

Chapter 16

Biomes

In Chapter 6, you learned about seasons, wind, ocean currents, and weather patterns. All of these elements work together to produce different climates in different parts of the world. In this chapter, you will learn about climates and climate regions called *biomes*. Earth has six main biomes that have particular plants and animals. These biomes are deserts, grasslands, temperate deciduous forests, rainforests, taiga, and tundras. In which biome do you live? What types of plants and animals live where you live?



Key Questions

1. *How do plants and animals survive in the desert?*
2. *In which biome would you find a moose?*
3. *What is your biome like?*



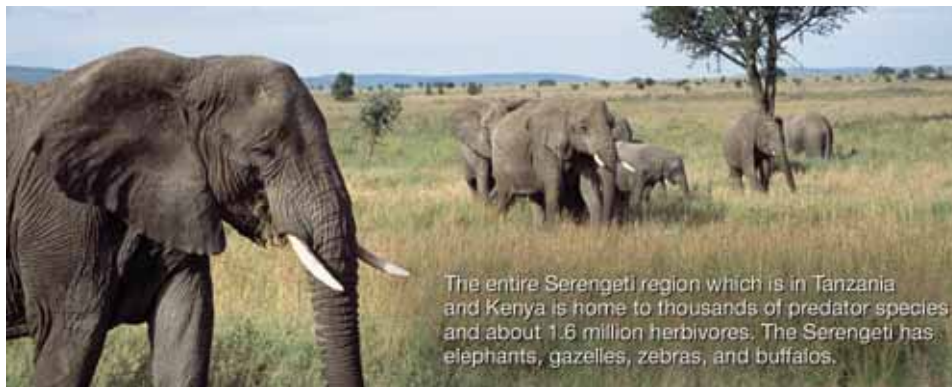
16.1 Climates and Biomes

Imagine someone gave you an airplane ticket to travel to Africa to see Serengeti National Park in Tanzania. If you like adventures, you might say “Great! When do I leave?” Then, you would want to pack your suitcase. But, what would you take? What is the climate like in Africa?

Climate

Factors that affect climate You learned about climates in Chapter 6. A *climate* is defined as the type of weather patterns that a place has, on average, over a long period time. If you wanted to know about the climate in a place you were about to visit, you might ask questions like “How hot and how cold does it usually get? Does it rain a lot? How often is the temperature below freezing?” Climate depends on many factors, including latitude, precipitation, elevation, topography, and distance from large bodies of water.

Weather patterns Weather is a term that describes the condition of the atmosphere in terms of temperature, wind, and atmospheric pressure. Changes in these conditions cause *weather patterns*. The Sun is the major source of energy for weather and weather patterns.

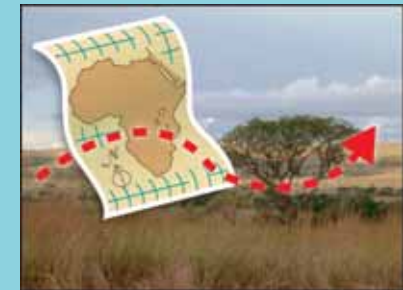


The entire Serengeti region which is in Tanzania and Kenya is home to thousands of predator species and about 1.6 million herbivores. The Serengeti has elephants, gazelles, zebras, and buffalos.



Packing for an adventure in the Serengeti

1. On a world atlas, find the Serengeti. Describe where it is located.
2. Make a prediction about the kind of weather the Serengeti will have next week.
3. Then, research the seasonal weather in this area on the Internet or in the library. Were you correct in your prediction?
4. Using what you learned, make a list of things you would need to pack in your suitcase to visit the Serengeti.





Characteristics of biomes

What is a biome? Scientists divide the planet into climate regions called **biomes**. Earth has six main biomes: deserts, grasslands, temperate deciduous forests, rainforests, taiga, and tundras. These biomes generally differ in their latitude, weather and relative humidity, amount of sunlight, and topography. Each biome has a unique set of plants and animals that thrive in its climate.

Latitude and humidity *Relative humidity* is a measure of how much water vapor an air mass contains (see full definition in Chapter 6). Humidity is related to plant and animal diversity. From the poles to the equator, humidity and the diversity of plants and animals increases.

Sunlight at the equator vs high latitudes Earth is hottest near the equator where the Sun is closest to being directly overhead year round. At the north and south poles, temperatures are much colder. This effect is related to the fact that light travels in straight parallel lines. To demonstrate what is happening, imagine shining a flashlight on a sheet of paper (Figure 16.1). The light makes a bright, small spot. By tilting the paper, you can make the light spot bigger and less intense.

VOCABULARY

biomes - major climate regions with particular plant and animal communities. Earth has six important biomes.

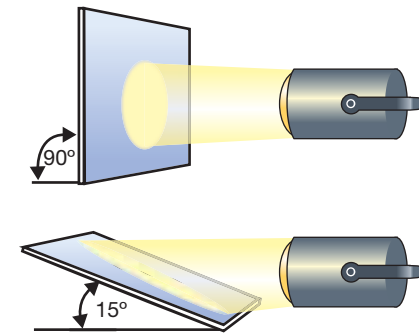
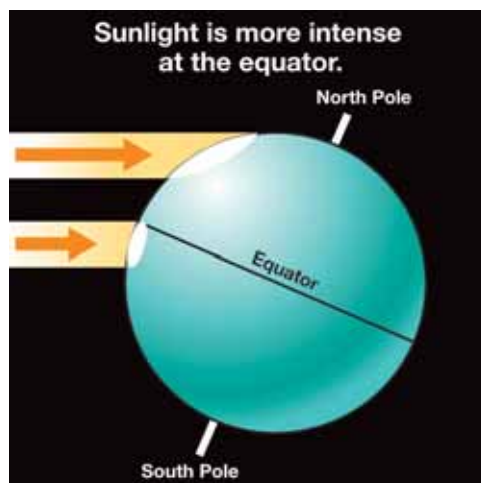


Figure 16.1: A flashlight shining on a piece of paper represents solar radiation reaching Earth. If you tilt the paper, the spot of light spreads out and becomes less intense.



At the equator, sunlight is direct and intense. Earth's north and south poles are tilted away from or toward the Sun depending on the time of year (review Chapter 6). The locations of the poles relative to the Sun and Earth's spherical surface mean that sunlight reaching these areas is spread out and less intense. As a result, the average yearly temperature at the equator is 27 °C (80 °F), while at the North Pole it is -18 °C (0 °F). Generally, as latitude (or distance from the equator) increases, the amount of incoming solar radiation decreases.

Other factors besides latitude can affect climates

Temperatures in inland regions

Have you ever wondered why cities near the ocean don't get as hot in the summer or as cold in the winter as inland cities at the same latitude? Portland, Oregon, and Minneapolis, Minnesota, are two cities near the same latitude (Figure 16.2). Look at Table 16.1 below to see how the average daily temperature ranges for these cities compare.

Table 16.1: Average daily temperature ranges for Portland and Minneapolis.

