Chapter 1 Exercises

Review Questions

1. The first forms of life on Earth were _____.
- **a.** plants
- **b.** microorganisms
- **c.** birds
- **d.** dinosaurs

2. A suggested and testable explanation for an event is called a _____.
- **a.** hypothesis
- **b.** variable
- **c.** theory
- **d.** control

3. Which of the following sciences is not considered a natural science?
- **a.** biology
- **b.** astronomy
- **c.** physics
- **d.** computer science

4. The type of logical thinking that uses related observations to arrive at a general conclusion is called _____.
- **a.** deductive reasoning
- **b.** the scientific method
- **c.** hypothesis-based science
- **d.** inductive reasoning

5. The process of _____ helps to ensure that a scientist's research is original, significant, logical, and thorough.
- **a.** publication
- **b.** public speaking
- **c.** peer review
- **d.** the scientific method

6. Farah notices that houseplants that are regularly exposed to music seem to grow more quickly than those in rooms with no music. As a result, Farah determines that plants grow better when exposed to music. This example most closely resembles which type of reasoning?
- **a.** inductive reasoning
- **b.** deductive reasoning
- **c.** neither because no hypothesis was made
- **d.** both inductive and deductive reasoning

7. The smallest unit of biological structure that meets the functional requirements of "living" is the _____.
- **a.** organ
- **b.** organelle
- **c.** cell
- **d.** macromolecule

8. Viruses are not considered living because they _____.
- **a.** are not made of cells
- **b.** lack cell nuclei
- **c.** do not contain DNA or RNA
- **d.** cannot reproduce

9. The presence of a membrane-enclosed nucleus is a characteristic of _____.
- **a.** prokaryotic cells
- **b.** eukaryotic cells
- **c.** living organisms
- **d.** bacteria

10. A group of individuals of the same species living in the same area is called a(n) _____.
- **a.** family
- **b.** community
- **c.** population
- **d.** ecosystem

11. Which of the following sequences represents the hierarchy of biological organization from the most inclusive to the least complex level?
- **a.** organelle → tissue → biosphere → ecosystem → population
- **b.** organ → organism → tissue → organelle → molecule
- **c.** organism → community → biosphere → molecule → tissue → organ
- **d.** biosphere → ecosystem → community → population → organism

12. Where in a phylogenetic tree would you expect to find the organism that had evolved most recently?

a. at the base
b. within the branches
c. at the nodes
d. at the branch tips

Critical Thinking Questions

13. Although the scientific method is used by most of the sciences, it can also be applied to everyday situations. Think about a problem that you may have at home, at school, or at work, and apply the scientific method to solve it.

14. Give an example of how applied science has had a direct effect on your daily life.

15. Name two topics that are likely to be studied by biologists, and two areas of scientific study that would fall outside the realm of biology.

16. Considering the topic of cancer, write a basic science question and an applied science question that a researcher interested in this topic might ask.

17. Select two items that biologists agree are necessary in order to consider an organism "alive." For each, give an example of a nonliving object that otherwise fits the definition of "alive."

18. Consider the levels of organization of the biological world, and place each of these items in order from smallest level of organization to most encompassing: skin cell, elephant, water molecule, planet Earth, tropical rainforest, hydrogen atom, wolf pack, liver.

19. You go for a long walk on a hot day. Give an example of a way in which homeostasis keeps your body healthy.

20. Using examples, explain how biology can be studied from a microscopic approach to a global approach.

Chapter 2 Exercises

Review Questions

1. If xenon has an atomic number of 54 and a mass number of 108, how many neutrons does it have?

a. 54
b. 27
c. 100
d. 108

2. Atoms that vary in the number of neutrons found in their nuclei are called _____.

a. ions
b. neutrons
c. neutral atoms
d. isotopes

3. Potassium has an atomic number of 19. What is its electron configuration?

a. Shells 1 and 2 are full, and shell 3 has nine electrons.
b. Shells 1, 2, and 3 are full, and shell 4 has three electrons.
c. Shells 1, 2, and 3 are full, and shell 4 has one electron.
d. Shells 1, 2, and 3 are full, and no other electrons are present.

4. Which type of bond represents a weak chemical bond?

a. hydrogen bond
b. atomic bond
c. covalent bond
d. nonpolar covalent bond

5. Which of the following statements is *not* true?

a. Water is polar.
b. Water stabilizes temperature.
c. Water is essential for life.
d. Water is the most abundant molecule in the Earth's atmosphere.

6. When acids are added to a solution, the pH should _____.

a. decrease
b. increase
c. stay the same
d. We cannot tell without testing.

7. We call a molecule that binds up excess hydrogen ions in a solution a(n) _____.

a. acid
b. isotope
c. base
d. donator

8. Which of the following statements is *true*?

a. Acids and bases cannot mix together.
b. Acids and bases will neutralize each other.
c. Acids, but not bases, can change the pH of a solution.
d. Acids donate hydroxide ions (OH^-); bases donate hydrogen ions (H^+).

9. Each carbon atom can bond with as many as _____ other atom(s) or molecule(s).

a. one
b. two
c. six
d. four

10. Which of the following is *not* a functional group that can bond with carbon?

a. sodium
b. hydroxyl
c. phosphate
d. carbonyl

Critical Thinking Questions

11. What makes ionic bonds different from covalent bonds?

12. Why are hydrogen bonds and van der Waals interactions necessary for cells?

13. Explain how buffers help prevent drastic swings in pH.

14. Why can some insects walk on water?

15. What property of carbon makes it essential for organic life?

16. Compare and contrast saturated and unsaturated triglycerides.

Chapter 3 Exercises

Review Questions

1. Dehydration synthesis leads to formation of _____.
- **a.** monomers
- **b.** polymers
- **c.** water and polymers
- **d.** none of these

2. During the breakdown of polymers, which of the following reactions takes place?
- **a.** hydrolysis
- **b.** dehydration
- **c.** condensation
- **d.** covalent bond

3. The following chemical reactants produce the ester ethyl ethanoate ($C_4H_8O_2$):

$$C_2H_6O + CH_3COOH$$

What type of reaction occurs to make ethyl ethanoate?
- **a.** condensation
- **b.** hydrolysis
- **c.** combustion
- **d.** acid-base reaction

4. An example of a monosaccharide is _____.
- **a.** fructose
- **b.** glucose
- **c.** galactose
- **d.** all of these

5. Cellulose and starch are examples of _____.
- **a.** monosaccharides
- **b.** disaccharides
- **c.** lipids
- **d.** polysaccharides

6. Plant cell walls contain which of the following in abundance?
- **a.** starch
- **b.** cellulose
- **c.** glycogen
- **d.** lactose

7. Lactose is a disaccharide formed by the formation of a _____ bond between glucose and _____.
- **a.** glycosidic; lactose
- **b.** glycosidic; galactose
- **c.** hydrogen; sucrose
- **d.** hydrogen; fructose

8. Which of the following is *not* an extracellular matrix role of carbohydrates?
- **a.** to protect an insect's internal organs from external trauma
- **b.** to prevent plant cells from lysing after the plant is watered
- **c.** to maintain the shape of a fungal spore
- **d.** to provide energy for muscle movement

9. Saturated fats have all of the following characteristics except:
- **a.** they are solid at room temperature
- **b.** they have single bonds within the carbon chain
- **c.** they are usually obtained from animal sources
- **d.** they tend to dissolve in water easily

10. Phospholipids are important components of _____.
- **a.** the plasma membrane of cells
- **b.** the ring structure of steroids
- **c.** the waxy covering on leaves
- **d.** the double bond in hydrocarbon chains

11. Cholesterol is an integral part of plasma membranes. Based on its structure, where is it found in the membrane?
- **a.** on the extracellular surface
- **b.** embedded with the phospholipid heads
- **c.** within the tail bilayer
- **d.** attached to the intracellular surface

12. The monomers that make up proteins are called _____.
- **a.** nucleotides
- **b.** disaccharides
- **c.** amino acids
- **d.** chaperones

13. The α helix and the β pleated sheet are part of which protein structure?
- **a.** primary
- **b.** secondary
- **c.** tertiary
- **d.** quaternary

14. Mad cow disease is an infectious disease where one misfolded protein causes all other copies of the protein to begin misfolding. This is an example of a disease impacting _____ structure.
- **a.** primary
- **b.** secondary
- **c.** tertiary
- **d.** quaternary

15. A nucleotide of DNA may contain _____.
- **a.** ribose, uracil, and a phosphate group
- **b.** deoxyribose, uracil, and a phosphate group
- **c.** deoxyribose, thymine, and a phosphate group
- **d.** ribose, thymine, and a phosphate group

16. The building blocks of nucleic acids are _____.
- **a.** sugars
- **b.** nitrogenous bases
- **c.** peptides
- **d.** nucleotides

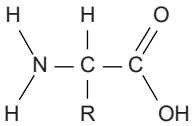
17. How does the double helix structure of DNA support its role in encoding the genome?
- **a.** The sugar-phosphate backbone provides a template for DNA replication.
- **b.** Transfer RNA pairing with the template strand creates proteins encoded by the genome.
- **c.** Complementary base pairing creates a very stable structure.
- **d.** Complementary base pairing allows for easy editing of both strands of DNA.

Critical Thinking Questions

18. Why are biological macromolecules considered organic?

19. What role do electrons play in dehydration synthesis and hydrolysis?

20. Amino acids have the following generic structure, where R represents different carbon-based side chains.



Describe how the structure of amino acids allows them to be linked into long peptide chains to form proteins.

21. Describe the similarities and differences between glycogen and starch.

22. Why is it impossible for humans to digest foods that contain cellulose?

23. Draw the ketose and aldose forms of a monosaccharide with the chemical formula $C_3H_6O_3$. How is the structure of the monosaccharide changed from one form to the other in the human body?

24. Explain at least three functions that lipids serve in plants and/or animals.

25. Why have *trans* fats been banned from some restaurants? How are they created?

26. Why are fatty acids better than glycogen for storing large amounts of chemical energy?

27. Part of cortisol's role in the body involves passing through the plasma membrane to initiate signaling inside a cell. Describe how the structures of cortisol and the plasma membrane allow this to occur.

28. Explain what happens if even one amino acid is substituted for another in a polypeptide chain. Provide a specific example.

29. Describe the differences in the four protein structures.

30. Aquaporins are proteins embedded in the plasma membrane that allow water molecules to move between the extracellular matrix and the intracellular space. Based on its function and location, describe the key features of the protein's shape and the chemical characteristics of its amino acids.

31. What are the structural differences between RNA and DNA?

32. What are the four types of RNA and how do they function?

Chapter 4 Exercises

Review Questions

1. When viewing a specimen through a light microscope, scientists use _____ to distinguish the individual components of cells.
- **a.** a beam of electrons
- **b.** radioactive isotopes
- **c.** special stains
- **d.** high temperatures

2. The _____ is the basic unit of life.
- **a.** organism
- **b.** cell
- **c.** tissue
- **d.** organ

3. Prokaryotes depend on _____ to obtain some materials and to get rid of wastes.
- **a.** ribosomes
- **b.** flagella
- **c.** cell division
- **d.** diffusion

4. Bacteria that lack fimbriae are less likely to _____.
- **a.** adhere to cell surfaces
- **b.** swim through bodily fluids
- **c.** synthesize proteins
- **d.** retain the ability to divide

5. Which of the following organisms is a prokaryote?
- **a.** amoeba
- **b.** influenza A virus
- **c.** charophyte algae
- **d.** *E. coli*

6. Which of the following is surrounded by two phospholipid bilayers?
- **a.** ribosomes
- **b.** vesicles
- **c.** cytoplasm
- **d.** nucleoplasm

7. Peroxisomes got their name because hydrogen peroxide is:
- **a.** used in their detoxification reactions
- **b.** produced during their oxidation reactions
- **c.** incorporated into their membranes
- **d.** a cofactor for the organelles' enzymes

8. In plant cells, the function of the lysosomes is carried out by _____.
- **a.** vacuoles
- **b.** peroxisomes
- **c.** ribosomes
- **d.** nuclei

9. Which of the following is both in eukaryotic and prokaryotic cells?
- **a.** nucleus
- **b.** mitochondrion
- **c.** vacuole
- **d.** ribosomes

10. Tay-Sachs disease is a genetic disorder that results in the destruction of neurons due to a buildup of sphingolipids in the cells. Which organelle is malfunctioning in Tay-Sachs?
- **a.** lysosome
- **b.** endoplasmic reticulum
- **c.** peroxisome
- **d.** mitochondria

11. Which of the following is *not* a component of the endomembrane system?
- **a.** mitochondrion
- **b.** Golgi apparatus
- **c.** endoplasmic reticulum
- **d.** lysosome

12. The process by which a cell engulfs a foreign particle is known as _____.
- **a.** endosymbiosis
- **b.** phagocytosis
- **c.** hydrolysis
- **d.** membrane synthesis

13. Which of the following is most likely to have the greatest concentration of smooth endoplasmic reticulum?
- **a.** a cell that secretes enzymes
- **b.** a cell that destroys pathogens
- **c.** a cell that makes steroid hormones
- **d.** a cell that engages in photosynthesis

14. Which of the following sequences correctly lists, in order, the steps involved in the incorporation of a proteinaceous molecule within a cell?

a. protein synthesis of the protein on the ribosome → modification in the Golgi apparatus → packaging in the endoplasmic reticulum → tagging in the vesicle

b. synthesis of the protein on the lysosome → tagging in the Golgi apparatus → packaging in the vesicle → distribution in the endoplasmic reticulum

c. synthesis of the protein on the ribosome → modification in the endoplasmic reticulum → tagging in the Golgi apparatus → distribution via the vesicle

d. synthesis of the protein on the lysosome → packaging in the vesicle → distribution via the Golgi apparatus → tagging in the endoplasmic reticulum

15. Congenital disorders of glycosylation are a growing class of rare diseases. Which organelle would be most commonly involved in the glycoprotein disorder portion of the group?

a. RER **c.** endosomes

b. ribosomes **d.** Golgi apparatus

16. Which of the following have the ability to disassemble and reform quickly?

a. microfilaments and intermediate filaments

b. microfilaments and microtubules

c. intermediate filaments and microtubules

d. only intermediate filaments

17. Which of the following do not play a role in intracellular movement?

a. microfilaments and intermediate filaments

b. microfilaments and microtubules

c. intermediate filaments and microtubules

d. only intermediate filaments

18. In humans, _____ are used to move a cell within its environment, while _____ are used to move the environment relative to the cell.

a. cilia; pseudopodia **c.** microtubules; flagella

b. flagella; cilia **d.** microfilaments; microtubules

Critical Thinking Questions

19. In your everyday life, you have probably noticed that certain instruments are ideal for certain situations. For example, you would use a spoon rather than a fork to eat soup because a spoon is shaped for scooping, while soup would slip between the tines of a fork. The use of ideal instruments also applies in science. In what situation(s) would the use of a light microscope be ideal, and why?

20. In what situation(s) would the use of a scanning electron microscope be ideal, and why?

21. In what situation(s) would a transmission electron microscope be ideal, and why?

22. What are the advantages and disadvantages of each of these types of microscopes?

23. Explain how the formation of an adult human follows the cell theory.

24. Antibiotics are medicines that are used to fight bacterial infections. These medicines kill prokaryotic cells without harming human cells. What part or parts of the bacterial cell do you think antibiotics target? Why?

25. Explain why not all microbes are harmful.

26. We know that ribosomes are abundant in red blood cells. In what other cells of the body would you find them in great abundance? Why?

27. What are the structural and functional similarities and differences between mitochondria and chloroplasts?

28. Why are plasma membranes arranged as a bilayer rather than a monolayer?

29. In the context of cell biology, what do we mean by "form follows function"? What are at least two examples of this concept?

30. In your opinion, is the nuclear membrane part of the endomembrane system? Why or why not? Explain your answer.

31. What are the similarities and differences between the structures of centrioles and flagella?

32. How do cilia and flagella differ?

33. Describe how microfilaments and microtubules are involved in the phagocytosis and destruction of a pathogen by a macrophage.

34. Compare and contrast the boundaries that plant, animal, and bacteria cells use to separate themselves from their surrounding environment.

Chapter 5 Exercises

Review Questions

1. Which plasma membrane component can be either found on its surface or embedded in the membrane structure?

a. protein
b. cholesterol
c. carbohydrate
d. phospholipid

2. Which characteristic of a phospholipid contributes to the fluidity of the membrane?

a. its head
b. cholesterol
c. a saturated fatty acid tail
d. double bonds in the fatty acid tail

3. What is the primary function of carbohydrates attached to the exterior of cell membranes?

a. identification of the cell
b. flexibility of the membrane
c. strengthening the membrane
d. channels through membrane

4. A scientist compares the plasma membrane composition of an animal from the Mediterranean coast with one from the Mojave Desert. Which hypothesis is most likely to be correct?

a. The cells from the Mediterranean coast animal will have more fluid plasma membranes.
b. The cells from the Mojave Desert animal will have a higher cholesterol concentration in the plasma membranes.
c. The cells' plasma membranes will be indistinguishable.
d. The cells from the Mediterranean coast animal will have a higher glycoprotein content, while the cells from the Mojave Desert animal will have a higher lipoprotein content.

5. Water moves via osmosis _____.

a. throughout the cytoplasm
b. from an area with a high concentration of other solutes to a lower one
c. from an area with a high concentration of water to one of lower concentration
d. from an area with a low concentration of water to higher concentration

6. The principal force driving movement in diffusion is the _____.

a. temperature
b. particle size
c. concentration gradient
d. membrane surface area

7. What problem is faced by organisms that live in fresh water?

a. Their bodies tend to take in too much water.
b. They have no way of controlling their tonicity.
c. Only salt water poses problems for animals that live in it.
d. Their bodies tend to lose too much water to their environment.

8. In which situation would passive transport *not* use a transport protein for entry into a cell?

a. water flowing into a hypertonic environment
b. glucose being absorbed from the blood
c. an ion flowing into a nerve cell to create an electrical potential
d. oxygen moving into a cell after oxygen deprivation

9. Active transport must function continuously because _____.

a. plasma membranes wear out
b. not all membranes are amphiphilic
c. facilitated transport opposes active transport
d. diffusion is constantly moving solutes in opposite directions

10. How does the sodium-potassium pump make the interior of the cell negatively charged?

a. by expelling anions
b. by pulling in anions
c. by expelling more cations than are taken in
d. by taking in and expelling an equal number of cations

11. What is the combination of an electrical gradient and a concentration gradient called?

a. potential gradient
b. electrical potential
c. concentration potential
d. electrochemical gradient

12. What happens to the membrane of a vesicle after exocytosis?

a. It leaves the cell.
b. It is disassembled by the cell.
c. It fuses with and becomes part of the plasma membrane.
d. It is used again in another exocytosis event.

13. Which transport mechanism can bring whole cells into a cell?

a. pinocytosis
b. phagocytosis
c. facilitated transport
d. primary active transport

14. In what important way does receptor-mediated endocytosis differ from phagocytosis?

a. It transports only small amounts of fluid.
b. It does not involve the pinching off of membrane.
c. It brings in only a specifically targeted substance.
d. It brings substances into the cell, while phagocytosis removes substances.

15. Many viruses enter host cells through receptor-mediated endocytosis. What is an advantage of this entry strategy?

a. The virus directly enters the cytoplasm of the cell.
b. The virus is protected from recognition by white blood cells.
c. The virus only enters its target host cell type.
d. The virus can directly inject its genome into the cell's nucleus.

16. Which of the following organelles relies on exocytosis to complete its function?

a. Golgi apparatus
b. vacuole
c. mitochondria
d. endoplasmic reticulum

17. Imagine a cell can perform exocytosis but only minimal endocytosis. What would happen to the cell?

a. The cell would secrete all its intracellular proteins.
b. The plasma membrane would increase in size over time.
c. The cell would stop expressing integral receptor proteins in its plasma membrane.
d. The cell would lyse.

18. Which of the following are only in plant cells?

a. gap junctions
b. desmosomes
c. plasmodesmata
d. tight junctions

19. The key components of desmosomes are cadherins and _____.

a. actin
b. microfilaments
c. intermediate filaments
d. microtubules

20. Diseased animal cells may produce molecules that activate death cascades to kill the cells in a controlled manner. Why would neighboring healthy cells also die?

a. The death molecule is passed through desmosomes.

b. The death molecule is passed through plasmodesmata.

c. The death molecule disrupts the extracellular matrix.

d. The death molecule passes through gap junctions.

Critical Thinking Questions

21. Why is it advantageous for the cell membrane to be fluid in nature?

22. Why do phospholipids tend to spontaneously orient themselves into something resembling a membrane?

23. How can a cell use an extracellular peripheral protein as the receptor to transmit a signal into the cell?

24. Discuss why the following affect the rate of diffusion: molecular size, temperature, solution density, and the distance that must be traveled.

25. Why does water move through a membrane?

26. Both of the regular intravenous solutions administered in medicine, normal saline and lactated Ringer's solution, are isotonic. Why is this important?

27. Describe two ways that decreasing temperature would affect the rate of diffusion of molecules across a cell's plasma membrane.

28. A cell develops a mutation in its potassium channels that prevents the ions from leaving the cell. If the cell's aquaporins are still active, what will happen to the cell? Be sure to describe the tonicity and osmolarity of the cell.

29. Where does the cell get energy for active transport processes?

30. How does the sodium-potassium pump contribute to the net negative charge of the interior of the cell?

31. Glucose from digested food enters intestinal epithelial cells by active transport. Why would intestinal cells use active transport when most body cells use facilitated diffusion?

32. The sodium/calcium exchanger (NCX) transports sodium into and calcium out of cardiac muscle cells. Describe why this transporter is classified as secondary active transport.

33. Why is it important that there are different types of proteins in plasma membranes for the transport of materials into and out of a cell?

34. Why do ions have a difficult time getting through plasma membranes despite their small size?

35. How does the structure of a plasmodesma differ from that of a gap junction?

36. Explain how the extracellular matrix functions.

37. Pathogenic *E. coli* have recently been shown to degrade tight junction proteins during infection. How would this provide an advantage to the bacteria?

Chapter 6 Exercises

Review Questions

1. Energy is stored in the long term in the bonds of _____ and used in the short term to perform work from a(n) _____ molecule.

a. ATP; glucose
b. an anabolic molecule; catabolic
c. glucose; ATP
d. a catabolic molecule; anabolic

2. DNA replication involves unwinding two strands of parent DNA, copying each strand to synthesize complementary strands, and releasing the parent and daughter DNA. Which of the following accurately describes this process?

a. This is an anabolic process.
b. This is a catabolic process.
c. This is both anabolic and catabolic.
d. This is a metabolic process but is neither anabolic nor catabolic.

3. Consider a pendulum swinging. Which type(s) of energy is/are associated with the pendulum in the following instances:

i. The moment at which it completes one cycle, just before it begins to fall back towards the other end
ii. The moment that it is in the middle between the two ends
iii. Just before it reaches the end of one cycle (just before instant i)

a. i. potential and kinetic, ii. potential and kinetic, iii. kinetic
b. i. potential, ii. potential and kinetic, iii. potential and kinetic
c. i. potential, ii. kinetic, iii. potential and kinetic
d. i. potential and kinetic, ii. kinetic, iii. kinetic

4. Which of the following comparisons or contrasts between endergonic and exergonic reactions is false?

a. Endergonic reactions have a positive ΔG, and exergonic reactions have a negative ΔG.
b. Endergonic reactions consume energy, and exergonic reactions release energy.
c. Both endergonic and exergonic reactions require a small amount of energy to overcome an activation barrier.
d. Endergonic reactions take place slowly, and exergonic reactions take place quickly.

5. Which of the following is the best way to judge the relative activation energies between two given chemical reactions?

a. Compare the ΔG values between the two reactions.
b. Compare their reaction rates.
c. Compare their ideal environmental conditions.
d. Compare the spontaneity between the two reactions.

6. Which of the following is *not* an example of an energy transformation?

a. turning on a light switch
b. solar panels at work
c. formation of static electricity
d. none of these

7. In each of the three systems, determine the state of entropy (low or high) when comparing the first and second:

i. The instant that a perfume bottle is sprayed compared with 30 seconds later
ii. An old 1950s car compared with a brand-new car
iii. A living cell compared with a dead cell

a. i. low, ii. high, iii. low
b. i. low, ii. high, iii. high
c. i. high, ii. low, iii. high
d. i. high, ii. low, iii. low

8. The energy released by the hydrolysis of ATP is _____.
- **a.** primarily stored between the alpha and beta phosphates
- **b.** equal to –57 kcal/mol
- **c.** harnessed as heat energy by the cell to perform work
- **d.** providing energy to coupled reactions

9. Which of the following molecules is likely to have the most potential energy?
a. sucrose **b.** ATP **c.** glucose **d.** ADP

10. Which of the following is *not* true about enzymes?
- **a.** They increase ΔG of reactions.
- **b.** They are usually made of amino acids.
- **c.** They lower the activation energy of chemical reactions.
- **d.** Each one is specific to the particular substrate(s) to which it binds.

11. An allosteric inhibitor does which of the following?
- **a.** binds to an enzyme away from the active site and changes the conformation of the active site, increasing its affinity for substrate binding
- **b.** binds to the active site and blocks it from binding substrate
- **c.** binds to an enzyme away from the active site and changes the conformation of the active site, decreasing its affinity for the substrate
- **d.** binds directly to the active site and mimics the substrate

12. Which of the following analogies best describes the induced-fit model of enzyme-substrate binding?
- **a.** a hug between two people
- **b.** a key fitting into a lock
- **c.** a square peg fitting through the square hole and a round peg fitting through the round hole of a children's toy
- **d.** the fitting together of two jigsaw puzzle pieces

Critical Thinking Questions

13. Does physical exercise involve anabolic and/or catabolic processes? Give evidence for your answer.

14. Name two different cellular functions that require energy that parallel human energy-requiring functions.

15. Explain in your own words the difference between a spontaneous reaction and one that occurs instantaneously. What causes this difference?

16. Describe the position of the transition state on a vertical energy scale, from low to high, relative to the position of the reactants and products for both endergonic and exergonic reactions.

17. Imagine an elaborate ant farm with tunnels and passageways through the sand where ants live in a large community. Now imagine that an earthquake shook the ground and demolished the ant farm. In which of these two scenarios, before or after the earthquake, was the ant farm system in a state of higher or lower entropy?

18. Energy transfers take place constantly in everyday activities. Think about these two scenarios: cooking on a stove and driving. Explain how the second law of thermodynamics applies to these two scenarios.

19. Do you think that the E_A for ATP hydrolysis is relatively low or high? Explain your reasoning.

20. With regard to enzymes, why are vitamins necessary for good health? Give examples.

21. Explain in your own words how enzyme feedback inhibition benefits a cell.

Chapter 7 Exercises

Review Questions

1. The energy currency used by cells is _____.
- **a.** ATP
- **b.** ADP
- **c.** AMP
- **d.** adenosine

2. A reducing chemical reaction _____.
- **a.** reduces the compound to a simpler form
- **b.** adds an electron to the substrate
- **c.** removes a hydrogen atom from the substrate
- **d.** is a catabolic reaction

3. During the second half of glycolysis, what occurs?
- **a.** ATP is used up.
- **b.** Fructose is split in two.
- **c.** ATP is made.
- **d.** Glucose becomes fructose.

4. What is removed from pyruvate during its conversion into an acetyl group?
- **a.** oxygen
- **b.** ATP
- **c.** B vitamin
- **d.** carbon dioxide

5. What do the electrons added to NAD^+ do?
- **a.** They become part of a fermentation pathway.
- **b.** They go to another pathway for ATP production.
- **c.** They energize the entry of the acetyl group into the citric acid cycle.
- **d.** They are converted to NADP.

