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In Loving Memory of Marion
To my lovely wife and best friend for her endless support and patience. Her forbearance allowed me to spend countless hours in isolation to write the first three editions of the Clinically Oriented Anatomy. Marion received a BA in 1977, and she carefully read every line of the manuscripts. Wonderful memories keep her in my heart and mind. I am grateful to my daughter Pam (B.Ed.) who assumed the office duties and to my son-in-law, Ron Crowe, for his technical skills. Both have helped me in reviewing the manuscript for this book. • (KLM)

To Our Children and Grandchildren
I am very proud of our five children—Warren, Pam, Karen, Laurel, and Kate, and our nine grandchildren—Kristin, Lauren, Caitlin, Mitchel, Jayme, Courtney, Brooke, Melissa, Alicia, and the First Great Grandchild, James. • (KLM)

To Muriel and Our Family
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To Enno and Our Family
To my husband, Enno, and to my family, Kristina, Erik, and Amy, for their support and encouragement. • (AMRA)

To Our Students
We hope you will enjoy reading this book, increase your understanding of clinically oriented anatomy, pass your exams,
and be excited and well prepared for your careers in patient care, research, and teaching. 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 Professors**

May our book be a helpful resource for you. We appreciate the numerous constructive comments we have received over the years from you. Your remarks have been invaluable to us in improving this edition.

**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.
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 degrees from The Ohio State University and the University of Western Ontario, 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, PhD, FAAA
Anne M.R. Agur, BSc (OT), MSc, PhD
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 eighth 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 eighth 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 21st century, and to this end, new features have been added and existing features updated.

**EXTENSIVE ART PROGRAM**

The extensive revision of the art program that distinguished the seventh edition continues into the eighth edition. Most illustrations were revised for the seventh edition, improving accuracy and consistency and giving classical art derived from *Grant’s Atlas of Anatomy* a fresh, vital, new appearance. The eighth edition includes further updates to figures and labeling to maximize clarity and
efficiency. Efforts started with the fourth edition continue to ensure that all the anatomy presented and covered in the text is also illustrated. The text and illustrations were 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; and tables are accompanied by illustrations to aid the student’s understanding of the structures efficiently described.

**CLINICAL BLUE BOXES**

Widely known as “blue boxes,” the highlighted clinical correlations are now titled “Clinical Blue Boxes.” They have evolved with changes in practice, and many of them are supported by photographs and/or dynamic color illustrations to help with understanding the practical value of anatomy. In this edition, the clinical boxes have undergone extensive review and revision and reflect many recent medical advances. Topics in the Clinical Blue Boxes are classified by the following icons to indicate the type of clinical information covered:

- **Anatomical variations** 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** 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** boxes feature the effects 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.

**Diagnostic procedures** discuss the anatomical features and observations that play a role in physical diagnosis.

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

**Pathology** boxes cover the effects 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.

**THE BOTTOM LINE SUMMARIES**

Frequent “The 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 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.

**VIDEOS, CASE STUDIES, AND BOARD REVIEW-STYLE QUESTIONS**

Clinical Blue Box videos, case studies, and interactive multiple-choice questions are available to students online at [http://thePoint.lww.com](http://thePoint.lww.com). These resources provide a convenient and comprehensive means of review and self-testing.

**TERMINOLOGY**

The terminology fully adheres to *Terminologia Anatomica: International Anatomical Nomenclature* (1998), generated by the Federative International Programme on Anatomical Terminologies (FIPAT) and 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 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.
- Updated organization of the chapters to match that of Grant’s Atlas of Anatomy and Grant’s Dissector.
- A thorough introductory chapter (Chapter 1: Overview and Basic Concepts) 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 introductory chapter 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. The eighth edition is now the first anatomy textbook to acknowledge and describe the structure and function of the enteric nervous system and its unique role in the innervation of the digestive tract.
- 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.

- **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 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.

