

GLENCOE

BIOLOGY

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CHAPTER 3 SAMPLER

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Quick Start Guide
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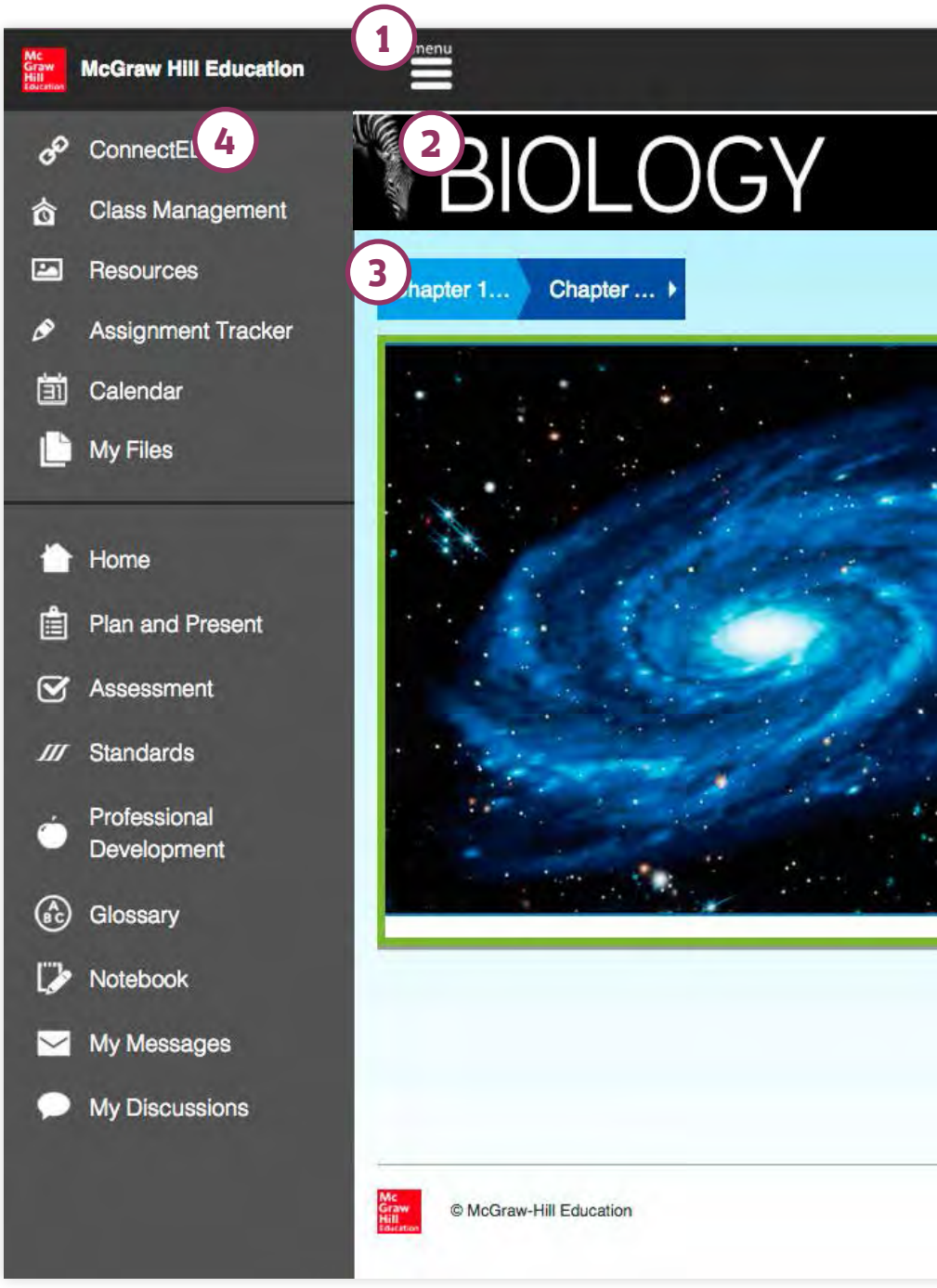
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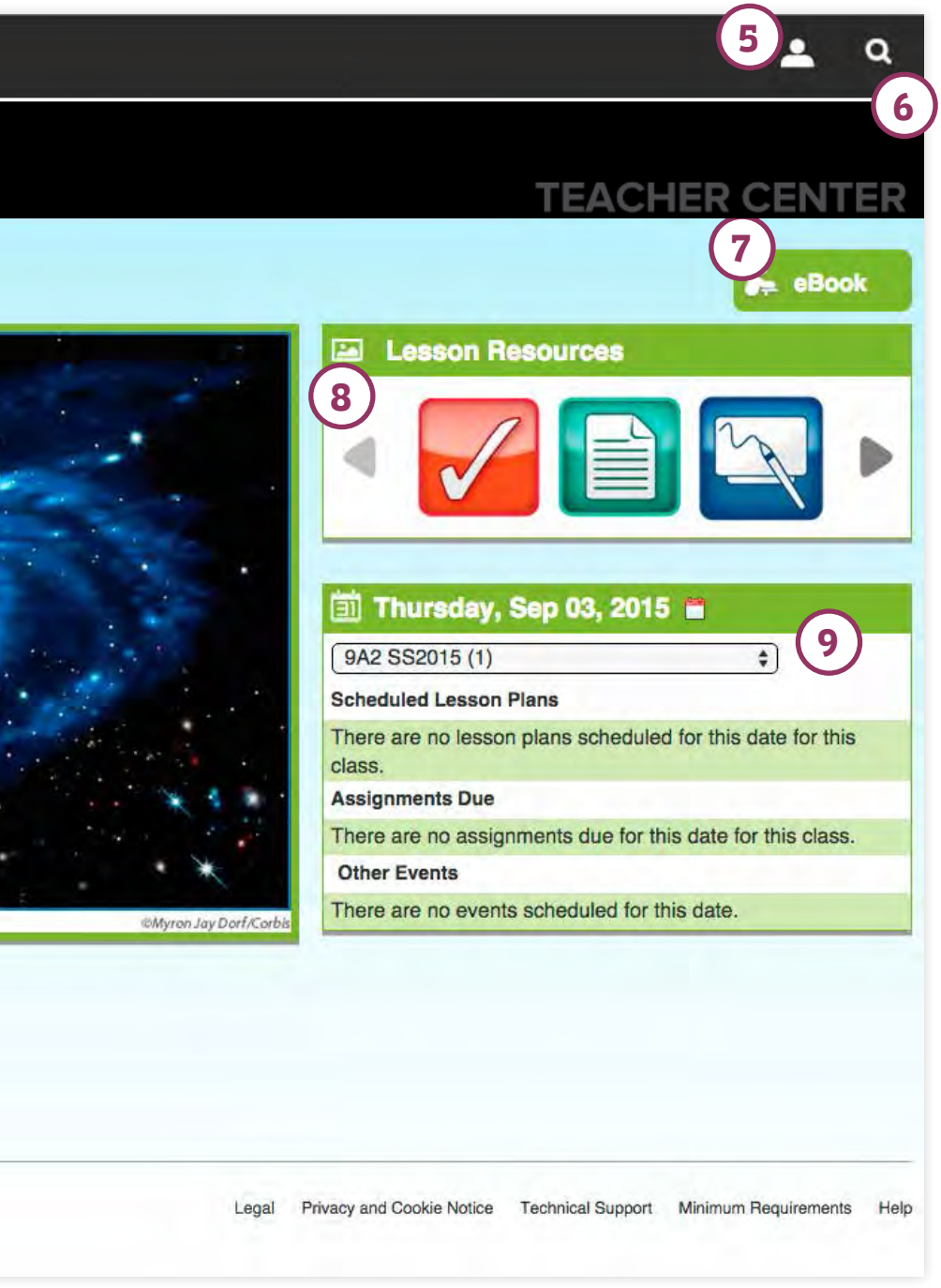
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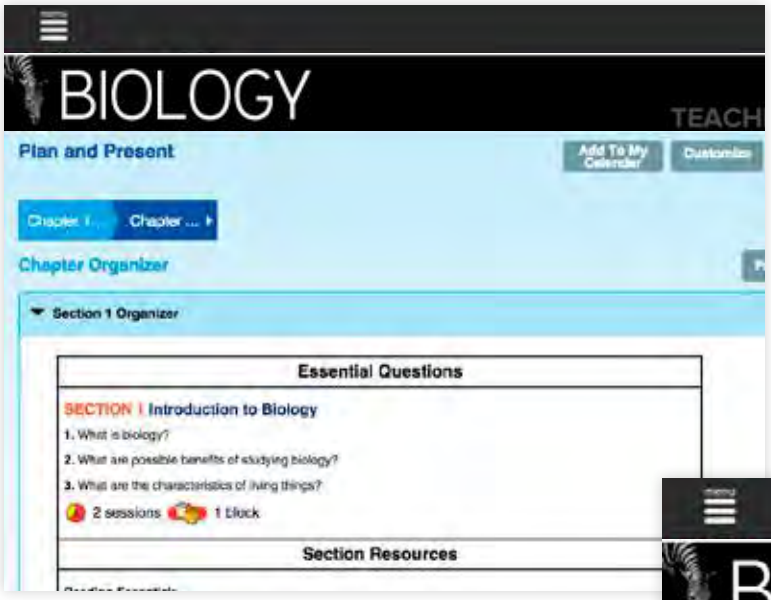
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- Science and Engineering Practices Handbook
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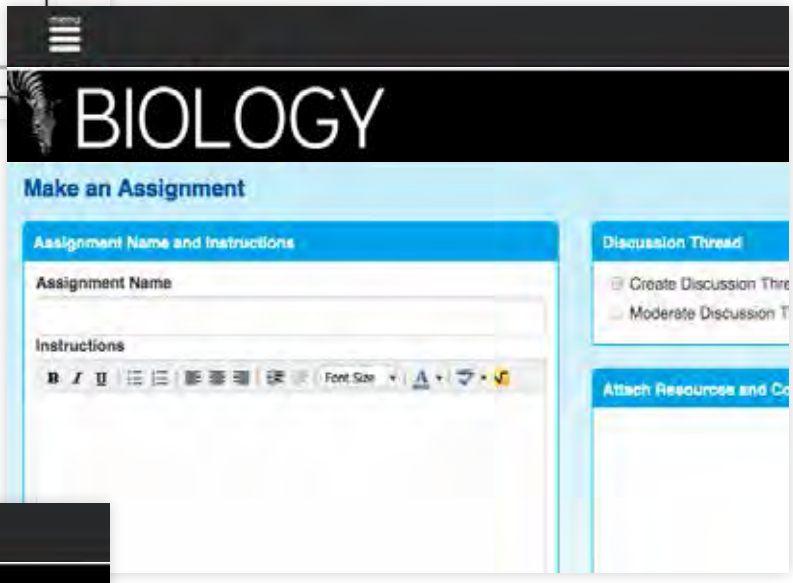
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Use Plan and Present to:

- Review teacher instructional content
- Access ready-to-use lessons
- Customize pre-built lessons with your own resources



Use Assignment Tracker to:

- View recently created assignments
- Review and edit class rosters
- Assign homework and activities
- Send and reply to student messages



Use Assessment to:

- Access test banks to tailor assessments
- Create customized worksheets to assign online or print and distribute
- Prepare students for assessments with online testing

A² DEVELOPMENT PROCESS

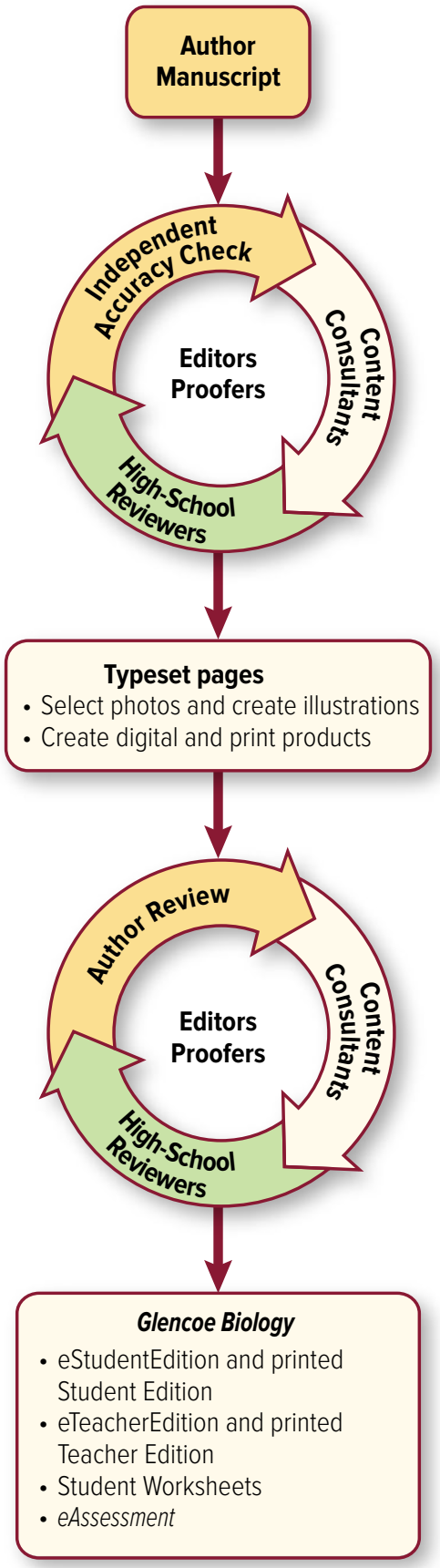
Why A²?

Accuracy **A**ssurance is central to McGraw-Hill Education's commitment to high-quality, learner-oriented, real-world, and error-free products. Also at the heart of our A² Development Process is a commitment to make the text **A**ccessible and **A**pproachable for both students and teachers. A collaboration among authors, content editors,academic advisors, and classroom teachers, the A² Development Process provides opportunities for continual improvement through customer feedback and thorough content review.

The A² Development Process begins with a review of the previous edition and a look forward to state and national standards. The authors combine expertise in teacher training and education with a mastery of biology content knowledge. As manuscript is created and edited, consultants review the accuracy of the content while our Teacher Advisory Board members examine the program from the points of view of both teacher and student. Student labs and teacher demonstrations are reviewed for both accuracy of content and safety. As design elements are applied, chapter content is again reviewed, as are photos and diagrams.

Throughout the life of the program, McGraw-Hill Education continues to troubleshoot and incorporate improvements. Our goal is to deliver to you a program that has been created, refined, tested, and validated as a successful tool for your continued **A**cademic **A**chievement.





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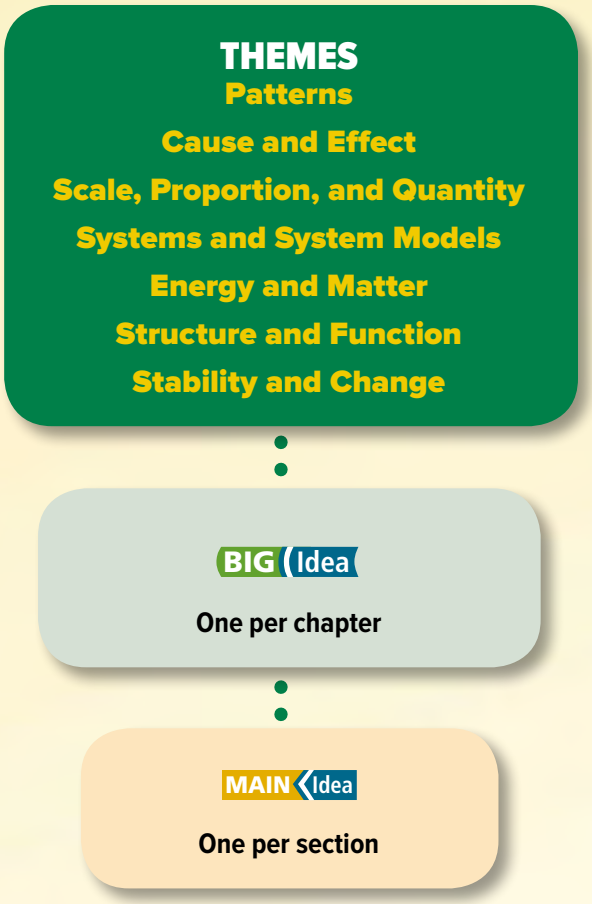
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Your book is divided into units and chapters that are organized around Themes, Big Ideas, and Main Ideas of biology.

