

CHAPTER 5 BIOMES: GLOBAL PATTERNS OF LIFE

Chapter Overview

Climate, temperature and precipitation, determine what vegetation and animals will inhabit an ecosystem. Understanding the major biomes by using specific examples of flora and fauna can illustrate these areas of the world. Aquatic ecosystems, including both marine and freshwater, are important aspects of the AP curriculum. Finally humans can alter and impact these ecosystems. The anthropogenic causes of habitat degradation and the impact on these ecosystems are studied and will be re-introduced in later chapters.

Topics and Key Concepts

Earth Systems and Resources

- Graph climatograms of the major terrestrial biomes and be able to identify a biome by viewing its climatogram.
- Identify the various zones found in the ocean, including the abiotic factors that define each zone and characteristic organisms found in each zone.

The Living World

- Correlate the adaptations of plants and animals to the biomes to which they have evolved.
- Distinguish the various types of coastal and wetland habitats
- Compare the nature of lakes and ponds, and describe the importance of thermal stratification and spring turnover.

Population

- Summarize the nature of human disturbance in oceans and in freshwater ecosystems.

Global Change

- Categorize the various types of forests, grasslands, and deserts based upon precipitation, altitude and temperature. Summarize the human disturbances found in each biome.

Key Terms

barrier island	deciduous	savanna
benthic	desert	swamp
biome	estuary	taiga
bog	fen	temperate rainforest
boreal forest	grassland	thermocline
chaparral	*mangrove forest	tide pool
cloud forest	marsh	tropical rainforest
*coniferous	pelagic	tropical seasonal forest
coral bleaching	phytoplankton	wetland
coral reef	salt marsh	

** These key terms are not boldfaced in the chapter text, but are still important for the AP Exam.*

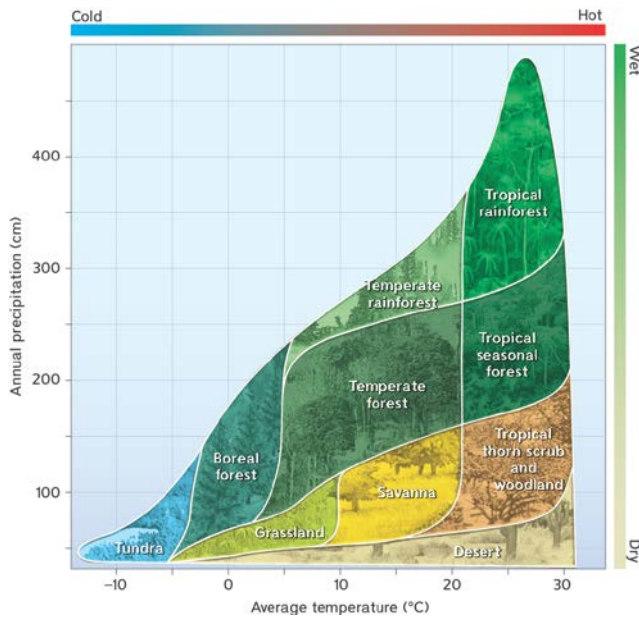
Pacing Guide

Plan to spend 5 to 7 days on this chapter.

Approach and Tips

Biomes are areas with similar climate conditions, growth patterns, and vegetation types. Figure 5.2 (p. 99, reproduced below) illustrates the central concept of this chapter: biomes are largely determined by temperature and precipitation.

This chapter should begin as review for students. Review basic geography, making sure students can differentiate between latitude and longitude, identify the continents, and have an awareness of population centers. Review basic plant structures so that students can understand the “whys” of where the various vegetation is found. A great satellite image of the population centers of the world can be displayed using a Smart Board. It will show students where the majority of people live and the difference between developing and developed countries. It is a good introduction to the next two chapters on populations. Students should be able to identify the location of a biome by looking at a map of the world. Remind them that boreal forests and polar grasslands don’t exist in the southern hemisphere. In your discussion of biome distribution, be sure to include the role altitude plays in regard to habitat and productivity.



It is easier for students to grasp the major abiotic and biotic characteristics of different biomes by starting at home. Ask students to think about where they live: temperature, precipitation, seasons, and so on. After they are armed with this knowledge, they can obtain knowledge on a different biome in order to be able to discuss and compare the similarities and differences between where they live and another area. Students should be able to discuss a native plant and animal in each, along with the effect humans have had on the area. It is important that students understand how organisms within a biome interact with the abiotic components of an ecosystem. While the AP exam will never ask a student to discuss a particular biome, it will assume that students have knowledge of each major biome, and students will apply this knowledge to several questions throughout the exam.