6. GTP or ATP is produced during the conversion of _____.
- **a.** isocitrate into α-ketoglutarate
- **b.** succinyl CoA into succinate
- **c.** fumarate into malate
- **d.** malate into oxaloacetate

7. How many NADH molecules are produced on each turn of the citric acid cycle?
- **a.** one
- **b.** two
- **c.** three
- **d.** four

8. What compound receives electrons from NADH?
- **a.** FMN
- **b.** ubiquinone
- **c.** cytochrome c_1
- **d.** oxygen

9. Chemiosmosis involves:
- **a.** the movement of electrons across the cell membrane
- **b.** the movement of hydrogen atoms across a mitochondrial membrane
- **c.** the movement of hydrogen ions across a mitochondrial membrane
- **d.** the movement of glucose through the cell membrane

10. Which of the following fermentation methods can occur in animal skeletal muscles?
- **a.** lactic acid fermentation
- **b.** alcohol fermentation
- **c.** mixed acid fermentation
- **d.** propionic fermentation

11. A major connection for sugars in glycolysis is _____.
- **a.** glucose-6-phosphate
- **b.** fructose-1,6-bisphosphate
- **c.** dihydroxyacetone phosphate
- **d.** phosphoenolpyruvate

12. Beta-oxidation is _____.
- **a.** the breakdown of sugars
- **b.** the assembly of sugars
- **c.** the breakdown of fatty acids
- **d.** the removal of amino groups from amino acids

13. The effect of high levels of ADP is to _____ in cellular respiration.
- **a.** increase the activity of specific enzymes
- **b.** decrease the activity of specific enzymes
- **c.** have no effect on the activity of specific enzymes
- **d.** slow down the pathway

14. The control of which enzyme exerts the most control on glycolysis?
- **a.** hexokinase
- **b.** phosphofructokinase
- **c.** glucose-6-phosphatase
- **d.** aldolase

Critical Thinking Questions

15. Why is it beneficial for cells to use ATP rather than energy directly from the bonds of carbohydrates? What are the greatest drawbacks to harnessing energy directly from the bonds of several different compounds?

16. Nearly all organisms on Earth carry out some form of glycolysis. How does that fact support or not support the assertion that glycolysis is one of the oldest metabolic pathways?

17. Because they lose their mitochondria during development, red blood cells cannot perform aerobic respiration; however, they do perform glycolysis in the cytoplasm. Why do all cells need an energy source, and what would happen if glycolysis were blocked in a red blood cell?

18. What is the primary difference between a circular pathway and a linear pathway?

19. How do the roles of ubiquinone and cytochrome c differ from the other components of the electron transport chain?

20. What accounts for the different number of ATP molecules that are formed through cellular respiration?

21. What is the primary difference between fermentation and anaerobic respiration?

22. Would you describe metabolic pathways as inherently wasteful or inherently economical? Why?

23. How does citrate from the citric acid cycle affect glycolysis?

24. Why might negative feedback mechanisms be more common than positive feedback mechanisms in living cells?

Chapter 8 Exercises

Review Questions

1. Which of the following components is *not* used by both plants and cyanobacteria to carry out photosynthesis?

a. chloroplasts
b. chlorophyll
c. carbon dioxide
d. water

2. What two main products result from photosynthesis?

a. oxygen and carbon dioxide
b. chlorophyll and oxygen
c. sugars/carbohydrates and oxygen
d. sugars/carbohydrates and carbon dioxide

3. In which compartment of the plant cell do the light-independent reactions of photosynthesis take place?

a. thylakoid
b. stroma
c. outer membrane
d. mesophyll

4. Which statement about thylakoids in eukaryotes is *not* correct?

a. Thylakoids are assembled into stacks.
b. Thylakoids exist as a maze of folded membranes.
c. The space surrounding thylakoids is called stroma.
d. Thylakoids contain chlorophyll.

5. Predict the end result if a chloroplast's light-independent enzymes developed a mutation that prevented them from activating in response to light.

a. G3P accumulation
b. ATP and NADPH accumulation
c. water accumulation
d. carbon dioxide depletion

6. How are the NADPH and G3P molecules made during photosynthesis similar?

a. They are both end products of photosynthesis.
b. They are both substrates for photosynthesis.
c. They are both produced from carbon dioxide.
d. They both store energy in chemical bonds.

7. Which of the following structures is *not* a component of a photosystem?

a. ATP synthase
b. antenna molecule
c. reaction center
d. primary electron acceptor

8. How many photons does it take to fully reduce one molecule of $NADP^+$ to NADPH?

a. 1
b. 2
c. 4
d. 8

9. Which complex is *not* involved in the establishment of conditions for ATP synthesis?

a. photosystem I
b. ATP synthase
c. photosystem II
d. cytochrome complex

10. From which component of the light-dependent reactions does NADPH form most directly?
- **a.** photosystem II
- **b.** photosystem I
- **c.** cytochrome complex
- **d.** ATP synthase

11. A plant exposed to only green light for a period of one week:
- **a.** fails to grow because chlorophyll *a* and *b* reflect green light.
- **b.** fails to grow because chlorophyll *a* and *b* absorb green light.
- **c.** grows normally because chlorophyll *a* and *b* reflect green light.
- **d.** grows normally because chlorophyll *a* and *b* absorb green light.

12. Plants containing only chlorophyll *b* are exposed to radiation with the following wavelengths: 10 nm (X-rays), 450 nm (blue light), 670 nm (red light), and 800 nm (infrared light). Which plants harness the most energy for photosynthesis?
- **a.** X-ray irradiated plants
- **b.** blue-light irradiated plants
- **c.** red-light irradiated plants
- **d.** infrared irradiated plants

13. Which molecule must enter the Calvin cycle continually for light-independent reactions to take place?
- **a.** RuBisCO
- **b.** RuBP
- **c.** 3-PGA
- **d.** CO_2

14. Which order of molecular conversions is correct for the Calvin cycle?
- **a.** RuBP + G3P → 3-PGA → sugarRuBP + G3P → 3-PGA → sugar
- **b.** RuBisCO → CO_2 → RuBP → G3PRuBisCO → CO_2 → RuBP → G3P
- **c.** RuBP + CO_2 → [RuBisCO] 3-PGA → G3PRuBP + CO_2 → [RuBisCO] 3-PGA → G3P
- **d.** CO_2 → 3-PGA → RuBP → G3PCO_2 → 3-PGA → RuBP → G3P

15. Where in eukaryotic cells does the Calvin cycle take place?
- **a.** thylakoid membrane
- **b.** thylakoid lumen
- **c.** chloroplast stroma
- **d.** granum

16. Which statement correctly describes carbon fixation?
- **a.** the conversion of CO_2 into an organic compound
- **b.** the use of RuBisCO to form 3-PGA
- **c.** the production of carbohydrate molecules from G3P
- **d.** the formation of RuBP from G3P molecules
- **e.** the use of ATP and NADPH to reduce CO_2

17. If four molecules of carbon dioxide enter the Calvin cycle (four "turns" of the cycle), how many G3P molecules are produced and how many are exported?
- **a.** 4 G3P made, 1 G3P exported
- **b.** 4 G3P made, 2 G3P exported
- **c.** 8 G3P made, 1 G3P exported
- **d.** 8 G3P made, 4 G3P exported

Critical Thinking Questions

18. What is the overall outcome of light reactions in photosynthesis?

19. Why are carnivores, such as lions, dependent on photosynthesis to survive?

20. Why are energy carriers thought of as either "full" or "empty"?

21. Describe how the grey wolf population would be impacted by a volcanic eruption that spewed a dense ash cloud that blocked sunlight in a section of Yellowstone National Park.

22. How does the closing of the stomata limit photosynthesis?

23. Describe the pathway of electron transfer from photosystem II to photosystem I in light-dependent reactions.

24. What are the roles of ATP and NADPH in photosynthesis?

25. How and why would the end products of photosynthesis be changed if a plant had a mutation that eliminated its photosystem II complex?

26. Why is the third stage of the Calvin cycle called the regeneration stage?

27. Which part of light-independent reactions would be affected if a cell could not produce the enzyme RuBisCO?

28. Why does it take three turns of the Calvin cycle to produce G3P, the initial product of photosynthesis?

29. Imagine a sealed terrarium containing a plant and a beetle. How does each organism provide resources for the other? Could each organism survive if it was the only living thing in the terrarium? Why or why not?

30. Compare the flow of energy with the flow of nutrients in a closed, sunny ecosystem consisting of a giraffe and a tree.

Chapter 9 Exercises

Review Questions

1. What property prevents the ligands of cell-surface receptors from entering the cell?
- **a.** The molecules bind to the extracellular domain.
- **b.** The molecules are hydrophilic and cannot penetrate the hydrophobic interior of the plasma membrane.
- **c.** The molecules are attached to transport proteins that deliver them through the bloodstream to target cells.
- **d.** The ligands are able to penetrate the membrane and directly influence gene expression upon receptor binding.

2. The secretion of hormones by the pituitary gland is an example of _____.
- **a.** autocrine signaling
- **b.** paracrine signaling
- **c.** endocrine signaling
- **d.** direct signaling across gap junctions

3. Why are ion channels necessary to transport ions into or out of a cell?
- **a.** Ions are too large to diffuse through the membrane.
- **b.** Ions are charged particles and cannot diffuse through the hydrophobic interior of the membrane.
- **c.** Ions do not need ion channels to move through the membrane.
- **d.** Ions bind to carrier proteins in the bloodstream, which must be removed before transport into the cell.

4. Endocrine signals are transmitted more slowly than paracrine signals because _____.
- **a.** the ligands are transported through the bloodstream and travel greater distances
- **b.** the target and signaling cells are close together
- **c.** the ligands are degraded rapidly
- **d.** the ligands don't bind to carrier proteins during transport

5. A scientist notices that when she adds a small, water-soluble molecule to a dish of cells, the cells turn off transcription of a gene. She hypothesizes that the ligand she added binds to a(n) _____ receptor.
- **a.** intracellular
- **b.** hormone
- **c.** enzyme-linked
- **d.** gated ion channel-linked

6. Where do DAG and IP_3 originate?
- **a.** They are formed by phosphorylation of cAMP.
- **b.** They are ligands expressed by signaling cells.
- **c.** They are hormones that diffuse through the plasma membrane to stimulate protein production.
- **d.** They are the cleavage products of the inositol phospholipid, PIP_2.

7. What property enables the residues of the amino acids serine, threonine, and tyrosine to be phosphorylated?
- **a.** They are polar.
- **b.** They are nonpolar.
- **c.** They contain a hydroxyl group.
- **d.** They occur more frequently in the amino acid sequence of signaling proteins.

8. Histamine binds to the H1 G protein-coupled receptor to initiate the itchiness and airway constriction associated with an allergic response. If a mutation in the associated G protein's alpha subunit prevented the hydrolysis of GTP, how would the allergic response change?
- **a.** There would be a more severe allergic response compared to normal G protein signaling.
- **b.** There would be a less severe allergic response compared to normal G protein signaling.
- **c.** There would be no allergic response.
- **d.** There would be no change compared to normal G protein signaling.

9. A scientist observes a mutation in the transmembrane region of EGFR that eliminates its ability to be stabilized by binding interactions during dimerization after ligand binding. Which hypothesis regarding the effect of this mutation on EGF signaling is most likely to be correct?
- **a.** EGF signaling cascades would be active for longer in the cell.
- **b.** EGF signaling cascades would be active for a shorter period of time in the cell.
- **c.** EGF signaling cascades would not occur.
- **d.** EGF signaling would be unaffected.

10. What is the function of a phosphatase?
- **a.** A phosphatase removes phosphorylated amino acids from proteins.
- **b.** A phosphatase removes the phosphate group from phosphorylated amino acid residues in a protein.
- **c.** A phosphatase phosphorylates serine, threonine, and tyrosine residues.
- **d.** A phosphatase degrades second messengers in the cell.

11. How does NF-κB induce gene expression?
- **a.** A small, hydrophobic ligand binds to NF-κB, activating it.
- **b.** Phosphorylation of the inhibitor Iκ-B dissociates the complex between it and NF-κB and allows NF-κB to enter the nucleus and stimulate transcription.
- **c.** NF-κB is phosphorylated and is then free to enter the nucleus and bind DNA.
- **d.** NF-κB is a kinase that phosphorylates a transcription factor that binds DNA and promotes protein production.

12. Apoptosis can occur in a cell when the cell is _____.
- **a.** damaged
- **b.** no longer needed
- **c.** infected by a virus
- **d.** all of these

13. What is the effect of an inhibitor binding an enzyme?
- **a.** The enzyme is degraded.
- **b.** The enzyme is activated.
- **c.** The enzyme is inactivated.
- **d.** The complex is transported out of the cell.

14. How does PKC's signaling role change in response to growth factor signaling versus an immune response?
- **a.** PKC interacts directly with signaling molecules in both cascades but only exhibits kinase activity during growth factor signaling.
- **b.** PKC interacts directly with signaling molecules in growth factor cascades but interacts with signaling inhibitors during immune signaling.
- **c.** PKC amplifies growth factor cascades but turns off immune cascades.
- **d.** PKC is activated during growth factor cascades but is inactivated during immune response cascades.

15. A scientist notices that a cancer cell line fails to die when he adds an inducer of apoptosis to his culture of cells. Which hypothesis could explain why the cells fail to die?
- **a.** The cells have a mutation that prevents the initiation of apoptosis signaling.
- **b.** The cells have lost expression of the receptor for the apoptosis-inducing ligand.
- **c.** The cells overexpress a growth factor pathway that inhibits apoptosis.
- **d.** all of these

16. Which type of molecule acts as a signaling molecule in yeasts?
- **a.** steroid
- **b.** autoinducer
- **c.** mating factor
- **d.** second messenger

17. Quorum sensing is triggered to begin when _____.
- **a.** treatment with antibiotics occurs
- **b.** bacteria release growth hormones
- **c.** bacterial protein expression is switched on
- **d.** a sufficient number of bacteria are present

18. A doctor is researching new ways to treat biofilms on artificial joints. Which approach would best help prevent bacterial colonization of the medical implants?

a. an increase in antibiotic dosing

b. the creation of implants with rougher surfaces

c. vaccination of patients against all pathogenic bacteria

d. inhibition of quorum sensing

Critical Thinking Questions

19. What is the difference between intracellular signaling and intercellular signaling?

20. How are the effects of paracrine signaling limited to an area near the signaling cells?

21. What are the differences between internal receptors and cell-surface receptors?

22. Cells grown in the laboratory are mixed with a dye molecule that is unable to pass through the plasma membrane. If a ligand is added to the cells, observations show that the dye enters the cells. What type of receptor did the ligand bind to on the cell surface?

23. Insulin is a hormone that regulates blood sugar by binding to its receptor, insulin receptor tyrosine kinase. How does insulin's behavior differ from steroid hormone signaling and what can you infer about its structure?

24. The same second messengers are used in many different cells, but the response to second messengers is different in each cell. How is this possible?

25. What would happen if the intracellular domain of a cell-surface receptor was switched with the domain from another receptor?

26. If a cell developed a mutation in its MAP2K1 gene (encodes the MEK protein) that prevented MEK from being recognized by phosphatases, how would the EGFR signaling cascade and the cell's behavior change?

27. What is a possible result of a mutation in a kinase that controls a pathway that stimulates cell growth?

28. How does the extracellular matrix control the growth of cells?

29. A scientist notices that a cancer cell line shows high levels of phosphorylated ERK in the absence of EGF. What are two possible explanations for the increase in phosphorylated ERK? Be specific in which proteins are involved.

30. What characteristics make yeasts a good model for learning about signaling in humans?

31. Why is signaling in multicellular organisms more complicated than signaling in single-celled organisms?

32. *Pseudomonas* infections are very common in hospital settings. Why would it be important for doctors to determine the bacterial load before treating an infected patient?

Chapter 10 Exercises

Review Questions

1. A diploid cell has _____ the number of chromosomes as a haploid cell.
- **a.** one-fourth
- **b.** half
- **c.** twice
- **d.** four times

2. An organism's traits are determined by the specific combination of inherited _____.
- **a.** cells
- **b.** genes
- **c.** proteins
- **d.** chromatids

3. The first level of DNA organization in a eukaryotic cell is maintained by which molecule?
- **a.** cohesin
- **b.** condensin
- **c.** chromatin
- **d.** histone

4. Identical copies of chromatin held together by cohesin at the centromere are called _____.
- **a.** histones
- **b.** nucleosomes
- **c.** chromatin
- **d.** sister chromatids

5. Chromosomes are duplicated during what stage of the cell cycle?
- **a.** G_1 phase
- **b.** S phase
- **c.** prophase
- **d.** prometaphase

6. Which of the following events does *not* occur during some stages of interphase?
- **a.** DNA duplication
- **b.** organelle duplication
- **c.** increase in cell size
- **d.** separation of sister chromatids

7. The mitotic spindles arise from which cell structure?
- **a.** centromere
- **b.** centrosome
- **c.** kinetochore
- **d.** cleavage furrow

8. Attachment of the mitotic spindle fibers to the kinetochores is a characteristic of which stage of mitosis?
- **a.** prophase
- **b.** prometaphase
- **c.** metaphase
- **d.** anaphase

9. Unpacking of chromosomes and the formation of a new nuclear envelope is a characteristic of which stage of mitosis?
- **a.** prometaphase
- **b.** metaphase
- **c.** anaphase
- **d.** telophase

10. Separation of the sister chromatids is a characteristic of which stage of mitosis?
- **a.** prometaphase
- **b.** metaphase
- **c.** anaphase
- **d.** telophase

11. The chromosomes become visible under a light microscope during which stage of mitosis?
- **a.** prophase
- **b.** prometaphase
- **c.** metaphase
- **d.** anaphase

12. The fusing of Golgi vesicles at the metaphase plate of dividing plant cells forms what structure?
- **a.** cell plate
- **b.** actin ring
- **c.** cleavage furrow
- **d.** mitotic spindle

13. At which of the cell cycle checkpoints do external forces have the greatest influence?
- **a.** G_1 checkpoint
- **b.** G_2 checkpoint
- **c.** M checkpoint
- **d.** G_0 checkpoint

14. What is the main prerequisite for clearance at the G_2 checkpoint?
- **a.** cell has reached a sufficient size
- **b.** an adequate stockpile of nucleotides
- **c.** accurate and complete DNA replication
- **d.** proper attachment of mitotic spindle fibers to kinetochores

15. If the M checkpoint is not cleared, what stage of mitosis will be blocked?
- **a.** prophase
- **b.** prometaphase
- **c.** metaphase
- **d.** anaphase

16. Which protein is a positive regulator that phosphorylates other proteins when activated?
- **a.** p53
- **b.** retinoblastoma protein (Rb)
- **c.** cyclin
- **d.** cyclin-dependent kinase (Cdk)

17. Many of the negative regulator proteins of the cell cycle were discovered in what type of cells?
- **a.** gametes
- **b.** cells in G_0
- **c.** cancer cells
- **d.** stem cells

18. Which negative regulatory molecule can trigger cell suicide (apoptosis) if vital cell cycle events do not occur?
- **a.** p53
- **b.** p21
- **c.** retinoblastoma protein (Rb)
- **d.** cyclin-dependent kinase (Cdk)

19. Which eukaryotic cell cycle event is missing in binary fission?
- **a.** cell growth
- **b.** DNA duplication
- **c.** mitosis
- **d.** cytokinesis

20. FtsZ proteins direct the formation of a _____ that will eventually form the new cell walls of the daughter cells.
- **a.** contractile ring
- **b.** cell plate
- **c.** cytoskeleton
- **d.** septum

Critical Thinking Questions

21. Compare and contrast a human somatic cell to a human gamete.

22. What is the relationship between a genome, chromosomes, and genes?

23. Eukaryotic chromosomes are thousands of times longer than a typical cell. Explain how chromosomes can fit inside a eukaryotic nucleus.

24. Briefly describe the events that occur in each phase of interphase.

25. Chemotherapy drugs such as *vincristine* (derived from Madagascar periwinkle plants) and *colchicine* (derived from autumn crocus plants) disrupt mitosis by binding to tubulin (the subunit of microtubules) and interfering with microtubule assembly and disassembly. Exactly what mitotic structure is targeted by these drugs and what effect would that have on cell division?

26. Describe the similarities and differences between the cytokinesis mechanisms found in animal cells versus those in plant cells.

27. List some reasons why a cell that has just completed cytokinesis might enter the G_0 phase instead of the G_1 phase.

28. What cell cycle events will be affected in a cell that produces mutated (nonfunctional) cohesin protein?

29. Describe the general conditions that must be met at each of the three main cell cycle checkpoints.

30. Compare and contrast the roles of the positive cell cycle regulators and the negative regulators.

31. What steps are necessary for Cdk to become fully active?

32. Rb is a negative regulator that blocks the cell cycle at the G_1 checkpoint until the cell achieves a requisite size. What molecular mechanism does Rb employ to halt the cell cycle?

33. Name the common components of eukaryotic cell division and binary fission.

34. Describe how the duplicated bacterial chromosomes are distributed into new daughter cells without the direction of the mitotic spindle.

Chapter 11 Exercises

Review Questions

1. Meiosis usually produces _____ daughter cells.
a. two haploid **b.** two diploid **c.** four haploid **d.** four diploid

2. What structure is most important in forming the tetrads?
a. centromere **c.** chiasma
b. synaptonemal complex **d.** kinetochore

3. At which stage of meiosis are sister chromatids separated from each other?
a. prophase I **b.** prophase II **c.** anaphase I **d.** anaphase II

4. At metaphase I, homologous chromosomes are connected only at what structures?
a. chiasmata **c.** microtubules
b. recombination nodules **d.** kinetochores

5. Which of the following is *not* true in regard to crossover?
a. Spindle microtubules guide the transfer of DNA across the synaptonemal complex.
b. Nonsister chromatids exchange genetic material.
c. Chiasmata are formed.
d. Recombination nodules mark the crossover point.

6. What phase of mitotic interphase is missing from meiotic interkinesis?
a. G_0 phase **b.** G_1 phase **c.** S phase **d.** G_2 phase

7. The part of meiosis that is similar to mitosis is _____.
a. meiosis I **b.** anaphase I **c.** meiosis II **d.** interkinesis

8. If a muscle cell of a typical organism has 32 chromosomes, how many chromosomes will be in a gamete of that same organism?
a. 8 **b.** 16 **c.** 32 **d.** 64

9. Which statement best describes the genetic content of the two daughter cells in prophase II of meiosis?
a. haploid with one copy of each gene **c.** diploid with two copies of each gene
b. haploid with two copies of each gene **d.** diploid with four copies of each gene

10. The pea plants used in Mendel's genetic inheritance studies were diploid, with 14 chromosomes in somatic cells. Assuming no crossing over events occur, how many unique gametes could one pea plant produce?
a. 28 **b.** 128 **c.** 196 **d.** 16,384

11. How do telophase I and telophase II differ during meiosis in animal cells?
a. Cells remain diploid at the end of telophase I but are haploid at the end of telophase II.
b. Daughter cells form a cell plate to divide during telophase I but divide by cytokinesis during telophase II.
c. Cells enter interphase after telophase I but not after telophase II.
d. Chromosomes can remain condensed at the end of telophase I but decondense after telophase II.

12. What is a likely evolutionary advantage of sexual reproduction over asexual reproduction?
a. Sexual reproduction involves fewer steps.
b. There is a lower chance of using up the resources in a given environment.
c. Sexual reproduction results in variation in the offspring.
d. Sexual reproduction is more cost-effective.

13. Which type of life cycle has both a haploid and diploid multicellular stage?
a. asexual life cycles **c.** most fungal life cycles
b. most animal life cycles **d.** alternation of generations

14. What is the ploidy of the most conspicuous form of most fungi?

a. diploid
b. haploid
c. alternation of generations
d. asexual

15. A diploid, multicellular life-cycle stage that gives rise to haploid cells by meiosis is called a _____.

a. sporophyte **b.** gametophyte **c.** spore **d.** gamete

16. Suppose hydras and jellyfish both live in a freshwater lake that is slowly being acidified by the runoff from a chemical plant built upstream. Which population is predicted to be better able to cope with the changing environment?

a. jellyfish
b. hydra
c. The populations will be equally able to cope.
d. Both populations will die.

17. Many farmers are worried about the decreasing genetic diversity of plants associated with generations of artificial selection and inbreeding. Why is limiting random sexual reproduction of food crops concerning?

a. Mutations during asexual reproduction decrease plant fitness.
b. Consumers do not trust identical-appearing produce.
c. Larger portions of the plant populations are susceptible to the same diseases.
d. Spores are not viable in an agricultural setting.

Critical Thinking Questions

18. Describe the process that results in the formation of a tetrad.

19. Explain how the random alignment of homologous chromosomes during metaphase I contributes to the variation in gametes produced by meiosis.

20. What is the function of the fused kinetochore found on sister chromatids in prometaphase I?

21. In a comparison of the stages of meiosis to the stages of mitosis, which stages are unique to meiosis and which stages have the same events in both meiosis and mitosis?

22. Why would an individual with a mutation that prevented the formation of recombination nodules be considered less fit than other members of its species?

23. Does crossing over occur during prophase II? From an evolutionary perspective, why is this advantageous?

24. List and briefly describe the three processes that lead to variation in offspring with the same parents.

25. Animals and plants both have diploid and haploid cells. How does the animal life cycle differ from the alternation of generations exhibited by plants?

26. Explain why sexual reproduction is beneficial to a population but can be detrimental to an individual offspring.

27. How does the role of meiosis in gamete production differ between organisms with a diploid-dominant life cycle and organisms with an alternation of generations life cycle?

28. How do organisms with haploid-dominant life cycles ensure continued genetic diversification in offspring without using a meiotic process to make gametes?

Chapter 12 Exercises

Review Questions

1. Mendel performed hybridizations by transferring pollen from the _____ of the male plant to the female ova.

a. anther
b. pistil
c. stigma
d. seed

2. Which is one of the seven characteristics that Mendel observed in pea plants?

a. flower size
b. seed texture
c. leaf shape
d. stem color

3. Imagine you are performing a cross involving seed color in garden pea plants. What F_1 offspring would you expect if you cross true-breeding parents with green seeds and yellow seeds, assuming yellow seed color is dominant over green?

a. 100% yellowish green seeds
b. 100% yellow seeds
c. 50% yellow; 50% green seeds
d. 25% green; 75% yellow seeds

4. Consider a cross to investigate the pea pod texture trait, involving constricted or inflated pods. Mendel found that the traits behave according to a dominant/recessive pattern in which inflated pods were dominant. If you performed this cross and obtained 650 inflated-pod plants in the F_2 generation, approximately how many constricted-pod plants would you expect to have?

a. 600
b. 165
c. 217
d. 468

5. In pea plants, violet flowers are dominant to white flowers, and axial flowers are dominant to terminal flowers. The genes controlling these traits lie on separate chromosomes. A scientist pollinates a true-breeding pea plant with violet, terminal flowers with pollen from a true-breeding pea plant with white, axial flowers. Which of the following observations would most accurately describe the F_2 generation?

a. 75% violet flowers; 75% terminal flowers
b. 75% white flowers in a terminal position
c. 75% violet flowers; 75% axial flowers
d. 75% violet flowers in an axial position

6. The observable traits expressed by an organism are described as its _____.

a. phenotype
b. genotype
c. alleles
d. zygote

7. A recessive trait will be observed in individuals that are _____ for that trait.

a. heterozygous
b. homozygous or heterozygous
c. homozygous
d. diploid

8. If black and white true-breeding mice are mated and the result is all gray offspring, what inheritance pattern would this be indicative of?

a. dominance
b. codominance
c. multiple alleles
d. incomplete dominance

9. The ABO blood groups in humans are expressed as the I^A, I^B, and i alleles. The I^A allele encodes the A blood group antigen, I^B encodes B, and i encodes O. Both A and B are dominant to O. If a heterozygous blood type A parent (I^Ai) and a heterozygous blood type B parent (I^Bi) mate, one quarter of their offspring will have AB blood type (I^AI^B) in which both antigens are expressed equally. Therefore, ABO blood groups are an example of _____.

a. multiple alleles and incomplete dominance
b. codominance and incomplete dominance
c. incomplete dominance only
d. multiple alleles and codominance

10. In a mating between two individuals that are heterozygous for a recessive lethal allele that is expressed in utero, what genotypic ratio (homozygous dominant:heterozygous:homozygous recessive) would you expect to observe in the offspring?

a. 1:2:1
b. 3:1:1
c. 1:2:0
d. 0:2:1

11. If the allele encoding polydactyly (six fingers) is dominant why do most people have five fingers?

a. Genetic elements suppress the polydactyl gene.
b. Polydactyly is embryonic lethal.
c. The sixth finger is removed at birth.
d. The polydactyl allele is very rare in the human population.