THEMES are cross-cutting concepts used throughout the entire book that help you tie what you learn together. They help you see the connections among major ideas and concepts.

BIG Idea appear in each chapter and help you focus on topics within the themes. The Big Ideas are broken down even further into Main Ideas.

MAIN Idea draw you into more specific details about biology. All the Main Ideas of a chapter add up to the chapter's Big Idea.



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LABS

Launch Lab

Start off each chapter with hands-on introduction to the subject matter.

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Launch Lab

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DATA ANALYSIS LAB

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LABS

Mini Lab Practice scientific methods and hone your lab skills with these quick activities.

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MiniLab

Practice scientific methods and hone your lab skills with these quick activities.

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MiniLab

LABS

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CONCEPTS IN MOTION

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CONCEPTS IN MOTION

Interactive Tables **Check your understanding by viewing interactive versions of tables in your text.**

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Animations

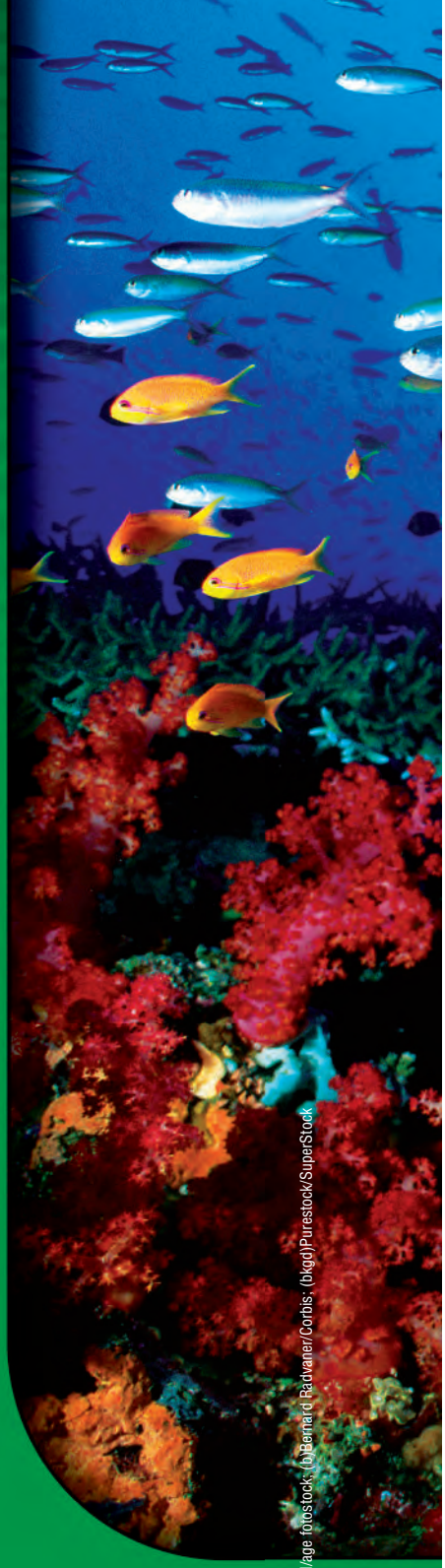
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CHAPTER 3

Communities, Biomes, and Ecosystems



(t)Jeff Hunter/Photographer's Choice RF/Getty Images; (c)Pixtal/age fotostock; (b)Bernard Radvaner/Corbis; (bkgd)Purestock/SuperStock

Launch Lab

What is my biological address?

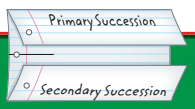
Just as you have a postal address, you also have a biological "address." As a living organism, you are part of interwoven ecological units that vary in size from as large as the whole biosphere to the place you occupy right now.

For a lab worksheet, use your StudentWorks™ Plus Online.

Launch Lab

FOLDABLES®

Make a shutter fold book using the labels shown. Use it to organize your notes on succession.





THEME FOCUS Cause and Effect

Constantly changing communities of plants and animals drive succession.

BIG Idea Limiting factors and ranges of tolerance are factors that determine where terrestrial biomes and aquatic ecosystems exist.

Section 1 • Community Ecology

Section 2 • Terrestrial Biomes

Section 3 • Aquatic Ecosystems

Section 1

Reading Preview

Essential Questions

- How do unfavorable abiotic and biotic factors affect species?
- How do ranges of tolerance affect the distribution of organisms?
- What are the stages of primary and secondary succession?

Review Vocabulary

abiotic factor: the nonliving part of an organism's environment

New Vocabulary

community
limiting factor
tolerance
ecological succession
primary succession
climax community
secondary succession

Community Ecology

MAIN Idea **All living organisms are limited by factors in the environment.**

Real-World Reading Link Wherever you live, you probably are used to the conditions of your environment. If it is cold outdoors, you might wear a coat, hat, and gloves. Bears have adaptations such as their warm fur coat to the cold so they do not need these types of clothes.

Communities

When you describe your community, you probably include your family, the students in your school, and the people who live nearby. A biological **community** is a group of interacting populations that occupy the same area at the same time. Therefore, your community also includes plants, other animals, bacteria, and fungi. Not every community includes the same variety of organisms. An urban community is different from a rural community, and a desert community is different from a polar community.

You have learned that organisms depend on one another for survival. You also learned about abiotic factors and how they affect individual organisms. How might abiotic factors affect communities? Consider soil, which is an abiotic factor. If soil becomes too acidic, some species might die or become extinct. This might affect food sources for other organisms, resulting in a change in the community.

Organisms adapt to the conditions in which they live. For example, a wolf's heavy fur coat enables it to survive in harsh winter climates, and a cactus's ability to retain water enables it to tolerate the dry conditions of a desert. Depending on which factors are present, and in what quantities, organisms can survive in some ecosystems but not in others. For example, the plants in the desert oasis shown in **Figure 1** decrease in number away from the water source.



©Yann Arthus-Bertrand/Corbis

Figure 1 Notice that populations of organisms live within a relatively small area surrounding the oasis.

Limiting factors Any abiotic factor or biotic factor that restricts the numbers, reproduction, or distribution of organisms is called a **limiting factor.** Abiotic limiting factors include sunlight, climate, temperature, water, nutrients, fire, soil chemistry, and space. Biotic limiting factors include living things, such as other plant and animal species. Factors that restrict the growth of one population might enable another to thrive. For example, in the oasis shown in **Figure 1,** water is a limiting factor for all of the organisms. Temperature also might be a limiting factor. Desert species must be able to withstand the heat of the Sun and the cold temperatures of desert nights.

Range of tolerance For any environmental factor, there is an upper limit and lower limit that define the conditions in which an organism can survive. For example, steelhead trout live in cool, clear coastal rivers and streams from California to Alaska. The ideal range of water temperature for steelhead trout is between 13°C and 21°C, as illustrated in **Figure 2.** However, steelhead trout can survive water temperatures from 9°C to 25°C. At these temperatures, steelhead trout experience physiological stress, such as inability to grow or reproduce. They will die if the water temperature goes beyond the upper and lower limits.

Have you ever had to tolerate a hot day or a boring activity? The ability of any organism to survive when subjected to abiotic factors or biotic factors is called **tolerance.** Consider **Figure 2** again. Steelhead trout tolerate a specific range of temperatures. That is, the range of tolerance of water temperature for steelhead is 9°C to 25°C. Notice that the greatest number of steelhead live in the optimum zone in which the temperature is best for survival. Between the optimum zone and the tolerance limits lies the zone of physiological stress. At these temperatures, there are fewer fish. Beyond the upper tolerance limit of 25°C and the lower tolerance limit of 9°C, there are no steelhead trout. Therefore, water temperature is a limiting factor for steelhead when water temperature is outside the range of tolerance.

Reading Check **Describe** the relationship between a limiting factor and a range of tolerance.

CAREERS IN BIOLOGY

Conservation Biologist Among other duties, a conservation biologist might tag and track animals in a community. Understanding the biotic and abiotic factors of the community can help explain changes in populations.

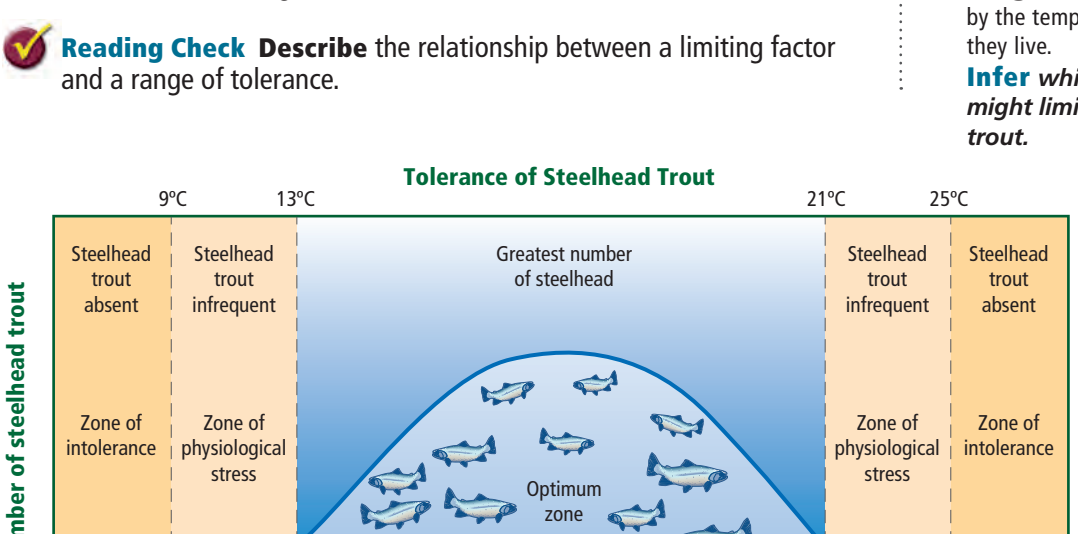


Figure 2 Steelhead trout are limited by the temperature of the water in which they live.
Infer *which other abiotic factors might limit the survival of steelhead trout.*

FOLDABLES®
Incorporate information from this section into your Foldable.

Ecological Succession

Ecosystems are constantly changing. They might be modified in small ways, such as a tree falling in the forest, or in large ways, such as a forest fire. They also might alter the communities that exist in the ecosystem. Forest fires can be good and even necessary for the forest community. Forest fires return nutrients to the soil. Some plants, such as fireweed, have seeds that will not sprout until they are heated by fire. Some ecosystems depend on fires to get rid of debris. If fires are prevented, debris builds up to the point where the next fire might burn the shrubs and trees completely. A forest fire might change the habitat so drastically that some species no longer can survive, but other species might thrive in the new, charred conditions.

The change in an ecosystem that happens when one community replaces another as a result of changing abiotic and biotic factors is **ecological succession.** There are two types of ecological succession—primary succession and secondary succession.

Primary succession On a solidified lava flow or exposed rocks on a cliff, no soil is present. If you took samples of each and looked at them under a microscope, the only biological organisms you would observe would be bacteria and perhaps fungal spores or pollen grains that drifted there on air currents. The establishment of a community in an area of exposed rock that does not have any topsoil is **primary succession,** which is illustrated in **Figure 3.** Primary succession usually occurs very slowly at first.

Almost all plants require soil for growth. But, how is soil formed? Usually lichens, a mutulaistic combination of a fungus and algae, begin to grow on the rock. Because lichens, along with some mosses, are among the first organisms to appear, they are called pioneer species. Pioneer species help to create soil by secreting acids that help to break down rocks.

VOCABULARY

SCIENCE USAGE V. COMMON USAGE

Primary

Science usage: first in rank, importance, value, or order
A doctor's primary concern should be the patient.

Common usage: the early years of formal education
Elementary grades, up to high school, are considered to comprise a student's primary education.

APPLYING PRACTICES

Engaging in Argument from Evidence Go to the Resource tab in ConnectED to find the Applying Practices worksheet *Local Ecosystem Dynamics.*

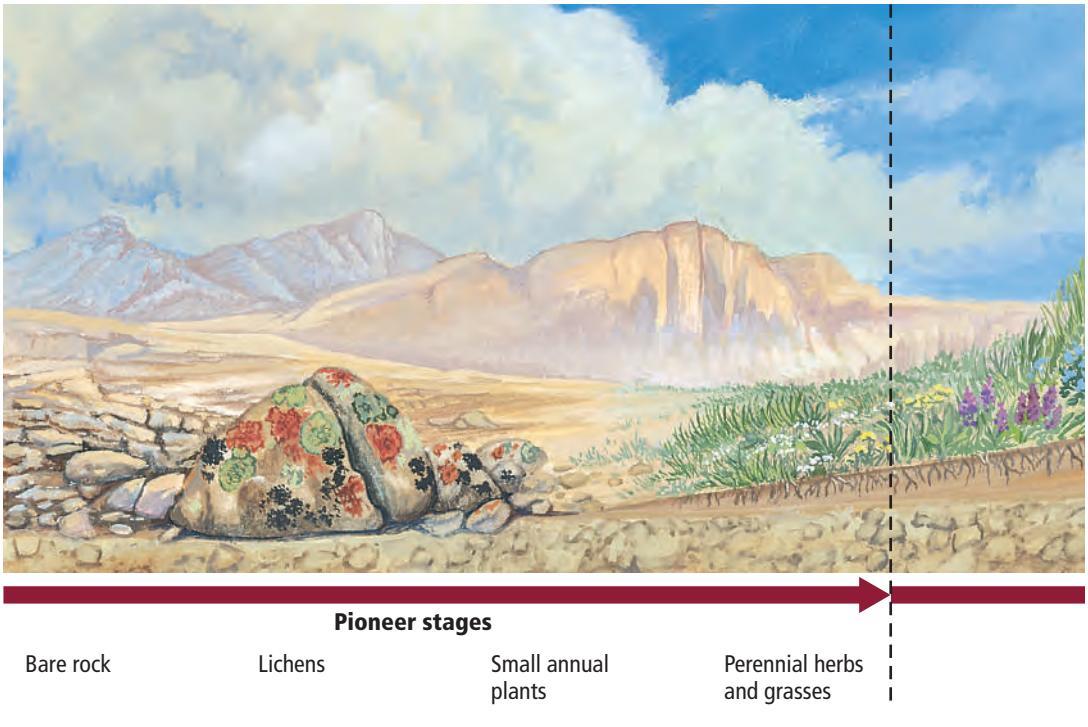


Figure 3 The formation of soil is the first step in primary succession. Once soil formation starts, there is progressive succession toward a climax community.

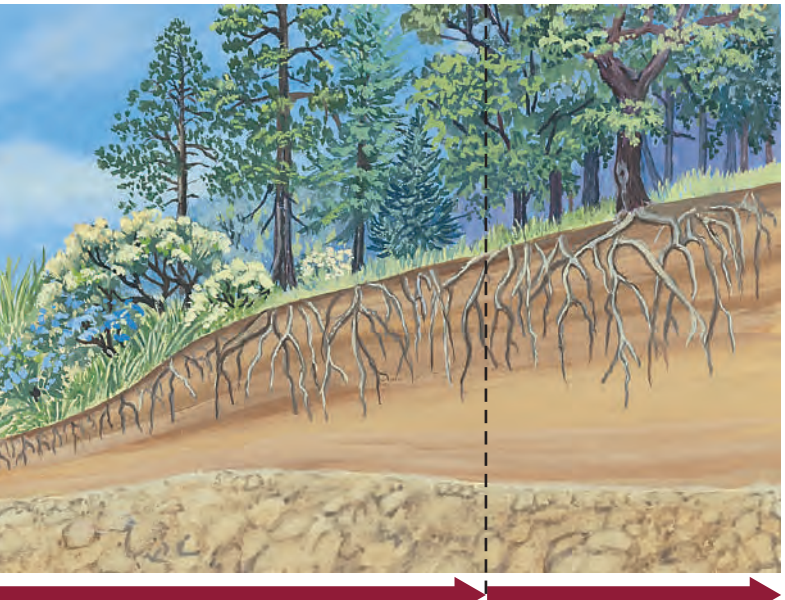
Animation

Video Lab

As pioneer organisms die, their decaying organic materials, along with bits of sediment from the rocks, make up the first stage of soil development. At this point, small weedy plants, including ferns, and other organisms such as fungi and insects, become established. As these organisms die, additional soil is created. Seeds, transported by animals, water, or wind, begin to grow in the newly formed soil. Eventually, enough soil is present so that shrubs and trees can grow.

