The University Of Jordan
Faculty Of Medicine

The Vertebral Column
Part 2

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Atlas and axis

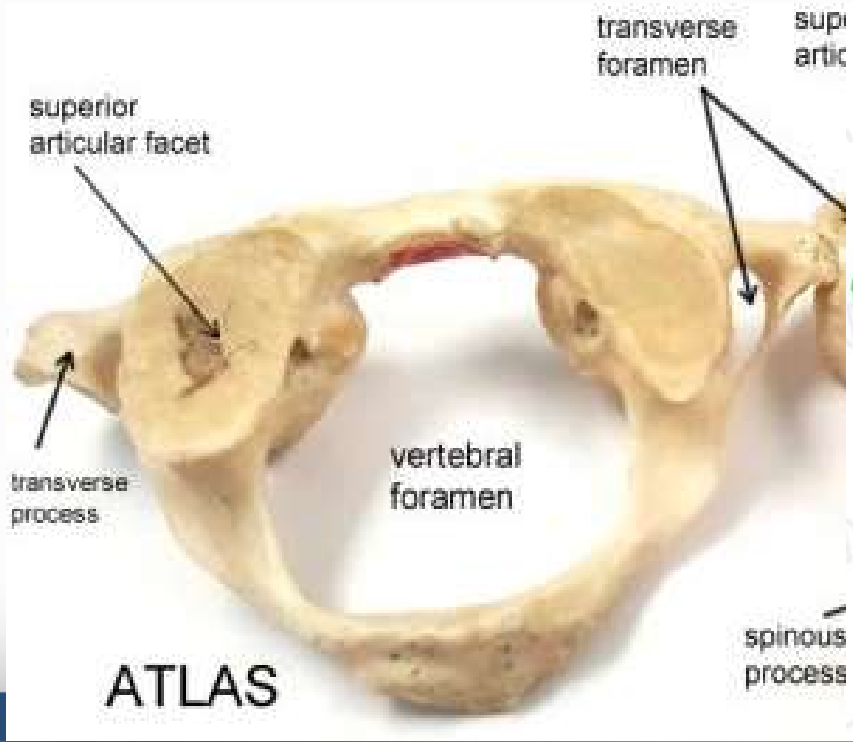
Atlas : is the 1st cervical vertebra.

It is ring-shaped and has two **lateral masses** connected by an **anterior arch** and a **posterior arch**.

Each lateral mass articulates

Above with an **occipital condyle** of the skull

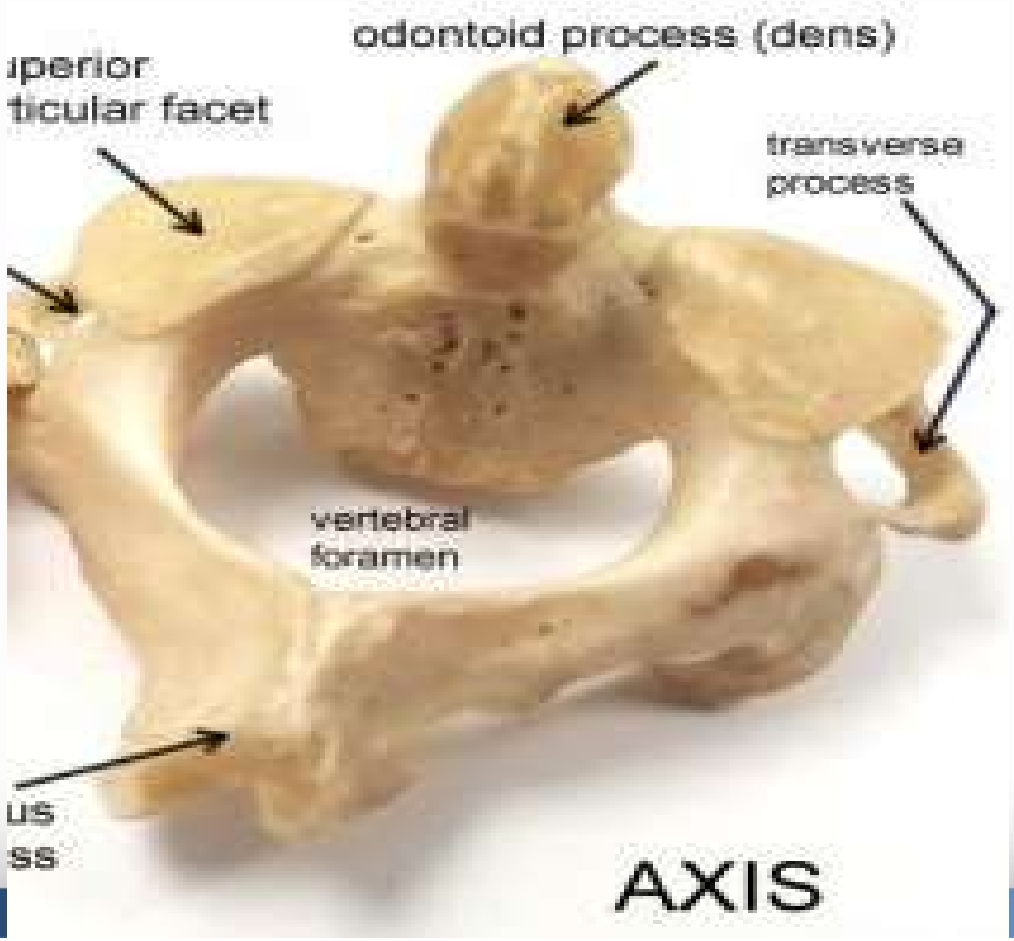
Below with the superior articular process of **axis** vertebra.



Location and
Structures
Passing through

Foramen
Magnum

Axis : is the 2nd cervical vertebra & is characterized by the large tooth-like dens (odontoid process), which extends superiorly from the vertebral body.



Atlanto-Occipital Joints

Articular Surface :

Occipital condyles, above and the superior articular surface of the atlas vertebra below.

Type : Synovial ellipsoid joint; biaxial

Ligaments

Anterior atlanto-occipital membrane: connects the anterior arch of the atlas to the anterior margin of the foramen magnum.

Posterior atlanto-occipital membrane: connects the posterior arch of the atlas to the posterior margin of the foramen magnum.

Movements They allow extension, forward and lateral flexion.

Anterior atlanto-occipital membrane

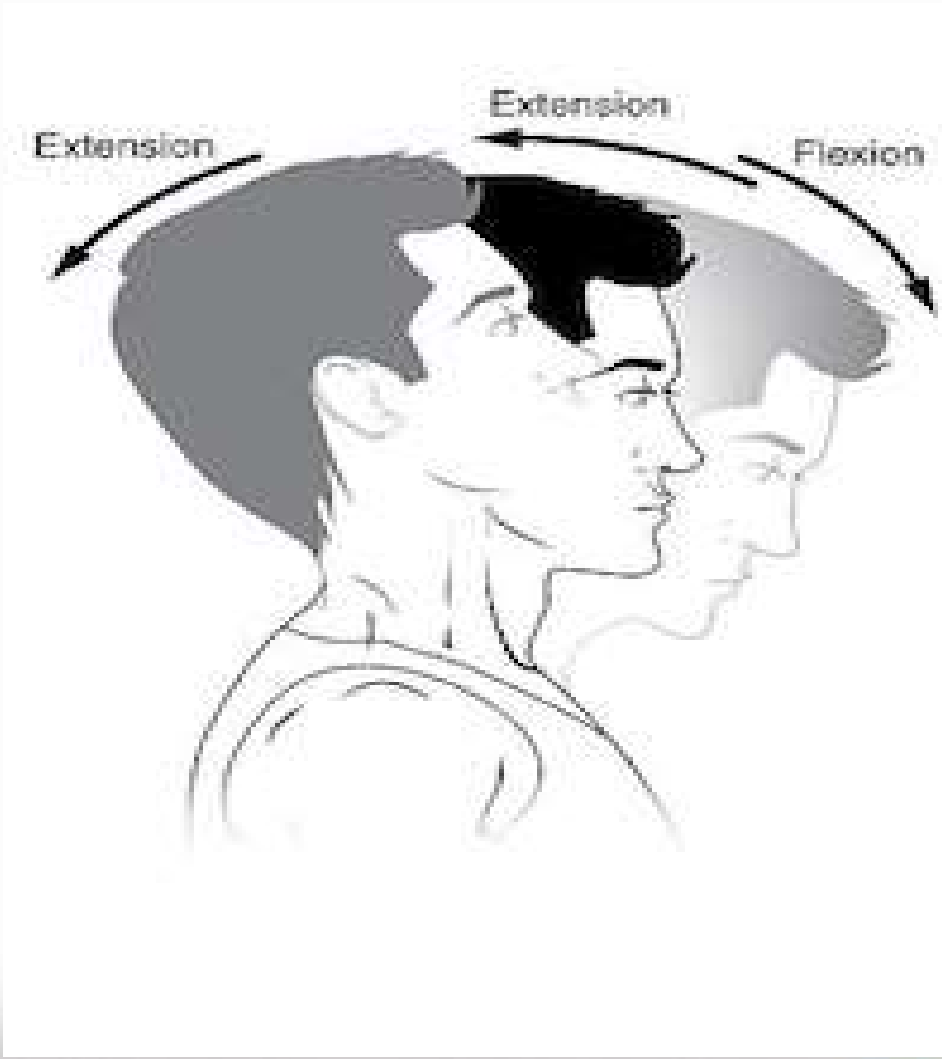
Posterior atlanto-occipital membrane

Forward flexion

Extension

lateral flexion

Cervical Lateral Flexion Stretch



Atlantoaxial Joints

A.The Median atlanto-axial Joint :

Articular Surface : between the odontoid process and the anterior arch of the atlas

Type: Pivot synovial joint

Ligaments

1-Apical ligament: connects the apex of the odontoid process to the anterior margin of foramen magnum.

