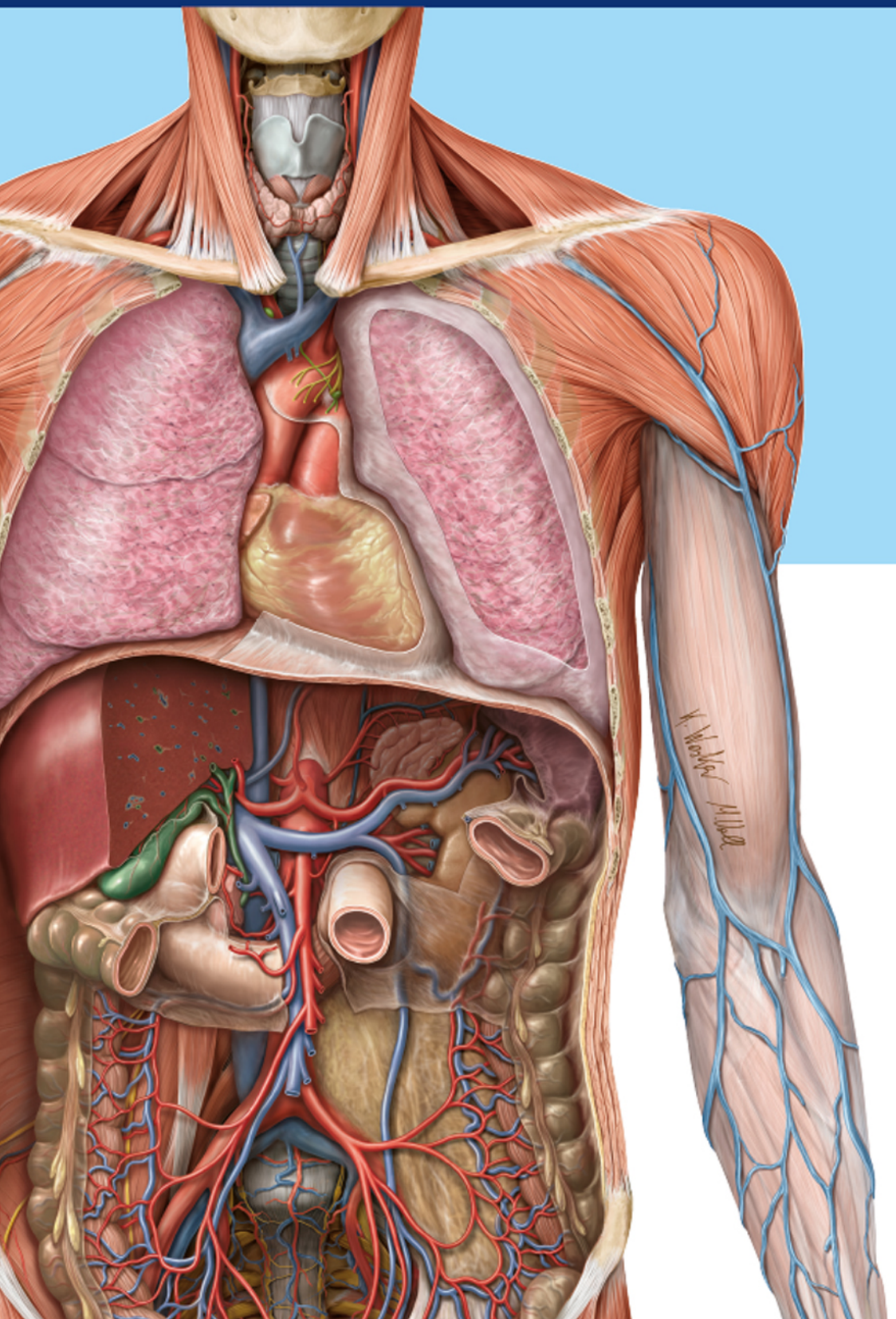
Atlas of Anatomy



Fourth Edition

Edited by
Anne M. Gilroy
Brian R. MacPherson
Jamie C. Wikenheiser

Based on the work of
Michael Schuenke
Erik Schulte
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Illustrations by
Markus Voll
Karl Wesker

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Fourth Edition

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2113 illustrations

Thieme

New York · Stuttgart · Delhi · Rio de Janeiro

Illustrators: Markus Voll and Karl Wesker
Development Editor: Judith Tomat
Production Editor: Barbara Chernow
Compositor: Carol Pierson, Chernow Editorial Services, Inc.

Library of Congress Cataloging-in-Publication Data

Names: Gilroy, Anne M., editor. | MacPherson, Brian R., editor. | Wikenheiser, Jamie C., editor. | Voll, Markus M., illustrator. | Wesker, Karl, illustrator. | Schünke, Michael. Thieme atlas of anatomy.
Title: Atlas of anatomy / edited by Anne M. Gilroy, Brian R. MacPherson, Jamie C. Wikenheiser ; based on the work of Michael Schuenke, Erik Schulte, Udo Schumacher ; illustrations by Markus Voll, Karl Wesker.
Other titles: Atlas of anatomy (Gilroy)
Description: Fourth edition. | New York : Thieme, [2020] | Includes index. | Summary: "An updated atlas that provides a clear, accurate, and fully illustrated guide to human anatomy"— Provided by publisher.
Identifiers: LCCN 2019058797 (print) | LCCN 2019058798 (ebook) | ISBN 9781684202034 (paperback) | ISBN 9781684202041 (ebook)
Subjects: MESH: Anatomy | Atlas
Classification: LCC QM25 (print) | LCC QM25 (ebook) | NLM QS 17 | DDC 611.0022/3—dc23
LC record available at https://lccn.loc.gov/2019058797
LC ebook record available at https://lccn.loc.gov/2019058798

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Thieme Publishers New York
333 Seventh Avenue, New York, NY 10001 USA
+1 800 782 3488, customerservice@thieme.com

Thieme Publishers Stuttgart
Rüdigerstrasse 14, 70469 Stuttgart, Germany
+49 [0]711 8931 421, customerservice@thieme.de

Thieme Publishers Delhi
A-12, Second Floor, Sector-2, Noida-201301
Uttar Pradesh, India
+91 120 45 566 00, customerservice@thieme.in

Thieme Revinter Publicações Ltda.
Rua do Matoso, 170 – Tijuca
Rio de Janeiro RJ 20270-135 – Brasil
+55 21 2563-9702
www.thiemerevinter.com.br

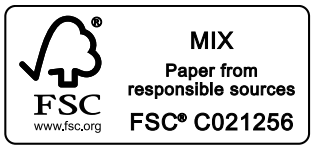
Cover design: Thieme Publishing Group

Printed in India by Replika Press Pvt. Ltd.

5 4 3 2 1

ISBN 978-1-68420-203-4

Also available as an e-book:
eISBN 978-1-68420-204-1



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Dedications

To the thousands of former students who have populated every specialty and migrated to every corner of this country, while dedicating their careers to making life better for thousands more. I am inspired by their empathy and kindness, and grateful to have been a small part of their journey.

And as always, to Colin and Bryan.

Anne M. Gilroy

To my friend and mentor Dr. Ken McFadden, who was responsible for my early training in gross anatomy and was a role model for success in teaching. I deeply appreciate the feedback I have received over the past 40 plus years from the thousands of students I have taught and who have made me an even better teacher. However, none of the success I have enjoyed in my life would have been possible without the constant support, assistance, and encouragement of my late wife, Cynthia Long.

Brian R. MacPherson

To my wife Jen and my son Quinn.

Jamie C. Wikenheiser

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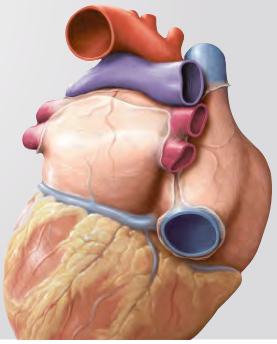

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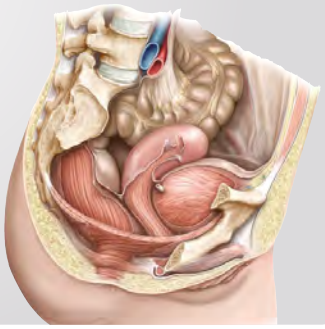

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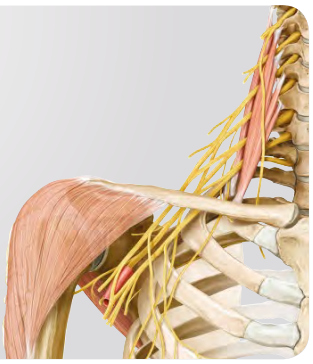

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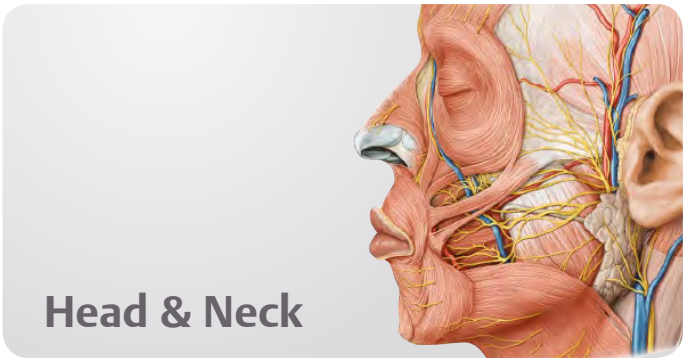

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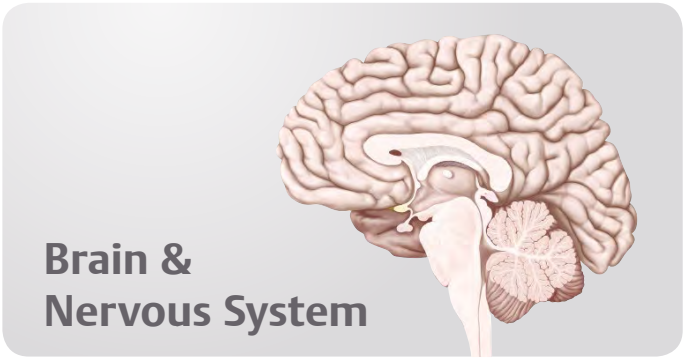

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Acknowledgments

We would like to thank the authors of the original award-winning *Thieme Atlas of Anatomy* three-volume series, Michael Schuenke, Erik Schulte, and Udo Schumacher, and the illustrators, Karl Wesker and Marcus Voll, for their work over the course of many years.

We thank the many instructors, students, and translators for our non-English versions, who have taken the time to point out to us what we have done well and brought to our attention errors, ambiguities, and new information, or have suggested how we could present a topic more effectively. This input, combined with our experience teaching with the *Atlas*, have guided our work on this edition.

We cordially thank the reviewers of the third edition, especially those who provided in-depth feedback:

- Jennifer Brueckner-Collins, PhD
  University of Louisville School of Medicine
  Louisville, Kentucky
- Jennifer Carr, PhD
  Salem State University
  Salem, Massachussetts
- C. Cem Denk, MD, PhD
  Hacettepe University
  Faculty of Medicine
  Ankara, Turkey
- Gary J. Farkas, PhD
  University of California, San Francisco School of Medicine
  San Francisco, California
- Derek Harmon, PhD
  University of California, San Francisco School of Medicine
  San Francisco, California
- Lindsey Kent (Class of 2020)
  West Virginia School of Osteopathic Medicine
  Lewisburg, West Virginia
- Barbie Klein, PhD
  University of California, San Francisco School of Medicine
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- Nancy Lin (Class of 2021)
  CUNY School of Medicine
  New York, New York
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  LSU Health Sciences Center
  New Orleans, Louisiana

Foreword

This *Atlas of Anatomy*, in my opinion, is the finest single-volume atlas of human anatomy that has ever been created. Two factors make it so: the images and the way they have been organized.

The artists, Markus Voll and Karl Wesker, have created a new standard of excellence in anatomical art. Their graceful use of transparency and their sensitive representation of light and shadow give the reader an accurate three-dimensional understanding of every structure.

The authors have organized the images so that they give just the flow of information a student needs to build up a clear mental image of the human body. Each two-page spread is a self-contained lesson that unobtrusively shows the hand of an experienced and thoughtful teacher. I wish I could have held this book in my hands when I was a student; I envy any student who does so now.

Robert D. Acland, 1941–2016
Louisville, Kentucky December 2015

Preface

In this new fourth edition of the *Atlas of Anatomy,* we are proud to offer what we believe is our best effort at presenting a clear and accurate story of human anatomy. A significant part of this effort is the addition of our newest co-author, Dr. Jamie C. Wikenheiser from the University of California, Irvine. Jamie's love of anatomy, attention to detail, and proud background in teaching excellence in anatomy at all student levels makes him a highly qualified addition to the editorship of the *Atlas* that will ensure its continued development.

As with previous editions, we have made every attempt to respond to the requests, comments, and critiques of our world-wide users. As always, we recognize that anatomy is a changing science. As concepts and terminology evolve, we feel a responsibility to pass this on and keep these aspects of the *Atlas* updated. Thus, our initial task for this edition was to update and further clarify the material already present in the *Atlas*. Among these modifications was a major revision of the many autonomic innervation wiring schematics. These are now uniformly designed to clearly differentiate between sympathetic and parasympathetic components and pre-and post-ganglionic fibers. We improved many tables by reorganizing and rewording the content and enlarging labels. Sectional and radiographic chapters in each unit, established in the third edition, have been expanded with more than forty additional MR and CT images, now accompanied, as are all sectional images throughout the *Atlas,* by new simplified navigators.

Another focus of this edition was to provide more written and schematic-based information that addresses complex anatomic concepts. This includes new schematics that complement other images, expanded legends that accompany images, and most notably, the addition of almost thirty new clinical boxes (most with illustrations) in every unit. These focus on function, pathology, anatomic variations, clinical procedures, diagnostic techniques, embryological development, and aging.

We continue to try to make difficult areas of anatomy more easily understood through better organization of chapter content and new diagrammatic approaches. The two-page spread that has been so popular in previous editions has been maintained in this edition, but an effort was made to improve their layouts by tabulating some content and adding more than 120 new illustrations and images. In this edition, the reader will notice major changes in two regions. In the abdomen and pelvic units, a greater focus is placed on the peritoneum, mesenteries, and peritoneal spaces. The inguinal region, a difficult area for students, is also expanded with new images and tables, as well as new and revised images of perineal structures. The head and neck unit is the second area of major revisions. In an effort to bring this material into alignment with the way it is usually encountered in the dissection lab, the chapter on the neck now precedes those on the head and includes new artwork that promotes the dissection views. Students will appreciate the reorganization and additional clarifying images of areas such as the cavernous sinus, pterygopalatine and infratemporal fossae, and oral and nasal cavities. Finally, a new expanded overview introduces the brain and nervous system chapter.

As always, we are extremely grateful for the contributions of the many colleagues and reviewers who provide important feedback on earlier editions, alert us to inaccuracies and ambiguities, and share suggestions for new material.

We recognize that our efforts, though important, are just one part of the process that brings this textbook to its final production. The entire Thieme Publishers team has encouraged and supported our efforts throughout this process. Our deep appreciation is extended to the most important contributors: Judith Tomat, Developmental Editor; Delia DeTurris, Acquisitions Editor, and Barbara Chernow, PhD, Production Manager, for their dedication and expertise in their respective fields and their confidence in our ability to produce a quality manuscript.

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December 2019

Preface to the First Edition

Each of the authors was amazed and impressed with the extraordinary detail, accuracy, and beauty of the illustrations that were created for the *Thieme Atlas of Anatomy*. We feel these images are one of the most significant additions to anatomical education in the past 50 years. It was our intent to use these exceptional illustrations as the cornerstone of our effort in creating a concise single volume *Atlas of Anatomy* for the curious and eager health science student.

Our challenge was first to select from this extensive collection those images that are most instructive and illustrative of current dissection approaches. Along the way, however, we realized that creating a single-volume atlas was much more than choosing images: each image has to convey a significant amount of detail while the appeal and labeling need to be clean and soothing to the eye. Therefore, hundreds of illustrations were drawn new or modified to fit the approach of this new atlas. In addition, key schematic diagrams and simplified summary-form tables were added wherever needed. Dozens of applicable radiographic images and important clinical correlates have been added where appropriate. Additionally, surface anatomy illustrations are accompanied by questions designed to direct the student's attention to anatomic detail that is most relevant in conducting the physical exam. Elements from each of these features are arranged in a regional format to facilitate common dissection approaches. Within each region, the various components are examined systemically, followed by topographical images to tie the systems together within the region. In all of this, a clinical perspective on the anatomical structures is taken. The unique two facing pages "spread" format focuses the user to the area/topic being explored.

We hope these efforts — the results of close to 100 combined years experience teaching the discipline of anatomy to bright, enthusiastic students — has resulted in a comprehensive, easy-to-use resource and reference.

We would like to thank our colleagues at Thieme Publishers who so professionally facilitated this effort. We cannot thank enough Cathrin E. Schulz, MD, Editorial Director, Educational Products, who so graciously reminded us of deadlines, while always being available to "trouble shoot" problems. More importantly, she encouraged, helped, and complimented our efforts.

We also wish to extend very special thanks and appreciation to Bridget Queenan, Developmental Editor, who edited and developed the manuscript with an outstanding talent for visualization and intuitive flow of information. We are very grateful to her for catching many details along the way while always patiently responding to requests for artwork and labeling changes.

Cordial thanks to Elsie Starbecker, Senior Production Editor, who with great care and speed produced this atlas with its over 2,200 illustrations. Finally, thanks to Rebecca McTavish, Developmental Editor, for joining the team in the correction phase. So very much of their hard work has made the *Atlas of Anatomy* a reality.

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March 2008

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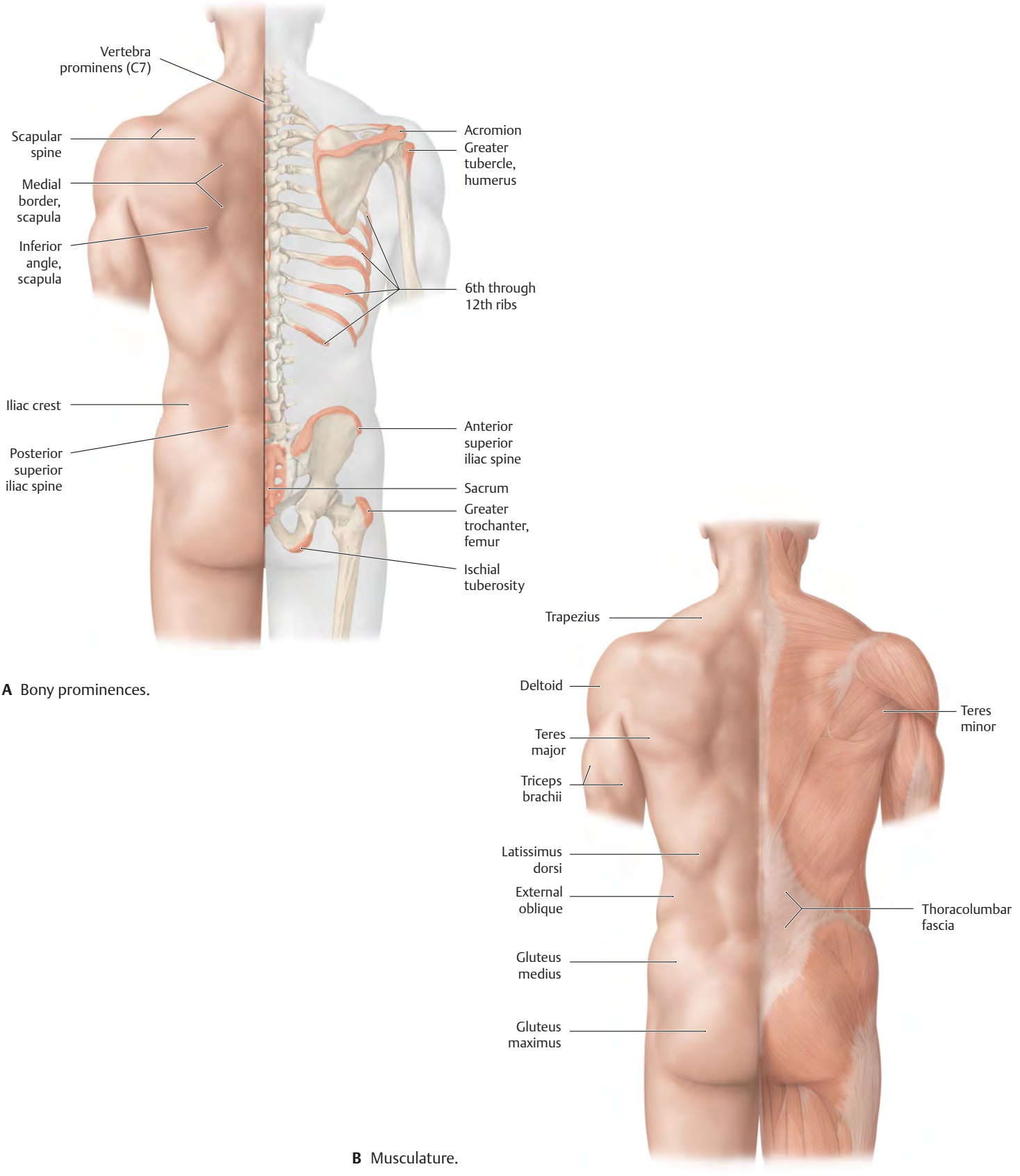
1 Surface Anatomy

Surface Anatomy

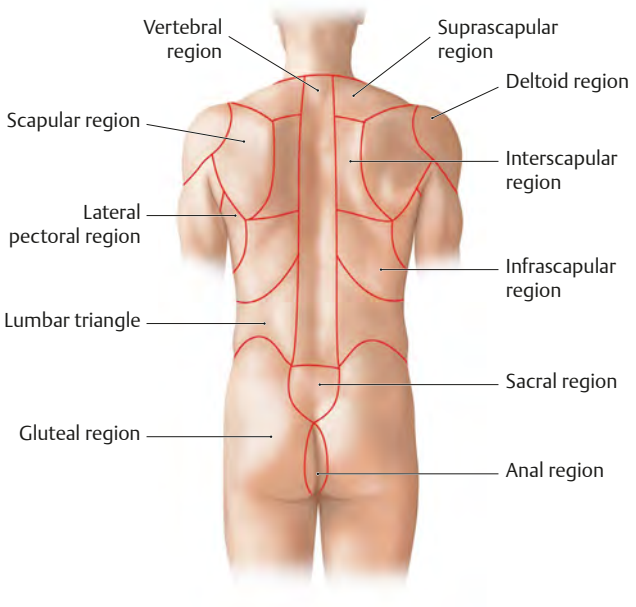
Fig. 1.1 **Palpable structures of the back**
Posterior view.



A Bony prominences.

B Musculature.

Fig. 1.2 **Regions of the back and buttocks**
Posterior view.



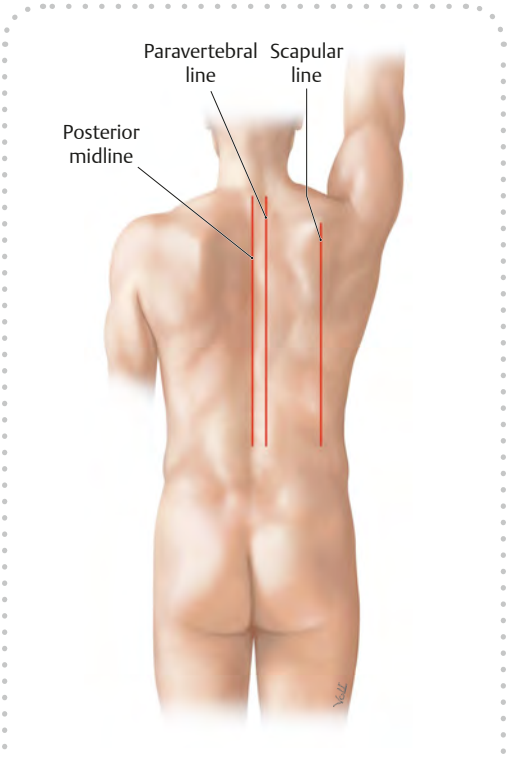


Fig. 1.3 **Spinous processes and landmarks of the back**
Posterior view.

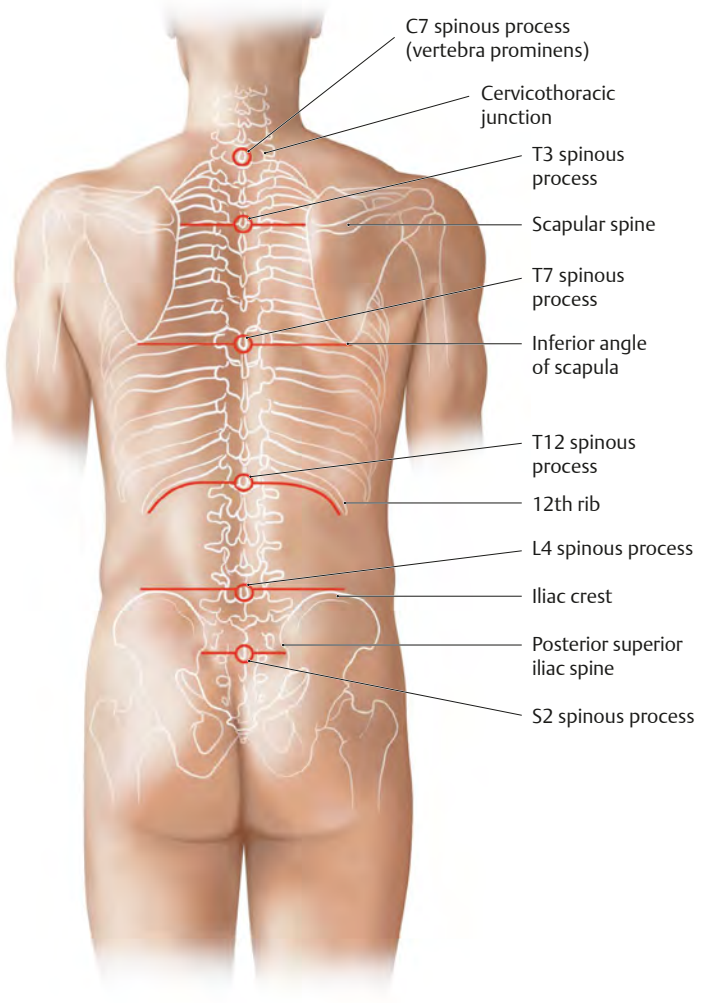


Table 1.1 **Reference lines of the back**

Posterior midline	Posterior trunk midline at the level of the spinous processes
Paravertebral line	Line at the level of the transverse processes
Scapular line	Line through the inferior angle of the scapula

Table 1.2 **Spinous processes that provide useful posterior landmarks**

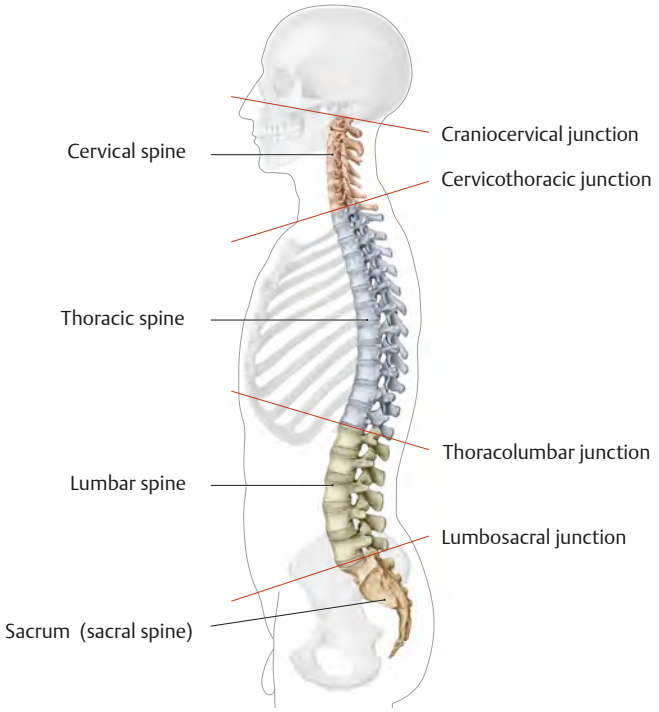
Vertebral spinous process	Posterior landmark
C7	Vertebra prominens (the projecting spinous process of C7 is clearly visible and palpable)
T3	The scapular spine
T7	The inferior angle of the scapula
T12	Just below the 12th rib
L4	The summit of the iliac crest
S2	The posterior superior iliac spine (recognized by small skin depressions directly over the iliac spines)

2 Bones, Ligaments & Joints

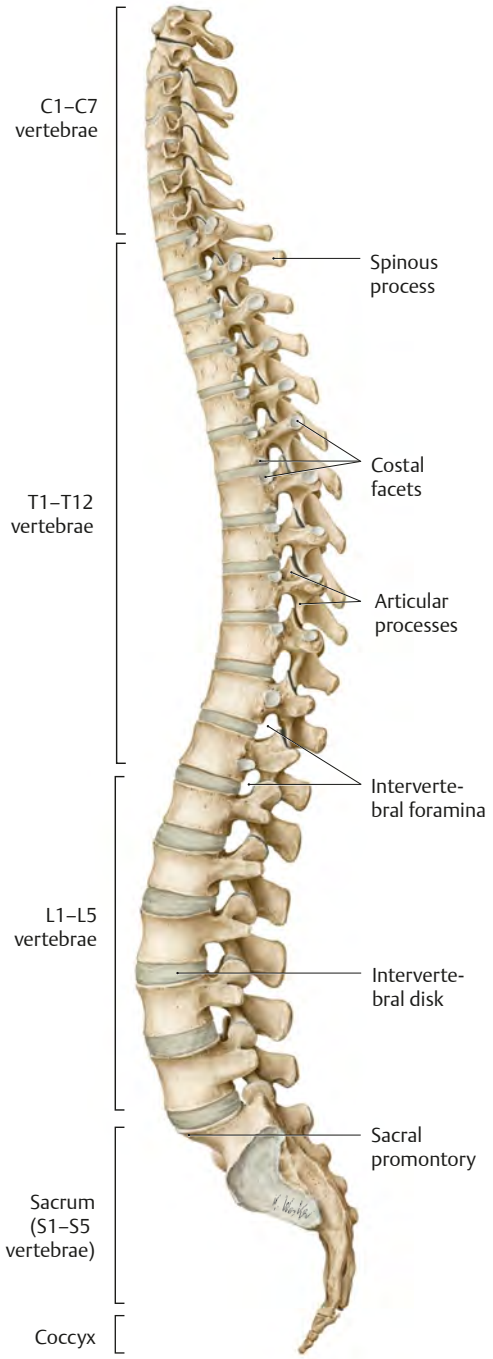
Vertebral Column: Overview

The vertebral column (spine) is divided into four regions: the cervical, thoracic, lumbar, and sacral spines. Both the cervical and lumbar spines demonstrate lordosis (inward curvature); the thoracic and sacral spines demonstrate kyphosis (outward curvature).

Fig. 2.1 **Vertebral column**
Left lateral view.



A Regions of the spine.



B Bony vertebral column.

Clinical box 2.1

Spinal development
The characteristic curvatures of the adult spine appear over the course of postnatal development, being only partially present in a newborn. The newborn has a "kyphotic" spinal curvature (**A**); lumbar lordosis develops later and becomes stable at puberty (**C**).

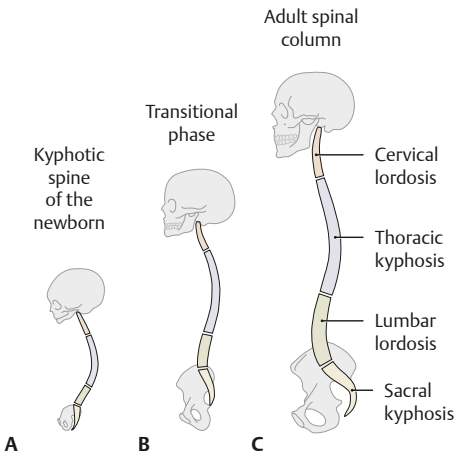
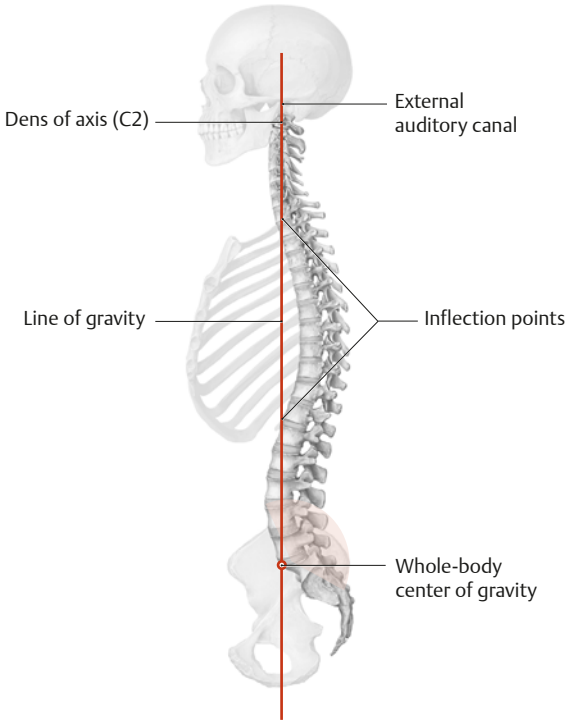
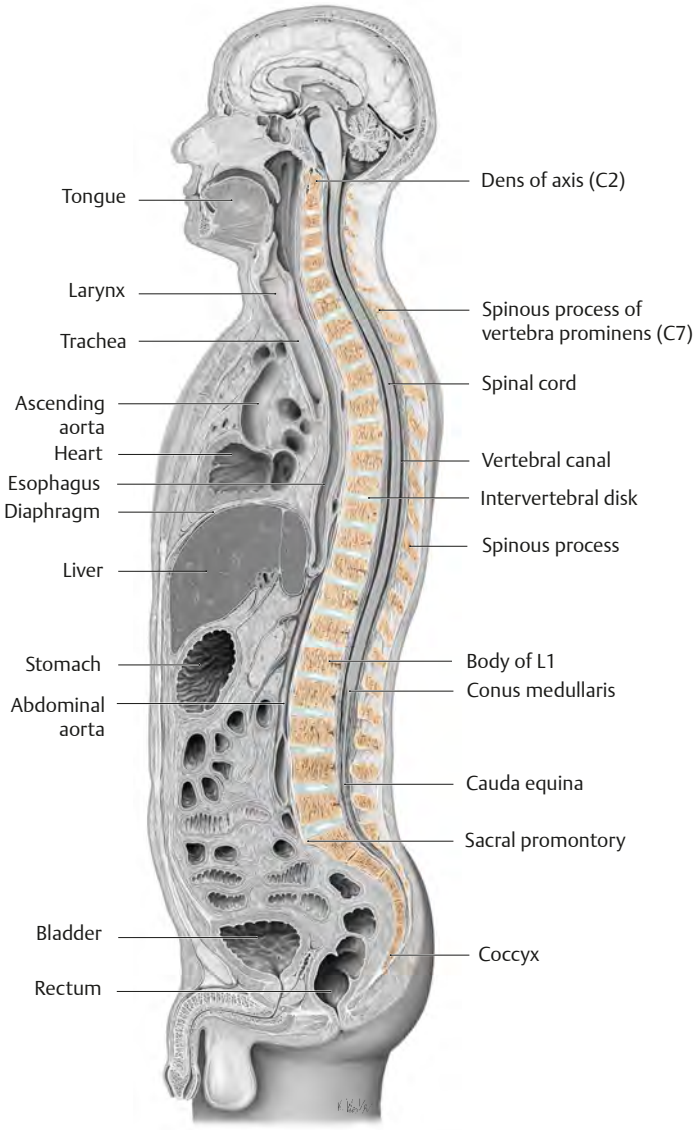


***Fig. 2.2* Normal anatomical position of the spine**
Left lateral view.



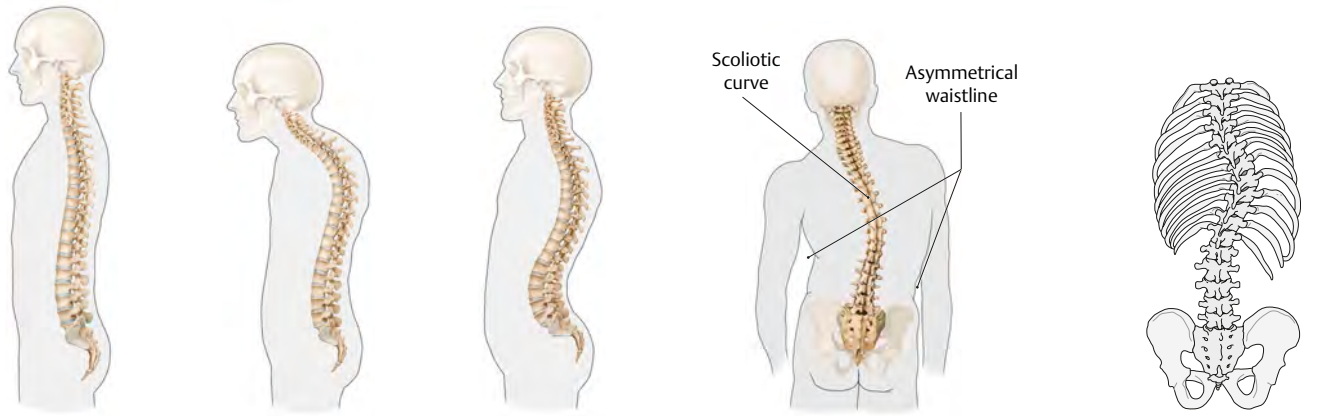
A Line of gravity. The line of gravity passes through certain anatomical landmarks, including the inflection points at the cervicothoracic and thoracolumbar junctions. It continues through the center of gravity (anterior to the sacral promontory) before passing through the hip joint, knee, and ankle.



B Midsagittal section through an adult male.

