APPENDIX A
ANSWERS TO CHAPTER ASSESSMENTS

Chapter 1
Introduction to Human Anatomy and Physiology

1.1 Origins of Medical Science

1. Describe how an early interest in the human body eventually led to the development of modern medical science. (p.10)

Our earliest ancestors probably became curious about the body during illnesses and injuries. At these times, they visited shamans who relied on superstition and magic. Throughout early time, this curiosity lead to discoveries of the healing powers of certain herbs and potions, especially to treat coughs, headaches, and other common problems. Not until about 2,500 years ago did these superstitious attitudes change and the body was looked at in the new light of modern science. Experiments, accurate observations, and tried techniques rapidly expanded knowledge of the human body. Greek and Latin words were used as a basis to describe body part locations and to explain their functions. This formed the basis for anatomy and physiology.

1.2 Anatomy and Physiology

2. Distinguish between anatomy and physiology. (p. 11)

Anatomy deals with the structure (morphology) of the body parts. This includes the shapes, forms, and placement of body organs and appendages. **Physiology** deals with the functions of body parts, what the body parts do, and how this is accomplished.

3. Explain the relationship between the form and function of body parts and give three examples. (p. 11)

The functional role will depend upon the manner in which the part is constructed. The human hand with its long, jointed fingers makes it possible for human beings to grasp things, etc.

1.3 Levels of Organization

4. Describe the relationship between each of the following pairs: molecules and cells, tissues and organs, organs and organ systems. (p. 12)

The basic unit of structure and function in the human body is the microscopic **cell**. These cells organize into layers that have common functions. These layers are called **tissues**. These tissues then group together to form **organs**. Groups of organs make up **organ systems**. Groups of organ systems make up the **organism**, which in this case is the human.

1.4 Characteristics of Life

5. Which characteristics of life can you identify in yourself? (p. 14)

Movement is the ability to self-initiate position changes of either the entire organism or a part of the organism, externally from place to place and/or internally, such as in peristalsis.

Responsiveness refers to the ability of an organism to detect changes either within itself or the environment surrounding it and then react to these changes.

Growth generally refers to an increase in body size without important changes to its general shape.

Reproduction is the process of making a new organism, as in parents producing offspring. It also discusses the process whereby cells can produce others like themselves to take the place of damaged or destroyed cells.

Respiration refers to the process of obtaining oxygen, using the obtained oxygen in release of energy from foods, and removing waste gases that are produced in the process.

Digestion is the chemical change of ingested foods into simpler substances that can be taken in and used by body parts.

Absorption is the passage of digested substances through membranes.

6. Identify those characteristics of living organisms that depend on metabolism. (p. 16)

The totality of chemical changes that occur within body parts. Conversion of food into energy is an example.

1.5 Maintenance of Life

7. Compare your own needs for survival with the requirements of organisms described in the chapter. (pp. 14-15)

Water, the most abundant substance in the body, is required for many metabolic processes. It provides the
environment for the metabolic processes to take place and then transports substances within the body. It is also important in the process of regulating body temperature.

Food is the substances that provide the body with the necessary chemical to sustain life, in addition to water.

These chemicals are used in a variety of ways by the body.

Oxygen, which makes up about one-fifth of air, is used in the process of releasing energy from food substances.

Heat, a form of energy, is a product of metabolic reactions. The rate at which these reactions occur is partly governed by the amount of heat present.

Pressure is a state in which a force is applied to something. Atmospheric pressure is an important role in breathing. Hydrostatic pressure, the pressure of fluid, plays an important role in the circulatory system.

8. Explain the relationship between homeostasis and the internal environment. (p. 15)

Homeostasis refers to the stable internal environment of an organism. In human beings, if the requirements
listed above become unstable, the body will react in certain ways to regain its stable internal environment. An example would be sweating to help decrease body temperature.

9. Describe a general physiological control system, including the role of negative feedback. (p. 16)

Homeostatic mechanisms detect changes away from the normal state. This stimulates responses in the opposite directions, which are called negative responses. This process is called **negative feedback**.

10. Explain the control of body temperature. (p. 16)

Control of body temperature is maintained by a self-regulating control mechanism that can receive signals about changes away from the normal set points and cause reactions that return conditions to normal.

11. Describe the homeostatic mechanisms that help regulate blood pressure and blood glucose – what do they have in common and how are they different? (p. 16)

Homeostasis is maintained in each of these situations by a self-regulating control mechanism that can receive signals about changes away from the normal set points and cause reactions that return conditions to normal.

1.6 Organization of the Human Body

12. Explain the difference between the axial and appendicular portions of the body. (p. 18)

Axial portion—This consists of the head, neck, and trunk.

Appendicular portion—This consists of the arms and the legs.

13. Identify the cavities within the axial portion of the body. (p. 18)

The **dorsal cavity** is located at the back of the organism. It can further be subdivided into two parts—the **cranial cavity** within the skull, which houses the brain; and the **spinal cavity**, which contains the spinal cord and is surrounded by sections of the backbone (vertebrae). The **ventral cavity** is the front part of the organism.
It is subdivided into two parts—a **thoracic cavity**, which houses the lungs and heart; and a **abdominopelvic cavity**, which houses the stomach, liver, spleen, gallbladder, small and a large intestines, urinary bladder, and the internal reproductive organs.

14. Define *viscera*. (p. 18)

The **viscera** are the organs found deep within a body cavity.

15. Describe the mediastinum and its contents. (p. 18)

The **mediastinum** is the region that separates the thoracic cavity into two compartments, which contain the right and left lungs.

16. Name the body cavity that houses each of the following organs: (p. 18)

a. Stomach—abdominal
b. Heart—thoracic
c. Brain—cranial
d. Liver—abdominal
e. Trachea—thoracic
f. Rectum—pelvic
g. Spinal cord—vertebral
h. Esophagus—thoracic
i. Spleen—abdominal
j. Urinary bladder—pelvic

17. List the cavities of the head and the contents of each cavity. (p. 20)

Oral cavity is the mouth area and contains the teeth and the tongue.
Nasal cavity is located within the nose and is divided into right and left portions by a nasal septum. Air-filled sinuses are connected to the nasal cavity, including the sphenoidal and frontal sinuses.
Orbital cavities contain the eyes and associated skeletal muscles and nerves.
Middle ear cavities are found inside the ear and contain the middle ear bones.

18. Distinguish between a parietal and a visceral membrane. (p. 20)

A **parietal membrane** refers to a membrane that is attached to the wall and forms the lining of a cavity
whereas a **visceral membrane** refers to a membrane that is deeper toward the interior and covers the internal organs contained within a cavity.

19. Describe the general contribution of each of the organ systems to maintaining homeostasis. (pp. 22 - 25)

Integumentary system—It protects underlying tissues, helps regulate body temperature, houses a variety of sensory receptors, and synthesizes certain products.
Skeletal system—It provides frameworks and protective shields for softer tissues; serves as attachments for muscles when body parts move. It also has a role in blood cell production and storage of inorganic salts.
Muscular system—It provides the forces that cause body movements. They also maintain posture and are the main source of body heat.

Nervous system—It provides the ability to detect changes that occur inside and outside the body. It interprets the sensory impulses and what to do in response to these impulses. It also plays a role in muscle contraction and gland secretions.
Endocrine system—It secretes hormones that alter metabolism of a target tissue.
Cardiovascular system—It pumps blood throughout the body. The blood serves as a fluid for transporting gases, nutrients, hormones, and wastes.
Lymphatic system—It transports tissue fluid back to the bloodstream and carries certain fatty substances away from the digestive organs. It also plays a role in immunity.
Digestive system—It receives various food molecules from the outside and converts them into simpler ones that can be absorbed.
Respiratory system—It provides for the intake and output of air and for the exchange of gases between blood and air.
Urinary system—It removes various wastes from the blood and assists in maintaining the body's water, electrolyte, and acid-base balances.
Reproductive system—It is responsible for the production of whole new organisms like itself.

20. List the major organs that compose each organ system and identify their functions. (pp. 22 - 25)

Integumentary system—It consists of the skin and various accessory organs such as the hair, nails, sweat glands, and sebaceous glands.
Skeletal system—It consists of the bones, ligaments, and cartilages.
Muscular system—It consists of the muscles.
Nervous system—It consists of the brain, spinal cord, nerves, and sense organs.
Endocrine system—It consists of glands that secrete hormones.
Cardiovascular system—It consists of the heart, arteries, veins, capillaries, and blood.
Lymphatic system—It consists of the lymphatic vessels, lymph fluid, lymph nodes, thymus gland, and spleen.
Digestive system—It consists of the mouth, tongue, teeth, salivary glands, pharynx, esophagus, stomach, liver, gallbladder, pancreas, small intestine, and large intestine.
Respiratory system—It consists of the nasal cavity, pharynx, larynx, trachea, bronchi, and lungs.
Urinary system—It consists of the kidneys, ureters, urinary bladder, and urethra.
Reproductive system—The male reproductive system consists of the scrotum, testes, epididymides, vasa deferentia, seminal vesicles, prostate gland, bulbourethral glands, penis, and urethra. The female reproductive system consists of the ovaries, uterine tubes, uterus, vagina, clitoris, and vulva.

1.7 Life-Span Changes

21. Describe physical changes associated with aging that occur during each decade past the age of thirty. (p. 27)

By the fourth or fifth decade our hair color fades, skin etches become wrinkles, elevated blood pressure, and slightly elevated blood glucose levels. The sixth decade sees grayer/whiter hair, deeper skin wrinkles, and waning immunity.

22. List age-associated changes that occur at the molecular, cellular, tissue and/or organ levels. (p. 27)

Some cells may not be able to divide, which slows wound healing. DNA repair slows and transport of substances into and out of cells, lose efficiency. Overall, we have a metabolic slowdown resulting from decreased thyroid function.

1.8 Anatomical Terminology

23. Write complete sentences using each of the following terms to correctly describe the relative locations of specific body parts: (pp. 27 - 28)

a. superior—The head is superior to the abdomen.
b. inferior—The legs are inferior to the chest.
c. anterior—The eyes are anterior to the brain.
d. posterior—The brain is posterior to the eyes.
e. medial—The nose is medial to the eyes.
f. lateral—The ears are lateral to the eyes.
g. bilateral--The lungs are bilateral.
h. ipsilateral—The spleen and descending colon are ipsilateral.
i. contralateral—The spleen and gallbladder are contralateral.
j. proximal—The elbow is proximal to the wrist.
k. distal—The fingers are distal to the wrist.
l. superficial—The epidermis is the superficial layer of the skin.
m. peripheral—The nerves that branch from the brain and spinal cord are peripheral nerves.
n. deep—The dermis is the deep layer of the skin.

