Chapter 3

Communities and Biomes

What You'll Learn

- You will identify factors that limit the existence of species to certain areas.
- You will describe how and why different communities form.
- You will compare and contrast biomes of Earth.

Why It's Important

Life on Earth is found in communities made up of different species. To understand life on Earth, it is important to know about the variations, tolerances, and adaptations of plants and animals in these communities.

Understanding the Photo

Marsh grasses, birds, a supply of water rich in food resources, and a clear blue sky. This community in the Chesapeake Bay is a small example of the elements that make up larger ecosystems, called biomes, that make up the living world. Not every biome has these particular organisms or conditions. Organisms that make up communities in other biomes will reflect the climate and latitude of that part of the world.

Breck P. Kent/Earth Scenes

Biology Online

Visit bdol.glencoe.com to

- study the entire chapter online
- access Web Links for more information and activities on communities and biomes
- review content with the Interactive Tutor and self-check quizzes

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Section 3.2

Biomes

SECTION PREVIEW

Objectives

Compare and contrast the photic and aphotic zones of marine biomes.

Identify the major limiting factors affecting distribution of terrestrial biomes.

Distinguish among biomes.

Review Vocabulary

biosphere: the portion of Earth that supports life (p. 36)

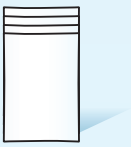
New Vocabulary

biome
photic zone
aphotic zone
estuary
intertidal zone
plankton
tundra
taiga
desert
grassland
temperate/deciduous forest
tropical rain forest

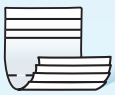
FOLDABLES Study Organizer

Biomes Make the following Foldable to help you understand the nature of terrestrial biomes.

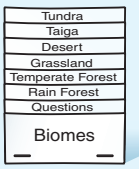
STEP 1 **Collect** 4 sheets of paper and layer them about 1.5 cm apart vertically. Keep the edges level.



STEP 2 **Fold** up the bottom edges of the paper to form 8 equal tabs.



STEP 3 **Fold** the papers and crease well to hold the tabs in place. Staple along the fold. **Label** each tab as shown.



Identify and Describe Before you read Section 3.2, label each tab with the name of a terrestrial biome. Label the final tab "Questions" and list questions you would like to have answered. As you read, describe the biomes on your Foldable and answer your questions.

What is a biome?

Ecosystems that reach similar climax communities can be grouped into a broader category called a biome. A **biome** is a large group of ecosystems that share the same type of climax community. There are terrestrial biomes and aquatic biomes, each with organisms adapted to the conditions characteristic of the biome. Biomes located on land are called terrestrial biomes. Organisms such as the cardon cactus shown here, populate terrestrial desert biomes. Oceans, lakes, streams, ponds, or other bodies of water are aquatic biomes.

Aquatic Biomes

As a human who lives on land, you may think of Earth as a terrestrial planet. But one look at a globe, a world map, or a photograph of Earth taken from space tells you there is an aquatic world, too. Approximately 75 percent of Earth's surface is covered with water. Most of that water is salty. Oceans, seas, and even some inland lakes contain salt water. Freshwater is confined to rivers, streams, ponds, and most lakes. Saltwater and freshwater environments have important differences. As a result, aquatic biomes are separated into marine biomes and freshwater biomes.

Cardon cactus

Tom Bean/DRK Photo

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Figure 3.5
Because estuaries provide an abundant supply of food and shelter, many fishes, clams, and commercially important shrimp live there while young. Many then move out of the estuary and into the ocean as they reach adulthood.
Analyze ***How does the movement of these organisms show an interaction with their environment?***

Marine biomes

Different parts of the ocean differ in abiotic factors (salinity, depth, availability of light, and temperature) and biotic factors found there. The oceans contain a large amount of biomass, or living material. Most of this biomass is made up of extremely small, often microscopic, organisms that humans usually don't see but that large marine animals, such as baleen whales, depend upon.

One of the ways ecologists study marine biomes is to make separate observations in shallow, sunlit zones (photic zones) and deeper, unlighted zones (aphotic zones). The portion of the marine biome that is shallow enough for sunlight to penetrate is called the **photic zone.** Shallow marine environments exist along the coastlines of most landmasses on Earth. These coastal ecosystems include bays, rocky shores, sandy beaches, mudflats, and estuaries. Coral reefs also are located in shallow water in warmer parts of the ocean. All are part of the photic zone. Deeper water that never receives sunlight makes up the **aphotic zone.** The aphotic zone includes the deepest, least explored areas of the ocean.

Estuaries—Mixed waters

If you were to follow the course of a river, you would, in most cases, reach a sea or ocean. Wherever rivers join oceans, freshwater mixes with salt water. In many such places, an estuary forms. An **estuary** (ES chuh wer ee) is a coastal body of water, partially surrounded by land, in which freshwater and salt water mix.

The salinity, or amount of salt, in an estuary ranges between that of seawater and that of freshwater, and depends on how much freshwater the river brings into the estuary. Salinity in the estuary also changes with the tide and so a wide range of organisms can live in estuaries. Estuaries, as illustrated in ***Figure 3.5,*** may contain salt marsh ecosystems, which are dominated by salt-tolerant smooth cordgrass, salt marsh hay, or eelgrasses. These grasses can grow so thick that their stems and roots form a tangled mat that traps food material and provides a "nursery" habitat for small developing snails, crabs, and shrimp. These organisms feed on decaying, suspended materials. In turn, these small organisms attract a wide range of predators, including birds.

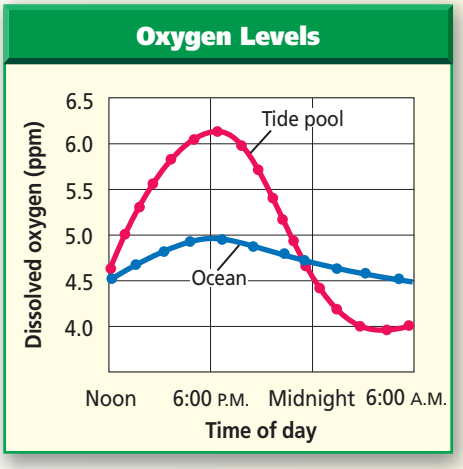
Physical Science Connection

Salinity and density of a solution Water that contains dissolved salts is denser than pure water. As the concentration of dissolved salts increases, the density of the solution increases. Because seawater is denser than freshwater, seawater tends to enter an estuary along the bottom.

Problem-Solving Lab 3.2

Analyze Information

How does oxygen vary in a tide pool?
Tide pools are depressions along rocky coasts that are covered by ocean water during high tide. During low tide, these tide pools become temporarily cut off from ocean water.



