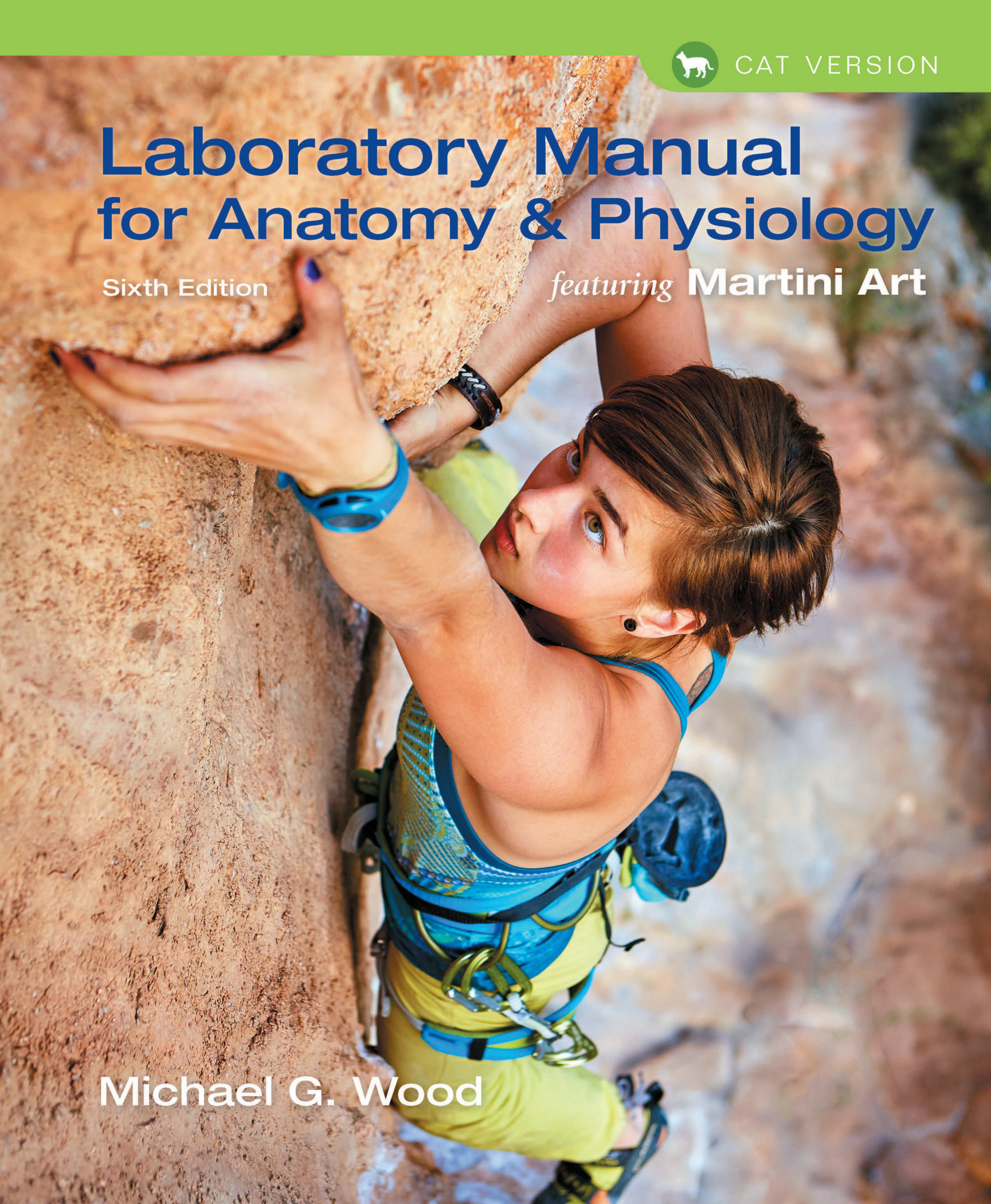
CAT VERSION
Laboratory Manual
for Anatomy & Physiology
Sixth Edition
featuring Martini Art
Michael G. Wood

Cat Version

# Laboratory Manual for Anatomy & Physiology

Sixth Edition

*featuring* **Martini Art**


## Michael G. Wood

*with*

William C. Ober, M.D.
*Art Coordinator and Illustrator*

Claire W. Garrison, R.N.
*Illustrator*

Ralph T. Hutchings
*Biomedical Photographer*

Shawn Miller
*Organ and Animal Dissector*

Mark Nielsen
*Organ and Animal Dissection Photographer*



PEARSON

# Preface

This laboratory manual is designed to serve the lab course that accompanies the two-semester anatomy and physiology lecture course. It provides students with comprehensive coverage of anatomy and physiology, beautiful full-color art and photographs, and an intuitive pedagogical framework. The primary goals of this manual are to provide students with hands-on experiences that reinforce the information they learn in the lecture course and to help them understand three-dimensional relationships, visualize complex structures, and comprehend intricate physiological processes.

The manual is written to correspond to all current two-semester anatomy and physiology textbooks, although those students and instructors using *Fundamentals of Anatomy & Physiology*, Tenth Edition, by Frederic H. Martini, Judi L. Nath, and Edwin F. Bartholomew will recognize here some of the superb art from that text by William Ober and Claire Garrison, Martini's renowned biomedical illustrators.

This sixth edition manual is available in three separate versions. The Main Version covers the full two-semester A&P curriculum, including dissections of the cow eye and of the sheep heart, brain, and kidney. The Cat Version includes all of the same material plus an additional section of nine cat dissection exercises encompassing the major body systems. The Pig Version, similarly, includes all of the material from the Main Version with a separate section of nine fetal pig dissection exercises. The Cat and Pig Versions make the manual more useful to instructors whose students perform animal dissections in the lab. The outstanding dissections and accompanying photographs are by Shawn Miller and Mark Neilsen and I thank each of them for their expertise.

## Organization

The lab manual contains 47 exercises, plus the 9 additional dissection exercises in each of the Cat and Pig Versions. Large systems, such as the skeletal, muscular, and nervous systems, appear across several exercises, the first serving as an overview exercise that introduces the major anatomical organization of the system. Programs with limited lab time might choose the overview exercises for a hands-on summary of these organ systems that can be completed during a short lab period.

### Exercise Organization

Each exercise is organized into a series of Lab Activities that divide the material into natural sets of information to focus students on related concepts. Every exercise begins with a list of the Lab Activities and a set of Learning Outcomes for student learning. A general introduction to the exercise gives students a preview of what they are about to learn; then individual activities focus on more specific study. The activities are self-contained, and instructors may easily assign only certain activities within an exercise.

Each Lab Activity section first introduces the activity and reviews the concepts necessary for understanding it. These are followed by two or three QuickCheck Questions that students can use to gauge their comprehension of the material before proceeding. The activity itself begins with a clearly marked list of Materials and the Procedures for carrying it out. Features such as Clinical Application boxes, Study Tip boxes, Draw It! activities, and Make a Prediction questions provide students with meaningful context and additional practice and review as they complete each activity. Each exercise concludes with a Review & Practice Sheet, which includes data reporting, review questions, and labeling and drawing activities to assess and reinforce student learning.

### Cat and Pig Dissection Exercises

Dissection gives students perspective on the texture, scale, and relationships of anatomy. For those instructors who choose to teach dissection in their laboratories, this manual is available in two dissection versions, the Cat Version and the Pig Version, featuring sections at the back of the manual detailing the dissection of the cat or fetal pig. Included are nine exercises that progress through the major body systems, with the goal of relating these exercises to students' study of the human body. Safety guidelines and disposal methods are incorporated into each dissection exercise.

### BIOPAC® Activities

Beginning with the second edition, this manual has featured exercises using the BIOPAC Student Lab System, an integrated suite of hardware and software that provides students with powerful tools for studies in physiology. BIOPAC is used in Exercises 22, 23, 30, 37, and 40, and can be easily identified by the BIOPAC logo to the left of the activity title. All of these BIOPAC activities feature step-by-step instructions, full-color art, and instructive screenshots to walk students through the procedures. The instructions in this lab manual are for use with the BIOPAC MP36 (or MP35/30) data acquisition unit, and Biopac Student Lab (BSL) Software version 3.7.5 or better. Instructions for use of the new two-channel data acquisition unit, the MP45, can be found in the Instructor Resources at MasteringA&P (masteringaandp.com).

## New to This Edition

In addition to the many technical changes in this edition, such as updated terminology and internal reorganization of exercises in response to reviewer feedback, this revision focuses on improving the visual presentation throughout and provides students with more opportunities for practice and review. These are the key changes in this new edition:

- **Larger, more visually effective art from Martini /Nath/ Bartholomew *Fundamentals of Anatomy & Physiology*, Tenth Edition**, appears throughout the manual. Improved text–art integration in the figure layouts enhances the readability of the art. Part captions are now integrated into the figures so that relevant text is located immediately next to each part of the figure. A new two-column design better showcases the Martini art.
- **Over 150 new photographs by author Michael Wood** add an "in the lab" style visual guide to histology, lab models, laboratory equipment, and dissections. The **new Dissection Photo Series** present a visual sequence of steps for organ dissections and lab instrument use.
- **More labeling activities** are offered within the tear-out end of exercise Review & Practice Sheets throughout the manual, including the dissection exercises. Photographs of laboratory models for labeling are also available at MasteringA&P as self-grading activities.
- **Improved "Draw It!" activities**, complete with blank drawing boxes for the student, are now signaled by a repeating color treatment to call out the hands-on learning opportunity for students. Several Draw It! activities include online video tutorials that demonstrate drawing techniques. See page xiii for more information.
- **New "Make a Prediction" questions** challenge students to think critically by asking conceptual and/or analytical questions. Students are asked to make predictions and propose hypotheses. This feature appears only where relevant—for example, in exercises that require data interpretation and analysis.
- **BIOPAC activities** have been extensively rewritten with an emphasis on streamlining the instructions to enhance usability of the manual in concert with the BIOPAC software. The number of BIOPAC data graphs has been reduced to prompt students to evaluate their own data during these physiological investigations. In addition, a new BIOPAC activity investigates Respiratory Rate and Depth (Exercise 40).
- **This Laboratory Manual comes with MasteringA&P.** MasteringA&P is the leading online homework, tutorial, and assessment system, designed to improve results by engaging students before, during, and after class. Instructors ensure students arrive ready to learn by assigning educationally effective content before class, and encourage critical thinking and retention with in-class resources such as Learning Catalytics™. Students can further master concepts after class through traditional and adaptive homework assignments that provide hints and answer-specific feedback. The MasteringA&P gradebook records scores for all automatically graded assignments in one place, while diagnostic tools offer access to rich data to assess student understanding and misconceptions. See page xii for more information.
- **NEW! Core Lab Topics Coaching Activities** use MasteringA&P data to determine the most frequently assigned exercises. A total of 37 new Coaching Activities tutor students through core lab topics such as blood typing and tracing blood from the heart to the hand. All Coaching Activities ask students to interact with visuals from the lab manual. Varied question types include multiple-choice, art-labeling, ranking, and sorting, as well as wrong-answer feedback and hints.
- **NEW! Exercise-opening MasteringA&P® banner** includes a detailed list of student media resources in the MasteringA&P Study Area, individually tailored to each exercise. The list showcases Practice Anatomy Lab™ (PAL)™ 3.0 navigation pathways, applicable A&P Flix™, and relevant PhysioEx™ 9.0 activities.
- **Updated terminology** throughout follows the nomenclature of *Terminologia Anatomica*, the standard of anatomical terminology published by the Federative Committee on Anatomical Terminology. Eponyms are frequently included in the narrative to expose students to both scientific and clinical usage of the language.

## Exercise-by-Exercise Changes

The following detailed outline summarizes the major changes by exercise:

**Exercise 1**

- The section on microscope safety has been revised for increased clarity.

**Exercise 2**

- Art has been updated.
- The review has a new labeling figure
- A Study Tip on understanding sectional anatomy has been added.

**Exercise 3**

- A new cadaver photo highlights the major organs of the ventral body cavity

**Exercise 4**

- The microscope photo has been updated.
- Three new figures highlight key microscope skills.

**Exercise 5**

- A new activity has been added on observing cells in each of the four major tissue groups. This is an excellent survey of the variety of cells and introduces cells making tissues.
- New mitosis micrographs have been added.
- The cell model labeling activity is new.

**Exercise 6**

- The new at-the-bench activity allows students to study active transport by examining the thyroid gland on a slide and observing where follicle cells have taken in stored hormone by endocytosis.

**Exercise 7**

- New micrographs highlight simple squamous, simple columnar, stratified squamous, and pseudostratified ciliated columnar epithelia.

**Exercise 8**

- New tissue photos feature areolar, adipose, dense regular, hyaline cartilage, elastic cartilage, fibrocartilage, and bone.

**Exercise 10**

- The neuron micrograph is new.

**Exercise 11**

- The micrographs have been updated.
- The Clinical Application on acne has been expanded.
- A new skin model for labeling has been added to the Review & Practice Sheet.

**Exercise 13**

- A new bone model photo for labeling has been added to the Review & Practice Sheet.

**Exercise 14**

- A new figure for gross anatomy of a vertebra and new figures of the skull have been added.
- The photograph of the floor of the skull has been improved.
- The Review & Practice Sheet has been greatly expanded with photographs for labeling structures of the skull, vertebrae, and thoracic cage.

**Exercise 15**

- Each labeled structure in the figures is described in text.
- A new description for the pectoral girdles has been provided.
- The Study Tip on the humerus is new.
- The pelvis photo is new.
- The procedure for an articulating skeleton is new.
- A new Laboratory Activity covers sex differences in the human skeleton.
- The expanded Review & Practice Sheet has 11 new labeling activities, one for each appendicular bone.

**Exercise 16**

- Lab Activity 5 has been expanded with the addition of shoulder and hip joint text and figures.

**Exercise 17**

- A muscle fiber model for labeling has been added.
- The neuromuscular junction is depicted in a new photo.

**Exercise 18**

- The Review & Practice Sheet has two new labeling activities with photos of the muscles of the head.

**Exercise 19**

- The labeling of the abdominal muscles has been rearranged into anatomical layers.
- The muscle model labeling photo in the Review & Practice Sheet is new.

**Exercise 20**

- A new figure of muscles of the upper limb and a new cadaver photo of the upper limb have been added.
- The rotator cuff is highlighted.
- The muscle model labeling photo in the Review & Practice Sheet is new.

**Exercise 21**

- Discussion of the thigh is supported with cadaver photos.
- The muscle labels are better sequenced.
- The muscle model labeling photo in the Review & Practice Sheet is new.

**Exercise 22**

- The number of pages has been reduced to save costs.
- The BIOPAC material has been updated to improve the link between manual and software screen prompts.

**Exercise 23**

- An application question about myasthenia gravis at the motor end plate has been added.
- BIOPAC material has been updated to improve the link between manual and software screens and prompts.

**Exercise 24**

- A spinal cord model has been provided for labeling in the Review & Practice Sheets
- The art has been tightened for better flow and reduced pages.

**Exercise 25**

- The meninges cadaver photo is new.
- New brain photos provide more useful lab views of the brain.
- A new sheep brain dissection sequence steps students through the dissection process.

**Exercise 26**

- The number of figures has been reduced to help students focus on the key anatomical differences between sympathetic and parasympathetic divisions.
- New headers in the exercise group important information.
- The Review & Practice Sheet has sections assignable in MasteringA&P.

**Exercise 27**

- New micrographs of general receptors have been provided.

**Exercise 29**

- The cow eye dissection now has a new step-wise photo series.
- Eye model photos have been added to the labeling section of the Review & Practice Sheet

**Exercise 30**

- The art and text was tightened up to reduce pages and provide cost savings to students.
- The narrative for the BIOPAC activity "Electrooculogram" has been revised for better use in conjunction with current versions of the BIOPAC software.

**Exercise 31**

- The use of scala vestibuli and scala tympani has been standardized.
- Art has been updated.
- Lab model photos are provided in the lab report.

**Exercise 33**

- The revised art includes new microphotographs**.**

**Exercise 34**

- The blood cell micrographs are new.
- A new lab activity on hemoglobin measurement has been added.

**Exercise 35**

- The sheep heart dissection photo series is new.
- Art has been updated.

**Exercise 36**

- The updated art program has flowcharts embedded into the art for better identification of blood vessels in sequence.
- The veins discussion has been reorganized to present lower limb drainage followed by abdominal veins and inferior vena cava.

**Exercise 37**

- The narrative in both of the BIOPAC activities has been extensively revised for better use in conjunction with BIOPAC software. Fewer BIOPAC graphs are needed, as computer screenshots cultivate data interpretation skills in students.
- Redesign of data tables guides students through the analysis.

**Exercise 38**

- Updated text uses the more common term *lymphatic* rather than *lymphoid*.

**Exercise 39**

- A new photograph series presents the use of a wet spirometer.

**Exercise 40**

- A new photograph of a wet spirometer provides a visual reference for equipment used in most A&P labs.
- The narratives for the BIOPAC activity "Volumes and Capacities" and "Respiratory Rate and Depth" have been completely revised for better use in conjunction with current versions of the BIOPAC software.

**Exercise 41**

- Expanded histological coverage of digestive organs—including salivary glands, stomach, small intestine, pancreas, liver, and gallbladder—is supported with new micrographs and corresponding narrative.

**Exercise 42**

- The narrative has been reworked for stronger association between the process of chemical digestion and the lab activities using various enzymes and substrates.
- The protein digestion activity has been redesigned to use albumin for a protein source for more consistent results.

**Exercise 43**

- Expanded histological coverage of urinary organs, including ureters, bladder, and urethra, is supported with new micrographs and a revised narrative.

**Exercise 45**

- Reorganization offers a better pedagogical sequence of the male and female anatomies with the study of gametogenesis coming after the anatomical studies.
- Expanded histological coverage of male and female organs is supported with new micrographs and a revised narrative.

**Exercise 46**

- Photographs of popular embryology models have been added to Review and Practice Sheets for labeling.

**Cat Dissection Exercises 1–9**

- Revised narrative offers closer art–text connection.
- New photographs of the ventral body cavity highlight endocrine glands for easy identification.
- Labeling activities have been added to the Review & Practice Sheets.

# Acknowledgments

I am grateful to a number of people for this sixth edition's excellent illustrations and photographs. Frederic H. Martini, main author of the outstanding and widely acclaimed Martini/Nath/Bartholomew, *Fundamentals of Anatomy & Physiology*, Tenth Edition, deserves credit for his insight and creativity in visualizing anatomical and physiological concepts with the talented biomedical illustrators William Ober and Claire Garrison. This lab manual benefits from their work through the inclusion of many illustrations from that book. I have also worked closely with them over the years to create specific illustrations for the manual. I also thank Judi L. Nath and Edwin F. Bartholomew, coauthors on *Fundamentals of Anatomy & Physiology*, for their continued support and encouragement. Shawn Miller and Mark Nielsen of the University of Utah are a gifted dissector/photographer team whose meticulous work is coupled with the Ober and Garrison illustrations in the Cat and Pig Dissection Versions of the manual. The award-winning human photographs in the manual are by biomedical photographer Ralph Hutchings.

In addition to the many micrographs that I prepared for the manual, I was fortunate to have Robert B. Tallitsch, an outstanding histologist/microphotographer and one of Ric Martini's coauthors on *Human Anatomy*, Eighth Edition, graciously provide many critical histological images.

Teaching and writing in anatomy and physiology brings joy to my life and I have been fortunate to have a career in both. I thank Del Mar College and my publisher, Pearson, for the many professional opportunities they have challenged me with over the years. Special thanks are extended to my biology colleagues at Del Mar College: Lillian Bass, Angelica Chapa, Kathy Dickinson, Zaldy Doyungan, Joyce Germany, Reba Jones, Billy Bob Long, Megan McKee, and Joel McKinney for their encouragement and support of the manual over the years and editions.