	Average daily temperature range	
Month	Portland	Minneapolis
January	1 – 7 °C, (34 – 45 °F)	-16 – -6 °C (3 – 21 °F)
July	14 – 27 °C (57 – 80 °F)	17 – 29 °C (63 – 84 °F)

Water helps regulate temperature

The differences in temperature between the two cities have to do with water, which is an effective moderator of temperature. Water warms up and cools down slowly. Land warms up and cools down quickly. Therefore, regions near water—like Portland—do not have extremely hot or cold weather. Similarly, wet areas like marshes and swamps don't experience the temperature extremes found in desert regions.

Latitude versus altitude

Latitude is an important factor in defining a biome. However, *altitude* is also a factor. The range of biomes that exist on Earth from the equator to the poles also exists if one goes from the bottom of a mountain to the top of a mountain (Figure 16.3).

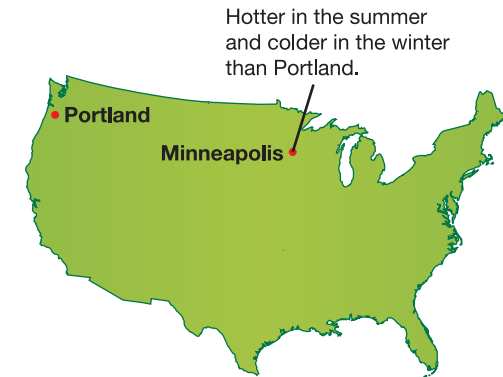


Figure 16.2: Portland and Minneapolis are near the same latitude.

SOLVE IT!

Questions about Table 16.1:

1. It is January 3rd and -10 °C outside. Where am I?
2. It is July 4th and 20 °C. Can you figure out from the table where I am? Why or why not?

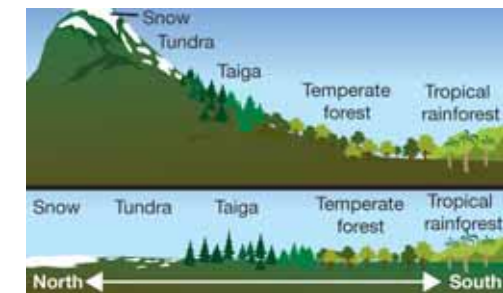
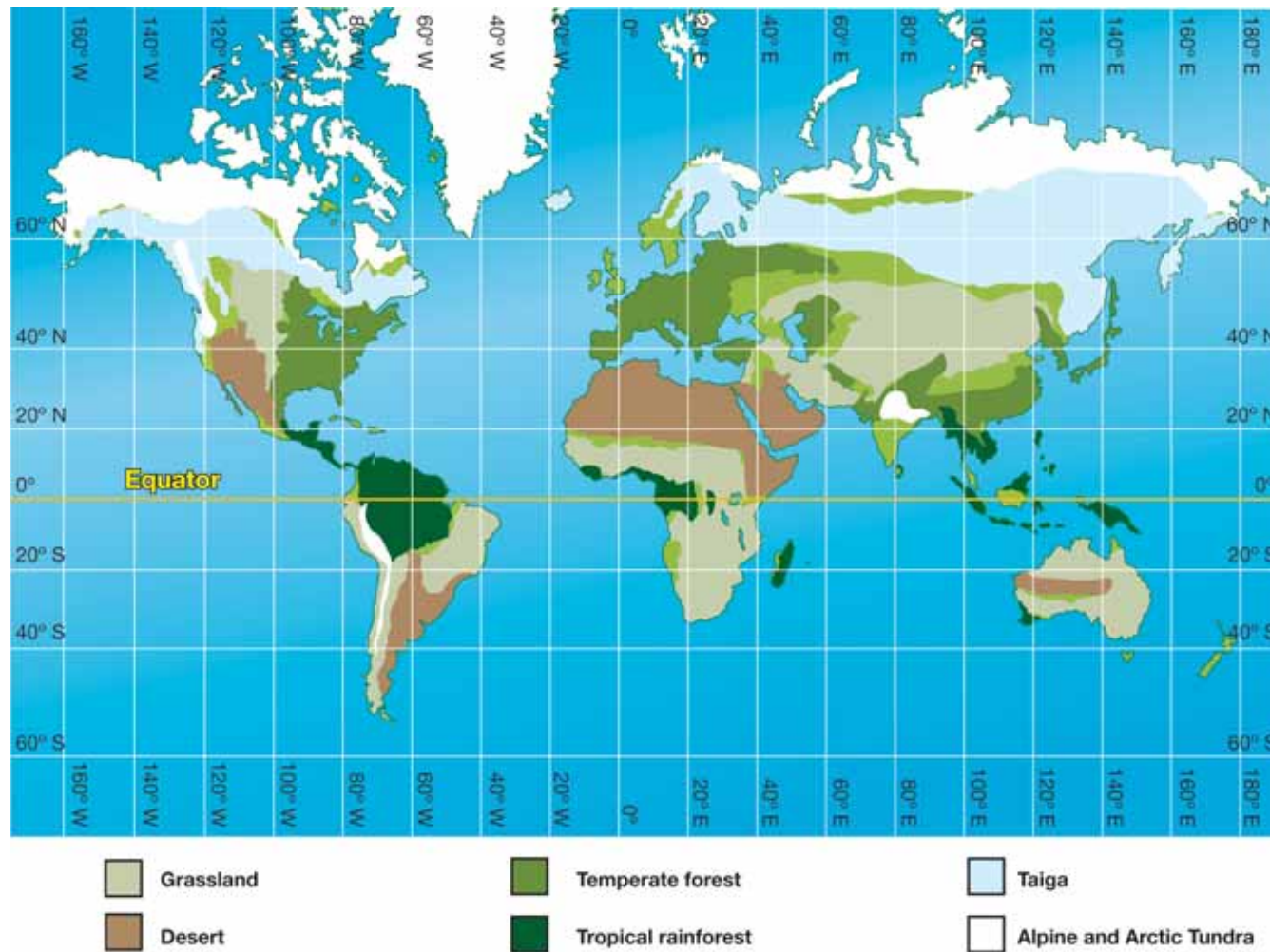


Figure 16.3: Latitude versus altitude for the Northern Hemisphere.



Earth's biomes



Plants and animals in biomes

- Communities** A biome is characterized by its plant and animal communities. The plants and animals in a community interact with each other and survive in a shared environment. The plants and animals in the environment have adaptations that allow them to obtain enough resources (such as food, water, or sunlight) to survive in the environment.
- Adaptations** For example, how might an animal survive in a hot desert? Jackrabbits have an adaptation to keep cool—enormous ears with many blood vessels near the surface (Figure 16.4). Blood running through the vessels speeds up heat transfer from the jackrabbit's body to the air so it stays cooler.
- Ecosystems** Biomes are large geographic areas. Within a biome, there are many interrelated ecosystems. An *ecosystem* is made up of the plants and animals that live there, plus nonliving things like soil, air, water, sunlight, and nutrients. The living and nonliving parts of an ecosystem work together, and each organism plays an important ecological role. On a baseball team, for example, important roles include coach, pitcher, catcher, outfielders, and infielders. Similarly, organisms play roles in their ecosystem.
- How many roles?** The number and types of organisms that an ecosystem can support depends on the resources available (food sources) and on environmental factors, such as the amount of available sunlight, water, and the temperature. For plants, another important factor is soil composition. The roles within a biome ecosystem depend on the quantity and type of resources. Each ecosystem of a particular biome type has organisms that play similar roles. For example, both a rainforest in South America and a rainforest in Australia have predators, herbivores, and decomposers suited to surviving in the rainforest environment.