24. Sketch the outline of a human body, and use lines to indicate each of the following sections: (p. 28)

a. Sagittal
b. Transverse
c. Coronal

See figure1.22 in textbook.

25. Sketch the abdominal area, and indicate the location of each of the following regions: (p. 30)

a. Epigastric
c. Umbilical
b. Hypchondriac
d. Lateral
e. Pubic
f. Inguinal

See figure 1.25(a) in textbook.

26. Sketch the abdominal area, and indicate the location of each of the following regions: (p. 30)

a. right upper quadrant
b. right lower quadrant
c. left upper quadrant
d. left lower quadrant

See figure 1.25(b) in textbook.

27. Provide the common name for the region to which each of the following terms refers: (p. 30)

a. acromial—point of shoulder
b. antebrachial—the forearm
c. axillary—the armpit
d. buccal—the cheek
e. celiac—the abdomen

f. coxal—the hip
g. crural—the leg
h. femoral—the thigh
i. genital—the reproductive organs
j. gluteal—the buttocks
k. inguinal—the depressed area of the abdominal wall near the thigh (groin).
l. mental—the chin
m. occipital—the lower back region of the head
n. orbital—the eye cavity
o. otic—the ear
p. palmar—the palm of the hand
q. pectoral—the chest
r. pedal—the foot
s. perineal—the region between the anus and external reproductive organs (perineum)
t. plantar—the sole of the foot
u. popliteal—the area behind the knee
v. sacral—the posterior region between the hipbones
w. sternal—the middle of the thorax, anteriorly
x. tarsal—the instep of the foot
y. umbilical—the navel
z. vertebral—spinal column

Chapter 2
Chemical Basis of Life
2.1 The Importance of Chemistry in Anatomy and Physiology
1. Define *chemistry*. (p. 58)
Chemistry considers the composition of substances and how they change.
2. Explain the difference between chemistry and biochemistry. (p. 58)
Chemistry is the study of the composition of substances and how they change. Biochemistry is the chemistry of living organisms.
2.2 Structure of Matter
3. Define *matter*. (p. 58)
Matter is anything that has weight and takes up space.
4. Define *compound*. (pp. 58 - 59)
A **compound** is the product of two or more elements being combined.
5. List the four most abundant elements in the human body. (p. 59)
The four most abundant elements are **hydrogen**, **oxygen**, **carbon**, and **nitrogen**.
6. Explain the relationship between elements and atoms. (p. 59)
An **element** is a basic substance that other things are composed from. Each individual element is made up of tiny, invisible particles called **atoms**. The atom is the smallest complete unit of an element.
7. Identify the major parts of an atom and where they are found within an atom. (pp. 59 – 60)
Each atom is composed of a central portion, called a **nucleus**, and one or more **electrons** that are in constant motion around the nucleus. The nucleus contains one or more large particles called **protons**, and can also contain one or more similarly-sized particles called **neutrons**.

8. Distinguish between protons and neutrons. (p. 60)
Protons carry a single, positive electrical charge (p+). **Neutrons** are uncharged and thus are electrically neutral (n0).
9. Explain why a complete atom is electrically neutral. (p. 60)
The electron carries a single negative electric charge. The protons carry a single positive electric charge.
Neutrons carry no charge, thereby making them electrically neutral. The atom is electrically neutral because there is the exact same number of protons and electrons, which effectively cancel each other out.
10. Distinguish between atomic number and atomic weight. (p. 60)
Atomic number represents the number of protons in an atom of a particular element. Since atoms are electrically neutral, it also tells you the number of electrons. **Atomic weight** represents the number of protons plus the number of neutrons in an atom of a particular element.
11. Define *isotope*. (p. 60)
Isotopes are elements with the same atomic number but different atomic weights.
12. Define *atomic radiation*. (p. 60)
Atomic radiation is the energy or atomic fragments that are given off by unstable isotopes.
13. Explain the relationship between molecules and compounds. (pp. 62 - 63)
A **molecule** is formed when two or more atoms of the same element bond together. A **compound** is formed when two or more elements of different atoms combine.
14. Explain how electrons are distributed within the electron shells of atoms. (p. 63)
The electrons of an atom are found in one or more shells around the nucleus. The maximum number of
electrons that each of the first three inner shells can hold is as follows:
First shell (closest to the nucleus) 2 electrons
Second shell 8 electrons
Third shell 8 electrons
15. Explain why some atoms are chemically inert. (p. 63)
An atom is chemically inert when the outermost electron shells are filled. These atoms cannot form chemical bonds.
16. An ionic bond forms when_____. (p. 64)
c. ions with opposite electrical charges attract.
17. A covalent bond forms when_____. (p. 64)
a. atoms share electrons.
18. Distinguish between a single covalent bond and a double covalent bond. (p. 64)
A **single covalent bond** occurs when atoms share one pair of electrons.
A **double covalent bond** occurs when atoms share two pairs of electrons.
19. Show the difference between the molecular formula and the structural formula of a specific compound. (pp. 62 and 64)
A **molecular formula** consists of the symbols of the elements in the molecule together with numbers to
indicate how many atoms of each element are present. It is essentially the recipe for that particular molecule or compound. A **structural formula** is drawn to represent how atoms are joined and arranged in various molecules. This is essentially the blueprint of how they fit together.
20. Explain how a hydrogen bond forms. (p. 65)

The attraction of the positive hydrogen end of a polar molecule to the negative nitrogen or oxygen end of
another polar molecule.

21. Identify three major types of chemical reactions. (p. 66)

A **synthesis reaction** occurs when two or more reactants bond together to make a new and more complex product. It can be symbolized as follows: A + B = AB. A **decomposition reaction** occurs when a more
complex substance is broken apart into smaller, simple substances. It can be symbolized as follows: AB = A + B. An **exchange reaction** occurs when parts of two molecules change positions. It can be symbolized as follows: AB + CD = AD + CB.

22. Define *reversible reaction*. (p. 66)

A **reversible reaction** is one in which the end product (or products) of the reaction can changed back to the
reactant (or reactants) that originally underwent the reaction A + B = AB.

23. Define *catalyst*. (p. 66)

A **catalyst** is a particular atom or molecule that can change the rate of a reaction without being consumed or changed by the reaction.

24. Define *electrolyte*, *acid, base, and salt*. (pp. 66 - 67)

An **electrolyte** is a substance that releases ions in water. An **acid** is an electrolyte that releases hydrogen ions (H+) in water. A **base** is an electrolyte that releases ions that can combine with hydrogen ions. These are usually hydroxyl ions (OH-). A **salt** is the product formed by the reactions of acids and bases.

25. Explain pH and how to use the pH scale. (p. 67)

pH measures the concentration of hydrogen ions found in substances. This system tracks the number
of decimal places in a hydrogen ion concentration without writing them out. Each whole number on the pH scale, which extends from 0 to 14, represents a tenfold difference in hydrogen ion concentration. As the hydrogen ion concentration increases, the pH number decreases. For example, a solution of pH 6 has ten times the hydrogen ion concentration as a solution with pH 7.

26. Define *buffer*. (p. 68)

A buffer is a chemical that resists pH change.

2.3 Chemical Constituents of Cells

27. Distinguish between inorganic and organic substances. (p. 68)

An **organic** substance contains both carbon and hydrogen atoms. An **inorganic** substance lacks carbon atoms.

28. Distinguish between electrolytes and non-electrolytes. (p. 68)

Electrolytes are inorganic substances that dissociate in water, forming ions. Organic compounds that dissolve in water usually do not release ions and are called non-electrolytes.

29. Describe the functions of water and oxygen in the human body. (pp. 68 - 69)

Water is the most abundant substance in the human body. It is a major component of blood and other body fluids. It is an important solvent. It also has an important role in the transportation of chemicals in the body.

Additionally, water can absorb and transport heat. **Oxygen** is used by cellular organelles in the process of releasing energy from glucose and certain other molecules. The resultant energy is used to drive the cell's metabolic activities.

30. List several ions that cells require and identify their functions. (p. 69)

Sodium (Na^{+}), chlorine (Cl^{-}), potassium (K^{+}), calcium (Ca^{+}), magnesium (Mg^{+2}), phosphate (PO^{4}_{-3}), carbonate (CO^{3}_{-2}), bicarbonate (HCO^{3-}), and sulfate (SO^{4}_{-2}) are the ions that play important roles in metabolic processes. These processes include maintenance of proper water concentrations and nerve functions, in body fluids, pH, blood clotting, bone development, energy transfer within cells, and muscle function.

31. Define *electrolyte balance*. (p. 69)

Electrolyte balance is the condition where the electrolytes are present in certain concentrations, both inside and outside cells, to maintain homeostasis.

32. Describe the general characteristics of carbohydrates. (p. 70)

Carbohydrates supply much of the energy for the cells. They supply building materials for certain cell
structures and are often stored as reserve energy. These molecules contain atoms of carbon, hydrogen, and oxygen. Carbohydrates usually have twice as many hydrogen as oxygen atoms. The carbon atoms are joined in chains that vary in length with the specific kinds of carbohydrates.

33. Distinguish between simple and complex carbohydrates. (p. 70)

Simple carbohydrates are the six-carbon sugars known as simple sugars. **Complex carbohydrates** are
formed when a number of simple sugar molecules are bound together to form molecules of varying size.

34. Describe the general characteristics of lipids. (p. 71)

Lipids are organic substances that are insoluble in water but soluble in certain organic solvents. They supply more energy, gram for gram, than carbohydrates. They contain carbon, hydrogen, and oxygen. Lipids contain a much smaller proportion of oxygen than carbohydrates.

35. List the three main types of lipids found in cells. (pp. 71 - 72)

Fats, phospholipids, and steroids have vital functions in cells.

36. Explain the difference between saturated and unsaturated fats. (p. 71)

A **saturated fat** contains no double bonds between carbon atoms. An **unsaturated fat** contains one or more double bonds between carbon atoms.

37. A hydrophilic molecule dissolves in:_____.(p. 72)

b. water but not lipid.