Solve the Problem

The graph shows results from tests of water samples taken in a tide pool and in the surrounding ocean. A scientist measured oxygen levels in ppm (parts per million). Both the ocean and tide pool have the same producer present, a green algae called *Cladophora.*

Thinking Critically

1. **Analyze Trends from Data** What can you tell about how the experiment was done using only the *x*- and *y*-axis information?
2. **Conclude** What is the importance of the green algae?
3. **Make Inferences from Data** What specific information was learned as a result of the experiment?

With the help of bacteria, decay of dead organisms proceeds quickly in an estuary and nutrients are released. Nutrients are recycled through the food web and as a result, microorganisms help maintain equilibrium.

The effects of tides

Daily, the gravitational pull of the sun and moon causes the rise and fall of ocean tides. The portion of the shoreline that lies between the high and low tide lines is called the **intertidal zone.** The size of this zone depends upon the slope of the land and the difference between the high and low tides. Intertidal ecosystems have high levels of sunlight, nutrients, and oxygen.

Tide pools, pools of water left when the water is at low tide, can isolate the organisms that live in the intertidal zone until the next high tide. Therefore, these areas can vary in nutrient and oxygen levels from one time of day to another. Compare and contrast oxygen content between tide pools and the ocean in the *Problem-Solving Lab* on this page.

Intertidal zones differ in rockiness and wave action. ***Figure 3.6*** shows a rocky intertidal zone. If the shore is rocky, waves constantly threaten to wash organisms into deeper water. Many intertidal animals, such as snails and sea stars, have adaptations that act by suction to hold onto wave-beaten rocks. Other animals, such as barnacles, secrete a strong glue that helps them remain anchored. If the shore is sandy, wave action keeps the bottom in constant motion.

Figure 3.6
Waves crashing against a rocky shore are a limiting factor for organisms in the intertidal zone.

Norbert Wu/Peter Arnold, Inc.

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Clams, worms, snails, crabs, and other organisms that live along sandy shores survive by burrowing into the sand.

In the light

As you move into deeper water, the ocean bottom is less affected by waves or tides. Thousands of organisms live in this shallow-water region. Nutrients washed from the land by rainfall and runoff contribute to the abundant life and high productivity of this region of the photic zone.

The photic zone of the marine biome also includes the vast expanse of open ocean that covers most of Earth's surface. Most of the organisms that live in the marine biome are plankton. **Plankton** are small organisms that drift and float in the waters of the photic zone. They include autotrophs, diatoms, eggs, and the juvenile stages of many marine animals. Plankton are important because they form the base of all aquatic food chains. Not all organisms that eat plankton are small. Baleen whales and whale sharks, some of the largest organisms that have ever lived, consume vast amounts of plankton. Examine plankton in the *MiniLab* shown here.

In the dark

Imagine a darkness blacker than night and pressure so intense it exerts hundreds of pounds of weight on every square centimeter of your body's surface. These are the conditions deep in the ocean where light does not penetrate. Much of the ocean is more than a kilometer deep. The animals living there are far below the photic zone where plankton abound. Many of them still depend on plankton for food, either directly, or indirectly, by eating organisms that feed on plankton.

MiniLab 3.2

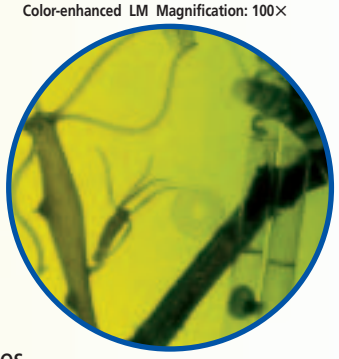
Compare and Contrast

Marine Plankton Plankton is the term used to define the floating protists, animal eggs and larvae present in an aquatic environment.

Procedure

1. Use a dropper to obtain a small sample of marine plankton.
2. Prepare a wet mount of the material. **CAUTION:** ***Handle microscope slides and coverslips carefully.***
3. Observe under low-power magnification of the microscope.
4. Look for a variety of organisms and diagram several different types. **CAUTION:** ***Wash hands with soap at the end of the lab.***

Color-enhanced LM Magnification: 100×



Marine plankton

Analysis

1. **Observe** Describe and draw two specific planktonic organisms. Identify some common characteristics.
2. **Distinguish** Are both autotrophs and heterotrophs present? How can you distinguish them?
3. **Explain Interactions in a Food Chain** Why are plankton important in food chains?

Freshwater biomes

Have you ever gone swimming or boating in a lake or pond? If so, you may have noticed different kinds of plants, such as cattails, growing around the shoreline and into the water. The shallow water in which these plants grow serves as home for tadpoles, aquatic insects, turtles that bask on rocks and fallen tree trunks, and worms and crayfishes that burrow into the muddy bottom. Insect larvae, whirligig beetles, dragonflies, and fishes such as minnows, bluegill, and carp also live here and are each part of the local food chain.

