

Anatomy & Embryology - MSS

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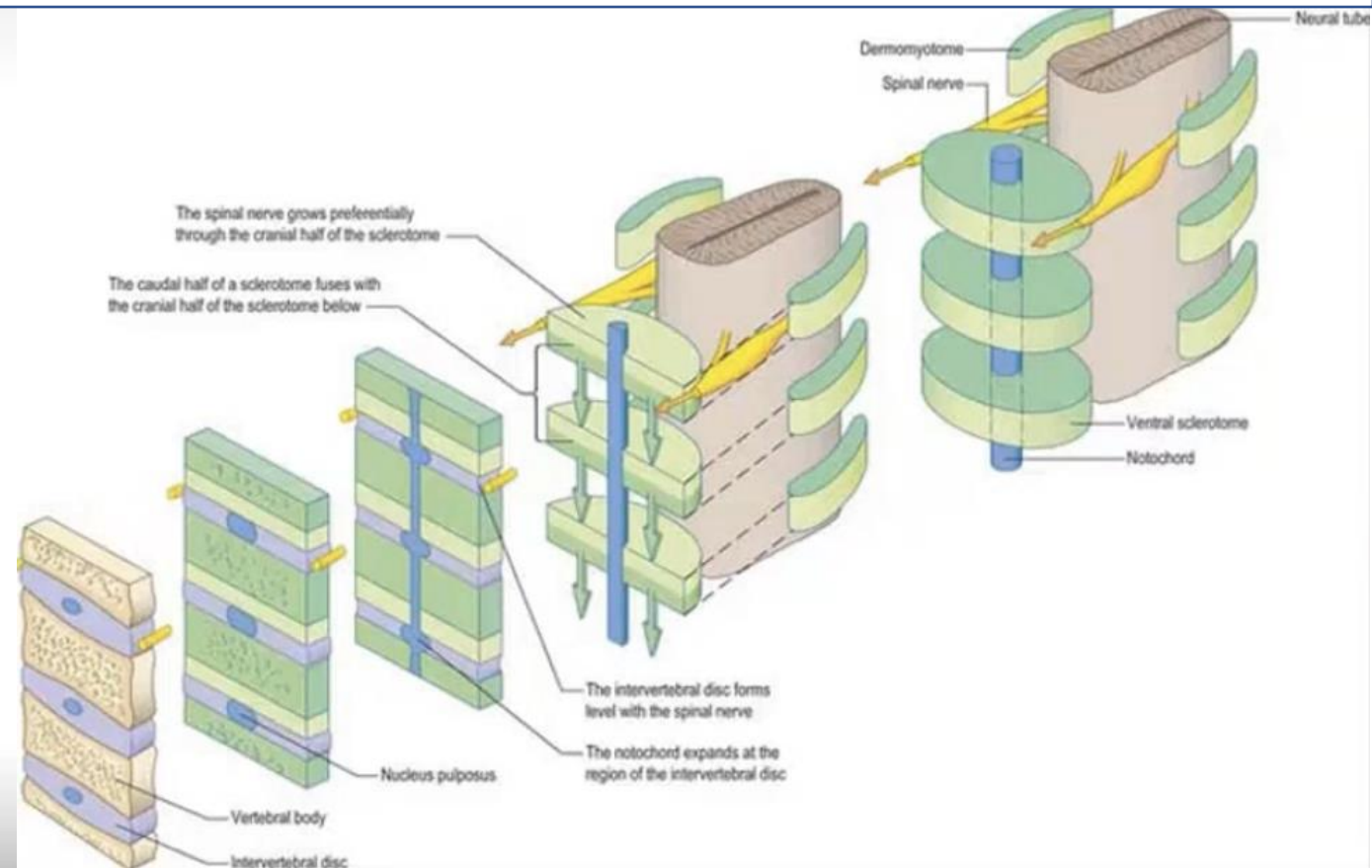
Vertebral Column (Spine)

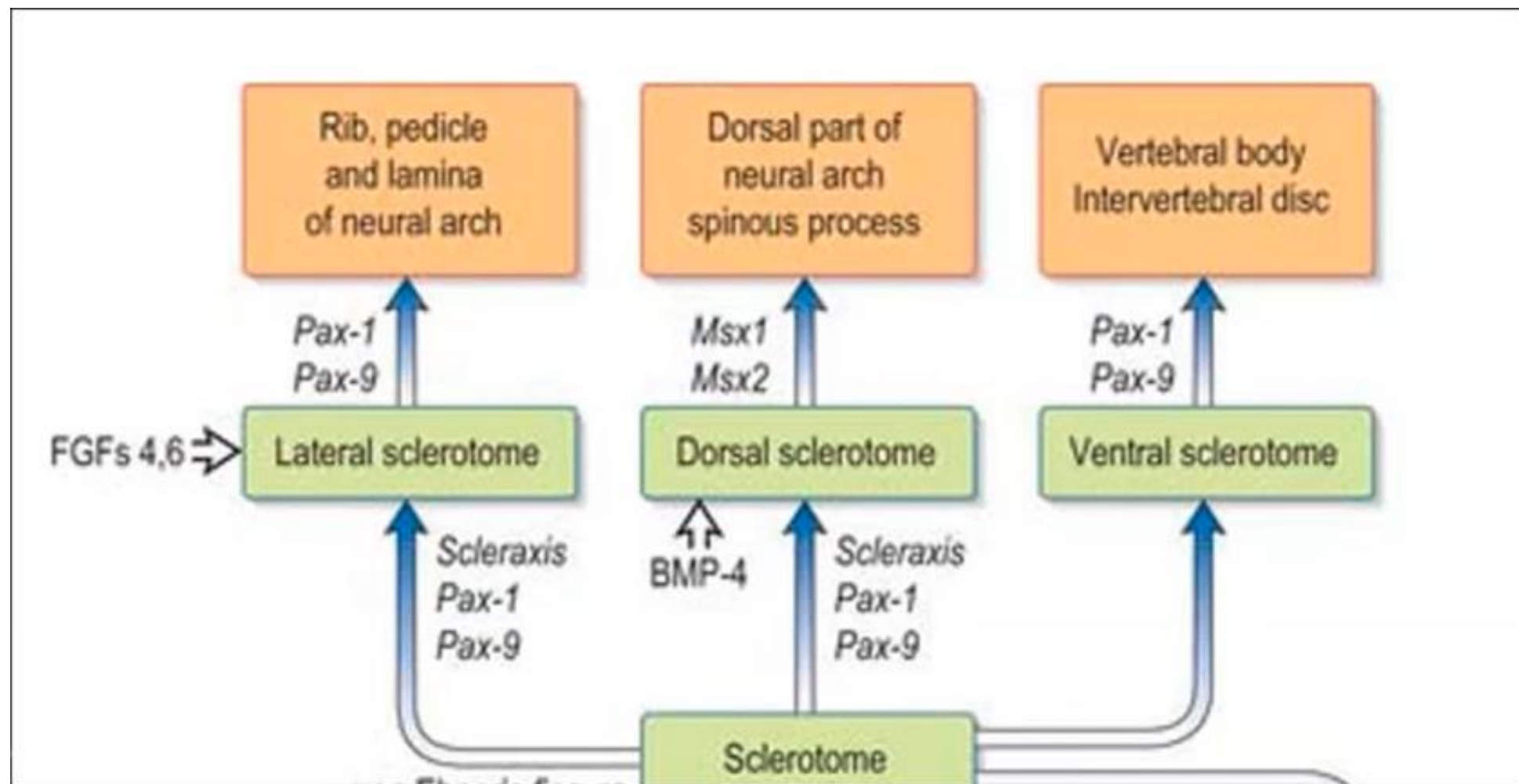
Embryology

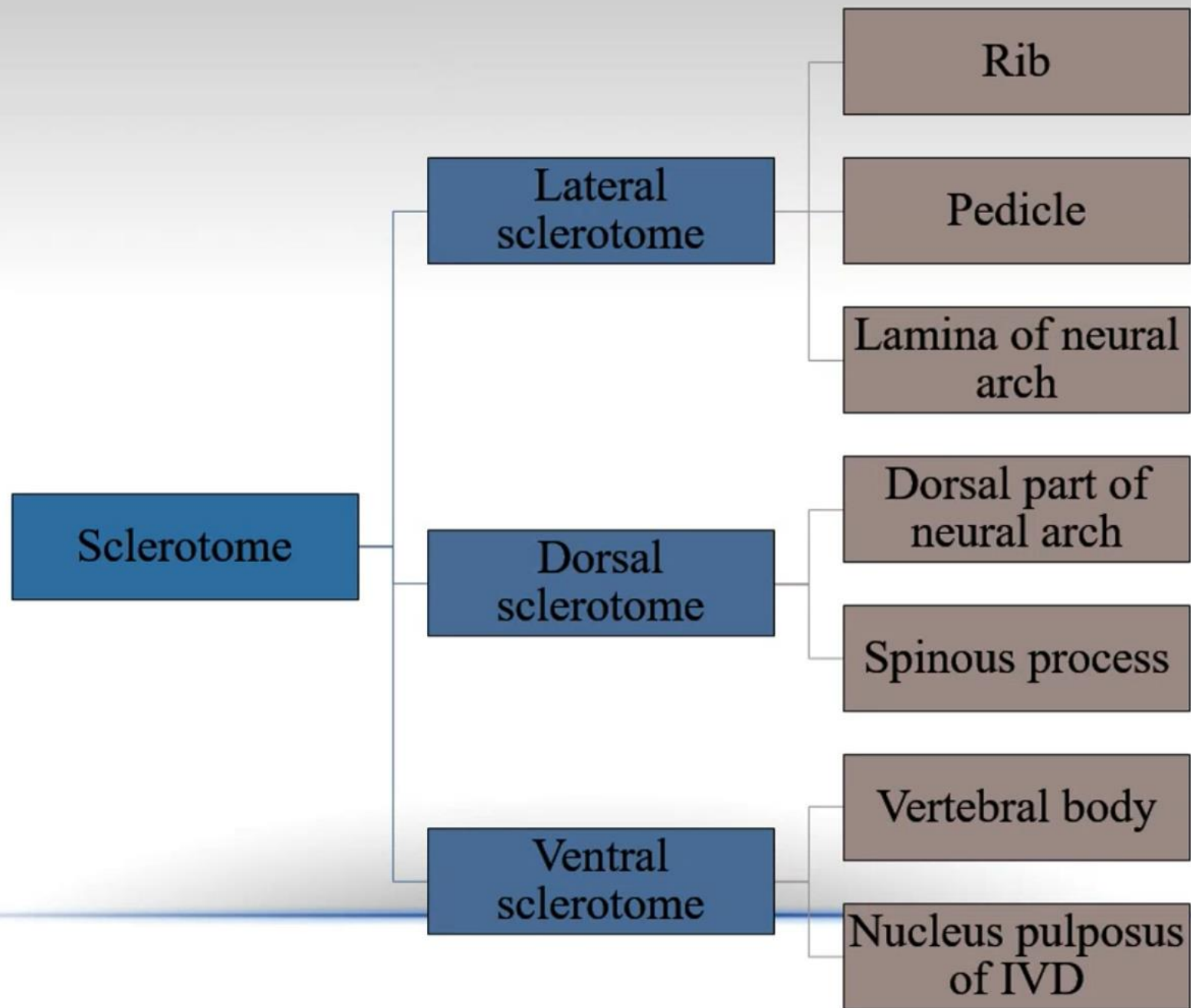
The vertebra is derived from condensation of mesenchyme of bilateral sclerotome around the notochord.

The sclerotome: lateral ventral and dorsal; each gives part of the vertebra

During the development of the fetus, blocks of mesenchyme are collected together forming somites which develop later on into Somites. Somites divide into dermomyotome & sclerotome. Dermomyotome: gives rise to muscles & skin. Sclerotome: gives hard structures then it further divides into lateral, ventral & dorsal







Vertebral Column

Cervical: 7

Thoracic: 12

Lumbar: 5

Sacral: 5 (fused to form 1 sacrum)

Coccygeal: 4 (fused to form coccyx)

Total= 33 (counted as 26 in the total bones of the body because of fusion.)

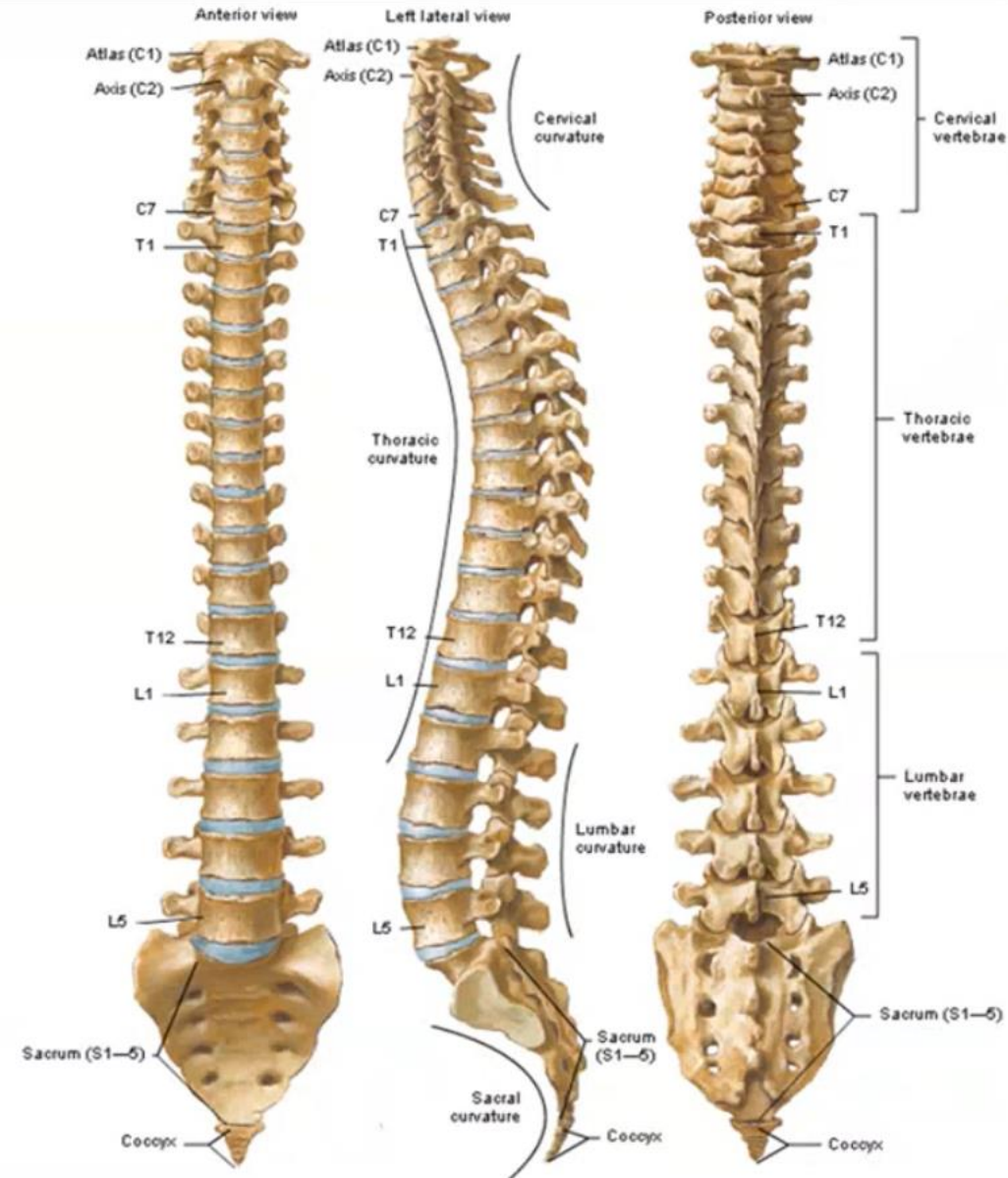


General Considerations ..1/3

Below the skull, the central axis of the body passes through the vertebral column.

The average length of the adult male vertebral column is 70 cm and in adult female 60 cm.

The vertebral bodies contribute 4/5 of the length of the vertebral column and the intervertebral discs 1/5.



