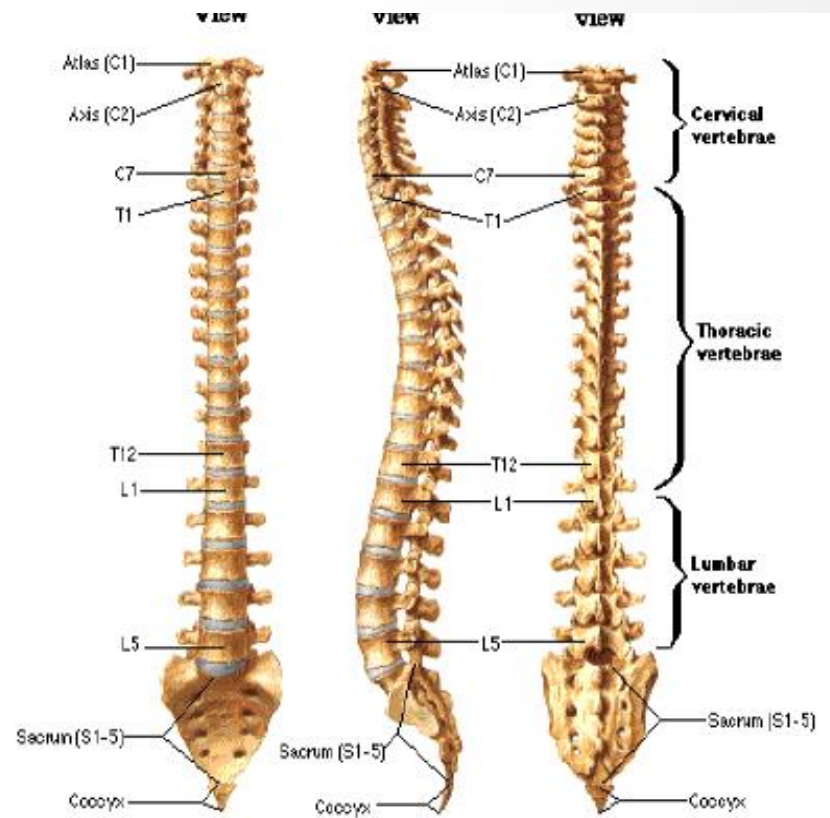


The Vertebral Column, The Ribs and The Sternum

S. LAFCI FAHRİOĞLU, MD. PhD.

The Vertebral Column (Spine)



The Vertebral Column-The spine (Columna vertebralis)

- **forms the skeleton of the back**
- **is part of the axial skeleton**
- **consists of a number of bones called “vertebrae”**
 - which are united by a series of intervertebral joints
- **has an important role in posture**
- **in support of body weight**
- **in locomotion**
- **in protection of the spinal cord and spinal nerve roots**

The Vertebral Column-The spine (Columna vertebralis)

- **is stabilized by ligaments**
- **provides a partly rigid and partly flexible for the body**
- **provides a pivot for the head (spine lies between head and limbs)**
- **contains the spinal cord (medulla spinalis)**
- **in addition spinal cord**
 - **spinal nerve roots**
 - **Their coverings- (meninges are located within the vertebral canal)**

The Vertebral Column-The spine (Columna vertebralis)

- **The vertebral canal**
 - formed by the foramina in the successive vertebrae
 - it contains spinal cord
- **During sitting: the vertebral column transmits the weight of the body across the sacroiliac joints(SIJ)**
- **During standing: body weight is transferred from the SIJ to the acetabula and then to the femur**

The Vertebral Column-The spine (Columna vertebralis)

- **It is usually consist of 33(34) vertebrae**
 - 24 of them are movable is called "Presacral vertebrae"
 - 7 cervical (cerv.)
 - 12 thorasic (thor.)
 - 5 lumbar (lumb.)
 - is responsible for the vertebral column flexibility
 - 9 (10) of them are fixed in each parts
 - 5 – sacral vertebrae → **SACRUM**
 - 4 (5) – coccygeal vertebrae are fused → **COCCYX**
- 24 movable
- 9 (10) fixed

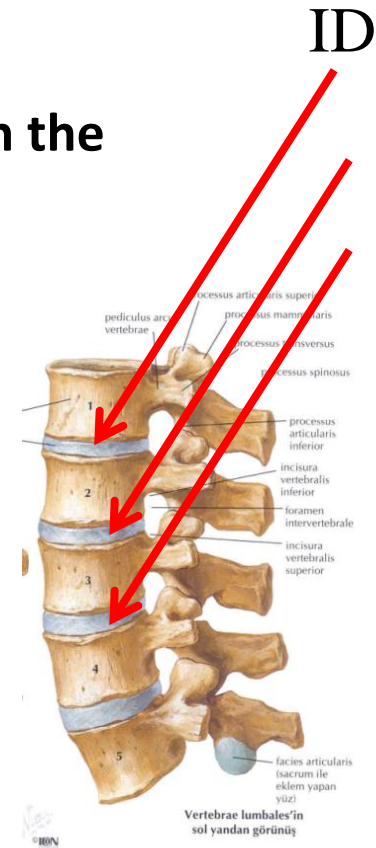
The Vertebral Column-The spine (Columna vertebralis)

- **Stability of the VC is provided by**
 - intervertebral disc
 - ligaments
 - muscles
 - the shape of vertebrae

The Vertebral Column-The spine (Columna vertebralis)

Vertebral column are supported by:

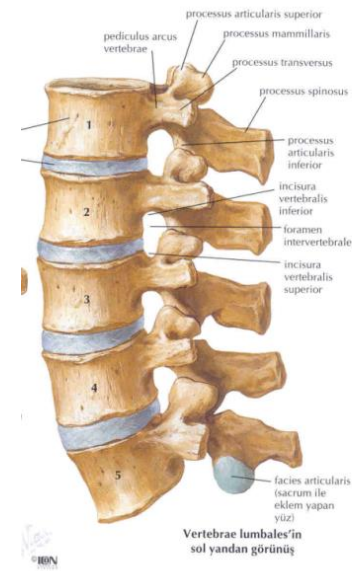
- **intervertebral disc-ID**
 - which play an important role in movements between the vertebrae
 - absorbing shocks
- **zygapophysial joints (between articular processes of vertebra)**
- **longitudinal ligaments**

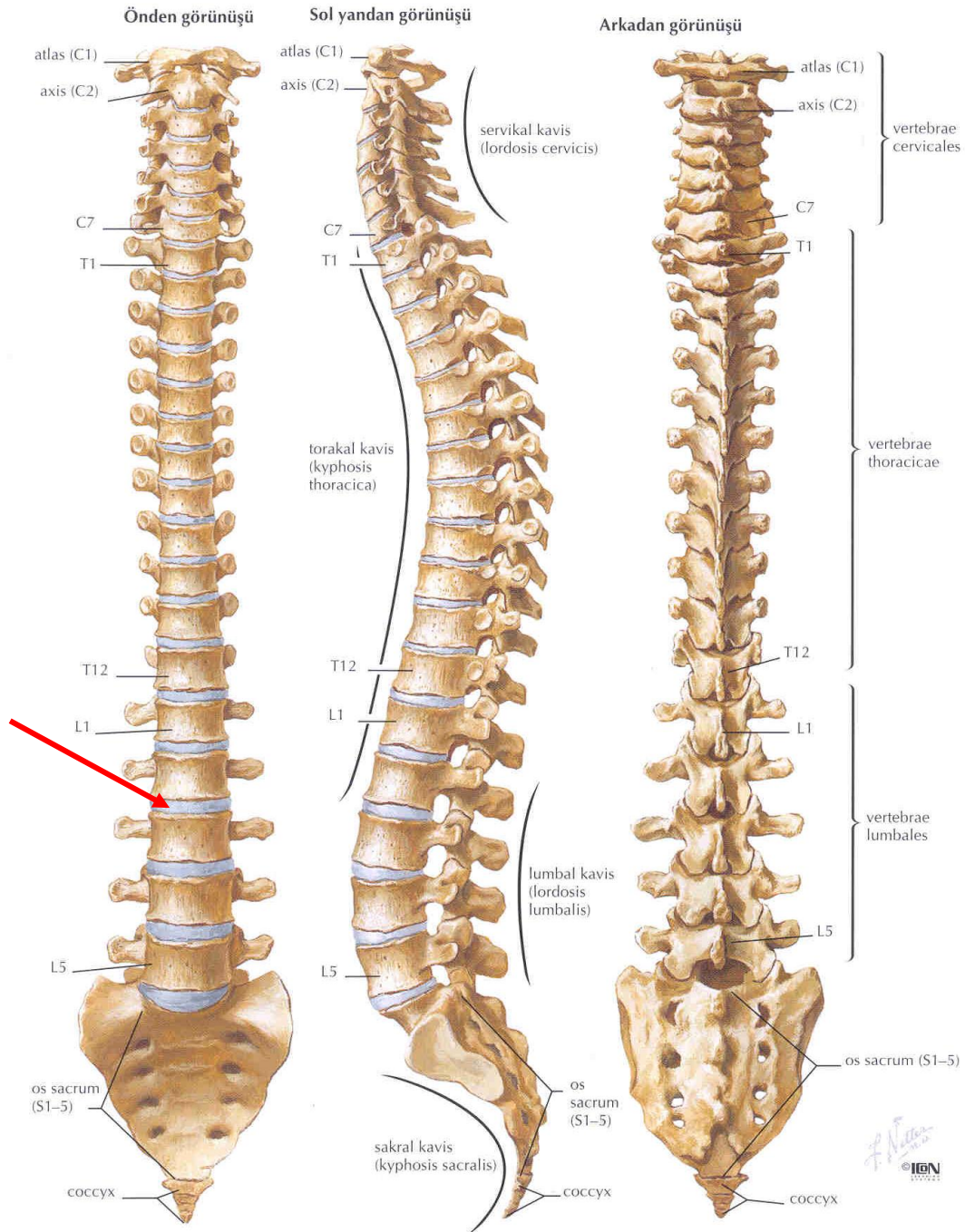


The Vertebral Column-The spine (Columna vertebralis)

- intervertebral disc
- zygapophysial joints
- longitudinal ligaments

**Prevent excessive
flexion and extension**

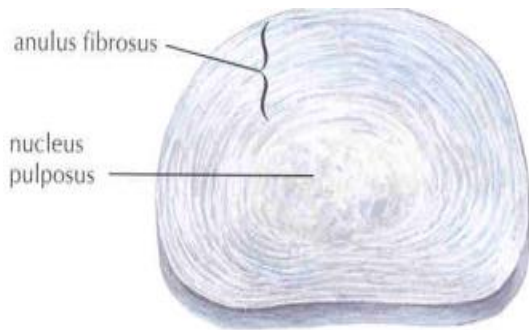




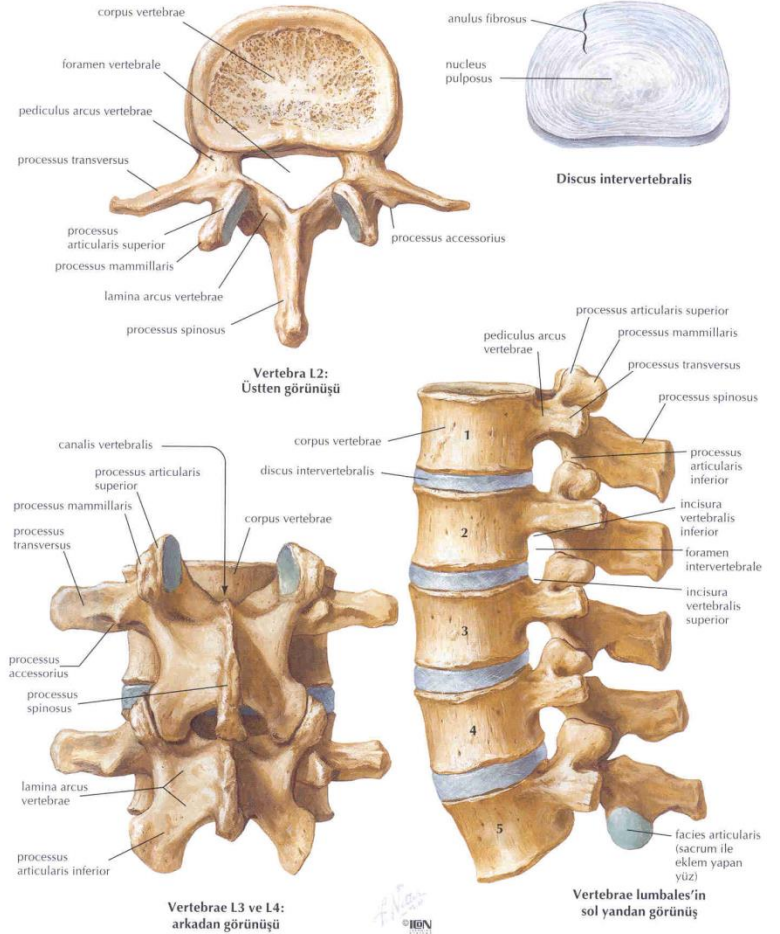
Intervertebral disc

- interposed between adjacent surfaces of the vertebral bodies
- provide the strongest attachment between the vertebrae.

- It has 2 main parts:
 - at the central: *nucleus pulposus*
 - around the nucleus pulposus: *anulus fibrosus*

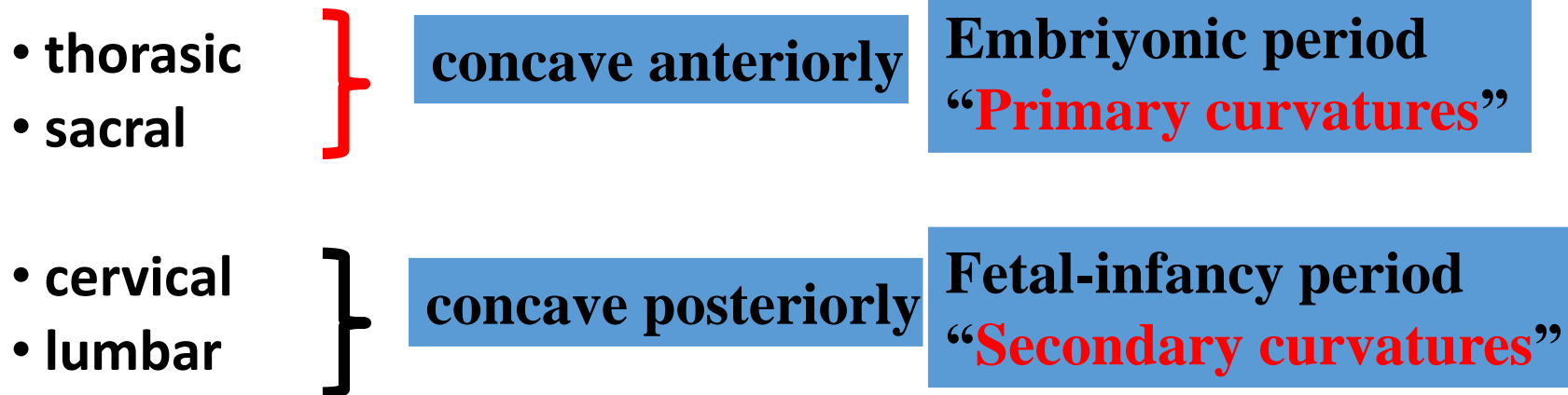


Discus intervertebralis

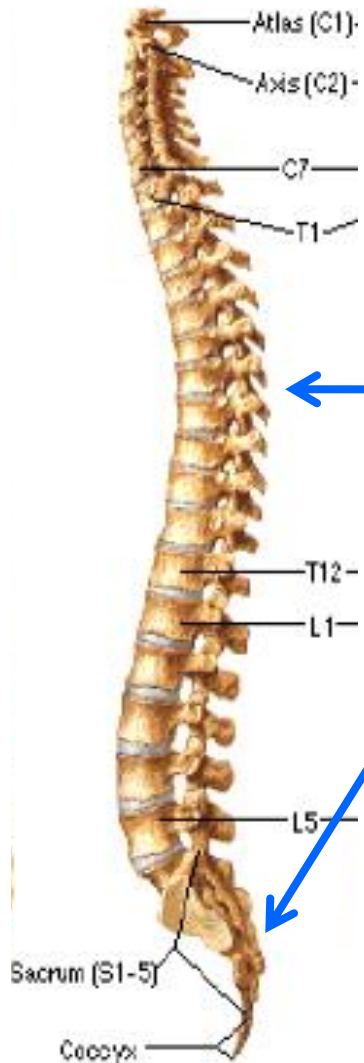


Curvatures of the vertebral column NORMALLY

- In adult lateral radiograph 4 anterioposterior curvatures are visible:



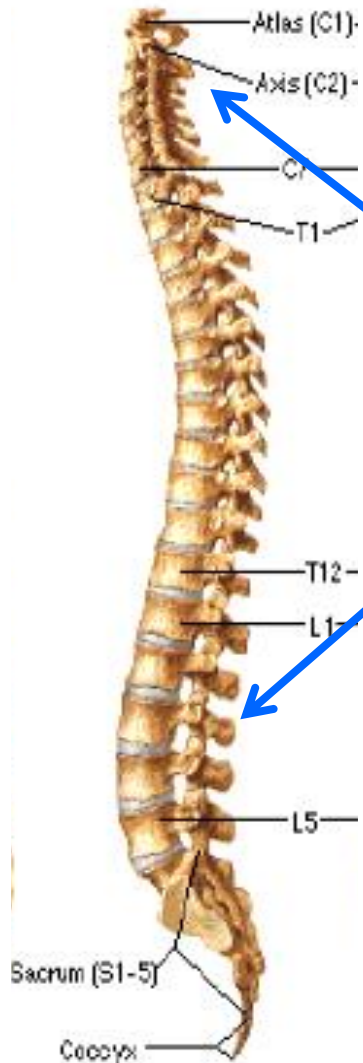
Curvatures of the vertebral column



thoracic

**Embryonic period
“Primary curvatures”**

sacral



**Cervical
curvature**

**when the child begins
to hold its head erect**

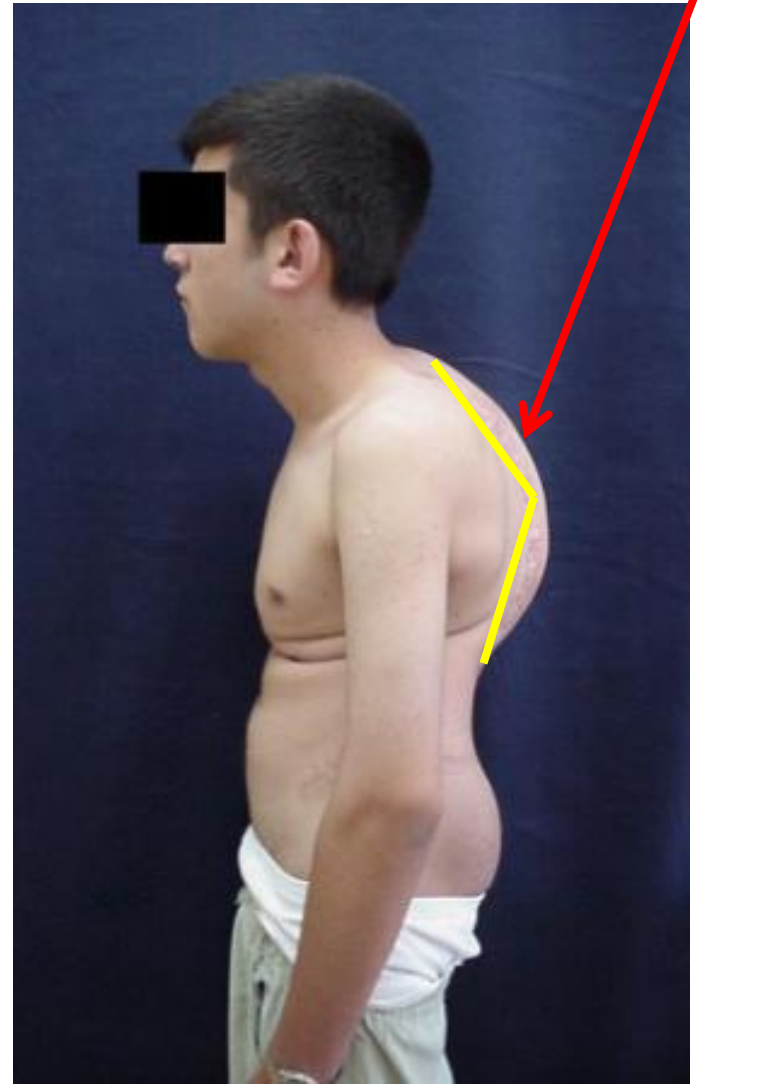
**Fetal-infancy period
“Secondary curvatures”**

**Lumbar
curvature**

when the child begins to walk

Curvatures anomalia of the vertebral column

- **Kyphosis:**
 - is the term used to describe an exaggeration in the sagittal curvature present in the thoracic part
 - it may be due to muscular weakness or structural changes in the vertebra and discs
 - Abnormal sitting posture and osteoporozis may lead to kyphosis



Curvatures anomalia of the vertebral column

- **Scoliosis:**

- is the term used to describe a lateral deviation of the vertebral column.
- abnormal curvature that is laterally
- The most common type of abnormal curvature
- Many case of scoliosis are of unknown origin, “idiopathic scoliosis”
- may result from an assymetric weakness of the vertebral muscle, is called “myopathic scoliosis”



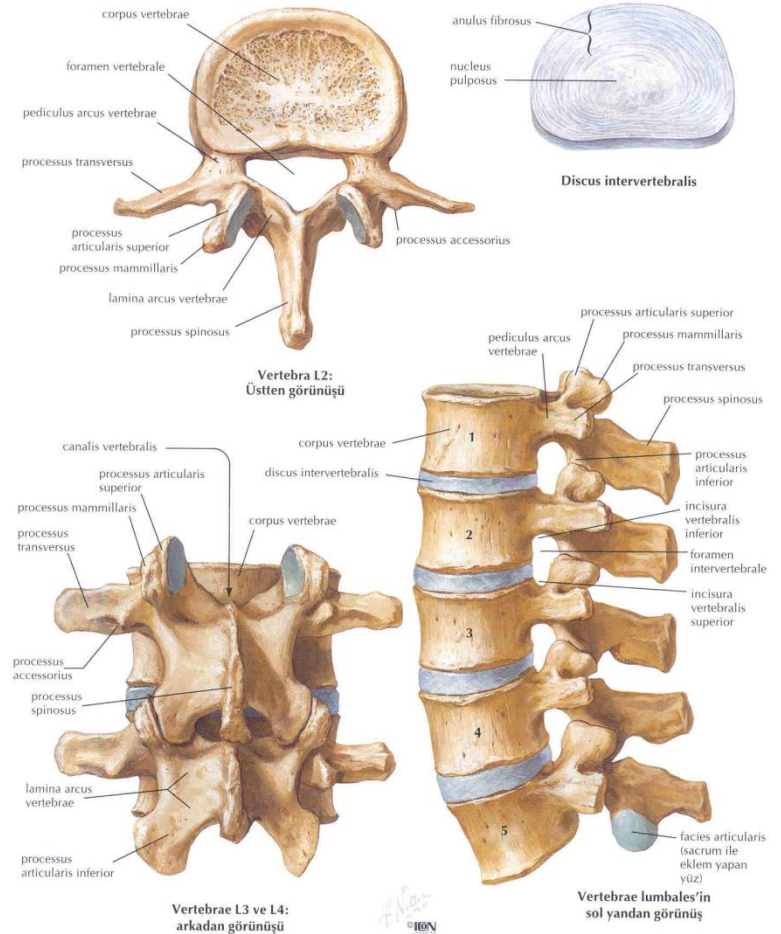
Curvatures anomalia of the vertebral column

- **Lordosis:**
 - abnormal curvature that is convex anteriorly
 - anterior curvature of the vertebral column
 - generally occurs in **lumbar region**
 - Pregnancy and extreme obesity can also result in temporary lumbar lordosis (After childbirth –loose weight it disappears)



The Vertebrae

- A typical vertebra is composed of two parts:
 - Body
 - Vertebral arch

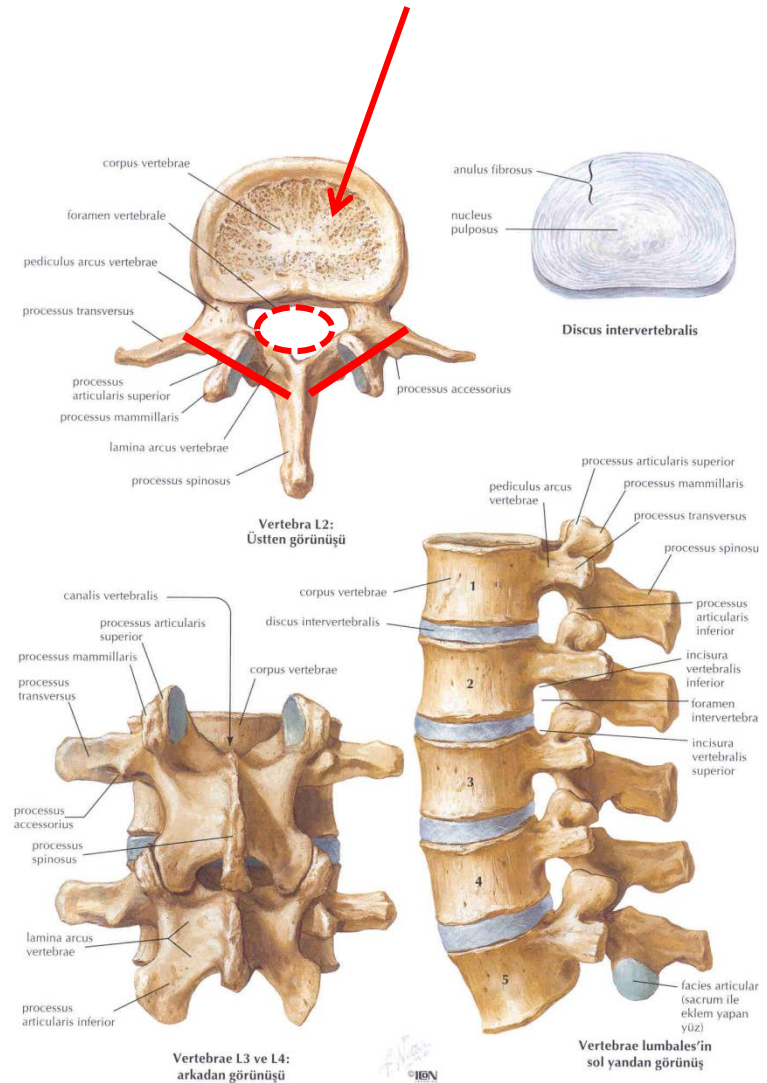


The Vertebrae

- A typical vertebra is consists of two parts:

- Body (anteriorly)
- Vertebral arch (posteriorly)

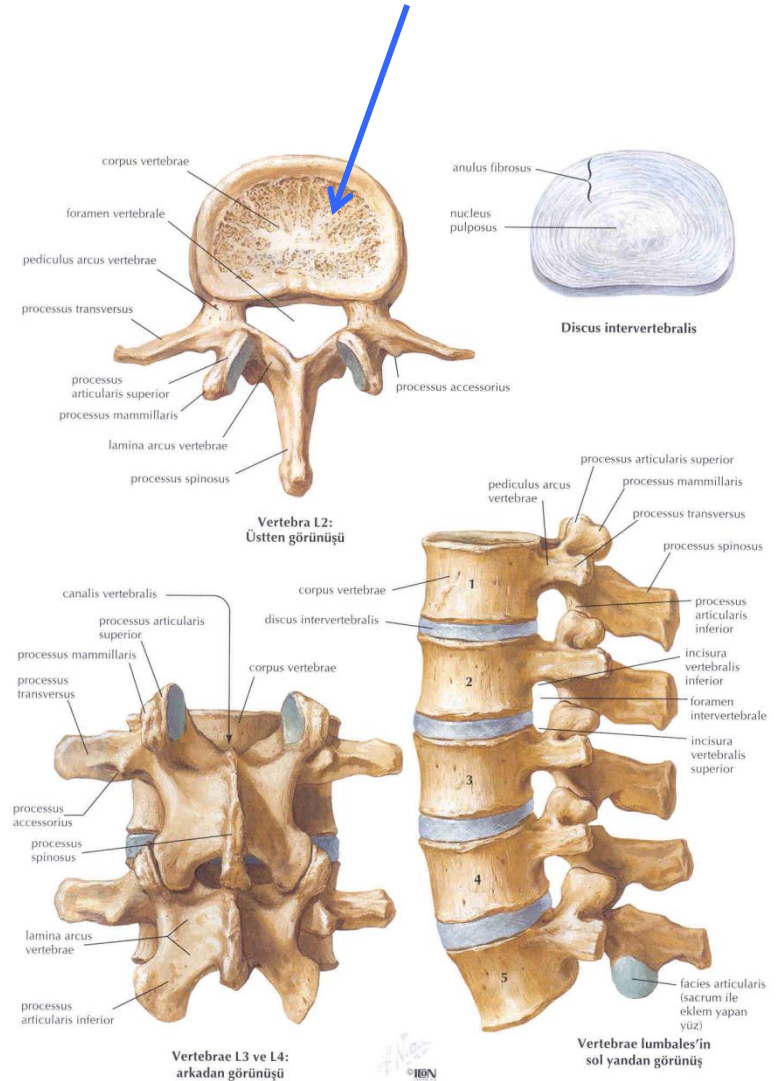
These enclose a space called the vertebral foramne



The Vertebrae

BODY:

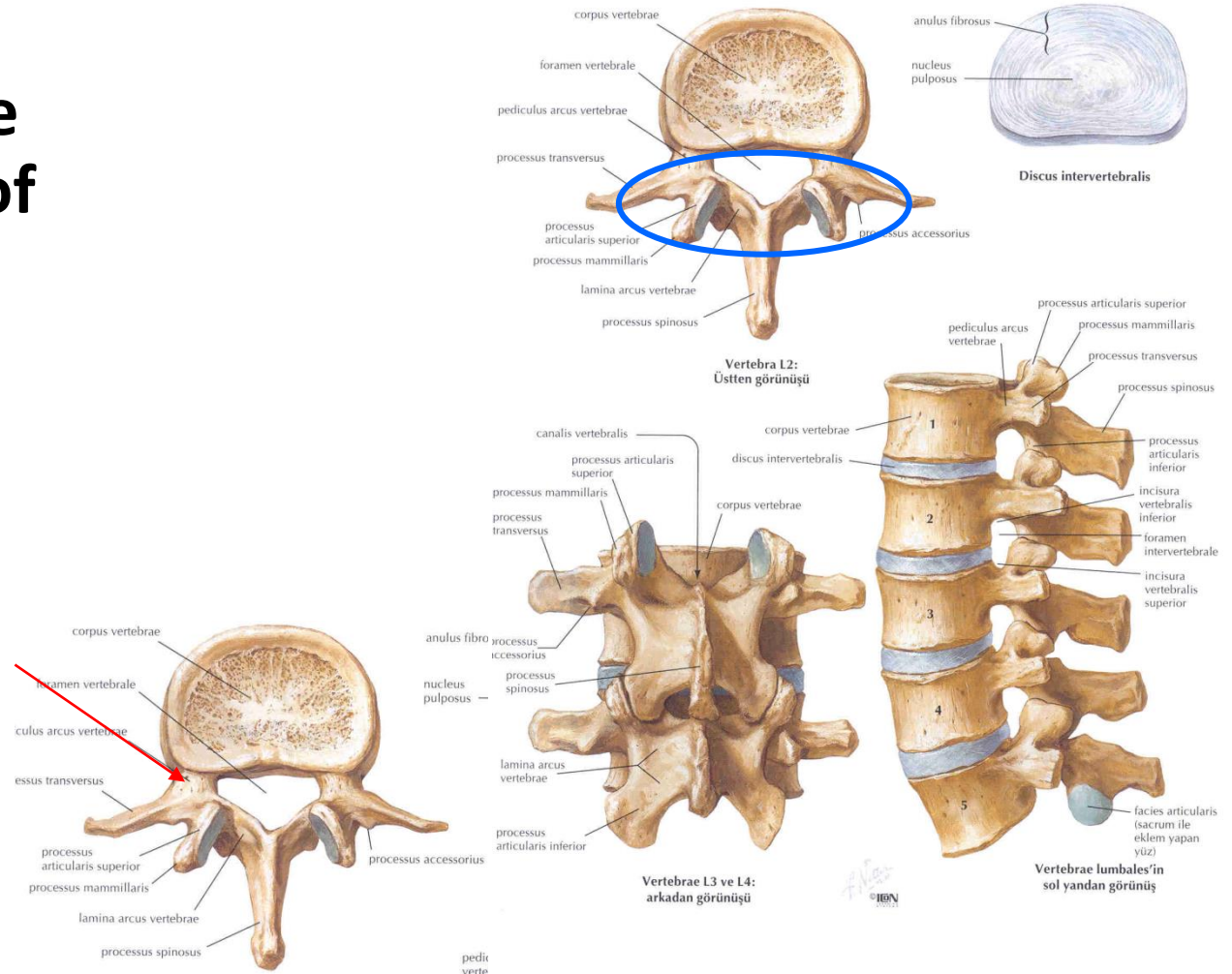
- Function of body is to support weight
- From C3 to S1 become progressively larger in order to bear progressively greater weight.



The Vertebrae

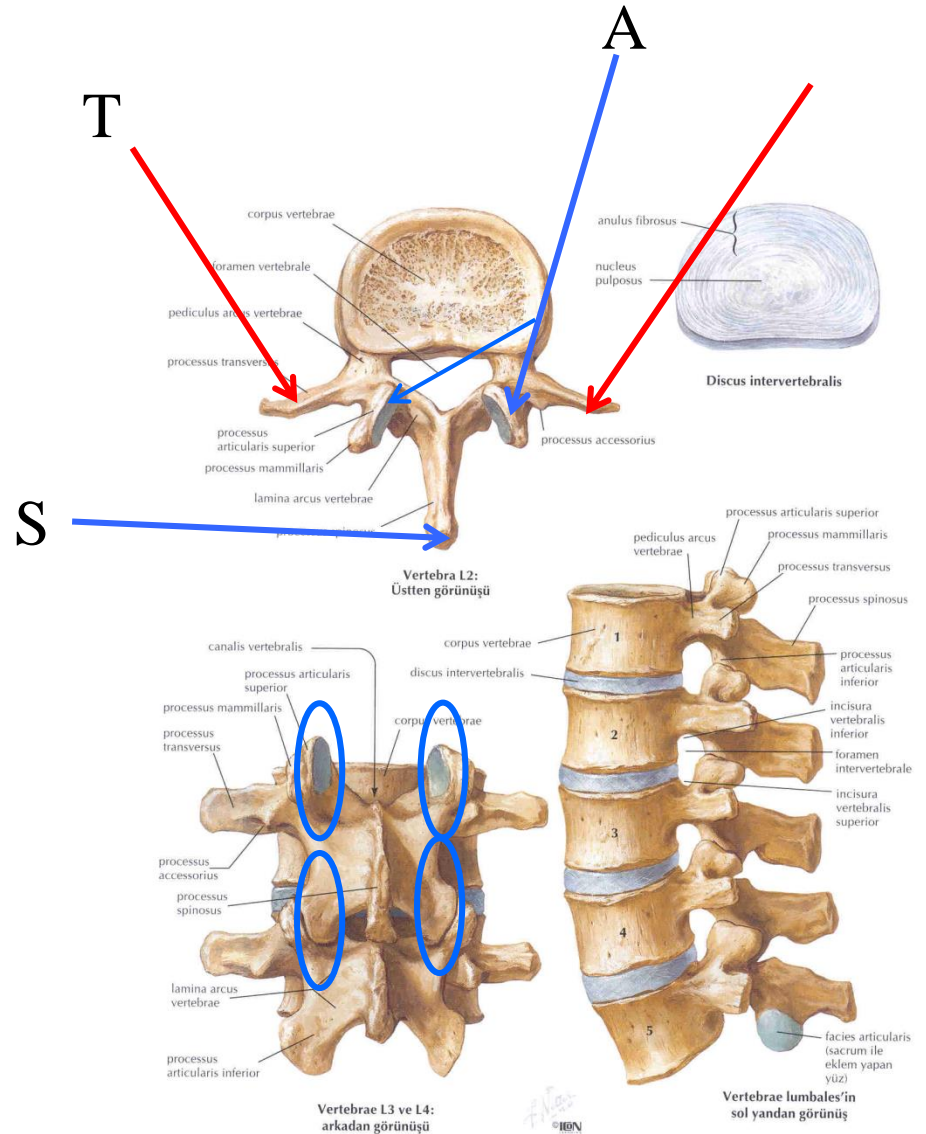
ARCH:

- is located at the posterior part of vertebra.
- it protects the neural tissues
- it is formed by
 - 2 pedicles
 - 2 lamina, complete the arch posteriorly



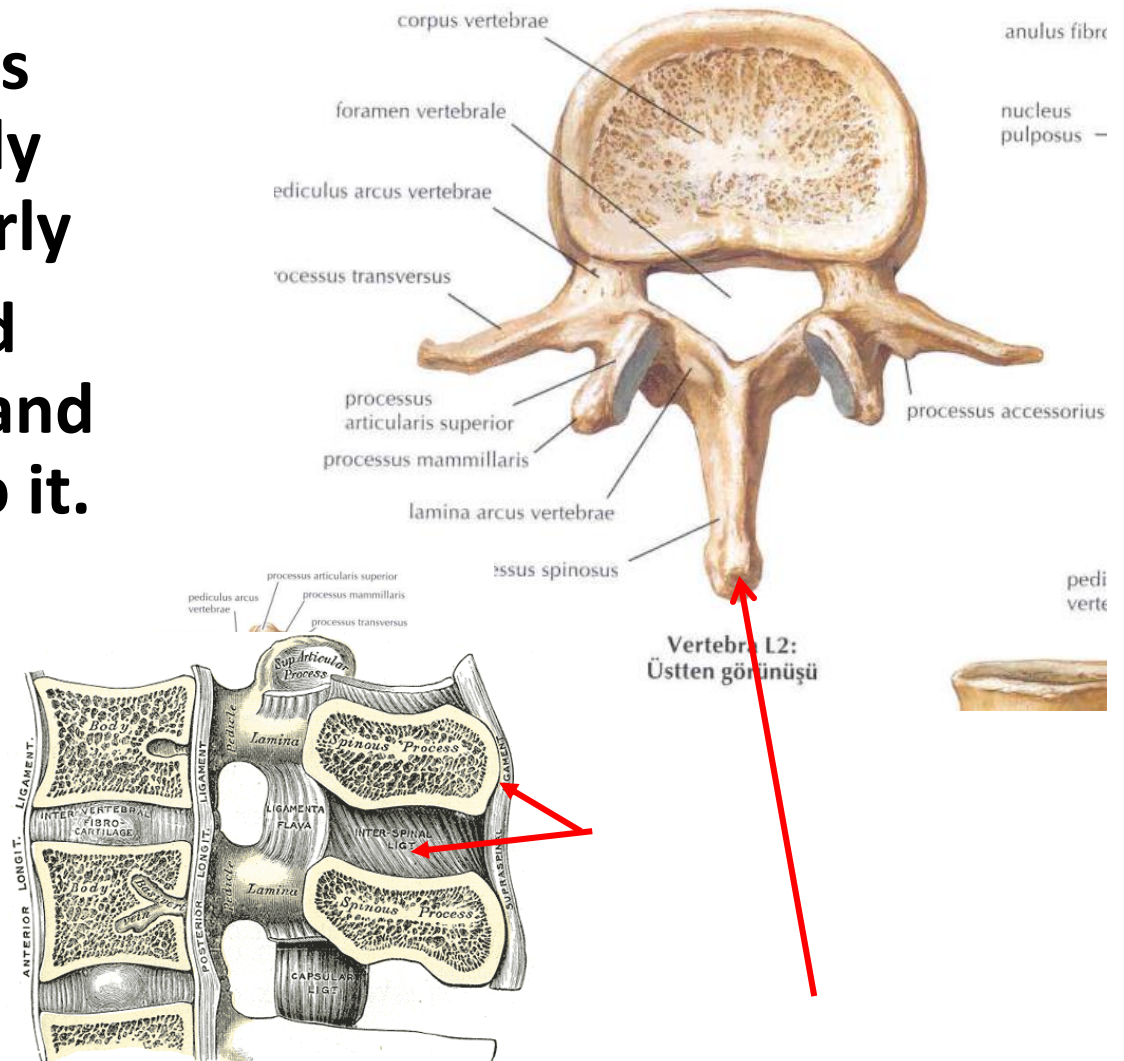
The Vertebrae

- 4 articular processes (2 sup, 2 inf.)
 - 2 transverse processes
 - 1 spinous process
- arise from the vertebral arch.
- **Muscles and ligaments attach to the spinous and transvers processes.**



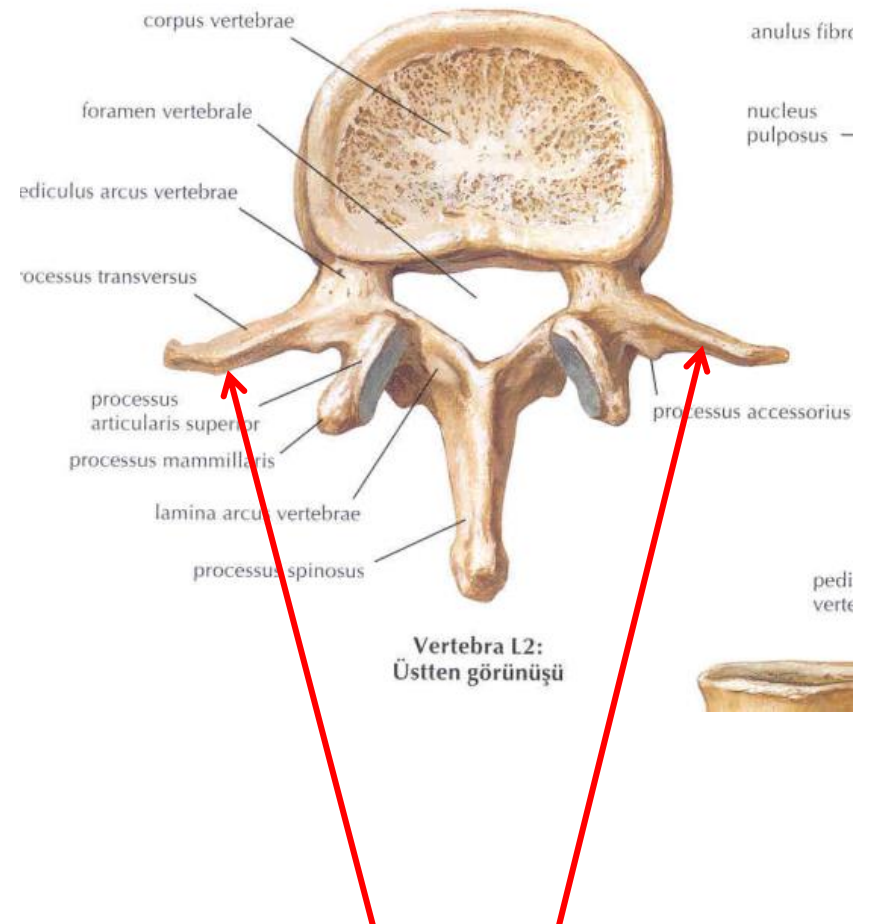
The Vertebrae

- Spinous processes project posteriorly or posteroinferiorly
- Supraspinous and interspinous lig. and muscles attach to it.
- it supports to vertebral column posteriorly



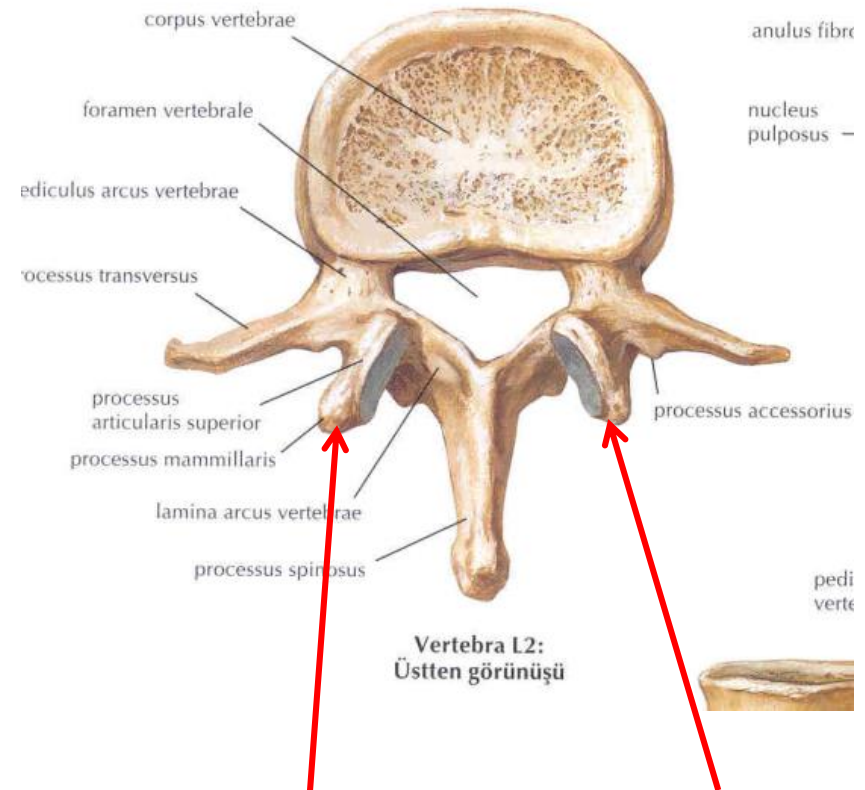
The transverse process

- Project laterally from the junction of pedicles and laminae
- It act as attachment for the muscles



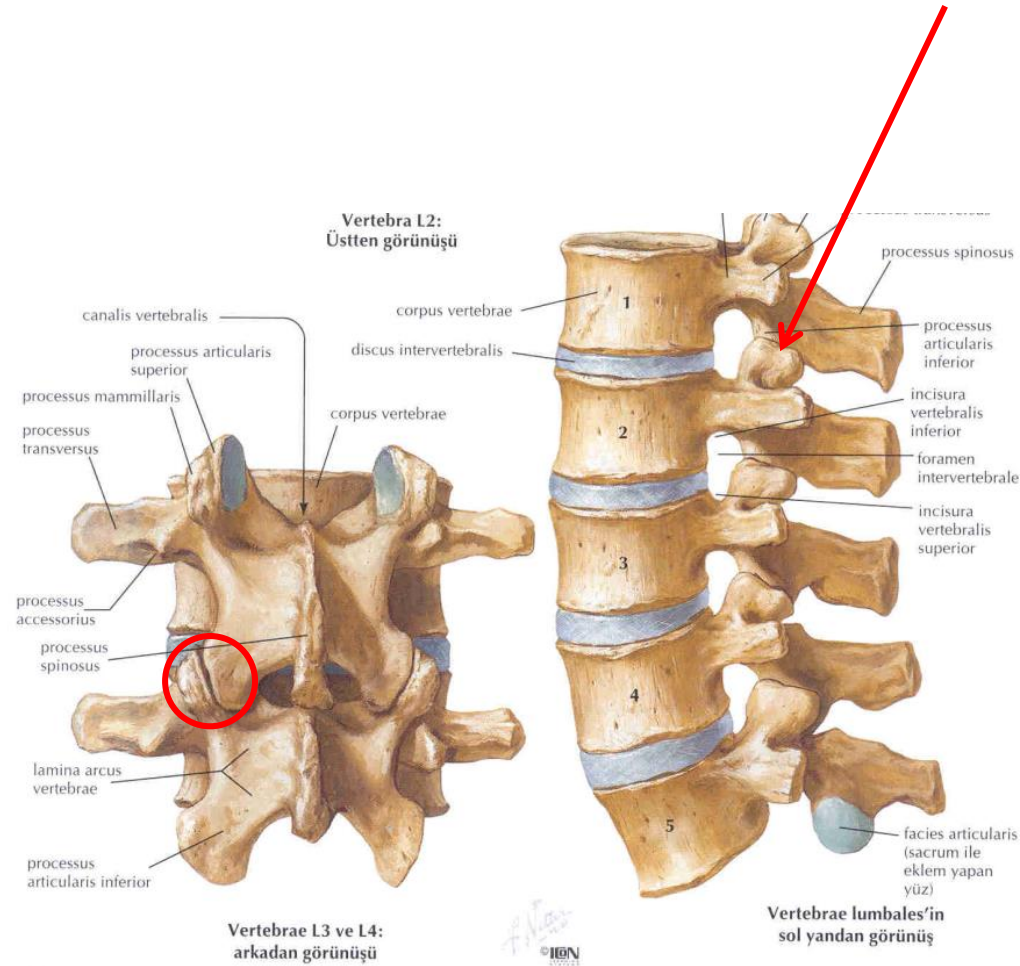
The articular process (zygapophysyses)

- arise from near the junction of pedicles and laminae
- each articular process has articular facet



The Vertebrae

- The contact between sup-inf articular process helps to prevent anterior movement of an superior vertebra on an inferior one.