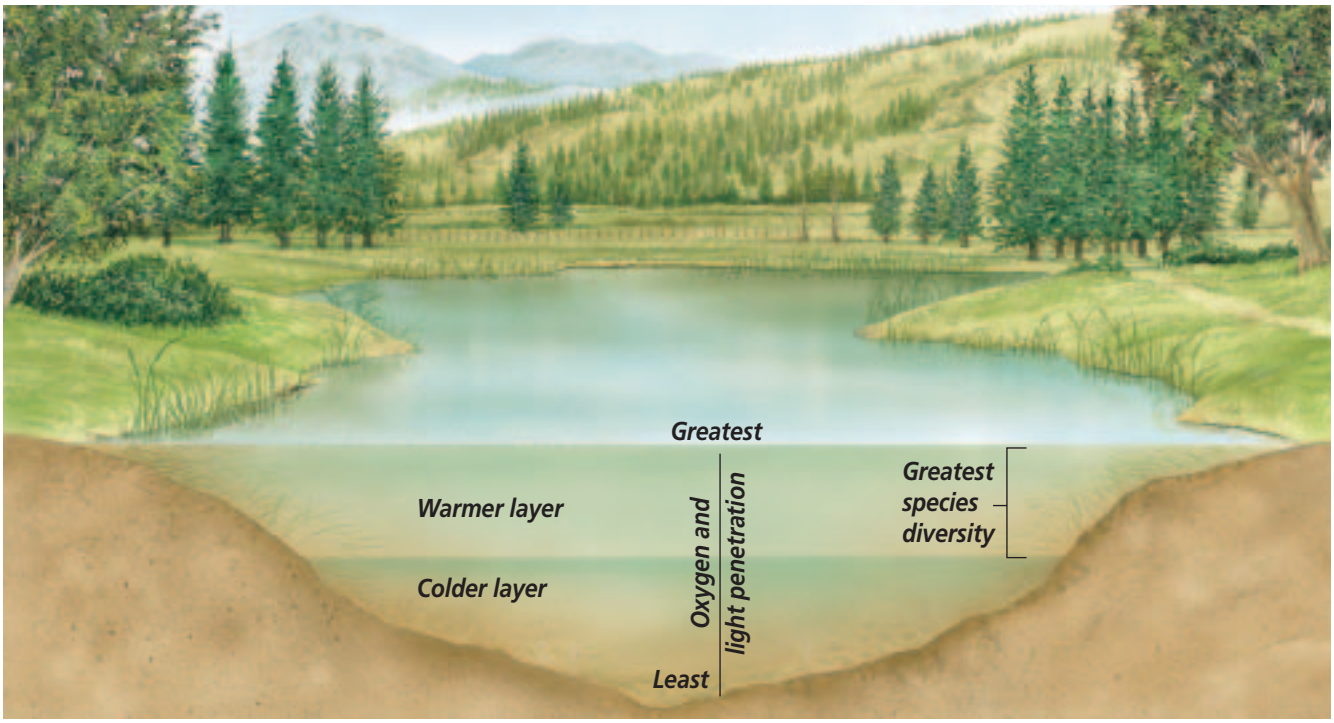


Figure 3.7
The shallow waters in this lake are exposed to sunlight. They are warmer and contain more oxygen, which can make these areas more productive than deeper, colder, more oxygen-poor layers.

Although the spring and summer sun heats the surface of a lake like the one in ***Figure 3.7***, the water a few feet below the surface remains cold. Cold water is more dense than warm water. If you were to dive all the way to the bottom of the lake, you would discover layers of increasingly colder water as you descended. These temperature variations within a lake are an abiotic factor that limits the kinds of organisms that can survive in deep lakes.

Another abiotic factor that limits life in deep lakes is light. Not enough sunlight penetrates to the bottom to support photosynthesis, so few aquatic plants or algae grow. As a result, population density is lower in deeper waters. As dead organisms drift to the bottom, bacteria break them down and recycle the nutrients. Decay takes place more slowly at the bottom of a deep lake.

Other aquatic biomes

Other places where land and water meet are called wetlands, but there are several different kinds of wetlands. Swamps have trees. Marshes do not, but both usually have water flowing through them. Marshes are found inland and in coastal regions. Both are highly productive and are the source of food for many migratory birds and other animals. Other wetland areas, called bogs, get their water supply from rain. Water does not flow through bogs.

Terrestrial Biomes

If you are setting off on an expedition beginning at the north pole and traveling south to the equator, what kinds of environmental changes do you expect to experience and why? The weather gets warmer, and you see a change in the sizes, numbers, and kinds of plants that cover the ground. At the polar cap, temperatures are always freezing and no plants exist. A little farther south, where temperatures sometimes rise above freezing but the soil never thaws completely, you would be attacked by hordes of mosquitoes and black flies. You'd see soggy ground with lichens and low-growing cushion plants.

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As you continue on your journey, temperatures rise a little and you enter forests of coniferous trees. Then there are deciduous forests, with moderate rainfall and temperatures. Farther on are grasslands and deserts, with high summertime temperatures and very little rain. Finally, as you approach the equator, you find yourself surrounded by the lush growth of a tropical forest, where it rains almost every day.

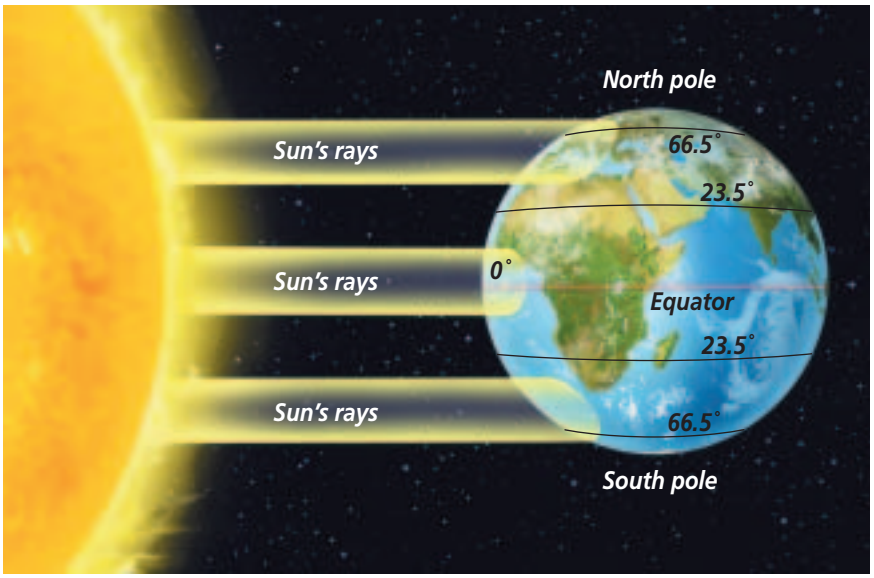

Figure 3.8
Because of Earth's curved surface, the sun's rays strike the equator more directly than areas toward the north or south poles.

Latitude and climate

What caused the changes that you experienced as you moved south from the north pole to the equator? As you traveled, you were changing latitude. Latitude describes your position in degrees north and south of the equator. Look at ***Figure 3.8.*** At different latitudes, the sun strikes Earth differently. As a result, the climate—wind, cloud cover, temperature, humidity and precipitation in that area—are different. Latitude and climate are abiotic factors that affect what plants and animals will survive in a given area. The graph in ***Figure 3.9*** shows how two abiotic factors—temperature and precipitation—influence the kind of climax community that develops. Small differences in temperature or precipitation can create different biomes. Look at the distribution of the six most common terrestrial biomes on pages 1062 and 1063 in the *Focus On*.

