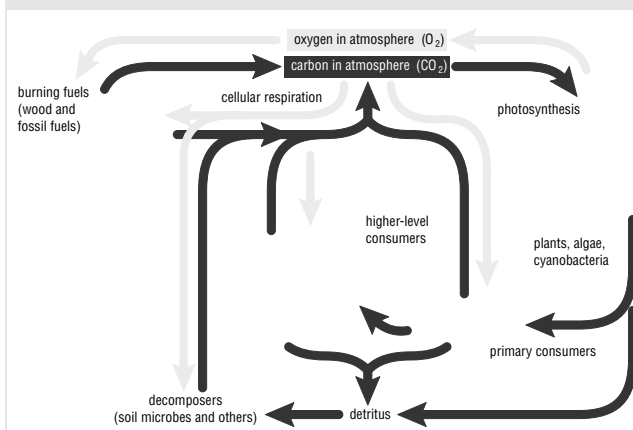


## Chapter 2 Review Answers

Student Textbook pages 64-65

### Answers to Understanding Concepts Questions

1.



2. Water has several properties that make it an excellent transporter of dissolved materials:

- Water has a unique chemical structure. A molecule of water is polar and therefore able to form hydrogen bonds, which enables it to dissolve a wide variety of ionic and molecular compounds.
- Water is less dense as a solid than as a liquid. Because of hydrogen bonding, water is less dense in its solid form than as a liquid, as the hydrogen bonds hold the water in an open crystalline structure as it freezes. Due to hydrogen bonding, water is densest at 4 °C and becomes less dense as it cools and warms below and above this value. This has key consequences for the cycling of nutrients in bodies of water, as warming and cooling exchanges nutrients between depths as water rises and sinks.
- Water has a relatively high boiling point and melting point. As a result, it can transport compounds over a wide range of temperatures.

- Water has special adhesive and cohesive properties. This means that water molecules are attracted to each other, as well as to other substances, making water a great transporter. For example, these qualities allow water to effectively transport nutrients up the xylem of plants.
3. (a) In the rapid cycling of carbon, plants remove carbon dioxide from the atmosphere and produce carbon-rich molecules in plant tissues. Plants fix much more carbon than they release through cellular respiration. Animals take up carbon by eating plant matter or other animals and release carbon dioxide through cellular respiration. Burning and decomposition of dead plant and animal matter and wastes releases carbon to the atmosphere and biosphere.
- (b) When plant and animal matter accumulate as fossil fuels, the carbon becomes part of slow cycling and is no longer available for living organisms to use in biological processes. Trees also store large amount of carbon in a form that is inaccessible to organisms and are, therefore, part of the slow cycling of carbon. Shelled aquatic organisms also store carbon in their shells for long periods, which is later incorporated into limestone.
4. Animals lose water from their bodies through urine, feces, and evaporation (includes sweating and breathing). Animals replace water by drinking, eating, and through cellular respiration (metabolic water). Some organisms also absorb water through their skin.
5. (a) A water molecule consists of two hydrogen atoms that are covalently bonded to one oxygen atom. The hydrogen end of the molecule has a slightly positive charge and the oxygen end has a slightly negative charge, making water a polar molecule. This polarity allows a water molecule to form a weak attraction, called a hydrogen bond, between the hydrogen of one molecule and the oxygen of a nearby molecule. Hydrogen bonding explains why ice floats on water. When water freezes, it expands because hydrogen bonds hold the water molecules in an open crystal structure. As a result, ice is less dense than liquid water, in which the molecules are packed more closely together.
- (b) The hydrogen end of a water molecule has a slightly positive charge and the oxygen end has a slightly negative charge, making water a polar molecule. This polarity allows it to dissolve a wide range of ionic and molecular compounds; hence, it is called the universal solvent.
- (c) Again, the hydrogen end of a water molecule has a slightly positive charge and the oxygen end has a slightly negative charge, making water a polar molecule. This polarity allows a water molecule to form hydrogen bonds. The polarity of water molecules and resultant hydrogen bonding causes attraction between water molecules (cohesion) and

attraction between water molecules and other substances (adhesion). As result, water has special adhesive and cohesive properties.

- 6. (a)** Living organisms are nitrogen reservoirs because they take in nitrogen from their food (animals), the soil (plants), and directly from the air (some bacteria), which they incorporate into proteins and DNA. Nitrogen is stored in these organisms and released back into the environment when their bodies (or parts of them) are decomposed or wastes are released. Some bacteria also release nitrogen in molecules they produce in metabolic reactions.

**(b)** Soil is a reservoir for nitrogen because it is home to bacteria that break down organic matter to produce ammonium, nitrate, and nitrite. Ammonium and nitrate are forms of nitrogen that are usable by plants. Nitrogen remains in the soil in these usable forms until plant roots absorb it or it is changed back into nitrogen gas by denitrifying bacteria.

