials **scissors, paper, aluminum foil, plastic wrap, 4 ice cubes, tape, shallow dish**

1. Make a chart like the one shown.
2. Cut a piece of paper just large enough to cover one ice cube. Do the same with the aluminum foil and plastic wrap.
3. Wrap one of the ice cubes in the paper. Seal the paper well with tape. Place the sealed ice cube in the dish. Record the time in your chart.

4. Repeat step 3 with the aluminum foil. Repeat again with the plastic wrap. Leave one ice cube unwrapped. Record the time you place each ice cube in the dish.
5. Observe the ice cubes in the dishes. Record the time when each ice cube melts completely.
6. Calculate the time it took for each ice cube to melt. Enter the times in your chart.

	Foil	Paper	Plastic	Unwrapped
Start Time				
Melted				
Time to Melt				

▶ Apply It

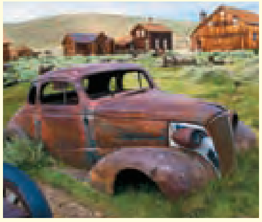
Interpret your data to **infer** which wrapper best insulated the ice cube.

1. Compare your result for the unwrapped ice cube to each of your other results. Which material was the best insulator? What was the time difference between that one and the unwrapped cube?
2. Which material was the poorest insulator? Why do you think so?
3. Why was it a good idea to keep one ice cube unwrapped?
4. What type of thermal energy transfer did you investigate? Explain your thinking.

SI-3. Develop, design and conduct safe, simple investigations or experiments to answer questions.

CHAPTER 6 Review

Visual Summary



Lesson 1 Physical changes start and end with the same kind of matter. Chemical changes form new kinds of matter.

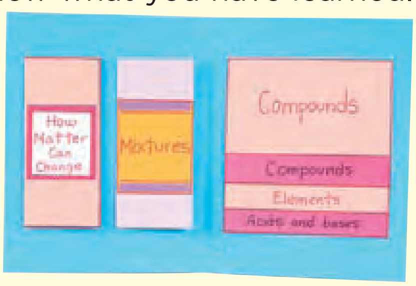
Lesson 2 Matter can be combined to form mixtures. Mixtures can be separated by their physical properties.

Lesson 3 Compounds are formed by chemical reactions between two or more elements.

Lesson 4 Thermal energy flows from warmer to cooler objects.

Make a FOLDABLES™ Study Guide

Tape your lesson study guides to a piece of paper as shown. Use your study guide to review what you have learned.



Vocabulary

Fill each blank with the best term from the list.

alloy, p. 293

compound, p. 302

evaporation, p. 283

change of state, p. 282

solution, p. 292

convection, p. 314

mixture, p. 292

chemical change, p. 284

1. A combination of two or more types of matter is a(n) ________.
PS-3

2. Rusting is a(n) ________.
PS-2

3. Two or more elements that are chemically combined make up a(n) ________.
PS-2

4. If thermal energy is added to a solid, a(n) ________ can occur.
PS-4

5. Bronze is a(n) ________ that is a mixture of several metals.
PS-2

6. The process that transfers thermal energy through liquids or gases is ________.
PS-5

7. A mixture in which two or more substances are blended together completely is called a(n) ________.
PS-1

8. A liquid changes to a gas during ________.
PS-1, PS-4

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Skills and Concepts

Answer each of the following in complete sentences.

9. **Sequence** How does water change from a solid to a liquid? Explain the sequence of events.
PS-1, PS-5

10. **Use Variables** You want to find out if light affects how fast a nail rusts. You plan an experiment to test and compare two nails. Which variable will you change? Which variables will you keep the same?
PS-2

11. **Critical Thinking** When carbon and oxygen combine, carbon dioxide forms. Is carbon dioxide a mixture, a solution, or a compound? Explain.
PS-2

12. **Summarize** What signal shows that a chemical change is occurring in the picture below? What are some other signals of chemical changes?
PS-2, PS-4

13. **Expository Writing** What kinds of changes occur as you blend pancake mix, milk, and an egg and then heat the batter to make pancakes?
PS-1, PS-2, PS-4

The Big Idea

14. How can matter change?
PS-A, PS-D

Performance Assessment

Mixture or Solution?

Your goal is to make one mixture and one solution using two substances.

1. Gather water, cooking oil, sugar, salt, and gravel or small rocks.
2. Choose two substances to make a mixture. Combine them. Tell how you know it is a mixture. Name the parts of your mixture.
3. Choose two substances to make a solution. Combine them. Tell how you know it is a solution. Name the parts of your solution.

Analyze Your Results

Would your mixture change if it were heated or cooled? Would your solution change? Explain.

Ohio Activity

Ohio has many places where you can snow ski or snowboard. Unlike mountainous states Ohio's winters have warm days that melt snow and cold days when it does not snow. To have as many ski days as possible, Ohio's ski resorts make their own snow. How do they do it? Research how a snow-making machine works. How cold does it have to be to make snow? Make a diagram showing how snow-making machines work.

Ohio Benchmark Practice

1 **A student puts a handful of soil into a bowl of water. He then stirs the soil with a spoon. What will happen after he stops stirring?**

A A solution of soil and water will be formed.

B The soil will form an alloy with the water.

C The soil will settle to the bottom of the bowl.

D The soil will evaporate.

PS-A

2 **Lynda heated a pot of water to 40°C. She poured equal amounts of the water into each of 4 cups. After 30 minutes, she measured the temperature of the water in each cup. The table summarizes her results.**

Cup	Temperature (in degrees Celsius)
1	22
2	28
3	33
4	36

Which cup is the **best** insulator?

A cup 1

B cup 2

C cup 3

D cup 4

SI-B, PS-D

3 **An object's temperature describes how much**

A weight it has.

B mass it has.

C thermal energy it has.

D volume it has.

SWK-A, PS-D

4 **Liquids are made of particles.**

In your Answer Document, draw or describe what happens to the particles in a liquid as the liquid is cooled.

Then draw or describe what happens to the particles as the liquid is heated. (2 points)

PS-D

5 **People wear gloves when outside in the winter.**

How do gloves help people stay warm?

A Gloves stop thermal energy from leaving their hands.

B Gloves slow down the thermal energy leaving their hands.

C Gloves stop cold from entering their bodies through their hands.

D Gloves slow down cold from entering their bodies through their hands.

PS-A

6 **When iron and oxygen combine, what is the result?**

A a chemical compound called rust

B a chemical mixture called rust

C a physical mixture called rust

D a chemical gas called rust

SI-B, PS-A

7 The table below shows changes of state for some common materials.

Changes of State		
Name	**Melting Point**	**Boiling Point**
copper	1,083°C	2,567°C
nitrogen	–210°C	–196°C
water	0°C	100°C
table salt	801°C	1,465°C
iron	1,538°C	2,861°C

Based on the table, which of the following is a valid conclusion?

A Nitrogen gas cannot change its state.

B Most solids change into liquids at similar temperatures.

C Metals become gases at relatively high temperatures.

D Particles of salt and water are similarly spaced.

PS-C

8 In your **Answer Document**, identify an example of a physical change and an example of a chemical change.

Then compare how easy or difficult it is to reverse each type of change. (4 points)

PS-A

9 A student squeezes lemon juice onto a saucer. He then dips a strip of blue litmus paper into the juice. What will happen next?

A The paper will turn red because lemon juice is a base.

B The paper will turn red because lemon juice is an acid.

C The paper will turn blue because lemon juice is a base.

D The paper will turn blue because lemon juice is an acid.

PS-A

10 Which would show the boiling point of water at 212 degrees?

A a radiation thermometer

B a thermal energy scale

C a Celsius thermometer

D a Fahrenheit thermometer

SI-A

11 A chef heated water in two different pots—one made of glass and one made of metal. She used the same amount of thermal energy and the same amount of water in each pot. The water in the metal pot heated faster because

A metal radiates thermal energy better than glass.

B glass radiates thermal energy better than metal.

C metal conducts thermal energy better than glass.

D glass conducts thermal energy better than metal.

PS-D

Literature

Magazine Article

from *Time for Kids*

MR. MIX-IT

by Nicole Iorio

As a kid in Puerto Rico, Maelo Cordova wondered what exactly is in shampoo that helps it clean hair. He also experimented—mixing cleaning products, for example, to get out spots.

In high school, Cordova discovered the name of his hobby, chemistry. He loved learning how substances combine to make new substances. After winning a top science award, he studied chemistry in college. He now works at a toy company.

At work, Cordova mixes chemicals and performs experiments, but he does his homework first. "I like to spend time investigating what I'm looking for before I get in the lab," Cordova explains.

For one project, he was asked to make icky, sticky play slime. His recipe was a little off. The goo came out harder than he wanted, and he almost tossed it into the trash. Instead, he saved the substance and went on to earn a patent for his new invention, Flubber. Says Cordova, "In science, you never throw anything away." His next mistake may turn out to be even more fun.

Write About It

Response to Literature What type of job would you like to have when you grow up? What skills does it require? Write a paragraph about your plans.

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Pharmacy Technician

Do you look forward to doing science activities? Do you also like working with people? If so, you might enjoy a career in health care. A pharmacy technician works with pharmacists, or people who fill prescriptions. This person may work in a pharmacy in a drugstore, grocery store, hospital, or nursing home.

To qualify for this career, you would train on the job. You might take classes to earn a certificate. Then you could work with a pharmacist. You would help prepare medicines, counsel patients, and work with insurance companies. Best of all, you would help people to recover from illnesses.

▲ A pharmacy technician helps people understand more about their medicine.

Pharmaceutical Researcher

Have you ever wondered where your medicine comes from? Some medicines, like aspirin, were first made from plants! Today, most are made in laboratories by pharmaceutical researchers.

If you are curious about how the body works and you want to make a difference, this career may be for you. To become a pharmaceutical researcher, you would study science in college. Then you would study medicine in graduate school.

▲ Pharmaceutical researchers work to develop new medicines.

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Reference

You can use a ruler to find the length of an object. ▶

Science Handbook

Measurements

Units of Measurement

Temperature

▶ The temperature on this thermometer reads 86 degrees Fahrenheit. That is the same as 30 degrees Celsius.

Length and Area

▶ This student is 3 feet plus 9 inches tall. That is the same as 1 meter plus 14 centimeters.

Mass

▶ You can measure the mass of these rocks in grams.

Volume of Fluids

▶ This bottle of water has a volume of 2 liters. That is a little more than 2 quarts.

Weight/Force

▶ This pumpkin weighs about 7 pounds. That means the force of gravity is 31.5 newtons.

Speed

▶ This student can ride her bike 100 meters in 50 seconds. That means her speed is 2 meters per second.

Table of Measures	
SI International Units/Metric Units	**Customary Units**
Temperature Water freezes at 0 degrees Celsius (°C) and boils at 100°C. **Length and Distance** 10 millimeters (mm) = 1 centimeter (cm) 100 centimeters = 1 meter (m) 1,000 meters = 1 kilometer (km) **Volume** 1 cubic centimeter (cm^3) = 1 milliliter (mL) 1,000 milliliters = 1 liter (L) **Mass** 1,000 milligrams (mg) = 1 gram (g) 1,000 grams = 1 kilogram (kg) **Area** 1 square meter (m^2) = 1 m x 1 m 10,000 square meters (m^2) = 1 hectare **Speed** meters per second (m/s) kilometers per hour (km/h) **Weight/Force** 1 newton (N) = 1 kg x $1m/s^2$	**Temperature** Water freezes at 32 degrees Fahrenheit (°F) and boils at 212°F. **Length and Distance** 12 inches (in.) = 1 foot (ft) 3 feet = 1 yard (yd) 5,280 feet = 1 mile (mi) **Volume of Fluids** 8 fluid ounces (fl oz) = 1 cup (c) 2 cups = 1 pint (pt) 2 pints = 1 quart (qt) 4 quarts = 1 gallon (gal) **Area** 1 square foot (ft^2) = 1 ft x 1 ft 43,560 square feet (ft^2) = 1 acre **Speed** miles per hour (mph) **Weight/Force** 16 ounces (oz) = 1 pound (lb) 2,000 pounds = 1 ton (T)

Measurements

Measure Time

You measure time to find out how long something takes to happen. Stopwatches and clocks are tools you can use to measure time. Seconds, minutes, hours, days, and years are some units of time.

Try it Use a Stopwatch to Measure Time

1. Get a cup of water and an antacid tablet from your teacher.
2. Tell your partner to place the tablet in the cup of water. Start the stopwatch when the tablet touches the water.
3. Stop the stopwatch when the tablet completely dissolves. Record the time shown on the stopwatch.

▲ Push the button on the top right of the stopwatch to start timing. Push the button again to stop timing.

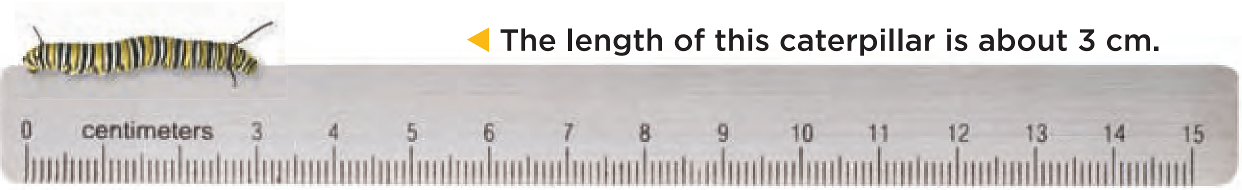
Measure Length

You measure length to find out how long or how far away something is. Rulers, tape measures, and metersticks are some tools you can use to measure length. You can measure length using units called meters. Smaller units are made from parts of meters. Larger units are made of many meters.

