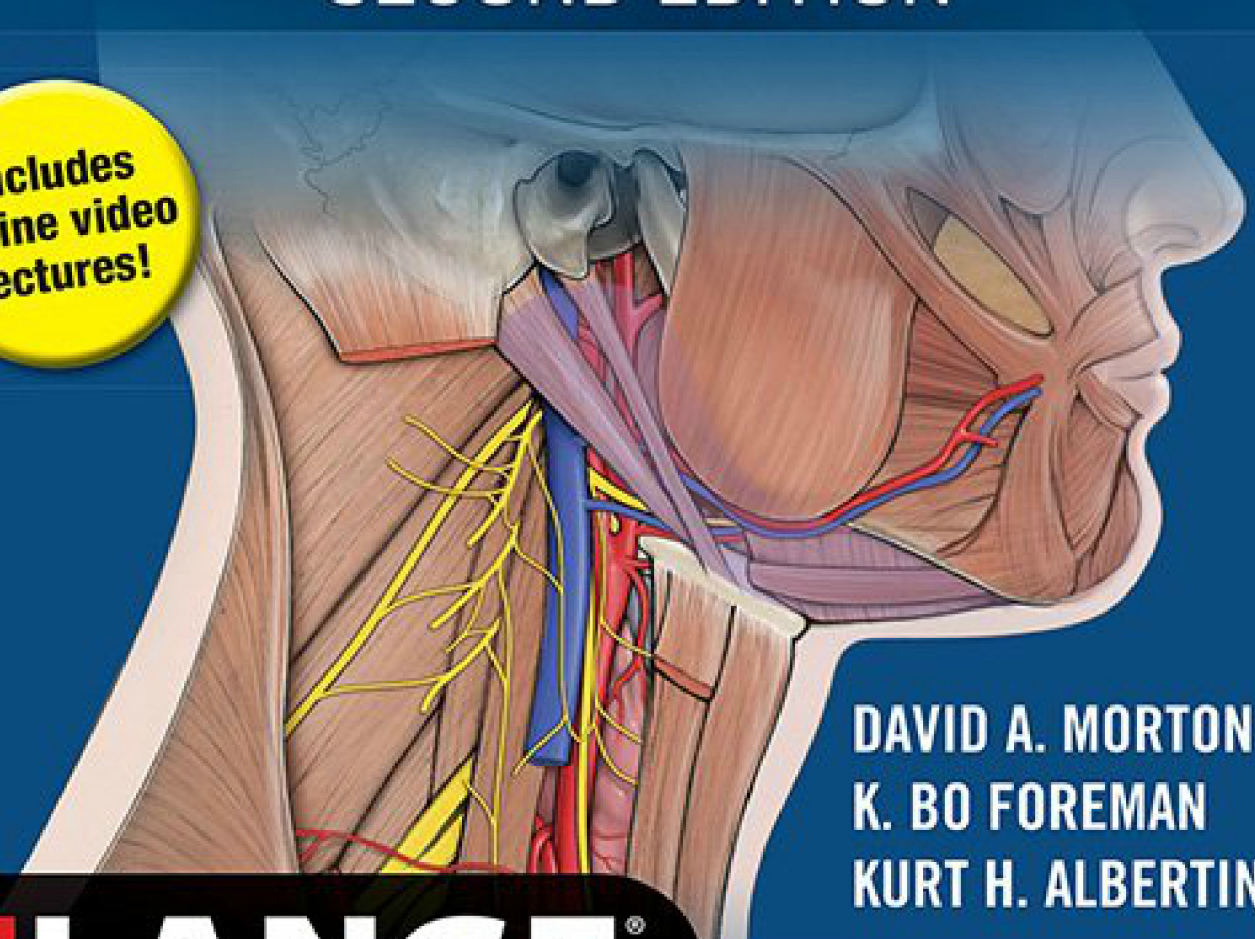
• THE BIG PICTURE •

GROSS ANATOMY

MEDICAL COURSE & STEP 1 REVIEW

SECOND EDITION

Includes online video lectures!



DAVID A. MORTON
K. BO FOREMAN
KURT H. ALBERTINE

Mc Graw Hill Education
LANGE®

THE BIG PICTURE

GROSS ANATOMY

Notice

Medicine is an ever-changing science. As new research and clinical experience broaden our knowledge, changes in treatment and drug therapy are required. The authors and the publisher of this work have checked with sources believed to be reliable in their efforts to provide information that is complete and generally in accord with the standards accepted at the time of publication. However, in view of the possibility of human error or changes in medical sciences, neither the authors nor the publisher nor any other party who has been involved in the preparation or publication of this work warrants that the information contained herein is in every respect accurate or complete, and they disclaim all responsibility for any errors or omissions or for the results obtained from use of the information contained in this work. Readers are encouraged to confirm the information contained herein with other sources. For example and in particular, readers are advised to check the product information sheet included in the package of each drug they plan to administer to be certain that the information contained in this work is accurate and that changes have not been made in the recommended dose or in the contraindications for administration. This recommendation is of particular importance in connection with new or infrequently used drugs.

