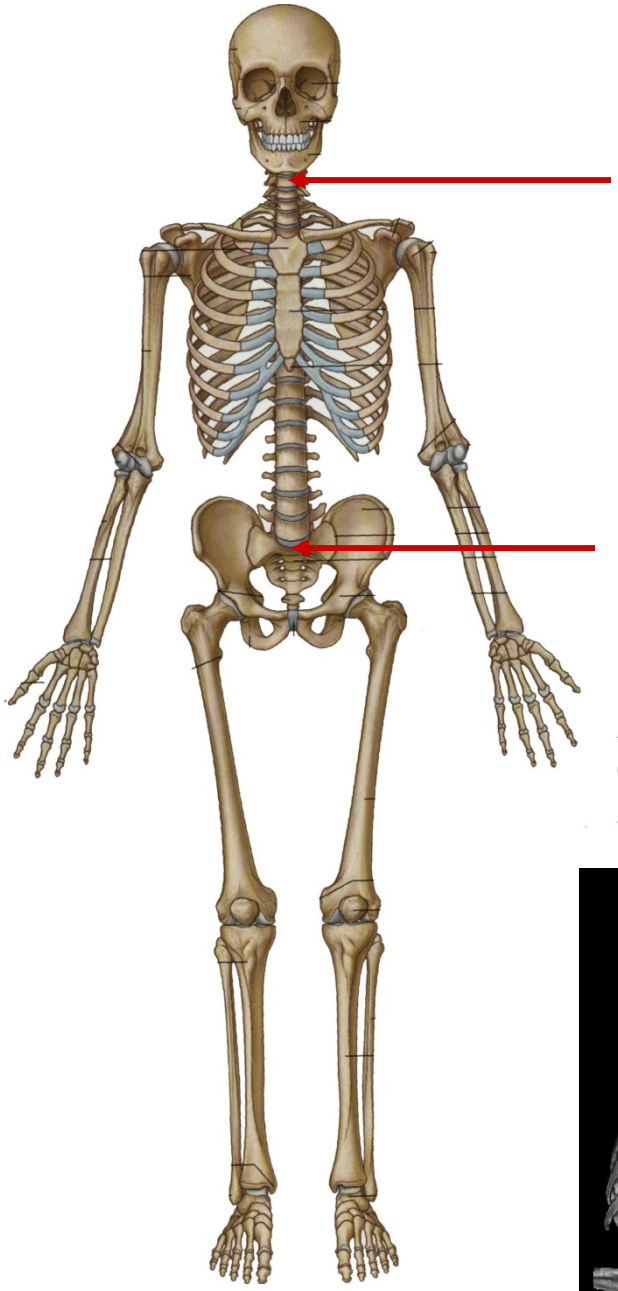
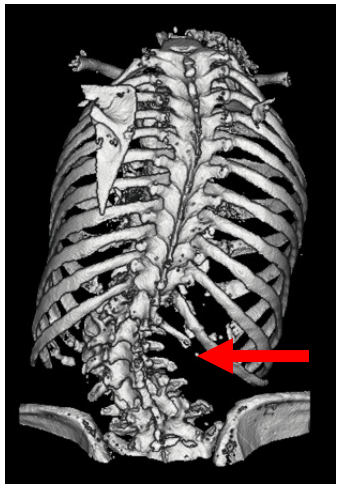
VERTEBRAL COLUMN OVERVIEW



VERTEBRAL COLUMN

ABNORMAL CURVATURE: SCOLIOSIS



Relevance

1- Nomenclature – the terms used to describe vertebrae (C,T,L,S,Co) form the basis for the description of Spinal nerves

2- Clinical relevance – Back problems second highest cause of disability
1. ‘Slipped’ disc – herniation of nucleus pulposus
2. Spinal curvature - Curvatures of spine – Common

VERTEBRAL COLUMN

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I. VERTEBRAL COLUMN - functions to support weight of body and protect spinal cord while permitting movements of trunk and providing for muscle attachments.

A. Typical vertebra

1. A typical vertebra (by convention thoracic or upper lumbar) consists of a body (anterior) and a vertebral arch (posterior) surrounding the vertebral canal (houses spinal cord).

2. The vertebral arch is composed of pedicles (projecting from the body) and laminae (uniting arch posteriorly).

3. Transverse processes (arising from arch laterally) and spinous processes (arising from arch posteriorly) provide for attachments of muscles and ligaments.

4. Spinal nerves exit the vertebral canal via intervertebral foramina (between pedicles of vertebrae) that are bordered by superior and inferior vertebral notches.

5. Superior and inferior articular processes - provide for joints between adjacent vertebrae; located at junction of pedicles and laminae; orientations of articular processes (also called facets) determine the types of movements that occur between vertebrae.

6. Bodies of adjacent vertebrae are also joined by intervertebral discs (see below).

B. Regional Variations - vertebral column is divided anatomically into regions; in each region, vertebrae are numbered superior to inferior:

2. SUMMARY OF FEATURES OF VERTEBRAE

Vertebra	#	Features	Articular Process Oriented	Movements
Cervical	7	Bodies small, Foramina transversaria (small in C7) C1 = Atlas - no body C2 = Axis - dens C7 = Vertebra prominens	Slanted (Superiorly and Medially)	Considerable freedom of movement: Flex-Extend, Lateral Flex, Rotate
Thoracic	12	Facets for ribs on bodies (heads of ribs), transverse processes (articular tubercles of ribs)	Coronal plane	Little movement: No Flex-Extend, Small Rotate
Lumbar	5	Large bodies	Sagittal plane	Flex-Extend, No Rotate
Sacral	5	Fused		Normally no movement
Coccygeal	3-5	Fused, rudimentary		No movement

ANATOMY HANDOUTS, TABLES

Lecture videos follow handouts (read handout)

Summary tables at end of handout – recap anatomical features, terms

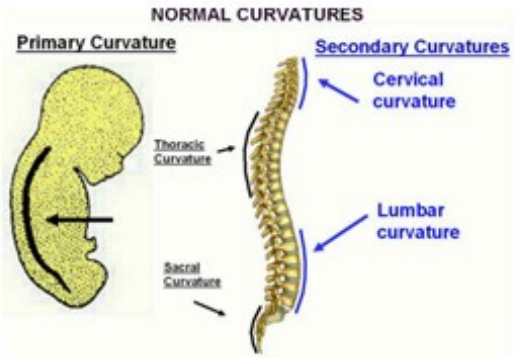
CLINICAL ANATOMY CHARTS - REVIEW FOR STEP 1 EXAM, CLINICAL INTEGRATION

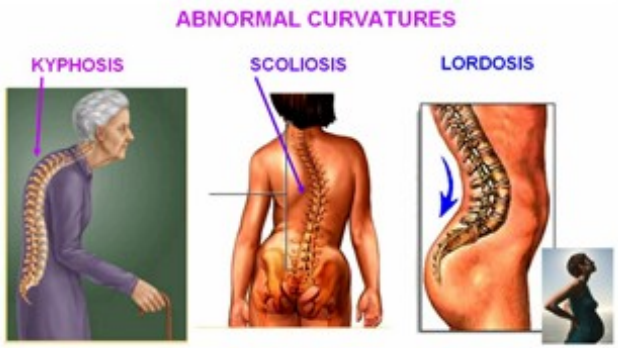
CLINICAL ANATOMY OF VERTEBRAE, SPINAL NERVES, REFLEXES

1) VERTEBRAE - NORMAL SPINAL CURVATURES: Primary = Concave Anterior - (fetal curvature); preserved in adult Thorax, Sacrum
Secondary = Concave Posterior (develop in childhood) - Cervical (support head), Lumbar (support body)

ABNORMAL CURVATURES - all can cause pain from compression of spinal nerves

	Curvature	Location (Most common)	Cause
Kyphosis	Exaggerated Concave **Anterior**	Often in **Thoracic Region (Hump back)**	**Osteoporosis**, etc. - loss of bone in bodies of vertebrae
Scoliosis	Exaggerated **Lateral**	**Thoracic, Lumbar** most common	**Hemivertebra** (half of vertebral body does not form in development), etc.
Lordosis	Exaggerate Concave **Posterior**	**Lumbar** (normal in pregnancy)	**Obesity, etc.**





Summarize anatomical features of clinical conditions, developmental abnormalities; useful for review for exams, including Step 1 Board Exam

VERTEBRAL COLUMN

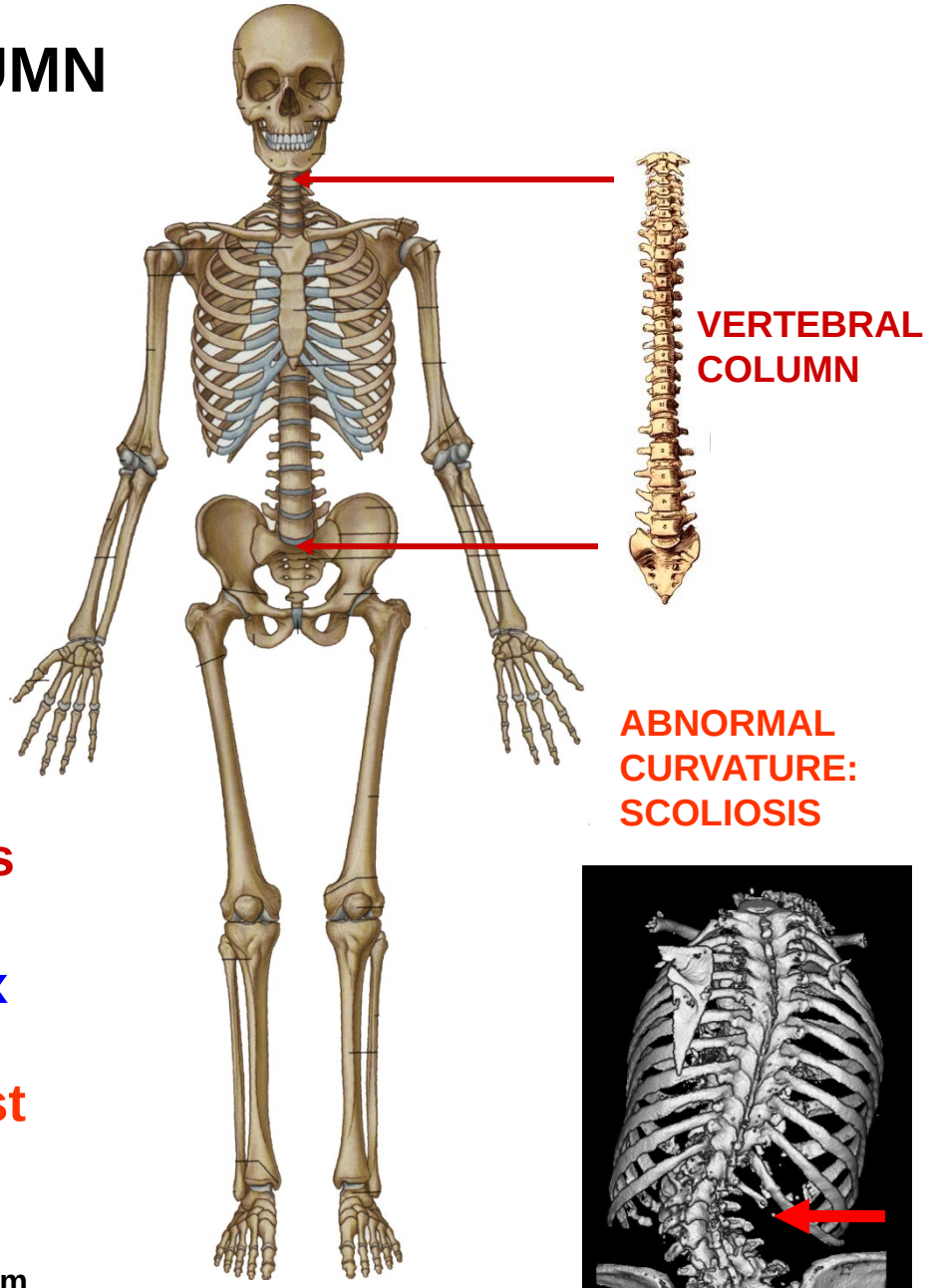
FUNCTIONS:

1) Support weight - transmits weight to pelvis and lower limbs

2) Houses and protects spinal cord - spinal nerves leave cord between vertebrae

3) Permits movements -*clinical problems

4) Provides for muscle attachments - muscles of back; also muscles of head, neck, upper extremity, thorax



ABNORMAL CURVATURE: SCOLIOSIS

***Back/spine problems - second most common cause of disability (after arthritis)**

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5816a2.htm

CDC web site: http://www.cdc.gov/

A. TYPICAL VERTEBRA – by convention thoracic

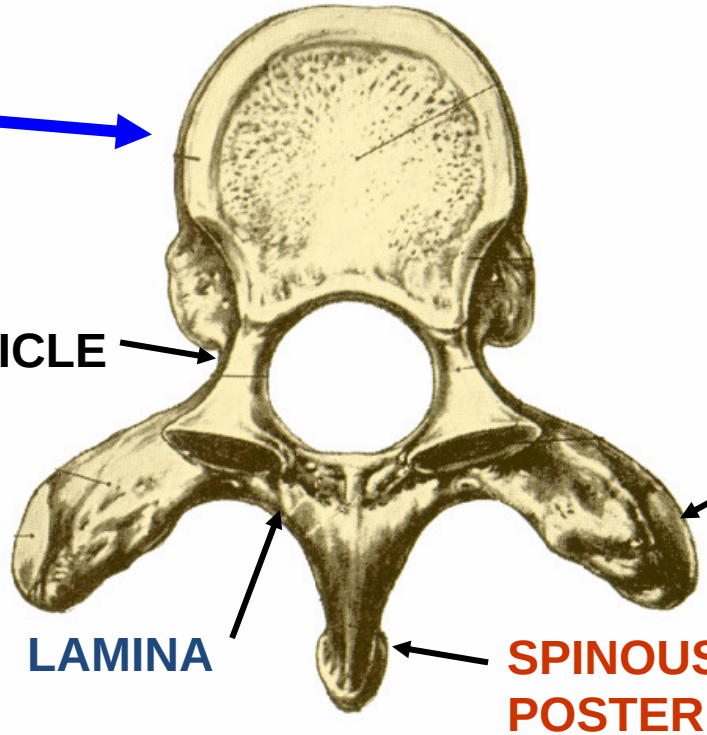
1. <u>BODY</u> – anterior, solid transmits weight
2. <u>VERTEBRAL ARCH</u> – posterior, surrounds vertebral canal, spinal cord; consists of a) PEDICLES – project from body
   b) LAMINAE – unite to form arch posteriorly

