LESSON PLAN OVERVIEW

CHAPTER 3: Ecology *(Foundational)*

PPT Pres. *PowerPoint Presentation* **LM** *Lab Manual* **EV** *ExamView*

PAGES	OBJECTIVES	PRINTED RESOURCES & MATERIALS	DIGITAL RESOURCES	ASSESSMENTS
3.1 *OUR LIVING PLANET*				
51–55	**3.1.1 Distinguish between ecosystems and the biosphere.** **3.1.2 Explain how biotic and abiotic factors work together to sustain life.** **BWS Design (explain)**	**Teacher Edition** • Case Study: *The Great Barrier Reef* • Mini Lab: *Who Is in the Community?* • Section 3.1 Review Answers **Materials** • ecosystem photos • opaque bowl • colored marbles • sampling tools	**BJU Press Trove*** • Video: *Cleaner Fish* • PPT Pres.: *Section 3.1 Slides*	**Student Edition** Section 3.1 Review **Assessments** Section 3.1 Quiz
LAB 3A *TAG!—MARK-AND-RECAPTURE SAMPLING AND POPULATION SIZE*				
LM 19–24	**Explain how mark and recapture can be used to estimate population size.** **Collect data by mark and recapture to answer a scientific question.** **Describe the limitations of the mark-and-recapture method of sampling.**			**Student Edition** Lab Report
3.2 *BIOMES*				
56–63	**3.2.1 Explain the role of climate in determining biome types.** **3.2.2 Classify biomes on the basis of their biotic and abiotic factors.** **3.2.3 Compare biomes and vertical zonation.**	**Teacher Edition** • Section 3.2 Review Answers **Materials** • sample climate data graphs	**BJU Press Trove** • PPT Pres.: *Section 3.2 Slides*	**Student Edition** Section 3.2 Review **Assessments** Section 3.2 Quiz
LAB 3B *MUST YOU BE SO COMPETITIVE?—INQUIRING INTO GROWTH RATE*				
LM 25–26	**Design and conduct an experiment to evaluate the effect of a selected factor on the growth rates of plants.** **Evaluate the experimental design on the basis of collected data.**	**Teacher Lab Manual** • Lab 3B Teacher Guide		Formal Lab Report

*Digital resources for homeschool users are available on Homeschool Hub.

PAGES	OBJECTIVES	PRINTED RESOURCES & MATERIALS	DIGITAL RESOURCES	ASSESSMENTS
3.3 *WEB OF LIFE*				
64–67	**3.3.1** Create food webs and ecological pyramids to represent the relationships between producers and consumers within an ecosystem. **3.3.2** Give examples of neutralism, competition, predation, parasitism, commensalism, and mutualism. **3.3.3** Evaluate a statement on the probability that life exists on other planets. BWS Design (evaluate, formulate)	**Teacher Edition** • Case Study: *Tide Pool Ecology* (p. 70) • Section 3.3 Review Answers **Materials** • images of animals	**BJU Press Trove** • Video: *Web of Life* • PPT Pres.: *Section 3.3 Slides*	**Student Edition** Section 3.3 Review **Assessments** Section 3.3 Quiz
CHAPTER 3 REVIEW				
68–71	Relate the study of ecology within the larger context of biology and to other content areas of science. Compare the workability of various models used in ecology. Evaluate the claim that Earth is divinely designed to support life. Estimate the size of a population of organisms using mark and recapture. (Lab 3A) Design, conduct, and evaluate an experiment to assess the effect of a selected factor on the growth rates of plants. (Lab 3B)	**Teacher Edition** • Chapter 3 Review Answers		**Student Edition** Chapter 3 Review
CHAPTER 3 TEST				
	Demonstrate knowledge of concepts from Chapter 3 by taking the test.		**BJU Press Trove** • EV: *Chapter 3 Test Bank*	**Assessments** Chapter 3 Test

CHAPTER *Objectives*

- Relate the study of ecology within the larger context of biology and to other content areas of science.
- Compare the workability of various models used in ecology.
- Evaluate the claim that Earth is divinely designed to support life.
- Estimate the size of a population of organisms using mark and recapture. (Lab 3A)
- Design, conduct, and evaluate an experiment to assess the effect of a selected factor on the growth rates of plants. (Lab 3B)

Chapter Overview

Chapter 3 is a foundational chapter that introduces the fascinating topic of *ecology*—the study of the complex interplay between different kinds of organisms and between organisms and their environment. Students will learn about the abiotic factors that differentiate between different types of biomes, the characteristics of those biomes, and the kinds of plants and animals that live in each. Throughout this chapter students will see that God has divinely engineered Earth to be a suitable home for living things.

