Unit 1 Review Answers

Student Textbook pages 68-71

Answers to Understanding Concepts Questions

1. In a terrestrial environment, plants capture energy from the Sun and store the energy in organic molecules. Consumers obtain energy by eating plants and other consumers. Decomposers obtain energy by consuming organic matter from all trophic levels.

2. Fungi are decomposers, not producers. Unlike plants, which are autotrophic, fungi are heterotrophic and, therefore, obtain energy and carbon by consuming organic matter.

3. Thermal vent bacteria are chemosynthetic and obtain energy by splitting hydrogen sulfide. Thermal vent bacteria store energy in organic molecules, which are consumed by the giant tubeworms or clams that the bacteria live in. Energy is then transferred to crabs and fish at the next trophic level.

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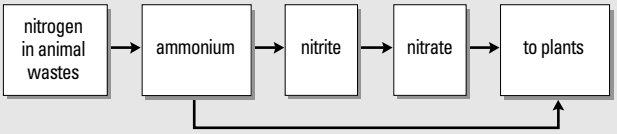

5. Plants and animals use phosphorous in ATP and DNA, and animals use phosphorous in bones and teeth.

6. If global productivity were to decrease, the lack of photosynthesis would decrease amounts of oxygen in the atmosphere and allow carbon dioxide to build up in the atmosphere.

7. (a) Assuming the dolphins eat squid, the dolphin and seabird (many are scavengers) populations would likely increase if the squid population increased.

(b) Food chains should be linear with phytoplankton at the first trophic level (producers), zooplankton at the second trophic level (primary consumers), fish at the third trophic level (secondary consumers), and seabirds at the fourth trophic level (tertiary consumers). Some students may include dolphins or squid in the food chain below seabirds, many of which are scavengers. All producer/consumer categories should be identified.

(c) Fish that eat zooplankton are secondary consumers, and will obtain only about 10% of the energy available in the zooplankton. If the zooplankton obtains only 2500 kJ (10% of the energy available in the phytoplankton), the fish will obtain only 250 kJ from the zooplankton.

8. A pyramid of biomass for the deciduous forest will be upright with a base that is wider than any of the other steps in the pyramid. The remaining steps of the pyramid should reflect the biomass of each trophic level (will be similar to those in the pyramid of numbers in the text). Student drawings should have all producer and consumer levels labelled.

9. Since only 17% of the energy will be used for growth, this will be the amount available to the next level in the food chain: 0.17×750 J = 127.5 J (130 J to correct significant figures)

10. Four properties of water that make it vital to living organisms are:

- The density of water is greatest at 4 °C, and so ice floats. This allows aquatic organisms to survive under ice for the winter.
- Water has a high heat capacity, and so water in body tissues is slow to cool or warm, and body temperature is regulated. Water evaporating from the surface of transpiring plants or sweating animals takes away heat, cooling the organism so it doesn't overheat.
- Because water molecules are polar, water can dissolve many types of compounds, within living systems or in the non-living environment, transporting nutrients so they are available to organisms.
- Cohesion (the attraction of water molecules to one another) and adhesion (the attraction of water molecules to molecules of other substances) allows water to travel up the xylem of plants by transpiration. This process is either directly or indirectly essential to many living organisms.

11. (a) The hydrologic cycle and sulfur cycle are involved in acid deposition. The nitrogen cycle is also important, but this is not highlighted in the text. Burning fossil fuels releases sulfur dioxide (and nitrogen oxides) into the atmosphere. These molecules react with water vapour to form acids that fall to Earth as various forms of acid deposition.

(b) A deciduous forest ecosystem can be harmed by acid deposition, which damages the tissues of plants. Further, acid entering aquatic systems can kill fish and harm other aquatic organisms.

12. (a) Compared to the Arctic, the tropical rainforest has much more productivity because the climate is warm and wet, with strong sunlight year round. There is also a more rapid cycling of nutrients in a tropical rainforest.

(b) Compared to a geologically inactive part of the sea floor (i.e., where there are no thermal vents or cold seeps), the coastal waters will have higher levels of productivity due to increased nutrient availability (this is an area of high nutrient turnover) and a greater amount of sunlight.

(c) Compared to a geologically inactive part of the sea floor, a region near a thermal vent will have much more productivity, due to the presence of hydrogen sulfide and the chemosynthetic bacteria that live near the vent, which use this chemical as a source of energy to create organic molecules that can support an entire ecosystem.

13. Earth's atmosphere today is composed of more oxygen and less carbon dioxide than it was three billion years ago. At that time, there was little to no oxygen in the atmosphere.