A mature community can eventually develop from bare rock, as illustrated in **Figure 3.** The stable, mature community that results when there is little change in the composition of species is a **climax community.** Scientists today realize that disturbances, such as climate change, are ongoing in communities; therefore, a true climax community is unlikely to occur.

Secondary succession Disturbances such as fire, flood, or a windstorm can disrupt a community. After a disturbance, new species of plants and animals might occupy the habitat. Over time, there is a natural tendency for the species belonging to the mature community to return. **Secondary succession** is the orderly and predictable change that takes place after a community of organisms has been removed but the soil has remained intact. Pioneer species—mainly plants that begin to grow in the disturbed area—are the first species to start secondary succession.



Intermediate stages

Grasses, shrubs, shade-intolerant trees

Mature community

Shade-tolerant trees

DATA ANALYSIS LAB 1

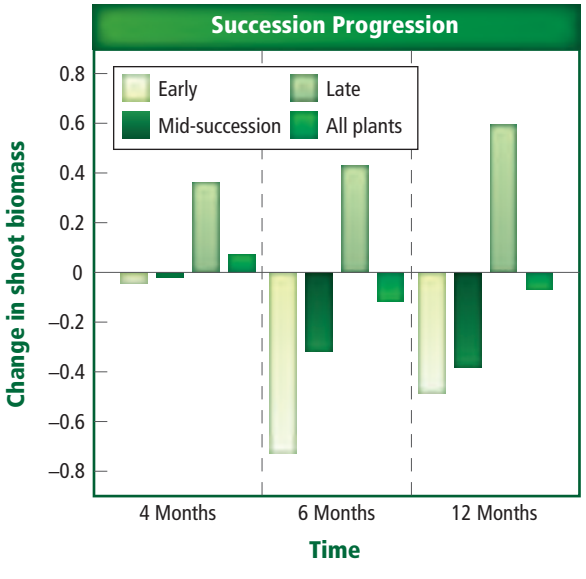
Based on Real Data*

Interpret the Data

How do soil invertebrates affect secondary succession in a grassland environment? An experiment was performed by adding soil invertebrates to controlled grassland communities. The growth of various plants was measured at four months, six months, and 12 months. Growth was measured by recording shoot biomass—the mass of the grass stems.

Data and Observations

The bars on the graph indicate the change in the biomass of the plants over time.



Think Critically

1. **Infer** what a negative value of change in shoot biomass indicates.
2. **Generalize** which communities were most positively affected and which were most negatively affected by the addition of soil invertebrates.

*Data obtained from: De Deyn, G.B. et al. 2003. Soil invertebrate fauna enhances grassland succession and diversity. *Nature* 422: 711–713.

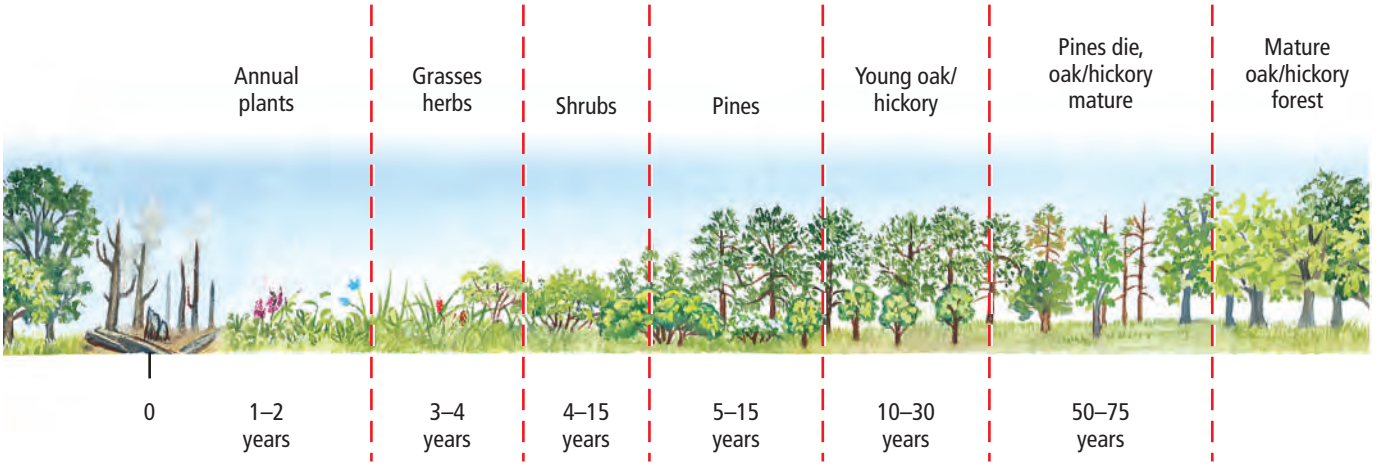


Figure 4 After a fire, a forest might appear devastated. However, a series of changes ultimately leads back to a mature community.

During secondary succession, as in primary succession, the community of organisms changes over a period of time. **Figure 4** shows how species composition changes after a forest fire. Secondary succession usually occurs faster than primary succession because soil already exists and some species still will be present (although there might be fewer of them). Also, undisturbed areas nearby can be sources of seeds and animals.

Succession's end point Ecological succession is a complex process that involves many factors. The end point of succession after a disturbance cannot be predicted. Natural communities are constantly changing at different rates, and the process of succession is very slow. Human activities also affect the species that might be present. Because of these factors, it is difficult to determine if succession has reached a climax community in many areas on Earth.

Section 1 Assessment

Section Summary

- Abiotic and biotic limiting factors restrict the growth of a population within a community.
- Organisms have a range of tolerance for each limiting factor that they encounter.
- Primary succession occurs on areas of exposed rock or bare sand (no soil).
- Communities progress until there is little change in the composition of species.
- Secondary succession occurs as a result of a disturbance in a mature community.

Understand Main Ideas

1. MAIN Idea **Identify** how temperature is a limiting factor for polar bears.
2. **Predict** how unfavorable abiotic and biotic factors affect a species.
3. **Describe** how ranges of tolerance affect the distribution of a species.
4. **Classify** the stage of succession of a field that is becoming overgrown with shrubs after a few years of disuse.

Think Critically

5. **Interpret Figure 2** and predict the general growth trend for steelhead trout in a stream that is 22°C.

MATH in Biology

6. Graph the following data to determine the range of tolerance for catfish. The first number in each pair of data is temperature in degrees Celsius, and the second number is the number of catfish found in the stream: (0, 0); (5, 0); (10, 2); (15, 15); (20, 13); (25, 3); (30, 0); (35, 0).

Online Quiz

Section 2

Terrestrial Biomes

Reading Preview

Essential Questions

- How is latitude related to the three major climate zones?
- What are the major abiotic factors that determine the location of a terrestrial biome?
- How are the terrestrial biomes distinguished based on climate and biotic factors?

Review Vocabulary

biome: a large group of ecosystems that share the same climate and have similar types of plant communities

New Vocabulary

weather
latitude
climate
tundra
boreal forest
temperate forest
woodland
grassland
desert
tropical savanna
tropical seasonal forest
tropical rain forest

MAIN Idea **Ecosystems on land are grouped into biomes primarily based on the plant communities within them.**

Real-World Reading Link If you live in the eastern part of the United States, you might live in an area surrounded by deciduous forests. If you live in the central part of the United States, there might be a grassy prairie nearby. Plant communities are specific to particular ecosystems.

Effects of Latitude and Climate

Regardless of where you live, you are affected by weather and climate. During a newscast, a meteorologist will make forecasts about the upcoming weather. **Weather** is the condition of the atmosphere at a specific place and time. What causes the variation in the weather patterns that you experience? What are the effects of these weather patterns on organisms that live in different areas on Earth? One of the keys to understanding communities is to be aware of latitude and climatic conditions.

Connection to Earth Science **Latitude** The distance of any point on the surface of Earth north or south from the equator is **latitude.** Latitudes range from 0° at the equator to 90° at the poles. Light from the Sun strikes Earth more directly at the equator than at the poles, as illustrated in **Figure 5.** As a result, Earth's surface is heated differently in different areas. Ecologists refer to these areas as polar, temperate, and tropical zones.

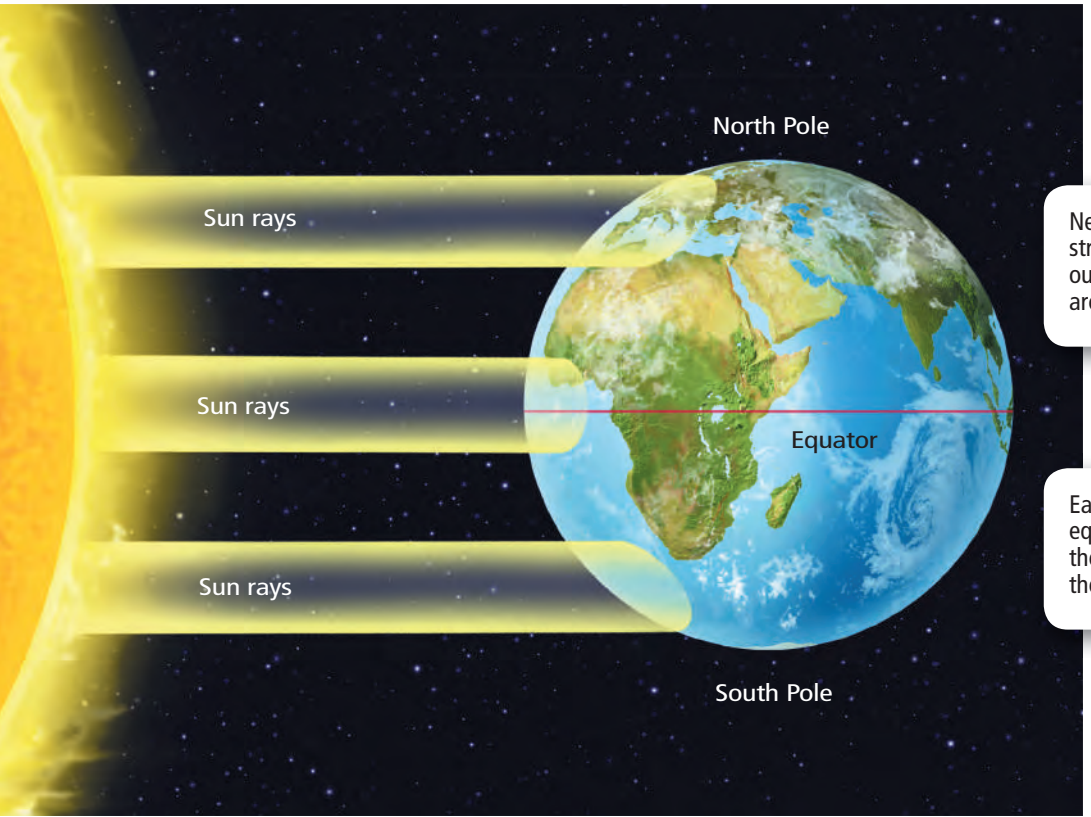
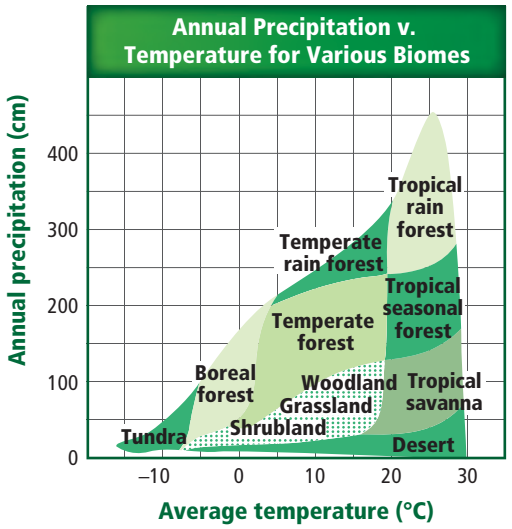


Figure 5 Because of Earth's curved surface, the Sun's rays strike the equator more directly than areas toward the north or south poles.



■ **Figure 6** Temperature and precipitation are two major factors that influence the kind of vegetation that can exist in an area.

Analyze ***which biome you would expect in an area that receives 200 cm of precipitation annually if the average annual temperature is 10°C.***

Personal Tutor

BrainPOP

Climate The average weather conditions in an area, including temperature and precipitation, describe the area's **climate.** An area's latitude has a large effect on its climate. If latitude were the only abiotic factor involved in climate, biomes would be spread in equal bands encircling Earth. However, other factors such as elevation, continental landmasses, and ocean currents also affect climate. The graph in **Figure 6** shows how temperature and precipitation influence the communities that develop in an area. You can investigate the relationship between temperature and latitude in **Minilab 1.**

A biome is a large group of ecosystems that share the same climate and have similar types of communities. It is a group of plant and animal communities that have adapted to a region's climate. A biome's ecosystems occur over a large area and have similar plant communities. Even a small difference in temperature or precipitation can affect the composition of a biome. Refer to **Figure 7** to learn how Earth's ocean currents and prevailing winds affect climate. Also illustrated in **Figure 7** are two ways humans might be affecting climate—through the hole in the ozone layer and through global warming. Global warming is in part a result of the greenhouse effect.

Major Land Biomes

Biomes are classified primarily according to the characteristics of their plants. Biomes also are characterized by temperature and precipitation. Animal species are an important characteristic of biomes as well. This section describes each of the major land biomes.

MiniLab 1

MiniLab

Formulate a Climate Model

How are temperature and latitude related? At the equator the climate is very warm. However, as you change latitude and move north or south of the equator, temperatures also change. This results in different latitudinal climate belts around the world.

Procedure

1. Read and complete the lab safety form.
2. Position a **lamp** so that it shines directly on the equator of a **globe.**
3. Predict how the temperature readings will change as you move a **thermometer** north or south, away from the equator.
4. Prepare a data table to record your observations.
5. Use the thermometer to take temperature readings at different latitudes as instructed by your teacher. **WARNING:** ***The lamp and bulb will be very hot.***
6. Record temperature readings in your data table.

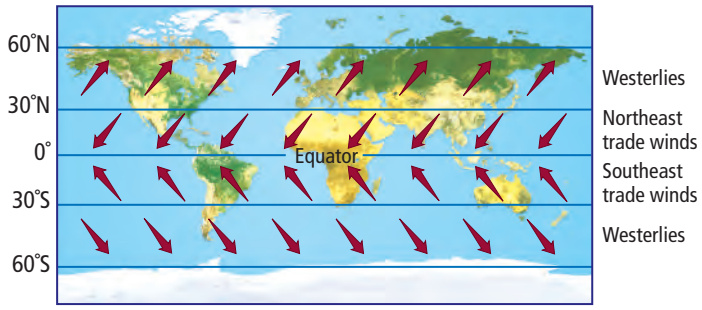
Analysis

1. **Model** climate belts by using your data to draw a diagram.
2. **Cause and Effect** Why do the temperature readings change as you move north or south of the equator?