2-Alar ligaments: connect the odontoid process to the occipital condyles.

3-Cruciate ligament:

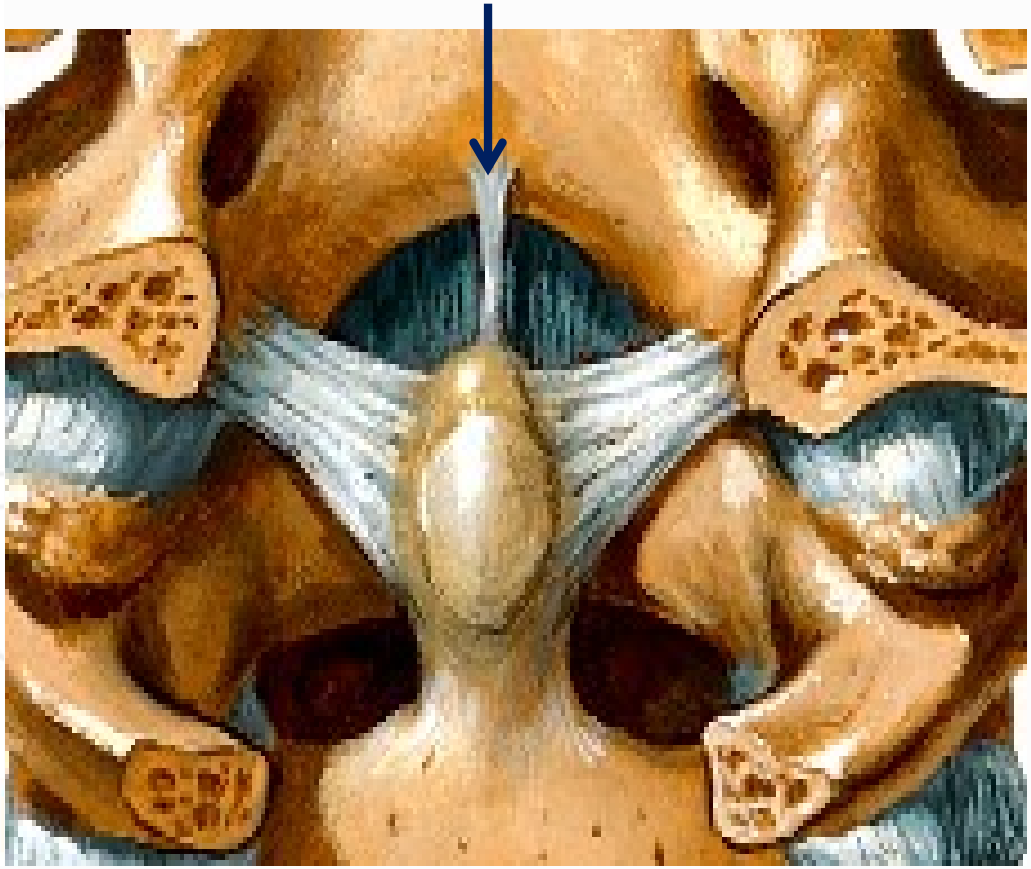
It consists of a transverse and a vertical parts.

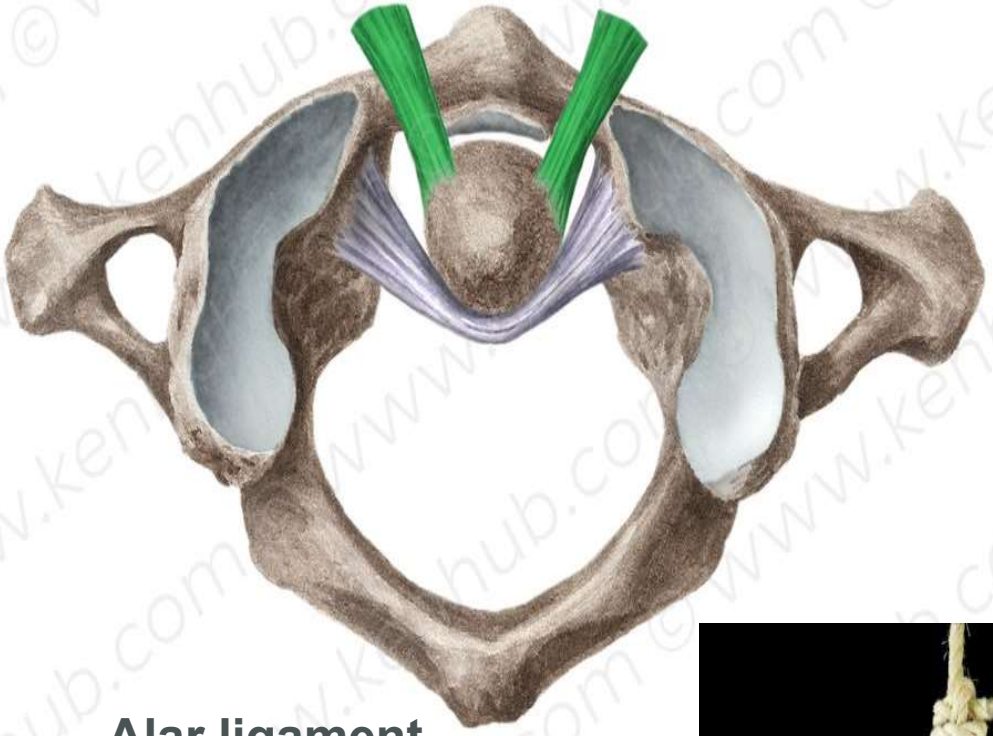
The transverse part is attached to the lateral mass of the atlas .

The vertical part runs from the body of the axis to cranial aspect of occipital bone

