

## Chapter 2:

4. 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

5. Atoms that vary in the number of neutrons found in their nuclei are called \_\_\_\_\_.

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

6. 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

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

- a. hydrogen bond

b. atomic bond

c. covalent bond

d. nonpolar covalent bond

8. 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.

9. When acids are added to a solution, the pH should \_\_\_\_\_.

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

10. We call a molecule that binds up excess hydrogen ions in a solution a(n) \_\_\_\_\_.

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

11. 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<sup>-</sup>); bases

donate hydrogen ions (H<sup>+</sup>).

12. Each carbon atom can bond with as many as \_\_\_\_\_ other atom(s) or molecule(s).

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

13. 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

14. What makes ionic bonds different from covalent bonds?

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

16. Discuss how buffers help prevent drastic swings in pH.

17. Why can some insects walk on water?

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

19. Compare and contrast saturated and unsaturated triglycerides

#### Chapter 3:

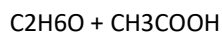
4. Dehydration synthesis leads to the formation of

- a. monomers
- b. polymers
- c. water and polymers
- d. none of the above

5. During the breakdown of polymers, which of the following reactions takes place?

- a. hydrolysis
- b. dehydration
- c. condensation
- d. covalent bond

6. The following chemical reactants produce the ester ethyl ethanoate (C<sub>4</sub>H<sub>8</sub>O<sub>2</sub>):



What type of reaction occurs to make ethyl ethanoate?

- a. condensation
- b. hydrolysis
- c. combustion
- d. acid-base reaction

7. An example of a monosaccharide is \_\_\_\_\_.

- a. fructose

- b. glucose
- c. galactose
- d. all of the above

8. Cellulose and starch are examples of:

- a. monosaccharides
- b. disaccharides
- c. lipids
- d. polysaccharides

9. Plant cell walls contain which of the following in abundance?

- a. starch
- b. cellulose
- c. glycogen
- d. lactose

10. 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

11. Which of the following is not an extracellular matrix role of carbohydrates?

- a. protect an insect's internal organs from external trauma
- b. prevent plant cells from lysing after the plant is watered

- c. maintain the shape of a fungal spore
- d. provide energy for muscle movement

12. 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

13. 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

14. 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

15. The monomers that make up proteins are called \_\_\_\_\_.

- a. nucleotides
- b. disaccharides
- c. amino acids
- d. chaperones

16. The  $\alpha$ -helix and the  $\beta$ -pleated sheet are part of which protein structure?

- a. primary
- b. secondary
- c. tertiary
- d. quaternary

17. 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

18. 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

19. The building blocks of nucleic acids are \_\_\_\_\_.

- a. sugars
- b. nitrogenous bases
- c. peptides
- d. nucleotides

20. 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. tRNA 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.

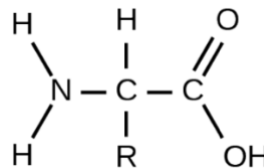
### Critical Thinking Questions

21. Why are biological macromolecules considered organic?

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

23. Amino acids have the generic structure seen below, 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.



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

25. Why is it impossible for humans to digest food that contains cellulose?

26. 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?

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

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

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

30. 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.

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

32. Describe the differences in the four protein structures.

33. 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.

