Unit D Changes in Living Systems

Chapter 1: The Biosphere of Life

Practice, pages 406 and 407

1. Since the angler is collecting live insects, which are a living part of the environment, this shows consideration for biotic factors.

2. **a.** Since the trees are a living part of the stream ecosystem, they are classified as biotic factors.

b. The water temperature is an abiotic factor.

c. Yes, it is possible for an organism to change abiotic factors in an ecosystem. This is demonstrated by the tree providing shade to prevent the Sun from raising the stream's water temperature.

3. An ecosystem consists of all the organisms in an area, as well as the abiotic factors with which they interact. When the angler chooses a particular fly for a species of fish, the angler is considering living parts of the environment. Due to knowledge about the abiotic parts of the fish's environment—sunlight and temperature—the angler can use the knowledge that the fish prefers the shaded, cooler water. The angler demonstrates an understanding of the fish's role in the stream ecosystem by placing the chosen fly in the optimum stream location.

Practice, page 407

4. The ideal habitat for begonias would include well-drained soil in a shady location.

5. The ideal habitat for petunias would include moist soil in a sunny location.

6. Growing plants in containers, such as pots and planters, provides the gardener with greater flexibility to provide the ideal habitat for a given variety of plants. The container for begonias could be set up to allow for both excellent drainage and movement to a shadier location. If the begonias are planted in the ground, these variables are more difficult to control.

Practice, page 409

7. If the farmer adds excessive fertilizer to the fields to improve the availability of nutrients like nitrogen for the crops, the run-off from those fields can carry the excess nitrogen to local waterways. This process can cause harmful algal blooms.

8. If the contaminated waterway is used by the farmer, or by the livestock for drinking water, then a valuable resource is no longer available to the farmer.

1.1 Questions, page 412

Knowledge

1. a. An abiotic factor is a physical, non-living part of an organism's environment.

b. An ecosystem is an interaction between the living and non-living parts of an environment, forming a self-regulating entity.

c. A habitat is the area where an organism lives its life.

Applying Concepts

2. Answers may include rainfall, nutrients in soil (nitrates and phosphates), temperature, sunlight, and wind. Farmers may ensure there are sufficient nutrients for crops by using fertilizers. Irrigation helps bring water to farmland. Planting windbreaks reduces the harmful effects of the wind.

3. A region's climate is described by the average annual precipitation and temperatures. Both precipitation and temperature are examples of abiotic factors that influence the climate of a given region.

4. A harmful algal bloom occurs when additional nutrients—such as nitrates and phosphates from fertilizers—enter a lake or stream. Algae will increase in numbers to a point where competition for resources leads to the death of a significant amount of the algae. The presence of masses of dead algae increases the population of decomposers breaking down the dead algae. This increased activity of decomposers will cause a reduction in dissolved oxygen. This, in turn, has a negative impact on other aquatic life, such as fish that use gills to extract the oxygen dissolved in water for use in their bodies.

5. Answers will vary. You should be able to estimate how much water you use in a week. A 25% reduction in available water should be possible.

Practice, pages 414 and 415

9. The dinosaur was the type of animal that dominated the central plains of Alberta up to 65 million years ago. This is known from the fossil record.

10. Prior to about 10 000 years ago, Alberta was covered in thick sheets of ice from the last great glaciation. Once climate changes caused this ice to retreat, grassland vegetation began to re-establish itself. There were many large herbivores, but climate changes and pressures from human hunters favoured the bison. As the other species became extinct, the bison flourished as they took advantage of vacancies in the food chain. By 5000 years ago, the bison was the dominant herbivore on the prairie landscape.

11. Head-Smashed-In Buffalo Jump is known around the world as a monument to the ingenuity of ancient peoples. Since the site was used by First Nations people for nearly 6000 years, it stands as a tribute to an enduring custom.

12. The nomadic lifestyle meant that the groups of people living on the plains had to travel lightly, carrying only the necessities of life. Following the herds of bison would mean that it was vital to be able to break camp quickly and move with some speed. Since these First Nations people were always moving and had minimal possessions, it is less likely that they would leave the same kind of artifacts as ancient people who had an agricultural way of life and generally stayed in one place.

13. Medicine wheels were gathering places and, as such, they represent one of the rare occasions when these nomadic people would meet. Therefore, the artifacts at these sites are quite unique. A second point is that these locations are often sacred places and burial grounds. Good citizens respect the places of worship and cemeteries of all faiths and traditions.

14. Many key events in the lives of First Nations people were seasonal, such as the migration of animals, and the harvest time of wild berries and herbs, not to mention the times for groups to meet for large gatherings and ceremonies.

Practice, page 416

15. Micro-organisms that live in the soil provide the grasses with essential nutrients, such as molecules containing nitrogen and phosphorus. These nutrients can be absorbed by the roots.

16. Bison are dependent upon the prairie grasses, which are dependent upon the micro-organisms living in the soil. Without the micro-organisms, there would be no food source for the bison.

