To my mom, Judy—for your unending love and support, I am forever grateful. You are precious to my heart. I love you.

Love,
—Melissa

I would like to dedicate this book to my family and to all of the students that have taken our classes and thus helped us make this book the best it can be!

—Robin

To Bready, Audrey, and Luke—you are my whole world. Get your cups off of my table!

Love,
—Lisa (Mom)
About the Authors

Melissa L. Greene, NORTHWEST MISSISSIPPI COMMUNITY COLLEGE

Melissa L. Greene is the Biology Department Chair at Northwest Mississippi Community College in Senatobia, MS. She earned her B.S. degree in biology from Christian Brothers University in Memphis, TN, and her M.S. in life science from the University of Maryland. Her primary research focus was neuroanatomy, which she conducted at the University of Tennessee Health Science Center. With 16 years of college teaching experience, Melissa has extensive experience teaching anatomy and physiology lecture and labs, introductory biology for nonmajors, and biology for majors both in the classroom and via an online forum. In addition, she advises students interested in pursuing careers in biology and the health professions. She is a member of the Human Anatomy and Physiology Society (HAPS) and the Mississippi Academy of Sciences. Melissa is on the board of the Northwest Faculty Association, where she serves as vice president. When not writing or teaching, she enjoys spending time with her family and traveling. Melissa actively supports the Memphis Oral School for the Deaf, where her niece was a student for four years.

Robin H. Robison, NORTHWEST MISSISSIPPI COMMUNITY COLLEGE

Robin H. Robison is in his twenty-ninth year of teaching anatomy and physiology at Northwest Mississippi Community College. He is finishing his fifth as the Director of Science Instruction for NWCC. Robin was the recipient of the 1997 Lamplighter Award for Excellence in Teaching at NWCC. He also received the Tate County Educator of the Year award in 1998. Robin is currently developing and teaching biology courses for NWCC’s eLearning department. Robin’s teaching style is very engaging and never boring. He inserts practical stories into his lectures that help the students relate to and understand the material. Robin is a product of the community college system, receiving his A.A. degree in biology from Northeast Mississippi Community College. He received his B.A. and M.S. degrees in biology from the University of Mississippi. Robin is a member of the Human Anatomy and Physiology Society.

Lisa C. Strong, NORTHWEST MISSISSIPPI COMMUNITY COLLEGE

Lisa C. Strong is the Biology Laboratory Coordinator and a full-time instructor at Northwest Mississippi Community College. She also began her own college career at Northwest before transferring to Delta State University, where she received her B.S. in biology education. She earned her master’s degree from the University of Mississippi in the spring of 2003. She has taught courses in human anatomy and physiology, microbiology, and general biology for 15 years. She has always had a passion for teaching and tries to instill a love for the sciences in her students. She is constantly seeking ways to engage her students through the use of innovative technology in the classroom. She is member of the Human Anatomy and Physiology Society.
Preface

After trying different A&P lab manuals over the years with varying success, we decided to write our own lab manual because it was clear the needs of our students were changing. As digital natives who represented a wide diversity of learning styles, our students needed a variety of learning modes and technology to help them prepare for lab and get the most out of their lab time.

Key Features

We developed several special features in our lab manual that provide students with different ways of preparing for lab and maximizing their learning during lab time:

- **A rich variety of pre-lab assignments** including multiple-choice and short-answer questions, coloring, drawing, labeling, and watching pre-lab videos provide students with different learning modes to help them better prepare for lab. The pre-lab assignments are not in-depth topic studies but rather a superficial overview that can be completed in a relatively short time. We know that not all instructors will cover every activity within a lab exercise, so we have broken down the pre-lab assignments by activities. This will allow the instructors the freedom to decide which activities they want their students to complete. Pre-lab assignments are also available as *auto-gradable pre-lab assignments in Mastering A&P*. Having students who are prepared for lab will make better use of instructional time.

- **Over 100 specially commissioned photos of anatomical models** from Altay, Denoyer-Geppert, 3B Scientific, and Ward's Science help students identify and locate key anatomical structures and landmarks. In addition, some exercises include *side-by-side photos of cadavers and anatomical models* for easy visual comparison.

- **Over 50 lab videos**, Practice Anatomy Lab 3.1 (PAL) and animations featured in selected pre-lab assignments and lab activities maximize student learning by reviewing key A&P concepts and lab procedures. Each lab video and media have been specially called out in the lab manual via a screenshot for easy reference.

The lab videos, PAL and animations can be assigned in Mastering and are also available in the Study Area of Mastering A&P.

- Please see the Quick Reference on the inside cover of this lab manual for a list of the lab videos and animations for each activity.

- **Updated PhysioEx 10.0 Laboratory Simulations in Physiology** provides newly formatted exercises in HTML for increased stability, web browser flexibility, and improved accessibility. The 12 Exercises contain more than 60 easy-to-use laboratory simulation activities that complement or replace wet labs, including those that are expensive or time-consuming to perform in class. Each 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 e-mail to their instructor. The online format with easy step-by-step instructions includes everything students need in one convenient place.
PhysioEx 10.0 includes the following features:

- 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 a course management system is provided for instructors, in the Instructor Resources in Mastering.

PhysioEx 10.0 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. Examines 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.