Figure 16.4: The large ears of a jackrabbit help this desert animal to cool down.



Biodiversity

Answer the following questions.

1. What does the term *diversity* mean?
2. What does the term *biodiversity* mean?
3. Does this statement surprise you? Why or why not?

The biodiversity of the desert is greater than for other biomes with the exception of the tropical rainforest.

4. Why is biodiversity in an ecosystem important?



16.1 Section Review

1. What is the main source of energy for weather?
2. Are climate and weather the same thing? If not, explain how these terms are different. (Hint: For more information, review Chapter 6.)
3. Write your own definitions of the terms *ecosystem* and *biome*. What is the difference between these terms?
4. The latitude and relative humidity of a region are used to define a biome. Why is humidity an important factor?
5. What happens to the intensity of solar radiation and Earth's average yearly temperature as you move from the equator to the South Pole or North Pole?
6. A jackrabbit has large ears that help it cool down in its desert biome.
 - a. Would this adaptation (the large ears) be a useful adaptation to have in a cold weather environment? Why or why not?
 - b. Make a prediction: What kinds of adaptations might be useful for a rabbit to have if it lives in Alaska (tundra biome)?
7. A photograph of an Arctic hare is shown in Figure 16.5. This animal lives in cold environments.
 - a. What adaptations do you see that this animal has?
 - b. How does the appearance of this animal compare to the jackrabbit in Figure 16.4?
8. The main grass in a grassland in North America is prairie grass. The main grass in a South American grassland is pampas grass. Would you expect the ecological role of these grasses in these two locations to be the same or different? Explain your answer.



What's your climate?

1. From the reading, list the factors that affect the climate of an area.
2. Use these factors to describe the climate where you live.



Figure 16.5: An Arctic hare.

16.2 Deserts and Grasslands

In this section, you will learn about two interesting biomes, deserts and grasslands.

Deserts

Desert regions A **desert** is a climate region that averages less than 35 centimeters of rainfall per year. Most deserts are found between the latitudes of 30° N and 30° S. Because of the lack of cloud cover, deserts receive more than twice as much incoming solar radiation as humid regions. They also emit almost twice as much radiation at night. As a result, deserts have large variations in daily high and low temperatures.



How deserts form You may wonder why there is so little rain in the desert. The answer depends on which desert you are talking about. The Sahara and Australian deserts are caused by regions of high atmospheric pressure found near 30° latitude lines (Figure 16.6). High pressure prevents air near the ground from rising and cooling. As a result, not much condensation takes place. When the condensation rate is lower than the evaporation rate, skies are usually clear and very little precipitation falls.



desert - a climate region that averages less than 35 centimeters of rainfall per year.



Figure 16.6: *The Sahara and Australian deserts are caused by regions of high atmospheric pressure found near 30° latitude lines.*



Rainshadow deserts Other deserts, such as one found in eastern Washington state, are caused by the “rainshadow effect.” Prevailing westerly winds blow moisture-filled air from the Pacific Ocean over the Washington coast. This air rises as it travels up the western slope of the Cascade mountain range and cools, causing condensation and lots of rain. By the time the air blows over the mountains to the eastern side, there is very little moisture left (Figure 16.7). Olympia, Washington, on the western side of the Cascades, receives an average of 201 centimeters of rain per year. This region has fertile, nutrient-rich land for growing trees. Yakima, on the eastern side, receives only 32 centimeters of rain per year and is a “rainshadow desert” (Figure 16.8).

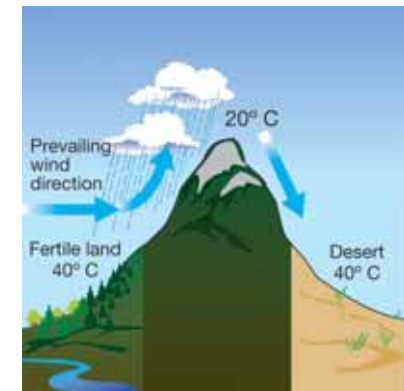


Figure 16.7: This graphic illustrates how the rainshadow effect works.

Fog deserts A third type of desert is known as a “fog desert.” Fog deserts are found on the west coasts of continents located between 20° and 30° latitude. Here the prevailing winds are easterly, so moisture-filled air does not blow in from the ocean. Cold water currents run along many of these coastlines. The cold water causes air to condense as fog over the ocean. The fog drifting over land causes a small amount of precipitation (rain). Fog deserts included the Baja desert of California and the Atacama desert in South America.

Desert life It might seem that few plants and animals could survive harsh desert conditions, but actually many different kinds of organisms have adapted to desert life. In fact, only the tropical rainforest biome contains a greater number of plant and animal species than the desert biome.

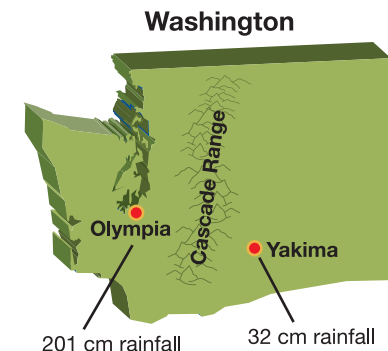


Figure 16.8: Due to the rainshadow effect Olympia, Washington receives an average of 201 centimeters of rain per year. Yakima receives only 32 centimeters of rainfall each year.

Grasslands

Grasslands are found on every continent except Antarctica. There are two types of grasslands: tropical grasslands, known as *savannas*, and *temperate grasslands*.



Savannas Savannas are found in parts of the tropics where there is not enough rainfall throughout the year to create a rainforest. Savannas are characterized by two seasons: rainy and dry. During the rainy season, which lasts for six to eight months, 50 to 127 centimeters of rain falls. This season is followed by a drought, which in many areas culminates with wildfires. The fires and the poor soil conditions prevent the growth of most trees. In fact, in some areas, trees grow only on termite mounds (Figure 16.9). The isolated trees found in savannas have cork-like bark or an outer coating that can withstand some fire damage.

Adaptations to survive fires Many large mammals of the savanna, including the wildebeest pictured at the right, have long legs that enable them to outrun fires. Smaller mammals burrow under the ground and stay there until the fire has passed over them. Most birds fly away from the fire, but several species, including the Fork-tailed Drongos, actually fly toward the fires so that they can feast on the hordes of insects trying to escape the heat.

VOCABULARY

grasslands - climate regions with too little rainfall to support a forest. Grasslands have grasses as the main vegetation.

