Anatomy and Physiology 6th edition Marieb Solutions Manual

SKU: 9780134156415-SOLUTIONS

CHAPTER

2 Chemistry Comes Alive

PART 1: BASIC CHEMISTRY

2.1 Matter and Energy

Matter is the stuff of the universe and energy moves matter

- Differentiate between matter and energy and between potential energy and kinetic energy.
- Describe the major energy forms.

2.2 Atoms and Elements

The properties of an element depend on the structure of its atoms

- Define chemical element and list the four elements that form the bulk of body matter.
- Define atom. List the subatomic particles and describe their relative masses, charges, and positions in the atom.
- Define atomic number, atomic mass, atomic weight, isotope, and radioisotope.

2.3 How is matter combined into molecules and mixtures?

Atoms bound together form molecules; different molecules can make mixtures

- Define molecule, and distinguish between a compound and a mixture.
- Compare solutions, colloids, and suspensions.

2.4 What are the three kinds of chemical bonds?

The three types of chemical bonds are ionic, covalent, and hydrogen

- Explain the role of electrons in chemical bonding and in relation to the octet rule.
- Differentiate among ionic, covalent, and hydrogen bonds.
- Compare and contrast polar and nonpolar compounds.

2.5 How do chemical reactions form, rearrange, or break bonds?

Chemical reactions occur when electrons are shared, gained, or lost

- Define the three major types of chemical reactions: synthesis, decomposition, and exchange. Comment on the nature of oxidation-reduction reactions and their importance.
- Explain why chemical reactions in the body are often irreversible.
- Describe factors that affect chemical reaction rates.

PART 2: BIOCHEMISTRY

2.6 What is the importance of inorganic compounds to the body?

Inorganic compounds include water, salts, and many acids and bases

- Explain the importance of water and salts to body homeostasis.
- Define acid and base, and explain the concept of pH.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

2.7 How are large organic compounds made and broken down?

Organic compounds are made by dehydration synthesis and broken down by hydrolysis

- Explain the role of dehydration synthesis and hydrolysis in forming and breaking down organic molecules.

2.8 Carbohydrates

Carbohydrates provide an easily used energy source for the body

- Describe and compare the building blocks, general structures, and biological functions of carbohydrates.

2.9 Lipids

Lipids insulate body organs, build cell membranes, and provide stored energy

- Describe the building blocks, general structures, and biological functions of lipids.

2.10 Proteins

Proteins are the body's basic structural material and have many vital functions

- Describe the four levels of protein structure.
- Describe enzyme action.

2.11 Nucleic Acids

DNA and RNA store, transmit, and help express genetic information

- Compare and contrast DNA and RNA.

2.12 The Energy Currency, ATP

ATP transfers energy to other compounds

- Explain the role of ATP in cell metabolism.

Suggested Lecture Outline

PART 1: BASIC CHEMISTRY

2.1 Matter is the stuff of the universe and energy moves matter (pp. 19–20)

A. Matter is anything that occupies space and has mass (p. 19).

1. The mass of an object is equal to the amount of matter in the object.

B. Matter exists in one of three states: solid, liquid, or gas. (p. 19)

C. Energy is the capacity to do work, and exists in two forms: potential (inactive) energy and kinetic (active) energy. (p. 20)

1. Energy exists in several forms:

a. Chemical energy is stored in chemical bonds, such as the bonds in food molecules.

b. Electrical energy results from the movement of charged particles, as when ions move across cell membranes.

c. Mechanical energy is energy directly involved with moving matter: Consider legs pedaling a bicycle.

d. Radiant energy is energy that travels in waves: light, for example.