Visualizing Global Effects on Climate

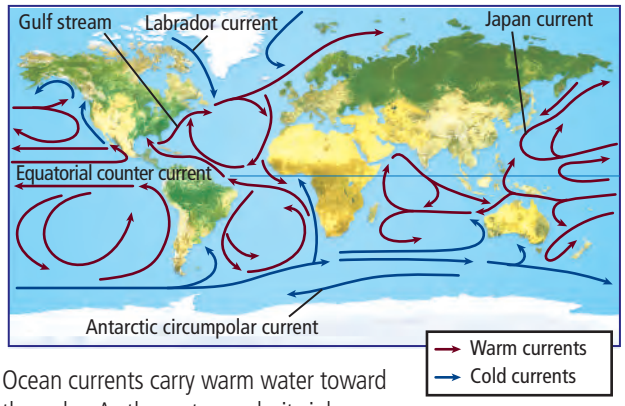
Figure 7
Some parts of Earth receive more heat from the Sun. Earth's winds and ocean currents contribute to climate and balance the heat on Earth. Many scientists think human impacts on the atmosphere upset this balance.

Winds on Earth



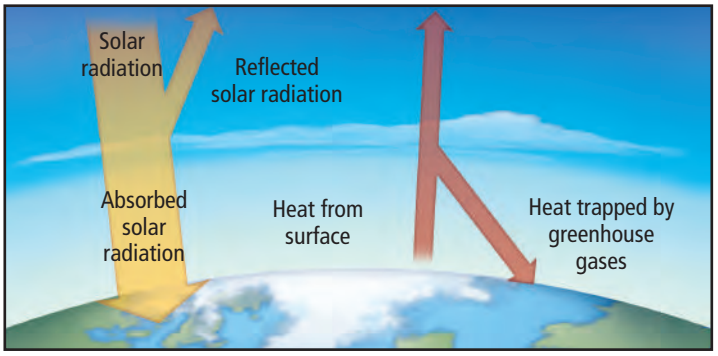
Winds are created from temperature imbalances. Distinct global wind systems transport cold air to warm areas and warm air to cold areas.

Earth's Ocean Currents



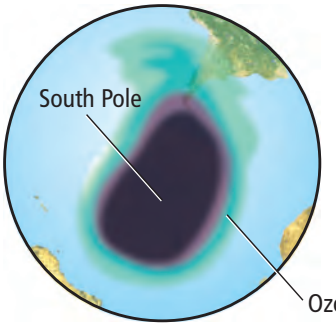
Ocean currents carry warm water toward the poles. As the water cools, it sinks toward the ocean floor and moves toward tropical regions.

Greenhouse Effect



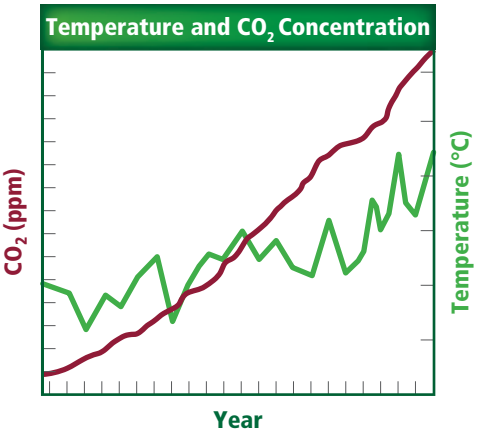
Earth's surface is warmed by the greenhouse effect. Certain gases in Earth's atmosphere, including naturally occurring water vapor, reduce the amount of energy Earth radiates into space. Other important greenhouse gases are carbon dioxide and methane.

Human Impact on the Atmosphere



The ozone layer is a protective layer in the atmosphere that absorbs most of the harmful UV radiation from the Sun. Atmospheric studies have indicated that chlorofluorocarbons (CFCs) contribute to a seasonal reduction in ozone concentration over Antarctica, forming the Antarctic ozone hole.

Animation



The measured increase of carbon dioxide (CO_2) in the atmosphere is mainly due to the burning of fossil fuels. As carbon dioxide levels have increased, the average global temperature has increased.



Figure 8 Tundra
Average precipitation: 15–25 cm per year
Temperature range: −70°C–12°C
Plant species: short grasses, shrubs
Animal species: caribou, polar bears, birds, insects, wolves, arctic hares, musk ox
Geographic location: south of the polar ice caps in the Northern Hemisphere
Abiotic factors: soggy summers; permafrost; cold and dark much of the year

Tundra Extending in a band below the polar ice caps across northern Europe, North America, and Siberia in Asia is the tundra. The **tundra** is a treeless biome with a layer of permanently frozen soil below the surface called permafrost. Although the ground thaws to a depth of a few centimeters in the summer, its constant cycles of freezing and thawing do not allow tree roots to grow. Some animals and shallow-rooted plants that have adapted to tundra conditions are illustrated in **Figure 8.**

Boreal forest South of the tundra is a broad band of dense evergreen forest extending across North America, Europe, and Asia, called the boreal forest. The **boreal forest,** illustrated in **Figure 9,** also is called northern coniferous forest, or taiga. Summers in the boreal forest are longer and somewhat warmer than in the tundra, enabling the ground to remain warmer than in the tundra. Boreal forests, therefore, lack a permafrost layer.

Figure 9 Boreal forest
Average precipitation: 30–84 cm per year
Temperature range: −54°C–21°C
Plant species: spruce and fir trees, deciduous trees, small shrubs
Animal species: birds, moose, beavers, deer, wolverines, lynx
Geographic location: northern part of North America, Europe, and Asia
Abiotic factors: summers are short and moist; winters are long, cold, and dry



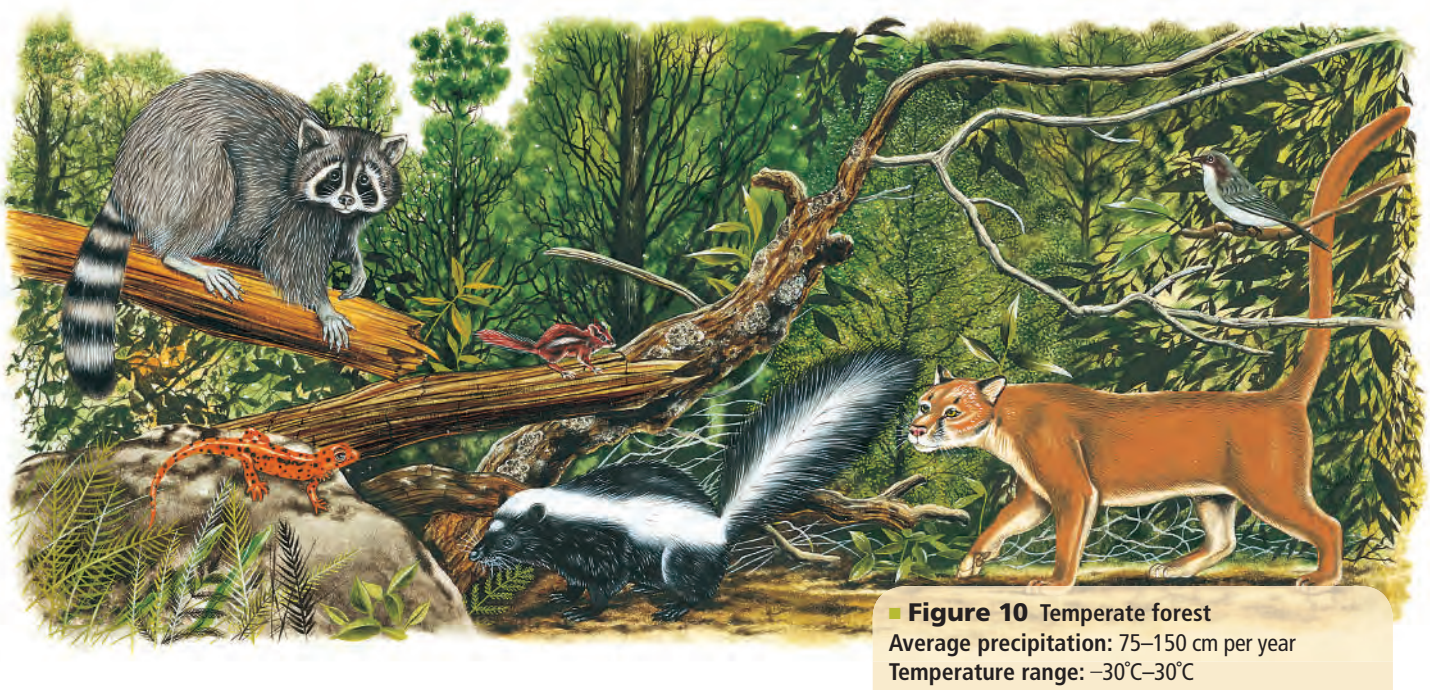


Figure 10 Temperate forest
Average precipitation: 75–150 cm per year
Temperature range: −30°C–30°C
Plant species: oak, beech, and maple trees, shrubs
Animal species: squirrels, rabbits, skunks, birds, deer, foxes, black bears, frogs, snakes
Geographic location: south of the boreal forests in eastern North America, eastern Asia, Australia, and Europe
Abiotic factors: well-defined seasons; summers are hot, and winters are cold

Temperate forest Temperate forests cover much of southeastern Canada, the eastern United States, most of Europe, and parts of Asia and Australia. As shown in **Figure 10,** the **temperate forest** is composed mostly of broad-leaved, deciduous (dih SIH juh wus) trees—trees that shed their leaves in autumn. The falling red, orange, and gold leaves return nutrients to the soil. All four seasons occur in temperate forests. In spring, warm temperatures and precipitation restart the growth cycles of plants and trees.

Temperate woodland and shrubland Open **woodlands** and mixed shrub communities are found in areas with less annual rainfall than in temperate forests. The woodland biome occurs in areas surrounding the Mediterranean Sea, on the western coasts of North and South America, in South Africa, and Australia. Areas that are dominated by shrubs, such as in California, are called the chaparral. **Figure 11** illustrates woodland and shrub communities.

Figure 11 Temperate woodland and shrubland
Average precipitation: 38–100 cm per year
Temperature range: 10°C–40°C
Plant species: evergreen shrubs, corn oak
Animal species: foxes, jackrabbits, birds, bobcats, coyotes, lizards, snakes, butterflies
Geographic location: surrounds the Mediterranean Sea, western coasts of North and South America, South Africa, and Australia
Abiotic factors: summers are very hot and dry; winters are cool and wet

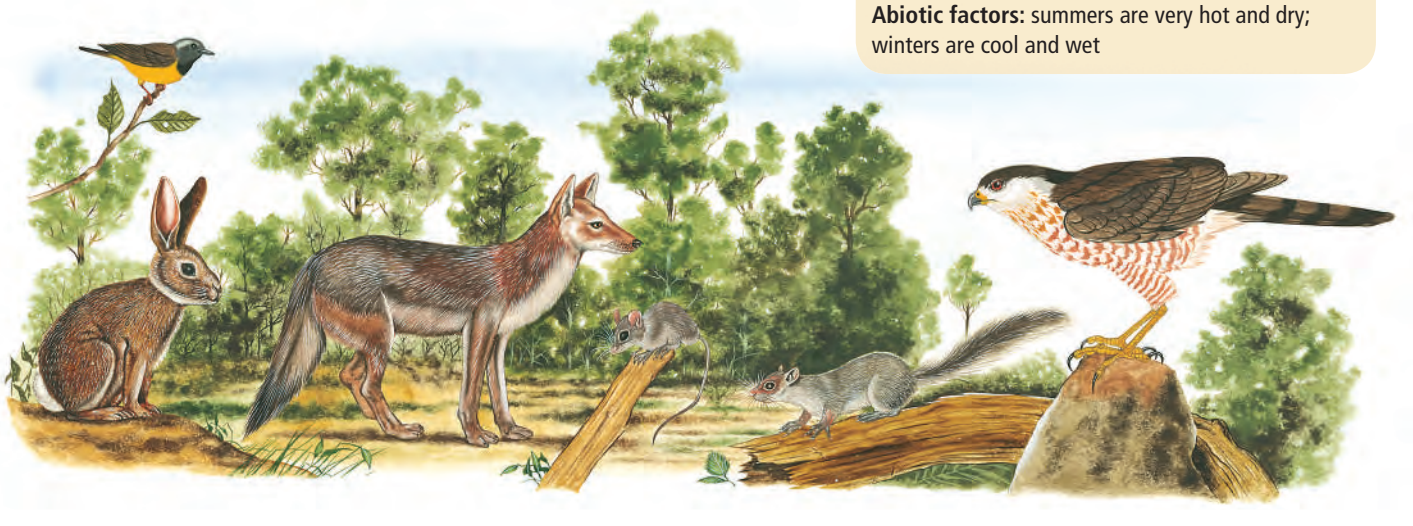




Figure 12 Temperate grassland
Average precipitation: 50–89 cm per year
Temperature range: −40°C–38°C
Plant species: grasses, herbs, flowers
Animal species: gazelles, bison, horses, lions, deer, mice, coyotes, foxes, wolves, birds, snakes, grasshoppers, spiders
Geographic location: North America, South America, Asia, Africa, and Australia
Abiotic factors: summers are hot, winters are cold, moderate rainfall, fires possible

Temperate grassland A biome that is characterized by fertile soils that are able to support a thick cover of grasses is called **grassland,** illustrated in **Figure 12.** Drought, grazing animals, and fires keep grasslands from becoming forests. Due to their underground stems and buds, perennial grasses and herbs are not eliminated by the fires that destroy most shrubs and trees. Temperate grasslands are found in the middle latitudes of North America, South America, Asia, Africa, and Australia. Grasslands are called steppes in Asia; prairies in North America; pampas and llanos in South America; savannas in Africa; and rangelands in Australia.

Desert Deserts exist on every continent except Europe. A **desert** is any area in which the annual rate of evaporation exceeds the rate of precipitation. You might imagine a desert as a desolate place full of sand dunes, but many deserts do not match that description. As shown in **Figure 13,** deserts can be home to a wide variety of plants and animals.

Figure 13 Desert
Average precipitation: 2–26 cm per year
Temperature range: high: 20°C–49°C, low: −18°C–10°C
Plant species: cacti, Joshua trees, succulents
Animal species: lizards, bobcats, birds, tortoises, rats, antelope, desert toads
Geographic location: every continent except Europe
Abiotic factors: varying temperatures, low rainfall



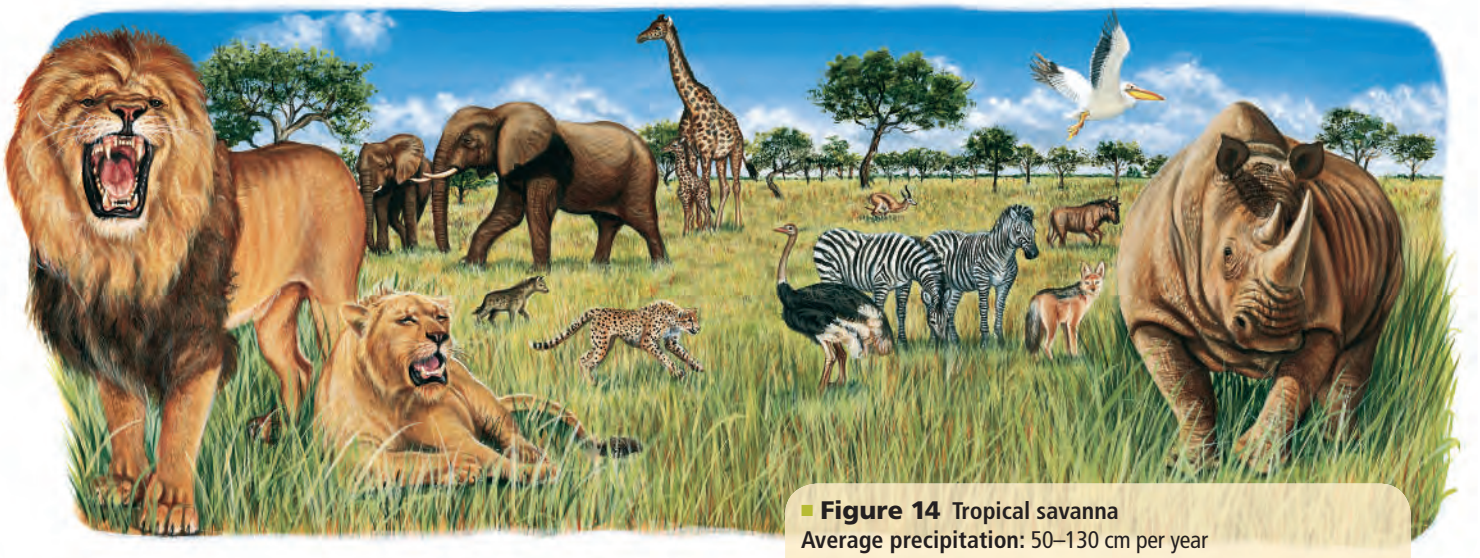


Figure 14 Tropical savanna
Average precipitation: 50–130 cm per year
Temperature range: 20°C–30°C
Plant species: grasses and scattered trees
Animal species: lions, hyenas, cheetahs, elephants, giraffes, zebras, birds, insects
Geographic location: Africa, South America, and Australia
Abiotic factors: summers are hot and rainy, winters are cool and dry

Tropical savanna A **tropical savanna** is characterized by grasses and scattered trees in climates that receive less precipitation than some other tropical areas. Tropical savanna biomes occur in Africa, South America, and Australia. The plants and animals shown in **Figure 14** are common to tropical savannas.