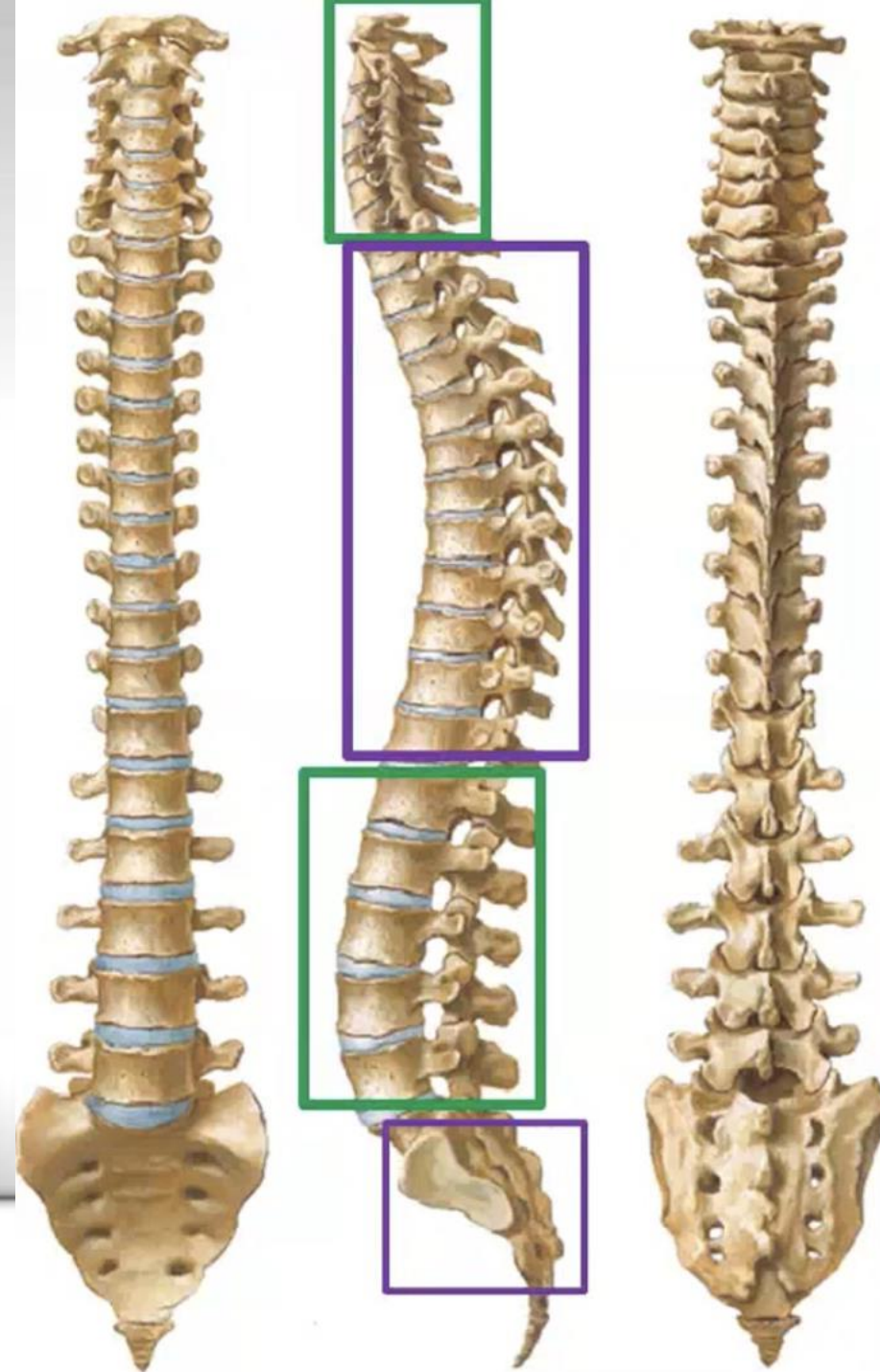
The vertebral bodies = 80% of the length of the vertebral column & the vertebral discs = 20% of the length of the vertebral column

General Considerations ..2/3

The cervical and lumbar regions show backward curvature (Lordosis) known as secondary curvature.

(Secondary because it develops after birth)

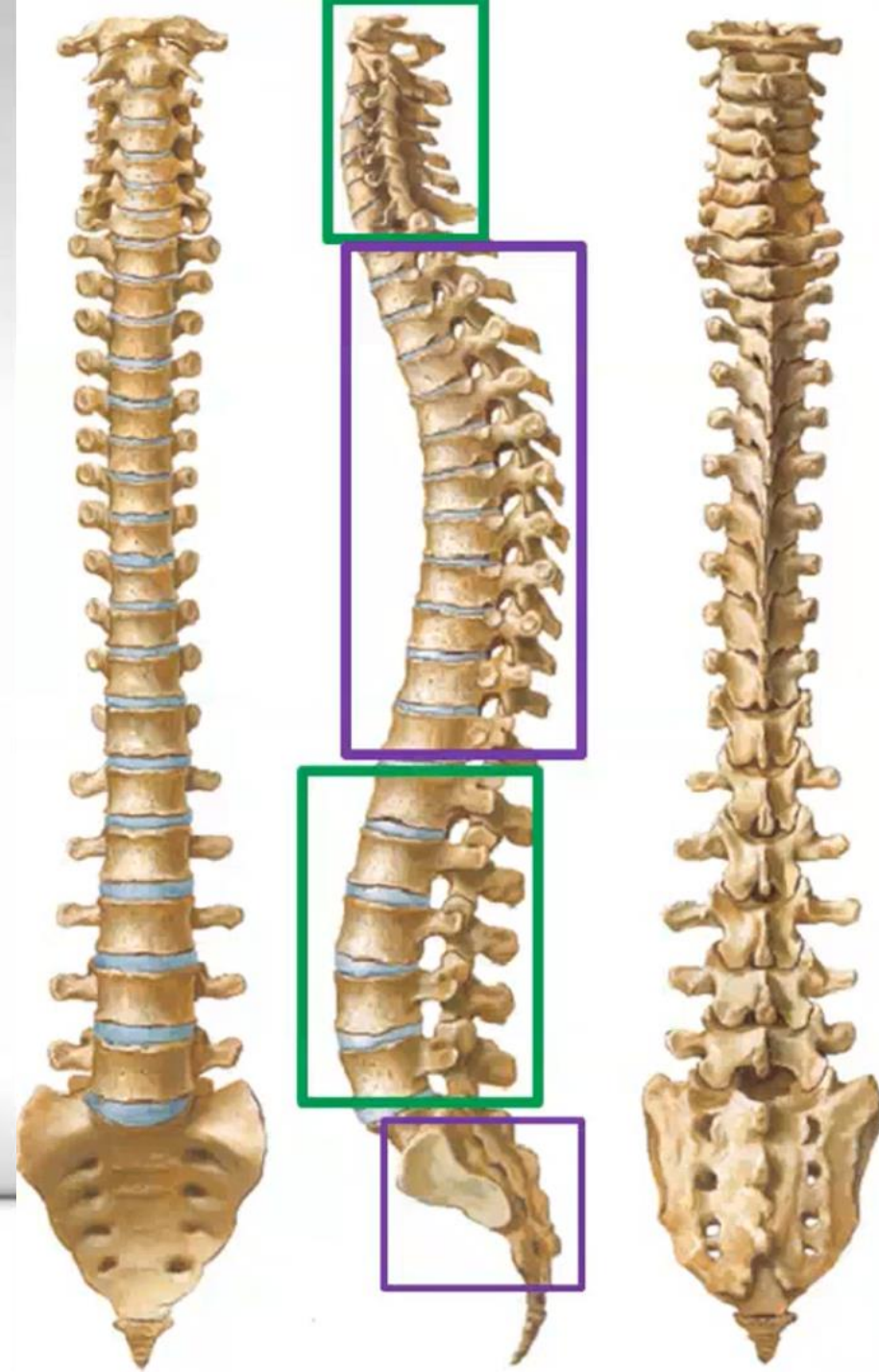
The thoracic and sacral regions show forward curvature (Kyphosis) corresponding to the primary curvature in the embryo.



General Considerations ..3/3

The primary curvature (Thoracic and sacral) is present at birth

The secondary curvature (cervical and lumbar) develops after birth



Movements at the Vertebral Column

Flexion: bending forward

Extension: bending backwards

Lateral flexion (Right/Left): bending side-wards

Rotation: Twisting the trunk

Circumduction: Doing movement [in sequence](#)

The axis of movement passes through the center of the vertebral bodies, so that the bodies do not move. ([Gliding movement](#))

Movements are mostly permitted by the cervical & lumbar spines.
Thicker the intervertebral disc, greater the degree of movement



Typical Vertebra ..1/2

Body:

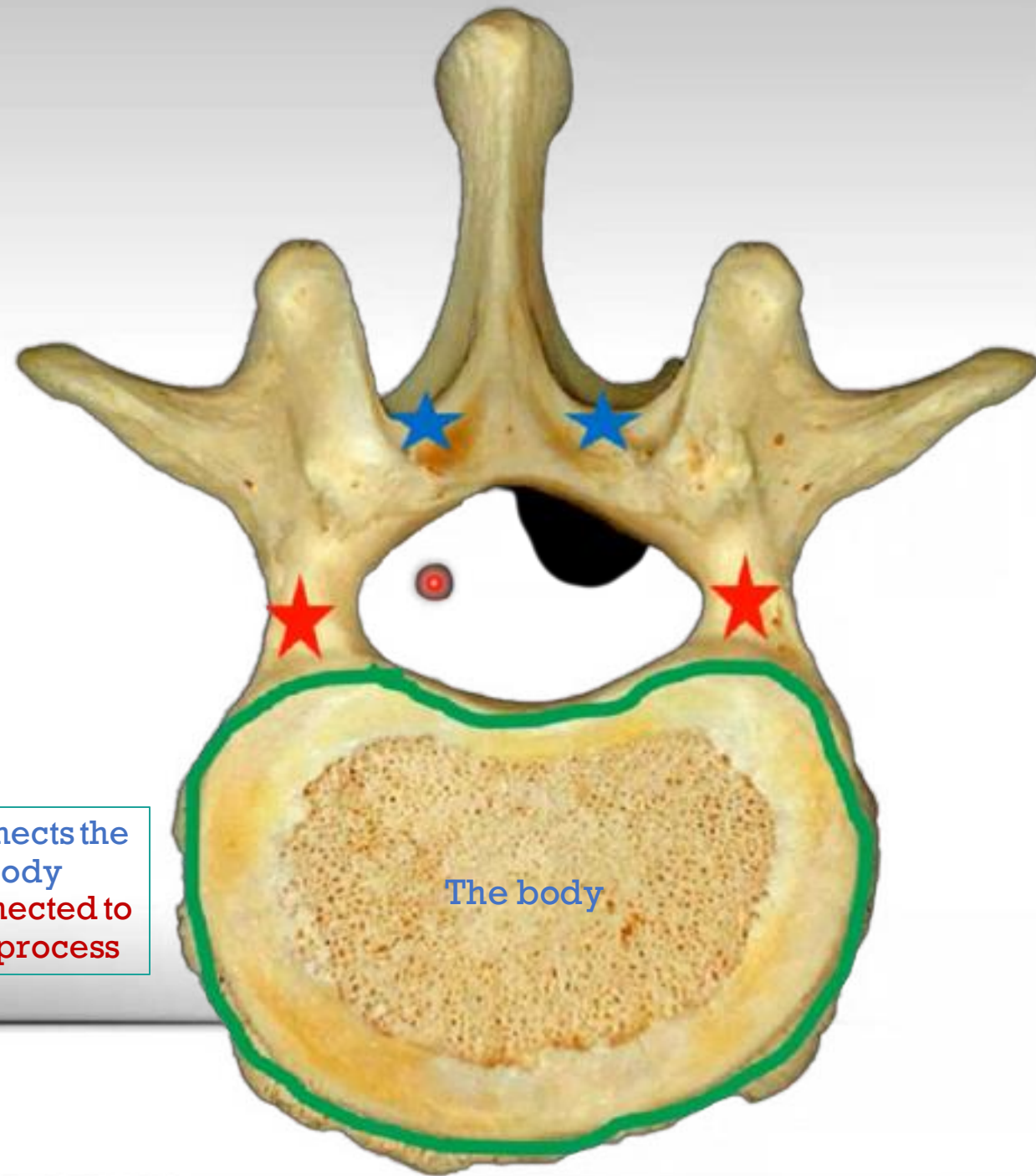
The center of the body consists of **cancellous bone** & it's encircled by **compact bone**

- Cylindrical, developed from calcified somite sclerotome
- Covered by the intervertebral disc (Fibrocartilage).

Vertebral (Neural) Arch:

- Consists of:
 - Pedicles (laterally) ★ (Anteriorly)
 - Lamina (Posteriorly) ★
- Forms the vertebral foramen and protects the spinal cord

Pedicle connects the arch to the body
Lamina connected to the spinous process



Typical Vertebra ..2/2
PROCESSES

(1) Spinous process ★

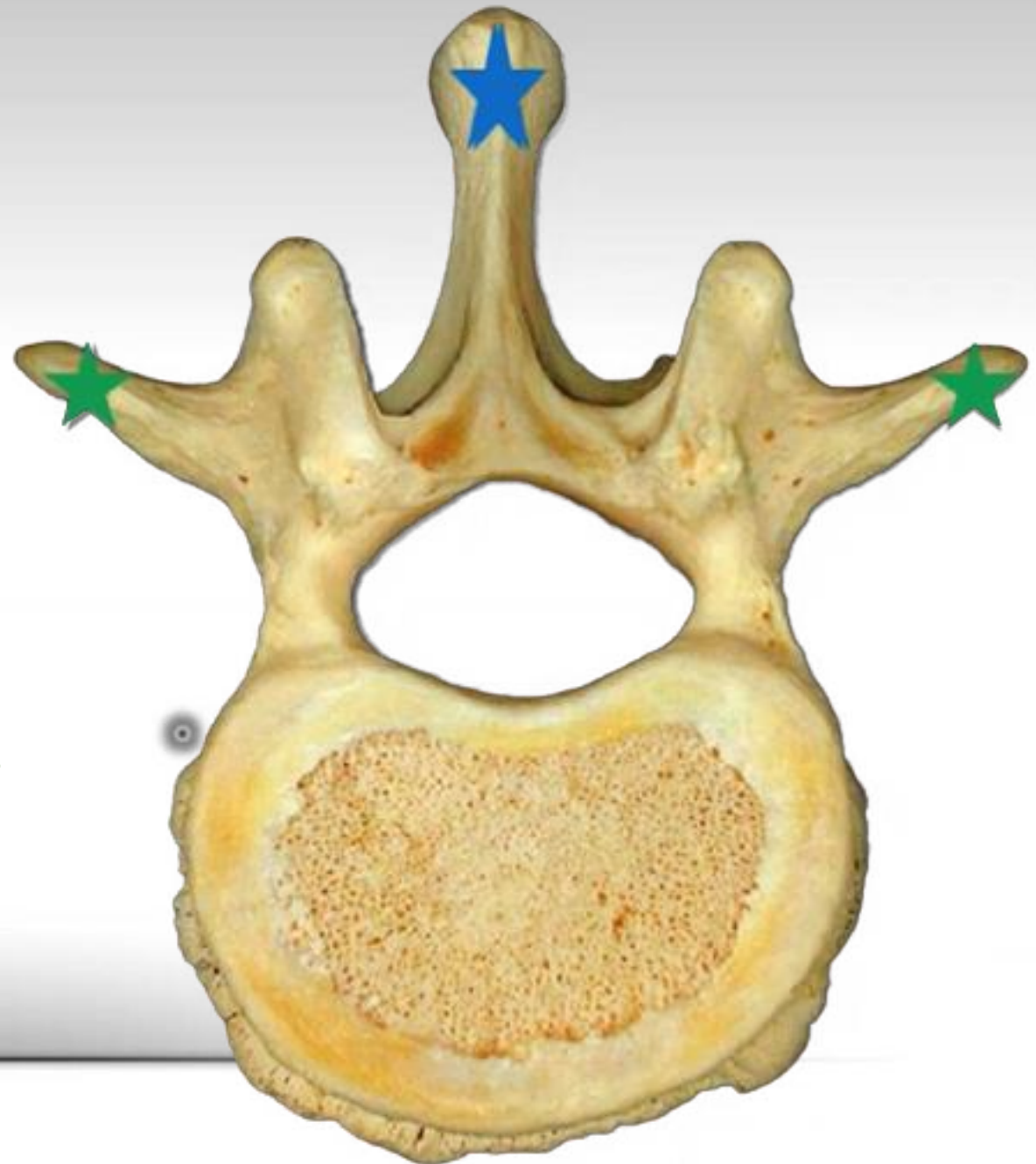
- Projects posteriorly
- Has special features in different parts

(2) Transverse processes ★

- Project laterally / Has special features in different parts

(3) Articular Processes (facets)

- 2 superior (facing posteriorly) and 2 inferior (facing anteriorly)



Foramina associated with the vertebral arch

(1) vertebral foramina

- Formed by the vertebral bodies and vertebral arches
- Collectively form the vertebral canal