NOSE

anterior

BODY

VERTEBRAL ARCH



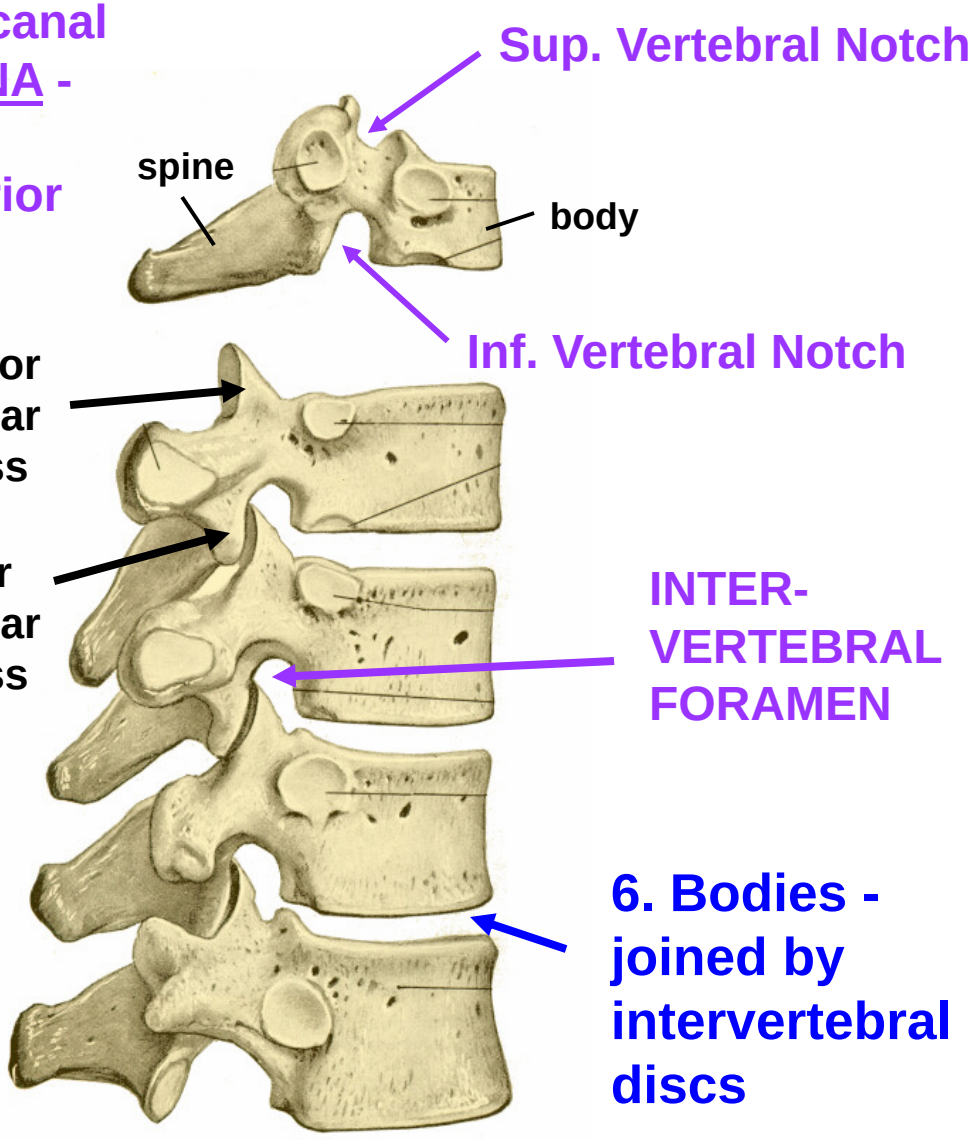
3. <u>TRANSVERSE AND SPINOUS PROCESSES</u> - projections from arch for muscle, ligament attach

LATERAL VIEW OF VERTEBRAE

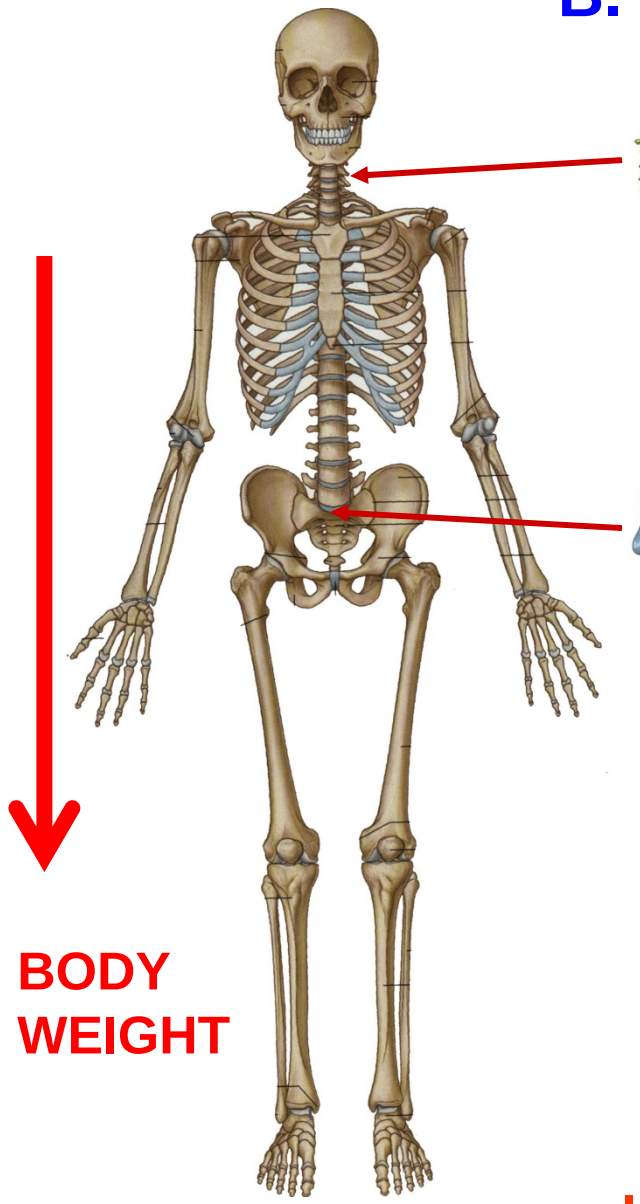
NOSE

4. Spinal nerves leave vertebral canal via INTERVERTEBRAL FORAMINA - between pedicles of vertebrae; bordered by – Superior and Inferior Vertebral Notches

5. SUPERIOR AND INFERIOR ARTICULAR PROCESSES - Articular processes also called Facets; at junction between pedicles and laminae; form joints between adjacent vertebrae; orientation of facets determine types of movements that occur between vertebrae



B. REGIONS OF VERTEBRAL COLUMN



Cervical (neck) - 7 vertebrae (C1-C7)

Thoracic (chest) - 12 vertebrae (T1-T12)

Lumbar (lower back) - 5 vertebrae (L1-L5)

Sacral (pelvis) - 5 fused vertebrae (S1-S5)

Coccygeal (tail) - 3 - 5 vertebrae (Co1-Co3)

- Structure of vertebrae differ in different regions
- Some cervical vertebrae are uniquely identifiable (ex. C1, C2 and C7)

Important Note: Nomenclature short hand: C6 means the sixth cervical vertebra

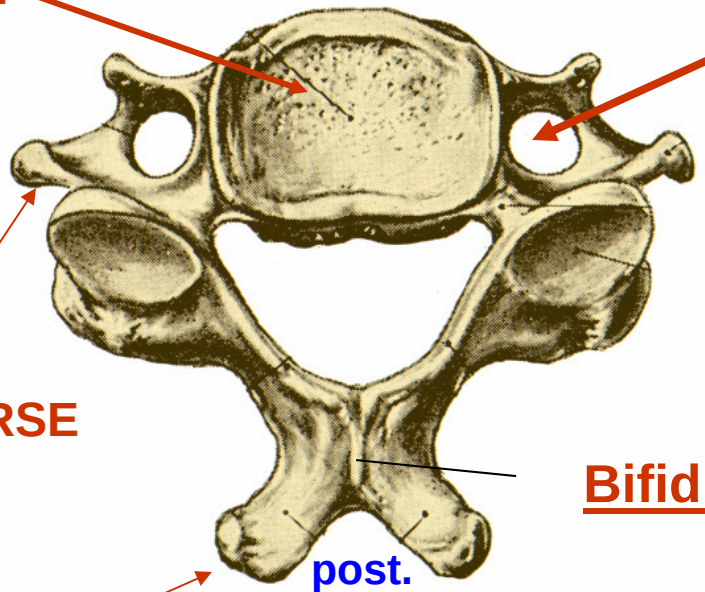
CERVICAL VERTEBRA

NOSE

BODY

ant.

- body is small



Foramen Transversarium - hole in transverse process (C1-C7) for **Vertebral artery and veins**

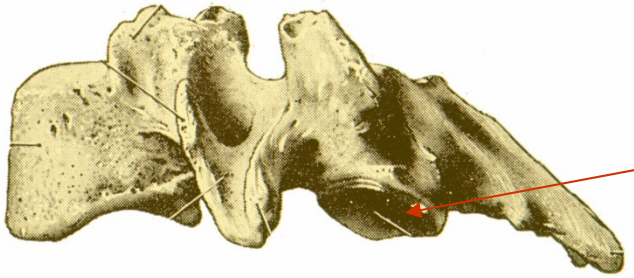
TRANSVERSE PROCESS

Bifid (divided) Spinous Process

post.

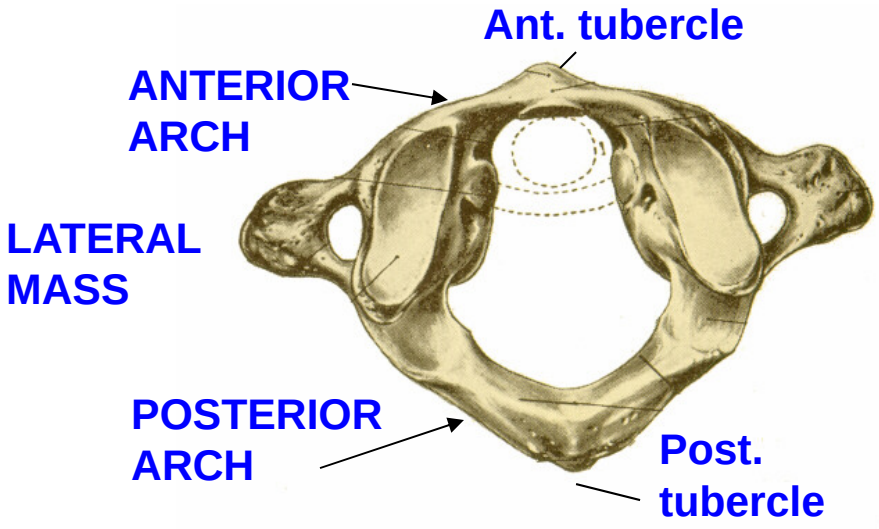
SPINOUS PROCESS – Bifid (divided) for Ligamentum nuchae

lat. view



ARTICULAR FACETS - angled superiorly and medially
- considerable freedom of movement

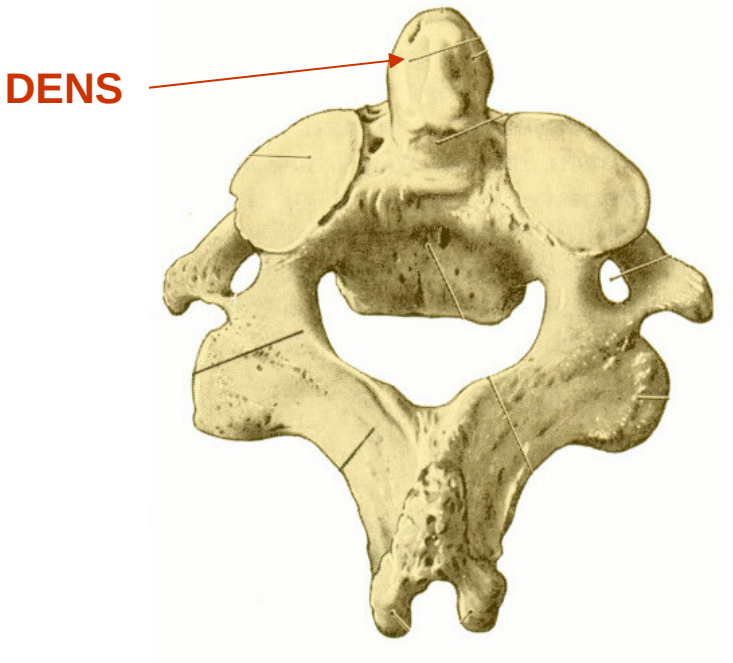
FIRST CERVICAL VERTEBRA = C1 (ATLAS)



