

TWELFTH EDITION

MAIN VERSION

# Human Anatomy & Physiology Laboratory Manual

Elaine N. Marieb  
Lori A. Smith



# Anatomy and Physiology

## Laboratory Safety Guidelines\*

1. Upon entering the laboratory, locate exits, fire extinguisher, fire blanket, chemical shower, eyewash station, first aid kit, containers for broken glass, and materials for cleaning up spills.
2. Do not eat, drink, smoke, handle contact lenses, store food, or apply cosmetics or lip balm in the laboratory. Restrain long hair, loose clothing, and dangling jewelry.
3. Students who are pregnant, are taking immunosuppressive drugs, or have any other medical conditions (e.g., diabetes, immunological defect) that might necessitate special precautions in the laboratory must inform the instructor immediately.
4. Wearing contact lenses in the laboratory is inadvisable because they do not provide eye protection and may trap material on the surface of the eye. Soft contact lenses may absorb volatile chemicals. If possible, wear regular eyeglasses instead.
5. Use safety glasses in all experiments involving liquids, aerosols, vapors, and gases.
6. Decontaminate work surfaces at the beginning and end of every lab period, using a commercially prepared disinfectant or 10% bleach solution. After labs involving dissection of preserved material, use hot soapy water or disinfectant.
7. Keep all liquids away from the edge of the lab bench to avoid spills. Clean up spills of viable materials using disinfectant or 10% bleach solution.
8. Properly label glassware and slides.
9. Use mechanical pipetting devices; mouth pipetting is prohibited.
10. Wear disposable gloves when handling blood and other body fluids, mucous membranes, and nonintact skin, and when touching items or surfaces soiled with blood or other body fluids. Change gloves between procedures. Wash hands immediately after removing gloves. (**Note:** Cover open cuts or scrapes with a sterile bandage before donning gloves.)
11. Place glassware and plasticware contaminated by blood and other body fluids in a disposable autoclave bag for decontamination by autoclaving, or place them directly into a 10% bleach solution before reuse or disposal. Place disposable materials such as gloves, mouthpieces, swabs, and toothpicks that have come into contact with body fluids into a disposable autoclave bag, and decontaminate before disposal.
12. To help prevent contamination by needlestick injuries, use only disposable needles and lancets. Do not bend the needles and lancets. Needles and lancets should be placed promptly in a labeled, puncture-resistant, leakproof container and decontaminated, preferably by autoclaving.
13. Do not leave heat sources unattended.
14. Report all spills or accidents, no matter how minor, to the instructor.
15. Never work alone in the laboratory.
16. Remove protective clothing before leaving the laboratory.

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\*Adapted from:

*Biosafety in Microbiological and Biomedical Laboratories (BMBL)*, Fifth Edition. 2007. U.S. Government Printing Office. Washington, D.C. [www.cdc.gov/od/OHS/biosfty/bmb15/bmb15toc.htm](http://www.cdc.gov/od/OHS/biosfty/bmb15/bmb15toc.htm)

Centers for Disease Control. 1996. "Universal Precautions for Prevention of Transmission of HIV and Other Bloodborne Infections." Washington, D.C. [www.cdc.gov/ncidod/dhqp/bp\\_universal\\_precautions.html](http://www.cdc.gov/ncidod/dhqp/bp_universal_precautions.html)

Johnson, Ted, and Christine Case. 2010. *Laboratory Experiments in Microbiology*, Ninth Edition. San Francisco: Pearson Benjamin Cummings.

*School Chemistry Laboratory Safety Guide*. 2006. U.S. Consumer Product Safety Commission. Bethesda, MD. [www.cpsc.gov/CPSPUB/PUBS/NIOSH2007107.pdf](http://www.cpsc.gov/CPSPUB/PUBS/NIOSH2007107.pdf)

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# Your time is valuable. Make the most of your time *inside and outside* the lab.

To help you manage your time inside and outside the A&P lab classroom, this best-selling manual works hand-in-hand with **Mastering A&P**, the leading online homework and learning program for A&P. This edition features dozens of new, full-color figures and photos, revamped Clinical Application questions, an expanded set of pre-lab videos, dissection videos, and more.

## 9 EXERCISE The Axial Skeleton

### Learning Outcomes


- ▶ Name the three parts of the axial skeleton.
- ▶ Identify the bones of the axial skeleton, either by examining disarticulated bones or by pointing them out on an articulated skeleton or skull, and name the important bone markings on each.
- ▶ Name and describe the different types of vertebrae.
- ▶ Discuss the importance of intervertebral discs and spinal curvatures.
- ▶ Identify three abnormal spinal curvatures.
- ▶ List the components of the thoracic cage.
- ▶ Identify the bones of the fetal skull by examining an articulated skull or image.
- ▶ Define *fontanelle*, and discuss the function and fate of fontanelles.
- ▶ Discuss important differences between the fetal and adult skulls.

#### Pre-Lab Quiz

Instructors may assign these and other Pre-Lab Quiz questions using **Mastering A&P™**

- The axial skeleton can be divided into the skull, the vertebral column, and the:  
a. thoracic cage      c. hip bones  
b. femur                d. humerus
- Eight bones make up the \_\_\_\_\_, which encloses and protects the brain.  
a. cranium            b. face                c. skull
- The \_\_\_\_\_ vertebrae articulate with the corresponding ribs.  
a. cervical            c. spinal  
b. lumbar              d. thoracic
- The \_\_\_\_\_, commonly referred to as the breastbone, is a flat bone formed by the fusion of three bones: the manubrium, the body, and the xiphoid process.  
a. coccyx              b. sacrum            c. sternum
- A fontanelle:  
a. is found only in the fetal skull  
b. is a fibrous membrane  
c. allows for compression of the skull during birth  
d. all of the above

#### Go to Mastering A&P™ > Study Area to improve your performance in A&P Lab.



Maxilla

#### > Lab Tools > Bone & Dissection Videos

Instructors may assign new Building Vocabulary coaching activities, Pre-Lab Quiz questions, Art Labeling activities, related bone videos and coaching activities, Practice Anatomy Lab Practical questions (PAL), and more using the **Mastering A&P™** Item Library.

#### Materials

- ▶ Intact skull and Beauchene skull
- ▶ X-ray images of individuals with scoliosis, lordosis, and kyphosis (if available)
- ▶ Articulated skeleton, articulated vertebral column, removable intervertebral discs
- ▶ Isolated cervical, thoracic, and lumbar vertebrae, sacrum, and coccyx
- ▶ Isolated fetal skull

**The axial skeleton** (the green portion of Figure 8.1 on p. 104) can be divided into three parts: the skull, the vertebral column, and the thoracic cage. This division of the skeleton forms the longitudinal axis of the body and protects the brain, spinal cord, heart, and lungs.

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**NEW! Mastering A&P study tools** are highlighted on the first page of each lab exercise, along with a photo preview of a related pre-lab video, image from Practice Anatomy Lab 3.1 (PAL), or animation.

**NEW! Mastering A&P assignments, including NEW Building Vocabulary Coaching Activities,** are signaled at appropriate points throughout the manual to help you connect the exercises to relevant assignments that can be auto-graded in Mastering A&P.

See p. 115

# Be Prepared: Learning in A&P Lab is an Active Process.

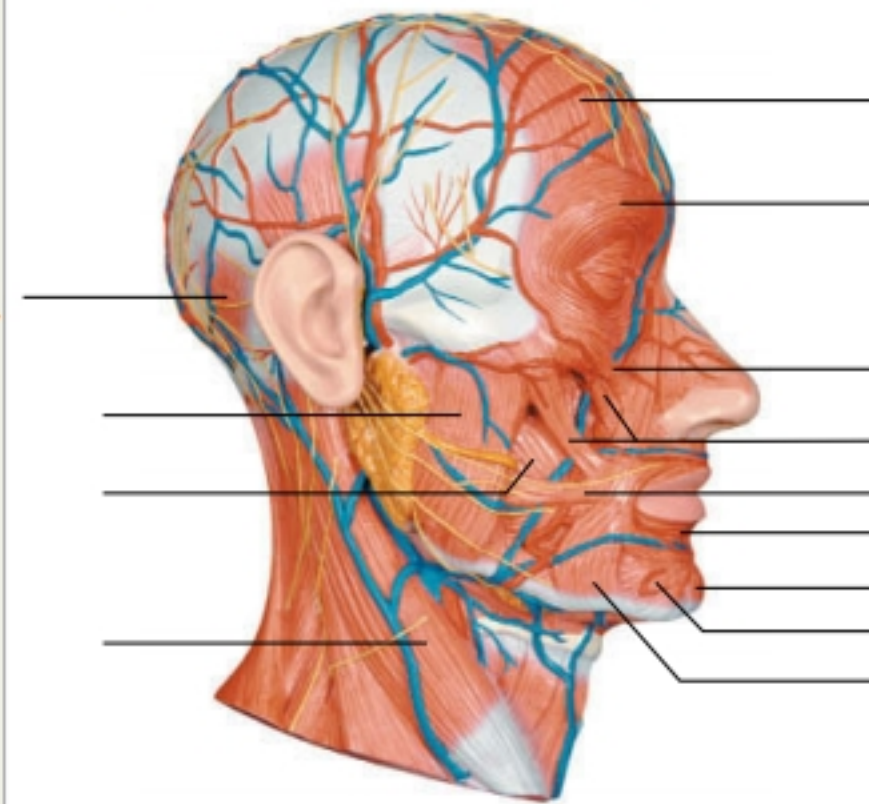
Before going into the lab, read the **background information** for the exercise, connect your reading to the figures and photos, complete the **pre-lab quiz**, and preview the questions in the tear-out **Exercise Review Sheet**. After lab, review your lab notes to remember important concepts. To improve your performance on lab practical exams, log into **Mastering A&P**, where you can watch related videos, practice with customized flashcards, and more.

**NEW! Dozens of full-color figures and photos** have been added to the Exercise Review Sheets, replacing black-and-white line drawings. Selected labeling questions are available as **new Art-Labeling assignments in Mastering A&P**.

See p. 224

## Muscles of the Head and Neck

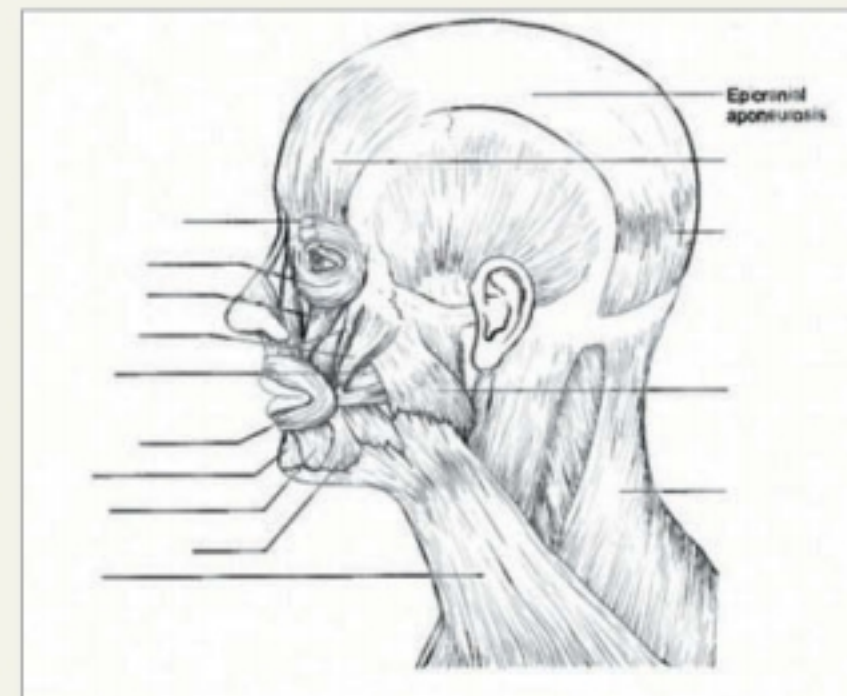
3. Using choices from the key at the right, correctly identify muscles provided with leader lines on the illustration.



Key:

- a. buccinator
- b. depressor anguli oris
- c. depressor labii inferioris
- d. frontal belly of the epicranius
- e. levator labii inferioris
- f. masseter
- g. mentalis
- h. occipital belly of the epicranius
- i. orbicularis oculi
- j. orbicularis oris
- k. risorius
- l. sternocleidomastoid
- m. zygomaticus minor and major

Compare to Previous Edition



**NEW! Clinical Application Questions** have been added to the Exercise Review Sheets to help you connect lab concepts with real-world clinical scenarios.

