Chapter 7

Testing Your Comprehension

1. Negative feedback loops are most common in nature, whereas positive loops sometimes result from human actions. When they do, they tend to move systems away from their homeostatic condition.

2. Excess nutrients in the runoff from the land fertilize the phytoplankton in the coastal marine ecosystem. This results in a rapid growth of the phytoplankton population. Dead phytoplankton and waste products then accumulate on the bottom, where bacterial decomposition consumes most of the available oxygen, causing hypoxia.

3. An ecosystem includes both the biotic community and its abiotic environment. “Community” refers strictly to the populations of living organisms in a given area.

4. Typically, energy moves through an ecosystem from its source (the sun) to plants or other photosynthetic primary producers. They are then consumed by a variety of organisms, which in turn are consumed by others. At each step, some energy is passed along to the consumer and some is lost as waste heat. Matter is also transferred up the food chain as organisms eat organisms on lower trophic levels, but matter from organisms’ waste and from dead organisms is consumed and broken down by detritivores and decomposers, returning matter to the soil so that in can be recycled through the food web.

5. Cars release significant amounts of CO$_2$ into the atmosphere from the combustion of fossil fuels. Photosynthesis is the process by which plants remove CO$_2$ from the atmosphere and store the carbon as sugar. The oceans are home to a large volume of phytoplankton which can remove CO$_2$ from the air by photosynthesis; CO$_2$ also dissolves in seawater, is incorporated into carbonate minerals, and collects as sediment on the ocean floor. The sediments eventually can become part of the Earth’s crust. This carbon returns to the atmosphere when the crustal plates are themselves recycled along plate boundaries, and some of the plate material is melted and erupts volcanically.


7. Human activity has accelerated the release of CO$_2$ into the atmosphere from the combustion of fossil fuels and cement production, as well as deforestation. High CO$_2$ concentrations in the atmosphere contribute to the greenhouse effect. We mine rocks containing phosphorus for use as fertilizer, and then allow excess phosphates to run into waterways, causing eutrophication. We also fix more nitrogen now by the Haber-Bosch process than is fixed naturally. This also can cause eutrophication, as well as some health effects on humans and other animals consuming nitrate-contaminated drinking water.

8. Evaporation is the conversion of water from its liquid to gaseous form. Transpiration is the special case of evaporation and release of water vapor from the leaves of plants. The water cycle impacts the other nutrient cycles because they all have water soluble forms: CO$_2$ dissolved as bicarbonate ions; nitrogen in the form of ammonia, nitrates, or nitrites; and phosphorus as phosphates.

9. Igneous rocks form when molten rock cools and solidifies. Sedimentary rocks form when sediments (which derive from the weathering, erosion, and deposition of other rocks and from biological sources) are compressed sufficiently to bind together. Greatly increased
pressures can modify the mineral structures of either igneous or sedimentary rocks, thereby forming metamorphic rocks.

10. When crustal plates collide, they may be forced upwards to form mountains. If one plate slides under another (subduction), the plate being subducted will melt, and may be ejected through cracks to the surface in a volcanic eruption, potentially forming mountains. When plates are sliding past one another, force may be built up over time and then released suddenly as the plates lurch past one another—an earthquake. Plate tectonics was most likely not discovered sooner because the processes are largely hidden from direct observation, and occur so slowly as to be almost imperceptible.

**Interpreting Graphs and Data**

1. Control: aboveground is approximately 380 g C/m²; belowground is approximately 9,600 g C/m²; total is approximately 10,000 g C/m². Fertilized treatment: aboveground is approximately 620 g C/m²; belowground is approximately 7,400 g C/m²; total is approximately 8,000 g C/m².

2. There was more aboveground C in the fertilized treatment than in the control (625 g C/m² for the fertilized treatment and only 375 g C/m² for the control). This suggests that the fertilizer did stimulate more aboveground plant growth. The decrease in belowground biomass may have been caused by either increased rates of decay or decreased rates of root growth.

3. The hypothesis is wrong—fertilization resulted in a net release of about 2,000 g C/m². The hypothesis did not consider that fertilization may stimulate more decomposition as well as more plant growth (see Fig 7.9, which shows the carbon cycle). Based on this study, one can predict that global climate change may cause an increase in the atmospheric concentration of CO₂.

**Calculating Ecological Footprints**

<table>
<thead>
<tr>
<th>Fertilizer application</th>
<th>Number of lawns</th>
<th>Pounds of nitrogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>To your 1/3-acre lawn</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>To the lawns of your classmates</td>
<td>Answers will vary</td>
<td>Answers will vary</td>
</tr>
<tr>
<td>To the lawns of all your schoolmates</td>
<td>Answers will vary</td>
<td>Answers will vary</td>
</tr>
<tr>
<td>To all the lawns in your hometown</td>
<td>Answers will vary</td>
<td>Answers will vary</td>
</tr>
<tr>
<td>To all the lawns in your state</td>
<td>Answers will vary</td>
<td>Answers will vary</td>
</tr>
<tr>
<td>To all the lawns in the United States</td>
<td>60,000,000</td>
<td>900,000,000</td>
</tr>
</tbody>
</table>
1. Much of the nitrogen is taken up by the grass, but much of it runs off and ends up in local waterways. Inorganic nitrogen-based fertilizer results from the Haber-Bosch process.
2. Overuse of fertilizers can have many of the environmental impacts discussed in this chapter (e.g., on p. 201). The production, transport, and application of fertilizer also involves use of fossil fuels, which themselves have environmental impacts.