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

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

#### Chapter 4:

4. 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

5. The \_\_\_\_\_ is the basic unit of life.

- a. organism
- b. cell
- c. tissue
- d. organ

6. Prokaryotes depend on \_\_\_\_\_ to obtain some materials and to get rid of wastes.

- a. ribosomes
- b. flagella
- c. cell division
- d. diffusion

7. 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

8. Which of the following organisms is a prokaryote?

- a. amoeba
- b. influenza A virus
- c. charophyte algae
- d. E. coli

9. Which of the following is surrounded by two phospholipid bilayers?

- a. the ribosomes
- b. the vesicles
- c. the cytoplasm
- d. the nucleoplasm

10. 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

11. In plant cells, the function of the lysosomes is carried out by \_\_\_\_\_.

- a. vacuoles
- b. peroxisomes
- c. ribosomes
- d. nuclei

12. Which of the following is both in eukaryotic and prokaryotic cells?

- a. nucleus
- b. mitochondrion
- c. vacuole
- d. ribosomes

13. 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

14. Which of the following is not a component of the endomembrane system?

- a. mitochondrion
- b. Golgi apparatus
- c. endoplasmic reticulum
- d. lysosome

15. The process by which a cell engulfs a foreign particle is known as:

- a. endosymbiosis
- b. phagocytosis
- c. hydrolysis
- d. membrane synthesis

16. 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

17. 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; 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; distribution via the vesicle
- d. synthesis of the protein on the lysosome; packaging in the vesicle; distribution via the Golgi; tagging in the endoplasmic reticulum

18. 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
- b. ribosomes
- c. endosomes
- d. Golgi apparatus

19. 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

20. 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

21. 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
- b. flagella; cilia
- c. microtubules; flagella
- d. microfilaments; microtubules

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

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

23. The key components of desmosomes are cadherins and \_\_\_\_\_.

- a. actin

- b. microfilaments
- c. intermediate filaments
- d. microtubules

24. 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

25. 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?

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

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

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

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

30. 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?

31. Explain why not all microbes are harmful.

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

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

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

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

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

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



38. How do cilia and flagella differ?

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

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

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

42. Explain how the extracellular matrix functions.

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

#### Chapter 5:

4. 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

5. 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

6. 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

7. 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.

8. 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

9. The principal force driving movement in diffusion is the \_\_\_\_\_.

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

10. 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.

11. 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

12. 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

13. 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

14. 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

15. 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.

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

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

17. 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.

18. 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.

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

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

20. 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.

#### 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. Which explanation identifies how 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?

## Chapter 6:

4. Energy is stored long-term in the bonds of \_\_\_\_\_ and used short-term to perform work from a(n) \_\_\_\_\_ molecule.

a. ATP : glucose

b. an anabolic molecule : catabolic molecule

c. glucose : ATP

d. a catabolic molecule : anabolic molecule

5. 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.

6. 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, and 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

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

a. Endergonic reactions have a positive  $\Delta G$  and exergonic reactions have a negative  $\Delta G$ .

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.

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

a. Compare the  $\Delta G$  values between the two reactions.

b. Compare their reaction rates.

c. Compare their ideal environmental conditions.

d. Compare the spontaneity between the two reactions.

9. 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 the above

10. 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, and 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

11. The energy released by the hydrolysis of ATP is\_\_\_\_\_

a. primarily stored between the alpha and beta phosphates

b. equal to  $-57 \text{ kcal/mol}$

c. harnessed as heat energy by the cell to perform work

d. providing energy to coupled reactions

12. Which of the following molecules is likely to have the most potential energy?

a. sucrose

b. ATP

c. glucose

d. ADP

13. Which of the following is not true about enzymes:

a. They increase  $\Delta G$  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.

14. 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.

15. 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

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

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

18. Explain in your own words the difference between a spontaneous reaction and one that occurs instantaneously, and what causes this difference.

19. 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.

20. 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?

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

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

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

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

#### Chapter 7:

4. The energy currency used by cells is \_\_\_\_\_.

a. ATP

b. ADP

c. AMP

d. adenosine

5. 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

6. 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.

7. What is removed from pyruvate during its conversion into an acetyl group?

- a. oxygen
- b. ATP
- c. B vitamin
- d. carbon dioxide

8. What do the electrons added to NAD<sup>+</sup> 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.

9. GTP or ATP is produced during the conversion of \_\_\_\_\_.

- a. isocitrate into  $\alpha$ -ketoglutarate
- b. succinyl CoA into succinate
- c. fumarate into malate
- d. malate into oxaloacetate

10. How many NADH molecules are produced on each turn of the citric acid cycle?

- a. one
- b. two

c. three

d. four

11. What compound receives electrons from NADH?

- a. FMN
- b. ubiquinone
- c. cytochrome c1
- d. oxygen

12. 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

13. 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

14. A major connection for sugars in glycolysis is \_\_\_\_\_.

- a. glucose-6-phosphate
- b. fructose-1,6-bisphosphate
- c. dihydroxyacetone phosphate

d. phosphoenolpyruvate

15. 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

16. 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

17. The control of which enzyme exerts the most control on glycolysis?

- a. hexokinase
- b. phosphofructokinase
- c. glucose-6-phosphatase
- d. aldolase

#### Critical Thinking Questions

18. 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?

