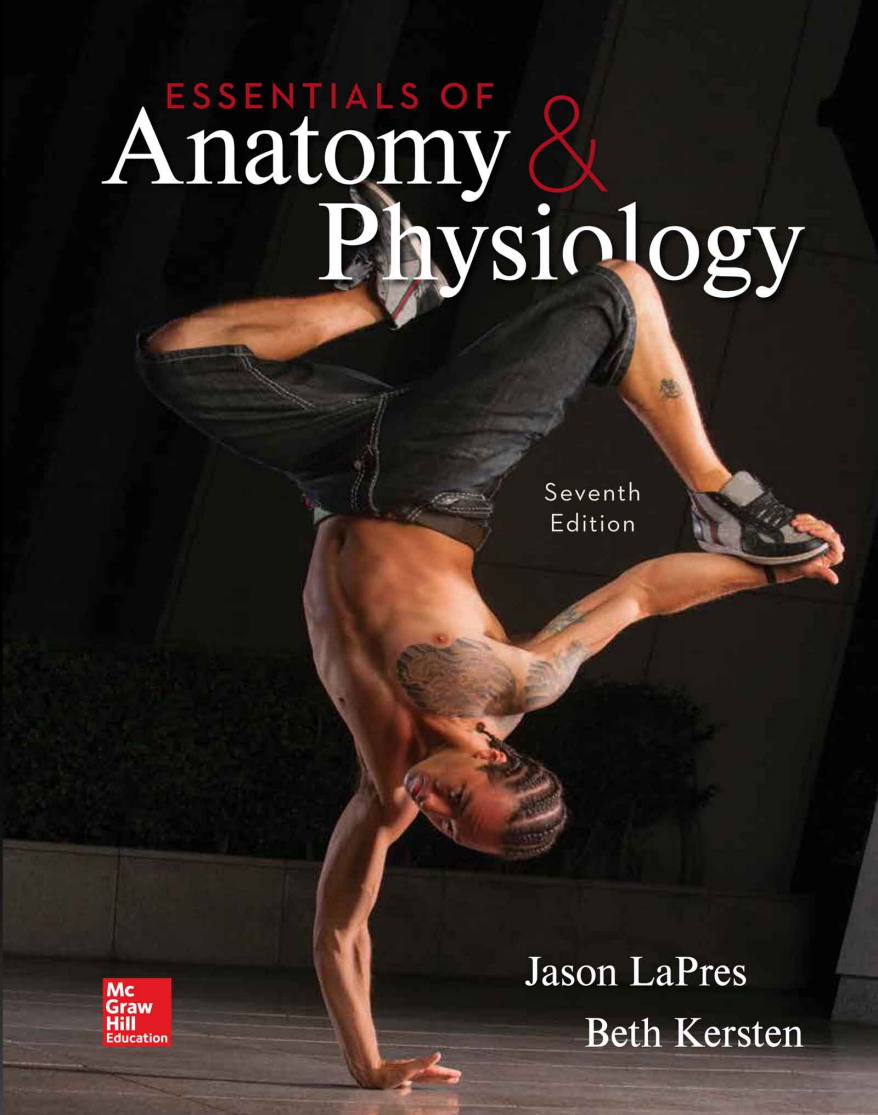
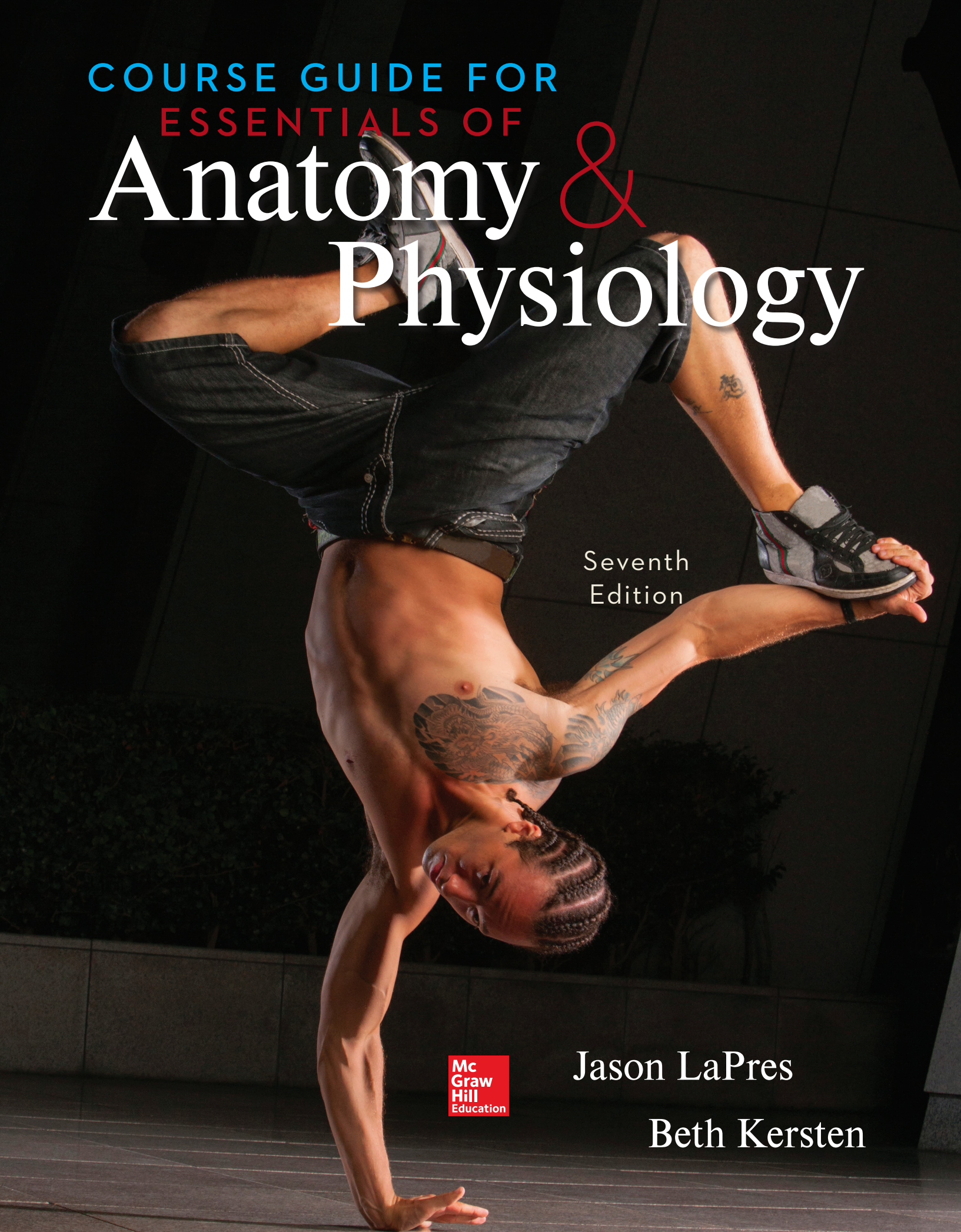

ESSENTIALS OF
Anatomy & Physiology
Seventh Edition
Jason LaPres
Beth Kersten
Mc Graw Hill Education

COURSE GUIDE FOR ESSENTIALS OF Anatomy & Physiology



Seventh Edition

Jason LaPres

Beth Kersten

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COURSE GUIDE FOR ESSENTIALS OF ANATOMY & PHYSIOLOGY, SEVENTH EDITION

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ABOUT THE AUTHORS

Courtesy of Jason LaPres

Jason LaPres

Lone Star College–CyFair

Jason LaPres received his Master's of Health Science degree with an emphasis in Anatomy and Physiology from Grand Valley State University in Allendale, Michigan.

Over the past 15 years, Jason has had the good fortune to be associated with a number of colleagues who have mentored him, helped increase his skills, and trusted him with the responsibility of teaching students who will be caring for others. Jason began his career in Michigan, where from 2001 to 2003 he taught as an adjunct at Henry Ford Community College, Schoolcraft College, and Wayne County Community College, all in the Detroit area. Additionally, at that time he taught high school chemistry and physics at Detroit Charter High School. Jason is currently Dean of Instruction and Professor of Biology at Lone Star College–CyFair in Houston, Texas. He has been with LSC since 2003. In his capacity with LSC he has served as Faculty Senate President for two of the six LSC campuses. His academic background is diverse and, although his primary teaching load is in the Human Anatomy and Physiology program, he has also taught classes in Pathophysiology and mentored several Honor Projects.

Prior to authoring this textbook, Jason produced dozens of textbook supplements and online resources for many other Anatomy and Physiology textbooks.

Courtesy of Beth Kersten

Beth Kersten

State College of Florida

Beth Ann Kersten is a tenured professor at the State College of Florida (SCF). Though her primary teaching responsibilities are currently focused on Anatomy and Physiology I and II, she has experience teaching comparative anatomy, histology, developmental biology, and nonmajor human biology. She authors a custom A&P I laboratory manual for SCF and sponsors a book scholarship for students enrolled in health science programs. She coordinates a peer tutoring program for A&P and is working to extend SCF's STEM initiative to local elementary schools. Beth employs a learning strength specific approach to guide students in the development of study skills focused on their learning strengths, in addition to improving other student skills such as time management and note taking.

Beth graduated with a PhD from Temple University where her research focused on neurodevelopment in zebrafish. Her postdoctoral research at the Wadsworth Research Center focused on the response of rat nerve tissue to the implantation of neural prosthetic devices. At Saint Vincent College, she supervised senior research projects on subjects such as the effects of retinoic acid on heart development in zebrafish and the ability of vitamin B12 supplements to regulate PMS symptoms in ovariectomized mice. Beth also maintains a membership in the Human Anatomy & Physiology Society.

Beth currently lives in North Port, Florida, with her husband John and daughter Melanie. As former Northerners, they greatly enjoy the ability to swim almost year round both in their pool and in the Gulf of Mexico.

CONTENTS

PREFACE

COURSE GUIDE FOR ESSENTIALS OF ANATOMY & PHYSIOLOGY Seventh Edition is designed for students who are enrolled in a one-semester course in human anatomy and physiology. The scope, organization, writing style, depth of presentation, and pedagogical aspects of the text have been tailored to meet the needs of students preparing for a career in one of the allied health professions, or taking the course as a general education requirement.

Acknowledgments

The development and production of this seventh edition has been a team effort. Our dedicated and creative teammates at McGraw-Hill Education have contributed greatly to the finished product. We gratefully acknowledge and applaud their efforts, and it has been a pleasure to work with these gifted professionals at each step of the process: Elizabeth Sievers (Senior Product Developer), Kate Scheinman (Contract Product Developer), Michael Ivanov (Senior Portfolio Manager), Sherry Kane (Senior Content Project Manager), and James Connely (Executive Marketing Manager).

Student-Centric Revision

Students taking a one-semester course in anatomy and physiology have diverse backgrounds, including limited exposure to biology and chemistry, and this presents a formidable challenge to the instructor. To help meet this challenge, this text is written in a clear and concise manner, which is free from excess jargon and simplifies the complexities of anatomy and physiology in ways that enhance understanding without diluting the essentials of the subject matter.

In preparation for this seventh edition, we surveyed 50 students (in a variety of majors, including allied health professions) and obtained detailed insight into how they would ideally engage with course materials. Stemming from those results, we adjusted the print and digital delivery of the content to align with student preferences.

Also, we are very pleased to incorporate real student data points and input, derived from thousands of our SmartBook™ users, to help guide our revision. SmartBook™ Heat Maps provided a quick visual snapshot of usage of portions of the text and the relative difficulty students experienced in mastering the content. With this data, we honed not only our text content revision but also the SmartBook™ probes.

Course Guide and Textbook

The previous edition of this title combined two elements: the *Textbook* and the *Study Guide*. For this new seventh edition, the two elements are split into two separate printed products. The *Textbook* content is updated and revised, and the *Study Guide* is expanded and enhanced to serve as a more robust *Course Guide*.

The intention of the *Course Guide* is to be a 1:1 workbook study partner as students read the *Textbook*. Through the student survey, we uncovered their ideal mix of print and digital course materials. With the strong integration of the Connect™ online assessment tools, including SmartBook™, we worked to create an optimal delivery package of the *Course Guide* and Connect™, with the option to purchase a printed version of the *Textbook* through Connect™ at a discounted rate.

Course Guide Organization

The companion *Course Guide* is an efficient mechanism for enhancing learning and reinforcing *Textbook* concepts. The *Course Guide* provides students with a hands-on learning experience that is intended to test their knowledge of course content through the completion of various activities such as figure labeling, fill-in-the-blank, true/false, and short answer questions. Answers to the *Course Guide* are included in the *Instructor Resource* site.

The *Course Guide* follows the organization of the *textbook* and tests students understanding of the text content.

1. A list of Selected Key Terms with definitions and derivations where helpful, is provided at the beginning of the chapter to inform students of some of the key terms to watch for in the chapter.
2. The chapter summary also appears at the start of each chapter, conveniently linked by section, and briefly states the important facts and concepts covered in the chapter.
3. Each chapter concludes with Clinical Insights and Critical Thinking exercises to reinforce student understanding of the content.

Changes in the Seventh Edition

The seventh edition has been substantially enhanced and improved.

- Revised all chapter text to focus on healthy conditions rather than "normal" conditions.
- Approximately 70 figures and tables were revised or are completely new.
- Revised descriptive language to improve the overall readability of the text. Terminology and phrasing more commonly used by students outside the classroom have been added where appropriate. By making the text easier to read, students will have an easier time grasping more complex anatomical and physiological content.
- Added more Check My Understanding sections to better assess student learning throughout the chapters.
- The Critical Thinking sections at the end of the chapters have been moved to the *Course Guide* to consolidate all of the assessment content into one resource, except for the Check My Understanding sections; these remain in the text to offer students opportunities to test their understanding before moving on in the chapter.
- *Course Guide* figures were updated to align with the figures within the lecture text. Figure labeling activities were also redesigned to provide the students with a more hands-on labeling experience.
- Revised each chapter's Selected Key Terms definitions to better align with the definitions within the chapter text.
- Updated art to create a more vibrant and consistent style.
- Updated terminology to align with the *Terminologia Anatomica*, *Terminologia Histologica*, and *Terminologia Embryologica*.
- Revised figure legends to include a descriptive title and separate legend.

