Summary

3–1 What Is Ecology?

Ecology is the scientific study of interactions among organisms and between organisms and their environment. Earth's organisms live in the biosphere. The biosphere consists of the parts of the planet in which all life exists. It includes land; water; and air, or atmosphere.

Ecology includes the study of all the different levels of life, ranging from the individual organism to the biosphere. Above the level of the individual organism is the species. A species is a group of organisms so similar to one another that they can breed together and produce fertile offspring. A group of individuals that belong to the same species and live in the same area is called a population. A collection of different populations that live together in an area is referred to as a community. An ecosystem includes all the organisms that live in a particular place, together with their physical environment. A group of ecosystems that have the same climate and similar dominant communities is called a biome.

Ecologists use three basic methods of research: observing, experimenting, and modeling. Observing often leads to questions and hypotheses. Experimenting can be used to test hypotheses. Experimenting may be done in a laboratory or in the natural world. Modeling helps ecologists understand complex processes.

3–2 Energy Flow

All organisms need to obtain energy from their environment to power life processes. Sunlight is the main energy source for life on Earth. Organisms that can capture energy from sunlight or chemicals and use that energy to produce food are called autotrophs, or producers. Only plants, some algae, and certain bacteria are producers. On land, plants are the main autotrophs.

The process in which autotrophs use light energy to make food is called photosynthesis. In photosynthesis, light provides the energy needed to turn carbon dioxide and water into oxygen and carbohydrates. The process in which autotrophs use chemical energy to produce carbohydrates is called chemosynthesis. Chemosynthesis is performed by only certain types of bacteria.

Organisms that rely on other organisms for their energy and food are called heterotrophs. Heterotrophs are also referred to as consumers. There are many different types of heterotrophs. Herbivores, such as cows, obtain energy by eating only plants. Carnivores, such as snakes, eat only animals. Omnivores, such as humans, eat both plants and animals. Detritivores, such as earthworms, feed on plant and animal remains and other dead matter. Decomposers, such as fungi, break down organic matter.

Energy flows through an ecosystem in one direction. It flows from the sun or from inorganic compounds, first to autotrophs and then to heterotrophs. A food chain is a series of steps in which organisms transfer energy by eating and being eaten. A food web links together all the food chains in an ecosystem. Each step in a food chain or food web is called a trophic level. Producers make up the first trophic level. Consumers make up higher trophic levels. Each consumer depends on the trophic level below it for energy.

An ecological pyramid is a diagram that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web. Types of ecological pyramids are energy pyramids, biomass pyramids, and pyramids of numbers. Energy pyramids show how much energy is available within each trophic level. Only about 10 percent of the energy available within one trophic level is transferred to organisms at the next trophic level.

Biomass pyramids show the biomass, or total amount of living tissue, within each trophic level. A pyramid of numbers shows the relative number of individual organisms at each trophic level.

3–3 Cycles of Matter

Matter, unlike energy, is recycled within and between ecosystems. Matter is passed from one organism to another and from one part of the biosphere to another through biogeochemical cycles. These cycles connect biological, geological, and chemical processes. Matter can cycle through the biosphere because biological systems do not use up matter; they only change it.

All living things require water to survive. Water cycles between the ocean, atmosphere, and land. Several different processes are involved in the water cycle, including evaporation and transpiration. Evaporation is the process in which water changes from a liquid to a gas. Transpiration is the process in which water evaporates from the leaves of plants.

All the chemical substances that an organism needs to survive are called nutrients. Like water, nutrients cycle within and between ecosystems.

The three most important nutrient cycles are the carbon, nitrogen, and phosphorus cycles. Carbon is a key ingredient of living tissue. Processes involved in the carbon cycle include photosynthesis and human activities such as burning. Nitrogen is needed by all organisms to build proteins. Processes involved in the nitrogen cycle include nitrogen fixation and denitrification. In nitrogen fixation, certain bacteria convert nitrogen gas into ammonia. In denitrification, other bacteria convert nitrogen compounds called nitrates back into nitrogen gas. Phosphorus is needed for molecules such as DNA and RNA. Most of the phosphorus in the biosphere is stored in rocks and ocean sediments. Stored phosphorus is gradually released into water and soil, where it is used by organisms.

The primary productivity of an ecosystem is the rate at which organic matter is created by producers. One factor that controls primary productivity is the amount of available nutrients. When an ecosystem is limited by a single nutrient that is scarce or cycles very slowly, this substance is called a limiting nutrient. If an aquatic ecosystem receives a large quantity of a limiting nutrient, there may be a sudden increase in the amount of algae, called an algal bloom.

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Section 3–1 What Is Ecology? (pages 63–65)

Key Concepts

- What different levels of organization do ecologists study?
- What methods are used to study ecology?

Interactions and Interdependence (page 63)

1. What is ecology? ____

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2. What does the biosphere contain? ____

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Levels of Organization (page 64)

3. Why do ecologists ask questions about events and organisms that range in complexity from an individual to the biosphere? ____

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4. Complete the table about levels of organization.