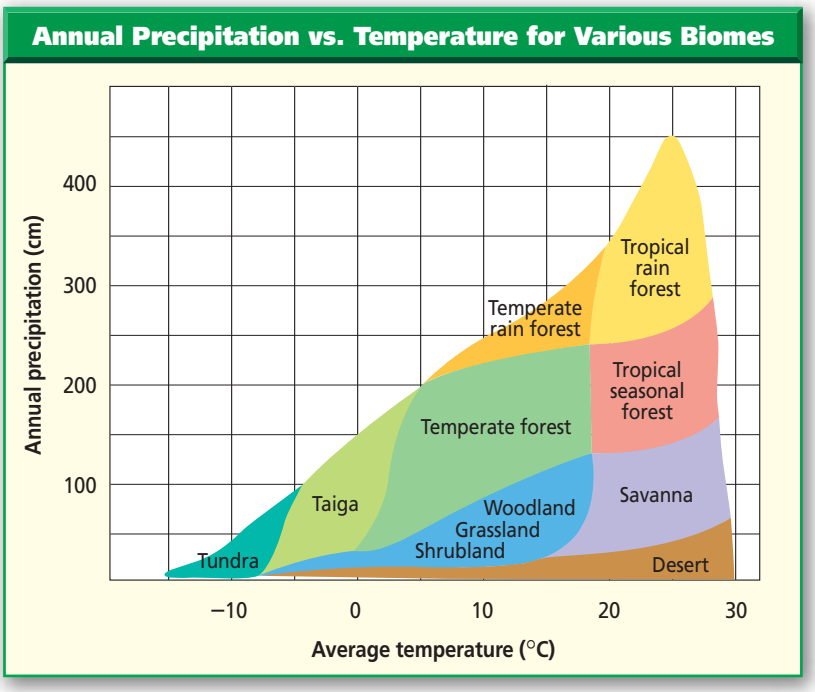

Figure 3.9
If you know the average annual temperature and rate of precipitation of a particular area, you should be able to determine the climax community that will develop. **Interpret Scientific Illustrations** ***In what biome does annual rainfall exceed 400 cm?***

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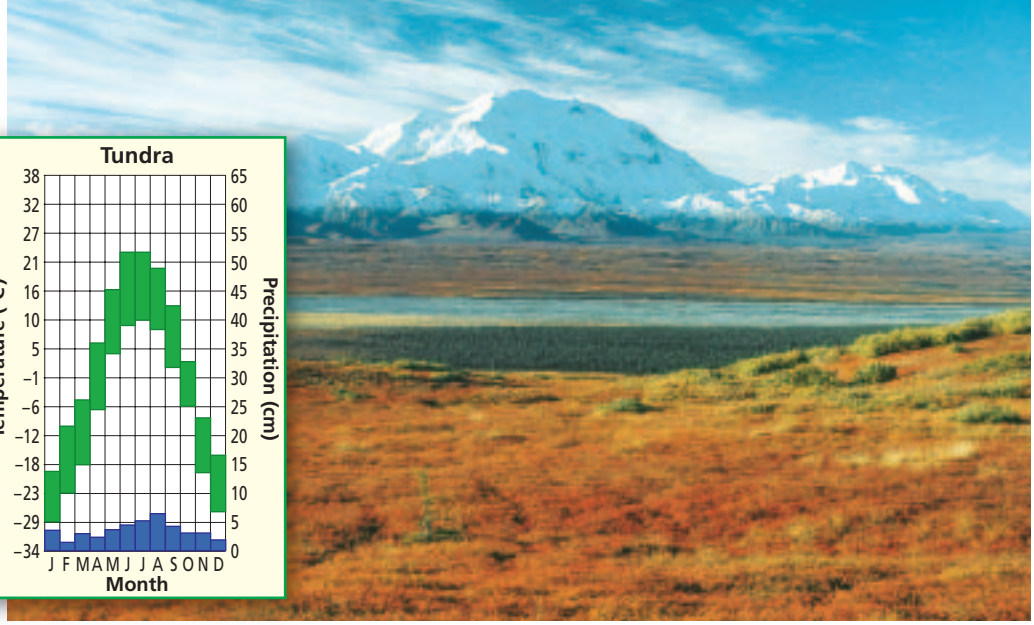


Figure 3.10
Grasses, grasslike sedges, small annuals, and reindeer moss, a type of lichen on which reindeer feed, are the most numerous producers of the tundra. The growing season may last fewer than 60 days.

Life on the tundra

As you begin traveling south from the north pole, you reach the first of two biomes that circle the north pole. This first area is the **tundra** (TUN druh), a treeless land with long summer days and short periods of winter sunlight.

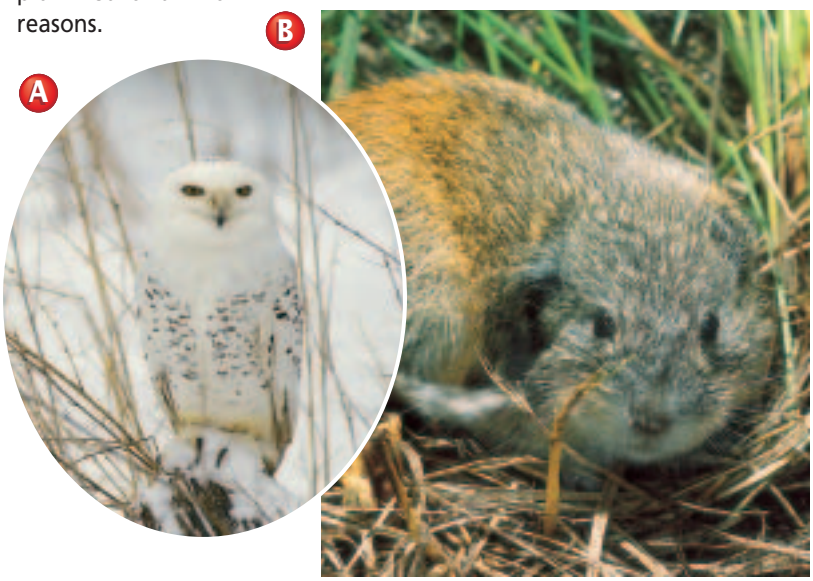
Because of its latitude, temperatures in the tundra never rise above freezing for long, and only the topmost layer of soil thaws during the summer. Underneath this top layer is a layer of permanently frozen ground called permafrost.

In most areas of the tundra, the topsoil is so thin that it can support only shallow-rooted grasses and other small plants. The soil is lacking in nutrients. The process of decay is slow due to the cold temperatures and, as a result, nutrients are not recycled quickly. Lack of nutrients limits the types of organisms the tundra can support.

Summer days on the tundra may be long, but the growing season is short. Because all food chains depend on the producers of the community, the short growing season limits the type of plants found in this biome shown in ***Figure 3.10***, to grasses, dwarf shrubs, and cushion plants. These organisms live a long time and are resistant to drought and cold.

Hordes of mosquitoes and blackflies are some of the most common tundra insects during the short summer. The tundra also is home to a variety of small mammals, including ratlike lemmings, weasels, arctic foxes, snowshoe hares, and even birds such as snowy owls and hawks. Musk oxen, caribou, and reindeer are among the few large animals that migrate into the area and graze during the summer months. ***Figure 3.11*** shows two common tundra animals.

Figure 3.11
Snowy owls **(A)** are predators of the lemming **(B)** in the tundra. Populations of lemmings rise to exceedingly high numbers periodically and then plummet for unknown reasons.



Reading Check **Explain** why the tundra is treeless.

