A light blue ECG (heart rate) line is drawn horizontally across the middle of the cover, partially overlapping the title text.

# HUMAN ANATOMY & PHYSIOLOGY

SECOND EDITION

Catharine C. Whiting



# Would you like to increase student engagement in your lab course?

**A Rich Variety of Activities:** Whiting's active-learning approach uses different learning modalities, such as labeling, sketching, touching, dissecting, interacting with groups, and making predictions to help engage students in the lab activities.

**LabBOOSTs** invite students to do hands-on demonstrations of key concepts.

## LabBOOST

**Visualizing the Brain** Students often notice that, when examined in a midsagittal section, the diencephalon and the brainstem together form the shape of a seahorse. The diencephalon is its head, the midbrain of the brainstem is its neck, the pons of the brainstem is its belly, and the medulla oblongata of the brainstem



is its tail. Just liken the cerebrum to an oversized cap and the cerebellum to a backpack, and you have a great word picture to help you remember the basic organization of the brain. Make a sketch of the brain based on this word picture. Then label the four major brain regions (cerebrum, diencephalon, brainstem, and cerebellum), the three components of the diencephalon, and the three components of the brainstem.

15

## Activity 1

### Exploring the Functional Anatomy of the Brain

#### Learning Outcomes

1. Identify assigned brain structures on a human brain model and/or anatomical charts, and describe the structure and function of each.
2. Locate the major functional areas of the cerebral cortex, and describe the function(s) of each.

#### Materials Needed

- Brain models and anatomical charts

#### Instructions

**CHART** In this activity you will focus on both the structure and function of the parts of the four major brain regions. First, locate on a brain model each of the structures listed in the Making Connections charts on the next two pages, and then discuss the function(s) of each structure with the other members of your lab group. Next, write a few words in the appropriate cells of the following charts to help you remember the descriptions and functions of each structure. Finally, brainstorm "connections to things I have already learned" with your lab group, and write the most helpful ones in the charts. Various cells of the charts have been completed for you as examples.

**Making Connections Charts** within the activities encourage students to apply previously learned concepts.

#### Making Connections: Cerebrum

Specific Structure	Description (Structure and/or Function)	Connections to Things I Have Already Learned
Convolution	Elevated ridge (gyrus) + shallow groove (sulcus)	
Central sulcus		
Longitudinal fissure		
Frontal lobe		
Parietal lobe		
Occipital lobe		Occipital region of the body; occipitalis muscle, occipital bone
Temporal lobe	Lateral cerebral lobe	
Insula		
Septum pellucidum		
Fornix		



# Do your students struggle with applying concepts . . .

**Bloom's Level II Application Questions** in Post-Lab Assignments in the lab manual challenge students to explain concepts and make predictions based on their understanding of the lab activities.

Post-lab quizzes are also assignable in  
**Mastering Anatomy & Physiology**

**POST-LAB Assignments**

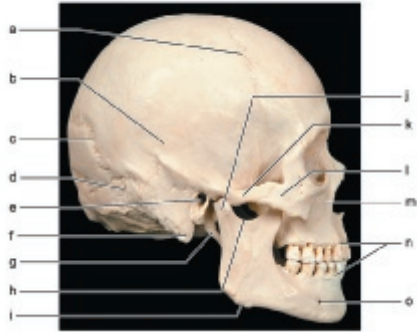
Name: \_\_\_\_\_ Date: \_\_\_\_\_ Lab Section: \_\_\_\_\_

**PART I. Check Your Knowledge**

**Activity 1: Studying the Bones of the Skull**

1. Identify the bones and bone markings in the accompanying lateral view of the skull.

a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_  
e. \_\_\_\_\_  
f. \_\_\_\_\_  
g. \_\_\_\_\_  
h. \_\_\_\_\_  
i. \_\_\_\_\_  
j. \_\_\_\_\_  
k. \_\_\_\_\_  
l. \_\_\_\_\_



a. \_\_\_\_\_  
b. \_\_\_\_\_  
c. \_\_\_\_\_  
d. \_\_\_\_\_  
e. \_\_\_\_\_  
f. \_\_\_\_\_  
g. \_\_\_\_\_  
h. \_\_\_\_\_  
i. \_\_\_\_\_  
j. \_\_\_\_\_  
k. \_\_\_\_\_  
l. \_\_\_\_\_

## PART II. Putting It All Together

### A. Review Questions

Answer the following questions using your lecture notes, your textbook, and/or your lab notes.

1. Why is the sphenoid bone considered to be the "keystone" bone of the cranium?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
2. Explain how the atlas and axis differ from a typical cervical vertebra, and how each difference reflects the bone's function.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. What is a ruptured disc, and what problem might it cause? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. When administering cardiopulmonary resuscitation (CPR), it is important to perform compressions on the body, not the inferior end, of the sternum. Why?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

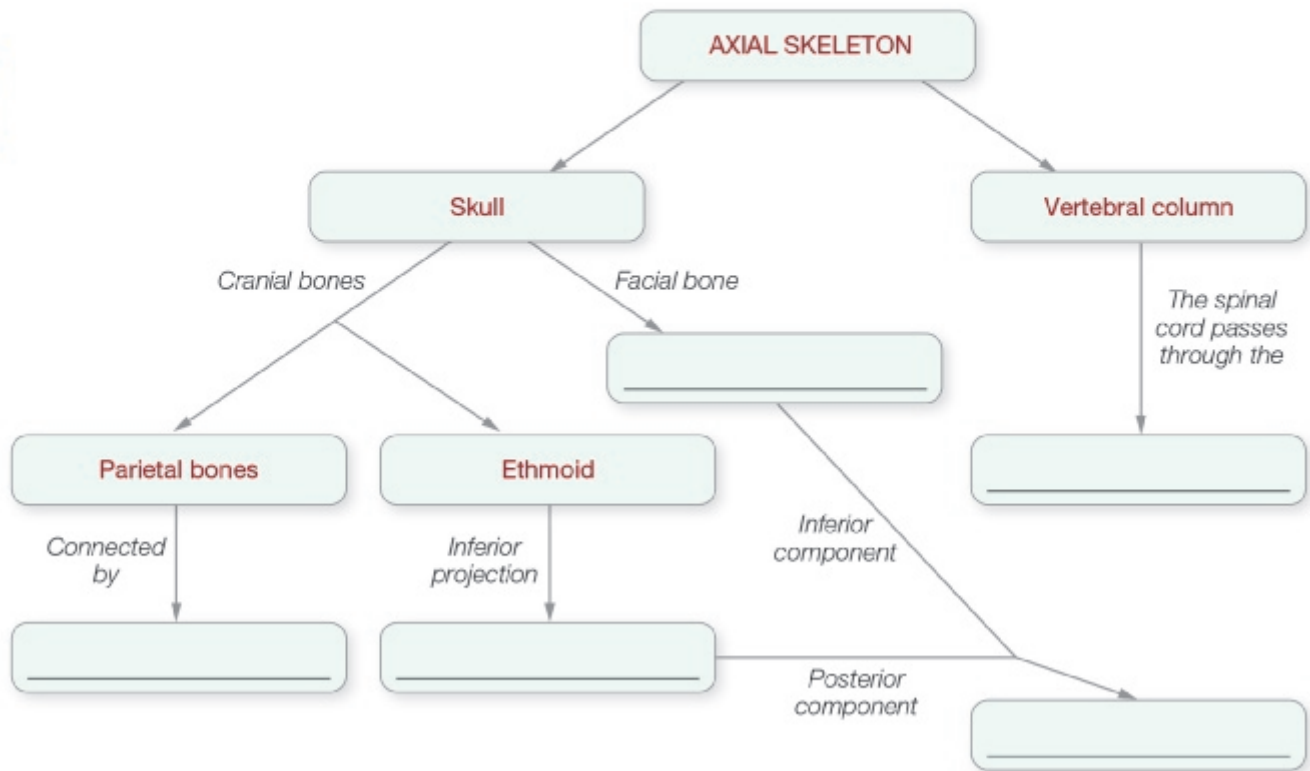
*\*Higher-level Bloom's questions, Clinical Scenarios, and Clinical Case Studies are also assignable in Mastering A&P.*

# . . . learned in lecture to lab?

## B. Concept Mapping

1. Fill in the blanks to complete this concept map outlining structures that are found in the midline.

nasal septum    perpendicular plate    sagittal suture    vertebral foramen    vomer



**Concept Maps** give students an opportunity to think about relationships among terms.



# Are your students prepared for lab?

**Whiting** helps your students be better prepared for lab by including new interactive activities that you can easily assign before lab.

**NEW! Pre-Lab Assignments in Mastering A&P** now test on the same content as Pre-Lab Assignments in the lab manual to ensure a consistent experience between the lab manual and Mastering. Post-Lab Assignments are also available in Mastering A&P.

**NEW! Pre-Lab Video Coaching Activities** focus on key concepts demonstrated in the activity and walk through procedures and steps of the lab activity. Includes "Pause and Predict" questions.

**Pre-Lab Videos** include: Compound Microscope, Diffusion and Osmosis, Muscle Contraction, Stretch Reflexes, Determining the Hematocrit, Blood Typing, ECG, Blood Pressure, Spirometry, and Salivary Amylase.

Mastering Anatomy & Physiology

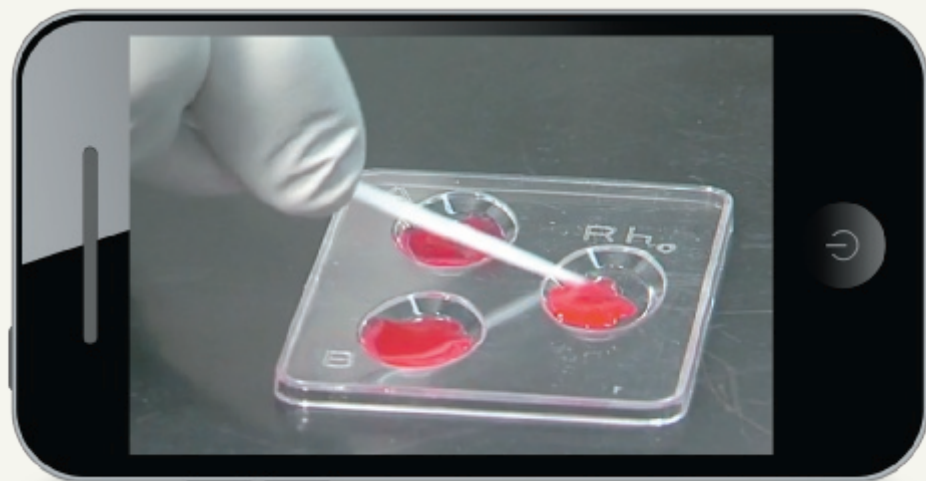
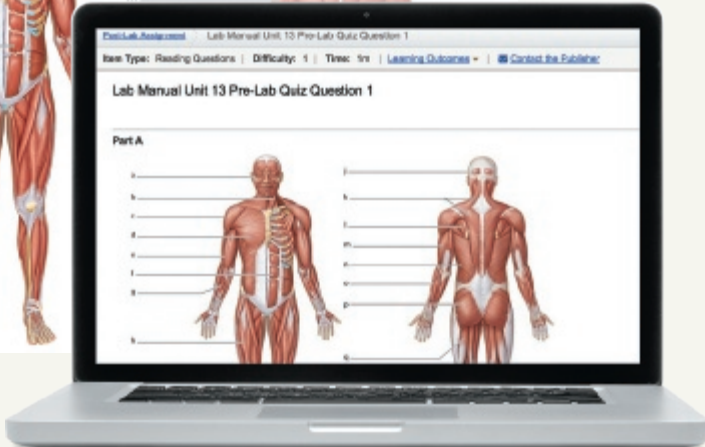
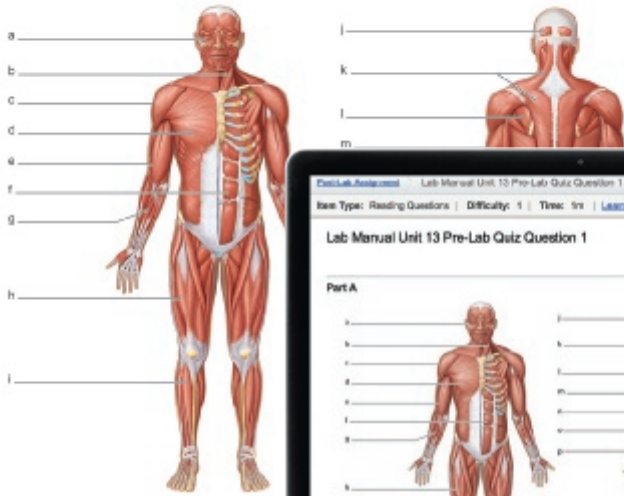
### PRE-LAB Assignments

To maximize learning, BEFORE your lab period, carefully read all assigned activities and the corresponding background information. Then, complete the pre-lab assignments below for each of the assigned activities.