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

20. 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?

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

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

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

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

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

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

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



## Chapter 8:

4. 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

5. 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

6. 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

7. 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.

8. 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

9. 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.

10. 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

11. How many photons does it take to fully reduce one molecule of NADP<sup>+</sup> to NADPH?

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

12. 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

13. 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

14. Three of the same species of plant are each grown under a different colored light for the same amount of time. Plant A is grown under blue light, Plant B is grown under green light, and Plant C is grown under orange light.

Assuming the plants use only chlorophyll a and chlorophyll b for photosynthesis, what would be the predicted order of the plants from most growth to least growth?

- a. A, C, B
- b. A, B, C
- c. C, A, B
- d. B, A, C

15. Plants containing only chlorophyll b are exposed to radiation with the following wavelengths: 10nm (x-rays), 450nm (blue light), 670nm (red light), and 800nm (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

16. Which molecule must enter the Calvin cycle continually for the light-independent reactions to take place?

- a. RuBisCO
- b. RuBP
- c. 3-PGA
- d. CO<sub>2</sub>

17. Which order of molecular conversions is correct for the Calvin cycle?

- a.  $\text{RuBP} + \text{G3P} \rightarrow 3\text{-PGA} \rightarrow \text{sugar}$
- b.  $\text{RuBisCO} \rightarrow \text{CO}_2 \rightarrow \text{RuBP} \rightarrow \text{G3P}$
- c.  $\text{RuBP} + \text{CO}_2 \rightarrow [\text{RuBisCO}] \text{ 3-PGA} \rightarrow \text{G3P}$
- d.  $\text{CO}_2 \rightarrow 3\text{-PGA} \rightarrow \text{RuBP} \rightarrow \text{G3P}$

18. Where in eukaryotic cells does the Calvin cycle take place?

- a. thylakoid membrane
- b. thylakoid lumen
- c. chloroplast stroma
- d. granum

19. Which statement correctly describes carbon fixation?

- a. the conversion of CO<sub>2</sub> 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<sub>2</sub>

20. 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

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

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

23. Why are energy carriers thought of as either “full” or “empty”?

24. 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.

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

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

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

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

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

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

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

32. 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?

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

#### Chapter 9:

5. 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.

6. 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

7. 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.

8. 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

9. 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

10. Where do DAG and IP3 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<sub>2</sub>.

11. What property enables the residues of the amino acids serine, threonine, and tyrosine to be phosphorylated?

a. They are polar.

b. They are non-polar.

c. They contain a hydroxyl group.

d. They occur more frequently in the amino acid sequence of signaling proteins.

12. Histamine binds to the H<sub>1</sub> G-protein-linked 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. More severe allergic response compared to normal G-protein signaling.
- b. Less severe allergic response compared to normal G-protein signaling.
- c. No allergic response.
- d. No change compared to normal G-protein signaling.

13. 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.

14. 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.

15. How does NF- $\kappa$ B induce gene expression?

- a. A small, hydrophobic ligand binds to NF- $\kappa$ B, activating it.
- b. Phosphorylation of the inhibitor I $\kappa$ B dissociates the complex between it and NF- $\kappa$ B, and allows NF- $\kappa$ B to enter the nucleus and stimulate transcription.
- c. NF- $\kappa$ B is phosphorylated and is then free to enter the nucleus and bind DNA.
- d. NF- $\kappa$ B is a kinase that phosphorylates a transcription factor that binds DNA and promotes protein production.

16. Apoptosis can occur in a cell when the cell is \_\_\_\_\_.

- a. damaged
- b. no longer needed
- c. infected by a virus
- d. all of the above

17. 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.

18. 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.

19. A scientist notices that a cancer cell line fails to die when they add 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 the above.