1) has no body only ring of bone
2) Anterior and Posterior Arches and Lateral mass
3) bumps on arches - Ant. and Post. Tubercles
4) has Foramina Transversaria
5) superior articular facets to occipital bone of skull; permits Flex-Ext 'yes' movement of head

**

SECOND CERVICAL VERTEBRA = C2 (AXIS)

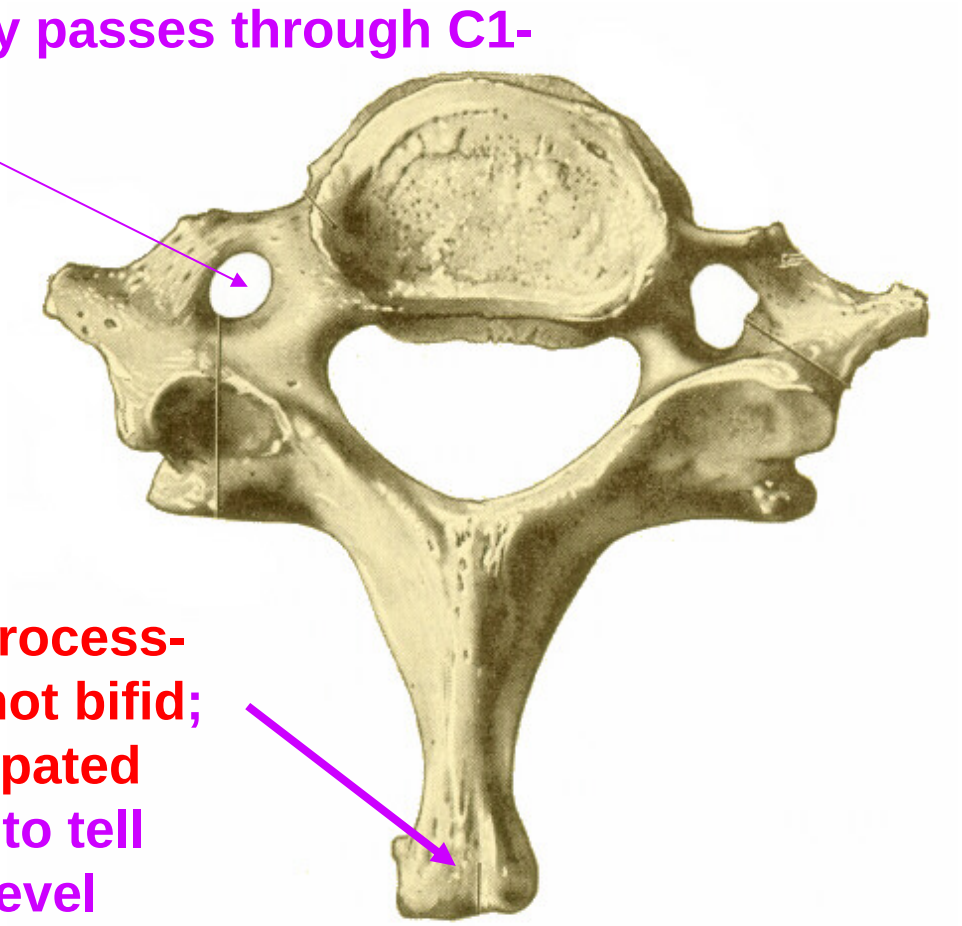


1) has peg-like Odontoid process = Dens (may be fused body of C1)
2) joint between C1-C2 is pivot joint allowing rotation; Rotation = 'no' movement of head; joint is important in hanging

**

SEVENTH CERVICAL VERTEBRA = C7 (VERTEBRA PROMINENS)

<u>Small Foramina Transversaria</u> - transmit only Vertebral Veins (Vert. Artery passes through C1-C6)



Spinous process- long and not bifid; can be palpated externally to tell vertebral level

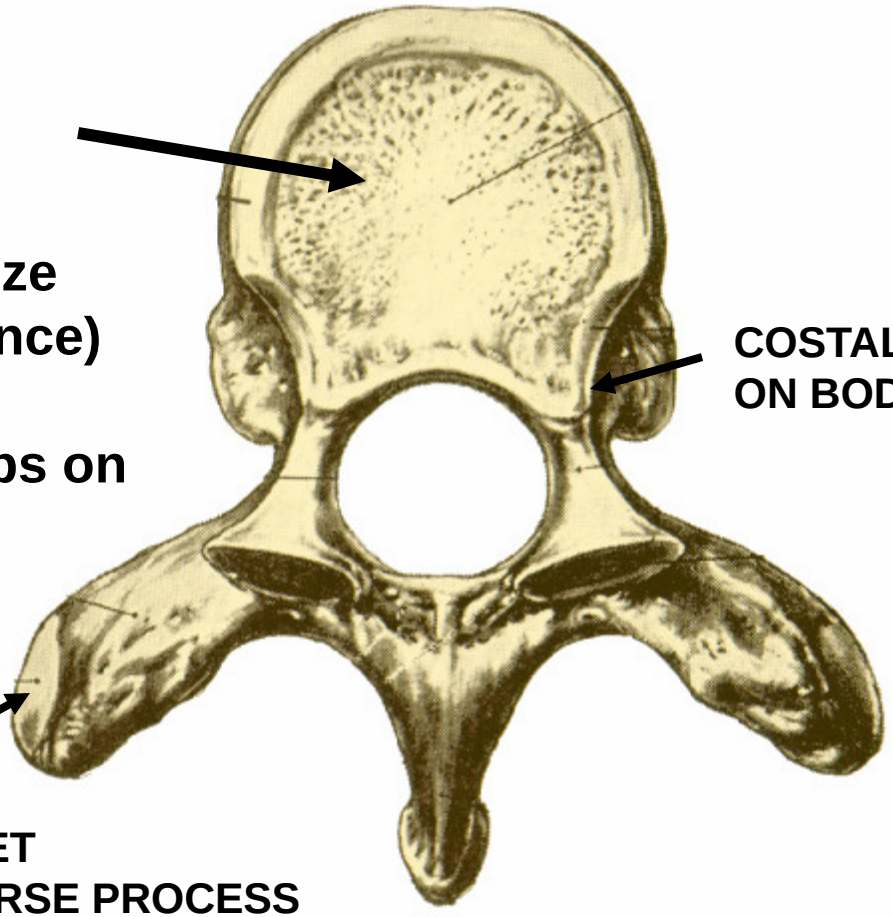
**

Clinical Note: The long spinous process of the seventh cervical vertebra (**C7**, Vertebra prominens) is **<u>palpable</u> can be used to identify the level of injury** (ex. physical examination for disc herniation after minor car accidents)

THORACIC VERTEBRA (12)

BODY – heart-shaped; larger than cervical vertebrae (bodies of vertebrae increase in size in rostral-caudal sequence)

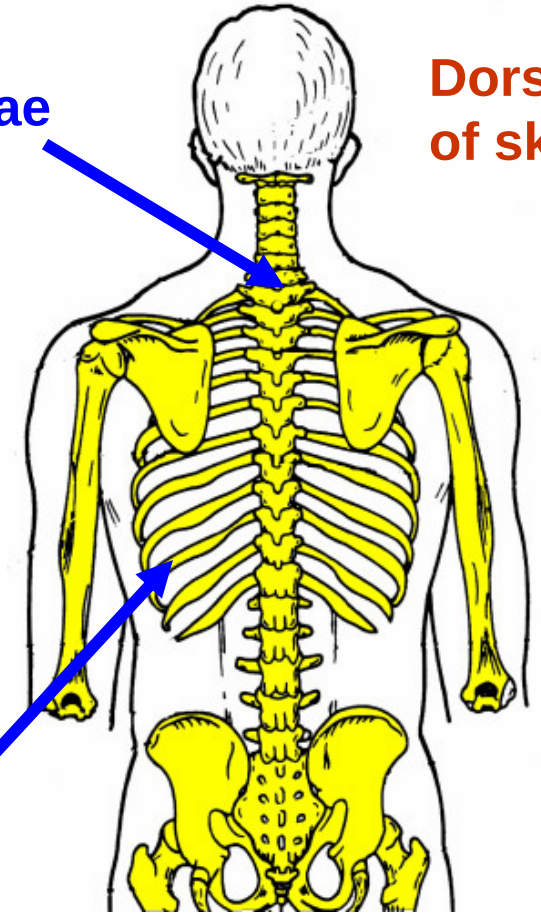
COSTAL FACETS for ribs on
- **body**
- **transverse process**



