



TEXTBOOK TESTBANKS

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Chapter 1

1. Which statement about biological diversity is FALSE?

- a. The plant kingdom includes species as relatively simple as algae and as complex as sequoias.
- b. No species can live in seemingly hostile environments such as hot springs and glaciers.
- c. Animal kingdom species range from nearly microscopic to very large.
- d. Organisms such as protozoa, yeast, and bacteria are present with great diversity in water and soil.
- e. Microscopic organisms can live on or within larger organisms.

ANSWER: b

2. What are molecules A and B called, if molecule A is large and transforms into a low-molecular-weight molecule B?

- a. A and B are both biological macromolecules.
- b. A and B are both metabolites.
- c. A is a biological macromolecule and B is a metabolite.
- d. A is a metabolite and B is a biological macromolecule.
- e. A is a protein and B is deoxyribonucleic acid.

ANSWER: c

3. Which animal metabolic process is highly similar to the plant process of capturing and converting light energy?

- a. capturing energy released from acid dissociation
- b. capturing energy released from DNA double helix formation
- c. capturing energy released from resisting the change in pH
- d. capturing energy released from glucose breakdown
- e. capturing energy released from the breakage of noncovalent bonds

ANSWER: d

4. When did life on Earth begin and when did human beings emerge, respectively?

- a. 3 billion years ago and 1 billion years ago
- b. 3.5 billion years ago and 0.5 billion years ago
- c. 3.5 billion years ago and 0.2 billion years ago
- d. 3.5 billion years ago and less than 0.1 billion years ago
- e. 3.5 billion years ago and 0.1 billion years ago

ANSWER: d

5. What are the main paths of the tree of life?

- a. eukarya and prokarya
- b. eukarya and archaea
- c. bacteria, prokarya, eukarya, and archaea
- d. bacteria and eukarya
- e. bacteria, eukarya, and archaea

ANSWER: e

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6. Which statement about DNA structure is INCORRECT?

- a. It is a branched polymer with a flexible backbone.
- b. The DNA backbone is built of repeating sugar–phosphate units.
- c. Each DNA strand has directionality due to identical orientation of the sugar–phosphate units.
- d. Each sugar is connected to two phosphate groups through different linkages.
- e. Its structure is a double helix composed of two intertwined strands.

ANSWER: a

7. What makes water a versatile solvent?

- a. stabilization of large molecular complexes
- b. ease of breaking different bonds
- c. irreversible breakage of different bonds
- d. simultaneous formation of a large number of hydrogen bonds
- e. stabilization by large molecular complexes

ANSWER: d

8. Which statement about covalent bonds is INCORRECT?

- a. A covalent bond is formed by the sharing of a pair of electrons between adjacent atoms.
- b. If more than one electron pair is shared, then a covalent bond becomes stronger.
- c. Existence of several resonance structures of nearly equal energies decreases stability of a compound.
- d. Some molecules possess several patterns of covalent bonding.
- e. The key properties of a bond are length and energy.

ANSWER: c

9. What is the energy of an ionic interaction?

- a. the product of a proportionality constant and charges of two atoms divided by the product of the dielectric constant and the distance between atoms
- b. the product of the dielectric constant and a sum of two charges divided by the product of the proportionality constant and the distance between charges
- c. the product of the dielectric constant and the distance between atoms divided by the product of the proportionality constant and charges of two atoms
- d. the product of the dielectric constant and two charges subtracted from the product of the proportionality constant and the distance between charges
- e. the difference between the proportionality constant and charges of two atoms multiplied by the dielectric constant

ANSWER: a

10. What is the reason for the existence of the hydrophobic effect?

- a. the tendency of water molecules to make a bond with hydrophobic proteins
- b. the tendency of polar molecules to self-associate in the presence of an aqueous solution
- c. the tendency of nonpolar molecules to self-associate in the presence of an aqueous solution

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- d. the inability of charged molecules to dissolve in water
- e. the property of nucleic acids to dissolve in water

ANSWER: c

11. Which statement about noncovalent bonds is CORRECT?

- a. Five fundamental noncovalent bonds differ in their geometry, strength, and specificity.
- b. In the strongest hydrogen bonds, all their components lie along a straight line.
- c. The transient asymmetry in the electronic charge distribution of one atom can induce a complementary asymmetry in the neighboring atoms due to hydrophobic interactions.
- d. The release of water from more ordered structures is unfavorable.
- e. Very strong repulsive forces become dominant at distances greater than the van der Waals contact distance.