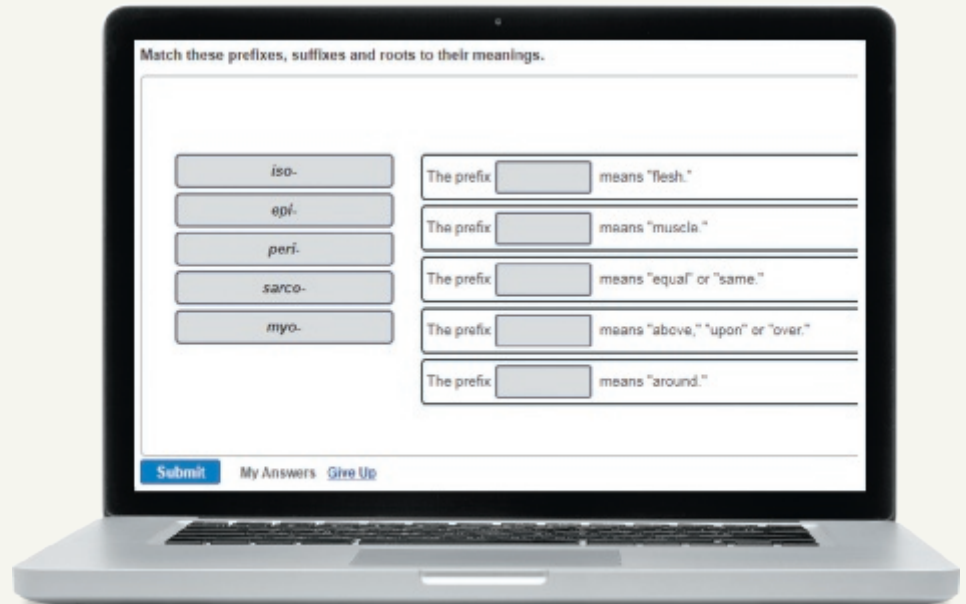
**PRE-LAB Activity 1: Determining How Skeletal Muscles Are Named**

1. Use the list of terms provided to label the accompanying diagram of skeletal muscles; check off each term as you label it.

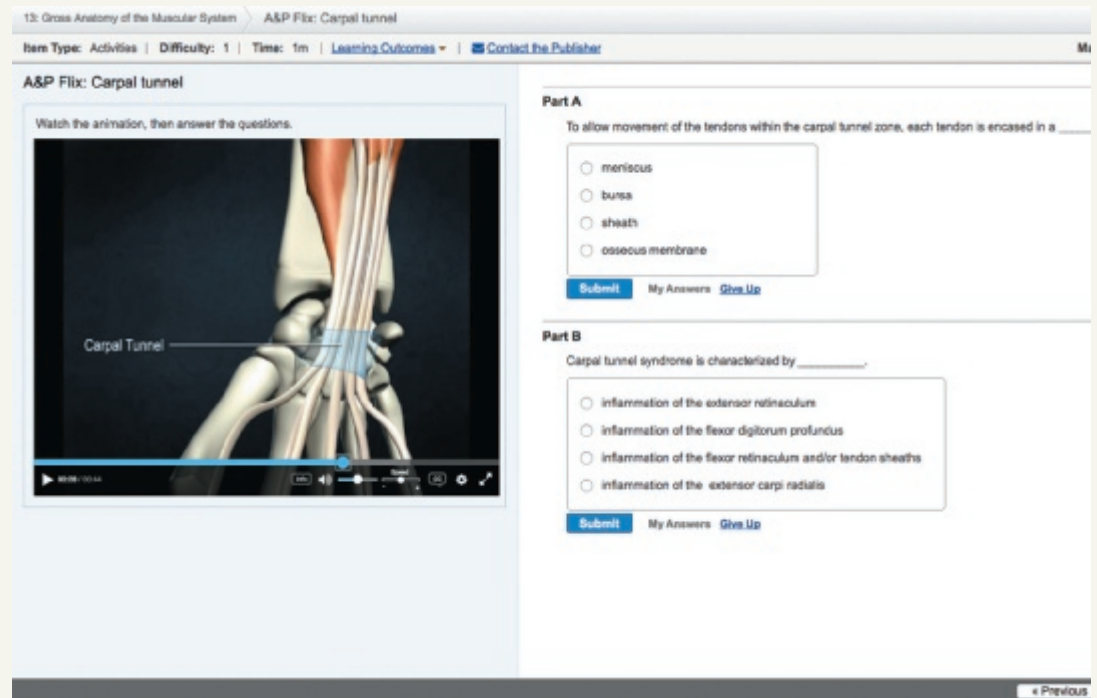
<input type="checkbox"/> biceps brachii	<input type="checkbox"/> gastrocnemius	<input type="checkbox"/> rectus abdominis
<input type="checkbox"/> biceps femoris	<input type="checkbox"/> gluteus maximus	<input type="checkbox"/> rectus femoris
<input type="checkbox"/> deltoid	<input type="checkbox"/> latissimus dorsi	<input type="checkbox"/> sternocleidomastoid
<input type="checkbox"/> epirapheus, occipital belly	<input type="checkbox"/> infraspinatus	<input type="checkbox"/> tibialis anterior
<input type="checkbox"/> extensor digitorum	<input type="checkbox"/> orbicularis oculi	<input type="checkbox"/> trapezius
<input type="checkbox"/> flexor carpi radialis	<input type="checkbox"/> pectoralis major	<input type="checkbox"/> triceps brachii



**NEW! Building Vocabulary Coaching Activities** give students practice learning and using word roots in context as they learn new A&P terms.



**A&P Flix** animations are 3D movie-quality anatomy animations that include origins, insertions, actions, and innervations of muscles and group muscle actions and joints.

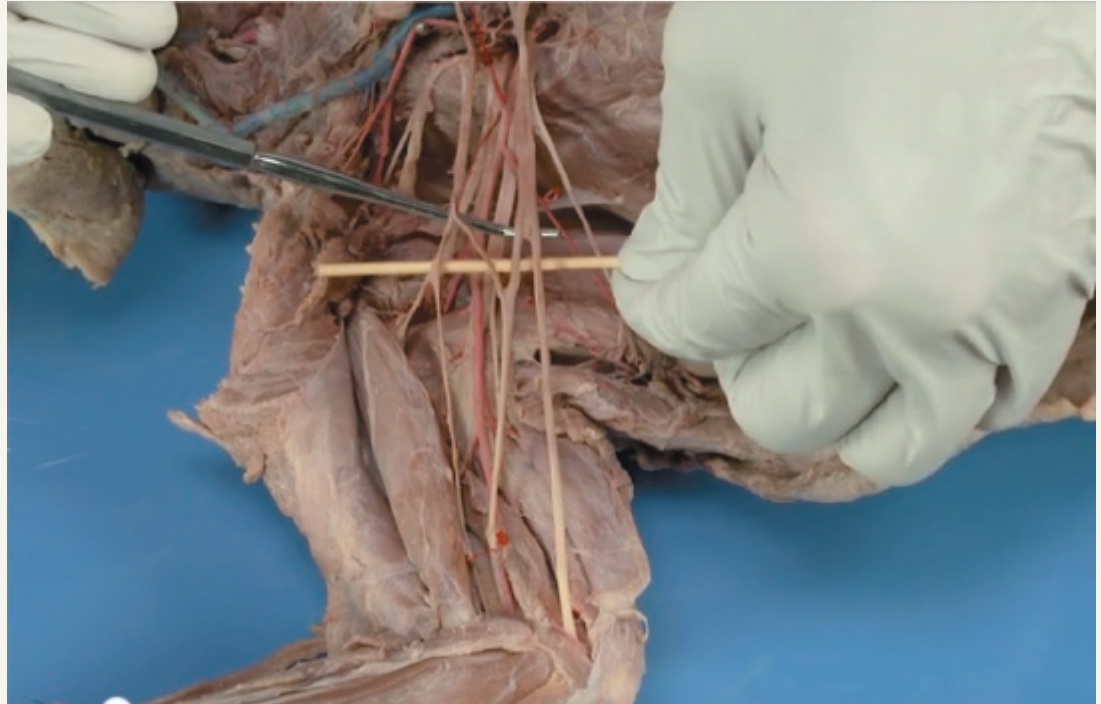


**Clinical Case Study Coaching Activities** increase problem-solving skills and prepare students for future careers in allied health. Corresponding Teaching Strategies, available in Instructor Resources in Mastering A&P, enable instructors to “flip” the classroom by providing valuable tips on when and how to use case studies. The worksheets and case studies are also available to students in the Study Area of Mastering A&P.

# Would your students benefit from 24/7 access to lab?

## NEW! Cat and Fetal Pig Dissection Video Coaching Activities

help students prepare for dissection and identify key anatomical structures. Each video includes 1-2 comparisons to human structures.




**Bone and Dissection Video Coaching Activities** help students identify bones and learn how to do organ dissections.

Item Type: Coaching Activities | Difficulty: 1 | Time: 3m | Learning Outcomes | Contact the Publisher | Manage this item: Standard View

### Temporomandibular Joint Video Questions

Watch the animation, then answer the questions.



**Part A**  
Identify the region of the mandible that forms part of the temporomandibular joint.

▶ Hints

- Mandibular fossa
- Mandibular condyle
- Coronoid process
- Mandibular notch

Submit My Answers Give Up

**Part B**  
Identify the region of the temporal bone that articulates with the mandible.

▶ Hints

- Mandibular condyle
- Styloid process
- Mandibular notch
- Mandibular fossa

Submit My Answers Give Up

**Part C**  
Identify the best description of the mandibular fossa.

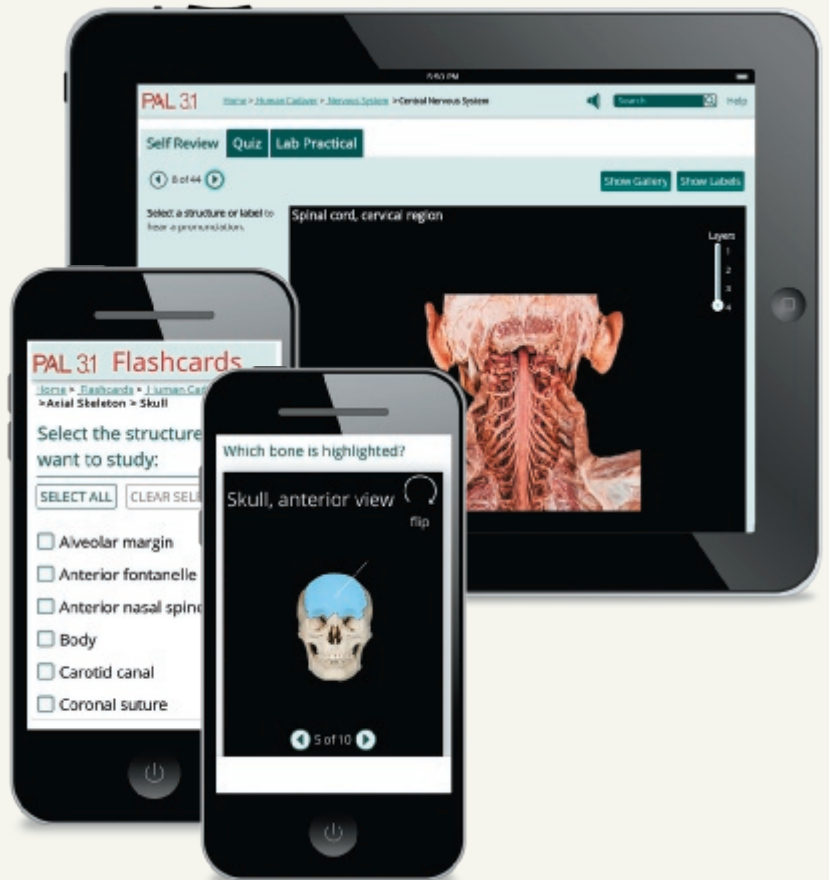
▶ Hints

◀ Previous Item Item 10 of 18 Next Item ▶



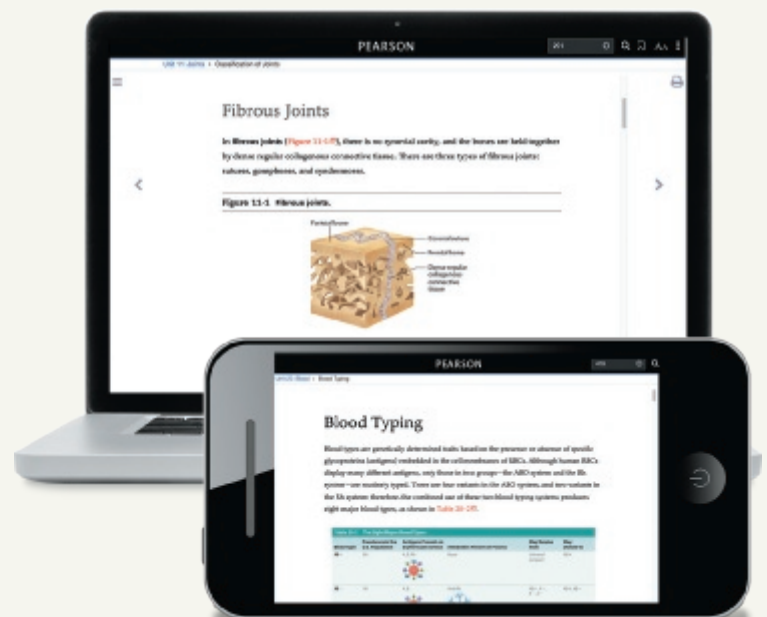
**IMPROVED! Practice Anatomy Lab 3.1 (PAL 3.1)** is now fully accessible on all mobile devices. This virtual anatomy study and practice tool gives students 24/7 access to the most widely used lab specimens including the human cadaver, anatomical models, histology, cat, and fetal pig. PAL is easy to use and includes built-in audio pronunciations, rotatable bones, and simulated fill-in-the-blank lab practical exams.

**NEW! PAL 3.1 Flashcards:** This new study tool in the Study Area of Mastering A&P allows students to create a customized, mobile-friendly deck of flashcards and quizzes based on images from PAL. Students generate personalized flashcards by selecting only those structures covered in their course.



**NEW! Pearson eText,** optimized for mobile, in Pearson's fully accessible platform, seamlessly integrates videos and gives students access to their lab manual anytime, anywhere.