RIBS- have bumps for articulation with vertebra

Vertebrae

Dorsal view
of skeleton



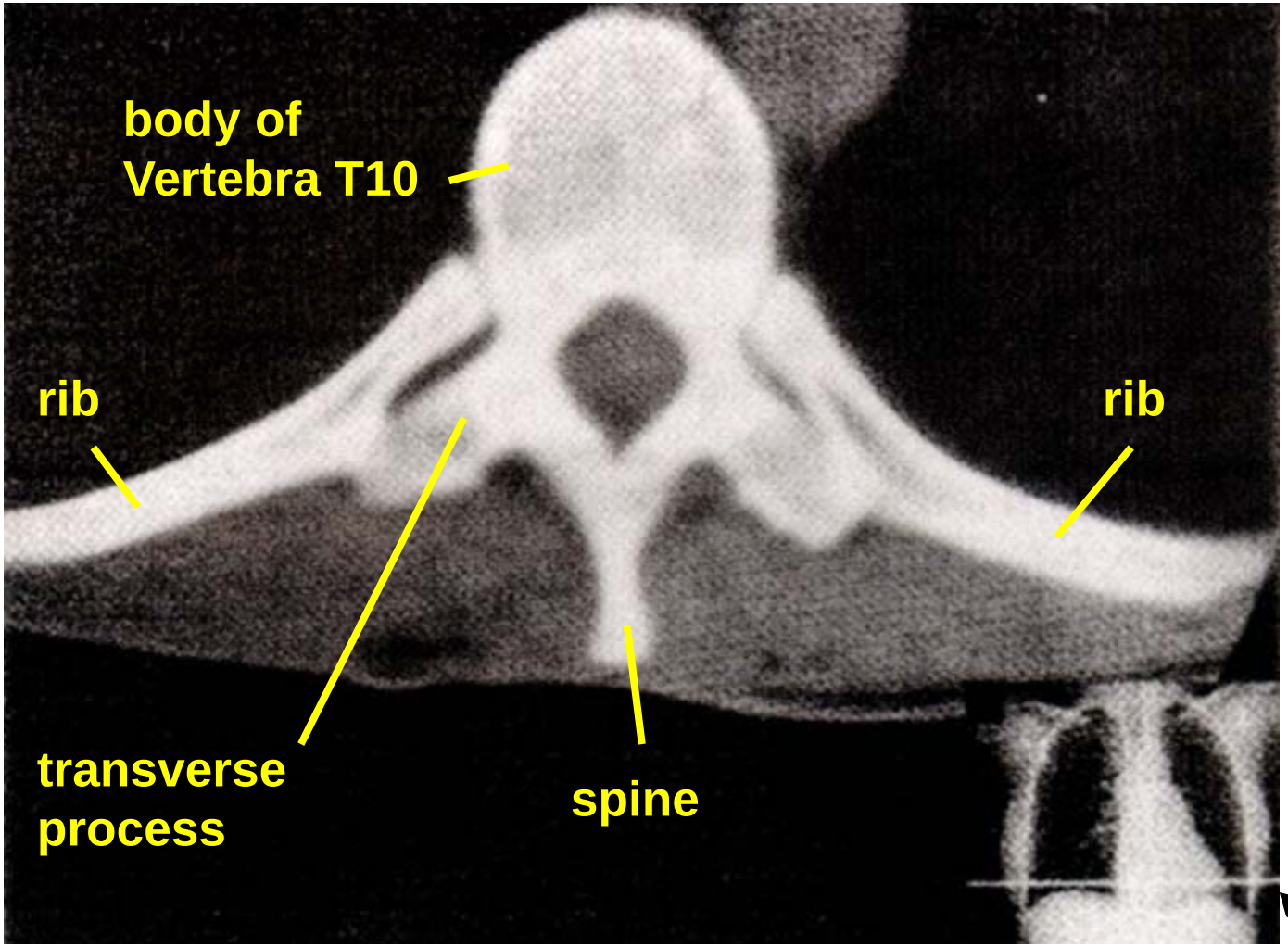
Ribs

Tubercle –
Articulates
with facet on
Transverse process

Head –
Articulates
with facet on Body

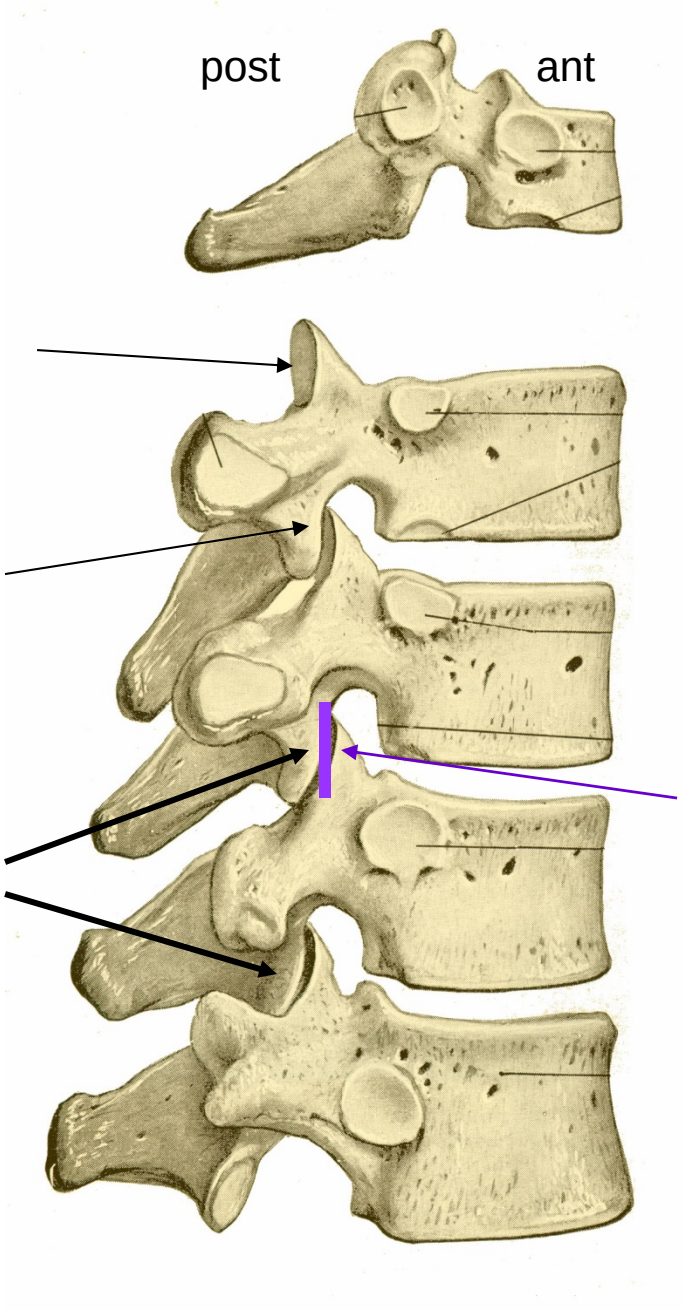
CT OF THORACIC VERTEBRA

Note: CT and X rays: bone and metal white, air black; soft tissues grey



QUESTION: LOOK AT THE ORIENTING ARROWS. GIVEN THE ORIENTATION, IN WHAT ANATOMICAL PLANE WAS THE SECTION TAKEN? HORIZONTAL. IN WHICH DIRECTION WOULD THE PATIENT'S NOSE BE POINTING (EX. TOWARD BOTTOM OF IMAGE)? TOP OF IMAGE

LATERAL VIEW OF THORACIC VERTEBRA



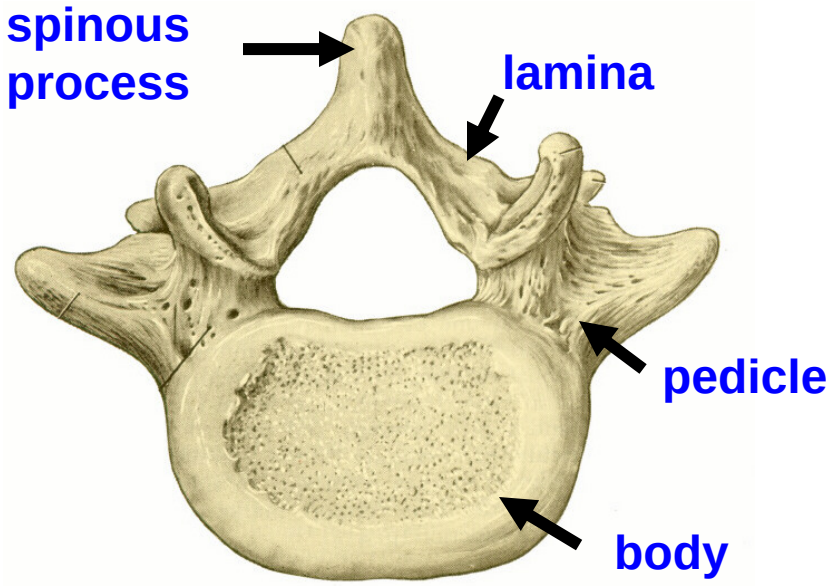
3. Costal Facets for Ribs - Body - Facets for Heads of rib Transverse Process - Facets for Tubercles of ribs

4. Spines of thoracic vertebrae - long and inclined posteriorly and inferiorly

5. Articular Processes in coronal plane

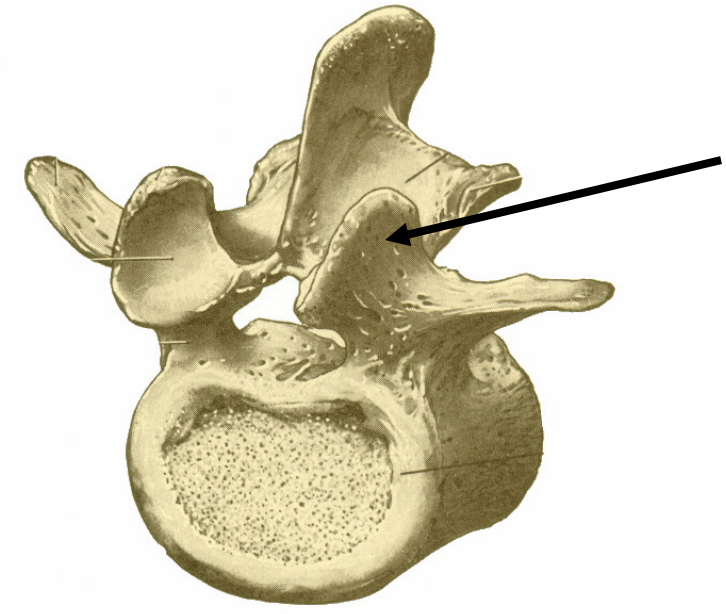
Note: Bodies increase in size from rostral to caudal = superior to inferior

LUMBAR VERTEBRA



Bodies - hefty
Pedicles - stout
Lamina - thick
Spinous Processes - broad

NOSE

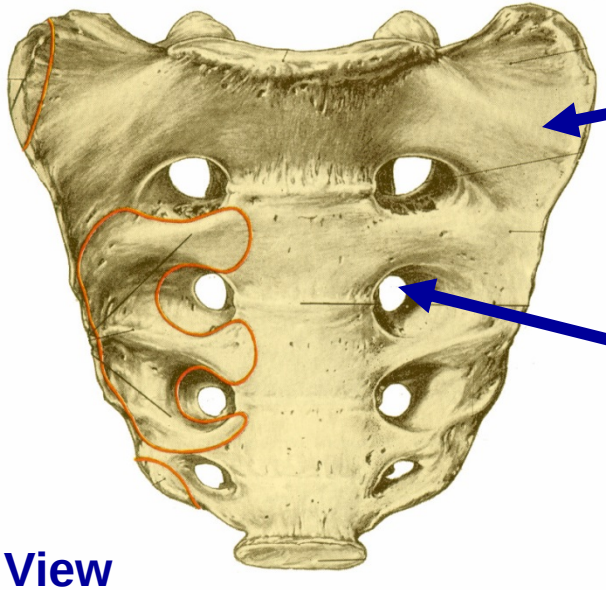


Articular processes in sagittal plane*

* - look at skeletons, models in lab

SACRUM = 5 FUSED VERTEBRAE

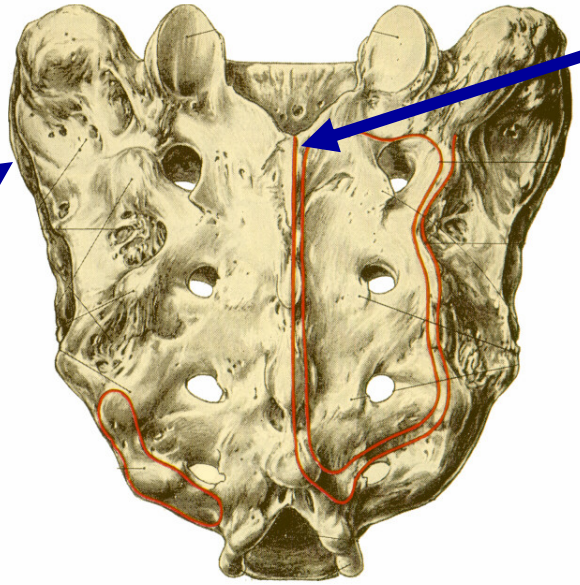
Ant. View



Lateral Mass = fused transverse processes

Anterior and Posterior Sacral foramina = Intervertebral Foramina for sacral spinal nerves

Post. View



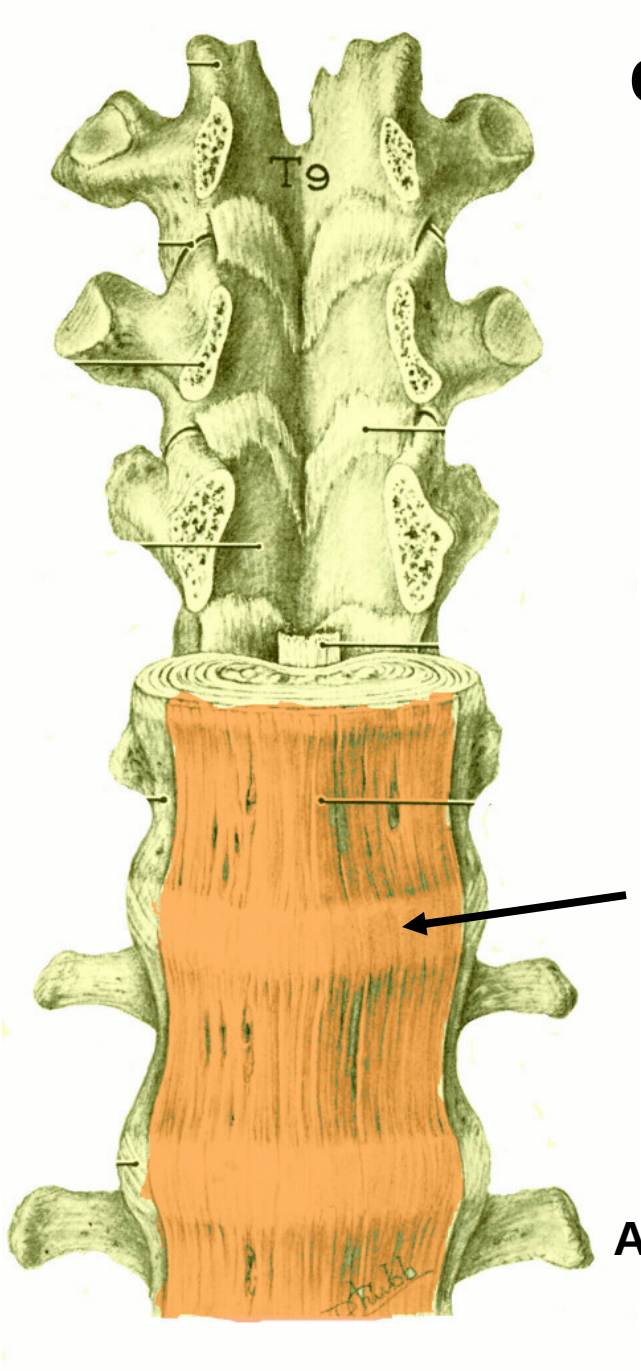
Medial Crest = fused spinous processes

Sacro-Iliac Joint

Sacro-Iliac Joint- transmits weight from vertebrae to pelvis (Innominate Bone)

COCCYX = 3-5 FUSED VERTEBRAE

RUDIMENTARY TAIL BONES



C. LIGAMENTS

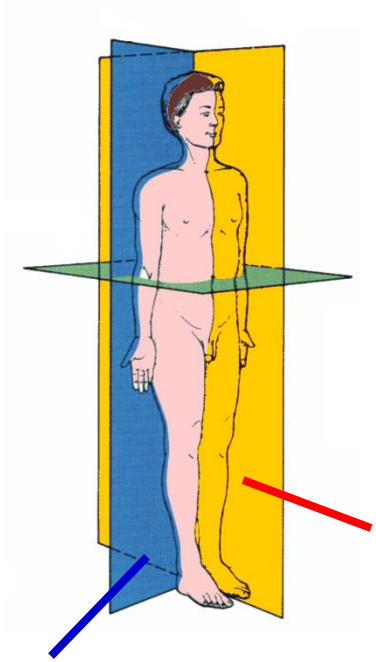
Adjacent vertebrae held tightly together (protect spinal cord)

