



MSS Module

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Axial Skeleton 2



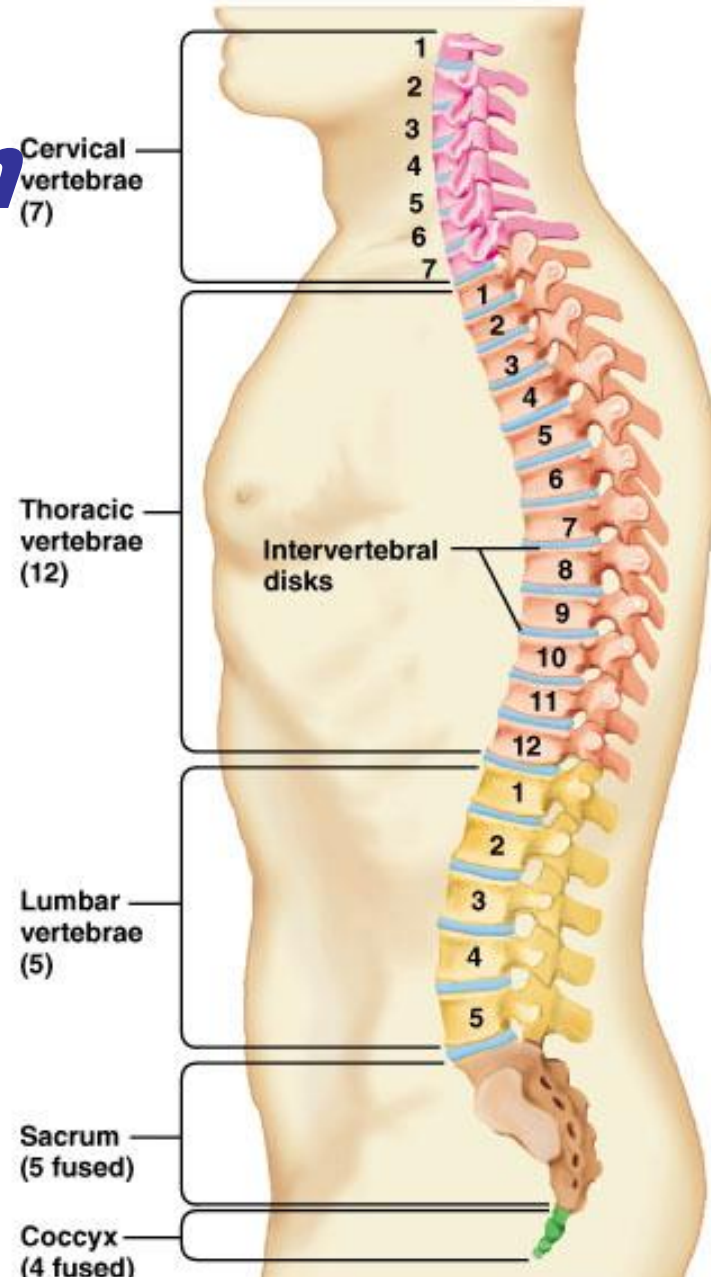
Lecture objectives

- **By the end of this session, you should be able to:**
 1. Know the different types of bones forming the axial skeleton.
 2. Identify the different features of the regional bones.
 3. Recognize specific features differentiating between its main parts.

Vertebral Column

Function:

1. Protects the spinal cord
2. Supports the head and body
3. Provide flexibility of movements.
4. Serves as a point of attachment for the ribs, pelvic girdle, and muscles of the back and upper limbs





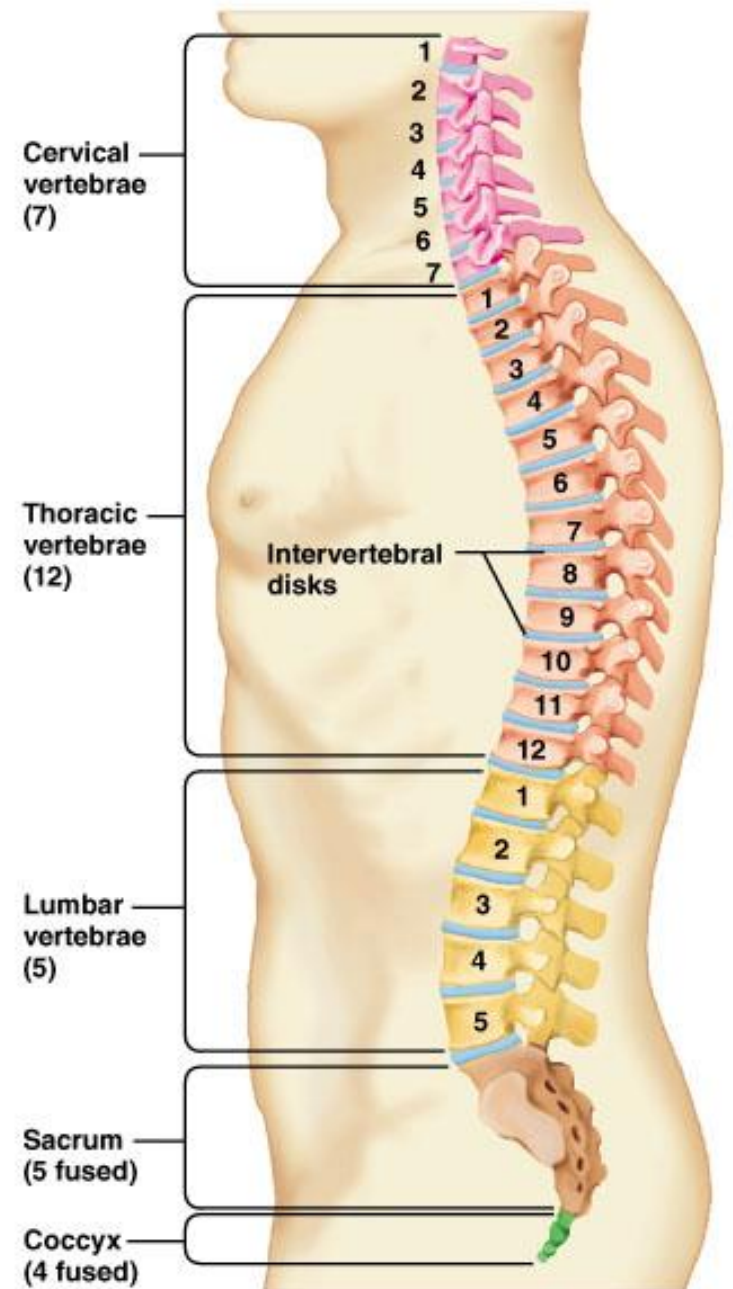
Vertebral Regions

- ***Vertebral Regions***

- Vertebrae are numbered
 - By region, from top (superior) to bottom(inferior)
 - C₁ articulates with skull, L₅ with sacrum
- Vertebrae of each region
 - Have characteristics determined by functions

Axial Skeleton

- ***The Vertebral Column (33 Vert.)***
- Cervical Vertebrae (7)
- Thoracic Vertebrae (12)
- Lumbar Vertebrae (5)
- Sacrum (5 Fused)
- Coccyx (4 Fused)



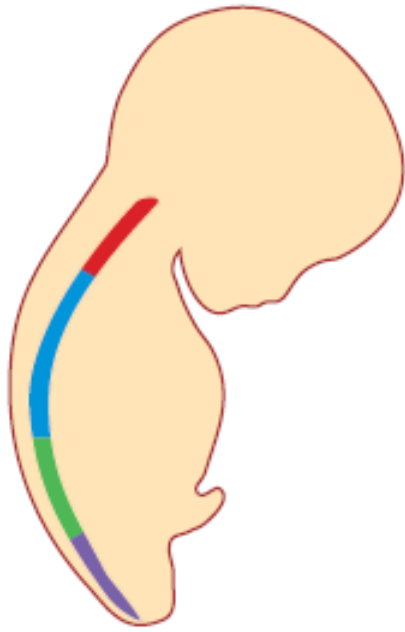


Curves of vertebral column

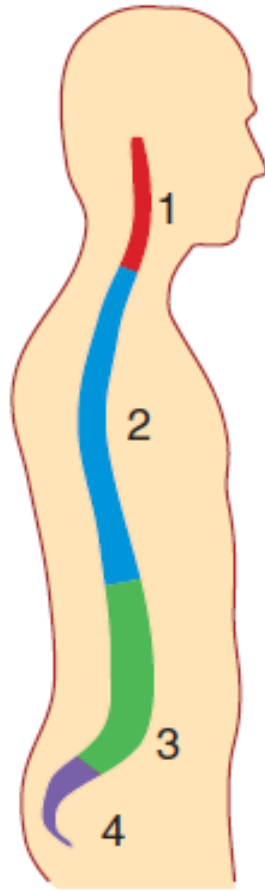
- **Primary curve:** The vertebral column is **concave anteriorly** at birth.

- **Secondary curves:**
 - (a) **The cervical curve:** becomes convex anteriorly when the child extends his head at the 3rd-4th month.

 - (b) **The lumbar curve:** becomes convex anteriorly when the child begins to walk between 12-18 months due to strengthening of the muscles of the back.

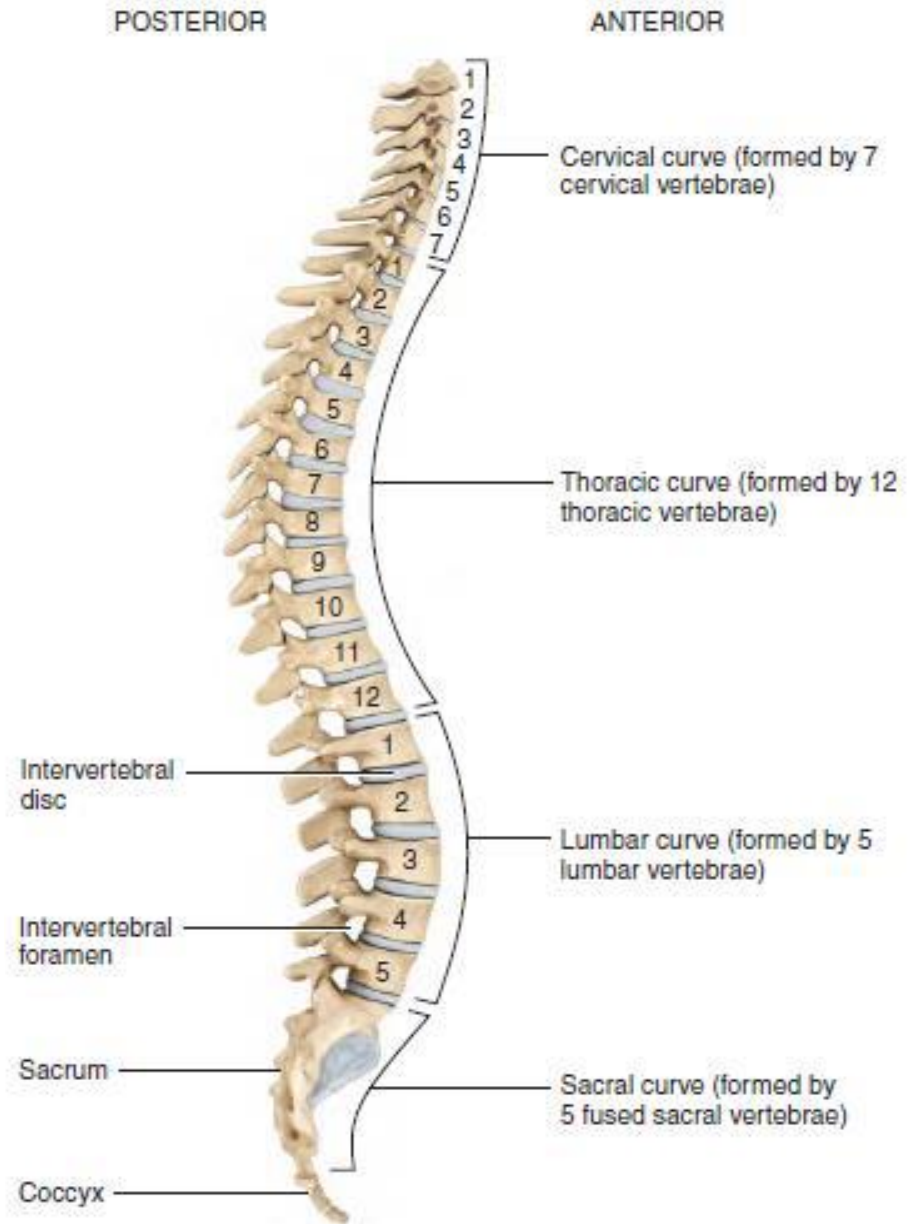


Single curve in fetus



Four curves in adult

(c) Fetal and adult curves





The Vertebral Column



(a) Kyphosis



(b) Lordosis

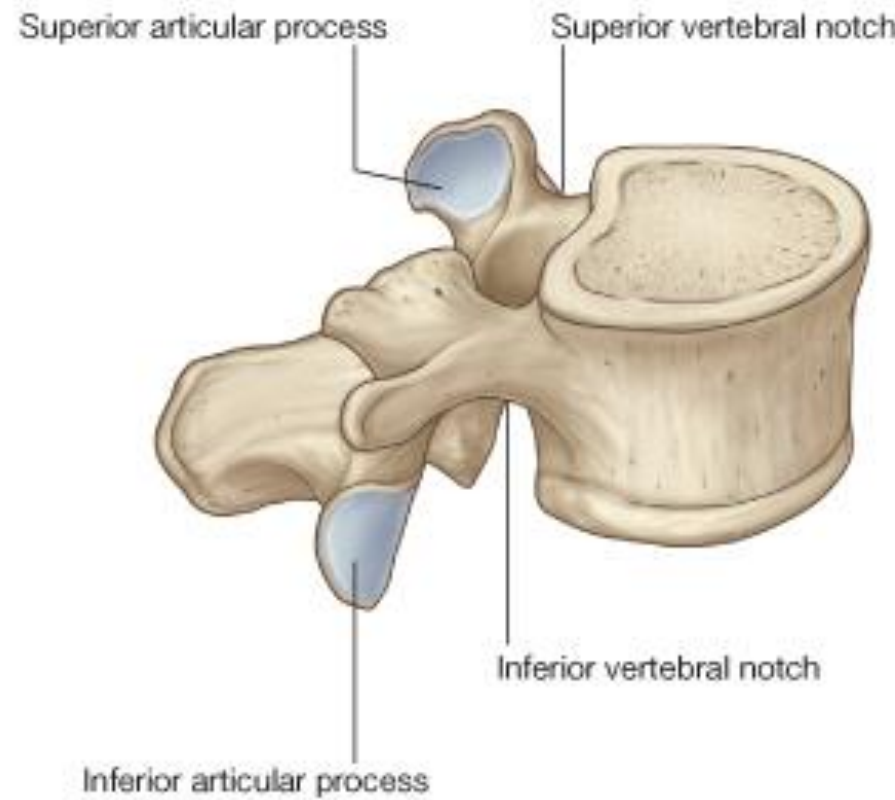
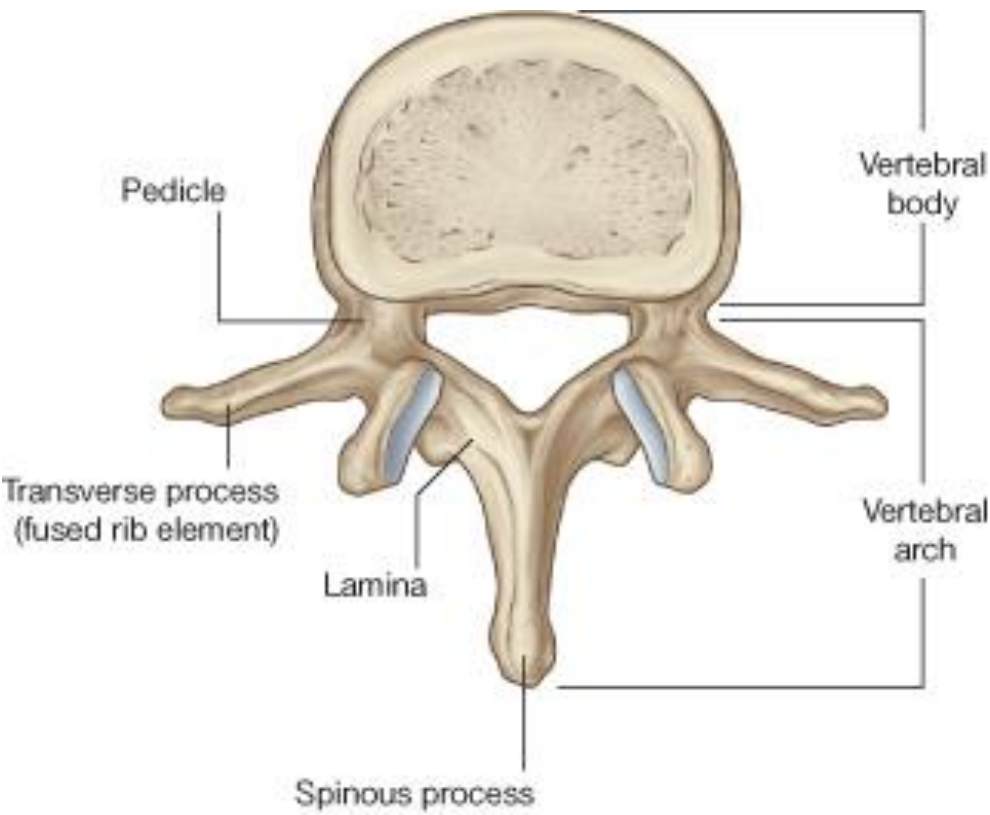


(c) Scoliosis



Typical Vertebrae

- *A typical vertebra consists of*
 - **1- Vertebral Body:** from the anterior part
 - **2- Vertebral arch:** form the lateral and posterior part
- The **vertebral foramen** lies between the vertebral arch and body
- The vertebral foramina of all the vertebrae together form the **vertebral (spinal) canal**, which contains and protects the spinal cord.





Typical Vertebrae

The vertebral arch of each vertebra formed of:

- A. **Two Pedicles:** short, thick processes attach to the vertebral body.

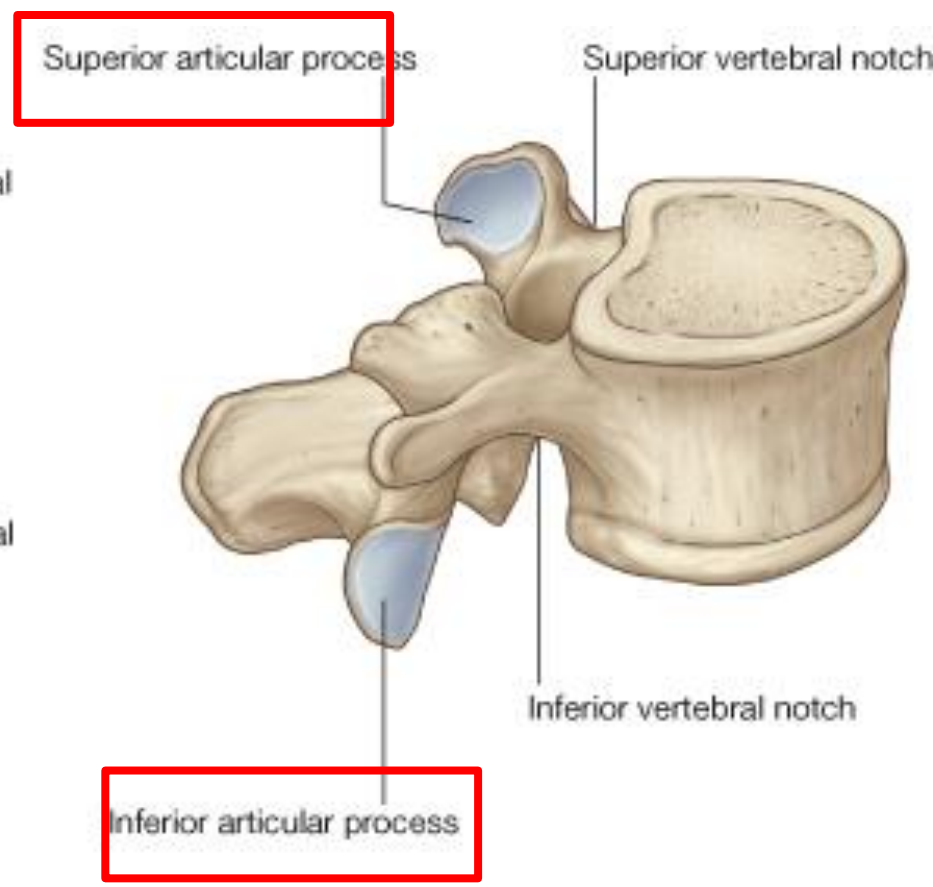
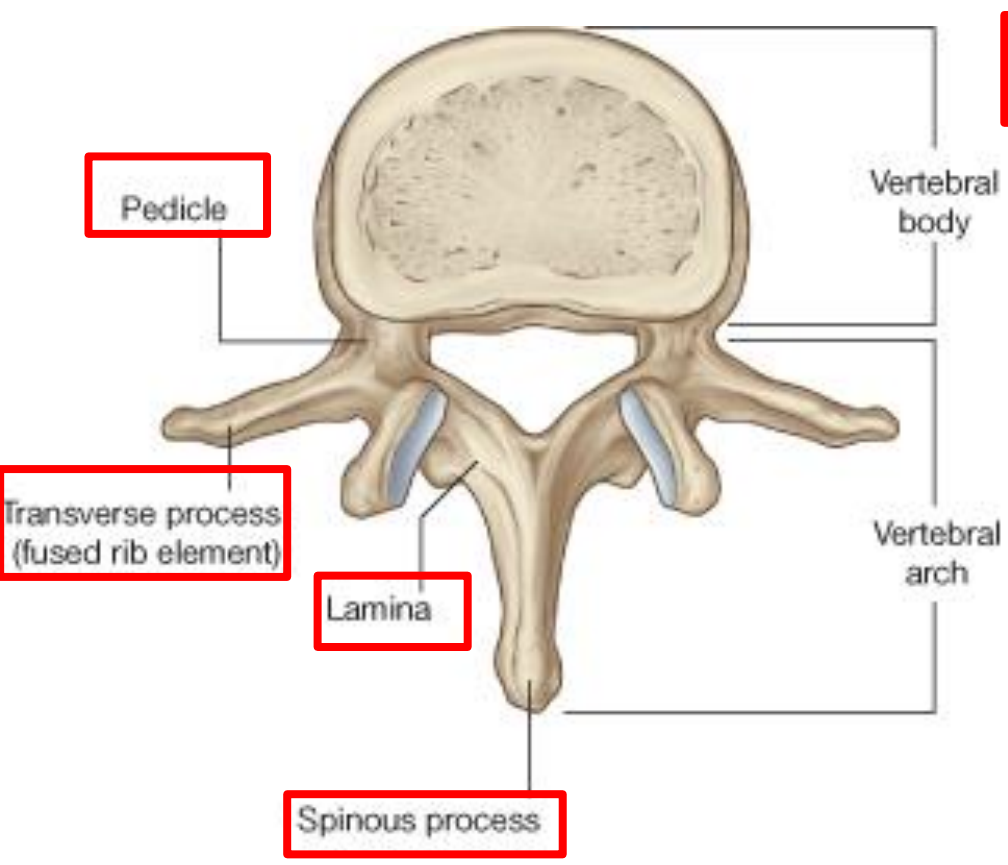
- B. **Two Laminae:** flat parts that join to form the posterior portion of the vertebral arch.



Typical Vertebrae

Extending from the vertebral arch are a number of processes:

- A. **Spinous process** projects posteriorly and inferiorly from the junction of the two laminae.
- B. **A transverse process** extends postero-laterally from the junction of the pedicle and lamina on each side
- C. **Superior and inferior articular processes**





The Vertebral Column

- ***Vertebral Foramina***

1. **Intervertebral foramina**

- Gaps between pedicles of adjacent vertebrae
- For nerve connections to spinal cord

2. **Vertebral canal**

- Formed by vertebral foramina
- Encloses the spinal cord



Intervertebral Discs

- Each 2 vertebrae are separated from each other by an intervertebral (IV) disc.

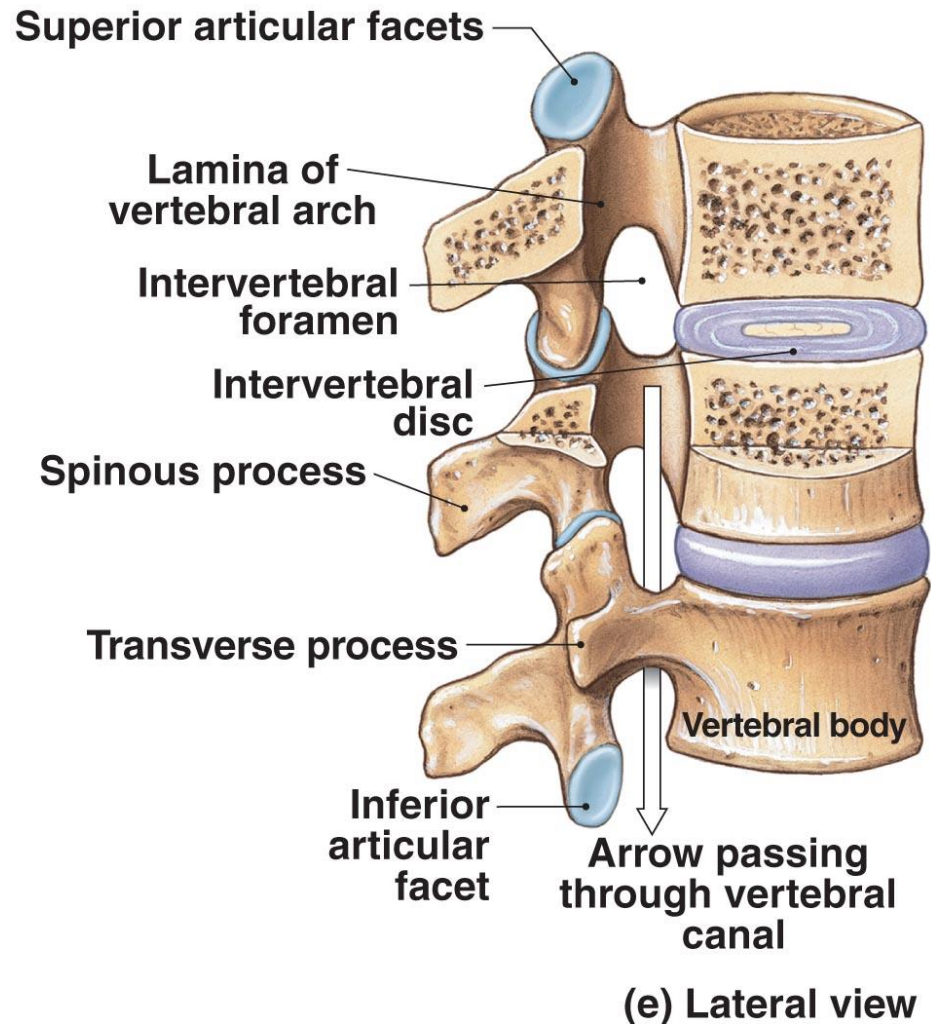
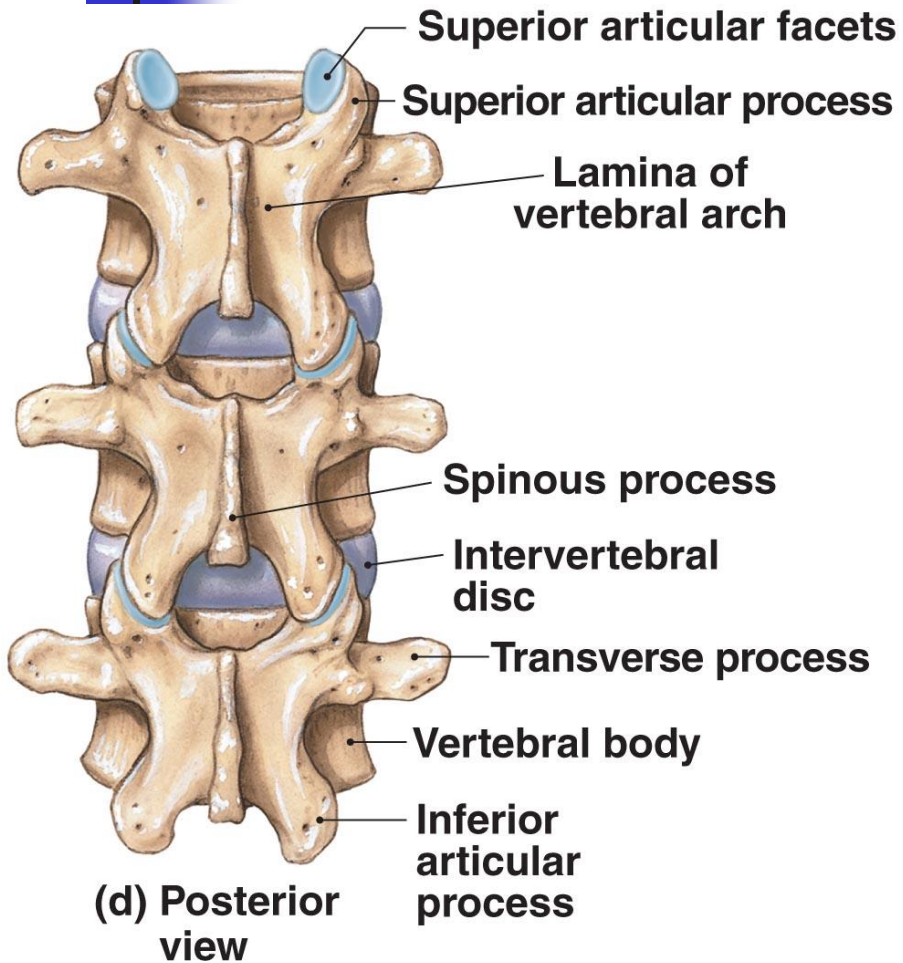
It is formed of 2 parts:

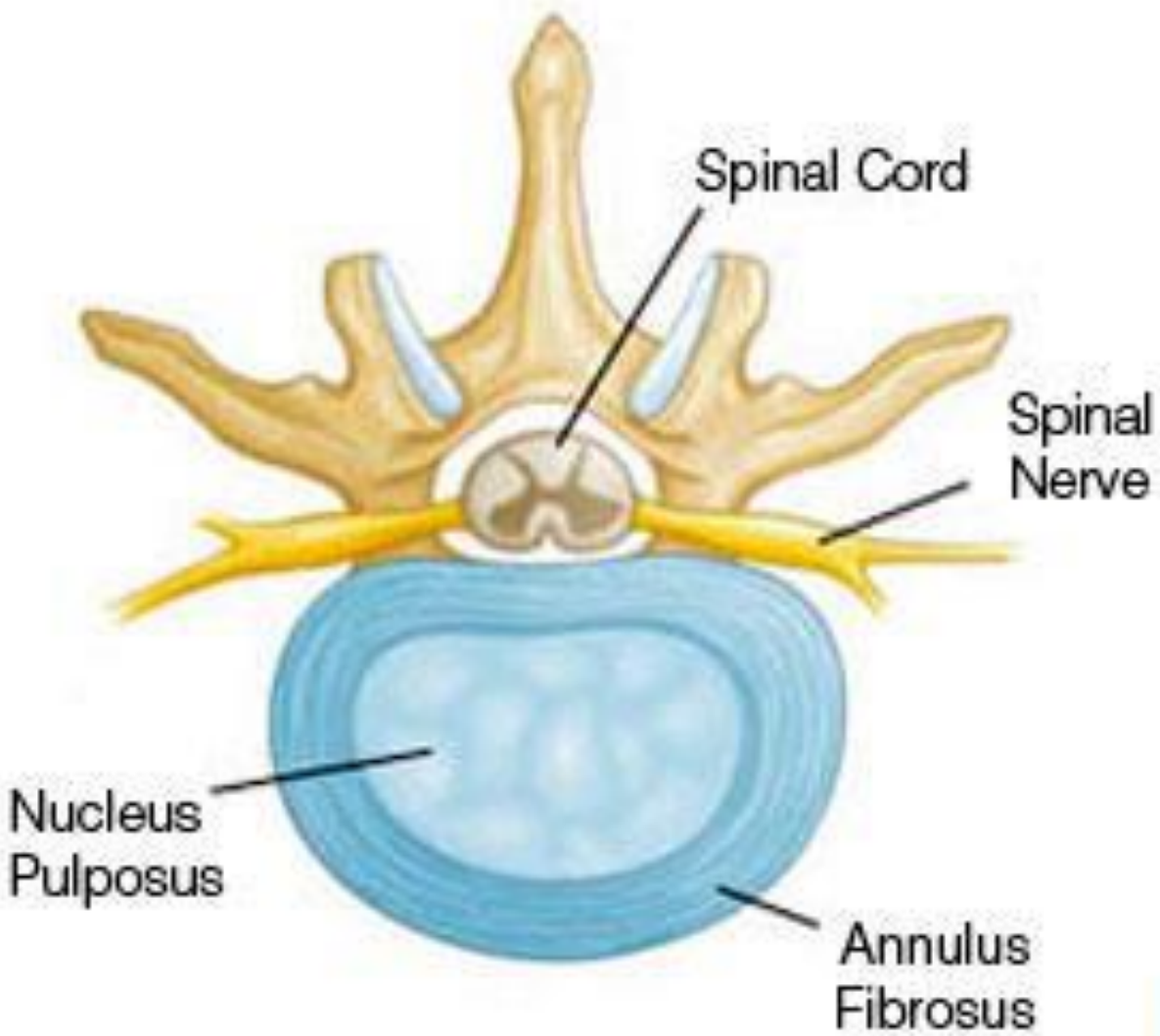
- A. An inner part called **nucleus pulposus**.
- B. An outer fibrous part called **annulus fibrosus**.