2. Energy is easily converted from one form to another, although some energy is lost to the environment in doing so.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

II. Composition of Matter: Atoms and Elements

2.2 The properties of an element depend on the structure of its atoms (pp. 21–24; Figs. 2.1–2.3; Table 2.1)

A. Elements are unique substances that cannot be broken down into simpler substances. (p. 21; Table 2.1)

1. Four elements—carbon, hydrogen, oxygen, and nitrogen—make up roughly 96% of body weight.

2. Each element is composed of atoms: mostly identical building blocks.

3. There are 118 elements recognized; each is designated by a one- or two-letter abbreviation called the atomic symbol.

B. Atomic Structure (pp. 21–22; Figs. 2.1–2.2)

1. Each atom has a central nucleus made up of protons and neutrons.

a. Protons have a positive charge, while neutrons have no charge, giving the nucleus a net positive charge.

b. Protons and neutrons each weigh 1 atomic mass unit.

2. Electrons occupy random positions within orbitals surrounding the nucleus, have a negative charge, and weightless 0 atomic mass units.

C. Identifying Elements (pp. 23–24; Fig. 2.3)

1. Elements are identified based on their number of protons, neutrons, and electrons.

2. The atomic number of an element is equal to the number of protons of an element; the number of electrons always equals the number of protons.

3. The mass number of an element is equal to the number of protons plus the number of neutrons.

4. Each element has isotopes, structural variations of an atom that have the same number of protons, but different numbers of neutrons.

5. The atomic weight of an element is a weighted average of the weight's mass numbers of all known isotopes of an element, based on their relative abundance in nature.

6. Radioisotopes are heavier, unstable isotopes of an element that spontaneously decompose into more stable forms, producing radioactivity.

a. The time for a radioisotope to lose one-half of its radioactivity is called the half-life.

2.3 Atoms bound together form molecules; different molecules can make mixtures (pp. 24–26; Fig. 2.4)

A. Molecules and Compounds (pp. 24–25)

1. A combination of two or more atoms is called a molecule.

2. A combination of two or more of the same atoms is a molecule of an element; a combination of two or more different atoms is a molecule of a compound.

B. Mixtures (pp. 25–26; Fig. 2.4)

1. Mixtures consist of two or more substances that are physically mixed.

2. Solutions are homogeneous mixtures of compounds that may be gases, liquids, or solids.

a. The substance present in the greatest amount (usually a liquid) is called the solvent, while substances dissolved in the solvent are called solutes.

b. Solutions may be described by their concentrations, often expressed as a percent, or molarity.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

3. Colloids (emulsions) are heterogeneous mixtures that often appear milky and have larger solute particles that do not settle out of solution.

4. Suspensions are heterogeneous mixtures with large, often visible solutes that will settle out of solution.

C. Distinguishing Mixtures from Compounds (p. 26)

1. In mixtures, no chemical bonding occurs between molecules; they can be separated into their chemical components by physical means, and may be heterogeneous.

2. In compounds, chemical bonding is possible between molecules, chemical processes are required to separate the components, and they are only homogenous.

2.4 The three types of chemical bonds are ionic, covalent, and hydrogen (pp. 26–31; Figs. 2.5–2.10)

A. A chemical bond is an energy relationship between the electrons of the reacting atoms (p. 27; Fig. 2.5).

1. The Role of Electrons in Chemical Bonding (p. 27)

a. Electrons occupy specific energy levels surrounding the nucleus, and each energy level holds a specific number of electrons.

b. Electrons fill energy levels beginning closest to the nucleus and progress outward.

c. The octet rule states that the maximum number of electrons available for bonding in the outer, or valence, shell is eight.

d. The octet rule, or rule of eights, states that the maximum number of electrons available for bonding in the outer, or valence, shell is eight; except for the first energy shell (stable with two electrons), atoms are stable with eight electrons in their outermost (valence) shell.

