Rapid Review Gross and Developmental Anatomy

SECOND EDITION

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RAPID REVIEW GROSS AND DEVELOPMENTAL ANATOMY, Second Edition

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To my mentors, Gerald Callas and the late Donald Duncan, whose encouragement and support made possible all that followed.

NAM

To the memory of my cousin Randy Gainer, who taught the principles he believed by example.

WAR

Series Preface

The First Editions of the *Rapid Review Series* have received high critical acclaim from students studying for the United States Medical Licensing Examination (USMLE) Step 1 and high ratings in *First Aid for the USMLE Step 1*. The Second Editions continue to be invaluable resources for time-pressed students. As a result of reader feedback, we have improved upon an already successful formula. We have created a learning system, including a print and electronic package, that is easier to use and more concise than other review products on the market.

SPECIAL FEATURES

Book

- Outline format: Concise, high-yield subject matter is presented in a study-friendly format. In addition, key words and phrases appear in bold throughout.
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Preface

The United States Medical Licensing Examination Step 1 incorporates the major themes and essential concepts of gross and developmental anatomy into relevant clinical vignettes. *Rapid Review Gross and Developmental Anatomy* is designed to help you review these themes and concepts while articulating their clinical relevance.

- High-yield margin notes recall topics of clinical significance that likely will be tested on Step 1.
- Clinical correlations appear in pink boxes directly within the outline to emphasize the clinical application of the preceding concept.
- Development and developmental defects are integrated into the outline.

- Simple, informative illustrations facilitate recall of essential gross anatomy and development.
- Comprehensive tables summarize essential clinically oriented information.
- Book and web questions emulate the USMLE Step 1 format. Complete discussion of each answer and distractor facilitates your review.

We hope that you will find this integrated approach helps you to prepare for your USMLE Step 1 examination. Good luck!

> N. Anthony Moore, PhD William A. Roy, PhD, PT

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N. Anthony Moore, PhD William A. Roy, PhD, PT

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TARGET TOPICS

- Functional relationships of vertebral column
- Embryonic development and relationships of spinal cord
- Congenital and acquired conditions of spine
- Organization of autonomic nervous system and visceral afferents
- Structure and functional components of typical spinal nerve

I. Typical Vertebra

• Body, vertebral arch, processes for muscular attachment and articulation with adjacent vertebrae, and vertebral foramen (Fig. 1-1)

A. Body

- Anterior weightbearing cylinder
- Covered by thin plates of hyaline cartilage superiorly and inferiorly

B. Vertebral arch

- U-shaped component attached to posterior aspect of body
- Provides attachment for spinous, transverse, and articular processes
- 1. Pedicle has superior and inferior vertebral notches.
- 2. Lamina fuses in posterior midline with opposite lamina.

C. Transverse process

D. Articular processes

- Superior and inferior articular processes projects from junction of pedicle and lamina separated by pars interarticularis
- · Form synovial joints with articular processes of adjacent vertebrae

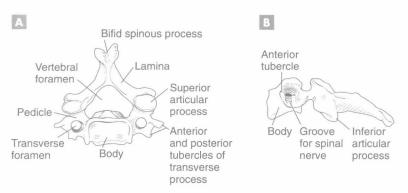
E. Vertebral foramen

- Space enclosed by vertebral arch and body
- · Collectively form vertebral canal for spinal cord and its coverings

F. Intervertebral foramen

- Formed between **inferior and superior vertebral notches** in pedicles of adjacent vertebrae
- Transmits spinal nerve and its related blood vessels

Compressing spinal nerve in intervertebral foramen may cause radiculopathy.



1-1: Typical cervical vertebra. A, Superior view. B, Lateral view.

Any **space-occupying lesion** in an intervertebral foramen may compress the spinal nerve or its roots and produce **back pain** that may radiate into an extremity. Motor nerve fibers may become involved, resulting in loss of strength.

