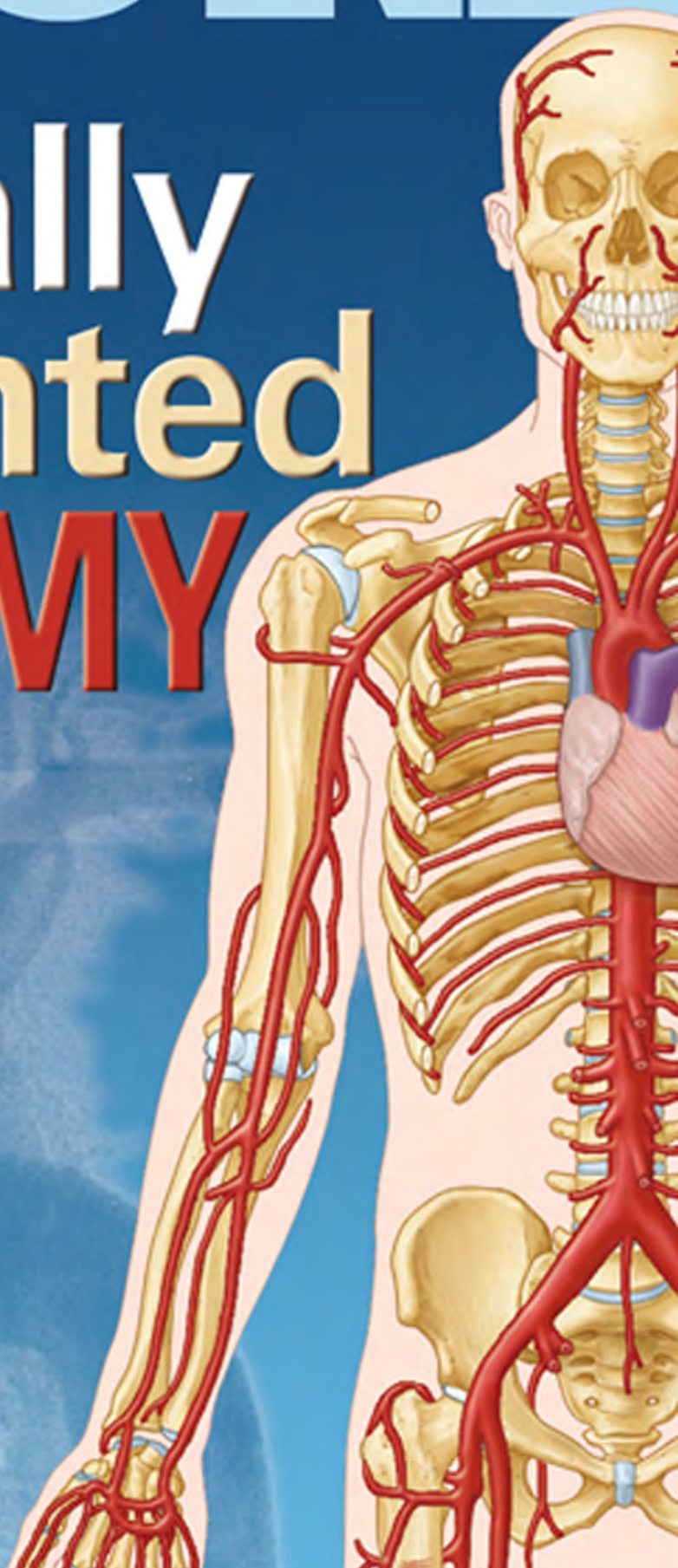
MOORE

Clinically Oriented ANATOMY

Seventh Edition

Keith L. Moore
Arthur F. Dalley
Anne M.R. Agur



Wolters Kluwer Health | Lippincott Williams & Wilkins

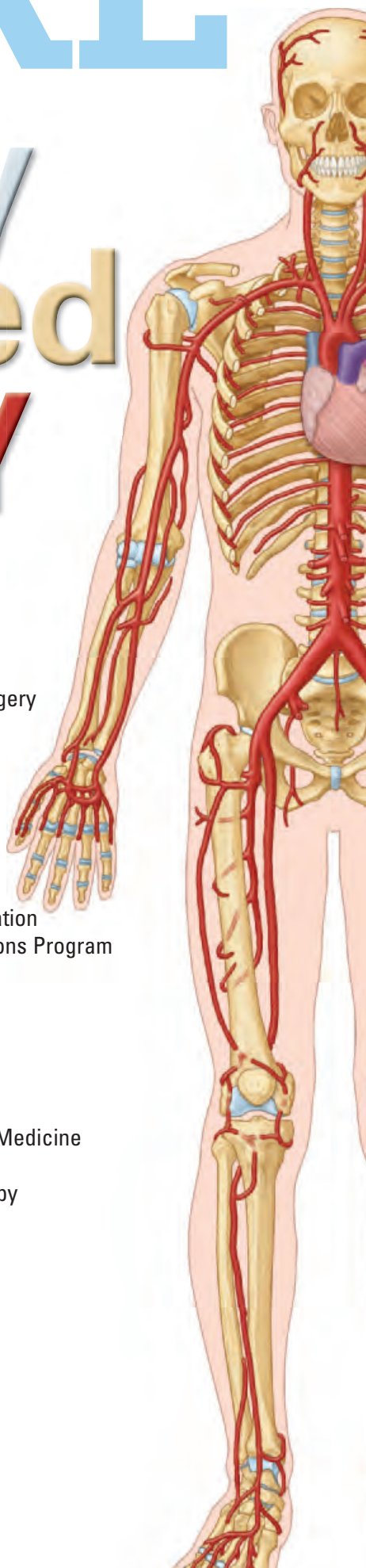
Clinically Oriented ANATOMY

Seventh Edition

MOORE

Clinically Oriented ANATOMY

Seventh Edition



Keith L. Moore, M.Sc., Ph.D., D.Sc. (Hon), F.I.A.C., F.R.S.M., F.A.A.A.
Professor Emeritus in Division of Anatomy, Department of Surgery
Former Chair of Anatomy and Associate
Dean for Basic Medical Sciences
Faculty of Medicine, University of Toronto
Toronto, Ontario, Canada

Arthur F. Dalley II, Ph.D.
Professor, Department of Cell and Developmental Biology
Adjunct Professor, Department of Orthopaedics and Rehabilitation
Director, Programs in Medical Gross Anatomy and Anatomical Donations Program
Vanderbilt University School of Medicine
Adjunct Professor for Anatomy
Belmont University School of Physical Therapy
Nashville, Tennessee, U.S.A.

Anne M. R. Agur, B.Sc. (OT), M.Sc., Ph.D.
Professor, Division of Anatomy, Department of Surgery, Faculty of Medicine
Department of Physical Therapy
Department of Occupational Science & Occupational Therapy
Division of Physiatry, Department of Medicine
Division of Biomedical Communications
Institute of Medical Science
Graduate Department of Rehabilitation Science
Graduate Department of Dentistry
University of Toronto
Toronto, Ontario, Canada

Wolters Kluwer Health | Lippincott Williams & Wilkins
Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Acquisitions Editor: Crystal Taylor
Product Manager: Julie Montalbano
Marketing Manager: Joy Fisher Williams
Art Director, Digital Content: Jennifer Clements
Artists: Imagineeringart.com, lead artist Natalie Intven, MSc, BMC
Designer: Terry Mallon
Compositor: SPi Global

7th Edition

351 West Camden Street
Baltimore, MD 21201

Two Commerce Square
2001 Market Street
Philadelphia, PA 19103

Printed in China

9 8 7 6 5 4 3 2 1

5th edition:
Italian Translation, 2008, published by Casa Editrice Ambrosiana
Portuguese Translation, 2007, published by Editora Guanabara Koogan
French Translation, 2007, published by DeBoeck Universite
Spanish Translation, 2007, published by Editorial Medica Panamericana, S.A.
Japanese Translation, 2008, published by MEDSI
Indonesian Translation, 2009, published by Penerbit Erlangga
Serbian Translation, 2009, published by Romanov Publishing Group
Korean Translation, 2009, published by Shin Heung
Complex Chinese Translation, 2009, published by The Leader Book Company
Macedonian Translation, 2010, published by Tabernakul Publishing
Albanian Translation, 2010, published by Tabernakul Publishing

6th edition:
Portuguese Translation, 2011, published by Editora Guanabara Koogan
French Translation, 2011, published by Deboeck Universite
Spanish Translation, 2010, published by Wolters Kluwer Spanish Language Program

---

Library of Congress Cataloging-in-Publication Data
Moore, Keith L.
Clinically oriented anatomy / Keith L. Moore, Arthur F. Dalley, Anne M.R. Agur. — 7th ed.
p. ; cm.
Includes bibliographical references and index.
ISBN 978-1-4511-1945-9 (pbk. : alk. paper)
I. Dalley, Arthur F. II. Agur, A. M. R. III. Title.
[DNLM: 1. Anatomy. QS 4]

612—dc23

2012041233

In Loving Memory of Marion

My best friend, wife, colleague, mother of our five children and grandmother of our nine grandchildren for her love, unconditional support, and understanding. Wonderful memories keep you in our hearts and minds. • (KLM)

To Pam and Ron

I am grateful to my eldest daughter Pam, who assumed the office duties her mother previously carried out. She is also helpful in many other ways. I am also grateful to my son-in-law Ron Crowe whose technical skills have helped me prepare the manuscript for this book. • (KLM)

To My Grandchildren

Melissa, Kristin, Alecia, Lauren, Mitchel, Caitin, Jayme, Courtney and Brooke. With best wishes for your future endeavours. Love, Grandpa • (KLM)

To Muriel

My bride, best friend, counselor, and mother of our sons; and to our family—Tristan, Lana, Elijah, Finley and Sawyer; Denver, and Skyler—with love and great appreciation for their support, understanding, good humor, and—most of all—patience. • (AFD)

To my husband, Enno, and my children, Erik and Kristina, for their support and encouragement. • (AMRA)

To Our Students

You will remember some of what you hear, much of what you read, more of what you see, and almost all of what you experience and understand fully.

To Anatomical Donors

With sincere appreciation to all those who donate their bodies for anatomical study and research, without whom anatomical textbooks and atlases, and anatomical study in general would not be possible.

Keith L. Moore, Ph.D., D.Sc. (Hon)., F.I.A.C., F.R.S.M., F.A.A.A.

Dr. Moore has been the recipient of many prestigious awards and recognitions. He has received the highest awards for excellence in human anatomy education at the medical, dental, graduate, and undergraduate levels—and for his remarkable record of textbook publications in clinically oriented anatomy and embryology—from both the American Association of Anatomists (AAA: Distinguished Educator Award, 2007) and the American Association of Clinical Anatomists (AACA: Honored Member Award, 1994). In 2008 Dr. Moore was inducted as a Fellow of the American Association of Anatomists. The rank of Fellow honors distinguished members who have demonstrated excellence in science and their overall contributions to the medical sciences. In 2012, Dr. Moore received an honorary Doctor of Science degree from The Ohio State University, the Queen Elizabeth II Diamond Jubilee Medal honoring significant contributions and achievements by Canadians, and the R. Benton Adkins, Jr. Distinguished Service Award for his outstanding record of service to the American Association of Clinical Anatomists.

Arthur F. Dalley II

Arthur F. Dalley II, Ph.D.

Anne M. R. Agur, B.Sc. (OT), M.Sc., Ph.D.

Preface

A third of a century has passed since the first edition of *Clinically Oriented Anatomy* appeared on bookstore shelves. Although the factual basis of anatomy is remarkable among basic sciences for its longevity and consistency, this book has evolved markedly since its inception. This is a reflection of changes in the clinical application of anatomy, new imaging technologies that reveal living anatomy in new ways, and improvements in graphic and publication technology that enable superior demonstration of this information. Efforts continue to make this book even more student friendly and authoritative. The seventh edition has been thoroughly reviewed by students, anatomists, and clinicians for accuracy and relevance and revised with significant new changes and updates.

KEY FEATURES

Clinically Oriented Anatomy has been widely acclaimed for the relevance of its clinical correlations. As in previous editions, the seventh edition places clinical emphasis on anatomy that is important in physical diagnosis for primary care, interpretation of diagnostic imaging, and understanding the anatomical basis of emergency medicine and general surgery. Special attention has been directed toward assisting students in learning the anatomy they will need to know in the twenty-first century, and to this end new features have been added and existing features updated.

Extensive art program. The seventh edition is distinguished by an extensive revision of the art program. Working with a team of artists from Imagineering, every illustration has been revised, improving accuracy and consistency and giving classical art derived from *Grant's Atlas of Anatomy* a fresh, vital, new appearance. An effort has been made to ensure that all the anatomy presented and covered in the text is also illustrated. The text and illustrations have been developed to work together for optimum pedagogical effect, aiding the learning process and markedly reducing the amount of searching required to find structures. The great majority of the clinical conditions are supported by photographs and/or color illustrations; multipart illustrations often combine dissections, line art, and medical images; tables are accompanied by illustrations to aid the student's understanding of the structures described.