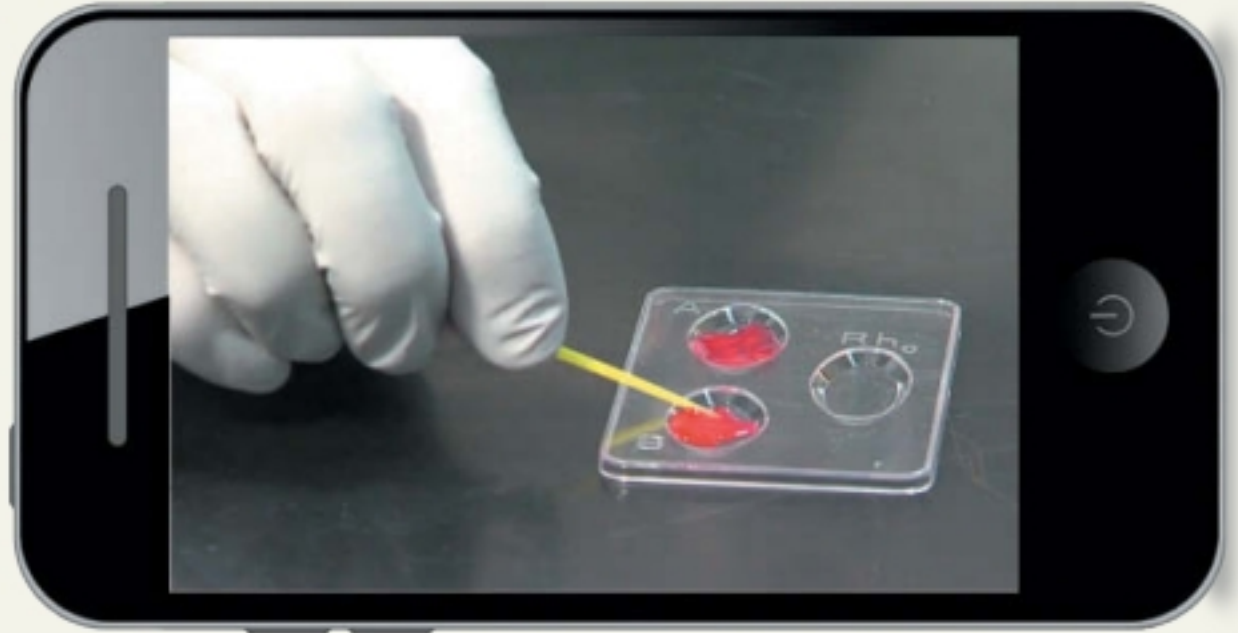
27. **+** As we age, we often become shorter. Explain why this might occur.

See p. 141

**NEW! Building Vocabulary Coaching Activities** are a fun way to learn word roots and A&P terminology while building and practicing important language skills.

# Get 24/7 videos, coaching, and practice with **Mastering A&P.**

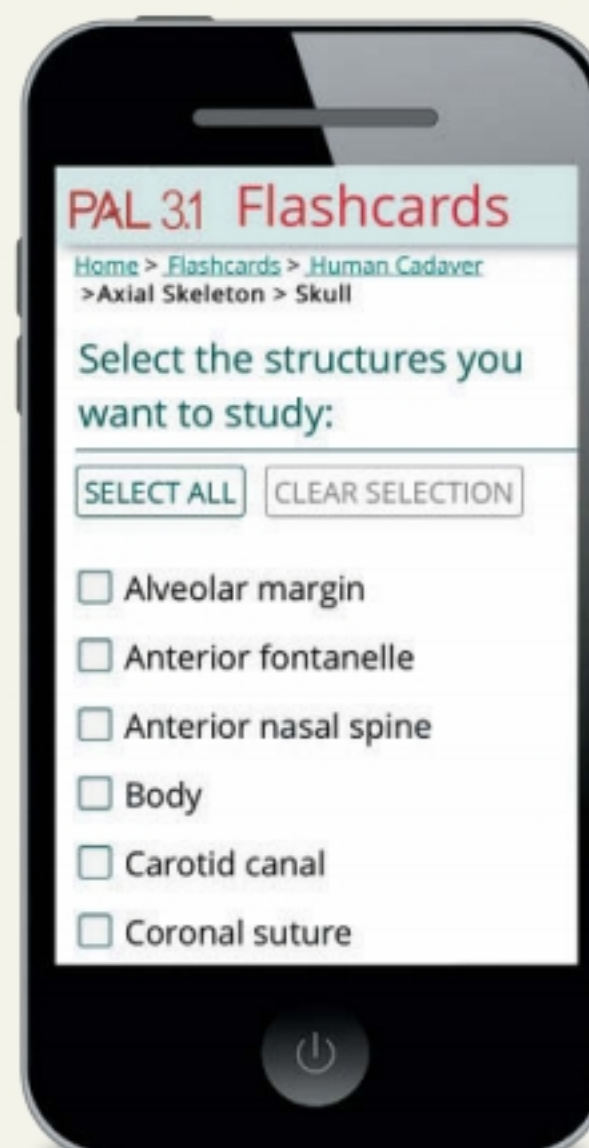
**EXPANDED!** 8 new Pre-Lab Video Coaching Activities in Mastering A&P (for a total of 18) focus on key concepts in the lab activity and walk you through important procedures. New pre-lab video topics include Preparing and Observing a Wet Mount, Examining a Long Bone, Initiating Pupillary Reflexes, Palpating Superficial Pulse Points, Auscultating Heart Sounds, and more.



**NEW!** Cat and Fetal Pig Dissection Video Coaching Activities help you prepare for dissection by previewing key anatomical structures. Each video includes one to two comparisons to human structures.



**NEW!** Customizable Practice Anatomy Lab (PAL) Flashcards allow you to create a personalized, mobile-friendly deck of flashcards and quizzes using images from PAL 3.1. You can generate flashcards using only the structures that your instructor has emphasized in lecture or lab.



**IMPROVED!** The Pearson eText mobile app allows you to access the complete lab manual online or offline, along with all of the videos described above.

# Additional Support for Students & Instructors

**Mastering A&P** offers thousands of tutorials, activities, and questions that can be assigned for homework and practice. Highlights of popular assignment options include the following:

**PhysioEx™ 9.1** is an easy-to-use lab simulation program that consists of 12 exercises containing 63 physiology lab activities that can be used to supplement or substitute for wet labs.

**IMPROVED! Practice Anatomy Lab 3.1** is now accessible on all mobile devices to give students 24/7 access to the most widely used lab specimens, including human cadaver, anatomical models, histology slides, cat, and fetal pig.

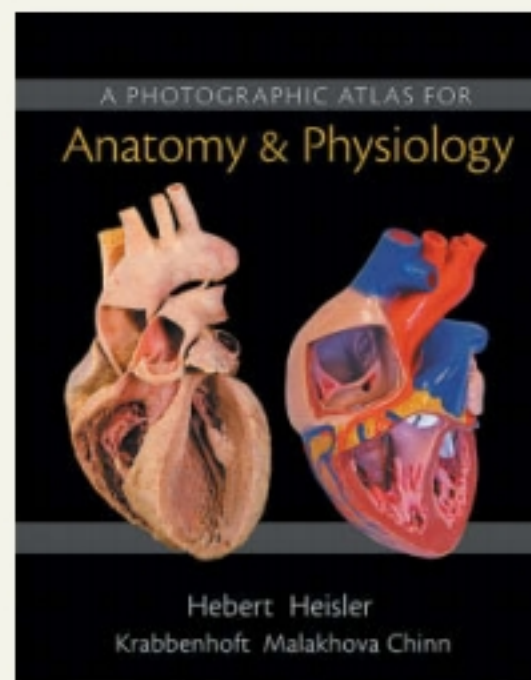
**Dynamic Study Modules** are manageable, mobile-friendly sets of questions with extensive feedback for students to test, learn, and retest until they master basic concepts.

- **NEW!** Instructors can select or deselect specific questions to customize assignments.
- **EXPANDED!** The Lab Manual Mastering A&P course now offers over 3,000 Dynamic Study Module questions, shared with the Marieb/Hoehn textbook *Human Anatomy & Physiology 11th Edition*.

The **Mastering A&P Instructor Resources Area** includes the following downloadable tools:

- **Customizable PowerPoint® lecture outlines** include customizable images and provide a springboard for lab prep.
- **All of the figures, photos, and tables from the manual** are available in JPEG and PowerPoint® formats, in labeled and unlabeled versions, and with customizable labels and leader lines.
- **Test bank** provides thousands of customizable questions across Bloom's taxonomy levels and includes all lab practical and quiz questions from Practice Anatomy Lab 3.1. Each question is tagged to chapter learning outcomes that can also be tracked within Mastering A&P assessments. Available in Microsoft® Word and TestGen® formats.
- **Animations and videos** bring A&P concepts to life and include pre-lab videos, bone videos, and dissection videos.
- **A comprehensive Instructor's Guide**, co-authored by Elaine Marieb and Lori Smith, includes prep instructions for each exercise, along with answer keys for all of the Exercise Review Sheets.

**A Photographic Atlas for Anatomy & Physiology**  
By Nora Hebert, Ruth E. Heisler, et al.  
ISBN 9780321869258



**Instructor Resource DVD with PowerPoint Lecture Outlines**  
ISBN 9780134777092

**Instructor's Guide for Human Anatomy & Physiology Lab Manual 13/e**  
ISBN 9780134778839

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# Human Anatomy & Physiology Laboratory Manual

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# About the Authors



## **Elaine N. Marieb**

After receiving her Ph.D. in zoology from the University of Massachusetts at Amherst, Elaine N. Marieb joined the faculty of the Biological Science Division of Holyoke Community College. While teaching at Holyoke Community College, where many of her students were pursuing nursing degrees, she developed a desire to better understand the relationship between the scientific study of the human body and the clinical aspects of the nursing practice. To that end, while continuing to teach full time, Dr. Marieb pursued her nursing education, which culminated in a Master of Science degree with a clinical specialization in gerontology from the University of Massachusetts. It is this experience that has informed the development of the unique perspective and accessibility for which her publications are known.

Dr. Marieb has given generously to provide opportunities for students to further their education. She funds the E. N. Marieb Science Research Awards at Mount Holyoke College, which promotes research by undergraduate science majors, and has underwritten renovation of the biology labs in Clapp Laboratory at that college. Dr. Marieb also contributes to the University of Massachusetts at Amherst, where she provided funding for reconstruction and instrumentation of a cutting-edge cytology research laboratory. Recognizing the severe national shortage of nursing faculty, she underwrites the Nursing Scholars of the Future Grant Program at the university.

In 2012 and 2017, Dr. Marieb gave generous philanthropic support to Florida Gulf Coast University as a long-term investment in education, research, and training for healthcare and human services professionals in the local community. In honor of her contributions, the university is now home to the Elaine Nicpon Marieb College of Health and Human Services.



## **Lori A. Smith**

Lori A. Smith received her Ph.D. in biochemistry from the University of California at Davis. Before discovering her passion for teaching, she worked as a research scientist and project leader in the medical diagnostics industry. In 1999, she joined the faculty at American River College in the Biology Department, where she teaches anatomy and physiology and microbiology to students preparing for nursing or other allied health careers. Since 2005, she has coauthored Pearson's PhysioEx™: Laboratory Simulations in Physiology and has continued to coauthor several Pearson lab manuals. Dr. Smith has been named Instructor of the Year by the American River College Associated Student Body, and she is a member of the Human Anatomy and Physiology Society (HAPS) and California Academy of Sciences. When not teaching or writing, she enjoys spending time with her family: hiking, cycling, and kayaking.

# Preface to the Instructor

The philosophy behind the revision of this manual mirrors that of all earlier editions. It reflects a still developing sensibility for the way teachers teach and students learn, informed by years of teaching the subject and by collecting suggestions from other instructors as well as from students enrolled in multifaceted healthcare programs. *Human Anatomy & Physiology Laboratory Manual* was originally developed to facilitate and enrich the laboratory experience for both teachers and students. This edition retains those same goals.