38. List at least three functions of proteins. (p. 72)

Proteins can be used as structural materials, energy sources, hormones, and receptors on cell surfaces that are specialized to bond to particular kinds of molecules. Others act as antibodies against foreign substances that can enter the body. Still others act as enzymes in metabolic processes. Proteins contain atoms of carbon, hydrogen, and oxygen. In addition, they always contain nitrogen atoms, and sometimes contain sulfur atoms as well.

39. Describe the function of an enzyme. (p. 73)

An **enzyme** is a molecule that acts as a catalyst in living systems. That is, it speeds specific chemical reactions without being consumed or changed in the process.

40. Identify the four levels of protein structure. (pp. 73 - 75)

The four levels are primary, secondary, tertiary, and quaternary.

41. Identify two types of macromolecules in which hydrogen bonds are important parts of the structure. (pp. 75 - 76)
Proteins and nucleic acids.
42. Describe how the change in shape of a protein may be either abnormal or associated with normal function. (p. 75)
When protein molecules lose their unique shape and become disorganized, they become **denatured**. This can be a result of exposure to excessive heat, radiation, electricity, or various chemicals. When they become denatured, it is a permanent change and they are therefore nonfunctional.
43. Describe the general characteristics of nucleic acids. (p. 75)
Nucleic acid molecules are generally very large and complex. They contain atoms of carbon, hydrogen, oxygen, nitrogen, and phosphorus. These are bound into building blocks called nucleotides.
44. Explain the general functions of nucleic acids. (p. 76)
These control all cell activities. They store information that is used by cell parts to construct specific kinds of protein molecules, including enzymes.

Instructor's Manual

to accompany

Hole's Human Anatomy and Physiology Laboratory Manual, Cat Version and Fetal Pig Version

Fourteenth Edition

Terry R. Martin
Kishwaukee College

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Supplemental Laboratory Exercises (these laboratory exercises are available online)

PREFACE

This instructor's manual is designed to assist those who are using the *Laboratory Manual to Accompany Hole's Human Anatomy and Physiology*, cat version and fetal pig version, fourteenth edition by Terry R. Martin. It describes the purpose of the laboratory manual and its special features, and provides suggestions for presenting the laboratory exercises to students. The instructor's manual also parallels the laboratory manual, exercise by exercise, providing labels for unlabeled diagrams and answers to questions that appear in the laboratory reports. For some exercises, special instructional suggestions that propose alternative procedures, laboratory equipment, or laboratory techniques are provided.

Most of the illustrations and labels parallel the textbook very closely as requested by many of the users of the laboratory manual. Many of the leader lines are arranged differently than the book, and several illustrations are different than the textbook. This has been requested also by many of the users of the laboratory manual. I have attempted to reach a balance that will be beneficial for all students and instructors.

AN OVERVIEW

The *Laboratory Manual to Accompany Hole's Human Anatomy and Physiology*, cat version and fetal pig version, fourteenth edition, was written to accompany the textbook *Hole's Human Anatomy and Physiology*, fourteenth edition, by Shier, Butler, and Lewis. As in the case of the textbook, the laboratory manual is planned for students pursuing careers in allied health fields who have minimal backgrounds in the physical and biological sciences.

The manual contains fifty-nine laboratory exercises and four online supplemental laboratory exercises that are closely integrated with the content of a textbook (four of these exercises only appear online via the text McGraw-Hill Connect site). The exercises are designed to review and illustrate various anatomical and physiological facts and principles presented in the textbook and to help students investigate some of these ideas in more detail.

The laboratory exercises include a variety of special features that are designed to stimulate student interest in the subject matter, to involve students in the learning process, and to guide them through the planned experiences. These features include the following:

Materials Needed. The laboratory materials listed are those that students require to complete the exercise and to perform the demonstrations and learning extensions.

Safety. If the laboratory exercise requires special safety guidelines, this section is included. General safety guidelines also appear inside the front cover.

Some institutions might have committees for reviewing labs using live animals, biohazards, and physiology experiments performed on students. Be sure your labs conform to their guidelines. You might find the forms available in Appendixes 3 and 4 useful at your school.

Purpose of the Exercise. The purpose provides a statement concerning the intent of the exercise—that is, what will be accomplished.

Learning Outcomes. The learning outcomes list in general terms what a student should be able to do after completing the exercise.

Introduction. The introduction briefly describes the subject of the exercise or the ideas that will be investigated.

Procedure. The procedure provides a set of detailed instructions for accomplishing the planned laboratory activities. Usually these instructions are presented in outline form so that a student can proceed through the exercise in stepwise fashion. Frequently, the student is referred to particular sections of a textbook for necessary background information or for review of subject matter presented in some previous part of the course.

The procedures include a wide variety of laboratory activities and, from time to time, direct the student to complete various tasks in the laboratory reports.

Demonstrations. Demonstrations appear in separate boxes. They describe specimens, specialized laboratory equipment, or other materials of interest that the instructor may want to display to enrich the student's laboratory experience.

Learning Extensions. Learning extensions also appear in separate boxes. They are planned to encourage students to extend their laboratory experiences. Some of these activities are open-ended in that they suggest how a student can plan an investigation or experiment and carry it out after receiving approval from the laboratory instructor.

Illustrations. Diagrams are used as aids for reviewing subject matter. Other illustrations provide visual instructions for performing steps in procedures or are used to identify parts of instruments or specimens. Micrographs often are included to help students identify microscopic structures or to evaluate student understanding of tissues.

Some figures, such as the skull, are presented so that they are suitable for coloring. You may want to have your students use colored pencils to highlight various parts of these illustrations. This activity should enhance their ability to observe the figures more carefully and help them locate and identify important anatomical features.

Laboratory Reports. Immediately following each exercise, there is a laboratory report to be completed by the student. These reports include various types of review activities, spaces for sketches of microscopic objects, tables for recording observations and experimental results, and questions dealing with the analysis of such data.

As a result of these laboratory exercises, students should develop a better understanding of the structural and functional characteristics of their bodies. In addition, their skills in gathering information by observation and experimentation should increase.

Exercise Selection

Although the laboratory manual contains fifty-nine separate exercises, it may not be possible to include all of them in any one program. However, because many of the exercises are relatively short and because the procedures of others are divided into sections, an instructor can easily select those exercises or parts of exercises that best meet the needs of a particular class.

These exercises also vary in the quantities of equipment needed to complete them; if necessary, an instructor can make some selection based upon the amount of laboratory equipment available for use by a class.

Animal Dissection

In the laboratory manual, the preserved cat or fetal pig is used as the major animal to be dissected. Detailed instructions for dissecting certain organs, such as the sheep brain, sheep heart, pig kidney, and mammalian eye are also included.

A laboratory option is to obtain a cadaver as a demonstration specimen. If this is not possible, consider a field trip to a location that has a prosected cadaver. A minimum of two viewings is recommended—one during muscle study and the other near the end of the course.

The Use of Animals in Biology Education*

The National Association of Biology Teachers (NABT) believes that the study of organisms, including nonhuman animals, is essential to the understanding of life on Earth. NABT recommends the prudent and responsible use of animals in the life science classroom. NABT believes that biology teachers should foster a respect for life. Biology teachers also should teach about the interrelationship and interdependency of all things.

Classroom experiences that involve nonhuman animals range from observation to dissection. NABT supports these experiences so long as they are conducted within the long-established guidelines of proper care and use of animals, as developed by the scientific and educational community.

As with any instructional activity, the use of nonhuman animals in the biology classroom must have sound educational objectives. Any use of animals, whether for observation or dissection, must convey substantive knowledge of biology. NABT believes that biology teachers are in the best position to make this determination for their students.

NABT acknowledges that no alternative can substitute for the actual experience of dissection or other use of animals and urges teachers to be aware of the limitations of alternatives. When the teacher determines that the most effective means to meet the objectives of the class do not require dissection, NABT accepts the use of alternatives to dissection including models and the various forms of multimedia. The Association encourages teachers to be sensitive to substantive student objections to dissection and to consider providing appropriate lessons for those students where necessary.

To implement this policy, NABT endorses and adopts the "Principle and Guidelines for the use of Animals in Precollege Education" of the Institute of Laboratory Animals Resources (National Research Council). Copies of the "Principle and Guidelines" may be obtained from the ILAR (2101 Constitution Avenue, NW, Washington DC 20418; 202-334-2590).

*Adopted by the Board of Directors in October 1995. This policy supersedes and replaces all previous NABT statements regarding animals in biology education.

Background Information

The procedures of many exercises begin by suggesting that students review specific sections of the textbook. If the subject matter involved in a particular exercise has been covered recently in lecture, the students may be able to accomplish such a review rather quickly. On the other hand, if the material has not been presented previously, this part of a procedure may be used as a means of introducing information needed to understand the ideas presented in the exercise.

When the procedure is used to introduce new material, an instructor may ask students to complete the first section before coming to the laboratory. Following this, some portion of the laboratory time may be needed for class discussion of the new material.

CORRELATION OF TEXTBOOK CHAPTERS AND LABORATORY EXERCISES

Textbook Chapters		*Related Laboratory Exercises*	
Ch. 1	Introduction to Human Anatomy and Physiology	Ex. 1	Scientific Method and Measurements
		Ex. 2	Body Organization and Terminology
Ch. 2	Chemical Basis of Life	Ex. 3	Chemistry of Life
Ch. 3	Cells	Ex. 4	Care and Use of the Microscope
		Ex. 5	Cell Structure and Function
		Ex. 6	Movements Through Membranes
		Ex. 7	Cell Cycle
Ch. 4	Cellular Metabolism		
Ch. 5	Tissues	Ex. 8	Epithelial Tissues
		Ex. 9	Connective Tissues
		Ex. 10	Muscle and Nervous Tissues
Ch. 6	Integumentary System	Ex. 11	Integumentary System
Ch. 7	Skeletal System	Ex. 12	Bones and Structure and Classification
		Ex. 13	Organization of the Skeleton
		Ex. 14	Skull
		Ex. 15	Vertebral Column and Thoracic Cage
		Ex. 16	Pectoral Girdle and Upper Limb
		Ex. 17	Pelvic Girdle and Lower Limb
Ch. 8	Joints of the Skeletal System	Ex. 18	Joint Structure and Movements
Ch. 9	Muscular System	Ex. 19	Skeletal Muscle Structure and Function
		Ex. 20	Muscles of the Head and Neck
		Ex. 21	Muscles of the Chest, Shoulder, and Upper Limb
		Ex. 22	Muscles of the Deep Back, Abdominal Wall, and Pelvic Floor
		Ex. 23	Muscles of the Hip and Lower Limb
		Ex. 24	Surface Anatomy
		Ex. 54	Cat (or Fetal Pig) Dissection: Musculature
Ch. 10	Nervous System I: Basic Structure and Function	Ex. 25	Nervous Tissue and Nerves
Ch. 11	Nervous System II: Divisions of the Nervous System	Ex. 26	Brain and Cranial Nerves
		Ex. 27	Dissection of the Sheep Brain
		Ex. 28	Spinal Cord and Meninges
		Ex. 29	Reflex Arc and Reflexes
Ch. 12	Nervous System III: Senses	Ex. 30	Receptors and General Senses
		Ex. 31	Smell and Taste
		Ex. 32	Ear and Hearing
		Ex. 33	Ear and Equilibrium
		Ex. 34	Eye Structure
		Ex. 35	Visual Tests and Demonstrations
Ch. 13	Endocrine System	Ex. 36	Endocrine Histology and Diabetic Physiology
Ch. 14	Blood	Ex. 37	Blood Cells and Blood Typing
Ch. 15	Cardiovascular System	Ex. 38	Heart Structure
		Ex. 39	Cardiac Cycle