**PhysioEx 9.1** assignments include pre-lab and postlab quizzes and printable review sheets.



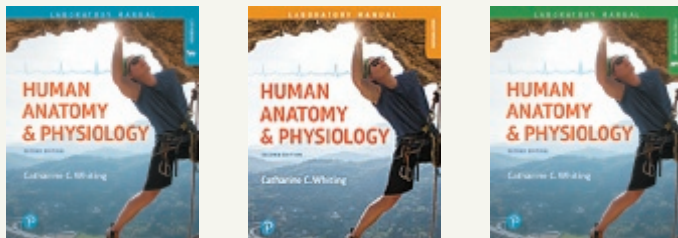
# Instructor & Student Resources

## Instructor Guide

This guide includes detailed instructions for setting up the laboratory, time allotments for each activity, and answers to the pre-lab assignments, activity questions, and post-lab assignments. Additionally, it describes strategies that encourage active learning, including sample concept maps and an overview of using concept mapping to increase student engagement. Finally, it discusses helpful hints for running an effective lab, ways to avoid common pitfalls, and extension activities that can be used to expand activities when time allows. Available as a download in Instructor Resources in Mastering A&P.

## Instructor Resources in Mastering A&P

These resources include editable pre-lab and post-lab quizzes, the Instructor Guide, instructions for each PhysioEx activity, Terminology Challenge Worksheets, Clinical Case Studies and Teaching Strategies for each case, A&P Flix (anatomy) in PPT, BIOPAC, and instructions for data acquisition systems including iWorx, Intellitool, and PowerLab.



## Three Versions

*Human Anatomy & Physiology Laboratory Manual: Making Connections*, 2nd Edition is available in three versions for your students: **Main**, **Cat** and **Fetal Pig**. The Cat and Fetal Pig versions are identical to the Main version except that they include seven additional cat dissection and nine additional fetal pig dissection exercises, respectively, at the back of the lab manual.

## Pearson Collections

Your lab manual should match your course, not the other way around. With Pearson Collections, you can quickly and easily create a lab manual with only the content you use. Visit <https://www.pearsonhighered.com/collections/> for more information.

## A Photographic Atlas for Anatomy & Physiology

0-32-186925-7 / 978-0-32-186925-8

by Nora Hebert, Ruth E. Heisler, Jett Chinn, Karen M. Krabbenhoft, Olga Malakhova

This photo atlas is the perfect lab study tool that helps students learn and identify key anatomical structures. Featuring photos from Practice Anatomy Lab 3.1 and other sources, the Atlas includes over 250 cadaver dissection photos, histology photomicrographs, and cat dissection photos, plus over 50 photos of anatomical models from the leading manufacturers, such as 3B Scientific, SOMSO, and Denoyer-Geppert Science Company

## Practice Anatomy Lab 3.1 Lab Guide

0-32-184025-9 / 978-0-32-184025-7

by Ruth E. Heisler, Nora Hebert, Jett Chinn, Karen M. Krabbenhoft, Olga Malakhova

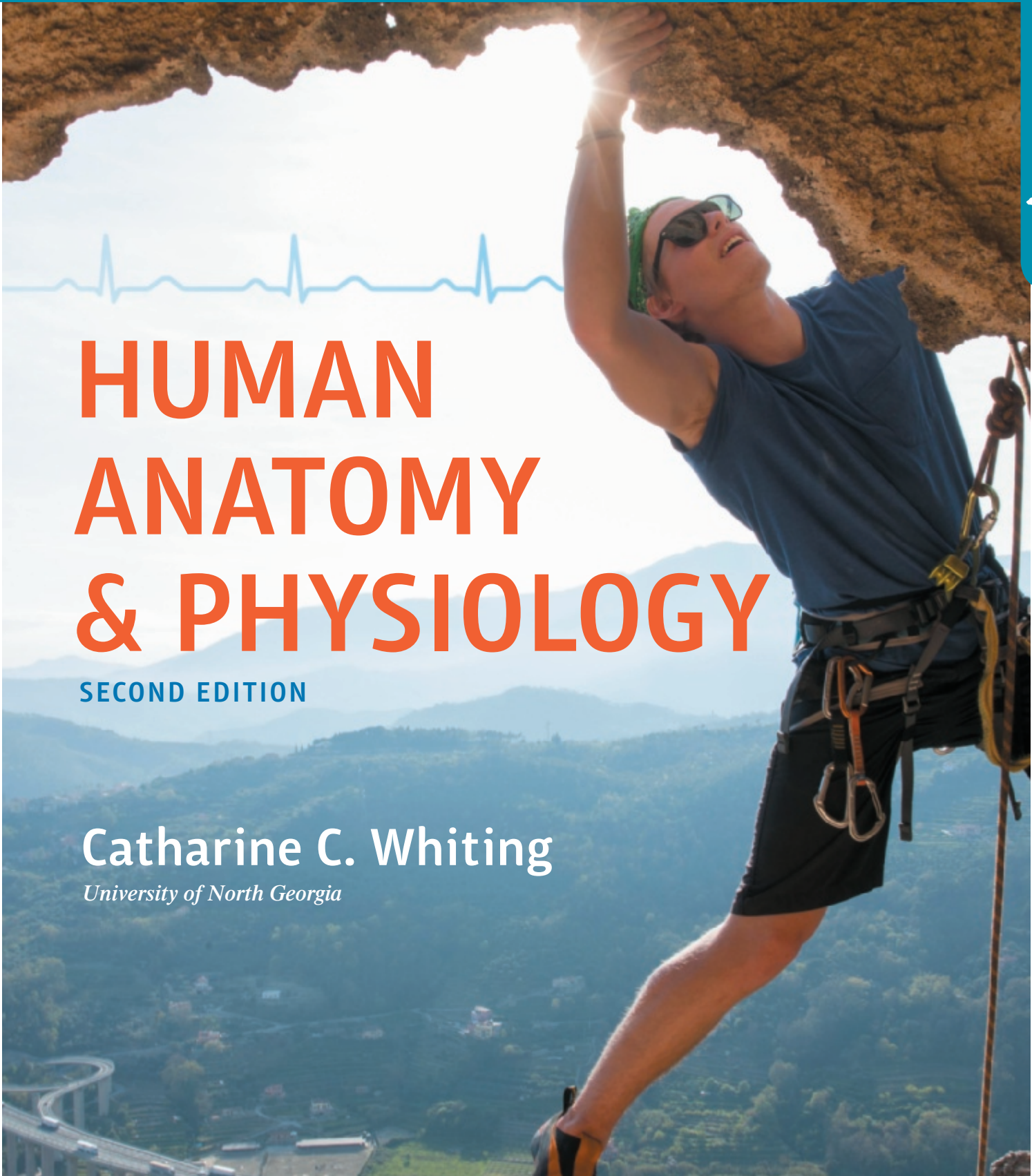
Written to accompany PAL 3.1, the Practice Anatomy Lab 3.1 Lab Guide contains exercises that direct the student to select images and features in PAL 3.1, and then assess their understanding with labeling, matching, short-answer, and fill-in-the-blank questions. Exercises cover three key lab specimens in PAL 3.1—human cadaver, anatomical models, and histology.

## The Anatomy Coloring Book, Fourth Edition

0-32-183201-9 / 978-0-32-183201-6

by Wynn Kapit and Lawrence M. Elson

For more than 35 years, *The Anatomy Coloring Book* has been the best-selling human anatomy coloring book. A useful tool for anyone with an interest in learning anatomical structures, this concisely written text features precise, extraordinary hand-drawn figures that were crafted especially for easy coloring and interactive study. The Fourth Edition features user-friendly two-page spreads with enlarged art, clearer, more concise text descriptions, and new boldface headings that make this classic coloring book accessible to a wider range of learners.



# HUMAN ANATOMY & PHYSIOLOGY

SECOND EDITION

Catharine C. Whiting

*University of North Georgia*



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# About the Author



**Catharine C. Whiting**, *University of North Georgia*

Cathy Whiting began her college career at Waycross Junior College before transferring to the University of Georgia and earning a B.S. degree in biology. She earned both M.S.T. and Ph.D. degrees in zoology at the University of Florida, training under an extraordinary mentor, Dr. Louis J. Guillette, a distinguished researcher, author, and educator who taught her how to do science and, more importantly, how to teach. With 25 years of college teaching experience, Whiting seeks to engage her students through active learning in order to facilitate the development of critical-thinking and problem-solving skills. She has discovered that passionate teaching leads to passionate learning and that students don't care how much you know until they know how much you care. The recipient of several teaching awards including Faculty Member of the Year, Advisor of the Year, and Master Teacher, she considers her greatest reward to be the privilege of teaching and impacting the lives of students.

# About the Media Contributor



**Karen L. Keller**, *Frostburg State University*

Karen Keller earned both her B.S. and M.S. degrees in biology from Frostburg State University and her Ph.D. in physiology from the University of Georgia, College of Veterinary Medicine. She has taught at community college and four-year college levels and has extensive experience teaching introductory biology, anatomy and physiology, musculoskeletal anatomy, microbiology, comparative vertebrate anatomy, histology, and parasitology courses. In addition, she advises students interested in pursuing careers in the health professions and is a member of the American Association of Anatomists, the Human Anatomy and Physiology Society, and the Northeast Association of Advisors for the Health Professions.

# Preface

## Why Did I Write This Lab Manual?

Since graduating from the University of Georgia with a BS in biology, I have been teaching in a wide variety of settings—as a laboratory assistant, as a high school teacher, as a graduate assistant, as a tutor/mentor for college athletes, as an assistant professor of biology at Wingate University, and, currently, as a professor of biology at the University of North Georgia–Gainesville. Regardless of the setting, I have always regarded teaching as an incredible opportunity and a great privilege. Through the years, I have learned that effective teaching requires much hard work, dedication, and enthusiasm. It involves a lifelong pursuit of both content knowledge and understanding how students learn. It involves challenging students to develop critical-thinking and problem-solving skills. Most importantly, it involves building relationships with students and investing in their lives. As a matter of fact, it was a late afternoon conversation with a group of students after lab in the fall of 2009 that inspired me to pursue writing a lab manual.

I set out to write a lab manual that was first and foremost a tool of engagement. In my experience, engaging students in an active learning environment is the key to student success in both the lecture and the laboratory setting. When students are engaged, exciting things happen. Attendance improves. Students enjoy being in class. Grades soar! Students begin to focus on learning instead of worrying about what is going to be on the test. My hope is that instructors will be able to use and adapt the activities in this manual to cultivate their own active learning environment and to

experience the joy of watching students fully engage in the learning process. Imagine having to run students out of the lab so that the next lab can get started. You will be amazed at what your students can accomplish when they are engaged, challenged, and inspired!

## How Is This Lab Manual Different?

*Human Anatomy & Physiology Laboratory Manual: Making Connections* distinguishes itself from other A&P lab manuals by focusing heavily on addressing the **three biggest teaching challenges** for A&P lab instructors: getting students to engage in the lab, to prepare for the lab, and to apply concepts in the lab.

## Getting Students Engaged in the Lab

For many instructors this is the #1 teaching problem in the lab course. The whole active-learning approach of *Human Anatomy & Physiology Laboratory Manual: Making Connections* is centered on getting students engaged in the lab and asking questions. We achieve this by including a **rich variety of hands-on activities that use different learning modes** including labeling, sketching, touching, dissecting, observing, conducting experiments, interacting with groups, and making predictions.

This lab manual includes many tried and true lab activities but also has some unique activities to help facilitate **active learning**, including those listed in the table below.

Unit	Activity	How it facilitates active learning
Unit 2 Introduction to the Organ Systems	Activity 3: Studying Homeostasis and Organ System Interactions	Students work together to research and explain how organ systems interact during the regulation of body temperature; high engagement factor; challenging task that requires students to think critically and discuss their ideas with lab group members
Unit 6 Histology	Activity 4: Constructing a Tissue Identification Concept Map	Students must interact (discuss, question, argue, etc.) to determine the best set of questions to identify the assigned tissue types; encourages students to think about tissues rather than just memorize them; high engagement and high energy; demands critical thinking and problem-solving skills
Unit 10 The Appendicular Skeleton	Activity 2: Identifying Bones in a Bag	Students identify bones and their features by touch only; high engagement and interaction as students discuss and review the assigned features of each bone as it is pulled out of the bag
Unit 13 Gross Anatomy of the Muscular System	Activity 1: Determining How Skeletal Muscles Are Named	Students complete an interactive overview activity that helps them understand how skeletal muscles are named; this activity teaches students a very useful approach to learning specific skeletal muscles (origin, insertion, innervation, and action) and prepares them for the remaining activities in the unit; actively engages students as they perform various muscle actions and locate muscles on different anatomical models throughout the lab

(continued)



Unit	Activity	How it facilitates active learning
Unit 15 The Central Nervous System: Brain and Spinal Cord	Activity 3: Identifying the Meninges/ Ventricles and Tracing the Flow of Cerebrospinal Fluid	Students engage in a high-energy, interactive cerebrospinal fluid “dance” as they learn about the production, flow, and return of CSF to venous circulation
Unit 18 The Endocrine System	Activity 3: Investigating Endocrine Case Studies: Clinician’s Corner	Mini case studies encourage students to apply the information that they have learned in Activity 1 and Activity 2; builds critical-thinking and problem-solving skills
Unit 23 Circulatory Pathways and the Physiology of Blood Vessels	Activity 1: Tracing Blood Flow—General Systemic Pathways	Students use their knowledge of heart and blood vessel anatomy obtained in previous units along with anatomical models to trace the pathway of blood from the left ventricle to four peripheral sites (eye, forearm, abdomen, and leg) and back to the right atrium; they work together to diagram, label, and explain the exchange of materials at the capillary bed
Unit 24 The Lymphatic System	Activity 4: Using a Pregnancy Test to Demonstrate Antigen–Antibody Reactions	An interactive “wet lab” that engages students as they perform an enzyme-linked immunosorbent assay (ELISA) to detect the presence of an antigen (human chorionic gonadotropin) in unknown samples
Unit 27 Anatomy of the Digestive System	Activity 3: Examining the Histology of Selected Digestive Organs	Interactive question set encourages student engagement and challenges students to make predictions and draw conclusions concerning the relationship between structure and function at the histological level
Unit 30 Physiology of the Urinary System	Activity 2: Simulating the Events of Urine Production and Urine Concentration	Hands-on activity using beads to simulate renal function; a question set takes students through a step-by-step process with increasingly challenging questions to help them better understand the role of the kidneys in maintaining homeostasis as well as to further identify structure/function relationships

**Key features** of *Human Anatomy & Physiology Laboratory Manual: Making Connections* that help facilitate active learning include the following.

