

Forest Biomes

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 the most diverse. The large trees of forests need a lot of water, so forests exist where temperatures are mild to hot and where rainfall is plentiful. Tropical, temperate, and coniferous forests are the three main forest biomes of the world.

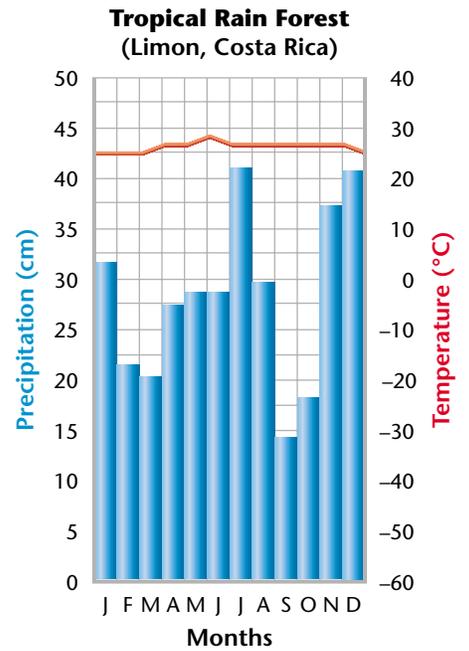
Tropical rain forests are located in a belt around the Earth near the equator, as shown in **Figure 5**. They help regulate world climate and play vital roles in the nitrogen, oxygen, and carbon cycles. Tropical rain forests are always humid and warm and get about 200 to 450 cm of rain a year. Because 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. Rapid decay of plants and animals occurs with the help of decomposers, organisms that break down dead organisms. Decomposers on the rain-forest floor break down dead organisms and return nutrients to the soil, but plants quickly absorb the nutrients. Some trees in the tropical rain forest support fungi that feed on dead organic matter on the rain-forest floor. In this relationship, fungi transfer the nutrients from the dead organic matter directly to the tree. Nutrients from dead organic matter are removed so efficiently that runoff from rain forests is often as pure 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 extra support to the tree in the thin soil.

Figure 5 ▶ The world’s tropical rain forests have heavy, year-round rainfall and fairly constant, warm temperatures.

▶ The rain forests that blanket the Andes Mountains of Ecuador are always humid and warm.