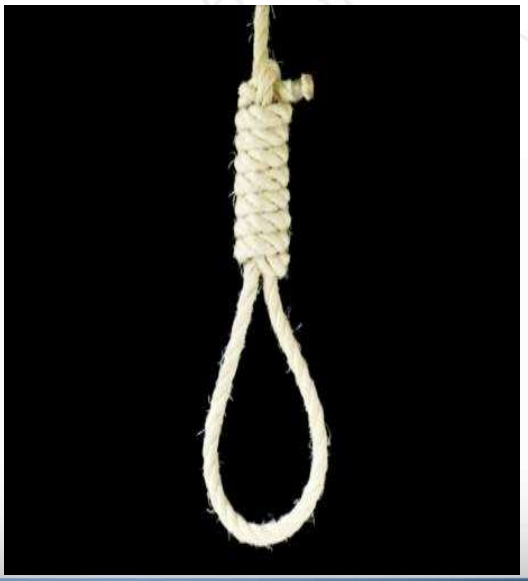
Movement : *Rotation*

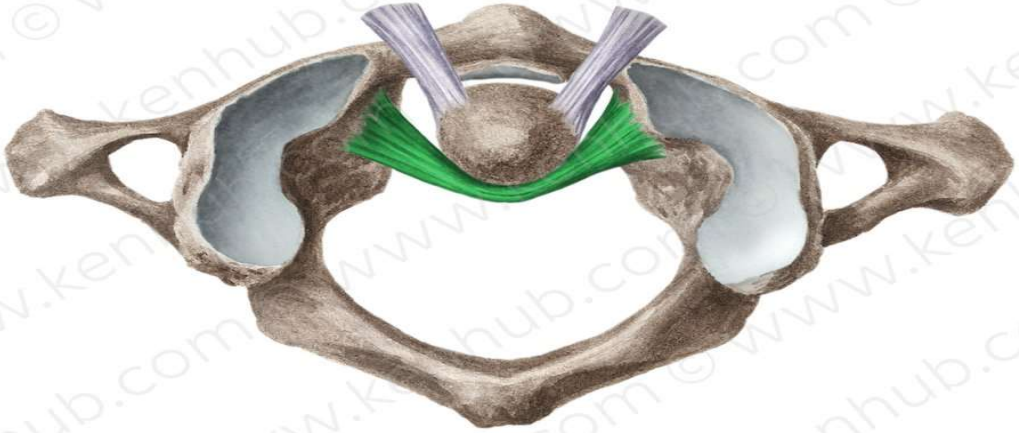
Apical Ligament





Alar ligament





Transverse ligament of atlas

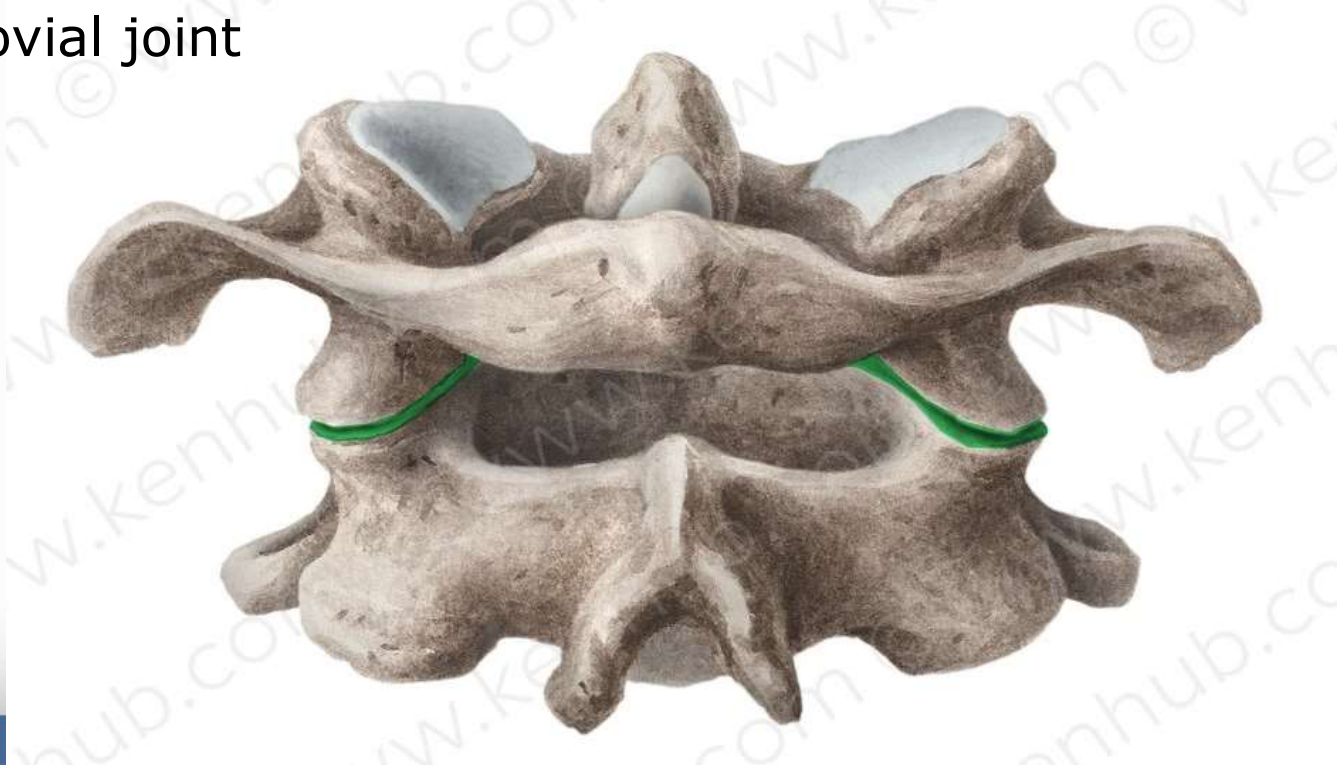
B.The Lateral atlanto-axial Joints :

Articular Surface :

Inferior surface of articular surface of the atlas and the superior axial articular facets

Type:

Plane synovial joint

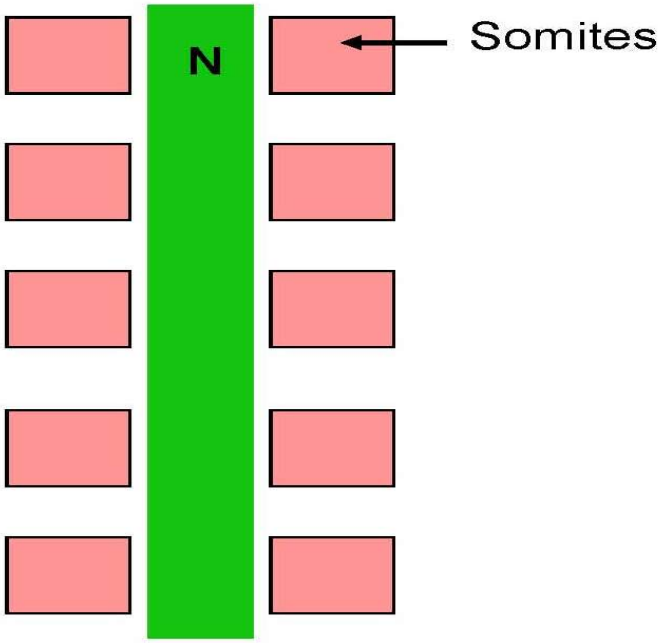


Development of Vertebral column

I. Mesenchymal stage

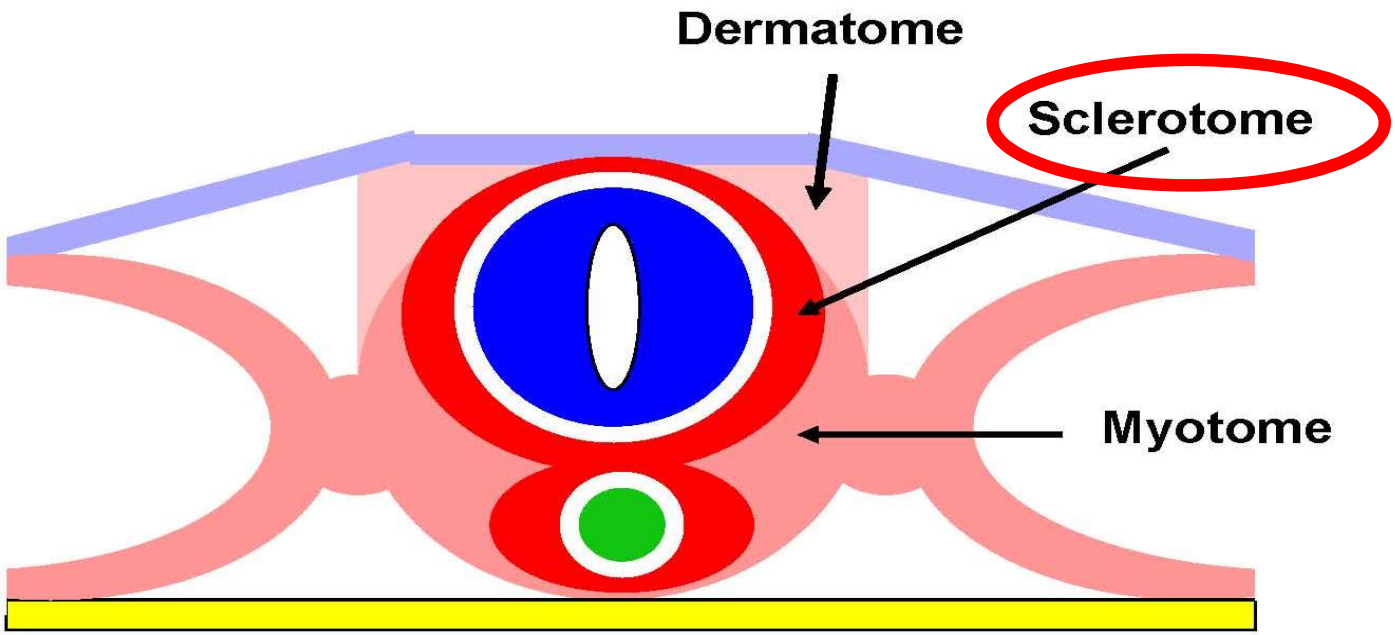
Time of development: **4th week**

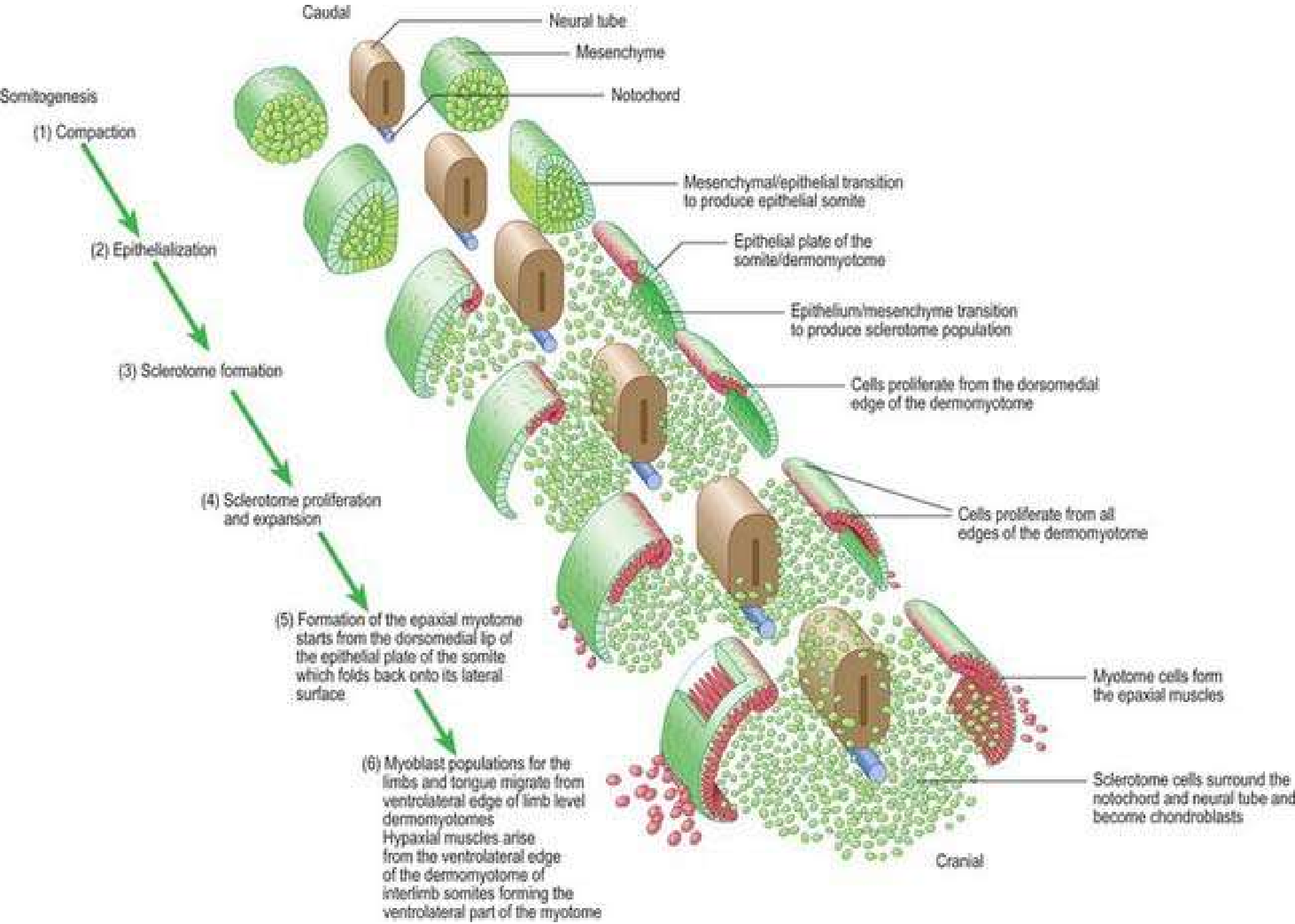
The paraxial mesoderm separates into blocks of tissue, called somites.
There are 44 pairs of somites adjacent to the notochord.