I thank the many students at Del Mar College whom I have had the privilege to be with in the classroom and laboratory. Teachers are lifelong learners and I have gained much insight from my students, many of whom are employed in health care and often interject real-life experiences of patients that directly relate to the laboratory topic.

I thank all of the talented and creative individuals at Pearson. Foremost, Caroline Ayres, project manager, oversaw the development and production of the sixth edition manual. Caroline's expertise with organizing and coordinating the enormous number of details and managing a challenging schedule was essential in all phases of this edition's development and I am sincerely grateful for her contributions. I am thankful for the support and encouragement of Cheryl Cechvala, executive editor. Cheryl has a gift for managing a resourceful team of editors, dissectors, photographers, and illustrators whose outstanding work is the foundation of this sixth edition. Thanks also to Becky Morgan, program manager; Nancy Tabor, project manager team lead; Timothy Nicholls, rights and permissions manager; and Christina Simpson, photo researcher; for their roles in the production of this text. I thank Mary Tindle and her fine team at Cenveo Publisher Services for their creative layout and attention to detail. I also thank tani hasegawa for her outstanding design—of both the cover and the interior—which gives this complex assemblage of text, illustrations, photographs, and procedures a user-friendly look. Marilyn Perry, design manager, oversaw the design process and provided crucial insight into our design complexities. The entire Pearson Science sales team deserves thanks for their fine efforts in presenting this manual to A&P instructors.

I offer thanks to the people who developed the stellar media available with this lab manual. Lauren Chen, media producer, managed the development of MasteringA&P for the manual. Sarah Young-Dualan was the media producer for Practice Anatomy Lab™ (PAL™) 3.0.

I have added over 150 new photographs that I have created in my anatomy laboratories. I am very appreciative of the creative and technically skilled team that prepared these images for this sixth edition.

I thank Biopac Systems, Inc., for their continued support and partnership with Pearson and assistance in incorporating activities for their state-of-the-art instrumentation into the sixth edition. I especially thank Mike Mullins at Biopac for his review of the manuscript and for his much appreciated involvement in the revision of the manual to match the latest Biopac software.

Reviewers helped guide the revision of this sixth edition and I thank them for their time and devotion to the manual.

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**John M. Ripper**
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I remain deeply grateful to my wife Laurie for enduring months of my late-night writing and the pressures of never-ending deadlines. I especially thank Laurie for her help with the new dissection photographs. Our girls are out of college now and we are thrilled to watch our daughters, Abi and Beth, start their families and careers. Abi and her husband Kit blessed the family with the first baby in 20 years and we are all spoiling our beautiful baby Fay. I am thankful for my mother, Janis G. Wood, for always being there for us. I appreciate my brother Matthew M. Wood and I also thank my sons-in-law Kit Semtner and Jess Alford for all they continue to do for our daughters and the Wood family.

Any errors or omissions in this edition are exclusively my responsibility and are not a reflection of the dedicated editorial and review team. Comments from faculty and students are welcomed and may be directed to me at the addresses below. I will consider each submission in the preparation of the next edition.

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# About the Author

MICHAEL G. WOOD received his Master's of Science in Biology in 1986 at Pan American University, now the University of Texas at Pan American in Edinburg, Texas. His graduate studies included vertebrate physiology and freshwater ecology. Presently he is a tenured Professor of Biology at Del Mar College in Corpus Christi, Texas, where he has taught over 15,000 students in anatomy and physiology and biology during the past 30 years. His excellence in teaching has been recognized by the Del Mar College community, and he is the recipient of numerous honors, including the "Educator of the Year," "Teacher of the Year," and "Master Teacher" awards. Wood is a member of the Human Anatomy and Physiology Society (HAPS) and enjoys attending their annual meeting when not involved in a writing project. He has a passion for science, reading, and playing guitar. Mike and his wife Laurie are new grandparents and enjoy traveling to see their daughters and granddaughter. They are both avid freshwater aquarists and cultivate a variety of tropical fish and shrimp. Mike and Laurie also breed papillon dogs and enjoy traveling, gardening, and exploring the great outdoors.

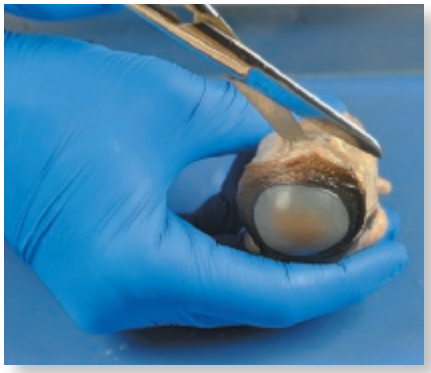
## Dedication

*With love to my daughter Beth, for her spirit and determination.*

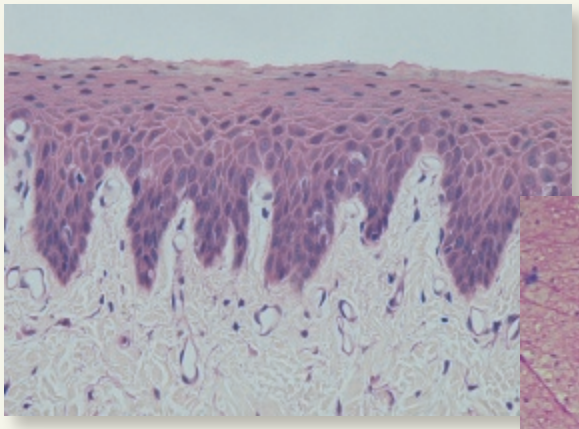
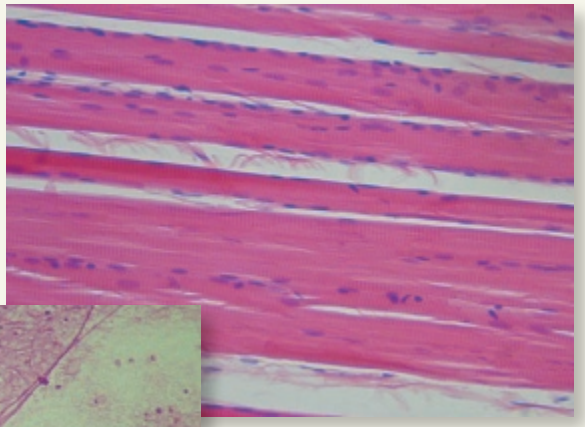
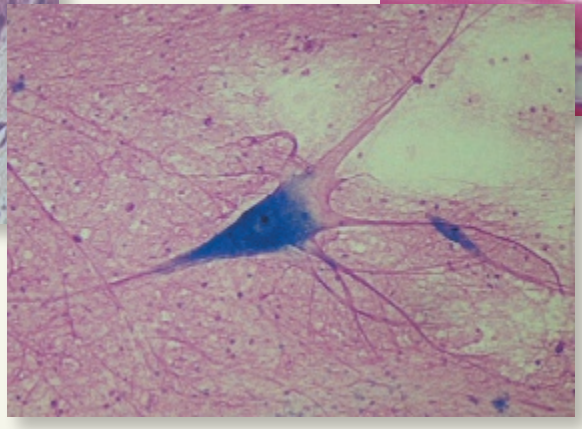
# NEW! A Photo Program that Matches

**Over 150 new photos walk students through step-by-step** animal organ dissections and core lab processes, while new histology images provide additional perspective and guidance.

## Step-by-Step Animal Organ Dissections

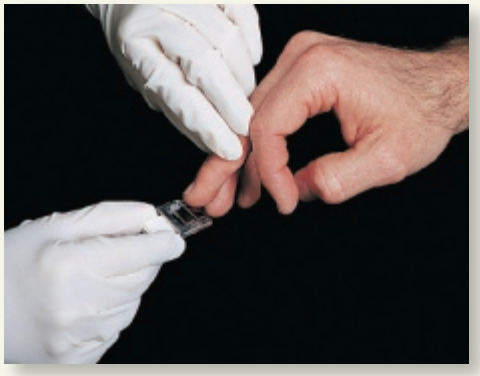




## Histology Photos

# What Students See in the Lab

## Lab Process Photos



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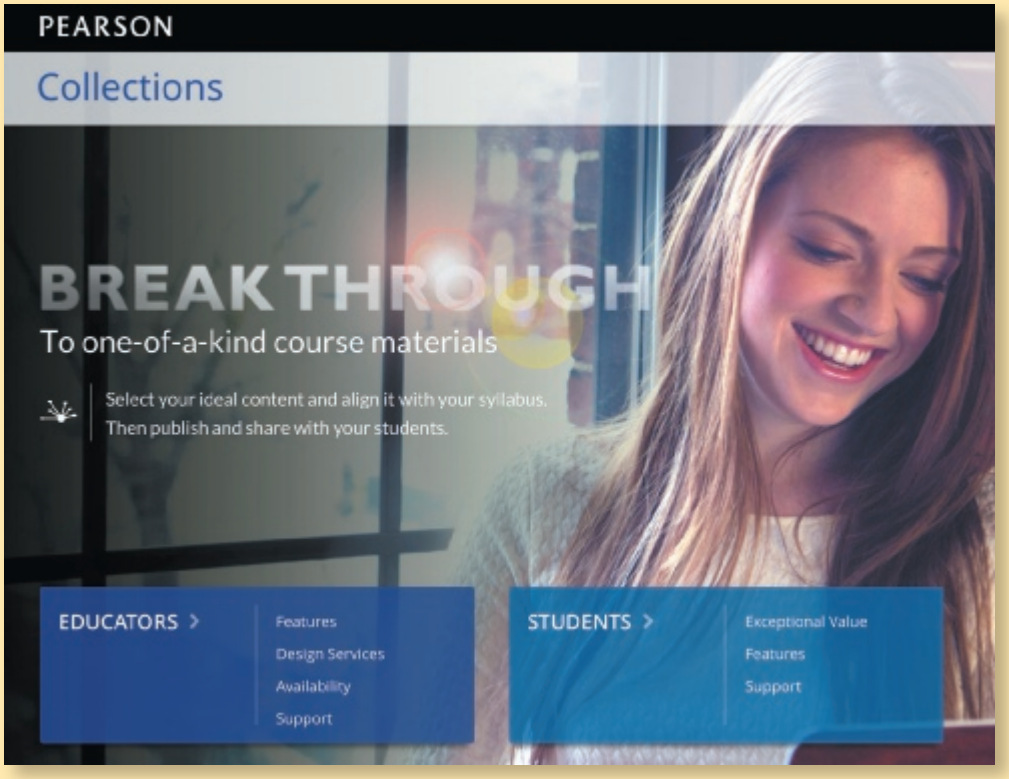


