SKELETAL SYSTEM

BY BINALFEW TSEHAY

Layout

- Overview of functional anatomy of musculoskeletal system
- Skeletal system
  - Axial Skeleton
    - CRANIUM
      - Facial Aspect of Cranium
      - Lateral Aspect of Cranium
      - Occipital Aspect of Cranium
      - Superior Aspect of Cranium
      - External Surface of Cranial Base
      - Internal Surface of Cranial Base
      - Walls of Cranial Cavity
    - OVERVIEW VERTEBRAL COLUMN and VERTEBRAE
      - Structure and Function of Vertebrae
      - Regional Characteristics of Vertebrae
      - Joints of Vertebral Column
      - Movements of Vertebral Column
      - Curvatures of Vertebral Column
      - Vasculature of Vertebral Column
    - Skeleton of Thoracic Wall
      - Joints of Thoracic Wall
      - Movements of Thoracic Wall

Appendicular skeleton

- BONES OF UPPER LIMB
  - Pectoral girdle
  - Free extremity
- JOINTS OF UPPER LIMB
- BONES OF LOWER LIMB
  - Pelvic girdle
  - Free lower extremity
- JOINTS OF LOWER LIMB

Functional anatomy of the musculoskeletal system

- Made up of the bony skeleton, contractile and non contractile soft tissues including muscles, tendons, ligaments, joint capsules articular cartilages and non articular cartilages.
- The musculoskeletal system is essentially a mechanical system, designed to support, protect and move the body, and capable of adapting to changing mechanical demands.

Cont.

- Their specific configuration varies with the anatomical sites by virtue of the type of loads these tissue experience and the movements that they are required to perform.
- As such, while the musculoskeletal system is governed by a set of underlying principles, there is a great deal of local variance throughout.
- This is why treatments for musculoskeletal injury and disease are divided into regions such as craniomaxillofacial, oral, shoulder, and elbow, hand. Etc

Cont.

- A special characteristic of muscle, tendons and joints is the possession of a rich sensory nerve supply, which detects the position of the body and the velocity of movement.

- The main functional attribute of bone is its specialized extracellular matrix, which is hardened by the deposition of calcium enabling it to function as a rigid lever.

Cont.

- As result of its location and function the musculoskeletal system commonly sustains traumatic injuries and degenerative changes.
- The impairments that develop from injury or disease can significantly affect an individuals ability to remain functional without further pathologic compromise.

Skeletal system

- The skeletal system consists of the specialized supporting connective tissues of:
  - The bony skeleton
  - Associated tissues of joints,
  - Cartilage

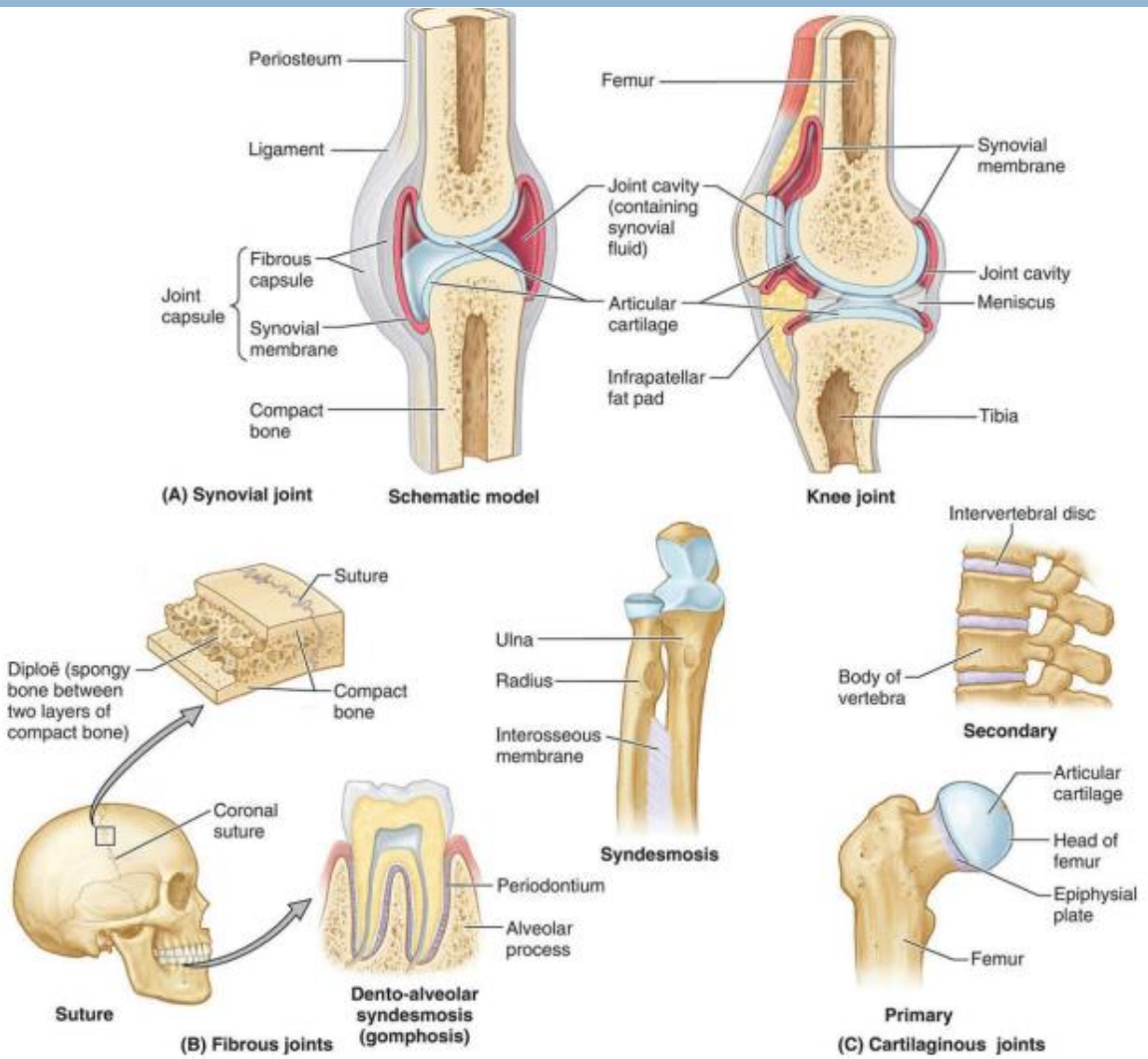
Cartilage

- Is a resilient, semirigid form of connective tissue that forms parts of the skeleton where more flexibility is required.
- It is *avascular*
- It has a capacity for continued and often **rapid interstitial and appositional growth**, and a high resistance to tension, compression and shearing, with some resilience and elasticity.
- Cartilage is covered by a fibrous perichondrium except at its junctions with bone and at synovial surfaces, which are lubricated by a secreted nutrient synovial fluid.
- The younger a person is, the more cartilage he or she has.

Types

- As a consequence of various functional requirements, three forms of cartilage have evolved, each exhibiting variations in matrix composition.
  - **Hyaline cartilage:** the most common form
  - **Elastic cartilage:** The more pliable and distensible; possesses collagen type II, an abundance of elastic fibers within its matrix.
  - **Fibrocartilage,** present in regions of the body subjected to pulling forces, is characterized by a matrix containing a dense network of coarse type I collagen fibers.

Joints



- Bones of the skeleton are connected with each other at joints
- Classification
  - According to the tissues that lie between the articulating structures
  - Based on level of movement

Stability of Joints

- The stability of a joint depends on three main factors:
  - The shape, size, and arrangement of the articular surfaces;
  - The ligaments;
  - and the tone of the muscles around the joint.

Bone

- A living tissue, is a highly specialized, hard form of connective tissue that makes up most of the skeleton.
- Bones of the adult skeleton provide
  - Support for the body and its vital cavities; it is the chief supporting tissue of the body.
  - Protection for vital structures (e.g., the heart).
  - The mechanical basis for movement (leverage).
  - Storage for salts (e.g., calcium).
  - A continuous supply of new blood cells (produced by the marrow in the medullary cavity of many bones).

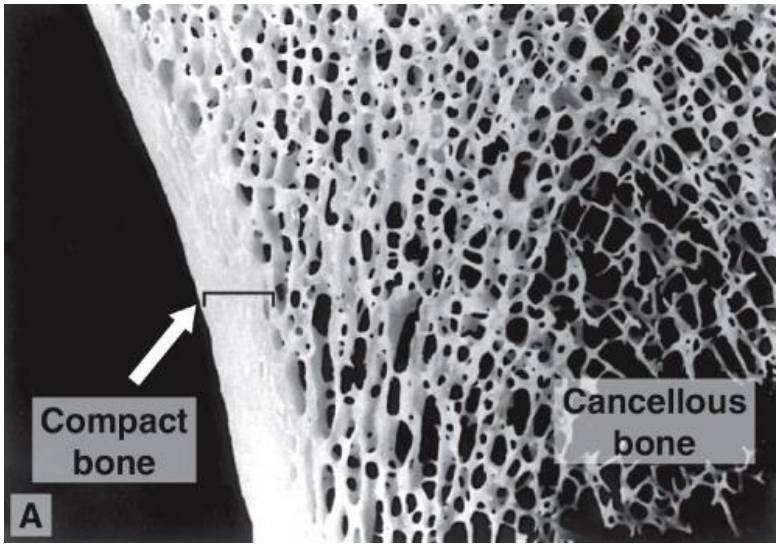
Cont.

- Bones are living organs that
  - Cause pain when injured,
  - Bleed when fractured,
  - Remodel in relationship to stresses placed on them,
  - Change with age.
  - *Atrophy* (decrease in size).
  - Absorbed,
  - *Hypertrophy*

Classification of Bones

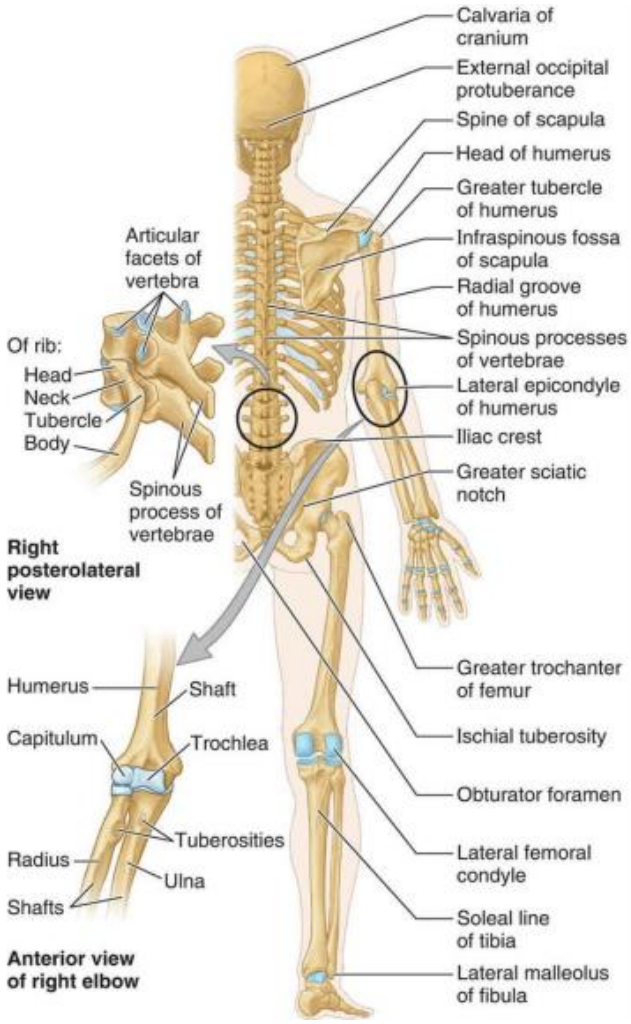
- Bones are classified according to their shape.
  - **Long bones**
  - **Short bones**
  - **Flat bones**
  - **Irregular bones**
  - **Sesamoid bones**

- Based on microscopic structure
  - Compact
  - Spongy



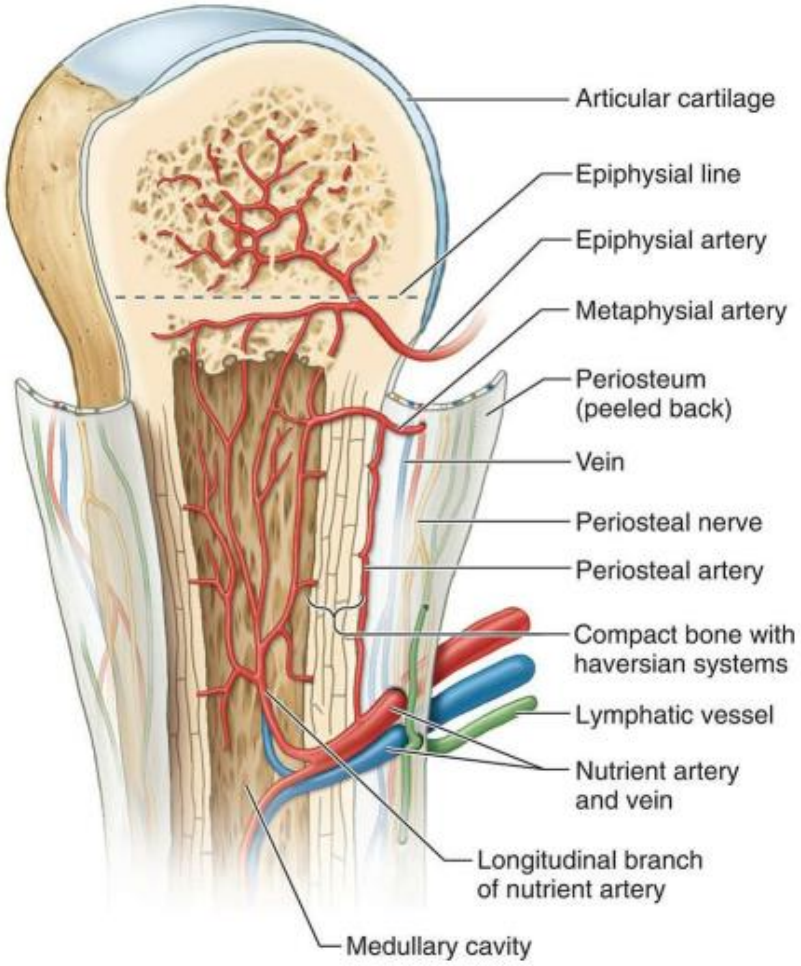
Bone Markings and Formations

- **Bone markings** appear wherever
  - tendons, ligaments, and fascias are attached or
  - where arteries lie adjacent to or enter bones.
- Other formations occur
  - In relation to the passage of a tendon
    - (to direct the tendon or improve its leverage) or
    - To control the type of movement occurring at a joint.



Vasculature and Innervation of Bones

- Bones are richly supplied with blood vessels.
- Most apparent are the **nutrient arteries** (one or more per bone) that arise as independent branches of adjacent arteries outside the periosteum and pass obliquely through the compact bone of the shaft of a long bone via **nutrient foramina**.
- The nutrient artery divides in the medullary cavity into longitudinal branches that proceed toward each end, supplying the bone marrow, spongy bone, and deeper portions of the compact bone



Cont.