THE BIG PICTURE

GROSS ANATOMY, MEDICAL COURSE AND STEP 1 REVIEW

SECOND EDITION

David A. Morton, PhD
Professor
Anatomy Director
Vice-Chair of Medical and Dental Education
Department of Neurobiology and Anatomy
University of Utah School of Medicine
Salt Lake City, Utah

K. Bo Foreman, PhD, PT
Associate Professor
Anatomy Director
Department of Physical Therapy and Athletic Training
University of Utah College of Health
Associate Editor, The Anatomical Record
Salt Lake City, Utah

Kurt H. Albertine, PhD, FAAAS, FAAA
Professor of Pediatrics, Medicine (Adjunct), and Neurobiology and Anatomy (Adjunct)
Edward B. Clark Endowed Chair IV of Pediatrics
Editor-In-Chief, *The Anatomical Record*
University of Utah School of Medicine
Salt Lake City, Utah

Mc Graw Hill Education

New York Chicago San Francisco Athens London Madrid Mexico City
Milan New Delhi Singapore Sydney Toronto

ISBN: 978-1-25-986264-9
MHID: 1-25-986264-X

The material in this eBook also appears in the print version of this title: ISBN: 978-1-25-986263-2,
MHID: 1-25-986263-1.

eBook conversion by codeMantra
Version 1.0

DEDICATION

To my wife Celine and our children Jared, Ireland, Gabriel, Max, and Jack; and their cousins Lia, Sophia, Joshua, Cayden, Ethan, Nathan, Kelsey, Robert, Stefani, Ella, Reid, Roman, Marcus, Jared, Hannah, Tanner, Liam, Maia, Riley, Sydney, Luke, Cole, Desiree, Celeste, Connlan, Isabelle, Nathan, Simon, Thomas, James, Alexandre, Lyla, Logan, William, Lincoln, Emmett, Andilynn, Greyson, Kennedy, Davis, Caleb, Charlotte, Adeline, and Penny.
I could not ask for a better family.

—David A. Morton

To my devoted family: my wife, Cindy, and our two daughters Hannah and Kaia. I would also like to posthumously dedicate this second edition to Dr. Carolee Moncur, without her mentorship and inspiration this book would not have been possible.

—K. Bo Foreman

To David and Bo, co-authoring this book (both editions) with you completes a mentoring circle for me. I am proud to have you as my colleagues and friends. To my wife, Laura Lake, and our adult children Erik and Kristin. Thank you for your patience with and understanding of my efforts to contribute to biomedical education and research. A delight for me is that the topic of human anatomy is enjoyed by our four grandchildren Breneé, Marlee, Callan, and Emery, each of whom leafs through the first edition of the *Big Picture Gross Anatomy* book. Hopefully, they will do the same with this, the second, edition.

—Kurt H. Albertine

This page intentionally left blank

CONTENTS

To access your complimentary online lecture videos, visit http://mhprofessional.com/usmle-anatomy-review.

SECTION 5: NECK

SECTION 6: UPPER LIMB

SECTION 7: LOWER LIMB

PREFACE

If you were asked to give a friend directions from your office to a restaurant down the street, your instructions may sound something like this—turn right at the office door, walk to the exit at the end of the hall, walk to the bottom of the stairs, take a left, exit out of the front of the building, walk across the bridge, continue straight for two blocks passing the post office and library, and you will see the restaurant on your right. If you pass the gas station, you have gone too far. The task is to get to the restaurant. The landmarks guide your friend along the way to complete the task.

Now, imagine if an anatomist were to give directions from the office to the restaurant in the same way most anatomy textbooks are written. Details would be relayed on the dimensions of the office, paint color, carpet thread count, position and dimensions of the desk in relation to the book shelf along the wall, including the number, types, and sizes of books lining the shelves, and door dimensions and office door material in relation to the other doors in the same building. This would occur over the course of 10 pages—and the friend still would not have left the office. The difference between you giving a friend directions to a restaurant and the anatomist giving directions to the same restaurant may be compared with the difference between many anatomy textbooks and this Big Picture textbook—taking a long time to get to the restaurant or possibly not finding it, versus succinct relevant directions that take you directly to the restaurant, respectively.

The purpose of this textbook, therefore, is to provide students with the necessary landmarks to accomplish their task—to understand the big picture of human anatomy in the context of health care—while bypassing the minutia. The landmarks used to accomplish this task are text and illustrations. They are complete, yet concise and both figuratively and literally provide the "Big Picture" of human anatomy.

The format of the book is simple. Each page-spread consists of text on the left-hand page and associated illustrations on the right-hand page. In this way, students are able to grasp the big picture of individual anatomy principles in bite-sized pieces, a concept at a time.

- Key structures are highlighted in bold when first mentioned.
- Bullets and numbers are used to break down important concepts.
- Approximately 450 full-color figures illustrate the essential anatomy.
- High-yield clinically relevant concepts throughout the text are indicated by an icon.
- Study questions and answers follow each section.
- A final examination is provided at the end of the text.

We hope you enjoy this text as much as we enjoyed writing it.

—David A. Morton

—K. Bo Foreman

—Kurt H. Albertine

ACKNOWLEDGMENTS

Early in his life my father, Gordon Morton, went to an art school. He purchased a copy of *Gray's Anatomy* to help him draw the human form. That book sat on our family's bookshelf all throughout my life and I would continually look through its pages in wonder of the complexity and miracle of the human body. After I completed high school my father gave me that book which I have kept in my office ever since. I acknowledge and thank my father and my mother (Gabriella) for their influence in my life. Thank you to my co-authors, Dr. Foreman and Dr. Albertine—they are a joy to work with and I look forward to many years of collaborating with them.

