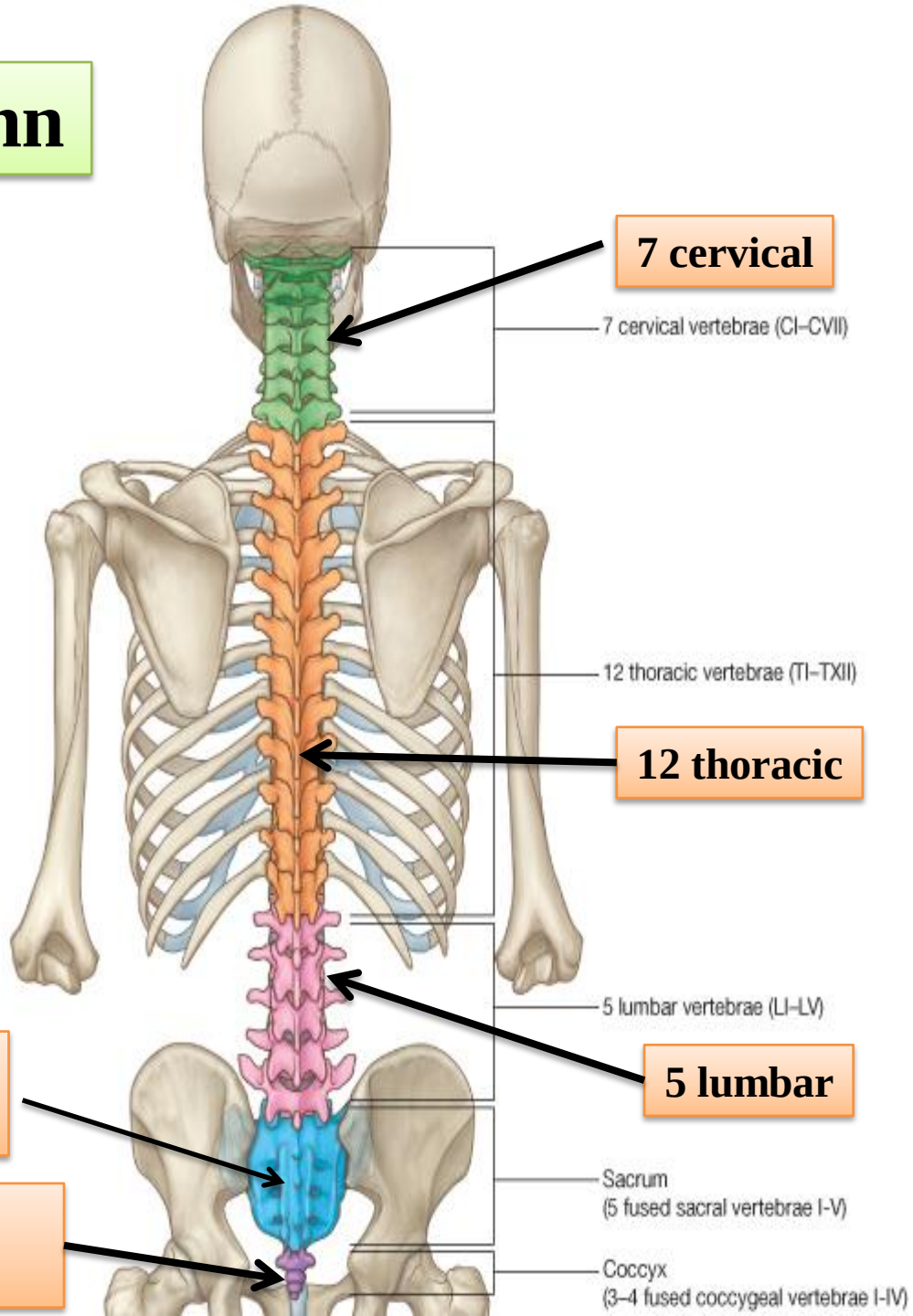
The Vertebral Column

Is composed of 33 vertebrae



5 sacral
(fused to form the sacrum)

4 coccygeal
(the lower 3 are commonly fused)

A typical vertebra consists of:

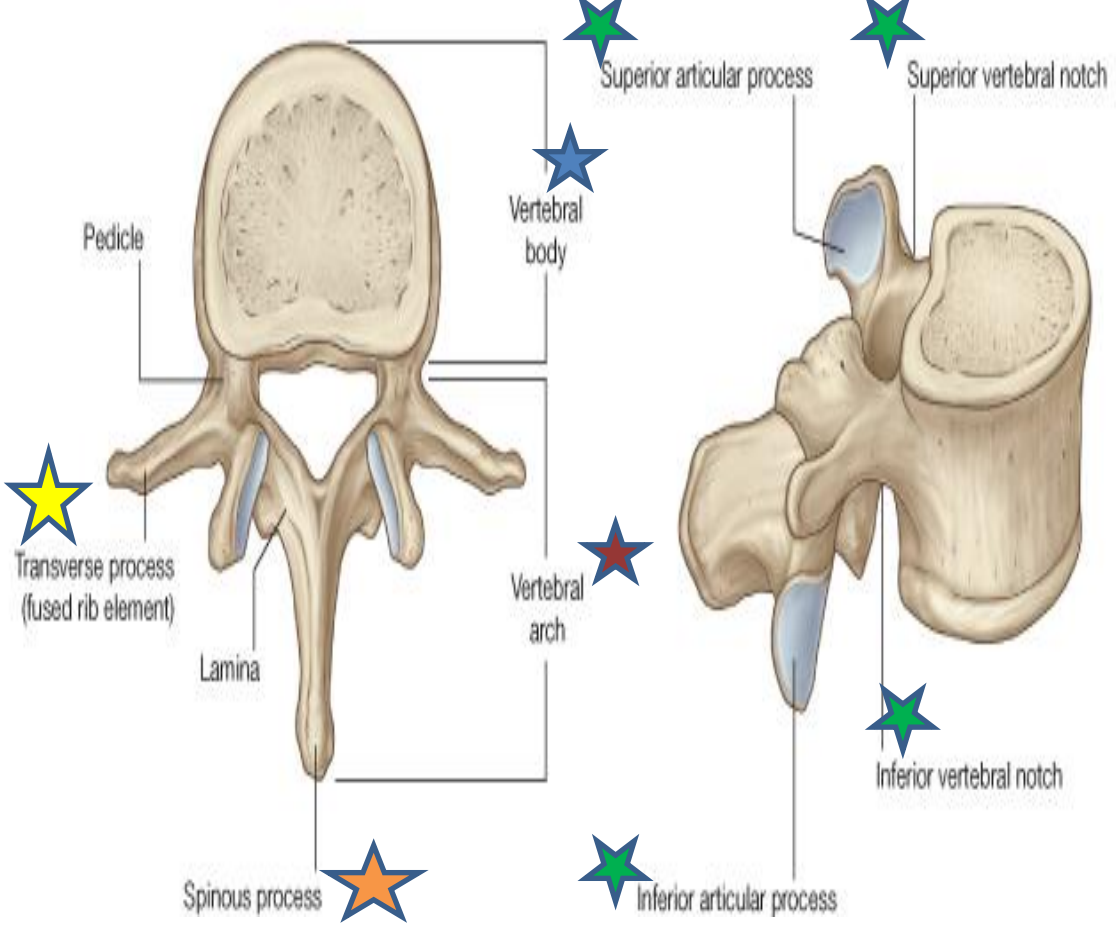
1-a rounded body anteriorly

2-a vertebral arch posteriorly.

They enclose a space called

The vertebral foramen

through which run the spinal cord and its coverings



The vertebral arch gives rise ***to seven processes:***

a-One spinous

b-Two transverse

c- Four articular

❖**The spinous process** is directed ***posteriorly***

from the junction of the two laminae.

❖**The transverse processes** are directed **laterally**

from the junction of the laminae and the pedicles

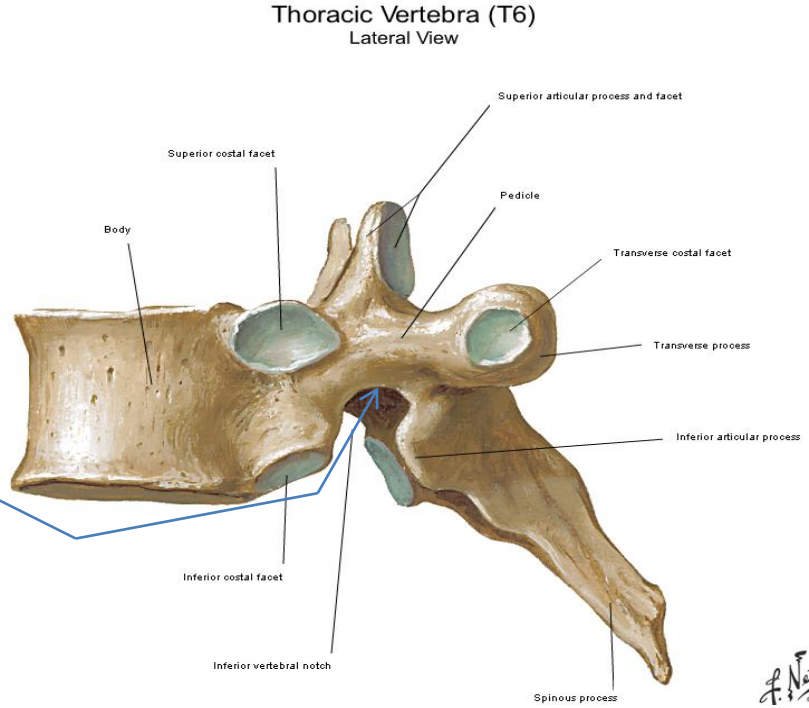
The articular processes are vertically arranged and consist of:

Two superior & **Two inferior processes**

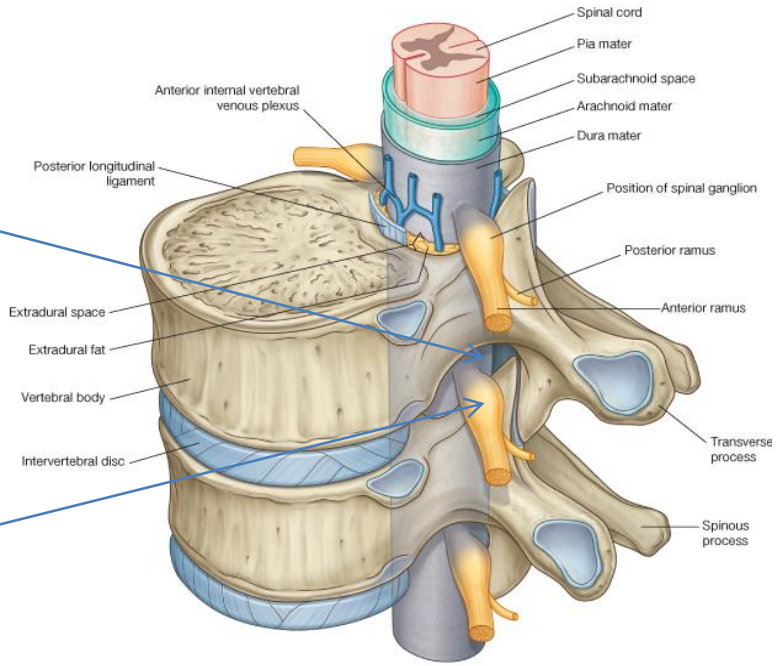
They arise from the junction of the laminae and the pedicles

.

❖**The pedicles are notched on their upper and lower borders Forming the superior and inferior vertebral notches.**



On each side the superior notch of one vertebra and the inferior notch of an adjacent vertebra together form an intervertebral foramen.



These foramina, in an articulated skeleton, serve to transmit the spinal nerves and blood vessels.

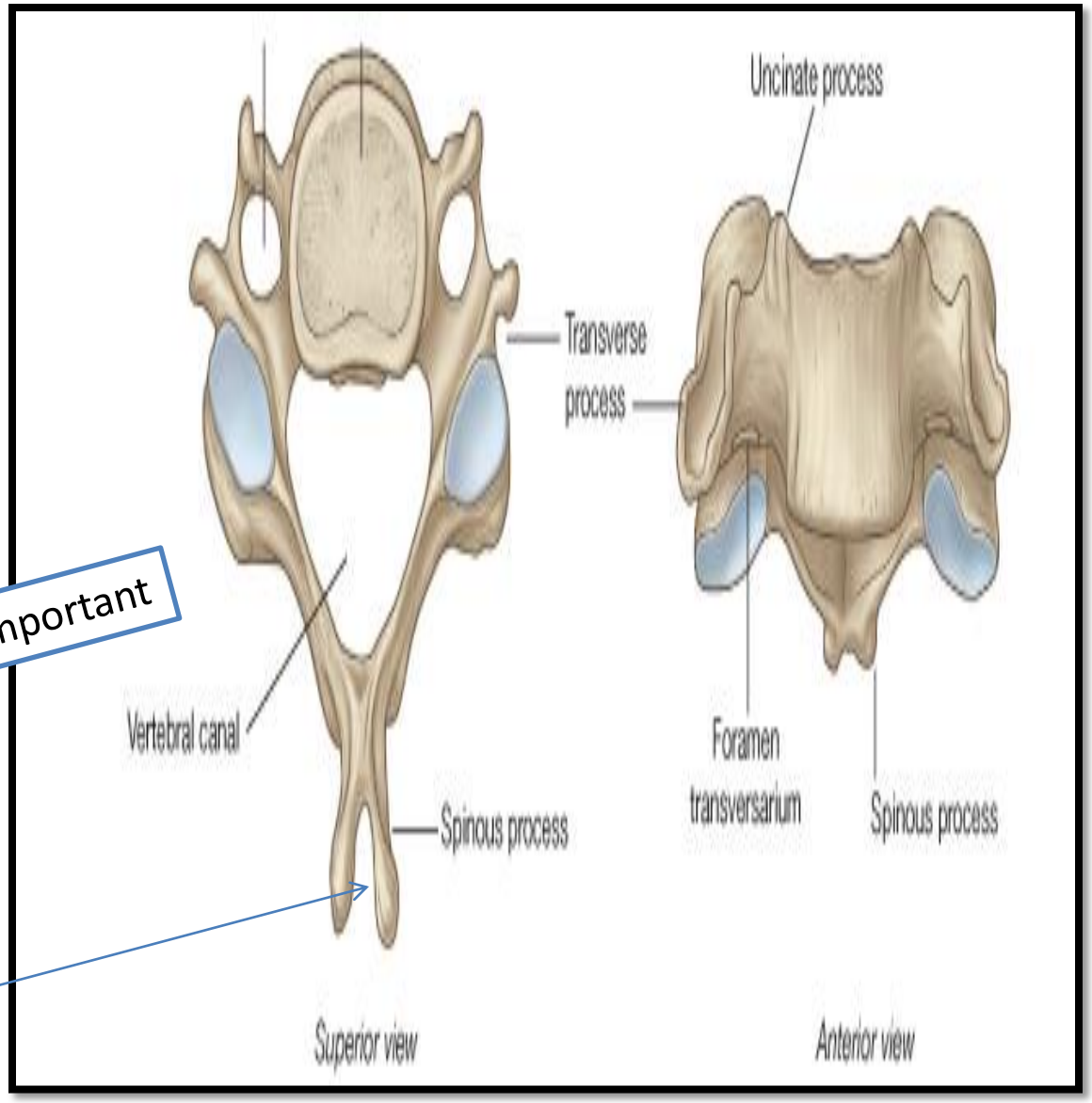
Characteristics of a Typical Cervical Vertebra

- The transverse processes possess ***a foramen transversarium*** ***for the passage of the vertebral artery and veins***

important

(note that the vertebral artery passes through the transverse processes C1 to 6 and not through C7).

