

# Biomes

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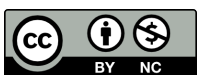
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# CHAPTER 1

# Biomes

## Lesson Objectives

- Identify and describe terrestrial biomes.
- Give an overview of aquatic biomes.

## Vocabulary

- aphotic zone
- aquatic biome
- climate
- dormancy
- estuary
- freshwater biome
- growing season
- intertidal zone
- marine biome
- photic zone
- phytoplankton
- terrestrial biome
- wetland
- zooplankton

## Introduction

If you look at the two pictures in **Figure 1.1**, you will see very few similarities. The picture on the left shows a desert in Africa. The picture on the right shows a rainforest in Australia. The desert doesn't have any visible plants, whereas the rainforest is densely packed with trees. What explains these differences?



**FIGURE 1.1**

Sahara Desert in northern Africa (left). Rainforest in northeastern Australia (right). Two very different biomes are pictured here. Both are found at roughly the same distance from the equator.

The two pictures in **Figure 1.1** represent two different biomes. A biome is a group of similar ecosystems with the same general abiotic factors and primary producers. Biomes may be terrestrial or aquatic.

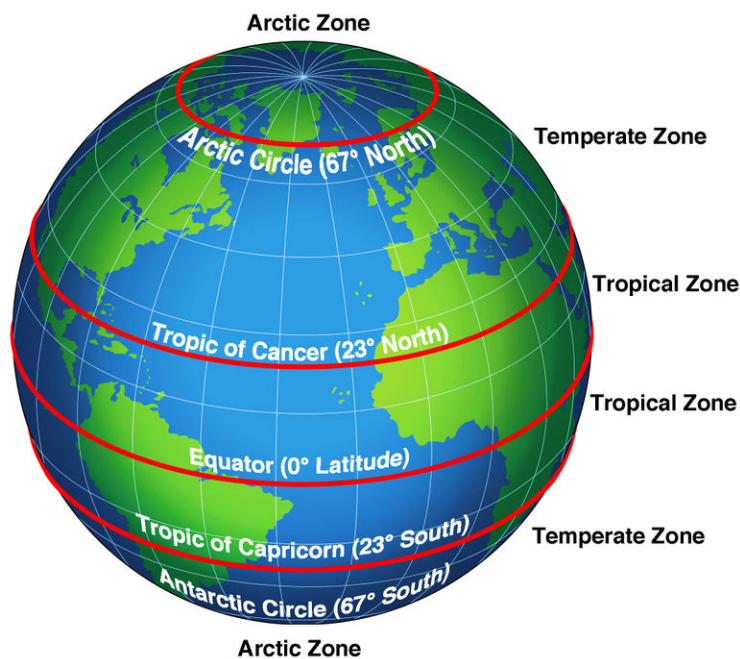
## Terrestrial Biomes

**Terrestrial biomes** include all the land areas on Earth where organisms live. The distinguishing features of terrestrial biomes are determined mainly by climate. Terrestrial biomes include tundras, temperate forests and grasslands, chaparral, temperate and tropical deserts, and tropical forests and grasslands.

### Terrestrial Biomes and Climate

**Climate** is the average weather in an area over a long period of time. Weather refers to the conditions of the atmosphere from day to day. Climate is generally described in terms of temperature and moisture.

Temperature falls from the equator to the poles. Therefore, major temperature zones are based on latitude. They include tropical, temperate, and arctic zones (see **Figure 1.2**). However, other factors besides latitude may also influence temperature. For example, land near the ocean may have cooler summers and warmer winters than land farther inland. This is because water gains and loses heat more slowly than does land, and the water temperature influences the temperature on the coast. Temperature also falls from lower to higher altitudes. That's why tropical zone mountain tops may be capped with snow.



**FIGURE 1.2**

Temperature Zones. Temperature zones are based on latitude. What temperature zone do you live in?

In terms of moisture, climates can be classified as arid (dry), semi-arid, humid (wet), or semi-humid. The amount of moisture depends on both precipitation and evaporation.

### Climate and Plant Growth

Plants are the major producers in terrestrial biomes. They have five basic needs: air, warmth, sunlight, water, and nutrients. How well these needs are met in a given location depends on the growing season and soil quality, both of which are determined mainly by climate.

- The **growing season** is the period of time each year when it is warm and wet enough for plants to grow. The growing season may last all year in a hot, wet climate but just a few months in a cooler or drier climate.
- Plants grow best in soil that contains plenty of nutrients and organic matter. Both are added to soil when plant litter and dead organisms decompose. Decomposition occurs too slowly in cold climates and too quickly in hot, wet climates for nutrients and organic matter to accumulate. Temperate climates usually have the best soil for plant growth.