- However, many small branches from the periosteal arteries of the periosteum are responsible for nourishment of most of the compact bone.
- Consequently, a bone from which the periosteum has been removed dies.

Cont.

- Veins accompany arteries through the nutrient foramina.
- Many large veins also leave through foramina near the articular ends of the bones.
- Bones containing red bone marrow have numerous large veins. Why?
- Lymphatic vessels are also abundant in the periosteum.

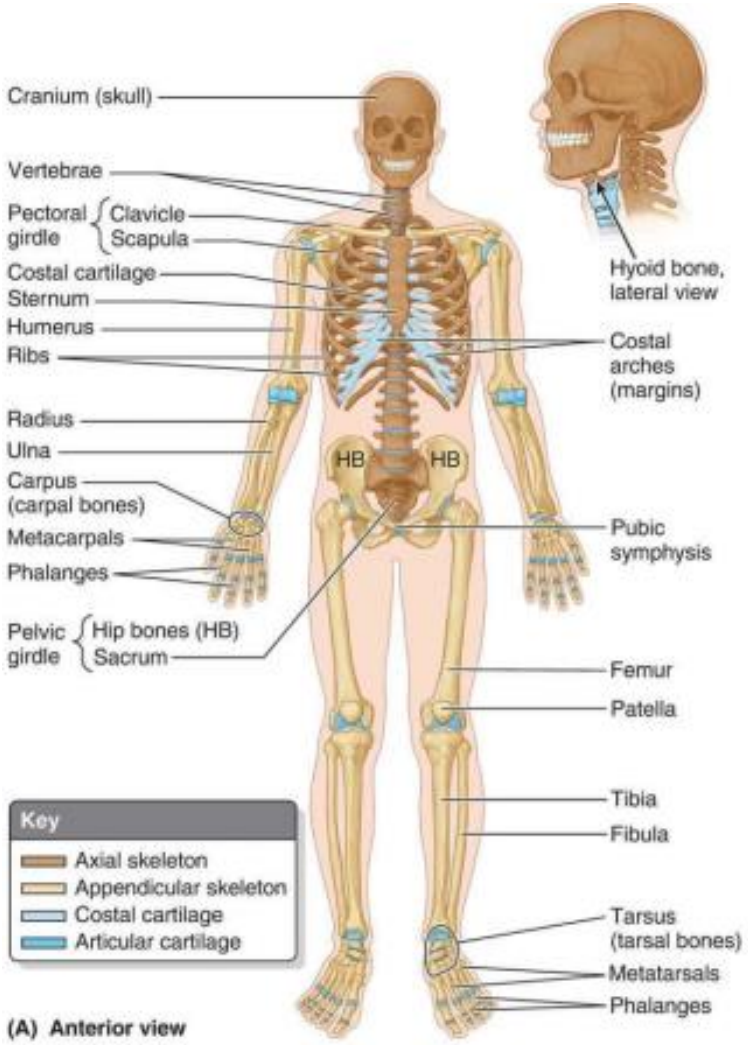
Cont.

- Nerves accompany blood vessels supplying bones.
- The periosteum is richly supplied with sensory nerves—**periosteal nerves**—that carry pain fibers.
- The periosteum is especially sensitive to tearing or tension, which explains the acute pain from bone fractures.
- **Bone itself is relatively sparsely supplied with sensory endings.**
- Within bones, **vasomotor nerves** cause constriction or dilation of blood vessels, regulating blood flow through the bone marrow.

CLINICAL BOX

- **Accessory (Supernumerary) Bones** can be mistaken as fractured bones
  - Wormian bones, foot
- **Heterotopic Bones,** Bones sometimes form in soft tissues where they are not normally present
- **Osteoporosis,** the organic and inorganic components of bone both decrease
- **Sternal Puncture**
- **Bone Growth and Assessment of Bone Age**
  - Knowledge of the sites where ossification centers occur, the times of their appearance, the rates at which they grow, and the times of fusion of the sites (times when synostosis occurs) is important in clinical medicine, forensic science, and anthropology.
  - A general index of growth during infancy, childhood, and adolescence is indicated by *bone age*, as determined from radiographs, usually of the hands

Functional parts of skeletal system



The skeletal system may be divided into two functional parts

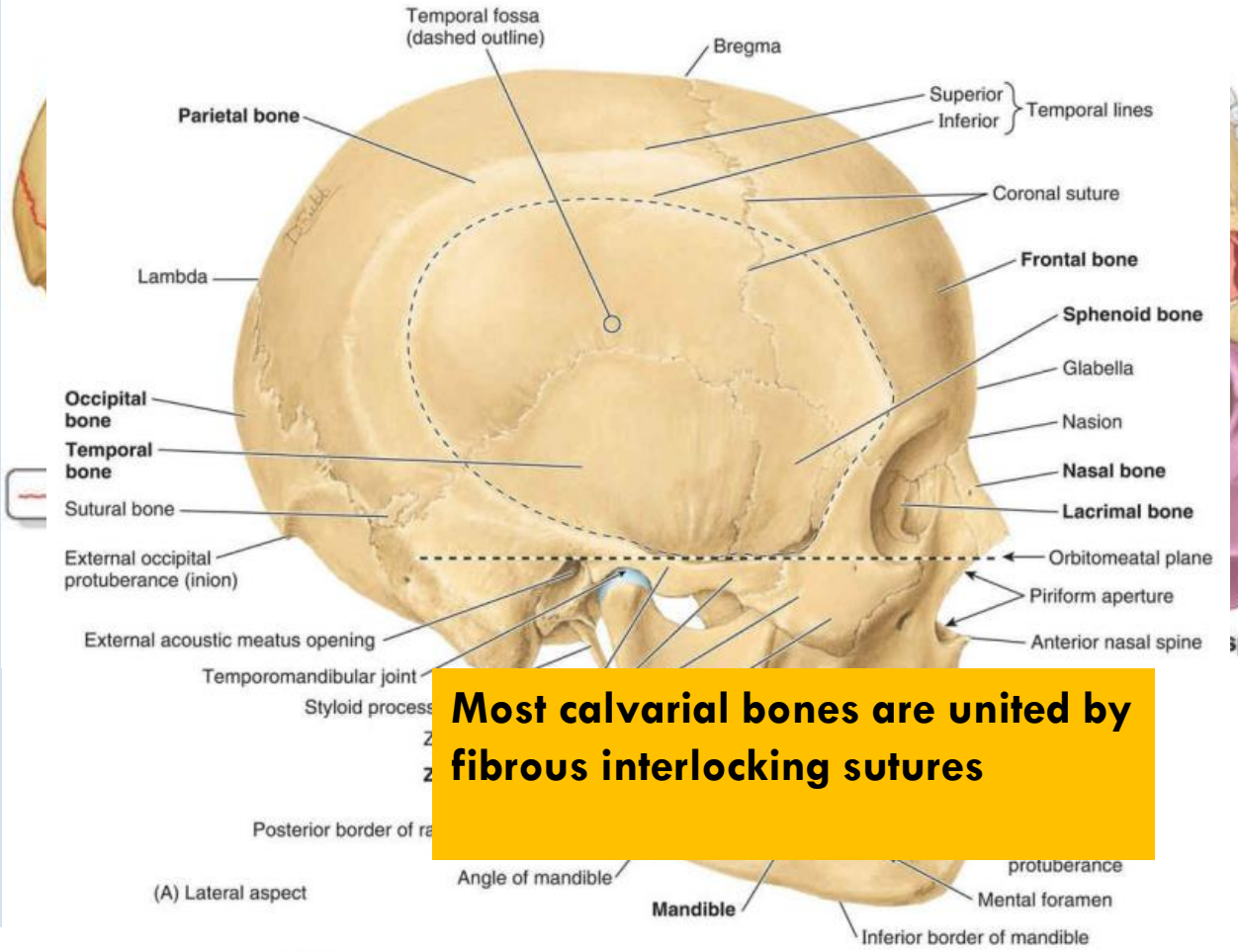
- The **axial skeleton** consists of the bones of the head (*cranium* or skull), neck (*hyoid bone* and *cervical vertebrae*), and trunk (*ribs, sternum, vertebrae*, and *sacrum*).
- The **appendicular skeleton** consists of the bones of the limbs, including those forming the pectoral (shoulder) and pelvic girdles.

The Skull vs Cranium???

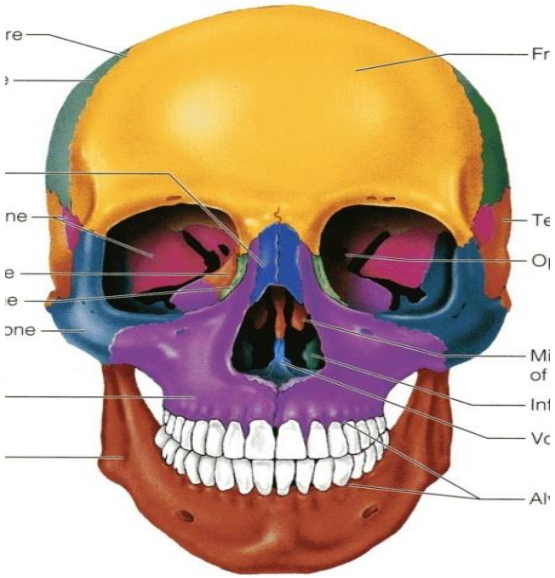
- There is confusion about exactly what the term skull means.
- It may mean the cranium (which includes the mandible) or the part of the cranium excluding the mandible.
- There has also been confusion because some people have used the term cranium for only the neurocranium.
- The Federative International Committee on Anatomical Terminology (FICAT) has decided to follow the Latin term cranium for the skeleton of the head.

Divisions of Skull

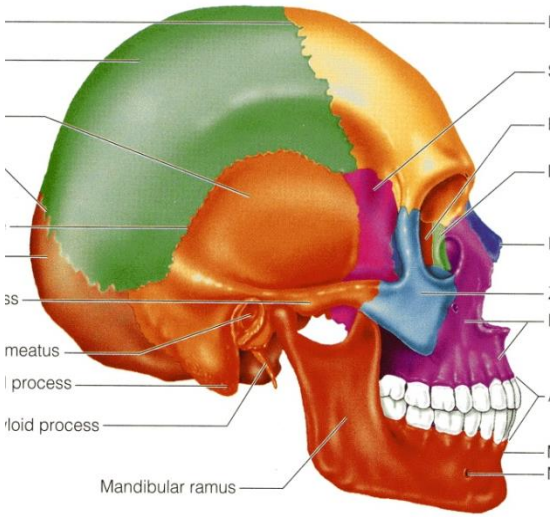
- The skull (Cranium) functionally can be divided into:
  - 1- Neurocranium
    - 1- Upper part the Vault (Calvaria or skull cap)
    - 2- Lower part called the base of the skull (basicranium).
    - 2- Viscerocranium (Facial Skeleton)



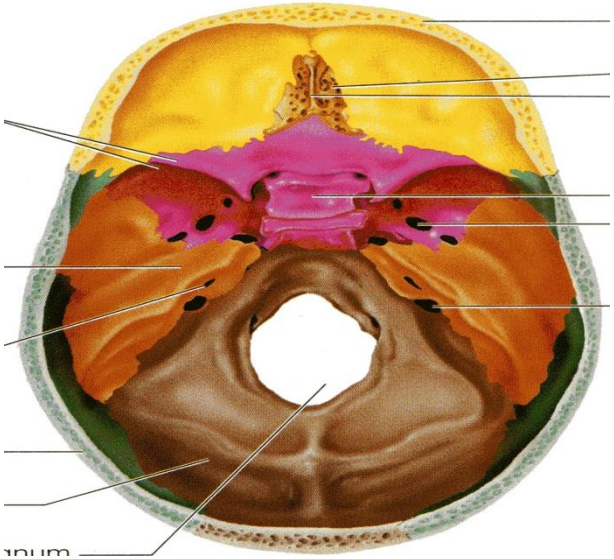
Most calvarial bones are united by fibrous interlocking sutures



