About the Author

Catharine C. Whiting, University of North Georgia

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

About the Media Contributor

Karen L. Keller, Frostburg State University

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

Why Did I Write This Lab Manual?

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

I set out to write a lab manual that was first and foremost a tool of engagement. In my experience, engaging students in an active learning environment is the key to student success in both the lecture and the laboratory setting. When students are engaged, exciting things happen. Attendance improves. Students enjoy being in class. Grades soar! Students begin to focus on learning instead of worrying about what is going to be on the test. My hope is that instructors will be able to use and adapt the activities in this manual to cultivate their own active learning environment and to experience the joy of watching students fully engage in the learning process. Imagine having to run students out of the lab so that the next lab can get started. You will be amazed at what your students can accomplish when they are engaged, challenged, and inspired!

How Is This Lab Manual Different?

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

Getting Students Engaged in the Lab

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

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

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

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

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

### Getting Students to Prepare for Lab

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

### Getting Students to Apply Concepts

A third challenge and goal in the lab course is to get students to see the connections between concepts learned in lecture and their application in the lab. This manual fosters students’ ability to make these connections with unique **Think About It** questions and **Making Connections** charts. **Post-Lab Assignments** also include Bloom’s Level II Review Questions and Concept Mapping.

### Other Key Features

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

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

#### Additional Photos of Lab Specimens

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

#### PhysioEx™ 9.1

PhysioEx 9.1 is an easy-to-use physiology lab simulation program that allows students to repeat labs as often as they like, perform experiments without animals, and conduct experiments that are difficult...
to perform in a wet lab environment because of time, cost, or safety concerns. Every exercise includes an overview, and every activity includes objectives, an introduction, a pre-lab quiz, the experiment, a post-lab quiz, review sheet questions, and a lab report that students can save as a PDF and print and/or email to their instructor. The online format with easy step-by-step instructions includes everything students need in one convenient place.

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

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

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

**PhysioEx 9.1 topics include the following.**

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

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

What's New in the Second Edition

Global changes include the following.

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

Unit-by-unit changes include the following.

Unit 1, Introduction to Anatomy and Physiology: Revised Figure 1-3 (common terms that describe the regions of the body surface) to make it more useful and student-friendly
Unit 2, Introduction to the Organ Systems: New and improved Activity 3: Studying Homeostasis and Organ System Interactions to help students better understand how to complete the organ system interaction worksheet
Unit 3, Chemistry: Updated LabBOOST with new photo to increase student understanding of protein structure and function
Unit 5, The Cell: Addition of compare and contrast charts in Activity 5: Exploring Cellular Diversity to stimulate critical thinking
Unit 7, The Integumentary System: Revised activity instructions to improve clarity
Unit 8, Introduction to the Skeletal System: Modified Activity 2: Classifying and Identifying Bones and Bone Markings to stimulate critical thinking; addition of spongy bone histology in Activity 4: Exploring the Microscopic Anatomy of Bone
Unit 9, The Axial Skeleton: Modified activities to increase higher order thinking
Unit 11, Joints: Addition of compare and contrast charts in Activity 3: Comparing and Contrasting the Structure and Function of Selected Synovial Joints to stimulate critical thinking
Unit 12, Introduction to the Muscular System: Muscle Tissue: Updated BIOPAC activities
Unit 14, Introduction to the Nervous System: Expanded Activity 4: Exploring the Histology of Nervous Tissue with new photomicrographs
Unit 15, The Central Nervous System: Brain and Spinal Cord: Reorganized content and modified instructions for Activity 1: Exploring the Functional Anatomy of the Brain to improve flow and clarity; updated BIOPAC activities
Unit 16, The Peripheral Nervous System: Nerves and Autonomic Nervous System: Reorganized content and modified activity instructions to improve flow and clarity
Unit 18, The Endocrine System: Revised question sets in Activity 1: Exploring the Organs of the Endocrine System to improve flow and clarity
Unit 23, Circulatory Pathways and the Physiology of Blood Vessels: Modified activity instructions to improve clarity
Unit 24, The Lymphatic System: Revised and improved Making Connections chart in Activity 1: Exploring the Organs of the Lymphatic System
Unit 25, Anatomy of the Respiratory System: Revised and improved Making Connections chart in Activity 1: Exploring the Organs of the Respiratory System
Unit 28, Physiology of the Digestive System: Expanded Activity 4: Tracing Digestive Pathways to build critical thinking skills
Unit 30, Physiology of the Urinary System: Modified instructions for Activity 2: Simulating the Events of Urine Production and Urine Concentration to improve clarity
Unit 31, Reproduction and Development: Expanded Activity 3: Examining the Microscopic Anatomy of Selected Reproductive Organs to include epididymis, penis, uterine tube, and uterus

