

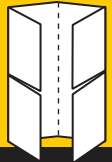
- 1 What Is a Biome?
- 2 Forest Biomes
- 3 Grassland, Desert, and Tundra Biomes

PRE-READING ACTIVITY



Four-Corner Fold

Before you read this chapter, create the **FoldNote** entitled "Four-Corner Fold" described in the Reading and Study Skills section of the Appendix. Label each flap of the four-corner fold with "Forest Biomes," "Grassland Biomes," "Desert Biomes," and "Tundra Biomes." As you read the chapter, define each biome, and write characteristics of each biome on the appropriate fold.



This thorny devil lives in the desert of Australia. The grooves in its rough skin help it collect water to drink. Water from rain or condensation lands on its back and runs along the tiny grooves to its mouth.




Earth is covered by many types of ecosystems. Ecologists group these ecosystems into larger areas known as biomes. A **biome** is a large region characterized by a specific type of climate and certain types of plants and animal communities. The map in **Figure 1** shows the locations of the world's major land, or terrestrial, biomes. In this chapter, you will take a tour through these terrestrial biomes—from lush rain forests to scorching deserts and the frozen tundra. When you read about each biome, notice the adaptations of the organisms to their very different environments.

Biomes and Vegetation

Biomes are described by their vegetation because the plants that grow in a certain region are the most noticeable characteristics of that region. The plants, in turn, determine the other organisms that can live there. For example, mahogany trees grow in tropical rain forests because they cannot survive cold, dry weather.

Organisms that depend on mahogany trees live where trees grow.

Plants in a particular biome have these adaptations that enable them to survive there. These adaptations include size, shape, and color. For example, plants that grow in the tundra tend to be short because they cannot obtain enough water to grow larger. They also have a short summer growing season. Desert plants, such as cactuses, do not have leaves. Instead, cactuses have specialized structures to conserve and retain water.

 **Reading Check** How are ecosystems related to biomes? (See the Appendix for answers to Reading Checks.)

Objectives

- ▶ Describe why vegetation is used to name a biome.
- ▶ Explain how temperature and precipitation determine which plants grow in an area.
- ▶ Explain how latitude and altitude affect which plants grow in an area.

Key Terms

biome
climate
latitude
altitude

Figure 1 ▶ The ecosystems of the world can be grouped into regions called *biomes*. These biomes, shown below, are named for the vegetation that grows there.

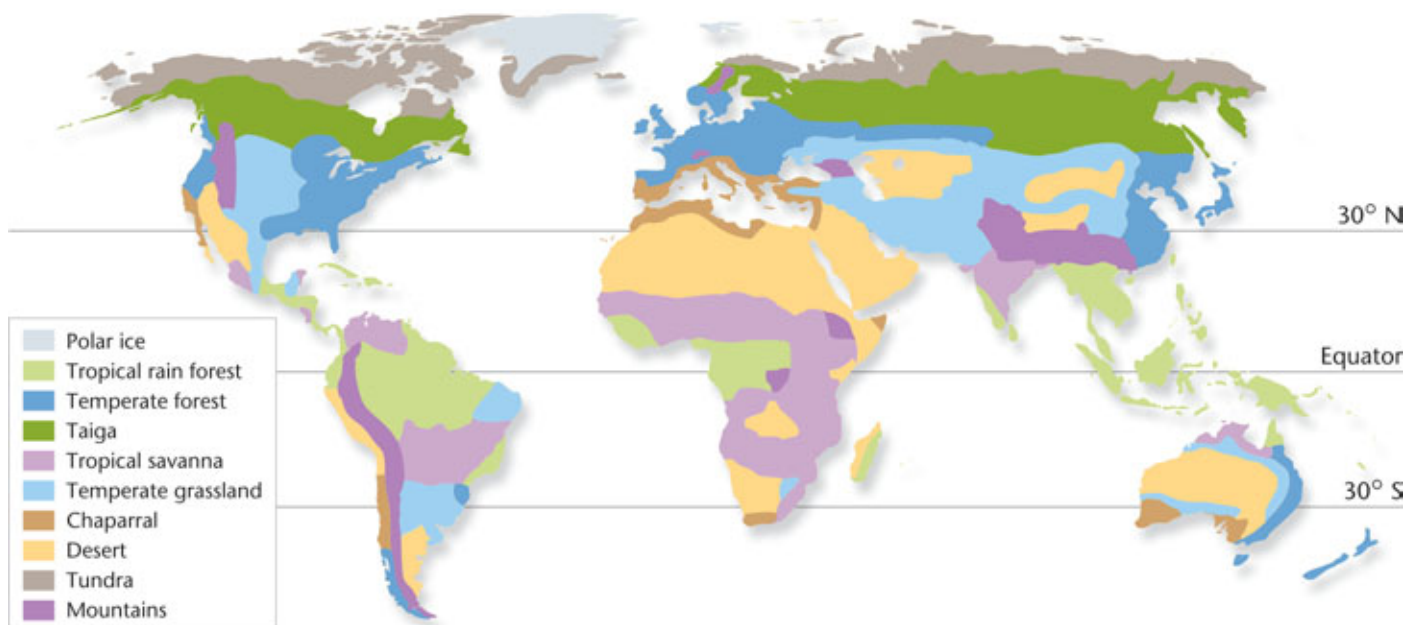
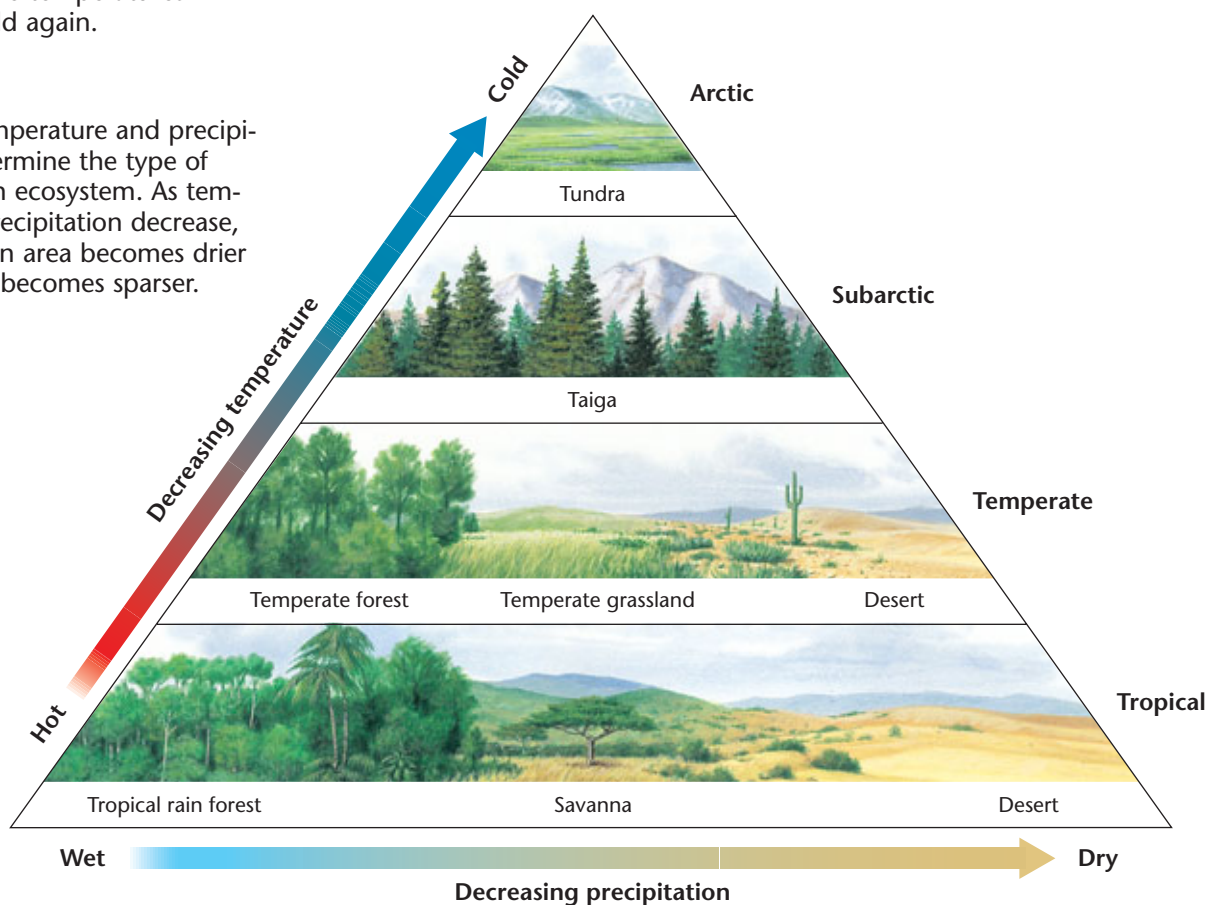




Figure 2 ► The soil of the tundra biome is frozen most of the year. Plants such as these have about two months in summer to grow and reproduce before temperatures become too cold again.

Figure 3 ► Temperature and precipitation help determine the type of vegetation in an ecosystem. As temperature and precipitation decrease, the climate of an area becomes drier and vegetation becomes sparser.



Biomes and Climate

Biomes are defined by their plant life, but what factors determine which plants can grow in a certain area? The main factor is climate. **Climate** refers to the weather conditions, such as temperature, precipitation, humidity, and winds, in an area over a long period of time. Temperature and precipitation are the two most important factors that determine a region's climate.

Temperature and Precipitation Most organisms are adapted to live within a certain range of temperatures and will not survive at temperatures too far outside of their range. Plants are also affected by the length of the growing season, as shown in **Figure 2**.

Precipitation also limits the organisms that are found in a biome. All organisms need water. The larger an organism is, the more water it needs. For example, biomes that do not receive enough rainfall to support large trees support communities dominated by small trees, shrubs, and grasses. In biomes where rainfall is not frequent, the vegetation is mostly made up of cactuses and desert shrubs. In extreme cases, lack of rainfall results in no plants, no matter what the temperature is. As shown in **Figure 3**, the higher the temperature and precipitation are, the taller and denser the vegetation is. Notice how much more vegetation exists in a hot, wet tropical rain forest than in a dry desert.

Reading Check Why does temperature limit which plants can grow in a certain biome?