### Climate and Biodiversity

Because climate determines plant growth, it also influences the number and variety of other organisms in a terrestrial biome. Biodiversity generally increases from the poles to the equator. It is also usually greater in more humid climates. This is apparent from the desert and rainforest biomes pictured in **Figure 1.1**.

### Climate and Adaptations

Organisms evolve adaptations that help them survive in the climate of the biome where they live. For example, in biomes with arid climates, plants may have special tissues for storing water (see **Figure 1.3**). The desert animals pictured in **Figure 1.4** also have adaptations for a dry climate.



**FIGURE 1.3**

Aloe Plant and Barrel Cactus. The aloe plant on the left stores water in its large, hollow leaves. The cactus plant on the right stores water in its stout, barrel-shaped stems.



**FIGURE 1.4**

Gila Monster and Kangaroo Rat. The Gila monster's fat tail is an adaptation to its dry climate. It serves as a storage depot for water. The kangaroo rat has very efficient kidneys. They produce concentrated urine, thus reducing the amount of water lost from the body.

In biomes with cold climates, plants may adapt by becoming dormant during the coldest part of the year. **Dormancy** is a state in which a plant slows down cellular activities and may shed its leaves. Animals also adapt to cold

temperatures. One way is with insulation in the form of fur and fat. This is how the polar bears in **Figure 1.5** stay warm.




**FIGURE 1.5**

Polar Bears. Thick fur and a layer of blubber keep polar bears warm in their Arctic ecosystem. Why do you think their fur is white? Why might it be an adaptation in an Arctic biome?

## Survey of Terrestrial Biomes

Terrestrial biomes are classified by climatic factors and types of primary producers. The world map in **Figure 1.6** shows where 13 major terrestrial biomes are found.

The following figures summarize the basic features of major terrestrial biomes. Think about how its biodiversity and types of plants and animals relate to its climate. For example, why do you think there are no amphibians or reptiles in tundra biomes? (Hint: Amphibians and reptiles cannot maintain a constant body temperature. Instead, they have about the same temperature as their surroundings.)



Alpine tundra in the Alps Mountains of Switzerland in Europe

## Tundra


**Other names:**  
Arctic tundra (high latitudes)  
Alpine tundra (high altitudes)

**Climate:** Arctic, acrid  
**Growing season:** Very short  
**Soil quality:** Very poor

**Biodiversity:** Very low

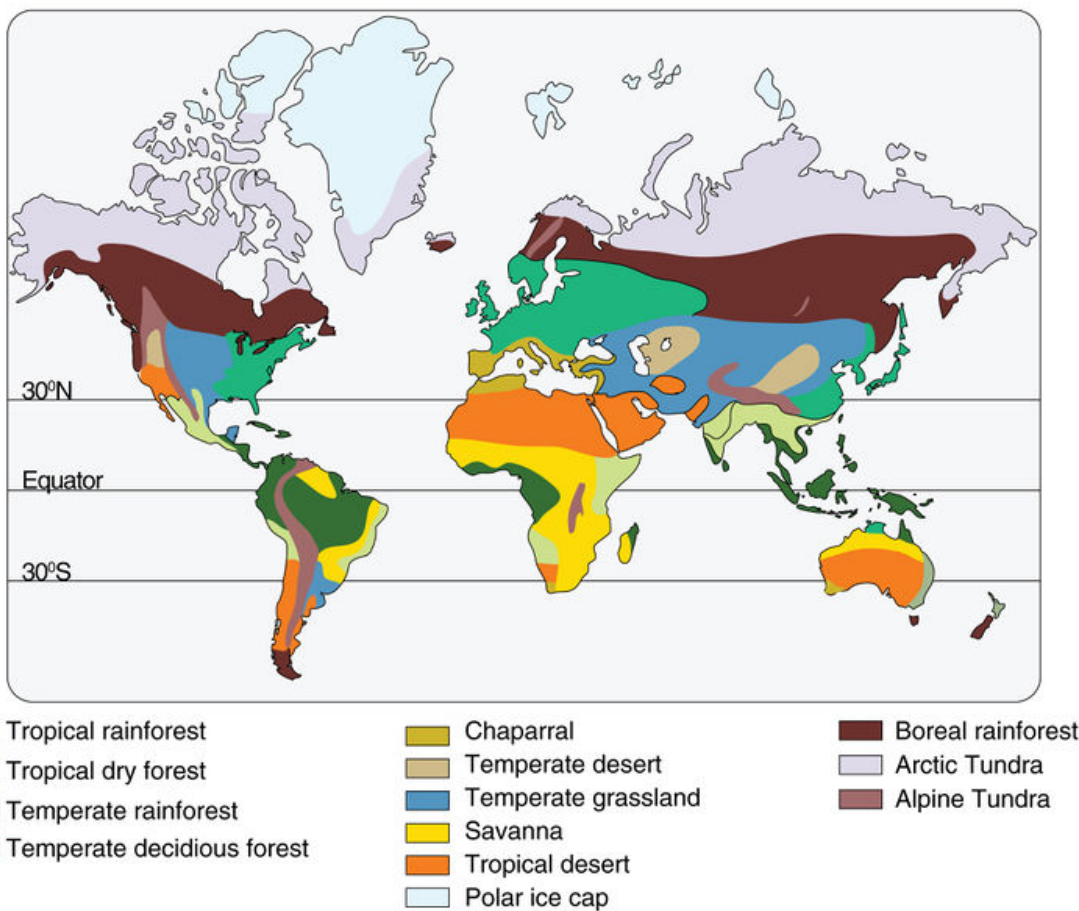
**Plants:** Mosses, grasses, and lichens; few herbaceous plants; no trees.