Clinical correlations. Popularly known as "blue boxes," the clinical information sections have grown, and many of them are supported by photographs and/or dynamic color illustrations to help with understanding the practical value of anatomy. In response to our readers' suggestions, the blue boxes have been grouped together within chapters, enabling presentation of topics with less interruption of the running text.

Bottom line summaries. Frequent "bottom line" boxes summarize the preceding information, ensuring that primary concepts do not become lost in the many details necessary for thorough understanding. These summaries provide a convenient means of ongoing review and underscore the big picture point of view.

Anatomy described in a practical, functional context. A more realistic approach to the musculoskeletal system emphasizes the action and use of muscles and muscle groups in daily activities, emphasizing gait and grip. The eccentric contraction of muscles, which accounts for much of their activity, is now discussed along with the concentric contraction that is typically the sole focus in anatomy texts. This perspective is important to most health professionals, including the growing number of physical and occupational therapy students using this book.

Surface anatomy and medical imaging. Surface anatomy and medical imaging, formerly presented separately, are now integrated into the chapter, presented at the time each region is being discussed, clearly demonstrating anatomy's relationship to physical examination and diagnosis. Both natural views of unobstructed surface anatomy and illustrations superimposing anatomical structures on surface anatomy photographs are components of each regional chapter. Medical images, focusing on normal anatomy, include plain and contrast radiographic, MRI, CT, and ultrasonography studies, often with correlative line art as well as explanatory text, to help prepare future professionals who need to be familiar with diagnostic images.

Case studies, accompanied by clinico-anatomical problems and board review-style multiple-choice questions. Interactive case studies and multiple-choice questions are available to our readers online at http://thePoint.lww.com, providing a convenient and comprehensive means of self-testing and review.

Terminology. The terminology fully adheres to *Terminologia Anatomica* (1998), approved by the International Federation of Associations of Anatomists (IFAA). Although the official English-equivalent terms are used throughout the book, when new terms are introduced, the Latin form, used in Europe, Asia, and other parts of the world, is also provided.

The roots and derivations of terms are provided to help students understand meaning and increase retention. Eponyms, although not endorsed by the IFAA, appear in parentheses in this edition—for example, sternal angle (angle of Louis)—to assist students who will hear eponymous terms during their clinical studies. The terminology is now available online at http://www.unifr.ch/ifaa.

RETAINED AND IMPROVED FEATURES

Students and faculty have told us what they want and expect from *Clinically Oriented Anatomy,* and we listened:

- A *comprehensive text* enabling students to fill in the blanks, as time allotted for lectures continues to decrease, laboratory guides become exclusively instructional, and multiauthored lecture notes develop inconsistencies in comprehension, fact, and format.
- A *resource capable of supporting areas of special interest and emphasis* within specific anatomy courses that *serves the anatomy needs of students during both the basic science and the clinical phases of their studies.*
- A *thorough Introduction* that covers important systemic information and concepts basic to the understanding of the anatomy presented in the subsequent regional chapters. Students from many countries and backgrounds have written to express their views of this book—gratifyingly, most are congratulatory. Health professional students have more diverse backgrounds and experiences than ever before. Curricular constraints often result in unjustified assumptions concerning the prerequisite information necessary for many students to understand the presented material. The Introduction includes efficient summaries of functional systemic anatomy. Students' comments specifically emphasized the need for a systemic description of the nervous system and the peripheral autonomic nervous system (ANS) in particular.
- Routine facts (such as muscle attachments, innervations, and actions) presented in *tables organized to demonstrate shared qualities and illustrated to demonstrate the provided information. Clinically Oriented Anatomy* provides more tables than any other anatomy textbook.
- *Illustrated clinical correlations* that not only describe but also *show anatomy as it is applied clinically.*
- *Illustrations that facilitate orientation.* Many orientation figures have been added, along with arrows to indicate the locations of the inset figures (areas shown in close-up views) and viewing sequences. Labels have been placed to minimize the distance between label and object, with leader lines running the most direct course possible.
- Blue boxes are classified by the following icons to indicate the type of clinical information covered:

Anatomical variations. These blue boxes feature anatomical variations that may be encountered in the dissection lab or in practice, emphasizing the clinical importance of awareness of such variations.

Life cycle. These blue boxes emphasize prenatal developmental factors that affect postnatal anatomy and anatomical phenomena specifically associated with stages of life—childhood, adolescence, adult, and advanced age.

Trauma. The effect of traumatic events—such as fractures of bones or dislocations of joints—on normal anatomy and the clinical manifestations and dysfunction resulting from such injuries are featured in these blue boxes.

Diagnostic procedures. Anatomical features and observations that play a role in physical diagnosis are targeted in these blue boxes.

Surgical procedures. These blue boxes address such topics as the anatomical basis of surgical procedures, such as the planning of incisions, and the anatomical basis of regional anesthesia.

Pathology. The effect of disease on normal anatomy, such as cancer of the breast, and anatomical structures or principles involved in the confinement or dissemination of disease within the body are the types of topics covered in these blue boxes.

- **Boldface type** indicates the main entries of anatomical terms, when they are introduced and defined. In the index, the page numbers of these main entries also appear in boldface type, so that the main entries can be easily located. Boldface type is also used to introduce clinical terms in the clinical correlation (blue) boxes.
- *Italic type* indicates anatomical terms important to the topic and region of study or labeled in an illustration that is being referenced.
- Useful content outlines appear at the beginning of every chapter.
- Instructor's resources and supplemental materials are available at http://thePoint.lww.com.

Anne M. R. Agur, Ph.D., joined Keith Moore and Arthur Dalley as a co-author for the sixth edition. From the outset, *Clinically Oriented Anatomy* has utilized materials from *Grant's Atlas,* for which Anne has had responsibility since 1991. Anne made significant contributions to previous

editions of *Clinically Oriented Anatomy* beyond the sharing of materials from *Grant's Atlas,* and has been involved in—and been an asset to—every stage of the development of this and the previous editions.

COMMITMENT TO EDUCATING STUDENTS

This book is written for health science students, keeping in mind those who may not have had a previous acquaintance with anatomy. We have tried to present the material in an interesting way so that it can be easily integrated with what will be taught in more detail in other disciplines such as physical diagnosis, medical rehabilitation, and surgery. We hope this text will serve two purposes: to educate and to excite. If students develop enthusiasm for clinical anatomy, the goals of this book will have been fulfilled.

Keith L. Moore
University of Toronto
Faculty of Medicine

Arthur F. Dalley II
Vanderbilt University
School of Medicine

Anne M. R. Agur
University of Toronto
Faculty of Medicine

ABBREVIATIONS

a., aa.	artery, arteries
ant.	anterior
B.C.E.	before the Common (Christian) era
C	cervical
C.E.	Common (Christian) era
Co	coccygeal
dim.	diminutive
e.g.	for example
et al.	and others
F	female
Fr.	French
G.	Greek
i.e.	that is
inf.	inferior
L	liter, lumbar
L.	Latin
lev.	levator
lit.	literally
M	male
m., mm.	muscle, muscles
Mediev.	medieval
Mod.	modern
post.	posterior
S	sacral
sup.	superior, superioris
supf.	superficial
T	thoracic
TA	*Terminologia Anatomica*
TE	Terminologia Embryologica
TH	Terminologia Histologica
v., vv.	vein, veins
vs.	versus

Acknowledgments

We wish to thank the following colleagues who were invited by the publisher to assist with the development of the seventh edition through their critical analysis.

- Ernest Adeghate, PhD, Chair, Department of Anatomy, United Arab Emirates University
- Christopher Bise, PT, MS, DPT, OCS, Assistant Professor, University of Pittsburgh; Physical Therapist at UPMC Children's Hospital of Pittsburgh
- Christopher Briggs, PhD, Assistant Professor, Department of Anatomy and Neuroscience, University of Melbourne, Australia
- Anjanette Clifford, BS, MS, DC, Assistant Professor of Master of Science Degree in Sports Science and Rehabilitation, Logan College of Chiropractic University
- James Culberson, PhD, Professor, Department of Neurobiology and Anatomy, West Virginia University
- Terry Dean, MD, PhD, Post-Doctoral Fellow, Department of Cell and Molecular Biology, University of Pennsylvania
- Robert Frysztak, PhD, Professor, Department of Physiology, National University Health Sciences
- Tom Gillingwater, MD, Professor, Department of Biological and Clinical Lab Sciences, University of Edinburgh, United Kingdom
- Daniel Graney, PhD, Professor, Department of Anatomy and Embryology, University of Washington School of Medicine
- Robert Hage, MD, PhD, DLO, MBA, Professor, Department of Anatomy, St.George's University, West Indies
- Beth Jones, PT, DPT, MS, OCS, Assistant Professor, Physical Therapy Program, Department of Orthopaedics and Rehabilitation, School of Medicine, University of New Mexico; Assistant Professor, Department of Cell Biology and Physiology, School of Medicine, University of New Mexico
- Randy Kulesza, PhD, Associate Professor, Department of Anatomy, Assistant Dean- Post Baccalaureate and MS in Biomedical Sciences Programs, Lake Erie College of Osteopathic Medicine
- Octavian Lucaciu, MD, PhD, Associate Professor, Department of Anatomy, Canadian Memorial Chiropractic College
- Linda McLoon, PhD, Professor, Department of Ophthalmology and Visual Neuroscience, University of Minnesota
- Gary Nieder, PhD, Professor, Department of Neuroscience, Cell Biology & Physiology, Wright State University
- El Sayed Nosair, PhD, Assistant Professor, Sharjah University, United Arab Emirates
- James Walker, PhD, Associate Professor, Department of Basic Medical Sciences, Purdue University; Associate Director, Department of Human Anatomy, Indiana University School of Medicine-Lafayette

Several students were also invited by the publisher to review the textbook:

- Shloka Ananthanarayana, Mount Sinai School of Medicine
- Jennifer Gulas, Universidad Autonoma de Guadalajara, Mexico
- Paul Johnson, Michigan State University
- Liying Low, University of Glasgow, Scotland
- Kristina Medhus, University of Texas Medical School-Houston
- Vanessa Scott, Albert Einstein College of Medicine
- Sara Thorp, Ohio University College of Osteopathic Medicine
- Ryckie Wade, University of East Anglia, United Kingdom

In addition to reviewers, many people—some of them unknowingly—helped us by perusing, discussing, or contributing to parts of the manuscript and/or providing constructive criticism of the text and illustrations in this and previous editions:

- Dr. Peter Abrahams, Prof. of Clinical Anatomy, Medical Teaching Centre, Institute of Clinical Education, Warwick Medical School, University of Warwick, Coventry, UK
- Dr. Robert D. Acland, Professor of Surgery/Microsurgery, Division of Plastic and Reconstructive Surgery, University of Louisville, Louisville, Kentucky
- Dr. Edna Becker, Associate Professor of Medical Imaging, University of Toronto Faculty of Medicine, Toronto
- Dr. Donald R. Cahill, Professor of Anatomy (retired; former Chair), Mayo Medical School; former Editor-in-Chief of Clinical Anatomy, Rochester, Minnesota
- Dr. Joan Campbell, Assistant Professor of Medical Imaging, University of Toronto Faculty of Medicine, Toronto
- Dr. Stephen W. Carmichael, Professor Emeritus, Mayo Medical School, Editor-in-Chief of Clinical Anatomy, Rochester, Minnesota
- Dr. Carmine D. Clemente, Professor of Anatomy and Orthopedic Surgery, University of California, Los Angeles School of Medicine, Los Angeles
- Dr. James D. Collins, Professor of Radiological Sciences, University of California, Los Angeles School of Medicine/Center for Health Sciences, Los Angeles