This manual, intended for students in introductory human anatomy and physiology courses, presents a wide range of laboratory experiences for students concentrating in nursing, physical therapy, pharmacology, respiratory therapy, and exercise science, as well as biology and premedical programs. The manual's coverage is intentionally broad, allowing it to serve both one- and two-semester courses, and it is available in versions that contain detailed guidelines for dissecting a cat or fetal pig laboratory specimen.

## Basic Approach and Features

The generous variety of experiments in this manual provides flexibility that enables instructors to gear their laboratory approach to specific academic programs or to their own teaching preferences. The manual remains independent of any textbook, so it contains the background discussions and terminology necessary to perform all experiments. Such a self-contained learning aid eliminates the need for students to bring a textbook into the laboratory.

Each of the 46 exercises leads students toward a coherent understanding of the structure and function of the human body. The manual begins with anatomical terminology and an orientation to the body, which together provide the necessary tools for studying the various body systems. The exercises that follow reflect the dual focus of the manual—both anatomical and physiological aspects receive considerable attention. As the various organ systems of the body are introduced, the initial exercises focus on organization, from the cellular to the organ system level. As indicated by the table of contents, the anatomical exercises are usually followed by physiological experiments that familiarize students with various aspects of body functioning and promote the critical understanding that function follows structure. The numerous physiological experiments for each organ system range from simple experiments that can be performed without specialized tools to more complex experiments using laboratory equipment, computers, and instrumentation techniques.

### Features



The dissection scissors icon appears at the beginning of activities that entail the dissection of isolated animal organs. In addition to the figures, isolated animal organs, such as the sheep heart and pig kidney, are employed to study anatomy because of their exceptional similarity to human organs.



Homeostasis is continually emphasized as a requirement for optimal health. Pathological conditions

are viewed as a loss of homeostasis; these discussions can be recognized by the homeostatic imbalance logo within the descriptive material of each exercise. This holistic approach encourages an integrated understanding of the human body. The homeostatic imbalance icon directs the student's attention to conditions representing a loss of homeostasis.



A safety icon notifies students that specific safety precautions must be observed when using certain equipment or conducting particular lab procedures. For example, when working with ether, students are to use a hood; and when handling body fluids such as blood, urine, or saliva, students are to wear gloves. All exercises involving body fluids (blood, urine, saliva) incorporate current Centers for Disease Control and Prevention (CDC) guidelines for handling human body fluids. Because it is important that nursing students in particular learn how to safely handle bloodstained articles, the manual has retained the option to use human blood in the laboratory. However, the decision to allow testing of human (student) blood or to use animal blood in the laboratory is left to the discretion of the instructor in accordance with institutional guidelines. The CDC guidelines for handling body fluids are reinforced by the laboratory safety procedures described on the inside front cover of this text, in Exercise 29: Blood, and in the *Instructor's Guide*. You can photocopy the inside front cover and post it in the lab to help students become well versed in laboratory safety.



**Group Challenge** activities are designed to enhance collaborative group learning and to challenge students to think critically, identify relationships between anatomical structures and physiological functions, and achieve a deeper understanding of anatomy and physiology concepts.



The BIOPAC<sup>®</sup> icon in a relevant exercise materials list signals the use of the BIOPAC<sup>®</sup> Student Lab System and alerts you to the equipment needed. BIOPAC<sup>®</sup> is used in Exercises 14, 18, 20, 21, 31, 33, 34, and 37. The instructions in the lab manual are for use with the BIOPAC<sup>®</sup> MP36/35 and MP45 data acquisition unit. Note that some exercises are not compatible with the MP45 data acquisition unit. For those exercises, the MP45 will not be listed in the Materials section. In this edition, the lab manual instructions are for use with BSL software 4.0.1 and above for Windows 10/8.x/7 or Mac OS X10.9–10.12. Refer to the Materials section in each exercise for the applicable software version. The Instructor Resources area of Mastering A&P provides the following additional support for alternative data acquisitions systems, including exercises that can be distributed to students:

- *BIOPAC<sup>®</sup> Instructions for the MP36 (or MP35/30) data acquisition unit* using BSL software versions earlier than 4.0.1 (for Windows and Mac) for Exercises 14, 18, 20, 21, 31, and 34
- *Powerlab<sup>®</sup> Instructions* for Exercises 14, 21, 31, 33, 34, and 37
- *iWorx<sup>®</sup> Instructions* for Exercises 14, 18, 21, 31, 33, 34, and 37
- *Intelitool<sup>®</sup> Instructions* for Exercises 14i, 21i, 31i, and 37i

- **Exercise Review Sheets** follow each laboratory exercise and provide space for recording and interpreting experimental results and require students to label diagrams and answer matching and short-answer questions. Selected questions can be assigned and automatically graded in Mastering A&P.
- **PhysioEx™ 9.1 Exercises**, located in the back of the lab manual and accessible through a subscription to Mastering A&P, are easy-to-use computer simulations that supplement or take the place of traditional wet labs safely and cost-effectively. These 12 exercises contain a total of 63 physiology laboratory activities that allow learners to change variables and test out various hypotheses for the experiments. PhysioEx™ allows students to repeat labs as often as they like, perform experiments without harming live animals, and conduct experiments that are difficult to perform because of time, cost, or safety concerns.

## Updated Content in This Edition of the Lab Manual

Throughout the manual, the narrative text has been streamlined and updated to make the language more understandable and to better meet the needs of today's students. Additional highlights include the following:

- **Dozens of new full-color figures and photos** replace black-and-white line drawings in the Exercise Review Sheets. Selected labeling questions in the manual can be assigned in Mastering A&P.
- **New Clinical Application questions** have been added to the Exercise Review Sheets and challenge students to apply lab concepts and critical-thinking skills to real-world clinical scenarios.
- **Updated BIOPAC® procedures** are included in the manual for eight lab exercises for the BIOPAC® 4.0 software upgrade. Procedures for Intelitool®, PowerLab®, and iWorx® remain available in the Instructor Resources area of Mastering A&P.
- **New Mastering A&P visual previews** appear on the first page of each lab exercise, highlighting a recommended pre-lab video, a related image from Practice Anatomy Lab 3.1 (PAL 3.1), or a helpful animation.
- **New Mastering A&P assignment recommendations** are signaled at appropriate points throughout the manual to help instructors assign related auto-graded activities and assessments.
- **Extensive updates and improvements** have been made to each of the 46 laboratory exercises in the manual to increase clarity and reduce ambiguity for students. Art within the exercises, the narrative, as well as the questions and figures within the Review Sheets have been updated. For a complete list of content updates, please refer to the *Instructor's Guide for Human Anatomy & Physiology Laboratory Manual 13/e* (ISBN 9780134778839 or in the Instructor Resources area of Mastering A&P).

## Highlights of Updated Content in Mastering A&P

**Mastering A&P**, the leading online homework, tutorial, and assessment system is designed to engage students and improve results by helping them stay on track in the course and quickly

master challenging anatomy and physiology concepts. Mastering A&P assignments support interactive features in the lab manual, including pre-lab video coaching activities; bone, muscle, and dissection videos; Dynamic Study Modules; *Get Ready for A&P*; plus a variety of Art Labeling questions, Clinical Application questions, and more. Highlights for this edition include the following:

- **8 new Pre-Lab Video Coaching Activities in Mastering A&P** (for a total of 18) focus on key concepts in the lab activity and walk students through important procedures. New pre-lab video titles include Preparing and Observing a Wet Mount, Examining a Long Bone, Initiating Pupillary Reflexes, Palpating Superficial Pulse Points, Auscultating Heart Sounds, and more.
- **New Cat and Fetal Pig Dissection Video Coaching Activities** help students prepare for dissection by previewing key anatomical structures. Each video includes one to two comparisons to human structures.
- **IMPROVED! Practice Anatomy Lab™ (PAL™ 3.1) is now fully accessible on all mobile devices**, including smartphones, tablets, and laptops. PAL is an indispensable virtual anatomy study and practice tool that gives students 24/7 access to the most widely used lab specimens, including human cadaver; anatomical models from leading manufacturers such as 3B Scientific, SOMSO, Denoyer-Geppert, Frey Scientific/Nystrom, Altay Scientific, and Ward's; histology; cat; and fetal pig. PAL 3.1 is easy to use and includes built-in audio pronunciations, rotatable bones, and simulated fill-in-the-blank lab practical exams.
- **New Customizable Practice Anatomy Lab (PAL) Flashcards** enable students to create a personalized, mobile-friendly deck of flashcards and quizzes using images from PAL 3.1. Students can generate flashcards using only the structures that their instructor emphasizes in lecture or lab.
- **New Building Vocabulary Coaching Activities** are a fun way for students to learn word roots and A&P terminology while building and practicing important language skills.
- **Expanded Dynamic Study Modules** help students study effectively on their own by continuously assessing their activity and performance in real time. Students complete a set of questions and indicate their level of confidence in their answer. Questions repeat until the student can answer them all correctly and confidently. These are available as graded assignments prior to class and are accessible on smartphones, tablets, and computers.
  - The Lab Manual Mastering A&P course now offers over 3000 Dynamic Study Module questions, shared with Marieb/Hoehn *Human Anatomy & Physiology*, 11th Edition.
  - Instructors can now remove questions from Dynamic Study Modules to better fit their course.
- **Expanded Drag-and-Drop Art Labeling Questions** allow students to assess their knowledge of terms and structures in the lab manual. Selected Exercise Review Sheet labeling activities in the manual are now assignable.

Please refer to the preceding pages for additional information about Mastering A&P and other resources for instructors and students.

# Acknowledgments

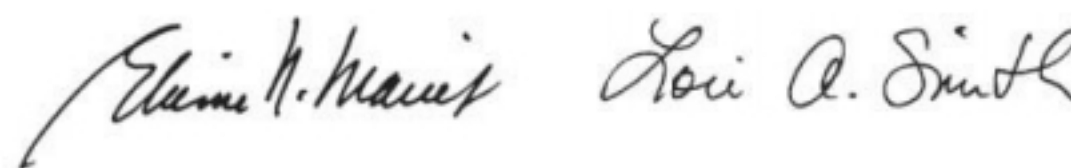
Continued thanks to our colleagues and friends at Pearson who collaborated with us on this edition, especially Editor-in-Chief Serina Beauparlant, Acquisitions Editor Lauren Harp, Editorial Assistant Dapinder Dosanjh, and Rich Content Media Producers Kimberly Twardochleb and Lauren Chen. We also thank the Pearson Sales and Marketing team for their work in supporting instructors and students, especially Senior A&P Specialist Derek Perrigo and Director of Product Marketing Allison Rona.

Special thanks go out to Amanda Kaufmann for her leadership and expertise in producing the 18 pre-lab videos that support this edition, and to Mike Mullins of BIOPAC®, who helped us update the instructions for consistency with the upgraded software.

We're also grateful to Michele Mangelli and her superb production team, who continue to cross every hurdle with

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Elaine N. Marieb & Lori A. Smith

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Credits C-1

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# 1 EXERCISE

## The Language of Anatomy

### Learning Outcomes

- ▶ Describe the anatomical position, and explain its importance.
- ▶ Use proper anatomical terminology to describe body regions, orientation and direction, and body planes.
- ▶ Name the body cavities, and indicate the important organs in each.
- ▶ Name and describe the serous membranes of the ventral body cavities.
- ▶ Identify the abdominopelvic quadrants and regions on a torso model or image.

### Pre-Lab Quiz



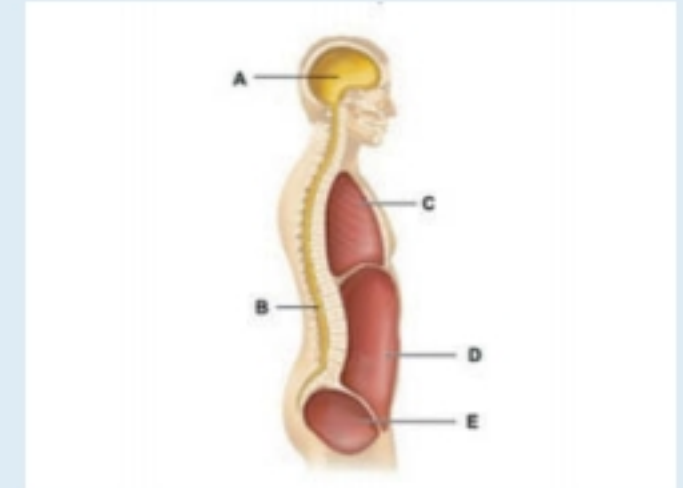
Instructors may assign these and other Pre-Lab Quiz questions using **Mastering A&P™**

1. Circle True or False. In anatomical position, the body is lying down.
2. Circle the correct underlined term. With regard to surface anatomy, abdominal / axial refers to the structures along the center line of the body.
3. The term *superficial* refers to a structure that is:
  - a. attached near the trunk of the body
  - b. toward or at the body surface
  - c. toward the head
  - d. toward the midline
4. The \_\_\_\_\_ plane runs longitudinally and divides the body into right and left sides.
  - a. frontal
  - b. sagittal
  - c. transverse
  - d. ventral
5. Circle the correct underlined terms. The dorsal body cavity can be divided into the cranial / thoracic cavity, which contains the brain, and the sural / vertebral cavity, which contains the spinal cord.