3 ECOLOGY

Extreme Life

We live on a planet that throbs with life to the extreme. Sometimes life takes hold in the most unexpected places—spots on Earth with no sunlight or air, some with oppressively hot or bitterly cold temperatures. Microbes have been found in the deepest ocean trenches, in acid lakes, and even buried deep under Antarctic ice.

Evolutionists look at these forms of life, called extremophiles, and wonder whether life like this exists outside of Earth. In fact, in 2024 NASA plans to send a probe to Europa, a moon of Jupiter with an icy surface. They suspect that this moon has liquid water beneath its icy surface and a tectonic structure like Earth's. But what will they find? Will it change the way we think about life on our planet?

3.1 OUR LIVING PLANET

The Biosphere

What makes Earth a good place for life?

Questions

How do ecologists categorize the living and nonliving parts of Earth?

How are living things affected by their environment?

Terms

biosphere
ecology
biodiversity
biome
ecosystem
habitat
niche
abiotic factor
biotic factor
population

The search for life originating outside our living planet on places like the moon, Mars, and Europa is called *astrobiology*. It is a hot, new field that is a moving force in NASA's space program. The problem for astrobiologists is that they haven't found life that comes from anywhere other than Earth despite spending millions of dollars developing the finest technology. None at all! So why look for life in space when there is so much around us?

Scientists are looking to extend their beliefs about life on Earth to space. If life and everything in the universe is a product of chance and a big bang, why wouldn't we see life elsewhere in the universe? In their view of biology, evolution is life's designer. The late Carl Sagan, former professor and astronomer at Cornell University, once said, "The universe is a pretty big place. If it's just us, seems like an awful waste of space." Life should be easy to find wherever we look, but that's not what we observe.

God designed life, and He made Earth for life. We see this in the wording and unfolding of the Creation account. The heavens, the earth, the waters, and the stars, sun, and moon are all mentioned in direct connection to the living things that God created. The stars are mentioned almost as an afterthought because life on this planet is the centerpiece of God's creation, though all of creation declares His glory (Ps. 19:1; Rom. 11:36). Earth is the shelter, the haven, the home for God's precious, living creation in the hostile environment of space. When we look around our living planet, we can see evidence of a God who cares and who provides for the living things He loves. The realm of life on Earth, called the **biosphere**, extends from a few kilometers into the atmosphere to a few kilometers into Earth's crust. This thin shell around us is the only place we know of where life can occur.

SECTION 3.1 *Overview*

What makes Earth a good place for life?

Objectives

3.1.1 **Distinguish between ecosystems and the biosphere.**

3.1.2 **Explain how biotic and abiotic factors work together to sustain life.** BWS

Biblical Worldview Shaping

Design (explain): God has wisely orchestrated many factors so that living things may thrive. (3.1.2)

Printed Resources

- Case Study: *The Great Barrier Reef*
- Mini Lab: *Who Is in the Community?*
- Review: Section 3.1 Review Answers
- Assessment: Section 3.1 Quiz

Digital Resources

- Video: *Cleaner Fish*

Materials

- ecosystem photos
- opaque bowl
- colored marbles
- sampling tools

Overview

Section 3.1 begins with the premise that God designed Earth for life. The Student Edition defines *ecology* and then examines the different scales at which the biosphere can be modeled, from biomes to niches. Lastly, two major divisions within biomes are considered—biotic and abiotic factors—including how they impact populations of organisms.

Field Trip Planning

A field trip is especially well-suited for reinforcing the content of Chapter 3 (see the Field Trip teacher note on page 66). We mention this here because you will need to do some planning ahead if you want to include such an activity.

ENGAGE

Cleaner Fish

Use the *Cleaner Fish* **video** to kick off your unit on ecology. This short video examines the cleaner fish's niche within the coral reef community. After students have viewed the video, ask the following questions to get them thinking about how different parts of the coral reef community interact. The words in bold italic in the answers are terms that will be defined in the chapter. This video is available as a digital resource.

What is the cleaner fish's "job"? *The cleaner fish removes parasites from other reef residents. This is its* ***niche****.*

What are some of the organisms that the cleaner fish interacts with? *other fish, corals; These are part of the coral reef* ***community****.*

What are some nonliving factors that affect the reef community? *sunlight, water, the structure of the reef; These are part of the cleaner fish's* ***habitat****.*