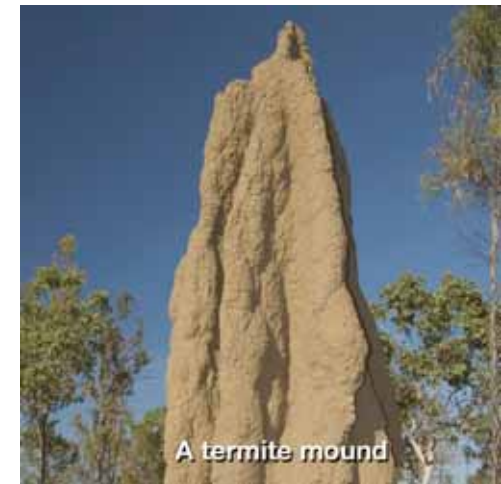


Figure 16.9: In savannas, trees sometimes grow in the soil of termite mounds.





Temperate grasslands Temperate grasslands grow in the middle latitude regions and receive most of their precipitation in late spring and early summer. Most temperate grasslands are found in the interior of continents, far from large bodies of water. The average yearly rainfall is between 51 and 89 centimeters. Summer temperatures can reach over 38 °C, while in the winter they can plummet below -40 °C. The soil is rich in nutrients, and much of this biome has been cleared for farmland. Trees are uncommon except along river valleys.

Location	Name used for grasslands
Central Asia	steppe
Southern Africa	savanna or veld
North America	prairie
South America	pampa
Australia	outback

Grasslands have many names Around the world, grasslands go by different names (Figure 16.10). In central Asia a grassland is called a *steppe*. A grassland is called a *savanna* or *veld* in southern Africa. In North America, a grassland is called a *prairie*. In South America, it is called a *pampa*. And in Australia, a grassland is called an *outback*.

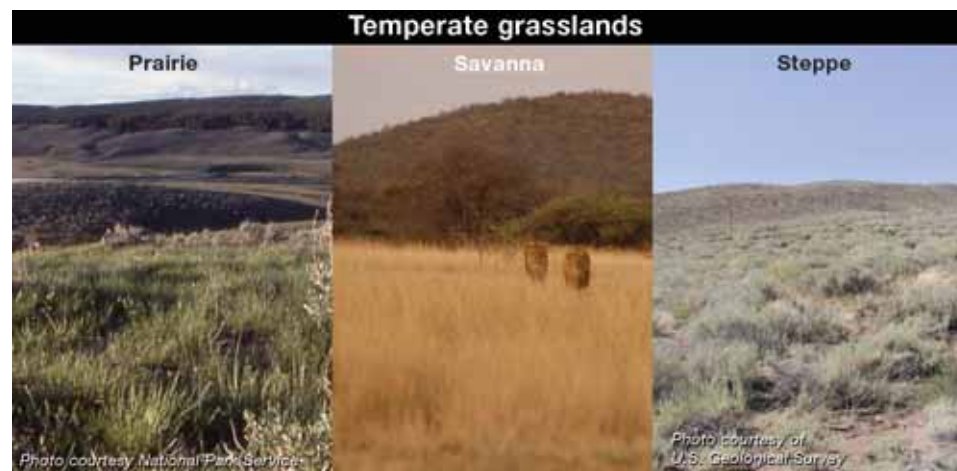


Figure 16.10: Grasslands have different names in different parts of the world.

16.2 Section Review

1. What is the maximum amount of average annual rainfall an area can have before it is no longer considered a desert biome?
2. What causes a desert to form?
3. In certain places you can be on one side of a mountain in a lush forest, but if you go to the other side of the mountain you are in a desert. What is this phenomenon called and what causes it?
4. What are the two types of grasslands? Describe both.
5. The graphs in Figure 16.11 show the average monthly precipitation for three areas throughout a year. Which graph most likely represents a desert biome? Explain your answer.
6. Few trees live on savannas. Explain why and explain how termites help trees survive in this biome.
7. Identify which biome characteristics below apply to deserts and which apply to grasslands.
 - a. Found on every continent besides Antarctica
 - b. Receive more than twice as much incoming solar radiation as more humid regions
 - c. Very hot during the day and very cool at night
 - d. Mostly found between 30° north and 30° south latitude
 - e. Has a rainy season and a dry season
 - f. Another word for this biome is a prairie, plain, or savanna
 - g. Wildfire is one of the main ecological concerns of this biome
8. Challenge question: Savannas are extremely prone to wildfires. However, animals can still survive there. Research a mammal (other than a wildebeest) that lives in a savanna and propose an explanation of how it can survive there. Use your classroom and library resources to help you.

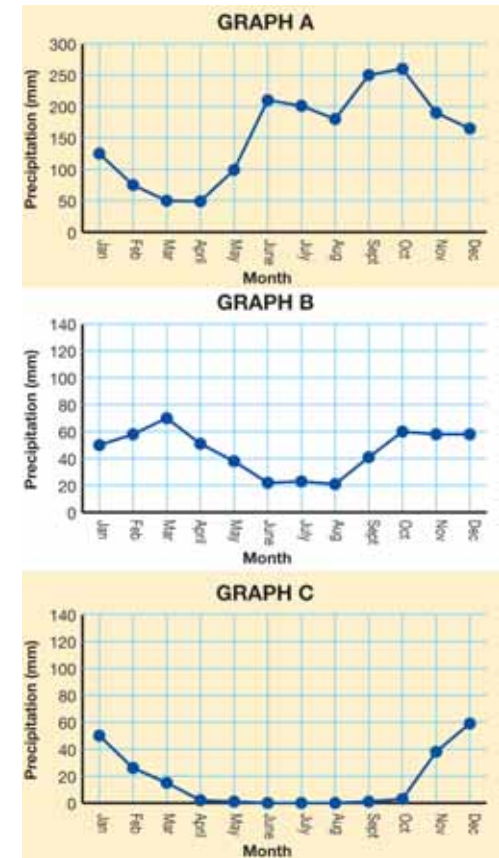


Figure 16.11: Use these graphs to answer question 5.

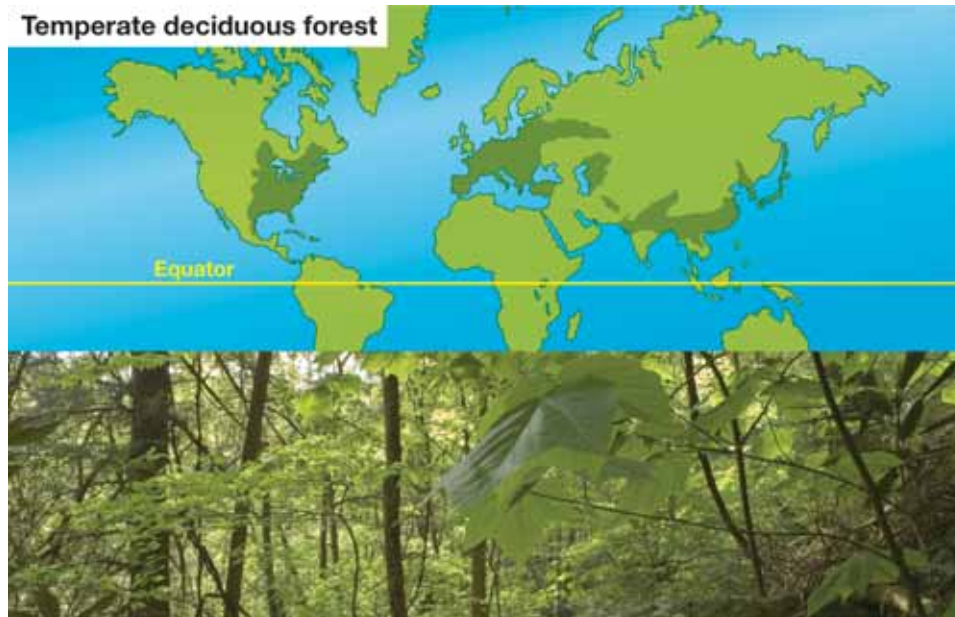


16.3 Temperate Forests and Rainforests

In this section, you will learn about two more biomes, temperate forests and rainforests.