**A** student new to any science is often overwhelmed at first by the terminology used in that subject. The study of anatomy is no exception. But without specialized terminology, confusion is inevitable. For example, what do *over*, *on top of*, *above*, and *behind* mean in reference to the human body? Anatomists have an accepted set of reference terms that are universally understood. These allow body structures to be located and identified precisely with a minimum of words.

This exercise presents some of the most important anatomical terminology used to describe the body and introduces you to basic concepts of **gross anatomy**, the study of body structures visible to the naked eye.

Go to **Mastering A&P™** > **Study Area** to improve your performance in **A&P Lab**.



Instructors may assign new Building Vocabulary coaching activities, Pre-Lab Quiz questions, Art Labeling activities, and more using the **Mastering A&P™** Item Library.

### Materials

- ▶ Human torso model (dissectible)
- ▶ Human skeleton
- ▶ Demonstration: sectioned and labeled kidneys (three separate kidneys uncut or cut so that [a] entire, [b] transverse sectional, and [c] longitudinal sectional views are visible)
- ▶ Gelatin-spaghetti molds
- ▶ Scalpel

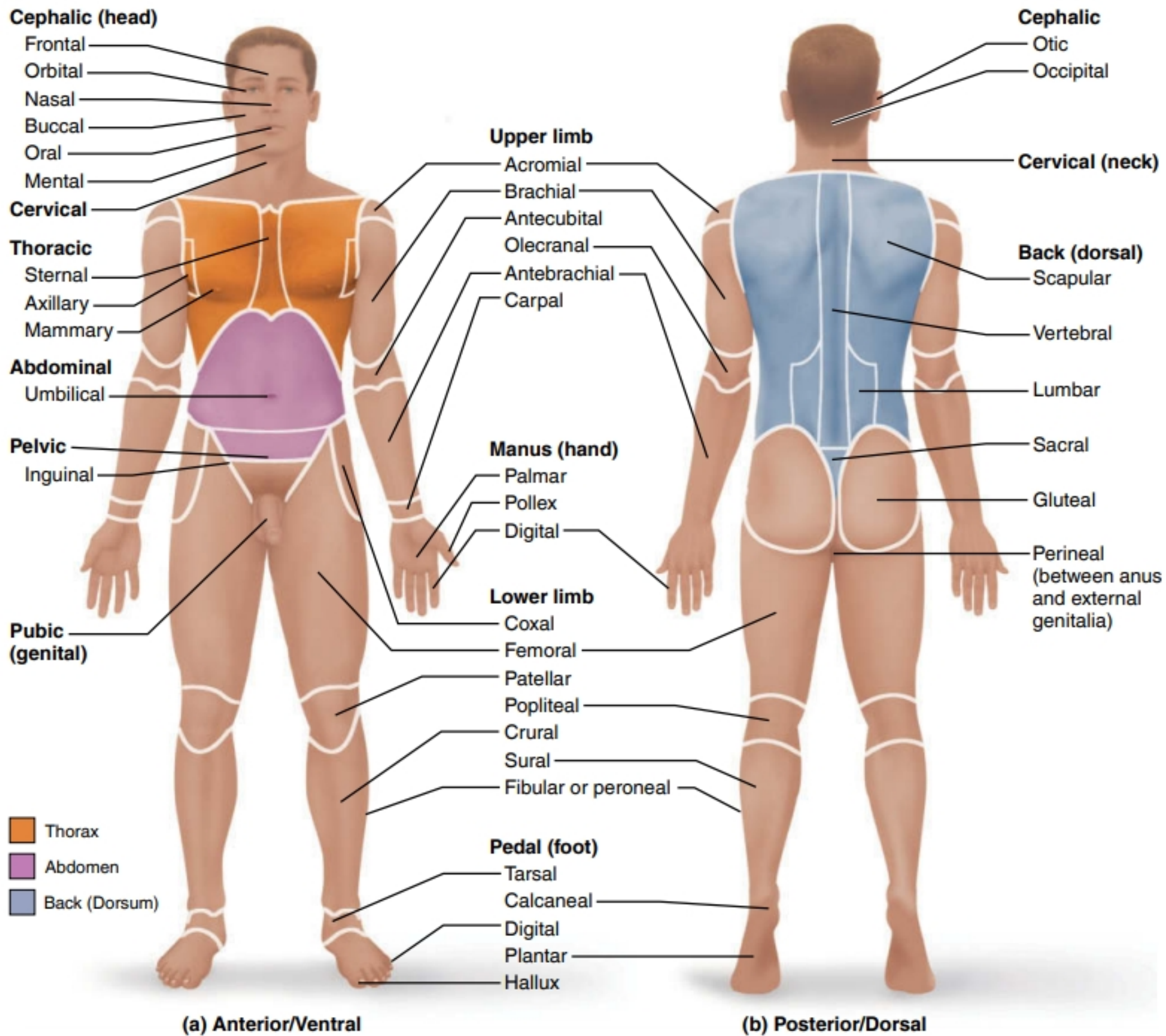
## Anatomical Position

When anatomists or doctors refer to specific areas of the human body, the picture they keep in mind is a universally accepted standard position called the **anatomical position**. In the anatomical position, the human body is erect, with the feet only slightly apart, head and toes pointed forward, and arms hanging at the sides with palms facing forward (Figure 1.1a). It is also

important to remember that “left” and “right” refer to the sides of the individual, not the observer.

Assume the anatomical position. The hands are held unnaturally forward rather than hanging with palms toward the thighs.

Check the box when you have completed this task.



**Figure 1.1 Anatomical position and regional terms.** Heels are raised to illustrate the plantar surface of the foot, which is actually on the inferior surface of the body.



Instructors may assign this figure as an Art Labeling Activity using **Mastering A&P™**

## Regional Anatomy

The body is divided into two main regions, the axial and appendicular regions. The **axial region** includes the head, neck, and trunk; it runs along the vertical axis of the body. The **appendicular region** includes the limbs, which are also

called the appendages or extremities. The body is also divided up into smaller regions within those two main divisions. **Table 1.1** summarizes the body regions that are illustrated in Figure 1.1.

Table 1.1 Regions of the Human Body (Figure 1.1)

Region	Description	Region	Description
Abdominal	Located below the ribs and above the hips	Nasal	Nose
Acromial	Point of the shoulder	Occipital	Back of the head
Antebrachial	Forearm	Olecranal	Back of the elbow
Antecubital	Anterior surface of the elbow	Oral	Mouth
Axillary	Armpit	Orbital	Bony eye socket
Brachial	Arm (upper portion of the upper limb)	Otic	Ear
Buccal	Cheek	Palmar	Palm of the hand
Calcaneal	Heel of the foot	Patellar	Kneecap
Carpal	Wrist	Pedal	Foot
Cephalic	Head	Pelvic	Pelvis
Cervical	Neck	Perineal	Between the anus and the external genitalia
Coxal	Hip	Plantar	Sole of the foot
Crural	Leg	Pollex	Thumb
Digital	Fingers or toes	Popliteal	Back of the knee
Femoral	Thigh	Pubic	Genital
Fibular (peroneal)	Side of the leg	Sacral	Posterior region between the hip bones
Frontal	Forehead	Scapular	Shoulder blade
Gluteal	Buttocks	Sternal	Breastbone
Hallux	Great toe	Sural	Calf
Inguinal	Groin	Tarsal	Ankle
Lumbar	Lower back	Thoracic	Chest
Mammary	Breast	Umbilical	Naval
Manus	Hand	Vertebral	Spine
Mental	Chin		

## Activity 1

### Locating Body Regions

Locate the anterior and posterior body regions on yourself, your lab partner, and a human torso model.

## Directional Terms

Study the terms below, referring to **Figure 1.2** for a visual aid. Notice that certain terms have different meanings, depending on whether they refer to a four-legged animal (quadruped) or to a human (biped).

**Superior/inferior** (*above/below*): These terms refer to placement of a structure along the long axis of the body. The nose, for example, is superior to the mouth, and the abdomen is inferior to the chest.

**Anterior/posterior** (*front/back*): In humans, the most anterior structures are those that are most forward—the face, chest, and

abdomen. Posterior structures are those toward the backside of the body. For instance, the spine is posterior to the heart.

**Medial/lateral** (*toward the midline/away from the midline or median plane*): The sternum (breastbone) is medial to the ribs; the ear is lateral to the nose.

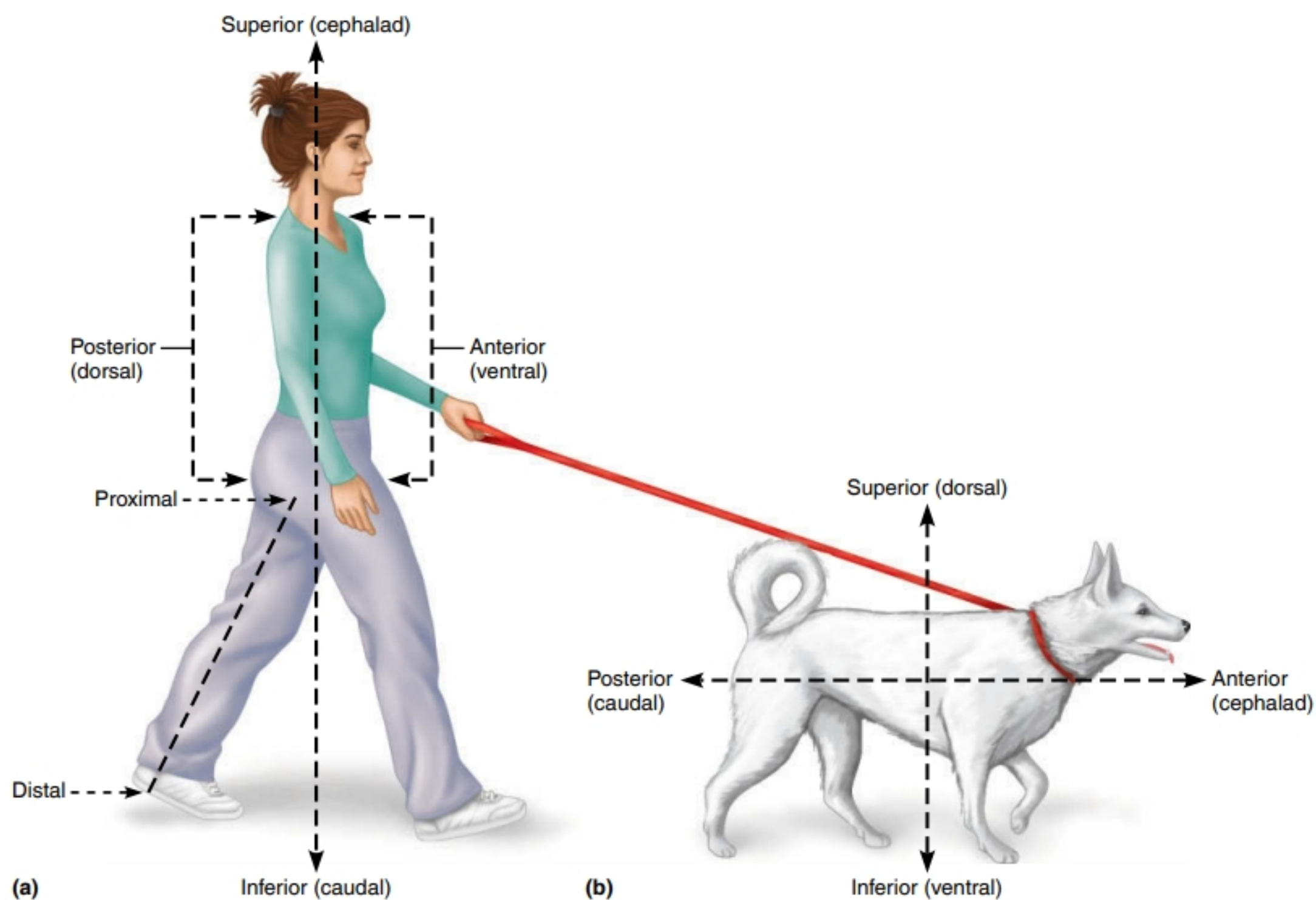
The terms of position just described assume the person is in the anatomical position. The next four term pairs are more absolute. They apply in any body position, and they consistently have the same meaning in all vertebrate animals.