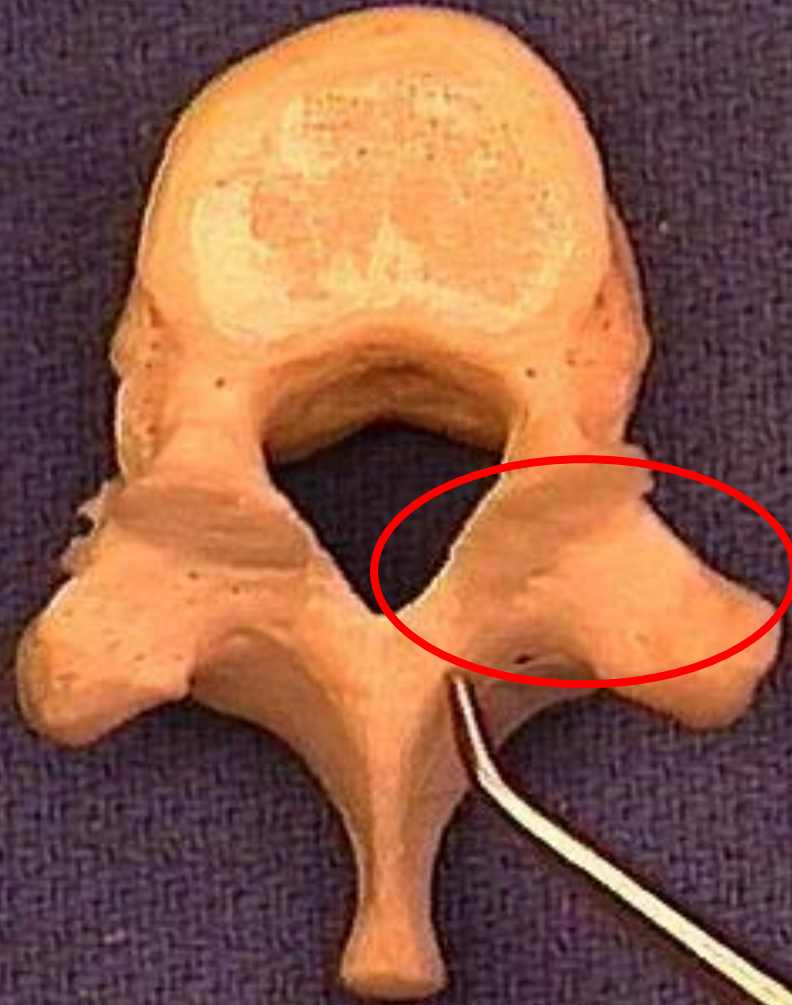
Body of the vertebra



Arch of vertebra-
Pedicle of the vertebra



Arch of vertebra-
Lamina of the vertebra

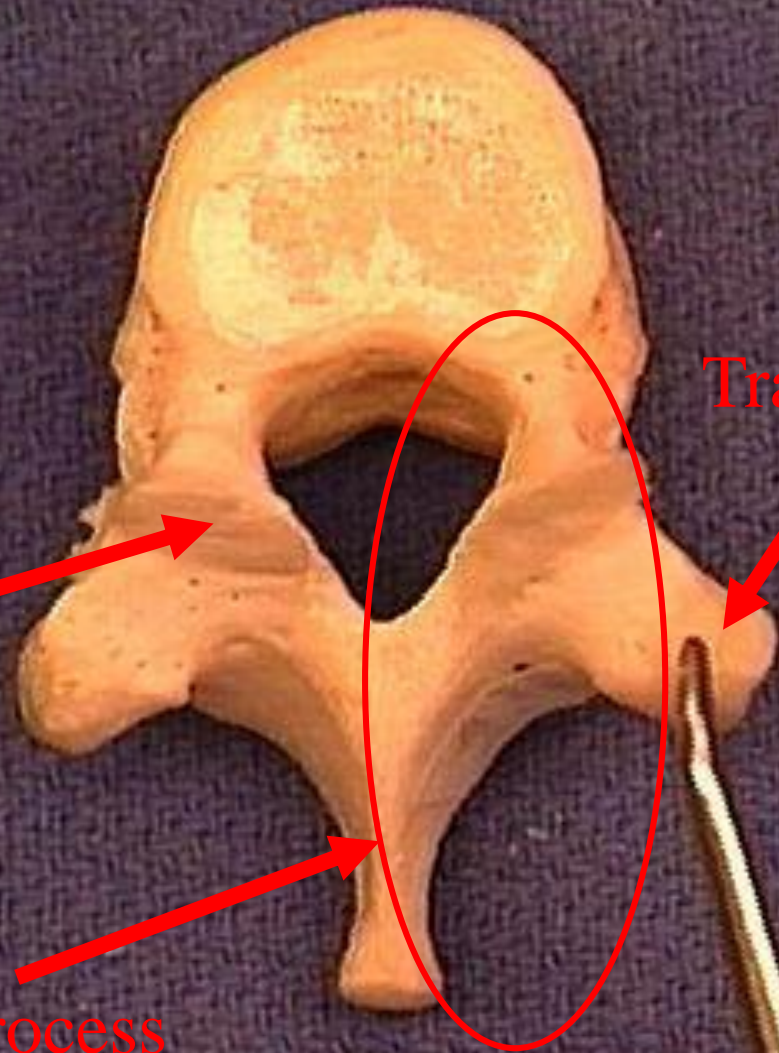


Arch of the vertebra
(ARCUS VERTEBRA)

Transvers process

Articular process

Spinous process

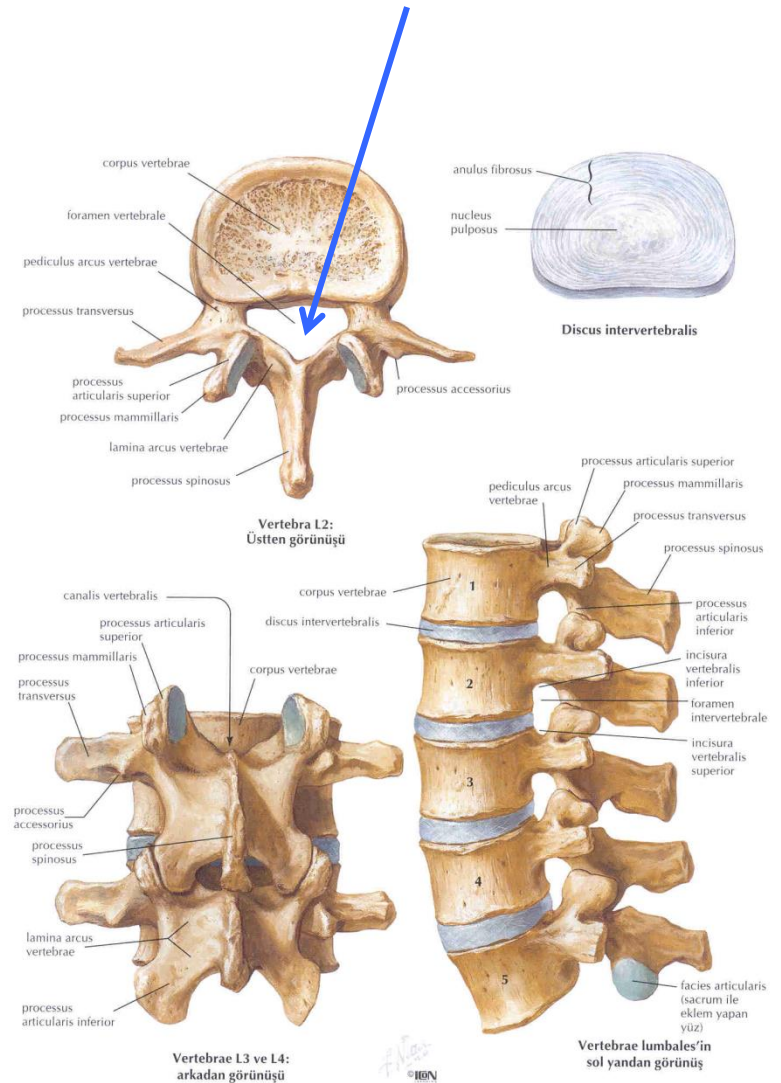


Vertebral foramen



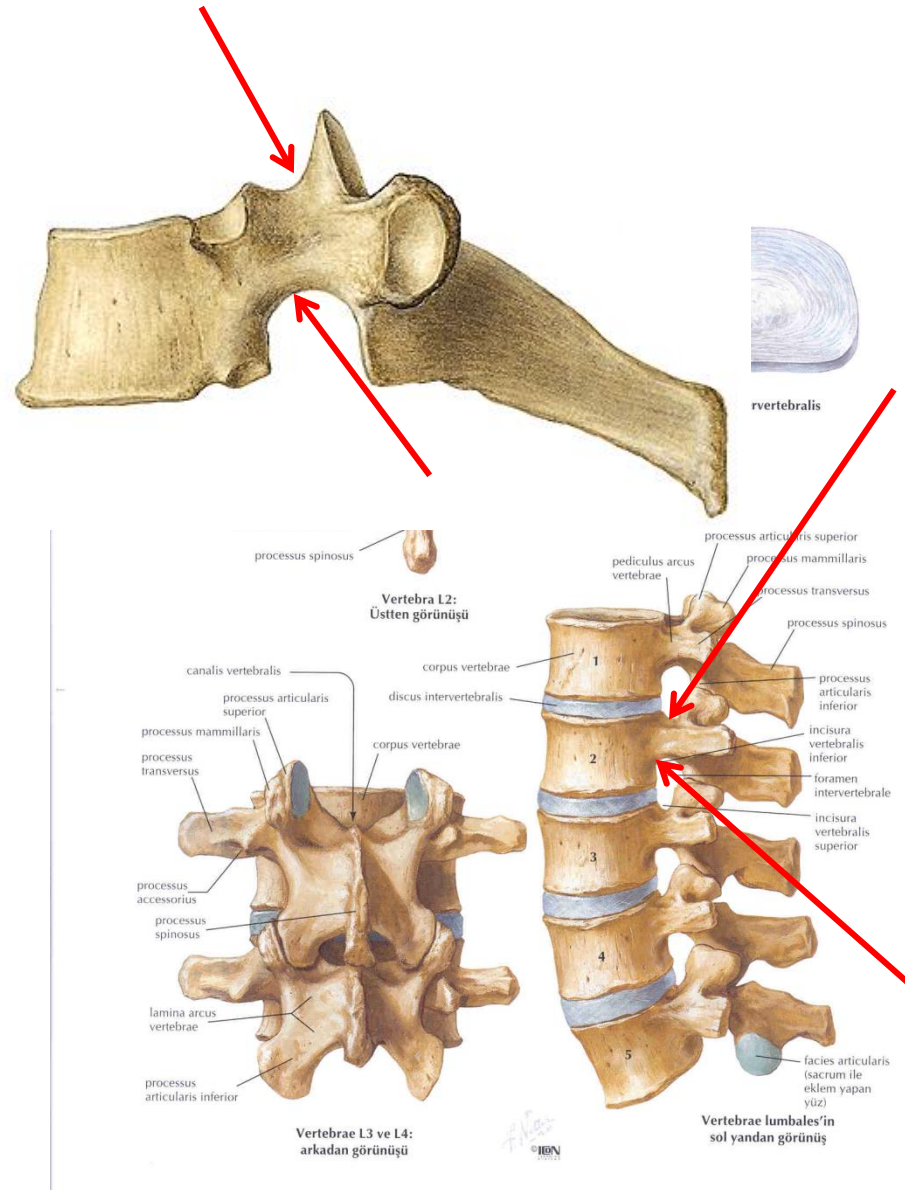
The Vertebrae

- The arch encloses aperture known as “The vertebral foramen”
- Successive vertebral foramen form the vertebral canal (spinal canal)
- it contains spinal cord, its meninges, nerve root and blood vessels.



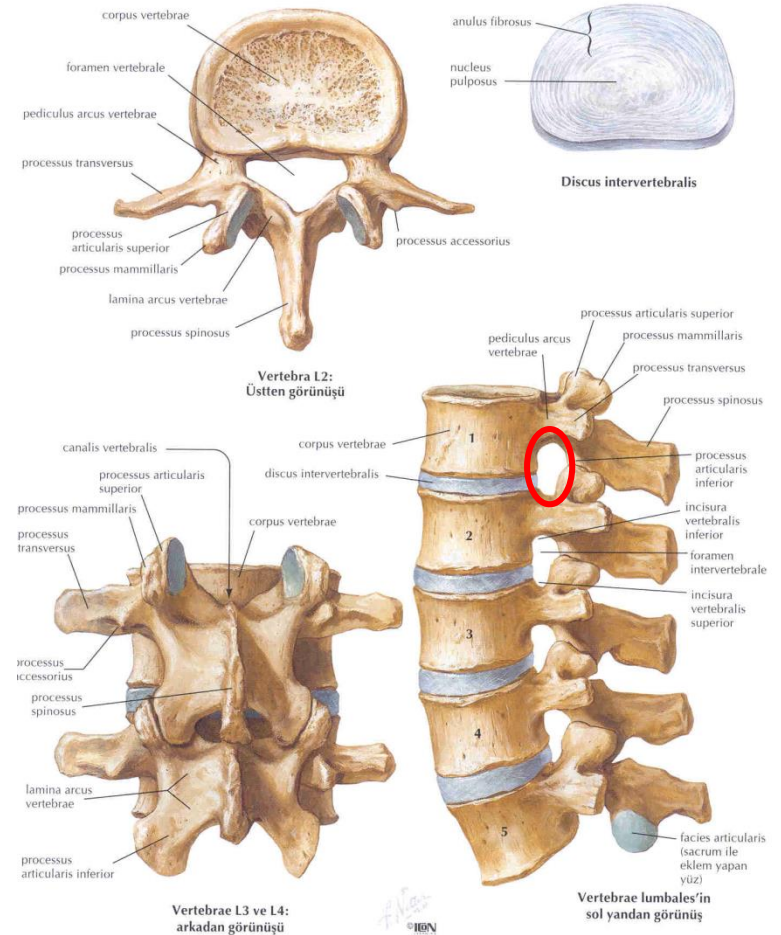
The Vertebrae

- Pedicle of vertebral arch are continuous posteriorly with the flat laminae.
- On each pedicle has small notch superiorly – inferiorly
 - “superior vertebral notch”
 - “inferior vertebral notch”



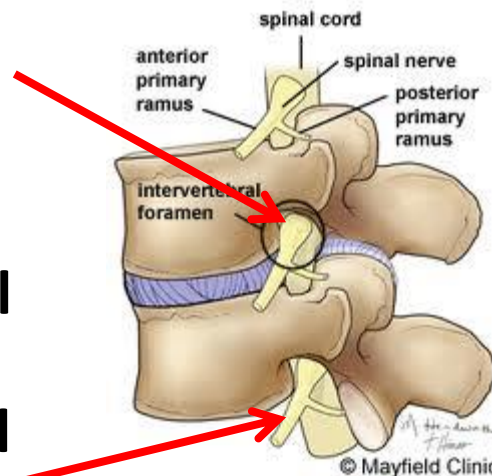
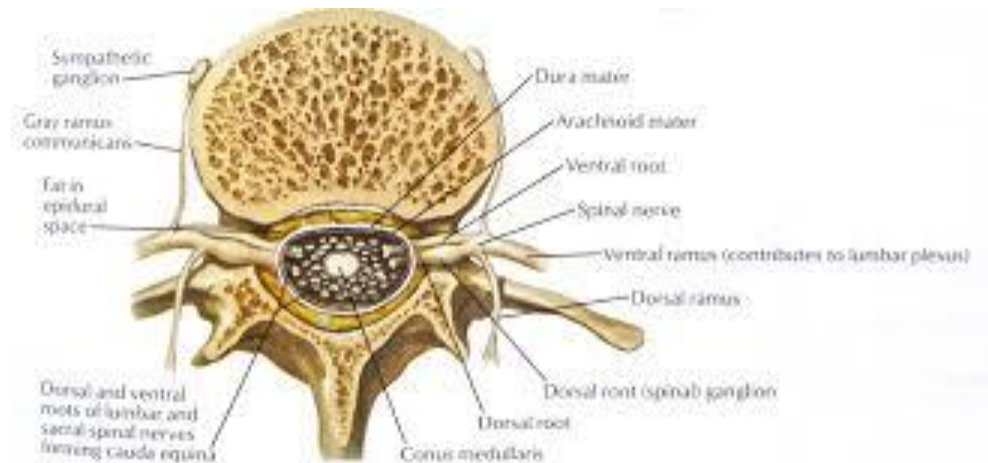
The Vertebrae

- When 2 vert. are in articulation by the vertebral notches are adjacent to each other and form an almost complete bony ring “intervertebral foramen”



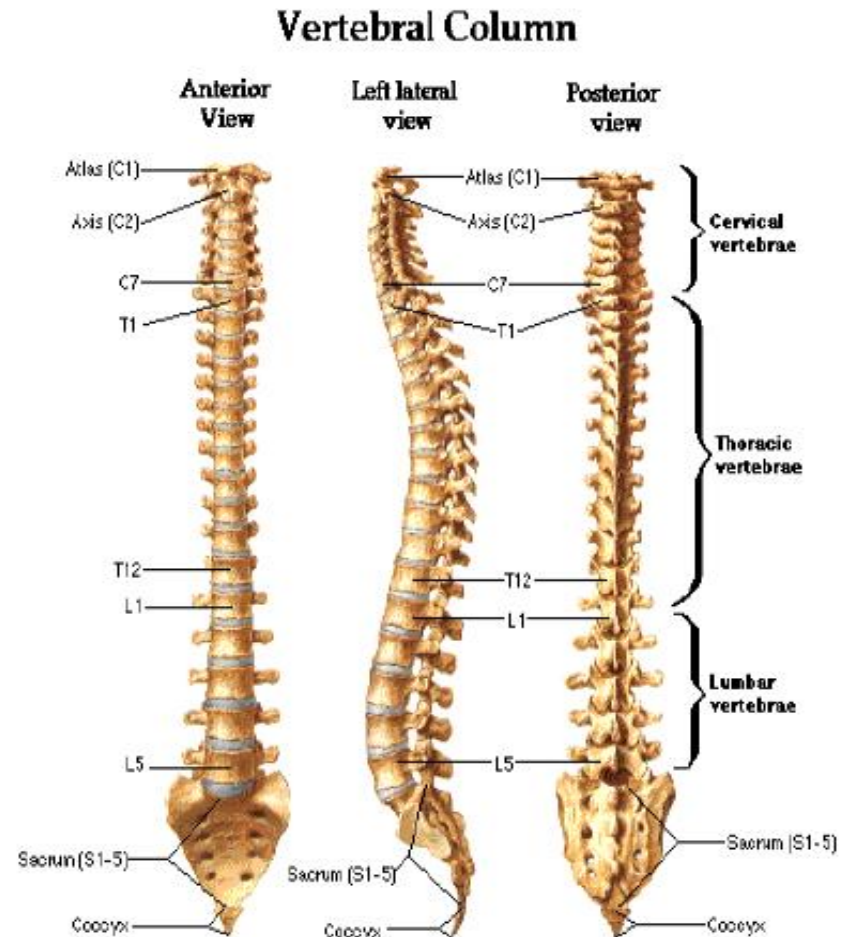
The Vertebrae

- ***Dorsal and ventral nerve roots and spinal cord are localized in the vertebral canal**
- ***Spinal ganglia are in the intervertebral foramen**
- **The dorsal and ventral nerve roots join each other to form a spinal nerve**



Regional characteristics of the vertebrae

Typical vertebra vary size and other characteristics from one region to another.



Vertebrae

- Cervical vertebrae 7
- Thoracic vertebrae 12
- Lumbar vertebrae 5
- Sacral vertebrae 5
- Coccygeal vertebrae 4-5
- Totally 33-34

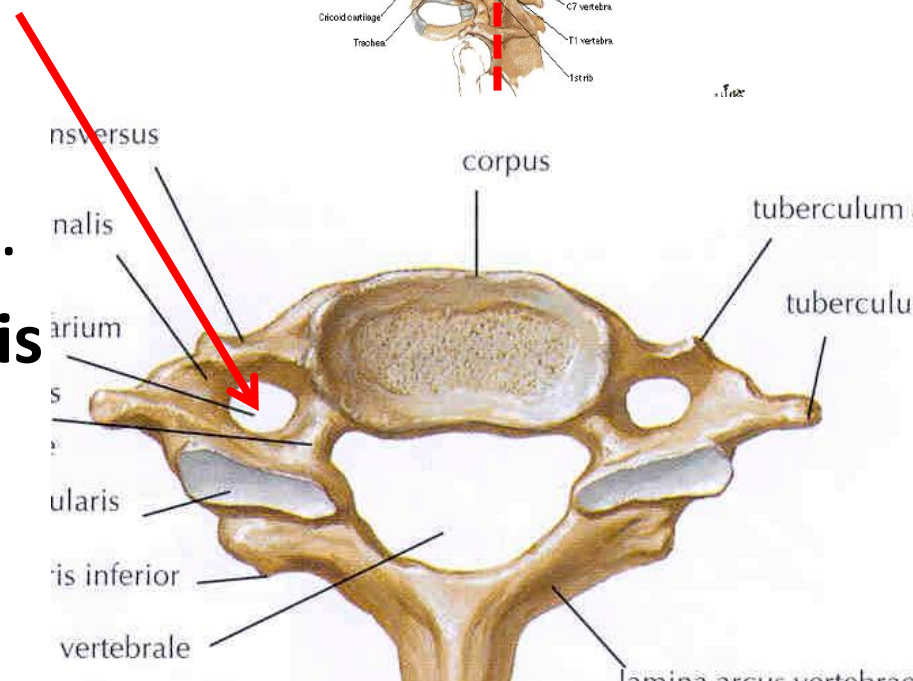
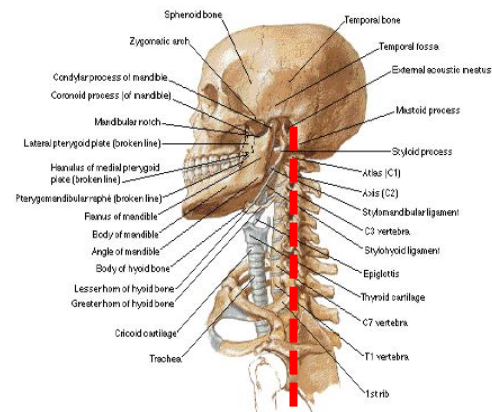
+



The cervical vertebrae

- Form the bony axis of the neck
- Distinctive feature: transverse foramen (Foramen transversarium) in each transverse process.
- Transverse foramen of C7 is smaller than those of the other cerv. vert.

Bony Framework of Head and Neck
Lateral View

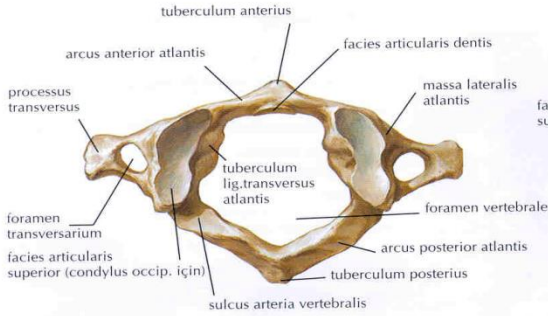


The cervical vertebrae

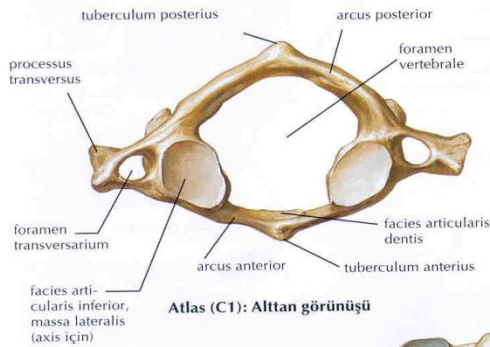
- Spinous process of 2-6. cervical vert. are short and bifid.



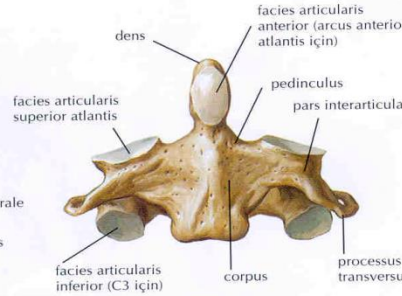
Atypical cervical vertebrae (C1,2,7)



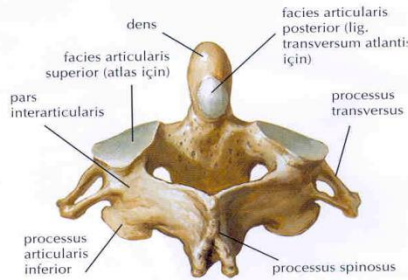
Atlas (C1): Üstten görünüşü



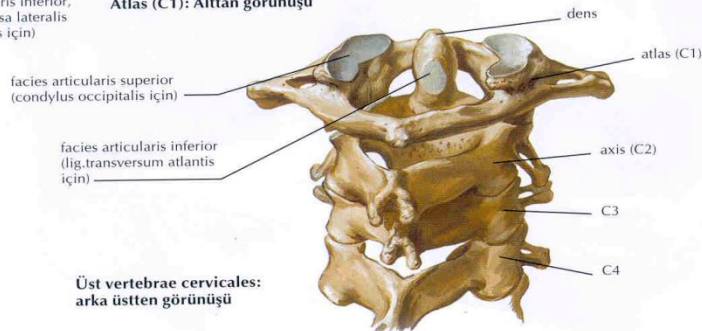
Atlas (C1): Alttan görünüşü



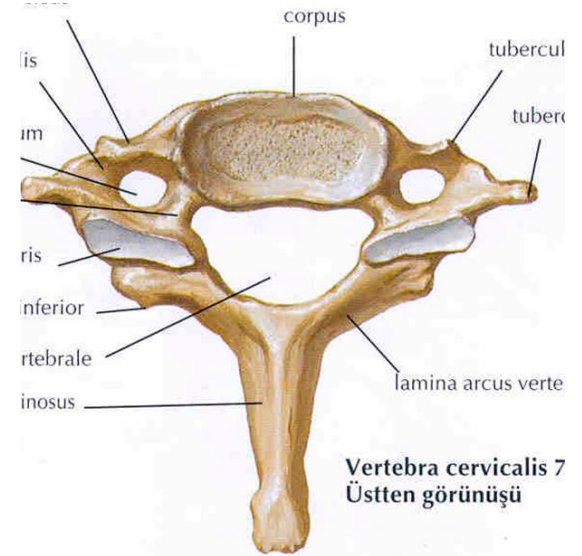
Axis (C2): Önden görünüşü



Axis (C2): Arka üstten görünüşü



Üst vertebrae cervicales: arka üstten görünüşü

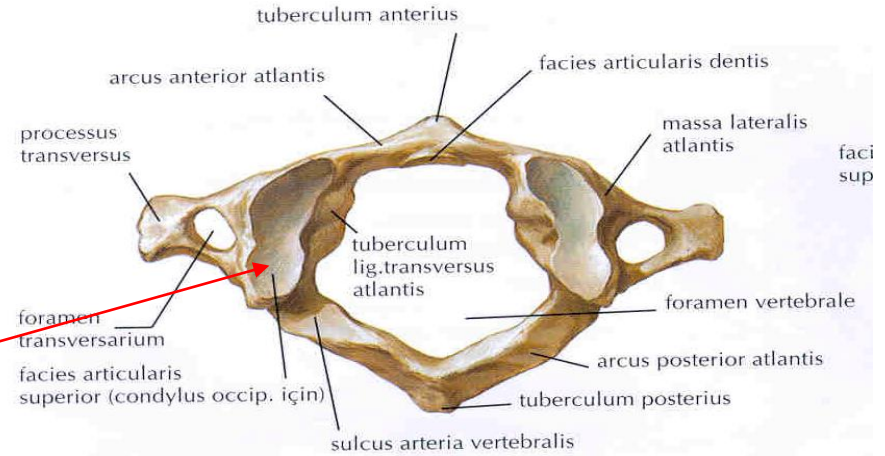


Vertebra cervicalis 7
Üstten görünüşü

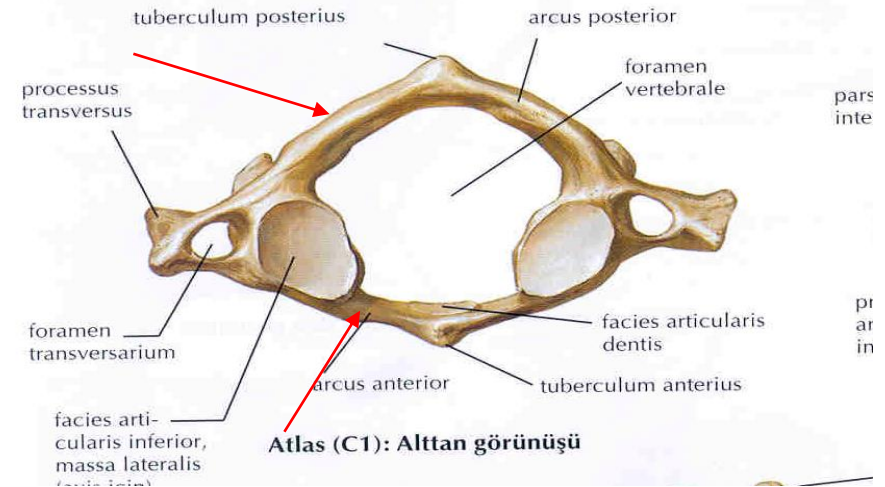
C7

Atlas (C1)