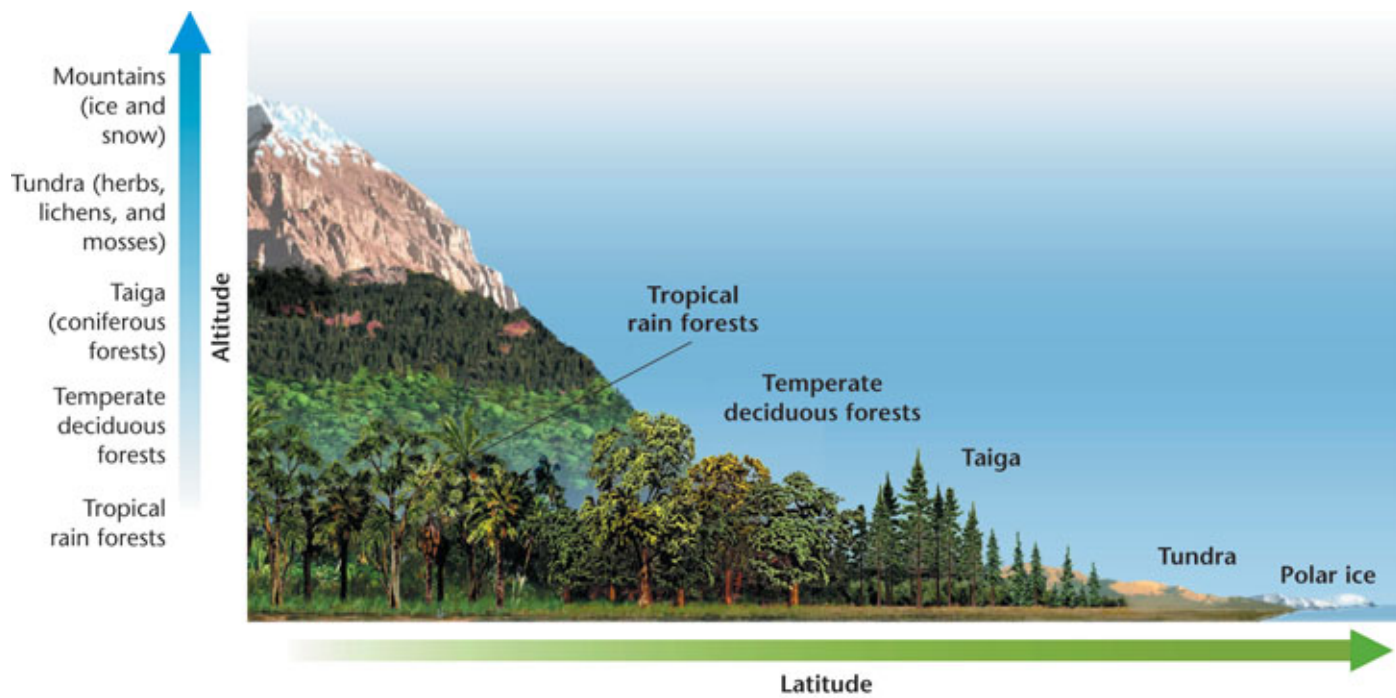


Figure 4 ► Latitude and altitude affect climate and vegetation in similar ways.

Latitude and Altitude Biomes and vegetation vary with latitude and altitude. **Latitude** is the distance north or south of the equator and is measured in degrees. **Altitude** is the height of an object above sea level. Climate varies with latitude and altitude. For example, climate gets colder as latitude and altitude increase. So, climate also gets colder as you move farther up a mountain.

Figure 4 shows that as latitude and altitude increase, biomes and vegetation change. For example, the trees of tropical rain forests usually grow closer to the equator, while the mosses and lichens of the tundra usually grow closer to the poles. The land located in the temperate region, between about 30° and 60° north latitudes and 30° and 60° south latitudes, is where most of the food in the world is grown. This region includes biomes such as temperate forests and grasslands, which usually have the moderate temperatures and fertile soil that are ideal for agriculture.



SECTION 1 Review

1. **Describe** how plants determine the name of a biome.
2. **Explain** how temperature affects which plants grow in an area.
3. **Explain** how precipitation affects which plants grow in an area.
4. **Define** *latitude* and *altitude*. How is latitude different from altitude? How do these factors affect the organisms that live in a biome?

CRITICAL THINKING

5. **Making Inferences** The equator passes through the country of Ecuador. But the climate in Ecuador can range from hot and humid to cool and dry. Write a short paragraph that explains what might cause this range in climate. **WRITING SKILLS**
6. **Analyzing Relationships** Look at Figure 1, and locate the equator and 30° north latitude. Which biomes are located between these two lines?



Objectives

- ▶ List three characteristics of tropical rain forests.
- ▶ Name and describe the main layers of a tropical rain forest.
- ▶ Describe one plant in a temperate deciduous forest and an adaptation that helps the plant survive.
- ▶ Describe one adaptation that may help an animal survive in the taiga.
- ▶ Name two threats to the world's forest biomes.

Key Terms

tropical rain forest
emergent layer
canopy
epiphyte
understory
temperate rain forest
temperate deciduous forest
taiga

The air is hot and heavy with humidity. You walk through the shade of the tropical rain forest, step carefully over tangles of roots and vines, and brush past enormous leaves. Life is all around you, but you see little vegetation on the forest floor. Birds call, and monkeys chatter from above.

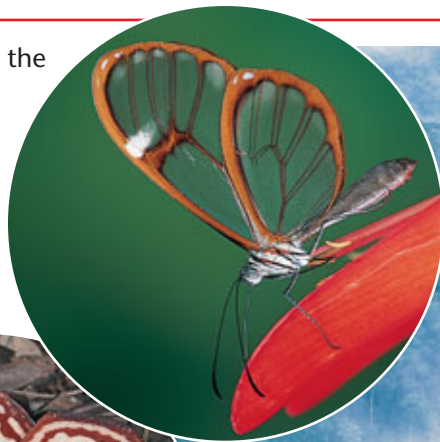
Tropical Rain Forests

Of all the biomes in the world, forest biomes are the most widespread and are home to the greatest diversity of plants, animals, and other organisms. Trees need a lot of water, so forests exist where precipitation is plentiful. Tropical forests, temperate forests, and taiga are the main forest biomes.

Tropical rain forests are located in a belt around the Earth near the equator, as shown in Figure 5. They help regulate world climate and play vital roles in the nitrogen, oxygen, and carbon cycles. Tropical rain forests are always humid and warm and get about 200 to 450 cm of rain a year. Because they are near the equator, tropical rain forests get strong sunlight year-round and maintain a relatively constant temperature year-round. This climate is ideal for a wide variety of plants and animals, as shown in Figure 6. The warm, wet conditions also nourish more species of plants than any other biome does. While one hectare (10,000 m²) of temperate forest usually contains a few species of trees, the same area of tropical rain forest may contain more than 100 species.

- ▶ Glasswing butterflies live in the rain forests of Costa Rica.

- ▶ The *Rafflesia keithii* flower grows in the rain forests of Borneo.





Nutrients in Tropical Rain Forests You might think that the diverse plant life grows on rich soil, but it does not. Most nutrients are within plants, not within soil. Organic matter decays quickly in hot, wet conditions. Decomposers on the rain-forest floor break down organic matter and return the nutrients to the soil, but plants quickly absorb the nutrients. Some trees in a tropical rain forest support fungi that feed on dead organic matter on the rain-forest floor. In this relationship, the fungi transfer the nutrients from the dead organic matter directly to the tree.

The nutrients are removed so efficiently from the soil in a tropical rain forest that water running out of the soil may be as clear as distilled water. Most tropical soils that are cleared of plants for agriculture lack nutrients and cannot support crops for more than a few years. Many of the trees form above-ground roots, called buttresses or braces, that grow sideways from the trees and provide the trees with extra support in the thin soil.

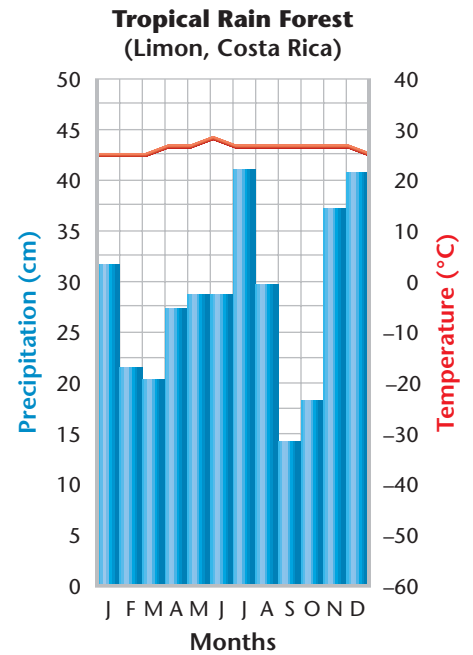


Figure 5 ► The world's tropical rain forests have heavy rainfall during much of the year and fairly constant, high temperatures.

► The tropical rain forests in the Andes mountains in Ecuador are among the wettest places on Earth.



► Scarlet macaws live in the trees of rain forests of Peru.

Figure 6 ► **Species of Tropical Rain Forests**

► These mountain gorillas live in the rain forests of Rwanda.





Figure 7 ► The plants in tropical rain forests form distinct layers. The plants in each layer are adapted to a particular level of light. The taller trees absorb the most light, while the plants near the forest floor are adapted to growing in the shade.

Layers of the Rain Forest In tropical rain forests, different types of plants grow in different layers, as shown in Figure 7. The four main layers above the forest floor are the emergent layer, the upper canopy, the lower canopy, and the understory. The top layer is called the **emergent layer**. This layer consists of the tallest trees, which reach heights of 60 to 70 m. Trees in the emergent layer grow and emerge into direct sunlight.

The next layer, considered the primary layer of the rain forest, is called the **canopy**. Trees in the canopy can grow more than 30 m tall. The tall trees form a dense layer that absorbs up to 95 percent of the sunlight. The canopy can be split into an upper canopy and a lower canopy. The lower canopy receives less light than the upper canopy does. Plants called **epiphytes**, such as the orchid in Figure 8, use the entire surface of a tree as a place to live. Epiphytes grow on tall trees for support. Some grow high in the canopy, where their leaves can reach the sunlight needed for photosynthesis. Growing on tall trees also allows them to absorb the water and nutrients that run down the tree after it rains. Most animals that live in the rain forest live in the canopy because they depend on the abundant flowers and fruits that grow there.

Below the canopy, very little light reaches the next layer, called the **understory**. Trees and shrubs that are adapted to shade grow here. Most plants in the understory do not grow more than 3.5 m tall. Herbs with large, flat leaves grow on the forest floor. These plants capture the small amount of sunlight that penetrates the understory. Most of our house plants are native to tropical rain-forest floors. Because they are adapted to low levels of light, they are able to grow indoors.