- Dr. Raymond F. Gasser, Emeritus Professor of Anatomy, Louisiana State University School of Medicine, New Orleans
- Dr. Ralph Ger (Deceased), Professor of Anatomy and Structural Biology, Albert Einstein College of Medicine, Bronx, New York
- Dr. Paul Gobee, Assistant Professor, Developer Anatomical E-Learning, Department of Anatomy & Embryology, Leiden University Medical Center, Leiden, Netherlands
- Dr. Douglas J. Gould, Professor of Biomedical Sciences, Oakland University William Beaumont School of Medicine, Detroit, Michigan
- Dr. Daniel O. Graney, Professor of Biological Structure, University of Washington School of Medicine, Seattle
- Dr. David G. Greathouse, former Professor and Chair, Belmont University School of Physical Therapy, Nashville, Tennessee
- Scott L. Hagan, 4th year Medical Student, Vanderbilt University School of Medicine, Nashville, TN
- Dr. Masoom Haider, Assistant Professor of Medical Imaging, University of Toronto Faculty of Medicine, Toronto
- Dr. John S. Halle, Professor and Chair, Belmont University School of Physical Therapy, Nashville, Tennessee
- Dr. Jennifer L. Halpern, Assistant Professor, Orthopedic Surgery—Oncology, Vanderbilt University School of Medicine, Nashville, Tennessee
- Dr. Nicole Herring, Assistant Professor, Anatomical Sciences and Neurobiology, University of Louisville School of Medicine, Louisville, Kentucky
- Dr. Walter Kuchareczyk, Professor and Neuroradiologist Senior Scientist, Department of Medical Resonance Imaging, University Health Network, Toronto, Ontario, Canada.
- Dr. Nirusha Lachman, Professor of Anatomy, Mayo Medical School, Rochester, Minnesota
- Dr. H. Wayne Lambert, Professor, Neurobiology and Anatomy Department, West Virginia University School of Medicine, Morgantown, West Virginia
- Dr. Michael von Lüdinghausen, University Professor, Anatomy Institute, University of Würzburg, Würzburg, Germany (retired)
- Dr. Shirley McCarthy, Director of MRI, Department of Diagnostic Radiology, Yale University School of Medicine, New Haven, Connecticut
- Dr. Lillian Nanney, Professor of Plastic Surgery and Cell and Developmental Biology, Vanderbilt University School of Medicine, Nashville, Tennessee
- Dr. Todd R. Olson, Professor of Anatomy and Structural Biology, Albert Einstein College of Medicine, Bronx, New York
- Dr. Wojciech Pawlina, Professor and Chair of Anatomy, Mayo Medical School, Rochester, Minnesota
- Dr. T. V. N. Persaud, Professor Emeritus of Human Anatomy and Cell Science, Faculties of Medicine and Dentistry, University of Manitoba, Winnipeg, Manitoba, Canada. Professor of Anatomy and Embryology, St. George's University, Granada, West Indies
- Dr. Cathleen C. Pettepher, Professor of Cancer Biology, Vanderbilt University School of Medicine, Nashville, Tennessee
- Dr. Thomas H. Quinn, Professor of Biomedical Sciences, Creighton University School of Medicine, Omaha, Nebraska
- Dr. Christopher Ramnanan, Assistant Professor, Department of Cellular and Functional Anatomy, Division of Clinical and Functional Anatomy, University of Ottawa Faculty of Medicine, Ottawa, Ontario, Canada
- Dr. David Resuehr, Assistant Professor, Department of Cellular, Developmental and Integrative Biology, University of Alabama at Birmingham School of Medicine, Birmingham, Alabama
- Dr. George E. Salter, Professor of Anatomy (retired), Department of Cell Biology, University of Alabama, Birmingham
- Dr. Ryan Splittgerber, Assistant Professor, Department of Genetics, Cell Biology and Anatomy, University of Nebraska Medical Center, College of Medicine, Omaha, Nebraska
- Dr. Tatsuo Sato, Professor and Head (retired), Second Department of Anatomy, Tokyo Medical and Dental University Faculty of Medicine, Tokyo
- Professor Colin P. Wendell-Smith, Department of Anatomy and Physiology, University of Tasmania, Hobart, Tasmania, Australia (retired)
- Dr. Andreas H. Weiglein, Professor, Institut fur Anatomie, Medical University Graz, Graz, Austria
- Dr. David G. Whitlock, Professor of Anatomy, University of Colorado Medical School, Denver

Art plays a major role in facilitating learning. We extend our sincere gratitude and appreciation for the skills, talents, and timely work of our medical illustrators for this edition. Wynne Auyeung and Natalie Intven from Imagineering did a superb job of managing a team of talented artists to revise all of the illustrations for a more consistent, vibrant art program. Photographs taken during a major surface anatomy photography project for the fifth edition continue to be a tremendous asset. E. Anne Rayner, Senior Photographer, Vanderbilt Medical Art Group did an excellent job photographing the surface anatomy models, working in association with authors Arthur Dalley and Anne Agur. We greatly appreciate the contribution the models made to the quality of both the previous and the current edition. Although the number of illustrations from *Grant's Atlas of Anatomy* continues to be reduced and replaced by new art, we gratefully acknowledge the excellence of Professor J. C. B. Grant's dissections and the excellent art done by the following: Dorothy Foster Chubb,

Elizabeth Blackstock, Nancy Joy, Nina Kilpatrick, David Mazierski, Stephen Mader, Bart Vallecoccia, Sari O'Sullivan, Kam Yu, Caitlin Duckwall, and Valerie Oxorn.

Many thanks also to those at Lippincott Williams & Wilkins who participated in the development of this edition: Crystal Taylor, Acquisitions Editor; Jennifer Clements, Art Director; and Julie Montalbano, Product Manager. Finally, thanks are due to the sales and marketing division at LWW, which has played a key role in the continued success of this book.

Keith L. Moore
Arthur F. Dalley II
Anne M. R. Agur

Contents

List of Clinical Blue Boxes

Introduction to Clinically Oriented Anatomy

1 Thorax

2 Abdomen

3 Pelvis and Perineum

4 Back

5 Lower Limb

6 Upper Limb

Figure Credits

INTRODUCTION

Fig. I.20 Based on Hamill JH, Knutzan K: Biochemical Basis of Human Movement. 2nd ed. Baltimore: Williams & Wilkins, 2003.
Fig. I.22C Based on Silverthorn. Human Physiology. 4th ed. Tappan, NJ: Pearson Education, 2007. P. 459.
Fig. I.50 Daffner RH: Clinical Radiology: The Essentials. 2nd ed. Baltimore: Williams & Wilkins, 1998.
Fig. I.53 Wicke L: Atlas of Radiologic Anatomy. 6th English ed. Ed and trans: Taylor AN. Baltimore: Williams & Wilkins, 1998. [Wicke L: Roentgen-Anatomie Normalbefunde. 5th ed. Munich: Urban and Schwarzenberg, 1995.]
Fig. I.54 Atlas of Radiologic Anatomy. 6th English ed.
Fig. I.55 Atlas of Radiologic Anatomy. 6th English ed.
Fig. I.56 Atlas of Radiologic Anatomy. 6th English ed.
Fig. BI.1 Reprinted with permission from van de Graaff K: Human Anatomy. 4th ed. Dubuque, IA: WC Brown, 1995.
Fig. BI.2 Rassner G: Atlas of Dermatology. 3rd ed. Trans: Burgdorf WHC. Philadelphia: Lea & Febiger, 1994 (photo); Stedman's Medical Dictionary. 27th ed. Baltimore: Lippincott Williams & Wilkins, 2000. (artist: Neil O. Hardy, Westport, CT).
Fig. BI.4 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. BI.5 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. BI.8 Based on Willis MC: Medical Terminology: The Language of Health Care. Baltimore: Lippincott Williams & Wilkins, 1995.
Fig. BI.9 Reprinted with permission from Roche Lexikon Medizin. 4th ed. Munich: Urban & Schwarzenberg, 1998.

CHAPTER 1

Fig. 1.20. B&C. Based on Clay JH, Pounds DM: Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed. Baltimore: Lippincott Williams & Wilkins, 2002.
Fig. 1.24C Based on Stedman's Medical Dictionary. 27th ed. (artist: Michael Schenk, Jackson, MS).
Fig. 1.30A Dean D, Herbener TE: Cross-Sectional Anatomy. Baltimore: Lippincott Williams & Wilkins, 2000.
Fig. 1.48 Adapted with permission from Moore KL, Persaud TVN. The Developing Human: Clinically Oriented Embryology. 7th ed. Philadelphia: Saunders, 2003. Fig. 8.5A, B, & D, p. 150.
Fig. 1.50 Adapted with permission from Torrent-Guasp F, Buckberg GD, Clemente C, et al.: The structure and function of the helical heart and its buttress wrapping. The normal macroscopic structure of the heart. Semin Thoracic Cardiovasc Surg 2001;13:30.
Fig. B1.6A Based on Bickley LS, Szilagyi PG: Bates' Guide to Physical Examination. 8th ed. Baltimore: Lippincott Williams & Wilkins, 2002.
Fig. B1.6B Brant WE, Helms CA: Fundamentals of Diagnostic Radiology. 2nd ed. Baltimore: Williams & Wilkins, 1999.
Fig. B1.7 Based on Hall-Craggs ECB: Anatomy as the Basis of Clinical Medicine. 3rd ed. Baltimore: Williams & Wilkins, 1995
Fig. B1.9 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B1.11A Based on Stedman's Medical Dictionary. 27th ed. Baltimore: Lippincott Williams & Wilkins, 2000. (artist: Mikki Senkarik, San Antonio, TX).
Fig. B1.11B Olympus America, Inc., Melville, NY.
Fig. B1.12A Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B1.12B Bates' Guide to Physical Examination, 10th ed., p. 300.
Fig. B1.13 Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT); photographs of bronchus, carina, and trachea—Feinsilver SH, Fein A: Textbook of Bronchoscopy. Baltimore: Williams & Wilkins, 1995; photograph of bronchoscopy procedure—courtesy of Temple University Hospital, Philadelphia.
Fig. B1.14 Clinical Radiology: The Essentials. 2nd ed.
Fig. B1.18 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B1.19 With permission from The Developing Human: Clinically Oriented Embryology. 7th ed. Figs. 14.15 and 14.14, p. 345–346.
Fig. B1.23 Siemens Medical Solutions USA, Inc.
Fig. B1.26 Based on figure provided by the Anatomical Chart Company.
Fig. B1.28 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B1.29 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT); photograph—courtesy of Quinton Cardiology, Inc.
Fig. B1.34 Based on Clinical Radiology: The Essentials. 2nd ed.
Fig. B1.37 Cross-Sectional Anatomy. P. 25.
Fig. B1.38B-E Madden ME. Introduction to Sectional Anatomy. Baltimore: Lippincott Williams & Wilkins, 2000.

CHAPTER 2

Fig. 2.5 Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 2.6B Based on Bates' Guide to Physical Examination. 10th ed., p 415; Fig. 2.6B(slices) Based on Grants' Atlas of Anatomy 12th ed. fig 2.6DE
Fig. 2.18 Based on Sauerland EK: Grant's Dissector. 12th ed. Baltimore: Lippincott Williams & Wilkins, 1999.
Fig. 2.33B Cormack DH, Clinically Integrated Histology, Baltimore: Lippincott Williams and Wilkins, 1998. (Fig. 8.8 p. 191)
Fig. 2.36B Based on Agur AMR: Grant's Method of Anatomy. 9th ed. Baltimore: Williams & Wilkins, 1975.
Fig. 2.43C Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. 2.47 Based on McConnell TH, Hull K: Human Form, Human Function: Essentials of Anatomy and Physiology. 1st ed. Baltimore: Lippincott Williams & Wilkins, 2011. fig. 14.16a, p. 565.
Fig. 2.48B Based on Grant's Dissector. 12th ed.
Fig. 2.57A Based on Grant's Method of Anatomy. 9th ed.
Fig. 2.57B Based on Grant's Method of Anatomy. 9th ed.
Fig. 2.58C Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT)
Fig. 2.59D Gartner LP, Hiatt JL: Color Atlas of Histology. 3rd ed. Baltimore: Lippincott Williams & Wilkins, 2001.
Fig. 2.62 Based on Bates' Guide to Physical Examination. 8th ed.