I express a warm thank you to Michael Weitz. His dedication, help, encouragement, vision, leadership, and friendship were key to the successful completion of this title. I also express great thanks to Susan Kelly. She was a joy to work with through rain, shine, snow, tennis competitions, and life in general—I thank her for her eagle eye and encouraging telephone conversations and e-mails. Thank you to Karen Davis, Armen Ovsepyan, Brian Kearns, John Williams, and to the folks at Dragonfly Media Group for the care and attention they provided in creating the images for this title. Finally, a warm thank you to my wife and best friend Celine. Her unyielding support and encouragement through long nights of writing were always there to cheer me on. I adore her.

—*David A. Morton*

I thank my parents, Ken Foreman and Lynn Christensen, as well as my mentor and friend, Dr. Albertine. A special thank you to Cyndi Schluender and my students for their contributions to my educational endeavors. I also express a great thanks to Dr. Morton for his continued encouragement and support in writing this textbook.

—*K. Bo Foreman*

Many medical educators and biomedical scientists contributed to my training that helped lead to writing medical education textbooks such as this one. Notable mentors are C.C.C. O'Morchoe, S. Zitzlsperger, and N.C. Staub. For this textbook, however, I offer my thanks to my co-authors Dr. Morton and Dr. Foreman. Co-authoring this textbook with them has been and continues to be a thrill because now my once doctoral degree students are my colleagues in original educational scholarship. What better emblem of success could a mentor ask for? So, to David and Bo, thank you! I enjoy watching your academic success as your careers flourish as medical educators and scholars.

—*Kurt H. Albertine*

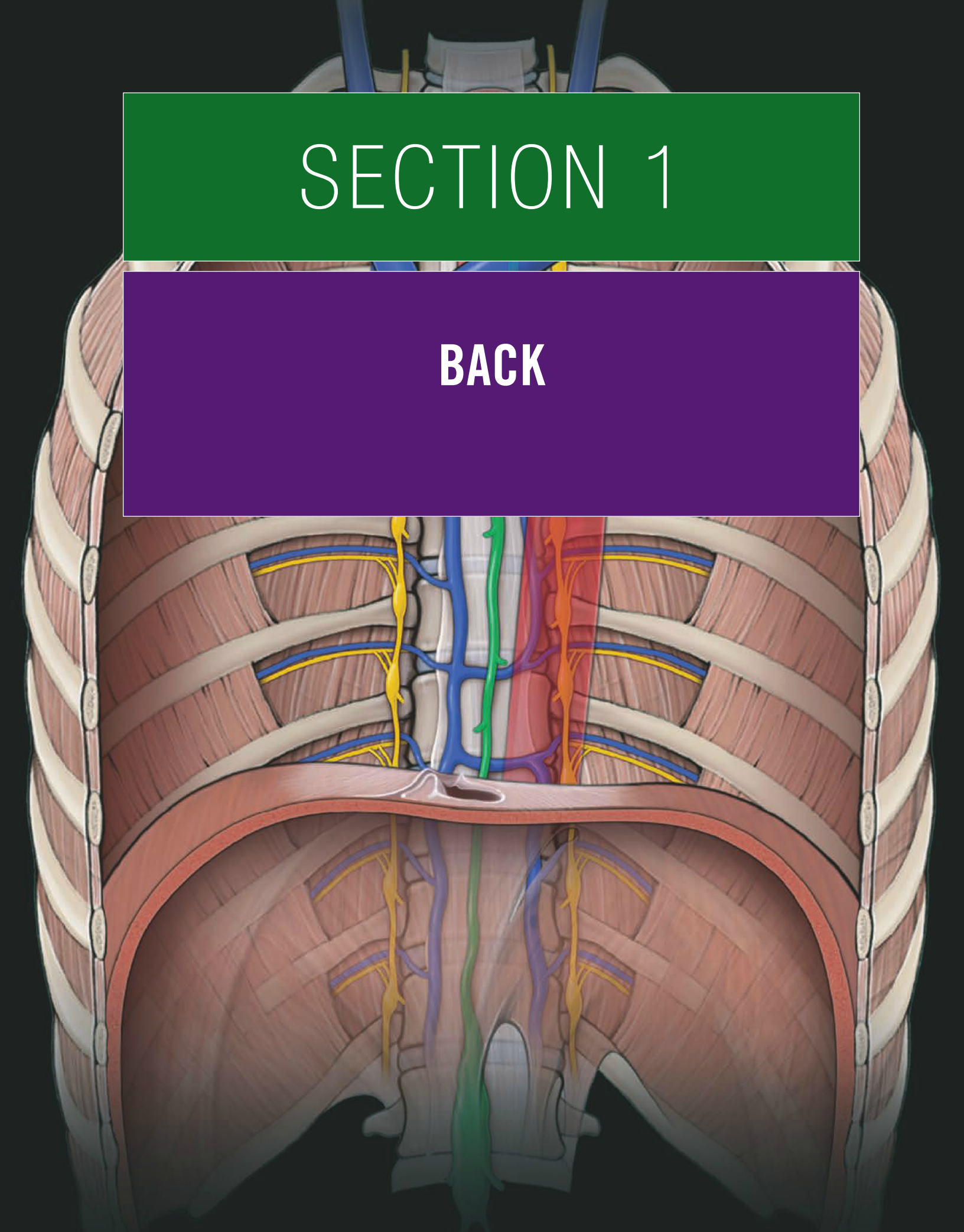
Aerial view of University of Utah campus, Salt Lake City, Utah. Photo taken by Kurt Albertine, educator and author.