Clinical box 2.2

Abnormal Vertebral Column Curvatures



A Normal

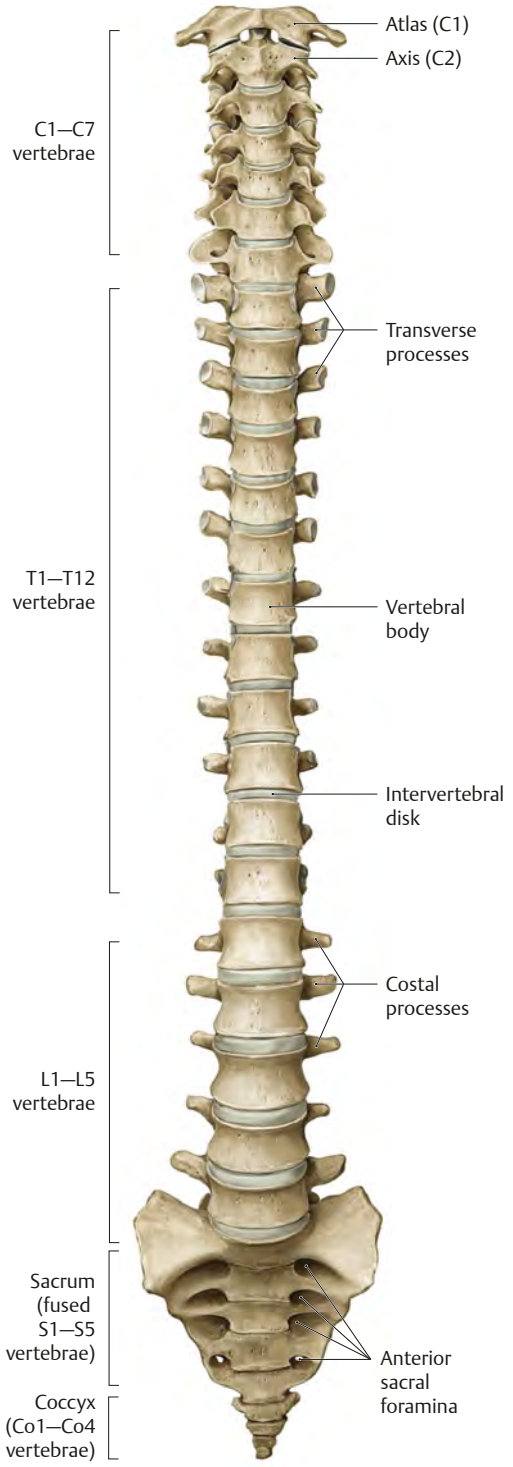
B Excessive kyphosis

C Excessive lordosis

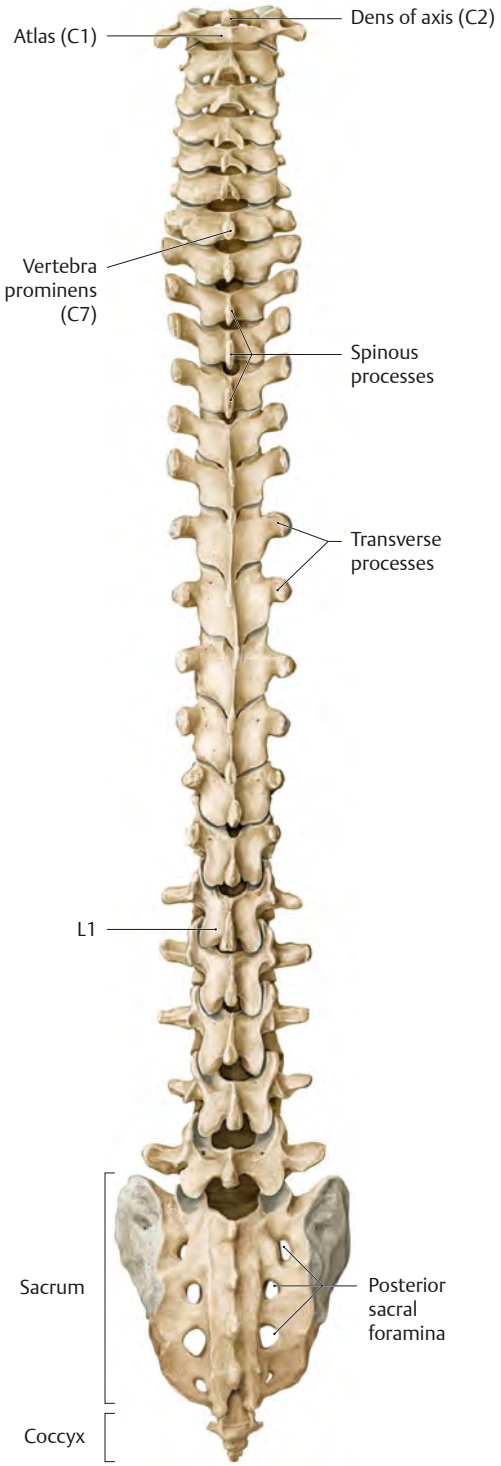
D Scoliosis

E Right convex thoracic scoliosis

Fig. 2.3 **Bones of the vertebral column**
The transverse processes of the lumbar vertebrae are originally rib rudiments and so are named costal processes.



A Anterior view.



B Posterior view.

Fig. 2.4 **Structural elements of a vertebra**
Left posterosuperior view. With the exception of the atlas (C1) and axis (C2), all vertebrae consist of the same structural elements.

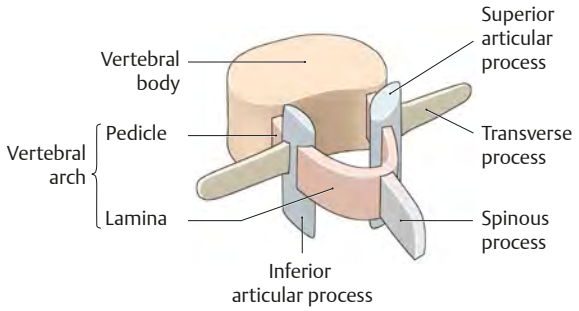
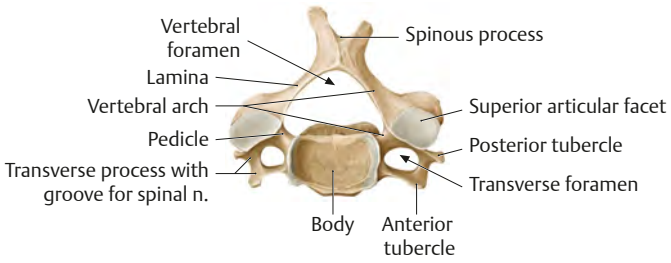
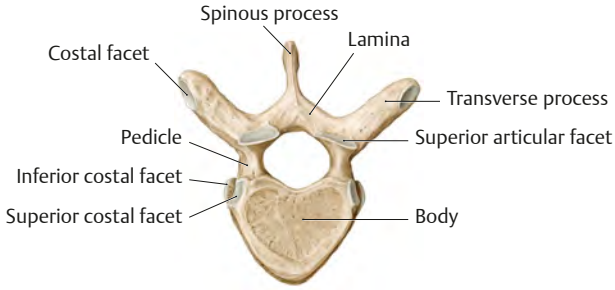


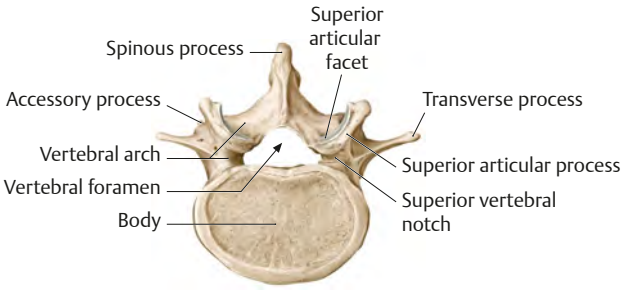
Fig. 2.5 **Typical vertebrae**
Superior view.



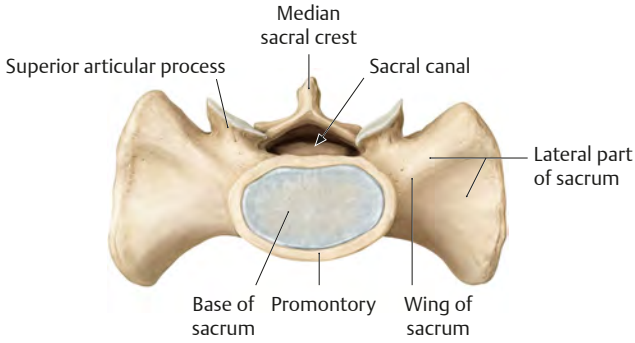
A Cervical vertebra (C4).



B Thoracic vertebra (T6).



C Lumbar vertebra (L4).



D Sacrum.

Table 2.1 **Structural elements of vertebrae**

Vertebrae	Body	Vertebral foramen	Transverse processes	Articular processes	Spinous process
Cervical vertebrae C3*–C7	Small (kidney-shaped)	Large (triangular)	Small (may be absent on C7); anterior and posterior tubercles enclose transverse foramen	Superoposteriorly and inferoanteriorly; oblique facets: most nearly horizontal	Short (C3–C5); bifid (C3–C6); long (C7)
Thoracic vertebrae T1–T12	Medium (heart-shaped); includes costal facets	Small (circular)	Large and strong; length decreases T1–T12; costal facets (T1–T10)	Posteriorly (slightly laterally) and anteriorly (slightly medially); facets in coronal plane	Long, sloping postero-inferiorly; tip extends to level of vertebral body below
Lumbar vertebrae L1–L5	Large (kidney-shaped)	Medium (triangular)	Called costal processes, long and slender; accessory process on posterior surface	Posteromedially (or medially) and anterolaterally (or laterally); facets nearly in sagittal plane; mammillary process on posterior surface of each superior articular process	Short and broad
Sacral vertebrae (sacrum) S1–S5 (fused)	Decreases from base to apex	Sacral canal	Fused to rudimentary rib (ribs, see **pp. 56–59**)	Superoposteriorly (SI) superior surface of lateral sacrum-auricular surface	Median sacral crest

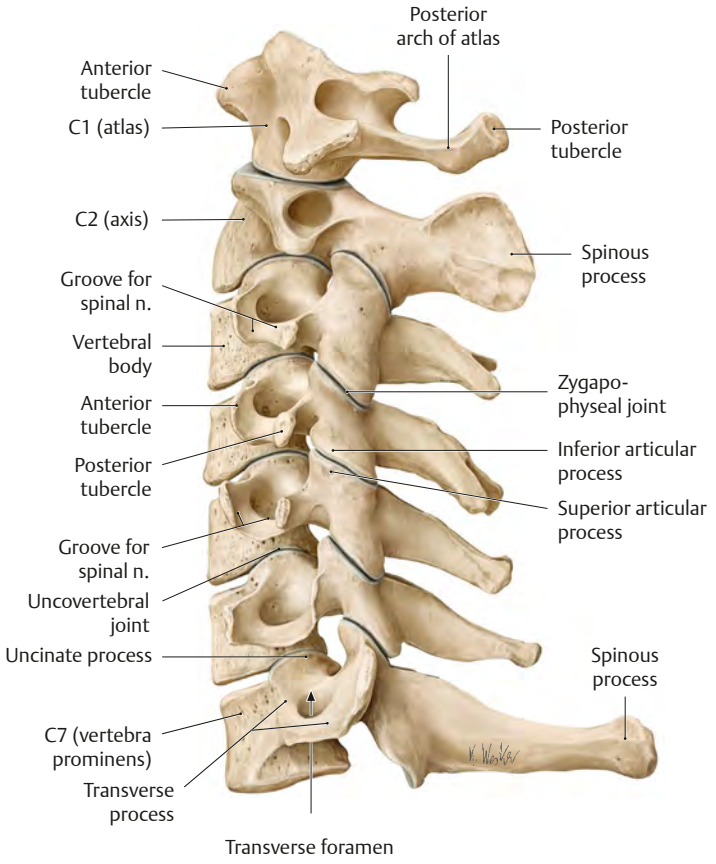
*C1 (atlas) and C2 (axis) are considered atypical (see **pp. 8–9**).

Cervical Vertebrae

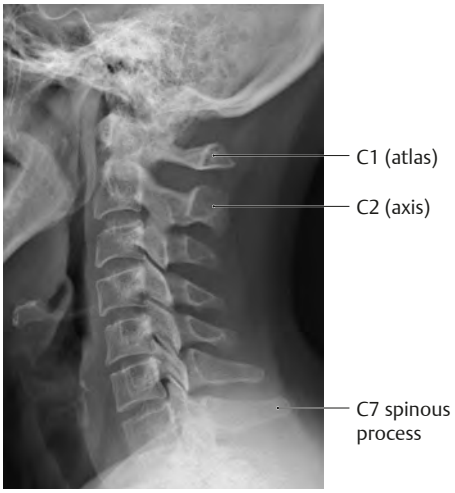
The seven vertebrae of the cervical spine differ most conspicuously from the common vertebral morphology. They are specialized to bear the weight of the head and allow the neck to move in all directions.

C1 and C2 are known as the atlas and axis, respectively. C7 is called the vertebra prominens for its long, palpable spinous process.

Fig. 2.6 **Cervical spine**
Left lateral view.

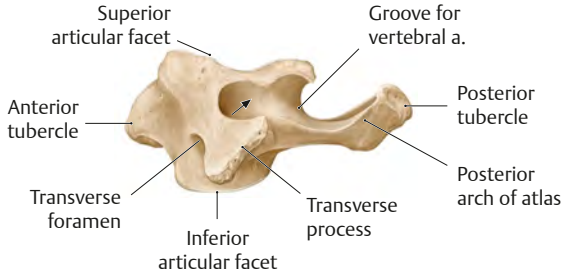


A Bones of the cervical spine, left lateral view.



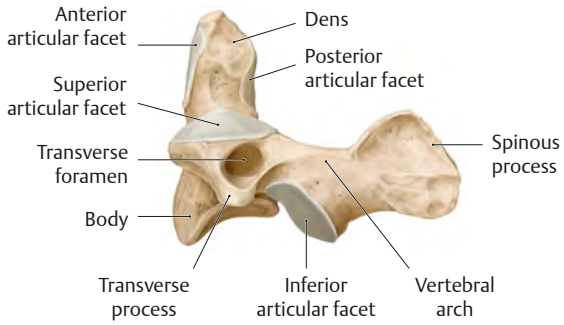
B Radiograph of the cervical spine, left lateral view.

Fig. 2.7 **Atlas (C1)**



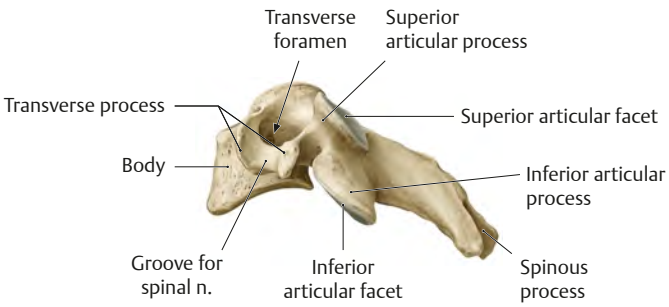
A Left lateral view.

Fig. 2.8 **Axis (C2)**



A Left lateral view.

Fig. 2.9 **Typical cervical vertebra (C4)**



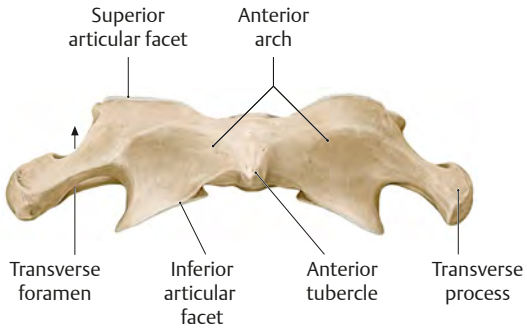
A Left lateral view.

Clinical box 2.3

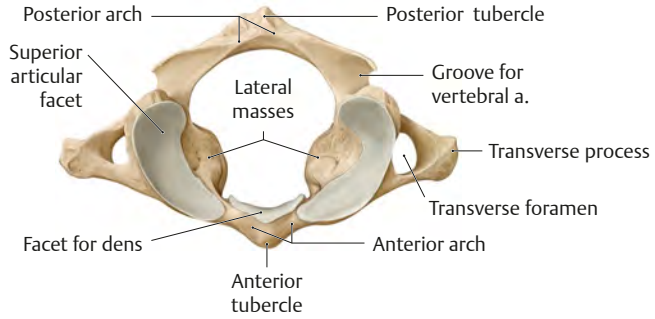
Injuries in the cervical spine

The cervical spine is prone to hyperextension injuries, such as "whiplash," which can occur when the head extends back much farther than it normally would. The most common injuries of the cervical spine are fractures of the dens of the axis, traumatic spondylolisthesis (anterior slippage of a vertebral body), and atlas fractures. Patient prognosis is largely dependent on the spinal level of the injuries (see **p. 42**).

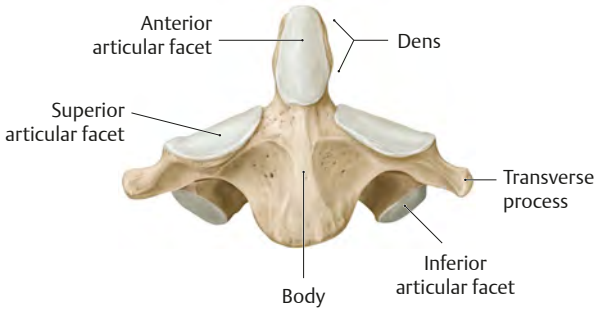
This patient hit the dashboard of his car while not wearing a seat belt. The resulting hyperextension caused the traumatic spondylolisthesis of C2 (axis) with fracture of the vertebral arch of C2, as well as tearing of the ligaments between C2 and C3. This injury is often referred to as "hangman's fracture."



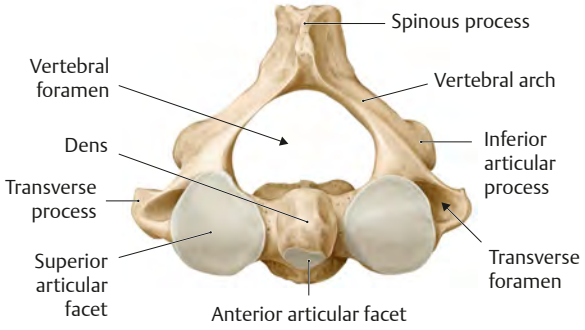
B Anterior view.



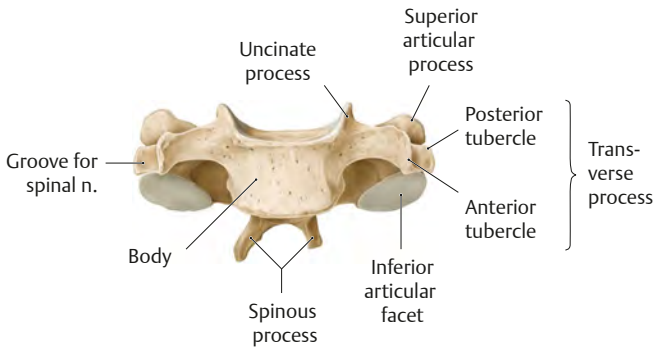
C Superior view.



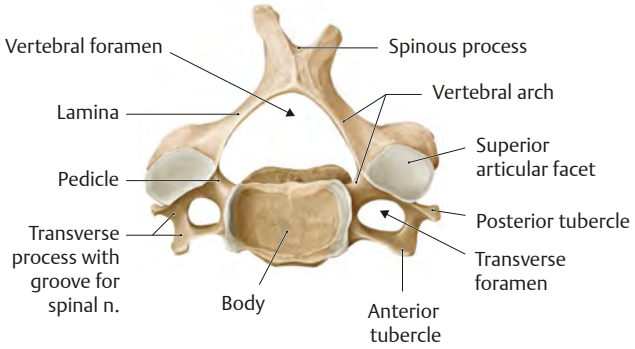
B Anterior view.



C Superior view.



B Anterior view.



C Superior view.

Fig. 2.10 **Thoracic spine**
Left lateral view.

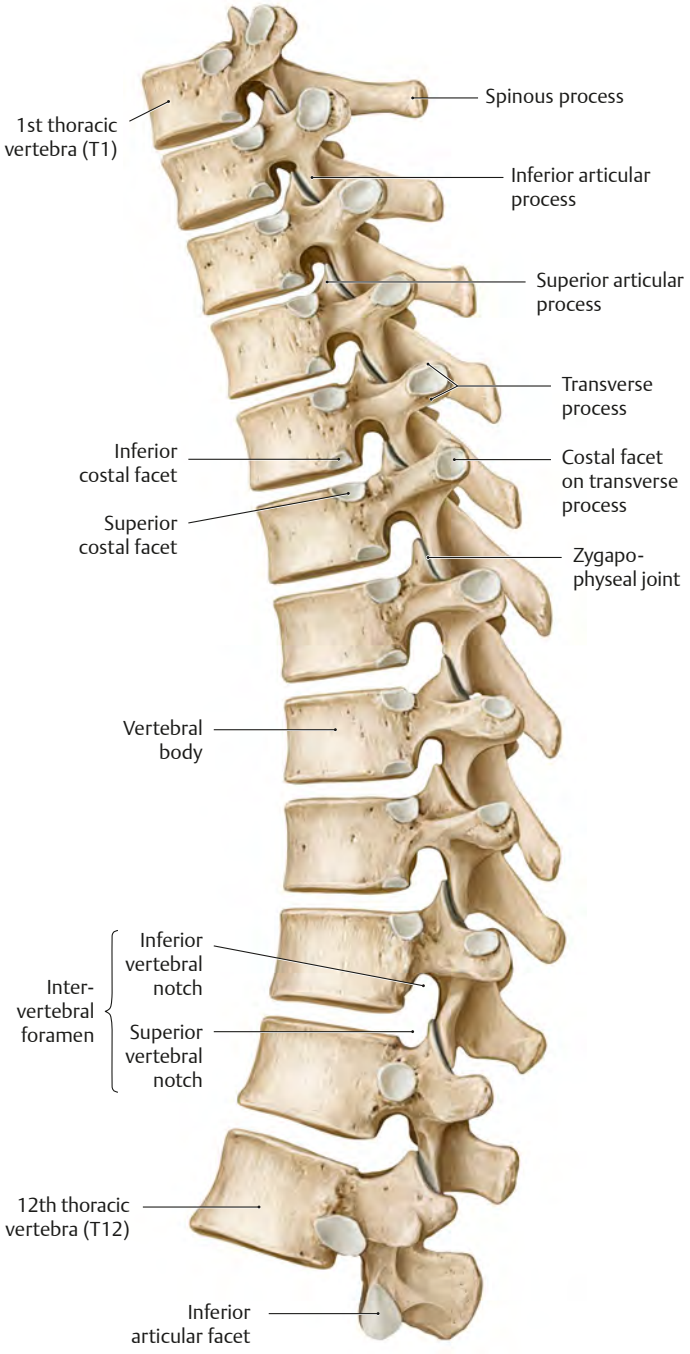
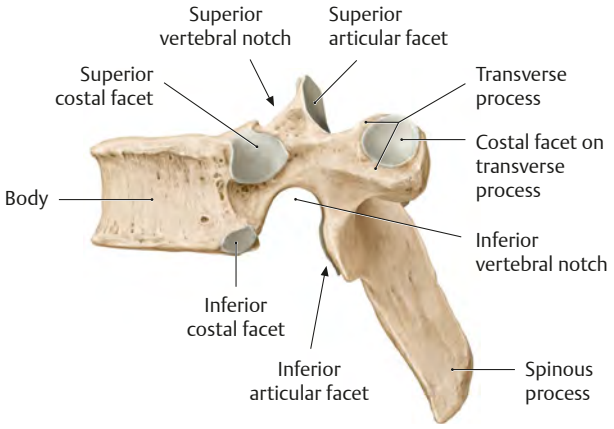
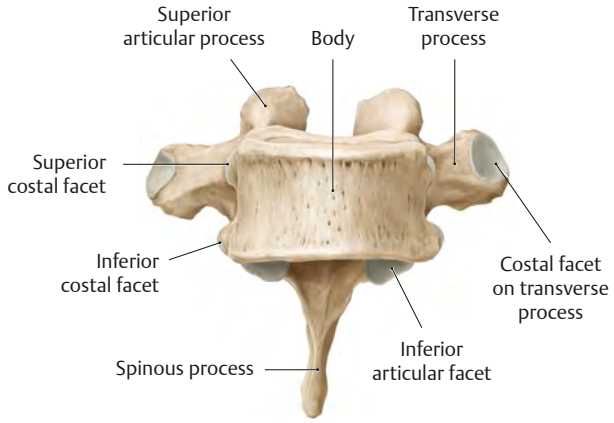


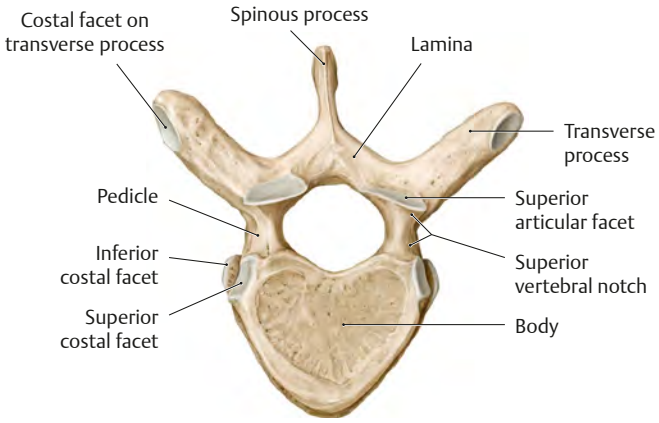
Fig. 2.11 **Typical thoracic vertebra (T6)**



A Left lateral view.



B Anterior view.



C Superior view.

Fig. 2.12 **Lumbar spine**
Left lateral view.

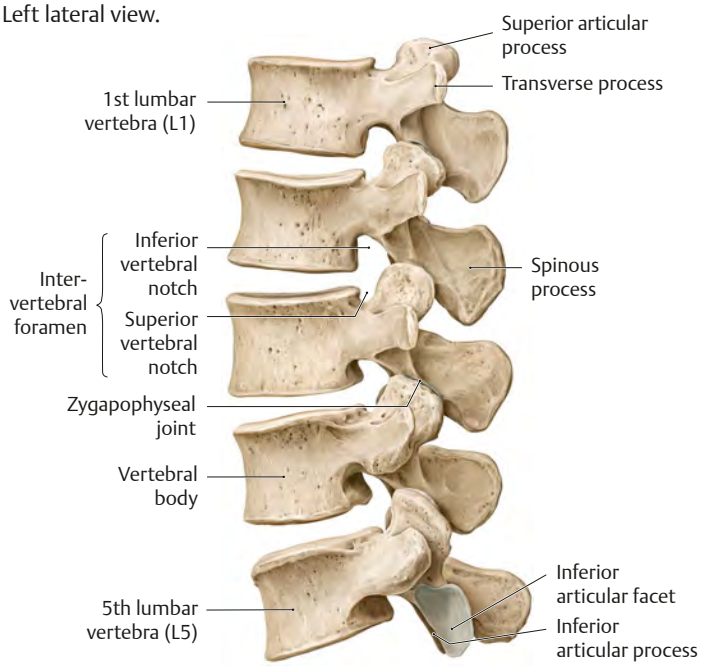
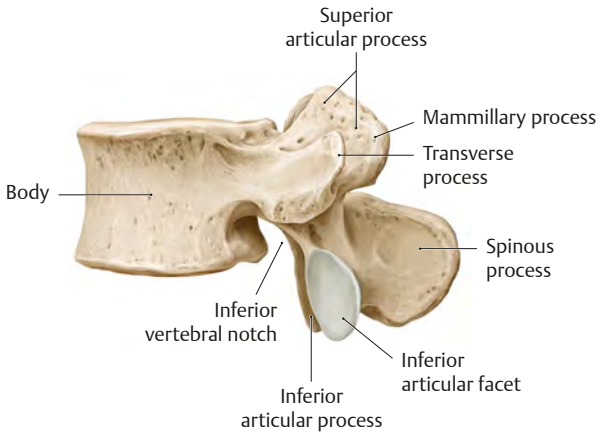
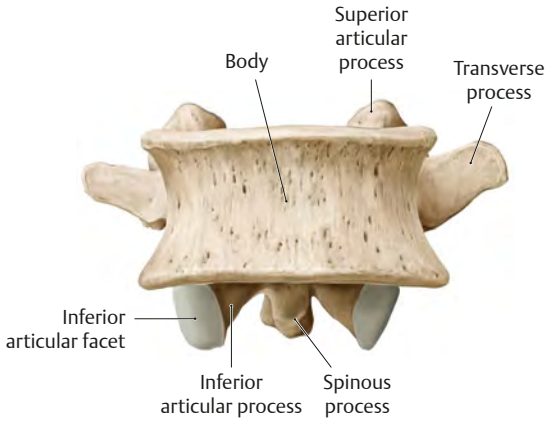


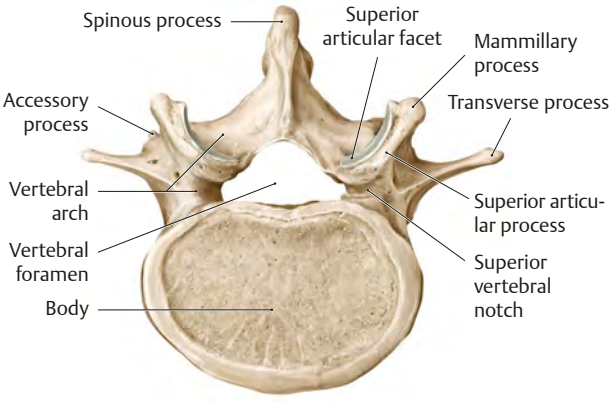
Fig. 2.13 **Typical lumbar vertebra (L4)**



A Left lateral view.



B Anterior view.



C Superior view.

Clinical box 2.4

Osteoporosis
The spine is the structure most affected by degenerative diseases of the skeleton, such as arthrosis and osteoporosis. In osteoporosis, more bone material gets reabsorbed than built up, resulting in a loss of bone mass. Symptoms include compression fractures and resulting back pain.

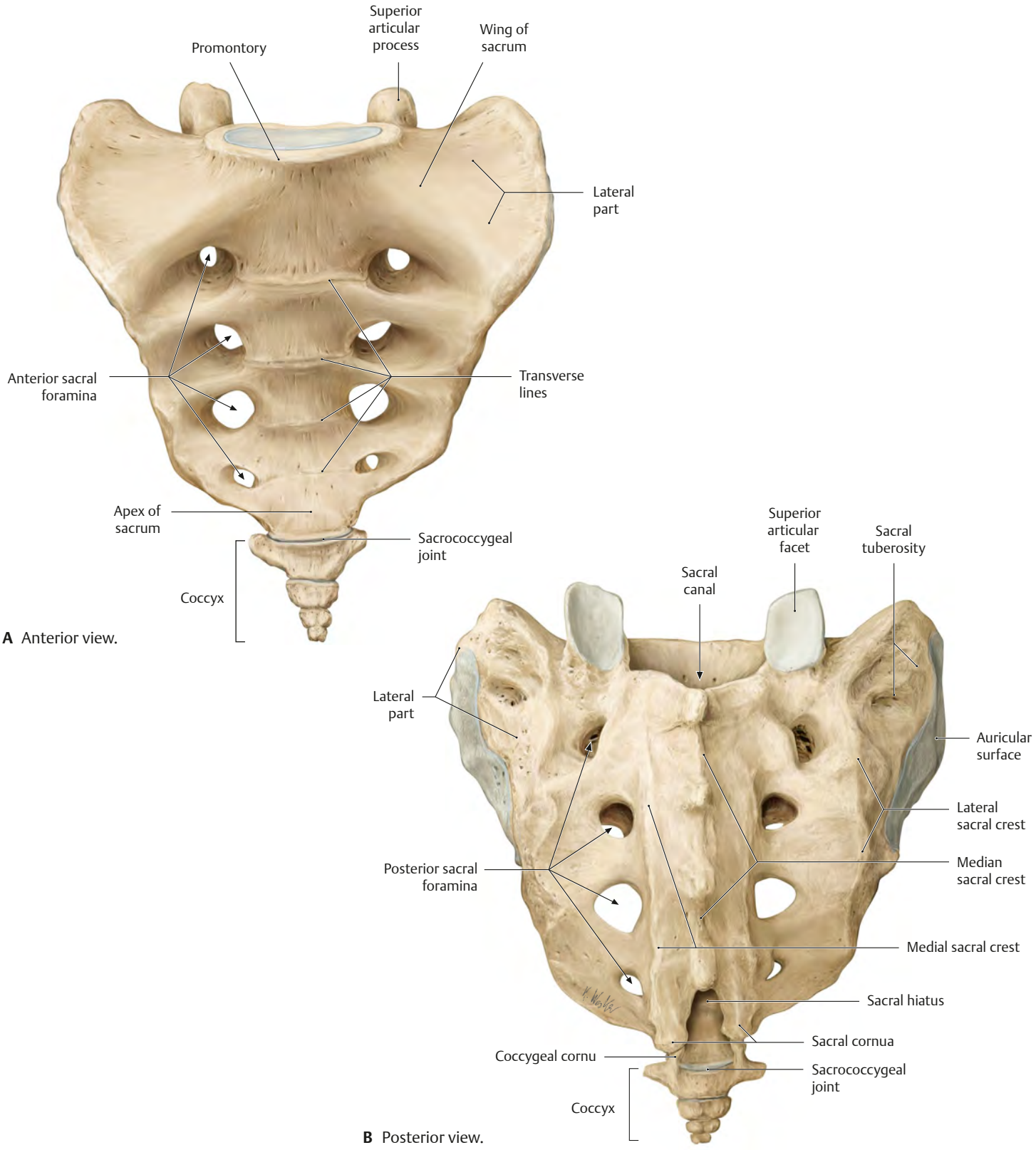
A Radiograph of a normal lumbar spine, left lateral view. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)

B Radiograph of an osteoporotic lumbar spine with a compression fracture at L1 (*arrow*). Note that the vertebral bodies are decreased in density, and the internal trabecular structure is coarse. (Reproduced from Jallo J, Vaccaro AR. Neurotrauma and Critical Care of the Spine, 1st ed. New York, NY: Thieme; 2009.)

Sacrum & Coccyx

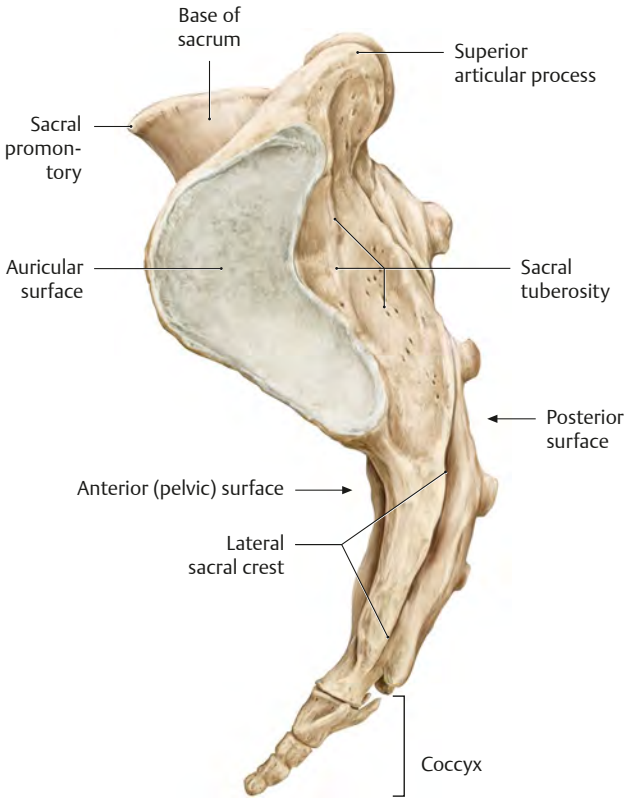
The sacrum is formed from five postnatally fused sacral vertebrae. The base of the sacrum articulates with the 5th lumbar vertebra, and the apex articulates with the coccyx, a series of three or four rudimentary vertebrae. See **Fig. 19.1, p. 230.**

Fig. 2.14 **Sacrum and coccyx**

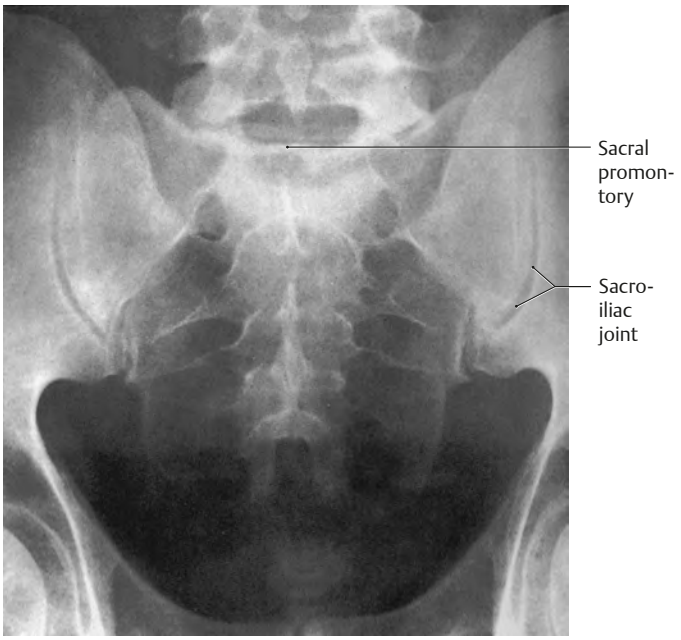


A Anterior view.

B Posterior view.

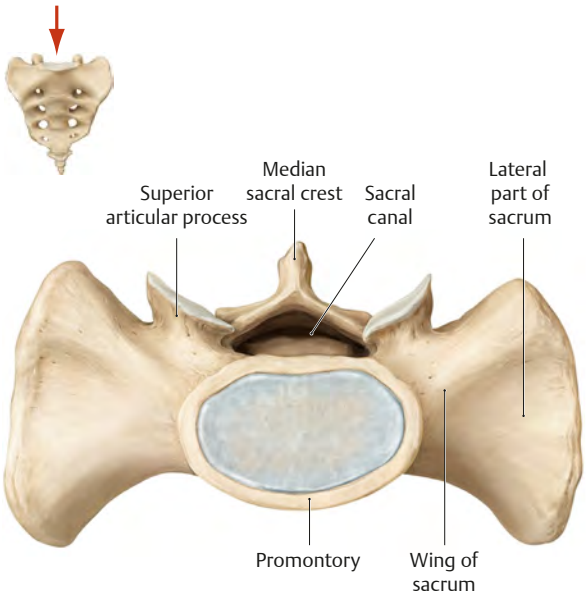


C Left lateral view.

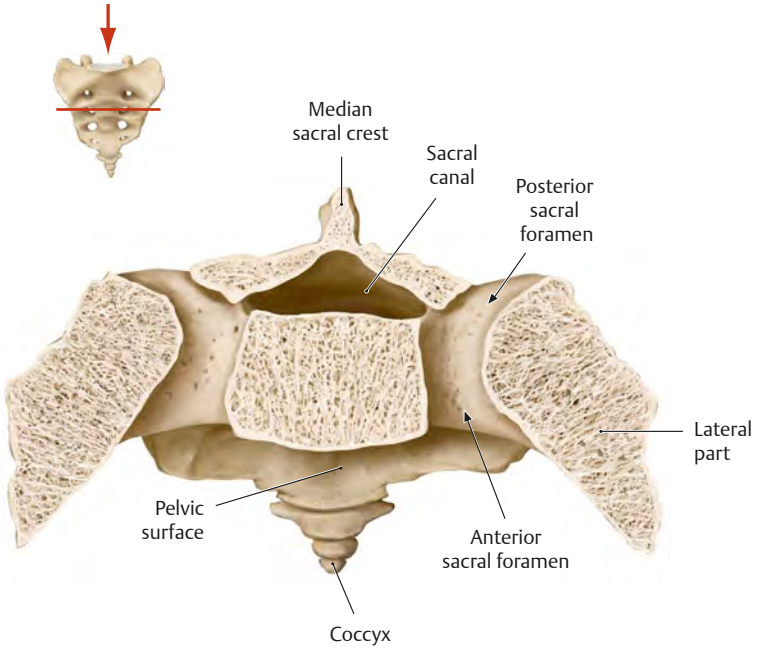


D Radiograph of sacrum, anteroposterior view. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)

Fig. 2.15 **Sacrum**
Superior view.