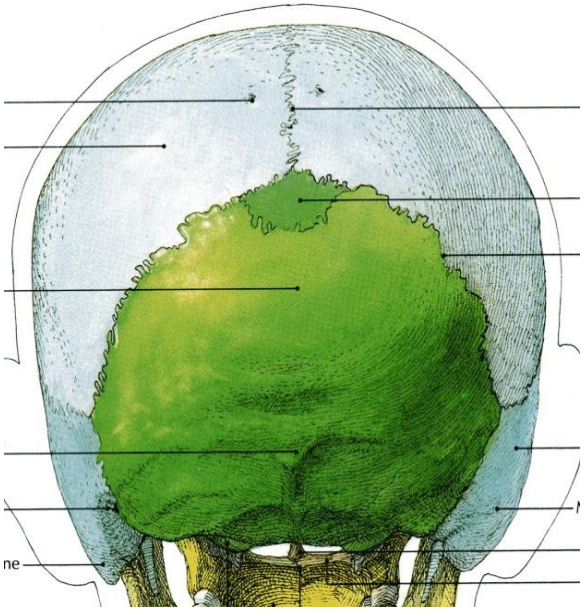
Norma frontalis



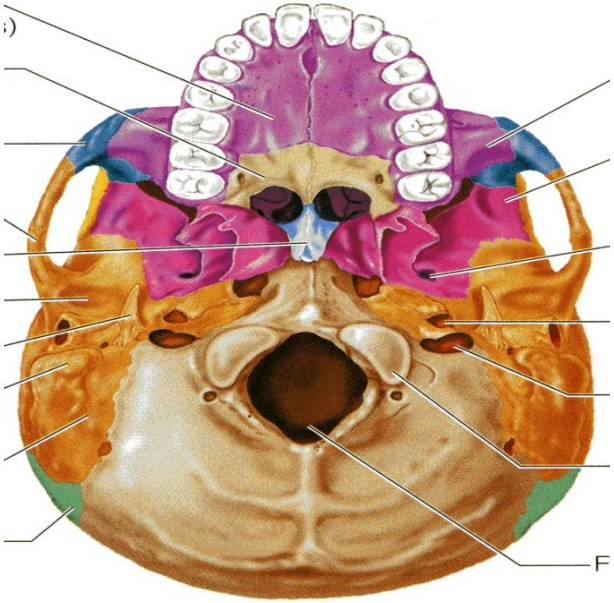
Norma Lateralis



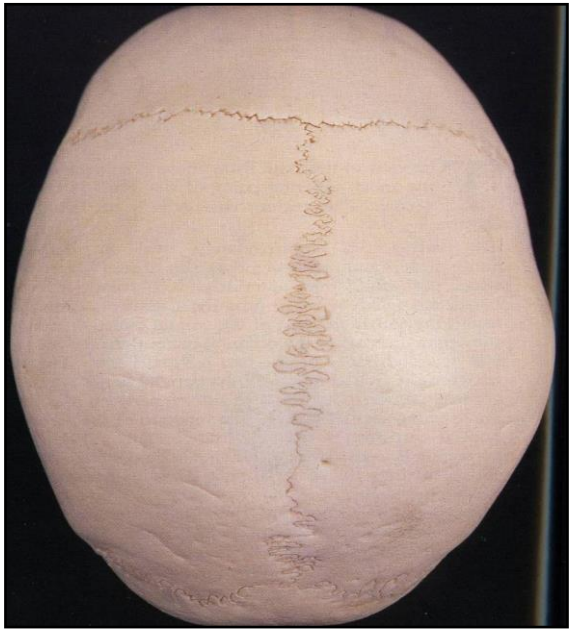
Basalis Interna



Norma occipitalis



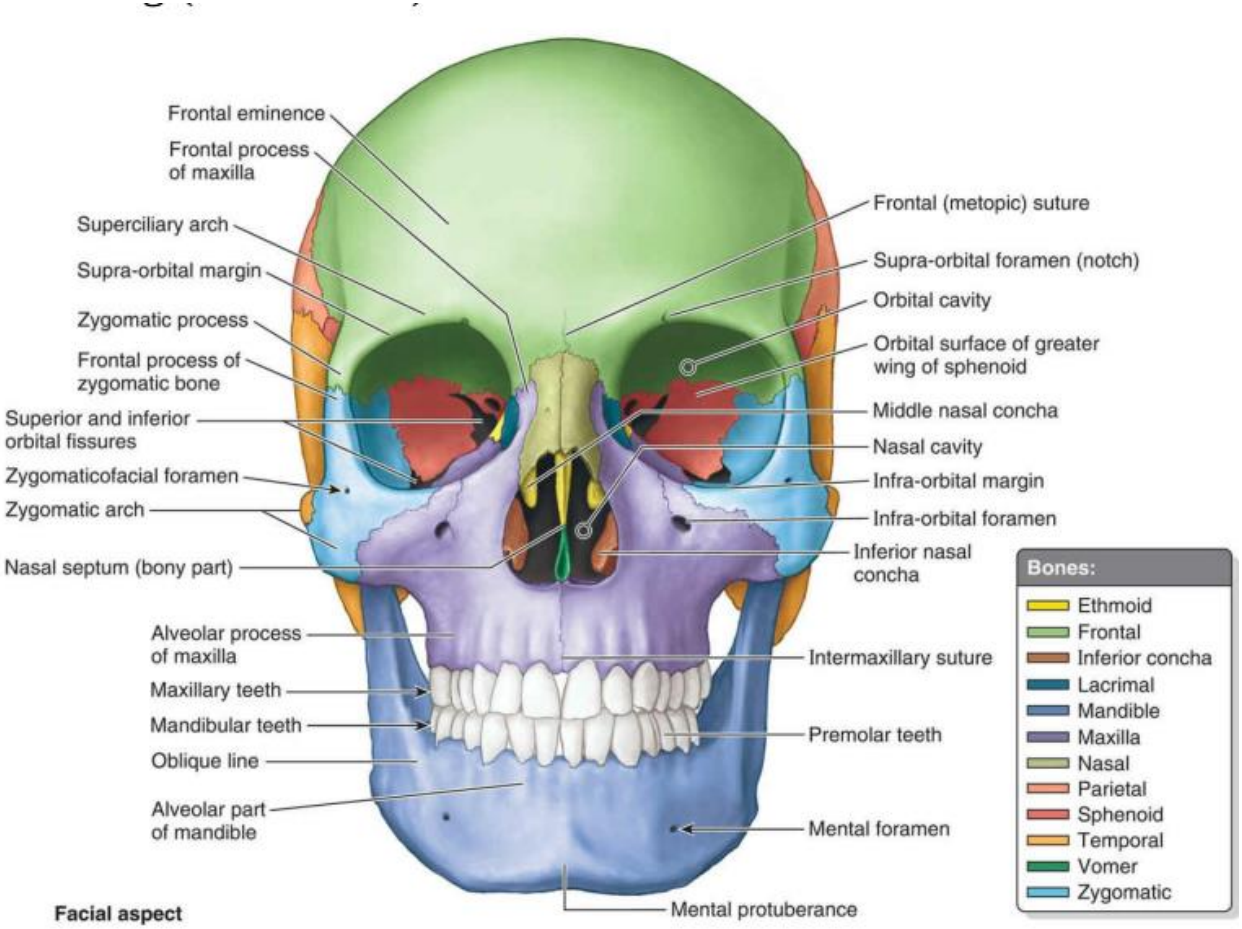
Basalis Externa



Norma Verticalis

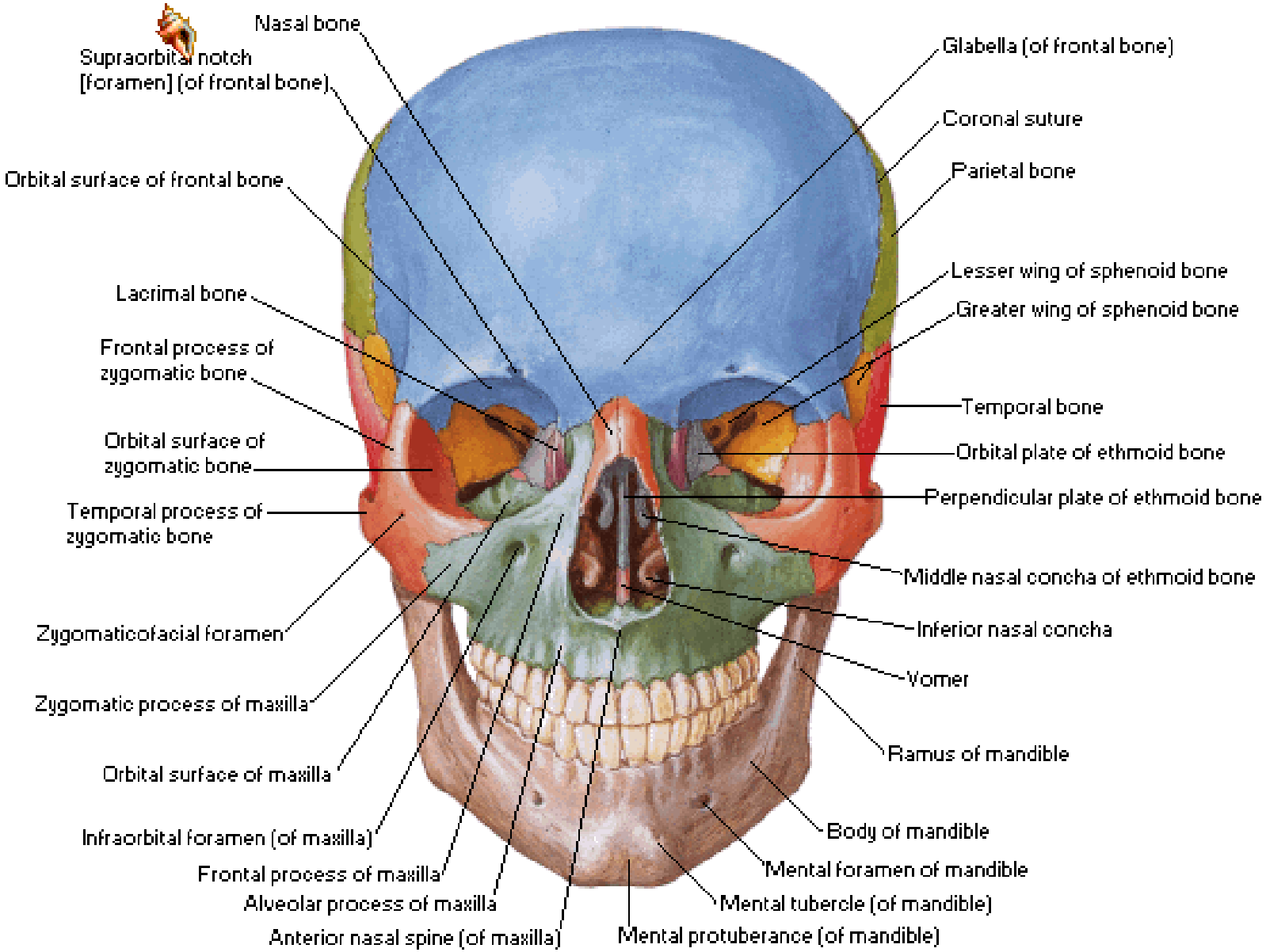
Facial Aspect of the Cranium

- Features of the anterior or facial (frontal) aspect of the cranium are the *frontal and zygomatic bones, orbits, nasal region, maxillae, and mandible.*



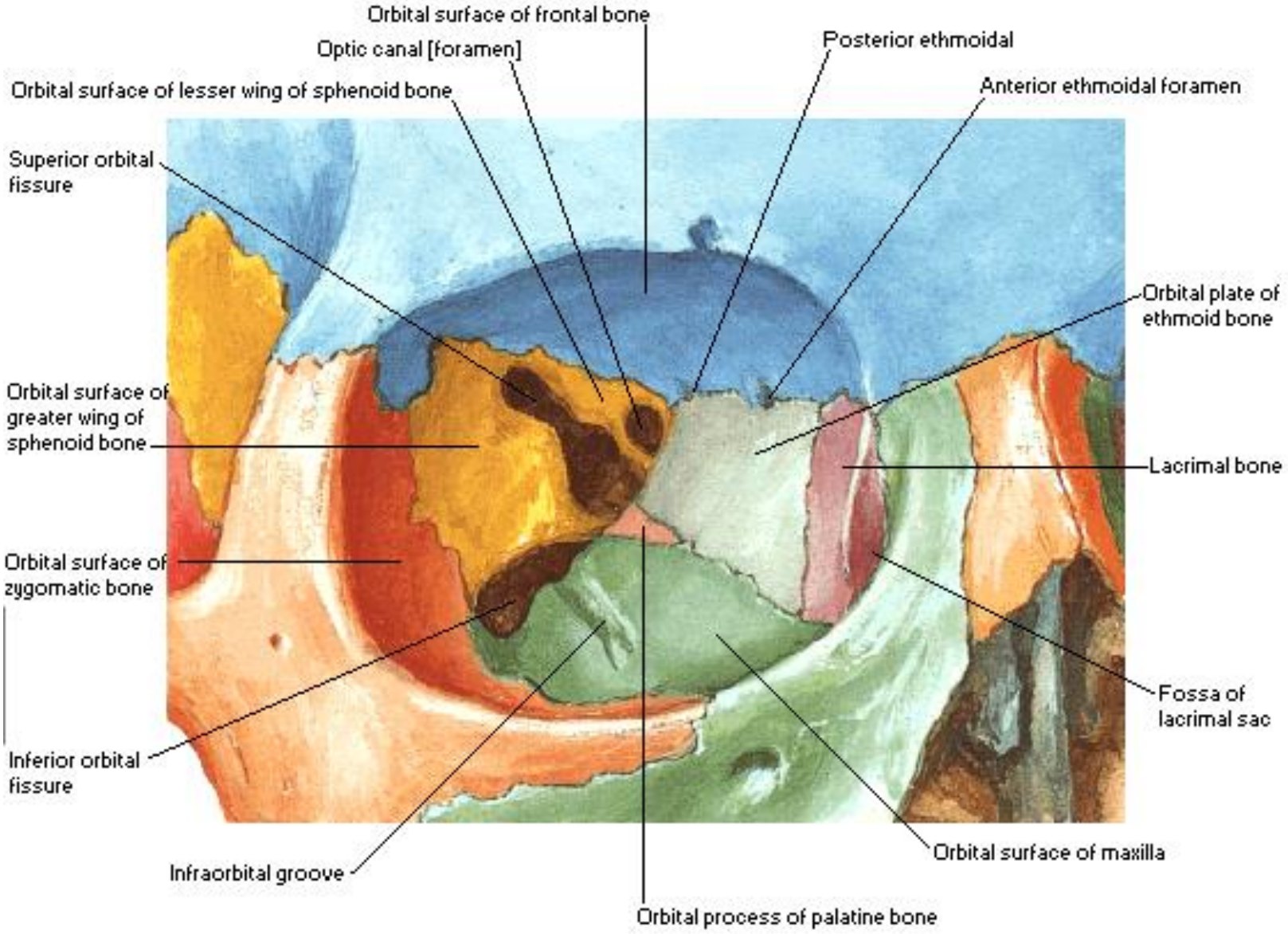
Skull

Anterior View



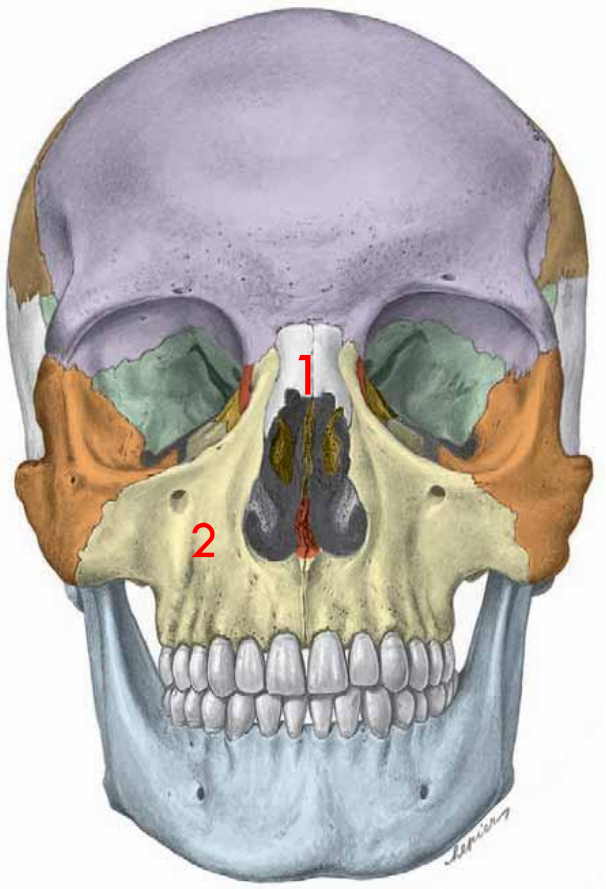
Right Orbit

Frontal and Slightly Lateral View

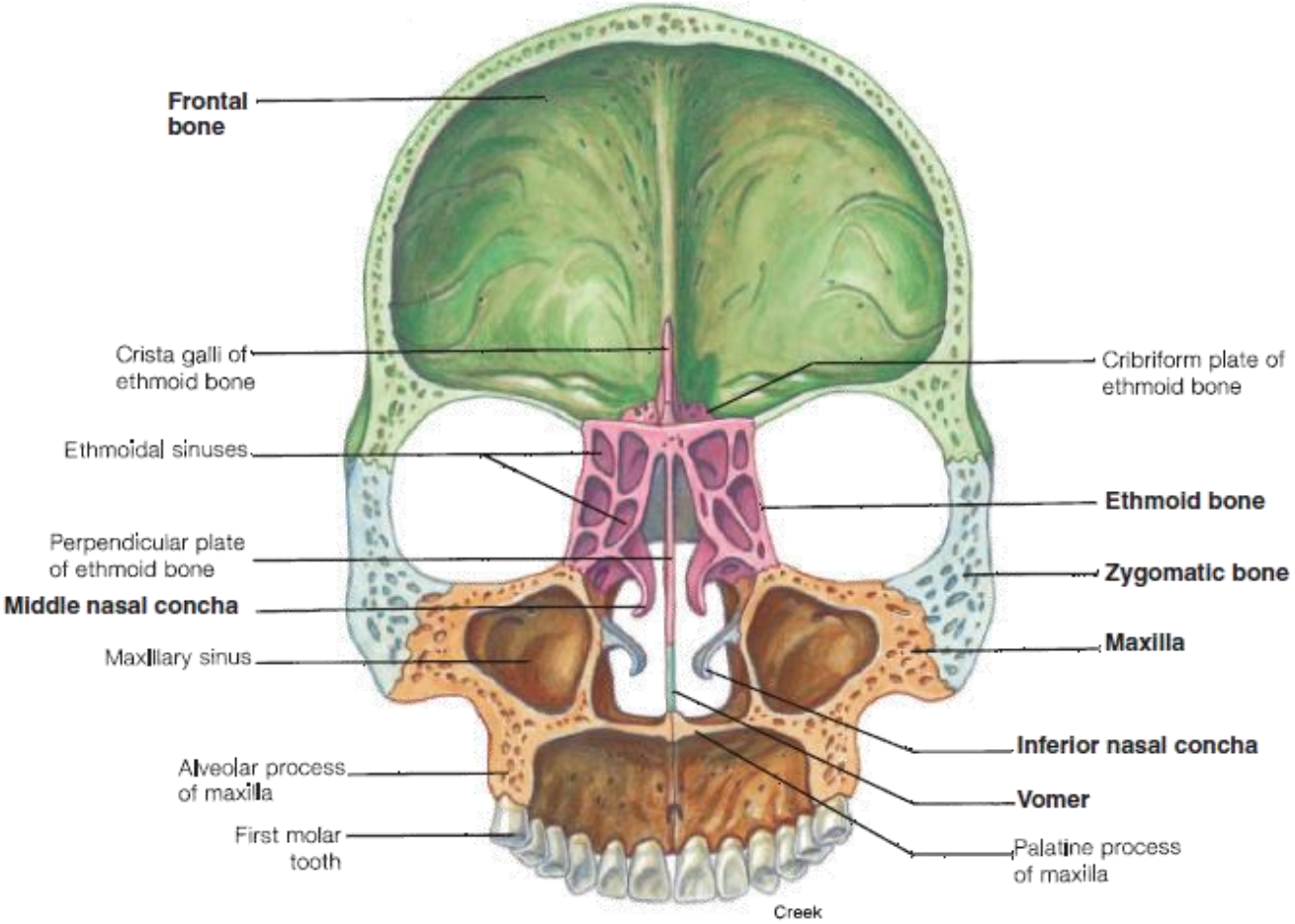


The Piriform Aperture (opening):