14. Metabolic water is the net water produced in cellular respiration.

15. The rapid cycling of carbon moves carbon relatively quickly through biotic and abiotic components of the biosphere. Producers remove carbon dioxide from the atmosphere and store carbon in organic molecules. Consumers release carbon dioxide during cellular respiration of these molecules. Decomposition releases carbon to the biosphere from organic waste. Carbon also moves between the atmosphere and the ocean surface. In comparison, the slow cycling of carbon adds carbon to nutrient reservoirs, such as coal, oil, peat, and the deep ocean, where it is not accessible to organisms for extensive periods of time.

16. (a) If photosynthetic organisms could capture twice the usual amount of solar radiation, global productivity would likely increase. The resulting increase in photosynthesis would remove more carbon dioxide from the atmosphere and increase levels of oxygen. As a result, the effects of global warming would decrease. More nutrients would be tied up in plants rather than being transported through the abiotic environment. If nutrients were available, algal blooms would likely increase in frequency, but as more nutrients would be tied up in plants, this is debatable.

(b) If photosynthetic organisms could only capture half the usual amount of solar radiation, global productivity would likely decrease. The decrease in photosynthesis would allow carbon dioxide to build up to higher levels in the atmosphere, while levels of oxygen would decrease. As a result, the effects of global warming would increase. Fewer nutrients would be tied up in plants and more would be transported through the abiotic environment.

17. (a) Dead zones are areas where aquatic life has been killed off due to lack of oxygen. They often result as a consequence of algal blooms.

(b) Human activities, including deforestation, inadequately treating sewage, livestock farming, and fertilizing fields and lawns can introduce excess phosphate into natural waters. The phosphate provides nutrients for the algae, resulting in an explosion of growth, an algal bloom. During an algal bloom, an excess growth of algae blocks out sunlight and aquatic plants die. As this organic matter is decomposed, oxygen is used up and fish and other aquatic animals that require oxygen die as well, resulting in a dead zone.

18. Increased krill farming may reduce the amount of krill available to organisms that consume krill in their natural ecosystem. The population of these consumers may reduce as a result. This population reduction may affect organisms at higher trophic levels that feed on the krill-consuming species. Thus, the entire food web in the ecosystem may be altered.

19. (a) Alberta's wetlands serve as water filters and water storage sites, they help control floods, and they are home to numerous species, such as the endangered whooping crane.

(b) Wetlands are natural water filters, which remove contaminants from the water.

Answers to Applying Concepts Questions

20. (a) There are two possibilities. The bacteria may be surviving by deriving energy from the chemosynthesis of hydrogen sulfide. The resulting sulfuric acid could be used by sulfate reducing bacteria, which would produce hydrogen sulfide as a by-product of their metabolism, which would further react with iron to form black iron sulfide. The hydrogen sulfide released by volcanoes could react with iron to form black iron sulfide as well. The other possibility is that the bacteria are photosynthetic. They are producing oxygen through this process and the oxygen is binding with free iron ions in water, rather than escaping into the atmosphere. This would also explain the black precipitate, which would consist of iron oxides.

(b) It is quite likely this planet could support other forms of life. If the bacteria are carrying out chemosynthesis, they may eventually begin to carry out photosynthesis as well. Or perhaps life forms totally foreign to us will develop on this planet that base their life processes on chemosynthesis. If the bacteria are photosynthetic, life could evolve that is similar to life on Earth.

21. Since 10% of 2500 J is 250 J, the deer will obtain 250 J by eating 1.25 kg of the shrub. Since 10% of 250 J is 25 J, 25 J of energy captured by the shrub would be passed on to the cougar when it eats 1.00 kg of deer meat, assuming all the energy from the shrub has been stored in that 1.00 kg of meat. Note that only 25 J of energy from the shrub is available to the cougar no matter how much meat the cougar consumes. The rest has been lost as heat energy or waste.

22. Stromatolites that contain black bands of iron oxides must have formed when free iron ions and dissolved oxygen were found in the oceans. As oxygen produced by photosynthesis built up, it would have become bound to the oceans' store of iron ions until there were no more free ions. At this point, the black bands in stromatolites would have stopped forming, as there were no more free ions in the water. Additional oxygen gas from photosynthesis would have escaped into Earth's atmosphere. If Earth's atmosphere had always contained oxygen, presumably the black bands of iron oxides would have formed earlier as atmospheric oxygen was mixed with ocean water, forming iron oxides.