12. A farmer raises black and white chickens. To his surprise, when the first generation of eggs hatch all the chickens are black with white speckles throughout their feathers. What should the farmer expect when the eggs are laid after interbreeding the speckled chickens hatch?

a. All the offspring will be speckled.
b. 75% of the offspring will be speckled, and 25% will be black.
c. 50% of the offspring will be speckled, 25% will be black, and 25% will be white.
d. 50% of the offspring will be black, and 50% of the offspring will be white.

13. Assuming no gene linkage, in a dihybrid cross of *AABB* x *aabb* with *AaBb* F_1 heterozygotes, what is the ratio of the F_1 gametes (*AB*, *aB*, *Ab*, *ab*) that will give rise to the F_2 offspring?

a. 1:1:1:1
b. 1:3:3:1
c. 1:2:2:1
d. 4:3:2:1

14. The forked-line and probability methods make use of what probability rule?

a. test cross
b. product rule
c. monohybrid rule
d. sum rule

15. How many different offspring genotypes are expected in a trihybrid cross between parents heterozygous for all three traits when the traits behave in a dominant and recessive pattern? How many phenotypes?

a. 64 genotypes; 16 phenotypes
b. 16 genotypes; 64 phenotypes
c. 8 genotypes; 27 phenotypes
d. 27 genotypes; 8 phenotypes

16. Labrador retrievers' fur color is controlled by two alleles, *E* and *B*. Any dog with the *ee* genotype develops into a yellow lab, while *B*?*E*? dogs become black labs, and *bbE* dogs become chocolate labs. This is an example of _____.

a. epistasis
b. codominance
c. incomplete dominance
d. linkage

17. Which of the following situations does *not* follow the law of independent assortment?

a. A blond person and a brown-haired person produce three offspring over time, all of whom have blond hair.
b. A white cow crossed with a brown bull produces roan cattle.
c. Mating a hog with a sow produces six female piglets.
d. Men are more likely to experience hemophilia than women.

Critical Thinking Questions

18. Describe one of the reasons why the garden pea was an excellent choice of model system for studying inheritance.

19. How would you perform a reciprocal cross for the characteristic of stem height in the garden pea?

20. Mendel performs a cross using a true-breeding pea plant with round, yellow seeds (both dominant traits) and a true-breeding pea plant with green, wrinkled seeds (both recessive traits). What is the probability that the offspring will have green, round seeds? Calculate the probability for the F_1 and F_2 generations.

21. Calculate the probability of selecting a heart or a face card from a standard deck of cards. Is this outcome more or less likely than selecting a card that is both a heart and a face card? Keep in mind that a standard deck of cards contains 52 cards, 13 of which are hearts and 12 of which are face cards.

22. The gene for flower position in pea plants exists as axial or terminal alleles. Given that axial is dominant to terminal, list all of the possible F_1 and F_2 genotypes and phenotypes from a cross involving parents that are homozygous for each trait. Express genotypes with conventional genetic abbreviations.

23. In pea plants, the allele for tall plants (*T*) is dominant to the allele for short plants (*t*). Use a Punnett square to predict the offspring in a cross between a short pea plant (homozygous recessive) and a tall pea plant (heterozygous). What is the phenotypic ratio of the offspring?

24. Red-green color blindness is an X-linked recessive trait. Can a human male be a carrier of red-green color blindness?

25. Why is it more efficient to perform a test cross with a homozygous recessive donor than a homozygous dominant donor? How could the same information still be found with a homozygous dominant donor?

26. Use the probability method to calculate the genotypes and genotypic proportions of a cross between *AABBCc* and *Aabbcc* parents.

27. Explain epistasis in terms of its Greek language roots "standing upon."

28. In Lesson 12.3, an example of epistasis was given for the summer squash. Cross white *WwYy* heterozygotes to prove the phenotypic ratio of 12 white:3 yellow:1 green that was given in the text.

29. People with trisomy 21 develop Down's syndrome. What law of Mendelian inheritance is violated in this disease? What is the most likely way this occurs?

30. A heterozygous pea plant produces violet flowers and yellow, round seeds. Describe the expected genotypes of the gametes produced by Mendelian inheritance. If all three genes are found on the same arm of one chromosome, should a scientist predict that inheritance patterns will follow Mendelian genetics?

Chapter 13 Exercises

Review Questions

1. X-linked recessive traits in humans (or in *Drosophila*) are observed _____.
- **a.** in more males than females
- **b.** in more females than males
- **c.** in males and females equally
- **d.** in different distributions depending on the trait

2. The first suggestion that chromosomes may physically exchange segments came from the microscopic identification of _____.
- **a.** synapsis
- **b.** sister chromatids
- **c.** chiasmata
- **d.** alleles

3. Which recombination frequency corresponds to independent assortment and the absence of linkage?
- **a.** 0
- **b.** 0.25
- **c.** 0.50
- **d.** 0.75

4. Which recombination frequency corresponds to perfect linkage and violates the law of independent assortment?
- **a.** 0
- **b.** 0.25
- **c.** 0.50
- **d.** 0.75

5. Which of the following codes describes position 12 on the long arm of chromosome 13?
- **a.** 13p12
- **b.** 13q12
- **c.** 12p13
- **d.** 12q13

6. In agriculture, polyploid crops (like coffee, strawberries, or bananas) tend to produce _____.
- **a.** more uniformity
- **b.** more variety
- **c.** larger yields
- **d.** smaller yields

7. Assume a pericentric inversion occurred in one of two homologs prior to meiosis. The other homolog remains normal. During meiosis, what structure, if any, would these homologs assume in order to pair accurately along their lengths?
- **a.** V formation
- **b.** cruciform
- **c.** loop
- **d.** Pairing would not be possible.

8. The genotype XXY corresponds to _____.
- **a.** Klinefelter syndrome
- **b.** Turner syndrome
- **c.** Triplo-X
- **d.** Jacobsen syndrome

9. Abnormalities in the number of X chromosomes tends to have milder phenotypic effects than the same abnormalities in autosomes because of _____.
- **a.** deletions
- **b.** nonhomologous recombination
- **c.** synapsis
- **d.** X inactivation

10. By definition, a pericentric inversion includes the _____.
- **a.** centromere
- **b.** chiasma
- **c.** telomere
- **d.** synapse

Critical Thinking Questions

11. Explain how the Chromosomal Theory of Inheritance helped to advance our understanding of genetics.

12. Using diagrams, illustrate how nondisjunction can result in an aneuploid zygote.

Chapter 14 Exercises

Review Questions

1. If DNA of a particular species were analyzed and contained 27% A, what would be the percentage of C?
a. 27% **b.** 30% **c.** 23% **d.** 54%

2. The experiments by Hershey and Chase helped confirm that DNA was the hereditary material based on the finding that _____.
a. radioactive phage were found in the pellet
b. radioactive cells were found in the supernatant
c. radioactive sulfur was found inside the cell
d. radioactive phosphorus was found in the cell

3. Bacterial transformation is a major concern in many medical settings. Why might health care providers be concerned?
a. Pathogenic bacteria could introduce disease-causing genes in nonpathogenic bacteria.
b. Antibiotic resistance genes could be introduced to new bacteria to create "superbugs."
c. Bacteriophages could spread DNA encoding toxins to new bacteria.
d. all of these

4. DNA double helix does not have which of the following?
a. antiparallel configuration **c.** major and minor grooves
b. complementary base pairing **d.** uracil

5. In eukaryotes, what is the DNA wrapped around?
a. single-stranded binding proteins **c.** polymerase
b. sliding clamp **d.** histones

6. Meselson and Stahl's experiments proved that DNA replicates by which mode?
a. conservative **c.** dispersive
b. semiconservative **d.** none of these

7. If the sequence of the 5′-3′ strand is AATGCTAC, then the complementary sequence has the following sequence:
a. 3′-AATGCTAC-5′ **c.** 3′-TTACGATG-5′
b. 3′-CATCGTAA-5′ **d.** 3′-GTAGCATT-5′

8. How did Meselson and Stahl support Watson and Crick's double-helix model?
a. They demonstrated that each strand serves as a template for synthesizing a new strand of DNA.
b. They showed that the DNA strands break and recombine without losing genetic material.
c. They proved that DNA maintains a double-helix structure while undergoing semiconservative replication.
d. They demonstrated that conservative replication maintains the complementary base pairing of each DNA helix.

9. Which of the following components is *not* involved during the formation of the replication fork?
a. single-strand binding proteins **c.** origin of replication
b. helicase **d.** ligase

10. Which of the following does the enzyme primase synthesize?
a. DNA primer **c.** Okazaki fragments
b. RNA primer **d.** phosphodiester linkage

11. In which direction does DNA replication take place?
a. 5′-3′ **b.** 3′-5′ **c.** 5′ **d.** 3′

12. A scientist randomly mutates the DNA of a bacterium. She then sequences the bacterium's daughter cells and finds that the daughters have many errors in their replicated DNA. The parent bacterium likely acquired a mutation in which enzyme?

a. DNA ligase
b. DNA pol II
c. primase
d. DNA pol I

13. The ends of the linear chromosomes are maintained by which of the following?

a. helicase
b. primase
c. DNA pol
d. telomerase

14. Which of the following is *not* a true statement comparing prokaryotic and eukaryotic DNA replication?

a. Both eukaryotic and prokaryotic DNA polymerases build off RNA primers made by primase.
b. Eukaryotic DNA replication requires multiple replication forks, while prokaryotic replication uses a single origin to rapidly replicate the entire genome.
c. DNA replication always occurs in the nucleus.
d. Eukaryotic DNA replication involves more polymerases than prokaryotic replication.

15. During proofreading, which of the following enzymes reads the DNA?

a. primase
b. topoisomerase
c. DNA pol
d. helicase

16. The initial mechanism for repairing nucleotide errors in DNA is _____.

a. mismatch repair
b. DNA polymerase proofreading
c. nucleotide excision repair
d. thymine dimers

17. A scientist identified an abnormally shortened protein in a fruit fly. She then determined that the abnormal protein was the result of a single base pair substitution in the gene that codes for the protein. What type of mutation is this?

a. silent
b. nonsense
c. missense
d. frameshift

Critical Thinking Questions

18. Explain Griffith's transformation experiments. What did he conclude from them?

19. Why were radioactive sulfur and phosphorus used to label bacteriophage in Hershey and Chase's experiments?

20. When Chargaff was performing his experiments, the tetranucleotide hypothesis, which stated that DNA was composed of GACT nucleotide repeats, was the most widely accepted view of DNA's composition. How did Chargaff disprove this hypothesis?

21. Provide a brief summary of the Sanger sequencing method.

22. Describe the structure and complementary base pairing of DNA.

23. Prokaryotes have a single circular chromosome, while eukaryotes have linear chromosomes. Describe one advantage and one disadvantage to the eukaryotic genome packaging compared to the prokaryotes.

24. How did the scientific community learn that DNA replication takes place in a semiconservative fashion?

25. Imagine the Meselson and Stahl experiments had supported conservative replication instead of semiconservative replication. What results would you predict to observe after two rounds of replication? Be specific regarding percent distributions of DNA incorporating ^{15}N and ^{14}N in the gradient.

26. DNA replication is bidirectional and discontinuous; explain your understanding of these concepts.

27. What are Okazaki fragments and how they are formed?

28. If the rate of replication in a particular prokaryote is 900 nucleotides per second, how long would it take 1.2 million base pair genomes to make two copies?

29. Explain the events taking place at the replication fork. If the gene for helicase is mutated, what part of replication will be affected?

30. What is the role of a primer in DNA replication? What would happen if you forgot to add a primer in a tube containing the reaction mix for a DNA sequencing reaction?

31. Quinolone antibiotics treat bacterial infections by blocking the activity of topoisomerase. Why does this treatment work? Explain what occurs at the molecular level.

32. How do the linear chromosomes in eukaryotes ensure that its ends are replicated completely?

33. What is the consequence of mutation of a mismatch repair enzyme? How will this affect the function of a gene?

34. An adult with a history of tanning has his genome sequenced. The beginning of a protein coding region of his DNA reads ATGGGGATATGGCAT. If the protein coding region of a healthy adult reads ATGGGGATATGAGCAT, identify the site and type of mutation.

Chapter 15 Exercises

Review Questions

1. The AUC and AUA codons in mRNA both specify isoleucine. What feature of the genetic code explains this?

a. complementarity
b. nonsense codons
c. universality
d. degeneracy

2. How many nucleotides are in 12 mRNA codons?

a. 12 **b.** 24 **c.** 36 **d.** 48

3. Which event contradicts the central dogma of molecular biology?

a. Poly-A polymerase enzymes process mRNA in the nucleus.
b. Endonuclease enzymes splice out and repair damaged DNA.
c. Scientists use reverse transcriptase enzymes to make DNA from RNA.
d. Codons specifying amino acids are degenerate and universal.

4. Which subunit of the *E. coli* polymerase confers specificity to transcription?

a. α **b.** β **c.** β' **d.** σ

5. The -10 and -35 regions of prokaryotic promoters are called consensus sequences because _____.

a. they are identical in all bacterial species
b. they are similar in all bacterial species
c. they exist in all organisms
d. they have the same function in all organisms

6. Three different bacteria species have the following consensus sequences upstream of a conserved gene.

	Species A	Species B	Species C
-10	TAATAAT	TTTAAT	TATATT
-35	TTGACA	TTGGCC	TTGAAA

Order the bacteria from most to least efficient initiation of gene transcription.

a. A > B > C **b.** B > C > A **c.** C > B > A **d.** A > C > B

7. Which feature of promoters can be found in both prokaryotes and eukaryotes?

a. GC box
b. TATA box
c. octamer box
d. -10 and -35 sequences

8. What transcripts will be most affected by low levels of α-amanitin?

a. 18S and 28S rRNAs
b. pre-mRNAs
c. 5S rRNAs and tRNAs
d. other small nuclear RNAs

9. How do enhancers and promoters differ?

a. Enhancers bind transcription factors to silence gene expression, while promoters activate transcription.
b. Enhancers increase the efficiency of gene expression but are not essential for transcription. Promoter recognition is essential to transcription initiation.
c. Promoters bind transcription factors to increase the efficiency of transcription. Enhancers bind RNA polymerases to initiate transcription.
d. There is no difference. Both are transcription factor-binding sequences in DNA.

10. Which pre-mRNA processing step is important for initiating translation?

a. poly-A tail
b. RNA editing
c. splicing
d. 7-methylguanosine cap

11. What processing step enhances the stability of pre-tRNAs and pre-rRNAs?

a. methylation
b. nucleotide modification
c. cleavage
d. splicing

12. A scientist identifies a pre-mRNA with the following structure:

What is the predicted size of the corresponding mature mRNA in base pairs (bp), excluding the 5′ cap and 3′ poly-A tail?

a. 220 bp **b.** 295 bp **c.** 140 bp **d.** 435 bp

13. The RNA components of ribosomes are synthesized in the _____.

a. cytoplasm
b. nucleus
c. nucleolus
d. endoplasmic reticulum

14. In any given species, there are at least how many types of aminoacyl-tRNA synthetases?

a. 20 **b.** 40 **c.** 100 **d.** 200

15. A scientist introduces a mutation that makes the 60S ribosomal subunit nonfunctional in a human cell line. What would be the predicted effect on translation?

a. Translation stalls after the initiation AUG codon is identified.
b. The ribosome cannot catalyze the formation of peptide bonds between the tRNAs in the A- and P-sites.
c. The ribosome cannot interact with mRNAs.
d. tRNAs cannot exit the E-site of the ribosome.

Critical Thinking Questions

16. Imagine if there were 200 commonly occurring amino acids instead of 20. Given what you know about the genetic code, what would be the shortest possible codon length? Explain.

17. Discuss how degeneracy of the genetic code makes cells more robust to mutations.

18. A scientist sequencing mRNA identifies the following strand:

CUAUGUGUCGUAACAGCCGAUGACCCG

What is the sequence of the amino acid chain this mRNA makes when it is translated?

19. If mRNA is complementary to the DNA template strand and the DNA template strand is complementary to the DNA nontemplate strand, then why are base sequences of mRNA and the DNA nontemplate strand not identical? Could they ever be?

20. In your own words, describe the difference between rho-dependent and rho-independent termination of transcription in prokaryotes.

21. A fragment of bacterial DNA reads:

3′-TACCTATAATCTCAATTGATAGAAGCACTCTAC-5′

Assuming that this fragment is the template strand, what is the sequence of mRNA that would be transcribed? (Hint: Be sure to identify the initiation site.)

22. A scientist observes that a cell has an RNA polymerase deficiency that prevents it from making proteins. Describe three additional observations that would together support the conclusion that a defect in RNA polymerase I activity, and not problems with the other polymerases, causes the defect.

23. Chronic lymphocytic leukemia patients often harbor nonsense mutations in their spliceosome machinery. Describe how this mutation of the spliceosome would change the final location and sequence of a pre-mRNA.

24. Transcribe and translate the following DNA sequence (nontemplate strand):

5′-ATGGCCGGTTATTAAGCA-3′

25. Explain how single nucleotide changes can have vastly different effects on protein function.

26. A normal mRNA that reads 5′-UGCCAUGGUAAUAACACAUGAGGCCUGAAC-3′ has an insertion mutation that changes the sequence to 5′-UGCCAUGGUUAAUAACACAUGAGGCCUGAAC-3′. Translate the original mRNA and the mutated mRNA and explain how insertion mutations can have dramatic effects on proteins. (Hint: Be sure to find the initiation site.)

Chapter 16 Exercises

Review Questions

1. Control of gene expression in eukaryotic cells occurs at which level(s)?
- **a.** only the transcriptional level
- **b.** epigenetic and transcriptional levels
- **c.** epigenetic, transcriptional, and translational levels
- **d.** epigenetic, transcriptional, post-transcriptional, translational, and post-translational levels

2. Post-translational control refers to:
- **a.** regulation of gene expression after transcription
- **b.** regulation of gene expression after translation
- **c.** control of epigenetic activation
- **d.** period between transcription and translation

3. How does the regulation of gene expression support continued evolution of more complex organisms?
- **a.** Cells can become specialized within a multicellular organism.
- **b.** Organisms can conserve energy and resources.
- **c.** Cells grow larger to accommodate protein production.
- **d.** Both a. and b.

4. If glucose is absent, but so is lactose, the *lac* operon will be _____.
- **a.** activated
- **b.** repressed
- **c.** activated, but only partially
- **d.** mutated

5. Prokaryotic cells lack a nucleus. Therefore, the genes in prokaryotic cells are:
- **a.** all expressed, all of the time
- **b.** transcribed and translated almost simultaneously
- **c.** transcriptionally controlled because translation begins before transcription ends
- **d.** both b. and c.

6. The *ara* operon is an inducible operon that controls the production of the sugar arabinose. When arabinose is present in a bacterium, it binds to the protein AraC, and the complex binds to the initiator site to promote transcription. In this scenario, AraC is a(n) _____.
- **a.** activator
- **b.** inducer
- **c.** repressor
- **d.** operator

7. What are epigenetic modifications?
- **a.** the addition of reversible changes to histone proteins and DNA
- **b.** the removal of nucleosomes from the DNA
- **c.** the addition of more nucleosomes to the DNA
- **d.** mutation of the DNA sequence

8. Which of the following are *true* characteristics of epigenetic changes?
- **a.** allow DNA to be transcribed
- **b.** move histones to open or close a chromosomal region
- **c.** are temporary
- **d.** all of these

9. The binding of _____ is required for transcription to start.
- **a.** a protein
- **b.** DNA polymerase
- **c.** RNA polymerase
- **d.** a transcription factor

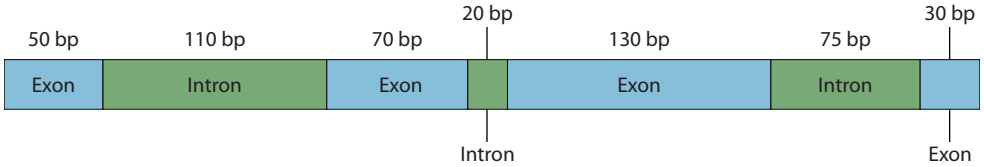
10. What will result from the binding of a transcription factor to an enhancer region?
- **a.** decreased transcription of an adjacent gene
- **b.** increased transcription of a distant gene
- **c.** alteration of the translation of an adjacent gene
- **d.** initiation of the recruitment of RNA polymerase

11. A scientist compares the promoter regions of two genes. Gene A's core promoter plus proximal promoter elements encompasses 70 bp. Gene B's core promoter plus proximal promoter elements encompasses 250 bp. Which of the scientist's hypotheses is most likely to be correct?
- **a.** More transcripts will be made from Gene B.
- **b.** Transcription of Gene A involves fewer transcription factors.
- **c.** Enhancers control Gene B's transcription.
- **d.** Transcription of Gene A is more controlled than transcription of Gene B.

12. Which of the following are involved in post-transcriptional control?
- **a.** control of RNA splicing
- **b.** control of RNA shuttling
- **c.** control of RNA stability
- **d.** all of these

13. Binding of an RNA-binding protein will _____ the stability of the RNA molecule.
- **a.** increase
- **b.** decrease
- **c.** neither increase nor decrease
- **d.** either increase or decrease

14. An unprocessed pre-mRNA has the following structure.



Which of the following is not a possible size (in bp) of the mature mRNA?
- **a.** 205 bp
- **b.** 180 bp
- **c.** 150 bp
- **d.** 100 bp

15. Alternative splicing has been estimated to occur in more than 95% of multi-exon genes. Which of the following is not an evolutionary advantage of alternative splicing?
- **a.** Alternative splicing increases diversity without increasing genome size.
- **b.** Different gene isoforms can be expressed in different tissues.
- **c.** Alternative splicing creates shorter mRNA transcripts.
- **d.** Different gene isoforms can be expressed during different stages of development.

16. Post-translational modifications of proteins can affect which of the following?
- **a.** protein function
- **b.** transcriptional regulation
- **c.** chromatin modification
- **d.** all of these

17. A scientist mutates eIF-2 to eliminate its GTP hydrolysis capability. How would this mutated form of eIF-2 alter translation?
- **a.** Initiation factors would not be able to bind to mRNA.
- **b.** The large ribosomal subunit would not be able to interact with mRNA transcripts.
- **c.** tRNAi-Met would not scan mRNA transcripts for the start codon.
- **d.** eIF-2 would not be able to interact with the small ribosomal subunit.

18. Cancer-causing genes are called _____.
- **a.** transformation genes
- **b.** tumor suppressor genes
- **c.** oncogenes
- **d.** mutated genes

19. Targeted therapies are used in patients with a set gene expression pattern. A targeted therapy that prevents the activation of the estrogen receptor in breast cancer would be beneficial to which type of patient?

a. patients who express the EGFR receptor in normal cells

b. patients with a mutation that inactivates the estrogen receptor

c. patients with a lot of the estrogen receptor expressed in their tumor

d. patients that have no estrogen receptor expressed in their tumor

Critical Thinking Questions

20. Name two differences between prokaryotic and eukaryotic cells and how these differences benefit multicellular organisms.

21. Describe how controlling gene expression will alter the overall protein levels in the cell.

22. Describe how transcription in prokaryotic cells can be altered by external stimulation, such as excess lactose in the environment.

23. What is the difference between a repressible and an inducible operon?

24. In cancer cells, alteration to epigenetic modifications turns off genes that are normally expressed. Hypothetically, how could you reverse this process to turn these genes back on?

25. A scientific study demonstrated that rat mothering behavior impacts the stress response in their pups. Rats that were born and raised with attentive mothers showed low activation of stress-response genes later in life, while rats with inattentive mothers had high activation of stress-response genes in the same situation. An additional study that swapped the pups at birth (i.e., rats born to inattentive mothers grew up with attentive mothers and vice versa) showed the same positive effect of attentive mothering. How do genetics and/or epigenetics explain the results of this study?

26. Some autoimmune diseases show a positive correlation with dramatically decreased expression of histone deacetylase 9 (HDAC9, an enzyme that removes acetyl groups from histones). Why would the decreased expression of HDAC9 cause immune cells to produce inflammatory genes at inappropriate times?

27. A mutation within the promoter region can alter transcription of a gene. Describe how this can happen.

28. What could happen if a cell had too much of an activating transcription factor present?

29. A scientist identifies a potential transcription regulation site 300 bp downstream of a gene and hypothesizes that it is a repressor. What experiment (with results) could they perform to support this hypothesis?

30. Describe how RBPs can prevent miRNAs from degrading an RNA molecule.

31. How can external stimuli alter post-transcriptional control of gene expression?

32. Protein modification can alter gene expression in many ways. Describe how phosphorylation of proteins can alter gene expression.

33. Alternative forms of a protein can be beneficial or harmful to a cell. What do you think would happen if too much of an alternative protein bound to the 3′ UTR of an RNA and caused it to degrade?

34. Changes in epigenetic modifications alter the accessibility and transcription of DNA. Describe how environmental stimuli, such as ultraviolet light exposure, could modify gene expression.

35. A scientist discovers a virus encoding a Protein X that degrades a subunit of the eIF4F complex. Knowing that this virus transcribes its own mRNAs in the cytoplasm of human cells, why would Protein X be an effective virulence factor?

36. New drugs are being developed that decrease DNA methylation and prevent the removal of acetyl groups from histone proteins. Explain how these drugs could affect gene expression to help kill tumor cells.

37. How can understanding the gene expression pattern in a cancer cell tell you something about that specific form of cancer?

Chapter 17 Exercises

Review Questions

1. GMOs are created by _____.
- **a.** generating genomic DNA fragments with restriction endonucleases
- **b.** introducing recombinant DNA into an organism by any means
- **c.** overexpressing proteins in *E. coli*
- **d.** all of these

2. Gene therapy can be used to introduce foreign DNA into cells _____.
- **a.** for molecular cloning
- **b.** by PCR
- **c.** of tissues to cure inheritable disease
- **d.** all of these

3. Insulin produced by molecular cloning _____.
- **a.** is of pig origin
- **b.** is a recombinant protein
- **c.** is made by the human pancreas
- **d.** is recombinant DNA

4. Bt toxin is considered to be _____.
- **a.** a gene for modifying insect DNA
- **b.** an organic insecticide produced by bacteria
- **c.** useful for humans to fight against insects
- **d.** a recombinant protein

5. The Flavr Savr tomato _____.
- **a.** is a variety of vine-ripened tomato in the supermarket
- **b.** was created to have better flavor and shelf life
- **c.** does not undergo soft rot
- **d.** all of these

6. ESTs are _____.
- **a.** generated after a cDNA library is made
- **b.** unique sequences in the genome
- **c.** useful for mapping using sequence information
- **d.** all of these

7. Linkage analysis _____.
- **a.** is used to create a physical map
- **b.** is based on the natural recombination process
- **c.** requires radiation hybrid mapping
- **d.** involves breaking and rejoining of DNA artificially

8. Genetic recombination occurs by which process?
- **a.** independent assortment
- **b.** crossing over
- **c.** chromosome segregation
- **d.** sister chromatids

9. Individual genetic maps in a given species are _____.
- **a.** genetically similar
- **b.** genetically identical
- **c.** genetically dissimilar
- **d.** not useful in species analysis

10. Information obtained by microscopic analysis of stained chromosomes is used in _____.
- **a.** radiation hybrid mapping
- **b.** sequence mapping
- **c.** RFLP mapping
- **d.** cytogenetic mapping

11. The chain termination method of sequencing _____.
- **a.** uses labeled ddNTPs
- **b.** uses only dideoxynucleotides
- **c.** uses only deoxynucleotides
- **d.** uses labeled dNTPs

12. Whole-genome sequencing can be used for advances in _____.
- **a.** the medical field
- **b.** agriculture
- **c.** biofuels
- **d.** all of these

13. Sequencing an individual person's genome _____.
- **a.** is currently possible
- **b.** could lead to legal issues regarding discrimination and privacy
- **c.** could help make informed choices about medical treatment
- **d.** all of these

14. What is the most challenging issue facing genome sequencing?
- **a.** the inability to develop fast and accurate sequencing techniques
- **b.** the ethics of using information from genomes at the individual level
- **c.** the availability and stability of DNA
- **d.** all of these

15. Genomics can be used in agriculture to _____.
- **a.** generate new hybrid strains
- **b.** improve disease resistance
- **c.** improve yield
- **d.** all of these

16. Genomics can be used on a personal level to _____.
- **a.** decrease transplant rejection
- **b.** predict genetic diseases that a person may have inherited
- **c.** determine the risks of genetic diseases for an individual's children
- **d.** all of these

17. What is a biomarker?
- **a.** the color coding of different genes
- **b.** a protein that is uniquely produced in a diseased state
- **c.** a molecule in the genome or proteome
- **d.** a marker that is genetically inherited

18. A protein signature is _____.
- **a.** the path followed by a protein after it is synthesized in the nucleus
- **b.** the path followed by a protein in the cytoplasm
- **c.** a protein expressed on the cell surface
- **d.** a unique set of proteins present in a diseased state

Critical Thinking Questions

19. Describe the process of Southern blotting.

20. A researcher wants to study cancer cells from a patient with breast cancer. Is cloning the cancer cells an option?

21. How would a scientist introduce a gene for herbicide resistance into a plant?

22. If you had a chance to get your genome sequenced, what are some questions you might be able to have answered about yourself?