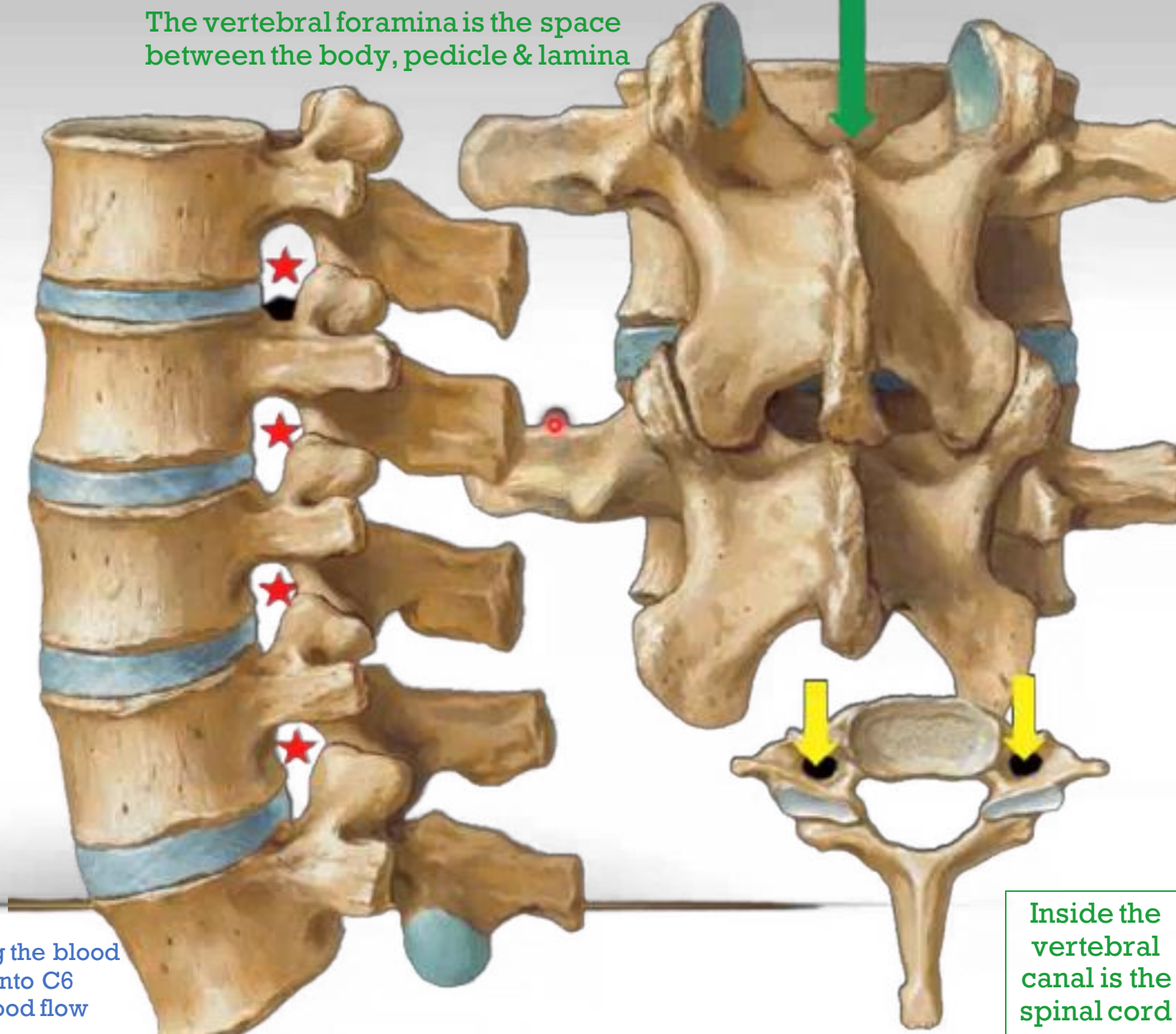
(2) Intervertebral foramina:

- Located between inferior and superior surfaces of pedicles of adjacent vertebra
- Transmit spinal nerves

((3) Transverse foramina:

- Present in the transverse foramina of the cervical vertebra
- Transmit vertebral artery (Except C7), veins and autonomic fibres associated with the artery.

The vertebral foramina is the space between the body, pedicle & lamina



Inside the vertebral canal is the spinal cord

Why doesn't the vertebral artery pass through C7?
The vertebral artery is a branch of the subclavian artery.
If it passes through C7, it'll create a sharp angle impeding the blood flow in the artery, that's why it leaves C7 & goes directly into C6 creating a gentle curve, so it doesn't interfere with the blood flow

Functions of the Vertebral Column

Protects the spinal cord & spinal nerves.

Supports the weight of the body superior to the level of the pelvis. *Specially when there's transmission of weight*

Provides a partly rigid & flexible axis for the body & an extended base on which the head is placed and rotates.

Plays an important role in posture & locomotion

Allows some sort of movement: Flexion, extension, rotation, etc.



Important Surface Landmarks Related to the Vertebral Column

In anatomy, we depend on certain **bony** landmarks to determine the surface anatomy of structures & we describe other structures in relation to it, because bony landmarks are fixed not like soft tissue.

T2: Jugular notch

T3: Base of the spine of the scapula

T4: beginning and end of the aortic arch, bifurcation of the trachea

T7: Inferior angle of the scapula

L4: iliac crest

S2: Posterior superior iliac spine

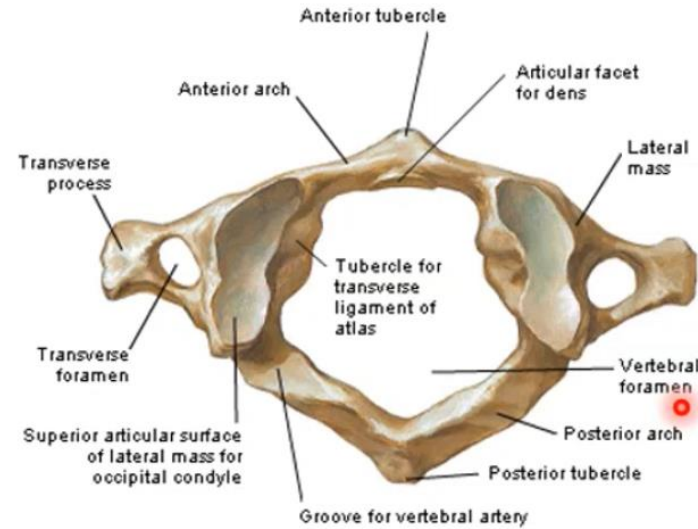
T4: The azygos vein ends in the superior vena cava at the level of T4

Spines are palpable in the midline from C7 to sacrum & coccyx, but before C7 you can't palpate the spines (C6, C5, C4... etc)

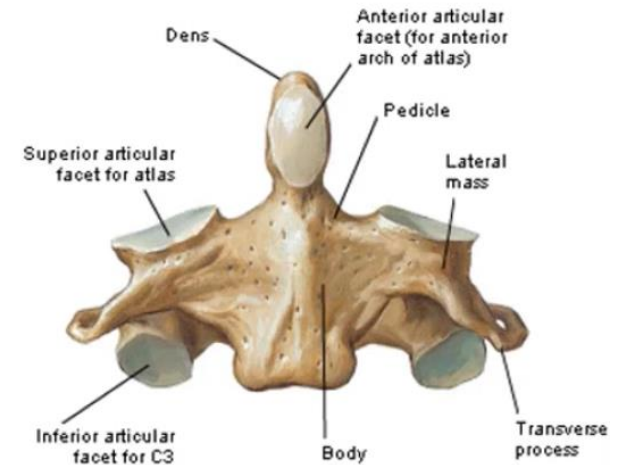


Cervical[®]
Vertebrae

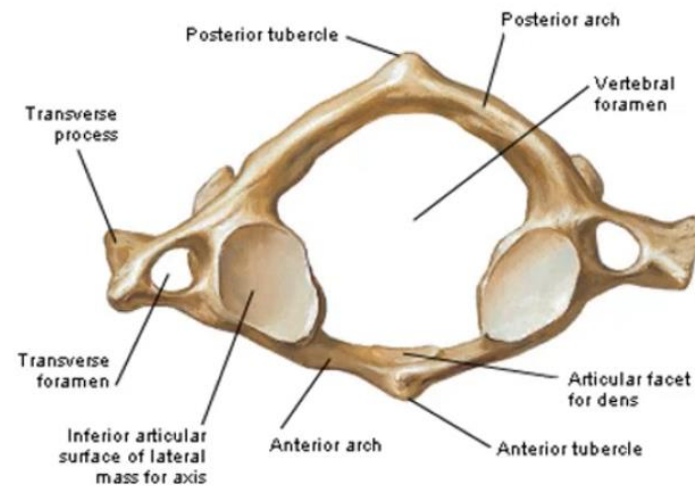
- All of the vertebrae have typical & atypical vertebrae
- C1 & C2 are **atypical**
- Going down the vertebral column, the cervical vertebra looks like the thoracic vertebrae & in the lower end of the thoracic region, the thoracic vertebra's shape becomes closer to the lumbar vertebrae



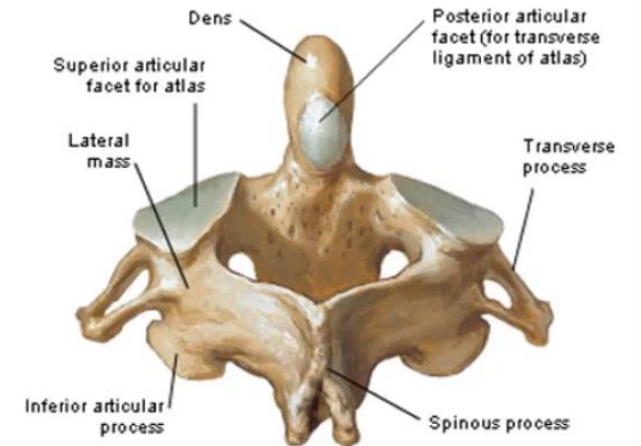
Atlas (C1): superior view



Axis (C2): anterior view



Atlas (C1): inferior view



Axis (C2): posterosuperior view

Atlas (C1)

The only vertebra that doesn't have a body or spinous process.

The widest cervical vertebra

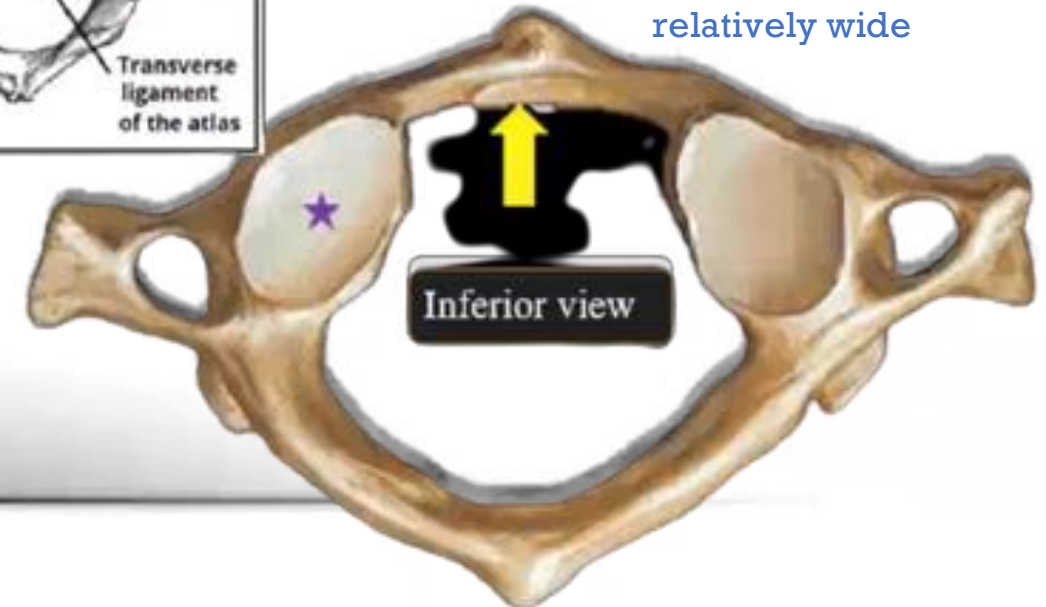
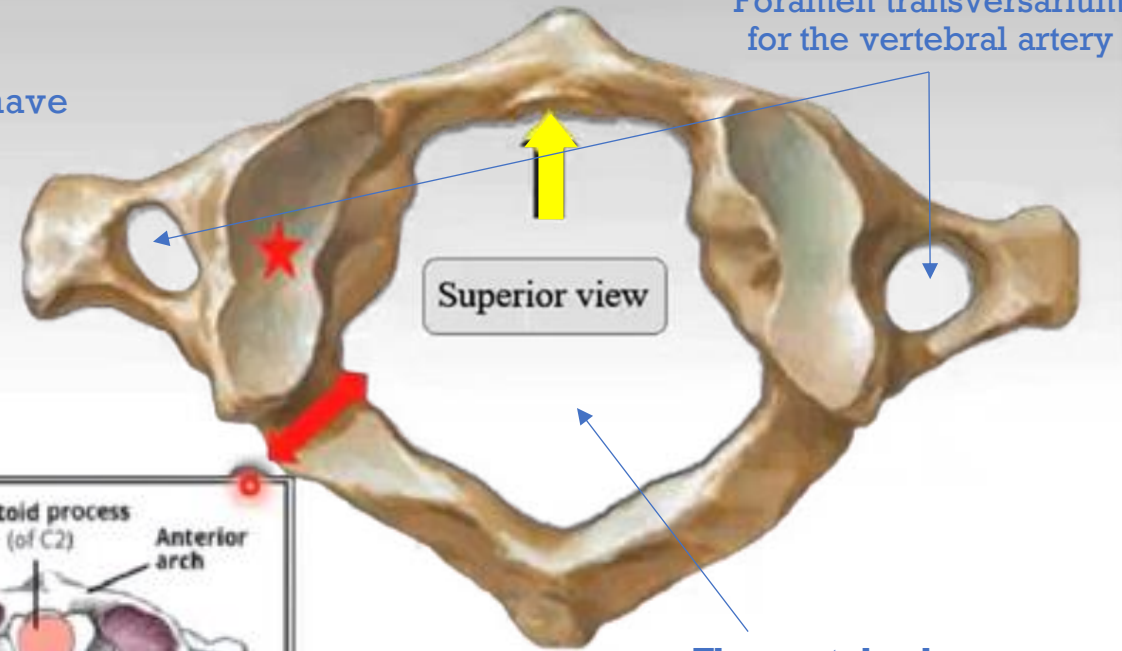
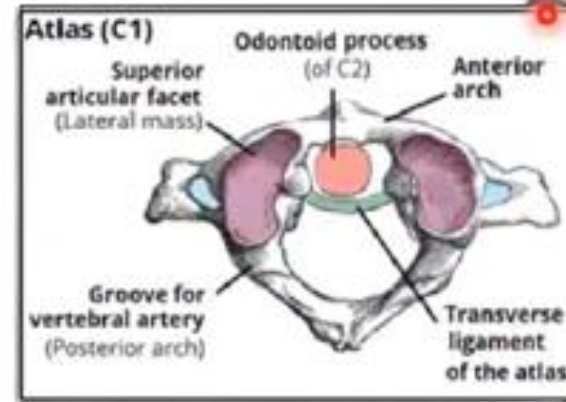
No vertebral body, No spinous process

Has **lateral masses** each contains:

- a superior articular facet (for articulation with occipital condyles) ★ occupying a wide area
- an inferior articular facet (for articulation with C2). ☆ a narrower area than the superior articular facet