**Cephalad (cranial)/caudal** (*toward the head/toward the tail*): In humans, these terms are used interchangeably with *superior* and *inferior*, but in four-legged animals they are synonymous with *anterior* and *posterior*, respectively.

**Ventral/dorsal** (*belly side/backside*): These terms are used chiefly in discussing the comparative anatomy of animals, assuming the animal is standing. In humans, the terms *ventral* and *dorsal* are used interchangeably with the terms *anterior* and *posterior*, but in four-legged animals, *ventral* and *dorsal* are synonymous with *inferior* and *superior*, respectively.

**Proximal/distal** (*nearer the trunk or attached end/farther from the trunk or point of attachment*): These terms are used primarily to locate various areas of the body limbs. For example, the fingers are distal to the elbow; the knee is proximal to the toes. However, these terms may also be used to indicate regions (closer to or farther from the head) of internal tubular organs.

**Superficial (external)/deep (internal)** (*toward or at the body surface/away from the body surface*): For example, the skin is superficial to the skeletal muscles, and the lungs are deep to the rib cage.



**Figure 1.2** Directional terms. (a) With reference to a human. (b) With reference to a four-legged animal.



Instructors may assign this figure as an Art Labeling Activity using **Mastering A&P™**

## Activity 2

### Practicing Using Correct Anatomical Terminology

Use a human torso model, a human skeleton, or your own body to practice using the regional and directional terminology.

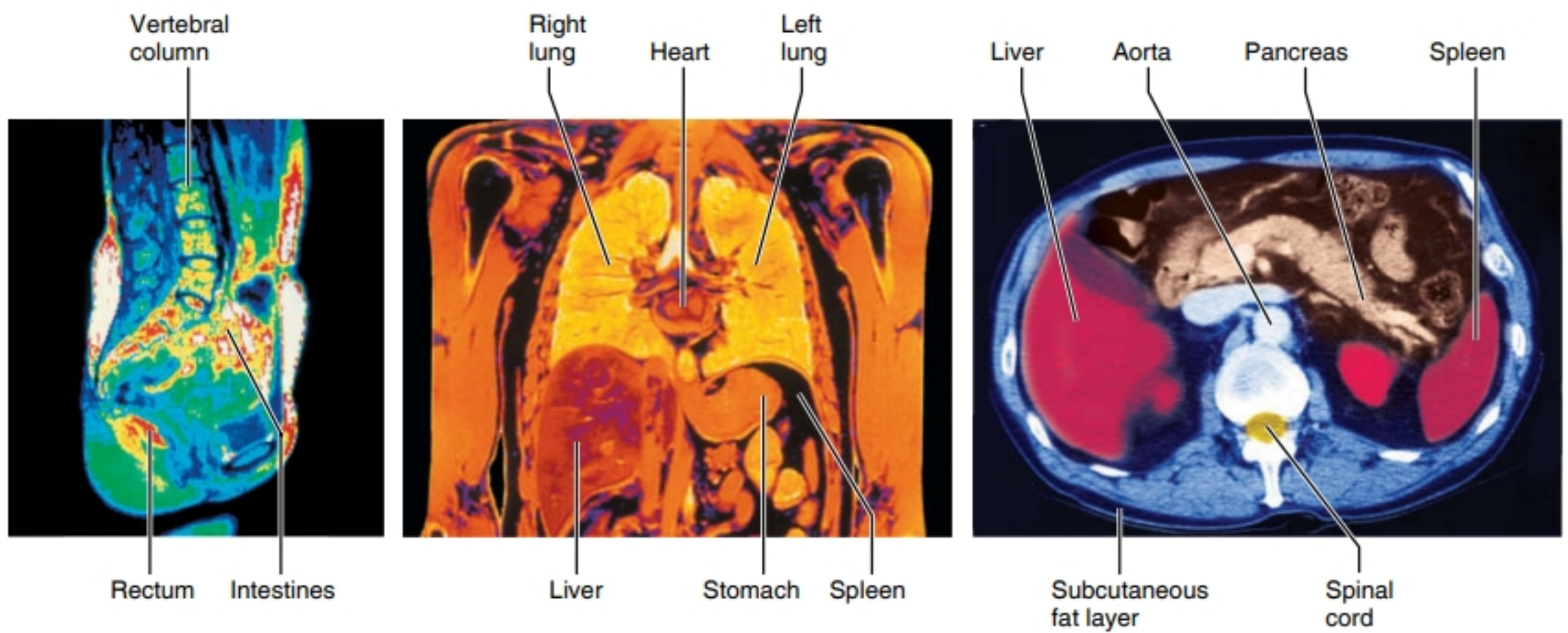
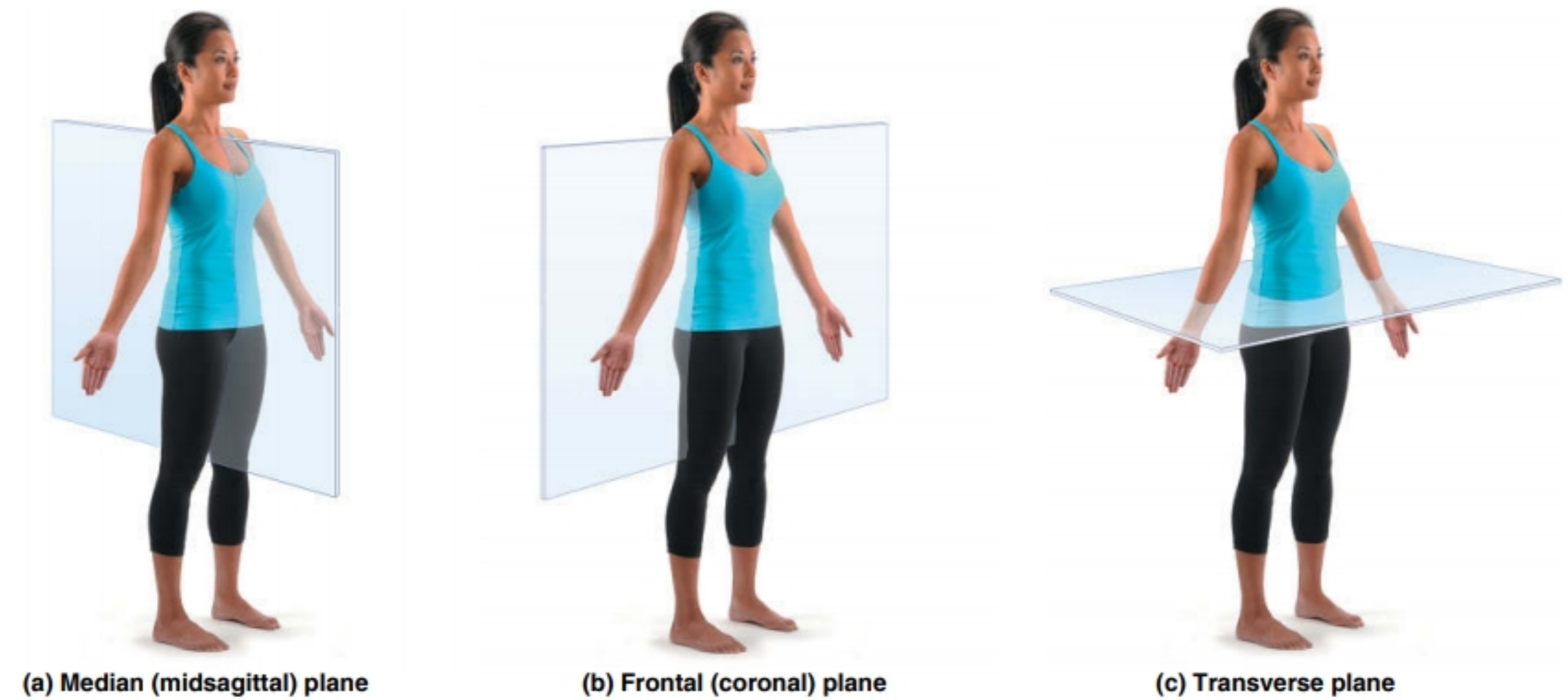
1. The popliteal region is \_\_\_\_\_ (anterior or posterior)
2. The acromial region is \_\_\_\_\_ to the otic region. (medial or lateral)

3. The femoral region is \_\_\_\_\_ to the tarsal region. (proximal or distal)
4. The bones are \_\_\_\_\_ to the skin. (superficial or deep)

## Body Planes and Sections

The body is three-dimensional, and in order to observe its internal structures, it is often necessary to make a **section**, or cut. When the section is made through the body wall or through an organ, it is made along an imaginary surface

or line called a **plane**. A section is named for the plane along which it is cut. Anatomists commonly refer to three planes (**Figure 1.3**), or sections, that lie at right angles to one another.



**Figure 1.3** Planes of the body with corresponding magnetic resonance imaging (MRI) scans. Note the transverse section is an inferior view.

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**Sagittal plane:** A sagittal plane runs longitudinally and divides the body into right and left parts. If it divides the body into equal parts, right down the midline of the body, it is called a **median**, or **midsagittal**, plane.

**Frontal plane:** Sometimes called a **coronal plane**, the frontal plane is a longitudinal plane that divides the body (or an organ) into anterior and posterior parts.

**Transverse plane:** A transverse plane runs horizontally, dividing the body into superior and inferior parts. When organs are sectioned along the transverse plane, the sections are commonly called **cross sections**.