- The spines are small and **bifid**
- The vertebral foramen is large and **triangular**



Characteristics of the Atypical Cervical Vertebrae

The first, second, and seventh cervical vertebrae are atypical.

The first cervical vertebra

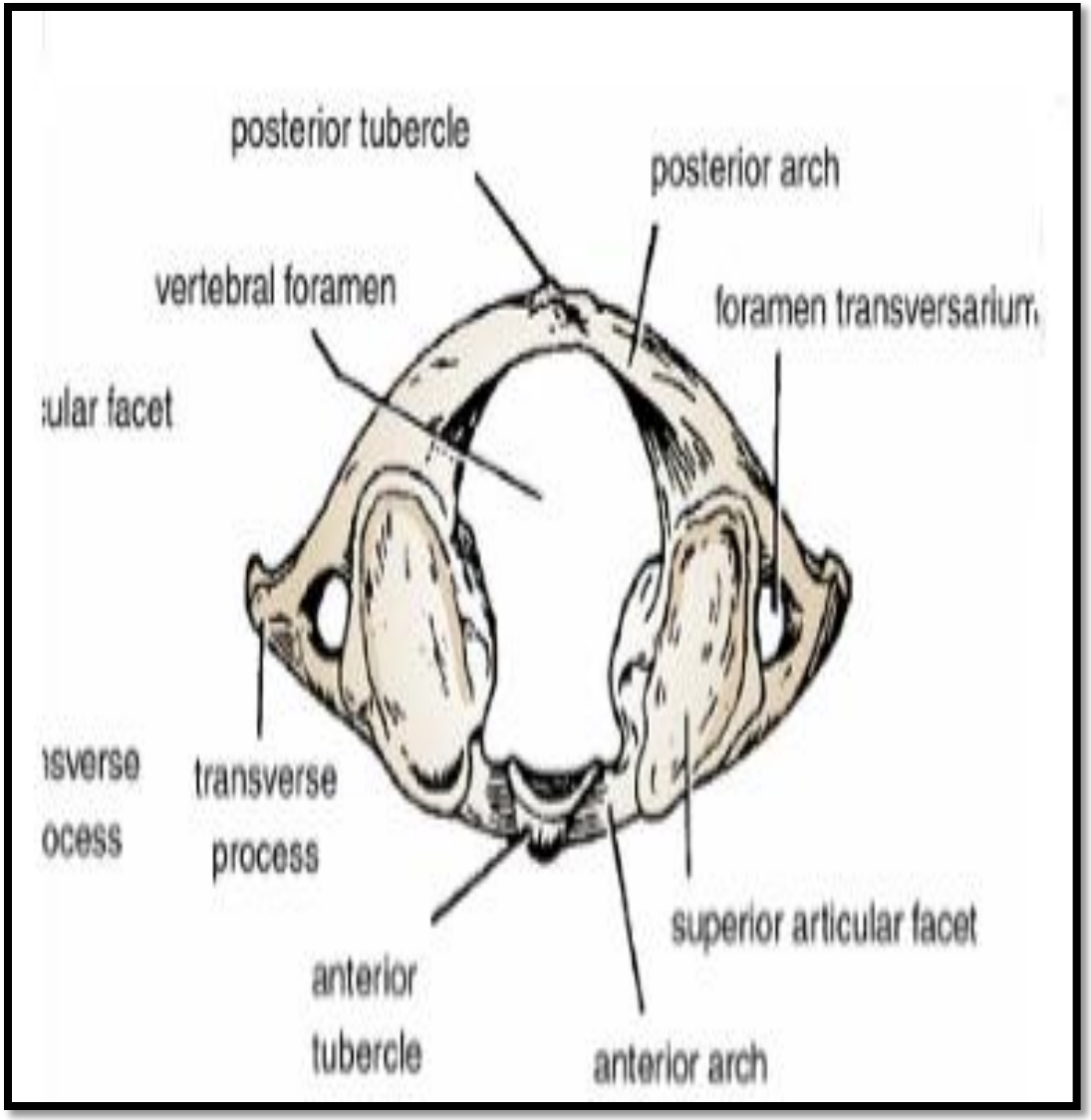
THE ATLAS

- does not possess ***a body or a spinous process***

- It has
- an ***anterior and posterior arch***

- It has a ***lateral mass*** on each side with articular surfaces on its **upper surface** for articulation with the **occipital condyles (atlanto-occipital joints)**

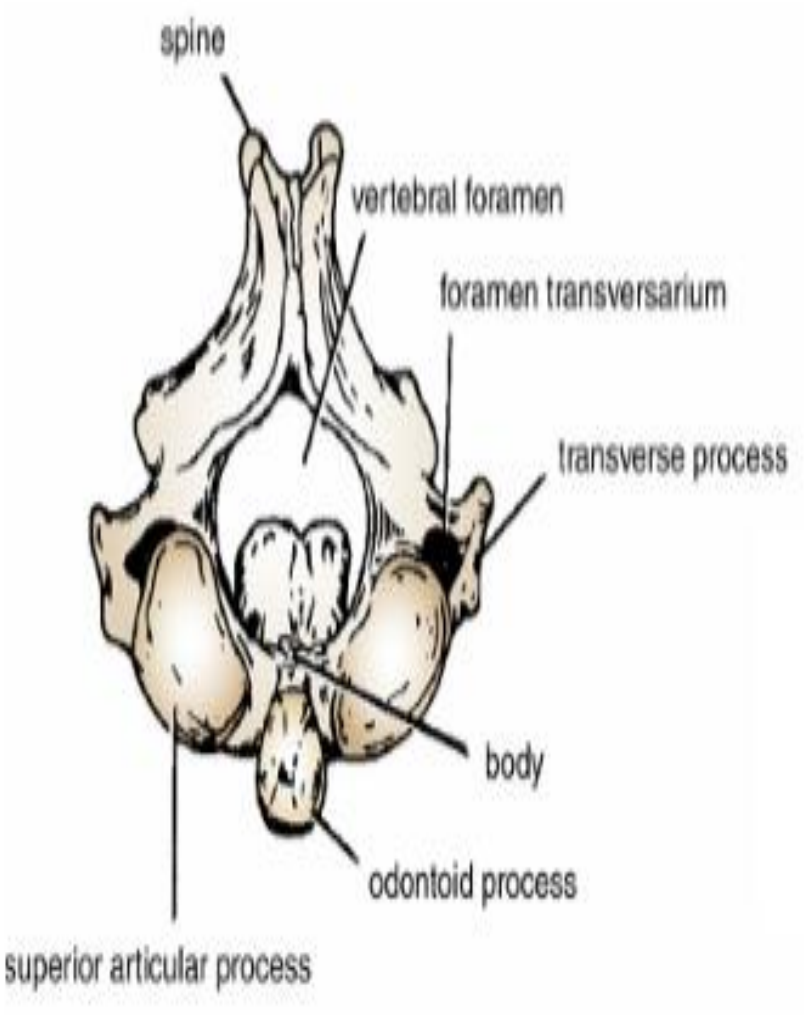
and
articular surfaces on **its lower surface**
for articulation with **the axis (atlantoaxial joints)**



The **second cervical** vertebra

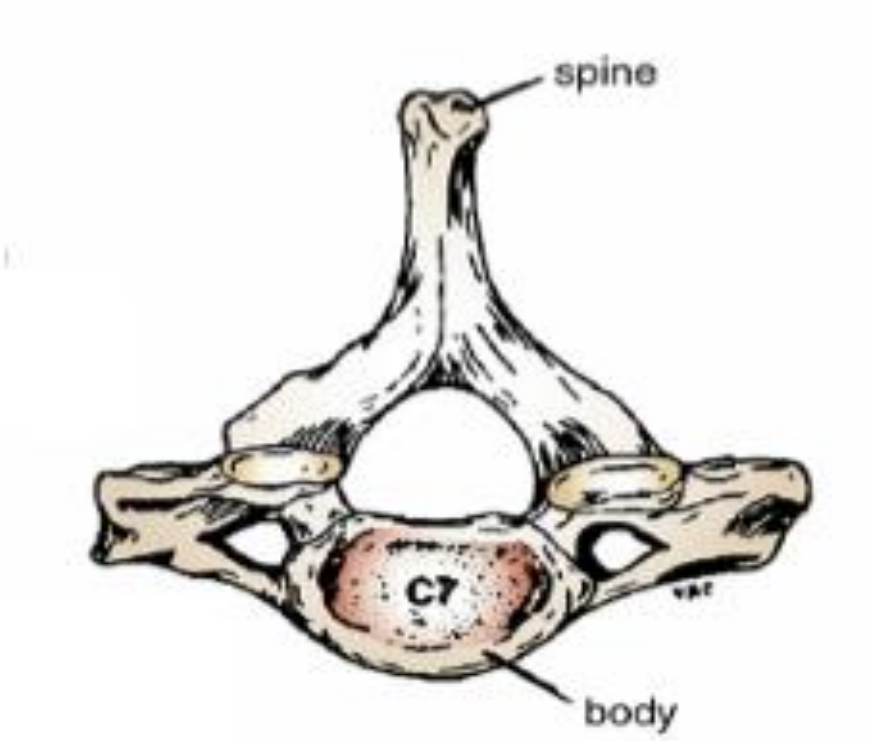
The AXIS

has a odontoid process that projects from the superior surface of the body (representing the body of the atlas that has fused with the body of the axis).



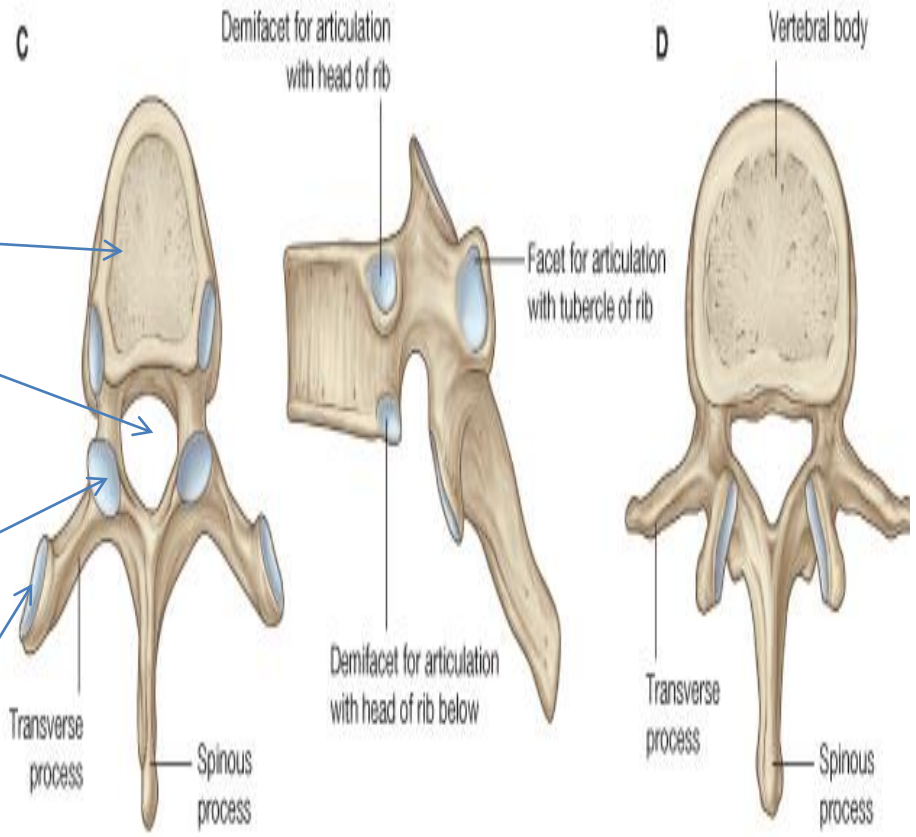
The seventh cervical vertebra

or vertebra **prominens**
is so named because it has the
longest spinous process,
and the process is not bifid.
The transverse process is large,
but the foramen transversarium is
small and
transmits the vertebral vein



Characteristics of a Typical Thoracic Vertebra

- The body is **heart shaped**
- The vertebral foramen is small and **circular**
- The spines are **long and inclined downward**
- **Costal facets are present on the sides of the bodies for articulation with the heads of the ribs**
- **Costal facets are present on the transverse processes for articulation with the tubercles of the ribs**



(T11 and 12 have no facets on the transverse processes)

Characteristics of a Typical Lumbar Vertebra

❖The body is large **and kidney shaped**

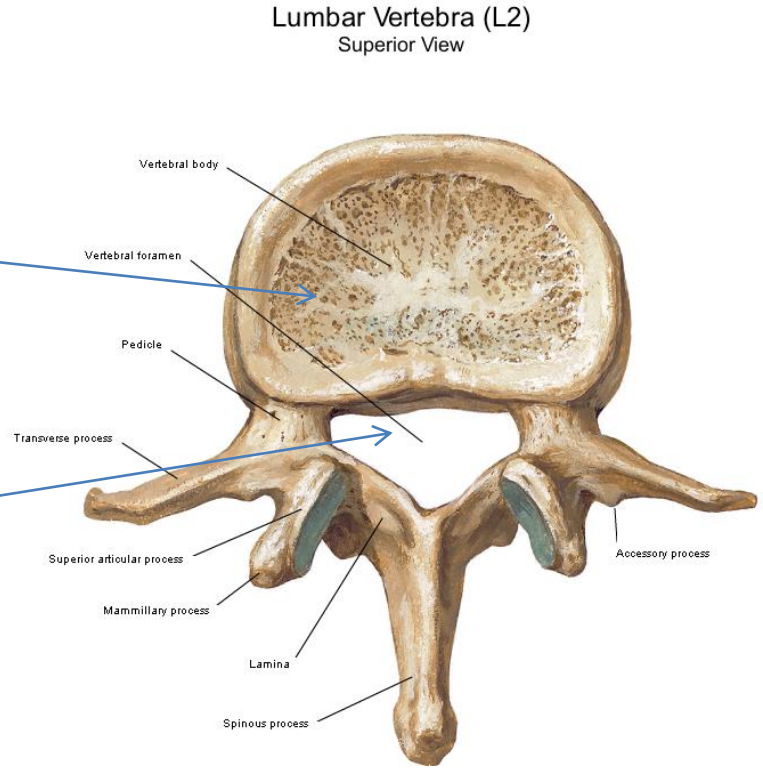
❖ The laminae are thick

❖ The vertebral foramina are triangular.