ANSWER: b

12. Which statement about ionic interactions in the formation of the DNA double helix is CORRECT?

- a. Separation of negatively charged phosphate groups with distances greater than 10 Å prevents unfavorable interactions.
- b. Only favorable ionic interactions take place when two strands of DNA come together.
- c. Ionic interactions cause the formation of the double helix.
- d. Disposition of negatively charged phosphate groups with distances greater than 10 Å provides only favorable interactions.
- e. Some unfavorable ionic interactions take place when two strands of DNA come together.

ANSWER: e

13. Which statement about the role of hydrogen bonds in DNA double helix formation is INCORRECT?

- a. The hydrophobic effect contributes to the favorability of base stacking.
- b. Hydrogen bonds contribute greatly to the overall process of double helix formation.
- c. There are more hydrogen bonds with water than bonds between the bases in single-stranded DNA.
- d. When two single strands come together, hydrogen bonds with water are broken and new hydrogen bonds between the bases of two DNA strands are formed.
- e. Hydrogen bonds contribute greatly to the specificity of bases binding.

ANSWER: b

14. Which statement about nonpolar interactions in the formation of the DNA double helix is INCORRECT?

- a. Van der Waals interactions are nearly optimal in a double-helical structure.
- b. Nonpolar surfaces of the bases are moved into contact with each other due to a more complete base stacking.
- c. Nucleotide bases tend to stack even in single-stranded DNA molecules.
- d. The separation distance of the planes of adjacent bases needs to be adjusted for the favorable van der Waals contacts.
- e. Surface complementarity maximizes the formation of hydrogen bonds and van der Waals interactions while minimizing the nonpolar surface area exposed to the aqueous environment.

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ANSWER: d

15. What is FALSE regarding the laws of thermodynamics?

- a. Energy can be neither created nor destroyed.
- b. The local decrease in enthalpy will increase the entropy of the surroundings.
- c. Heat is a manifestation of the kinetic energy associated with the random motion of molecules.
- d. Within chemical systems, potential energy is related to the likelihood that atoms will store energy in some form.
- e. Ordered structures can be formed within a system only if the entropy of the surroundings will proportionally increase.

ANSWER: d

16. The heat content of a system is called:

- a. entropy.
- b. enthalpy.
- c. kinetic energy.
- d. potential enthalpy.
- e. kinetic entropy.

ANSWER: b

17. Why does a spontaneous chemical process always increase the entropy of the universe?

- a. The system entropy will increase if and only if the entropy of surroundings is greater than the ratio of the heat transferred to the surroundings and their temperature.
- b. The total entropy will increase if and only if the product of temperature and the change in system entropy is lower than zero.
- c. The total entropy will increase if and only if the change in enthalpy is lower than zero.
- d. The system enthalpy will increase only when the change in temperature is greater than zero.
- e. The total entropy will increase if and only if the entropy of a system is greater than the ratio of the heat transferred to surroundings and their temperature.

ANSWER: e

18. How was the fact that formation of the double helix does not violate the second law of thermodynamics experimentally confirmed?

- a. in a water bath monitoring the change in entropy to check whether it remains constant
- b. in a water bath monitoring the change in heat to sustain a constant temperature in the bath
- c. in a water bath monitoring the change in entropy to sustain a constant temperature in the bath
- d. in a water bath monitoring the free energy to sustain constant heat content in the bath
- e. in a water bath monitoring the change in heat to sustain constant Gibbs energy in the bath

ANSWER: b

19. A proton exists in a solution as:

- a. H^+ .

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- b. a water molecule.
- c. a deprotonated water molecule.
- d. a hydronium ion.
- e. H_2O^+ .

