

## Section 2.3 Review Answers

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1. The biosphere is considered an open system due to the constant input of solar energy and radiation of heat energy into space.
  2. Productivity is the rate at which an ecosystem's producers capture and store energy within organic compounds over a certain length of time.
  3. In summer, grasslands can have greater productivity than a forest because animals are constantly consuming the grass and new grass is constantly being grown to replace it. As a result, new biomass may accumulate at a faster rate than it does in a forest, where only limited amounts of biomass are consumed.
  4. Four variables affecting terrestrial productivity are:
    - Nutrient levels, which limit productivity if in short supply.
    - Rainfall, which limits productivity if in short supply.
    - Solar radiation and heat. Low levels limit productivity at the forest floor and in some biomes; excess ultraviolet radiation also limits productivity.
    - The number of producers present in the ecosystem. Productivity increases at a greater rate if more producers are present.
  5. Two variables that determine productivity in the oceans are:
    - Nutrient availability, which limits productivity if in short supply. Most nutrients in oceans are found at the mouths of rivers and in coastal upwelling zones. They are also released following seasonal melting of ice.
    - Solar radiation. Sufficient solar radiation allows for considerable productivity near the ocean surface, while decreased solar radiation in deeper waters tends to limit productivity.
  6. The Gaia Hypothesis states that the biosphere acts like an organism in that it is self-regulating and maintains environmental conditions within certain limits.
  7. Stromatolites hold clues about the composition of Earth's atmosphere and oceans from 3.8 to 2.5 billion years ago. Prior to this time, the atmosphere lacked free oxygen and bacteria and bacteria-like organisms grew, forming thick mounds in shallow seas, lagoons, and lakes. As the micro-organisms died, they formed sedimentary rocks called stromatolites over time. Some stromatolites, estimated to be 2.5 billion years old or more, suggest that, around this time, the level of oxygen in the oceans had started to increase. Scientists have identified bands of iron oxides in stromatolites from this period, which formed when iron ions combined with dissolved oxygen in the oceans.
- Stromatolites that are less than 1.8 billion years old do not have black bands of iron oxides, most likely due to the fact that, at this time, most of the iron ions in the oceans were already bound in iron oxides. With the ocean's store of iron ions used up, the oxygen produced by photosynthesis was free to build up as oxygen gas and eventually to escape into Earth's atmosphere. Thus scientists know that oxygen levels in the atmosphere were higher after that point in time.
8. (a) Algal blooms occur when excess phosphate or nitrate enters a body of water (phosphate is the more limiting growth factor as it is found in smaller amounts in the environment). Human activities that lead to algal blooms include deforestation, discharge of inadequately treated sewage water, raising livestock, and fertilizing lawns and agricultural fields.
  - (b) Seasonal turnover of nutrient rich water and warmer temperatures can promote algal blooms in the late summer and early fall. Algal blooms can block out sunlight, resulting in the death of aquatic plants. Decomposition of the dead organic matter depletes oxygen, which kills off fish and other aquatic organisms that require oxygen, resulting in a dead zone.
  9. (a) An increase in annual hydrogen sulfide levels would increase the amount of sulfur being rapidly cycled in the sulfur cycle. Further bacterial metabolism would also lead to an increase in the amount of sulfate available to plants, as well as in the atmosphere. The latter would result in an increase in acid deposition. As a result, the overall rate of rapid cycling of sulfur would probably also increase.
  - (b) Increased amounts of acid deposition would harm the plants in a temperate deciduous forest and acidify natural bodies of water, harming vulnerable aquatic producers, thus inhibiting productivity.