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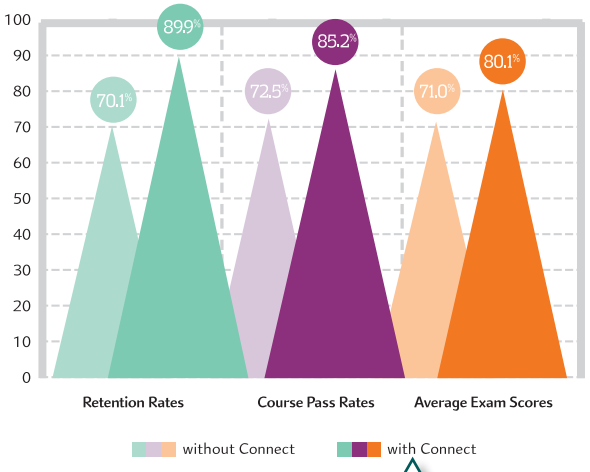

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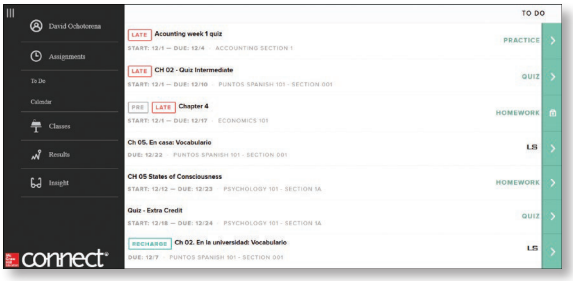

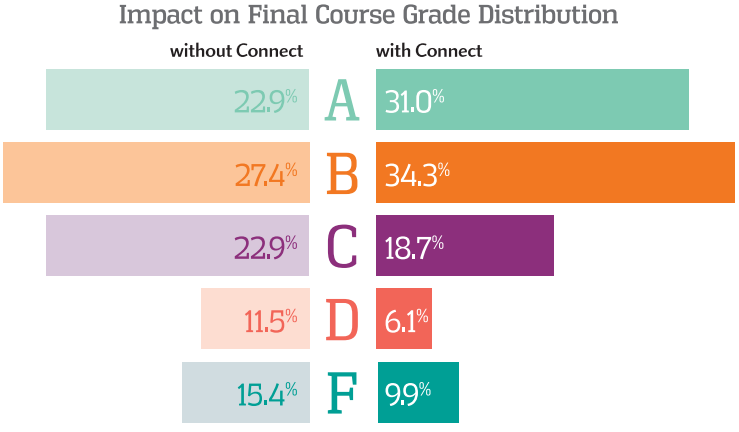

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CHAPTER

1

Introduction to the Human Body

Module 1
Body Orientation

CHAPTER OUTLINE

SELECTED KEY TERMS

Anatomy (ana = apart; tom = to cut) The study of the structure of living organisms.
Appendicular (append = to hang) Pertaining to the upper and lower limbs.
Axial (ax = axis) Pertaining to the longitudinal axis of the body.
Body region (regio = boundary) A portion of the body with a special identifying name.
Directional term (directio = act of guiding) A term that references how the position of a body part relates to the position of another body part.
Effector (efet = result) A structure that functions by performing an action that is directed by an integrating center.
Homeostasis (homeo = same; sta = make stand or stop) Maintenance of a relatively stable internal environment.
Integrating center (integratus = make whole) A structure that functions to interpret information and coordinate a response.
Metabolism (metabole = change) The sum of the chemical reactions in the body.
Parietal (paries = wall) Pertaining to the wall of a body cavity.
Pericardium (peri = around; cardi = heart) The membrane surrounding the heart.
Peritoneum (ton = to stretch) The membrane lining the abdominal cavity and covering the abdominal organs.
Physiology (physio = nature; logy = study of) The study of the function of living organisms.
Plane (planum = flat surface) Imaginary two-dimensional flat surface that marks the direction of a cut through a structure.
Pleura (pleura = rib) The membrane lining the thoracic cavity and covering the lungs.
Receptor (recipere = receive) A structure that functions to collect information.
Section (sectio = cutting) A flat surface of the body produced by a cut through a plane of the body.
Serous membrane (serum = watery fluid; membrana = thin layer of tissue) A two-layered membrane that lines body cavities and covers the internal organs.
Visceral (viscus = internal organ) Pertaining to organs in a body cavity.

Chapter Summary

1.1 Anatomy and Physiology

- Human anatomy is the study of body structure and organization.
- Human physiology is the study of body functions.

1.2 Levels of Organization

- The body consists of several levels of organization of increasing complexity.
- From simple to complex, the organizational levels are chemical, cellular, tissue, organ, organ system, and organismal.
- The organs of the body are arranged in coordinated groups called organ systems.
- The 11 organ systems of the body are

integumentary	cardiovascular
skeletal	lymphoid
muscular	respiratory
nervous	urinary
endocrine	reproductive
digestive	

1.3 Directional Terms

- Directional terms are used to describe the relative positions of body parts.
- Directional terms occur in pairs, with the members of a pair having opposite meanings.

anterior–posterior	proximal–distal
superior–inferior	external–internal
medial–lateral	parietal–visceral
central–peripheral	

1.4 Body Regions

- The body is divided into two major portions: the axial portion and the appendicular portion.
- The axial portion is subdivided into the head, neck, and trunk.
- The head and neck contain cervical, cranial, and facial regions. The cranial and facial regions combine to form the cephalic region.
- The facial region consists of orbital, nasal, oral, and buccal regions.
- The trunk consists of anterior, posterior, lateral, and inferior regions.
- Anterior trunk regions include the abdominal, inguinal, pectoral, pubic, sternal, and umbilical regions.
- Posterior trunk regions include the dorsal, gluteal, lumbar, sacral, scapular, and vertebral regions.
- Lateral trunk regions are the axillary and coxal regions.
- Inferior trunk regions are the genital and perineal regions.
- The appendicular portion of the body consists of the upper and lower limbs.
- The upper limb is attached to the trunk at the shoulder. Regions of the upper limb are the antebrachial, brachial, carpal, cubital, deltoid, digital, and palmar regions.
- The lower limb is attached to the trunk at the hip. Regions of the lower limb are the crural, digital, femoral, patellar, pedal, plantar, popliteal, sural, and tarsal regions.

1.5 Body Planes and Sections

- Well-defined planes are used to guide sectioning of the body or organs.
- The common planes are transverse, sagittal, and frontal.
- The common planes produce longitudinal sections and cross sections of the body.

1.6 Body Cavities

- The cranial cavity is located within the skull, and the vertebral canal is located within the vertebral column.
- The thoracic cavity lies above the diaphragm. It consists of two lateral pleural cavities and the mediastinum, which contains the pericardial cavity.
- The abdominopelvic cavity lies below the diaphragm. It consists of a superior abdominal cavity and an inferior pelvic cavity.
- The body cavities are lined with protective and supportive membranes.
- The meninges consist of three membranes that line the cranial cavity and vertebral canal and that enclose the brain and spinal cord.
- The parietal pleurae line the walls of the thoracic cage, while the visceral pleurae cover the surfaces of the lungs.
- The pleural cavity is the space between the parietal and visceral pleurae.
- The parietal pericardium is a saclike membrane in the mediastinum that surrounds the heart. The visceral pericardium is attached to the surface of the heart.
- The pericardial cavity is the space between the parietal and visceral pericardia.
- The parietal peritoneum lines the walls of the abdominal cavity but does not extend into the pelvic cavity. The visceral peritoneum covers the surface of abdominal organs.
- The peritoneal cavity is the space between the parietal and visceral peritoneum.
- The mesenteries are double-layered folds of the visceral peritoneum that support internal organs.
- Kidneys, pancreas, and parts of the intestines are located behind the parietal peritoneum in the retroperitoneal space.

1.7 Abdominopelvic Subdivisions

- The abdominopelvic cavity is subdivided into either four quadrants or nine regions as an aid in locating organs.
- The four quadrants are
  right upper — left upper
  right lower — left lower
- The nine regions are
  epigastric — right flank
  left hypochondriac — hypogastric (pubic)
  right hypochondriac — left inguinal
  umbilical — right inguinal
  left flank

1.8 Maintenance of Life

- Metabolism is the sum of all of the body's chemical reactions. It consists of anabolism, the synthesis of body chemicals, and catabolism, the breakdown of body chemicals.
- The basic needs of the body are food, water, oxygen, body temperature, and atmospheric pressure.
- Homeostasis is the maintenance of a relatively stable internal environment.
- Homeostasis is regulated by negative-feedback mechanisms.
- Negative-feedback mechanisms consist of three components: receptors, integrating center, and effectors.
- Positive-feedback mechanisms promote an ever-increasing change from the norm.

1.1 Anatomy and Physiology

Learning Objective

1. Define anatomy and physiology.

1. Write the terms that match the phrases in the spaces at the right.
   a) The study of tissues _____
   b) The study of body organization and structure _____
   c) The study of body functions _____

1.2 Levels of Organization

Learning Objectives

2. Describe the levels of organization in the human body.
3. List the major organs and functions for each organ system.

1. List the levels of organization from the most complex to the simplest.
   a) _____ d) _____
   b) _____ e) _____
   c) _____ f) _____
2. Write the terms that match the phrases in the spaces at the right.
   a) A coordinated group of organs. _____
   b) Structural and functional units of the body. _____
   c) An aggregation of similar cells. _____

3. Match the names of the organ systems with the phrases.

Cardiovascular	Integumentary	Nervous
Digestive	Lymphoid	Respiratory
Endocrine	Male Reproductive	Skeletal
Female Reproductive	Muscular	Urinary

a) Stomach, liver, intestines. _____
b) Brain, spinal cord, nerves. _____
c) Secretes hormones. _____
d) Skin, hair, nails. _____
e) Returns lymph to blood; provides immunity. _____
f) Bones, ligaments, cartilages. _____
g) Contraction enables movement. _____
h) Transports materials to and from cells. _____
i) Kidneys, ureters, urinary bladder. _____
j) Testes, penis, prostate. _____
k) Ovaries, uterine tubes, uterus, vagina. _____
l) Blood, heart, arteries, veins. _____
m) Supports the body. _____
n) Secretes hormones that regulate functions. _____
o) Regulates volume of body fluids. _____
p) Protects underlying tissues. _____
q) Rapid coordination of body functions. _____
r) Digests food and absorbs nutrients. _____
s) Gas exchange between air and blood. _____
t) Larynx, trachea, bronchi, and lungs. _____

1.3 Directional Terms

Learning Objective

4. Use directional terms to describe the locations of body parts.

1. Provide the term that correctly completes each statement.

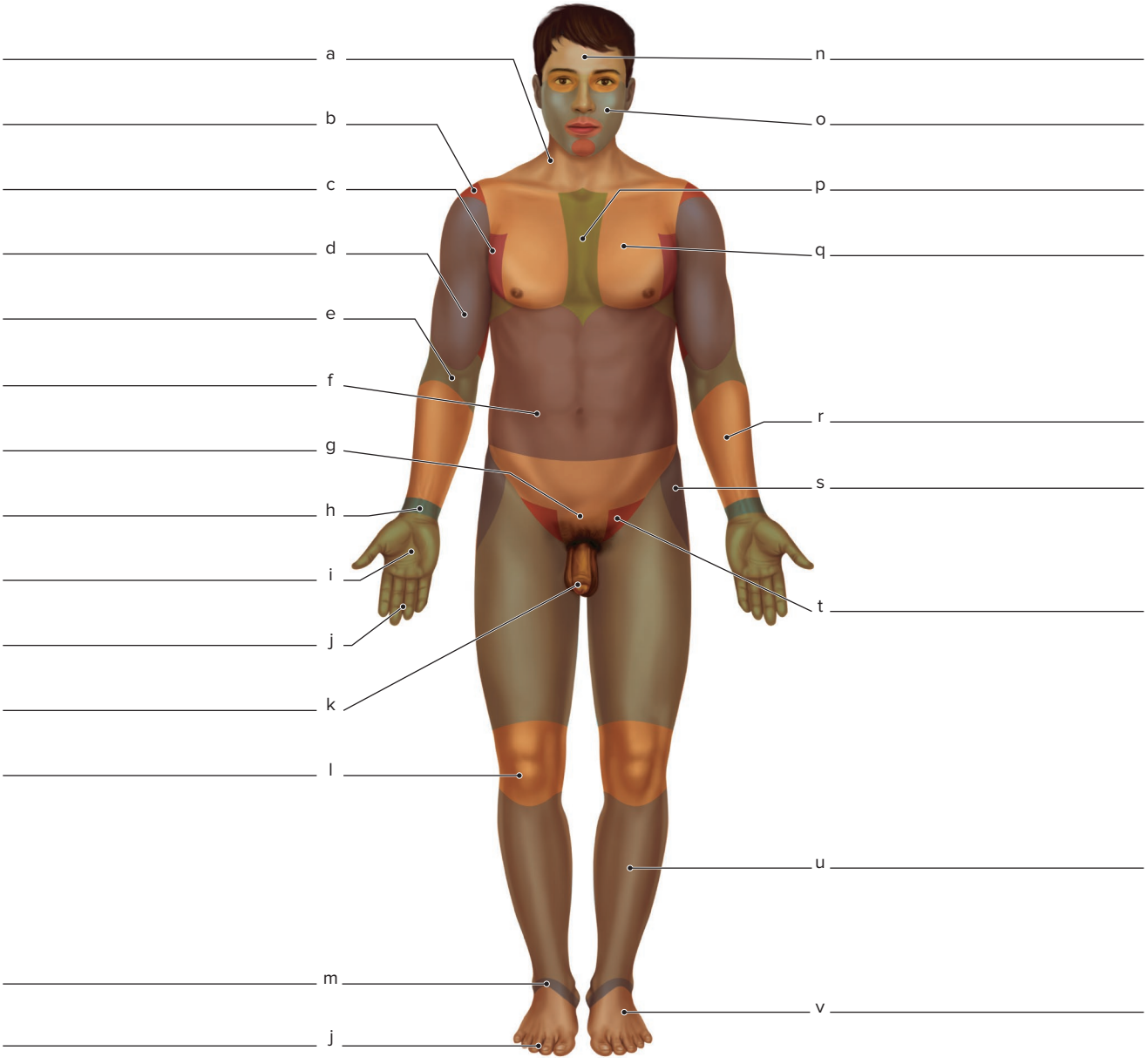
a) The head is _____ to the neck. _____
b) The hand is _____ to the wrist. _____
c) The skin is _____ to the muscles. _____
d) The mouth is _____ to the nose. _____
e) The elbow is _____ to the wrist. _____
f) The ear is on the _____ surface of the head. _____
g) The umbilicus is on the _____ body surface. _____
h) The hip is on the _____ body surface. _____
i) The buttocks are on the _____ body surface. _____