Function:

1. Links adjacent vertebral bodies together
 2. Allows spinal motion & provide stability
 3. Act as shock absorbers
- Its dislocation called **disc prolapse** causes a compression of one of the adjacent spinal nerves leading to severe pain.

The Vertebral Column







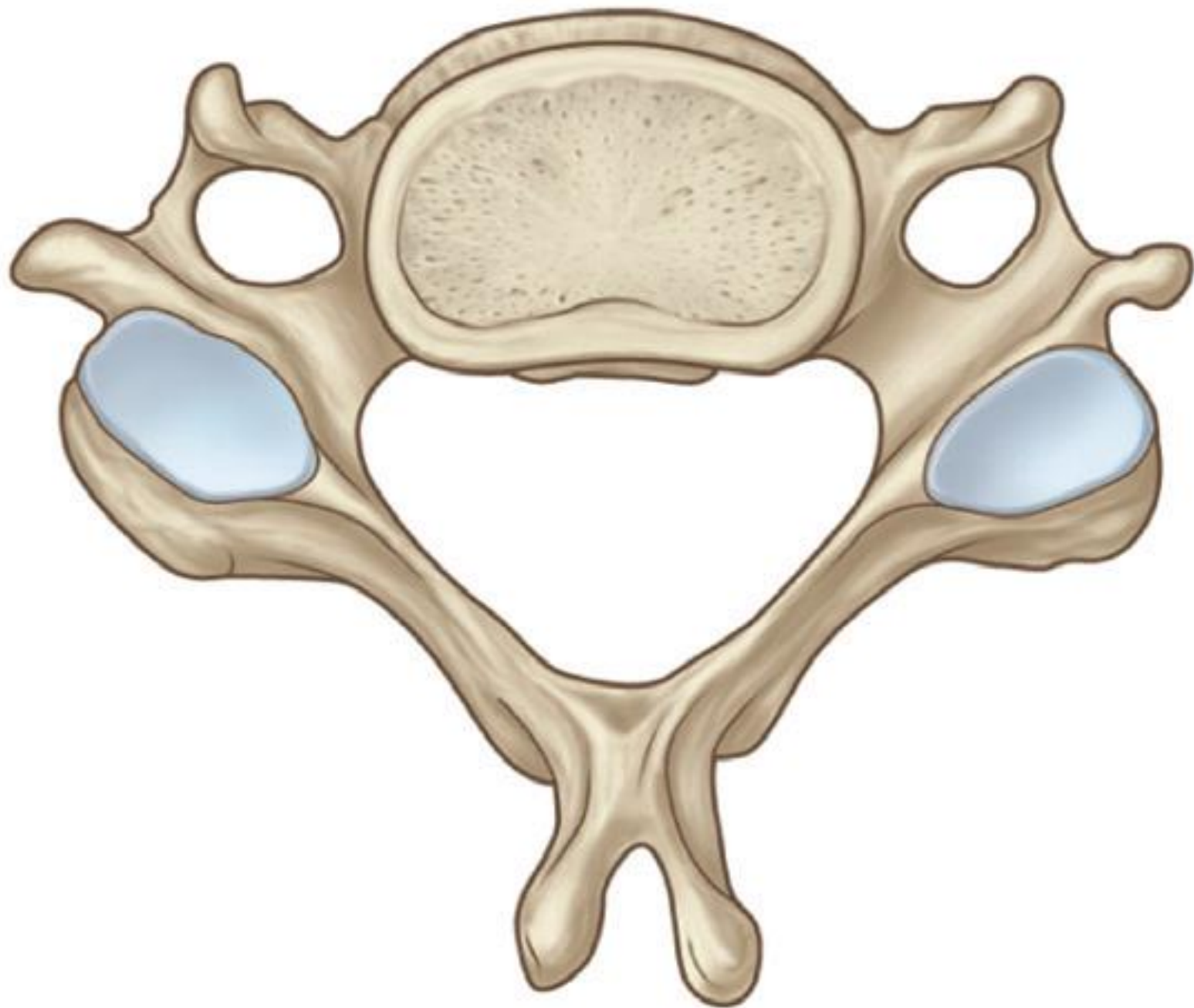
The Cervical Vertebrae

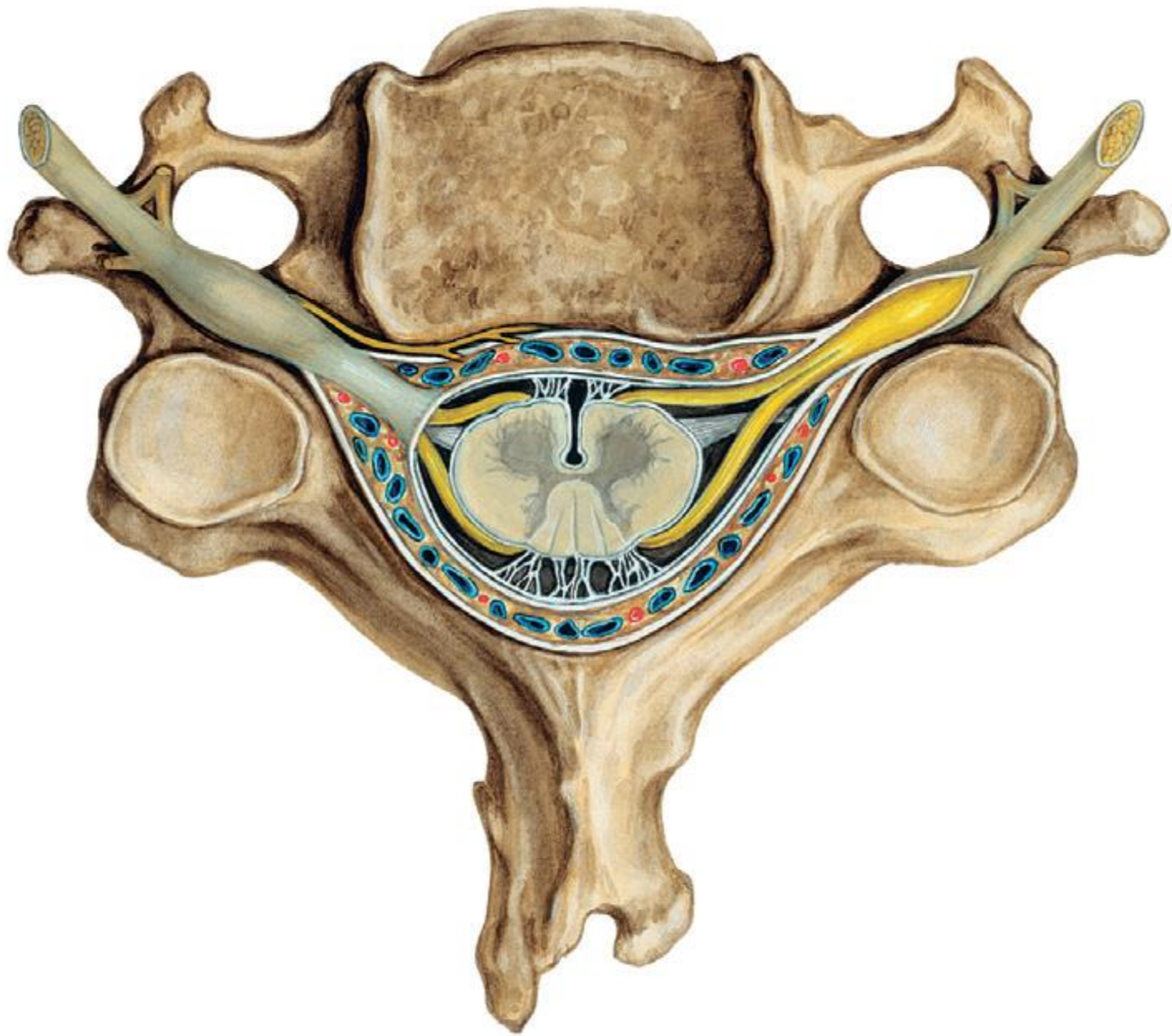
- Small body (support only head)
- Large vertebral foramen (largest part of spinal cord)
- Concave superior surface
- Slopes posterior to anterior



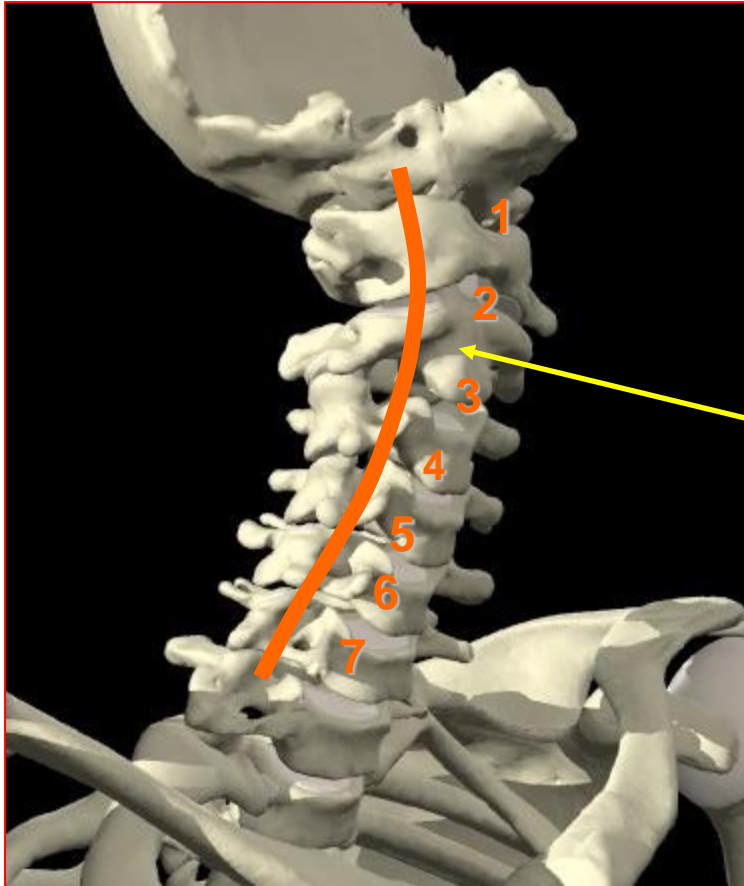
The Cervical Vertebrae

- The first (**C1= Atlas**) and second (**C2= Axis**) cervical vertebrae are specialized to facilitate movement of the head
- C₁ (**atlas**) has no spinous process
 - All others have short spinous processes
 - **Tip of most spinous process is notched (bifid)**





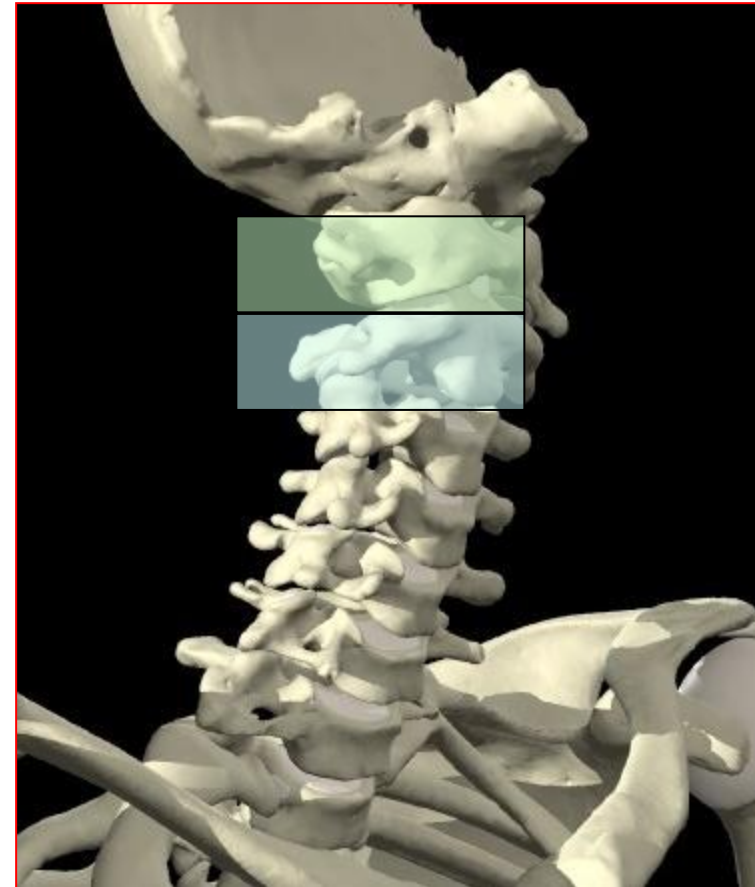
Cervical Spine Anatomy

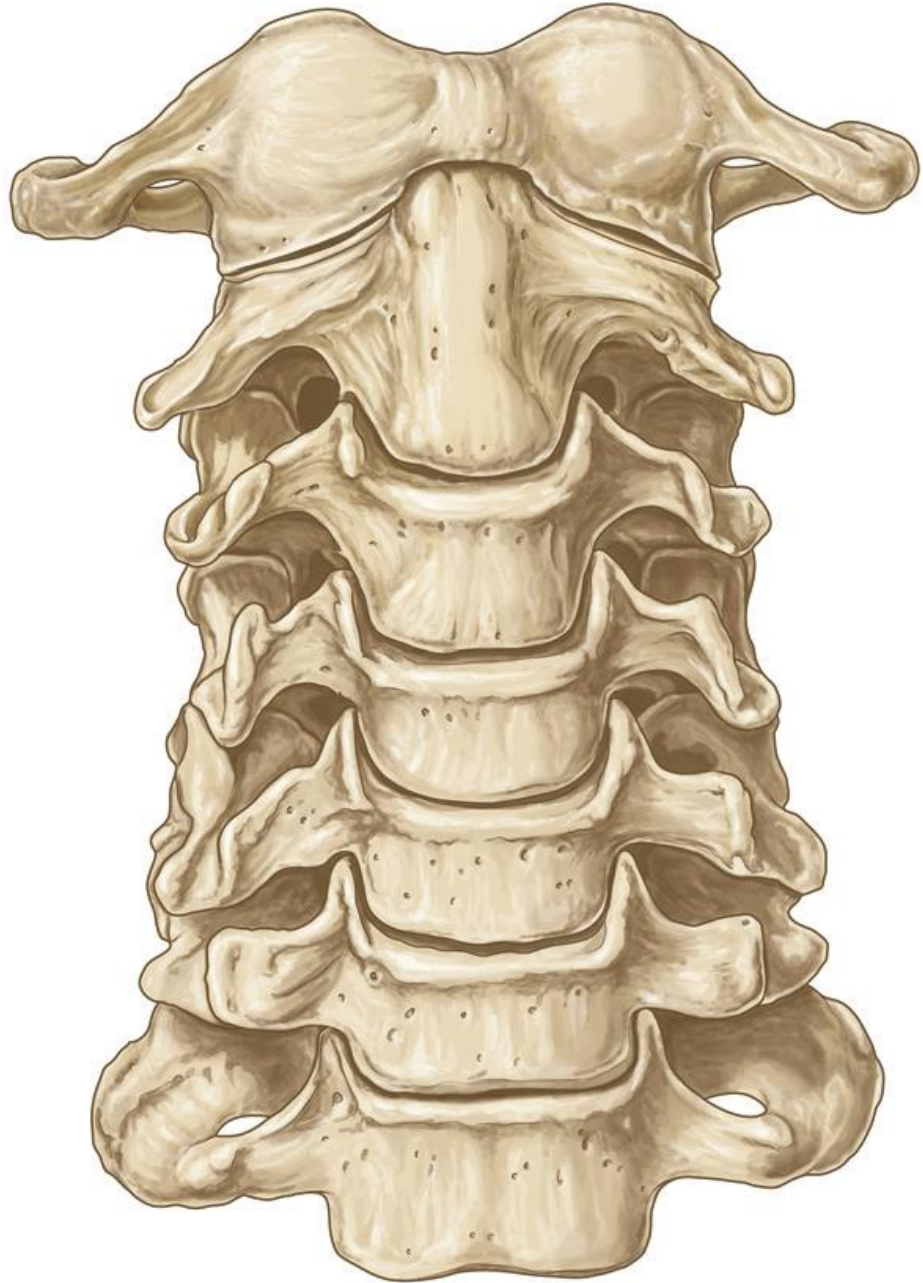


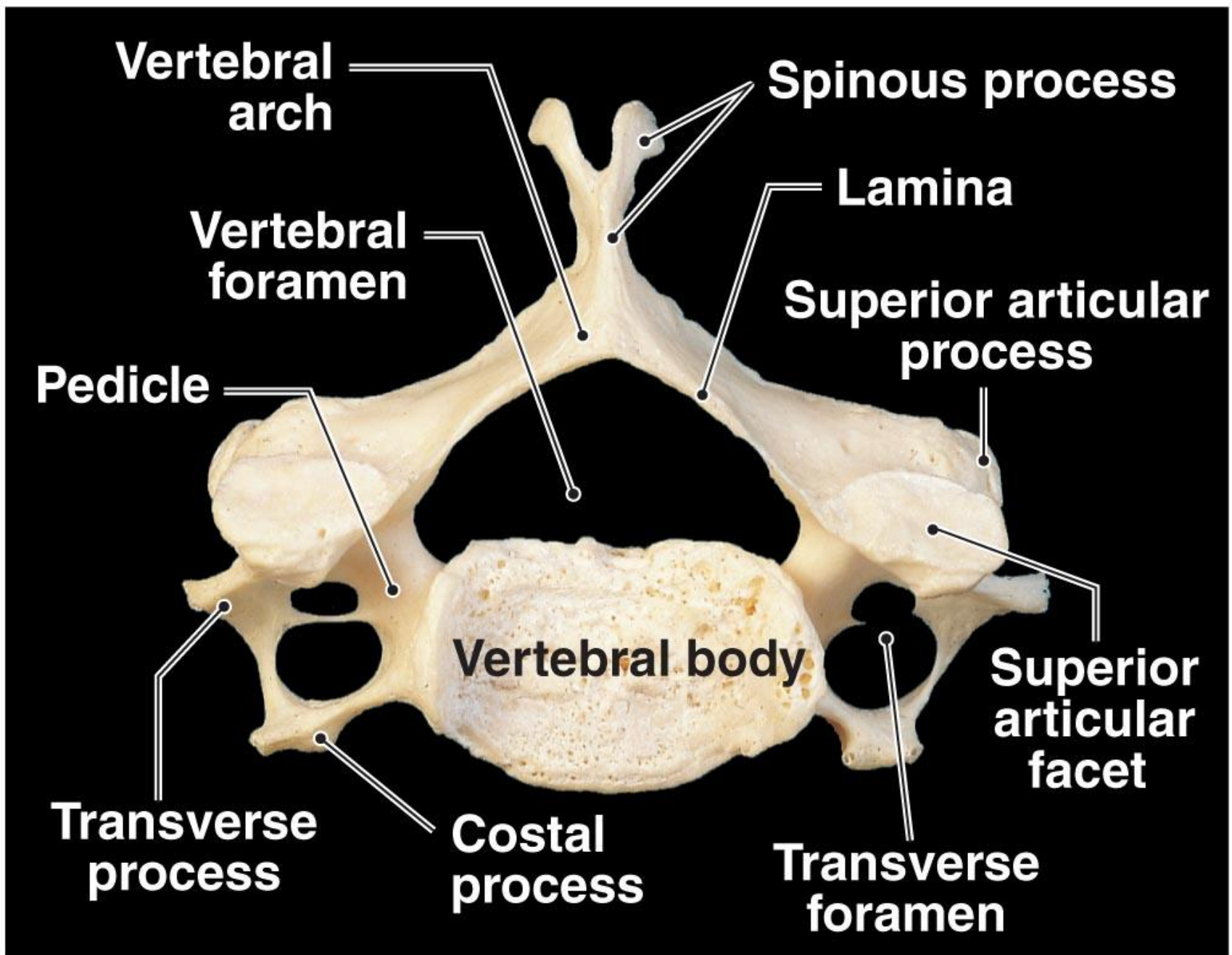
- **Vertebrae (7)**
- **Intervertebral discs (6)**
- **Pairs of exiting nerve roots (8)**

Cervical Spine Anatomy

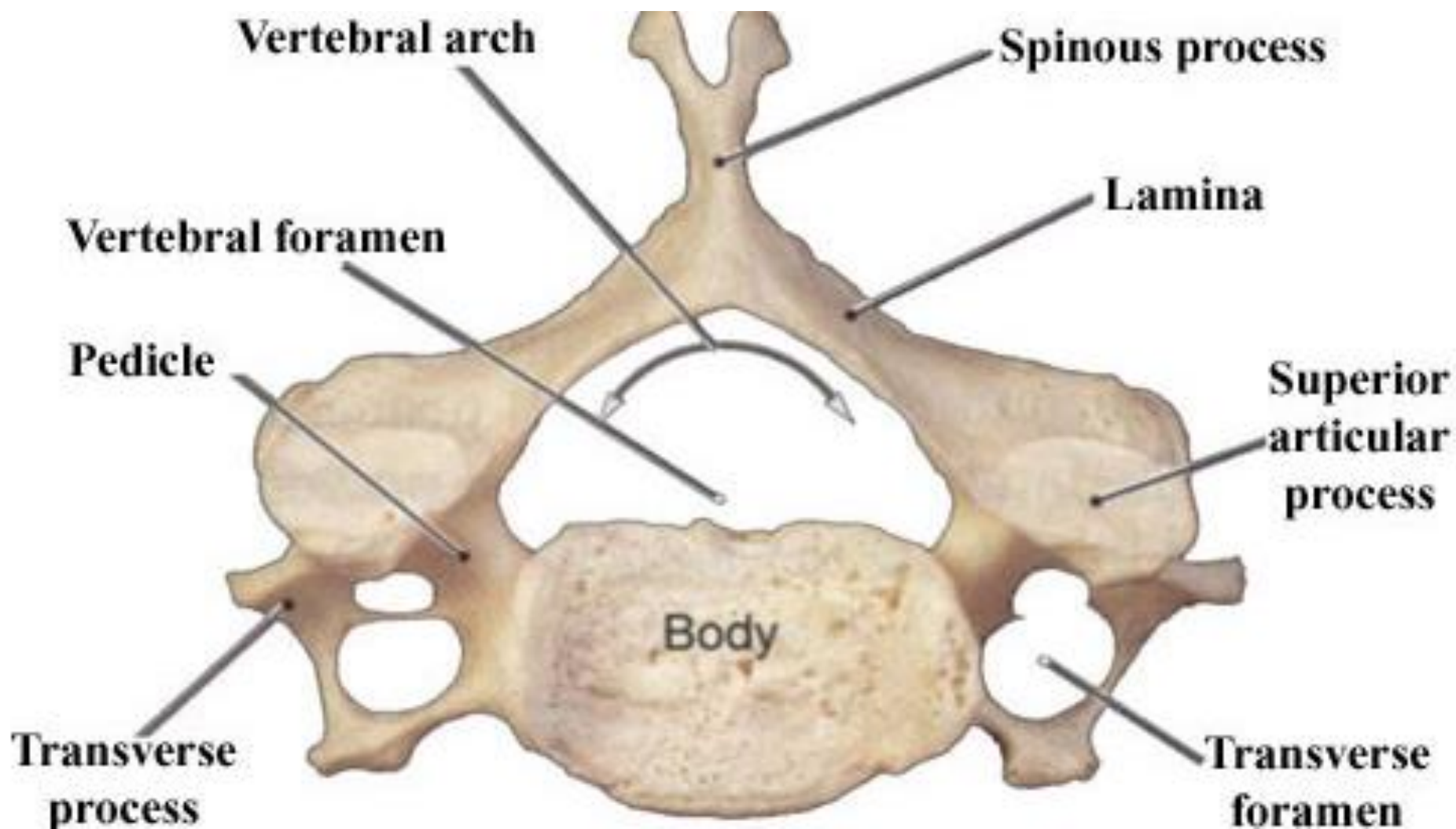
- Approximately 50% of flexion-extension motion occurs at occiput-C1
- Approximately 50% of rotation occurs at C1-C2
- Lesser amounts of flexion-extension, rotation, and lateral bending occur segmentally between C2-C7

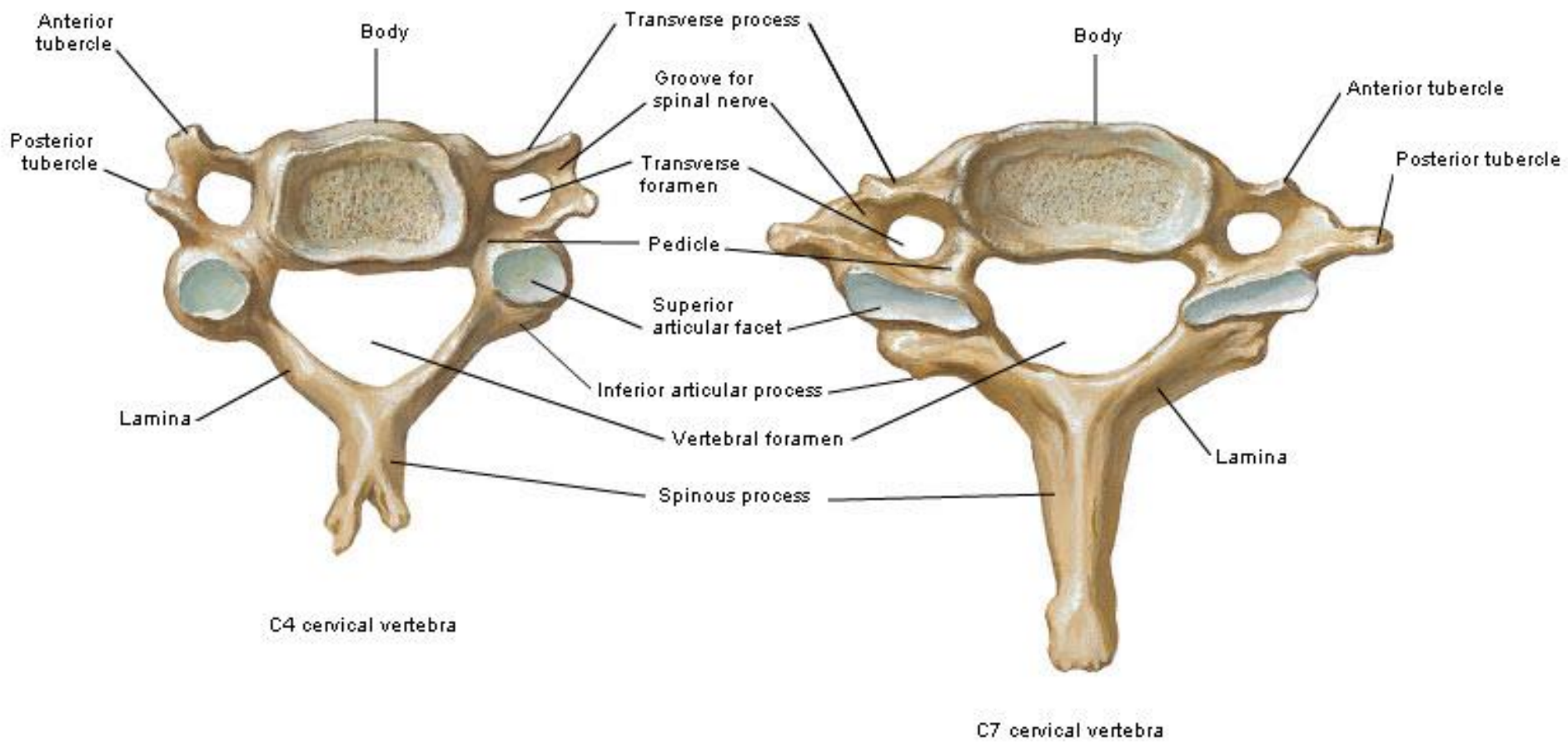


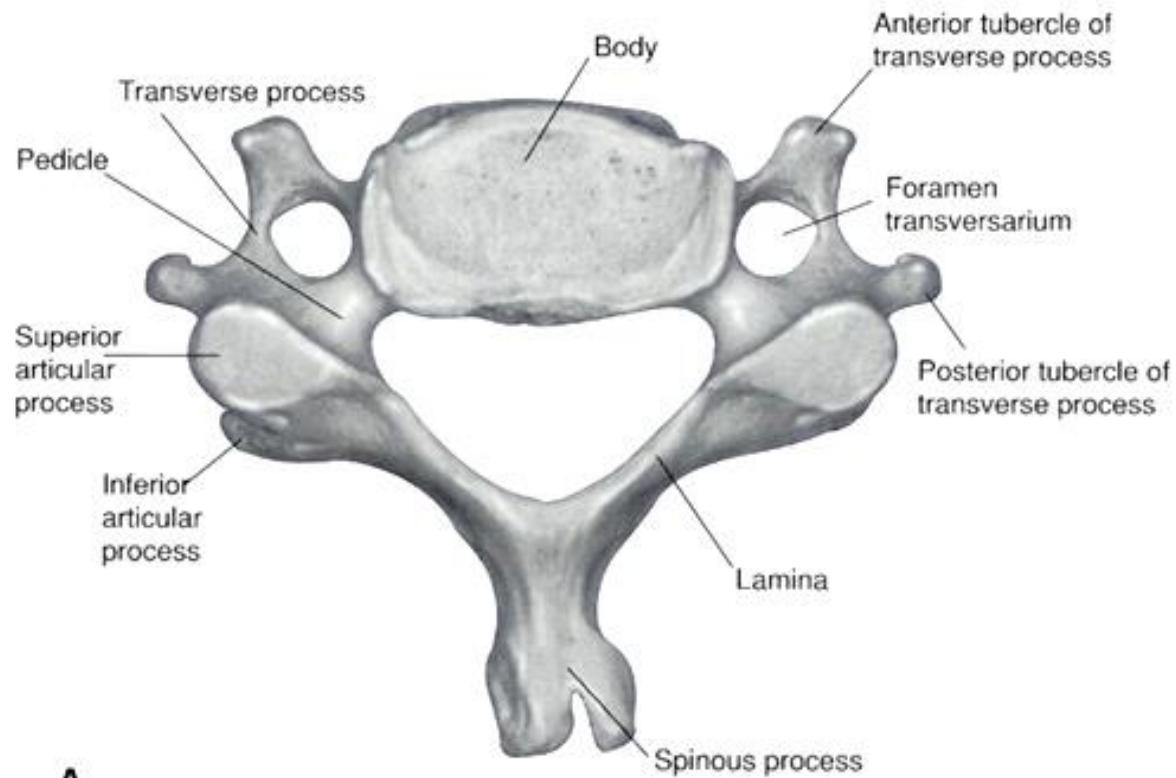




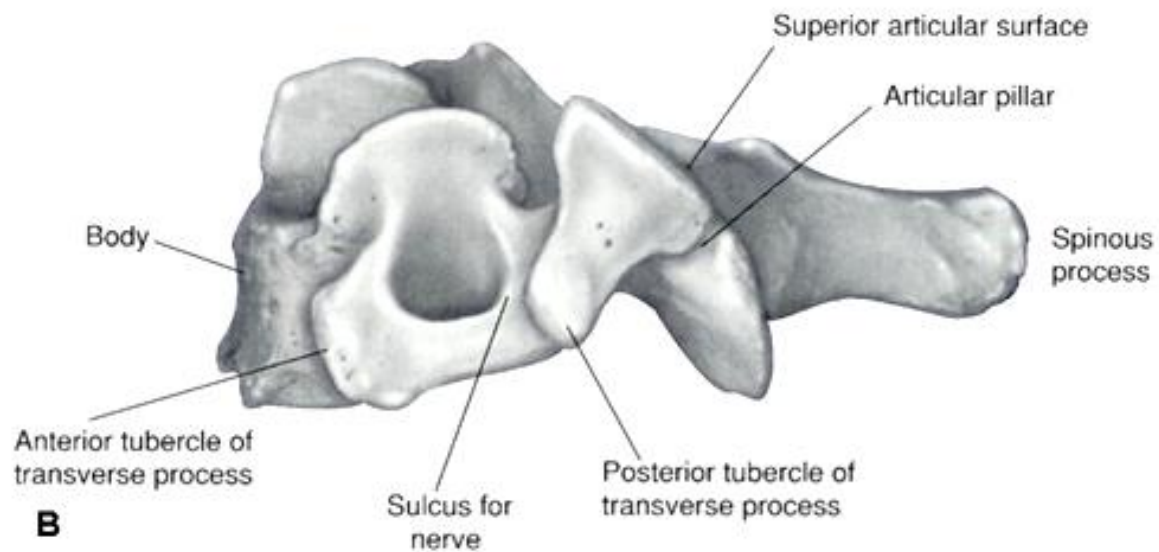
(b) Typical cervical vertebra (superior view)