ABOUT THE AUTHORS

David A. Morton completed his undergraduate degree at Brigham Young University, Provo, Utah, and his graduate degrees at the University of Utah School of Medicine, Salt Lake City. He currently serves as Vice-Chair of Medical and Dental Education and is a member of the Curriculum Committee at the University of Utah School of Medicine. Dr. Morton has been awarded the Early Career Teaching Award, Preclinical Teaching Awards, Leonard W. Jarcho, M.D. Distinguished Teaching Award, and the University of Utah Distinguished Teaching Award. Dr. Morton is an adjunct professor in the Physical Therapy Department and the Department of Family and Preventive Medicine. He also serves as a visiting professor at Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, West Africa.

K. Bo Foreman completed his undergraduate degree in physical therapy at the University of Utah and his graduate degree at the University of Utah School of Medicine. Currently, he is an Associate Professor at the University of Utah in the Department of Physical Therapy and Athletic Training where he teaches gross anatomy and neuroanatomy. In addition to his teaching responsibilities, Dr. Foreman also serves as the Director of the Motion Analysis Core Facility and has an active research program in biomechanics. Furthermore, he is an adjunct Associate Professor in the Departments of Mechanical Engineering, Neurobiology and Anatomy, Orthopaedics, and Plastic Surgery. Dr. Foreman has been awarded the Early Career Teaching Award from the University of Utah and the Basmajian Award from the American Association of Anatomists.

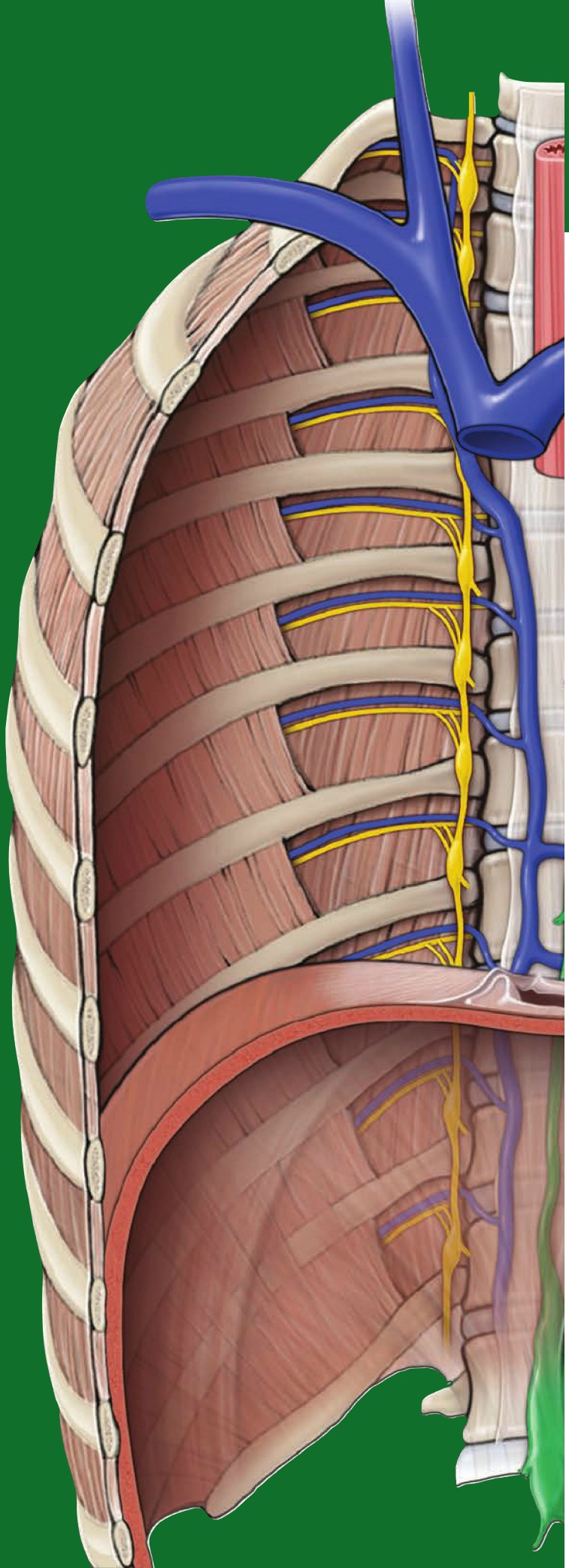
Kurt H. Albertine completed his undergraduate studies in biology at Lawrence University, Appleton, Wisconsin, and his graduate studies in human anatomy at Loyola University of Chicago, Stritch School of Medicine. He completed postdoctoral training at the University of California, San Francisco, Cardiovascular Research Institute. He has taught human gross anatomy for 40 years. Dr. Albertine established the Human Anatomy Teacher-Scholar Training Program in the Department of Neurobiology & Anatomy at the University of Utah School of Medicine. The goal of this training program is to develop teacher-scholars of human anatomy to become leaders of anatomy teachers on a national level, contribute teaching innovations, and design and perform teaching outcomes research for upcoming generations of medical students. Graduates of this training program include Dr. Morton and Dr. Foreman.