1. ANTERIOR LONGITUDINAL LIGAMENT -

Strong band joins bodies on anterior side

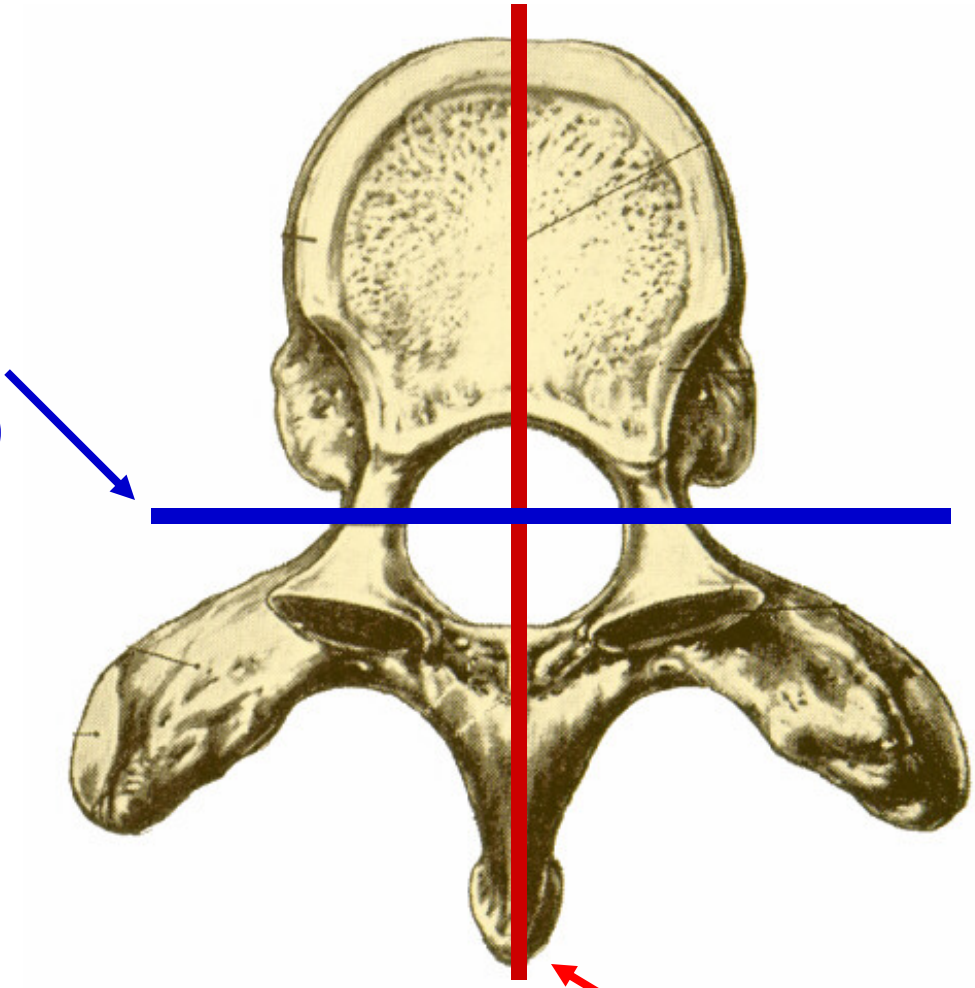
Anterior view

CORONAL SECTION - through Vertebral Canal (view ligaments as if standing in vertebral canal)



Coronal

Sagittal



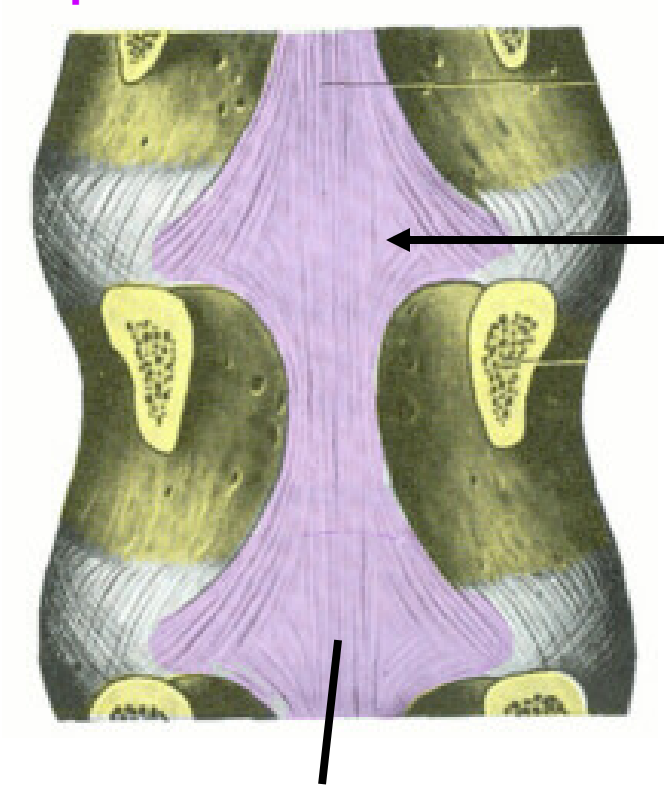
anterior

posterior

SAGITTAL SECTION
actually in median sagittal plane

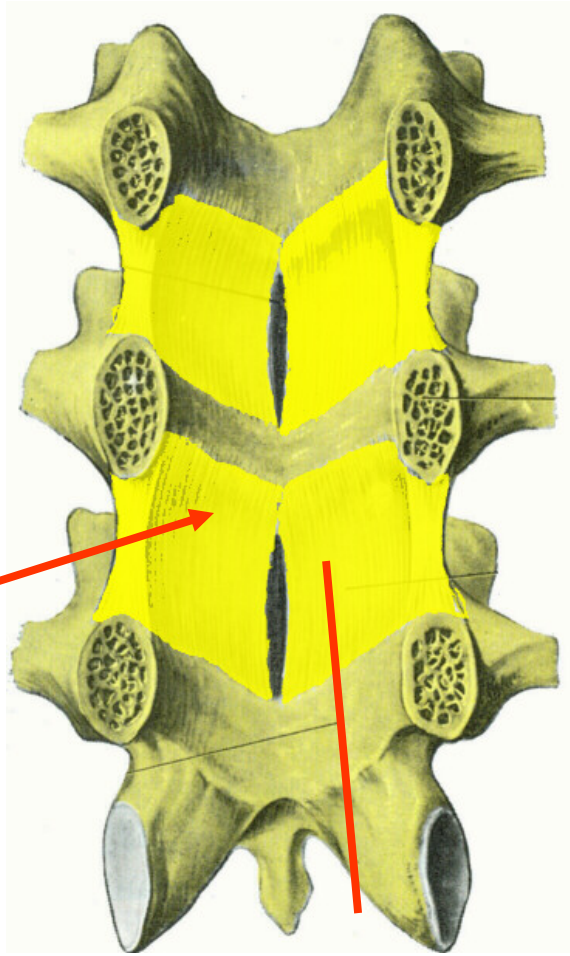
VIEW FROM INSIDE VERTEBRAL COLUMN

On post. Side of bodies



LOOK ANTERIOR

LOOK POSTERIOR

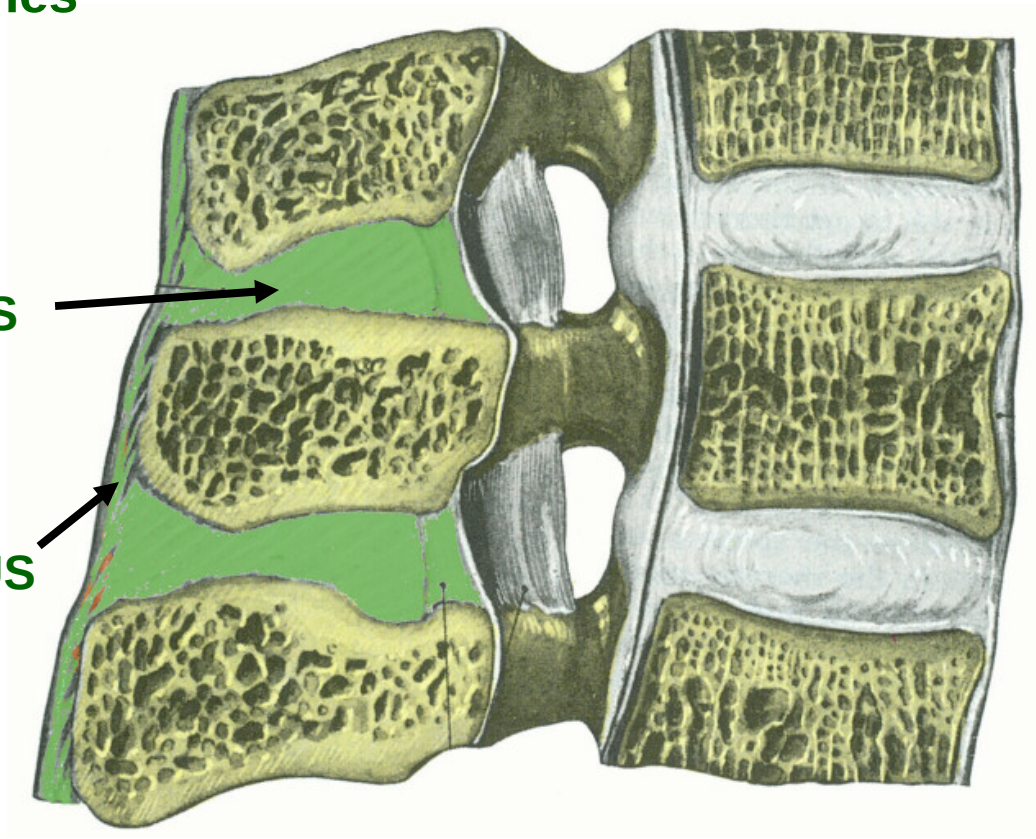


2. POSTERIOR LONGITUDINAL LIGAMENT- weaker, narrower band (inside vertebral canal)

3. LIGAMENTA FLAVA - yellow elastic bands connecting laminae

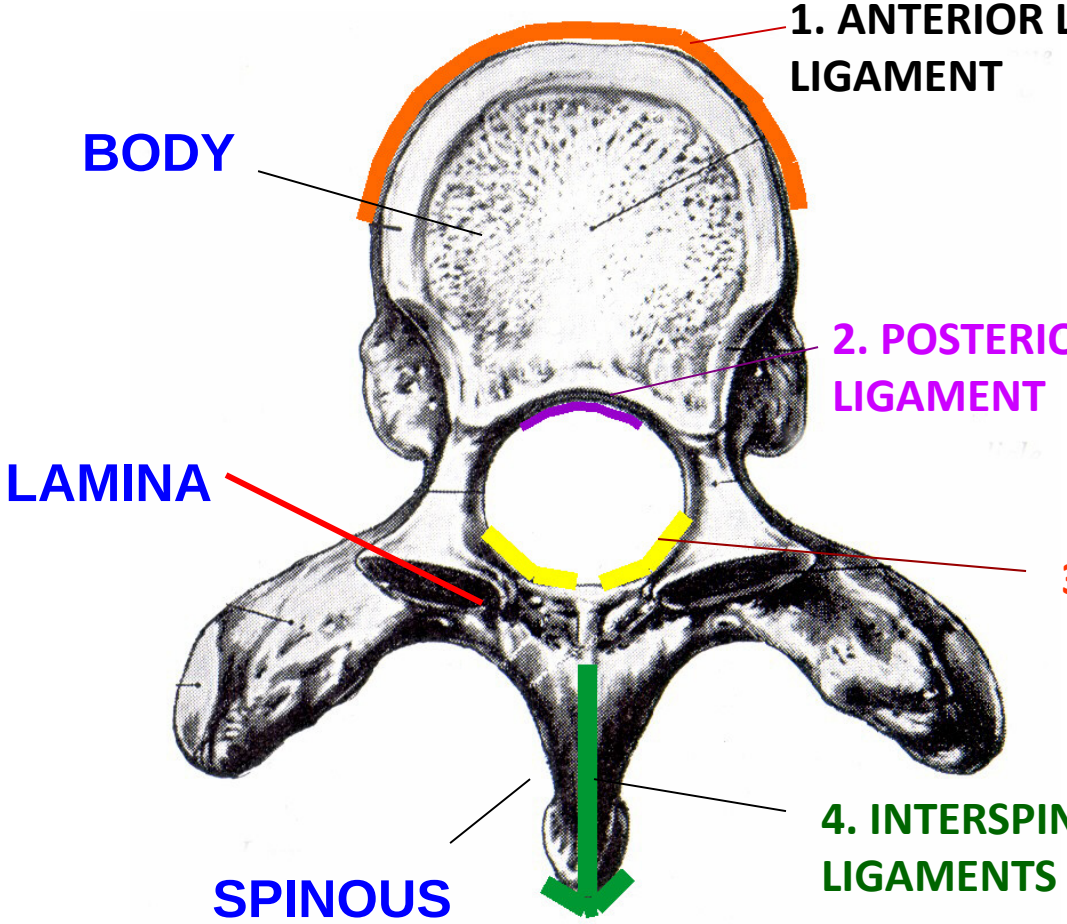
SAGITTAL SECTION

4. INTERSPINOUS AND SUPRASPINOUS LIGAMENTS - connect spines

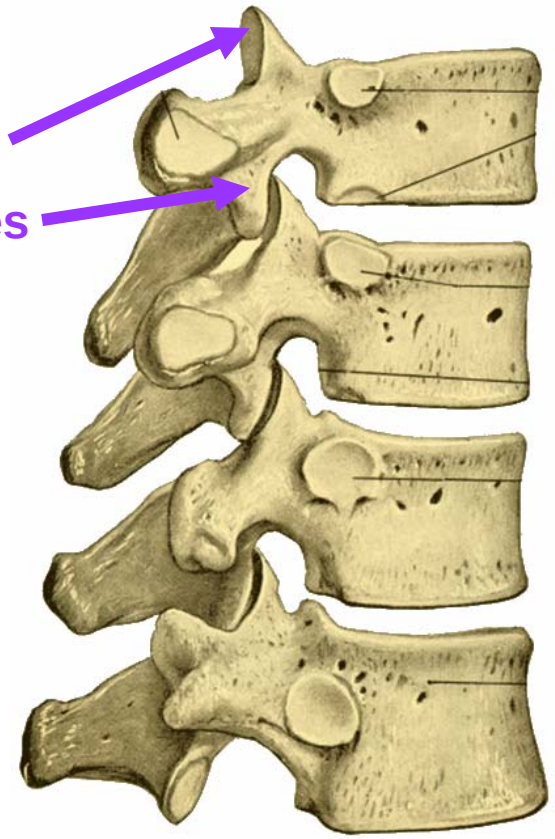


Greatly thickened in cervical region to form **LIGAMENTUM NUCHAE** - from Ext. Occip. Protuberance of skull to C7; Support Head, Provide muscle attachments

