

**Ecosystems, Energy, and Matter**

1. Describe the fundamental relationship between autotrophs and heterotrophs in an ecosystem.
2. Explain how the first and second laws of thermodynamics apply to ecosystems.
3. Explain how decomposition connects all trophic levels in an ecosystem.

**Primary Production in Ecosystems**

4. Explain why the amount of energy used in photosynthesis is so much less than the amount of solar energy that reaches Earth.
5. Define and compare gross primary production and net primary production.
6. Define and compare net primary production and standing crop.
7. Compare primary productivity in specific marine, freshwater, and terrestrial ecosystems.

**Secondary Production in Ecosystems**

8. Explain why energy is said to flow rather than cycle within ecosystems.
9. Explain what factors may limit production in aquatic ecosystems.
10. Describe an experiment that provided evidence that iron availability limits oceanic primary production in some regions. Explain how iron availability is related to nitrogen availability in these regions.
11. Explain why areas of upwelling in the ocean have exceptionally high levels of primary production.
12. Distinguish between each of the following pairs of terms:
  - a. primary and secondary production
  - b. production efficiency and trophic efficiency
13. Explain why the production efficiency of a human is much less than the production efficiency of a mosquito.
14. Distinguish among pyramids of net production, pyramids of biomass, and pyramids of numbers.
15. Explain why aquatic ecosystems may have inverted biomass pyramids.
16. Explain why worldwide agriculture could feed more people if all humans consumed only plant material.
17. Explain the green-world hypothesis. Describe five factors that may act to keep herbivores in check.

**The Cycling of Chemical Elements in Ecosystems**

18. Describe the four nutrient reservoirs and the processes that transfer the elements between reservoirs.
19. Name the main processes driving the water cycle.
20. Name the major reservoirs of carbon.
21. Describe the nitrogen cycle and explain the importance of nitrogen fixation to all living organisms. Name three other key bacterial processes in the nitrogen cycle.
22. Describe the phosphorus cycle and explain how phosphorus is recycled locally in most ecosystems.
23. Explain how decomposition affects the rate of nutrient cycling in ecosystems.
24. Describe how net primary production and the rate of decomposition vary with actual evapotranspiration.
25. Describe the experiments at Hubbard Brook that revealed the key role that plants play in regulating nutrient cycles.

**Human Impact on Ecosystems and the Biosphere**

26. Describe how agricultural practices can interfere with nitrogen cycling.
27. Explain how “cultural eutrophication” can alter freshwater ecosystems.
28. Describe the causes and consequences of acid precipitation.
29. Explain why toxic compounds usually have the greatest effect on top-level carnivores.
30. Describe how increased atmospheric concentrations of carbon dioxide could affect Earth.
31. Describe the causes and consequences of ozone depletion.