What’s New in Mastering A&P

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

A project of this magnitude is truly a team effort, and I have been a part of an amazing team. I have so many people to thank. I will be forever grateful to Acquisitions Editor Gretchen Puttkamer for bringing me onto the team, for helping me to create a vision for this project, and for having the patience to coach me through those rough beginnings. A heartfelt thanks to Serina Beauparlant, Editor-in-Chief, for her unending support, encouragement, and direction. Her extraordinary dedication to this project inspired me to give this lab manual my all and to keep my eyes on the finish line. Kudos also to Allison Rona, Director of Product Marketing, and Derek Perrigo, Senior Anatomy & Physiology Specialist, for their marketing guidance and advice. I am also grateful to Senior Content Producer Lauren Hill, Media Content Producers Patrice Fabel and Keri Rand, and Videographer Amanda Kaufmann for their excellent work spearheading Mastering A&P and the new media for this edition.

The production of this book was a herculean task expertly managed by Arielle Grant, Content Producer at Pearson and Norine Strang, Senior Project Manager at Cengage Learning Services. Many thanks to Stephanie Marquez, who provided guidance to the illustrators at Imagineering Art. Thanks also to Karin Kipp for her excellent photo research, and to Joanna Dinsmore for her eagle-eyed copyediting.

I want to thank Media Contributor Karen Keller of Frostburg State University for her superb job authoring the new fetal pig dissection videos and for writing several units for the first edition. Many thanks go to Michael Midgley, Quinnipiac University, for his thoughtful feedback and for updating the BIOPAC activities. I’m also grateful to Lori Smith, American River College, for sharing her excellent pre-lab videos. A special thanks to Carol Britson, University of Mississippi, Jill Feinstein, Richland Community College, and Elizabeth Hodgson, York College of Pennsylvania, for their advice and authorship of new assessments in Mastering. Thanks to Patricia Brady Wilhelm of Johnson & Wales University for her outstanding work on the cat dissection videos and units for the first edition. Thanks also to Wendy Rappazzo of Harford Community College, who authored clinical questions for Mastering A&P. I am grateful to Shari Boyce of Messiah College and Anna Gilletly of Central New Mexico Community College for their assistance in editing and preparing units. A huge thank you to Kate Phillips of Quinnipiac University, Carolyn Lebsack of Linn-Benton Community College, Steve Leadon of Durham Technical Community College, Michelle Gaston of Northern Virginia Community College, and Bert Atsma of Union County College for their meticulous accuracy checks. I also want to thank Professor Sam Chen for his willingness to share his cerebrospinal fluid “dance”!

I owe a very special thanks to Erin Amerman for writing an outstanding textbook for this lab manual to accompany. Erin is a truly gifted writer with an incredible insight into how students learn.

I would like to thank several of my colleagues at the University of North Georgia for their help, support, and valuable insights. A special thanks to John Hamilton for his expert photography. I owe JB Sharma a debt of gratitude for being an endless source of encouragement and a model of teaching excellence. I want to thank Lynne Berdanier for listening to my wild ideas and for her willingness to try them out in her labs. A special thanks to Jeanelle Morgan, our fearless leader on the Gainesville campus, who is an unending source of support, encouragement and guidance. Finally, to Malynde Weaver, my friend, my colleague, and teacher/advisor extraordinaire—your character, your wisdom, and your focus will always inspire me.

To my current and former students, you are the inspiration for this project. Your passion for learning motivates me to be the best teacher that I can be. A special shout out to the students who helped with the fetal pig manuscript and dissection photos for the first edition: Axel, Meg, Ryan B, and Ryan M. I also want to express my heartfelt appreciation to all of my students who have served as A&P teaching assistants through the years. Oh, the adventures we have shared! To my lead TA, Jessica, your enthusiasm, your energy, and your passion are contagious. You are going to be one incredible A&P professor! You are the reason that I teach!

Words cannot express the depth of my gratitude for the late Dr. Louis J. Guillette and the tremendous impact that he had on my life. He was my mentor, my professor, and my friend. He invested in my life and he taught me how to teach. He believed in me so many years ago, and that belief not only changed the direction of my life but also instilled in me a confidence in my abilities that took root and enabled me to pursue my dreams.