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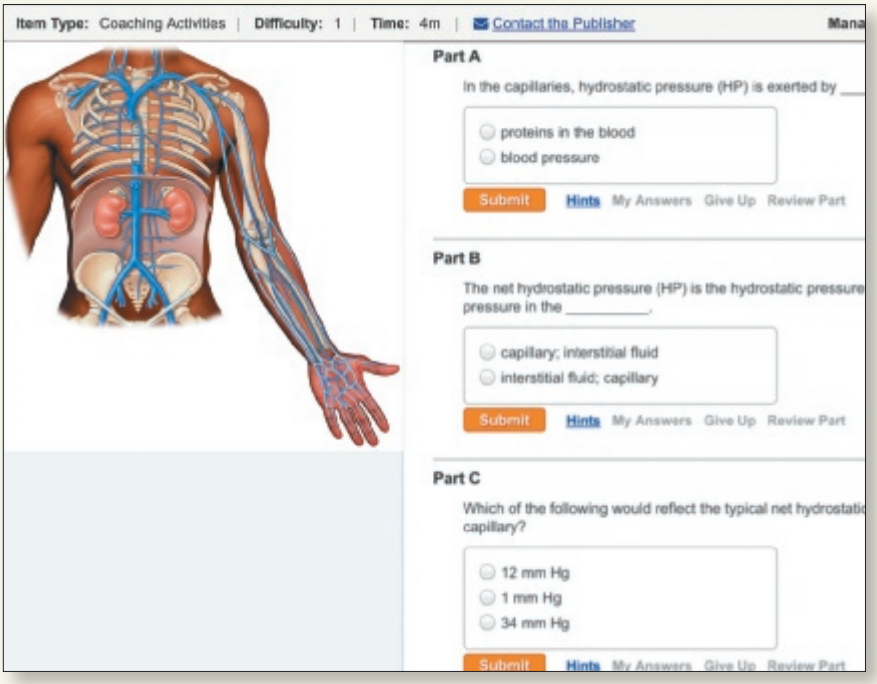
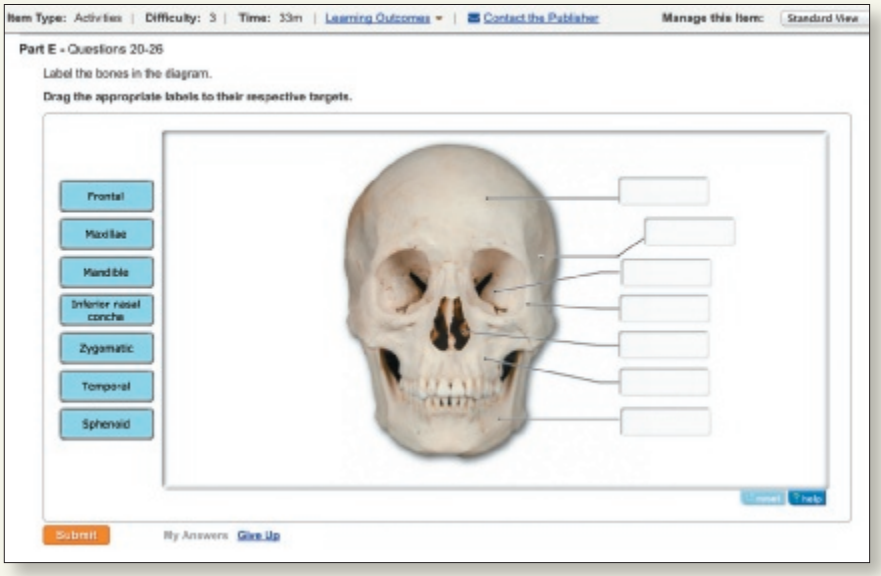
# MasteringA&P **Coaches Students**

**NEW!**
## Core Lab Topic Coaching Activities

**Over 35 new Coaching Activities** tutor students through core lab topics, such as blood typing, or tracing blood from the heart to the hand. One new Coaching Activity for each lab exercise is assignable in MasteringA&P.




**NEW!**
## Assignable Review & Practice Sheets

**Items from the Review &** Practice Sheets at the end of each lab exercise are assignable in MasteringA&P. Assignments include art-labeling activities, and multiple-choice and matching questions.

# Through Tough Lab Topics

## NEW! Draw It! Tutorials

**Draw It! Tutorials include brief videos that feature author Michael Wood** teaching students how to sketch selected structures, systems, and processes, such as cells and body cavities, in order to better understand and remember them. QR codes in the lab manual allow students to access the tutorials for on-the-go study. Corresponding Coaching Activities for each Draw It! Tutorial are assignable in MasteringA&P.

2 IN THE LAB

### Materials

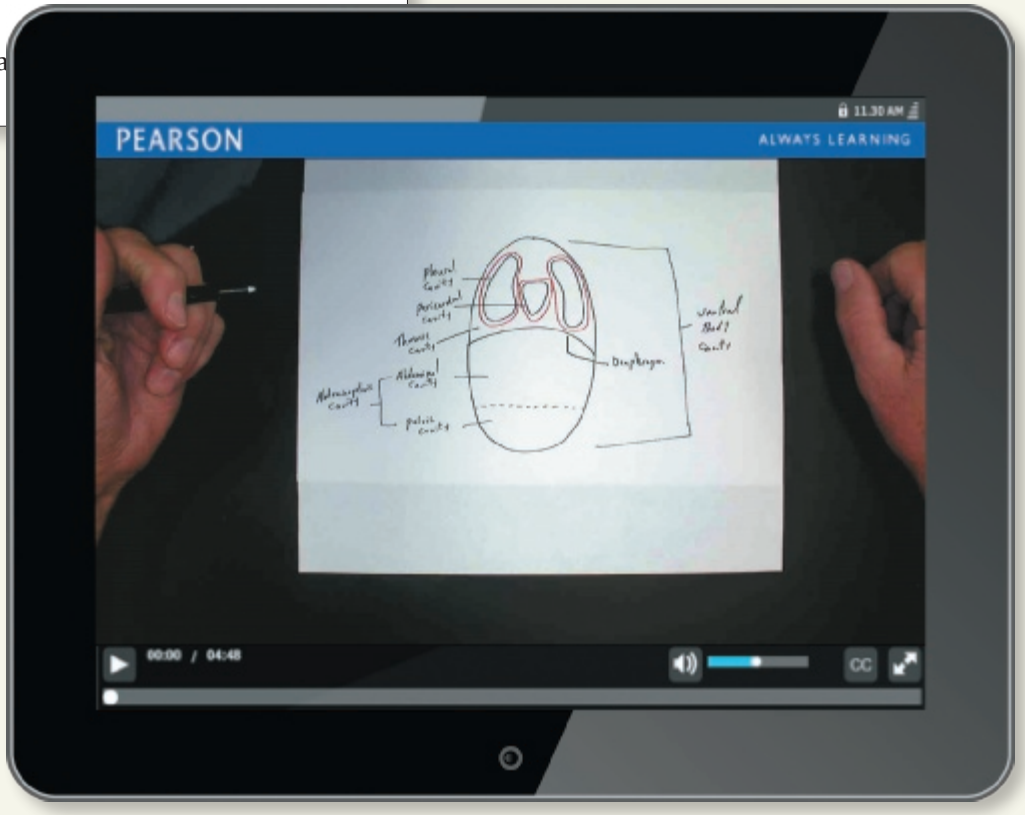
- ☐ Compound microscope, slide, and coverslip
- ☐ Newspaper cut into small pieces
- ☐ Dropper bottle containing water
- ☐ Prepared slide: simple cuboidal epithelium (kidney slide)

**Draw It!**

VIDEO TUTOR

### Procedures: Preparing and Observing a Wet-Mount Slide

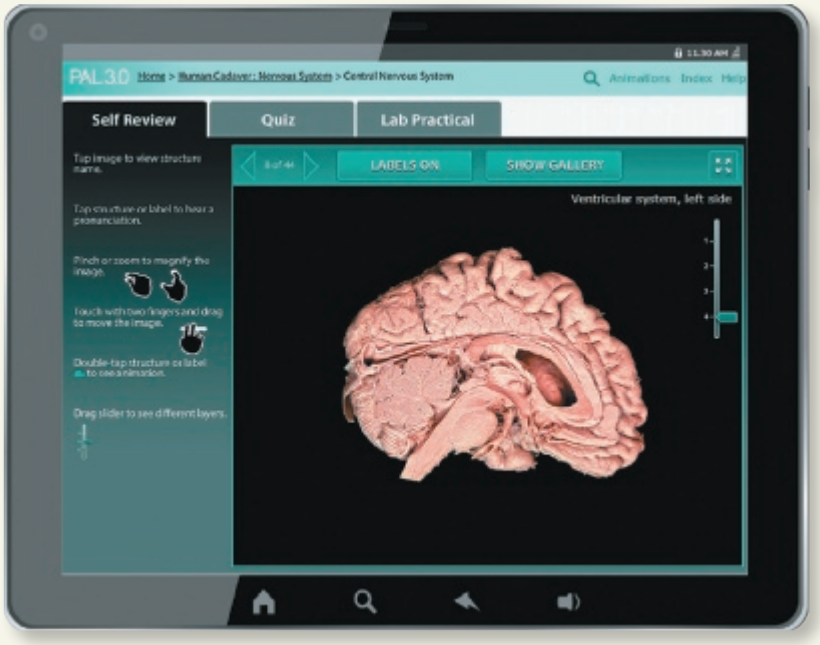
1. Make a wet-mount slide of a
follows:



# An Easy Way for Students to Study

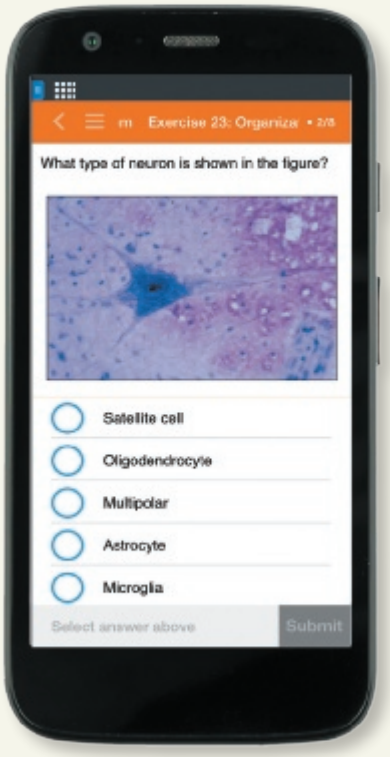
## Practice Anatomy Lab

**Practice Anatomy Lab™ (PAL™) 3.0** is a virtual anatomy study and practice tool that gives students 24/7 access to the most widely used lab specimens, including the human cadaver, anatomical models, histology, cat, and fetal pig. PAL 3.0 is easy to use and includes built-in audio pronunciations, rotatable bones, and simulated fill-in-the-blank lab practical exams. The PAL 3.0 app is available for iPad or Android tablet.

