**Chapter 1 Biochemistry: An Evolving Science**

Multiple-Choice Questions

1) DNA is made from the building blocks adenine, guanine, cytosine and \_\_\_\_\_.

A) uridine

B) thymine

C) inosine

D) ribose

E) None of the answers is correct.

Answer: B

Section: 1.2

2) The DNA backbone is made from repeating \_\_\_\_\_.

A) monosaccharide units

B) amino acid units

C) sugar-phosphate units

D) fatty acid

E) None of the answers is correct.

Answer: C

Section: 1.2

3) The number of hydrogen bonds formed between A and T is \_\_\_\_\_.

A) 1

B) 2

C) 3

D) 4

E) 2 if in DNA, 3 if in RNA

Answer: B

Section: 1.2

4) The number of hydrogen bonds formed between G and C is \_\_\_\_\_.

A) 1

B) 2

C) 3

D) 4

E) 2 if in RNA, 3 if in DNA

Answer: C

Section: 1.2

5) The fundamental groups of organisms include Eukarya, Bacteria, and \_\_\_\_\_.

A) Plantae

B) Animalia

C) Protista

D) Archaea

E) Fungi

Answer: D

Section: 1.1

6) Which of the following are the strongest bonds in molecules?

A) covalent bonds

B) ionic bonds

C) hydrogen bonds

D) metallic bonds

E) None of the answers is correct.

Answer: A

Section: 1.1

7) Which of the following describes the relationship between the strengths of hydrogen and covalent bonds?

A) Hydrogen bonds are always stronger than covalent bonds.

B) Hydrogen bonds and covalent bonds have equivalent strength.

C) Hydrogen bonds are always weaker than covalent bonds.

D) With a few exceptions, most hydrogen bonds are stronger than covalent bonds.

E) With a few exceptions, most covalent bonds are stronger than hydrogen bonds.

Answer: C

Section: 1.3

8) The matter within a defined region of space is referred to as the \_\_\_\_\_.

A) universe

B) system

C) outer space

D) wormhole

E) None of the answers is correct.

Answer: B

Section: 1.3

9) For a spontaneous reaction, the *G* must be \_\_\_\_\_.

A) positive

B) negative

C) greater than 1

D) between 1 and 0

E) 0

Answer: B

Section: 1.3

10) The term \_\_\_\_\_ is used to indicate Gibbs free energy.

A) Δ*H*

B) Δ*E*

C) Δ*S*

D) Δ*G*

E) Δ*T*

Answer: D

Section: 1.3

11) Which of the following is considered a metabolite, a substance that is chemically transformed in a biochemical process?

A) deoxyribonucleic acid

B) glycerol

C) protein

D) ribonucleic acid

E) polysaccharide

Ans: B

Section: 1.1

12) The structure of DNA described by Watson and Crick included

A) a double helix.

B) the sugar phosphate backbone aligned in the center of the helix.

C) the base pairs that are stacked on the inside of the double helix.

D) both a double helix and the sugar phosphate backbone aligned in the center of the helix

E) a double helix and the base pairs that are stacked on the inside of the double helix

Ans: E

Section: 1.2

13) What did Watson and Crick suggest to be significant about the base pairing found in the helix?

A) It allowed the DNA to twist in a helix.

B) The DNA could be circular.

C) It was a mechanism for copying.

D) All of the answers are correct.

E) None of the answers is correct.

Ans: C

Section: 1.3

14) Approximately what percentage of the human genome encodes proteins?

A) 50%

B) 90%

C) 20%

D) 3%

E) None of the answers is correct.

Ans: D

Section: 1.4

15) What gives proteins such a dominant role in biochemistry?

A) the rigidity of the peptide backbone

B) the ability to act as a blueprint

C) the ability to self-replicate

D) the ability to spontaneously fold into complex three-dimensional structures

E) All of the answers are correct.

Ans: D

Section: 1.4

16) If the whole chain is used in a nonoverlapping frame, how many amino acids are defined by this DNA sequence: ATGTTTGGACTA?

A) two B) three C) four D) six E) twelve

Ans: C Section: 1.4

17) What is the [H+] concentration in a urine sample that has a pH of 6?

A) 10–6 M

B) 10–8 M

C) 106 M

D) 10–14 M

E) 6 M

Ans: A

Section 1.3

18) Which is the correct order of decreasing bond strengths?