II. Vertebral Column

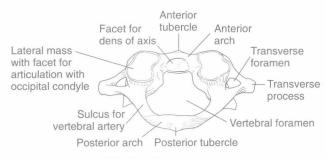
- Comprises 33 vertebrae in normal adult: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 4 coccygeal
- A. Cervical vertebrae (Table 1-1; see also Fig. 1-1)
 - 1. Typical cervical vertebrae: C3-C6
 - a. **Spinous processes** are often bifid and allow neck extension because they are short.
 - b. **Articular processes** with nearly horizontal facets allow relatively free movement in all directions at expense of stability.
 - c. Transverse foramen in transverse process allows passage of vertebral artery and vein.
 - d. **Sulcus for spinal nerve** is located on transverse process superiorly between **anterior** and **posterior tubercles.**
 - 2. C1 (atlas) (Fig. 1-2; see also Table 1-1)
 - Midline anterior tubercle on anterior arch and posterior tubercle on posterior arch
 - Sulcus on posterior arch on each side for vertebral artery
 - Allows flexion and extension of head at atlanto-occipital joints (nodding head "yes")
 - 3. **C2** (axis) (Fig. 1-3; see also Table 1-1)
 - Allows **rotation of atlas,** carrying head, at atlantoaxial joints (shaking head "no")
 - 4. C7
 - Called vertebra prominens because of its long spinous process, which helps in counting vertebrae
 - Small transverse foramen does not contain vertebral artery.

Carotid tubercle on C6 i pressure point to control bleeding from carotid artery.

fracture occur only in cervical spine.

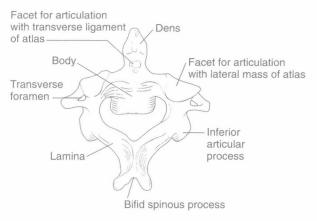
Vertebra	Body	Spinous Process	Transverse Process	Articular Processes
C1 (atlas)	None; anterior and posterior arches with paired lateral masses	None; tubercle on posterior arch	Long and stout; transverse foramen	Articulates with skull at atlanto- occipital joints and with axis at atlantoaxial joints
C2 (axis)	Dens projects superiorly from its body	Short; often bifid	Short; transverse foramen	Facets lie in horizontal plane (superior to inferior)
C3-C6	Small and broad transversely	Short; often bifid	Small and short; transverse foramen	Facets lie in horizontal plane (superior to inferior)
Thoracic vertebrae	Cylindrical and heart-shaped; costal facets for heads of ribs	Long; angled inferiorly	Large; articular facets for articulation with tubercle of ribs	Facets lie in frontal plane (anterior to posterior)
Lumbar vertebrae	Relatively large, wide, and kidney-shaped	Short, thick, quadrangular; project posteriorly	Thin; relatively long	Facets lie in sagittal plane (left to right)

TABLE 1-1: Features of Vertebrae

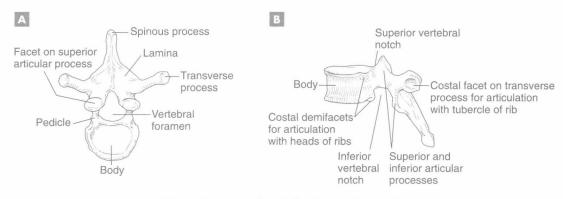


1-2: C1 (atlas), superior view.

Dislocations may cause cervical vertebrae to move out of alignment because articular surfaces lie in a horizontal plane and are less stable. Although the spinal cord may be compressed, it may escape severe injury because of the large vertebral canal. Nevertheless, all movement of injured patients should be minimized until the cervical spine is properly stabilized. Injury to the cervical spinal cord may not appear on a radiograph.



1-3: C2 (axis), posterosuperior view.



1-4: Typical thoracic vertebra. A, Superior view. B, Lateral view.

Failure of segmentation of cervical vertebrae results in congenital fusion, causing **Klippel-Feil syndrome**, which is characterized by a short, stiff neck.