❖The transverse processes are long and slender.

❖The spinous processes are short, flat, and quadrangular and project backward.

❖The articular surfaces of the superior articular processes face medially, and those of the inferior articular processes face laterally.



The sacrum

consists of five rudimentary vertebrae fused together

Articulations

1-The upper border, or base, of the bone articulates with **the fifth lumbar vertebra**

2-The narrow inferior border articulates with **the coccyx.**

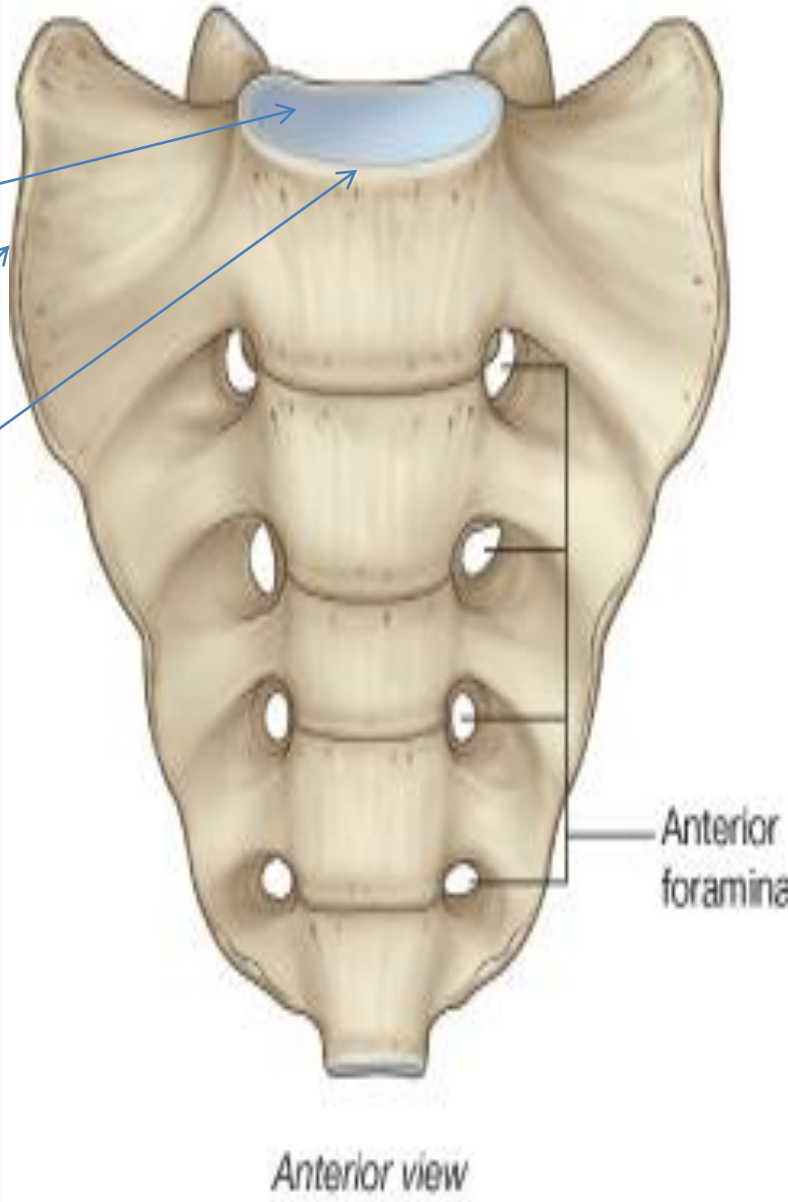
3-Laterally, the sacrum articulates with the two iliac bones to form the **sacroiliac joints**

The anterior and upper margin of the first sacral vertebra bulges forward and is known as the **sacral promontory**

➢The sacral promontory in the female is of considerable obstetric importance and is used when measuring the size of the pelvis.

The laminae of the fifth sacral vertebra, and sometimes those of the fourth also, fail to meet in the midline, forming **THE SACRAL HIATUS**

The anterior and posterior surfaces of the sacrum each have four foramina on each side for the passage of the anterior and posterior rami of the **sacral nerves**



COCCYX

The coccyx consists of four vertebrae fused together to form a single, small triangular bone that articulates at its base with the lower end of the sacrum

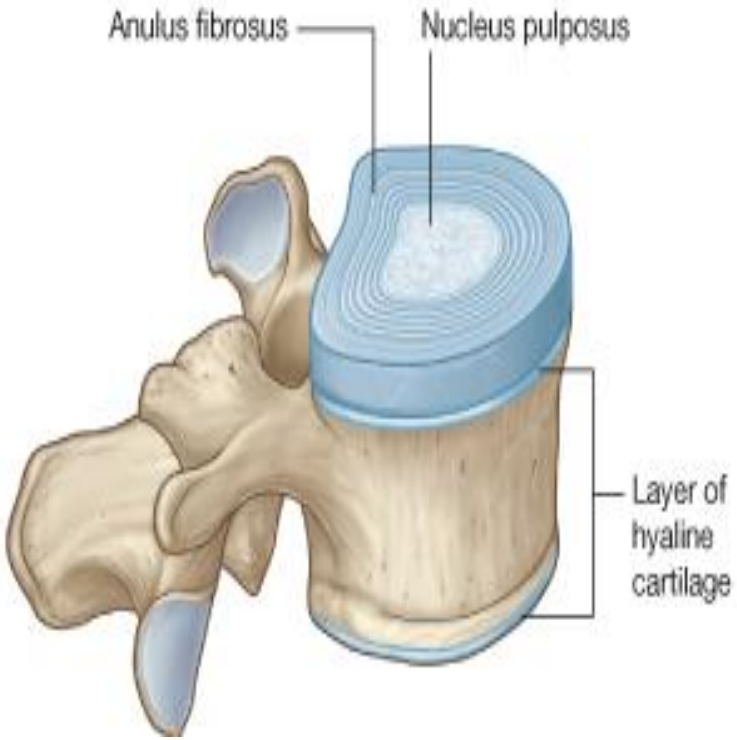
The first coccygeal vertebra is usually not fused or is incompletely fused with the second vertebra.

Intervertebral Discs

Their physical characteristics permit them to serve as shock absorbers when the load on the vertebral column is suddenly increased, as when one is jumping from a height.

Their elasticity allows the rigid vertebrae to move one on the other.

Unfortunately, their resilience is gradually lost with advancing age.

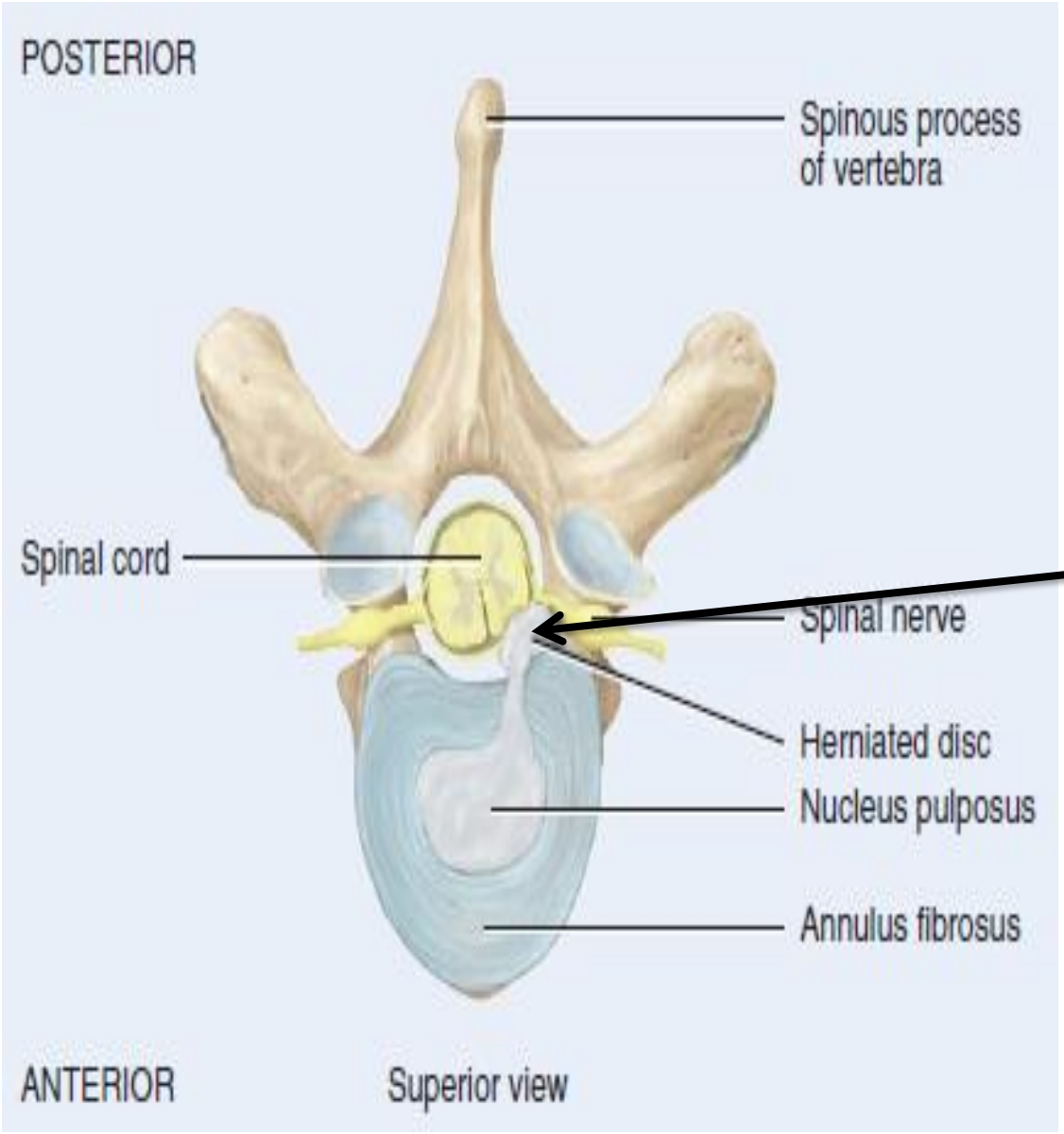


Each disc consists of **a peripheral part,** the **anulus fibrosus**, and a **central part**, the **nucleus pulposus**

The anulus fibrosus is composed of **FIBROCARTILAGE**, in which the collagen fibers are arranged in concentric layers or sheets.

The nucleus pulposus in children and adolescents is an ovoid mass of **gelatinous** material containing a large amount of water, a small number of collagen fibers, and a few cartilage cells.

It is normally under pressure and situated slightly nearer to the posterior than to the anterior margin of the disc.



The pressure developed in the nucleus pulposus may be great enough to rupture the surrounding fibrocartilage (annulus fibrosus).
If this occurs, the nucleus pulposus may herniate (protrude) posteriorly or into one of the adjacent vertebral bodies
This condition is called a herniated

(slipped) disc

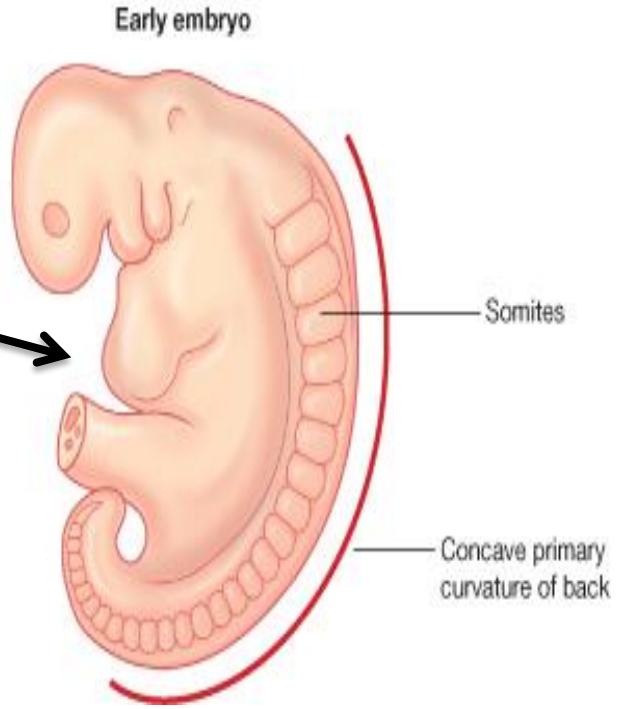
The disc usually slips posteriorly toward the **spinal cord and spinal nerves.**
This movement exerts pressure on the spinal nerves, causing **local weakness and acute pain**


LIV vertebra
Disc protrusion

Curves of the Vertebral Column

Curves in the Sagittal Plane

In the fetus,
the vertebral column has one continuous anterior concavity

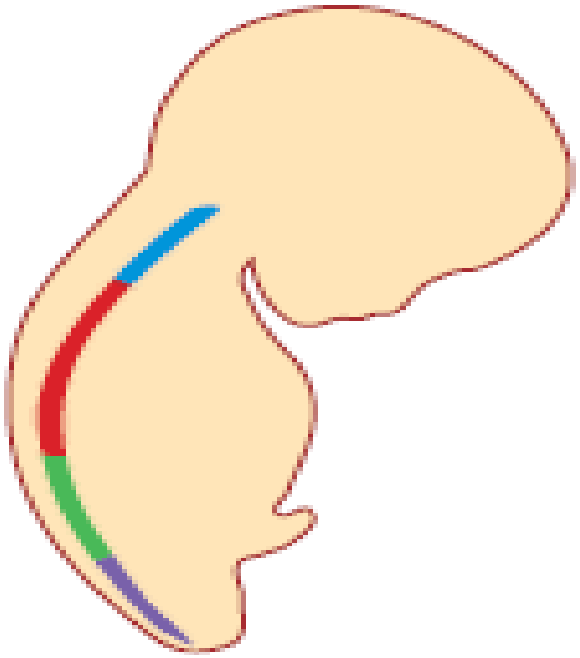


After birth,
when the child becomes able to raise his or her head and keep it poised on the vertebral column,
the cervical part of the vertebral column becomes **concave posteriorly**