The anterior arch contains a facet for articulation with the dens of the axis. ↑

The posterior arch has a groove for the vertebral artery and C1 spinal nerve. ↘



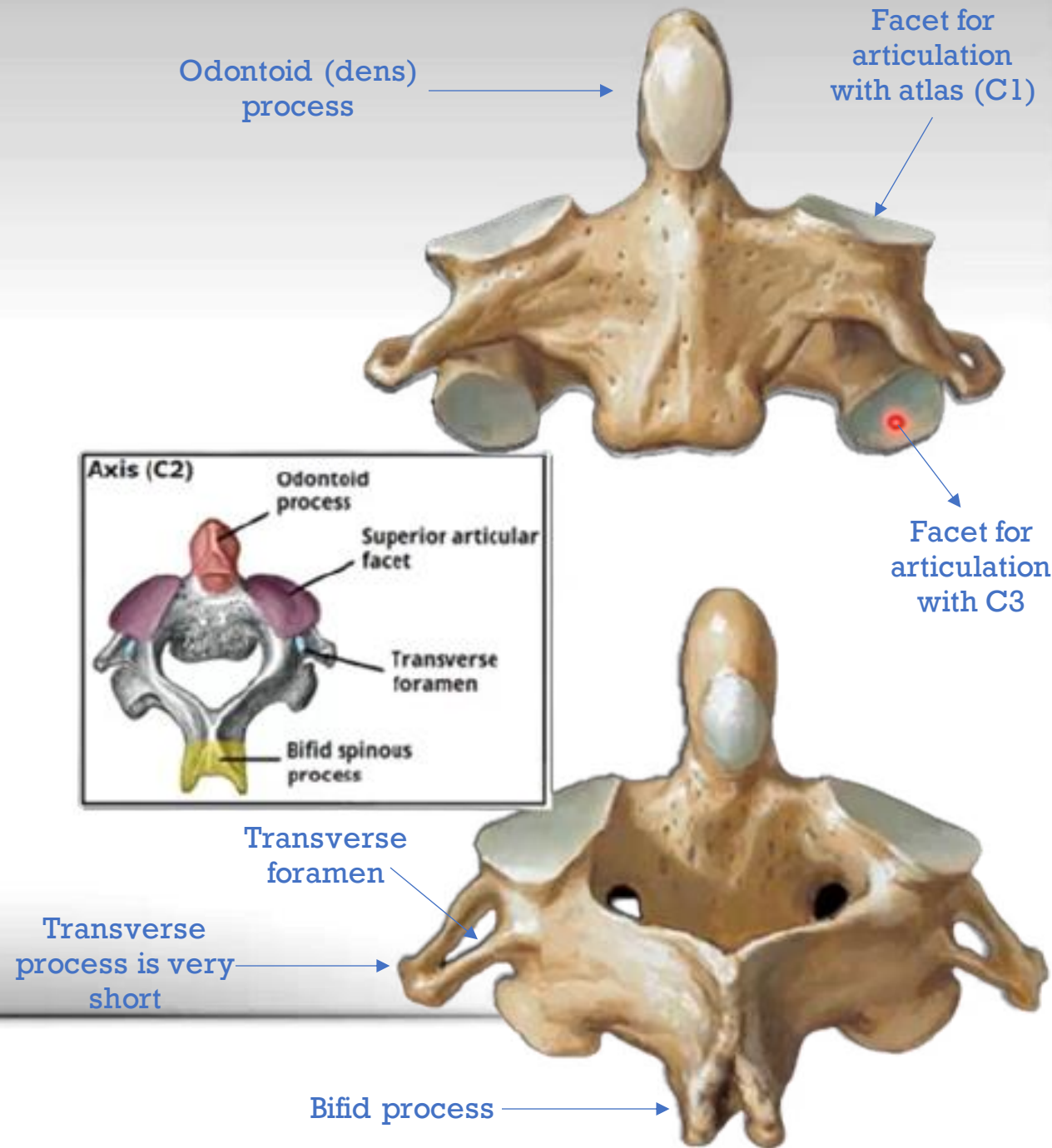
Axis (C2)

Has the smallest transverse process

Has dens (odontoid process) which extends superiorly from the anterior portion of the vertebra
(To articulate with C1)

The dens articulates with the anterior arch of the atlas, creating the **medial atlanto-axial joint**. This allows for rotation of the head independently of the torso.

Has **superior articular facets**, which articulate with the inferior articular facets of the atlas to form the two lateral atlanto-axial joints.

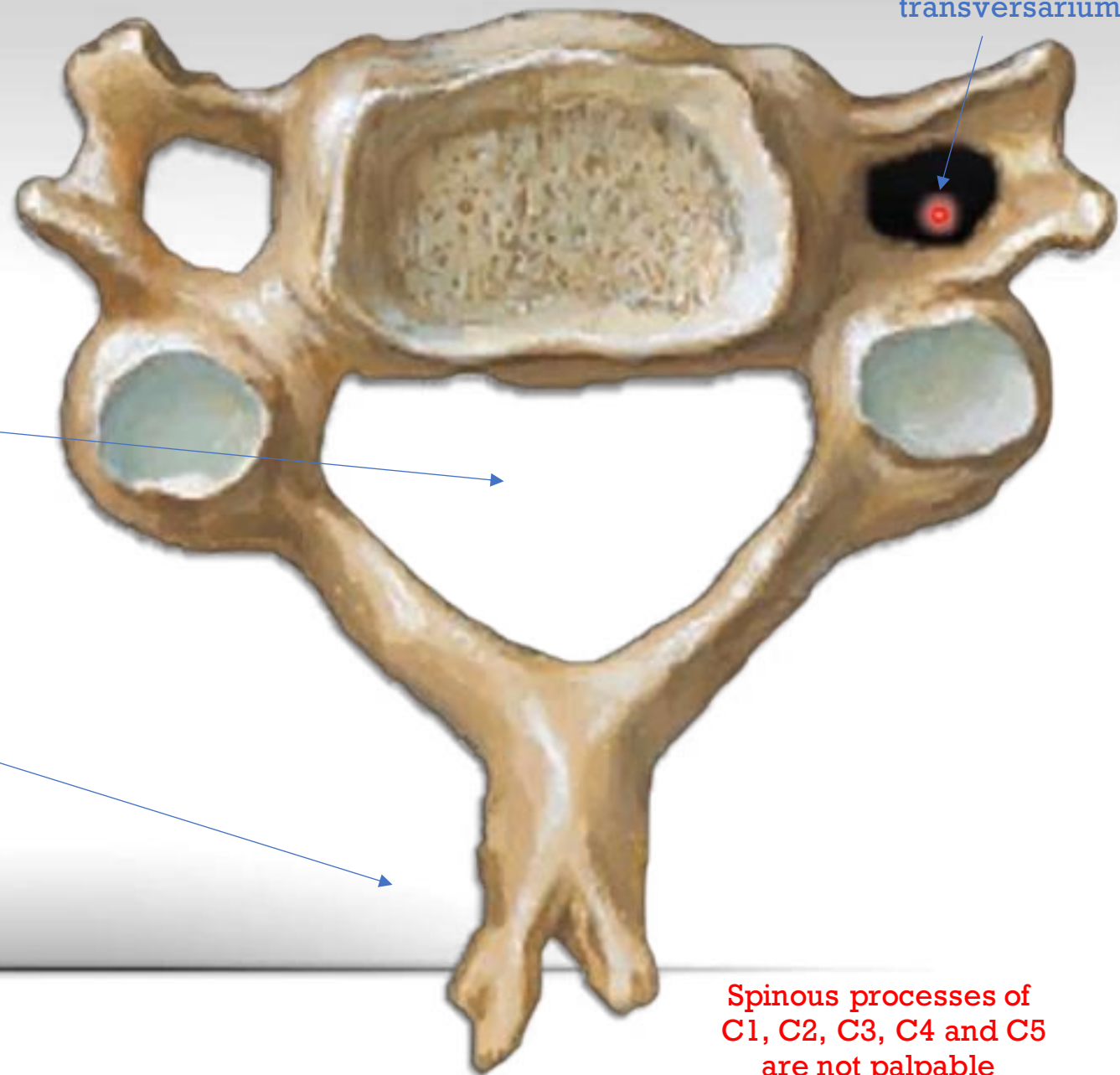


Typical Cervical Vertebra (C3-C6)

Triangular vertebral foramen.

Bifid spinous process

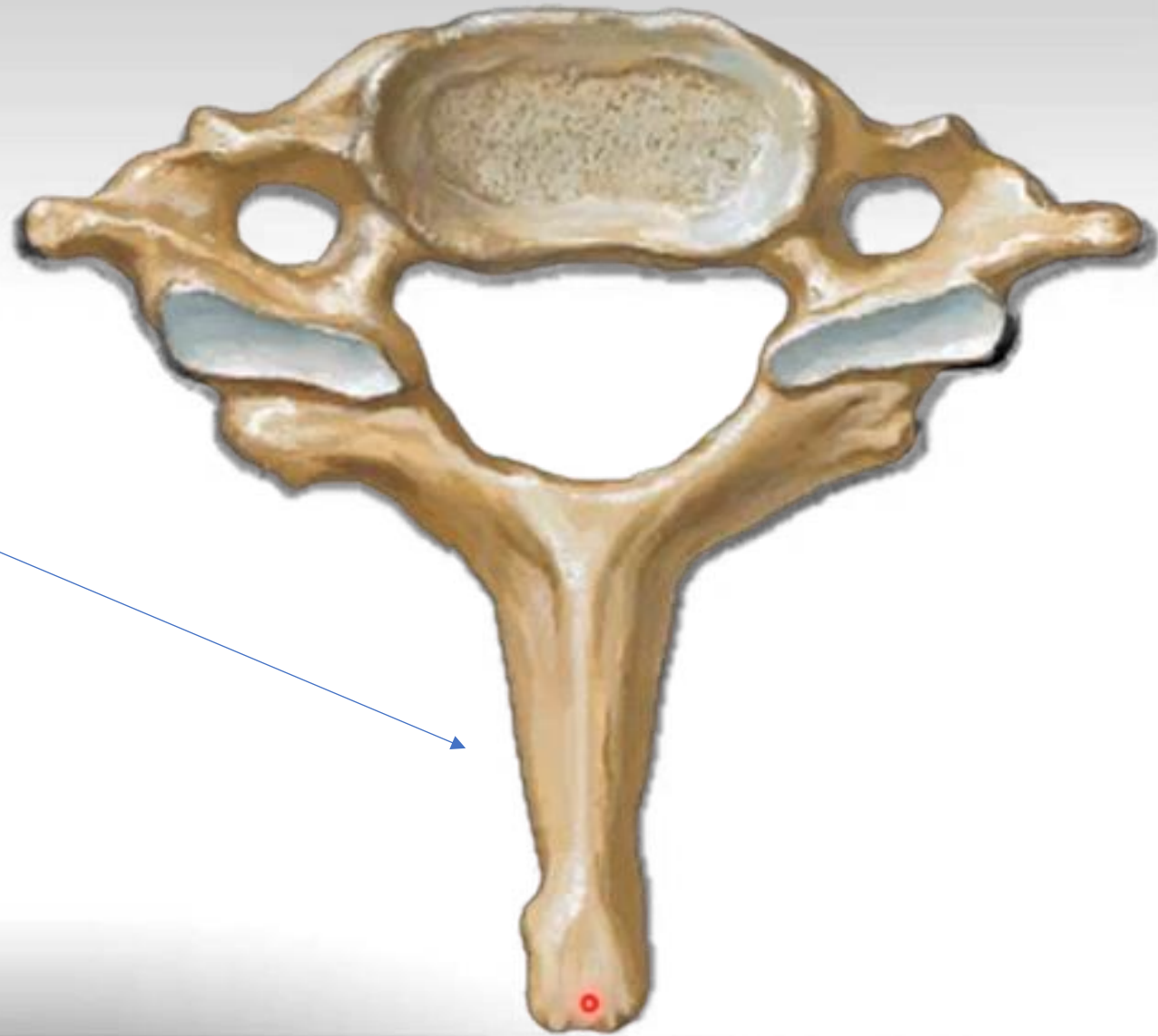
Transverse foramina – holes in the transverse processes. They give passage to the vertebral artery (Except C7), vein and sympathetic nerves.



Cervical Vertebra (C7)

Non bifid, thick spinous process, almost horizontal.

The vertebral artery does not pass through the transverse foramen



Thoracic
(Dorsal)
Vertebrae



General Features of Typical Thoracic Vertebrae (T2-T9)

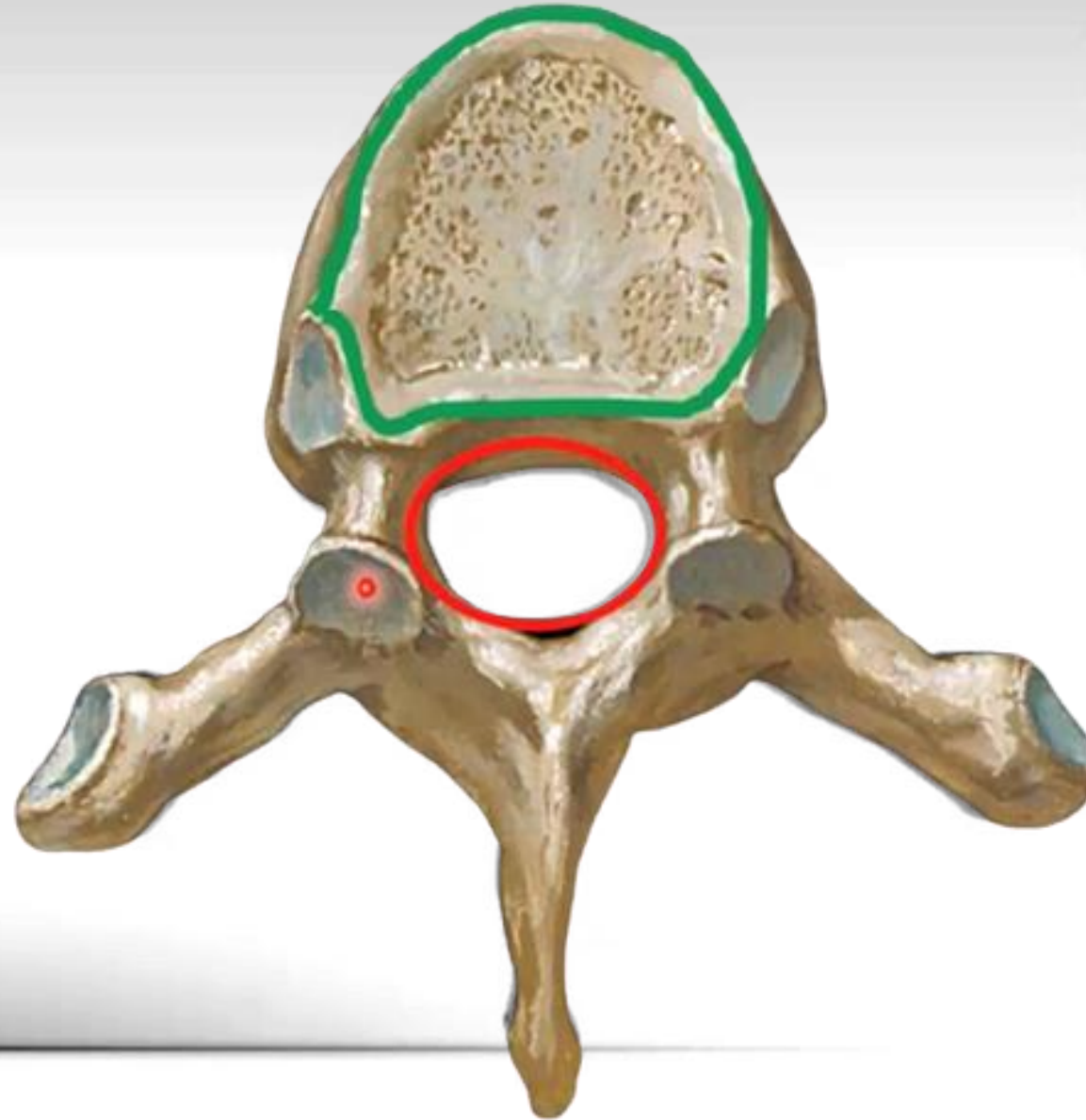
Body: Heart shaped; one or two costal facets for articulation with head of rib
Depending on the ribs attached to the vertebra (atypical vertebra)

Vertebral foramen: Circular and smaller than those of cervical and lumbar vertebrae

Transverse processes: Long and strong and extend posterolaterally; length diminishes from T1 to T12 **Gradually**

Articular processes: Superior facets directed posteriorly and slightly laterally; inferior facets directed anteriorly and slightly medially; plane of facets lies on arc centered around vertebral body

Spinous process: Long slope posteroinferiorly; tips extend to level of vertebral body below **They overlie each other**