Practice, page 417

17. Prairie-dog towns have been called the grocery stores of the prairies because the towns contain a rich variety of food sources compacted into a small area. Some animals come to feed on the prairie dogs, while others eat the rich vegetation that grows in these areas. The short vegetation also makes it easier for organisms that eat insects to find their prey. Other organisms use the prairie-dog towns as habitat because the vacated burrows can be renovated for their own purposes. Top predators, such as peregrine falcons and red-tailed hawks, also find prairie-dog towns to be a rich source of food.

18. In the following examples, the animals benefit by being provided with food, shelter, and medical care. The benefits for the human depend upon the specific example. In the case of the association between a person who is visually impaired and a seeing-eye dog, the human benefits from the dog's sense of sight. In the case of a person and a pet dog or cat, the human benefits from companionship. A dairy farmer benefits from the milk provided by the cow.

Practice, page 418

19. **a.** This is an example of mutualism. The purple coneflower benefits by enhanced pollination, while the butterfly benefits from the nectar.

b. This is an example of parasitism. The nematode benefits from the nutrients in the purple coneflower's roots, while the plant is harmed by the loss of these same nutrients.

c. This is either an example of commensalism or mutualism. Joseph benefits from the medicinal effects of the leaves. If the plant benefits from having its dead leaves removed, then it is mutualism. If the removal of these leaves is of little consequence to the plant, then it is an example of commensalism.

20. The relationship between the monarch butterfly and the viceroy butterfly is probably commensalism. The viceroy benefits from the monarch's colouring, while the monarch is largely unaffected.

1.2 Questions, page 422

Knowledge

1. **a.** A biological community is made up of interacting populations that live in a certain area at a certain time.

b. A population is a group of organisms, all of the same species, that interbreed and live in the same area at the same time.

c. Mutualism is a form of symbiosis in which both organisms benefit.

d. Commensalism is a form of symbiosis where one organism benefits, while the other organism is neither helped nor harmed.

e. Parasitism is a form of symbiosis where one organism benefits at the expense or harm of another organism.

f. Competition is an interaction in which two or more organisms compete for the same limited resource.

g. Predation is an interaction where one organism—the predator—kills and eats another organism—the prey.

2. The main difference between predation and parasitism is that predation results in one organism being killed to provide nutrients for another organism. It is not in the interest of the parasite to kill the host—if the host is killed, the parasite might die as well if it cannot find a new host.

3. Sunlight provides the energy required by plants for photosynthesis.

Applying Concepts

4. The relationship between the sea anemone and the clown fish is a type of symbiosis called mutualism. In this relationship, both organisms benefit. The clown fish gets shelter and a source of food from the sea anemone, and the clown fish removes harmful parasites from the sea anemone.

5. The relationship between the grass and the spruce tree is an example of competition. This is not an example of symbiosis because neither species benefits. Both the grass and the spruce tree must expend energy to gather the limited resources of water and nutrients.

6. The relationship between the person and the fungus is a type of symbiosis called parasitism. In this relationship, the fungus benefits from nutrients absorbed from the person's skin. The person is harmed by both the loss of nutrients and the hot, itchy irritation caused by the fungus.

Practice, page 424

21. Note the following table.

ROLES OF ORGANISMS WITHIN THE PRAIRIE GRASSLAND ECOSYSTEM

Category			Description of Role	Example
producer			• uses photosynthesis to convert light energy into chemical energy	• grasses • purple coneflower
consumer	herbivore	primary consumer	• obtains energy from producers—green plants, algae, and phytoplankton	• black-tailed prairie dog • bison • grasshopper
	carnivore	secondary consumer	• obtains energy from herbivores	• cowbird • swift fox
		tertiary consumer	• obtains energy from other carnivores	• red-tailed hawk • peregrine falcon
	omnivore	primary, secondary, and tertiary consumer	• obtains energy from both plants and animals	• sparrow • skunk
	scavenger	primary, secondary, and tertiary consumer	• obtains energy from other animals it did not kill itself	• coyote • magpie
decomposer			• obtains energy from dead organic matter by breaking down complex organic molecules into simpler molecules	• bacteria • fungi

Practice, page 426

22. Grasses would be added to the first trophic level with the other producers. Black-tailed prairie dogs and bison would be added to the second trophic level with the primary consumers. Cowbirds, burrowing owls, and swift foxes would be added to the third trophic level with the other secondary consumers. Red-tailed hawks are tertiary consumers, so they would be added to the fourth trophic level. Sparrows and skunks are omnivores, so their trophic level is dependent upon what they happen to be eating at the time. In a similar way, scavengers like magpies are also difficult to place because it depends what they are eating at the time.

23. When an organism at the top of the pyramid dies, its body becomes a source of energy and nutrients for scavengers and then decomposers. The scavengers and decomposers will only store 10% of the energy in their bodies—they will use the other 90% for their own bodily processes to be released as heat. The energy stored in the bodies of scavengers and decomposers will eventually decay, and then the transformation to heat is complete.