20. Which type of molecule acts as a signaling molecule in yeasts?

a. steroid

b. autoinducer

c. mating factor

d. second messenger

21. 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

22. 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. Increase antibiotic dosing

b. Create implants with rougher surfaces

c. Vaccinate patients against all pathogenic bacteria

d. Inhibit quorum sensing

### Critical Thinking Questions

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

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

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

26. 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?

27. 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?

28. 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?

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

30. 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?

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

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

33. 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.

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

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

36. 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:

3. A diploid cell has \_\_\_\_\_ the number of chromosomes as a haploid cell.

- a. one-fourth
- b. half
- c. twice
- d. four times

4. An organism's traits are determined by the specific combination of inherited \_\_\_\_\_.

- a. cells.
- b. genes.
- c. proteins.
- d. chromatids.

5. The first level of DNA organization in a eukaryotic cell is maintained by which molecule?

- a. cohesin
- b. condensin
- c. chromatin
- d. histone

6. Identical copies of chromatin held together by cohesin at the centromere are called \_\_\_\_\_.

- a. histones.
- b. nucleosomes.
- c. chromatin.
- d. sister chromatids.

7. Chromosomes are duplicated during what stage of the cell cycle?

- a. G1 phase
- b. S phase
- c. prophase
- d. prometaphase

8. 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

9. The mitotic spindles arise from which cell structure?

- a. centromere
- b. centrosome
- c. kinetochore
- d. cleavage furrow

10. 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

11. 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

12. Separation of the sister chromatids is a characteristic of which stage of mitosis?

- a. prometaphase
- b. metaphase
- c. anaphase
- d. telophase

13. The chromosomes become visible under a light microscope during which stage of mitosis?

- a. prophase
- b. prometaphase
- c. metaphase
- d. anaphase

14. 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

15. Which of the following is the correct order of events in mitosis?

- a. Sister chromatids line up at the metaphase plate. The kinetochore becomes attached to the mitotic spindle. The nucleus reforms and the cell divides. Cohesin proteins break down and the sister chromatids separate.



b. The kinetochore becomes attached to the mitotic spindle. Cohesin proteins break down and the sister chromatids separate. Sister chromatids line up at the metaphase plate. The nucleus reforms and the cell divides.

c. The kinetochore becomes attached to the cohesin proteins. Sister chromatids line up at the metaphase plate. The kinetochore breaks down and the sister chromatids separate. The nucleus reforms and the cell divides.

d. The kinetochore becomes attached to the mitotic spindle. Sister chromatids line up at the metaphase plate. Cohesin proteins break down and the sister chromatids separate. The nucleus reforms and the cell divides.

16. At which of the cell-cycle checkpoints do external forces have the greatest influence?

- a. G1 checkpoint
- b. G2 checkpoint
- c. M checkpoint
- d. G0 checkpoint

17. What is the main prerequisite for clearance at the G2 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

18. If the M checkpoint is not cleared, what stage of mitosis will be blocked?

- a. prophase
- b. prometaphase

c. metaphase

d. anaphase

19. 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)

20. Many of the negative regulator proteins of the cell cycle were discovered in what type of cells?

- a. gametes
- b. cells in G0
- c. cancer cells
- d. stem cells

21. 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)

22. \_\_\_\_\_ are changes to the order of nucleotides in a segment of DNA that codes for a protein.

- a. Proto-oncogenes
- b. Tumor suppressor genes
- c. Gene mutations

d. Negative regulators

23. A gene that codes for a positive cell-cycle regulator is called a(n) \_\_\_\_\_.

- a. kinase inhibitor.
- b. tumor suppressor gene.
- c. proto-oncogene.
- d. oncogene.

24. A mutated gene that codes for an altered version of Cdk that is active in the absence of cyclin is a(n) \_\_\_\_\_.

- a. kinase inhibitor.
- b. tumor suppressor gene.
- c. proto-oncogene.
- d. oncogene.

25. Which molecule is a Cdk inhibitor that is controlled by p53?

- a. cyclin
- b. anti-kinase
- c. Rb
- d. p21

26. Which eukaryotic cell-cycle event is missing in binary fission?

- a. cell growth
- b. DNA duplication
- c. karyokinesis
- d. cytokinesis

27. 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

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

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

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

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

32. 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?