**Animals:** Insects; birds (summer only); no amphibians or reptiles; mammals such as rodents, arctic hares, arctic foxes, polar bears; caribou (summer only); mountain goats and chinchillas (alpine tundra only)



Arctic tundra on the northern coast of Alaska in the United States





**FIGURE 1.6**

Worldwide Distribution of Terrestrial Biomes. This map shows the locations of Earth's major terrestrial biomes.



Boreal forest in central (inland) Alaska, United States

## Boreal Forest

**Other names:** Taiga, northern conifer forest

**Climate:** Subarctic, semi-arid

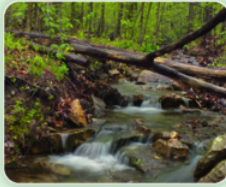
**Growing season:** Short

**Soil quality:** Poor

**Biodiversity:** Low

**Plants:** Conifers such as cedar, spruce, pine, and fir; mosses and lichens

**Animals:** Insects; birds (mainly in summer); no amphibians or reptiles; mammals such as rodents, rabbits, minks, raccoons, bears, and moose; caribou (winter only)



Temperate deciduous forest in Pennsylvania, eastern United States

## Temperate Deciduous Forest

**Other names:** Temperate hardwood forest, temperate broadleaf forest

**Climate:** Temperate, semi-humid

**Growing season:** Medium

**Soil quality:** Good

**Biodiversity:** High

**Plants:** Broadleaf deciduous trees such as beech, maple, oak, and hickory; ferns, mosses, and shrubs; many herbaceous plants

**Animals:** Insects, amphibians, reptiles, and birds; mammals such as mice, chipmunks, squirrels, raccoons, foxes, deer, black bears, bobcats, and wolves



Temperate grassland in Nebraska, midwestern United States

## Temperate Grassland

**Other names:** Prairie, outback, pampa, steppe

**Climate:** Temperate, semi-arid

**Growing season:** Medium

**Soil quality:** Excellent

**Biodiversity:** Medium-high

**Plants:** Grasses; other herbaceous plants; no trees

**Animals:** Invertebrates such as worms and insects; amphibians, reptiles, and birds; mammals such as mice, prairie dogs, rabbits, foxes, wolves, coyotes, bison, and antelope; kangaroo (only in Australia)



Chaparral in southern California, United States

## Chaparral

**Other names:** Mediterranean scrub forest

**Climate:** Temperate, semi-arid

**Growing season:** Medium

**Soil quality:** Poor

**Biodiversity:** Low-medium

**Plants:** Shrubs and small trees such as scrub oak and scrub pine

**Animals:** Insects, reptiles, and birds; mammals such as rodents and deer



Desert in southern California, United States

## Desert

**Climate:** Temperate or tropical, arid

**Growing season:** Varies

**Soil quality:** Very poor

**Biodiversity:** None-low

**Plants:** Plants adapted to dryness, such as cacti, sagebrush, and mesquite; virtually no plants if extremely arid

**Animals:** Insects, reptiles, and birds; mammals such as rodents and coyotes





Tropical rainforest in Ecuador, South America

## Tropical Rainforest

**Climate:** Tropical, humid  
**Growing season:** Year-round  
**Soil quality:** Excellent

**Biodiversity:** Very high

**Plants:** Tall flowering, broadleaf evergreen trees; vines and epiphytes; few plants on forest floor

**Animals:** Insects, amphibians, reptiles, and birds; mammals such as monkeys, sloths, leopards, jaguars, pigs, and tigers



Elephant grazing in its grassland ecosystem.