Tropical seasonal forest **Figure 15** illustrates a tropical seasonal forest. **Tropical seasonal forests,** also called tropical dry forests, grow in areas of Africa, Asia, Australia, and South and Central America. In one way, the tropical seasonal forest resembles the temperate deciduous forest because during the dry season, almost all of the trees drop their leaves to conserve water.

Reading Check **Compare and contrast** tropical savannas and tropical seasonal forests.

Figure 15 Tropical seasonal forest
Average precipitation: >200 cm per year
Temperature range: 20°C–25°C
Plant species: deciduous and evergreen trees, orchids, mosses
Animal species: elephants, tigers, monkeys, koalas, rabbits, frogs, spiders
Geographic location: Africa, Asia, Australia, and South and Central America
Abiotic factors: rainfall is seasonal





Figure 16 Tropical rain forest
Average precipitation: 200–1000 cm per year
Temperature range: 24°C–27°C
Plant species: broadleaf evergreens, bamboo, ferns, orchids
Animal species: chimpanzees, Bengal tigers, elephants, orangutans, bats, toucans, sloths, cobra snakes
Geographic location: Central and South America, southern Asia, west central Africa, and northeastern Australia
Abiotic factors: humid all year, hot and wet

Tropical rain forest Warm temperatures and large amounts of rainfall throughout the year characterize the **tropical rain forest** biome illustrated in **Figure 16.** Tropical rain forests are found in much of Central and South America, southern Asia, west central Africa, and northeastern Australia. The tropical rain forest is the most diverse of all land biomes. Tall, broad-leaved trees with branches heavy with mosses, ferns, and orchids make up the canopy of the tropical rain forest. Shorter trees, shrubs, and plants, such as ferns and creeping plants, make up another layer, or understory, of tropical rain forests.

Other Terrestrial Areas

You might have noticed that the list of terrestrial biomes does not include some important areas. Many ecologists omit mountains from the list. Mountains are found throughout the world and do not fit the definition of a biome because their climate characteristics and plant and animal life vary depending on elevation. Polar regions also are not considered true biomes because they are ice masses and not true land areas with soil.

Mountains If you go up a mountain, you might notice that abiotic conditions, such as temperature and precipitation, change with increasing elevation. These variations allow many communities to exist on a mountain. As **Figure 17** illustrates, biotic communities also change with increasing altitude, and the tops of tall mountains may support communities that resemble those of the tundra.

Virtual Lab

Study Tip

Summaries Review the terrestrial biomes featured in this section. Choose one or two biomes and write two sentences that summarize the information.

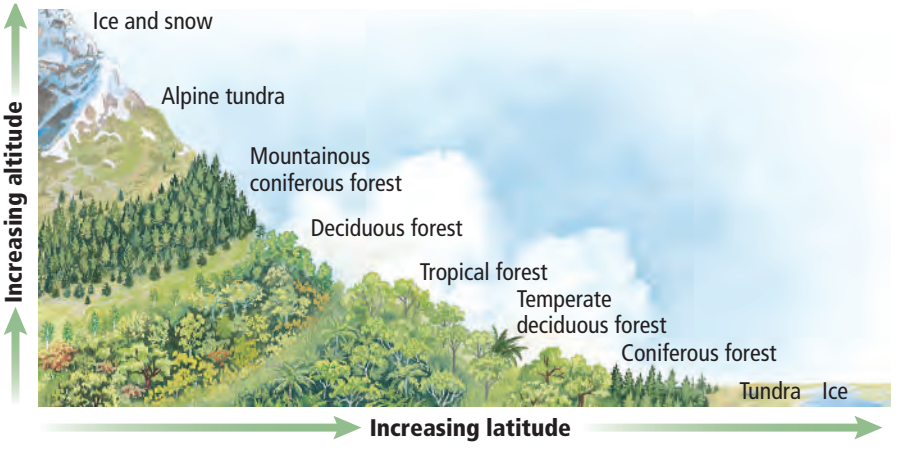


Figure 17 As you climb a mountain or increase in latitude, the temperature drops and the climate changes.
Describe *the relationship between altitude and latitude.*



Figure 18 A surprising number of species inhabit the polar regions, including these penguins in Antarctica.

Polar regions Polar regions border the tundra at high latitudes, and these regions are cold all year. The coldest temperature ever recorded, –89°C, was in Antarctica, the continent that lies in the southern polar region. In the northern polar region lies the ice-covered Arctic Ocean and Greenland. Covered by a thick layer of ice, the polar regions might seem incapable of sustaining life. However, as shown in **Figure 18**, colonies of penguins live in Antarctica. Additionally, whales and seals patrol the coasts, preying on penguins, fish, or shrimplike invertebrates called krill. The arctic polar region supports even more species, including polar bears and arctic foxes. Human societies have also inhabited this region throughout history. Although the average winter temperature is about –30°C, the arctic summer in some areas is warm enough for vegetables to be grown.

CAREERS IN BIOLOGY

Climatologist Unlike meteorologists, who study current weather conditions, climatologists study long-term climate patterns and determine how climate changes affect ecosystems.

Section 2 Assessment

Section Summary

- Latitude affects terrestrial biomes according to the angle at which sunlight strikes Earth.
- Latitude, elevation, ocean currents, and other abiotic factors determine climate.
- Two major abiotic factors define terrestrial biomes.
- There are nine major terrestrial biomes. There are two additional terrestrial regions that do not fit into these categories.

Understand Main Ideas

1. MAIN Idea **Describe** the nine major terrestrial biomes.
2. **Describe** the abiotic factors that determine a terrestrial biome.
3. **Summarize** variations in climate among three major zones as you travel south from the equator toward the South Pole.
4. **Indicate** the differences between temperate grasslands and tropical savannas.
5. **Compare and contrast** the climate and biotic factors of tropical seasonal forests and temperate forests.

Think Critically

6. **Hypothesize** why the tropical rain forests have the greatest diversity of living things.

WRITING in Biology

7. Tropical forests are being felled at a rate of 17 million hectares per year, which represents almost two percent of the forest area. Use this information to write a pamphlet describing how much rain forest area exists and when it might be gone.

Frank Krahmer/Getty Images

Online Quiz

Section 3

Reading Preview

Essential Questions

- What are the major abiotic factors that determine the aquatic ecosystems?
- What are transitional aquatic ecosystems and why are they important?
- What are the zones of marine ecosystems?

Review Vocabulary

salinity: a measure of the amount of salt in a body of water

New Vocabulary

sediment
littoral zone
limnetic zone
plankton
profundal zone
wetlands
estuary
intertidal zone
photic zone
aphotic zone
benthic zone
abyssal zone

Aquatic Ecosystems

MAIN Idea **Aquatic ecosystems are grouped based on abiotic factors such as water flow, depth, distance from shore, salinity, and latitude.**

Real-World Reading Link Think about the body of water that is closest to where you live. What are its characteristics? How deep is it? Is it freshwater or salt water? For centuries, bodies of water have been central to cultures around the world.

The Water on Earth

When you think about water on Earth, you might recall a vacation at the ocean or a geography lesson in which you located Earth's oceans and seas. You probably have heard about other large bodies of water, such as the Amazon river and the Great Salt Lake. A globe of Earth is mainly blue in color because the planet is largely covered with water. Ecologists recognize the importance of water because of the biological communities that water supports. In this section, you will read about freshwater, transitional, and marine aquatic ecosystems. You also will read about the abiotic factors that affect these ecosystems.

Freshwater Ecosystems

The major freshwater ecosystems include ponds, lakes, streams, rivers, and wetlands. Plants and animals in these ecosystems are adapted to the low salt content in freshwater and are unable to survive in areas of high salt concentration. Only about 2.5 percent of the water on Earth is freshwater, as illustrated by the circle graph on the left in **Figure 19.** The graph on the right in **Figure 19** shows that of that 2.5 percent, 68.9 percent is contained in glaciers, 30.8 percent is groundwater, and only 0.3 percent is found in lakes, ponds, rivers, streams, and wetlands. Interestingly, almost all of the freshwater species live in this 0.3 percent.

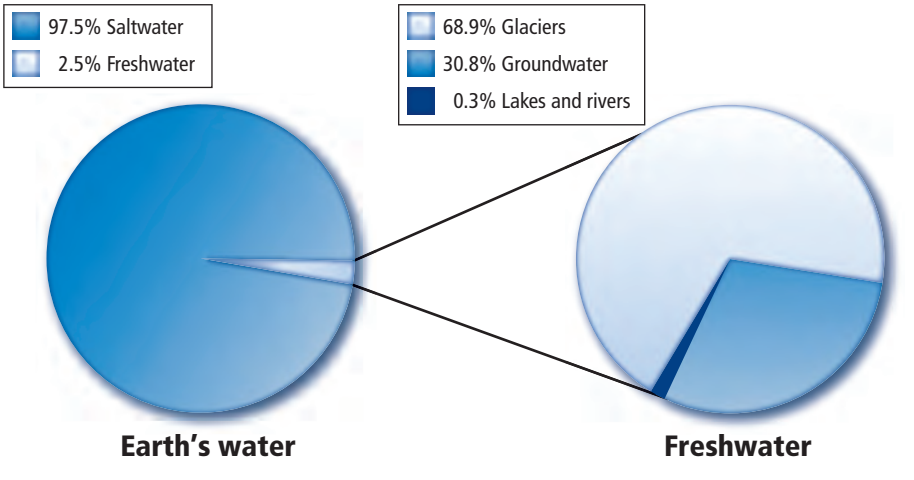


Figure 19 The vast majority of Earth's water is salt water. Most of the freshwater supply is locked in glaciers.

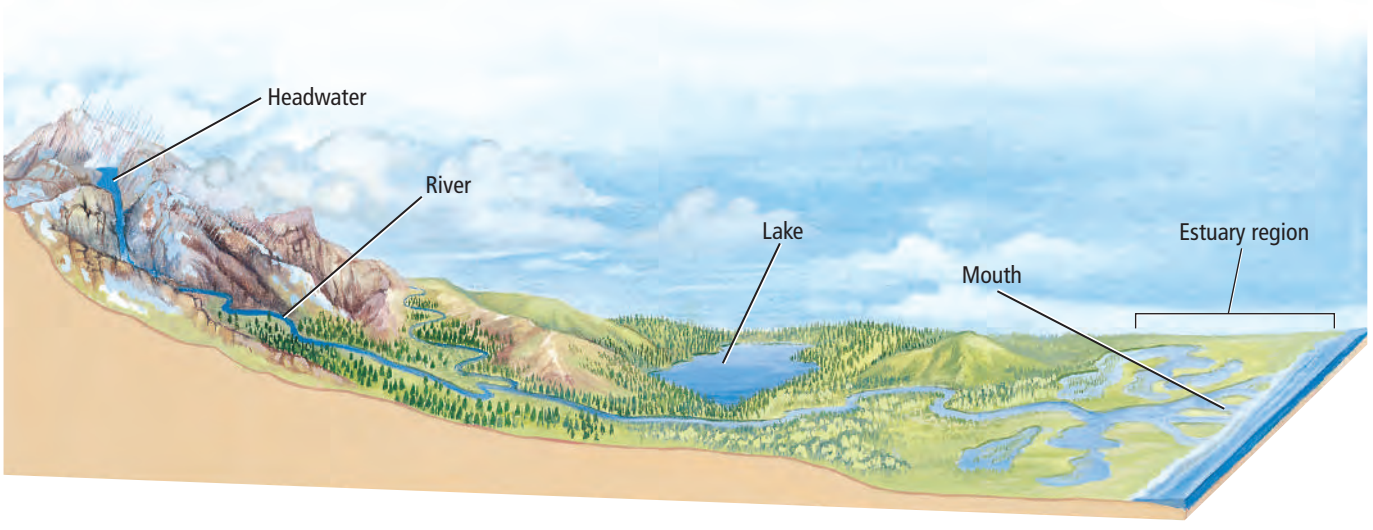


Figure 20 Mountain streams have clear, cold water that is highly oxygenated and supports the larvae of many insects and the coldwater fish that feed on them. Rivers become increasingly wider, deeper, and slower. At the mouth, many rivers divide into many channels where wetlands or estuaries form.

Rivers and streams

The water in rivers and streams flows in one direction, beginning at a source called a headwater and traveling to the mouth, where the flowing water empties into a larger body of water, as illustrated in **Figure 20.** Rivers and streams also might start from underground springs or from snowmelt. The slope of the landscape determines the direction and speed of the water flow. When the slope is steep, water flows quickly, causing a lot of sediment to be picked up and carried by the water. **Sediment** is material that is deposited by water, wind, or glaciers. As the slope levels, the speed of the water flow decreases and sediments are deposited in the form of silt, mud, and sand.

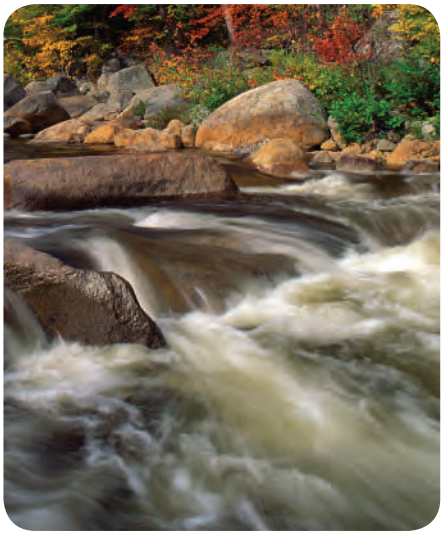
The characteristics of rivers and streams change during the journey from the source to the mouth. Interactions between wind and the water stir up the water's surface, which adds a significant amount of oxygen to the water. Interactions between land and water result in erosion, in nutrient availability, and in changing the path of the river or stream.

The currents and turbulence of fast-moving rivers and streams prevent much accumulation of organic materials and sediment. For this reason, there are usually fewer species living in rapid waters similar to that in **Figure 21.** An important characteristic of life in rivers and streams is the ability to withstand the constant water current. Plants that root themselves into the streambed are common in areas where water is slowed by rocks or sandbars. Young fish hide in these plants and feed on the drifting microscopic organisms and aquatic insects.

In slow-moving water, insect larvae are the primary food source for many fish, including American eel, brown bullhead catfish, and trout. Other organisms, such as crabs and worms, are sometimes present in calm water. Animals that live in slow-moving water include newts, tadpoles, and frogs.

Reading Check **Describe** key abiotic factors that define rivers and streams.

Figure 21 The turbulent churning action of fast-moving rivers and streams does not allow for many plants to take root or for other species to inhabit these waters.