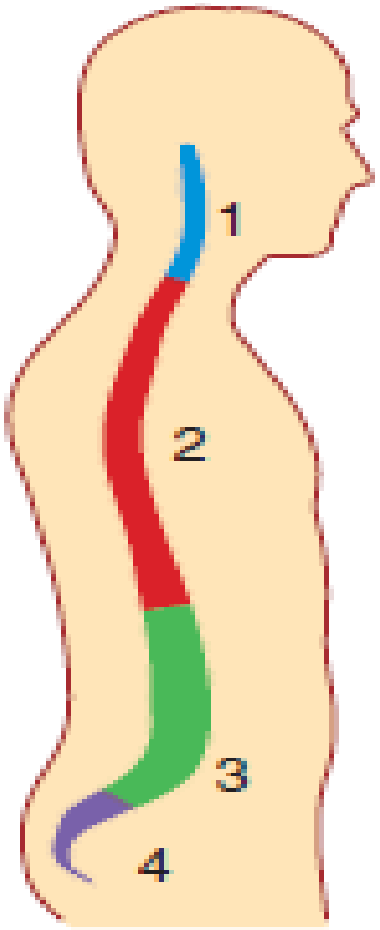
Toward the end of the first year,
when the child begins

to stand upright

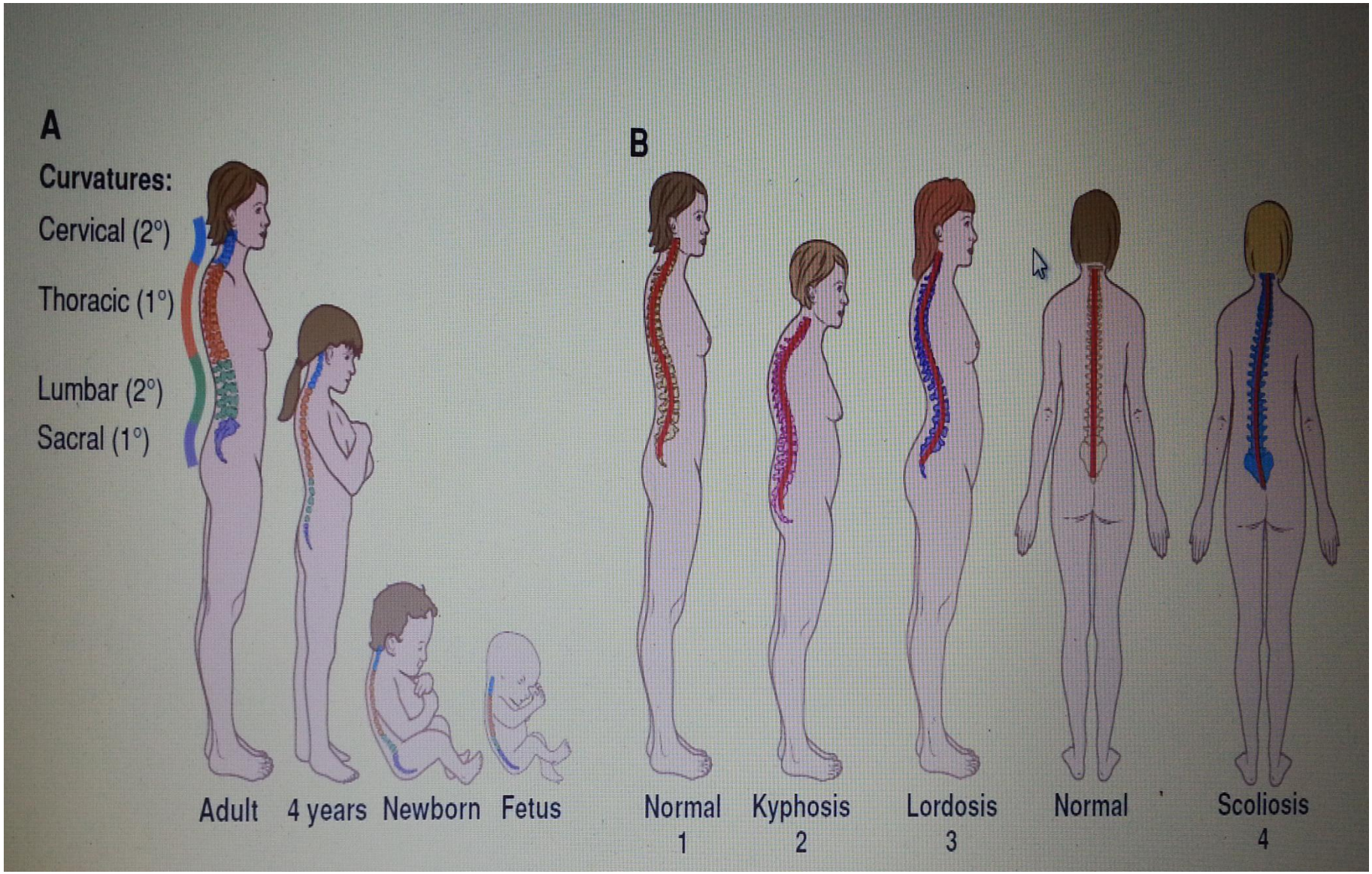
the lumbar part of the vertebral column becomes **concave posteriorly.**



Single curve in fetus

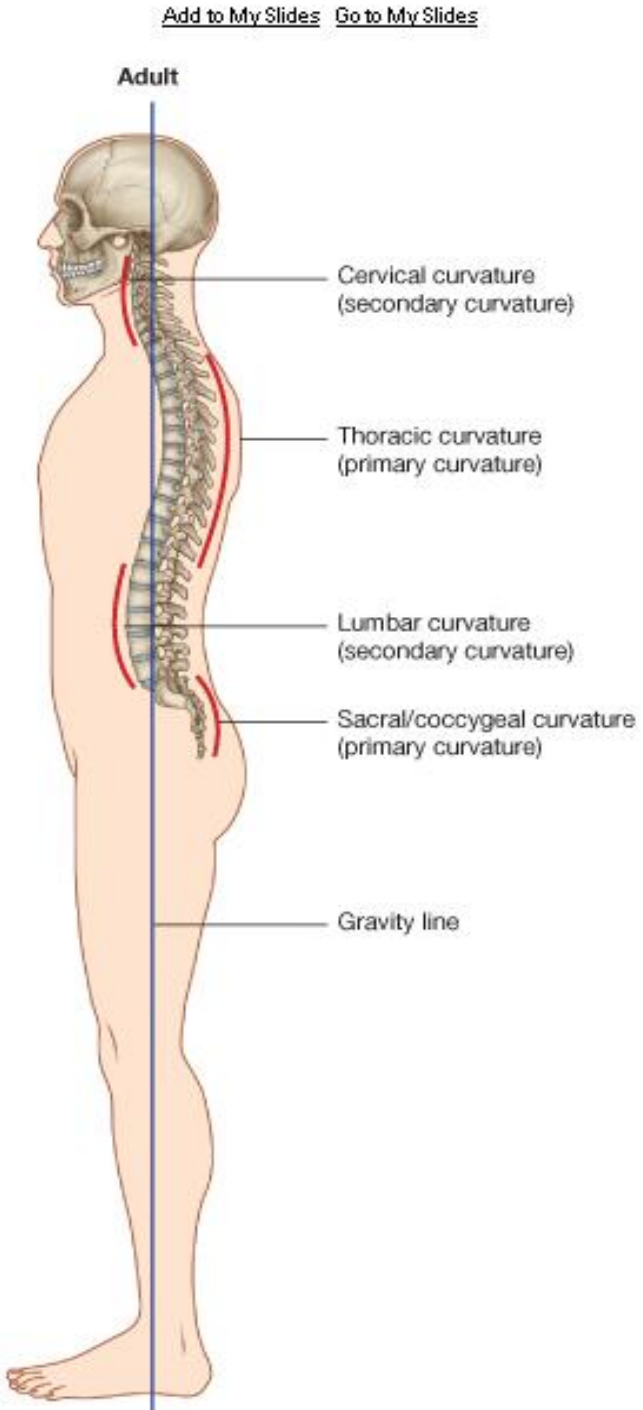


Four curves in adult


A
Curvatures:
Cervical (2°)
Thoracic (1°)
Lumbar (2°)
Sacral (1°)
Adult
4 years
Newborn
Fetus
B
Normal
1
Kyphosis
2
Lordosis
3
Normal
Scoliosis
4

The development of these secondary curves is largely caused by modification in the shape of the intervertebral discs.
In the adult in the standing position the vertebral column therefore exhibits in the sagittal plane the ***following regional curves:***

CERVICAL, posterior concavity
THORACIC, posterior convexity
LUMBAR, posterior concavity
SACRAL, posterior convexity
.



Abnormal Curves of the Vertebral Column

Kyphosis is an **exaggeration in the sagittal curvature** present in the **thoracic** part of the vertebral column.
It can be caused by muscular weakness or by structural changes in the vertebral bodies or by intervertebral discs.

Lordosis is an exaggeration in the sagittal curvature present in the **lumbar region.**
Lordosis may be caused by an increase in the weight of the abdominal contents, as with the gravid uterus or a large ovarian tumor

Scoliosis is a lateral deviation of the vertebral column.
This is most commonly found in the thoracic region and may be caused by muscular or vertebral defects

Abnormal Curves of the Vertebral Column

Various conditions may ***exaggerate the normal curves of the vertebral column, or the column may acquire a lateral bend, resulting in abnormal curves of the vertebral column***.

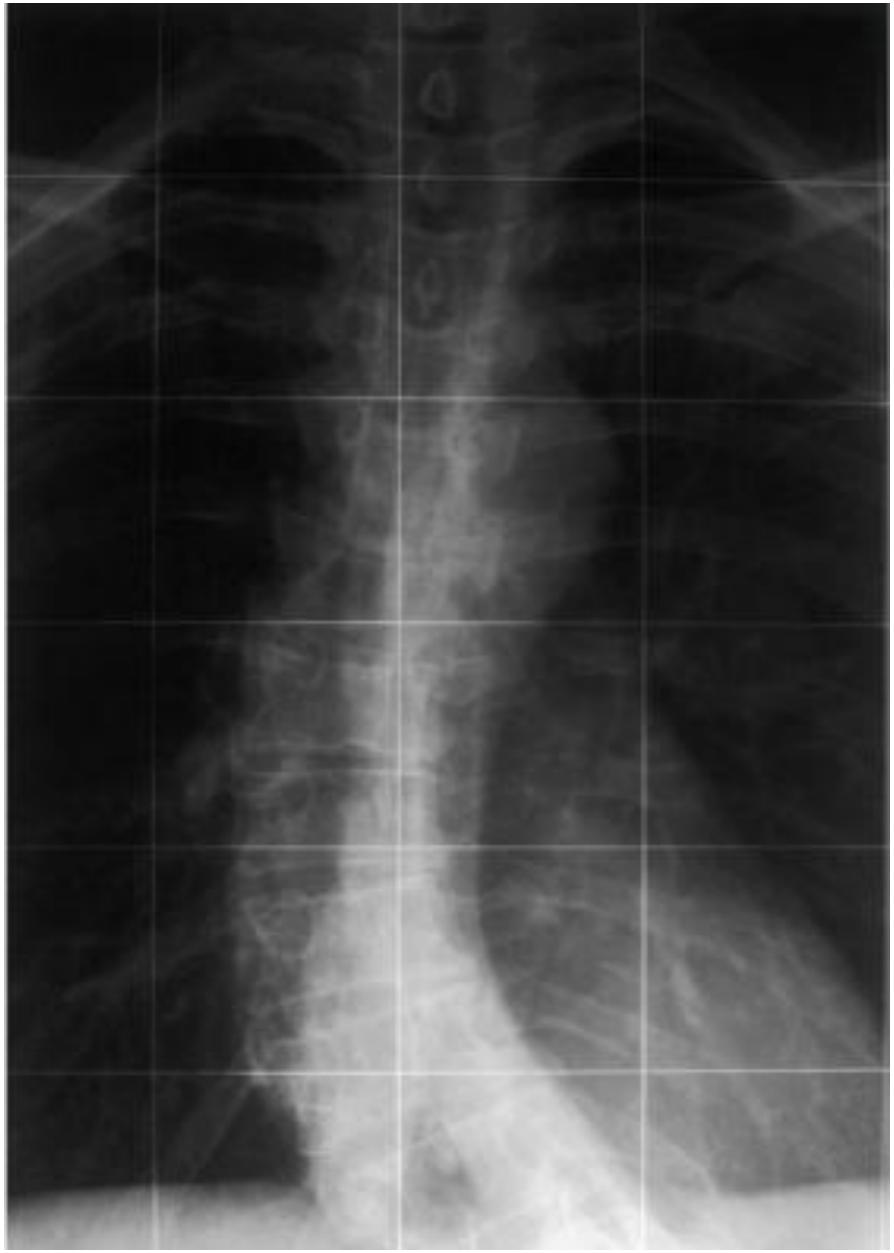
Scoliosis :
the most common of the abnormal curves is ***a lateral bending of the vertebral column*** *,usually in the* **thoracic region**

Kyphosis :(*hump)*
Is an increase in the thoracic curve of the vertebral column

Lordosis :*bent backward*
is an increase in the lumbar curve of the vertebral column

(a) Scoliosis (b) Kyphosis (c) Lordosis

Radiograph of thoracic scoliosis



Joints of the Vertebral Column

The two major types of joints between vertebrae are:

1- Symphyses between vertebral bodies

2- Synovial joints between articular processes

- A typical vertebra has a total of six joints with adjacent vertebrae:
  - four synovial joints (two above and two below)
  - two symphyses (one above and one below).
  - Each symphysis includes an intervertebral disc.

❖ Although the movement between any two vertebrae is limited, the summation of movement among all vertebrae results in a large range of movement by the vertebral column.

