Section 3

Water on Earth

Reading Preview

Key Concepts

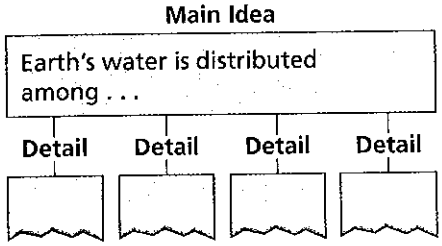
- How do people and other living things use water?
- How is Earth's water distributed?
- How does Earth's water move through the water cycle?

Key Terms

- photosynthesis
- habitat
- groundwater
- water cycle
- transpiration
- precipitation

Target Reading Skill

Identifying Main Ideas As you read the Distribution of Earth's Water section, write the main idea in a graphic organizer like the one below. Then write four supporting details that further explain the main idea.



Lab zone Discover Activity

Where Does the Water Come From?

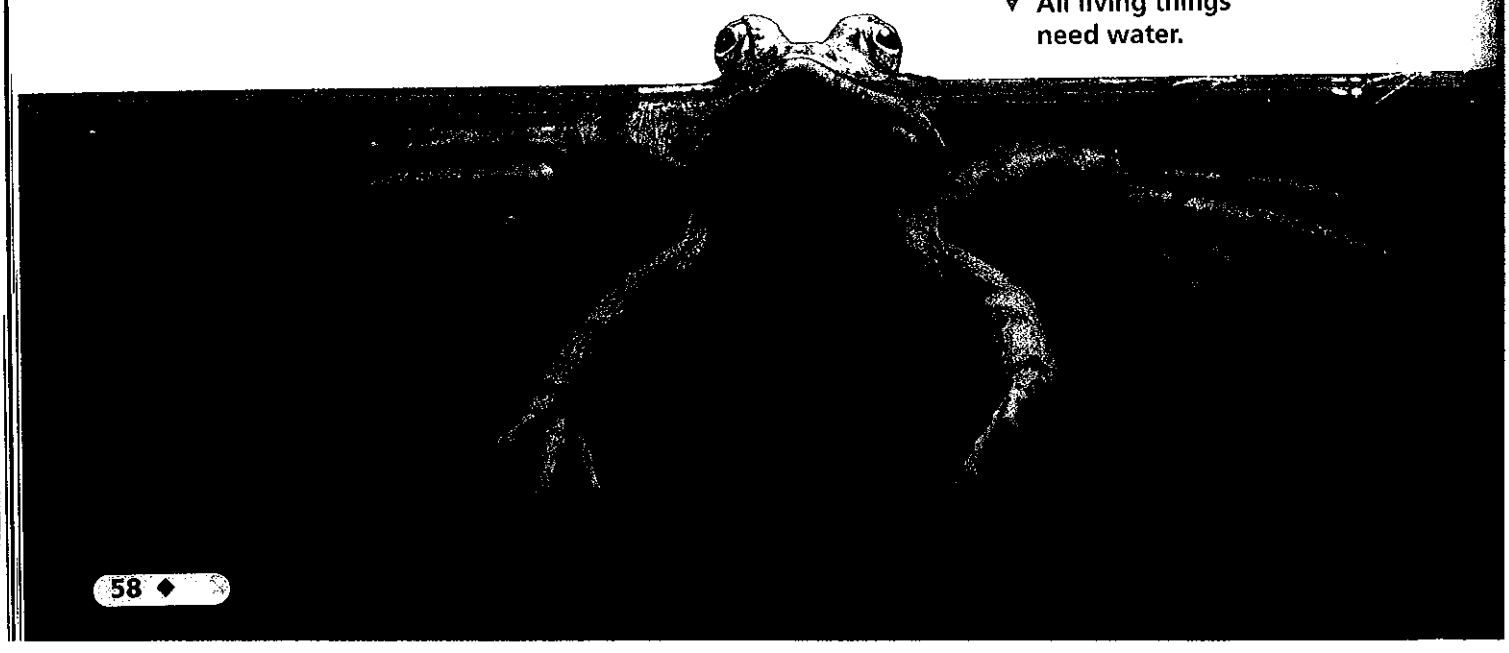
1. Fill a glass with ice cubes and water, taking care not to spill any water. Set the glass aside for 5 minutes.
2. Observe the outside of the glass. Pick up the glass and examine the surface it was sitting on.

Think It Over

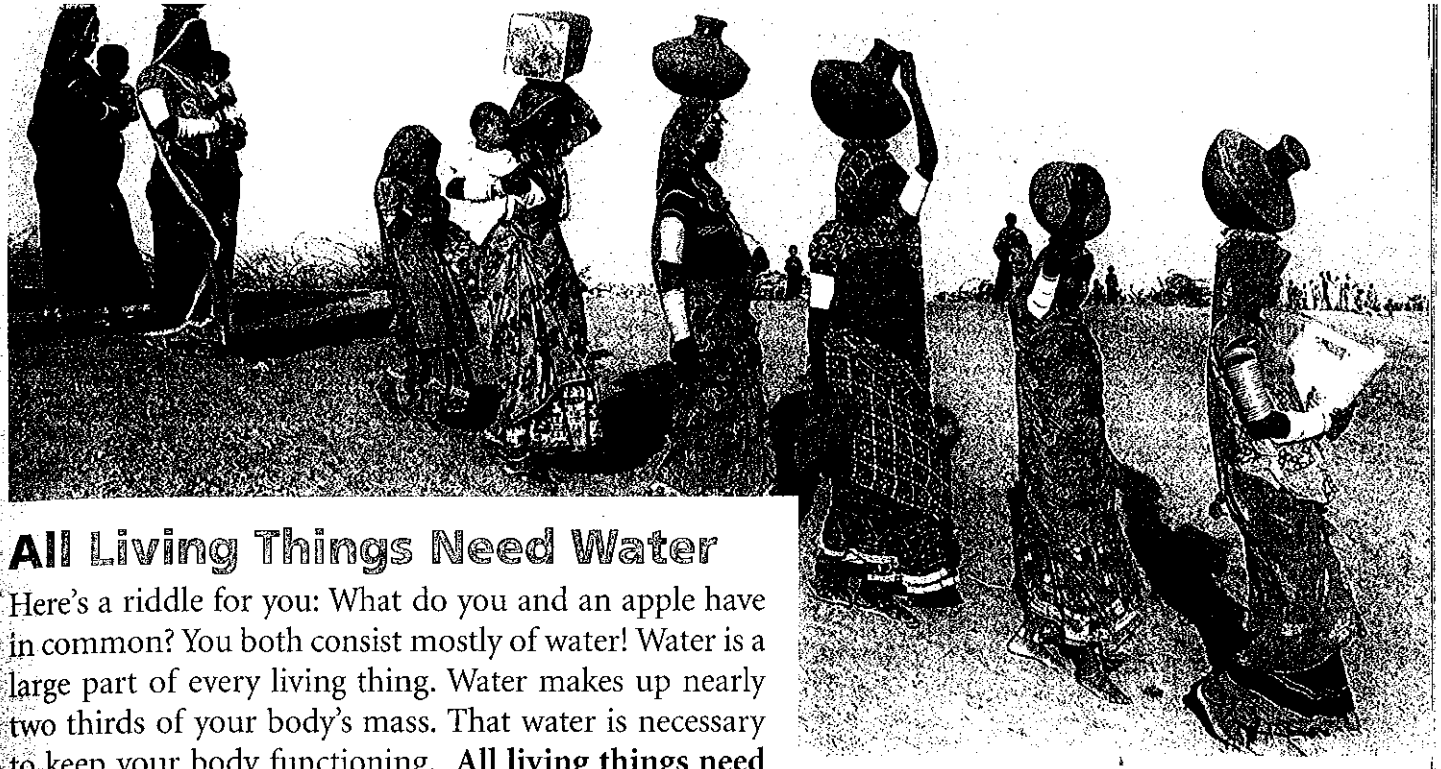
Inferring Where did the water on the outside of the glass come from? How do you think it got there?

In a galaxy called the Milky Way, nine planets orbit a star known simply as the sun. Some of the planets have spectacular rings. Others have volcanoes that are larger than continents or storms that last for centuries. But only one of the planets, Earth, has a surface covered mainly by water. In fact, oceans cover about 70 percent of our planet's surface. That's why Earth is often called the "blue planet."

Earth differs from the other planets in another important way. It is the only place known thus far where you, your classmates, your pets, your plants, and every other living thing can survive. The wide variety of life on Earth could not exist without water.



▼ All living things need water.



All Living Things Need Water

Here's a riddle for you: What do you and an apple have in common? You both consist mostly of water! Water is a large part of every living thing. Water makes up nearly two thirds of your body's mass. That water is necessary to keep your body functioning. **All living things need water in order to carry out their body processes. In addition, many living things use water for shelter.**

Body Processes All organisms need water to carry out their body processes. Water allows organisms to obtain chemicals from their surroundings, break down food, grow, reproduce, and move substances within their bodies. Humans and other animals drink water or obtain it indirectly by eating foods that contain water. Many animals can live several weeks without food. But they cannot survive more than a few days without water.

Plants and other organisms that make their own food also need water in order to carry out their food-making processes. **Photosynthesis** (foh toh SIN thuh sis) is the process by which plants use water, along with carbon dioxide and energy from the sun, to make their own food. Animals and other organisms depend on the food made by plants during photosynthesis. Animals may eat the plants or eat organisms that eat the plants.

Shelter Bodies of water provide habitats for many living things. An organism's **habitat** is the place where it lives and obtains all the things it needs to survive. You are probably familiar with large water-dwelling organisms such as sharks. But most water-dwelling organisms are microscopic, such as amoebas. In fact, aquatic, or water, habitats contain more organisms than land habitats.

Reading Checkpoint **What is a habitat?**

FIGURE 13
Essential for Life
As part of their daily routine, these women in Pakistan must walk to a well to get the water they need.
Interpreting Photographs *What can you infer about the availability of fresh water in the region where these women live?*

Distribution of Earth's Water

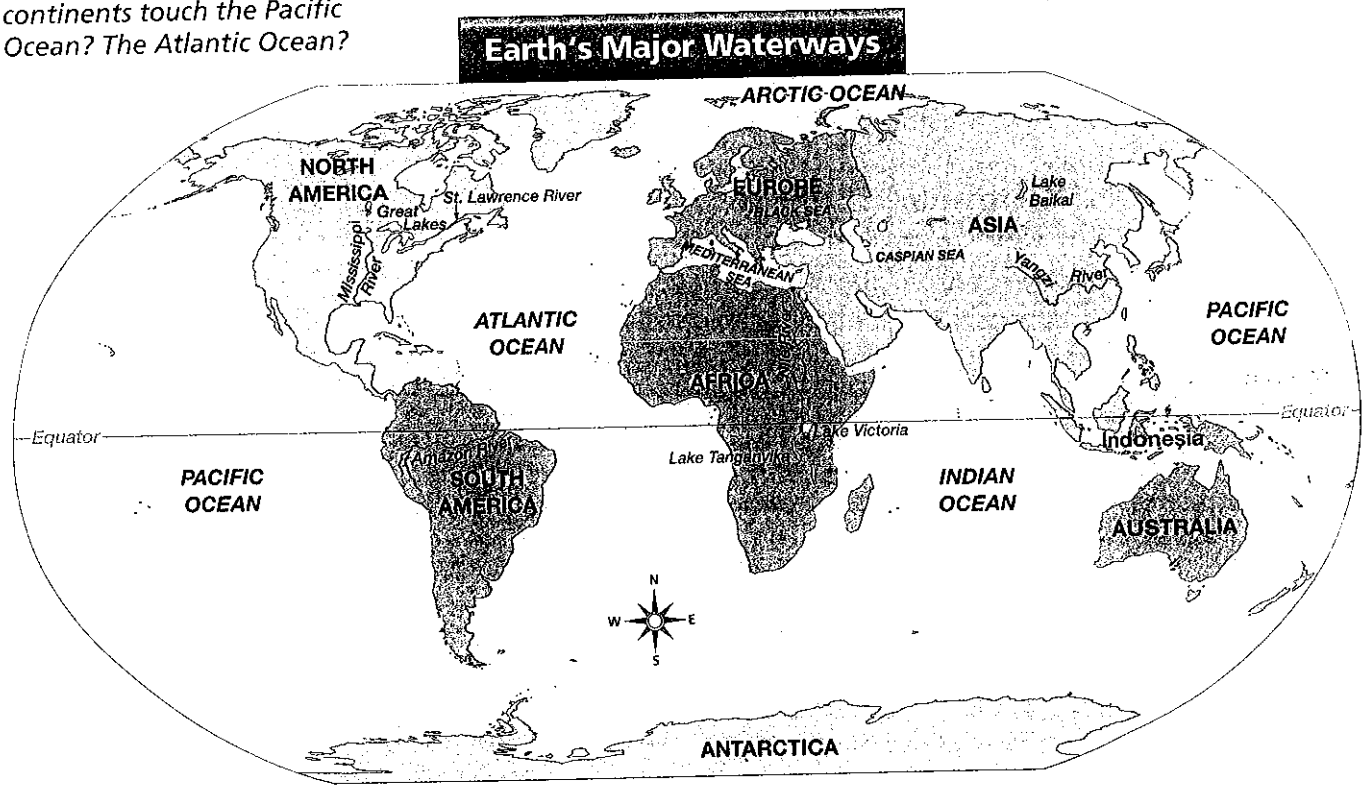
Look at Figure 15. It shows how water is distributed among saltwater and freshwater sources on Earth. **Most of Earth's water—roughly 97 percent—is salt water found in oceans. Only 3 percent is fresh water.**