©Creatas/PunchStock

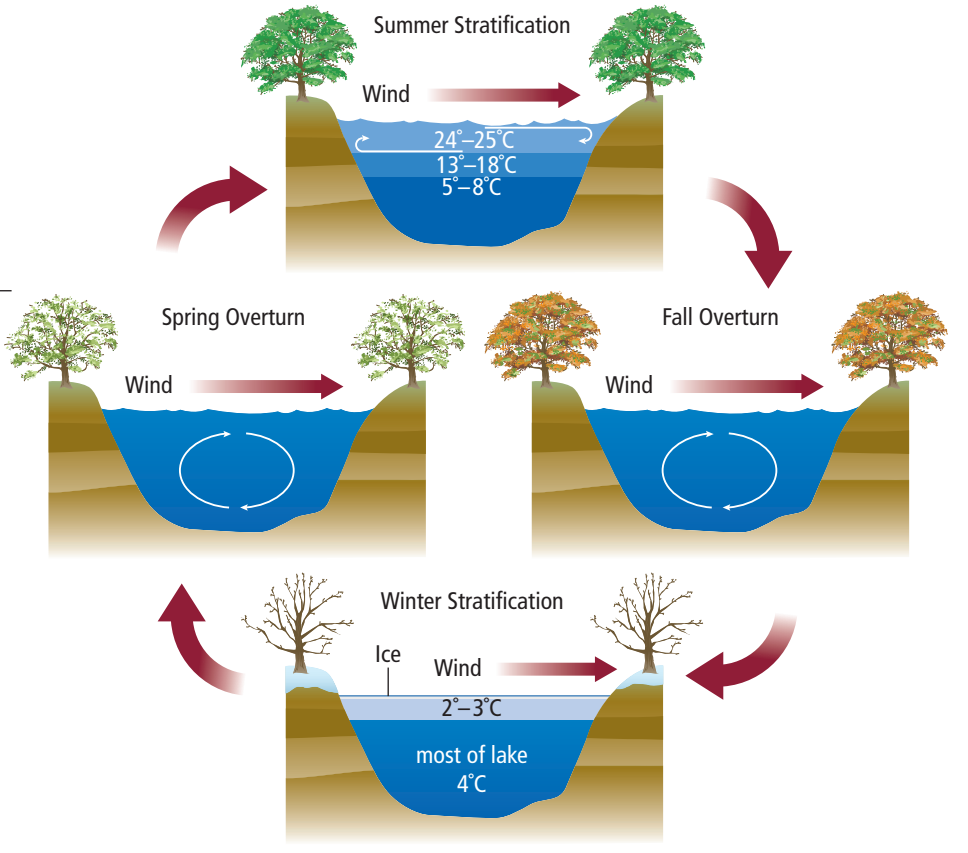


Figure 22 The temperature of lakes and ponds varies depending on the season. During spring and autumn, deep water receives oxygen from the surface water and surface water receives inorganic nutrients from the deep water.

Compare *the type of life that might live in a shallow lake in the tropics to one in the mid-latitudes.*

Lakes and ponds

An inland body of standing water is called a lake or a pond. It can be as small as a few square meters or as large as thousands of square meters. Some ponds might be filled with water for only a few weeks or months each year, whereas some lakes have existed for thousands of years. **Figure 22** illustrates how in temperate regions the temperature of lakes and ponds varies depending on the season.

During the winter, most of the water in a lake or pond is the same temperature. In the summer, the warmer water on top is less dense than the colder water at the bottom. During the spring and fall, as the water warms or cools, turnover occurs. The top and bottom layers of water mix, often due to winds, and this results in a uniform water temperature. This mixing circulates oxygen and brings nutrients from the bottom to the surface.

Nutrient-poor lakes, called oligotrophic (uh lih goh TROH fihk) lakes, often are found high in the mountains. Few plant and animal species are present as a result of small amounts of organic matter and nutrients. Nutrient-rich lakes, called eutrophic (yoo TROH fihk) lakes, usually are found at lower altitudes. Many plant and animal species are present as a result of organic matter and plentiful nutrients, some of which come from agricultural and urban activities.

Lakes and ponds are divided into three zones based on the amount of sunlight that penetrates the water. The area closest to the shore is the **littoral** *(LIH tuh rul)* **zone.** The water in this zone is shallow, which allows sunlight to reach the bottom. Many producers, such as aquatic plants and algae, live in these shallow waters. The abundance of light and producers make the littoral zone an area of high photosynthesis. Many consumers also inhabit this zone, including frogs, turtles, worms, crustaceans, insect larvae, and fish.

Vocabulary

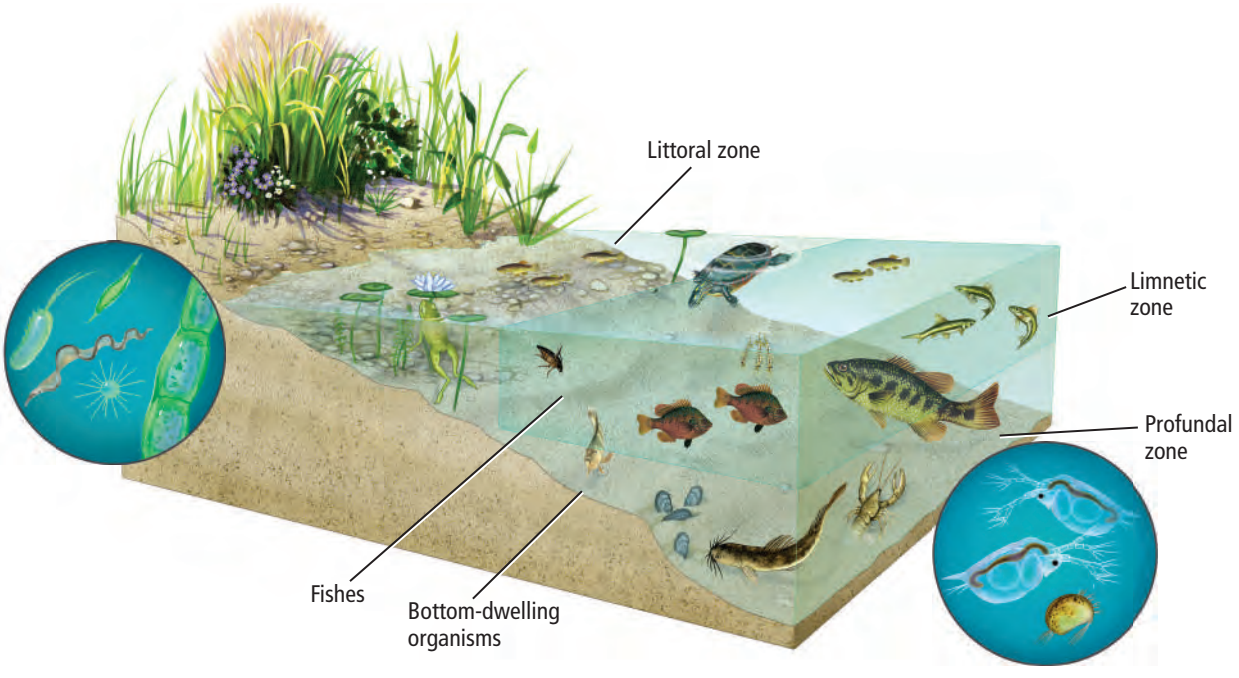
Word origin

Eutrophic/oligotrophic

eu– prefix; from Greek, meaning *well*

oligo– prefix; from Greek, meaning *few*

–trophic; from Greek, meaning *nourish*



The **limnetic** (lihm NEH tihk) **zone** is the open water area that is well lit and is dominated by plankton. **Plankton** are free-floating photosynthetic autotrophs that live in freshwater or marine ecosystems. Many species of freshwater fish live in the limnetic zone because food, such as plankton, is readily available.

Minimal light is able to penetrate through the limnetic zone into the deepest areas of a large lake, which is called the **profundal** (pruh FUN dul) **zone.** The profundal zone is therefore much colder and lower in oxygen than the other two zones. A limited number of species live in this harsh environment. **Figure 23** identifies the zones and biodiversity of lakes and ponds.

■ **Figure 23** Most of a lake's biodiversity is found in the littoral and limnetic zones. However, many species of bottom dwellers depend on nutrients and materials that drift down from above.

MiniLab 2

Prepare a Scientific Argument

MiniLab

Should an environment be disturbed? One of the greatest challenges that we face as a species is balancing the needs of an ever-growing human global population with the needs of wildlife and the quality of the global environment. Imagine this scenario: The county commissioners are considering a proposal to build a road through the local pond and wetlands. This road will provide much-needed access to areas of work, and will help boost the economy of a struggling town. This will mean that the pond and surrounding wetlands must be drained and filled. Many people support the proposal, while many people oppose it. How will a compromise be reached?

Procedure

1. Prepare a comparison table in which you can list pros and cons.
2. Identify the pros and cons for draining the pond and building the road, for keeping the pond and not building the road, or for building the road elsewhere.

Analysis

1. **Design** a plan to support one course of action. What steps could you take to achieve your goal? Be prepared to share and defend your plan to the rest of the class.
2. **Think critically** about why decisions involving the environment are difficult to make.

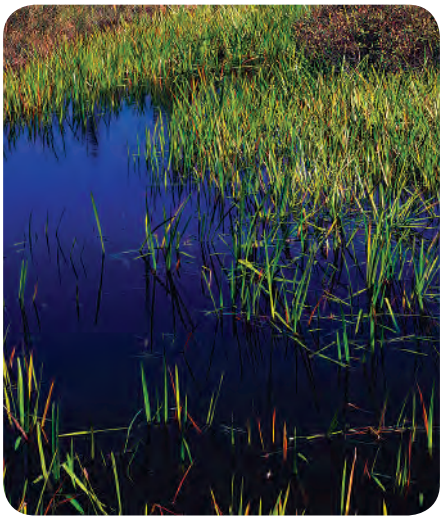


Figure 24 Bogs are a type of wetland characterized by moist, decaying plant material and dominated by mosses.

Transitional Aquatic Ecosystems

In many areas, aquatic ecosystems do not look like a stream or a pond or even an ocean. In fact, many aquatic environments are a combination of two or more different environments. These areas, which ecologists call transitional aquatic ecosystems, can be areas where land and water or salt water and freshwater intermingle. Wetlands and estuaries are common examples of transitional aquatic ecosystems.

Wetlands Areas of land such as marshes, swamps, and bogs that are saturated with water and that support aquatic plants are called **wetlands.** Plant species that grow in the moist, humid conditions of wetlands include duckweed, pond lilies, cattails, sedges, mangroves, cypress, and willows. Bogs, like the cedar bog shown in **Figure 24,** are wet and spongy areas of decomposing vegetation that also support many species of organisms. Wetlands have high levels of species diversity. Many amphibians, reptiles, birds (such as ducks and herons), and mammals (such as raccoons and mink) live in wetlands.

Estuaries Another important transitional ecosystem is an estuary, shown in **Figure 25.** Estuaries are among the most diverse ecosystems, rivaled only by tropical rain forests and coral reefs. An **estuary** (ES chuh wer ee) is an ecosystem that is formed where freshwater from a river or stream merges with salt water from the ocean. Estuaries are places of transition, from freshwater to saltwater and from land to sea, that are inhabited by a wide variety of species. Algae, seaweeds, and marsh grasses are the dominant producers. However, many animals, including a variety of worms, oysters, and crabs, depend on detritus for food. Detritus (dih TRY tus) is comprised of tiny pieces of organic material.

Mangrove trees also can be found in tropical estuaries, such as the Everglades National Park in Florida, where they sometimes form swamps. Many species of marine fishes and invertebrates, such as shrimp, use estuaries as nurseries for their young. Waterfowl, such as ducks and geese, depend on estuary ecosystems for nesting, feeding, and migration rest areas.

VOCABULARY

ACADEMIC VOCABULARY

Comprise
to be made up of
Your community is comprised of your family, your classmates, and people who live nearby.

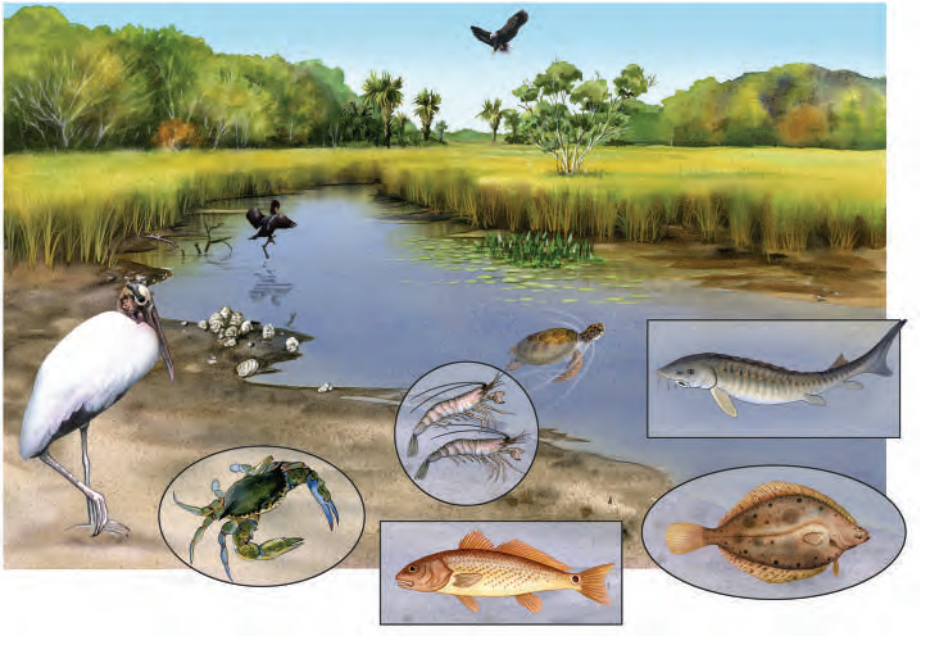


Figure 25 Salt-tolerant plants above the low-tide line dominate estuaries formed in temperate areas.

Infer *how an estuary would differ in a tropical area.*

©Design Pics Inc./Alamy

Salt marshes are transitional ecosystems similar to estuaries. Salt-tolerant grasses dominate above the low-tide line, and seagrasses grow in submerged areas of salt marshes. Salt marshes support different species of animals, such as shrimp and shellfish.

Marine Ecosystems

Connection to Earth Science Earth is sometimes called "the water planet." As such, marine ecosystems have a significant impact on the planet. For example, through photosynthesis, marine algae consume carbon dioxide from the atmosphere and produce over 50 percent of the atmosphere's oxygen. Additionally, the evaporation of water from oceans eventually provides the majority of precipitation—rain and snow. Like ponds and lakes, oceans are separated into distinct zones.

Intertidal zone The **intertidal** (ihn tur TY dul) **zone** is a narrow band where the ocean meets land. Organisms that live in this zone must be adapted to the constant changes that occur as daily tides and waves alternately submerge and expose the shore. The intertidal zone is further divided into vertical zones, as illustrated in **Figure 26.** The area of the spray zone is dry most of the time. It is only during high tides that this part of the shoreline is sprayed with salt water, and few plants and animals are able to live in this environment. The high-tide zone is under water only during high tides. However, this area receives more water than the spray zone, so more plants and animals are able to live there. The mid-tide zone undergoes severe disruption twice a day as the tides cover and uncover the shoreline with water. Organisms in this area must be adapted to long periods of air and water. The low-tide zone is covered with water unless the tide is unusually low and is the most populated area of the intertidal zone.

Reading Check **Describe** environmental variation in intertidal zones.