Post-lab assessments are designed to check students’ understanding of the material presented in the lab exercise and, like the pre-lab, use a variety of questions best suited to assess students’ understanding of the material. When appropriate, additional anatomical model or cadaver images (not identical to those in the procedure) are used. Each post-lab assessment ends with Apply What You Learned questions. These are clinical application-type questions that require students to use critical thinking skills to relate each lab to an overall understanding of how body systems work together.

Correlates with Amerman’s Human Anatomy & Physiology. As A&P instructors, we have noticed that students often are unable to correlate the lab manual to the textbook. For example, the numbering of the lab exercises and textbook chapters.
typically do not correspond. With our laboratory manual, we purposely organized the lab exercises so they correspond to the chapters of the textbook we use, *Human Anatomy & Physiology* by Erin Amerman. So when you are working on Chapter 19 (Blood) from the Amerman textbook, Lab exercise 19 in our lab manual will be the blood lab as well. Terminology and most of the illustrations match the Amerman textbook. However, educators and students not using Amerman’s textbook will still find our exercises applicable and effective.

- **Affordability** is key because we know that for students, finances may be an issue. That is why we have worked hard to provide this high-quality lab manual and premium digital content at an affordable price. We also know that students are not the only ones dealing with financial issues. Many departments have experienced budget cuts and lack of funds. We have included many cost-effective lab activities in our lab manual with information in the Instructor Guide on where to purchase the materials used. *Practice Anatomy Lab* is a virtual study and practice tool that includes a wealth of photos of models and cadavers that otherwise might not be accessible to all students. We also have included *PhysioEx* activities to supplement or replace the expensive physiology equipment that is lacking in many laboratories.

- **Three versions** are offered. *Laboratory Manual for Human Anatomy & Physiology: A Hands-on Approach* is available in three versions for your students: Main, Cat, and Pig. The Cat and Pig versions are identical to the Main version except that they include seven additional cat dissection and nine additional fetal pig dissection exercises, respectively, at the back of the lab manual.

- **Custom options** are available. If a customized version of our lab manual is desired, customization by activity level is now available via the Pearson Custom Library. Instructors can easily select which activities they want and/or add their own original material to their custom lab manual.

### Mastering A&P

Mastering A&P is an online learning and assessment system proven to help students learn. It helps instructors maximize lab time with customizable, easy-to-assign, automatically graded assessments that motivate students to learn outside class and arrive prepared for lab. The powerful gradebook provides unique insight into student and class performance.

### Assignments in Mastering A&P

Instructors can easily assign the following in the Item Library in Mastering A&P. Please note that the Item Library for Greene is available in the stand-alone Mastering course for Greene. It is also available in the Book/Source menu in the Item Library for our 2-semester A&P textbooks by Amerman, Marieb, and Martini.

- **Pre-lab and post-lab quizzes for each activity** in the lab manual that test on the same content found in the pre-lab and post-lab assignments in the lab manual, excluding the color and draw questions.

- **"Roots to Remember" Coaching Activities** – Each exercise begins with an assignable activity that gives students practice learning and using word roots in context as they learn new A&P terms.

- **Chemistry Review Tutorials**

- **Art Labeling Activities**

- **“Apply What You Learned” – Bloom’s Taxonomy Level II Application/Analysis Questions**

- **Lab Assistant Videos, Pre-lab Videos, and Animation Coaching Activities** maximize student learning by reviewing key A&P concepts and lab procedures.

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

- **Cat Dissection and Fetal Pig Dissection Video Coaching Activities** help students prepare for dissection and identify key anatomical structures. Each video includes one or two comparisons to human structures.

- **A&P Flix and BioFlix Animations** are 3D movie-quality anatomy and biology animations.

- **Practice Anatomy Lab 3.1 Test Bank** includes over 6000 multiple-choice and fill-in-the-blank questions.

- **PhysioEx 10.0 Assignments** include pre-lab and post-lab quizzes.

- **Clinical Scenario and Nurses Need Physiology Coaching Activities** provide students with additional practice in applying concepts to clinical situations.

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

**Instructor Resources in Mastering A&P**

The Instructor Resources include the following:

**Computerized Test Bank** for every activity and learning outcome that saves instructors time in creating lab quizzes and practicals. Instructors can create tests through TestGen by selecting questions from the provided Test Bank of multiple-choice and art-based questions, customizing questions as needed or adding in new question content. TestGen also allows randomization of the questions to produce up to 25 different versions of the same test. The Test Bank is also available in Microsoft Word format.

**Instructor Guide** contains instructions for setting up the laboratory activity; where to purchase lab materials; time allotments for each activity; learning objectives for each Exercise and answers to the pre-lab assignments, activity questions, and post-lab assessments, including the Apply What You Learned questions.

**Lab Videos & Animations** including A&P Flix and Bio Flix 3D Animations, Big Picture Animations, Bone & Dissection Videos, Cat Dissection Videos, Fetal Pig Dissection Videos, Get Ready for A&P Video Tutors, IP Anatomy Review Animations, Lab Assistant Videos, and Pre-lab Videos.

**Practice Anatomy Lab Instructor Resources** include PAL 3.1 animations, all images from PAL in PowerPoint and JPEG formats, PAL Test Bank, and PAL Lab Guide Answer Key.

**PhysioEx Instructor Resources** include PEx 10.0 and PhysioEx Test Bank.

**Alternative Data Acquisition Instructions** include instructions and exercises for BIOPAC, PowerLab, iWorx, and Intelitool.