		Ex. 40	Blood Vessel Structure, Arteries, and Veins
		Ex. 41	Pulse Rate and Blood Pressure
		Ex. 55	Cat (or Fetal Pig) Dissection: Cardiovascular
Ch. 16	Lymphatic System and Immunity	Ex. 42	Lymphatic System
Ch. 17	Digestive System	Ex. 43	Digestive Organs
		Ex. 44	Action of a Digestive Enzyme
		Ex. 56	Cat (or Fetal Pig) Dissection: Digestive System
Ch. 18	Nutrition and Metabolism		
Ch. 19	Respiratory System	Ex. 45	Respiratory Organs
		Ex. 46	Breathing and Respiratory Volumes
		Ex. 47	Control of Breathing
		Ex. 56	Cat (or Fetal Pig) Dissection: Digestive System
Ch. 20	Urinary System	Ex. 48	Urinary Organs
		Ex. 49	Urinalysis
		Ex. 58	Cat (or Fetal Pig) Dissection: Urinary System
Ch. 21	Water, Electrolyte, and Acid-Base Balance		
Ch. 22	Reproductive Systems	Ex. 50	Male Reproductive System
		Ex. 51	Female Reproductive System
		Ex. 59	Cat (or Fetal Pig) Dissection: Reproductive
Systems			
Ch. 23	Pregnancy, Growth, and Development	Ex. 52	Fertilization and Early Development
Ch. 24	Genetics and Genomics	Ex. 53	Genetics

CORRELATION OF TEXTBOOK CHAPTERS AND SUPPLEMENTAL LABORATORY EXERCISES

Ch. 9	Muscular System	Ex. 60	Skeletal Muscle Contraction
Ch. 10	Nervous System I: Basic Structure and Function	Ex. 61	Nerve Impulse Stimulation
Ch. 14	Blood	Ex. 62	Blood Testing
Ch. 15	Cardiovascular System	Ex. 63	Factors Affecting the Cardiac Cycle

SUGGESTED TIME SCHEDULE

Different instructional programs provide different lengths of time for laboratory preparations, work activities, and follow-up discussions. Other factors that influence the time required for each exercise are the availability and variety of laboratory equipment and materials. Consequently, it is difficult to make precise suggestions for the amounts of time that should be set aside for particular laboratory exercises.

The suggested time schedule was prepared with these limitations in mind. The hours listed for each exercise indicate the minimal time that probably will be needed for students who are acquainted with the subject matter of the exercise to complete the laboratory work. Students who lack background information and who have to read various sections of the textbook before beginning an exercises probably will require additional time. Similarly, students who are expected to complete the laboratory reports in class may need more time.

Laboratory Exercise		*Minimal Time*
Ex. 1	Scientific Method and Measurements	2 hr.
Ex. 2	Body Organization and Terminology	2 hr.
Ex. 3	Chemistry of Life	2 hr.
Ex. 4	Care and Use of the Microscope	2 hr.
Ex. 5	Cell Structure and Function	2 hr.
Ex. 6	Movements Through Membranes	3 hr.
Ex. 7	Cell Cycle	1 hr.
Ex. 8	Epithelial Tissues	2 hr.
Ex. 9	Connective Tissues	2 hr.
Ex. 10	Muscle and Nervous Tissues	1 hr.
Ex. 11	Integumentary System	1 hr.
Ex. 12	Bone Structure and Classification	1 hr.
Ex. 13	Organization of the Skeleton	1 hr.
Ex. 14	Skull	3 hr.
Ex. 15	Vertebral Column and Thoracic Cage	2 hr.
Ex. 16	Pectoral Girdle and Upper Limb	2 hr.
Ex. 17	Pelvic Girdle and Lower Limb	2 hr.
Ex. 18	Joint Structure and Movements	2 hr.
Ex. 19	Skeletal Muscle Structure and Function	1 hr.
Ex. 20	Muscles of the Head and Neck	1 hr.
Ex. 21	Muscles of the Chest, Shoulder, and Upper	
Ex. 22	Muscles of the Deep Back, Abdominal Wall, and Pelvic Floor	1 hr.
Ex. 23	Muscles of the Hip and Lower Limb	2 hr.
Ex. 24	Surface Anatomy	2 hr.
Ex. 25	Nervous Tissue and Nerves	2 hr.
Ex. 26	Brain and Cranial Nerves	2 hr.
Ex. 27	Dissection of the Sheep Brain	2 hr.
Ex. 28	Spinal Cord and Meninges	1 hr.
Ex. 29	Reflex Arc and Reflexes	1 hr.
Ex. 30	Receptors and General Senses	2 hr.
Ex. 31	Smell and Taste	2 hr.
Ex. 32	Ear and Hearing	2 hr.

Laboratory Exercise		*Minimal Time*
Ex. 33	Ear and Equilibrium	1 hr.
Ex. 34	Eye Structure	3 hr.
Ex. 35	Visual Tests and Demonstrations	2 hr.
Ex. 36	Endocrine Histology and Diabetic Physiology	3 hr.
Ex. 37	Blood Cells and Blood Typing	3 hr.
Ex. 38	Heart Structure	2 hr.
Ex. 39	Cardiac Cycle	3 hr.
Ex. 40	Blood Vessel Structure, Arteries, and Veins	3 hr.
Ex. 41	Pulse Rate and Blood Pressure	2 hr.
Ex. 42	Lymphatic System	2 hr.
Ex. 43	Digestive Organs	2 hr.
Ex. 44	Action of a Digestive Enzyme	2 hr.
Ex. 45	Respiratory Organs	2 hr.
Ex. 46	Breathing and Respiratory Volumes	1 hr.
Ex. 47	Control of Breathing	1 hr.
Ex. 48	Urinary Organs	2 hr.
Ex. 49	Urinalysis	3 hr.
Ex. 50	Male Reproductive System	2 hr.
Ex. 51	Female Reproductive System	2 hr.
Ex. 52	Fertilization and Early Development	2 hr
Ex. 53	Genetics	2 hr.
Ex. 55	Cat (or Fetal Pig) Dissection: Cardiovascular System	3 hr.
Ex. 56	Cat (or Fetal Pig) Dissection: Digestive System	2 hr.
Ex. 57	Cat (or Fetal Pig) Dissection: Respiratory System	2 hr.
Ex. 58	Cat (or Fetal Pig) Dissection: Urinary System	1 hr.
Ex. 59	Cat (or Fetal Pig) Dissection: Reproductive Systems	2 hr.
Ex. 60	Skeletal Muscle Contraction	3 hr.
Ex. 61	Nerve Impulse Stimulation	3 hr.
Ex. 62	Blood Testing	2 hr.
Ex. 63	Factors Affecting the Cardiac Cycle	3 hr.

LABORATORY EXERCISE 1
SCIENTIFIC METHOD AND MEASUREMENTS

Critical Thinking Application Answers

Answers and data will vary.

Laboratory Report Answers

PART A

1. (experimental results)
2. (experimental results)
3. Answers will vary, however many students will conclude that the data will support the original hypothesis.

PART B

1 – 6. Answers will vary

LABORATORY EXERCISE 2
BODY ORGANIZATION AND TERMINOLOGY

Instructional Suggestions

If a dissectible human torso model (manikin) is not available, you might want to have students consult the figures in various sections of a textbook, particularly the body sections in the reference plates, to gain some understanding of the organizational pattern of the human body.

Figure Labels

FIG. 2.1

1. Thoracic cavity
2. Abdominal cavity
3. Abdominopelvic cavity
4. Pelvic cavity
5. Cranial cavity
6. Vertebral canal (spinal cavity)

FIG. 2.2*a*

1. Visceral pleura
2. Pleural cavity
3. Parietal pleura
4. Visceral pericardium (epicardium)
5. Pericardial cavity
6. Parietal pericardium

FIG. 2.2*b*

7. Visceral peritoneum
8. Peritoneal cavity
9. Parietal peritoneum

FIG. 2.5

1. Sagittal plane (median; midsagittal plane)
2. Frontal (coronal) plane
3. Transverse (horizontal) plane

FIG. 2.6*a*

1. Epigastric region
2. Right hypochondriac region
3. Right lateral (lumbar) region
4. Umbilical region
5. Right inguinal (iliac) region
6. Left hypochondriac region
7. Left lateral (lumbar) region
8. Left inguinal (iliac) region
9. Pubic (hypogastric) region

FIG. 2.6*b*

10. Right upper quadrant (RUQ)
11. Right lower quadrant (RLQ)
12. Left upper quadrant (LUQ)
13. Left lower quadrant (LLQ)

FIG. 2.7*a*

1. Nasal
2. Oral
3. Cervical
4. Acromial
5. Axillary
6. Mammary
7. Brachial
8. Antecubital
9. Abdominal
10. Antebrachial
11. Carpal
12. Palmar
13. Digital
14. Gential
15. Crural
16. Tarsal
17. Cephalic
18. Frontal
19. Orbital
20. Buccal
21. Mental
22. Sternal
23. Pectoral
24. Umbilical
25. Inguinal
26. Coxal
27. Patellar
28. Pedal

FIG. 2.7*b*

1. Otic
2. Occipital
3. Acromial
4. Vertebral
5. Brachial
6. Dorsum
7. Cubital
8. Lumbar
9. Sacral
10. Gluteal
11. Perineal
12. Femoral
13. Popliteal
14. Sural (calf)
15. Plantar