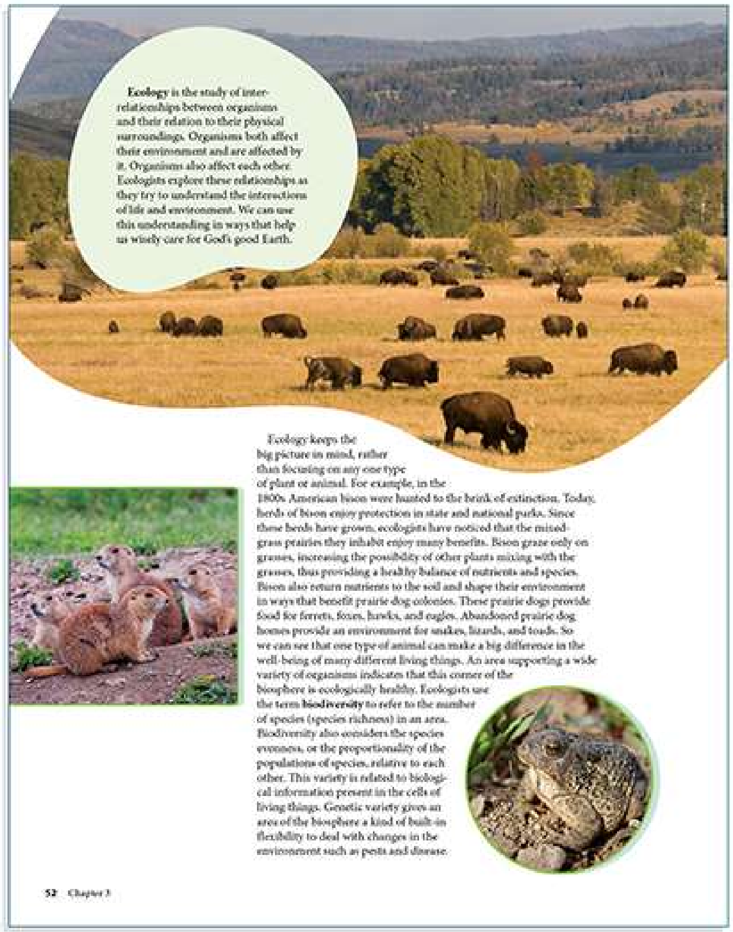
INSTRUCT

Organizing Information

Some students will benefit from using graphic organizers (see Appendix B) to keep track of the many vocabulary terms and concepts presented in this chapter. A **hierarchy chart** can be used to organize hierarchical information, such as the relationships between the terms *biosphere, biome, ecosystem, habitat,* and *niche*. Students should include a brief definition of each term and one or two examples to jog their memories.

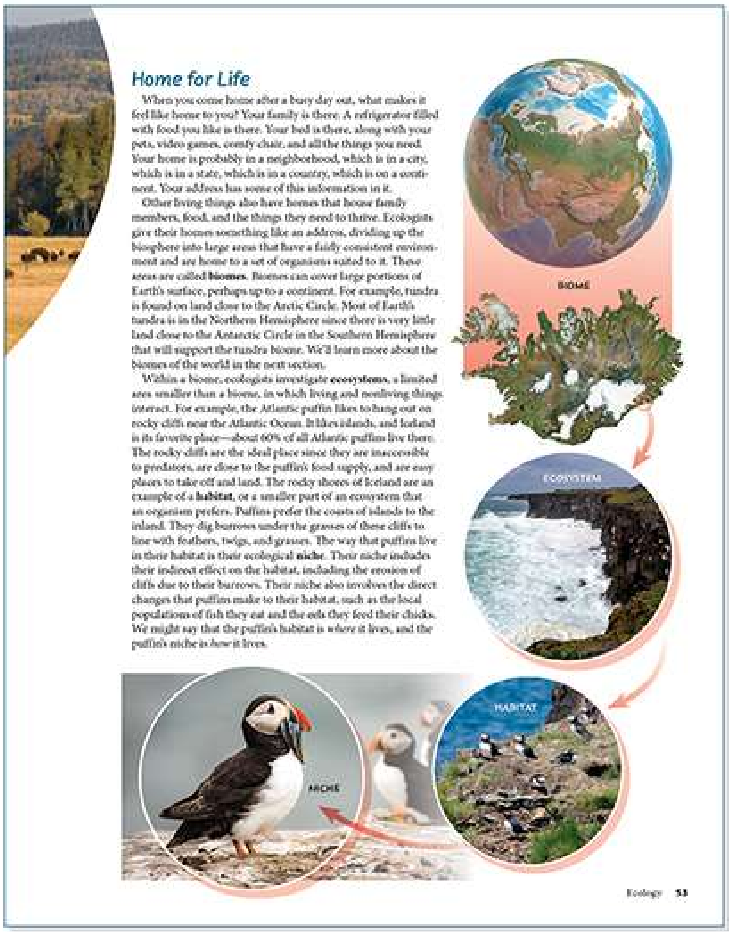
Clarifying the Biosphere

Emphasize that the biosphere is not delineated by easily seen physical boundaries, such as that between the earth and sky or between the sky and sea. The biosphere exists wherever living things can exist, and that includes some places that might be counterintuitive, such as in the ocean's abyssal plain or even deep underground. Often the organisms that thrive on the fringes of the biosphere are extremophilic bacteria that can tolerate extremes of temperature or pressure and have unusual metabolic pathways for obtaining energy (see page 256).