**Clinical Case Studies** include case studies and worksheets to increase problem-solving skills and prepare students for future careers in allied health. **Teaching Strategies** for each case include introduction to the case, student learning objectives, prerequisites, and tips for how to use and assign the case in your course and “flipped classroom.” The case studies and worksheets are also available to students in the Study Area of Mastering.

**Study Area in Mastering**

Students get access to the following study tools in the Study Area of Mastering A&P:

- **Lab Assistant Videos, Pre-lab Videos, Bone and Dissection Videos and Animations** are integrated into each lab exercise for quick, easy access.

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

- **PAL 3.1 FLASHCARDS**, a popular student tool, allows students to create a customized, mobile-friendly deck of flashcards and quizzes based on images from PAL. Students generate personalized flashcards by selecting only those structures covered in their course.

- **PhysioEx™ 10.0 Laboratory Simulations in Physiology**

- **Pearson eText** (included with Mastering with eText for *Laboratory Manual for Human Anatomy & Physiology: A Hands-on Approach*), optimized for mobile use in Pearson’s fully accessible platform, seamlessly integrates videos and gives students access to their lab manual anytime, anywhere.

**Class-Tested and Approved**

Making this lab manual, including the text, the art, the photos, and the videos, was an intensive, collaborative process. Each draft of the manuscript was sent to A&P lab instructors and other content experts to evaluate the quality of the activities and accuracy, the art and photo program; and the overall pedagogical effectiveness. Our team worked closely together to analyze the feedback and determine which changes were necessary to improve the lab exercises. In addition, over 200 A&P instructors and 3000 students provided feedback through extensive focus groups and class-testing prior to publication.
Acknowledgments

It is hard to believe that this lab manual began seven years ago as an idea among friends on a trip home from a conference. We had a vision to create a laboratory manual that was user-friendly for the instructor and the student. Pooling our collective knowledge of anatomy and physiology, as well as what tools and techniques work in the lab setting, we set out on this journey five years ago, working diligently through holidays, weekends, and nights. However, none of this would have been possible without the support of our families, friends, and our incredible team at Pearson. They have seen us through the good and the bad times and have been patient with us during the trials and also celebrated the accomplishments. We are so grateful to have had such wonderful individuals in our lives during this journey.

To our Pearson team, you are the most amazing group of individuals we could have ever hoped to work with on this project. We extend a very special thank you to our Editor-in-Chief, Serina Beauparlant. Not only did she dedicate herself completely to this project, but she also became a dear friend in the process. We are all so grateful for the opportunity to have worked with her on this project. Serina is simply the heart and soul of Pearson A&P. She has guided us from start to finish; without Serina there would be no book.

We also would like to thank our longtime Pearson sales representative, Melissa Bland. Melissa has been one of our biggest supporters from the beginning. She encouraged us to get into the ring of publishing and opened many doors for us at Pearson.

We extend a very special thank you to Dapinder Dosanjh. Dapinder kept us on task through a majority of this project. Without her, we would have been lost. We always looked forward to our weekly task list, and we are sure she looked forward to our fifty follow-up emails. We are forever grateful for having had her on our team.

We want to thank Amanda JS Kaufmann and Mike Sloat for filming, editing, and producing our Lab Assistant Videos. Thanks are due Nathan Dixon for the amazing photographs of anatomical models as well as the cover photo that was taken especially for this lab manual. We appreciate the hard work of Tanya Martin, our development editor, and also want to thank Jay McElroy for the tremendous artwork. Special thanks go to Dr. Carol Britson of the University of Mississippi, who kindly advised on this lab manual and shared her impressive lab materials with us.

A huge “thank you” goes out to the Editorial Board, who served as eagle-eye reviewers throughout the development of this project: Sheri Boyce of Messiah College, Maria Carles of Northern Essex Community College, Karen Dunbar Kareiva of Ivy Tech Community College, Ewa Gorski of Community College of Baltimore County, Kerrie Hoar of University of Wisconsin–La Crosse, J. Ellen Lathrop-Davis of Community College of Baltimore County, Shawn Macauley of Muskegon Community College, Shelly Watkins of Central Carolina Community College, and Darrellyn Williams of University of Arkansas–Pulaski Tech College.

We also want to acknowledge the excellent contributions by Dr. Karen L. Keller of Frostburg State University and Jennifer Reaves of Jackson State Community College, who authored the Cat and Pig Dissection Exercises, respectively. Thank you to Wendy Rappazzo, Harford Community College, who contributed the “Apply What You Learned” questions.

To our colleague and dear friend, Angel Nickens, we appreciate all your help and advice. Thank you for your help in developing the Computerized Test Bank. In addition to Angel Nickens, we must also thank all of our colleagues, both past and present, who have inspired us, reviewed exercises, class-tested material, and supported us all through this process. Thank you so much, Dr. Lindsay Massie, Kim Poland, Phillip Correro, Shay Carter, Bud Donahou, Mary Bonds, Bobby King, Pat Miller, Dr. Jerry Hollis, Dr. Larry Sylvester, Dr. Sarah Holt, Dr. Darrell Barnes, Paul Grisham, Dr. Carol Cleveland, Dr. George Hilliard, Anissa McGinnis, and Dr. Michael McPherson.