SECTION 1

BACK

This page intentionally left blank



CHAPTER 1

BACK ANATOMY

SUPERFICIAL BACK MUSCLES

BIG PICTURE

The superficial back muscles consist of the trapezius, levator scapulae, rhomboid major, rhomboid minor, and latissimus dorsi muscles (Figure 1-1A; Table 1-1). Although these muscles are located in the back, they are considered to be muscles of the upper limbs because they connect the upper limbs to the trunk and assist in upper limb movements via the scapula and humerus. Because these are upper limb muscles, they are innervated by the ventral rami of spinal nerves (brachial plexus branches), with the exception of the trapezius muscle (which is innervated by CN XI). These muscles are discussed in greater detail in Section VI, Upper Limb, but are included here because these muscles overly the deep back muscles.

TRAPEZIUS MUSCLE

- **Topography.** The most superficial back muscle; has a triangular shape, with three unique fiber orientations giving rise to multiple actions.
- **Proximal attachment(s).** Occipital bone, nuchal ligament, spinous processes of C7–T12.
- **Distal attachment(s).** Scapular spine, acromion, and clavicle.
- **Action(s).** Scapular elevation (superior fibers); scapular retraction (middle fibers), and scapular depression (lower fibers); upward rotation (all fibers working together).
- **Innervation.** Spinal accessory nerve (CN XI), which arises from the spinal cord, ascends through the foramen magnum into the skull and descends through the jugular foramen along the deep surface of the trapezius.

LEVATOR SCAPULAE MUSCLE

- **Topography.** Located deep to the trapezius muscle and superior to the rhomboids.
- **Proximal attachment(s).** Transverse processes of upper cervical vertebrae.
- **Distal attachment(s).** Superior angle of the scapula.
- **Action(s).** Elevation and downward rotation of the scapula.
- **Innervation.** Dorsal scapular nerve (C5); branches from C4–C5 ventral rami.

RHOMBOID MAJOR AND MINOR MUSCLES

- **Topography.** Located deep to the trapezius and inferior to the levator scapulae muscles.
- **Proximal attachment(s).** Spinous processes of C7–T1 (minor) and T2–T5 (major).
- **Distal attachment(s).** Medial border of the scapula.
- **Action(s).** Retraction of the scapula.
- **Innervation.** Dorsal scapular nerve (C5).

LATISSIMUS DORSI MUSCLE

- **Topography.** A broad, flat muscle in the lower region of the back.
- **Proximal attachment(s).** Spinous processes of T7 to the sacrum via the thoracolumbar fascia.
- **Distal attachment(s).** Intertubercular groove of the humerus.
- **Action(s).** Adduction, extension, and medial rotation of the humerus at the glenohumeral joint.
- **Innervation.** Thoracodorsal nerve (C6–C8).

SCAPULAR MOVEMENTS

Muscles move the scapula in the following directions (Figure 1-1B):

- **Elevation.** Scapula moves superiorly (as in shrugging the shoulders).
- **Depression.** Scapula moves inferiorly.
- **Protraction (abduction).** Scapula moves away from the midline.
- **Retraction (adduction).** Scapula moves away toward the midline.
- **Rotation.** Rotation of the scapula is defined by the direction that the glenoid fossa faces (glenoid fossa faces superiorly for upward rotation and inferiorly for downward rotation).