Ecology is the study of interrelationships between organisms and their relation to their physical surroundings. Organisms both affect their environment and are affected by it. Organisms also affect each other. Ecologists explore these relationships as they try to understand the interactions of life and environment. We can use this understanding in ways that help us wisely care for God's good Earth.

Ecology keeps the big picture in mind, rather than focusing on any one type of plant or animal. For example, in the 1800s American bison were hunted to the brink of extinction. Today, herds of bison enjoy protection in state and national parks. Since these herds have grown, ecologists have noticed that the mixed-grass prairies they inhabit enjoy many benefits. Bison graze only on grasses, increasing the possibility of other plants mixing with the grasses, thus providing a healthy balance of nutrients and species. Bison also return nutrients to the soil and shape their environment in ways that benefit prairie dog colonies. These prairie dogs provide food for ferrets, foxes, hawks, and eagles. Abandoned prairie dog homes provide an environment for snakes, lizards, and toads. So we can see that one type of animal can make a big difference in the well-being of many different living things. An area supporting a wide variety of organisms indicates that this corner of the biosphere is ecologically healthy. Ecologists use the term **biodiversity** to refer to the number of species (species richness) in an area. Biodiversity also considers the species evenness, or the proportionality of the populations of species, relative to each other. This variety is related to biological information present in the cells of living things. Genetic variety gives an area of the biosphere a kind of built-in flexibility to deal with changes in the environment such as pests and disease.



Home for Life

When you come home after a busy day out, what makes it feel like home to you? Your family is there. A refrigerator filled with food you like is there. Your bed is there, along with your pets, video games, comfy chair, and all the things you need. Your home is probably in a neighborhood, which is in a city, which is in a state, which is in a country, which is on a continent. Your address has some of this information in it.

Other living things also have homes that house family members, food, and the things they need to thrive. Ecologists give their homes something like an address, dividing up the biosphere into large areas that have a fairly consistent environment and are home to a set of organisms suited to it. These areas are called **biomes**. Biomes can cover large portions of Earth's surface, perhaps up to a continent. For example, tundra is found on land close to the Arctic Circle. Most of Earth's tundra is in the Northern Hemisphere since there is very little land close to the Antarctic Circle in the Southern Hemisphere that will support the tundra biome. We'll learn more about the biomes of the world in the next section.

Within a biome, ecologists investigate **ecosystems**, a limited area smaller than a biome, in which living and nonliving things interact. For example, the Atlantic puffin likes to hang out on rocky cliffs near the Atlantic Ocean. It likes islands, and Iceland is its favorite place—about 60% of all Atlantic puffins live there. The rocky cliffs are the ideal place since they are inaccessible to predators, are close to the puffin's food supply, and are easy places to take off and land. The rocky shores of Iceland are an example of a **habitat**, or a smaller part of an ecosystem that an organism prefers. Puffins prefer the coasts of islands to the inland. They dig burrows under the grasses of these cliffs to line with feathers, twigs, and grasses. The way that puffins live in their habitat is their ecological **niche**. Their niche includes their indirect effect on the habitat, including the erosion of cliffs due to their burrows. Their niche also involves the direct changes that puffins make to their habitat, such as the local populations of fish they eat and the eels they feed their chicks. We might say that the puffin's habitat is *where* it lives, and the puffin's niche is *how* it lives.

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The Interconnectedness of Earth's Systems

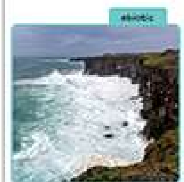
It's tempting to think of biomes or ecosystems as standalone systems, but remember that these are categories created to help us model very complex systems by dividing them up into more manageable chunks. The factors that come into play in these various "chunks" are not always obvious. Northern Ireland, for example, is at the same latitude as central Quebec yet has a much milder year-round climate because of the influence of the Gulf Stream, which in turn is driven by the sun's heating of the ocean's surface in the tropics, thousands of kilometers away from Northern Ireland. Nearly every ecological tier, from biome to habitat, is influenced by factors from *outside* that system.

case study

THE GREAT BARRIER REEF

Off the coast of Australia lies the Great Barrier Reef, the largest coral reef in the world. Corals are alive, and they attract other living creatures such as sea turtles, clownfish, sea anemones, and crown-of-thorns starfishes. Striped surgeonfish tend to stay near the reef because they have slender, elongated bodies that can slip between cracks in the reef when pursued by predators such as barracuda. Striped surgeonfish are bottom feeders, scooping algae off the ocean floor. But they feed on photosynthetic organisms, so they live only in shallow areas of the ocean. They are territorial, vigorously defending their grazing grounds from other striped surgeonfish and other algae eaters such as damselfish. Male striped surgeonfish are usually surrounded by a harem of females. The striped surgeonfish is important to its ecosystem because it keeps algae and plankton from taking over the area and returns nutrients to the water to nourish other living things.

