ANATOMY AND PHYSIOLOGY (C.I.)

HUMAN ANATOMY
(Mod. A)

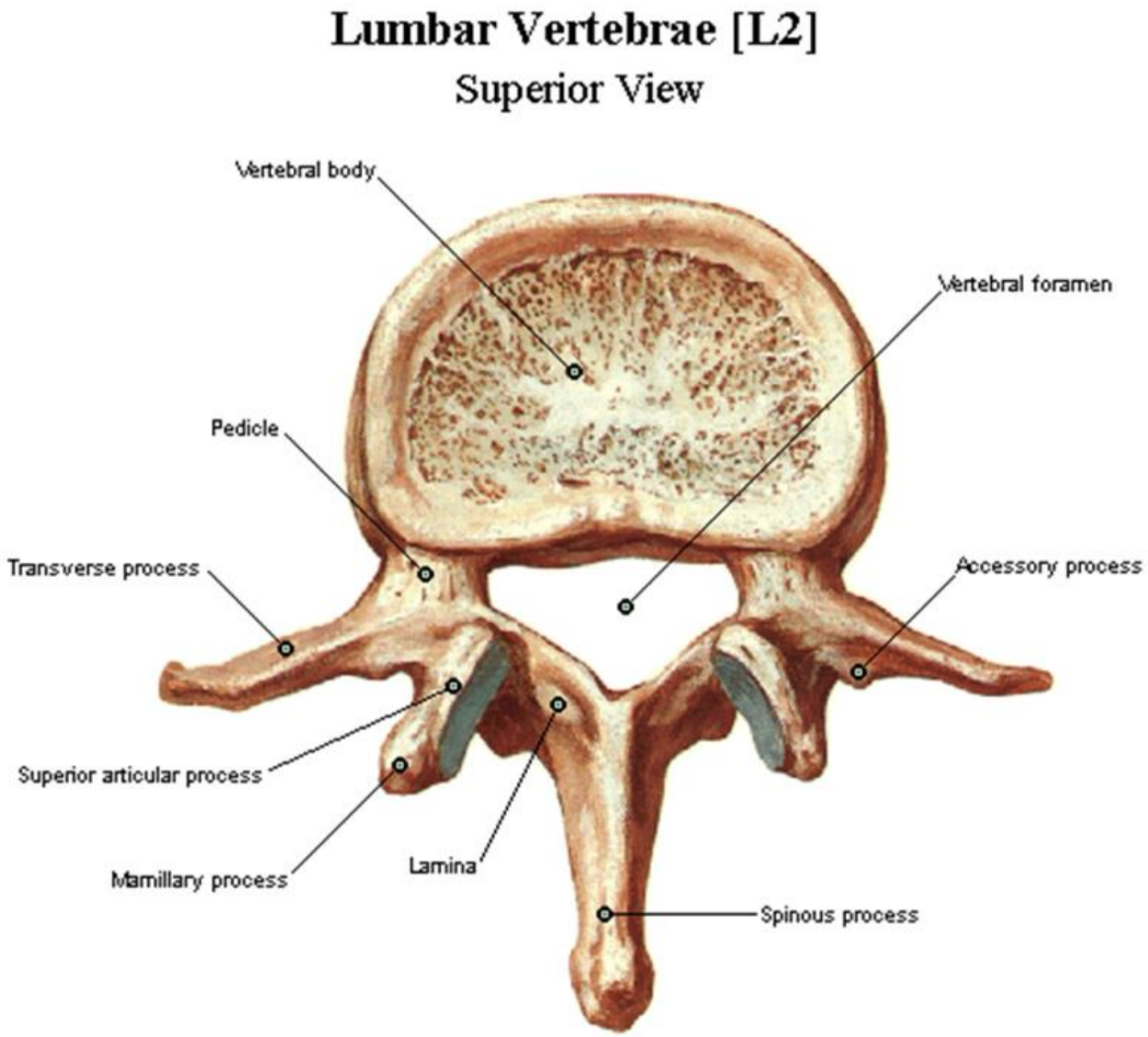
THE SKELETON

AXIAL SKELETON – The vertebral column

LUMBAR VERTEBRAE

THE VERTEBRAL COLUMN - Lumbar vertebrae

The lumbar vertebra is the simplest one and shows structures that can be found in all the other vertebrae it can be described first because its structure is that of a typical vertebra.

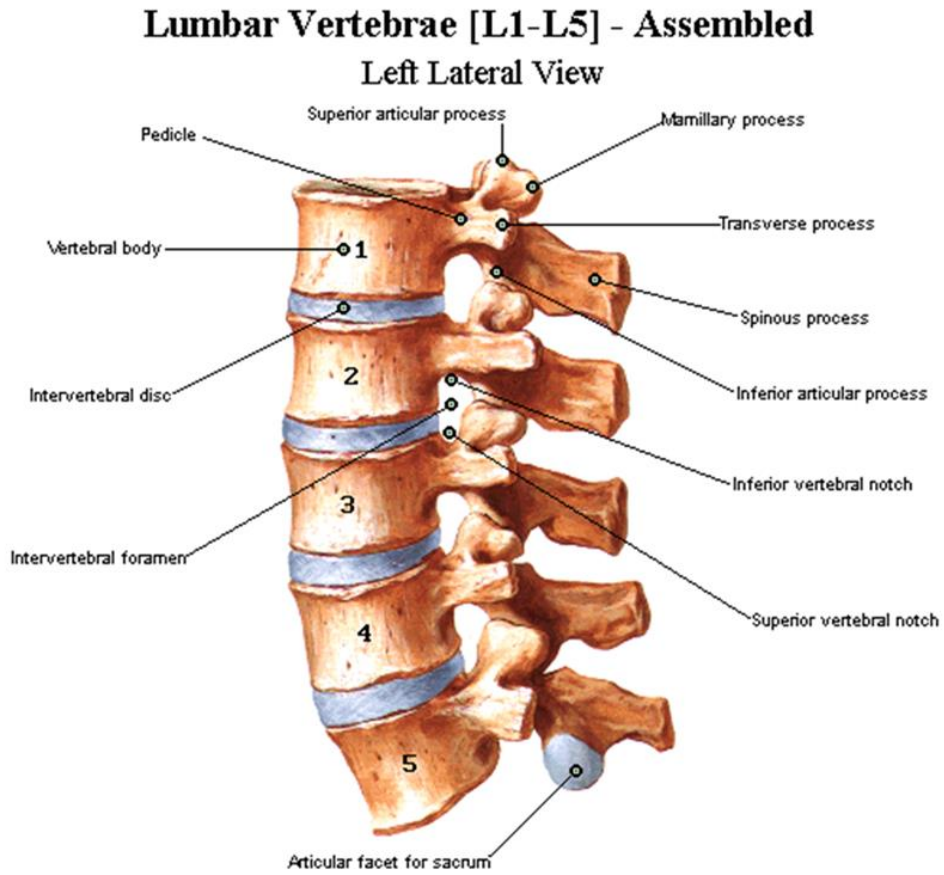


A typical vertebra consists of **2 portions**:

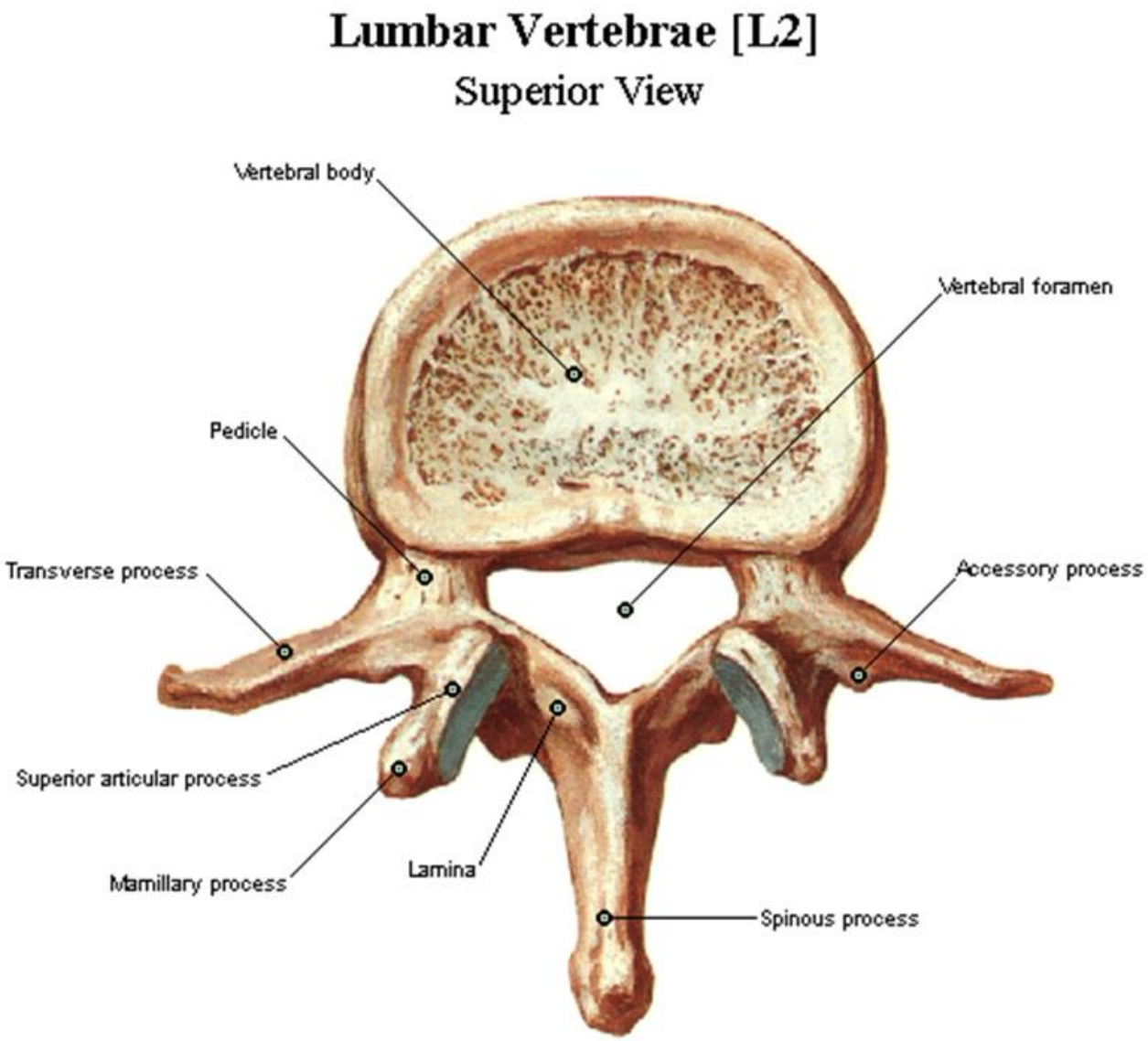
A) the VERTEBRAL BODY (anterior portion)

It is the part that supports the body weight, so it changes in size according to the region of the spine.

It shows a cylindrical shape with an i) upper ii) lower articular surface and a iii) circumferential/lateral surface that delimits it.



THE VERTEBRAL COLUMN - Lumbar vertebrae

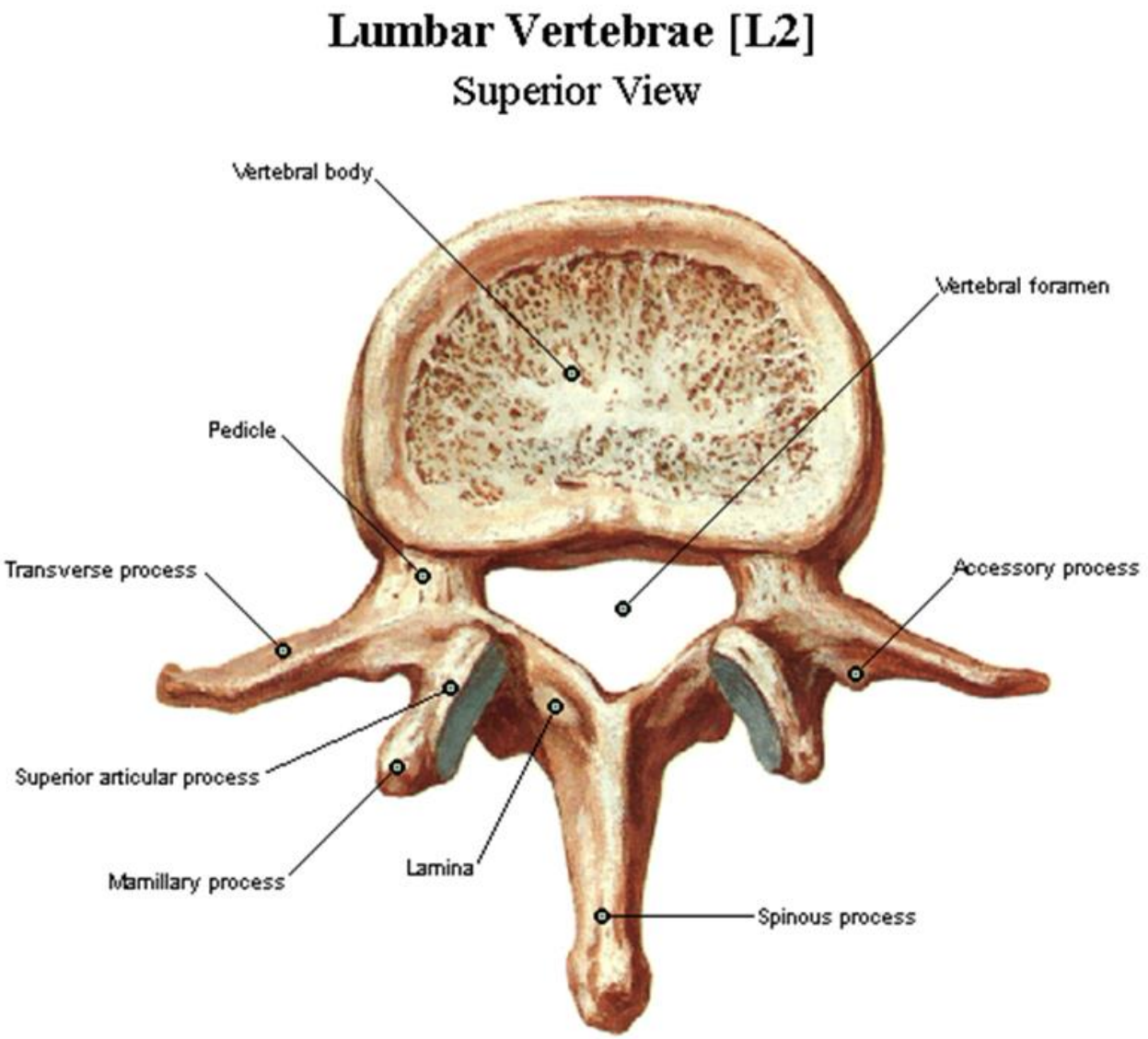


A typical vertebra consists of **2 portions**:

B) the VERTEBRAL ARCH (posterior portion)
It extends posteriorly from the vertebral body; together with the body, it delimits the **VERTEBRAL FORAMEN**

the vertebral foramina of all of the vertebrae align and delimit the **VERTEBRAL (SPINAL) CANAL,** which contains the spinal cord.

THE VERTEBRAL COLUMN - Lumbar vertebrae



A typical vertebra consists of **2 portions**:

B) the VERTEBRAL ARCH (posterior portion)

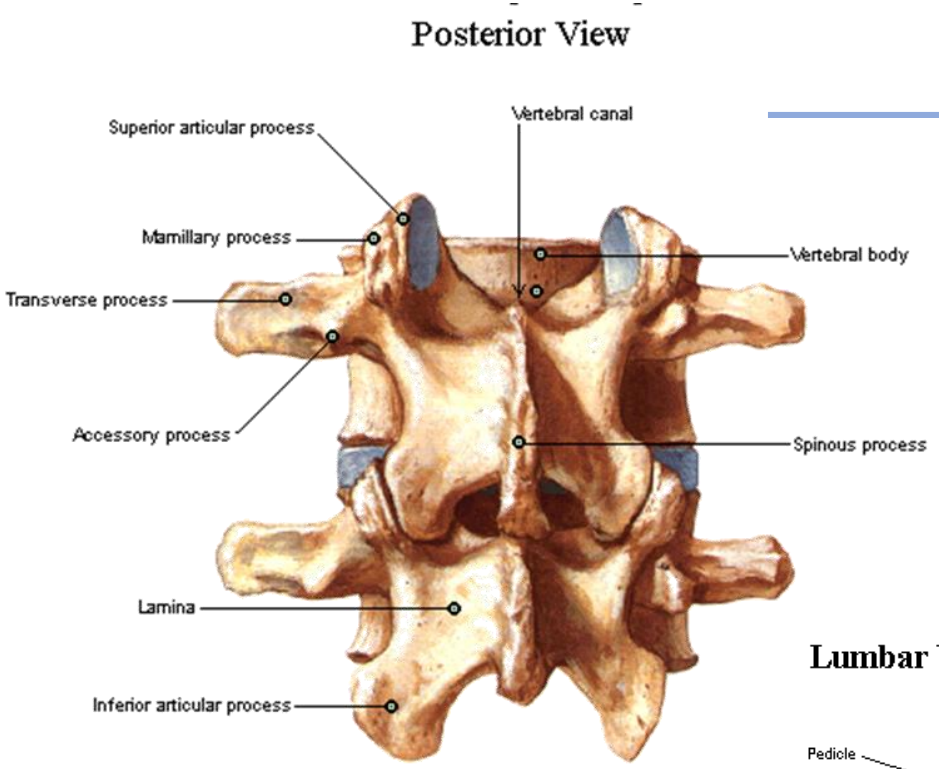
It consists of multiple bony structures:
- 2 PEDICLES which are anchored to the posterior side of the vertebral body.

- **2 VERTEBRAL LAMINAE** which extend medially and posteriorly from the pedicles. The laminae join posteriorly and continue in a single bony structure that extends posteriorly and is called the **SPINOUS PROCESS**

- **TRANSVERSE PROCESSES**: project laterally and arise from the junction point between the pedicle and lamina.

- **ARTICULAR PROCESSES**: project or face upward (**SUPERIOR**) or downward (**INFERIOR**) on each side of the vertebrae.

THE VERTEBRAL COLUMN - Lumbar vertebrae



Considering 2 contiguous vertebrae from the posterior side

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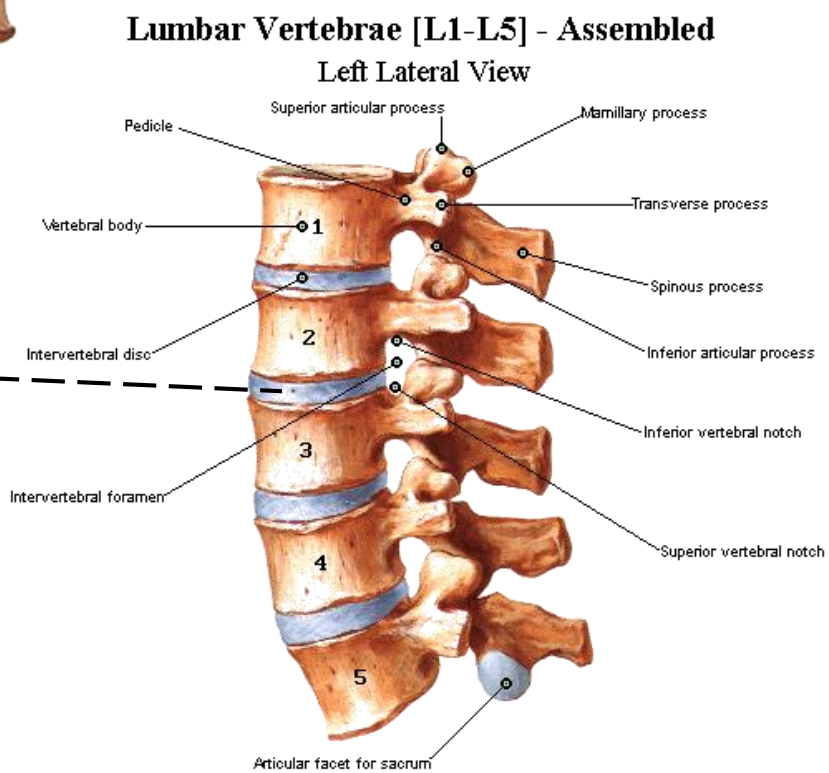
the 2 inferior articular processes of one vertebra articulate with the 2 superior articular processes from the next lower vertebra.