Temperate deciduous forests

A biome with **seasons** **Temperate deciduous forests** are found in middle-latitude regions, where there are four distinct seasons. The winter temperatures in some places dip as low as -30°C , and in the summer they can be as warm as 30°C . There are between four and six frost-free months each year. Average yearly rainfall is 75 to 150 centimeters, enough to support the growth of broad-leafed, deciduous trees like oak, beech, maple, basswood, cottonwood, and willow. The word *deciduous* means these trees lose their leaves the end of the growing season (Figure 16.12).



VOCABULARY

temperate deciduous forests

- climate regions in the mid-latitudes that have four seasons.

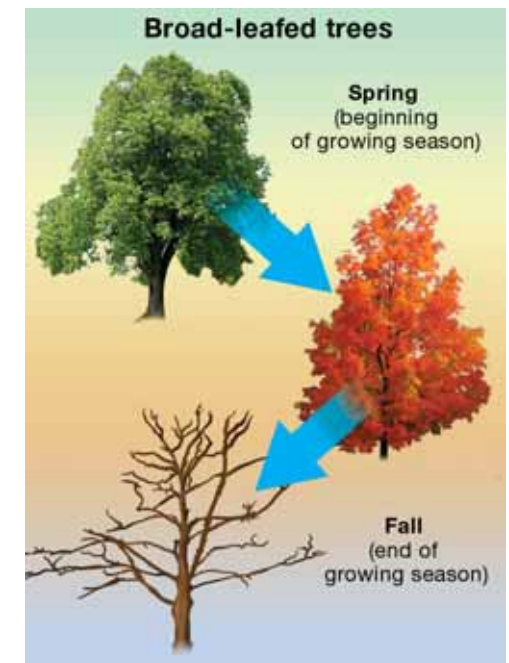


Figure 16.12: Broad-leafed deciduous trees lose their leaves in the fall, the end of the growing season.

Tropical rainforests

Tropical rainforests **Tropical rainforests** are found near the equator—between the latitudes of 23.5° N and 23.5° S. They have an average rainfall of at least 200 centimeters per year. This large amount of precipitation occurs in the area where the northern and southern hemisphere trade winds meet. The intense Sun and warm ocean water cause this converging air to rise. As the air rises, it cools, condensing into clouds and rain. This cycle happens over and over, causing a period of thundershowers in the warmest part of the afternoon almost every day. Because the tropical rainforests are near the equator, the temperature varies little year round, averaging about 20 to 25 °C.



Rainforest life Although tropical rainforests cover less than 6 percent of Earth's land, these biomes have extremely high biodiversity. Half of all of the animal and plant species in the world are found there. There can be as many as 100 different species of plants per hectare (2.47 acres). The most abundant type of plants are tall trees that form a dense canopy. Many foods we enjoy, including Brazil nuts, bananas, pineapple, cocoa, coffee, vanilla and cinnamon flavorings, and coconut originate in tropical rainforests (Figure 16.13).

VOCABULARY

tropical rainforests - climate regions found near the equator that have a lot of rainfall and high biodiversity.



Figure 16.13: Many foods we enjoy, including Brazil nuts, bananas, pineapple, cocoa, coffee, vanilla and cinnamon flavorings, and coconut originate in tropical rainforests.



Trees and global climate

According to NASA data, an area of tropical rainforest the size of North Carolina is destroyed every year. Land is cleared for crops, grazing, lumber, or firewood. When clear-cutting occurs in this type of biome, the thin topsoil soon washes away, exposing thick clay that is almost useless for agriculture. This clay absorbs the Sun's energy and then emits infrared radiation, which is absorbed by greenhouse gases. This process warms the atmosphere.

Trees prevent some of this warming. Leaves appear green because they reflect green visible light. Light at this wavelength is not as readily absorbed by greenhouse gases as infrared radiation (Figure 16.14). In a forested area, more of the Sun's energy is reflected directly back to space without first being absorbed by greenhouse gases. In this way, trees keep Earth cooler.

Figure 16.14: Recall from Chapter 6 that “greenhouse gases” describe certain gases in Earth’s atmosphere. Like the glass in a greenhouse, greenhouse gases can slow down Earth’s natural heat-loss processes. These gases are useful because they keep Earth warm.

Temperate rainforests

Like temperate deciduous forests, temperate rainforests are found in the middle-latitude regions (Figure 16.15). For example, temperate rainforests are found in coastal areas of the Pacific Northwest. Because these rainforests are in temperate areas, they may have temperate deciduous forest plants like oak trees. Like a tropical rainforest though, temperate rainforests experience a lot of rain (about 250 centimeters per year). Temperate rainforests are cool and periodically covered in fog which provides more moisture for the plants.



Figure 16.15: Temperate rainforests are found in the middle-latitude regions.

16.3 Section Review

1. How many seasons do temperate regions have? What are they?
2. The term *deciduous* describes broad-leafed trees.
 - a. What does this term mean?
 - b. Why might deciduous trees be suited for a biome with seasons?
3. Figure 16.16 shows three graphs, each with the average monthly precipitation for a given area throughout the year. Which graph most likely represents a temperate deciduous forest biome? Explain why you chose the graph you did.
4. Fill in the blanks to make this description of a tropical rainforest accurate.

Tropical rainforests cover less than _____% of Earth's land, but _____ of all animal and plant species are found there.
5. How are temperate rainforests and tropical rainforests similar? How are they different?
6. How do tropical rainforests keep our planet cooler?
7. Describe one way that you benefit from tropical rainforests.
8. Research Question: Rainforests in Australia can be compared to rainforests in South America in terms of climate and the variety of animals that live there. The Australian rainforest has kangaroos, wallabies, and bandicoots. The South American rainforest has sloths, deer, monkeys, rodents, and wild, large cats. Research the ecological roles of these and other animals in this biome. Perform your research using your school library resources, the Internet, videos, or CD-ROMs that describe biomes.