B. Ionic bonds are chemical bonds that form between two atoms that transfer one or more electrons from one atom to the other. (p. 28; Figs. 2.6, 2.9)

1. The atom that receives the electron takes on a negative charge and becomes an anion, while the atom that loses the electron acquires a positive charge, becoming a cation.

a. Most ionic compounds form salts, and when dry, form crystals that are held together by ionic bonds.

b. Covalent bonds occur when pairs of atoms share electrons, and atoms may share one, two, or three pairs of electrons, forming single, double, or triple bonds. (pp. 28–29, Figs. 2.7–2.9)

2. Covalent bonds may be either nonpolar, sharing their electrons equally, or polar, sharing their electrons unevenly.

a. Nonpolar molecules have a balanced distribution of the shared electrons' charge across the bond.

b. In polar molecules, electrons are more attracted to one atom (an electronegative atom) than the other (an electropositive atom), resulting in the area of the bond closest to the electronegative atom assuming a partial negative charge, while the area close to the electropositive atom takes on a partial positive charge.

c. A polar molecule is often referred to as a dipole due to the two poles of charges contained in the molecule.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

C. Hydrogen bonds are formed when a hydrogen that is covalently bonded to one atom (often oxygen or nitrogen) is attracted to another electronegative atom, forming a sort of "bridge."

1. Hydrogen bonding is responsible for molecular attractions between water molecules that create surface tension.

2. Hydrogen bonds are responsible for stabilizing the three dimensional shapes of large molecules.

2.5 Chemical reactions occur when electrons are shared, gained, or lost (pp. 31–34; Fig. 2.11)

A. A chemical equation describes what happens in a reaction by indicating number and type of reactants, chemical composition of the products, and the relative proportion of each reactant and product (if balanced). (p. 31)

B. Types of Chemical Reactions (pp. 32–33; Fig. 2.11)

1. Synthesis (combination) reactions involve formation of chemical bonds and are the basis of anabolic, or constructive, processes in cells.

2. In a decomposition reaction, a molecule is broken down into smaller molecules by breaking chemical bonds and is a degradative, or catabolic, process.

3. Exchange (displacement) reactions involve both synthesis and decomposition reactions, and involve parts of reactants "trading places," forming new products.

4. Oxidation-reduction reactions are special exchange reactions in which electrons are exchanged between reactants: the molecule losing electrons is oxidized, and the molecule receiving the electrons is reduced.

C. Energy Flow in Chemical Reactions (p. 33)

1. In exergonic reactions (often catabolic or oxidative reactions), energy is released, producing products that have lower potential energy than the reactants, while endergonic reactions (often anabolic reactions) result in products that contain more potential energy than the reactants.

D. Reversibility of Chemical Reactions (p. 33)

1. Reversible reactions are indicated by double arrows pointing in opposite directions.

2. A chemical equilibrium occurs when the rate of the forward reaction equals the rate of the reverse reaction, resulting in no net change in the amount of reactants or products, and is shown by the presence of arrows of equal length in the chemical equation.

E. Factors Influencing the Rate of Chemical Reactions (pp. 33–34)

1. Chemicals react when they collide with enough force to overcome the repulsion by their electrons.

2. An increase in temperature increases the rate of a chemical reaction by increasing the kinetic energy of the molecules.

3. Higher concentrations of reactants result in a faster rate of reaction because the likelihood of collisions between molecules increases.

4. Higher concentrations of reactants result in a faster rate of reaction. Smaller molecules move faster and tend to collide more frequently, increasing the rate of a reaction.

5. Catalysts increase the rate of a chemical reaction without taking part in the reaction.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

PART 2: BIOCHEMISTRY

2.6 Inorganic compounds include water, salts, and many acids and bases (pp. 34–37; Figs. 2.12–2.13)

A. Water (p. 34)

1. Water is the most important inorganic molecule, and makes up 60–80% of the volume of most living cells.

2. Water has a high heat capacity, meaning that it absorbs and releases a great deal of heat before it changes temperature.

3. Water has a high heat of vaporization, meaning that it takes a great deal of energy (heat) to break the bonds between water molecules.

4. Water, called the universal solvent, is a polar molecule that plays a role in dissociation of ionic molecules, forms hydration layers that protect charged molecules from other charged particles, and functions as an important transport medium in the body.

5. Water is an important reactant in many chemical reactions.

6. Water forms a protective cushion around organs of the body.

B. Salts (pp. 34–35; Fig. 2.12)

1. Salts are ionic compounds containing cations other than H^+ and anions other than the hydroxyl (OH^-) ion that dissociate in water into their component ions when dissolved.