Of that 3 percent, about three quarters is frozen in huge masses of ice near the North and South poles. Almost a quarter of the fresh water is underground. A tiny fraction of Earth's fresh water occurs in lakes and rivers. An even tinier fraction is found in the atmosphere, most of it in the form of invisible water vapor, the gaseous form of water.

Oceans To explore Earth's waters, take an imaginary boat trip around the world. Starting in Florida, you head southeast across the Atlantic Ocean toward Africa. Swinging around the continent's southern tip, you enter the smaller but deeper Indian Ocean. Next, you travel east across the Pacific Ocean. This vast ocean covers an area greater than all the land on Earth combined. Pacific, Atlantic, Indian—these are the names used for the different parts of the ocean. But the waters are really all interconnected, making up one big ocean.

Reading Checkpoint **Where is most fresh water located?**

FIGURE 14
Earth's oceans are all connected, enabling a ship to sail all the way around the world. This map also shows some of the world's major rivers and lakes.
Interpreting Maps *Which continents touch the Pacific Ocean? The Atlantic Ocean?*



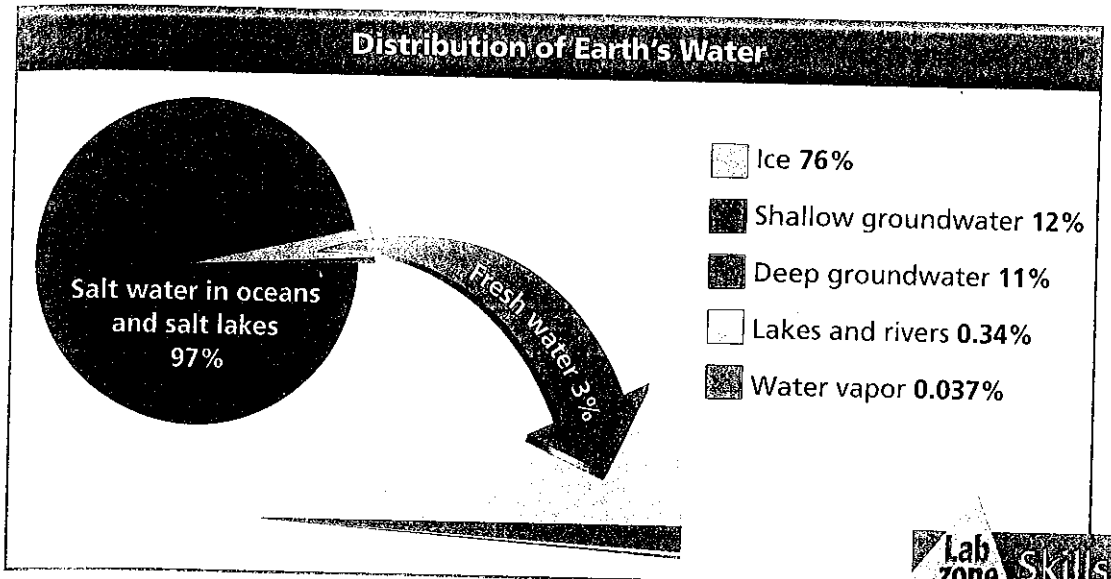


FIGURE 15
Most of Earth's water is salt water. Only 3 percent is fresh water. Of that fresh water, only a tiny fraction is available for human use.

Ice How can you get back to Florida? You could sail all the way around South America. But watch out for icebergs! These floating chunks of ice are made of fresh water. Icebergs in the southern Pacific and southern Atlantic oceans have broken off from massive sheets of ice that cover most of Antarctica. If you traveled around the North Pole, you would also find icebergs in the Arctic Ocean and in the North Atlantic.

Rivers and Lakes To see fresh water in rivers and lakes, you'll have to make a side trip inland. Sail north past Nova Scotia, Canada, to the beginning of the St. Lawrence Seaway. Navigate through the series of locks along the St. Lawrence River. Suddenly the river widens and you enter Lake Ontario, one of North America's five Great Lakes. The Great Lakes contain nearly 20 percent of all the water in the world's freshwater lakes.

Groundwater Some of the fresh water on Earth can't be seen from a sailboat. To find it, you would have to go underground. When it rains or snows, some water soaks into the ground. This water trickles down through spaces between particles of soil and rock. Eventually the water reaches a layer of rock that it cannot move through. Water that fills the cracks and spaces in underground soil and rock layers is called **groundwater.** Far more fresh water is located underground than in all of Earth's rivers and lakes. You'll learn more about groundwater in Section 6.

Lab zone Skills Activity

Calculating

This activity shows how Earth's water is distributed.

1. Fill a 1-liter plastic bottle with water to represent the total water on Earth.
2. Measure 97 percent, or 970 milliliters (mL), of the water and pour it into a large bowl to represent salt water on Earth.
3. Label five cups to represent Earth's freshwater sources. Figure 15 shows the percentage of water in each freshwater source. Using this graph, calculate how much of the remaining 30 mL of water should be poured into each cup.
4. Use a graduated cylinder to measure the amount of water for each cup. Use a plastic dropper for amounts that are too small to measure accurately.

Which cups contain water that is easily available to humans? How do these amounts compare to the amount in Step 1?

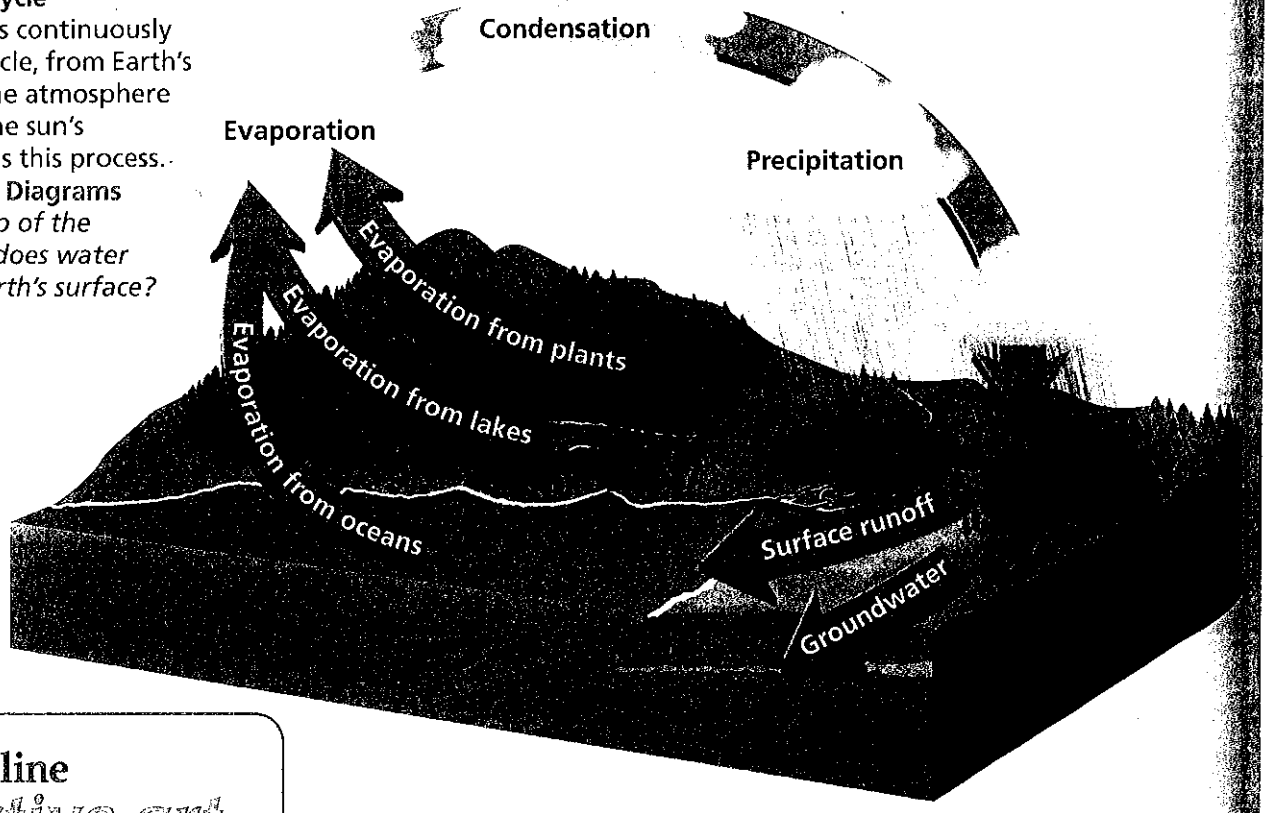


FIGURE 16
The Water Cycle
Water moves continuously through a cycle, from Earth's surface to the atmosphere and back. The sun's energy drives this process.
Interpreting Diagrams
In which step of the water cycle does water return to Earth's surface?

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The Water Cycle

Earth's water is naturally recycled through the water cycle. The **water cycle** is the continuous process by which water moves from Earth's surface to the atmosphere and back. **In the water cycle, water moves from bodies of water, land, and living things on Earth's surface to the atmosphere and back to Earth's surface.** As shown in Figure 16, the water cycle has three major steps—evaporation, condensation, and precipitation. The cycle itself has no real beginning or end. But it is driven by an energy source—the sun.

Water Evaporates As you learned earlier, evaporation is the process by which molecules at the surface of a liquid absorb enough energy to change to a gaseous state. Water is constantly evaporating from the surfaces of oceans and large lakes. Smaller amounts evaporate from the soil, puddles, and even from your skin. Plants play a role, too, in this step of the water cycle. Plants draw in water from the soil through their roots. Eventually the water is given off through the leaves as water vapor in a process called **transpiration.**

Condensation Forms Clouds What happens after a water molecule evaporates? Warm air carries the water molecule upward. At higher altitudes, air tends to become much colder. Cold air cannot hold as much water vapor as warm air can. As a result, some of the water vapor cools and condenses into liquid water. Condensed droplets of water clump together around tiny dust particles in the air, forming clouds.

Water Falls As Precipitation As more water vapor condenses, the water droplets in a cloud grow larger and larger. Eventually, they become so heavy that they fall back to Earth. Water that falls to Earth as rain, snow, hail, or sleet is called **precipitation.**

Most precipitation falls directly into the ocean. The precipitation that falls on land may evaporate immediately or run off the surface into rivers and lakes. From there, it may evaporate or flow back into the ocean. In addition, some water may trickle down into the ground. After a long time, this groundwater may reach a river, lake, or ocean and continue the cycle by evaporating again.