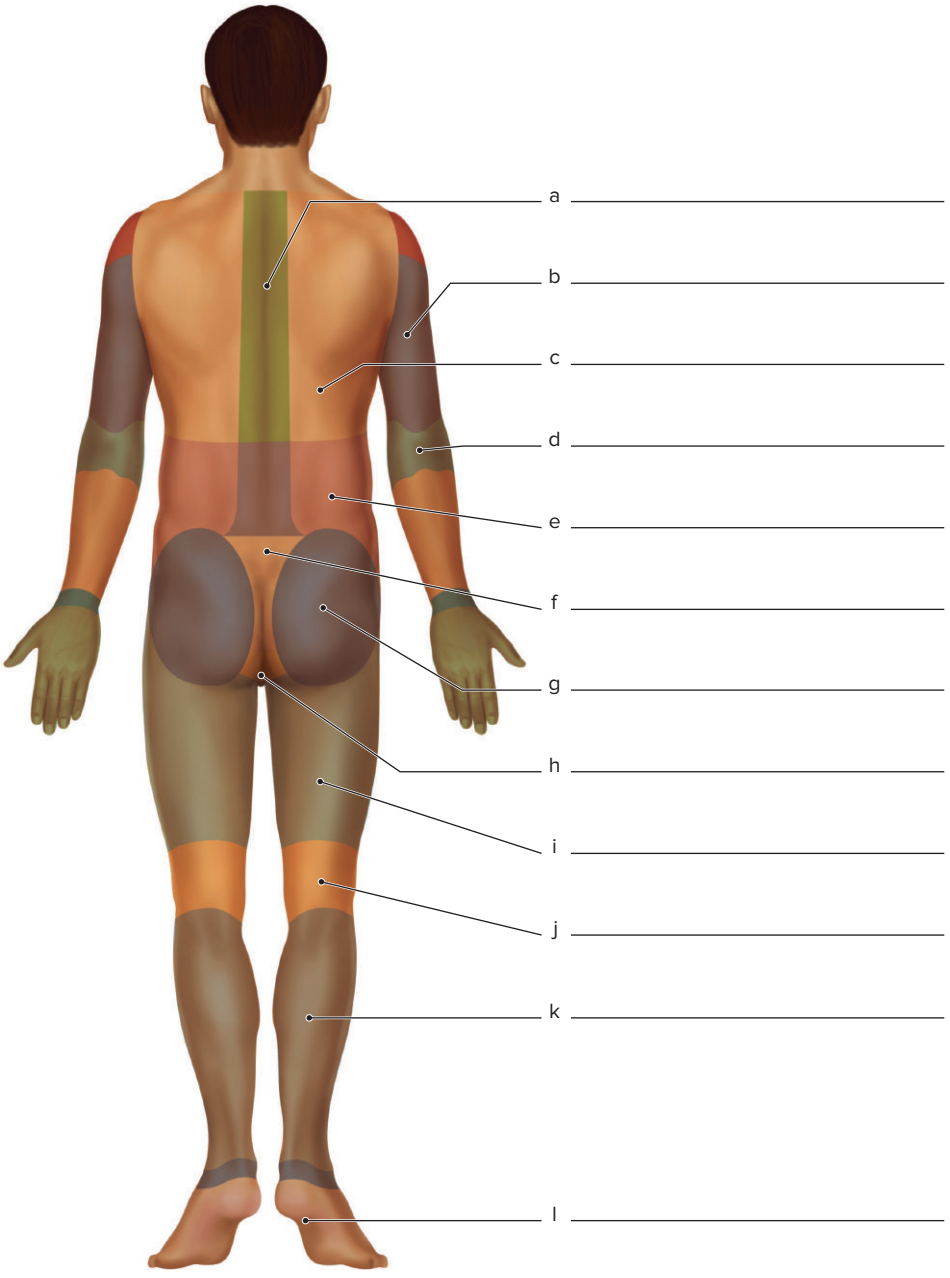
1.4 Body Regions

Learning Objective

5. Locate the major body regions on a diagram or anatomical model.

1. Label the body regions by placing the correct term in the space by the correct label. (See text figure 1.4 Major Regions of the Body.) AP|R





1.5 Body Planes and Sections

Learning Objective

6. Describe the three planes used in making sections of the body or body parts.

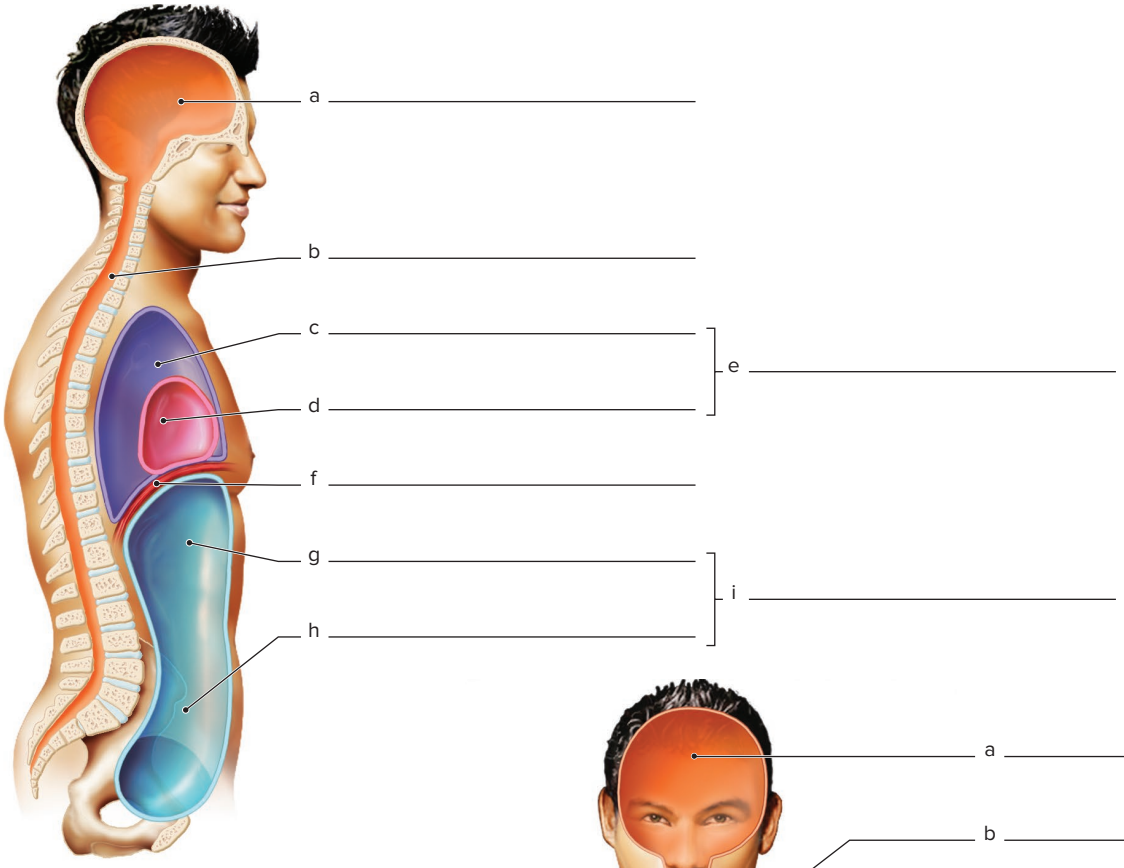
1. Name the planes that match the statements.
   a) Divides the body into equal left and right halves. _____
   b) Divides the body into superior and inferior portions. _____
   c) Divides the body into left and right portions. _____
   d) Divides the body into anterior and posterior portions. _____
   e) Any cut along the longitudinal axis of a structure. _____
   f) Any cut at a 90° angle to the longitudinal axis of a structure. _____
   g) A cut between the longitudinal axis and a 90° angle of a structure. _____

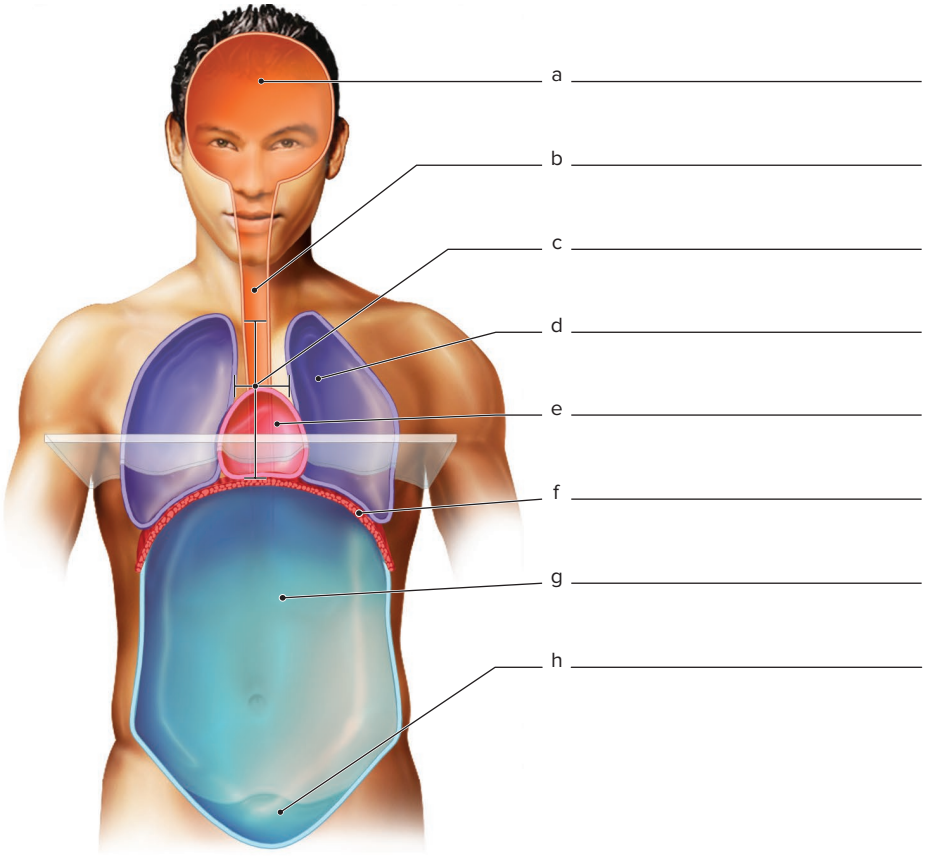
1.6 Body Cavities

Learning Objectives

7. Locate the body cavities and their subdivisions and membranes on a diagram.
8. Name the organs located in each body cavity.

1. Label the body cavities and related structures by placing the correct term in the space by the correct label. (See text figure 1.6 Body Cavities and Their Subdivisions.) AP|R





2. Place the letter of the cavity where the organ is located in the blank beside the organ name. Answers may be used more than once.

a) Abdominal cavity	c) Mediastinum	e) Pleural cavity
b) Cranial cavity	d) Pelvic cavity	f) Vertebral canal
_____ Brain	_____ Lungs	_____ Stomach
_____ Gallbladder	_____ Rectum	_____ Thymus
_____ Heart	_____ Small intestine	_____ Urinary bladder
_____ Liver	_____ Spinal cord	

3. Write the names of the membranes that match the statements in the spaces at the right.

a) Covers the surface of the heart. _____
b) Covers the surface of the stomach. _____
c) Lines the abdominal cavity. _____
d) Surrounds the brain. _____
e) Lines the thoracic cavity. _____
f) Lines the vertebral canal. _____
g) Covers the surface of the lungs. _____
h) Forms double-membrane sac around heart. _____
i) Double-layered membranes supporting abdominal organs. _____

1.7 Abdominopelvic Subdivisions

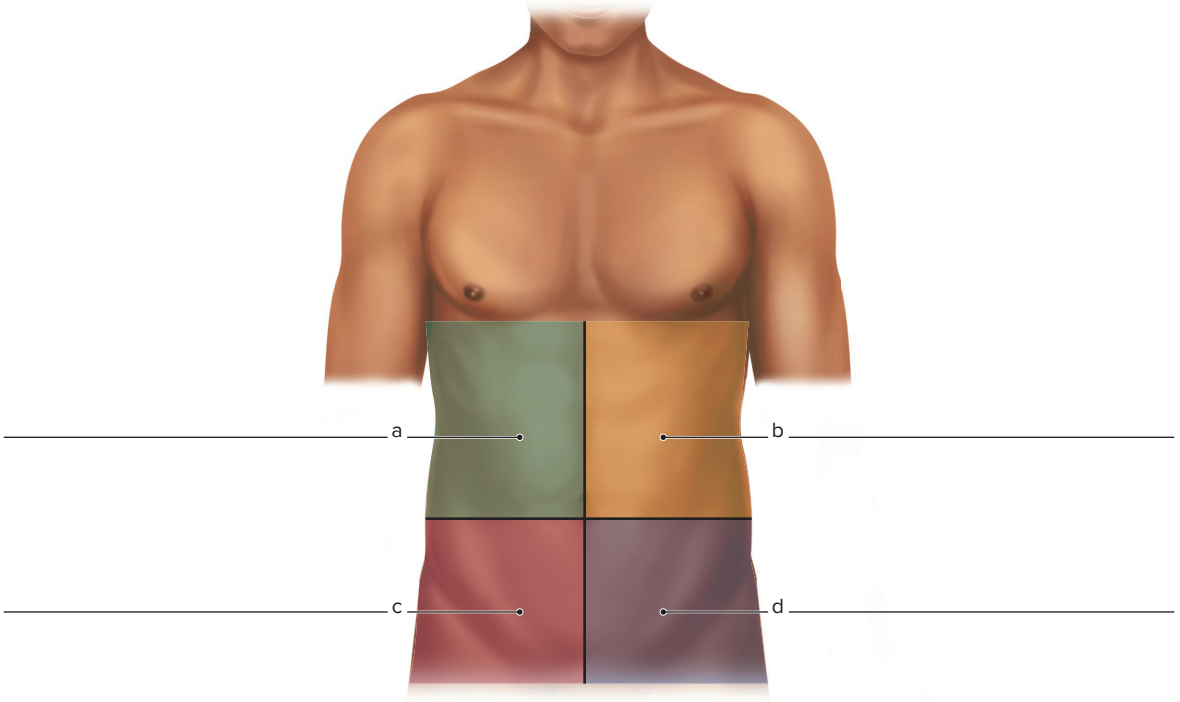
Learning Objectives

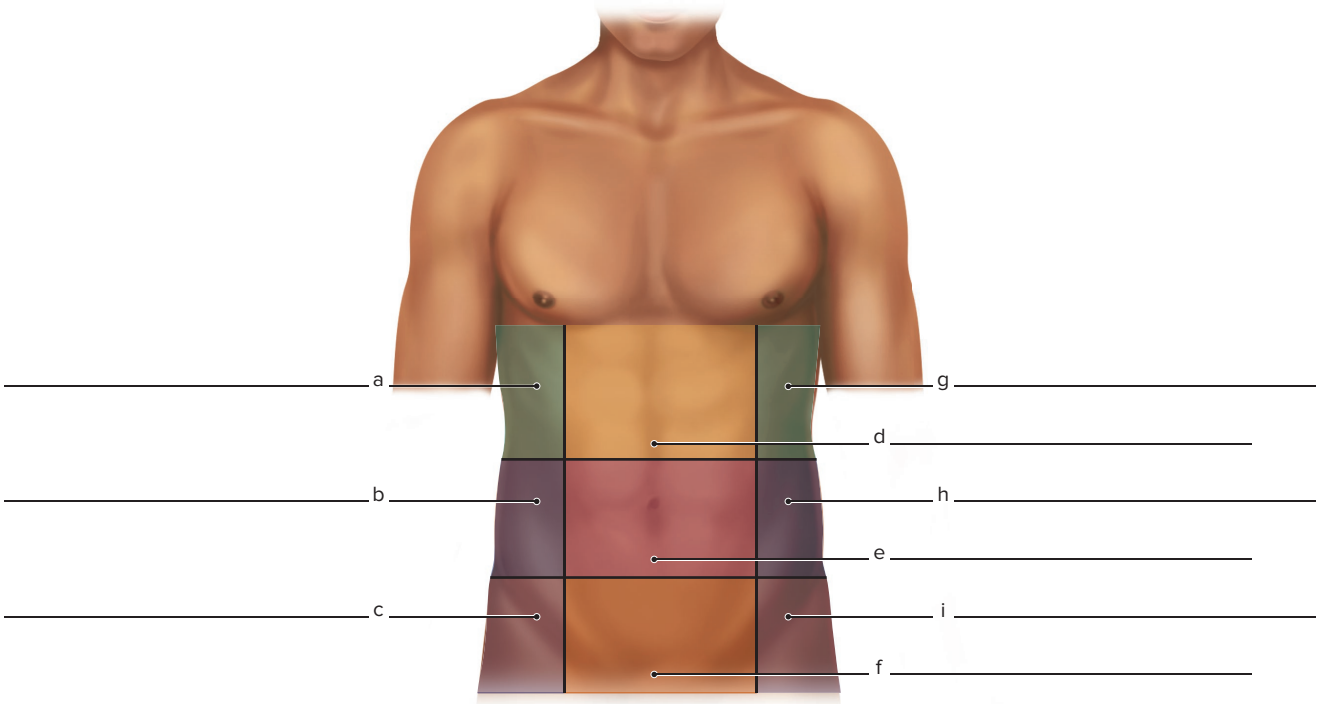
9. Name the abdominopelvic quadrants and regions.
10. Locate the abdominopelvic quadrants and regions on a diagram.