23. Why is so much effort being poured into genome mapping applications?

24. How could a genetic map of the human genome help find a cure for cancer?

25. Explain why metagenomics is probably the most revolutionary application of genomics.

26. How can genomics be used to predict disease risk and treatment options?

27. How has proteomics been used in cancer detection and treatment?

28. What is personalized medicine?

Chapter 18 Exercises

Review Questions

1. Which scientific concept did Charles Darwin and Alfred Wallace independently discover?
- **a.** mutation
- **b.** natural selection
- **c.** overbreeding
- **d.** sexual reproduction

2. Which of the following situations will lead to natural selection?
- **a.** The seeds of two plants land near each other and one grows larger than the other.
- **b.** Two types of fish eat the same kind of food, and one is better able to gather food than the other.
- **c.** Male lions compete for the right to mate with females, with only one possible winner.
- **d.** all of these

3. Which description is an example of a phenotype?
- **a.** A certain duck has a blue beak.
- **b.** A mutation occurred to a flower.
- **c.** Most cheetahs live solitary lives.
- **d.** both a. and c.

4. Which situation is most likely an example of convergent evolution?
- **a.** Squid and humans have eyes similar in structure.
- **b.** Worms and snakes both move without legs.
- **c.** Some bats and birds have wings that allow them to fly.
- **d.** all of these

5. Which situation would most likely lead to allopatric speciation?
- **a.** Flood causes the formation of a new lake.
- **b.** A storm causes several large trees to fall down.
- **c.** A mutation causes a new trait to develop.
- **d.** An injury causes an organism to seek out a new food source.

6. What is the main difference between dispersal and vicariance?
- **a.** One leads to allopatric speciation, whereas the other leads to sympatric speciation.
- **b.** One involves the movement of the organism, and the other involves a change in the environment.
- **c.** One depends on a genetic mutation occurring, and the other does not.
- **d.** One involves closely related organisms, and the other involves only individuals of the same species.

7. Which variable increases the likelihood of allopatric speciation taking place more quickly?
- **a.** lower rate of mutation
- **b.** longer distance between divided groups
- **c.** increased instances of hybrid formation
- **d.** equivalent numbers of individuals in each population

8. What is the main difference between autopolyploid and allopolyploid?
- **a.** the number of chromosomes
- **b.** the functionality of the chromosomes
- **c.** the source of the extra chromosomes
- **d.** the number of mutations in the extra chromosomes

9. Which reproductive combination produces hybrids?
- **a.** when individuals of the same species in different geographical areas reproduce
- **b.** when any two individuals sharing the same habitat reproduce
- **c.** when members of closely related species reproduce
- **d.** when offspring of the same parents reproduce

10. Which condition is the basis for a species to be reproductively isolated from other members?
- **a.** It does not share its habitat with related species.
- **b.** It does not exist out of a single habitat.
- **c.** It does not exchange genetic information with other species.
- **d.** It does not undergo evolutionary changes for a significant period of time.

11. Which situation is *not* an example of a prezygotic barrier?
- **a.** Two species of turtles breed at different times of the year.
- **b.** Two species of flowers attract different pollinators.
- **c.** Two species of birds display different mating dances.
- **d.** Two species of insects produce infertile offspring.

12. Which term is used to describe the continued divergence of species based on the low fitness of hybrid offspring?
- **a.** reinforcement
- **b.** fusion
- **c.** stability
- **d.** punctuated equilibrium

13. Which components of speciation would be least likely to be a part of punctuated equilibrium?
- **a.** a division of populations
- **b.** a change in environmental conditions
- **c.** ongoing gene flow among all individuals
- **d.** a large number of mutations taking place at once

Critical Thinking Questions

14. If a person scatters a handful of garden pea plant seeds in one area, how would natural selection work in this situation?

15. Why do scientists consider vestigial structures evidence for evolution?

16. How does the scientific meaning of "theory" differ from the common vernacular meaning?

17. Explain why the statement that a monkey is more evolved than a mouse is incorrect.

18. Why do island chains provide ideal conditions for adaptive radiation to occur?

19. Two species of fish had recently undergone sympatric speciation. The males of each species had a different coloring through which the females could identify and choose a partner from her own species. After some time, pollution made the lake so cloudy that it was hard for females to distinguish colors. What might take place in this situation?

20. Why can polyploidy individuals lead to speciation fairly quickly?

21. What do both rate of speciation models have in common?

22. Describe a situation where hybrid reproduction would cause two species to fuse into one.

Chapter 19 Exercises

Review Questions

1. What is the difference between micro- and macroevolution?

a. Microevolution describes the evolution of small organisms, such as insects, while macroevolution describes the evolution of large organisms, like people and elephants.

b. Microevolution describes the evolution of microscopic entities, such as molecules and proteins, while macroevolution describes the evolution of whole organisms.

c. Microevolution describes the evolution of organisms in populations, while macroevolution describes the evolution of species over long periods of time.

d. Microevolution describes the evolution of organisms over their lifetimes, while macroevolution describes the evolution of organisms over multiple generations.

2. Population genetics is the study of _____.

a. how selective forces change the allele frequencies in a population over time

b. the genetic basis of population-wide traits

c. whether traits have a genetic basis

d. the degree of inbreeding in a population

3. Which of the following populations is *not* in Hardy-Weinberg equilibrium?

a. a population with 12 homozygous recessive individuals (*yy*), 8 homozygous dominant individuals (*YY*), and 4 heterozygous individuals (*Yy*)

b. a population in which the allele frequencies do not change over time

c. $p^2 + 2pq + q^2 = 1$

d. a population undergoing natural selection

4. One of the original Amish colonies came from a ship of colonists from Europe. The ship's captain, who had polydactyly, a rare dominant trait, was one of the original colonists. Today, we see a much higher frequency of polydactyly in the Amish population. This is an example of _____.

a. natural selection

b. genetic drift

c. founder effect

d. both b. and c.

5. When male lions reach sexual maturity, they leave their group in search of a new pride. This can alter the allele frequencies of the population through which of the following mechanisms?

a. natural selection

b. genetic drift

c. gene flow

d. random mating

6. Which of the following evolutionary forces can introduce new genetic variation into a population?

a. natural selection and genetic drift

b. mutation and gene flow

c. natural selection and nonrandom mating

d. mutation and genetic drift

7. What is assortative mating?

a. when individuals mate with those who are similar to themselves

b. when individuals mate with those who are dissimilar to themselves

c. when individuals mate with those who are the most fit in the population

d. when individuals mate with those who are least fit in the population

8. When closely related individuals mate with each other, or inbreed, the offspring are often not as fit as the offspring of two unrelated individuals. Why?
   a. Close relatives are genetically incompatible.
   b. The DNA of close relatives reacts negatively in the offspring.
   c. Inbreeding can bring together rare, deleterious mutations that lead to harmful phenotypes.
   d. Inbreeding causes normally silent alleles to be expressed.

9. What is a cline?
   a. the slope of a mountain where a population lives
   b. the degree to which a mutation helps an individual survive
   c. the number of individuals in the population
   d. gradual geographic variation across an ecological gradient

10. Which type of selection results in greater genetic variance in a population?
    a. stabilizing selection
    b. directional selection
    c. diversifying selection
    d. positive frequency-dependent selection

11. When males and females of a population look or act differently, it is referred to as _____.
    a. sexual dimorphism
    b. sexual selection
    c. diversifying selection
    d. a cline

12. The good genes hypothesis is a theory that explains what?
    a. why more fit individuals are more likely to have more offspring
    b. why alleles that confer beneficial traits or behaviors are selected by natural selection
    c. why some deleterious mutations are maintained in the population
    d. why individuals of one sex develop impressive ornamental traits

Critical Thinking Questions

13. Solve for the genetic structure of a population with 12 homozygous recessive individuals (*yy*), 8 homozygous dominant individuals (*YY*), and 4 heterozygous individuals (*Yy*).
14. Explain the Hardy-Weinberg principle of equilibrium theory.
15. Imagine you are trying to test whether a population of flowers is undergoing evolution. You suspect there is selection pressure on the color of the flower; bees seem to cluster around the red flowers more often than the blue flowers. In a separate experiment, you discover blue flower color is dominant to red flower color. In a field, you count 600 blue flowers and 200 red flowers. What would you expect the genetic structure of the flowers to be?
16. Describe a situation in which a population would undergo the bottleneck effect and explain what impact that would have on the population's gene pool.
17. Describe natural selection and give an example of natural selection at work in a population.
18. Provide examples of two different kinds of clines.
19. Give an example of a trait that may have evolved as a result of the handicap principle and explain your reasoning.
20. List the ways in which evolution can affect population variation and describe how they influence allele frequencies.

Chapter 20 Exercises

Review Questions

1. What is used to determine phylogeny?
- **a.** mutations
- **b.** DNA
- **c.** evolutionary history
- **d.** organisms on earth

2. What do scientists in the field of systematics accomplish?
- **a.** discover new fossil sites
- **b.** organize and classify organisms
- **c.** name new species
- **d.** communicate among field biologists

3. Which statement about the taxonomic classification system is correct?
- **a.** There are more domains than kingdoms.
- **b.** Kingdoms are the top category of classification.
- **c.** Classes are divisions of orders.
- **d.** Subspecies are the most specific category of classification.

4. On a phylogenetic tree, which term refers to lineages that diverged from the same place?
- **a.** sister taxa
- **b.** basal taxa
- **c.** rooted taxa
- **d.** dichotomous taxa

5. Which statement about analogies is correct?
- **a.** They occur only as errors.
- **b.** They are synonymous with homologous traits.
- **c.** They are derived by similar environmental constraints.
- **d.** They are a form of mutation.

6. What do scientists use to apply cladistics?
- **a.** homologous traits
- **b.** homoplasies
- **c.** analogous traits
- **d.** monophyletic groups

7. What is true about organisms that are a part of the same clade?
- **a.** They all share the same basic characteristics.
- **b.** They evolved from a shared ancestor.
- **c.** They usually fall into the same classification taxa.
- **d.** They have identical phylogenies.

8. Why do scientists apply the concept of maximum parsimony?
- **a.** to decipher accurate phylogenies
- **b.** to eliminate analogous traits
- **c.** to identify mutations in DNA codes
- **d.** to locate homoplasies

9. The transfer of genes by a mechanism not involving reproduction is called:
- **a.** meiosis
- **b.** web of life
- **c.** horizontal gene transfer
- **d.** gene fusion

10. Identify the term that describes the following definition:
Particles that transfer genetic material from one species to another, especially in marine prokaryotes
- **a.** horizontal gene transfer
- **b.** lateral gene transfer
- **c.** genome fusion device
- **d.** gene transfer agents

11. What does the trunk of the classic phylogenetic tree represent?
- **a.** single common ancestor
- **b.** pool of ancestral organisms
- **c.** new species
- **d.** old species

12. Which phylogenetic model proposes that all three domains of life evolved from a pool of primitive prokaryotes?
- **a.** tree of life
- **b.** web of life
- **c.** ring of life
- **d.** network model

Critical Thinking Questions

13. How does a phylogenetic tree relate to the passing of time?

14. Some organisms that appear very closely related on a phylogenetic tree may not actually be closely related. Why is this?

15. List the different levels of the taxonomic classification system.

16. Dolphins and fish have similar body shapes. Is this feature more likely a homologous or analogous trait?

17. Why is it so important for scientists to distinguish between homologous and analogous characteristics before building phylogenetic trees?

18. Describe maximum parsimony.

19. Compare three different ways that eukaryotic cells may have evolved.

20. Describe how aphids acquired the ability to change color.

Chapter 21 Exercises

Review Questions

1. Which statement is *true*?
- **a.** A virion contains DNA and RNA.
- **b.** Viruses are acellular.
- **c.** Viruses replicate outside of the cell.
- **d.** Most viruses are easily visualized with a light microscope.

2. The viral _____ play(s) a role in attaching a virion to the host cell.
- **a.** core
- **b.** capsid
- **c.** envelope
- **d.** both b. and c.

3. Viruses _____.
- **a.** all have a round shape
- **b.** cannot have a long shape
- **c.** do not maintain any shape
- **d.** vary in shape

4. The observation that the bacteria genus *Chlamydia* contains species that can only survive as intracellular parasites supports which viral origin hypothesis?
- **a.** progressive
- **b.** regressive
- **c.** self-replicating
- **d.** virus-first

5. A scientist discovers a new virus with a linear, RNA genome surrounded by a helical capsid. The virus is most likely a member of which family based on structure classification?
- **a.** rabies virus
- **b.** herpesviruses
- **c.** retroviruses
- **d.** influenza viruses

6. Which statement is *not* true of viral replication?
- **a.** A lysogenic cycle kills the host cell.
- **b.** There are six basic steps in the viral replication cycle.
- **c.** Viral replication does not affect host cell function.
- **d.** Newly released virions can infect adjacent cells.

7. Which statement is *true* of viral replication?
- **a.** In the process of apoptosis, the cell survives.
- **b.** During attachment, the virus attaches at specific sites on the cell surface.
- **c.** The viral capsid helps the host cell produce more copies of the viral genome.
- **d.** mRNA works outside of the host cell to produce enzymes and proteins.

8. Which statement is *true* of reverse transcriptase?
- **a.** It is a nucleic acid.
- **b.** It infects cells.
- **c.** It transcribes RNA to make DNA.
- **d.** It is a lipid.

9. Oncogenic virus cores can be _____.
- **a.** RNA
- **b.** DNA
- **c.** neither RNA nor DNA
- **d.** either RNA or DNA

10. Which is *true* of DNA viruses?
- **a.** They use the host cell's machinery to produce new copies of their genome.
- **b.** They all have envelopes.
- **c.** They are the only kind of viruses that can cause cancer.
- **d.** They are not important plant pathogens.

11. A bacteriophage can infect _____.
- **a.** the lungs
- **b.** viruses
- **c.** prions
- **d.** bacteria

12. People with the CCR5Δ32 mutation of a T cell surface protein can be exposed to some strains of HIV-1 without becoming sick. What step of the virus life cycle is likely to be inhibited with this mutation?

a. release
b. reverse transcription
c. uncoating
d. attachment

13. An apple grower notices that several of his apple trees have fungi growing on their trunks and have developed necrotic ring spots, while other trees in the orchard lack fungi and appear healthy. What is the most likely conclusion the farmer can make about the virus infecting his apple trees?

a. The apple trees were infected by horizontal transmission.
b. The fungi carry disease.
c. The fungi attract disease-carrying insects.
d. The apple trees were infected by vertical transmission.

14. Which of the following is *not* used to treat active viral disease?

a. vaccines
b. antiviral drugs
c. antibiotics
d. phage therapy

15. Vaccines _____.

a. are similar to viroids
b. are only needed once
c. kill viruses
d. stimulate an immune response

16. A patient presents at the clinic with an acute viral infection. Assays that analyze the viral life cycle classify the virus into Group V with a segmented genome. Which virus does the patient most likely have?

a. rabies virus
b. picornavirus
c. HIV-1
d. influenza A virus

17. Which of the following is *not* associated with prions?

a. replicating shapes
b. mad cow disease
c. DNA
d. toxic proteins

18. Which statement is *true* of viroids?

a. They are single-stranded RNA particles.
b. They reproduce only outside of the cell.
c. They produce proteins.
d. They affect both plants and animals.

Critical Thinking Questions

19. The first electron micrograph of a virus (tobacco mosaic virus) was produced in 1939. Before that time, how did scientists know that viruses existed if they could not see them? (Hint: Early scientists called viruses "filterable agents.")

20. Varicella-zoster virus is a double-stranded DNA virus that causes chicken pox. How does its genome structure provide an evolutionary advantage over a single-stranded DNA virus?

21. Classify the rabies virus (a rhabdovirus family member) and HIV-1 with both the Baltimore and genomic structure systems. Compare your results; what conclusions can be made about these two different methods?

22. Why can't dogs catch the measles?

23. One of the first and most important targets for drugs to fight infection with HIV (a retrovirus) is the reverse transcriptase enzyme. Why?

24. In this chapter, you were introduced to different types of viruses and viral diseases. Briefly discuss the most interesting or surprising thing you learned about viruses.

25. Although plant viruses cannot infect humans, what are some of the ways in which they affect humans?

26. A bacteriophage with a lytic life cycle develops a mutation that allows it to also go through the lysogenic cycle. How would this provide an evolutionary advantage over the other bacteriophages that can only spread through lytic cycles?

27. Why is immunization after being bitten by a rabid animal so effective, and why aren't people vaccinated for rabies like dogs and cats are?

28. The vaccine Gardasil that targets human papilloma virus (HPV), the etiological agent of genital warts, was developed after the anti-HPV medication podofilox. Why would doctors still want a vaccine created after antiviral medications were available?

29. Prions are responsible for variant Creutzfeldt-Jakob disease, which has resulted in over 100 human deaths in Great Britain during the last 10 years. How do humans contract this disease?

30. How are viroids like viruses?

31. A botanist notices that a tomato plant looks diseased. How could the botanist confirm that the agent causing disease is a viroid, not a virus?

Chapter 22 Exercises

Review Questions

1. The first forms of life on Earth were thought to be _____.
- **a.** single-celled plants
- **b.** prokaryotes
- **c.** insects
- **d.** large animals such as dinosaurs

2. Microbial mats _____.
- **a.** are the earliest forms of life on Earth
- **b.** obtained their energy and food from hydrothermal vents
- **c.** are multilayered sheets of prokaryotes including mostly bacteria but also archaea
- **d.** all of these

3. The first organisms that oxygenated the atmosphere were _____.
- **a.** cyanobacteria
- **b.** phototrophic organisms
- **c.** anaerobic organisms
- **d.** all of these

4. Halophiles are organisms that require _____.
- **a.** a salt concentration of at least 0.2 M
- **b.** high sugar concentration
- **c.** the addition of halogens
- **d.** all of these

5. Many of the first prokaryotes to be cultured in a scientific lab were human or animal pathogens. Why would these species be more readily cultured than nonpathogenic prokaryotes?
- **a.** Pathogenic prokaryotes are hardier than nonpathogenic prokaryotes.
- **b.** Nonpathogenic prokaryotes require more supplements in their growth media.
- **c.** Most of the necessary culture conditions could be inferred for pathogenic prokaryotes.
- **d.** Pathogenic bacteria can grow as free bacteria, but nonpathogenic bacteria only grow as parts of large colonies.

6. The presence of a membrane-enclosed nucleus is a characteristic of _____.
- **a.** prokaryotic cells
- **b.** eukaryotic cells
- **c.** all cells
- **d.** viruses

7. Which of the following consist of prokaryotic cells?
- **a.** bacteria and fungi
- **b.** archaea and fungi
- **c.** protists and animals
- **d.** bacteria and archaea

8. The cell wall is _____.
- **a.** interior to the cell membrane
- **b.** exterior to the cell membrane
- **c.** a part of the cell membrane
- **d.** interior or exterior, depending on the particular cell

9. Organisms most likely to be found in extreme environments are _____.
- **a.** fungi
- **b.** bacteria
- **c.** viruses
- **d.** archaea

10. Prokaryotes stain as gram-positive or gram-negative because of differences in the cell _____.
- **a.** wall
- **b.** cytoplasm
- **c.** nucleus
- **d.** chromosome

11. Pseudopeptidoglycan is a characteristic of the walls of _____.
- **a.** eukaryotic cells
- **b.** bacterial prokaryotic cells
- **c.** archaean prokaryotic cells
- **d.** bacterial and archaean prokaryotic cells

12. The lipopolysaccharide layer (LPS) is a characteristic of the wall of _____.
- **a.** archaean cells
- **b.** gram-negative bacteria
- **c.** bacterial prokaryotic cells
- **d.** eukaryotic cells

13. Which of the following elements is *not* a micronutrient?
- **a.** boron
- **b.** calcium
- **c.** chromium
- **d.** manganese

14. Prokaryotes that obtain their energy from chemical compounds are called _____.
- **a.** phototrophs
- **b.** auxotrophs
- **c.** chemotrophs
- **d.** lithotrophs

15. Ammonification is the process by which _____.
- **a.** ammonia is released during the decomposition of nitrogen-containing organic compounds
- **b.** ammonium is converted to nitrite and nitrate in soils
- **c.** nitrate from soil is transformed to gaseous nitrogen compounds, such as NO, N_2O, and N_2
- **d.** gaseous nitrogen is fixed to yield ammonia

16. Plants use carbon dioxide from the air and are, therefore, called _____.
- **a.** consumers
- **b.** producers
- **c.** decomposer
- **d.** carbon fixers

17. Cyanobacteria harness energy from the sun through photosynthesis and oxidize water to provide electrons for energy generation. Thus, we classify cyanobacteria as _____.
- **a.** photolithotrophs
- **b.** photoautotrophs
- **c.** chemolithoautotrophs
- **d.** chemoorganotrophs

18. A disease that is constantly present in a population is called _____.
- **a.** pandemic
- **b.** epidemic
- **c.** endemic
- **d.** re-emerging

19. Which of the statements about biofilms is correct?
- **a.** Biofilms are considered responsible for diseases such as cystic fibrosis.
- **b.** Biofilms produce dental plaque and colonize catheters and prostheses.
- **c.** Biofilms colonize open wounds and burned tissue.
- **d.** All statements are correct.

20. Which of these statements is *true*?
- **a.** An antibiotic is any substance produced by an organism that is antagonistic to the growth of prokaryotes.
- **b.** An antibiotic is any substance produced by a prokaryote that is antagonistic to the growth of other viruses.
- **c.** An antibiotic is any substance produced by a prokaryote that is antagonistic to the growth of eukaryotic cells.
- **d.** An antibiotic is any substance produced by a prokaryote that prevents growth of the same prokaryote.

21. A person in England arrives at a medical clinic with a fever and swollen lymph nodes shortly after returning from a visit to New Mexico. For which bacteria should the doctor test the patient?
- **a.** *Salmonella enterica*
- **b.** *Borrelia burgdorferi*
- **c.** *Clostridium botulinum*
- **d.** *Yersinia pestis*

22. MRSA has emerged as a serious infectious disease, with the first case of methicillin-resistant *S. aureus* being detected in 1961. Why are medical professionals so concerned when antibiotics exist that can kill MRSA?
- **a.** MRSA can transfer methicillin resistance to other bacteria.
- **b.** Patients are not treated with the correct antibiotics rapidly enough to prevent serious illness.
- **c.** MRSA could acquire additional antibiotic resistance genes from other bacteria to become a "superbug."
- **d.** All statements are correct.

23. Which of these occurs through symbiotic nitrogen fixation?
- **a.** The plant benefits from using an endless source of nitrogen.
- **b.** The soil benefits from being naturally fertilized.
- **c.** Bacteria benefit from using photosynthates from the plant.
- **d.** All of these occur.

24. Medications that treat bacterial infections are called _____.
- **a.** pesticides
- **b.** bioremediators
- **c.** recalcitrant compounds
- **d.** antibiotics

25. Bioremediation includes _____.
- **a.** the use of prokaryotes that can fix nitrogen
- **b.** the use of prokaryotes to clean up pollutants
- **c.** the use of prokaryotes as natural fertilizers
- **d.** all of these

26. In addition to providing yogurt with its unique flavor and texture, lactic acid-producing bacteria also provide what additional benefit during food production?
- **a.** providing xenobiotics
- **b.** lowering the pH to kill pathogenic bacteria
- **c.** pasteurizing milk products
- **d.** breaking down lactose for lactose-intolerant individuals

Critical Thinking Questions

27. Describe briefly how you would detect the presence of a non-culturable prokaryote in an environmental sample.

28. Why do scientists believe that the first organisms on Earth were extremophiles?

29. A new bacterial species is discovered and classified as an endolith, an extremophile that lives inside rock. If the bacteria were discovered in the permafrost of Antarctica, describe two extremophile features the bacteria must possess.

30. Mention three differences between bacteria and archaea.

31. Explain the statement that both bacteria and archaea have the same basic structures but are built from different chemical components.

32. A scientist isolates a new species of prokaryote. He notes that the specimen is a bacillus with a lipid bilayer and cell wall that stains positive for peptidoglycan. Its circular chromosome replicates from a single origin of replication. Is the specimen most likely an Archaea, a gram-positive bacterium, or a gram-negative bacterium? How do you know?

33. Think about the conditions (temperature, light, pressure, and organic and inorganic materials) that you may find in a deep-sea hydrothermal vent. What type of prokaryotes, in terms of their metabolic needs (autotrophs, phototrophs, chemotrophs, etc.) would you expect to find there?

34. Farmers continually rotate the crops grown in different fields to maintain nutrients in the soil. How would planting soybeans in a field the year after the field was used to grow carrots help maintain nitrogen in the soil?

35. Imagine a region of soil became contaminated, killing bacteria that decompose dead plants and animals. How would this affect the carbon cycle in the area? Be specific in stating where carbon would accumulate in the cycle.

36. Explain the reason why the imprudent and excessive use of antibiotics has resulted in a major global problem.

37. Researchers have discovered that washing spinach with water several times does not prevent foodborne diseases due to *E. coli*. How can you explain this fact?

38. Your friend believes that prokaryotes are always detrimental and pathogenic. How would you explain to them that they are wrong?

39. Many people use antimicrobial soap to kill bacteria on their hands. However, overuse may actually increase the risk of infection. How could this occur?

Chapter 23 Exercises

Review Questions

1. What event is thought to have contributed to the evolution of eukaryotes?
- **a.** global warming
- **b.** glaciation
- **c.** volcanic activity
- **d.** oxygenation of the atmosphere

2. Which characteristic is shared by prokaryotes and eukaryotes?
- **a.** cytoskeleton
- **b.** nuclear envelope
- **c.** DNA-based genome
- **d.** mitochondria

3. Mitochondria most likely evolved by _____.
- **a.** a photosynthetic cyanobacterium
- **b.** cytoskeletal elements
- **c.** endosymbiosis
- **d.** membrane proliferation

4. Which of these protists is believed to have evolved following a secondary endosymbiosis?
- **a.** green algae
- **b.** cyanobacteria
- **c.** red algae
- **d.** chlorarachniophytes

5. In 2016, scientists published the genome of *Monocercomonoides* and demonstrated that this organism has no detectable mitochondrial genes. However, its genome was arranged in linear chromosomes wrapped around histones which are contained within the nucleus. *Monocercomonoides* is therefore a(n) _____.
- **a.** bacterium
- **b.** archaean
- **c.** eukaryote
- **d.** endosymbiont

6. Which of the following observations about a bacterium would distinguish it from the last eukaryotic common ancestor?
- **a.** a double-stranded DNA genome
- **b.** lack of a membrane-bound structure surrounding the genome
- **c.** fatty acids in the lipid bilayer of the plasma membrane
- **d.** enclosed by a cell wall

7. Protists that have a pellicle are surrounded by _____.
- **a.** silica dioxide
- **b.** calcium carbonate
- **c.** carbohydrates
- **d.** proteins

8. Protists with the capabilities to perform photosynthesis and to absorb nutrients from dead organisms are called _____.
- **a.** photoautotrophs
- **b.** mixotrophs
- **c.** saprobes
- **d.** heterotrophs

9. Which of these locomotor organs would likely be the shortest?
- **a.** a flagellum
- **b.** a cilium
- **c.** an extended pseudopod
- **d.** a pellicle

10. Alternation of generations describes which of the following?
- **a.** The haploid form can be multicellular; the diploid form is unicellular.
- **b.** The haploid form is unicellular; the diploid form can be multicellular.
- **c.** Both the haploid and diploid forms can be multicellular.
- **d.** Neither the haploid nor the diploid forms can be multicellular.