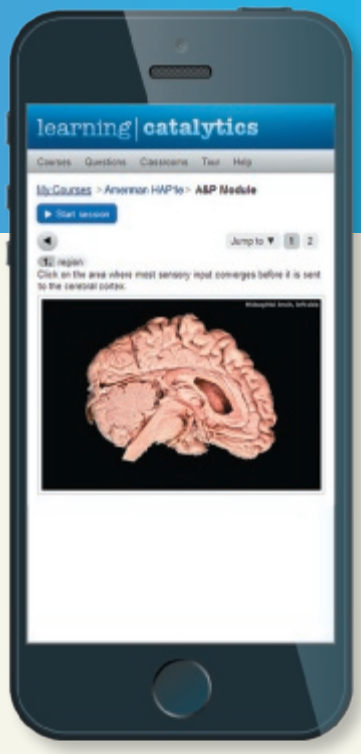



## Dynamic Study Modules

**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 with a unique answer format that also asks them to indicate their confidence level. Questions repeat until the student can answer them all correctly and confidently. Once completed, Dynamic Study Modules explain the concept using materials from the text. These are available as graded assignments prior to class, and accessible on smartphones, tablets, and computers.



# Anywhere, Anytime




## NEW! Learning Catalytics

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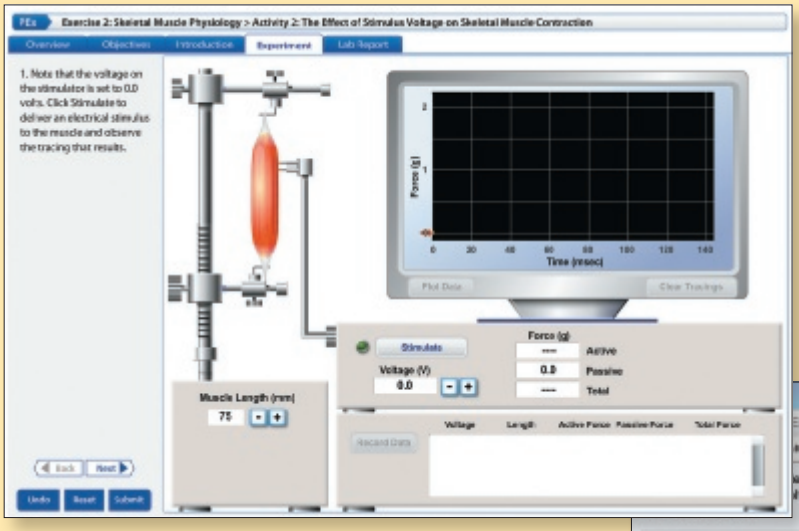
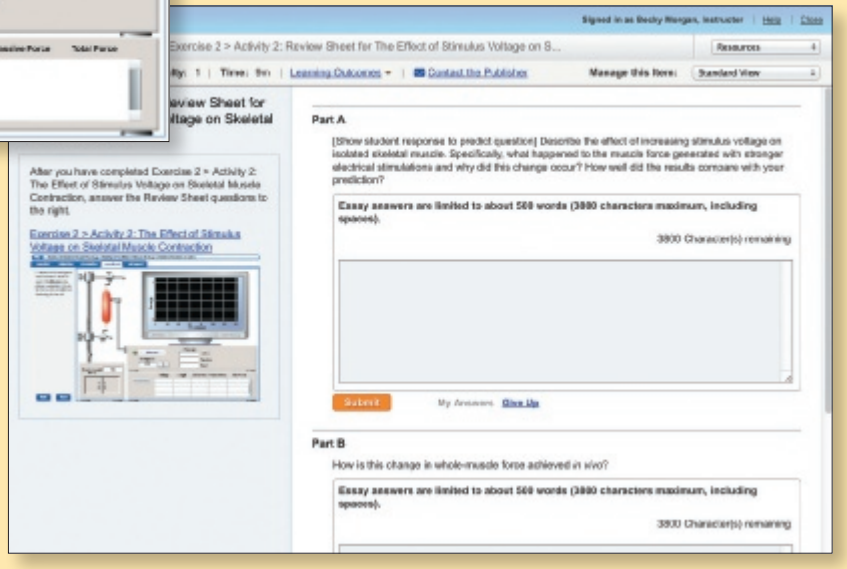
## PhysioEx 9.1




**PhysioEx™ 9.1 is an easy-to-use 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. PhysioEx 9.1 is assignable in MasteringA&P.



# Contents

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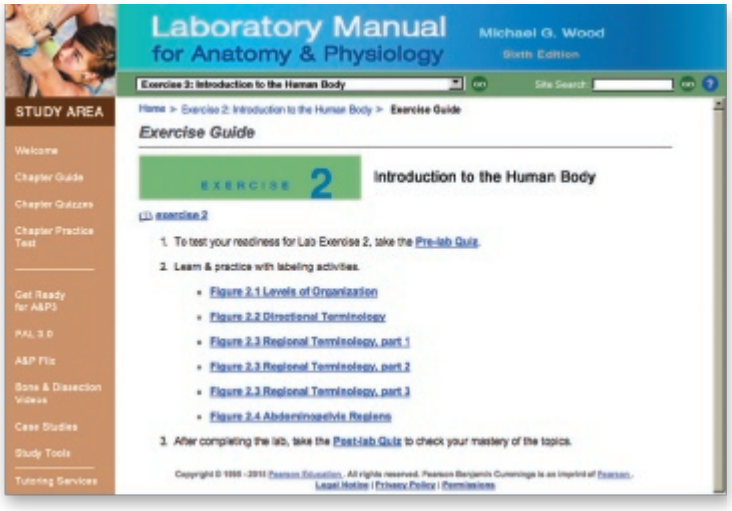
Exercise 1

# Laboratory Safety

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## Learning Outcomes

*On completion of this exercise, you should be able to:*

1. Locate all safety equipment in the laboratory.
2. Demonstrate how to clean up and dispose of broken glass safely.
3. Show how to handle glassware safely, including insertion and removal of glass rods used with stoppers.
4. Demonstrate how to plug in and unplug electrical devices safely.
5. Explain how to protect yourself from and dispose of body fluids.
6. Demonstrate how to mix solutions and measure chemicals safely.
7. Describe how to safely work with body fluids.
8. Describe the potential dangers of each laboratory instrument.
9. Discuss disposal techniques for chemicals, body fluids, and other hazardous materials.

Experiments and exercises in the anatomy and physiology laboratory are, by design, safe. Some of the hazards are identical to those found in your home, such as broken glass and the risk of electrical shock. The major hazards can be grouped into six categories: glassware, electrical, body fluids, chemical, laboratory instruments, and preservatives. The following is a discussion of the hazards each category poses and a listing of safety guidelines you should follow to prevent injury to yourself and others while in the laboratory. Proper disposal of biological and chemical wastes ensures that these contaminants will not be released into your local environment.

## Laboratory Safety Rules

The following guidelines are necessary to ensure that the laboratory is a safe environment for students and faculty alike:

1. No unauthorized persons are allowed in the laboratory. Only students enrolled in the course and faculty are to enter the laboratory.
2. Never perform an unauthorized experiment. Unless you have your instructor's permission, never make changes to any experiment that appears either in this manual or in a class handout.
3. Do not smoke, eat, chew gum, or drink in the laboratory.
4. Always wash your hands before and after each laboratory exercise involving chemicals, preserved materials, or body fluids, and immediately after cleaning up spills.
5. Wear shoes at all times while in the laboratory.
6. Be alert to unsafe conditions and to unsafe actions by other individuals in the laboratory. Call attention to those conditions or activities. Someone else's accident can be as dangerous to you as one that you cause.
7. Glass tubes called *pipettes* are commonly used to measure and transfer solutions. Never pipette a solution by mouth. Always use a pipette bulb. Your instructor will demonstrate how to use the particular type of bulb available in your laboratory.
8. Immediately report all spills and injuries to the laboratory faculty.
9. Inform the laboratory faculty of any medical condition that may limit your activities in the laboratory.

## Location of Safety Equipment

Write here the location of each piece of safety equipment as your instructor explains how and when to use it:

nearest telephone _____

first aid kit _____

fire exits _____

fire extinguisher _____

eye wash station _____

chemical spill kit _____

fan switches _____

biohazard container _____

## Glassware

Glassware is perhaps the most dangerous item in the laboratory. Broken glass must be cleaned up and disposed of safely. Other glassware-related accidents can occur when a glass rod or tube breaks while you are attempting to insert it into a cork or rubber stopper.

### Broken Glass

- Sweep up broken glass immediately. Never use your hands to pick up broken glass. Instead, use a whisk broom and dustpan to sweep the area clear of all glass shards.
- Your laboratory most likely has a "broken glass bucket" in which to discard broken glass. If it does not, place broken glass in a box, tape the box shut, and write "BROKEN GLASS INSIDE" in large letters across it. Your laboratory instructor will arrange for disposal of the sealed box.