Special appreciation goes to the Northwest Mississippi Community College administrators: former President Dr. Gary L. Spears, former Vice President Richie Lawson, President Dr. Michael Heindl, and Vice President Dr. Matthew Domas. Without the support of these men, this project would not have been possible.

Each of us would like to say a very special thank you to our families for all their sacrifices during this project.

Melissa:
I would like to thank my parents, Judy, Jerry and Linda Greene, for their constant encouragement and prayers. Thank you to all of my family, the Greenes and the Gardners. Your love and support mean the world to me, and I love you all. I would like to thank my teachers and professors. Thank you to all of my teachers at SBEC for everything you taught me. Thank you to my
biology professors at CBU: Dr. Mary Ogilvie, Dr. Stan Eisen, Dr. Anna Ross, Dr. Malinda Fitzgerald, and Bro. Edward Salgado. Your knowledge and expertise in the classroom are the reason I decided to teach biology every day. Thank you to Dr. Mark S. LeDoux for being a tremendous mentor and sharing your knowledge of neuroanatomy and research with me. Finally, I would like to thank my Northwest students, past and present, who have taught me so much and helped make me a better instructor.

Robin: I would like to thank my wife, Robbie, who has been my biggest supporter; my two daughters, Randi and Rylee; and Randi’s husband, Caleb Aldridge. Special thanks to my parents Joyce and James Robison, especially for that microscope when I was 12; it changed my life. Thanks go to my sister Jamie Loper and brother Chad. Thanks also go to all the teachers, especially Bonnie Stowers, who helped me become the teacher I am.

Lisa: I would like to say thank you to my husband, Bready, for the countless weekends you have spent hanging out with the kids and never once complained. To my kids, Audrey and Luke, I would like to thank you for tagging along during holidays and afternoons and getting along (most of the time) while we worked. Finally, I would like to thank my parents, especially my mom, for always being an encouragement.

