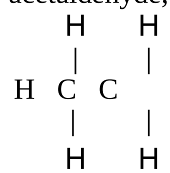
Solution Manual for Microbiology An Introduction 12th Edition Tortora Funke Case 0321929152 9780321929150

Learning Objectives	Check Your Understanding
2-1 Describe the structure of an atom and its relation to the physical properties of elements.	How does $^{14}_{6}C$ differ from $^{12}_{6}C$? What is the atomic number of each carbon atom? The atomic weight?
2-2 Define *ionic bond, covalent bond, hydrogen bond, molecular weight,* and *mole*.	Differentiate an ionic bond from a covalent bond.
2-3 Diagram three basic types of chemical reactions.	This chemical reaction below is used to remove chlorine from water. What type of reaction is it? $HClO + Na_2SO_3 \rightarrow Na_2SO_4 + HCl$
2-4 List several properties of water that are important to living systems.	Why is the polarity of a water molecule important?
2-5 Define *acid*, *base*, *salt*, and *pH.*	Antacids neutralize acid by the following reaction. $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + H_2O$ Identify the acid, base, and salt.
2-6 Distinguish organic and inorganic compounds.	Define *organic.*
2-7 Define *functional group.*	Add the appropriate functional group(s) to the ethyl group below to produce each of the following compounds: ethanol, acetic acid, acetaldehyde, ethanolamine, diethyl ether. 
2-8 Identify the building blocks of carbohydrates.	Give an example of a monosaccharide, a disaccharide, and a polysaccharide.
2-9 Differentiate simple lipids, complex lipids, and steroids.	How do simple lipids differ from complex lipids?
2-10 Identify the building blocks and structure of proteins.	What two functional groups are in all amino acids?

2-11 Identify the building blocks of nucleic acids.	How do DNA and RNA differ?
2-12 Describe the role of ATP in cellular activities.	Which can provide more energy for a cell and why: ATP or ADP?

New in This Edition

- The section on activation energy has been revised.

Chapter Summary

Introduction (p. 24)

ASM 3.2: The interactions of microorganisms among themselves and with their environment are determined by their metabolic abilities (e.g., quorum sensing, oxygen consumption, nitrogen transformations). ASM 6.2: Microorganisms provide essential models that give us fun-damental knowledge about life processes.

1. The science of the interaction between atoms and molecules is called chemistry.
2. The metabolic activities of microorganisms involve complex chemical reactions.
3. Microbes break down nutrients to obtain energy and to make new cells.

The Structure of Atoms (pp. 25–26)

1. An atom is the smallest unit of a chemical element that exhibits the properties of that el-ement.
2. Atoms consist of a nucleus, which contains protons and neutrons, and electrons, which move around the nucleus.
3. The atomic number is the number of protons in the nucleus; the total number of protons and neutrons is the atomic weight.

Chemical Elements (pp. 25–26)

4. Atoms with the same number of protons and the same chemical behavior are classified as the same chemical element.
5. Chemical elements are designated by abbreviations called chemical symbols.
6. About 26 elements are commonly found in living cells.
7. Atoms that have the same atomic number (are of the same element) but different atomic weights are called isotopes.

Electronic Configurations (p. 26)

8. In an atom, electrons are arranged around the nucleus in electron shells.

9. Each shell can hold a characteristic maximum number of electrons.
10. The chemical properties of an atom are due largely to the number of electrons in its outermost shell.

How Atoms Form Molecules: Chemical Bonds (pp. 27–30)

1. Molecules are made up of two or more atoms; molecules consisting of at least two different kinds of atoms are called compounds.
2. Atoms form molecules in order to fill their outermost electron shells.
3. Attractive forces that bind two atoms together are called chemical bonds.
4. The combining capacity of an atom—the number of chemical bonds the atom can form with other atoms—is its valence.