A

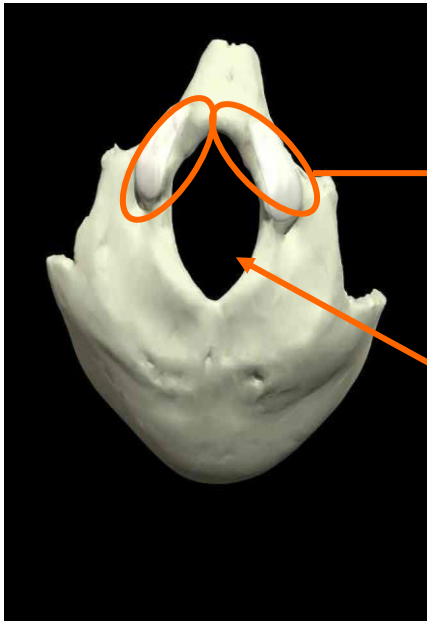


B

Atlas

- ***Atlas:***
- **No vertebral body**
- **Transverse processes**
- **No true spinous process**
- **Has a large, round foramen transversaria**
- **Supports the weight of the skull through 2 facet surfaces (atlanto-occipital joint)**
 - **Flexion and extension (primary movement)**
 - **Lateral flexion (slight)**



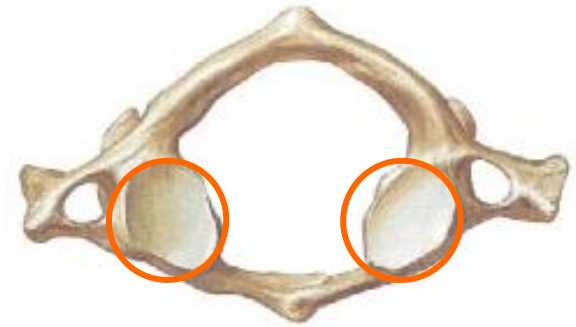


Occipital condyles Superior

Foramen magnum

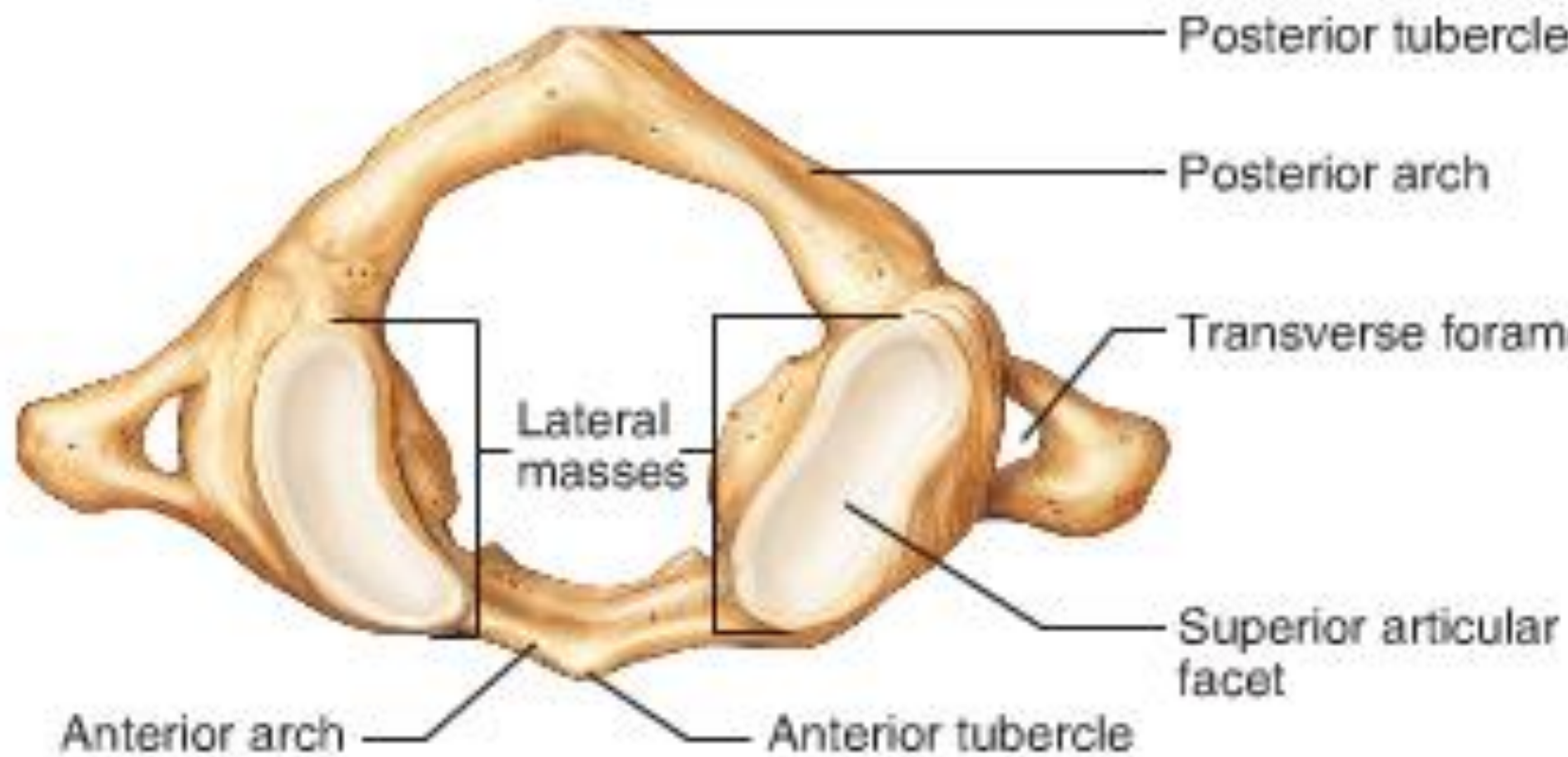


Inferior

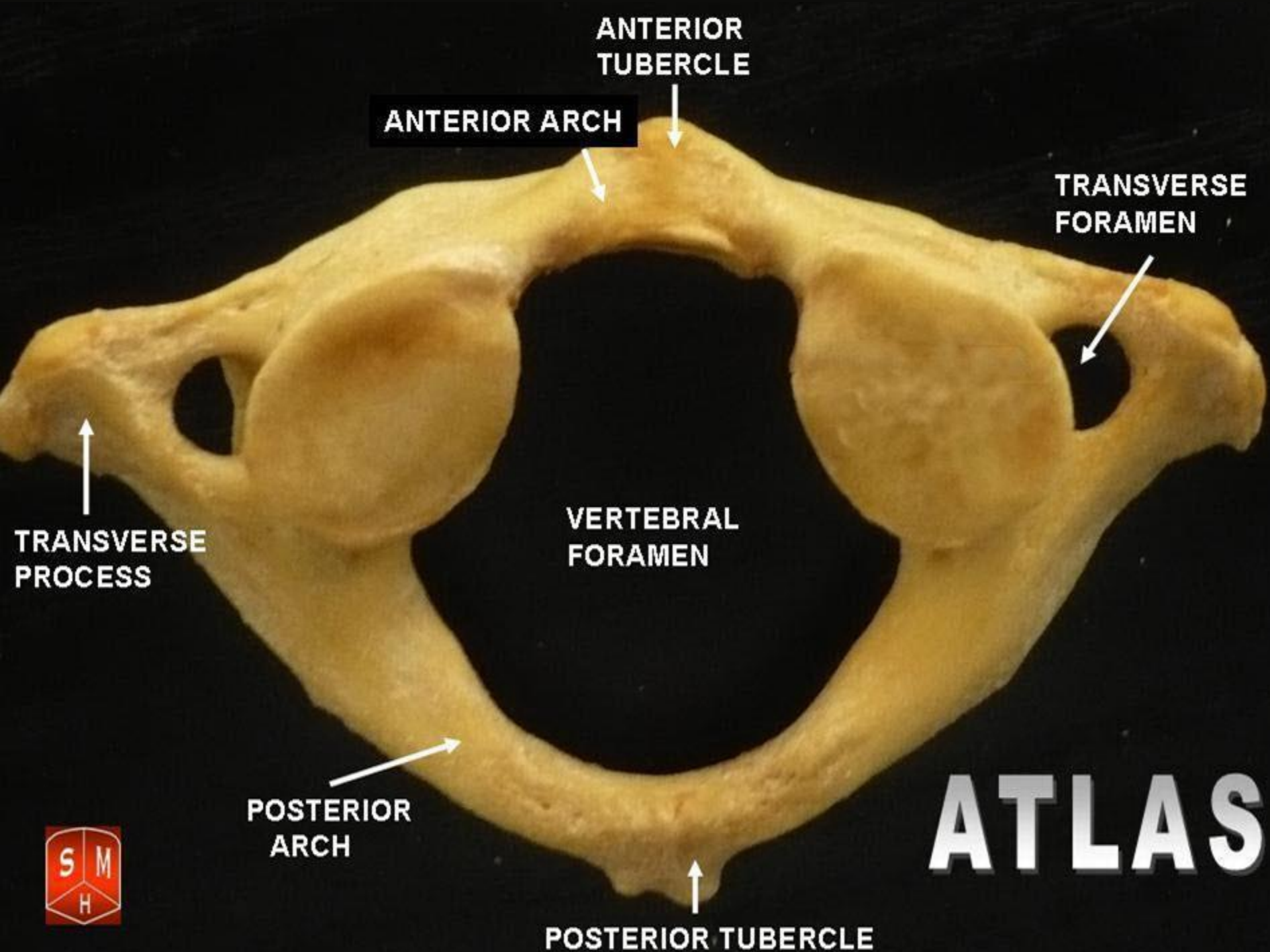


C₁

Posterior







ANTERIOR TUBERCLE

ANTERIOR ARCH

TRANSVERSE FORAMEN

TRANSVERSE PROCESS

VERTEBRAL FORAMEN

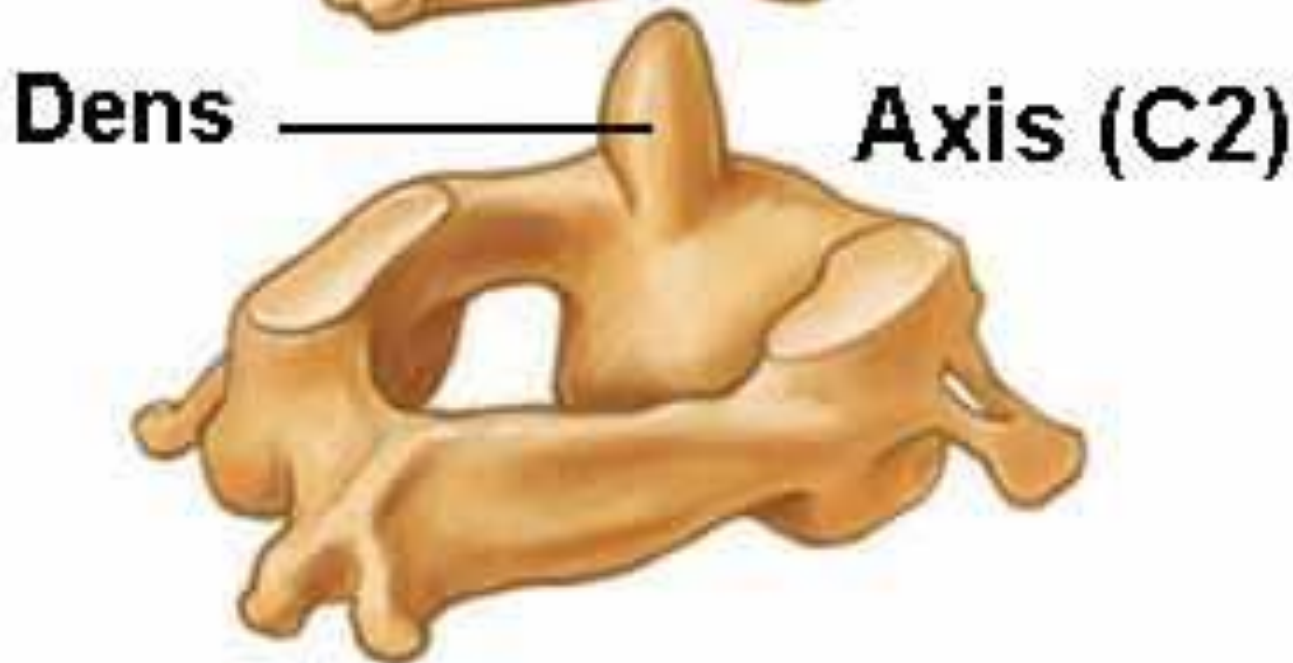
POSTERIOR ARCH

POSTERIOR TUBERCLE

ATLAS



Cervical Vertebrae



Axis

- ***Axis (C₂)***
- **Supports the atlas**
- **Has heavy spinous process**
- **Axis and atlas bodies fuse during development to form the dens**



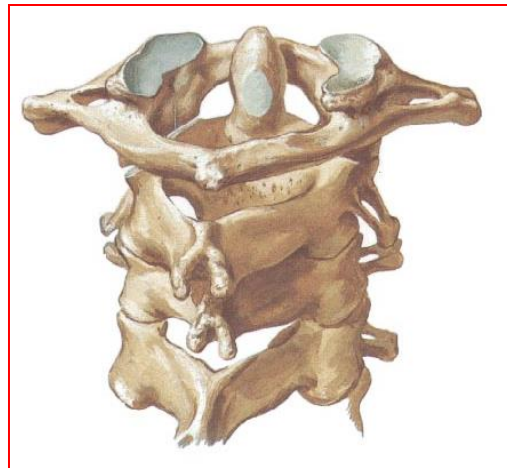
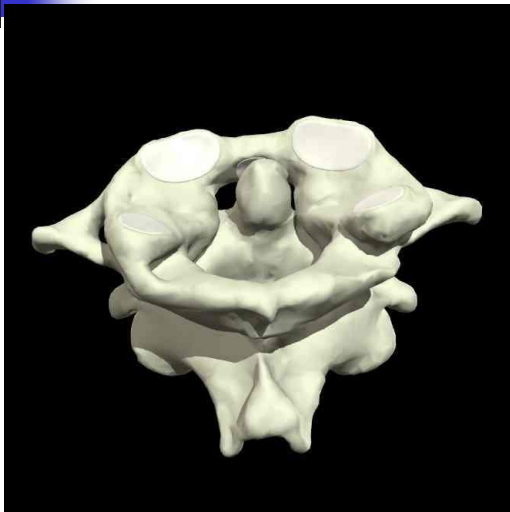
Axis

Atlanto-axial joint:

- Formed of dens and atlas articulation
- Allows rotation of the skull
- Median atlanto-axial joint
– Pivot synovial
- Lateral atlanto-axial joint
– Plane synovial



Cervical Spine Anatomy



- The odontoid process of the axis (C2) extends cranially to form the axis of rotation with atlas (C1)

Axis

Dens
(Odontoid process)

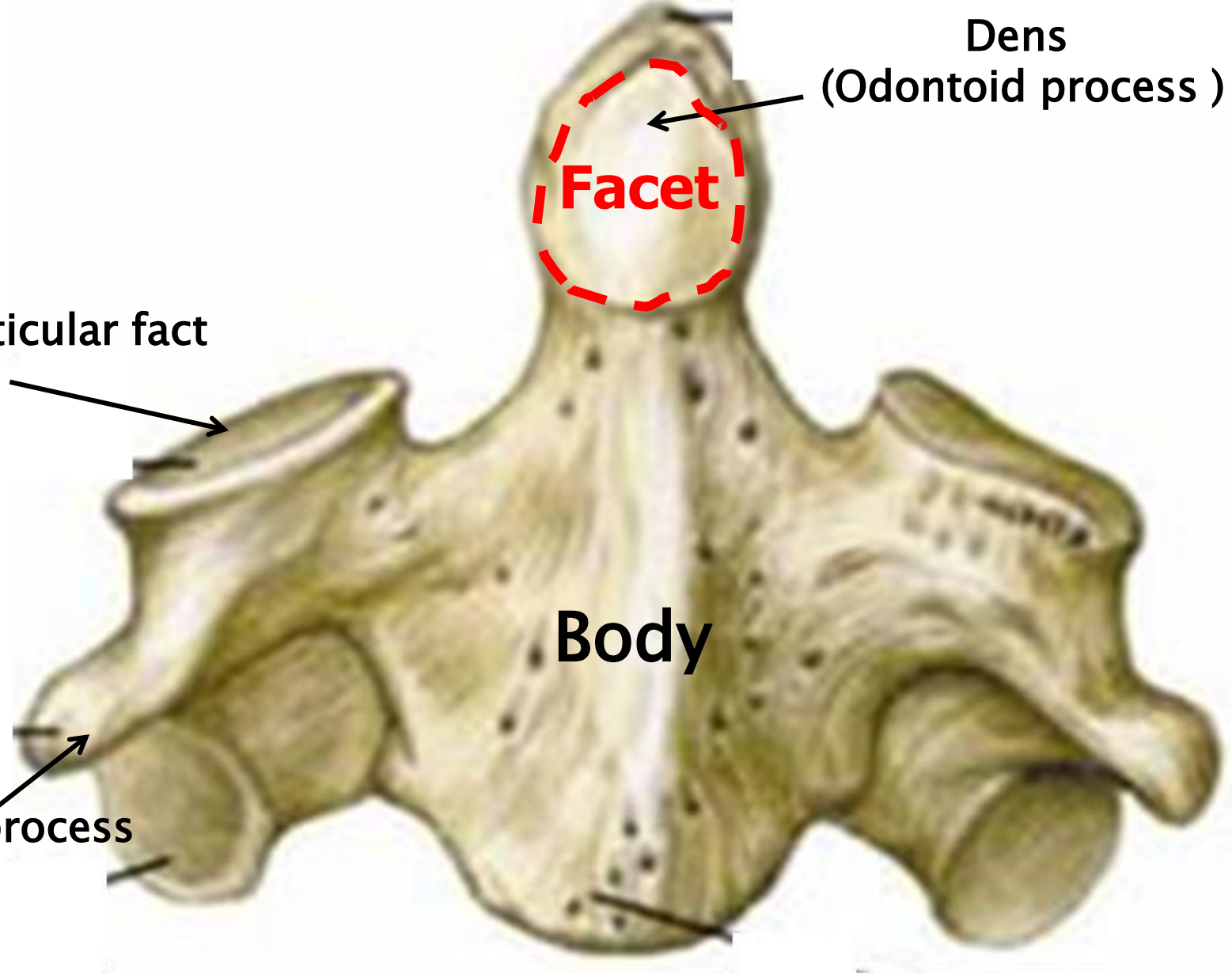
Facet

Superior articular fact

Body

Transverse process

Anterior view



Cervical Spine Anatomy

**anterior
view**



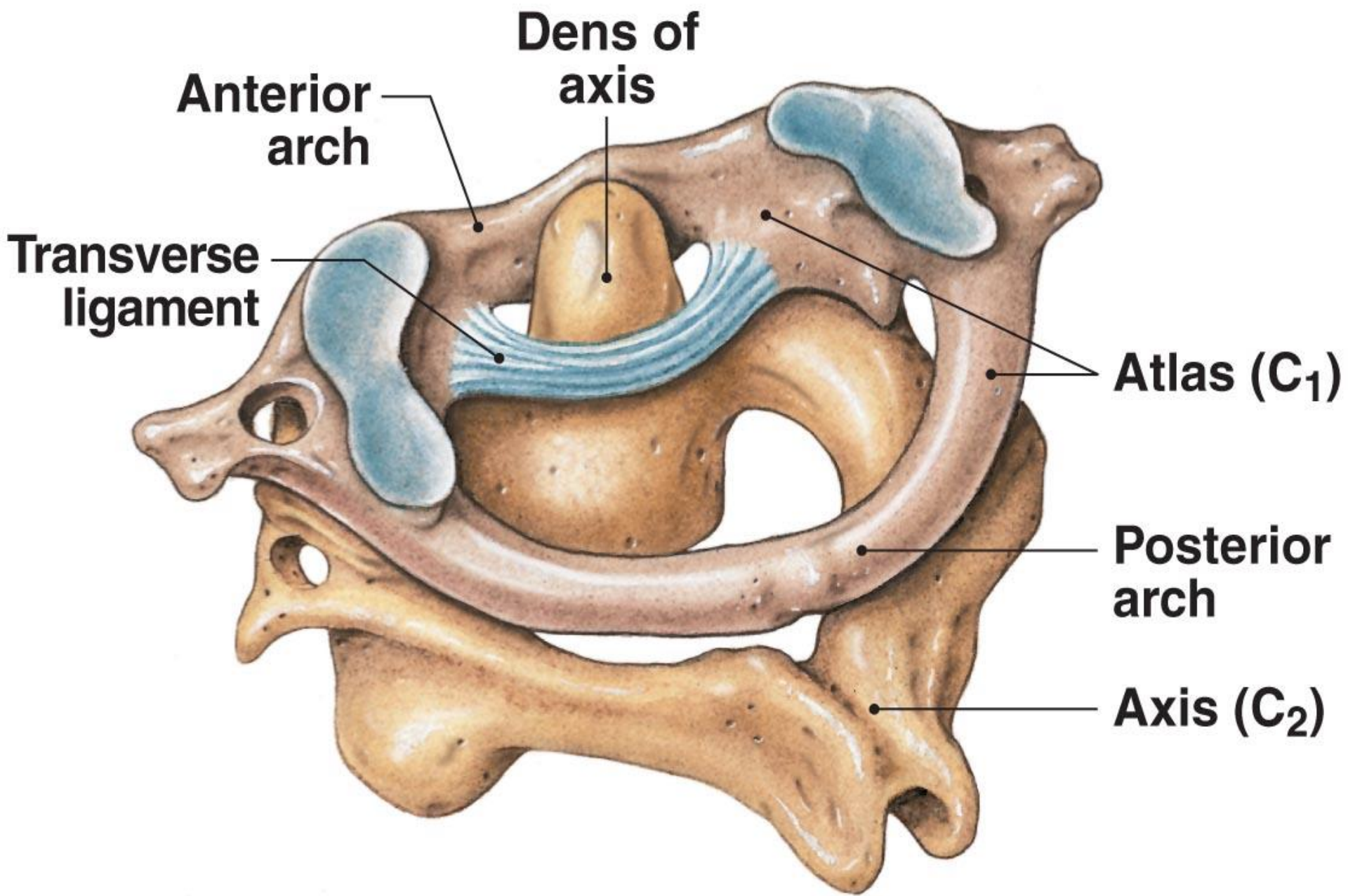
**posterior
view**



- **Atypical cervical**
- **vertebra C2 (axis)**
- **Odontoid process or dens**
- **Vertebral canal/foramen**
- **Facet joints**
- **Transverse process**
- **Transverse foramen**
- **Bifid spinous process**
- **Lamina**



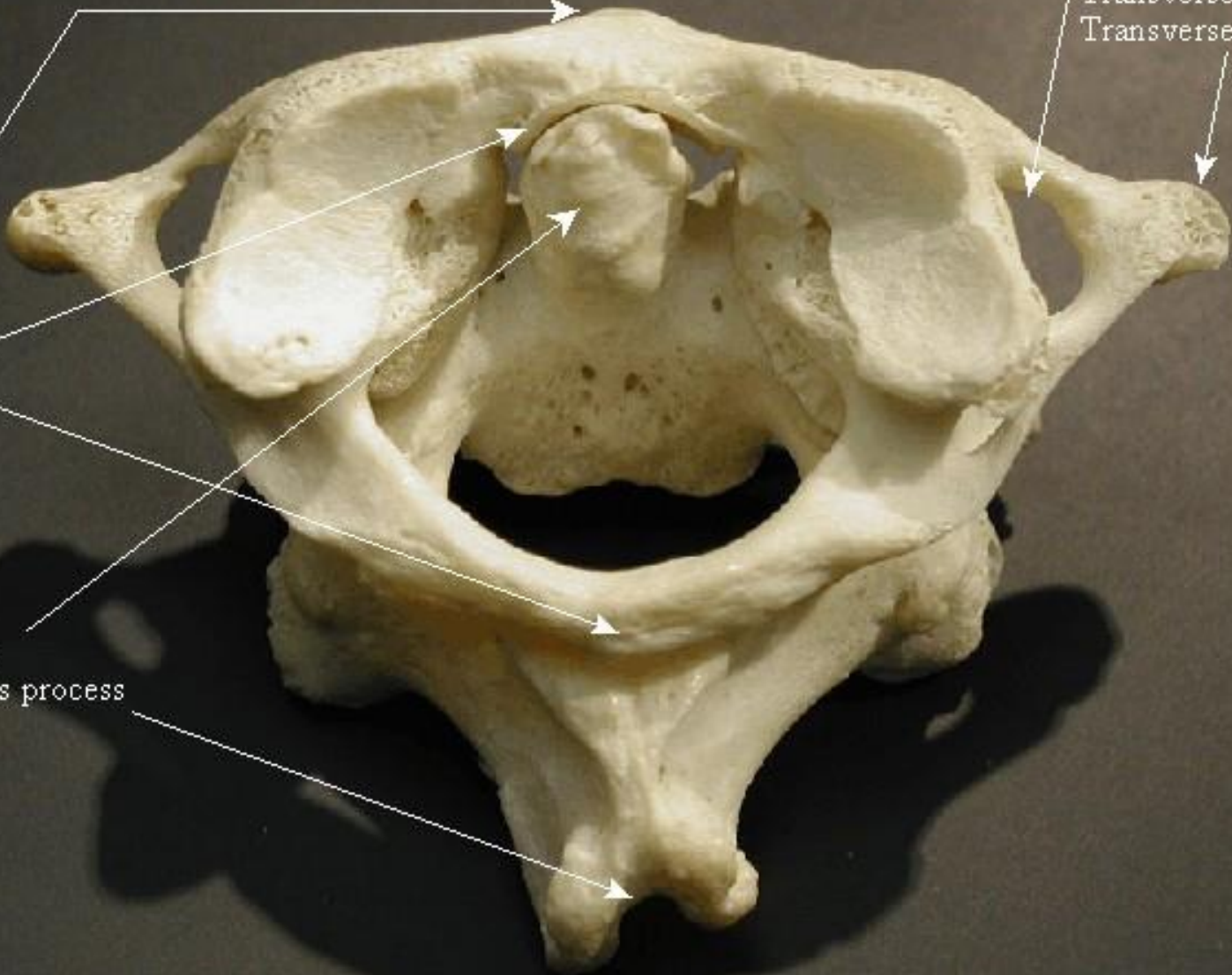




(d) The atlas–axis complex

ATLAS ARTICULATED WITH AXIS
(Allows head to shake "no.")

Transverse foramen
Transverse process



Atlas: (C-1)
No centrum
Articular surface
No spinous process

Axis: (C-2)
Odontoid process
Bifurcated spinous process



Cervical Vertebrae 7

Vertebra prominens (C₇)

- Transitions to thoracic vertebrae
- Has a long spinous process with a broad tubercle
- Has large transverse processes
- **Ligamentum nuchae** (elastic ligament) extends from C₇ to skull

C7





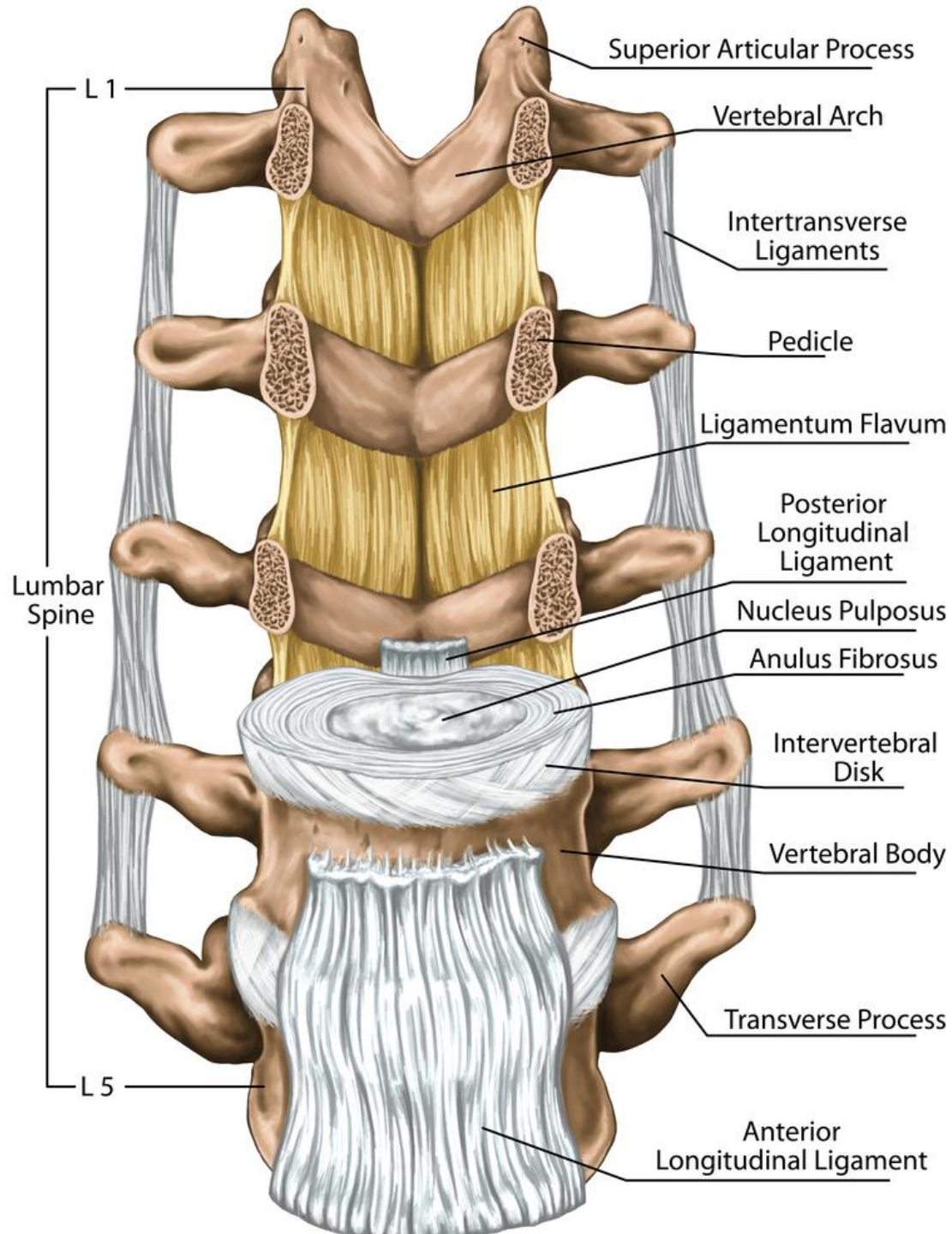
Ligamentous Anatomy

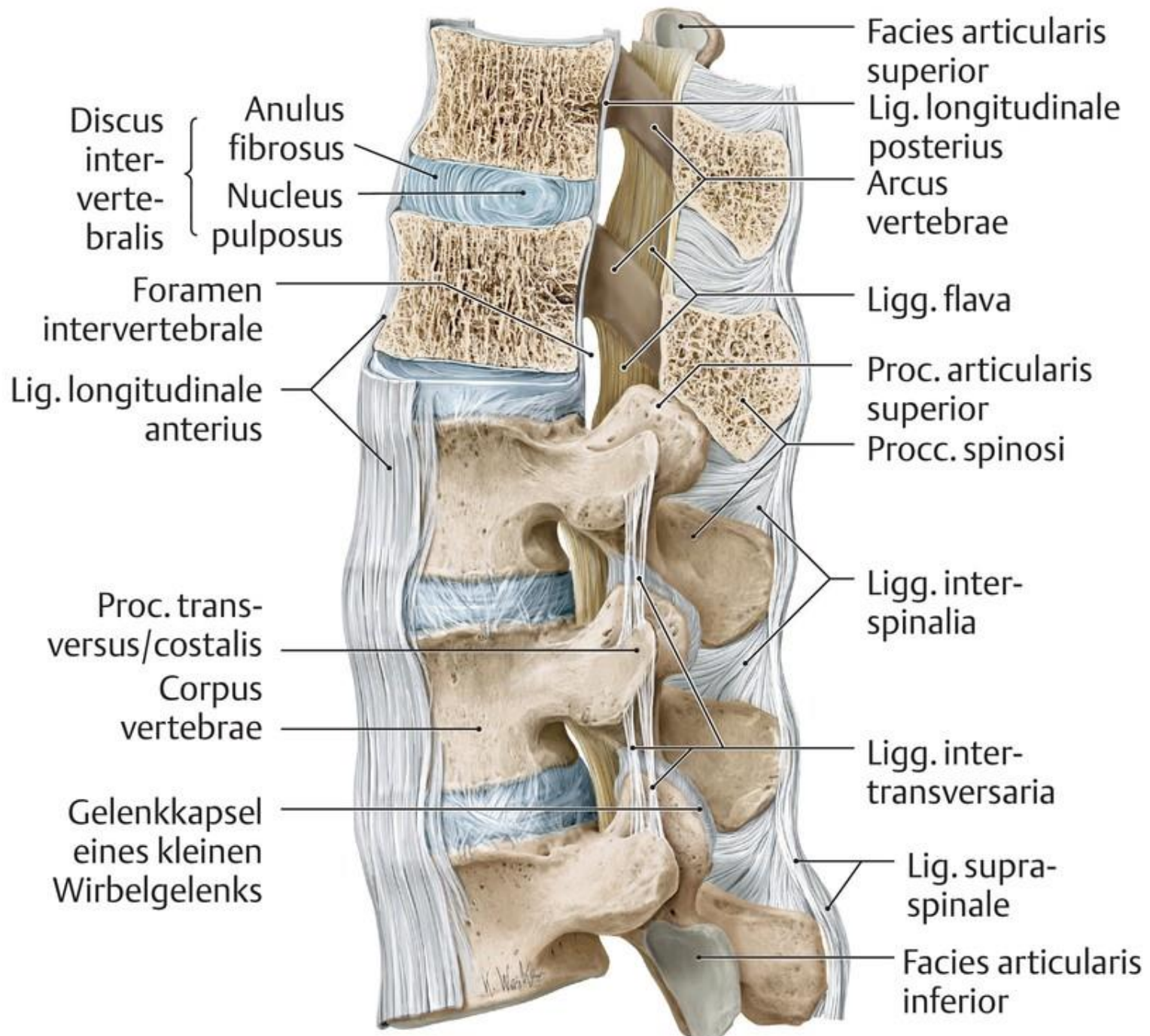
- **Anterior longitudinal ligament**
 - Reinforces anterior discs, limits extension
- **Posterior longitudinal ligament**
 - Reinforces posterior discs, limits flexion
- **Ligamentum nuchae in neck = supraspinous ligament in the rest of the vertebral column**
 - Thicker than in thoracic/lumbar regions
 - Limits flexion



