Chapter 1 Review Answers

Student Textbook pages 30–31

Answers to Understanding Concepts Questions

1. Like other decomposers, mushrooms do not make organic compounds from inorganic molecules. Mushrooms use organic material from dead producers and consumers to make energy-rich organic molecules, and are thus classified as heterotrophs.

2. Producers around thermal vents use the chemical energy from hydrogen sulfide to produce necessary organic molecules by chemosynthesis.

3. Food chains are limited in length because very little energy (5–20%) is transferred from one step of a food chain to the next.

4. (a) Ecologists use the "rule of 10," a rough approximation of the amount of energy that moves from one trophic level up to the next.

(b) The assumption is useful for getting an overall picture of energy transfer in an ecosystem. The rule is an oversimplification, however, because the efficiency with which energy is transferred from one trophic level to the next varies among species from 5–20%.

5. Weather patterns in the Arctic are changing; the sea ice is unusually thin in areas; the spring melt season is starting earlier in the year. Students might also suggest changing patterns of plant growth and distribution of animal populations.

6. Not all of the solar energy that reaches Earth's atmosphere is converted to chemical energy because only some of the solar energy reaches Earth's surface, the rest is reflected or absorbed by clouds and the atmosphere. Of the energy that reaches Earth's surface, some is further reflected and absorbed by water, land, ice, and vegetation. Further, photosynthesis is not 100% efficient (some energy is given off as heat).

7. A food web shows the interconnectedness of trophic levels better than a food chain. Neither a food chain nor a food web, however, gives a quantitative representation of the energy transferred. A pyramid of biomass would more accurately show the transfer of energy than a pyramid of numbers, especially since some types of vegetation would be difficult to count as individuals.

8. Sea otters eat sea urchins, which feed on kelp. As sea otter numbers decline due to predation by transient orcas, the sea urchin numbers will go up because there are fewer otters to prey upon them. As the sea urchin population increases, there are more sea urchins to graze upon the kelp, and its population will decline.

9. (a) Many species have varied diets and therefore feed at more than one trophic level. Bears, for example, eat plants and animals. Decomposers, such as mushrooms, may consume nutrients at any trophic level.

(b) When consumers have one food source, if anything happens to their food source, the consumers may starve. The loss of these consumers will have further repercussions throughout the food web on species that consume them. A wider menu selection means that consumers are less likely to be affected by a decrease in one of their food sources.

10. Decomposers are heterotrophic and feed on all trophic levels and obtain energy and carbon from organic molecules. Producers, however, are the first step in the transfer of energy in the biosphere. Producers get energy from sunlight (or inorganic molecules, in the case of chemosynthetic organisms), and thus occupy the lowest level of a food chain.

Answers to Applying Concepts Questions

11. (a) Pyramids make useful models because the size of each step in the pyramid can be used to represent the number of organisms, biomass, or energy found in each trophic level. Because of the rule of 10 there tends to be smaller number of organisms, biomass, or energy in each successvie step resulting in a pyramid shape.

(b) Pyramids of numbers represent the relative numbers of organisms per trophic level; pyramids of energy represent the total amount of energy that is transferred through each trophic level; and pyramids of biomass represent the amount of dry mass of living or once living tissue in each trophic level, usually in g/m^2. Pyramids of energy, unlike pyramids of numbers or pyramids of biomass, cannot be inverted.

12. Winters in southern Alberta are generally cold and dry, which prevents prairie grasses from growing. Summer droughts can also limit the growth of prairie grasses.

13. A lynx would expend considerable energy to capture its prey, the snowshoe hare, while the snowshoe hare would not have to expend much energy to eat the grass.

14. Of the 200 J in the caterpillar's food, 100 J go to feces and 63 J are used in cellular respiration: 100 J + 63 J = 163 J, and $\frac{163\text{ J}}{200\text{ J}} = 81.5\%$. This energy is not available to the next trophic level.

15. The phytoplankton grows and reproduces at a rate that far exceeds that of the zooplankton. However, the phytoplankton are eaten by zooplankton as quickly as they reproduce. As a result, their biomass is lower than that of the zooplantkton and the pyramid of biomass appears inverted.

