

## Chapter Outline

- 41.1 – Ecological Systems Vary over Space and Time
- 41.2 – Solar Energy Input and Topography Shape Earth's Physical Environments
- 41.3 – Biogeography Reflects Physical Geography
- 41.4 – Biogeography Also Reflects Geological History
- 41.5 – Human Activities Affect Ecological Systems on a Global Scale

An ecological system (biome) is composed of the populations of organisms living and interacting together in a particular environment. Some ecological systems are small, while others can be as large as the boreal forest stretching across much of Canada. A particular ecosystem, such as a small pond, might appear to have well-defined borders, but there are often organisms from neighboring ecosystems, like herons and raccoons, that feed on life in the pond. No ecosystem is completely isolated, particularly from physical parameters like water and sunlight (energy) that constantly move into and out of ecosystems.

An ecosystem develops and exists within its long-term climate trends, primarily patterns of temperature and moisture. On any given day or week, *weather* describes short-term changes in atmospheric conditions. By comparison, long-term averages over many years or decades are known as *climate*. Latitude, elevation, and topography are the primary factors that determine an area's climate and thus the distribution of different types of terrestrial biomes.

Chapter 41 spans **Big Idea 1**, **Big Idea 2**, and **Big Idea 4**. The specific parts of the AP Biology curriculum covering **Big Idea 1**: The process of evolution drives the diversity and unity of life, include:

- **1.B.2:** Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
- **1.C.2:** Speciation may occur when two populations become reproductively isolated from each other.

The specific parts covering **Big Idea 2**: Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis, include:

- **2.C.2:** Organisms respond to changes in their external environments.
- **2.D.1:** All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.

The specific parts addressing **Big Idea 4**: Biological systems interact, and these systems and their interactions possess complex properties, include:

- **4.B.2:** Cooperative interactions within organisms promote efficiency in the use of energy and matter.
- **4.B.4:** Distribution of local and global ecosystems changes over time.
- **4.C.4:** The diversity of species within an ecosystem may influence the stability of the ecosystem.

## Chapter Review

**Concept 41.1** introduces the ecological concepts. An ecosystem comprises a biological community interacting with its environment. This concept requires consideration of the interactions within and between biotic (living organisms) and abiotic (physical environment) factors. A community description includes all of the populations in a given area interacting with each other, while a population is one group of individuals of a single species living and interbreeding in a particular location.

1. Consider this statement by a school principal: "Our school is committed to providing a welcoming environment for our diverse community." Describe two things in this statement that are inaccurate from an ecological/biological perspective.

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2. Identify three biotic components found in most ecosystems.

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3. Identify three abiotic components found in most ecosystems. Briefly propose a biological impact of each component.

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4. Interactions between the members of a population of unicellular organisms can be compared to the interactions between the cells of a multicellular organism. Discuss two similarities and two differences between the bacterial community of the human gut and the bacterial community of a forest community.

Similarities:

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Differences:

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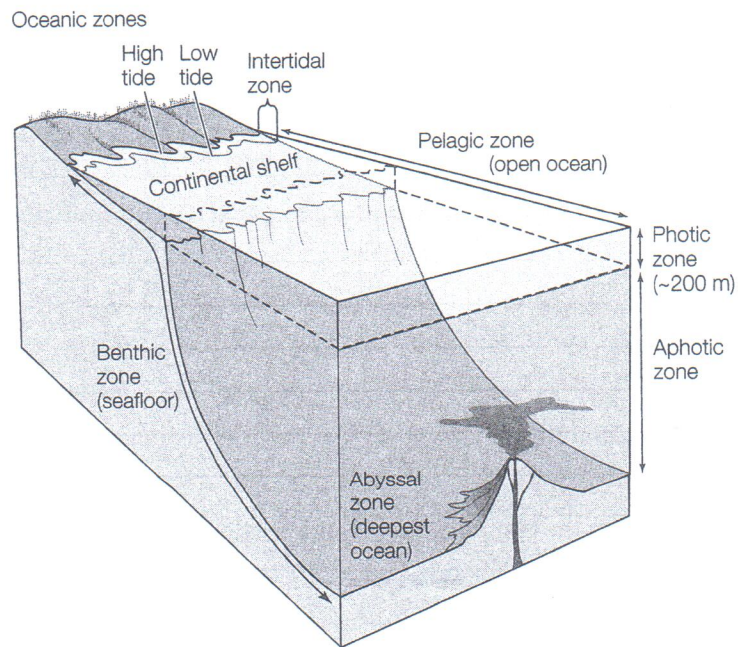
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One novel organism found in the community of organisms surrounding these deep sea vents is the giant tubeworm. These tubeworms have no mouth or digestive tract, but inside them are billions of bacteria per gram of body tissue.

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**Concept 41.2** discusses the abiotic components of ecosystems. The uneven distribution of solar energy across the Earth's surface sets global wind patterns in motion, which in turn drive the global ocean surface currents. Water and climate diagrams summarize the climate of ecosystems.