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

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



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



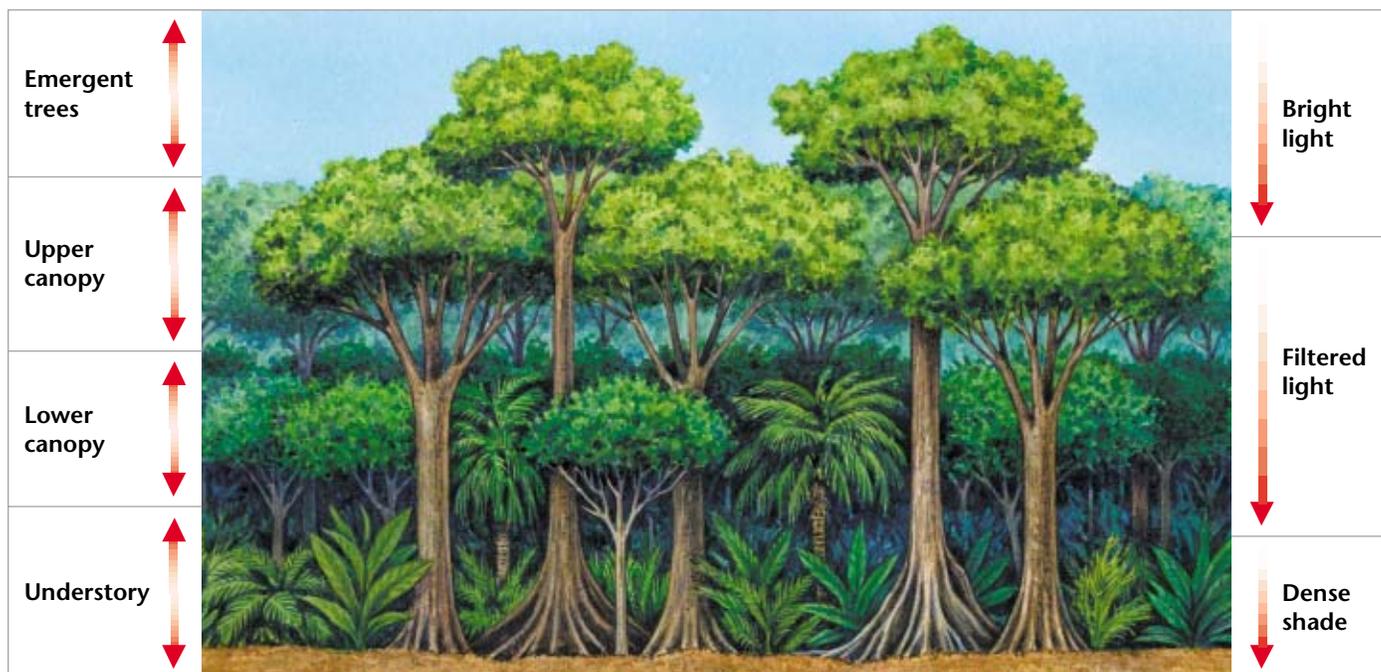


Figure 7 ► The plants in tropical rain forests form distinct layers. The plants in each layer are adapted to a particular level of light. The taller trees absorb the most light, while the plants near the forest floor are adapted to growing in the shade.

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. The trunks of trees this tall can measure up to 5 m around. Trees in the emergent layer grow and emerge into direct sunlight. Animals such as eagles, bats, monkeys, and snakes live in the emergent layer.

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 and 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 adapted to shade grow in the understory. Most plants in the understory do not grow more than 3.5 m tall. Herbs with large, flat leaves that grow on the forest floor capture the small amount of sunlight that penetrates the understory. These plants must be able to grow in the darker spots. When fallen trees create an opening in the canopy, tree seedlings that are adapted to grow quickly compete with other seedlings on the forest floor for sunlight.

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 to avoid competition. 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 and 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 1 the long tongue of a collared anteater, 2 the strong, curved beak of a wreathed hornbill, 3 the shape of a Costa Rican mantis, and 4 an orchid attached to a tall tree.



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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. If the habitat that an organism depends on is destroyed, the organism is at risk of disappearing.

Animals and plants are not the only organisms that live in rain forests. An estimated 50 million native peoples live in tropical rain forests. These native peoples are also threatened by habitat destruction. Because they obtain nearly everything they need from the forest, the loss of their habitat could be devastating. This loss of habitat may force them to leave their homes and move into cities. This drastic change of lifestyle may also cause the native peoples to lose their culture and traditions along the way.

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.

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 five 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. So, 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.

flows freely down the river and spreads across fields and into towns during the seasonal monsoon rains.

Deforestation has also caused terrible floods in places such as Bangladesh. The Ganges River rises 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 Olympic Mountains, a large amount of rainfall is produced. This 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

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.

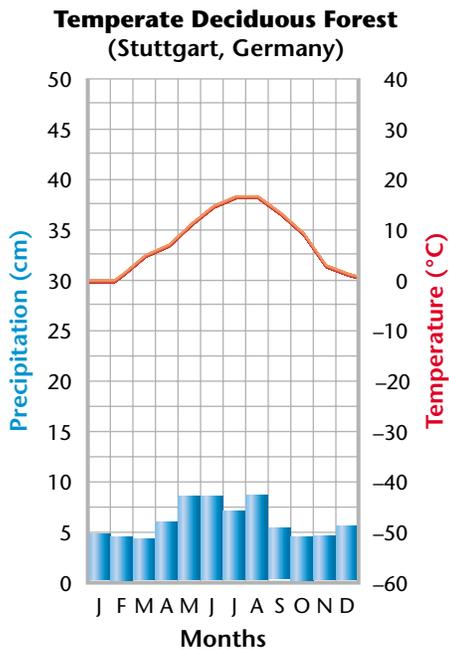
CRITICAL THINKING

1. Identifying Relationships

How might the floods 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.



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.