- Ring-shaped bone
- Supports the skull
- Kidney shaped, concave, superior articular facet for occipital condyle
- Has no *spinous process* or *body* (lateral mass)
- It consists of anterior and posterior arch
- Arch has tubercle

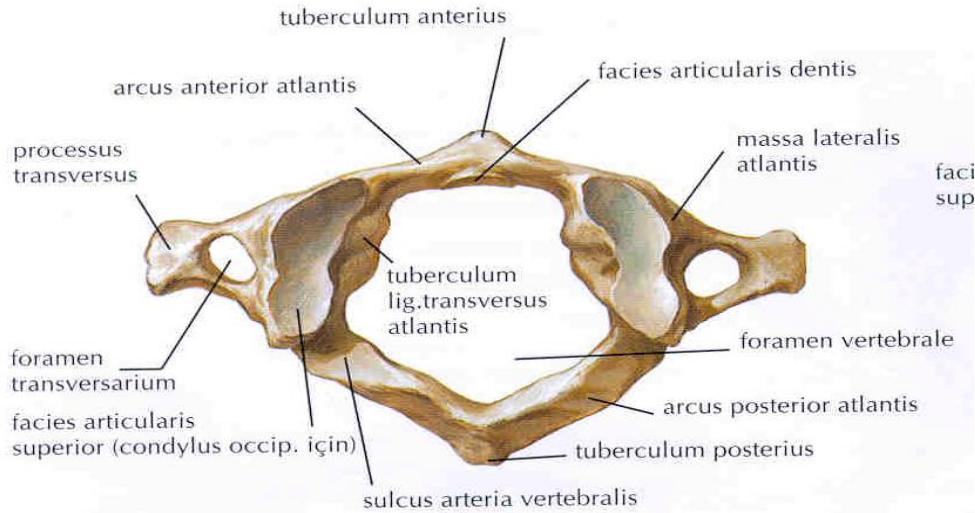


Atlas (C1): Üstten görünüşü

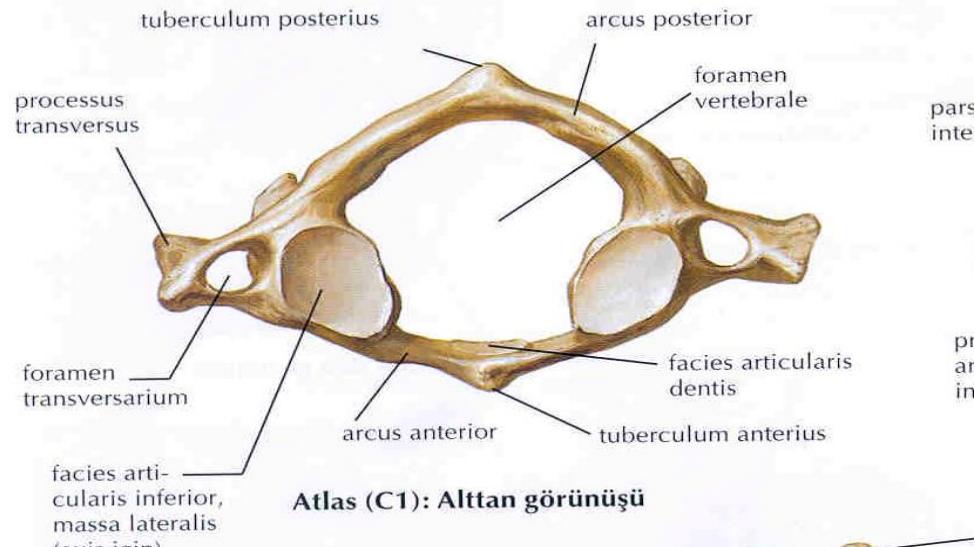


Atlas (C1): Alttan görünüşü

Atlas (C1)



Atlas (C1): Üstten görünüşü



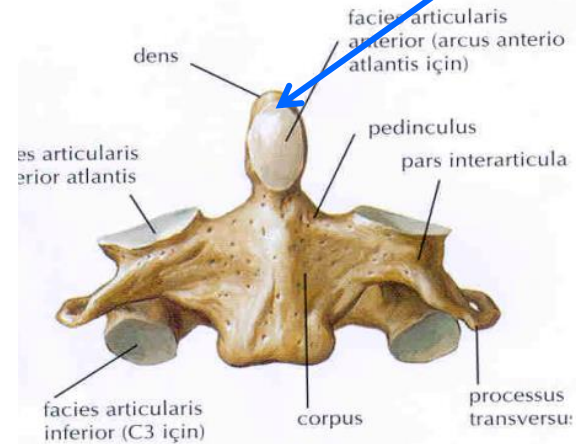
Atlas (C1): Alttan görünüşü

- Body -
- Spinosus processus -
- Lateral massa atlantis +
- Anterior arch atlantis +
- Posterior arch atlantis +
- Anterius tuberculum +
- Fovea dentis +
- Posterius tuberculum +
- Superior articular facet+
- Groove for vertebral a. +
- Inferior articular facet+

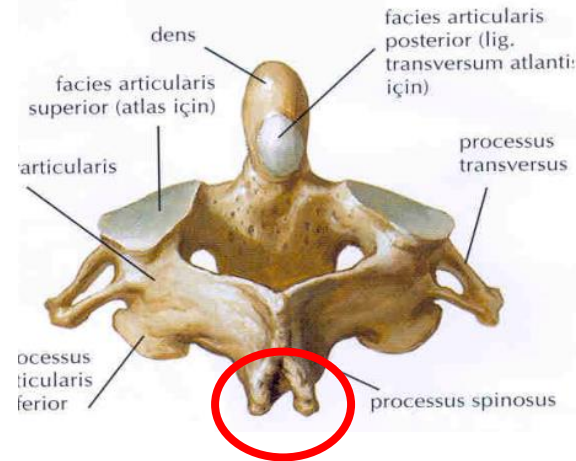
Axis (C2)

Dens axis

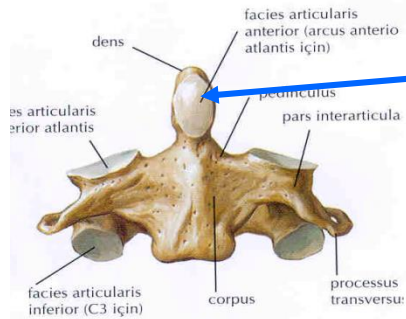
- Strongest of the cerv. ver.
- The blunt tooth-like dens “*dens axis*”
- has large bifid spinous process.



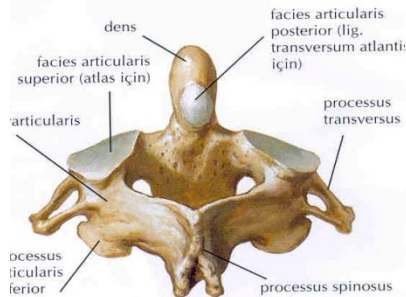
Axis (C2): Önden görünüşü



Axis (C2)



Axis (C2): Önden görünüşü

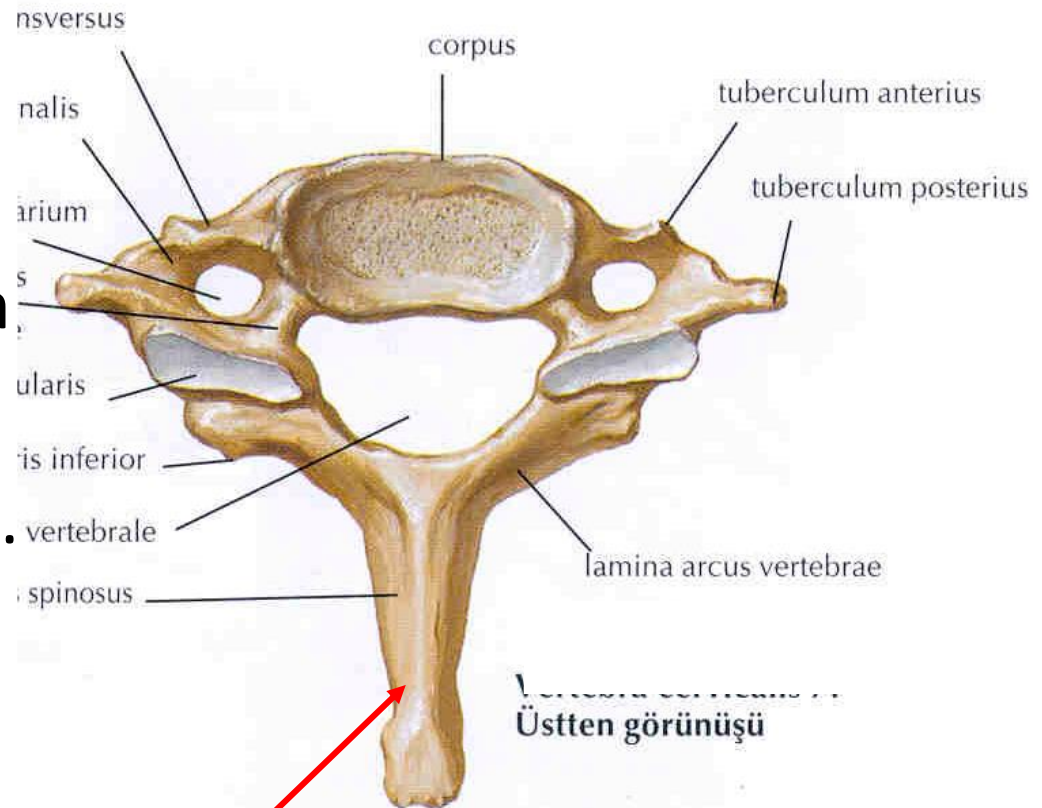


Dens axis

- Dens axis+
 - Neck of dens+
 - Anterior articularis facet+
 - Posterior articular facet +

Vertebra prominens (C7)

- Long, nonbifid spinous process
- is visible through the skin
- easily recognized lat cerv. radiograph
- large transverse process

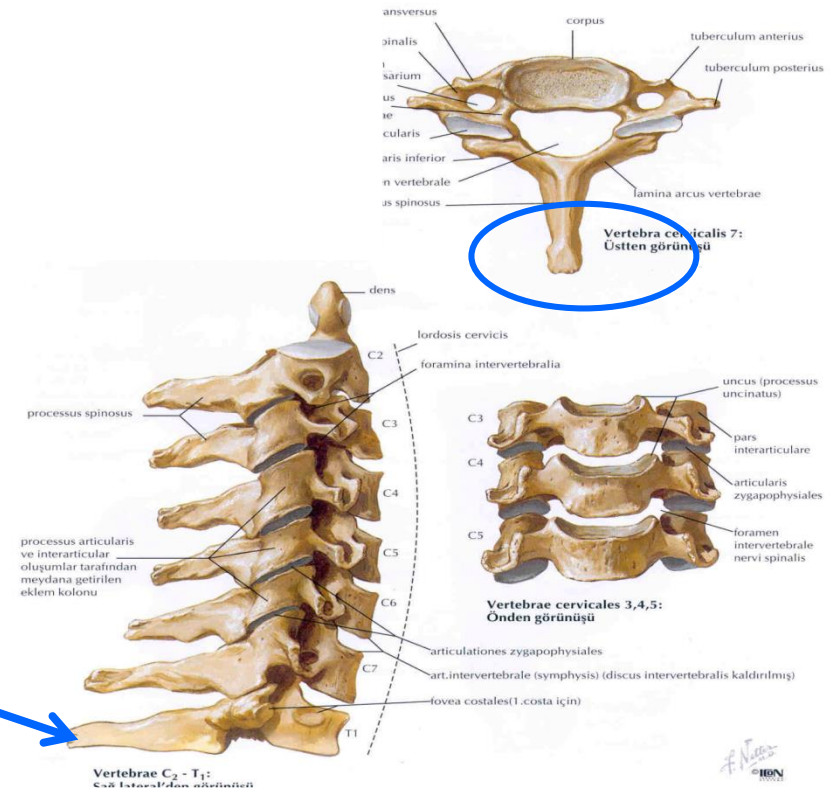


Processus spinosus

Vertebra prominens (C7)

- Spinous process of 7. cerv. vert. is long, nonbifids.
- “vert. prominens”
 - it can easily palpable subcutaneously

easily recognized lat cerv. radiograph



occipital condyle

anterior arch of atlas

odontoid process

body of axis

mandible

epiglottis

hyoid

thyroid cartilage calcification

body of seventh cervical vertebra

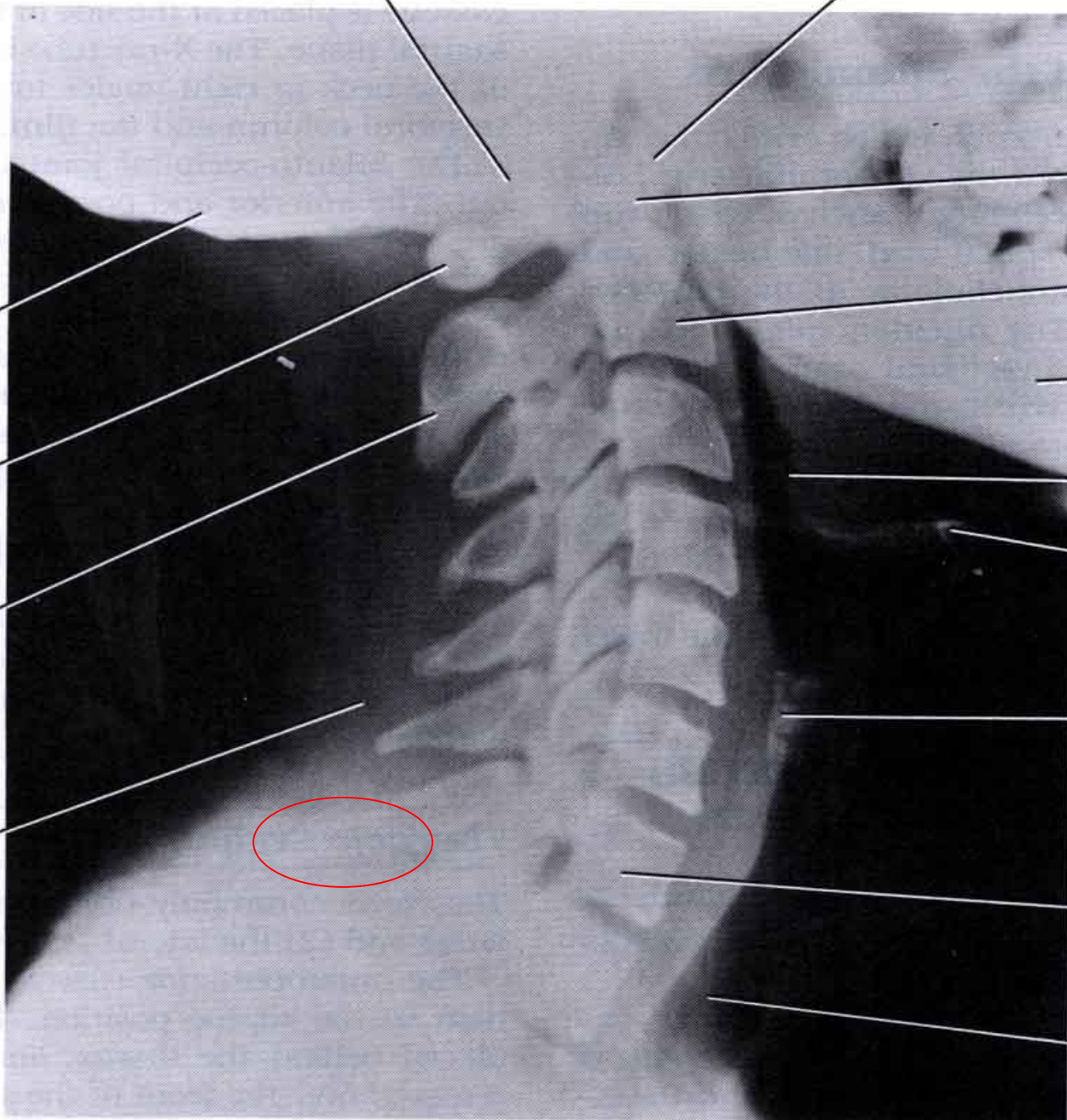
trachea

occipital bone

posterior arch of atlas

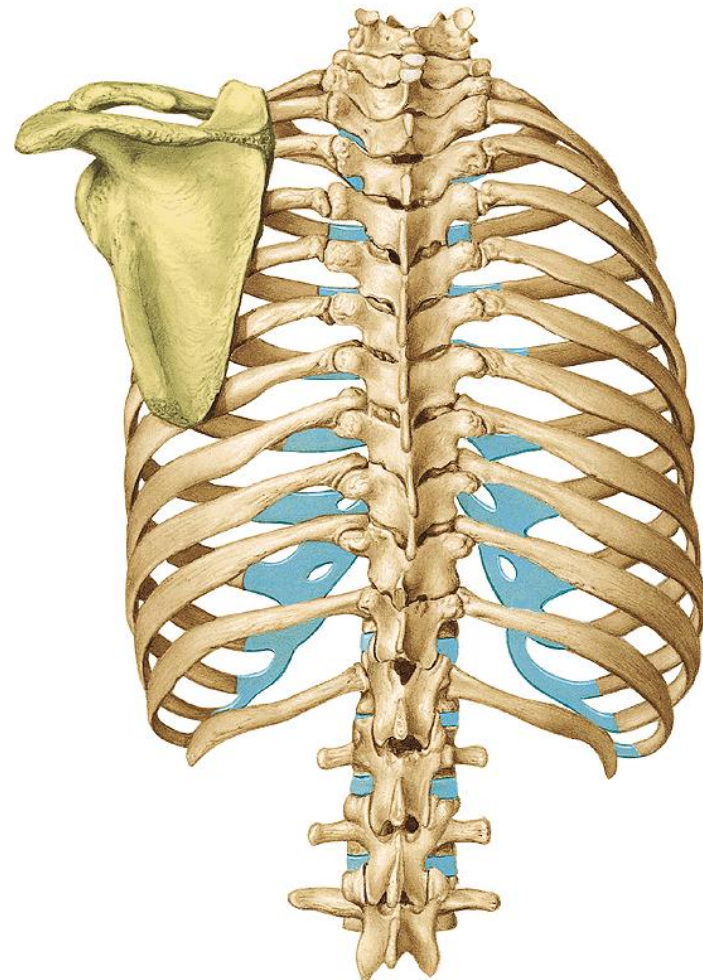
spine of axis

postvertebral muscles



The thoracic vertebrae(T1-12)

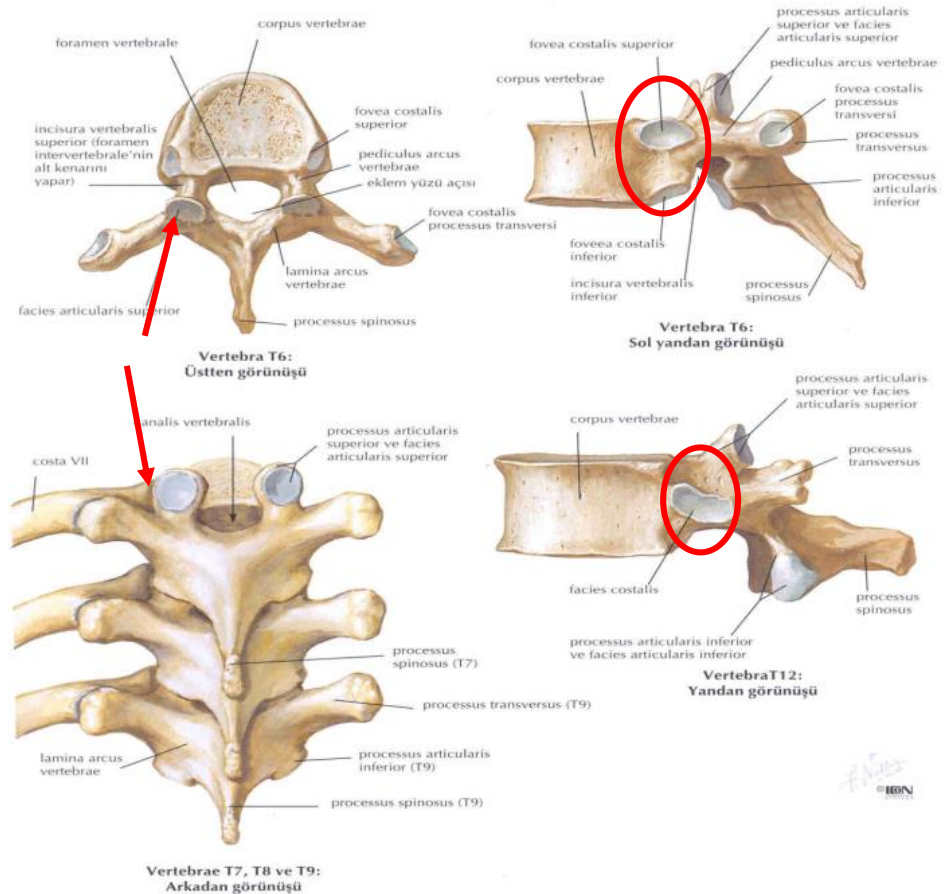
- 12 thoracic vertebra articulate with ribs



Posterior view

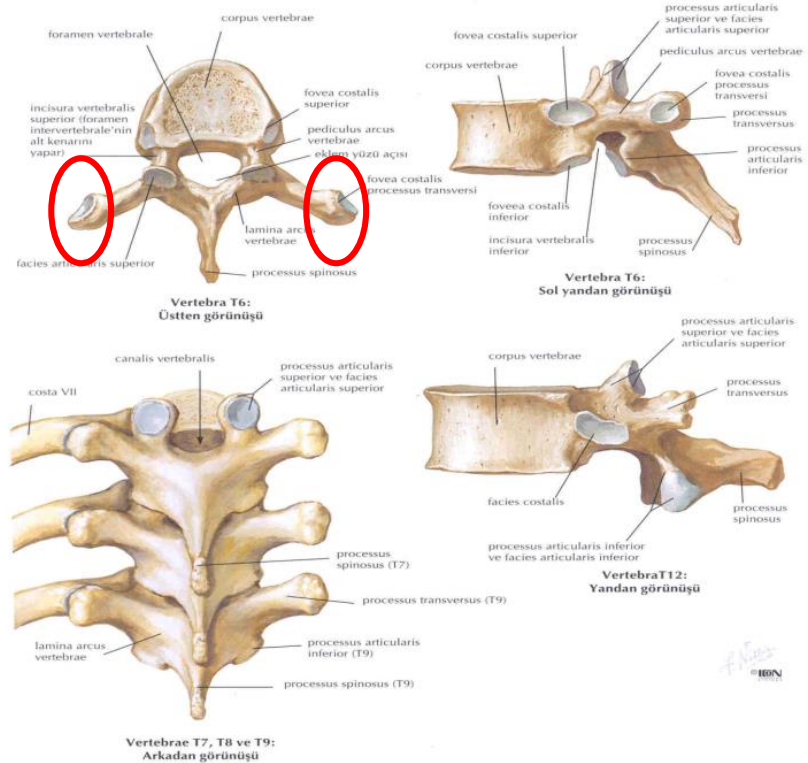
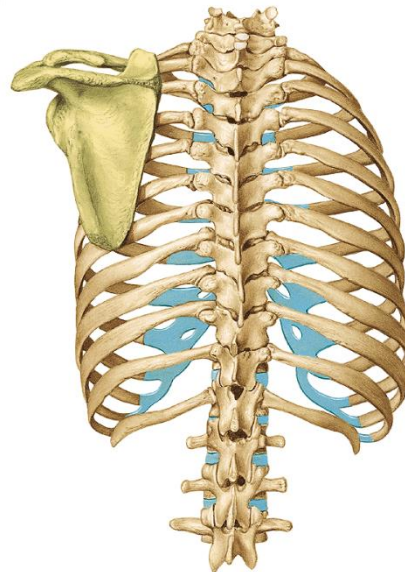
The thoracic vertebrae(T1-12)

- characterized by articular facet for 12 ribs
- Generally TV has facet on superior and inferior part of lateral side of the body.
- for articulation with the head of rib.