I am deeply grateful to my husband, Mark, and to our three incredible teenagers, Jesse, Eli, and Ashton, for their patience (most of the time) as I managed deadlines amidst the demands of our crazy yet incredible life filled with activities—swimming, football, baseball, basketball, and color guard, just to name a few! Mark, this project would never have happened without you. You are the love of my life—an incredible husband and father—and I am blessed beyond measure. You remind me daily with your words and actions of what is really important in life, and you help me keep my priorities in order.

Finally, I want to express my deepest gratitude to my parents, Dan and Lou Cox. Their unending love and support enabled me to pursue my dream of becoming a college professor. Furthermore, Dad’s dedication to his career as a doctor and Mom’s extraordinary nursing skills taught me that teaching, like medicine, is more about building relationships and service than anything else.
First and Second Edition
Text and Media Reviewers

Pius Aboloye, North Lake College (DCCCD)
Joslyn Ahlgren, University of Minnesota
Michele Alexandre, Durham Technical Community College
Chris Allen, Lone-Star College at University Park
Emily Allen, Rowan College of Gloucester County
Marcia Anglin, Miami Dade College–North campus
Rosalie Arienti, Central Maine Community College–Auburn
Erin Arnold, Jefferson State Community College
Mary Ann Arnold Hedrick, Wytheville Community College
Marianne Baricic, Raritan Valley Community College
Verona Barr, Heartland Community College
Dena Berg, Tarrant County College NW
Sheri Boyce, Messiah College
Ron Bridges, Pellissippi State Community College
Carol A. Britson, University of Mississippi
Kathleen Broomall, Miami University–Hamilton
Geralyn Caplan, Owensboro Community & Technical College
Michelle Carey, Hutchinson Community College
Maria Carles, Northern Essex Community College
Carol Carr, John Tyler Community College
Ellen Carson, Florida State College–Jacksonville
Peter Charles, Durham Technical Community College
Elizabeth Collins, Iowa Central Community College
Teresa Cowan, Baker College
Ken Crane, Texarkana College
Mary Dettman, Seminole State College
Karen Dunbar-Kareiva, Ivy Tech Community Colleges
Kathryn Englehart, Kennebec Valley Community College
Sondra Evans, Florida State College–Jacksonville
Georgia Everett, Ivy Tech Community College
Jill Feinstein, Richland Community College
Tracy Felton, Union County College
Christine Foley, Southwest Texas Junior College–Del Rio Campus
Lori Frear, Wake Tech Community College
Kim Fredricks, Viterbo University
Lynn Gargan, Tarrant County College NE
Lori Garrett, Parkland College
Michelle Gaston, Northern Virginia Community College
Carol Gavaiseski, Bellingham Technical College
Anna Gilletly, Central New Mexico Community College
Miriam Golbert, College of the Canyons
Joanna Greene, Ivy Tech Community College–Anderson
Tammy Greene, Ivy Tech Community College–Kokomo
Tim Grogan, Valencia College
Juan Guzman, Florida Gateway College
Bill Hanna, Massasoit Community College
Lesleigh Hastings, Wake Tech Community College
Stephanie Havemann, Alvin Community College
Heidi Hawkins, College of Southern Idaho
D. J. Hennager, Kirkwood Community College
Charmaine Henry, Baker University
Austin Hicks, University of Alabama
Elizabeth Hodgson, York College of Pennsylvania
Julie Huggins, Arkansas State University
Jody Johnson, Arapahoe Community College
Karen Keller, Frostburg State University
Suzanne Kempke, St. Johns River Community College
Christine Kistel, Mount Wachusett Community College
M. Anne Lachelt, Iowa Central Community College
Ellen Lathrop-Davis, Community College of Baltimore County
Steven Leadon, Durham Technical Community College
Carolyn Lebsack, Linn-Benton Community College
Stephen Lebsack, Linn-Benton Community College
Jeffrey Lee, Essex Community College
Leona Levitt, Union County College
Shawn Macaulay, Muskegon Community College
Christine Maney, Salem State College
Bruce Maring, Daytona State College
Robert Marino, Capital Community College
Sarah Matarese, St. George’s School
Cherie McKeever, Montana State University–Great Falls
Annie McKinnon, Howard College
Michael Midgeley, Quinipiac University
Justin Moore, American River College
Regina Munro, Chandler Gilbert Community College
Karen Murch-Shafer, University of Nebraska–Omaha
Jacqueline Nesbit, University of New Orleans
Zvi Ostrin, Hostos Community College
Ellen Ott-Reeves, Blinn College–Bryan Campus
Debbie Palatino, Roane State Community College
Kevin Ragland, Nashville State Community College
Wendy Rappazzo, Harford Community College
Jean Revie, South Mountain Community College
Travis Robb, Allen Community College–Burlingame
Fredy Ruiz, Miami Dade College
Tracy Rusco, East Central College
Amy Ryan, Clinton Community College
Linda Schams, Viterbo University
Jeff Schinske, De Anza College
Steven Schneider, South Texas College
Dorothy C. Scholl, University of New Mexico
Maureen Scott, Norfolk State
Marielen Shaner, University of New Mexico
George Steer, Jefferson College of Health Sciences
Maura O. Stevenson, Quinipiac University
James Stittsworth, Florida State College–Jacksonville
Deborah Temperly, Delta College
Terry Thompson, Wor-Wic Community College
Carlene Tonini-Boutacoff, College of San Mateo
Liz Torrano, American River College
Olga E. Vazquez, Valencia College
Lisa Welch, Weatherford College
Deb Wiepz, Madison Area Technical College
Darrellyn Williams, Pulsaski Technical College
Gina M. Zainelli, Gateway Technical College