So why do so many puffins make Iceland their home? A variety of factors make it an ideal location for them. Some aspects of their ecosystem—the water, the wind, the rocky cliffs, the cooler temperatures—are elements of the physical environment. These nonliving aspects of an ecosystem are called **abiotic factors**. Other factors—the fish they eat, other puffins, and the seals, foxes, and gulls that prey on them—are living parts of their ecosystem, or **biotic factors**. This would include parasites, like the fleas and ticks that sometimes plague puffins. As part of God's design for our planet, all life—its balance and sustenance—depends on the interaction between abiotic and biotic factors. For instance, abundant nutrients and plenty of summer sunshine in the Northern Hemisphere (abiotic factors) produce the masses of phytoplankton (biotic factor) that are the first link in the arctic food chain that includes puffins. The living things that inhabit the same ecosystem are called a *community*, like the neighborhood that you live in.



Puffins spend most of the time during the year bobbing around on the ocean. But they're not loners. They nest in colonies and often lay eggs all at the same time, and the number of breeding couples in a colony changes every year. They rely on each other to defend the colony from predators. The more the merrier! This is an example of a **population**, a group of organisms of the same species interacting in the same area. Ecologists monitor the populations of animals living in an ecosystem to learn more about the ecosystem and the relationships between biotic and abiotic factors in that environment.

Within a population an ecologist can look at the attributes of the population, such as how many live in a certain area, the ratio of males to females, and so on. This could involve studying individual puffins or puffin couples. The goal would be to learn about the things that individual puffins need, the way they raise their chicks, the way they behave in relation to the colony, and the way individual puffins or groups of puffins interact within the colony. This is an example of how ecologists study individual organisms to learn more about populations, communities, and ecosystems to better care for the place we all call home.

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Biotic and Abiotic Factors

Use a **visual analysis** as a formative assessment to check students' understanding of biotic versus abiotic factors in an ecosystem. Have students create a T-Chart (see Appendix B) and label one side of their T-Chart *Biotic* and the other side *Abiotic*. Show students a photo of an ecosystem with some animals in it, such as a savanna with different kinds of grazing animals. Allow them a minute or two to identify as many environmental components as they can and place each of them in the appropriate category. Afterward, have some students share their answers. Correct any misconceptions that arise.

Alternatively, you can write out individual biotic and abiotic factors on sticky notes. Place these around the classroom, then have teams of students analyze them and move them to a T-Chart that you have created.

APPLY

Where Do I Fit In?

Use a **personal analogy** to assess students' grasp of the concepts from Section 1. Starting with thinking of themselves as an individual organism—a student—students should make determinations about their niches and the populations and communities they belong to. They should also identify the parts of their educational environment that are analogous to a habitat, ecosystem, and biome.

- niche: My role is to learn new things.
- population: This refers to the other students at my school.
- community: This refers to the students at my school plus the other people who work there, such as teachers, aides, and custodians.
- habitat: This is my classroom.
- ecosystem: This is the school that my classroom is part of.
- biome: This is the town where my school is located.

MINI LAB: *Who Is in the Community?*

Use the **mini lab activity** to illustrate how scientists make estimates about the size and composition of a community.

The bowl should be opaque so that only the top layer of marbles can be seen. A wide-mouth jar may also be used. It is helpful, but not absolutely necessary, to know the percentage of each color in your marble mixture. A known mixture will allow students to calculate the percent error of their estimates. To make things more interesting, instead of thoroughly mixing the marbles, you may choose to layer them by color, much as real organisms are sorted in vertically zonated systems. Students who dip only shallow samples from such a system will have large errors in their estimates of the percentage of each color.