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Life on the taiga

Just south of the tundra lies another biome that circles the north pole. The **taiga** (TI guh) also is called the boreal or northern coniferous forest. The taiga, shown in ***Figure 3.12,*** forms an almost continuous belt of coniferous trees worldwide. Common trees are larch, fir, hemlock, and spruce trees.

How can you tell when you leave the tundra and enter the taiga? The line between these two biomes can be indistinct, and one can blend into the other. For example, if the soil in the taiga is waterlogged, a peat swamp habitat develops that looks much like tundra. Because of their latitude, taiga communities usually are somewhat warmer and wetter than tundra. However, the prevailing climatic conditions are still harsh, with long, severe winters and short, mild summers.

In the taiga, which stretches across much of Canada, Northern Europe, and Asia, permafrost is usually absent. The topsoil, which develops slowly from decaying coniferous needles, is acidic and poor in minerals. When fire or logging disrupt the taiga community, the first trees to recolonize the land may be birch, aspen, or other deciduous species because the new soil conditions are within their ranges of tolerance. The abundance of trees in the taiga provides more food and shelter for animals than the tundra. More large species of animals are found in the taiga as compared with the tundra. ***Figure 3.13*** shows some animals of the taiga. Others include weasels, red squirrels, voles, elk, red deer, and moose, along with a variety of migratory birds.

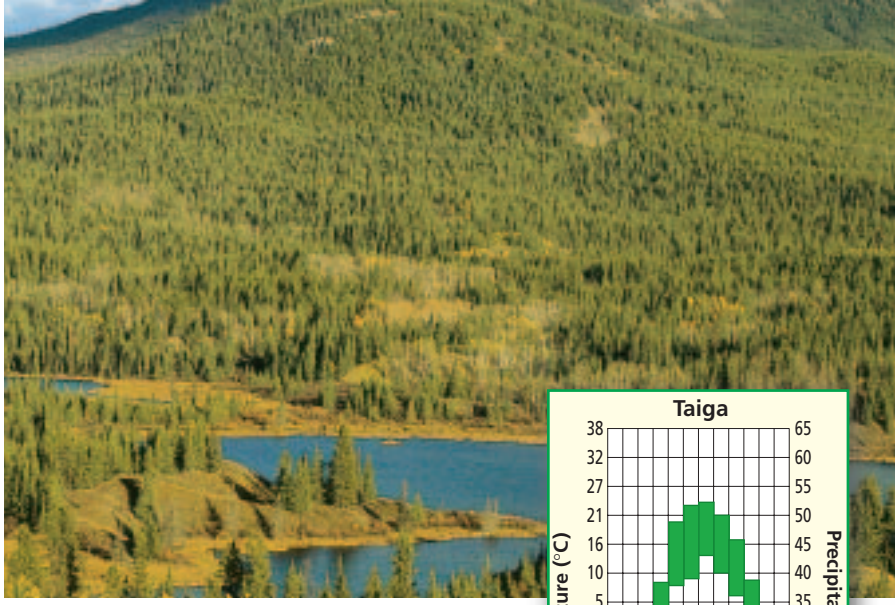

Figure 3.12
The dominant climax plants of the taiga in North America are primarily fir and spruce trees. **Evaluate Data** ***What is the range of temperature in the taiga?***

Figure 3.13
Taiga animals are adapted for cold temperatures.

A The lynx is a predator that depends on the snowshoe hare as a primary source of food.

B During the winter, the snowshoe hare grows a thick, white coat with extra hair on its feet.

C Caribou are large, herbivorous, migrating mammals. Herds of them spend spring and summer on the tundra and the rest of the year in the taiga.

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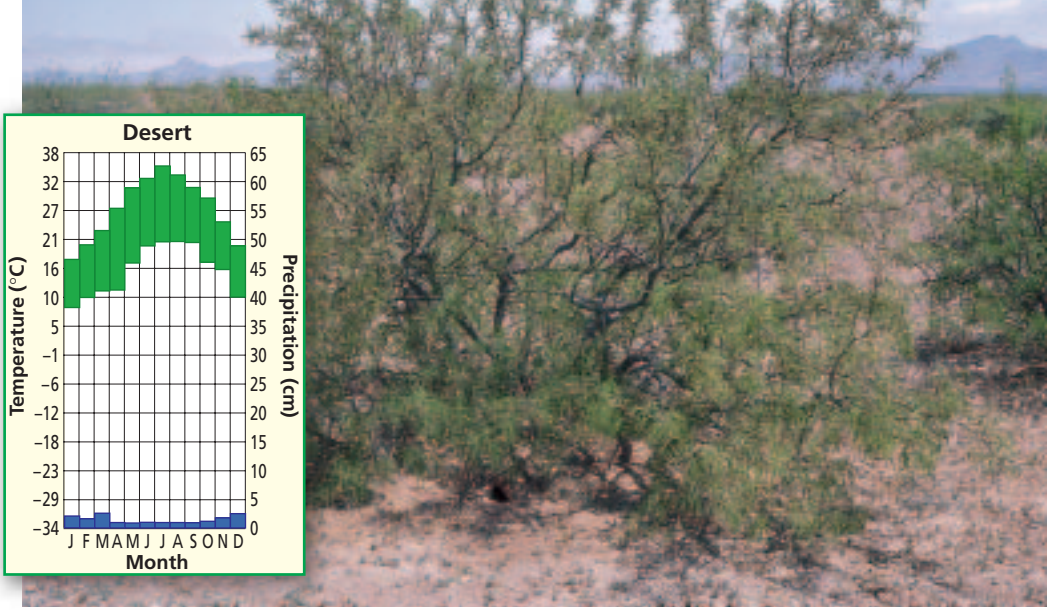

Figure 3.14
Creosote bushes cover many square kilometers of desert in the southwestern United States. These plants are adapted with small leaves containing a substance that deters herbivores from feeding on them.

Life in the desert

The driest biome is the desert biome. A **desert** is an arid region with sparse to almost nonexistent plant life. Deserts usually get less than 25 cm of precipitation annually. One desert, the Atacama Desert in Chile, is the world's driest place. This desert receives an annual rainfall of less than 0.004 inches because it is in the rain shadow of the Andes.

With rainfall as the major limiting factor, vegetation in deserts varies greatly. Areas that receive more rainfall produce a shrub community that may include drought-resistant trees such as mesquite. Less rainfall results in scattered plant life and produces an environment with large areas of bare ground. The driest deserts are drifting sand dunes. Plants such as the creosote (KREE uh soht) bush shown in ***Figure 3.14*** have various adaptations for living in arid areas. Many desert plants are annuals that germinate from seed and grow to maturity quickly after sporadic rainfall. Cacti have leaves reduced to spines, photosynthetic stems, and thick waxy coatings—all adaptations that conserve water. The leaves of some desert plants curl up, or even drop off altogether, thus reducing water loss during extremely dry spells. Spines, thorns, or poisons also are adaptations thought to discourage herbivores.