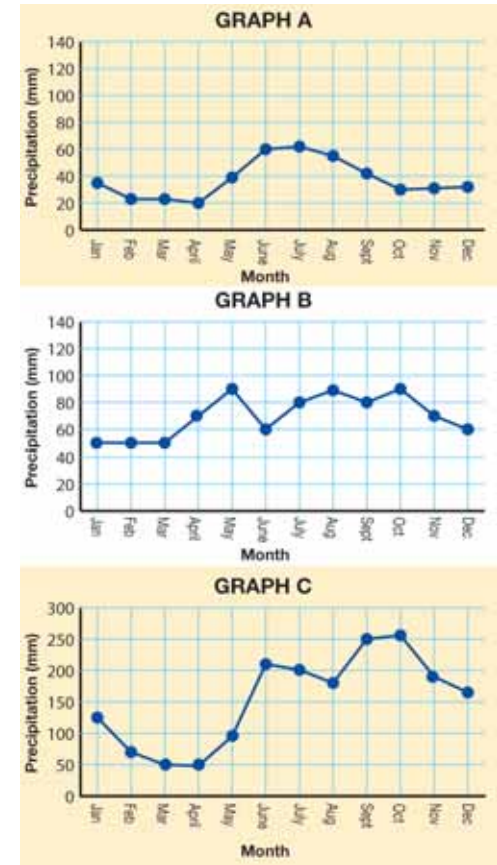


Figure 16.16: Use these graphs to answer question 3.

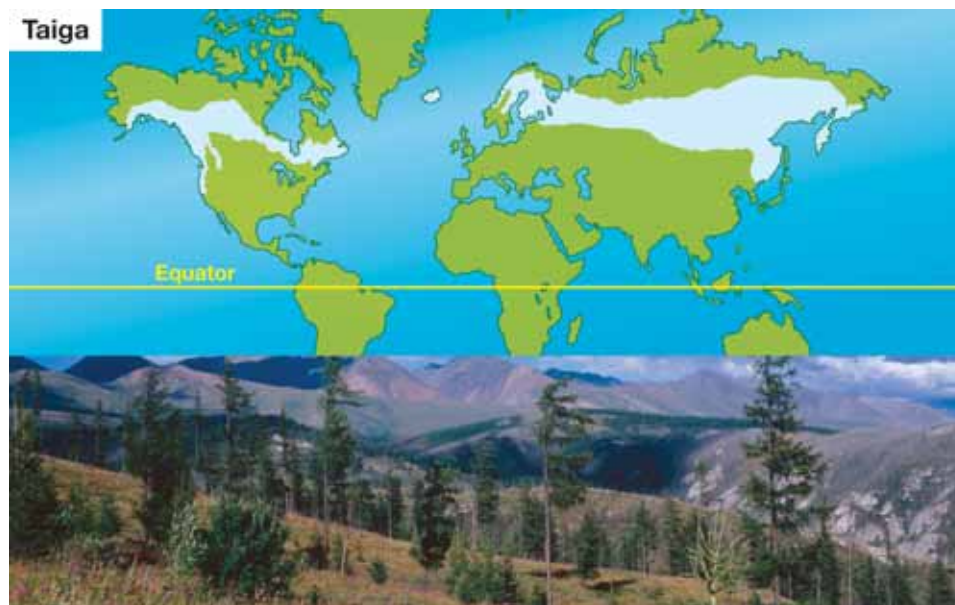


16.4 Taigas and Tundras

In this section, you will learn about the largest and coldest biomes on Earth. The taiga is the largest land biome and the tundra is the coldest.

The taiga

The largest land biome The **taiga**, otherwise known as a boreal or coniferous forest, is the largest land biome. The taiga can be found between the latitudes of 50° and 70° N in North America and Eurasia, including Canada and Russia. The average temperature in the taiga is below freezing for at least six months of the year. This makes it difficult for animals to stay year-round. Some do stay put, some hibernate, and some migrate (Figure 16.17). Annual precipitation averages 40 to 100 centimeters. Much of this falls during the short growing season (approximately 130 days). Summer temperatures rarely reach above 21°C.



VOCABULARY

taiga - the largest climate region, found in the higher latitudes; also known as a boreal or coniferous forest.



Figure 16.17: Taiga animals. Which of these animals might migrate during the freezing months?

Taiga life Evergreen trees with needle-like leaves are the most common type of vegetation found in the taiga, which is the Russian word for forest (Figure 16.18). These include pine, fir, and spruce trees. All of these trees are cone-shaped, which helps them shed snow so its weight doesn't break their branches. The needle shape of the leaves helps prevent moisture loss in the winter. This is important because trees can't take in water from frozen soil. The fact that they don't lose their needles in the fall means that they don't have to waste time in the early spring growing new ones, and can get started on photosynthesis as soon as it is warm enough. The roots of these trees are shallow and spread out wide. This makes it possible for them to take in surface water from melting snow and ice even though much of the ground underneath them is still frozen.

Snow keeps things warm! Did you know that snow is a great insulator? In the taiga biome, a thick layer of snow (often several meters deep) falls before the coldest part of the winter. The air spaces between snow crystals prevent the ground underneath from losing more and more heat as the winter progresses (Figure 16.19).

Surviving the winter in the taiga While air temperatures may be well below 0 °C for weeks on end, the ground temperature will remain right around freezing. Mice and other small mammals make tunnels in the snow that link their burrows and food stashes. The temperature in the burrows remains fairly constant, even when the outside air temperature plummets.



Figure 16.18: *Evergreen trees with needle-like leaves are the most common type of vegetation found in the taiga.*



Figure 16.19: *The air spaces between snow crystals prevent the*



Tundra

Tundra **Tundra** is the coldest biome on Earth. The word tundra comes from a Finnish word for treeless land. There are two types of tundra—Arctic tundra, found in a band around the Arctic Ocean, and alpine tundra, found high in mid-latitude mountains.



Arctic tundra Arctic tundra has a growing season of only 50 to 60 days. The average winter temperature is -34°C . Summer temperatures rarely exceed 12°C . As a result of these cold temperatures, the ground is permanently frozen from 25 centimeters to about 100 centimeters below the surface. This frozen ground is called *permafrost* (Figure 16.20). There is a thin layer of soil above the permafrost that does thaw in summertime, but it is not deep enough to support the growth of trees. Lichens, mosses, grasses, and a few woody shrubs are the most common plants in the Arctic tundra.



ground from losing more and more heat as the winter progresses.



tundra - a climate region located in high latitudes; known as the coldest land biome.

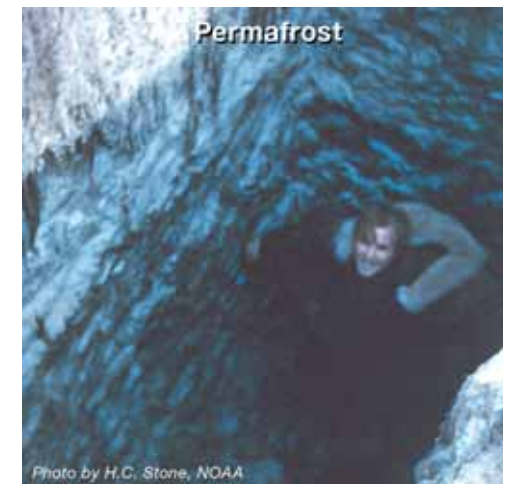


Figure 16.20: This individual is standing in a deep hole cut into permafrost.