Practice, pages 427 and 428

24. The "Pyramid of Numbers" does not include the fact that many of the organisms at lower trophic levels have individual masses that are very small. Individual blades of grass, nematodes in the soil, and insects all contribute huge values to the "Pyramid of Numbers." This effect is counterbalanced in the "Biomass Pyramid" because the mass of each individual is considered when mass is determined.

25. **a.** As an insect feeds on plants that have been sprayed with DDT, the pesticide enters the insect's body. If the concentration is too low to immediately kill the insect, the insect continues to feed on the leaves and the DDT concentration within the fatty tissues increases. A bird that eats a number of the insects contaminated with DDT ends up consuming a higher concentration of the DDT than the insect did. If the bird continues to feed on these contaminated insects, the concentration of DDT within the bird's fatty tissues continues to increase. Since the bird is feeding on very large numbers of insects, it is reasonable to see how the concentration of DDT in the birds can be hundreds of times greater than it is in the insects.

b. A top predator, like a falcon, may annually consume dozens of birds that contain significant concentrations of DDT within their fatty tissues. As the falcon continues to consume these birds for several years, the concentration of DDT can build to be hundreds of times larger than the amount found within the fatty tissues of the individual birds it eats.

c. The concentration of DDT is magnified several thousand times from the insects to the birds that feed upon them. The concentration could then be magnified an additional hundreds of times more from the insect-eating birds to a top predator, like a falcon. The net result is that the concentration of DDT in the fatty tissues of the falcon could be hundreds of thousands of times greater than the concentration in the insects.

d. The use of nonpersistent pesticides that biodegrade into less harmful substances prevents the biological magnification demonstrated in the previous parts of question 25.

26. Predators at the top of the energy pyramid have access to only a tiny portion of the total energy made available by the producers. This means predators have small numbers because they usually have to cover a large area in search of prey. The small numbers spread over a wide range make top predators susceptible to extinction.

Practice, page 432

27. Food webs look like spider webs.

28. **a.** The producers are the algae because arrows showing the direction of energy flow start with the algae. The algae are the first link in the chain.

b. The primary consumers are the snails, waterfleas, mosquito larvae, and tadpoles because these organisms get their energy straight from the producers.

c. The secondary consumers are the dragonfly larvae and the sticklebacks.

d. The tertiary consumers are the giant water bug, the grebe, the perch, and the frog, with the northern pike as the top predator. Note that parasites, like leeches, are usually not considered tertiary consumers due to the variety of organisms they feed on.

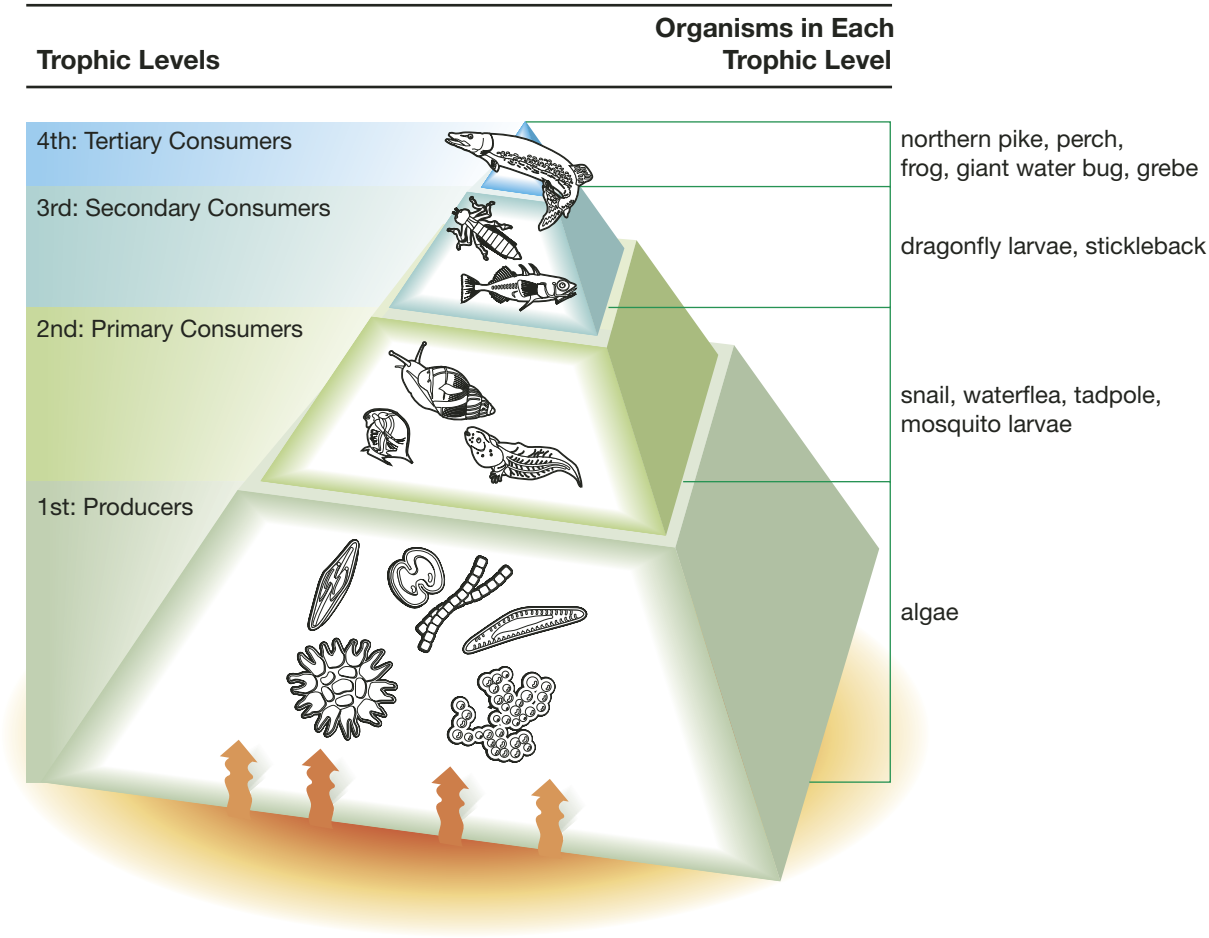
29. a. The food web communicates that producers occupy the first trophic level with arrows that start with the producers showing the direction of energy flow. Since the arrows always point away from the producers, this communicates that they are the first link in the chain and provide the basic food that supports all other levels.