These junctions form slightly moveable joints between the adjacent vertebrae.

ARTICOLAZIONE INTERSOMATICA



Two adjacent vertebrae articulate through:

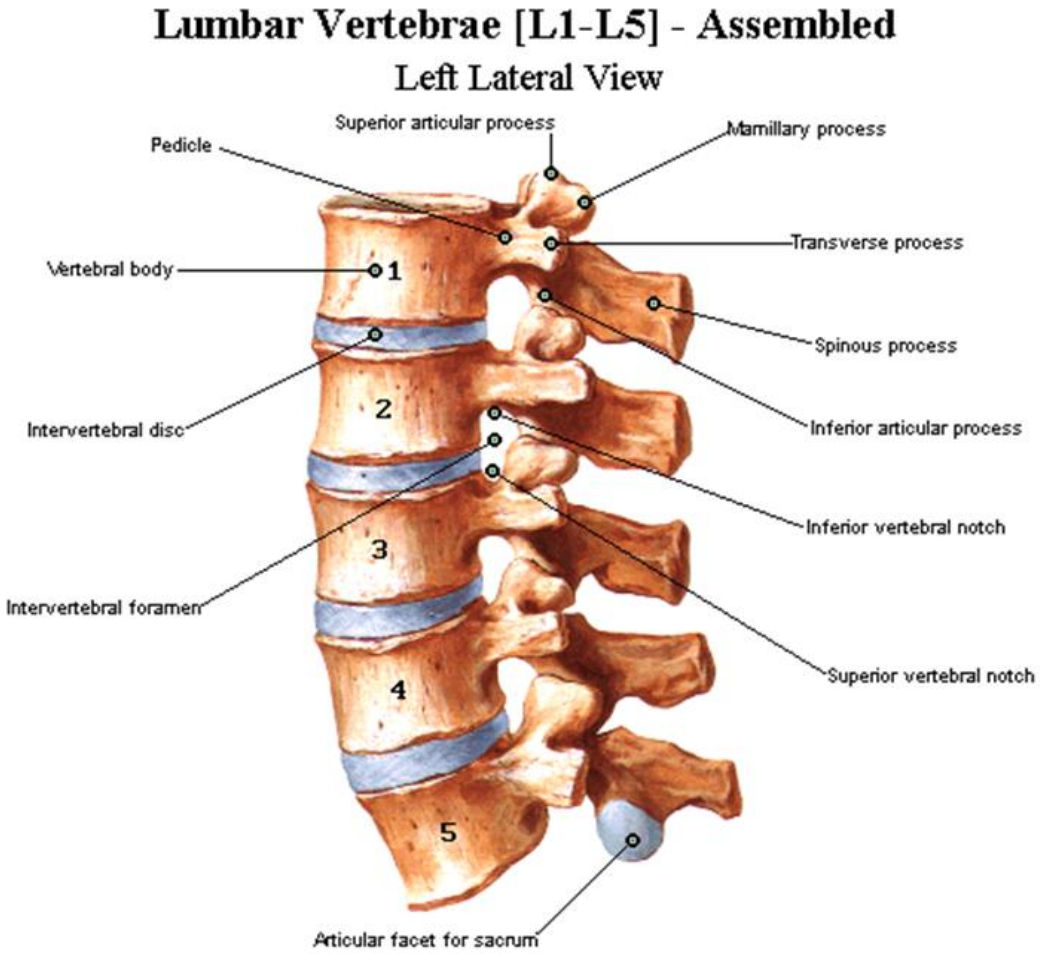
- the vertebral bodies
- the articular processes (2 superior a.p. and 2 inferior a.p.)

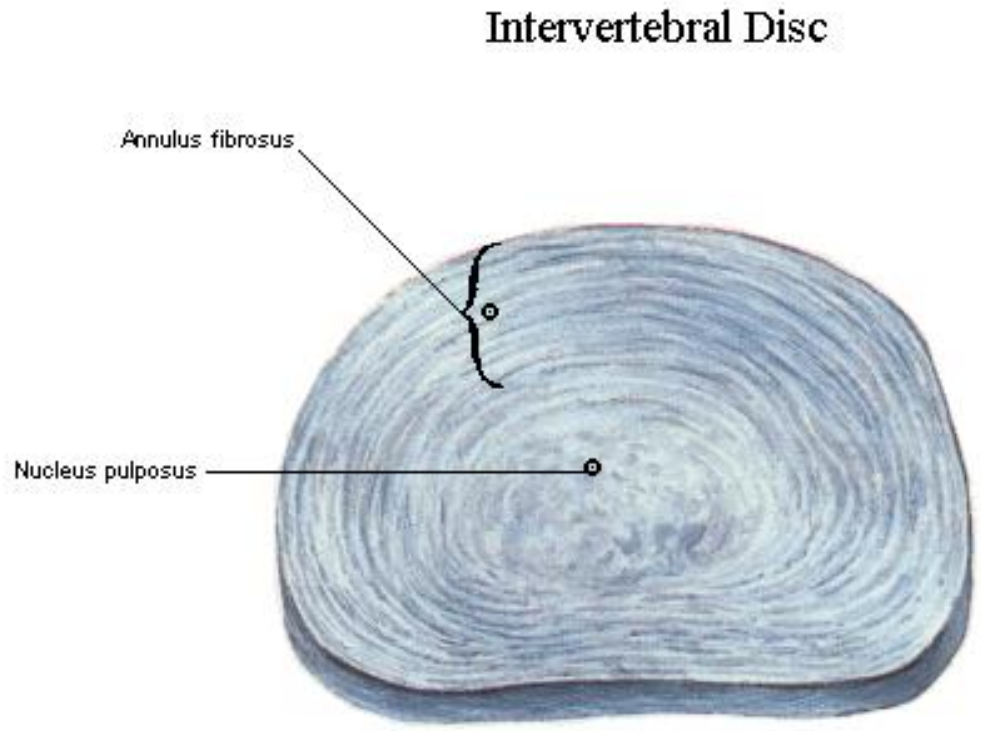
In each pair of vertebrae, each vertebra shows:

- 3 joints with the next higher vertebra e
- 3 joints with the next lower vertebra

In fact, <u>each vertebra has 6 joints</u>
- 3 upwards
- 3 downwards

THE VERTEBRAL COLUMN - Lumbar vertebrae



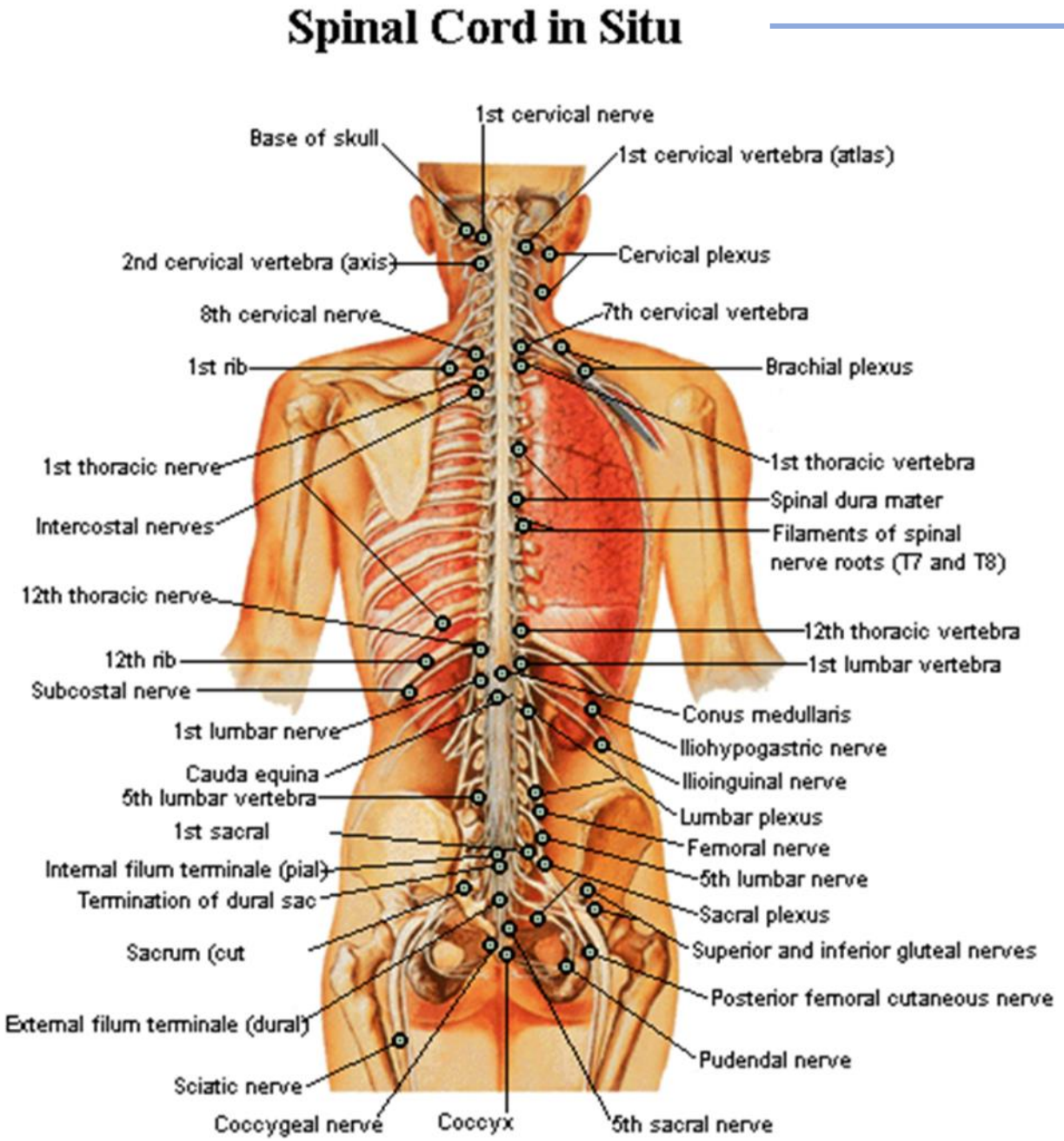


The joints between the vertebral bodies or **intervertebral disc joints** are mediated by a fibrocartilaginous disc called INTERVERTEBRAL DISC, which consists of two components:

- a PERIPHERAL PORTION → Annulus fibrosus (made of a more fibrotic tissue)

- a CENTRAL PORTION → Nucleus pulposus (gel-like structure, rich in proteoglycans that retain water; it has a shock-absorbing function and allows for movements between adjacent vertebrae)

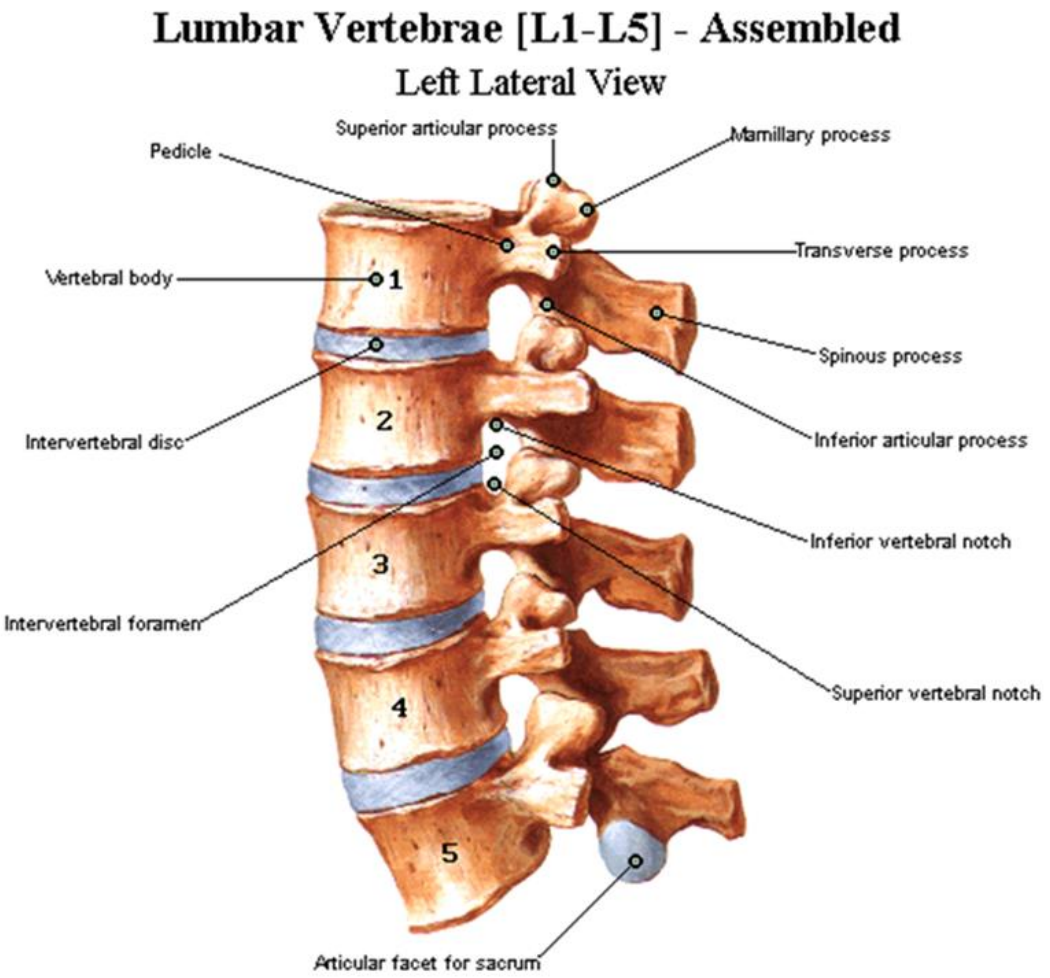
THE VERTEBRAL COLUMN



The figure presents the vertebral canal opened behind, showing the spinal cord inside. From the spinal cord, the SPINAL NERVES emerge

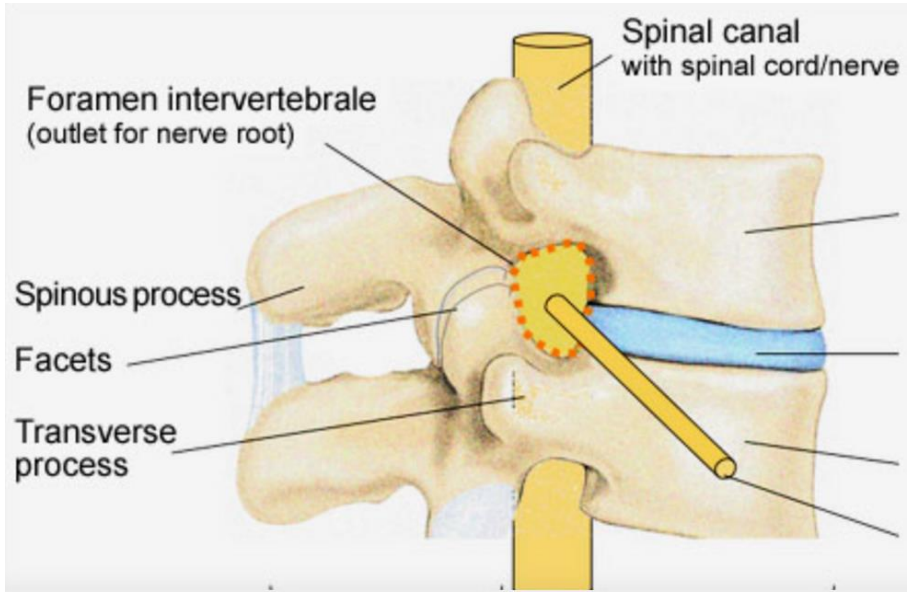
The spinal cord actually does not occupy the entire vertebral canal but it ends at the passage between L1-L2 vertebrae; below, the CAUDA EQUINA is found which consists of a bundle of spinal nerve roots that descend from the spinal cord that will have to exit at the lumbar and sacral level.

THE VERTEBRAL COLUMN



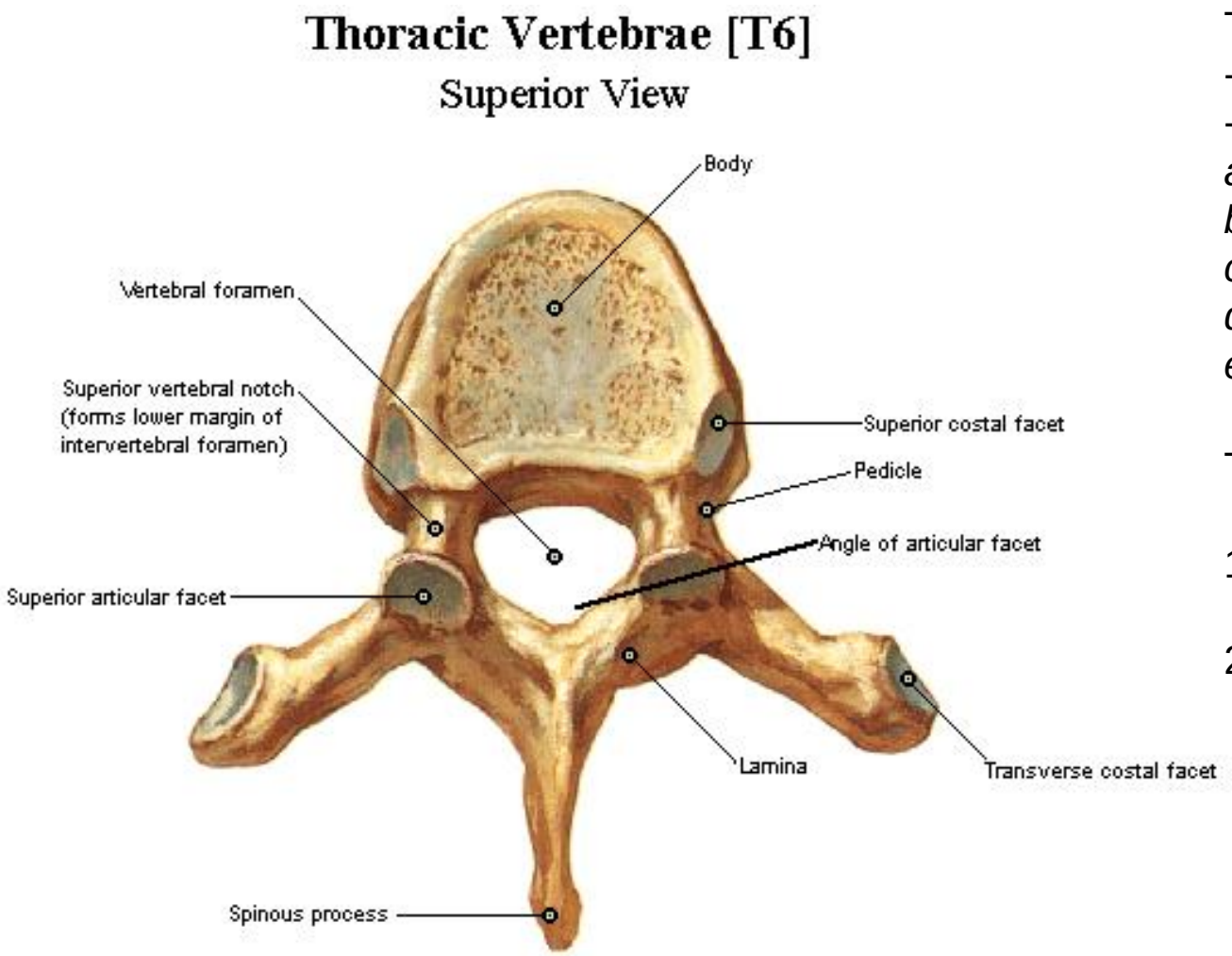
The spinal nerves must exit the vertebral canal to innervate the skin/muscles