11. The amoeba *E. histolytica* is a pathogen that forms liver abscesses in infected individuals. Its metabolic classification is most likely _____.
- **a.** anaerobic heterotroph
- **b.** mixotroph
- **c.** aerobic phototroph
- **d.** phagocytic autotroph

12. Which protist group exhibits mitochondrial remnants with reduced functionality?
- **a.** slime molds
- **b.** diatoms
- **c.** parabasalids
- **d.** dinoflagellates

13. Conjugation between two *Paramecia* produces _____ total daughter cells.
a. 2 **b.** 4 **c.** 8 **d.** 16

14. What is the function of the raphe in diatoms?
a. locomotion
b. defense
c. capturing food
d. photosynthesis

15. What genus of protists appears to contradict the statement that unicellularity restricts cell size?
a. *Dictyostelium*
b. *Ulva*
c. *Plasmodium*
d. *Caulerpa*

16. A marine biologist analyzing water samples notices a protist with a calcium carbonate shell that moves by pseudopodia extension. The protist is likely to be closely related to which species?
a. *Fuligo septica* (dog vomit slime mold)
b. *Circogonia icosahedra* (radiolarian)
c. *Euglena viridis*
d. *Ammonia tepida*

17. An example of carbon fixation is _____.
a. photosynthesis
b. decomposition
c. phagocytosis
d. parasitism

18. Which parasitic protist evades the host immune system by altering its surface proteins with each generation?
a. *Paramecium caudatum*
b. *Trypanosoma brucei*
c. *Plasmodium falciparum*
d. *Phytophthora infestans*

19. Which of the following is *not* a way that protists contribute to the food web?
a. They fix carbon into organic molecules.
b. They occupy the apex producer niche.
c. They enter symbiotic relationships with animals.
d. They recycle nutrients back into the carbon and nitrogen cycles.

Critical Thinking Questions

20. Describe the hypothesized steps in the origin of eukaryotic cells.

21. Some aspects of eukaryotes are more similar to Archaea, while other aspects of eukaryotic cell composition appear more closely related to Bacteria. Explain how endosymbiosis could resolve this paradox.

22. Explain in your own words why sexual reproduction can be useful if a protist's environment changes.

23. *Giardia lamblia* is a cyst-forming protist parasite that causes diarrhea if ingested. Given this information, against what type(s) of environments might *G. lamblia* cysts be particularly resistant?

24. Explain how the definition of protists ensures that the kingdom Protista includes a wide diversity of cellular structures. Provide an example of two different structures that perform the same function for their respective protist.

25. The chlorophyte (green algae) genera *Ulva* and *Caulerpa* both have macroscopic leaflike and stemlike structures, but only *Ulva* species are considered truly multicellular. Explain why.

26. Why might a light-sensing eyespot be ineffective for an obligate saprobe? Suggest an alternative organ for a saprobic protist.

27. Opisthokonta includes animals and fungi as well as protists. Describe the key feature of this phylum and an example of how an organism in each kingdom uses this feature.

28. Describe two ways in which *Paramecium* differ from the projected traits of the last eukaryotic common ancestor.

29. How does killing *Anopheles* mosquitoes affect the *Plasmodium* protists?

30. Without treatment, why does African sleeping sickness invariably lead to death?

31. Describe how increasing stress to the ocean would affect a food chain containing zooxanthellae, corals, parrotfish, and sharks.

Chapter 24 Exercises

Review Questions

1. Which polysaccharide is usually found in the cell wall of fungi?
- **a.** starch
- **b.** glycogen
- **c.** chitin
- **d.** cellulose

2. Which of these organelles is *not* found in a fungal cell?
- **a.** chloroplast
- **b.** nucleus
- **c.** mitochondrion
- **d.** Golgi apparatus

3. The wall dividing individual cells in a fungal filament is called a _____.
- **a.** thallus
- **b.** hypha
- **c.** mycelium
- **d.** septum

4. During sexual reproduction, a homothallic mycelium contains _____.
- **a.** all septated hyphae
- **b.** all haploid nuclei
- **c.** both mating types
- **d.** none of these

5. The life cycles of perfect fungi are most similar to which other organism?
- **a.** hydra that undergo asexual budding
- **b.** diploid-dominant pea plants
- **c.** haploid-dominant green algae
- **d.** bacteria undergoing binary fission

6. The most primitive phylum of fungi is the _____.
- **a.** Chytridiomycota
- **b.** Zygomycota
- **c.** Glomeromycota
- **d.** Ascomycota

7. Members of which phylum produce a club-shaped structure that contains spores?
- **a.** Chytridiomycota
- **b.** Basidiomycota
- **c.** Glomeromycota
- **d.** Ascomycota

8. Members of which phylum establish a successful symbiotic relationship with the roots of trees?
- **a.** Ascomycota
- **b.** Deuteromycota
- **c.** Basidiomycota
- **d.** Glomeromycota

9. The fungi that had no known method of reproduction used to be classified as _____.
- **a.** Ascomycota
- **b.** Deuteromycota
- **c.** Basidiomycota
- **d.** Glomeromycota

10. A scientist discovers a new species of fungus that introduces genetic diversity during reproduction by creating a diploid zygote. This new species cannot belong to which modern phylum of fungi?
- **a.** Zygomycota
- **b.** Glomeromycota
- **c.** Chytridiomycota
- **d.** Deuteromycota

11. What term describes the close association of a fungus with the root of a tree?
- **a.** a rhizoid
- **b.** a lichen
- **c.** a mycorrhiza
- **d.** an endophyte

12. Why are fungi important decomposers?
- **a.** They produce many spores.
- **b.** They can grow in many different environments.
- **c.** They produce mycelia.
- **d.** They recycle carbon and inorganic minerals by the process of decomposition.

13. Consider an ecosystem where all the fungi not involved in mycorrhizae are eliminated. How would this affect nitrogen intake by plants?

a. Nitrogen intake would increase.
b. Nitrogen intake would not change.
c. Nitrogen intake would decrease.
d. Nitrogen intake would stop.

14. A fungus that climbs up a tree reaching higher elevation to release its spores in the wind and does not receive any nutrients from the tree or contribute to the tree's welfare is described as a _____.

a. commensal
b. mutualist
c. parasite
d. pathogen

15. A fungal infection that affects nails and skin is classified as _____.

a. systemic mycosis
b. mycetismus
c. superficial mycosis
d. mycotoxicosis

16. The targets for antifungal drugs are much more limited than antibiotics or antiviral medications. Why?

a. There are more bacteria and viruses than fungi.
b. Fungi can only be targeted during sexual reproduction, while bacteria and viruses can be targeted at any point in their lifespan.
c. Fungi cause topical infections, while viruses and bacteria cause systemic infections.
d. Human cells are much more similar to fungi cells than bacteria or viruses.

17. Yeast is a facultative anaerobe. This means that alcohol fermentation takes place only if:

a. the temperature is close to 37°C
b. the atmosphere does not contain oxygen
c. sugar is provided to the cells
d. light is provided to the cells

18. The advantage of yeast cells over bacterial cells to express human proteins is that:

a. yeast cells grow faster
b. yeast cells are easier to manipulate genetically
c. yeast cells are eukaryotic and modify proteins similarly to human cells
d. yeast cells are easily lysed to purify the proteins

19. Why are fungal insecticides an attractive alternative to chemical pesticides for growing food crops?

a. Human consumption of fungal insecticides would not make a person sick, but ingestion of chemical pesticides can be harmful to humans.
b. A single fungal insecticide would kill a wider variety of insects than a chemical pesticide.
c. Fungal insecticides can eliminate both harmful insects and plant pathogens, while chemical pesticides only kill insects.
d. Fungal insecticides will decompose dying plants, enhancing the nitrogen content of the soil, while chemical pesticides are not decomposers.

Critical Thinking Questions

20. What are the evolutionary advantages for an organism to reproduce both asexually and sexually?

21. Compare plants, animals, and fungi, considering these components: cell wall, chloroplasts, plasma membrane, food source, and polysaccharide storage. Be sure to indicate fungi's similarities and differences to plants and animals.

22. Why is the large surface area of mycelium essential for nutrient acquisition by fungi?

23. What is the advantage for a basidiomycete to produce a showy and fleshy fruiting body?

24. For each of the four groups of perfect fungi (Chytridiomycota, Zygomycota, Ascomycota, and Basidiomycota), compare the body structure and features, and provide an example.

25. Why does protection from light actually benefit the photosynthetic partner in lichens?

26. Ambrosia bark beetles carry *Ambrosiella* fungal spores to trees, then bore holes and lay their eggs with the fungus. When the new larvae hatch, they eat the fungus that has germinated in the holes. Describe how this relationship can be classified as mutualistic.

27. Ecologists often attempt to introduce new plants to restore degraded land. In an arid climate, scientists recommend introducing plants with arbuscular mycorrhizae. How would the mycorrhizae increase the plants' survival compared to plants without mycorrhizae?

28. Why can superficial mycoses in humans lead to bacterial infections?

29. Historically, artisanal breads were produced by capturing wild yeasts from the air. Prior to the development of modern yeast strains, the production of artisanal breads was long and laborious because many batches of dough ended up being discarded. Can you explain why?

30. How would treating an area of a forest with a broad-spectrum fungicide alter the carbon and nitrogen cycles in the area?

Chapter 25 Exercises

Review Questions

1. The land plants are probably descendants of which group?
- **a.** green algae
- **b.** red algae
- **c.** brown algae
- **d.** angiosperms

2. Alternation of generations means that plants produce:
- **a.** only haploid multicellular organisms
- **b.** only diploid multicellular organisms
- **c.** only diploid multicellular organisms with single-celled haploid gametes
- **d.** both haploid and diploid multicellular organisms

3. Which of the following traits of land plants allows them to grow in height?
- **a.** alternation of generations
- **b.** waxy cuticle
- **c.** tracheids
- **d.** sporopollenin

4. How does a haplontic plant population maintain genetic diversity?
- **a.** Zygotes are produced by random fusion.
- **b.** Gametes are created through meiosis.
- **c.** Diploid spores undergo independent assortment during mitosis.
- **d.** The zygote undergoes meiosis to generate a haploid sporophyte.

5. What characteristic of Charales would enable them to survive a dry spell?
- **a.** sperm with flagella
- **b.** phragmoplasts
- **c.** sporopollenin
- **d.** chlorophyll *a*

6. Which one of these characteristics is present in land plants and *not* in Charales?
- **a.** alternation of generations
- **b.** flagellated sperm
- **c.** phragmoplasts
- **d.** plasmodesmata

7. A scientist sequences the genome of *Chara*, red algae, and a tomato plant. What result would support the conclusion that charophytes should be included in the kingdom Plantae?
- **a.** The *Chara* genome is more similar to the red algae than the tomato plant.
- **b.** All three genomes are distinctly different.
- **c.** The *Chara* genome is more similar to the tomato plant genome than the red algae genome.
- **d.** The tomato plant genome is distinct from the red algae genome.

8. Which of the following features does *not* support the inclusion of charophytes in the kingdom Plantae?
- **a.** Charophyte chloroplasts contain chlorophyll *a* and *b*.
- **b.** Charophyte plant cell walls contain plasmodesmata to allow transfer between cells within multicellular organisms.
- **c.** Charophytes do not exhibit growth throughout the entire plant body.
- **d.** Charophytes are multicellular organisms that lack vascular tissue.

9. Which of the following structures is *not* found in bryophytes?
- **a.** a cellulose cell wall
- **b.** chloroplast
- **c.** sporangium
- **d.** root

10. Stomata appear in which group of plants?
- **a.** Charales
- **b.** liverworts
- **c.** hornworts
- **d.** mosses

11. The chromosome complement in a moss protonema is:
- **a.** 1*n*
- **b.** 2*n*
- **c.** 3*n*
- **d.** varies with the size of the protonema

12. Why do mosses grow well in the Arctic tundra?
- **a.** They grow better at cold temperatures.
- **b.** They do not require moisture.
- **c.** They do not have true roots and can grow on hard surfaces.
- **d.** There are no herbivores in the tundra.

13. A botanist travels to an area that has experienced a long, severe drought. While examining the bryophytes in the area, he notices that many are in the same life-cycle stage. Which life-cycle stage *should* be the most common?
- **a.** zygote
- **b.** gametophyte
- **c.** sporophyte
- **d.** archegonium

14. Microphylls are characteristic of which types of plants?
- **a.** mosses
- **b.** liverworts
- **c.** club mosses
- **d.** ferns

15. A plant in the understory of a forest displays a segmented stem and slender leaves arranged in a whorl. It is probably a _____.
- **a.** club moss
- **b.** whisk fern
- **c.** fern
- **d.** horsetail

16. The following structures are found on the underside of fern leaves and contain sporangia:
- **a.** sori
- **b.** rhizomes
- **c.** megaphylls
- **d.** microphylls

17. The dominant organism in fern is the _____.
- **a.** sperm
- **b.** spore
- **c.** gamete
- **d.** sporophyte

18. What seedless plant is a renewable source of energy?
- **a.** club moss
- **b.** horsetail
- **c.** *Sphagnum* moss
- **d.** fern

19. How do mosses contribute to replenishing nitrogen in the soil?
- **a.** Mosses fix nitrogen from the air.
- **b.** Mosses harbor cyanobacteria that fix nitrogen.
- **c.** Mosses die and return nitrogen to the soil.
- **d.** Mosses decompose rocks and release nitrogen.

20. Megaphylls most likely evolved _____.
- **a.** independently several different times in vascular plants
- **b.** once in vascular plants
- **c.** independently several different times in nonvascular plants
- **d.** once in nonvascular plants

Critical Thinking Questions

21. Why did land plants lose some of the accessory pigments present in brown and red algae?

22. What is the difference between extant and extinct?

23. Describe at least two challenges that cactuses had to overcome that cattails did not.

24. Describe a minimum of two ways that plants changed the land environment to support the emergence of land animals.

25. To an alga, what is the main advantage of producing drought-resistant structures?

26. In areas where it rains often, mosses grow on roofs. How do mosses survive on roofs without soil?

27. What are the three classes of bryophytes?

28. Describe two adaptations that are present in mosses but not hornworts or liverworts, which reflect steps of evolution toward land plants.

29. Bryophytes form a monophyletic group that transitions between green algae and vascular plants. Describe at least one similarity and one difference between bryophyte reproduction and green algae reproduction.

30. How did the development of a vascular system contribute to the increase in the size of plants?

31. Which plant is considered the most advanced seedless vascular plant, and why?

32. Ferns are simultaneously involved in promoting rock weathering while preventing soil erosion. Explain how a single plant can perform both these functions and how these functions are beneficial to its ecosystem.

Chapter 26 Exercises

Review Questions

1. Seed plants are _____.
- **a.** all homosporous
- **b.** mostly homosporous with some heterosporous
- **c.** mostly heterosporous with some homosporous
- **d.** all heterosporous

2. Besides the seed, what other major structure diminishes a plant's reliance on water for reproduction?
- **a.** flower
- **b.** fruit
- **c.** pollen
- **d.** spore

3. In which of the following geological periods would gymnosperms have dominated the landscape?
- **a.** Carboniferous
- **b.** Permian
- **c.** Triassic
- **d.** Eocene (present)

4. Which of the following structures widens the geographic range of a species and is an agent of dispersal?
- **a.** seed
- **b.** flower
- **c.** leaf
- **d.** root

5. Which of the following traits characterizes gymnosperms?
- **a.** The plants carry exposed seeds on modified leaves.
- **b.** Reproductive structures are located in a flower.
- **c.** After fertilization, the ovary thickens and forms a fruit.
- **d.** The gametophyte is the longest phase of the life cycle.

6. Megasporocytes will eventually produce which of the following?
- **a.** pollen grain
- **b.** sporophytes
- **c.** male gametophytes
- **d.** female gametophytes

7. What is the ploidy of the following structures: gametophyte, seed, spore, sporophyte?
- **a.** $1n$, $1n$, $2n$, $2n$
- **b.** $1n$, $2n$, $1n$, $2n$
- **c.** $2n$, $1n$, $2n$, $1n$
- **d.** $2n$, $2n$, $1n$, $1n$

8. In the northern forests of Siberia, a tall tree is most likely a:
- **a.** conifer
- **b.** cycad
- **c.** *Ginkgo biloba*
- **d.** gnetophyte

9. Which of the following structures in a flower is *not* directly involved in reproduction?
- **a.** the style
- **b.** the stamen
- **c.** the sepal
- **d.** the anther

10. Pollen grains develop in which structure?
- **a.** the anther
- **b.** the stigma
- **c.** the filament
- **d.** the carpel

11. In the course of double fertilization, one sperm cell fuses with the egg and the second one fuses with _____.
- **a.** the synergids
- **b.** the polar nuclei of the center cell
- **c.** the egg as well
- **d.** the antipodal cells

12. Corn develops from a seedling with a single cotyledon, displays parallel veins on its leaves, and produces monosulcate pollen. It is most likely:
- **a.** a gymnosperm
- **b.** a monocot
- **c.** a eudicot
- **d.** a basal angiosperm

13. Which of the following plant structures is *not* a defense against herbivory?
- **a.** thorns
- **b.** spines
- **c.** nectar
- **d.** alkaloids

14. White and sweet-smelling flowers with abundant nectar are probably pollinated by _____.
- **a.** bees and butterflies
- **b.** flies
- **c.** birds
- **d.** wind

15. Abundant and powdery pollen produced by small, indistinct flowers is probably transported by _____.
- **a.** bees and butterflies
- **b.** flies
- **c.** birds
- **d.** wind

16. Plants are a source of _____.
- **a.** food
- **b.** fuel
- **c.** medicine
- **d.** all of these

Critical Thinking Questions

17. The Cretaceous Period was marked by the increase in number and variety of angiosperms. Insects also diversified enormously during the same period. Can you propose the reason or reasons that could foster coevolution?

18. What role did the adaptations of seeds and pollen play in the development and expansion of seed plants?

19. The Mediterranean landscape along the seashore is dotted with pines and cypresses. The weather is not cold, and the trees grow at sea level. What evolutionary adaptation of conifers makes them suitable to the Mediterranean climate?

20. What are the four modern-day phyla of gymnosperms?

21. Some cycads are considered endangered species, and their trade is severely restricted. Customs officials stop suspected smugglers who claim that the plants in their possession are palm trees, not cycads. How would a botanist distinguish between the two types of plants?

22. What are the two structures that allow angiosperms to be the dominant form of plant life in most terrestrial ecosystems?

23. Biosynthesis of nectar and nutrient-rich pollen is energetically very expensive for a plant. Yet, plants funnel large amounts of energy into animal pollination. What are the evolutionary advantages that offset the cost of attracting animal pollinators?

24. What is biodiversity, and why is it important to an ecosystem?

Chapter 27 Exercises

Review Questions

1. Which of the following is *not* a feature common to most animals?
- **a.** development into a fixed body plan
- **b.** asexual reproduction
- **c.** specialized tissues
- **d.** heterotrophic nutrient sourcing

2. During embryonic development, unique cell layers develop into specific groups of tissues or organs during a stage called _____.
- **a.** the blastula stage
- **b.** the germ layer stage
- **c.** the gastrula stage
- **d.** the organogenesis stage

3. Which of the following phenotypes would most likely be the result of a *Hox* gene mutation?
- **a.** abnormal body length or height
- **b.** two different eye colors
- **c.** the contraction of a genetic illness
- **d.** two fewer appendages than normal

4. Which of the following organisms is most likely to be a diploblast?
- **a.** sea star
- **b.** shrimp
- **c.** jellyfish
- **d.** insect

5. Which of the following is *not* possible?
- **a.** radially symmetrical diploblast
- **b.** diploblastic eucoelomate
- **c.** protostomic coelomate
- **d.** bilaterally symmetrical deuterostome

6. An animal whose development is marked by radial cleavage and enterocoely is _____.
- **a.** a deuterostome
- **b.** an annelid or mollusk
- **c.** either an acoelomate or eucoelomate
- **d.** none of these

7. Consulting the modern phylogenetic tree of animals, which of the following would *not* constitute a clade?
- **a.** deuterostomes
- **b.** lophotrochozoans
- **c.** Parazoa
- **d.** Bilateria

8. Which of the following is thought to be the most closely related to the common animal ancestor?
- **a.** fungal cells
- **b.** protist cells
- **c.** plant cells
- **d.** bacterial cells

9. As with the emergence of the Acoelomorpha phylum, it is common for _____ data to misplace animals in close relation to other species, whereas _____ data often reveals a different and more accurate evolutionary relationship.
- **a.** molecular; morphological
- **b.** molecular; fossil record
- **c.** fossil record; morphological
- **d.** morphological; molecular

10. Which of the following periods is the earliest during which animals may have appeared?
- **a.** Ordovician Period
- **b.** Cambrian Period
- **c.** Ediacaran Period
- **d.** Cryogenian Period

11. What type of data is primarily used to determine the existence and appearance of early animal species?
- **a.** molecular data
- **b.** fossil data
- **c.** morphological data
- **d.** embryological development data

12. The time between 541–485 million years ago marks which period?
- **a.** Cambrian Period
- **b.** Silurian Period
- **c.** Ediacaran Period
- **d.** Devonian Period

13. Until recent discoveries suggested otherwise, animals existing before the Cambrian Period were believed to be:
- **a.** small and ocean-dwelling
- **b.** small and nonmotile
- **c.** small and soft-bodied
- **d.** small and radially symmetrical or asymmetrical

14. Plant life first appeared on land during which of the following periods?
- **a.** Cambrian Period
- **b.** Ordovician Period
- **c.** Silurian Period
- **d.** Devonian Period

15. Approximately how many mass extinction events occurred throughout the evolutionary history of animals?
- **a.** 3
- **b.** 4
- **c.** 5
- **d.** more than 5

Critical Thinking Questions

16. Why might the evolution of specialized tissues be important for animal function and complexity?

17. Describe and give examples of how humans display all of the features common to the animal kingdom.

18. How have *Hox* genes contributed to the diversity of animal body plans?

19. Using the following terms, explain what classifications and groups humans fall into, from the most general to the most specific: symmetry, germ layers, coelom, cleavage, and embryological development.

20. Explain some of the advantages brought about through the evolution of bilateral symmetry and coelom formation.

21. Describe at least two major changes to the animal phylogenetic tree that have come about due to molecular or genetic findings.

22. How is it that morphological data alone might lead scientists to group animals into erroneous evolutionary relationships?

23. Briefly describe at least two theories that attempt to explain the cause of the Cambrian explosion.

24. How is it that most, if not all, of the extant animal phyla today evolved during the Cambrian Period if so many massive extinction events have taken place since then?

Chapter 28 Exercises

Review Questions

1. Mesohyl contains _____.
- **a.** a polysaccharide gel and dead cells
- **b.** a collagen-like gel and suspended cells for various functions
- **c.** spicules composed of silica or calcium carbonate
- **d.** multiple pores

2. The large central opening in the parazoan body is called the _____.
- **a.** gemmule
- **b.** spicule
- **c.** ostia
- **d.** osculum

3. Most sponge body plans are slight variations on a simple tube-within-a-tube design. Which of the following is a key limitation of sponge body plans?
- **a.** Sponges lack the specialized cell types needed to produce more complex body plans.
- **b.** The reliance on osmosis/diffusion requires a design that maximizes the surface-area-to-volume ratio of the sponge.
- **c.** Choanocytes must be protected from the hostile exterior environment.
- **d.** Spongin cannot support heavy bodies.

4. Cnidocytes are found in _____.
- **a.** phylum Porifera
- **b.** phylum Nemertea
- **c.** phylum Nematoda
- **d.** phylum Cnidaria

5. Cubozoans are _____.
- **a.** polyps
- **b.** medusoids
- **c.** polymorphs
- **d.** sponges

6. While collecting specimens, a marine biologist finds a sessile Cnidarian. The medusas that bud from it swim by contracting a ring of muscle in their bells. To which class does this specimen belong?
- **a.** class Hydrozoa
- **b.** class Cubozoa
- **c.** class Scyphozoa
- **d.** class Anthozoa

7. Which group of flatworms are primarily ectoparasites of fish?
- **a.** monogeneans
- **b.** trematodes
- **c.** cestodes
- **d.** turbellarians

8. The rhynchocoel is a _____.
- **a.** circulatory system
- **b.** fluid-filled cavity
- **c.** primitive excretory system
- **d.** proboscis

9. Which of the following is a characteristic of Annelids?
- **a.** pseudocoelom
- **b.** true coelom
- **c.** no coelom
- **d.** none of these

10. A mantle and mantle cavity are present in _____.
- **a.** phylum Echinodermata
- **b.** phylum Adversoidea
- **c.** phylum Mollusca
- **d.** phylum Nemertea

11. How does segmentation enhance annelid locomotion?
- **a.** Segmentation creates repeating body structures so that the entire organism functions in synchrony.
- **b.** Segmentation allows specialization of different body regions.
- **c.** Neural segmentation allows annelids to localize sensations.
- **d.** Muscle contractions can be localized to specific regions of the body to coordinate movement.

12. The embryonic development in nematodes can have up to _____ larval stages.
- **a.** one
- **b.** two
- **c.** three
- **d.** four

13. The nematode cuticle contains _____.
- **a.** glucose
- **b.** skin cells
- **c.** chitin
- **d.** nerve cells

14. Crustaceans are _____.
- **a.** ecdysozoans
- **b.** nematodes
- **c.** arachnids
- **d.** parazoans

15. Flies are _____.
- **a.** chelicerates
- **b.** hexapods
- **c.** arachnids
- **d.** crustaceans

16. Which of the following is *not* a key advantage provided by the exoskeleton of terrestrial arthropods?
- **a.** prevents desiccation
- **b.** protects internal tissue
- **c.** provides mechanical support
- **d.** grows with the arthropod throughout its life

17. Echinoderms have _____.
- **a.** triangular symmetry
- **b.** asymmetry
- **c.** hexagonal symmetry
- **d.** pentaradial symmetry

18. The circulatory fluid in echinoderms is _____.
- **a.** blood
- **b.** mesohyl
- **c.** water
- **d.** saline

19. Which of the following features does *not* distinguish humans as a member of phylum Chordata?
- **a.** Human embryos undergo indeterminate cleavage.
- **b.** A spinal cord runs along an adult human's dorsal side.
- **c.** Human embryos exhibit pharyngeal arches and gill slits.
- **d.** The human coccyx forms from an embryonic tail.

20. The sister taxon of the Chordata is the _____.
- **a.** Mollusca
- **b.** Arthropoda
- **c.** Ambulacraria
- **d.** Rotifera

Critical Thinking Questions

21. Describe the different cell types and their functions in sponges.

22. Describe the feeding mechanism of sponges and identify how it is different from other animals.

23. Explain the function of nematocysts in cnidarians.

24. Compare the structural differences between Porifera and Cnidaria.

25. Compare the differences in sexual reproduction between Porifera and Cubozoans. How does the difference in fertilization provide an evolutionary advantage to the Cubozoans?

26. How does the tapeworm body plan support widespread dissemination of the parasite?

27. Describe the morphology and anatomy of mollusks.

28. What are the anatomical differences between nemertines and mollusks?

29. How does a change in the circulatory system organization support the body designs in cephalopods compared to other mollusks?

30. Describe the features of *Caenorhabditis elegans* that make it a valuable model system for biologists.

31. What are the different ways in which nematodes can reproduce?

32. Why are tardigrades essential to recolonizing habits following destruction or mass extinction?

33. Describe the various superclasses that phylum Arthropoda can be divided into.

34. Compare and contrast the segmentation seen in phylum Annelida with that seen in phylum Arthropoda.

35. How do terrestrial arthropods of the subphylum Hexapoda impact the world's food supply? Provide at least two positive and two negative effects.