Reading Check In which layer of the rain forest is most of the animal life found?

Connection to Chemistry

Medicines from Plants Many of the medicines we use come from plants native to tropical rain forests. Chemists extract and test chemicals found in plants to determine if the chemicals can cure or fight diseases. Rosy periwinkle, a plant that grows in the tropical rain forests of Madagascar, is the source of two medicines, vinblastine and vincristine. Vinblastine is used to treat Hodgkin's disease, a type of cancer, and vincristine is used to treat childhood leukemia.

Species Diversity in Rain Forests The tropical rain forest is the biome with the greatest amount of species diversity. The diversity of rain-forest vegetation has led to the evolution of a diverse community of animals. Most rain-forest animals are specialists that use specific resources in particular ways. Some rain-forest animals have amazing adaptations for capturing prey, and other animals have adaptations that they use to escape predators. For example, the collared anteater in **Figure 8** uses its long tongue to reach insects in small cracks and holes where other animals cannot reach. The wreathed hornbill (shown below) uses its strong, curved beak to crack open nutshells. Insects, such as the Costa Rican mantis in **Figure 8**, use camouflage to avoid predators. These insects may be shaped like leaves or twigs.



Ecofact

A Little Land, A Lot of Species
Tropical rain forests cover less than 7 percent of Earth's land surface but contain at least 50 percent of all the plant and animal species in the world.




Figure 8 ▶ Examples of plant and animal adaptations in the tropical rain forest include ❶ the long tongue of a collared anteater, ❷ the strong, curved beak of a wreathed hornbill, ❸ the shape of a Costa Rican mantis, and ❹ an orchid attached to a tall tree.

Threats to Rain Forests Tropical rain forests once covered about 20 percent of Earth's surface. Today, they cover only about 7 percent. Every minute of every day, 100 acres of tropical rain forest are cleared for logging operations, agriculture, or oil exploration. *Habitat destruction* occurs when land inhabited by an organism is destroyed or altered. Habitat destruction is the usual reason for a species becoming extinct.

An estimated 50 million people live in tropical rain forests. These people are also threatened by habitat destruction. Their food, building materials, culture, and traditions come from and are uniquely connected to the rain forest. The loss of this habitat destroys their way of life.

Plants and animals that live in rain forests are also threatened by trading. Many plant species found only in tropical rain forests are valuable and marketable to industries. Animals are threatened by exotic-pet trading. Some exotic-pet traders illegally trap animals, such as parrots, and sell them in pet stores at high prices.

 **Reading Check** What are two main threats to the organisms that live in tropical rain forests?

CASE STUDY

Deforestation, Climate, and Floods

A plant absorbs water from the soil through its roots and transports the water to its stems and leaves. Water then evaporates from pores in plant leaves into the atmosphere through a process called *transpiration*. A large tree may transpire as much as 5 tons of water on a hot day. Water absorbs heat when it evaporates. Therefore, the temperature is much cooler under a tree on a hot day than under a wood or brick shelter. Trees that provide shade around homes keep homes much cooler in the summer.

When rain falls on a forest, much of the rain is absorbed by plant roots and transpired into the air as water vapor. Water vapor forms rain clouds. Much of this water will fall as rain somewhere downwind from the forest. Because of the role trees play in

transpiration, *deforestation*, the clearing of trees, can change the climate. If a forest is cut down or replaced by smaller plants, much of the rainfall is not absorbed by plants. Instead, the rain runs off the soil and causes flooding as well as soil erosion. The climate downwind from the forest becomes drier.

Deforestation led to the disastrous flooding of the Yangtze River in China in 1998. More than 2,000 people died in the floods, and at least 13 million people had to leave their homes. When the Yangtze River flooded, the water poured into a flood plain where over 400 million people lived. It is estimated that 85 percent of the forest in the Yangtze River basin has been cut down. The millions of tons of water that these trees once absorbed now



► A man makes his way past flooded buildings in his street on a makeshift raft after the Yangtze River flooded in July 1998. Water of the Yangtze River reached record-high levels.

flow freely down the river and spread across fields and into towns during the seasonal monsoon rains.

Deforestation has also caused terrible floods in places such as Bangladesh. The Ganges River starts high in the Himalaya Mountains and flows through Bangladesh. Deforestation of the Himalaya

Temperate Forests

Temperate rain forest occurs in North America, Australia, and New Zealand. Temperate rain forests have large amounts of precipitation, high humidity, and moderate temperatures. The Pacific Northwest shown, in **Figure 9**, houses North America's only temperate rain forest, where tree branches are draped with mosses and tree trunks are covered in lichens. The forest floor is blanketed with lush ferns. Evergreen trees that are 90 m tall, such as the Sitka spruce and the Douglas fir, dominate the forest. Other large trees, such as western hemlock, Pacific silver fir, and redwood, can also be found in temperate rain forests.

Even though the temperate rain forest of the Pacific Northwest is located north of most other rain forests, it still maintains a moderate temperature year-round. The temperate rain forest also rarely freezes because the nearby Pacific Ocean waters keep temperatures mild by blowing cool ocean wind over the forest. As this ocean wind meets the coastal mountains, a large amount of rainfall is produced. The rainfall keeps the temperate rain forest cool and moist.



Figure 9 ▶ The only temperate rain forest in North America is located in the Pacific Northwest, as shown above in Olympic National Park in Washington State.



▶ Deforestation reduces the amount of water that is absorbed by plants after it rains. The more trees that are cleared from a forest, the more likely a flood will occur in that area.

Mountains left few trees to stop the water flowing down the mountain. So, most of the water flows into the river when it rains. Heavy rains have eroded and carried away so much soil from the slopes of the mountains that the soil has formed a new

island in the Bay of Bengal, which is off the coast of Bangladesh.

People are beginning to understand the connection between deforestation and floods. People held protests in northern Italy in 2000 after floods covered a town that had

EARTH SCIENCE CONNECTION

never been flooded before. The townspeople claimed that authorities had permitted developers to cover the hills with homes. These developers cut down most of the trees and covered much of the land with asphalt. After heavy rains, the water was no longer absorbed by trees and soil, so the water flowed down the hills and flooded the town.

CRITICAL THINKING

1. Identifying Relationships

How might deforestation in China and other countries affect the overall climate of the Earth?

2. Analyzing a Viewpoint

Imagine that you are a city council member and must vote on whether to clear a forest so that a mall can be built. List the pros and cons of each viewpoint. After reviewing your list, how would you vote? Explain your answer.

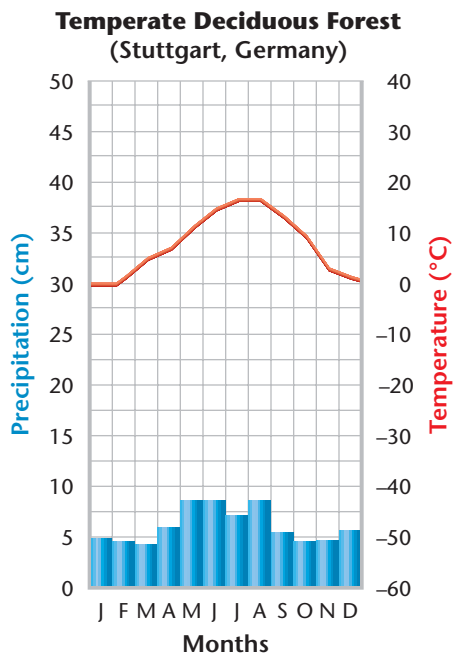


Figure 10 ► The difference between summer and winter temperatures in temperate deciduous forests is extreme.



Figure 11 ► The change of seasons in a temperate deciduous forest in Michigan is shown below.



Temperate Deciduous Forests

If you walk through a North American deciduous forest in the fall, you will immerse yourself in color. Leaves in every shade of orange, red, and yellow crackle beneath your feet. Most birds have flown south. The forest is quieter than it was in the summer. You see mostly chipmunks and squirrels gathering and storing the food they will need during the long, cold winter.

In **temperate deciduous forests**, trees drop their broad, flat leaves each fall. These forests once dominated vast regions of the Earth, including parts of North America, Europe, and Asia. Today, temperate deciduous forests are generally located between 30° and 50° north latitudes, as shown in **Figure 10**. The range of temperatures in a temperate deciduous forest can be extreme, and the growing season lasts for only four to six months. Summer temperatures can soar to 35°C. Winter temperatures often fall below freezing, so little water is available for plants. Just as temperatures change with the seasons, so does the vegetation, as shown in **Figure 11**. Although there is enough moisture for decomposition, temperatures are low during the winter. As a result, organic matter decomposes fairly slowly. This means that the soil contains more organic matter and nutrients than the soil in a tropical rain forest.

Plants of Temperate Deciduous Forests Like the plants of tropical rain forests, the plants in deciduous forests grow in layers. Tall trees, such as maple, oak, and birch, dominate the forest canopy. Small trees and shrubs cover the understory. Because the floor of a deciduous forest gets more light than the floor of a rain forest does, more plants such as ferns, herbs, and mosses grow in a deciduous forest.

Temperate-forest plants are adapted to survive seasonal changes. In the fall, most deciduous trees begin to shed their leaves. In the winter, moisture in the soil changes to ice, which causes the remaining leaves to fall to the ground. Herb seeds, bulbs, and rhizomes (underground stems) become dormant in the ground and are insulated by the soil, leaf litter, and snow. In the spring, when the sunlight increases and the temperature rises, trees grow new leaves, seeds germinate, and rhizomes and roots grow new shoots and stems.

Animals of Temperate Deciduous Forests The animals of temperate deciduous forests are adapted to use the forest plants for food and shelter. Squirrels eat the nuts, seeds, and fruits in the treetops. Bears feast on the leaves and berries of the forest plants. Grasshoppers, such as the one shown in **Figure 12**, eat almost all types of vegetation found throughout the forest. Deer and other herbivores nibble leaves from trees and shrubs.

Many birds nest in the relative safety of the canopy. Most of these birds are migratory. Because many birds cannot survive harsh winters, each fall they fly south for warmer weather and more available food. Each spring, they return north to nest and feed. Animals that do not migrate use various strategies for surviving the winter. For example, some mammals reduce their activity so that they do not need as much food for energy.



Figure 12 ▶ Grasshoppers, woodpeckers, and deer are among the many animals that live in the temperate deciduous forest.

Taiga

The **taiga** is the northern coniferous forest that stretches in a broad band across the Northern Hemisphere just below the Arctic Circle. As shown in **Figure 13**, winters are long (6 to 10 months) and have average temperatures that are below freezing and often fall to -20°C . Many trees seem like straight, dead shafts of bark and wood—until you look up and see their green tops. Plant growth is most abundant during the summer months because of nearly constant daylight and larger amounts of precipitation.