A) hydrogen bonds, covalent bonds, van der Waals interactions

B) hydrogen bonds, electrostatic interactions, covalent bonds

C) van der Waals interactions, covalent bonds, hydrogen bonds

D) covalent bonds, hydrogen bonds, van der Waals interactions

E) hydrophobic interactions, hydrogen bonds, electrostatic interactions

Ans: D

Section: 1.3

19) The energies for hydrogen bonds are approximately

A) 400 kJ mol–1.

B) 100–240 kJ mol–1.

C) 4–20 kJ mol–1.

D) 200 kJ mol–1.

E) None of the answers is correct.

Ans: C

Section: 1.3

20) Which of the following is a hydrogen bond donor?

A) the N in N—H D

B) the H in S—H

C) the O in P—O

D) the H in O—H

E) None of the answers is correct.

Ans: D

Section: 1.3

21) Typical van der Waals energies are about

A) 4–20 kJ mol–1.

B) 2–4 kJ mol–1.

C) 200 kJ mol–1.

D) 500–1000 kJ mol–1.

E) None of the answers is correct.

Ans: B

Section: 1.3

22) What two properties of water are important for biological interactions?

A) the polarity of water

B) the density of water

C) the cohesive properties of water

D) the polarity of water and the cohesive properties of water

E) the density of water and the cohesive properties of water

Ans: D

Section: 1.3

23) The First Law of Thermodynamics states

A) diversity is the result of gradual evolution.

B) the total entropy of a system and its surroundings always increases for a spontaneous

process.

C) the total energy of a system and its surroundings is constant.

D) light is both particle and wave.

E) None of the answers is correct.

Ans: C

Section: 1.3

24) The Second Law of Thermodynamics states

A) the total entropy of a system and its surroundings always increases for a spontaneous

process.

B) temperatures will always decrease in a spontaneous process.

C) the total energy of a system and its surroundings is constant.

D) diversity is the result of gradual evolution.

E) None of the answers is correct.

Ans: A

Section: 1.3

25) Which of the following atoms commonly found in biological molecules are often hydrogen-bond acceptors?

A) carbon

B) oxygen

C) nitrogen

D) All of the answers are correct.

E) oxygen and nitrogen

Ans: E

Section: 1.3

26) Entropy is defined as

A) a spontaneous reaction.

B) the enthalpy of the system.

C) the measure of randomness of a system.

D) the amount of heat exchanged.

E) None of the answers is correct.

Ans: C

Section: 1.3

27) If a particular reaction has a negative *G*, is it likely to occur?

A) Not unless energy is added to the system

B) Yes, if it is coupled to another reaction

C) Yes, it is spontaneous.

D) No, it is not spontaneous.

E) Yes, as long as the temperature increases

Ans: C

Section: 1.3

28) What happens to nonpolar molecules in water?

A) They dissolve independently.

B) They aggregate together.

C) They precipitate.

D) All of the answers are correct.

E) None of the answers is correct.

Ans: B

Section: 1.3

29) What is the [A–]/[HA] ratio when a weak acid is in a solution one pH unit below its p*K*a?

A) 1:1

B) 1:10

C) 10:1

D) 2:1

E) None of the answers is correct.

Ans: B

Section 1.3

30) Why does DNA denature when the pH is raised above 9?

A) Protons dissociate from guanine bases disrupting the hydrogen bonding to the other strand.

B) Protons bind to guanine residues giving them additional positive charges which disrupt the hydrogen bonding to the other strand.

C) Protons bind to functional groups that serve as hydrogen-bond acceptors, thus disrupting the hydrogen bonding to the other strand.

D) Protons dissociate from the phosphate groups in the backbone, which disrupts the hydrogen-bonding pattern between strands.

E) None of the answers is correct.

Ans: A

Section 1.3

31) The simplest way to depict stereochemistry is to use

A) ball-and-stick models.

B) ribbon diagrams.

C) space-filling models.

D) Fisher projections.

E) None of the answers is correct.

Ans: D

Section: Appendix

32) Using the Henderson–Hasselbalch equation, calculate the pH of a buffer solution made from 0.20 M CH3COOH and 0.050 M CH3COO– that has p*K*a= 4.7.

A) 5.3

B) 4.1

C) 2.5

D) 0.4

E) None of the answers is correct.