b. The food web communicates that herbivores occupy the second trophic level by the fact that they occupy the second link in the chain. Also, arrows showing energy flow point from producers to herbivores.

c. The tertiary consumers have the greatest number of links between themselves and the producers.

30.

Energy Pyramid for a Freshwater Ecosystem



Note: Parasites, like leeches, are not normally included on diagrams for energy pyramids because they can obtain energy from a variety of sources.

1.3 Questions, page 432

Knowledge

1. **a.** A primary consumer or herbivore is an organism that obtains food by feeding on photosynthetic organisms.

b. A secondary consumer or carnivore is an organism that obtains food by feeding on primary consumers.

c. A tertiary consumer is an organism that obtains its food by feeding on secondary consumers (other carnivores).

d. A decomposer is a smaller organism—such as bacteria and fungi—that breaks down complex organic molecules into simpler inorganic molecules.

e. A food chain is the pathway along which food is transferred from one trophic level to the next.

f. A food web is the interconnecting feeding relationships within an ecosystem.

g. A trophic level is the division of species within an ecosystem, based upon their source of energy.

h. An ecological pyramid is a diagram that shows the relative amounts of energy, the number of organisms, or the matter contained within each trophic level in a food chain or food web.

i. Biomass refers to the total amount of dry living tissue within a given trophic level.

j. A pyramid of numbers is an ecological pyramid that shows the relative number of individual organisms at each trophic level.

k. A pyramid of energy is an ecological pyramid that shows the relative amount of energy stored in the organisms found within a given trophic level.

l. A pyramid of biomass is an ecological pyramid that represents the amount of living organic matter at each trophic level.

2. In general, only 10% of the energy from one trophic level is passed on to the next trophic level within an energy pyramid.

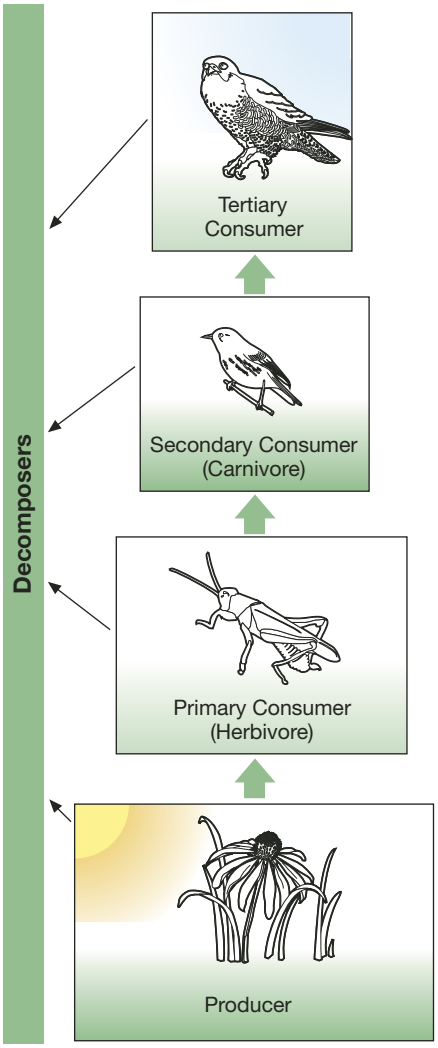
3. The arrows represent the direction energy flows in a food chain.

4. Producers are able to produce their own nutrients by absorbing energy from the Sun or from inorganic compounds. Consumers cannot produce their own nutrients, and they must obtain their energy by eating other organisms.

Applying Concepts

5. Producers are always found at the starting point of a food web.

6.



a. The arrows represent the direction in which energy flows between the various trophic levels.

b. The decrease in widths for each pyramid box represents smaller amounts of energy and biomass as you move from a lower level to a higher level.

c. Decomposers will be found outside of the pyramid. Each trophic level provides energy and matter to the decomposers.