Text and Media Reviewers

Renee Albano, Florida State College at Jacksonville
Patricia Alfing, Davidson County Community College
David Allard, Texas A&M University—Texas A&M University
Deborah Anderson, St. Norbert College
Meghan Andrikianich, Lorain County Community College
David Ansardi, Calhoun Community College
Ros Arienti, Central Maine Community College
Erin Arnold, Jefferson State Community College
Rena Bacon, Ramapo College of New Jersey
Jerry Barton, Tarrant County College
Melody Bell, Vernon College
Celina Bellencauc, Florida Southern College
Jennifer Bergner, Helena College University of Montana
Claudie Biggers, Amarillo College
Jerry Bowen, Rogers State University
Sheri Boyce, Messiah College
Bridget Boyle, Northwest Iowa Community College
Betsy Brantley, Valencia College
Sacha Bratinova, Delaware Technical Community College
Ron Bridges, Pellissippi State Community College
Carol Britton, University of Mississippi
Jennifer Buntz, Central New Mexico Community College
Susan Burgoon, Amarillo College
Beth Campbell, Itawamba Community College
Maria Carles, Northern Essex Community College
Robert Caron, Bristol Community College
Jocelyn Cash, Central Piedmont Community College
Jose Chestnut, Essex County College
Robert Cleary, Keiser University
Jan Clifton-Gaw, Ivy Tech Community College, Anderson
Vickie Clouse, Montana State University–Northern
Justin Cobb, John Wood Community College
Joy Colley, Aiken Technical College
Beth Collins, Iowa Central Community College
Mary Colon, Seminole State College of Florida
Teresa Cowan, Baker College of Auburn Hills
Nicholas Curtis, Ave Maria University
Kara Danner, Wallace Community College
Deanna Denault, Franklin Pierce University
Elisa Di Menna, Central New Mexico Community College
Lynn Diener, Mount Mary University
Gregory Diersen, Martin Luther College
Matthew Dodge, Olympic College
Wayne Dugge, St. Louis Community College - Meramec
Karen Dunbar Kareiva, Ivy Tech Community College, Valparaiso
Marirose Ethington, Genesee Community College
Colin Everhart, St. Petersburg College
Jamal Fakhoury, College of Central Florida
Jun Farnsworth, Vincennes University
Sarah Fauque, Lindsey Wilson College
Jill Feinstein, Richland Community College
Tashauna Felix, Community College of Baltimore County
Julie Fischer, Wallace Community College
Polly Fourman, Chandler-Gilbert Community College
Tamara Frank, Nova Southeastern University
Janice Fritz, St. Clair County Community College
Manuela Gardner, California State University, Long Beach
Emily Getty, Ivy Tech Community College, Kokomo
Nicolette Giasolli, Metropolitan State University of Denver
Gary Glaser, Genesee Community College
Wanda Goleman, Northwestern State University
Ewa Gorski, Community College of Baltimore County
Tammy Greene, Ivy Tech Community College, Kokomo
Tim Grogan, Valencia College
Mark Haekefele, Community College of Denver
William Hairston, Harrisburg Area Community College
Niloufar Haque, New York City College of Technology
Clare Hayes, Metropolitan State University of Denver
Martha Heath-Sinclair, Hawkeye Community College
Dawn Hilliard, Northeast Mississippi Community College
Heather Hinkle, Reading Area Community College
Dale Horeth, Tidewater Community College—Virginia Beach
Vanessa Hormann, Broward College
Sheela Huddle, Harrisburg Area Community College
Julie Huggins, Arkansas State University
Gayle Insler, Adelphi University
Cynthia Jackson, Nashville State Community College
Mark Jaffe, Nova Southeastern University
Jerilyn Belle James, Beville State Community College
Debbi Johnson, Western Connecticut State University
Svanrthi Kanethi, Lanier Tech–Georgia
Joseph Kazery, Mississippi College
Suzanne Kempke, St. Johns River State College
Amy Kennedy, Central Carolina Community College
Lynda Kiesler, Riverland Community College
Niveditha Krishnamurthy, Chandler-Gilbert Community College
Tyjuanna LaBennett, North Carolina Central College
Daudi Langat, Labette Community College
Dominic Lannutti, El Paso Community College
Richard LaRock, Spencerian College
J. Ellen Lathrop-Davis, Community College of Baltimore County
Zane Laws, Cisco College
Steve Leadon, Durham Technical Community College
Katie Leefebvre-Ruggieri, Bristol Community College
Robert Lehr, Community College of Vermont
Andrea LeSchack, Trident Technical College
Jerri Lindsey, Tarrant County College
Sarah Lovern, Concordia University Wisconsin
Paul Luyster, Tarrant County College
Shawn Macauley, Muskegon Community College
Debra Machuca, Portland Community College
Julie Maharrey, Jefferson State Community College
Ken Malachowsky, Florence-Darlington Technical College
Augustin Manuzak, Hawaii’i Pacific University
Patricia Marquardt, Wayne County Community College
District
Helen Maserang, South Texas College
Nicole Mashburn, Calhoun Community College
James F. McCaughern-Carucci, St. Johns River State College
Tom McDonald, Pima Community College
Tiffany Mcfalls-Smith, Kentucky Community & Technical College System–Elizabethtown
Joan Mckearnan, Anoka-Ramsey Community College
Annie McKinnon, Howard College
Karen McLellan, Purdue University Fort Wayne
Rollin Medcalf, Pima Community College
Judy Metcalf, Texas A&M University–Corpus Christi
Melanie Meyer, Community College of Vermont
Emilie Miller, Columbia Gorge Community College
Melinda Miller, Pearl River Community College
Evelyn Mobley, Chattanooga State Community College
Mary Monck, Holy Family University
Brandon Montoya, Cincinnati State Technical and Community College
Karen Moore, St. Johns River State College
Laurie Munro, Community College of Aurora
Rosario Murdie, Ivy Tech Community College, South Bend-Elkhart
Anita Naravane, St. Petersberg College
Necia Nicholas, Pensacola State College
Russell Nolan, Baton Rouge Community College
Alfred Noubani, Delaware Technical Community College
Lilian Ogari, Baptist College of Health Sciences
Richard Olexa, St. Petersburg College
Bernardo Ortega, The College at Brockport, SUNY
Shelly Paradies, SUNY Orange
Vijay Parkash, Broward College
Candace Paschal, El Centro College
Jerri Nicole Pearce, Itawamba Community College
Christopher Pellino, Saint Peter’s University
Carla Perry, Community College of Philadelphia
Andrew Piercy, Valencia College
Angela Poole, Berry College
Saeed Rahmanian, Roane State Community College
Wendy Rappazzo, Harford Community College
Jonathan Reason, Concordia University Ann Arbor
Jennifer Reaves, Jackson State Community College
Gary Reid, Trinity Valley Community College–Terrell
Jackie Reynolds, Richland College
Deborah Rhoden, Snead State Community College
Nancy Risner, Ivy Tech Community College, East Central
Cyril Robinson, The Citadel, The Military College of South Carolina
Ronald Rossetti, Worcester State University
Hiranya Roychowdhury, New Mexico State University
Mir Saleem, Nova Southeastern University
Dee Sato, Cypress College
Cheston Saunders, Bladen Community College
Michelle Scanavino, Moberly Area Community College
Victoria Schneider, Montgomery College
Dorothy Scholl, University of New Mexico
Kimberly Schorr, Hawaii’i Community College
Jennifer Schroeder, Millikin University
Jay Schwartz, State College of Florida
Mary Scott, Dodge City Community College
Hurley Shepherd, Baptist College of Health Sciences
Marilyn Shopper, Johnson County Community College
Heidi Silkey, Mount Wachusett Community College
Michael Silva, El Paso Community College
Mitzi Simerlein, Ivy Tech Community College, Valparaiso
Olufemi Sodeinde, New York City College of Technology
Kim Sonanstine, Wallace Community College
Sheryll Soukup, Illinois Wesleyan University
Vetaley Stashenko, Palm Beach State College
Sherry Stewart, Navarro College
Sarah Strafford, Community College of Vermont
Rob Swatski, Harrisburg Area Community College
Laura Sweet, Eastern Michigan University
Maryam Taabodi, University of Maryland Eastern Shore
Stephanie Tacquard, Alvin Community College
Barry Tanowitz, Santa Barbara City College
Candice Thomas, University of Central Arkansas
Rita Thrasher, Pensacola State College
Diane Tice, SUNY Morrisville
Todd Tolar, Wallace Community College
Dawn Turner, University of Charleston
Kim Van Vliet, St. Johns River State College
Mark Wagner, Portland Community College
Melodie Wakefield, St. Petersburg College
Shelly Watkins, Central Carolina Community College
Jennifer Welch, Madisonville Community College
Kathy White, St. Philip's College
John Whitlock, Mount Aloysius College
Rachel Willard, Arapahoe Community College
Darrellyn Williams, University of Arkansas–Pulaski Technical College
Goldie Willis, Roane State Community College
Stephen Wright, Carson-Newman University
Jay Zimmer, Gardner-Webb University
# Brief Contents