### Inserting Glass into a Stopper

- Never force a dry glass rod or tube into the hole cut in a cork or rubber stopper. Use a lubricant such as glycerin or soapy water to ease the glass through the stopper.
- To insert a glass rod or tube into a stopper, always push on the rod/tube near the stopper. Doing so reduces the length of glass between the stopper and your hand and greatly decreases your chance of breaking the rod and jamming glass into your hand.

## Electrical Equipment

Electrical hazards in the laboratory are similar to those in your home. A few commonsense guidelines will almost eliminate the risk of electrical shock.

- Do not force an electrical plug into an outlet. If the plug does not easily fit into the outlet, inform your laboratory instructor.
- Unplug all electrical cords by pulling on the plug, not the cord. Pulling on the cord may loosen wires inside the cord, which can cause an electrical short and possibly an electrical shock to anyone touching the cord.
- Never plug in or unplug an electrical device in a wet area.
- Uncoil an electrical cord that is wrapped around the base of a microscope before plugging the cord into an electrical outlet. Wrapping electrical cords around the microscope can damage the microscope or the cord.

## Body Fluids

The three body fluids most frequently encountered in the laboratory are saliva, urine, and blood. Because body fluids can harbor infectious organisms, safe handling and disposal procedures must be followed to prevent infecting yourself and others.

- Work only with your own body fluids. It is beyond the scope of this manual to explain proper protocol for collecting and experimenting on body fluids from another individual.

- Never allow a body fluid to touch your unprotected skin. Always wear gloves and safety glasses when working with body fluids—even though you are using your own fluids.
- Always assume that a body fluid can infect you with a disease. Putting this safeguard into practice will prepare you for working in a clinical setting where you may be responsible for handling body fluids from the general population.
- Clean up all body-fluid spills with either a 10 percent bleach solution or a commercially prepared disinfectant labeled for this purpose. Always wear gloves during the cleanup, and dispose of contaminated wipes in a biohazard container.

## Chemicals

Most chemicals used in laboratories are safe. Following a few simple guidelines will protect you from chemical hazards:

- Be aware of chemicals that may irritate skin or stain clothing. Chemical containers are usually labeled to show contents and potential hazards. Handling and disposal of all chemicals should follow OSHA guidelines and regulations. Most laboratories and chemical stockrooms keep copies of technical chemical specifications, called *Safety Data Sheets (SDS)*. These publications from chemical manufacturers detail the proper use of the chemicals and the known adverse effects they may cause. All individuals have a federal right to inspect these documents. Ask your laboratory instructor for more information on SDS.
- Never touch a chemical with unprotected hands. Wear gloves and safety glasses when weighing and measuring chemicals and during all experimental procedures involving chemicals.
- Always use a spoon or spatula to take a dry chemical from a large storage container. Do not shake a dry chemical out of its jar; doing so may result in your dumping the entire container of chemical onto yourself and your workstation.
- When pouring out a volume of a solution kept in a large container, always pour the approximate amount required into a smaller beaker first and then pour from this beaker to fill your glassware with the solution. Attempting to pour from a large storage container directly into any glassware other than a beaker may result in spilled solution coming into contact with your skin and clothing.
- To keep from contaminating a storage container, do not return the unused portion of a chemical to its original container. Dispose of the excess chemical as directed by your instructor. Do not pour any chemicals—unused or used—down the sink unless directed to do so by your instructor.
- When mixing solutions, always add a chemical to water; never add water to the chemical. By adding the chemical to the water, you reduce the chance of a strong chemical reaction occurring.

## Laboratory Instruments

You will use a variety of scientific instruments in the anatomy laboratory. Safety guidelines for specific instruments are included in the appropriate exercises. This discussion concerns the instruments most frequently used in laboratory exercises.

- ***Microscope:*** The microscope is the main instrument you will use in the study of anatomy. Exercise 4 of this manual is devoted to the use and care of this instrument.
- ***Dissection tools:*** Working with sharp blades and points always presents the possibility of injury. Always cut away from yourself, and never force a blade through a tissue. Use small knife strokes for increased blade control rather than large cutting motions. Always use a sharp blade, and dispose of used blades in a specially designated "sharps" container. Carefully wash and dry all instruments upon completion of each dissection.

  Special care is necessary while changing disposable scalpel blades. Your instructor may demonstrate the proper technique for blade replacement. Always wash the used blade before removing it from the handle. Examine the handle and blade, and determine how the blade fits onto the handle. Do not force the blade off the handle. If you have difficulty changing blades, ask your instructor for assistance.
- ***Water bath:*** A water bath is used to incubate laboratory samples at a specific temperature. Potential hazards involving water baths include electrical shock due to contact with water and burn-related injuries caused by touching hot surfaces or spilling hot solutions. Electrical hazards are minimized by following the safety rules concerning plugging and unplugging of electrical devices. Avoid burns by using tongs to immerse or remove samples from a water bath. Point the open end of all glassware containing a sample away from yourself and others. If the sample boils, it could splatter out and burn your skin. Use a water-bath rack to support all glassware, and place hot samples removed from a water bath in a cooling rack. Monitor the temperature and water level of all water baths. Excessively high temperatures increase the chance of burns and usually ruin an experiment. When using boiling water baths, add water frequently, and do not allow all the water to evaporate.
- ***Microcentrifuge:*** A microcentrifuge is used for blood and urine analyses. The instrument spins at thousands of revolutions per minute. Although the moving parts are housed in a protective casing, it is important to keep all loose hair, clothing, and jewelry away from the instrument. Never open the safety lid while the centrifuge is on or spinning. Do not attempt to stop a spinning centrifuge with your hand. The instrument has an internal braking mechanism that stops it safely.

## Preservatives

Most animal and tissue specimens used in the laboratory have been treated with chemicals to prevent decay. These preservatives are irritants and should not contact your skin, eyes, nose, mouth, or any other body opening. The following guidelines will protect you from these hazards:

- If you are pregnant, limit your exposure to all preservatives. Discuss the laboratory exercise with your instructor. Perhaps you can observe rather than perform the dissection.
- Always wear gloves and safety glasses when working with preserved material.
- Your laboratory may be equipped with exhaust fans to ventilate preservative fumes during dissections. Do not hesitate to ask your instructor to turn on the fans if the preservative odor becomes bothersome.
- Some preservatives are toxic or carcinogenic, and all require special handling. Drain as much preservative as possible from a specimen before beginning a dissection. Pour the drained preservative into either the specimen storage container or a dedicated container provided by your instructor. Never pour preservative down the sink drain.
- Promptly wipe up all spills and clean your work area when you have completed a dissection. Keep your gloves on during the cleanup, and dispose of gloves and paper towels in the proper biohazard container.

## Disposal of Chemical and Biological Wastes

To safeguard the environment and individuals employed in waste collection, it is important to dispose of all potentially hazardous wastes in specially designed containers. State and federal guidelines detail the storage and handling procedures for chemical and biological wastes. Your laboratory instructor will manage the wastes produced in this course.

- ***Body fluids:*** Objects contaminated with body fluids are considered a high-risk biohazard and must be disposed of properly. Special biohazard containers will be available during exercises that involve body fluids. A special sharps container may be provided for glass, needles, and lancets.
- ***Chemical wastes:*** Most chemicals used in undergraduate laboratories are relatively harmless and may be diluted in water and poured down the drain. Your instructor will indicate during each laboratory session which chemicals can be discarded in this manner. Other chemicals should be disposed of in a dedicated waste container.
- ***Preservatives and preserved specimens:*** Dispose of preservatives in a central storage container maintained for that purpose. As noted earlier, never pour preservative solutions down the sink drain. Dispose of all preserved specimens by wrapping them in a plastic bag filled with an absorbent material such as cat litter and placing the bag in a designated area for pickup by a hazardous-waste company.

Name _____

Date _____ Section _____

# Laboratory Safety

## A. Short-Answer Questions

**1.** Discuss how to protect yourself from body fluids, such as saliva and blood.

**2.** Why should you consider a body fluid capable of infecting you with a disease?

**3.** Describe how to dispose of materials contaminated with body fluids.

**4.** Explain how to safely plug and unplug an electrical device.

**5.** Discuss how to protect yourself from preservatives used on biological specimens.

**6.** Why are special biohazard containers used for biological wastes?

**7.** Explain how to clean up broken glass.

**8.** List the location of the following safety items in the laboratory.

first aid kit _____

nearest telephone _____

eye wash station _____

fire exits _____

fire extinguisher _____

chemical spill kit _____

fan switches _____

biohazard container _____

**9.** Your instructor informs you that a chemical is not dangerous. How should you dispose of the chemical?

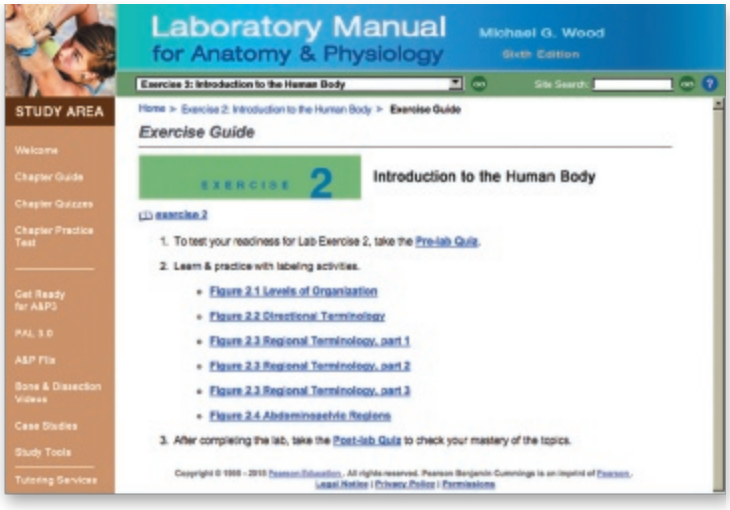
**10.** What precautions should you take while using a centrifuge?