Fig. 2.64E Based on Grant's Dissector. 12th ed.
Fig. 2.67B–E Reprinted with permission from Karaliotas C. et al: Liver and Biliary Tract Surgery: Embryological Anatomy to 3D-Imaging and Transplant Innovations. Vienna: Springer, 2007.
Fig. 2.90 Based on Rosse C, Gaddum-Rosse P: Hollinshead's Textbook of Anatomy. 5th ed. Philadelphia, Lippincott-Raven, 1997.
Fig. 2.91A Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 2.102B & C Cross-Sectional Anatomy.
Fig. B2.2 Lockhart RD, Hamilton GF, Fyfe FW: Anatomy of the Human Body. Philadelphia: Lippincott, 1959
Fig. B2.3 ACD Based on Tank W, Gest TR: LWW Atlas of Anatomy. Baltimore: Lippincott Williams & Wilkins, 2008. Plate 5.11A
Fig. B2.7 Based on Stedman's Medical Dictionary. 27th ed.; photograph—courtesy of Mission Hospital, Mission Viejo, CA.
Fig. B2.8 Fundamentals of Diagnostic Radiology. 2nd ed
Fig. B2.9 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B2.10 Based on Stedman's Medical Dictionary. 28th ed. Baltimore: Lippincott Williams & Wilkins, 2006 (artist: Mikki Senkarik, San Antonio, TX).
Fig. B2.11 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B2.12 Based on Bates, 10th ed., p. 429
Fig. B2.15B Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy)
Fig. B2.16 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B2.17 Photograph of colonoscope—Olympus America, Inc; photograph of diverticulosis—Schiller, KFR et al. Colour Atlas of Endoscopy. Chapman and Hall, London, 1986, Springer Science and Business Media; drawings—Stedman's Medical Dictionary. 27th ed. (diverticulosis—artist: Neil O. Hardy, Westport, CT; colonoscopy—artist: Mikki Senkarik, San Antonio, TX).
Fig. B2.18 Based on Cohen BS. Medical Terminology. 4th ed. Baltimore: Lippincott Williams & Wilkins, 2003. Fig. 12.8.
Fig. B2.19A Bates 10th ed., p. 444.
Fig. B2.22 Based on Bates' Guide to Physical Examination and History Taking. 8th ed. Baltimore: Lippincott Williams and Wilkins, 2003.
Fig. B2.27 Rubin et al., Rubin's Pathology: Clinicopathologic Foundations of Medicine. 4th ed. Baltimore: Lippincott Williams & Wilkins: 2004.
Fig. B2.29 Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B2.30 (inset) Based on Stedman's Medical Dictionary. 28th ed.
Fig. B2.33 Stedman's Dictionary for Health Professionals and Nursing. 5th ed. Baltimore: Lippincott Williams & Wilkins, 2005. P. 987.
Fig. B2.34A Reprinted with permission from Moore KL, Persaud TVN: Before We Are Born. 7th ed., Saunders (Elsevier), Philadelphia, 2008. Fig. 9.10; courtesy of Dr. Nathan E. Wiseman, Professor of Surgery, Children's Hospital, University of Manitoba, Winnipeg, Manitoba, Canada.
Fig. B2.34B Reprinted with permission from Moore KL, Persaud TVN: The Developing Human. 8th ed., Saunders (Elsevier), Philadelphia 2008. Fig. 8.12C; courtesy of Dr. Prem S. Sahni, formerly of Department of Radiology, Children's Hospital, Winnipeg, Manitoba, Canada.
Fig. B2.35 Reprinted with permission from Medscape Gastroenterology 6 (1), 2004. http://www.medscape.com/viewarticle/474658 ©2004, Medscape.
Fig. 2.36 Based on Hardin, DMJr: Acute Appendicitis: Review and Update. American Family Physician. 60(7):2027-34 (1999) Fig. 1B©Floyd E. Hosmer
Fig. B 2.37B Based on Eckert, P et al.: Fibrinklebung, Indikation und Anwendung. München: Urban & Schwarzenberg, 1986.
Fig. TB 2.1 Based on LWW Atlas of Anatomy Plates 5.10B, 5.11B, and 5.11C.

CHAPTER 3

Fig. 3.14B Based on DeLancey JO. Structure support of the urethra as it relates to stress urinary incontinence: The hammock hypothesis. Am J Obstet Gynecol 1994;170:1713–1720
Fig. 3.38A Left—Based on Dauber W: Pocket Atlas of Human Anatomy. Rev. 5th ed. New York: Thieme: 2007. P. 195.
Fig. 3.51B Based on Clemente, CD: Anatomy: A Regional Atlas of the Human Body. 5th ed. Baltimore: Lippincott Williams & Wilkins, 2006. Fig. 272.1.
Fig. 3.61E Based on Das Lexicon der Gesundheit. Munich: Urban & Schwarzenberg Verlag, 1996 (artist: Jonathan Dimes), p. 3.
Fig. 3.72D Lee JKT, Sagel SS, Stanley RJ, et al.: Computed Body Tomography with MRI Correlation. 3rd ed. Baltimore: Lippincott Williams & Wilkins, 1998.
Fig. B3.2B Based on Anatomy as the Basis of Clinical Medicine. 3rd ed.
Fig. B3.7A & B Reprinted with permission from LearningRadiology.com.
Fig. B3.9 Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.10 Based on Hartwig W: Fundamental Anatomy. Baltimore: Lippincott Williams & Wilkins; 2007. P. 176.
Fig. B3.11 Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.14A & B Based on Beckmann CR. Obstetrics and Gynecology. 4th ed. Baltimore: Lippincott Williams and Wilkins, 2002.
Fig. B3.16 Reprinted with permission from Stuart GCE, Reid DF. Diagnostic studies. In: Copeland LJ, ed. Textbook of Gynecology. Philadelphia: Saunders, 1993.
Fig. B3.17A–D Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.18A & B Based on Fuller J, Schaller-Ayers J: A Nursing Approach. 2nd ed. Philadelphia: Lippincott, 1994. Fig. B3.11 (artist: Larry Ward, Salt Lake City, UT).
Fig. B3.20A & C–E Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.22 Based on Obstetrics and Gynecology. 4th ed.
Fig. B3.23 Based on A Nursing Approach. 2nd ed.
Fig. B3.24 Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.26A Based on Stedman's Medical Dictionary. 28th ed.
Fig. B3.26B With permission from Bristow RE, Johns Hopkins School of Medicine, Baltimore, MD.
Fig. 3.27A-C Based on LWW Atlas Plate 6.19A, p. 276
Fig. B3.28 Based on Obstetrics and Gynecology. 4th ed.
Fig. B3.29A and B Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.32 Based on Stedman's Medical Dictionary. 27th ed.
Fig. B3.33A Based on Stedman's Medical Dictionary. 27th ed. (artist: Neil O. Hardy, Westport, CT) and Clinically Oriented Anatomy, 7th ed., fig. B3.30B
Fig. B3.33B Edwards L, ed: Atlas of Genital Dermatology. Baltimore: Lippincott Williams & Wilkins, 2004.

CHAPTER 4

Fig. 4.1C Based on Olson TR: Student Atlas of Anatomy. Baltimore: Williams & Wilkins, 1996.
Fig. 4.4 Based on Pocket Atlas of Human Anatomy. Rev. 5th ed. Fig. B, p. 49.
Fig. 4.7D Becker RF, Wilson JW, Gehweiler JA: Anatomical Basic of Medical Practice. Baltimore: Williams & Wilkins, 1974.
Fig. 4.30 Based on Student Atlas of Anatomy.
Fig. 4.31 Based on Student Atlas of Anatomy.
Fig. B4.3A–E Based on Clark CR: The Cervical Spine. 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 1998.
Fig. B4.3F & G Computed Body Tomography with MRI Correlation. 3rd ed.
Fig. B4.10 Van de Graff. Human Anatomy. 4th ed. Dubuque: WC Brown. P. 163.

Fig. B4.11 Median MRI ©LUHS2008. Loyola University Health System, Maywood, IL. transverse MRI—Choi S-J et al. The use of MRI to predict the clinical outcome of non-surgical treatment for lumbar I-V disc herniation. Korean J Radiol 2007;8:156–163:5a.
Fig. B4.13B GE Healthcare, www.medcyclo.com.
Fig. B4.13C Cross-sectional Human Anatomy.
Fig. B4.13D LearningRadiology.com.
Fig. B4.13E LearningRadiology.com.
Fig. B4.15C Based on The Cervical Spine. 3rd ed.
Fig. B4.16B Based on eMedicine.com, 2008/ http://www.emedicine.com/sports/TOPIC71.HTM.
Fig. B4.16C Based on Drake R et al.: Gray's Atlas of Anatomy. New York: Churchill Livingstone, 2004. P. 30.
Fig. B4.17F Science Photo Library/Custom Medical Stock Photo, Inc.
Fig. B4.17G Princess Margaret Rose Orthopaedic Hospital/Science Photo Library/Photo Researchers, Inc.; right—Anatomical Basic of Medical Practice.

CHAPTER 5

Fig. 5.5A Atlas of Radiologic Anatomy. 6th English ed.
Fig. 5.21E Based on Rose J, Gamble JG. Human Walking. 2nd ed. Baltimore: Williams & Wilkins, 1994.
Fig. 5.21G Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.22C Based on Melloni, JL: Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins. Lippincott Williams & Wilkins, 1988.
Fig. 5.34A & B Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.40A Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.40F Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed. Fig. 9.12, p. 342.
Fig. 5.40H Based on Basic Clinical Massage Therapy, 2nd. Ed. Fig. 9.14, p. 344.
Fig. 5.42(left) Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.42(right) Based on Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins. P. 173.
Fig. 5.55C–F Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.60F–K Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.68A & H Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.68C Based on Basic Clinical Massage Therapy and Grant's Atlas of Anatomy, 13th ed., Fig. 78, p. 453
Fig. 5.69A,C Based on Grant's Atlas of Anatomy. 13th ed.
Fig. 5.69B Based on Grant's Atlas of Anatomy, 13th ed., Fig. 6.78C
Fig. 5.69D Based in part on Grant's Atlas of Anatomy, 13th ed., Fig. 5.80C, p. 455
Fig. 5.73 Based on Basmajian JV, Slonecker CE: Grant's Method of Anatomy: A Clinical Problem-Solving Approach. 11 ed. Baltimore: Williams & Wilkins, 1989.
Fig. 5.76A Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.79A & B Based on Kapandji, IA. The Physiology of the Joints. Vol. 2: Lower Limb. 5th ed. Edinburgh, UK, Churchill Livingstone, 1987.
Fig. 5.79C Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed.
Fig. 5.80B Atlas of Radiologic Anatomy. 6th English ed.
Fig. 5.85B Atlas of Radiologic Anatomy. 6th English ed.
Fig. 5.92B Based on Student Atlas of Anatomy.
Fig. 5.95A Atlas of Radiologic Anatomy. 6th English ed.
Fig. B5.1A Yochum TR, Rowe LJ. Essentials of Skeletal Radiology, Vol. 1, 2nd ed., Baltimore: Lippincott Williams & Wilkins, 1996. Fig. 9.85, p. 707.
Fig. B5.1B Brunner, LC, Kuo TY: Hip fractures in adults. Am Fam Phys 2003;67(3):Fig. 2.
Fig. B5.1D Rossi F, Dragoni S. Acute avulsion fractures of the pelvis in adolescent competitive athletes. Skel Radiol 2001;30(3):Fig. 7.
Fig. B5.3D Yochum TR, Rowe LJ. Essentials of Skeletal Radiology, 3rd Ed. Baltimore: Lippincott Williams & Wilkins, 2005.
Fig. B5.4 Essentials of Skeletal Radiology, 3rd ed.
Fig. B5.5 ©eMedicine.com, 2008.
Fig. B5.8D Hatch RL et al.: Diagnosis and management of metatarsal fractures. Am Fam Phys 2007;76(6):217.
Fig. B5.8E Essentials of Skeletal Radiology, Vol. 1, 2nd edition, Fig. 9.104A, p. 737.
Fig. B5.9 Davies M. The os trigonum syndrome. Foot 2004;14(3):Fig. 2.
Fig. B5.10 Doda P, Peh W: Woman with possible right toe fracture. Asia Pacific J Fam Med 2006;5(3):50.
Fig. B5.11A Reprinted with permission from Roche Lexikon Medizin. 4th ed.
Fig. B5.11B–D Stedman's Medical Dictionary. 28th ed. (artist: Neil O. Hardy, Westport, CT), p. 2090.
Fig. B5.12 LearningRadiology.com.
Fig. B5.13B Kavanagh EC et al.: MRI findings in bipartite patella. Skel Radiol 2007;36(3):Fig. 1a.
Fig. B5.14 Bates 10e, p. 699 upper fig.
Fig. B5.22 Bates 10e, p. 700, upper fig.
Fig. B5.25 Bates 10e, p. 485, posterior tibial pulse
Fig. B5.26(top) www.xray200.co.uk
Fig. B5.27 Bates 10e, p. 485, dorsalis pedis pulse.
Fig. B5.28 Essentials of Skeletal Radiology. 2nd ed.
Fig. B5.30 Drawings—Willis MC: Medical Terminology: A Programmed Learning Approach to the Language of Health Care. Baltimore: Lippincott Williams & Wilkins, 2002; radiograph—Clinical Radiology—The Essentials.
Fig. B5.32A–C Modified from Palastanga NP, Field DG, Soames R: Anatomy and Human Movement. 4th ed. Oxford, UK: Butterworth-Heinemann, 2002.
Fig. B5.32D Clinical Radiology—The Essentials.
Fig. B5.34 Based on Roche Lexikon Medizin. 4th ed.
Fig. B5.35C Stedman's Medical Dictionary. 28th ed, p. 1184.