1.4 Questions, page 439

Knowledge

1. A base line and a series of transects provide a systematic way to take ecological measurements from a number of different ecosystem locations. The base line is normally set up parallel to the longest side of the pond, with transects running perpendicular to the base line so that each transect includes a section of both a terrestrial ecosystem and an aquatic ecosystem.

2. Abiotic factors could include any of the following: air temperature, soil temperature, water temperature, amount of cloud cover (percentage), exposure (direct sunlight or shade), pH of soil, pH of water, wind speed, characteristics of the soil, and characteristics of the bottom sediment.

Applying Concepts

3. If each group simply chooses its own location, it is likely most of the samples will be taken from areas that are convenient, comfortable, or of interest to the group. This style of sampling might exclude areas that seem less desirable to the group, but which nevertheless contain valuable information that adds to the ecosystem's complete description.

Practice, page 441

31. In previous science courses, you learned that chemical reactions involve energy and that chemical reactions often produce new substances. These substances are often in the form of a gas, or a solid or liquid of a different colour. In a forest fire, vast amounts of energy are released as shown by the heat and light generated. The smoke and gases released from this reaction indicate that new substances with unique properties were produced.

32. A prescribed burn attempts to mimic the natural pattern of smaller fires that occur more frequently, but burn with less intensity, than larger fires. One advantage of this practice is that it reduces the accumulation of fuel, such as old branches and pine needles, so that a large catastrophic fire is less likely. Another advantage is that fire helps to maintain the long-term health and diversity of the forest habitat.

Practice, page 443

33. a. It is more effective to water lawns early in the morning rather than in mid-afternoon because less water is lost to evaporation when the Sun's rays are less intense and the air is cooler.

b. A soaker hose is more effective than a sprinkler for watering trees and shrubs because a sprinkler shoots water into the air—this increases the surface area of water exposed to the air and leads to greater losses due to evaporation.

34. a. This is not a contradiction because the water is still attached to Earth. However, because the water is deep within Earth, it cannot be circulated within the water cycle.

b. As far as ecosystems are concerned, the water used for oilfield injection can never again be utilized by life because it is contaminated and made inaccessible by its location deep within Earth. Given that there is only so much fresh water available, environmentalists would argue that it is short-sighted to deny water to future generations to satisfy current demands for oil.

35. Wildfires remove much of the surface vegetation that provides shade and shelter to the soil. This has the effect of increasing the daily temperature extremes experienced by organisms living within the soil. Wildfires can also cause the organic compounds to become distilled during the burning. This produces a waxy substance that creates a waterproof layer just below the soil's surface. This layer reduces the amount of water that can penetrate deeper soil layers.

Practice, page 446

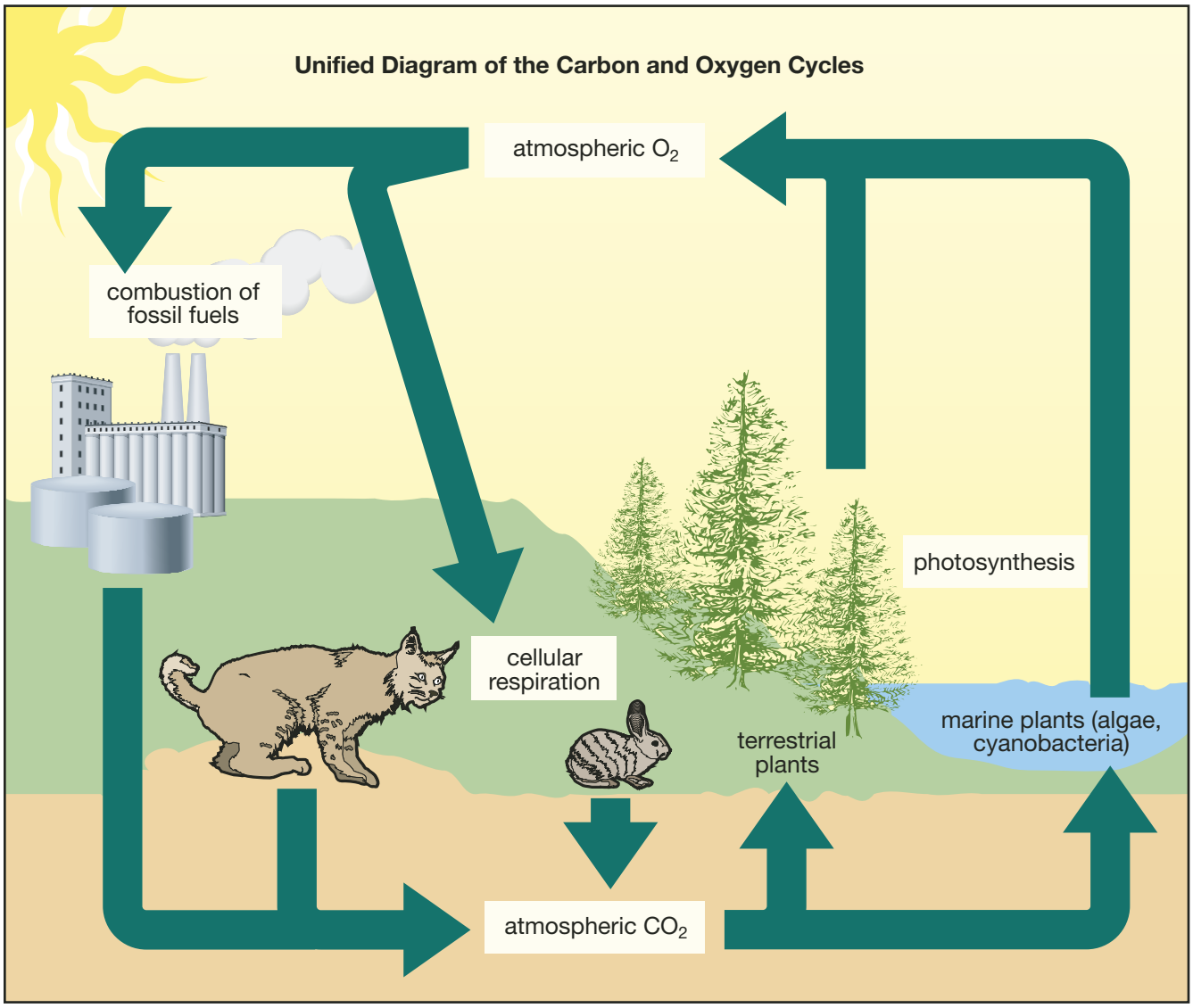
36. There is no need to memorize both equations because the reactants of one equation are simply the products of the other and vice versa.