Figures 5.5 to 5.12 in your Cunningham 14th edition textbook include climatograms. Most students are not familiar with graphs giving more than one set of information at a time. Be sure to discuss the individual components of each graph. You will probably have to call their attention to the changing scales, so that if they are presented with two or more graphs to compare side by side they do not overlook this detail.

The penetration and concentration of light plays a key role in biological activity in both terrestrial and aquatic ecosystems. Students can experience the impact of the concentration of light by performing a simple experiment. Be sure to have students develop the investigation themselves. First, the angle of the sunlight striking the earth plays a role in its intensity. Shine a light on a sphere (representing the earth) at different angles (from the same distance) to measure how concentrated the light is and how much area the light covers. Students may want to have a thermometer in order to measure the temperature over a period of

time in each location. To investigate light penetration, students could shine the light on a horizontal surface from increasing heights. Again, measuring the temperature and size of the beam will give students an indication of what happens below the surface of the water. If you have one available, a light meter would be a nice addition to the experiment.

Marine ecosystems are not as well understood as land biomes. Explain that marine ecosystems are characterized by their distance from shore and light penetration. Note the importance of photosynthetic organisms to the food web. Temperature and light penetration determine biodiversity and productivity. Again, ask the students if they know the ocean ecosystem with the highest level of biodiversity. Coral reefs make up less than 1% of the ocean floor but have the greatest biodiversity. Have students investigate why mangrove forests, estuaries and barrier islands are important ecosystems.

Freshwater systems include streams, lakes, ponds, and some wetlands. Students should know the relationship between, light, dissolved oxygen, and temperature as they pertain to living organisms in the lake. Wetlands are important ecosystems due to their ability to clean and filter water. You can demonstrate this using a tall beaker, a piece of screen across the top, and a section of sod sitting on the screen. Pour silty water on the sod and watch the water that percolates through into the beaker. You may want to have students perform this activity with household products added to the water needing to be cleaned. They are also important for migratory waterfowl. Students should also learn about some very specific ecosystems, such as the Everglades.

Estuaries are areas where fresh water meets salt water. Plants living there have adapted to the presence of salt in the water. Tolerance of salt is another activity your students could investigate. Have students prepare salt water in different concentrations. Moisten a paper towel with the water sample and place it in a plastic bag with radish seeds. The seeds will germinate in a few days and students can observe how tolerant they are of the salt. The same experiment can be performed using fertilizer in correlation with a discussion on runoff.

Upon completion of this chapter, students should be aware that human impact occurs globally and that it takes a very long time to repair damage that has been done. Many times it is impossible for the ecosystem to recover from the impact. This would be a good time to have students think about legislation that protects the environment, as well as how they as individuals can lessen their impact on the ecosystem. Each student should be able to discuss a law or other legislation that deals with the protection of ecosystems. Ask students if they know how humans impact a particular biome, for example, a grassland. Habitat alteration as well as overgrazing might be answers. Habitat destruction, whether it is for resources, agriculture or human habitation is an important human disturbance that appears

on the AP exam quite frequently. Having students address specific biomes and the possible types of disturbances will help them to have a clear understanding of these concepts. Students need very clear reasons why and how humans impact biomes. Saying “habitat destruction” is not sufficient; habitat destruction of a wetland that is drained to build homes is much more specific. It is important to stress global climate change as well.

Common Mistakes and Misconceptions

A common mistake that students make in this chapter is that they generally believe that the soils in the rainforest are fertile when in fact they are extremely poor. Students also think that the desert is devoid of life, when in reality, it is very diverse. Hierarchical relationships from species up to biomes need clarification.

It is easy for students to minimize the importance of this chapter after hearing that the AP exam will not ask them to directly describe a particular biome. However, questions on the exam will peripherally address biomes, and will rely on students having an understanding of natural interactions within a biome as well as human impacts on each biome.

Finally, students do not always fully comprehend the effect of global climate change on each biome. Many believe that it is just based on opinion.

Activities

Biome Identification

Have students create climatograms to identify specific biomes based upon temperature and precipitation. The National Oceanic and Atmospheric Administration (NOAA) has a downloadable climatogram activity here: https://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Climatograms.pdf In addition, NASA has a climatogram-biome matching lesson here: http://earthobservatory.nasa.gov/Experiments/Biome/graphmatch_advanced.php

Biome Table

Have students create a table that they will use over the next several chapters. The table should include the name of each biome, annual precipitation, temperature, characteristic flora and fauna, and human disturbances that threaten the biome. Have students leave room the right of their table so they can add more columns as pertinent information comes up in subsequent chapters (such as soil type in Chapter 10).