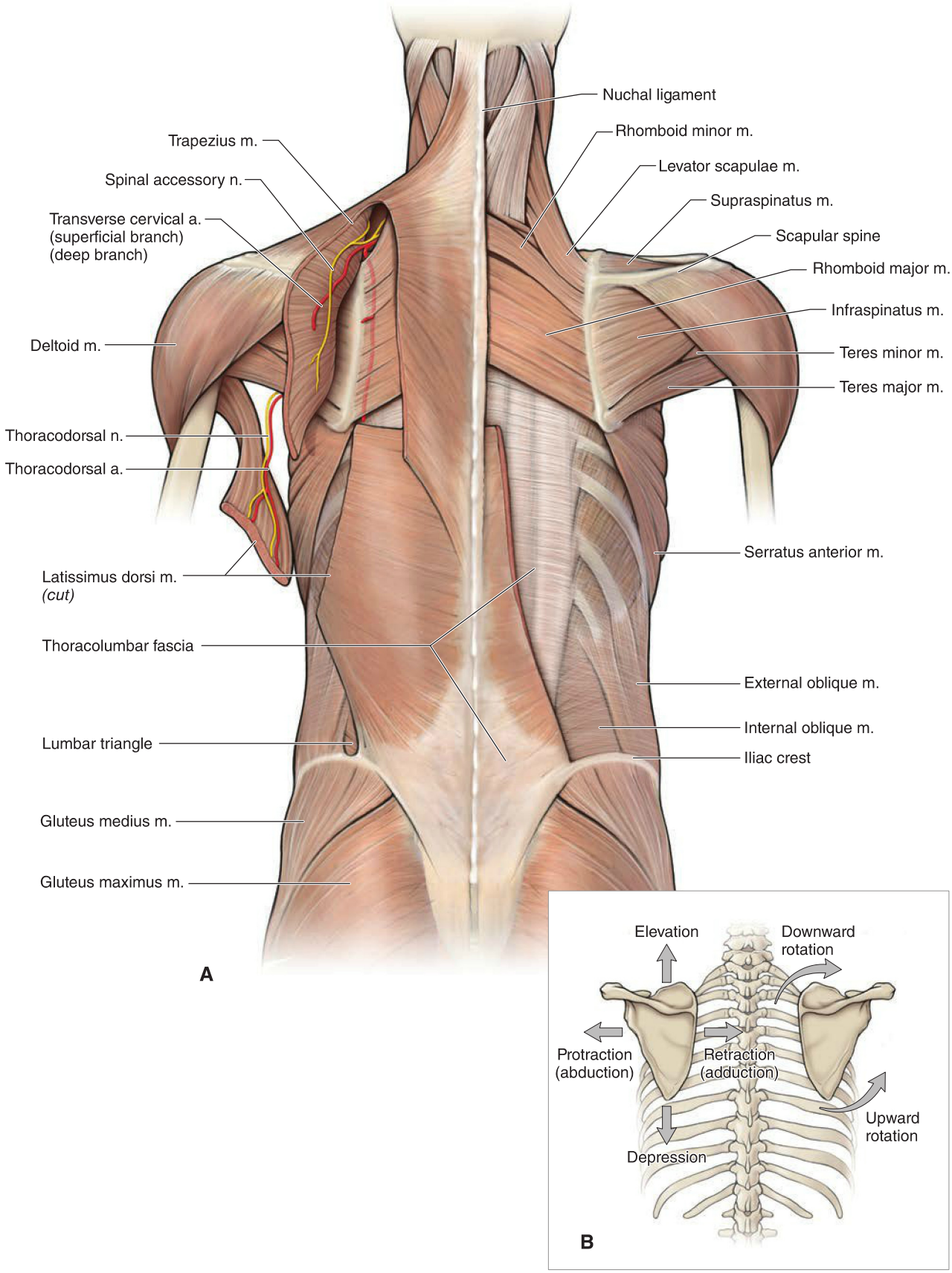


Figure 1-1: **A**. Superficial muscles of the back. **B**. Movements of the scapula.

DEEP BACK MUSCLES

BIG PICTURE

The deep back muscles are the true back muscles because they primarily act on the vertebral column. They are also referred to as intrinsic back muscles, epaxial muscles, and paraspinal muscles. The deep back muscles consist of the splenius capitis and cervicis, erector spinae, transversospinalis, and suboccipital muscles (Table 1-2). These deep back muscles are segmentally innervated by the dorsal rami of spinal nerves at each vertebral level where they attach. It is not important to know every detailed attachment for the deep back muscles; however, you should realize that these muscles are responsible for maintaining posture and are in constant use during body movements.

SPLENIUS CAPITIS AND CERVICIS MUSCLES

- **Topography.** Located deep to levator scapulae and rhomboid muscles, and superficial to erector spinae muscles (Figure 1-2A and B).
- **Action(s).** Bilateral contraction: extension of head and neck; unilateral contraction: lateral flexion and rotation of head and neck.
- **Innervation.** Segmentally innervated by dorsal rami.

ERECTOR SPINAE MUSCLES

- **Topography.** The erector spinae muscles consist of three separate muscles (from lateral to medial): iliocostalis, longissimus, and spinalis (Figure 1-2A and B).
- **Attachment(s).** The erector spinae muscles ascend throughout the length of the back as rope-like series of fascicles, with various bundles arising as others are inserting; each fascicle spans from 6 to 10 segments between bony attachments.
- **Action(s).** Bilateral contraction: extension of the vertebral column and control of posture; unilateral contraction: lateral flexion of vertebral column.
- **Innervation.** Segmentally innervated by dorsal rami.

TRANSVERSOSPINALIS MUSCLES

- **Topography.** Located deep to the erector spinae muscles. From superficial to deep, the transversospinalis muscles include the semispinalis, multifidus, and rotatores (Figure 1-2A and B).
- **Attachment(s).** Muscle fibers arise from a transverse process and ascend between one to six vertebral levels to attach to the spinous process of neighboring vertebrae.
- **Action(s).** Bilateral contraction: extension of the vertebral column; unilateral contraction: rotation of vertebral column to the contralateral side of the contracting transversospinalis muscle.
- **Innervation.** Segmentally innervated by dorsal rami.

SUBOCCIPITAL MUSCLES

- **Topography.** Located inferior to the occipital bone and deep to the semispinalis capitis muscle (Figure 1-2C). The suboccipital muscle group consists of the rectus capitis posterior major and minor and obliquus capitis superior and inferior.
- **Attachment(s).** Occipital bone, C1 and C2 vertebrae.
- **Action(s).** Mainly postural muscles, but may contribute to extension and rotation of the head.
- **Innervation.** Dorsal ramus of C1 spinal nerve (also known as the suboccipital nerve).

SUBOCCIPITAL TRIANGLE

- **Borders.** A triangle formed by the rectus capitis posterior major, obliquus capitis superior, and obliquus capitis inferior muscles.
- **Contents.** Structures associated with the suboccipital triangle are the following:
  - **Vertebral artery.** Exits the transverse foramen of the C1 vertebra, courses across the floor of the suboccipital triangle, ascends through the foramen magnum, and supplies the posterior region of the brain.
  - **Suboccipital nerve** (dorsal ramus of C1). Emerges between the occipital bone and C1 vertebra; innervates the suboccipital muscles.
  - **Greater occipital nerve** (dorsal ramus of C2). Emerges below the obliquus capitis inferior muscle; supplies sensory innervation to the back of the scalp.