LEVELS OF ORGANIZATION

Level	Definition
Species	
	A group of individuals that belong to the same species and live in the same area
Community	
Ecosystem	
	A group of ecosystems that have the same climate and dominant communities

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5. What is the highest level of organization that ecologists study? ________________

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Ecological Methods (page 65)

6. What are the three basic approaches scientists use to conduct modern ecological research?

   a. ________________ b. ________________ c. ________________

7. Why might an ecologist set up an artificial environment in a laboratory?

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8. Why are many ecological phenomena difficult to study? ________________

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9. Why do ecologists make models? ________________

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10. Is the following sentence true or false? An ecological model may consist of a mathematical formula. ________________

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Section 3–2 Energy Flow (pages 67–73)

Key Concepts

- Where does the energy for life processes come from?
- How does energy flow through living systems?
- How efficient is the transfer of energy among organisms in an ecosystem?

Producers (pages 67–68)

1. What is at the core of every organism's interaction with the environment?

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2. What source of energy do organisms use if they don't use the sun's energy?

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3. What are autotrophs? _______________________________

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4. Why are autotrophs also called producers? ____________________

5. What do autotrophs do during photosynthesis? ____________________

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6. For each of the following, write which kind of autotroph is the main producer.

a. Land: _______________________________

b. Upper layers of ocean: _______________________

c. Tidal flats and salt marshes: ____________________

7. What is chemosynthesis? _______________________________

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8. Where do bacteria that carry out chemosynthesis live? ______________

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Consumers (pages 68–69)

9. Heterotrophs are also called ____________________.

10. Plant and animal remains and other dead matter are collectively called

____________________.

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11. Complete the table about types of heterotrophs.

TYPES OF HETEROTROPHS

Type	Definition	Examples
Herbivore		Cows, rabbits
	Heterotroph that eats animals	
Omnivore		Humans, bears, crows
Detritivore		
Decomposer		

Feeding Relationships (pages 69–71)

12. How does energy flow through an ecosystem? ______________________________

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13. Complete the table about feeding relationships.

FEEDING RELATIONSHIPS

Relationship	Description
Food Chain	
Food Web	

14. What does a food web link together? ______________________________
15. What is a trophic level? ______________________________
16. In a food web, what organisms make up the first trophic level? ______________
17. What does a consumer in a food chain depend on for energy? ______________

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Ecological Pyramids (pages 72–73)

18. What is an ecological pyramid? ______________________________

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19. Why is it that only part of the energy stored in one trophic level is passed on to the next level? ______________________________

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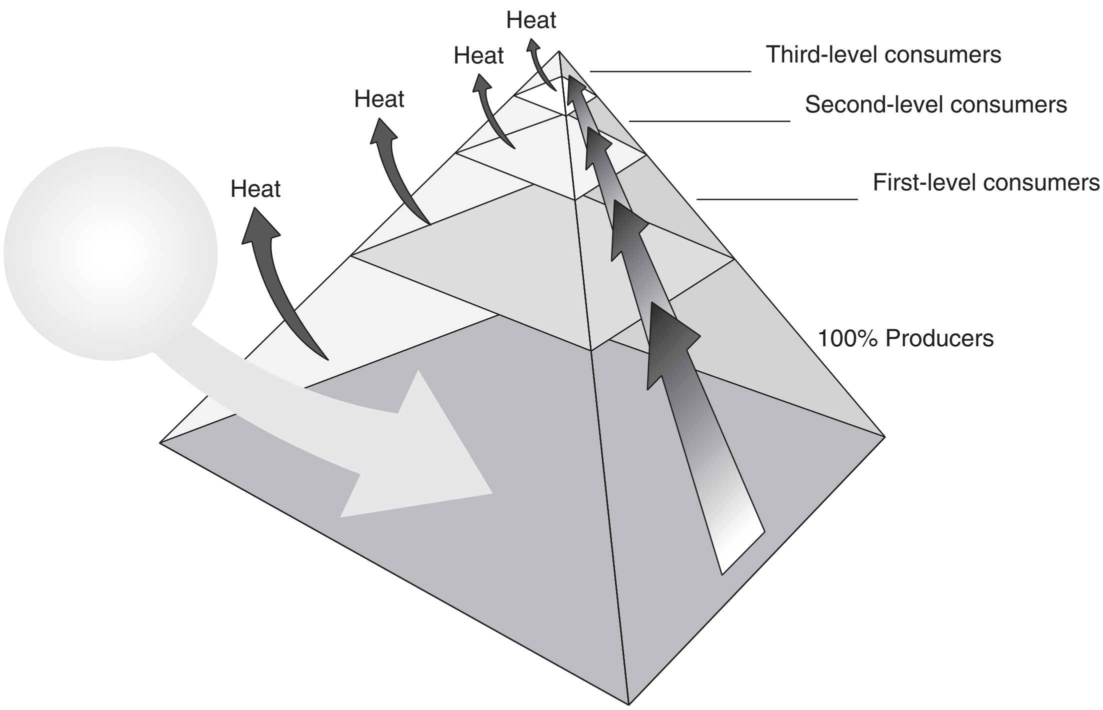
20. Complete the energy pyramid by writing the source of the energy for the food web and how much energy is available to first-, second-, and third-level consumers.