Questions for Review

1. What is the relationship between biodiversity and altitude? What are the two most important abiotic factors?
As altitude increases biodiversity decreases. The two most important abiotic factors are temperature and precipitation.
2. In a temperate forest the nutrients are held in the soil. In a tropical rainforest the nutrients are held in the living organisms. How does deforestation impact each of these biomes immediately? After 5 years? After 10 years?
It will be easier for the temperate forest to recover since the nutrients for plant growth are in the soil. The tropical rainforest will not recover since the nutrients went with the trees and plants. This was evident when the rainforest was cleared for cattle ranching purposes. The rainforest will not recover in 5 years or 10 years, whereas the temperate forest will undergo secondary succession, but the climax community will not be evident until many years later.
3. What are three similarities and three differences in the climate graphs of grassland and deciduous forest?
Three similarities are average temperature, have temperature fluctuations, and have year round precipitation. The differences are the amount of rainfall, the grasslands have wet/dry conditions, and the deciduous forest has a relatively consistent year round precipitation.
4. Coral reefs are made up of colonies of the coral animal and algae that lives within it. What is the relationship between the two organisms? What happens when the ocean temperature rises?
This is a symbiotic relationship called mutualism. When the ocean temperature rises the algae leave the coral and the coral dies or bleaches.
5. What characteristics of the plants that live in a grassland make the grasslands soil so rich and deep? What characteristics of the plants that live in a rainforest make the soil there so poor and shallow?
The plants in the grassland are deep rooted and are a diverse mix of grasses and flowering herbaceous plants. When they decompose over the winter, they return many nutrients back to the soil. Since the growth of plants in the tropical rainforest depend upon the rapid decomposition of dead leaves and vegetation, little nutrients remain on the forest floor. In other words, the plants grow quickly since the conditions of temperature and precipitation are ideal.

Practice Questions

Multiple Choice:

Directions questions 1-5: The lettered choices below correspond to the descriptions given in questions 1-5. Select the one lettered choice that best fits each statement. Each choice may be used once, more than once, or not at all.

- (A) Temperate deciduous forest
- (B) Desert
- (C) Taiga
- (D) Tundra
- (E) Savanna

1. Desertification from domestic grazing is a threat in this biome
2. In this biome plants have water storing leaves and stems
3. At one time this biome covered the Eastern half of the United States
4. Biome with a treeless landscape but has grasses, mosses and lichens
5. Biome with low productivity because of a short growing season

Directions: For each of the following questions, select the one lettered choice that best answers the question.

6. Coastal zones that have high productivity and diversity include all of the following except
 - (A) estuaries
 - (B) salt marshes
 - (C) coral reefs
 - (D) oyster reefs
 - (E) mangroves
7. The 2 most human dominated biomes of the world are
 - (A) deserts and tundra
 - (B) tundra and coniferous forests
 - (C) temperate broad-leaf forests and chaparral
 - (D) chaparral and desert
 - (E) temperate broad-leaf forest and temperate rainforests

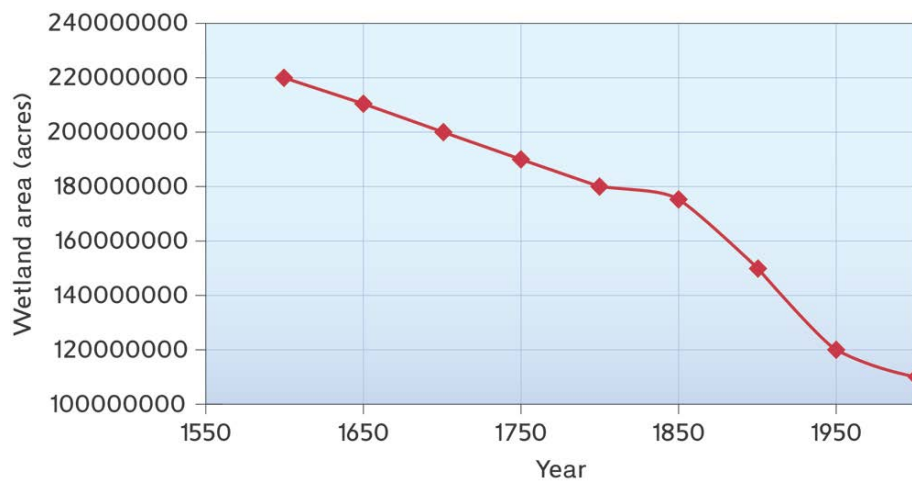
8. Which of the following is NOT a wetland?
- (A) swamp
 - (B) bog
 - (C) fen
 - (D) salt marsh
 - (E) coral reef
9. Trees and grasses in terrestrial biomes are equivalent to _____ in marine ecosystems.
- (A) zooplankton
 - (B) phytoplankton
 - (C) fish
 - (D) shrimp
 - (E) coral
10. This zone in freshwater ecosystems contains the lowest amount of dissolved oxygen.
- (A) littoral
 - (B) hypolimnion
 - (C) epilimnion
 - (D) benthos
 - (E) thermocline

Free-Response Question:

Directions: Answer all parts of the following question. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. A wetland is a biologically diverse and important ecosystem. In the United States, wetlands have been disappearing since 1600 until 2000.

