

HUMAN PHYSIOLOGY

AN INTEGRATED APPROACH

SEVENTH EDITION

Dee Unglaub Silverthorn, Ph.D.

UNIVERSITY OF TEXAS, AUSTIN

WITH CONTRIBUTIONS BY

Bruce R. Johnson, Ph.D.

CORNELL UNIVERSITY

AND

William C. Ober, M.D.

ILLUSTRATION COORDINATOR

Claire E. Ober, R.N.

ILLUSTRATOR

Andrew C. Silverthorn, M.D.

CLINICAL CONSULTANT

PEARSON

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ABOUT THE AUTHOR

DEE UNGLAUB SILVERTHORN

studied biology as an undergraduate at Newcomb College of Tulane University, where she did research on cockroaches. For graduate school, she switched to studying crabs and received a Ph.D. in marine science from the Belle W. Baruch Institute for Marine and Coastal Sciences at the University of South Carolina. Her research interest is epithelial transport, and most recently work in her laboratory has focused on transport properties of the chick allantoic membrane. Her teaching career started in the Physiology Department at the Medical University of South Carolina but over the years she has taught a wide range of students, from medical and college students to those still preparing for higher education. At the University of Texas–Austin, she teaches physiology in both lecture and laboratory settings, and instructs graduate students on developing teaching skills in the life sciences. She has received numerous teaching awards and honors, including a 2011 UT System Regents' Outstanding Teaching Award, the



Michael Chirillo, Dee Silverthorn, and Kevin Christmas

the president of the Human Anatomy and Physiology Society in 2012–2013, has served as editor-in-chief of *Advances in Physiology Education*, and is currently chair of the American Physiological Society Book Committee. She works with members of the International Union of Physiological Sciences to improve physiology education in developing countries, and this book has been translated into seven languages. Her free time is spent creating multimedia fiber art and enjoying the Texas hill country with her husband, Andy, and their dogs.

2009 Outstanding Undergraduate Science Teacher Award from the Society for College Science Teachers, the American Physiological Society's Claude Bernard Distinguished Lecturer and Arthur C. Guyton Physiology Educator of the Year, and multiple awards from UT–Austin, including the Burnt Orange Apple Award. The first edition of her textbook won the 1998 Robert W. Hamilton Author Award for best textbook published in 1997–1998 by a University of Texas faculty member. Dee was

About the Illustrators

William C. Ober, M.D. (*art coordinator and illustrator*) received his undergraduate degree from Washington and Lee University and his M.D. from the University of Virginia. He also studied in the Department of Art as Applied to Medicine at Johns Hopkins University. After graduation, Dr. Ober completed a residency in Family Practice and later was on the faculty at the University of Virginia in the Department of Family Medicine and in the Department of Sports Medicine. He also served as Chief of Medicine of Martha Jefferson Hospital in Charlottesville, VA. He is currently a visiting Professor of Biology at Washington & Lee University, where he has taught several courses and led student trips to the Galapagos Islands. He was part of the Core Faculty at Shoals Marine Laboratory, where he taught Biological Illustration for 22 years. The textbooks illustrated by Medical & Scientific Illustration have won numerous design and illustration awards.

Claire E. Ober, R.N.

(*illustrator*) practiced pediatric and obstetric nursing before turning to medical illustration as a full-time career. She returned to school at Mary Baldwin College where she received her degree with distinction in studio art. Following a five-year apprenticeship, she has worked as Dr. Ober's partner in Medical and Scientific Illustration since 1986. She was also on the Core Faculty at Shoals Marine Laboratory and co-taught Biological Illustration at both Shoals Marine Lab and at Washington and Lee University.



About the Clinical Consultant



Andrew C. Silverthorn, M.D. is a graduate of the United States Military Academy (West Point). He served in the infantry in Vietnam, and upon his return entered medical school at the Medical University of South Carolina in Charleston. He was chief resident in family medicine at the University of Texas Medical Branch, Galveston, and is currently a family physician in solo practice in Austin, Texas. When Andrew is not busy seeing patients, he may be found on the golf course or playing with his two rescue dogs, Molly and Callie.

About the Contributor



Bruce Johnson is a Senior Research Associate in the Department of Neurobiology and Behavior at Cornell University. He earned biology degrees at Florida State University (B.A.), Florida Atlantic University (M.S.), and at the Marine Biological Laboratory in Woods Hole (Ph.D.) through the Boston University Marine Program. At Cornell he teaches a laboratory course entitled Principles of Neurophysiology. He is a coauthor of *Crawdad*: a CD-ROM lab manual for Neurophysiology and the Laboratory Manual for Physiology, and he continues development of model preparations for student neuroscience laboratories. Bruce has directed and taught in neuroscience faculty workshops sponsored by NSF (*Crawdad*), ADInstruments (*Crawdad* and *CrawFly*), and the Faculty for Undergraduate Neuroscience (FUN), and in neuroscience courses at the Universities of Copenhagen and Cologne, the Marine Biological Laboratory, and the Shoals Marine Laboratory. He has received outstanding educator and distinguished teaching awards at Cornell University, and the FUN Educator of the Year Award. He is a past president of FUN and presently the Associate Editor for the *Journal of Undergraduate Neuroscience Education*. Bruce's research addresses the cellular and synaptic mechanisms of motor network plasticity.