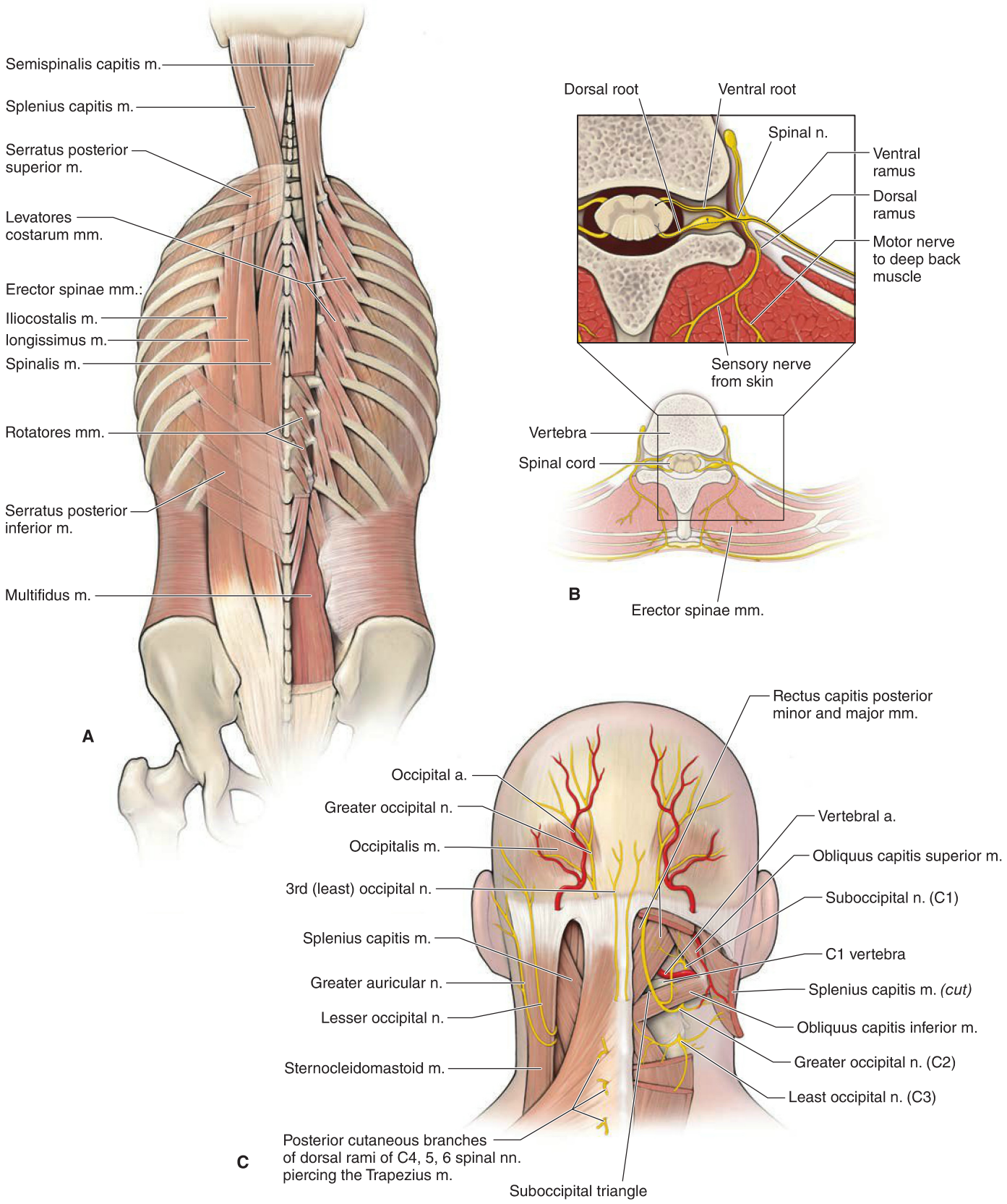


Figure 1-2: **A**. Deep back muscles with erector spinae muscles on the left and deeper transversospinalis muscles on the right. **B**. Axial section of the back showing the dorsal rami. **C**. Suboccipital region on the right side.

VERTEBRAL COLUMN

BIG PICTURE

The vertebral column is approximately 75 cm in length and consists of 33 vertebrae (7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 3–4 coccygeal). These vertebrae, along with their ligaments and intervertebral discs, form the flexible, protective, and supportive vertebral column that maintains posture, supports the body and head, and protects the spinal cord. The vertebral column is versatile in that it is rigid to provide protection and stability and yet flexible to enable movement.

VERTEBRAL COLUMN OVERVIEW

The vertebral column consists of cervical (C), thoracic (T), lumbar (L), sacral (S), and coccygeal (Co) vertebrae (Figure 1-3A; Table 1-3). To simplify their descriptions, the first letter of its region refers to each vertebra. For example, the "fourth cervical vertebra" is simply referred to as the "C4 vertebra."

- **Cervical vertebrae.** Located in the neck (cervical region); the **ligamentum nuchae**, a large ligament that courses down the back of the neck, connects the skull to the spinous processes of C1–C6. The first spinous process that is palpable deep to the skin is C7 and is called the **vertebral prominens**.
- **Thoracic vertebrae.** Located in the thoracic region and articulate with the 12 pairs of ribs.
- **Lumbar vertebrae.** Located in the lower back and are distinguished by their massive vertebral bodies.
- **Sacral vertebrae.** There are five fused sacral vertebrae (S1–S5), which form a single bone (sacrum).
- **Coccygeal vertebrae.** There are three to four fused coccygeal vertebrae (Co1–Co4), which form the coccyx bone ("tail bone").