**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
Arthur F. Dalley II
Anne M. R. Agur
ABBREVIATIONS

a., aa.  artery, arteries
ant.    anterior
b.c.e.  before the Common (Christian) era
C       cervical
c.e.    Common (Christian) era
Co      coccygeal
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
M       male
m., mm. muscle, muscles
Mediev. medieval
Mod.    modern
post.   posterior
S       sacral
sup.    superior
supf.   superficial
T       thoracic
TA  Terminologia Anatomica
TE  Terminologia Embryologica
TH  Terminologia Histologica
v., vv.  vein, veins
vs.  versus
We would like to acknowledge the following experts who reviewed and suggested updates for the clinical content in the Clinical Blue Boxes:

- **Hassan Amarilli, MBBS, MS (Surgery), FUICC, Professor and Chair, Department of Anatomy, American University of Antigua College of Medicine, Coolidge, Antigua**
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- **Elaine Lonnemann PT, DPT, OCS, FAAOMPT, Associate Professor, Bellarmine University, Louisville, KY**
- **Lisa M. Murray, MS; ACSM Certified Exercise Physiologist, Program Coordinator Kinesiology, Nutrition, Health/Wellness and Physical Education, Pierce College, Fort Steilacoom, WA**
- **Carol Scott-Conner, EH, MD, PhD, MBA, FACS, Professor Emeritus, Department of Surgery, University of Iowa Roy J. and Lucille A. Carver College of Medicine, Iowa City, IA**

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- **Robert Hage, MD, PhD, DLO, MBA, Professor, Department of Anatomy, St. George’s University, West Indies**
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Artwork 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. Wynne Auyeung and Natalie Intven from Imagineering did a superb job of managing a team of talented artists to revise most illustrations in the seventh edition for a more consistent, vibrant art program. Wolters Kluwer Director for Art and Digital Content Jennifer Clements has been instrumental to the updating of artistic detail and efficient and accurate labeling in this and the two previous editions. Rob Duckwall from Dragonfly Media Group revised many of the illustrations for the eighth edition. Photographs taken during a major surface anatomy photography project for the fifth edition continue to be a tremendous asset. We are indebted to Joel A. Vilensky, Ph.D., and Edward C. Weber, M.D., for providing the many new medical images that appear in the eighth edition. 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 rendered by the following: Dorothy Foster Chubb, Elizabeth...

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Keith L. Moore
Arthur F. Dalley II
Anne M. R. Agur
1. OVERVIEW AND BASIC CONCEPTS

Approaches to Studying Anatomy
- Regional Anatomy
- Systemic Anatomy
- Clinical Anatomy

Anatomicomedical Terminology
- Anatomical Position
- Anatomical Planes
- Terms of Relationship and Comparison
- Terms of Laterality
- Terms of Movement

Anatomical Variations

Integumentary System

Fascias, Fascial Compartments, Bursae, and Potential Spaces

Skeletal System
- Cartilage and Bones
- Classification of Bones
Bone Markings and Formations
Bone Development
Vasculature and Innervation of Bones
Joints

**Muscle Tissue and Muscular System**
Types of Muscle (Muscle Tissue)
Skeletal Muscles
Cardiac Striated Muscle
Smooth Muscle

**Cardiovascular System**
Vascular Circuits
Blood Vessels

**Lymphoid System**

**Nervous System**
Central Nervous System
Peripheral Nervous System
Somatic Nervous System
Autonomic Nervous System

**Medical Imaging Techniques**
Conventional Radiography
Computed Tomography
Ultrasonography
Magnetic Resonance Imaging
Nuclear Medicine Imaging

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Overview of Back and Vertebral Column
Vertebrae
Structure and Function of Vertebrae
Regional Characteristics of Vertebrae
Ossification of Vertebrae
Variations in Vertebrae

Vertebral Column
Joints of Vertebral Column
Movements of Vertebral Column
Curvatures of Vertebral Column
Vasculature of Vertebral Column
Nerves of Vertebral Column

Muscles of Back
Extrinsic Back Muscles
Intrinsic Back Muscles
Surface Anatomy of Back Muscles
Suboccipital and Deep Neck Muscles

Contents of Vertebral Canal
Spinal Cord
Spinal Nerves and Nerve Roots
Spinal Meninges and Cerebrospinal Fluid (CSF)
Vasculature of Spinal Cord and Spinal Nerve Roots

3. UPPER LIMB

Overview of Upper Limb
Comparison of Upper and Lower Limbs
Bones of Upper Limb
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  Scapula
  Humerus
Bones of Forearm
Bones of Hand
Surface Anatomy of Upper Limb Bones

**Fascia, Efferent Vessels, Cutaneous Innervation, and Myotomes of Upper Limb**

- Fascia of Upper Limb
- Venous Drainage of Upper Limb
- Lymphatic Drainage of Upper Limb
- Cutaneous Innervation of Upper Limb
- Motor Innervation (Myotomes) of Upper Limb