Movements by the vertebral column include flexion, extension, lateral flexion, rotation, and circumduction

Symphyses Joints Between Two Vertebral Bodies

intervertebral disc

The upper and lower surfaces of the bodies of adjacent vertebrae are covered *by thin plates of hyaline cartilage*. Sandwiched between the plates of hyaline cartilage is an intervertebral disc of fibrocartilage

The collagen fibers of the disc ***strongly unite the bodies of the two vertebrae.***

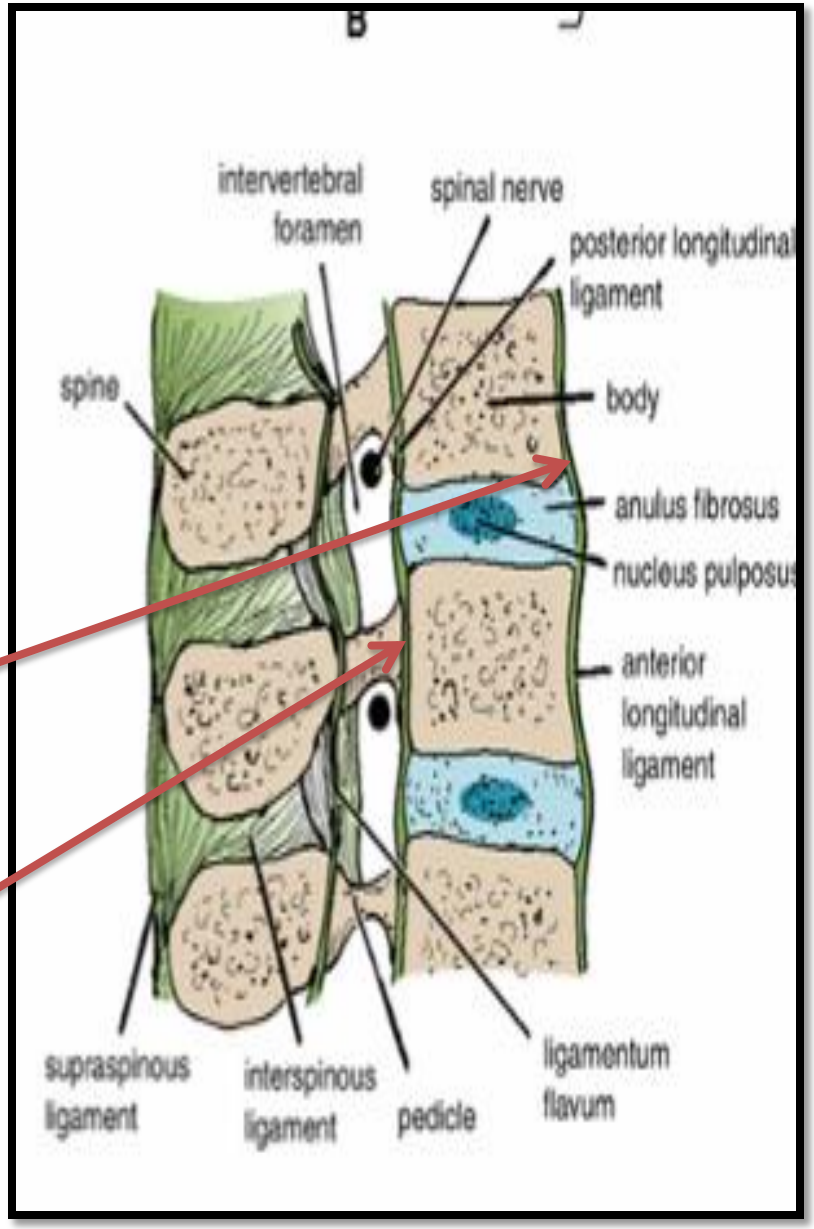
Ligaments

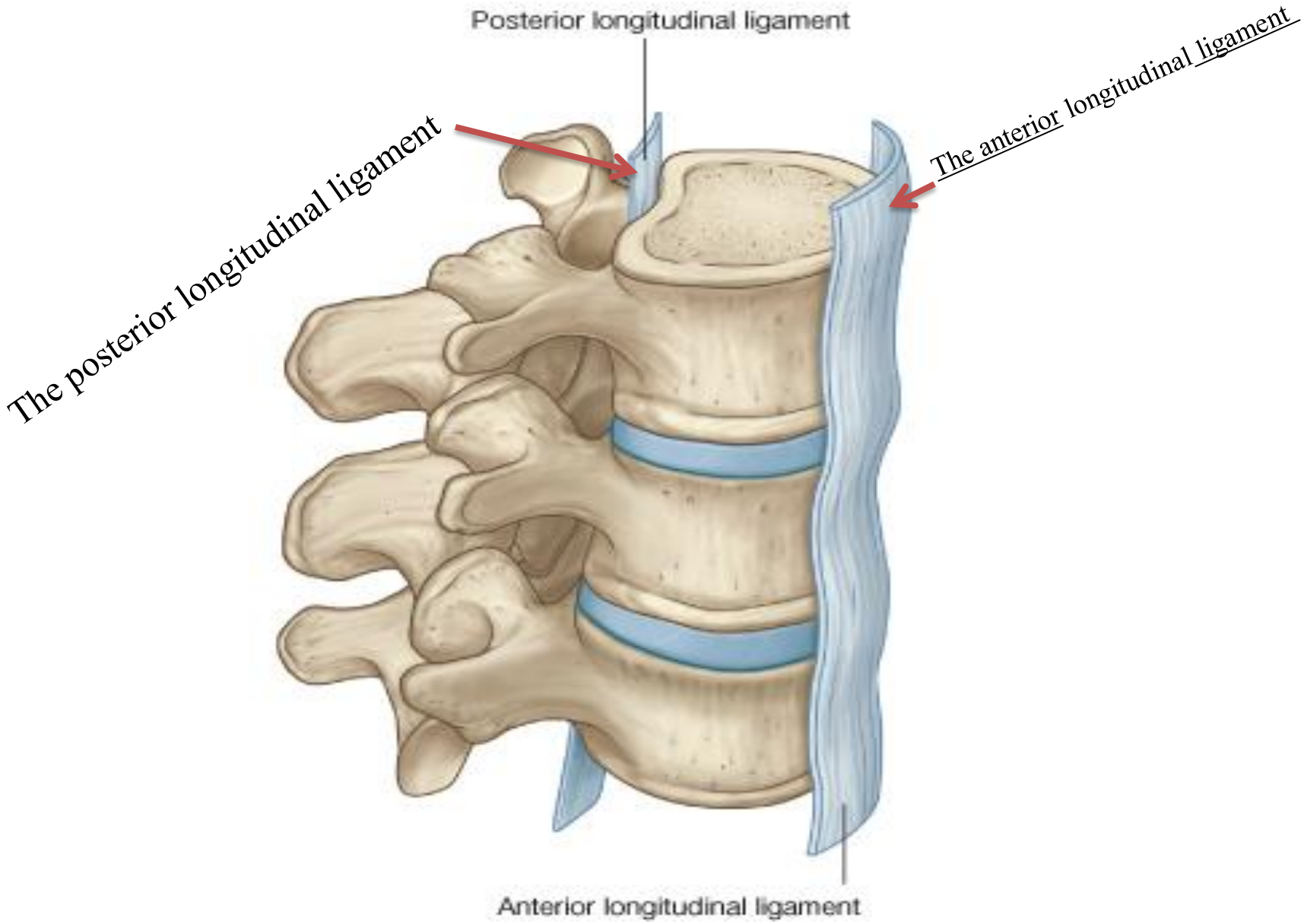
The anterior and posterior longitudinal ligaments run as continuous bands down the anterior and posterior surfaces of the vertebral column from the skull to the sacrum

The anterior longitudinal ligament is **wide and is strongly** attached to **the front and sides of the vertebral bodies** and to the intervertebral discs.

The posterior longitudinal ligament

is weak and narrow and is attached to the posterior borders **of the discs**. These ligaments hold **the vertebrae firmly** together but at the same time **permit a small amount of movement to take place between them.**




Posterior longitudinal ligament
The posterior longitudinal ligament
The anterior longitudinal ligament
Anterior longitudinal ligament

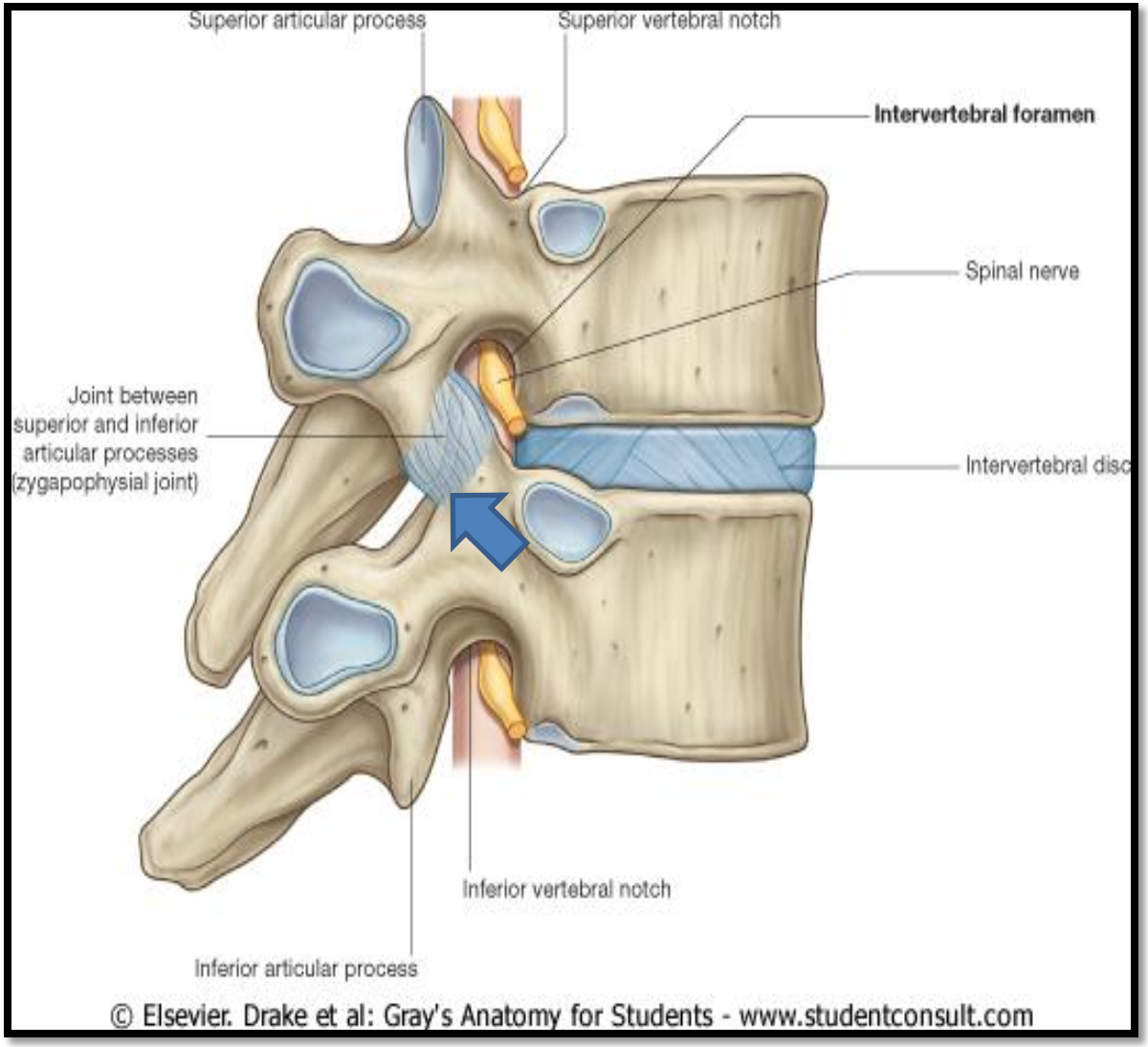
Joints Between Two Vertebral Arches

Joints between vertebral arches (zygapophysial joints)
The synovial joints between superior and inferior articular processes on adjacent vertebrae are the

Clinicians often refer to parts of the back in shorthand terms that are not strictly anatomical, for example facet joints and apophyseal joints are terms used instead of **zygapophysial joints**

➢The articular facets are covered with hyaline cartilage, and the joints are surrounded by a capsular ligament

➢**In cervical regions**, the zygapophysial joints slope inferiorly from anterior to posterior. This orientation facilitates flexion and extension.
➢**In thoracic regions**, the joints are oriented vertically and limit flexion
and extension, but **facilitate rotation**
In lumbar regions, the joint surfaces are curved and adjacent processes interlock, thereby limiting range of movement, though ***flexion and extension*** are still major movements in the lumbar region.



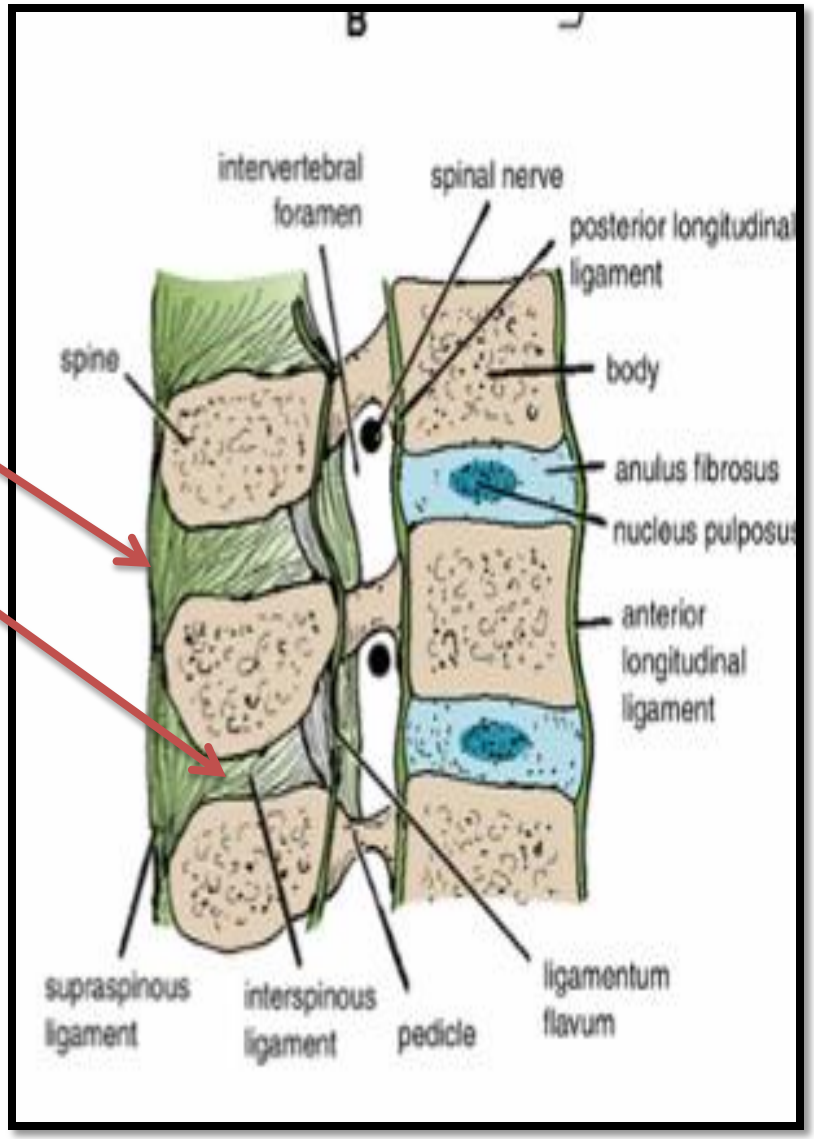
Ligaments

1-Supraspinous ligament:
This runs between the tips of adjacent spines.

2-Interspinous ligament:
This connects adjacent spines.