Ligamentous Anatomy

- **Interspinous/intertransverse ligaments**
 - Limit flexion and rotation/limits lateral flexion
- **Ligamentum flavum**
 - Attach lamina of one vertebrae to another, reinforces articular facets
 - Limits flexion and rotation





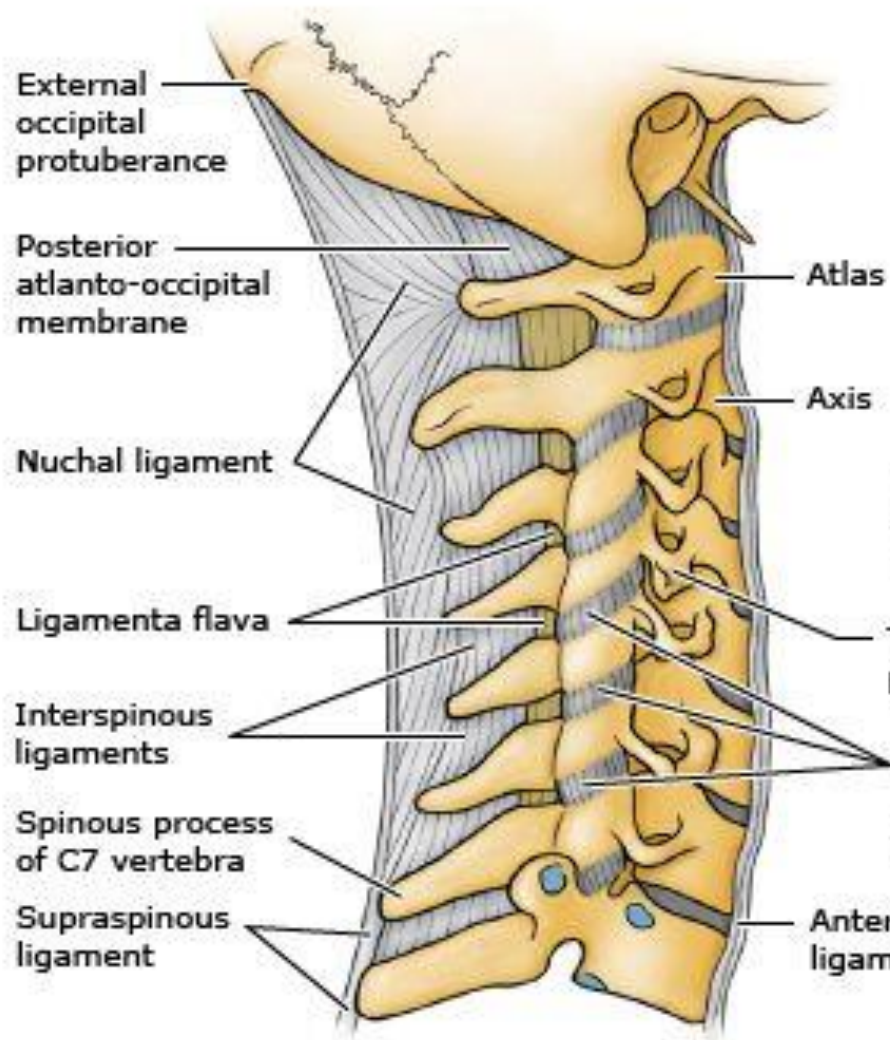
Discus intervertebralis {
 Anulus fibrosus
 Nucleus pulposus

Foramen intervertebrale
 Lig. longitudinale anterius

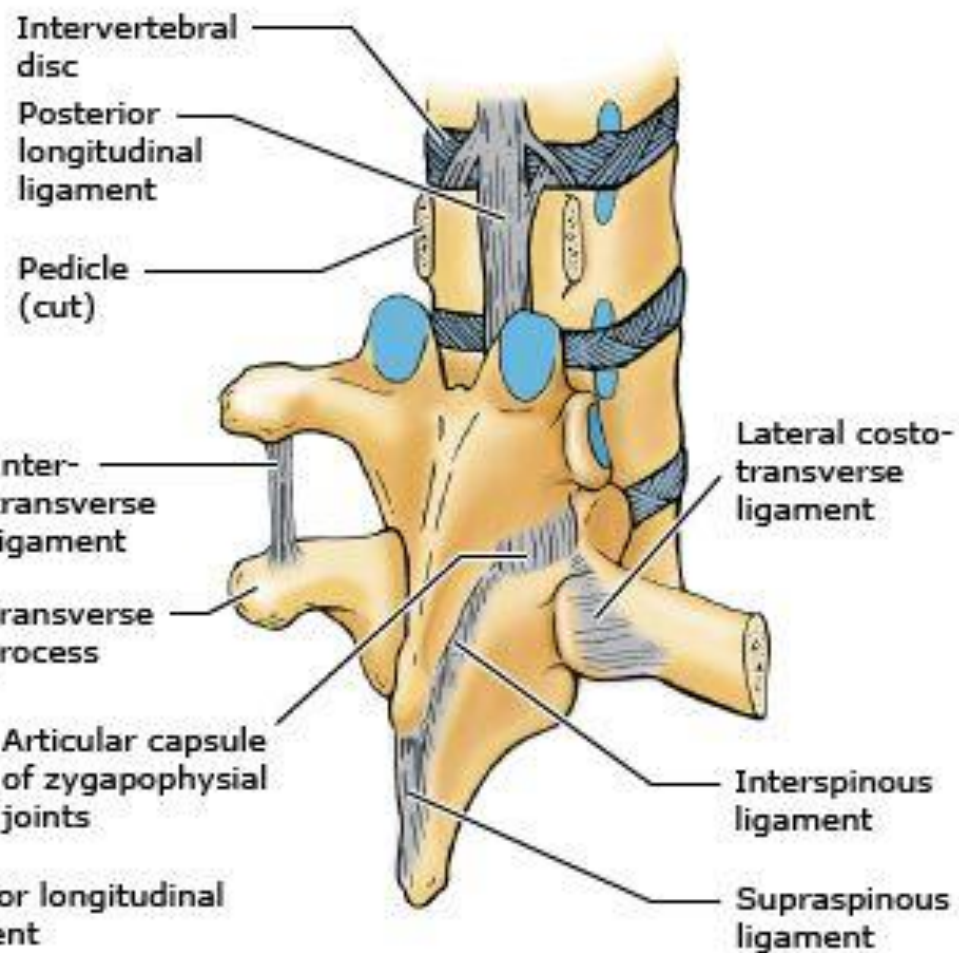
Proc. transversus/costalis
 Corpus vertebrae

Gelenkkapsel eines kleinen Wirbelgelenks

Facies articularis superior
 Lig. longitudinale posterius
 Arcus vertebrae
 Lig. flava
 Proc. articularis superior
 Procc. spinosi
 Lig. interspinalia
 Lig. intertransversaria
 Lig. supraspinale
 Facies articularis inferior



A Right lateral view

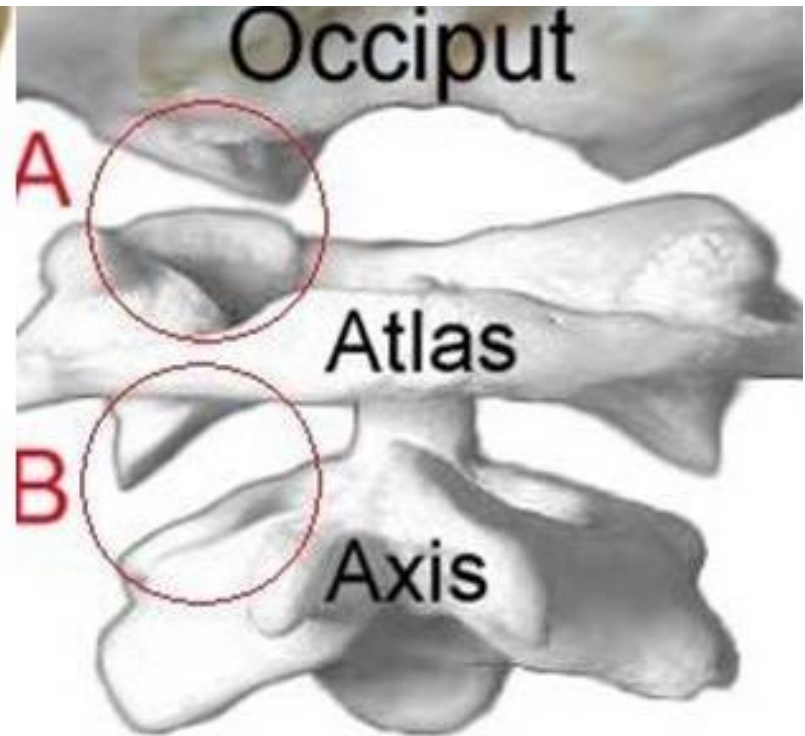


B Right posterior oblique view

Atlanto-Occipital joint



Posterior View
Cervical Spine



A: Atlanto-Occipital Joint
B: Atlanto-Axial Joint



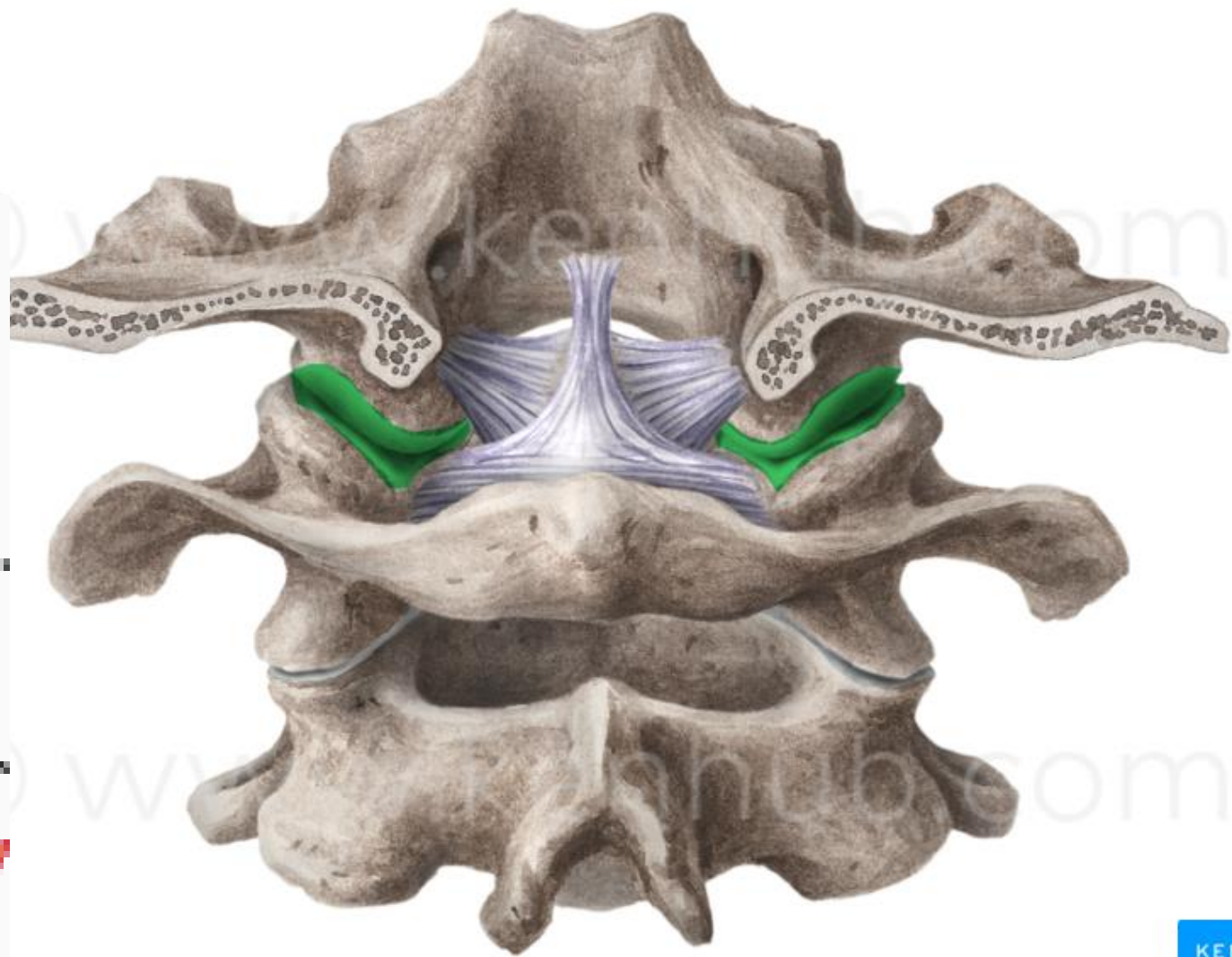
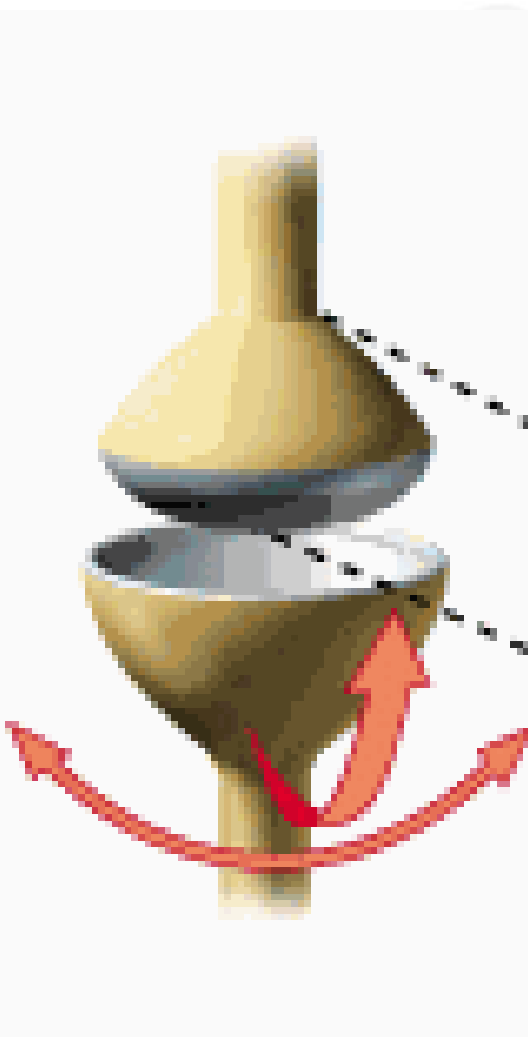
Type and Movement

Atlanto-Occipital joint - Ellipsoid synovial joint

The skull moves along two axis (biaxial joint).

It makes:

- 1- Flexion and extension (YES/NO or nodding movement).
- 2- Lateral flexion.



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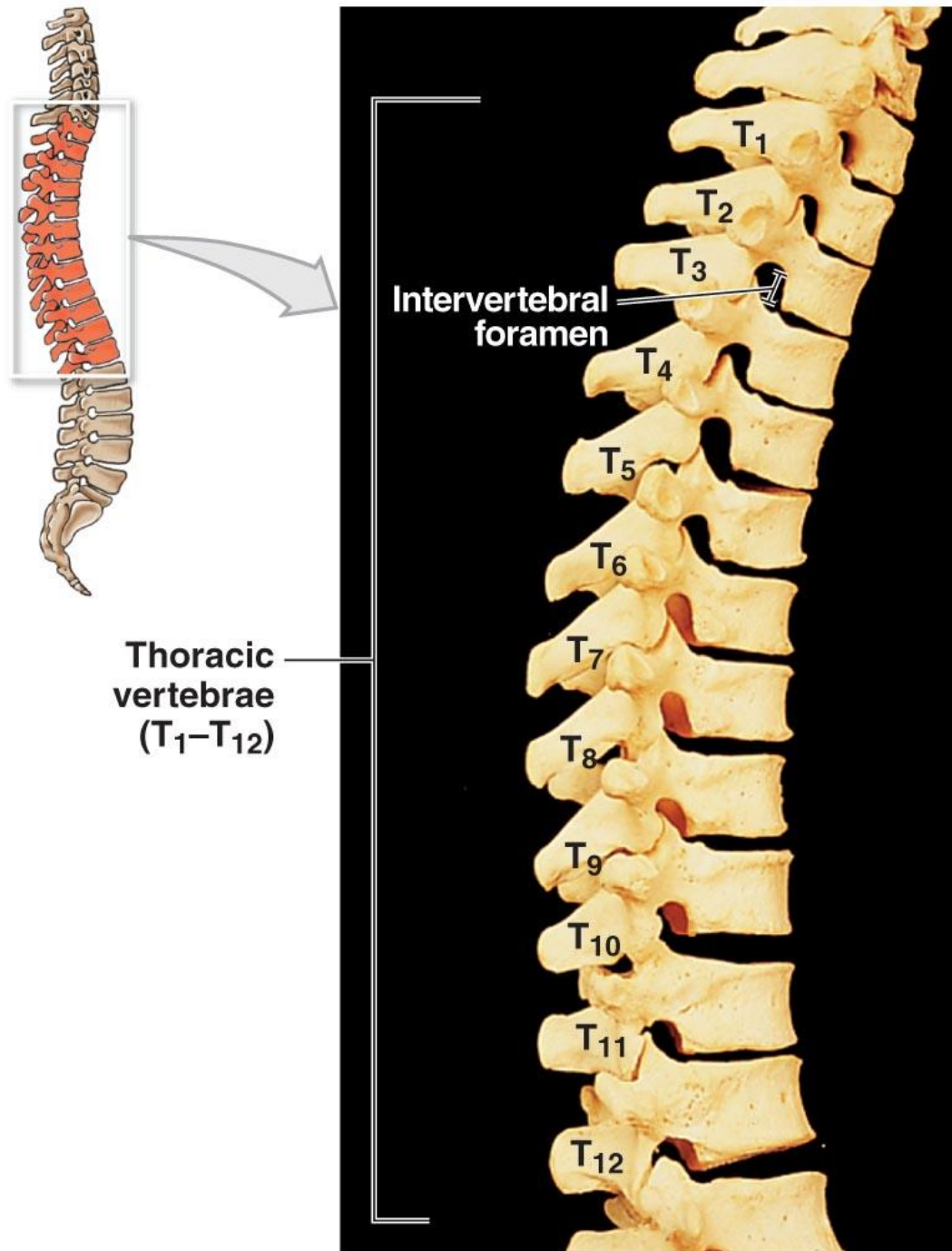
Thoracic Vertebrae

- **Thoracic vertebrae** (T_1-T_{12})

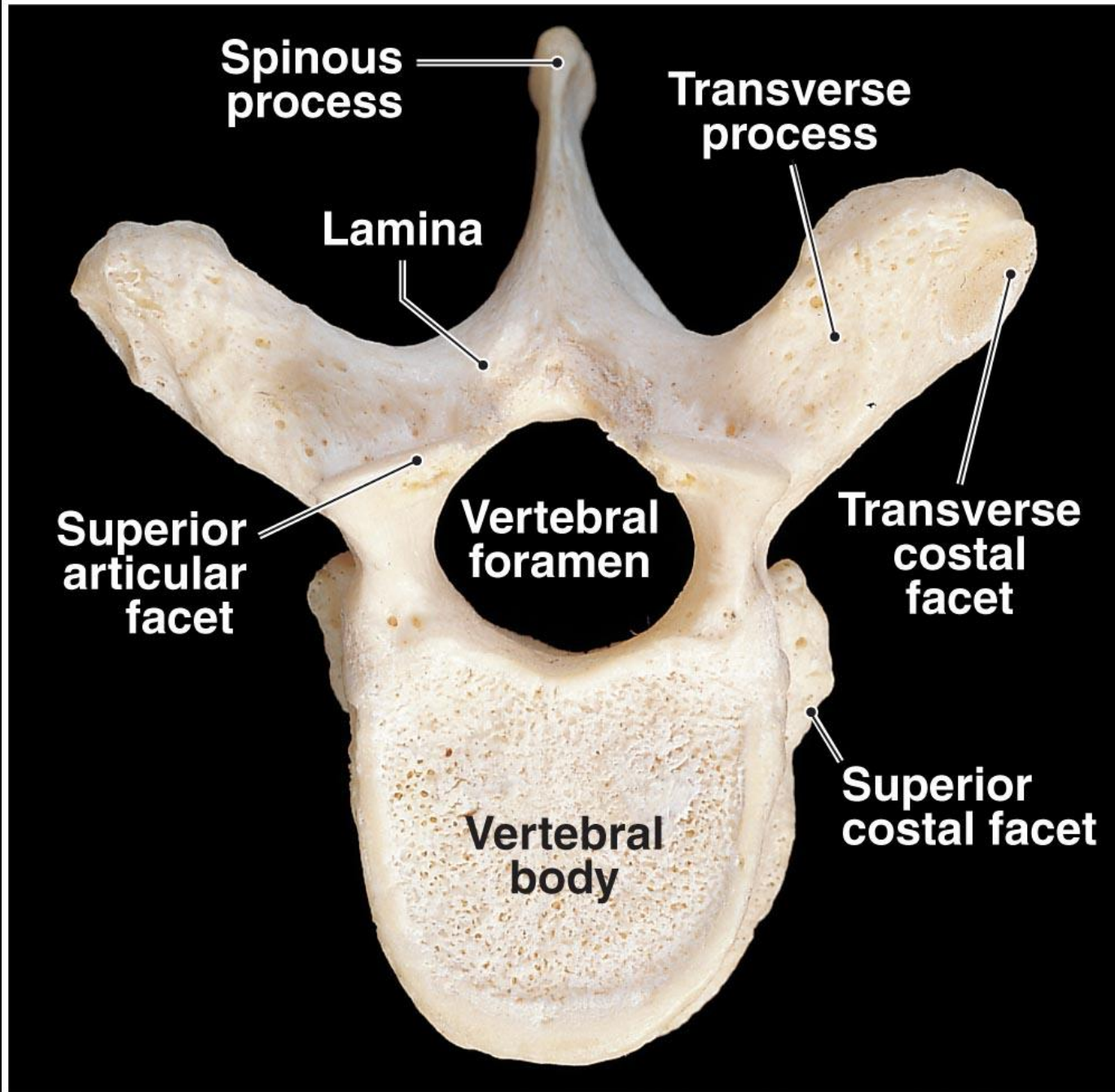
1. Have heart-shaped bodies
2. Larger bodies than in C_1-C_7
3. Smaller vertebral foramen than in C_1-C_7
4. Long, slender spinous processes
5. Body and transverse processes contain **costal**

facets:

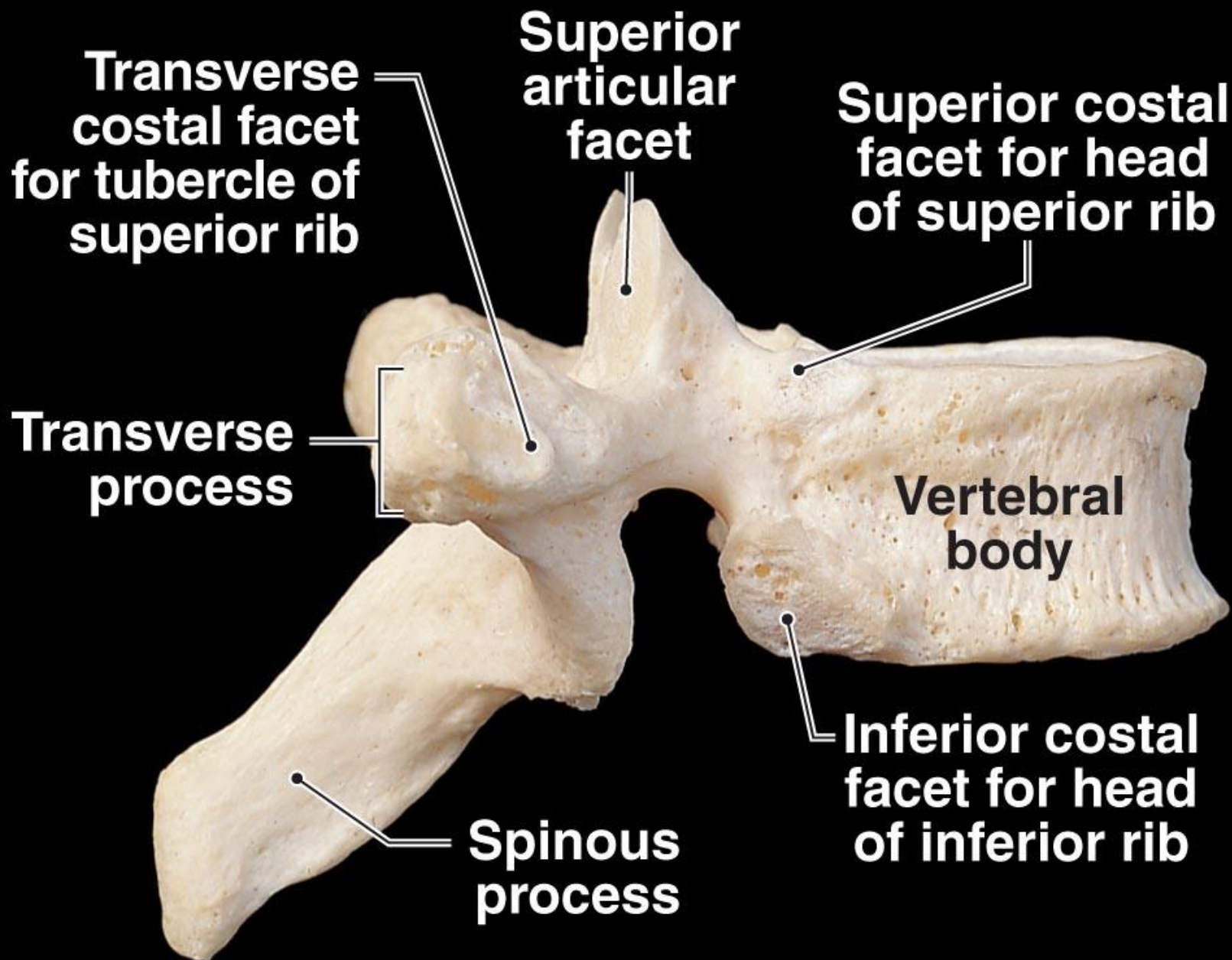
- Which articulate with heads & tubercles of the ribs