2. All ions are electrolytes that conduct electrical currents in solution, an important feature to body functions.

C. Acids and Bases (pp. 35–37; Fig. 2.13)

1. Acids, also known as proton donors, have a sour taste and dissociate in water to yield hydrogen ions and anions.

2. Bases, also called proton acceptors, taste bitter, feel slippery, and absorb hydrogen ions.

3. The relative concentration of hydrogen ions is measured in concentration units called pH units.

a. The greater the concentration of hydrogen ions in a solution, the more acidic the solution, and the pH value is lower.

b. The greater the concentration of hydroxyl ions (lower H^+ concentration), the more basic, or alkaline, the solution, resulting in a higher pH value.

c. The pH scale extends from 0–14. A pH of 7 is neutral; a pH below 7 is acidic; a pH above 7 is basic or alkaline.

4. Neutralization occurs when an acid and a base are mixed together, creating displacement reactions that form a salt and water.

5. A buffer is a combination of a weak acid and weak base that resists large fluctuations in pH that would be damaging to living tissues by releasing H^+ when pH rises, and binding up H^+ when pH drops.

2.7 Organic compounds are made by dehydration synthesis and broken down by hydrolysis (pp. 37–38; Fig. 2.14)

A. Carbohydrates, lipids, proteins, and nucleic acids are molecules unique to living systems, and all contain carbon, making them organic compounds (pp. 37–38).

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

2.8 Carbohydrates provide an easily used energy source for the body (pp. 38–40; Fig. 2.15)

A. Carbohydrates are a group of molecules, classified as either monosaccharides, disaccharides, or polysaccharides, that contain carbon hydrogen and oxygen, and include sugars and starches. (pp. 38–39)

B. Monosaccharides are simple sugars, named for the number of carbons they contain, that are single-chain or single-ring structures. (p. 39)

C. Disaccharides are formed when two monosaccharides are joined by dehydration synthesis. (p. 39)

D. Polysaccharides are long chains of monosaccharides linked together by dehydration synthesis: two biologically important polysaccharides are starch and glycogen. (p. 40)

E. In the body, carbohydrates are primarily used as an energy source. (p. 40)

2.9 Lipids insulate body organs, build cell membranes, and provide stored energy (pp. 40–43; Fig. 2.16; Table 2.2)

A. Lipids are insoluble in water, but dissolve readily in nonpolar solvents, and include triglycerides, phospholipids, steroids, and other lipoid molecules. (p. 40)

B. Triglycerides, called neutral fats, consist of glycerol (a sugar alcohol) and fatty acids (linear hydrocarbon chains). (pp. 41–43)

1. Triglycerides are found mainly beneath the skin, and serve as insulation and mechanical protection.

2. The fatty acids may be either saturated, having only single bonds between adjacent carbons, or unsaturated, bearing at least one double bond between a pair of carbons in the chain.

C. Phospholipids are diglycerides with a phosphorus-containing group and two fatty acid chains that are primarily used to construct cell membranes. (p. 43) Steroids, including cholesterol, are flat molecules made up of four interlocking hydrocarbon rings and are used in the body in cell membranes and hormones.

D. Eicosanoids are derived from arachidonic acid, and function in blood clotting and regulation of blood pressure, inflammation, and labor contractions. (p. 43)

2.10 Proteins are the body's basic structural material and have many vital functions (pp. 43–48; Figs. 2.17–2.20; Table 2.3)

A. Proteins are the basic structural material of the body and play vital roles in cell function. (p.43)

B. Proteins are long chains of amino acids connected by peptide bonds, which join the amine of one amino acid to the acid of the next. (p. 43)

C. The structure of proteins has four structural levels: (p. 44)

1. The linear sequence of amino acids is the primary structure.

2. Proteins twist and turn on themselves to form a more complex secondary structure, either spiraled α- helices or β- pleated sheets.

3. A more complex structure is tertiary structure, resulting from protein folding upon itself to form a ball-like structure.