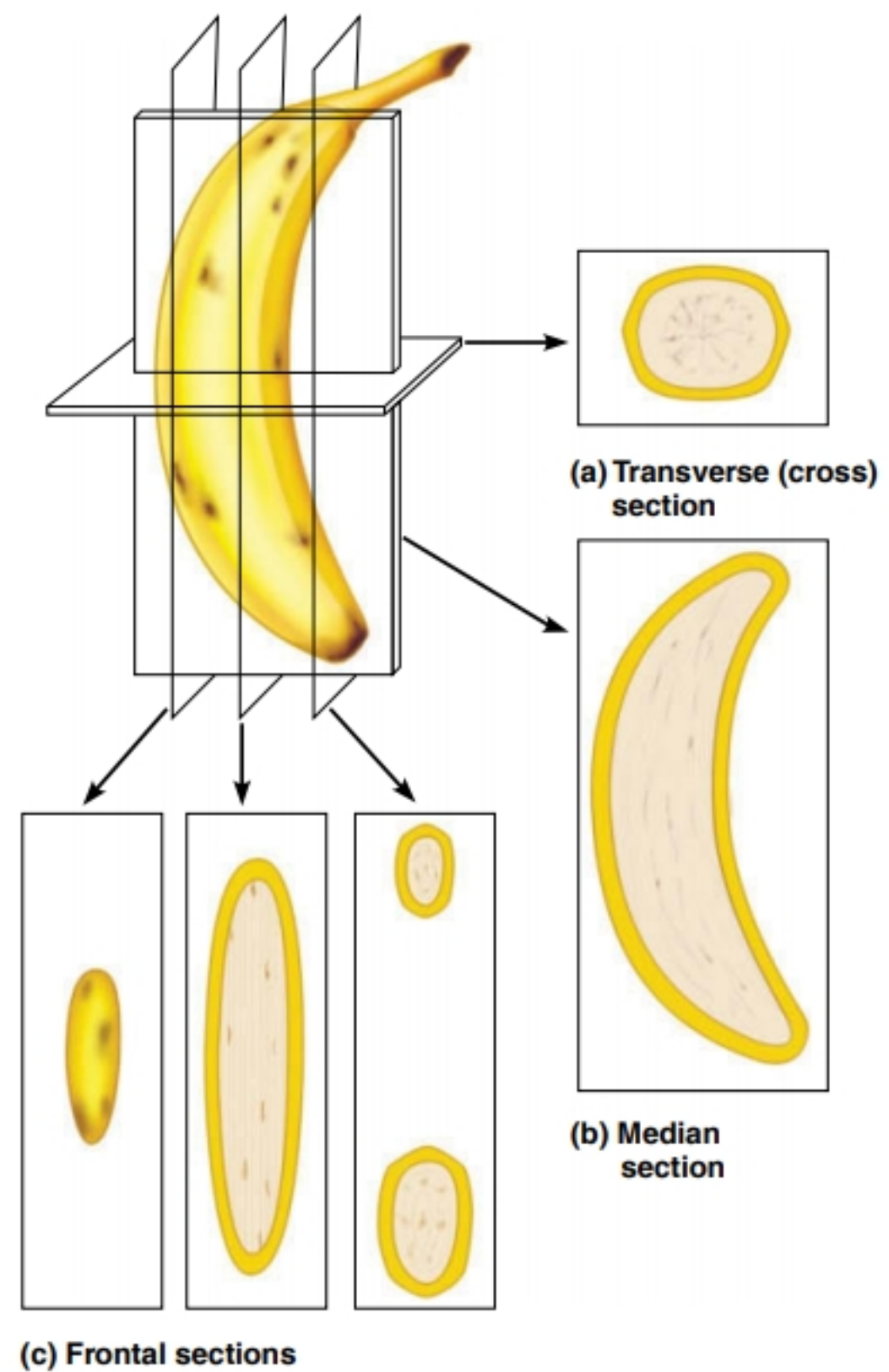
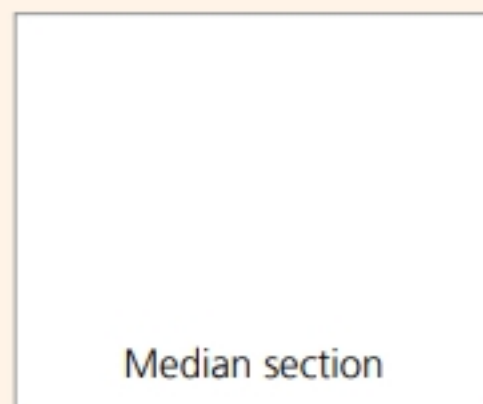
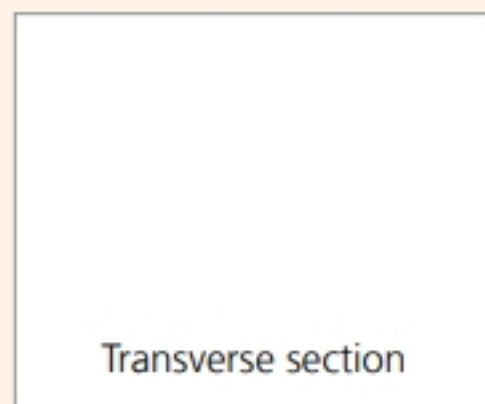
On microscope slides, the abbreviation for a longitudinal section (sagittal or frontal) is l.s. Cross sections are abbreviated x.s. or c.s.

A median or frontal plane section of any nonspherical object, be it a banana or a body organ, provides quite a different view from a cross section (**Figure 1.4**).

### Activity 3

#### Observing Sectioned Specimens

1. Go to the demonstration area and observe the transversely and longitudinally cut organ specimens (kidneys).
2. After completing instruction 1, obtain a gelatin-spaghetti mold and a scalpel, and take them to your laboratory bench. (Essentially, this is just cooked spaghetti added to warm gelatin, which is then allowed to gel.)
3. Cut through the gelatin-spaghetti mold along any plane, and examine the cut surfaces. You should see spaghetti strands that have been cut transversely (x.s.) and some cut longitudinally (a median section).
4. Draw the appearance of each of these spaghetti sections below, and verify the accuracy of your section identifications with your instructor.



**Figure 1.4** Objects can look odd when viewed in section. This banana has been sectioned in three different planes (**a–c**), and only in one of these planes (**b**) is it easily recognized as a banana. If one cannot recognize a sectioned organ, it is possible to reconstruct its shape from a series of successive cuts, as from the three serial sections in (**c**).

## Body Cavities

The axial region of the body has two large cavities that provide different degrees of protection to the organs within them (Figure 1.5).

### Dorsal Body Cavity

The dorsal body cavity can be subdivided into the **cranial cavity**, which lies within the rigid skull and encases the brain, and the **vertebral (or spinal) cavity**, which runs through the bony vertebral column to enclose the delicate spinal cord.

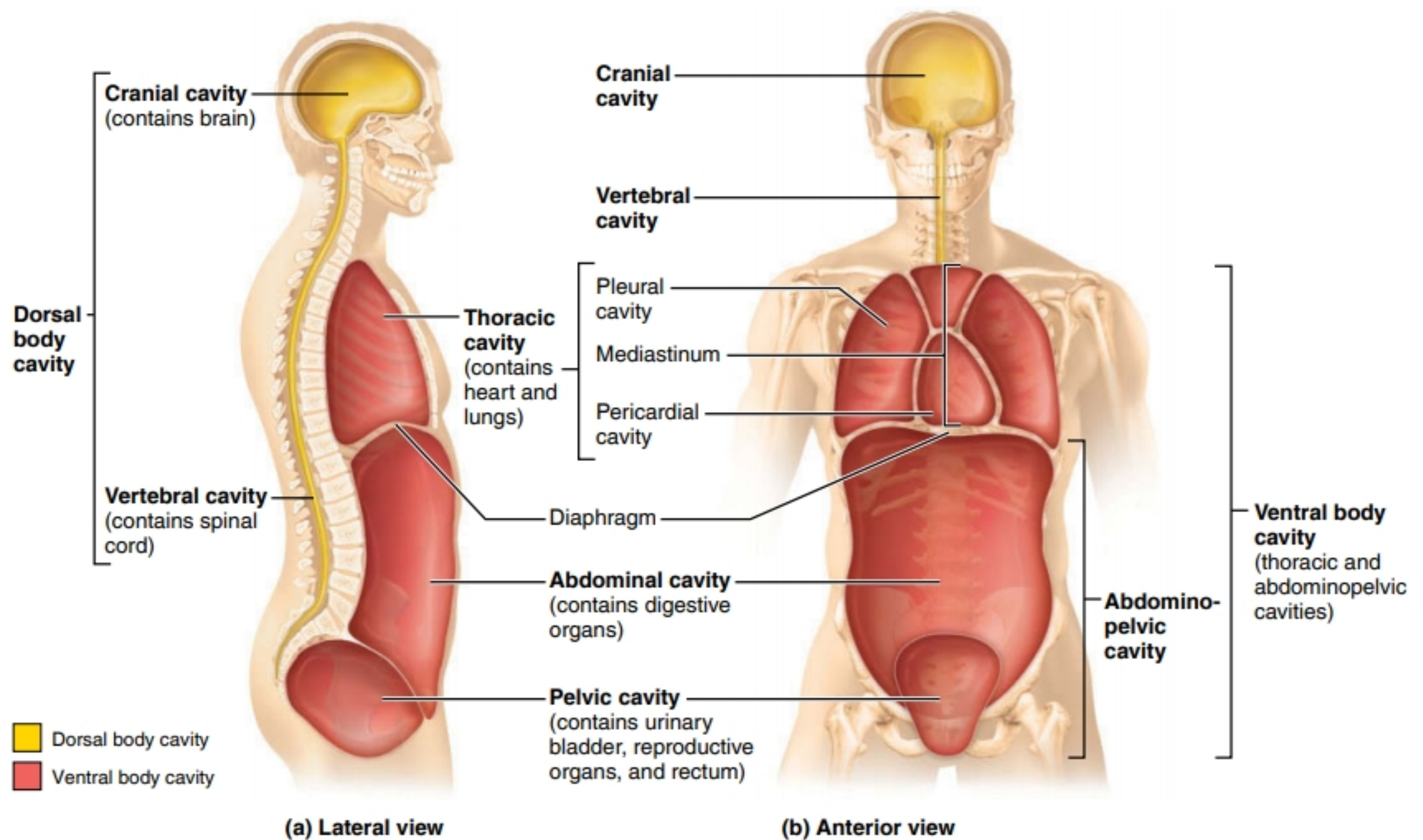
### Ventral Body Cavity

Like the dorsal cavity, the ventral body cavity is subdivided. The superior **thoracic cavity** is separated from the rest of the ventral cavity by the dome-shaped diaphragm. The heart and lungs, located in the thoracic cavity, are protected by the bony rib cage. The cavity inferior to the diaphragm is referred to

as the **abdominopelvic cavity**. Although there is no further physical separation of the ventral cavity, some describe the abdominopelvic cavity as two areas: a superior **abdominal cavity**, the area that houses the stomach, intestines, liver, and other organs, and an inferior **pelvic cavity**, the region that is partially enclosed by the bony pelvis and contains the reproductive organs, bladder, and rectum.

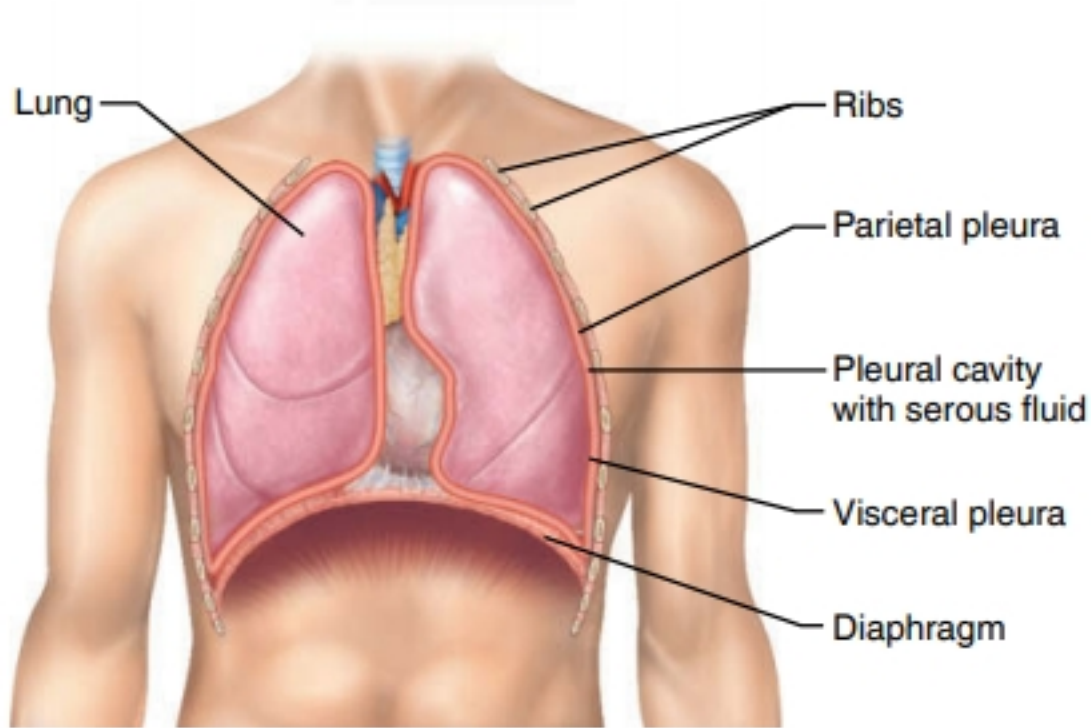
### Serous Membranes of the Ventral Body Cavity

The walls of the ventral body cavity and the outer surfaces of the organs it contains are covered with a very thin, double-layered membrane called the **serosa**, or **serous membrane**. The part of the membrane lining the cavity walls is referred to as the **parietal serosa**, and it is continuous with a similar membrane, the **visceral serosa**, covering the external surface of the organs within the cavity. These membranes produce a thin lubricating fluid that allows the visceral organs to slide over one another or to rub against the body wall with minimal