Permafrost stores carbon dioxide Permafrost has a very important function on our planet: It stores carbon dioxide. Here's how the process works. Usually, when plants die, they decompose into soil. This process releases carbon dioxide into the air. However, when an Arctic tundra plant dies, the cold temperatures prevent it from rapidly decaying into soil. Instead, at least part of its structure remains intact until it is frozen in the permafrost. In fact, remains of plants 1,000 years old have been found in the permafrost. Since the plant structures don't completely decay, carbon that would have been released into the atmosphere as carbon dioxide stays in the ground. For this reason, permafrost is called a "carbon sink" (Figure 16.21).

Alpine tundra Alpine tundra occurs in middle-latitude regions, but at very high altitudes. Alpine tundra biomes occur in the Andes Mountains in South America, in the Rocky Mountains in North America, and in the Himalayan Mountains. Cold temperatures, windy conditions, and thin soil create an environment where only plants similar to those in the Arctic regions can survive. In rocky alpine regions, lichens and mosses are the dominant plants, but in alpine meadows, grasses and small woody shrubs can be found.



What is a "carbon sink"?

Permafrost is known as a "carbon sink." A sink is an area where more carbon is stored than is released into the atmosphere. Some scientists are concerned that if Earth warms up several degrees, the permafrost will begin to melt. If this happens, the frozen plants would decompose and release carbon dioxide into the air. The permafrost would no longer serve as a "sink." It would become a source of carbon dioxide (a greenhouse gas) in the atmosphere.

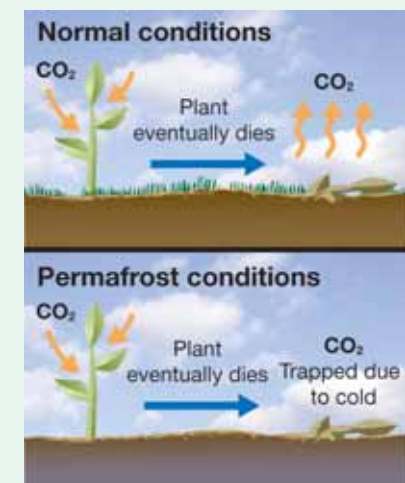


Figure 16.21: *Permafrost is a carbon sink.*



16.4 Section Review

1. Why is it difficult for animals to live in a taiga biome year-round?
2. If you have ever cared for a houseplant, you know that plants need water. Describe how evergreen trees have adapted to obtain enough water to survive in the taiga.
3. Snow is a cold substance, but it can keep the ground from losing heat. How does it do that?
4. The latitude for tundra was not given in the text. What do you think the tundra latitude range would be? Check your answer by researching this information on the Internet.
5. From the list of countries or regions below, list which ones fall in the taiga biome.

a. Antarctica	b. Australia
c. Canada	d. Russia
e. United States	f. Brazil
6. What characteristics would you expect Arctic tundra plants to have?
7. Figure 16.22 shows an Arctic fox in the summer and then in the winter on the tundra. From these photographs, state one way that this animal is adapted to live in this biome.
8. Permafrost is known as a “carbon sink.”
 - a. What is a carbon sink?
 - b. Why is permafrost considered a carbon sink?
 - c. How will global warming affect tundra biomes?



Figure 16.22: *The Arctic fox in the summer (top) and in the winter (bottom).*



Ecological Impact of Forest Fires

What comes to mind when you hear the words “forest fire”? Do you see a fire burning completely out of control? Most of us do imagine raging fires burning vast acres of woods. Unwanted and uncontrollable fires are called wildfires. While it is true that wildfires are not good, it is also true that not all fires in the forest are bad. Some natural fires are healthy for a forest’s plants, trees, and animals. Curiously, smaller and lower-intensity fires serve an important purpose: preventing huge, destructive wildfires.



Humans: friends or foes?

A forest is an ecosystem, or natural grouping of plants, animals, and organisms that live together and share an environment. Scientists study how fire affects the animals, trees, and other plants in the forest ecosystem.

How do forest fires start? In one of two ways, typically: lightning or human interference. The human causes include arson, sparks from brush-clearing equipment, campfires, and smoking.

Efforts to prevent fires have affected the makeup of our national forestland. As a result, human interference has caused larger, more damaging fires. It’s hard to imagine that the results of fire prevention can be so harmful, but when there is a lack of fire, debris accumulates on the forest floor creating fuel. That debris includes pine needles, cones, twigs, branches, plants, and small trees. Too much debris feeds a wildfire, increasing its size and temperature. Fires are no longer confined to the ground and travel up small trees. The burning foliage adds even more fuel. When this happens, trees are killed as a result of the fire’s intensity. The forest and soil are ruined and rendered unable to support new plant growth.

Fires threaten not only plant and animal species but also human life. People are moving into rural areas along forest borders. So now when a wildfire occurs, houses also are at risk. The 2003 Cedar fire in Southern California was the largest in state history. A huge amount of fuel, blowing winds, and drought combined to create intense fires that burned over 280,000 acres, destroyed 2,232 homes, and killed 14 people.



Scientists are learning that some fires benefit the forest ecosystem. Long before human involvement, fires in the wilderness were allowed to burn naturally. Fires cleared the forest floor of dangerous debris. New plants and trees grew, the soil became richer, and food was available for animals. The ecosystems took part in a natural cycle of destruction and regrowth.

One big fire lab: Yellowstone

Yellowstone National Park has an average of 24 fires each year caused by lightning. Over the past 30 years, there have been more than 300 fires sparked by lightning, and they were allowed to burn naturally. When low intensity fires do happen naturally, they help the forest remain healthy.

When there is a fire at Yellowstone, park workers monitor the situation closely. If it is caused by a human, the fire is extinguished immediately. In 1972, the park decided to let most natural fires burn as long as they posed no danger to humans. A great deal has been learned since then. For instance, in 1988 Yellowstone had its driest summer ever, but did not have a record number of fires. While 36 percent of the park was burned by fire, scientists learned even more afterward. Pinecone seeds, plants, and wildflowers grew in the nutrient-rich soil. Birds used the remaining trees to build nests, and insects returned, too. The forest was alive with many plants and animals!

Some trees require fire

There are many trees that can withstand fire or adapt to it. Although lodgepole pines are not resistant to fire, they need fire to open their cones glued shut with resin. Heat melts the resin, opening the cones to release seeds into the soil.

Fire is also important for maintaining the health of redwood trees. These giant trees have bark that is 2 to 4 feet thick. The bark insulates the tree from heat. After a fire, rich soil is formed and Sequoia seeds sprout new plants. Fires thin out the forest, letting in sunlight to help the seedlings grow.



A healthy and vibrant forest ecosystem benefits from fire, which clears debris, allows new plants to grow, provides food for animals, kills diseases, and creates rich soil. Wildfires will always be part of the cycle of life in the forest.

Questions:

1. Why is a fire policy that stops all fires not a good policy?
2. How is fire beneficial to a forest?
3. Describe several fire-resistant or fire-adapted trees.



CHAPTER ACTIVITY

Biome Expedition

Each individual biome is a region of Earth that has a unique set of plants and animals that thrive in its particular climate. In this chapter you have studied the desert, tundra, taiga, temperate deciduous forest, tropical rainforest, and grassland. Each biome is equipped with a unique set of characteristics and harsh conditions, which you have studied. For instance, the desert is extraordinarily dry, and creatures that live there must have special adaptations to deal with a lack of water.