Laboratory Report Answers

PART A

1. a	4. a	7. a	10. e
2. d	5. b	8. c	11. d
3. a	6. c	9. d	12. a

PART B

1. c	4. g	7. e	10. b
2. d	5. j	8. f	11. a
3. h	6. i	9. k	

PART C

1. Inferior	4. Anterior	7. Distal	10. (Correct)
2. (Correct)	5. (Correct)	8. (Correct)	11. Contralateral
3. (Correct)	6. (Correct)	9. (Correct)	12. Posterior

PART D

1. e	4. i	7. g	10. h
2. k	5. l	8. c	11. f
3. b	6. j	9. d	12. a

PART E

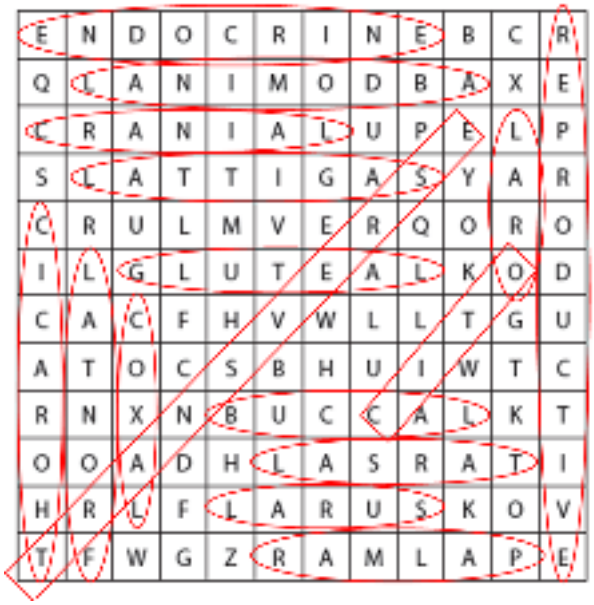
1. l	4. i	7. j	10. a
2. c	5. k	8. g	11. b
3. h	6. f	9. d	12. e

Critical Thinking Application Answers

PART F

1. LUQ	4. RUQ
2. RLQ	5. LUQ or LLQ
3. Any or all quadrants	6. LUQ

PART G



LABORATORY EXERCISE 3
CHEMISTRY OF LIFE

Instructional Suggestions

1. The 7 assorted common liquids for the pH tests could include among the following: orange juice, lemon juice, milk, bottled water, baking soda solution, aspirin solution, borax solution, ammonia, vinegar, antacid, liquid soap, cola, and diluted catsup. Any beverage can be used, and any household product, even solids if they can be dissolved.

2. The unknown compounds could include among the following: diluted milk, diluted corn syrup, chicken or beef broth, diluted potato soup, diluted pudding, salad dressing, egg substitute, and diluted yogurt. It is very important to use some numbering code to keep track of which unknown is which. The unknowns often look alike and are easily confused. The students need to be instructed to take care not to contaminate their unknown. They need to be reminded to perform all tests, as students often think if they get one positive result they can stop. Be aware that different brands of food products can contain different ingredients. Inform the students when heating the samples using Benedict's solution, if there is a protein present it may denature or become solid, which should not be interpreted as a positive result.

Laboratory Report Answers

PART A (matching)

1.	b	5.	f	9.	k
2.	e	6.	i	10.	g
3.	h	7.	c	11.	a
4.	j	8.	d	12.	l

PART A (molecules and bonding)

1.	1; 1	3.	(sketches)	5.	Ionic
2.	17; 7	4.	No; No	6.	(sketches)

PART B

1. (experimental results)
2. (experimental results)
3. No
4. Various substances dissolved in tap water will influence the pH
5. (experimental results)

PART C

1.	(experimental results)	3.	(experimental results)
2.	(experimental results)	4.	(experimental results)

Critical Thinking Application Answers

Answers will vary. However, albumin has the highest protein value along with the lowest amount of carbohydrates (starch and sugar.)

PART D

1 – 4. (experimental results) Answers will vary depending upon the unknown compound selected.

LABORATORY EXERCISE 4
CARE AND USE OF THE MICROSCOPE

Instructional Suggestions

1. To stimulate student interest in use of the microscope, you may want to have students prepare wet mounts of pond water and observe the various forms of life present. A plankton net is a helpful device to concentrate pond organisms. Students can be encouraged to bring samples of pond water to class in preparation for this experiment.

2. You may want to provide students with prepared slides of major human organs to examine as a way of increasing their experience with using the microscope.

3. If oil-immersion objectives are available, you may want to provide students with prepared slides of various forms of bacteria to observe using these objectives.

Critical Thinking Application Answers

Answers will vary depending upon the order of the three colored threads. However, the colored thread on the top will be in focus first, the middle one second, and the bottom one last as the student continues to turn the fine adjustment the same direction.

Laboratory Report Answers

PART A

1. 100×
2. 1,000×

PART B

1. (sketch)
2. About 4.5 mm for scanning power (using 4× objective)
3. About 4,500 micrometers
4. About 2.2 mm
5. About 2,200 micrometers

PART C

1. (sketch)
2. About 1.7 mm (using a 10× objective)
3. The diameter of the scanning-power field of view is about 2.6 times greater than that of the low-power field of view.
4. Student is unable to see two adjacent mm lines on the scale in a high-power field of view.
5. Light intensity is decreased when high-power objective is used.
6. (sketch)
7. Upside down and reversed from right to left
8. Left
9. Toward the observer

PART D

1. f
2. i
3. c
4. a
5. h
6. j
7. d
8. b
9. g
10. e

PART E

(sketches)

LABORATORY EXERCISE 5
CELL STRUCTURE AND FUNCTION

Instructional Suggestions

1. Instead of preparing cheek cell slides, you may want to have students prepare slides of plant cells using *Elodea* leaves or onion skin.
2. If live frogs are available, you may want to pith the frogs and have students prepare wet mounts using small samples of the ciliated epithelium that lines the oral cavity. They also can prepare smears of frog blood and stain the cells with methylene blue, and prepare wet mounts of sperm cells from the testes of the male frogs. You then might provide students with prepared slides of human ciliated epithelium, blood, and sperm cells and have the students compare the frog cells with the human cells.

Figure Labels

FIG. 5.1

1. Flagellum
2. Centrioles
3. Golgi apparatus
4. Smooth endoplasmic reticulum
5. Nucleus
6. Nuclear envelope
7. Mitochondrion
8. Ribosomes
9. Cell membrane
10. Cilia

Critical Thinking Application Answers

The outer body surface is the same tissue as inside the cheek, however outer surface cells are dead from drying out.

Laboratory Report Answers

PART A

1. a
2. g
3. k
4. l
5. i
6. f
7. c
8. b
9. d
10. e
11. h
12. j

PART B

1. (sketch)
2. The wet-mount cells look like shells or "ghosts." The stained cells made the nucleus and other cellular components more clearly visible.
3. Yes. The stained cheek cells are essentially the same size and shape; however, the process of cell removal may cause many of the cells to become folded and distorted.

PART C

1. (sketches)
2. They should always notice cytoplasm, nucleus, nuclear envelope, and cell membrane
3. Answers will vary.

PART D (FIG. 5.4)

1. Nucleolus
2. Chromatin
3. Nuclear envelope
4. Rough endoplasmic reticulum
5. Mitochondria
6. Answers will vary
7. Only nonliving cells can be observed, and only sections of a cell can be observed

LABORATORY EXERCISE 6
MOVEMENTS THROUGH MEMBRANES

Instructional Suggestion

Instead of using human blood for Procedure C, you may want to substitute some other type of animal blood obtained from a meat packing house, a veterinarian, or a biological supplier. The hemolysis experiment, using RBCs from a safe source, demonstrates concepts of osmosis, tonicity, and membrane characteristics.

Laboratory Report Answers

PART A

1. (experimental results)
2. (experimental results)
3. Answers will vary.
4. Diffusion is the movement of a substance from an area of higher concentration to an area of lower concentration as a result of molecular motion.

Critical Thinking Application Answers

1. Yes
2. Yes
3. No

PART B

1. Answers will vary.
2. Answers will vary.
3. Water entered the thistle tube through the membrane, thus increasing the volume of liquid in the tube as a result of osmosis.
4. Osmosis is the movement of water molecules from an area of higher concentration to an area of lower concentration through a selectively permeable membrane.

Critical Thinking Application Answers

1. Yes
2. No
3. Yes

PART C

1. (sketches)
2. Tube 3. There was a net movement of water out of the cells.
3. Tube 1. There was a net movement of water into the cells.
4. Tube 2. There was no net movement of water into or out of the cells.

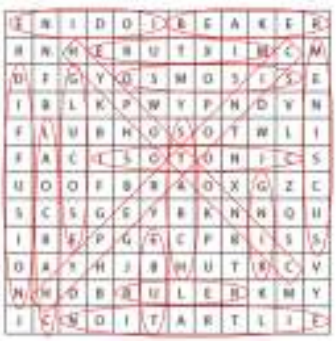
PART D

1. Water, glucose, and starch.
2. The tests for glucose and starch were positive.
3. Gravity
4. Charcoal
5. Pore in the filter paper were too small.
6. Filtration is the movement of substances through a membrane as a result of hydrostatic pressure that is greater on one side of the membrane than on the other side.

Critical Thinking Application Answers

1. No
2. Yes
3. Yes

PART E



LABORATORY EXERCISE 7
CELL CYCLE

Figure Labels

FIG. 7.4

1. Chromosome (chromatid)
2. Centromere
3. Centrioles
4. Spindle fiber (microtubules)

Critical Thinking Application Answers

Interphase. Even in rapidly dividing cells interphase is the most prevalent because it requires the longest period of time for growth and duplication of cell structures.

Laboratory Report Answers

PART A

Table:

Stage	Major Events Occurring
Interphase	Growth, duplication of cell structures, and normal metabolism take place.
Prophase	Nuclear envelope and nucleolus disperse; chromatin fibers condense, forming chromosomes (paired chromatids); centrioles move to opposite sides of the cell.
Metaphase	Chromosomes align midway between centrioles.
Anaphase	Microtubules pull sister chromatids toward centrioles.
Telophase	Chromosomes elongate and become chromatin fibers; nuclear envelopes reassemble.
Cytokinesis	Cell membrane constricts, dividing cell into new cells (daughter cells).