Virtual Lab

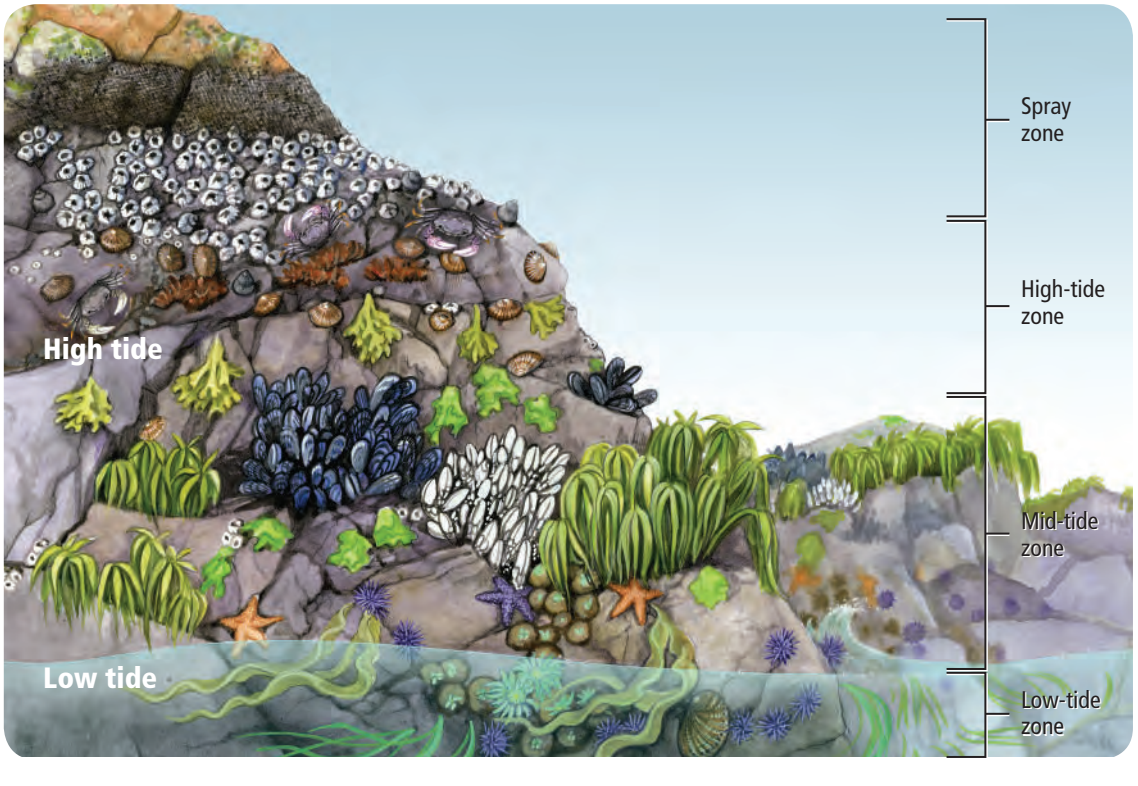
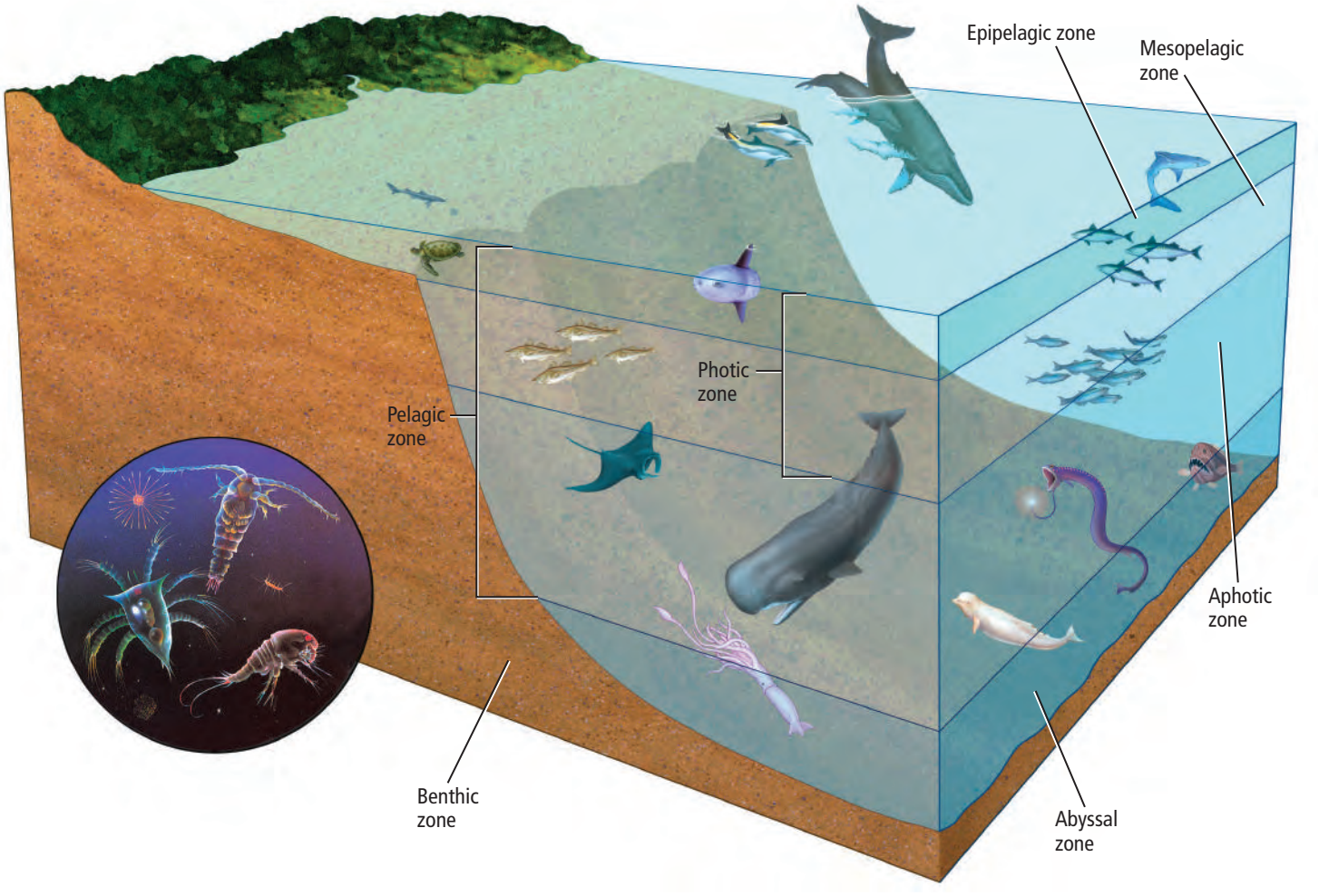


Figure 26 The intertidal zone is further divided into zones where different communities exist.

Compare and contrast *the zones illustrated in* **Figures 23** *and* **26.**



■ **Figure 27** Producers are found in the photic zone. Consumers live in the pelagic, abyssal, and benthic zones.

VOCABULARY

WORD ORIGIN

Photic
comes from the Greek word *photos,* meaning *light.*

Open ocean ecosystems

As illustrated in **Figure 27,** the zones in the open ocean include the pelagic (puh LAY jihk) zone, abyssal (uh BIH sul) zone, and benthic zone. The area to a depth of about 200 m of the pelagic zone is the **photic zone,** also called the euphotic zone. The photic zone is shallow enough that sunlight is able to penetrate. As depth increases, light decreases. Autotrophic organisms in the photic zone include surface seaweeds and plankton. Animals in the photic zone include many species of fish, sea turtles, jellyfish, whales, and dolphins. Many of these animals feed on plankton, but others feed on larger species. The photic zone is subdivided into the epipelagic zone and the mesopelagic zone, as shown in **Figure 27.**

Below the photic zone lies the **aphotic zone,** an area where sunlight is unable to penetrate. This region of the pelagic zone remains in constant darkness and generally is cold, but there is thermal layering with a mixing of warm and cold ocean currents. Organisms that depend on light energy to survive cannot live in the aphotic zone.

The **benthic zone** is the area along the ocean floor that consists of sand, silt, and dead organisms. In shallow benthic zones, sunlight can penetrate to the bottom of the ocean floor. As depth increases, light and temperature decrease. Species diversity tends to decrease with depth, except in areas with hydrothermal vents, where shrimp, crabs, and many species of tubeworms are found. Many species of fishes, octopuses, and squids live in the benthic zone.

The deepest region of the ocean is called the **abyssal zone.** Water in this area is very cold. Most organisms in this zone rely on food materials that drift down from the zones above. However, on the seafloor along the boundaries of Earth's plates, hydrothermal vents spew large amounts of hot water, hydrogen sulfide, and other minerals. Scientists have found bacterial communities existing in these locations that can use the sulfide molecules for energy. These organisms are at the bottom of a food chain that includes invertebrates, such as clams and crabs, and vertebrates, such as fishes.

Coastal ocean and coral reefs One of the world's largest coral reefs is off the southern coast of Florida. Coral reefs are among the most diverse ecosystems. They are widely distributed in warm shallow marine waters. Coral reefs form natural barriers along continents that protect shorelines from erosion. The dominant organisms in coral reefs are corals. When you think of coral, you might picture a hard, stony structure, but this is only the framework secreted by tiny animal polyps. Corals are soft-bodied invertebrates that live in the stonelike structures.

Most coral polyps have a symbiotic relationship with algae called zooxanthellae (zoo uh zan THEL uh). These algae provide corals with food, and in turn, the coral provides protection and access to light for the algae. Corals also feed by extending tentacles to obtain plankton from the water. Other coral reef animals include species of microorganisms, sea slugs, octopuses, sea urchins, sea stars, and fishes. **Figure 28** shows only a small portion of the diversity of Florida's coral reef.

Like all ecosystems, coral reefs are sensitive to changes in the environment. Changes that are the result of naturally occurring events, such as increased sediment from a tsunami, can cause the death of a reef. Human activities, such as land development and harvesting for calcium carbonate, also can damage or kill a coral reef. Today, ecologists monitor reefs and reef environments to help protect these delicate ecosystems.



Figure 28 Coral reefs off the southern tip of Florida are among the world's largest and most diverse reefs.

APPLYING PRACTICES

PBL Go to the resources tab in ConnectED to find the PBL *Microbeads, Mega-Problem.*

Section 3 Assessment

Section Summary

- Freshwater ecosystems include ponds, lakes, streams, rivers, and wetlands.
- Wetlands and estuaries are transitional aquatic ecosystems.
- Marine ecosystems are divided into zones that are classified according to abiotic factors.
- Estuaries and coral reefs are among the most diverse of all ecosystems.

Understand Main Ideas

1. MAIN Idea **List** the abiotic factors that are used to classify aquatic ecosystems.
2. **Apply** what you know about ponds. Do you think the same organisms that would live in a seasonal pond would live in a pond that existed year-round? Explain.
3. **Describe** an ecological function of an estuary.
4. **Describe** the zones of the open ocean.

Think Critically

5. **Infer** how autotrophs in the abyssal zone of the ocean are different from those of the photic zone.

MATH in Biology

6. In November 2004, the floodgates of Glen Canyon Dam opened in an attempt to improve the Colorado River habitat. The release topped 1161 m^3/s—four times the usual daytime flow. Based on this information, about how much water normally flows through the dam on a daily basis?

©Image100/PunchStock

In the Field

Career: Wildlife Conservation Biologist

The Last Wild Place On Earth

Imagine you are hiking through a dense forest, thick with undergrowth and trailing vines. There are no roads or even footpaths. Sound like a nightmare? To wildlife conservation biologist Dr. Michael Fay, it's paradise.



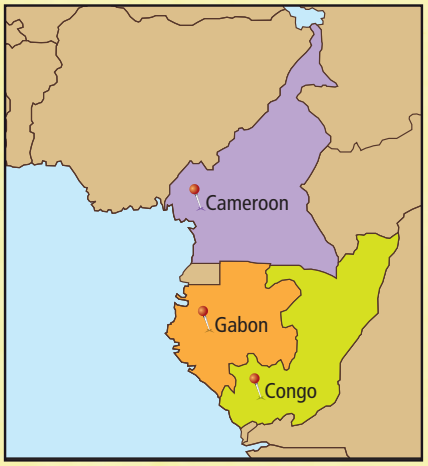
Megatransect Fay is a conservation biologist who studies how human activities affect ecosystems. While working in central Africa, Fay realized that a vast, intact forest corridor untouched by human activities ran from the center of the continent to the Atlantic Ocean. Fay envisioned walking the length of this corridor to study what he called "the last wild place on Earth." He named this historic project Megatransect.

Through the heart of Africa Megatransect began in 1999. During the 15-month journey, Fay's team covered 3200 km on foot, traveling through the republics of Congo, Cameroon, and Gabon. Thirteen national parks have been created in Gabon as a result of Fay's work.

Megatransect data at work
Megatransect data are helping to define human impact in measurable terms. Using satellite and field data, conservation biologists have designed a global map called the Human Footprint, which describes the extent of human influence in central Africa.

The success of Megatransect led to the funding of Megaflyover, a 110,000-km journey over Africa in a small airplane. Fay began his eight-month flight in 2004. The plane was mounted with a high-resolution digital camera that was matched with a Global Positioning Satellite (GPS) in an attempt to build on data collected during Megatransect.

West Central Africa



CAREERS in Biology

Oral Report Research to learn more about Fay's work since the African Megatransect. Develop an oral presentation describing the skills and knowledge that make his projects successful.

MICHAEL NICHOLS/National Geographic Stock

BIOLAB

Design Your Own

FIELD INVESTIGATION: A POND IN A JAR

Background: **Ecologists study parts of the biosphere. Each part is a unit containing many complex interactions between living things, such as food chains and food webs and the physical environment, the water cycle, and the mineral cycle. Smaller parts of the biosphere, such as communities and ecosystems, are the most practical for ecologists to explore and investigate.**

Question: *What can we learn from studying a miniaturized biological ecosystem?*

Materials

glass or clear plastic gallon jars
pond water
pond mud
appropriate cultures and select living organisms
Choose any other materials that would be appropriate to this lab.

Safety Precautions



WARNING: ***Use care when handling jars of pond water.***

Plan and Perform the Experiment

1. Read and complete the lab safety form.
2. Prepare an observation table as instructed.
3. Brainstorm and plan the step-by-step miniaturization of a pond community. Make sure your teacher has approved your plan before you proceed.
4. Decide on a particular aspect of your miniature community to evaluate and design an appropriate experiment. For example, you might test the effect of sunlight on your ecosystem.
5. Carry out your experiment.

Analyze and Conclude

1. **Explain** why you conducted your experiment slowly in a step-by-step manner. What might have happened if you poured everything into the jar all at once?
2. **Identify** the independent variable and the dependent variable.
3. **Design an experiment** Did your experiment have a control? Explain.
4. **Analyze and conclude** how your community differs from a pond community found in nature.
5. **Error analysis** How effective was your design? Explain possible sources of errors.



WRITING in Biology

Communicate Write a short story in which you describe what it would be like to be a microscopic animal living in your pond-in-a-jar.



(t)©Ariel Skelley/Blend Images/Corbis; (cl)Matt Meadows; (cr)Alan Thorton/Getty Images; (b)S Meltzer/PhotoLink/Getty Images

Chapter 3 Study Guide

THEME FOCUS Change Specific organisms are present during different stages of succession.

BIG Idea Limiting factors and ranges of tolerance are factors that determine where terrestrial biomes and aquatic ecosystems exist.

Section 1 Community Ecology

community (p. 60)
limiting factor (p. 61)
tolerance (p. 61)
ecological succession (p. 62)
primary succession (p. 62)
climax community (p. 63)
secondary succession (p. 63)

MAIN Idea All living organisms are limited by factors in the environment.

- Abiotic and biotic limiting factors restrict the growth of a population within a community.
- Organisms have a range of tolerance for each limiting factor that they encounter.
- Primary succession occurs on areas of exposed rock or bare sand (no soil).
- Communities progress until there is little change in the composition of species.
- Secondary succession occurs as a result of a disturbance in a mature community.

Section 2 Terrestrial Biomes

weather (p. 65)
latitude (p. 65)
climate (p. 66)
tundra (p. 68)
boreal forest (p. 68)
temperate forest (p. 69)
woodland (p. 69)
grassland (p. 70)
desert (p. 70)
tropical savanna (p. 71)
tropical seasonal forest (p. 71)
tropical rain forest (p. 72)

MAIN Idea Ecosystems on land are grouped into biomes primarily based on the plant communities within them.