Could you survive for three days with one suitcase worth of equipment and no shelter? You must plan carefully because it is likely that you would need different equipment to survive in the tundra than to survive in the tropical rainforest. Your challenge is to survive in one of these biomes for three days and two nights. The most important thing you can do to survive is to pack the proper equipment. Good luck on your expedition!

What you will do

You will be working in groups for this activity

1. Your teacher will assign the biome and the season for which you are packing.
2. Make a list of the most difficult obstacles you are going to face during the 3 days and 2 nights you will be in the biome. Remember you have no food or shelter provided for you, but for this exercise, imagine your biome expedition suitcase is big enough to fit any equipment you want to bring.
3. Based on the list of harsh conditions in the biome, discuss with your group what equipment you absolutely need to bring on the expedition.
4. Choose the five most important pieces of equipment to bring with you in order to survive in the biome for a few days.

5. Now, you and your group mates will share the contents of your biome expedition suitcase with your class. Do not tell your classmates why you are bringing each item, simply tell them what you are bringing.
6. When you are done with your presentation, allow your classmate to guess for which biome and season you packed. How did your classmates do? Did they guess correctly?

Reflection

Write a paragraph reflecting on the items you chose for your trip. Are there any items you would exchange or add to your suitcase? Are there any items you would remove?



Chapter 16 Assessment

Vocabulary

Select the correct term to complete the sentences

biome	taiga
deserts	tundra
temperate deciduous forests	tropical rainforests
grasslands	

Sections 16.1, 16.2, and 16.3

- _____ are characterized by a cover of various grasses, and a dry climate.
 - An area can only be considered a _____ if it receives less than 35 cm of rain a year.
 - A _____ is a large region of Earth that has a unique set of plants and animals that thrive in its climate.
 - _____ are found in middle-latitude regions and have four distinct seasons.
 - Another name for a boreal or coniferous forest is _____.
 - Although _____ cover less than 6 percent of Earth's land, half of all of the animal and plant species in the world live in this biome.
 - Permafrost is found in this extremely cold biome: _____
- Read the following paragraph and explain the role Earth and the Sun are playing in this phenomenon:
In the northern hemisphere, we often associate "going south" with "getting warm." Birds, for example, fly south for the winter. States in the American South and Southwest are known as the sunbelt states. But in the southern hemisphere, the opposite is true. Birds fly north for the winter. The warmest part of Australia is the northern section.
 - If you live near a coastline, would you expect your weather to be milder or more extreme than if you lived far away from the coast? Explain your answer.
 - You can expect to find tundra in the high northern latitudes of the northern hemisphere. Where would you expect to find a tundra ecosystem on a mountain?
 - Explain why plants and animals that are unique to a particular continent can play extremely similar roles as other kinds of plants and animals in similar environments elsewhere.
 - A plant that lives in the desert most likely has the following characteristics.
 - A deep root system to get groundwater deep within the ground.
 - A shallow, sprawling root system to collect any/all of the rain that falls to the ground.
 - Thick leaves to help the plant deal with dry conditions.
 - All of the above

Concepts

Section 16.1

- The _____ in a region depends on latitude, precipitation, elevation, topography and the distance from large bodies of water.
- Explain how latitude, humidity and sunlight play a role in defining a biome.

Section 16.2

- Why do deserts have large variations in daily high and low temperatures?
- Why does Yakima, Washington have relatively little rainfall each year?

10. How is a temperate grassland like a savanna? How are these two types of grasslands different?
11. What role do termites play in a savanna biome?

Section 16.3

12. How many seasons are there in temperate deciduous forests?
13. If you were to visit a tropical rainforest, what could you expect to happen each afternoon? Why?
14. Why doesn't the temperature of a tropical rainforest change very much?
15. Why is so much area of the tropical rainforest destroyed each year?
16. Where are temperate rainforests found?

Section 16.4

17. Contrast a deciduous (broad-leaf) tree of a temperate deciduous forest with an evergreen tree in a taiga.
18. List the adaptations that evergreen trees have to help them survive the extreme conditions of the winter in the taiga.
19. In the chapter you learned that snow can keep the ground warm. Explain how this cold-weather stuff keeps things warm!
20. _____ is ground that is permanently frozen from 25 cm to about 100 cm below the surface in the tundra.
21. Arctic tundra has a growing season of _____
 - a. 6 months
 - b. 50-60 days
 - c. 20-30 days
 - d. 4 months
22. What is the difference between alpine and arctic tundra?

23. Describe the difference in the length of days during the summer compared to the winter in the arctic tundra. What accounts for this difference?

Math and Writing Skills

Section 16.1

1. Explain why the average yearly temperature at the North Pole is -18°C while the average yearly temperature at the equator is 27°C .
2. Study the following map showing population density and the Earth's biomes map from the chapter (Section 16.1).



Courtesy of NASA, NRCS, USDA

- a. Which biomes have the most densely populated areas according to the maps?
- b. Which biomes have the least densely populated areas according to the maps?



- c. Propose an explanation as to why different biomes or world areas have such vastly different population densities.
 - d. Did any of the data surprise you? Why or why not?
3. Answer these questions using the Earth's biome map:
 - a. What biome is located at 60°N and 100°E?
 - b. What biome is located at 0° and 60°W?
 - c. What biome is located at 40°N and 80°W?
 - d. Give the latitude and longitude for a grassland biome on the map.
 - e. Give the latitude and longitude for a desert biome on the map.

Section 16.2

4. Pick one of the types of grasslands listed in Figure 16.10 and research it using the Internet or your library.
 - a. What is the main type of vegetation in this grassland?
 - b. What kinds of animals live in this grassland?
 - c. List one or more adaptations that animals have to live in this biome?

Section 16.3

5. Writing from a point of view:
 - a. People that inhabit the tropical rainforest are destroying it at an extremely fast rate. Write a paragraph that justifies why this is being done.
 - b. Cutting down the rain forest has ecological consequences. What are these consequences? Write a paragraph that explains why the tropical rainforest should not be cut down.
6. Explain the connection between tropical rainforests, and greenhouse gases and global warming?

Section 16.4

7. Use this table to answer the questions below.

Biome	Temperature range	
	Low temp (°C)	High Temp (°C)
Tropical rainforest	20	25
Tundra	-34	12

- a. Which biome has the biggest range of temperature?
 - b. Which biome gets the warmest?
 - c. Which biome gets the coldest?
 - d. Using the data above, construct a bar graph that shows the average high temperatures and the average low temperatures for the rainforest compared to the tundra.
8. Antarctica is a special place on Earth. It is the coldest place and gets little or no rainfall making it a very cold desert! Research Antarctica and describe this unique biome in terms of its rainfall, temperature, and plant and animal life.

Chapter Project—People and Places

People live in biomes along with plants and animals. Pick a biome that interests you. Find out about the types of people that have lived in this biome long before cars, electricity, and the Internet. It is possible that ancestors of these people still live in this biome! Answer these questions:

1. How did these people survive in this biome?
2. What did these people do to find food?
3. What kinds of shelters did these people build to protect themselves?
4. What kinds of customs did these people have?