SUMMARY: LOCATION OF LIGAMENTS

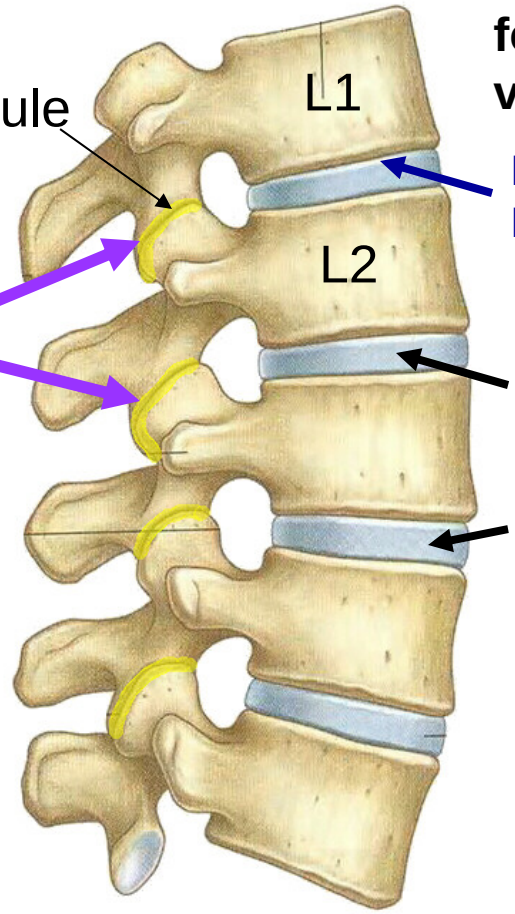


D. JOINTS BETWEEN VERTEBRAE



Articular Processes (Facets)

Joints between Articular Processes



Discs named for adjacent vertebra

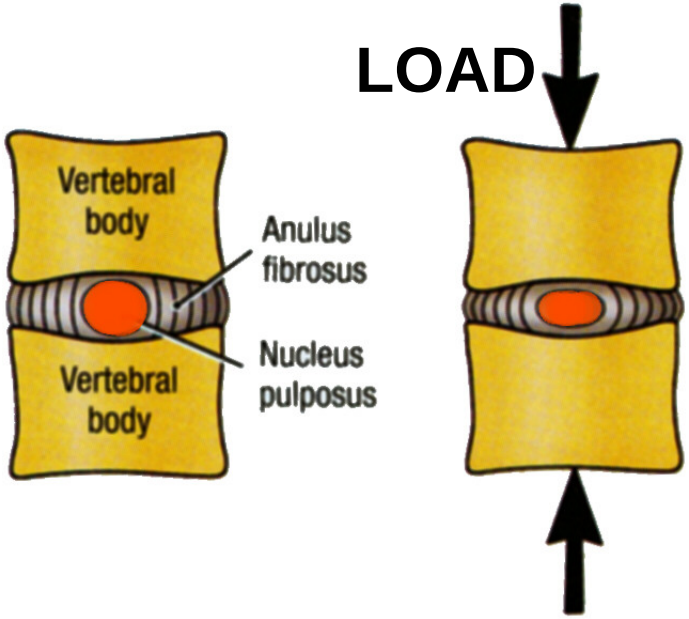
Disc between L1, L2

2. Inter-vertebral Discs - interposed between bodies

1. Joints between Articular Processes (facets) - Synovial Plane joints that permit Sliding Movements; immobilized in Facet Fusion Surgery

Note: Synovial joints have a connective tissue capsule and synovial fluid inside the capsule; synovial fluid minimizes friction and lubricates the joint

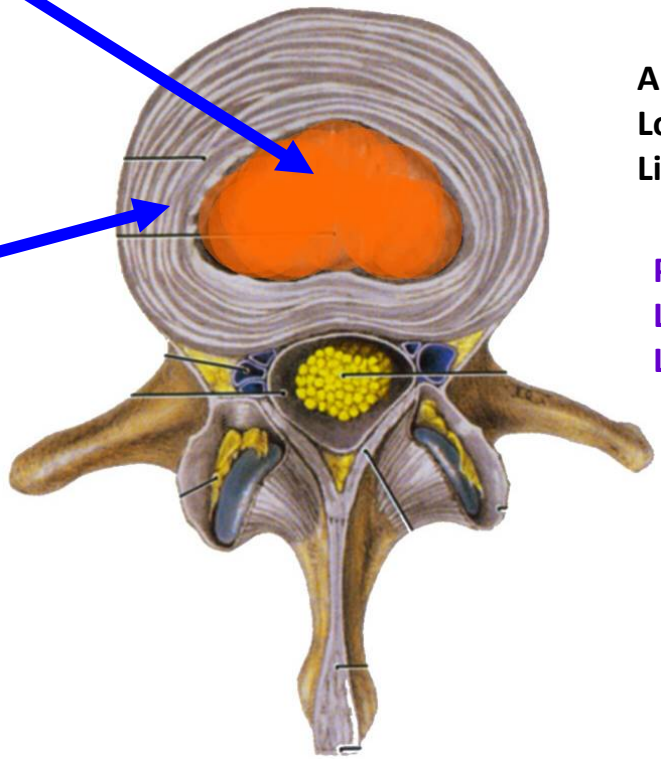
STRUCTURE/ FUNCTION OF INTERVERTEBRAL DISC

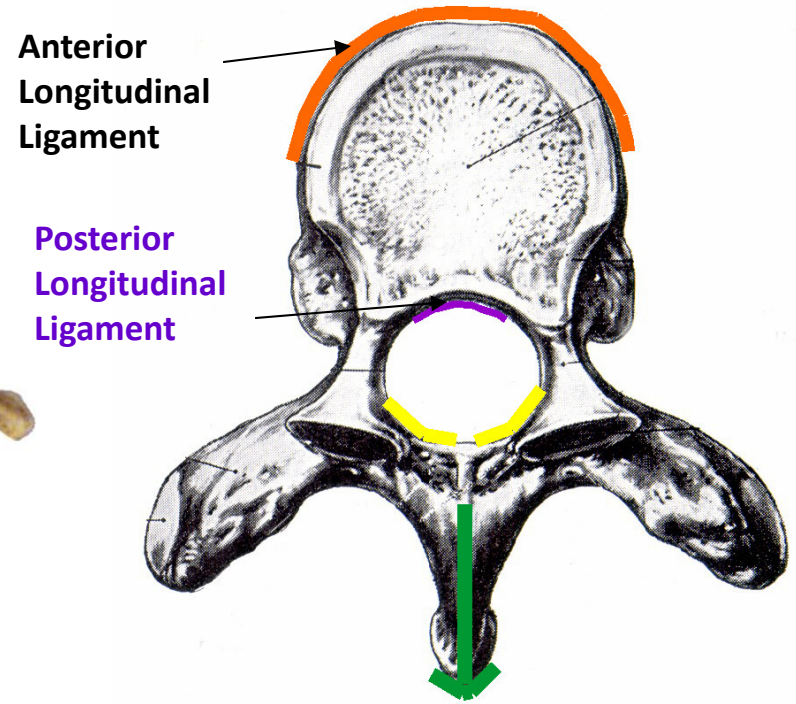


Shock absorbers; in young quite strong; trauma to vertebra produces fractures

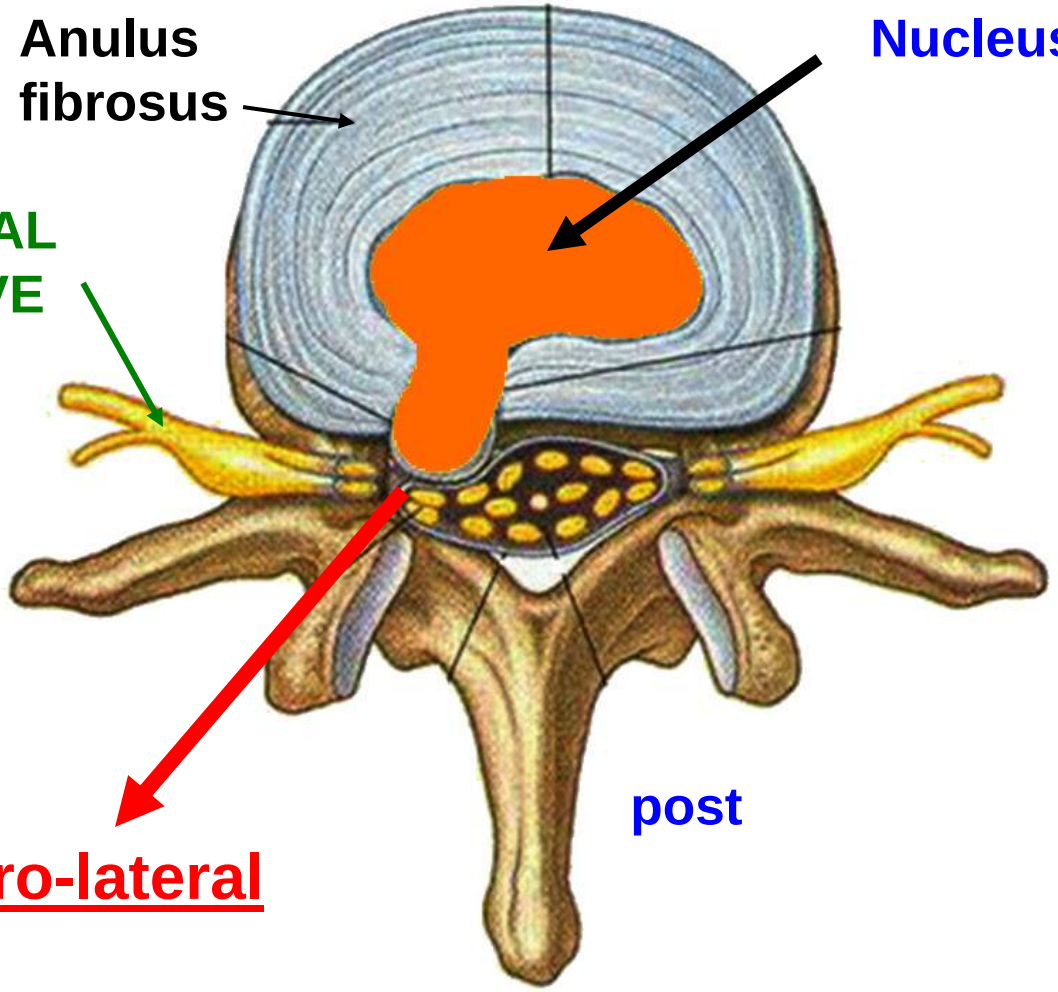
a) Nucleus pulposus- inner gelatinous core

b) Anulus fibrosus - collagen fibers and fibrocartilage





DAMAGE TO INTERVERTEBRAL DISC



In older people.

1) degenerative changes in anulus fibrosus (start in teens)

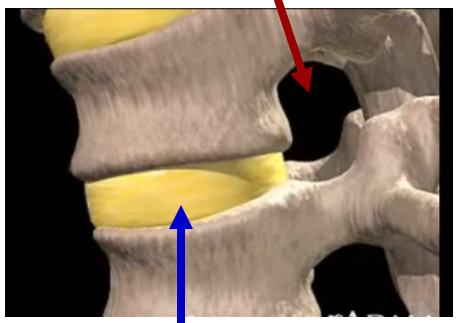
2) strain back can cause **herniation of nucleus pulposus** = 'Slipped Disc'

Clinical Note: Herniation is typically in a Postero-Lateral Direction, lateral to Posterior Longitudinal Ligament; often L4-L5 or L5-S1; can lead to nerve compression at the intervertebral foramen **

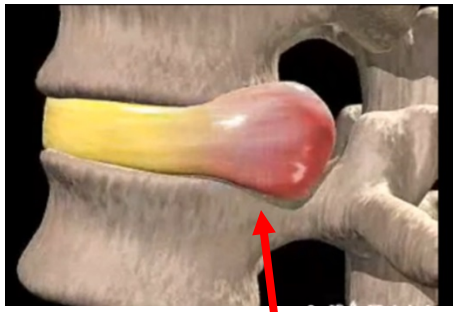
HERNIATION OF NUCLEUS PULPOSUS OF INTERVERTEBRAL DISC