**(c)** Freshwater contains soluble nitrogen-containing compounds, such as nitrate, that have run-off from the soil, while oceans contain bacterial communities that convert nitrogen gas into forms that are usable by phytoplankton and aquatic plants (ammonium and nitrate). Most bodies of water also contain nitrogen that is released by decomposition.

**(d)** The atmosphere is a reservoir for nitrogen because denitrifying bacteria convert nitrite and nitrate into nitrogen gas, which enters the atmosphere. Nitrogen gas makes up 78% of the atmosphere. It is removed from this reservoir by nitrogen fixation by bacteria, the conversion of nitrogen gas into nitrate by lightning, and some human activities.
- 7.** Carbon, sulfur, oxygen, and nitrogen cycle through Earth's atmosphere; phosphorous does not.
- 8.** Excess phosphate can act as a fertilizer to increase algal growth. Significantly high amounts of phosphate in bodies of water can cause algal blooms. The overgrowth of algae in such blooms can block out sunlight so that aquatic plants in the water below die, as they can no longer photosynthesize. Decomposition of this excess organic matter uses up much of the oxygen in the water, resulting in the death of fish and other aquatic animals that require oxygen. This area becomes devoid of life and is known as a dead zone.
- 9. (a)** Photosynthesis caused the increase in atmospheric oxygen levels.

**(b)** Scientists examine stromatolites to gather evidence about past levels of atmospheric oxygen. Stromatolites with black bands of iron oxides were formed when the oceans contained oxygen and free iron ions, and the atmosphere likely contained little to no free oxygen. Stromatolites without black bands were probably formed when the oceans no longer contained iron ions that were not bound up in iron oxides. As a result, oxygen produced by photosynthesis was able to escape into the atmosphere after this point in time.
- 10.** Fertilizers contain usable forms of nitrogen, phosphorous, sulfur, and other nutrients that optimize plant growth.
- 11. (a)** Plants can use ammonium and nitrate.

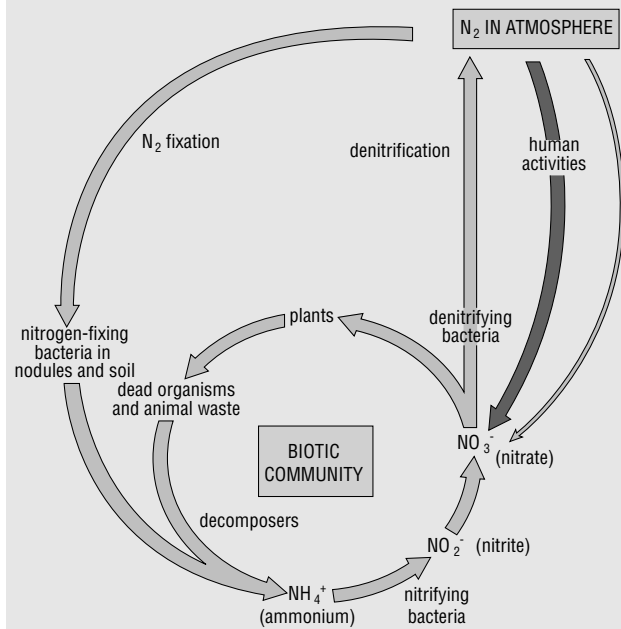
**(b)** Nitrogen-fixing bacteria transform atmospheric nitrogen into a form of nitrogen that plants can use: ammonium. Through ammonification, bacteria also decompose organic matter to produce ammonium, which is further transformed into nitrite and then into nitrate by still more bacteria.

**(c)** Denitrifying bacteria convert nitrite and nitrate into nitrogen gas.
- 12. (a)** Acid deposition is a process by which emissions, such as those containing sulfur, undergo chemical change in the atmosphere and are deposited in the environment as dry particles and gases, or as wet acid precipitation, including rain, snow, and fog. In eastern Canada, high levels of manufacturing result in the burning a large amount of fossil fuel. This combustion releases sulfur dioxide into the atmosphere. The sulfur dioxide reacts with water vapour in the atmosphere to form sulfurous and sulfuric acid that falls with rain, snow, or sleet.

**(b)** The sulfur cycle and water cycle are involved in acid deposition. Some students may add that the nitrogen cycle is also involved, which is correct, although it is not clearly stated in the text.
- 13.** In the nitrogen cycle, elemental nitrogen, as well as nitrogen compounds in the lithosphere, cycle through the atmosphere in order to return once again to the soil of the lithosphere. In fact, the atmosphere is a significant nitrogen reservoir. In contrast to the nitrogen cycle, phosphorus does not cycle through the atmosphere at all. Instead, the lithosphere is a significant phosphorus reservoir. Both substances, however, are essential components of living cells, and the soil of the lithosphere is the key means by which these substances are passed (ingested or absorbed) as nutrients into living cells and released (through feces and decomposition) as nutrients to enrich the soil once again.
- 14.** The term "ecosystem services" refers to the benefits that an ecosystem provides to its human inhabitants. These benefits include breathable air, natural filtration of water, food, pollination, erosion control, and climate stability.
- 15.** Although nutrients may be plentiful in the deep ocean, not enough light penetrates deep waters to allow for high productivity from photosynthesis. In coastal areas, productivity is greater because coastal upwellings supply nutrient-rich water from the deep ocean, while shallow water ensures producers receive high levels of sunlight for photosynthesis.