Look at the ruler below. Each number represents 1 centimeter (cm). There are 100 centimeters in 1 meter. In between each number are 10 lines. Each line is equal to 1 millimeter (mm). There are 10 millimeters in 1 centimeter.

Try it Find Length with a Ruler

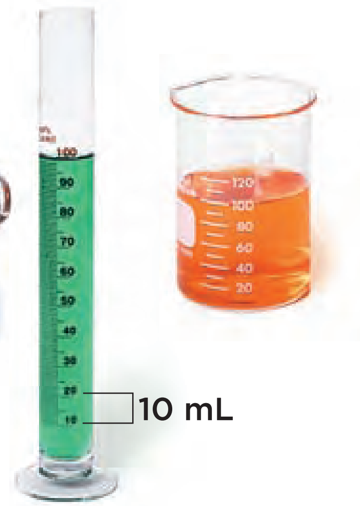
Place a ruler on your desk. Line up a pencil with the "0" mark on the ruler. Record the length of the pencil in centimeters.



◄ The length of this caterpillar is about 3 cm.

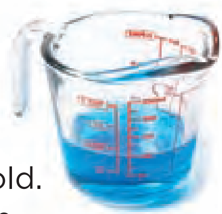
Measure Liquid Volume

Volume is the amount of space something takes up. Beakers, measuring cups, and graduated cylinders are tools you can use to measure liquid volume. These containers are marked in units called milliliters (mL).



▲ This graduated cylinder can measure volumes up to 100 mL. Each number on the cylinder represents 10 mL.

Try it **Measure Liquid Volume**



1. Gather a few empty plastic containers of different shapes and sizes.
2. Use a graduated cylinder to find the volume of water each container can hold. To start, fill the graduated cylinder with water, then pour the water into the container. Continue pouring this until the container is full. Keep track of the number of milliliters you add.

Measure Mass

Mass is the amount of matter an object has. You use a balance to measure mass. To find the mass of an object, you compare it with objects whose masses you know. Grams are units people use to measure mass.

Try it **Measure the Mass of a Box of Crayons**

1. Place a box of crayons on one side of a pan balance.
2. Add gram masses to the other side until the two sides of the balance are level.
3. Add together the numbers on the gram masses. This total equals the mass of the box of crayons.

Measurements

Measure Force/Weight

You measure force to find the strength of a push or pull. Force can be measured in units called newtons (N). A spring scale is a tool used to measure force.

Weight is a measure of the force of gravity pulling down on an object. A spring scale measures the pull of gravity. One pound is equal to about 4.5 newtons.

Try it **Measure the Weight of an Object**

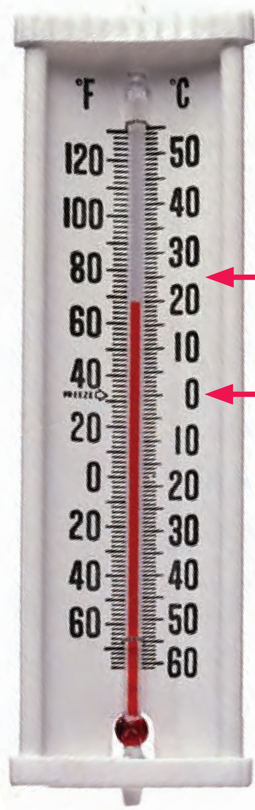
1. Hold a spring scale by the top loop. Put a small object on the bottom hook.
2. Slowly, let go of the object. Wait for the spring to stop moving.
3. Read the number of newtons next to the tab. This is the object's weight.

Measure Temperature

Temperature (TEM•puhr•uh•chuhr) is how hot or cold something is. You use a tool called a thermometer (thuhr•MOM•i•tuhr) to measure temperature. In the United States, temperature is often measured in degrees Fahrenheit (°F). However, you can also measure temperature in degrees Celsius (°C).

Try it **Read a Thermometer**

1. Fill a beaker with ice water. Then put a thermometer in the water.
2. Wait several minutes. Read the number next to the top of the red liquid inside the thermometer. This is the temperature.
3. Repeat with warm water.

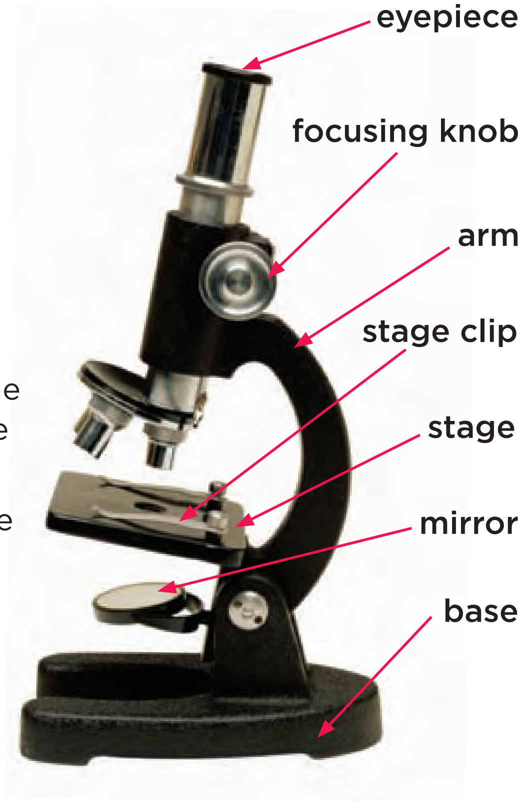


This thermometer shows temperature in both degrees Fahrenheit and degrees Celsius.

Tools of Science

Use a Microscope

A microscope (MYE•kruh•skohp) is a tool that magnifies objects, or makes them look larger. A microscope can make an object look hundreds or thousands of times larger. Look at the photo to learn the different parts of a microscope.



Try it Examine Salt Grains

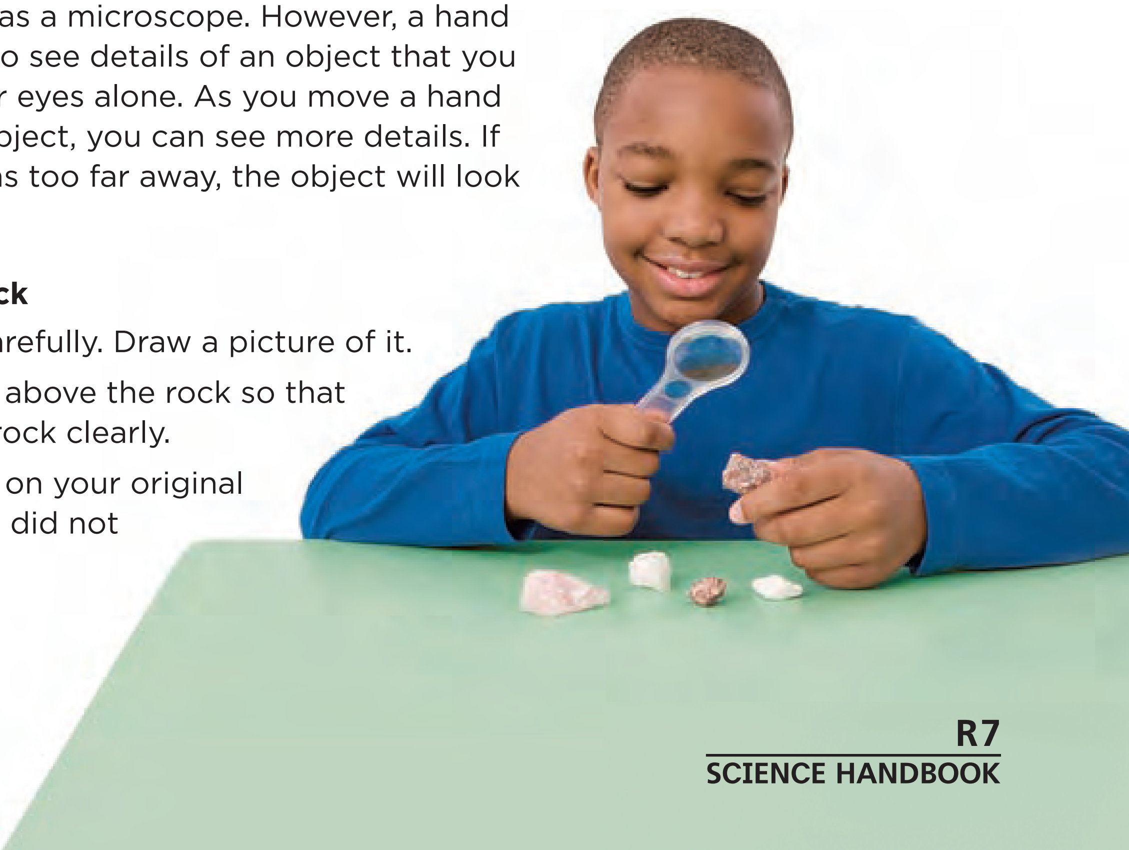
1. Move the mirror so that it reflects light up toward the stage. ⚠ **Be Careful**. Never point the mirror at bright lights or the Sun. This can cause permanent eye damage.
2. Place a few grains of salt on a slide. Put the slide under the stage clips on the stage. Be sure that the salt grains are over the hole in the stage.
3. Look through the eyepiece. Turn the focusing knob slowly until the salt grains come into focus. Draw a picture of what you see.

Use a Hand Lens

A hand lens is another tool that magnifies objects. It is not as powerful as a microscope. However, a hand lens still allows you to see details of an object that you cannot see with your eyes alone. As you move a hand lens away from an object, you can see more details. If you move a hand lens too far away, the object will look blurry.

Try it Magnify a Rock

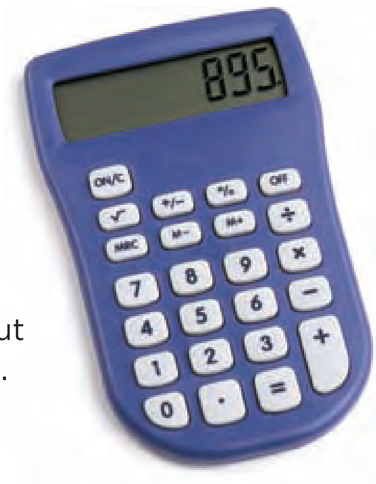
1. Look at a rock carefully. Draw a picture of it.
2. Hold a hand lens above the rock so that you can see the rock clearly.
3. Fill in any details on your original drawing that you did not see before.



Tools of Science

Use a Calculator

Sometimes during an experiment, you have to add, subtract, multiply, or divide numbers. A calculator can help you carry out these operations.



Try it Convert from °F to °C

Water boils at 212°F. Use a calculator to convert 212°F into degrees Celsius.

1. Press the [ON] key. Then, enter the number 212 by pressing [2][1][2].
2. Subtract 32 by pressing [-][3][2].
3. Multiply by 5 by pressing [x][5].
4. Finally, divide by 9 by pressing [÷][9]. Press [=]. This is the temperature in degrees Celsius.

Now, convert 100°F into degrees Celsius.

Use a Camera

During an experiment or nature study, it helps to observe and record changes that happen over time. Sometimes it can be difficult to see these changes if they happen very quickly or very slowly. A camera can help you keep track of visible changes. Studying photos can help you understand what happened over the course of time.

Try it Gather Data From a Photo

The photos below show a panda eight days after birth and then several months later. What differences do you notice? How has the panda changed over those months? Now think of something else that changes over time. With the help of an adult, use a camera to take photos at different times. Compare your photos.

Computers

Use a Computer

A computer has many uses. You can use a computer to get information from compact discs (CDs) and digital videodiscs (DVDs). You can also use a computer to write reports and to show information.

The Internet connects your computer with computers around the world, so you can collect all kinds of information. When using the Internet, visit only Web sites that are safe and reliable. Your teacher can help you find safe and reliable sites to use. Whenever you are online, never give any information about yourself to others.

Try it Use a Computer for a Project

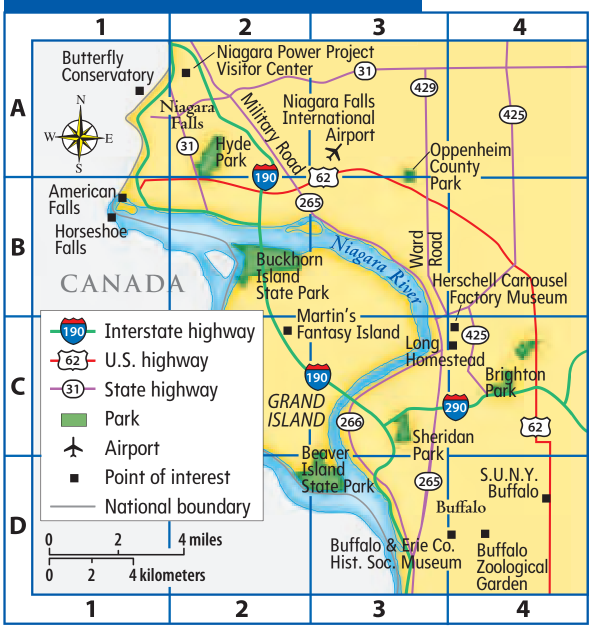
1. Choose an environment to research. Then use the Internet to find out about this environment. Where is the environment located in the world? What is the climate like in the environment? What kinds of plants and animals live there?
2. Use DVDs or other sources from the library to find out more about your chosen environment.
3. Use the computer to write a report about the information you gathered. Then share your report with others.

Make Maps

Locate Places

A map is a drawing that shows an area from above. Many maps have numbers and letters along the top and side. The letters and numbers help you find locations. The Buffalo Zoological Garden, for example, is located at D4 below. To find it, place a finger on the letter D along the side of the map and another finger on the number 4 at the top. Then move your fingers straight across and down the map until they meet. Now find B1? What is there?