DEDICATION

This edition is dedicated to all my graduate teaching assistants, from Carol, Jan, and Peter to Kevin, Michael, and Sarah, and everyone in between. Their enthusiasm for teaching and creative ideas have been a continual inspiration.



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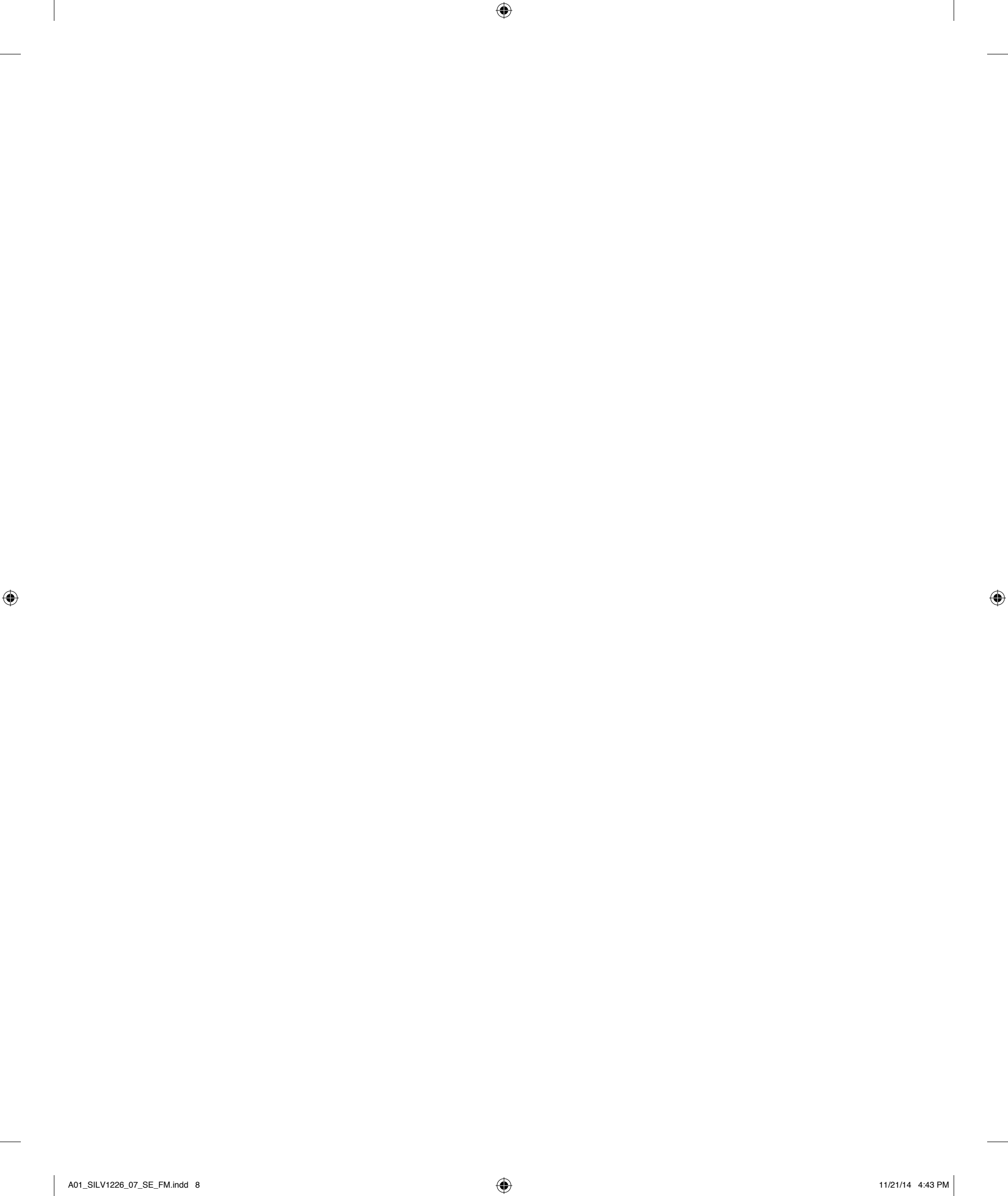
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NEW TO THIS EDITION

The seventh edition of *Human Physiology: An Integrated Approach* builds upon the thorough coverage of integrative and molecular physiology topics that have been the foundation of this book since its first publication. The text has been revised with extensive content updates, particularly in the areas of neurobiology and reproductive physiology. Chapter 21 on the digestive system and Chapter 26 on reproductive physiology have been reorganized.