- Latitude affects terrestrial biomes according to the angle at which sunlight strikes Earth.
- Latitude, elevation, ocean currents, and other abiotic factors determine climate.
- Two major abiotic factors define terrestrial biomes.
- There are nine major terrestrial biomes. There are two additional terrestrial regions that do not fit into these major categories.

Section 3 Aquatic Ecosystems

sediment (p. 75)
littoral zone (p. 76)
limnetic zone (p. 77)
plankton (p. 77)
profundal zone (p. 77)
wetlands (p. 78)
estuary (p. 78)
intertidal zone (p. 79)
photic zone (p. 80)
aphotic zone (p. 80)
benthic zone (p. 80)
abyssal zone (p. 81)

MAIN Idea Aquatic ecosystems are grouped based on abiotic factors such as water flow, depth, distance from shore, salinity, and latitude.

- Freshwater ecosystems include ponds, lakes, streams, rivers, and wetlands.
- Wetlands and estuaries are transitional aquatic ecosystems.
- Marine ecosystems are divided into zones that are classified according to abiotic factors.
- Estuaries and coral reefs are among the most diverse of all ecosystems.

Vocabulary eGames

Chapter 3 Assessment

Section 1

Vocabulary Review

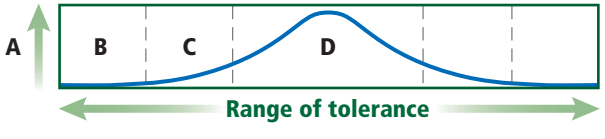
Choose the correct italicized term to complete each sentence.

1. An area of forest that experiences very little change in species composition is a *climax community/primary succession.*
2. The amount of oxygen in a fish tank is a *tolerance zone/limiting factor* that affects the number of fish that can live in the tank.
3. *Ecological succession/Secondary succession* describes the events that take place on a hillside that has experienced a destructive mudslide.

Understand Main Ideas

4. Lack of iron in the photic zone of the open ocean restricts the size of plankton populations. Iron is what kind of factor for marine plankton?
   A. distribution
   B. tolerance
   C. limiting
   D. biotic

For questions 5-7, use the generalized graph below that describes an organism's tolerance to a particular factor.



5. According to the graph, which letter represents the zone of intolerance for the factor in question?
   A. A
   B. B
   C. C
   D. D
6. What does the letter "D" represent in the graph?
   A. zone of intolerance
   B. zone of physiological stress
   C. optimum range
   D. upper limit
7. Which letter in the graph represents the zone of physiological stress?
   A. A
   B. B
   C. C
   D. D
8. Which place would you most likely find pioneer species growing?
   A. climax forest
   B. coral reef
   C. disturbed grassland
   D. newly formed volcano

Constructed Response

9. **CAREERS IN BIOLOGY** A state park and wildlife department stocks several bodies of water, including rivers and lakes, with rainbow trout. The trout survive but do not reproduce. In terms of tolerance, discuss what might be happening.

Use the image below to answer question 10.



10. **Short Answer** Describe how the successional stages would differ from primary succession.
11. MAIN Idea Explain why the concepts of limiting factors and tolerance are important in ecology.

Think Critically

12. THEME FOCUS Cause and Effect Infer whether species diversity increases or decreases after a fire on a grassland. Explain your response.
13. **Generalize** the difference between a successional stage and a climax community.

Section 2

Vocabulary Review

Choose the vocabulary term from the Study Guide page that best fits each definition below.

14. the condition of the atmosphere
15. the average conditions in an area
16. a biome characterized by evaporation exceeding precipitation

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Chapter 3 Assessment

Understand Main Ideas

17. Which best describes the distribution of communities on a tall mountain?

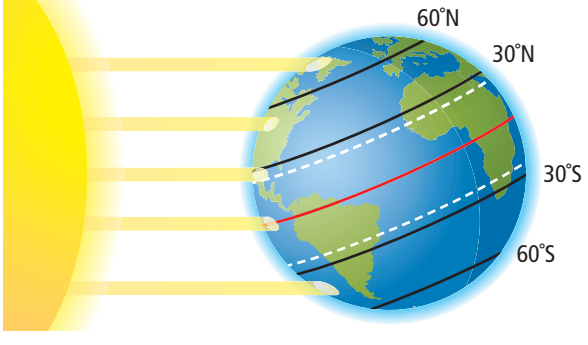
A. Evergreen forests exist up to the tree line and no vegetation is found above the tree line.

B. Several communities might be stratified according to altitude and might end in an ice field at the top of the highest mountains.

C. As altitude increases, tall trees are replaced by shorter trees, and ultimately are replaced by grasses.

D. Tundra-like communities exist at the top of the highest mountains, and deserts are found at the lower elevations.

Use the diagram below to answer question 18.



18. Which area receives the least amount of solar energy per unit of surface area?

A. north of 60°N and south of 60°S

B. south of 30°N and north of 30°N

C. between the Tropic of Cancer and the Tropic of Capricorn

D. north and south temperate zones

19. What is the name for large geographic areas with similar climax communities?

A. assemblages **C.** successions

B. communities **D.** biomes

20. Which biome occurs in the United States and once contained huge herds of grazing herbivores?

A. boreal forest **C.** grassland

B. temperate forest **D.** savanna

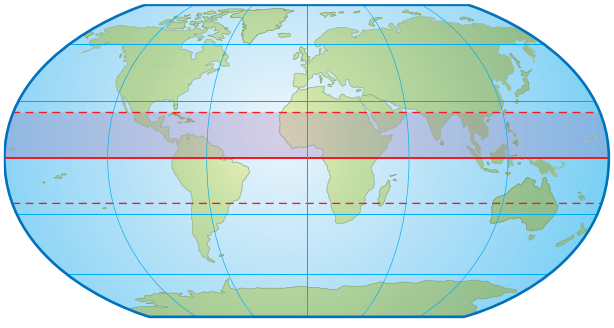
21. Which land biome contains the greatest species diversity?

A. tundra **C.** desert

B. grassland **D.** tropical rain forest

Constructed Response

Use the image below to answer question 22.



22. Open Ended Describe a biome that might be found in the shaded area shown above.

23. Open Ended In December 2004, a huge iceberg caused a large number of penguin chicks to die of starvation. Ice shelves broke apart in areas where the air temperature increased. The parents of the penguins were cut off from their food source. How is this an example of temperature as a limiting factor?

Think Critically

24. MAIN Idea Suggest why land biomes are classified according to their plant characteristics rather than according to the animals that inhabit them.

25. Classify a biome that is warm to hot in the summer and cool or cold in the winter and that receives approximately 50–89 cm of precipitation annually.

Section 3

Vocabulary Review

Replace the underlined words with the correct terms from the Study Guide page.

26. A(n) area where freshwater and salt water meet provides habitat for a diversity of organisms.

27. The well-lit portion of the ocean is the area where all of the photosynthetic organisms live.

28. The shoreline of the ocean contains communities that are layered depending on how long they are submerged by tides.

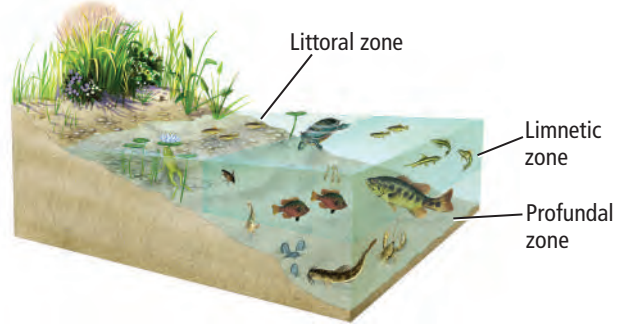
Online Test Practice

Understand Main Ideas

29. Where is the largest percentage of water located?

A. groundwater **C.** oceans
B. rivers **D.** glaciers

Use the diagram below to answer question 30.



30. In which area of the lake is there likely to be the greatest diversity of plankton?

A. littoral zone **C.** profundal zone
B. limnetic zone **D.** aphotic zone

31. Which best describes the intertidal zone on a rocky shore?

A. The dominant low-energy community is likely to be an estuary.
B. The communities are adapted to shifting sands due to incoming waves.
C. The communities are stratified from the high-tide line to the low-tide line.
D. The organisms in the community constantly require dissolved oxygen.

Constructed Response

32. Short Answer How is light a limiting factor in oceans?

33. Short Answer Describe characteristics of an estuary.

34. Open Ended Describe adaptations of an organism living in the abyssal zone of the ocean.

Think Critically

35. **Predict** the consequences a drought would have on a river such as the Mississippi River.

36. MAIN Idea Compare the intertidal zone with the photic zone in terms of tidal effect.

Summative Assessment

37. BIG Idea Explain the importance of limiting factors and ranges of tolerance for a specific biome or ecosystem.

38. WRITING in Biology Choose a biome other than the one in which you live. Write an essay explaining what you think you would like and what you think you would dislike about living in your chosen biome.

DBQ Document-Based Questions

"Leaf mass per area (LMA) measures the leaf dry-mass investment per unit of light-intercepting leaf area deployed. Species with high LMA have a thicker leaf blade or denser tissue, or both."

"Plant ecologists have emphasized broad relationships between leaf traits and climate for at least a century. In particular, a general tendency for species inhabiting arid and semi-arid regions to have leathery, high-LMA leaves has been reported. Building high-LMA leaves needs more investment per unit leaf area. Construction cost per unit leaf mass varies relatively little between species: leaves with high protein content (typically low-LMA leaves) tend to have low concentrations of other expensive compounds such as lipids or lignin, and high concentrations of cheap constituents such as minerals. Leaf traits associated with high LMA (for example, thick leaf blade; small, thick-walled cells) have been interpreted as adaptations that allow continued leaf function (or at least postpone leaf death) under very dry conditions, at least in evergreen species."

Data obtained from: Wright, I.J. et al. The worldwide leaf economics spectrum. *Nature* 428:821–828.

39. From the information presented, would you expect leaves on trees in the tropical rain forest to contain large quantities of lipids? Explain your answer in terms of energy investment.

40. Hypothesize how high-LMA leaves are adapted for dry conditions.

Online Test Practice

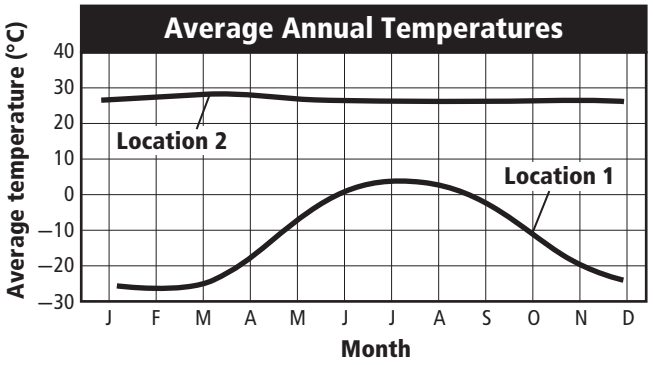
Standardized Test Practice

Cumulative

Multiple Choice

1. If science can be characterized as discovery, then technology can be characterized as which?
   - **A.** application
   - **B.** information
   - **C.** manufacturing
   - **D.** reasoning

Use the illustration below to answer questions 2 and 3.

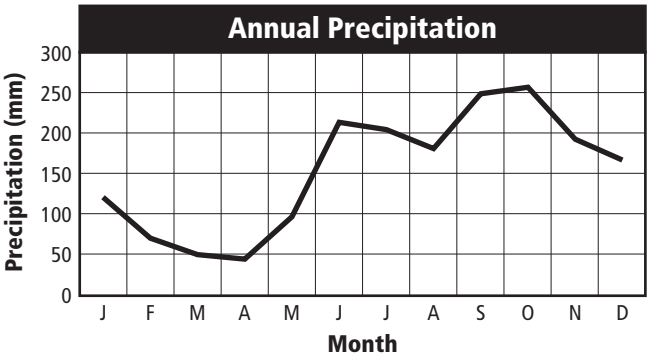


2. Based on the graph above, which term describes Location 2?
   - **A.** oceanic
   - **B.** polar
   - **C.** temperate
   - **D.** tropical

3. Suppose that in Location 2 there is very little rainfall during the year. What would be the name of that biome in this region?
   - **A.** desert
   - **B.** tundra
   - **C.** temperate forest
   - **D.** tropical rain forest

4. Which process is associated with long-term cycling of matter through the biosphere?
   - **A.** breakdown of organic material by decomposers
   - **B.** formation and weathering of minerals in rocks
   - **C.** formation of compounds used for food by living organisms
   - **D.** movement of fresh water from the land into bodies of water through run-off

Use the illustration below to answer question 5.



5. Look at the information in the graph. From what kind of biome are these data probably taken?
   - **A.** desert
   - **B.** tundra
   - **C.** temperate forest
   - **D.** tropical rain forest

6. Which system of measurement is the basis for many of the SI units?
   - **A.** binary
   - **B.** English
   - **C.** metric
   - **D.** number

7. Which of these organisms is a decomposer?
   - **A.** a bacterium that makes food from inorganic compounds
   - **B.** a clam that takes in water and filters food
   - **C.** a fungus that gets nutrients from dead logs
   - **D.** a plant that makes food using sunlight

8. Which distinguishes scientific ideas from popular opinions?
   - **A.** Popular opinions are always rational and logical.
   - **B.** Popular opinions depend on research and evidence.
   - **C.** Scientific ideas are always testable and repeatable.
   - **D.** Scientific ideas depend on anecdotes and hearsay.

Short Answer

9. How is a tundra similar to and different from a boreal forest? Use a Venn diagram to organize information about the similarities and differences of these biomes.

10. What is the role of a pioneer species in primary succession?

11. Give two examples of how the human body shows the living characteristic of organization.

12. Suppose a certain insect species lives only in a specific species of tree. It feeds off the sap of the tree and produces a chemical that protects the tree from certain fungi. What kind of relationship is this?

13. Why would you expect to find different animals in the photic and aphotic zones of the ocean?

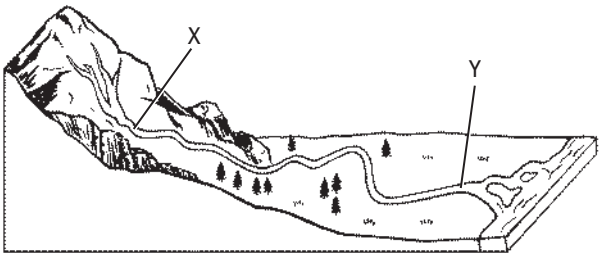
14. Suppose a gardener learns that the soil in a garden has low nitrogen content. Describe two ways to increase the nitrogen available for plants in the garden.

15. Explain how the establishment of a climax community through primary succession differs from the establishment of a climax community that occurs through secondary succession.

16. Why is the ability to adapt an important characteristic of living things?

Extended Response

Use the illustration below to answer question 17.



17. Based on the information in the illustration above, what can you infer about the major differences between the freshwater ecosystems at Point X and Point Y?

18. Suppose a nonnative species is introduced into an ecosystem. What is one kind of community interaction you might expect from the other organisms in that ecosystem?

Essay Question

Suppose there is a dense temperate forest where people do not live. After a few hot, dry months, forest fires have started to spread through the forest area. There is no threat of the fires reaching areas inhabited by humans. Some people are trying to get the government to intervene to control the fires, while others say the fires should be allowed to run their natural course.

Using the information in the paragraph above, answer the following question in essay format.

19. Explain which side of this debate you would support. Provide evidence based on what you know about change in ecosystems.

NEED EXTRA HELP?

If You Missed Question . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Review Section . . .	3.2	3.2	3.2	2.3	3.3	1.2	2.2	1.3	3.2	3.1	1.1	2.1	3.3	2.3	3.1	1.1	3.3	3.3	3.1, 3.2

GLENCOE

BIOLOGY

Unit 1 Ecology
Unit 2 The Cell
Unit 3 Genetics
Unit 4 History of Biological Diversity
Unit 5 Bacteria, Viruses, Protists, and Fungi
Unit 6 Plants
Unit 7 Invertebrates
Unit 8 Vertebrates
Unit 9 The Human Body

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