4. Quaternary structure results from two or more polypeptide chains grouped together to form a complex protein.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

D. Fibrous and Globular Proteins (p. 45)

1. Fibrous proteins are extended, strand-like, insoluble molecules that provide mechanical support and tensile strength to tissues.

2. Globular proteins are compact, spherical, water-soluble, and chemically active molecules that oversee most cellular functions.

E. Protein denaturation is a loss of the specific three-dimensional structure of a protein, leading to a potential loss of function, that may occur when globular proteins experience changes in environmental factors such as temperature and pH. (pp. 45–46)

F. Enzymes and Enzyme Activity (pp. 47–48)

1. Enzymes are globular proteins that act as biological catalysts, enabling biological processes to happen quickly enough to support life.

2. Enzymes may be purely protein or may consist of two parts, the protein apoenzyme and non-protein cofactor, that are collectively called a holoenzyme.

3. Each enzyme is chemically specific, binding only certain substrates, and possesses an active site, the location on the protein that catalyzes the reaction.

4. Enzymes work by lowering the energy required by a reaction, the activation energy.

2.11 DNA and RNA store, transmit, and help express genetic information (pp. 48–50; Fig. 2.21; Table 2.4)

A. Nucleic acids have two primary classes: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). (p. 48)

B. Nucleotides are the structural units of nucleic acids, and consist of three components: a pentose sugar, a phosphate group, and a nitrogen-containing base. (p. 48)

C. Five nitrogenous bases are used in nucleic acids: two large, double-ringed purines, adenine (A) and guanine (G), and three smaller, single-ring pyrimidines, cytosine (C), uracil (U), and thymine (T). (p. 49)

D. DNA is the genetic material of the cell and is found within the nucleus. (p. 50)

1. DNA has two primary roles: it replicates itself before cell division and provides instructions for making all of the proteins found in the body.

2. The structure of DNA is a double-stranded polymer containing the nitrogenous bases adenine, thymine, guanine, and cytosine, and the sugar deoxyribose.

3. Bonding of the nitrogenous bases in DNA occurs between complementary pairs: A bonds to T, and G bonds to C.

E. RNA is located outside the nucleus and is used to make proteins using the instructions provided by the DNA. (p. 50)

1. The structure of RNA is a single-stranded polymer containing the nitrogenous bases A, G, C, and U, and the sugar ribose.

2. In RNA, complementary base pairing occurs between G and C, and A and U.

2.12 ATP transfers energy to other compounds (pp. 50–51; Figs. 2.22–2.23)

A. ATP is the primary energy transfer molecule used in the cell. (p. 50)

B. ATP is an adenine-containing RNA nucleotide that has two additional phosphate groups attached, connected by high-energy bonds. (p. 50)

C. Energy is transferred from ATP to other systems in cells by removing the terminal phosphate from ATP and binding it to other compounds, a process called phosphorylation. (p. 51)

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

Cross References

Additional information on topics covered in Chapter 2 can be found in the chapters listed below.

1. Chapter 3: Phospholipids in the composition and construction of membranes; DNA replication and roles of DNA and RNA in protein synthesis; cellular ions; enzymes and proteins in cellular structure and function; hydrogen bonding
2. Chapter 9: Function of ATP in muscle contraction; role of ions in generating muscle cell contraction
3. Chapter 11: ATP, ions, and enzymes in the nervous impulse
4. Chapter 15: Steroid- and amino acid–based hormones
5. Chapter 21: Acid-base balance
6. Chapter 22: Digestive enzyme function; acid function of the digestive system; digestion of proteins, carbohydrates, and lipids
7. Chapter 23: Oxidation-reduction reaction; importance of ions (minerals) in life processes; metabolism of carbohydrates, lipids, and proteins; basic chemistry of life examples
8. Chapter 24: Renal control of electrolytes
9. Chapter 25: Acid-base balance, electrolytes, and buffers; sodium and sodium-potassium pump
10. Appendix E: Periodic Table of the Elements

