Review Questions

1. Describe a temperate deciduous forest (Core Case Study) and explain why it serves as an example of how differences in climate lead to the formation of different types of ecosystems.

- Temperate deciduous forest experience four seasons and broad leaf trees tend to lose their leaves during the fall. Differences in climate, mostly from average annual precipitation and temperature, lead to the formation of tropical (hot), temperate (moderate), and polar (cold) deserts, grasslands, and forests.

2. Distinguish between weather and climate. Describe three major factors that determine how air circulates in the lower atmosphere. Describe how the properties of air, water, and land affect global air circulation. Define ocean currents and explain how they, along with global air circulation, support the formation of forests, grasslands, and deserts.

- Weather is a set of physical conditions of the lower atmosphere such as temperature, precipitation, humidity, wind speed, cloud cover, and other factors in a given area over a period of hours or days.
- Climate is an area’s general pattern of atmospheric conditions over periods ranging from at least three decades to thousands of years.
- Three major factors determine how air circulates in the lower atmosphere:
  o Uneven heating of the earth’s surface by the sun
  o Rotation of the earth on its axis
  o Properties of air, water, and land
- Heat from the sun evaporates ocean water and transfers heat from the oceans to the atmosphere, especially near the hot equator. This evaporation of water creates giant
cyclical convection cells that circulate air, heat, and moisture both vertically and from place to place in the atmosphere.
- The earth’s air circulation patterns, prevailing winds, and configuration of continents and oceans result in giant convection cells in which warm, moist air rises and cools, and cool, dry air sinks. These cells lead to an irregular distribution of climates and deserts, grasslands, and forests.

3. Define and give four examples of a greenhouse gas. What is the greenhouse effect and why is it important to the earth’s life and climate?

- Greenhouse gases include several gases in the atmosphere, including water vapor (H₂O), carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O), which absorb and release heat that warms the atmosphere.
- The earth’s surface absorbs solar energy and transforms it to heat, which then rises into the lower atmosphere. Some of this heat escapes into space, but some is absorbed by molecules of greenhouse gases and emitted into the lower atmosphere. This natural warming effect of the troposphere is called the greenhouse effect.
- The greenhouse gases and the natural greenhouse effect play an essential role in determining the earth’s average temperatures and its climates.

4. What is the rain shadow effect and how can it lead to the formation of deserts? Why do cities tend to have more haze and smog, higher temperatures, and lower wind speeds than the surrounding countryside?

- The rain shadow effect is a reduction of rainfall and loss of moisture from the landscape on the side of mountains facing away from prevailing surface winds. Warm, moist air in onshore winds loses most of its moisture as rain and snow on the windward slopes of a mountain range. This leads to semi-arid and arid conditions on the leeward side of the mountain range and the land beyond.
- Cities have building materials that absorb and hold heat, buildings that block wind flow, and motor vehicles and the climate-control systems of buildings that release large quantities of heat and pollutants, resulting in more haze and smog, higher temperatures, and lower wind speeds than the surrounding countryside.

5. What is a biome? Explain why there are three major types of each of the major biomes (deserts, grasslands, and forests). Describe how climate and vegetation vary with latitude and elevation.

- Biomes are large terrestrial regions, such as forests, deserts, and grasslands, with distinct climates and certain species (especially vegetation) adapted to them.
- The three major biomes are determined by the amount of precipitation.
- Differences in climate, mostly from average annual precipitation and temperature, lead to the formation of tropical (hot), temperate (moderate), and polar (cold) deserts, grasslands, and forests.
Both climate and vegetation vary with latitude and elevation. If you climb a tall mountain from its base to its summit, you would encounter deciduous forest, coniferous forest, tundra, then mountain ice and snow.

6. Describe how the three major types of deserts differ in their climate and vegetation. Why are desert ecosystems fragile? How do desert plants and animals survive?

- **Tropical deserts** are hot and dry most of the year with few plants and a hard, windblown surface strewn with rocks and some sand.
- **Temperate deserts** have high daytime temperatures in summer and low in winter and there is more precipitation than in tropical deserts, with sparse vegetation consisting mostly of widely dispersed, drought-resistant shrubs and cacti or other succulents adapted to the lack of water and temperature variations.
- **Cold deserts** have cold winters and warm or hot summers and low precipitation, with desert plants and animals having adaptations that help them stay cool and get enough water to survive.