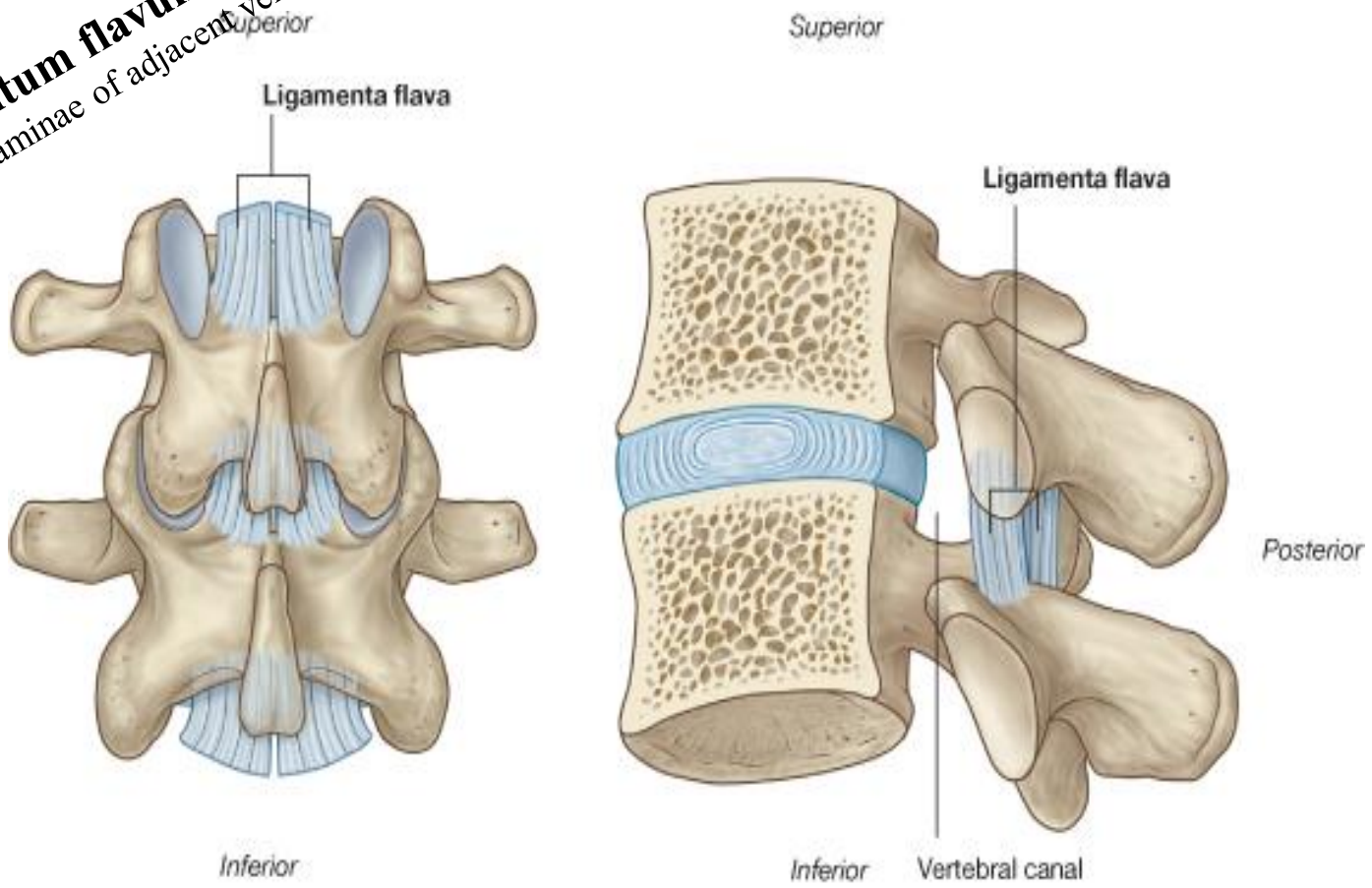
3-Intertransverse ligaments:
These run between adjacent transverse processes.

5-Ligamentum flavum:
This connects the laminae of adjacent vertebrae.



Ligamentum flavum:

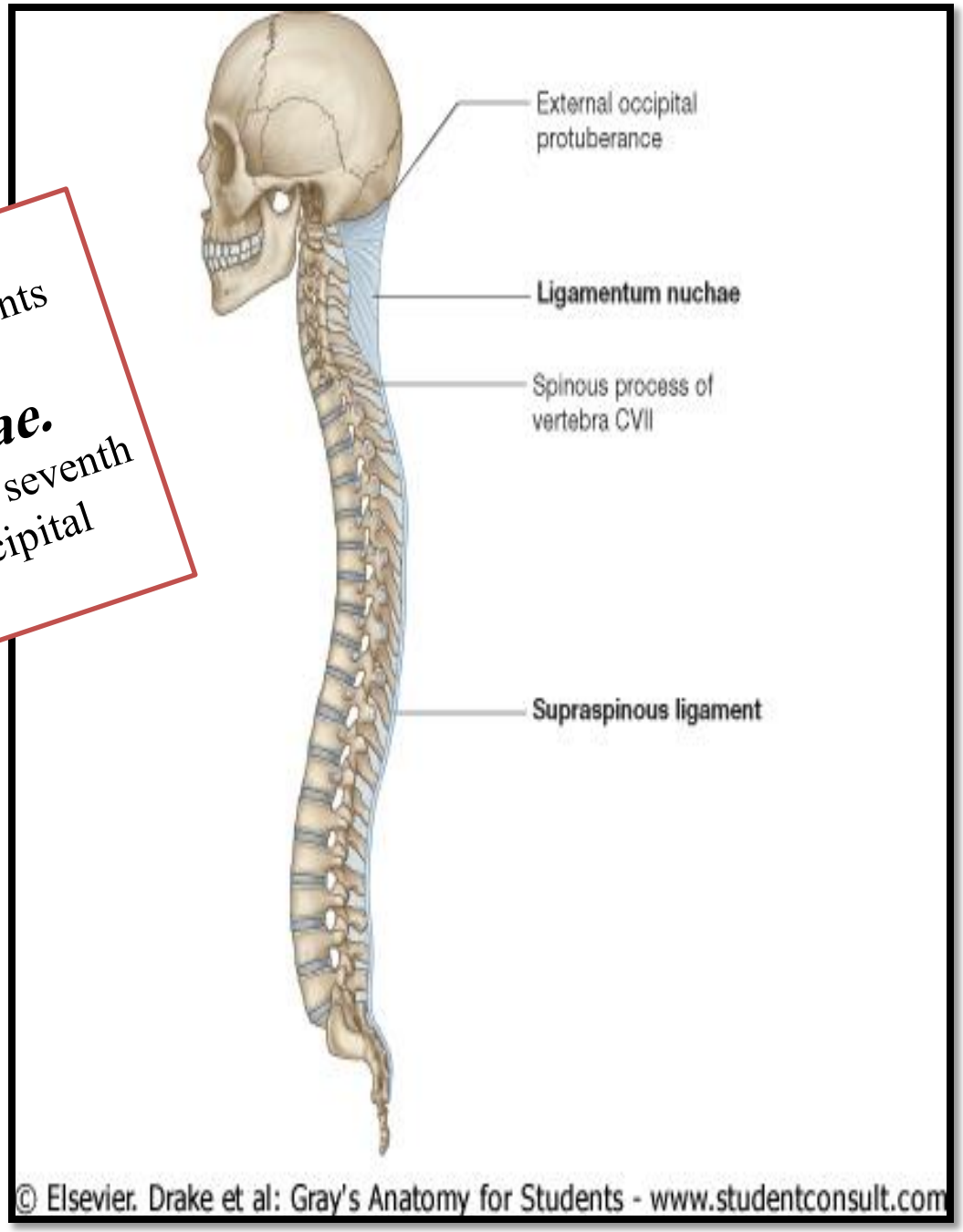
This connects the laminae of adjacent vertebrae



In the cervical region,

the supraspinous and interspinous ligaments are greatly thickened to form the strong ***ligamentum nuchae.***

The latter extends from the spine of the seventh cervical vertebra to the external occipital protuberance of the skull



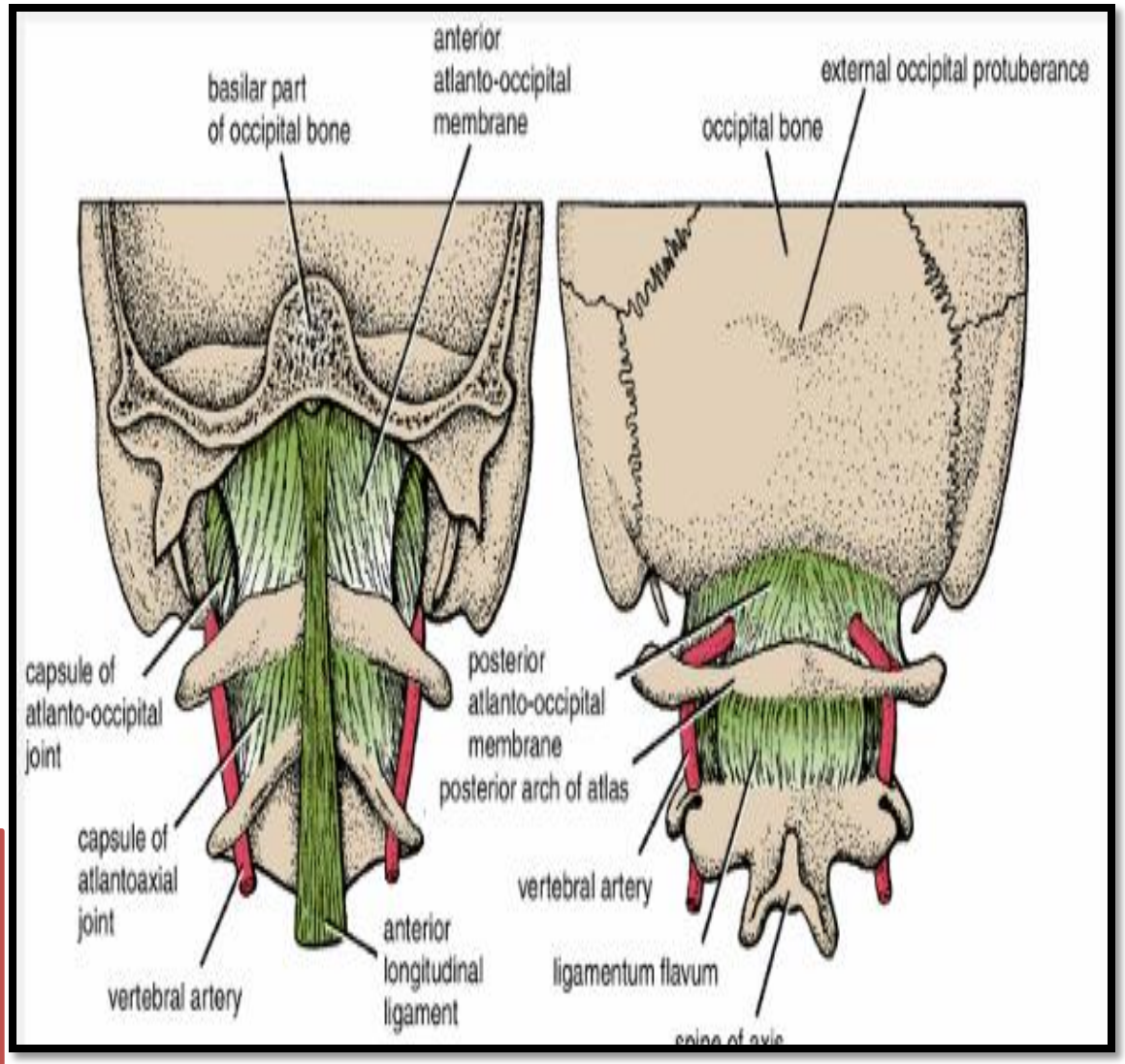
Atlanto-occipital Joints

- Atlanto-occipital joints are the articulations between the superior articular surfaces of atlas (C1) and the occipital condyles of the skull.

The action of **nodding the head (as in indicating "yes")** Flexion, extension **and sideways tilting of the head (**lateral flexion). occurs at these joints.

These are synovial joints and have **no intervertebral disc.**

- The **anterior and posterior atlanto-occipital membranes limit excessive movement at this joint**



No rotation is possible

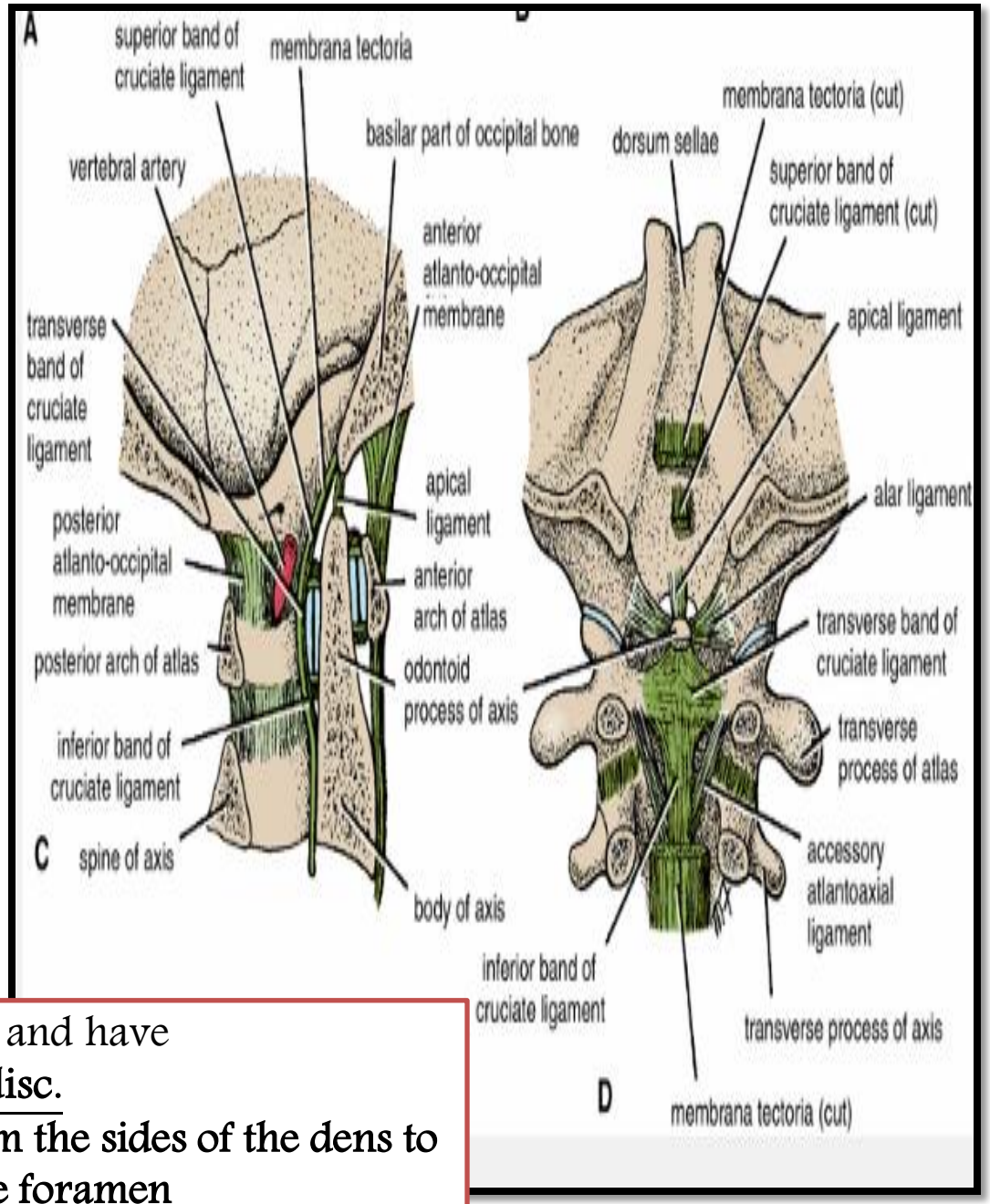
Atlantoaxial Joints

- Atlantoaxial joints are the articulations between atlas (C1) and axis (C2

which include two

- **lateral atlantoaxial joints between the inferior facets of C1 and superior facets of C2,**
- **and one median atlantoaxial joint between the anterior arch of C1 and the dens of C2.**

The action of **turning the head side-to-side (as in indicating "no") occurs at these joints.**



These are synovial joints and have **no intervertebral disc.**

- The **alar ligaments, which extend from the sides of the dens to the lateral margins of the foramen** magnum, limit excessive movement at this joint.