CHAPTER 6

Fig. 6.17 LWW Atlas of Anatomy. Baltimore: Pl. 2.53, p. 82.
Fig. 6.32 Basic Clinical Massage Therapy: Integrating Anatomy and Treatment, 2nd ed. Fig. 4.28, p. 147.
Fig. 6.49B–D, F, & G Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed. Figs. 5.1, 5.12, 5.3, 5.6, and 5.10, pgs. 193, 201, 195, 197, and 199.
Fig. 6.53 Based on Hoppenfeld, S, de Boer P. Surgical Exposures in Orthopaedics, 3rd ed. Baltimore: Lippincott Williams & Wilkins, 2003. Fig. 2.27, p. 89.
Fig. 6.60B & C Basic Clinical Massage Therapy, 2nd ed. Fig. 5.5, p. 186.
Fig. 6.92 Modified from Biomechanical Basis of Human Motion. Fig. 5.8, p. 153.
Fig. 6.93 Platzer W. Color Atlas of Human Anatomy. Vol. 1: Locomotor System. 4th ed. New York: Thieme, 1992, p. 147 and 149.
Fig. 6.102 Based on LWW Atlas of Anatomy Plate 2.43
Fig. 6.103 B and C Based on from Anatomy as the Basis of Clinical Medicine. 3rd ed.
Fig. 6.109B Grant's Method of Anatomy: A Clinical Problem-Solving Approach. 11th ed.
Fig. B6.5 Rowland LP: Merritt's Textbook of Neurology. 9th ed. Baltimore: Williams & Wilkins, 1995.
Fig. B6.9 Left—Meschan I. An Atlas of Anatomy Basic to Radiology. Philadelphia: Saunders, 1975; right—Salter RB. Textbook of Disorders

and Injuries of the Musculoskeletal System. 3rd ed. Baltimore: Williams & Wilkins, 1998.
Fig. B6.13 Bates, 10th ed, p. 697 bottom left.
Fig. B6.14 Based on Anderson MK, Hall SJ, Martin M: Foundations of Athletic Training. 3rd ed. Baltimore: Lippincott Williams & Wilkins, 1995.
Fig. B6.31 www.xray200.co.uk.
Fig. B6.37A John Sleezer/MCT/Landov.
Fig. B6.37B Basic Clinical Massage Therapy: Integrating Anatomy and Treatment, second edition. Fig. 5-35, p. 223.
Fig. B6.38 Textbook of Disorders and Injuries of the Musculoskeletal System. 3rd ed.

CHAPTER 7

Fig. 7.16 LWW Atlas of Anatomy. Plate 7.29, p. 324
Fig. 7.25 Based on LWW Atlas of Anatomy Plate 7.73, p. 368
Fig. 7.26 Based on LWW Atlas of Anatomy Plate 7.74, p. 369
Fig. 7.28A Based on LWW Atlas of Anatomy Plate 7.50B, p. 345.
Fig. 7.31C Based on LWW Atlas of Anatomy Plate 760B, p. 365.
Fig. 7.44A Based on Anatomy as the Basis of Clinical Medicine. 3rd ed.
Fig. 7.46A Based on LWW Atlas of Anatomy. Plate 7.58B, p. 353.
Fig. 7.51A Based on Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins, p. 149.
Fig. 7.51B Based on Human Anatomy. 4th ed. Fig. 15.18, p. 419.
Fig. 7.52 Welch Allyn, Inc., Skaneateles Falls, NY.
Fig. 7.53 Based on Human Anatomy. 4th ed. Fig. 15.17.
Fig. 7.54B Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins. P. 141.
Fig. 7.54C Based on Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins. P. 143.
Fig. 7.56A–D Based on Girard, Louis: Anatomy of the Human Eye. II. The Extra-ocular Muscles. Teaching Films, Inc. Houston, TX.
Fig. 7.57 Based on Melloni's Illustrated Review of Human Anatomy: By Structures—Arteries, Bones, Muscles, Nerves, Veins. P. 189.
Fig. 7.65 Based in part on Clemente C. Atlas of Anatomy 6th ed., Baltimore: Lippincott Williams and Wilkins, 2011. figs. 529-531.
Fig. 7.71 Based on Paff, GH: Anatomy of the Head & Neck. Philadelphia: WB Saunders Co., 1973. Fig. 122.3, p. 62-63.
Fig. 7.72 Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment, 2nd ed. Figs. 3.15, 3.16, and 3.19, p. 82, 84, and 86.
Fig. 7.88 Based on LWW Atlas of Anatomy Plate 7.39A
Fig. 7.90A Based on LWW Atlas of Anatomy Plate 7-40A, p. 335
Fig. 7.90C Based on LWW Atlas of Anatomy Plate 7-38C., p. 333
Fig. 7.98 Based on Anatomy of the Head & Neck. Figs. 238–240, p. 142–143 and Grant's Atlas of Anatomy, 13th ed., Fig. 7.78B, p. 705.
Fig. 7.100B & C Based on Hall-Craggs ECB: Anatomy as the Basis of Clinical Medicine. 2nd ed. Baltimore: Williams & Wilkins, 1990. Fig. 9.100, p. 536.
Fig. 7.112 Based on LWW Atlas of Anatomy. Pl. 7.66B& C.
Fig. 7.120 Seeley RR, Stephens TR, and Tate P: Anatomy & Physiology. 6th ed. New York: McGraw-Hill 2003. Fig. 15.28, p. 532.
Fig. B7.12 Ger R, Abrahams P, Olson T: Essentials of Clinical Anatomy. 3rd ed. New York: Parthenon, 1996. Fig. B7.12.
Fig. B7.14 ©LUHS2008. Loyola University Health System, Maywood, IL.
Fig. B7.15 Skin Cancer Foundation.
Fig. B7.20A Visuals Unlimited.
Fig. B7.20B Courtesy of Dr. Gerald S. Smyser, Altru Health System, Grand Forks, ND.
Fig. B7.23 Stedman's Medical Dictionary. 28th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B7.24 Mann IC: The Development of the Human Eye. New York: Grune & Stratton. 1974.
Fig. B7.25 Welch Allyn, Inc., Skaneateles Falls, NY.
Fig. B7.26 Medical Terminology. 4th ed.
Fig. B7.27 Digital Reference of Ophthalmology, Edward S. Harkness Eye Institute, Department of Ophthalmology of Columbia University.
Fig. B7.28 Stedman's Medical Dictionary. 28th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B7.29 Mehrle G, Augenheikunde fur Krankenpfegeberufe S aufl. Munchen: Urban & Fischer, 1991.
Fig. B7.32 The Developing Human: Clinically Oriented Embryology. 7th ed.
Fig. B7.33A – D Stedman's Medical Dictionary, 28th ed. (artist: Neil O. Hardy, Westport, CT).
Fig. B7.39 Courtesy of Eugene Kowaluk Photography.
Fig. B7.41 Turner, JS: An overview of head and neck. In Walker HK, Hall WD, Hurst JW, eds: Clinical Methods—The History, Physical and Laboratory Examinations. Butterworths, 1990. Figs. 119.1 and 119.2.
Fig. B7.42 Anatomy as the Basis of Clinical Medicine. 3rd ed.
Fig. B7.43 Bechara Y. Ghorayeb MD, Houston, TX.
Fig. B7.44 Welch Allyn, Inc., Skaneateles Falls, NY.
Fig. B7.45 Stedman's Medical Dictionary. 28th ed. (artist: Neil O. Hardy, Westport, CT).

CHAPTER 8

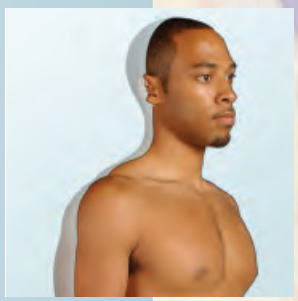
Fig. 8.1 Based on LWW Atlas of Anatomy Plate 7.13, p. 308 and Tank, PW, Grant's Dissector, 15th ed., Baltimore: Lippincott Williams and Wilkins, 2012, Fig 7.6, p. 209 and 7.10, p. 214
Fig. 8.4A Based on LWW Atlas of Anatomy Plate 7.10A&B, p. 305
Fig. 8.7A Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed., Fig. 3.28
Fig. 8.7B&F Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed., Fig. 6.24
Fig. 8.7CDE Based on Basic Clinical Massage Therapy: Integrating Anatomy and Treatment. 2nd ed. Fig. 8.7 CDE
Fig. 8.12 Based on Grant's Dissector, 15e, Fig. 7-5, p. 208
Fig. 8.20 Based on LWW Atlas of Anatomy Plate 7.73, p 368.
Fig. 8.24A Based on Grant's Dissector. 15th ed., Fig. 7.11
Fig. 8.32C Based on Pocket Atlas of Human Anatomy. 5th ed. P. 169, Fig. C, p. 169.
Fig. 8.43 Based on LWW Atlas of Anatomy Plate 7.10
Fig. 8.44A Abrahams P: The Atlas of the Human Body. San Diego, CA: Thunder Bay Press, 2002. P. 66.
Fig. 8.46B Based on LWW Atlas of Anatomy Plate 7-21, p. 316
Fig. B8.1 Based on Merritt's Textbook of Neurology. 9th ed.
Fig. B8.3 Based on Siemens Medical Solutions USA, Inc.
Fig. B8.6 Based on Sadler TW. Langman's Medical Embryology. 7th ed. Baltimore: Williams & Wilkins, 1995.
Fig. B8.7 Leung AKC, Wong Al, Robson WLLM: Ectopic thyroid gland simulating a thyroglossal duct cyst. Can J Surg 1995;38:87. ©1995 Canadian Medical Association.
Fig. B8.9 Klima: Schilddrüsen-Sonographie. München: Urban & Schwarzenberg Verlag, 1989.
Fig. B8.11 Based on Rohen JW et al.: Color Atlas of Anatomy: A Photographic Study of the Human Body. 5th ed. Baltimore: Lippincott Williams & Wilkins, 2002.
Fig. B8.12 Based on Stedman's Medical Dictionary. 27th ed.

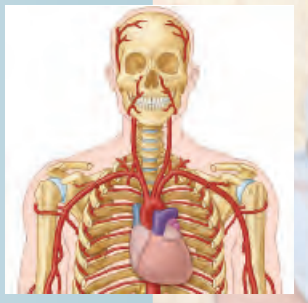
CHAPTER 9

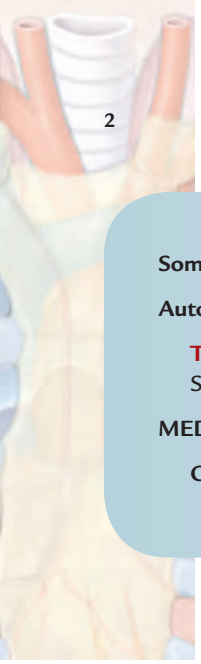
No credits

***Note**: Credits for figures based on* Grant's Atlas of Anatomy *and* Essential Clinical Anatomy *illustrations are available at thePoint.lww.com.*

Introduction to Clinically Oriented Anatomy







APPROACHES TO STUDYING ANATOMY

Anatomy is the setting (structure) in which the events (functions) of life occur. This book deals mainly with functional *human gross anatomy*—the examination of structures of the human that can be seen without a microscope. The three main approaches to studying anatomy are regional, systemic, and clinical (or applied), reflecting the body's organization and the priorities and purposes for studying it.

Regional Anatomy

Regional anatomy (topographical anatomy) considers the organization of the human body as major parts or segments (Fig. I.1): a main body, consisting of the head, neck, and trunk (subdivided into thorax, abdomen, back, and pelvis/perineum), and paired upper limbs and lower limbs. All the major parts may be further subdivided into areas and regions. Regional anatomy is the method of studying the body's structure by focusing attention on a specific part (e.g., the head), area (the face), or region (the orbital or eye region); examining the arrangement and relationships of the various systemic structures (muscles, nerves, arteries, etc.) within it; and then usually continuing to study adjacent regions in an ordered sequence. Outside of this Introduction, the regional approach is followed in this book, with each chapter addressing the anatomy of a major part of the body. This is the approach usually followed in anatomy courses that have a laboratory component involving dissection. When studying anatomy by this approach, it is important to routinely put the regional anatomy into the context of that of adjacent regions, parts, and of the body as a whole.

Regional anatomy also recognizes the body's organization by layers: skin, subcutaneous tissue, and deep fascia covering the deeper structures of muscles, skeleton, and cavities, which contain *viscera* (internal organs). Many of these deeper structures are partially evident beneath the body's outer covering and may be studied and examined in living individuals via surface anatomy.