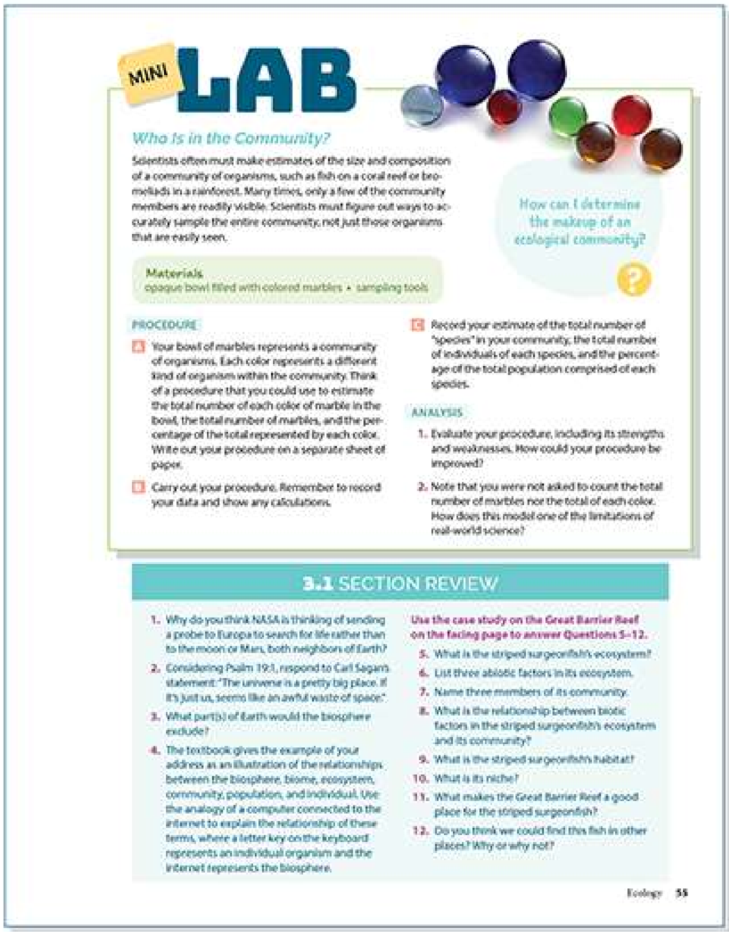
A small measuring cup or aquarium dip net makes a logical sampling tool, but provide students with a variety of options, some useful and some not so useful (e.g., masking tape, chopsticks, tongs).

Students' procedures will vary. Having a dip net or measuring cup should suggest the possibility of dipping samples from the bowl, counting the marbles in each sample, and extrapolating the data to the entire bowl of marbles. Some students may realize that increasing the number of dipped samples will increase the reliability of the data and produce better population estimates.

Instead of having students turn in their work, you may choose to review their answers in a discussion.

Answers

1. Answers will vary. Some students may realize that the most accurate estimate will be one produced by evaluating the entire content of the bowl of marbles. A more manageable and realistic improvement would simply be to increase the number of samples to provide more reliable data.



MINI LAB

Who Is in the Community?

Scientists often must make estimates of the size and composition of a community of organisms, such as fish on a coral reef or bromeliads in a rainforest. Many times, only a few of the community members are readily visible. Scientists must figure out ways to accurately sample the entire community, not just those organisms that are easily seen.

How can I determine the makeup of an ecological community?

Materials
opaque bowl filled with colored marbles • sampling tools

PROCEDURE

A Your bowl of marbles represents a community of organisms. Each color represents a different kind of organism within the community. Think of a procedure that you could use to estimate the total number of each color of marble in the bowl, the total number of marbles, and the percentage of the total represented by each color. Write out your procedure on a separate sheet of paper.

B Carry out your procedure. Remember to record your data and show any calculations.

C Record your estimate of the total number of "species" in your community, the total number of individuals of each species, and the percentage of the total population comprised of each species.

ANALYSIS

1. Evaluate your procedure, including its strengths and weaknesses. How could your procedure be improved?
2. Note that you were not asked to count the total number of marbles nor the total of each color. How does this model one of the limitations of real-world science?

3.1 SECTION REVIEW

1. Why do you think NASA is thinking of sending a probe to Europa to search for life rather than to the moon or Mars, both neighbors of Earth?
2. Considering Psalm 19:1, respond to Carl Sagan's statement: "The universe is a pretty big place. If it's just us, seems like an awful waste of space."
3. What part(s) of Earth would the biosphere exclude?
4. The textbook gives the example of your address as an illustration of the relationships between the biosphere, biome, ecosystem, community, population, and individual. Use the analogy of a computer connected to the internet to explain the relationship of these terms, where a letter key on the keyboard represents an individual organism and the internet represents the biosphere.

Use the case study on the Great Barrier Reef on the facing page to answer Questions 5–12.

5. What is the striped surgeonfish's ecosystem?
6. List three abiotic factors in its ecosystem.
7. Name three members of its community.
8. What is the relationship between biotic factors in the striped surgeonfish's ecosystem and its community?
9. What is the striped surgeonfish's habitat?
10. What is its niche?
11. What makes the Great Barrier Reef a good place for the striped surgeonfish?
12. Do you think we could find this fish in other places? Why or why not?