Continuing the revision of the art introduced last edition, we created additional Review and Essentials figures that students can use for quick review as well as new Anatomy Summaries and concept maps. Figures from previous editions that were significantly modified or eliminated are still available to instructors on the Instructor's DVD.

A new feature in the book is the addition of online Video Tutors that can be accessed by using the QR codes found in related figures. These short videos explain complex topics or show physiology in action in research and medicine. Finally, every chapter now begins with a list of Learning Outcomes (LO) for the chapter.

CHAPTER-BY-CHAPTER CONTENT UPDATES

Chapter 1

- Added DOI numbers to literature citation information

Chapter 2

- Updated information on chromium supplements
- Expanded discussion of proteins

Chapter 3

- Expanded discussion of fluid compartments
- Updated Running problem on HPV and Pap smears to reflect latest guidelines for management of abnormal tests
- New discussion of retinoids

Chapter 4

- New Figure Question
- Updated information on Tay Sachs testing

Chapter 5

- New Essentials figure on membrane potential
- Video Tutor walking through the problems in Figure 5.4
- Video Tutor demonstrations of diffusion (Fig. 5.6) and membrane potential (Fig. 5.23)
- New figures for osmotic pressure and transport across membranes
- New concept map of fluid compartments
- Updated transporter gene families and transporter classification

- New quantitative Figure Questions for equilibrium potential
- New Figure Questions for insulin secretion
- Updated information on caveolae

Chapter 6

- Updated information on cytokines
- New discussion of catalytic receptors

Chapter 7

- Updated information on:
 - prolactin
 - short-loop negative feedback
- New discussion of tertiary pathologies

Chapter 8

- Expanded discussion of electrical synapses
- New Essentials figure on integration of synaptic signaling

Chapter 9

- BRAIN and Human Connectome
- Updated information on:
 - sleep
 - circadian rhythms
 - jet lag and shift work disorder
 - serotonin/norepinephrine reuptake inhibitors
 - treatment of infantile spasms (West syndrome)
 - language processing
- New table on brain imaging techniques, including CLARITY
- New discussion of PTSD Cranial nerve mnemonic

Chapter 10

- Updated discussion of
 - pain
 - olfactory processing
 - taste transduction
 - Merkel cell mechanotransduction
- New: olfactory (Bowman's) glands

Chapter 11

- New information on dysautonomia
- New Anatomy Summary for autonomic nervous system
- Updated information on drug treatment for tobacco use disorder

Chapter 12

- Updated information on:
 - skeletal muscle fiber types
 - store-operated calcium channels (STIM1, Orai1)
- New figure on fast- and slow-twitch muscles

Chapter 13

- Updated information on Golgi tendon organ function

Chapter 14

- Updated Running Problem to include cardiac stents and treatment for heart attacks
- Updated info on stem cells for cardiac problems
- Video Tutor showing electrocardiogram recording (Fig. 14.15)

Chapter 15

- Video Tutor demonstrating orthostatic hypotension and the baroreceptor reflex (Fig. 15.14)
- New Figure Questions and Quantitative Question
- Updated information on hypertension

Chapter 16

- New Essentials figure on the complete blood count
- Updated information on:
 - ferritin
 - platelets and thrombocytopenia
 - contact activation pathway
 - cell injury pathway
- New Concept Check questions

Chapter 17

- New information on pulmonary function testing and FEV₁ (forced expiratory volume in one second)
- Video Tutor of pulmonary function testing (Fig. 17.7)
- Video Tutor of lung model and negative intrapleural pressure (Fig. 17.10)
- Video Tutor showing effect of breathing pattern on expired CO₂ (Fig. 17.13)
- New table on gas laws
- Updated information on:
 - COPD
 - velocity of air flow
- New algorithm for calculating lung volumes
- New end-of-chapter questions

Chapter 18

- Video Tutor demonstration of oxygen transport by hemoglobin (Fig. 18.8)
- Updated information on:
 - central regulation of ventilation
 - central chemoreceptors
 - blood substitutes
- Expanded discussion and questions on the Fick equation

Chapter 19

- Expanded histology of the nephron
- Video Tutor demonstrating renal clearance (Fig. 19.13)
- New quantitative and graphing end-of-chapter questions
- New information on primary cilia as flow sensors
- Expanded “useful equations” table

Chapter 20

- New quantitative problem on osmotic diuresis
- Emerging Concepts box on WNK kinases