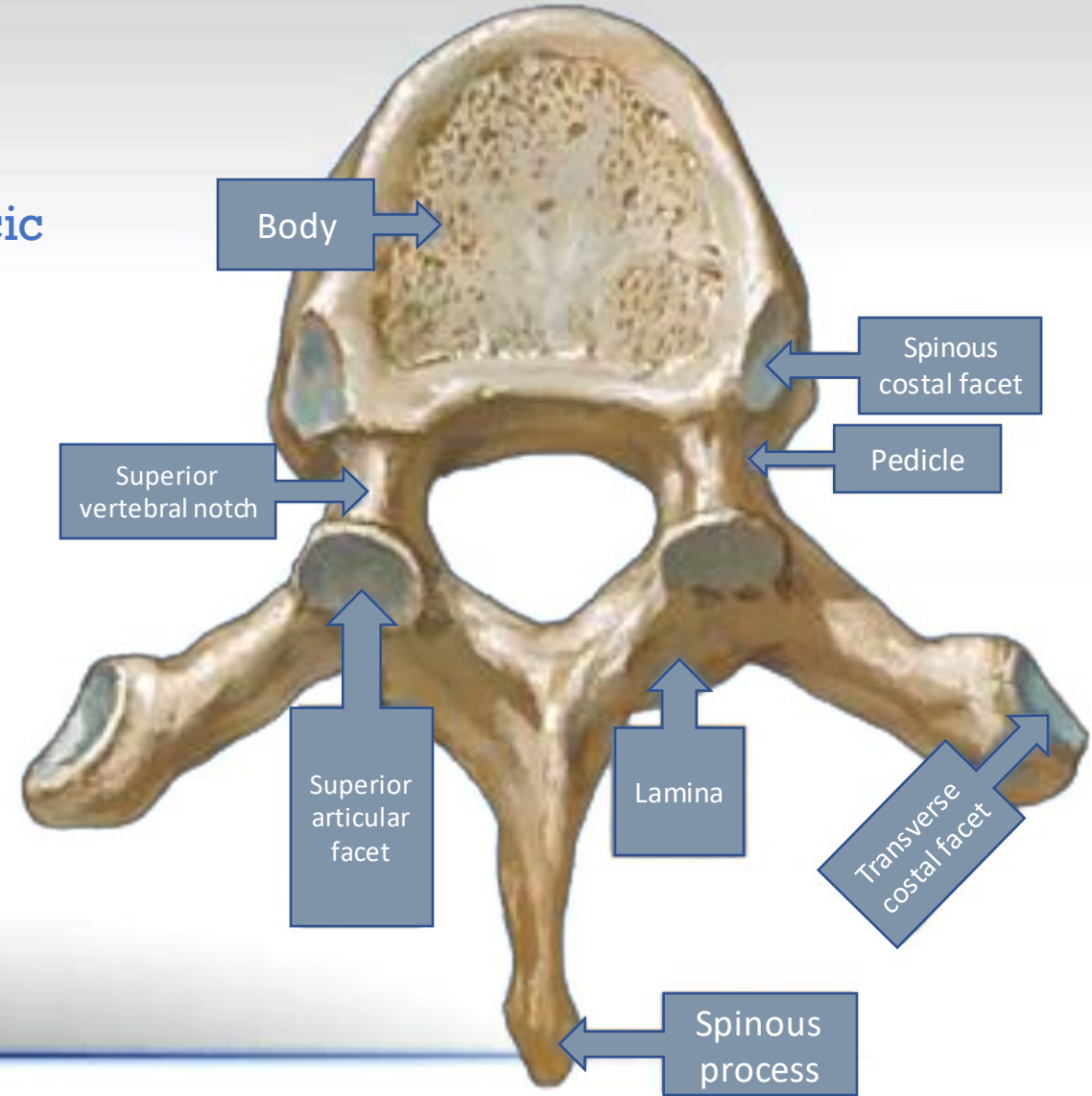
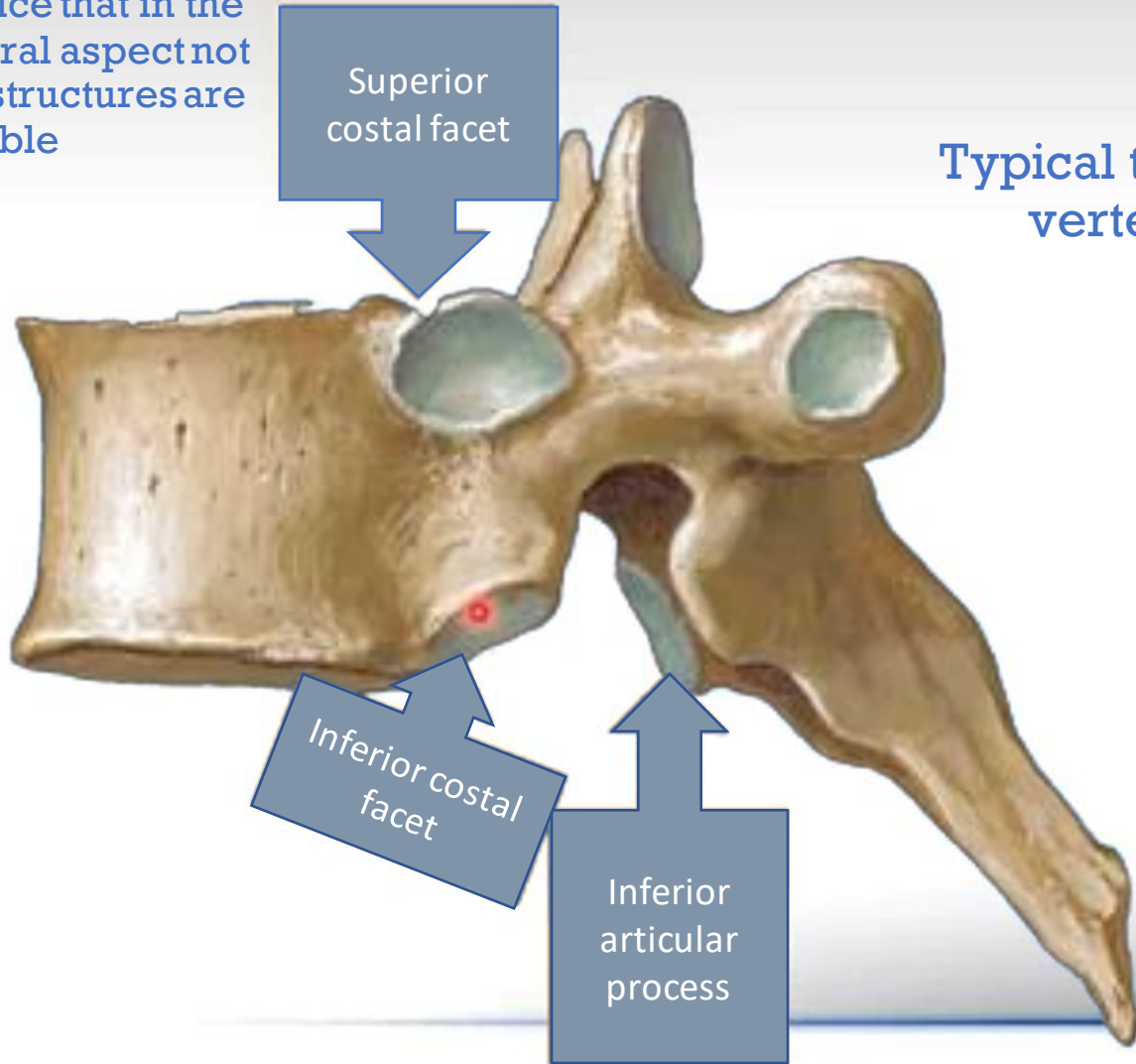
T6 Lateral view

or D6

T6 Superior view

Notice that in the lateral aspect not all structures are visible

Typical thoracic vertebra



Atypical Vertebrae

T1: the superior facet is not a demifacet, as it is the only vertebra to articulate with the first rib.

T10: A single pair of whole facets is present which articulate with the 10th rib. These facets are located across both the vertebral body and the pedicle.

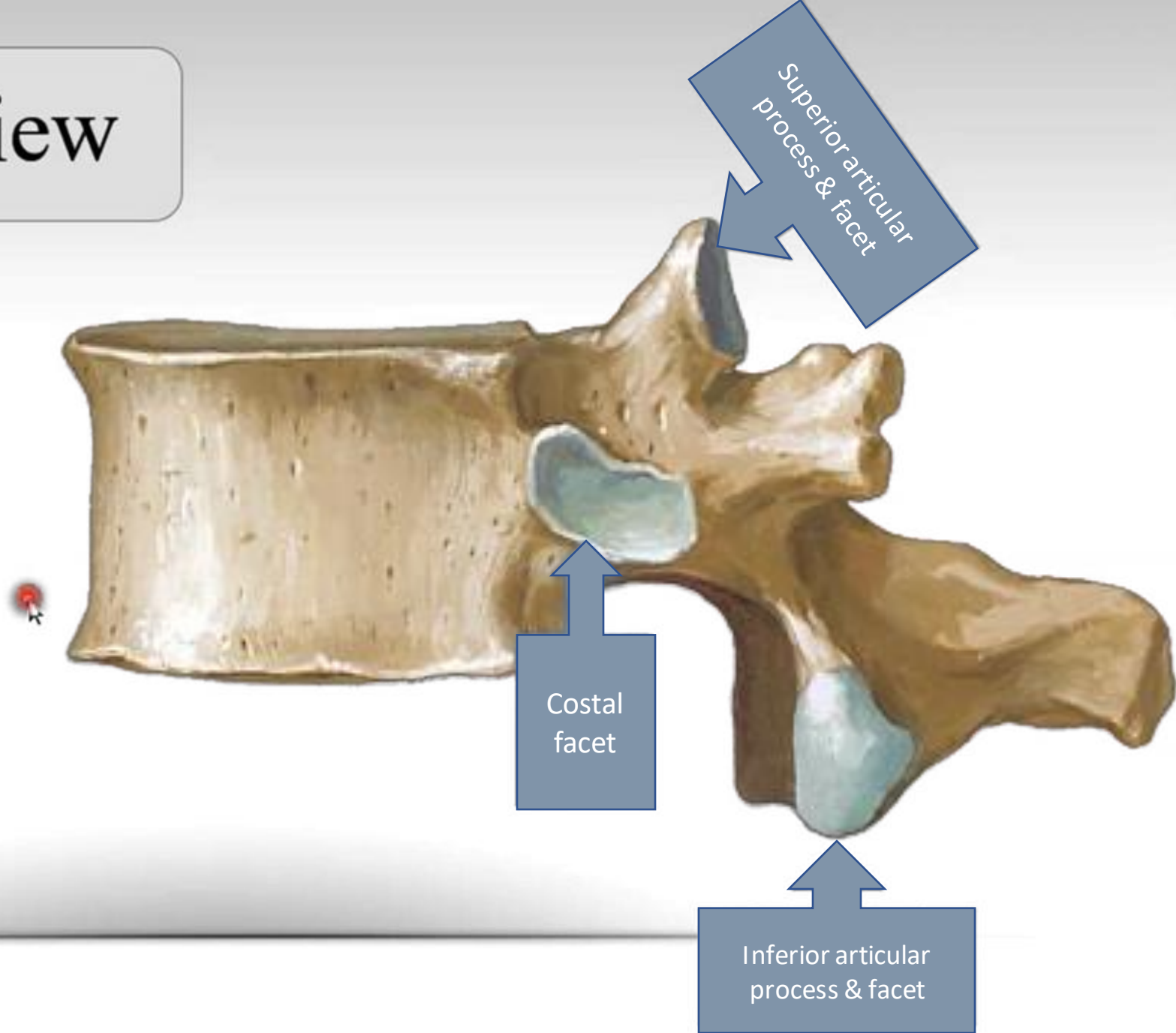
T11 & T12: Each have a single pair of entire costal facets, which are located on the pedicles.

Notes on the previous slide:

Demifacet means half facet and it articulates with part of the head

Usually one rib articulates with 2 vertebrae due to having a demifacet
except in the first , tenth , eleventh and twelfth ribs they articulate with one
vertebra due to having a full facet

T12 Lateral View





Lumbar
Vertebrae

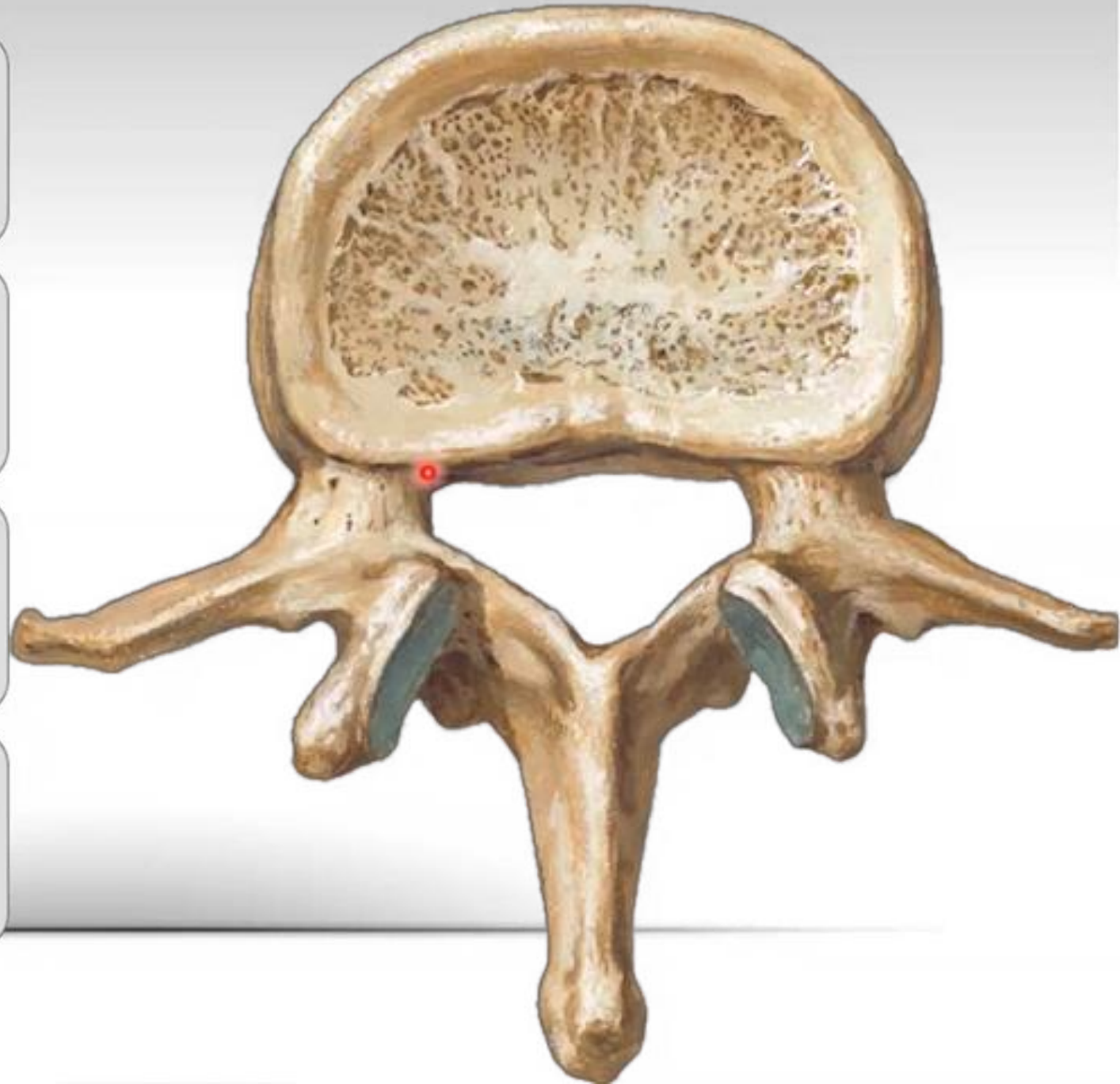
The size of the body increases from L1 to L5.