## Tropical Grassland

**Other names:** Savanna  
**Climate:** Tropical, semi-arid  
**Growing season:** Year-round  
**Soil quality:** Poor

**Biodiversity:** Low-medium

**Plants:** Grasses, scattered clumps of trees

**Animals:** Insects, reptiles, and birds; mammals such as zebras, giraffes, antelopes, lions, cheetahs, and hyenas

## Aquatic Biomes

Terrestrial organisms are generally limited by temperature and moisture. Therefore, terrestrial biomes are defined in terms of these abiotic factors. Most aquatic organisms do not have to deal with extremes of temperature or moisture. Instead, their main limiting factors are the availability of sunlight and the concentration of dissolved oxygen and nutrients in the water. These factors vary from place to place in a body of water and are used to define **aquatic biomes**.

### Aquatic Biomes and Sunlight

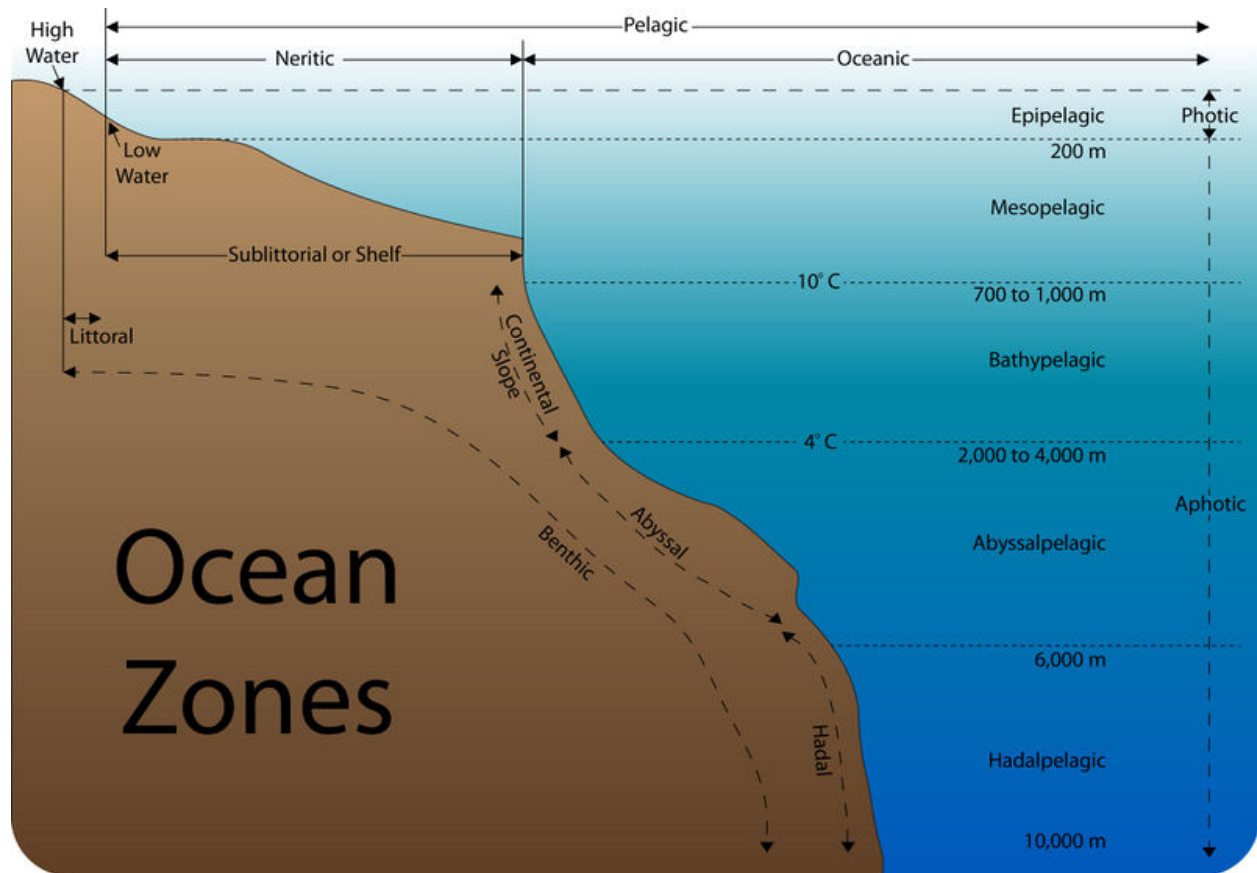
In large bodies of standing water, including the ocean and lakes, the water can be divided into zones based on the amount of sunlight it receives:

1. The **photic zone** extends to a maximum depth of 200 meters (656 feet) below the surface of the water. This is where enough sunlight penetrates for photosynthesis to occur. Algae and other photosynthetic organisms can make food and support food webs.
2. The **aphotic zone** is water deeper than 200 meters. This is where too little sunlight penetrates for photosynthesis to occur. As a result, food must be made by chemosynthesis or else drift down from the water above.

These and other aquatic zones in the ocean are identified in **Figure 1.7**.

### Aquatic Biomes and Dissolved Substances

Water in lakes and the ocean also varies in the amount of dissolved oxygen and nutrients it contains:



**FIGURE 1.7**

The ocean is divided into many different zones, depending on distance from shore and depth of water.

1. Water near the surface of lakes and the ocean usually has more dissolved oxygen than does deeper water. This is because surface water absorbs oxygen from the air above it.
2. Water near shore generally has more dissolved nutrients than water farther from shore. This is because most nutrients enter the water from land. They are carried by runoff, streams, and rivers that empty into a body of water.
3. Water near the bottom of lakes and the ocean may contain more nutrients than water closer to the surface. When aquatic organisms die, they sink to the bottom. Decomposers near the bottom of the water break down the dead organisms and release their nutrients back into the water.

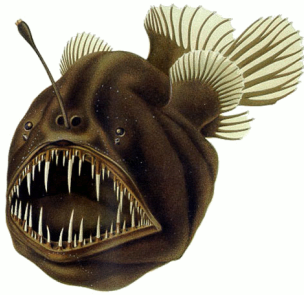
### Aquatic Organisms

Aquatic organisms generally fall into three broad groups: plankton, nekton, and benthos. They vary in how they move and where they live.

1. Plankton are tiny aquatic organisms that cannot move on their own. They live in the photic zone. They include phytoplankton and zooplankton. **Phytoplankton** are bacteria and algae that use sunlight to make food. **Zooplankton** are tiny animals that feed on phytoplankton.
2. Nekton are aquatic animals that can move on their own by “swimming” through the water. They may live

in the photic or aphotic zone. They feed on plankton or other nekton. Examples of nekton include fish and shrimp.

3. Benthos are aquatic organisms that crawl in sediments at the bottom of a body of water. Many are decomposers. Benthos include sponges, clams, and anglerfish like the one in **Figure 1.8**. How has this fish adapted to a life in the dark?



**FIGURE 1.8**

Anglerfish. This anglerfish lives between 1000 and 4000 meters below sea level. No sunlight penetrates to this depth. The rod-like structure on its face has a glow-in-the-dark tip. It is covered with microorganisms that give off their own light. The fish wiggles the structure like a worm to attract prey. In the darkness, only the rod-like worm is visible.

## Marine Biomes

Anglerfish live in the ocean. Aquatic biomes in the ocean are called **marine biomes**. Organisms that live in marine biomes must be adapted to the salt in the water. For example, many have organs for excreting excess salt. Two ocean zones are particularly challenging to marine organisms: the intertidal zone and the deep ocean.

The **intertidal zone** is the narrow strip along the coastline that is covered by water at high tide and exposed to air at low tide (see **Figure 1.9**). There are plenty of nutrients and sunlight in the intertidal zone. However, the water is constantly moving in and out, and the temperature keeps changing. These conditions require adaptations in the organisms that live there, such as the barnacles in **Figure 1.10**.

Bay of Fundy Tides



Low Tide



High Tide

**FIGURE 1.9**

These pictures show the intertidal zone of the Bay of Fundy, on the Atlantic coast in Maine. Can you identify the intertidal zone from the pictures?

Organisms that live deep in the ocean must be able to withstand extreme water pressure, very cold water, and complete darkness. However, even here, thriving communities of living things can be found. Organisms cluster around hydrothermal vents in the ocean floor. The vents release hot water containing chemicals that would be toxic to most other living things. The producers among them are single-celled chemoautotrophs. They make food using energy stored in the chemicals. The tube worms in this chapter's opening photo depend on these chemoautotrophs for food.