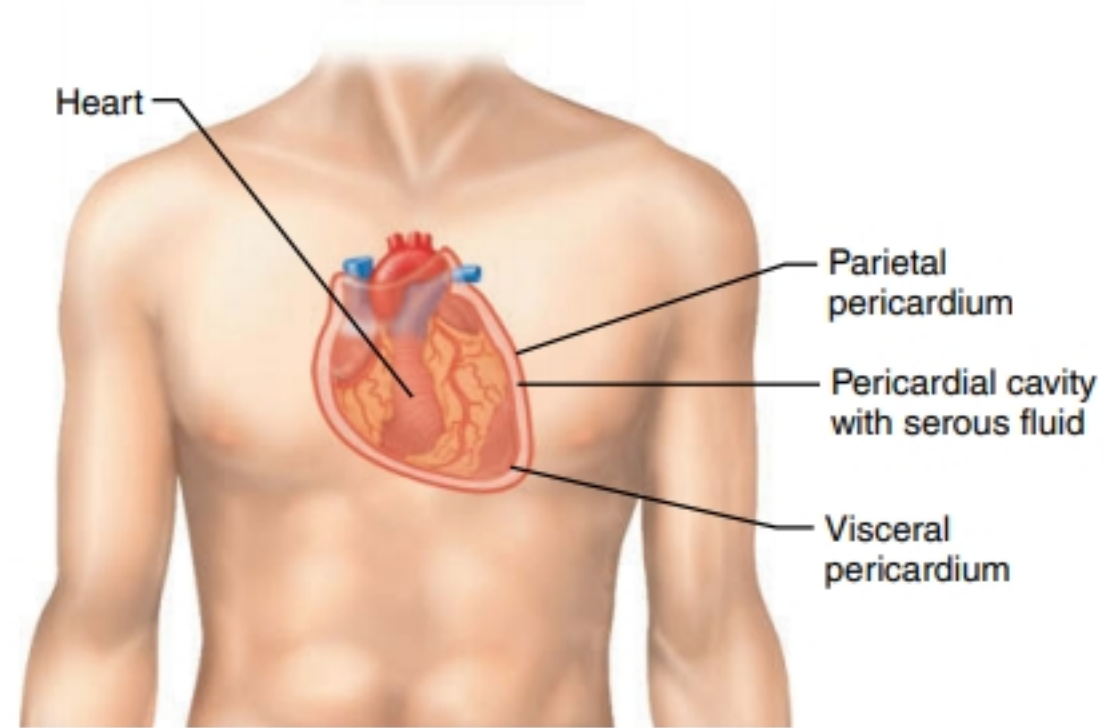


**Figure 1.5** Dorsal and ventral body cavities and their subdivisions.

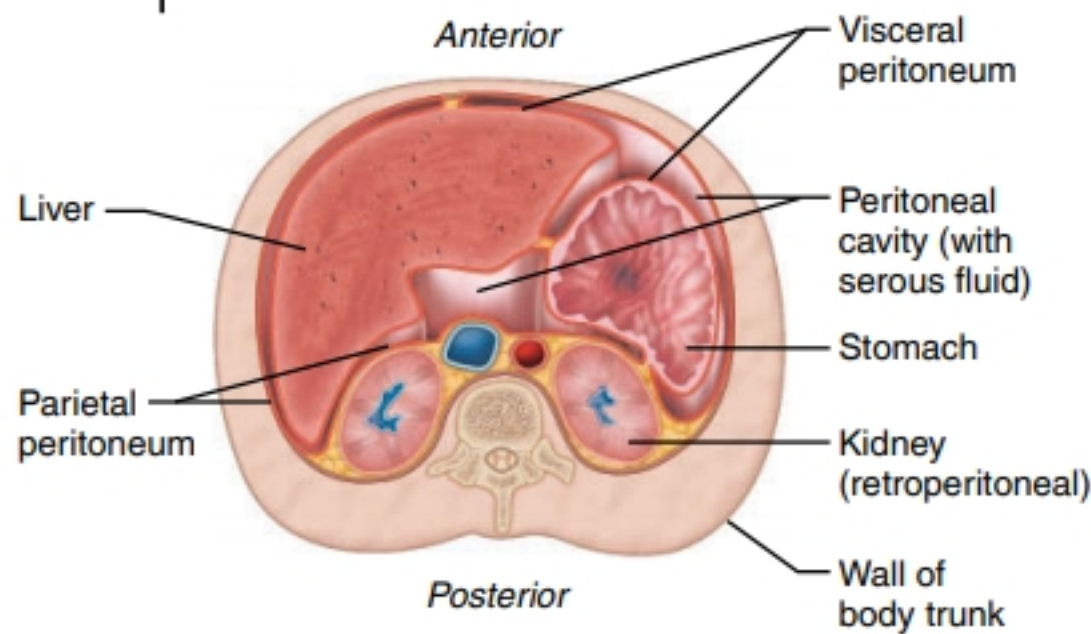
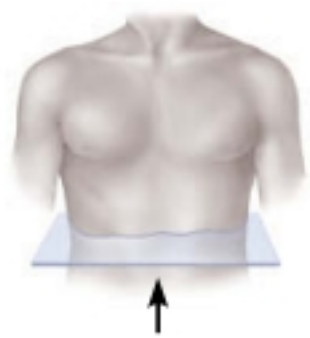
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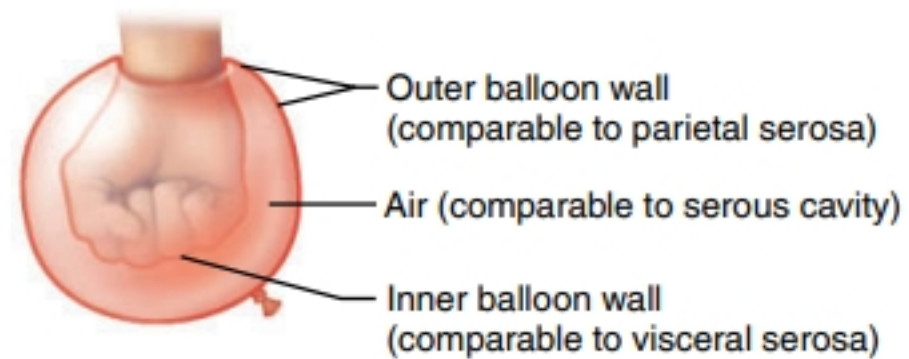
(a) Serosae associated with the lungs: pleura



(b) Serosae associated with the heart: pericardium



(c) Serosae associated with the abdominal viscera: peritoneum



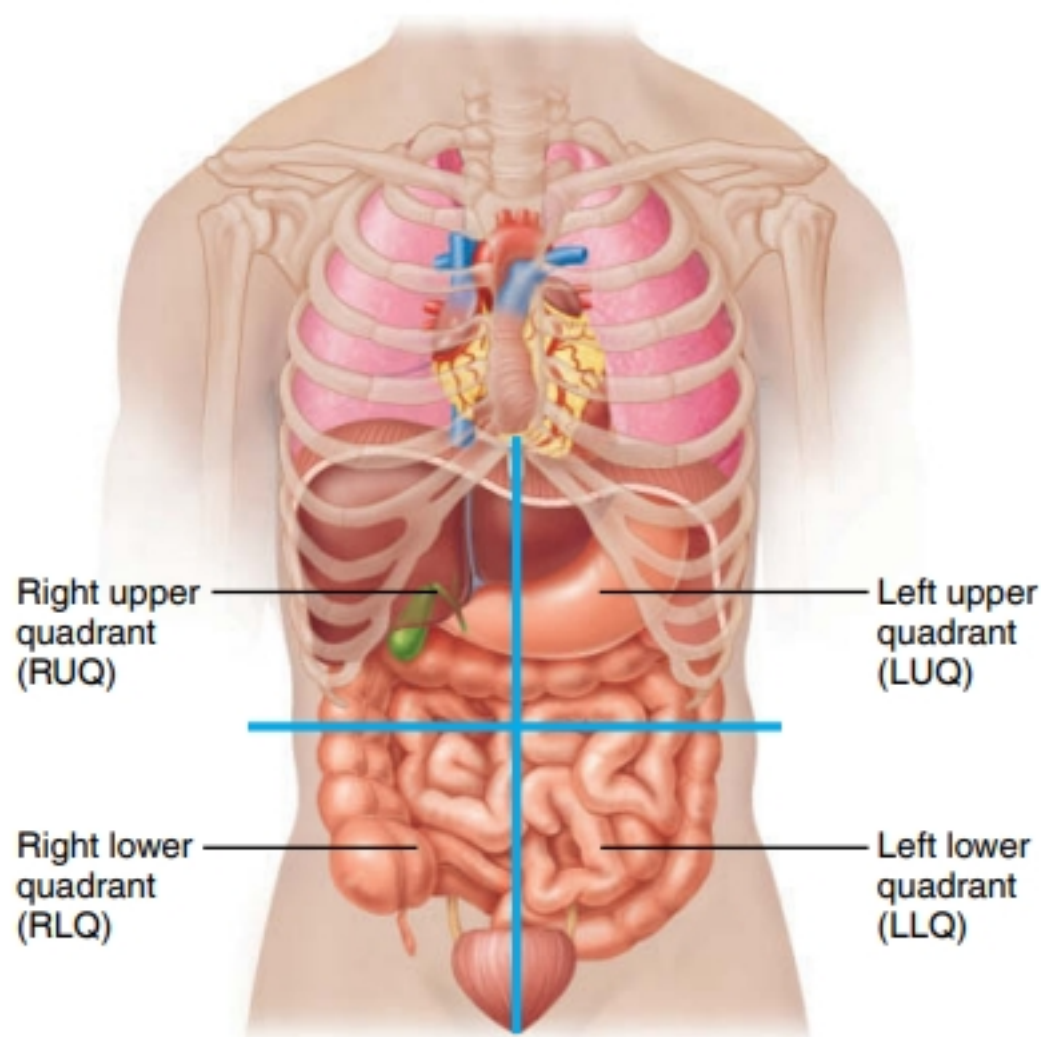
(d) Model of the serous membranes and serous cavity

**Figure 1.6** Serous membranes of the ventral body cavities.

friction. Serous membranes also compartmentalize the various organs to prevent infection in one organ from spreading to others.

The specific names of the serous membranes depend on the structures they surround. The serosa lining the abdominal

cavity and covering its organs is the **peritoneum**, the serosa enclosing the lungs is the **pleura**, and the serosa around the heart is the **pericardium** (Figure 1.6). A fist pushed into a limp balloon demonstrates the relationship between the visceral and parietal serosae (Figure 1.6d).



**Figure 1.7 Abdominopelvic quadrants.** Superficial organs are shown in each quadrant.

### Abdominopelvic Quadrants and Regions

Because the abdominopelvic cavity is quite large and contains many organs, it is helpful to divide it up into smaller areas for discussion or study.

Most physicians and nurses use a scheme that divides the abdominal surface and the abdominopelvic cavity into four approximately equal regions called **quadrants**. These quadrants

## Activity 4

### Identifying Organs in the Abdominopelvic Cavity

Examine the human torso model to respond to the following questions.

Name two organs found in the left upper quadrant.