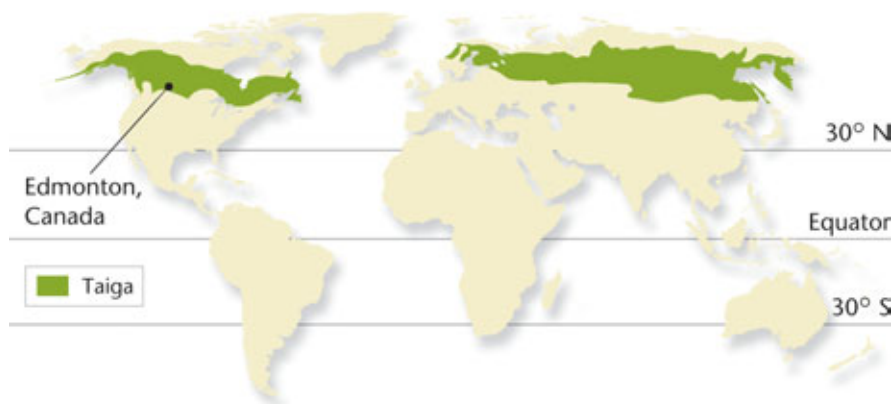


Figure 13 ▶ The taiga has long, cold winters and small amounts of precipitation, as shown in the climatogram below.

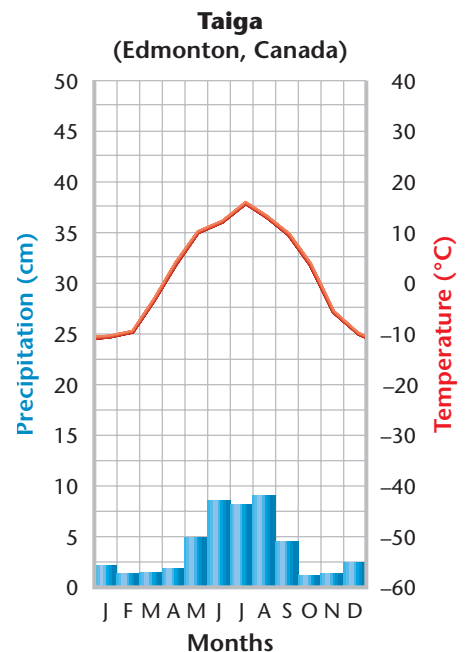




Figure 14 ► The taiga has cold winter temperatures, a small amount of annual precipitation, and coniferous trees. The seeds of conifers are protected inside tough cones like the one above. Also, the narrow shape and waxy coating of conifer needles help the tree retain water.

Plants of the Taiga A conifer is a tree with needle-like leaves and seeds that develop in cones. The shape of the leaves and their waxy coating prevent the tree from losing too much water. This is especially important when the ground is frozen and the roots cannot replace lost water by absorbing more from the soil. As **Figure 14** shows, many conifers are shaped like a large cone. The cone-like shape helps to prevent snow from building up on the branches and causing the branches to break under the weight.

Conifer needles contain substances that make the soil acidic when the needles fall to the ground. Most plants cannot grow in acidic soil, which is one reason the forest floor of the taiga has few plants. In addition, soil forms slowly in the taiga because the climate and acidity of the fallen leaves slow decomposition.

Animals of the Taiga The taiga has many lakes and swamps that in summer attract birds that feed on aquatic organisms. Many birds migrate south to avoid winter in the taiga. Because food is scarce during the winter, some year-round residents, such as jumping mice, burrow underground to hibernate. As shown in **Figure 15**, some animals, such as snowshoe hares, have adapted to avoid predation by lynxes, wolves, and foxes by shedding their brown summer fur and growing white fur that camouflages them in the winter snow.



Figure 15 ► In the taiga, a snowshoe hare's fur changes color according to the seasons to help camouflage the animal from predators.

SECTION 2 Review

1. **List** three characteristics of tropical rain forests.
2. **Name** the main layers of a tropical rain forest. What kinds of plants grow in each layer?
3. **Describe** two ways in which tropical rain forests of the world are being threatened.
4. **Describe** how a plant survives the change of seasons in a temperate deciduous forest. Write a short paragraph to explain your answer. **WRITING SKILLS**

CRITICAL THINKING

5. **Evaluating Information** Which would be better suited for agricultural development: the soil of a tropical rain forest or the soil of a temperate deciduous forest? Explain your answer.
6. **Identifying Relationships** How does a snowshoe hare avoid predation by other animals during the winter in a taiga biome? How might this affect the animal that depends on the snowshoe hare for food?



In areas with too little precipitation for large trees to survive, the biomes are dominated by smaller plants. Where there is almost no rainfall at all, few plants can grow and we find desert. Thus, warm areas with little precipitation are characterized by savanna and desert biomes. Temperate areas have grassland, chaparral, and desert biomes, and cold areas have tundra and desert biomes.

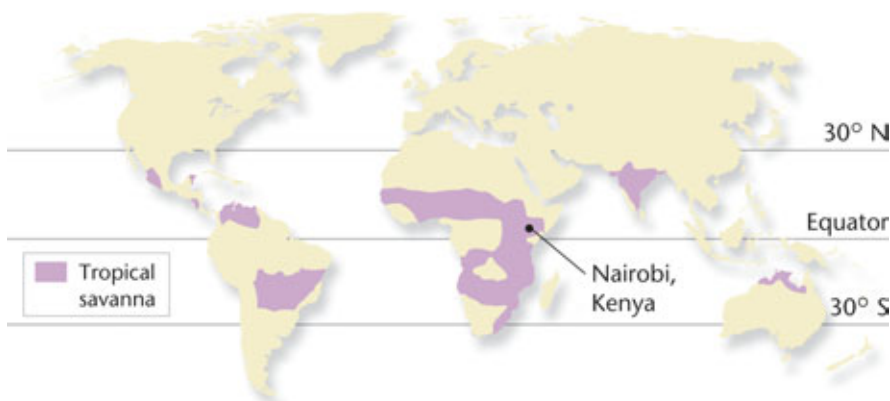
Savannas

Parts of Africa, western India, northern Australia, and some parts of South America are covered by grassland called *savanna*. A

savanna is a tropical biome dominated by grasses, shrubs, and small trees. As Figure 16 shows, rain falls mainly during the wet season, which lasts for only a few months of the year. This is the only time that plants can grow. The plants support an amazing variety of herbivores, such as antelopes, giraffes, and elephants, as well as the predators that hunt them—cheetahs, lions, and hyenas, for example.

Plants of the Savanna Because most of the rain falls during the wet season, plants must be able to survive prolonged periods of time without water. During the dry season, plants lose their leaves or die down to the ground. When the rain returns, they start to grow again. Many plants have large, horizontal root systems so they can draw water from as large an area as possible. The coarse savanna grasses have vertical leaves that expose less of their surface area to the hot sun to further help the grasses conserve water. Some trees of the savanna also lose their leaves during the dry season to conserve water. Trees and shrubs often have thorns or sharp leaves that keep hungry herbivores away.

Reading Check Name two herbivores and two predators that savanna plants support.



Objectives

- ▶ Describe the difference between tropical and temperate grasslands.
- ▶ Describe the climate in a chaparral biome.
- ▶ Describe two desert animals and the adaptations that help them survive.
- ▶ Describe one threat to the tundra biome.

Key Terms

savanna
temperate grassland
chaparral
desert
tundra
permafrost

Figure 16 ▶ Savannas have periods of heavy rainfall followed by periods of drought.

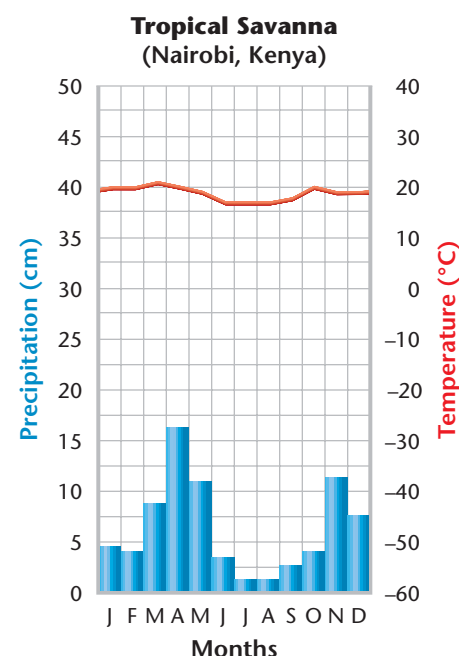


Figure 17 ► Herbivores of the savanna, such as the elephants shown here, range widely in search of food.

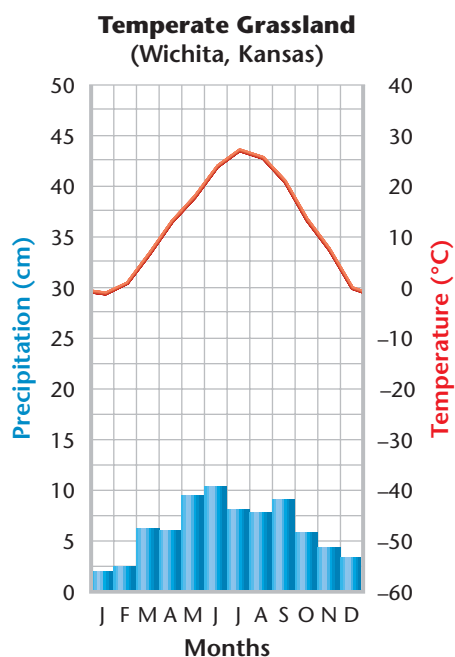


Geofact

Deep Soil Gravel or sand becomes fertile soil when decomposers slowly break down organic matter such as dead leaves. Decomposers work most effectively in hot, wet weather. As a result, the world's deepest soil is in grasslands. In temperate grassland biomes, winters are cold and summers are dry, which causes leaves to break down slowly. So, organic matter builds up over time. Some North American prairies had more than 2 m of topsoil when the first farmers arrived.

Animals of the Savanna Grazing herbivores, such as the elephants shown in Figure 17, have adopted a migratory way of life. They follow the rains to areas of newly sprouted grass and watering holes. Some predators follow and stalk migratory animals for food. Many savanna animals give birth only during the rainy season, when food is most abundant and the young are more likely to survive. Also, some species of herbivores eat vegetation at different heights than other species do. For example, small gazelles graze on grasses, black rhinos browse on shrubs, and giraffes feed on tree leaves.

