Answer Key

Directed Reading

SECTION: ENERGY IN LIVING SYTEMS

1. b
2. c
3. d
4. a
5. 4
6. 2
7. 3
8. 1
9. sunlight, carbon dioxide, and water
10. glucose (or carbohydrates) and oxygen
11. glucose (or carbohydrates) and oxygen
12. carbon dioxide, water, and energy
13. the chloroplast
14. the mitochondrion
15. Diagrams should show a chloroplast and the products of photosynthesis along an arrow pointing to a mitochondrion; an arrow from the mitochondrion should show the products of cellular respiration pointing to the chloroplast; the diagram should be similar to the one in the middle of SE, p. 199.
16. During cellular respiration, stored chemical energy is released gradually in a series of enzyme-assisted reactions. When a log is burned, stored chemical energy is released quickly as heat and light.
17. ATP is a molecule that cells make to store energy and break down to release energy; is called a portable energy currency because cells can "earn it" or make it in one place and "spend it"or use it another place.
18. Energy is released from an ATP molecule when one of three phosphate groups is removed from the molecule, forming an ADP molecule.
19. ATP synthase is an enzyme that catalyzes the synthesis of ATP. It also acts as a carrier protein for hydogen ions. The flow of hydrogen ions through ATP synthase powers the production of ATP.
20. The electron transport chain is a series of molecules on the inner membranes of mitochondria and chloroplasts; electrons pass along these molecules, releasing energy as they move from molecule to molecule. The release in energy allows hydrogen ions to be pumped to the outer compartment of either organelle.

SECTION: PHOTOSYNTHESIS

1. A chloroplast has outer and inner membranes. Inside the inner membrane is a space called the stroma; inside the stroma is another membrane called the thylakoid membrane. The outer membrane is not selective in what it lets pass through it. The inner membrane is very selective.
2. thylakoids
3. Pigments
4. wavelengths
5. chlorophyll
6. electrons
7. electron carrier
8. First, water is split by an enzyme and chlorophyll molecules take the electrons from the hydrogen leaving hydrogen ions. Second, using energy from excited electrons, a protein in the thylakoid membrane pumps hydrogen ions into the thylakoid, creating a concentration gradient across the membrane. Finally, energy from the diffusion of hydrogen ions through ATP synthase is used to make ATP from ADP.
9. Excited electrons are replaced by de-energized electrons from a chlorophyll molecule. The excited electrons combine with hydrogen ions and an electron acceptor called $NADP^+$ to form NADPH, a substance that stores energy.
10. 3
11. 1
12. 2
13. They are used to provide energy for the stage of photosynthesis in which sugar is produced.
14. Carbon dioxide from the air enters the chloroplast; an enzyme adds it to a five-carbon sugar to make a six-carbon sugar. Three of these are produced Each of these splits into two three-carbon sugars. To these are added phosphate groups from ATP and

electrons from NADPH. One of the three-carbon sugar molecules leaves the Calvin cycle and is used to make glucose or other energy-storing organic compounds. The other three-carbon sugar molecules are used to regenerate the five-carbon starting compound and continue the Calvin cycle.

15. light intensity, carbon dioxide concentration, and temperature

SECTION: CELLULAR RESPIRATION

1. cellular respiration
2. ATP
3. glucose
4. glycolysis
5. In the first step, glucose is the starting product and two three-carbon sugars are the end products. In the second step the three-carbon sugars are the starting products and NADH are the ending products. In the third step, the modified three-carbon sugar from the second step is converted to pyruvate; four molecules of ATP are produced.
6. anaerobic
7. aerobic, more
8. Krebs cycle, pyruvate, 34 ATP
9. Energy is released.
10. Energy is transferred into each molecule through which the electrons pass. The electrons are transported in the inner membranes of mitochondria.
11. Hydrogen ions are pumped out of the inner chamber of the mitochondria, setting up a concentration gradient for hydrogen ions across the membrane.
12. Hydrogen ions diffuse through this enzyme, providing energy from ATP production.
13. Oxygen combines with hydrogen ions and spent electrons to form water. If oxygen is not present, the electron transport chain stops and the Krebs cycle also stops.
14. electron transport chain
15. alcoholic, lactic acid
16. NAD^+, ATP, glycolysis

12. The Krebs cycle because it includes the electron transport chain, which produces up to 34 molecules of ATP, which are added to the two ATP molecules produced by the Krebs cycle; glycolysis produces a net of two ATP molecules and fermentation produces no ATP molecules.