A Base of sacrum, superior view.



B Transverse section through second sacral vertebra demonstrating anterior and posterior sacral foramina, superior view.

Fig. 2.16 **Intervertebral disk in the vertebral column**
Midsagittal section of T11–T12, left lateral view. The intervertebral disks occupy the spaces between vertebrae (intervertebral joints, see **p. 16**).

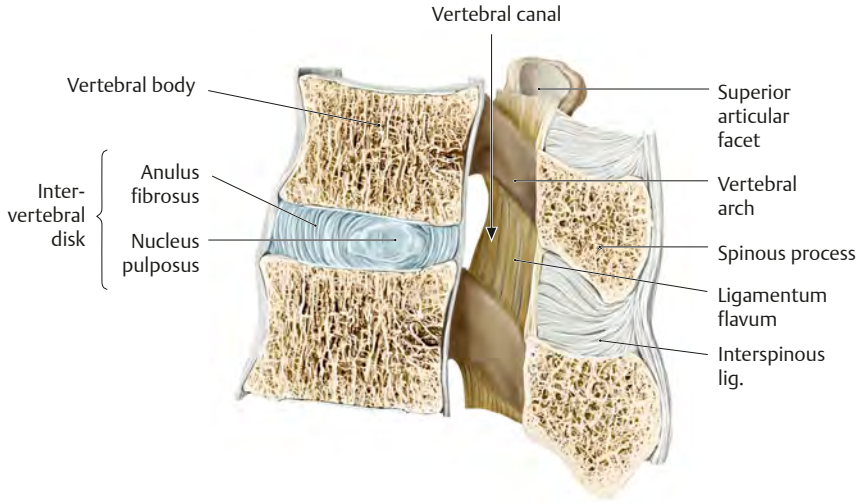


Fig. 2.17 **Structure of intervertebral disk**
Anterosuperior view with the anterior half of the disk and the right half of the end plate removed. The intervertebral disk consists of an external fibrous ring (anulus fibrosus) and a gelatinous core (nucleus pulposus).

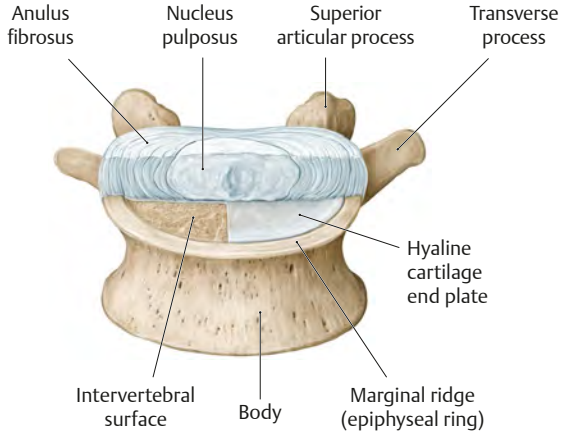


Fig. 2.18 **Relation of intervertebral disk to vertebral canal**
Fourth lumbar vertebra, superior view.

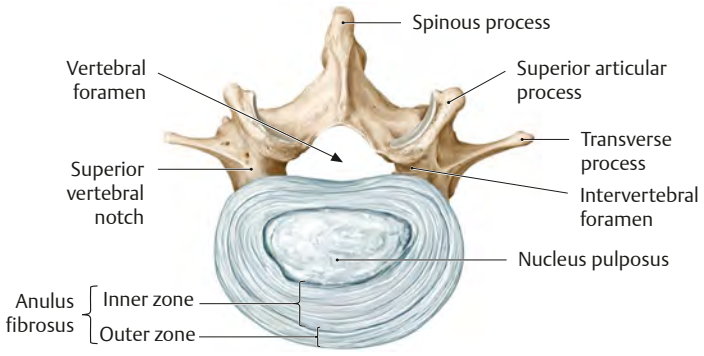
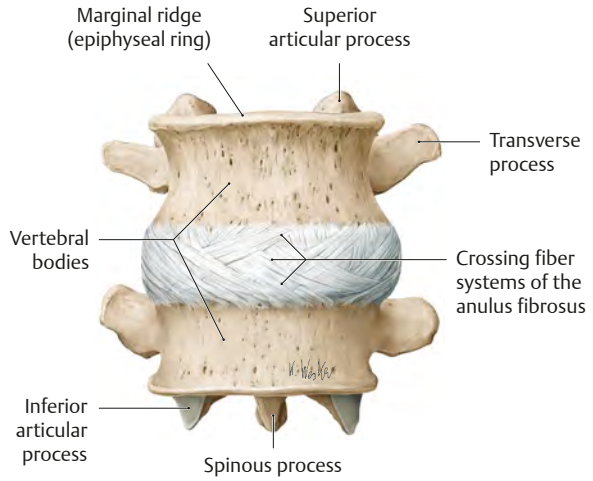


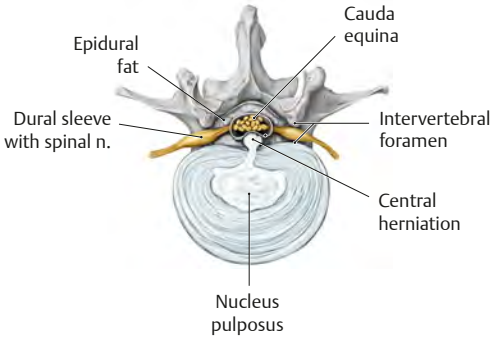
Fig. 2.19 **Outer zone of the annulus fibrosus**
Anterior view of L3–L4 with intervertebral disk.



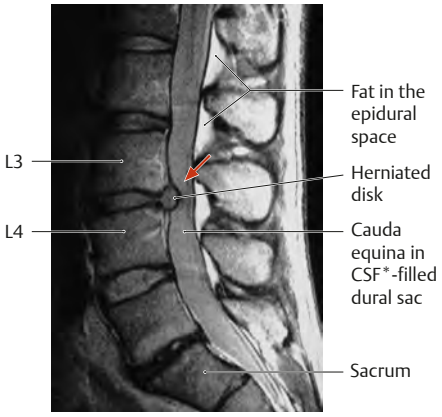
Clinical box 2.5

Disk herniation in the lumbar spine

As the stress resistance of the anulus fibrosus declines with age, the tissue of the nucleus pulposus may protrude through weak spots under loading. If the fibrous ring of the anulus ruptures completely, the herniated material may compress the contents of the intervertebral foramen (nerve roots and blood vessels—see posterolateral herniation below). These patients often suffer from severe local back pain. Pain is also felt in the associated dermatome (see **p. 42**). When the motor part of the spinal nerve is affected, the muscles served by that spinal nerve will show weakening. It is an important diagnostic step to test the muscles innervated by a nerve from a certain spinal segment, as well as the sensitivity in the specific dermatome. Example: The first sacral nerve root innervates the gastrocnemius and soleus muscles; thus, standing or walking on toes can be affected (see **p. 446**).

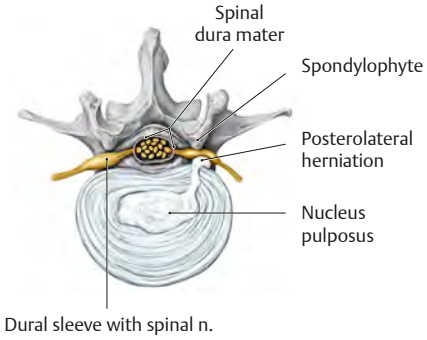


A Superior view.

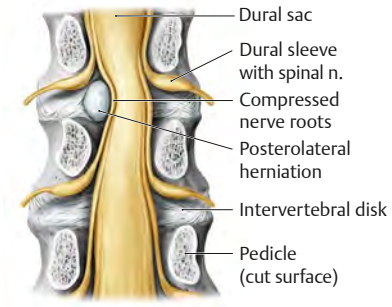


B Midsagittal T2-weighted MRI (magnetic resonance image).

Posterior herniation (A, B) In the MRI, a conspicuously herniated disk at the level of L3–L4 protrudes posteriorly (transligamentous herniation). The dural sac is deeply indented at that level. *CSF (cerebrospinal fluid).

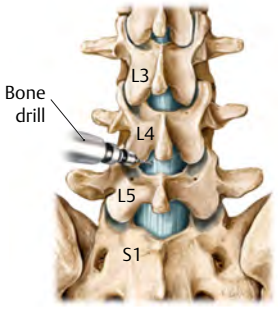


C Superior view.

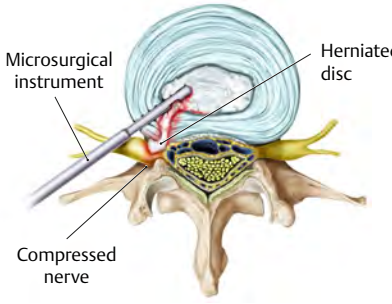


D Posterior view, vertebral arches removed.

Posterolateral herniation (C, D) A posterolateral herniation may compress the spinal nerve as it passes through the intervertebral foramen. If more medially positioned, the herniation may spare the nerve at that level but impact nerves at inferior levels.



E



F

Microdiscectomy surgery (**E, F**) is performed in order to remove a portion of a herniated disc that is irritating the nerve root. Through a small incision, the erector spinae muscles are reflected laterally to expose the ligamentum flavum, which is then removed in order to access the nerve roots in the spinal canal. A small portion of the facet joint may be removed to both facilitate access and relieve pressure on the nerve roots. Only the herniated portion of the disk is removed with the remaining tissue left intact.

Joints of the Vertebral Column: Overview

Table 2.2 Joints of the vertebral column

Craniovertebral joints		
①	Atlanto-occipital joints	Occiput–C1
②	Atlantoaxial joints	C1–C2
Joints of the vertebral bodies		
③	Uncovertebral joints	C3–C7
④	Intervertebral joints	C2–S1
Joints of the vertebral arch		
⑤	Zygapophyseal joints	C2–S1

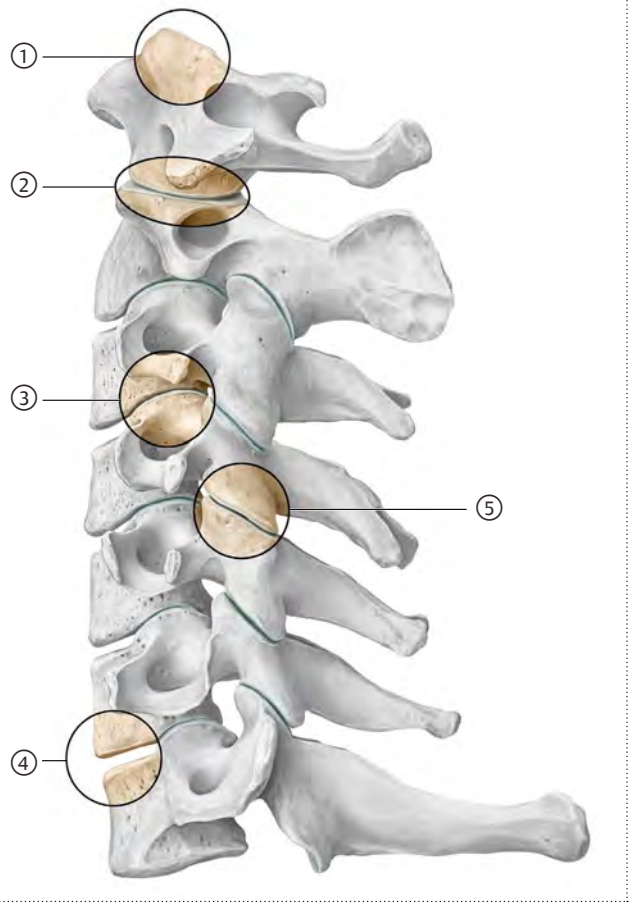
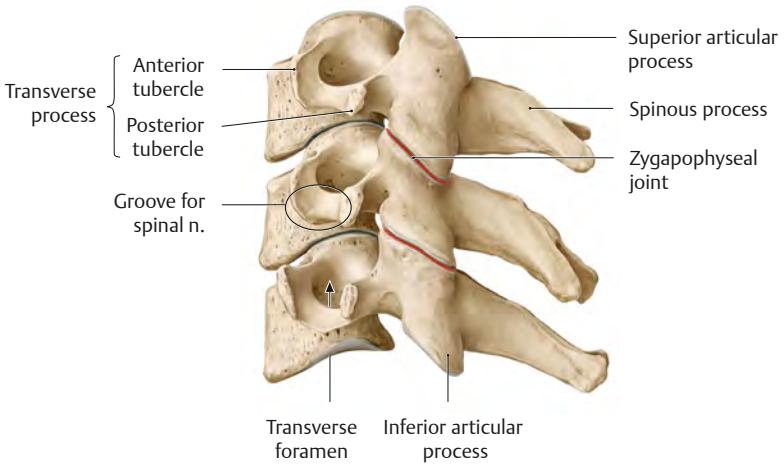
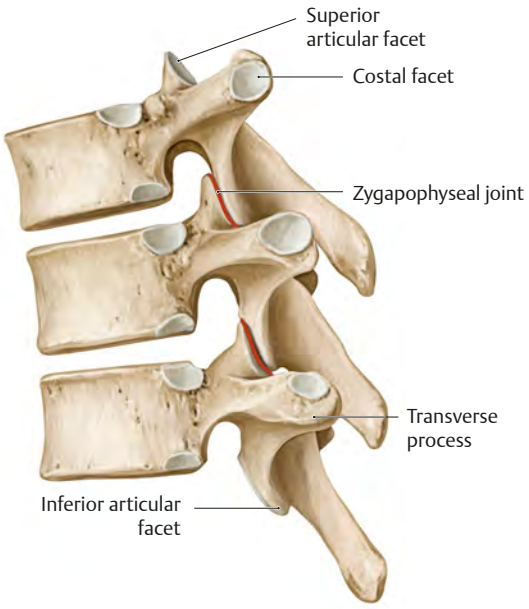


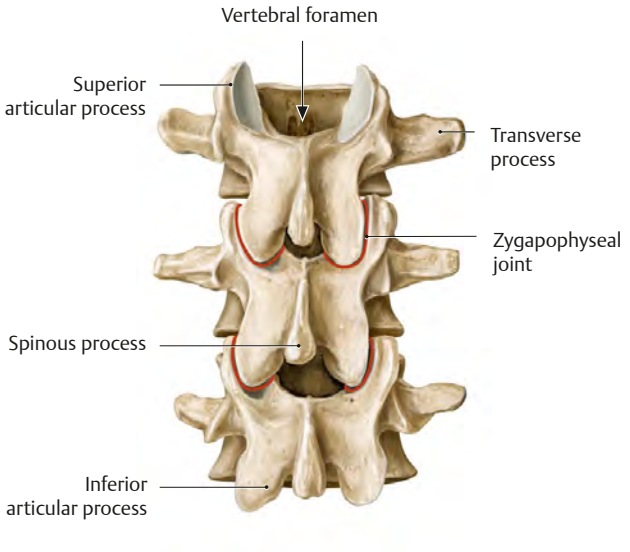
***Fig. 2.20* Zygapophyseal (intervertebral facet) joints**
The orientation of the zygapophyseal joints differs between the spinal regions, influencing the degree and direction of movement.



A Cervical region, left lateral view. The zygapophyseal joints lie 45 degrees from the horizontal.



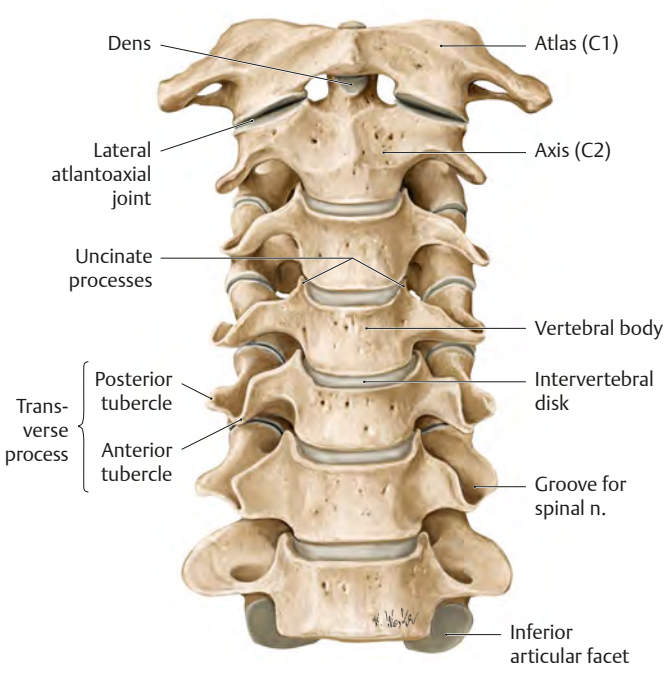
B Thoracic region, left lateral view. The joints lie in the coronal plane.



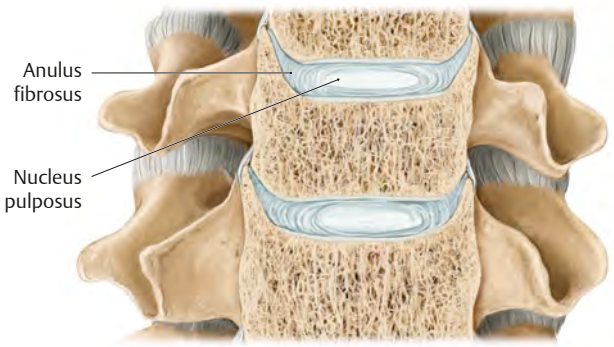
C Lumbar region, posterior view. The joints lie in the sagittal plane.

Fig. 2.21 Uncovertebral joints

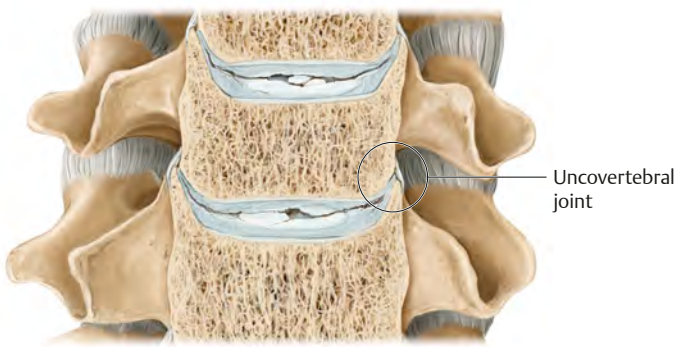
Anterior view. Uncovertebral joints form during childhood between the uncinate processes of C3–C7 and the vertebral bodies immediately superior. The joints may result from fissures in the cartilage of the disks that assume an articular character. If the fissures become complete tears, the risk of nucleus pulposus herniation is increased (see **p. 15**).



A Uncovertebral joints in the cervical spine of an 18-year-old man, anterior view.



B Uncovertebral joint (enlarged), anterior view of coronal section.

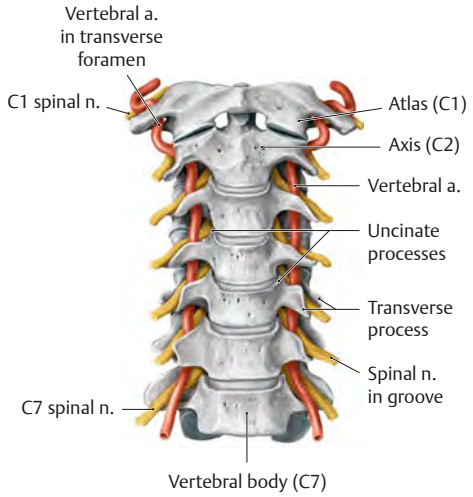


C Uncovertebral joints, split intervertebral disks, anterior view of coronal section.

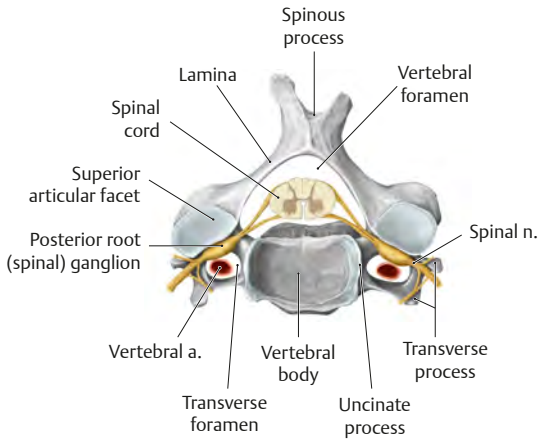
Clinical box 2.6

Proximity of the spinal nerve and vertebral artery to the uncinate process

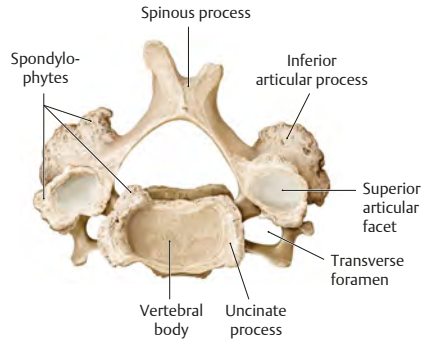
The spinal nerve and vertebral artery pass through the intervertebral and transverse foramina, respectively (**A** and **B**). Bony outgrowths (osteophytes) on the uncinate process (**C**) resulting from uncovertebral arthrosis (degeneration) may compress both the nerve and the artery and can lead to chronic pain in the cervical region.



A Cervical spine, anterior view.

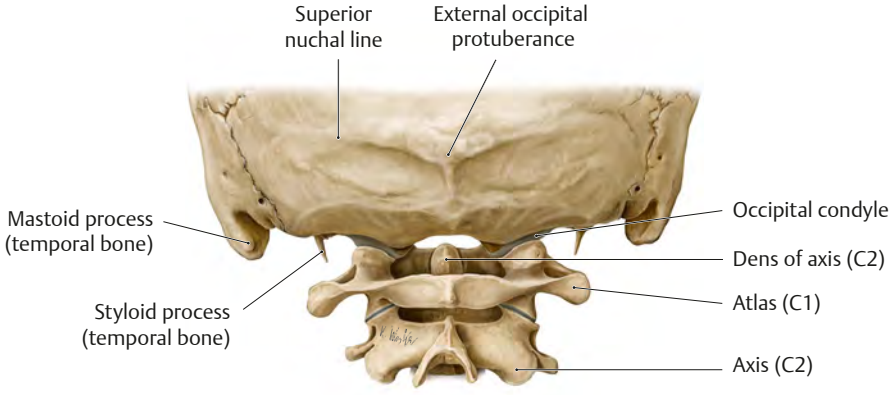


B Fourth cervical vertebra, superior view.

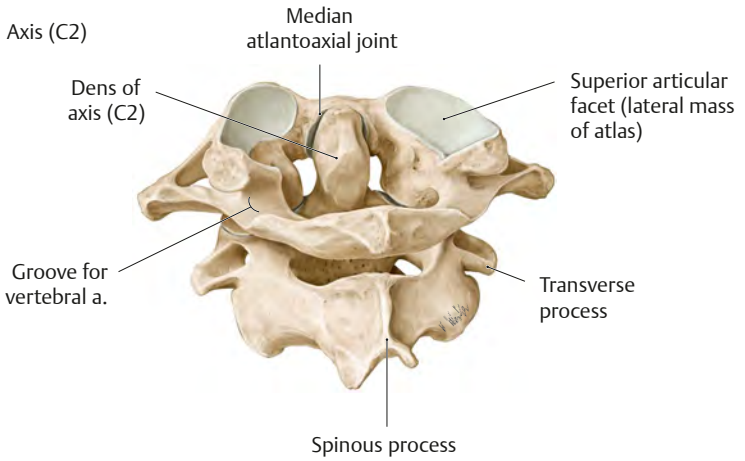


C Advanced uncovertebral arthrosis of the fourth cervical vertebra, superior view.

Fig. 2.22 Craniovertebral joints

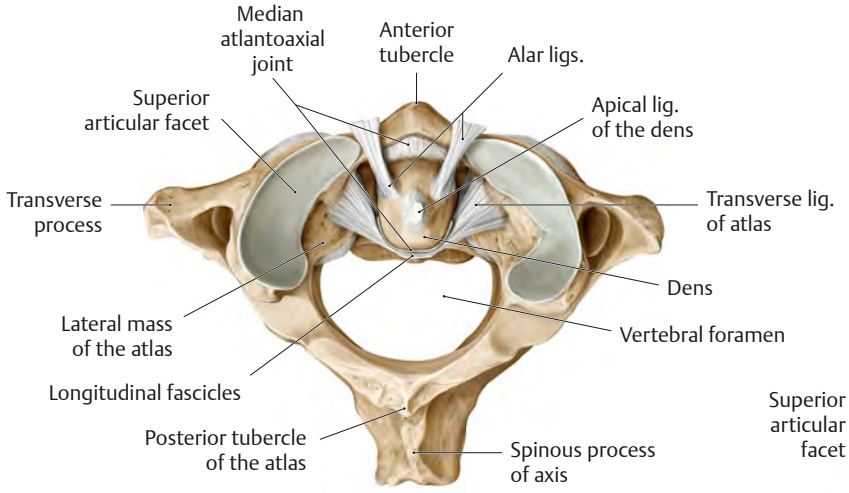


A Posterior view.

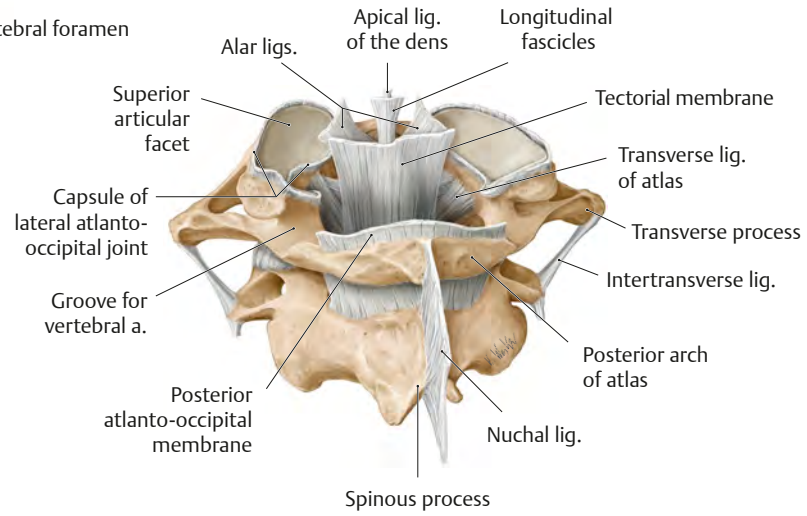


B Atlas and axis, posterosuperior view.

Fig. 2.23 Ligaments of the craniovertebral joints



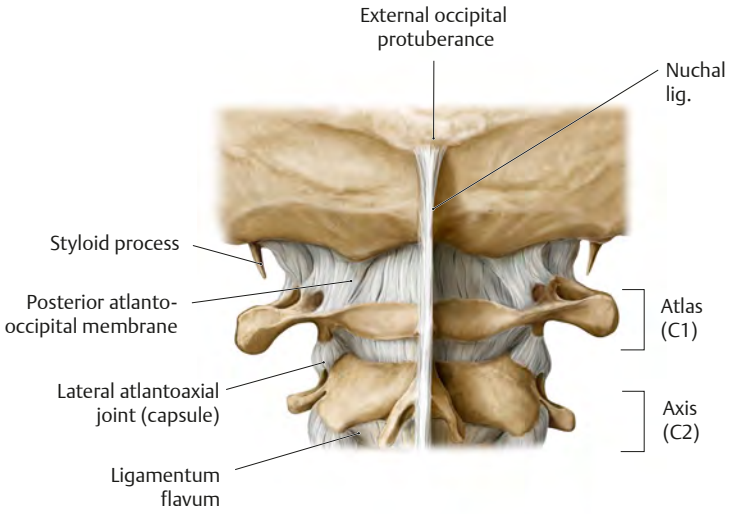
A Ligaments of the median atlantoaxial joint, superior view. The fovea of the atlas is hidden by the joint capsule.



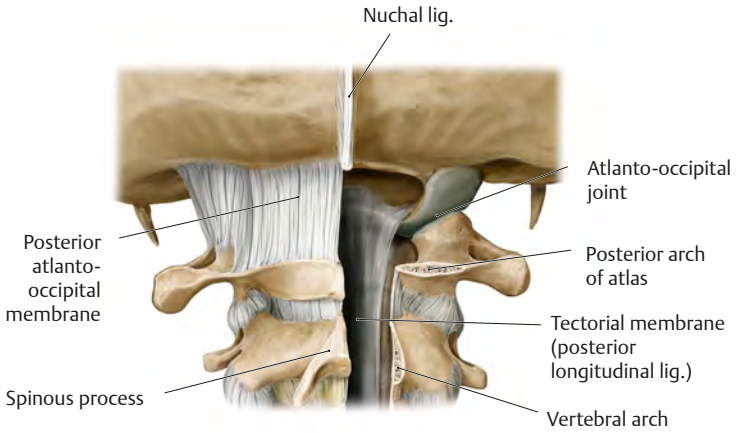
B Ligaments of the craniovertebral joints, posterosuperior view. The dens of the axis is hidden by the tectorial membrane.

The atlanto-occipital joints are the two articulations between the convex occipital condyles of the occipital bone and the slightly concave superior articular facets of the atlas (C1). The atlantoaxial joints are the two lateral and one medial articulations between the atlas (C1) and axis (C2).

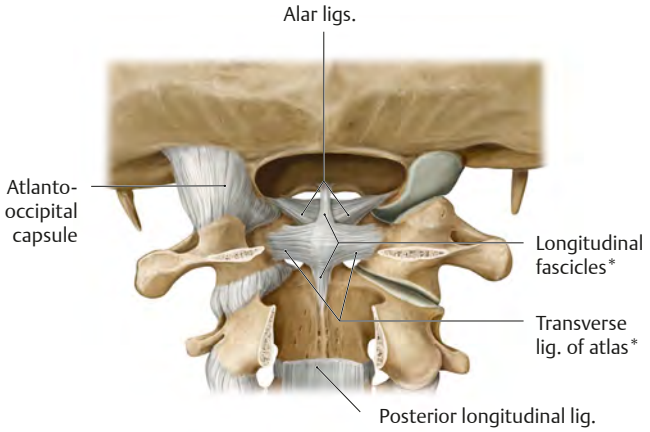
Fig. 2.24 Dissection of the craniovertebral joint ligaments



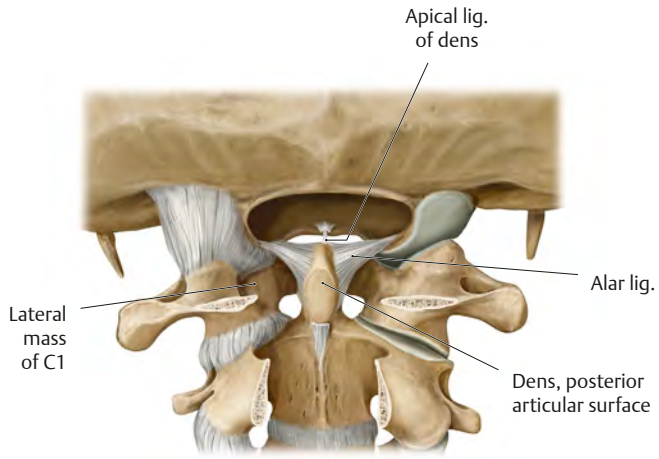
A Nuchal ligament and posterior atlanto-occipital membrane.



B Posterior longitudinal ligament. *Removed:* Spinal cord; vertebral canal windowed.



C Cruciform ligament of atlas (*). *Removed:* Tectorial membrane, posterior atlanto-occipital membrane, and vertebral arches.



D Alar and apical ligaments. *Removed:* Transverse ligament of atlas.

Vertebral Ligaments: Overview & Cervical Spine

The ligaments of the spinal column bind the vertebrae and enable the spine to withstand high mechanical loads and shearing stresses and limit the range of motion. The ligaments are subdivided into vertebral body ligaments and vertebral arch ligaments.

Fig. 2.25 Vertebral ligaments

Viewed obliquely from the left posterior view.

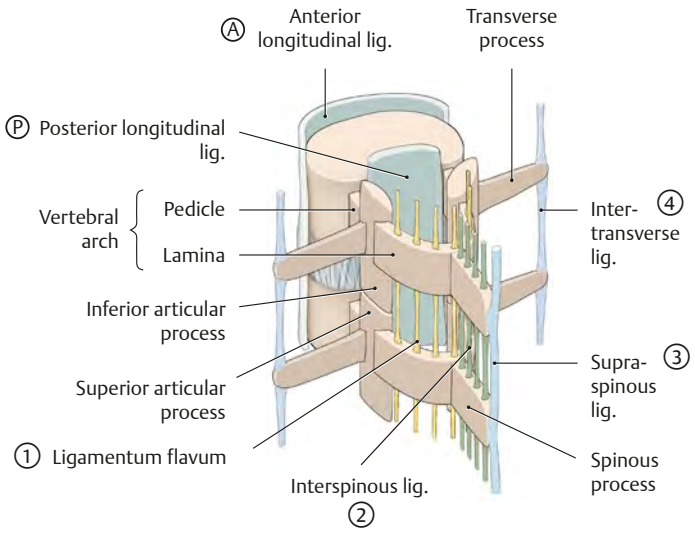


Table 2.3 **Vertebral ligaments**

Ligament		Location
Vertebral body ligaments		
Ⓐ	Anterior longitudinal lig.	Along anterior surface of vertebral body
Ⓟ	Posterior longitudinal lig.	Along posterior surface of vertebral body
Vertebral arch ligaments		
①	Ligamentum flavum	Between laminae
②	Interspinous lig.	Between spinous process
③	Supraspinous lig.	Along posterior ridge of spinous processes
④	Intertransverse lig.	Between transverse processes
Nuchal lig.*		Between external occipital protuberance and spinous process of C7

*Corresponds to a supraspinous ligament that is broadened superiorly.

Fig. 2.26 Anterior longitudinal ligament

Anterior view with base of skull removed.

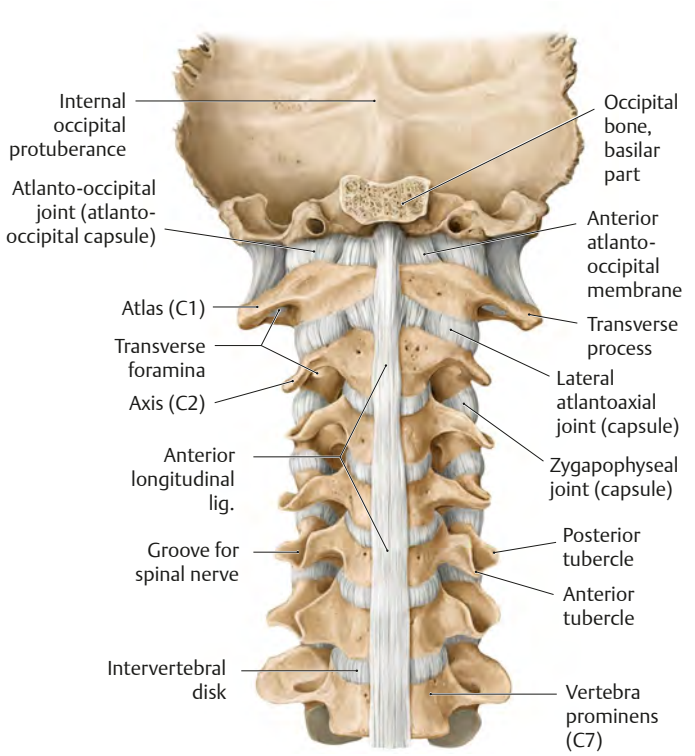


Fig. 2.27 Posterior longitudinal ligament

Posterior view with vertebral canal opened via laminectomy and spinal cord removed. The tectorial membrane is a broadened expansion of the posterior longitudinal ligament.