Figure 18 ► Temperate grasslands are characterized by small amounts of rainfall, periodic droughts, and high temperatures in the summer.



Temperate Grasslands

Temperate grassland covers large areas of the interior of continents, where there is moderate rainfall, but still too little for trees to grow. The prairies in North America, the steppes in Asia, the veldt in South Africa, and the pampas in South America are temperate grasslands. Their locations are shown in Figure 18. Two examples of temperate grasslands are shown in Figure 19.

Mountains often play a crucial role in maintaining grasslands. For example, in North America, rain clouds moving from the west release most of their moisture as they pass over the Rocky Mountains. As a result, the shortgrass prairie just east of the Rockies receives so little rain that it looks almost like a desert.





The amount of rain increases as you move east, which permits the growth of taller grasses and some shrubs. Grassland plants dry out in the summer, so lightning strikes often start fires.

Plants of Temperate Grasslands Temperate grassland vegetation consists of grasses and wildflowers. Although there is only a single layer of vegetation, many species may be present. Shrubs and trees grow only where the soil contains extra water, usually on the banks of streams.

The root systems of grassland plants form dense layers that survive drought and fire. **Figure 20** shows how the heights of grasses and the depths of their roots vary.

Grasslands are highly productive because of their fertile soil. The summer is hot and the winter is cold, so the plants die back to their roots in the winter. Low temperatures in the winter slow decomposition. As a result, the rate at which dead plants decay is slower than the rate at which new vegetation is added each year. Over time, organic matter accumulates in the soil. This means that grasslands have the most fertile soil in the world. Most grasslands have been converted to farmland for growing crops such as wheat and corn.

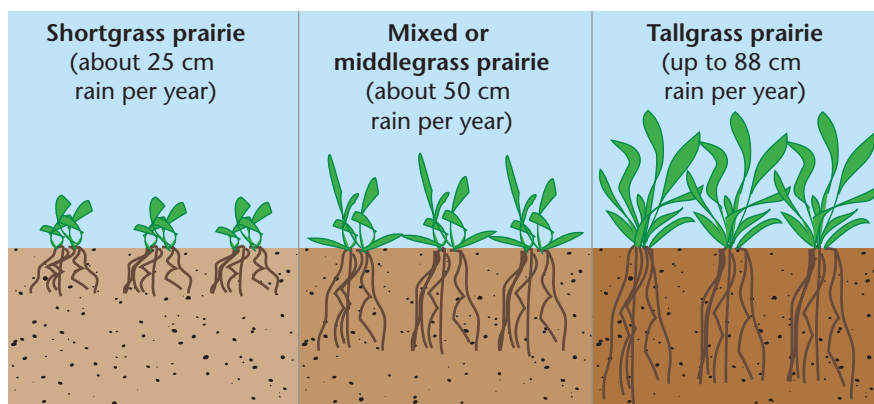


Figure 19 ► The steppes in Asia (left) and the pampas in South America (right) are dominated by grasses and other plants that are adapted to temperate grasslands.

Connection to History

The State of Bison More than 60 million bison once roamed the temperate grasslands of North America. But these large grass-eating mammals were almost brought to extinction by the late 1800s because of hunting by western settlers. By 1889, fewer than 1,100 bison remained in North America! The first bill to save the bison was introduced by Congress in 1874. In 1903, President Theodore Roosevelt started the National Wildlife Refuge System to provide protected areas for bison and other animals. Today, North America has more than 200,000 bison.

Figure 20 ► The height of grassland plants and the depth of their roots depend on the amount of rainfall that the grasslands receive.

Figure 21 ► Prairie dogs, such as those shown here, live in temperate grasslands. Prairie dogs live in colonies and burrow in the ground to build mounds, holes, and tunnels.



QuickLAB



Sponging It Up

Procedure

1. Completely saturate **two small sponges** with **water** and allow the excess water to drain off.
2. Measure each sponge's mass by using an **electric balance**. Record the mass.
3. Using **plastic wrap**, completely cover one of the sponges.
4. Place the sponges outside in a sunny place for 10 to 15 minutes.
5. Measure each sponge's mass after removing it from outside. Record the mass.

Analysis

1. Which sponge lost the most mass? Why?
2. How was the covering you created for the sponge similar to the adaptations of the plants in the chaparral biome?

Animals of Temperate Grasslands Grazing animals, such as pronghorn antelope and bison, have large, flat back teeth for chewing the coarse prairie grasses. Other grassland animals, such as badgers, prairie dogs, and burrowing owls, live protected in underground burrows as shown in **Figure 21**. The burrows shield the animals from fire and weather and protect them from predators on the open grasslands.

Threats to Temperate Grasslands Farming and overgrazing have changed the grasslands. Grain crops cannot hold the soil in place as well as native grasses can because the roots of crops are shallow and the soil is ploughed regularly, so soil erosion eventually occurs. Erosion is also caused by overgrazing. When grasses are constantly eaten and trampled, the grasses cannot regenerate or hold the soil. This constant use can change fruitful grasslands into less productive, desertlike biomes.

Chaparral

Temperate woodland biomes have fairly dry climates but receive enough rainfall to support more plants than a desert does. One type of temperate woodlands consists of scattered tree communities made up of coniferous trees such as piñon pines and junipers, as shown in **Figure 22**.

The chaparral is a temperate shrubland biome that is found in all five parts of the world with a Mediterranean climate. These areas have moderately dry, coastal climates, with little or

Figure 22 ► Temperate woodlands are usually too dry to support a forest, but they receive sufficient precipitation to support vegetation that grows in bunches, such as the piñon and juniper trees shown here.





no rain in the summer. Look at the famous white letters that spell Hollywood across the California hills in **Figure 23**. Now imagine the scrub-covered settings common in old westerns. Both of these landscapes are part of the chaparral biome. As shown in **Figure 24**, chaparral is located in the middle latitudes, about 30° north and south of the equator.

Plants of the Chaparral Most chaparral plants are low-lying, ever-green shrubs and small trees that tend to grow in dense patches. Common chaparral plants include chamise, manzanita, scrub oak, olive trees, and herbs, such as sage and bay. These plants have small, leathery leaves that retain water. The leaves also contain oils that promote burning, which is an advantage because natural fires destroy trees that might compete with chaparral plants for light and space. Chaparral plants are so well adapted to fire that they can resprout from small bits of surviving plant tissue.

Animals of the Chaparral A common adaptation of chaparral animals is camouflage, which is shape or coloring that allows an animal to blend into its environment. Animals such as quail, lizards, chipmunks, and mule deer have a brownish-gray coloring that lets them move through the brush without being noticed.

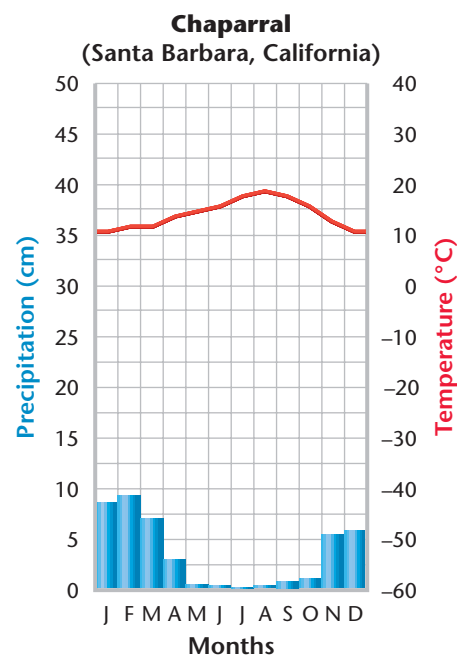
Threats to the Chaparral Worldwide, the greatest threat to chaparral is human development. Because chaparral biomes get a lot of sun, are near the oceans, and have a mild climate year-round, humans tend to develop the land for commercial and residential use.

 **Reading Check** How does camouflage help chaparral animals?



Figure 23 ► The chaparral biome in the Hollywood hills is home to plants such as the manzanita, which is shown above.

Figure 24 ► Chaparral biomes are located in areas that have Mediterranean climates.



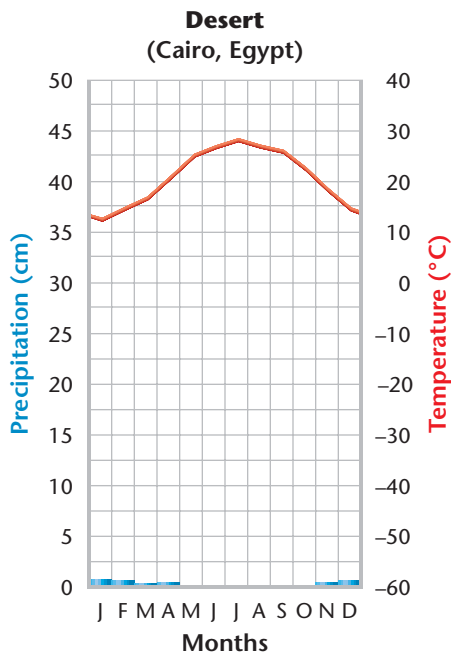


Figure 25 ► Deserts are the driest places on Earth. They typically receive less than 25 cm of precipitation a year.



Deserts

When some people think of a desert, they think of the hot sand that surrounds the Egyptian pyramids. Other people picture the Sonoran Desert and its mighty saguaro cactuses, or the magnificent rock formations of Monument Valley in Arizona and Utah. Many kinds of deserts are located throughout the world, but one characteristic that they share is that they are the driest places on Earth.

Deserts are areas that have widely scattered vegetation and receive very little rain. In extreme cases, it never rains and there is no vegetation. The distribution of Earth's deserts is shown in **Figure 25**. Even in hot deserts near the equator, there is so little insulating moisture in the air that the temperature changes rapidly during a 24-hour period. The temperature may go from 40°C (104°F) during the day to near-freezing at night. Deserts are often located near mountain ranges, which block the passage of rain clouds.

► The flapnecked chameleon lives in the deserts of Botswana.



► The Sonoran Desert in Arizona appears lush with plant life just after the winter rains.



Plants of the Desert All desert plants have adaptations for obtaining and conserving water, which allow the plants to live in dry, desert conditions. Plants called *succulents*, such as cactuses, have thick, fleshy stems and leaves that store water. Their leaves also have a waxy coating that prevents water loss. Sharp spines on cactuses keep thirsty animals from devouring the plant's juicy flesh. Rainfall rarely penetrates deeply into the soil, so many plants' roots spread out just under the surface of the soil to absorb as much rain as possible.