16. Wetlands are natural filtration systems, which decontaminate water. Wetlands also provide food and shelter to numerous life forms.

17.



18. Water dissolves a wide range of ionic compounds and molecules. This means that water can transport nutrients and gases in organisms and the abiotic environment. Water vapour is a greenhouse gas, and thus traps heat in Earth's atmosphere. Because water has a high heat capacity, large bodies of water moderate temperatures over nearby land, and ocean currents carry heat from place to place. When plants lose water via transpiration or animals sweat, the evaporating water takes heat with it and cools the organism. Organisms resist environmental temperature changes somewhat because their body tissues contain large amounts of water and are, therefore, slow to heat or cool. Water also stays liquid over a wide range of temperatures and floats as ice, allowing aquatic organisms to live under the ice in winter. Because water is densest at 4 °C, cooling and warming also result in nutrient turnover, supporting life.

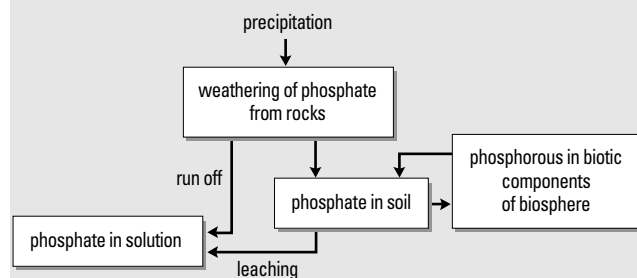
### Answers to Applying Concepts Questions

19. The researchers could conduct a controlled experiment by setting up a series of tanks with water, the same type and amount of algae, the same type and amount of nutrients, and exposure to the same amount of UVR and visible light. The tanks should be exposed to a range of temperatures (the manipulated variable). The researchers could assess the results based on algal death or productivity, or by checking for mutations in the algal DNA.

20. (a) It appears that vegetation maintains water in an ecosystem and reduces erosion; therefore, downstream flooding may be directly caused by deforestation.
- (b) Large-scale deforestation would decrease transpiration, and instead of moving through plants, water would move quickly over land into bodies of water. A lack of moisture in the air would probably change patterns of precipitation.
- (c) The amount of nitrate in streams from deforested areas was high compared to the amount in streams from forested areas. The results suggest that nitrate was washed out of the soil in the deforested areas.
- (d) Deforestation can result in a reduction of available nitrate that would be otherwise taken up by plants to enter the food chain. This nitrate may be more easily washed from the soil into streams and other natural bodies of water. Excess nitrate in downstream areas could result in algal blooms. In general, there will be more nitrogen in the aquatic parts of the cycle and less in the terrestrial parts.
- (e) The lack of nutrients could inhibit new plant growth in a previously deforested area, as could the soil's inability to hold moisture.
21. Precipitation could wash pesticides in a landfill into the ground water, compromising its quality.
22. (a) The heavy rains likely carried bacteria in the manure into the ground water that served as the town's water supply.
- (b) Two safeguards would be more stringent water testing by qualified personnel and acting quickly on the results. Actions could include isolating a drinking water supply from the source of contamination or adding more chlorine to drinking water.

### Answers to Making Connections Questions

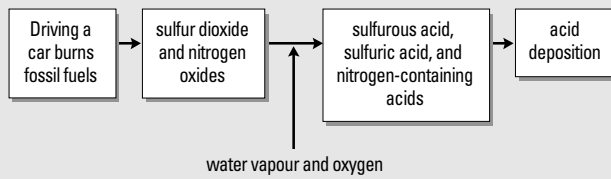
23.



24. Garbage can be defined as waste. Students may tackle questions such as: If a grizzly bear leaves a half-eaten moose, is it garbage if the waste is eventually eaten by scavengers and decomposed? Pollution is the contamination of the environment, generally by certain chemicals or disease-causing organisms. Wild animals may release disease-causing organisms into the environment. Unless wild animals are themselves contaminated with

toxic chemicals, however, they do not pollute the environment with toxic chemicals.

**25. (a)**



**(b)** Sulfur dioxide and nitrogen oxides released over Alberta may enter atmospheric circulation. The resulting acid deposition will then fall in an ecosystem elsewhere in the country.