They exit through the INTERVERTEBRAL FORAMINA delimited by
- the wo vertebral pedicles of the adjacent vertebrae
- the articular processes articulated with each other
- the vertebral bodies and intervertebral discs (anteriorly)



THORACIC VERTEBRAE

THE VERTEBRAL COLUMN - Thoracic vertebrae



They have the same basic structure of the lumbar vertebrae

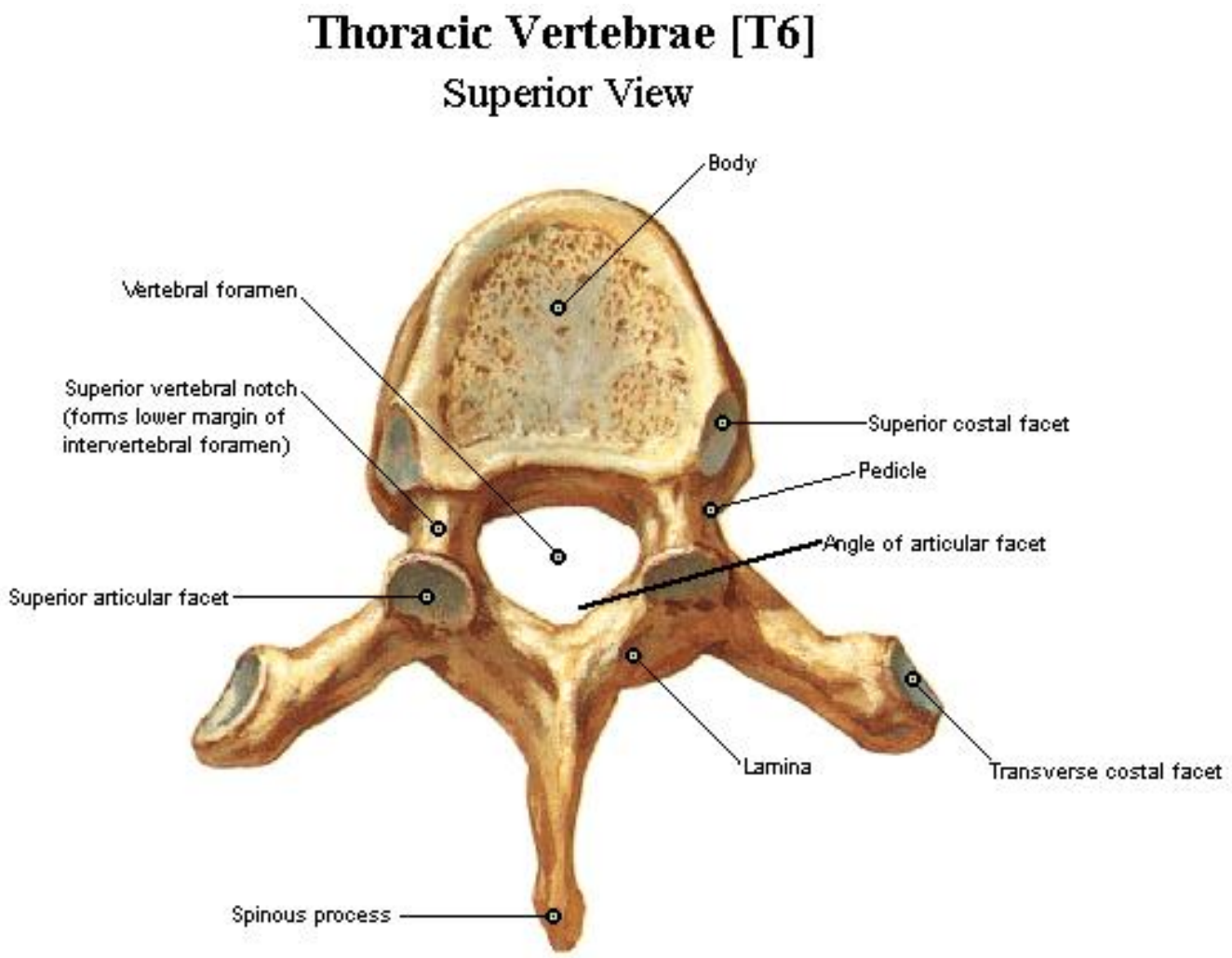
- *VERTEBRAL BODY (anterior)*
- *VERTEBRALE ARCH (posterior) which consists of:*

a) 2 pedicles
b) 2 laminae
c) the spinous process
d) 2 transverse processes
e) 2 pairs of articular processes (superior and inferior)

The joints between 2 vertebrae occur through:

1. the intervertebral disc joint (anteriorly) mediated by the intervertebral disc
2. the two posterior joints between the articular processes

THE VERTEBRAL COLUMN – Thoracic vertebrae



WHAT IS DIFFERENT IN THE THORACIC VERTEBRAE?

A) DIMENSIONS

the thoracic v. support a smaller portion of the body than the lumbar v., therefore they are SMALLER

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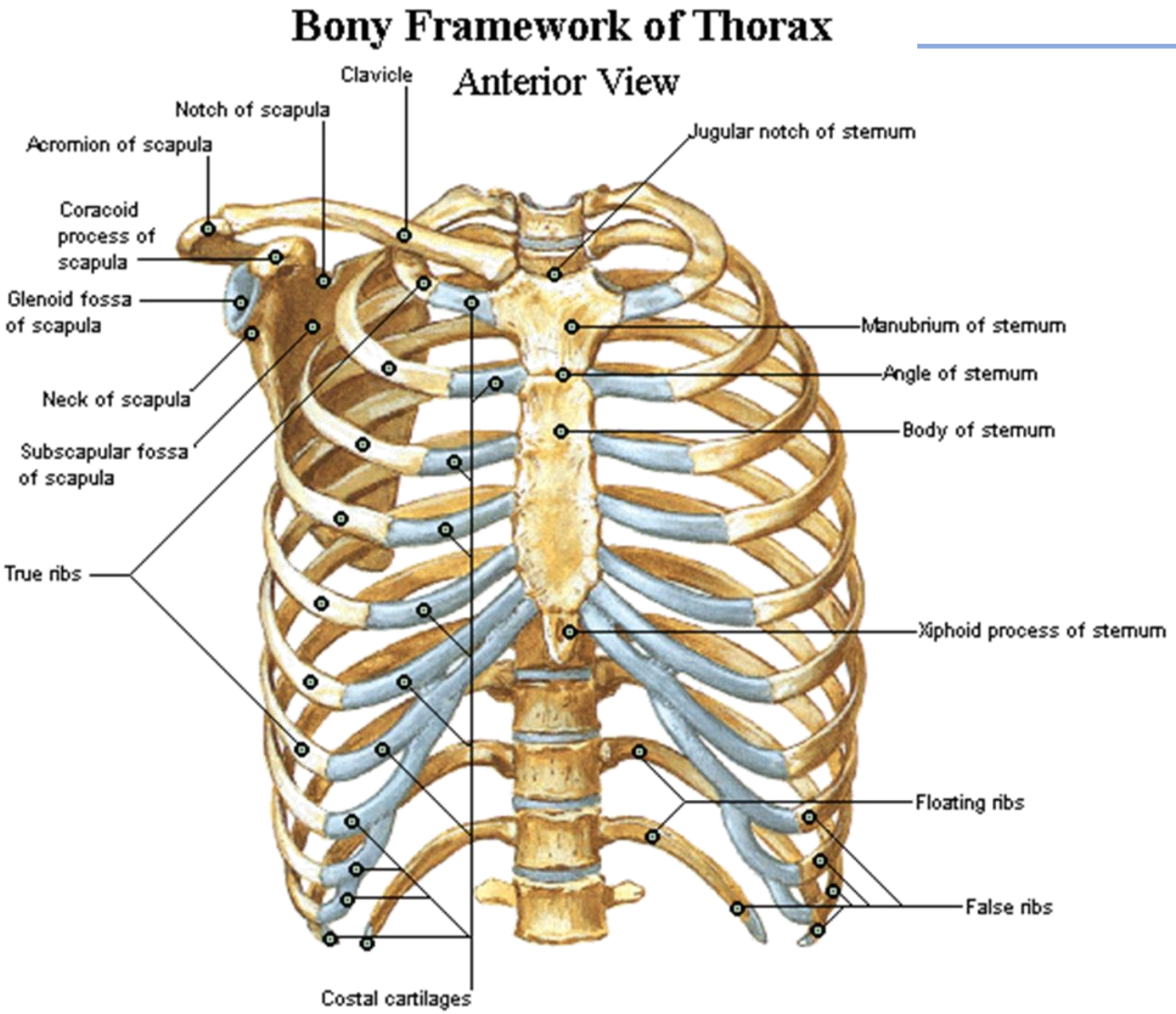
<u>The vertebral body - which supports the majority of the weight - is smaller</u>

B) JOINT WITH THE RIBS

AXIAL SKELETON – The Rib Cage



THORACIC CAGE or RIB CAGE

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It is THE SKELETON OF THE THORAX

It is formed by;

THORACIC VERTEBRAE,

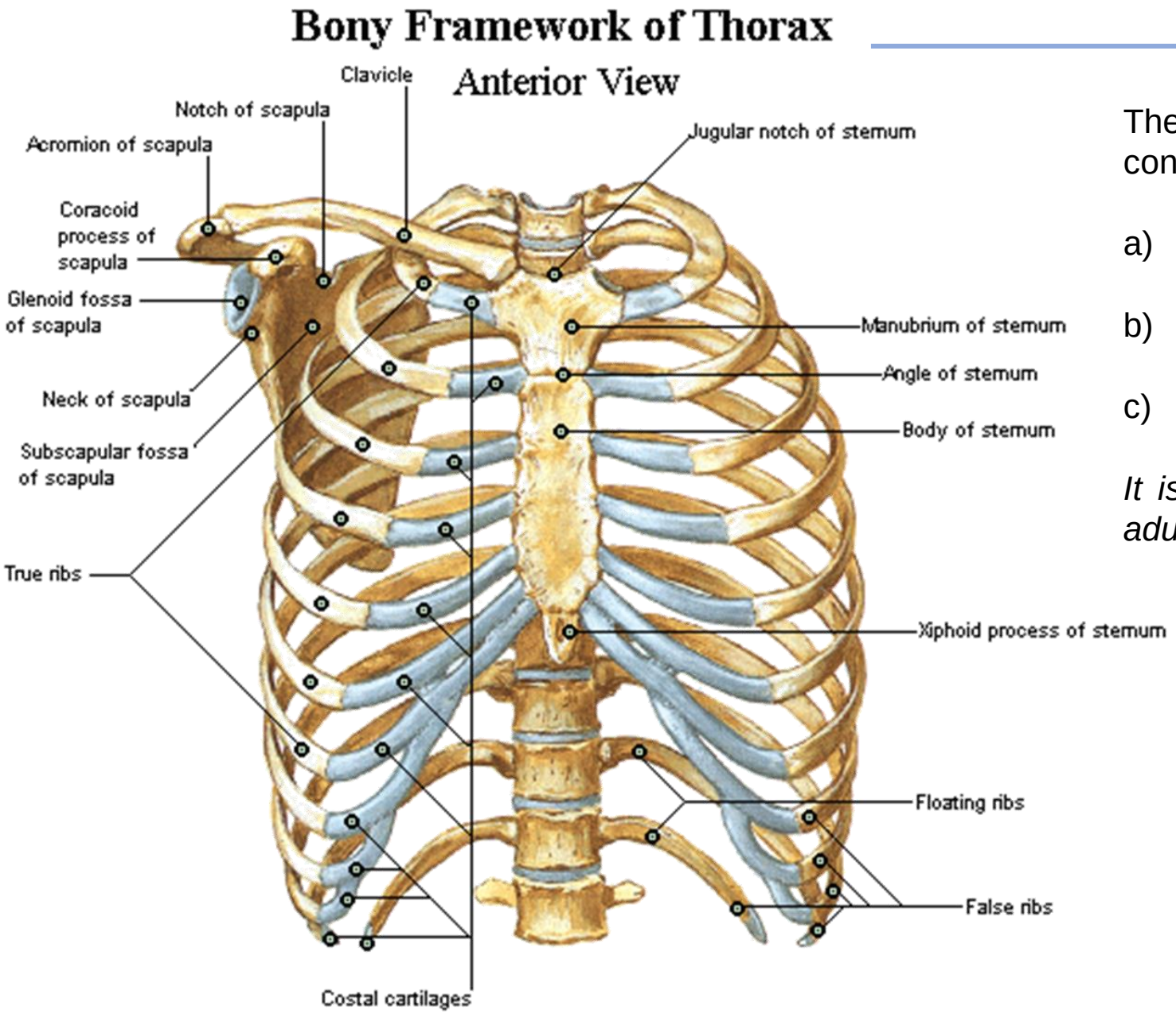
+

RIBS (12 PAIRS)

+

STERNUM

RIB CAGE

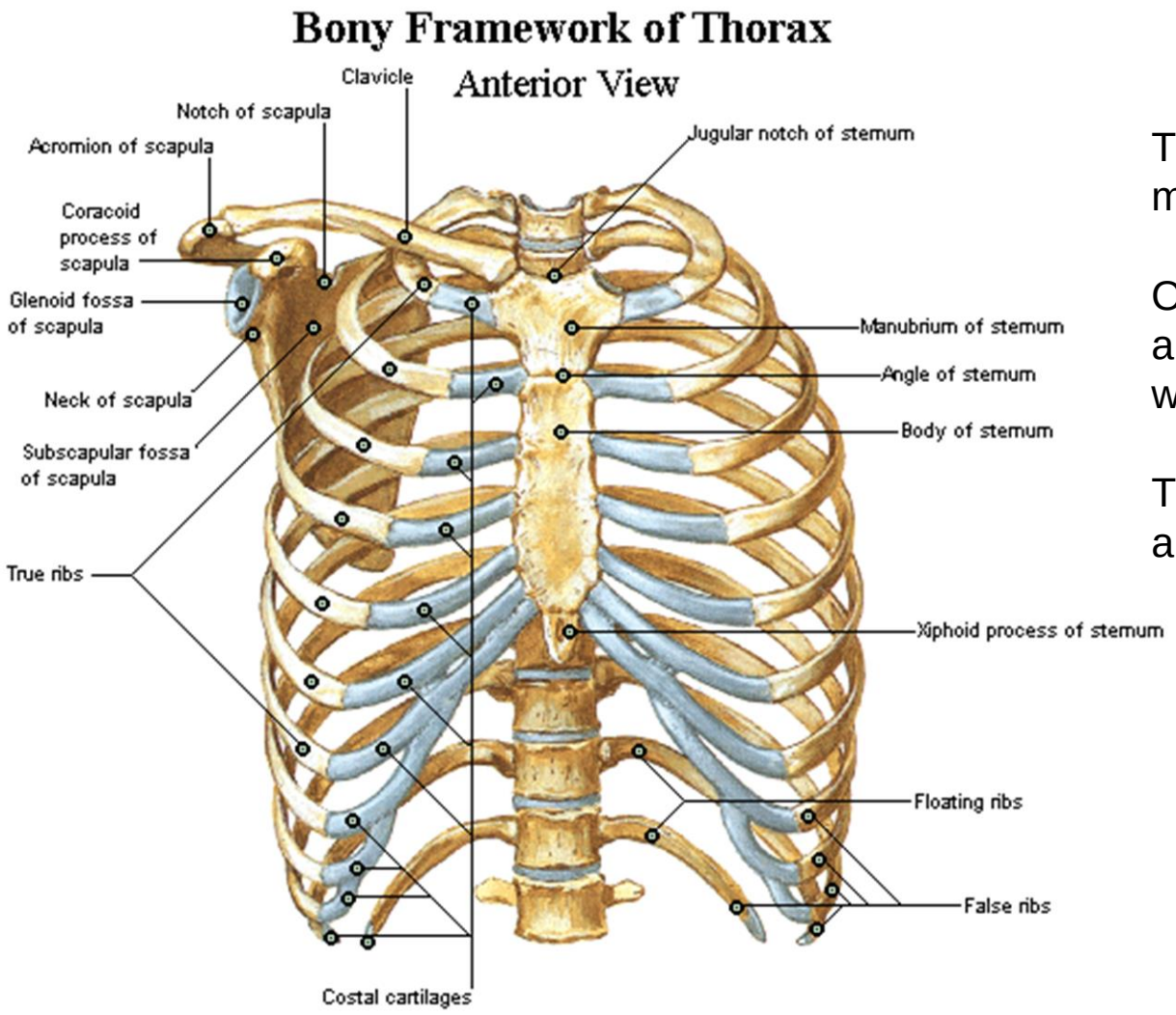


The STERNUM closes the rib cage anteriorly and consists of THREE PORTIONS:

a) the **STERNAL MANUBRIUM** (the most cranial portion)
b) the **BODY of STERNUM** (the intermediate and longest portion)
c) the **XYPHOID** process

It is a flat bone → it contains red marrow even in adulthood

RIB CAGE



The sternal manubrium shows a slight depression at its upper margin, in the median position → **JUGULAR NOTCH**

On each side there is another notch/depression given by the articular surface with the **CLAVICLE**, which medially articulates with the sternal manubrium → **STERNOCLAVICULAR JOINT**

The **CLAVICLE** articulates **laterally** with the **SCAPULA**, which articulates with the **HUMERUS**