Niagara Falls, New York



Try it Make a Map

Make a map of an area in your community. It might be a park or the area between your home and school. Include numbers and letters along the top and side. Use a compass to find north, and mark north on your map.

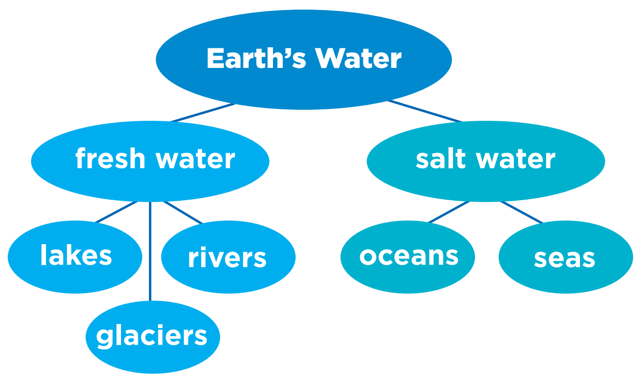
Idea Maps

The Niagara Falls map shows how places are connected to each other. Idea maps, on the other hand, show how ideas are connected to each other. Idea maps help you organize information about a topic.

Look at the idea map below. It connects ideas about water. This map shows that Earth's water can be fresh water or salt water. The map also shows three sources of fresh water. You can see that there is no connection between "rivers" and "salt water" on the map. This can remind you that salt water does not flow in rivers.

Try it Make an Idea Map

Make an idea map about a topic you are learning in science. Your map can include words, phrases, or even sentences. Arrange your map in a way that makes sense to you and helps you understand the connection between ideas.



Make Charts

Charts are useful for recording information during an experiment and for communicating information. In a chart, only the column or the row has meaning but not both. In this chart, one column lists living things. A second column lists nonliving things.

Living	Nonliving
tree	rock
chipmunk	puddle
bird	cloud

Try it **Organize Data in a Chart**

Take a survey of your class. Find out each student's favorite kind of pet. Make a chart to show this information. Remember to show your information in columns or in rows.

Make Tables

Tables also help to organize data, or information. Tables have columns that run up and down and rows that run across. Column and row headings tell you what kind of data they hold.

The table below shows the properties of some minerals. Which mineral in the table has a white streak? Which mineral is yellow in color?

Try it **Organize Data in a Table**

Collect a few minerals from your teacher. Observe the properties of each. Make a table like the one shown. Use the same column headings. Record the properties of each mineral.

Mineral Identification Table

	Hardness	Luster	Streak	Color	Other
pyrite	6–6.5	metallic	greenish-black	brassy yellow	called "fool's gold"
quartz	7	nonmetallic	none	colorless, white, rose, smoky, purple, brown	
mica	2–2.5	nonmetallic	none	dark brown, black, or silver-white	flakes when peeled
feldspar	6	nonmetallic	none	colorless, beige, pink	
calcite	3	nonmetallic	white	colorless, white	bubbles when acid is placed on it

Organizing Data

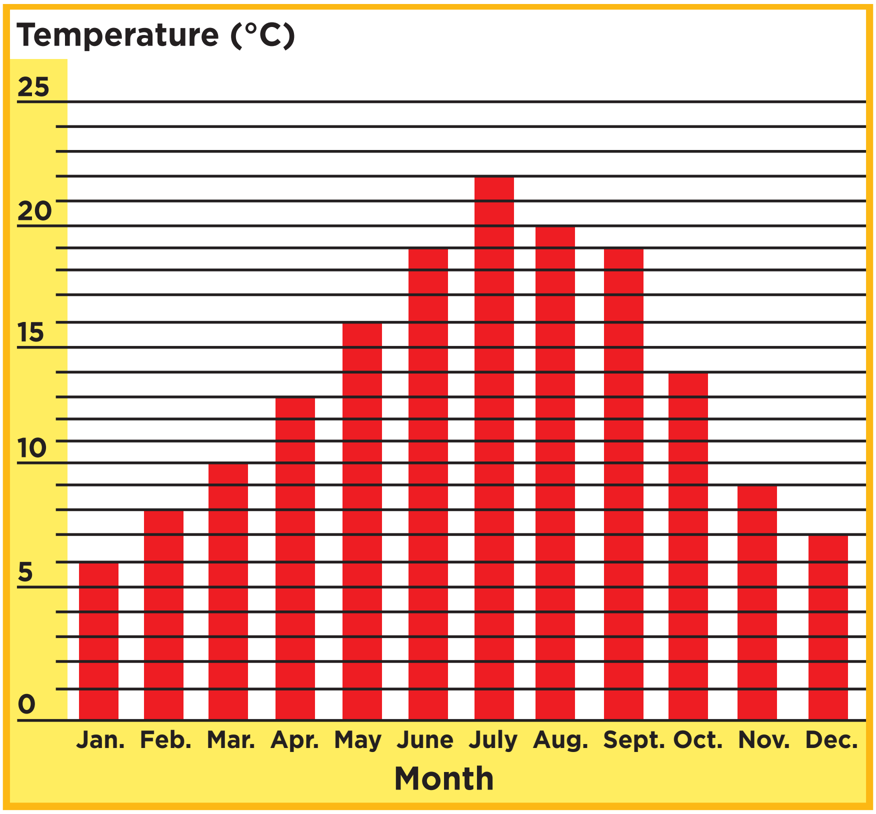
Make Graphs

Graphs also help organize data. Graphs make it easy to notice trends and patterns. There are many kinds of graphs.

Bar Graphs

A bar graph uses bars to show data. What if you want to find the warmest and coldest months for your city? Every month you find the average temperature in the newspaper. You can organize the temperatures in a bar graph so you can easily compare them.

Month	Temperature (°C)
January	6
February	8
March	10
April	13
May	16
June	19
July	22
August	20
September	19
October	14
November	9
December	7



1. Look at the bar for the month of April. Put your finger at the top of the bar. Move your finger straight over to the left to find the average temperature for that month.
2. Find the highest bar on the bar graph. This bar represents the month with the highest average temperature. Which month is it? What is the average temperature for this month?
3. Look at the bars of the graph. What pattern do you notice in the temperatures from January to December?

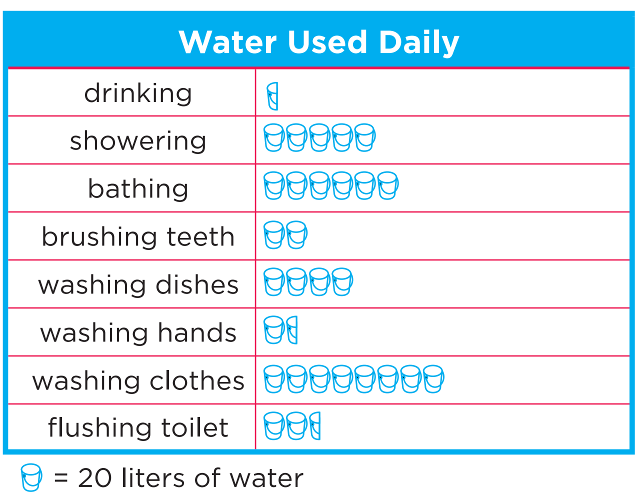
Pictographs

A pictograph uses symbols, or pictures, to show information. What if you collect information about how much water your family uses each day?

Water Used Daily (liters)	
drinking	10
showering	100
bathing	120
brushing teeth	40
washing dishes	80
washing hands	30
washing clothes	160
flushing toilet	50

You can organize this information into a pictograph. In the pictograph below, each bucket means 20 liters of water. A half bucket means half of 20, or 10, liters of water.

1. Which activity uses the most water?
2. Which activity uses the least water?



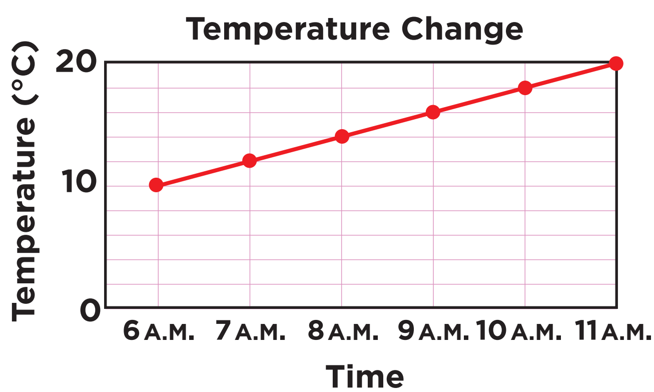
Line Graphs

A line graph can show how information changes over time. What if you measure the temperature outdoors every hour starting at 6 A.M.?

Time	Temperature (°C)
6 A.M.	10
7 A.M.	12
8 A.M.	14
9 A.M.	16
10 A.M.	18
11 A.M.	20

Now organize your data by making a line graph. Follow these steps.

1. Make a scale along the bottom and side of the graph. Label the scales.
2. Draw a point on the graph for each temperature measured each hour.
3. Connect the points.
4. How do the temperatures and times relate to each other?



Human Body Systems

The Skeletal System

Feel your elbows, wrists, and fingers. What are those hard parts? Bones! Bones make up the skeletal system. The skeletal system is one of many body systems. A body system is a group of organs that work together to perform a specific job.

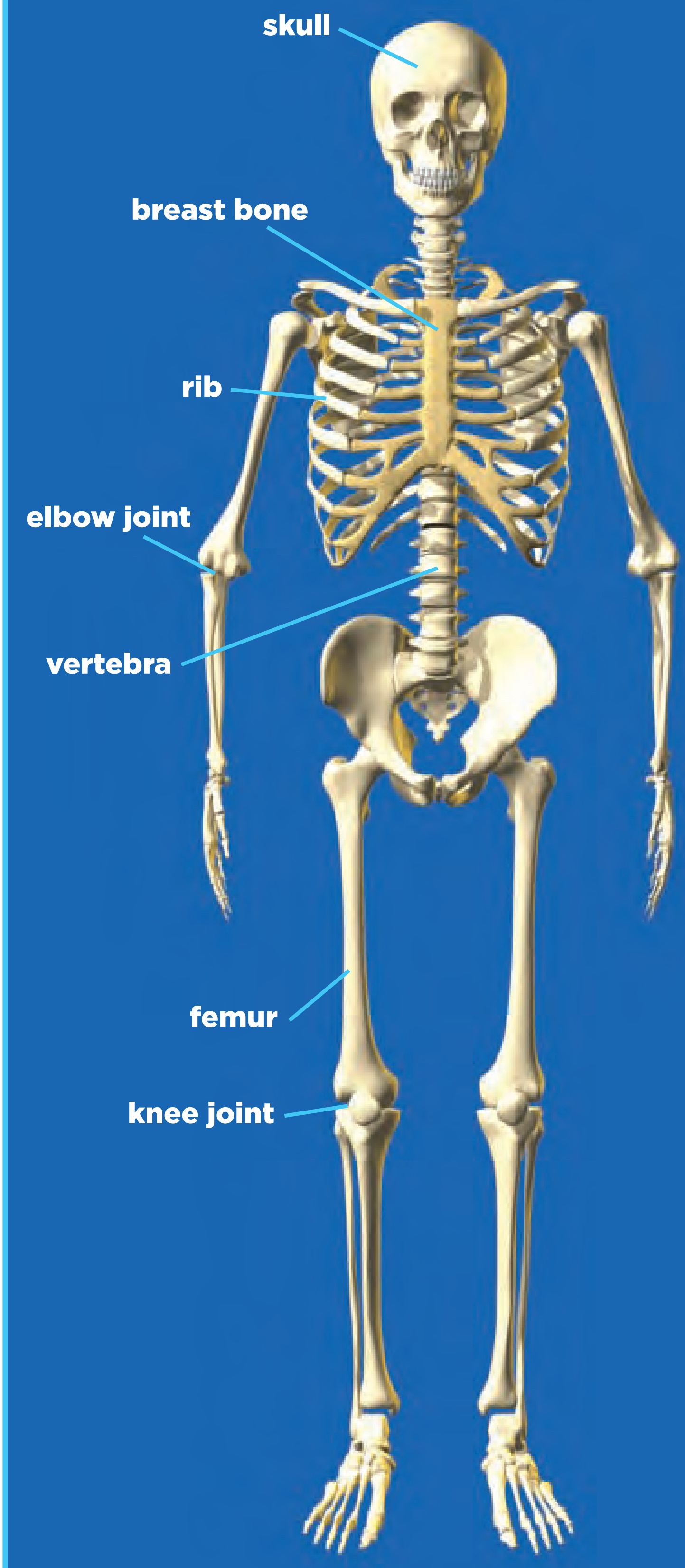
The skeletal system is made up of 206 bones. Each bone has a particular job. The long, strong leg bones support the body's weight. The skull protects the brain. The hip bones help you move. Together, bones do important jobs to keep the body active and healthy.

- Bones support the body and give the body its shape.
- Bones protect organs in the body.
- Bones work with muscles to move the body.
- Bones store minerals and produce blood for the body.

Joints

A joint is a place where two or more bones meet. There are three main types of joints.

Immovable joints form where bones fit together too tightly to move. The 29 bones of your skull meet at immovable joints. Partly movable joints are places where bones can move a little. Ribs are connected to the breastbone with these joints. Movable joints, like the knee, are places where bones can move easily. The knee lets the bones of your leg move.



The Muscular System

Together, all the muscles in the body form the muscular system. Muscles allow the body to move. Without muscles, you would not be able to run, smile, breathe, or even blink.

Most muscles are attached to bones and skin. These are called skeletal muscles. To move bones back and forth, skeletal muscles usually work in pairs. Each pulls on a bone in a different direction. When you want to move, your brain sends a message to a pair of skeletal muscles. One muscle contracts, or gets shorter. It pulls on the bone and skin. The other muscle relaxes to let the bone move.