Surface anatomy is an essential part of the study of regional anatomy. It is specifically addressed in this book in "surface anatomy sections" (orange background) that provide knowledge of what lies under the skin and what structures are perceptible to touch (palpable) in the living body at rest and in action. We can learn much by observing the external form and surface of the body and by observing or feeling the superficial aspects of structures beneath its surface. The aim of this method is to *visualize* (recall distinct mental images of) structures that confer contour to the surface or are palpable beneath it and, in clinical practice, to distinguish any unusual or abnormal findings. In short, surface anatomy requires a thorough understanding of the anatomy of the structures beneath the surface. In people with stab wounds, for example, a physician must be able to visualize the deep structures that may be injured. Knowledge of surface anatomy can also decrease the need to memorize facts because the body is always available to observe and palpate.

Physical examination is the clinical application of surface anatomy. **Palpation** is a clinical technique, used with **observation** and **listening** for examining the body. *Palpation of arterial pulses,* for instance, is part of a physical examination. Students of many of the health sciences will learn to use instruments to facilitate examination of the body (such as an *ophthalmoscope* for observation of features of the eyeballs) and to listen to functioning parts of the body (a *stethoscope* to auscultate the heart and lungs).

Regional study of deep structures and abnormalities in a living person is now also possible by means of radiographic and sectional imaging and endoscopy. *Radiographic and sectional imaging (radiographic anatomy)* provides useful information about normal structures in living individuals, demonstrating the effect of muscle tone, body fluids and pressures, and gravity that cadaveric study does not. *Diagnostic radiology* reveals the effects of trauma, pathology, and aging on normal structures. In this book, most radiographic and many sectional

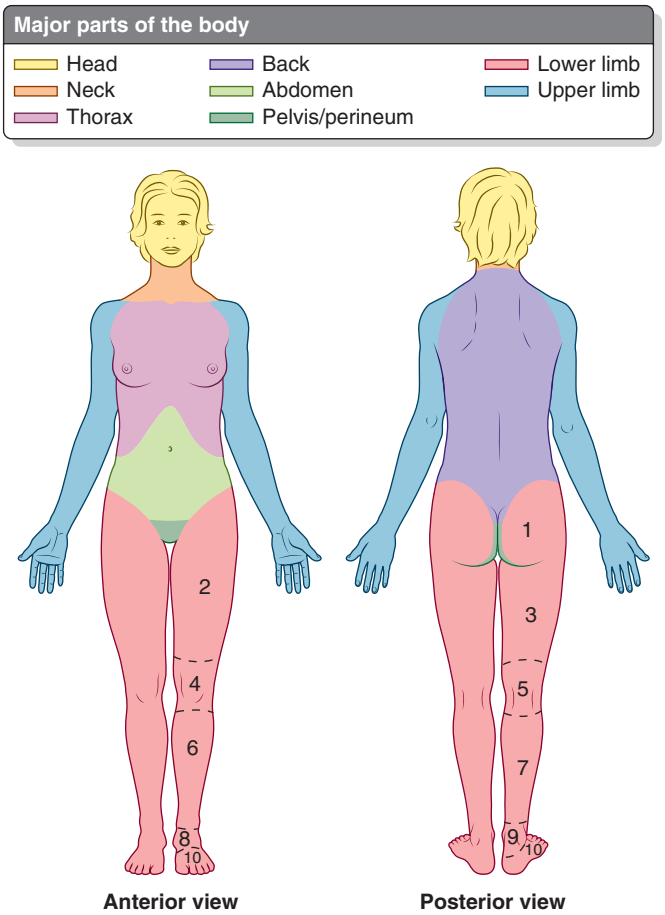


FIGURE I.1. Major parts of the body and regions of the lower limb. Anatomy is described relative to the anatomical position illustrated here.

images are integrated into the chapters where appropriate. The medical imaging sections at the end of each chapter provide an introduction to the techniques of radiographic and sectional imaging and include series of sectional images that apply to the chapter. *Endoscopic techniques* (using a insertable flexible fiber optic device to examine internal structures, such as the interior of the stomach) also demonstrate living anatomy. The detailed and thorough learning of the three-dimensional anatomy of deep structures and their relationships is best accomplished initially by dissection. In clinical practice, surface anatomy, radiographic and sectional images, endoscopy, and your experience from studying anatomy will combine to provide you with knowledge of your patient's anatomy.

The computer is a useful adjunct in teaching regional anatomy because it facilitates learning by allowing interactivity and manipulation of two- and three-dimensional graphic models. **Prosections,** carefully prepared dissections for the demonstration of anatomical structures, are also useful. However, learning is most efficient and retention is highest when didactic study is combined with the experience of first-hand **dissection**—that is, learning by doing. During dissection you observe, palpate, move, and sequentially reveal parts of the body. In 1770, Dr. *William Hunter,* a distinguished Scottish anatomist and obstetrician, stated: "Dissection alone teaches us where we may cut or inspect the living body with freedom and dispatch."

Systemic Anatomy

Systemic anatomy is the study of the body's organ systems that work together to carry out complex functions. The basic systems and the field of study or treatment of each (in parentheses) are:

- The **integumentary system** (*dermatology*) consists of the skin (L. *integumentum,* a covering) and its appendages—hairs, nails, and sweat glands, for example—and the subcutaneous tissue just beneath it. The skin, an extensive sensory organ, forms the body's outer, protective covering and container.
- The **skeletal system** (*osteology*) consists of bones and cartilage; it provides our basic shape and support for the body and is what the muscular system acts on to produce movement. It also protects vital organs such as the heart, lungs, and pelvic organs.
- The **articular system** (*arthrology*) consists of joints and their associated ligaments, connecting the bony parts of the skeletal system and providing the sites at which movements occur.
- The **muscular system** (*myology*) consists of skeletal muscles that act (contract) to move or position parts of the body (e.g., the bones that articulate at joints), or smooth and cardiac muscle that propels, expels, or controls the flow of fluids and contained substance.
- The **nervous system** (*neurology*) consists of the *central nervous system* (brain and spinal cord) and the *peripheral nervous system* (nerves and ganglia, together with their motor and sensory endings). The nervous system controls and coordinates the functions of the organ systems, enabling the body's responses to and activities within its environment. The sense organs, including the olfactory organ (sense of smell), eye or visual system *(ophthalmology),* ear (sense of hearing and balance—*otology*), and gustatory organ (sense of taste), are often considered with the nervous system in systemic anatomy.
- The **circulatory system** (*angiology*) consists of the cardiovascular and lymphatic systems, which function in parallel to transport the body's fluids.
  - The **cardiovascular system** (*cardiology*) consists of the heart and blood vessels that propel and conduct blood through the body, delivering oxygen, nutrients, and hormones to cells and removing their waste products.

  - The **lymphatic system** is a network of lymphatic vessels that withdraws excess tissue fluid (lymph) from the body's interstitial (intercellular) fluid compartment, filters it through lymph nodes, and returns it to the bloodstream.
- The **alimentary** or **digestive system** (*gastroenterology*) consists of the digestive tract from the mouth to the anus, with all its associated organs and glands that function in ingestion, mastication (chewing), deglutition (swallowing), digestion, and absorption of food and the elimination of the solid waste (feces) remaining after the nutrients have been absorbed.
- The **respiratory system** (*pulmonology*) consists of the air passages and lungs that supply oxygen to the blood for cellular respiration and eliminate carbon dioxide from it. The diaphragm and larynx control the flow of air through the system, which may also produce tone in the larynx that is further modified by the tongue, teeth, and lips into speech.
- The **urinary system** (*urology*) consists of the kidneys, ureters, urinary bladder, and urethra, which filter blood and subsequently produce, transport, store, and intermittently excrete urine (liquid waste).
- The **genital (reproductive) system** (*gynecology* for females; *andrology* for males) consists of the gonads (ovaries and testes) that produce oocytes (eggs) and sperms, the ducts that transport them, and the genitalia that enable their union. After conception, the female reproductive tract nourishes and delivers the fetus.
- The **endocrine system** (*endocrinology*) consists of specialized structures that secrete hormones, including discrete ductless endocrine glands (such as the thyroid gland), isolated and clustered cells of the gut and blood vessel walls, and specialized nerve endings. **Hormones** are organic molecules that are carried by the circulatory system to distant effector cells in all parts of the body. The influence of the endocrine system is thus as broadly distributed as that of the nervous system. Hormones influence metabolism and other processes, such as the menstrual cycle, pregnancy, and parturition (childbirth).

None of the systems functions in isolation. The passive skeletal and articular systems and the active muscular system collectively constitute a *supersystem,* the **locomotor system** or **apparatus** (*orthopedics*), because they must work together to produce locomotion of the body. Although the structures directly responsible for locomotion are the muscles, bones, joints, and ligaments of the limbs, other systems are indirectly involved as well. The brain and nerves of the nervous system stimulate them to act; the arteries and veins of the circulatory system supply oxygen and nutrients to and remove waste from these structures; and the sensory organs (especially vision and equilibrium) play important roles in directing their activities in a gravitational environment.

In this Introduction, an overview of several systems significant to all parts and regions of the body will be provided before Chapters 1 through 8 cover regional anatomy in detail. Chapter 9 also presents systemic anatomy in reviewing the cranial nerves.

Clinical Anatomy

Clinical anatomy (applied anatomy) emphasizes aspects of bodily structure and function important in the practice of medicine, dentistry, and the allied health sciences. It incorporates the regional and systemic approaches to studying anatomy and stresses clinical application.

Clinical anatomy often involves inverting or reversing the thought process typically followed when studying regional or systemic anatomy. For example, instead of thinking, "The action of this muscle is to . . . ," clinical anatomy asks, "How would the absence of this muscle's activity be manifest?" Instead of noting, "The . . . nerve provides innervation to this area of skin," clinical anatomy asks, "Numbness in this area indicates a lesion of which nerve?"

Clinical anatomy is exciting to learn because of its role in solving clinical problems. The clinical correlation boxes (popularly called "blue boxes," appearing on a blue background) throughout this book describe practical applications of anatomy. "Case studies," such as those on the Clinically Oriented Anatomy website (http://thePoint.lww.com/COA7e), are integral parts of the clinical approach to studying anatomy.

The Bottom Line

STUDYING ANATOMY

Anatomy is the study of the structure of the human body. ♦ Regional anatomy considers the body as organized into segments or parts. ♦ Systemic anatomy sees the body as organized into organ systems. ♦ Surface anatomy provides information about structures that may be observed or palpated beneath the skin. ♦ Radiographic, sectional, and endoscopic anatomy allows appreciation of structures in living people, as they are affected by muscle tone, body fluids and pressures, and gravity. ♦ Clinical anatomy emphasizes application of anatomical knowledge to the practice of medicine.

ANATOMICOMEDICAL TERMINOLOGY

Anatomical terminology introduces and makes up a large part of medical terminology. To be understood, you must express yourself clearly, using the proper terms in the correct way. Although you are familiar with common, colloquial terms for parts and regions of the body, you must learn the *international anatomical terminology* (e.g., axillary fossa instead of armpit and clavicle instead of collarbone) that enables precise communication among healthcare professionals and scientists worldwide. Health professionals must also know the common and colloquial terms people are likely

to use when they describe their complaints. Furthermore, you must be able to use terms people will understand when explaining their medical problems to them.

The terminology in this book conforms to the new *International Anatomical Terminology. Terminologia Anatomica* (TA) and *Terminologia Embryologica (TE)* list terms both in Latin and as English equivalents (e.g., the common shoulder muscle is *musculus deltoideus* in Latin and *deltoid* in English). Most terms in this book are English equivalents. Official terms are available at www.unifr.ch/ifaa. Unfortunately, the terminology commonly used in the clinical arena may differ from the official terminology. Because this discrepancy may be a source of confusion, this text clarifies commonly confused terms by placing the unofficial designations in parentheses when the terms are first used—for example, *pharyngotympanic tube* (auditory tube, eustachian tube) and *internal thoracic artery* (internal mammary artery). *Eponyms,* terms incorporating the names of people, are not used in the new terminology because they give no clue about the type or location of the structures involved. Further, many eponyms are historically inaccurate in terms of identifying the original person to describe a structure or assign its function, and do not conform to an international standard. Notwithstanding, commonly used eponyms appear in parentheses throughout the book when these terms are first used—such as *sternal angle* (angle of Louis)—since you will surely encounter them in your clinical years. Note that eponymous terms do not help to locate the structure in the body. The Clinically Oriented Anatomy website (http://thePoint.lww.com/COA7e) provides a list of eponymous terms.

Structure of terms. Anatomy is a descriptive science and requires names for the many structures and processes of the body. Because most terms are derived from Latin and Greek, medical language may seem difficult at first; however, as you learn the origin of terms, the words make sense. For example, the term *gaster* is Latin for stomach or belly. Consequently, the esophagogastric junction is the site where the esophagus connects with the stomach, gastric acid is the digestive juice secreted by the stomach, and a digastric muscle is a muscle divided into two bellies.