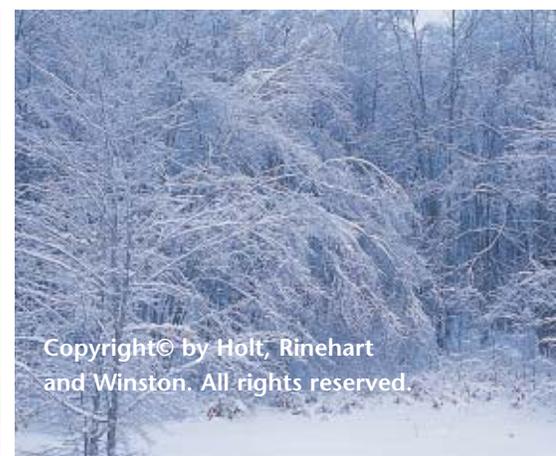
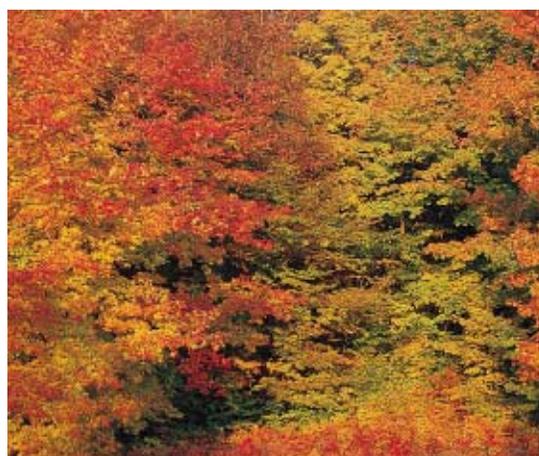
In **temperate deciduous forests**, trees drop their broad, flat leaves each fall. These forests once dominated vast regions of the Earth, including parts of North America, Europe, and Asia. Today, temperate deciduous forests are generally located between 30° and 50° north latitude, as shown in Figure 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. Temperatures vary due to a change of seasons, as shown in Figure 11. Temperate deciduous forests are moist. They receive 75 to 125 cm of precipitation annually. The rain and snow help decompose dead organic matter, such as fallen leaves, which in turn contributes to the rich, deep soils of temperate deciduous forests.

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 forest floor in a deciduous forest gets more light than that of a rain forest does, more plants such as ferns, herbs, and mosses grow in a deciduous forest.

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.



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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. Also, herb seeds, bulbs, and rhizomes, which are underground stems, become dormant in the ground and are insulated by the soil, leaf litter, and snow. In the spring, when sunlight increases and temperatures rise, 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 forest plants. Grasshoppers, such as the one shown in **Figure 12**, eat almost all types of vegetation found throughout the forest, while 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 the birds cannot survive the harsh winters, each fall they fly south for warmer weather and for 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, mammals and insects reduce their activity so that they do not need as much food for energy.

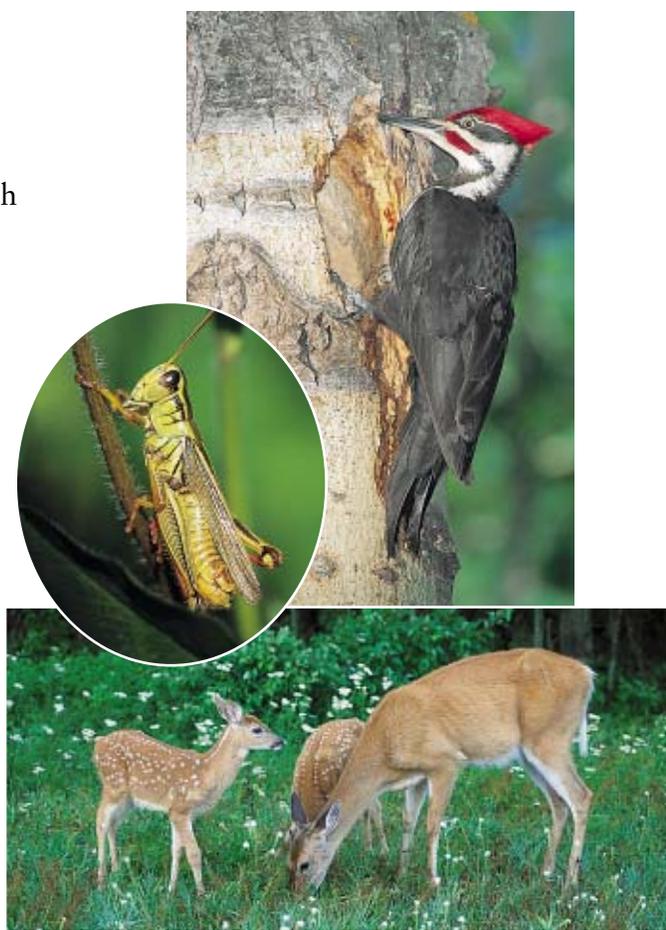


Figure 12 ▶ Grasshoppers, woodpeckers, and deer are among many animals that live in the temperate deciduous forest.