Lecture Hints

1. Students are commonly intimidated by chemistry or think they do not like it. Make chemistry relevant by frequently mentioning how the concepts they cover now will be applied in later topics. Also, when encountering those applications later in the course, make a point to reconnect them to the rules and principles presented in this chapter.
2. The Internet is a wealth of good animations that allow students to see chemistry happening. Find some short animations to show during class as you lecture to allow students to visualize what you are saying.
3. As an alternative to presenting the chemistry in Chapter 2 as a distinct block of material, you could provide the absolute minimum coverage of the topics at this time and expand upon topics later as areas of application are discussed.
4. Students often find the concept of isotopes confusing. A clear distinction between atomic mass and atomic weight will help clarify the topic.
5. Oxidation-reduction reactions involve the loss and gain of electrons. The reactant oxidized will lose electrons, while the reactant reduced will gain electrons. One easy way to remember this is by using the phrase “Leo the lion goes ger.” Leo stands for “loss of electrons is oxidation,” and ger for “gain of electrons is reduction.”
6. In biological oxidation-reduction reactions, the loss and gain of electrons is often associated with the loss and gain of hydrogen atoms. Electrons are still being transferred since the hydrogen atom contains an electron.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

7. Students often do not align polar and nonpolar bonds strictly with covalent bonds. In order to ensure that they do not impart these qualities to ionic bonds, emphasize the difference between the stable sharing of electrons in covalent bonds, even when the compound is in water, versus the dissociation of ionic bonds and the resulting gain or loss of electrons experienced by these molecules.
8. The relationship between the terms *catalyst* and *enzyme* can be clarified by asking the students if all enzymes are catalysts and if all catalysts are enzymes.
9. Table 2.4 is an excellent summary of the differences between DNA and RNA. This information will be important when discussing protein synthesis.
10. The importance of ATP to the workings of the cell should be emphasized. Students should realize that without ATP, molecules cannot be synthesized or degraded, cells cannot maintain boundaries, and life processes cease.
11. The cycling back and forth between ATP and ADP is a simple but important concept often overlooked by students.

Activities/Demonstrations

1. Audiovisual materials are listed in the Multimedia in the Classroom and Lab section of this *Instructor Guide.* (p. 347)
2. Obtain and/or construct 3-D models of various types of biological molecules such as glucose, DNA, protein, and lipids.
3. Bring in materials or objects that are composed of common elements, for example, a gold chain, coal, copper pipe, cast iron. Also provide examples of common compounds such as water, table salt, vinegar, and sodium bicarbonate. Solicit definitions of *atom*, *element*, and *compound* and an explanation of how an atom and a molecule of a compound differ.
4. Obtain a two-foot-long piece of thick string or cord. Slowly twist to exhibit primary, secondary, and tertiary levels of protein organization.
5. Obtain an electrolyte testing system (lightbulb setup connected to electrodes) and prepare a series of solutions such as salt, acid, base, glucose, etc. Place the electrodes into the solutions to illustrate the concept of electrolytes.
6. Prepare two true solutions (1% sodium chloride; 1% glucose) and two colloidal solutions (1% boiled starch, sol state; Jell-O®, gel state). Turn off the room lights and pass a beam of light through each to demonstrate the Tyndall effect of colloids.
7. Obtain two strings of dissimilar "pop-it" beads. Put the beads together to demonstrate a synthesis reaction, and take them apart to demonstrate a decomposition reaction. Take a bead from each different chain and put them together to illustrate an exchange reaction.
8. Use a metal or plastic "coil" toy to demonstrate denaturation of an enzyme. Tie colored yarn on the coil at two sites that are widely separated, and then twist the coil upon itself to bring the two pieces of yarn next to each other. Identify the site where the yarn pieces are next to each other as the active site. Then remind students that when the hydrogen bonds holding the enzyme (or structural protein) in its specific 3-D structure are broken, the active site (or structural framework) is destroyed. Untwist the coil to illustrate this point.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