Many desert shrubs drop their leaves during dry periods and grow new leaves when it rains again. When conditions are too dry, some plants die and drop seeds that stay dormant in the soil until the next rainfall. Then, new plants quickly germinate, grow, and bloom before the soil becomes dry again. Some desert plants have adapted so that they can survive even if their water content drops to as low as 30 percent of their mass. Water levels below 50 to 75 percent are fatal for most plants.

Animals of the Desert Reptiles, such as Gila monsters and rattlesnakes, have thick, scaly skin that prevents water loss. Amphibians, such as the spadefoot toad, survive scorching desert summers by *estivating*—burying themselves in the ground and sleeping through the dry season. Some animals, such as the elf owl shown in **Figure 26**, nest in cactuses to avoid predators. Desert insects and spiders are covered with body armor that helps them retain water. In addition, most desert animals are nocturnal, which means they are active mainly at night or at dusk, when the air is cooler.



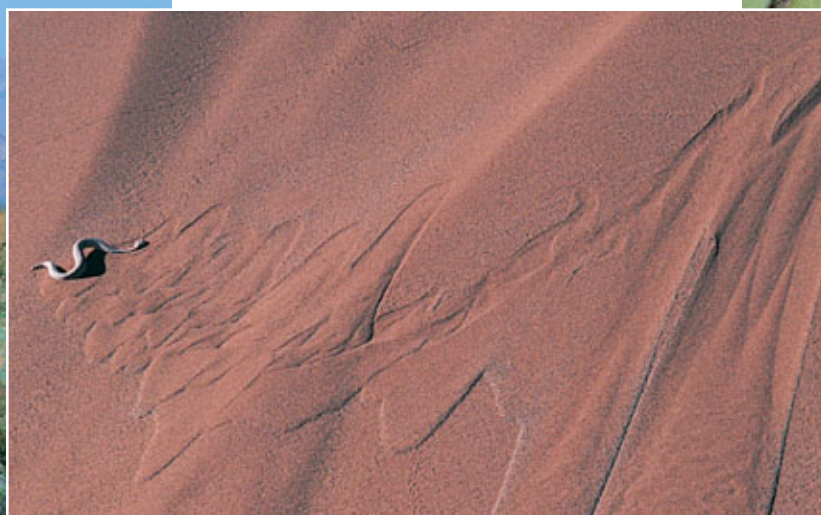
FIELD ACTIVITY

Miniature Desert Create a miniature desert by growing a small cactus garden. Purchase two or three small cactus plants, or take several cuttings from a large cactus. To take cuttings, carefully break off the shoots growing at the base of the parent cactus. Place the plants in rocky or sandy soil similar to the soil in a desert. Keep the cactuses in bright sunlight, and do not water them frequently. Record your observations of your cactus garden in your **Ecolog**.

Figure 26 ► Desert plants survive harsh conditions by growing deep roots to reach groundwater and by having specialized structures that limit the loss of water. Desert animals bury themselves underground or burrow in cactuses to avoid extreme temperatures and predators.



► Elf owls burrow in cactuses to avoid hot temperatures during the day.



► This sidewinder has a unique way of moving so that only small portions of its body are in contact with the hot sands at any one time.



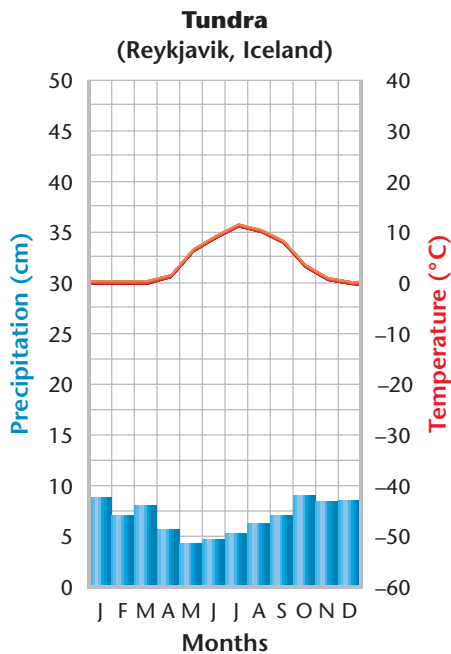


Figure 27 ► The precipitation that the tundra biome receives remains frozen much of the year.



Tundra

The **tundra** biome is located in northern arctic regions, as shown in **Figure 27**. The winter is too cold and dry to permit the growth of trees in this biome. In many areas of the tundra, the deeper layers of soil, called **permafrost**, are permanently frozen throughout the year. As a result, the topsoil is very thin. In the summer, when the thin topsoil layer thaws, the tundra landscape becomes quite moist and spongy and is dotted with bogs. These wet areas are ideal breeding grounds for enormous numbers of swarming insects, such as mosquitoes and black flies, and for the many birds that feed on the insects.

Vegetation of the Tundra **Figure 28** shows the Alaskan tundra in the summer. Mosses and lichens, which can grow without soil, cover vast areas of rocks in the tundra. The soil is thin, so plants have wide, shallow roots to help anchor them against the icy winds. Most flowering plants of the tundra, such as campion and gentian, are short. Growing close to the ground keeps the plants out of the wind and helps them absorb heat from the sunlit soil during the brief summer. Woody plants and perennials such as willow and birch have evolved dwarf forms and grow flat or grow along the ground.

Graphic

Organizer

Venn Diagram

Create the **Graphic Organizer** entitled “Venn Diagram” described in the Appendix. Label the circles with “Tundra” and “Desert.” Then, fill in the diagram with characteristics that each biome shares with the other.



Figure 28 ► During its brief summer, the Alaskan tundra is covered by flowering plants and lichens.






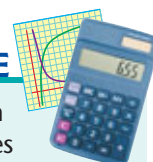
Figure 29 ▶ Many migratory animals, such as geese (left) and caribou (below), return to the tundra each year to breed.



Animals of the Tundra Millions of migratory birds fly to the tundra to breed in the summer. Food is abundant in the form of plants, mollusks, worms, and especially insects. Caribou, shown in **Figure 29**, migrate throughout the tundra in search of food and water. Wolves roam the tundra and prey on caribou, moose, and smaller animals, such as lemmings, mice, and hares. These animals burrow underground during the winter but they are still active. Many animals that live in the tundra year-round, such as arctic foxes, lose their brown fur and grow white fur that camouflages them with the winter snow. These animals are also extremely well insulated.

Threats to the Tundra The tundra is one of the most fragile biomes on the planet. Its food chains are relatively simple, so they are easily disrupted. Because conditions are so extreme, the land is easily damaged and slow to recover. Until recently, the tundra was undisturbed by humans. But oil has been located in some tundra regions, such as in northern Alaska. Oil exploration, extraction, and transport has disrupted the habitats of the plants and animals in many parts of the tundra. Pollution caused by spills or leaks of oil and other toxic materials may also poison the food and water sources of the organisms that live in the tundra. 

MATH PRACTICE



U.S. Oil Production On average, the United States produces an estimated 8.1 million barrels of oil per day. How many millions of barrels of oil does the United States produce in 1 year? If all of the oil-producing countries of the world produce an estimated 74.13 million barrels of oil per day, what percentage of worldwide oil does the United States produce?

SECTION 3 Review

1. **Describe** two desert animals and the adaptations that help them survive.
2. **Describe** how tropical grasslands differ from temperate grasslands.
3. **Compare** the plants that live in deserts with the plants that live in the tundra biome.
4. **Describe** one threat to the tundra biome.

CRITICAL THINKING

5. **Making Inferences** Former grasslands are among the most productive farming regions. Read the description of temperate grasslands in this section and explain why this statement is true. **READING SKILLS**
6. **Analyzing Relationships** Explain why elephants and caribou, which live in very different biomes, both migrate.

1 What Is a Biome?



Key Terms

biome, 153
 climate, 154
 latitude, 155
 altitude, 155

Main Ideas

- ▶ Scientists classify the ecosystems of the world into large areas called *biomes*.
- ▶ Biomes are described by their plant life because specific climate conditions support the growth of specific types of vegetation.
- ▶ Climate determines which plants can grow in an area. Latitude and altitude affect climate in similar ways.

2 Forest Biomes



tropical rain forest, 156
 emergent layer, 158
 canopy, 158
 epiphyte, 158
 understory, 158
 temperate rain forest, 161
 temperate deciduous forest, 162
 taiga, 163

- ▶ Major forest biomes include tropical rain forest, temperate rain forest, temperate deciduous forest, temperate evergreen forest, and taiga.
- ▶ Tropical rain forests have high rainfall and high temperatures throughout the year. They are the most diverse of all biomes.
- ▶ Temperate forests experience seasonal variations in precipitation and temperature. Their vegetation is adapted to surviving these changes.
- ▶ Forest biomes are threatened by deforestation through logging, ranching, and farming.

3 Grassland, Desert, and Tundra Biomes



savanna, 165
 temperate grassland, 166
 chaparral, 168
 desert, 170
 tundra, 172
 permafrost, 172

- ▶ Savannas are located north and south of tropical rain forests and have distinct wet seasons.
- ▶ Temperate grasslands get too little rainfall to support trees. Grasslands are dominated mostly by different types of grasses and flowering plants.
- ▶ Deserts are the driest biomes on Earth.
- ▶ Plants and animals found in each biome adapt to the environment in which they live.

Using Key Terms

Use each of the following terms in a separate sentence.

1. *biome*
2. *climate*
3. *epiphyte*
4. *tundra*
5. *permafrost*

For each pair of terms, explain how the meanings of the terms differ.

6. *understory* and *canopy*
7. *latitude* and *altitude*
8. *chaparral* and *desert*
9. *tropical rain forest* and *temperate deciduous forest*



STUDY TIP

Concept Maps Remembering words and understanding concepts are easier when information is organized in a way that you recognize. For example, you can use key terms and key concepts to create a concept map that links them together in a pattern you will understand and remember.