PART B

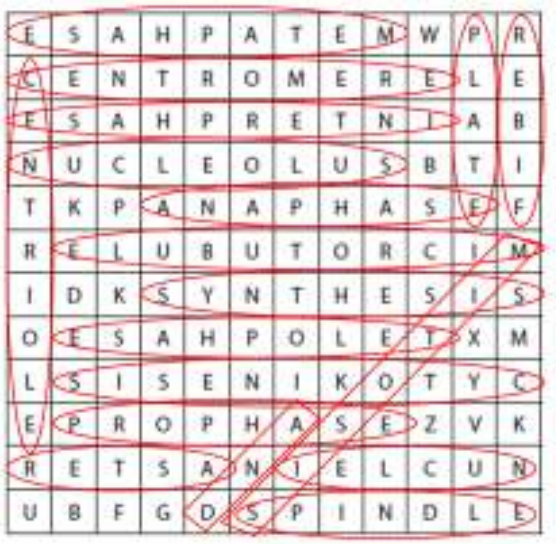
(sketches)

PART C (FIG. 7.6a-d)

1. a. Metaphase
   b. Telophase
   c. Prophase
   d. Anaphase

2. 3
   5
   2
   1
   4
   6

PART D



Case Study 1

Hematology

AIDS

Answers:

1. This individual has Acquired Immunodeficiency Syndrome (AIDS) caused by the Human Immunodeficiency Virus (HIV).
2. The hematocrit abnormality is caused by the dehydration.
3. Some current treatments include: AZT (Zidovudine) and ddI (Didanosine), both antiretroviral agents which slow the replication of the virus, prevent occurrence or recurrence of opportunistic infections, and boost the immune system.
4. The individual is experiencing hypokalemia prior to treatment.
5. This abnormal potassium level could cause cardiac arrhythmias due to the hyperpolarization of the resting membrane potential.

Case Study 2

Gastrointestinal

Hiatal Hernia

Answers:

1. The disorder is a hiatal hernia. This is a structural defect in which a weakened diaphragm allows a portion of the stomach to pass through the esophageal diaphragmatic opening into the chest when intra-abdominal pressure increases.
2. Adequate lower esophageal pressure at the lower esophageal sphincter normally prevents gastric reflux into the esophagus when lying down or bending over.
3. The parasympathetic division of the autonomic nervous system (cholinergic) innervates the lower esophageal sphincter (LES). Therefore, cholinergic agonists would increase LES contraction, preventing gastric reflux. Anticholinergic agents would decrease LES pressure.
4. Histamine (H2) antagonists are recommended because they reduce gastric acidity by selectively blocking the H2 receptors (which mediate gastric secretion).
5. Elevation of the head of the bed is recommended to encourage gravitational flow of the gastric contents toward the pyloric end of the stomach.

The normal pH of the esophagus is 6-7.
The normal pH of the stomach is 2-5.

Case Study 11

Hematology

Polycythemia

Answers:

1. The disorder of this individual is polycythemia.
2. The arterial O_2 saturation and erythropoietin levels are important in confirming that the increased hematocrit is not due to hypoxemia or an abnormally elevated erythropoietin level. The O_2 saturation level would indicate if there is a physiologic stimulus for the increased erythrocyte production.
3. Phlebotomy is the letting of blood for transfusion pheresis, diagnostic testing, or experimental procedures.
4. Phlebotomy (removal of the whole blood) removes both blood cells and plasma. The plasma volume is replaced within days, whereas the erythrocytes take several weeks to be replaced.
5. Myelosuppressive therapy is therapy for the suppression of the bone marrow's production of blood cells and platelets.
6. Myelosuppressive therapy may be needed to suppress the erythrocyte production in the myeloid tissue if the hematocrit continues to rise after the phlebotomies.

Case Study 12

Cardiovascular

Primary Hypertension

Answers:

1. This individual has primary hypertension. (If this person had an elevated plasma renin level, he would be diagnosed as having renal hypertension.)
2. The ideal body weight for a 5-foot 6-inch male of medium frame is 140-160 lb.

The sites of action for the pharmacologic agents prescribed for this individual follow:
Oral diuretic: acts on the kidney to increase urinary output and therefore decrease the circulating fluid volume and decrease blood pressure.
Beta-blocker: blocks the beta receptors on the heart to decrease the work of the heart.

PREFACE

TheInstructor's Manualisdesigned to assist instructors who use *Hole's Human Anatomyand Physiology, Fourteenth Edition,* in their human anatomyand physiology courses byoffering LectureSuggestions and Guidelines, Application Questions, and Critical Thinking Issues forthe list of learningoutcomes that precedeeachtextbook chapter.

Answers to ChapterAssessments andAnswers toIntegrativeAssessments/Critical ThinkingQuestions areincluded in the Appendices. Each question has been tied toa student learningoutcome.

CHAPTER1
INTRODUCTIONTOHUMANANATOMYAND PHYSIOLOGY

Learning Outcomes

1.1 Origins of Medical Science

1:Identify someofthe early discoveries thatleadto our current understanding ofthe human body.

LectureSuggestions andGuidelines

1. Give an overview ofthe roles of primitive doctors.
2. Comparevarious beliefs regardingthe connection between natural forces andthe human body.
3. Identifythe origins ofbasic terms used in thestudyof anatomyand physiology.

Application Question(s)

1. Ask students to develop a chart of basic terms found in thelanguageofanatomy and physiology.
   Answer: Responses should include aminimum of 50 modern terms accompanied bytheirGreek/Latin derivatives.

Critical Thinking Issue(s)

1. Compare and contrastseveralancient uses of herbs and potions.
   Answer: Students maybe required to research this topic viathe library, used book stores, or theInternet.

1.2 Anatomy andPhysiology

2:Explainhowanatomyandphysiologyare related.

LectureSuggestions andGuidelines

1. Give an overview ofthestudyof anatomyand physiology.
2. Describethe relationshipbetween the structures of bodyparts and thefunctions of thesebodyparts.
3. Comparethe scientificresearchefforts of an anatomist with the concerns ofa physiologist.

Application Question(s)

1. The function ofabodypart (physiology)is determined bythe wayitis constructed (anatomy). How does this relationship applyto thehuman heart?Ask students to give otherexamples, which illustrate this concept.
   Answer: Thehuman heartis constructed such thattwo superior atria serveto receiveblood and two inferior, thick-walled ventricles serveto pump blood. The

heart is muscular, has threemajortissue layers, and contains aseries of valves, which insureone-wayblood flow.

2. Ask students to demonstrate ways in which structuredetermines function by providingexamples outside the human body.
   Answer: Examples willvary. Some possibilities include small appliances,such as atoaster, amixer, orapotato peeler. Clocks, automobile parts, and tools would be other examples.

Critical Thinking Issue(s)

1. Howdoes the arrangement of parts in thehumanhand comparein functional effectiveness to analogous parts in other animals?
   Answer: Thehuman hand is composed oflong, jointed fingers, anopposable digit, and dermal papillae, allof which enhancegrippingability.
2. The authors state that"recently,researchers discovered apreviouslyunknown musclebetween two bones in thehead."What characteristics would help scientists relatethe anatomyofthis "new"muscleto its physiology?
   Answer: The action ofthemuscle, the shapeof themuscle, the location ofthe muscle's origin and insertion, the number oforigins, the exact location ofthe muscle, and its relative size.

1.3 Levels ofOrganization

3:List the levels oforganizationinthe human body andthe characteristics of each.

LectureSuggestions andGuidelines

1. Introducethe major levels of structural complexity.
2. Discuss how the humanbodyillustrates levels oforganization to include atoms, molecules, macromolecules, organelles, cells, tissues, organs, organ systems, and organism.

Application Question(s)

1. Ask students to applytheconcept of structural complexitybypreparingaflow chart, which illustrates thelevels of organization foroneof themajororgan systems of thehuman body.
   Answer: Differences willbecome evident for each organ system oncethestudent reaches the cell, tissue, and organ levels.

Critical Thinking Issue(s)

1. Ask students to applytheconcept of levels of structural complexityto an example otherthan thehuman body.
   Answer: For example, asingle lettercombines with other letters to form aword. A group ofwordsformsasentence. Agroupof related sentences forms a paragraph. Paragraphscombineto form pages. Pagescombineto form chapters, which then combineto form abook, etc.

1.4 Characteristics ofLife

4:List and describe themajorcharacteristics oflife.

LectureSuggestions andGuidelines

1. Introducetheconcept ofmaintaininglifethroughnecessarylifefunctions.
2. Brieflydiscuss theten major characteristics of lifeshared byallorganisms.
3. Describethephysical and chemical events, whichconstitute metabolism.

Application Question(s)

1. Ask students to compareand contrast a newborn baby,ateenager,andasenior citizen in terms ofthe ten characteristics oflife, includingmovement, responsiveness,growth,reproduction, respiration, digestion, absorption, circulation, assimilation, and excretion.
   Answer: Responses will vary.

Critical Thinking Issue(s)

1. Thesum of allchemical and physical eventsand reactions in the human body constitutes metabolism.Howmight diabetes mellitus bedefined as a metabolic diseasein terms ofthe ten major characteristics oflife?
   Answer: Students shouldexpress their responses byillustratingdiabetes'effects on movement, responsiveness,growth, reproduction, respiration, digestion, absorption, circulation, assimilation, and excretion.

5:Giveexamples of*metabolism*.

LectureSuggestions andGuidelines

1. Definemetabolism as thesum total of allof thechemical reactions in thebody.
2. Describerespiration asan exampleof ametabolicprocess.
3. Describedigestion as an exampleof ametabolicprocess.

Application Question(s)

1. Ask students to comparehuman metabolic processes with processes of other animals.
   Answer: Comparisonsmayincludemammals, fish, invertebrates, insects, etc.

Critical Thinking Issue(s)

1. Ask students to predict the direeffects on the human bodywhen oneof themajor metabolicprocesses malfunctions.
   Answer: Responses should include adiscussion ofthe effects on homeostasis.

1.5 MaintenanceofLife

6:List and describe themajorrequirements oforganisms.

LectureSuggestions andGuidelines

1. Describeenvironmental factors required of organismsto maintain life, including water, food, oxygen, heat, and pressure.
2. Discuss which requirements of organisms areprovided from the external environment.