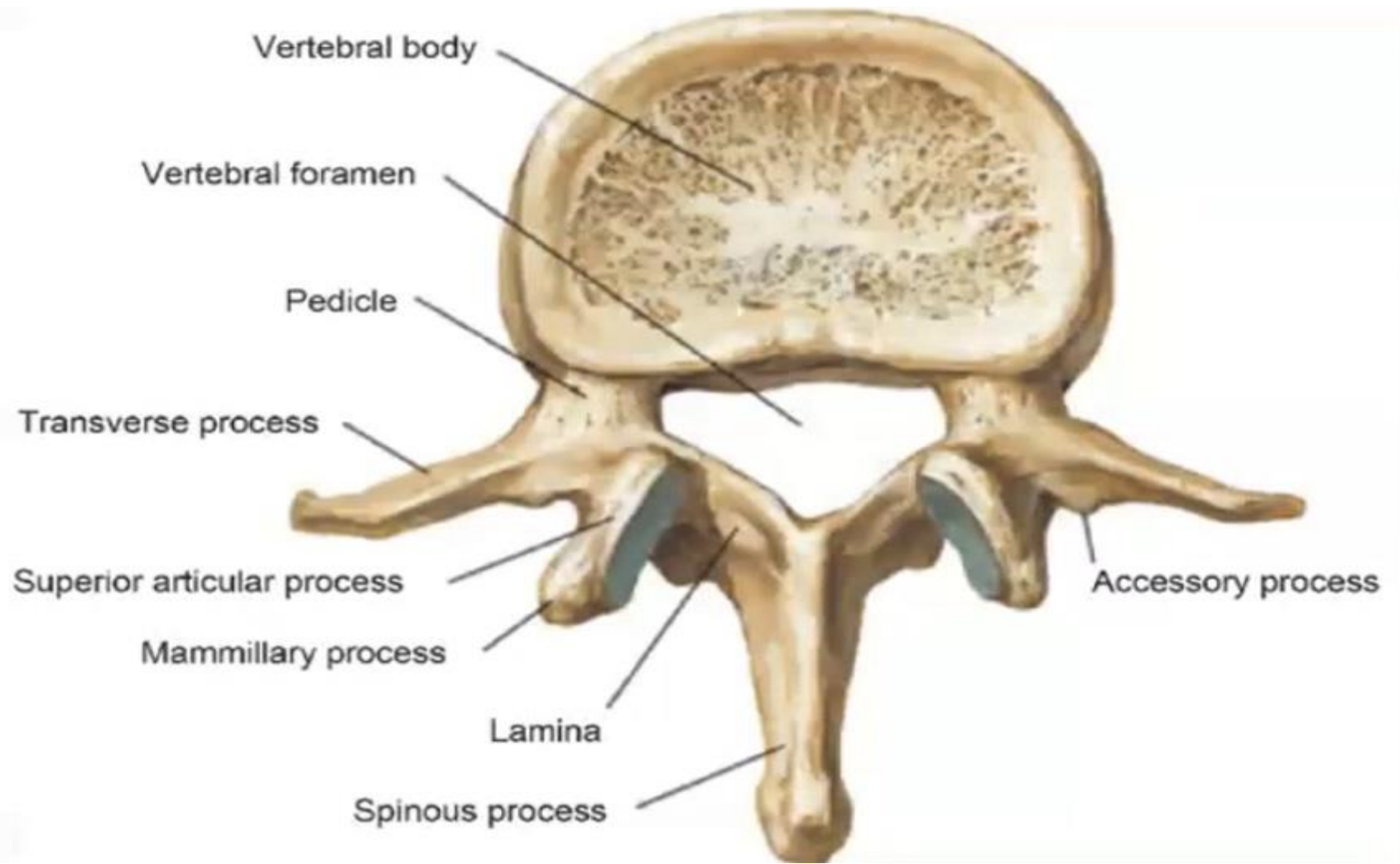
While the size of the transverse processes decrease

The vertebral foramen is flattened triangular.




The transverse processes are short with no facets.

L5 vertebra has the heaviest body, smallest spinous process, and thickest transverse process.

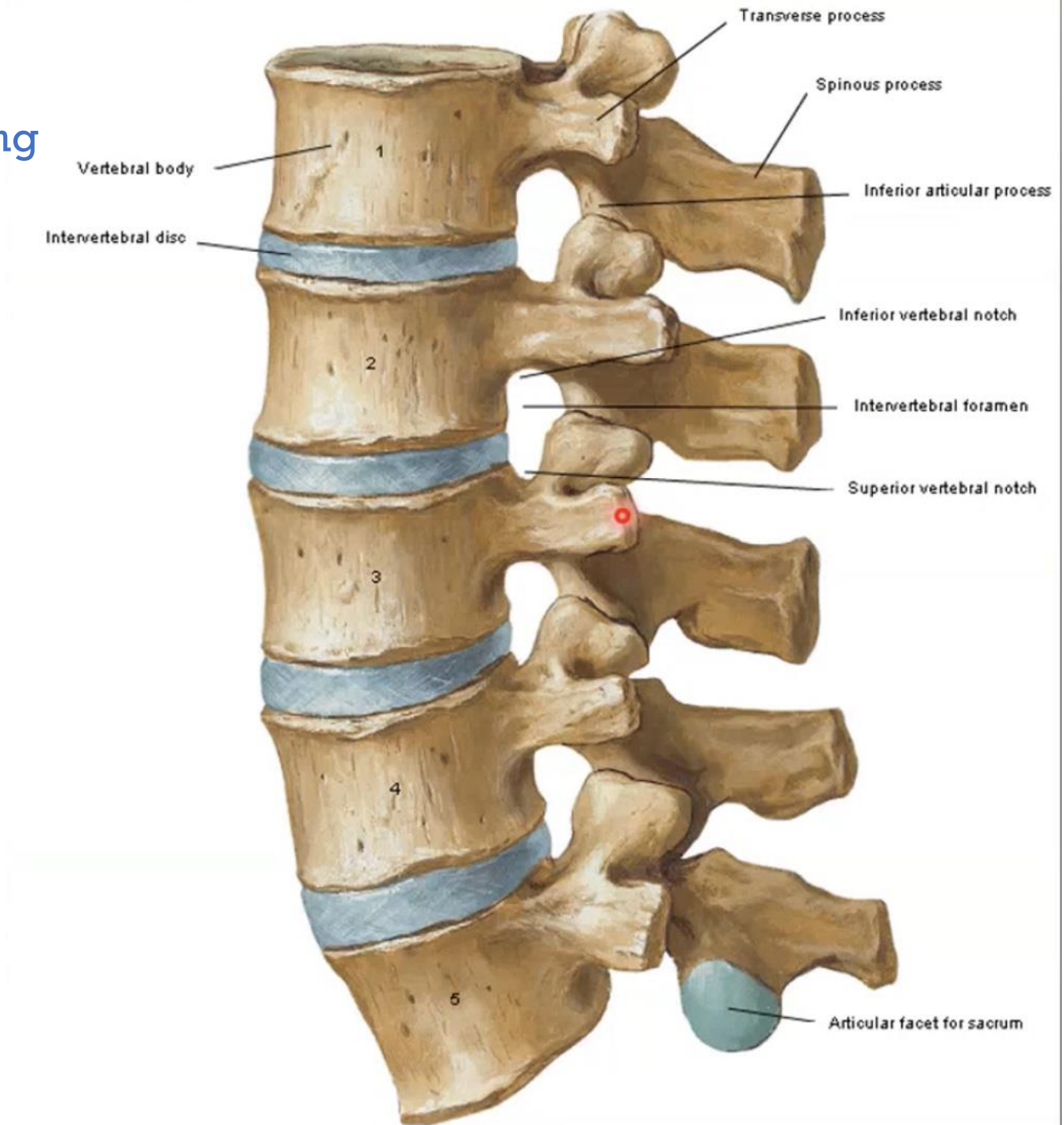




Comparison of Cervical, Thoracic, and Lumbar Vertebrae

Characteristic	Cervical vertebrae	Thoracic vertebrae	Lumbar vertebrae
Body shape and size	Small and oval; C ₁ lacks a body; C ₂ has the dens on the superior surface of its body	Larger and heart-shaped; contain costal facets	Largest and kidney-shaped
Vertebral foramen shape	Triangular	Circular	Flattened triangular
Transverse processes	Contain transverse foramina	Long; contain articular facets for ribs	Short with no facets or foramina
Spinous processes	Most are fork-shaped; C ₁ lacks a spinous process	Long; point inferiorly	Thick; point posteriorly
Appearance (superior view)			

Lumbar vertebrae articulating with each other

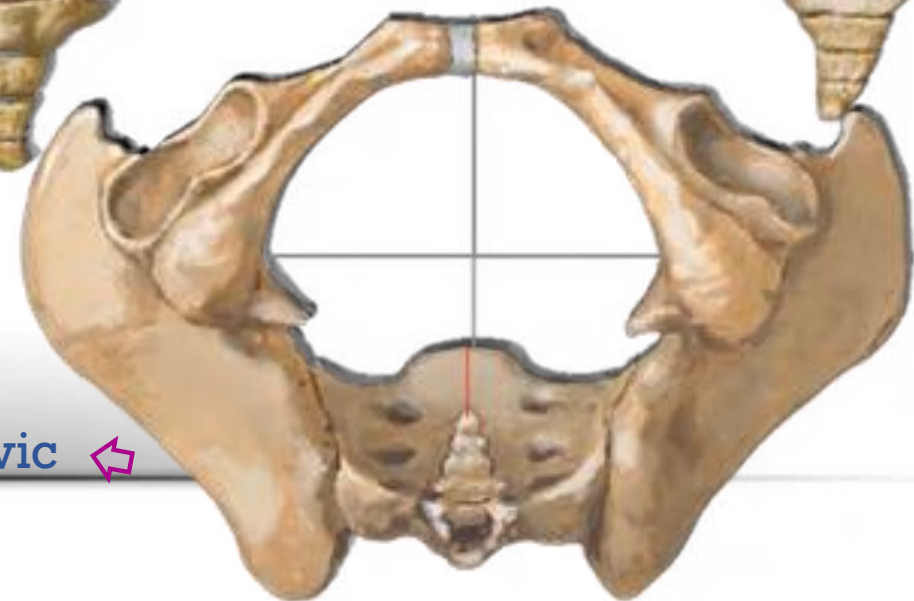
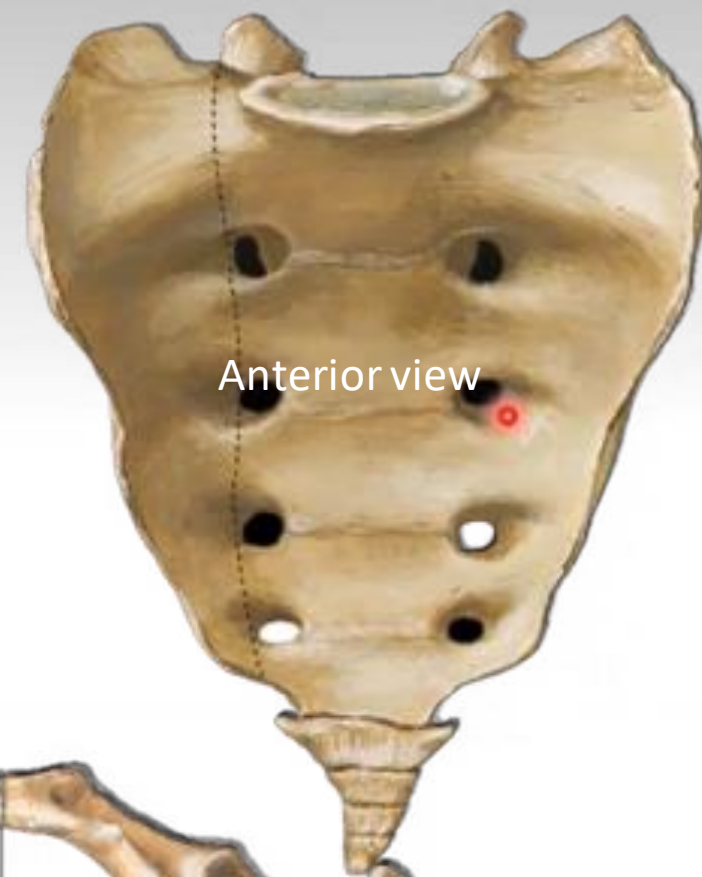


Sacrum

Large, triangular wedge-shaped composed of 5 fused segments (vertebrae).

Has 4 pairs of anterior and 4 pairs of posterior foramina.

Forms the posterior part of the pelvis and strengthen it.



Between two hip bones
(considered part of the pelvic
region most of the time)

Parts of the Sacrum

Why is it called median sacral crest?
To differentiate between the two types of crests in the posterior view

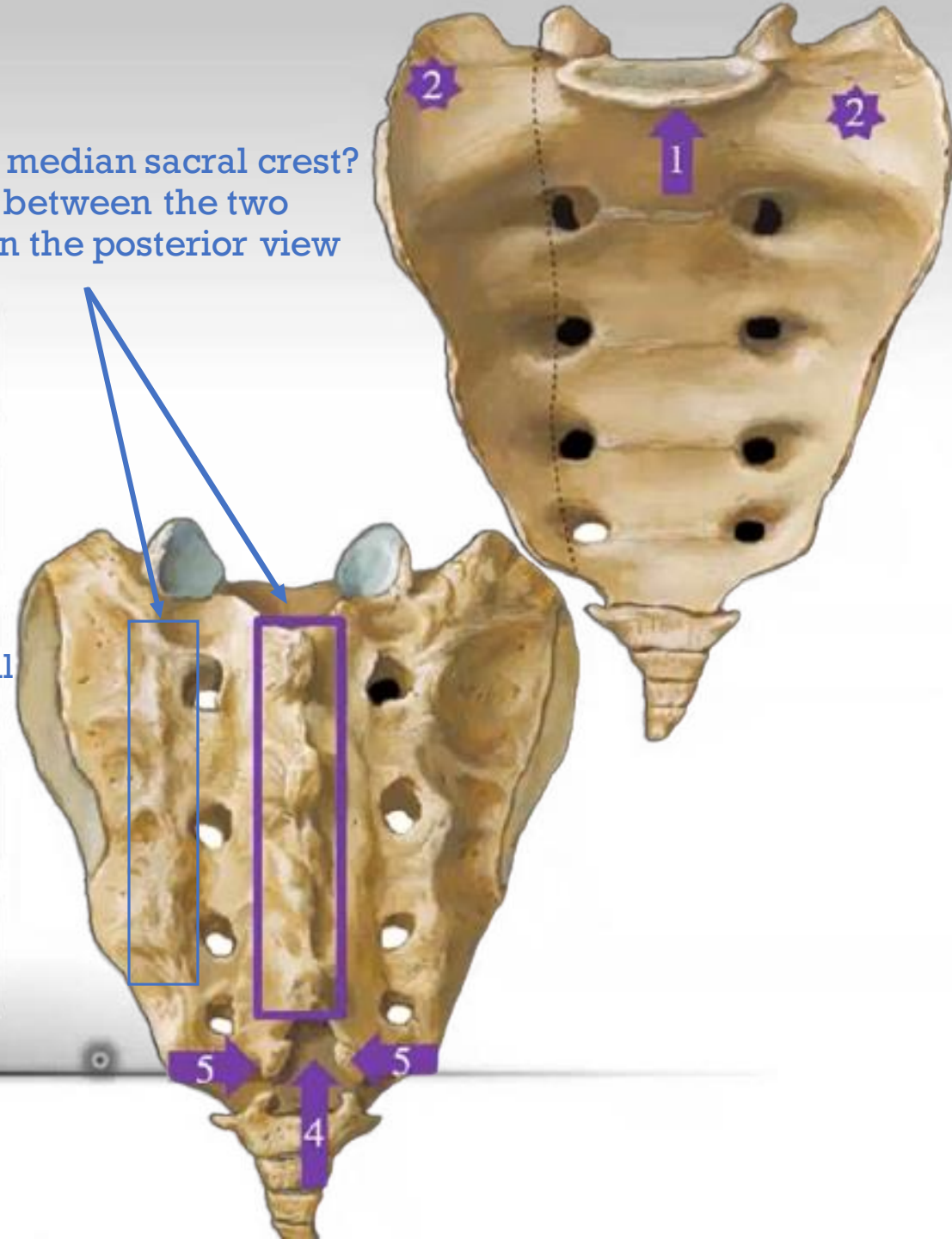
(1) Promontory: the prominent anterior edge of S1.

(2) Ala: fused transverse and costal processes of S1 (the superolateral part of the sacrum).