Ionic Bonds (p. 27)

5. A positively or negatively charged atom or group of atoms is called an ion.
6. A chemical attraction between ions of opposite charge is called an ionic bond.
7. To form an ionic bond, one ion is an electron donor, and the other ion is an electron acceptor.

Covalent Bonds (p. 27–28)

8. In a covalent bond, atoms share pairs of electrons.
9. Covalent bonds are stronger than ionic bonds and are far more common in organic molecules.

Hydrogen Bonds (pp. 28–29)

10. A hydrogen bond exists when a hydrogen atom covalently bonded to one oxygen or nitrogen atom is attracted to another oxygen or nitrogen atom.
11. Hydrogen bonds form weak links between different molecules or between parts of the same large molecule.

Molecular Weight and Moles (pp. 29–30)

12. The molecular weight is the sum of the atomic weights of all the atoms in a molecule.
13. A mole of an atom, ion, or molecule is equal to its atomic or molecular weight expressed in grams.

Chemical Reactions (pp. 30–31)

1. Chemical reactions are the making or breaking of chemical bonds between atoms.
2. A change of energy occurs during chemical reactions.
3. Endergonic reactions require more energy than they release; exergonic reactions release more energy.
4. In a synthesis reaction, atoms, ions, or molecules are combined to form a larger molecule.

Copyright © 2016 Pearson Education, Inc.

5. In a decomposition reaction, a larger molecule is broken down into its component molecules, ions, or atoms.
6. In an exchange reaction, two molecules are decomposed, and their subunits are used to synthesize two new molecules.
7. The products of reversible reactions can readily revert to form the original reactants.

Important Biological Molecules (pp. 31–46)

Inorganic Compounds (pp. 32–34)

1. Inorganic compounds are usually small, ionically bonded molecules.

Water (p. 32)

2. Water is the most abundant substance in cells.
3. Because water is a polar molecule, it is an excellent solvent.
4. Water is a reactant in many of the decomposition reactions of digestion.
5. Water is an excellent temperature buffer.

Acids, Bases, and Salts (pp. 32–33)

6. An acid dissociates into H^+ and anions.
7. A base dissociates into OH^- and cations.
8. A salt dissociates into negative and positive ions, neither of which is H^+ or OH^-.

Acid–Base Balance: The Concept of pH (pp. 33–34)

9. The term *pH* refers to the concentration of H^+ in a solution.
10. A solution of pH 7 is neutral; a pH value below 7 indicates acidity; pH above 7 indicates alkalinity.
11. The pH inside a cell and in culture media is stabilized with pH buffers.

Organic Compounds (pp. 34–46)

1. Organic compounds always contain carbon and hydrogen.
2. Carbon atoms form up to four bonds with other atoms.
3. Organic compounds are mostly or entirely covalently bonded, and many of them are large molecules.

Structure and Chemistry (pp. 34–35)

4. A chain of carbon atoms forms a carbon skeleton.
5. Functional groups of atoms are responsible for most of the properties of organic molecules.
6. The letter *R* may be used to denote the remainder of an organic molecule.
7. Frequently encountered classes of molecules are R—OH (alcohols) and R—COOH (organic acids).
8. Small organic molecules may combine into very large molecules called macromolecules.

Copyright © 2016 Pearson Education, Inc.

9. Monomers usually bond together by dehydration synthesis, or condensation reactions, that form water and a polymer.

10. Organic molecules may be broken down by hydrolysis, a reaction involving the splitting of water molecules.

Carbohydrates (pp. 36–37)

11. Carbohydrates are compounds consisting of atoms of carbon, hydrogen, and oxygen, with hydrogen and oxygen in a 2:1 ratio.

12. Monosaccharides contain from three to seven carbon atoms.

13. Isomers are two molecules with the same chemical formula but different structures and properties—for example, glucose ($C_6H_{12}O_6$) and fructose ($C_6H_{12}O_6$).