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2. There is normally no way for scientists to count all the members of a population of organisms. Therefore, total numbers are nearly always estimates, not known quantities.

LAB 3A: *Tag!*

Use this **guided discovery lab activity** to introduce students to a real-world technique used by biologists to estimate population sizes: mark-and-recapture sampling. Students should be able to do this activity after finishing Section 3.1.

What makes Earth a good place for life?

The main reason, of course, why Earth is a good place for life is that our wise and caring Creator designed it to meet the needs of living things. Earth has the necessary balance of all the things needed for living things to thrive, among which are liquid water, year-round mild temperatures, an abundance of energy, and a variety of habitats that provide living things with food and shelter.

ASSESS

Section 3.1 Review

Assign the section review as a **formative assessment** to help students solidify their understanding of Section 1.

Section 3.1 Quiz

Use the Section 3.1 quiz as a **formative assessment** to check students' understanding of Section 1.

Section 3.1 Review Answers

1. Scientists at NASA suspect that Europa has liquid water and a structure like Earth's, providing some of the things that we think life needs to exist in the universe. (p. 51)
2. The heavens, among other things, exist to declare the glory of God. How important the glory of God is to a person will determine whether he thinks a vast universe without life is a waste. Christians know that God's glory is infinite. So why not have a universe as big as ours? (p. 51)
3. The biosphere would exclude any place on Earth where things can't live, such as in its interior or the upper reaches of the atmosphere. (p. 51)
4. Answers will vary. One letter key represents an individual organism. The other letter keys represent a population. The non-letter keys together with the letter keys represent a community living in an ecosystem, represented by the keyboard. The keyboard, together with the monitor, mouse, and tower, stand for the biome, which along with other biomes (computers connected to the internet) represent the biosphere. (pp. 51–54)
5. the Great Barrier Reef (or coral reefs) (p. 54)
6. Accept any three: light, salt water, dissolved oxygen in the water, water temperature, water depth, water pressure, ocean floor, and ocean currents (not all of which are specifically mentioned in the Student Edition). (p. 54)
7. Accept any three: damselfish, clown fish, sea anemones, coral reef, crown-of-thorns, algae, and plankton, all of which are mentioned in the Student Edition. (p. 54)
8. The biotic factors and the community of the striped surgeonfish are the same. (p. 54)
9. the ocean floor near coral reefs (p. 52)
10. Male surgeonfish are territorial and form harems. Surgeonfish return nutrients to the water to maintain algae and plankton populations. Surgeonfish compete with damselfish and are prey for barracuda. (p. 54)
11. The Great Barrier Reef has the right combination of biotic and abiotic factors to make a good home for the striped surgeonfish. (p. 54)
12. Yes. This fish can live in other places that have similar biotic and abiotic factors. (p. 54)

SECTION 3.2 *Overview*

Why do certain organisms live in certain places?

Objectives

- 3.2.1 **Explain the role of climate in determining biome types.**
- 3.2.2 **Classify biomes on the basis of their biotic and abiotic factors.**
- 3.2.3 **Compare biomes and vertical zonation.**

Printed Resources

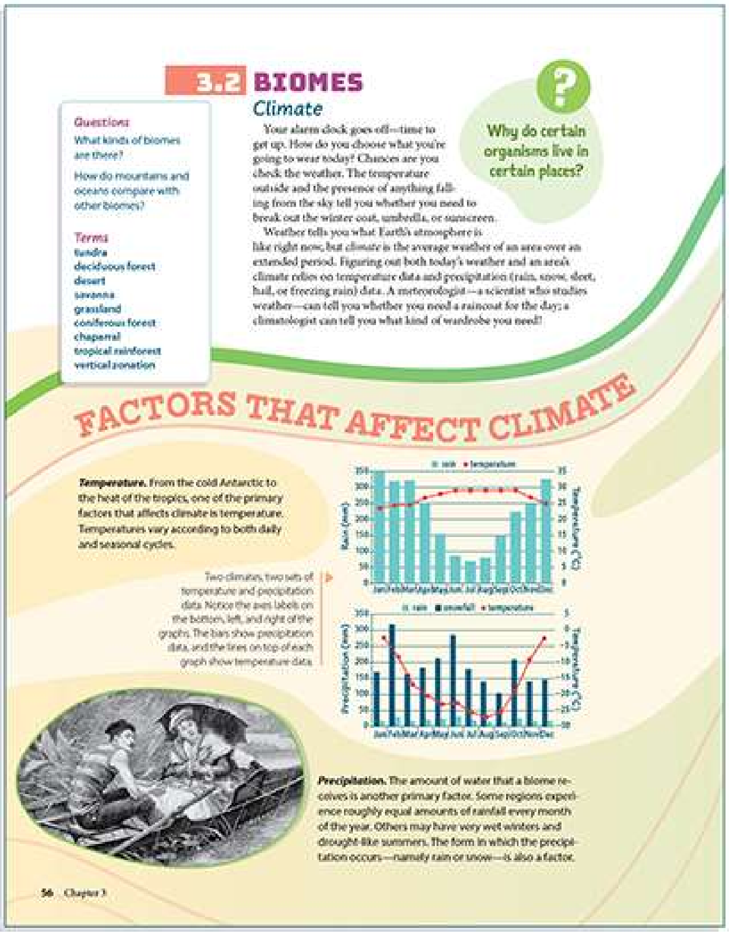
- Review: Section 3.2 Review Answers
- Assessment: Section 3.2 Quiz