VERTEBRAL CURVATURES

The adult spine is curved in four parts due to fetal and postnatal development of the vertebral column (Figure 1-3B and C).

- **Primary (kyphotic) curvatures.** Develop during the fetal period in relation to the flexed fetal position.
  - Primary curvatures are concave anteriorly and are located in the thoracic regions (optimize space for heart and lungs) and sacral regions (optimize space in pelvic cavity for a developing fetus).
- **Secondary (lordotic) curvatures.** Develop during the postnatal period.
  - Secondary curvatures are concave posteriorly and are located in the cervical region (develops when the infant holds its head upright while sitting) and lumbar region (develops when the infant begins to stand and walk).

▼ Abnormal primary curvatures are referred to as **kyphosis (excessive kyphosis)**, whereas abnormal secondary curvatures are referred to as **lordosis (excessive lordosis)**. Patients may present with abnormal lateral curvatures (**scoliosis**), which may be due to muscular dominance of one side over the other or to poor posture or congenital problems. To diagnose scoliosis, the physician may ask the patient to bend forward to determine if one side of the thorax is higher than the other due to asymmetry of the spine. ▼

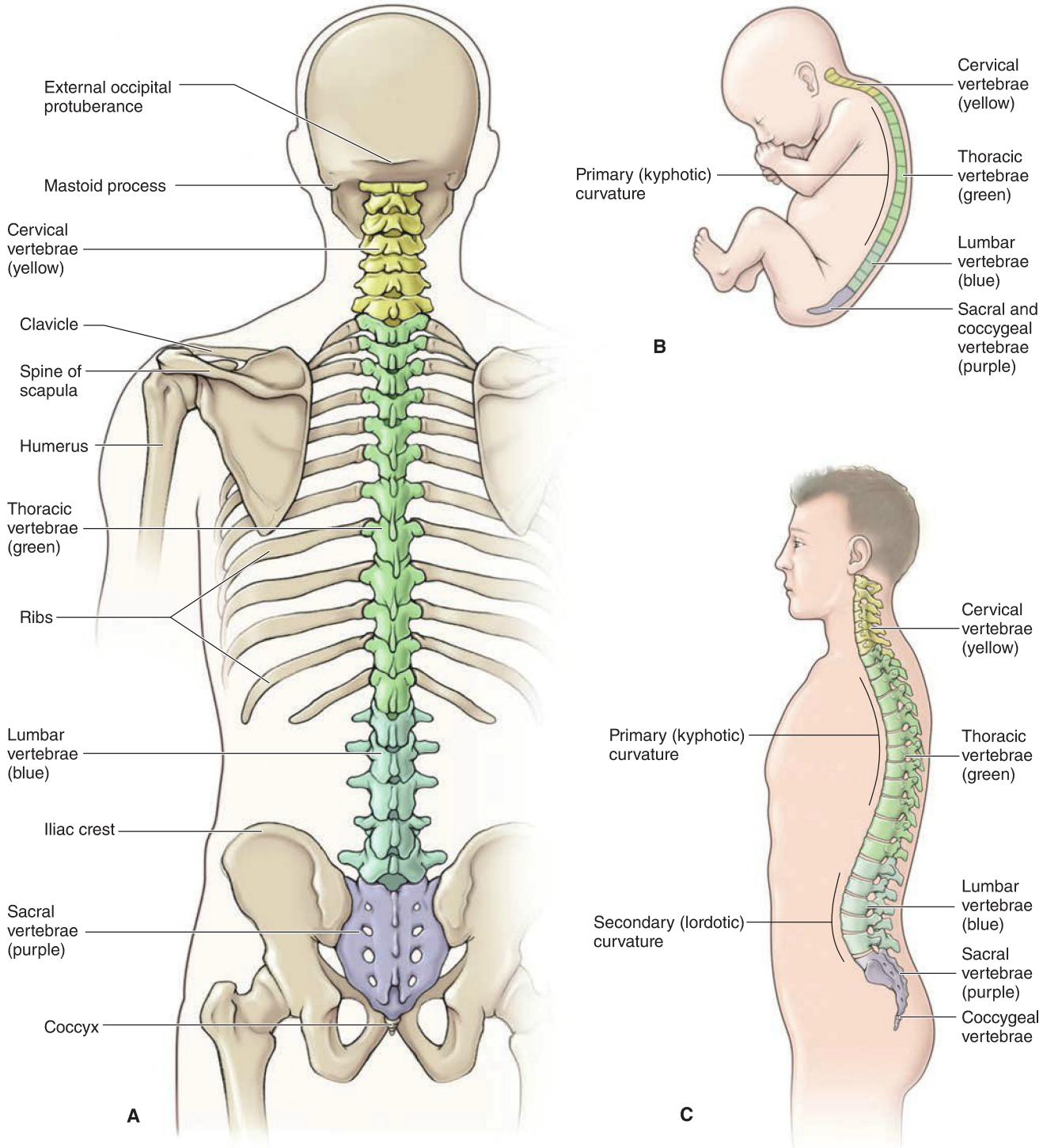


Figure 1-3: **A**. Posterior view of the vertebral column. **B.** Primary curvature of newborn. **C.** Normal curvatures of an adult.