Frontal view

Each somite divides into three regions: dermatome, sclerotome, and myotome.




Caudal
Neural tube
Mesenchyme
Notochord
Somitogenesis
(1) Compaction
(2) Epithelialization
(3) Sclerotome formation
(4) Sclerotome proliferation and expansion
(5) Formation of the epaxial myotome starts from the dorsomedial lip of the epithelial plate of the somite which folds back onto its lateral surface
(6) Myoblast populations for the limbs and tongue migrate from ventrolateral edge of limb level dermomyotomes
Hypaxial muscles arise from the ventrolateral edge of the dermomyotome of interlimb somites forming the ventrolateral part of the myotome
Mesenchymal/epithelial transition to produce epithelial somite
Epithelial plate of the somite/dermomyotome
Epithelium/mesenchyme transition to produce sclerotome population
Cells proliferate from the dorsomedial edge of the dermomyotome
Cells proliferate from all edges of the dermomyotome
Myotome cells form the epaxial muscles
Sclerotome cells surround the notochord and neural tube and become chondroblasts
Cranial

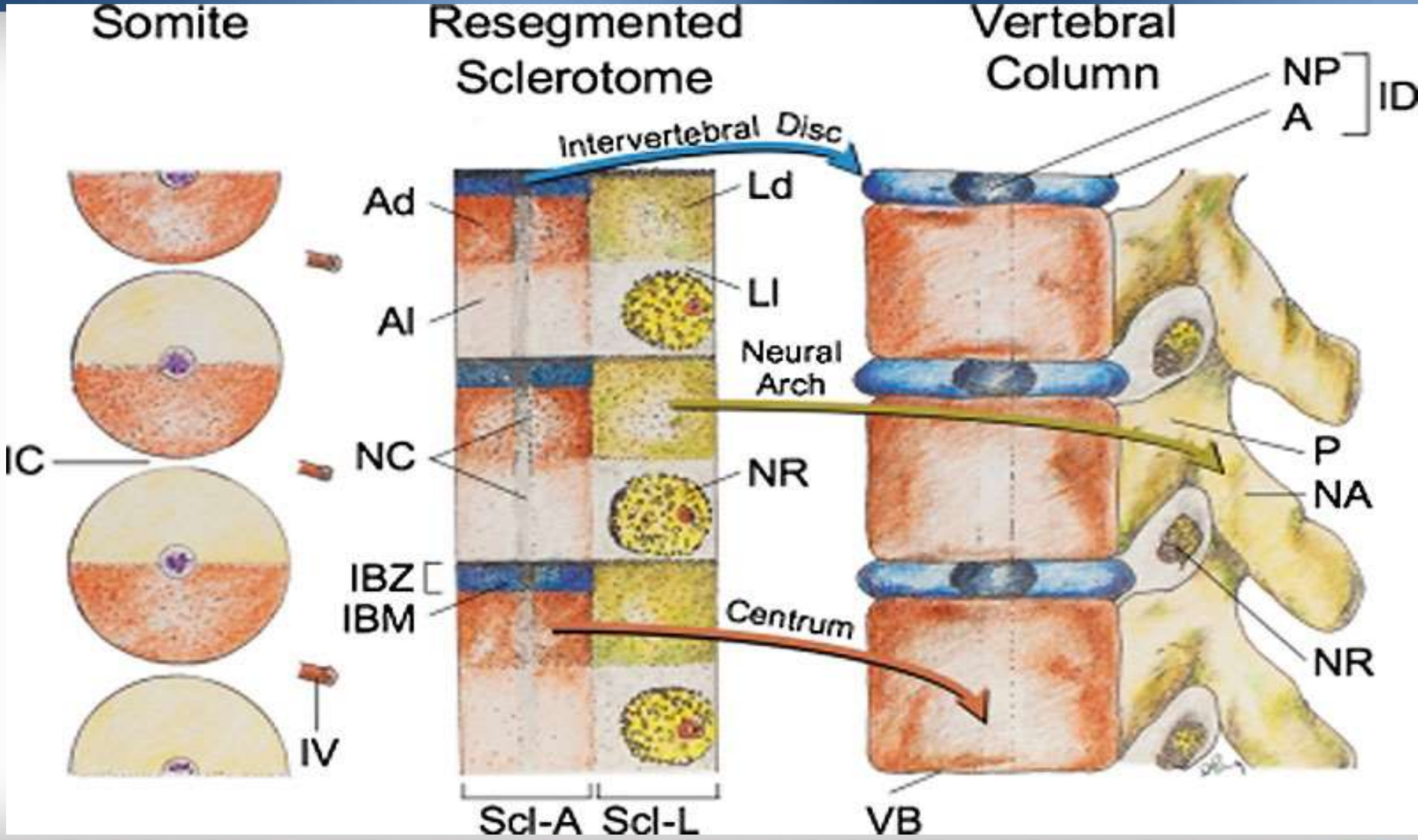
Differentiation of sclerotomic segments

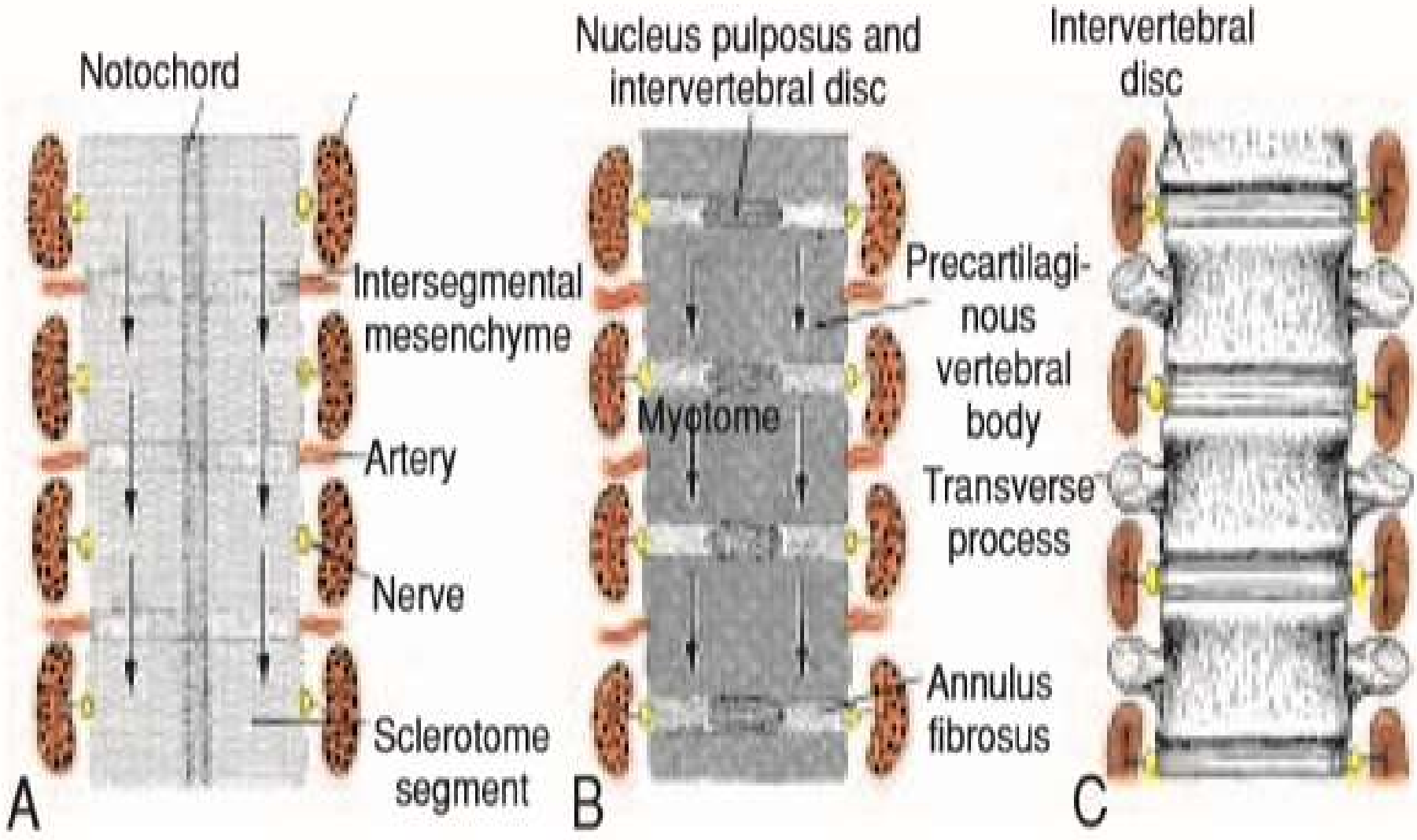
- ✓ The sclertome surround the notochord and form segments called protovertebrea
- ✓ Each protovertebrea differentiated into