CLAVICLE + SCAPULA

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PECTORAL GIRDLE

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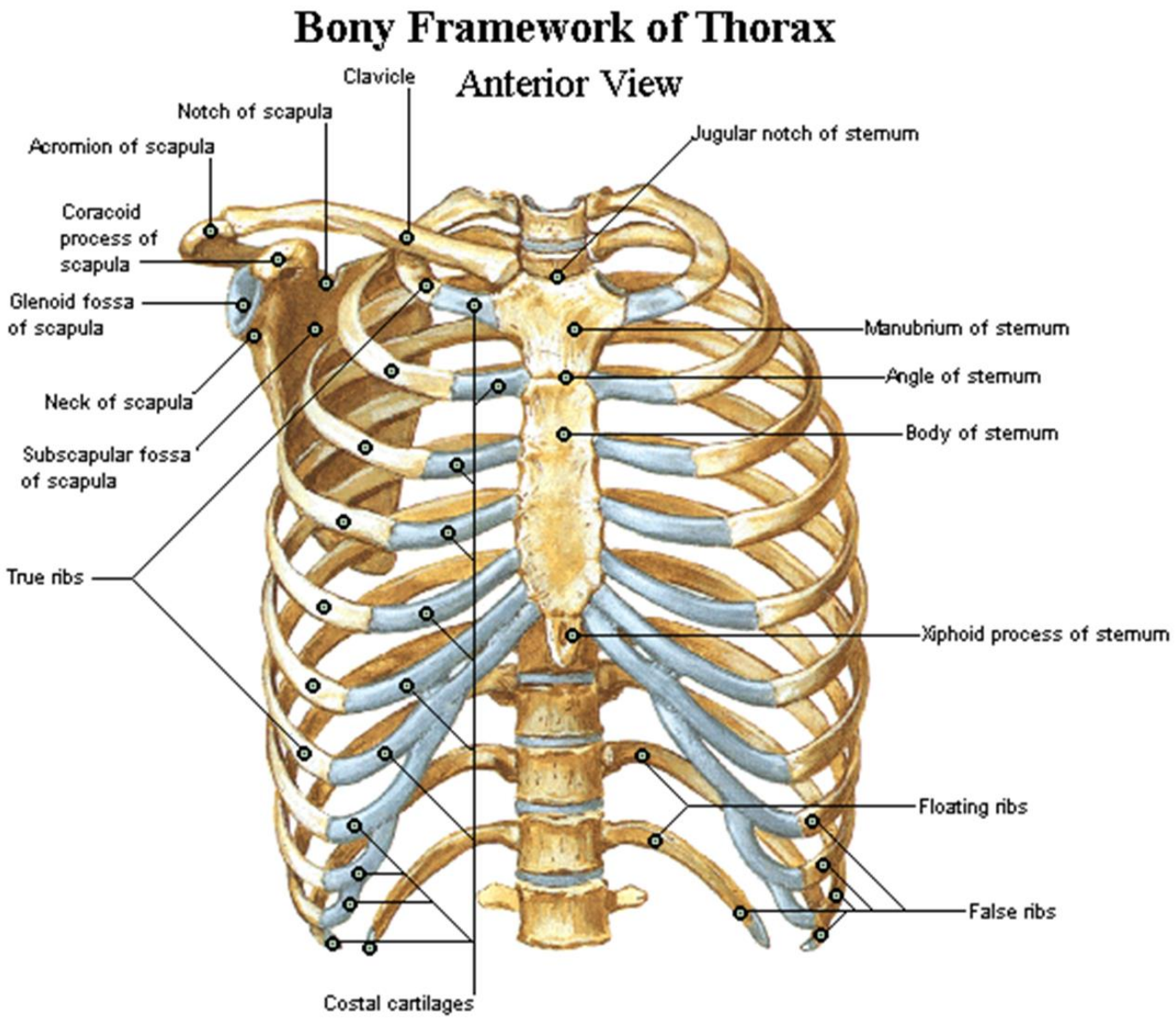
<u>Connects the humerus with the trunk of the body</u>

RIB CAGE

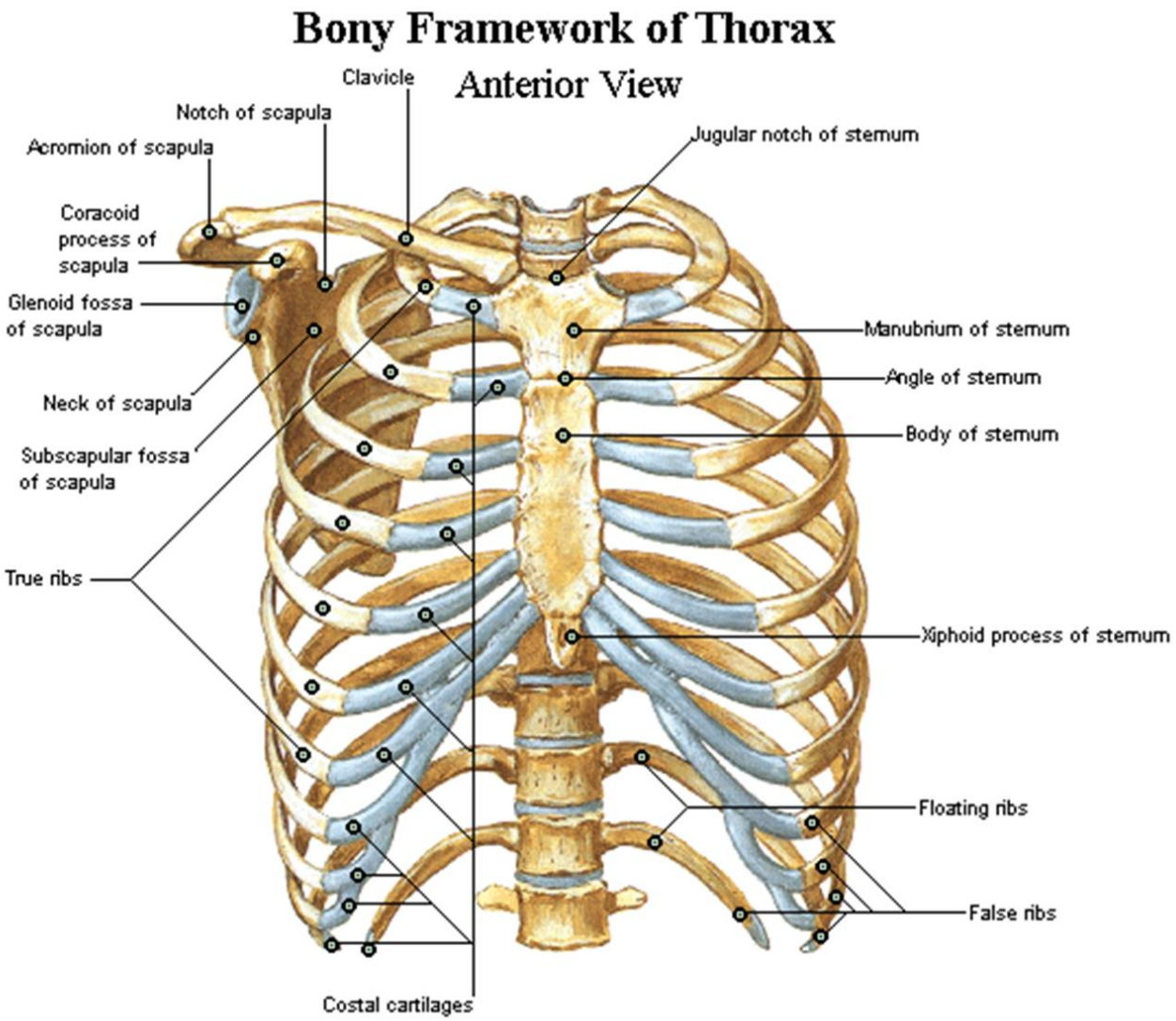


<u>The ribs are articulated on the lateral margins of the sternum</u>

BUT not all the ribs

OF 12 PAIRS OF RIBS,
THE FIRST 7 PAIRS (FROM TOP TO BOTTOM) **ARE ARTICULATED DIRECTLY WITH THE STERNUM**
through a hyaline cartilage structure

RIB CAGE



Ribs consist of

→ a preponderant BONE portion
→ a CARTILAGINE portion (hyaline cartilage)

So, it is possible to distinguish:
- the BONY RIB = bone portion
- the COSTAL CARTILAGE = cartilage portion which extends anteriorly from the anterior margin of the bony rib

The cartilage portions of the first 7 pairs of ribs articulate with the lateral margin of sternum

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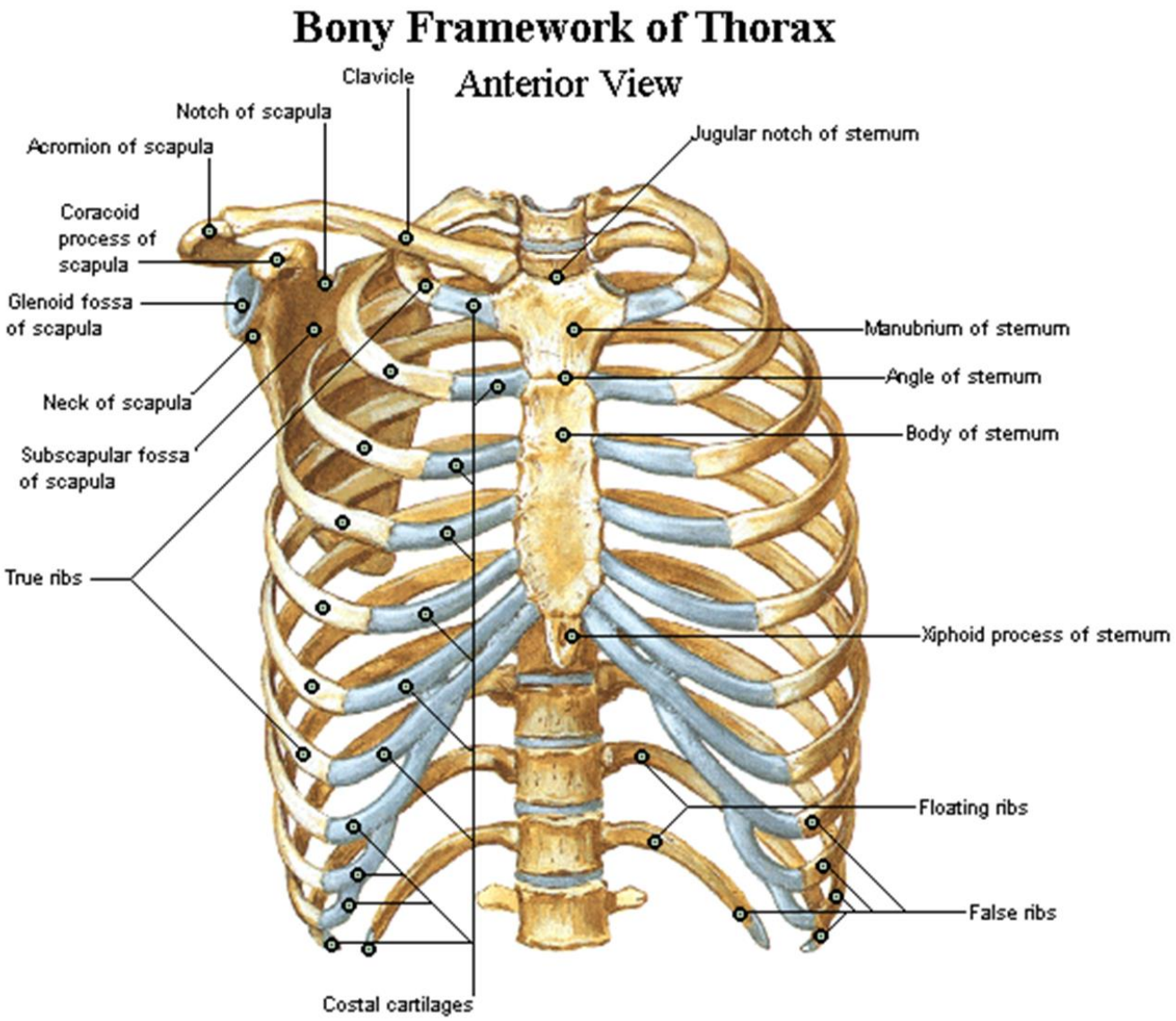
TRUE RIBS

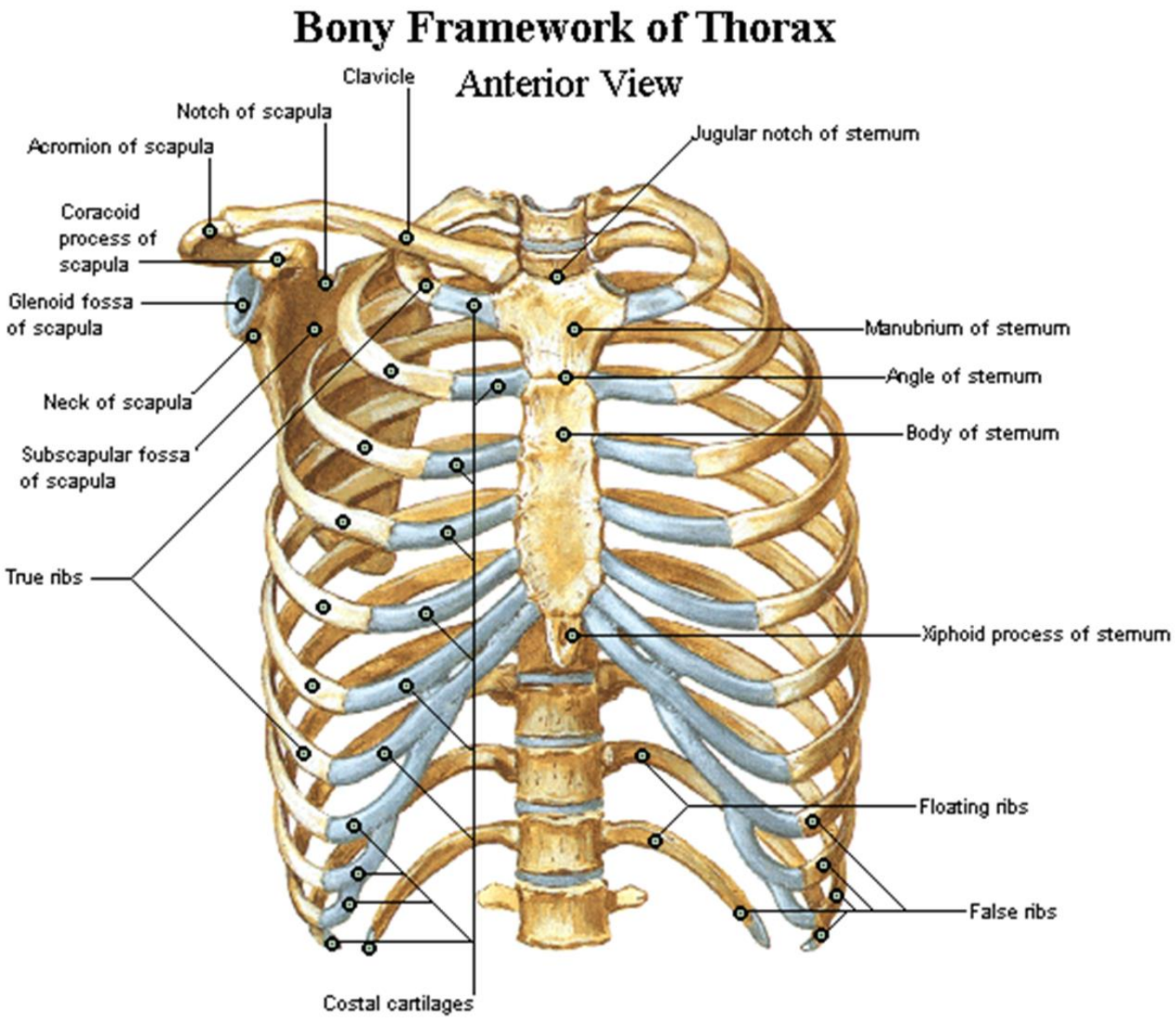
RIB CAGE



- **1st RIB** → articulates with the MANUBRIUM OF STERNUM
- **2nd RIB** → articulates at the passage MANUBRIUM / BODY OF STERNUM
- **3rd – 7th RIBS** → articulate with the lateral margin of the BODY OF STERNUM

No rib articulates with the xiphoid process

RIB CAGE



FALSE RIBS (8-12)

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THEY DO NOT ARTICULATE WITH THE STERNUM

- **8th-10th rib pairs** → the costal cartilage articulates with the .cartilage portion of the next higher rib

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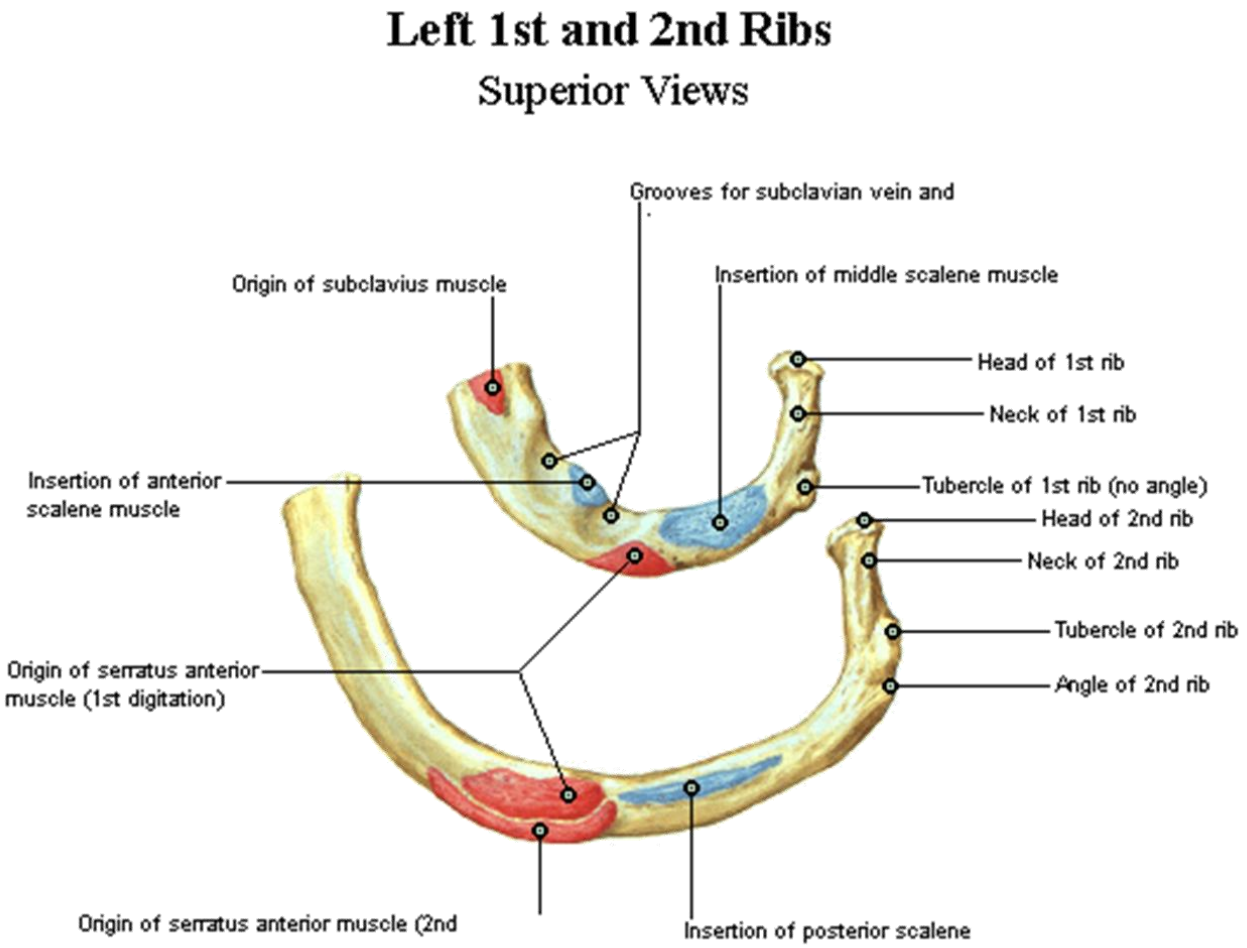
The costal cartilage of the 8th rib bends upwards and articulates
with the costal cartilage of the 7th rib (9th with 8th; 10th with 9th)

↓

- This structure of ribs (8-10) defines the **COSTAL ARCH**

- **11th-12th rib pairs** → the costal cartilage does not articulate with other structures → **FLOATING RIBS**

RIB CAGE



The figure represent the BONE PORTION of the first and the second ribs (superior view), which have a curvilinear profile, an anterior end from which the costal cartilage extends and a posterior end that is more complex and consists of specific structures:

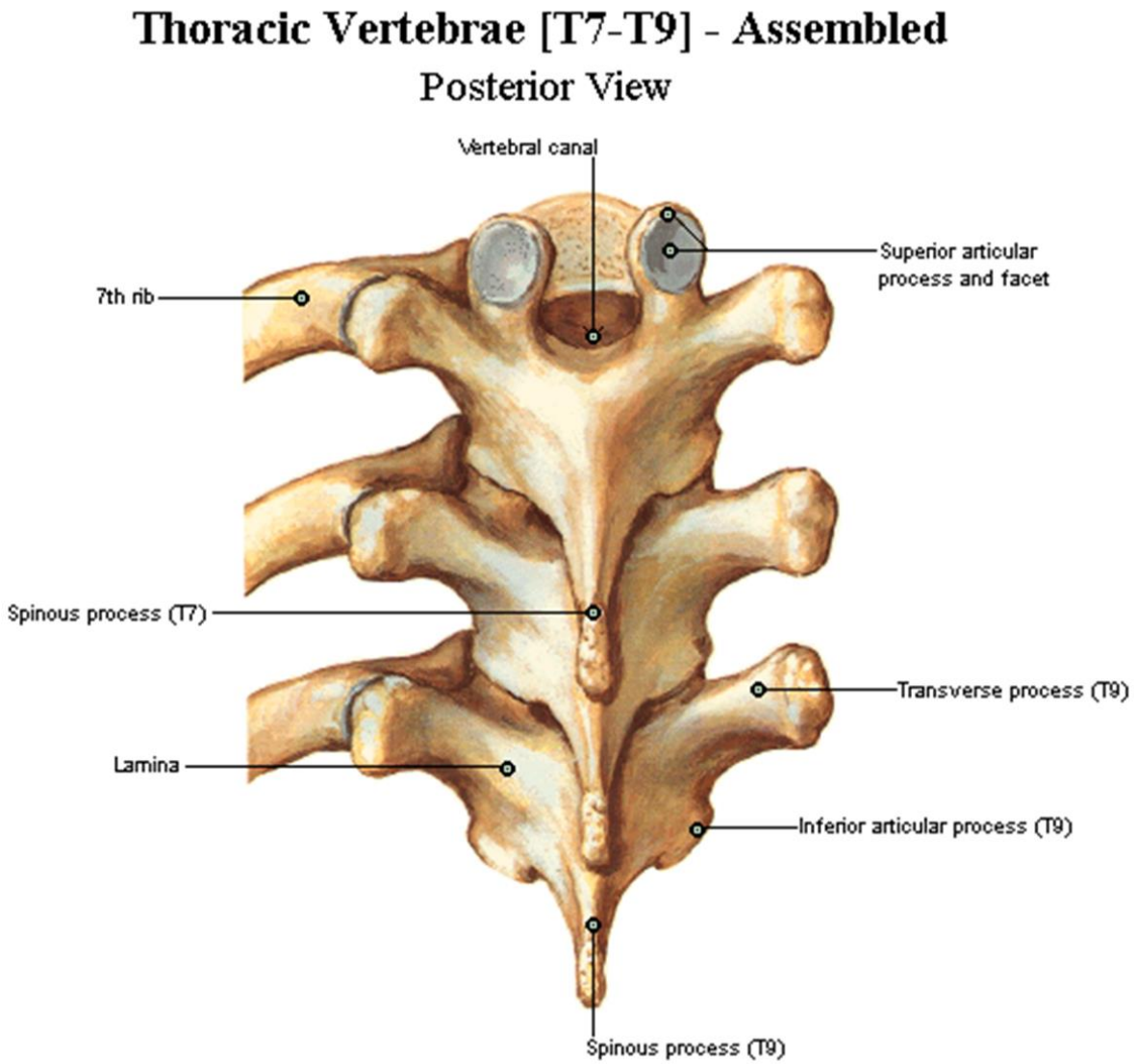
The posterior end is called the HEAD OF THE RIB

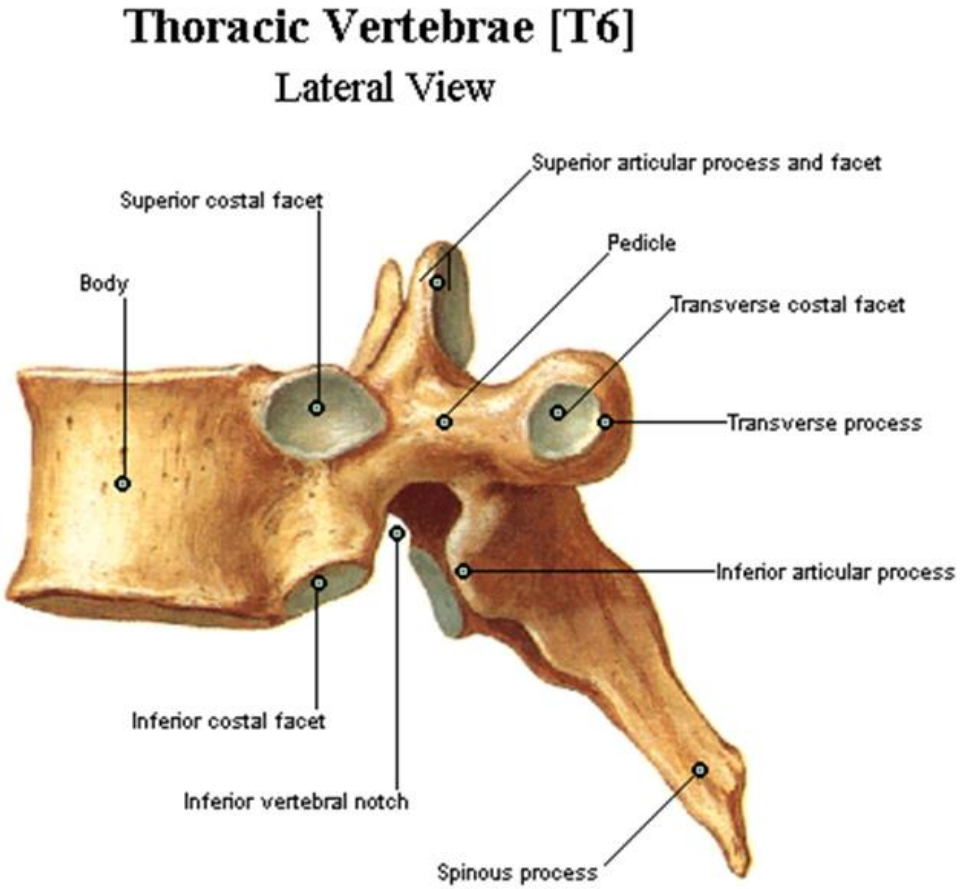
Lateral to the head is a narrowed portion called the NECK OF THE RIB

A small bump on the posterior rib surface is the TUBERCLE OF THE RIB

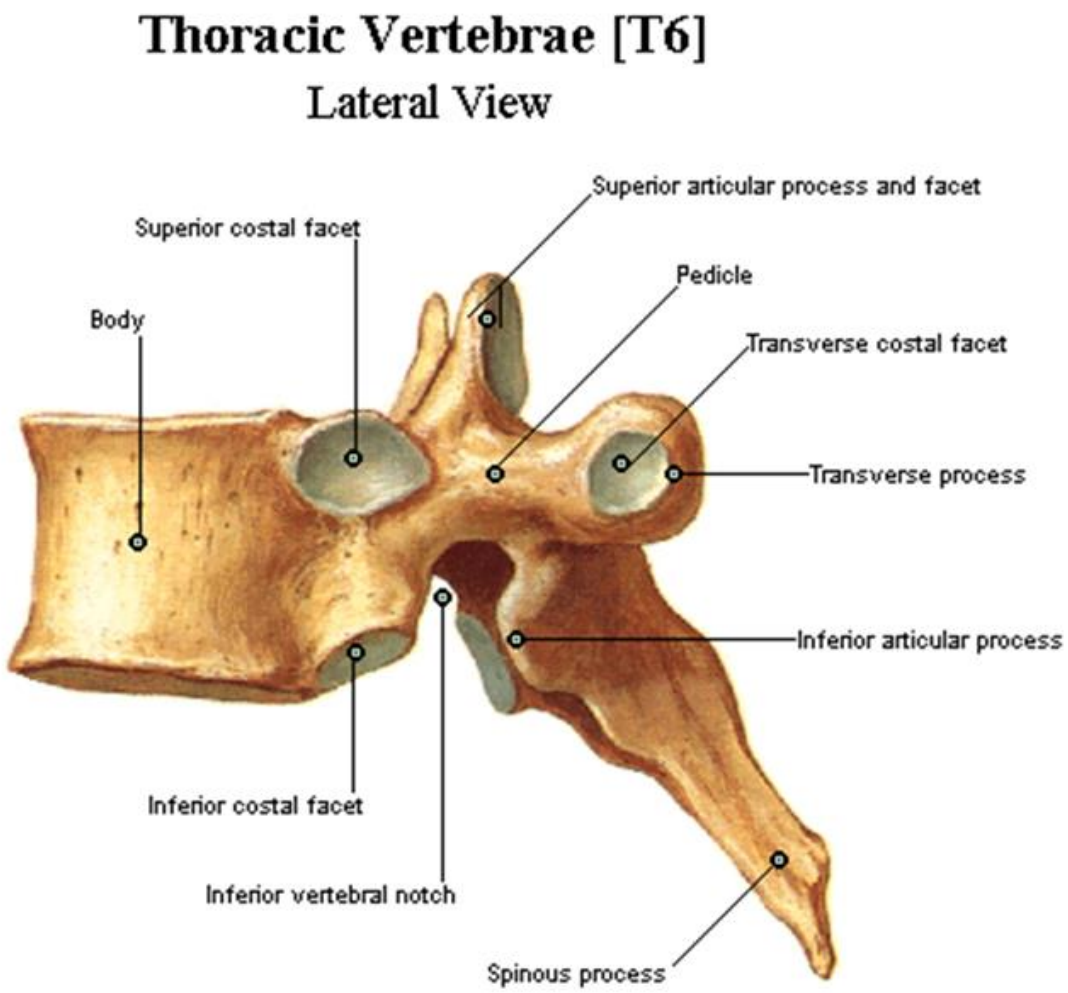
From the tubercle, the BODY OF THE RIB extends forward

HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?





HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?



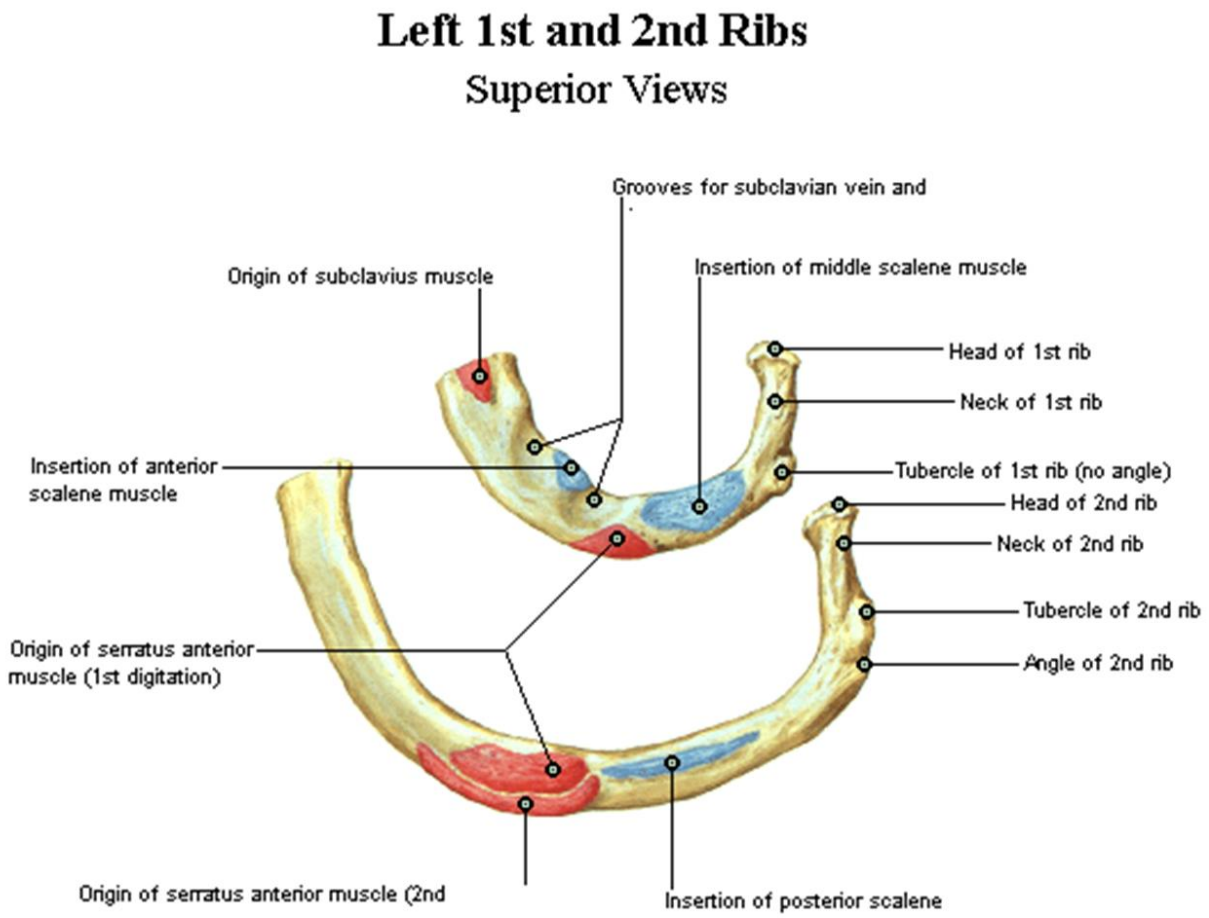
Differently from the lumbar v., the **THORACIC V.** present further articular facets (n = 3) which will allow for the articulation with the ribs.

Therefore, each thoracic vertebra (except the first and last) presents:
+ 3 costal facets on the right
+ 3 costal facets on the left

Of these three facets:
n. 1 = at the level of the transverse process (hyaline cartilage): TRANSVERSE COSTAL FACET

n. 2 = at the level of the vertebral body (one upper and one lower): SUPERIOR and INFERIOR COSTAL FACETS

HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?



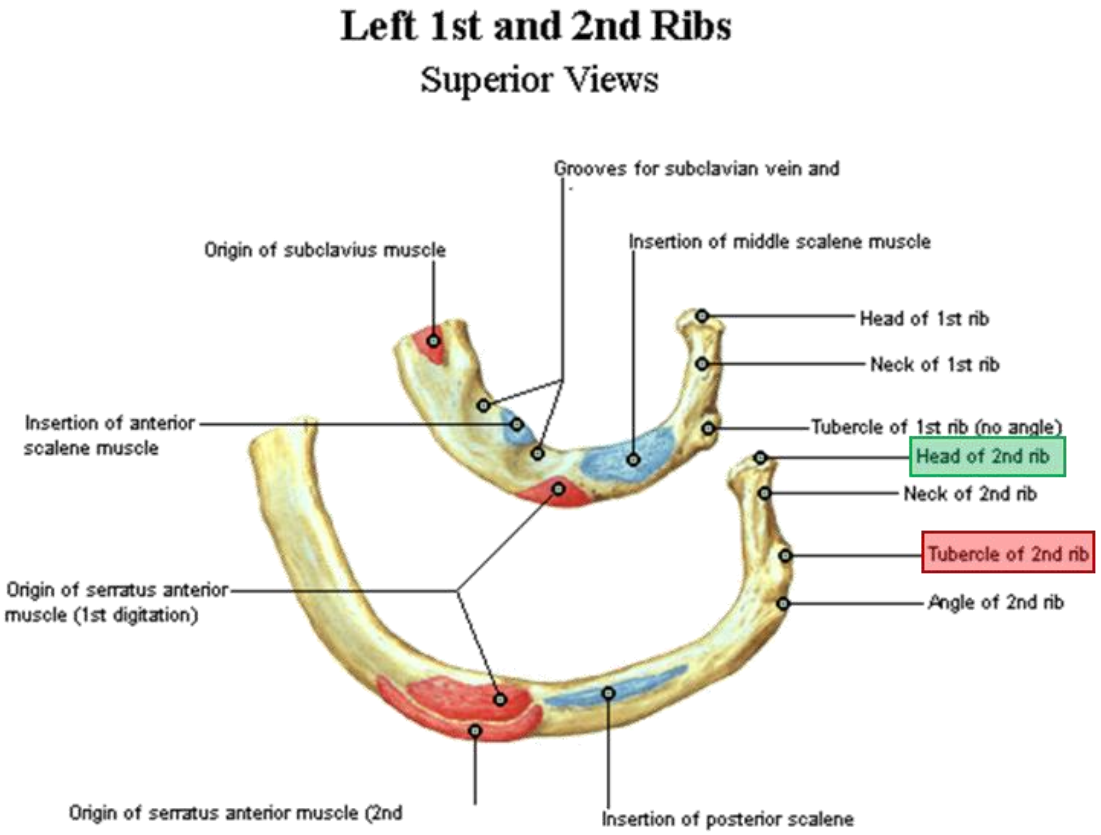
Each rib also has 3 articular facets (not visible here):

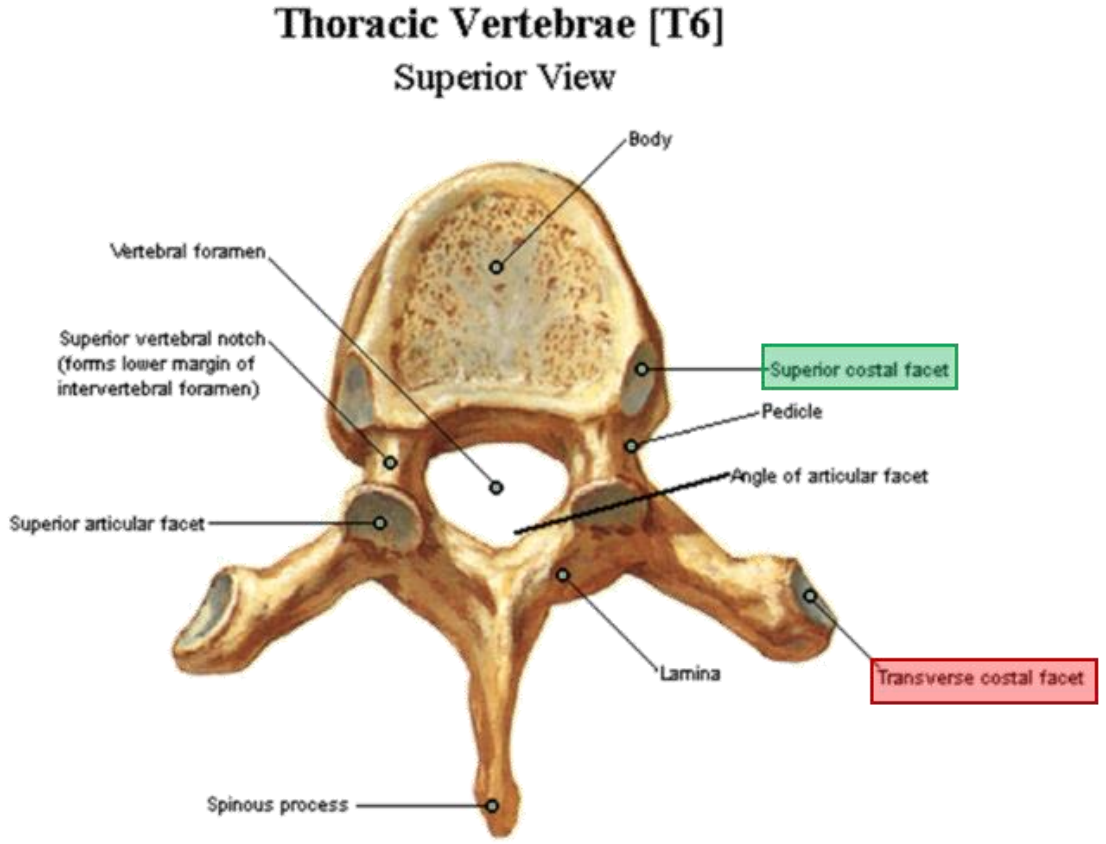
- One at the level of the TUBERCLE OF THE RIB
- Two at the level of the HEAD OF THE RIB

HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?