The thoracic vertebrae(T1-12)

- each superior 10 vertebra's transverse processes have facet to articulate with tubercle of rib

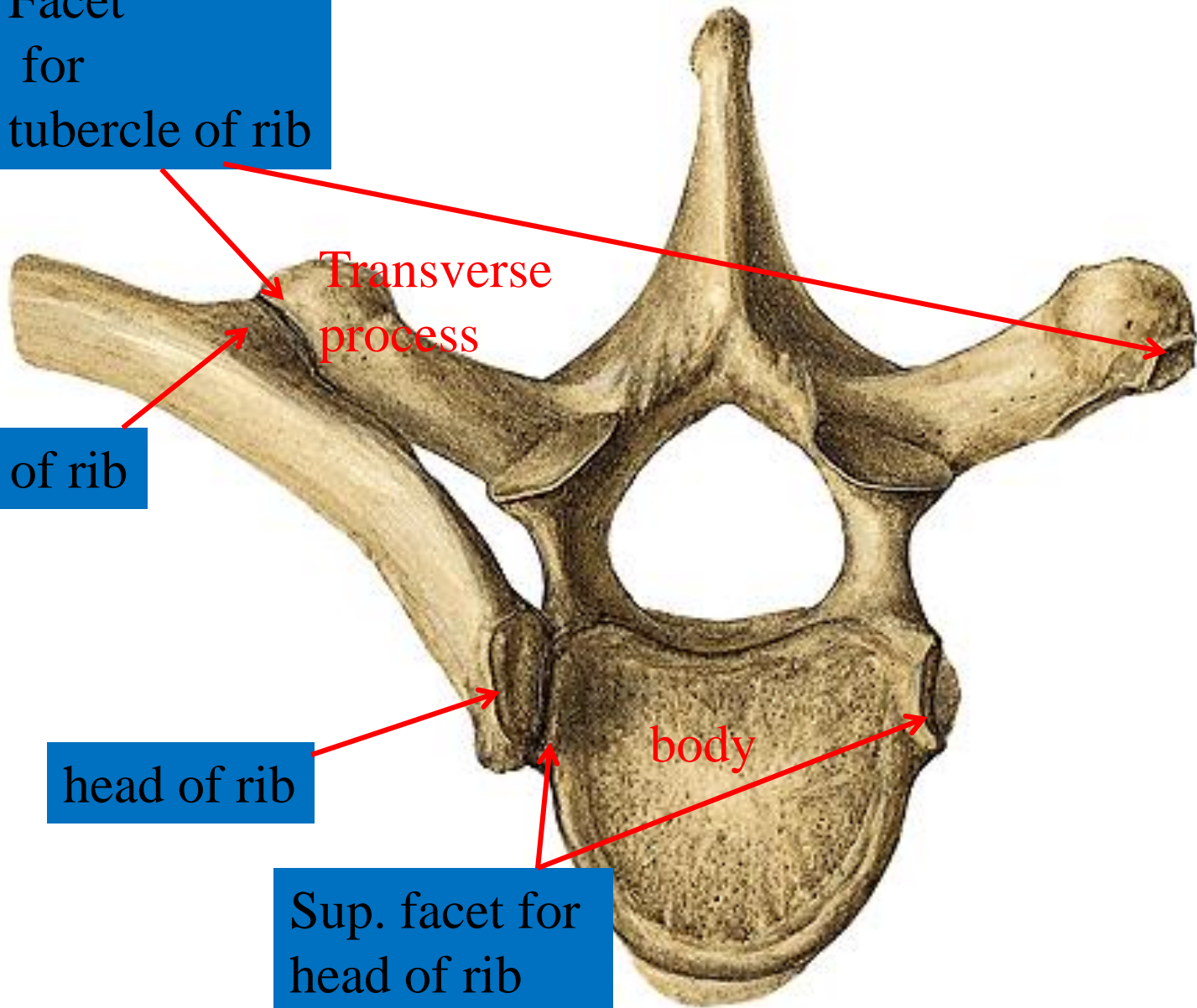


Facet
for
tubercle of rib

tubercle of rib

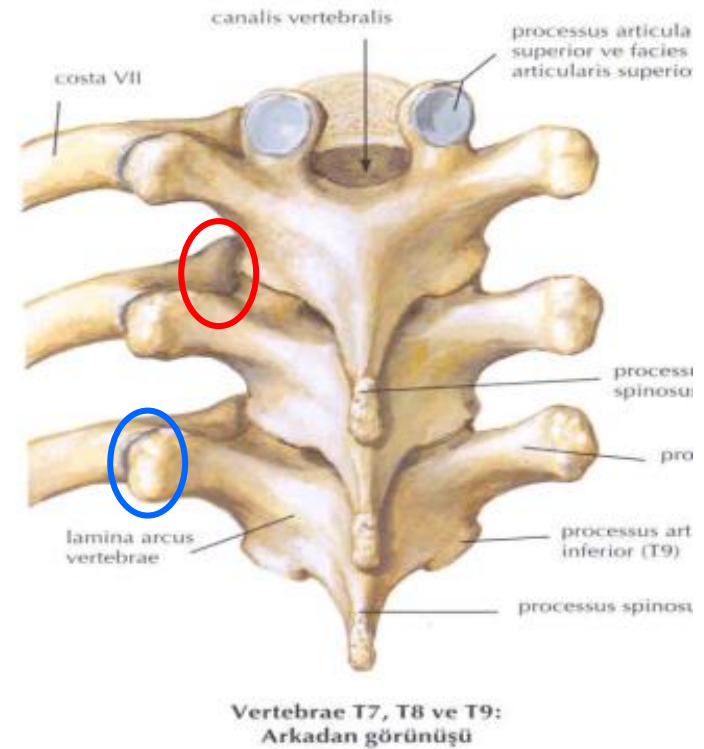
head of rib

Sup. facet for
head of rib

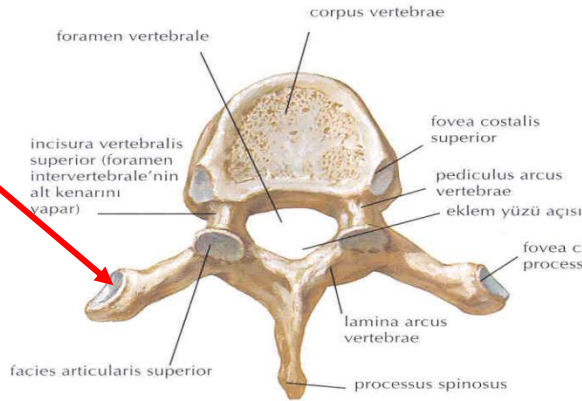


The thoracic vertebrae (T1-12)

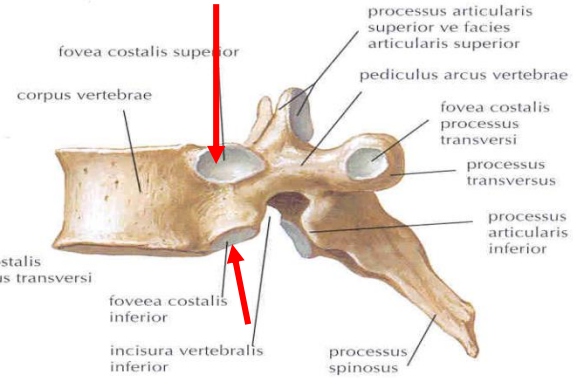
- Facets on each body of vertebra, articulate with related *head of rib*.
- Facet on each transverse process of vertebra articulate with *tubercle of rib*.



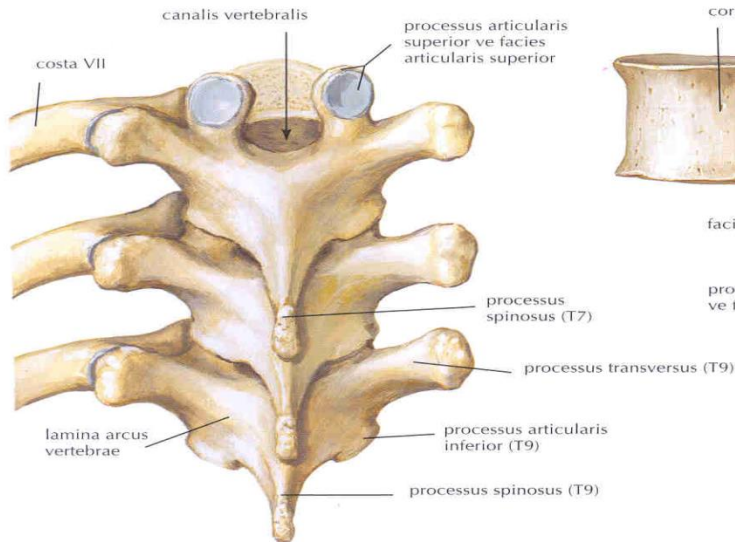
The thoracic vertebrae(T1-12)



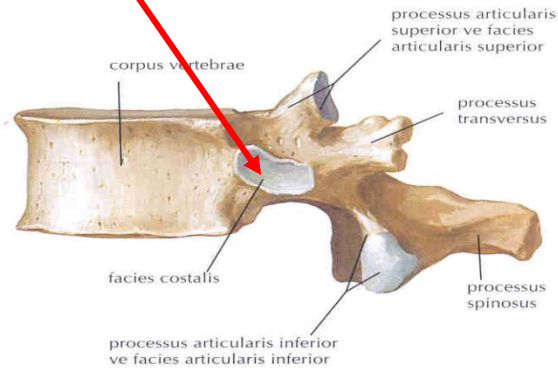
**Vertebra T6:
Üstten görünüşü**



**Vertebra T6:
Sol yandan görünüşü**



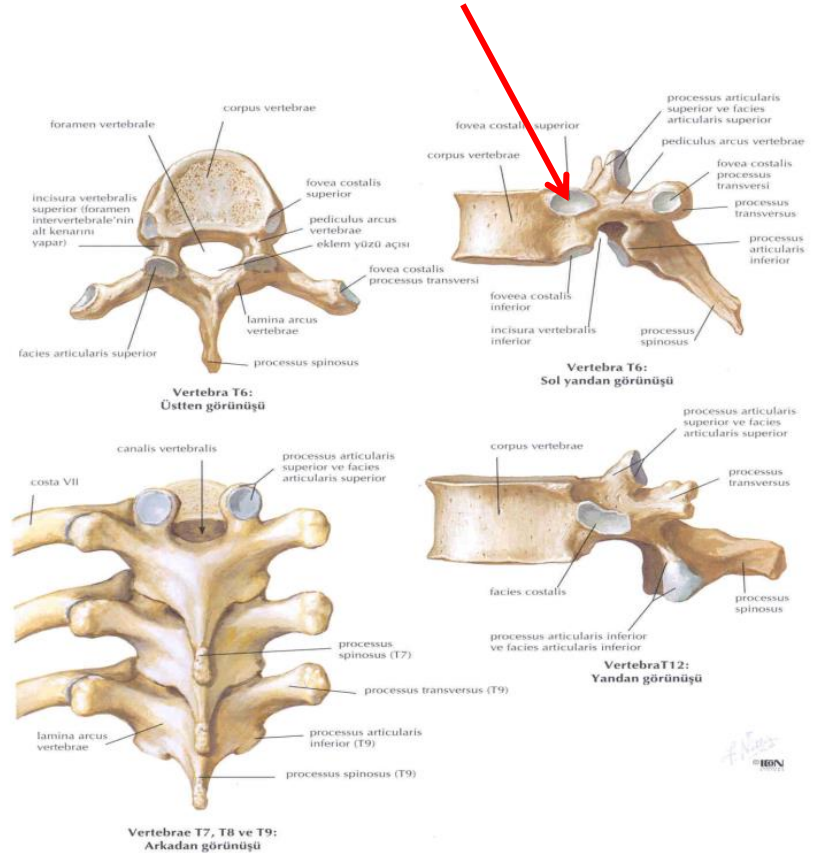
**Vertebrae T7, T8 ve T9:
Arkadan görünüşü**



**Vertebra T12:
Yandan görünüşü**

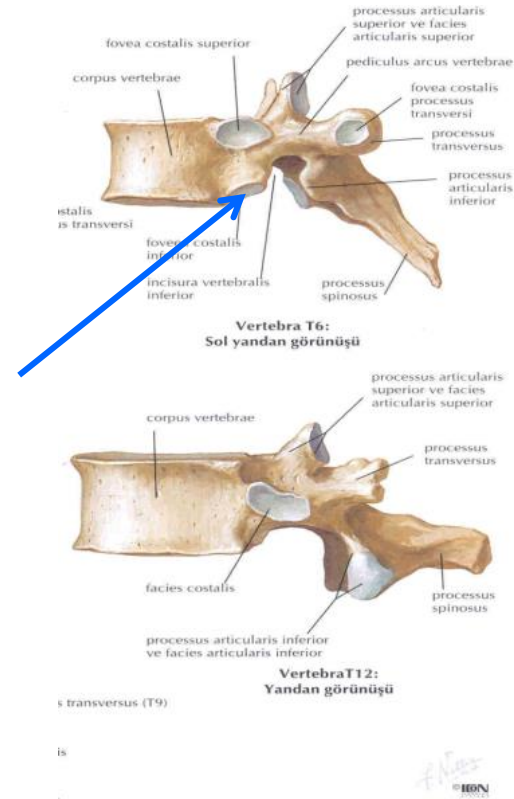
The thoracic vertebrae(T1-12)

- Generally: TV has hemi (half) facet on superior and inferior part of lateral side of body.
- Exceptionally, the 1. TV. has “complete” costal facet on the superior edge of the body for the *first rib*.



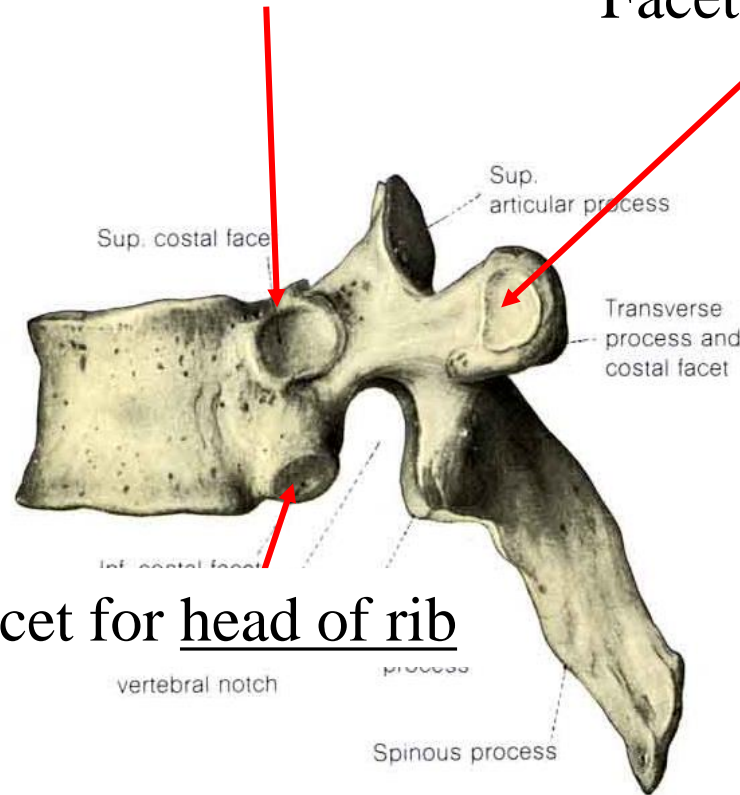
The thoracic vertebrae

- Hemifacet on the inferior edge which contributes to the articular surface for the *rib*.



sup. facet for head of rib

Facet for tubercle of rib



inf. facet for head of rib

EXCEPTIONS

TV1:

Sup. facet for head of rib COMPLETE FACET

Inf. facet for head of rib DEMIFACET

TV10:

Sup. facet for head of rib DEMIFACET

Inf. facet for head of rib ABSENT!!!

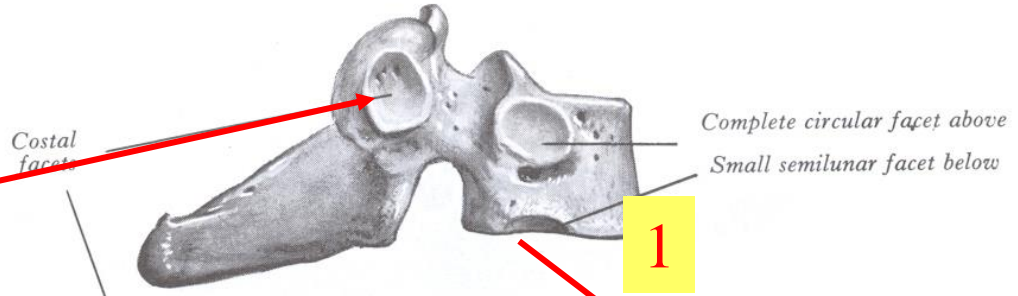
TV11-12:

at the middle height of the corpus

facet for head of rib COMPLETE FACET

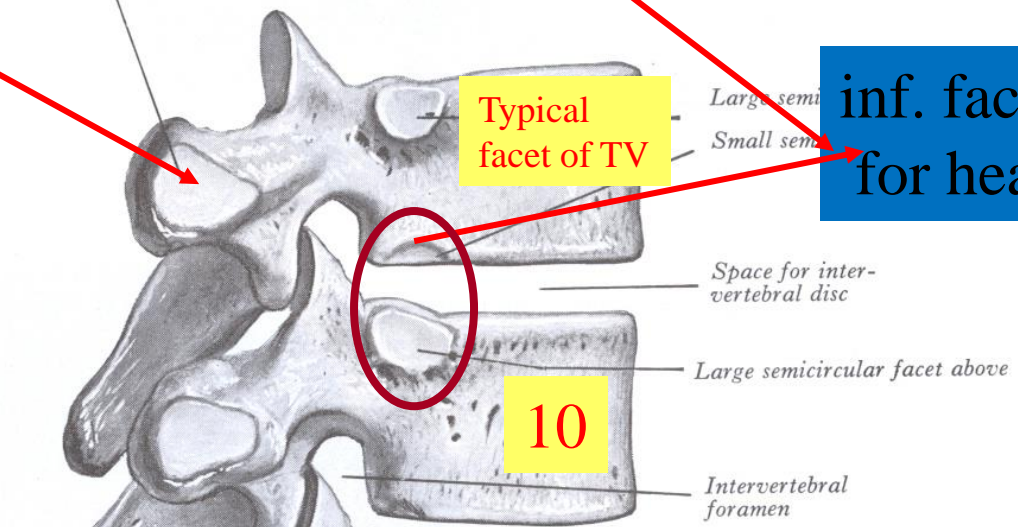
1., 10., 11., 12. TV

have atypical facet for head of rib!!!



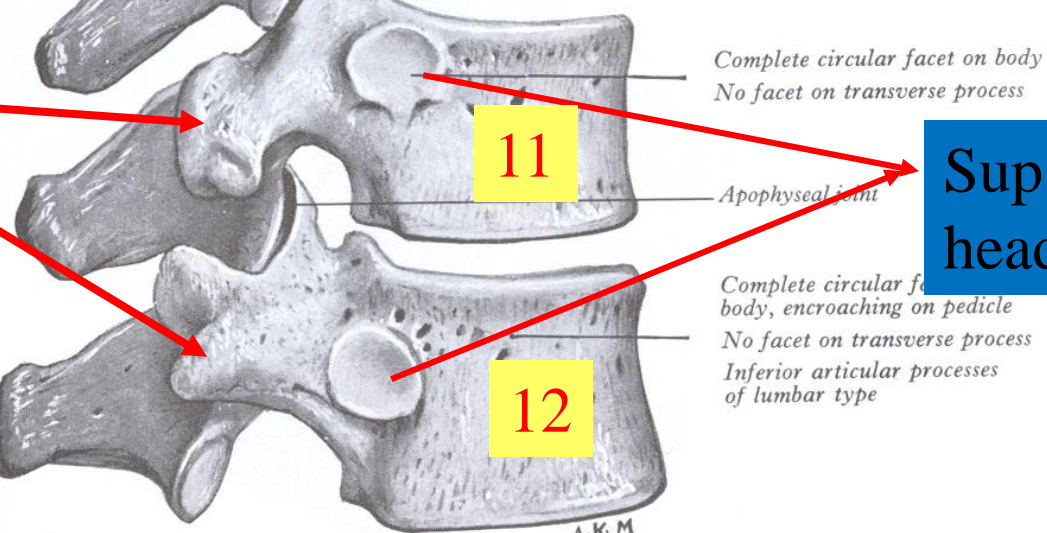
Facet for tubercle of rib

inf. facet for head of rib



No facet for tubercle of rib

Sup. facet for head of rib



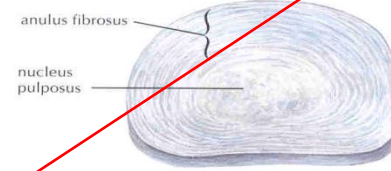
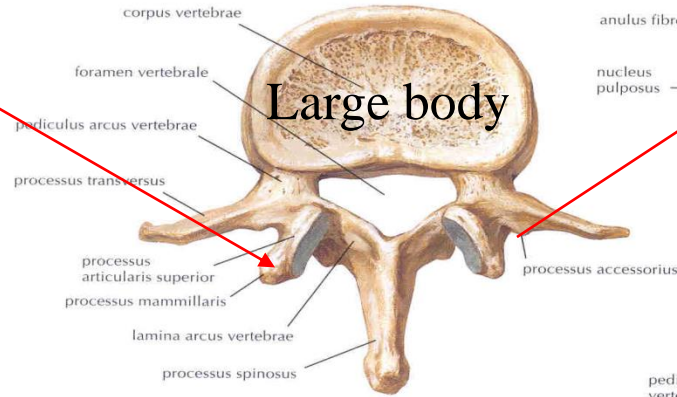
Thoracal Vertebrae (TV)

- Spinous process of TV tend to be long and slender, so can be palpated and observed through the skin
- 1.-4. TV are atypical: have some features of cervical vertebra (differ from typical ones)
 - 1. TV has *horizontal* spinous process, *long* transverse process
- 5.-8 TV.(middle 4 thorasic vert.) are typical
- 9.-12. TV (inferior 4 TV.) are atypical: often have features of lumbar vertebrae
- 11.-12. TV have no facet for tubercle of rib

Lumbar Vertebrae (L1-5)