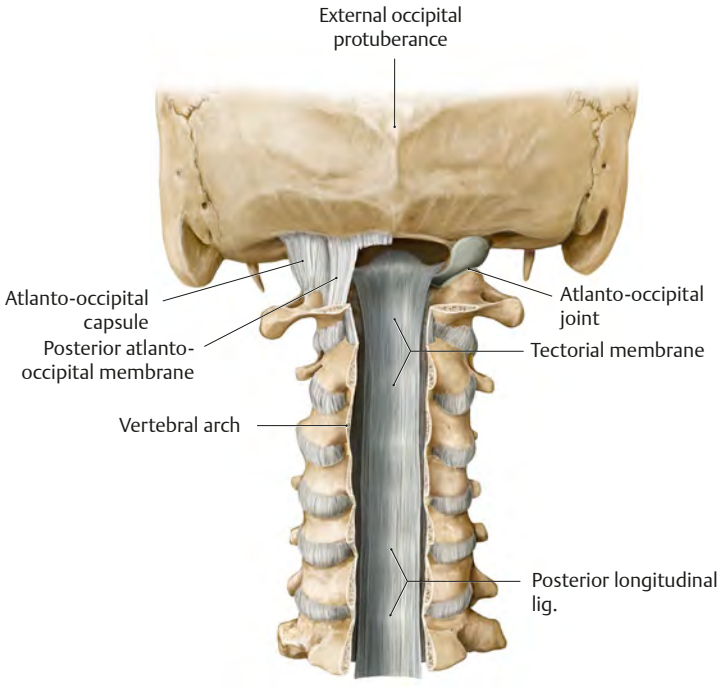
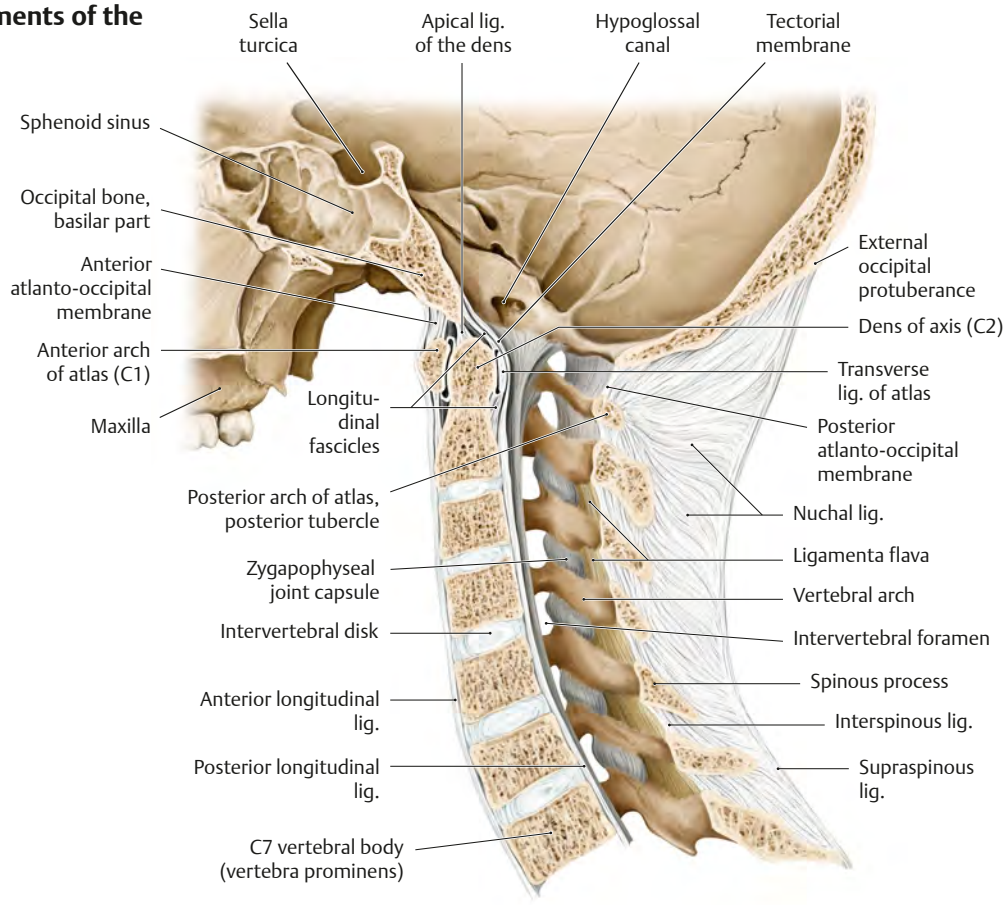
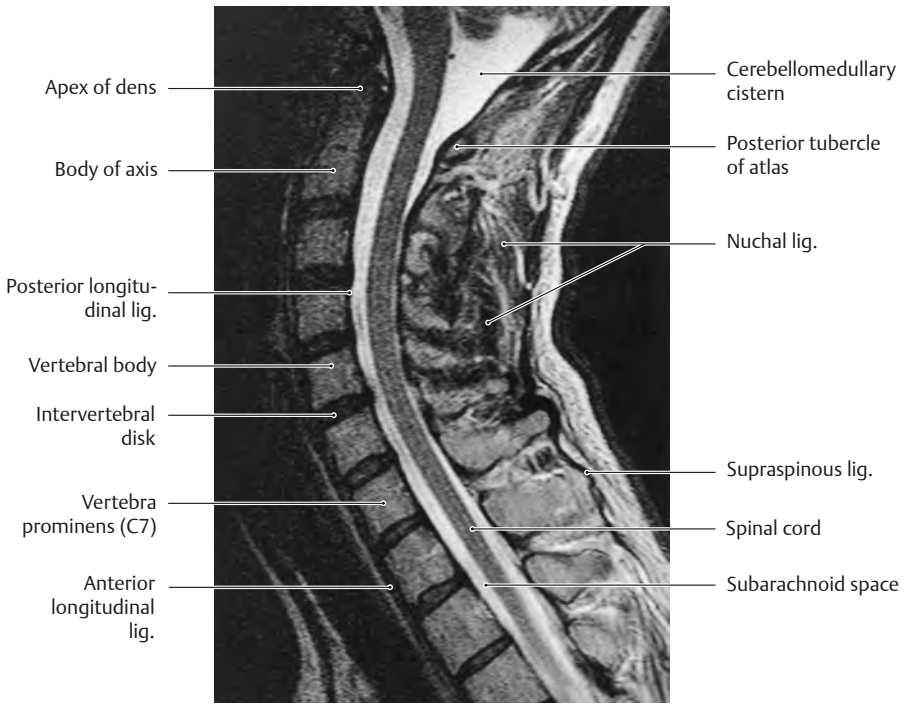


***Fig. 2.28* Ligaments of the cervical spine**
Mid-sagittal view.

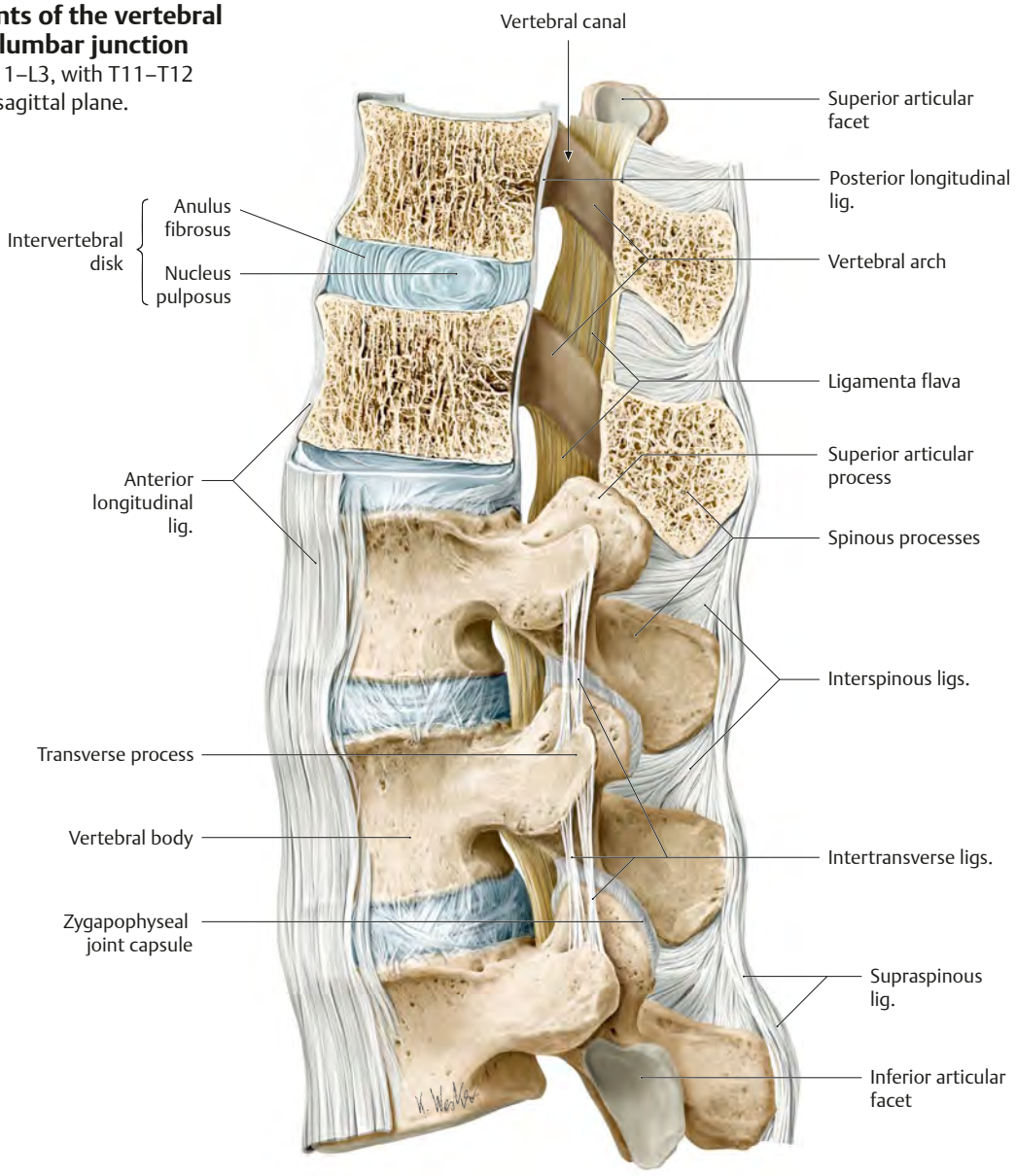


A Midsagittal section, left lateral view. The nuchal ligament is the broadened, sagittally oriented part of the supraspinous ligament that extends from the vertebra prominens (C7) to the external occipital protuberance.



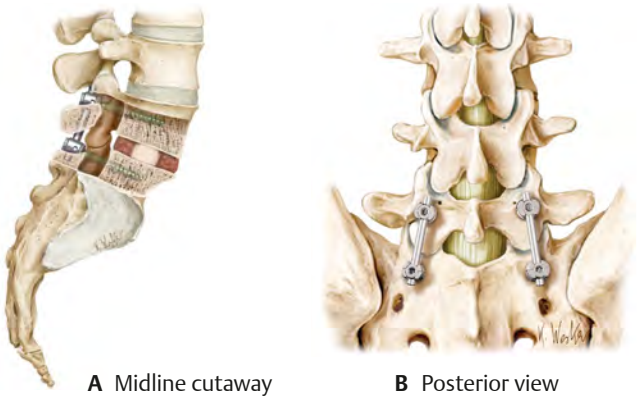
B Midsagittal T2-weighted MRI, left lateral view.

Fig. 2.29 **Ligaments of the vertebral column: Thoracolumbar junction**
Left lateral view of T11–L3, with T11–T12 sectioned in the midsagittal plane.



Clinical box 2.7

Spinal fusion procedure
Spinal fusion is a surgical procedure used to restore stability to the vertebral column or to eliminate painful motion. The basic idea involves fusing two or more vertebrae so they will heal into a single, solid bone. Fusions can take place at any part of the vertebral column.



A Midline cutaway **B** Posterior view

Fig. 2.30 **Anterior longitudinal ligament**
Anterior view of L3–L5.

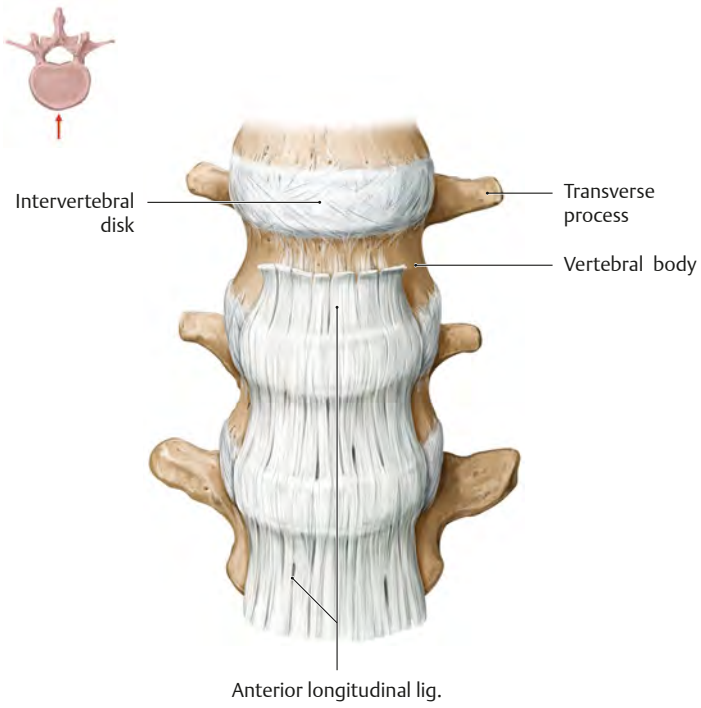


Fig. 2.31 **Ligamenta flava and intertransverse ligaments**
Anterior view of opened vertebral canal at level of L2–L5.
Removed: L2–L4 vertebral bodies.

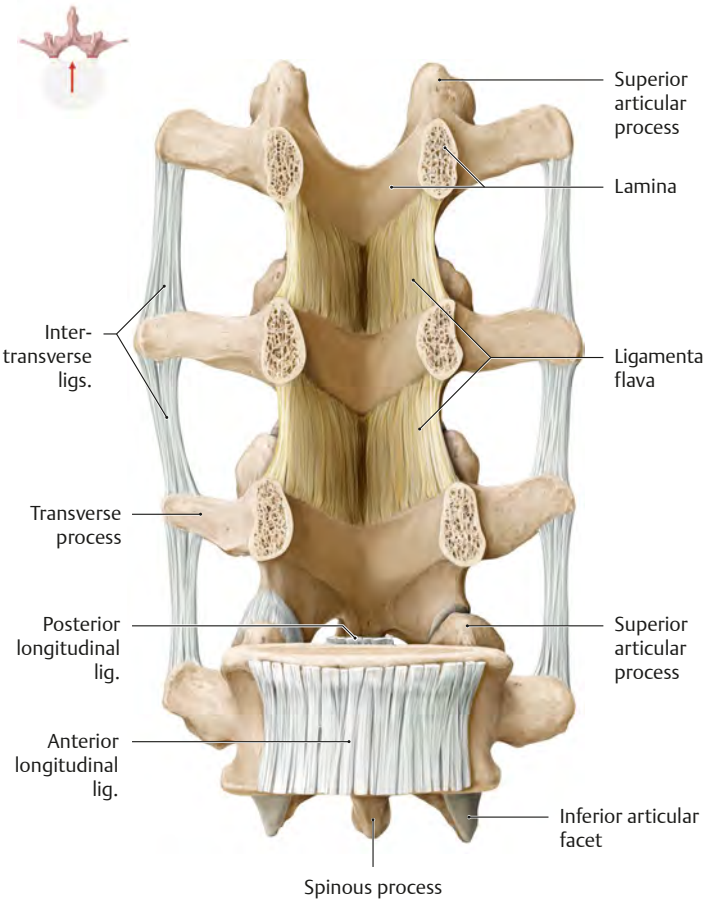
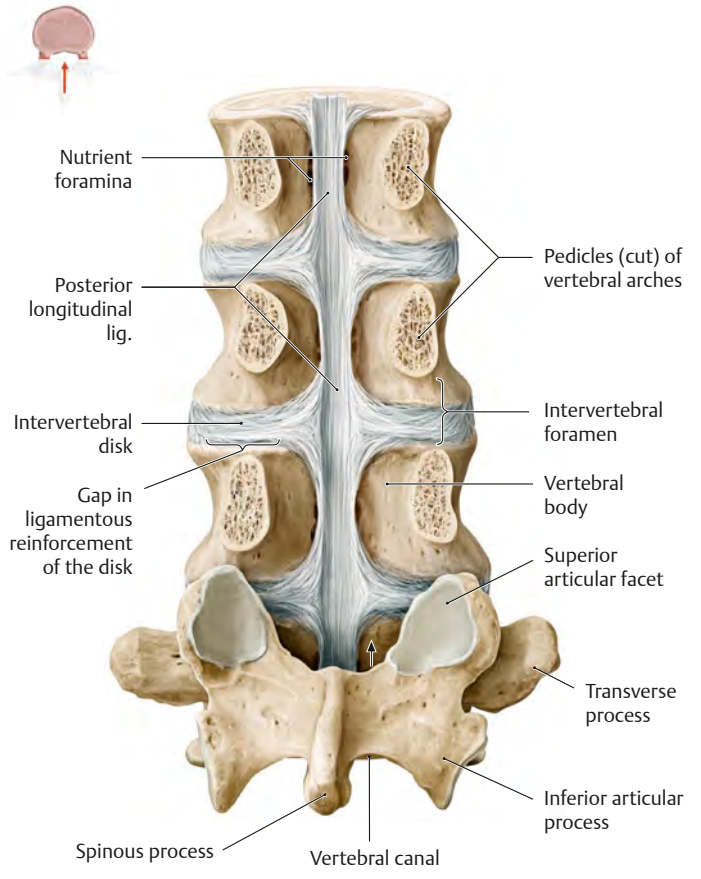


Fig. 2.32 **Posterior longitudinal ligament**
Posterior view of opened vertebral canal at level of L2–L5.
Removed: L2–L4 vertebral arches at pedicular level.



3 Muscles

Muscles of the Back: Overview

The muscles of the back are divided into two groups, the extrinsic and the intrinsic muscles, which are separated by the posterior layer of the thoracolumbar fascia. The superficial extrinsic muscles are considered muscles of the upper limb that have migrated to the back; these muscles are discussed in the Upper Limb, **pp. 312–317.**

Fig. 3.1 **Superficial extrinsic muscles of the back**
Posterior view. *Removed:* Trapezius and latissimus dorsi (right). *Revealed:* Thoracolumbar fascia. *Note:* The posterior layer of the thoracolumbar fascia is reinforced by the aponeurotic origin of the latissimus dorsi.

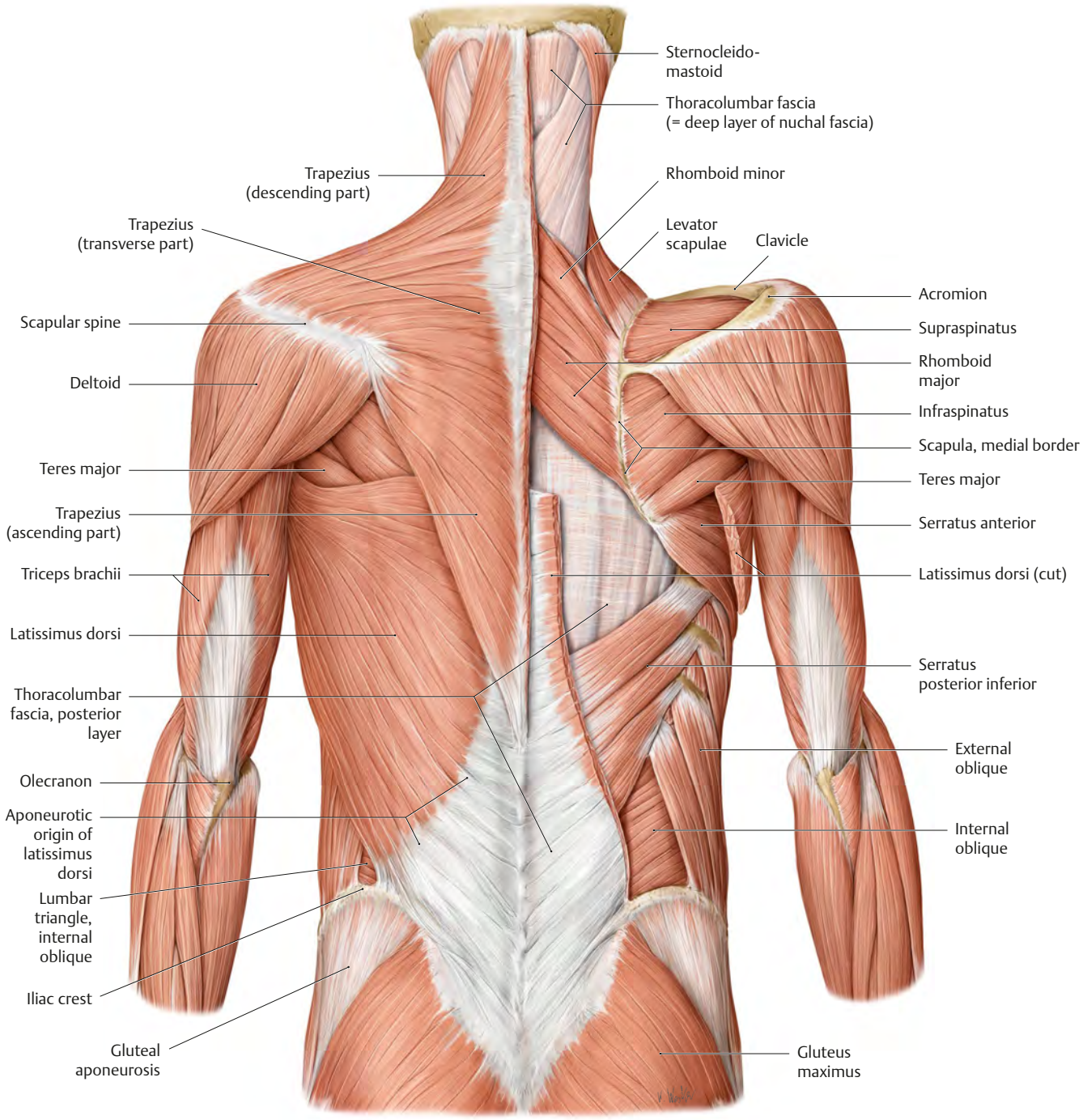
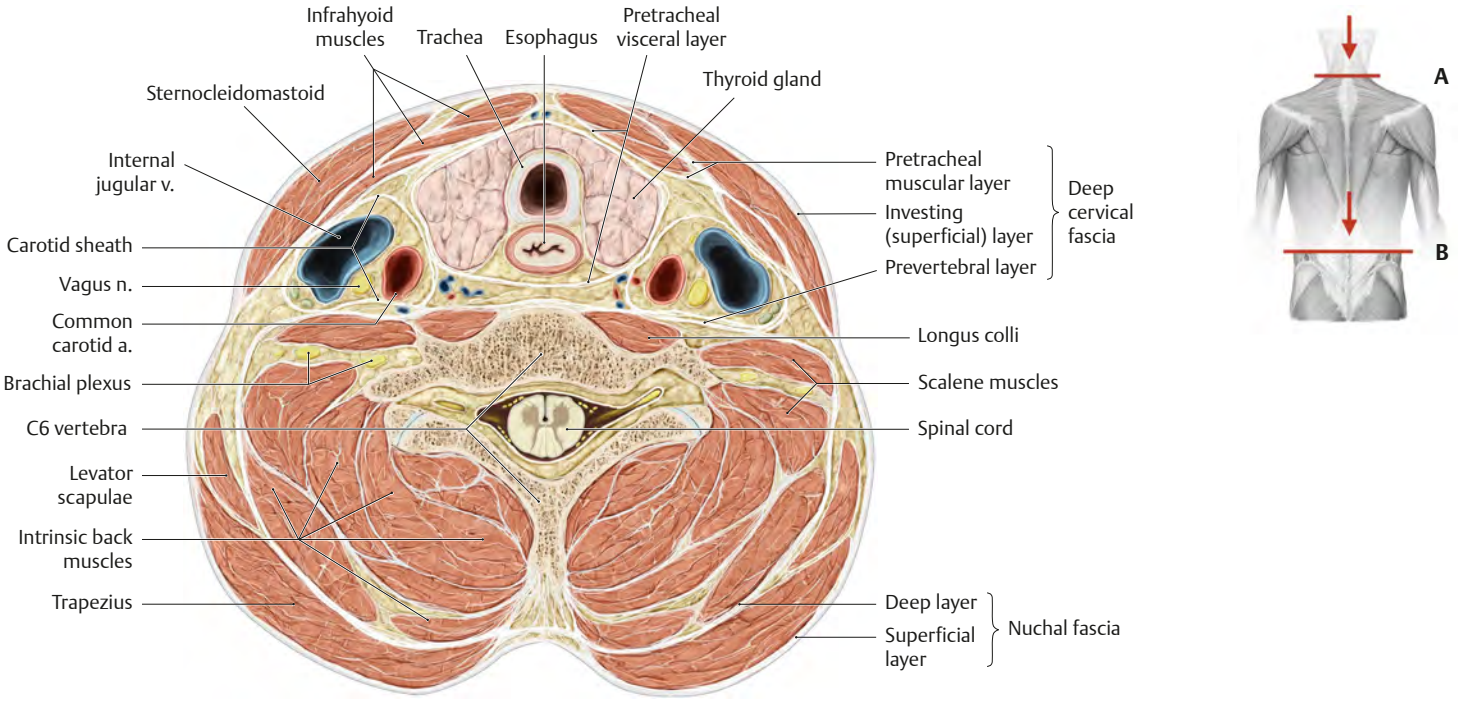
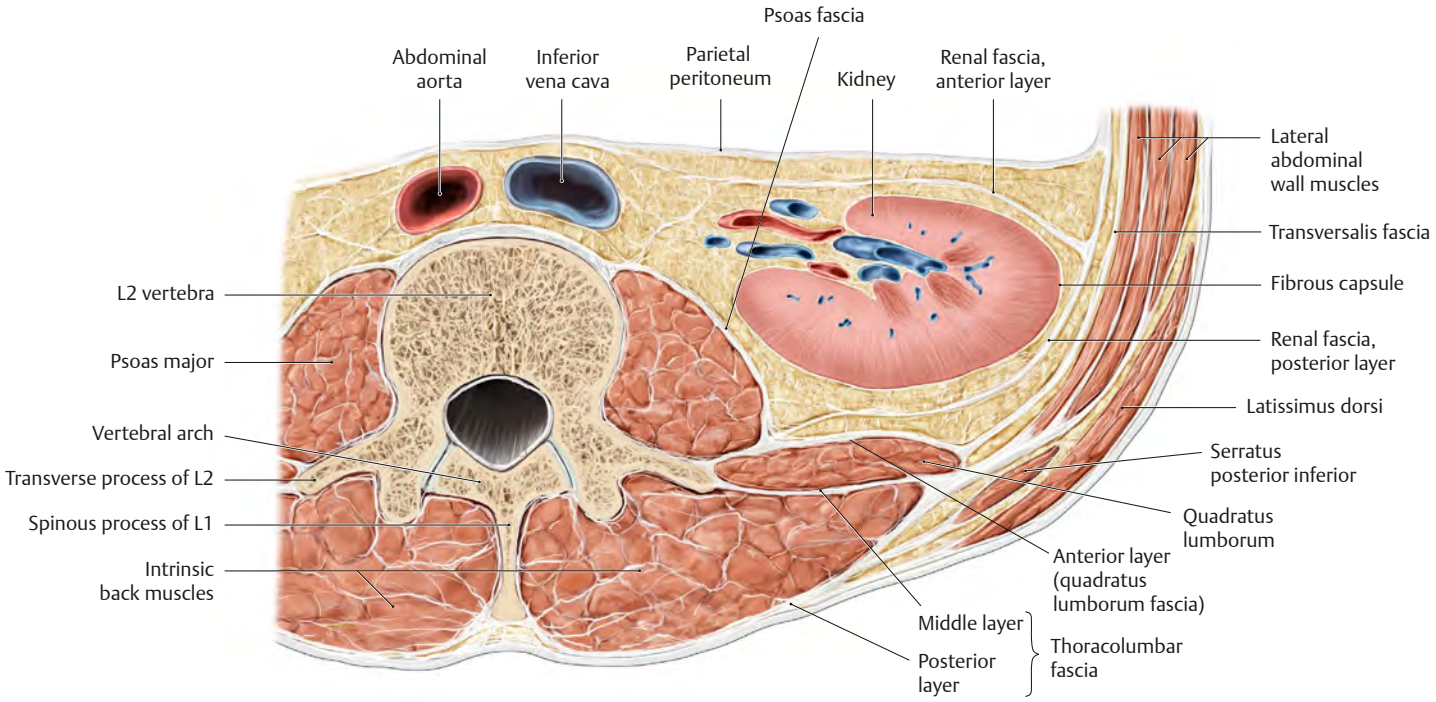


Fig. 3.2 Thoracolumbar fascia

Transverse section, superior view. The intrinsic back muscles are sequestered in an osseofibrous canal, formed by the thoracolumbar fascia, the vertebral arches, and the spinous and transverse processes of associated vertebrae. The thoracolumbar fascia consists of a posterior and middle layer that unite at the lateral margin of the intrinsic back muscles. In the neck, the posterior layer blends with the nuchal fascia (deep layer), becoming continuous with the deep cervical fascia (prevertebral layer).



A Transverse section at level of C6 vertebra, superior view.



B Transverse section at level of L2, superior view.
Removed: Cauda equina and anterior trunk wall.

Fig. 3.3 **Muscles in the nuchal region**
Posterior view. *Removed:* Trapezius, sternocleidomastoid, splenius, and semispinalis muscles (right). *Revealed:* Nuchal muscles (right).

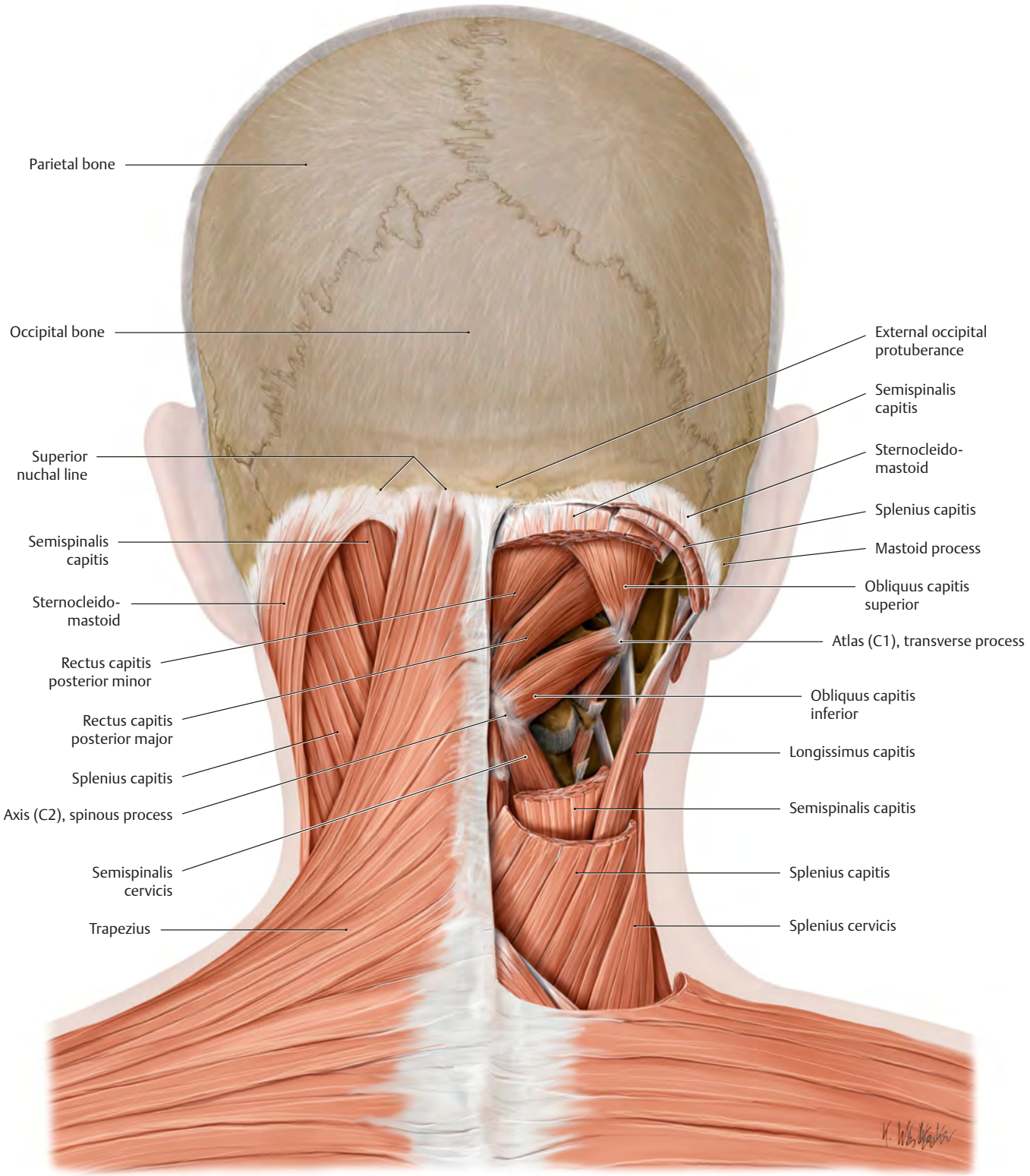
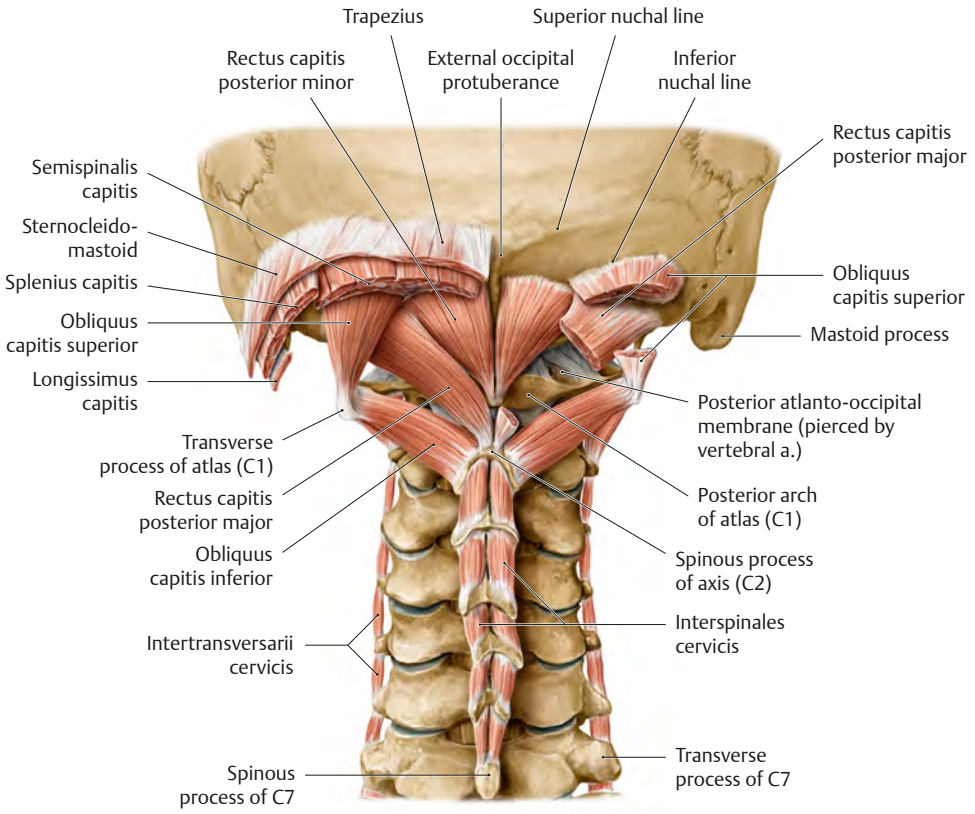
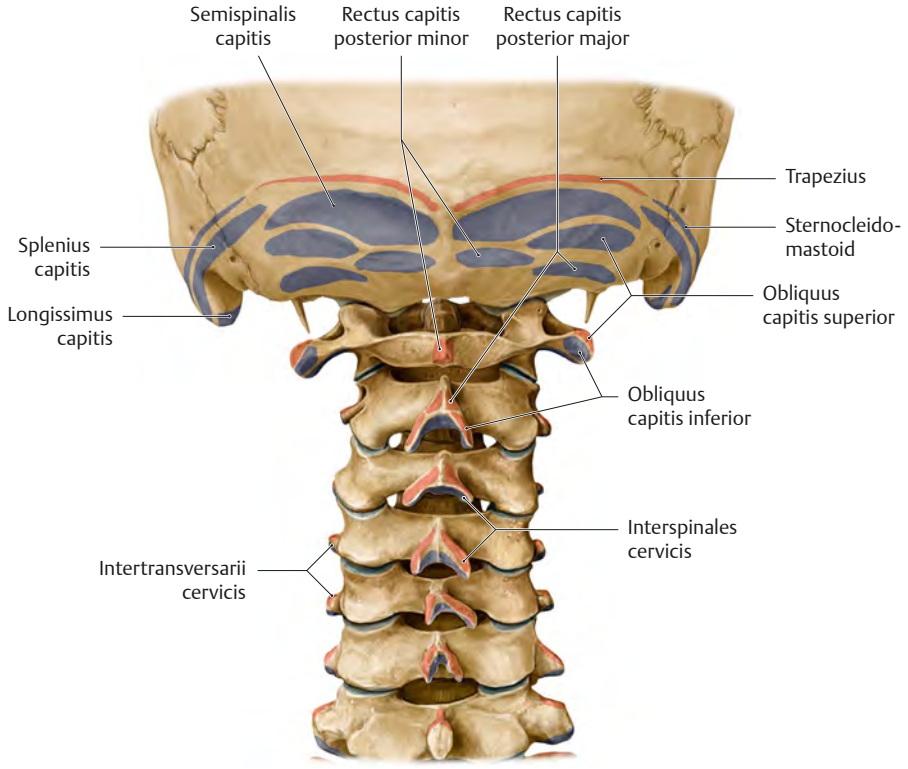


Fig. 3.4 **Short nuchal muscles**

Posterior view. See **Fig. 3.6.** Three of the short nuchal muscles (obliquus capitis inferior, obliquus capitis superior and the rectus capitis posterior major) form the boundaries of the suboccipital triangle (region).



A Course of the short nuchal muscles.

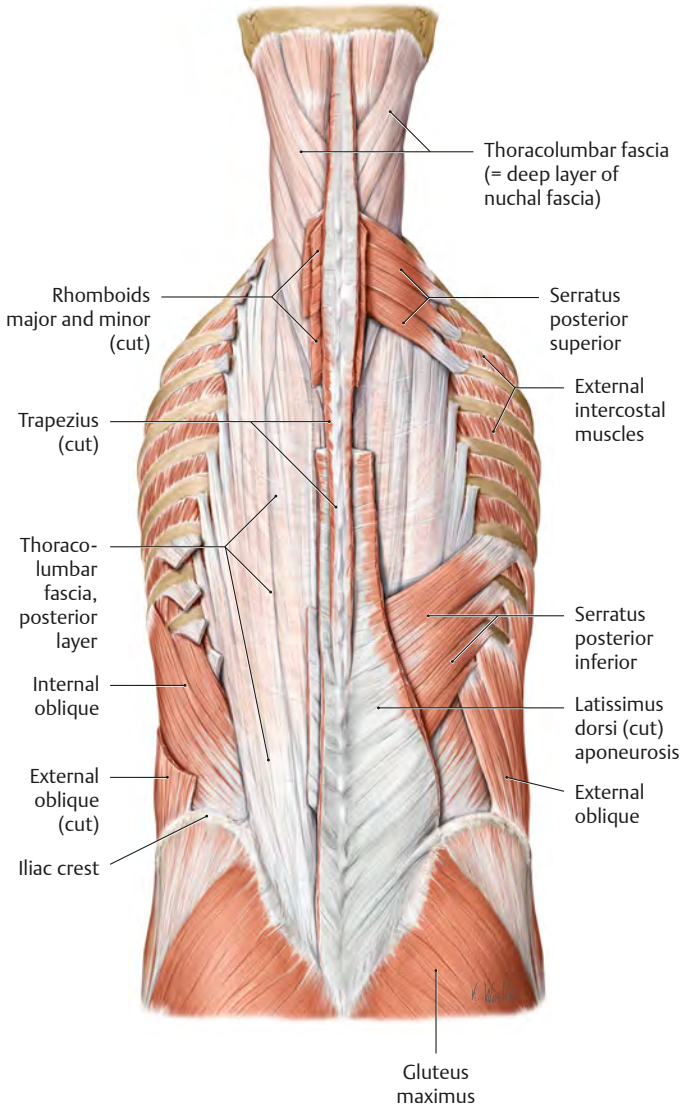


B Suboccipital region. Muscle origins are shown in red, insertions in blue.