Chapter 21

- Major reorganization of topics
- New Essentials figures on GI motility, The Pancreas
- New Figure Questions and Concept Checks
- New Emerging Concepts box on the human microbiome project

Chapter 22

- New information on
 - uncoupling protein 1 (UCP1) in brown fat
 - SGLT2 inhibitors
- New discussion of hormones and metabolism
- Updated discussion on control of food intake
- New quantitative problem on BMI
- New questions on diabetes

Chapter 23

- Updated information on
 - POMC and food intake update
- New information on
 - monocarboxylate transporter for thyroid hormones
 - mechanical stress, primary cilia, and bone remodeling
 - calbindin in Ca²⁺ absorption
- New Graph Question

Chapter 24

- New Anatomy Summary on the immune system
- Updated information on HPV
- New concept map for the immune system
- Expanded discussion of antibodies
- New section on Rh blood groups

Chapter 25

- Video Tutor demonstrating the effect of exercise on cardiovascular and pulmonary function (Figs. 25.5, 25.8)
- New Running Problem on malignant hyperthermia

Chapter 26

- New art for hormonal control of spermatogenesis and follicular development
- Updated information:
 - developmental timeline of ovarian follicles
 - reproductive aging
- New Running problem: primary ovarian insufficiency (POI, also called premature ovarian failure) and treatment with *in vitro* activation (IVA)
- Expanded information on environmental estrogens

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Jane Lubisher, University of Texas
Young-Jin Son, University of Texas

Supplements

Damian Hill once again worked with me to revise and improve the Instructor Resource Manual and Student Workbook that accompany the book. I believe that supplements should reflect the style and approach of the text, so I am grateful that Damian has continued to be my alter-ego for so many editions.

I would also like to thank my colleagues who helped with the test bank and media supplements for this edition: Paul Wagner, Tracy Wagner, Cheryl Neudauer, Chad Wayne, Michelle Harrison, and Myriam Alhadeff Feldman.

The Development and Production Team

Writing a manuscript is only a first step in the long and complicated process that results in a bound book with all its ancillaries. The team that works with me on book development deserves a lot of credit for the finished product. In this edition, Bill and Claire Ober, my art coauthors, created thoughtful updates to the art to make it more user-friendly. Once again, Yvo Riezebos designed a striking cover that reflects how science is really art. Anne A. Reid, my long-time developmental editor, was a joy to work with, and helps ensure that what I write can be understood by students.

The team at Pearson Education worked tirelessly to see this edition move from manuscript to bound book. My acquisitions editor, Kelsey Volker Churchman, was always supportive and ready to help. She also continued what has become a tradition with my revisions by delivering a baby girl as we were completing the production process. Ashley Williams, assistant editor, kept track of everyone and everything for us. Chriscelle Palaganas, Program Manager, provided excellent guidance and support throughout the whole production process.

The task of coordinating production fell to Pearson Project Manager Lauren Beebe. Andrea Stefanowicz handled composition and project management, and Project Manager Cynthia Mutheardy at the art house, Imagineering, managed the team that prepared Bill and Claire's art for production. Kristin Piljay was the photo researcher who found the wonderful new photos that appear in this edition. Annie Wang was the assistant media producer who kept my supplements authors on task and on schedule. Christy Lesko is the director of marketing who works with the excellent sales teams at Pearson Education and Pearson International, and Allison Rona is the Senior Marketing Manager for the anatomy and physiology list.

Special Thanks

This edition I owe a special debt of gratitude to my graduate teaching assistants: Kevin Christmas, a Ph.D. student in exercise physiology, and Michael Chirillo, an M.D.-Ph.D. student who is doing his doctoral research at UT-Austin and his medical studies at University of Texas Health Science Center at Houston. (They are shown with me in the photograph in the About the Author section. Michael is on the left, Kevin is on the right.) In addition to working with my classes of 240 students each semester, they played a major role in helping create and performing in the new Video Tutors that debut with this edition. My thanks also go to Ryan Kelley, the videographer, who in his free time is a radio-TV-film major at UT-Austin.

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A Work in Progress

One of the most rewarding aspects of writing a textbook is the opportunity it has given me to meet or communicate with other instructors and students. In the years since the first edition was published, I have heard from people around the world and have had the pleasure of hearing how the book has been incorporated into their teaching and learning.

Because science textbooks are revised every 3 or 4 years, they are always works in progress. I invite you to contact me or my publisher with any suggestions, corrections, or comments about this edition. I am most reachable through e-mail at silverthorn@utexas.edu. You can reach my editor at the following address:

Applied Sciences
Pearson Education
1301 Sansome Street
San Francisco, CA 94111

Dee U. Silverthorn
University of Texas
Austin, Texas