Active Reading

SECTION: ENERGY IN LIVING SYTEMS

1. a putting together of carbon dioxide and water, using light energy, to form compounds that store chemical energy
2. capable of producing organic compounds that serve as food by oneself (without help from other living organisms)
3. They can eat substances produced by autotrophs, eat autotrophs, or eat other organisms that have eaten autotrophs.
4. A heterotroph must obtain organic compounds, or food, by consuming other organisms or by consuming substances (fruits, seeds, etc.) other organisms have made.
5. Cellular respiration is the process by which organisms break down organic compounds to get energy. Both autotrophs and heterotrophs use cellular respiration to get the energy they need.
6. The analogy identifies a classification group and a specific member of that group. Students might mention that how organisms feed forms the basis of the classification groups.
7. d

SECTION: PHOTOSYNTHESIS

1. The first sentence: Photosynthesis is directly affected by various environmental factors.
2. A decrease in light intensity would cause a similar decrease in the rate of photosynthesis of the plant.
3. Once all of the pigments in a plant are in use, an increase in light intensity has no effect on the photosynthesis rate of the plant.
4. The concentration of carbon dioxide steadily increased during the study, causing an increased rate of photosynthesis until the concentration was above the level at which the plant could take up any more carbon dioxide. Then the rate of photosynthesis leveled off
5. As the air temperature dropped, the enzymes mediating photosynthesis became less and less efficient. This caused a steady decrease in the rate of photosynthesis.
6. b

SECTION: CELLULAR RESPIRATION

1. It begins with the process of glycolysis, which occurs in the cytoplasm of a cell.
2. Glycolysis takes place in the absence of oxygen.
3. It is broken down to form two three-carbon molecules of pyruvate.
4. The energy originally came from sunlight when the glucose was produced via photosynthesis.
5. a

Vocabulary Review (Basic)

1. b
2. c
3. e
4. a
5. d
6. Chlorophyll
7. thylakoid
8. electron transport chain
9. Calvin cycle
10. aerobic
11. anaerobic
12. glycolysis
13. Krebs cycle
14. fermentation

Vocabulary Review (General)

1. photosynthesis
2. Calvin cycle
3. Krebs cycle
4. cellular respiration
5. pigment
6. chlorophyll
7. thylakoid
8. electron transport chain
9. fermentaion
10. ATP
11. aerobic
12. anaerobic
13. glycolysis
14. ATP synthase

Science Skills

INTERPRETING INFORMATION

1. food chain A: corn—10,000 kcal; human vegetarians—1,000 kcal; food chain B: corn—10,000 kcal; cattle—1,000 kcal; human meat eaters—100 kcal
2. rice—15,000 kcal; rice and vegetable eaters—1,500 kcal;
3. Because 90 percent of the energy from one trophic level never makes it to the next level, there is rarely enough energy available to sustain a fifth trophic level.
4. Some energy is lost as heat, and some is used up by the organism in metabolic processes, such as cellular respiration or fermentation that involve the breakdown of glucose and other organic compounds.
5. Producing vegetables requires less land than raising livestock, because the livestock require vegetable crops to eat. If more people adopt a vegetarian diet, land can be used more efficiently to raise more food for people rather than for animals.

Concept Mapping

1. glucose
2. glycolysis
3. anaerobic process
4. fermentation
5. NAD^+
6. pyruvate
7. Krebs cycle
8. electron transport chain

(Items 7 and 8 are interchangable.)

Critical Thinking

1. e
2. d
3. c
4. b
5. g
6. a
7. f
8. f
9. c
10. a
11. h
12. e
13. b
14. d
15. g
16. e, g
17. f, c
18. i, h
19. b, d
20. a, g
21. c
22. d
23. a
24. b
25. a