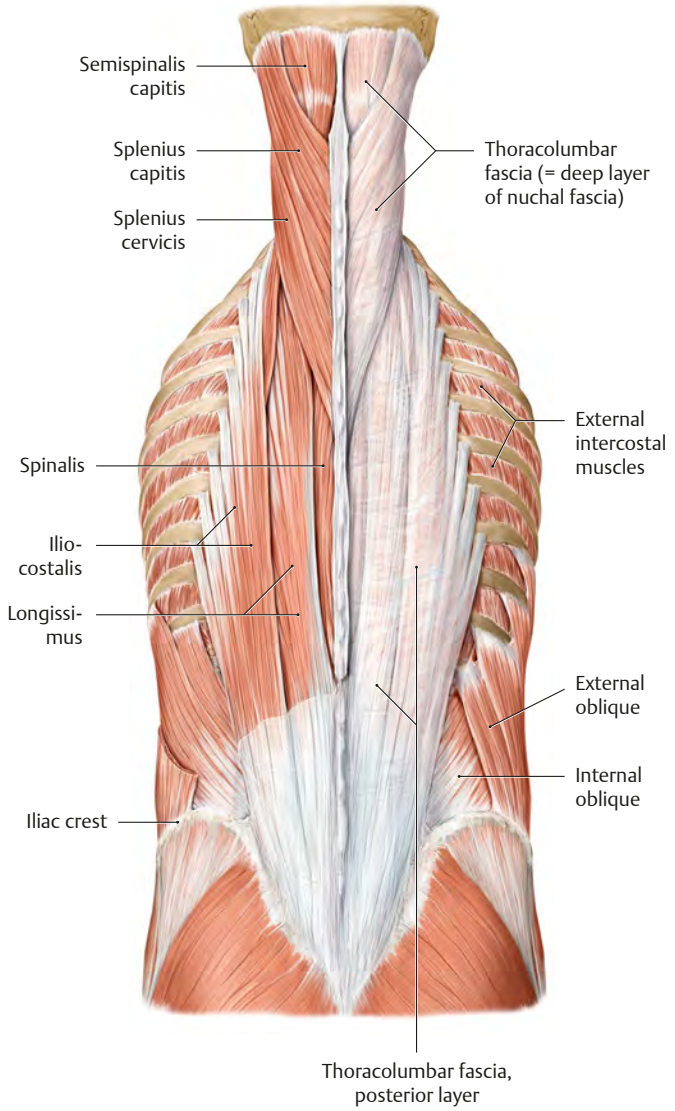
Intrinsic Muscles of the Back

The extrinsic muscles of the back (trapezius, latissimus dorsi, levator scapulae, and rhomboids) are discussed in the Upper Limb, **pp. 312–313.** The serratus posterior, considered an intermediate extrinsic back muscle, has been included with the superficial intrinsic muscles in this unit.

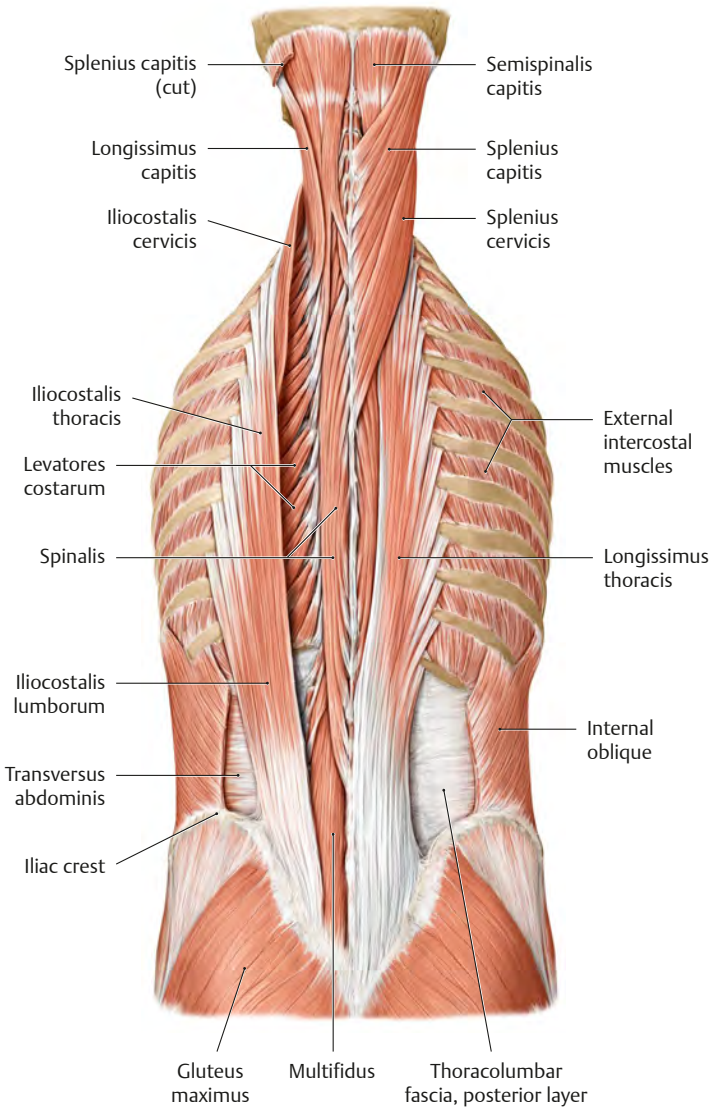
Fig. 3.5 **Intrinsic muscles of the back**
Posterior view. Sequential dissection of the thoracolumbar fascia, superficial intrinsic muscles, intermediate intrinsic muscles, and deep intrinsic muscles of the back.



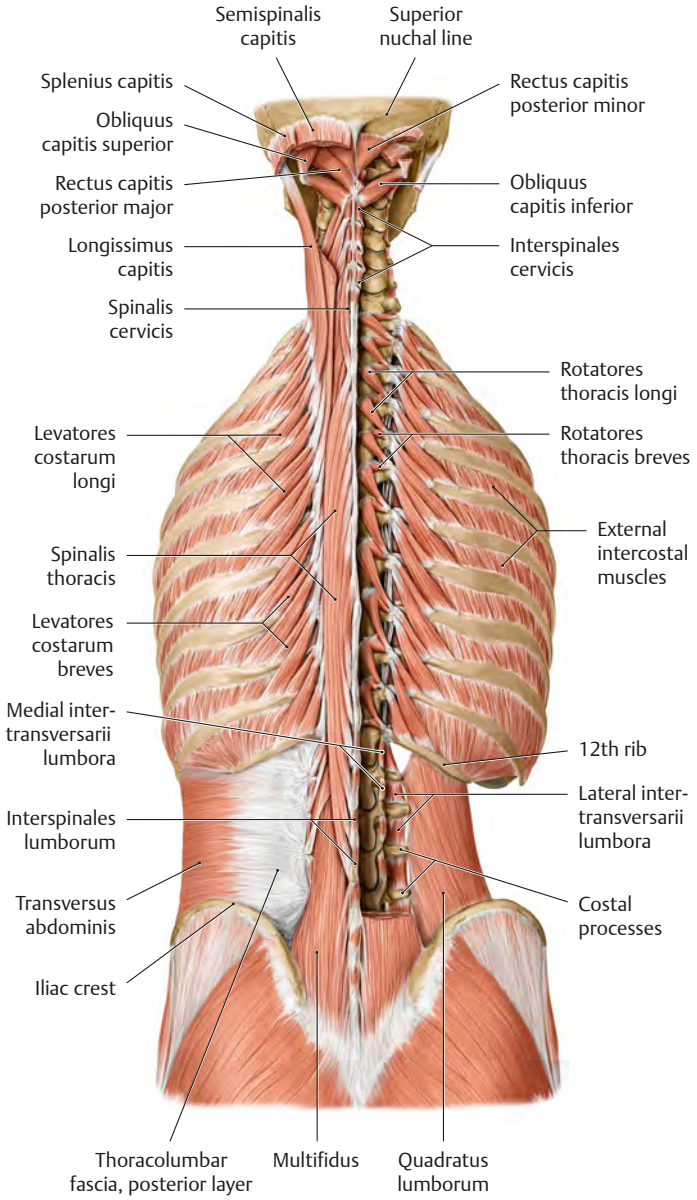
A Thoracolumbar fascia. *Removed:* Shoulder girdles and extrinsic back muscles (except serratus posterior and aponeurotic origin of latissimus dorsi). *Revealed:* Posterior layer of thoracolumbar fascia.



B Superficial and intermediate intrinsic back muscles. *Removed:* Thoracolumbar fascia, posterior layer (left). *Revealed:* Erector spinae and splenius muscles.

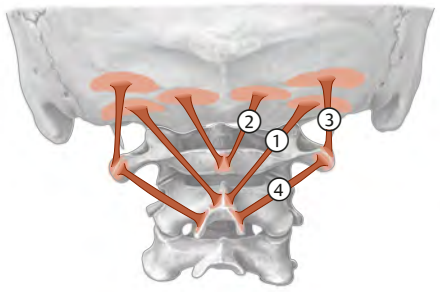


C Intermediate and deep intrinsic back muscles. *Removed:* Longissimus thoracis and cervicis, splenius muscles (left); iliocostalis (right). *Note:* The posterior layer of the thoracolumbar fascia gives origin to the internal oblique and transversus abdominis. *Revealed:* Deep muscles of the back.

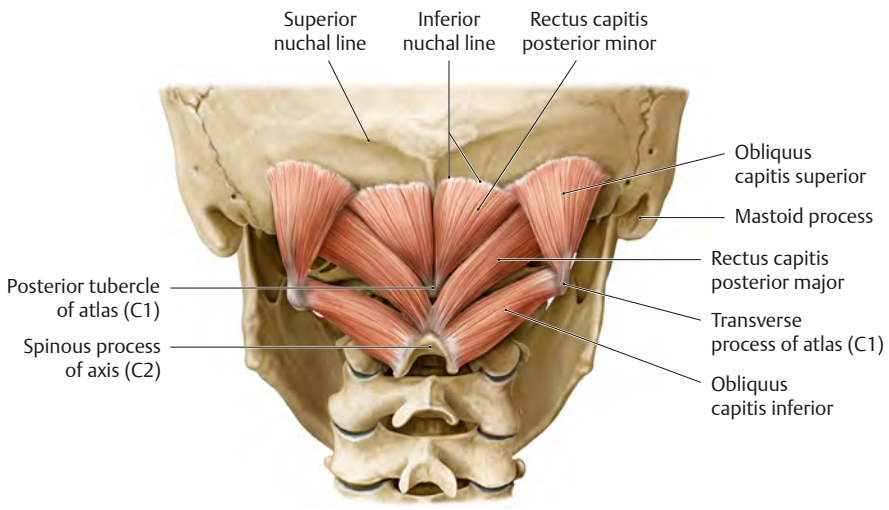


D Deep intrinsic back muscles. *Removed:* Superficial and intermediate intrinsic back muscles (all); deep fascial layer and multifidus (right). *Revealed:* Intertransversarii and quadratus lumborum (right).

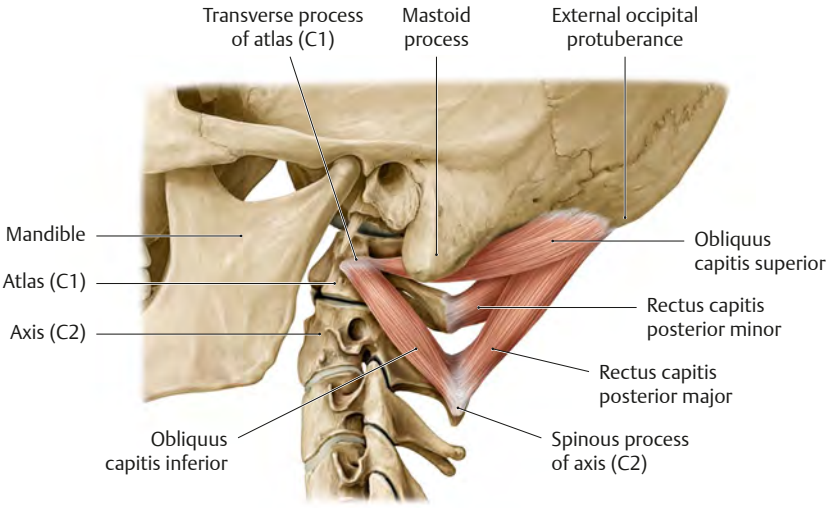
Fig. 3.6 **Short nuchal and craniovertebral joint muscles**



A Posterior view, schematic.



B Suboccipital muscles, posterior view.

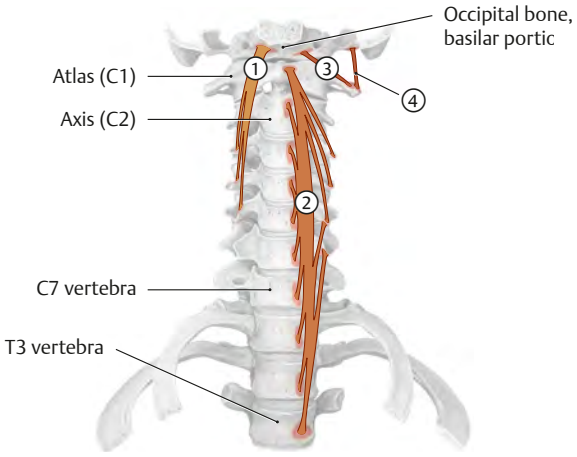


C Suboccipital muscles, left lateral view.

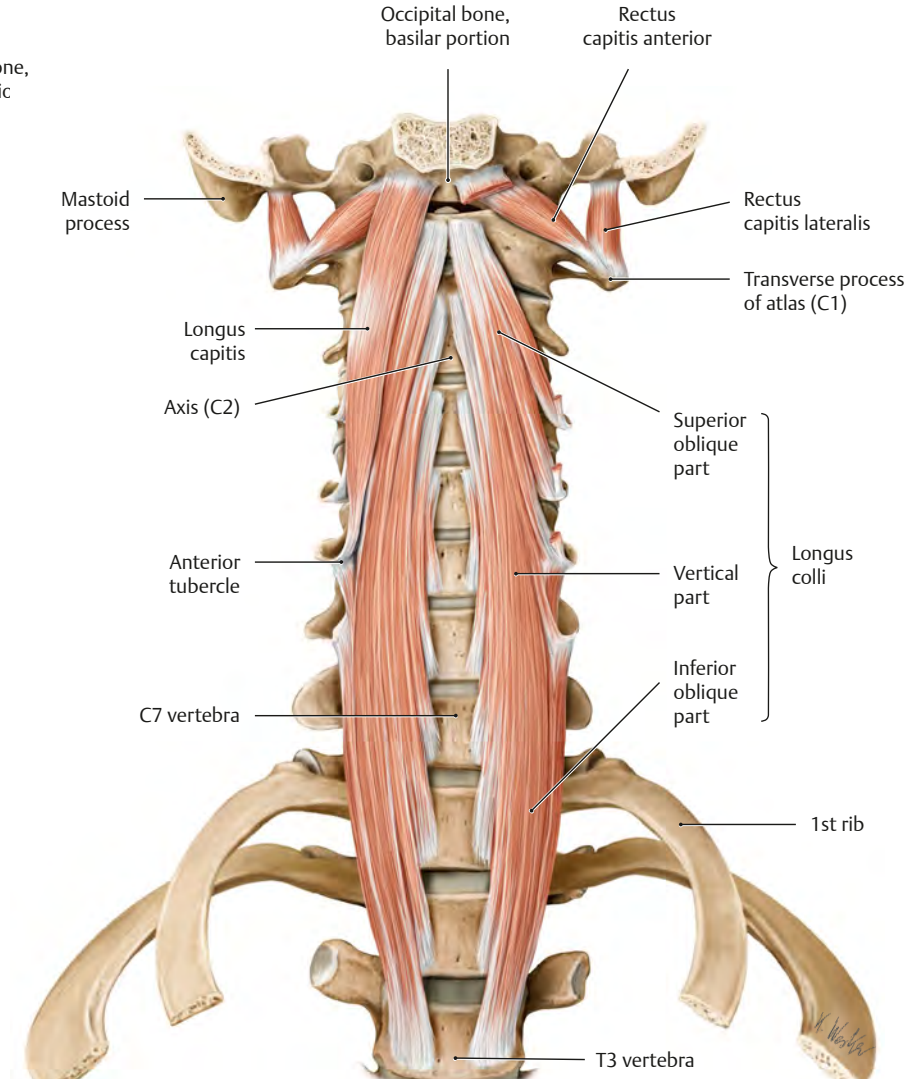
Table 3.1 **Short nuchal and craniovertebral joint muscles**

Muscle		Origin	Insertion	Innervation	Action
Rectus capitis posterior	① Rectus capitis posterior major	C2 (spinous process)	Occipital bone (inferior nuchal line, middle third)	C1 (posterior ramus = suboccipital n.)	*Bilateral:* Extends head *Unilateral:* Rotates head to same side
	② Rectus capitis posterior minor	C1 (posterior tubercle)	Occipital bone (inferior nuchal line, inner third)		
Obliquus capitis	③ Obliquus capitis superior	C1 (transverse process)	Occipital bone (inferior nuchal line, middle third; above rectus capitis posterior major)		*Bilateral:* Extends head *Unilateral:* Flexes head to same side; rotates to opposite side
	④ Obliquus capitis inferior	C2 (spinous process)	C1 (transverse process)		*Bilateral:* Extends head *Unilateral:* Rotates head to same side

Fig. 3.7 **Prevertebral muscles**



A Anterior view, schematic.



B Prevertebral muscles, anterior view. *Removed:* Longus capitis (left); cervical viscera.

Table 3.2 **Prevertebral muscles**

Muscle		Origin	Insertion	Innervation	Action
① Longus capitis		C3–C6 (transverse processes, anterior tubercles)	Occipital bone (basilar part)	Direct branches from cervical plexus (C1–C3)	*Bilateral:* Flexes head *Unilateral:* Flexes and slightly rotates head to same side
② Longus colli (cervicis)	Vertical (medial) part	C5–T3 (anterior sides of vertebral bodies)	C2–C4 (anterior sides of vertebral bodies)	Direct branches from cervical plexus (C2–C6)	*Bilateral:* Flexes cervical spine *Unilateral:* Flexes and rotates cervical spine to same side
	Superior oblique part	C3–C5 (transverse processes, anterior tubercles)	C1 (transverse process, anterior tubercle)		
	Inferior oblique part	T1–T3 (anterior sides of vertebral bodies)	C5–C6 (transverse processes, anterior tubercles)		
③ Rectus capitis anterior		C1 (lateral mass)	Occipital bone (basilar part)	C1 (anterior ramus)	*Bilateral:* Flexion at atlanto-occipital joint *Unilateral:* Lateral flexion at atlanto-occipital joint
④ Rectus capitis lateralis		C1 (transverse process)	Occipital bone (basilar part, lateral to occipital condyles)		

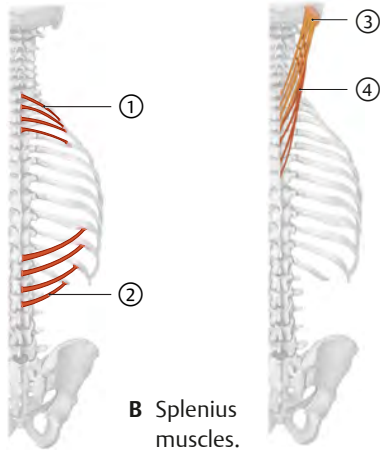
Muscle Facts (II)

The intrinsic back muscles are divided into superficial, intermediate, and deep layers. The serratus posterior muscles are extrinsic back muscles, innervated by the anterior rami of intercostal nerves, not the posterior rami, which innervate the intrinsic back muscles. They are included here as they are encountered in dissection of the back musculature.

Table 3.3 Superficial intrinsic back muscles

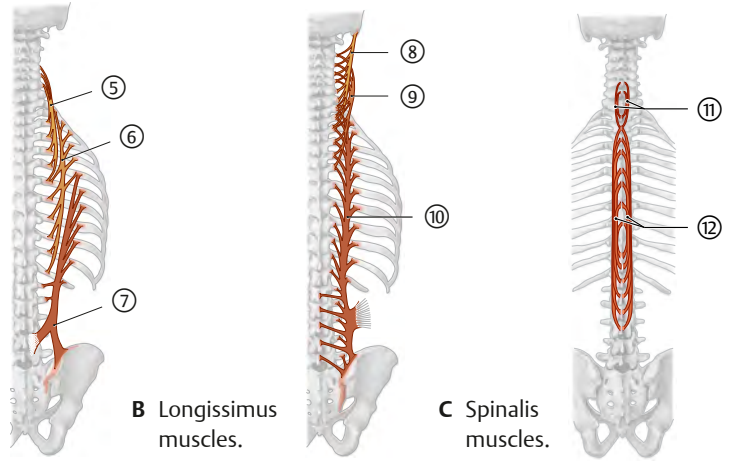
Muscle		Origin	Insertion	Innervation	Action
Serratus posterior	① Serratus posterior superior	Nuchal lig.; C7–T3 (spinous processes)	2nd–4th ribs (superior borders)	Spinal nn. T2–T5 (anterior rami)	Elevates ribs
	② Serratus posterior inferior	T11–L2 (spinous processes)	8th–12th ribs (inferior borders, near angles)	Spinal nn. T9–T12 (anterior rami)	Depresses ribs
Splenius	③ Splenius capitis	Nuchal lig.; C7–T3 or T4 (spinous processes)	Lateral 1/3 nuchal line (occipital bone); mastoid process (temporal bone)	Spinal nn. C1–C6 (posterior rami, lateral branches)	*Bilateral:* Extends cervical spine and head *Unilateral:* Laterally flexes and rotates head to the same side
	④ Splenius cervicis	T3–T6 or T7 (spinous processes)	C1–C3/4 (transverse processes)		

***Fig. 3.8* Superficial intrinsic back muscles, schematic**
Right side, posterior view.



A Serratus posterior. **B** Splenius muscles.

***Fig. 3.9* Intermediate intrinsic back muscles, schematic**
Right side, posterior view. These muscles are collectively known as the erector spinae.

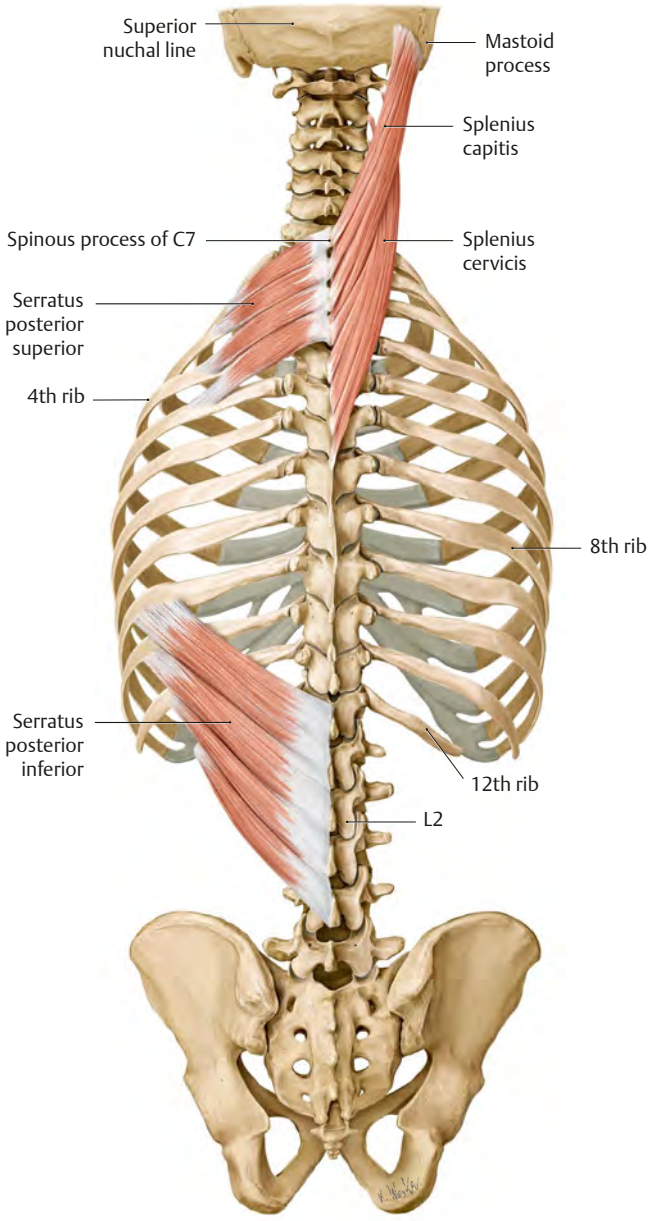


A Iliocostalis muscles. **B** Longissimus muscles. **C** Spinalis muscles.

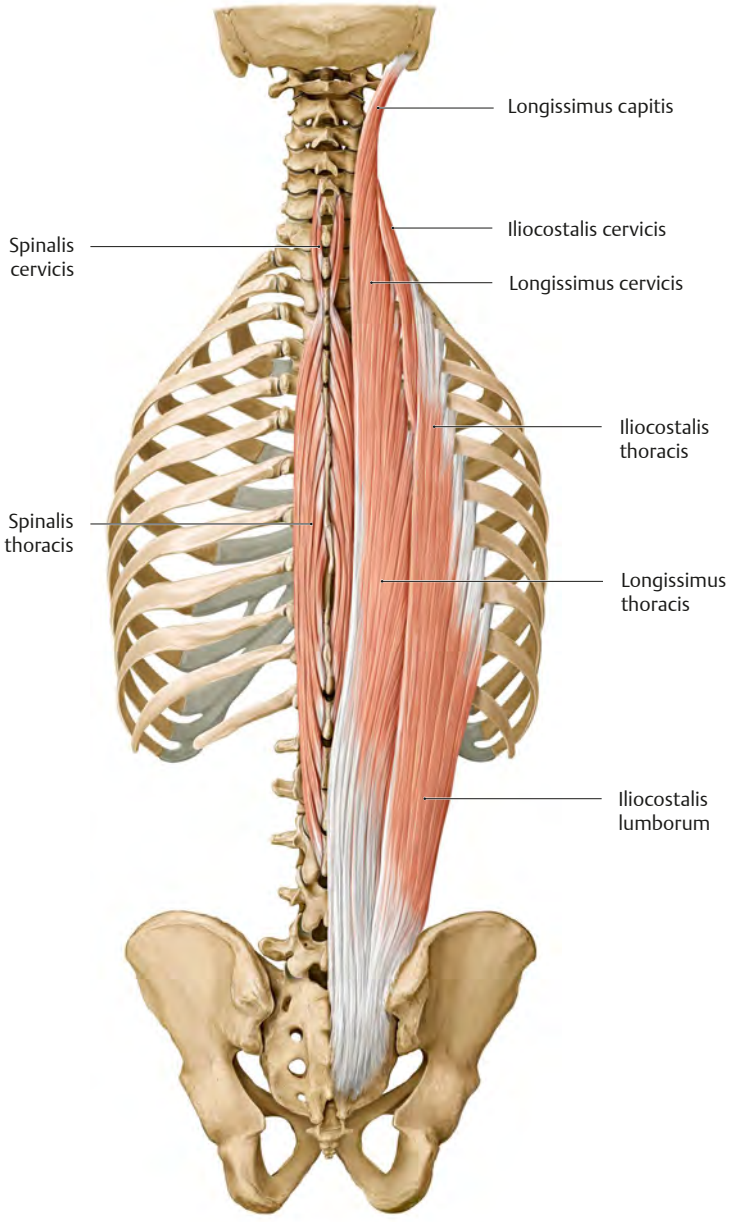
Table 3.4 Intermediate intrinsic back muscles (erector spinae)

Muscle		Origin	Insertion	Innervation	Action
Iliocostalis	⑤ Iliocostalis cervicis	3rd–7th ribs	C4–C6 (transverse processes)	Spinal nn. C8–L1 (posterior rami, lateral branches)	*Bilateral:* Extends spine *Unilateral:* Flexes spine laterally to same side
	⑥ Iliocostalis thoracis	7th–12th ribs	1st–6th ribs		
	⑦ Iliocostalis lumborum	Sacrum; iliac crest; thoracolumbar fascia (posterior layer)	6th–12th ribs; thoracolumbar fascia (posterior layer); upper lumbar vertebrae (transverse processes)		
Longissimus	⑧ Longissimus capitis	T1–T3 (transverse processes); C4–C7 (transverse and articular processes)	Temporal bone (mastoid process)	Spinal nn. C1–L5 (posterior rami, lateral branches)	*Bilateral:* Extends head *Unilateral:* Flexes and rotates head to same side
	⑨ Longissimus cervicis	T1–T6 (transverse processes)	C2–C5 (transverse processes)		*Bilateral:* Extends spine *Unilateral:* Flexes spine laterally to same side
	⑩ Longissimus thoracis	Sacrum; iliac crest; lumbar vertebrae (spinous processes); lower thoracic vertebrae (transverse processes)	2nd–12th ribs; thoracic and lumbar vertebrae (transverse processes)		
Spinalis	⑪ Spinalis cervicis	C5–T2 (spinous processes)	C2–C5 (spinous processes)	Spinal nn. (posterior rami)	*Bilateral:* Extends cervical and thoracic spine *Unilateral:* Flexes cervical and thoracic spine to same side
	⑫ Spinalis thoracis	T10–L3 (spinous processes, lateral surfaces)	T2–T8 (spinous processes, lateral surfaces)		

Fig. 3.10 **Superficial and intermediate intrinsic back muscles**
Posterior view.



A Superficial back muscles:
Splenius and serratus posterior muscles.



B Intermediate intrinsic back muscles (erector spinae): Iliocostalis, longissimus, and spinalis muscles.

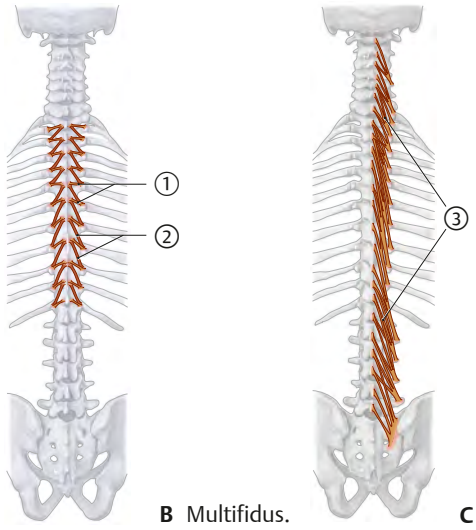
Muscle Facts (III)

The deep intrinsic back muscles are divided into two groups: transversospinalis and deep segmental muscles. The transversospinalis muscles pass between the transverse and spinous processes of the vertebrae.

Table 3.5 Transversospinalis muscles

Muscle		Origin	Insertion	Innervation	Action
Rotatores	① Rotatores breves	T1–T12 (between transverse and spinous processes of adjacent vertebrae)		Spinal nn. (posterior rami)	*Bilateral:* Extends thoracic spine *Unilateral:* Rotates thoracic spine to opposite side
	② Rotatores longi	T1–T12 (between transverse and spinous processes, skipping one vertebra)			
Multifidus ③		Sacrum, ilium, mamillary processes of L1–L5, transverse and articular processes of T1–T4, C4–C7	Superomedially to spinous processes, skipping two to four vertebrae		*Bilateral:* Extends spine *Unilateral:* Flexes spine to same side, rotates it to opposite side
Semispinalis	④ Semispinalis capitis	C4–T7 (transverse and articular processes)	Occipital bone (between superior and inferior nuchal lines)		*Bilateral:* Extends thoracic and cervical spines and head (stabilizes craniovertebral joints)
	⑤ Semispinalis cervicis	T1–T6 (transverse processes)	C2–C5 (spinous processes)		*Unilateral:* Flexes head, cervical and thoracic spines to same side, rotates to opposite side
	⑥ Semispinalis thoracis	T6–T12 (transverse processes)	C6–T4 (spinous processes)		

***Fig. 3.11* Transversospinalis muscles**
Posterior view, schematic.



A Rotatores muscles. **B** Multifidus. **C** Semispinalis.

***Fig. 3.12* Deep segmental muscles**
Posterior view, schematic.

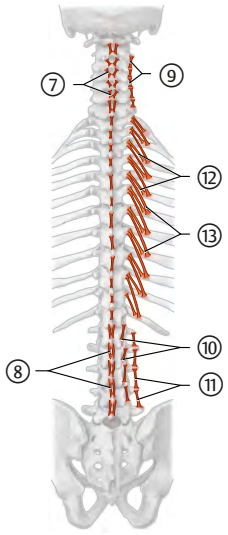
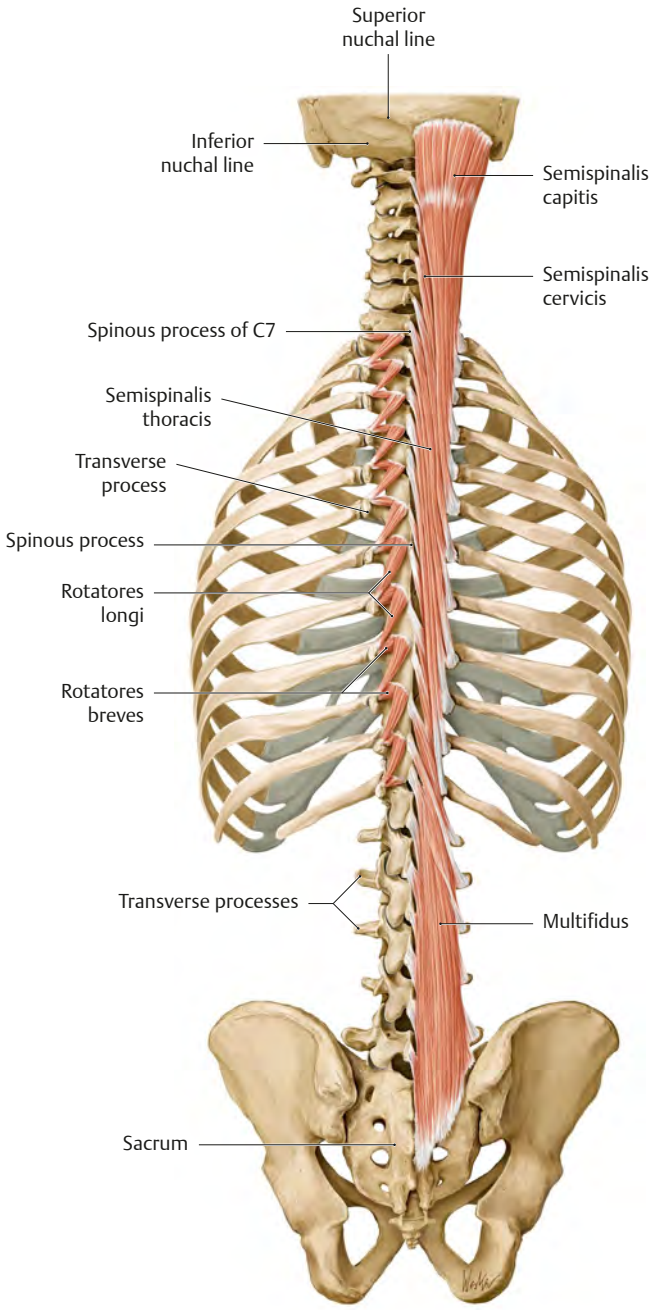


Table 3.6 Deep segmental back muscles

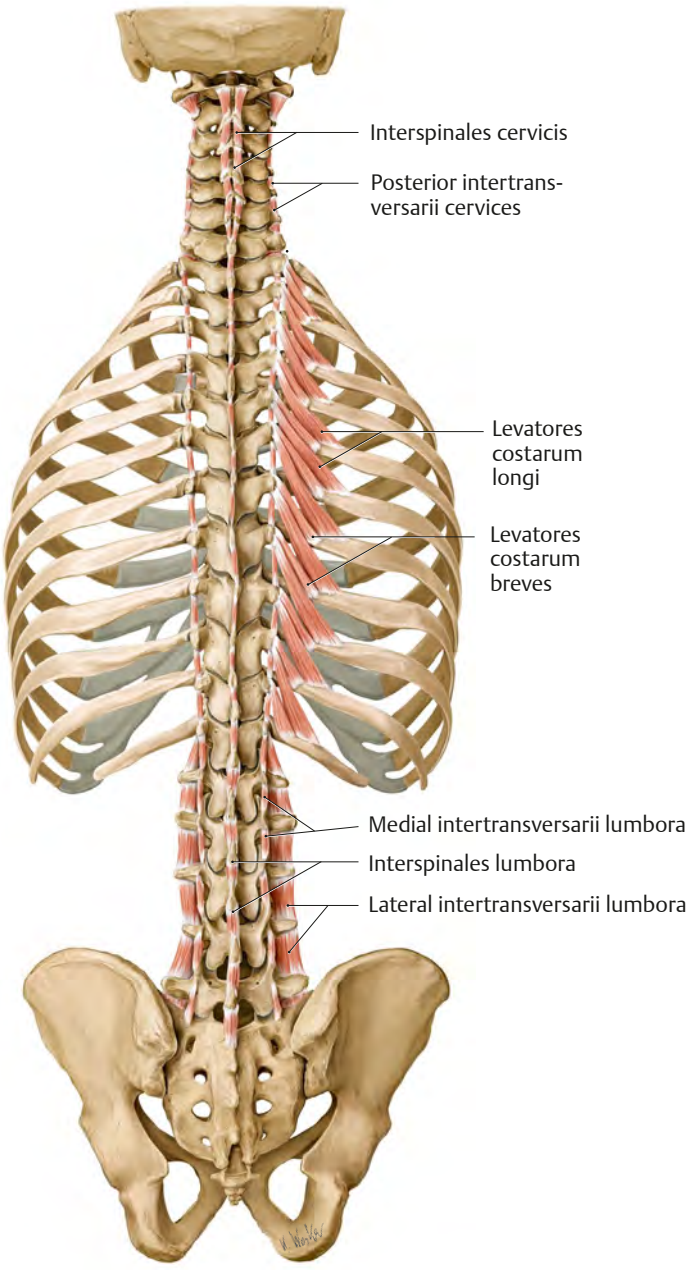
Muscle		Origin	Insertion	Innervation	Action
Interspinales*	⑦ Interspinales cervicis	C1–C7 (between spinous processes of adjacent vertebrae)		Spinal nn. (posterior rami)	Extends cervical and lumbar spines
	⑧ Interspinales lumbora	L1–L5 (between spinous processes of adjacent vertebrae)			*Bilateral:* Stabilizes and extends the cervical and lumbar spines *Unilateral:* Flexes the cervical and lumbar spines laterally to same side
Inter-transversarii*	Anterior intertransversarii cervices	C2–C7 (between anterior tubercles of adjacent vertebrae)		Spinal nn. (anterior rami)	
	⑨ Posterior intertransversarii cervices	C2–C7 (between posterior tubercles of adjacent vertebrae)		Spinal nn. (posterior rami)	
	⑩ Medial intertransversarii lumbora	L1–L5 (between mammillary processes of adjacent vertebrae)			
	⑪ Lateral intertransversarii lumbora	L1–L5 (between transverse processes of adjacent vertebrae)		Spinal nn. (anterior rami)	
Levatores costarum	⑫ Levatores costarum breves	C7–T11 (transverse processes)	Costal angle of next lower rib	Spinal nn. (posterior rami)	*Bilateral:* Extends thoracic spine *Unilateral:* Flexes thoracic spine to same side, rotates to opposite side
	⑬ Levatores costarum longi		Costal angle of rib two vertebrae below		

*Both the interspinales and intertransversarii muscles traverse the entire spine; only their clinically relevant components have been included.

Fig. 3.13 **Deep intrinsic back muscles**
Posterior view.



A Transversospinalis muscles: Rotatores, multifidus, and semispinalis.