**Pectoral and Scapular Regions**

- Anterior Axio-Appendicular Muscles
- Posterior Axio-Appendicular and Scapulohumeral Muscles
- Surface Anatomy of Pectoral, Scapular, and Deltoid Regions

**Axilla**

- Axillary Artery
- Axillary Vein
- Axillary Lymph Nodes
- Brachial Plexus

**Arm**

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- Brachial Artery
- Veins of Arm
- Nerves of Arm
- Cubital Fossa
- Surface Anatomy of Arm and Cubital Fossa

**Forearm**

- Compartments of Forearm
Muscles of Forearm
Arteries of Forearm
Veins of Forearm
Nerves of Forearm
Surface Anatomy of Forearm

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Long Flexor Tendons and Tendon Sheaths in Hand
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Veins of Hand
Nerves of Hand
Surface Anatomy of Hand

Joints of Upper Limb
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Acromioclavicular Joint
Glenohumeral Joint
Elbow Joint
Proximal Radio-Ulnar Joint
Distal Radio-Ulnar Joint
Wrist Joint
Intercarpal Joints
Carpometacarpal and Intermetacarpal Joints
Metacarpophalangeal and Interphalangeal Joints

4. THORAX

Overview of Thorax
Thoracic Wall
5. ABDOMEN

Overview: Walls, Cavities, Regions, and Planes

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Fascia of Anterolateral Abdominal Wall
Muscles of Anterolateral Abdominal Wall
Neurovasculature of Anterolateral Abdominal Wall
Internal Surface of Anterolateral Abdominal Wall
Inguinal Region
Spermatic Cord, Scrotum, and Testes
Surface Anatomy of Anterolateral Abdominal Wall

Peritoneum and Peritoneal Cavity
Embryology of Peritoneal Cavity
Peritoneal Formations
Subdivisions of Peritoneal Cavity

Abdominal Viscera
Overview of Abdominal Viscera and Digestive Tract
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Stomach
Small Intestine
Large Intestine
Spleen
Pancreas
Liver
Biliary Ducts and Gallbladder
Kidneys, Ureters, and Suprarenal Glands
Summary of Innervation of Abdominal Viscera

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Diaphragmatic Apertures
Actions of Diaphragm

Posterior Abdominal Wall
Fascia of Posterior Abdominal Wall
Muscles of Posterior Abdominal Wall
Nerves of Posterior Abdominal Wall
Vessels of Posterior Abdominal Wall
Sectional Medical Imaging of Abdomen

6. PELVIS AND PERINEUM

Introduction to Pelvis and Perineum

Pelvic Girdle

- Bones and Features of Pelvic Girdle
- Orientation of Pelvic Girdle
- Pelvic Girdle Sexual Differences
- Joints and Ligaments of Pelvic Girdle

Pelvic Cavity

- Walls and Floor of Pelvic Cavity
- Peritoneum and Peritoneal Cavity of Pelvis
- Pelvic Fascia

Neurovascular Structures of Pelvis

- Pelvic Arteries
- Pelvic Veins
- Lymph Nodes of Pelvis
- Pelvic Nerves

Pelvic Viscera

- Urinary Organs
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- Male Internal Genital Organs
- Female Internal Genital Organs
- Lymphatic Drainage of Pelvic Viscera

Perineum

- Fasciae and Pouches of Urogenital Triangle
- Features of Anal Triangle
- Male Urogenital Triangle
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Overview of Lower Limb

Development of Lower Limb

Bones of Lower Limb

Arrangement of Lower Limb Bones

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Ilium

Femur

Patella

Tibia and Fibula

Bones of Foot

Surface Anatomy of Bones of Foot

Fascia, Veins, Lymphatics, Efferent Vessels, and Cutaneous Nerves of Lower Limb

Subcutaneous Tissue and Fascia

Venous Drainage of Lower Limb

Lymphatic Drainage of Lower Limb

Cutaneous Innervation of Lower Limb

Motor Innervation of Lower Limb

Posture and Gait

Standing at Ease

Walking: The Gait Cycle

Anterior and Medial Regions of Thigh

Organization of Proximal Lower Limb
Anterior Thigh Muscles
Medial Thigh Muscles
Neurovascular Structures and Relationships in Anteromedial Thigh
Surface Anatomy of Anterior and Medial Regions of Thigh

Gluteal and Posterior Thigh Regions
Gluteal Region: Buttocks and Hip Region
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1. OVERVIEW AND BASIC CONCEPTS

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6. PELVIS AND PERINEUM

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