**11.** How are preservatives correctly discarded?

**12.** Discuss how to safely measure and mix chemicals.

Exercise 2

# Introduction to the Human Body

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- Bone and dissection videos

## Learning Outcomes

*On completion of this exercise, you should be able to:*

1. Define *anatomy* and *physiology* and discuss the specializations of each.
2. Describe each level of organization in the body.
3. Describe anatomical position and its importance in anatomical studies.
4. Use directional terminology to describe the relationships of the surface anatomy of the body.
5. Use regional terminology to identify the gross anatomy of the body.
6. Describe and identify the major planes and sections of the body.
7. Locate all abdominopelvic quadrants and regions on laboratory models.
8. Identify the location of the cranial and spinal cavities.
9. Describe the two main divisions of the ventral cavity.
10. Describe and identify the serous membranes of the body.

## Lab Activities



**CLINICAL** APPLICATION



Knowledge about what lies beneath the skin and how the body works has been slowly amassed over a span of nearly 3000 years. It may be obvious to us now that any logical practice of medicine depends on an accurate knowledge of human anatomy, yet people have not always realized this. Through most of human history, corpses were viewed with superstitious awe and dread. Observations of anatomy by dissection were illegal, and medicine therefore remained an elusive practice that often harmed rather than helped the unfortunate patient. Despite these superstitions and prohibitions, however, there have always been scientists who wanted to know the human body as it really is rather than how it was imagined to be.

The founder of anatomy was the Flemish anatomist and physician Andreas Vesalius (1514–1564). Vesalius set about to describe human structure accurately.

In 1543, he published his monumental work, *De Humani Corporis Fabrica (On the Structure of the Human Body)*, the first meaningful text on human anatomy. In this work he corrected more than 200 errors of earlier anatomists and produced drawings that are still useful today. The work done by Vesalius laid the foundation for all future knowledge of the human body. Merely imagining the body's internal structure at last became unacceptable in medical literature.

Many brilliant anatomists and physiologists since the time of Vesalius have contributed significantly to the understanding of human form and function. Advances in medicine and in the understanding of the human body continue at an accelerated pace. For accuracy and consistency, this manual follows the terminology of the publication *Terminologia Anatomica* as endorsed by the International Federation of Associations of Anatomists.

## 1 Organization of the Body

**Anatomy** is the study of body structures. Early anatomists described the body's **gross anatomy,** which includes the large parts such as muscles and bones. As knowledge of the body advanced and scientific tools permitted more detailed observations, the field of anatomy began to diversify into such areas as **microanatomy,** the study of microscopic structures; **cytology,** the study of cells; and **histology,** the study of **tissues,** which are groups of cells that coordinate their efforts toward a common function.

**Physiology** is the study of how the body functions and of the work that cells must do to keep the body stable and operating efficiently. **Homeostasis** (hō-mē-ō-STĀ-sis; *homeo-,* unchanging + *stasis,* standing) is the maintenance of a relatively steady internal environment through physiological work. Stress, inadequate diet, and disease disrupt the normal physiological processes and may, as a result, lead to either serious health problems or death.

The various **levels of organization** at which anatomists and physiologists study the body are reflected in the fields of specialization in anatomy and physiology. Each higher level increases in structural and functional complexity, progressing from chemicals to cells, tissues, organs, and finally the organ systems that function to maintain the organism.

**Figure 2.1** uses the cardiovascular system to illustrate these levels of organization. The simplest is the **chemical level,** sometimes called the *molecular level,* shown at the bottom of the figure. Atoms such as carbon and hydrogen bond together and form molecules. The heart, for instance, contains protein molecules that are involved in contraction of the cardiac muscle. Molecules are organized into cellular structures called *organelles,* which have distinct shapes and functions. The organelles collectively constitute the next level of organization, the **cellular level.** Cells are the fundamental level of biological organization because it is cells, not molecules, that are alive. Different types of cells working together constitute the **tissue level.** Although tissues lack a distinct shape, they are distinguishable by cell type, such as the various cells that comprise the pancreas. Tissues function together at the **organ level.** At this level, each organ has a distinct three-dimensional shape and a range of functions that is broader than the range of functions for individual cells or tissues. The **organ system level** includes all the organs of a system interacting to accomplish a common goal. The heart and blood vessels, for example, constitute the cardiovascular organ system and physiologically work to move blood through the body. All organ systems make up the individual, which is referred to as the **organism level.**

### QuickCheck Questions

1.1 What is the lowest living level of organization in the body?

1.2 What is homeostasis?

## 1 IN THE LAB

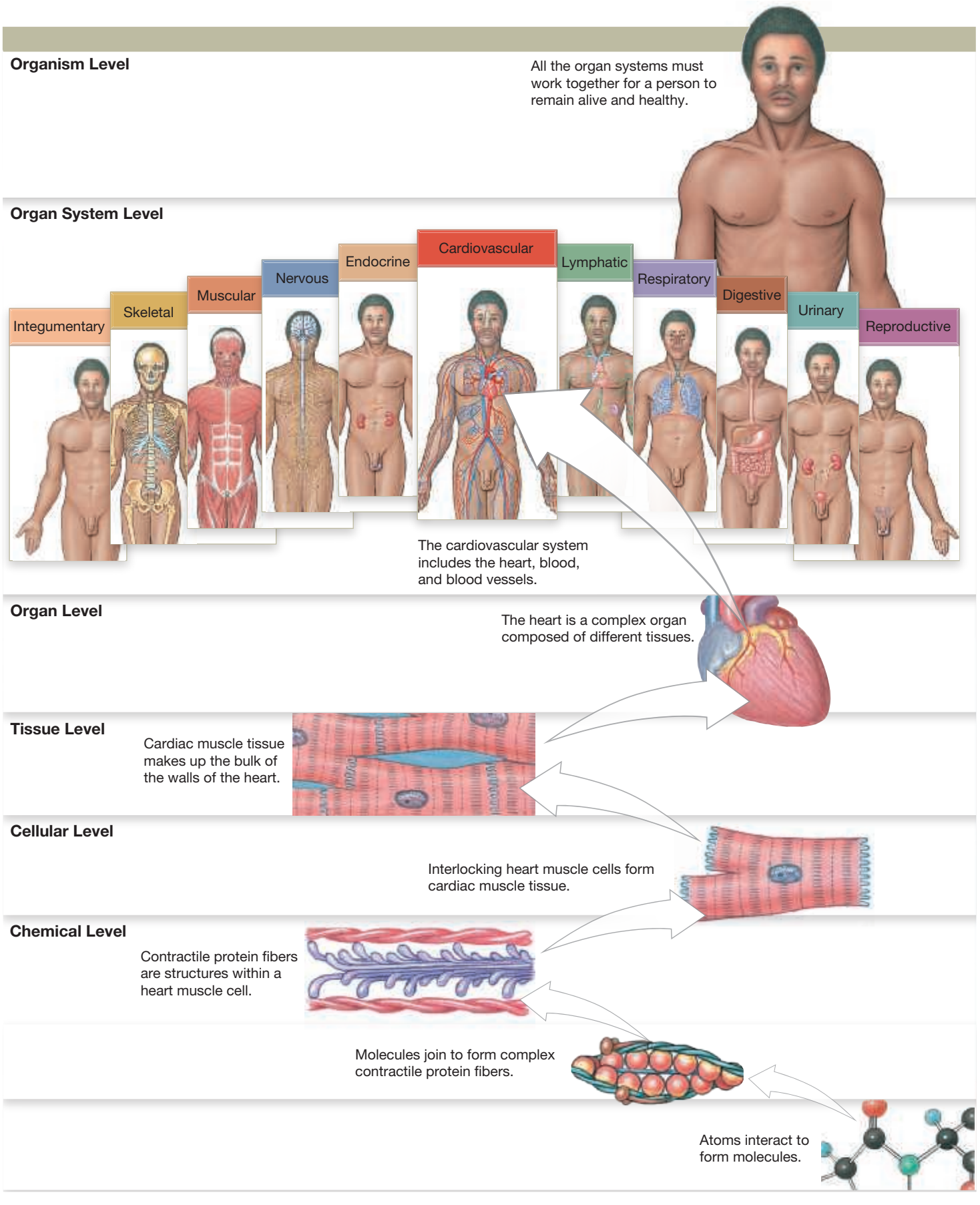
### Materials

- ☐ Variety of objects and object sets, each representing a level of organization
- ☐ Torso models
- ☐ Articulated skeleton
- ☐ Charts

### Procedures

1. Classify each object or object set as to the level of organization it represents. Write your answers in the spaces provided.
   - Molecular level _____
   - Cellular level _____
   - Tissue level _____
   - Organ level _____
   - Organ system level _____
   - Organism level _____

**Figure 2.1** Levels of Organization



**Study Tip** Getting Organized for Success

Major challenges in the anatomy and physiology laboratory are organizing and processing a substantial volume of information and working with the language of science. Much of the information is obtained through your reading of the lab manual. It is important that you pay attention to the anatomical terminology. Pronounce each term and note its spelling. Break apart the word into its prefix and suffix. Write the word with a definition or example.

Being prepared for lab enables you to spend more hands-on time with the laboratory material. Before class, read the appropriate exercise(s) in this manual, study the figures, and review the Laboratory Activities in the assigned sections. Relate the laboratory material to the theory concepts covered in the lecture component of the course.

Management of your daily schedule is necessary to dedicate several hours to studying anatomy and physiology. Reading typically takes a considerable time commitment, and more technical material may require several readings for you to clearly understand the concepts. ■

## 2 Anatomical Position and Directional Terminology

The human body can bend and stretch in a variety of directions. Although this flexibility allows us to move and manipulate objects in our environment, it can cause difficulty when describing and comparing structures. For example, what is the correct relationship between the wrist and the elbow? If your upper limb is raised above your head, you might reply that the wrist is above the elbow. With your upper limb at your side, you would respond that the wrist is below the elbow. Each response appears correct, but which is the proper anatomical relationship?