7. Describe how the three major types of grasslands differ in their climate and vegetation. What is a savanna? Why have many of the world’s temperate grasslands disappeared? What is permafrost?

- Tropical grasslands like the savanna contain widely scattered clumps of trees such as acacia, which are covered with thorns that keep some herbivores away. This biome usually has warm temperatures year-round and alternating dry and wet seasons.
- Temperate grassland has winters that can be bitterly cold, summers that are hot and dry, and annual precipitation that is fairly sparse and falls unevenly through the year. Most of the grasses die and decompose each year, and organic matter accumulates to produce a deep, fertile soil.
- Cold grasslands, or arctic tundra (Russian for “marshy plain”), lie south of the Arctic polar ice cap. During most of the year, these treeless plains are bitterly cold. Winters are long and dark, and scant precipitation falls mostly as snow. Under the snow, this biome is carpeted with a thick, spongy mat of low-growing plants—primarily grasses, mosses, lichens, and dwarf shrubs.
- Many of the world’s natural temperate grasslands have disappeared because their fertile soils are useful for growing crops and grazing cattle.
- Permafrost is the underground soil in which captured water stays frozen for more than two consecutive years.

8. What are the three major types of forests? Describe how these three types differ in their climate and vegetation. Why is biodiversity so high in tropical rain forests? Why do most soils in tropical rain forests hold few plant nutrients? Describe what happens in temperate deciduous forests in the winter and fall. What are coastal coniferous or temperate rain forests? What important ecological roles do mountains play?

- Tropical rain forests are found near the equator where hot, moisture-laden air rises and dumps its moisture; these lush forests have year-round, uniformly warm temperatures, high humidity, and heavy rainfall almost daily.
- Temperate deciduous forests grow in areas with moderate average temperatures that change significantly with the season, supporting species such as oak, hickory, maple, poplar, and beech.
- Cold forests have intense cold and drought in winter when snow blankets the ground, and trees that take advantage of the brief summers because they need not take time to grow new needles.
- Tropical rain forest life forms occupy a variety of specialized niches in distinct layers. Stratification of specialized plant and animal niches in a tropical rain forest enables the coexistence of a great variety of species (high species diversity).
- Dropped leaves, fallen trees, and dead animals decompose quickly because of the warm, moist conditions and the hordes of decomposers. This rapid recycling of scarce soil nutrients explains why there is so little plant litter on the ground. Instead of being stored in the soil, about 90% of plant nutrients released by decomposition are quickly taken up and stored by trees, vines, and other plants.
- The trees found in deciduous forests survive cold winters by dropping their leaves in the fall and becoming dormant through the winter.
- Coastal coniferous forests or temperate rain forests are found in scattered coastal temperate areas that have ample rainfall or moisture from dense ocean fogs. Dense stands of large conifers once dominated undisturbed areas of this biome along the coast of North America, from Canada to northern California.
- Mountains help to regulate the earth’s climate. Mountaintops covered with ice and snow reflect some solar radiation back into space, which helps to cool the earth and offset global warming.

9. About what percentage of the world’s major terrestrial ecosystems are being degraded or used unsustainably? Summarize how human activities have affected the world’s deserts, grasslands, forests, and mountains. How is the warming climate likely to change the earth’s biomes?
- 60% are being degraded.
- Ways that we have affected deserts include: large desert cities, soil destruction by off road vehicles, soil salinization from irrigation, depletion of groundwater, land disturbance, and pollution from mineral extraction.
- Ways that we have affected grasslands include: conversion to cropland, release of CO2 to atmosphere from burning grassland, overgrazing by livestock, and oil production and off-road vehicles in arctic tundra.
- Ways that we have affected forests include: clearing for agriculture, livestock grazing, timber, urban development, conversion of diverse forests to tree plantations, damage from off-road vehicles, and pollution of forest streams.
- Climate disruption is likely to cause biomes to either move from the equator to the poles or to become smaller and eventually disappear. The rate of change may be too quick for vegetative movement/adjustment.
10. Describe the connections between the climates, terrestrial systems, and the three principles of sustainability (see back cover).

- The climate is driven by solar power and determines what the biodiversity in any terrestrial system will be. Nutrients are cycled throughout these systems and the rate of cycling is generally determined by the climate.