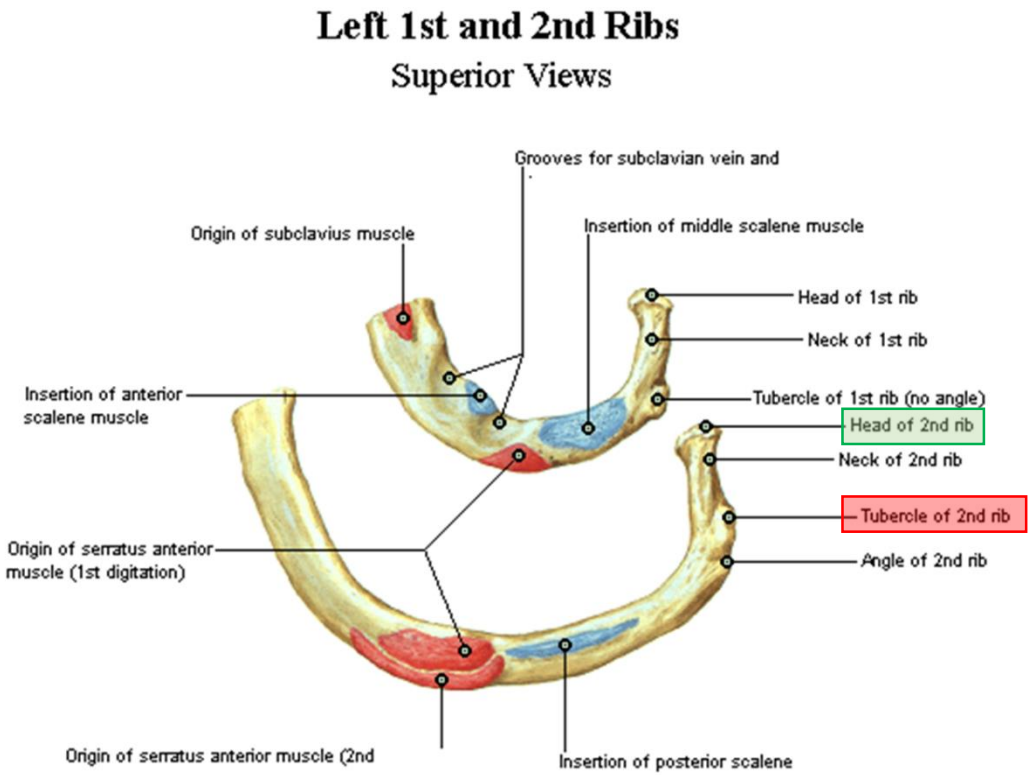
The articular facet of the tubercle of the rib articulates with the costal facet of the transvers process

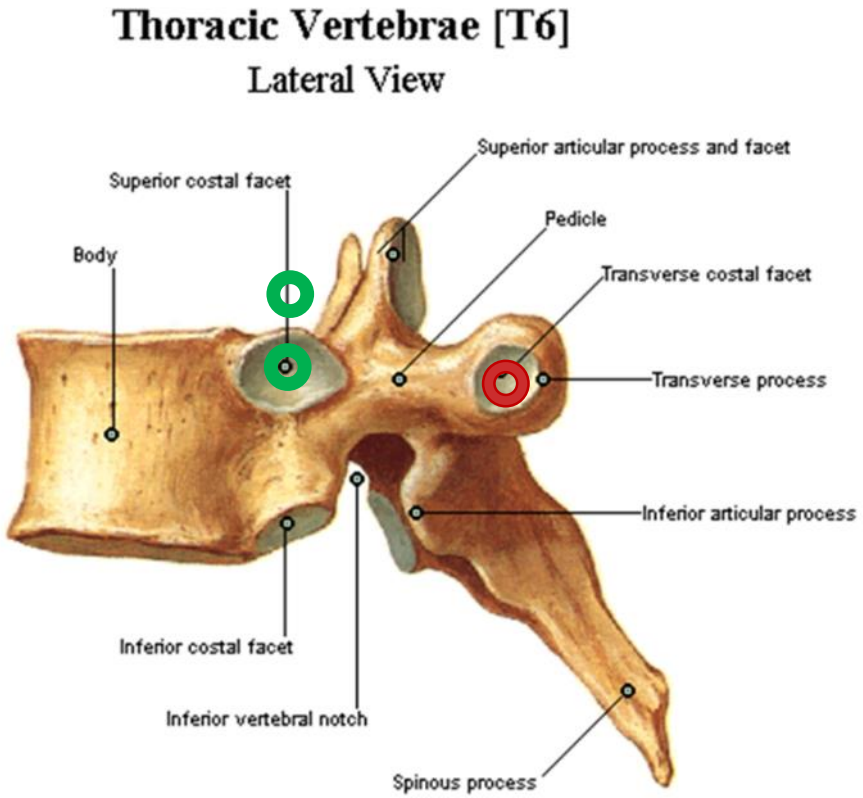
The 2 articular facets of the head of the rib articulate with the costal facets of the vertebral body





HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?



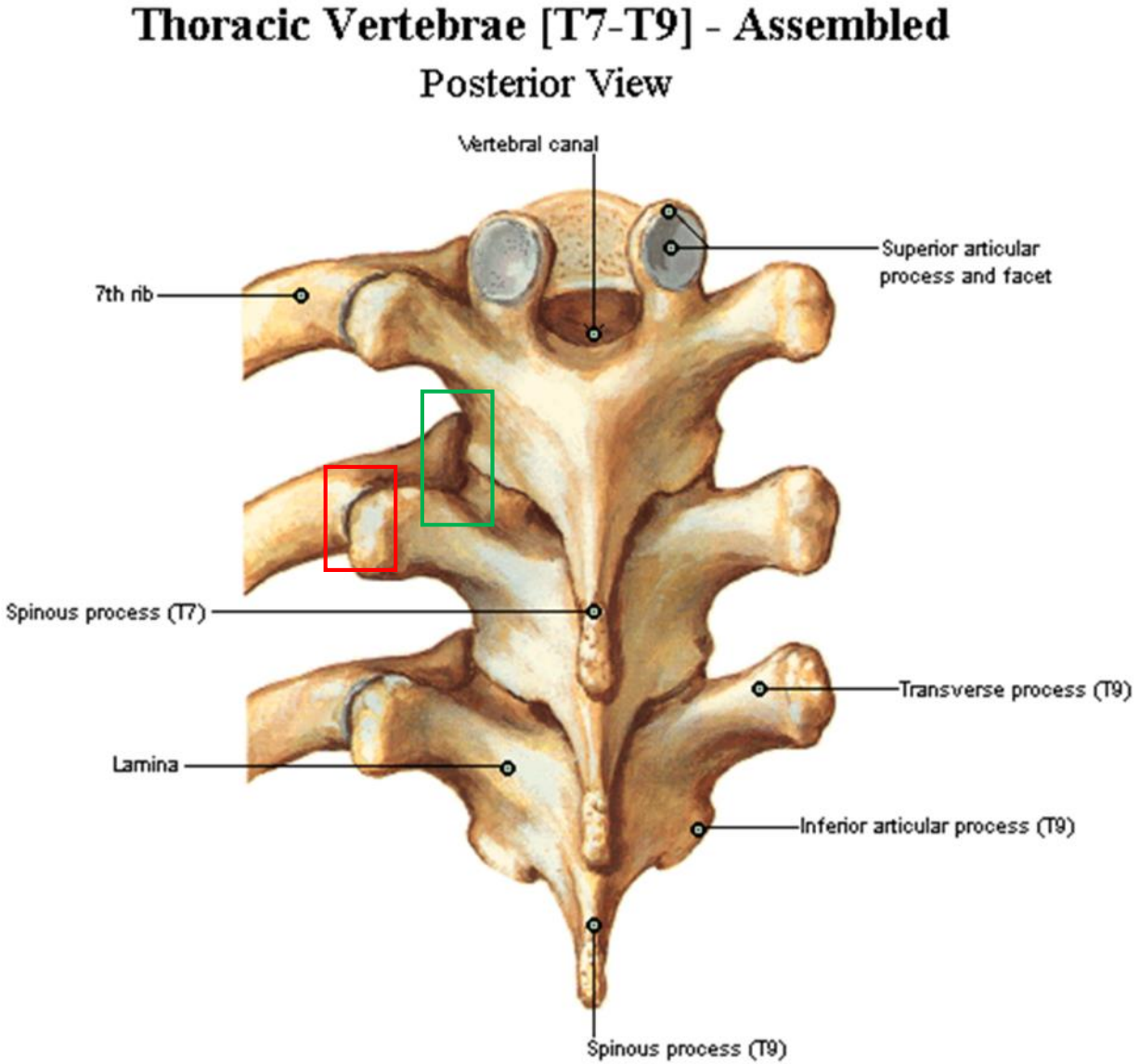


The articular facet of the tubercle of the rib articulates with the costal facet of the transvers process of the same numbered vertebra

The 2 articular facets of the head of the rib articulate with the costal facets of the vertebral body:

a. Inferior articular facet of the head of the rib → superior costal facet of the vertebral body of the same numbered vertebra;
b. Superior articular facet of the head of the rib → inferior costal facet of the vertebral body of the next higher vertebra.

HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?



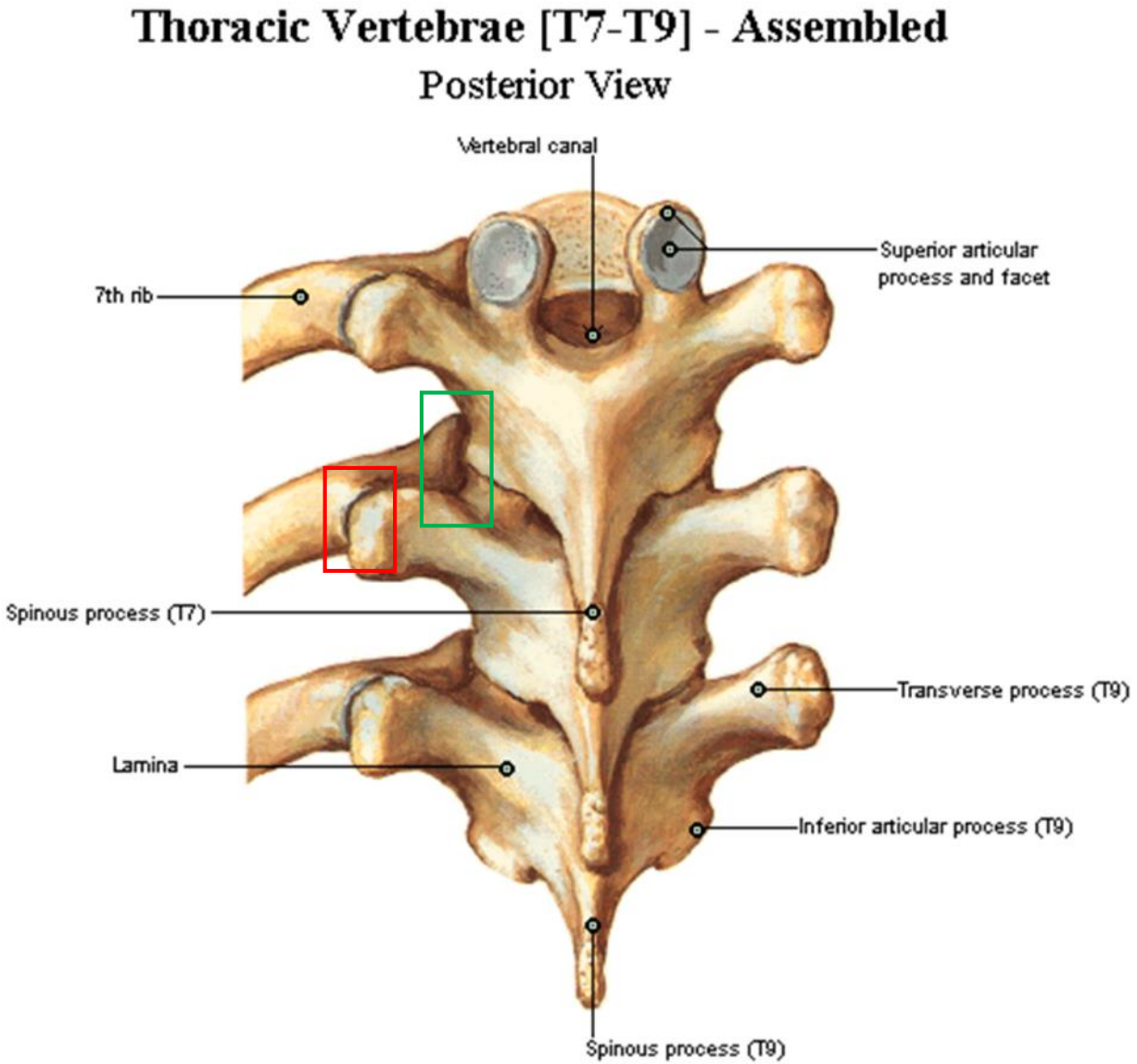
From the posterior view, let's understand better:

8th RIB – 8th VERTEBRA

a) **TUBERCLE** articulates with the TRANSVERSE PROCESS

b) HEAD ARTICULATES WITH 2 VERTEBRAE:
1. mainly with the same numbered vertebra (i.e. rib 8, vertebra 8)
2. To a lesser degree, with the next higher vertebra (i.e. rib 8 vertebra 7)

HOW ARE THE RIBS and THORACIC VERTEBRAE ARTICULATED POSTERIORLY?



To resume:

The tubercle of the rib articulates with the facet located on the transverse process of the same numbered vertebra.

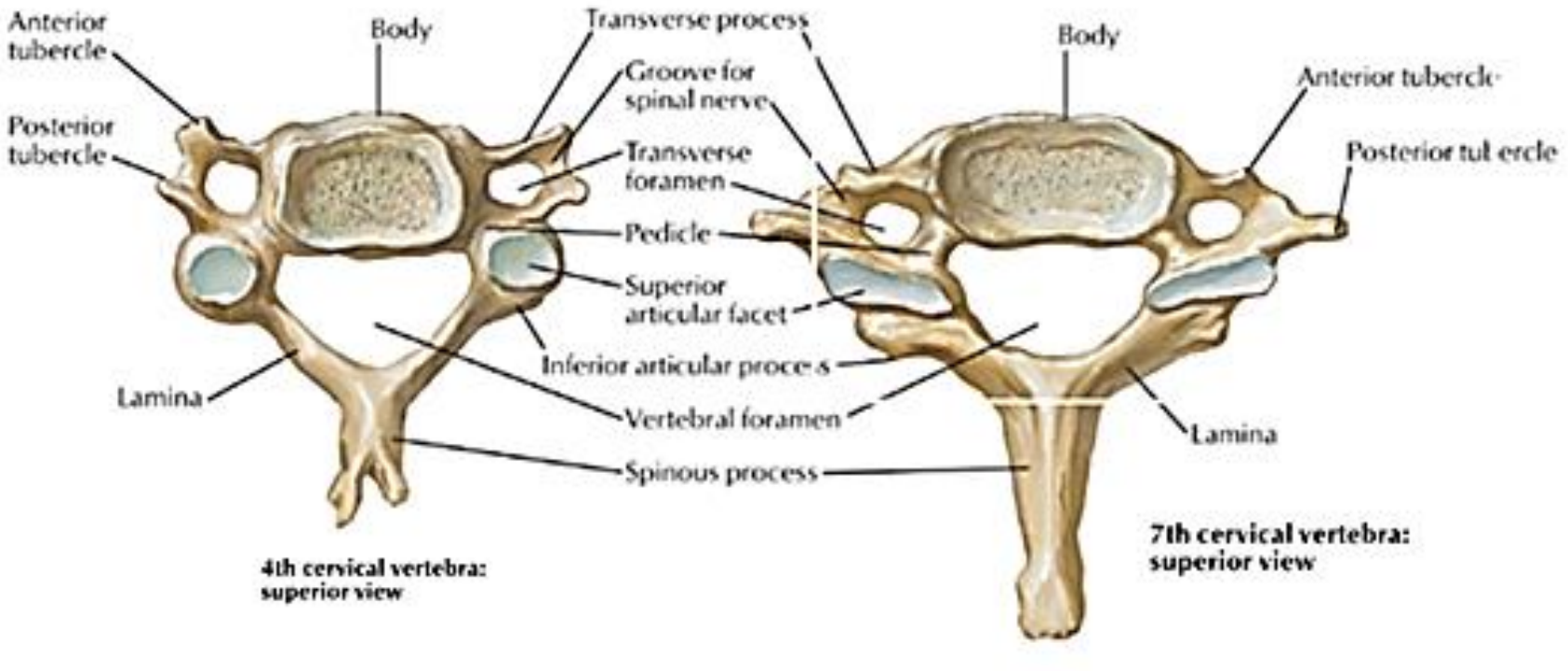
The head of the rib articulates primarily with the costal facet located on the body of the same numbered thoracic vertebra and to a lesser degree, with the costal facet located on the body of the next higher vertebra.

AXIAL SKELETON – The vertebral column

CERVICAL VERTEBRAE

THE VERTEBRAL COLUMN – Cervical vertebrae

The cervical spine consists of 7 vertebrae which present the same basic organization as the lumbar and thoracic v.:
clearly there are no articular costal facets



STRUCTURE

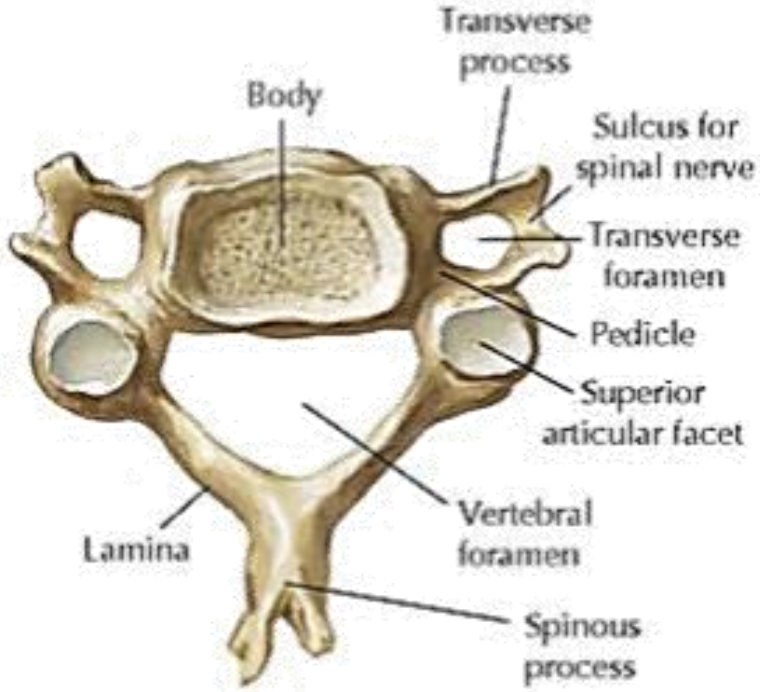
- ANTERIOR VERTEBRAL BODY

- POSTERIOR VERTEBRAL ARCH consisting of:

a) 2 pedicles
b) 2 laminae
c) spinous process
d) transverse processes
e) superior articular facets
f) inferior articular facets

THE VERTEBRAL COLUMN – Cervical vertebrae

WHAT ARE THE DIFFERENCES WITH RESPECT TO THE LUMBAR VERTEBRAE?