\_\_\_\_\_ and \_\_\_\_\_

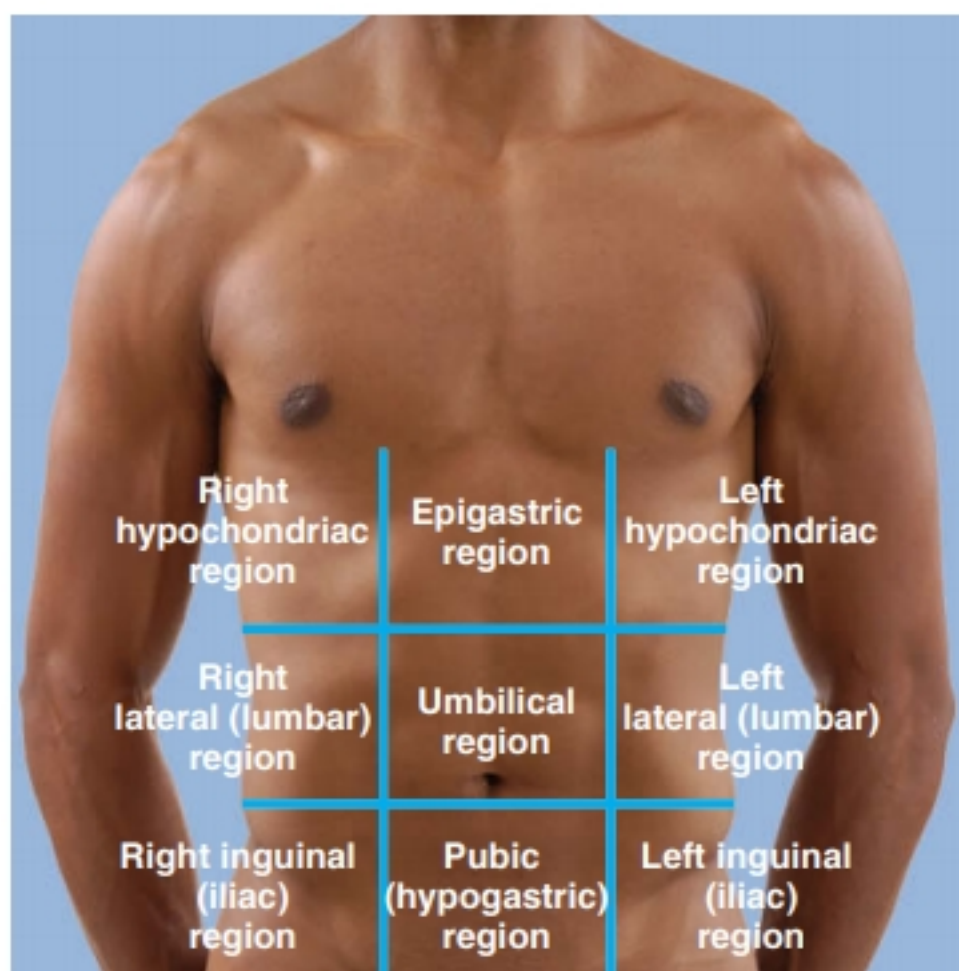
Name two organs found in the right lower quadrant.

\_\_\_\_\_ and \_\_\_\_\_

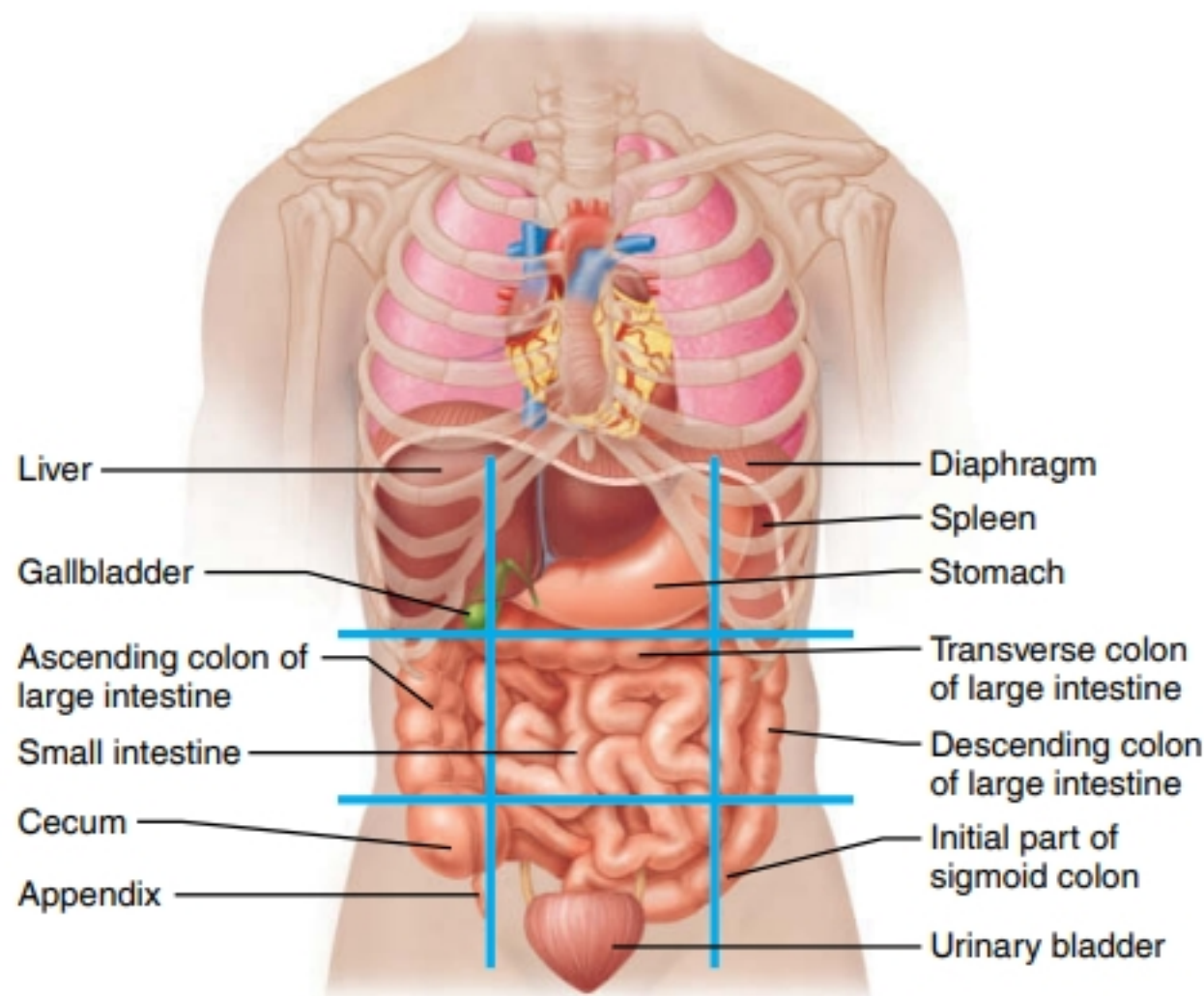
What organ (Figure 1.7) is divided into identical halves by the median plane? \_\_\_\_\_

are named according to their relative position—that is, *right upper quadrant*, *right lower quadrant*, *left upper quadrant*, and *left lower quadrant* (Figure 1.7). Note that the terms *left* and *right* refer to the left and right side of the body in the figure, not the left and right side of the art on the page.

A different scheme commonly used by anatomists divides the abdominal surface and abdominopelvic cavity into nine separate regions by four planes (Figure 1.8). As you read



(a)



(b)

**Figure 1.8 Abdominopelvic regions.** Nine regions delineated by four planes. (a) The superior horizontal plane is just inferior to the ribs; the inferior horizontal plane is at the superior aspect of the hip bones. The vertical planes are just medial to the nipples. (b) Superficial organs are shown in each region.

Instructors may assign this figure as an Art Labeling Activity using **Mastering A&P™**

through the descriptions of these nine regions, locate them in Figure 1.8, and note the organs contained in each region.

**Umbilical region:** The centermost region, which includes the umbilicus (navel)

**Epigastric region:** Immediately superior to the umbilical region; overlies most of the stomach

**Pubic (hypogastric) region:** Immediately inferior to the umbilical region; encompasses the pubic area

**Inguinal, or iliac, regions:** Lateral to the hypogastric region and overlying the superior parts of the hip bones

**Lateral (lumbar) regions:** Between the ribs and the flaring portions of the hip bones; lateral to the umbilical region

**Hypochondriac regions:** Flanking the epigastric region laterally and overlying the lower ribs

## Activity 5

### Locating Abdominopelvic Surface Regions

Locate the regions of the abdominopelvic surface on a human torso model.

## Other Body Cavities

Besides the large, closed body cavities, there are several types of smaller body cavities (Figure 1.9). Many of these are in the head, and most open to the body exterior.

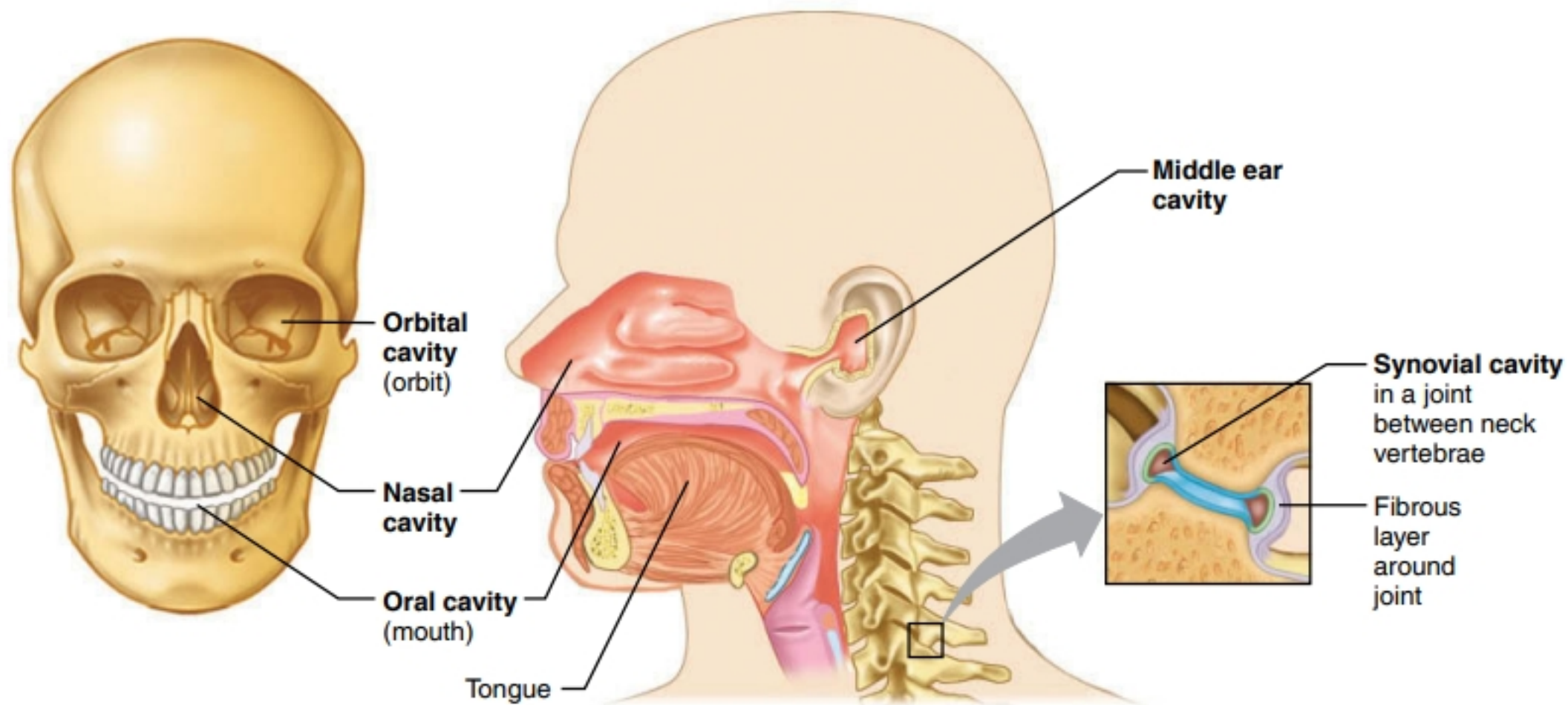
**Oral cavity:** The oral cavity, commonly called the *mouth*, contains the tongue and teeth. It is continuous with the rest of the digestive tube, which opens to the exterior at the anus.

**Nasal cavity:** Located within and posterior to the nose, the nasal cavity is part of the passages of the respiratory system.

**Orbital cavities:** The orbital cavities (orbits) in the skull house the eyes and present them in an anterior position.

**Middle ear cavities:** Each middle ear cavity lies just medial to an eardrum and is carved into the bony skull. These cavities contain tiny bones that transmit sound vibrations to the hearing receptors in the inner ears.

**Synovial cavities:** Synovial cavities are joint cavities—they are enclosed within fibrous capsules that surround the freely movable joints of the body, such as those between the vertebrae and the knee and hip joints. Like the serous membranes of the ventral body cavity, membranes lining the synovial cavities secrete a lubricating fluid that reduces friction as the enclosed structures move across one another.



**Figure 1.9 Other body cavities.** The oral, nasal, orbital, and middle ear cavities are located in the head and open to the body exterior. Synovial cavities are found in joints between bones, such as the vertebrae of the spine, and at the knee, shoulder, and hip.

# 1 EXERCISE

## REVIEW SHEET

# The Language of Anatomy

Name \_\_\_\_\_ Lab Time/Date \_\_\_\_\_

### Regional Terms

- Describe completely the standard human anatomical position. \_\_\_\_\_  
\_\_\_\_\_
- Use the regional terms to correctly label the body regions indicated on the figures below.