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 that often fall to -20°C . In the taiga, the forest floor is dark and has little vegetation. Many trees seem like straight, dead shafts of bark and wood—until you look up and see their green tops. The growing season in the taiga may be as short as 50 days depending on latitude. Plant growth is most abundant during the summer months because of nearly constant daylight and larger amounts of precipitation.

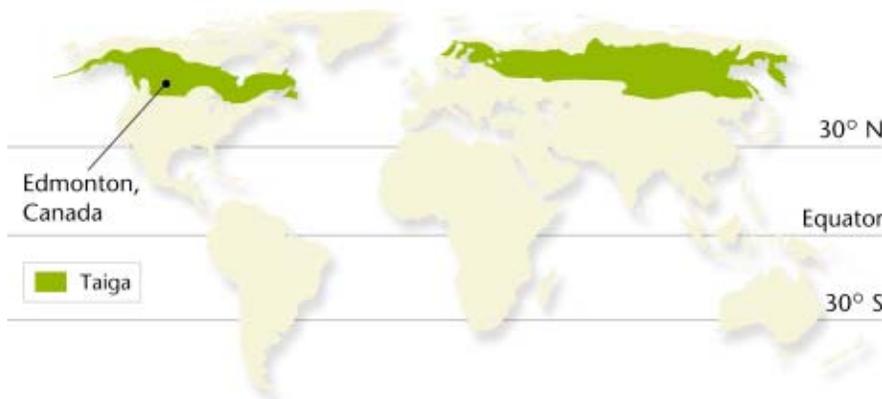


Figure 13 ▶ The taiga has long, cold winters and small amounts of precipitation, as shown in the climatogram below.

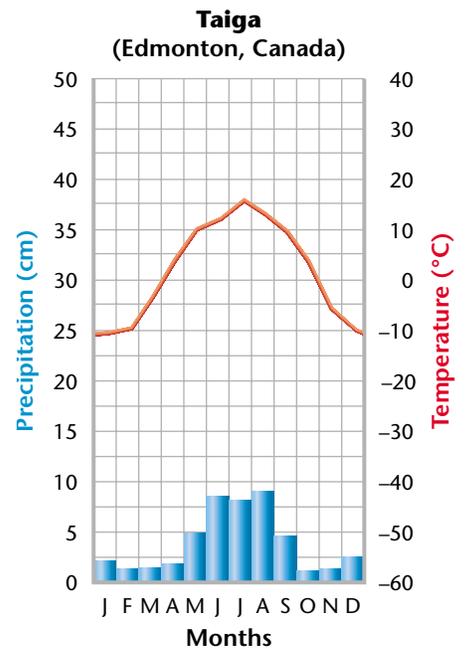




Figure 14 ▶ The taiga has cold winter temperatures, a small amount of annual precipitation, and coniferous trees. The seeds of conifers are protected inside tough cones like the one above. Also, the narrow shape and waxy coating of conifer needles help the tree retain water.

Plants of the Taiga A *conifer* is a tree that has seeds that develop in cones. Most conifers do not shed their needle-shaped leaves, which help them survive harsh winters. The leaves' narrow shape and waxy coating retain water for the tree when the moisture in the ground is frozen. As shown in **Figure 14**, a conifer's pointed shape also helps the tree shed snow to the ground so that it does not become weighed down.

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 insects, fish, or other aquatic organisms. Many birds migrate south to avoid winter in the taiga. Some year-round residents, such as shrews and rodents, may burrow underground during the winter, because the deep snow cover insulates the ground. Moose and snowshoe hares eat any vegetation they can find. 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

- List** three characteristics of tropical rain forests.
- Name** the main layers of a tropical rain forest. What kinds of plants grow in each layer?
- Describe** two ways in which the forest biomes of the world are being threatened.
- 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

- 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.
- 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?