

THE LIVING WORLD: ECOSYSTEMS

1. Explain how the availability of resources influences species interactions.

- a. Ecosystems are the result of biotic and abiotic interactions. In a predator-prey relationship, the predator is an organism that eats another organism (the prey).
- b. Symbiosis is a close and long-term interaction between two species in an ecosystem. Types of symbiosis include mutualism, commensalism, and parasitism
- c. Competition can occur within or between species in an ecosystem where there are limited resources. Resource partitioning— using the resources in different ways, places, or at different times—can reduce the negative impact of competition on survival.

2. Describe the global distribution and principal environmental aspects of terrestrial biomes.

- a. A biome contains characteristic communities of plants and animals that result from, and are adapted to, its climate.
- b. Major terrestrial biomes include taiga, temperate rainforests, temperate seasonal forests, tropical rainforests, shrubland, temperate grassland, savanna, desert, and tundra.
- c. The global distribution of nonmineral terrestrial natural resources, such as water and trees for lumber, varies because of some combination of climate, geography, latitude and altitude, nutrient availability, and soil.
- d. The worldwide distribution of biomes is dynamic; the distribution has changed in the past and may again shift as a result of global climate changes.

3. Describe the global distribution and principal environmental aspects of aquatic biomes.

- a. Freshwater biomes include streams, rivers, ponds, and lakes. These freshwater biomes are a vital resource for drinking water.
- b. Marine biomes include oceans, coral reefs, marshland, and estuaries. Algae in marine biomes supply a large portion of the Earth's oxygen, and also take in carbon dioxide from the atmosphere.
- c. The global distribution of nonmineral marine natural resources, such as different types of fish, varies because of some combination of salinity, depth, turbidity, nutrient availability, and temperature.

4. Explain how solar energy is acquired and transferred by living organisms.

- a. Primary productivity is the rate at which solar energy (sunlight) is converted into organic compounds via photosynthesis over a unit of time.
- b. Gross primary productivity is the total rate of photosynthesis in a given area.
- c. Net primary productivity is the rate of energy storage by photosynthesizers in a given area, after subtracting the energy lost to respiration.
- d. Productivity is measured in units of energy per unit area per unit time (e.g., kcal/m²/yr).
- e. Most red light is absorbed in the upper 1m of water, and blue light only penetrates deeper than 100m in the clearest water. This affects photosynthesis in aquatic ecosystems, whose photosynthesizers have adapted mechanisms to address the lack of visible light.

5. Explain how energy flows and matter cycles through trophic levels.

- a. All ecosystems depend on a continuous inflow of high-quality energy in order to maintain their structure and function of transferring matter between the environment and organisms via biogeochemical cycles.
- b. Biogeochemical cycles are essential for life and each cycle demonstrates the conservation of matter.
- c. In terrestrial and near-surface marine communities, energy flows from the sun to producers in the lowest trophic levels and then upward to higher trophic levels.

6. Determine how the energy decreases as it flows through ecosystems.

- a. The 10% rule approximates that in the transfer of energy from one trophic level to the next, only about 10% of the energy is passed on.
- b. The loss of energy that occurs when energy moves from lower to higher trophic levels can be explained through the laws of thermodynamics.

7. Describe food chains and food webs, and their constituent members by trophic level.

- a. A food web is a model of an interlocking pattern of food chains that depicts the flow of energy and nutrients in two or more food chains.
- b. Positive and negative feedback loops can each play a role in food webs. When one species is removed from or added to a specific food web, the rest of the food web can be affected

THE LIVING WORLD: BIODIVERSITY

1. Explain levels of biodiversity and their importance to ecosystems.

- a. Biodiversity in an ecosystem includes genetic, species, and habitat diversity.
- b. The more genetically diverse a population is, the better it can respond to environmental stressors. Additionally, a population bottleneck can lead to a loss of genetic diversity.
- c. Ecosystems that have a larger number of species are more likely to recover from disruptions.
- d. Loss of habitat leads to a loss of specialist species, followed by a loss of generalist species. It also leads to reduced numbers of species that have large territorial requirements
- e. Species richness refers to the number of different species found in an ecosystem.