Many terms provide information about a structure's shape, size, location, or function or about the resemblance of one structure to another. For example, some muscles have descriptive names to indicate their main characteristics. The *deltoid muscle,* which covers the point of the shoulder, is triangular, like the symbol for *delta,* the fourth letter of the Greek alphabet. The suffix *-oid* means "like"; therefore, *deltoid* means like delta. *Biceps* means two-headed and *triceps* means three-headed. Some muscles are named according to their shape—the *piriformis muscle,* for example, is pear shaped (L. *pirum,* pear + L. *forma,* shape or form). Other muscles are named according to their location. The *temporal muscle* is in the temporal region (temple) of the cranium (skull). In some cases, actions are used to describe muscles—for example, the *levator scapulae* elevates the scapula (L. shoulder blade). Anatomical terminology applies logical reasons for the names of muscles and other parts of the body, and if you learn their meanings and think about them as you read and dissect, it will be easier to remember their names.

Abbreviations. Abbreviations of terms are used for brevity in medical histories and in this and other books, such as in tables of muscles, arteries, and nerves. Clinical abbreviations are used in discussions and descriptions of signs and symptoms. Learning to use these abbreviations also speeds note taking. Common anatomical and clinical abbreviations are provided in this text when the corresponding term is introduced—for example, temporomandibular joint (TMJ). The Clinically Oriented Anatomy website (http://thePoint.lww.com/COA7e) provides a list of commonly used anatomical abbreviations. More extensive lists of common medical abbreviations may be found in the appendices of comprehensive medical dictionaries (e.g., *Stedman's Medical Dictionary,* 28th ed.).

Anatomical Position

All anatomical descriptions are expressed in relation to one consistent position, ensuring that descriptions are not ambiguous (Figs. I.1 and I.2). One must visualize this position in the mind when describing patients (or cadavers), whether they are lying on their sides, supine (recumbent, lying on the back, face upward), or prone (lying on the abdomen, face downward). The **anatomical position** refers to the body position as if the person were standing upright with the:

- head, gaze (eyes), and toes directed anteriorly (forward),
- arms adjacent to the sides with the palms facing anteriorly, and
- lower limbs close together with the feet parallel.

This position is adopted globally for anatomicomedical descriptions. By using this position and appropriate terminology, you can relate any part of the body precisely to any other part. It should also be kept in mind, however, that gravity causes a downward shift of internal organs (viscera) when the upright position is assumed. Since people are typically examined in the supine position, it is often necessary to describe the position of the affected organs when supine, making specific note of this exception to the anatomical position.

Anatomical Planes

Anatomical descriptions are based on four imaginary planes (median, sagittal, frontal, and transverse) that intersect the body in the anatomical position (Fig. I.2):

- The **median plane** (median sagittal plane), the vertical plane passing longitudinally through the body, divides the body into right and left halves. The plane defines the midline of the head, neck, and trunk where it intersects the surface of the body. *Midline* is often erroneously used as a synonym for the median plane.
- **Sagittal planes** are vertical planes passing through the body *parallel to the median plane. Parasagittal* is commonly used but is unnecessary because any plane parallel to and on either side of the median plane is sagittal

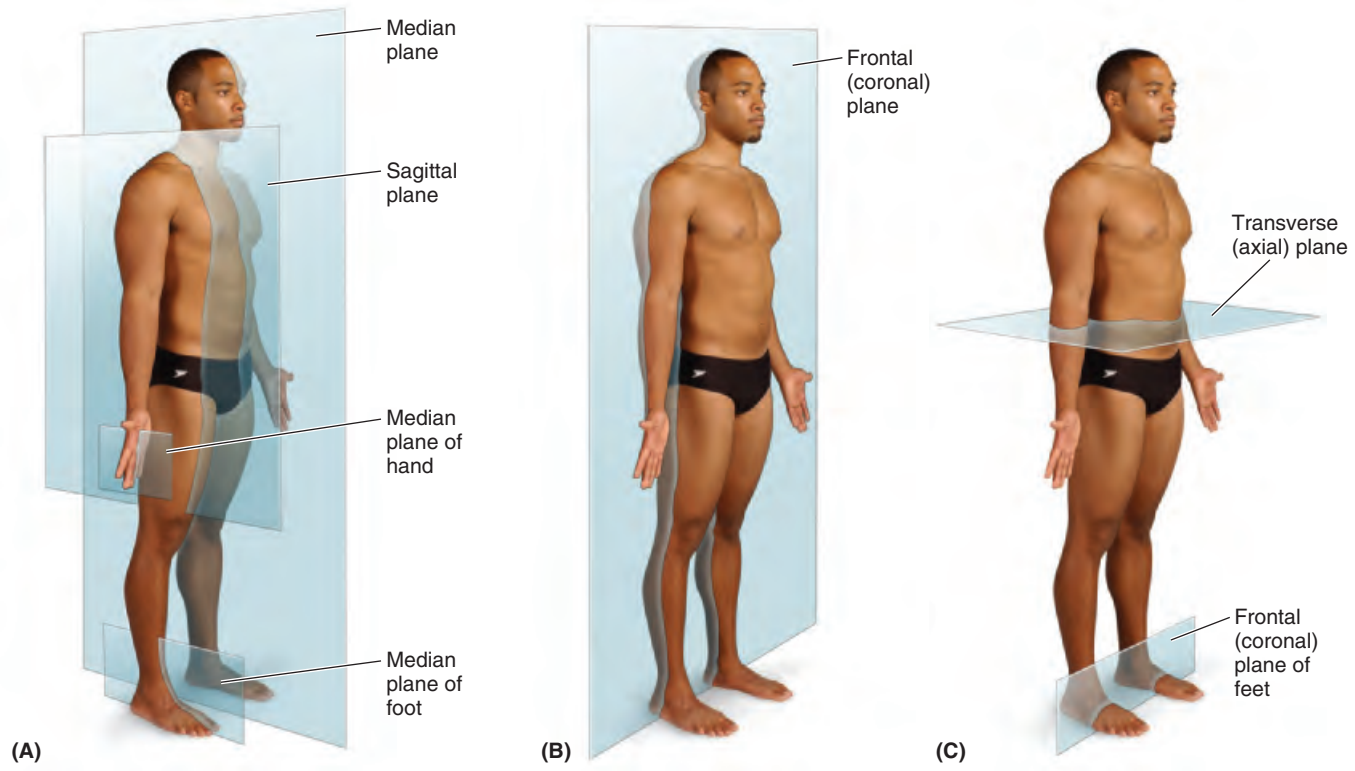


FIGURE I.2. Anatomical planes. The main planes of the body are illustrated.

by definition. However, a plane parallel and near to the median plane may be referred to as a *paramedian plane.*

- **Frontal (coronal) planes** are vertical planes passing through the body *at right angles to the median plane,* dividing the body into anterior (front) and posterior (back) parts.
- **Transverse planes** are horizontal planes passing through the body *at right angles to the median and frontal planes,* dividing the body into superior (upper) and inferior (lower) parts. Radiologists refer to transverse planes as *transaxial,* which is commonly shortened to *axial planes.*

Since the number of sagittal, frontal, and transverse planes is unlimited, a reference point (usually a visible or palpable landmark or vertebral level) is necessary to identify the location or level of the plane, such as a "transverse plane through the umbilicus" (Fig. I.2C). Sections of the head, neck, and trunk in precise frontal and transverse planes are symmetrical, passing through both the right and left members of paired structures, allowing some comparison.

The main use of anatomical planes is to describe *sections* (Fig. I.3):

- **Longitudinal sections** run lengthwise or parallel to the long axis of the body or of any of its parts, and the term applies regardless of the position of the body. Although median, sagittal, and frontal planes are the standard (most commonly used) longitudinal sections, there is a 180° range of possible longitudinal sections.
- **Transverse sections,** or cross sections, are slices of the body or its parts that are cut at right angles to the longitudinal axis of the body or of any of its parts. Because the long axis of the foot runs horizontally, a transverse section of the foot lies in the frontal plane (Fig. I.2C).
- **Oblique sections** are slices of the body or any of its parts that are not cut along the previously listed anatomical planes. In practice, many radiographic images and anatomical sections do not lie precisely in sagittal, frontal, or transverse planes; often they are slightly oblique.

Anatomists create sections of the body and its parts anatomically, and clinicians create them by planar imaging technologies, such as computerized tomography (CT), to describe and display internal structures.

Terms of Relationship and Comparison

Various adjectives, arranged as pairs of opposites, describe the relationship of parts of the body or compare the position of two structures relative to each other (Fig. I.4). Some of these terms are specific for comparisons made in the anatomical position, or with reference to the anatomical planes:

Superior refers to a structure that is nearer the **vertex,** the topmost point of the cranium (Mediev. L., skull). **Cranial** relates to the cranium and is a useful directional term, meaning toward the head or cranium. **Inferior** refers to a structure that is situated nearer the sole of the foot. **Caudal** (L. *cauda,* tail) is a useful directional term that means toward the feet or tail region, represented in humans by the coccyx (tail bone), the small bone at the inferior (caudal) end of the vertebral column.

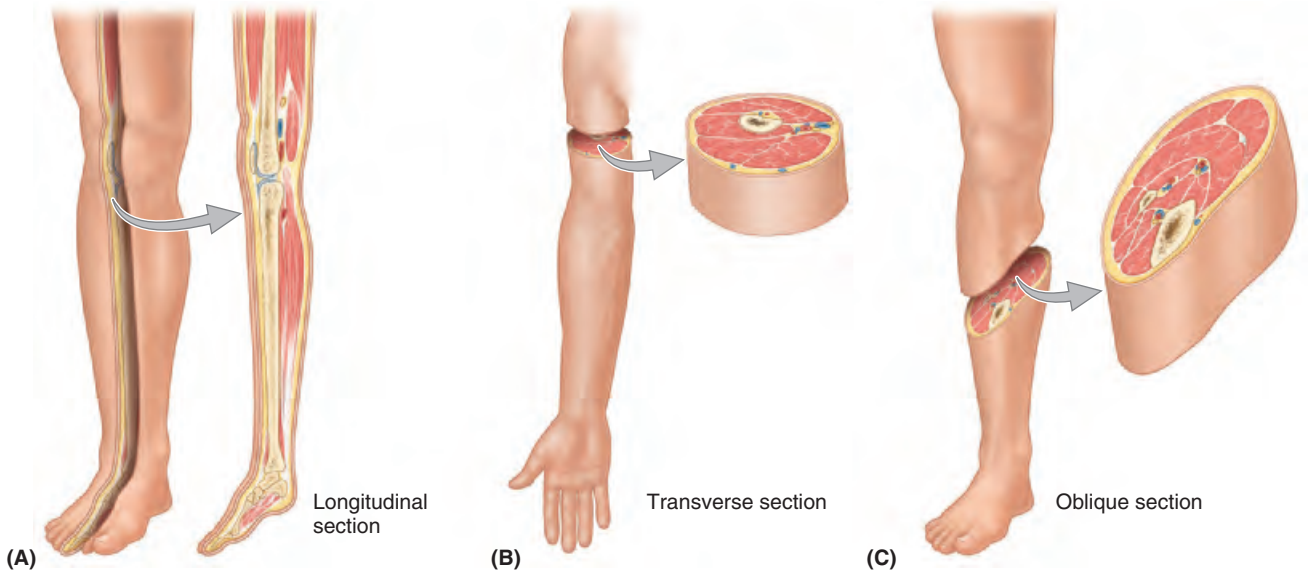


FIGURE I.3. Sections of the limbs. Sections may be obtained by anatomical sectioning or medical imaging techniques.

Posterior (dorsal) denotes the back surface of the body or nearer to the back. **Anterior** (ventral) denotes the front surface of the body. **Rostral** is often used instead of anterior when describing parts of the brain; it means toward the rostrum (L. for beak); however, in humans it denotes nearer the anterior part of the head (e.g., the frontal lobe of the brain is rostral to the cerebellum).

Medial is used to indicate that a structure is nearer to the median plane of the body. For example, the 5th digit of the hand (little finger) is medial to the other digits. Conversely, **lateral** stipulates that a structure is farther away from the median plane. The 1st digit of the hand (thumb) is lateral to the other digits.

Dorsum usually refers to the superior aspect of any part that protrudes anteriorly from the body, such as the dorsum of the tongue, nose, penis, or foot. It is also used to describe the posterior surface of the hand, opposite the **palm.** Because the term dorsum may refer to both superior and posterior surfaces in humans, the term is easier to understand if one thinks of a quadripedal plantigrade animal that walks on its palms and soles, such as a bear. The **sole** is the inferior aspect or bottom of the foot, opposite the dorsum, much of which is in contact with the ground when standing barefoot. The surface of the hands, the feet, and the digits of both corresponding to the dorsum is the **dorsal surface,** the surface of the hand and fingers corresponding to the palm is the **palmar surface,** and the surface of the foot and toes corresponding to the sole is the **plantar surface.**

Combined terms describe intermediate positional arrangements: **inferomedial** means nearer to the feet and median plane—for example, the anterior parts of the ribs run inferomedially; **superolateral** means nearer to the head and farther from the median plane.