The **dens is secured in its position by the following**

The dens is secured in its position by the following.

- **The cruciate ligament**
- **Alar ligaments**
- **Tectorial membrane**,

which is a continuation of the posterior longitudinal ligament.

Clinical Consideration

Atlantoaxial dislocation (subluxation)
is caused by the
rupture of the transverse ligament of
atlas due to trauma
(e.g., Jefferson fracture) or rheumatoid arthritis.

Hangman Fracture occurs when a force is
applied with the neck *hyperextended (e.g., extension component*
of whiplash, car accident when chin or forehead strikes
dashboard, head-on collision in football, or **hanging**) and
places the spinal cord at risk.

This allows mobility of the dens
(part of C2) within the vertebral canal, which places at risk the cervical spinal cord
(leading **to quadriplegia**)
and/or medulla (respiratory paralysis leading to sudden death).

Vertebral fractures

- Vertebral fractures can occur anywhere throughout the vertebral column.
- In most instances, the fracture will heal under appropriate circumstances.
- At the time of injury, it is not the fracture itself, but related damage to the contents of the vertebral canal and the surrounding tissues that determines the severity of the patient's condition.

Vertebral column stability is divided into three clinical 'columns':

1-the **anterior column** consists of
the vertebral bodies + the anterior longitudinal ligament

2-the **middle column** comprises
the vertebral body + the posterior longitudinal ligament

3-the **posterior column** is made up of the ligamenta flava, the interspinous ligaments and supraspinous ligaments, and the ligamentum nuchae in the cervical vertebral column

Destruction of one of the clinical columns is usually a stable injury requiring little more than rest and appropriate analgesia.

Disruption of two columns is highly likely to be unstable and requires fixation and immobilization.

A three-column spinal injury usually results in a significant neurologic event and requires fixation to prevent further extension of the neurologic defect and to create vertebral column stability

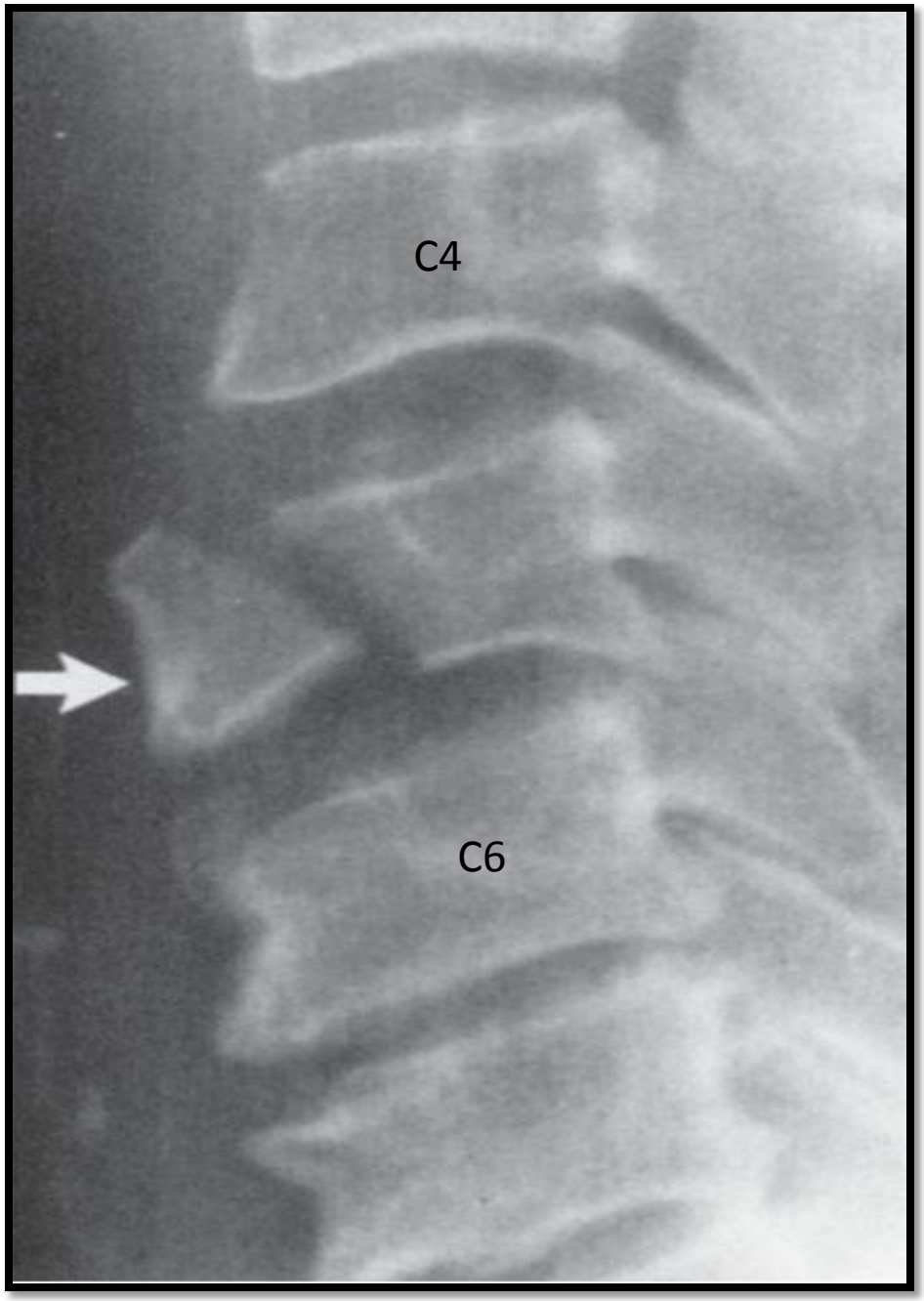
see **Teardrop Fracture**

Read only

Teardrop Fracture is caused by hyperflexion of the cervical region (e.g., diving into
shallow water, rebound flexion component of whiplash
from a rear-end car accident, head-on collision in football)
and places the spinal cord at risk

important

<u>A teardrop fracture includes</u>
the following pathology:
Avulsion fracture of a cervical vertebral body ("teardrop body")
fracture of the spinous process,
posterior subluxation of vertebrae,
Compression of the spinal cord,
tear of the anterior longitudinal ligament
tear/disruption of the posterior longitudinal
ligament, LF, (IS) ligament, and supraspinous (SS) ligament.



Nerve Supply of Vertebral Joints

Read only

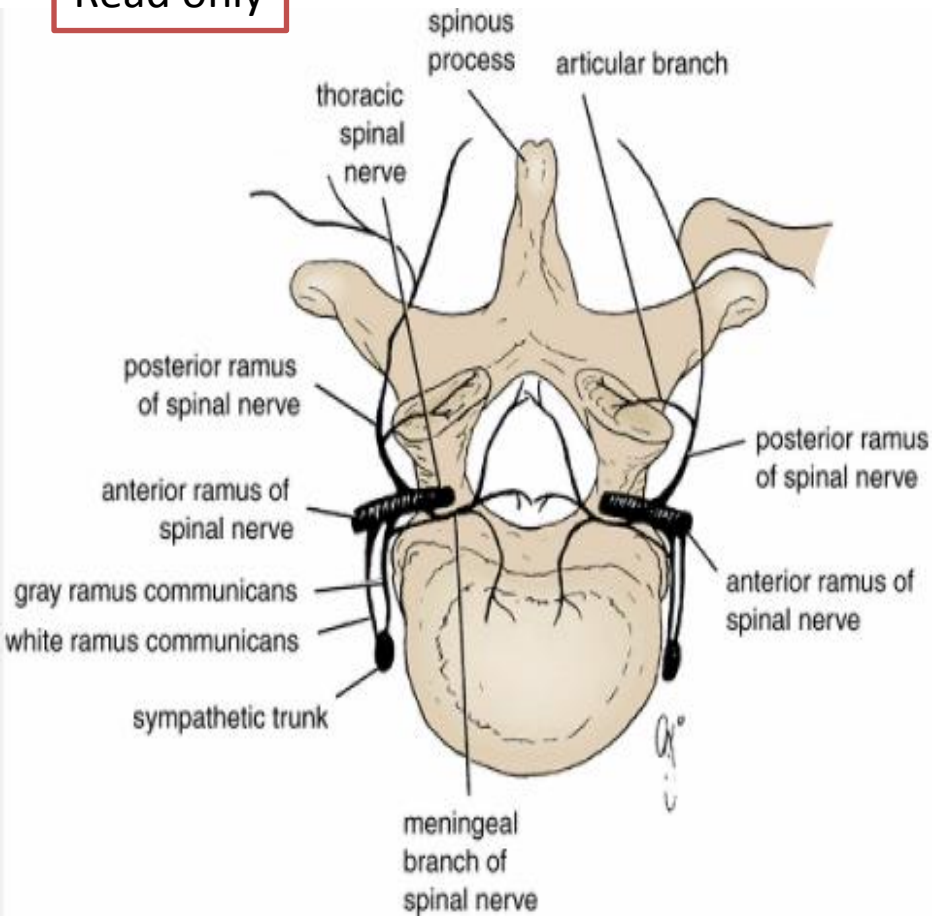
The joints between the vertebral bodies are innervated by

<u>the small meningeal branches of each spinal nerve</u>

The nerve arises from the spinal nerve as it ***exits from the intervertebral foramen.***

It then re-enters the vertebral canal through the intervertebral foramen and supplies the ***meninges, ligaments, and intervertebral discs.***

The joints between the articular processes are innervated by branches from ***the posterior rami of the spinal nerves***



Muscles of the Back

The muscles of the back may be divided into **three groups:**

1-The superficial muscles: connected with the shoulder girdle.

2-The intermediate muscles: involved with movements of the thoracic cage.

3-The deep muscles or postvertebral muscles belonging to the vertebral column

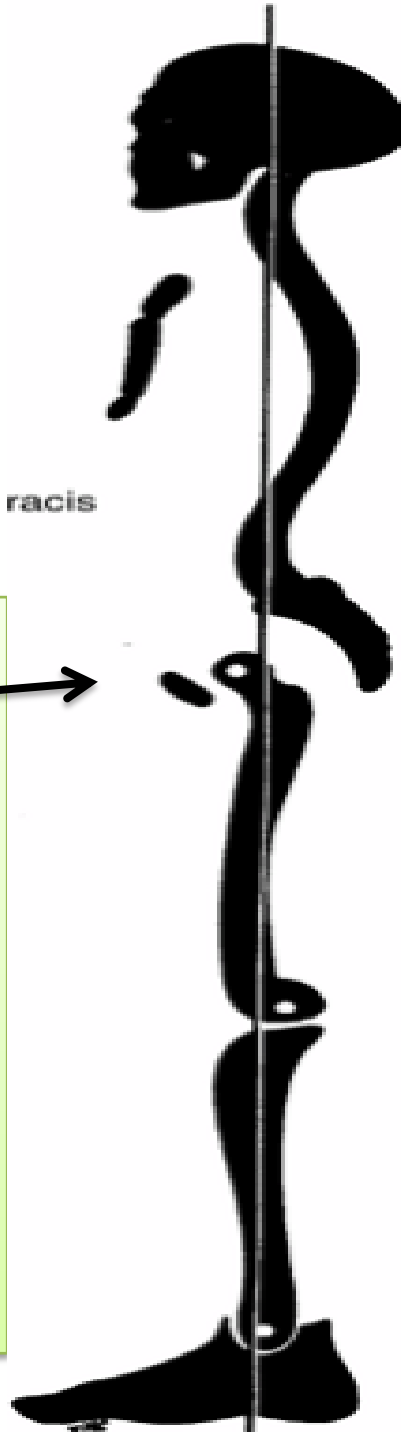
Deep Muscles of the Back (Postvertebral Muscles)

➢ ***In the standing position,***

the line of gravity passes ***through the odontoid process*** of the axis,
behind the centers of the hip joints,
and in front of the knee and ankle joints
thus, greater part of the body weight falls
in front of the vertebral column.

It is, therefore, not surprising to find that the postvertebral muscles of the back **are well developed in humans.**

The postural tone of these muscles is the major factor responsible for the maintenance of the normal curves of the vertebral column.



Superficial Vertically Running Muscles

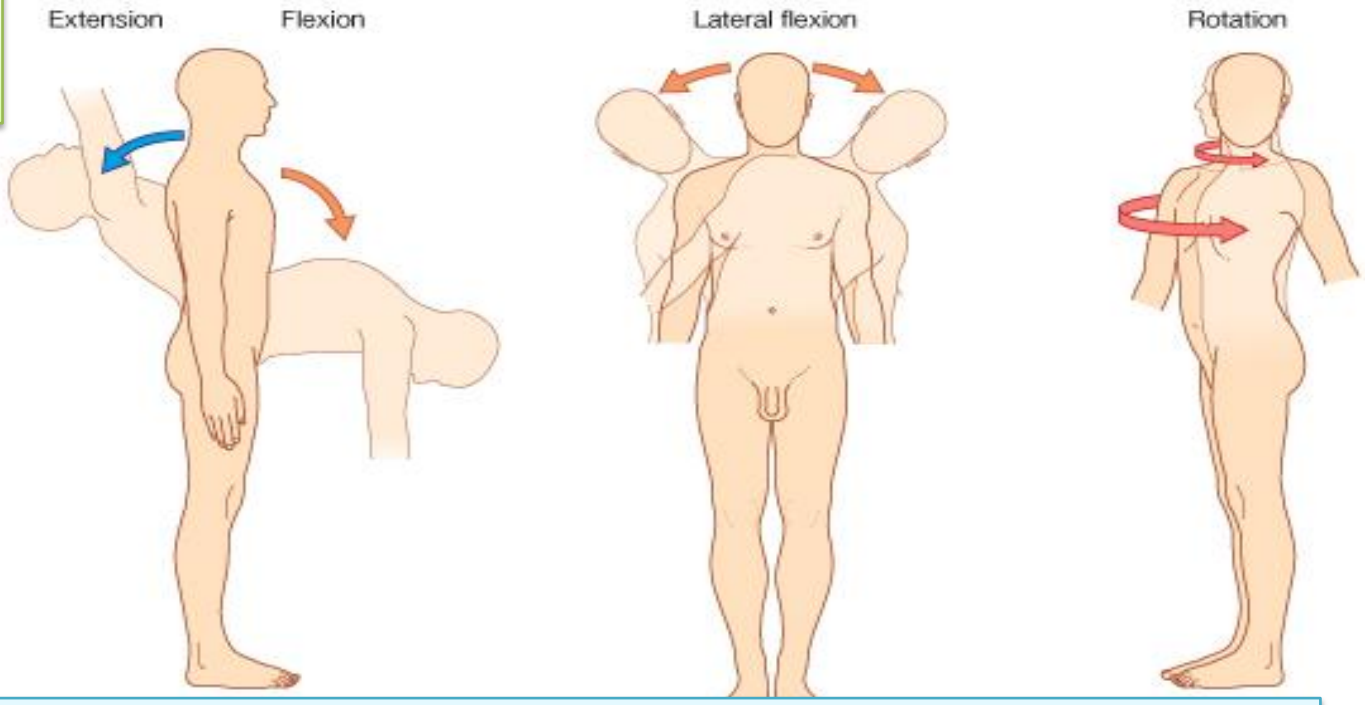
Erector spinae muscle
Iliocostalis
Longissimus
spinalis

Intermediate Oblique Running Muscles

Transversospinalis:
SEMISPINALIS
MULTIFUDUS
ROTATORS

VERTEBRAL COLUMN MOVEMENT

The following movements are possible: flexion, extension, lateral flexion, rotation, and circumduction.