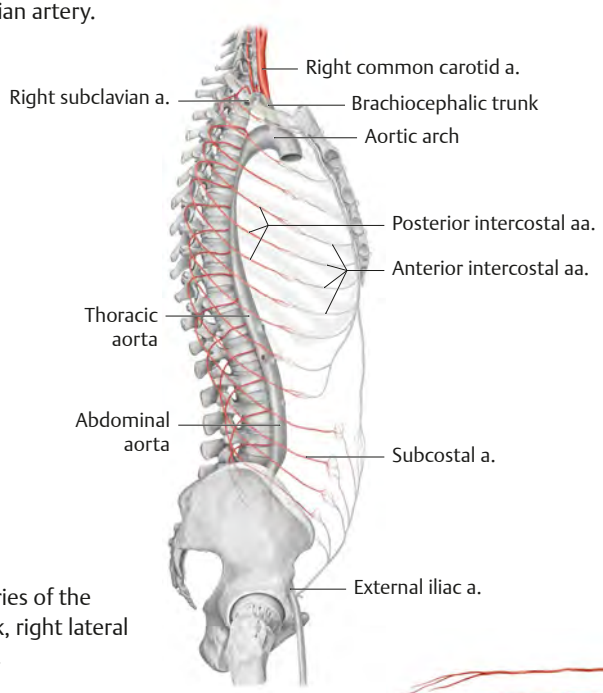
B Deep segmental muscles: Interspinales, intertransversarii, and levatores costarum.

4 Neurovasculature

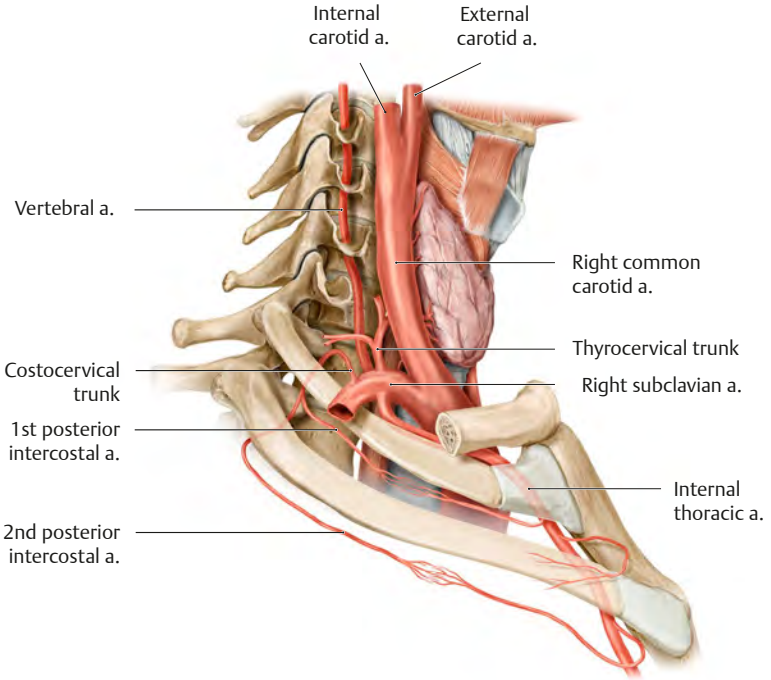
Arteries & Veins of the Back

Fig. 4.1 **Arteries of the back**

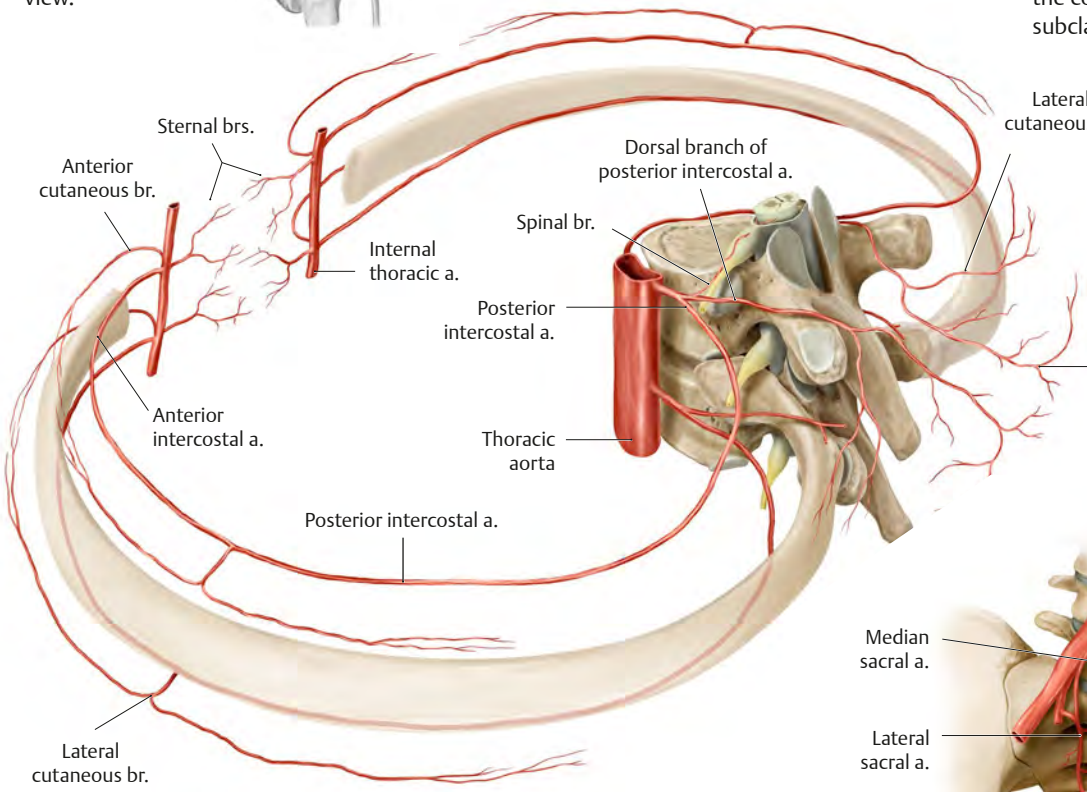
The structures of the back are supplied by branches of the posterior intercostal arteries, which arise from the thoracic aorta or from the subclavian artery.



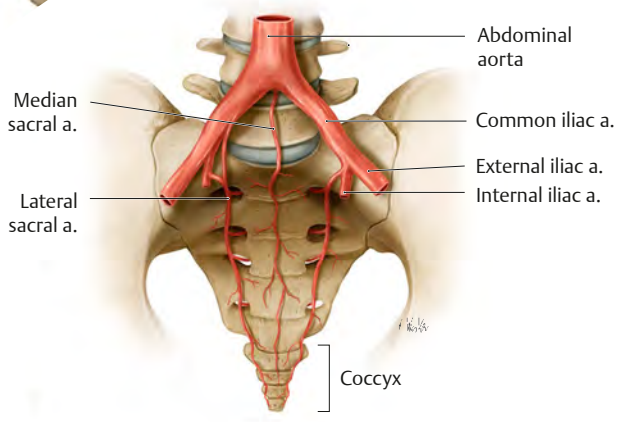
A Arteries of the trunk, right lateral view.



B Vascular supply to the nuchal region, posterolateral view. *Note:* The first and second posterior intercostal arteries arise from the costocervical trunk, a branch of the subclavian artery.



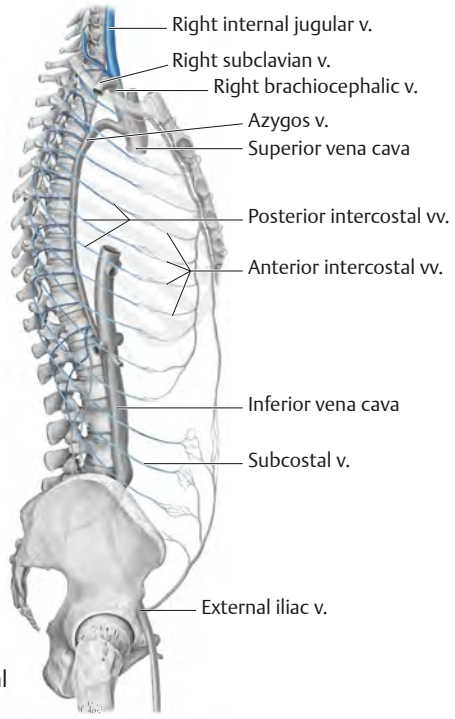
C Posterior intercostal arteries, oblique posterosuperior view. The posterior intercostal arteries give rise to cutaneous and muscular branches, as well as spinal branches that supply the spinal cord.



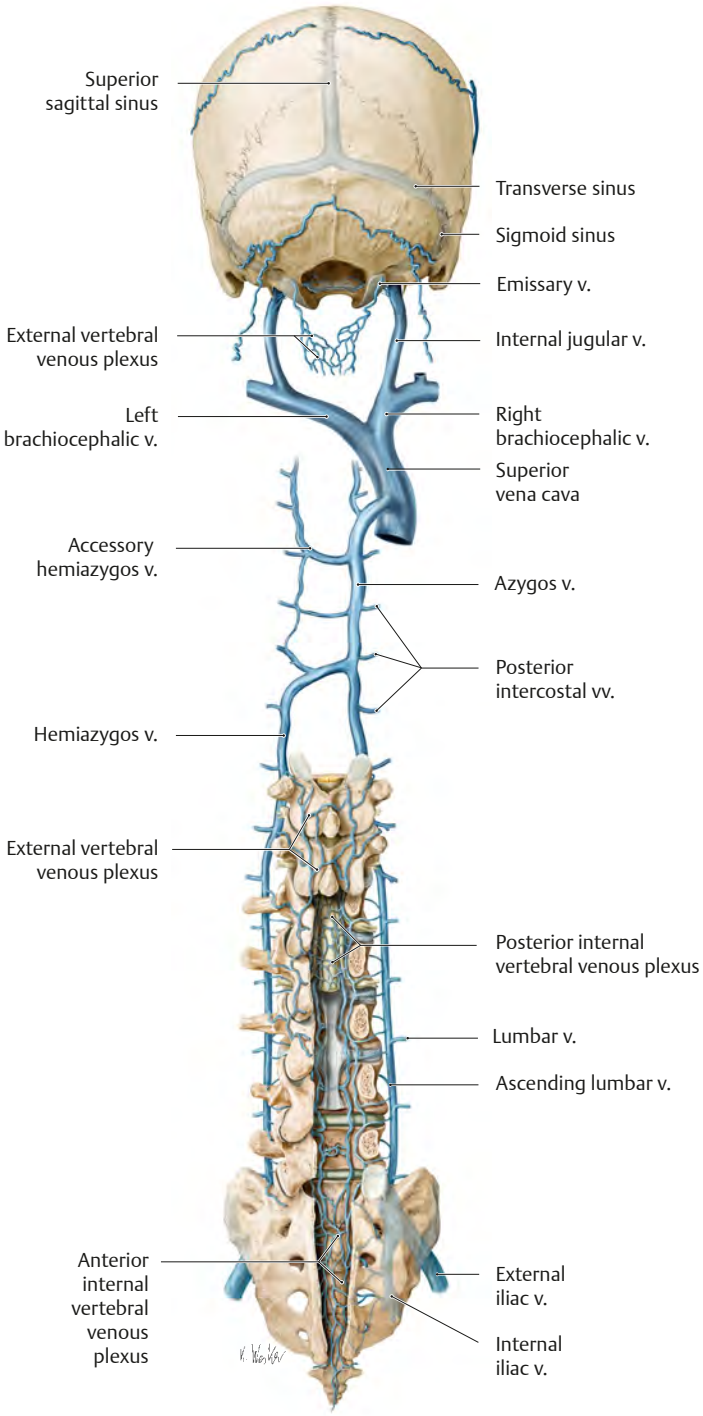
D Vascular supply to the sacrum, anterior view.

Fig. 4.2 Veins of the back

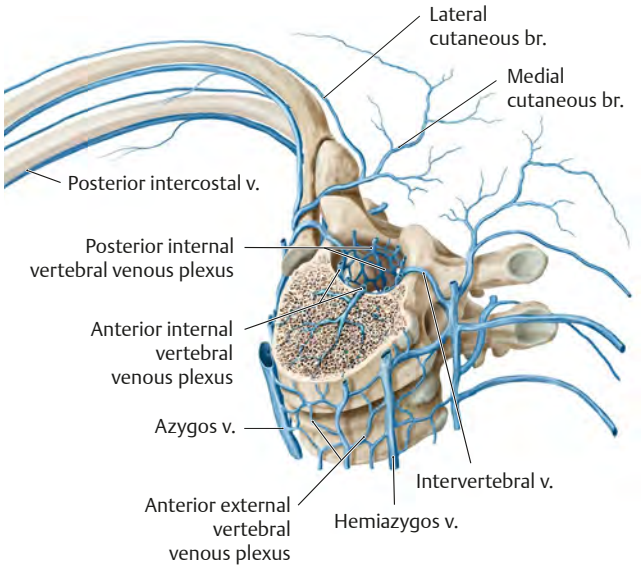
The veins of the back drain into the azygos vein via the posterior intercostal veins, hemiazygos vein, and ascending lumbar veins. The interior of the spinal column is drained by the vertebral venous plexus that runs the length of the spine.



A Veins of the trunk, right lateral view.



B Vertebral venous plexus, posterior view with vertebral canal windowed in the lumbar and sacral spine. The external vertebral venous plexus communicates with the sigmoid sinus through emissary veins in the skull. The *external* vertebral venous plexus is divided into an anterior and a posterior portion that run along the exterior of the vertebral column. The anterior and posterior *internal* vertebral venous plexus run in the vertebral foramen and drain the spinal cord.



C Intercostal veins and anterior vertebral venous plexus, anterosuperior view. The intercostal veins follow a similar course to the intercostal nerves and arteries (see **pp. 36, 38**). *Note:* The anterior external vertebral venous plexus can be seen communicating with the azygos vein.

Nerves of the Back

The back receives its innervation from branches of the spinal nerves. The *posterior (dorsal) rami* of the spinal nerves supply most of the intrinsic muscles of the back. The extrinsic muscles of the back are supplied by the *anterior (ventral) rami* of the spinal nerves.

Fig. 4.3 **Nerves of the back**
Cross section of the vertebral column and spinal cord with surrounding musculature, superior view.

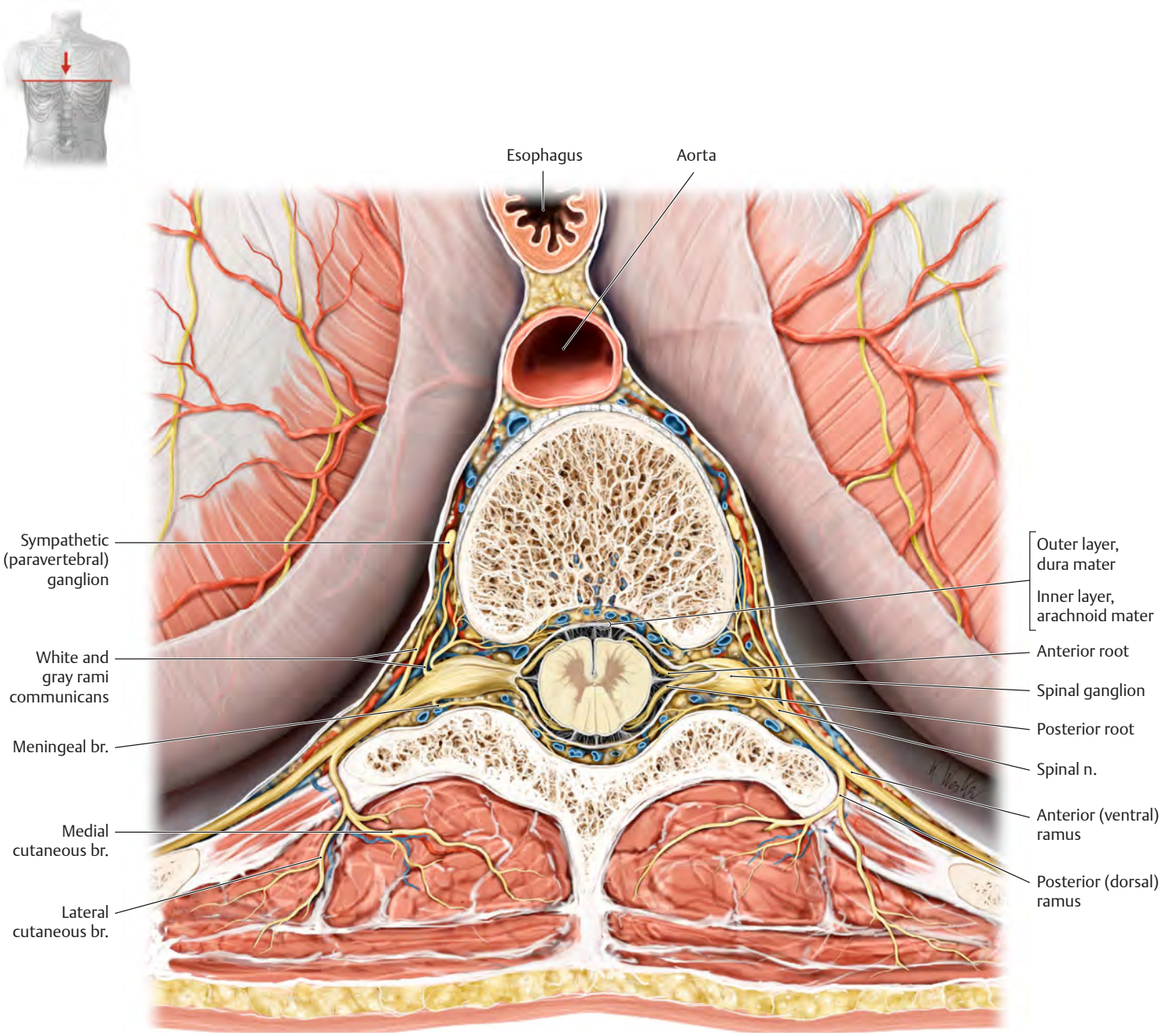


Fig. 4.4 Nerves of the nuchal region

Right side, posterior view.

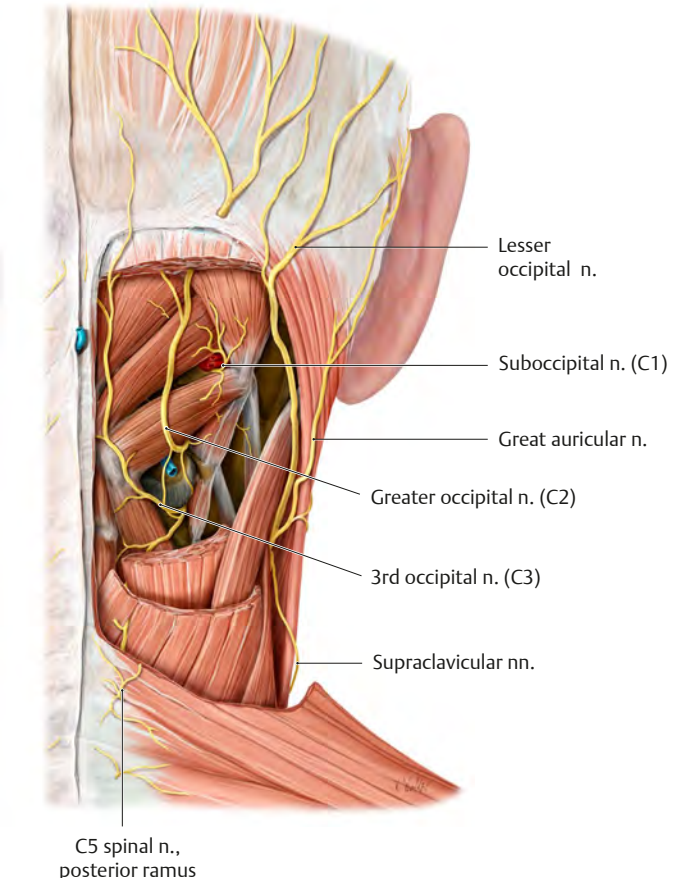


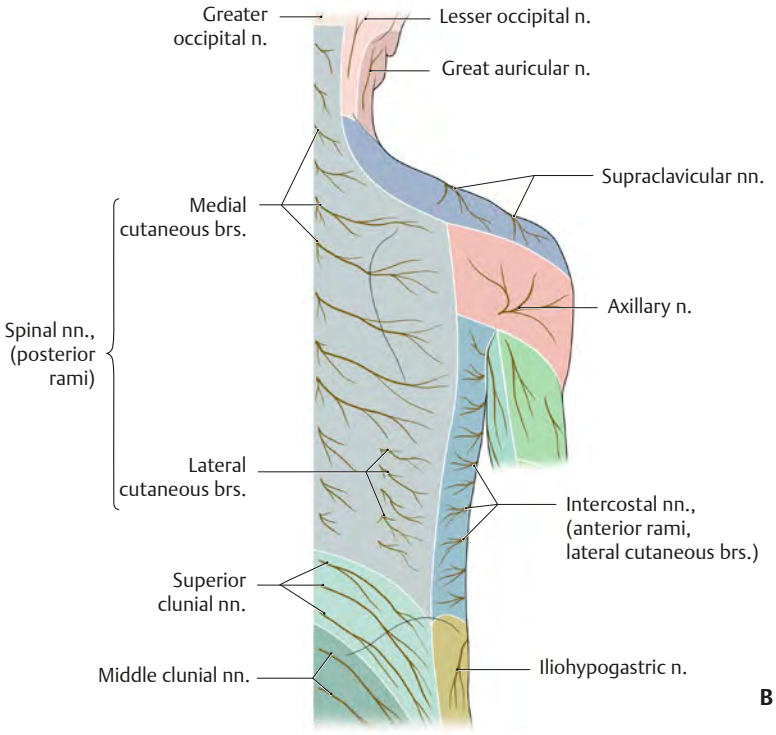
Table 4.1 Nerves of the nuchal region

Branches		Function
Posterior (dorsal) ramus	Suboccipital n. (C1)	Innervates the rectus capitis posterior major and minor; and obliquus capitis superior and inferior
	Greater occipital n. (C2)	Assits in the innervation of the semispinalis capitis muscle and supplies skin behind the auricle and the scalp to the coronal suture
	Third occipital n. (C3)	Assists in the innervation of the semispinalis capitis muscle, the C2-C3 facet joint, and supplies a small area of skin just below the superior nuchal line
Anterior (ventral) ramus	Lesser occipital n. (C2)	Cutaneous only, supplies an area of scalp posterolateral to the auricle, and the skin on the upper third of the medial aspect of the auricle
	Greater auricular n. (C2, C3)	Cutaneous only, supplies an area of skin over the parotid gland, the majority of the pinna, lateral neck, and posterior to the auricle

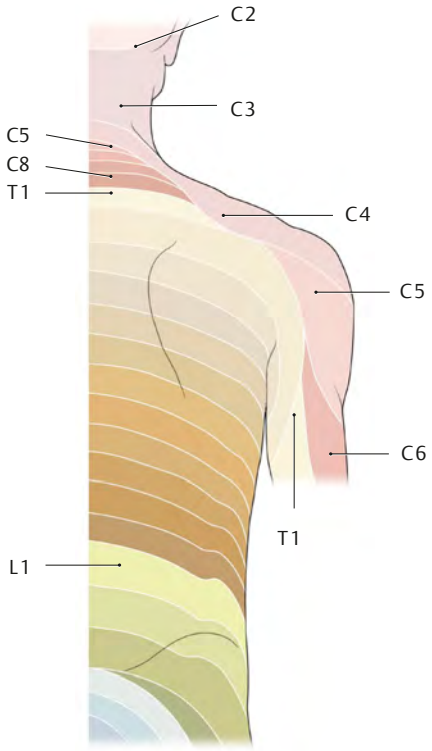
The anterior rami of C1-C3 also give rise to the ansa cervicalis, which innervates the infrahyoid muscles (see **p. 524).

Fig. 4.5 Cutaneous innervation of the back

Color denotes the skin areas innervated by (**A**) particular peripheral nerves or (**B**) particular pairs of segmental spinal nerves. Patterns of loss of cutaneous sensation can be helpful in diagnosis of nerve lesions.



A Cutaneous innervation patterns of specific peripheral nerves.



B Dermatomes: Dermatomes are bilateral band-like areas of skin receiving innervation from a single pair of spinal nerves (from a single segment of the spinal cord). *Note:* Spinal nerve C1 is purely motor; consequently there is no C1 dermatome.

Spinal Cord

The dura mater of the cranial cavity is composed of two layers, the periosteal and meningeal. Only the meningeal layer extends into the vertebral canal with the spinal cord. The periosteal layer of dura terminates at the foramen magnum and is replaced in the vertebral canal with the periosteum of the vertebral bone. Due to this structural difference in the two regions, the dural sac is not adherent to the bone of the vertebral canal as it is in the cranial cavity.

***Fig. 4.6* Spinal cord in situ**
Posterior view with vertebral canal windowed.

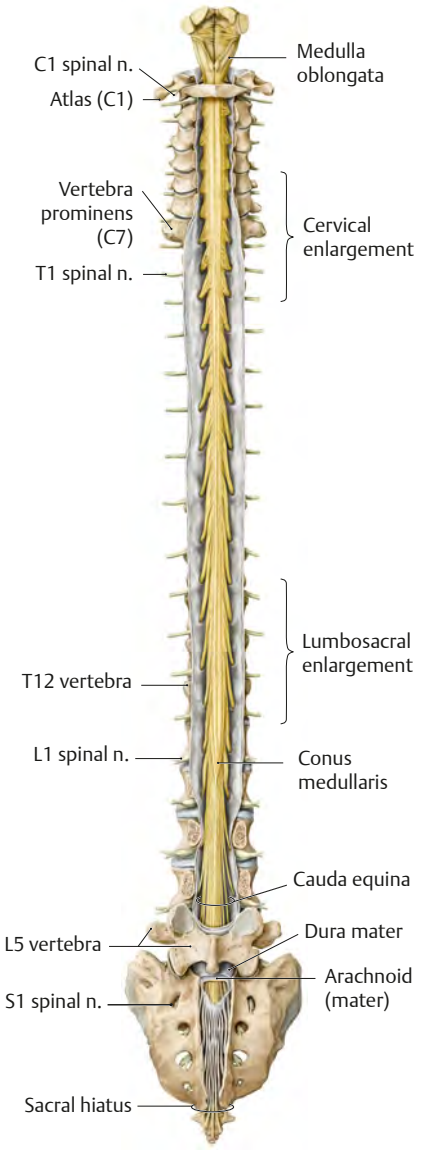


***Fig. 4.7* Spinal cord and its meningeal layers**
Posterior view. The dura mater is opened and the arachnoid is sectioned. The detailed anatomy of the spinal cord can be found on **pp. 690–691.**

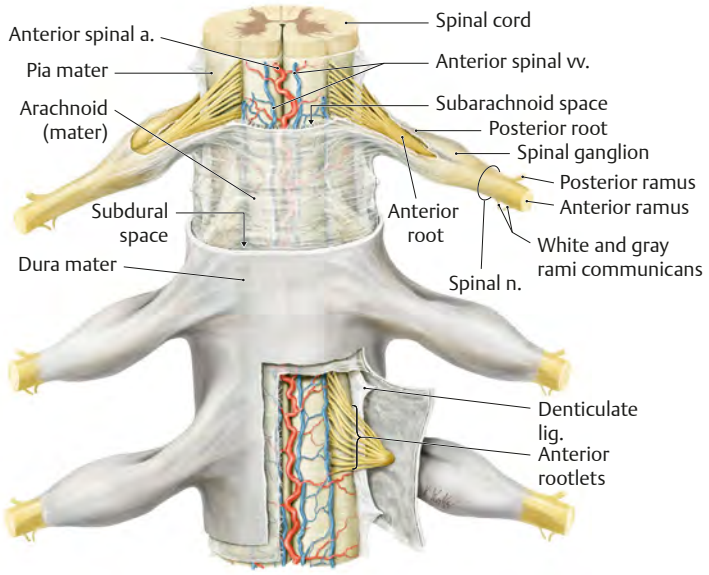
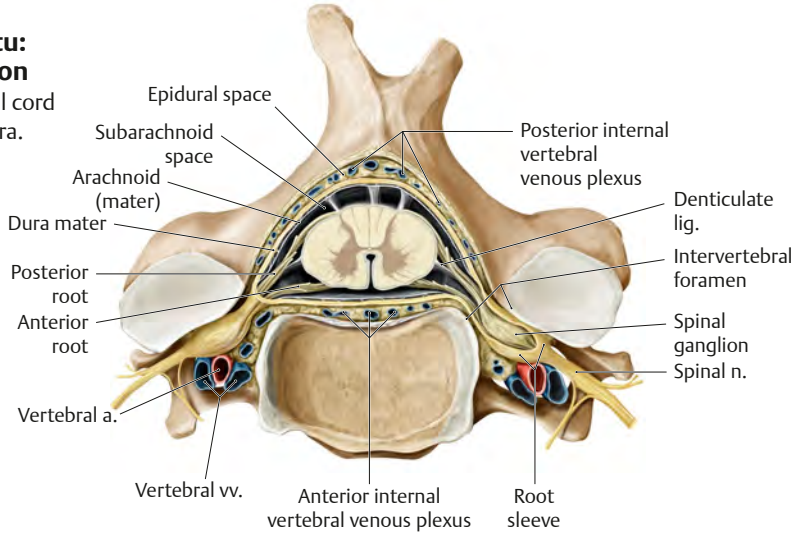


***Fig. 4.8* Cervical spinal cord in situ: Transverse section**
Superior view. Spinal cord at level of C4 vertebra.



Clinical box 4.1

Spina Bifida

Spina bifida is a neural tube defect that occurs when the spine and spinal cord do not form properly. In the United States, it affects about one out of every 1,500 newborns. There are three main types.

- **Spina bifida occulta (A)** is the most common congenital anomaly of the vertebral column in which the laminae of L5 and/or S1 fail to develop. The defect is often hidden and most individuals are unaware they have the condition because there is only a small defect in the vertebrae. There is generally no disturbance of spinal function.
- **Spina bifida (meningocele) (B)** occurs when one or more vertebral arches fail to develop and presents with a herniation or sac of only the meninges. The spinal cord and nerves are normal and not severely affected.
- **Spina bifida (myelomeningocele) (C)** occurs when multiple vertebral arches fail to develop resulting in a herniation of both the meninges and spinal nerves. This is the most severe form exposing the newborn to life threatening infections, bowel and bladder dysfunction, and total paralysis of the lower extremities.

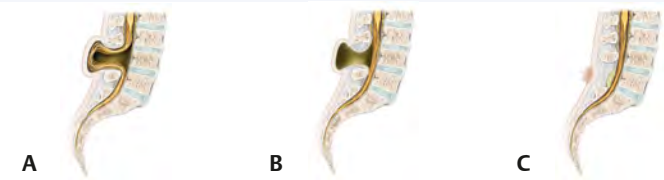


Fig. 4.9 **Cauda equina in the vertebral canal**
Posterior view. The lamina and posterior surface of the sacrum have been partially removed.

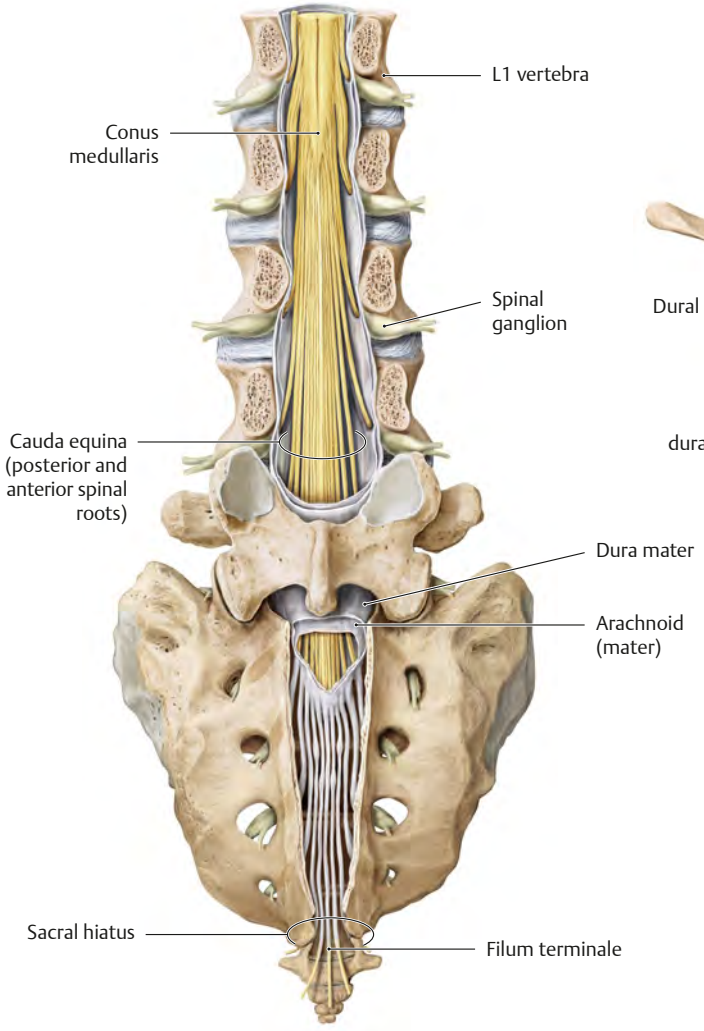


Fig. 4.10 **Cauda equina in situ: Transverse section**
Superior view. Cauda equina at level of L2 vertebra.

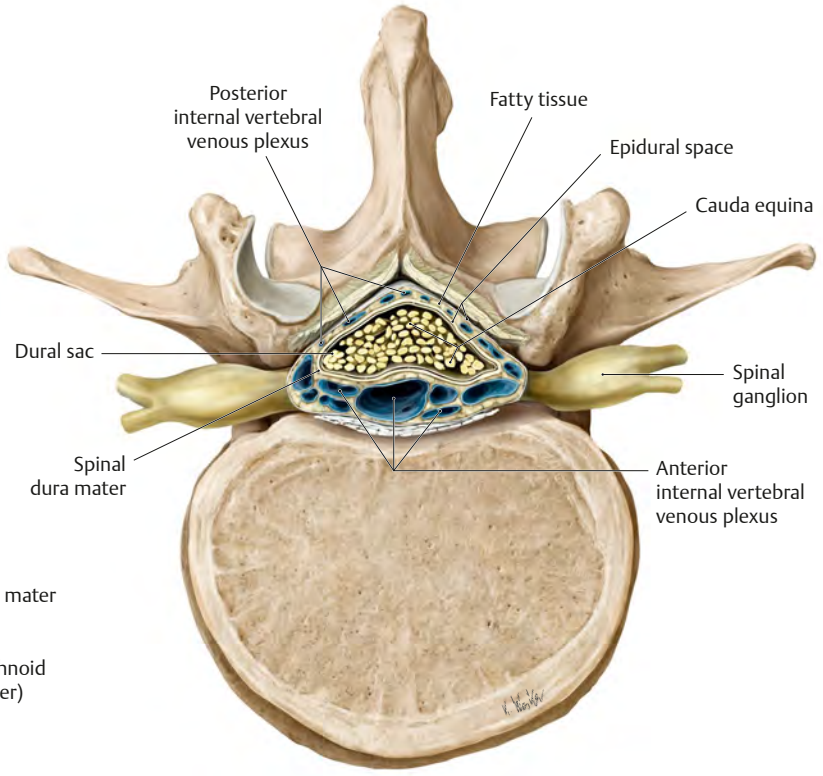
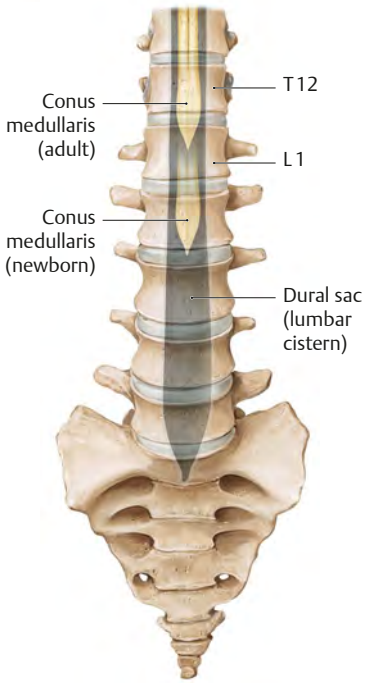
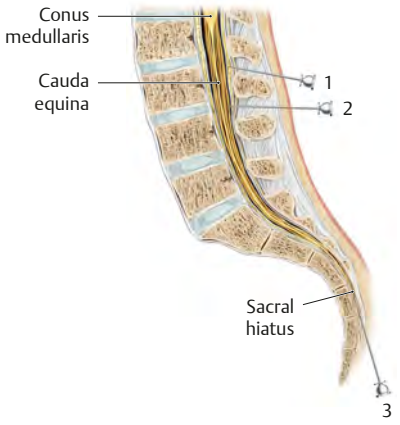


Fig. 4.11 **Spinal cord, dural sac, and vertebral column at different ages.**
Anterior view. Longitudinal growth of the spinal cord lags behind that of the vertebral column. At birth, the distal end of the spinal cord, the conus medullaris, is at the level of the L3 vertebral body, but in the average adult it extends to the level of L1/L2. The dural sac always extends into the upper sacrum.



Clinical box 4.2

Lumbar puncture
A needle introduced into the dural sac (lumbar cistern) generally slips past the spinal nerve roots without injuring the spinal cord or spinal nerves. Cerebrospinal fluid (CSF) samples are therefore taken between the L3 and L4 vertebrae (2), once the patient has leaned forward to separate the spinous processes of the lumbar spine.



Anesthesia
Lumbar anesthesia may be administered in a similar fashion (2). Epidural anesthesia is administered by placing a catheter in the epidural space without penetrating the dural sac (1). This may also be done by passing a needle through the sacral hiatus (3).

Fig. 4.12 Spinal cord segment

The spinal cord consists of 31 segments, each innervating a specific area of the skin (a dermatome) of the head, trunk, or limbs. Afferent (sensory) posterior rootlets and efferent (motor) anterior rootlets form the posterior and anterior roots of the spinal nerve for that segment. The two roots fuse to form a mixed (motor and sensory) spinal nerve that exits the intervertebral foramen and immediately thereafter divides into an anterior and posterior ramus.