Critical Thinking/Discussion Topics

1. Discuss how two polysaccharides, starch and cellulose, each having the same subunit (glucose), have completely different properties. Why can we digest starch but not cellulose?
2. How and why can virtually all organisms—plant, animal, and bacteria—use the exact same energy molecule, ATP?
3. How could a substance such as alcohol be a solvent under one condition and a solute under another? Provide examples of solid, liquid, and gaseous solutions.
4. Describe how weak bonds can hold large macromolecules together.
5. Why can we state that most of the volume of matter, such as the tabletop you are writing on, is actually empty space?
6. When you drive up your driveway at night, you see the light from the headlights on the garage door, but not in the air between the car and the door. Why? What would be observed if the night were foggy?
7. Why are water molecules at the surface of a drop of water closer together than those in the interior?

Library Research Topics

1. Explore the use of radioisotopes in medicine.
2. Study the mechanisms by which DNA can repair itself.
3. Locate the studies of Niels Bohr concerning the structure of atoms and the location of electrons. Determine why his work with hydrogen gas provided the foundation of our knowledge about matter.
4. How can a doughnut provide us with so much "energy"? Find out exactly where this energy is coming from.
5. Phospholipids have been used for cell membrane construction by all members of the "cellular" world. What special properties do these molecules have to explain this phenomenon?
6. What are the problems associated with trans fatty acids in the diet? How has awareness of these effects changed our food practices?
7. Virtually every time an amino acid chain consisting of all 20 amino acids is formed in the cell, it twists into an alpha helix, then folds upon itself into a glob. Why?
8. What advances in science have come out of the sequencing of the human genome (the Human Genome Project)?
9. What is DNA fingerprinting? Explore the applications of this technology.
10. How has the discovery of micro RNAs changed our understanding of what regulates functions in cells?

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

List of Figures and Tables

All of the figures in the main text are available in JPEG format, PPT, and labeled and unlabeled format on the Instructor Resource DVD. All of the figures and tables will also be available in Transparency Acetate format. For more information, go to www.pearsonhighered.com/educator.

Figure 2.1	Two models of the structure of an atom.
Figure 2.2	Atomic structure of the three smallest atoms.
Figure 2.3	Isotopes of hydrogen.
Figure 2.4	The three basic types of mixtures.
Figure 2.5	Chemically inert and reactive elements.
Figure 2.6	Formation of an ionic bond.
Figure 2.7	Formation of covalent bonds.
Figure 2.8	Carbon dioxide and water molecules have different shapes, as illustrated by molecular models.
Figure 2.9	Ionic, polar covalent, and nonpolar covalent bonds compared along a continuum.
Figure 2.10	Hydrogen bonding between polar water molecules.
Figure 2.11	Types of chemical reactions.
Figure 2.12	Dissociation of salt in water.
Figure 2.13	The pH scale and pH values of representative substances.
Figure 2.14	Dehydration synthesis and hydrolysis.
Figure 2.15	Carbohydrate molecules important to the body.
Figure 2.16	Lipids.
Figure 2.17	Amino acids are linked together by peptide bonds.
Figure 2.18	Levels of protein structure.
Figure 2.19	Enzymes lower the activation energy required for a reaction.
Figure 2.20	Mechanism of enzyme action.
Figure 2.21	Structure of DNA.
Figure 2.22	Structure of ATP (adenosine triphosphate).
Figure 2.23	Three examples of cellular work driven by energy from ATP.
Table 2.1	Common Elements Composing the Human Body
Table 2.2	Representative Lipids Found in the Body
Table 2.3	Representative Types of Proteins in the Body
Table 2.4	Comparison of DNA and RNA

Answers to End-of-Chapter Questions

Multiple-Choice and Matching Question answers appear in Appendix A-1 of the main text.

