About the Author

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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

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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.

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<thead>
<tr>
<th>Unit</th>
<th>Activity</th>
<th>How it facilitates active learning</th>
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<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>
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(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.

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

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 adrenocorticotrophic hormone and a variety of endocrine disorders.

- **Exercise 5: Cardiovascular Dynamics**. Allows students to perform experiments that would be difficult if not impossible to do in a traditional laboratory. Topics include vessel resistance and pump (heart) mechanics.

- **Exercise 6: Cardiovascular Physiology**. Examines variables influencing heart activity. Topics include setting up and recording baseline heart activity, the refractory period of cardiac muscle, and an investigation of factors that affect heart rate and contractility.

- **Exercise 7: Respiratory System Mechanics**. Investigates physical and chemical aspects of pulmonary function. Students collect data simulating normal lung volumes. Other activities examine factors such as airway resistance and the effect of surfactant on lung function.

- **Exercise 8: Chemical and Physical Processes of Digestion**. Examines factors that affect enzyme activity by manipulating (in compressed time) enzymes, reagents, and incubation conditions.

- **Exercise 9: Renal System Physiology**. Stimulates the function of a single nephron. Topics include factors influencing glomerular filtration, the effect of hormones on urine function, and glucose transport maximum.

- **Exercise 10: Acid-Base Balance**. Topics include respiratory and metabolic acidosis/alkalosis and renal and respiratory compensation.

- **Exercise 11: Blood Analysis**. Topics include hematocrit determination, erythrocyte sedimentation rate determination, hemoglobin determination, blood typing, and total cholesterol determination.

- **Exercise 12: Serological Testing**. Investigates antibody–antigen 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 Puttkammer 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.

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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 Sheri Boyce of Messiah College and Anna Gilletty of Central New Mexico Community College for their advice 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.

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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 have never 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.
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