Precipitation is the source of all fresh water on and below Earth's surface. The water cycle renews the usable supply of fresh water on Earth. For millions of years, the total amount of water on Earth has remained fairly constant—rates of evaporation and precipitation are balanced.

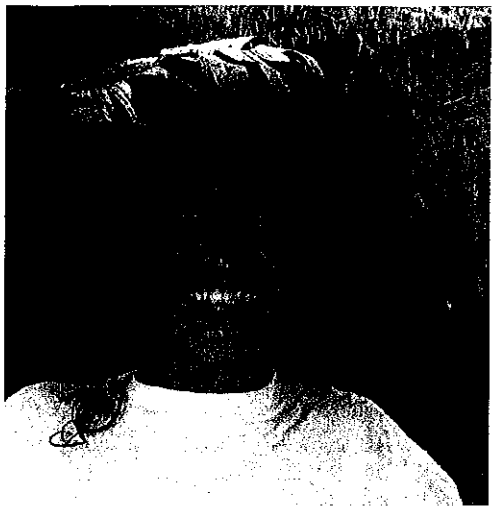


FIGURE 17
Precipitation
Precipitation is part of the water cycle. But you might not want it falling on your head!

Reading Checkpoint **List three sources from which water evaporates.**

Section 3 Assessment

Target Reading Skill Identifying Main Ideas Use your graphic organizer to help you answer Question 2 below.

Reviewing Key Concepts

1. a. **Describing** What are two reasons that living things need water?
   b. **Applying Concepts** Why can't animals survive more than a few days without water?
   c. **Developing Hypotheses** Some desert animals live for many days without drinking water. How do you think these animals survive?
2. a. **Listing** What are the four main sources of water on Earth?
   b. **Classifying** Which of the four main water sources contain salt water? Which contain fresh water?
   c. **Making Judgments** Which freshwater source is most important to people? Use facts to defend your answer.
3. a. **Identifying** What three major steps make up the water cycle?
   b. **Sequencing** Starting with a puddle on a sunny day, describe how water might move through the water cycle and eventually fall back as rain.

Writing in Science

Product Label Create a product label for bottled drinking water, explaining to consumers why water is a precious resource.

Reading Preview

Key Concepts

- What is a river system?
- How do ponds and lakes form?
- What changes can occur in lakes?

Key Terms

- tributary • watershed
- divide • reservoir • nutrient
- eutrophication

Target Reading Skill

Outlining As you read, make an outline of this section. Use the red headings for the main ideas and the blue headings for the supporting ideas.

Surface Water
I. River systems
A. Tributaries
B.
C.
II. Ponds and lakes
A.

Lab zone Discover Activity

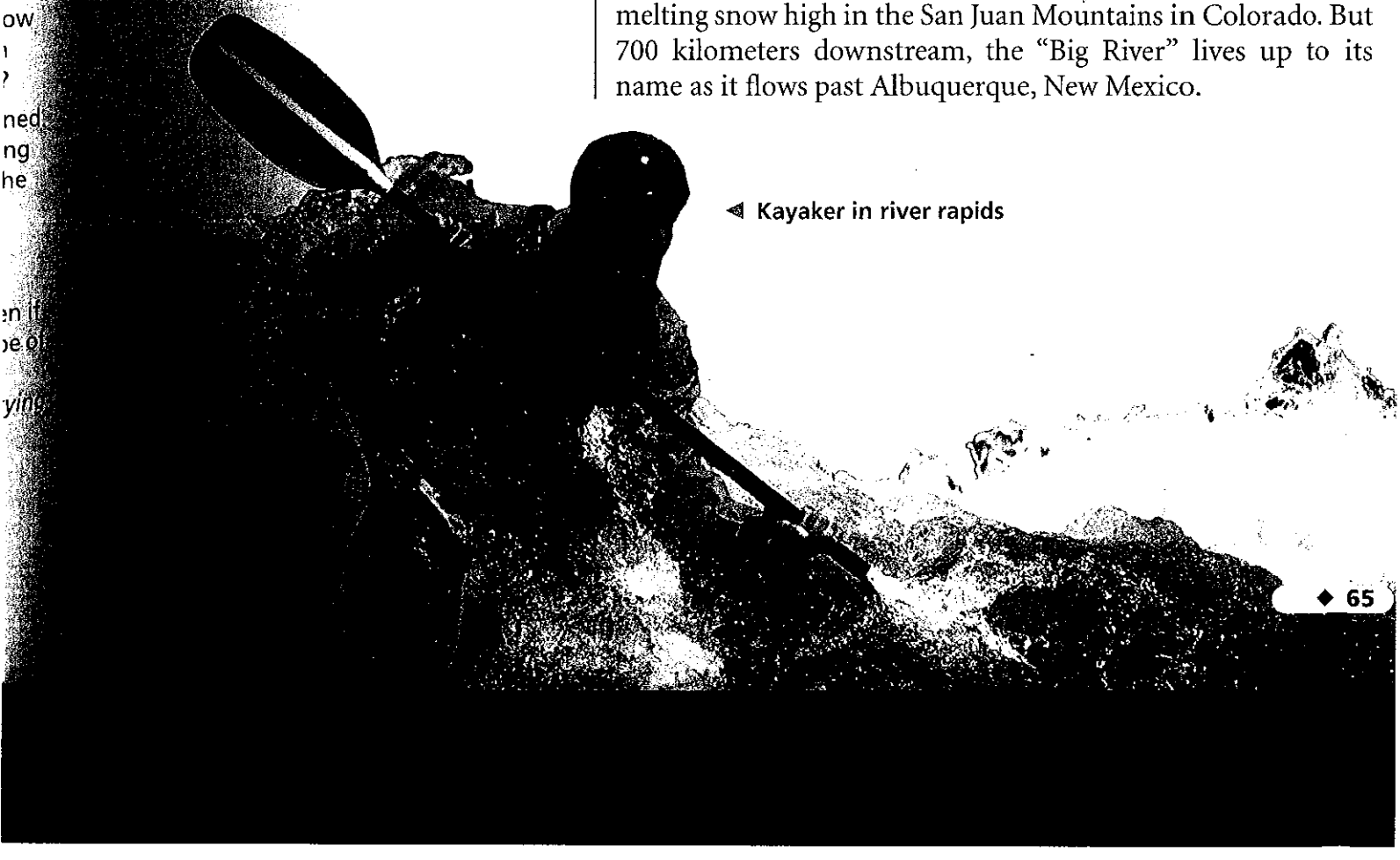
What's in Pond Water?

1. Using a hand lens, observe a sample of pond water.
2. Make a list of everything you see in the water. If you don't know the name of something, write a short description or draw a picture.
3. Your teacher has set up a microscope with a slide of pond water. Observe the slide under the microscope and add any new items to your list. Wash your hands with soap when you are done.

Think It Over

Classifying Use one of these systems to divide the items on your list into two groups: moving/still, living/nonliving, or microscopic/visible without a microscope. What does your classification system tell you about pond water?

Imagine that you are a raindrop falling from the clouds to Earth's surface. Down, down, you go and then, splash! You land in the tumbling waters of a fast-moving stream. You are in one of Earth's freshwater sources. Fresh water on Earth may be moving, as in streams and rivers, or still, as in ponds and lakes. All fresh water, however, comes from precipitation. For example, the Rio Grande—the "Big River"—begins as trickles of melting snow high in the San Juan Mountains in Colorado. But 700 kilometers downstream, the "Big River" lives up to its name as it flows past Albuquerque, New Mexico.



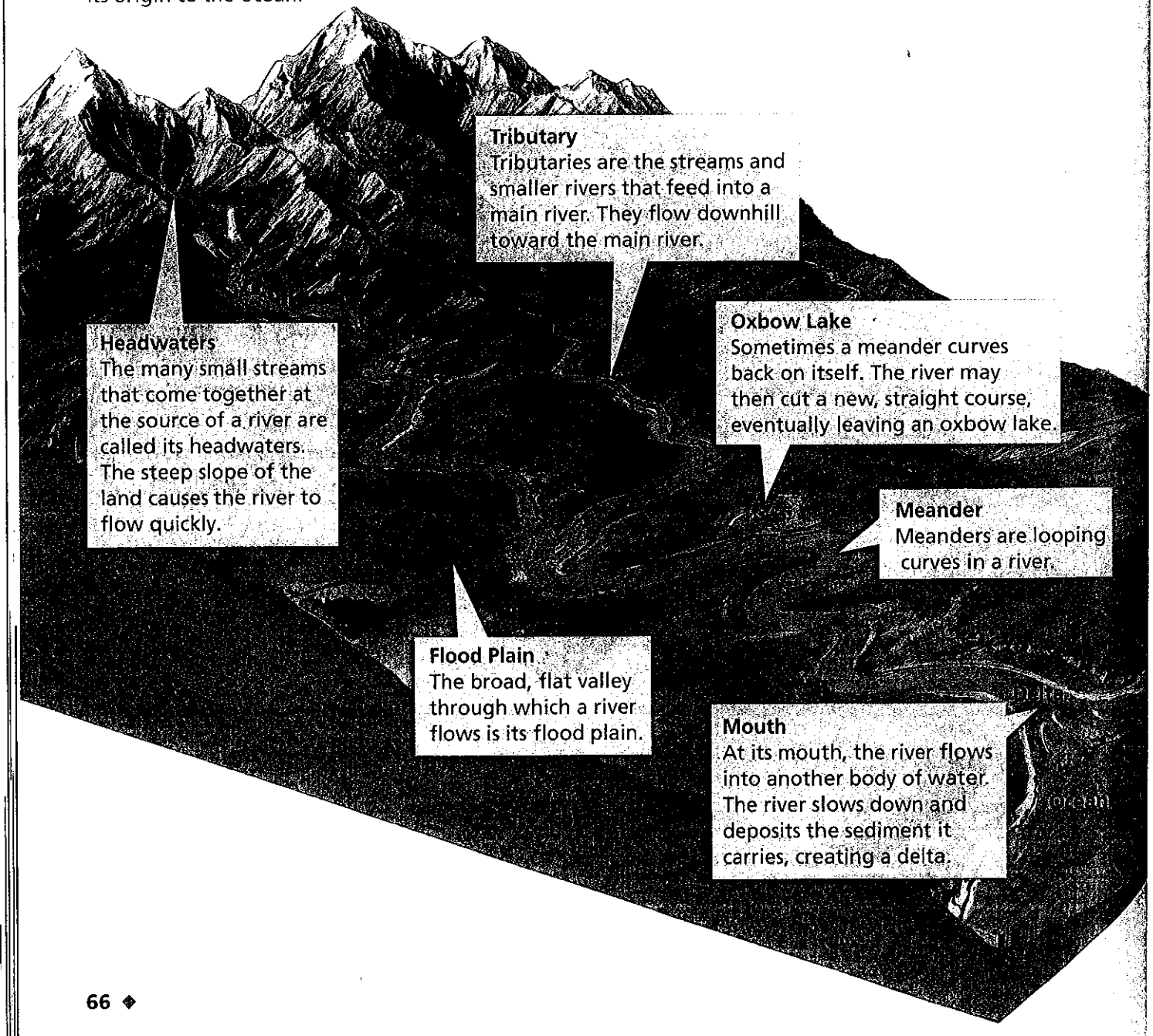
◀ Kayaker in river rapids

River Systems

If you were hiking in the mountains of Colorado, you could observe the path of the runoff from melting snow. As you followed one small stream downhill, you would notice that the stream reached another stream and joined it. These streams flow into a small river. Eventually this path would lead you to the Rio Grande itself. Figure 18 shows the parts of a typical river.

Tributaries The streams and smaller rivers that feed into a main river are called **tributaries.** Tributaries flow downward toward the main river, pulled by the force of gravity. **A river and all its tributaries together make up a river system.**

FIGURE 18
Exploring a River
Notice the changes that occur as a river flows from its origin to the ocean.