## MAIN LAB EXERCISES

1. Introduction to Anatomy and Physiology  
2. The Chemistry of Life  
3. The Cell  
4. Histology  
5. The Integumentary System  
6. Bones and Bone Tissue  
7. The Skeletal System  
8. Articulations  
9. The Muscular System  
10. Muscle Tissue and Physiology  
11. Introduction to the Nervous System and Nervous Tissue  
12. The Central Nervous System  
13. The Peripheral Nervous System  
14. The Autonomic Nervous System and Homeostasis  
15. The Special Senses  
16. The Endocrine System  
17. The Cardiovascular System I: The Heart  
18. The Cardiovascular System II: The Blood Vessels  
20. The Lymphatic System and Immunity  
21. The Respiratory System  
22. The Digestive System  
23. Metabolism and Nutrition  
24. The Urinary System  
25. Fluid, Electrolyte, and Acid-Base Balance  
26. The Reproductive System  
27. Human Development

## PIG DISSECTION EXERCISES

1. Examining Surface Anatomy and Preparing the Fetal Pig for Dissection  
2. Skeletal Muscles of the Fetal Pig  
3. Spinal Cord and Spinal Nerves of the Fetal Pig  
4. Endocrine System of the Fetal Pig  
5. Cardiovascular System of the Fetal Pig  
6. Digestive System of the Fetal Pig  
7. Respiratory System of the Fetal Pig  
8. Urinary System of the Fetal Pig  
9. Reproductive System of the Fetal Pig

## Credits

Credits I-1

## Index

Index I-1
Contents

LAB EXERCISE 1

Introduction to Anatomy and Physiology 1

Pre-Lab Assignments 2

1A Laboratory Safety 8
   PROCEDURE Understanding Laboratory Safety 8

1B The Scientific Method 9
   PROCEDURE Using the Scientific Method to Compare Arm Span and Height 10

1C Human Body Systems 11
   PROCEDURE Identifying Human Body Systems, Organs, and Functions 13

1D Anatomical Position and Directional Terminology 20
   PROCEDURE Demonstrating Anatomical Position and Using Directional Terminology 21

1E Regional Terminology 22
   PROCEDURE Using Regional Terminology to Describe Areas of the Body 22

1F Planes of Section 23
   PROCEDURE Identifying Planes of Section 24

1G Body Cavities, Abdominopelvic Quadrants and Regions, and Serous Membranes 25
   PROCEDURE 1 Identifying Major Organs within Body Cavities and Abdominopelvic Quadrants and Regions 27
   PROCEDURE 2 Understanding the Structure of Serous Membranes 28

Post-Lab Assessments 29

LAB EXERCISE 2

The Chemistry of Life 37

Pre-Lab Assignments 38

2A The Periodic Table, Atomic Structure, and Chemical Bonds 40
   PROCEDURE 1 Using the Periodic Table to Determine Atomic Number, Atomic Mass, and Number of Subatomic Particles 40
   PROCEDURE 2 Using the Periodic Table to Draw Atomic Structure 42
   PROCEDURE 3 Illustrating Chemical Bonds 44

2B Enzymes 44
   PROCEDURE Determining Enzyme-Substrate Specificity of Lactase on Lactose, Sucrose, and Maltose 45

2C The pH Scale 46
   PROCEDURE Determining the pH of Various Household Chemicals 47

2D Organic Molecules 48
   PROCEDURE 1 Testing for the Presence of Monosaccharides and Disaccharides 52
   PROCEDURE 2 Testing for the Presence of Starch 53
   PROCEDURE 3 Testing for the Presence of Peptides and Proteins 54
   PROCEDURE 4 Testing for the Presence of Lipids 54
   PROCEDURE 5 Determining the Chemical Composition of Various Foods 54
   PROCEDURE 6 Extracting Human DNA from Cheek Cells 55

Post-Lab Assessments 57

LAB EXERCISE 3

The Cell 61

Pre-Lab Assignments 62

3A Microscopy 65
   PROCEDURE 1 Exploring the Parts of a Compound Light Microscope 65
   PROCEDURE 2 Calculating Total Magnification 67
   PROCEDURE 3 Focusing a Compound Light Microscope 67
   PROCEDURE 4 Estimating the Diameter of the Microscope Field 69
   PROCEDURE 5 Determining Depth of Field 70
   PROCEDURE 6 Working with a Dissecting Microscope 70

3B Cell Structure 71
   PROCEDURE 1 Identifying Cellular Organelles and Structures 73
   PROCEDURE 2 Preparing a Wet Mount and Observing Cheek Cells 74
   PROCEDURE 3 Observing Various Types of Cells 74

3C Membrane Function 76
   PROCEDURE 1 Examining the Effects of Temperature on the Rate of Diffusion 79
   PROCEDURE 2 Observing Diffusion across a Selectively Permeable Membrane 79
   PROCEDURE 3 Examining the Effect of Tonicity on Osmosis 80
   PROCEDURE 4 Examining the Effects of Particle Size on Filtration 81