▲ There are 53 muscles in your face. You use 12 of them whenever you smile.

◄ To bend his arm, this boy's biceps contract while his triceps relax.

Some muscles work without you even thinking about it. The heart is made of muscle. It pumps blood throughout the body even while you sleep. Smooth muscle in the lungs helps you breathe. Smooth muscle in the stomach helps you digest food.

Human Body Systems

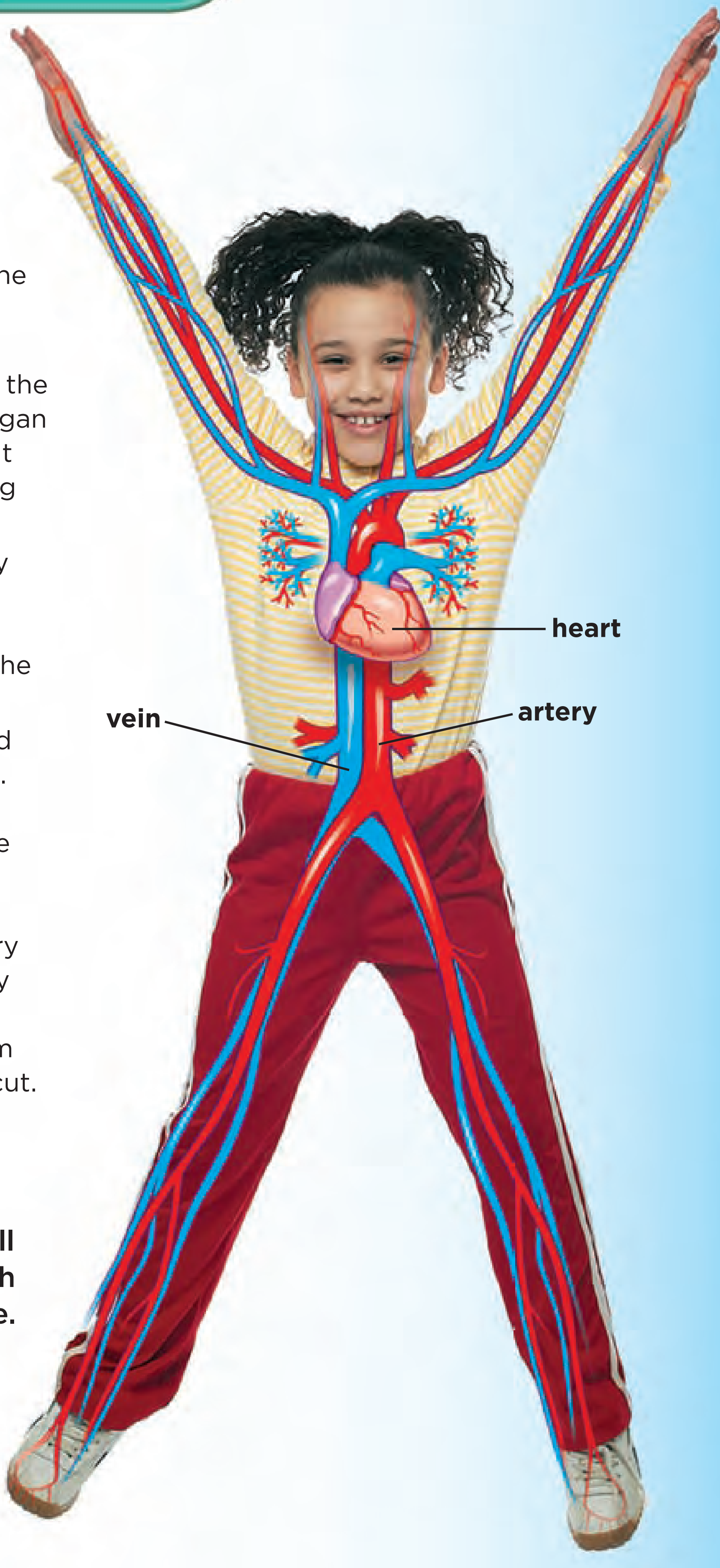
The Circulatory System

The body's cells need a constant supply of oxygen and nutrients. The circulatory (SUR•kyuh•luh•tawr•ee) system is responsible for sending these things throughout the body. The circulatory system is made up of the heart, blood vessels, and blood.

Blood rich in oxygen travels from the lungs to the heart. The heart is an organ about the size of a fist. It beats about 70 to 90 times each minute, pumping blood through the blood vessels.

Blood vessels are tubes that carry blood. There are two main types of blood vessels. Arteries are blood vessels that carry blood away from the heart. Veins carry blood back to it.

Blood contains plasma, red blood cells, white blood cells, and platelets. Plasma is the liquid part of blood. It carries nutrients and other things the body needs. Red blood cells carry oxygen to all the cells of your body. Red blood cells and plasma also carry wastes, such as carbon dioxide, away from cells. White blood cells work to fight disease. Platelets keep you from bleeding too much when you get a cut.



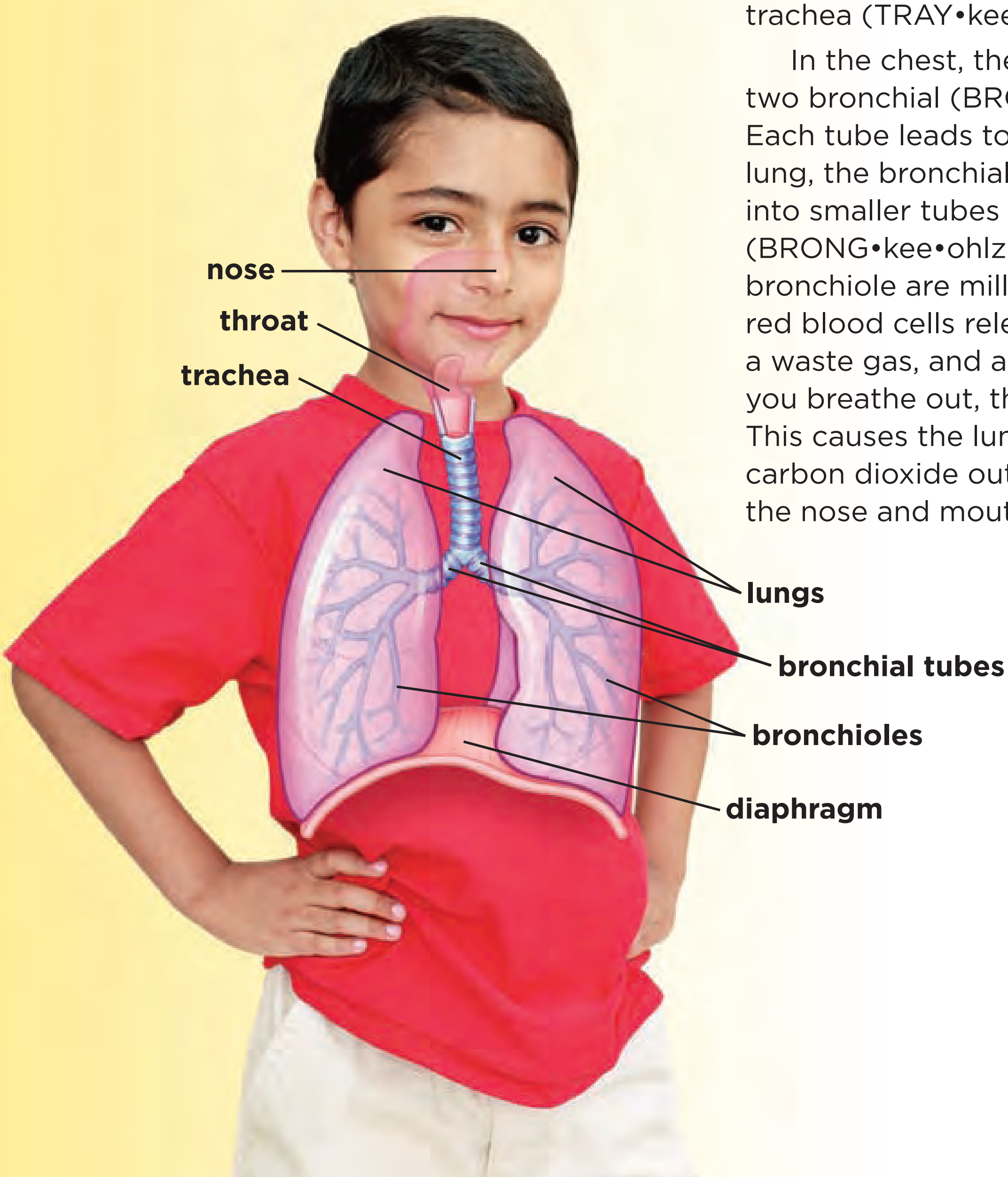
◀ This is how a red blood cell looks through a microscope.

The Respiratory System

The respiratory (RES•puhr•uh•tawr•ee) system helps the body take in oxygen and give off carbon dioxide and other waste gases. All of the cells in your body require oxygen to work properly. You take in oxygen from the air when you breathe.

Every time you inhale, a muscle called the diaphragm (DYE•uh•fram) contracts. This makes room in your lungs for air. Air is taken in through the nose or mouth. This air travels down the throat into the trachea (TRAY•kee•uh).

In the chest, the trachea splits into two bronchial (BRONG•kee•uhl) tubes. Each tube leads to a lung. Inside each lung, the bronchial tube branches off into smaller tubes called bronchioles (BRONG•kee•ohlz). At the end of each bronchiole are millions of tiny air sacs. Here, red blood cells release carbon dioxide, a waste gas, and absorb oxygen. When you breathe out, the diaphragm relaxes. This causes the lungs to deflate and push carbon dioxide out of your body through the nose and mouth.



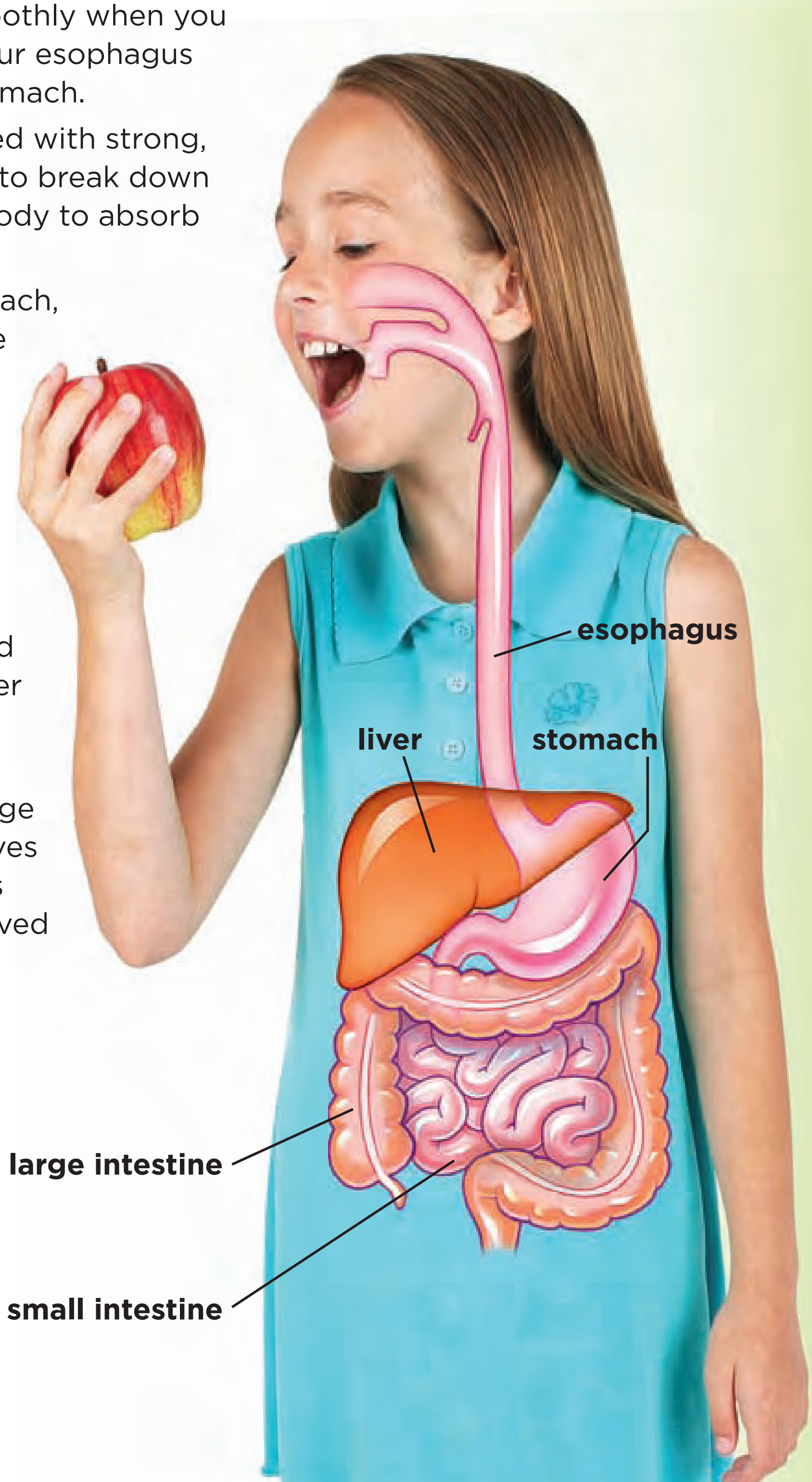
The Digestive System

The digestive (dye•JES•tiv) system is responsible for breaking down food into nutrients the body can use. Digestion begins when you chew food. Chewing breaks food into smaller pieces and moistens it with saliva. Saliva helps food travel smoothly when you swallow. The food travels down your esophagus (i•SOF•uh•guhs) and into your stomach.