- **LabBOOSTS** invite students to do hands-on demonstration of key concepts.
- **Making Connections charts** within activities encourage students to apply previously learned concepts.
- **Guided Questions** within the activities help students think about the relevant concepts and how they apply to the activity.
- **Quick Tips** provide hints for performing activities or mnemonics for remembering key terms.
- **Clinical Connection** boxes highlight relevant diseases or conditions and help reinforce learning of key concepts.

## Getting Students to Prepare for Lab

This manual helps address this problem by providing extensive **Pre-Lab Assignments** that include pre-lab activity questions *for each activity* in the unit. These pre-lab questions are intended to get the student to peruse the lab activities *before* lab. Assignable Pre-Lab Assessments are also available in *Mastering A&P*.

## Getting Students to Apply Concepts

A third challenge and goal in the lab course is to get students to see the connections between concepts learned in lecture and their application in the lab. This manual fosters students’

ability to make these connections with unique **Think About It** questions and **Making Connections** charts. **Post-Lab Assignments** also include **Bloom’s Level II Review Questions** and **Concept Mapping**.

## Other Key Features


### Companion Lab Manual to Erin Amerman’s *Human Anatomy & Physiology*

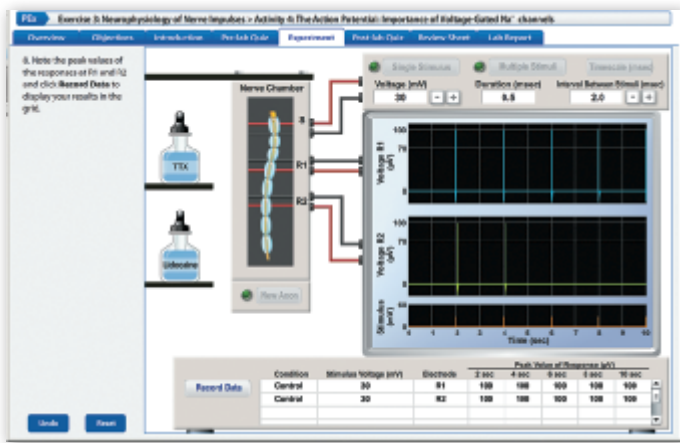
This lab manual was developed as the companion lab manual to Erin Amerman’s *Human Anatomy & Physiology* textbook and reflects the **same superb art program** and **terminology** found in the Amerman textbook.

### Additional Photos of Lab Specimens

This lab manual contains additional images not found in the Amerman textbook, including photos of **anatomical models**, **cadaver images**, and **histology photomicrographs**.

### PhysioEx™ 9.1

 **PhysioEx 9.1** is an easy-to-use physiology lab simulation program that allows students to repeat labs as often as they like, perform experiments without animals, and conduct experiments that are difficult



to perform in a wet lab environment because of time, cost, or safety concerns. Every exercise includes an overview, and every activity includes objectives, an introduction, a pre-lab quiz, the experiment, a post-lab quiz, review sheet questions, and a lab report that students can save as a PDF and print and/or email to their instructor. The online format with easy step-by-step instructions includes everything students need in one convenient place.

Each exercise and activity is referenced in the lab manual; students are then directed to access them in PhysioEx in Mastering A&P. Pre-lab and post-lab quizzes and review sheets for PhysioEx are assignable in Mastering A&P.

PhysioEx 9.1 includes 12 exercises containing a total of 63 physiology lab activities. The program features the following.


- **Input data variability** allows students to change variables and test various hypotheses for the experiments.
- **Step-by-step instructions** put everything students need to do to complete the lab in one convenient place. Students gather data, analyze results, and check their understanding, all on screen.
- **Stop & Think Questions and Predict Questions** help students think about the connection between the activities and the physiological concepts they demonstrate.
- **Greater data variability in the results** reflects more realistically the results that students would encounter in a wet lab experiment.
- **Pre-Lab and Post-Lab Quizzes and short-answer review sheets** are offered to help students prepare for and review each activity.
- **Students can save their lab report as a PDF**, which they can print and/or e-mail to their instructor.
- **A Test Bank of assignable Pre-Lab and Post-Lab Quizzes** for use with TestGen or its course management system is provided for instructors.
- **Seven wet lab videos of lab experiments** demonstrate the actual experiments, making it easy for students to understand and visualize the content of the PhysioEx simulations. Wet lab videos demonstrate the following PhysioEx experiments: Cell Transport, Skeletal

Muscle, Nerve Impulses, Blood Typing, Cardiovascular Physiology, Use of a Water-filled Spirometer, and BMR Measurement.

### PhysioEx 9.1 topics include the following.

- **Exercise 1: Cell Transport Mechanisms and Permeability.** Explores how substances cross the cell membranes. Topics include simple and facilitated diffusion, osmosis, filtration, and active transport.
- **Exercise 2: Skeletal Muscle Physiology.** Provides insights into the complex physiology of skeletal muscle. Topics include electrical stimulation, isometric contractions, and isotonic contractions.
- **Exercise 3: Neurophysiology of Nerve Impulses.** Investigates stimuli that elicit action potentials, stimuli that inhibit action potentials, and factors affecting the conduction velocity of an action potential.
- **Exercise 4: Endocrine System Physiology.** Investigates the relationship between hormones and metabolism, the effect of estrogen replacement therapy, the diagnosis of diabetes, and the relationship between the levels of cortisol and adrenocorticotropic hormone and a variety of endocrine disorders.
- **Exercise 5: Cardiovascular Dynamics.** Allows students to perform experiments that would be difficult if not impossible to do in a traditional laboratory. Topics include vessel resistance and pump (heart) mechanics.
- **Exercise 6: Cardiovascular Physiology.** Examines variables influencing heart activity. Topics include setting up and recording baseline heart activity, the refractory period of cardiac muscle, and an investigation of factors that affect heart rate and contractility.
- **Exercise 7: Respiratory System Mechanics.** Investigates physical and chemical aspects of pulmonary function. Students collect data simulating normal lung volumes. Other activities examine factors such as airway resistance and the effect of surfactant on lung function.
- **Exercise 8: Chemical and Physical Processes of Digestion.** Examines factors that affect enzyme activity by manipulating (in compressed time) enzymes, reagents, and incubation conditions.
- **Exercise 9: Renal System Physiology.** Stimulates the function of a single nephron. Topics include factors influencing glomerular filtration, the effect of hormones on urine function, and glucose transport maximum.
- **Exercise 10: Acid-Base Balance.** Topics include respiratory and metabolic acidosis/alkalosis and renal and respiratory compensation.
- **Exercise 11: Blood Analysis.** Topics include hematocrit determination, erythrocyte sedimentation rate determination, hemoglobin determination, blood typing, and total cholesterol determination.
- **Exercise 12: Serological Testing.** Investigates antigen-antibody reactions and their role in clinical tests used to diagnose a disease or an infection.

## BIOPAC

 **BIOPAC**® Activities that utilize the Biopac Student Labs data acquisition system are included in Unit 12, *Introduction to the Muscular System: Muscle Tissue*; Unit 15, *The Central Nervous System: Brain and Spinal Cord*; Unit 21, *Physiology of the Heart*; and Unit 26, *Physiology of the Respiratory System*.

## What's New in the Second Edition

**Global changes** include the following.

- **NEW “What You Need to Know Before You Start This Unit”** section at the beginning of each unit helps students determine what they need to review before lab.
- **Over 30 REVISED illustrations** based on the new/ revised art in Amerman’s *Human Anatomy & Physiology*, 2nd edition.
- **12 NEW photos added, including 5 photomicrographs, 3 cadaver, and 4 anatomical models.**
- **NEW pronunciation guides** help reduce frustration associated with learning a new, complex vocabulary.
- **REVISED Making Connections** charts have been reorganized so they are now easier to complete during lab time.
- **REVISED background material** helps students come to lab better prepared by summarizing key concepts and reinforcing topics taught in lecture.
- **REVISED Pre-Lab and Post-Lab Questions** help students focus on key concepts and improve critical-thinking skills.

**Unit-by-unit changes** include the following.

Unit 1, Introduction to Anatomy and Physiology: Revised Figure 1-3 (common terms that describe the regions of the body surface) to make it more useful and student-friendly

Unit 2, Introduction to the Organ Systems: New and improved Activity 3: Studying Homeostasis and Organ System Interactions to help students better understand how to complete the organ system interaction worksheet

Unit 3, Chemistry: Updated LabBOOST with new photo to increase student understanding of protein structure and function

Unit 5, The Cell: Addition of compare and contrast charts in Activity 5: Exploring Cellular Diversity to stimulate critical thinking

Unit 7, The Integumentary System: Revised activity instructions to improve clarity

Unit 8, Introduction to the Skeletal System: Modified Activity 2: Classifying and Identifying Bones and

Bone Markings to stimulate critical thinking; addition of spongy bone histology in Activity 4: Exploring the Microscopic Anatomy of Bone

Unit 9, The Axial Skeleton: Modified activities to increase higher order thinking

Unit 11, Joints: Addition of compare and contrast charts in Activity 3: Comparing and Contrasting the Structure and Function of Selected Synovial Joints to stimulate critical thinking

Unit 12, Introduction to the Muscular System: Muscle Tissue: Updated BIOPAC activities

Unit 14, Introduction to the Nervous System: Expanded Activity 4: Exploring the Histology of Nervous Tissue with new photomicrographs

Unit 15, The Central Nervous System: Brain and Spinal Cord: Reorganized content and modified instructions for Activity 1: Exploring the Functional Anatomy of the Brain to improve flow and clarity; updated BIOPAC activities

Unit 16, The Peripheral Nervous System: Nerves and Autonomic Nervous System: Reorganized content and modified activity instructions to improve flow and clarity

Unit 18, The Endocrine System: Revised question sets in Activity 1: Exploring the Organs of the Endocrine System to improve flow and clarity

Unit 23, Circulatory Pathways and the Physiology of Blood Vessels: Modified activity instructions to improve clarity

Unit 24, The Lymphatic System: Revised and improved Making Connections chart in Activity 1: Exploring the Organs of the Lymphatic System

Unit 25, Anatomy of the Respiratory System: Revised and improved Making Connections chart in Activity 1: Exploring the Organs of the Respiratory System

Unit 28, Physiology of the Digestive System: Expanded Activity 4: Tracing Digestive Pathways to build critical thinking skills

Unit 30, Physiology of the Urinary System: Modified instructions for Activity 2: Simulating the Events of Urine Production and Urine Concentration to improve clarity

Unit 31, Reproduction and Development: Expanded Activity 3: Examining the Microscopic Anatomy of Selected Reproductive Organs to include epididymis, penis, uterine tube, and uterus

## What's New in Mastering A&P

Please see the front of this lab manual for information on the new media and assignments for the second edition of Whiting, found in Mastering A&P.



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## First and Second Edition Text and Media Reviewers

Pius Aboloye, *North Lake College (DCCCD)*  
Joslyn Ahlgren, *University of Florida*  
Michele Alexandre, *Durham Technical Community College*  
Chris Allen, *Lone-Star College at University Park*  
Emily Allen, *Rowan College of Gloucester County*  
Marcia Anglin, *Miami Dade College–North campus*  
Rosalie Arienti, *Central Maine Community College–Auburn*  
Erin Arnold, *Jefferson State Community College*  
Mary Ann Arnold Hedrick, *Wytheville Community College*  
Marianne Baricevic, *Raritan Valley Community College*  
Verona Barr, *Heartland Community College*  
Dena Berg, *Tarrant County College NW*  
Sheri Boyce, *Messiah College*  
Ron Bridges, *Pellissippi State Community College*  
Carol A. Britson, *University of Mississippi*  
Kathleen Broomall, *Miami University–Hamilton*  
Geraldyn Caplan, *Owensboro Community & Technical College*  
Michelle Carey, *Hutchinson Community College*  
Maria Carles, *Northern Essex Community College*  
Carol Carr, *John Tyler Community College*  
Ellen Carson, *Florida State College–Jacksonville*  
Peter Charles, *Durham Technical Community College*  
Elizabeth Collins, *Iowa Central Community College*  
Teresa Cowan, *Baker College*  
Ken Crane, *Texarkana College*  
Mary Dettman, *Seminole State College*  
Karen Dunbar-Kareiva, *Ivy Tech Community Colleges*  
Kathryn Englehart, *Kennebec Valley Community College*  
Sondra Evans, *Florida State College–Jacksonville*  
Georgia Everett, *Ivy Tech Community College*  
Jill Feinstein, *Richland Community College*  
Tracy Felton, *Union County College*  
Christine Foley, *Southwest Texas Junior College–Del Rio Campus*  
Lori Frear, *Wake Tech Community College*  
Kim Fredricks, *Viterbo University*  
Lynn Gargan, *Tarrant County College NE*  
Lori Garrett, *Parkland College*  
Michelle Gaston, *Northern Virginia Community College*  
Carol Gavareski, *Bellingham Technical College*  
Anna Gilletly, *Central New Mexico Community College*  
Miriam Golbert, *College of the Canyons*  
Joanna Greene, *Ivy Tech Community College–Anderson*  
Tammy Greene, *Ivy Tech Community College–Kokomo*  
Tim Grogan, *Valencia College*  
Juan Guzman, *Florida Gateway College*  
Bill Hanna, *Massasoit Community College*  
Lesleigh Hastings, *Wake Tech Community College*  
Stephanie Havemann, *Alvin Community College*  
Heidi Hawkins, *College of Southern Idaho*  
D. J. Hennager, *Kirkwood Community College*