3D The Cell Cycle 82
   PROCEDURE Identifying the Stages of the Cell Cycle and Mitosis 86

xvii
LAB EXERCISE 11

Introduction to the Nervous System and Nervous Tissue 311

Pre-Lab Assignments 312

11A Nervous Tissue 314

PROCEDURE 1 Identifying the Components of Nervous Tissue 315
PROCEDURE 2 Exploring the Anatomy of Neurons and Neuroglia 317

11B Electrophysiology of Neurons 319

PROCEDURE Understanding Electrophysiology of Neurons 319

11C Neuronal Synapses 321

PROCEDURE 1 Comparing Electrical and Chemical Synapses 322
PROCEDURE 2 Understanding Chemical Synaptic Transmission 323

11D PhysioEx™ Activities 323

PEX ACTIVITY 1 The Resting Membrane Potential 323
PEX ACTIVITY 2 Receptor Potential 323
PEX ACTIVITY 3 The Action Potential: Threshold 323
PEX ACTIVITY 4 The Action Potential: Importance of Voltage-Gated Na+ Channels 323
PEX ACTIVITY 5 The Action Potential: Measuring Its Absolute and Relative Refractory Periods 323
PEX ACTIVITY 6 The Action Potential: Coding for Stimulus Intensity 323
PEX ACTIVITY 7 The Action Potential: Conduction Velocity 323
PEX ACTIVITY 8 Chemical Synaptic Transmission and Neurotransmitter Release 323
PEX ACTIVITY 9 The Action Potential: Putting It All Together 323

Post-Lab Assessments 325

LAB EXERCISE 12

The Central Nervous System 329

Pre-Lab Assignments 330

12A The Brain 332

PROCEDURE 1 Identifying the Major Structures of the Human Brain and Their Functions 336
PROCEDURE 2 Dissecting a Preserved Sheep Brain 339

12B The Spinal Cord 341

PROCEDURE Examining Spinal Cord Anatomy 343

Post-Lab Assessments 345

Post-Lab Assessments 305
Contents

18D Arterial Blood Pressure 508
   PROCEDURE Measuring Blood Pressure before and after Exercise 509
18E Ankle-Brachial Index 511
   PROCEDURE Determining the Ankle-Brachial Index Using a Doppler Ultrasound Device 511
18F PhysioEx™ Activities 512
   PEX ACTIVITY 1 Studying the Effect of Blood Vessel Radius on Blood Flow Rate 512
   PEX ACTIVITY 2 Studying the Effect of Blood Viscosity on Blood Flow Rate 512
   PEX ACTIVITY 3 Studying the Effect of Blood Vessel Length on Blood Flow Rate 512
   PEX ACTIVITY 4 Studying the Effect of Blood Pressure on Blood Flow Rate 512
   PEX ACTIVITY 5 Studying the Effect of Vessel Radius on Pump Activity 512
   PEX ACTIVITY 6 Studying the Effect of Stroke Volume on Pump Activity 512
   PEX ACTIVITY 7 Compensation in Pathological Cardiovascular Conditions 512

Post-Lab Assessments 451

LAB EXERCISE 17
The Cardiovascular System I: The Heart 455

Pre-Lab Assignments 456
17A Structure of the Heart 462
   PROCEDURE 1 Identifying the Anatomy of the Heart 465
   PROCEDURE 2 Dissecting a Preserved Heart 468
17B Blood Flow Pathway through the Heart 470
   PROCEDURE Tracing the Pathway of Blood through the Heart 470
17C Cardiac Muscle Tissue 472
   PROCEDURE Identifying Components of Cardiac Muscle Tissue 472
17D The Cardiac Cycle 473
   PROCEDURE 1 Recording Electrical Activity in the Heart 476
   PROCEDURE 2 Auscultating Heart Sounds 479
17E PhysioEx™ Activities 480
   PEX ACTIVITY 1 Investigating the Refractory Period of Cardiac Muscle 480
   PEX ACTIVITY 2 Examining the Effect of Vagus Nerve Stimulation 480
   PEX ACTIVITY 3 Examining the Effect of Temperature on Heart Rate 480
   PEX ACTIVITY 4 Examining the Effect of Chemical Modifiers on Heart Rate 480
   PEX ACTIVITY 5 Examining the Effects of Various Ions on Heart Rate 480

Post-Lab Assessments 481

LAB EXERCISE 18
The Cardiovascular System II: The Blood Vessels 485

Pre-Lab Assignments 486
18A Blood Vessel Anatomy 490
   PROCEDURE Identifying Blood Vessels and Their Anatomy 492
18B Major Arteries and Veins 494
   PROCEDURE 1 Identifying Major Arteries and Veins 503
   PROCEDURE 2 Tracing Blood Flow 506
18C Pulse Palpation and Pulse Rate 507
   PROCEDURE Palpating Pulse and Calculating Pulse Rate before and after Exercise 507
18D Arterial Blood Pressure 508
   PROCEDURE Measuring Blood Pressure before and after Exercise 509
18E Ankle-Brachial Index 511
   PROCEDURE Determining the Ankle-Brachial Index Using a Doppler Ultrasound Device 511
18F PhysioEx™ Activities 512
   PEX ACTIVITY 1 Studying the Effect of Blood Vessel Radius on Blood Flow Rate 512
   PEX ACTIVITY 2 Studying the Effect of Blood Viscosity on Blood Flow Rate 512
   PEX ACTIVITY 3 Studying the Effect of Blood Vessel Length on Blood Flow Rate 512
   PEX ACTIVITY 4 Studying the Effect of Blood Pressure on Blood Flow Rate 512
   PEX ACTIVITY 5 Studying the Effect of Vessel Radius on Pump Activity 512
   PEX ACTIVITY 6 Studying the Effect of Stroke Volume on Pump Activity 512
   PEX ACTIVITY 7 Compensation in Pathological Cardiovascular Conditions 512