36. Describe the different classes of echinoderms using examples.

Chapter 29 Exercises

Review Questions

1. Which of the following is *not* contained in phylum Chordata?
- **a.** Cephalochordata
- **b.** Echinodermata
- **c.** Urochordata
- **d.** Vertebrata

2. Which group of invertebrates is most closely related to vertebrates?
- **a.** cephalochordates
- **b.** echinoderms
- **c.** arthropods
- **d.** urochordates

3. Hagfish, lampreys, sharks, and tuna are all chordates that can also be classified into which group?
- **a.** craniates
- **b.** vertebrates
- **c.** cartilaginous fish
- **d.** cephalochordates

4. Members of Chondrichthyes differ from members of Osteichthyes by having (a) _____.
- **a.** jaw
- **b.** bony skeleton
- **c.** cartilaginous skeleton
- **d.** two sets of paired fins

5. Members of Chondrichthyes are thought to be descended from fishes that had _____.
- **a.** a cartilaginous skeleton
- **b.** a bony skeleton
- **c.** mucus glands
- **d.** slime glands

6. A marine biologist catches a species of fish they have never seen before. Upon examination, they determine that the species has a predominantly cartilaginous skeleton and a swim bladder. If its pectoral fins are not fused with its head, to which category of fish does the specimen belong?
- **a.** rays
- **b.** Osteichthyes
- **c.** sharks
- **d.** hagfish

7. Which of the following is *not* true of Acanthostega?
- **a.** It was aquatic.
- **b.** It had gills.
- **c.** It had four limbs.
- **d.** It laid shelled eggs.

8. Frogs belong to which order?
- **a.** Anura
- **b.** Urodela
- **c.** Caudata
- **d.** Apoda

9. During the Mesozoic Period, diapsids diverged into _____.
- **a.** pterosaurs and dinosaurs
- **b.** mammals and reptiles
- **c.** lepidosaurs and archosaurs
- **d.** Testudines and Sphenodontia

10. Squamata includes _____.
- **a.** crocodiles and alligators
- **b.** turtles
- **c.** tuataras
- **d.** lizards and snakes

11. Which of the following reptile groups gave rise to modern birds?
- **a.** Lepidosaurs
- **b.** Pterosaurs
- **c.** Anapsids
- **d.** Archosaurs

12. A bird or feathered dinosaur is _____.
- **a.** Neornithes
- **b.** *Archaeopteryx*
- **c.** Enantiornithes
- **d.** Paleognathae

13. Which of the following feather types helps to reduce drag produced by wind resistance during flight?
- **a.** flight feathers
- **b.** primary feathers
- **c.** secondary feathers
- **d.** contour feathers

14. Eccrine glands produce _____.
- **a.** sweat
- **b.** lipids
- **c.** scents
- **d.** milk

15. Monotremes include which of the following?
- **a.** kangaroos
- **b.** koalas
- **c.** bandicoots
- **d.** platypuses

16. The evolution of which of the following features of mammals is hardest to trace through the fossil record?
- **a.** jaw structure
- **b.** mammary glands
- **c.** middle ear structure
- **d.** development of hair

17. Which of the following is *not* an anthropoid?
- **a.** lemurs
- **b.** monkeys
- **c.** apes
- **d.** humans

18. Which of the following is part of a clade believed to have died out, leaving no descendants?
- **a.** *Paranthropus robustus*
- **b.** *Australopithecus africanus*
- **c.** *Homo erectus*
- **d.** *Homo sapiens sapiens*

19. Which of the following human traits is *not* a shared characteristic of primates?
- **a.** hip structure supporting bipedalism
- **b.** detection and processing of three-color vision
- **c.** nails at the end of each digit
- **d.** enlarged brain area associated with vision and reduced area associated with smell

Critical Thinking Questions

20. What are the characteristic features of the chordates?

21. What is the structural advantage of the notochord in the human embryo? Be sure to compare the notochord with the corresponding structure in adults.

22. What can be inferred about the evolution of the cranium and vertebral column from examining hagfishes and lampreys?

23. Why did gnathostomes replace most agnathans?

24. Explain why frogs are restricted to a moist environment.

25. Describe the differences between the larval and adult stages of frogs.

26. Describe how metamorphosis changes the structures involved in gas exchange over the life cycle of animals in the clade Anura and what evolutionary advantage this change provides.

27. Describe the functions of the four extraembryonic membranes present in amniotic eggs.

28. What characteristics differentiate lizards and snakes?

29. Based on how reptiles thermoregulate, which climates would you predict to have the highest reptile population density and why?

30. Explain why birds are thought to have evolved from theropod dinosaurs.

31. Describe three skeletal adaptations that allow for flight in birds.

32. How would the chest structure differ between ostriches, penguins, and terns?

33. Describe three unique features of the mammalian skeletal system.

34. Describe three characteristics of the mammalian brain that differ from other vertebrates.

35. How did the evolution of jaw musculature allow mammals to spread?

36. How did archaic *Homo sapiens* differ from anatomically modern humans?

37. Why is it so difficult to determine the sequence of hominin ancestors that have led to modern *Homo sapiens*?

Chapter 30 Exercises

Review Questions

1. Plant regions of continuous growth are made up of _____.
- **a.** dermal tissue
- **b.** vascular tissue
- **c.** meristematic tissue
- **d.** permanent tissue

2. Which of the following is the major site of photosynthesis?
- **a.** apical meristem
- **b.** ground tissue
- **c.** xylem cells
- **d.** phloem cells

3. Stem regions at which leaves are attached are called _____.
- **a.** trichomes
- **b.** lenticels
- **c.** nodes
- **d.** internodes

4. Which of the following cell types forms most of the inside of a plant?
- **a.** meristem cells
- **b.** collenchyma cells
- **c.** sclerenchyma cells
- **d.** parenchyma cells

5. Tracheids, vessel elements, sieve-tube cells, and companion cells are components of _____.
- **a.** vascular tissue
- **b.** meristematic tissue
- **c.** ground tissue
- **d.** dermal tissue

6. The primary growth of a plant is due to the action of the _____.
- **a.** lateral meristem
- **b.** vascular cambium
- **c.** apical meristem
- **d.** cork cambium

7. Which of the following is an example of secondary growth?
- **a.** increase in length
- **b.** increase in thickness or girth
- **c.** increase in root hairs
- **d.** increase in leaf number

8. Secondary growth in stems is usually seen in _____.
- **a.** monocots
- **b.** dicots
- **c.** both monocots and dicots
- **d.** neither monocots nor dicots

9. Roots that enable a plant to grow on another plant are called _____.
- **a.** epiphytic roots
- **b.** prop roots
- **c.** adventitious roots
- **d.** fibrous roots

10. The _____ forces selective uptake of minerals in the root.
- **a.** pericycle
- **b.** epidermis
- **c.** endodermis
- **d.** root cap

11. Newly formed root cells begin to form different cell types in the _____.
- **a.** zone of elongation
- **b.** zone of maturation
- **c.** root meristem
- **d.** zone of cell division

12. The stalk of a leaf is known as the _____.
- **a.** petiole
- **b.** lamina
- **c.** stipule
- **d.** rachis

13. Leaflets are a characteristic of _____ leaves.
- **a.** alternate
- **b.** whorled
- **c.** compound
- **d.** opposite

14. Cells of the _____ contain chloroplasts.
- **a.** epidermis
- **b.** vascular tissue
- **c.** periderm
- **d.** mesophyll

15. Which of the following is most likely to be found in a desert environment?
- **a.** broad leaves to capture sunlight
- **b.** spines instead of leaves
- **c.** small leaves with many stomata
- **d.** wide, flat leaves that can float

16. When stomata open, what occurs?
- **a.** Water vapor is lost to the external environment, increasing the rate of transpiration.
- **b.** Water vapor is lost to the external environment, decreasing the rate of transpiration.
- **c.** Water vapor enters the spaces in the mesophyll, increasing the rate of transpiration.
- **d.** Water vapor enters the spaces in the mesophyll, decreasing the rate of transpiration.

17. Which cells are responsible for the movement of photosynthates through a plant?
- **a.** tracheids, vessel elements
- **b.** tracheids, companion cells
- **c.** vessel elements, companion cells
- **d.** sieve-tube elements, companion cells

18. The main photoreceptor that triggers phototropism is a _____.
- **a.** phytochrome
- **b.** cryptochrome
- **c.** phototropin
- **d.** carotenoid

19. Phytochrome is a plant pigment protein that _____.
- **a.** mediates plant infection
- **b.** promotes plant growth
- **c.** mediates morphological changes in response to red and far-red light
- **d.** inhibits plant growth

20. A mutant plant has roots that grow in all directions. Which of the following organelles would you expect to be missing in the cell?
- **a.** mitochondria
- **b.** amyloplast
- **c.** chloroplast
- **d.** nucleus

21. Green bananas or unripe avocadoes can be kept in a brown bag to ripen faster. The hormone released by the fruit and trapped in the bag is probably:
- **a.** abscisic acid
- **b.** cytokinin
- **c.** ethylene
- **d.** gibberellic acid

22. A decrease in the level of which hormone releases seeds from dormancy?
- **a.** abscisic acid
- **b.** cytokinin
- **c.** ethylene
- **d.** gibberellic acid

23. A seedling germinating under a stone grows at an angle away from the stone and upward. This response to touch is called _____.
- **a.** gravitropism
- **b.** thigmonasty
- **c.** thigmotropism
- **d.** skototropism

Critical Thinking Questions

24. What type of meristem is found only in monocots, such as lawn grasses? Explain how this type of meristematic tissue is beneficial in lawn grasses that are mowed each week.

25. Which plant part is responsible for transporting water, minerals, and sugars to different parts of the plant? Name the two types of tissue that make up this overall tissue and explain the role of each.

26. Describe the roles played by stomata and guard cells. What would happen to a plant if these cells did not function correctly?

27. Compare the structure and function of xylem to that of phloem.

28. Explain the role of the cork cambium in woody plants.

29. What is the function of lenticels?

30. Besides the age of a tree, what additional information can annual rings reveal?

31. Give two examples of modified stems and explain how each example benefits the plant.

32. Compare a tap root system with a fibrous root system. For each type, name a plant that provides a food in the human diet. Which type of root system is found in monocots? Which type of root system is found in dicots?

33. What might happen to a root if the pericycle disappeared?

34. How do dicots differ from monocots in terms of leaf structure?

35. Describe an example of a plant with leaves that are adapted to cold temperatures.

36. The process of bulk flow transports fluids in a plant. Describe the two main bulk flow processes.

37. Owners and managers of plant nurseries have to plan lighting schedules for a long-day plant that will flower in February. What lighting periods will be most effective? What color of light should be chosen?

38. What are the major benefits of gravitropism for a germinating seedling?

39. Fruit and vegetable storage facilities are usually refrigerated and well ventilated. Why are these conditions advantageous?

40. Stomata close in response to bacterial infection. Why is this response a mechanism of defense for the plant? Which hormone is most likely to mediate this response?

Chapter 31 Exercises

Review Questions

1. For an element to be regarded as essential, all of the following criteria must be met, except:
- **a.** No other element can perform the function.
- **b.** The element is directly involved in plant nutrition.
- **c.** The element is inorganic.
- **d.** The plant cannot complete its life cycle without the element.

2. The nutrient that is part of carbohydrates, proteins, and nucleic acids and that forms biomolecules is _____.
- **a.** nitrogen
- **b.** carbon
- **c.** magnesium
- **d.** iron

3. Most _____ are necessary for enzyme function.
- **a.** micronutrients
- **b.** macronutrients
- **c.** biomolecules
- **d.** essential nutrients

4. What is the main water source for land plants?
- **a.** rain
- **b.** soil
- **c.** biomolecules
- **d.** essential nutrients

5. Which factors affect soil quality?
- **a.** chemical composition
- **b.** history of the soil
- **c.** presence of living organisms and topography
- **d.** all of these

6. Soil particles that are 0.1 to 2 mm in diameter are called _____.
- **a.** sand
- **b.** silt
- **c.** clay
- **d.** loam

7. A soil consists of layers called _____ that, taken together, are called a _____.
- **a.** soil profiles; horizon
- **b.** horizons; soil profile
- **c.** horizons; humus
- **d.** humus; soil profile

8. What is the term used to describe the solid rock that lies beneath the soil?
- **a.** sand
- **b.** bedrock
- **c.** clay
- **d.** loam

9. Which process produces an inorganic compound that plants can easily use?
- **a.** photosynthesis
- **b.** nitrogen fixation
- **c.** mycorrhization
- **d.** Calvin cycle

10. Through mycorrhization, a plant obtains important nutrients, such as _____.
- **a.** phosphorus, zinc, and copper
- **b.** phosphorus, zinc, and calcium
- **c.** nickel, calcium, and zinc
- **d.** all of these

11. What term describes a plant that requires nutrition from a living host plant?
- **a.** parasite
- **b.** saprophyte
- **c.** epiphyte
- **d.** insectivorous

12. What is the term for a plant that grows on another plant without relying on it for nutrition?
- **a.** rhizobia
- **b.** mycorrhizae
- **c.** epiphyte
- **d.** nitrogen-fixing nodule

Critical Thinking Questions

13. What type of plant problems result from nitrogen and calcium deficiencies?

14. List two essential macronutrients and two essential micronutrients.

15. Describe the main differences between a mineral soil and an organic soil.

16. Name and briefly explain the factors that affect soil formation.

17. Describe how topography influences the characteristics and fertility of a soil.

18. Why is biological nitrogen fixation an environmentally friendly way of fertilizing plants?

19. What is the main difference, from an energy point of view, between photosynthesis and biological nitrogen fixation?

20. Why is a root nodule a nutritional adaptation of a plant?

Chapter 32 Exercises

Review Questions

1. In a plant's male reproductive organs, development of pollen takes place in a structure known as the _____.
- **a.** stamen
- **b.** microsporangium
- **c.** anther
- **d.** tapetum

2. The stamen consists of a long stalk called the filament that supports the _____.
- **a.** stigma
- **b.** sepal
- **c.** style
- **d.** anther

3. The _____ are collectively called the calyx.
- **a.** sepals
- **b.** petals
- **c.** tepals
- **d.** stamens

4. The pollen lands on which part of the flower?
- **a.** stigma
- **b.** style
- **c.** ovule
- **d.** integument

5. After double fertilization, a zygote and _____ form.
- **a.** an ovule
- **b.** an endosperm
- **c.** a cotyledon
- **d.** a suspensor

6. The fertilized ovule gives rise to the _____.
- **a.** fruit
- **b.** seed
- **c.** endosperm
- **d.** embryo

7. What is the term for a fruit that develops from tissues other than the ovary?
- **a.** simple fruit
- **b.** aggregate fruit
- **c.** multiple fruit
- **d.** accessory fruit

8. The _____ is the outermost covering of a fruit.
- **a.** endocarp
- **b.** pericarp
- **c.** exocarp
- **d.** mesocarp

9. A useful method of asexual reproduction for propagating hard-to-root plants is _____.
- **a.** grafting
- **b.** layering
- **c.** cuttings
- **d.** budding

10. Which of the following is an advantage of asexual reproduction?
- **a.** Cuttings taken from an adult plant show increased resistance to diseases.
- **b.** Grafted plants can more successfully endure drought.
- **c.** When cuttings or buds are taken from an adult plant or plant parts, the resulting plant will grow into an adult faster than a seedling.
- **d.** Asexual reproduction takes advantage of a more diverse gene pool.

11. Plants that flower once in their lifetime are known as _____.
- **a.** monoecious
- **b.** dioecious
- **c.** polycarpic
- **d.** monocarpic

12. Plant species that complete their life cycle in one season are known as _____.
- **a.** biennials
- **b.** perennials
- **c.** annuals
- **d.** polycarpic

Critical Thinking Questions

13. Describe the reproductive organs inside a flower.

14. Describe the two-stage life cycle of plants: the gametophyte stage and the sporophyte stage.

15. Describe the four main parts, or whorls, of a flower.

16. Discuss the differences between a complete flower and an incomplete flower.

17. Why do some seeds undergo a period of dormancy, and how do they break dormancy?

18. Discuss some ways in which fruit seeds are dispersed.

19. What are some advantages of asexual reproduction in plants?

20. Describe natural and artificial methods of asexual reproduction in plants.

21. Discuss the life cycles of various plants.

22. How are plants classified on the basis of flowering frequency?

Chapter 33 Exercises

Review Questions

1. Which type of animal maintains a constant internal body temperature?
- **a.** endotherm
- **b.** ectotherm
- **c.** coelomate
- **d.** mesoderm

2. The symmetry found in animals that move swiftly is _____.
- **a.** radial
- **b.** bilateral
- **c.** sequential
- **d.** interrupted

3. What term describes the condition of a desert mouse that lowers its metabolic rate and "sleeps" during the hot day?
- **a.** turgid
- **b.** hibernation
- **c.** estivation
- **d.** normal sleep pattern

4. A plane that divides an animal into equal right and left portions is _____.
- **a.** diagonal
- **b.** midsagittal
- **c.** coronal
- **d.** transverse

5. A plane that divides an animal into dorsal and ventral portions is _____.
- **a.** sagittal
- **b.** midsagittal
- **c.** coronal
- **d.** transverse

6. The pleural cavity is a part of which cavity?
- **a.** dorsal cavity
- **b.** thoracic cavity
- **c.** abdominal cavity
- **d.** pericardial cavity

7. How could the increasing global temperature associated with climate change impact ectotherms?
- **a.** Ectotherm diversity will decrease in cool regions.
- **b.** Ectotherms will be able to be active all day in the tropics.
- **c.** Ectotherms will have to expend more energy to cool their body temperatures.
- **d.** Ectotherms will be able to expand into new habitats.

8. Although most animals are bilaterally symmetrical, a few exhibit radial symmetry. What is an advantage of radial symmetry?
- **a.** It confuses predators.
- **b.** It allows the animal to gather food from all sides.
- **c.** It allows the animal to undergo rapid, purposeful movement in any direction.
- **d.** It allows an animal to use its dorsal surface to sense its environment.

9. Which type of epithelial cell is best adapted to aid diffusion?
- **a.** squamous
- **b.** cuboidal
- **c.** columnar
- **d.** transitional

10. Which type of epithelial cell is found in glands?
- **a.** squamous
- **b.** cuboidal
- **c.** columnar
- **d.** transitional

11. Which type of epithelial cell is found in the urinary bladder?
- **a.** squamous
- **b.** cuboidal
- **c.** columnar
- **d.** transitional

12. Which type of connective tissue has the most fibers?
- **a.** loose connective tissue
- **b.** fibrous connective tissue
- **c.** cartilage
- **d.** bone

13. Which type of connective tissue has a mineralized different matrix?
- **a.** loose connective tissue
- **b.** fibrous connective tissue
- **c.** cartilage
- **d.** bone

14. The cell found in bone that breaks it down is called an _____.
- **a.** osteoblast
- **b.** osteocyte
- **c.** osteoclast
- **d.** osteon

15. The cell found in bone that makes the bone is called an _____.
- **a.** osteoblast
- **b.** osteocyte
- **c.** osteoclast
- **d.** osteon

16. Plasma is the _____.
- **a.** fibers in blood
- **b.** matrix of blood
- **c.** cell that phagocytizes bacteria
- **d.** cell fragment found in the tissue

17. The type of muscle cell under voluntary control is the _____.
- **a.** smooth muscle
- **b.** skeletal muscle
- **c.** cardiac muscle
- **d.** visceral muscle

18. The part of a neuron that contains the nucleus is the _____.
- **a.** cell body
- **b.** dendrite
- **c.** axon
- **d.** glial

19. Why are intercalated discs essential to the function of cardiac muscle?
- **a.** The discs maintain the barriers between the cells.
- **b.** The discs pass nutrients between cells.
- **c.** The discs ensure that all the cardiac muscle cells beat as a single unit.
- **d.** The discs control the heart rate.

20. When faced with a sudden drop in environmental temperature, an endothermic animal will _____.
- **a.** experience a drop in its body temperature
- **b.** wait to see if it goes lower
- **c.** increase muscle activity to generate heat
- **d.** add fur or fat to increase insulation

21. Which is an example of negative feedback?
- **a.** lowering of blood glucose after a meal
- **b.** blood clotting after an injury
- **c.** lactation during nursing
- **d.** uterine contractions during labor

22. Which method of heat exchange occurs during direct contact between the source and animal?
- **a.** radiation
- **b.** evaporation
- **c.** convection
- **d.** conduction

23. The body's thermostat is located in the _____.
- **a.** homeostatic receptor
- **b.** hypothalamus
- **c.** medulla
- **d.** vasodilation center

24. Which of the following is *not* true about acclimatization?
- **a.** Acclimatization allows animals to compensate for changes in their environment.
- **b.** Acclimatization improves function in a new environment.
- **c.** Acclimatization occurs when an animal tries to re-establish a homeostatic set point.
- **d.** Acclimatization is passed on to offspring of acclimated individuals.

25. Which of the following is *not* a way that ectotherms can change their body temperatures?
- **a.** sweating for evaporative cooling
- **b.** adjusting the timing of their daily activities
- **c.** seek out or avoid direct sunlight
- **d.** huddle in a group

Critical Thinking Questions

26. How does diffusion limit the size of an organism? How is this counteracted?

27. What is the relationship between BMR and body size? Why?

28. Explain how using an open circulatory system constrains the size of animals.

29. Describe one key environmental constraint for ectotherms and one for endotherms. Why are they limited by different factors?

30. How can squamous epithelia both facilitate diffusion and prevent damage from abrasion?

31. What are the similarities between cartilage and bone?

32. Multiple sclerosis is a debilitating autoimmune disease that results in the loss of the insulation around neuron axons. What cell type is the immune system attacking, and how does this disrupt the transfer of messages by the nervous system?

33. When a person leads a sedentary life, their skeletal muscles atrophy, but their smooth muscles do not. Why?

34. Why are negative feedback loops used to control body homeostasis?

35. Why is a fever a "good thing" during a bacterial infection?

36. How is a condition such as diabetes a good example of the failure of a set point in humans?

37. On a molecular level, how can endotherms produce their own heat by adjusting processes associated with cellular respiration? If needed, review Chapter 7 for details on respiration.

Chapter 34 Exercises

Review Questions

1. Which of the following is a pseudo-ruminant?
a. cow **b.** pig **c.** crow **d.** horse

2. Which of the following statements is *false*?
a. Roughage takes a long time to digest.
b. Birds eat large quantities at one time so that they can fly long distances.
c. Cows do not have upper teeth.
d. In pseudo-ruminants, roughage is digested in the cecum.

3. The acidic nature of chyme is neutralized by _____.
a. potassium hydroxide **c.** bicarbonates
b. sodium hydroxide **d.** vinegar

4. The digestive juices from the liver are delivered to the _____.
a. stomach **c.** duodenum
b. liver **d.** colon

5. A scientist dissects a new species of animal. If the animal's digestive system has a single stomach with an extended small intestine, to which animal could the dissected specimen be closely related?
a. lion **c.** earthworm
b. snowshoe hare **d.** eagle

6. Which of the following statements is *false*?
a. Essential nutrients can be synthesized by the body.
b. Vitamins are required in small quantities for bodily function.
c. Some amino acids can be synthesized by the body, while others need to be obtained from diet.
d. Vitamins come in two categories: fat soluble and water soluble.

7. Which of the following is a water-soluble vitamin?
a. vitamin A **c.** vitamin K
b. vitamin E **d.** vitamin C

8. What is the primary fuel for the body?
a. carbohydrates **c.** protein
b. lipids **d.** glycogen

9. Excess glucose is stored as _____.
a. fat **c.** glycogen
b. glucagon **d.** lipids

10. Many distance runners "carb load" the day before a big race. How does this eating strategy provide an advantage to the runner?
- **a.** The carbohydrates cause the release of insulin.
- **b.** The excess carbohydrates are converted to fats, which have a higher calorie density.
- **c.** The glucose from the carbohydrates lets the muscles make excess ATP overnight.
- **d.** The excess carbohydrates can be stored in the muscles as glycogen.

11. Where does the majority of protein digestion take place?
- **a.** stomach
- **b.** duodenum
- **c.** mouth
- **d.** jejunum

12. Lipases are enzymes that break down _____.
- **a.** disaccharides
- **b.** lipids
- **c.** proteins
- **d.** cellulose

13. Which of the following conditions is most likely to cause constipation?
- **a.** bacterial infection
- **b.** dehydration
- **c.** ulcer
- **d.** excessive cellulose consumption

14. Which hormone controls the release of bile from the gallbladder?
- **a.** pepsin
- **b.** amylase
- **c.** CCK
- **d.** gastrin

15. Which hormone stops acid secretion in the stomach?
- **a.** gastrin
- **b.** somatostatin
- **c.** gastric inhibitory peptide
- **d.** CCK

16. In the famous conditioning experiment, Pavlov demonstrated that his dogs started drooling in response to a bell sounding. What part of the digestive process did he stimulate?
- **a.** cephalic phase
- **b.** gastric phase
- **c.** intestinal phase
- **d.** elimination phase

Critical Thinking Questions

17. How does the polygastric digestive system aid in digesting roughage?

18. How do birds digest their food in the absence of teeth?

19. What is the role of the accessory organs in digestion?

20. Explain how the villi and microvilli aid in absorption.

21. Name two components of the digestive system that perform mechanical digestion. Describe how mechanical digestion contributes to acquiring nutrients from food.

22. What are essential nutrients?

23. What is the role of minerals in maintaining good health?

24. Discuss why obesity is a growing epidemic.

25. There are several nations where malnourishment is a common occurrence. What may be some of the health challenges posed by malnutrition?

26. Generally describe how a piece of bread can power your legs as you walk up a flight of stairs.

27. In the 1990s, fat-free foods became popular among people trying to lose weight. However, many dieticians now conclude that the fat-free trend made people less healthy and heavier. Describe how this could occur.

28. Explain why some dietary lipid is a necessary part of a balanced diet.

29. The gut microbiome (the bacterial colonies in the intestines) have become a popular area of study in biomedical research. How could varying gut microbiomes impact a person's nutrition?

30. Many mammals become ill if they drink milk as adults even though they could consume it as babies. What causes this digestive issue?

31. Describe how hormones regulate digestion.

32. Describe one or more scenarios where loss of hormonal regulation of digestion can lead to diseases.

Chapter 35 Exercises

Review Questions

1. Why are open circulatory systems advantageous to some animals?
- **a.** They use less metabolic energy.
- **b.** They help the animal move faster.
- **c.** They do not need a heart.
- **d.** They help large insects develop.

2. Some animals use diffusion instead of a circulatory system. Examples include _____.
- **a.** birds and jellyfish
- **b.** flatworms and arthropods
- **c.** mollusks and jellyfish
- **d.** none of these

3. Blood flow that is directed through the lungs and back to the heart is called _____.
- **a.** unidirectional circulation
- **b.** gill circulation
- **c.** pulmonary circulation
- **d.** pulmocutaneous circulation

4. White blood cells _____.
- **a.** can be classified as granulocytes or agranulocytes
- **b.** defend the body against bacteria and viruses
- **c.** are also called leukocytes
- **d.** all of these

5. Platelet plug formation occurs at which point?
- **a.** when large megakaryocytes break up into thousands of smaller fragments
- **b.** when platelets are dispersed through the bloodstream
- **c.** when platelets are attracted to a site of blood vessel damage
- **d.** none of these

6. In humans, the plasma comprises what percentage of the blood?
- **a.** 45%
- **b.** 55%
- **c.** 25%
- **d.** 90%

7. The red blood cells of birds differ from mammalian red blood cells because _____.
- **a.** they are white and have nuclei
- **b.** they do not have nuclei
- **c.** they have nuclei
- **d.** they fight disease

8. The heart's internal pacemaker beats by _____.
- **a.** an internal implant that sends an electrical impulse through the heart
- **b.** the excitation of cardiac muscle cells at the sinoatrial node followed by the atrioventricular node
- **c.** the excitation of cardiac muscle cells at the atrioventricular node followed by the sinoatrial node
- **d.** the action of the sinus

9. During the systolic phase of the cardiac cycle, the heart is _____.
- **a.** contracting
- **b.** relaxing
- **c.** contracting and relaxing
- **d.** filling with blood

10. Cardiomyocytes are similar to skeletal muscle because _____.
- **a.** they beat involuntarily
- **b.** they are used for weight lifting
- **c.** they pulse rhythmically
- **d.** they are striated

11. How do arteries differ from veins?

- **a.** Arteries have thicker smooth muscle layers to accommodate the changes in pressure from the heart.
- **b.** Arteries carry blood.
- **c.** Arteries have thinner smooth muscle layers and valves and move blood by the action of skeletal muscle.
- **d.** Arteries are thin walled and are used for gas exchange.