Inside the stomach food is mixed with strong, acidic juices. This causes the food to break down further, making it easier for your body to absorb nutrients from the food.

After passing through the stomach, food moves into the small intestine (in•TES•tin). This is where most nutrients are absorbed. The small intestine is a narrow tube about 6 meters (20 feet) long. It is coiled tightly so it fits inside the body. As food passes through the small intestine, digested nutrients are absorbed into the blood. The blood then carries these nutrients to other parts of the body.

After food has passed through the small intestine, it enters the large intestine. The large intestine removes water from the unused food that is left. Then the unused food is removed from the body as waste.



The Excretory System

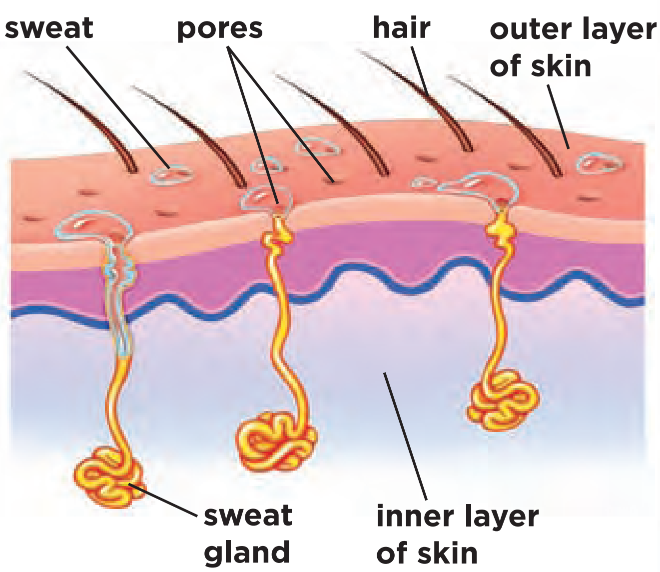
The excretory (EK•skri•tawr•ee) system gets rid of waste products from your cells. Waste products are materials the body does not need, such as extra water and salts. The liver, kidneys, bladder, and skin are some organs of the excretory system.

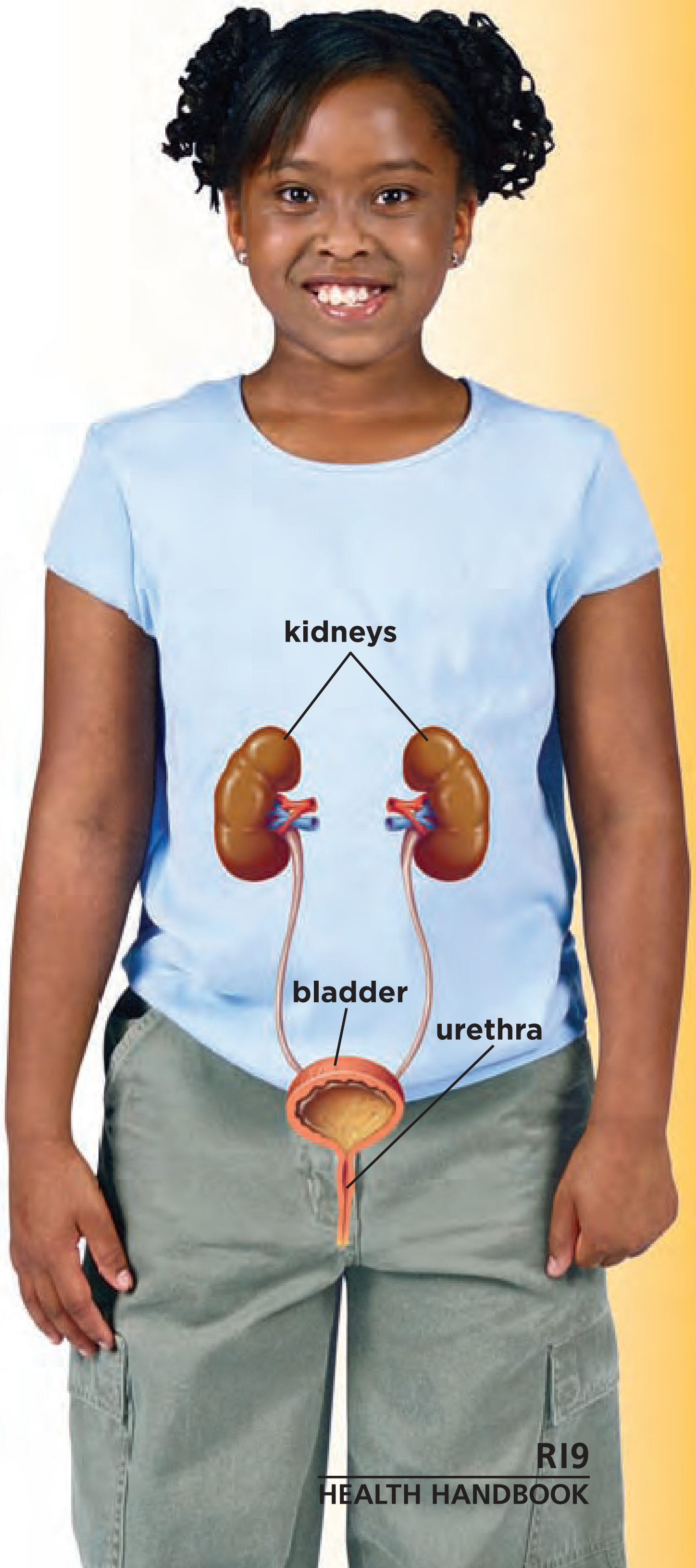
Liver, Kidneys, and Bladder

The liver filters wastes from the blood. It changes wastes into a chemical call urea and sends the urea to the kidneys. Kidneys turn urea into urine. Urine flows from the kidney to the bladder. It is stored in the bladder until it is pushed out of the body through the urethra.

Skin

The skin takes part in excretion when a person sweats. Sweat glands in the inner layer of skin produce sweat. Sweat is made up of water and minerals that the body does not need. Sweat is excreted onto the outer layer of the skin. Sweating cools the body and helps it maintain an internal temperature of about 98°F (37°C).



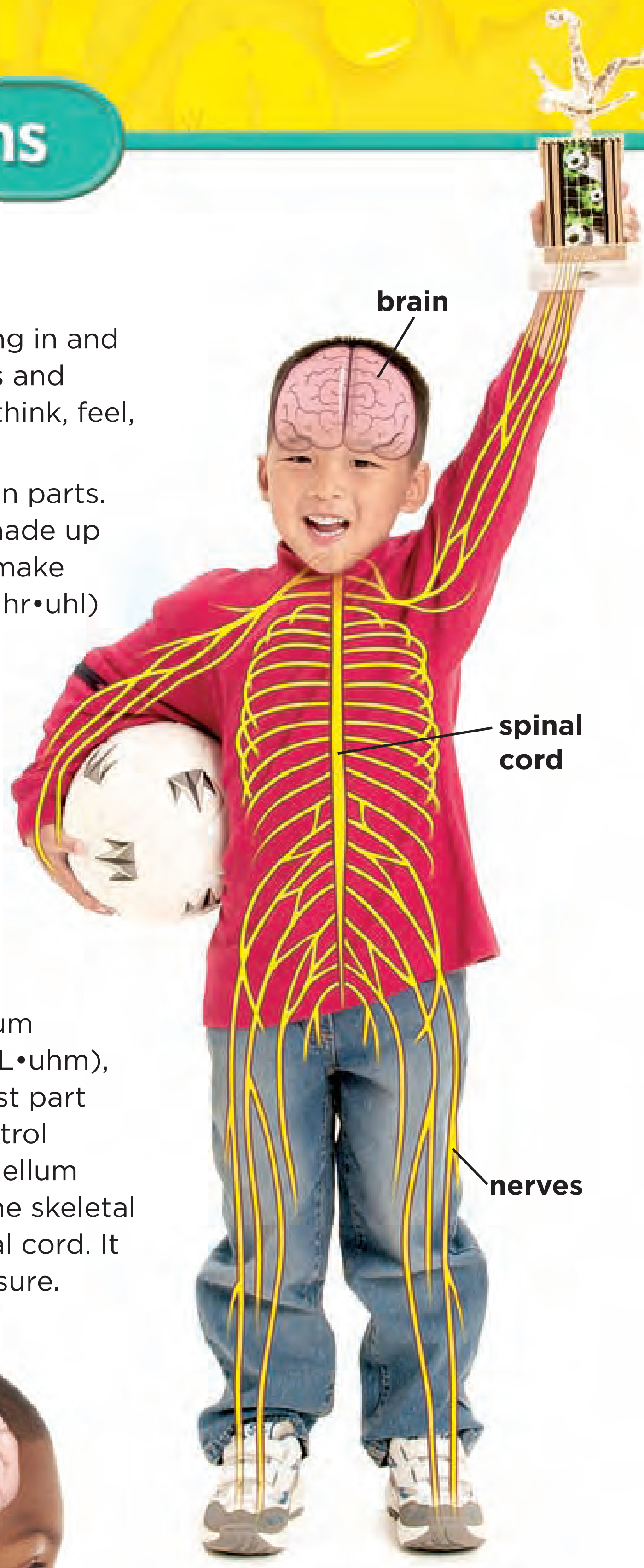


Human Body Systems

The Nervous System

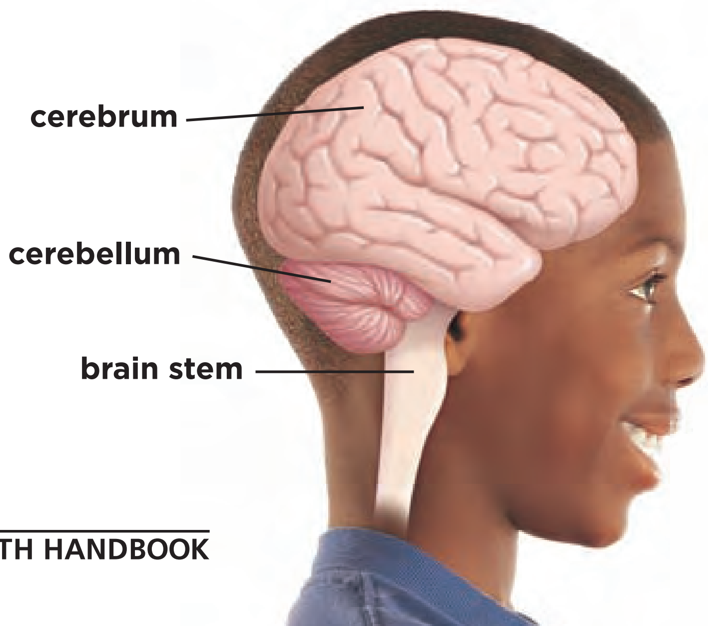
The nervous system is responsible for taking in and responding to information. It controls muscles and helps the body balance. It allows a person to think, feel, and even dream.

The nervous system is made up of two main parts. The first part, the central nervous system, is made up of the brain and spinal cord. All other nerves make up the second part, the peripheral (puh•RIF•uhr•uhl) nervous system. Nerves from the peripheral nervous system receive sensory information from cells in the body. They pass this information on to the brain through the spinal cord. When the brain receives this information, it makes decisions about how the body should respond. Then it passes this new information back through the spinal cord to the nerves, and the body responds.



The Brain

The brain has three main parts, the cerebrum (suh•REE•bruhm), the cerebellum (ser•uh•BEL•uhm), and the brain stem. The cerebrum is the largest part of the brain. It stores memories and helps control information received by the senses. The cerebellum helps the body keep its balance and directs the skeletal muscles. The brain stem connects to the spinal cord. It controls heartbeat, breathing, and blood pressure.



The Senses

Different nerves in the body take in information from the environment. These nerves are responsible for the body's sense of sight, hearing, smell, taste, and touch.

Sight

Light reflects off an object, such as a leaf, and into the eye. The reflected light passes through the pupil in the iris. Cells in the eye change light into electrical signals. The signals travel through the optic nerve to the brain.

Hearing

Sound waves enter the outer ear. They reach the eardrum and cause it to vibrate. Cells in the ear change the sound waves into electrical signals. The signals travel along the auditory nerve to the brain.

Smell

As a person breathes, chemicals in the air mix with mucus in the upper part of the nose. When they reach certain cells in the nose, those cells send information along the olfactory nerve to the brain.

Taste

On the tongue are more than 10,000 tiny bumps, called taste buds. Each taste bud can sense four main tastes—sweet, sour, salty, and bitter. The taste buds send information along a nerve to the brain.

Touch

Different nerve cells in the skin give the body its sense of touch. They help a person tell hot from cold, wet from dry, and hard from soft. Each cell sends information to the spinal cord. The spinal cord then sends the information to the brain.

Immune System

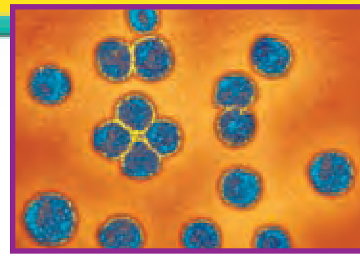
The immune system protects the body from germs. Germs cause disease and infection. Most of the time, the immune system is able to prevent germs from entering the body. Skin, tears, and saliva are parts of the immune system. They work to kill germs and keep them out of the body.

When germs do find a way into your body, white blood cells help find and kill them quickly before you become ill. White blood cells are part of the blood. They travel through blood vessels and lymph (LIMF) vessels. Lymph vessels are similar to blood vessels. However, instead of carrying blood, they carry a fluid called lymph. Many white blood cells are made and live in lymph nodes. Here, they filter out harmful materials from the body.