Understanding Key Ideas

10. Approximately what percentage of the Earth's species do tropical rain forests contain?
 - a. 7 percent
 - b. 20 percent
 - c. 40 percent
 - d. 50 percent
11. Animal species of the tropical rain forest
 - a. compete more for available resources than species native to other biomes do.
 - b. have adaptations that minimize competition.
 - c. have adaptations to cope with extreme variations in climate.
 - d. are never camouflaged.
12. Migration of animals in the savanna is mostly a response to
 - a. predation.
 - b. altitude.
 - c. rainfall.
 - d. temperature.
13. Spadefoot toads survive the dry conditions of the desert by
 - a. migrating to seasonal watering holes.
 - b. finding underground springs.
 - c. burying themselves in the ground.
 - d. drinking cactus juice.
14. The tundra is most suitable to a vertebrate that
 - a. requires nesting sites in tall trees.
 - b. is coldblooded.
 - c. has a green outer skin for camouflage.
 - d. can migrate hundreds of kilometers each summer.
15. A biome that has a large amount of rainfall, high temperatures, and poor soil is a
 - a. temperate woodland.
 - b. temperate rain forest.
 - c. tropical rain forest.
 - d. savanna.
16. The two main factors that determine where organisms live are
 - a. soil type and precipitation.
 - b. temperature and precipitation.
 - c. altitude and precipitation.
 - d. temperature and latitude.
17. Which of the following biomes contains large trees?
 - a. savanna
 - b. temperate rain forest
 - c. chaparral
 - d. desert
18. The most common types of plants in the taiga biome are
 - a. deciduous trees.
 - b. short shrubs.
 - c. coniferous trees.
 - d. grasses.

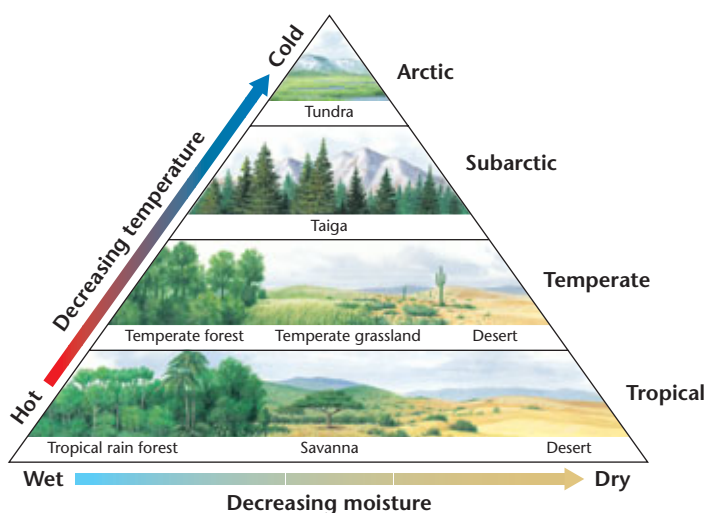
Short Answer

19. Unlike the jungles you see in movies, the floor of an undisturbed tropical rain forest usually has little vegetation. Explain why it lacks vegetation.
20. What is the relationship between root systems and erosion in a grassland ecosystem?
21. How might a mountain affect where particular types of biomes are located?
22. Well-preserved mammoths have been found buried in the tundra. Explain why the tundra preserves animal remains well.
23. How does deforestation contribute to a change in climate and increase the chance of floods in a biome?

Interpreting Graphics

Use the diagram below to answer questions 24–26.

24. Why are tall trees found in the taiga but not in the tundra?
25. As moisture decreases, what happens to the amount of vegetation in an area?
26. What does the diagram tell you about the temperature of and precipitation in temperate grasslands?



Concept Mapping



27. Use the following terms to create a concept map: *threats to an ecosystem, erosion, overgrazing, logging, grasslands, rain forests, tundra, deserts, oil extraction, and irrigation.*

Critical Thinking

28. **Comparing Processes** American prairies and Asian steppes contain different plant species but are dominated by grasses. Write a short paragraph that explains why the two grasslands contain different species but the same types of plants. **WRITING SKILLS**
29. **Classifying Information** Read the description of tropical rain forests in this chapter, and list two factors that are responsible for the biodiversity of this biome. Describe two reasons for the decline of tropical rain forests. **READING SKILLS**
30. **Analyzing Relationships** If you took a population of squirrels from the southeastern United States and introduced them into a Central American rain forest, they would probably not survive. Why do you think the squirrels would not survive even though they are naturally adapted to life in a forest?
31. **Making Inferences** How might prairie fires set from natural and human causes have affected the evolution of fire resistance in prairie grasses?

Cross-Disciplinary Connection

32. **Geography** Use a world map to find locations of the various biomes. Then, make a poster that contains photos or illustrations of plants and animals native to each biome.

Portfolio Project

33. **Food Webs in Your Biome** Do a special project on the ecosystems in your biome. Use field guides to find out what plants and animals live in your biome. Then, draw a food web that shows how organisms in each ecosystem could be related.



MATH SKILLS

Use the table below to answer questions 34–35.

Amount of Tropical Rainforest		
Country	Amount of tropical rain forest (km ²)	Amount of annual deforestation (km ² /y)
A	1,800,000	50,000
B	55,000	3,300
C	22,000	6,000
D	530,000	12,000
E	80,000	700

34. **Making Calculations** What percentage of tropical rain forest is being destroyed each year in country A? in country D?
35. **Interpreting Statistics** According to the table, which country's tropical rain forest will be completely destroyed first? Which country's rain forest will be completely destroyed last?



WRITING SKILLS

36. **Communicating Main Ideas** Describe the importance of conserving the biomes of the world. What can you do to help conserve the world's biomes?
37. **Writing From Research** Choose one biome and research the threats that exist against it. Write a short essay that describes the threats and any actions that are being taken to help save the biome.



READING SKILLS

Read the passage below, and then answer the questions that follow.

The Tropics and other regions of high biodiversity include some of the economically poorest countries on Earth. These countries are trying to use their natural resources to build their economies and to raise the standard of living for their citizens. Several conservation strategies offer ways for developing countries to benefit economically from preserving their biodiversity.

For example, in a *debt-for-nature swap*, richer countries or private conservation organizations pay some of the debts of a developing country. In exchange, the developing country agrees to take steps to protect its biodiversity, such as setting up a preserve or launching an education program for its citizens. Another idea to help local people make money from intact ecosystems is to set up a national park to attract tourists. People who want to see the ecosystem and its unique organisms will pay money for nature guides, food, and lodging. This idea is called *ecotourism*.

- The main objective of both a *debt-for-nature swap* and *ecotourism* is
 - economic gain.
 - education of citizens.
 - preservation of biodiversity.
 - Both (a) and (c)
- According to the passage, which of the following statements is true?
 - Regions of high biodiversity are not worth saving.
 - Intact ecosystems are ecosystems that are most developed.
 - A debt-for-nature swap is an example of international compromise.
 - Launching education programs for citizens does not help protect ecosystems.



Understanding Concepts

Directions (1–4): For *each* question, write on a separate sheet of paper the letter of the correct answer.

- 1** Which of the following describes a biome?
 - A. all the areas on Earth that are life-supporting
 - B. weather conditions in an area for a specific time period
 - C. a region characterized by specific climate and organism communities
 - D. an area where the animal population interacts with its abiotic environment
- 2** What type of forest has the greatest biodiversity?
 - F. taiga forest
 - G. temperate deciduous forest
 - H. temperate rain forest
 - I. tropical rain forest
- 3** What is the diversity of the species in an area dependent on?
 - A. plant life
 - B. rainfall
 - C. sunlight
 - D. temperature
- 4** What are the main factors that determine weather?
 - F. altitude, latitude, precipitation, temperature
 - G. altitude, latitude, precipitation, vegetation
 - H. air currents, altitude, temperature, vegetation
 - I. air currents, precipitation, temperature, vegetation

Directions (5–6): For *each* question, write a short response.

- 5** A temperate grassland is a biome that is dominated by grasses and that has very few trees. How are temperate grasslands threatened by overgrazing?
- 6** Compare and contrast the tundra and desert biomes.

Reading Skills

Directions (7–8): Read the passage below. Then answer the questions.

When rain falls on a forest, much of the rain is absorbed by plant roots and transpired into the air as water vapor. The water vapor forms rain clouds. Much of the water in the clouds will fall as rain somewhere downwind from the forest. Clearing the trees results in deforestation, which can change the climate.

Deforestation led to the disastrous flooding of the Yangtze River in China in 1998. More than 2,000 people died in the floods, and at least 13 million people had to leave their homes. It is estimated that 85 percent of the forest in the Yangtze River basin has been cut down. So the millions of tons of water these trees once absorbed now flows freely down the river and spreads across the fields into towns during the seasonal monsoon rains.

- 7** How could future flooding on the Yangtze River be avoided?
 - A. replanting crops
 - B. rebuilding homes
 - C. replanting trees
 - D. rebuilding walls
- 8** Examine the climate change produced by deforestation.

Directions (9): Read the passage below. Then answer the question.

Tropical rain forests are located in a belt around the Earth near the equator. The climate is ideal for a wide variety of plants and animals. In tropical rain forests, different types of plants grow in different layers. The main layers above the forest floor are, in order from top to bottom, the emergent layer, the canopy, and the understory.

- 9** Which layer of a tropical rain forest receives the least sunlight, and why?

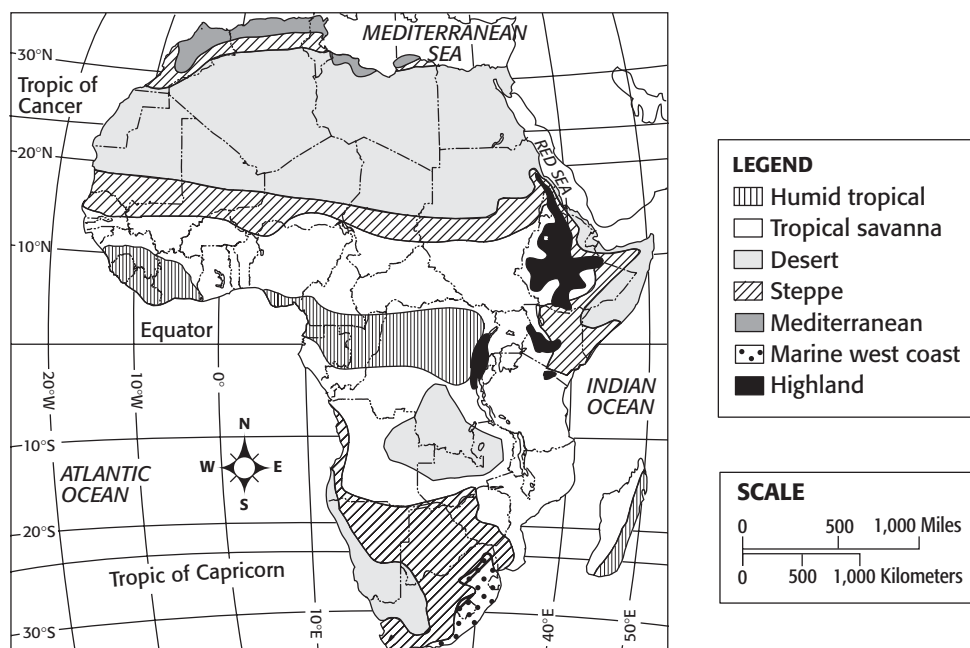


Interpreting Graphics

Directions (10–13): For *each* question below, record the correct answer on a separate sheet of paper.