12. High blood pressure would be a result of _____.

- **a.** a high cardiac output and high peripheral resistance
- **b.** a high cardiac output and low peripheral resistance
- **c.** a low cardiac output and high peripheral resistance
- **d.** a low cardiac output and low peripheral resistance

Critical Thinking Questions

13. Describe a closed circulatory system.

14. Describe systemic circulation.

15. Describe the cause of different blood type groups.

16. List some of the functions of blood in the body.

17. How does the lymphatic system work with blood flow?

18. Describe the cardiac cycle.

19. What happens in capillaries?

20. How does blood pressure change during heavy exercise?

Chapter 36 Exercises

Review Questions

1. The respiratory system _____.
- **a.** provides body tissues with oxygen
- **b.** provides body tissues with oxygen and carbon dioxide
- **c.** establishes how many breaths are taken per minute
- **d.** provides the body with carbon dioxide

2. Air is warmed and humidified in the nasal passages. This helps to _____.
- **a.** ward off infection
- **b.** decrease sensitivity during breathing
- **c.** prevent damage to the lungs
- **d.** all of these

3. Which is the order of airflow during inhalation?
- **a.** nasal cavity, trachea, larynx, bronchi, bronchioles, alveoli
- **b.** nasal cavity, larynx, trachea, bronchi, bronchioles, alveoli
- **c.** nasal cavity, larynx, trachea, bronchioles, bronchi, alveoli
- **d.** nasal cavity, trachea, larynx, bronchioles, bronchi, alveoli

4. The inspiratory reserve volume measures the _____.
- **a.** amount of air remaining in the lung after a maximal exhalation
- **b.** amount of air that the lung holds
- **c.** amount of air that can be further exhaled after a normal breath
- **d.** amount of air that can be further inhaled after a normal breath

5. Of the following, which does *not* explain why the partial pressure of oxygen is lower in the lung than in the external air?
- **a.** Air in the lung is humidified; therefore, water vapor pressure alters the pressure.
- **b.** Carbon dioxide mixes with oxygen.
- **c.** Oxygen is moved into the blood and is headed to the tissues.
- **d.** Lungs exert a pressure on the air to reduce the oxygen pressure.

6. The total lung capacity is calculated using which of the following formulas?
- **a.** residual volume + tidal volume + inspiratory reserve volume
- **b.** residual volume + expiratory reserve volume + inspiratory reserve volume
- **c.** expiratory reserve volume + tidal volume + inspiratory reserve volume
- **d.** residual volume + expiratory reserve volume + tidal volume + inspiratory reserve volume

7. How would paralysis of the diaphragm alter inspiration?
- **a.** It would prevent contraction of the intercostal muscles.
- **b.** It would prevent inhalation because the intrapleural pressure would not change.
- **c.** It would decrease the intrapleural pressure and allow more air to enter the lungs.
- **d.** It would slow expiration because the lung would not relax.

8. Restrictive airway diseases _____.
- **a.** increase the compliance of the lung
- **b.** decrease the compliance of the lung
- **c.** increase the lung volume
- **d.** decrease the work of breathing

9. Alveolar ventilation remains constant when _____.
- **a.** the respiratory rate is increased while the volume of air per breath is decreased
- **b.** the respiratory rate and the volume of air per breath are increased
- **c.** the respiratory rate is decreased while increasing the volume per breath
- **d.** both a. and c.

10. Which of the following will *not* facilitate the transfer of oxygen to tissues?
- **a.** decreased body temperature
- **b.** decreased pH of the blood
- **c.** increased carbon dioxide
- **d.** increased exercise

11. The majority of carbon dioxide in the blood is transported by _____.

a. binding to hemoglobin
b. dissolution in the blood
c. conversion to bicarbonate
d. binding to plasma proteins

12. The majority of oxygen in the blood is transported by _____.

a. dissolution in the blood
b. being carried as bicarbonate ions
c. binding to blood plasma
d. binding to hemoglobin

Critical Thinking Questions

13. Describe the function of these terms and describe where they are located: main bronchus, trachea, alveoli, and acinus.

14. How does the structure of alveoli maximize gas exchange?

15. What does FEV1/FVC measure? What factors may affect FEV1/FVC?

16. What is the reason for having residual volume in the lung?

17. How can a decrease in the percent of oxygen in the air affect the movement of oxygen in the body?

18. If a patient has increased resistance in their lungs, how can this detected by a doctor? What does this mean?

19. How would increased airway resistance affect intrapleural pressure during inhalation?

20. Explain how a puncture to the thoracic cavity (from a knife wound, for instance) could alter the ability to inhale.

21. When someone is standing, gravity stretches the bottom of the lung down toward the floor to a greater extent than the top of the lung. What implication could this have on the flow of air in the lungs? Where does gas exchange occur in the lungs?

22. What would happen if no carbonic anhydrase were present in red blood cells?

23. How does the administration of 100% oxygen save a patient from carbon monoxide poisoning? Why wouldn't giving carbon dioxide work?

Chapter 37 Exercises

Review Questions

1. Which of the following is a barrier against pathogens provided by the skin?
a. high pH
b. mucus
c. tears
d. desiccation

2. Although interferons have several effects, they are particularly useful against infections with which type of pathogen?
a. bacteria
b. viruses
c. fungi
d. helminths

3. Which organelle do phagocytes use to digest engulfed particles?
a. lysosome
b. nucleus
c. endoplasmic reticulum
d. mitochondria

4. Which innate immune system component uses MHC I molecules directly in its defense strategy?
a. macrophages
b. neutrophils
c. NK cells
d. interferon

5. Which of the following is both a phagocyte and an antigen-presenting cell?
a. NK cell
b. eosinophil
c. neutrophil
d. macrophage

6. Which immune cells bind MHC molecules on APCs via CD8 coreceptors on their cell surfaces?
a. T_H cells
b. CTLs
c. mast cells
d. basophils

7. What "self" pattern is identified by NK cells?
a. altered self
b. missing self
c. normal self
d. non-self

8. The acquired ability to prevent an unnecessary or destructive immune reaction to a harmless foreign particle, such as a food protein, is called _____.
a. the T_H2 response
b. allergy
c. immune tolerance
d. autoimmunity

9. Upon re-exposure to a pathogen, a memory B cell can differentiate to which cell type?
a. CTL
b. naïve B cell
c. memory T cell
d. plasma cell

10. Foreign particles circulating in the blood are filtered by the _____.
a. spleen
b. lymph nodes
c. MALT
d. lymph

11. Allergy to pollen is classified as _____.
a. an autoimmune reaction
b. immunodeficiency
c. delayed hypersensitivity
d. immediate hypersensitivity

12. A potential cause of acquired autoimmunity is _____.
a. tissue hypersensitivity
b. molecular mimicry
c. histamine release
d. radiation exposure

13. Autoantibodies are probably involved in _____.
a. reactions to poison ivy
b. pollen allergies
c. systemic lupus erythematosus
d. HIV/AIDS

14. Which of the following diseases is *not* due to autoimmunity?
- **a.** rheumatic fever
- **b.** systemic lupus erythematosus
- **c.** diabetes mellitus
- **d.** HIV/AIDS

15. The structure of an antibody is similar to the extracellular component of which receptor?
- **a.** MHC I
- **b.** MHC II
- **c.** BCR
- **d.** none of these

16. The first antibody class to appear in the serum in response to a newly encountered pathogen is _____.
- **a.** IgM
- **b.** IgA
- **c.** IgG
- **d.** IgE

17. What is the most abundant antibody class detected in the serum upon re-exposure to a pathogen or in reaction to a vaccine?
- **a.** IgM
- **b.** IgA
- **c.** IgG
- **d.** IgE

18. Breastfed infants typically are resistant to disease because of _____.
- **a.** active immunity
- **b.** passive immunity
- **c.** immune tolerance
- **d.** immune memory

Critical Thinking Questions

19. Different MHC I molecules between donor and recipient cells can lead to rejection of a transplanted organ or tissue. Explain the mechanism through which this occurs.

20. If a series of genetic mutations prevented some, but not all, of the complement proteins from binding antibodies or pathogens, would the entire complement system be compromised?

21. Explain the difference between an epitope and an antigen.

22. What is a naïve B or T cell?

23. How does the T_H1 response differ from the T_H2 response?

24. In mammalian adaptive immune systems, T cell receptors are extraordinarily diverse. What function of the immune system results from this diversity, and how is this diversity achieved?

25. How do B and T cells differ with respect to the antigens that they bind to?

26. Why is the immune response after reinfection much faster than the adaptive immune response after the initial infection?

27. What are the benefits and costs of antibody cross-reactivity?

Chapter 38 Exercises

Review Questions

1. When dehydrated human patients need to be given fluids intravenously, they are given _____.
- **a.** water, which is hypotonic with respect to body fluids
- **b.** saline at a concentration that is isotonic with respect to body fluids
- **c.** glucose because it is a nonelectrolyte
- **d.** blood

2. The sodium ion is at the highest concentration in _____.
- **a.** intracellular fluid
- **b.** extracellular fluid
- **c.** blood plasma
- **d.** none of these

3. Cells in a hypertonic solution tend to _____.
- **a.** shrink due to water loss
- **b.** swell due to water gain
- **c.** stay the same size due to water moving into and out of the cell at the same rate
- **d.** none of these

4. The macula densa is/are _____.
- **a.** present in the renal medulla
- **b.** dense tissue present in the outer layer of the kidney
- **c.** cells present in the DCT and collecting tubules
- **d.** present in blood capillaries

5. The osmolarity of body fluids is maintained at _____.
- **a.** 100 mOsm
- **b.** 300 mOsm
- **c.** 1,000 mOsm
- **d.** It is not constantly maintained.

6. The gland located at the top of the kidney is the _____ gland.
- **a.** adrenal
- **b.** pituitary
- **c.** thyroid
- **d.** thymus

7. Active transport of K^+ in Malpighian tubules ensures that _____.
- **a.** water follows K^+ to make urine
- **b.** osmotic balance is maintained between waste matter and bodily fluids
- **c.** both a. and b.
- **d.** neither a. nor b.

8. Contractile vacuoles in microorganisms _____.
- **a.** exclusively perform an excretory function
- **b.** can perform many functions, one of which is excretion of metabolic wastes
- **c.** originate from the cell membrane
- **d.** both b. and c.

9. Flame cells are primitive excretory organs found in _____.
- **a.** arthropods
- **b.** annelids
- **c.** mammals
- **d.** flatworms

10. BUN is _____.
- **a.** blood urea nitrogen
- **b.** blood uric acid nitrogen
- **c.** an indicator of blood volume
- **d.** an indicator of blood pressure

11. Human beings accumulate _____ before excreting nitrogenous waste.
- **a.** nitrogen
- **b.** ammonia
- **c.** urea
- **d.** uric acid

12. Renin is made by _____.

a. granular cells of the juxtaglomerular apparatus
b. the kidneys
c. the nephrons
d. all of these

13. Patients with Addison's disease _____.

a. retain water
b. retain salts
c. lose salts and water
d. have too much aldosterone

14. Which hormone elicits the "fight-or-flight" response?

a. epinephrine
b. mineralocorticoids
c. antidiuretic hormone
d. thyroxine

Critical Thinking Questions

15. Why is excretion important in order to achieve osmotic balance?

16. Why do electrolyte ions move across membranes by active transport?

17. Why are the loop of Henle and vasa recta important for the formation of concentrated urine?

18. Describe the structure of the kidney.

19. Why might specialized organs have evolved for excretion of wastes?

20. Explain two different excretory systems other than the kidneys.

21. In terms of evolution, why might the urea cycle have evolved in organisms?

22. Compare and contrast the formation of urea and uric acid.

23. Describe how hormones regulate blood pressure, blood volume, and kidney function.

24. How does the renin-angiotensin-aldosterone system function? Why is it controlled by the kidneys?

Chapter 39 Exercises

Review Questions

1. A newly discovered hormone contains four amino acids linked together. Under which chemical class would this hormone be classified?
- **a.** lipid-derived hormone
- **b.** amino acid-derived hormone
- **c.** peptide hormone
- **d.** glycoprotein

2. Which class of hormones can diffuse through plasma membranes?
- **a.** lipid-derived hormones
- **b.** amino acid-derived hormones
- **c.** peptide hormones
- **d.** glycoprotein hormones

3. Why are steroids able to diffuse across the plasma membrane?
- **a.** Their transport protein moves them through the membrane.
- **b.** They are amphipathic, allowing them to interact with the entire phospholipid.
- **c.** Cells express channels that let hormones flow down their concentration gradient into the cells.
- **d.** They are nonpolar molecules.

4. A new antagonist molecule has been discovered that binds to and blocks plasma membrane receptors. What effect will this antagonist have on testosterone, a steroid hormone?
- **a.** It will block testosterone from binding to its receptor.
- **b.** It will block testosterone from activating cAMP signaling.
- **c.** It will increase testosterone-mediated signaling.
- **d.** It will not affect testosterone-mediated signaling.

5. What effect will a cAMP inhibitor have on a peptide hormone-mediated signaling pathway?
- **a.** It will prevent the hormone from binding its receptor.
- **b.** It will prevent activation of a G protein.
- **c.** It will prevent activation of adenylate cyclase.
- **d.** It will prevent activation of protein kinases.

6. When insulin binds to its receptor, the complex is endocytosed into the cell. This is an example of _____ in response to hormone signaling.
- **a.** cAMP activation
- **b.** generating an intracellular receptor
- **c.** activation of a hormone response element
- **d.** receptor down-regulation

7. Drinking alcoholic beverages causes an increase in urine output. This most likely occurs because alcohol _____.
- **a.** inhibits ADH release
- **b.** stimulates ADH release
- **c.** inhibits TSH release
- **d.** stimulates TSH release

8. FSH and LH release from the anterior pituitary is stimulated by _____.
- **a.** TSH
- **b.** GnRH
- **c.** T_3
- **d.** PTH

9. What hormone is produced by beta cells of the pancreas?
- **a.** T_3
- **b.** glucagon
- **c.** insulin
- **d.** T_4

10. When blood calcium levels are low, PTH stimulates _____.
- **a.** excretion of calcium from the kidneys
- **b.** excretion of calcium from the intestines
- **c.** osteoblasts
- **d.** osteoclasts

11. How would mutations that completely ablate the function of the androgen receptor impact the phenotypic development of humans with XY chromosomes?
- **a.** Patients would appear phenotypically female.
- **b.** Patients would appear phenotypically male with underdeveloped secondary sex characteristics.
- **c.** Patients would appear phenotypically male but could not produce sperm.
- **d.** Patients would express both male and female secondary sex characteristics.

12. A rise in blood glucose levels triggers release of insulin from the pancreas. This mechanism of hormone production is stimulated by _____.
- **a.** humoral stimuli
- **b.** hormonal stimuli
- **c.** neural stimuli
- **d.** negative stimuli

13. Which mechanism of hormonal stimulation would be affected if signaling and hormone release from the hypothalamus were blocked?
- **a.** humoral and hormonal stimuli
- **b.** hormonal and neural stimuli
- **c.** neural and humoral stimuli
- **d.** hormonal and negative stimuli

14. A scientist hypothesizes that the pancreas's hormone production is controlled by neural stimuli. Which observation would support this hypothesis?
- **a.** Insulin is produced in response to sudden stress without a rise in blood glucose.
- **b.** Insulin is produced in response to a rise in glucagon levels.
- **c.** Beta cells express epinephrine receptors.
- **d.** Insulin is produced in response to a rise in blood glucose in the brain.

15. Which endocrine glands are associated with the kidneys?
- **a.** thyroid glands
- **b.** pituitary glands
- **c.** adrenal glands
- **d.** gonads

16. Which of the following hormones is not produced by the anterior pituitary?
- **a.** oxytocin
- **b.** growth hormone
- **c.** prolactin
- **d.** thyroid-stimulating hormone

17. Recent studies suggest that blue light exposure can impact human circadian rhythms. This suggests that blue light disrupts the function of the _____ gland(s).
- **a.** adrenal
- **b.** pituitary
- **c.** pineal
- **d.** thyroid

Critical Thinking Questions

18. Although there are many different hormones in the human body, they can be divided into three classes based on their chemical structure. What are these classes, and what is one factor that distinguishes them?

19. Where is insulin stored, and why would it be released?

20. Glucagon is the peptide hormone that signals for the body to release glucose into the bloodstream. How does glucagon contribute to maintaining homeostasis throughout the body? What other hormones are involved in regulating the blood glucose cycle?

21. Name two important functions of hormone receptors.

22. How can hormones mediate changes?

23. Why is cAMP-mediated signal amplification not required in steroid hormone signaling? Describe how steroid signaling is amplified instead.

24. Name and describe a function of one hormone produced by the anterior pituitary and one hormone produced by the posterior pituitary.

25. Describe one direct action of growth hormone (GH).

26. Researchers have recently demonstrated that stressed people are more susceptible to contracting the common cold than people who are not stressed. What kind of stress must the infected patients be experiencing, and why does it make them more susceptible to the virus?

27. How is hormone production and release primarily controlled?

28. Compare and contrast hormonal and humoral stimuli.

29. Oral contraceptive pills work by delivering synthetic progestins to a woman every day. Describe why this is an effective method of birth control.

30. What does aldosterone regulate, and how is it stimulated?

31. The adrenal medulla contains two types of secretory cells; what are they, and what are their functions?

32. How would damage to the posterior pituitary gland affect the production and release of ADH and inhibiting hormones?

Chapter 40 Exercises

Review Questions

1. Which form of reproduction is thought to be best in a stable environment?
a. asexual **c.** budding
b. sexual **d.** parthenogenesis

2. Which form of reproduction can result from damage to the original animal?
a. asexual **c.** budding
b. fragmentation **d.** parthenogenesis

3. Which form of reproduction is useful to an animal with little mobility that reproduces sexually?
a. fission **c.** parthenogenesis
b. budding **d.** hermaphroditism

4. Genetically unique individuals are produced through _____.
a. sexual reproduction **c.** budding
b. parthenogenesis **d.** fragmentation

5. External fertilization occurs in which type of environment?
a. aquatic **c.** savanna
b. forested **d.** steppe

6. Which term applies to egg development within the female with nourishment derived from a yolk?
a. oviparity **c.** ovoviviparity
b. viviparity **d.** all of these

7. Which term applies to egg development outside the female with nourishment derived from a yolk?
a. oviparity **c.** ovoviviparity
b. viviparity **d.** all of these

8. Sperm are produced in the _____.
a. scrotum **c.** seminiferous tubules
b. seminal vesicles **d.** prostate gland

9. The bulk of semen is made by the _____.
a. scrotum **c.** seminiferous tubules
b. seminal vesicles **d.** prostate gland

10. Which of the following cells in spermatogenesis is diploid?
a. primary spermatocyte **c.** spermatid
b. secondary spermatocyte **d.** sperm

11. Which organ has the same embryonic origin as the penis?
a. clitoris **c.** greater vestibular glands
b. labia majora **d.** vagina

12. Which organ has an endometrial lining that will support a developing baby?
a. labia minora **c.** ovaries
b. breast **d.** uterus

13. How many eggs are produced as a result of one meiotic series of cell divisions?
a. one **c.** three
b. two **d.** four

14. Which hormone causes Leydig cells to make testosterone?
a. FSH **c.** inhibin
b. LH **d.** estrogen

15. Which hormone causes FSH and LH to be released?
a. testosterone
b. estrogen
c. GnRH
d. progesterone

16. Which hormone signals ovulation?
a. FSH
b. LH
c. inhibin
d. estrogen

17. Which hormone causes the regrowth of the endometrial lining of the uterus?
a. testosterone
b. estrogen
c. GnRH
d. progesterone

18. Nutrient and waste requirements for the developing fetus are handled during the first few weeks by _____.
a. the placenta
b. diffusion through the endometrium
c. the chorion
d. the blastocyst

19. Progesterone is made during the third trimester by the _____.
a. placenta
b. endometrial lining
c. chorion
d. corpus luteum

20. Which contraceptive method is 100% effective at preventing pregnancy?
a. condom
b. oral hormonal methods
c. sterilization
d. abstinence

21. Which type of short-term contraceptive method is generally more effective than others?
a. barrier
b. hormonal
c. natural family planning
d. withdrawal

22. Which hormone is primarily responsible for the contractions during labor?
a. oxytocin
b. estrogen
c. β-HCG
d. progesterone

23. Major organs begin to develop during which part of human gestation?
a. fertilization
b. first trimester
c. second trimester
d. third trimester

24. Which of the following is *false*?
a. The endoderm, mesoderm, and ectoderm are germ layers.
b. The trophoblast is a germ layer.
c. The inner cell mass is a source of embryonic stem cells.
d. The blastula is often a hollow ball of cells.

25. During cleavage, the mass of cells _____.
a. increases
b. decreases
c. doubles with every cell division
d. does not change significantly

26. Which of the following gives rise to the skin cells?
a. ectoderm
b. endoderm
c. mesoderm
d. none of these

27. The ribs form from the _____.
a. notochord
b. neural plate
c. neural tube
d. somites

Critical Thinking Questions

28. Why is sexual reproduction useful if only half the animals can produce offspring, and two separate cells must be combined to form a third?

29. What determines the sex in the offspring of birds and mammals?

30. What are the advantages and disadvantages of external and internal forms of fertilization?

31. Why would paired external fertilization be preferable to group spawning?

32. Describe the phases of the human sexual response.

33. Compare spermatogenesis and oogenesis as to timing of the processes and the number and types of cells finally produced.

34. If male reproductive pathways are not cyclical, how are they controlled?

35. Describe the events in the ovarian cycle leading up to ovulation.

36. Describe the major developments during each trimester of human gestation.

37. Describe the stages of labor.

38. What do you think would happen if multiple sperm fused with one egg?

39. Why do mammalian eggs have a small concentration of yolk, while bird and reptile eggs have a large concentration of yolk?

40. Explain how the different germ layers give rise to different tissue types.

41. Explain the role of axis formation in development.

Chapter 41 Exercises

Review Questions

1. Where does perception occur?
- **a.** spinal cord
- **b.** cerebral cortex
- **c.** receptors
- **d.** thalamus

2. If a person's cold receptors no longer convert cold stimuli into sensory signals, that person has a problem with the process of _____.
- **a.** reception
- **b.** transmission
- **c.** perception
- **d.** transduction

3. After somatosensory transduction, the sensory signal travels through the brain as a(n) _____ signal.
- **a.** electrical
- **b.** pressure
- **c.** optical
- **d.** thermal

4. Many people experience motion sickness while traveling in a car. This sensation results from contradictory inputs arising from which senses?
- **a.** proprioception and kinesthesia
- **b.** somatosensation and equilibrium
- **c.** gustation and vibration
- **d.** vision and vestibular system

5. The _____ are found only in _____ skin and detect skin deflection.
- **a.** Meissner's corpuscles; hairy
- **b.** Merkel's disks; glabrous
- **c.** hair receptors; hairy
- **d.** Krause end bulbs; hairy

6. If you were to burn your epidermis, what receptor type would you most likely burn?
- **a.** free nerve endings
- **b.** Ruffini endings
- **c.** Pacinian corpuscle
- **d.** hair receptors

7. Many diabetic patients are warned by their doctors to test their glucose levels by pricking the sides of their fingers rather than the pads. Pricking the sides avoids stimulating which receptor?
- **a.** Krause end bulbs
- **b.** Meissner's corpuscles
- **c.** Ruffini ending
- **d.** nociceptors

8. Which of the following has the fewest taste receptors?
- **a.** fungiform papillae
- **b.** circumvallate papillae
- **c.** foliate papillae
- **d.** filiform papillae

9. How many different taste molecules do taste cells each detect?
- **a.** one
- **b.** five
- **c.** ten
- **d.** It depends on the spot on the tongue.

10. Salty foods activate the taste cells by _____.
- **a.** exciting the taste cell directly
- **b.** causing hydrogen ions to enter the cell
- **c.** causing sodium channels to close
- **d.** binding directly to the receptors

11. All sensory signals except _____ travel to the _____ in the brain before the cerebral cortex.
- **a.** vision; thalamus
- **b.** olfaction; thalamus
- **c.** vision; cranial nerves
- **d.** olfaction; cranial nerves

12. How is the ability to recognize the umami taste an evolutionary advantage?
- **a.** Umami identifies healthy foods that are low in salt and sugar.
- **b.** Umami enhances the flavor of bland foods.
- **c.** Umami identifies foods that might contain essential amino acids.
- **d.** Umami identifies foods that help maintain electrolyte balance.

13. In sound, pitch is measured in _____, and volume is measured in _____.
- **a.** nanometers (nm); decibels (dB)
- **b.** decibels (dB); nanometers (nm)
- **c.** decibels (dB); hertz (Hz)
- **d.** hertz (Hz); decibels (dB)

14. Auditory hair cells are indirectly anchored to the _____.
- **a.** basilar membrane
- **b.** oval window
- **c.** tectorial membrane
- **d.** ossicles

15. Which of the following are found both in the auditory system and the vestibular system?
- **a.** basilar membrane
- **b.** hair cells
- **c.** semicircular canals
- **d.** ossicles

16. Benign Paroxysmal Positional Vertigo is a disorder where some of the calcium carbonate crystals in the utricle migrate into the semicircular canals. Why does this condition cause periods of dizziness?
- **a.** The hair cells in the semicircular canals will be constantly activated.
- **b.** The hair cells in the semicircular canals will now be stimulated by gravity.
- **c.** The utricle will no longer recognize acceleration.
- **d.** There will be too much volume in the semicircular canals for them to detect motion.

17. Why do people over 55 often need reading glasses?
- **a.** Their cornea no longer focuses correctly.
- **b.** Their lens no longer focuses correctly.
- **c.** Their eyeball has elongated with age, causing images to focus in front of their retina.
- **d.** Their retina has thinned with age, making vision more difficult.

18. Why is it easier to see images at night using peripheral, rather than central, vision?
- **a.** Cones are denser in the periphery of the retina.
- **b.** Bipolar cells are denser in the periphery of the retina.
- **c.** Rods are denser in the periphery of the retina.
- **d.** The optic nerve exits at the periphery of the retina.

19. A person catching a ball must coordinate their head and eyes. What part of the brain is helping to do this?
- **a.** hypothalamus
- **b.** pineal gland
- **c.** thalamus
- **d.** superior colliculus

20. A satellite is launched into space but explodes after exiting the Earth's atmosphere. Which statement accurately reflects the observations made by an astronaut on a space walk outside the International Space Station during the explosion?
- **a.** The astronaut would see the explosion but would not hear a boom.
- **b.** The astronaut would not sense the explosion.
- **c.** The astronaut would see the explosion and then hear the boom.
- **d.** The astronaut would feel the concussive force of the explosion but will not see it.

Critical Thinking Questions

21. If a person sustains damage to axons leading from sensory receptors to the central nervous system, which step or steps of sensory perception will be affected?

22. In what way does the overall magnitude of a stimulus affect the just-noticeable difference in the perception of that stimulus?

23. Describe the difference in the localization of the sensory receptors for general and special senses in humans.

24. What can be inferred about the relative sizes of the areas of cortex that process signals from skin not densely innervated with sensory receptors and skin that is densely innervated with sensory receptors?

25. Many studies have demonstrated that women are able to tolerate the same painful stimuli for longer than men. Why don't all people experience pain the same way?

26. From the perspective of the recipient of the signal, in what ways do pheromones differ from other odorants?

27. What might be the effect on an animal of not being able to perceive taste?

28. A few recent cancer detection studies have used trained dogs to detect lung cancer in urine samples. What is the hypothesis behind this study? Why are dogs a better choice of detectors in this study than humans?

29. How would a rise in altitude likely affect the speed of a sound transmitted through air? Why?

30. How might being in a place with less gravity than Earth has (such as Earth's moon) affect vestibular sensation, and why?

31. How does the structure of the ear allow a person to determine where a sound originates?

32. How could the pineal gland, the brain structure that plays a role in annual cycles, use visual information from the suprachiasmatic nucleus of the hypothalamus?

33. How is the relationship between photoreceptors and bipolar cells different from other sensory receptors and adjacent cells?

34. Cataracts, the medical condition where the lens of the eye becomes cloudy, are a leading cause of blindness. Describe how developing a cataract would change the path of light through the eye.