1. Select the abdominopelvic quadrant and abdominopelvic region in which the following structures are located.

Quadrants	**Regions**	
a) Right upper	e) Epigastric	j) Right hypochondriac
b) Left upper	f) Hypogastric	k) Right inguinal
c) Right lower	g) Left hypochondriac	l) Right flank
d) Left lower	h) Left inguinal	m) Umbilical
	i) Left flank	
_____ Gallbladder	_____ Stomach	
_____ Spleen	_____ Ascending colon	
_____ Rectum	_____ Urinary bladder	
_____ Right kidney	_____ Left kidney	
_____ Appendix	_____ Pancreas	

2. Label the abdominopelvic quadrants and abdominopelvic regions by writing the correct terms in the spaces within the diagram. (See text figure 1.9 Abdominopelvic Subdivisions.) AP|R





1.8 Maintenance of Life

Learning Objectives

11. Define metabolism, anabolism, and catabolism.
12. List the five basic needs essential for human life.
13. Define homeostasis.
14. Explain how homeostasis relates to both healthy body functions and disorders.
15. Describe the general mechanisms of negative feedback and positive feedback.

1. Write the terms that match the statements in the spaces at the right.
   a) Maintenance of a dynamic balance of substances in body fluids. _____
   b) Breakdown of complex substances. _____
   c) Synthesis of complex substances. _____
   d) Mechanism regulating homeostasis. _____
   e) Sum of the chemical reactions that occur in the body. _____
   f) List the five basic needs essential for human life. _____
   _____
   _____
   _____
   _____
   g) Components of a negative-feedback mechanism. _____
   _____
   _____

Clinical Insights and Critical Thinking

1. A patient complains of pain in the epigastric region. What organs may be involved? _____
2. A patient complains of pain in the right lower quadrant. What organs may be involved? _____
3. How is homeostasis related to health and disease? _____
4. A hypoglycemic (low blood glucose level) patient is given orange juice to drink. Explain how this increases the blood glucose level and the organ systems involved. _____

5. Describe the location of the kneecap in as many ways as you can using directional terms. _____

6. Describe where serous membranes are located in the body, name the three types of serous fluid, and explain the function of serous fluid. _____

7. Explain how negative-feedback mechanisms regulate homeostasis. _____

CHAPTER

2

Chemicals of Life

Module 2
Cells & Chemistry

CHAPTER OUTLINE

SELECTED KEY TERMS

Atom (atomos = indivisible) The smallest unit of an element.
Carbohydrate (carbo = carbon; hydr = water) An organic molecule composed of carbon, hydrogen, and oxygen, with a 1:2:1 ratio.
Chemical bond (bond from band = fasten) Joining of chemical substances using attractions between electrons.
Chemical formula (formula = draft or small form) Shorthand notation showing the type and number of atoms in a molecule.
Chemical reaction (re = again; actionem = put into motion) Process involving the formation and/or breakage of chemical bonds resulting in new combinations of atoms.
Compound (componere = to place together) A substance formed by atoms from two or more elements combined by ionic or covalent bonds.
Element A substance that cannot be broken down into simpler substances by ordinary chemical means.
Enzyme (en = in; zym = ferment) A protein that catalyzes chemical reactions.
Inorganic substance (in = not) Small, simple substance that usually does not have carbon and hydrogen in the same substance.
Lipid (lip = fat) An organic macromolecule containing mostly carbon and hydrogen, with small amounts of oxygen. Lipids do not mix with water.
Molecule (molecula = little mass) A substance formed by two or more atoms bonded together by covalent bonds.
Nucleic acid (nucle = kernel) A complex organic macromolecule composed of nucleotides.
Organic substance (organon = from living things) Large, complex substances that contain both carbon and hydrogen in the same molecule, usually with oxygen too.
Protein A group of nitrogen-containing organic macromolecules formed of amino acids.

Chapter Summary

2.1 Atoms and Elements

- Matter is composed of elements, substances that cannot be broken down into simpler substances by chemical means.
- Oxygen, carbon, hydrogen, and nitrogen form 96% of the human body by weight.
- An atom is the smallest unit of an element.
- An atom consists of a nucleus formed of protons (+1) and neutrons (neutral), and electrons (−1) that orbit the nucleus.
- Electrons fill electron shells from inside to outside.
- The outermost shell containing electrons is the valence shell.
- Elements are characterized by their atomic numbers, chemical symbols, and atomic mass.
- Isotopes of an element have differing numbers of neutrons.
- Radioisotopes emit radiation.

2.2 Molecules and Compounds

- A molecule is formed of two or more atoms joined by covalent bonds.
- A compound is formed of atoms from two or more elements combined by ionic or covalent bonds.
- A molecular formula indicates the types of elements and the number of atoms of each element in a molecule.
- A structural formula adds to a molecular formula by also showing how the atoms fit together.
- Chemical bonds join atoms to form molecules.
- An ionic bond is the force of attraction between two ions with opposite electrical charges. It results from one atom donating one or more electrons to another atom.
- A covalent bond is formed between two atoms by the sharing of electrons in the valence shell.
- Nonpolar covalent bonds share electrons equally; polar covalent bonds share electrons unequally.
- Nonpolar substances are hydrophobic (water fearing); polar substances and ions are hydrophilic (water loving).
- A hydrogen bond is a weak force of attraction between a slightly positive H atom and a slightly negative atom either in the same molecule or in different molecules, or between ions and polar molecules.
- Synthesis reactions combine simpler substances to produce more complex substances.
- Decomposition reactions break down complex substances into simpler substances.
- Exchange reactions involve both decomposition of the reactants and synthesis of new products.
- Reversible reactions may occur in either direction depending on the environment.

2.3 Substances Composing the Human Body

- Inorganic substances do *not* contain both carbon and hydrogen. Organic substances contain *both* carbon and hydrogen.
- Water (H_2O) is the most abundant inorganic substance in the body, and it is the solvent of living systems.
- There are two major water compartments: intracellular fluid (65% of body water) and extracellular fluid (35% of body water).
- Electrolytes ionize (dissociate) in water, producing ions. The resulting solution can conduct electricity.
- Nonelectrolytes are substances that do not produce ions in water, and they do not conduct electricity.
- An acid releases H^+ in an aqueous solution, and a base releases OH^- or absorbs H^+ in an aqueous solution.
- pH is a measure of the relative concentrations of H^+ and OH^- in a solution.
- A buffer keeps the pH of a solution relatively constant by picking up or releasing H^+.
- A salt releases positively and negatively charged ions in an aqueous solution, but they are neither H^+ nor OH^-.
- Organic molecules are synthesized by dehydration synthesis and broken down by hydrolysis.
- Carbohydrates are composed of C, H, and O in a 1:2:1 ratio.
- Monosaccharides are the building units of carbohydrates. Disaccharides consist of two monosaccharides. Polysaccharides are formed of many monosaccharides.
- Lipids are a diverse group of organic macromolecules that include triglycerides, phospholipids, and steroids.
- Triglycerides (fats) consist of three fatty acids bonded to glycerol. Unsaturated fats differ from saturated fats by having one or more double carbon–carbon bonds in their fatty acids. Excess nutrients are stored as fats.
- Phospholipids consist of two fatty acids and a phosphate group bonded to glycerol.
- Steroids are an important group of lipids that includes sex hormones and cholesterol.
- Proteins are macromolecules formed of many amino acids. The 20 different kinds of amino acids are distinguished by their R groups.
- Amino acids are joined by peptide bonds.
- Structural proteins form parts of cells and tissues. Functional proteins include enzymes, transporters, and antibodies.
- Enzymes catalyze chemical reactions.
- Nucleic acids are very large macromolecules formed of many nucleotides.
- A nucleotide consists of a five-carbon sugar (ribose in RNA and deoxyribose in DNA), a phosphate group, and a nitrogenous base.
- There are two types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). DNA determines hereditary traits and controls cellular functions. RNA works with DNA in the synthesis of proteins.
- Adenosine triphosphate (ATP) is a modified nucleotide that temporarily holds energy in high-energy phosphate bonds and releases that energy to power chemical reactions in a cell.

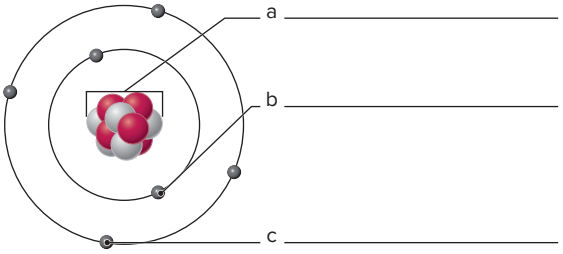
2.1 Atoms and Elements

Learning Objectives

1. Describe the basic structure of an atom.
2. Distinguish between atoms, isotopes, and radioisotopes.

1. Write the terms that match the phrases in the spaces at the right.
   a) Smallest unit of an element. _____
   b) Positively charged subatomic particle. _____
   c) Negatively charged subatomic particle. _____
   d) Subatomic particle with no charge. _____
   e) Substance that cannot be broken down into any simpler substance. _____
   f) Atoms of the same element, with different numbers of neutrons. _____
   g) Most abundant element in the body. _____

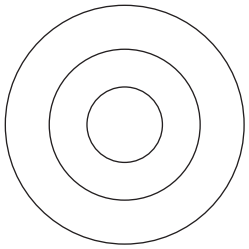
2. Label the atom shown by placing the name of the component in the space by the label, and then provide the responses to the phrases below. (See text figure 2.2 Atomic Structures of Hydrogen and Carbon.)



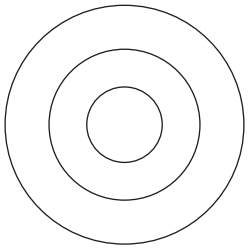
   a) Atomic number of this atom. _____
   b) Atomic mass of this atom. _____
   c) Number of electrons needed to complete its outer shell. _____
   d) Type of chemical bond that joins this atom to other atoms. _____
   e) Symbol of this atom. _____

3. Diagram an atom of each of these elements.

Oxygen



Nitrogen



2.2 Molecules and Compounds

Learning Objectives

3. Explain the meaning of a chemical formula.
4. Compare and contrast molecular formula and structural formula.
5. Compare and contrast ionic, nonpolar covalent, polar covalent, and hydrogen bonds.
6. Compare synthesis, decomposition, exchange, and reversible reactions.

1. Write the terms that match the phrases in the spaces at the right.
   a) Substance composed of two or more atoms from the same element. _____
   b) Substance built by ionic or covalent bonds. _____
   c) Number of chlorine atoms in $CaCl_2$. _____
   d) Chemical bond resulting from the donation of electron(s) from one atom to another. _____
   e) Chemical bond resulting from the sharing of valence electrons by two atoms. _____
   f) An atom with a net electrical charge. _____
   g) The attractive force between a slightly positive H atom and a slightly negative O atom. _____
   h) Chemical bonds forming organic molecules. _____
   i) Electrons in the outer shell. _____

2. Indicate the kinds and numbers of atoms in a glucose molecule ($C_6H_{12}O_6$).

Kinds of Atoms	Numbers of Atoms

3. Identify the pH values as acid (A) or base (B). Circle the pH with the highest concentration of H^+.
   _____ pH 2.8 _____ pH 6.8 _____ pH 7.4 _____ pH 9.5 _____ pH 3.7

4. Answer the following questions.
   a) What type of chemical reaction forms new bonds? _____
   b) What type of chemical reaction results in more numerous, smaller molecules? _____
   c) What type of chemical reaction can proceed in two different directions? _____

2.3 Substances Composing the Human Body

Learning Objectives

7. Distinguish between inorganic and organic substances.
8. Explain the importance of water and its locations in the body.
9. Compare and contrast electrolytes and nonelectrolytes, and acids and bases.
10. Explain the use of the pH scale.
11. Explain the importance of buffers.

12. Distinguish between carbohydrates, lipids, proteins, and nucleic acids and their roles in the body.
13. Explain the role of enzymes.
14. Describe the mechanism of enzymatic action.
15. Describe the structure and function of adenosine triphosphate (ATP).

1. Identify the following substances as either organic (O) or inorganic (I).

_____ NaCl	_____ Lipids	_____ $CaPO_4$
_____ Nucleic acids	_____ Salts	_____ $C_6H_{12}O_6$
_____ Proteins	_____ Most acids	_____ CH_4
_____ Most bases	_____ Carbohydrates	_____ CO_2
_____ Amino acids	_____ Steroids	_____ Monosaccharides
_____ Fatty acids	_____ Glycerol	_____ Nucleotides

2. Write the terms that match the phrases in the spaces at the right.

a) Most abundant substance in the body _____
b) Substances dissolved in a liquid. _____
c) A substance that releases H^+. _____
d) Splitting of ionic compounds into ions. _____
e) A measure of the H^+ concentration in a solution. _____
f) Chemicals that keep the pH of a solution relatively constant. _____
g) Class of macromolecules formed of many simple sugars joined together. _____
h) Type of reaction that joins two glucose molecules to form maltose. _____
i) Storage form of carbohydrates in the body. _____
j) Composed of three fatty acids and one glycerol. _____
k) Composed of two fatty acids and a phosphate group joined to one glycerol. _____
l) Type of fat whose fatty acids contain no carbon-carbon double bonds. _____
m) Macromolecules used to store excess energy reserves. _____
n) Class of lipids that includes sex hormones. _____
o) Class of macromolecules formed of 50 to thousands of amino acids. _____
p) Chemical bonds that determine the three-dimensional shape of proteins. _____
q) Bonds joining amino acids together in proteins. _____
r) A single-stranded nucleic acid that is involved in protein synthesis. _____
s) Building units of nucleic acids. _____
t) Steroid that tends to plug arteries when in excess. _____
u) Sugar in DNA molecules. _____

v) Primary carbohydrate fuel for cells. _____

w) Building units of proteins. _____

x) Water compartment containing about 65% of the water in the body. _____

y) Molecule releasing energy to power chemical reactions within cells. _____

z) Double-stranded nucleic acid. _____

aa) Molecules catalyzing chemical reactions in cells. _____

bb) Type of reaction breaking a large molecule into smaller molecules. _____

cc) Macromolecule controlling protein synthesis in cells. _____

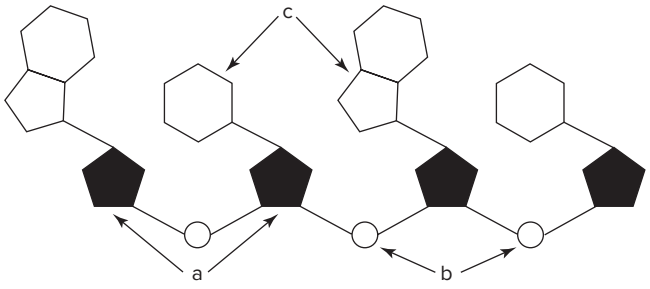
dd) Element whose atoms form the backbone of organic molecules. _____

3. Match the four classes of organic macromolecules with the listed substances.

a) Carbohydrates	b) Lipids	c) Proteins	d) Nucleic acids
_____ Amino acids	_____ Nucleotides	_____ Enzymes	
_____ Steroids	_____ Monosaccharides	_____ RNA	
_____ Glycogen	_____ Triglycerides	_____ DNA	
_____ Cholesterol	_____ Starch	_____ Fatty acids	

4. Place the appropriate letter in the blank next to the parts of the small portion of an RNA molecule shown and draw a line around one nucleotide.