- The anterior nasal opening in the cranium
- Boundaries:
  - Two Nasal bones (Sup)(1)
  - Two Maxillary bones (Lat, Inf.)
- The **bony nasal septum** can be observed through this aperture, dividing the nasal cavity into right and left parts.
- On the lateral wall of each nasal cavity are curved bony plates, the **nasal conchae**

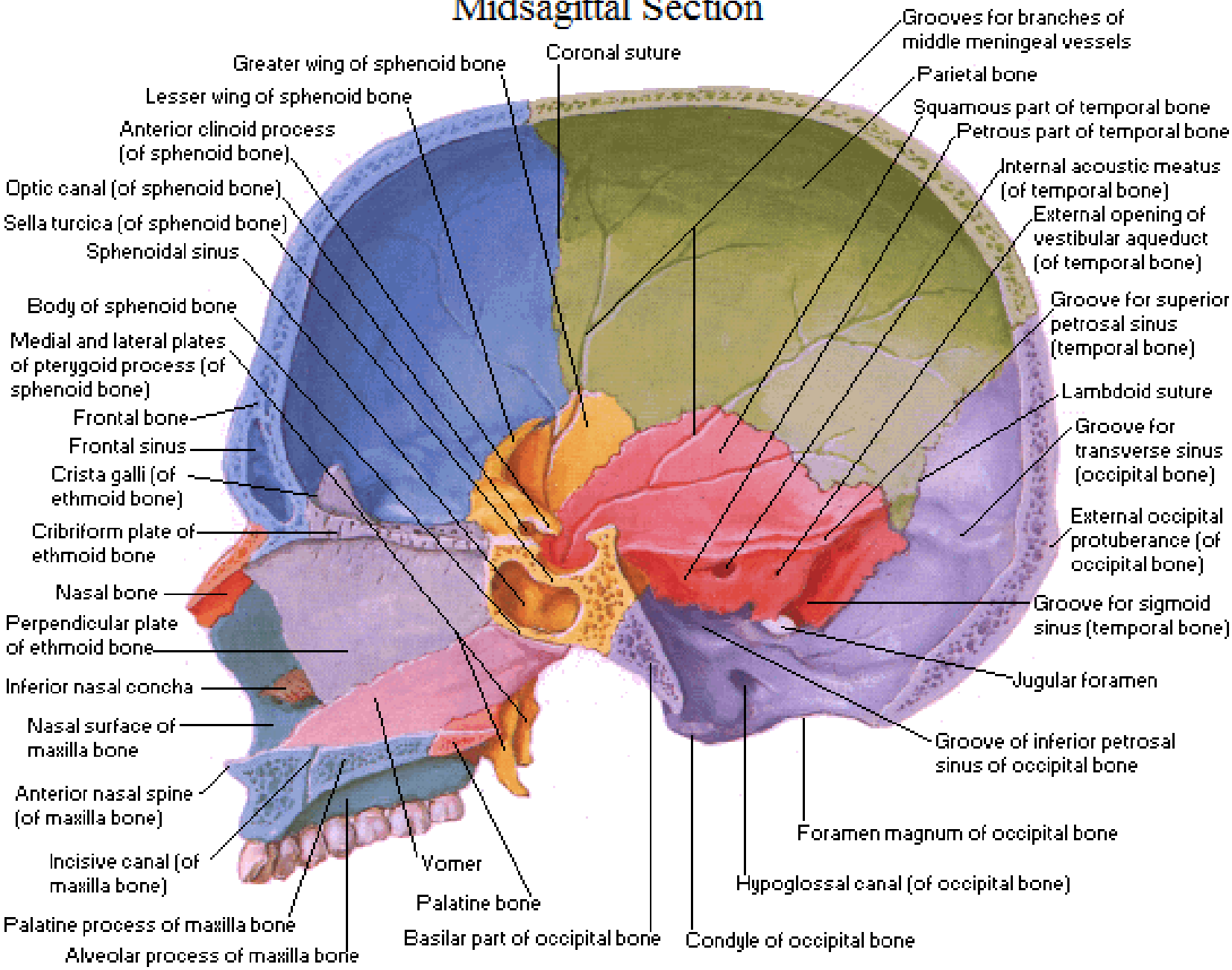


View???


Frontal bone
Crista galli of ethmoid bone
Cribriform plate of ethmoid bone
Ethmoidal sinuses
Ethmoid bone
Perpendicular plate of ethmoid bone
Zygomatic bone
Middle nasal concha
Maxilla
Maxillary sinus
Inferior nasal concha
Alveolar process of maxilla
Vomer
First molar tooth
Palatine process of maxilla
Creek

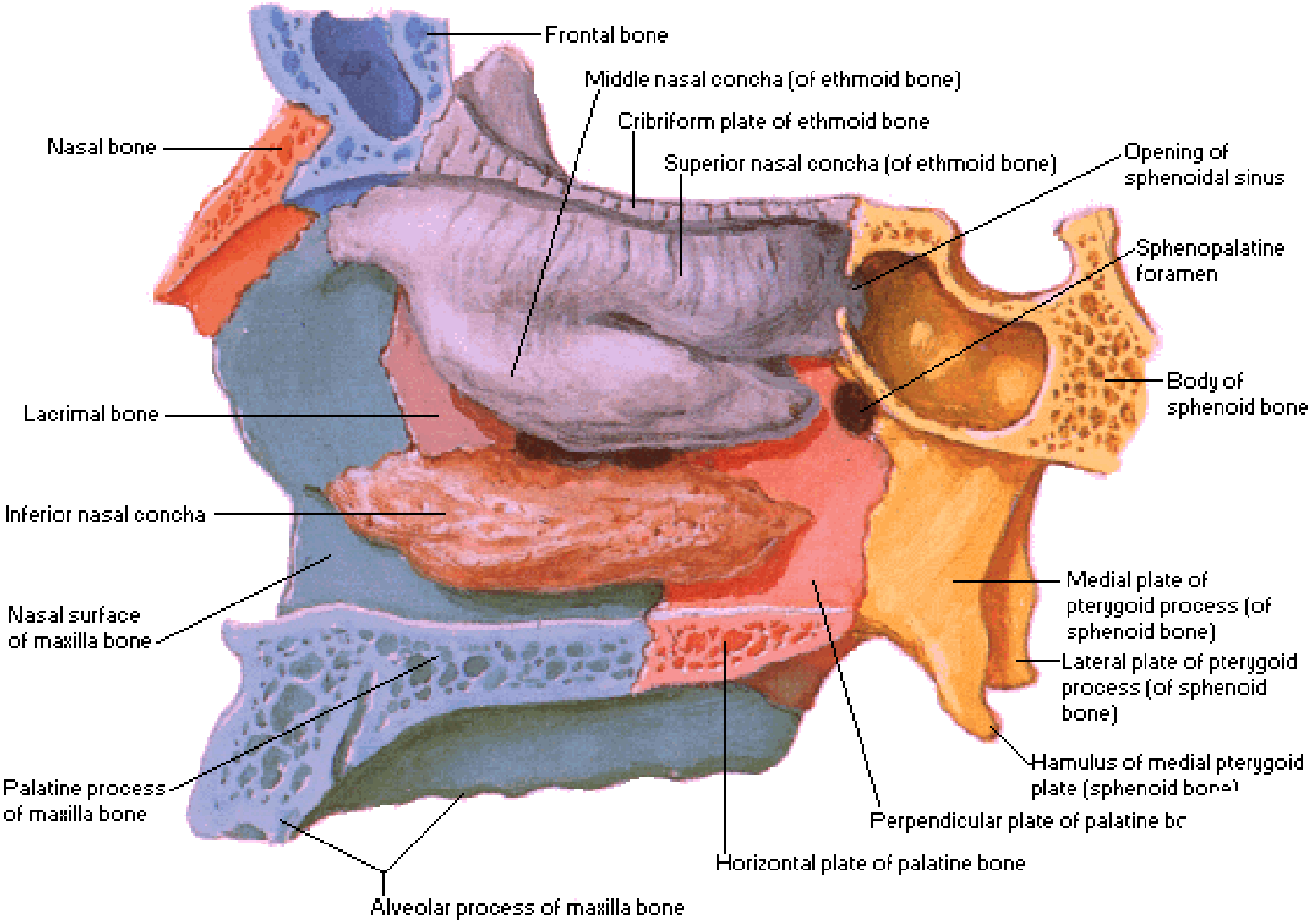
Skull

Midsagittal Section



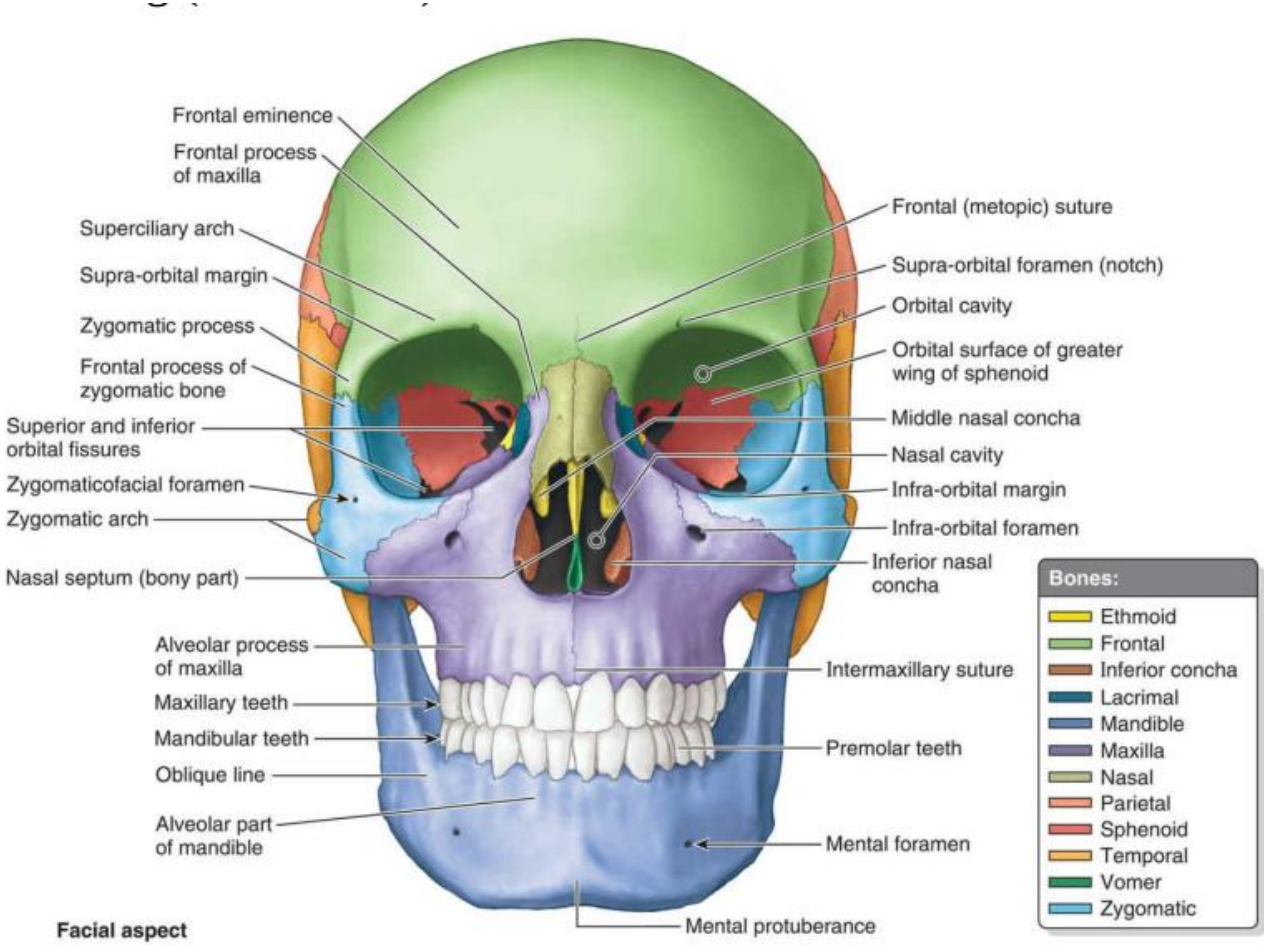
Skull - Nasal Conchae Exposed

Sagittal Section



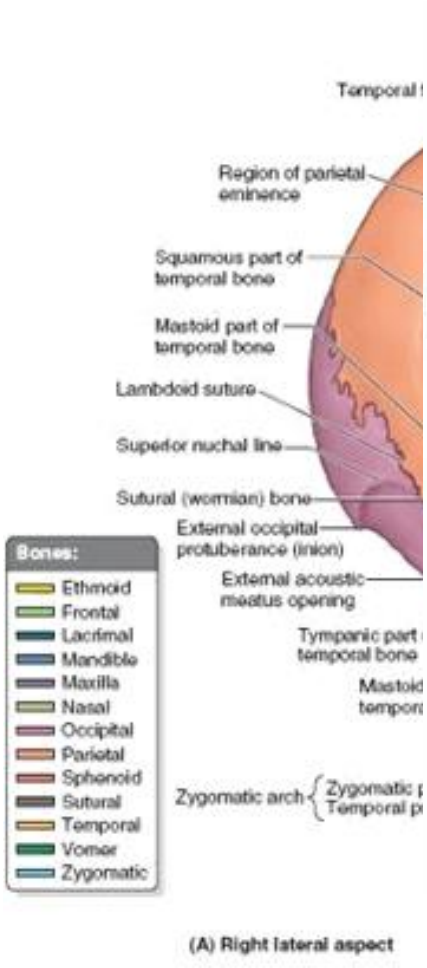
Frontal Bone: (Forehead Bone)