23. Student suggestions may include the following:

- A sustainable food source, such as a garden, since there is no outside access to food; possibly with drip filtration or another water-wise feature to help conserve water, and a water re-collection system to reuse run-off
- An oxygen-carbon dioxide exchange system, such as the garden
- A light source for the garden, such as sunlight or artificial full-spectrum light
- A power source, such as solar radiation, and a means of harnessing that power, such as solar panels
- A water filtration and recycling system to recycle water in urine and feces
- A waste composting system that will allow human and plant waste to be reused, providing nutrients and organic matter for the garden

24. (a) When algae or cyanobacteria reproduce in large numbers, they block out sunlight, which results in the death of aquatic plants. The decomposition of the resulting organic matter uses up all of the oxygen in the water. Other aquatic organisms in the area are starved of oxygen and die. Cyanobacterial blooms are more dangerous than algal blooms because harmful toxins may be released.

(b) Excess phosphate tends to be responsible for algal blooms.

(c) Run-off from deforested areas, inadequately treated sewage, and run-off from livestock farms, agricultural fields, and lawns may contain excess phosphate and nitrate.

25. The pyramid of biomass will be upright and should have a wide base for the producers and proportionally smaller steps for primary and secondary consumers. All biomass values [700 g/m^2 (producers), 132 g/m^2 (primary consumers), and 11 g/m^2 (secondary consumers)] and producer/consumer levels should be labelled.

26. A living organism is self-regulating and can maintain internal conditions within certain limits. Like an organism, the biosphere is self-regulating: For example, the production of carbon dioxide through cellular respiration is balanced by the uptake of carbon dioxide in photosynthesis. Similarly, all matter in the biosphere is recycled. There is a constant input of energy into the biosphere in the form of solar radiation which makes up for energy that is transformed into unusable heat.

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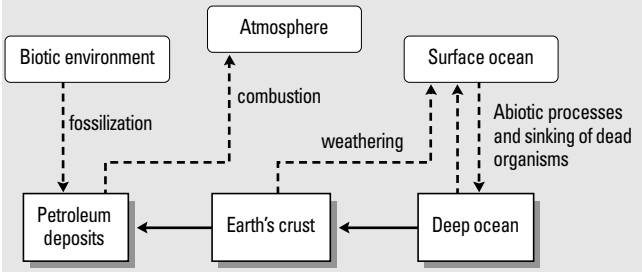
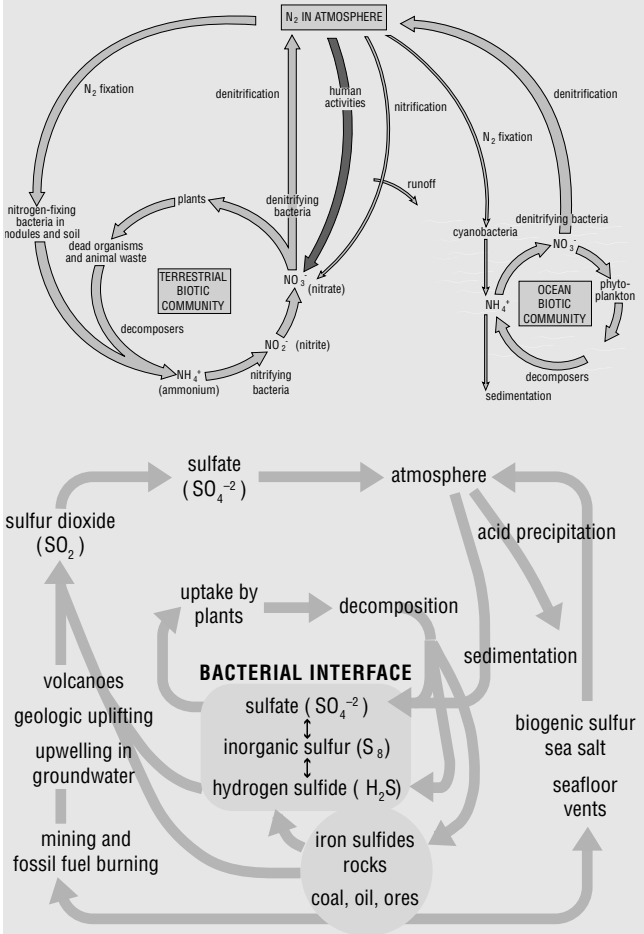


The slow cycling of carbon
Dotted arrows indicate connections to rapid cycling of carbon

28. (a) The carbon cycle is greatly influenced by deforestation and burning fossil fuels, which release carbon dioxide into the atmosphere. The sulfur cycle is influenced by human activities such as burning of fossil fuels, which releases sulfur dioxide into the atmosphere. Sulfur is also mined. (Students may also make a case for other biogeochemical cycles.)

(b) Bacteria play important roles in the nitrogen cycle by carrying out nitrogen fixation, ammonification, nitrification and denitrification. Bacteria play important roles in the sulfur cycle by converting sulfate to inorganic sulfur and hydrogen sulfide. Bacteria also carry out the reverse reactions.