Charmaine Henry, *Baker University*  
Austin Hicks, *University of Alabama*  
Elizabeth Hodgson, *York College of Pennsylvania*  
Julie Huggins, *Arkansas State University*  
Jody Johnson, *Arapahoe Community College*  
Karen Keller, *Frostburg State University*  
Suzanne Kempke, *St. Johns River Community College*  
Christine Kisiel, *Mount Wachusett Community College*  
M. Anne Lachelt, *Iowa Central Community College*  
Ellen Lathrop-Davis, *Community College of Baltimore County*  
Steven Leadon, *Durham Technical Community College*  
Carolyn Lebsack, *Linn-Benton Community College*  
Stephen Lebsack, *Linn-Benton Community College*  
Jeffrey Lee, *Essex Community College*  
Leona Levitt, *Union County College*  
Shawn Macauley, *Muskegon Community College*  
Christine Maney, *Salem State College*  
Bruce Maring, *Daytona State College*  
Robert Marino, *Capital Community College*  
Sarah Matarese, *St. George's School*  
Cherie McKeever, *Montana State University–Great Falls*  
Annie McKinnon, *Howard College*  
Michael Midgley, *Quinnipiac University*  
Justin Moore, *American River College*  
Regina Munro, *Chandler Gilbert Community College*  
Karen Murch-Shafer, *University of Nebraska–Omaha*  
Jacqueline Nesbit, *University of New Orleans*  
Zvi Ostrin, *Hostos Community College*  
Ellen Ott-Reeves, *Blinn College–Bryan Campus*  
Debbie Palatinus, *Roane State Community College*  
Kevin Ragland, *Nashville State Community College*  
Wendy Rappazzo, *Harford Community College*  
Jean Revie, *South Mountain Community College*  
Travis Robb, *Allen Community College–Burlingame*  
Fredy Ruiz, *Miami Dade College*  
Tracy Rusco, *East Central College*  
Amy Ryan, *Clinton Community College*  
Linda Schams, *Viterbo University*  
Jeff Schinske, *De Anza College*  
Steven Schneider, *South Texas College*  
Dorothy C. Scholl, *University of New Mexico*  
Maureen Scott, *Norfolk State*  
Marieken Shaner, *University of New Mexico*  
George Steer, *Jefferson College of Health Sciences*  
Maura O. Stevenson, *Quinnipiac University*  
James Stittsworth, *Florida State College–Jacksonville*  
Deborah Temperly, *Delta College*  
Terry Thompson, *Wor-Wic Community College*  
Carlene Tonini-Boutacoff, *College of San Mateo*  
Liz Torrano, *American River College*  
Olga E. Vazquez, *Valencia College*  
Lisa Welch, *Weatherford College*  
Deb Wiepz, *Madison Area Technical College*  
Darrellyn Williams, *Pulaski Technical College*  
Gina M. Zainelli, *Gateway Technical College*

# Brief Contents

## UNIT

<b>1</b> Introduction to Anatomy and Physiology	1	<b>24</b> The Lymphatic System	517
<b>2</b> Introduction to the Organ Systems	15	<b>25</b> Anatomy of the Respiratory System	537
<b>3</b> Chemistry	31	<b>26</b> Physiology of the Respiratory System	553
<b>4</b> The Microscope	51	<b>27</b> Anatomy of the Digestive System	571
<b>5</b> The Cell	65	<b>28</b> Physiology of the Digestive System	599
<b>6</b> Histology	85	<b>29</b> Anatomy of the Urinary System	613
<b>7</b> The Integumentary System	109	<b>30</b> Physiology of the Urinary System	631
<b>8</b> Introduction to the Skeletal System	127	<b>31</b> Reproduction and Development	649
<b>9</b> The Axial Skeleton	147		
<b>10</b> The Appendicular Skeleton	181		
<b>11</b> Joints	209		
<b>12</b> Introduction to the Muscular System: Muscle Tissue	229		
<b>13</b> Gross Anatomy of the Muscular System	253		
<b>14</b> Introduction to the Nervous System	293		
<b>15</b> The Central Nervous System: Brain and Spinal Cord	313		
<b>16</b> The Peripheral Nervous System: Nerves and Autonomic Nervous System	343		
<b>17</b> General and Special Senses	369		
<b>18</b> The Endocrine System	399		
<b>19</b> Blood	419		
<b>20</b> Anatomy of the Heart	439		
<b>21</b> Physiology of the Heart	455		
<b>22</b> Anatomy of Blood Vessels	471		
<b>23</b> Circulatory Pathways and the Physiology of Blood Vessels	499		



## CAT Dissection Exercises

<b>1</b> Exploring the Muscular System of the Cat	C-1
<b>2</b> Exploring the Spinal Nerves of the Cat	C-21
<b>3</b> Exploring the Respiratory System of the Cat	C-27
<b>4</b> Exploring the Digestive System of the Cat	C-33
<b>5</b> Exploring the Cardiovascular System of the Cat	C-41
<b>6</b> Exploring the Urinary System of the Cat	C-49
<b>7</b> Exploring the Reproductive System of the Cat	C-53

INDEX I-1

# Contents

## UNIT 1 Introduction to Anatomy and Physiology 1

**PRE-LAB** Assignments 2

**Activity 1:** Identifying Body Regions and Exploring Surface Anatomy 6

**Activity 2:** Identifying Body Cavities and Abdominopelvic Regions 8

**Activity 3:** Demonstrating and Identifying Body Planes of Section 9

**Activity 4:** Assisting the Coroner 10

**POST-LAB** Assignments 11

## UNIT 2 Introduction to the Organ Systems 15

**PRE-LAB** Assignments 16

**Activity 1:** Locating and Describing Major Organs and Their Functions 18

**Activity 2:** Using Anatomical Terminology to Describe Organ Locations 22

**Activity 3:** Studying Homeostasis and Organ System Interactions 24

**POST-LAB** Assignments 27

## UNIT 3 Chemistry 31

**PRE-LAB** Assignments 32

**Activity 1:** Exploring the Chemical Properties of Water 36

**Activity 2:** Determining pH and Interpreting the pH Scale 38

**Activity 3:** Observing the Role of Buffers 40

**LabBOOST** Protein Structure 43

**Activity 4:** Analyzing Enzymatic Activity 44

**POST-LAB** Assignments 47

## UNIT 4 The Microscope 51

**PRE-LAB** Assignments 52

**Activity 1:** Identifying the Parts of the Microscope 54

**Activity 2:** Using the Microscope to View Objects 55

**Activity 3:** Determining Field Diameter and Estimating the Size of Objects 57

**LabBOOST** Metric Conversions 59

**Activity 4:** Perceiving Depth of Field 59

**Activity 5:** Caring for the Microscope 59

**POST-LAB** Assignments 61

## UNIT 5 The Cell 65

**PRE-LAB** Assignments 66

**LabBOOST** Organelles 70

**Activity 1:** Making a Wet Mount 71

**Activity 2:** Identifying Cell Structures and Describing Their Functions 71

**Activity 3:** Examining the Possible Role of Osmosis in Cystic Fibrosis 72

**Activity 4:** Identifying the Stages of the Cell Cycle 76

**Activity 5:** Exploring Cellular Diversity 77

**PhysioEx Exercise 1:** Cell Transport Mechanisms and Permeability 78

**POST-LAB** Assignments 79

## UNIT 6 Histology 85

**PRE-LAB** Assignments 86

**Activity 1:** Examining Epithelial Tissue 91

**Activity 2:** Characterizing Connective Tissue 98

**Activity 3:** Exploring Nervous and Muscle Tissue 99

**Activity 4:** Constructing a Tissue Identification Concept Map 101

**POST-LAB** Assignments 103

## UNIT 7 The Integumentary System 109

**PRE-LAB** Assignments 110

**Activity 1:** Identifying and Describing Skin Structures 116

**Activity 2:** Examining the Histology of the Skin 118

**Activity 3:** Determining Sweat Gland Distribution 120

**POST-LAB** Assignments 121

## UNIT 8 Introduction to the Skeletal System 127

**PRE-LAB** Assignments 128

**Activity 1:** Reviewing Skeletal Cartilages 130

**Activity 2:** Classifying and Identifying Bones and Bone Markings 135



**Activity 3:** Examining the Gross Anatomy of a Long Bone 137

**LabBOOST** Osteon Model 139

**Activity 4:** Exploring the Microscopic Anatomy of Bone 139

**Activity 5:** Examining the Chemical Composition of Bone 141

**POST-LAB** Assignments 143

## **UNIT 9** The Axial Skeleton 147

**PRE-LAB** Assignments 148

**Activity 1** Studying the Bones of the Skull 158

**Activity 2** Examining the Fetal Skull 163

**Activity 3** Studying the Bones of the Vertebral Column and Thoracic Cage 169

**Activity 4** Identifying Bones in a Bag 173

**POST-LAB** Assignments 175

## **UNIT 10** The Appendicular Skeleton 181

**PRE-LAB** Assignments 182

**LabBOOST** The Pelvic Bones 187

**Activity 1:** Studying the Bones of the Appendicular Skeleton 192

**Activity 2:** Identifying Bones in a Bag 200

**POST-LAB** Assignments 201

## **UNIT 11** Joints 209

**PRE-LAB** Assignments 210

**Activity 1:** Identifying and Classifying Joints 216

**Activity 2:** Demonstrating Movements Allowed by Synovial Joints 218

**Activity 3:** Comparing and Contrasting the Structure and Function of Selected Synovial Joints 222

**POST-LAB** Assignments 225

## **UNIT 12** Introduction to the Muscular System: Muscle Tissue 229

**PRE-LAB** Assignments 230

**Activity 1:** Identifying the Structural Components of a Skeletal Muscle 233

**Activity 2:** Examining the Microscopic Anatomy of Skeletal Muscle Tissue and the Neuromuscular Junction 237

**LabBOOST** Visualizing Sliding Filaments 239

**Activity 3:** Stimulating Muscle Contraction in Glycerinated Skeletal Muscle Tissue 241

**Activity 4:** Electromyography in a Human Subject Using **BIOPAC** 243

**PhysioEx Exercise 2:** Skeletal Muscle Physiology 246

**POST-LAB** Assignments 247

## **UNIT 13** Gross Anatomy of the Muscular System 253

**PRE-LAB** Assignments 254

**Activity 1:** Determining How Skeletal Muscles Are Named 257

**Activity 2:** Mastering the Muscles of the Head and Neck 266

**Activity 3:** Mastering the Muscles of the Trunk 272

**Activity 4:** Mastering the Muscles of the Upper Limb 278

**Activity 5:** Mastering the Muscles of the Lower Limb 284

**POST-LAB** Assignments 285

## **UNIT 14** Introduction to the Nervous System 293

**PRE-LAB** Assignments 294

**Activity 1:** Calculating Reaction Time 297

**Activity 2:** Investigating the Motor Neuron 302

**Activity 3:** Investigating the Chemical Synapse 303

**Activity 4:** Exploring the Histology of Nervous Tissue 305

**PhysioEx Exercise 3:** Neurophysiology of Nerve Impulses 306

**POST-LAB** Assignments 307

## **UNIT 15** The Central Nervous System: Brain and Spinal Cord 313

**PRE-LAB** Assignments 314

**LabBOOST** Visualizing the Brain 322

**Activity 1:** Exploring the Functional Anatomy of the Brain 322

**Activity 2:** Electroencephalography in a Human Subject Using **BIOPAC** 324

**Activity 3:** Identifying the Meninges/Ventricles and Tracing the Flow of Cerebrospinal Fluid 328


**Activity 4:** Examining the Functional Anatomy of the Spinal Cord 332

**Activity 5:** Dissecting a Sheep Brain and Spinal Cord 334

**POST-LAB** Assignments 337

## **UNIT 16** The Peripheral Nervous System: Nerves and Autonomic Nervous System 343

**PRE-LAB** Assignments 344

 **LabBOOST** Learning the Cranial Nerves 350

**Activity 1:** Learning the Cranial Nerves 351

**Activity 2:** Evaluating the Function of the Cranial Nerves 352

**Activity 3:** Identifying the Spinal Nerves and Nerve Plexuses 356

**Activity 4:** Analyzing a Spinal Reflex 358

**Activity 5:** Exploring the Autonomic Nervous System 359

**POST-LAB** Assignments 363

## **UNIT 17** General and Special Senses 369

**PRE-LAB** Assignments 370

**Activity 1:** Identifying General Sensory Receptors and Exploring Their Structure and Function 374

**Activity 2:** Examining the Structure and Function of Olfactory and Gustatory Receptors 377

**Activity 3:** Exploring the Structure and Function of the Eye 380

**Activity 4:** Dissecting a Mammalian Eye 383

**Activity 5:** Performing Visual Tests 384

**Activity 6:** Exploring the Structure and Function of the Ear 389

**Activity 7:** Performing Hearing and Equilibrium Tests 391

**POST-LAB** Assignments 393

## **UNIT 18** The Endocrine System 399

**PRE-LAB** Assignments 400

**Activity 1:** Exploring the Organs of the Endocrine System 407

**Activity 2:** Examining the Microscopic Anatomy of the Pituitary Gland, Thyroid Gland, Parathyroid Gland, Adrenal Gland, and Pancreas 409