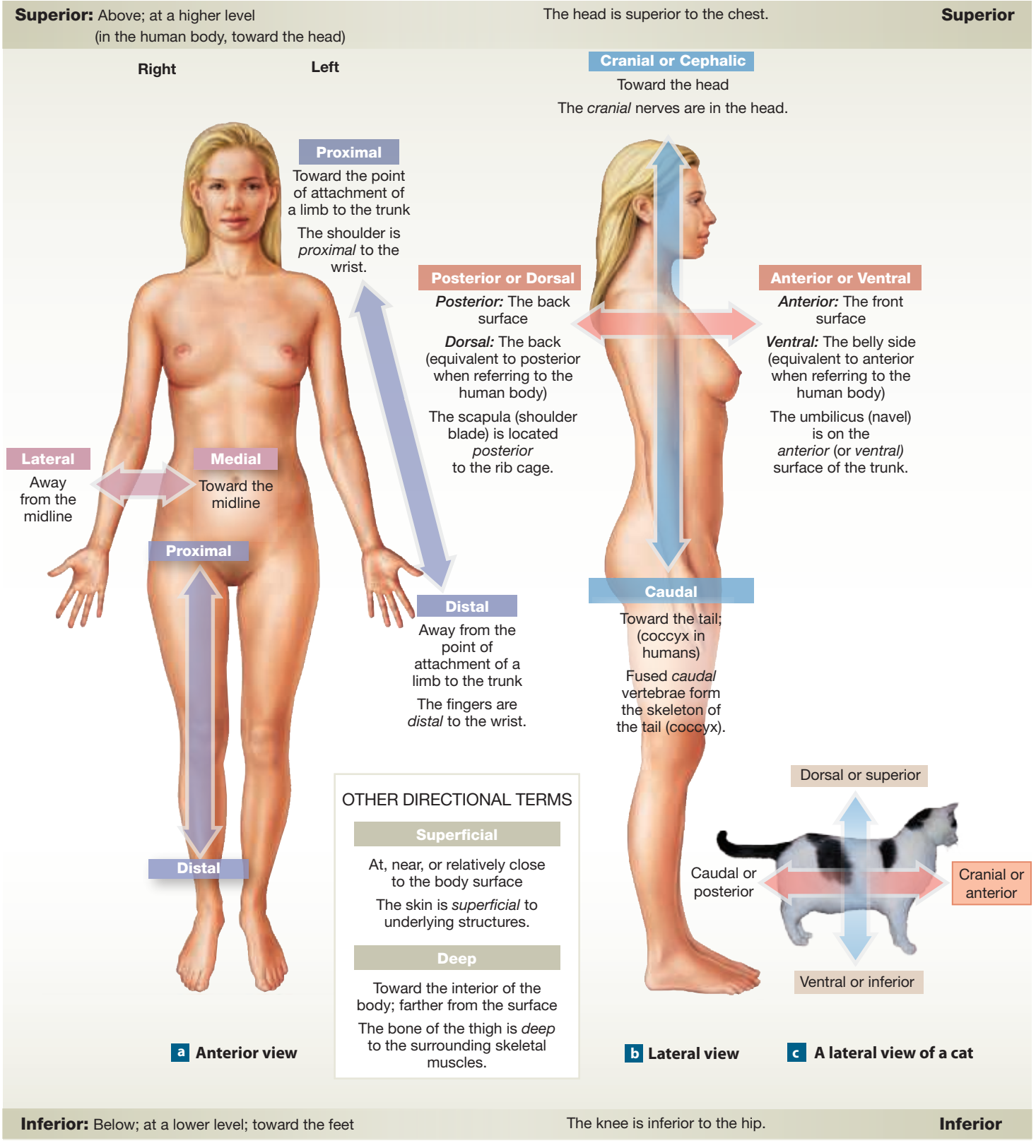
For anatomical study, the body is always referred to as being in the **anatomical position.** In this position, the individual is standing erect with the feet pointed forward, the eyes straight ahead, and the palms of the hands facing forward with the upper limbs at the sides (**Figure 2.2**). An individual in the anatomical position is said to be **supine** (soo-PĪN) when lying on the back and **prone** when lying face down.

Imagine attempting to give someone directions if you could not use terms such as *north* and *south* or *left* and *right*. These words have a unique meaning and guide the traveler toward a destination. Describing the body also requires specific terminology. Expressions such as *near*, *close to*, or *on top of* are too vague for anatomical descriptions. To prevent misunderstandings, precise terms are used to describe the locations and spatial relationships of anatomy. These terms have their roots in the Greek and Latin languages. **Table 2.1** and Figure 2.2 display the most frequently used directional terms. Notice that most of them can be grouped into opposing pairs, or antonyms.

**Table 2.1 Directional Terms (see Figure 2.2)**

| Term | Region or Reference | Example |
|---|---|---|
| **Anterior** | The front; before | The navel is on the *anterior* surface of the trunk. |
| **Ventral** | The belly side (equivalent to anterior when referring to human body) | In humans, the navel is on the *ventral* surface. |
| **Posterior** | The back; behind | The shoulder blade is located *posterior* to the rib cage. |
| **Dorsal** | The back (equivalent to posterior when referring to human body) | The *dorsal* body cavity encloses the brain and spinal cord. |
| **Cranial or cephalic** | The head | The *cranial*, or *cephalic*, border of the pelvis is on the side toward the head rather than toward the thigh. |
| **Superior** | Above; at a higher level (in human body, toward the head) | In humans, the cranial border of the pelvis is *superior* to the thigh. |
| **Caudal** | The tail (coccyx in humans) | The hips are *caudal* to the waist. |
| **Inferior** | Below; at a lower level | The knees are *inferior* to the hips. |
| **Medial** | Toward the body's longitudinal axis; toward the midsagittal plane | The *medial* surfaces of the thighs may be in contact; moving medially from the arm across the chest surface brings you to the sternum. |
| **Lateral** | Away from the body's longitudinal axis; away from the midsagittal plane | The thigh articulates with the *lateral* surface of the pelvis; moving laterally from the nose brings you to the eyes. |
| **Proximal** | Toward an attached base | The thigh is *proximal* to the foot; moving proximally from the wrist brings you to the elbow. |
| **Distal** | Away from an attached base | The fingers are *distal* to the wrist; moving distally from the elbow brings you to the wrist. |
| **Superficial** | At, near, or relatively close to the body surface | The skin is *superficial* to underlying structures. |
| **Deep** | Farther from the body surface | The bone of the thigh is *deep* to the surrounding skeletal muscles. |

**Figure 2.2 Directional Terminology** Important directional terms used in this text are indicated by arrows; definitions and descriptions are included in Table 2.1.



- **Superior** and **inferior** describe vertical positions. *Superior* means above, *inferior* means below. For example, on a person in the anatomical position, the head is superior to the shoulders and the knee is inferior to the hip.
- **Anterior** and **posterior** refer to front and back, respectively. *Anterior* means in front of or forward, and *posterior* means in back of or toward the back. The anterior surface of the body comprises all front surfaces, including the palms of the hand, and the posterior surface includes all the back surfaces. In addition to describing locations, these directional terms describe position *relationships*, which means that one body part can be described using both terms. The heart, for example, is posterior to the breastbone and anterior to the spine.
- In four-legged animals, the anatomical position is with all four limbs on the ground, and therefore the meanings of some directional terms change (Figure 2.2c). *Superior* now refers to the back, or **dorsal,** surface, and *inferior* refers to the belly, or **ventral,** surface. **Cranial** and *anterior* mean toward the head in four-legged animals, and **caudal** and *posterior* mean toward the tail in four-legged animals and toward the coccyx in humans.
- **Medial** and **lateral** describe positions relative to the body's *midline*, the vertical middle of the body or any structure in the body. *Medial* has two meanings. It describes one structure as being closer to the body's midline than some other structure; for instance, the ring finger is medial to the middle finger when the hand is held in the anatomical position. *Medial* also describes a structure that is permanently between others; for example, the nose is medial to the eyes. *Lateral* means either farther from the body's midline or permanently to the side of some other structure; the eyes are lateral to the nose, and, in the anatomical position, the middle finger is lateral to the ring finger.
- **Proximal** refers to parts near another structure. **Distal** describes structures that are distant from other structures. These terms are frequently used to describe the proximity of a structure to its point of attachment on the body. For example, the thigh bone (femur) has a proximal region where it attaches to the hip and a distal region toward the knee.
- **Superficial** and **deep** describe layered structures. *Superficial* refers to parts on or close to the surface. Underneath an upper layer are *deep*, or *bottom*, structures. The skin is superficial to the muscular system, and bones are usually deep to the muscles.

Some directional terms seem to be interchangeable, but there is usually a precise term for each description. For example, *superior* and *proximal* both describe the upper region of limb bones. When discussing the point of attachment of a bone, *proximal* is the more descriptive term. When describing the location of a bone relative to an inferior bone, the term *superior* is used.

### QuickCheck Questions

2.1 Why is having a precisely defined anatomical position important in anatomical studies?

2.2 What is the relationship of the shoulder joint to the elbow joint?

2.3 Which directional term describes the relationship of muscles to the skin?

## 2 IN THE LAB

### Materials

- ☐ Yourself or a laboratory partner
- ☐ Torso models
- ☐ Anatomical charts
- ☐ Anatomical models

### Procedures

1. Assume the anatomical position. Consider how this orientation differs from your normal stance.
2. Review each directional term presented in Figure 2.2.
3. Use the laboratory models and charts and your own body (or your partner's) to practice using directional terms while comparing anatomy. The Review & Practice Sheet at the end of this exercise may be used as a guide for comparisons.

## 3 Regional Terminology

Approaching the body from a regional perspective simplifies the learning of anatomy. Body surface features are used as anatomical landmarks to assist in locating internal structures; as a result, many internal structures are named after an overlying surface structure. For example, the back of the knee is called the popliteal (pop-LIT-ē-al) region, and the major artery in the knee is the popliteal artery. **Table 2.2** and **Figure 2.3** present the major regions of the body.

The head is referred to as the **cephalon** and consists of the **cranium,** or skull, and the **face.** The neck is the **cervical** region. The main part of the body is the **trunk,** which attaches the neck, upper limbs, and lower limbs. The **thoracic** region is the thorax, or chest. Inferior to the thorax is the **abdominal** region, which narrows at the **pelvis.** The back surface of the