_____ Nitrogen bases _____ Ribose sugars _____ Phosphate groups



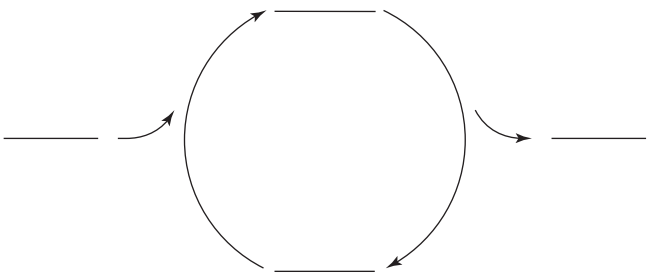
5. Show the interaction of ADP, ATP, P_i, and energy in the formation and breakdown of ATP by placing the numbers of the responses in the correct spaces provided.

a) ADP

b) ATP

c) Energy from nutrient molecules + $\oplus P_i$

d) Energy released for cellular processes + $\oplus P_i$



6. Explain the importance of the shape of an enzyme. _____

7. How does a change in pH change the shape of and inactivate an enzyme? _____

Clinical Insights and Critical Thinking

1. Why does a diet high in saturated fats increase the risk of coronary heart disease? _____

2. A patient in a coma is brought to the emergency room. A blood test shows that he has severe hypoglycemia (abnormally low blood glucose) and acidosis. Treatment is begun immediately to increase both blood glucose and pH.
   a) Why is a healthy level of blood glucose important? _____
   b) Why is severe acidosis a problem? _____

3. Potassium (K) has an atomic number of 19. How many electrons are in its valence shell? What type of chemical bond is it likely to form? _____

4. The pH of an aqueous solution is 6.0. Explain how the addition of the following substances would alter (or not alter) the pH of the solution.
   a) HCl _____
   b) NaOH _____
   c) H_2O _____

CHAPTER

3

Cell

Anatomy & Physiology REVEALED
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Module 2
Cells & Chemistry

CHAPTER OUTLINE

SELECTED KEY TERMS

Active transport Movement of substances across a plasma membrane, requiring the expenditure of energy by the cell.
Cell (cella = room) The simplest structural and functional living unit of an organism.
Cellular respiration Breakdown of organic nutrients in cells, to release energy and form ATP.
Centrioles (centr = center) Paired cylindrical organelles that form the mitotic spindle during cell division.
Chromosome (chrom = color; soma = body) A threadlike or rodlike structure in the nucleus that is composed of DNA and protein.
Cytoplasm (cyt = cell; plasma = molded) The semifluid material located between the nucleus and the plasma membrane.
Cytosol (sol = soluble) The gellike fluid of the cytoplasm.
Diffusion The net movement of a substance from an area of higher concentration to an area of lower concentration.
Endocytosis (end = inside; cyt = cell; sis = condition) The process by which the plasma membrane engulfs, or internalizes, solid particles and droplets of liquid.
Exocytosis (exo = outside) The process by which a cell releases substances by fusion of a secretory vesicle with the plasma membrane.
Mitosis (mit = thread; sis = condition) Process by which a cell divides to form two new daughter cells with the same number and composition of chromosomes as the parent cell.
Nucleus (nucle = kernel) Spherical organelle containing chromosomes that control cellular functions.
Organelle (elle = little) A specialized structure with specific function(s) within a cell.
Osmosis The passive movement of water across a selectively permeable membrane.
Passive transport Movement of substances across a plasma membrane without expenditure of energy by the cell.
Plasma membrane Outer boundary of a cell.
Selectively permeable membrane A membrane that allows only certain substances to enter or exit the cell.

Chapter Summary

3.1 The Human Cell

- The human body is composed of about 300 types of cells.
- Each type of cell has a unique structure for performing specific functions.

3.2 Cell Structure

- The plasma membrane is composed of a double layer of phospholipid molecules along with associated cholesterol and protein molecules. It is selectively permeable and controls the movement of the materials into and out of cells.
- The cytoplasm, which is composed of cytosol and organelles, lies outside the nucleus and is enveloped by the plasma membrane.
- The nucleus is a large, spherical organelle surrounded by the nuclear envelope.
- Chromosomes, composed of DNA and protein, are found in the nucleus. The uncoiled chromosomes appear as chromatin in nondividing cells.
- The nucleolus is the site of ribosome synthesis.
- Ribosomes are tiny organelles formed of rRNA and protein. They are sites of protein synthesis.
- The endoplasmic reticulum (ER) consists of membranes that form channels for transport of materials within the cell. RER is studded with ribosomes that synthesize proteins for export from the cell. SER lacks ribosomes and is involved in lipid synthesis.
- The Golgi complex packages materials into vesicles for secretion from the cell or transport within the cell.
- Mitochondria are large, double-membraned organelles within which aerobic respiration occurs.
- Lysosomes are small vesicles that contain digestive enzymes used to digest foreign particles, worn-out parts of a cell, or an entire damaged cell.
- The cytoskeleton is formed by microtubules and microfilaments, and is used in maintaining cell structure and cell movement.
- A pair of centrioles, used in cell division, is present near the cell's nucleus. The wall of each centriole is composed of microtubules arranged in groups of three.
- Cilia are short, hairlike projections on the free surface of certain cells. The beating of cilia moves materials along the cell surface.
- Each sperm swims by the beating of a flagellum, a long, whiplike projection.

3.3 Transport Across Plasma Membranes

- Passive transport does not require the expenditure of energy by the cell.
- Diffusion is the movement of a substance from an area of higher concentration to an area of lower concentration. It is caused by the constant motion of substances in gases and liquids.
- Substances diffuse across the plasma membrane by simple diffusion, channel-mediated diffusion, and carrier-mediated diffusion.
- Osmosis is the passive movement of water across a selectively permeable membrane.
- Hypotonic solutions have a higher water concentration than the cells. Hypertonic solutions have a lower water concentration than the cells. Isotonic solutions have the same water concentration as the cells.
- Cells in hypotonic solutions have a net gain of water. Cells in hypertonic solutions have a net loss of water. Cells in isotonic solutions have no net change of water content.
- Active transport requires the cell to expend energy.
- Active transport mechanisms include carrier-mediated active transport, endocytosis, and exocytosis.

3.4 Cellular Respiration

- Cellular respiration is the breakdown of nutrients in cells to release energy and form ATP molecules, which power cellular processes.
- Cellular respiration of glucose involves anaerobic respiration and aerobic respiration.
- Cellular respiration of a glucose molecule yields a net of 36–38 ATP. A net of 2 ATP is produced during anaerobic respiration, which occurs in the cytosol. A net of 34–36 ATP is produced during aerobic respiration, which occurs in mitochondria.

3.5 Protein Synthesis

- Protein synthesis involves the interaction of DNA, mRNA, rRNA, and tRNA.
- The sequence of bases in DNA determines the sequence of codons in mRNA, which, in turn, determines the sequence of amino acids in a protein.

$$\text{DNA} \xrightarrow[\textit{Transcription}]{} \text{mRNA} \xrightarrow[\textit{Translation}]{} \text{Protein}$$

3.6 Cell Division

- Mitosis produces two daughter cells that have the same number and composition of chromosomes. It enables growth and tissue repair.
- Meiosis results in the production of ova and sperm. Four daughter cells are formed that have half the number of chromosomes as the parent cell.
- Most of a cell cycle is spent in interphase, where cells carry out average life functions. In cells destined to divide, chromosomes and centrioles are replicated in interphase.
- After chromosome replication, mitosis is the orderly process of separating and distributing chromosomes equally to the daughter cells.
- Mitosis consists of four phases: prophase, metaphase, anaphase, and telophase.

3.1 The Human Cell

Learning Objective

1. Describe human cells.

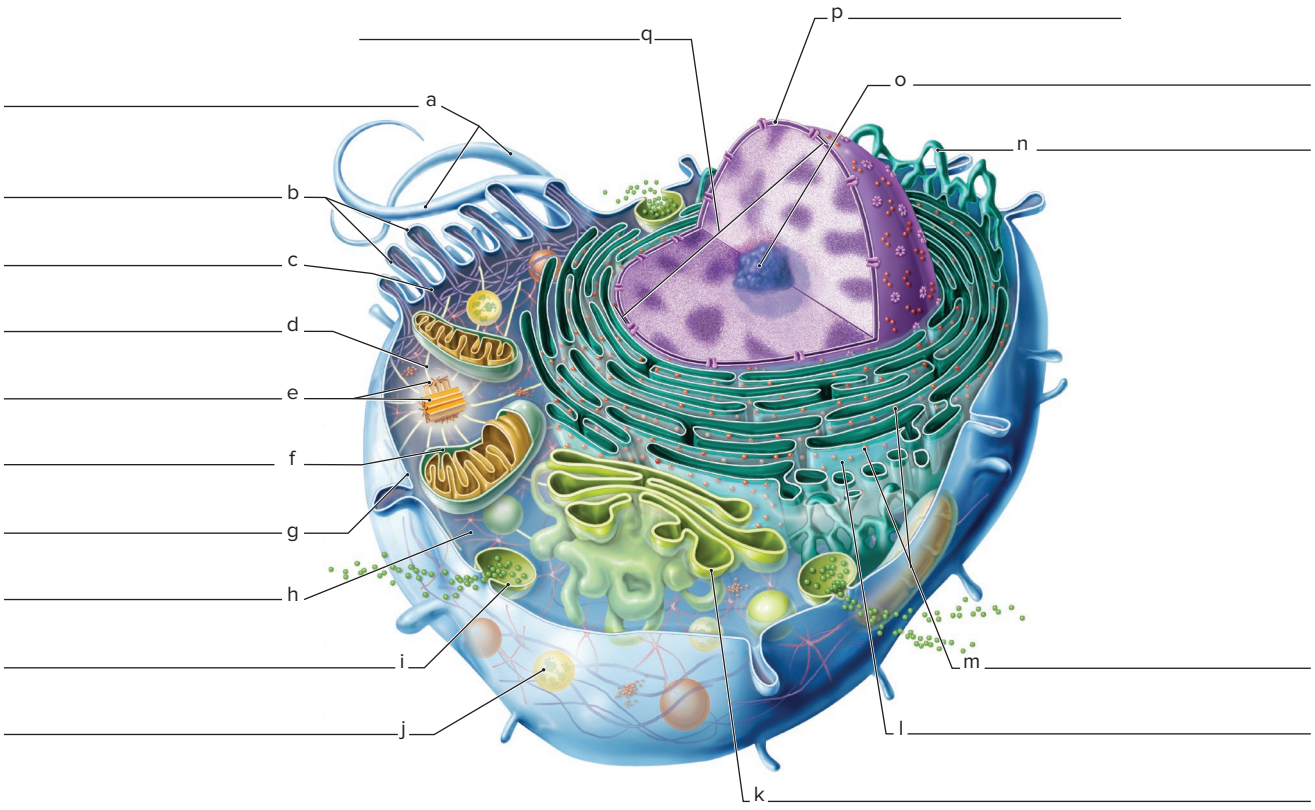
1. What is the approximate number of cells composing the human body? _____
2. What is the approximate number of different types of cells in the human body? _____
3. What tool is used to view human cells? _____

3.2 Cell Structure

Learning Objective

2. Describe the structure and function(s) of each part of a generalized cell.

1. Label the diagram of the cell by writing the names of the labeled parts in the spaces provided. (See text figure 3.1 Cell Structure.) AP|R



2. Write the terms that match the phrases in the spaces at the right.
   a) Endoplasmic reticulum with ribosomes. _____
   b) Forms cytoskeleton (two answers). _____
   _____
   c) Packages materials for export from cell. _____
   d) Sites of protein synthesis, composed of rRNA. _____
   e) Composed of DNA and protein. _____
   f) Site of RNA synthesis within nucleus. _____
   g) Site of anaerobic respiration. _____
   h) Increases surface area of a cell. _____
   i) Endoplasmic reticulum without ribosomes. _____
   j) Vesicles with digestive enzymes. _____
   k) Provides motility for sperm. _____
   l) Short cylinders formed of microtubules. _____
   m) Semifluid material around organelles. _____
   n) Short, hairlike projections that move substances across cell surfaces. _____
   o) Controls movement of materials into and out of the cell. _____
   p) Sites of aerobic respiration. _____
   q) Contains chromosomes. _____
   r) Forms channels for material transport in the cytoplasm. _____
   s) Molecule determining inheritance. _____
   t) Organelle controlling cell functions. _____
   u) Membrane protein that forms a pore through the plasma membrane. _____
   v) Membrane protein that binds and moves specific substances across the plasma membrane. _____
   w) Membrane proteins that allow cells to recognize each other. _____
   x) Membrane proteins that bind substances, like hormones. _____

3.3 Transport Across Plasma Membranes

Learning Objectives

3. Compare the mechanisms of passive and active transport of substances across the plasma membrane.
4. Describe osmosis and tonicity, and the effect of tonicity on the cells.

1. Match the terms and phrases. More than one answer may apply.

   Diffusion Osmosis Phagocytosis Pinocytosis

   a) Passive movement of water across the selectively permeable membrane. _____

b) A process that uses the plasma membrane to engulf solid particles. _____

c) A process that uses the plasma membrane to engulf liquid droplets. _____

d) Movement of a substance from an area of high concentration to an area of low concentration. _____

e) Results from random motion of substances. _____

2. Identify the transport processes as either active (A) or passive (P).

_____ Channel-mediated _____ Osmosis

_____ Diffusion _____ Pinocytosis

_____ Phagocytosis _____ Exocytosis

3. Write the missing words in the spaces at the right.

a) A cell does not change in size after it is placed in a(n) _____ solution. _____

b) A cell will increase in size after it is placed in a(n) _____ solution. _____

c) A cell will decrease in size after it is placed in a(n) _____ solution. _____

d) Ions move across the plasma membrane from an area of high concentration to an area of low concentration by the process of _____. _____

e) Sodium and potassium ions move across the plasma membrane against their concentration gradient by the process of _____. _____

f) Oxygen and carbon dioxide move across the plasma membrane by the process of _____. _____

3.4 Cellular Respiration

Learning Objectives

5. Describe cellular respiration and its importance.
6. Compare aerobic respiration and anaerobic respiration.

1. Write the summary equation for the cellular respiration of glucose in the blank space provided. Words may be used instead of chemical formulas. _____

_____

2. Provide the term that correctly completes each statement.

a) List the products of cellular respiration. _____

_____

b) The primary source of energy captured in ATP. _____

3. Explain why cellular respiration is a continuous process. _____

_____

_____

3.5 Protein Synthesis

Learning Objectives

7. Describe the process of protein synthesis.
8. Explain the roles of DNA and RNA in protein synthesis.

1. Provide the term that correctly completes each statement.
   a) The genetic code consists of the sequence of bases in _____ molecules. _____
   b) The genetic code is transcribed to the sequence of bases in _____ molecules. _____
   c) Molecule that carries instructions for protein synthesis to ribosomes. _____
   d) Molecule that carries an amino acid to a ribosome for addition to an amino acid chain. _____
   e) Small molecules that join to form a protein during translation. _____

3.6 Cell Division

Learning Objectives

9. Describe the two types of cell division and their roles.
10. Describe each phase of mitosis.

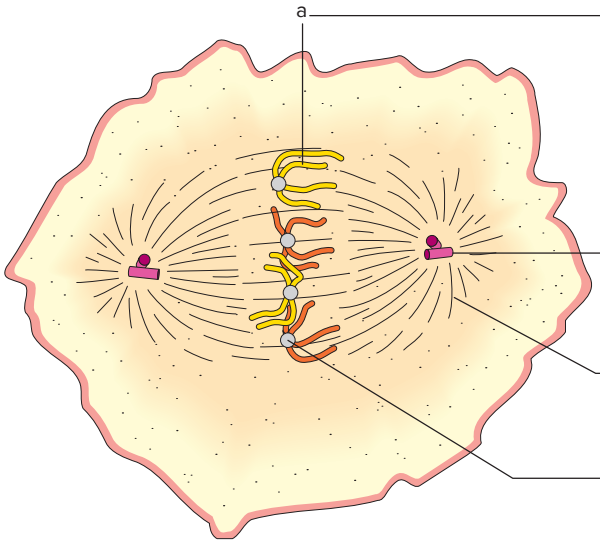
1. Indicate the type of cell division described by the statements.
   a) Provides new cells for growth and repair. _____
   b) Forms sperm and ova. _____
   c) Daughter cells have the same chromosome number and composition as the parent cell. _____
   d) Daughter cells have half the number of chromosomes as the parent cell. _____
2. Select the phase of the cell cycle described by the statements.