 **LabBOOST** Microscopic Anatomy of the Adrenal Cortex 411

**Activity 3:** Investigating Endocrine Case Studies: Clinician's Corner 412

**PhysioEx Exercise 4:** Endocrine System Physiology 413

**POST-LAB** Assignments 415

## **UNIT 19** Blood 419

**PRE-LAB** Assignments 420

**Activity 1:** Exploring the Formed Elements of Blood 423

**Activity 2:** Performing a Hematocrit 425

**Activity 3:** Performing a Differential White Blood Cell Count 426

**Activity 4:** Determining Coagulation Time 428

**Activity 5:** Determining Blood Types 430

**PhysioEx Exercise 11:** Blood Analysis 432

**POST-LAB** Assignments 433

## **UNIT 20** Anatomy of the Heart 439

**PRE-LAB** Assignments 440

**Activity 1:** Examining the Functional Anatomy of the Heart 444

**Activity 2:** Dissecting a Mammalian Heart 446

**Activity 3:** Reviewing the Microscopic Structure of Cardiac Muscle Tissue 448

**Activity 4:** Tracing Circulatory Pathways 450


**POST-LAB** Assignments 451

## **UNIT 21** Physiology of the Heart 455

**PRE-LAB** Assignments 456

**Activity 1:** Recording and Interpreting an Electrocardiogram 460

**Activity 2:** Auscultating Heart Sounds 461

**Activity 3:** Electrocardiography in a Human Subject Using  BIOPAC 462

**PhysioEx Exercise 6:** Cardiovascular Physiology 466

**POST-LAB** Assignments 467

## **UNIT 22** Anatomy of Blood Vessels 471

**PRE-LAB** Assignments 472

 **LabBOOST** Blood Vessel Pathways 475

**Activity 1:** Identifying the Major Arteries That Supply the Head, Neck, Thorax, and Upper Limbs 480

**Activity 2:** Identifying the Major Arteries That Supply the Abdominopelvic Organs and the Lower Limbs 481

**Activity 3:** Identifying Veins That Drain into the Venae Cavae 487

**Activity 4:** Examining the Histology of Arteries and Veins 489

**POST-LAB** Assignments 491

## **UNIT 23** Circulatory Pathways and the Physiology of Blood Vessels 499

**PRE-LAB** Assignments 500

**Activity 1:** Tracing Blood Flow—General Systemic Pathways 505

**Activity 2:** Tracing Blood Flow—Specialized Systemic Pathways 506

**Activity 3:** Tracing Blood Flow—Pulmonary Circulation 508

**Activity 4:** Tracing Blood Flow—Fetal Circulation 510

**Activity 5:** Measuring Blood Pressure and Examining the Effects of Body Position and Exercise 511

**PhysioEx Exercise 5:** Cardiovascular Dynamics 512

**POST-LAB** Assignments 513

## **UNIT 24** The Lymphatic System 517

**PRE-LAB** Assignments 518

**Activity 1:** Exploring the Organs of the Lymphatic System 524

**Activity 2:** Examining the Histology of a Lymph Node, a Tonsil, and the Spleen 526

**Activity 3:** Tracing the Flow of Lymph through the Body 527

**Activity 4:** Using a Pregnancy Test to Demonstrate Antigen–Antibody Reactions 529

**PhysioEx Exercise 12:** Serological Testing 532

**POST-LAB** Assignments 533

## **UNIT 25** Anatomy of the Respiratory System 537

**PRE-LAB** Assignments 538

**Activity 1:** Exploring the Organs of the Respiratory System 544

**Activity 2:** Examining the Microscopic Anatomy of the Trachea and Lungs 547

**Activity 3:** Examining a Sheep Pluck 548

**POST-LAB** Assignments 549

## **UNIT 26** Physiology of the Respiratory System 553

**PRE-LAB** Assignments 554

**Activity 1:** Analyzing the Model Lung and Pulmonary Ventilation 558

**Activity 2:** Measuring Respiratory Volumes in a Human Subject Using  559

**Activity 3:** Determining Respiratory Volumes and Capacities at Rest and Following Exercise 562

**Activity 4:** Investigating the Control of Breathing 564

**PhysioEx Exercise 7:** Respiratory System Mechanics 566

**POST-LAB** Assignments 567

## **UNIT 27** Anatomy of the Digestive System 571

**PRE-LAB** Assignments 572

**Activity 1:** Exploring the Organs of the Alimentary Canal 578

**Activity 2:** Exploring the Accessory Organs of the Digestive System 582

**Activity 3:** Examining the Histology of Selected Digestive Organs 589

**POST-LAB** Assignments 593

## **UNIT 28** Physiology of the Digestive System 599

**PRE-LAB** Assignments 600

**Activity 1:** Analyzing Amylase Activity 603

**Activity 2:** Analyzing Pepsin Activity 604

**Activity 3:** Analyzing Lipase Activity 606

**Activity 4:** Tracing Digestive Pathways 606

**PhysioEx Exercise 8:** Chemical and Physical Processes of Digestion 608

**POST-LAB** Assignments 609


## **UNIT 29** Anatomy of the Urinary System 613

**PRE-LAB** Assignments 614

**Activity 1:** Exploring the Organs of the Urinary System 620

**Activity 2:** Dissecting a Mammalian Kidney 622

**Activity 3:** Examining the Microscopic Anatomy of the Kidney, Ureter, and Urinary Bladder 625

 **LabBOOST** Anatomy of the Renal Corpuscle 626  
**POST-LAB** Assignments 627

## **UNIT 30** Physiology of the Urinary System 631

**PRE-LAB** Assignments 632

**Activity 1:** Demonstrating the Function of the Filtration Membrane 636

**Activity 2:** Simulating the Events of Urine Production and Urine Concentration 637

**Activity 3:** Using the Results of a Urinalysis to Make Clinical Connections 641

 **LabBOOST** Understanding Tonicity 642

**PhysioEx™ Exercise 9:** Renal System Physiology 644

**PhysioEx™ Exercise 10:** Acid-Base Balance 644

**POST-LAB** Assignments 645

## **UNIT 31** Reproduction and Development 649

**PRE-LAB** Assignments 650

**Activity 1:** Examining Male Reproductive Anatomy 658

**Activity 2:** Examining Female Reproductive Anatomy 659

**Activity 3:** Exploring the Microscopic Anatomy of Selected Reproductive Organs 661

**Activity 4:** Comparing Spermatogenesis and Oogenesis 668

**Activity 5:** Exploring Fertilization and the Stages of Prenatal Development 673

**Activity 6:** Examining the Placenta 676

**POST-LAB** Assignments 677



## **Cat Dissection Exercises**

- 1 Exploring the Muscular System of the Cat C-1
- 2 Exploring the Spinal Nerves of the Cat C-21
- 3 Exploring the Respiratory System of the Cat C-27
- 4 Exploring the Digestive System of the Cat C-33
- 5 Exploring the Cardiovascular System of the Cat C-41
- 6 Exploring the Urinary System of the Cat C-49
- 7 Exploring the Reproductive System of the Cat C-53

INDEX I-1



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# 1

## Unit Outline

# Introduction to Anatomy and Physiology

**A**natomy and physiology (A&P) is a fascinating subject, but learning it can be very challenging. Even though learning A&P involves a great deal of memorization, memorizing is only the first step. Effective learning requires you to apply the knowledge you attain in critical-thinking and problem-solving activities.

Learning A&P requires a tremendous level of discipline, motivation, and determination. It is hard work, and it demands a commitment to daily study. In this lab manual, you will encounter a wide variety of study strategies designed to motivate you to become engaged in the learning process. You will be encouraged to participate fully in your lab group, to establish a regular study group, and to be willing to try new study techniques—all so that you can learn more information than you ever thought possible in a two-course sequence.

We will begin building your foundation in the principles of anatomy and physiology by learning the basic anatomical terminology that you will use throughout A&P I and A&P II, and when communicating with health care professionals throughout your career.

### What You Need to Know Before You Start This Unit

- Definition of anatomy
- Definition of physiology

### Anatomical Terminology

**Activity 1:** Identifying Body Regions and Exploring Surface Anatomy

### Body Cavities and Membranes

**Activity 2:** Identifying Body Cavities and Abdominopelvic Regions

### Body Planes of Section

**Activity 3:** Demonstrating and Identifying Body Planes of Section

### Applying Anatomical Terminology

**Activity 4:** Assisting the Coroner



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## PRE-LAB Assignments

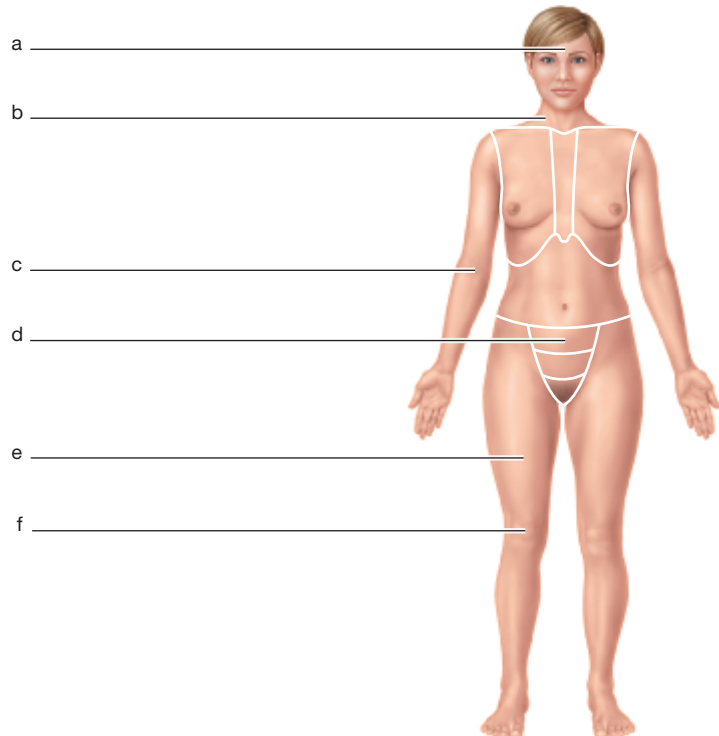
To maximize learning, BEFORE your lab period, carefully read all assigned activities and the corresponding background information. Then, complete the pre-lab assignments below for each of the assigned activities.

### PRE-LAB Activity 1: Identifying Body Regions and Exploring Surface Anatomy

- Which of the following descriptions of the anatomical position is *incorrect*?
  - arms straight
  - palms facing posteriorly
  - toes facing forward
  - feet slightly apart
- Match each of the following descriptions with the correct directional term.
 

a. The sternum is _____ to the vertebrae.	1. posterior/dorsal
b. The feet are _____ to the hands.	2. distal
c. The elbows are _____ to the abdomen.	3. anterior/ventral
d. The skin is _____ to the skeleton.	4. deep
e. The heart is _____ to the sternum.	5. lateral
f. The lungs are _____ to the ribs.	6. superficial
g. The chest is _____ to the abdomen.	7. inferior
h. The knee is _____ to the hip.	8. superior
i. The fingers are _____ to the thumb.	9. proximal
j. The elbow is _____ to the wrist.	10. medial
- Use the list of terms provided to label the accompanying illustration; check off each term as you label it.

- antecubital
- cervical
- frontal
- patellar
- pelvic
- femoral





### PRE-LAB Activity 2: Identifying Body Cavities and Abdominopelvic Regions

- The dorsal body cavity is subdivided into the \_\_\_\_\_ cavity and the \_\_\_\_\_ cavity.
- The ventral body cavity is subdivided into the \_\_\_\_\_ cavity and the \_\_\_\_\_ cavity.
- Which abdominopelvic region(s) is(are) located *directly*
  - inferior to the umbilical region? \_\_\_\_\_
  - lateral to the epigastric region? \_\_\_\_\_
  - superior to the right iliac region? \_\_\_\_\_
  - inferior to the left hypochondriac region? \_\_\_\_\_
  - lateral to the hypogastric region? \_\_\_\_\_
- The innermost layer of the serous membrane surrounding the lungs is called the \_\_\_\_\_ pleura.
- The outermost layer of the serous membrane surrounding the heart is called the \_\_\_\_\_ pericardium.

### PRE-LAB Activity 3: Demonstrating and Identifying Body Planes of Section

- Which plane of section divides the body into anterior and posterior parts? \_\_\_\_\_
- Which plane of section divides the body into superior and inferior parts? \_\_\_\_\_
- Which plane of section divides the body into right and left parts? \_\_\_\_\_

### PRE-LAB Activity 4: Assisting the Coroner

- The pelvis is \_\_\_\_\_ to the ribs.
  - superior
  - lateral
  - inferior
  - distal
- Which of the following descriptions best applies to the term medial?
  - the nose relative to the ears
  - the knee relative to the ankle
  - the lips relative to the nose
  - the ears relative to the eyes
- Which of the following descriptions best applies to the term superior?
  - the sternum relative to the lungs
  - the wrist relative to the elbow
  - the eyebrows relative to the eyes
  - the fingers relative to the palm
- The visceral pericardium is \_\_\_\_\_ (superficial/deep) to the parietal pericardium.

## Anatomical Terminology

Learning anatomy is sometimes compared to learning a new language because of the vast number of terms that are specific to the study of the human body. Because these terms are widely used in health care professions, it is essential that you become fluent in using them.