- Forms: Forehead, superior orbital margin and orbital roof.
- **Contents:** frontal sinuses.
- **Landmarks:**
  - **Superciliary arches** (more prominent in males)
  - Medially, (G**labella)**
- **Foramens: Medial 1/3 = Supraorbital notch or foramen.** Transmits?
- **Articulations?**

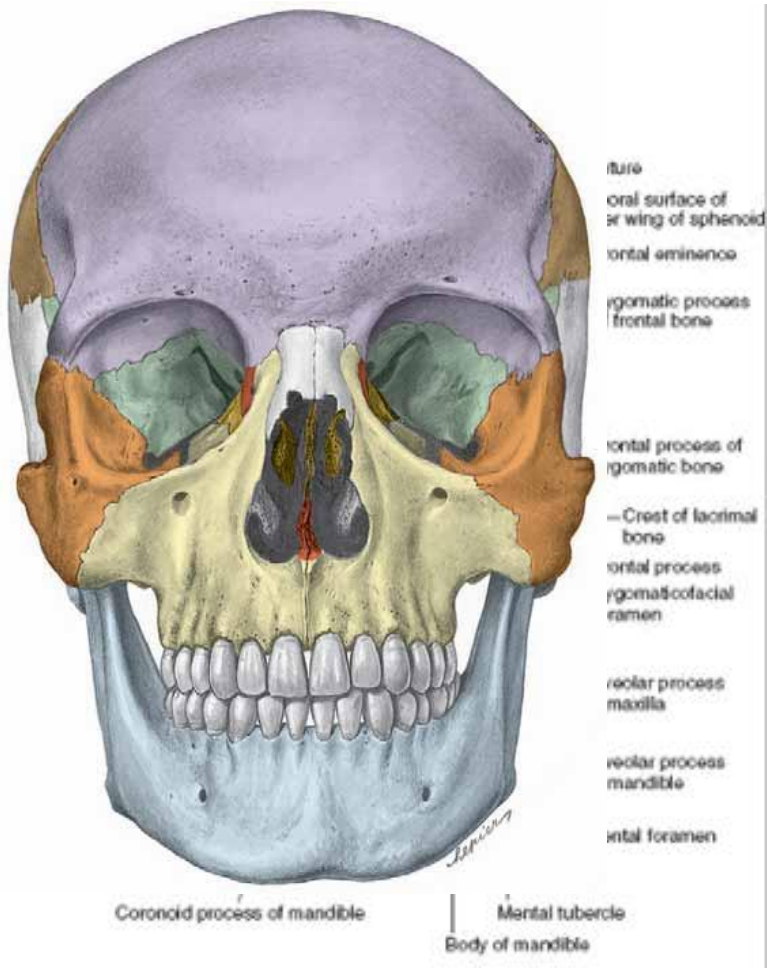


Zygomatic Bone

- **Forms:** prominence of a cheek, the walls of the temporal and infratemporal fossae, **zygomatic arch** anterolateral rims, walls, floor, and much of the infra-orbital margins of the orbits.
- **Contents: No Sinus**
- **Landmarks: ?**
- **Foramens: zygomaticofacial foramen?**
- **Articulations:?**
  - frontal, sphenoid, and temporal bones and the maxillae

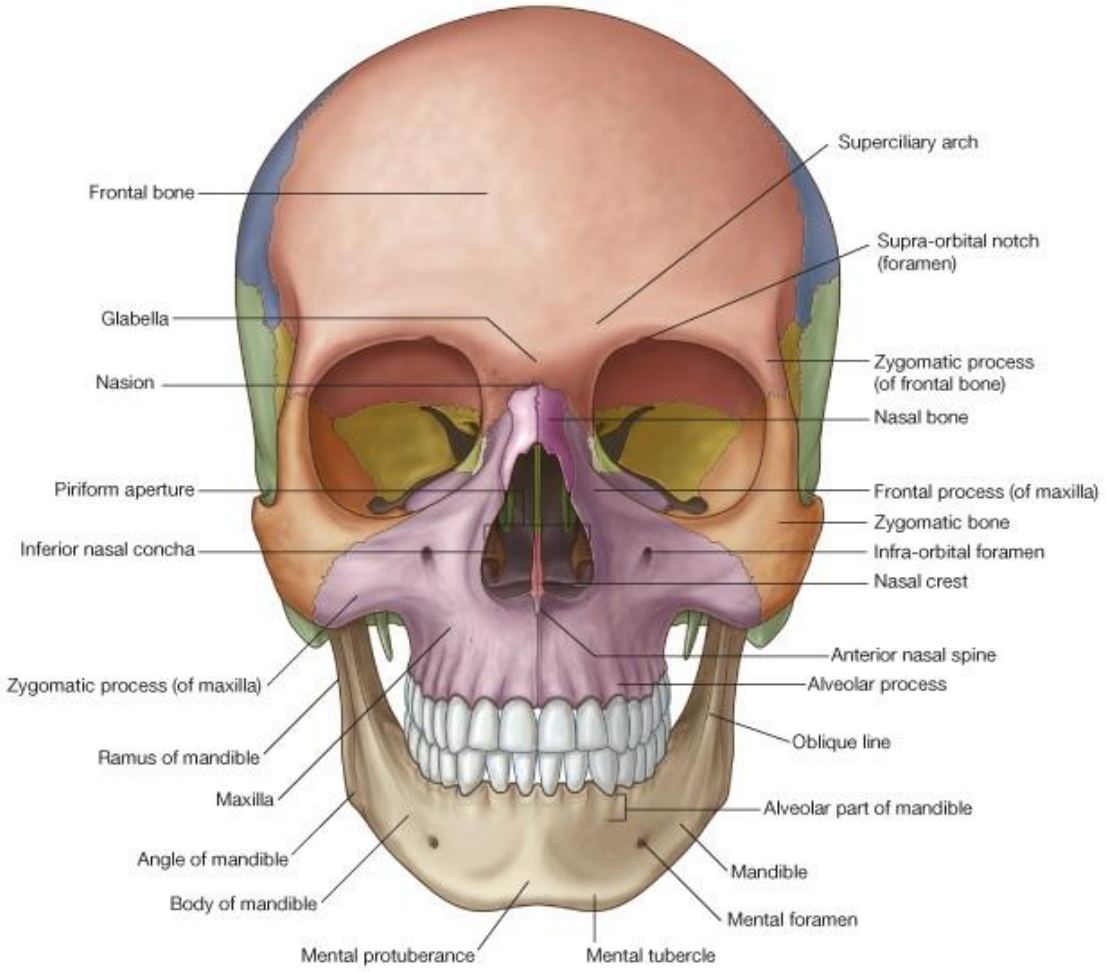


(A) Right lateral aspect



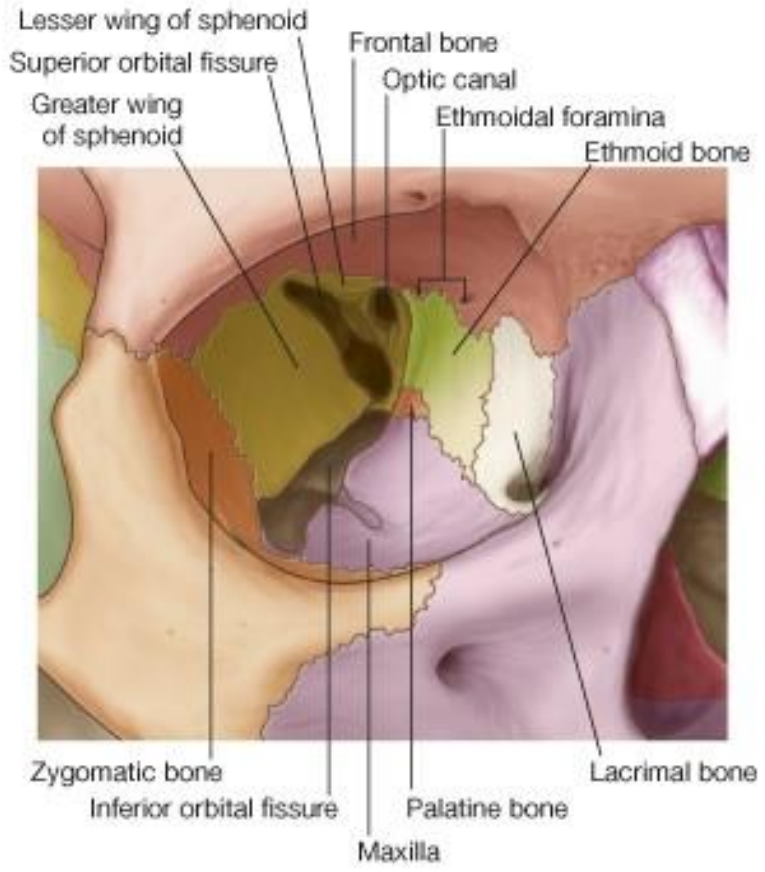
The Nasal Bone

- **Forms:** nasal bridge, sup. Border of Piriform aperture
- **Articulations: internasal suture, frontonasal suture**



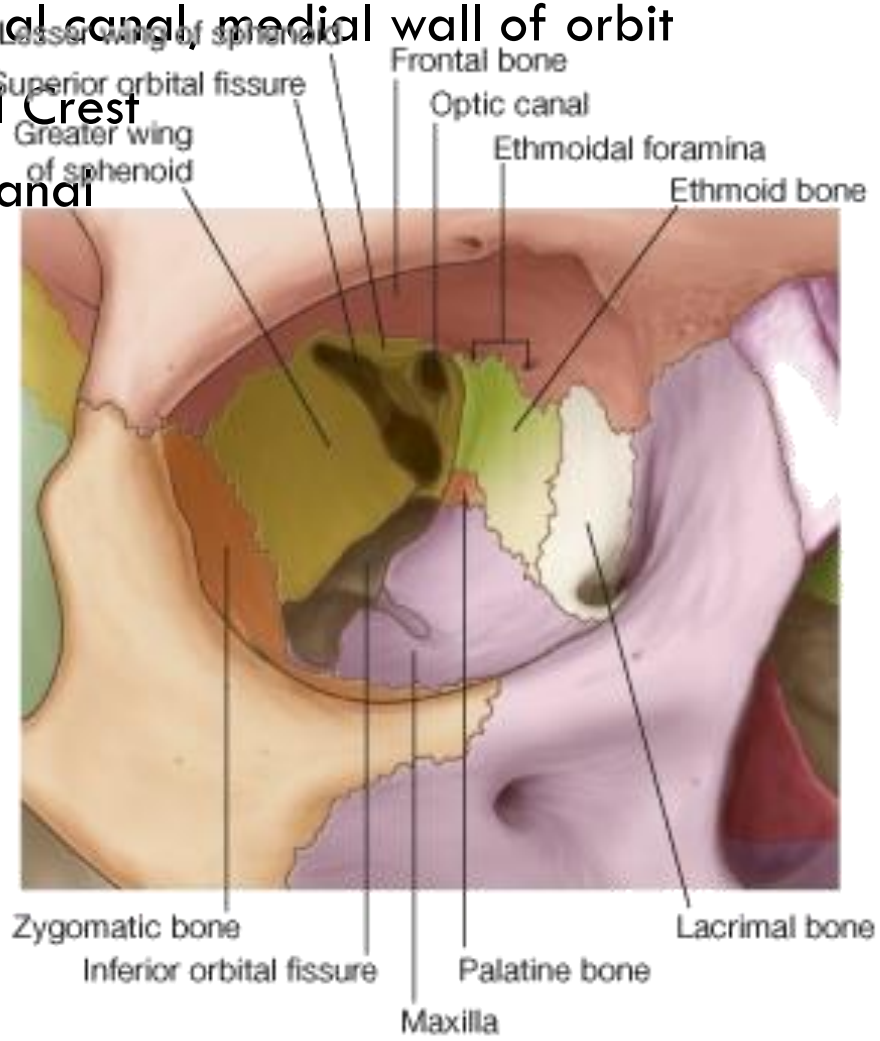
The Anterior Orbital Opening

- Superiorly by frontal bone
- Inferiorly by Maxillary bone
- Laterally by frontal process of Zygomatic bone and Zygomatic process of frontal bone
- Medially by frontal process of Maxillary bone and Maxillary process of Frontal bone.



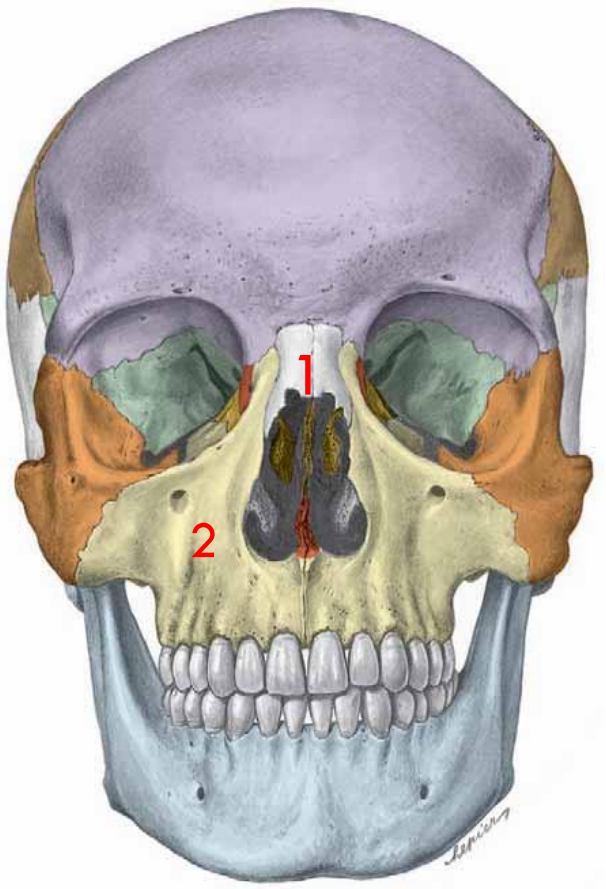
Lacrimal Bone

- **Forms:** Post crest of Lacrimal canal, medial wall of orbit
- **Landmarks:** Post. Lacrimal Crest
- **Foramens:** nasolacrimal canal
- **Articulations:?**