Application Question(s)

1. Ask students to provide examples of ways in which the human bodyrequires pressureto maintain life.
   Answer: Examples might include: a) hydrostaticpressure, which is necessaryfor kidneyfiltration; b) blood pressuredueto heart action, which keeps blood flowing through the blood vessels;c) pressureon both surfaces of the eardrum, in order forthe eardrum to vibrate freely; or d) atmospheric and pulmonarypressure, which is vital to the mechanisms of breathing.

Critical Thinking Issue(s)

1. Wateris themostabundant substancein thebody.Which properties makewater vital to themaintenanceofhuman lifein the event of:
   a. vigorous exercise;
   b. transport ofnutrients,gases, andwastes;
   c. fooddigestion;
   d. movement of bonewithin ajoint cavity?

   Answer: a) Waterprevents sudden changes in bodytemperatureduето its high heat capacity. b) Nutrients, gases, andwastes candissolve in watersincewateris an excellent solvent. Water also acts as atransport and exchangemedium as well. c) Watermoleculesare added to thebonds of larger biological molecules to break them down duringdigestion. d) Synovial fluids, which contain awaterbase, lubricate themovement of bones within jointcavities. Wateris present in all body lubricants.

7:Explaintheimportance of homeostasisto survival.

LectureSuggestions andGuidelines

1. Describehomeostasis asadynamicstateofequilibrium.
2. Discuss thebody's rolein maintainingarelativelystableinternal environment.

Application Question(s)

1. How can theconcept ofhomeostatic imbalancebe applied to the following situations?Can homeostasisbe restored?How?
   a. dental caries
   b. akidneystone
   c. abulgingintervertebral disc

   Answer: a) fillingor extracting; b)"passing"itthrough the urinarytract, lithotripsy, surgical excision; c)physical therapy,medication, surgery

Critical Thinking Issue(s)

1. Howwould environmental pollution (air, water, soil) threaten homeostasisand the survival of organisms?
   Answer: Answers will vary.

8:Describe theparts ofa homeostaticmechanismandexplain howthey function together.

LectureSuggestions andGuidelines

1. Describetheprocess bywhich homeostatic mechanisms regulatebody temperature, blood pressure, and blood sugar concentration.
2. Define and discuss positive and negative feedbackmechanisms.

Application Question(s)

1. Applytheconcept of negative feedbackmechanisms bycomparing ahome heatingsystem to the regulation of bodytemperaturein thehuman body.
   Answer: a) Set the thermostat to 70 degreesF. b)Room temperaturedropsbelow 70 degrees; furnace comes on. c) Room temperature rises until it reaches approximately70 degrees. 4) Thermostat transmits signal to shut off furnace. The human bodyoperates inan analogous waythrough the useof a receptor and control center (thermostat located in the hypothalamus) and an effector (the heatingsystem) toregulate bodytemperature.

Critical Thinking Issue(s)

1. Howdoes a homeostaticcontrol mechanismregulate blood glucose levelswhen the level is too high?Toolow?
   Answer: When blood glucoselevels aretoo high,the pancreas releases insulin into the blood, uptakeofglucosein mostbodycells isenhanced, the liver captures glucoseand stores itasglycogen, and the bloodglucose levels begin to decline. When blood glucoselevels aretoo low, thepancreas releasesglucagon intothe blood, theliver breaks downglycogen andreleases glucose,and the bloodglucose levels begin to rise.

1.6 OrganizationoftheHumanBody

9:Identify thelocationsofthemajorbody cavities.
and
10:List the organs locatedineachmajorbody cavity.
and
11:Nameandidentifythe locations ofthemembranes associatedwith the thoracic andabdominopelvic cavities.

LectureSuggestions andGuidelines

1. Definethe terms axial portion and appendicular portion.
2. Introducethe two sets ofinternal cavities that provide protection to theorgans within them.

3. Describethelocation ofthedorsal bodycavity, includingthecranialand spinal cavities.
4. Describethelocation oftheventral bodycavity, includingthe thoraciccavity, diaphragm, and abdominopelvic cavities.
5. Brieflydescribethe oral,nasal, orbital,and middleear cavities.
6. Describethe cranial cavity,which houses the brain, and thespinal cavity, which contains thespinal cord and is surrounded byvertebrae.
7. Locate thethoraciccavityviscera, includingthe heart, lungs, esophagus, trachea, and the thymusgland.
8. Describethelocation ofthemediastinum.
9. Locate thevisceraof theabdominopelvic cavity, includingthe stomach, liver, spleen, gallbladder, small and largeintestines, urinarybladder, and the internal reproductiveorgans.
10. Introducethe terms visceral and parietal.
11. Describethepleural membranes, which line thethoraciccavityand coverthe lungs.
12. Describethepericardialmembranes, which surround the heart andcover its surface.
13. Describetheperitoneal membranes, which linethe abdominopelviccavityand cover theorgans inside.
14. Definethe pleural, pericardial, and peritoneal cavities.

Application Question(s)

1. Ask the students to useadissectible manikin to illustrate themajorbodycavities, the membranesassociated with those cavities, theorgans found in each cavity, and the nineseparateregions which comprise theabdominopelvic cavity. **Answer:** N/A.

Critical Thinking Issue(s)

1. A boxer received multiple blows to thethoracic,abdominal, and pelvic regions. Whyaretheorganscontained in the abdominal region themostvulnerable? **Answer:** Thepelvicorgans receivesome additional protection from thebony pelvis. Thethoracic organs areshielded somewhat bythe sternumand rib cage. However, the abdominalorgans lie in a cavity, which is not reinforced bybone, but ratherareprotected onlybyabdominal muscles.

   12:Namethemajororgansystems, andlist theorgans associatedwitheach. and
   13:Describe thegeneral function ofeachorgansystem.

LectureSuggestions andGuidelines

1. Introducethe major organ systems of thehuman body, includingintegumentary, skeletal, muscular, nervous, endocrine, digestive,respiratory,cardiovascular, lymphatic, urinary, and reproductivesystems.

2. Describeand locatethemajororgans ofeach system, usingwallcharts, models, and overhead transparencies.

Application Question(s)

1. Ask the students to develop a chart which illustrates themajororgan systems to includethe name ofthesystem, the major organsassociated with each system, and the major functions of each system.
   Answer: N/A.

Critical Thinking Issue(s)

1. Howmight a physiologistplacethe organ systems into categories accordingto theirmain functions?Usethe terms bodycovering, support and movement, integration and coordination, transport, absorption and excretion, and reproduction.
   Answer: Bodycovering-integumentary; support and movement-skeletal and muscular; integration andcoordination-nervousand endocrine; transport-cardiovascular and lymphatic; absorption andexcretion digestive,respiratory,and urinary; reproduction-reproductive

1.7 Life-SpanChanges

14: Identify changes relatedto aging, fromthemicroscopic tothe whole- body level.

LectureSuggestions andGuidelines

1. Describe agingas a partoflife.
2. Give examples of the evidenceof agingat thetissue, cell, and molecularlevels.
3. Describethe effects of lifestylechoices uponaging.

Application Question(s)

1. Havestudents makea comparison of ababy,a40-year old adult, andasenior citizen in terms ofthe evidenceof agingat thetissue, cell, molecular, andwhole-bodylevels.
   Answer: Responses will vary.

Critical Thinking Issue(s)

1. Ask students to describecompareand contrast various products on the market that claim to impedethe agingprocess. Which of these claims aredifficult to believe? Why?
   Answer: Responses will vary.

1.8 Anatomical Terminology

15:Properly use theterms that describe relativepositions, body sections, and body regions.

LectureSuggestions andGuidelines

1. Use anatomicalterminologyto describerelative positions of thebodyparts. Name each term, defineeach term, provide an illustration to depict each term, and give practicalexamples of each.
2. Demonstrate thethreemajor planes: sagittal, frontal, and transverse, byusing anatomical models and textbook photographs.
3. Introducetermswhich designate bodyregions. Definethe four-quadrant and nine-region systems fordescribingthe subdivisionsof the abdominal area.

Application Question(s)

1. Haveeach student develop twentyflash cards, each of which contains thename of abodypart on oneside,and adescription of its relative position usingappropriate anatomical terms on the reverse. Collect thecardsand quizthe students with them.
   Answer: Responses will vary.

CriticalThinking Issue(s)

1. Ask students to chooseonediseaseor set of symptoms, anddescribethe patient's condition as explicitlyaspossible usingappropriate directional terms, body planes, sections, and regions. Theinstructor maywish to analyzereal-lifemedical recordreports with the class. (Rememberto insurepatient confidentiality). **Answer:** N/A.

Topical ChapterOutline

1.1Origins of Medical Science
1.2 Anatomyand Physiology
1.3Levels of Organization
1.4 Characteristics ofLife
1.5 MaintenanceofLife
   a. Requirements of Organisms
   b. Homeostasis
1.6 Organization oftheHuman Body
   a. BodyCavities
   b. Thoracicand Abdominal Membranes
   c. Organ Systems (BodyCovering, Support and Movement,Integration and Coordination, Transport,Absorption and Excretion, Reproduction)
1.7Life-Span Changes
1.8 Anatomical Terminology
   a. RelativePosition
   b. BodySections
   c. BodyRegions

CHAPTER2
CHEMICALBASISOFLIFE

Learning Outcomes

2.1 The Importance of Chemistry in Anatomy and Physiology

1:Giveexamples of howthestudy ofliving materials requires an understanding ofchemistry.

LectureSuggestions andGuidelines

1. Introducebiochemistry'simportancein understandingphysiological processes, developingnew medications and treatment modalities, andimprovingnutrition.
2. Discuss the concept that chemical reactions arethebasisfor allphysiological processes in thebody.Integrate this concept with earlierdiscussions ofthe necessarylifefunctions, includingmovement,growth, respiration,and digestion, etc.

Application Question(s)

1. Ask each student to research onetherapeuticdrug currentlyon the market and applyits chemical composition, modeof action, and possibleadversereactions to the concept that chemistryis essential for an understandingof physiology.
   Answer: Responses will vary.

Critical Thinking Issue(s)

1. Streptomycin, anaminoglycosideantibiotic, is averyeffectivebacterialgrowth inhibitor. Whyis itso effective, i.e., what is the link between its chemical composition and bacterial physiology?
   Answer: Streptomycin binds to specific sites on ribosomes, thus interfering with translation. This results in incorrect amino acid sequencing, the precursor to protein synthesis. Thesealterations ultimatelydisrupt bacterialgrowth.