7. Contrast climate change with weather change. Provide an example of each.

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8. Describe how Earth's weather patterns are affected by the tilt of the Earth on its axis. Include equatorial and temperate comparisons. Be sure to discuss how much atmosphere the energy from the sun must penetrate to reach Earth's surface at different latitudes.

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9. Propose the climatic and biological effects of each of the following alterations:

a. Earth's tilt changes from  $23.5^\circ$  to  $5^\circ$ .

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b. Earth's tilt gets reversed.

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c. Earth's tilt changes from  $23.5^\circ$  to  $25^\circ$ .

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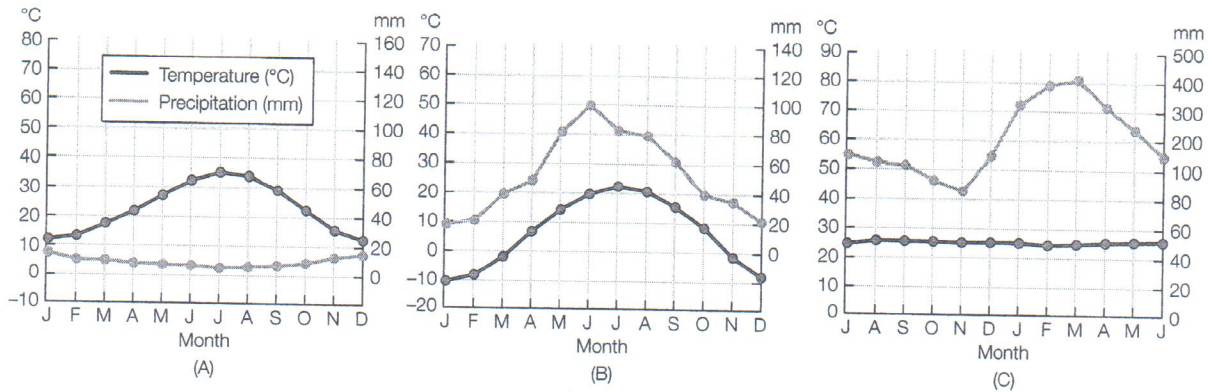
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Answer questions 10–13 using the following climate diagrams, which show temperature and precipitation data for three locations.



10. Select the diagram (A, B, or C) that best represents climate near the equator, and explain your choice.

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11. Select the diagram (A, B, or C) that represents the latitude 30° North, where there is typically a high rate of evaporation from the surface, and dry, warm air sinking to the surface. Identify and describe the biome that would be found here.

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12. Select the diagram (A, B, or C) that would have the longest growing season, and explain your choice.

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13. Diagram C includes varying precipitation throughout the year. Select the month with the lowest precipitation and discuss why this reduction occurs at that time. Suggest a biome that might be found in a region with this precipitation pattern.

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14. Organisms' activities are affected by interactions with abiotic factors. Explain how each of the factors in the table below could affect the behavior and health of the marine organisms shown.

	Coral reef	Fish	Sea otter
Nutrient availability			
Temperature change from 22°C to 18°C (72°F to 64°F)			
Salinity change from 32ppt to 25ppt			
pH change from 8.18 to 8.07			

**Concept 41.3** surveys the major biomes of the world and their physical conditions.

15. Define the term *biome* and discuss how biomes are determined. Describe the type of biome you live in, linking your description to the definition of that biome.

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**Concept 41.4** examines the geologic history of Earth, including plate tectonics, in shaping the distribution of organisms we see today. The movement of the plates has shaped our world into seven major biogeographic regions.

18. Explain how major geological events, such as plate tectonics, impact ecosystem distribution.

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19. South American and African tectonic plates moved apart approximately 100 million years ago. Explain what evidence you would look for in the fossil record to support this finding.

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**Concept 41.5** addresses the many ways that human activity has affected the complexity and heterogeneity of the world's ecosystems. The previous epochs of life are labeled according to the dominant life form during that time period. Some suggest that we are now in the Anthropocene period, or "Age of Humans."

20. Describe two human activities that have altered ecosystems, and discuss the effects of the alteration on biodiversity.

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## Science Practices & Inquiry

In the AP Biology Curriculum Framework, there are seven **Science Practices**. In this chapter, we focus on **Science Practice 6**: The student can work with scientific explanations and theories. More specifically, we focus on **Science Practice 6.3**: The student can articulate the reasons that scientific explanations and theories are refined or replaced.

Question 21 asks you to explain how the distribution of ecosystems changes over time by identifying large-scale events that have resulted in these changes in the past (**Learning Objective 4.20**).

21. Identify two large-scale events (not caused by humans) that have changed the distribution of ecosystems in the past. For each event, describe how the ecosystems changed, and predict how they might change again in the future.

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