14. Monosaccharides may form disaccharides and polysaccharides by dehydration synthesis.

Lipids (pp. 37–39)

15. Lipids are a diverse group of compounds distinguished by their insolubility in water.

16 Simple lipids (fats) consist of a molecule of glycerol and three molecules of fatty acids.

17. A saturated lipid has no double bonds between carbon atoms in the fatty acids; an unsaturated lipid has one or more double bonds. Saturated lipids have higher melting points than unsaturated lipids.

18. Phospholipids are complex lipids consisting of glycerol, two fatty acids, and a phosphate group.

19. Steroids have carbon ring structures; sterols have a functional hydroxyl group.

Proteins (pp. 39–45)

20. Amino acids are the building blocks of proteins.

21. Amino acids consist of carbon, hydrogen, oxygen, nitrogen, and sometimes sulfur.

22. Twenty amino acids occur naturally in proteins.

23. By linking amino acids, peptide bonds (formed by dehydration synthesis) allow the formation of polypeptide chains.

24. Proteins have four levels of structure: primary (sequence of amino acids), secondary (helices or pleats), tertiary (overall three-dimensional structure of a polypeptide), and quaternary (two or more polypeptide chains).

25. Conjugated proteins consist of amino acids combined with inorganic or other organic compounds.

Nucleic Acids (pp. 44–46)

26. Nucleic acids—DNA and RNA—are macromolecules consisting of repeating nucleotides.

27. A nucleotide is composed of a pentose, a phosphate group, and a nitrogen-containing base. A nucleoside is composed of a pentose and a nitrogen-containing base.

Copyright © 2016 Pearson Education, Inc.

28. A DNA nucleotide consists of deoxyribose (a pentose) and one of the following nitrogen-containing bases: thymine or cytosine (pyrimidines) or adenine or guanine (purines).

Copyright © 2016 Pearson Education, Inc.

29. DNA consists of two strands of nucleotides wound in a double helix. The strands are held together by hydrogen bonds between purine and pyrimidine nucleotides: AT and GC.

30. Genes consist of sequences of nucleotides.

31. An RNA nucleotide consists of ribose (a pentose) and one of the following nitrogen-containing bases: cytosine, guanine, adenine, or uracil.

Adenosine Triphosphate (ATP) (p. 46)

32. ATP stores chemical energy for various cellular activities.

33. When the bond to ATP's terminal phosphate group is hydrolyzed, energy is released.

34. The energy from oxidation reactions is used to regenerate ATP from ADP and inorganic phosphate.

The Loop

1. Have students study Chapter 2 and use the Study Questions as a self-test.

2. Have students study Chapter 2 and take a pretest for Chapter 5. Pretests can be administered individually during office hours, open laboratories, or study sessions. Students who score at least 9 points out of 15 questions from the Chapter 2 Test Bank show mastery. A student who does not achieve mastery can study and take a second chapter test.

3. Students with some chemistry but less than one year of college chemistry may find it useful to have the last half of this chapter, "Important Biological Molecules," which begins on page 31, used as an introduction to Chapter 5, "Microbial Metabolism."

Answers

Figure Questions		
Figure	Question	Answer
2.1	What is the atomic number of this atom?	Six. It is carbon.
2.2	What is an ionic bond?	An ionic bond is an *attraction* between atoms that have lost or gained electrons (ions).
2.3	What is a covalent bond?	A covalent bond is formed by the *sharing* of electrons between atoms.
2.4	Which chemical elements are usually involved in hydrogen bonding?	Hydrogen and oxygen or nitrogen. A hydrogen bond is an attraction between a hydrogen atom that is covalently bonded to one oxygen or nitrogen atom and another oxygen or nitrogen atom.
2.5	What happens during ionization?	An atom or molecule gains or loses charged particles such as electrons.

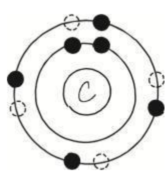
Copyright © 2016 Pearson Education, Inc.