   Interphase Prophase Metaphase Anaphase Telophase

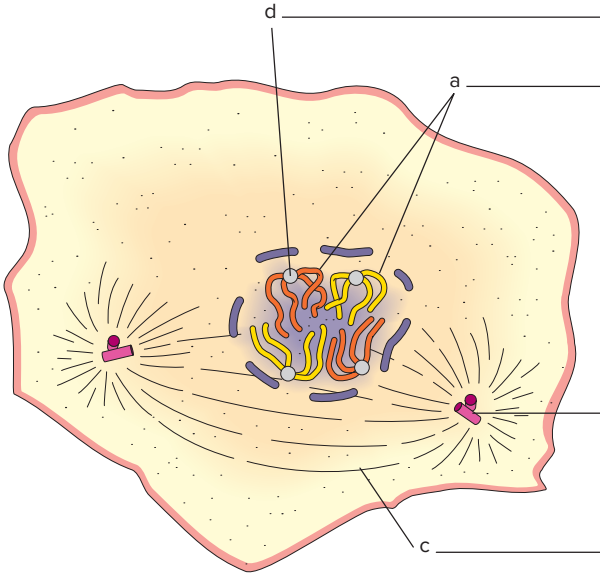
   a) Division of the cytoplasm. _____
   b) Replication of chromosomes. _____
   c) Chromosomes appear as threadlike bodies. _____
   d) Chromatids move toward ends of mitotic spindle. _____
   e) New nuclei start to form. _____
   f) Occupies most of cell cycle. _____
   g) Chromosomes line up at equator of mitotic spindle. _____
   h) Cell performs its average life functions. _____
3. Human body cells have 46 chromosomes. How many chromosomes are in daughter cells formed by mitosis? _____

4. Write the names of the cell parts in spaces a–e and write the names of the mitotic phases in spaces f–i.

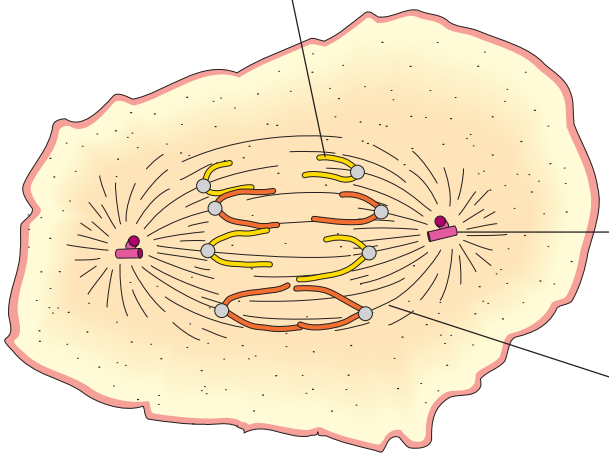
Centrioles	Chromosome	Spindle fiber
Centromere	Chromatid	



f _____



g _____



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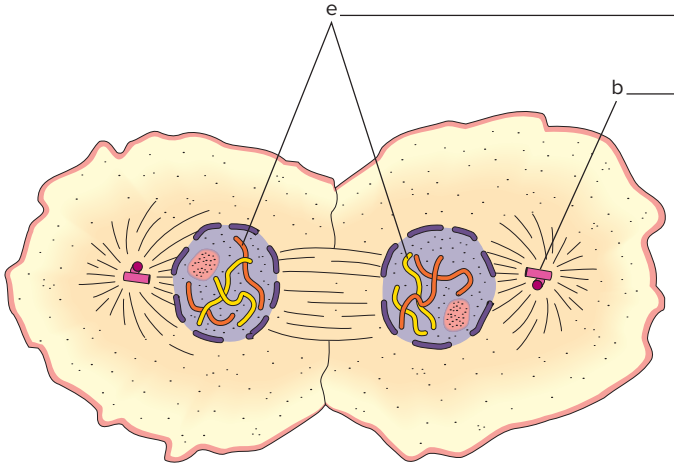

i _____

Clinical Insights and Critical Thinking

1. When you drink a glass of water, how does the water enter your blood? _____

   Why does this occur? _____

2. Explain how a chemotherapy drug that disrupts the formation of spindle fibers kills cancer cells.

3. How do the characteristics of a substance determine the transport mechanism that will be utilized to move it across the plasma membrane? _____

4. How is the correct sequence of amino acids in proteins determined? _____

5. How are glucose, pyruvic acid, mitochondria, oxygen, ADP, and ATP involved in aerobic cellular respiration? _____

6. How does mitosis yield daughter cells with the same DNA content? _____

CHAPTER

4

Tissues and Membranes

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Module 3
Tissues

CHAPTER OUTLINE

SELECTED KEY TERMS

Adipose tissue (adip = fat) A connective tissue that stores fat.
Bone tissue A hard connective tissue with a rigid matrix of calcium salts and fibers.
Cartilage tissue A connective tissue with a relatively rigid, semisolid matrix.
Connective tissue (connect = to join) A tissue that binds other tissues together.
Epithelial tissue (epi = upon, over; thel = delicate) A thin tissue that covers body and organ surfaces and lines body cavities, and forms secretory portions of glands; epithelium.
Fibroblast (fibro = fiber; blast = germ) A cell that produces fibers and ground substance in connective tissue.
Matrix The extracellular substance in connective tissue.
Mucous membrane Epithelial membrane that lines tubes or cavities of organ systems, with openings to the external environment.
Muscle tissue (mus = mouse) A tissue whose cells are specialized for contraction.
Nerve tissue A tissue that forms the brain, spinal cord, and nerves.
Serous membrane Epithelial membrane that lines the thoracic and abdominopelvic cavities and covers most of the internal organs within these cavities.
Tissue (tissu = woven) A group of similar cells performing similar functions.

Chapter Summary

4.1 Introduction to Tissues

- Embryonic stem cells are unspecialized cells that divide to form all types of specialized cells.
- Adult stem cells are partially specialized cells that divide to produce only certain related types of specialized cells.
- A tissue is a group of fully specialized cells that perform similar functions.
- The different tissues of the body are classified into four basic types of tissues: epithelial, connective, muscle, and nerve tissues.

4.2 Epithelial Tissues

- Epithelial tissue covers the surface of the body and the surfaces of organs, and lines the body cavities.
- Epithelial tissue is composed of closely packed cells with little extracellular material.
- Epithelial tissues are attached to underlying connective tissue by a noncellular basement membrane.
- Epithelial tissue lacks blood vessels.
- Epithelial tissues function in absorption, secretion, filtration, diffusion, osmosis, protection, and friction reduction.
- Epithelial tissues are classified according to the number of cell layers and the shape of the free surface cells. The epithelial tissues are

Simple Epithelium

- squamous
- cuboidal
- columnar
- pseudostratified ciliated columnar

Stratified Epithelium

- stratified squamous
- transitional

4.3 Connective Tissues

- Connective tissue is composed of relatively few cells located within a large amount of matrix.
- All connective tissues but cartilage tissue are supplied with blood vessels.
- Connective tissue binds other tissues together and provides support and protection for organs and the body.
- Connective tissue is classified according to the nature of the matrix. The connective tissues are

Loose Connective Tissue

- Areolar connective tissue
- Adipose tissue
- Reticular tissue

Dense Connective Tissue

- Dense regular connective tissue
- Dense irregular connective tissue
- Elastic connective tissue

Cartilage Tissue

- Hyaline cartilage
- Elastic cartilage
- Fibrocartilage

Bone Tissue

Blood

4.4 Muscle Tissues

- Muscle tissue is composed of muscle cells that are specialized for contraction.
- Contraction of muscle tissue enables movement of the body and internal organs.
- Muscle tissue is classified according to its location in the body, the characteristics of the muscle cells, and the type of contractions (voluntary or involuntary).
- Three types of muscle tissue are skeletal, cardiac, and smooth muscle tissue.

4.5 Nerve Tissue

- Nerve tissue consists of neurons and neuroglia.
- Neurons consist of a cell body and long, thin neuronal processes, and are adapted to form and conduct nerve impulses.
- Nerve tissue forms the brain, spinal cord, and nerves.

4.6 Body Membranes

- Membranes in the body are either epithelial membranes or connective tissue membranes.
- Epithelial membranes are composed of both epithelial and connective tissues, while connective tissue membranes are composed of connective tissue only.
- There are three types of epithelial membranes: serous, mucous, and cutaneous.
- Examples of connective tissue membranes are meninges, perichondrium, periosteum, and synovial membranes.

4.1 Introduction to Tissues

Learning Objectives

1. Compare embryonic stem cells and adult stem cells.
2. Describe the four basic types of tissue.

1. Select the tissues described by the statements.

Epithelial Connective Muscle Nerve

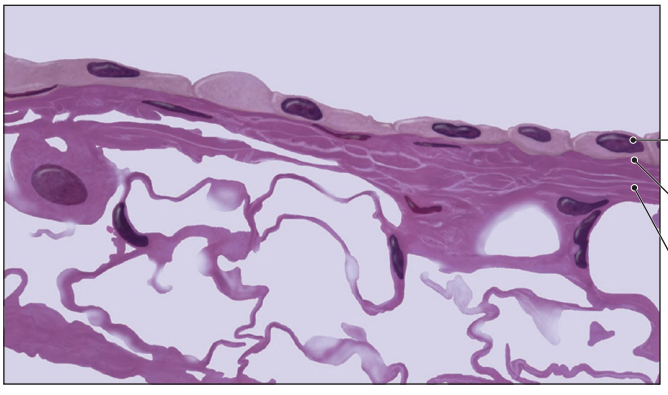
a) Adapted for contraction. _____
b) Contains scattered cells within a matrix. _____
c) Sheets of closely packed cells. _____
d) Composed of neurons and neuroglia. _____
e) Produces heat. _____
f) Supports and binds together other tissues. _____
g) Lines body cavities and covers organs. _____
h) Forms and conducts electrical impulses. _____
i) Functions in absorption and secretion. _____

4.2 Epithelial Tissues AP|R

Learning Objectives

3. Describe the distinguishing characteristics of epithelial tissues.
4. Identify the common locations and general functions of each type of epithelial tissue.

1. Write the names of the epithelial tissues in the spaces provided (a–f) and write the name of each indicated structure next to its corresponding label (g–k). (See text figures 4.3 to 4.8.) AP|R



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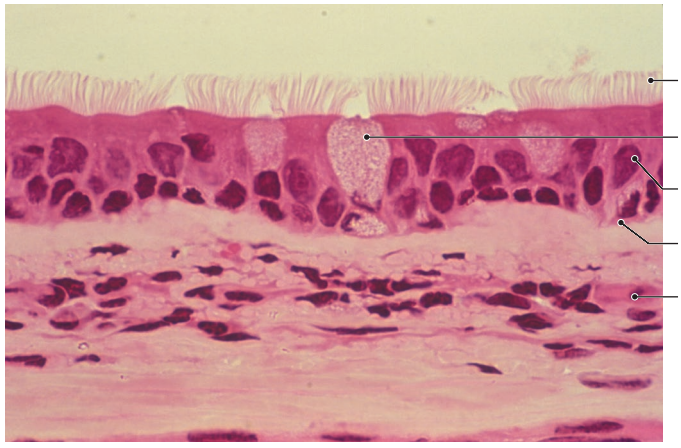

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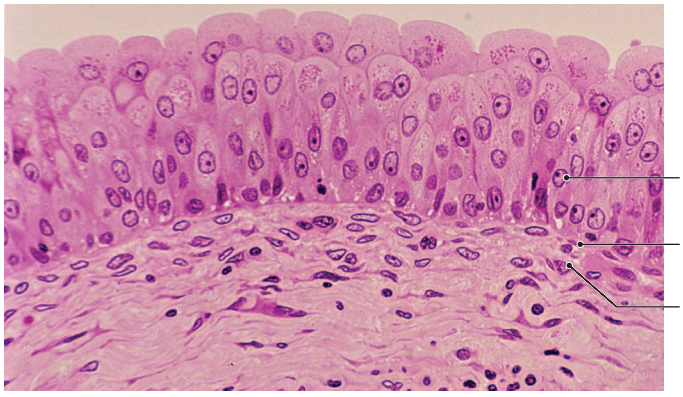

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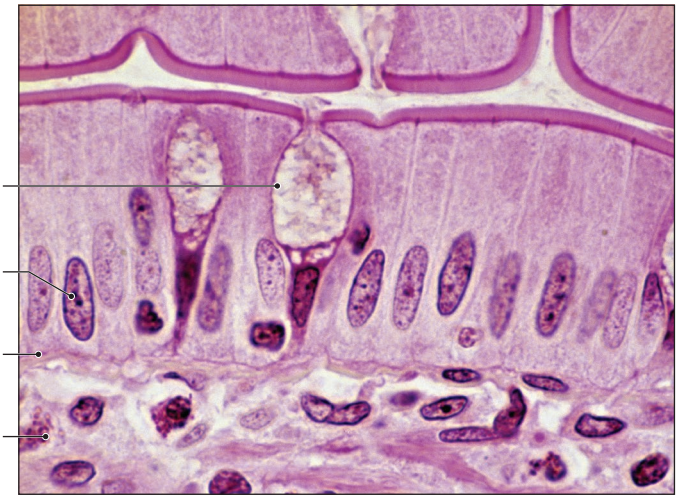