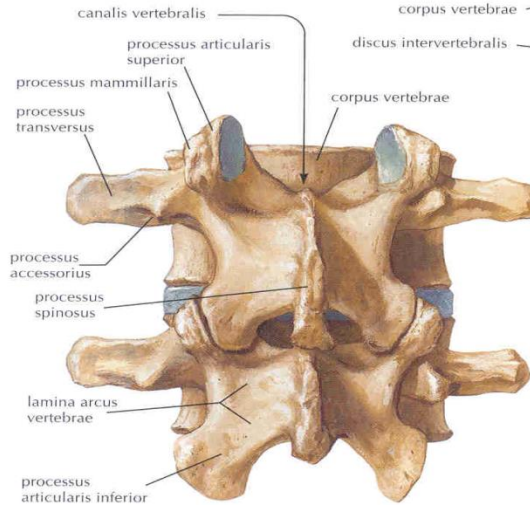
Processus mamillaris

Processus
accessorius

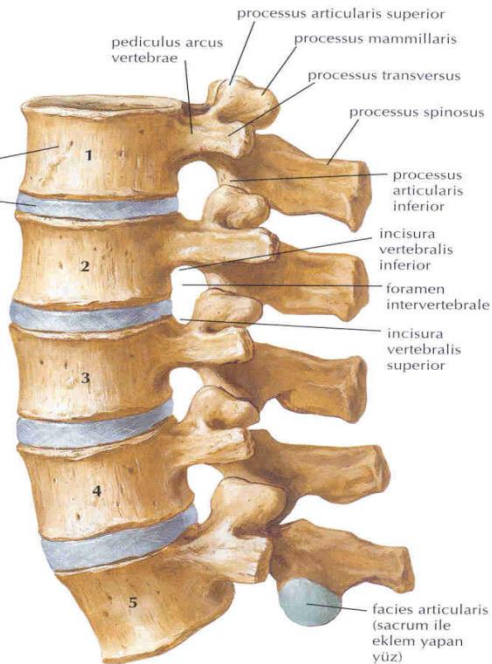


Discus intervertebralis

Vertebra L2:
Üstten görünüşü



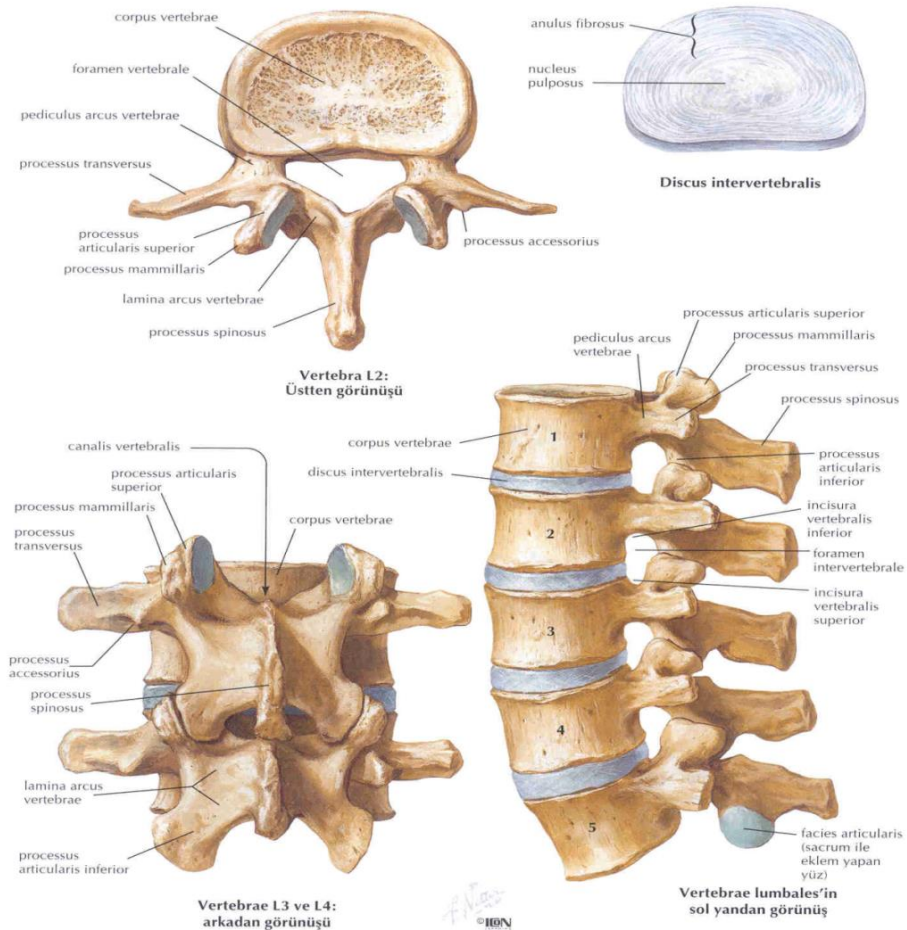
Vertebrae L3 ve L4:
arkadan görünüşü



Vertebrae lumbales'in
sol yandan görünüşü

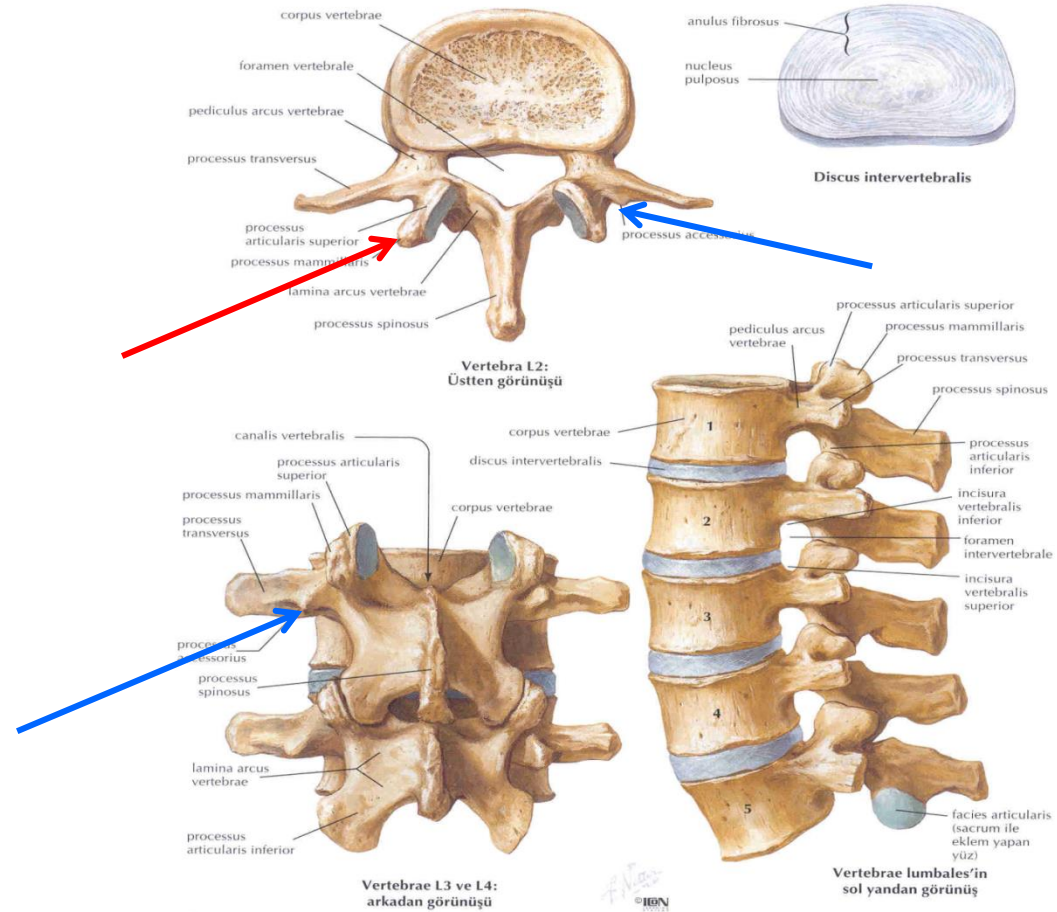
Lumbar Vertebrae (L1-5)

- Their spinous process are prominent, rectangular
- Large body
- Absent of the costal facets
- Vertebral foramina oval to triangular
- 5. LV largest , stout transverse processes
- 5. LV. is largely responsible for the *lumbosacral angle*.



Lumbar Vertebrae (L1-5)

- Mamillary body at the posterolateral side of superior facet for successive vertebra
- Accessory processes at the posteroinferior side of transverse process



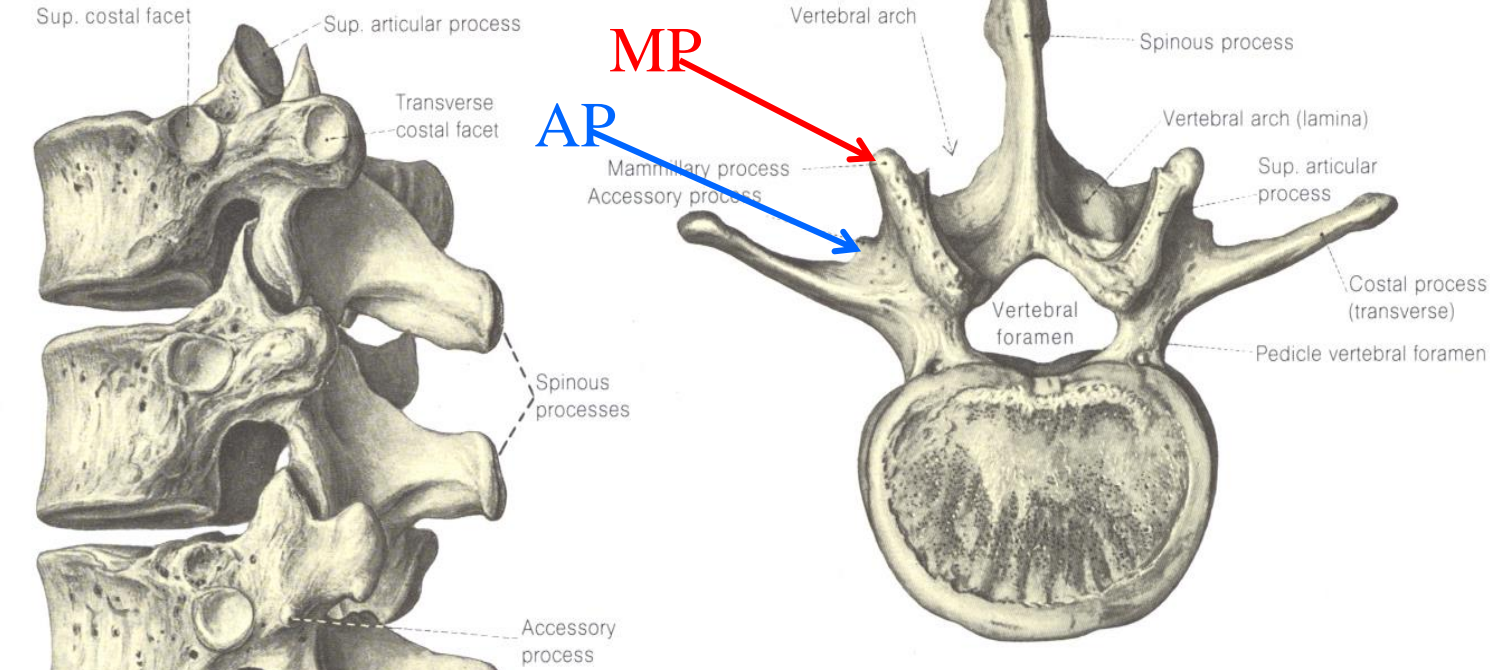
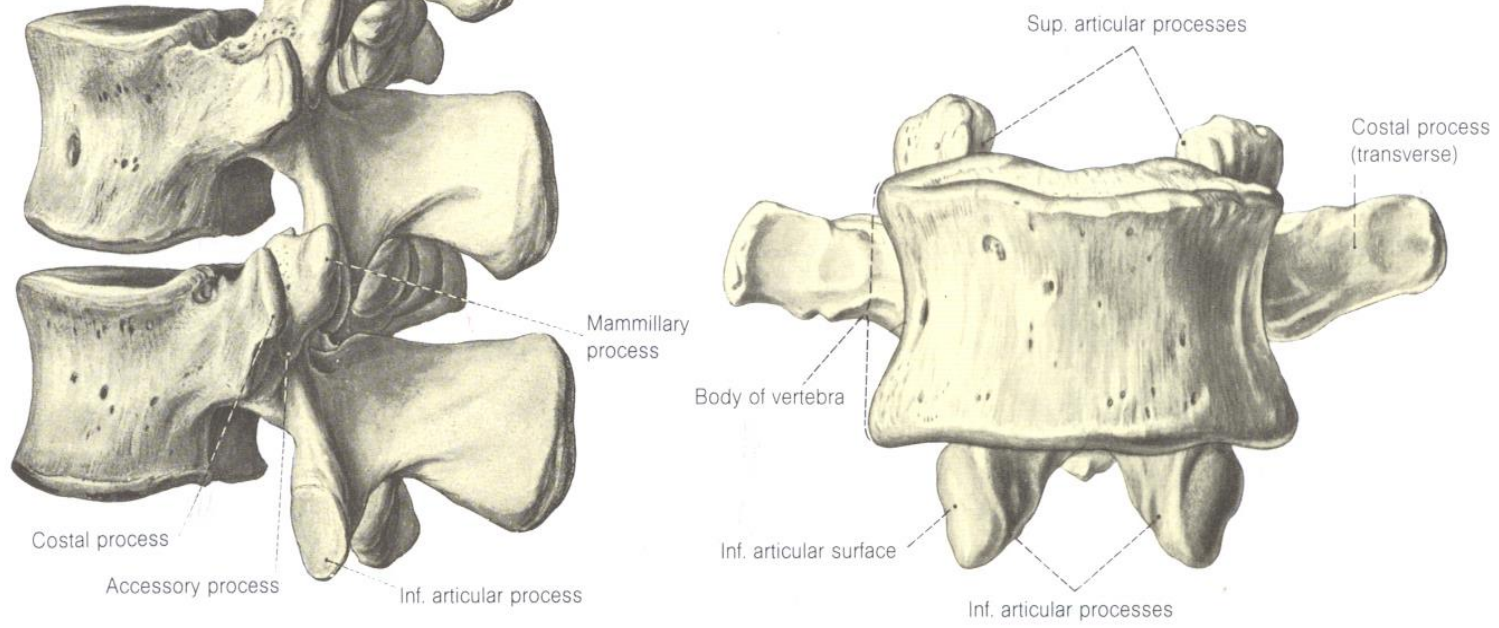
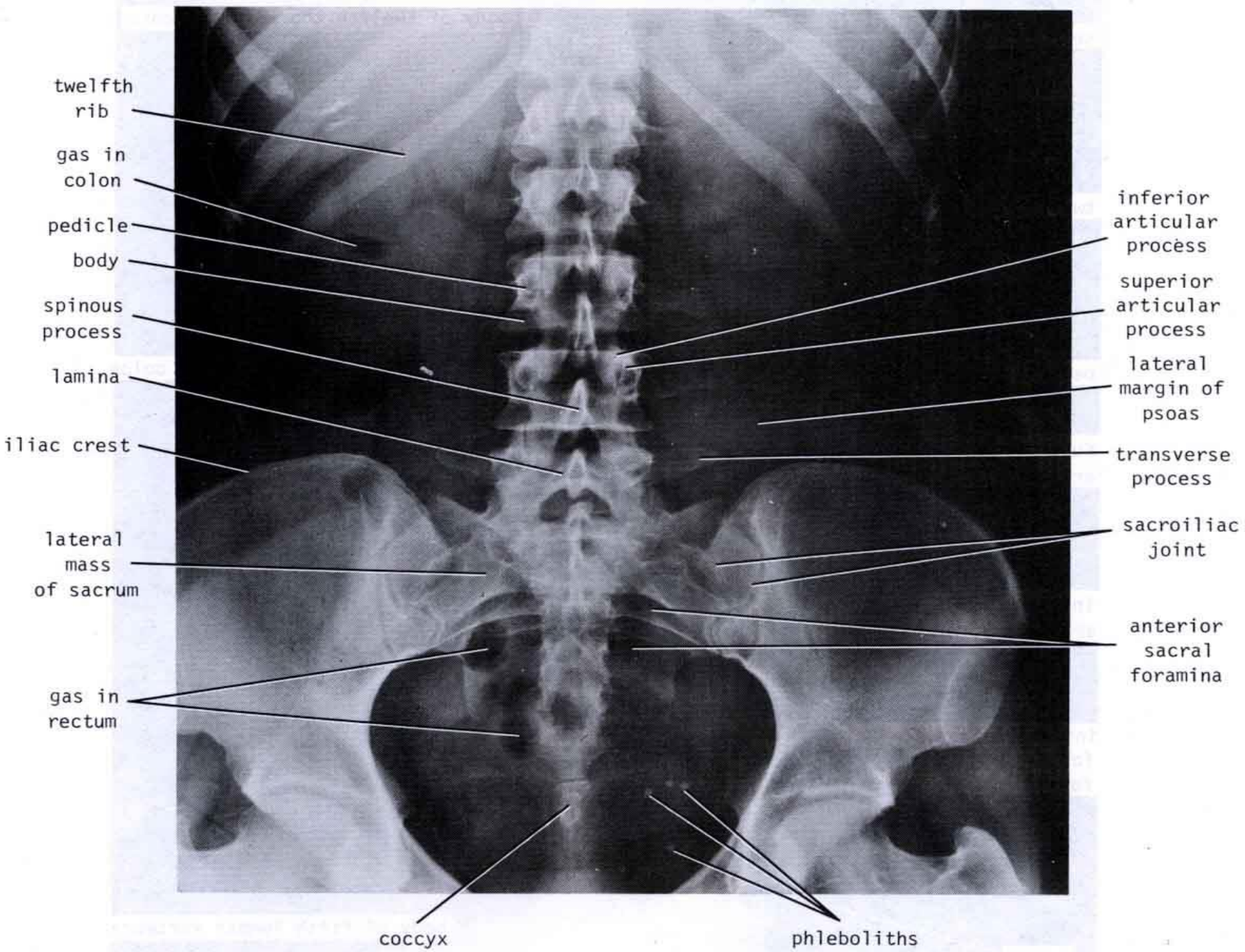


Fig. 344. Lumbar vertebra. Cranial view.





twelfth
rib

gas in
colon

pedicle

body

spinous
process

lamina

iliac crest

lateral
mass
of sacrum

gas in
rectum

inferior
articular
process

superior
articular
process

lateral
margin of
psoas

transverse
process

sacroiliac
joint

anterior
sacral
foramina

coccyx

phleboliths

Sacrum

- Triangular, large wedge shaped bone is usually composed of 5 fused SV in adult.
- Sacrum provides strength and stability of pelvis
- Transmits the weight of body to pelvic girdle through the SIJ.
- base & apex
- Pelvic (anterior) & dorsal (posterior) surfaces
- Lateral parts- auricular surface

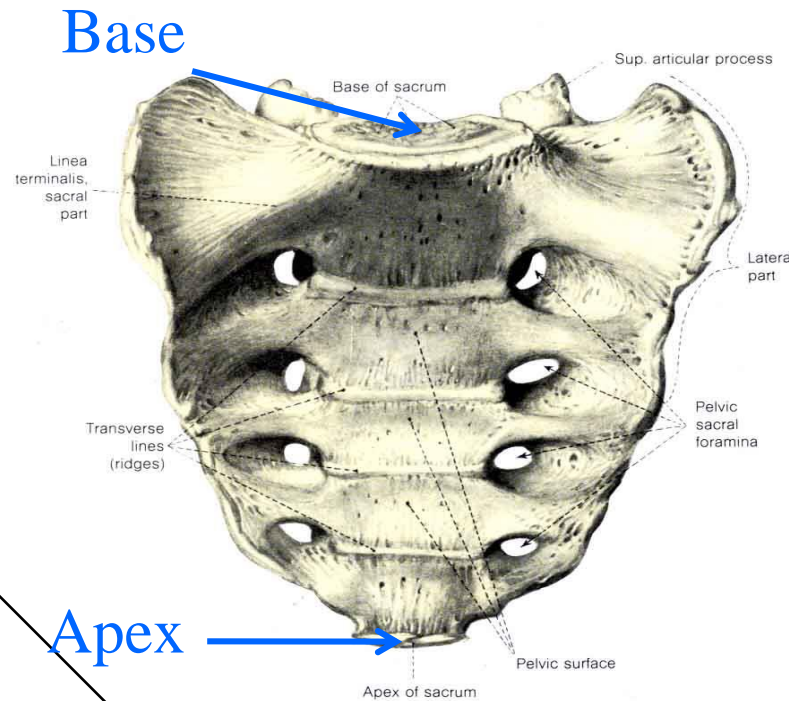
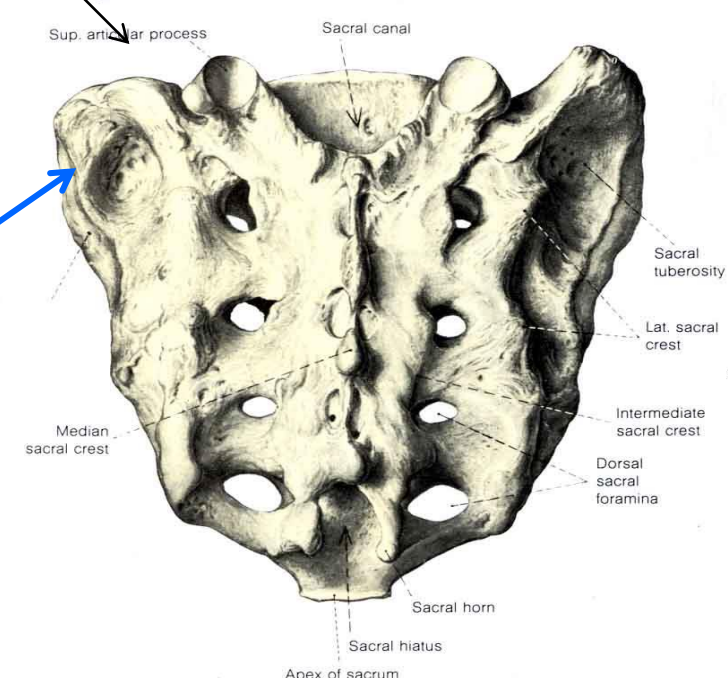
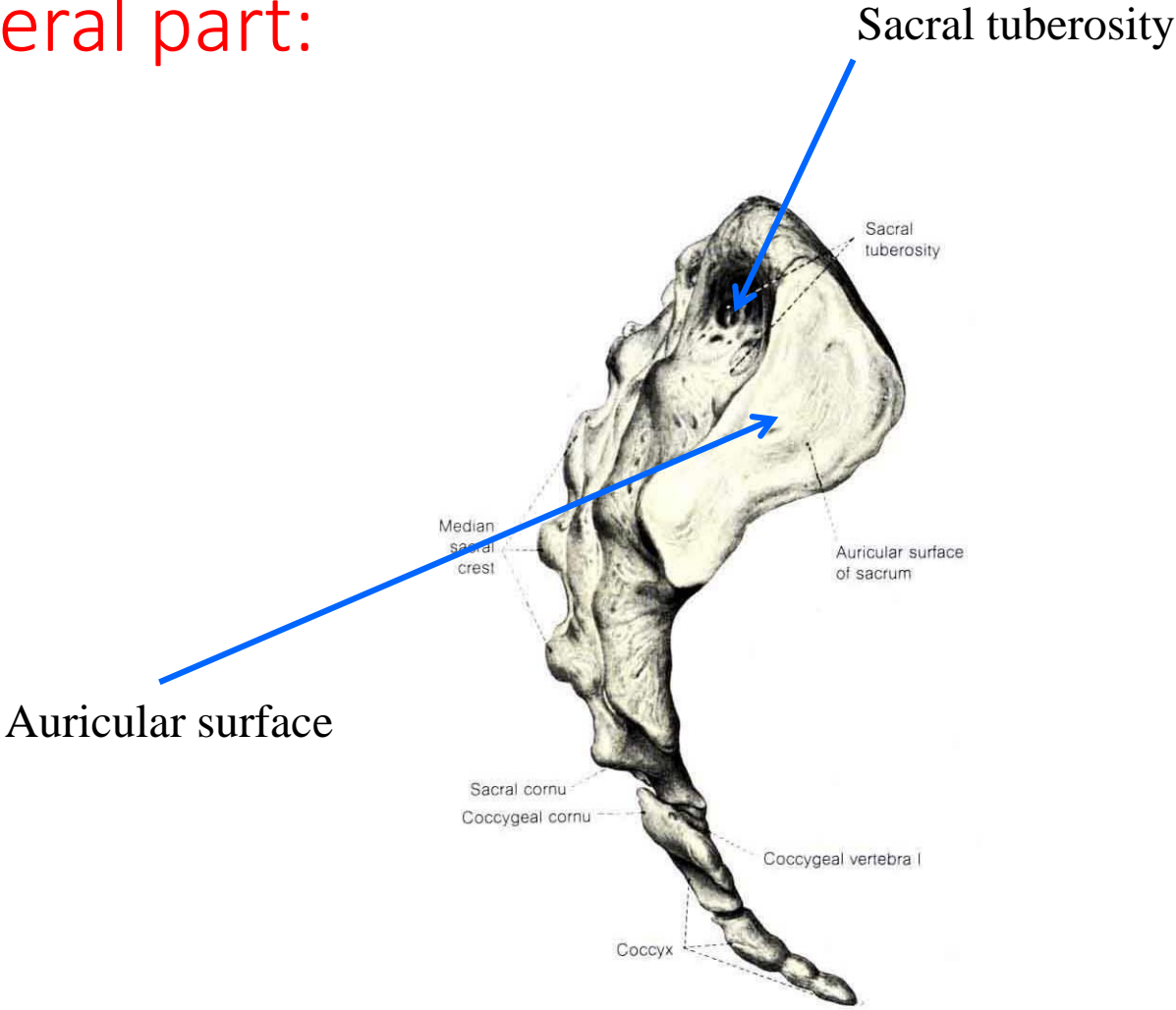


Fig. 365. The sacrum. Ventral view, pelvic surface. Δ



Sacrum

Lateral part:



Sacrum

Pelvic surface:

- Anterior sacral foramina
- Transverse lines

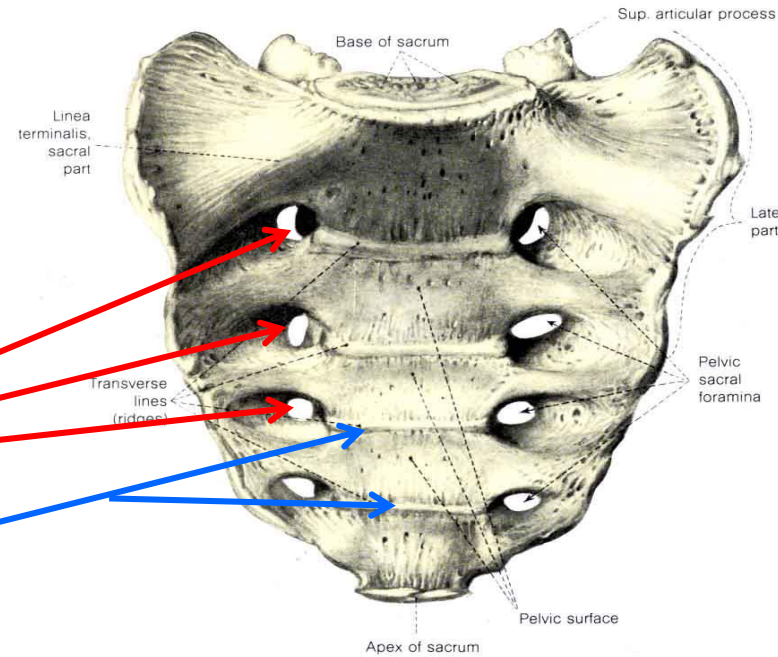
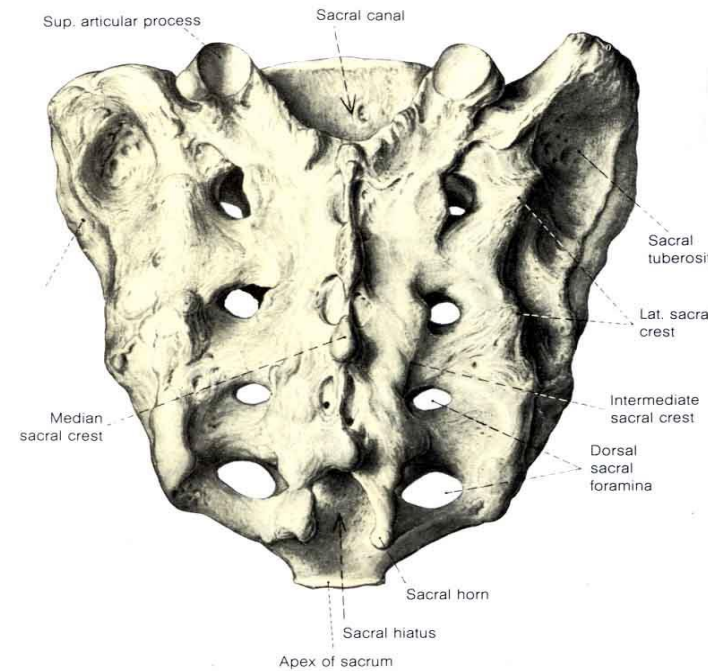