White blood cells are not always able to kill germs before the germs start to reproduce in your body. When germs reproduce, they cause illness. Even while you feel ill, the immune system works to kill and remove germs until you are well again.

◀ **This is how a white blood cell looks through a microscope.**

Viruses and Bacteria



▲ A cold virus as seen through a microscope.

One of the main types of germs that makes the body ill are viruses. Illness from a virus like a cold or flu can be a big deal. Yet, viruses themselves are very small. In fact, you need a special microscope, an electron microscope, to look at a virus.

Viruses need to be inside living cells, called hosts, in order to reproduce. As they reproduce, viruses take nutrients and energy from the cell. They can even produce harmful materials that make the body itch or have dangerously high temperatures.

▲ *E. coli* bacteria as seen through a microscope.

The other main type of germ that can make the body ill is bacteria. Bacteria are tiny, one-celled organisms. They can live on most surfaces and are able to reproduce outside of cells. Some bacteria can have a harmful effect on the body. Other bacteria, however, are good for the body. Some bacteria in your body, for example, help you digest food.

You can help your body defend itself against germs. Here's what you can do.

- Eat healthful foods. This helps your body get all of the nutrients it needs to stay healthy. A healthy body is better able to fight germs.

- Be active. Being active makes your body fit. A fit body is better able to fight germs.

- Get a yearly check-up. Make sure you get all of your immunizations. Follow directions when taking medicines given to you by a doctor.

- Get plenty of rest. You need about 10 hours of sleep every night. Sleeping helps repair your body. Get extra rest when you are ill.

- Do not share cups or utensils with other people. Germs can be on objects you touch. Wash your hands, especially before eating and drinking. By washing your hands, you kill germs and make it harder for harmful things to get into your body.

Nutrients

Nutrients are materials in foods that help the body grow, get energy, and stay healthy. By eating a balance of healthful foods, your body gets the nutrients it needs to do all of these things.

There are six kinds of nutrients—carbohydrates, vitamins, minerals, proteins, water, and fats. Each nutrient helps the body in different ways.


carbohydrates

Carbohydrates

Carbohydrates are the main source of energy for the body. Starches and sugars are two types of carbohydrates. Starches come from foods like bread, pasta, and cereal. They provide long-lasting energy. Sugars come from fruits and can be used immediately by the body for energy.

Vitamins

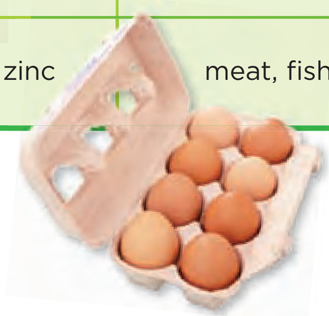
Vitamins help keep the body healthy. They also help to build new cells in the body. The table below shows some vitamins and their sources.

Vitamin	Sources	Benefits
A	milk, fruit, carrots, green vegetables	keeps eyes, teeth, gums, skin, and hair healthy
C	citrus fruits, strawberries, tomatoes	helps heart, cells, and muscles function
D	milk, fish, eggs	helps keep teeth and bones strong

Minerals

Minerals help form new bone and blood cells. They also help your muscles and nervous system work properly. Here are some minerals and their sources.

Mineral	Sources	Benefits
calcium	yogurt, milk, cheese, and green vegetables	builds strong teeth and bones
iron	meat, beans, fish, whole grains	helps red blood cells function properly
zinc	meat, fish, eggs	helps your body grow and helps to heal wounds



Fats

Fats help the body use other nutrients and store vitamins. Fats also help the cells of the body to work properly. They even help keep the body warm. Fats can be found in foods such as meats, eggs, milk, butter, and nuts. Oils also contain fats. Though some fats help the body, some fats can cause health problems.

fats

Water

Water is one of the most important nutrients. About $\frac{2}{3}$ of the body is made up of water! Water makes up most of the body's cells. It helps the body remove waste and protects joints. It also prevents the body from getting too hot.

Proteins

Proteins are a part of every living cell. Proteins help bones and muscles grow. They even help the immune system fight diseases. Foods high in protein are milk, eggs, meats, fish, nuts, and cheese.

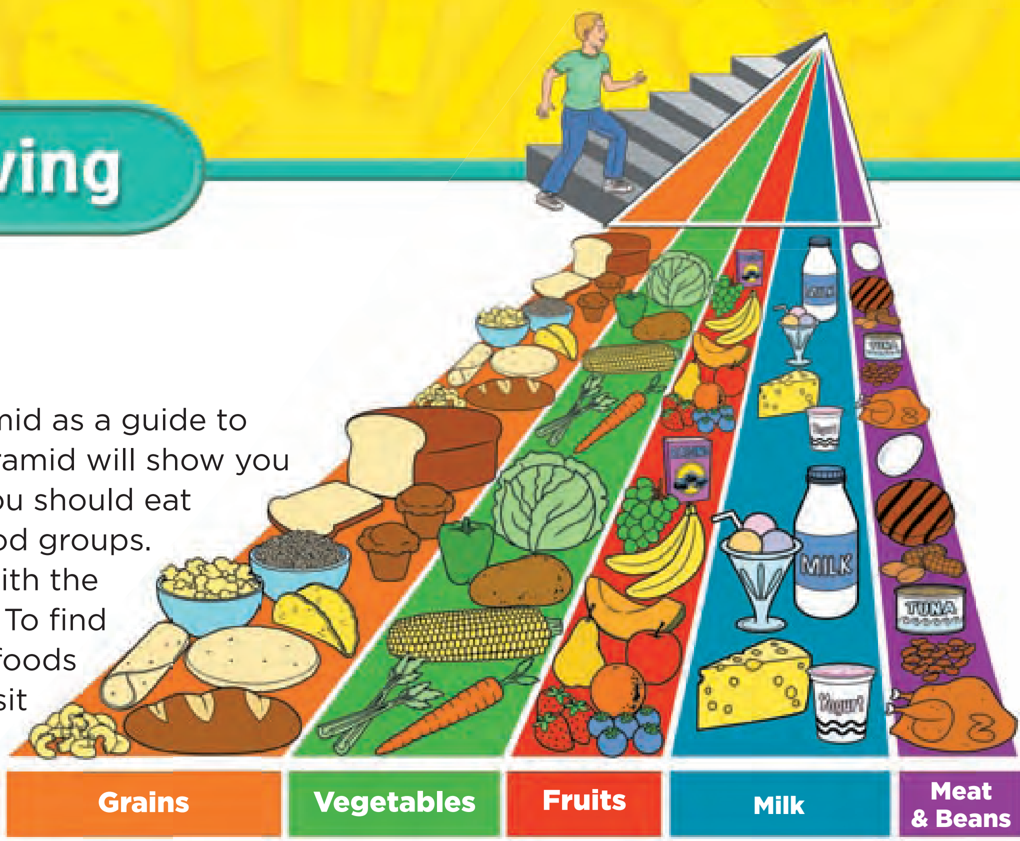
proteins

Healthy Living

Stay Fit

MyPyramid

You can use MyPyramid as a guide to healthful eating. The pyramid will show you the amounts of foods you should eat from each of the five food groups. A food group is foods with the same kinds of nutrients. To find the correct amounts of foods that are right for you, visit www.MyPyramid.gov



Be Drug-Free

Do not use cigarettes, illegal drugs, or alcohol. These things can harm your body. They can keep you from growing properly and becoming fit.

Be Physically Active

You need to be physically active for at least 60 minutes every day. When you are physically active, you become physically fit. When you are physically fit, your heart, lungs, bones, joints, and muscles stay strong. You keep a healthful weight and lower the risk of disease. You do not have to be on a sports team to be physically active. You just need to move your body. Running, biking, and swimming are just some ways to be physically active.

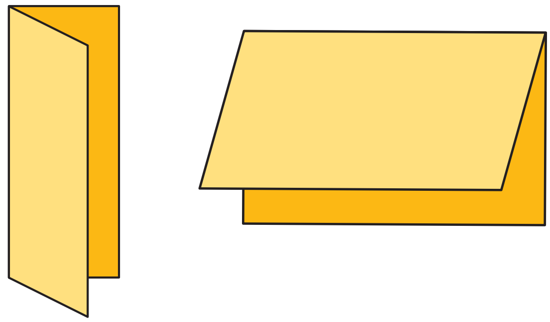
FOLDABLES™ by Dinah Zike

Folding Instructions

The following pages offer step-by-step instructions to make the Foldables study guides.

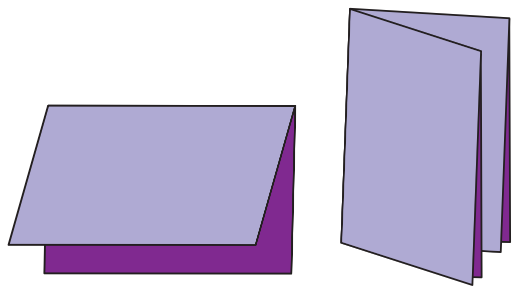
Half-Book

1. Fold a sheet of paper ($8\frac{1}{2}$" x 11") in half.
2. This book can be folded vertically like a hot dog or ...
3. ... it can be folded horizontally like a hamburger.



Folded Book

1. Make a Half-Book.
2. Fold in half again like a hamburger. This makes a ready-made cover and two small pages inside for recording information.

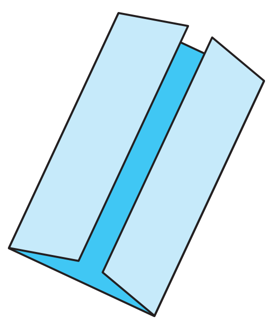


Pocket Book

1. Fold a sheet of paper ($8\frac{1}{2}$" x 11") in half like a hamburger.
2. Open the folded paper and fold one of the long sides up two inches to form a pocket. Refold along the hamburger fold so that the newly formed pockets are on the inside.
3. Glue the outer edges of the two-inch fold with a small amount of glue.

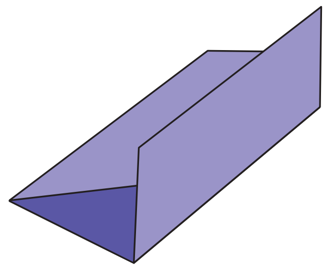
Shutter Fold

1. Begin as if you were going to make a hamburger, but instead of creasing the paper, pinch it to show the midpoint.
2. Fold the outer edges of the paper to meet at the pinch, or midpoint, forming a Shutter Fold.



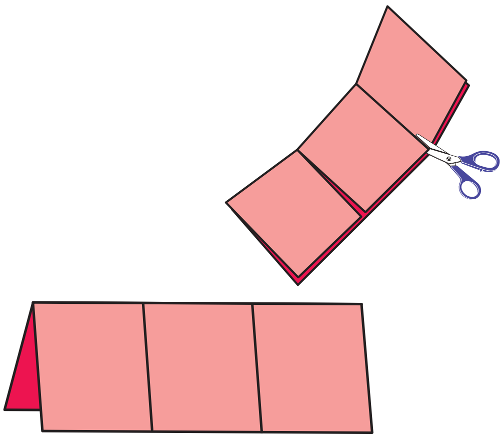
Trifold Book

1. Fold a sheet of paper ($8\frac{1}{2}$″ x 11″) into thirds.
2. Use this book as is, or cut into shapes.



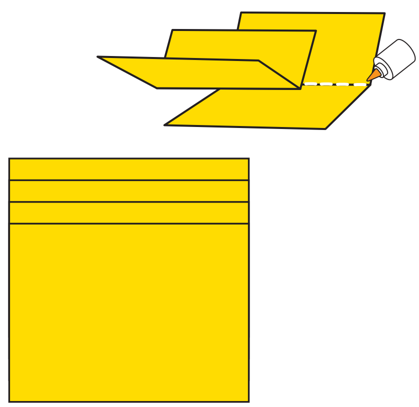
Three-Tab Book

1. Fold a sheet of paper like a hot dog.
2. With the paper horizontal and the fold of the hot dog up, fold the right side toward the center, trying to cover one half of the paper.
3. Fold the left side over the right side to make a book with three folds.
4. Open the folded book. Place one hand between the two thicknesses of paper and cut up the two valleys on one side only. This will create three tabs.



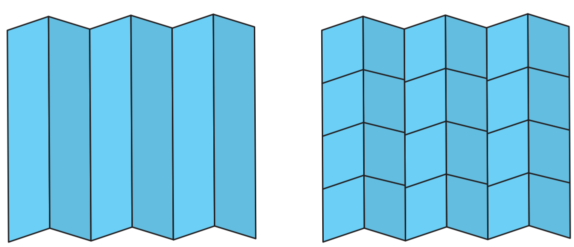
Layered-Look Book

1. Stack two sheets of paper ($8\frac{1}{2}$″ x 11″) so that the back sheet is one inch higher than the front sheet.
2. Bring the bottoms of both sheets upward and align the edges so that all of the layers or tabs are the same distance apart.
3. When all the tabs are an equal distance apart, fold the papers and crease well.
4. Open the papers and glue them together along the valley, or inner center fold, or staple them along the mountain.



Folded Table or Chart

1. Fold the number of vertical columns needed to make the table or chart.
2. Fold the horizontal rows needed to make the table or chart.
3. Label the rows and columns.



Glossary

Use this glossary to learn how to pronounce and understand the meanings of the science words used in this book. The page number at the end of each definition tells you where to find that word in the book.