Other terms of relationship and comparisons are independent of the anatomical position or the anatomical planes, relating primarily to the body's surface or its central core:

Superficial, intermediate, and **deep** describe the position of structures relative to the surface of the body or the relationship of one structure to another underlying or overlying structure.

External means outside of or farther from the center of an organ or cavity, while **internal** means inside or closer to the center, independent of direction.

Proximal and **distal** are used when contrasting positions nearer to or farther from the attachment of a limb or the central aspect of a linear structure, respectively.

Terms of Laterality

Paired structures having right and left members (e.g., the kidneys) are **bilateral,** whereas those occurring on one side only (e.g., the spleen) are **unilateral.** Designating whether you are referring specifically to the right or left member of bilateral structures can be critical, and is a good habit to begin at the outset of one's training to become a health professional. Something occurring on the same side of the body as another structure is **ipsilateral;** the right thumb and right great (big) toe are ipsilateral, for example. **Contralateral** means occurring on the opposite side of the body relative to another structure; the right hand is contralateral to the left hand.

Terms of Movement

Various terms describe movements of the limbs and other parts of the body (Fig. I.5). Most movements are defined in relationship to the anatomical position, with movements occurring within, and around axes aligned with, specific anatomical planes. While most movements occur at joints where two or more bones or cartilages articulate with one another, several non-skeletal structures exhibit movement (e.g., tongue, lips, eyelids). Terms of movement may also be considered in pairs of oppositing movements:

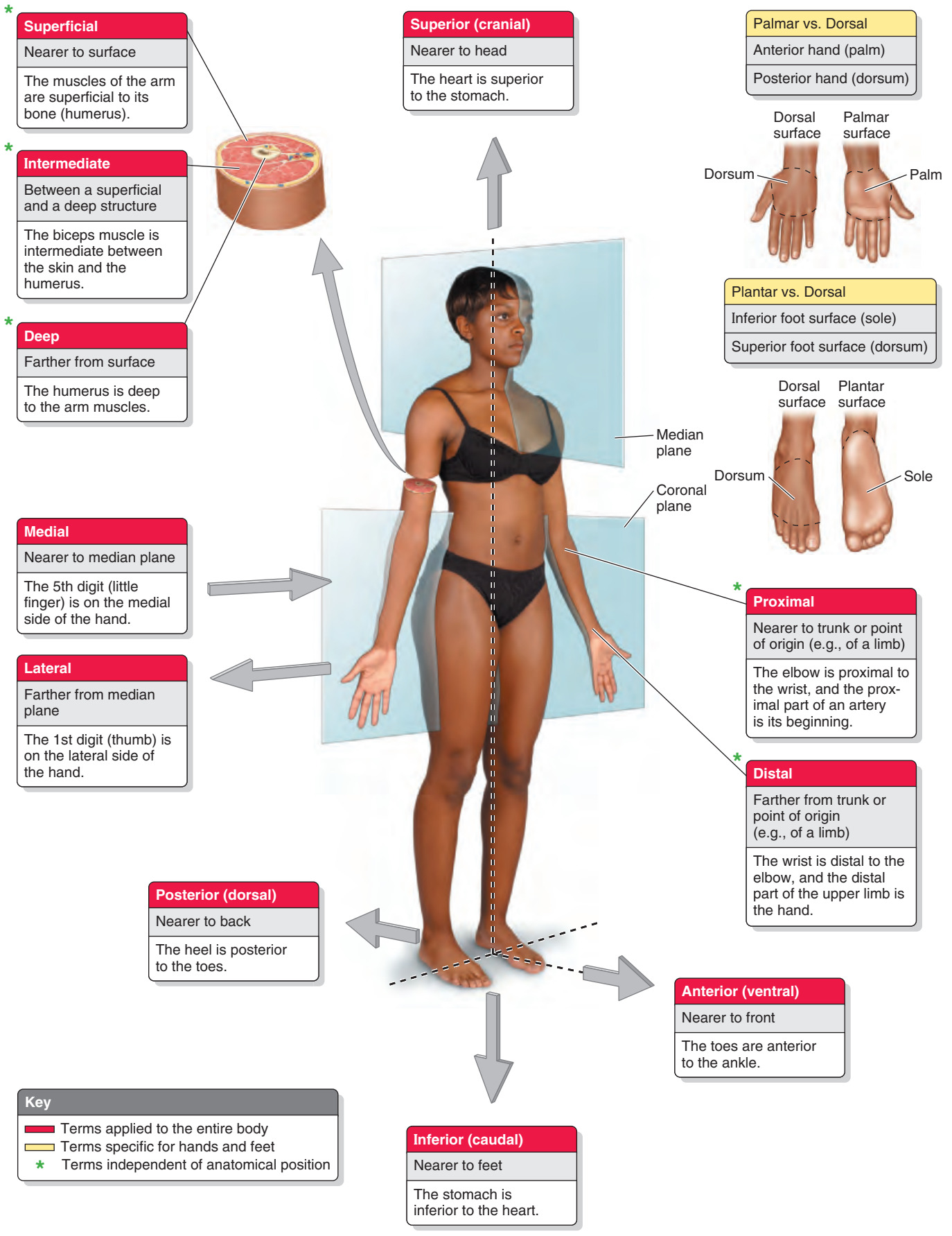
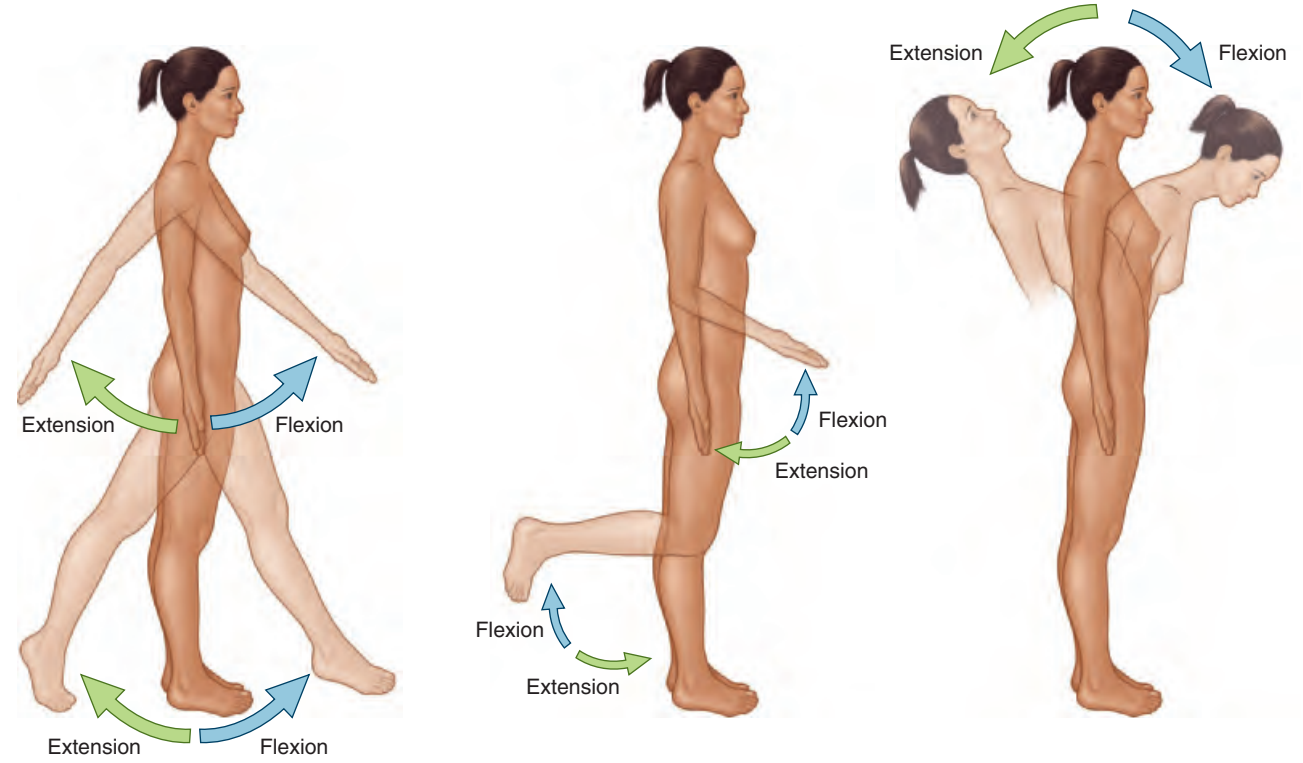


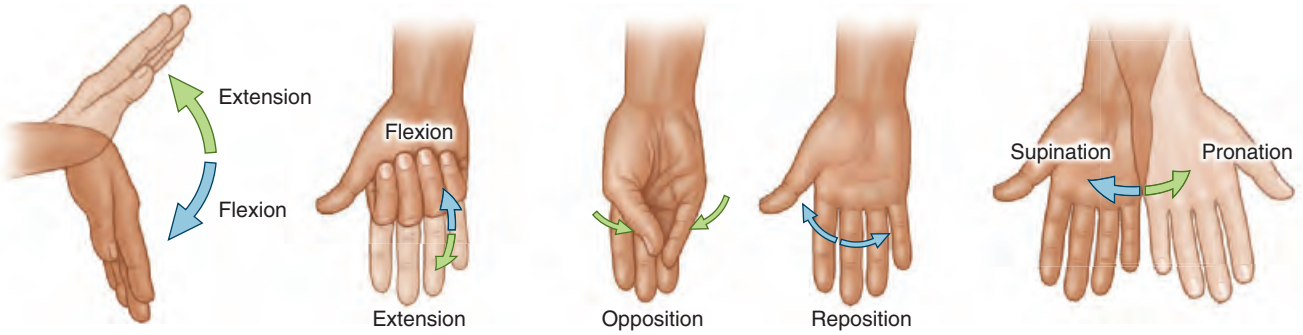
FIGURE I.4. Terms of relationship and comparison. These terms describe the position of one structure relative to another.



(A) Flexion and extension of upper limb at shoulder joint and lower limb at hip joint

Flexion and extension of forearm at elbow joint and of leg at knee joint

Flexion and extension of vertebral column at intervertebral joints

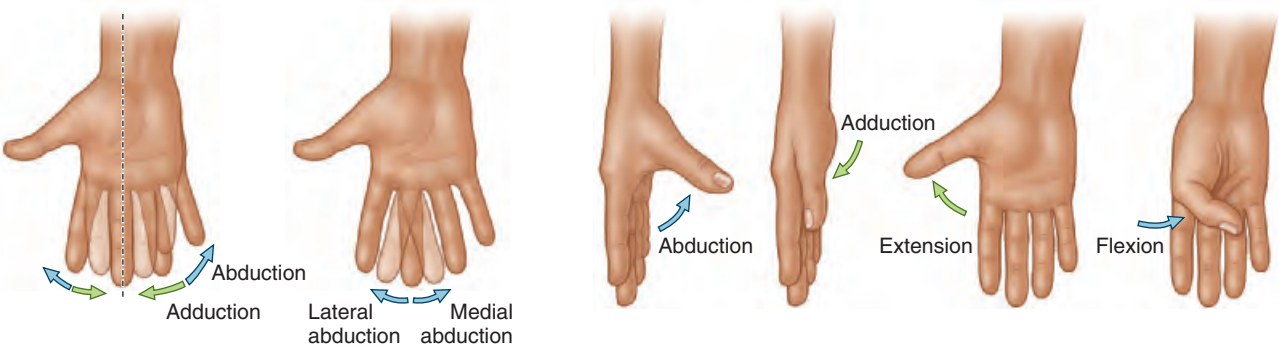


(B) Flexion and extension of hand at wrist joint

Flexion and extension of digits (fingers) at metacarpophalangeal and interphalangeal joints

(C) Opposition and reposition of thumb and little finger at carpometacarpal joint of thumb combined with flexion at metacarpophalangeal joints

(D) Pronation and supination of forearm at radio-lnar joints



(E) Abduction and adduction of 2nd, 4th, and 5th digits at metacarpo-phalangeal joints

Abduction of 3rd digit at metacarpophalangeal joint

(F) The thumb is rotated 90° relative to other structures. Abduction and adduction at metacarpophalangeal joint occurs in a sagittal plane; flexion and extension at metacarpophalangeal and interphalangeal joints occurs in frontal planes, opposite to these movements at all other joints.

FIGURE I.5. Terms of movement. These terms describe movements of the limbs and other parts of the body; most movements take place at joints, where two or more bones or cartilages articulate with one another.