### Anatomical Position

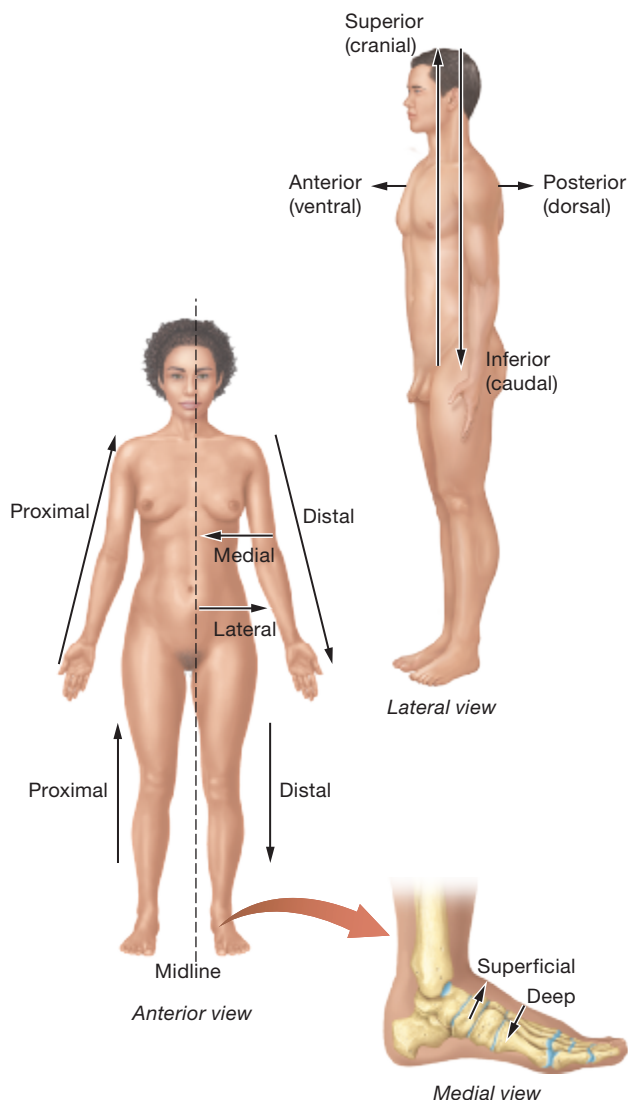
**Anatomical position** is the universally accepted standard position that scientists and medical professionals use to communicate information concerning parts of the body. In anatomical position (**Figure 1-1**), the body is erect and facing forward; the arms are straight and at the sides of the body, with the palms facing forward; and the feet are slightly apart, with the toes pointing forward.



**Figure 1-1** Anatomical position.

## Directional Terms

Another effective way of communicating in anatomy is to use directional terms, which describe the locations of body structures in relationship to other structures. **Figure 1-2** illustrates the most common directional terms, plus gives their definitions and some examples of how each might be used.



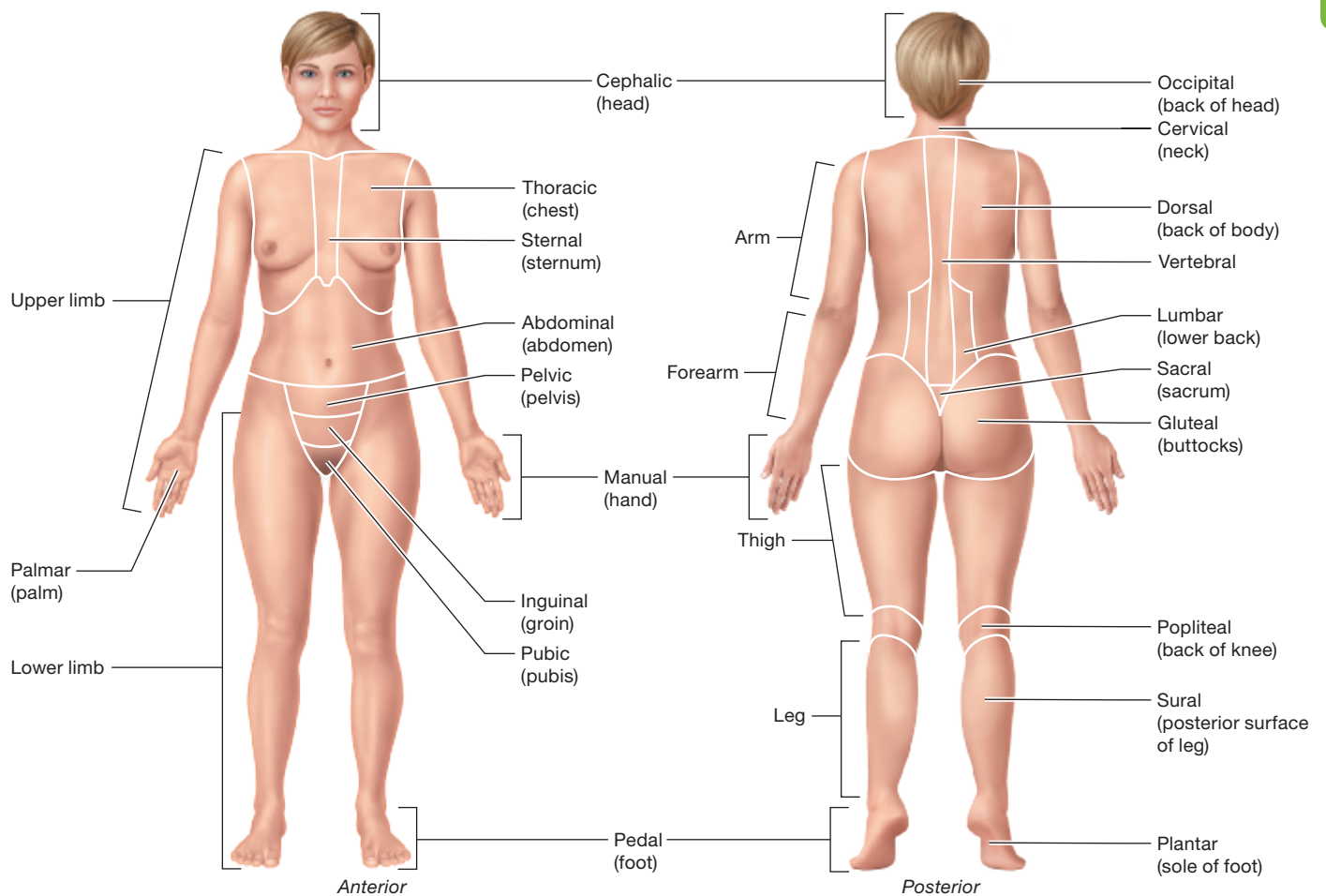
**Figure 1-2** Common directional terms.

## Surface Anatomy/Body Regions

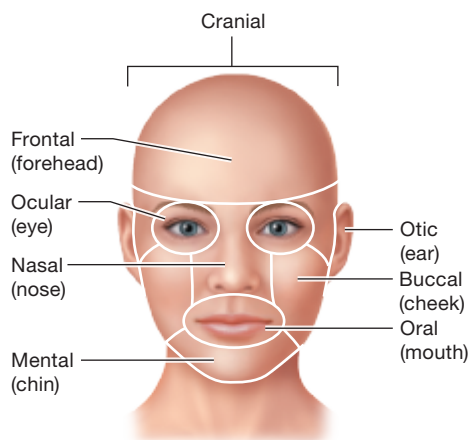
Regional terms are used to identify specific areas on the surface of the body. **Figure 1-3** illustrates the most common terms describing various body regions.

In the following lab activity, you will explore the anatomical terms that describe various regions of the surface of the body.

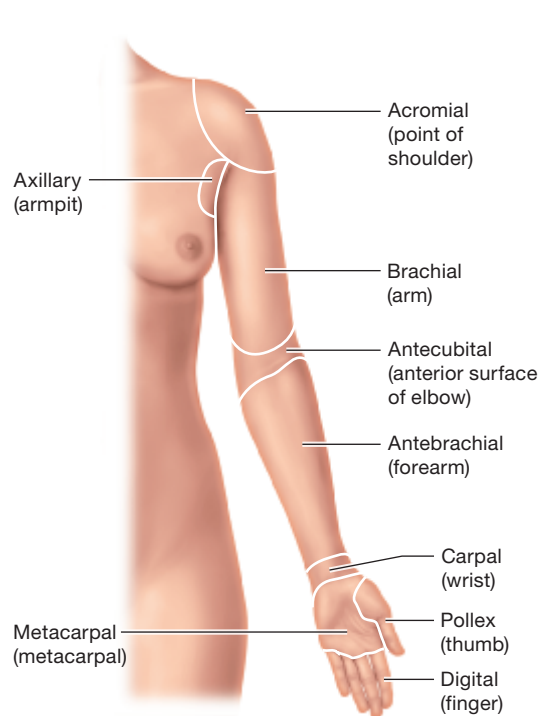
TERM	DEFINITION	EXAMPLES
<b>Anterior</b> (ventral)	Toward the front	<ul style="list-style-type: none"> <li>The palms are on the anterior side of the body.</li> <li>The esophagus is anterior to the spinal cord.</li> </ul>
<b>Posterior</b> (dorsal)	Toward the back	<ul style="list-style-type: none"> <li>The occipital bone is on the posterior cranium (skull).</li> <li>The spinal cord is posterior to the esophagus.</li> </ul>
<b>Superior</b> (cranial)	Toward the head	<ul style="list-style-type: none"> <li>The nose is superior to the mouth.</li> <li>The neck is superior to the chest.</li> </ul>
<b>Inferior</b> (caudal)	Toward the tail	<ul style="list-style-type: none"> <li>The nose is inferior to the forehead.</li> <li>The umbilicus (belly button) is inferior to the chest.</li> </ul>
<b>Proximal</b>	Closer to the point of origin (generally the trunk)	<ul style="list-style-type: none"> <li>The knee is proximal to the ankle.</li> <li>The shoulder is proximal to the elbow.</li> </ul>
<b>Distal</b>	Farther away from the point of origin (generally the trunk)	<ul style="list-style-type: none"> <li>The foot is distal to the hip.</li> <li>The wrist is distal to the elbow.</li> </ul>
<b>Medial</b>	Closer to the midline of the body or a body part; on the inner side of	<ul style="list-style-type: none"> <li>The ear is medial to the shoulder.</li> <li>The index finger is medial to the thumb.</li> </ul>
<b>Lateral</b>	Farther away from the midline of the body or a body part; on the outer side of	<ul style="list-style-type: none"> <li>The shoulder is lateral to the chest.</li> <li>The thumb is lateral to the index finger.</li> </ul>
<b>Superficial</b>	Closer to the surface	<ul style="list-style-type: none"> <li>The skin is superficial to the muscle.</li> <li>Muscle is superficial to bone.</li> </ul>
<b>Deep</b>	Farther below the surface	<ul style="list-style-type: none"> <li>Bone is deep to the skin.</li> <li>Bone is deep to muscle.</li> </ul>



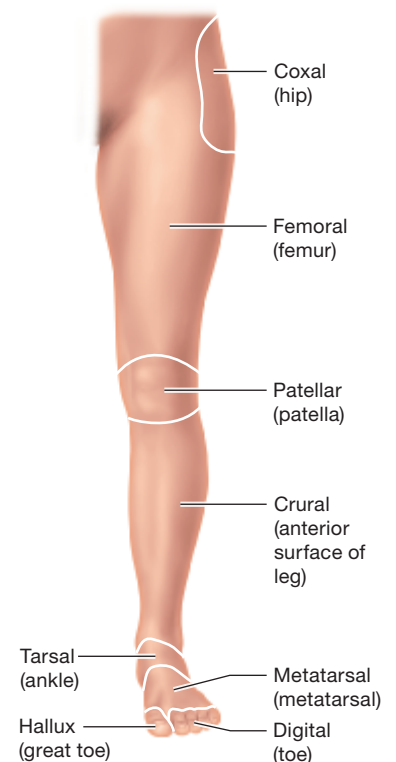
(a) Anterior and posterior views of the full body



(b) Head, anterior view



(c) Upper limb, anterior view



(d) Lower limb, anterior view

**Figure 1-3** Common terms that describe the regions of the body surface.



## Activity 1

# Identifying Body Regions and Exploring Surface Anatomy

### Learning Outcomes

1. Use regional terms for surface anatomy accurately.
2. Identify specific skeletal muscles based on regional terminology.

### Materials Needed

- Laminated body region poster
- Water-soluble markers
- Muscle models
- Labeling tape

### Instructions

1. Working as a group, use the laminated body region poster and water-soluble markers to identify and label as many regional terms as possible from memory. Your instructor will set a time limit for the activity. When you are finished, use your lab manual to determine the number of body regions correctly identified and report the number to your instructor. Then correct and finish labeling the poster.