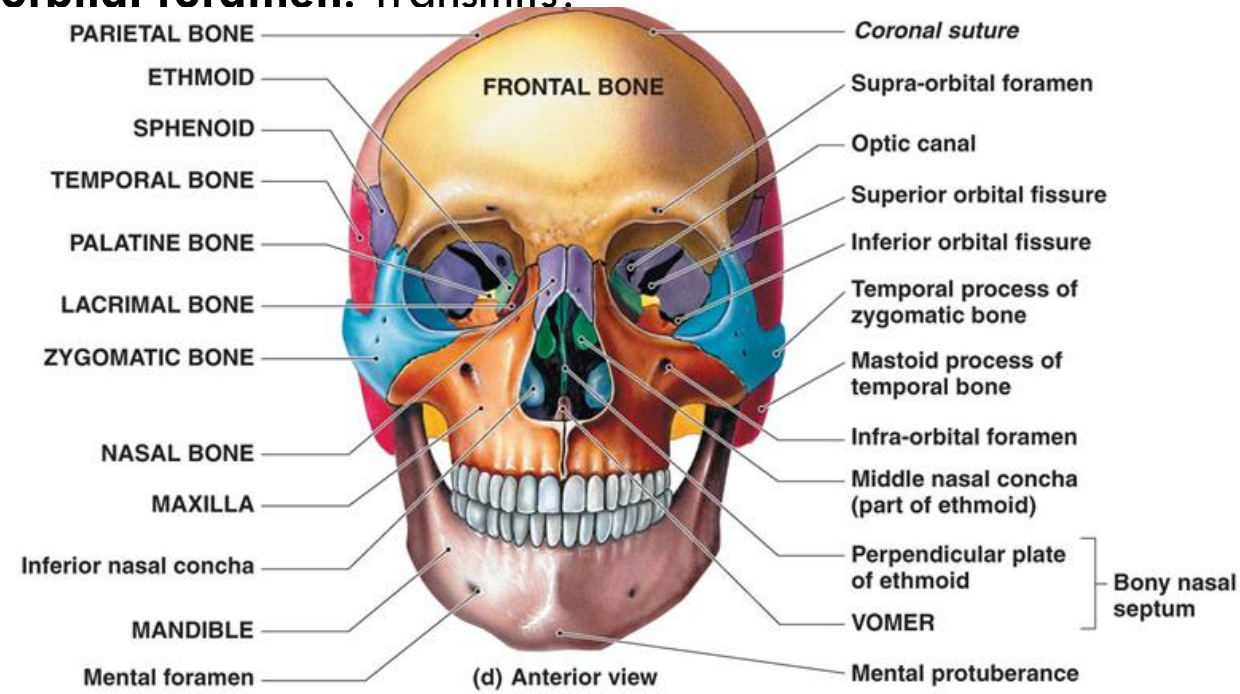
The Piriform Aperture (opening):

- The anterior nasal opening in the cranium
- Boundaries:
  - Two Nasal bones (Sup)(1)
  - Two Maxillary bones (Lat, Inf.)
- The **bony nasal septum** can be observed through this aperture, dividing the nasal cavity into right and left parts.
- On the lateral wall of each nasal cavity are curved bony plates, the **nasal conchae**



Maxillary Bone

- **Forms:** upper jaw, floor of orbit, nasolacrimal canal, roof of mouth
- **Contents:** Maxillary Sinuses
- surround **piriform aperture**
- **Landmarks: Alveolar process, intermaxillary suture**
- **Foramens: infraorbital foramen**. Transmits?
- **Articulations?**

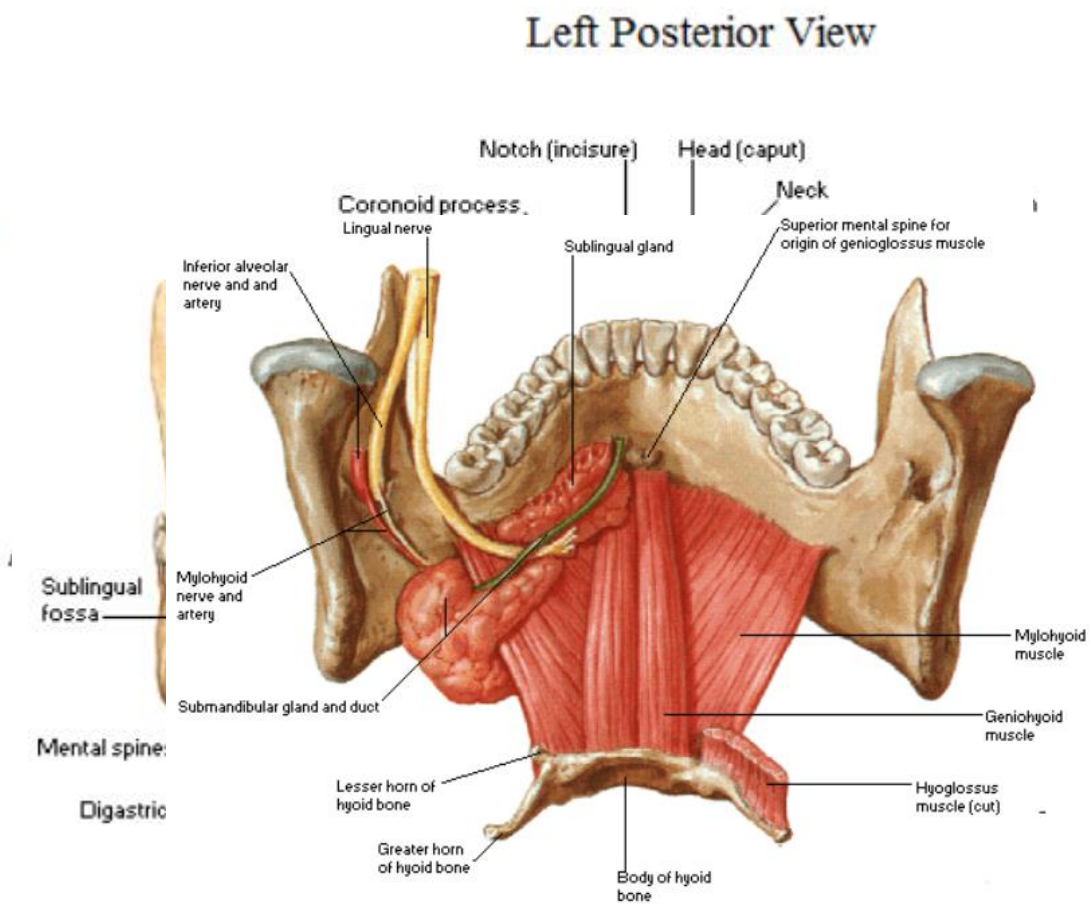


The Mandible

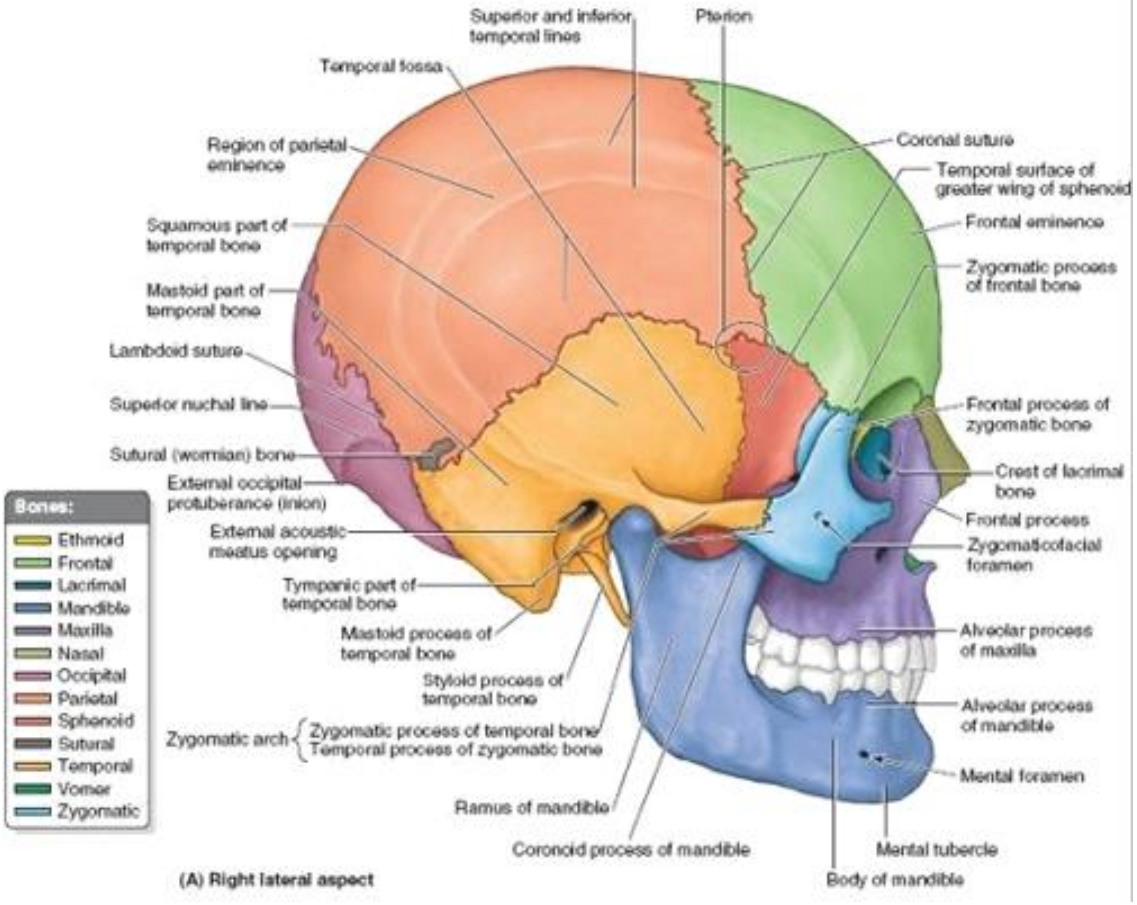
- Is a U-shaped bone with an alveolar part that supports the **mandibular teeth**
- Contents: Horizontal **body** and Vertical **ramus of mandible** (3)
- Landmarks: **mental protuberance (Chin) , mental tubercles.**
- **Foramens: mental foramen inferior to 2nd premolar:**
- **The Ramus Has :**

  1- Coronoid Process

  2-Condylar Process



Lateral Aspect of the Cranium



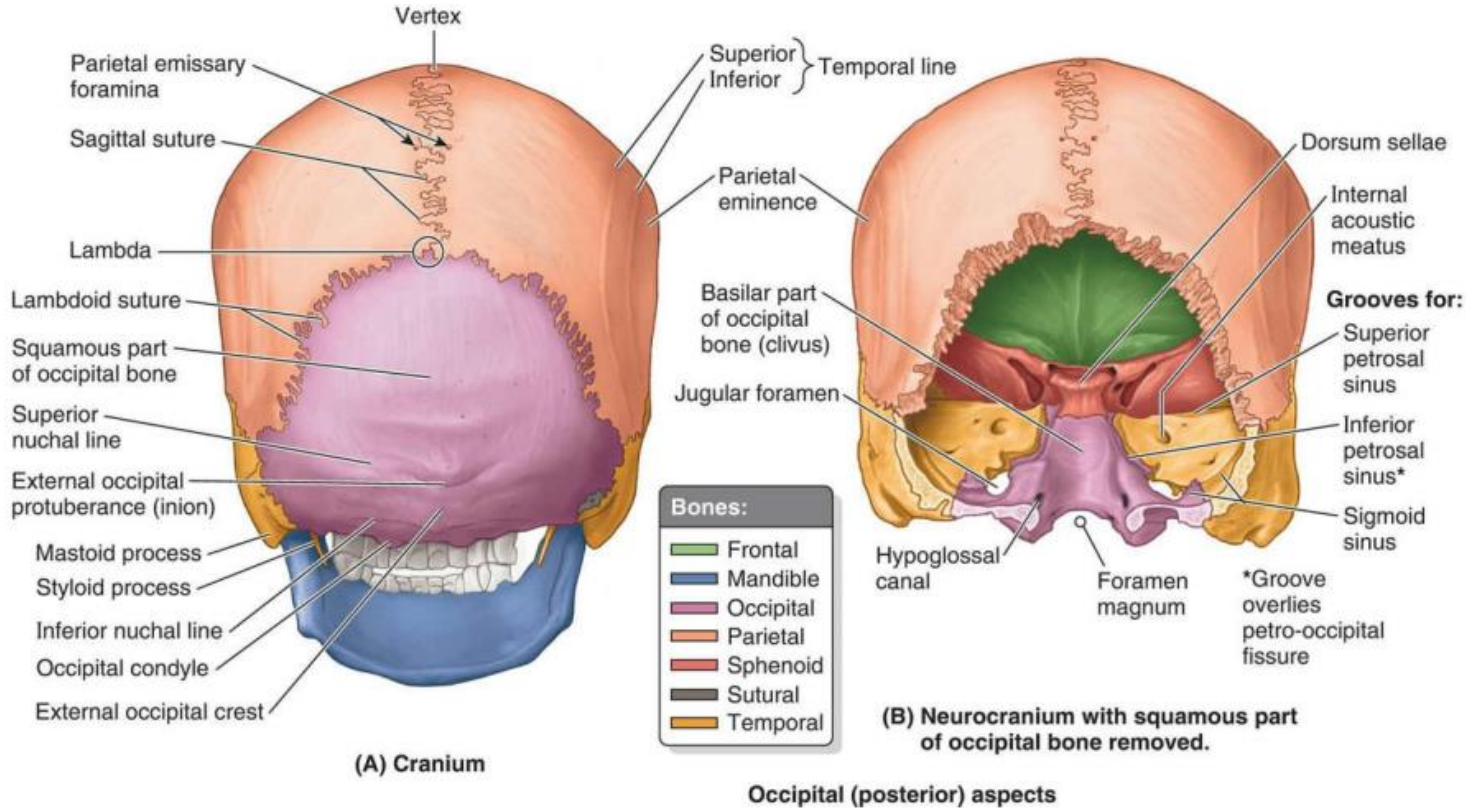
- **Formed by both the:**
  - **Neurocranium (the temporal fossa, the external acoustic opening, and the mastoid process of the temporal bone)**
  - **The viscerocranium (the infratemporal fossa, zygomatic arch, and lateral aspects of the maxilla and mandible)**

Temporal Bone

- Forms: Inferolateral aspects of the skull, Parts of the cranial floor
- **Squamous part**
  - Includes mandibular fossa and articular tubercle (articular eminence) for articulation at temporomandibular joint
- **Tympanic part**
  - Forms floor and anterior wall of external acoustic meatus
- **Mastoid part**
  - (1) Contains mastoid air cells
  - (2) Includes mastoid process, which develops after birth
- **Petrous part**
  - Contains inner ear, part of middle ear, and carotid canal
  - Petrous temporal bone fracture causes CSF otorrhea and the Battle sign.
- *The temporal bone is fractured in 75% of skull base fractures.*
- **Foramens:** carotid canal, jugular, stylomastoid, foramen lacerum, ext & internal Acoustic meatus,
- Articulations:?