2.6	How do acids and bases differ?	Acids dissociate into an anion and a hydrogen ion (H^+). Bases dissociate into

Copyright © 2016 Pearson Education, Inc.

		a cation and a hydroxide ion (OH^-).
2.7	At what pH are the concentrations of H^+ and OH^- equal?	7
2.8	What is the difference between a polymer and a monomer?	A polymer consists of smaller molecules called monomers.
2.9	How do saturated and unsaturated fatty acids differ?	Unsaturated lipids have one or more double bonds between carbon atoms.
2.10	Where are phospholipids found in cells?	Membranes
2.11	Where are sterols found in cells?	Membranes
2.12	What distinguishes one amino acid from another?	Side groups called R groups
2.13	Which isomer is always found in proteins?	L-isomers
2.14	How are amino acids related to proteins?	Proteins are composed of amino acids.
2.15	What property of a protein enables it to carry out specific functions?	The three-dimensional shape
2.17	How are DNA and RNA similar in structure?	Both are polymers of nucleotides.
2.18	How is ATP similar to a nucleotide in RNA? In DNA?	Ribose is the sugar in the adenosine nucleotides in ATP and RNA. Deoxyribose is the sugar in the adenosine in DNA.

Review

1. Atoms with the same atomic number and chemical behavior are classified as chemical elements.
2. 

3. **a.** Ionic
   b. Single covalent bond
   c. Double covalent bonds
   d. Hydrogen bond
4. **a.** Synthesis reaction, condensation, or dehydration
   b. Decomposition reaction, digestion, or hydrolysis
   c. Exchange reaction
   d. Reversible reaction

5. The enzyme lowers the activation energy required for the reaction and therefore speeds up this decomposition reaction.