2. For each of the following muscles, write the body region in which it is found. Then, using muscle models and model identification keys provided by your instructor, find each muscle and label it with a piece of tape.

rectus abdominis m. \_\_\_\_\_

brachialis m. \_\_\_\_\_

biceps femoris m. \_\_\_\_\_

epicranium m. \_\_\_\_\_

mentalis m. \_\_\_\_\_

gluteus maximus m. \_\_\_\_\_

## Body Cavities and Membranes

The human body is divided into several fluid-filled cavities, each containing specific organs. The two major body cavities are the **dorsal** (posterior) **cavity** and the **ventral** (anterior) **cavity** (Figure 1-4). The dorsal body cavity is

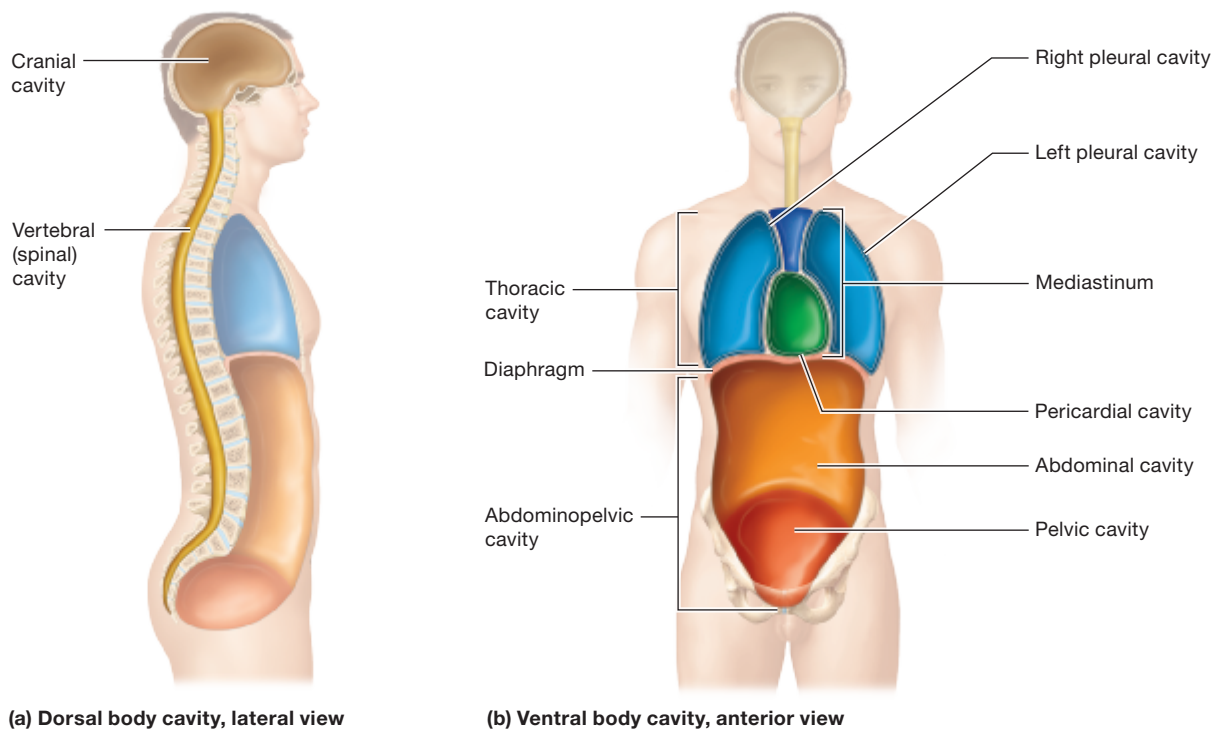
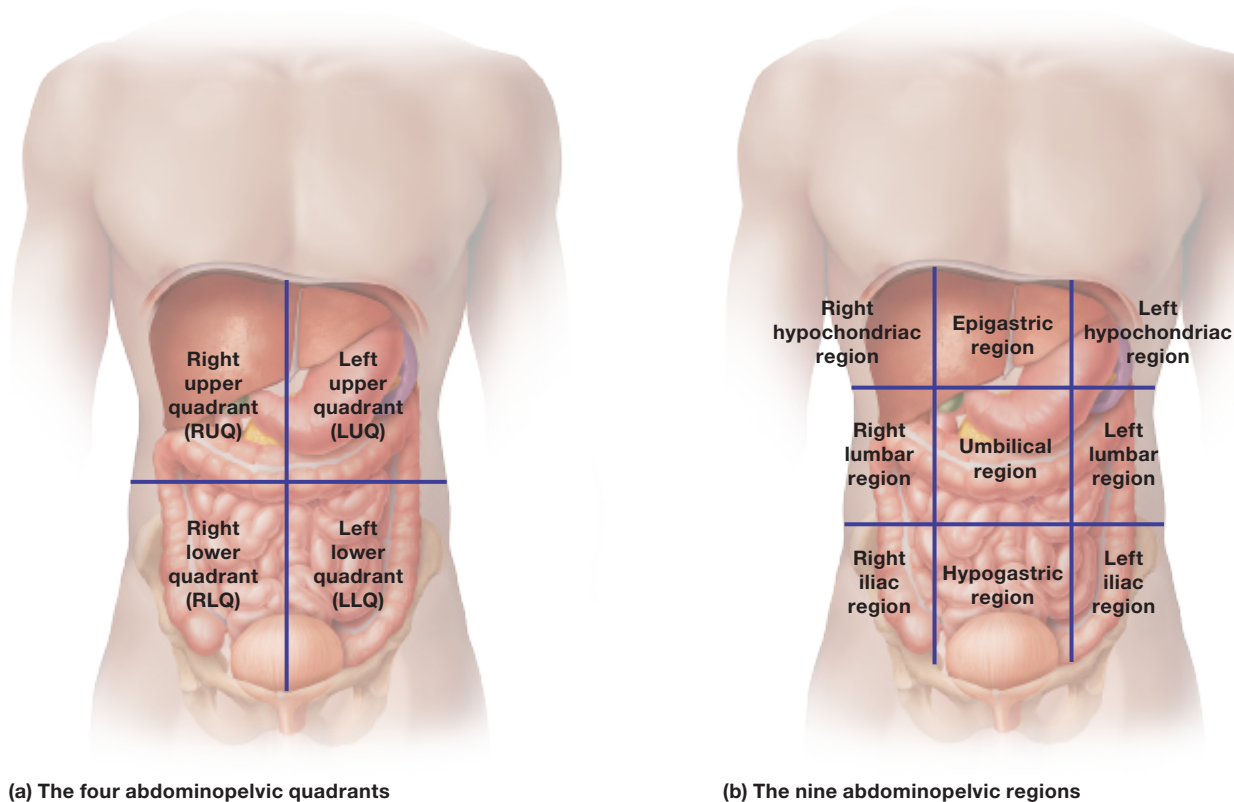


Figure 1-4 The major body cavities.



**Figure 1-5** Divisions of the abdominopelvic cavity.

subdivided into the **cranial cavity**, which houses the brain, and the **vertebral (spinal) cavity**, which houses the spinal cord. The ventral body cavity is divided by the diaphragm into the thoracic cavity and the abdominopelvic cavity.

The **thoracic cavity** can be subdivided into the medial mediastinum and the right and left pleural cavities. The mediastinum contains numerous organs, including the esophagus, trachea, bronchi, and heart, the last of which is enclosed by the **pericardial cavity**. Inferior to the diaphragm is the **abdominopelvic cavity**, consisting of the **abdominal cavity**, which contains the digestive organs, and the **pelvic cavity**, which contains the urinary bladder, reproductive organs, and rectum.

Most of the organs in the ventral body cavity are surrounded by **serous membranes**, which are thin, double-layered sacs. The outer layer of the membrane is the **parietal**

**layer**; the inner layer of the membrane covers the organ and is called the **visceral layer**. The two layers of the serous membranes are separated by a narrow cavity filled with a clear serous (watery) fluid, which is secreted by the membranes and prevents friction as the organs move within the ventral body cavity. The pleura covers the lungs, the pericardium covers the heart, and the peritoneum covers most of the abdominal organs.

The abdominopelvic cavity is typically divided into either four quadrants or nine regions (**Figure 1-5**). Clinicians divide the cavity into four quadrants: the right upper quadrant (RUQ), left upper quadrant (LUQ), right lower quadrant (RLQ), and left lower quadrant (LLQ). Anatomists subdivide the cavity into nine regions: the right hypochondriac, epigastric, left hypochondriac, right lumbar, umbilical, left lumbar, right iliac, hypogastric or pubic, and left iliac regions.

## Activity 2

# Identifying Body Cavities and Abdominopelvic Regions

### Learning Outcomes

1. Identify the body cavities that make up the dorsal cavity and those that make up the ventral cavity, and list the major organs found in each.
2. Describe the two ways in which the abdominopelvic cavity is commonly subdivided.
3. Explain the structure and function of a serous membrane, and name the serous membranes in the ventral body cavity.

### Materials Needed

- Torso model
- Quart-sized plastic sealable bag
- Food coloring
- Miscellaneous anatomical models

### Instructions

#### A. Body Cavities and Abdominopelvic Regions

##### CHART

Identify the body cavities and abdominopelvic regions listed in the following charts on an anatomical model. Then complete the charts as you name the major organs found in each.

Dorsal Body Cavity	
Subdivision	Organ(s)
Cranial cavity	
Vertebral cavity	

Ventral Body Cavity	
Subdivision	Organ(s)
Thoracic cavity	
Abdominopelvic cavity	
• Right hypochondriac region	
• Epigastric region	
• Left hypochondriac region	
• Right lumbar region	
• Umbilical region	
• Left lumbar region	
• Right iliac region	
• Hypogastric region	
• Left iliac region	

#### B. Serous Membranes

Use a plastic sealable bag containing 15 ml (1 tablespoon) of water plus one drop of food coloring as a model for the parietal layer of a serous membrane, the visceral layer of a serous membrane, and a serous fluid-filled cavity.

1. Place the plastic bag on top of the heart model.

*The portion of the bag adjacent to the heart represents the \_\_\_\_\_, the water-filled space represents the \_\_\_\_\_, and the outermost portion of the bag represents the \_\_\_\_\_.*

2. Next, place the plastic bag on top of the lung model.

*The portion of the bag adjacent to the lung represents the \_\_\_\_\_, the water-filled space represents the \_\_\_\_\_, and the outermost portion of the bag represents the \_\_\_\_\_.*

3. Finally, place the plastic bag on top of the model of the small intestine.

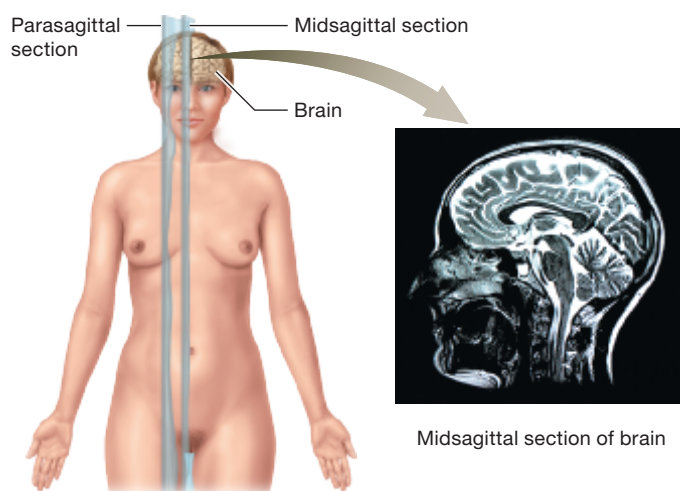
*The portion of the bag adjacent to the small intestine represents the \_\_\_\_\_, the water-filled space represents the \_\_\_\_\_, and the outermost portion of the bag represents the \_\_\_\_\_.*

4. What are the functions of the serous membranes and serous fluid? \_\_\_\_\_

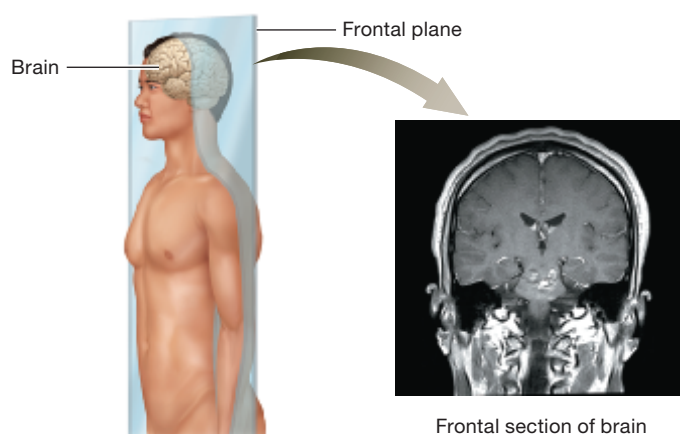
## Body Planes of Section

When viewing the internal anatomy of organs on models, on diagrams, and in specimens, it is important to understand the various types of cuts, or sections, that have been made to show the internal structures. In the health professions, these planes of section are also observed in various types of images, such as MRI and CT scans. **Figure 1-6** illustrates the three most commonly used planes:

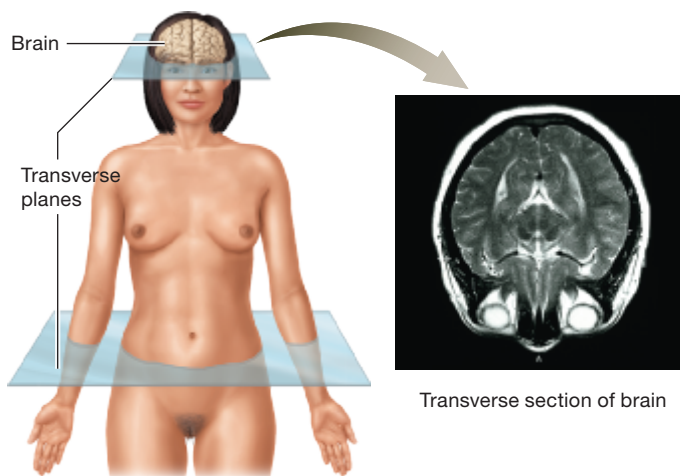
1. A **sagittal plane** is a section made parallel to the body's longitudinal axis; it divides the body into right and left parts. A **midsagittal** (median) **plane** divides the body into equal right and left parts; a **parasagittal plane** divides the body into unequal right and left parts.



(a) Sagittal plane



(b) Frontal plane



(c) Transverse plane

**Figure 1-6** Planes of section.

2. A **frontal** (coronal) **plane** is a section made parallel to the body's longitudinal axis; it divides the body into anterior and posterior parts.
3. A **transverse** (cross-sectional) **plane** is a section made perpendicular to the body's longitudinal axis; it divides the body into superior and inferior parts.

**Activity 3****Demonstrating and Identifying Body Planes of Section****Learning Outcome**

1. Demonstrate and describe anatomical planes of section.

**Materials Needed**

- Modeling clay
- Plastic knife
- Anatomical models

**Instructions****A. Modeling Clay Activity**

1. Assign each member of your lab group one of the following body planes: a sagittal plane, a frontal plane, or a transverse plane.
2. Each student should then mold a ball of modeling clay into a "head" that has two eyes, a nose, and a mouth.
3. Using a plastic knife, each student should demonstrate the assigned body plane by cutting a clay "head" and describing the cut to the other members of the lab group.

**B. Identifying Body Planes**

**CHART** Complete the following chart as you identify the anatomical planes of section represented in anatomical models provided by your instructor.

Anatomical Plane of Section Represented
Model 1
Model 2
Model 3
Model 4