Area of Wetlands in the United States 1600-2000



- (a) Calculate the difference in acres of wetlands in 1600 and acres of wetlands in 2000. Calculate the percent decrease of wetlands during this time period.
- (b) Explain one reason for this trend.
- (c) Identify and describe TWO wetland ecosystems.
- (d) Identify and describe TWO ecosystem services that wetlands provide.

Answers to Practice Questions

Multiple Choice:

1. E
2. B
3. A
4. D
5. D
6. D
7. C
8. E
9. B
10. D

Free-Response Question:

This question has a total possible of 11 points. However, only 10 points can be earned.

1. (a) 2 points total. 1 point for calculating the difference in acres and 1 point for calculating the percent decrease.

$$\text{Difference} = 220,000,000 - 110,000,000 = 110,000,000 \text{ acres}$$

$$\% \text{ decrease} = 110,000,000 / 220,000,000 \times 100\% = 50\%$$

- (b) 1 point for indicating that some form of habitat alteration has taken place either due to human habitation or agricultural purposes.
- (c) 4 points total. 1 point for each identification (2 points total) and 1 point for each description (2 points total)

Wetland	Description
swamps	Shallow ecosystems, saturated or submerged in water, with trees
marshes	Shallow ecosystems, saturated or submerged in water, without trees
fens	mainly fed by groundwater, mineral-rich water specially adapted plant species
bogs	saturated ground, composed of deep layers of accumulated, undecayed vegetation known as peat
salt marshes	tidal, rich diversity

- (d) 4 points total 1 point for each identification (2 points total) and 1 point for each description.

Ecosystem service	Description
water filtration	filter runoff, filter pollutants from water
water storage	recharge groundwater with clean water
flood reduction	protect from erosion and storm damage
habitat for migratory birds	nesting and breeding sites
aesthetics	aesthetically pleasing to view
birdwatching	many birds breeding and nesting to view

Answers to questions in the Student Edition:

Case Study AP Document-Based Question (page 98)

- (A) Ecosystem services that benefit the women of Kenya include: water purification and supply—forests help purify precious water supplies, and without them the women of Kenya must travel farther for clean water; wood for fuel and cooking—most households in Kenya do not have electricity and need wood to keep warm and cook; food—forests help keep the soil fertile so crops can grow, and deforestation is associated with decreased soil quality; and water regulation—closed canopy forests are naturally occurring water regulation mechanisms, and without them the water in Kenya is inconsistent and poorly distributed.
- (B) Environmental degradation can lead to economic instability by reducing the productivity of land relied on for a variety of products (agriculture, recreation, lumber, etc.). It can also cause the displacement of large amounts of people because of climate change or the destruction of ecosystems, which can lead to many refugees trying to flee countries with declining ecosystems. It can also lead to countries fighting over limited resources like water, land for growing crops, wood for fuel, and other natural resources.

AP Connections Review Answers (pages 114-115)

Multiple-Choice

1. a. All would be correct except choice *a* because desert animals produce little urine.
2. e. The temperature will not impact the amount of light penetrating the water, whereas the turbidity, amount of sediment, tannins, and depth affect the light penetration.
3. a. Swamps are covered by trees, whereas in marshes, grasses predominate.
4. d. The upper stratum of the lake has the greatest amount of DO because the euphotic zone is where the producers are located that produce the oxygen. The surface water layer would be much warmer than the deeper layers of water because it is the summer. The decomposers would decrease the dissolved oxygen. The thermocline

is in the intermediate strata in a lake. The deep water in the center of the lake would be cold.

Data Analysis and Free-Response Questions

1A 2.72 mm of H₂O/yr (average of five points ~2.55, 2.6, 2.75, 2.8, 2.9)

1B An average tropical forest and a tundra are 43.5% different in primary productivity
(Tundra = 2.25 g/m²/yr; Tropical forest = 3.5 g/m²/yr; $[(3.5-2.25)/((3.5+2.25)/2)]*100$)

2A Mining in a desert is especially disruptive to the ecosystem because vegetation is slow growing and sparse and when it is damaged the soil doesn't hold onto moisture as well resulting in increasingly drier soils. These damaged soils drift and are hard to restabilize. Deciduous forests, on the other hand, grow back quickly – but it's a matter of if the organisms living in the forest can wait for that recovery.