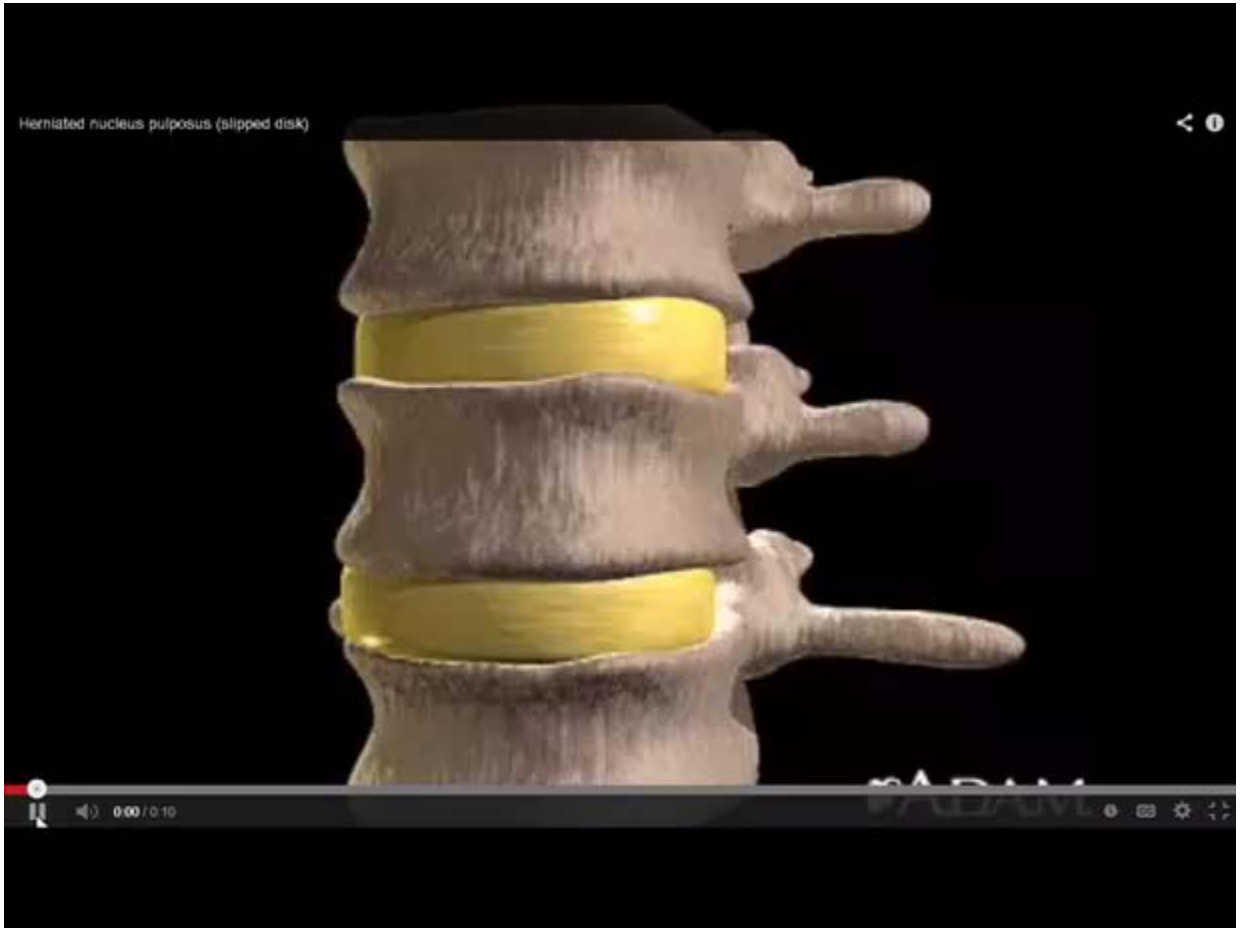
LATERAL VIEW

INTERVERTEBRAL FORAMEN



INTERVERTEBRAL DISC



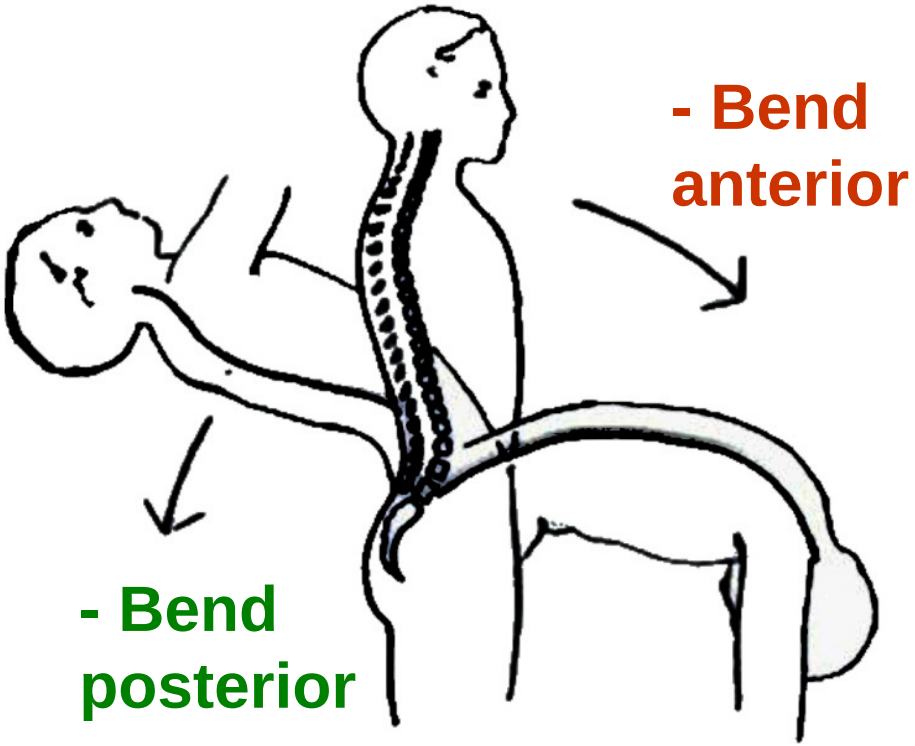


Note: Herniation = displacement of a structure from its normal position.

E. MOVEMENTS OF VERTEBRAL COLUMN

a. Extension

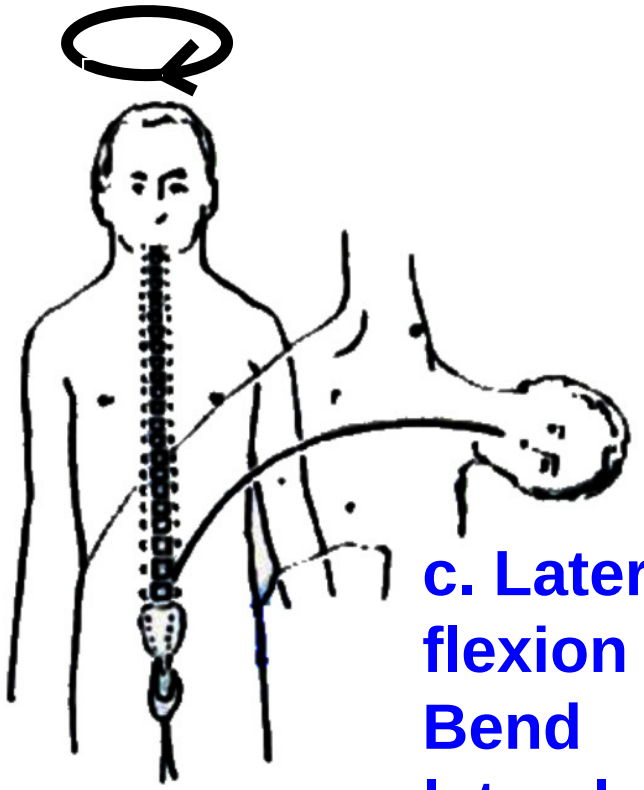
b. Flexion



- Bend anterior

- Bend posterior

d. Rotation = rotation about long axis of spinal column



c. Lateral flexion - Bend lateral

MOVEMENTS OF VERTEBRAE IN DIFFERENT REGIONS-

Determined by orientations of articular facets

a. CERVICAL (C3-C7)-

permit considerable flexion-extension, lateral flexion, rotation - useful - move head

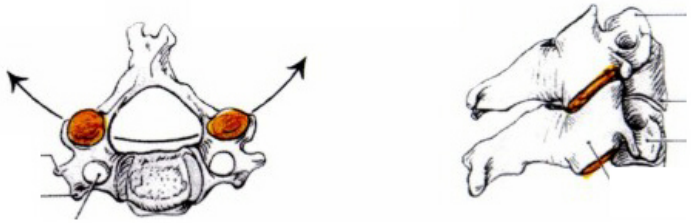
b. THORACIC

permit some rotation - little or no flex-extend (also limited by ribs); useful - no flex down on heart, lungs

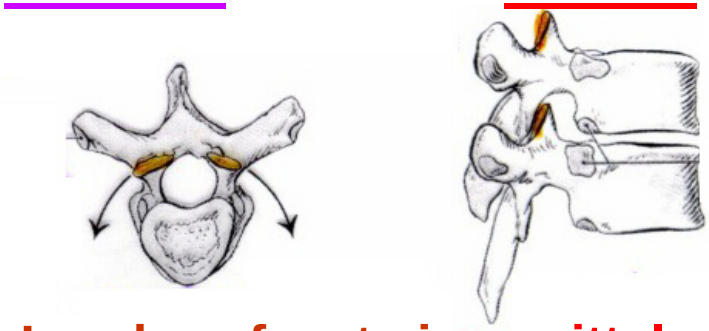
c. LUMBAR

permit flex-extend, little or no rotation; useful - tie shoes; help increase abdominal pressure; dangerous - increase load, pressure on vertebral discs

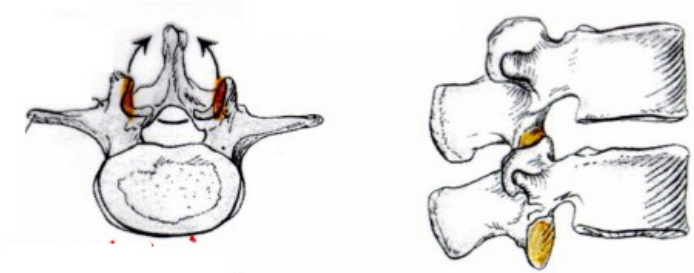
Cervical (C3-C7) - facets angled superiorly and medially



Thoracic - facets in coronal plane



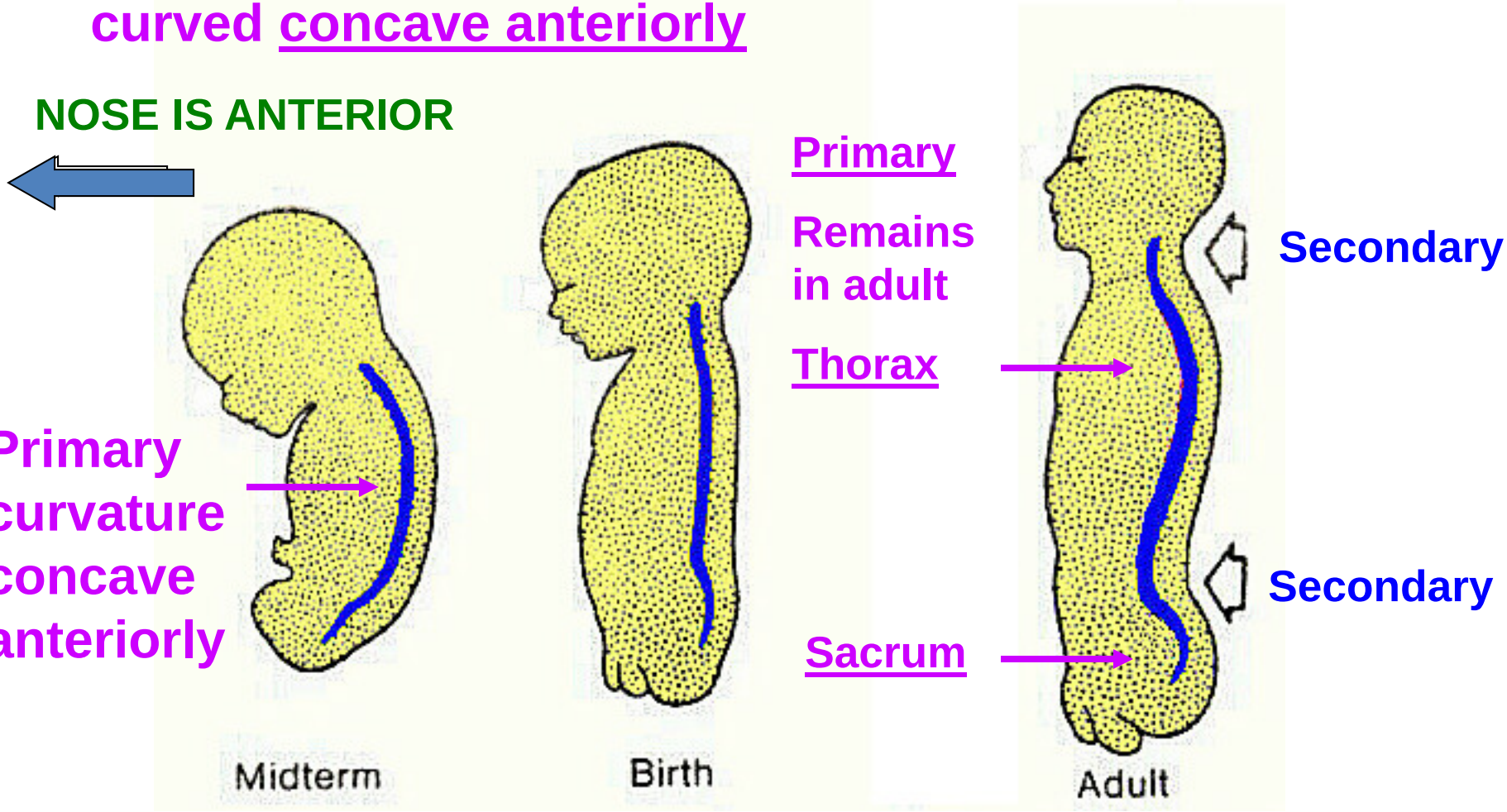
Lumbar- facets in sagittal plane



F. SPINAL CURVATURES - some normal, some abnormal

1. Normal Primary curvature - fetal position - curved concave anteriorly

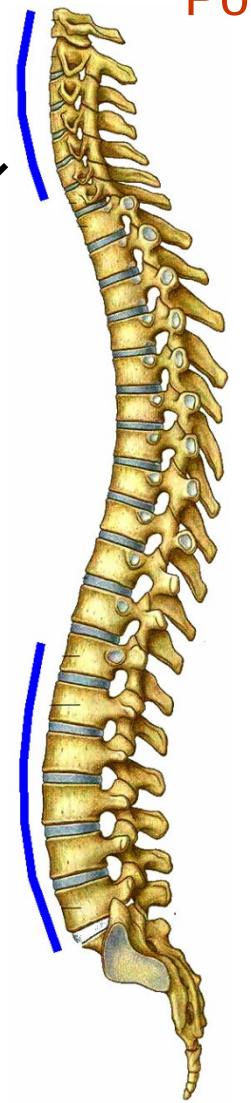
NOSE IS ANTERIOR



2. Normal Secondary Curvatures- Develop in early childhood

NOSE IS ANTERIOR

Ant Post



Cervical curvature

Lumbar curvature

a. Cervical curvature - concave posteriorly - help support head

b. Lumbar curvature
- **concave posteriorly**
- **develops with walking**
- **helps support trunk, upper body**

c. Lateral curvature - concave to side opposite handedness - helps to carry bags of money