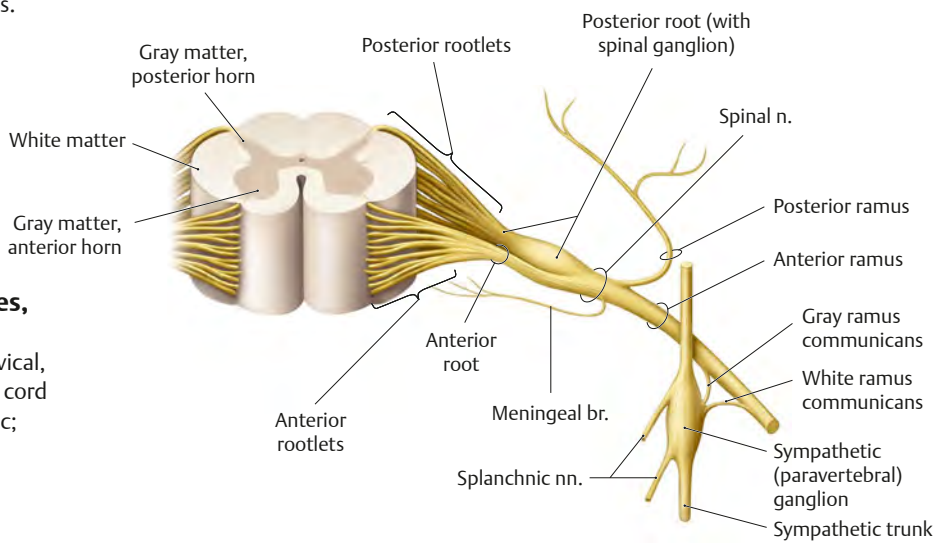
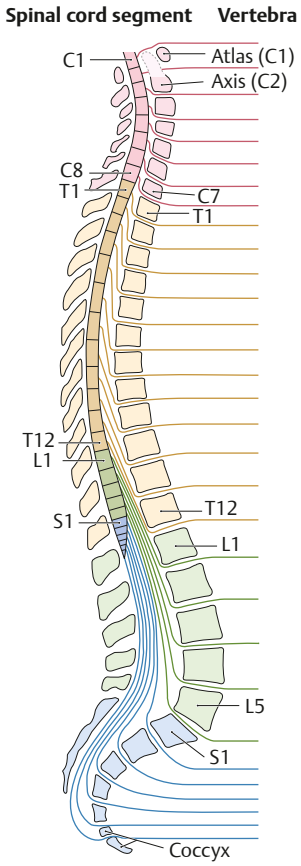
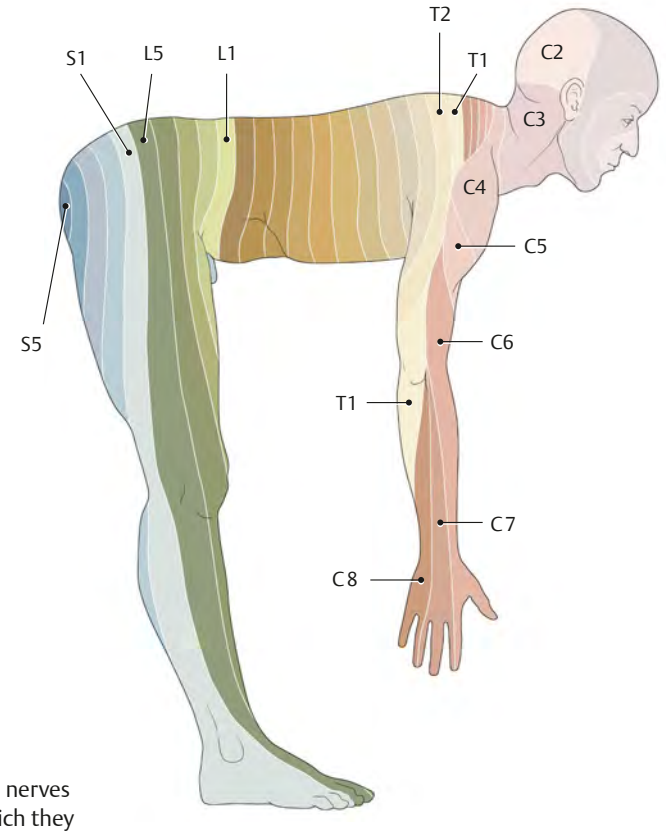


Fig. 4.13 Spinal cord segments, dermatomes, and effects of spinal cord lesions

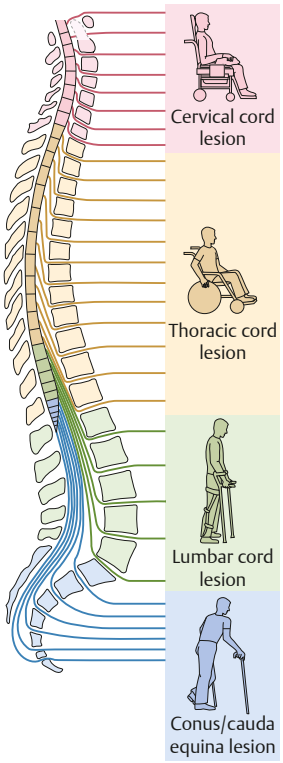
The spinal cord is divided into four major regions: cervical, thoracic, lumbar, and sacral. The regions of the spinal cord are designated by colors: red, cervical; brown, thoracic; green, lumbar; blue, sacral.



A Spinal cord segments. Initially spinal nerves pass out above the vertebrae for which they are numbered. However, since there is an 8th cervical spinal nerve but no 8th cervical vertebrae, C8 passes out above vertebral level T1, and the spinal nerve for T1, and those following, pass out below the vertebral level for which they are numbered.

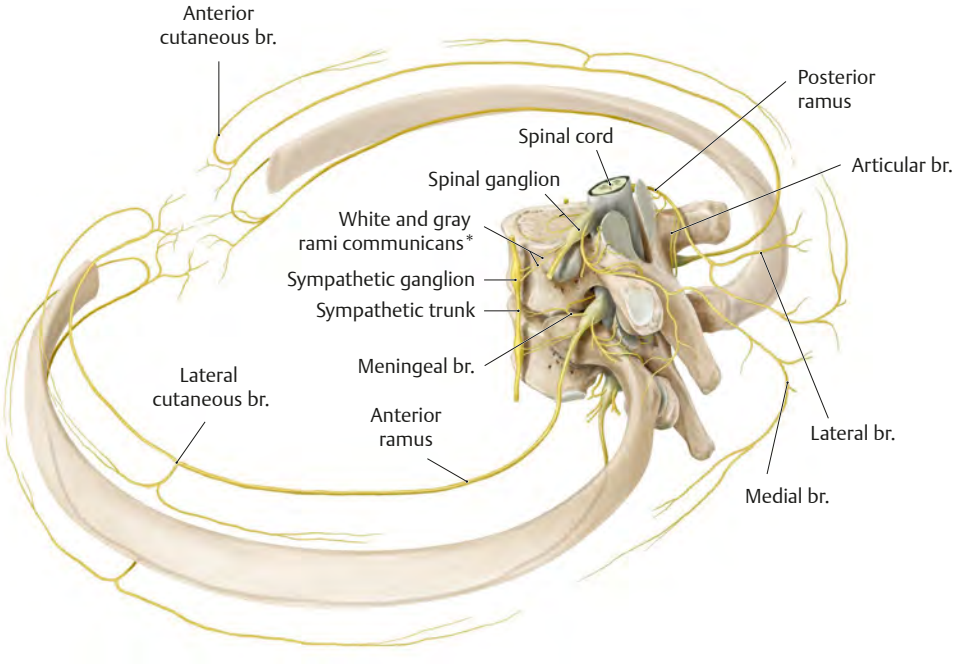


B Dermatomes, band-like areas of skin receiving sensory innervation from a single pair of spinal nerves (from a single segment of the spinal cord). *Note:* Spinal nerve C1 is purely motor; consequently there is no C1 dermatome.

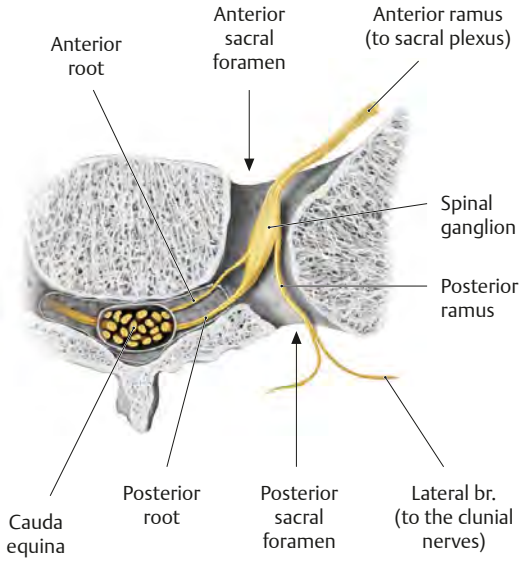


C Effects of lesions in each region of the spinal cord.

Fig. 4.14 Spinal nerve branches



A Superolateral view of a thoracic spinal nerve. The *posterior (dorsal) rami* of the spinal nerves give rise to muscular and cutaneous branches, as well as articular branches to the zygapophyseal joints. The *anterior (ventral) rami* of the spinal nerves form the cervical plexus (C1–C4), the brachial plexus (C5–T1), the lumbar plexus (T12–L4), and the sacral plexus (L4–S3). The anterior rami of spinal nerves T1–T11 produce the intercostal nerves (T12 produces the subcostal nerve).



B Spinal nerve branches in the sacral foramina. Superior view of transverse section through right half of sacrum.

Table 4.2 **Branches of a spinal nerve**

Branches			Territory
Meningeal br.			Spinal meninges; ligaments of spinal column
Posterior (dorsal) ramus	Medial brs.	Articular br.	Zygapophyseal joints
		Muscular br.	Intrinsic back muscles
		Cutaneous br.	Skin of posterior head, neck, back, and buttocks
	Lateral brs.	Cutaneous br.	
		Muscular br.	Intrinsic back muscles
Anterior (ventral) ramus	Lateral cutaneous brs.		Skin of lateral chest wall
	Anterior cutaneous brs.		Skin of anterior chest wall

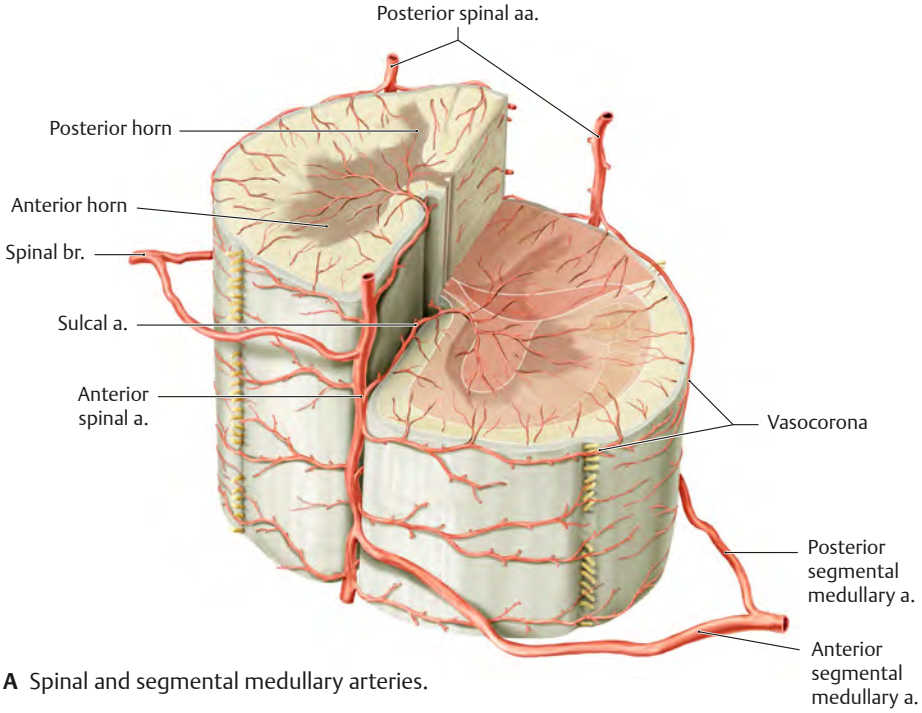
*The white and gray rami communicans carry pre- and postganglionic fibers between the sympathetic trunk and spinal n.

Arteries & Veins of the Spinal Cord

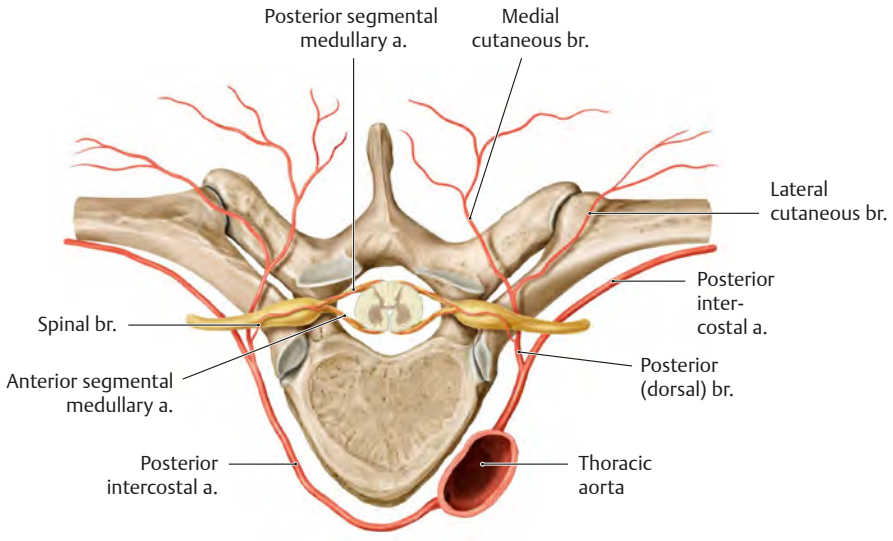
Like the spinal cord itself, the arteries and veins of the spinal cord consist of multiple horizontal systems (blood vessels of the spinal cord segments) that are integrated into a vertical system.

Fig. 4.15 Arteries of the spinal cord

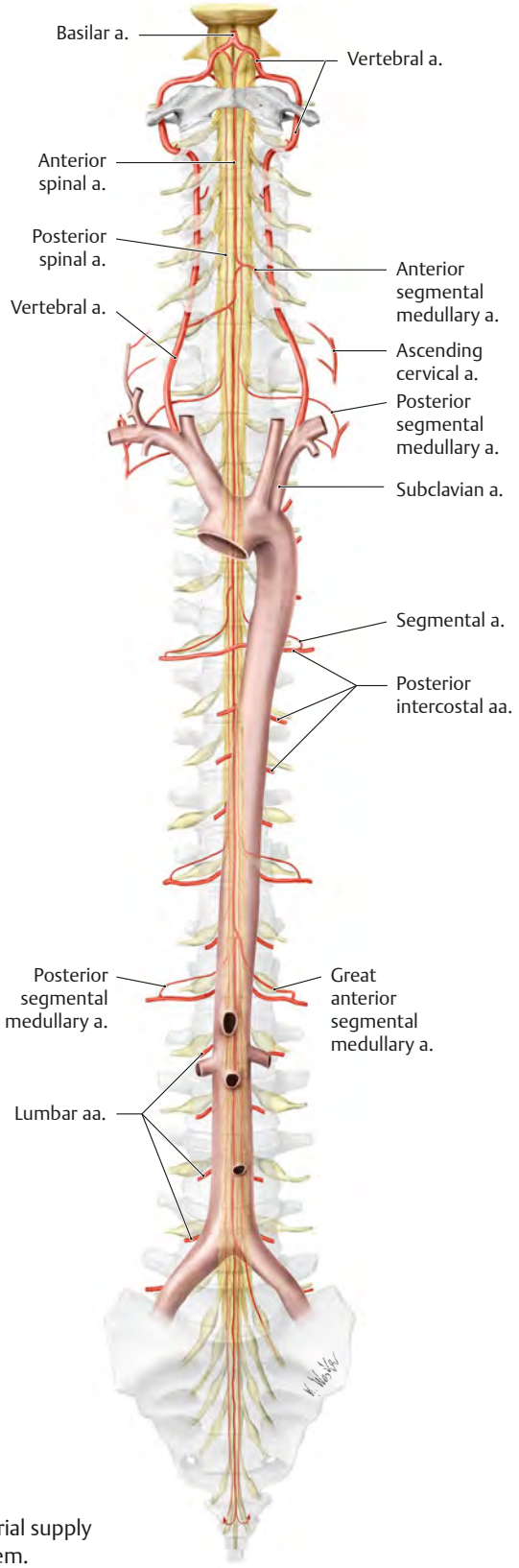
The unpaired anterior and paired posterior spinal arteries typically arise from the vertebral arteries. As they descend within the vertebral canal, the spinal arteries are reinforced by anterior and posterior segmental medullary arteries. Depending on the spinal level, these reinforcing branches may arise from the vertebral, ascending or deep cervical, posterior intercostal, lumbar, or lateral sacral arteries.



A Spinal and segmental medullary arteries.



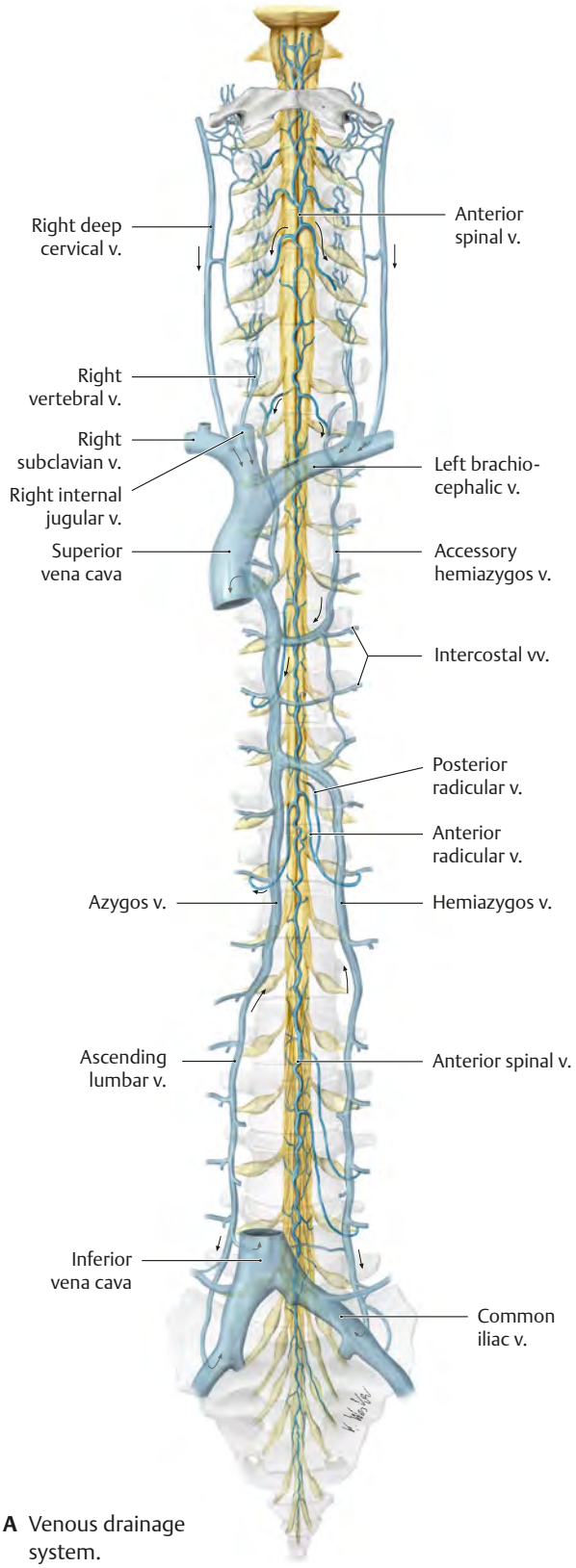
B Origins of the segmental medullary arteries. In the thorax, the segmental medullary arteries arise from the spinal branch of the posterior intercostal arteries (see **p. 36**).



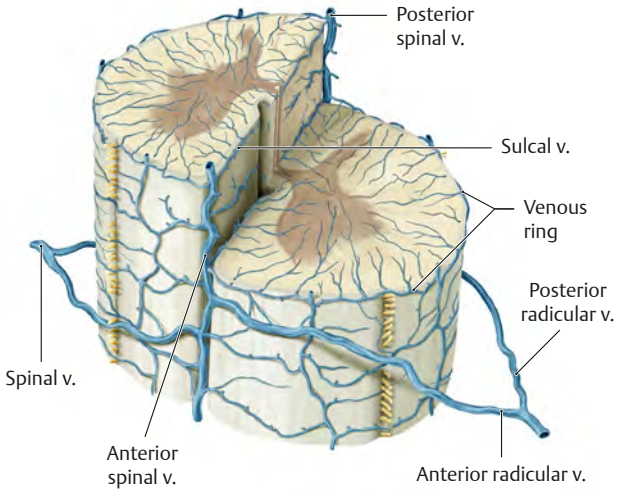
C Arterial supply system.

Fig. 4.16 Veins of the spinal cord

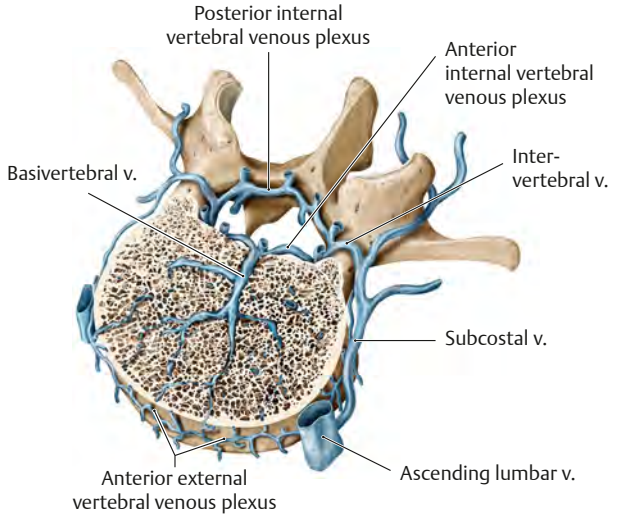
The interior of the spinal cord drains via venous plexuses into an anterior and a posterior spinal vein. The radicular and spinal veins connect the veins of the spinal cord with the internal vertebral venous plexus. The intervertebral and basivertebral veins connect the internal and external venous plexuses, which drain into the azygos system.



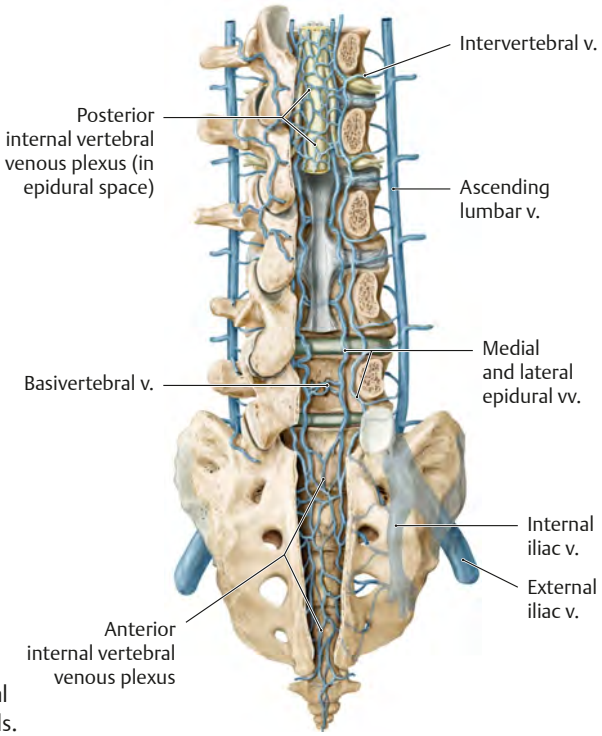
A Venous drainage system.



B Spinal and radicular veins.



C Vertebral venous plexuses.



D Veins in the sacral and lumbar canals.

Fig. 4.17 **Neurovasculature of the nuchal region**
Posterior view. *Removed:* Trapezius, sternocleidomastoid, and semispinalis capitis. *Revealed:* Suboccipital region.

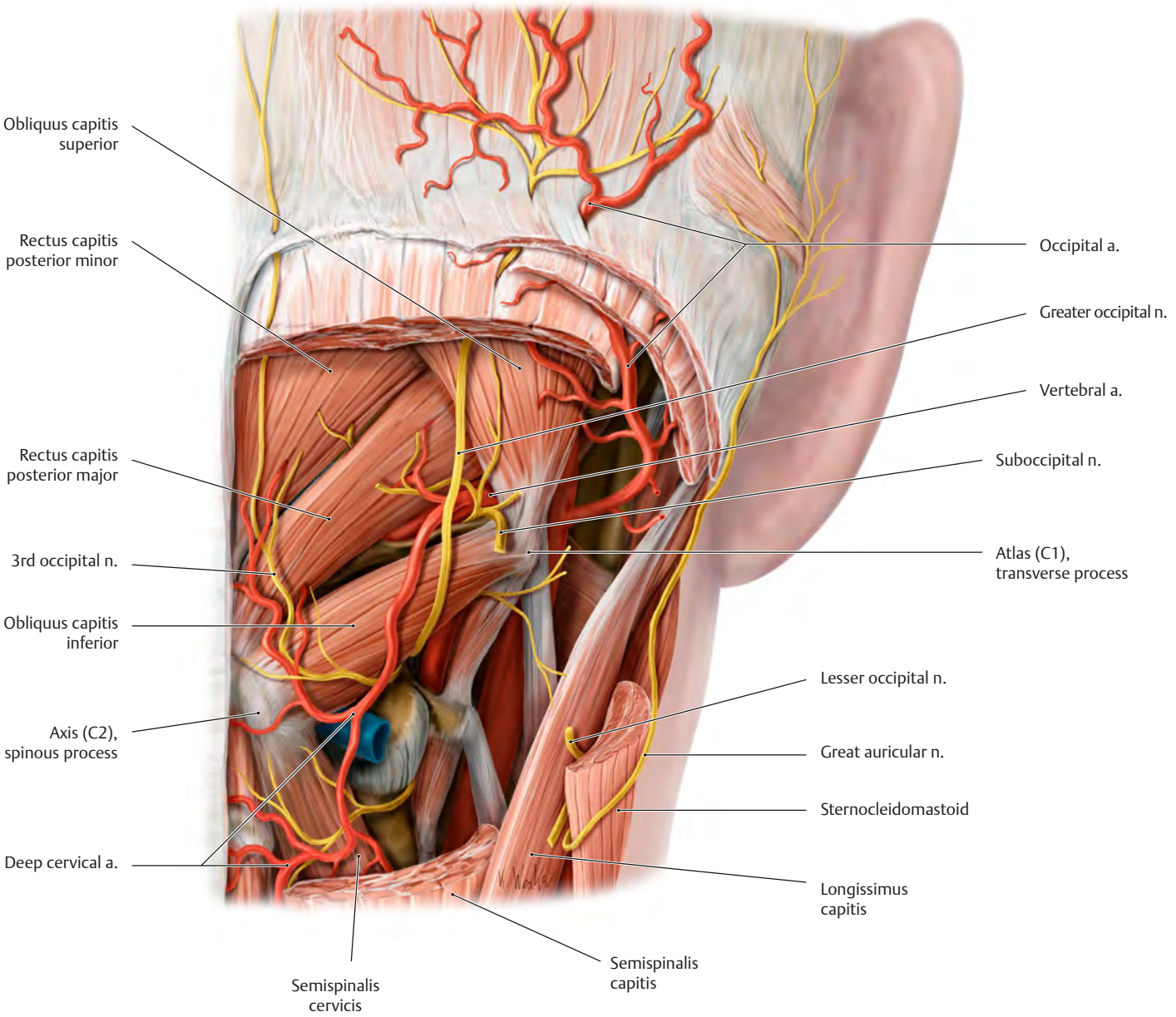
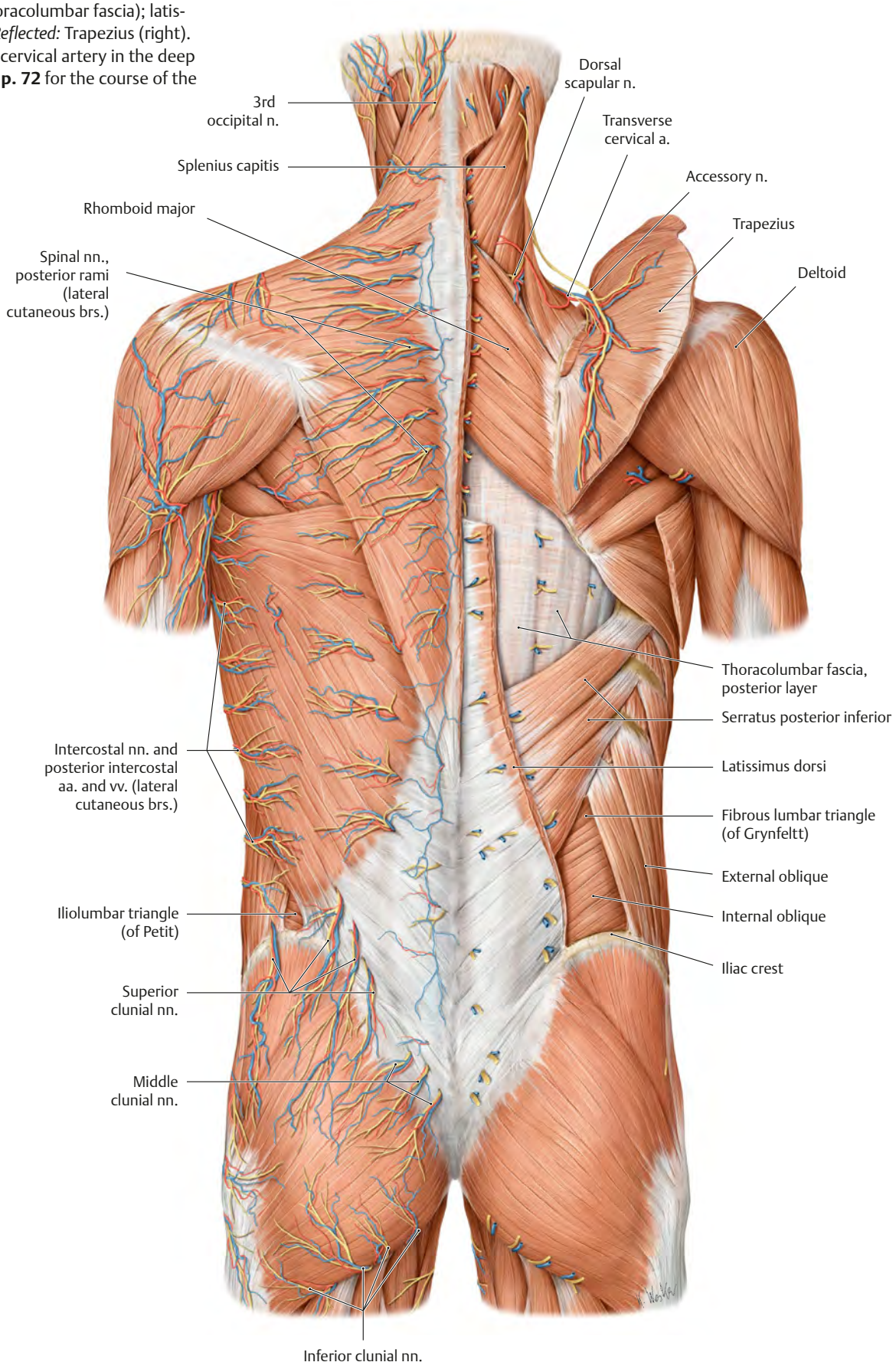


Fig. 4.18 **Neurovasculature of the back**
Posterior view. *Removed:* Muscle fascia (except posterior layer of thoracolumbar fascia); latissimus dorsi (right). *Reflected:* Trapezius (right). *Revealed:* Transverse cervical artery in the deep scapular region. See **p. 72** for the course of the intercostal vessels.



5 Sectional & Radiographic Anatomy

Radiographic Anatomy of the Back (I)

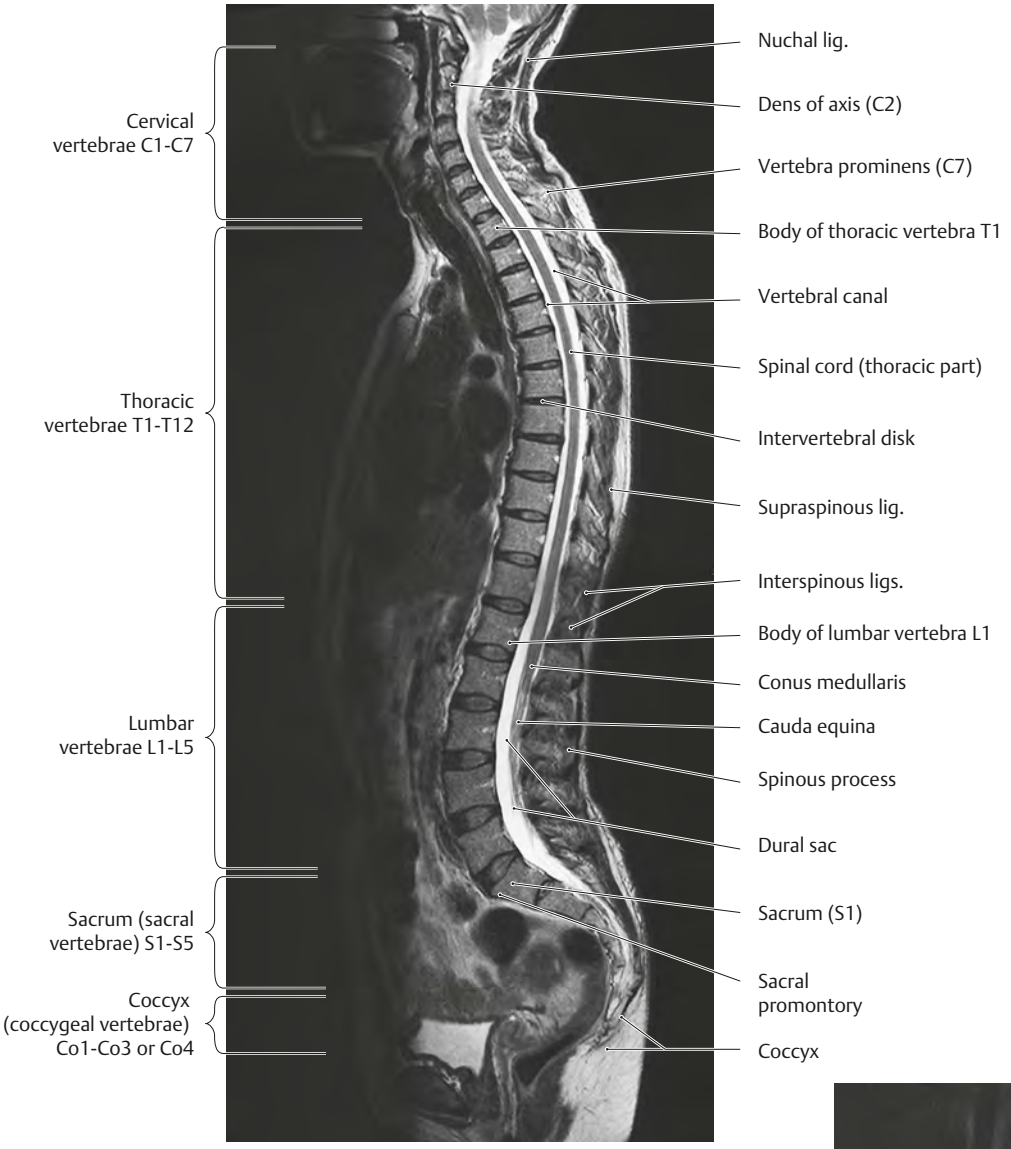
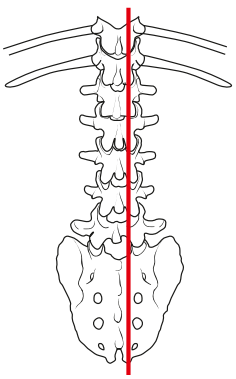


Fig. 5.1 **MRI of the spine**
Sagittal view. (Reproduced from Moeller TB, Reif E. Atlas of Sectional Anatomy: The Musculoskeletal System. New York, NY: Thieme; 2009.)



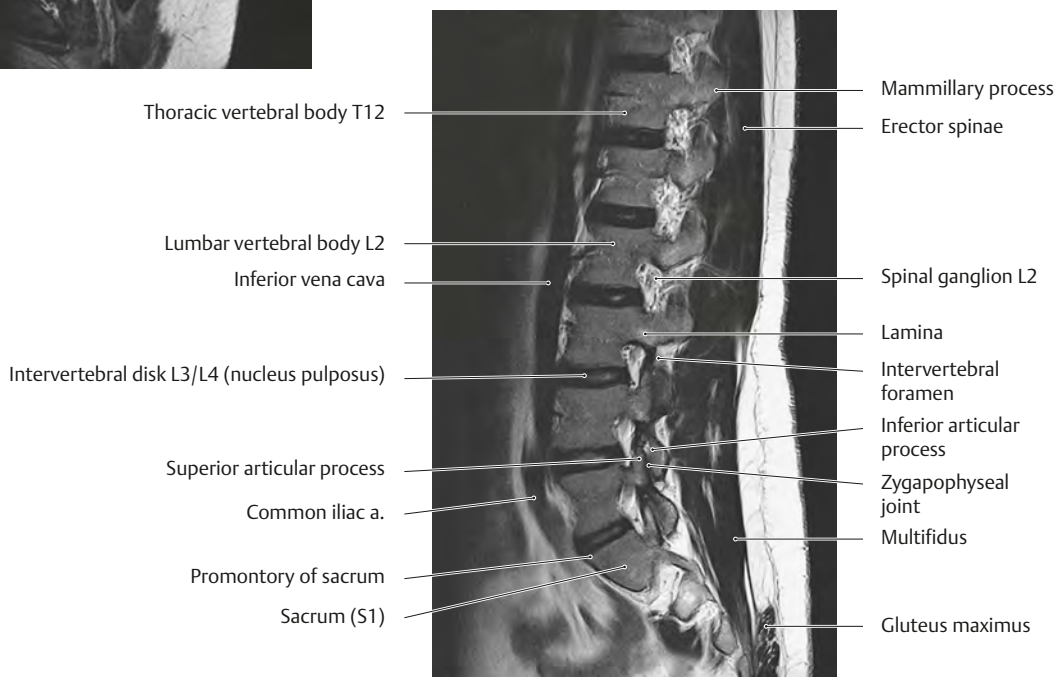


Fig. 5.2 **MRI of the lumbar spine**
Parasagittal view. (Reproduced from Moeller TB, Reif E. Atlas of Sectional Anatomy: The Musculoskeletal System. New York, NY: Thieme; 2009.)