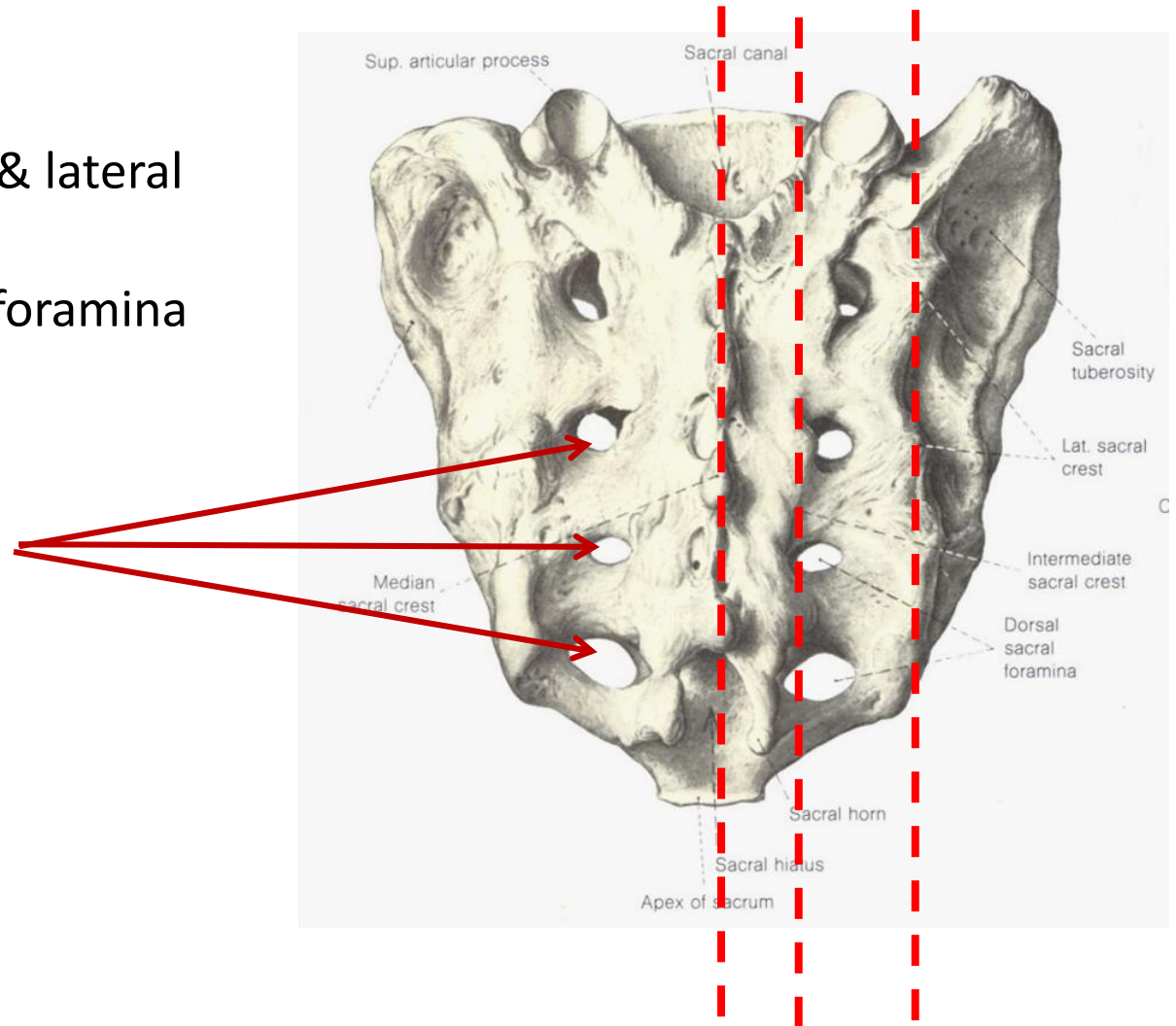
Fig. 365. The sacrum. Ventral view, pelvic surface. Δ



Sacrum

Dorsal surface:

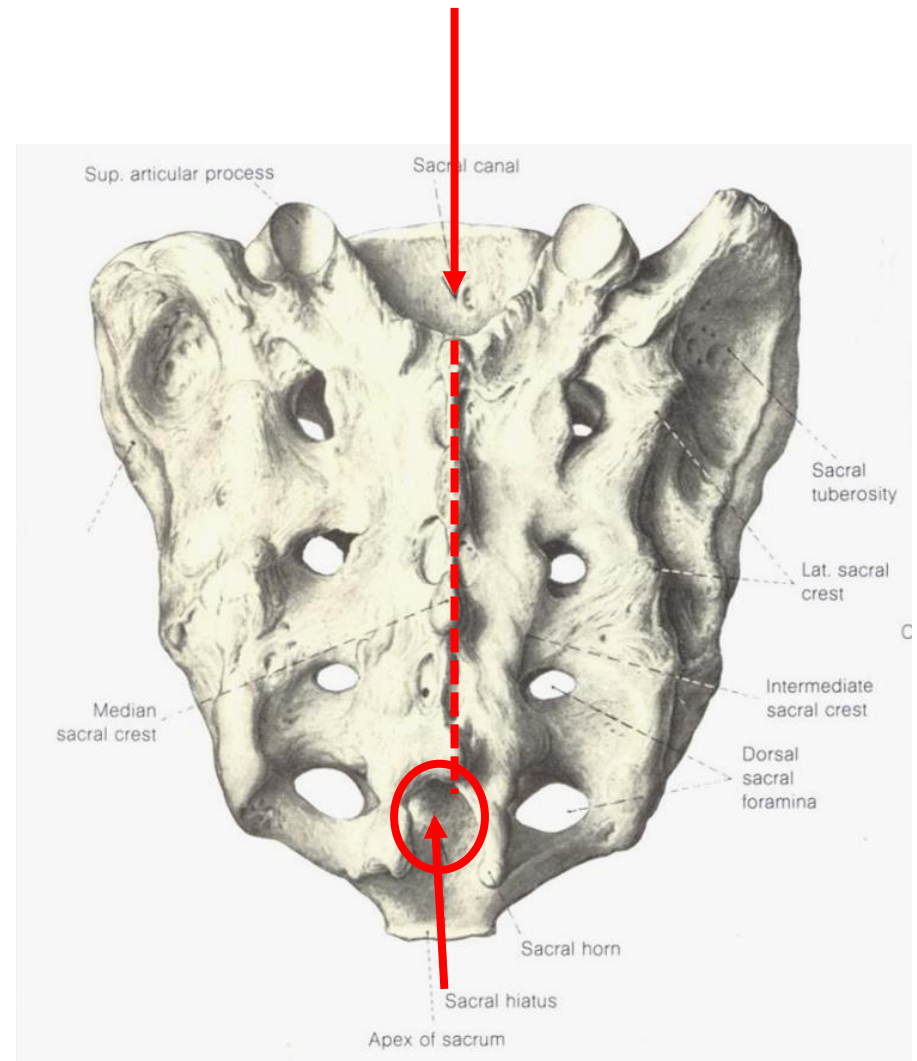
- Median, medial & lateral crests
- Posterior sacral foramina



Sacrum

Dorsal surface:

- Sacral canal-vertebral canal
- Sacral hiatus-



Sacrum

Pelvic surface:

- Promontorium

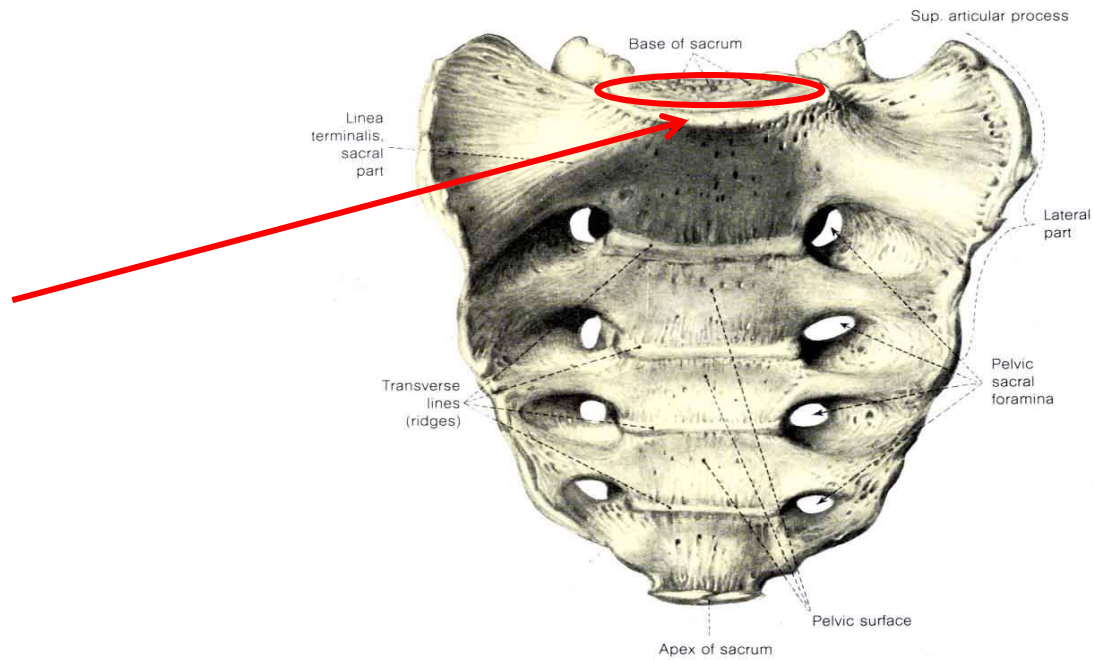
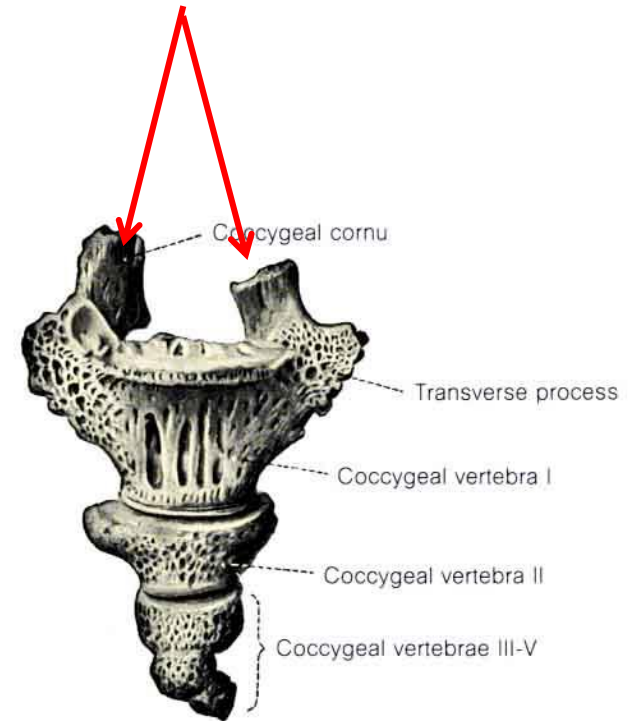


Fig. 365. The sacrum. Ventral view, pelvic surface. △

Coccyx

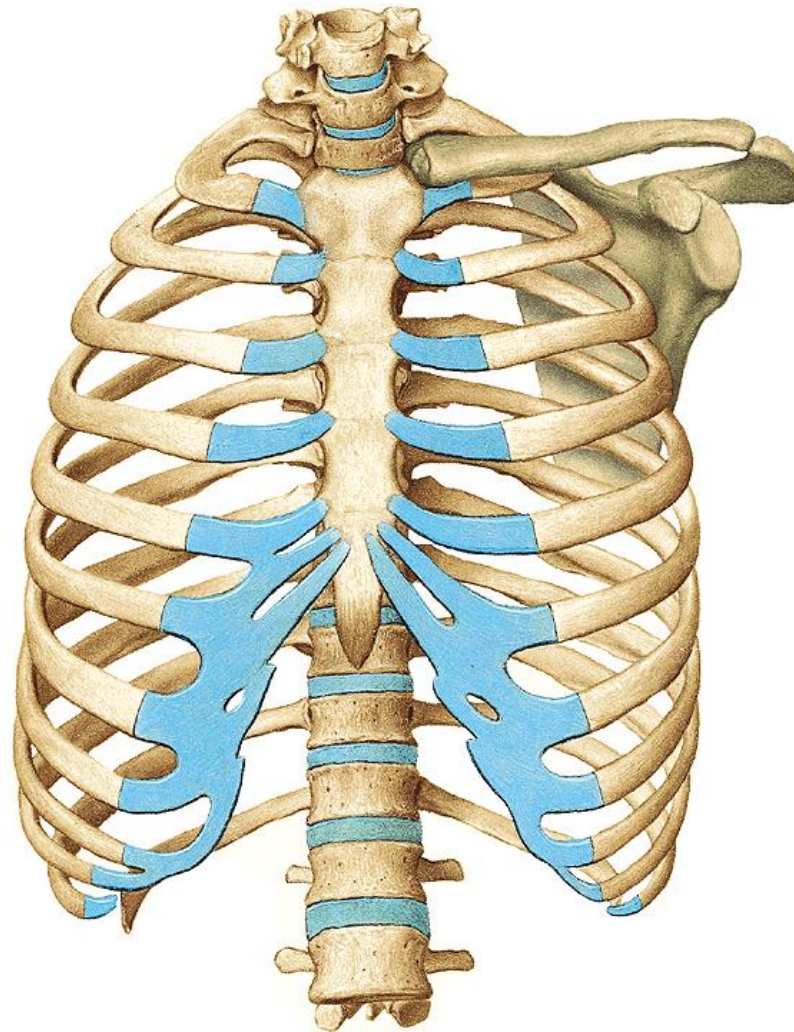
- Tailbone is the remnant of the tail which human embryos have until the beginning of the 8. weeks.
- Usually 4 rudimentary vertebrae are present
- Coccygeal cornu---the represent remnant of pedicles and transvers proc. of typical vertebra.
- it gives no support to the vert. column.
- it provides attachment point for lig. and muscles.

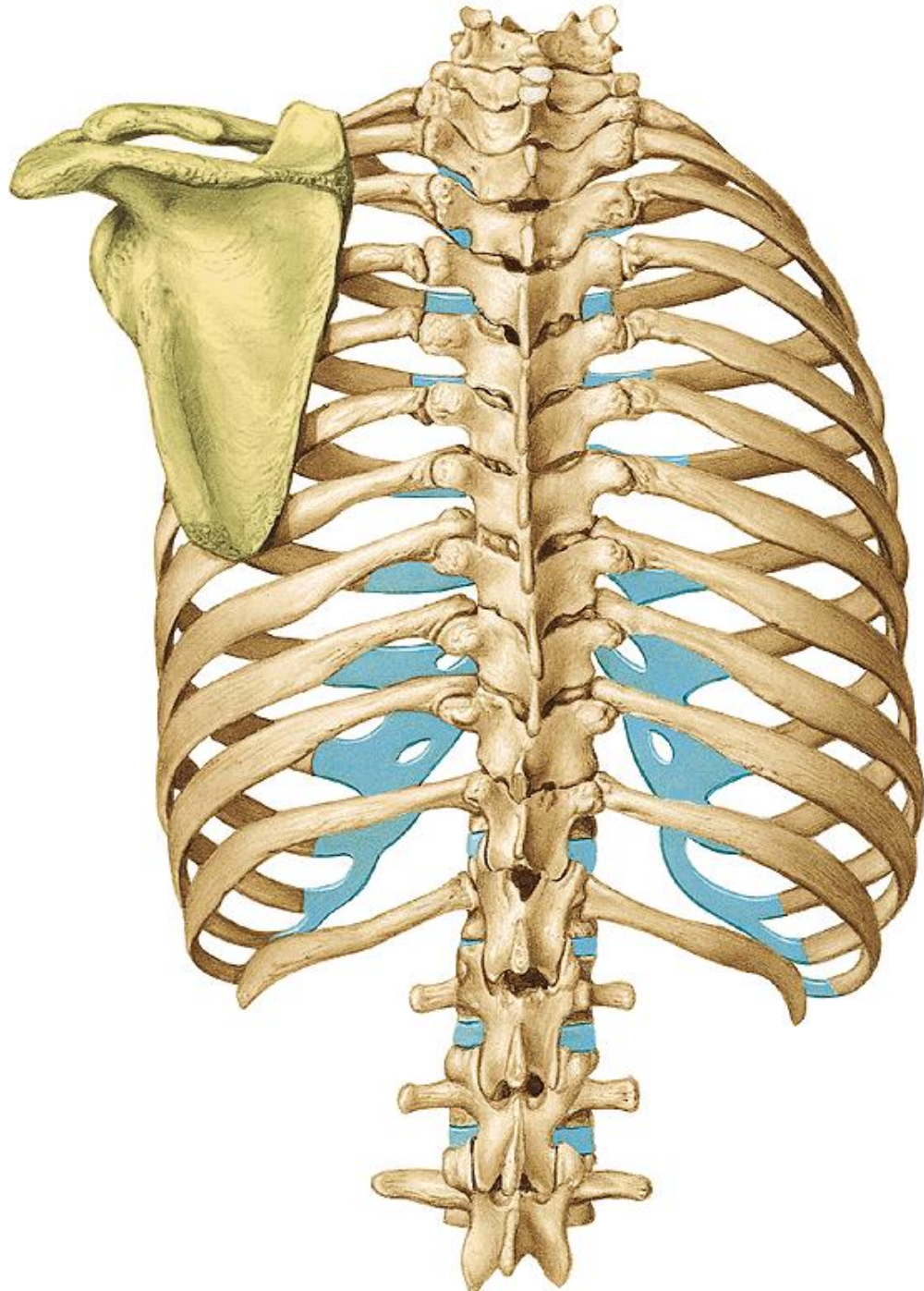




Good evening

Ribs (costae)

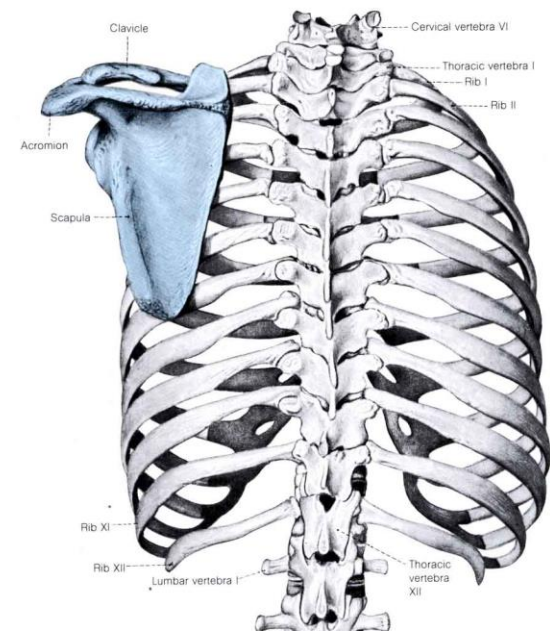




Ribs (costae)

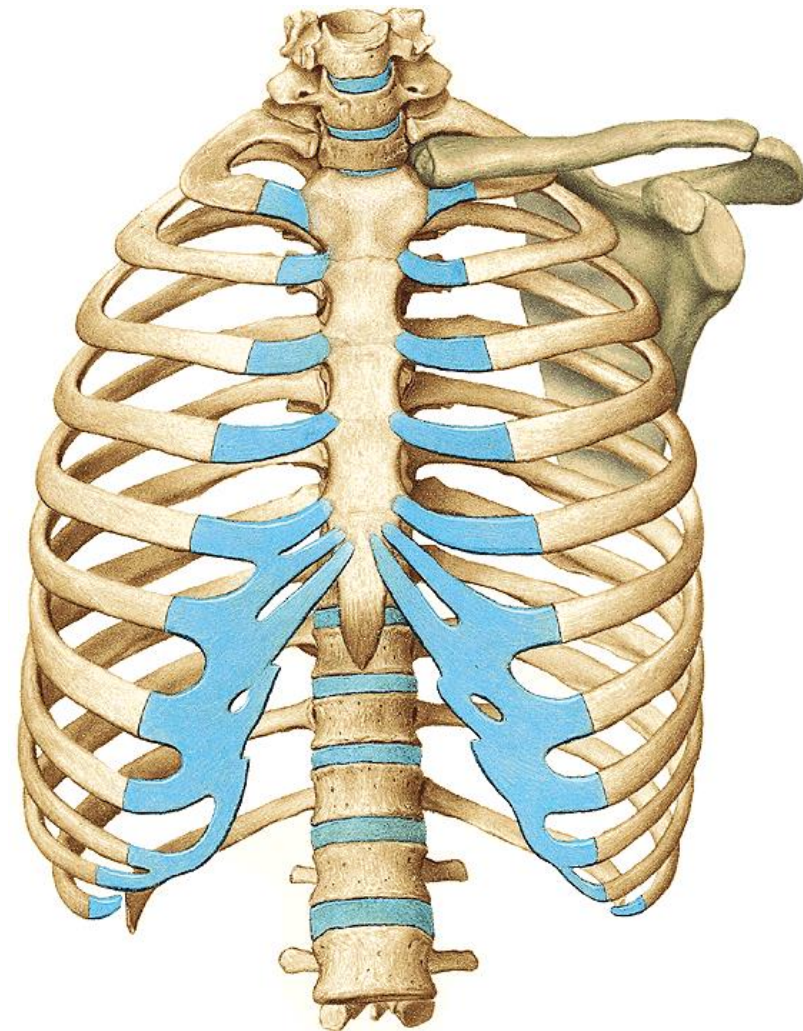
- elongated flat bones form the largest part the thoracic cage.
- Sternum
- Costal cartilage
- vertebra

Form the other part of thoracic cage



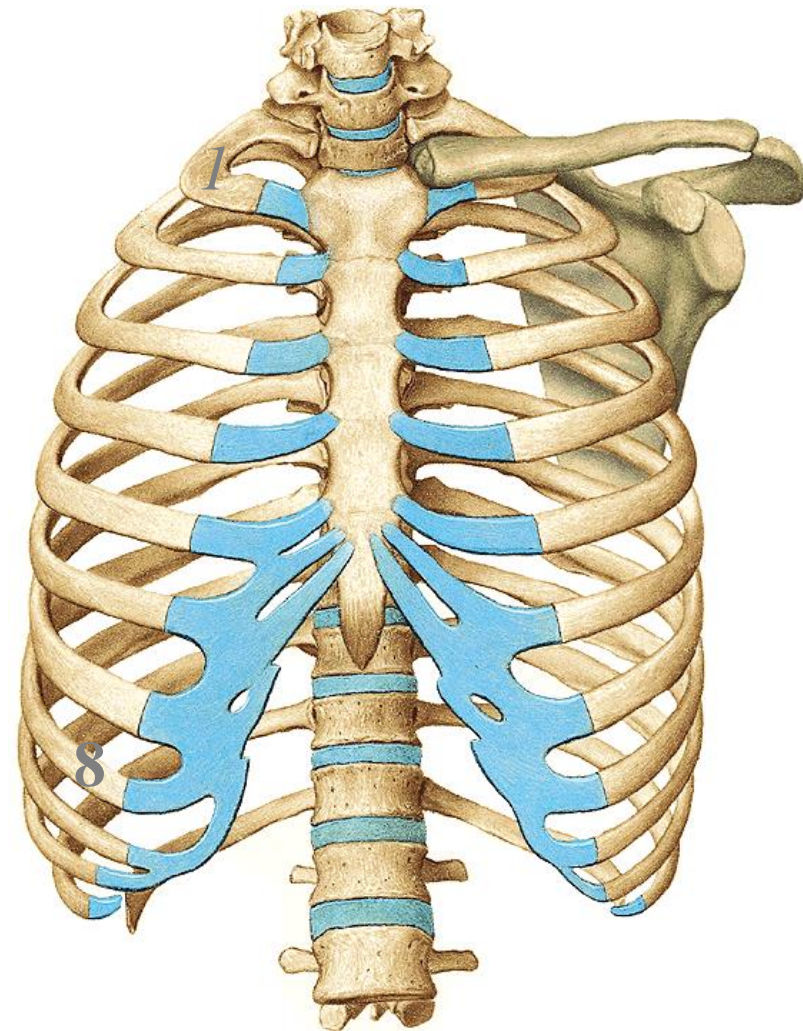
Ribs (costae)

- Long, thin, curved slightly twisted arches of bone
- Usually 12 pairs of ribs, may be increased by the development of cervical or lumbar ribs, decreased by agenesis
- **True ribs- vertebrosteral ribs (costa verae): 1-7 ribs:** articulate with the sternum (their costal cartilage direct attach to sternum)



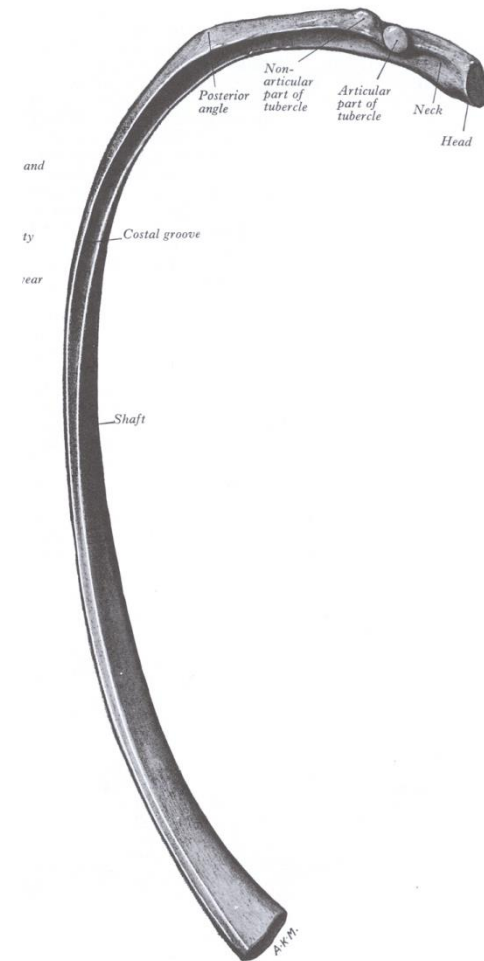
Ribs (costae)

- **False ribs-vertebrocostal ribs (costa spuriae) 8-12:** artic. with the sternum through the costal cartilage of previous rib (indirect attachment to sternum)
- **Floating ribs (fluctuantes) 11., 12.:** don't attached sternum, anterior ends are free
- 1. shortest, 8. longest
- Costal cartilages

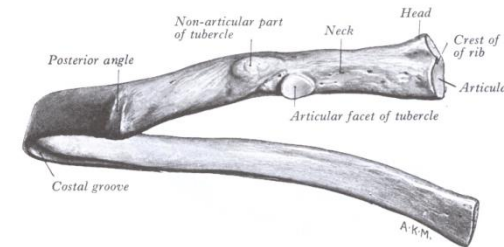


Typical ribs

- Ribs 3-10 are typical.
- Head
 - articular facet
 - crest of head of rib (not in 1,11,12)
- Neck
- Crest of neck of rib
- Body



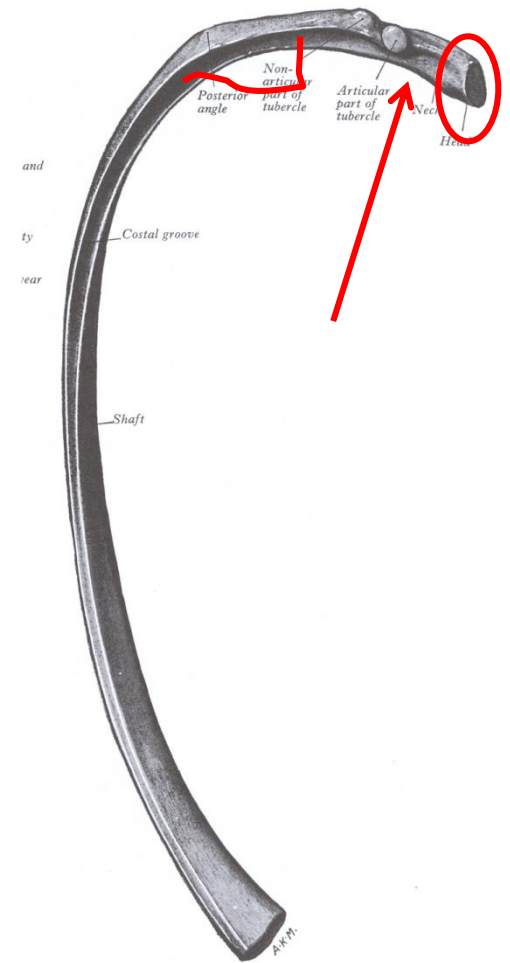
3.83 A typical rib of the left side: inferior aspect.