Right handed

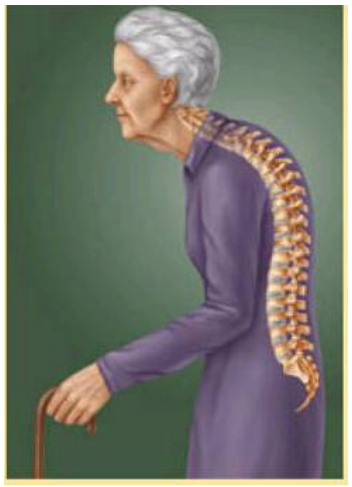
3. ABNORMAL CURVATURES

a. KYPHOSIS - 'hump' back, exaggerated curvature concave anteriorly

NORMAL

KYPHOSIS

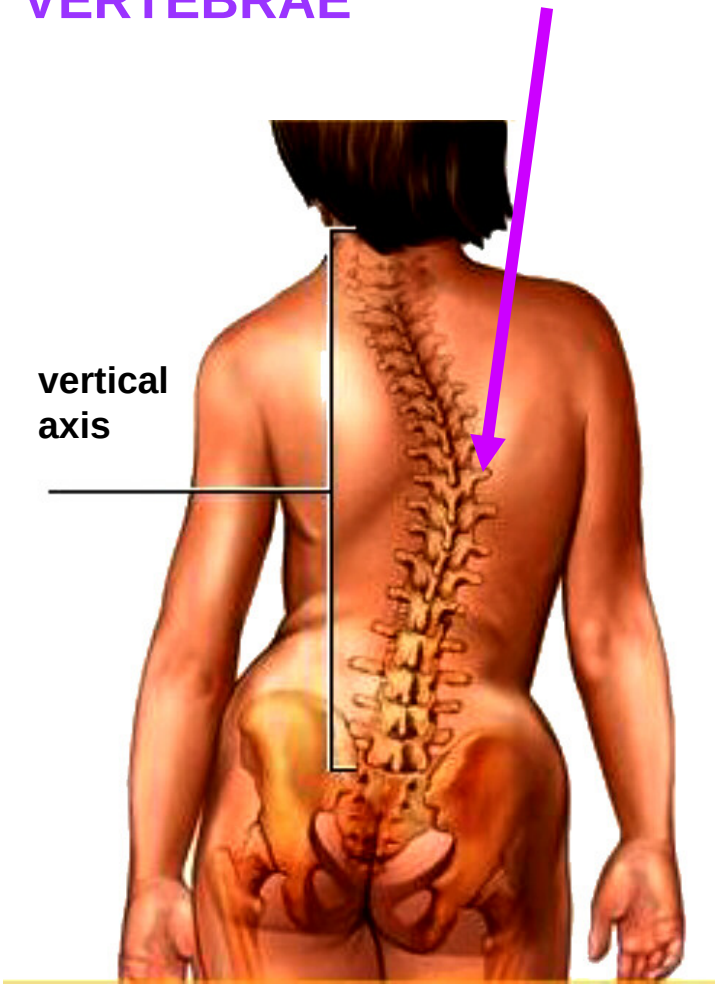
Concave anteriorly



Usually in thorax of elderly

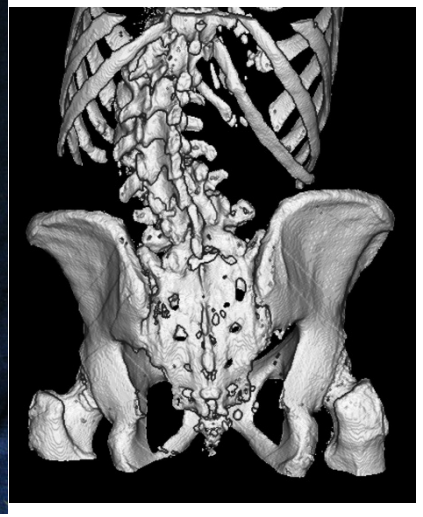
b. SCOLIOSIS - abnormal lateral curvature ('kink' in spine)

SCOLIOSIS OF THORACIC VERTEBRAE

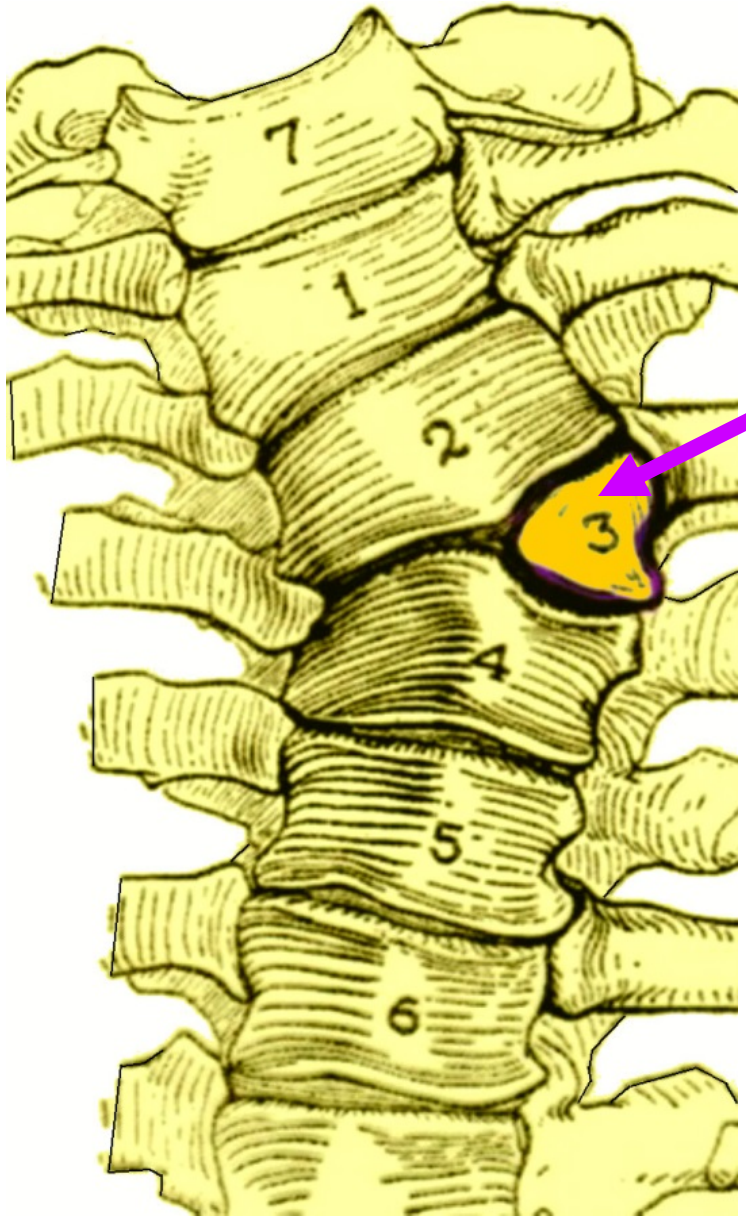


PROSECTION IN GROSS LAB: SCOLIOSIS OF LUMBAR VERTEBRAE

Skeleton reconstructed from CT of cadaver

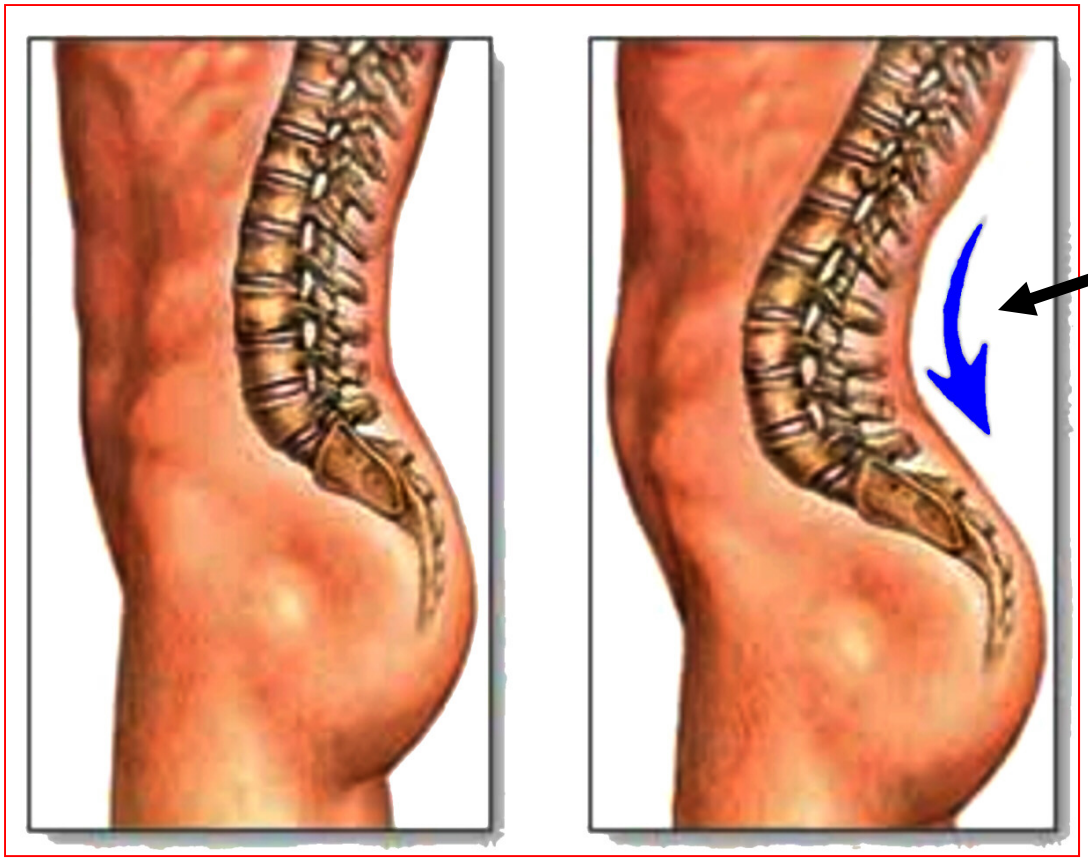


SCOLIOSIS- can be due to **'presence of hemivertebra' -** one half of a vertebra fails to develop



HEMI-VERTEBRA

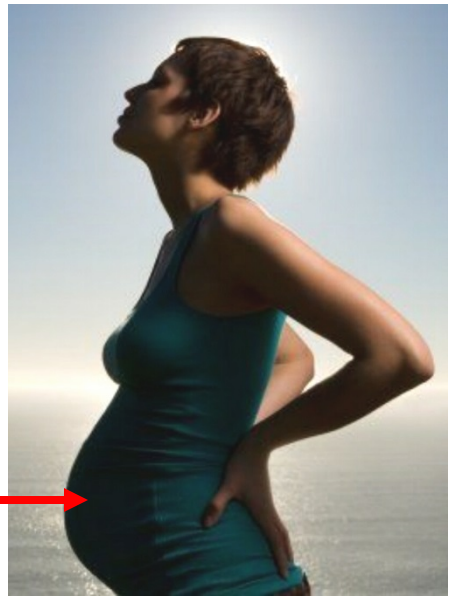
ABNORMAL CURVATURE - LORDOSIS



c. LORDOSIS =
exaggerated lumbar curvature

Concave posteriorly

NORMAL IN PREGNANCY



ABNORMAL CAUSE - OBESITY

center of mass shifts anteriorly

3 SUMMARY CHARTS - CURVATURES, VERTEBRAE, LIGAMENTS

SUMMARY OF SPINAL CURVATURES

	Curvature	Location (Most common)	Cause/Function
Normal			
Primary	Concave Anterior	All of vertebral column; retained in Thoracic, Sacral Regions	
Secondary	Concave Posterior	Cervical, Lumbar Regions	Cervical (hold up head), Lumbar (support body)
Lateral	Concave away from side of handedness	Cervical, Lumbar mainly	Aid in lifting heavy objects (shift center of gravity)
Abnormal			
Kyphosis	Exaggerated Concave Anterior	Often in Thoracic Region	Osteoporosis, etc.
Scoliosis	Exaggerated Lateral	Thoracic, Lumbar most common	Hemivertebra (half of vertebral body does not form)
Lordosis	Exaggerate Concave Posterior	Lumbar (normal in pregnancy)	Obesity

**

SUMMARY OF FEATURES OF VERTEBRAE

Vertebra	#	Features	Articular Process Oriented	Movements
Cervical	7	Bodies small, Foramina transversaria (small in C7) C1 = Atlas - no body C2 = Axis - dens C7 = Vertebra prominens	Slanted (Superiorly and Medially)	Flex-Extend, Lateral Flex, Rotate
Thoracic	12	Facets for ribs on bodies (heads of ribs), transverse processes (articular tubercles of ribs)	Coronal plane	No Flex-Extend, Small Rotate
Lumbar	5	Large bodies	Sagittal plane	Flex-Extend, No Rotate
Sacral	5	Fused		Normally no movement
Coccygeal	3-5	Fused, rudimentary		No movement