Post-Lab Assessments 535

LAB EXERCISE 19
Blood 519

Pre-Lab Assignments 520
19A Formed Elements of Blood 522
   PROCEDURE 1 Identifying the Formed Elements of Blood 524
   PROCEDURE 2 Performing a Differential White Blood Cell Count 526
19B Blood Disorders 526
   PROCEDURE 1 Identifying Blood Disorders and Parasitic Infections 528
   PROCEDURE 2 Identifying Vessel Abnormalities and Blood Clots 530
19C Blood Typing 530
   PROCEDURE 1 Determining Blood Types Using Simulated Blood 532
   PROCEDURE 2 Determining Blood Type Compatibility 533
19D PhysioEx™ Activities 534
   PEX ACTIVITY 1 Hematocrit Determination 534
   PEX ACTIVITY 2 Erythrocyte Sedimentation Rate 534
   PEX ACTIVITY 3 Hemoglobin Determination 534
   PEX ACTIVITY 4 Blood Typing 534
   PEX ACTIVITY 5 Blood Cholesterol 534

Post-Lab Assessments 535

Contents  xxii
LAB EXERCISE 24
The Urinary System 639

Pre-Lab Assignments 640
24A Overview of the Urinary System 643
PROCEDURE Identifying Organs of the Urinary System 643
24B Anatomy of the Urinary System 644
PROCEDURE 1 Examining the Anatomy of the Kidney 646
PROCEDURE 2 Dissecting a Preserved Kidney 647
PROCEDURE 3 Identifying the Components of a Nephron 650
PROCEDURE 4 Identifying the Blood Vessels of a Kidney 651
PROCEDURE 5 Examining the Anatomy of the Urinary Tract 653
24C Physiology of the Urinary System 656
PROCEDURE 1 Understanding Renal Physiology 657
PROCEDURE 2 Tracing Fluid Flow through the Urinary System 658
PROCEDURE 3 Performing a Urinalysis 658
24D PhysioEx™ Activities 660
PEX ACTIVITY 1 The Effect of Arteriole Radius on Glomerular Filtration 660
PEX ACTIVITY 2 The Effect of Pressure on Glomerular Filtration 660
PEX ACTIVITY 3 Renal Response to Altered Blood Pressure 660
PEX ACTIVITY 4 Solute Gradients and Their Impact on Urine Concentration 660
PEX ACTIVITY 5 Reabsorption of Glucose via Carrier Proteins 660
PEX ACTIVITY 6 The Effect of Hormones on Urine Formation 660

Post-Lab Assessments 661

LAB EXERCISE 25
Fluid, Electrolyte, and Acid-Base Balance 667

Pre-Lab Assignments 668
25A Homeostasis 669
PROCEDURE Examining the Effects of Buffers 675
25B PhysioEx™ Activities 676
PEX ACTIVITY 1 Hyperventilation 676
PEX ACTIVITY 2 Rebreathing 676
PEX ACTIVITY 3 Renal Responses to Respiratory Acidosis and Respiratory Alkalosis 676
PEX ACTIVITY 4 Respiratory Responses to Metabolic Acidosis 676

Post-Lab Assessments 677

LAB EXERCISE 26
The Reproductive System 681

Pre-Lab Assignments 682
26A Male Reproductive System 685
PROCEDURE 1 Examining Male Reproductive Organs and Structures 689
PROCEDURE 2 Tracing Sperm from Production to Ejaculation 691
26B Female Reproductive System 692
PROCEDURE Examining Female Reproductive Organs and Structures 695
26C Reproductive System Physiology 696
PROCEDURE 1 Identifying the Stages of Meiosis 698
PROCEDURE 2 Examining Sperm 700
PROCEDURE 3 Exploring Hormonal Regulation of the Ovarian and Uterine Cycles 704
PROCEDURE 4 Examining Ovarian Follicles 704

Post-Lab Assessments 705

LAB EXERCISE 27
Human Development 709

Pre-Lab Assignments 710
27A Overview of Human Development 711
PROCEDURE Identifying Events and Structures of Prenatal Development 722
27B Pregnancy and Childbirth 724
PROCEDURE Identifying Events and Structures of Childbirth 725

Post-Lab Assessments 727

PIG DISSECTION EXERCISES

1 Examining Surface Anatomy and Preparing the Fetal Pig for Dissection P-1
2 Skeletal Muscles of the Fetal Pig P-7
3 Spinal Cord and Spinal Nerves of the Fetal Pig P-19
4 Endocrine System of the Fetal Pig P-23
5 Cardiovascular System of the Fetal Pig P-29
6 Digestive System of the Fetal Pig P-41
7 Respiratory System of the Fetal Pig P-47
8 Urinary System of the Fetal Pig P-51
9 Reproductive System of the Fetal Pig P-57

CREDITS Credits-1
INDEX I-1