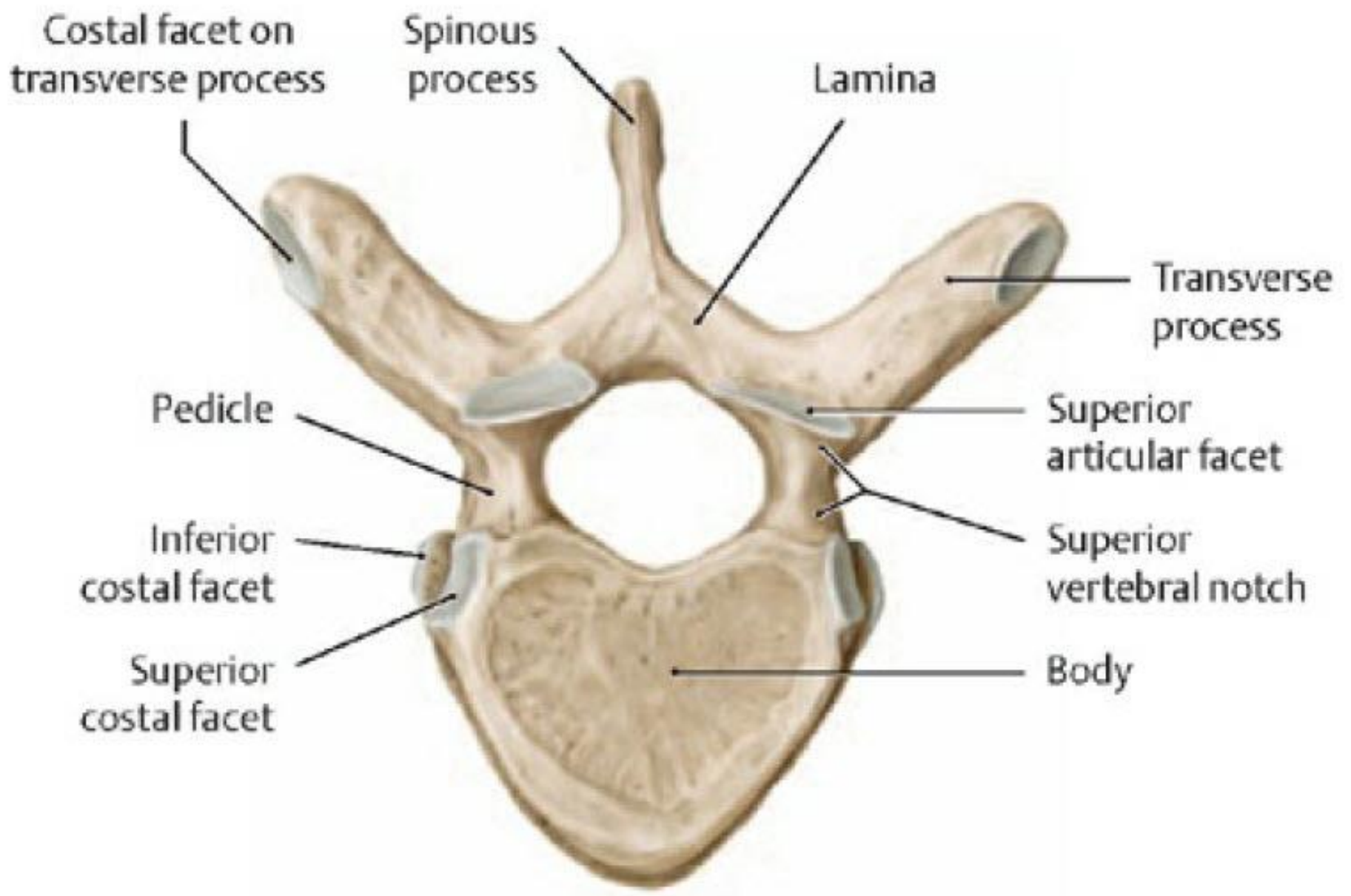
(a) Thoracic vertebrae, lateral view



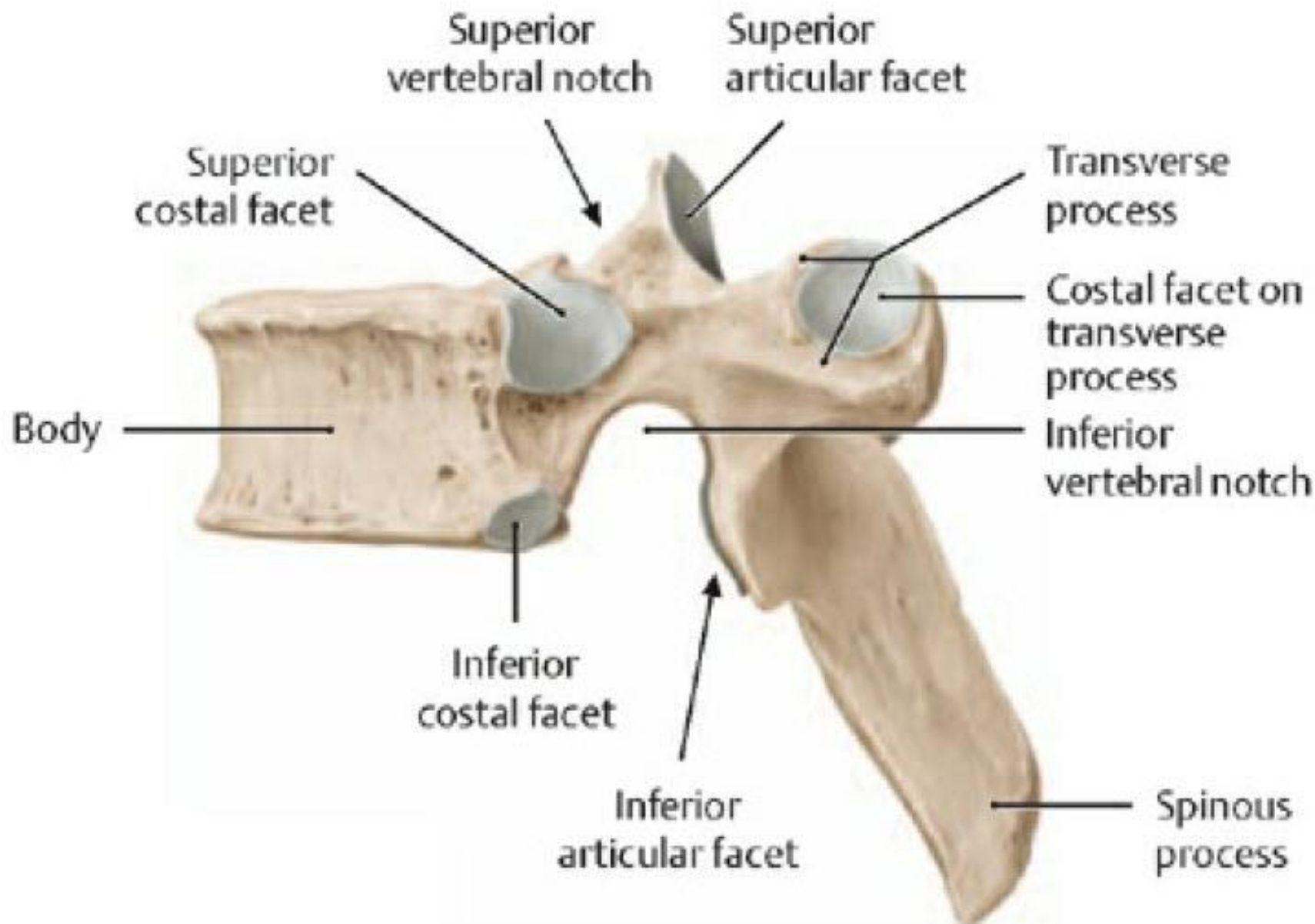
(b) Thoracic vertebra, superior view



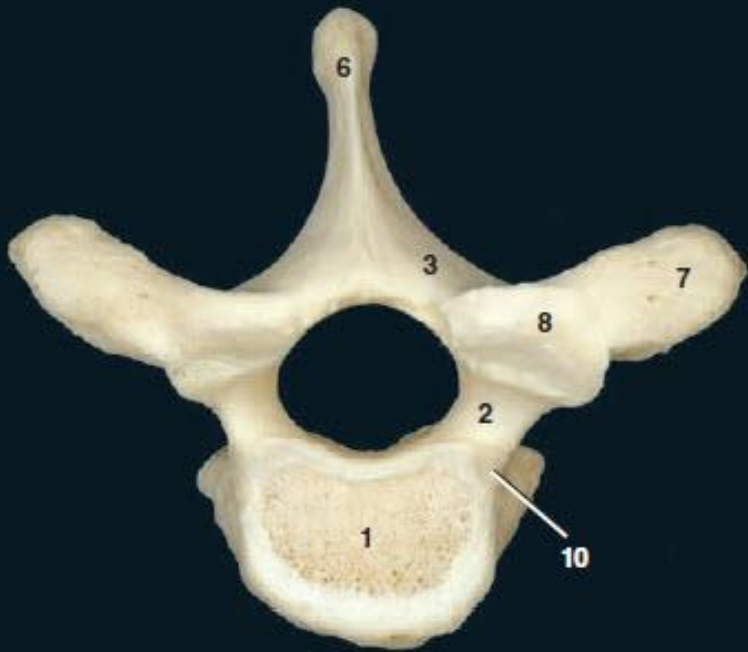
(c) Thoracic vertebra, lateral view



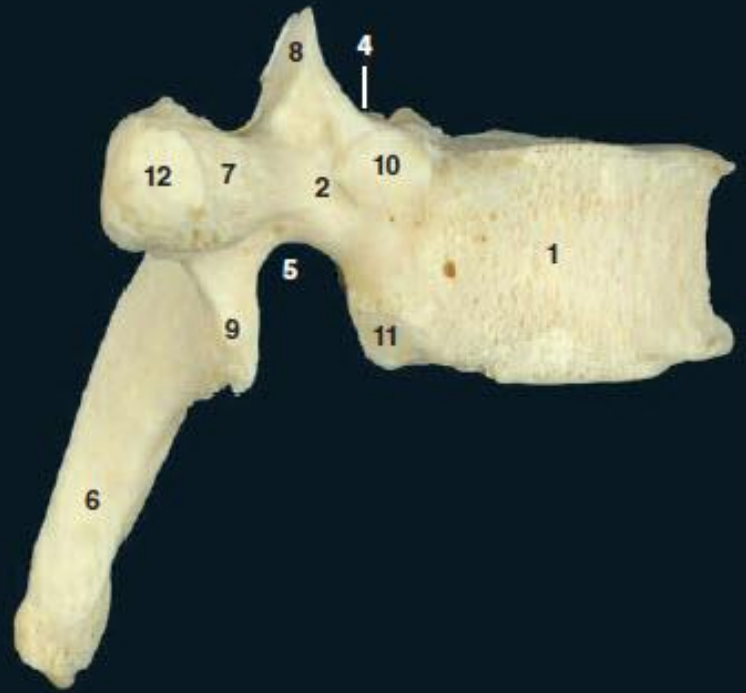
b Sixth thoracic vertebra



b Sixth thoracic vertebra



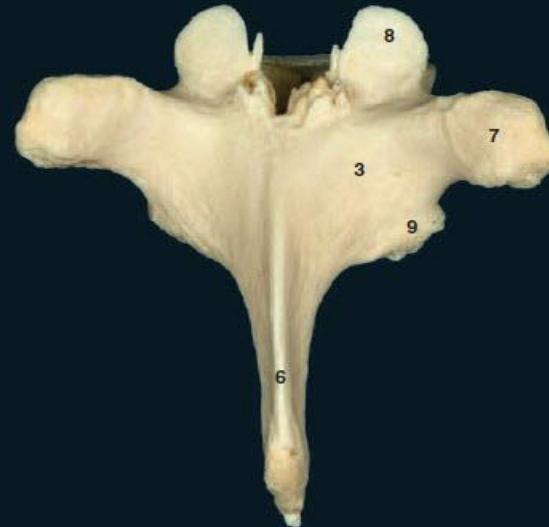
Thoracic vertebra
Superior view, anterior at bottom



Thoracic vertebra
Lateral view, anterior at right



Thoracic vertebra
Anterior view, superior at top

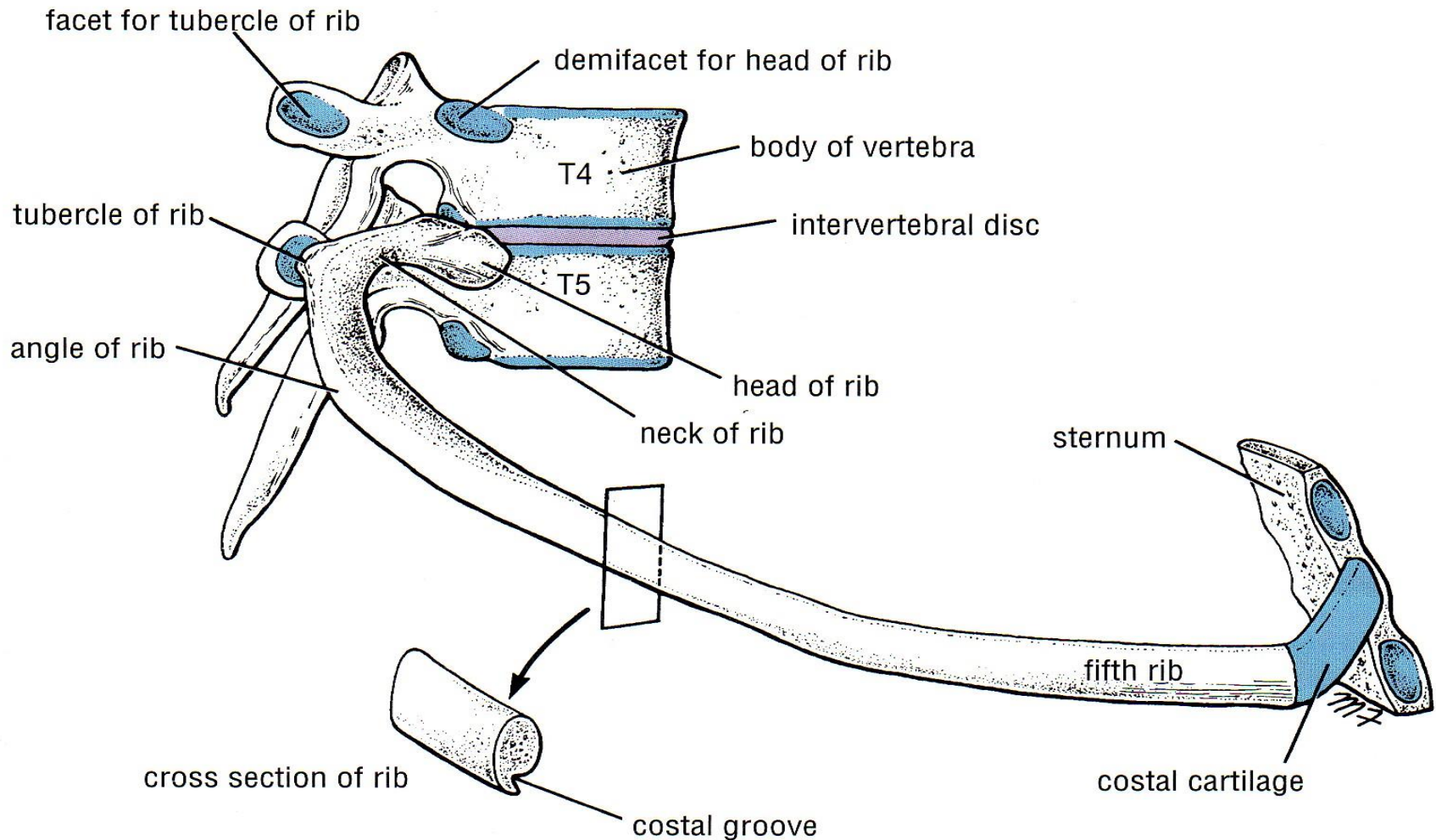


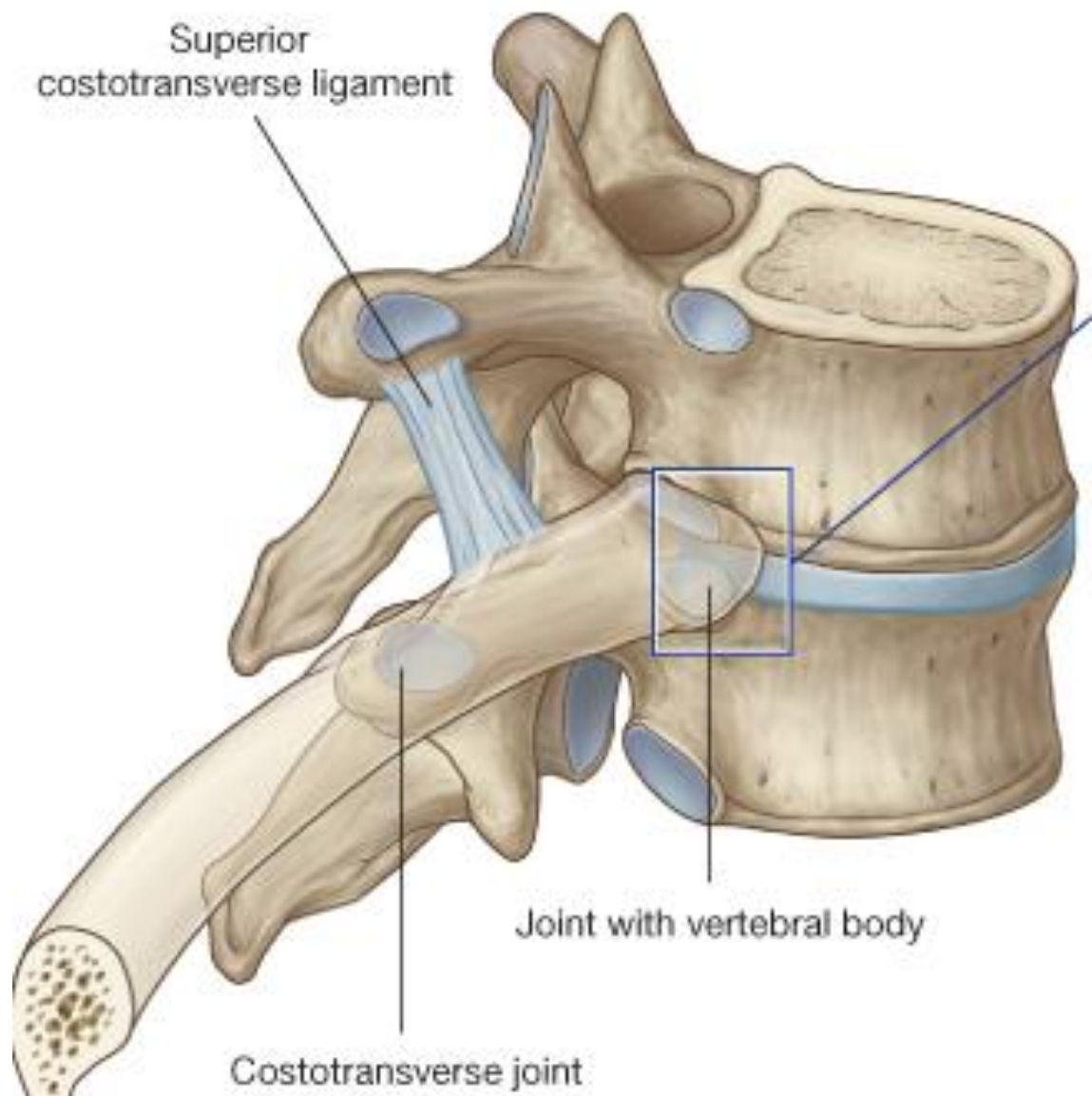
Thoracic vertebra
Posterior view, superior at top

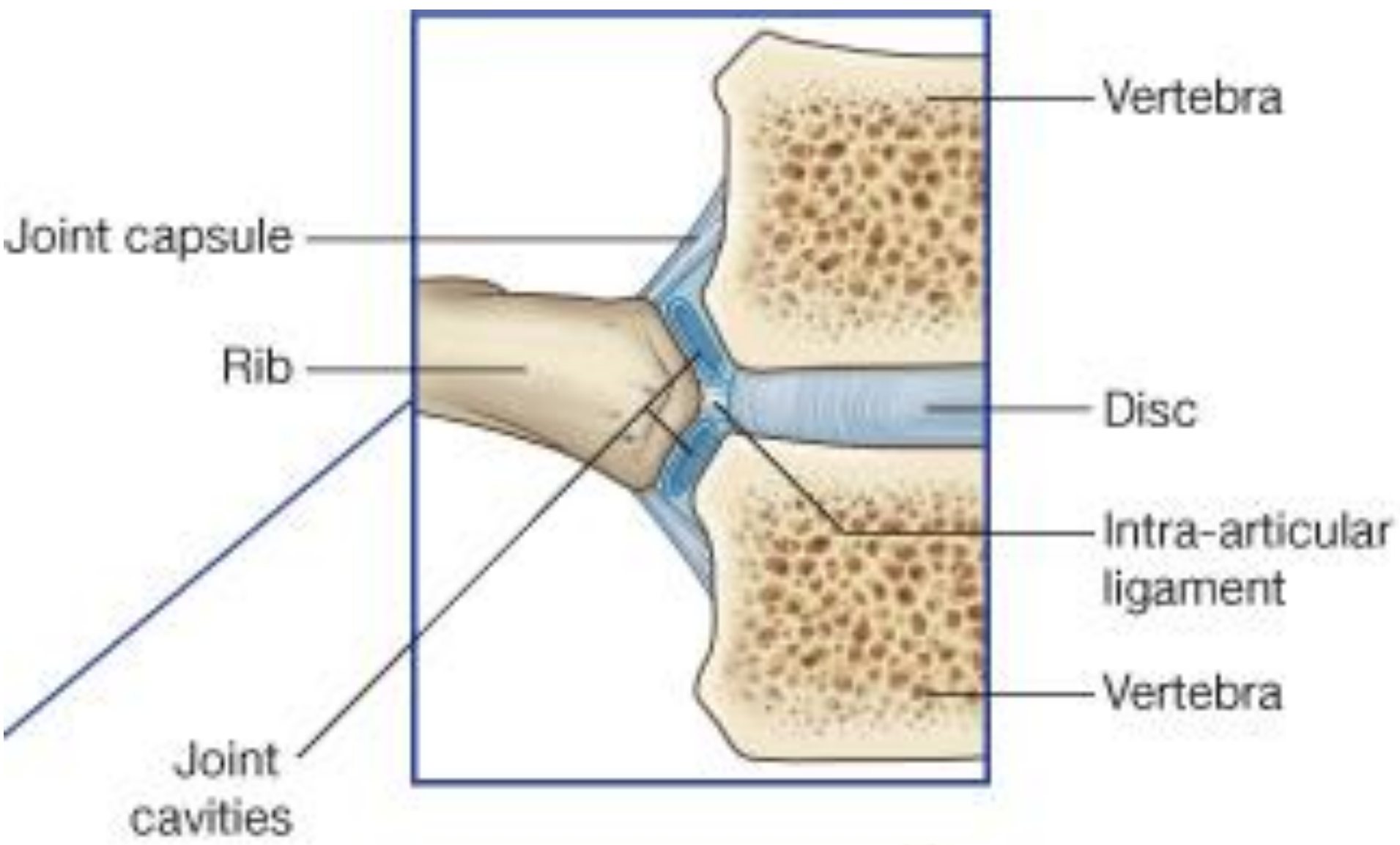
Joints of the Vertebrae

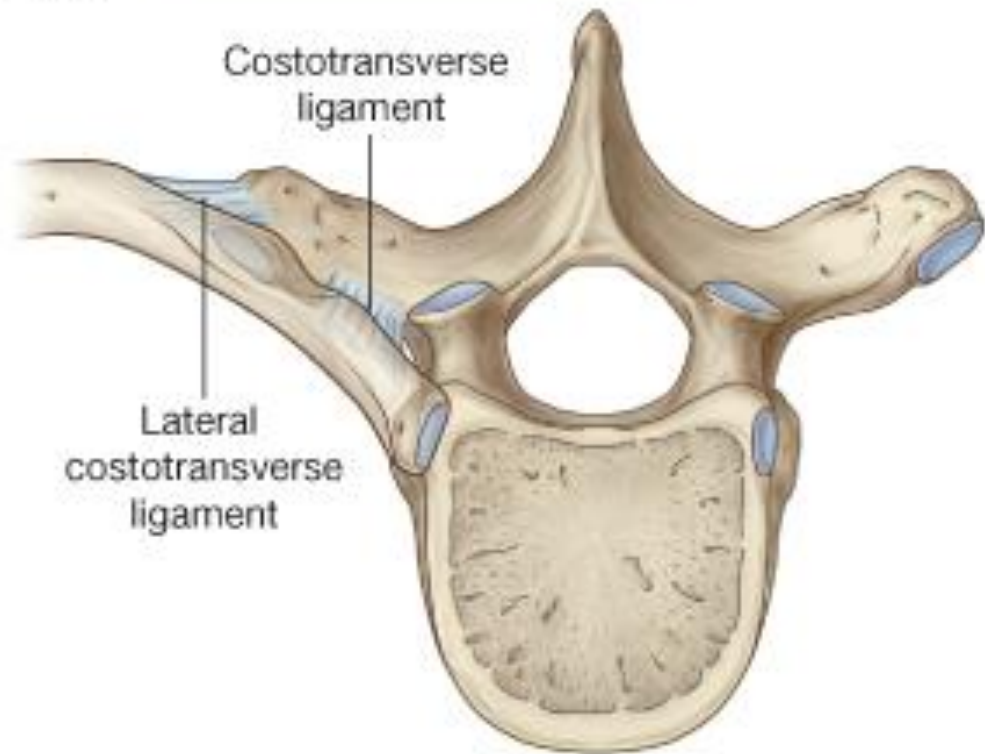
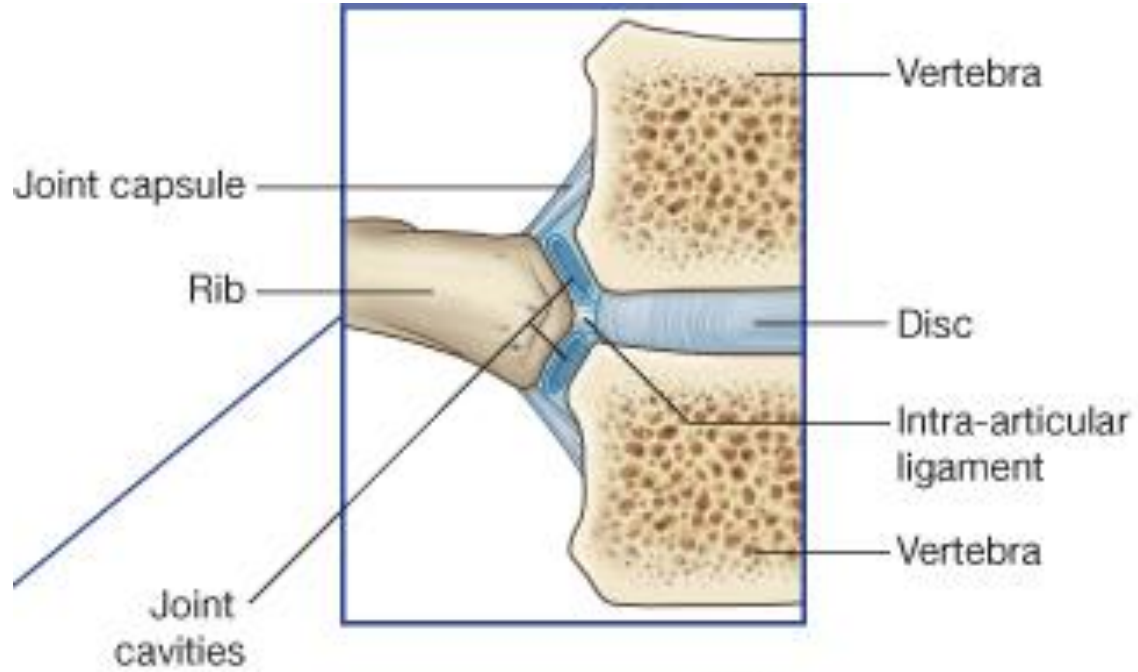
- Superior & inferior articular facets, superior & inferior costal facets (Costovertebral joints), Costotransverse joints → *ALL Plane synovial joints*
- Intervertebral discs → *2ry cartilaginous joint*

Articulation between Thoracic vertebrae and the ribs





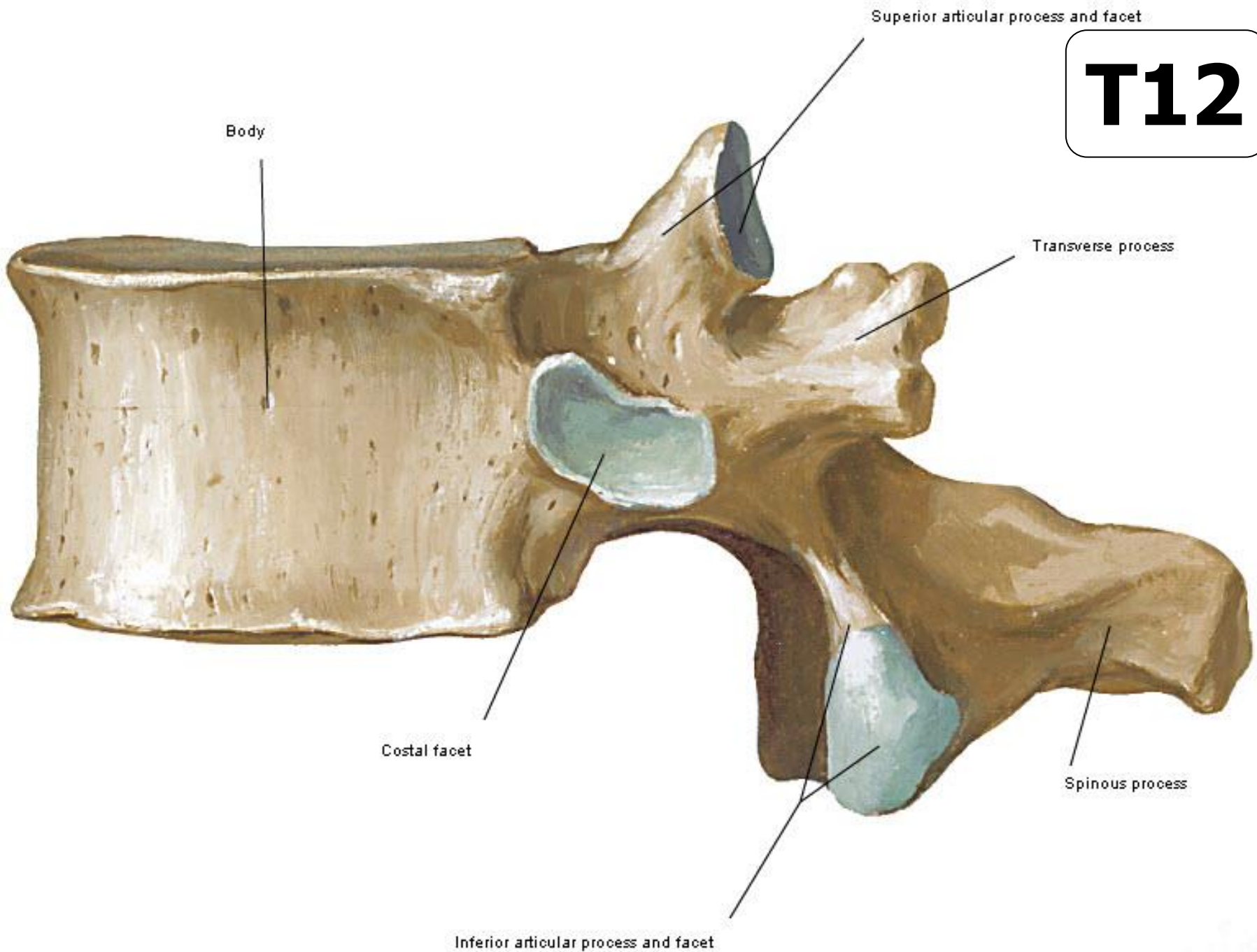


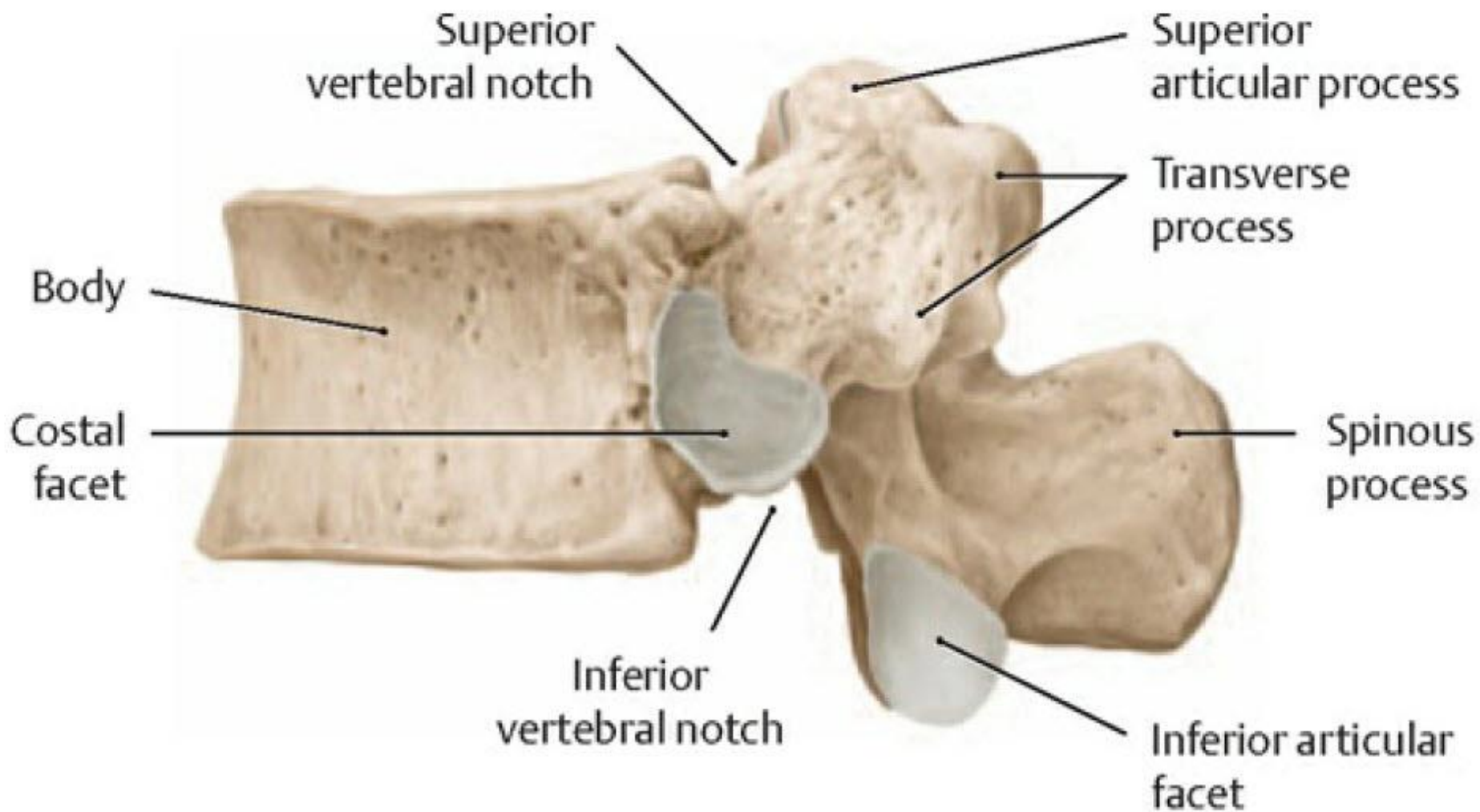


T12



T12





c Twelfth thoracic vertebra



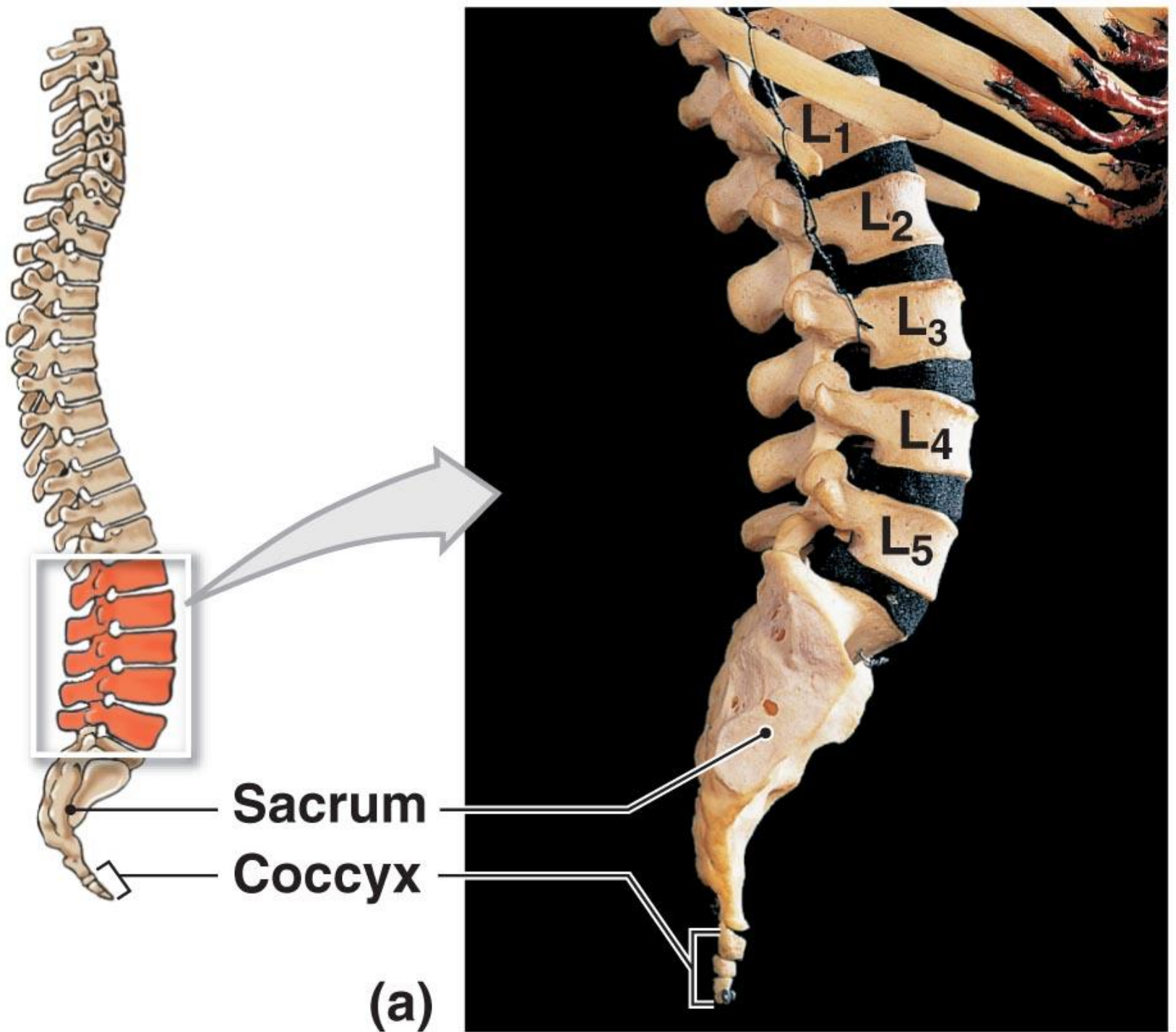
Sternocostal Joints

- Rib 1 to sternum (manubrium)
 - 1ry cartilaginous joint (**No movement**)
- Ribs 2 – 7 true ribs
 - **Synovial** (gliding) joints
- Ribs 8-10 = false, articulate with fibrous tissue
- 11-12 = floating (**No Articulation Anteriorly**)