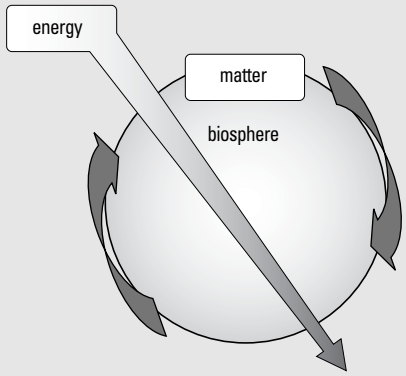
(c) Students should illustrate the nitrogen cycle or sulfur cycle.



29. The batteries rust and leak their contents of heavy metals. The metals dissolve in water from precipitation, and are transported to ground water, rivers, and streams. Some metals, such as mercury, end up in the food chain where they biomagnify. (Micro-organisms can convert elemental mercury to methylmercury).

30. (a) Biogeochemical cycles exemplify how all matter on Earth is cycled. Matter can be broken down and put together in different ways but not removed from Earth. Energy is not cycled. It can be passed from one trophic level to another, but with each energy transformation, some energy becomes unusable.

(b)



31. Sulfur reducing bacteria such as *Desulfovibrio* produce hydrogen sulfide, which reacts with the heavy metals in solution. The heavy metal sulfide compounds would precipitate, trapping the heavy metals and keeping them out of the food chain. Sulfur oxidizers will convert excess hydrogen sulfide to sulfate, which sulfate reducers can use to produce more hydrogen sulfide. Students may also suggest using aquatic plants and then removing them after phytoremediation.

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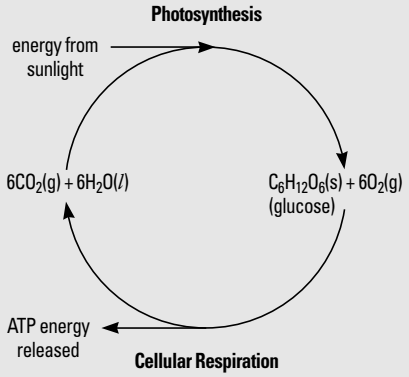

Answers to Making Connections Questions

33. (a) Over-application of insecticides and herbicides, if they are not target-specific, could kill off soil organisms, thereby changing the soil's structure.

(b) The amount of usable nitrogen and phosphorous in soil tends to be limited, and instead of depending on the action of soil micro-organisms to make nitrogen available and abiotic natural processes to make phosphorous available, it may be simpler and more effective to add synthetic fertilizers.

34. Because the croplands farther south support large numbers of snow geese, these same numbers will be looking for food in the Arctic, where the growing season is very short and productivity is modest. The large numbers of snow geese may be over-consuming vegetation

on the tundra. Therefore, culling some of the geese might help protect the tundra ecosystem.

35. Human activities that affect biogeochemical cycles can have far-reaching effects. Pollutants, such as DDT, can join the hydrologic cycle and travel long distances in the atmosphere and liquid water. Pollutants can join the carbon cycle by entering the food chain; some kinds of pollutants will become concentrated in higher-level consumers due to biomagnification.

36. (a) Floods can wash various pollutants, pathogens, and organic matter into water supplies, making the water unfit for drinking and washing. Water treatment facilities have more work to do than usual following a flood. Therefore, citizens should restrict their water-use so that water treatment facilities can keep up with demand.

(b) The heavy rains in 2005 are considered to be atypical in Alberta. Scientists do not believe that the heavy rains in one season will make up for potentially many years of drought. Alberta has experienced many droughts in the past, and if global temperatures rise, the rate of evaporation of water will likely increase, making Alberta even drier. As Alberta's human population grows, the demand for water will also increase. Many societal uses of water affect its quality, which could place usable water in short supply.

37. (a) A pond should not be considered an ecosystem, as it is not self-sustaining: it must have a constant inflow of fresh water or it will dry up due to evaporation.

(b) A fish aquarium should not be considered an ecosystem, as it is not self-sustaining: it must have a constant inflow of food, nutrients, and oxygen, or the organisms in it will die. Neither is it self-regulating: it requires a pump and regular cleaning.

(c) A wheat farm should not be considered an ecosystem, as it is not self-sustaining: it must be planted regularly, watered, and fertilized. Neither is it self-regulating: it must be harvested, pests must be removed, etc. if it is to stay healthy and productive.

(d) A city should not be considered an ecosystem, as it is not self-sustaining: it must have a constant inflow of food, power, and water to survive.

(e) Earth should not be considered an ecosystem, as it is not self-sustaining: it must have a constant inflow of energy from the sun. It is, however, self-regulating.