6. **a.** Lipid

b. Protein

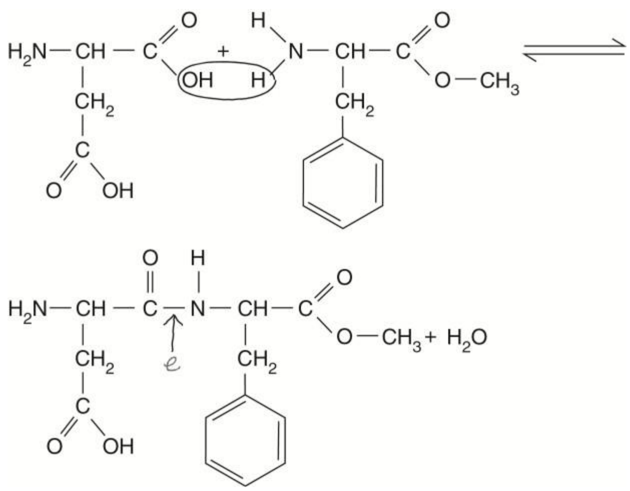
c. Carbohydrate

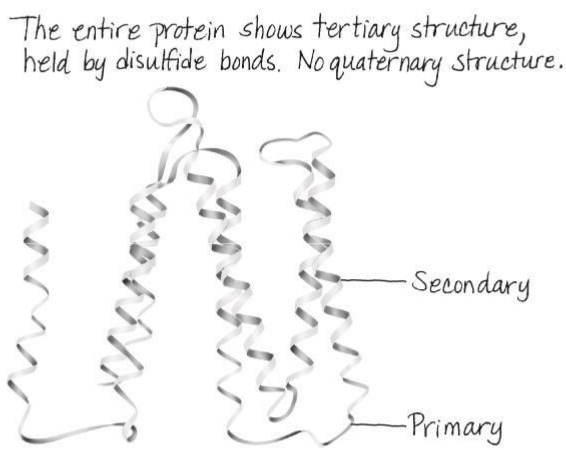
d. Nucleic acid

7. **a.** Amino acids

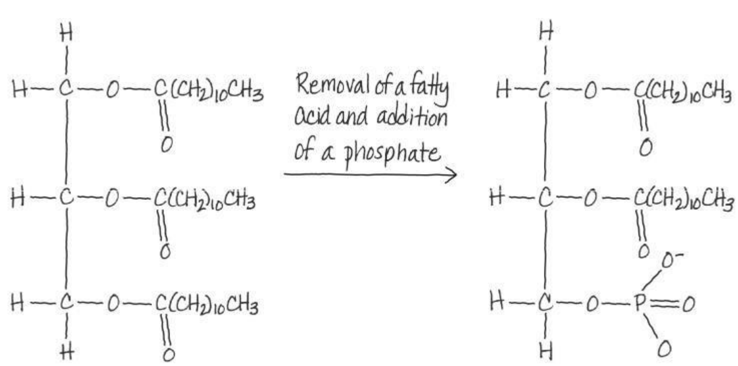
b. Right to left

c. Left to right





8.



9.

10. Fungi

Copyright © 2016 Pearson Education, Inc.

Multiple Choice

1. c **6.** c
2. b **7.** a
3. b **8.** a
4. e **9.** b
5. b **10.** c

Analysis

1. **a.** Synthesis reaction

   b. H_2CO_3 is an acid.

2. ATP and DNA have 5-carbon sugars. ATP has ribose, and DNA has deoxyribose; ATP and DNA contain the purine, adenine.
3. To maintain the proper fluidity, the percentage of unsaturated lipids decreases at the higher temperature.
4. These animals have cellulose-degrading bacteria in specialized structures in their digestive tracts.

Clinical Applications and Evaluation

1. PHB is a fatty acid used as an energy storage molecule by *Ralstonia*.
2. *T. ferrooxidans* can oxidize sulfur ("thio") as well as iron ("ferro"). The oxidation of sulfide in pyrite produces sulfuric acid, which dissolves the limestone. Gypsum forms in a subsequent exchange reaction.

$$2S^{2-} + 3O_2 + 2H_2O \rightarrow 2SO_4^{2-} + 4H^+$$

$$2CaCO_3 + 4H^+ + 2SO_4^{2-} \rightarrow 2CaSO_4 + 2H^+ + 2HCO_3^-$$

3. **a.** Amino acid

   b. Phenylalanine is not present in the baby's blood.

   c. The phenylalanine from the aspartame (see Review question 7) will accumulate in their bodies.

4. Amphotericin B would not work against most bacteria because they lack sterols. Fungi have sterols and are generally susceptible to amphotericin B. Human cells have sterols.
5. Methionine and cysteine

Case Study: Kesterson National Wildlife Refuge

Background

Kesterson National Wildlife Refuge, California: In the San Joaquin Valley, irrigation water wasn't draining properly, and crops were dying in the waterlogged soil. In 1981, a drainage system was built to channel irrigation runoff into shallow ponds called Kesterson Reservoir.

In addition to receiving field runoff, the new reservoir was to be a waterfowl habitat. In

Copyright © 2016 Pearson Education, Inc.

1983, an unusually large number of dead birds were found, indicating that something was wrong with the water.

Copyright © 2016 Pearson Education, Inc.

Selenium from the soil (in the form of selenate, SeO_4^{2-}) was dissolving in the irrigation water and being carried to Kesterson Reservoir, where it stayed. The concentration of selenium in Kesterson rose to 29 times higher than what was considered safe.

Kesterson Reservoir has been drained and filled with soil to prevent the killing of more birds, but the selenium remains. Further study has revealed 14 other locations experiencing this so-called “Kesterson Effect.”

A number of bacteria, including *Bacillus, Acinetobacter,* and *Pseudomonas,* can convert selenate (SeO_4^{2-}) to nontoxic elemental selenium. The bacteria do this for their own survival—to prevent the accumulation of toxic levels in their cells.

Question

What is the chemical reaction that shows how the bacteria make Se^0, using hydrogen sulfide (H_2S) and selenate?

The Solution

$$SeO_4^{2-} + 4H_2S \rightarrow Se^0 + 4H_2O + 4S^0$$