Materials

- Sample climate data graphs

Overview

Section 3.2 examines the factors that determine climate and the role that climate in turn plays in determining the characteristics of Earth's biomes. This is followed by a survey of Earth's major biomes. The section concludes with a brief look at how biomes are affected by vertical zonation.



3.2 BIOMES

Climate

Questions
What kinds of biomes are there?
How do mountains and oceans compare with other biomes?

Terms
tundra
deciduous forest
desert
savanna
grassland
coniferous forest
chaparral
tropical rainforest
vertical zonation

Why do certain organisms live in certain places?

Your alarm clock goes off—time to get up. How do you choose what you're going to wear today? Chances are you check the weather. The temperature outside and the presence of anything falling from the sky tell you whether you need to break out the winter coat, umbrella, or sunscreen.

Weather tells you what Earth's atmosphere is like right now, but *climate* is the average weather of an area over an extended period. Figuring out both today's weather and an area's climate relies on temperature data and precipitation (rain, snow, sleet, hail, or freezing rain) data. A meteorologist—a scientist who studies weather—can tell you whether you need a raincoat for the day; a climatologist can tell you what kind of wardrobe you need!

FACTORS THAT AFFECT CLIMATE

Temperature. From the cold Antarctic to the heat of the tropics, one of the primary factors that affects climate is temperature. Temperatures vary according to both daily and seasonal cycles.

Two climates, two sets of temperature and precipitation data. Notice the axes labels on the bottom, left, and right of the graphs. The bars show precipitation data, and the lines on top of each graph show temperature data.

Precipitation. The amount of water that a biome receives is another primary factor. Some regions experience roughly equal amounts of rainfall every month of the year. Others may have very wet winters and drought-like summers. The form in which the precipitation occurs—namely rain or snow—is also a factor.

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ENGAGE

Recalling Definitions

Use a **warm-up** to activate prior knowledge from the previous lesson. Write the vocabulary terms from Section 3.1 on the board, but in random order, such as *biome*, *population*, *ecology*, *biosphere*, *biotic factor*, *niche*, *ecosystem*, *abiotic factor*, *habitat*, *biodiversity*. Give students two to three minutes to write down definitions for each term. Give pairs of students another minute or two to compare answers, then call on students for answers. Correct any misconceptions that may arise.

INSTRUCT

Climate Data

Use some **guided graphic analysis** to help students master the skill of reading climate data graphs, such as those on this page. With their combinations of lines and bars as well as labels on three axes instead of the more usual two, these will no doubt be confusing to some students, especially if they are below grade level in math. Do an internet search on temperature and precipitation graphs, climate graphs, or climographs. You should find many examples of graphs like the ones on this page. Choose one that you can display to the class with its title removed or obscured. Guide students through an analysis of the graph's data, then ask them what biome they think the data represents. You may find it helpful to do an additional example for the same type of biome, but for an area whose data curves look significantly different, such as two rainforests—one with wet and dry seasons and the other with a more even distribution of rain throughout the year.

Call on additional students to talk through the process using additional examples. Wrap up the practice by giving one or two examples for students to analyze independently; then verify their answers.

Abiotic Factors

Students may find a **T-Chart** (see Appendix B) handy for organizing the information about abiotic factors on pages 56–57. One side of the chart should be labeled *Abiotic Factor* and the other *Effects on Biome*. Have students fill in the relevant details as you cover the material.

> **DIFFERENTIATED INSTRUCTION**
>
> ***Memorization Aid***
>
> The hierarchical relationship of the terms *niche*, *habitat*, *ecosystem*, and *biome* will help some students recall the definitions of those terms. You can reduce the rigor of the warm-up exercise by leaving those terms in that order.