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

34. List some reasons why a cell that has just completed cytokinesis might enter the G<sub>0</sub> phase instead of the G<sub>1</sub> phase.

35. What cell-cycle events will be affected in a cell that produces mutated (non-functional) cohesin protein?

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

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

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

39. Rb is a negative regulator that blocks the cell cycle at the G<sub>1</sub> checkpoint until the cell achieves a requisite size. What molecular mechanism does Rb employ to halt the cell cycle?

40. Outline the steps that lead to a cell becoming cancerous.

41. Explain the difference between a proto-oncogene and a tumor-suppressor gene.

42. List the regulatory mechanisms that might be lost in a cell producing faulty p53.

43. p53 can trigger apoptosis if certain cell-cycle events fail. How does this regulatory outcome benefit a multicellular organism?

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

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

### Chapter 11:

2. Meiosis usually produces \_\_\_\_\_ daughter cells.

- a. two haploid
- b. two diploid
- c. four haploid
- d. four diploid

3. What structure is most important in forming the tetrads?

- a. centromere
- b. synaptonemal complex
- c. chiasma
- d. kinetochore

4. At which stage of meiosis are sister chromatids separated from each other?

- a. prophase I
- b. prophase II
- c. anaphase I
- d. anaphase II

5. At metaphase I, homologous chromosomes are connected only at what structures?

- a. chiasmata
- b. recombination nodules
- c. microtubules
- d. kinetochores

6. 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.

7. What phase of mitotic interphase is missing from meiotic interkinesis?

- a. G0 phase
- b. G1 phase
- c. S phase
- d. G2 phase

8. The part of meiosis that is similar to mitosis is \_\_\_\_\_.

- a. meiosis I
- b. anaphase I
- c. meiosis II
- d. interkinesis

9. 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

10. 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
- b. haploid with two copies of each gene
- c. diploid with two copies of each gene
- d. diploid with four copies of each gene

11. 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

12. 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.

13. 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.

14. Which type of life cycle has both a haploid and diploid multicellular stage?

- a. asexual life cycles
- b. most animal life cycles
- c. most fungal life cycles
- d. alternation of generations

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

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

16. 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

17. 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.

18. 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

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

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

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

22. 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?

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

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

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

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

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

28. 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?

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

## Chapter 12:

5. Mendel performed hybridizations by transferring pollen from the \_\_\_\_\_ of the male plant to the female ova.

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

6. 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

7. Imagine you are performing a cross involving seed color in garden pea plants. What F1 offspring would you expect if you cross true-breeding parents with green seeds and yellow seeds? Yellow seed color is dominant over green.

- a. 100 percent yellow-green seeds
- b. 100 percent yellow seeds
- c. 50 percent yellow, 50 percent green seeds
- d. 25 percent green, 75 percent yellow seeds

8. 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 F2 generation, approximately how many constricted-pod plants would you expect to have?

- a. 600

- b. 165
- c. 217
- d. 468

9. 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<sub>2</sub> 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

10. The observable traits expressed by an organism are described as its \_\_\_\_\_.

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

11. A recessive trait will be observed in individuals that are \_\_\_\_\_ for that trait.

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

12. 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

13. The ABO blood groups in humans are expressed as the I<sup>A</sup>, I<sup>B</sup>, and i alleles. The I<sup>A</sup> allele encodes the A blood group antigen, I<sup>B</sup> encodes B, and i encodes O. Both A and B are dominant to O. If a heterozygous blood type A parent (I<sup>A</sup>i) and a heterozygous blood type B parent (I<sup>B</sup>i) mate, one quarter of their offspring will have AB blood type (I<sup>A</sup>I<sup>B</sup>) 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

14. 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

15. 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.

16. 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 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.

17. Assuming no gene linkage, in a dihybrid cross of AABB x aabb with AaBb F1 heterozygotes, what is the ratio of the F1 gametes (AB, aB, Ab, ab) that will give rise to the F2 offspring?