Different scientists classify biomes in different ways. The map below shows one way to classify the biomes in Africa. Use this map to answer questions 10 through 13.

Biomes of Africa



- 10** What can be inferred about the biomes of Africa?
- F. Africa has a large concentration of tropical rain forests.
 - G. Africa has a limited number of plant and animal communities.
 - H. Africa has all types of plant life because of the many diverse biomes.
 - I. Africa has large desert areas that get less than 25.0 cm of precipitation a year.
- 11** Which biome covers the most surface area in Africa?
- A. desert
 - B. highland
 - C. Mediterranean
 - D. steppe
- 12** According to the map, which of the following determines the characteristics of a biome?
- F. geographic borders
 - G. latitude
 - H. longitude
 - I. the Indian ocean
- 13** What geographic features are near 10°N, 40°E?
- A. mountains
 - B. plains
 - C. rivers
 - D. volcanoes

Test TIP

When several questions refer to the same graph, table or map, answer the questions you are most sure of first.

Objectives

- **Collect** information from international, national, and local resources about the biome in which you live.
- **USING SCIENTIFIC METHODS** **Perform** field observations to identify the name of the biome in which you live.

Materials

binoculars (optional)
field guide to local flora and fauna
globe or atlas
graph paper (optional)
notebook
pencil or pen
ruler



- **Climatograms** The temperature and precipitation for Austin, Texas is shown in this climatogram.

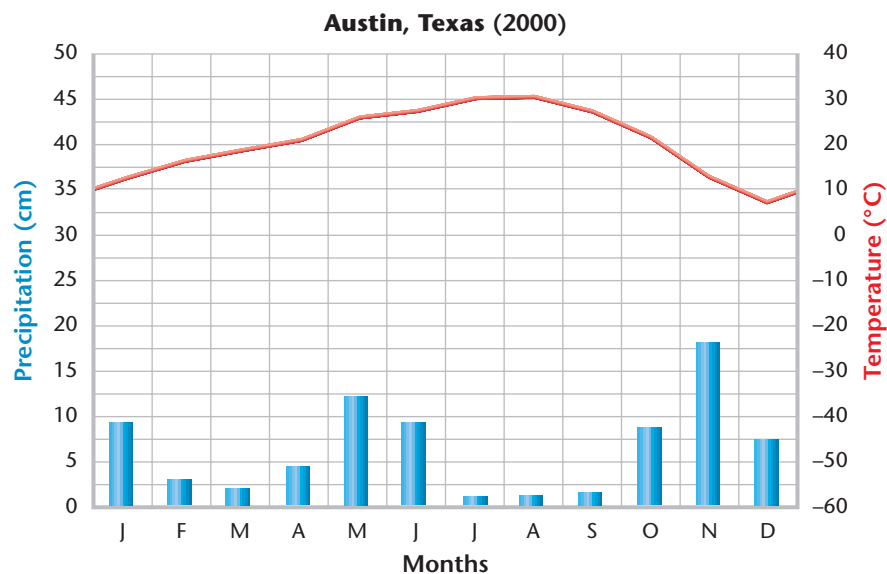
Identify Your Local Biome

In what biome do you live? Do you live in a temperate deciduous forest, a desert, or a temperate grassland, such as a prairie or savanna? In this lab, you will explore certain characteristics of the biome in which you live. With the information you gather, you will be able to identify which biome it is.

Procedure

1. Use a globe or atlas to determine the latitude at which you live. Record this information.
2. Consider the topography of the place where you live. Study the contour lines on a map or surface variations on a globe. What clues do you find that might help identify your biome? For example, is your area located near a mountain or an ocean? Record your findings.
3. Prepare a climatogram of your area. A climatogram is a graph that shows average monthly values for two factors: temperature and precipitation. Temperature is expressed in degrees Celsius and is plotted as a smooth curve. Precipitation values are given in centimeters and are plotted as a histogram.

To make a climatogram of your area, obtain monthly averages of precipitation and temperature for one year from your local TV or radio weather station. Make a data table, and record these values. Next, draw the vertical and horizontal axes of your climatogram in your notebook or on graph paper. Then, show the temperature scale along the vertical axis on the right side of the graph and the precipitation scale along the vertical axis on the left side of the graph. Show months of the year along the horizontal axis. Finally, plot your data.



4. Go outside to observe the plants growing in your area. Bring a field guide, and respond to the following items in your notebook.
 - a. Sketch or describe as many plants that are common in your area as you can. Use your field guide to identify each of these species.
 - b. Describe three or more adaptations of each plant to the local climate.
 - c. Which of the plants that you observed are native to your area? Which have been introduced by humans? Which of the introduced plants can survive on their own in local conditions? Which of the introduced plants require extensive human care to remain alive?
 - d. Look for evidence that animals have left behind—footprints, nests, dens or burrows, hair or feathers, scratches, or urine markings. Sketch or describe as many different animal species as possible. Identify each species by using your field guide.
 - e. Describe three or more adaptations that each animal has developed in order to survive in local climatic conditions.

Analysis

1. **Analyzing Data** Compare your local climatogram to the biome climatograms shown in this chapter. Which biome has a climatogram most similar to your climatogram?
2. **Analyzing Results** Consider your latitude, topographical findings, and observations of local plants and animals. Combine this information with your climatogram, and determine which biome best matches the area in which you live.

Conclusions

3. **Evaluating Results** Does your climatogram match any of the seven major terrestrial climatograms shown in the chapter? Explain how any differences between your biome and the biome in the chapter that your biome most clearly matches might influence the adaptations of local animals and plants.
4. **Applying Conclusions** Organisms create features of the biome in which they live. What features of your biome are created by the organisms that live there?

Extension

1. **Classifying Information** Name the three plant adaptations and the three animal adaptations that you observed. Explain in detail how each of these adaptations meets the conditions of your biome.



► **Biomes** These two cities are located in two different biomes. Stamford, Vermont (top) is located in a temperate deciduous forest, and Tucson, Arizona (bottom) is located in a desert.



A LITTLE PIECE OF CAJUN PRAIRIE

Cajun prairie is a distinct grassland, named for the settlers who lived there. It once covered more than 2.5 million acres of southwest Louisiana. Today, only about 100 acres of Cajun prairie remain. If the work of two biologists and many volunteers pays off, however, a little piece of Cajun prairie will always exist in Louisiana.

“I think that saving Cajun prairie is important because once it is gone, you cannot bring it back,” says Charles Allen, a retired professor from the University of Louisiana and the botanist for Louisiana’s Fort Polk. “There are plants and animals there that have never been tested for uses by humans. We could be losing a plant that would cure cancer, or provide food or fiber,” he says.

Allen and biologist Malcolm Vidrine, a professor of biology at Louisiana State University in Eunice, have been working for almost two decades to restore Cajun prairie.

Although Cajun prairie and the tallgrass prairies of the Midwest both belong to the temperate grassland biome, Cajun prairie soil has unique characteristics. It is

made of tight, heavy clays that formed as a result of coastal flooding and rains. This soil, combined with frequent lightning fires, makes it difficult for trees to grow but easy for prairie plants to flourish.

Settling on the Prairie

In the mid-1700s, many French Acadians, also known as Cajuns, arrived in Louisiana from Nova Scotia, Canada. They sustained themselves for over 100 years by fishing, hunting, and some farming. They also sustained their environment because their lifestyle caused little damage to the prairie.

The establishment of the railroad in the late 1800s brought new settlers to farm the rich land. These settlers brought with them new, more intensive agricultural practices and established herds of cattle that overgrazed the vegetation. By the early 20th century, most of the Cajun prairie had disappeared.



► Charles Allen is shown here collecting seeds from a compass plant at a Cajun prairie remnant. The leaves of the compass plant face east to catch the sun.

Today, the Cajun prairie ecosystem is labelled as “impaired globally” by the Nature Conservancy, an organization dedicated to preserving natural communities. There are now fewer than 100 acres of Cajun prairie left in Louisiana. The railroad led to the near disappearance of the prairie, but it has also played an important role

► Cajun prairie, preserved on this 10-acre site, once covered nearly 10 percent of Louisiana.





► Volunteers such as these students used seeds and sod gathered from remnants to create a new Cajun prairie habitat in Eunice, Louisiana.

in saving the last remaining pieces of prairie. The remaining prairie is mostly in remnants of small, narrow strips along railroad right-of-ways. Because the railroad owned these pieces of land, they were never farmed.

The Eunice Cajun Prairie Restoration Project

In the late 1980s, Allen and Vidrine located as many remnant strips as they could. They chose 10 of the strips and studied them carefully. They found almost 500 species of plants in the 10 strips.

The Eunice Cajun Prairie Restoration Project began in the summer of 1988. Its goal was to restore and preserve a small Cajun prairie in the city of Eunice, Louisiana.

A 10-acre site in Eunice was mowed, and herbicide was used to destroy the nonnative vegetation. Volunteers from local elementary and high schools collected bags of seeds from Cajun prairie plants

growing in the remnant strips. That winter, controlled burns were used to prepare the site. On a designated planting day, the students spread the seeds they had collected. The site was then lightly tilled. Sod was removed from the remnant strips and replanted at the Eunice site during the next three seasons.

Restoration is an ongoing effort. Yearly controlled burns maintain the habitat. The fires destroy shrubs and trees, but do not kill most of the prairie plants. Spot herbicides are used on the more pervasive nonnative species, such as the Chinese tallow tree, the most threatening nonnative species for the prairie. The seeds of this tree are easily spread when birds eat the seeds and deposit them in droppings.

Today, nearly 300 native Cajun prairie species, including little blue-stem, Eastern gama grass, blazing stars, and hairy sunflower, have been reestablished at the site. As well, the rare wild coco orchid



► To maintain the habitat, volunteers remove nonnative vegetation such as this vasey grass.

(*Eulophia ecrista*) has been found at the site. This is a very positive sign because few of these orchids have been found in the remnant strips or in Louisiana. Much of the Eunice site is now almost completely Cajun prairie.

What Do You Think?

Are there threatened habitats in your area? What factors do you think led to the loss of these habitats? Is it possible for people to settle in a habitat without having a negative impact? How were the Cajuns able to sustain themselves on the prairie without destroying the habitat?