16. The pyramid of numbers for a grassland ecosystem is upright because numerous individual plants (represented by a wide base) support the primary consumers. The pyramid of numbers for a northern boreal forest is inverted because individual trees (represented by a narrow base) can support numerous consumer organisms.

17. (a) For Ecosystem A, students should create one upright pyramid of biomass, with decomposers shown to the side, and one upright pyramid of numbers. All producer/consumer levels should be labelled on each pyramid and the width of each tier should be approximately proportionate to the biomass and number of organisms, respectively. For Ecosystem B, students should create an inverted pyramid of biomass. Producers (phytoplankton) and primary consumers (zooplankton) should be labelled on the pyramid. The width of each tier should be approximately proportionate to the biomass.

(b) Using a pyramid of biomass enables biologists to overcome limitations of pyramids of numbers such as size variances (e.g., one dandelion would carry the same producer status as one tree) and difficulties representing differences in numbers of organisms at different trophic levels (e.g., a single secondary consumer compared with billions of primary consumers). A disadvantage might be the difficulty in obtaining suitable samples to estimate dry mass with sufficient accuracy. Accept all reasonable answers.

18. Relevant traditional knowledge of the taiga could include the changes in the relative abundance of game and other species over time, the ages of organisms (number of young versus aging organisms), weather patterns and vegetation through the seasons, number or presence of certain species of insects, number of trophic levels (for example, a top carnivore is no longer hunting in a certain region), and so forth.

19. (a) (mass of strawberries)(0.10) = 1 kg

mass of strawberries = 10 kg

(b) (mass of plant material)(0.10)(0.10)(0.10) = 1 kg

mass of plant material = 1000 kg

Answers to Making Connections Questions

20. (a) With each energy transfer in a food chain, some energy is converted to an unusable form, such as heat. This energy is lost to the next trophic level. Using the rule of 10, only about 10% of the energy in one trophic level is transferred to the next trophic level. When people eat a mainly grain-based diet, there is just one energy transfer between two trophic levels. When people eat a mainly meat-based diet, two or more energy transfers occur between three or more trophic levels. Energy is lost in each of these transfers. As such, cropland used to raise livestock, such as cattle, only produces 10% of the useable energy that cropland used to grow grain does. This means that it takes less cropland (about 10 times less) to feed people a grain-based diet than it does to support enough livestock to feed the same number of people a meat-based diet. Food chains supporting student answers should include a comparison of the amount of the Sun's energy available to humans eating a grain-based diet versus a meat-based diet. For a grain-based food chain, grain will be at the first trophic level and humans at the second. Grain will assimilate 2% of the Sun's energy and humans will assimilate 0.2% of the Sun's energy. For a meat-based diet, food chains will depict more trophic levels depending on the type of meat eaten (beef, fish, etc.). For a food chain in which beef is consumed, grain will occupy the first trophic level, cattle the second, and humans the third. Grain will assimilate 2% of the Sun's energy, cattle 0.2%, and humans 0.02%.

(b) First, humans are a part of various food webs. Traditionally, some people—the Inuit, for example—are hunters and fishers. If these people stopped all hunting and fishing, it is possible that the stability of the food webs they are part of would be reduced. Second, not all land is suitable for growing crops. People living in colder climates, in particular, might be challenged to grow enough crops over the short summers.

21. If less prey is available to this orca population, less energy will be available to them as top predators of the marine food chain. If less prey is available to the orca's main prey

species, these species may decrease in body size or in number of organisms, indirectly leading to less energy transfer to the orca as well. While toxic chemicals, such as PCBs, would adversely affect animals at all trophic levels, some may be more susceptible to pollutants than others. If the orcas' prey is more susceptible to pollutants, they may again decrease in size or number, resulting in less energy transfer to the orca. The same holds true if the primary food source of the orcas' main prey species decreases in size or number due to pollutants. Toxic chemicals, may especially affect orcas themselves, since PCBs and similar pollutants biomagnify in the food chain, reaching their highest concentration in top carnivores. Increase in commercial and private vessels may also stress the marine ecosystem, possibly resulting in changes in energy transfer similar to those stated above.