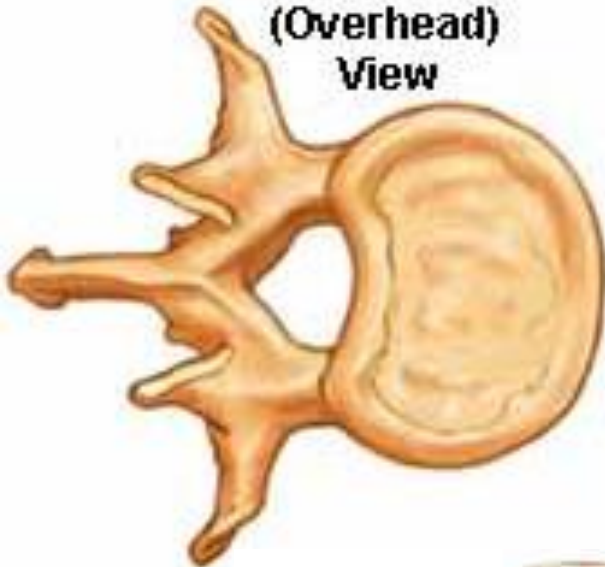
Lumbar Vertebrae

- **Lumbar vertebrae (L₁–L₅)**
 1. Largest vertebrae
 2. Oval-shaped bodies
 3. No costal or transverse costal facets
 4. Triangular vertebral foramen



Lumbar Vertebrae

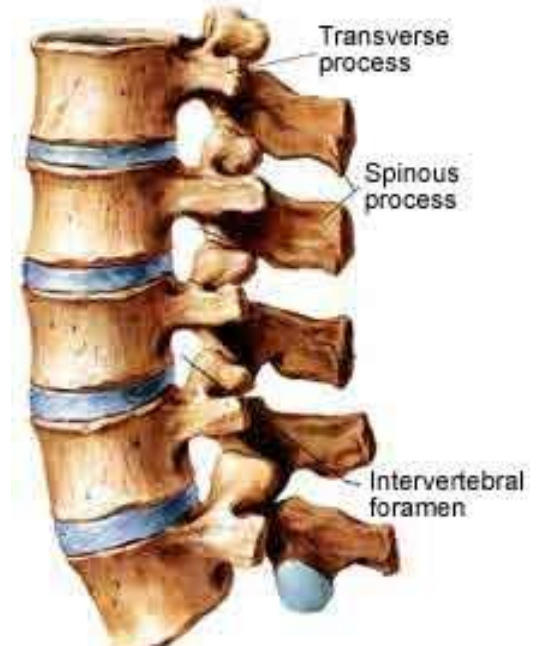
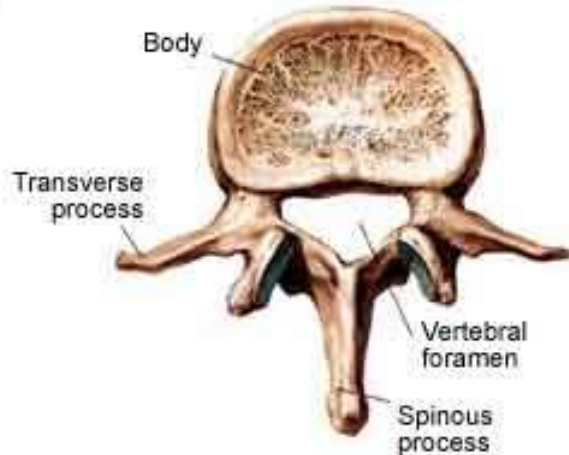
**Axial
(Overhead)
View**

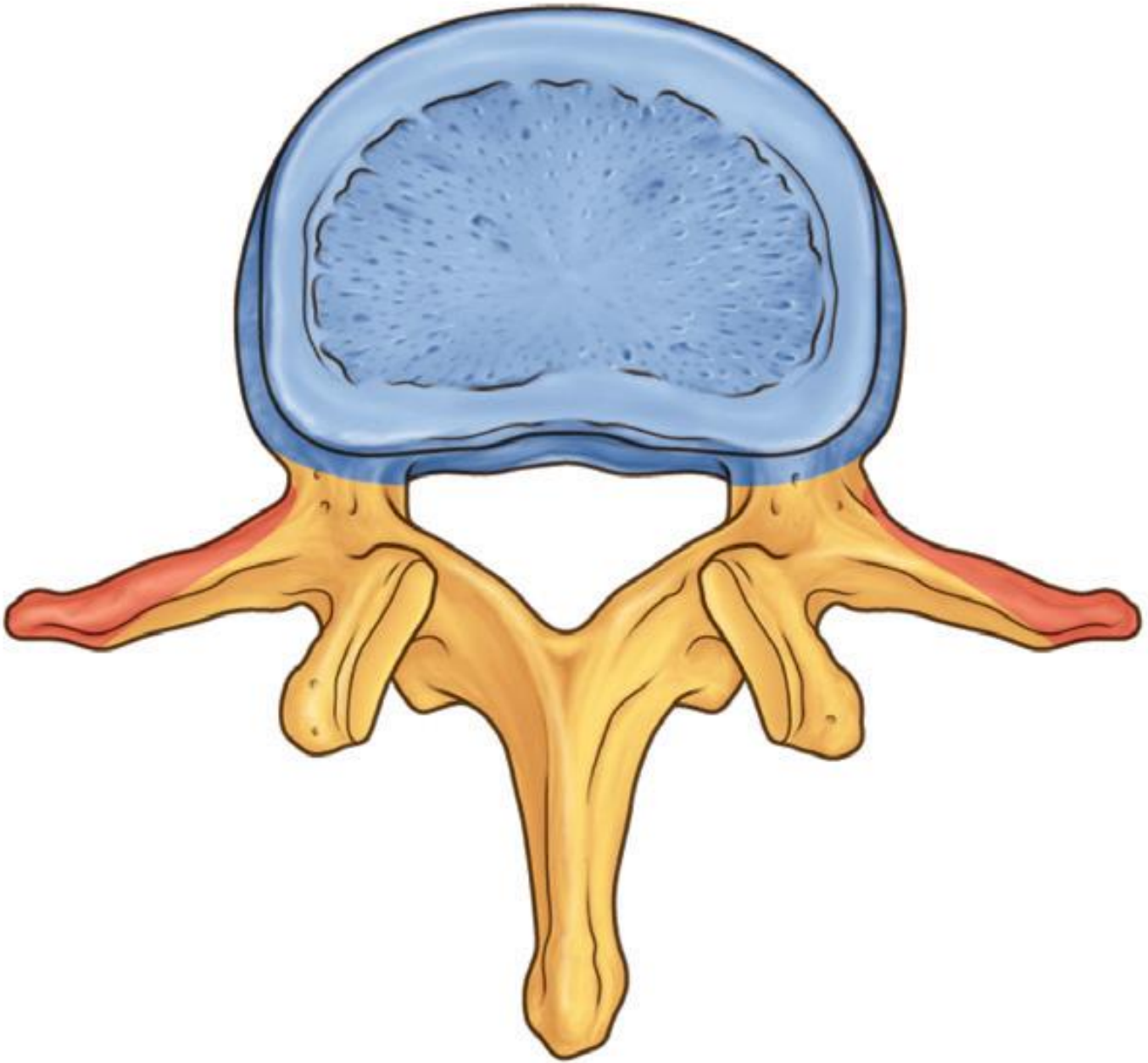


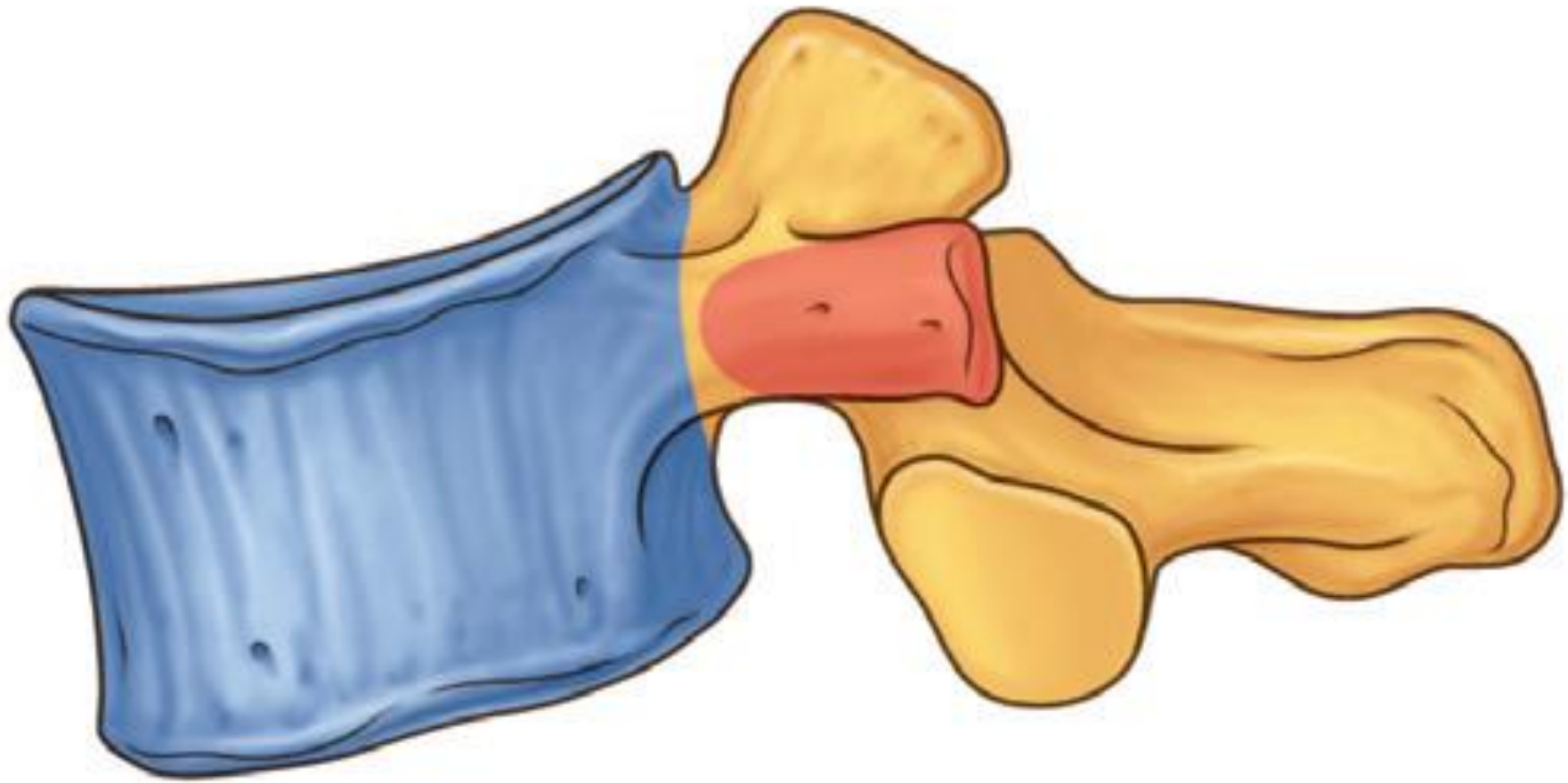
**Lateral
(Side)
View**

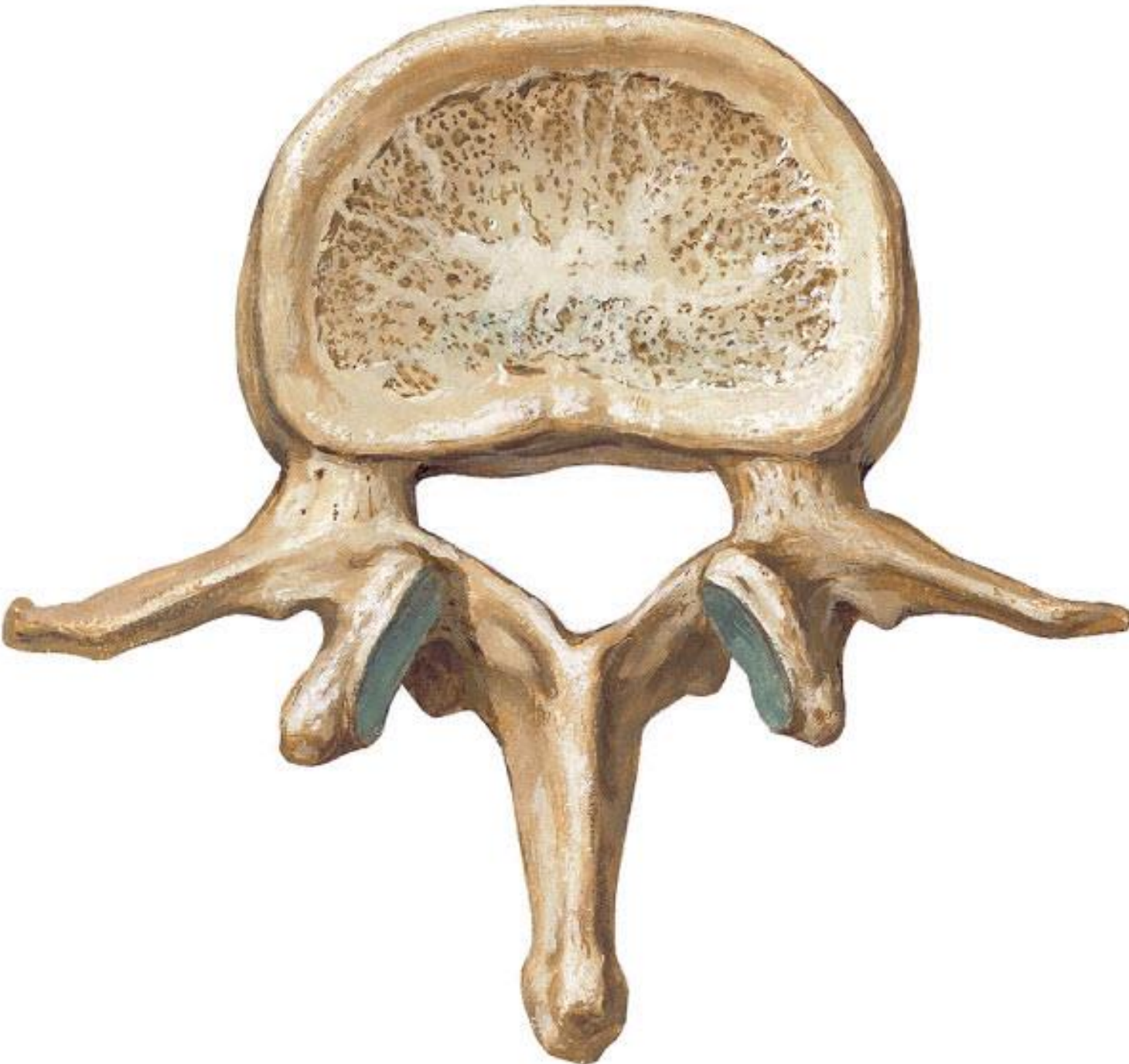


**Annulus
fibrosus** **Nucleus
pulposus**

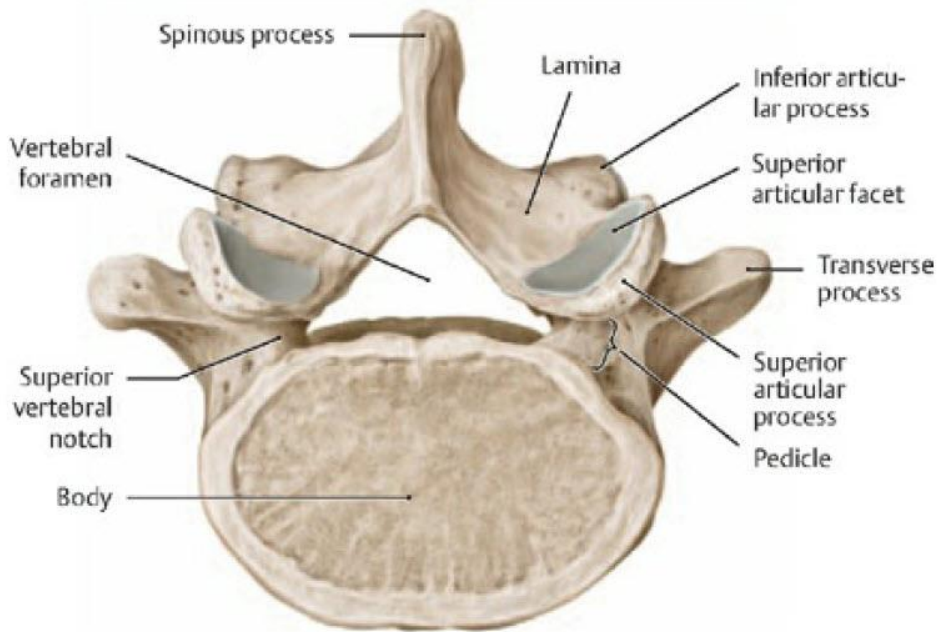




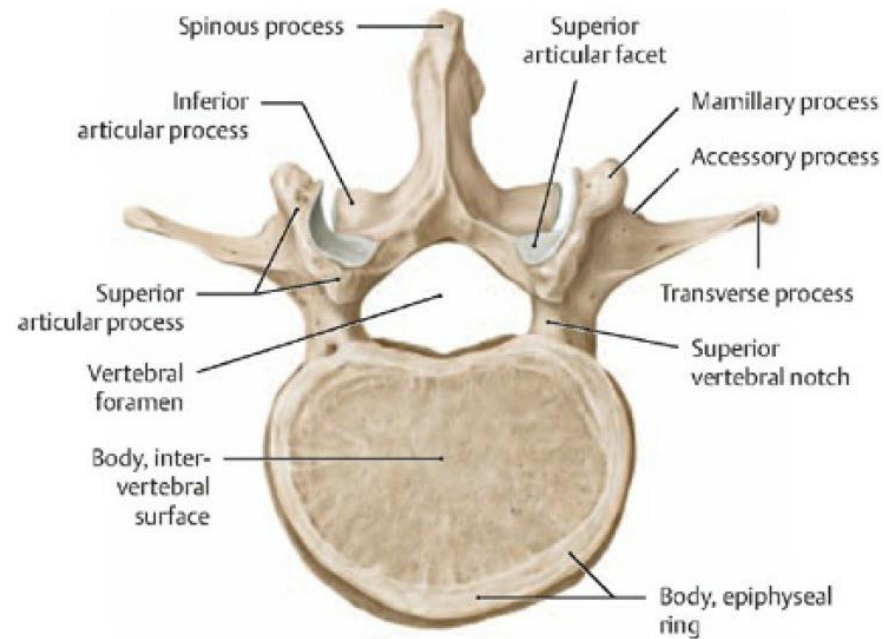




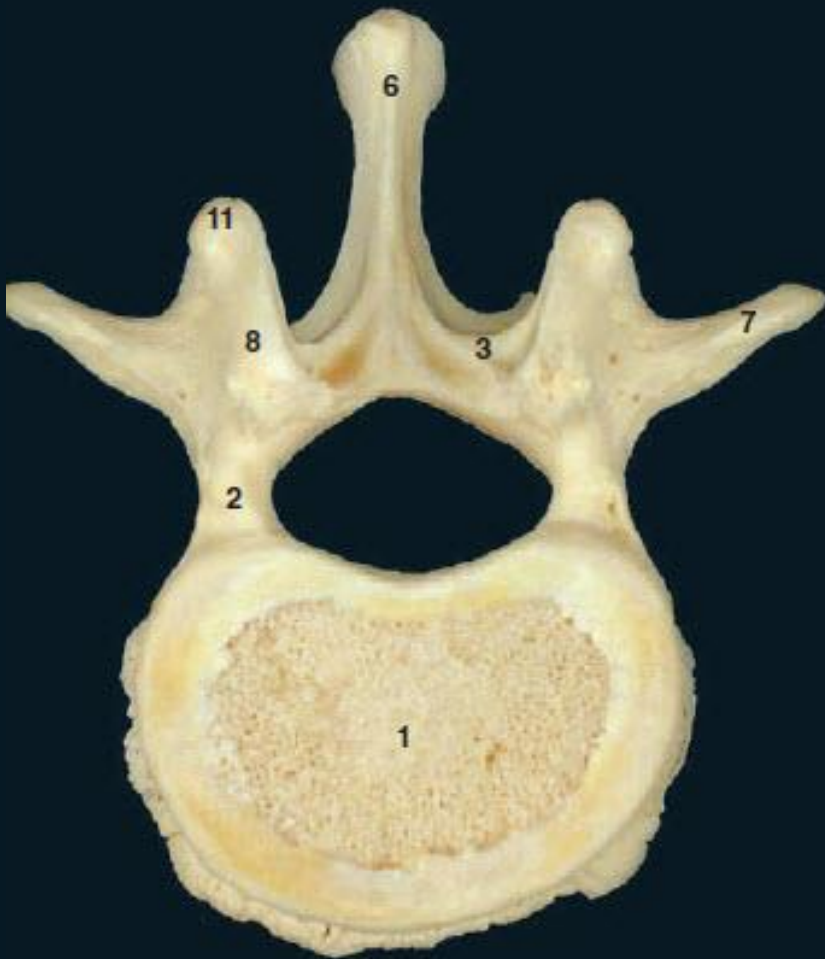
Lumbar Vertebrae



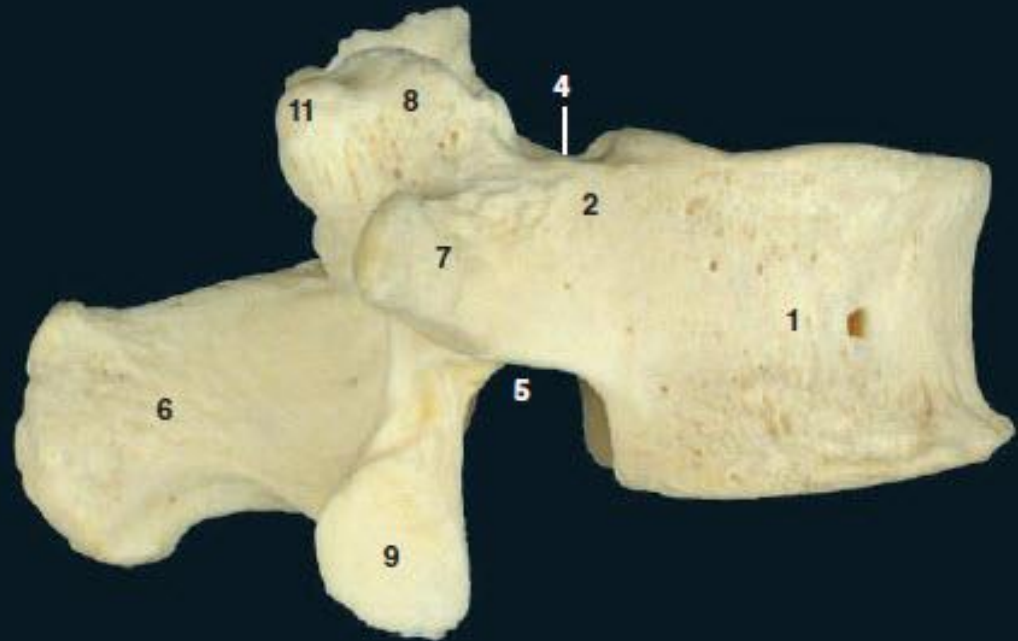
c Fifth lumbar vertebra



a Second lumbar vertebra



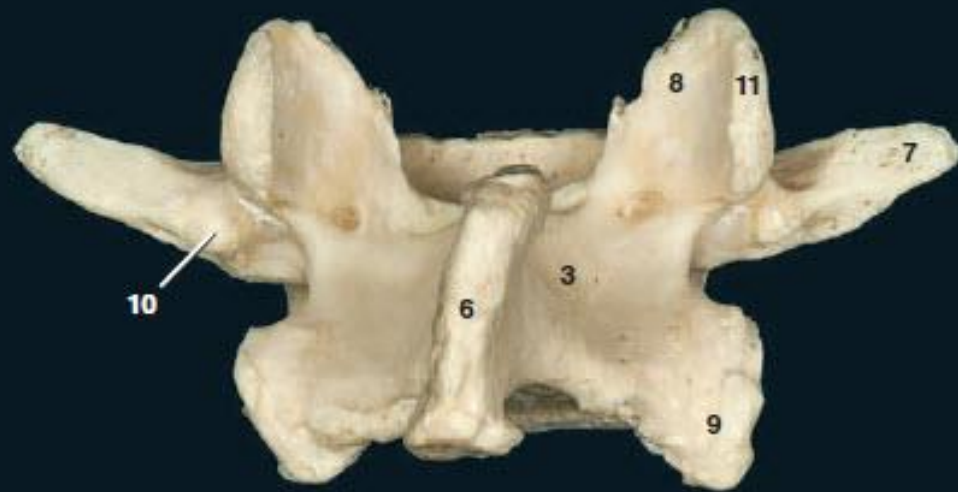
Lumbar vertebra
Superior view, anterior at bottom



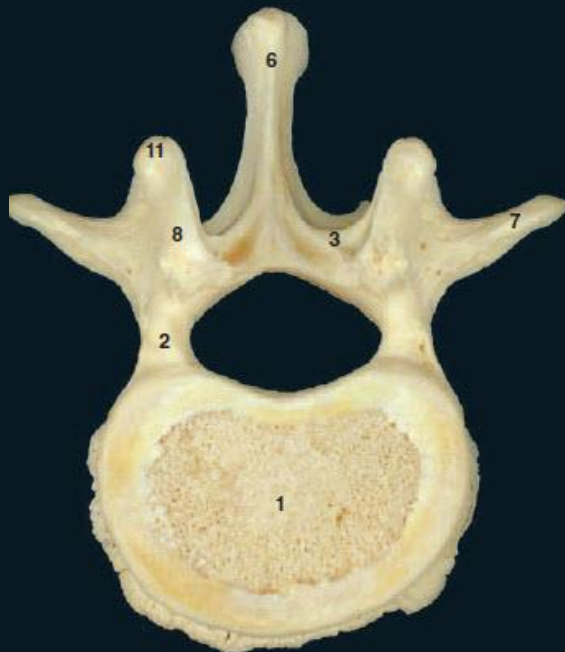
Lumbar vertebra
Lateral view, anterior at right



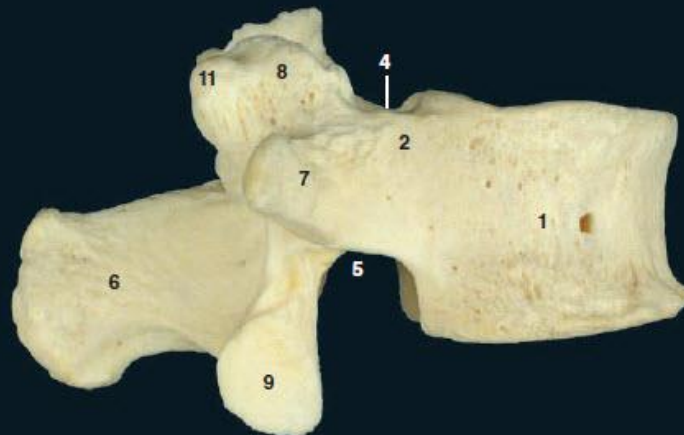
Lumbar vertebra
Anterior view, superior at top



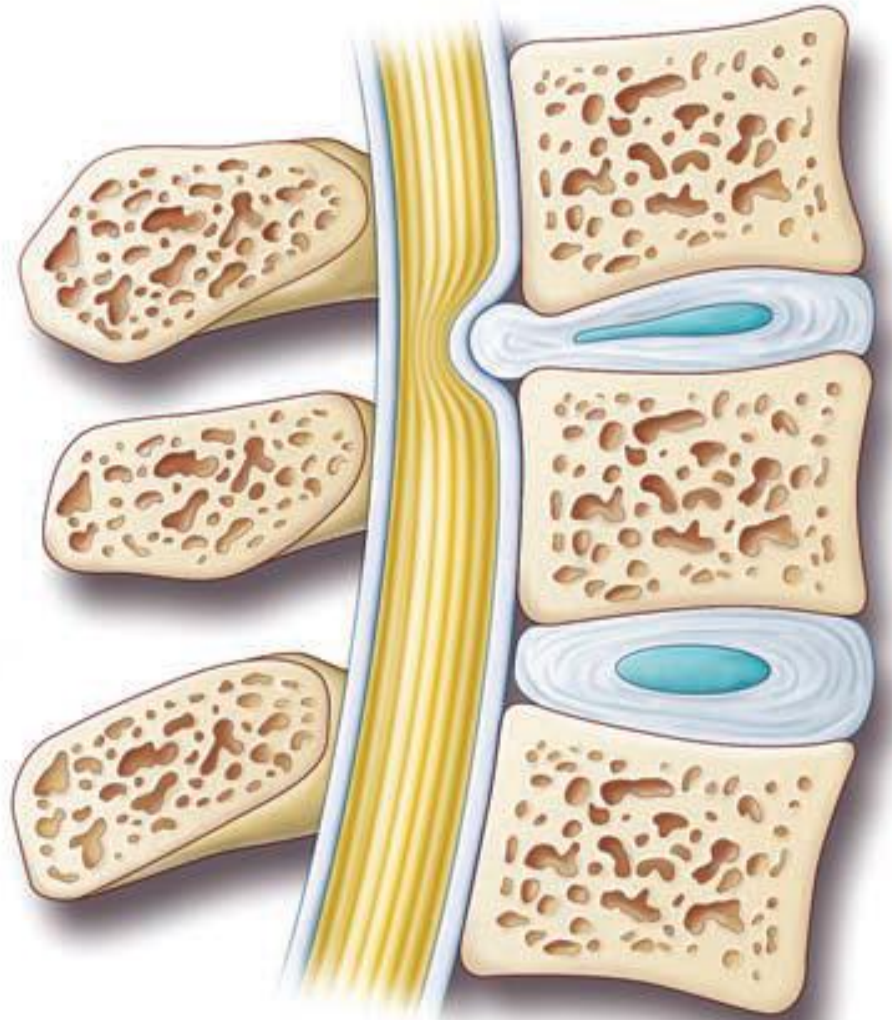
Lumbar vertebra
Posterior view, superior at top