Ans: B

Section 1.3

33) What are the primary chemical components present in a phosphate buffer at pH 7.4?

A) H3PO4 and PO43–

B) H2PO4– and PO43–

C) HPO42– and PO43–

D) H2PO4– and HPO42–

E) H3PO4 and HPO42–

Ans: D

Section 1.3

Short-Answer Questions

34) What are some of the medical implications of the human genome project?

Ans: The obvious use is in diagnosing disease and in developing methods to treat and cure diseases. Physicians will be able to account for individual genetic differences in determining the best medical treatment. Other answers may be correct.

Section: Introduction

35) What is the significance of hydrogen bonding in biochemical structures such as DNA?

Ans: The bonds are weak enough to be easily disrupted; yet when many are present, they provide the stabilization necessary for larger structures such as DNA.

Section: 1.2

36) Describe resonance structures.

Ans: Resonance structures are ways of writing covalent bonds in which two or more alternate bonding patterns can be achieved. This is due to the sharing of electrons over several atoms. Common examples are found in peptide bonds, and in some of the DNA/RNA bases. Adenine is shown in the text.

Section: 1.3

37) What is significant about the fact that metabolic processes are common to many organisms?

Ans: These metabolic processes are extremely old, geologically, originating in a common ancestor.

Section: 1.1

38) How is water able to be a solvent for so many biological molecules?

Ans: Many biological molecules have polar characteristics. Water is extremely polar and is capable of competing with other polar molecules by weakening their electrostatic and hydrogen bonds. The oxygen atom can act as a hydrogen-bond acceptor, and the hydrogen can act as a donor.

Section: 1.3

39) What is the net effect of many van der Waals interactions?

Ans: At the interface of two large molecules, the numerous van der Waals interactions can substantially affect and stabilize the interaction.

Section: 1.3

40) If most proteins are found surrounded by water in the cell, what type of functional groups would you expect to find on the surface of a water-soluble protein?

Ans: Polar and charged amino-acid residues would be present on the surface of the protein.

Section: 1.3

41) How are electrostatic forces used in protein folding?

Ans: The attraction of two oppositely charged functional groups would be one of the forces helping to form the three-dimensional shape of the protein.

Section: 1.3

42) If the First Law of Thermodynamics is true, how can biological processes be carried out?

Ans: Although energy cannot be created or destroyed, it can take on different forms, such as heat or chemical energy. Thus, the energy can be stored as chemical bond energy, which can be used to do work.

Section: 1.3

43) How can a cell exist if the Second Law of Thermodynamics is true?

Ans: Entropy in a local area can be decreased, but only at the expense of increased entropy in the larger area, or universe.

Section: 1.3

44) Provide a simple example of a process in which the entropy of a system changes.

Ans: Several examples can be provided, including the random mixture of atoms when two different gases are mixed, or the creation of water molecules from energy gained following the mixture of oxygen and hydrogen under certain conditions.

Section: 1.3

45) When solutions containing complementary single strands of DNA are mixed, a loss of entropy occurs. How is it that the Second Law of Thermodynamics is not violated?

Ans: Heat must be released to the surroundings.

Section: 1.3

46) What is the significance of using *G* in biochemistry?

Ans: Gibbs free energy, also called the free-energy change, is used to describe the energetics of a reaction. This symbol is used to determine if particular reactions will be spontaneous or biologically feasible.

Section: 1.3

47) What thermodynamic and free-energy changes participate in protein folding?

Ans: A combination of hydrogen bonds and van der Waals forces affect enthalpy and the entropy associated with hydrophobic interactions.

Section: 1.3

48) How do hydrophobic interactions aid in protein folding?

Ans: Hydrophobic interactions cause some nonpolar amino acids to aggregate and form the interior of the protein. This results in a net release of heat and a favorable change in the system enthalpy.

Section: 1.4

49) What are the enthalpy and entropy changes that accompany the formation of DNA double helices from complementary single strands of DNA?

Ans: There is a loss of entropy from the system because there are fewer degrees of freedom in the double helix as compared to the single strands. Therefore, heat must be released when the two strands combine to form the double helix so as not to violate the Second Law of Thermodynamics.

Section: 1.3

50) Describe the shape of methane.

Ans: Methane is tetrahedral, with bond angles of about 109°.

Section: Appendix