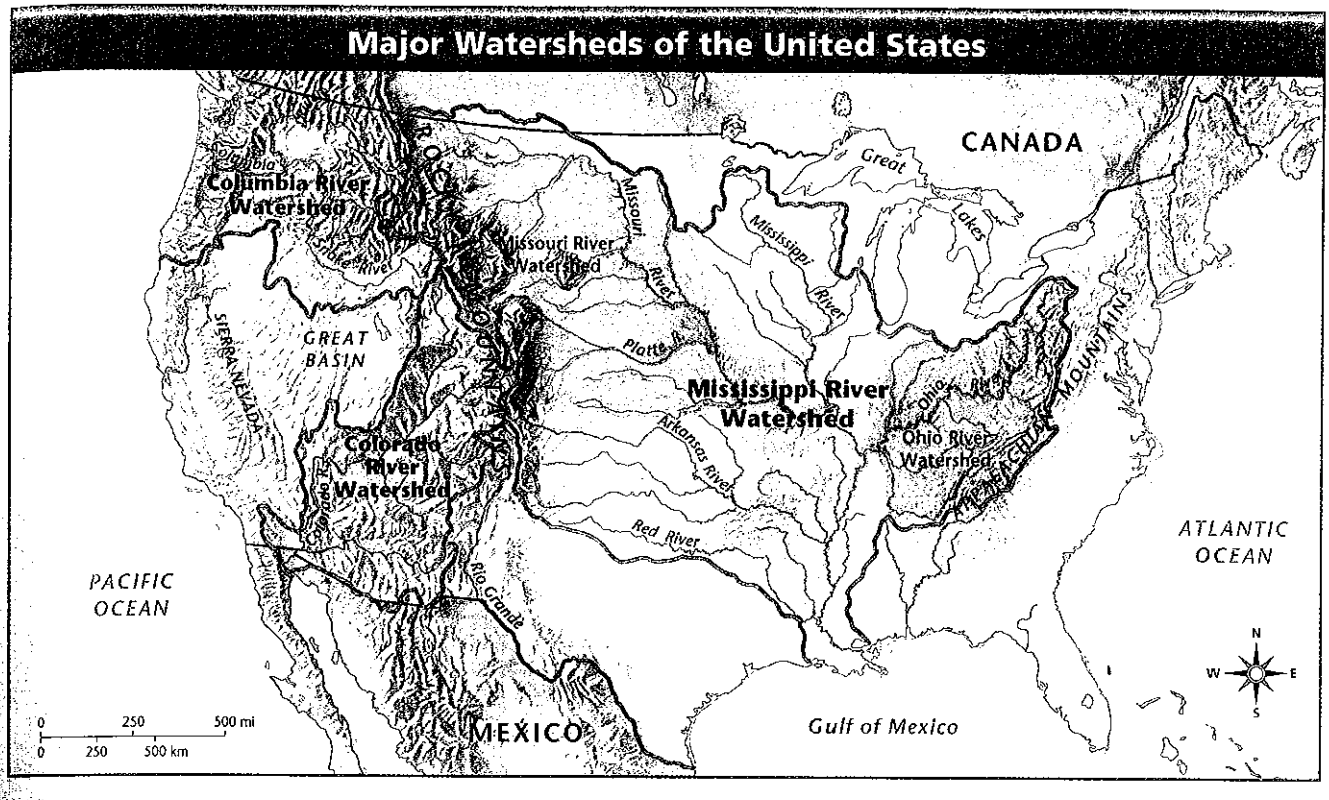


FIGURE 19
Major Watersheds
This map shows watersheds of several large rivers in the continental United States. Each river's watershed consists of the region drained by the river and all its tributaries. Interpreting Maps *What large rivers are tributaries of the Mississippi River?*

Watersheds Just as all the water in a bathtub flows toward the drain, all the water in a river system drains into a main river. The land area that supplies water to a river system is called a **watershed.** Watersheds are sometimes known as drainage basins.

As you can see in Figure 19, the Missouri and Ohio rivers are quite large. Yet they flow into the Mississippi River. So large rivers may be tributaries of still larger rivers. When rivers join another river system, the areas they drain become part of the largest river's watershed. You can identify a river's watershed on a map by drawing an imaginary line around the region drained by all its tributaries. The watershed of the Mississippi River, the largest river in the United States, covers nearly one third of the country!

Divides What keeps watersheds separate? One watershed is separated from another by a ridge of land called a **divide.** Streams on each side of the divide flow in different directions. The Continental Divide, the longest divide in North America, follows the line of the Rocky Mountains. West of the Continental Divide, water either flows toward the Pacific Ocean or into the dry Great Basin. Between the Rocky Mountains and the Appalachian Mountains, water flows toward the Mississippi River or directly into the Gulf of Mexico.

Reading Checkpoint What is a divide?

Lab zone Skills Activity

Inferring

The Nile River in Africa flows from south to north. What can you infer about the slope of the land through which the Nile River flows? (*Hint:* Think about the factors that determine how a river system forms.)

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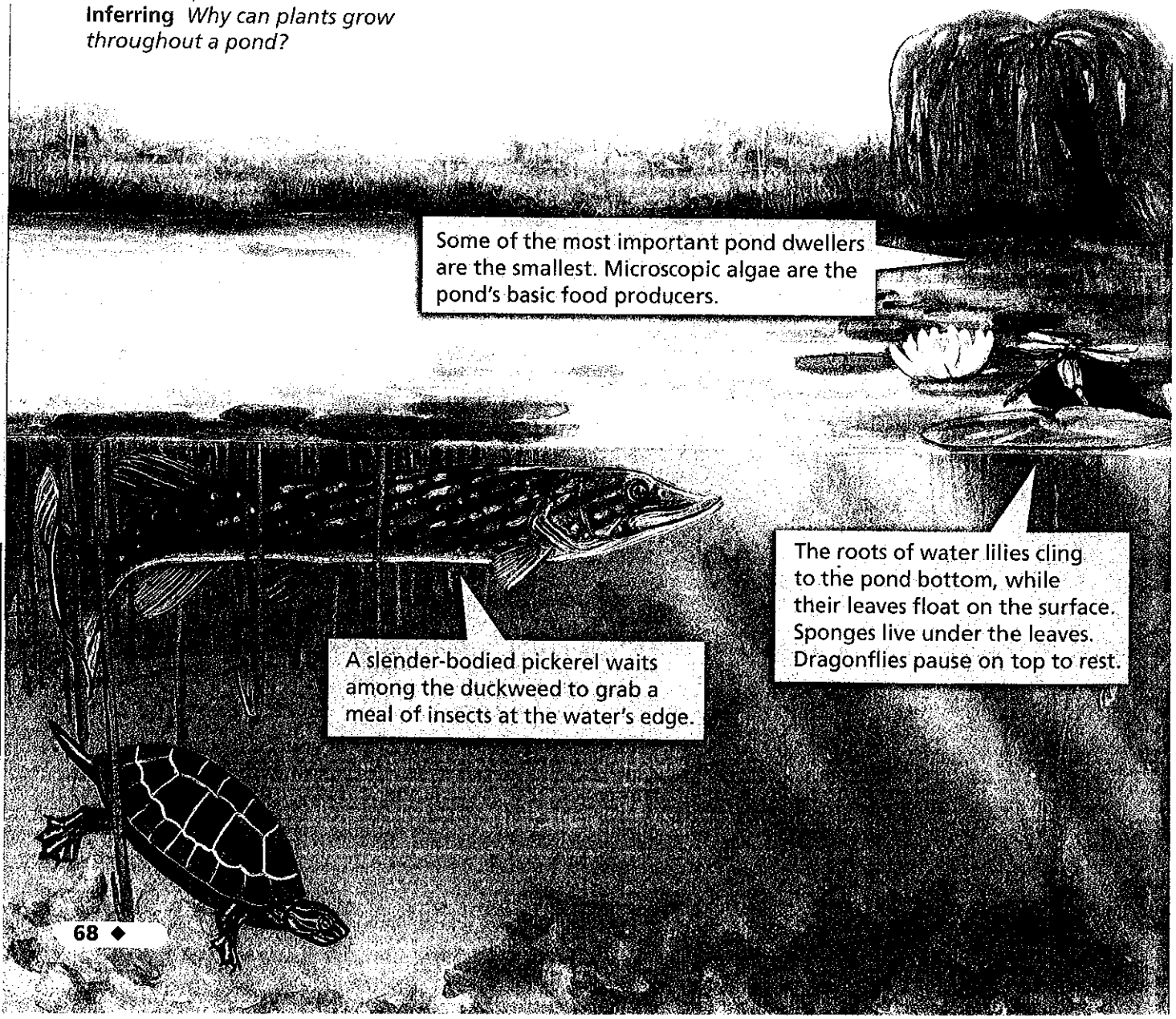
Ponds and Lakes

Ponds and lakes are bodies of fresh water. Unlike the moving water in streams and rivers, ponds and lakes contain still, or standing, water. How can you tell the difference between ponds and lakes? There is no definite rule. In general, however, ponds are smaller and shallower than lakes. Sunlight usually reaches to the bottom of all parts of a pond. Most lakes have areas where the water is too deep for sunlight to reach the bottom.

Ponds and lakes form when water collects in hollows and low-lying areas of land. Where does the water come from? Some ponds and lakes are supplied by rainfall, melting snow and ice, and runoff. Others are fed by rivers or groundwater. As a pond or lake gains water from these sources, it also loses water to natural processes. For example, water may eventually flow out of a body of fresh water into a river. Water also evaporates from the surface of a pond or lake.

FIGURE 20
Life in a Pond
From its shallow edges to its muddy bottom, a pond is rich with life.
Inferring *Why can plants grow throughout a pond?*



Exploring a Pond A pond might seem calm and peaceful at first glance. But look closer—do you notice the silvery minnows gliding beneath the surface? Plop! A frog has jumped into the water. The quiet pond is actually a thriving habitat, supporting a wide diversity of living things, as shown in Figure 20.

If you've ever waded in a pond, you know that the muddy bottom is often covered with weeds. Because the water is shallow enough for sunlight to reach the bottom, plants grow throughout a pond. Plantlike organisms called algae also live in the pond. As the plants and algae use sunlight to make food through photosynthesis, they also produce oxygen. Animals in the pond use the oxygen and food provided by plants and algae.