A

abiotic factor (ā'bī·ot'ik fak'tə r) A nonliving part of an ecosystem. (p. 84)

accommodation (ə ·kom'ə ·dā·shə n) An individual organism's response to changes in its ecosystem. (p. 116)

acid (as'id) A substance that tastes sour and turns blue litmus paper red. (p. 304)

adaptation (a'də p·tā'shə n) A trait that helps one kind of living thing survive in its environment. (p. 106)

air mass (âr mas) A large region of the atmosphere where the air has similar properties throughout. (p. 210)

air pressure (âr presh'ə r) The force of air pushing down on an area. (p. 191)

alloy (al'oi) A mixture of one metal with one or more metals or substances. (p. 292)

Pronunciation Key

The following symbols are used throughout this Glossary.

a	**a**t	e	**e**nd	o	h**o**t	u	**u**p	hw	**wh**ite	ə	**a**bout
ā	**a**pe	ē	m**e**	ō	**o**ld	ū	**u**se	ng	so**ng**		tak**e**n
ä	f**a**r	i	**i**t	ôr	f**or**k	ü	r**u**le	th	**th**in		penc**i**l
âr	c**a**re	ī	**i**ce	oi	**oi**l	ů	p**u**ll	th	**th**is		lem**o**n
ô	l**a**w	îr	p**ier**ce	ou	**ou**t	ûr	t**ur**n	zh	mea**s**ure		circ**u**s

' = primary accent; shows which syllable takes the main stress, such as **kil** in **kilogram** (kil' e gram').

' = secondary accent; shows which syllables take lighter stresses, such as **gram** in **kilogram**.

LOG ON e-Glossary at www.macmillanmh.com

area (âr′ē·ə) The number of unit squares that fit inside a surface. (p. 255)

atmosphere (at′mə s·fîr′) The blanket of gases that surrounds Earth. (p. 188)

atom (at′ə m) The smallest particle of an element. All atoms of one element are alike, but are different from those of any other element. (p. 264)

avalanche (av′ə ·lanch′) A large, sudden movement of ice and snow down a hill or mountain. (p. 176)

B

barometer (bə ·rom′i·tə r) A device for measuring air pressure. (p. 192)

base (bās) A substance that tastes bitter and turns red litmus paper blue. (p. 304)

biotic factor (bi·ot′ik fak′tə r). A living part of an ecosystem. (p. 84)

buoyancy (boi′ə n·sə) The upward force of a liquid or gas on an object. (p. 245)

C

cast (kast) A fossil formed or shaped within a mold. (p. 113)

cell (sel) The smallest unit of living matter. (p. 26)

change of state (chānj uv stāt) A physical change of matter from one state—solid, liquid, or gas—to another state because of a change in the energy of the matter. (p. 282)

chemical change (kə m′i·kə l chānj) A change that produces new matter with different properties from the original matter. (p. 284)

climate (klī′mə t) The average weather pattern of a region over time. (p. 220)

cloud (kloud) A collection of tiny water droplets or ice crystals in the atmosphere. (p. 199)

cold front (kōld frunt) A boundary where a cold air mass slides under a warm air mass. (p. 211)

community (kə ·mū′ni·tē) All the populations in an ecosystem. (p. 86)

competition (kom′pə ·tish′ə n) The struggle among living things for water, food, or other resources. (p. 97)

compound (kom′pound) A substance made when two or more elements join and lose their own properties. (p. 302)

condensation (kon′den·sā′shə n) The process of a gas changing to a liquid. (p. 199)

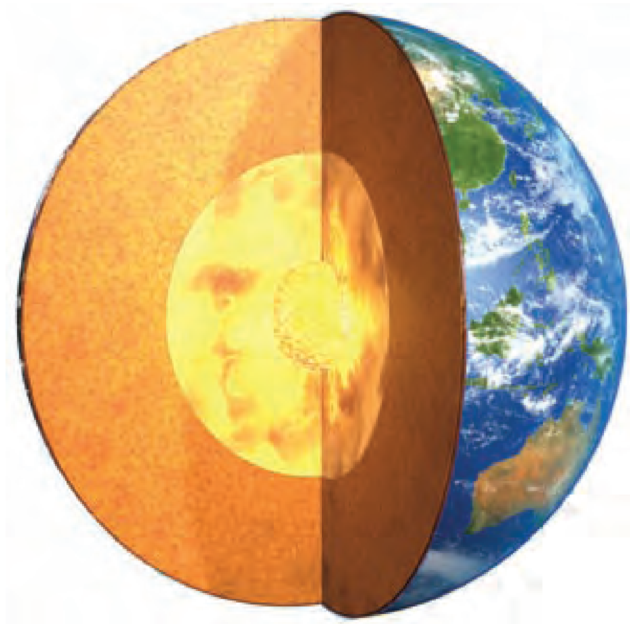
conduction (kə n·duk′shə n) The transfer of energy between two objects that are touching. (p. 314)

conductor (kə n·duk′tə r) A material through which heat or electricity flows easily. (p. 315)

consumer (kə n·sü′mə r) An organism that cannot make its own food. (p. 93)

convection (kə n·vek′shə n) The transfer of energy by flowing gases or liquid, such as the rising of warm air from a heater. (p. 314)

crust (krust) Solid rock that makes up the Moon's and Earth's outermost layers. (p. 142)



current (kûr′ə nt) The directed flow of a gas or liquid. (p. 222)

D

decomposer (dē′kə m·pō′zə r) An organism that breaks down wastes and the remains of other organisms into simpler substances. (p. 93)

density (den′si·tē) The amount of matter in a given space. In scientific terms, density is the amount of mass in a unit of volume. (p. 256)

deposition (de′pə ·zish′ə n) The dropping off of eroded soil and bits of rock. (p. 163)

distillation (dis′tə ·lā′shə n) The use of evaporation and condensation to separate the parts of a mixture. (p. 296)

E

earthquake (ûrth′kwāk′) A sudden shaking of the rock that makes up Earth's crust. (p. 150)

ecosystem (ē′kō·sis′tə m) The living and nonliving things in an environment, and all of their interactions. (p. 84)

element (el′ə ·mə nt) A substance that is made up of only one type of matter. (p. 264)

energy pyramid (en′ə r·jē pir′ə ·mid′) A diagram that shows the amount of energy available at each level of a food web in an ecosystem. (p. 98)

erosion (i·rō′zhə n) The removing of weathered rock. (p. 162)

evaporation (i·vap′ə ·rā′shə n) The process of a liquid changing to a gas. (pp. 238, 296)

experiment (ek·sper′ə ·ment′) A test designed to support or disprove a hypothesis; to perform such a test. (p. 6)

extinct (ek·stingkt′) Said of an organism no longer alive on Earth. (p. 118)

F

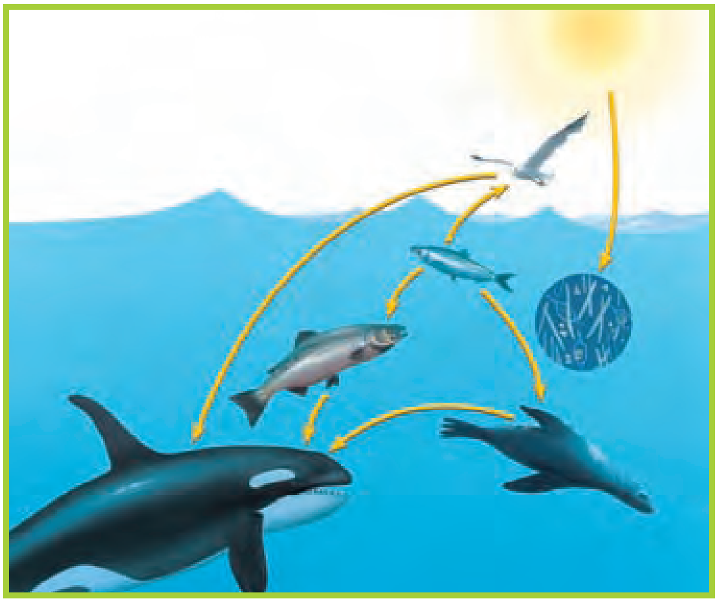
filter (fil′tə r) A tool that physically separates matter by size. It has a mesh or a screen that retains the bigger pieces but allows smaller pieces to fall through the holes. (p. 295)

filtration (fil·trā′shə n) A method of separating the parts of a mixture using a filter. (p. 295)

flood (flud) A great flow of water over land that is usually dry. (p. 172)

food chain (füd chān) The path that energy takes from one organism to another in the form of food. (p. 94)

food web (füd web) The food chains that overlap in an ecosystem. (p. 96)



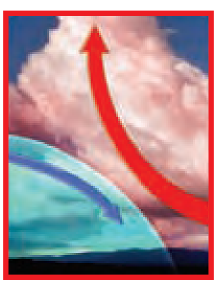
forecast (fôr′kast′) A prediction about the weather; the act of making such a prediction. (p. 213)

fossil (fos′ə l) Any evidence of an organism that lived in the past. (p. 112)

fossil fuel (fos′ə l fū′ə l) A source of energy made from the remains of ancient, once-living things. (p. 116)

freeze (frēz) To change state from a liquid to a solid. (p. 199)

front (frunt) A boundary between air masses with different temperatures. (p. 211)



G

gas (gas) A state of matter that has no definite shape or volume. (p. 247)

germination (jer′mə ·nā′shə n) When something begins to grow, as when a seed sprouts into a new plant. (p. 68)

gravity (grav′i·tē) A force of attraction, or pull, between objects. (p. 258)

H

habitat (hab′i·tat′) The home of an organism. (p. 85)

heat (hēt) The movement of thermal energy from warmer to cooler objects. (p. 312)

humidity (hū·mid′i·tē) A measurement of how much water vapor is in the air. (p. 190)

hurricane (hûr′i·kān′) A very large, swirling storm with strong winds and heavy rains. (p. 174)

hypothesis (hī·poth′ə ·sis) A statement that can be tested using the scientific method. (p. 7)

I

imprint (im′print) A fossil made by a print or an impression. (p. 113)

inner core (in′ər kôr) A sphere of solid material at the center of Earth. (p. 142)

insulator (in′sə·lā′tər) A material that slows or stops the flow of energy, such as heat, electricity, and sound. (p. 315)

K

kingdom (king′dəm) The largest group into which an organism can be classified. (p. 39)

L

landslide (land′slīd′) A sudden movement of rock and soil down a slope. (p. 176)

length (lengkth) The number of units that fit along one edge of an object. (p. 255)

life cycle (līf sī′kēl) The stages of growth and change that an organism goes through. (p. 69)

liquid (lik′wid) A state of matter that has a definite volume but no definite shape. (p. 246)

M

mantle (man′təl) The layer of rock below Earth's crust. (p. 142)

mass (mas) The amount of matter making up an object. (p. 244)

matter (mat′ər) Anything that has mass and takes up space. (p. 244)

melt (melt) To change state from a solid to a liquid. (p. 204)

metal (met′əl) Any of a group of elements that conducts heat and electricity, has a shiny luster, and can be hammered into a sheet. (p. 265)

metric system (met′rik sis′təm) A system of measurement based on units of ten. It is used in most countries and in all scientific work. (p. 254)

mixture (miks′chər) Two or more types of matter that are blended together and keep their own properties. (p. 292)

mold (mōld) An empty space in rock that once held the remains of a living thing. (p. 113)

moraine (mə·rān′) A mound of rock and glacial till made by a glacier. (p. 165)

mountain (moun′tə n) A tall landform that rises to a peak. (p. 149)

N

nonrenewable resource (non′ri·nü′ə ·bə l rē′sôrs′) A natural material or source of energy that is useful to people and cannot be replaced easily. (p. 116)

O

organ (ôr′gə n) A group of tissues that work together to do a certain job. (p. 31)

organism (ôr′gə ·niz·ə m) A living thing that carries out basic life functions on its own. (p. 26)

organ system (ôr′gə n sis′tə m) A group of organs that work together to carry out a life function. (p. 31)

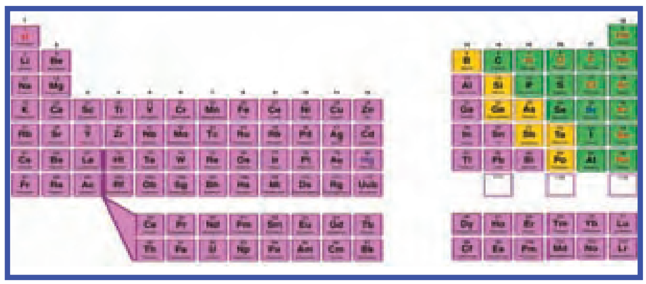
outer core (out′ə r kôr) The liquid layer below Earth's mantle. (p. 142)

ovary (ō′və ·rē) A structure containing egg cells. (p. 66)

oxygen (ok′sə ·jə n) A gas found in air and water that most plants and animals need to live. (p. 26)

P

periodic table (pîr′ē·od′ik tā′bə l) A chart that classifies all the known elements by their properties. (p. 266)



photosynthesis (fō′tō·sin′thə ·sis) The process in green plants and certain other organisms that uses energy from sunlight to make food from water and carbon dioxide. (p. 54)

physical change (fiz′i·kə l chānj) A change that begins and ends with the same type of matter. (p. 280)

plateau (pla·tō′) A high landform with a flat top. (p. 149)

pollination (pol′ə·nā′shən) The transfer of a flower's pollen from anther to pistil. (p. 67)

population (pop′yə·lā′shən) All of the members of a single type of organism in an ecosystem. (p. 86)

precipitation (pri·sip′i·tā′shən) Water in the atmosphere that falls to Earth as rain, snow, hail, or sleet. (p. 199)

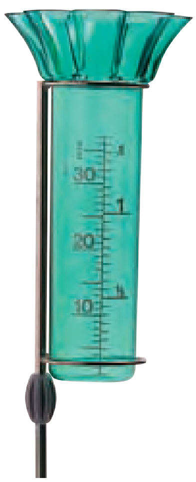
producer (prə·dü′sər) An organism, such as a plant, that makes its own food. (p. 92)

property (prop′ər·tē) A characteristic of matter that can be observed or measured. (p. 244)