Chapter 42 Exercises

Review Questions

1. Neurons contain _____, which can receive signals from other neurons.
- **a.** axons
- **b.** mitochondria
- **c.** dendrites
- **d.** Golgi bodies

2. A(n) _____ neuron has one axon and one dendrite extending directly from the cell body.
- **a.** unipolar
- **b.** bipolar
- **c.** multipolar
- **d.** pseudounipolar

3. Glia that provide myelin for neurons in the brain are called _____.
- **a.** Schwann cells
- **b.** oligodendrocytes
- **c.** microglia
- **d.** astrocytes

4. Meningitis is a viral or bacterial infection of the brain. Which cell type is the first to have its function disrupted during meningitis?
- **a.** astrocytes
- **b.** microglia
- **c.** neurons
- **d.** satellite glia

5. For a neuron to fire an action potential, its membrane must reach _____.
- **a.** hyperpolarization
- **b.** the threshold of excitation
- **c.** the refractory period
- **d.** inhibitory postsynaptic potential

6. After an action potential, the opening of additional voltage-gated _____ channels and the inactivation of sodium channels cause the membrane to return to its resting membrane potential.
- **a.** sodium
- **b.** potassium
- **c.** calcium
- **d.** chloride

7. What is the term for protein channels that connect two neurons at an electrical synapse?
- **a.** synaptic vesicles
- **b.** voltage-gated ion channels
- **c.** gap junction protein
- **d.** sodium-potassium exchange pumps

8. Which of the following molecules is *not* involved in the maintenance of the resting membrane potential?
- **a.** potassium cations
- **b.** ATP
- **c.** voltage-gated ion channels
- **d.** calcium cations

9. The _____ lobe contains the visual cortex.
- **a.** frontal
- **b.** parietal
- **c.** temporal
- **d.** occipital

10. The _____ connects the two cerebral hemispheres.
- **a.** limbic system
- **b.** corpus callosum
- **c.** cerebellum
- **d.** pituitary

11. Neurons in the _____ control motor reflexes.
- **a.** thalamus
- **b.** spinal cord
- **c.** parietal lobe
- **d.** hippocampus

12. Phineas Gage was a nineteenth century railroad worker who survived an accident that drove a large iron rod through his head. If the injury resulted in him becoming temperamental and capricious, which part of his brain was damaged?
- **a.** frontal lobe
- **b.** hippocampus
- **c.** parietal lobe
- **d.** temporal lobe

13. Activation of the sympathetic nervous system causes _____.
- **a.** increased blood flow into the skin
- **b.** a decreased heart rate
- **c.** an increased heart rate
- **d.** increased digestion

14. Where are parasympathetic preganglionic cell bodies located?
- **a.** cerebellum
- **b.** brainstem
- **c.** dorsal root ganglia
- **d.** skin

15. Motor nerve endings release _____ onto muscle.
- **a.** acetylcholine
- **b.** norepinephrine
- **c.** dopamine
- **d.** serotonin

16. Parkinson's disease is caused by the degeneration of neurons that release _____.
- **a.** serotonin
- **b.** dopamine
- **c.** glutamate
- **d.** norepinephrine

17. Patients with ADHD are often treated with _____ medications.
- **a.** tranquilizer
- **b.** antibiotic
- **c.** stimulant
- **d.** anti-seizure

18. Strokes are often caused by _____.
- **a.** neurodegeneration
- **b.** blood clots or burst blood vessels
- **c.** seizures
- **d.** viruses

19. Why is it difficult to identify the cause of many nervous system disorders?
- **a.** The genes associated with the diseases are not known.
- **b.** There are no obvious defects in brain structure.
- **c.** The onset and display of symptoms varies between patients.
- **d.** all of these

20. Why do many patients with neurodevelopmental disorders develop secondary disorders?
- **a.** Their genes predispose them to schizophrenia.
- **b.** Stimulant medications cause new behavioral disorders.
- **c.** Behavioral therapies only improve neurodevelopmental disorders.
- **d.** Dysfunction in the brain can affect many aspects of the body.

Critical Thinking Questions

21. How are neurons like other cells? How are they unique?

22. Multiple sclerosis causes demyelination of axons in the brain and spinal cord. Why is this problematic?

23. Many neurons have only a single axon but many terminals at the end of the axon. How does this end structure of the axon support its function?

24. How does myelin aid propagation of an action potential along an axon? How do the nodes of Ranvier help this process?

25. What are the main steps in chemical neurotransmission?

26. Describe how long-term potentiation can lead to a nicotine addiction.

27. What methods can be used to determine the function of a particular brain region?

28. What are the main functions of the spinal cord?

29. Alzheimer's disease involves three of the four lobes of the brain. Identify one of the involved lobes and describe the lobe's symptoms associated with the disease.

30. What are the main differences between the sympathetic and parasympathetic branches of the autonomic nervous system?

31. What are the main functions of the sensory-somatic nervous system?

32. Describe how the sensory-somatic nervous system reacts by reflex to a person touching something hot. How does this allow for rapid responses in potentially dangerous situations?

33. Scientists have suggested that the autonomic nervous system is not well adapted to modern human life. How is the sympathetic nervous system an ineffective response to the everyday challenges faced by modern humans?

34. What are the main symptoms of Alzheimer's disease?

35. What are possible treatments for patients with major depression?

Chapter 43 Exercises

Review Questions

1. The forearm consists of the _____.
- **a.** radius and ulna
- **b.** radius and humerus
- **c.** ulna and humerus
- **d.** humerus and carpus

2. The pectoral girdle consists of the _____.
- **a.** clavicle and sternum
- **b.** sternum and scapula
- **c.** clavicle and scapula
- **d.** clavicle and coccyx

3. All of the following are groups of vertebrae except _____.
- **a.** thoracic
- **b.** cervical
- **c.** lumbar
- **d.** pelvic

4. Which of these is a facial bone?
- **a.** frontal
- **b.** occipital
- **c.** lacrimal
- **d.** temporal

5. Which of the following is *not* a true statement comparing exoskeletons and endoskeletons?
- **a.** Endoskeletons can support larger organisms.
- **b.** Only endoskeletons can grow as an organism grows.
- **c.** Exoskeletons provide greater protection of the internal organs.
- **d.** Exoskeletons provide less mechanical leverage.

6. The Haversian canal _____.
- **a.** is arranged as rods or plates
- **b.** contains the bone's blood vessels and nerve fibers
- **c.** is responsible for the lengthwise growth of long bones
- **d.** synthesizes and secretes matrix

7. The epiphyseal plate _____.
- **a.** is arranged as rods or plates
- **b.** contains the bone's blood vessels and nerve fibers
- **c.** is responsible for the lengthwise growth of long bones
- **d.** synthesizes and secretes bone matrix

8. The cells responsible for bone resorption are _____.
- **a.** osteoclasts
- **b.** osteoblasts
- **c.** fibroblasts
- **d.** osteocytes

9. Compact bone is composed of _____.
- **a.** trabeculae
- **b.** compacted collagen
- **c.** osteons
- **d.** calcium phosphate only

10. Osteoporosis is a condition where bones become weak and brittle. It is caused by an imbalance in the activity of which cells?
- **a.** osteoclasts and osteoblasts
- **b.** osteoclasts and osteocytes
- **c.** osteoblasts and chondrocytes
- **d.** osteocytes and chondrocytes

11. While assembling a skeleton of a new species, a scientist points to one of the bones and observes that it looks like the most likely site of leg muscle attachment. What kind of bone did they indicate?
- **a.** sesamoid bone
- **b.** long bone
- **c.** trabecular bone
- **d.** flat bone

12. Synchondroses and symphyses are _____.
- **a.** synovial joints
- **b.** cartilaginous joints
- **c.** fibrous joints
- **d.** condyloid joints

13. The movement of bone away from the midline of the body is called _____.
- **a.** circumduction
- **b.** extension
- **c.** adduction
- **d.** abduction

14. Which of the following is *not* a characteristic of the synovial fluid?
- **a.** lubrication
- **b.** shock absorption
- **c.** regulation of water balance in the joint
- **d.** protection of articular cartilage

15. The elbow is an example of which type of joint?
- **a.** hinge
- **b.** pivot
- **c.** saddle
- **d.** gliding

16. A high ankle sprain is an injury caused by over-stretching the ligaments connecting the tibia and fibula. What type of joint is involved in this sprain?
- **a.** ball-and-socket
- **b.** gomphosis
- **c.** syndesmosis
- **d.** symphysis

17. In relaxed muscle, the myosin-binding site on actin is blocked by _____.
- **a.** titin
- **b.** troponin
- **c.** myoglobin
- **d.** tropomyosin

18. The cell membrane of a muscle fiber is called a _____.
- **a.** myofibril
- **b.** sarcolemma
- **c.** sarcoplasm
- **d.** myofilament

19. The muscle relaxes if no new nerve signal arrives. However, the neurotransmitter from the previous stimulation is still present in the synapse. The activity of _____ helps to remove this neurotransmitter.
- **a.** myosin
- **b.** action potential
- **c.** tropomyosin
- **d.** acetylcholinesterase

20. The ability of a muscle to generate tension immediately after stimulation is dependent on _____.
- **a.** myosin interaction with the M line
- **b.** overlap of myosin and actin
- **c.** actin attachments to the Z line
- **d.** none of these

21. Botulinum toxin causes flaccid paralysis of the muscles and is used for cosmetic purposes under the name Botox. Which of the following is the most likely mechanism of action of Botox?
- **a.** Botox decreases the production of acetylcholinesterase.
- **b.** Botox increases calcium release from the sarcoplasmic reticulum.
- **c.** Botox blocks the ATP binding site in actin.
- **d.** Botox decreases the release of acetylcholine from motor neurons.

Critical Thinking Questions

22. What are the major differences between the male and female pelvis that permit childbirth in females?

23. What are the major differences between the pelvic girdle and the pectoral girdle that allow the pelvic girdle to bear the weight of the body?

24. Both hydrostatic and exoskeletons can protect internal organs from harm. Contrast the ways the skeletons perform these functions.

25. Scoliosis is a medical condition where the spine develops a sideways curvature. How would this change interfere with the normal function of the spine?

26. What are the major differences between spongy bone and compact bone?

27. What are the roles of osteoblasts, osteocytes, and osteoclasts?

28. Thalidomide was a morning sickness drug administered during pregnancy that caused babies to be born without arm bones. If recent studies have shown that thalidomide prevents the formation of new blood vessels, describe the type of bone development inhibited by the drug and what stage of ossification was affected.

29. What movements occur at the hip joint and knees as you bend down to touch your toes?

30. What movement(s) occur(s) at the scapulae when you shrug your shoulders?

31. Describe the joints and motions involved in taking a step forward if a person is initially standing still. Assume the person holds their foot at the same angle throughout the motion.

32. How would muscle contractions be affected if ATP were completely depleted in a muscle fiber?

33. What factors contribute to the amount of tension produced in an individual muscle fiber?

34. What effect will low blood calcium have on neurons? What effect will low blood calcium have on skeletal muscles?

35. Skeletal muscles can only produce a mechanical force as they are contracted, but a leg flexes and extends while walking. How can muscles perform this task?

Chapter 44 Exercises

Review Questions

1. Which of the following is a biotic factor?
- **a.** wind
- **b.** disease-causing microbe
- **c.** temperature
- **d.** soil particle size

2. The study of nutrient cycling though the environment is an example of which of the following?
- **a.** organismal ecology
- **b.** population ecology
- **c.** community ecology
- **d.** ecosystem ecology

3. Understory plants in a temperate forest have adaptations to capture limited _____.
- **a.** water
- **b.** nutrients
- **c.** heat
- **d.** sunlight

4. An ecologist hiking up a mountain may notice different biomes along the way due to changes in all of the following, except _____.
- **a.** elevation
- **b.** rainfall
- **c.** latitude
- **d.** temperature

5. Which of the following biomes is characterized by abundant water resources?
- **a.** deserts
- **b.** boreal forests
- **c.** savannas
- **d.** tropical wet forests

6. Which of the following biomes is characterized by short growing seasons?
- **a.** deserts
- **b.** tropical wet forests
- **c.** Arctic tundras
- **d.** savannas

7. Where would you expect to find the most photosynthesis in an ocean biome?
- **a.** aphotic zone
- **b.** abyssal zone
- **c.** benthic realm
- **d.** intertidal zone

8. A key feature of estuaries is _____.
- **a.** low light conditions and high productivity
- **b.** salt water and fresh water
- **c.** frequent algal blooms
- **d.** little or no vegetation

9. Which of the following is an example of a weather event?
- **a.** The hurricane season lasts from June 1 through November 30.
- **b.** The amount of atmospheric CO_2 has steadily increased during the last century.
- **c.** A windstorm blew down trees in the Boundary Waters Canoe Area in Minnesota on July 4, 1999.
- **d.** Deserts are generally dry ecosystems having very little rainfall.

10. Which of the following natural forces is responsible for the release of carbon dioxide and other atmospheric gases?
- **a.** the Milankovitch cycles
- **b.** volcanoes
- **c.** solar intensity
- **d.** burning of fossil fuels

Critical Thinking Questions

11. Ecologists often collaborate with other researchers interested in ecological questions. Describe the levels of ecology that would best lend themselves to collaboration because of the similarities in questions asked. What levels of ecology might be more difficult for collaboration?

12. The population is an important unit in ecology as well as other biological sciences. How is a population defined, and what are the strengths and weaknesses of this definition? Are there some species that at certain times or places are not in populations?
13. Compare and contrast ocean upwelling and spring-and-fall turnovers.
14. Many endemic species are found in areas that are geographically isolated. Suggest a plausible scientific explanation for why this is so.
15. The extremely low precipitation of subtropical desert biomes might lead one to expect fire to be a major disturbance factor; however, fire is more common in the temperate grassland biome than in the subtropic desert biome. Why is this?
16. In what ways are the subtropical desert and the arctic tundra similar?
17. Scientists have discovered the bodies of humans and other living things buried in bogs for hundreds of years but not yet decomposed. Suggest a possible biological explanation for why such bodies are so well preserved.
18. Describe the conditions and challenges facing organisms living in the intertidal zone.
19. Compare and contrast how natural- and human-induced processes have influenced global climate change.
20. Predict possible consequences if carbon emissions from fossil fuels continue to rise.

Chapter 45 Exercises

Review Questions

1. Which of the following methods will tell an ecologist about both the size and density of a population of immobile organisms?
a. mark and recapture
b. mark and release
c. quadrat
d. life table

2. Which of the following is best at showing the life expectancy of an individual within a population?
a. quadrat
b. mark and recapture
c. survivorship curve
d. life table

3. Humans have which type of survivorship curve?
a. Type I
b. Type II
c. Type III
d. Type IV

4. How is a clumped population distribution beneficial for prey animals?
a. Being a member of a larger group provides protection for each individual from predators.
b. Prey animals rely on each other to acquire food.
c. Prey animals live in small family groups to raise young.
d. Clumped population distributions ensure that at least one member of the population knows how to identify the seasonal migration route.

5. Which of the following is associated with long-term parental care?
a. few offspring
b. many offspring
c. semelparity
d. fecundity

6. Which of the following is associated with multiple reproductive episodes during a species' lifetime?
a. semiparity
b. iteroparity
c. semelparity
d. fecundity

7. Which of the following is associated with the reproductive potential of a species?
a. few offspring
b. many offspring
c. semelparity
d. fecundity

8. Species with limited resources usually exhibit a(n) _____ growth curve.
a. logistic
b. logical
c. experimental
d. exponential

9. The maximum rate of increased characteristic of a species is called its _____.
a. limit
b. carrying capacity
c. biotic potential
d. exponential growth pattern

10. The population size of a species capable of being supported by the environment is called its _____.
a. limit
b. carrying capacity
c. biotic potential
d. logistic growth pattern

11. Species that have many offspring at one time are usually _____.
a. *r*-selected
b. *K*-selected
c. both *r*- and *K*-selected
d. not selected

12. A forest fire is an example of _____ regulation.
a. density-dependent
b. density-independent
c. *r*-selected
d. *K*-selected

13. Primates are examples of _____.
a. density-dependent species
b. density-independent species
c. *r*-selected species
d. *K*-selected species

14. Which of the following statements does *not* support the conclusion that giraffes are *K*-selected species?
- **a.** Giraffes are approximately 6 feet tall and weigh 150 pounds at birth.
- **b.** Wild giraffes begin mating at 6 to 7 years of age.
- **c.** Newborn giraffes are capable of coordinated walking within an hour of birth and running within 24 hours of birth.
- **d.** Giraffes rarely give birth to twins.

15. Which of the following events would *not* negatively impact Yellowstone's grey wolf carrying capacity?
- **a.** snow in winter
- **b.** a beaver damming a river upstream
- **c.** a forest fire
- **d.** chronic wasting disease in the deer population

16. A country with zero population growth is likely to be _____.
- **a.** in Africa
- **b.** in Asia
- **c.** economically developed
- **d.** economically underdeveloped

17. Which type of country has the greatest proportion of young individuals?
- **a.** economically developed
- **b.** economically underdeveloped
- **c.** countries with zero population growth
- **d.** countries in Europe

18. Which of the following is *not* a way that humans have increased the carrying capacity of the environment?
- **a.** agriculture
- **b.** using large amounts of natural resources
- **c.** domestication of animals
- **d.** use of language

19. The first species to live on new land, such as that formed from volcanic lava, are called _____.
- **a.** climax community
- **b.** keystone species
- **c.** foundation species
- **d.** pioneer species

20. Which type of mimicry involves multiple species with similar warning coloration that are all toxic to predators?
- **a.** Batesian mimicry
- **b.** Müllerian mimicry
- **c.** Emsleyan mimicry
- **d.** Mertensian mimicry

21. A symbiotic relationship where both coexisting species benefit from the interaction is called _____.
- **a.** commensalism
- **b.** parasitism
- **c.** mutualism
- **d.** communism

22. Which of the following is *not* a mutualistic relationship?
- **a.** a shark using an aquatic cleaning station
- **b.** a helminth feeding from its host
- **c.** a bumblebee collecting pollen from a flower
- **d.** bacteria living in the gut of humans

23. The ability of rats to learn how to run a maze is an example of _____.
- **a.** imprinting
- **b.** classical conditioning
- **c.** operant conditioning
- **d.** cognitive learning

24. The training of animals usually involves _____.
- **a.** imprinting
- **b.** classical conditioning
- **c.** operant conditioning
- **d.** cognitive learning

25. The sacrifice of the life of an individual so that the genes of relatives may be passed on is called _____.
    a. operant learning
    b. kin selection
    c. kinesis
    d. imprinting

26. Why are polyandrous mating systems more rare than polygynous mating?
    a. Only males are capable of multiple rounds of reproduction within a single breeding season.
    b. Only females care for the young.
    c. Females usually experience more intrasexual selection pressure than males.
    d. Females usually devote more energy to offspring production and development.

Critical Thinking Questions

27. Describe how a researcher would determine the size of a penguin population in Antarctica using the mark and release method.

28. The CDC released the following data in its 2013 Vital Statistics report.

Age Interval	Number Dying in Age Interval	Number Surviving at Beginning of Interval	Mortality Rate
0–10	756	100,000	
11–20	292	99,244	
21–30	890	98,953	
31–40	1,234	98,164	
41–50	2,457	96,811	
51–60	5,564	94,352	
61–70	10,479	88,788	

Calculate the mortality rate for each age interval and describe the trends in adult and childhood mortality per 100,000 births in the United States in 2013.

29. Why is long-term parental care not associated with having many offspring during a reproductive episode?

30. Describe the difference in evolutionary pressures experienced by an animal that begins reproducing early and an animal that reproduces late in its life cycle.

31. Describe the rate of population growth that would be expected at various parts of the S-shaped curve of logistic growth.

32. Describe how the population of a species that survives a mass extinction event would change in size and growth pattern over time beginning immediately after the extinction event.

33. Give an example of how density-dependent and density-independent factors might interact.

34. Describe the age structures in rapidly growing countries, slowly growing countries, and countries with zero population growth.

35. Since the introduction of the Endangered Species Act, the number of species on the protected list has more than doubled. Describe how the human population's growth pattern contributes to the rise in endangered species.

36. Describe the competitive exclusion principle and its effects on competing species.

37. Jaguars are a keystone species in the Amazon. Describe how they can be so essential to the ecosystem despite being significantly less abundant than many other species.

38. Describe Pavlov's dog experiments as an example of classical conditioning.

39. Describe the advantage of using an aural or pheromone signal to attract a mate as opposed to a visual signal. How might the population density contribute to the evolution of aural or visual mating rituals?

Chapter 46 Exercises

Review Questions

1. The ability of an ecosystem to return to its equilibrium state after an environmental disturbance is called _____.

a. resistance
b. restoration
c. reformation
d. resilience

2. A recreated ecosystem in a laboratory environment is known as a _____.

a. mesocosm
b. simulation
c. microcosm
d. reproduction

3. Decomposers are associated with which class of food web?

a. grazing
b. detrital
c. inverted
d. aquatic

4. The primary producers in an ocean grazing food web are usually _____.

a. plants
b. animals
c. fungi
d. phytoplankton

5. What term describes the use of mathematical equations in the modeling of linear aspects of ecosystems?

a. analytical modeling
b. simulation modeling
c. conceptual modeling
d. individual-based modeling

6. The position of an organism along a food chain is known as its _____.

a. locus
b. location
c. trophic level
d. microcosm

7. The loss of an apex consumer would impact which trophic level of a food web?

a. primary producers
b. primary consumers
c. secondary consumers
d. all of these

8. A food chain would be a better resource than a food web to answer which question?

a. How does energy move from an organism in one trophic level to an organism on the next trophic level?
b. How does energy move within a trophic level?
c. What preys on grasses?
d. How is organic matter recycled in a forest?

9. The weight of living organisms in an ecosystem at a particular point in time is called _____.

a. energy
b. production
c. entropy
d. biomass

10. Which term describes the process whereby toxic substances increase along trophic levels of an ecosystem?

a. biomassification
b. biomagnification
c. bioentropy
d. heterotrophy

11. Organisms that can make their own food using inorganic molecules are called _____.

a. autotrophs
b. heterotrophs
c. photoautotrophs
d. chemoautotrophs

12. In the English Channel ecosystem, the number of primary producers is smaller than the number of primary consumers because _____.
- **a.** the apex consumers have a low turnover rate
- **b.** the primary producers have a low turnover rate
- **c.** the primary producers have a high turnover rate
- **d.** the primary consumers have a high turnover rate

13. What law of chemistry determines how much energy can be transferred when it is converted from one form to another?
- **a.** the first law of thermodynamics
- **b.** the second law of thermodynamics
- **c.** the conservation of matter
- **d.** the conservation of energy

14. The mussels that live at the NW Eifuku volcano are examples of _____.
- **a.** chemoautotrophs
- **b.** photoautotrophs
- **c.** apex predators
- **d.** primary consumers

15. The movement of mineral nutrients through organisms and their environment is called a _____ cycle.
- **a.** biological
- **b.** bioaccumulation
- **c.** biogeochemical
- **d.** biochemical

16. Most carbon is present in the atmosphere as _____.
- **a.** carbon dioxide
- **b.** carbonate ion
- **c.** carbon dust
- **d.** carbon monoxide

17. The majority of water found on Earth is _____.
- **a.** ice
- **b.** water vapor
- **c.** fresh water
- **d.** salt water

18. The average time a molecule spends in its reservoir is known as _____.
- **a.** residence time
- **b.** restriction time
- **c.** resilience time
- **d.** storage time

19. The process whereby oxygen is depleted by the growth of microorganisms due to excess nutrients in aquatic systems is called _____.
- **a.** dead zoning
- **b.** eutrophication
- **c.** retrofication
- **d.** depletion

20. The process whereby nitrogen is brought into organic molecules is called _____.
- **a.** nitrification
- **b.** denitrification
- **c.** nitrogen fixation
- **d.** nitrogen cycling

21. Which of the following approaches would be the most effective way to reduce greenhouse carbon dioxide?
- **a.** increase waste deposition into the deep ocean
- **b.** plant more environmentally suitable plants
- **c.** increase use of fuel sources that do not produce carbon dioxide as a byproduct
- **d.** decrease livestock agriculture

22. How would loss of fungi in a forest effect biogeochemical cycles in the area?
- **a.** Nitrogen could no longer be fixed into organic molecules.
- **b.** Phosphorus stores would be released for use by other organisms.
- **c.** Sulfur release from eroding rocks would cease.
- **d.** Carbon would accumulate in dead organic matter and waste.

Critical Thinking Questions

23. Compare and contrast food chains and food webs. What are the strengths of each concept in describing ecosystems?

24. Describe freshwater, ocean, and terrestrial ecosystems.

25. Compare grazing and detrital food webs. Why would they both be present in the same ecosystem?

26. How does the microcosm modeling approach differ from utilizing a holistic model for ecological research?

27. How do conceptual and analytical models of ecosystems complement each other?

28. Compare the three types of ecological pyramids and how well they describe ecosystem structure. Identify which ones can be inverted and give an example of an inverted pyramid for each.

29. How does the amount of food a warm-blooded animal (endotherm) eats relate to its net production efficiency (NPE)?

30. A study uses an inverted pyramid to demonstrate the relationship between sharks, their aquatic prey, and phytoplankton in an ocean region. What type of pyramid must be used? What does this convey to readers about predation in the area?

31. Describe what a pyramid of numbers would look like if an ecologist modeled the relationship between bird parasites, blue jays, and oak trees in a hectare. Does this match the energy flow pyramid?

32. Describe nitrogen fixation and why it is important to agriculture.

33. What are the factors that cause dead zones? Describe eutrophication, in particular, as a cause.

34. Why are drinking water supplies still a major concern for many countries?

35. Discuss how the human disruption of the carbon cycle has caused ocean acidification.

Chapter 47 Exercises

Review Questions

1. With an extinction rate of 100 E/MSY and an estimated 10 million species, how many extinctions are expected to occur in a century?

a. 100
b. 10,000
c. 100,000
d. 1,000,000

2. An adaptive radiation is _____.

a. a burst of speciation
b. a healthy level of UV radiation
c. a hypothesized cause of a mass extinction
d. evidence of an asteroid impact

3. The number of currently described species on the planet is about _____.

a. 17,000
b. 150,000
c. 1.5 million
d. 10 million

4. A mass extinction is defined as _____.

a. a loss of 95% of species
b. an asteroid impact
c. a boundary between geological periods
d. a loss of 50% of species

5. A secondary plant compound might be used for which of the following?

a. a new crop variety
b. a new drug
c. a soil nutrient
d. a pest of a crop pest

6. Pollination is an example of _____.

a. a possible source of new drugs
b. chemical diversity
c. an ecosystem service
d. crop pest control

7. What is an ecosystem service that performs the same function as a pesticide?

a. pollination
b. secondary plant compounds
c. crop diversity
d. predators of pests

8. Which two extinction risks may be a direct result of the pet trade?

a. climate change and exotic species introduction
b. habitat loss and overharvesting
c. overharvesting and exotic species introduction
d. habitat loss and climate change

9. Exotic species are especially threatening to which kind of ecosystem?

a. deserts
b. marine ecosystems
c. islands
d. tropical forests

10. Certain parrot species cannot be brought to the United States to be sold as pets. What is the name of the legislation that makes this illegal?

a. Red List
b. Migratory Bird Act
c. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
d. Endangered Species Act (ESA)

11. What was the name of the first international agreement on climate change?
- **a.** Red List
- **b.** Montreal Protocol
- **c.** International Union for the Conservation of Nature (IUCN)
- **d.** Kyoto Protocol

12. About what percentage of land on the planet is set aside as a preserve of some type?
- **a.** 1%
- **b.** 6%
- **c.** 11%
- **d.** 15%

Critical Thinking Questions

13. Describe the evidence for the cause of the Cretaceous–Paleogene (K–Pg) mass extinction.

14. Describe the two methods used to calculate contemporary extinction rates.

15. Explain how biodiversity loss can impact crop diversity.

16. Describe two types of compounds from living things that are used as medications.

17. Describe the mechanisms by which human population growth and resource use causes increased extinction rates.

18. Explain what extinction threats a frog living on a mountainside in Costa Rica might face.

19. Describe two considerations in conservation preserve design.

20. Describe what happens to an ecosystem when a keystone species is removed.