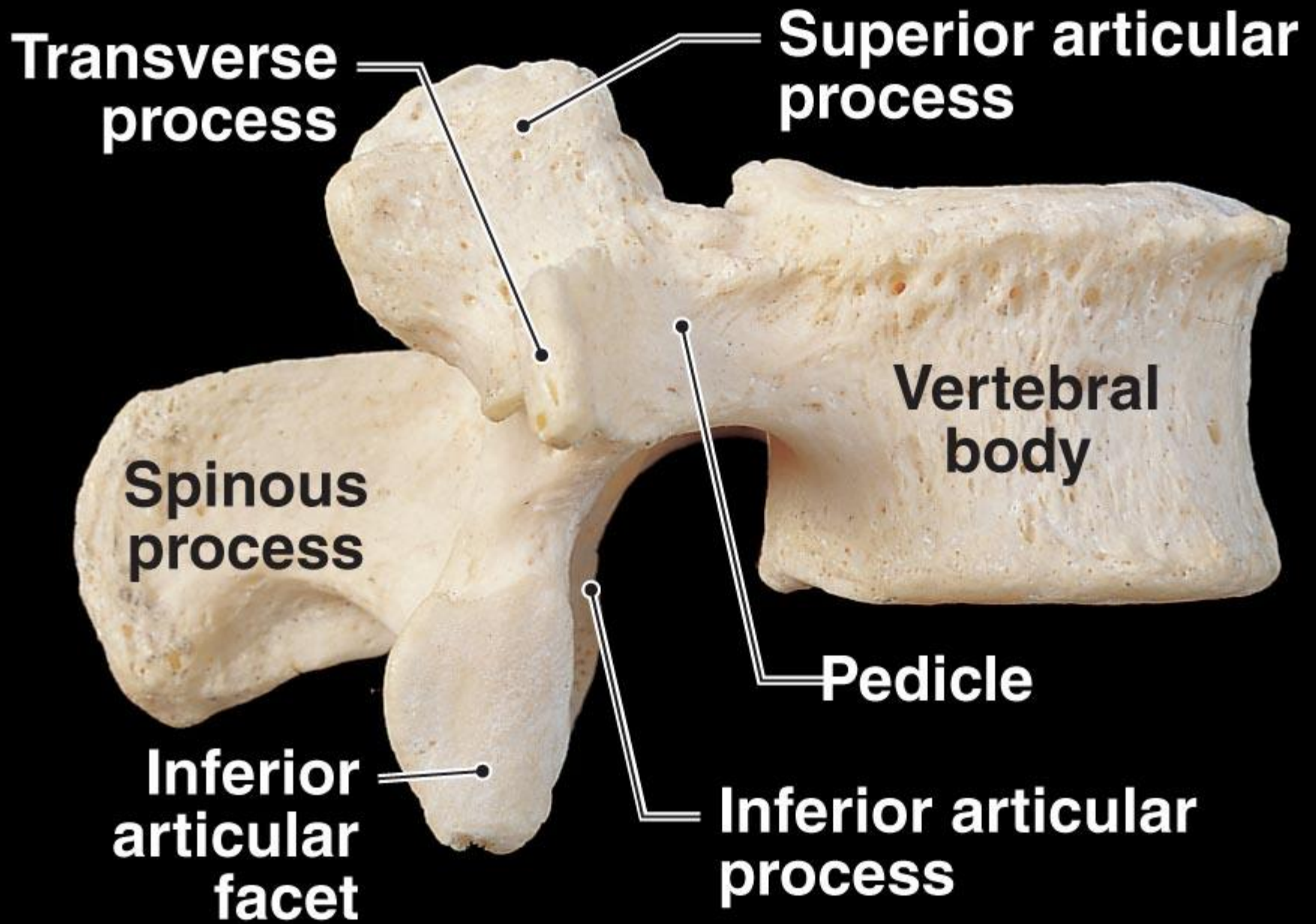


Lumbar vertebra
Superior view, anterior at bottom

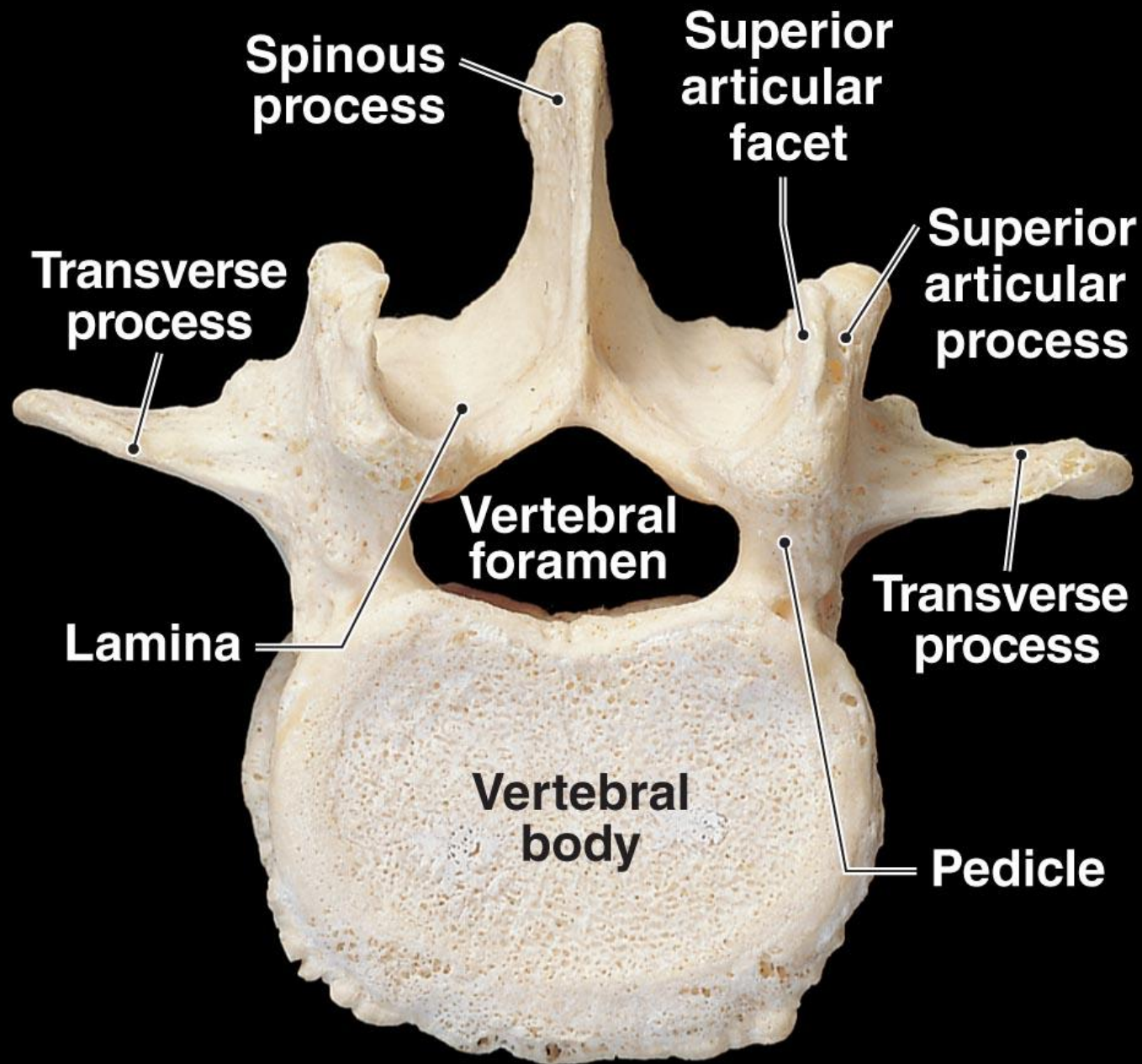


Lumbar vertebra
Lateral view, anterior at right





(b) Lateral view



(c) Superior view



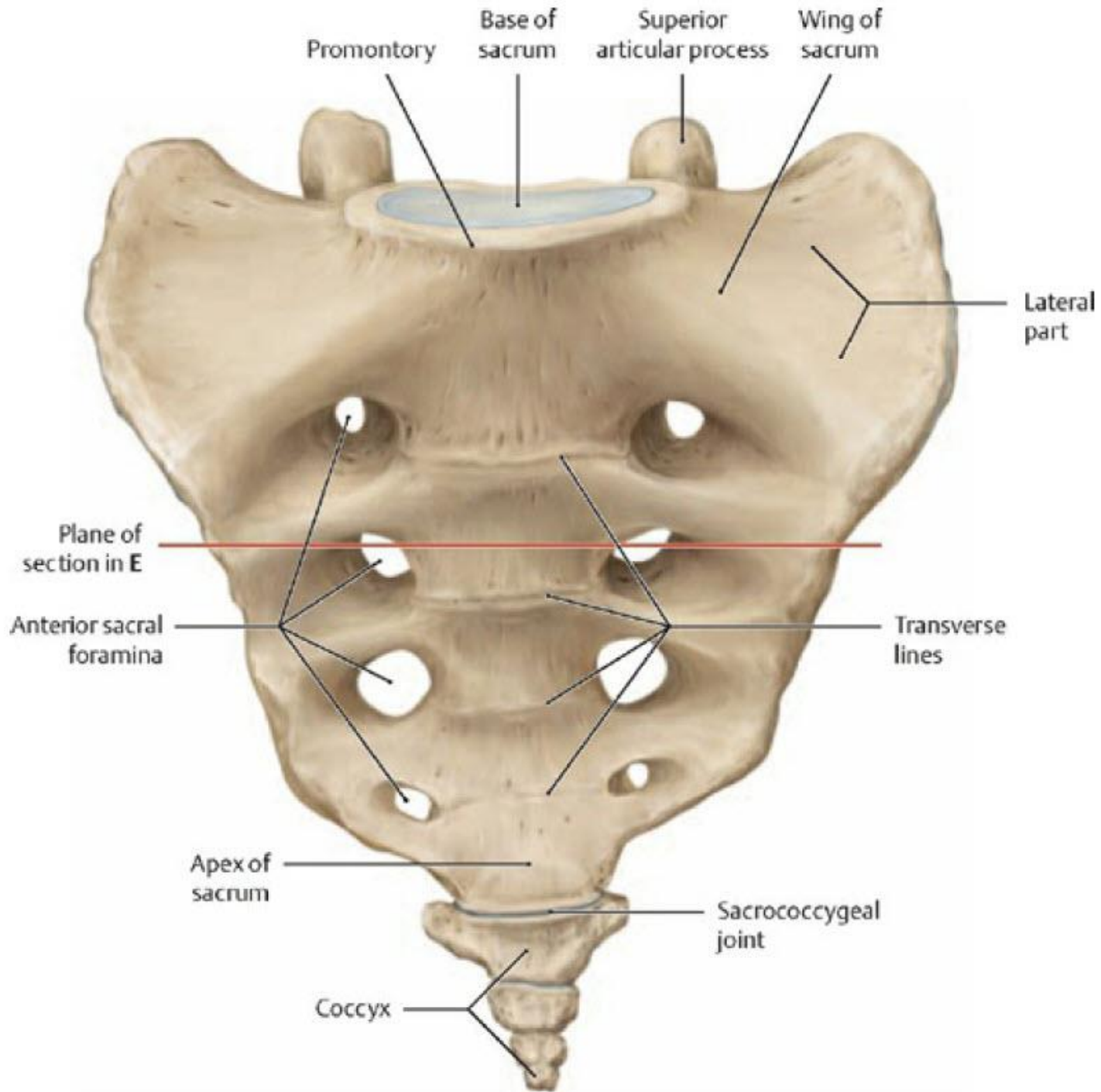
The Sacrum

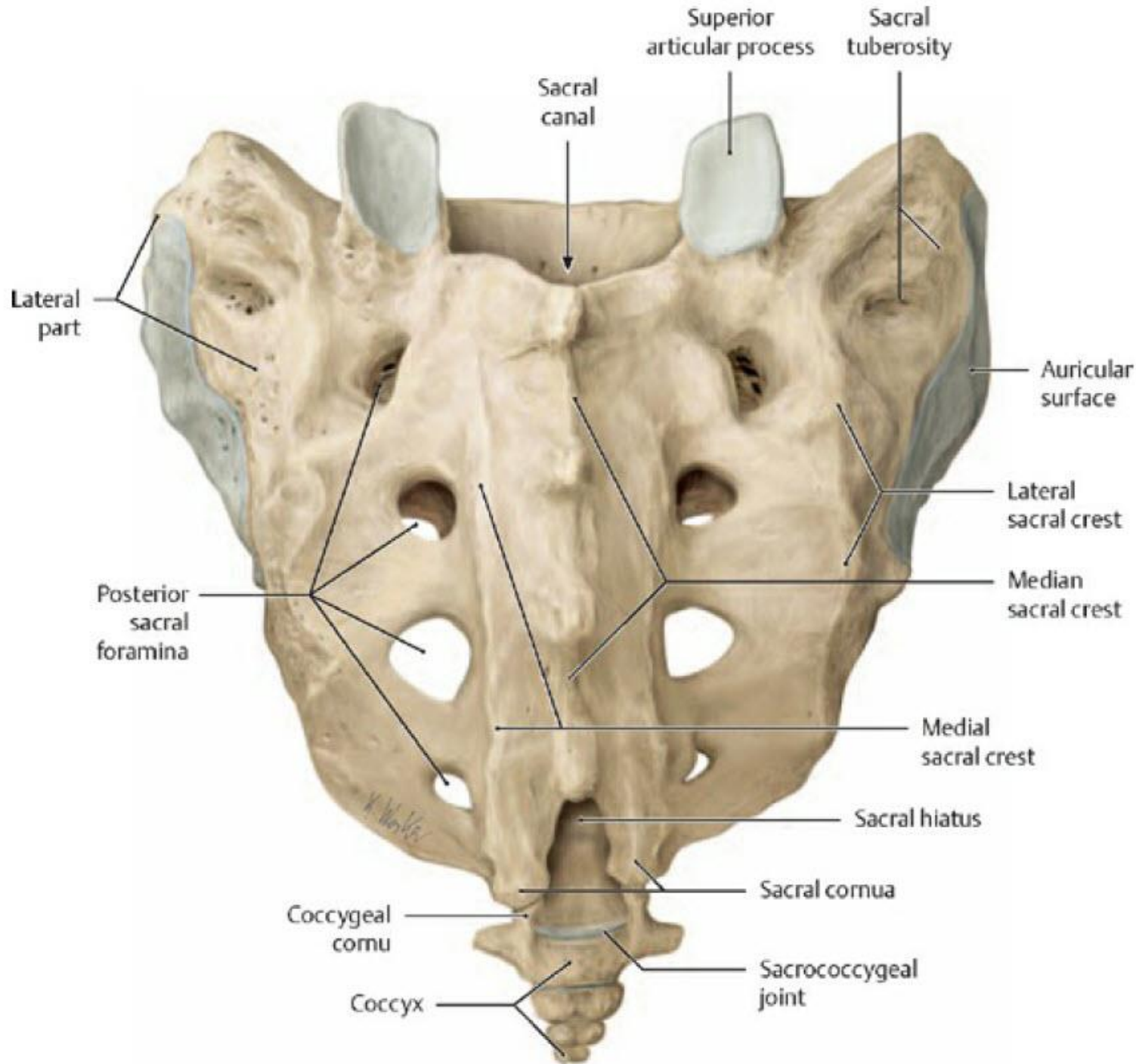
- Is curved, more in males than in females
- Protects reproductive, urinary, and digestive organs
- Attaches
 - The axial skeleton to pelvic girdle of appendicular skeleton
 - Broad muscles that move the thigh
- The adult sacrum
 - Consists of five fused sacral vertebrae
 - Fuses between puberty and ages 25–30
 - Leaving transverse ***bony ridges indicating line of fusion***



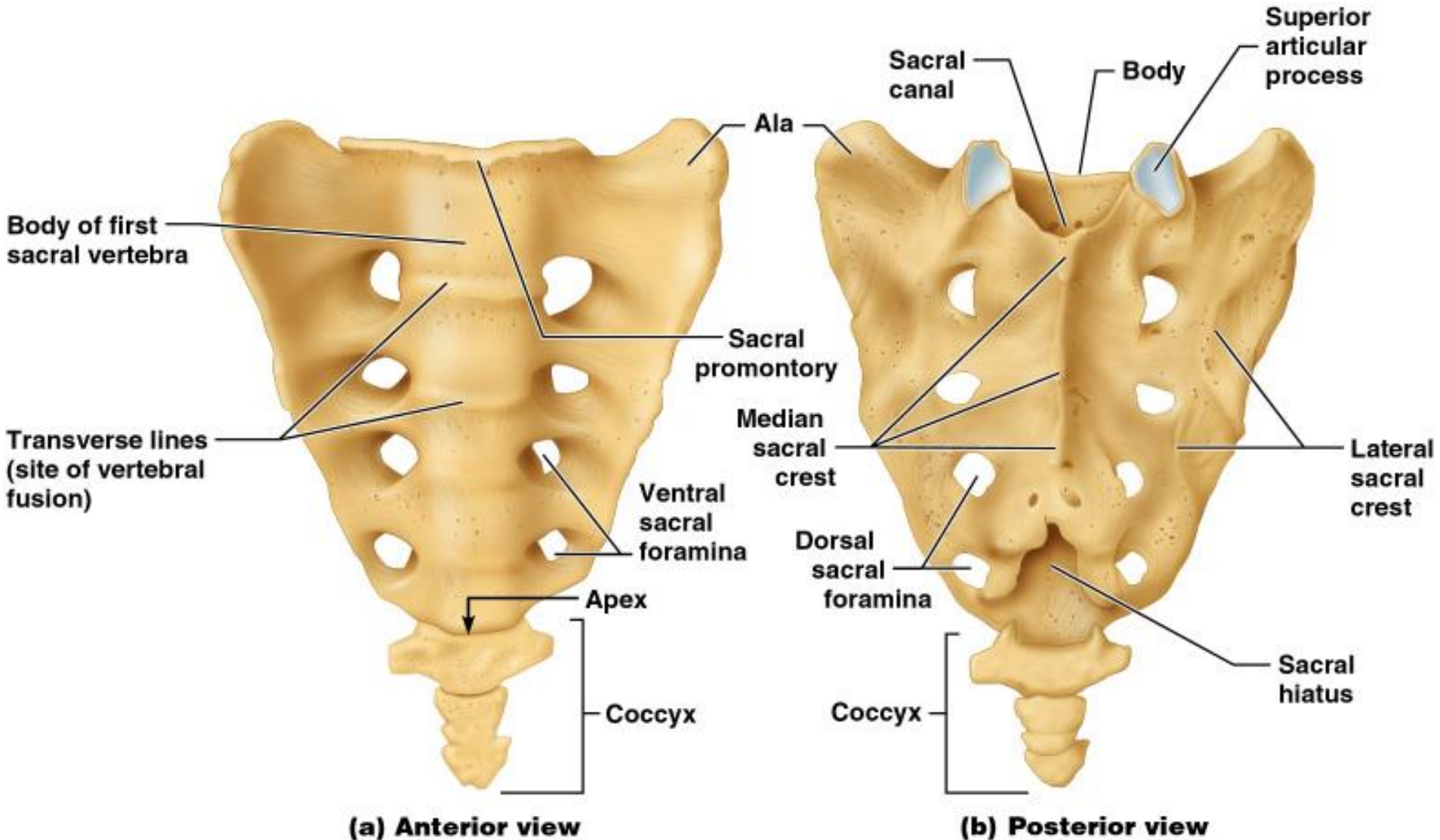
The Coccyx

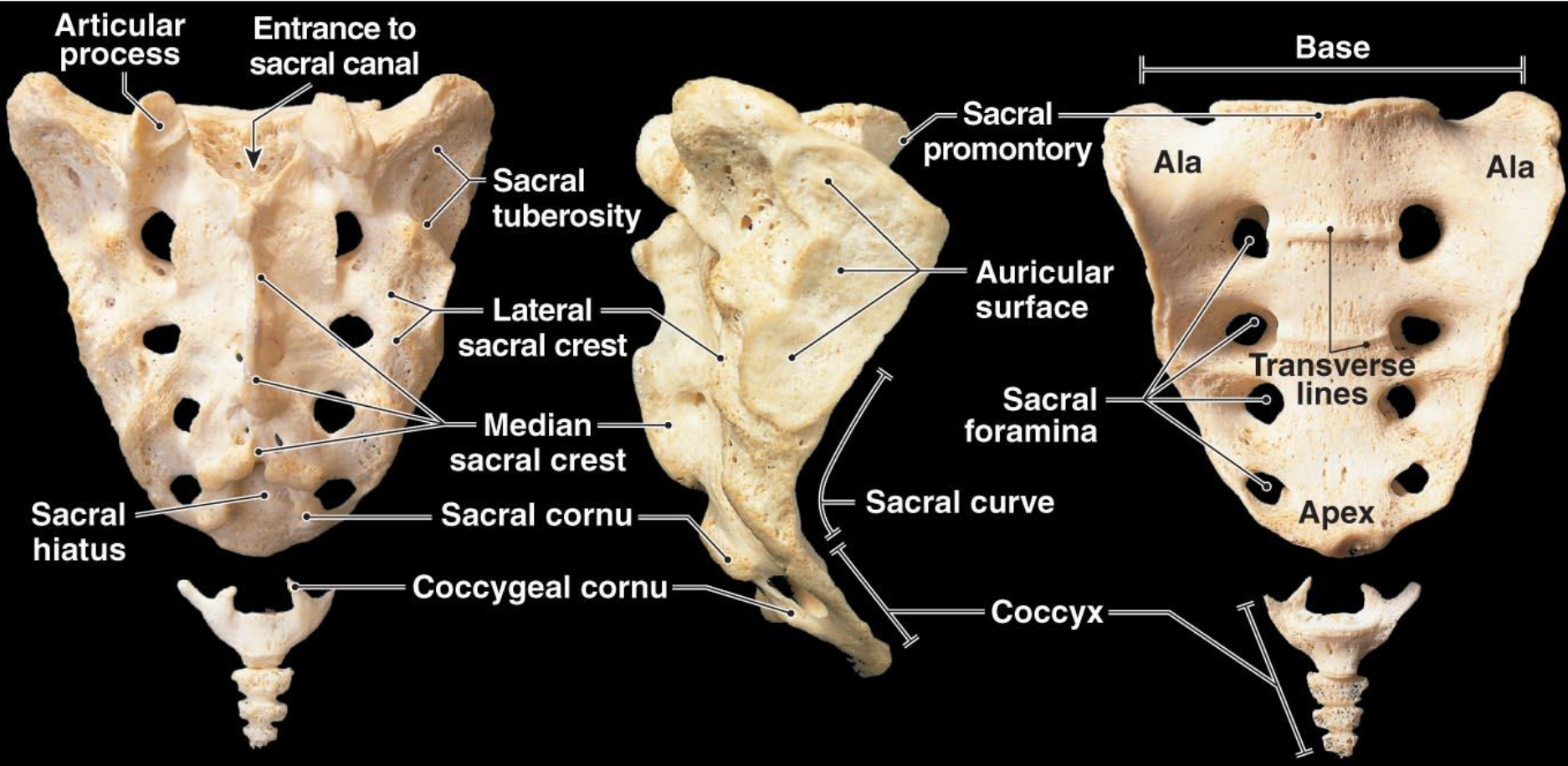
- Attaches ligaments and a constricting muscle of the anus and perineum
- Mature coccyx
 - Consists of 3-4 fused **coccygeal vertebrae**
- First two coccygeal vertebrae:
 - Have transverse processes
 - Have unfused vertebral arches
- **Coccygeal cornua**
 - Formed by laminae of first coccygeal vertebra





Sacrum & Coccyx





(a) Posterior surface

(b) Lateral surface

(c) Anterior surface



Thoracic Cage

- ***The skeleton of the chest***
 - Supports the **thoracic cavity**
 - Consists of:
 1. Thoracic vertebrae
 2. Ribs
 3. Sternum (breastbone)
- The Rib Cage
 - Formed of ribs and sternum



Function of the Thoracic Cage

- Protects organs of the thoracic cavity
 - Heart, lungs, and thymus
- Attaches muscles
 - For respiration
 - Of the vertebral column
 - Of the pectoral girdle
 - Of the upper limbs



Thoracic Cage

- ***Ribs***

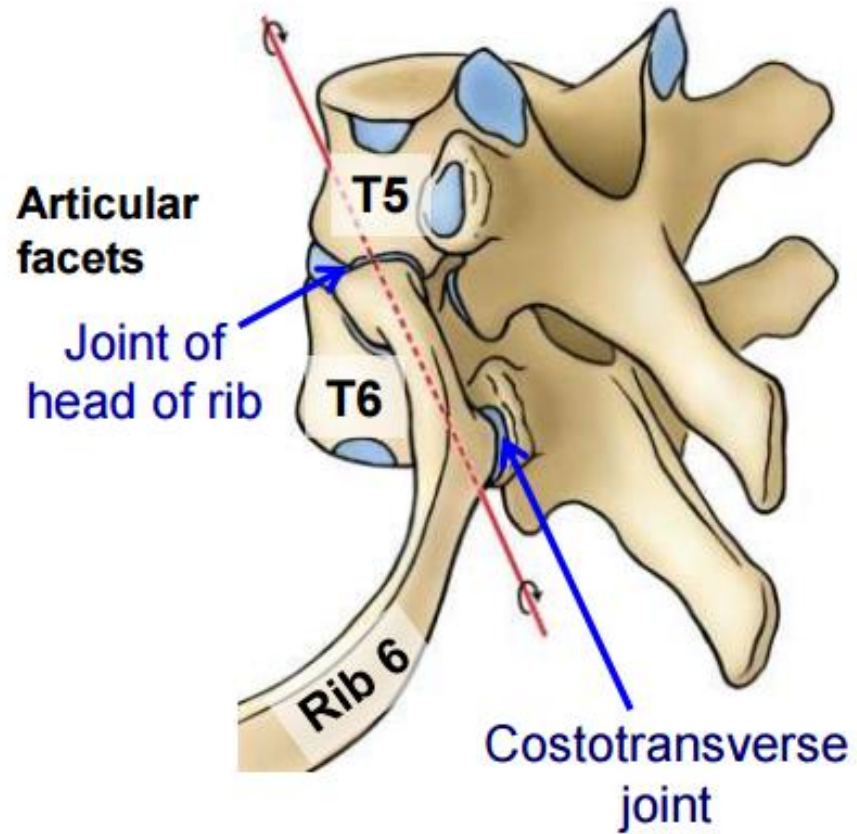
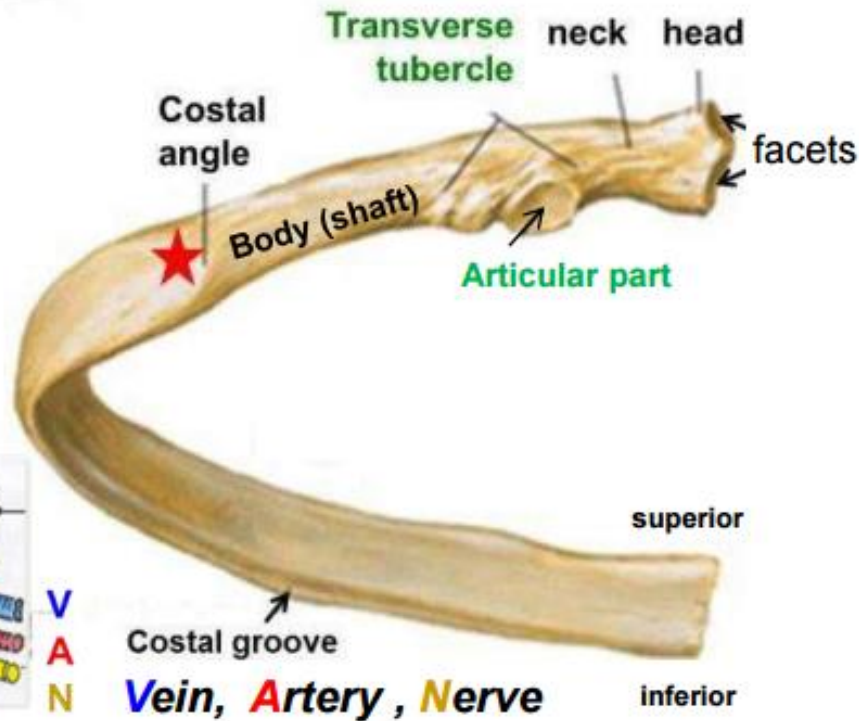
- Are mobile
- Can absorb shock
- Functions of ribs
 - Rib movements (breathing):
 1. Affect width and depth of thoracic cage
 2. Changing its volume



Typical Rib

- A typical rib is a long, twisted, flat bone.
- A rib has a **head, neck, tubercle, shaft, and angle**
- The anterior end of each rib is attached to the corresponding costal cartilage

TYPICAL RIBS: Ribs 3-9





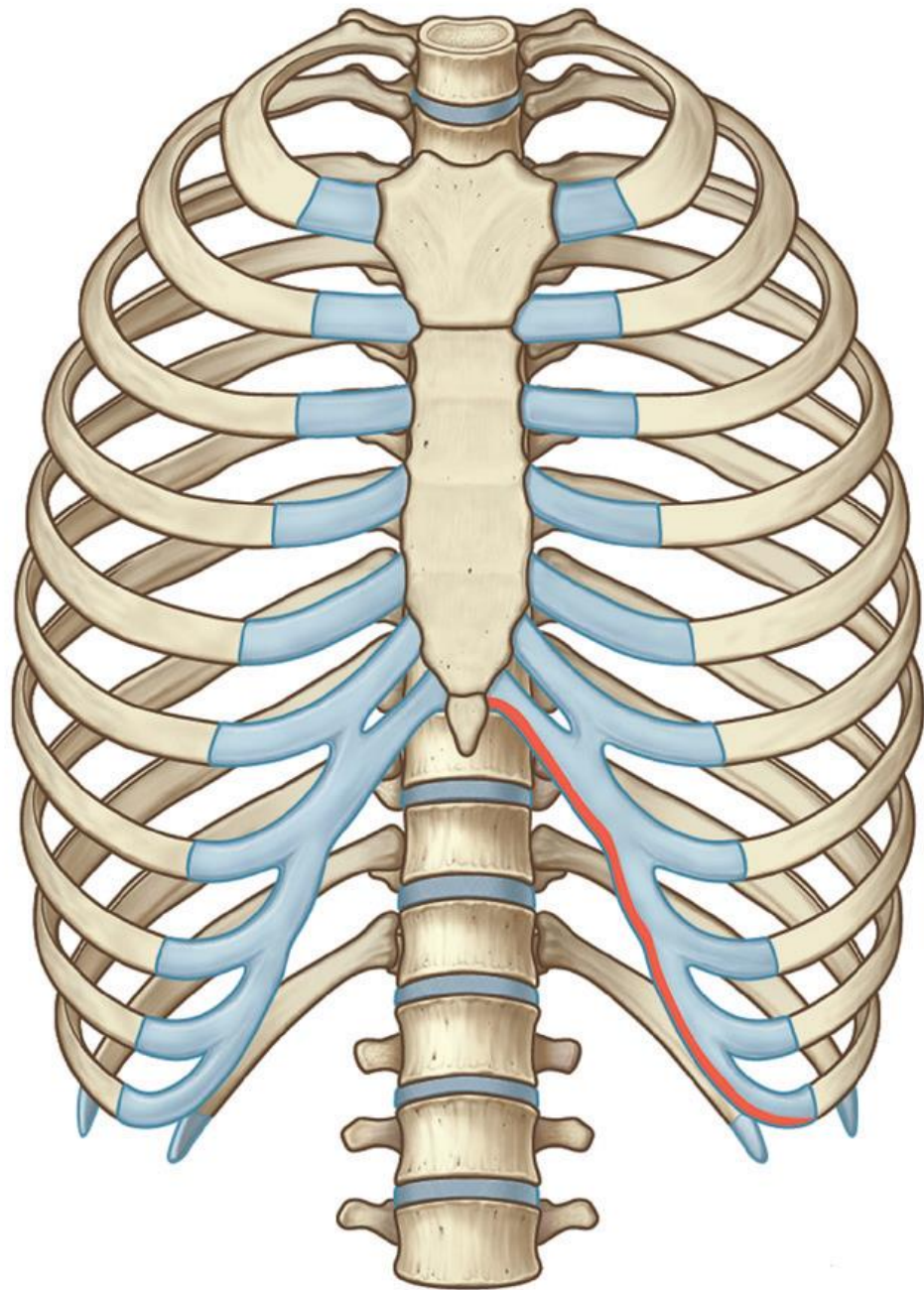
Thoracic Cage

- **Ribs 1–7 (true ribs)**

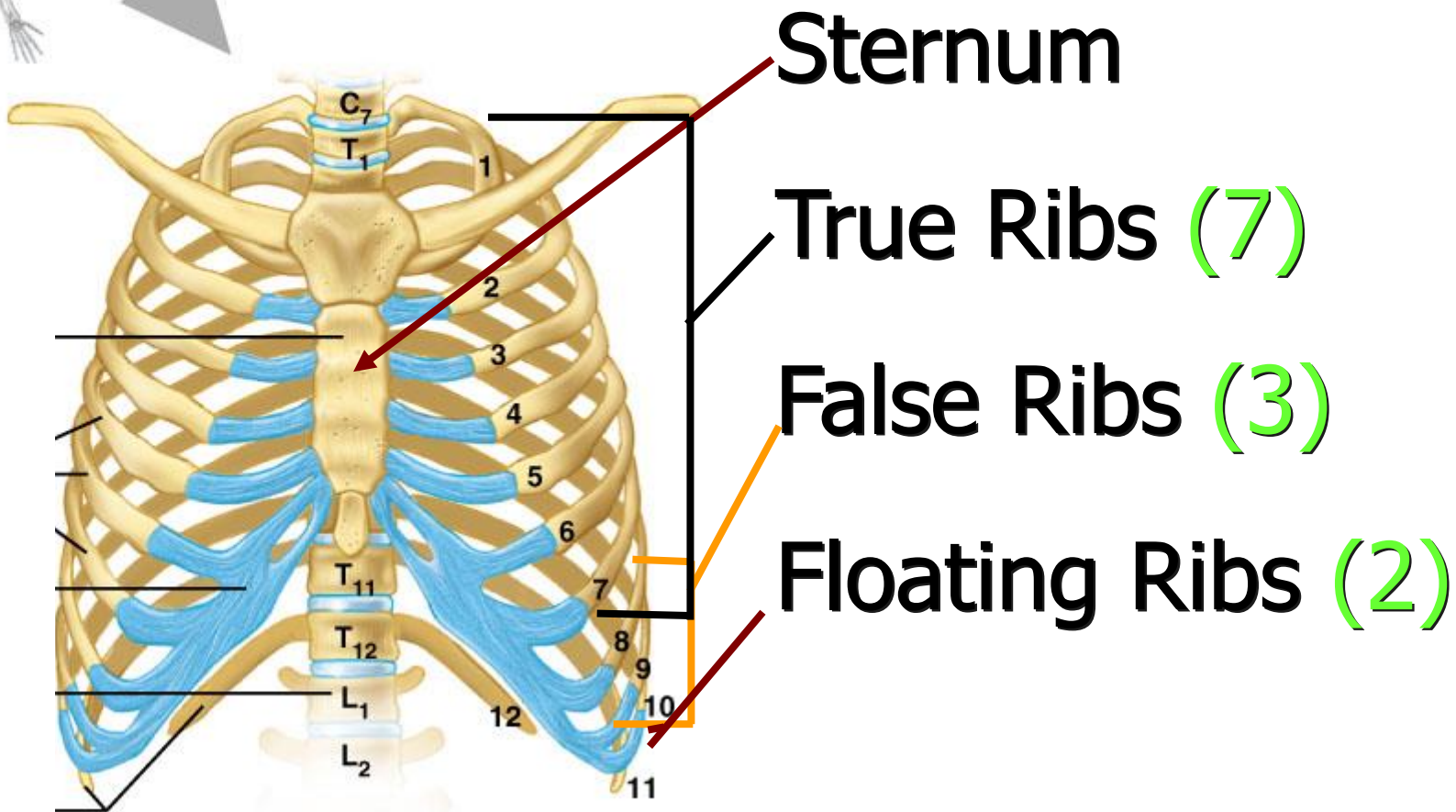
- *Vertebrosternal ribs*
- Connected to the sternum by **costal cartilages**