(3) Median sacral crest: fused spinous processes of all sacral vertebrae
(Palpable)

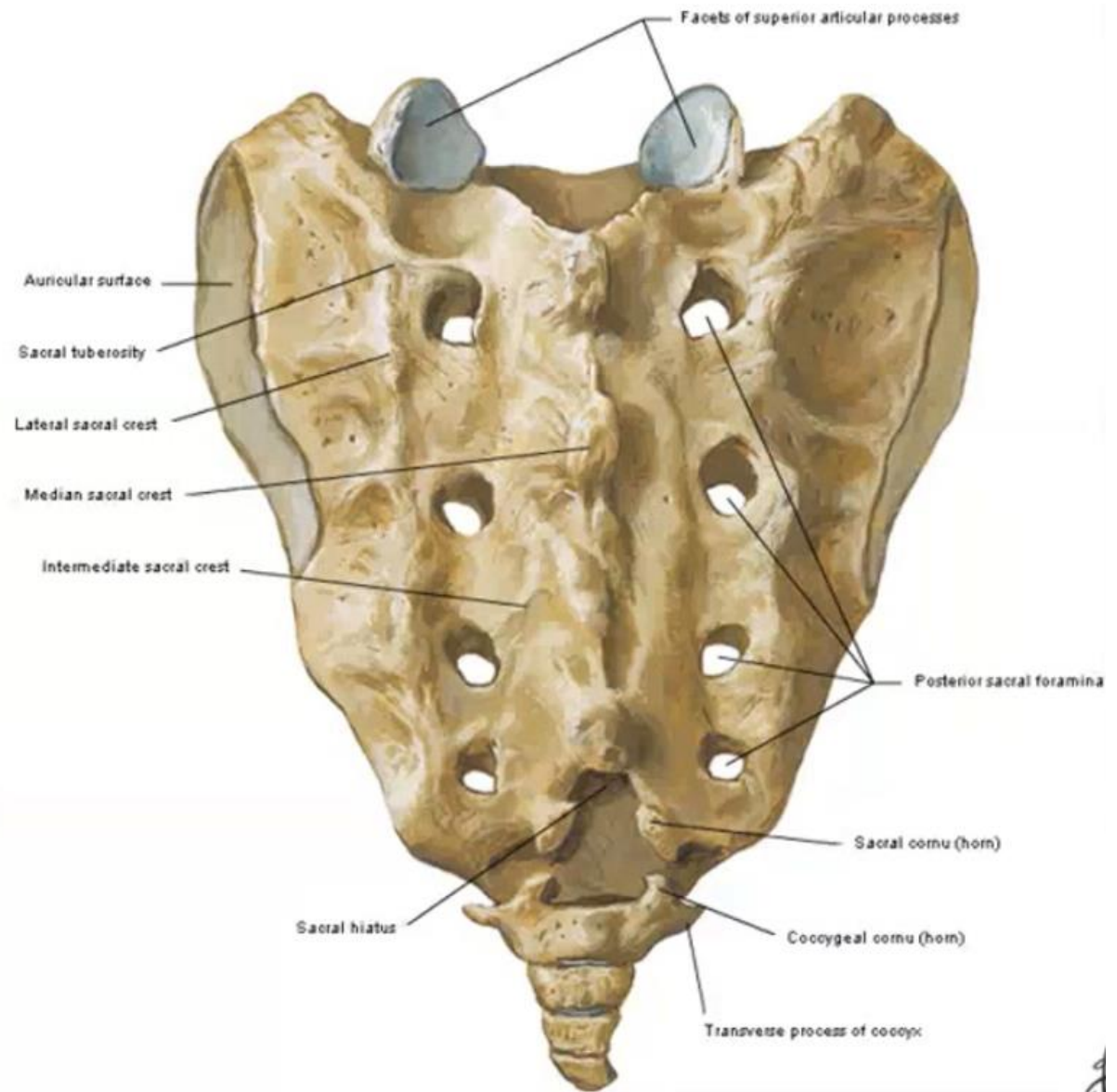
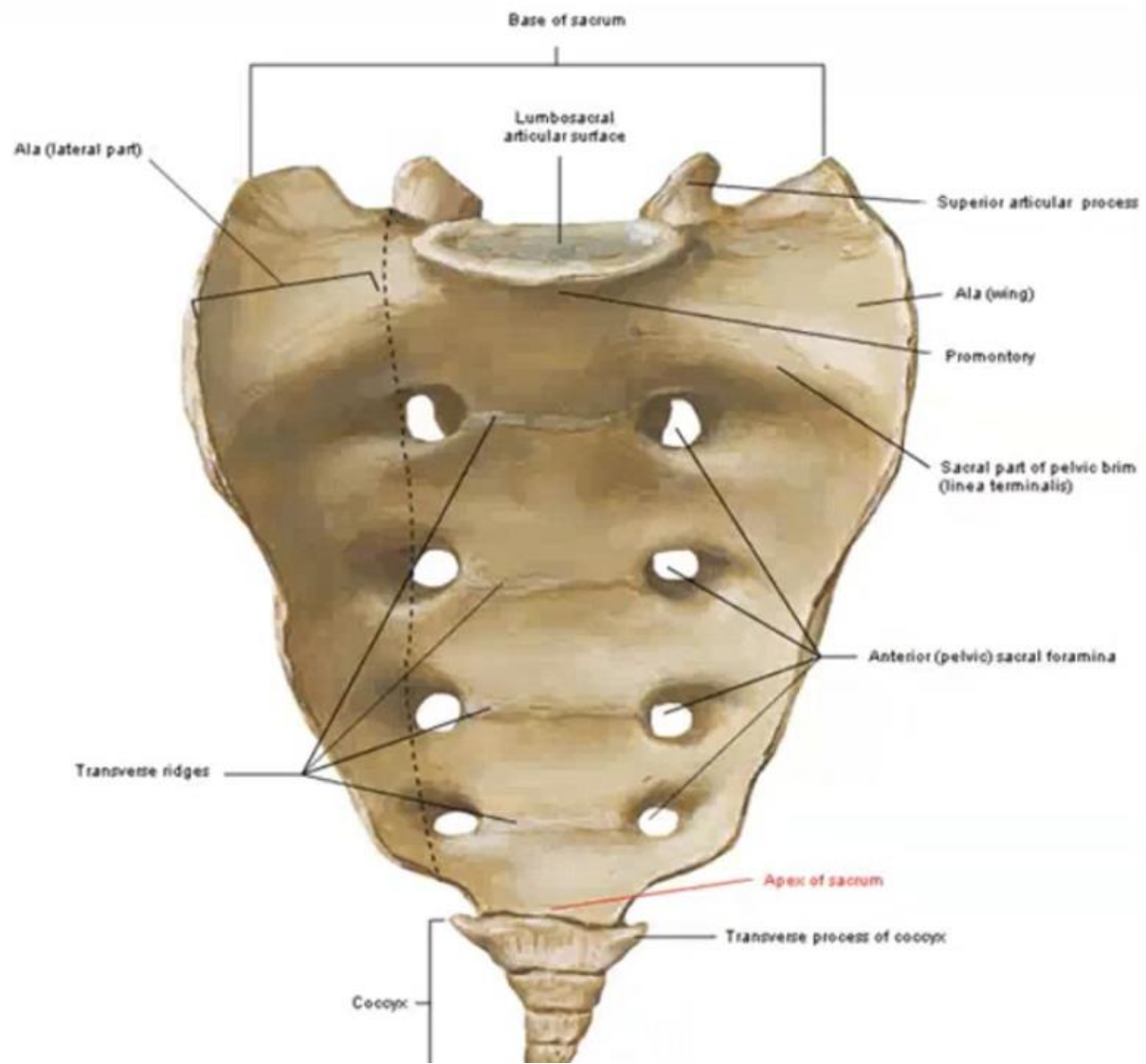
(4) Sacral hiatus: formed by fusion of the lamina of S5.

(5) Sacral cornu: Pedicles of S5.



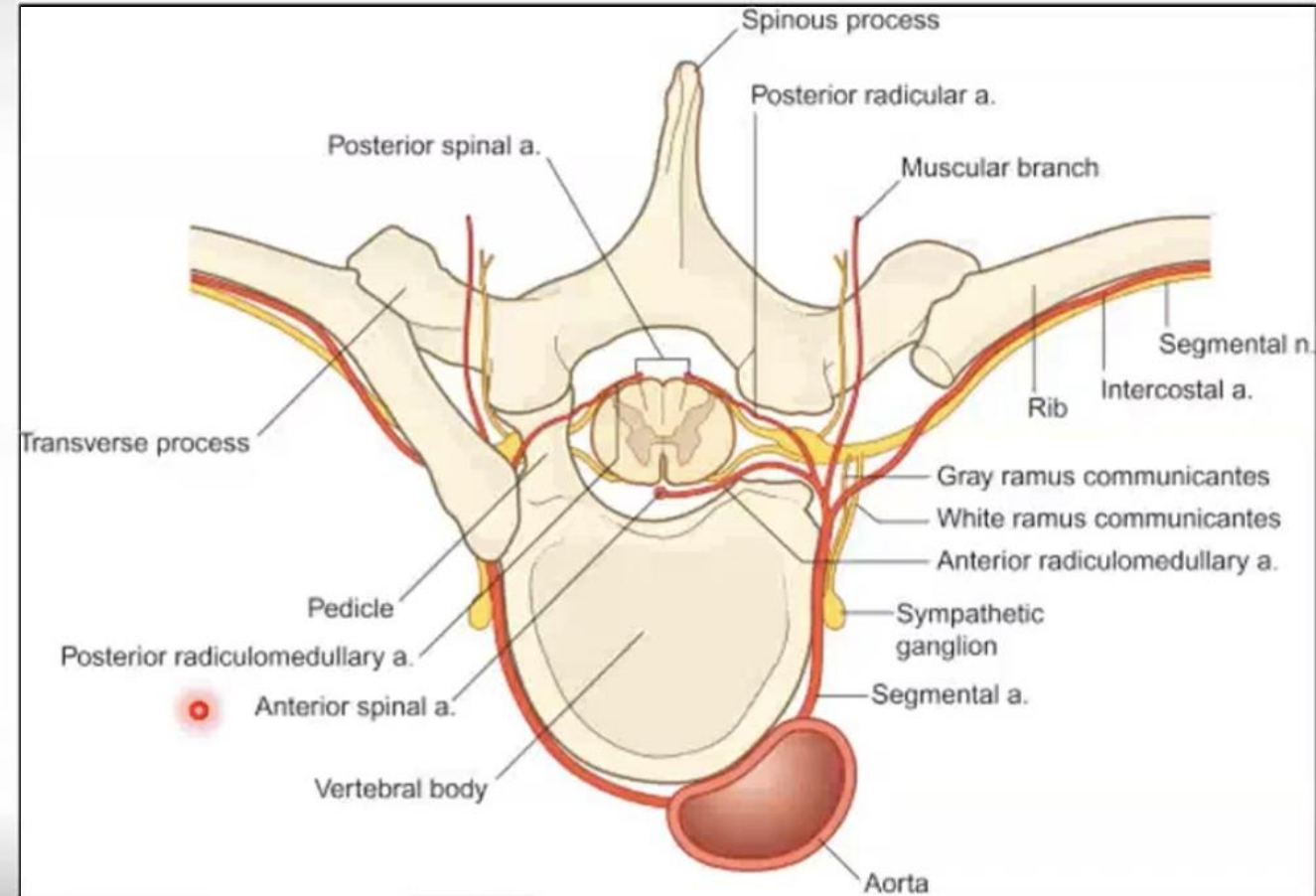
Notes:

- 1) The sacral hiatus is important for extradural anesthesia.
- 2) For spinal analgesia we determine the level of L4 then we level up by one vertebra and give the analgesic
- 3) Why do we need to give the analgesic in that specific place?
Because the spinal cord is terminated at the lower boarder of L1 in adults and to avoid harming the spinal cord we pick an area lower than L1
- 4) Why L4 precisely?
Because we can palpate L4 easily (it is at the level of iliac crest)
- 5) We use the spinal analgesia for pelvis and lower limbs operations (blockage of spinal nerves)



Arteries of the vertebral column

The vertebrae are supplied segmentally by the vertebral, ascending and deep cervical, posterior intercostal, lumbar and lateral sacral arteries, which give multiple small branches to the vertebral bodies.



Veins of the vertebral column

Communicate with each other via branches

The richly supplied red marrow of the vertebral body drains through its posterior surface by a pair of large basivertebral veins into **the internal vertebral venous plexus**, which lies inside the vertebral canal, outside the dura. It drains into **the external vertebral venous plexus**.

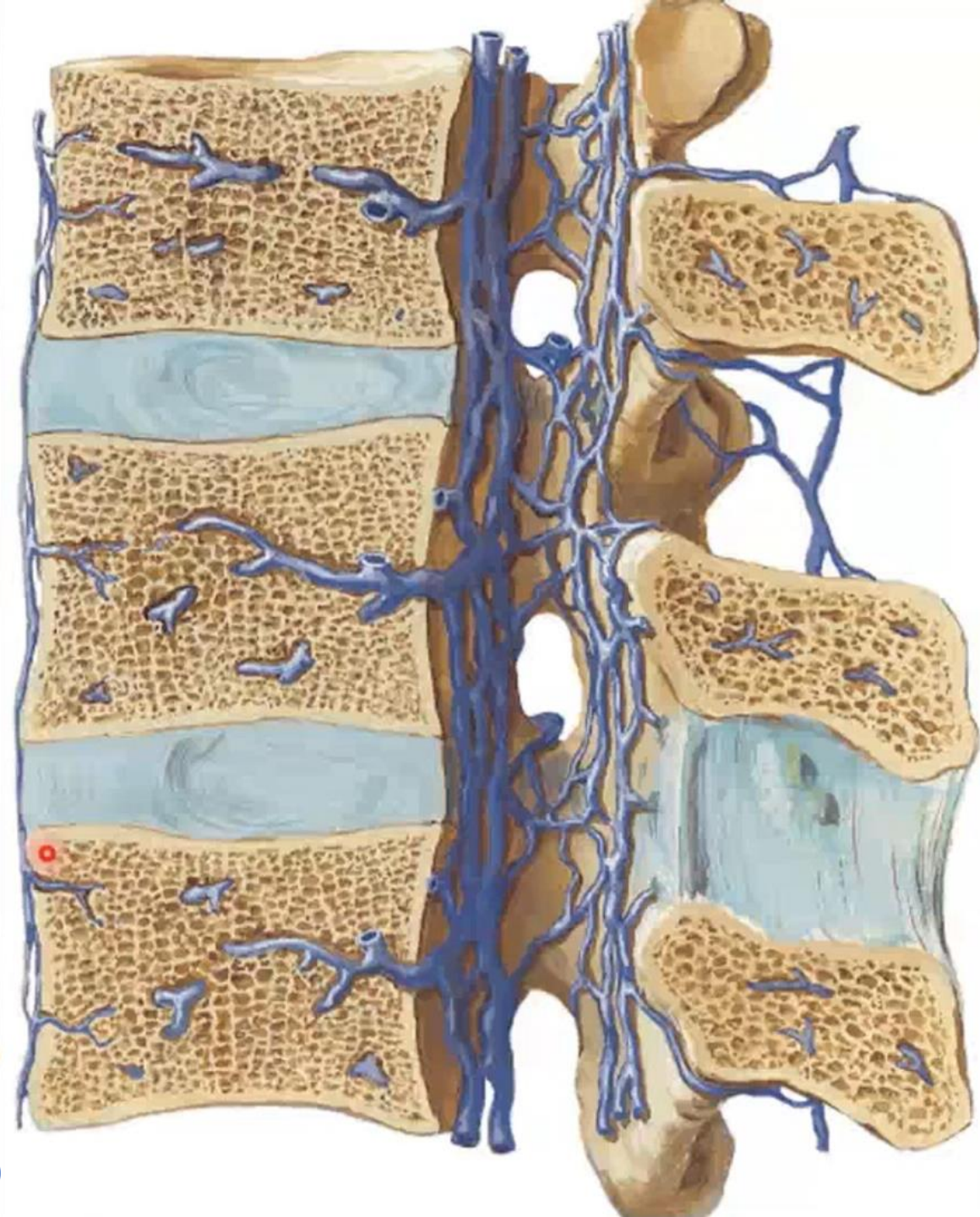
This intramuscular plexus, which also receives blood from the neural arch, drains into the regional segmental veins (vertebral, posterior intercostal, lumbar and lateral sacral veins), which in turn drain into brachiocephalic veins, superior vena cava, inferior vena cava and internal iliac veins.

Venous communication is thus established in the pelvis with veins draining the pelvic viscera, in the abdomen with the renal veins, in the thorax with the azygos venous system, and in the neck with the inferior thyroid veins.

In this way, by reflux blood flow through these largely valveless veins, malignant disease may spread from prostate, kidney, breast, bronchus and thyroid gland to the bodies of the vertebrae.