2. Describe ecosystem services and the results of human disruptions to ecosystem services.

- a. There are four categories of ecosystem services: provisioning, regulating, cultural, and supporting.
- b. Anthropogenic activities can disrupt ecosystem services, potentially resulting in economic and ecological consequences.

3. Describe island biogeography and the role of island biogeography in evolution.

- a. Island biogeography is the study of the ecological relationships and distribution of organisms on islands, and of these organisms' community structures.
- b. Islands have been colonized in the past by new species arriving from elsewhere.
- c. Many island species have evolved to be specialists versus generalists because of the limited resources, such as food and territory, on most islands. The long-term survival of specialists may be jeopardized if and when invasive species, typically generalists, are introduced and outcompete the specialists.

4. Describe ecological tolerance.

- a. Ecological tolerance refers to the range of conditions, such as temperature, salinity, flow rate, and sunlight that an organism can endure before injury or death results.
- b. Ecological tolerance can apply to individuals and to species.

5. Explain how natural disruptions, both short-and long-term, impact an ecosystem.

- a. Natural disruptions to ecosystems have environmental consequences that may, for a given occurrence, be as great as, or greater than, many human-made disruptions.
- b. Earth system processes operate on a range of scales in terms of time. Processes can be periodic, episodic, or random.
- c. Earth's climate has changed over geological time for many reasons.
- d. Sea level has varied significantly as a result of changes in the amount of glacial ice on Earth over geological time.
- e. Major environmental change or upheaval commonly results in large swathes of habitat change
- f. Wildlife engages in both short- and long-term migration for a variety of reasons, including natural disruptions.

6. Describe how organisms adapt to their environment.

- a. Organisms adapt to their environment over time, both in short- and long-term scales, via incremental changes at the genetic level.
- b. Environmental changes, either sudden or gradual, may threaten a species' survival, requiring individuals to alter behaviors, move, or perish.

7. Describe ecological succession and the effect of ecological succession on ecosystems.

- a. There are two main types of ecological succession: primary and secondary succession.
- b. Pioneer members of an early successional species commonly move into unoccupied habitat and over time adapt to its particular conditions, which may result in the origin of new species.
- c. Succession in a disturbed ecosystem will affect the total biomass, species richness, and net productivity over time.
- d. A keystone species in an ecosystem is a species whose activities have a particularly significant role in determining community structure.
- e. An indicator species is a plant or animal that, by its presence, abundance, scarcity, or chemical composition, demonstrates that some distinctive aspect of the character or quality of an ecosystem is present.
- f. Specialist species tend to be advantaged in habitats that remain constant, while generalist species tend to be advantaged in habitats that are changing.

EARTH SYSTEMS AND RESOURCES: CLIMATE

1. Explain how environmental factors can result in atmospheric circulation.

- a. Global wind patterns primarily result from the most intense solar radiation arriving at the equator, resulting in density differences and the Coriolis effect.

2. Explain how the sun's energy affects the Earth's surface.

- a. Incoming solar radiation (insolation) is the Earth's main source of energy and is dependent on season and latitude.
- b. The angle of the sun's rays determines the intensity of the solar radiation. Due to the shape of the Earth, the latitude that is directly horizontal to the solar radiation receives the most intensity.
- c. The highest solar radiation per unit area is received at the equator and decreases toward the poles.
- d. The solar radiation received at a location on the Earth's surface varies seasonally, with the most radiation received during the location's longest summer day and the least on the shortest winter day.
- e. The tilt of Earth's axis of rotation causes the Earth's seasons and the number of hours of daylight in a particular location on the Earth's surface.

3. Describe how the Earth's geography affects weather and climate.

- a. Weather and climate are affected not only by the sun's energy but by geologic and geographic factors, such as mountains and ocean temperature.
- b. A rain shadow is a region of land that has become drier because a higher elevation area blocks precipitation from reaching the land.

4. Describe the environmental changes and effects that result from El Niño or La Niña events (El Niño–Southern Oscillation).

- a. El Niño and La Niña are phenomena associated with changing ocean surface temperatures in the Pacific Ocean. These phenomena can cause global changes to rainfall, wind, and ocean circulation patterns.
- b. El Niño and La Niña are influenced by geological and geographic factors and can affect different locations in different ways.