Acknowledgments ix
# Brief Contents

## UNIT

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

## CAT Dissection Exercises

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exploring the Muscular System of the Cat</td>
</tr>
<tr>
<td>2</td>
<td>Exploring the Spinal Nerves of the Cat</td>
</tr>
<tr>
<td>3</td>
<td>Exploring the Respiratory System of the Cat</td>
</tr>
<tr>
<td>4</td>
<td>Exploring the Digestive System of the Cat</td>
</tr>
<tr>
<td>5</td>
<td>Exploring the Cardiovascular System of the Cat</td>
</tr>
<tr>
<td>6</td>
<td>Exploring the Urinary System of the Cat</td>
</tr>
<tr>
<td>7</td>
<td>Exploring the Reproductive System of the Cat</td>
</tr>
</tbody>
</table>

INDEX | I-1
Activity 3: Examining the Gross Anatomy of a Long Bone 137

LabBOOST Osteon Model 139

Activity 4: Exploring the Microscopic Anatomy of Bone 139

Activity 5: Examining the Chemical Composition of Bone 141

POST-LAB Assignments 143

UNIT 9 The Axial Skeleton 147

PRE-LAB Assignments 148

Activity 1 Studying the Bones of the Skull 158

Activity 2 Examining the Fetal Skull 163

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

Activity 4 Identifying Bones in a Bag 173

POST-LAB Assignments 175

UNIT 10 The Appendicular Skeleton 181

PRE-LAB Assignments 182

LabBOOST The Pelvic Bones 187

Activity 1: Studying the Bones of the Appendicular Skeleton 192

Activity 2: Identifying Bones in a Bag 200

POST-LAB Assignments 201

UNIT 11 Joints 209

PRE-LAB Assignments 210

Activity 1: Identifying and Classifying Joints 216

Activity 2: Demonstrating Movements Allowed by Synovial Joints 218

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

POST-LAB Assignments 225

UNIT 12 Introduction to the Muscular System: Muscle Tissue 229

PRE-LAB Assignments 230

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

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

LabBOOST Visualizing Sliding Filaments 239

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

Activity 4: Electromyography in a Human Subject Using BioPac™ 243

PhysioEx Exercise 2: Skeletal Muscle Physiology 246

POST-LAB Assignments 247

UNIT 13 Gross Anatomy of the Muscular System 253

PRE-LAB Assignments 254

Activity 1: Determining How Skeletal Muscles Are Named 257

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

Activity 3: Mastering the Muscles of the Trunk 272

Activity 4: Mastering the Muscles of the Upper Limb 278

Activity 5: Mastering the Muscles of the Lower Limb 284

POST-LAB Assignments 285

UNIT 14 Introduction to the Nervous System 293

PRE-LAB Assignments 294

Activity 1: Calculating Reaction Time 297

Activity 2: Investigating the Motor Neuron 302

Activity 3: Investigating the Chemical Synapse 303

Activity 4: Exploring the Histology of Nervous Tissue 305

PhysioEx Exercise 3: Neurophysiology of Nerve Impulses 306

POST-LAB Assignments 307

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

PRE-LAB Assignments 314

LabBOOST Visualizing the Brain 322

Activity 1: Exploring the Functional Anatomy of the Brain 322

Activity 2: Electroencephalography in a Human Subject Using BioPac™ 324

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

Activity 4: Examining the Functional Anatomy of the Spinal Cord 332
Activity 2: Identifying the Major Arteries That Supply the Abdominopelvic Organs and the Lower Limbs 481
Activity 3: Identifying Veins That Drain into the Venae Cavae 487
Activity 4: Examining the Histology of Arteries and Veins 489