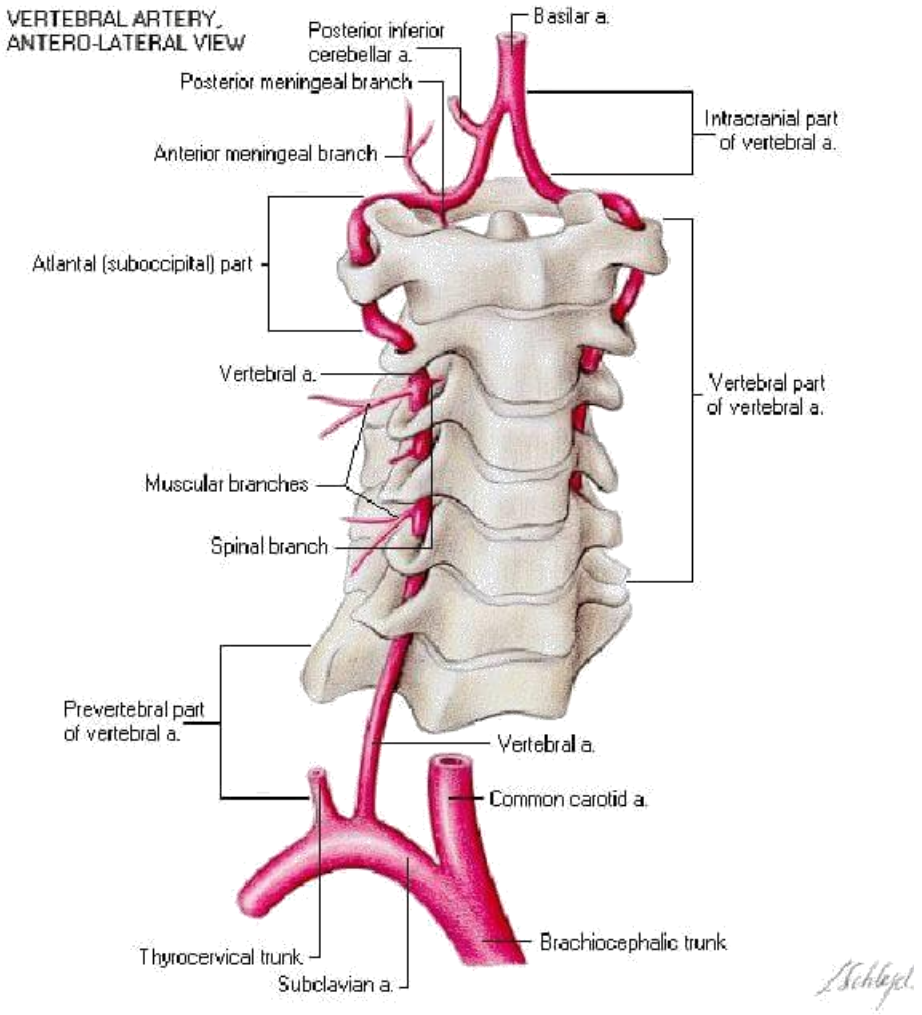
4th cervical vertebra: superior view

Cervical vertebrae: lateral view

- **DIMENSION** (smaller)

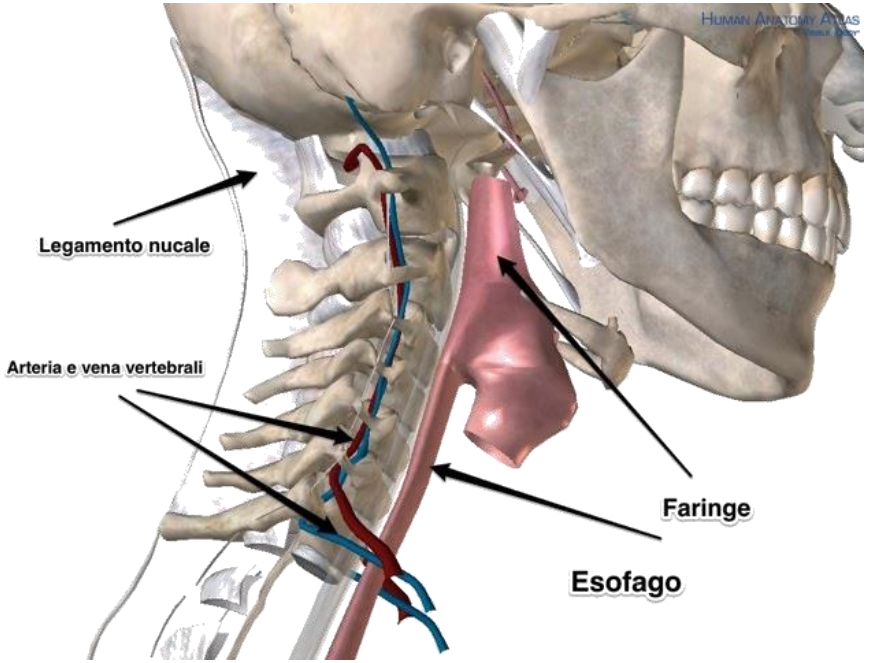
- **MORE COMPLEX MORPHOLOGY OF TRANSVERSE PROCESSES**
  Each has a **FORAMEN TRANSVERSARIUM or TRANSVERSE FORAMEN**
  All together, the transverse foramina form a canal through which the vertebral vessels (i.e. vertebral artery and vertebral vein) pass.

THE VERTEBRAL COLUMN – Cervical vertebrae



VERTEBRAL ARTERY → Enters C6 and goes from C6 to C1 along the transverse foramina, both on the right and left sides

VERTEBRAL VEIN → It runs downwards, starting from C1 and also passes through C7

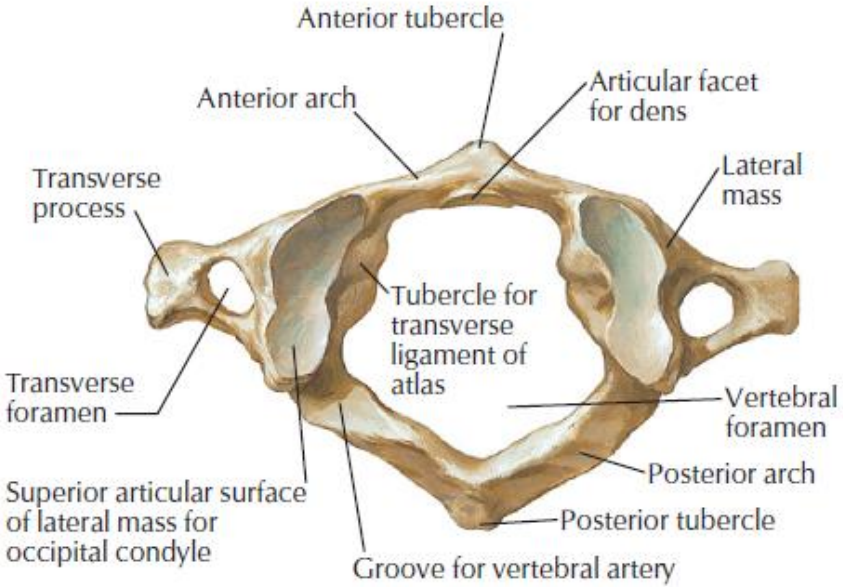


The vertebral arteries will enter the cranial cavity and contribute to the vascularization of the brain. The other two arteries that supply the brain are the two internal carotid arteries.

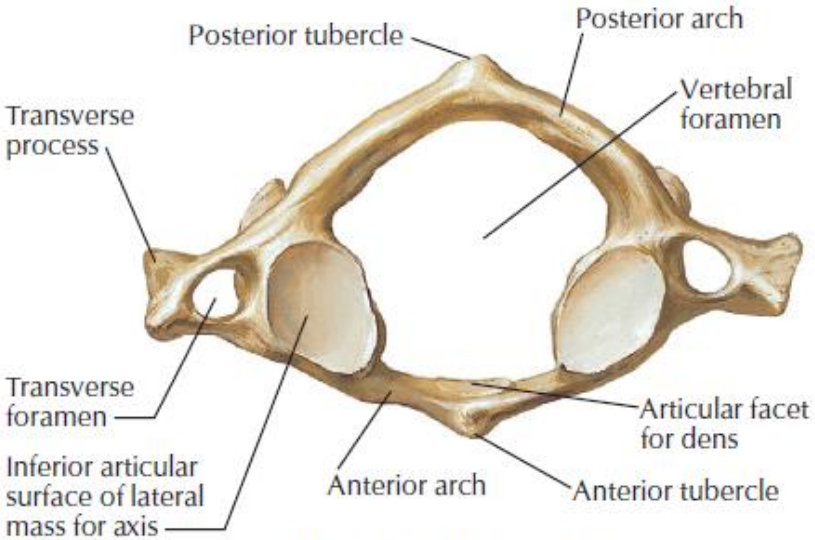
C1 AND C2 ANATOMY

C1 → ATLAS

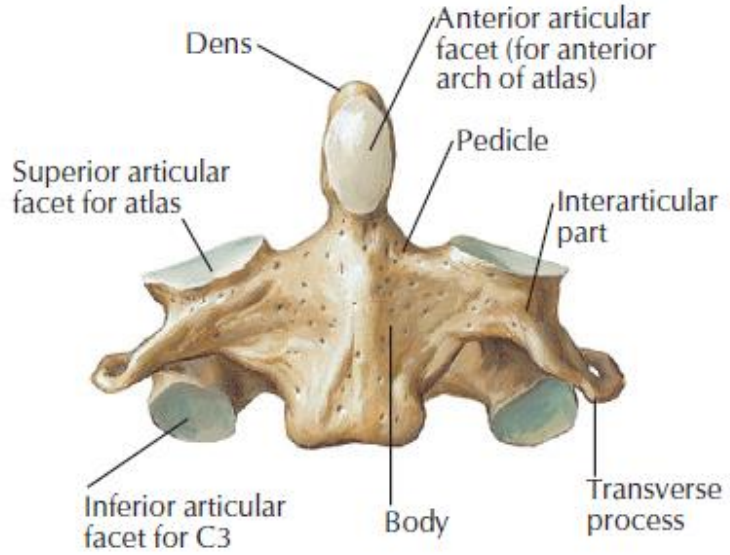
C2 → AXIS



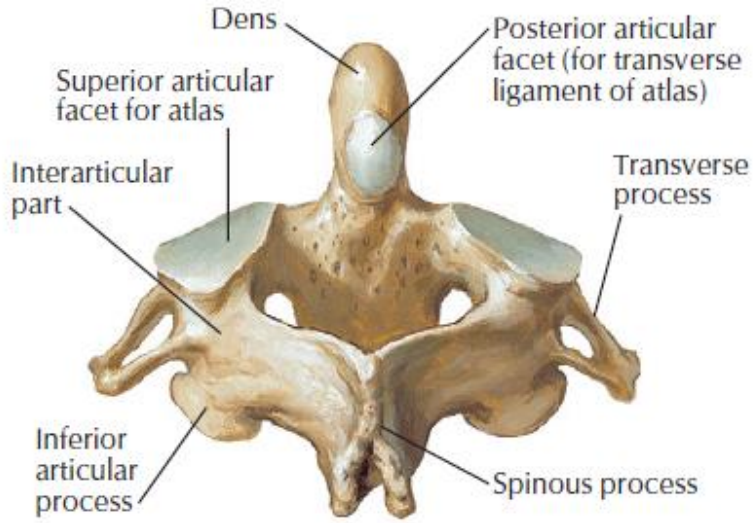
Atlas (C1): superior view



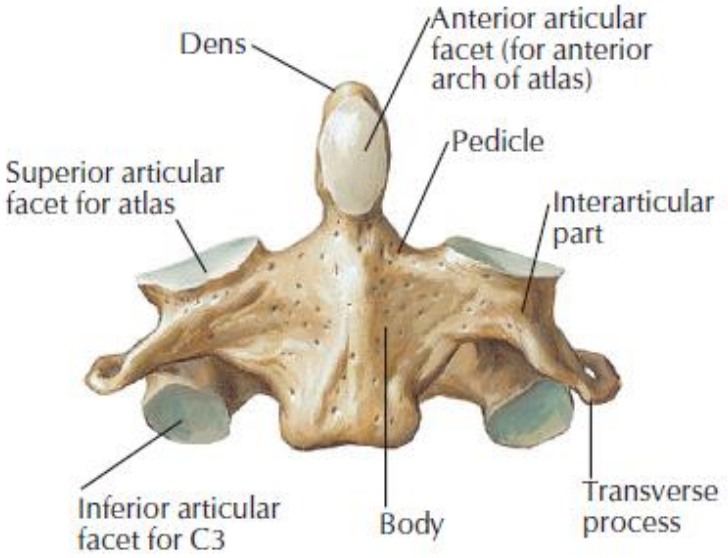
Atlas (C1): inferior view



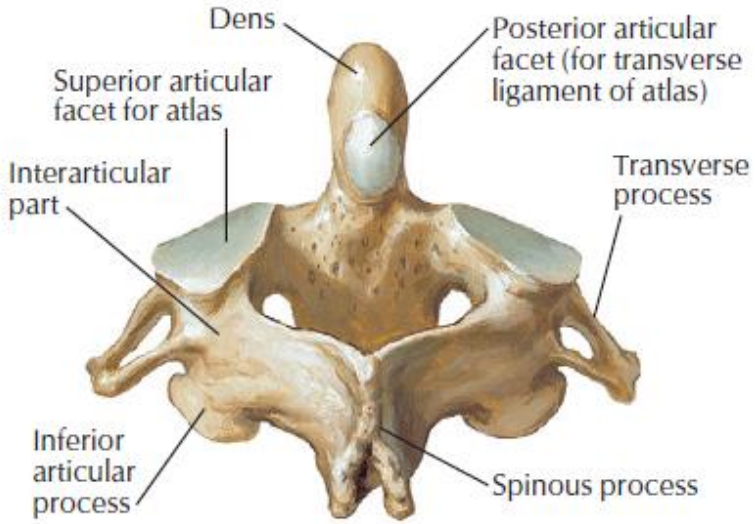
Axis (C2): anterior view



Axis (C2): posterosuperior view



Axis (C2): anterior view



Axis (C2): posterosuperior view

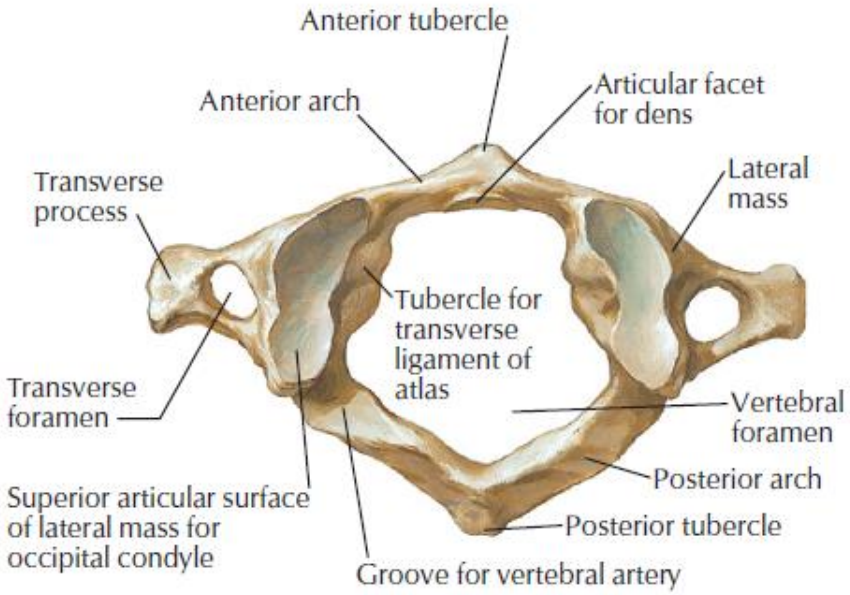
C2 → AXIS

STRUCTURE

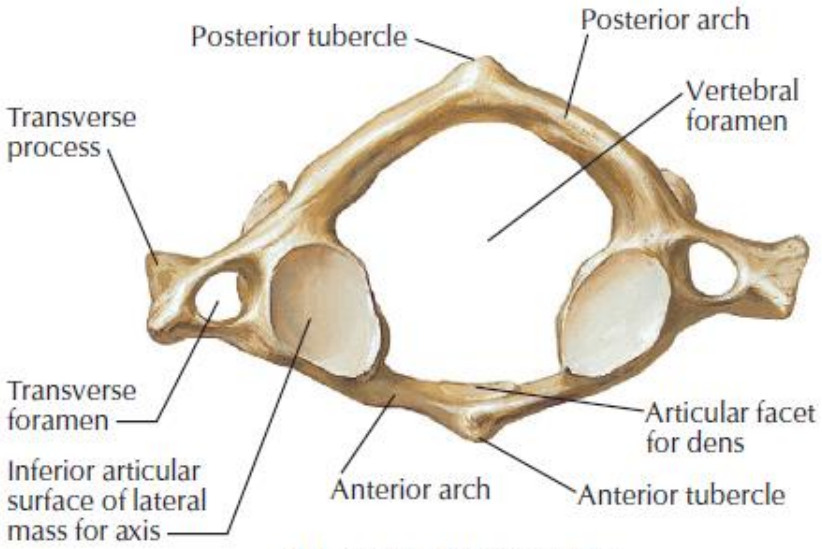
- **The organization is the same as the cervical vertebrae** with the presence of the transverse foramen

- However, it presents an additional process of elliptical shape which, starting from the upper side of the vertebral body, extends upwards and is called the **DENS OF THE AXIS or ODONTOID PROCESS**

THE VERTEBRAL COLUMN – Cervical vertebrae



Atlas (C1): superior view



Atlas (C1): inferior view

C1 → ATLAS

Different morphology! The vertebral body is absent!