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

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

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

19. 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

20. 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

21. 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 who 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



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

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

24. Mendel performs a cross using a true-breeding pea plant with round, yellow seeds and a true-breeding pea plant with green, wrinkled seeds. What is the probability that offspring will have green, round seeds? Calculate the probability for the F1 and F2 generations.

25. Calculate the probability of selecting a heart or a face card when heart suit face cards are excluded from a standard deck of cards. Is this outcome more or less likely than selecting a heart suit face card from a standard deck of cards?

26. 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 F1 and F2 genotypes and phenotypes from a cross involving parents that are homozygous for each trait. Express genotypes with conventional genetic abbreviations.

27. Use a Punnett square to predict the offspring in a cross between a dwarf pea plant (homozygous recessive) and a tall pea plant (heterozygous). What is the phenotypic ratio of the offspring?

28. Can a human male be a carrier of red-green color blindness?

29. 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?

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

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

32. In Section 12.3, "Laws of Inheritance," 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.

33. 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?

34. 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:

4. 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

5. The first suggestion that chromosomes may physically exchange segments came from the microscopic identification of \_\_\_\_\_.

- a. synapsis
- b. sister chromatids
- c. chiasmata
- d. alleles

6. Which recombination frequency corresponds to independent assortment and the absence of linkage?

- a. 0
- b. 0.25
- c. 0.50
- d. 0.75

7. 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

8. Which of the following codes describes position 12 on the long arm of chromosome 13?

- a. 13p12
- b. 13q12
- c. 12p13
- d. 12q13

9. In agriculture, polyploid crops (like coffee, strawberries, or bananas) tend to produce \_\_\_\_\_.

- a. more uniformity
- b. more variety
- c. larger yields
- d. smaller yields

10. 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

11. The genotype XXY corresponds to

- a. Klinefelter syndrome
- b. Turner syndrome
- c. Triplo-X
- d. Jacob syndrome

12. 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

13. By definition, a pericentric inversion includes the \_\_\_\_\_.

- a. centromere
- b. chiasma
- c. telomere
- d. synapse

#### Critical Thinking Questions

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

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

#### Chapter 14:

4. If DNA of a particular species was analyzed and it was found that it contains 27 percent A, what would be the percentage of C?

- a. 27 percent
- b. 30 percent
- c. 23 percent
- d. 54 percent

5. The experiments by Hershey and Chase helped confirm that DNA was the hereditary material on the basis of 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

6. 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 non-pathogenic 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 the above.

7. DNA double helix does not have which of the following?

- a. antiparallel configuration
- b. complementary base pairing
- c. major and minor grooves
- d. uracil

8. In eukaryotes, what is the DNA wrapped around?

- a. single-stranded binding proteins
- b. sliding clamp
- c. polymerase
- d. histones

9. Meselson and Stahl's experiments proved that DNA replicates by which mode?

- a. conservative
- b. semi-conservative
- c. dispersive
- d. none of the above

10. If the sequence of the 5'-3' strand is AATGCTAC, then the complementary sequence has the following sequence:

- a. 3'-AATGCTAC-5'
- b. 3'-CATCGTAA-5'
- c. 3'-TTACGATG-5'
- d. 3'-GTAGCATT-5'

11. 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 semi-conservative replication.
- d. They demonstrated that conservative replication maintains the complementary base pairing of each DNA helix.

12. Which of the following components is not involved during the formation of the replication fork?

- a. single-strand binding proteins
- b. helicase
- c. origin of replication
- d. ligase

13. Which of the following does the enzyme primase synthesize?

- a. DNA primer
- b. RNA primer
- c. Okazaki fragments

d. phosphodiester linkage

14. In which direction does DNA replication take place?

- a. 5'-3'
- b. 3'-5'
- c. 5'
- d. 3'

15. 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

16. The ends of the linear chromosomes are maintained by

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

17. 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.