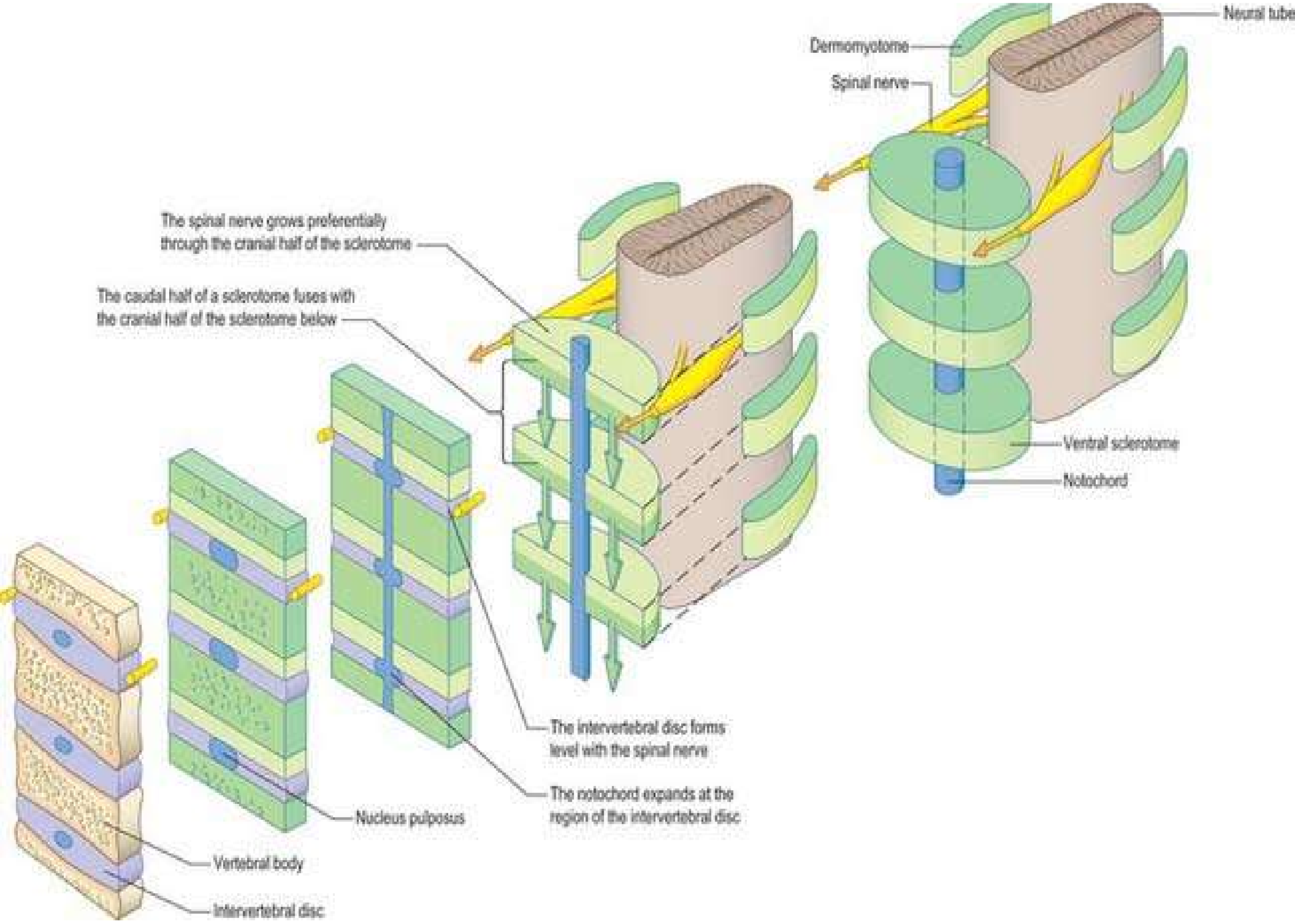
  Cephalic part (less condensed or light)

  Caudal part (more condensed or dark)

  - ✓ The caudal condensed part of each protovertebrea fuses with the cranial light part of the below one forming a blastemal vertebra which is composed of mesenchymal tissue .
  - ✓ The fused mass forming the centrum of the vertebra


Somite
Resegmented Sclerotome
Vertebral Column
Intervertebral Disc
Ad
Ld
Al
Ll
Neural Arch
IC
NC
NR
P
NA
IBZ
IBM
Centrum
NR
IV
Scl-A
Scl-L
VB
NP
A
ID


Notochord
Intersegmental mesenchyme
Artery
Nerve
Sclerotome segment
A
Nucleus pulposus and intervertebral disc
Myotome
B
Precartilagi-nous vertebral body
Transverse process
Annulus fibrosus
Intervertebral disc
C


Neural tube
Dermomyotome
Spinal nerve
The spinal nerve grows preferentially through the cranial half of the sclerotome
The caudal half of a sclerotome fuses with the cranial half of the sclerotome below
Ventral sclerotome
Notochord
The intervertebral disc forms level with the spinal nerve
The notochord expands at the region of the intervertebral disc
Nucleus pulposus
Vertebral body
Intervertebral disc

- The centrum gives rise to two dorsal ,costal and lateral (transverse) processes
- The dorsal processes surround the neural tube and fuse together in the midline to form lamina and spine
- The fate of costal and lateral processes differ according to the region

Cervical : they unites to form foramen transversum

Thoracic : the costal form ribs and lateral form the transverse process

Lumbar : fused to form transverse process

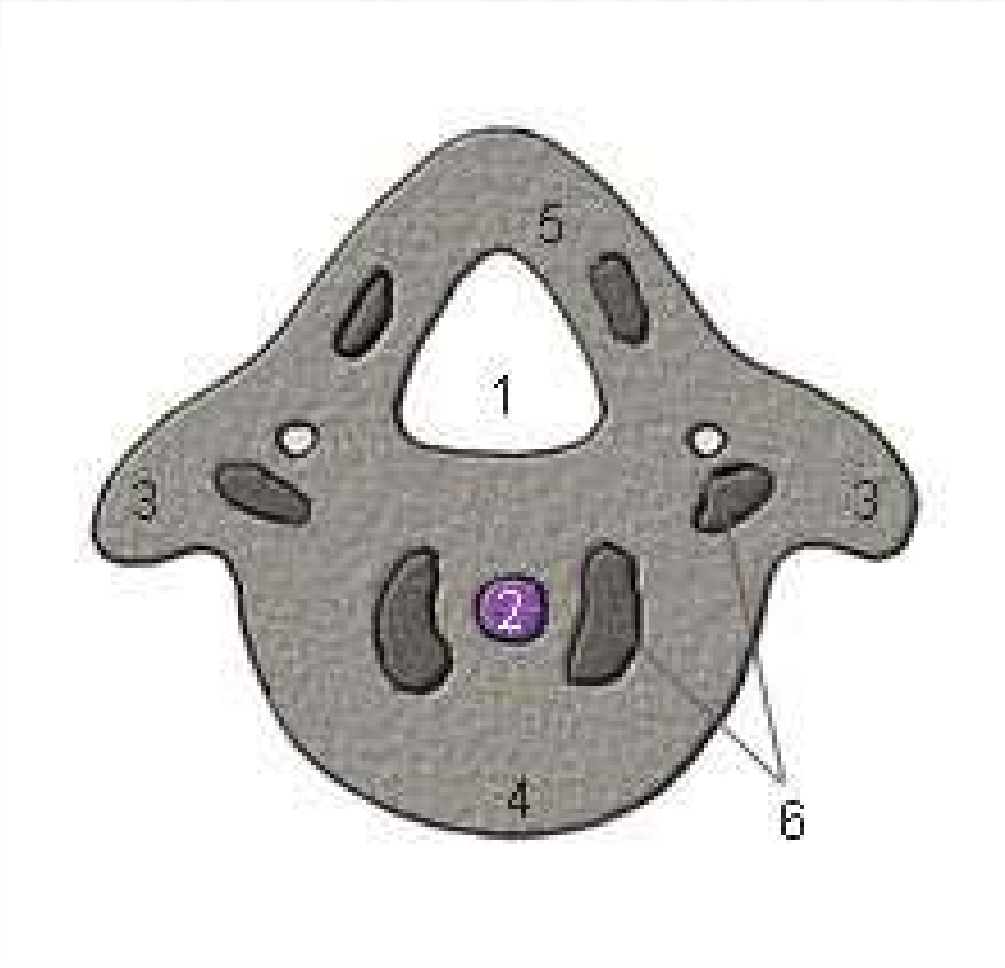
Sacral : they unite to form lateral mass of the sacrum

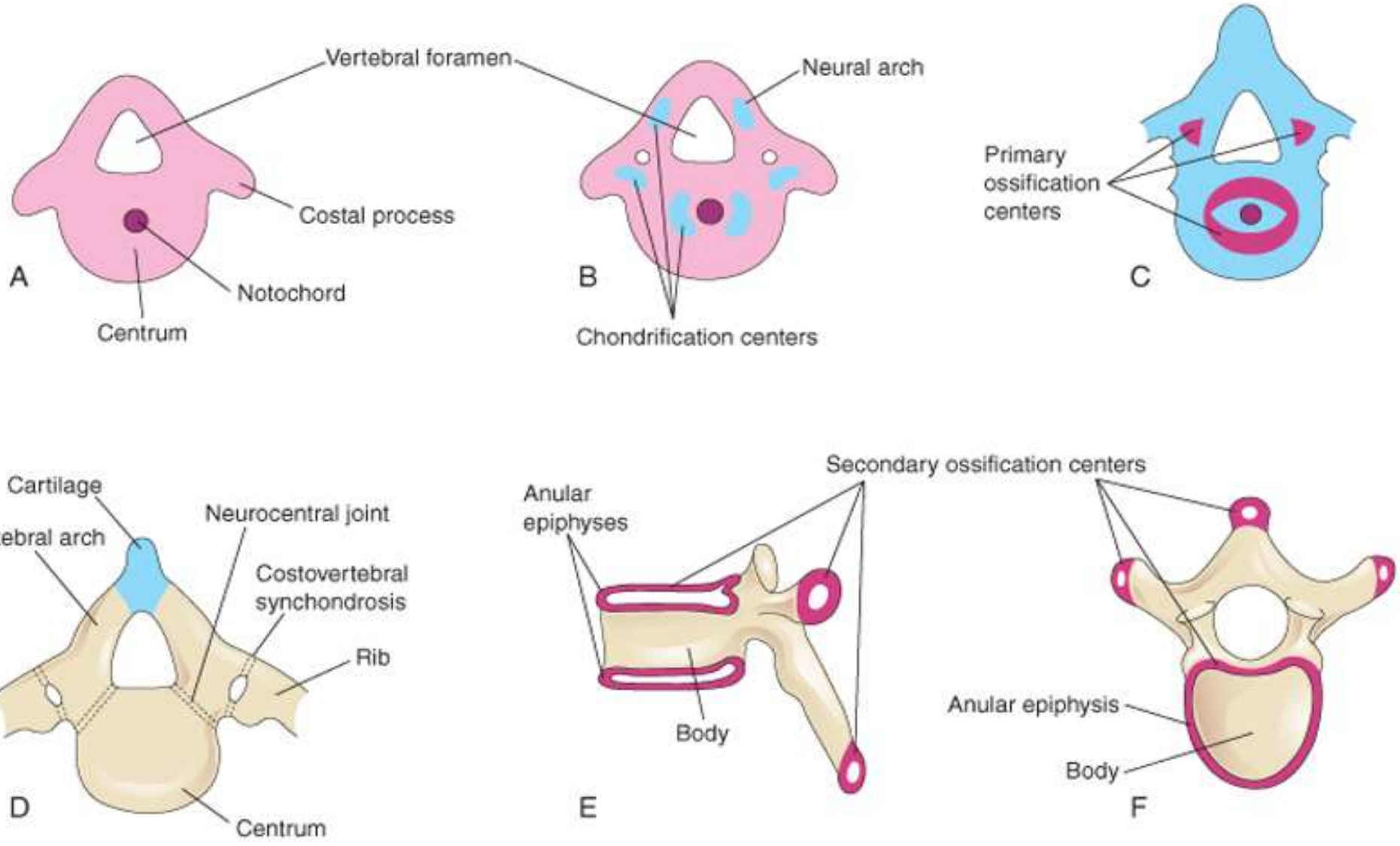
II. Cartilaginous stage:

In the 6th week of development, the mesenchymal vertebrae are chondrofied, so that a mesenchmyal vertebral column is transformed into a cartilaginous one.

III. Bony stage

By the 8th week of development, three primary centers appear which transform each vertebra into a bony structure.




Vertebral foramen
Costal process
Notochord
Centrum
A
Neural arch
Chondrification centers
B
Primary ossification centers
C
Cartilage
Vertebral arch
Neurocentral joint
Costovertebral synchondrosis
Rib
Centrum
D
Anular epiphyses
Secondary ossification centers
Body
E
Anular epiphysis
Body
F

Fate of the notochord :

- In the region of the vertebral bodies, it degenerates completely.
- In the intervertebral regions, it forms the nucleus pulposus of each intervertebral disc while the annulus fibrosus of each disc is derived from the scleretomic mesenchyme

Congenital anomalies

Spina bifida

Cause: Failure of fusion of the two dorsal processes resulting in midline defect usually in lumbosacral region

Spina bifida occulta : The defect is covered with skin only

Spina bifida cystica :

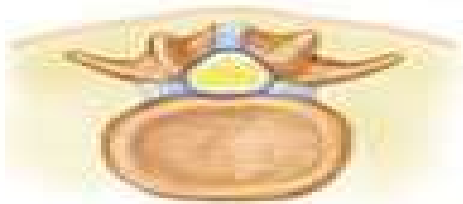
A)Meningocele :There is an opening in the spine where the meninges, come through like a sac. The sac is filled with cerebrospinal fluid and there is usually no nerve damage.

B) Myelomeningocele :The meninges and spinal nerves come through the open part of the spine. This is causes nerve damage and severe disabilities.

C) Myeloschisis : the neural tissue is exposed to the surface


Spina bifida occulta
Meningocele
Myelomeningocele

Cyst on baby's back from spina bifida



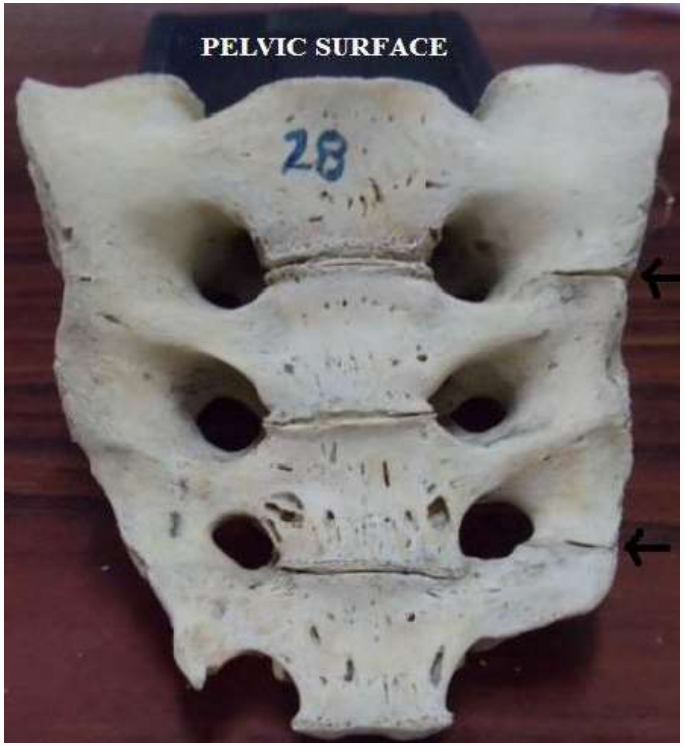
Normal newborn vertebra

A. Spina bifida occulta
B. Spina bifida with meningocele
C. Spina bifida with meningomyelocele
D. Spina bifida with myeloschisis

Sacralization of 5th lumbar vertebra : The 5th lumbar vertebra fuses with the sacrum

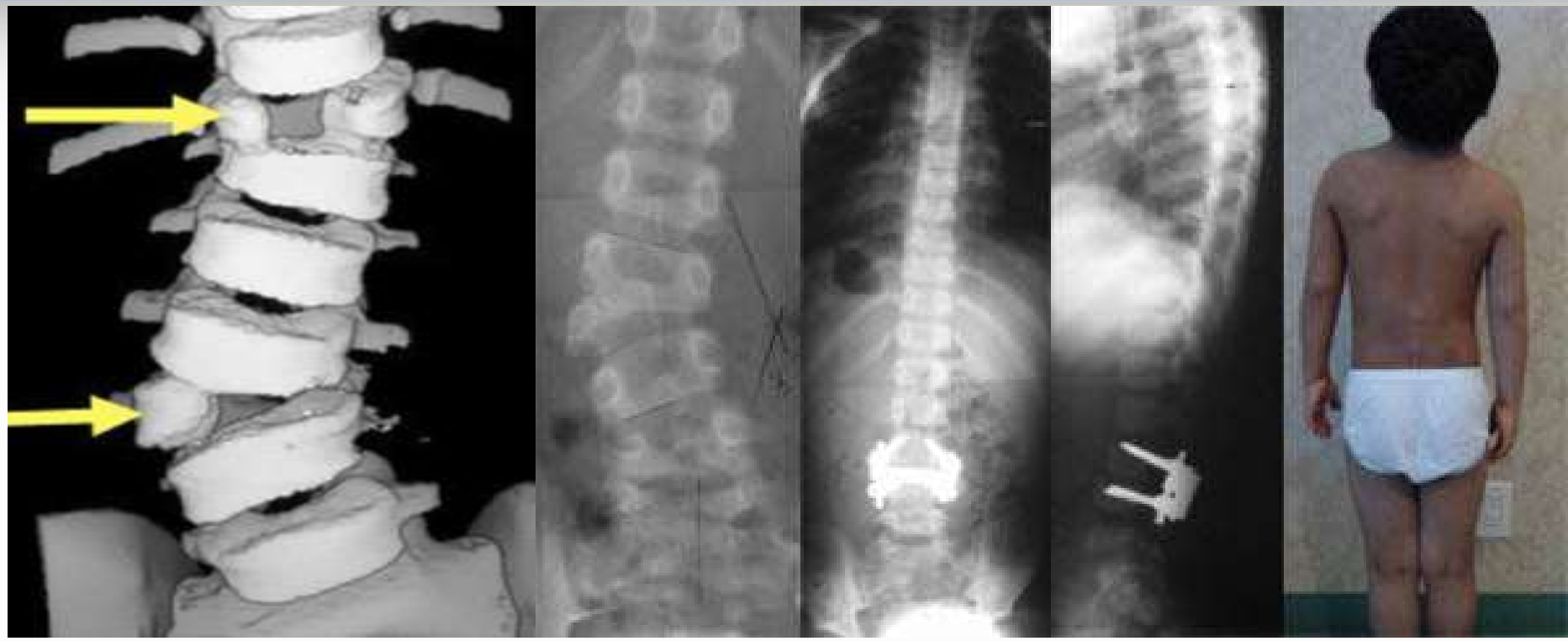
Lumbralization of 1st sacral vertebra : separation of the 1st piece of sacrum to form a separate vertebra