POST-LAB Assignments 491

UNIT 23 Circulatory Pathways and the Physiology of Blood Vessels 499

PRE-LAB Assignments 500
Activity 1: Tracing Blood Flow—General Systemic Pathways 505
Activity 2: Tracing Blood Flow—Specialized Systemic Pathways 506
Activity 3: Tracing Blood Flow—Pulmonary Circulation 508
Activity 4: Tracing Blood Flow—Fetal Circulation 510
Activity 5: Measuring Blood Pressure and Examining the Effects of Body Position and Exercise 511
PhysieEx Exercise 5: Cardiovascular Dynamics 512

POST-LAB Assignments 513

UNIT 24 The Lymphatic System 517

PRE-LAB Assignments 518
Activity 1: Exploring the Organs of the Lymphatic System 524
Activity 2: Examining the Histology of a Lymph Node, a Tonsil, and the Spleen 526
Activity 3: Tracing the Flow of Lymph through the Body 527
Activity 4: Using a Pregnancy Test to Demonstrate Antigen–Antibody Reactions 529
PhysieEx Exercise 12: Serological Testing 532

POST-LAB Assignments 533

UNIT 25 Anatomy of the Respiratory System 537

PRE-LAB Assignments 538
Activity 1: Exploring the Organs of the Respiratory System 544
Activity 2: Examining the Microscopic Anatomy of the Trachea and Lungs 547
Activity 3: Examining a Sheep Pluck 548

POST-LAB Assignments 549

UNIT 26 Physiology of the Respiratory System 553

PRE-LAB Assignments 554
Activity 1: Analyzing the Model Lung and Pulmonary Ventilation 558
Activity 2: Measuring Respiratory Volumes in a Human Subject Using BIO PAC 559
Activity 3: Determining Respiratory Volumes and Capacities at Rest and Following Exercise 562
Activity 4: Investigating the Control of Breathing 564
PhysieEx Exercise 7: Respiratory System Mechanics 566

POST-LAB Assignments 567

UNIT 27 Anatomy of the Digestive System 571

PRE-LAB Assignments 572
Activity 1: Exploring the Organs of the Alimentary Canal 578
Activity 2: Exploring the Accessory Organs of the Digestive System 582
Activity 3: Examining the Histology of Selected Digestive Organs 589

POST-LAB Assignments 593

UNIT 28 Physiology of the Digestive System 599

PRE-LAB Assignments 600
Activity 1: Analyzing Amylase Activity 603
Activity 2: Analyzing Pepsin Activity 604
Activity 3: Analyzing Lipase Activity 606
Activity 4: Tracing Digestive Pathways 606
PhysieEx Exercise 8: Chemical and Physical Processes of Digestion 608

POST-LAB Assignments 609

UNIT 29 Anatomy of the Urinary System 613

PRE-LAB Assignments 614
Activity 1: Exploring the Organs of the Urinary System 620
Activity 2: Dissecting a Mammalian Kidney 622
Activity 3: Examining the Microscopic Anatomy of the Kidney, Ureter, and Urinary Bladder 625
UNIT 30  Physiology of the Urinary System  631

PRE-LAB Assignments  632
Activity 1: Demonstrating the Function of the Filtration Membrane  636
Activity 2: Simulating the Events of Urine Production and Urine Concentration  637
Activity 3: Using the Results of a Urinalysis to Make Clinical Connections  641

LabBOOST Understanding Tonicity  642
PhysieEx Exercise 9: Renal System Physiology  644
PhysieEx Exercise 10: Acid-Base Balance  644
POST-LAB Assignments  645

UNIT 31  Reproduction and Development  649

PRE-LAB Assignments  650
Activity 1: Examining Male Reproductive Anatomy  658

Activity 2: Examining Female Reproductive Anatomy  659
Activity 3: Exploring the Microscopic Anatomy of Selected Reproductive Organs  661
Activity 4: Comparing Spermatogenesis and Oogenesis  668
Activity 5: Exploring Fertilization and the Stages of Prenatal Development  673
Activity 6: Examining the Placenta  676
POST-LAB Assignments  677

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

INDEX  I-1