Many desert mammals are small herbivores that remain under cover during the heat of the day, emerging at night to forage on plants. The kangaroo rat is a desert herbivore that does not have to drink water. These rodents obtain the water they need from the water content in their food. Coyotes, hawks, owls, and roadrunners are carnivores that feed on the snakes, lizards, and small mammals of the desert. Scorpions are an example of a desert carnivore that uses venom to capture prey. Two of the many reptiles that make the desert their home are shown in ***Figure 3.15***.

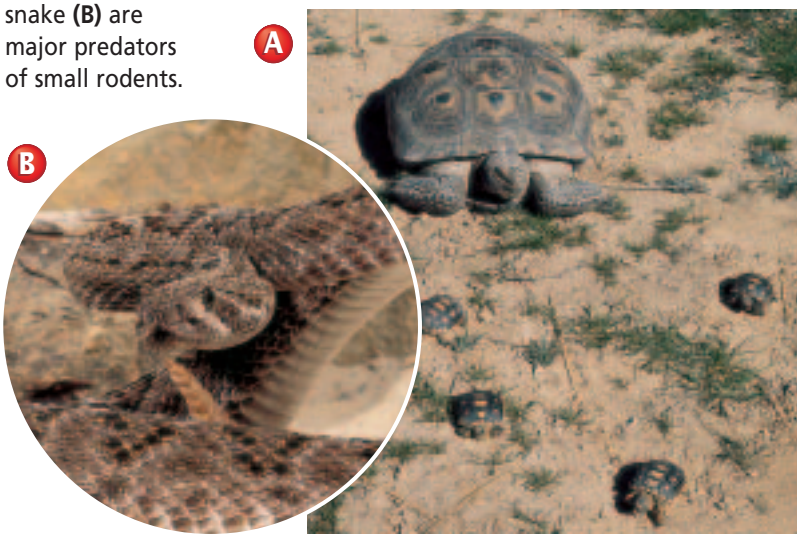

Figure 3.15
Desert tortoises **(A)** feed on insects and plants. Venomous snakes such as the diamondback rattlesnake **(B)** are major predators of small rodents.

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Life in the grassland

If an area receives between 25 and 75 cm of precipitation annually, a grassland usually forms. **Grasslands** are large communities covered with rich soil, grasses, and similar plants. Grasslands, such as the ones shown in ***Figure 3.16,*** occur principally in climates that experience a dry season, where insufficient water exists to support forests.

Grasslands contain few trees per hectare, though larger numbers of trees usually are found near streams and other water sources. This biome has a higher biological diversity than deserts, often having more than 50 species per hectare.

The soils of grasslands have considerable humus content because many grasses die off each winter, leaving byproducts to decay and build up in the soil. Grass roots survive through the winter, enlarging every year to form a continuous underground mat called sod.

Some grasslands are ideal for growing cereal grains such as oats, rye, and wheat. Each of these is a different species of grass; therefore, grasslands are known as the breadbaskets of the world. Many other plant species live in this environment, including drought-resistant and late-summer flowering species of wildflowers, such as blazing stars and sunflowers.

At certain times of the year, many grasslands are populated by herds of grazing animals. Bison, a species of mammal shown in ***Figure 3.16A,*** once ranged over the American prairie, but are now found only in small pockets of rangeland. Other important prairie animals include jack rabbits, deer, elk, and prairie dogs. Prairie dogs are seed-eating rodents that build underground "towns" that are known to stretch mile after mile under the grassland. Foxes and ferrets prey on prairie dogs. Many species of insects, birds, and reptiles, also make their homes in grasslands.

The term *prairie* is used in Australia, Canada, and the United States. Similar communities are called *steppes* in Russia, *savannas* in Africa, and *pampas* in Argentina. Grasslands in the United States can be found in the central and southwestern states.