Sacralization



Lumbralization

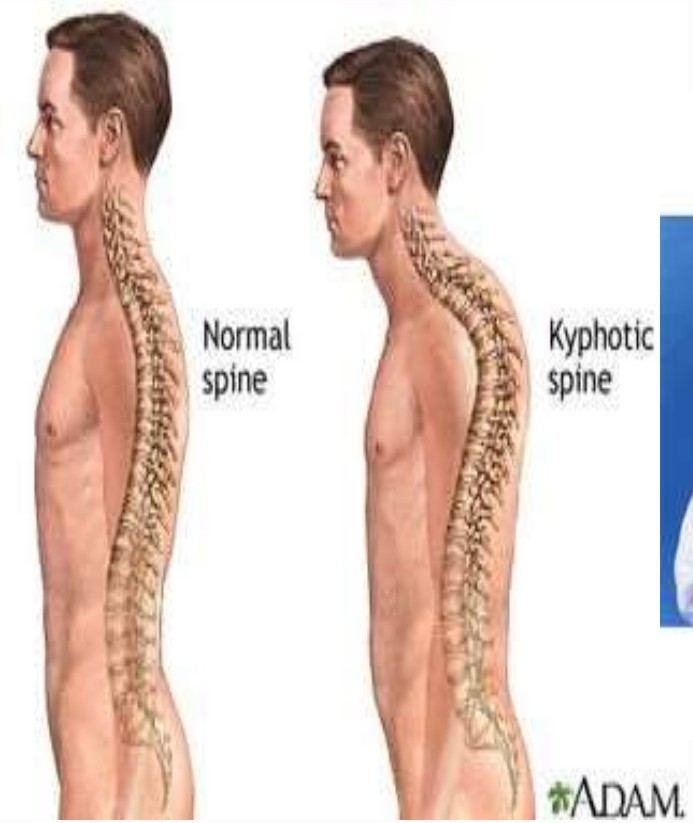
Hemivertebra



Cause: failure of one of the chondrofication center to appear so failure of half of vertebra to form

Feature: defective vertebra produce scoliosis (lateral curvature)

Congenital kyphosis



The Jordan University
Faculty Of Medicine

Diaphragm

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Diaphragm

- ✓ The diaphragm is a fibromuscular partition between thorax and abdomen
- ✓ Viewed from infront, the ***lateral regions*** of the diaphragm are raised into smooth ***convex domes*** (called the right cupola and left cupola) and a ***central area*** (related to pericardium and heart) which is slightly lower and more ***horizontal*** than the cupolae.
- ✓ The right cupola ***is higher*** (due to the liver) and less mobile than the left one.

Diaphragm

Origin :

Sternal part : arising from the posterior surface of the xiphoid process

Costal part **:** arising from the deep surfaces of the lower six ribs and their costal cartilages

***Vertebral* part :** arising by two crura and five arcuate ligaments (one median, two medial and two lateral arcuate ligaments)

The two crura :-

The right crus : is attached to the anterolateral surfaces of the bodies of the upper *3* lumbar vertebrae and the intervening discs.

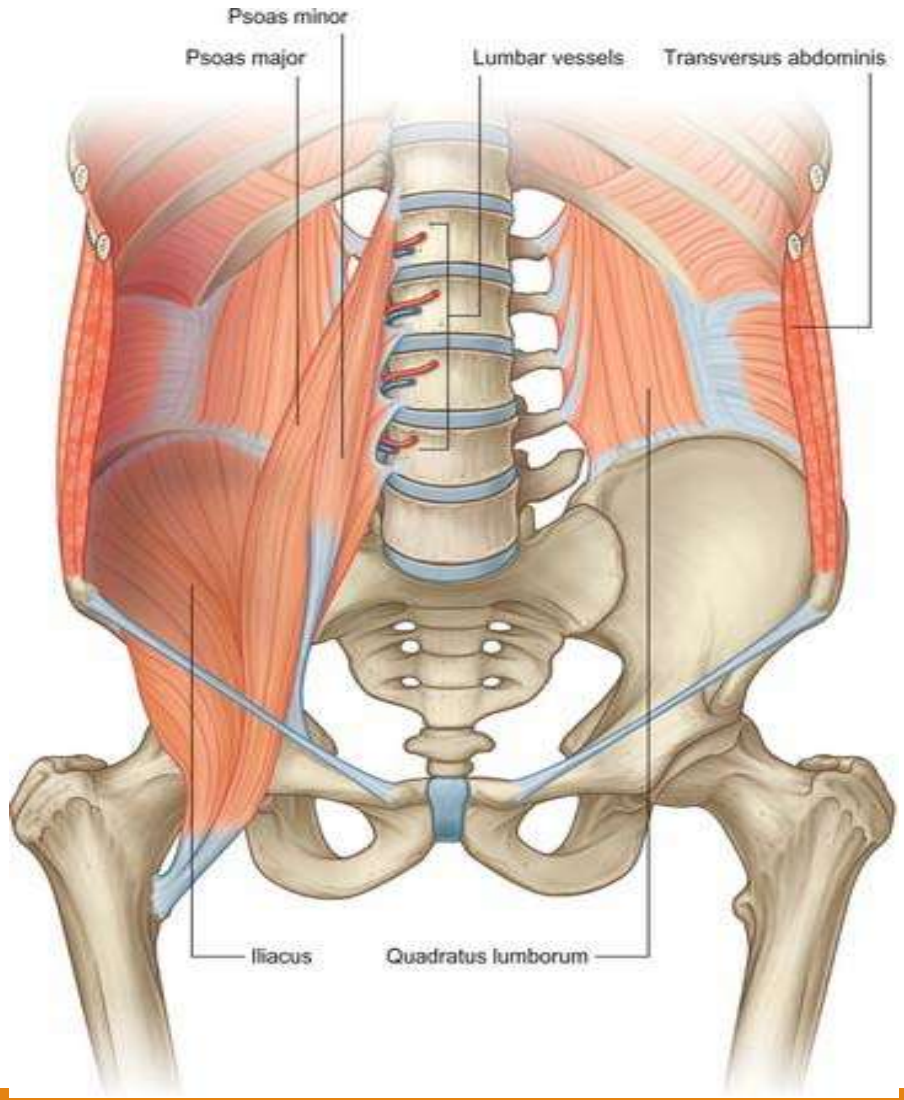
It has *three* special features;

a- It is *larger, longer* ***and stronger*** to overcome the resistance offered by the liver during descent of the diaphragm

b- Some of its muscle fibers ***run up*** to left , to surround the oesophagus.

c- Some fibers *descend* to form the suspensory ligament of the duodenum.

Left crus : anterolateral surfaces of the bodies of the upper *two* lumbar vertebrae and the intervening discs.


Psoas minor
Psoas major
Lumbar vessels
Transversus abdominis
Iliacus
Quadratus lumborum

The five Arcuate ligaments :-

- **Median arcuate ligament**, connecting the two crura, it cross the aorta.
- **Medial arcuate ligaments;**
  - ❖ It extends from the side of the L2 vertebral body to the front of the L1 lumbar transverse process.
  - ❖ They lie across the upper part of psoas major
- **Lateral arcuate ligaments;**
  - ❖ It extends from the front of the transverse process of L1 vertebra to the lower margin of 12th rib.
  - ❖ They lie across the upper part of the quadratus lumborum muscle
  - ❖ Occasionally, the muscle fibers arising from this ligament are deficient, so a vertebro-costal triangle exists and posterior surface of the kidney is in direct contact with pleura

Insertion :

All muscle fibres of the diaphragm converge on a strong apneurosis called the central tendon

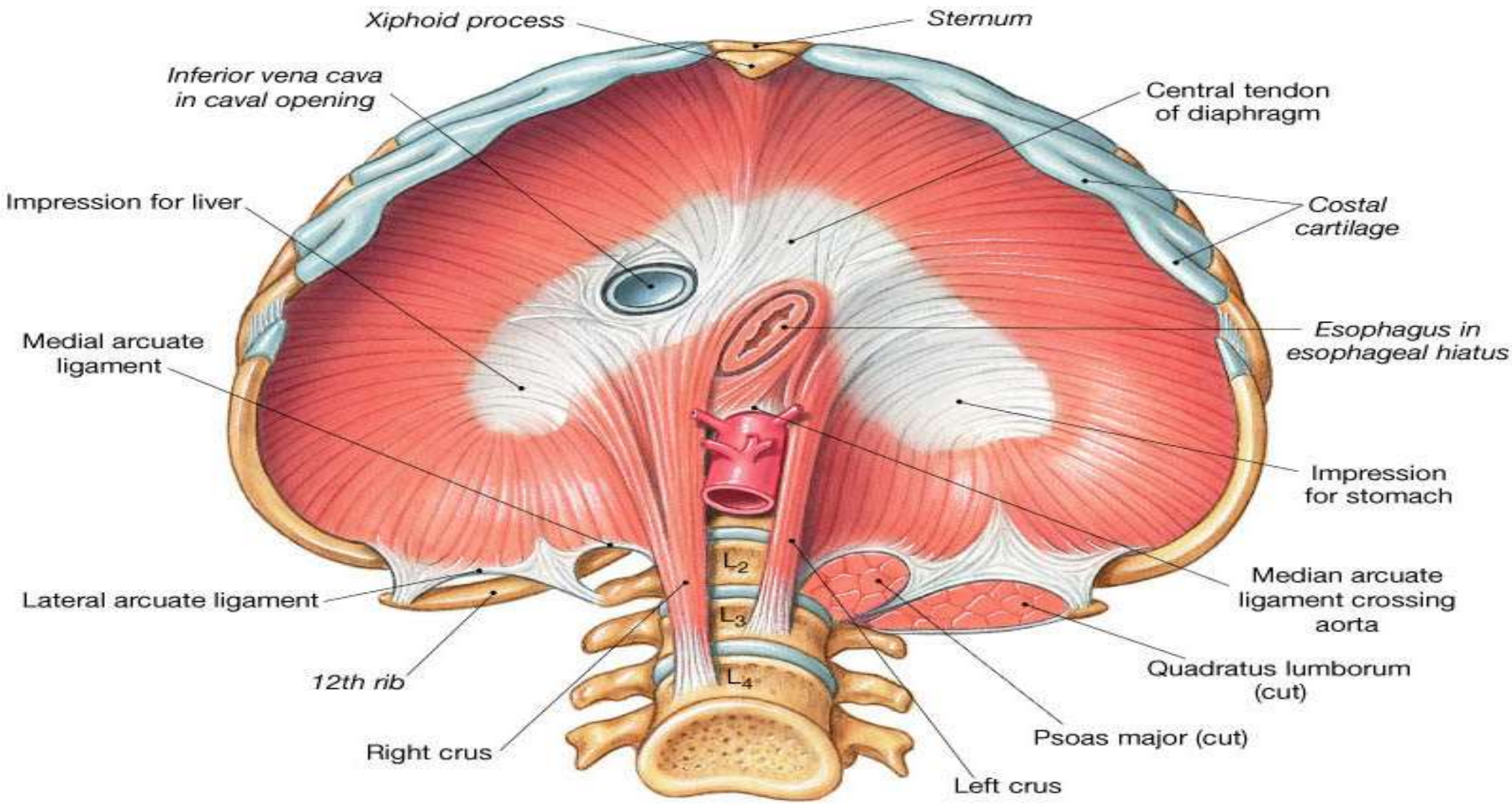
Nerve Supply :

Motor nerve supply: The right and left phrenic nerves (C3, 4, 5).