37. The common feature of decomposition, combustion of fossil fuels, cellular respiration, volcanic activity, and wildfires is that all of these activities release carbon dioxide into the atmosphere.

38. Alberta's boreal forests are a source of oxygen and a sink for carbon dioxide. Even areas of peat bogs or muskeg serve a vital role because they are excellent carbon sinks, and in some cases are thousands of years old. If these wetlands are drained, then the process of decomposition begins and these areas become sources of carbon instead of sinks.

Practice, page 447

39. This diagram shows the key processes of the carbon cycle and the oxygen cycle.



40. Carbon and oxygen both occur in organic molecules like glucose ($C_6H_{12}O_6(aq)$) and carbon dioxide ($CO_2(g)$).

41. The source of energy for photosynthesis is light energy from the Sun.

42. Atmospheric oxygen levels needed to be sufficiently high to build an ozone layer to shield life from the Sun's harmful ultraviolet rays. The oxygen levels would also need to be high enough to support cellular respiration in animals.

Practice, page 450

43. Plants cannot use air as a source of nitrogen because nitrogen in the air is in the form of nitrogen gas, N_2. This molecule is very stable and requires a lot of energy to break it up into more usable forms.

44. The soil in a post-fire habitat tends to have high concentrations of nitrogen. In addition, the soil also tends to be warmer and less acidic. This makes more favourable conditions for the micro-organisms in soil that fix nitrogen.

45. Humans obtain the nitrogen they need from protein. Foods high in protein include soybeans, meat, and eggs.

1.5 Questions, page 452

Knowledge

1. **a.** Transpiration is the loss of water vapour from a plant through its leaves.

b. Nitrogen fixation is the process of converting nitrogen gas into ammonia.

c. The process of converting ammonia into nitrates or nitrites is nitrification.

d. Denitrification is the process of converting nitrates in the soil into nitrogen gas.

e. Nitrifying bacteria are a type of soil bacteria that convert ammonia into nitrates and nitrites.

f. Denitrifying bacteria are a type of soil bacteria that convert nitrates in soil and releases them to the atmosphere as nitrogen gas.

2. A biogeochemical cycle is a series of chemical reactions involved in the movement of elements and compounds between the living and non-living components of an ecosystem. The water cycle, the carbon cycle, the oxygen cycle, and the nitrogen cycle are all examples of biogeochemical cycles.

3. Carbon cycles and oxygen cycles have much in common because the main life processes involved in each of these cycles are cellular respiration and photosynthesis. An important difference is that while oxygen composes about 21% of the atmosphere, carbon dioxide makes up only about 0.03%. This means that the carbon cycle is only a small part of the total oxygen system. Oxygen is also involved in the nitrogen cycle, the phosphorous cycle, and the sulfur cycle.

Applying Concepts

4. Even though the atmosphere contains 78% nitrogen gas, plants cannot directly use this form of nitrogen. For the soil to absorb nitrogen from the atmosphere, it must have legumes present that can convert the nitrogen into ammonia. The ammonia is converted by a type of soil bacteria known as nitrifying bacteria, which will convert ammonia into either nitrates or nitrites.

5. Legumes are plants that support nitrogen-fixing bacteria. By alternating wheat—which tends to deplete the soil of its nitrogen—with a legume crop, nitrogen levels within the soil can be restored without such a heavy dependence on chemical fertilizers.