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**FIGURE 1.10**

Barnacles. Barnacles secrete a cement-like substance that anchors them to rocks in the intertidal zone.

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### Monitoring Marine Protected Areas

Is overfishing an important issue? What would happen if fish populations dwindled? Marine Protected Areas are no-fishing zones that have recently been established up and down the California coast, in the hope of allowing fish to breed, grow large, and replenish state waters. Scientists monitor these areas to determine if this process is working.




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### Freshwater Biomes

**Freshwater biomes** have water that contains little or no salt. They include standing and running freshwater biomes. Standing freshwater biomes include ponds and lakes. Lakes are generally bigger and deeper than ponds. Some of the water in lakes is in the aphotic zone where there is too little sunlight for photosynthesis. Plankton and plants (such as the duckweed in **Figure 1.11**) are the primary producers in standing freshwater biomes.

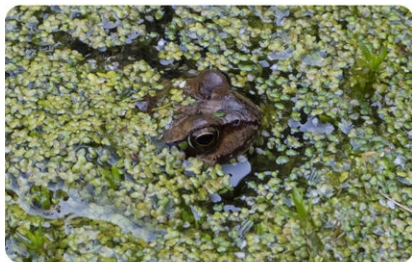
Running freshwater biomes include streams and rivers. Rivers are usually larger than streams. Streams may start with runoff or water seeping out of a spring. The water runs downhill and joins other running water to become a stream. A stream may flow into a river that empties into a lake or the ocean. Running water is better able to dissolve oxygen and nutrients than standing water. However, the moving water is a challenge to many living things. Algae and plants (such as the cattails in **Figure 1.11**) are the primary producers in running water biomes.

### Wetlands

A **wetland** is an area that is saturated with water or covered by water for at least one season of the year. The water may be freshwater or salt water. Wetlands are extremely important biomes for several reasons:

- They store excess water from floods.

## Freshwater Producers



Duckweed in a pond



Cattails in a stream

FIGURE 1.11

The pond on the left has a thick mat of duckweed plants. They cover the surface of the water and use sunlight for photosynthesis. The cattails on the right grow along a stream bed. They have tough, slender leaves that can withstand moving water.

- They slow down runoff and help prevent erosion.
- They remove excess nutrients from runoff before it empties into rivers or lakes.
- They provide a unique habitat that certain communities of plants need to survive.
- They provide a safe, lush habitat for many species of animals, so they have high biodiversity.

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### Lesson Summary

- Terrestrial biomes are determined mainly by climate. Climate influences plant growth, biodiversity, and adaptations of land organisms. Terrestrial biomes include tundras, temperate forests and grasslands, chaparral, temperate and tropical deserts, and tropical forests and grasslands.
- Aquatic biomes are determined mainly by sunlight and concentrations of dissolved oxygen and nutrients in the water. Aquatic organisms are either plankton, nekton, or benthos. Marine biomes are found in the salt water of the ocean. Freshwater biomes include standing and running water biomes. Wetlands are extremely important biomes. They may have freshwater or salt water.

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### Lesson Review Questions

#### Recall

1. What is climate? How does it differ from weather?
2. What is a rain shadow?
3. How does climate influence plant growth?
4. Identify two types of tundra and where they are found.
5. In which biome are you most likely to find grasses, zebras, and lions?
6. What is the photic zone of the ocean?



## Apply Concepts

7. Compare the data for Seattle and Denver in **Table 1.1**. Seattle is farther north than Denver. Why is Seattle warmer?

**TABLE 1.1:** Seattle versus Denver

City, State	Latitude (°N)	Altitude (ft above sea level)	Location (relative to ocean)	Average Low Temperature in January (°F)
Seattle, Washington	48	429	Coastal	33
Denver, Colorado	41	5183	Interior	15

8. If you were to design a well-adapted desert animal, what adaptations would you give it to help it survive in its desert biome?

## Think Critically

9. Explain the relationship between biodiversity and climate in terrestrial biomes.

10. Compare and contrast plankton, nekton, and benthos.

11. A developer wants to extend a golf course into a wetland. Outline environmental arguments you could make against this plan.

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## Points to Consider

You read in this lesson that wetlands have high biodiversity.

- In general, what abiotic factors do you think contribute to high biodiversity?
- Do you think Earth's biodiversity is increasing or decreasing? Why?

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