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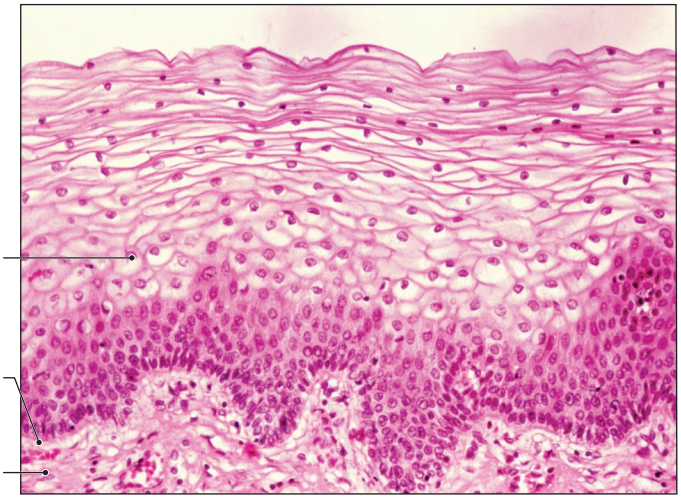
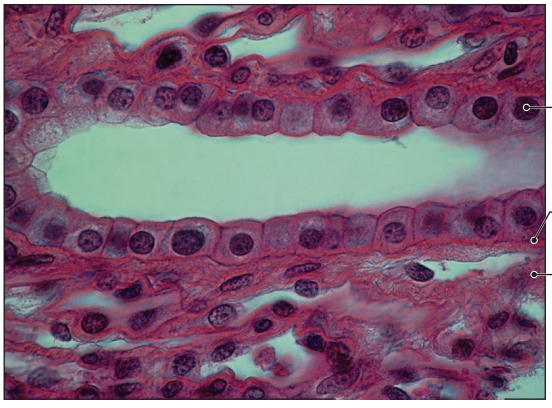


e _____



f _____

2. In each of the spaces provided, write the letter of the epithelial tissue described by the statement.

a) Simple squamous
b) Simple cuboidal
c) Simple columnar
d) Pseudostratified ciliated columnar
e) Stratified keratinized squamous
f) Stratified nonkeratinized squamous
g) Transitional

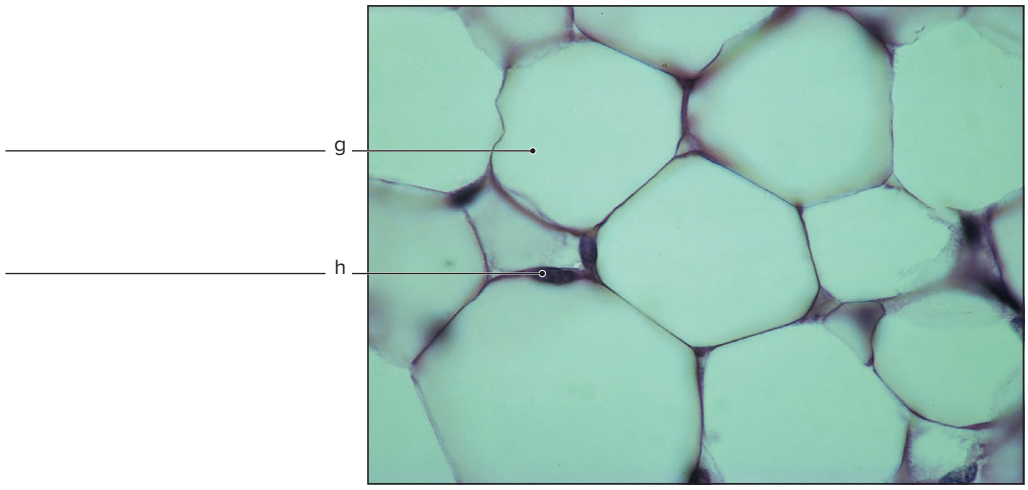
_____ Forms secretory portion of glands.
_____ Lines inner surfaces of blood vessels.
_____ Lines inner surfaces of stomach and intestines.
_____ Lines inner surfaces of respiratory passages.
_____ Forms kidney tubules.
_____ Forms outer layer of skin.
_____ Lines inner surfaces of urinary tract.
_____ Lines inner surface of mouth and vagina.
_____ Contain goblet cells. (2 answers)
_____ Forms air sacs of lungs.

4.3 Connective Tissues AP|R

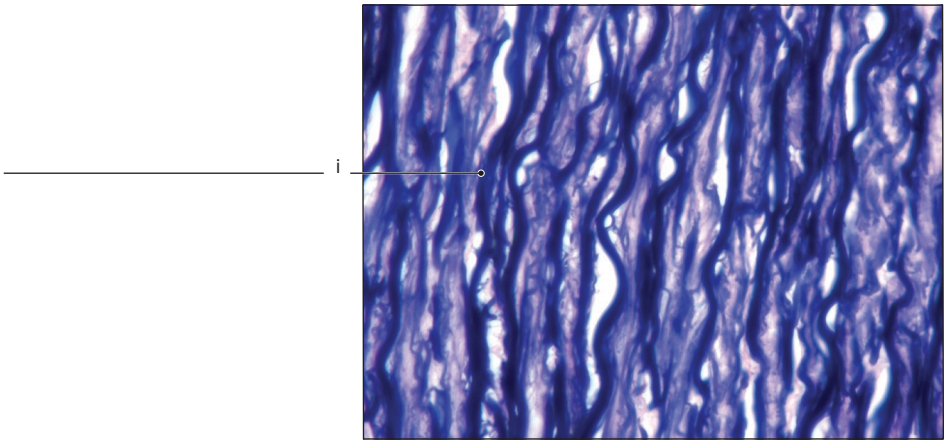
Learning Objectives

5. Describe the distinguishing characteristics of each type of connective tissue.
6. Identify the common locations and general functions of each type of connective tissue.

1. Write the names of the loose and dense connective tissues in the spaces provided (a–f) and write the name of each structure next to its corresponding label (g–o). (See text figures 4.9 to 4.14.) AP|R



a _____



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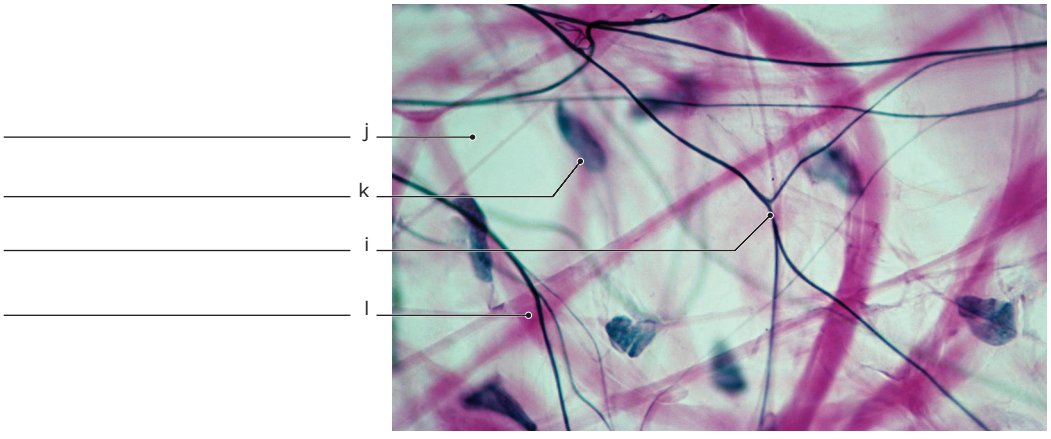

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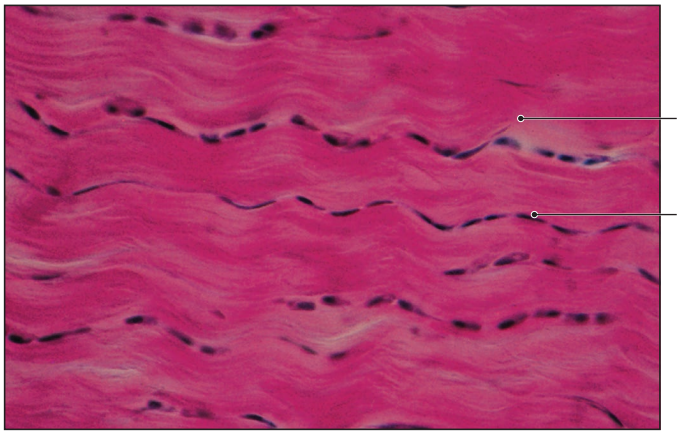
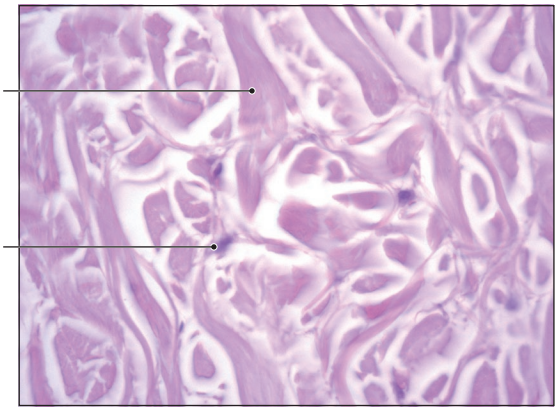


d _____



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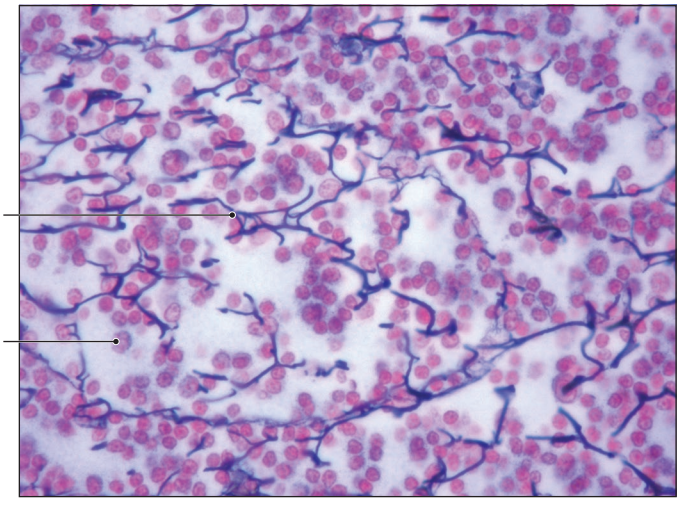


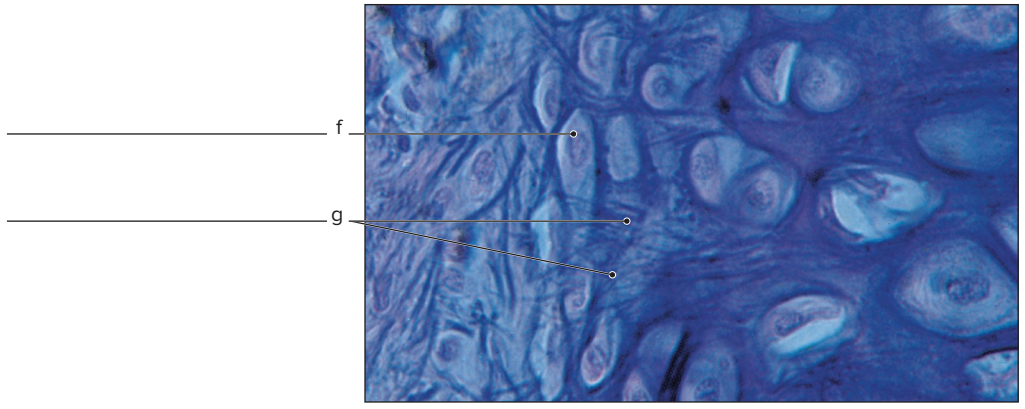
f _____

2. In each of the spaces provided, write the letter of the connective tissue described by the statement.

a) Areolar
b) Adipose
c) Reticular
d) Dense regular
e) Dense irregular
f) Elastic

_____ Storage area for fat.
_____ Binds skin to muscles. (2 answers)
_____ Forms ligaments and tendons.
_____ In walls of arteries.
_____ Supportive framework for internal organs.
_____ Acts as filter in lymph nodes.
_____ Maintain liver and spleen structure.
_____ Insulates body.
_____ Tightly packed, parallel collagen fibers.
_____ Enables expansion and recoil of lungs.
_____ Protective cushion for internal organs.
_____ Innermost region of the dermis.

3. Write the names of the connective tissues with specialized functions in the spaces provided (a–e) and write the name of each structure next to its corresponding label (f–q). (See text figures 4.15 to 4.19.) AP|R



a _____

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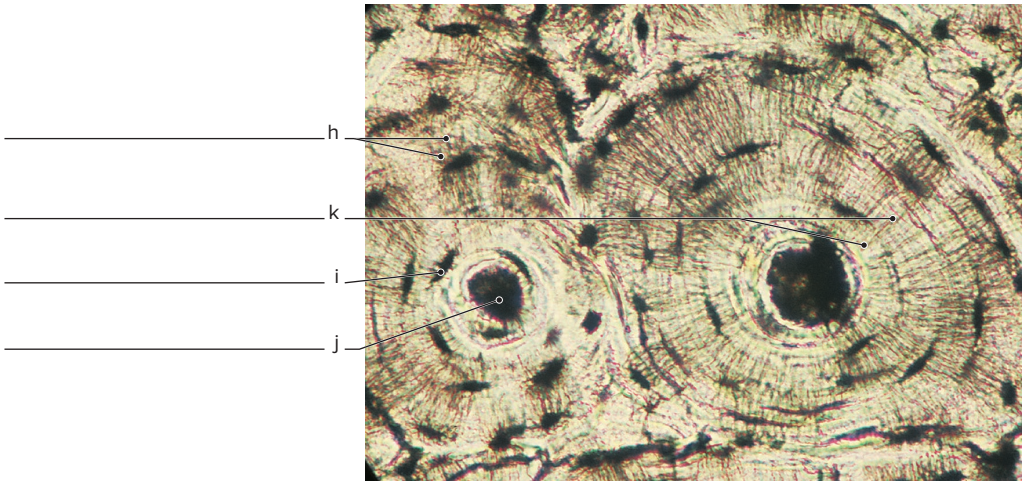

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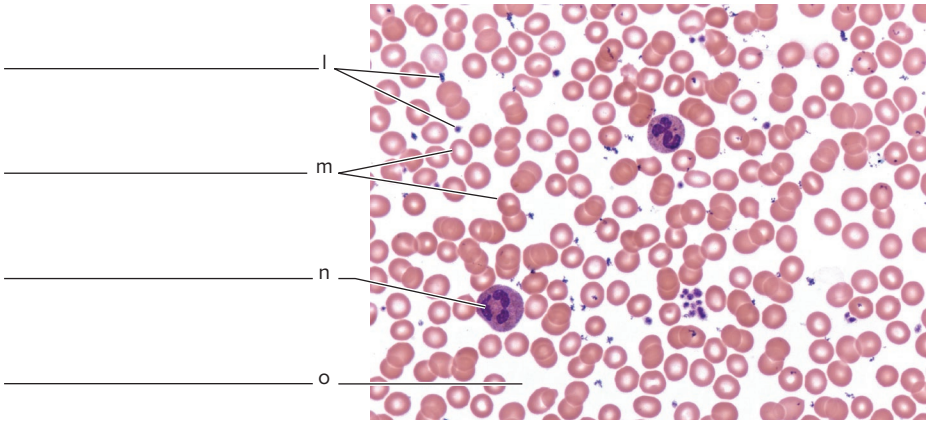

c _____

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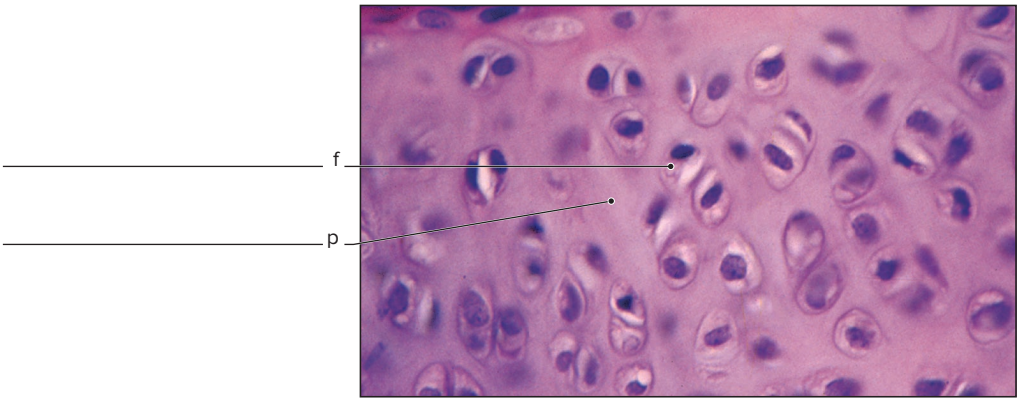