The shortage of nitrogen is in the usable compounds of nitrogen, nitrates, and nitrites. Bacteria in the soil must convert the atmospheric nitrogen to ammonia, and then to nitrates and nitrites.

6. Denitrifying bacteria are used to treat sewage because they convert nitrates into nitrogen gas. This gas is released into the atmosphere and is not harmful to the environment. Meanwhile, nitrates may pollute aquatic environments.

Practice, page 455

46. a. A symbiotic association is a long-term relationship between two species where both species benefit.

b. The alga is a photosynthetic organism, so it is a source of glucose and other nutrients to the fungus.

47. a. In the story, paper products were used to print advertising flyers; to produce boxes, tissue paper, and paper bags; and to package the fast food that the two shoppers likely enjoyed as a quick snack.

b. In the story, petroleum products were used not only to transport the two shoppers to the mall, but they were also used to produce many of the synthetic materials that would have played a role in this trip. The list of petroleum products would include all the plastics used for the automobile's interior, the shopping bags, the cellophane wrappers, and many of the fixtures and decorations within the mall. Petroleum products would also have played an indirect role in the manufacturing of the car, the roads, the buildings of the mall, as well as the purchased products. If the shoppers were wearing clothing made of nylon or polyester, these fabrics would be included on the list because they are petroleum products. Natural gas would likely have been used to heat both Ravi's home and the mall.

Practice, page 456

48. Habitat fragmentation begins with the boreal forest being divided up with roads, seismic lines, and pipeline corridors. This creates more habitat for moose and provides wolves with easy access to the area. The increasing numbers of wolves hunt down the most susceptible prey, which happens to be the woodland caribou.

49. Hand-cut, low-impact seismic lines leave smaller scars in the landscape that are much easier for nature to heal than wider-cut roads. Since these seismic lines are narrow, the equipment used is also of a smaller scale and is much less likely to cause damage to the surface vegetation. Damage to surface vegetation leads to erosion and excessive sediment flowing into local rivers and streams.

Practice, page 458

50. A mass poisoning of black-tailed prairie dogs would remove the main food source for both swift foxes and black-footed ferrets. Both predators would have their numbers depleted through starvation or by becoming poisoned themselves from eating the poisoned prairie dogs.

51. The burrowing owl relied upon the black-tailed prairie dog to produce habitat—short vegetation made it easier for these owls to find insects and the birds used the abandoned burrows to make their own burrows. Farmland removed the habitat of the black-tailed prairie dog and, therefore, removed the habitat of the burrowing owl.

52. The disappearance of the black-tailed prairie dog means the removal of the principal food source of both the black-footed ferret and the swift fox. These predators cannot survive without an adequate supply of prey. The burrowing owl cannot survive without the black-tailed prairie dog because it depends on the prairie dog to generate its habitat. Since so many other species cannot survive without the black-tailed prairie dog, this burrowing animal can be considered to be a keystone species.

Practice, page 459

53. The boreal forest covers much of the Northern Hemisphere and provides Earth with oxygen, a sink for carbon, and a reservoir of fresh water.

54. Biodiversity is linked to the health of the boreal forest because food webs and biogeochemical cycles are so interconnected that it is impossible to predict all the long-term implications if key species are eliminated. Since people cannot know what the consequences will be to this important ecosystem, biodiversity should be maintained.

55. Earth's biodiversity is important to people because more than 40% of prescription drugs are based upon compounds discovered in natural species. Given that scientists have only tested a fraction of the current species for their potential medical applications, it would be short-sighted to let species fall into extinction. A second reason why biodiversity is important is that biodiversity ensures there is an adequate genetic reservoir of plants to develop new varieties more resistant to drought and disease. Finally, biodiversity and the health of forests is at the heart of a multimillion dollar tourism industry that provides people with recreation and other benefits that add to the quality of life.

Practice, page 461

56. a. This proposal attempts to use money—a common unit of measurement in both systems. The idea is that now some aspects of the ecological system can be accounted for in the economic system because these ecological aspects are measured in the same units.

b. If a decision is made that detracts from the ability of the boreal forest to provide its ecological goods and services, then an ecological cost associated with that decision shows up on the financial balance sheet.

c. There are several challenges to overcome in implementing this kind of approach. It is important for all stakeholders to agree on the dollar value of each environmental service provided by the forest. Attaching a dollar value to things like carbon storage, oxygen production, and biodiversity maintenance will be very difficult. A greater challenge would be to assign a dollar value to the quality of life that forests provide to people who enjoy them for hiking and camping. Is it even possible to equate things like beauty and peace of mind with dollars?

Practice, page 461

57. a. It is not really necessary to print advertisements on paper flyers. Many stores now have an electronic version of their promotions available on a website. If you are looking for the lowest price of an item, you can simply look it up online. Other alternatives include advertisements on radio and TV.

b. The connection between paper consumption and the loss of biodiversity is trees. Trees are needed to make paper and are essential in creating habitat for many organisms. As trees are cut down and made into paper, habitat is destroyed and there is a corresponding loss of biodiversity.

c. As electronic technologies become more available to students and schools, the reliance on resources printed on paper could be reduced.