Occipital Aspect of the Cranium

- **The posterior or occipital aspect of the cranium is composed of the *occiput, parts of the parietal bones, and mastoid parts of the temporal bones .***

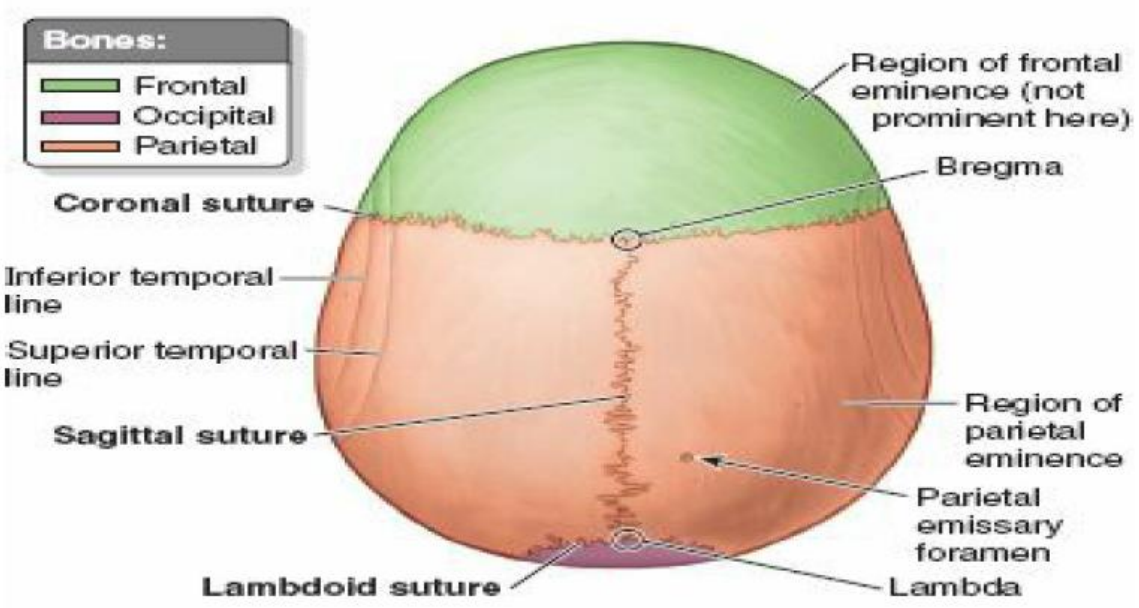


Occipital Bone

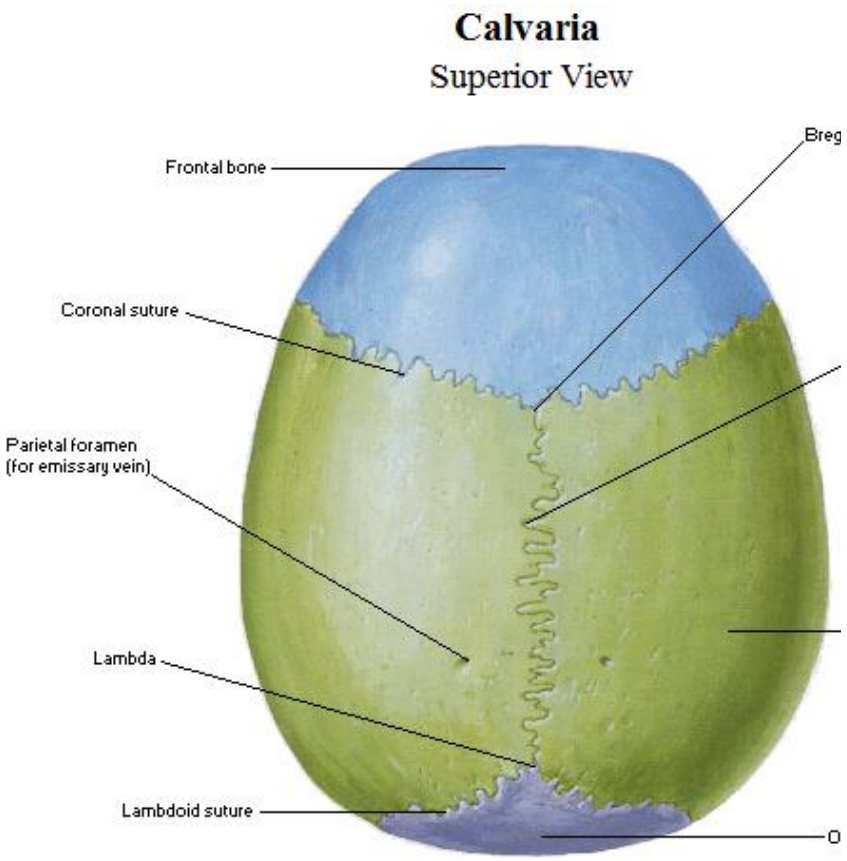
- Forms: Base of the skull
- Consists of **basilar, squamous, and paired lateral parts enclosing foramen magnum** where the spinal cord is continuous with the brainstem.
- **Basilar part (basioccipital)**
  - Articulates with body of sphenoid at former site of sphenooccipital synchondrosis, which is important in skull growth
- **Lateral part**
  - Includes occipital condyle, condylar fossa and canal, and hypoglossal canal
- **Squamous part**
  - Landmarks: External occipital protuberance, sup & inf nuchal line,

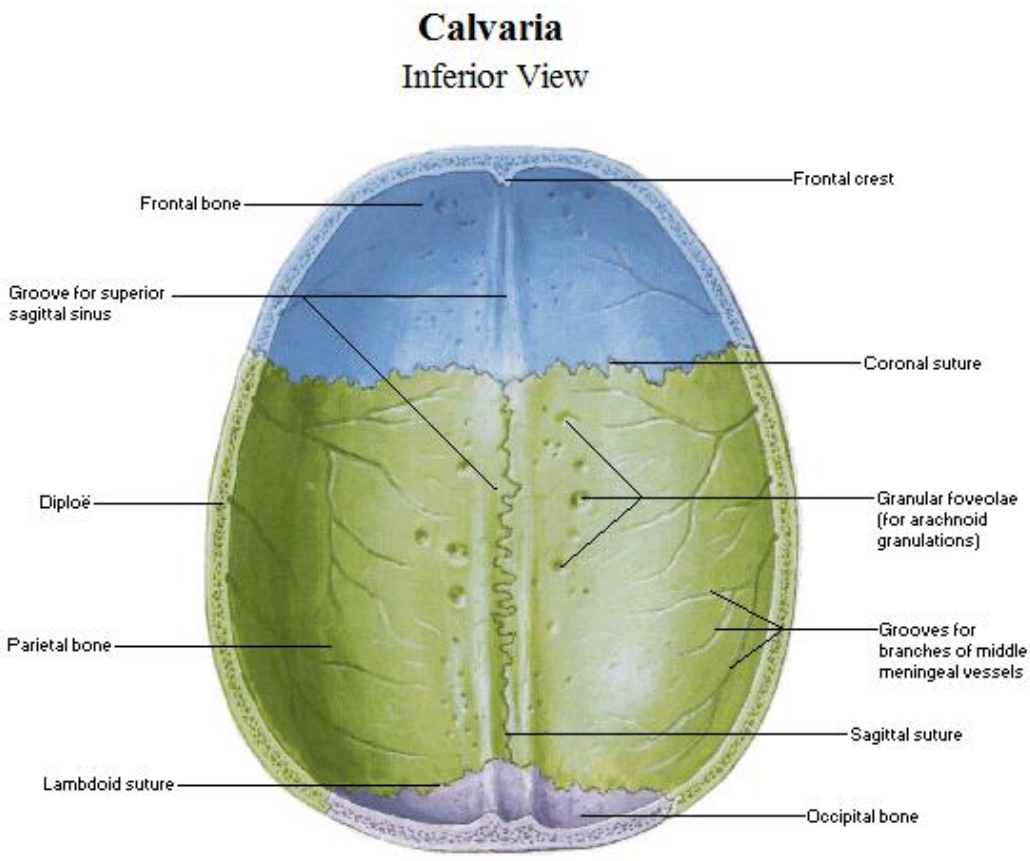
Superior Aspect of the Cranium

- The superior (vertical) aspect of the cranium usually somewhat oval in form, broadens posterolaterally at the parietal eminences.
  - The coronal suture separates the frontal and parietal bones ,
  - the sagittal suture separates the parietal bones, and
  - the lambdoid suture separates the parietal and temporal bones from the occipital bone.



Superior Aspect of the Cranium





Parietal Bone

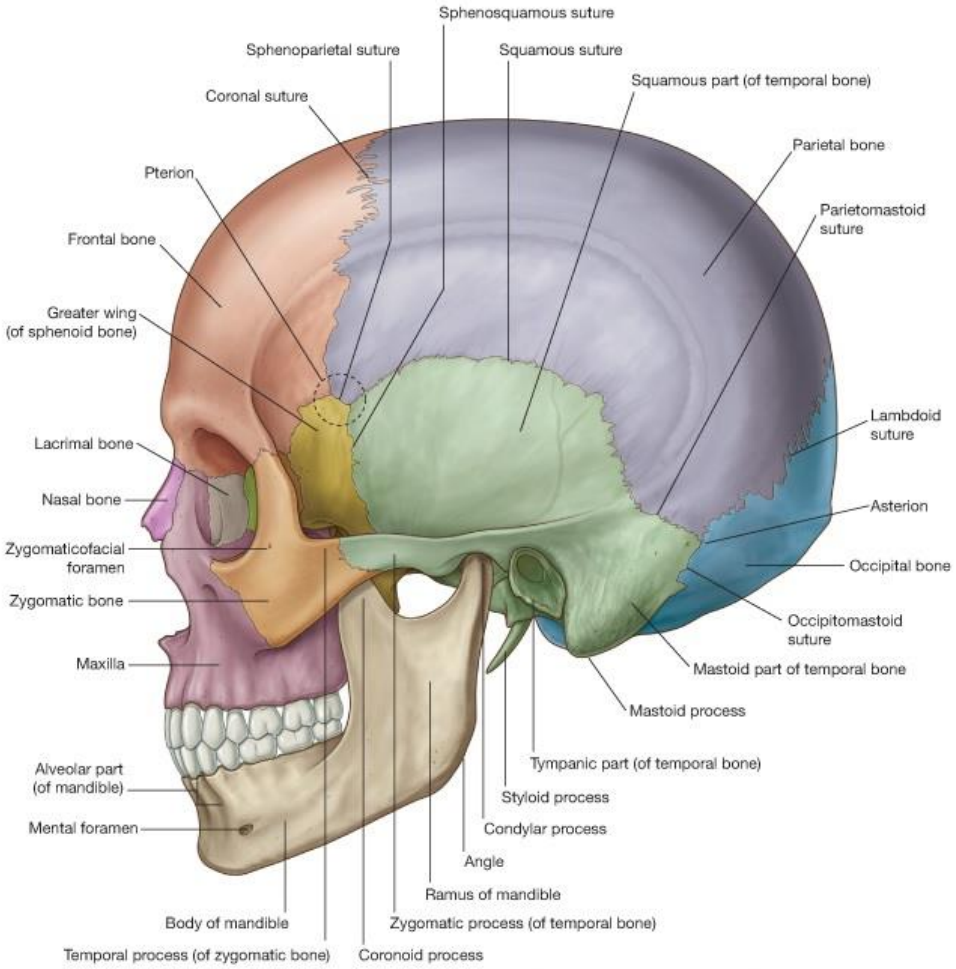
- **Forms:** cranial roof and sides
- **Contents: No**
- **Landmarks: ? Markings**
- **Foramens:** Parietal foramen
- **Articulations:**

  1- Medially- Parietal bone in the midline at ? suture

  2- Anteriorly- frontal bone at ? suture

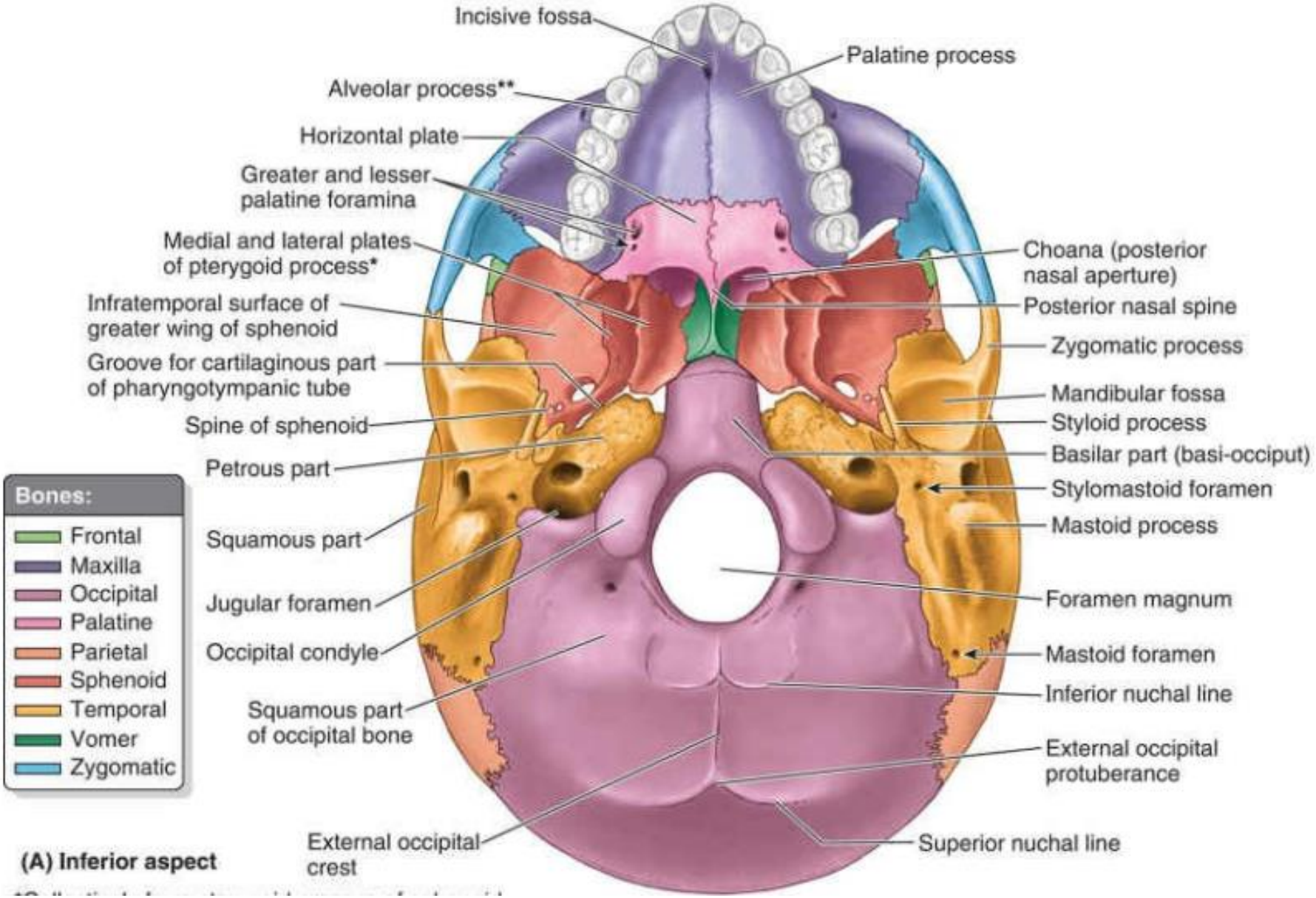
  3- Posteriorly- occipital bone at ? suture

  4- Laterally- Temporal bone at parieto-temporal suture (squamous part anteriorly and mastoid part posteriorly)



External Surface of the Cranial Base

- The cranial base (basicranium) is
  - the inferior portion of the neurocranium (floor of the cranial cavity) and
  - viscerocranium minus the mandible.
- The external surface of the cranial base features
  - the alveolar arch of the maxillae;
  - the palatine processes of the maxillae; and
  - the palatine, sphenoid, vomer, temporal, and occipital bones.