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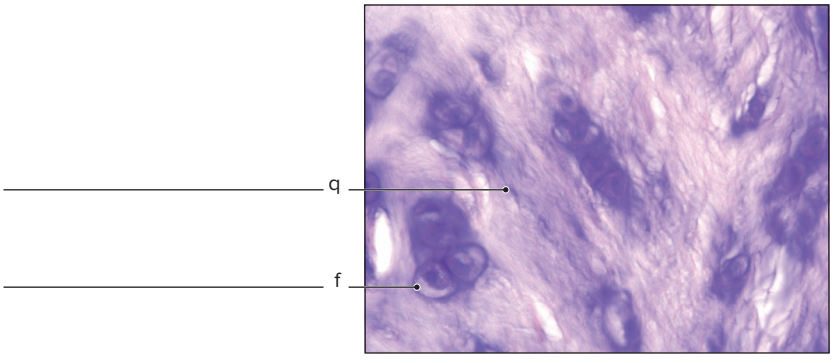


e _____

Courtesy of Beth Ann Kersten

4. In each of the spaces provided, write the letter of the connective tissue described by the statement.

a) Elastic cartilage c) Fibrocartilage e) Hyaline cartilage
b) Bone tissue d) Blood

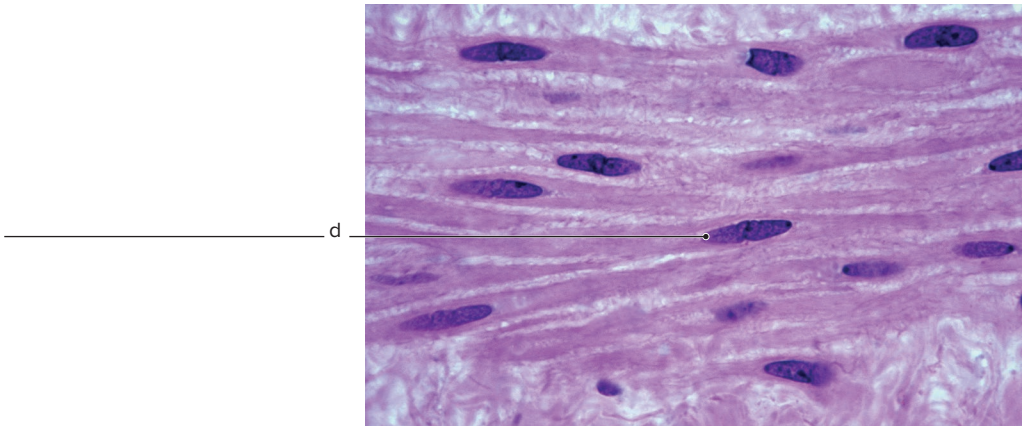
_____ Forms intervertebral discs.
_____ Forms epiglottis.
_____ Forms embryonic bones.
_____ Has a liquid matrix.
_____ Has a smooth, glassy matrix.
_____ Has fibers that impart elasticity.
_____ Has a hard, rigid matrix.
_____ Has dense collagen fibers to resist strong pressures.

4.4 Muscle Tissues AP|R

Learning Objectives

7. Describe the distinguishing characteristics and locations of each type of muscle tissue.
8. Identify the general functions of each type of muscle tissue.

1. Write the names of the muscle tissues in the spaces provided (a–c) and write the name of each structure next to its corresponding label (d–f). (See text figures 4.20 to 4.22.) AP|R



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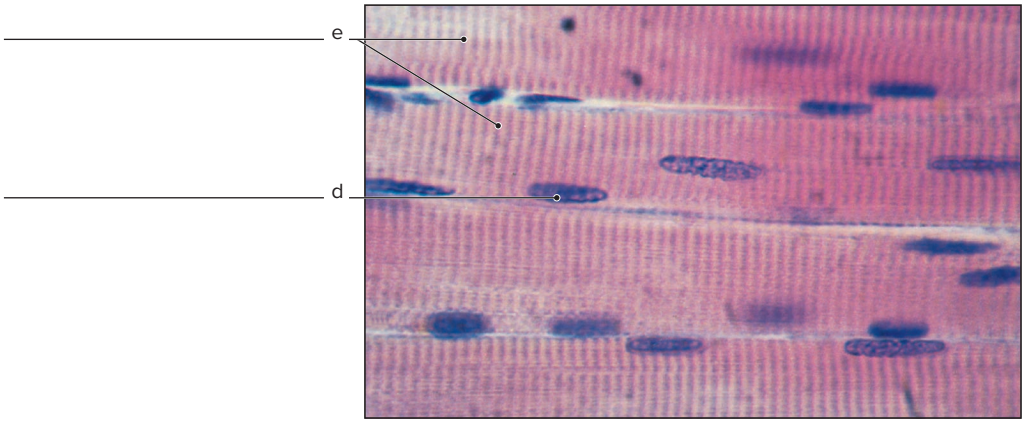

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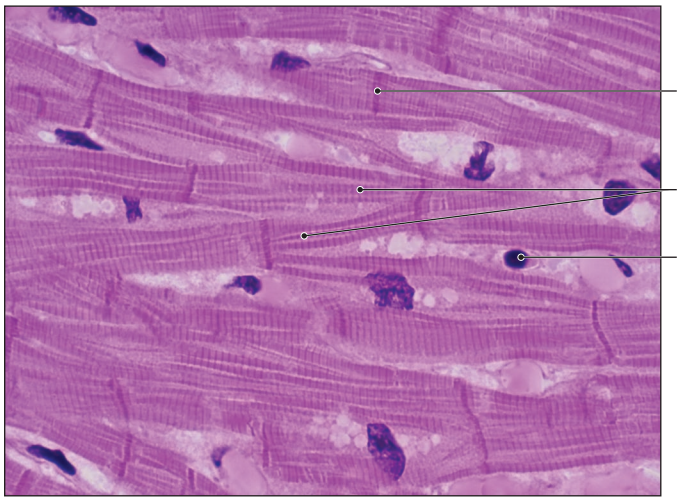


2. In each of the spaces provided, write the letter of the muscle tissue(s) described by the statement.

a) Cardiac b) Skeletal c) Smooth

_____ Voluntary
_____ Involuntary (2 answers)
_____ In walls of intestine
_____ Slow contractions
_____ Rapid contractions
_____ In walls of heart

4.5 Nerve Tissue

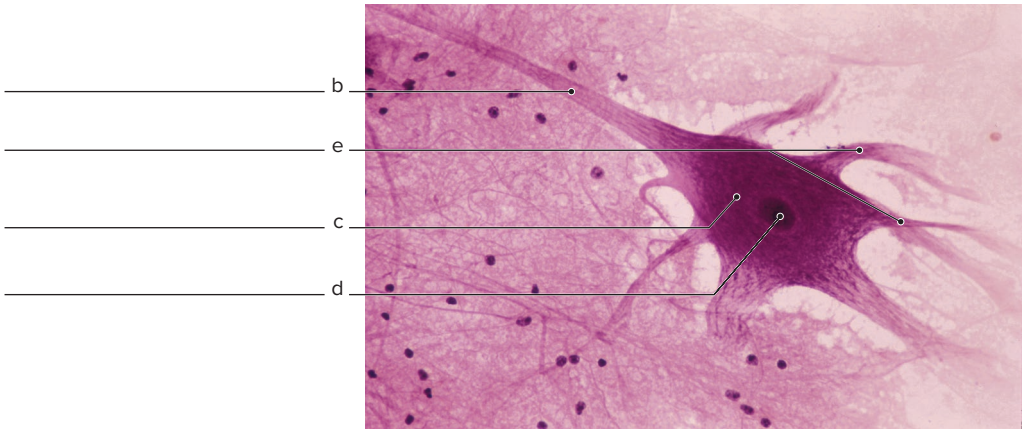
Learning Objectives

9. Describe the distinguishing characteristics and general functions of nerve tissue.
10. Identify the common locations of nerve tissue.

1. Indicate whether each statement is true (T) or false (F).

_____ Nerve cells are called neuroglia.
_____ The nucleus of a neuron is located in the cell body.
_____ Neurons generate and transmit nerve impulses.
_____ Supporting cells in nerve tissue are fibroblasts.

2. Write the name of the large cell in the space provided (a) and write the name of each structure of the cell next to its corresponding label (b–e). (See text figure 4.23 Nerve Tissue.) AP|R



4.6 Body Membranes

Learning Objectives

11. Compare epithelial and connective tissue membranes.
12. Describe the locations and functions of each type of epithelial membrane.
13. Identify examples of connective tissue membranes.

1. In each of the spaces provided, write the letter of the membrane described by the statement.

a) Cutaneous membrane
b) Meninges
c) Mucous membranes
d) Perichondrium
e) Periosteum
f) Serous membranes
g) Synovial membranes

_____ Line the abdominal cavity and cover most abdominal organs.
_____ Protective covering of the brain and spinal cord.
_____ Covers the entire body.
_____ Epithelial membranes. (3 answers)
_____ Covers the surfaces of cartilage tissue.
_____ Line tubes and cavities that open to the external environment.
_____ Line cavities of freely movable joints.
_____ Covers surfaces of bones.
_____ Secrete a watery fluid to reduce friction. (2 answers)
_____ Secretions help to trap foreign particles and pathogens.

Clinical Insights and Critical Thinking

1. Most cancers are carcinomas. How do you explain this? _____

2. Judy tore a knee cartilage on a skiing vacation. Can she expect a rapid recovery? _____ Explain. _____

3. Explain why the innermost region of the skin's dermis is composed of dense irregular connective tissue and not dense regular connective tissue. _____

4. Why is stratified squamous epithelium not found within the lungs? _____

5. Why is it important for homeostasis that cardiac and smooth muscle tissue are involuntary? _____

6. How are skeletal muscle tissue, dense regular connective tissue, and bone involved in the movement of limbs?

CHAPTER

5

Integumentary System

Module 4
Integumentary System

CHAPTER OUTLINE

SELECTED KEY TERMS

Apocrine sweat gland (apo = detached; crin = separate off) A sweat gland depositing secretions into a hair follicle.
Cutaneous (cutane = skin) Pertaining to the skin.
Dermal papillae (papilla = nipple) Nipplelike projections of the dermis at the dermis-epidermis boundary.
Dermis (derm = skin) The innermost layer of the skin.
Eccrine sweat gland (ec = out from) A sweat gland depositing secretions onto the skin surface.
Epidermis (epi = upon) The outer layer of the skin.
Hair follicle (folli = bag) An inward, tubular extension of the epidermis containing the hair root.
Integument (integere = to cover) The skin.
Keratin (kerat = horny, hard) Tough, fibrous protein that provides waterproofing and abrasion protection for the epidermis.
Melanin (melan = black) The brown-black pigment formed by melanocytes.
Sebaceous gland (seb = grease, oil) A gland depositing sebum into a hair follicle.
Subcutaneous tissue (sub = below) The loose connective tissue beneath the skin.
Sweat gland A sweat-producing gland.

Chapter Summary

5.1 Functions of the Skin

- The skin is also called the cutaneous membrane or integument.
- The functions of the skin are protection, excretion, temperature regulation, sensory perception, synthesis of vitamin D, and absorption.

5.2 Structure of the Skin and Subcutaneous Tissue

- The skin is composed of an outer epidermis that covers the inner dermis.
- The epidermis consists of keratinized stratified squamous epithelium, which lacks blood vessels.
- The epidermis is organized into five layers in thick skin and four layers in thin skin.
- New epithelial cells are constantly formed by the stratum basale. As the cells migrate toward the surface, they become keratinized, die, and finally are sloughed off.
- The epidermis contains four types of cells: keratinocytes, melanocytes, dendritic cells, and tactile epithelial cells.
- The dermis is divided into a papillary layer made of areolar connective tissue and a reticular layer made of dense irregular connective tissue containing both collagen and elastic fibers.
- The dermis contains blood vessels, nerves, and sensory receptors.
- Dermal papillae create dermal ridges that produce finger and toe print patterns.
- The dermal papillae and epidermal ridges help to interlock the dermis and epidermis.
- The subcutaneous tissue attaches the skin to underlying tissues and organs, absorbs impact, and stores fat.
- The subcutaneous tissue consists of areolar connective tissue and adipose tissue. It contains blood vessels and nerves.

5.3 Skin Color

- The color of the skin is inherited and results from the presence of three pigments: hemoglobin in dermal blood vessels, carotene in the epidermis and subcutaneous tissue, and melanin in the epidermis.
- Melanin is a brown-black pigment produced by melanocytes in the stratum basale of the epidermis and is incorporated into the keratinocytes.
- Melanin protects the body from UV radiation.

5.4 Accessory Structures

- Accessory structures are formed from the epidermis.
- Hair consists of keratinized epidermal cells that are formed at the base of a hair follicle.
- An arrector muscle of hair is attached to the side of each hair follicle at one end and to the papillary layer of the dermis at the other end. Its contraction pulls the hair into a more erect position.
- Hair occurs over most of the body.
- Glands associated with the skin are the sebaceous, sweat, and ceruminous glands.
- Sebaceous glands produce sebum, an oily secretion that is deposited into hair follicles.
- There are two types of sweat glands: apocrine and eccrine. Apocrine sweat glands occur in axillary and genital areas and secrete a relatively thick sweat that is deposited into hair follicles. Eccrine sweat glands occur all over the body and secrete a watery sweat that is deposited onto the surface of the skin.
- Eccrine sweat is used to cool the body, wash the skin surface, remove chemicals from blood, and protect against pathogens. Apocrine sweat contains pheromones.
- Ceruminous glands are located in the external acoustic meatus and secrete a waxy substance called cerumen.
- Nails protect the tips of fingers and toes.
- Nails are formed of layers of heavily keratinized and dead keratinocytes.

5.5 Temperature Regulation

- Average healthy human body temperature is 36.8°C (98.2°F).
- Body heat is produced by decomposition reactions.
- When body temperature rises above an individual's set point, blood vessels in the dermis dilate to increase heat loss and sweat is produced. The evaporation of sweat increases heat loss.
- When body temperature falls below an individual's set point, blood vessels in the dermis are constricted to reduce heat loss and arrector muscles of hair contract. Under extreme heat loss, spontaneous skeletal muscle contractions (shivering) produce additional heat.
- When temperature regulation is overwhelmed, hypothermia and hyperthermia become medical emergencies.

5.6 Aging of the Skin

- After 50 years of age, wrinkles and sagging skin become noticeable.
- The effects of aging are caused by a breakdown of collagen and elastic fibers, a decrease in sebum production, a decrease in melanin production, and a decrease in subcutaneous fat.

5.7 Disorders of the Skin

- Infectious disorders of the skin include acne, athlete's foot, boils, fever blisters, and impetigo.
- Noninfectious disorders of the skin include alopecia, bed bugs, bedsores, blisters, burns, calluses and corns, common moles, dandruff, eczema, hives, and psoriasis.