R

radiation (rā′dē·ā′shən) The transfer of energy through space. (p. 315)

rain gauge (rān gāj) A device that measures how much precipitation has fallen. (p. 192)



reproduction (rē·prə·duk′shən′) The making of offspring. (p. 66)

respiration (res′pə·rā′shən) The using and releasing of energy in a cell. (p. 55)

root (rüt) The part of a plant that takes in water and minerals. (p. 53)

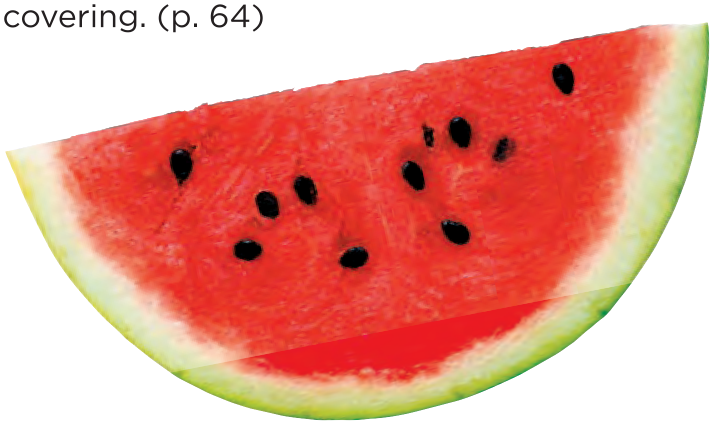
root hair (rüt hâr) One of the threadlike cells on a root that takes in water and minerals. (p. 53)

rust (rust) A solid brown compound formed when iron combines chemically with oxygen. (p. 284)

S

scientific method (sī′ən·tif′ik meth′əd) An organized process that scientists use to answer questions. (p. 4)

seed (sēd) An undeveloped plant with stored food sealed in a protective covering. (p. 64)



seismic wave (sīz′mik wāv) A vibration caused by an earthquake. (p. 152)

seismograph (sīz′mə·graf′) An instrument that detects and records earthquakes. It shows seismic waves as curvy lines along a graph. (p. 152)

solid (sol′id) A state of matter that has a definite shape and volume. (p. 246)

solution (sə·lü′shən) A mixture in which one or more kinds of matter are mixed evenly in another kind of matter. (p. 292)

spore (spôr) A cell in a seedless plant that can grow into a new plant. (p. 56)

stationary front (stā′shə ·ner′ē frunt) A boundary between air masses that are not moving. (p. 211)

stem (stem) The part of a plant that holds the plant up and carries food, water, and other materials to and from the roots and leaves. (p. 53)

stimulus (stim′yə ·lə s) *pl. n.*, **stimuli** (stim′yə ·lî) *sing*. Something in the environment that causes a living thing to react. (p. 104)

stomata (stō′mə ·tə) *pl. n.*, **stoma** (stō′mə) *sing*. Pores in the bottom of leaves that open and close to let in air or give off water vapor. (p. 55)

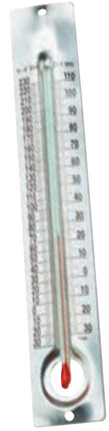
T

tarnish (tär′nish) Discoloration of metal by exposure to air. (p. 284)

temperature (tem′pə r·ə ·chə r) A measurement of how hot or cold something is. (p. 190)

terminus (tûrm′i·nə s) The downhill end of a glacier where debris is deposited. (p. 165)

thermometer (thûr′mom′i·tə r) A tool used to measure temperature. (p. 192)



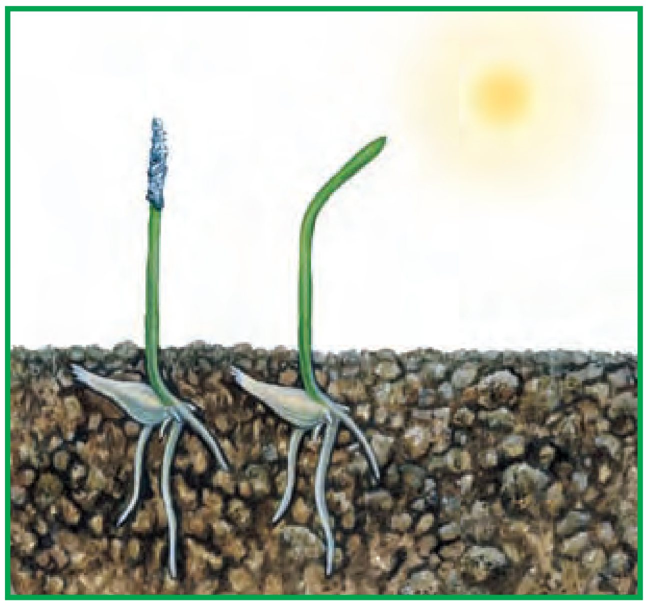
tissue (tish′ü) A group of similar cells that work together to carry out a job. (p. 31)

tornado (tôr·nā′dō) A swirling column of wind that moves across the ground in a narrow path. (p. 175)

trait (trāt) A characteristic of a living thing. (p. 38)

transpiration (tran′spə ·rā′shə n) The release of excess water vapor through the stomata of a plant. (p. 55)

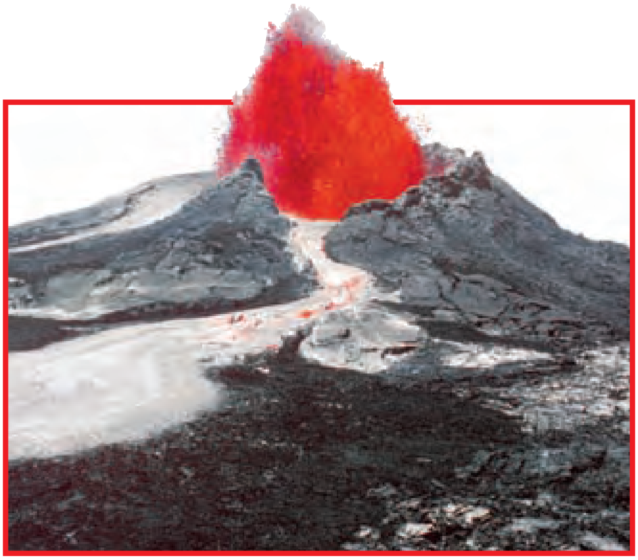
tropism (trōp′iz′ə m) The reaction of a plant to a stimulus. (p. 105)



V

variable (vâr′ē·ə ·bə l) Something that can be changed or controlled in an experiment. (p. 5)

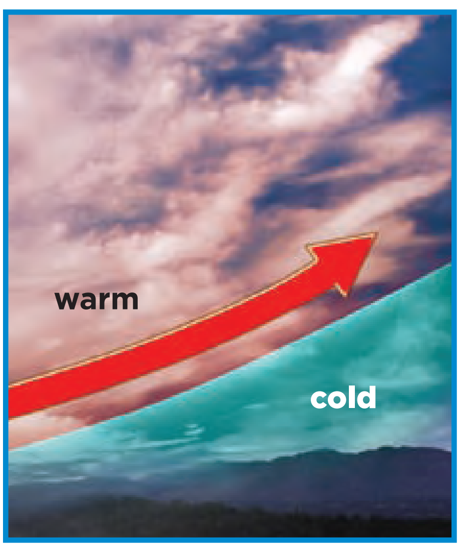
volcano (vol′kā·nō) A mountain that builds up around an opening in Earth's crust. (p. 154)



volume (vol′ūm) A measure of how much space matter takes up. (p. 245)

W

warm front (wôrm frunt) A boundary between air masses that allows a warm air mass to slide up and over a cold air mass. (p. 171)



water cycle (wô′tə r sī′kə l) The constant movement of water between Earth's surface and the atmosphere. (p. 200)

water vapor (wô′tə r vā′pə r) Water in the form of a gas. (p. 198)

weathering (weth′ə r·ing) The breaking down of rocks into smaller pieces. (p. 160)

weight (wāt) The measure of the pull of gravity between an object and Earth. (p. 258)

wind vane (wind vān) A device that moves to show which way the wind is blowing. (p. 192)

Index

Note: Pages followed by an asterisk (*) indicate activities.

M

N

O

Y

Science Standards

Ohio Science Benchmarks – Grades 3-5

Earth and Space Sciences (ESS)

A. Explain the characteristics, cycles and patterns involving Earth and its place in the solar system.

B. Summarize the processes that shape Earth's surface and describe evidence of those processes.

C. Describe Earth's resources including rocks, soil, water, air, animals and plants and the ways in which they can be conserved.

D. Analyze weather and changes that occur over a period of time.

Life Sciences (LS)

A. Differentiate between the life cycles of different plants and animals.

B. Analyze plant and animal structures and functions needed for survival and describe the flow of energy through a system that all organisms use to survive.

C. Compare changes in an organism's ecosystem/habitat that affect its survival.

Physical Sciences (PS)

A. Compare the characteristics of simple physical and chemical changes.

B. Identify and describe the physical properties of matter in its various states.

C. Describe the forces that directly affect objects and their motion.

D. Summarize the way changes in temperature can be produced and thermal energy transferred.

E. Trace how electrical energy flows through a simple electrical circuit and describe how the electrical energy can produce thermal energy, light, sound and magnetic forces.

F. Describe the properties of light and sound energy.

Science and Technology (ST)

A. Describe how technology affects human life.

B. Describe and illustrate the design process.

Scientific Inquiry (SI)

A. Use appropriate instruments safely to observe, measure, and collect data when conducting a scientific investigation.

B. Organize and evaluate observations, measurements and other data to formulate inferences and conclusions.

C. Develop, design and safely conduct scientific investigations and communicate the results.

Scientific Ways of Knowing (SWK)

A. Distinguish between fact and opinion and explain how ideas and conclusions change as new knowledge is gained.

B. Describe different types of investigations and use results and data from investigations to provide the evidence to support explanations and conclusions.

C. Explain the importance of keeping records of observations and investigations that are accurate and understandable.

D. Explain that men and women of diverse countries and cultures participate in careers in all fields of science.

Grade Level Indicators – Grade 4

Earth and Space Sciences (ESS)

Earth Systems

1. Explain that air surrounds us, takes up space, moves around us as wind, and may be measured using barometric pressure.

2. Identify how water exists in the air in different forms (e.g., in clouds, fog, rain, snow and hail).

3. Investigate how water changes from one state to another (e.g., freezing, melting, condensation and evaporation).

4. Describe weather by measurable quantities such as temperature, wind direction, wind speed, precipitation and barometric pressure.

5. Record local weather information on a calendar or map and describe changes over a period of time (e.g., barometric pressure, temperature, precipitation symbols and cloud conditions).

6. Trace how weather patterns generally move from west to east in the United States.

7. Describe the weather which accompanies cumulus, cumulonimbus, cirrus and stratus clouds.

Processes That Shape the Earth

8. Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas and glacial moraines).

9. Identify and describe how freezing, thawing and plant growth reshape the land surface by causing the weathering of rock.

10. Describe evidence of changes on Earth's surface in terms of slow processes (e.g., erosion, weathering, mountain building and deposition) and rapid processes (e.g. volcanic eruptions, earthquakes and landslides).

Life Sciences (LS)

Heredity

1. Compare the life cycles of different plants including germination, maturity, reproduction and death.

Diversity and Interdependence of Life

2. Relate plant structures to their specific functions (e.g., growth, survival and reproduction).

3. Classify common plants according to their characteristics (e.g., tree leaves, flowers, seeds, roots and stems).

4. Observe and explore that fossils provide evidence about plants that lived long ago and the nature of the environment at that time.

5. Describe how organisms interact with one another in various ways (e.g., many plants depend on animals for carrying pollen or dispersing seeds).

Physical Sciences (PS)

Nature of Matter

1. Identify characteristics of a simple physical change (e.g., heating or cooling can change water from one state to another and the change is reversible).

2. Identify characteristics of a simple chemical change. When a new material is made by combining two or more materials, it has chemical properties that are different from the original materials (e.g., burning paper, vinegar and baking soda).

3. Describe objects by the properties of the materials from which they are made and that these properties can be used to separate or sort a group of objects (e.g., paper, glass, plastic and metal).

4. Explain that matter has different states (e.g., solid, liquid and gas) and that each state has distinct physical properties.

Nature of Energy

5. Compare ways the temperature of an object can be changed (e.g., rubbing, heating and bending of metal).

Science and Technology (ST)

Understanding Technology

1. Explain how technology from different areas (e.g., transportation, communication, nutrition, healthcare, agriculture, entertainment and manufacturing) has improved human lives.
2. Investigate how technology and inventions change to meet peoples' needs and wants.

Abilities To Do Technological Design

3. Describe, illustrate and evaluate the design process used to solve a problem.

Scientific Inquiry (SI)

Doing Scientific Inquiry

1. Select the appropriate tools and use relevant safety procedures to measure and record length, weight, volume, temperature and area in metric and English units.
2. Analyze a series of events and/or simple daily or seasonal cycles, describe the patterns and infer the next likely occurrence.
3. Develop, design and conduct safe, simple investigations or experiments to answer questions.
4. Explain the importance of keeping conditions the same in an experiment.
5. Describe how comparisons may not be fair when some conditions are not kept the same between experiments.
6. Formulate instructions and communicate data in a manner that allows others to understand and repeat an investigation or experiment.

Scientific Ways of Knowing (SWK)

Nature of Science

1. Differentiate fact from opinion and explain that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
2. Record the results and data from an investigation and make a reasonable explanation.
3. Explain discrepancies in an investigation using evidence to support findings.

Ethical Practices

4. Explain why keeping records of observations and investigations is important

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