ANSWER: d

20. What is the direct consequence of the bent shape of a water molecule?

- a. Water is highly cohesive.
- b. Distribution of charge is asymmetric.
- c. Hydrogen atoms possess a net negative charge.
- d. The oxygen atom possesses a net positive charge.
- e. The water molecule is able to form hydrogen bonds.

ANSWER: b

21. Why are free interactions of water molecules in bulk water more favorable than more ordered interactions with nonpolar compounds?

- a. The total entropy in such interactions increases because the Gibbs free energy is positive.
- b. The total entropy in such interactions decreases because the Gibbs free energy is negative.
- c. The enthalpy of the ordered state is lower than the enthalpy of the bulk state.
- d. The total entropy in such interactions increases because the Gibbs free energy is negative.
- e. The total entropy in such interactions decreases because the Gibbs free energy is positive.

ANSWER: d

22. What is the concentration of hydroxide ions $[\text{OH}^-]$ in an aqueous solution with pH 9?

- a. 10^{-9} M
- b. 10^{-14} M
- c. 10^5 M
- d. 9 M
- e. 10^{-5} M

ANSWER: e

23. Which statement about acid–base relations is CORRECT?

- a. If $[\text{H}^+]$ is higher than 10^{-3} , pH is above 3.
- b. If $[\text{OH}^-]$ is 10^{-9} , pH is 7.
- c. If $[\text{H}^+]$ is lower than 10^{-9} , pH is below 9.
- d. If $[\text{OH}^-]$ is higher than 10^{-3} , pH is below 3.
- e. If $[\text{OH}^-]$ is 10^{-7} , pH is 7.

ANSWER: e

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24. Which component of DNA bases is the most susceptible to hydroxide ions?

- a. proton of N-1 atom of guanine base
- b. proton of O atom of guanine base
- c. proton of N-3 atom of thymine base
- d. proton of O atom of adenine base
- e. proton of N-1 atom of adenine base

ANSWER: a

25. What is a pK_a value in an acid–base reaction?

- a. the equilibrium constant for proton dissociation
- b. concentration of hydrogen ions in the solution
- c. a quantitative measure of the strength of an acid in the solution
- d. the equilibrium constant for the dissociation of water
- e. concentration of hydroxide ions in the solution

ANSWER: c

26. What is pK_a of a buffer solution ($pH = 5.05$) containing 0.2 M sodium acetate and 0.1 M acetic acid?

- a. 4.75
- b. 0.2
- c. 0.3
- d. 4.45
- e. 1.58

ANSWER: a

27. Which statement is INCORRECT if the buffer capacity is not consumed upon addition of a strong acid to the solution?

- a. There are more protonated forms of the buffer compound than deprotonated ones.
- b. When hydrogen ions are added to this buffer solution they remain free.
- c. The pH differs from the pK_a value of the buffer's base component.
- d. There are more deprotonated forms of the buffer compound than protonated ones.
- e. Such a buffer is not actually a buffer and cannot mitigate the pH changes.

ANSWER: d

28. By which factor will the 1 M buffer sodium acetate ($pK_a = 4.75$) increase the amount of acid required to produce a drop of pH from 7.4 to 7.3 in comparison with pure water where a respective change in $[H^+]$ is equal to 1×10^{-8} M?

- a. 5,600
- b. 60
- c. 60,000
- d. 1

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e. 600

ANSWER: c

29. What is the average difference in the genome sequence between each pair of individuals?

- a. 1 different base per 200 bases
- b. 1 different base per 20 bases
- c. 1 different base per 100 bases
- d. 1 different base per 1000 bases
- e. 1 different base per 2000 bases

ANSWER: a

30. Which statement about genetic variations is CORRECT?

- a. Predisposition inevitably results in the onset of a disease.
- b. Only a few genetic variations are connected to some ailments.
- c. Several genetic variations are required to cause a disease.
- d. The average difference between two people within one ethnic group is lower than the difference between the averages of two different ethnic groups.
- e. A particular variation can lead to a predisposition to the development of a particular disease rather than to its inevitable development.