- B. Thoracic vertebrae (Fig. 1-4; see also Table 1-1)
 - Articular processes have facets oriented to favor lateral bending and rotation, although range of movement is limited by rib cage, thin intervertebral discs, and overlapping spinous processes.
 - 1. Typical thoracic vertebrae: T2-T9
 - Costal demifacets on body articulate with head of corresponding rib and rib below.
 - Costal facet on transverse process articulates with tubercle of corresponding rib.

2. T1

- Complete facet on superior body articulates with entire head of rib 1.
- Demifacet on inferior body articulates with superior part of head of rib 2.

 Only complete facets are on bodies for articulation with entire head of corresponding rib.

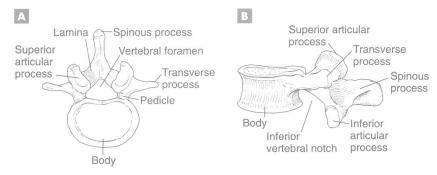
Traumatic injury to the thoracic vertebrae may produce **dislocation with fracture**, because articular facet joints are arranged vertically. An **aortic aneurysm** may cause left-sided erosion to bodies of T5–T8, as seen on a radiograph.

- C. Lumbar vertebrae (Figs. 1-5 and 1-6; see also Table 1-1)
 - Articular processes have facets oriented to favor flexion and extension.

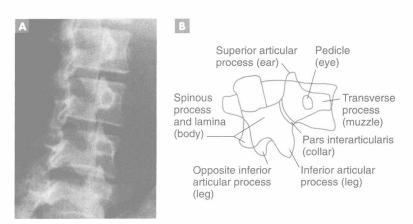
Traumatic injury to lumbar vertebrae may produce **dislocation with fracture** because articular surfaces are arranged vertically.

Fracture of the pars interarticularis occurs frequently in lumbar vertebrae (**spondylolysis**), with the posterior part separating from the anterior part. The vertebral column is not misaligned.

Lumbar spinal stenosis causes neurogenic claudication in the elderly.



1-5: Typical lumbar vertebra. A, Superior view. B, Lateral view.



1-6: A, Oblique radiograph of lumbar spine showing characteristic "Scottie dog" appearance (B).

Spondylolisthesis may interfere with childbirth.

In **spondylolisthesis**, a vertebral body is displaced forward on the vertebral body immediately below. It occurs frequently at the L5/S1 level, often secondary to spondylolysis. Alignment of the vertebral column is compromised, and the cauda equina may be affected. Patients with spondylolisthesis may encounter difficulty during childbirth because of the resulting narrowed pelvic inlet.

D. Sacrum

- · Wedge-shaped bone formed by fusion of five sacral vertebrae
- Articulates superiorly with L5 at lumbosacral joint and laterally with hip bones at sacroiliac joints
- Four pairs of anterior sacral foramina for ventral rami and four pairs of posterior sacral foramina for dorsal rami of spinal nerves S1–S4
- Sacral canal contains dural sac down to lower border of S2
- **Sacral hiatus** in place of spine and laminae of S5 (and sometimes S4) with **sacral cornua** located laterally

When administering **caudal anesthesia**, sacral cornua are used as landmarks to locate the sacral hiatus.

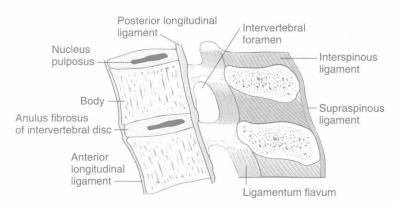
E. Coccyx

 Triangular bone formed from fusion of four coccygeal vertebrae; often Col is not fused

III. Joints and Ligaments of Vertebral Column

A. Joints between vertebrae

- 1. Intervertebral discs (Figs. 1-7 and 1-8)
 - Fibrocartilaginous joints between bodies of adjacent vertebrae except C1/C2, sacrum, and coccyx
 - · Separated from each vertebral body by thin plate of hyaline cartilage
 - Permit little movement between adjacent vertebrae but cumulatively allow considerable flexibility of column
 - · Function as shock absorbers



1-7: Ligaments connecting vertebrae.