2.2 StructureofMatter

2:Describe therelationships among matter, atoms, andcompounds.
and
3:Describehowatomicstructuredetermines howatoms interact.
and
4:Explainhowmolecular andstructural formulas symbolize the composition ofcompounds.

LectureSuggestions andGuidelines

1. Introducetheconcept ofmatterin threephysical forms and give examples of each in thehuman body.
   Examples: solids-bones andmuscles; liquids-blood and interstitial fluid;gases-oxygenand carbondioxide

2. Lectureon the composition of matter. Define atoms, electrons, protons, neutrons, ions, molecules, elements, and compounds.
3. Describeboth themajorand trace elements foundin thehuman body.
4. Introducethe periodictable, and discuss the atomic structureofelements 1 through 12 in terms ofatomicnumber, atomic symbol, atomic weight, and isotopes.
5. Discuss thetypes of chemical bonds, includingionic, covalent, and hydrogen bonds.
6. Introducetheconcept ofmolecular and structuralformulas.

Application Question(s)

1. Ask students to make flash cards ofthefirst twentyelements on theperiodic table. Thename of the element would appear on oneside ofthe card, thereverse side should listthe atomicnumber, the chemical symbol, and amajor useof the element in the human body.
   Answer: N/A.
2. Prepareball-and-stick models of several simplemolecules. Ask students to name the molecule, identifywhich atoms arecontained in the molecule, and discuss the number and typeofchemical bonds involved. What would be the resultof changingthe molecule byaltering abond orrearrangingtheatoms?
   Answer: Responses will vary.
3. Bringin a varietyof common elements found in the human body. Ask students to find eachelement on theperiodictable and describeits major uses. Examples might include carbon,sulfur, zinc, copper, iodine,magnesium, iron, phosphorus, and calcium.
   Answer: Responses will vary.

Critical Thinking Issue(s)

1. What arethe advantagesofusingultrasound technologyfordiagnostic medical imaging?
   Answer: a) Theequipment used is relativelyinexpensive. b)Ultrasound has no harmful effects on living tissue because it uses high-frequencysound wavesto obtain the desired image.c) Sonographyis anexcellent tool fordetectinglocation and position ofthe fetusand for determining fetalagebyemployingsound echoes with verylow penetratingpower.

5:Describe threetypesofchemical reactions.

LectureSuggestions andGuidelines

1. Introducethe three majortypes ofchemical reactions in the human body: a) synthesis reactions, in which two ormore atomsormolecules combinetoform a larger, more complexstructure; b) decomposition reactions, in whichamolecule is broken down into smallermolecules, atoms, or ions; and c) exchangereactions, which involveboth synthesisand decomposition.
2. Definethe terms product,reactant, and catalyst.

Application Question(s)

1. Ask students to applyanexampleof each majorkind of chemicalreaction occurringin thehuman body.
   Answer: Examples might include the following: synthesis—the combining of amino acids to form a protein molecule; decomposition—the breakdown of glycogen bythe livertobe released as smaller units of glucose; exchange—neutralizinghydrochloricacid in the stomach byswallowing an alkaline solution to form asalt and water.

Critical Thinking Issue(s)

1. Brieflydescribethe conversion ofglucoseto carbon dioxide and waterwithin human cells. What kind of chemicalreaction is it? Wheredoes itoccur?
   Answer: The absorptionofglucoseoccurs at theplasmamembrane.It is converted intoglucose-6-phosphate.In the cell's cytosol,glucose-6-phosphate is broken down bycatalystsinto pyruvate,which is then absorbed bythe mitochondrion. Pyruvateis decomposed to carbondioxide and waterbya sequenceof reactions requiringoxygen.

   6:Describe thedifferencesamong acids, bases, andsalts.
   and
   7:ExplainthepHscale.
   and
   8: Explainthefunctionof buffers inresisting pH change.

LectureSuggestions andGuidelines

1. Definethe terms acid, base, and salt.
2. Introducethe pH scaleand giveexamples of typical household chemicalswhich arecharacteristic ofvaryingdegrees of acidityandbasicity.
3. Discuss acid-base concentrations in terms of relative concentration ofhydrogen ions and hydroxyl ions and explain theirrelevancyto thepH scale.
4. Introduce four electrolytes of clinical diagnostic importance: sodium, chloride, potassium, and bicarbonate. Explain theirimportancein thehuman body.
5. Definebufferandgive an exampleof its significance

Application Question(s)

1. Bywhat mechanisms does the bodymaintain homeostasisthrough acid-base balanceof bodyfluids?
   Answer: The regulationof acid-basebalance depends upon a) buffer systems;the chiefbuffers oftheblood arecarbonicacid, bicarbonate salt, and hemoglobin; b) excretion of acids of bases bythe kidneys; and 3) excretion of carbondioxide by the lungs.

Critical Thinking Issue(s)

1. A patient arrives in theER in severemetabolicacidosis. What does this mean, and what could bethecause?

Answer: Metabolic acidosismaydevelop as aresultof anyoneof thethree followingsituations: a) a diseasestatewhichcauses an excess of acid ions,such as duringdiabeticacidosis or starvation; b) a condition such as renal failurein which thereexists an inadequate excretion ofacids; or c) duringextreme loss of sodium bicarbonate caused, for example, bychronic diarrhea.In eachcasethereis aprimarydeficitof alkalineions with resultingacidosis.

2.3 Chemical Constituents ofCells

9:List themajorgroups ofinorganic chemicals commonincellsandexplain the function(s) ofeachgroup.

LectureSuggestions andGuidelines

1. Describemajor inorganicmolecules found in thehuman body, includingwater, oxygen,and carbondioxide. Discuss some functions of each molecule.
2. Describemajor inorganicions foundin thehuman body, includingbicarbonate, calcium, carbonate,chloride, hydrogen, magnesium, phosphate, potassium, sodium, and sulfate. Discuss some functions of each ion.

Application Question(s)

1. Ask students to applytheir knowledgeof inorganic substances bymakingachart of at least threeinorganicmolecules and at least ten inorganicions which includes the name ofthe moleculeor ion, its symbolorformula, and adescription of the organ system(s), as discussed in Chapter1, each of thesesubstances wouldserve, alongwith its specificfunction.
   Answer: Seetextbook—Inorganic Substances Common in Cells.

Critical Thinking Issue(s)

1. Although most carbondioxide is transported in plasma, small amounts of carbon dioxide arecarried bound to thehemoglobin insideof red bloodcells. Howis this possible, sincered bloodcells seek to transport oxygen, notcarbondioxide, in the red blood cells?Howdoes this differ from the transport of carbonmonoxide, a potentiallylethalgas, when bound to hemoglobinin largeamounts?
   Answer: Thestructureof carbondioxide molecules issuchthat, when carried inside red blood cells, itallows forbinding at different sites than oxygen on the hemoglobin molecule. Thus, oxygenand carbondioxide do not compete forthe same bindingsite. Carbon monoxide, however, competes with oxygenforthe same bindingsites on thehemoglobin molecule. Hemoglobin molecules havea higheraffinityforcarbonmonoxide than foroxygen, and carbonmonoxidewill capturetheavailable bindingsites over time. Thus, the body's tissues willbe deprived ofoxygen leadingto impaired homeostasisand death.

10:Describe thegeneral functionsofthemainclasses oforganic molecules in cells.

LectureSuggestions andGuidelines

1. Introducecarbohydrates,lipids, proteins, and nucleic acids.
2. Describewhich elements arepresent in each of the aboveorganic compounds, list theirbuildingblocks, discuss functions of each type, andgive examples ofthese organic substances foundin thehuman body.
3. Illustrate thegeneralized structureofcarbohydrates, lipids, proteins, and nucleic acids.
4. Distinguish between monosaccharides, disaccharides, andpolysaccharides.
5. Describemajor lipids, includingneutral fats, phospholipids, steroids, such as cholesterol, and other lipoid substances, such as the fat soluble vitamins and lipoproteins.
6. Discuss functional proteins, includingenzymes, hormones, immunoglobulins, actin and myosin, and hemoglobin.
7. Introducethe structureofDNA andRNA.

Application Question(s)

1. Ask students to give examples of typical monosaccharides, disaccharides,and polysaccharides.
   Answer: a) Monosaccharides: glucose-blood sugar; galactoseand fructose-converted toglucose; ribose and deoxyribose-integral structures of nucleicacids; b)Disaccharides: sucrose-canesugar, which is a combination ofglucoseand fructose; lactose-milk sugar, which is acombination ofglucose andgalactose; maltose-malt sugar, which is a combination oftwo glucosemolecules;
   c) Polysaccharides: starch-foundin grains and vegetables; glycogen-stored in the liver and laterconvertedto glucoseto meet thebody's needs.
2. Ask students to preparealist of twentyof theirfavorite foods. Collect package labels of each foranalysis. Which aresources of carbohydrates?Proteins? Fats? Should thestudent consider changinghis/hereatinghabits?
   Answer: Responses will vary.

Critical Thinking Issue(s)

1. Ask students to chooseoneorgan system discussed in Chapter1 and describe what possible effects a cholesterol-rich diet might haveupon the organ system theychoose.
   Answer: Examples might include the following: a)digestivesystem—themost common types ofgallstones havebeen shown to consist of amixtureof cholesterol, calcium, andbilirubin.A smaller percent aremadeof pure cholesterol. Gallstones maycauseablockageof the releaseofbile;lead to infection, and in some cases, thereis a much higher incidenceofcancer ofthe gallbladder in patients who havehadahistoryofgallstones;b)cardiovascular system—high cholesterollevels can lead to thebuildup ofplaqueon arterial walls. The coronaryarteries arefrequentlyaffected byatherosclerosis (plaque accumulation) andarteriosclerosis(hardeningof the arteries), theend stageof the disease. Occlusions can lead to ischemia, and subsequent myocardial infarction.

Topical ChapterOutline

2.1 The importance of Chemistry in Anatomy and Physiology
2.2 Structureof Matter
- a. Elements and Atoms b. AtomicStructure
- c.Isotopes
- d. Molecules and Compounds e. Bondingof Atoms
- f. Chemical Reactions
- g. Acids, Bases, andSalts
- h. Acid andBaseConcentrations

2.3 Chemical Constituents of Cells
- a.InorganicSubstances (Water, Oxygen, CarbonDioxide, andInorganic Salts)
- b. Organic Substances (Carbohydrates,Lipids, Proteins, andNucleicAcids)