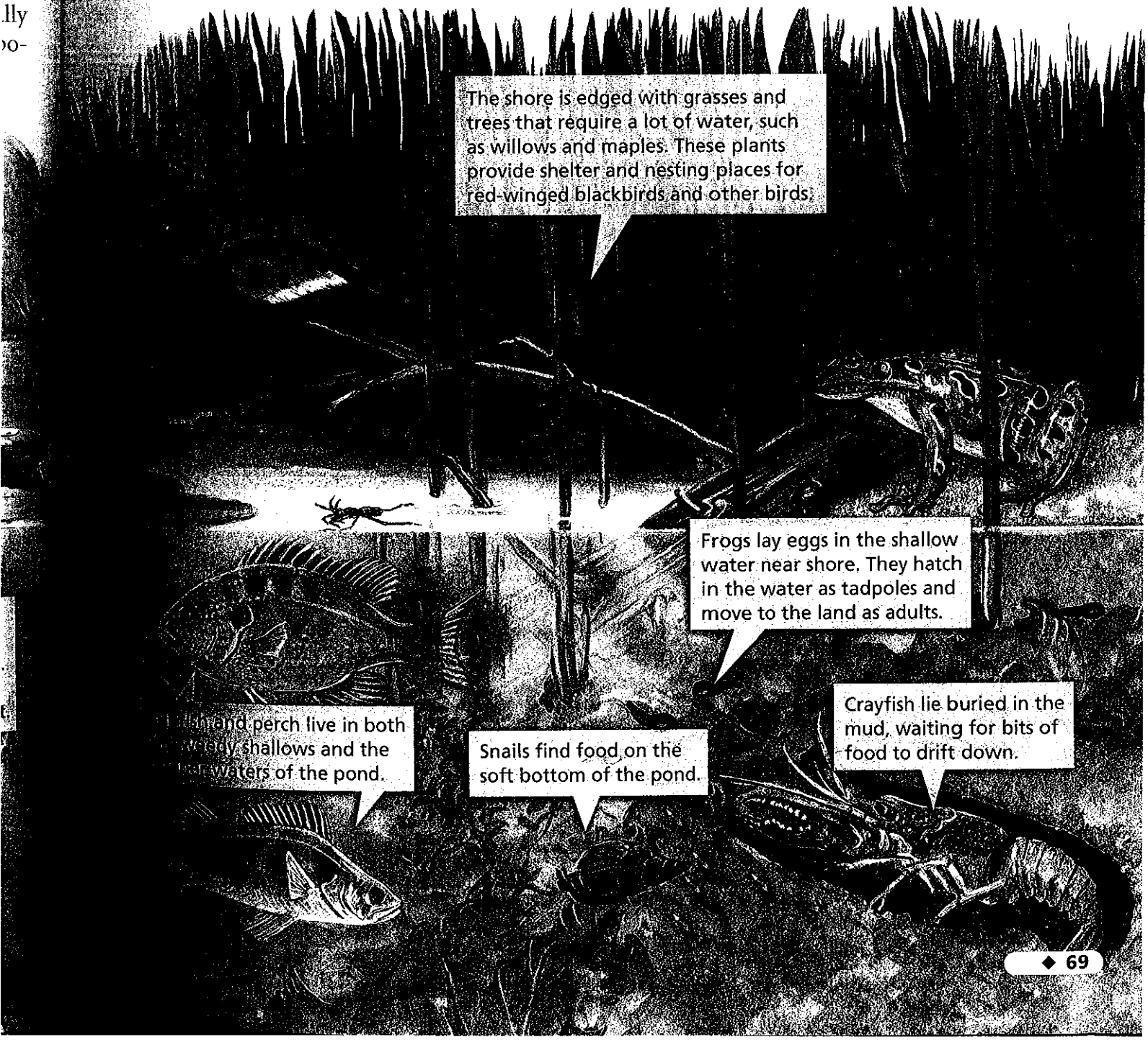
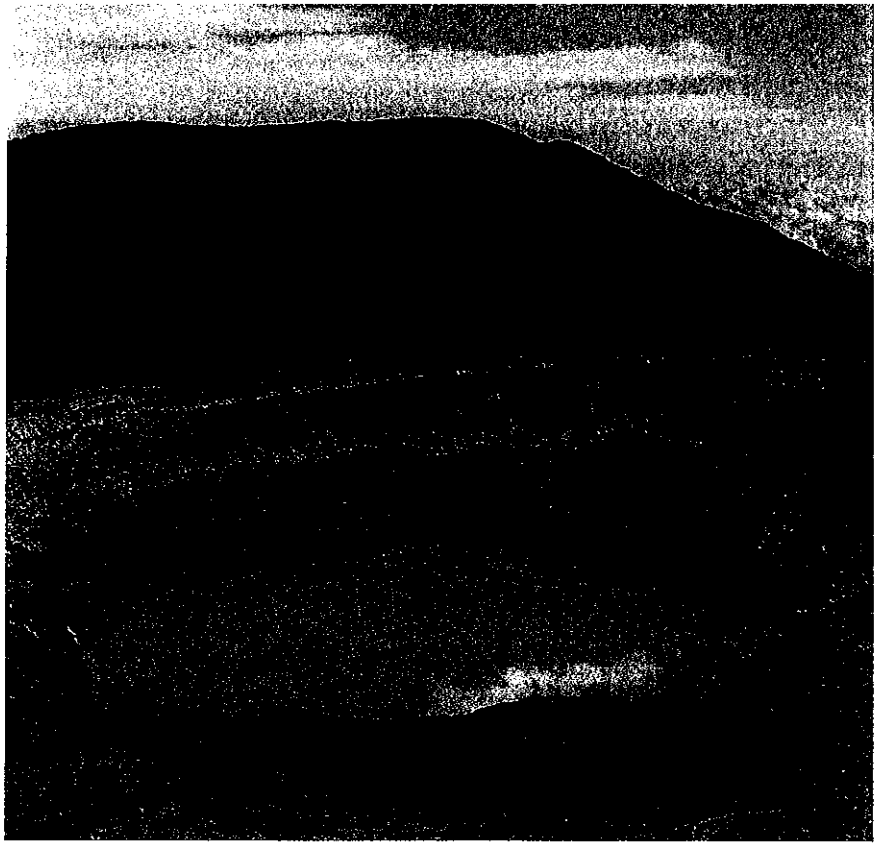


FIGURE 21

Types of Lakes

A lake can be formed either by a natural process or by human efforts. **Interpreting Photographs** *What are three ways that lakes are formed?*



Volcanic Lake
Volcanic lakes such as this one in Costa Rica form when water fills the craters of old volcanoes.

Exploring a Lake Suppose you were shown a picture of a sandy beach. Waves are breaking on the shore. The water stretches as far as the eye can see. Gulls are screeching overhead. Where was the picture taken? Your first guess might be the ocean. But this immense body of water could actually be a lake! You could be viewing a photo of a beach in Indiana, on the shore of Lake Michigan.

Most lakes are not as large as Lake Michigan. But recall that lakes are generally deeper and bigger than ponds. A lake bottom may consist of sand, pebble, or rock, whereas the bottom of a pond is usually covered with mud and algae.

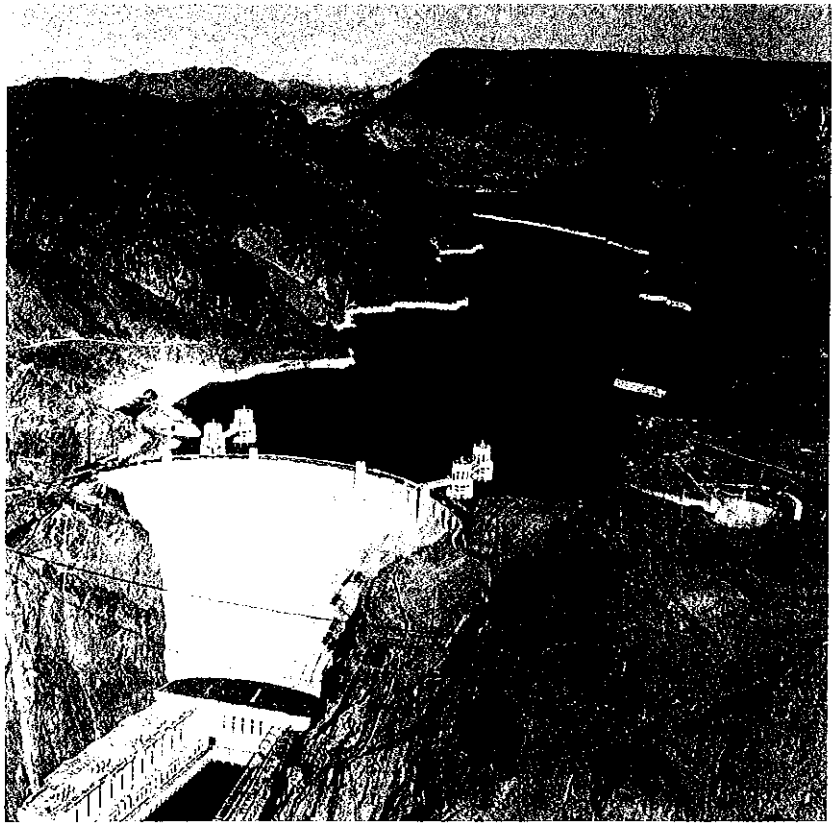
In the shallow water near shore, the wildlife of a lake is similar to that of a pond. Water beetles scurry over the slippery, moss-covered rocks. Loons and kingfishers pluck fishes from the open water. But sunlight does not reach the bottom of a deep lake, as it does in a pond. As a result, only a few organisms can live in lake's chilly, dark depths. There are no plants, but mollusks, such as clams, and worms move along the lake bottom. They feed on food particles that drift down from the surface. Deep lake waters are also home to large, bony fishes such as pike and sturgeon. These fishes eat the tiny bottom-dwellers. They also swim to the surface to feed on other fishes and even small birds.

Lab zone Skills Activity

Classifying

Crumple up a piece of wax paper. Straighten out the paper to model a landscape with hills and valleys. Use a permanent marker to draw lines along the highest divides of the landscape. Then draw circles where lakes and ponds will form on the landscape. Place the wax paper in a sink and sprinkle water over the landscape to simulate rain. Observe where the water collects. Which areas would you classify as ponds? Which would be lakes? Explain your reasoning.

Glacier-Made Lake
Lake Louise in Alberta, Canada, was formed by the movements of glaciers.



Human-Made Lake
The Lake Mead reservoir is part of the Hoover Dam complex in the southwestern United States.

Lake Formation As you read earlier, lakes and ponds form when water collects in hollows and low-lying areas of land. Let's take a closer look at some natural processes that can result in the formation of a lake. A river channel, for example, can form a lake as it changes over time. It bends and loops as it encounters obstacles in its path. Eventually, a new channel might form, cutting off a loop. The cut-off loop may become an oxbow lake.

Some other natural lakes, such as the Great Lakes, formed in depressions created by ice sheets that melted at the end of the Ice Age. Other lakes were created by movements of Earth's crust. Such movements formed the deep valleys in central Africa that lie below Lake Tanganyika and Lake Victoria. Still other lakes are the result of volcanoes. An erupting volcano can cause a flow of lava or mud that blocks a river and forms a lake. Some lakes form in the empty craters of volcanoes.

People can also create a lake by building a dam across a river. The lake may be used for supplying drinking water, for irrigating fields, and for recreation. A lake that stores water for human use is called a **reservoir.**

Reading Checkpoint What is a reservoir?

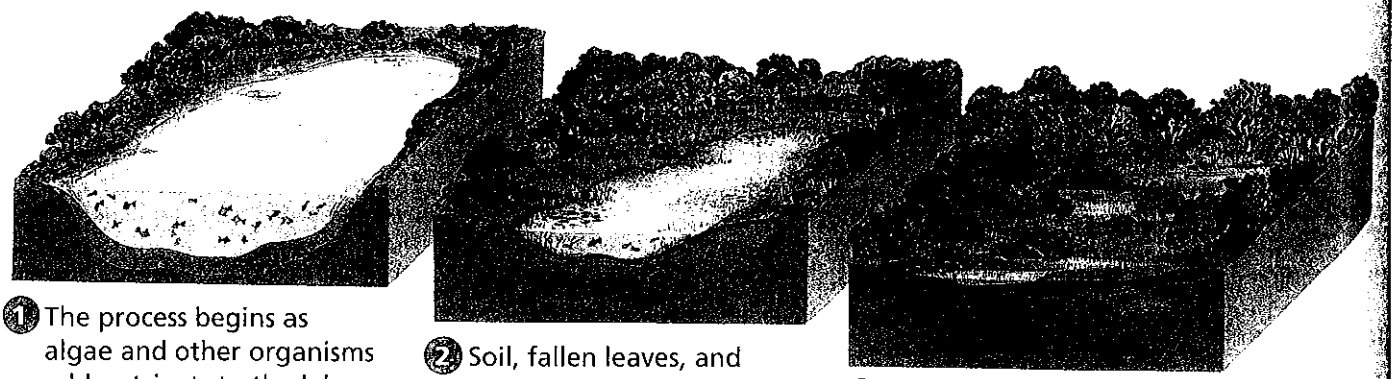
How Lakes Can Change

A maple tree in fall looks very different than it does in the summer. The green leaves change to brilliant shades of red, orange, and yellow. Lakes can change with the seasons, too. Lakes change for many reasons. **In addition to seasonal changes, a lake can undergo long-term changes that may eventually lead to its death.**

Seasonal Changes Seasonal changes in lakes are common in cool, northern areas of North America. In summer, the sun warms the upper layer of water in a lake. The warm water floats on top of the cooler, denser, lower layer. But in fall, the top layer cools off, too. As the top layer cools, it becomes denser and sinks. This causes the lake waters to mix. This mixing, also called lake turnover, causes materials to rise from the lake bottom. Lake turnover refreshes the supply of nutrients throughout the lake. **Nutrients** are substances such as nitrogen and phosphorus that enable plants and algae to grow.