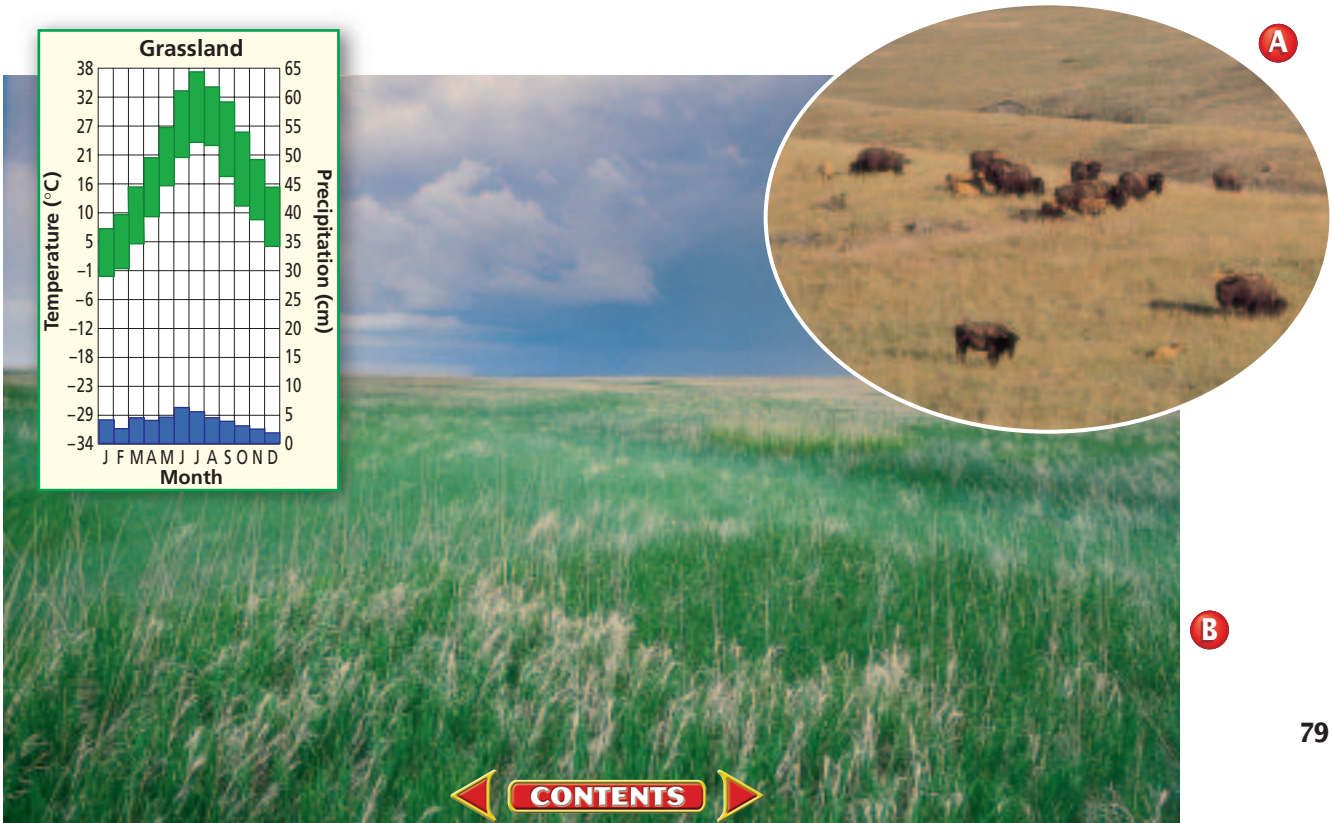

Figure 3.16
The prairies of America support bison as well as many species of large mammals, birds, and insects **(A).** Summers are hot, winters are cold, and rainfall is often uncertain in a temperate grassland **(B).**

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Figure 3.17
There are many types of temperate forests, each characterized by two or three dominant species of trees. Typical trees of the temperate forest include birch, hickory, oak, beech, and maple.

(t)Barbara Cushman Rowell/DRK Photo

Life in the temperate forest

When precipitation ranges from about 70 to 150 cm annually in the temperate zone, temperate deciduous forests, like the one in ***Figure 3.17***, develop. **Temperate** or **deciduous forests** are dominated by broad-leaved hardwood trees that lose their foliage annually. Examples of these trees include maple, oak, birch, elm, and ash.

European settlers cleared vast tracts of temperate forest for farmland and lumber. Since then, secondary succession has restored much of the original forest, especially in the eastern United States.

The soil of temperate forests usually consists of a top layer that is rich in humus and a deeper layer of clay. If mineral nutrients released by the decay of the humus are not immediately absorbed by the roots of the living trees, they may be washed into the clay and lost from the food web for many years.

The animals that live in the temperate deciduous forest, as shown in ***Figure 3.18***, include squirrels, mice, rabbits, deer, and bears. Many birds, such as bluejays, live in the forest all year long, whereas other birds migrate seasonally.

Figure 3.18
Black bears are residents of temperate forests in the United States. Other abundant animals in temperate forests are squirrels and salamanders.

(bl)Jeff Lepore/Photo Researchers , (bc)M.H. Sharp/Photo Researchers, (br)Joe McDonald/Visuals Unlimited

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Life in rain forests

Rain forests are home to more species of organisms than any other biome on Earth. There are two types of rain forests in the world—the temperate rain forest and the more widely known tropical rain forest shown in ***Figure 3.19***. Both are identified by extensive amounts of moisture supplied by rainfall or by coastal clouds and fog. Temperate rain forests are found on the Olympic Peninsula in Washington state and in other places throughout the world, such as South America, New Zealand, and Australia. The huge number of species in rain forests has made their protection an important objective.

As their name implies, **tropical rain forests** have warm temperatures, wet weather, and lush plant growth. These forests are warm because they are near the equator. The average temperature is about 25°C. They are moist because wind patterns drop a lot of precipitation on them. Rain forests receive at least 200 cm of rain annually; some rain forests receive 600 cm.

Why do tropical rain forests contain so many species? The following hypotheses have been proposed by ecologists:

1. Due to their location near the equator, tropical rain forests were not covered with ice during the last ice age. Thus, the communities of species had more time to evolve and greater biodiversity exists.
2. Unlike the temperate forests—where deciduous trees drop their leaves in autumn—the warm weather near the equator gives tropical rain forest plants year-round growing conditions. This creates a greater food supply in tropical rain forests, which can support larger numbers of organisms.
3. Tropical rain forests provide a multitude of habitats and niches for diverse organisms.

One reason for the large number of niches in rain forests is vertical layering. How are these layers, or stories, arranged? Find out by studying ***Figure 3.20*** on the next page. From top to bottom, the three major stories are the *canopy*, *understory*, and *ground* layers. The layers often blend together, but their differences allow many organisms to find a niche.

Most of the nutrients in a tropical rain forest are tied up in the living material. There are very few nutrients held in the soil and most are quickly recycled through complex food webs. The hot humid climate enables ants, termites, fungi, bacteria, and other decomposers to break down dead plants and animals rapidly. Plants must quickly absorb these nutrients before they are carried away from the soil by rain.

Tropical rain forest habitats support a wide variety of plants and animals. This makes them the most species-rich places on Earth.

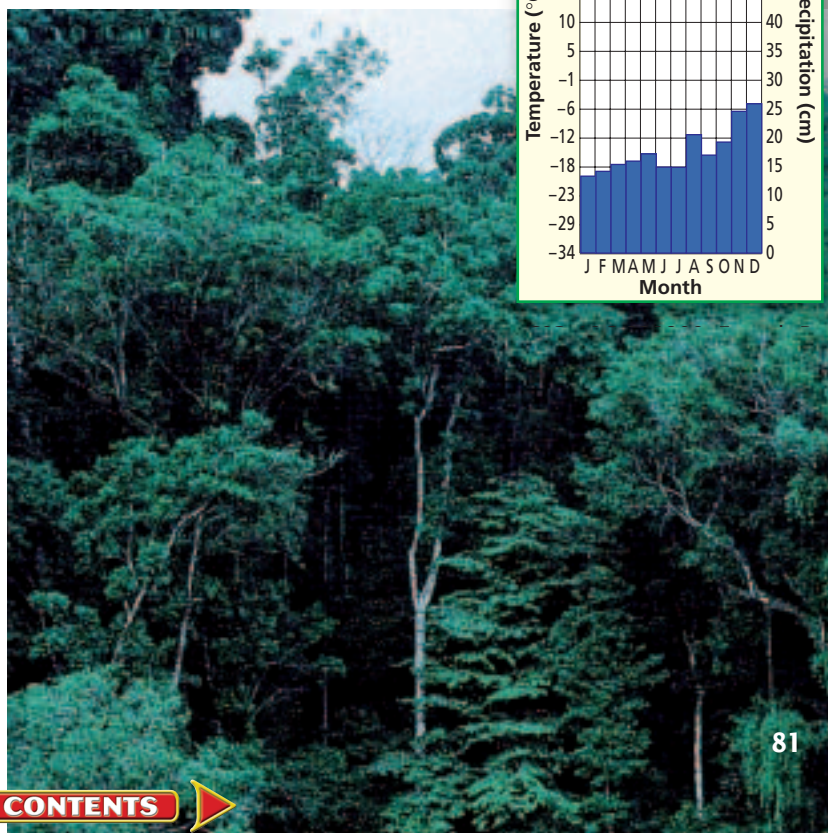

Figure 3.19
Warm temperatures, high humidity, and abundant rainfall allow the growth and great species diversity found in rain forests.