ANSWER: e

31. Which statement about the microbiome is CORRECT?

- a. There are about 10 times more human cells than microbial cells in the body.
- b. The human microbiome does not play a role in obesity.
- c. The microbiome present on a body remains constant throughout a human life.
- d. The microbiome present on different body surfaces is largely distinct.
- e. Many species of the human microbiome have been grown in cultures.

ANSWER: d

32. What principle is comparative genomics based on?

- a. Biological polymers are evolutionary and functionally related in all living organisms.
- b. There is a link between evolution and biochemistry.
- c. DNA can be isolated from previously known organisms.
- d. Biological polymers are greatly variable between single-celled and multicellular organisms.
- e. The sequence variation between remotely related individuals is quite substantial compared to differences in populations.

ANSWER: a

33. Which statement about DNA is INCORRECT?

- a. The most fundamental role of DNA is to encode the sequences of proteins.
- b. The genetic code is the set of rules that links the DNA sequence to the encoded protein sequence.

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- c. Gene is the fundamental unit of hereditary information.
- d. The control regions account for only a small portion of the human genome.
- e. There are about 100,000 protein-coding genes in the human genome.

ANSWER: e

34. What is the number of hydrogen bonds formed between A and T nucleotides?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

ANSWER: b

35. What is the number of hydrogen bonds formed between G and C nucleotides?

- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

ANSWER: c

36. The structure of DNA described by Watson and Crick includes:

- a. a triple helix.
- b. a triple helix composed of three intertwined strands.
- c. base pairs that are stacked on the inside of the double helix.
- d. a sugar-phosphate backbone that lies on the inside of the helix.
- e. base pairs that are stacked on the outside of the triple helix.

ANSWER: c

37. What did Watson and Crick suggest to be significant about the base-pairing found in the DNA helix?

- a. It allowed the DNA to twist in a helix.
- b. The DNA could be circular.
- c. It was a good base for the mechanism of copying genetic information.
- d. Only one of the strands could act as a template.
- e. The DNA sequence was determined by the sequence of RNA.

ANSWER: c

38. What gives proteins such a dominant role in biochemistry?

- a. rigidity of the peptide backbone
- b. ability to act as a blueprint
- c. ability to self-replicate

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- d. ability to spontaneously fold into complex three-dimensional structures
- e. usage of 40 different building blocks

ANSWER: d

39. What is the concentration of hydrogen ions in a urine sample that has a pH of 6?

- a. 10^{-6} M
- b. 10^{-8} M
- c. 10^6 M
- d. 10^{-14} M
- e. 6 M

ANSWER: a

40. Order the type of interactions by the bond strength in descending value.

- a. hydrogen bonds, covalent bonds, van der Waals interactions
- b. covalent bonds, van der Waals interactions, hydrogen 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

ANSWER: d

41. Which of the following is a hydrogen bond donor?

- a. the N in H- - -N—HD
- b. the S in S—H- - -O
- c. the O and P in P—O- - -H
- d. the H in O—H- - -O
- e. the O in O—H- - -NN

ANSWER: d

42. If a particular reaction has a negative ΔG , is it likely to occur?

- a. Not unless energy is added to the system.
- b. Yes, if it is coupled with another reaction.
- c. Yes, it is spontaneous.
- d. No, it is not spontaneous.
- e. Yes, as long as the temperature increases.

ANSWER: c

43. What is the $[A^-]:[HA]$ ratio when a weak acid is in a solution one pH unit below its pK_a ?

- a. 1:1
- b. 1:10
- c. 10:1

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d. 2:1

e. 1:2

ANSWER: b

44. Using the Henderson–Hasselbalch equation, calculate the pH of a buffer solution made from 0.20 M CH_3COOH and 0.05 M CH_3COO^- that has $\text{p}K_a = 4.7$.

a. 5.3

b. 4.1

c. 2.5

d. 0.4

e. 5.0

ANSWER: b

45. What are the primary chemical components present in a phosphate buffer at $\text{pH} = 7.4$?

a. H_3PO_4 and PO_4^{3-}

b. H_2PO_4^- and PO_4^{3-}

c. HPO_4^{2-} and PO_4^{3-}

d. H_2PO_4^- and HPO_4^{2-}

e. H_3PO_4 and HPO_4^{2-}

ANSWER: d