Long-Term Changes The second type of change that may occur in a lake happens over a long period of time. The organisms in a lake constantly release waste products into the water. The wastes and the remains of dead organisms contain nutrients such as nitrates and phosphates. Algae feed on these nutrients. Over many years, the nutrients build up in the lake in a process called **eutrophication** (yoo troh fih KAY shun). As eutrophication causes more algae to grow, a thick, green scum forms on the surface of the water. Recall that algae are present in ponds as well as lakes. So eutrophication can also occur in ponds.

FIGURE 22
Long-Term Changes in a Lake
Lakes and ponds change gradually over time. **Relating Cause and Effect** *What effect does an increase in nutrient levels have on a lake?*



1. The process begins as algae and other organisms add nutrients to the lake. These nutrients support more plant growth.
2. Soil, fallen leaves, and decaying matter pile up on the bottom of the lake. The lake becomes shallower and marshy.
3. Eventually, the plants completely fill the lake, creating a grassy meadow.

Death of a Body of Fresh Water When the algae layer becomes so thick that it blocks out the sunlight, plants in the lake or pond can no longer carry out photosynthesis. They stop producing food and oxygen, and they die. As dead organisms in the water decay, the amount of oxygen in the water decreases. Many of the fish and other water animals no longer have enough oxygen to live. Material from decaying plants and animals piles up on the bottom, and the lake or pond becomes shallower. The sun warms the water to a higher temperature and more plants take root in the rich bottom mud. Eventually, the body of fresh water becomes completely filled with plants. The remaining water evaporates, and a grassy meadow takes the place of the former lake or pond.

Eutrophication is not the only change that can lead to the death of a lake or pond. Sometimes, water may leave a pond more rapidly than it enters it. This can happen when the source of water for a pond—a stream, for example—dries up or is cut off from the pond by natural processes such as erosion. In addition, streams and rivers carry sediments into ponds or lakes. Over a long period of time, these sediments can fill in the body of water.

FIGURE 23
Halting Eutrophication
In some locations, a community will periodically clean out a pond or lake in order to prolong its life.

Reading Checkpoint **What kinds of materials can build up over time at the bottom of a lake?**

Section 4 Assessment

Target Reading Skill Outlining Use the information in your outline to help you answer the questions below.

Reviewing Key Concepts

1. a. **Identifying** What bodies of water make up a river system?
   b. **Summarizing** How is a watershed related to a river system?
   c. **Applying Concepts** How could you determine the boundaries of a river system by studying a map of the United States?
2. a. **Reviewing** How are lakes different from ponds?
   b. **Explaining** Explain how ponds and lakes form.
   c. **Comparing and Contrasting** What is the major difference between a reservoir and most other types of lakes?
3. a. **Explaining** What causes lake turnover?
   b. **Sequencing** Describe the changes that take place at each stage of eutrophication.

Lab zone **At-Home Activity**

The Knuckle Divide Have a family member make a fist and put it on a paper towel, knuckles facing up. Dribble water from a spoon so that it falls onto the person's knuckles. As you both observe how the water flows over the hand, explain how the knuckles model a mountain range. Which parts of the hand represent a watershed?

Section 5

Wetland Environments

Reading Preview

Key Concepts

- What are the common types of freshwater wetlands?
- Which human activities threaten the Florida Everglades?
- What important functions do wetlands serve?

Key Term

- wetland

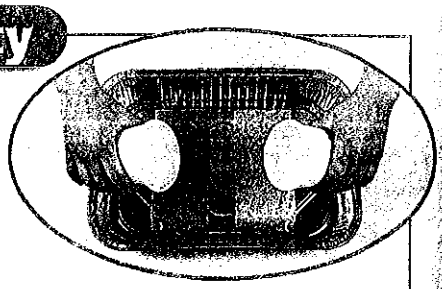
Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what* or a *how* question for each heading. As you read, write the answers to your questions.

Wetland Environments

Question	Answer
What are the types of wetlands?	Three types of wetlands are . . .

Lab zone Discover Activity



Wet or Dry?

1. Hold a kitchen sponge under water until it is soaked. Then squeeze out the water until the sponge is just damp.
2. Place the damp sponge next to a dry sponge in a pan.
3. Pour water into two paper cups until each is half full.
4. Hold a cup in each hand, about 10 centimeters above the pan. Pour the water onto both sponges at the same time.

Think It Over

Observing Which of the sponges absorbs water faster? How are your observations related to what might happen in areas of wet and dry land?

Imagine coming home from a long trip, only to find that your house is gone and has been replaced by a parking lot! Millions of migrating birds have had a similar experience. But people are beginning to understand the importance of wetlands, both to wildlife and to people. A **wetland** is a land area that is covered with a shallow layer of water during some or all of the year. These soggy regions, as you'll learn, are important in many ways.

Marsh Marshes, such as this one in Washington State, are grassy areas covered with shallow water.

FIGURE 24
Freshwater Wetlands
Freshwater wetlands can differ in many ways. **Predicting** *Which types of wetlands are you more likely to find in northern areas?*

Types of Wetlands

Wetlands help control floods and provide habitats for many species. They form in places where water is trapped in low areas or where groundwater seeps to the surface. Wetlands may be as small as a roadside ditch or cover as much area as a city. Some wetlands fill up during spring rains, only to dry up during long, hot summers. Others are covered with water year-round.

The three common types of freshwater wetlands are marshes, swamps, and bogs. As shown in Figure 24, these wetlands are quite diverse. Marshes are usually grassy areas covered by shallow water or a stream. They teem with cattails and other tall, grasslike plants. Swamps look more like flooded forests, with trees and shrubs sprouting from the water. Many swamps are located in warm, humid climates, where trees grow quickly. Bogs are more common in cooler northern areas. They often form in depressions left by melting ice sheets thousands of years ago. The water in bogs tends to be acidic, and mosses thrive in these conditions.

Wetlands along coasts usually contain both fresh and salt water. Coastal wetlands include salt marshes and mangrove forests. Salt marshes are found along both coasts of the United States. Tall, strong grasses grow in the rich, muddy bottoms of salt marshes. Mangrove forests are found along the southeastern coast of the United States. In these forests, the mangrove trees are short and have thick, tangled roots.

Reading Checkpoint **Name three types of freshwater wetlands.**

Go Online NSTA SCILINKS

For: Links on wetlands
Visit: www.SciLinks.org
Web Code: scn-0814

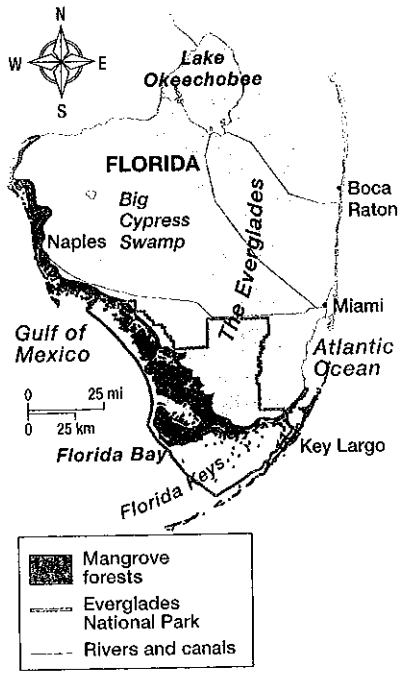
Swamp Swamps look like flooded forests. Clumps of Spanish moss hang from the trees in this Louisiana swamp.

Bog Mosses thrive in the acidic water in bogs. Colorful flowers dot a bed of velvety moss in this bog in Montana.

FIGURE 25

Florida Everglades

A rich variety of living things make their homes in the Everglades. **Observing** *Why is the Everglades sometimes called a "river of grass"?*



The Everglades: A Wetland

If you were to walk down a path in Florida's Everglades National Park, you would feel the ground squish under your feet. Water is the key to the Everglades, a unique region of wetlands. A shallow stream of water moves slowly over the gently sloping land from Lake Okeechobee south to Florida Bay. Tall, sharp-edged blades of sawgrass grow in the water. The thick growth of sawgrass gave this region its Native American name, *Pa-hay-okee*, which means "river of grass." Low-lying islands are scattered throughout the sawgrass marsh.

Everglades Wildlife In the Everglades, fishes and snakes gobble up tiny organisms in the warm, muddy water. Wading birds in bright colors—pink flamingos, white egrets, and purple gallinules—stand on skinny legs in the water. A raccoon digs for alligator eggs, unaware of the alligator lying low in the water nearby.

The Everglades provide habitats for many rare or endangered species. The endangered Florida panther lives in the wildest parts of the Everglades. Many species of birds, such as the wood stork and the roseate spoonbill, depend on the Everglades as a nesting area. The manatee, or sea cow, lives in the mangrove forests along the coast. Because manatees swim slowly, they are easily injured by the propellers of powerboats. They have become an endangered species as a result of increased boating.

Everglades palm

White-tailed deer

Flamingos

Raccoon

Purple gallinule

American alligator

Threats to the Everglades The Everglades are a fragile environment. Nearby farming has introduced new chemicals into the slow-moving waters of the marsh, upsetting the balance of nutrients. Outside the protected limits of the national park, developers have filled in areas of wetland to build homes and roads. New organisms brought into the area accidentally or for pest control compete with other organisms for space and food. **Agriculture, development, and the introduction of new species are some human activities that threaten the Florida Everglades.**

Water that once flowed into the Everglades from Lake Okeechobee has been diverted for farming and household use. New canals and levees built to provide drinking water and to control flooding have changed the flow of water into and out of the Everglades. Some areas are drying up, while others are flooded.

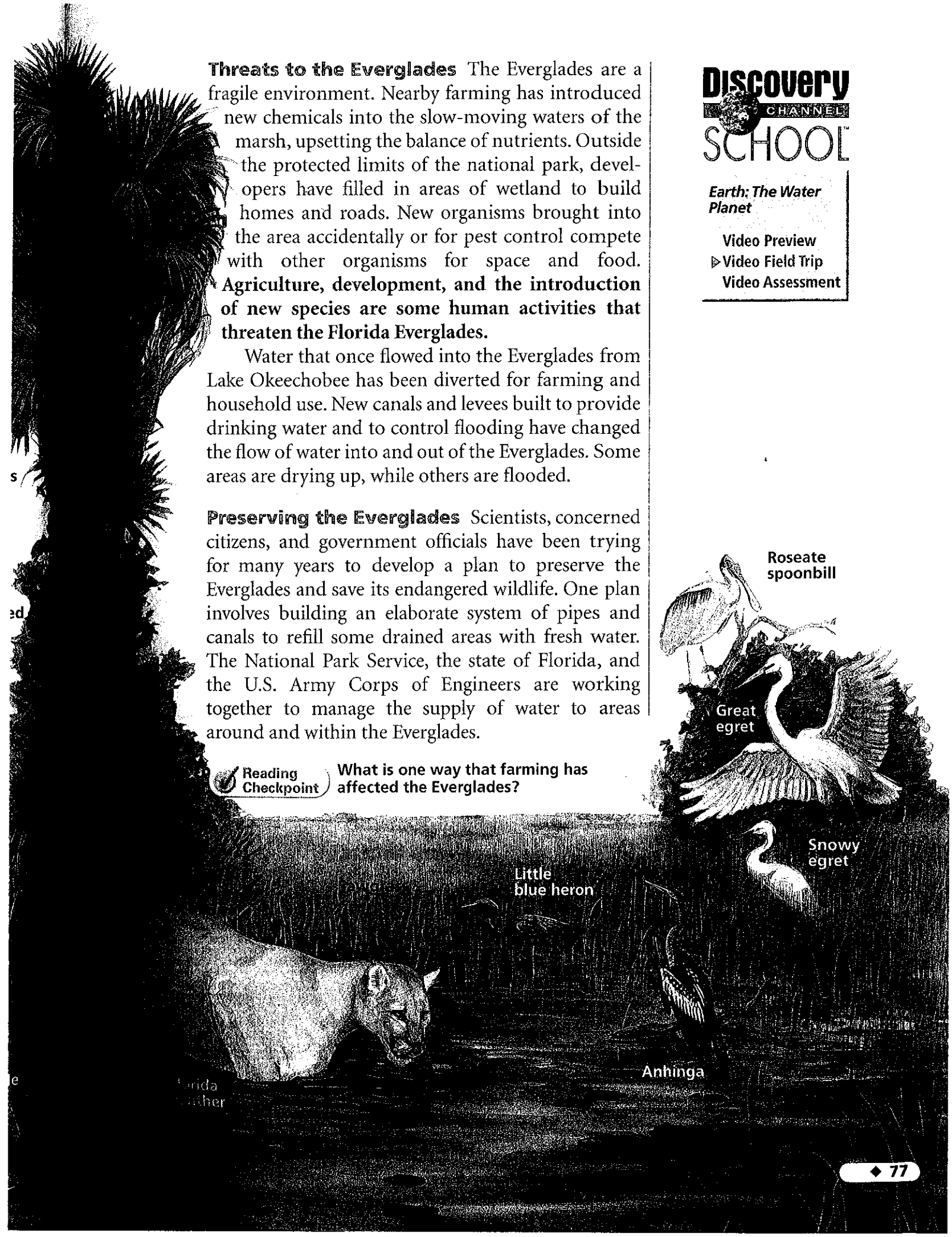
Preserving the Everglades Scientists, concerned citizens, and government officials have been trying for many years to develop a plan to preserve the Everglades and save its endangered wildlife. One plan involves building an elaborate system of pipes and canals to refill some drained areas with fresh water. The National Park Service, the state of Florida, and the U.S. Army Corps of Engineers are working together to manage the supply of water to areas around and within the Everglades.