Short Answer Essay Questions

23. Energy is defined as the capacity to do work, or to put matter into motion. Energy has no mass, takes up no space, and can be measured only by its effects on matter. Potential energy is the energy stored in an object because of its position in relation to other objects. Kinetic energy is energy released as an object produces movement. (p. 20)

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

24. Energy may be released in another form such as heat or light, which may be partly unusable. In this instance, energy is not "lost," but simply converted to another form. (p. 20)

25. **a.** Calcium: Ca, **b.** Carbon: C, **c.** Hydrogen: H, **d.** Iron: Fe, **e.** Nitrogen: N, **f.** Oxygen: O, **g.** Potassium: K, **h.** Sodium: Na (Appendix E)

26. **a.** All three atoms are carbon (atomic number = 6, indicating six protons). (p. 23)
b. All possess different numbers of neutrons (12, 13, 14), resulting in different atomic masses. (p. 23)
c. Due to the different numbers of neutrons, these atoms are isotopes. (p. 24)
d. See Figure 2.1, which provides a drawing of a planetary model. (p. 21)

27. **a.** Add the products of the molecular weight of each type of atom in the molecule X and the number of each type of atom in the molecule. s$C_9H_8O_4$: (9 carbon atoms × 12 amu/C) + (8 hydrogen atoms × 1 amu/H) + (4 oxygen atoms × 16 amu/O) = 180 g.
b. Total molecular weight equals the number of grams in one mole, in this case, 180 g/M.
c. Divide the number of grams in the bottle by the number of grams in one mole of aspirin. 450 g/bottle / 180 g/M = 2.5 moles/bottle of aspirin. (p. 26)

28. **a.** Two oxygen atoms: Covalent. **b.** Four hydrogen atoms and one carbon atom: Covalent
c. A potassium atom: Ionic **d.** A fluorine atom: Ionic. (pp. 26–27)

29. Hydrogen bonds are weak bonds that form when a hydrogen atom, already covalently linked to an electronegative atom, is attracted by another electronegative atom. Hydrogen bonding is common between water molecules, and in binding large molecules such as DNA and protein into specific three-dimensional shapes. (pp. 28–29)

30. **a.** The reversibility of the reaction can be indicated by double reaction arrows pointed in opposing directions.
b. When arrows are of equal length, the reaction is at equilibrium.
c. Chemical equilibrium is reached when, for each molecule of product formed, one product molecule breaks down, releasing the same reactants. (p. 33)

31. Primary structure—linear sequence of amino acids in a polypeptide chain; secondary structure—coiling of primary structure into alpha helix or ß-pleated sheet; tertiary structure—folding of alpha helices or beta-pleated sheets into a ball-like, or globular, molecule. (p. 44)

32. Dehydration refers to the joining together of two molecules by the removal of water. In the synthesis of disaccharides or peptides and proteins, monosaccharides are joined to form disaccharides, and amino acids are joined to form dipeptides (and proteins) by this process. Hydrolysis refers to the breakdown of a larger molecule such as a disaccharide into small molecules or monosaccharides by the addition of water at the bond that joins them. In this process, a larger molecule, the disaccharide, was degraded to produce smaller molecules. (pp. 37–38)

33. Enzymes decrease activation energy and decrease the randomness of reactions by binding reversibly to the reacting molecules and holding them in the proper position(s) to interact. (p. 47)

34. The surface tension of water tends to pull water molecules into a spherical shape, and since the glass does not completely overcome this attractive force, water can elevate slightly above the rim of the glass. (p. 30)

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual

Suggested Readings

Beckett, E. L., Yates, Z., Veysey, M., Duesing, K., and Lucock, M. (2014). "The role of vitamins and minerals in modulating the expression of microRNA." *Nutrition Research Reviews*, 27(1), 94–106.

Pasiakos, S. M., Cao, J. J., Margolis, L. M., Sauter, E. R., Whigham, L. D., McClung, J. P., and Young, A. J. (2013). "Effects of high-protein diets on fat-free mass and muscle protein synthesis following weight loss: a randomized controlled trial." *FASEB Journal*, 27(9), 3837–3847.

Wizert, A., Iskander, D., and Cwiklik, L. (2014). "Organization of Lipids in the Tear Film: A Molecular-Level View." *Plos ONE*, 9(3), 1–10.

Copyright © 2017 Pearson Education, Inc.

Anatomy and Physiology 6th edition Marieb Solutions Manual