58. a. Urban sprawl contributes to habitat destruction by creating towns and cities with large surface areas that consume the surrounding forests, grasslands, and wetlands. Increased fuel consumption means more petroleum exploration and production, resulting in habitat destruction.

b. Urban sprawl creates cities in which people are dependent upon motor vehicles because everything is so spread out and mass transit is not as cost-effective when the population is dispersed over a larger area. An increased motor-vehicle use means an increased use of fossil fuels. This also contributes to habitat destruction.

c. By choosing a lifestyle so dependent upon motor vehicles and the burning of fossil fuels, there is an increased need for seismic lines to be cut through forests in a search for more petroleum. There is also an increased need for pipeline corridors, oil wells, and service roads. All of these needs cause the fragmentation of the forest ecosystem.

1.6 Questions, page 462

Knowledge

1. a. Habitat destruction is the permanent alteration of vital characteristics in an organism's habitat.

b. Habitat fragmentation is the conversion of formerly continuous habitat into patches of habitat separated by non-habitat areas.

c. An invasive species is a species that does not normally occur in an area. It is introduced by human action and then expands to become a breeding population that threatens the area's biodiversity.

2. Habitat destruction is a threat to biodiversity because no species can survive without an adequate habitat. The burrowing owl is an endangered species because its ideal habitat is the natural short-grass prairie landscape. The burrowing owl particularly thrives in areas of black-tailed prairie dog towns. Modern agriculture has almost completely pushed the black-tailed prairie dog out of Alberta, and there is very little short-grass prairie landscape left.

3. It is important for the health of an ecosystem to maintain its biodiversity because species are interconnected through food webs and biogeochemical cycles. No one can predict all the possible negative consequences if key species are removed from an ecosystem. Beyond supporting the biosphere that makes life possible on Earth, biodiversity has many other effects that have consequences for people. Many drugs have been developed from compounds discovered in living species. The natural world provides a vital genetic reservoir from which new varieties of disease-resistant crops can be developed. And, finally, biodiversity provides people with a beautiful environment as a source of both recreation and pleasure.

Applying Concepts

4. Habitat destruction and habitat fragmentation could be reduced by the following strategies:

- Eat more vegetarian meals.
- Consume fewer fossil fuels by using public transportation.
- Use less paper.
- Produce less waste by buying products that use less packaging.
- Conserve water by not running the tap when brushing teeth.
- Participate in public forums that discourage urban sprawl.

5. There are more than six billion people on Earth, so every little action by an individual is multiplied by six billion. As an example, if every person used one less kilogram of paper every month, that would save six billion kilograms of paper and a corresponding huge number of trees. Given that 20% of the world's population in the rich, industrialized countries consumes more than 80% of the world's resources, an even greater responsibility falls on the shoulders of Canadians to reduce demands on the world's resources.

6. The central meaning of this comment is that pollution problems shown in the photograph are rooted in the collective attitudes and behaviour of our society. It would appear that other short-term priorities, such as the convenience of disposable items, an insistence on excessive packaging, and an unending need to buy more consumer products, takes priority over the long-term priority of caring for the environment.

Chapter 2: Changing Populations

2.1 Questions, page 475

Knowledge

1. People who attempt to inhabit a rugged landscape are often called pioneers. These people had to be quite hardy to survive the challenging conditions of their new environment, just like the first organisms to grow in a new environment. The human pioneers also changed the environment by their activity.

2. Many pioneering people came to North America to escape overcrowding and a lack of resources in their home countries. Like human pioneers, pioneer species benefit by having fewer organisms to compete with for resources.

3. The following stages in the correct order in which they would be observed during primary succession are the following: bare rock, lichens, mosses, thin soil, grasses, deep humus-rich soil, shrubs, deciduous trees, and coniferous trees.

Applying Concepts

4. a. Soil may have been removed by the process of glaciation, avalanches, rock slides, or strip-mining. However, the answer could be any plausible event that would result in the removal of soil from the habitat.

b. There are several stages of succession to be observed in Figure D2.8. You can make reference to Figure D2.5. The stages of succession are more advanced as viewers move from the foreground to the background. In the foreground, rocks speckled with lichens are surrounded by mosses and grasses. In the background, flowering shrubs eventually lead to a climax community of coniferous trees.

c. The cracks would collect more of the soil and humus to allow for later succession species—such as grasses—to grow sooner.

d. Trees in the background—members of the climax community—have the greatest biomass and, therefore, are the most productive. They collect the solar radiation at the canopy layer above the surface where grasses and other plants are located.

Practice, page 478

1. The aerial photo of the Banff area in Figure D2.14 shows a golf course on the right side. If there are no natural meadows for grazing, the golf course would become a much more attractive grazing ground that would bring elk and deer into close contact with humans at the risk of both species.

2. The thick climax forest pushes right up to the town's border. This would put the town in great jeopardy because there is no fire buffer.