Reading Checkpoint **What is one way that farming has affected the Everglades?**

Discovery Channel School

Earth: The Water Planet

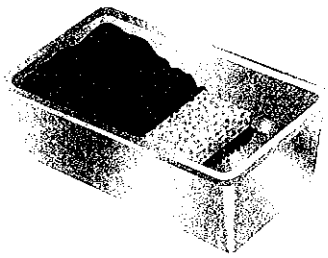
Video Preview
▷ Video Field Trip
Video Assessment



Lab zone Try This Activity

A Natural Filter

1. Cover your work surface with newspaper. In one end of a loaf pan, build a sloping hill of damp soil.
2. Add water to the other end of the pan to form a lake.
3. Use a watering can to sprinkle rain onto the hill. Observe what happens to the hill and the lake.
4. Empty the water out of the pan and rebuild the hill.



5. Now push a sponge into the soil across the bottom of the hill to model a wetland.
6. Repeat Steps 2 and 3.

Observing Based on your observations, describe how wetlands filter water.

Importance of Wetlands

If you've ever enjoyed tart cranberry sauce or tasty wild rice, you've eaten plants that grow in wetlands. The layer of water covering a wetland can range from several centimeters to a few meters deep. Dead leaves and other plant and animal materials serve as natural fertilizers. They add nitrogen, phosphates, and other nutrients to the water and soil.

Importance to Wildlife **Because of their sheltered waters and rich supply of nutrients, wetlands provide habitats for many living things.** Recall the many plants and animals that live in or near a pond—reeds, frogs, snails, dragonflies, turtles. Some of these same organisms live in freshwater wetlands year-round. Insects dart about, finding food and shelter among wetland plants. Birds nest in and around the wetlands, feeding on the plants and darting insects. In addition, some larger animals, such as manatees, live in the wetlands year-round.

Other animals spend only part of their lives in the wetlands. Have you ever seen or heard a flock of geese flying overhead? The geese may be flying south to make a temporary home in a wetland. As winter approaches, geese, ducks, and other waterfowl travel from Alaska and Canada to warmer climates. They pass millions of small, shallow marshes along their routes. The birds stop at these marshes to rest and feed. The birds then make their way to the large southern marshes where they spend the winter.

FIGURE 26
Wetlands Wildlife
Manatees depend on rich wetland habitats for food and breeding sites.

Importance to People Many people, including farmers and builders, once thought wetlands were worthless. They assumed that wetland areas could not be used unless they were drained and filled in. Thousands of square kilometers of wetlands were developed for farms, homes, and businesses. Beginning in the 1970s, however, the government passed laws to protect wetland habitats.

What prompted these laws? Scientific studies showed that wetlands serve important functions for people as well as for wildlife. For example, as water moves slowly through a wetland, some waste materials settle out. Other wastes may be absorbed by plants, such as those shown in Figure 27. The thick network of plant roots also traps silt and mud. **In this way, wetlands act as natural water filters. They also help control floods by absorbing extra runoff from heavy rains.** Wetlands are like giant sponges, storing water until it gradually drains or evaporates. When wetlands are destroyed, the floodwaters are not absorbed. Instead, the water runs off the land quickly, worsening flood problems.

FIGURE 27
Natural Filters
Some wetland plants, such as the pickerel weed shown here, filter pollutants from water. **Inferring** *How are wetland plants like pickerel weed important to people?*

Reading Checkpoint **What prompted wetlands protection laws?**

Section 5 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Defining** What is a wetland?
   b. **Classifying** What are the three major types of freshwater wetlands?
   c. **Comparing and Contrasting** How are the three major types of freshwater wetlands similar? How are they different?
2. a. **Listing** List three activities that threaten the Florida Everglades.
   b. **Summarizing** What is being done to preserve the Everglades?
   c. **Making Judgments** Some of the plans to restore the Everglades will require millions of dollars and would negatively affect local farmers. What information would you consider in deciding what should be done?
3. a. **Describing** Name one way that wetlands benefit wildlife and one way that wetlands benefit people.
   b. **Explaining** How do wetlands help reduce water pollution?
   c. **Developing Hypotheses** Without plants, could a wetland still filter water? Explain.

Lab zone At-Home Activity

Runoff Take a family member outside to observe how water runs off different materials. Pour some water in the grass and watch what happens. Then pour some water on the sidewalk or driveway. What happened to the water in each case? How does this relate to the role of wetlands in controlling floods? Why would floods be more frequent if wetlands were paved over?

Section 6

Water Underground

Reading Preview

Key Concepts

- How does water move through underground layers of soil and rock?
- How do people obtain water from an aquifer?

Key Terms

- permeable • impermeable
- saturated zone • water table
- unsaturated zone • aquifer
- artesian well

Target Reading Skill

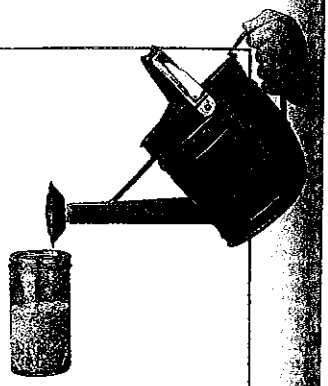
Previewing Visuals Before you read, preview Figure 29. Then write one question that you have about the diagram in a graphic organizer like the one below. As you read, answer your question.

Bringing Up Groundwater

Q. What is an artesian well?
A.
Q.

Lab zone Discover Activity

Where Does the Water Go?



1. Add pebbles to a jar to form a layer about 5 centimeters deep. Cover the pebbles with a layer of dry sand about 3 centimeters thick. Pour the sand in slowly to avoid moving the pebbles. These materials represent underground soil layers.
2. Sprinkle water onto the sand to simulate rainfall.
3. Looking through the side of the jar, observe the path of the water as it soaks through the layers. Wash your hands when you are finished with this activity.

Think It Over

Observing Describe what happened when the water reached the bottom of the jar.

When you were a little child, did you ever dig a hole in the ground hoping to find a buried treasure? You probably never found a trunk full of gold. But there was a certain kind of treasure hidden underground. If you had dug past the tangled grass roots and small stones, the bottom of your hole would have filled with water. You would have "struck groundwater!" In the days before public water systems, water underground was truly a hidden treasure. Today, many people still rely on the water underground to meet their water needs.

How Water Moves Underground

Where does this underground water come from? Like the water in rivers, lakes, and glaciers, it comes from precipitation. Recall that precipitation can evaporate, run off the surface, or soak into the ground. If water soaks into the ground, it trickles downward, following the pull of gravity.

If you pour water into a glass full of pebbles, the water trickles down around the pebbles until it reaches the bottom of the glass. Then the water begins to fill up the spaces between the pebbles. **In the same way, water underground trickles down between particles of soil and through cracks and spaces in layers of rock.**

Effects of Different Materials Different types of rock and soil have different-sized spaces, or pores, between their particles, as shown in Figure 28. The size of the pores determines how easily water moves through rock and soil. If the pores are connected, this too affects water movement. Because they have large and connected pores, materials such as sand and gravel allow water to pass through, or permeate. They are thus known as **permeable** materials.

As water soaks down through permeable rock and soil, it eventually reaches layers of material that it cannot pass through. These materials have few or no pores or cracks. Two examples are clay and granite. Clay and granite are **impermeable,** meaning that water cannot pass through easily.

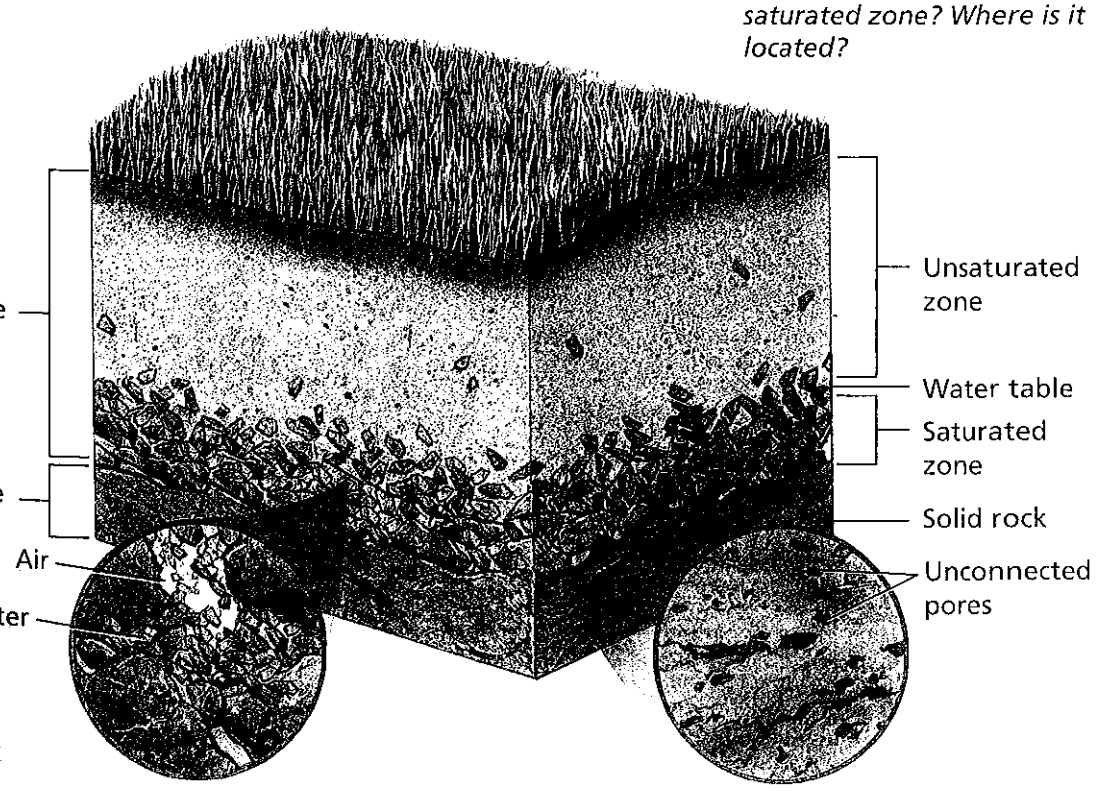
Water Zones Once water reaches an impermeable layer, it is trapped. It can't soak any deeper. Instead, the water begins to fill up the spaces above the impermeable material. The area of permeable rock or soil that is totally filled, or saturated, with water is called the **saturated zone.** The top of the saturated zone is the **water table.** If you know the depth of the water table in your area, you can tell how deep you must dig to reach groundwater.