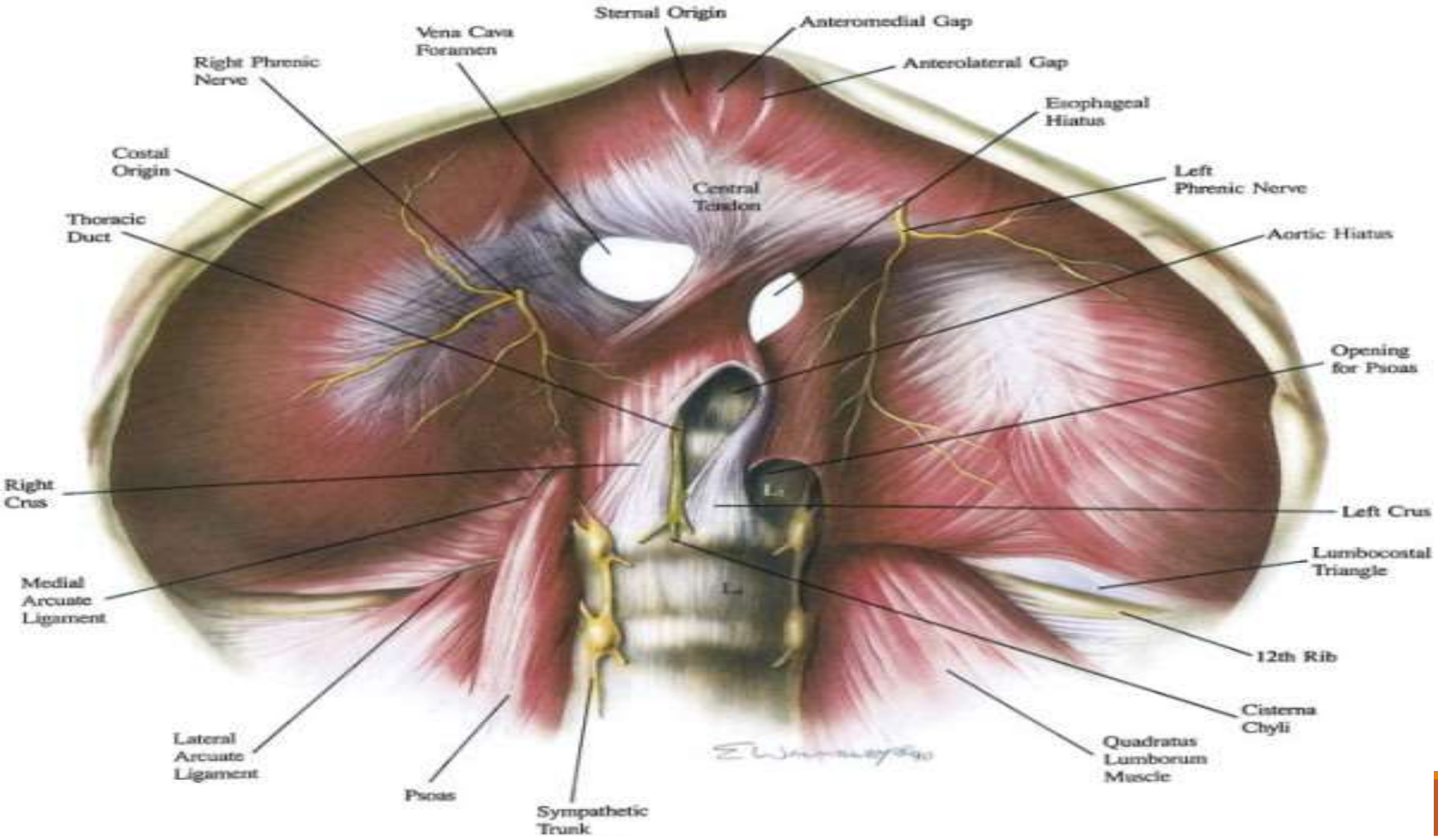
Sensory supply; phrenic and lower intercostal nerves.

Arterial supply :

Inferior phrenic arteries (from abdominal aorta), musculophrenic and pericardio-phrenic arteries.



(a) Inferior view


Sternal Origin
Anteromedial Gap
Vena Cava Foramen
Right Phrenic Nerve
Anterolateral Gap
Esophageal Hiatus
Costal Origin
Left Phrenic Nerve
Central Tendon
Thoracic Duct
Aortic Hiatus
Opening for Psoas
Right Crus
Left Crus
Lumbocostal Triangle
Medial Arcuate Ligament
12th Rib
Cisterna Chyli
Lateral Arcuate Ligament
Quadratus Lumborum Muscle
Psoas
Sympathetic Trunk

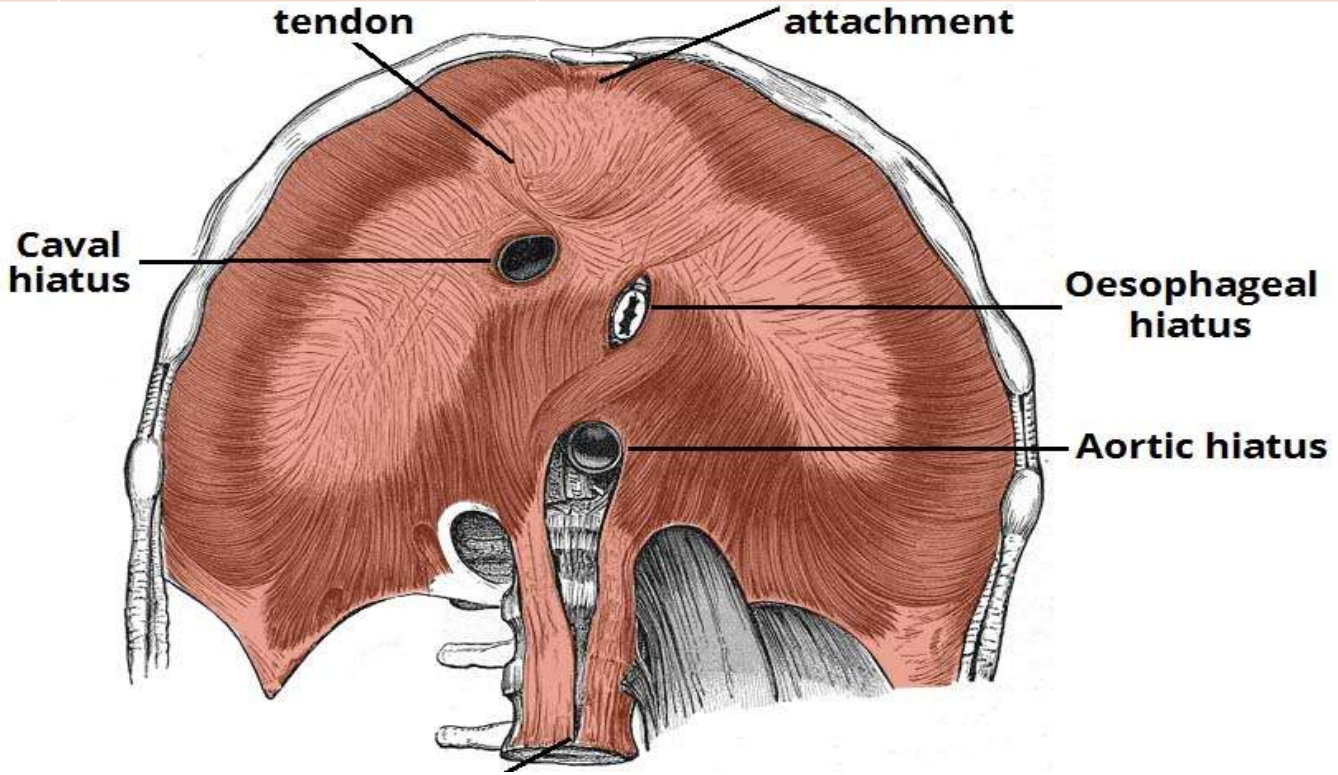
Function of the diaphragm

1. **Muscle of inspiration**
2. **Muscle of abdominal straining:** The contraction of the diaphragm is raising the intra-abdominal pressure
3. **Weight-lifting muscle**:

4- Thoracoabdominal pump: Pump for blood and lymph

Major Opening of the diaphragm :

Opening	Level	Structures passing through it
Aortic (middle)	12th thoracic vertebra	aorta, the thoracic duct, and the azygos vein.
Oesophageal opening (Left)	10th thoracic vertebra	oesophagus, the right and left vagus nerves
Vena Caval (Right)	8th thoracic vertebra	It transmits the inferior vena cava and terminal branches of the right phrenic nerve.



Minor foramina of the diaphragm :

(2 arteries and 5 nerves)

1- Superior epigastric artery.

2- Musculophrenic artery.

3- The left phrenic nerve.

4- The lower five intercostal nerves.

5- Subcostal nerve and vessels; *posterior* to the lateral arcuate ligaments

6- Sympathetic trunks; *posterior* to the medial arcuate ligaments

7- Splanchnic nerves (greater and lesser).

Thank you