Fig. 5.3 **Radiograph of the cervical spine**
Lateral view. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)

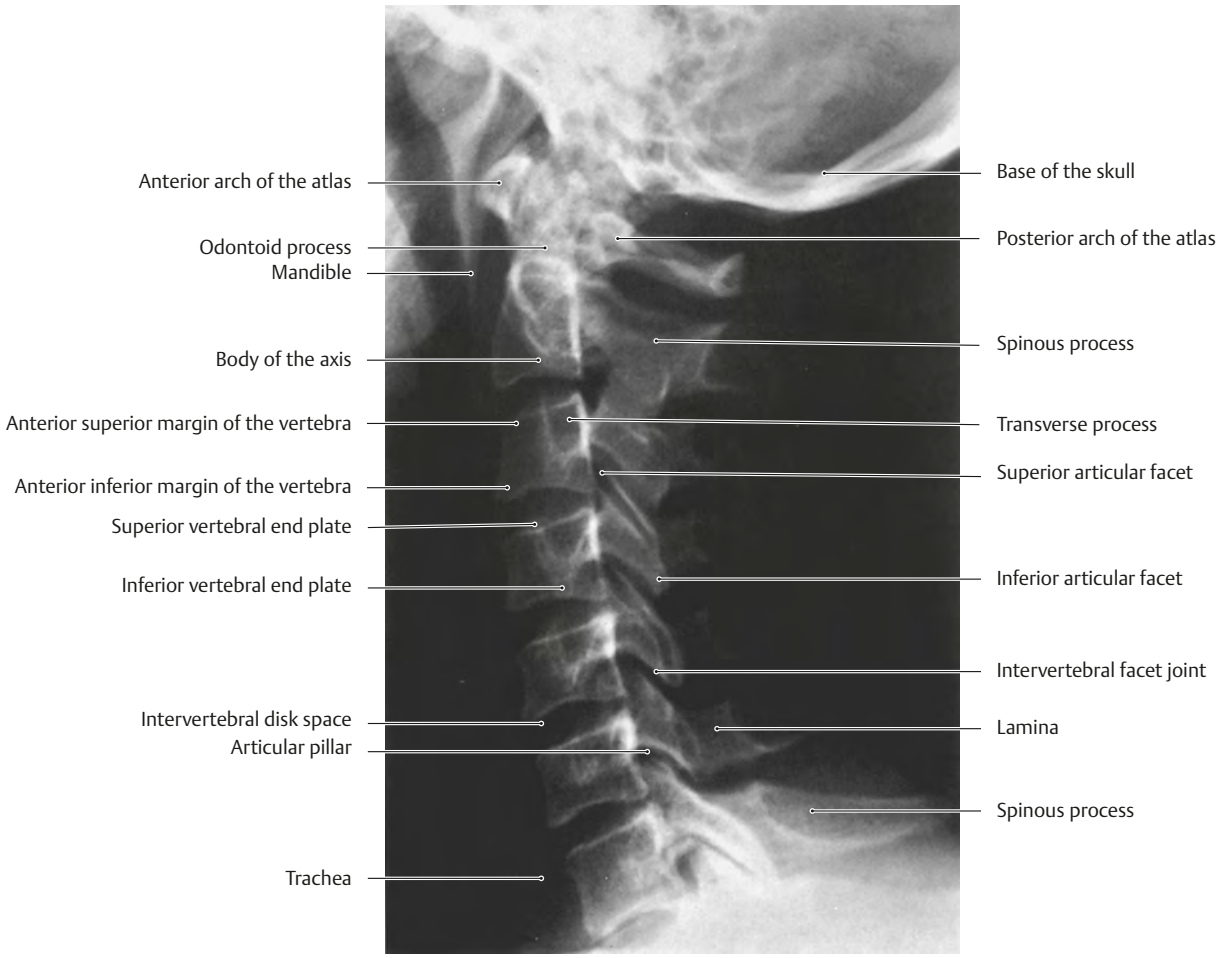


Fig. 5.4 **Radiograph of the thoracic spine**
Anteroposterior view. Lower thoracic region. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)

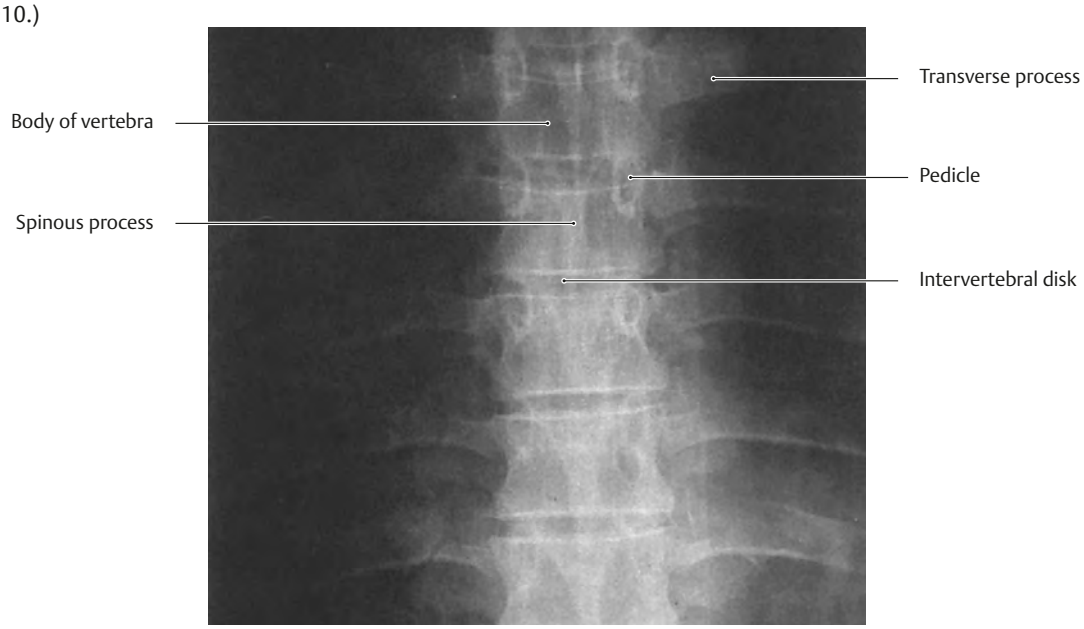


Fig. 5.5 **Radiograph of the lumbar spine**
Lateral view. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)

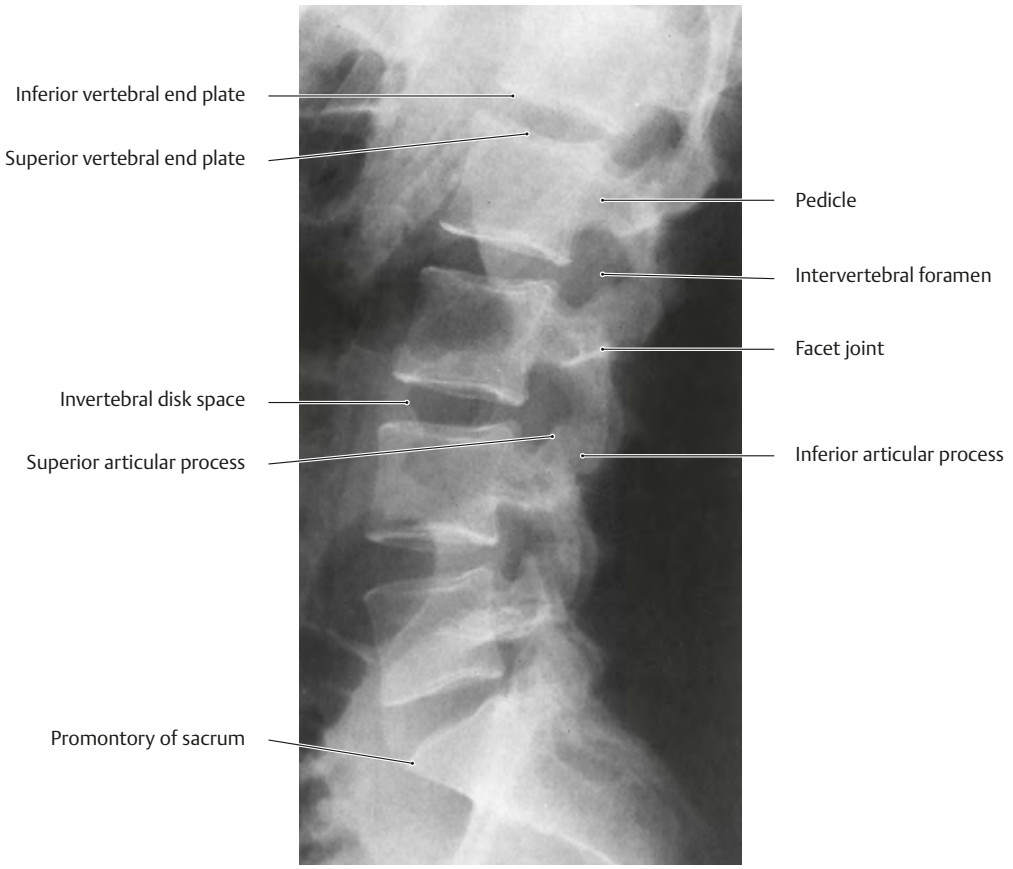
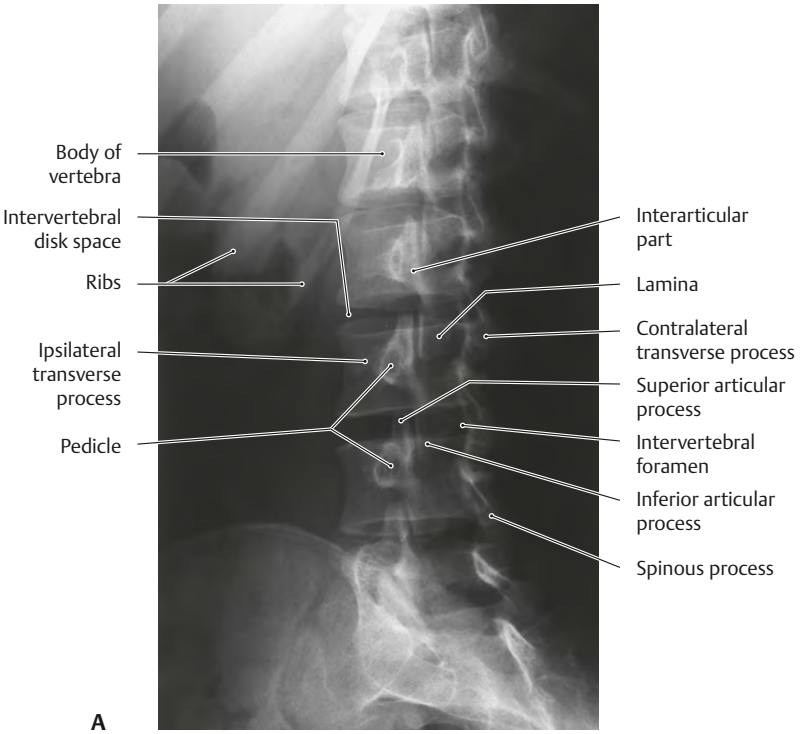


Fig. 5.6 **Radiograph of the lumbar spine**
Oblique view. (Reproduced from Moeller TB, Reif E. Pocket Atlas of Radiographic Anatomy, 3rd ed. New York, NY: Thieme; 2010.)



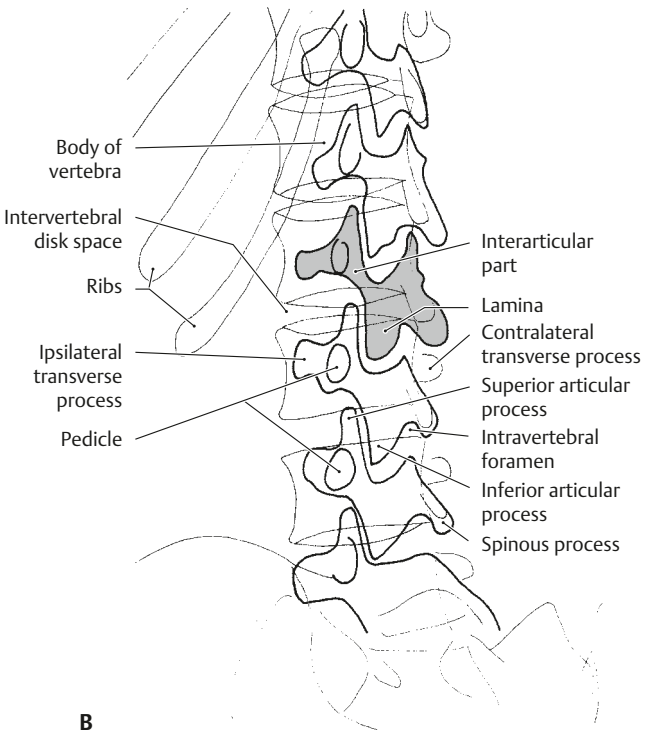


Fig. 5.7 **MRI of the sacrum I**
Oblique view. (Reproduced from Moeller TB, Reif E. Atlas of Sectional Anatomy: The Musculoskeletal System. New York, NY: Thieme; 2009.)

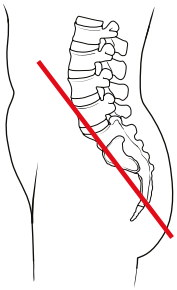
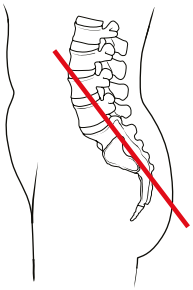
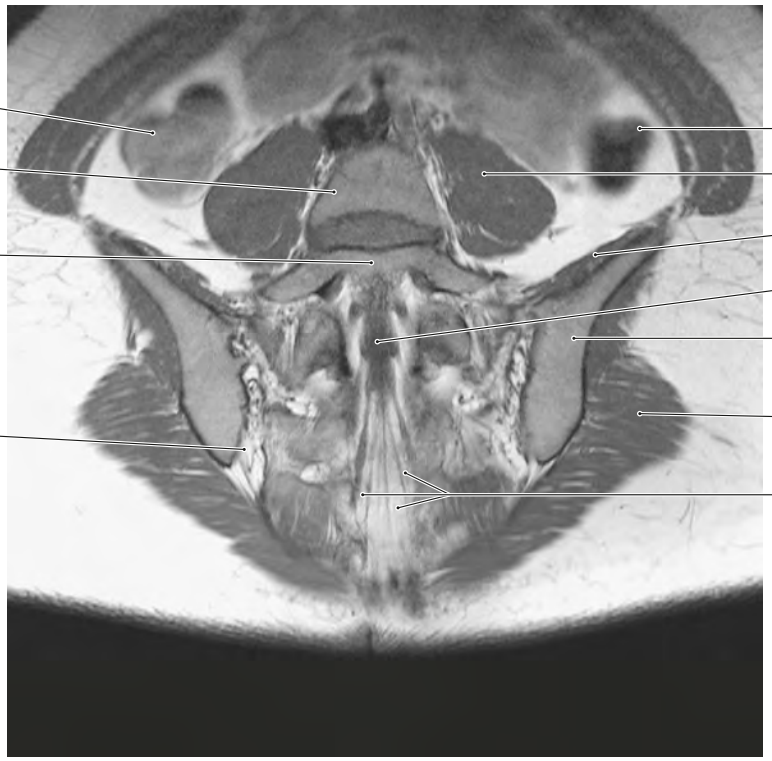
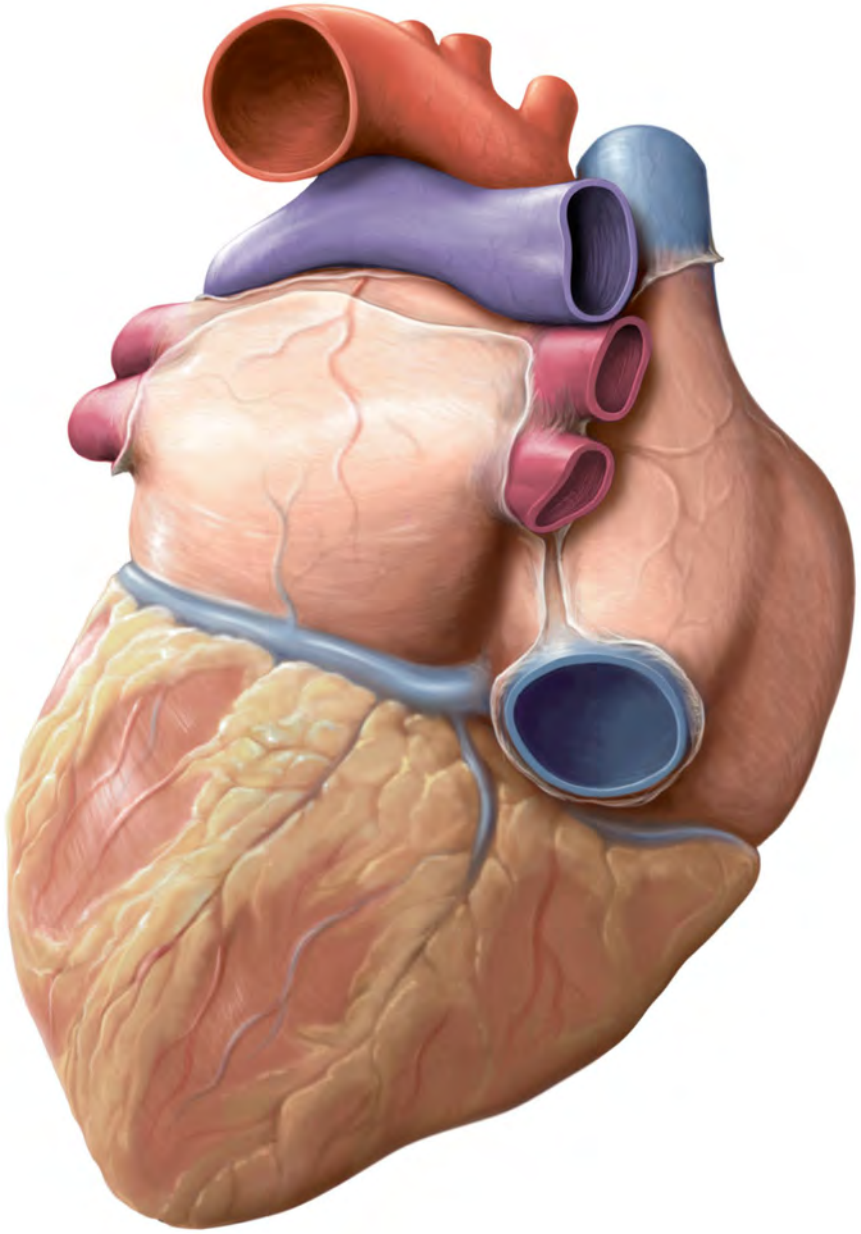


Fig. 5.8 **MRI of the sacrum II**
Oblique view. (Reproduced from Moeller TB, Reif E. Atlas of Sectional Anatomy: The Musculoskeletal System. New York, NY: Thieme; 2009.)







Thorax

6 Surface Anatomy

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6 Surface Anatomy

Surface Anatomy

Fig. 6.1 **Regions of the thorax**
Anterior view.

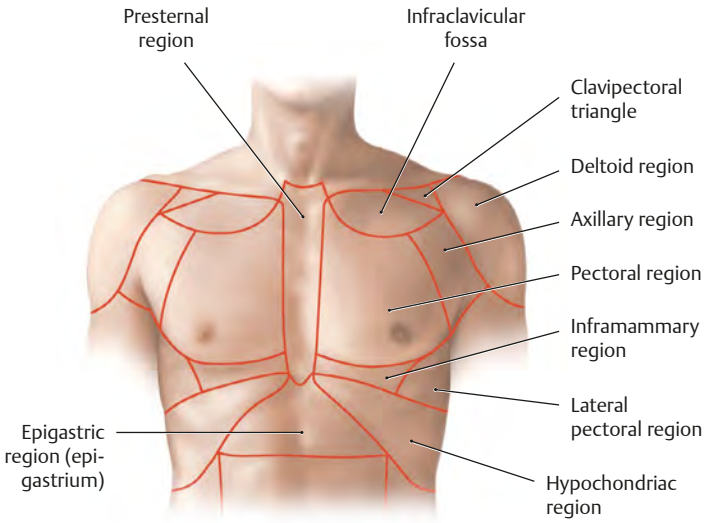
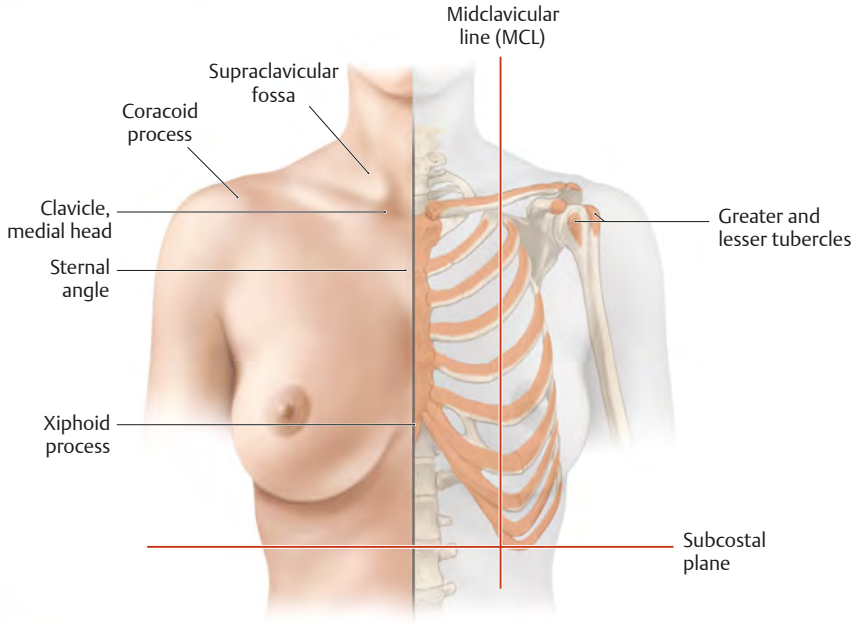
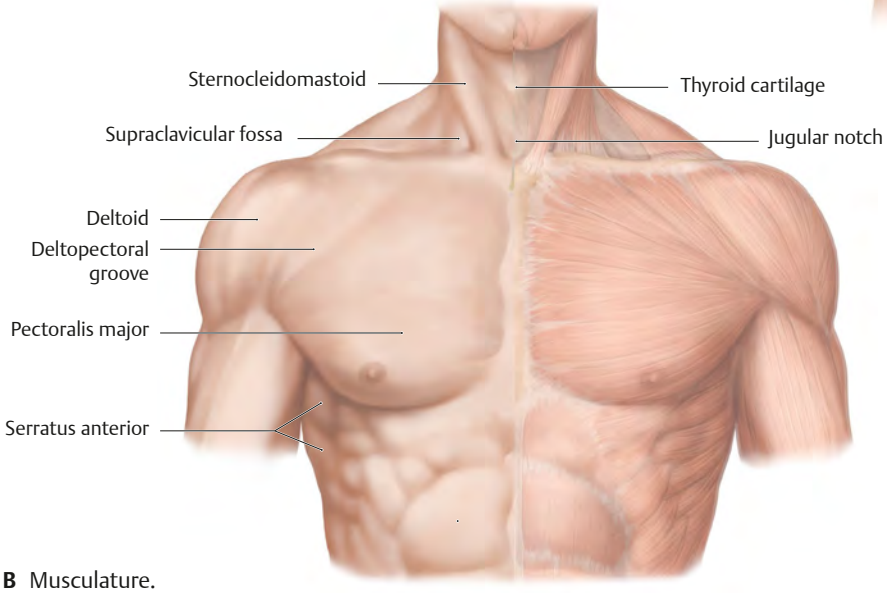


Fig. 6.2 **Palpable structures of the thorax**
Anterior view.

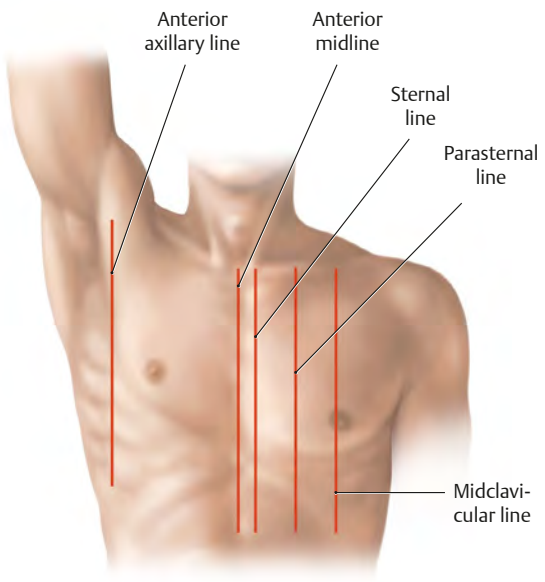


A Bony prominences.

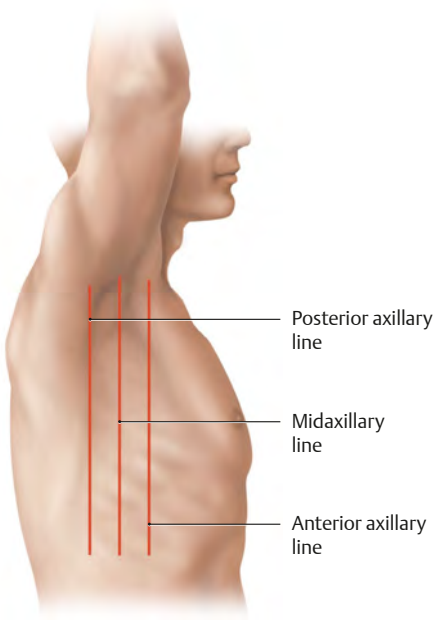


B Musculature.

Fig. 6.3 Vertical reference lines of the thorax

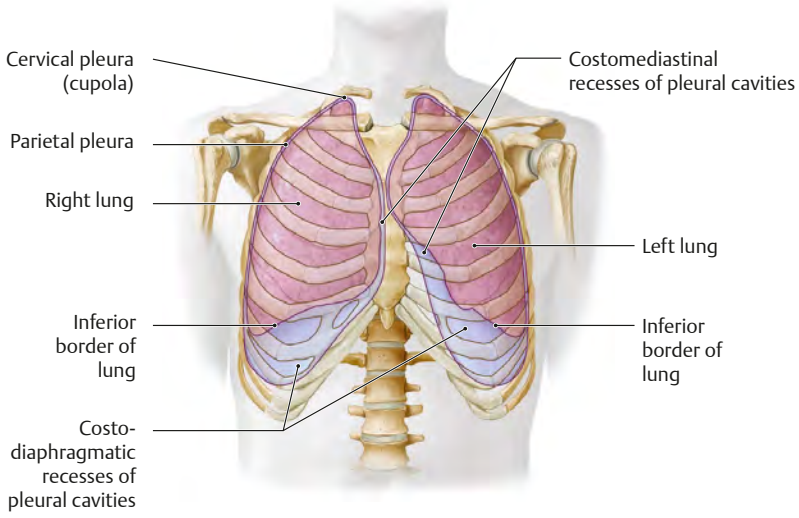


A Anterior view.

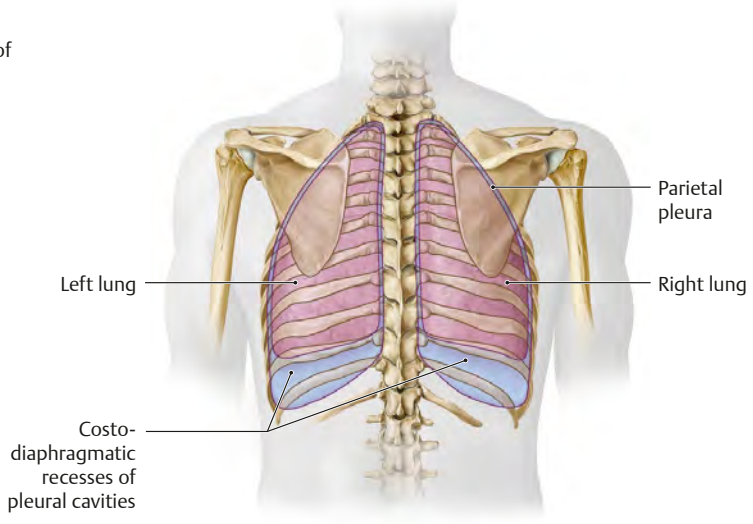


B Right lateral view.

Fig. 6.4 Pleural cavities and lungs projected onto the thoracic skeleton



A Anterior view.



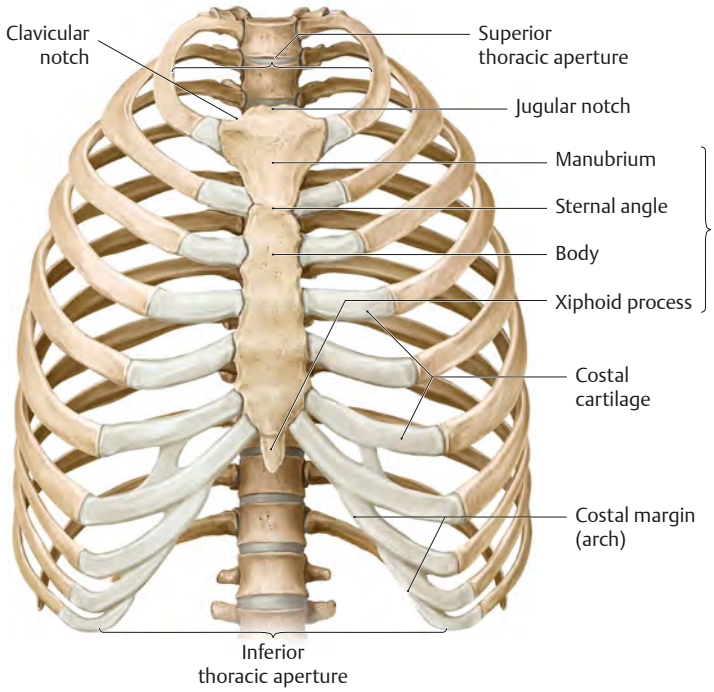
B Posterior view.

7 Thoracic Wall

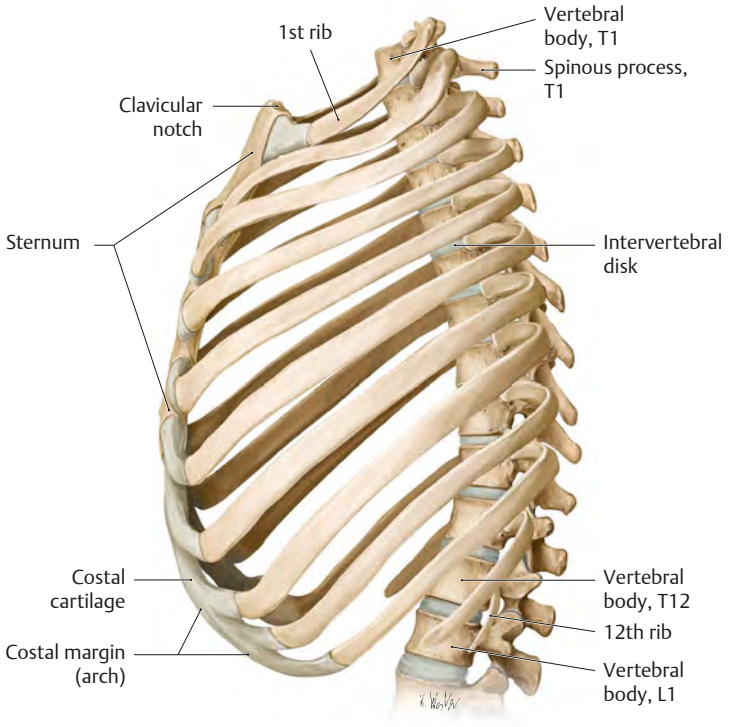
Thoracic Skeleton

The thoracic skeleton consists of 12 thoracic vertebrae (**p. 10**), 12 pairs of ribs with costal cartilages, and the sternum. In addition to participating in respiratory movements, it provides a measure of protection to vital organs. The female thorax is generally narrower and shorter than the male equivalent.

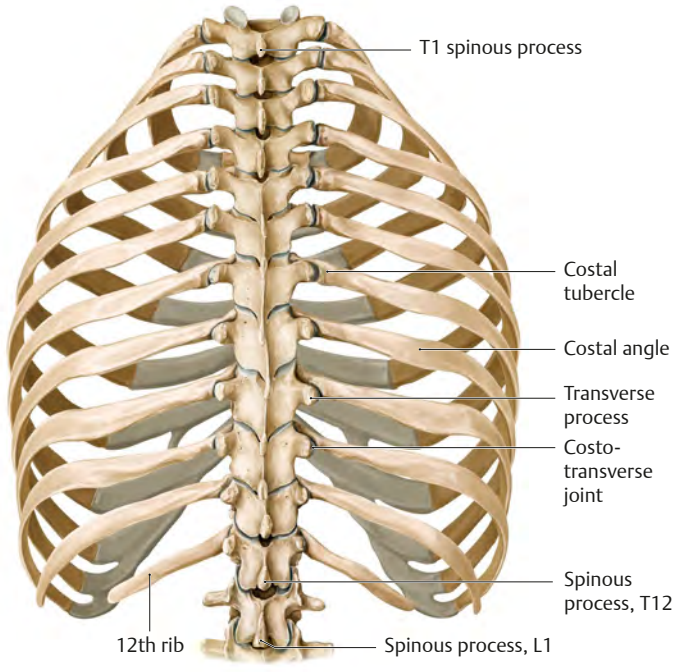
Fig. 7.1 **Thoracic skeleton**



A Anterior view.



B Left lateral view.



C Posterior view.

Fig. 7.2 **Structure of a thoracic segment**
Superior view of 6th rib pair.

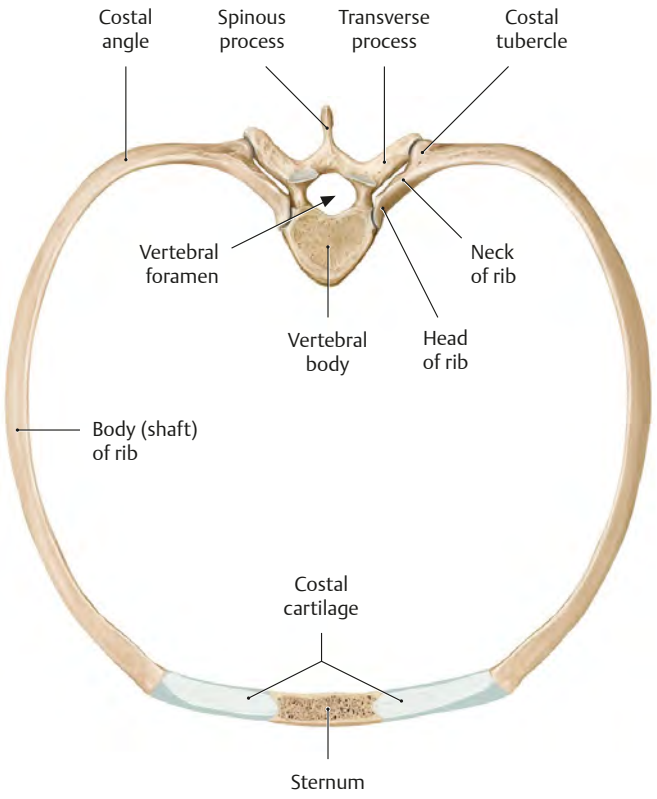
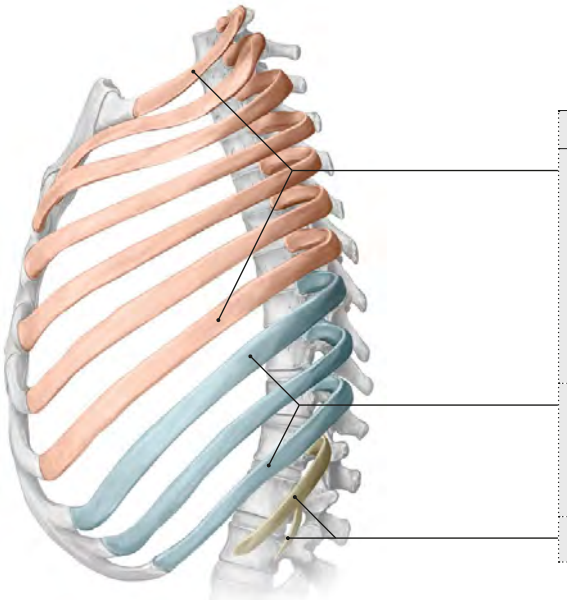


Table 7.1 **Elements of a thoracic segment**

Vertebra		
Rib	Bony part (costal bone)	Head
		Neck
		Costal tubercle
		Body (including costal angle)
	Costal part (costal cartilage)	
Sternum (articulates with costal cartilage of true ribs only; see **Fig. 7.3**)		

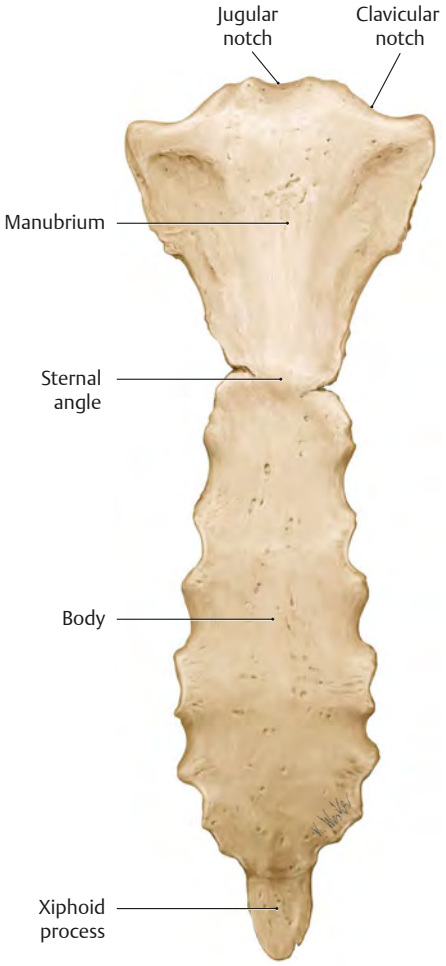
Fig. 7.3 **Types of ribs**
Left lateral view.



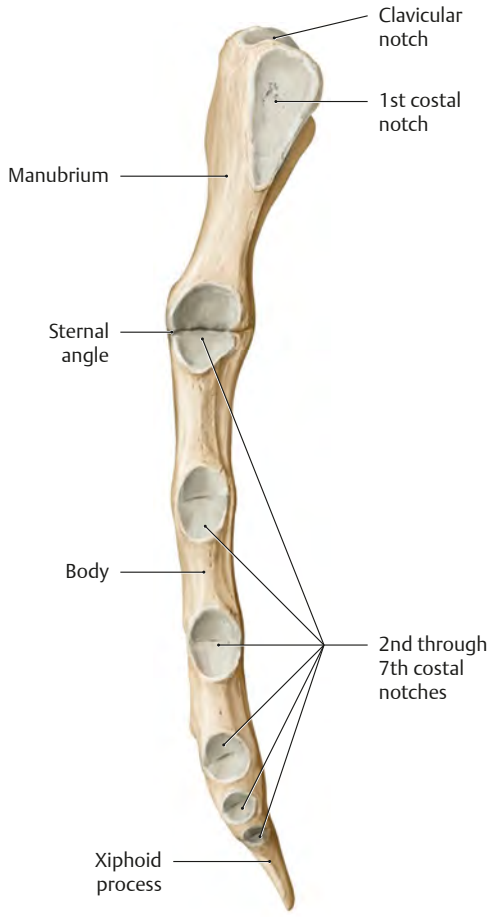
Rib type	Ribs	Anterior articulation
True ribs	1–7	Sternum (costal notches)
False ribs	8–10	Rib above
Floating ribs	11, 12	None

***Fig. 7.4* Sternum**

The sternum is a dagger-like bone consisting of the manubrium (the handle), body (blade), and xiphoid process (tip of blade). The junction of the manubrium and body (the sternal angle) is typically elevated and marks the articulation of the second rib. The sternal angle (projected posteriorly to intersect with T4/5) is an important landmark for internal structures.



A Anterior view.



B Left lateral view. The costal notches are sites of articulation with the costal cartilage of the true ribs (see **Fig. 7.3**).