STRUCTURE

- **POSTERIOR ARCH**, with two portions that correspond to the laminae in the other vertebrae

↓

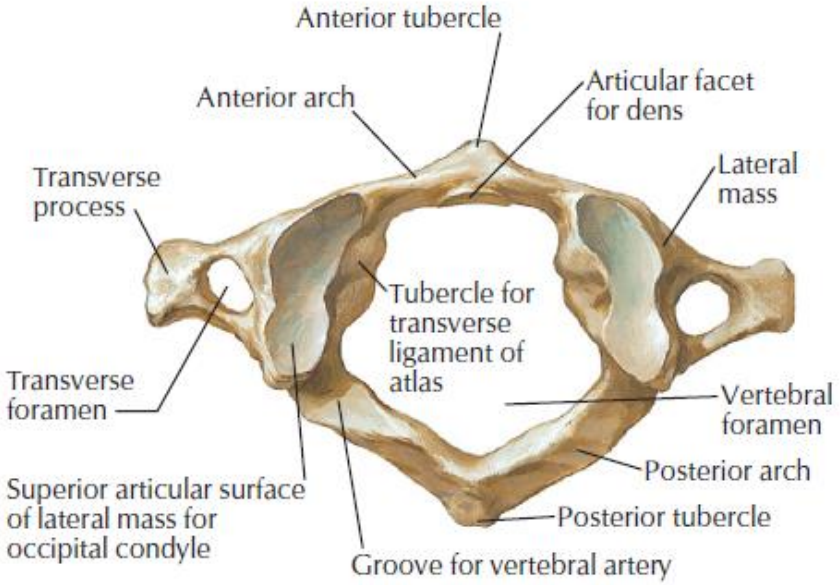
It presents a **POSTERIOR TUBERCULE** which in the other vertebrae corresponds to the spinous process

ANTERIOR ARCH, which presents an anterior tubercle

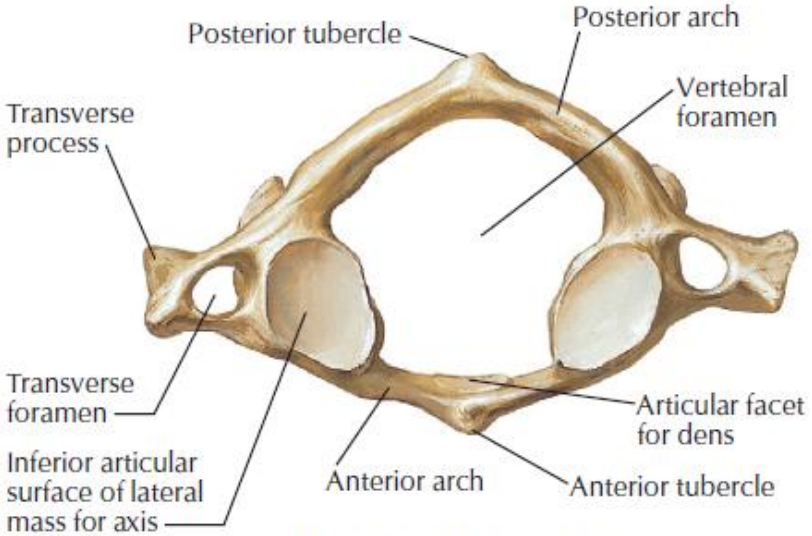
↓

the vertebral body is absent because the body of the Atlas fused with the body of the Axis during development, giving rise to the Dens of the Axis

THE VERTEBRAL COLUMN – Cervical vertebrae



Atlas (C1): superior view



Atlas (C1): inferior view

C1 → ATLAS

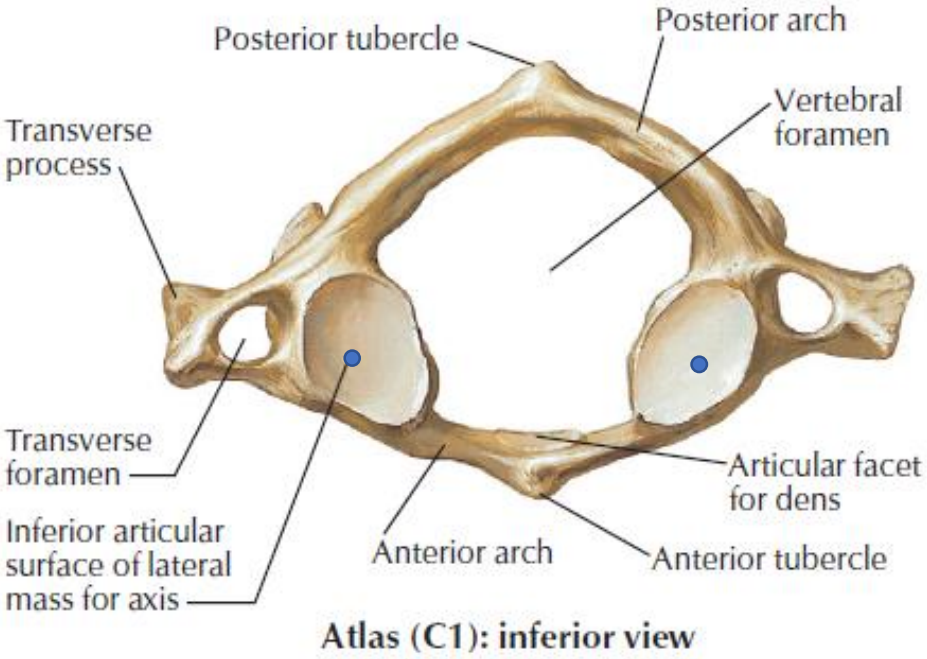
Different morphology! The vertebral body is absent!

Anterior arch and posterior arch continue laterally with:

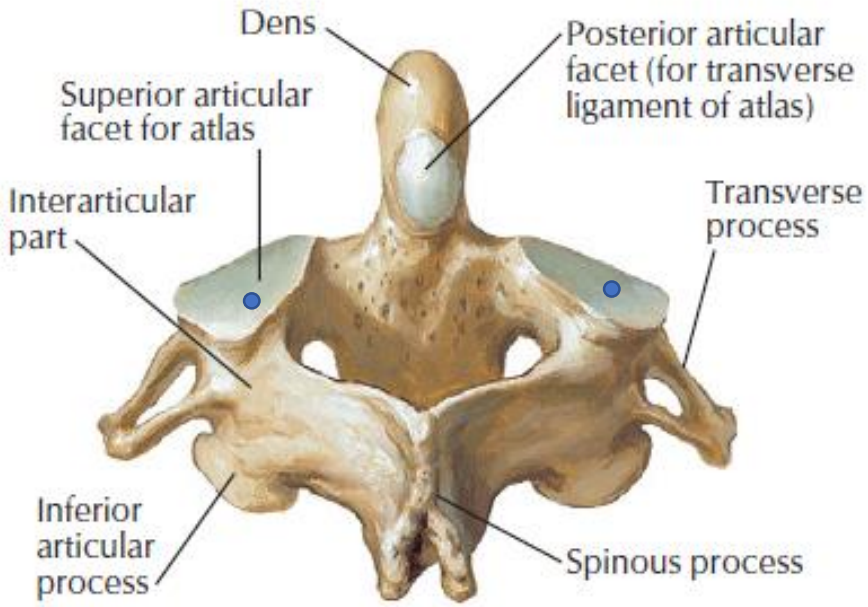
- **2 LATERAL MASSES OF THE ATLAS**, characterized by two superior articular surfaces and two inferior articular surfaces

- **2 TRANSVERSE PROCESSES** which extend laterally (similar to those seen for the other cervical v.) starting from the two lateral masses

C1 JOINTS



Atlas (C1): inferior view



Axis (C2): posterosuperior view

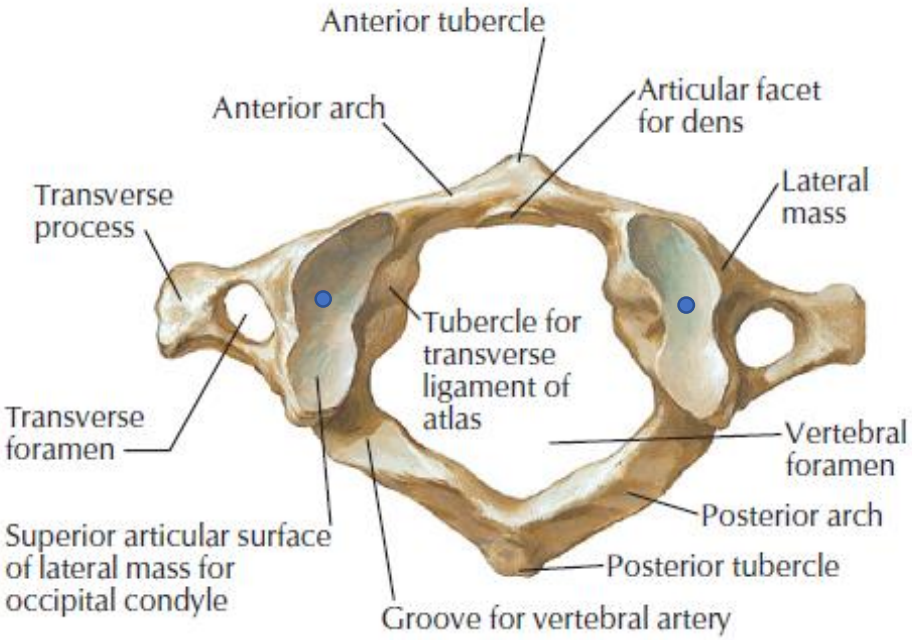
THE 2 INFERIOR ARTICULAR SURFACES OF THE ATLAS

articulate with

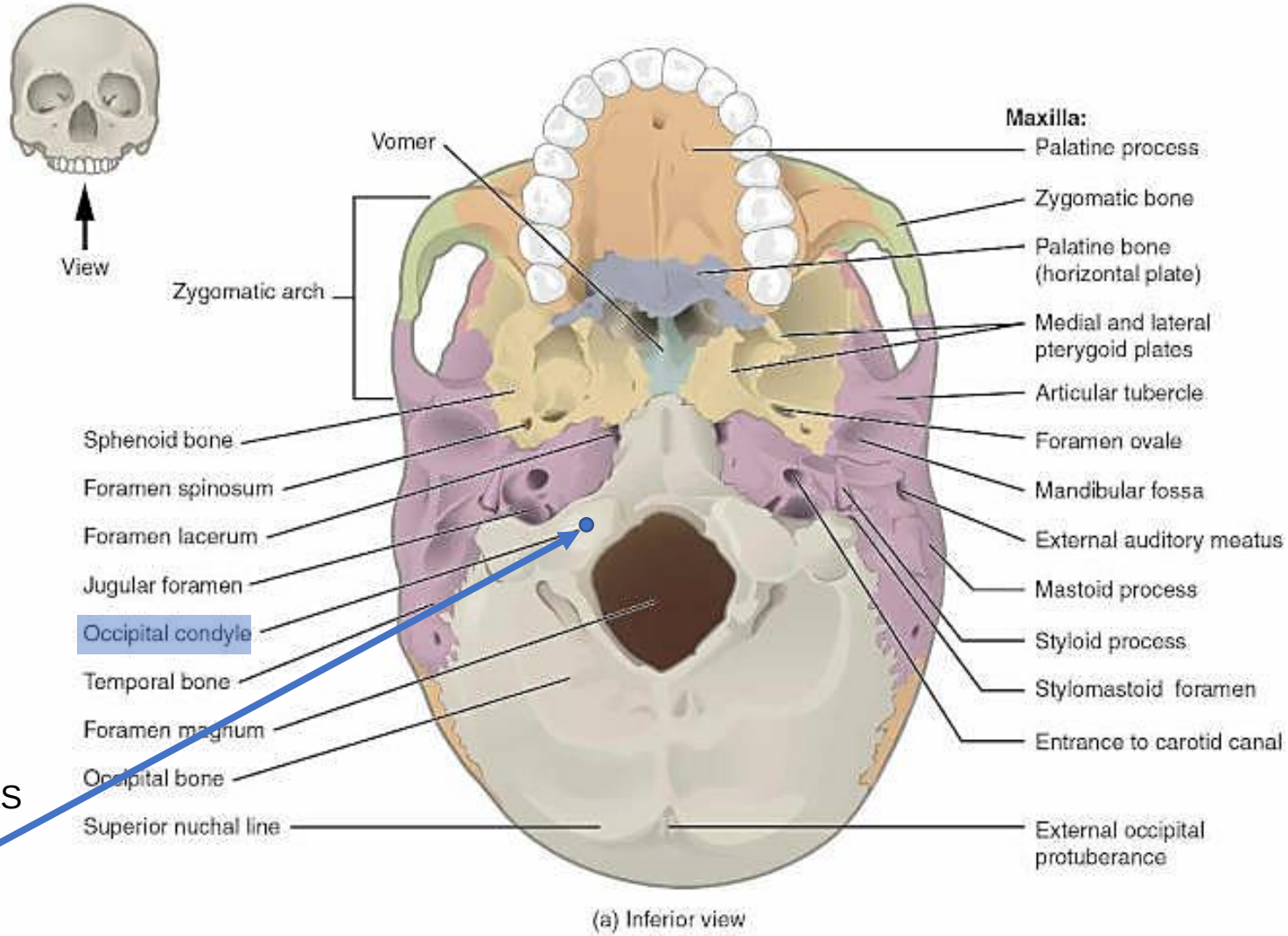
THE 2 SUPERIOR ARTICULAR SURFACES OF THE AXIS

THE VERTEBRAL COLUMN – Cervical vertebrae

C1 JOINTS



Atlas (C1): superior view



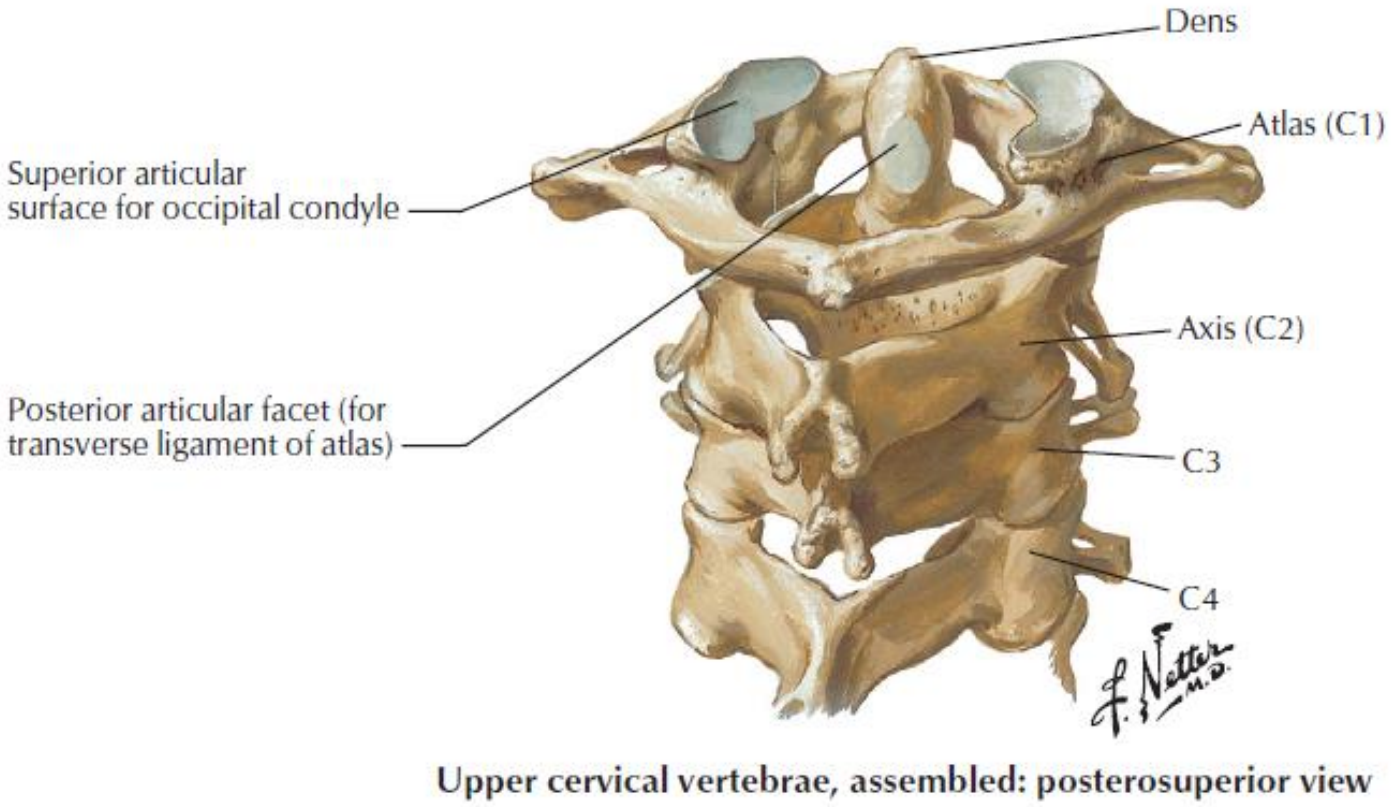
(a) Inferior view

THE 2 SUPERIOR ARTICULAR SURFACES OF THE ATLAS

articulate with

THE SKULL, through the OCCIPITAL CONDYLES

C1-C2 JOINT



Upper cervical vertebrae, assembled: posterosuperior view

The Dens of the Axis is placed immediately behind the anterior arch of the Atlas;
It is therefore placed in the space delimited by the arches and lateral masses of the Atlas and is placed in relation with its anterior arch

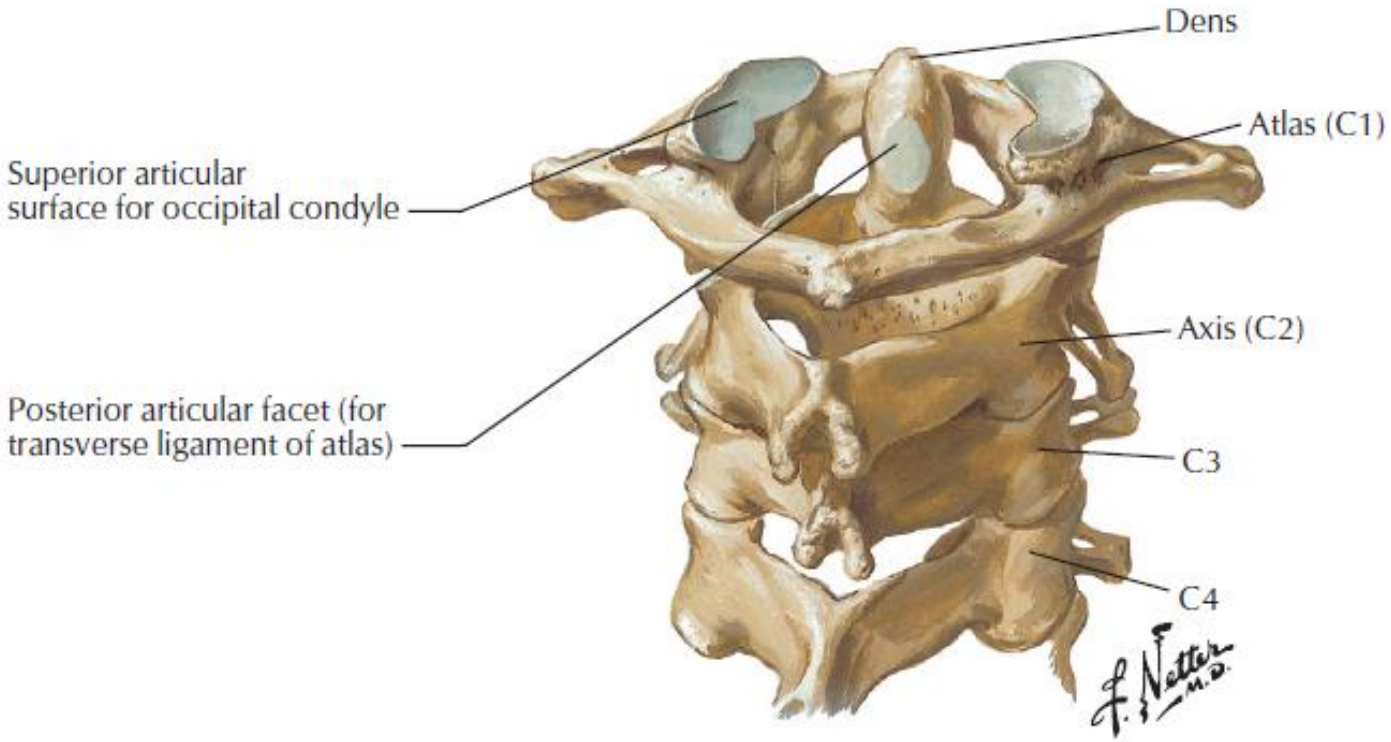
↓

The anterior side of the Dens has an articular surface that articulates with the posterior side of the anterior arch of the Atlas

Another recognizable articular facet:
here the **TRANSVERSE LIGAMENT OF THE ATLAS** passes from a lateral mass of the Atlas to the contralateral one, running behind the Dens and keeping contact with its posterior surface.

Dens of Axis: it articulates with the anterior arch and is related to the transverse ligament of the Atlas

C1-C2 JOINT



Upper cervical vertebrae, assembled: posterosuperior view

To resume:

The articulation between Atlas and Axis is:

At the level of the inferior articular surfaces of C1/superior articular surfaces of C2, on the right and left sides
Between the Dens of the Axis and the anterior arch of the Atlas/transverse ligament of the Atlas

↓

This last joint is crucial for the
ROTATIONAL MOVEMENT OF THE HEAD ON THE NECK

ANATOMY AND PHYSIOLOGY (C.I.)

HUMAN ANATOMY
(Mod. A)

THE SKELETON