Soil and rock layers above the water table contain some moisture, too. But here the pores contain air as well as water. They are not saturated. Therefore, the layer of rocks and soil above the water table is called the **unsaturated zone.**

Reading Checkpoint **Give an example of a permeable material.**

Go Online
SCILINKS NSTA
For: Links on water underground
Visit: www.SCiLinks.org
Web Code: scn-0815

FIGURE 28
Groundwater Formation
Differences in the materials that form layers underground determine where groundwater forms. Water can move through certain layers but not others.
Interpreting Diagrams *What is the saturated zone? Where is it located?*



Bringing Up Groundwater

Suppose you live far from a city, town, or body of fresh water. How could you reach groundwater to use it for your daily needs? You may be in luck: the water table in your area might be only a few meters underground. In fact, in some places the water table actually meets the surface. Springs can form as groundwater bubbles or flows out of cracks in the rock. A short distance away, the water table may be deep underground.

Aquifers Any underground layer of rock or sediment that holds water is called an **aquifer.** Aquifers can range in size from a small underground patch of permeable material to an area the size of several states. The huge Ogallala aquifer lies beneath the plains of the Midwest, from South Dakota to Texas. Millions of people obtain drinking water from this underground storehouse. The aquifer also provides water for crops and livestock.

Do you picture groundwater as a large, still pool beneath Earth's surface? In fact, the water is moving, seeping through layers of rock. The rate of movement depends largely on the slope of the aquifer and the permeability of the rocks. Groundwater in some aquifers moves only a few centimeters a day. At that rate, the water moves about 10 meters a year. Groundwater may travel hundreds of kilometers and stay in an aquifer for thousands of years before coming to the surface again.

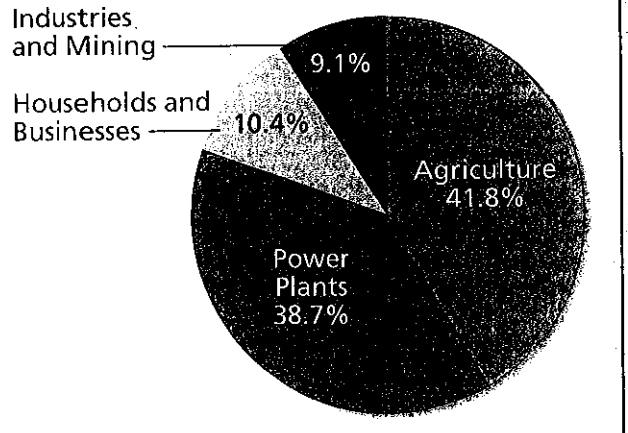
Math Analyzing Data

Uses of Water

The graph shows water use in the United States. Each category of water use is represented by a different color. Use the graph to answer the questions below.

1. **Reading Graphs** How many categories of water use are shown on the graph?
2. **Interpreting Data** The two largest categories of water use combine to make up about what percentage of the total water used in the United States?
3. **Interpreting Data** Which of the categories of water use shown in the graph represents the largest use of water in the United States? Which represents the smallest?
4. **Predicting** How would an increase in the amount of irrigation affect this graph?

Water Use in the United States



5. **Calculating** If the total daily usage of water in the United States is 1,280 billion liters, about how many liters are used each day by power plants?

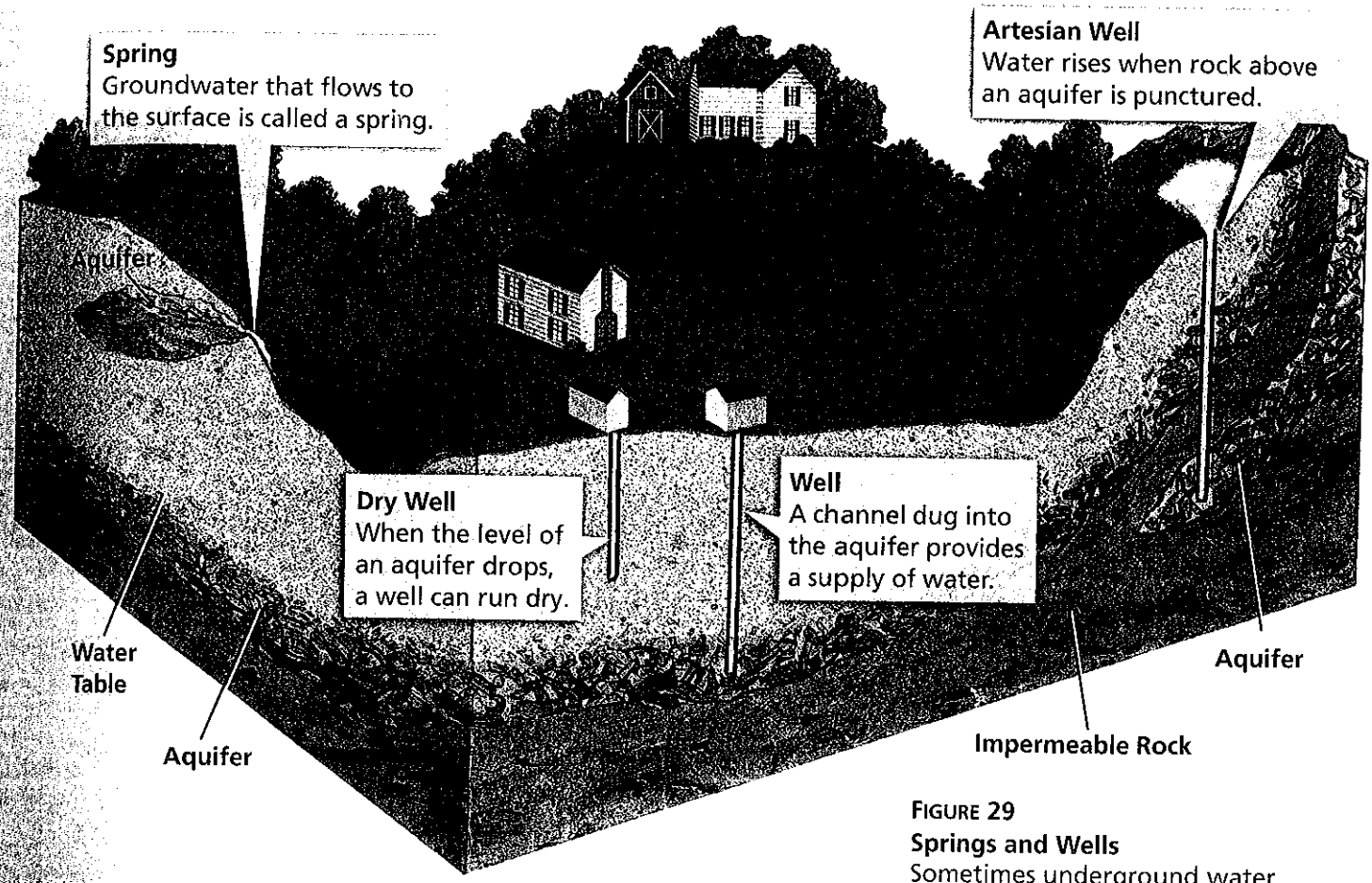


FIGURE 29
Springs and Wells
Sometimes underground water comes to the surface naturally. Other times, people use energy to obtain groundwater.
Comparing and Contrasting *How do the ordinary well, artesian well, and dry well differ?*

Wells The depth of a water table can vary greatly over a small area. Its level may vary as well. Generally, the level of a water table follows the shape of underground rock layers, as shown in Figure 29. But it can rise during heavy rains or snow melts, and then fall in times of dry weather. So what do you do if the depth and level of the water table in your area is far underground? How can you bring the water to the surface?

Since ancient times, people have brought groundwater to the surface for drinking and other everyday uses. **People can obtain groundwater from an aquifer by drilling a well below the water table.** Locate the well near the center of Figure 29. Because the bottom of the well is in a saturated zone, the well contains water. Notice the level of the bottom of the dry well in the diagram. Because this well does not reach below the water table, water cannot be obtained from it.

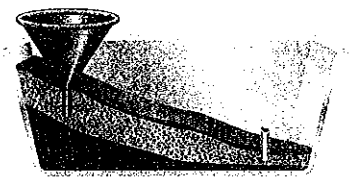
Reading Checkpoint **Why might a water table rise? Why might a water table fall?**

Lab zone Try This Activity

An Artesian Well

For this activity, cover your desk with newspaper.

1. Cover the bottom of a loaf pan with clay. Pile the clay higher at one end. Cover the clay with about 4 cm of moist sand.
2. Cover the sand with a thin sheet of clay. Seal the edges of the clay tightly against the pan.
3. Push a funnel into the high end so the bottom of the funnel is in the sand.



4. Insert a short piece of plastic straw through the clay and into the sand layer at the low end. Remove the straw, discard it, and then insert a new piece of straw into the same hole.
5. Slowly pour water into the funnel. Do not let the water overflow.
6. Observe the level of water in the straw.

Making Models How is your model like a real artesian well? How is it different?

Using Pumps Long ago, people dug wells by hand. They lined the sides of the well with brick and stone to keep the walls from collapsing. To bring up the water, they lowered and raised a bucket. People may also have used simple pumps, like the one shown in Figure 30. Today, however, most wells are dug with well-drilling equipment. Mechanical pumps bring up the groundwater.

Pumping water out of an aquifer lowers the water level near the well. If too much water is pumped out too fast, a well may run dry. The owners of the well will have to dig deeper to reach the lowered water table, or wait for rainfall to refill the aquifer. New water that enters the aquifer from the surface is called recharge.

Relying on Pressure Now you know how to bring groundwater to the surface. But what if that didn't work? You might not be out of luck. You might be able to drill an artesian well. In an **artesian well** (ahr TEEZH un), water rises because of pressure within an aquifer.

Look back at Figure 29 and locate the artesian well. In some aquifers, groundwater becomes trapped between two layers of impermeable rock or sediment. This water is under great pressure from the weight of the rock above. If the top layer of rock is punctured, the pressure sends water spurting up through the hole. No pump is necessary—in an artesian well, pressure does the job.

FIGURE 30
Working for Water Here a resident of Bangladesh uses a hand pump to bring groundwater to the surface. **Interpreting Photographs** *What is one disadvantage of a hand pump?*

Springs and Geysers Sometimes, groundwater comes to the surface through natural processes. You read that places where groundwater bubbles or flows out of cracks in the rock are called springs. Most springs contain water at normal temperatures. Others, like those in Figure 31, contain water that is warmed by the hot rocks deep below the surface. The heated water bubbles to the surface in hot springs.

In some areas, you might see a fountain of boiling hot water and white steam burst into the air. This is a geyser, a type of hot spring from which the water periodically erupts. The word *geyser* comes from an Icelandic word, *geysir*, which means "gusher."

A geyser forms when very hot water that has been circulating deep underground begins to rise through narrow passages in the rock. Heated gases and bubbles of steam are forced up these passages by the pressure of the hot water boiling below. Just as pressure builds up in a partly blocked water pipe, the pressure within these narrow openings in the rock increases. Finally, the gases, steam, and hot water erupt high into the air.

FIGURE 31
A Hot Spring
A Japanese macaque takes advantage of the warm water that rises to the surface of a hot spring in Nagano, Japan.

Reading Checkpoint **How do geysers form?**

Section 6 Assessment

Target Reading Skill **Previewing Visuals** Refer to your questions and answers about Figure 29 to help you answer Question 2 below.

Reviewing Key Concepts

1. a. **Reviewing** What happens to water in the ground when it reaches impermeable materials?
   b. **Explaining** What two factors determine how easily water can move through underground materials?
   c. **Inferring** Would an impermeable material have large or small pores? Would the pores be connected or unconnected? Explain.
2. a. **Describing** How can people obtain water from an aquifer?
   b. **Interpreting Diagrams** Using Figure 29 as a guide, explain why is it important to know the depth of an aquifer before drilling a well.
   c. **Problem Solving** During the winter, you draw your water from a well on your property. Every summer, the well dries up. What might be the reason for the change?

Writing in Science

Formal Letter Water usage in your town has risen in recent years due to population growth. Your town obtains its water from a nearby aquifer. You are concerned that the water level of the aquifer may be going down. Write a letter to local government officials explaining your concerns. Describe the effect of heavy water usage on the aquifer and suggest measures that can be taken to avoid a water shortage.