Because these venous plexuses communicate with different sites in the body, they can be a route for the spread of diseases

Site of metastasis to several tumors (which means advanced stages of the tumor)



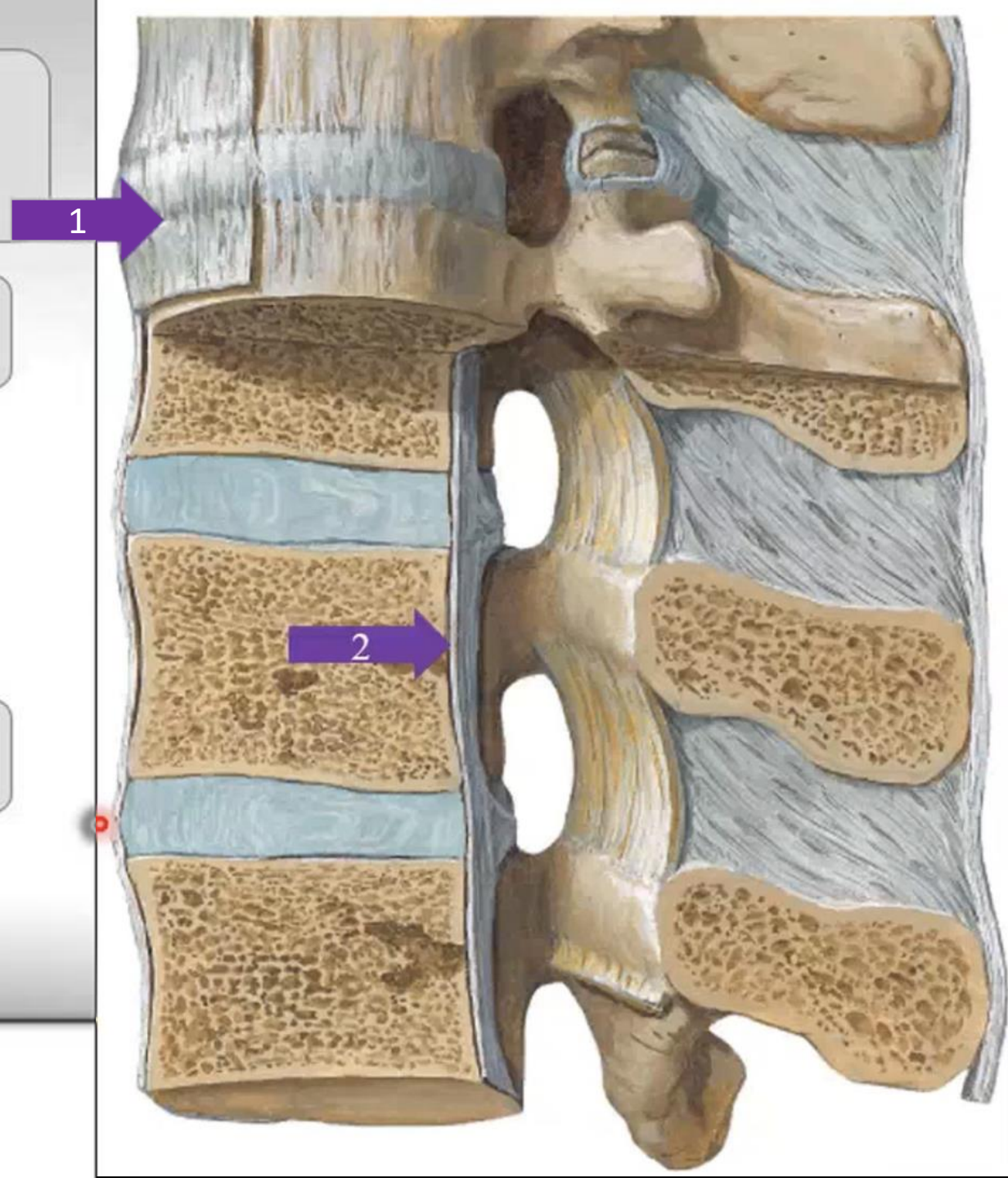
Ligaments of the vertebral column ..1/3

Anterior longitudinal ligament (1):

- Strong and broad
- Attached to the anterior surfaces of vertebral bodies and intervertebral discs.
- Extends from the sacrum to the anterior tubercle of atlas.
- Continues as atlanto-occipital membrane.

Posterior longitudinal ligament (2):

- Located inside the vertebral canal
- Attached to the posterior surfaces of IVD and adjacent vertebral bodies.
- Continues in the foramen magnum as membrana tectoria

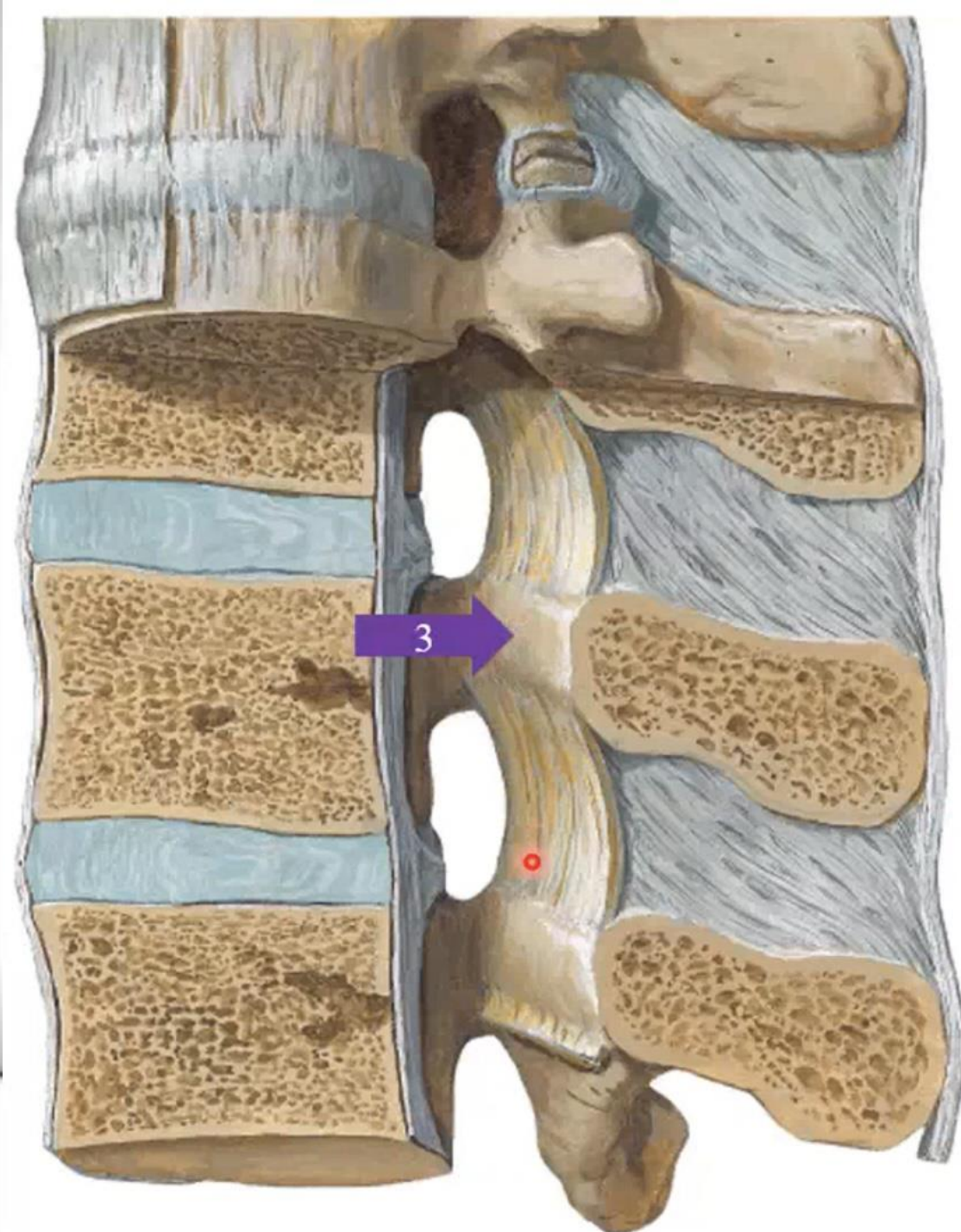


Ligaments of the vertebral column ..2/3

Ligamentum flavum in the cervical region has the highest amount of elastic fibers to compensate with its movement

Ligamentum flavum (3):

- Yellow in color due to high content of elastic fibres.
- Connects adjacent lamina
- Restores the vertebral column to erect posture after flexion
- Attached to the posterior arch of the atlas.
- Continues as the *posterior atlanto-occipital membrane*.



Notes:

*Remember that elastic connective tissue is always called yellow connective tissue while fibrous connective tissue is always called white connective tissue

We can call the Atlanto-occipital membrane of the anterior longitudinal ligament : anterior Atlanto-occipital membrane to differentiate between the two membranes (posterior Atlanto-occipital membrane)

* If the question only mentioned (Atlanto-occipital membrane) it means the anterior membrane

Ligaments of the vertebral column ..3/3

Interspinous ligaments (4):

- Connect adjacent spines

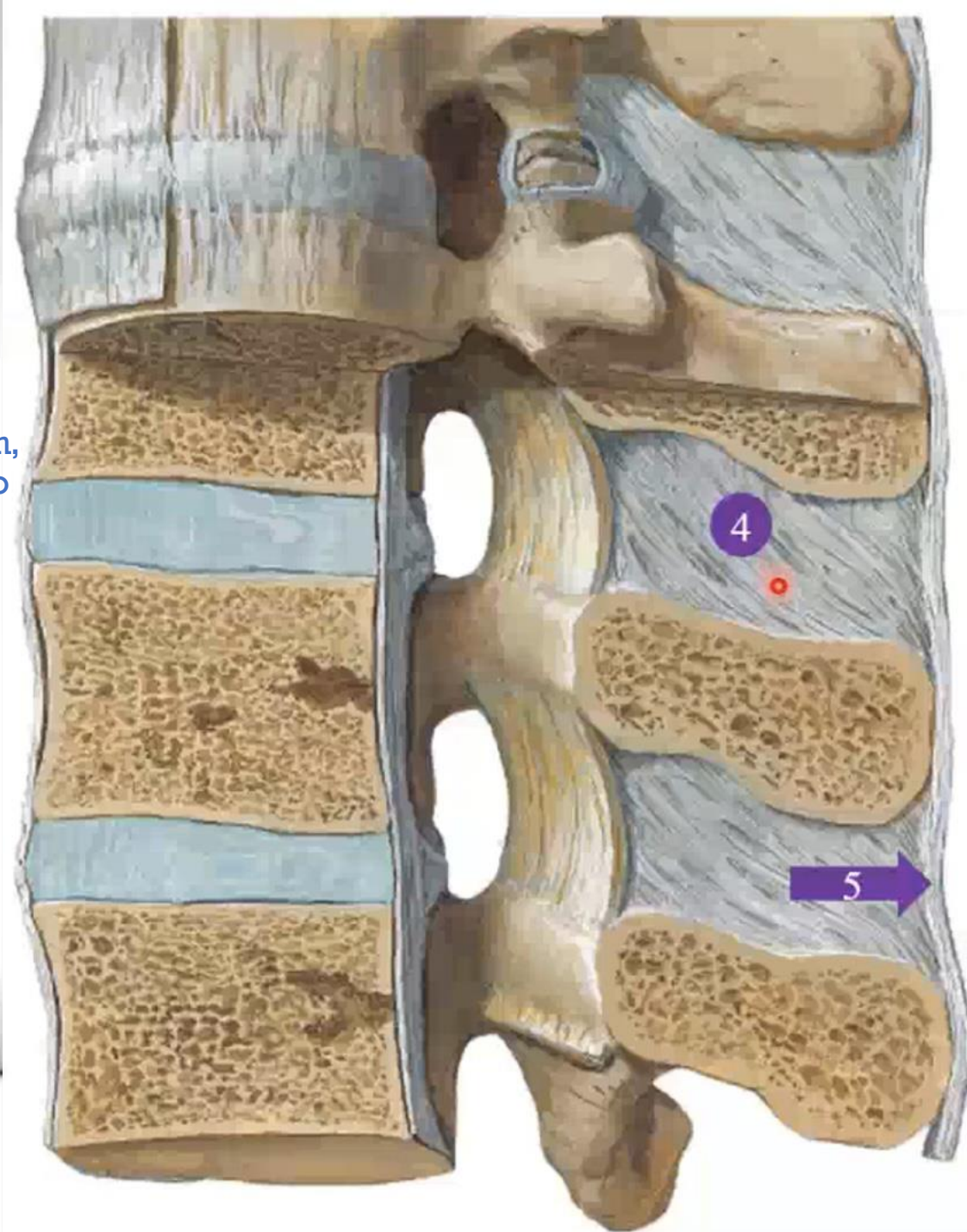
Supraspinous ligaments (5):

- Connects the tips of adjacent spines

Ligamentum Nuchae:

- Thickened inter and supraspinous ligaments in the cervical region.

In the cervical region, they are thickened to give attachment to certain muscles (trapezius) and become the ligamentum nuchae



1) Peripheral aspect
anulus: circular in shape
Fibrosus: contains collagen Type I
Doesn't contain perichondrium

Intervertebral Disc (IVD)

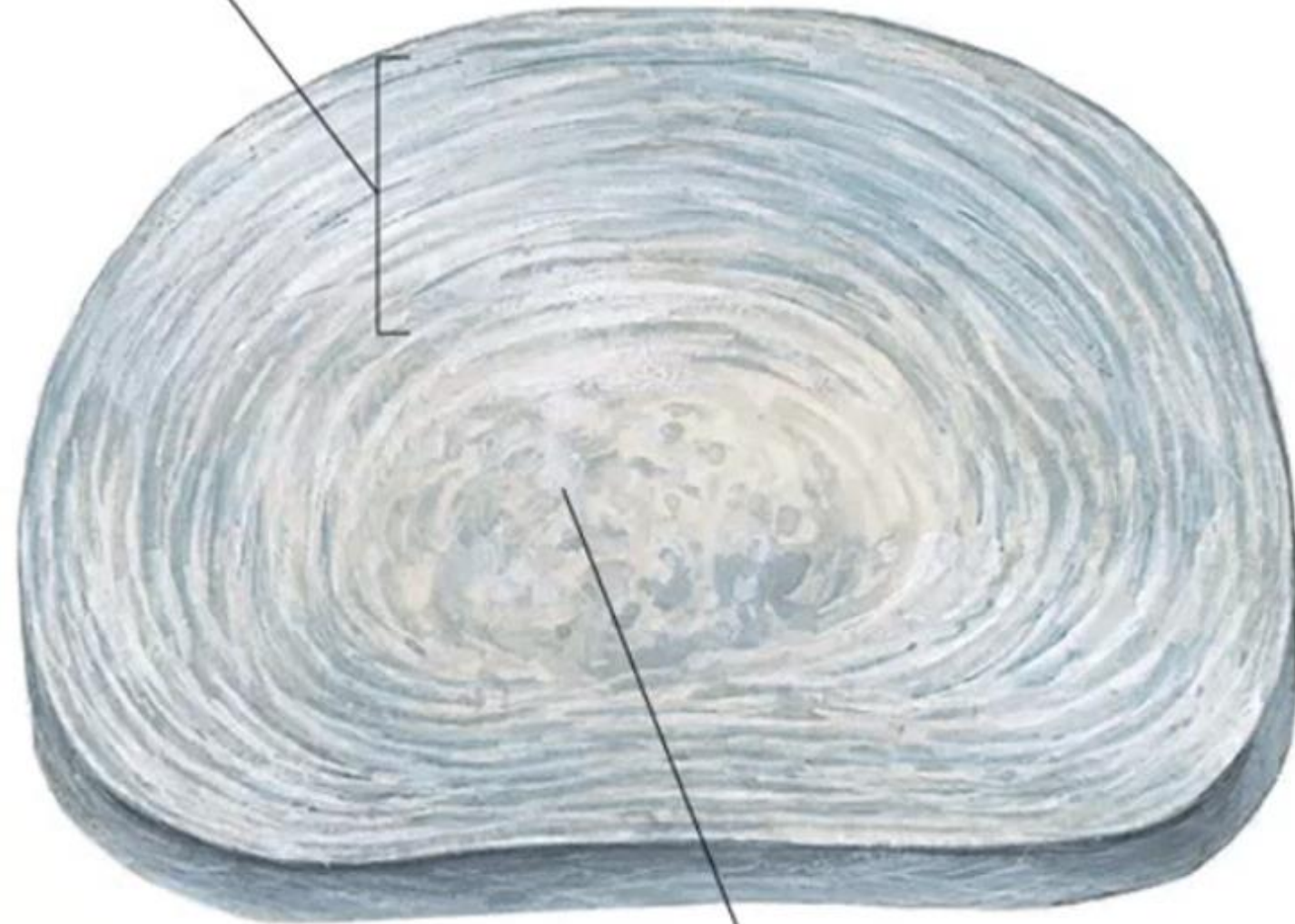
3) The nucleus pulposus Disseminates
(spreads) the pressure along the whole
vertebral body

4) Disc prolapse: when there is a tear
in the anulus fibrosus causing the
nucleus to herniate and compress the
spinal nerves

5) Common sites for disc herniation are
L4-L5 / L3-L4 + cervical region
But that doesn't mean it can't happen
elsewhere

6) When it (disc herniation) happens in the
cervical region the patient can feel pain in
that area + in his Upper limbs .
While a pain can be felt in the lower limbs
if it took place in the lumbar region

Anulus fibrosus



2) Jelly like
substance

Nucleus pulposus