Gregory G. Dimijian/Photo Researchers

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INSIDE STORY

A Tropical Rain Forest

Figure 3.20

In the layers of a tropical rain forest are niches for thousands of species of plants and animals. Ecologists generally consider rain forests to have a storied structure. The illustration shows organisms in a Central American tropical rain forest. **Critical Thinking** ***Research plants and animals in the tropical rain forest. Analyze relationships among organisms. Analyze the interactions that might occur between organisms in the different stories.***

A Canopy The canopy layer, 25–45 meters high, is a living roof. The tree tops are exposed to rain, sunlight, and strong winds. A few giant trees called emergents poke through the canopy. Monkeys frequently pass through. Birds, such as scarlet macaws, live on the fruits and nuts of the trees.

B Understory In the understory, the air is still, humid, and dark. Vines grow from the soil to the canopy. Leaf cutter ants harvest leaves and bring them to the ground. Plants include ferns, broad-leaved shrubs, and dwarf palms. Insects are common in the understory. The limbs of the trees are hung with a thick layer of epiphytes, plants that get most of their moisture from the air. Birds and bats prey upon the insects. Tree frogs are common understory amphibians. Reptiles include chameleons and snakes.

C Ground The ground layer is a moist forest floor. Leaves and other organic materials decay quickly. Roots spread throughout the top 18 inches of soil. There is great competition for nutrients. Mammals living on the ground include rodents and cats, such as the jaguar. Ants, termites, earthworms, bacteria, and fungi live in the soil and quickly decompose organic materials.

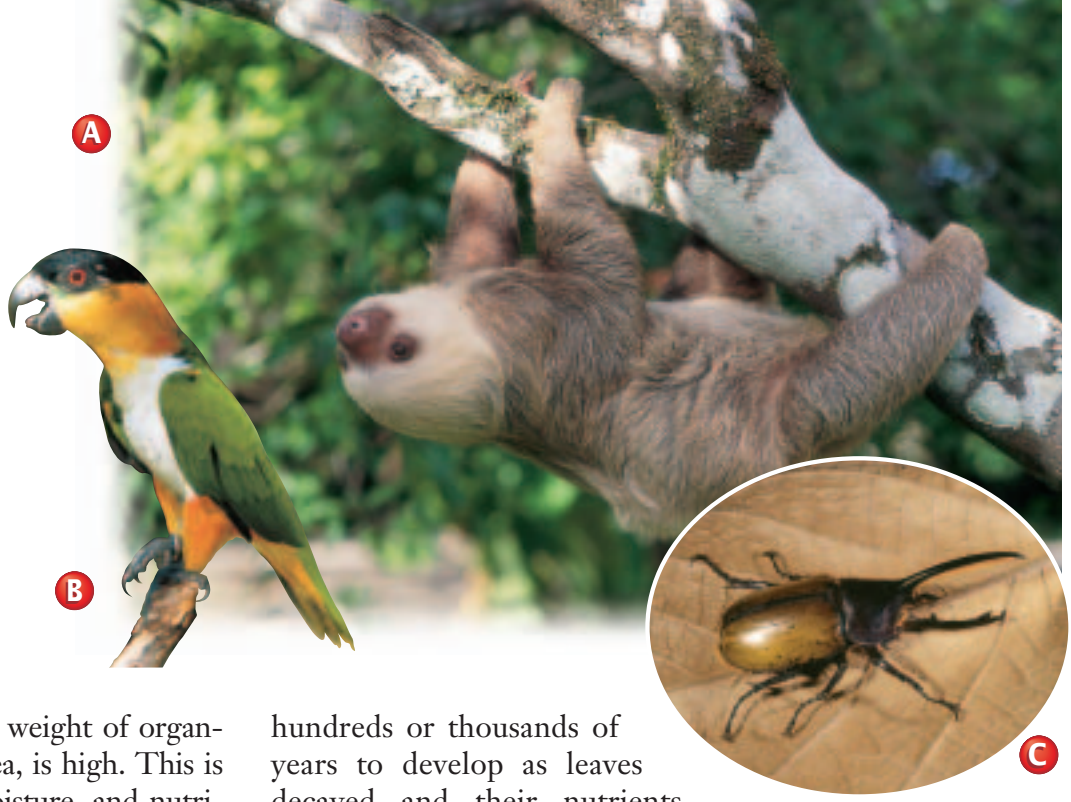

Figure 3.21
Tropical rain forests are rich ecosystems. Sloths **(A)** and other mammals, as well as a multitude of bird species like this black-headed caique **(B),** live in the rain forest canopy. Insects, such as this Hercules beetle **(C),** are numerous in the understory.

Biomass, the total weight of organisms living in the area, is high. This is because sunlight, moisture, and nutrients are available in abundance for plants to convert light energy to chemical energy. This energy is used by the plants and passed to consumers, such as those pictured in ***Figure 3.21.***

Some rain forest plants are important sources of medicinal products and hardwood trees and have provided a source of income for people. Agricultural land is not common in rain forests. The soil there does not convert to cropland easily. In temperate deciduous forests, topsoil has taken hundreds or thousands of years to develop as leaves decayed and their nutrients became part of the soil. In contrast, soils in rain forests do not have substantial amounts of organic matter because leaf matter, which contains nutrients, disappears so quickly. Without organic matter, once rain forest soil is exposed and farmed, it becomes hard, almost brick-like, and nutrient-poor in a matter of a few years. Research is underway to find out how people can manage these lands so that they will be able to obtain the food and products they need.

Section Assessment

Understanding Main Ideas

1. Explain how organisms in the photic and aphotic zones are interdependent.
2. Describe the role of bacteria in maintaining healthy ecosystems. Give examples of where bacteria act in ecosystems.
3. Explain the interactions that take place in a tropical rain forest by describing two or more food chains that you would find there. Then show how these food chains might be part of a larger food web.
4. Describe three variations you would observe as you travel south from a taiga into a temperate forest.
5. Compare the biodiversity of the temperate forest biome with the tropical forest biome.

Thinking Critically

6. In reading before a family trip, George found that the area they were traveling to was cold in winter, hot in summer, and most of the land was planted in fields of wheat. Infer which biome George's family would visit. Explain your choice.

Skill Review

7. **Get the Big Picture** Make a table to show the climate, plant types, plant adaptations, animal types, and animal adaptations for the terrestrial biomes. For more help, refer to *Get the Big Picture* in the **Skill Handbook.**

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