Flexion is a forward movement
Extension is a backwardmovement
Both are extensive ***in the cervical and lumbar regions***
but restricted in the thoracic region.
Lateral flexion is the bending of the body to one or the other side.
It is extensive in the cervical and lumbar regions but restricted in the thoracic region.

Rotation is a twisting of the vertebral column. This is least extensive in the **lumbar region**.

Circumduction is a combination of all these movements.

important

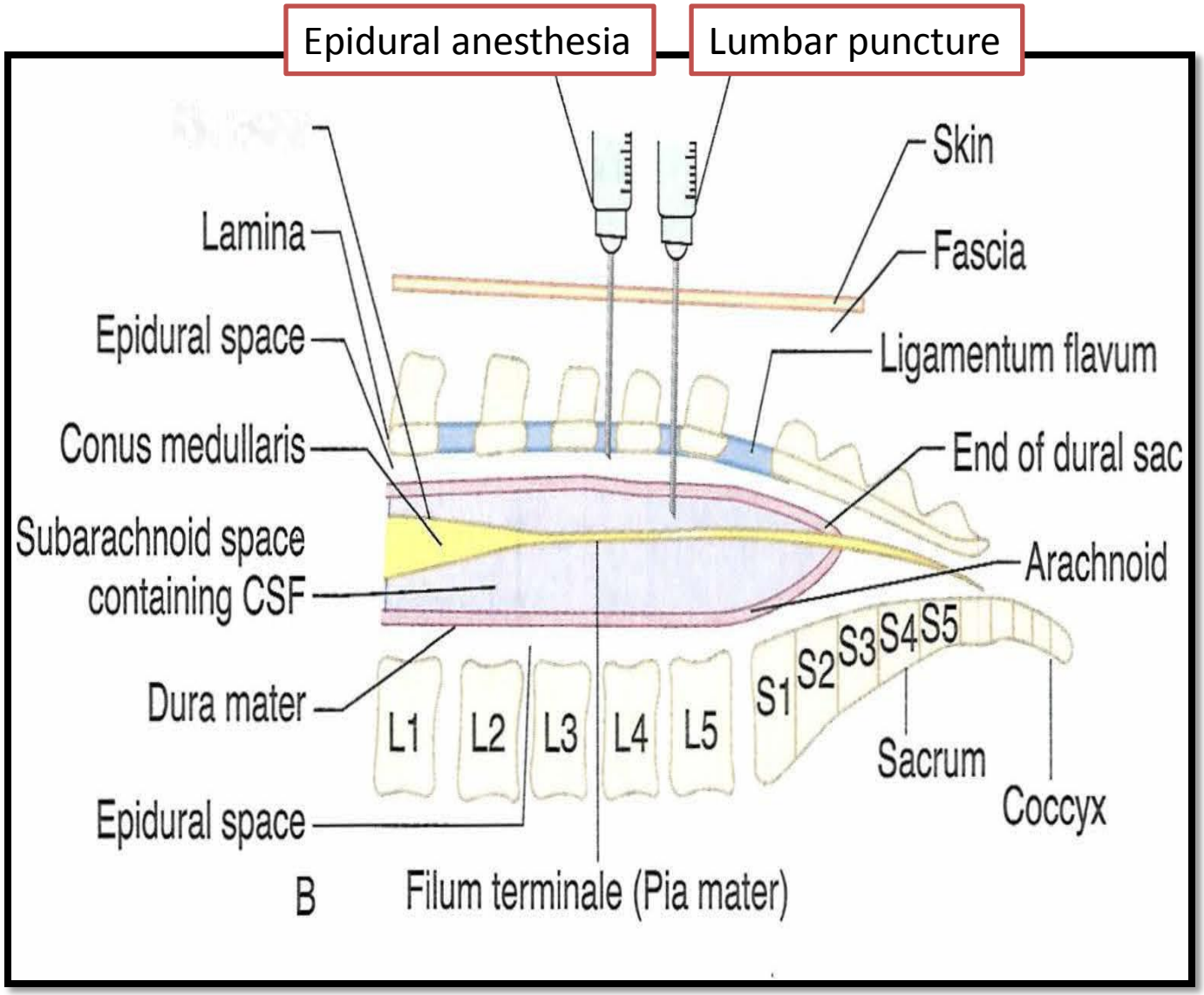
Is thought to be the route of early metastasis of carcinoma from the lung, breast, and prostate gland to bones and the central nervous system (CNS).

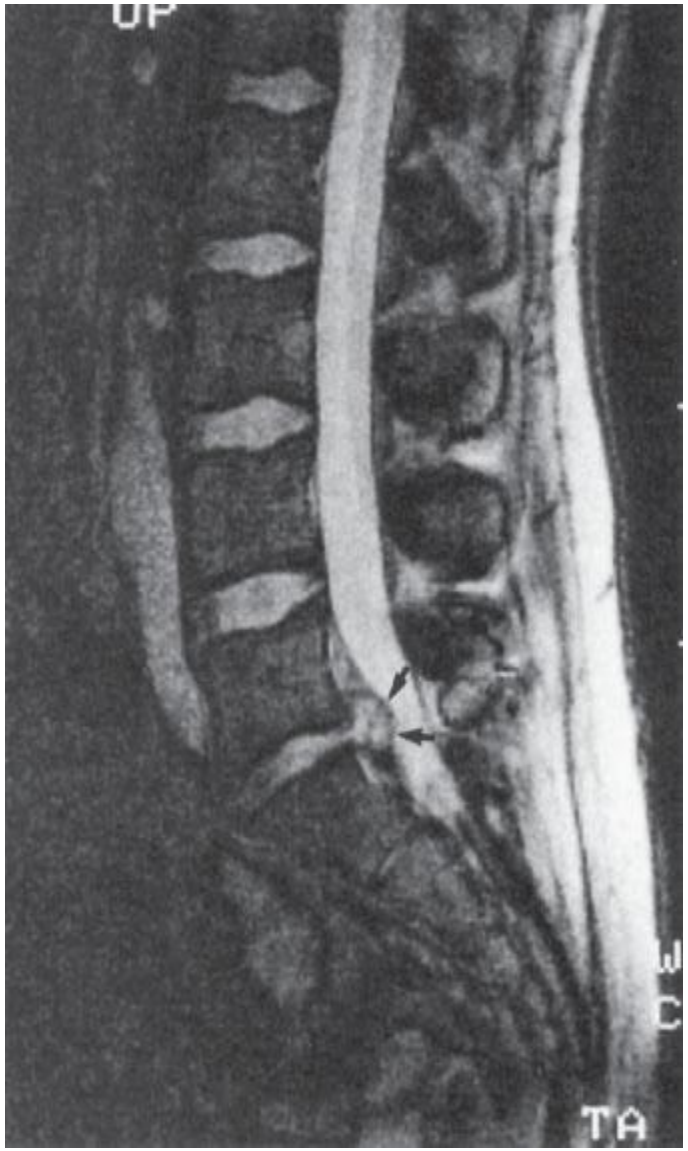
VERTEBRAL VENOUS SYSTEM

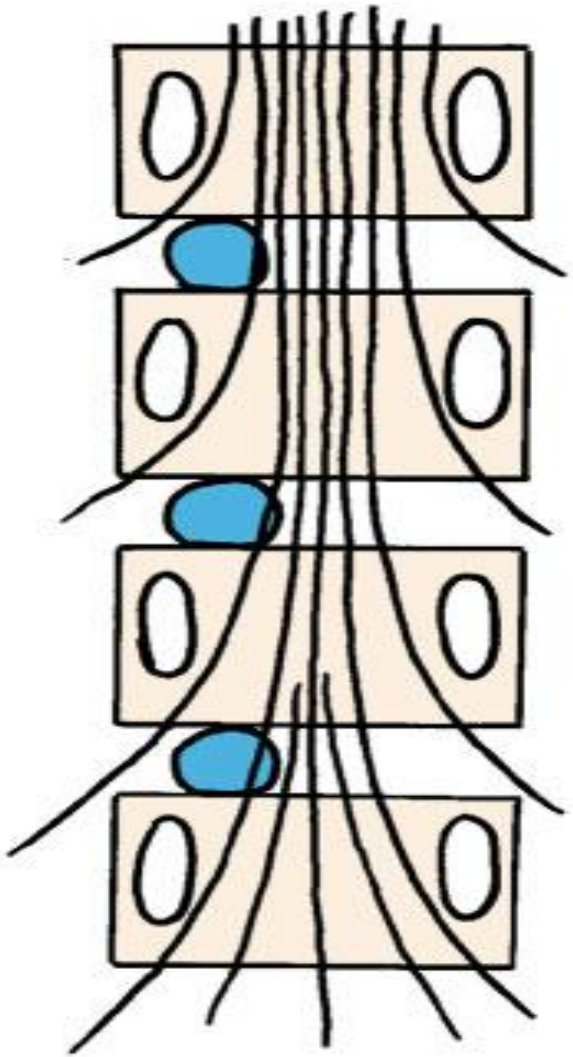
- Is a valveless plexiform of veins
- Lies in the epidural space between the wall of the vertebral canal and the dura mater and

receives tributaries from
the spinal cord
and vertebrae,
vertebral veins,
basilar plexus, and
occipital and sigmoid dural sinuses.

- Forms anterior and posterior ladder-like confi gurations by anastomosing longitudinal and transverse veins.
- .The anterior veins receive the **basivertebral veins, which lie within**
the vertebral bodies.
- Also communicates superiorly with **the cranial dural sinuses**,
inferiorly with the pelvic vein,
and **in the thoracic and abdominal regions with both the azygos and caval systems.**


Epidural anesthesia
Lumbar puncture
Skin
Fascia
Lamina
Epidural space
Ligamentum flavum
Conus medullaris
End of dural sac
Subarachnoid space
containing CSF
Arachnoid
Dura mater
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Sacrum
Coccyx
Epidural space
B
Filum terminale (Pia mater)


UP
TA



A typical ribs

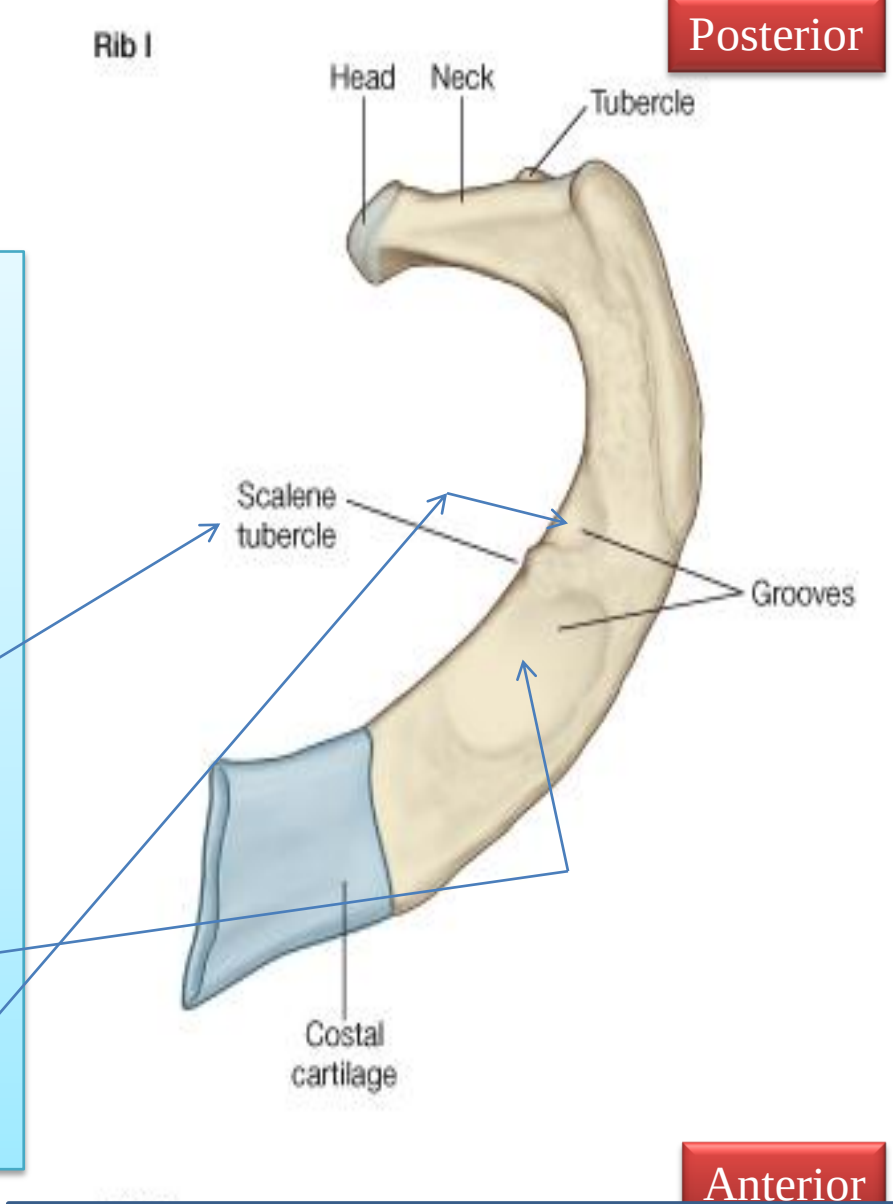
For example, *Rib I*

- **It is flat in the horizontal plane**
- Has **broad superior and inferior surfaces**
- The head articulates ***only with the body of vertebra TI and therefore has only one articular surface.***
- **The superior surface of the rib is characterized by a distinct tubercle, THE SCALENE TUBERCLE, which separates two smooth grooves The anterior groove is caused by**

THE SUBCLAVIAN VEIN

and the posterior groove is caused by the

SUBCLAVIAN ARTERY



Intercostal Spaces

1-SKIN

2-SUPERFISCIAL FASCIA

3- THREE MUSCLES OF RESPIRATION:

THE EXTERNAL INTERCOSTAL

THE INTERNAL INTERCOSTAL

THE INNERMOST INTERCOSTAL MUSCLE

4-THE ENDOTHORACIC FASCIA

5-THE PARIETAL PLEURA.

The intercostal nerves and blood vessels run between the intermediate **(internal intercostal)** and deepest layers **(innermost intercostal)** of muscles

They are arranged in the following order from above downward:

INTERCOSTAL VEIN

INTERCOSTAL ARTERY

INTERCOSTAL NERVE

(VAN)