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

a. primase

b. topoisomerase

c. DNA polymerase

d. helicase

19. The initial mechanism for repairing nucleotide errors in DNA is \_\_\_\_\_.

a. mismatch repair

b. DNA polymerase proofreading

c. nucleotide excision repair

d. thymine dimers

20. A scientist creates fruit fly larvae with a mutation that eliminates the exonuclease function of DNA pol. Which prediction about the mutational load in the adult fruit flies is most likely to be correct?

a. The adults with the DNA pol mutation will have significantly more mutations than average.

b. The adults with the DNA pol mutation will have slightly more mutations than average.

c. The adults with the DNA pol mutation will have the same number of mutations as average.

d. The adults with the DNA pol mutation will have fewer mutations than average.

## Critical Thinking Questions

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

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

23. 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?

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

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

26. 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.

27. How did the scientific community learn that DNA replication takes place in a semi-conservative fashion?

28. Imagine the Meselson and Stahl experiments had supported conservative replication instead of semi-conservative replication. What results would you predict to observe after two rounds of replication?

Be specific regarding percent distributions of DNA incorporating  $^{15}\text{N}$  and  $^{14}\text{N}$  in the gradient.

29. DNA replication is bidirectional and discontinuous; explain your understanding of those concepts.

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

31. 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?

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

33. 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?

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

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

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

37. 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:

4. 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

5. How many nucleotides are in 12 mRNA codons?

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

6. 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.

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

- a.  $\alpha$
- b.  $\beta$
- c.  $\beta'$
- d.  $\sigma$

8. 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

9. 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.  $A > C > B$

10. 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

11. What transcripts will be most affected by low levels of  $\alpha$ -amanitin?

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

12. 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.

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

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

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

- a. methylation

- b. nucleotide modification
- c. cleavage
- d. splicing

15. 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. 220bp
- b. 295bp
- c. 140bp
- d. 435bp

16. The RNA components of ribosomes are synthesized in the \_\_\_\_\_.

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

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

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

18. 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

19. 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.

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

21. 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?

22. 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?

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



24. 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.)

25. 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.

26. 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.

27. Transcribe and translate the following DNA sequence (nontemplate strand): 5'-ATGCGCCGTTATTAAGCA-3'.

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

#### Chapter 16:

4. 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

5. 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

6. 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.

7. If glucose is absent, but so is lactose, the lac operon will be \_\_\_\_\_.

- a. activated
- b. repressed
- c. activated, but only partially
- d. mutated

8. 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. b and c are both true

9. The ara operon is an inducible operon that controls the breakdown 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

10. 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

11. Which of the following are true 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 the above

12. The binding of \_\_\_\_\_ is required for transcription to start.

a. a protein

b. DNA polymerase

c. RNA polymerase

d. a transcription factor

13. 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

14. A scientist compares the promoter regions of two genes. Gene A's core promoter plus proximal promoter elements encompasses 70bp. Gene B's core promoter plus proximal promoter elements encompasses 250bp. 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.

15. Which of the following are involved in post-transcriptional control?

a. control of RNA splicing

b. control of RNA shuttling

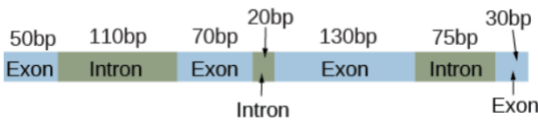
c. control of RNA stability

d. all of the above

16. 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

17. An unprocessed pre-mRNA has the following structure:



Which of the following is not a possible size (in bp) of the mature mRNA?

- a. 205bp
- b. 180bp
- c. 150bp
- d. 100bp

18. 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.

19. Post-translational modifications of proteins can affect which of the following?

- a. protein function

- b. transcriptional regulation
- c. chromatin modification
- d. all of the above

20. 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. tRNA<sup>i</sup>-Met would not scan mRNA transcripts for the start codon.
- d. eIF-2 would not be able to interact with the small ribosomal subunit.

21. Cancer causing genes are called \_\_\_\_\_.

- a. transformation genes
- b. tumor suppressor genes
- c. oncogenes
- d. mutated genes

22. 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 lots of the estrogen receptor expressed in their tumor

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

#### Critical Thinking Questions

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

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

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

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

27. 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?

28. A scientific study demonstrated that rat mothering behavior impacts the stress response in their pups. Rats that were born and grew up 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?

29. 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?

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

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

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

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

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

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

36. 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?

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

38. 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?

39. 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.

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