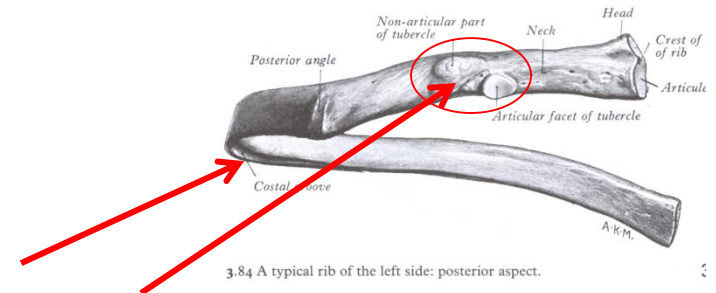
3.84 A typical rib of the left side: posterior aspect.

Typical ribs

- Body
 - external & internal surfaces
 - Angle: the point of greatest change in curvature
 - tubercle: posterior surface at the neck-body, most prominent in superior ribs.
 - groove of rib - intercostal v.-a.-n.

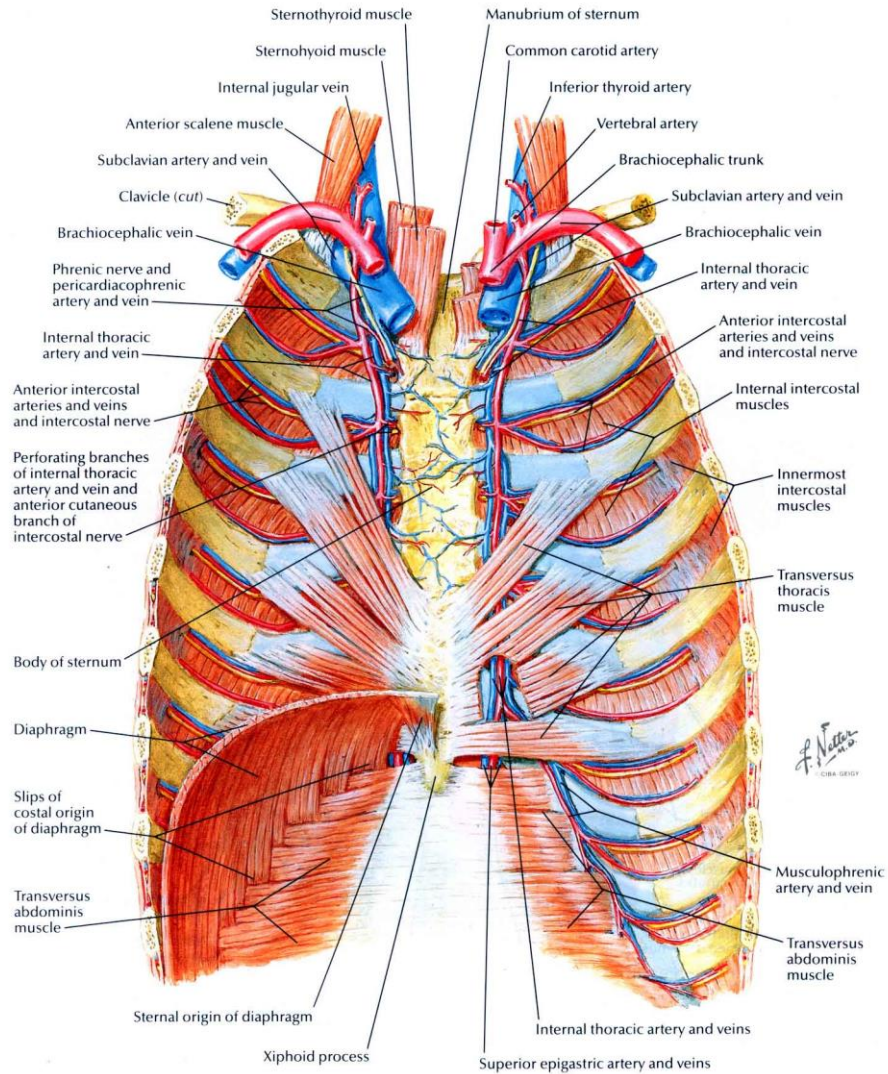


3.83 A typical rib of the left side: inferior aspect.



3.84 A typical rib of the left side: posterior aspect.

Anterior Thoracic Wall: Internal View



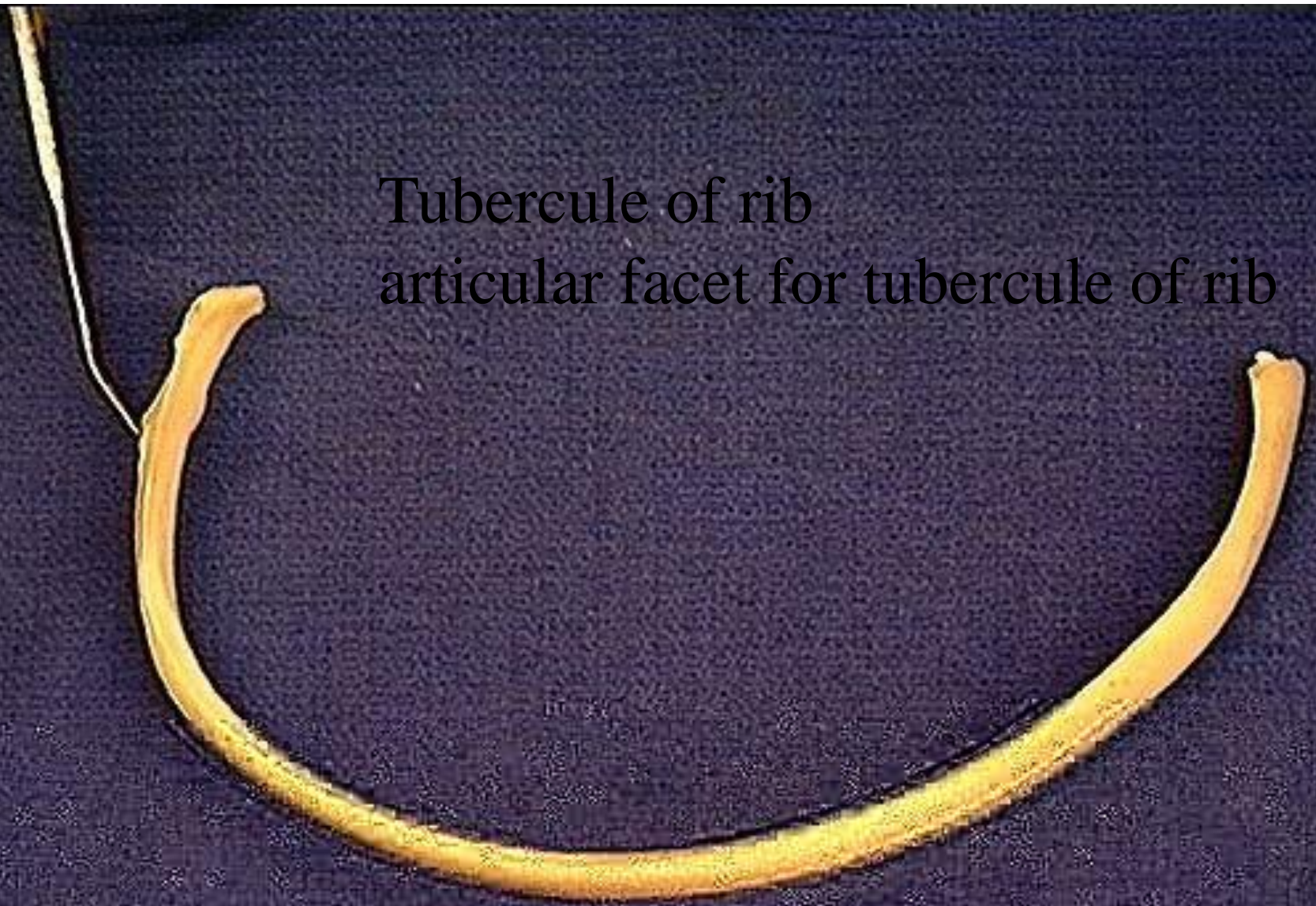
Head of rib (costa)



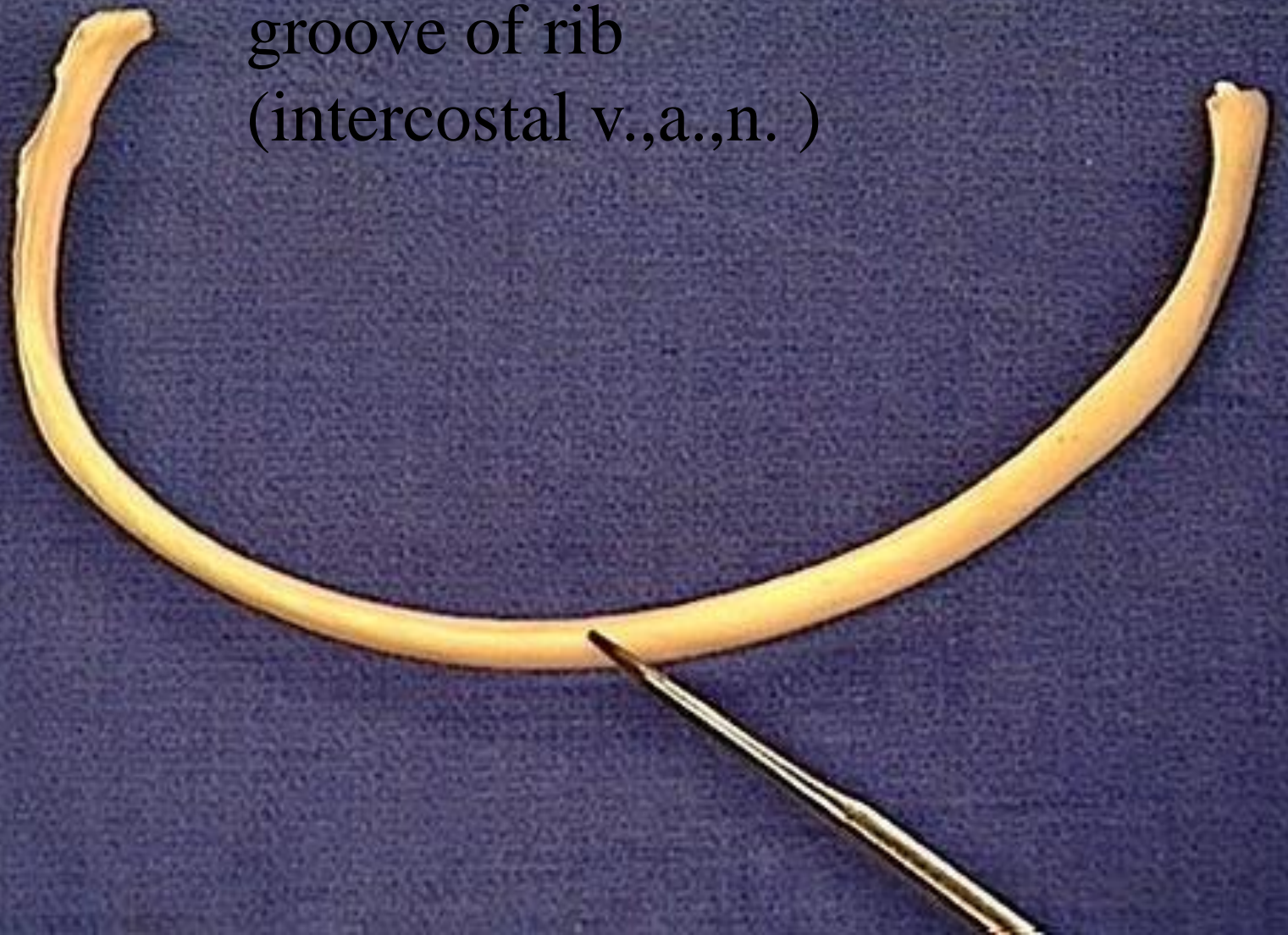
Neck of rib (costa)



Tubercle of rib
articular facet for tubercle of rib



Body of rib
groove of rib
(intercostal v.,a.,n.)



Atypical ribs

- 1
 - Sup & inf surfaces
 - No angle, tubercle, groove
 - Grooves for subclavian a & v
 - Tubercle for anterior and middle scalene mm.



Atypical ribs

2

- Tuberosity for serratus ant m
- Tubercle for post scalene m
- Groove of rib is not prominent



Atypical ribs

- **11**
 - No tubercle
- **12**
 - No angle, tubercle, groove

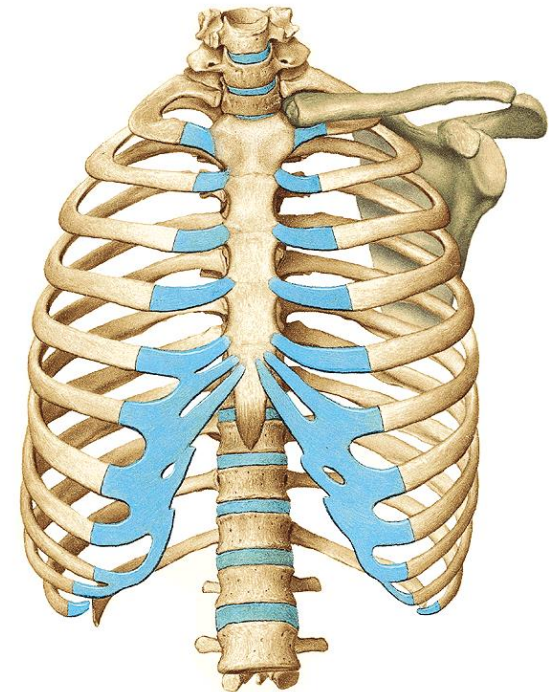
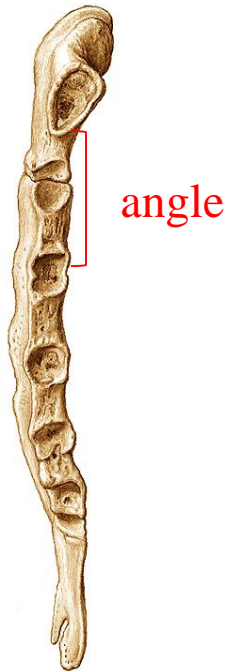
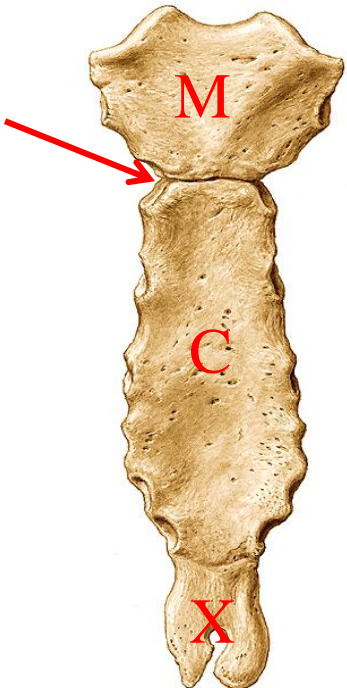


Atypical ribs

- Costae prima (I)
- Costae secunda (II)
- Costae undecima (XI)
- Costae duodecima (XII)

Sternum

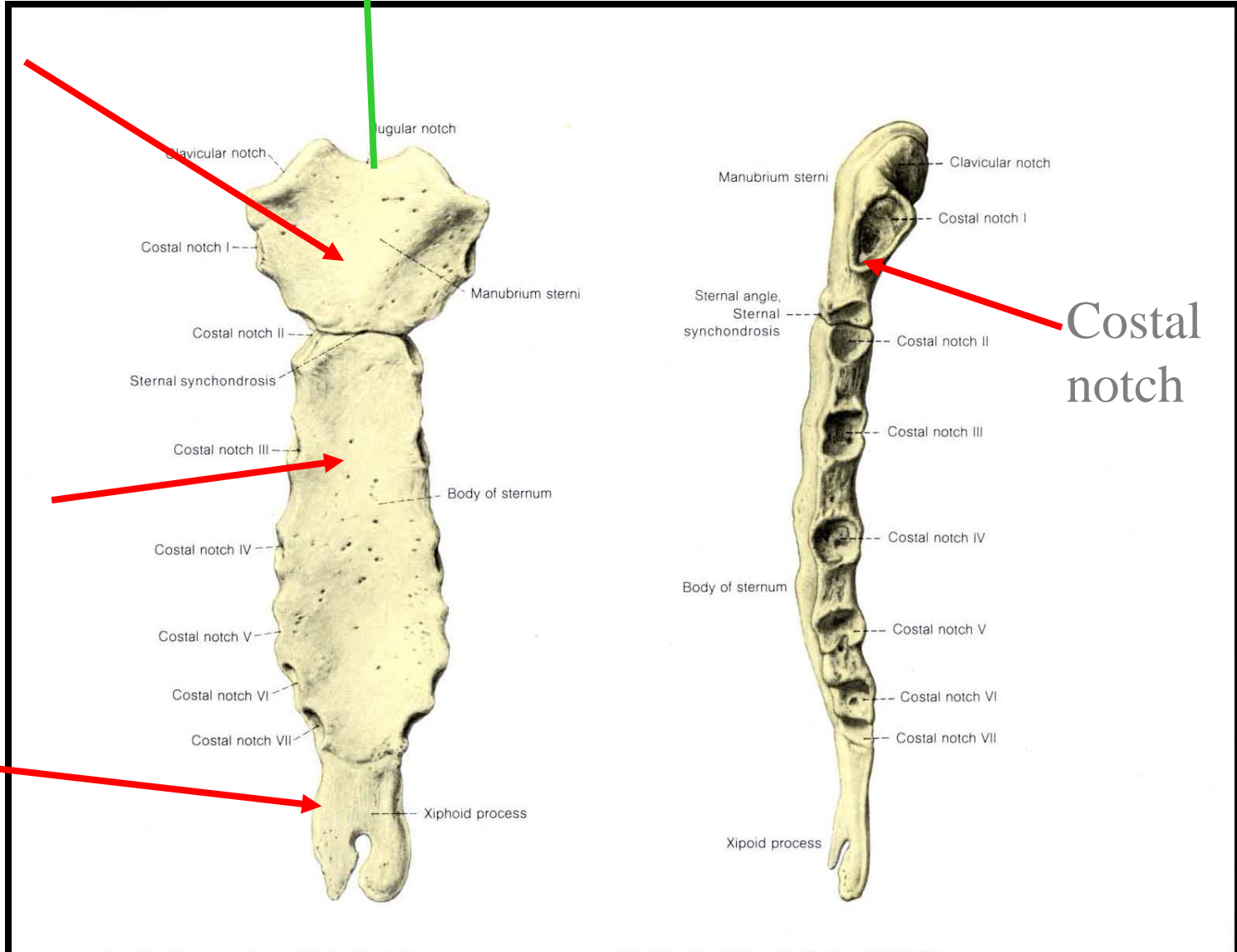
- Manubrium (jugular, clavicular & costal notches)
- Body (2. rib joins sternal angle)
- Xiphoid process (at T10-11 level)



Jugular notch

Sternum

Manubrium



Body

Costal notch

Xiphoid process

Manubrium sterni

Clavicular notch

Costal notch I

Sternal angle,
Sternal
synchondrosis

Costal notch II

Costal notch III

Costal notch IV

Body of sternum

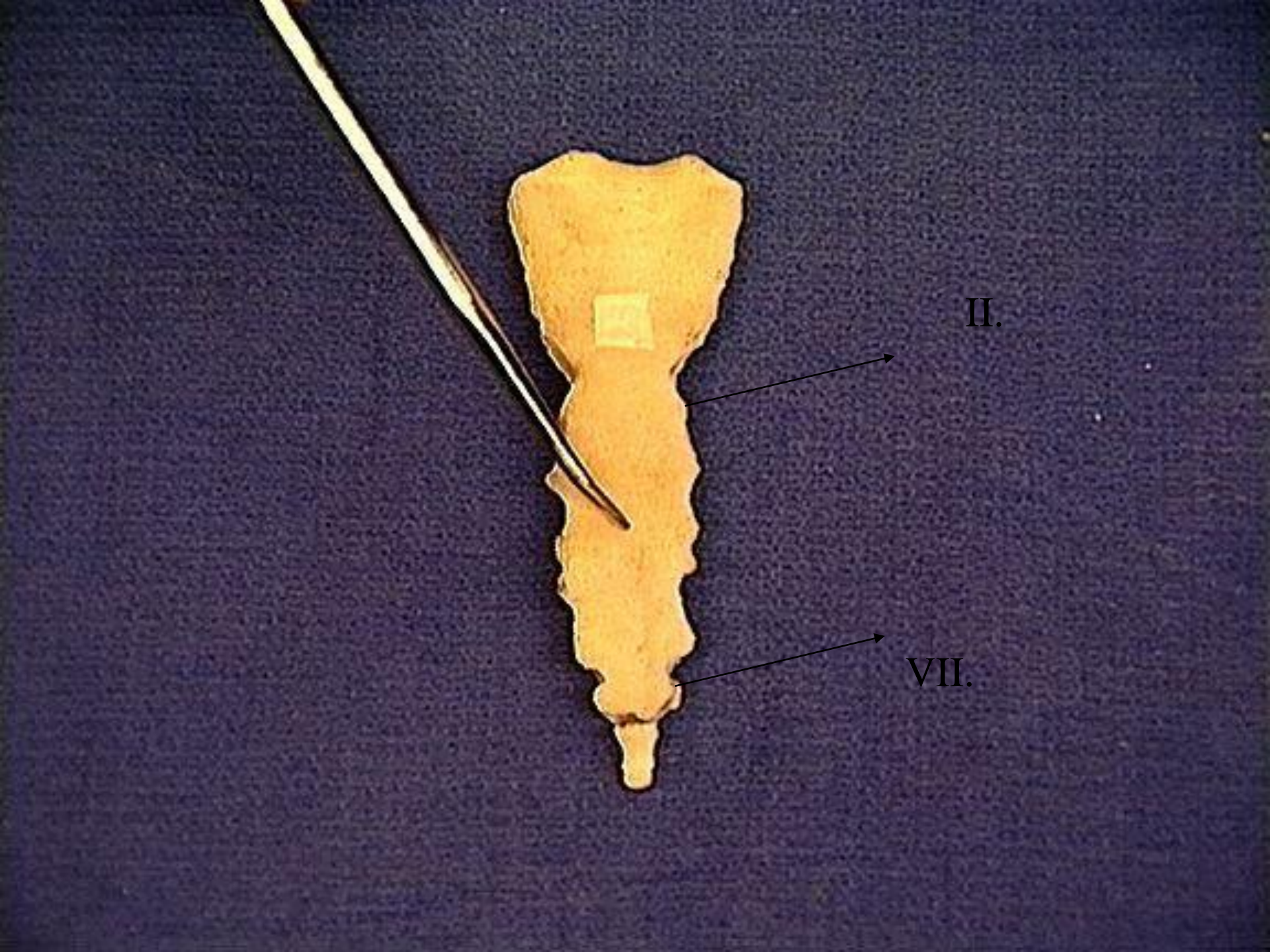
Costal notch V

Costal notch VI

Costal notch VII

Xiphoid process





II.

VII.





Sternal angle

- The line between manubrium and body junction forms an anteriorly projection
- it is located about 5 cm inferior to the jugular notch