21. What is biomass? ____

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22. What does a biomass pyramid represent? ____

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23. What does a pyramid of numbers show? ____

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24. Why can each trophic level support only about one tenth the amount of living tissue of the level below it? ____

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Reading Skill Practice

When you read about complex topics, writing an outline can help you organize and understand the material. Outline Section 3–2 by using the headings and subheadings as topics and subtopics and then writing the most important details under each topic. Do your work on a separate sheet of paper.

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Section 3–3 Cycles of Matter (pages 74–80)

Key Concepts

- How does matter move among the living and nonliving parts of an ecosystem?
- How are nutrients important in living systems?

Introduction (page 74)

1. What are the four elements that make up over 95 percent of the body in most organisms? ____________________

Recycling in the Biosphere (page 74)

2. How is the movement of matter through the biosphere different from the flow of energy? ____________________

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3. Matter moves through an ecosystem in ____________________.
4. What do biogeochemical cycles connect? ____________________

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The Water Cycle (page 75)

5. Water can enter the atmosphere by evaporating from the leaves of plants in the process of ____________________.
6. Circle the letter of each process involved in the water cycle.
   - **a.** precipitation
   - **b.** evaporation
   - **c.** runoff
   - **d.** fertilization

Nutrient Cycles (pages 76–79)

7. What are nutrients? ____________________

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8. What are the three nutrient cycles that play especially prominent roles in the biosphere?
   - **a.** ____________________
   - **b.** ____________________
   - **c.** ____________________
9. What are three large reservoirs where carbon is found in the biosphere?
   - **a.** As carbon dioxide gas in the ____________________
   - **b.** As dissolved carbon dioxide in the ____________________
   - **c.** As coal, petroleum, and calcium carbonate rock found ____________________
10. In what process do plants use carbon dioxide? ____________________

11. Why do all organisms require nitrogen? ____

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12. What is nitrogen fixation? ____

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13. What is denitrification? ____

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14. What role does denitrification play in the nitrogen cycle? ____________________

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15. Circle the letter of each sentence that is true about the phosphorus cycle.
   - **a.** Phosphate is released as rocks and sediments wear down.
   - **b.** Plants absorb phosphate from the soil or from water.
   - **c.** Phosphorus is abundant in the atmosphere.
   - **d.** Organic phosphate cannot move through food webs.

16. Why is phosphorus essential to living things? _____________________________

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Nutrient Limitation (page 80)

17. What is the primary productivity of an ecosystem? __________________________

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18. If a nutrient is in short supply in an ecosystem, how will it affect an organism?

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19. When is a substance called a limiting nutrient? ____________________________

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20. Why do algal blooms occur? ____

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Vocabulary Review

Matching *In the space provided, write the letter of the definition that best matches each term.*

_____ **1.** biosphere
_____ **2.** community
_____ **3.** autotroph
_____ **4.** chemosynthesis
_____ **5.** detritivore
_____ **6.** biomass
_____ **7.** transpiration
_____ **8.** denitrification
_____ **9.** biome
_____ **10.** trophic level

a. collection of different populations that live together in an area
b. consumer that feeds on plant and animal remains and other dead matter
c. process in which water evaporates from the leaves of plants
d. combined parts of the planet in which all life exists
e. each step in a food chain or food web
f. total amount of living tissue within a trophic level
g. organism that can capture energy and use it to produce food
h. group of ecosystems that have the same climate and similar dominant communities
i. process in which organisms use chemical energy to produce carbohydrates
j. process in which bacteria convert nitrates into nitrogen gas

True or False *Determine whether each statement is true or false. If it is true, write* true *in the space provided. If the statement is false, change the underlined word or words to make the statement true.*

_____________ **11.** A(An) <u>species</u> is a collection of all the organisms that live in a particular place, together with their physical environment.

_____________ **12.** The process in which autotrophs use light energy to make carbohydrates is called <u>nitrogen fixation</u>.

_____________ **13.** Heterotrophs that eat both plants and animals are referred to as <u>carnivores</u>.

_____________ **14.** A(An) <u>food web</u> links together all the food chains in an ecosystem.

_____________ **15.** The rate at which organic matter is created by producers is called the <u>limiting nutrient</u> of an ecosystem.

_____________ **16.** <u>Ecology</u> is the scientific study of interactions among organisms and between organisms and their environment.

_____________ **17.** A(An) <u>community</u> is a group of individuals that belong to the same species and live in the same area.

_____________ **18.** Autotrophs are also called <u>consumers</u>.

_____________ **19.** Organisms that break down organic matter are called <u>herbivores</u>.

_____________ **20.** The process in which water changes from a liquid to a gas is called <u>evaporation</u>.