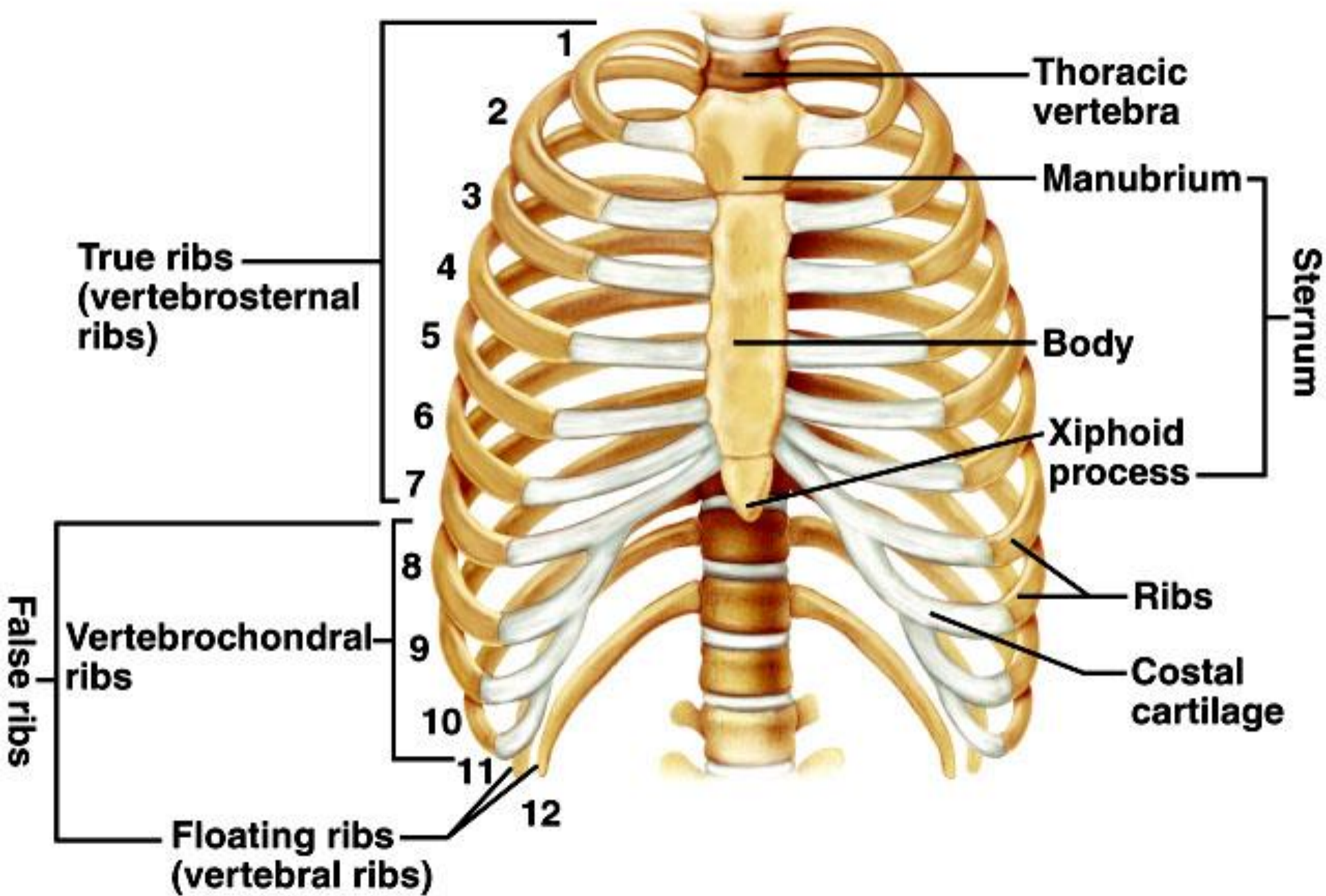
- **Ribs 8–12 (false ribs)**

- Do not attach directly to the sternum
- *Vertebrochondral ribs* (ribs 8–10)
 - Fuse together
 - Merge with cartilage before reaching the sternum
- *Floating or vertebral ribs* (ribs 11–12)
 - Connect only to the vertebrae and back muscles
 - Have no connection with the sternum



The Thoracic Cage





Thoracic vertebra

Manubrium

Body

Xiphoid process

Ribs

Costal cartilage

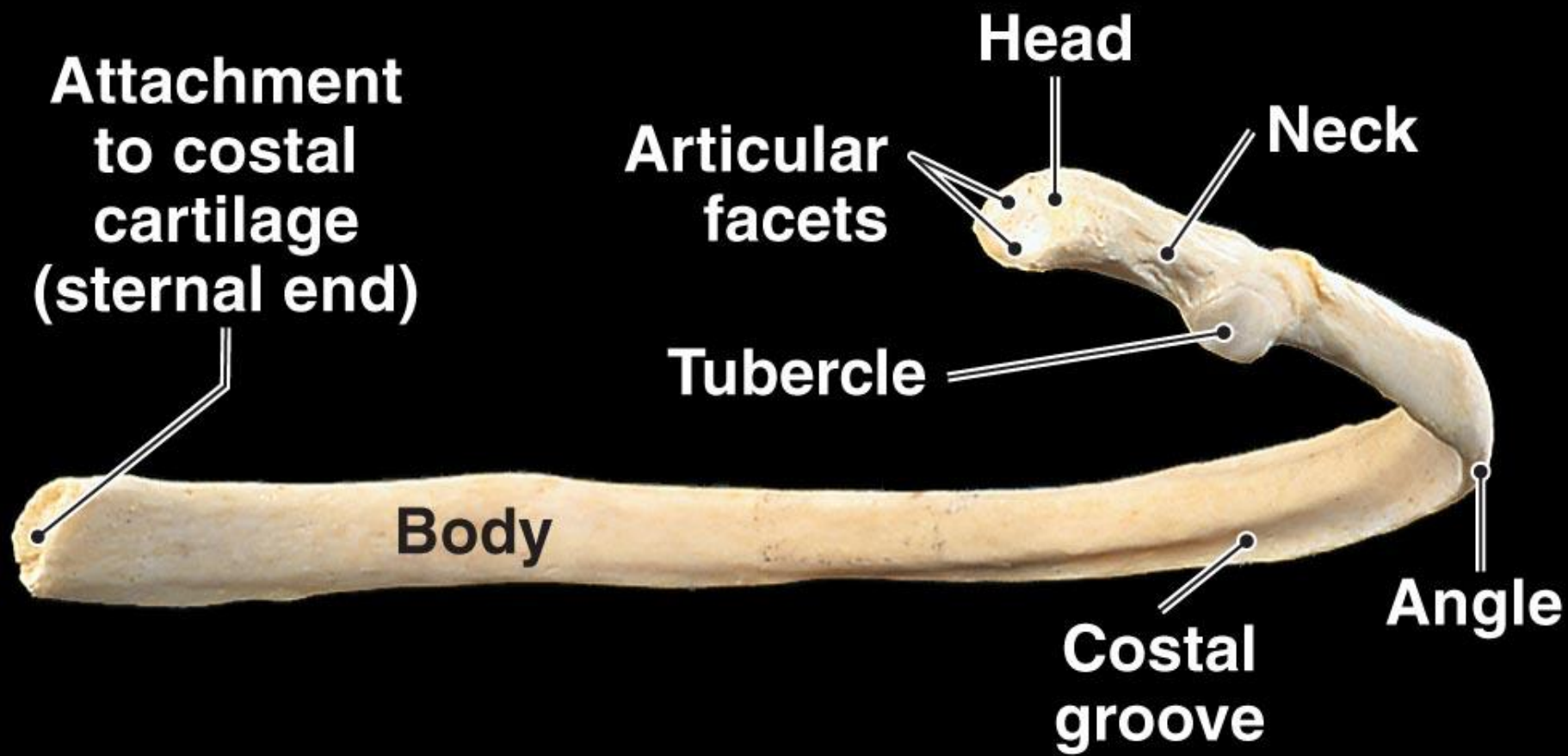
Sternum

True ribs (vertebrosternal ribs)

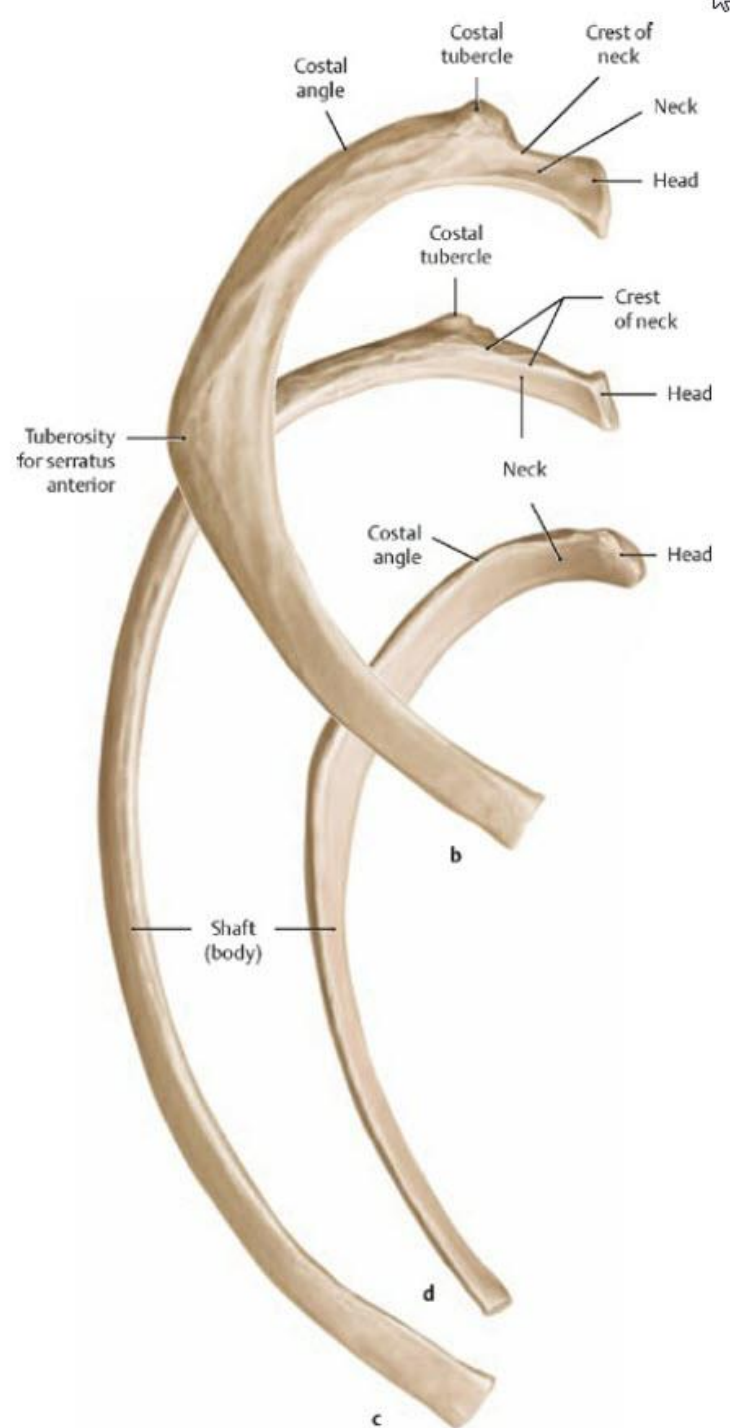
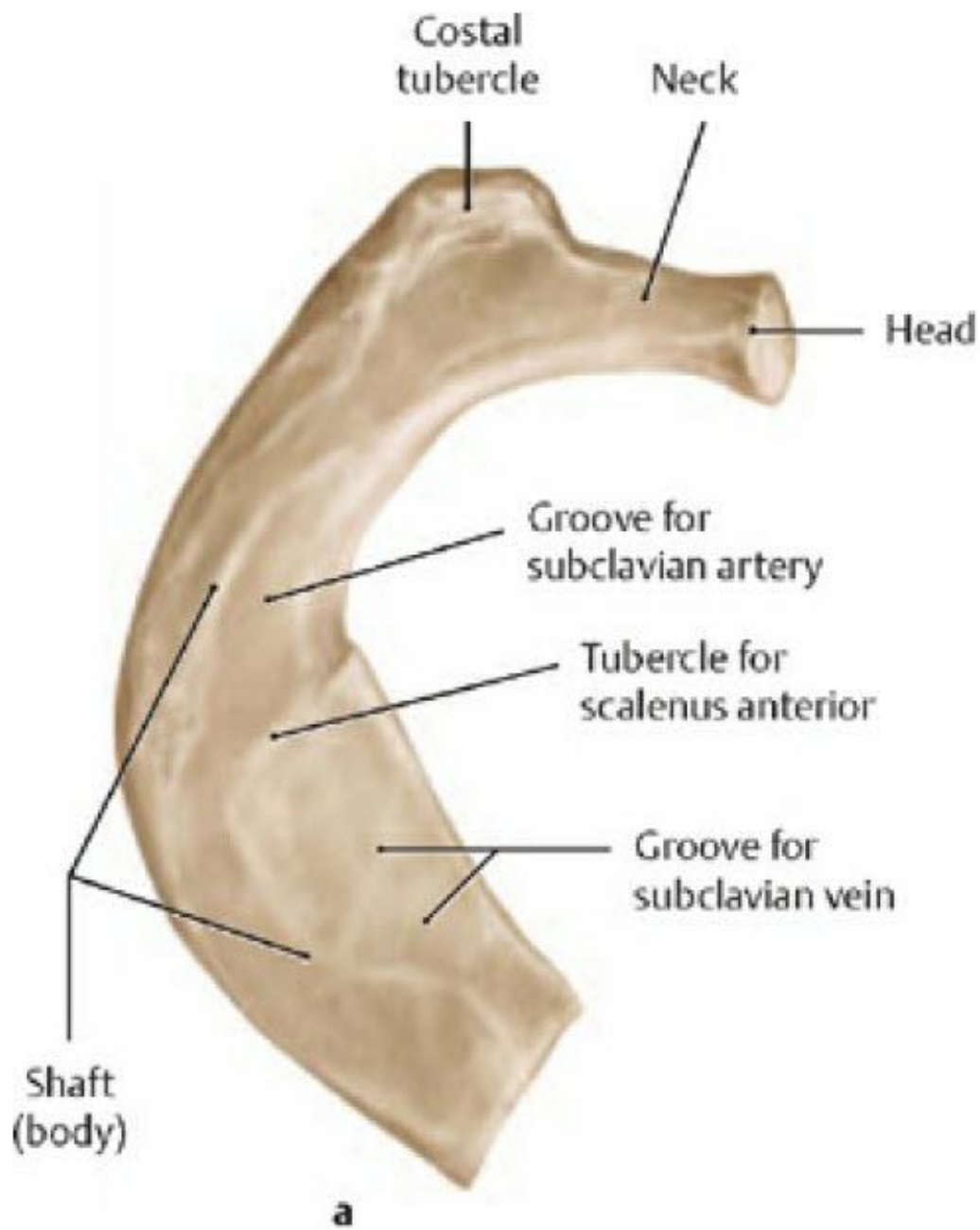
False ribs (vertebrochondral ribs)

Floating ribs (vertebral ribs)

False ribs



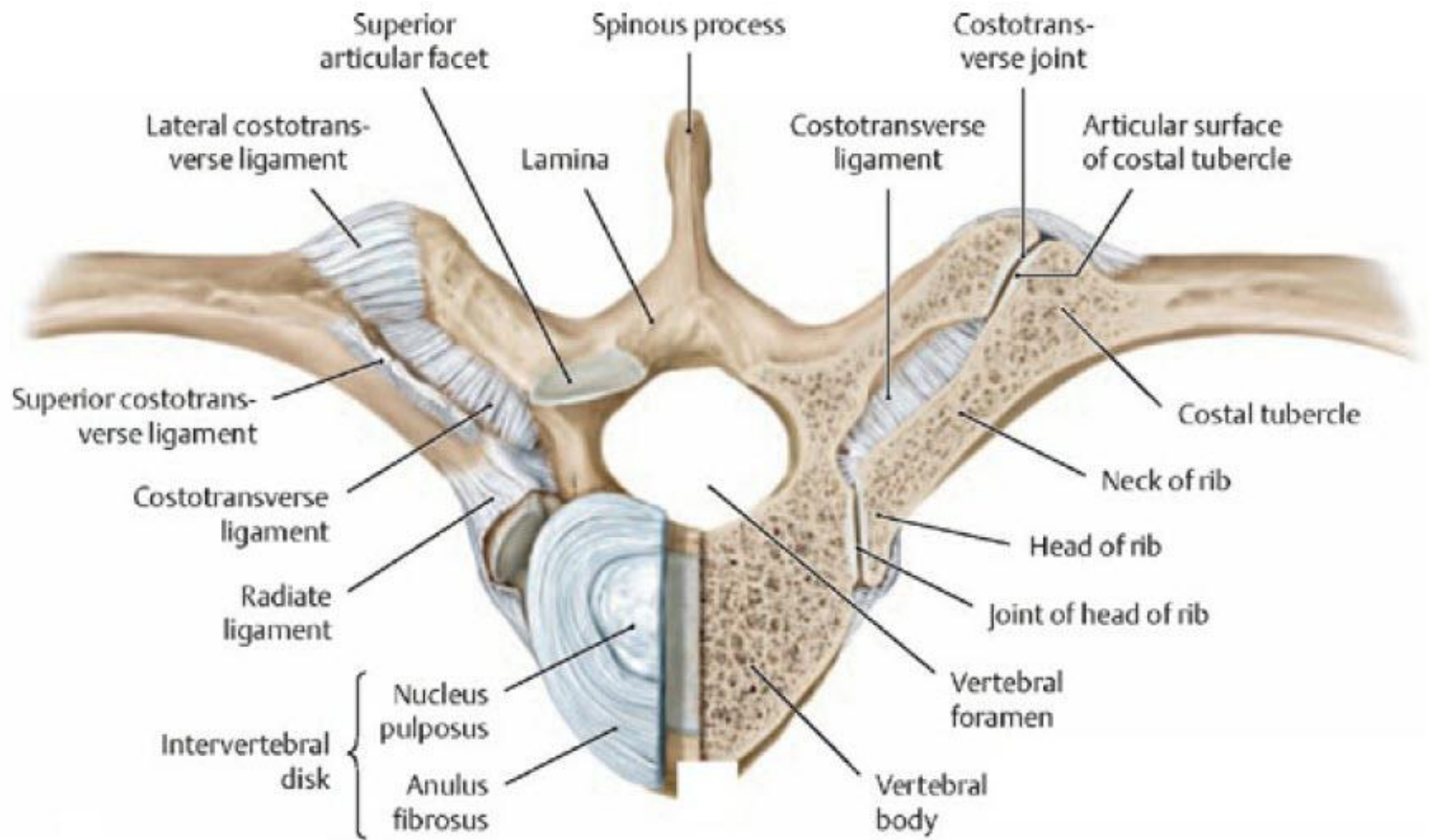
(b) Posterior view

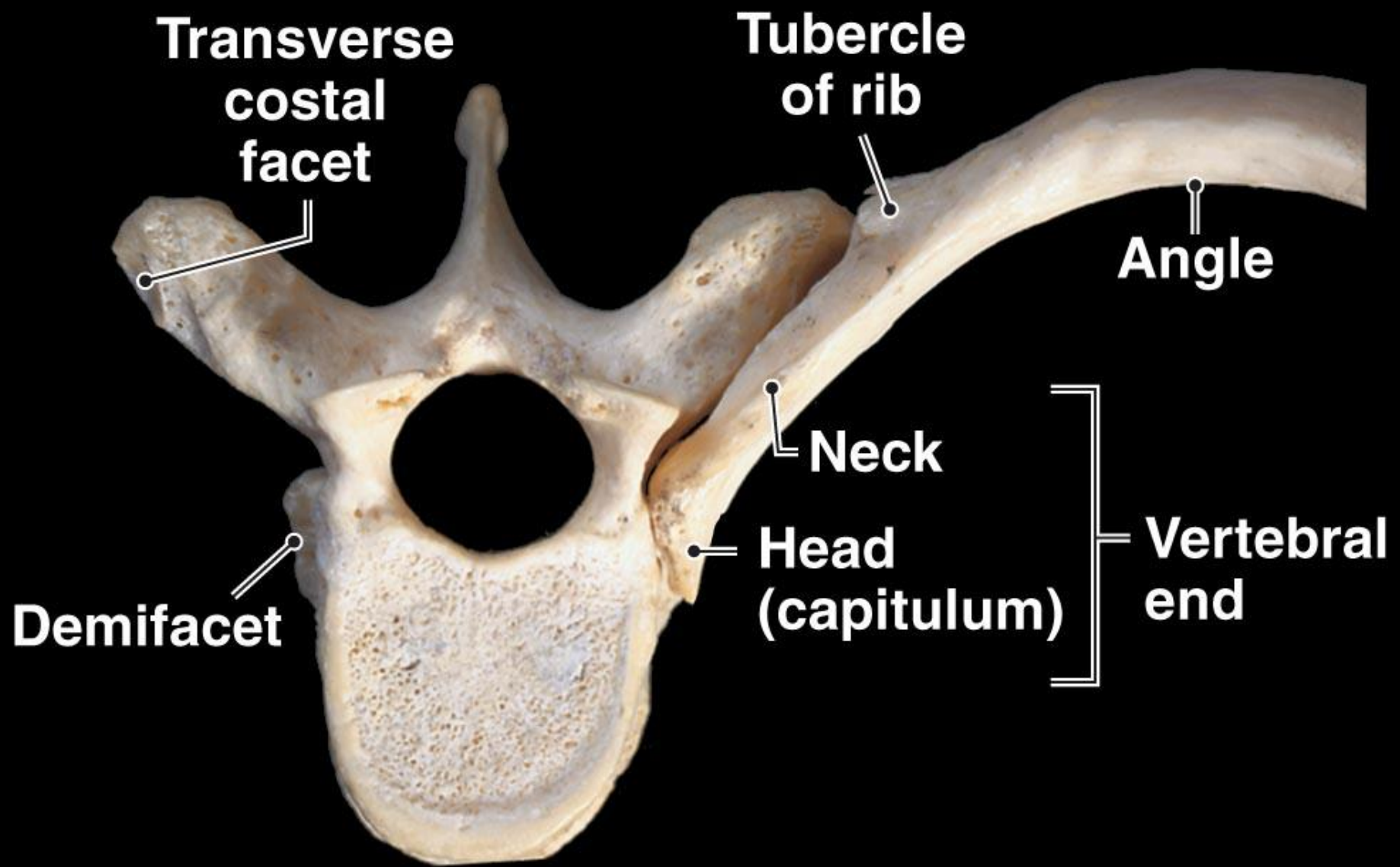


H**I**



Ribs and thoracic vertebra





(a) Superior view



The Sternum

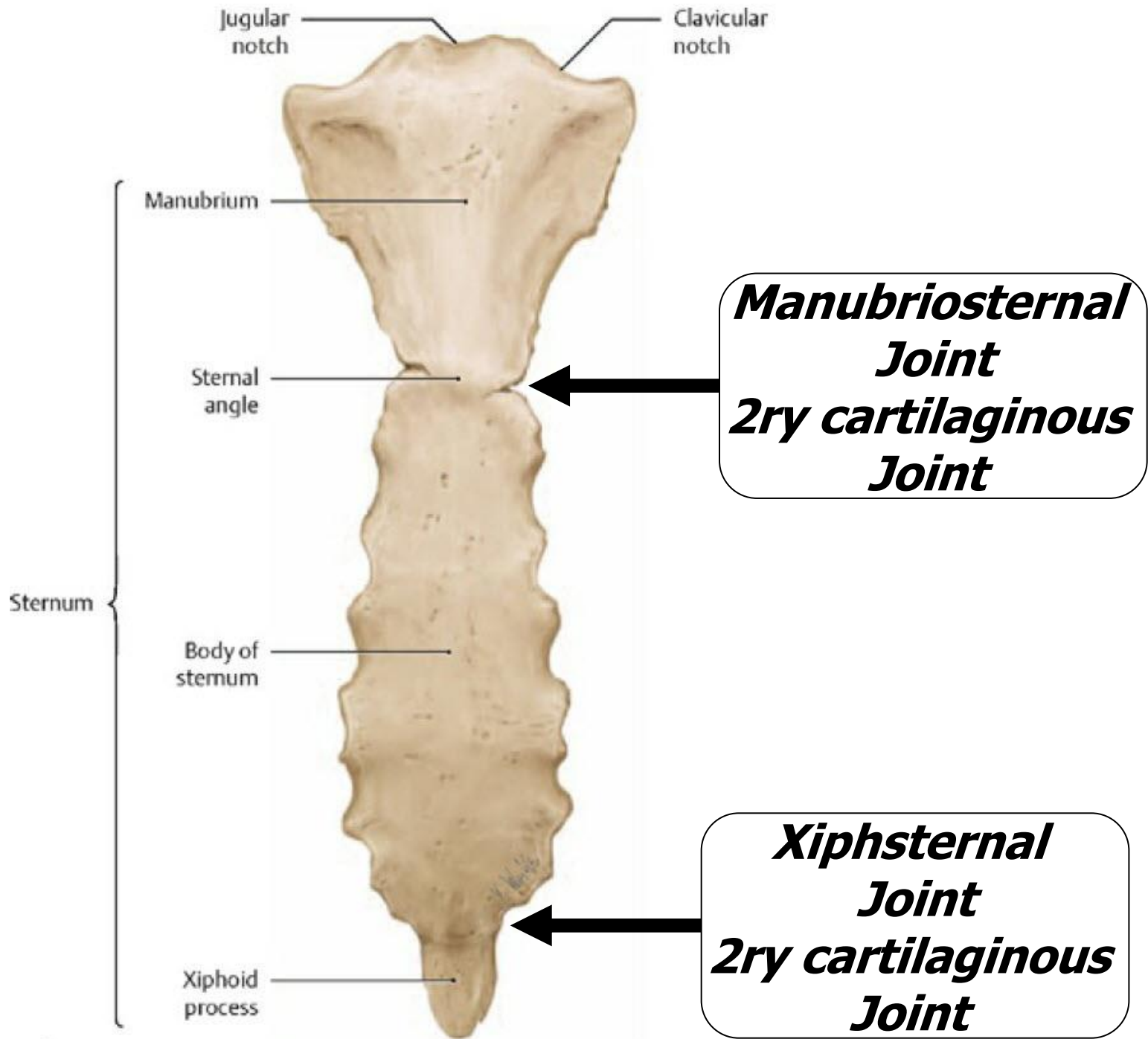
- A flat bone
- In the midline of the thoracic wall
- Three parts of the sternum
 - *The manubrium*
 - *The sternal body*
 - *The xiphoid process*



The Sternum

■ *Manubrium*

- The superior portion of sternum
- Broad, triangular shape
- Articulates with clavicles (collarbones)
- Articulates with cartilages of first rib pair
- Has a **jugular notch**, a shallow indentation between clavicular articulations





The Sternum

- ***The sternal body***

- Is tongue-shaped
- Attaches to the **manubrium**
- Attaches to costal cartilages of ribs 2–7

- ***The xiphoid process***

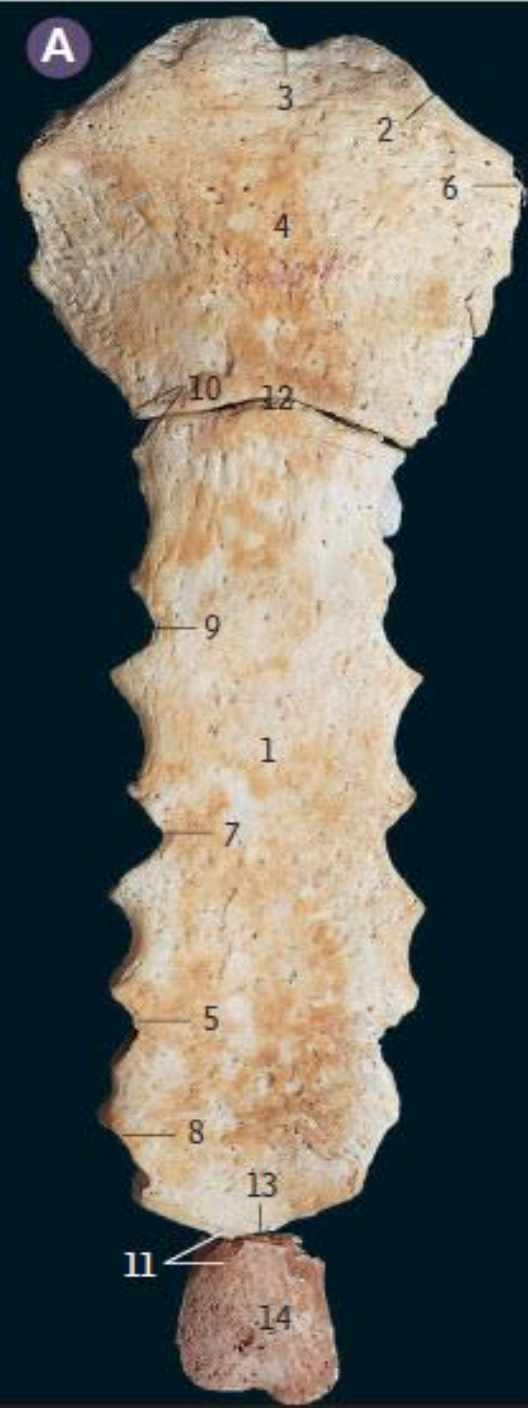
- Is the smallest part of the sternum
- Attaches to the sternal **body**
- Attaches to *diaphragm* and *rectus abdominis* muscles

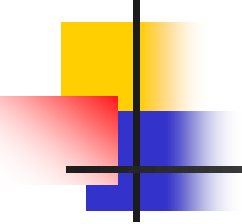


Development of the Sternum

- **The developing sternal body**
 - Completes fusion about age 25
 - Leaving transverse lines

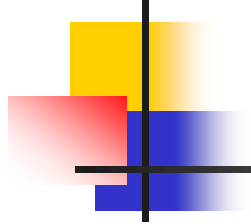
- **The xiphoid process**
 - Is the last part of sternum to fuse
 - Can easily be broken away



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- For further inquiries **PLZ** feel free to contact at any time through email

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Thank You