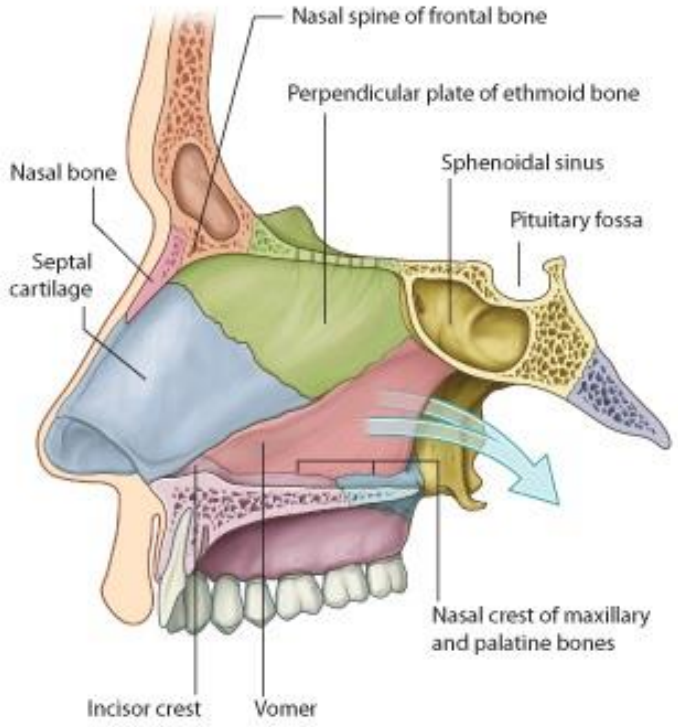


(A) Inferior aspect

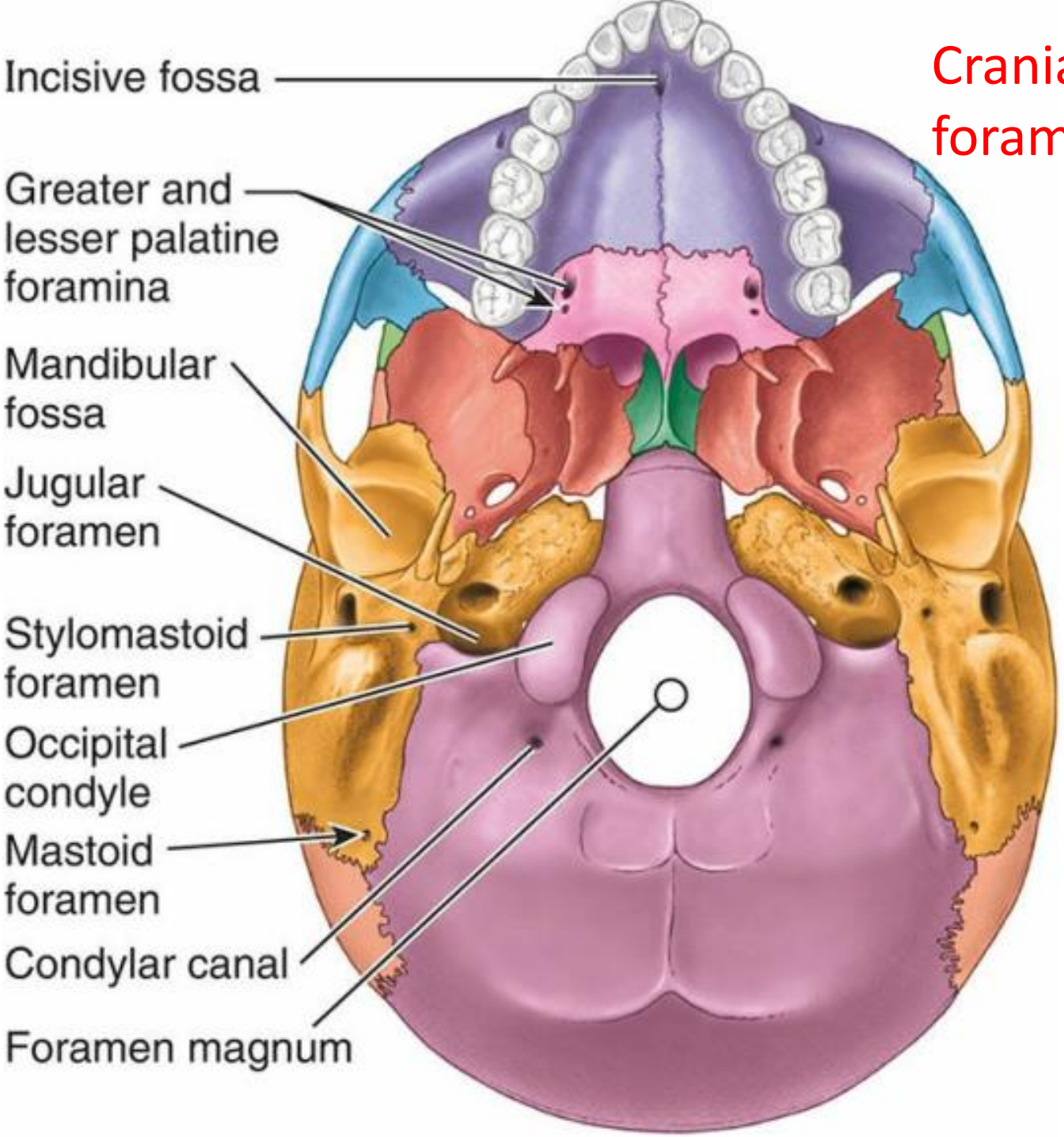
Vomer

- **Forms:** posteroinferior part of the nasal septum
- **Articulations:**

1. Superiorly - sphenoid bone and sphenoidal processes of the palatine bones.
2. Inferiorly - nasal crests of the maxilla and palatine bones.
3. Anteriorly - perpendicular plate of the ethmoid bone and the nasal septal cartilage.
4. Posteriorly – No ??

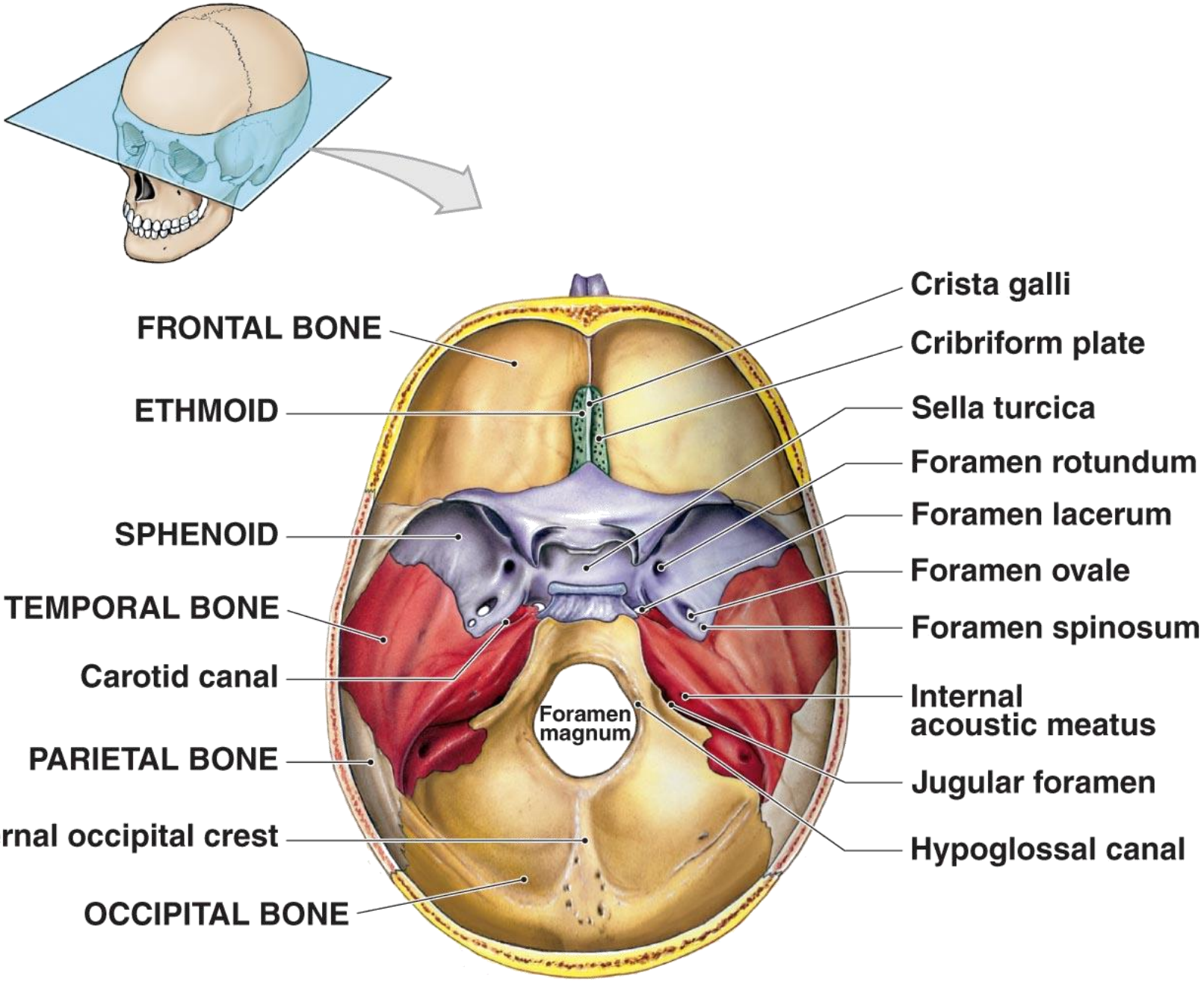


Cranial foramina.



Internal Surface of the Cranial Base

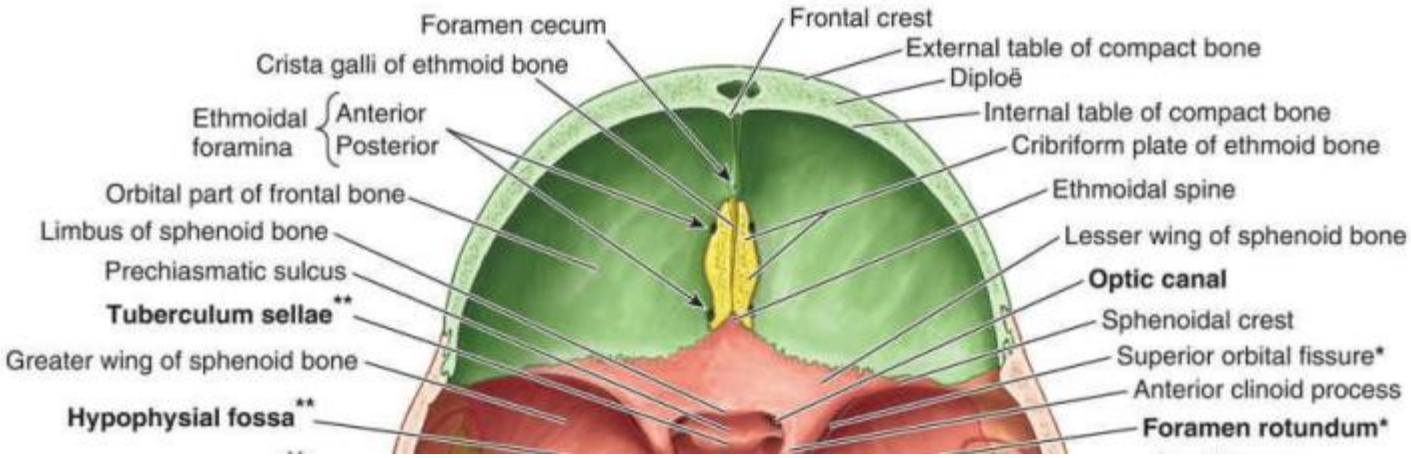
- The internal surface of the cranial base has three large depressions that lie at different levels:
  - the anterior,
  - middle, and
  - posterior cranial fossae, which form the bowl-shaped floor of the cranial cavity.
- The anterior cranial fossa is at the highest level, and the posterior cranial fossa is at the lowest level.



(b) Horizontal Section

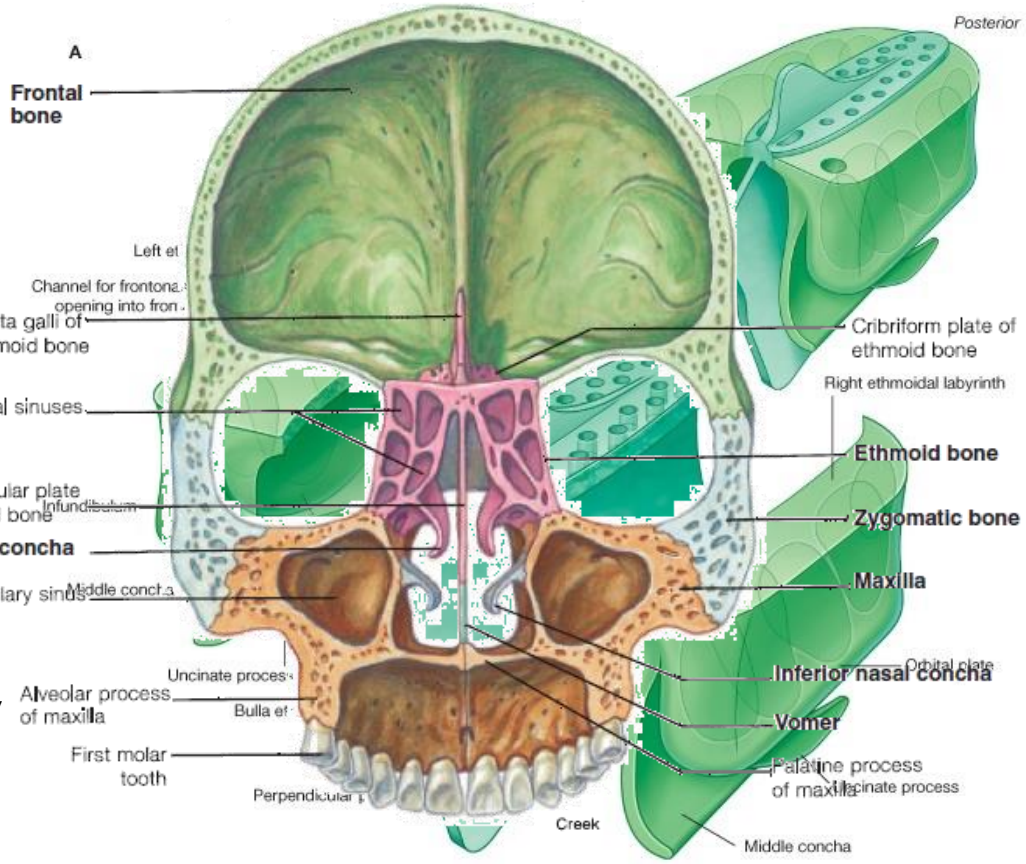
Anterior Cranial Fossa

- The shallowest of the three cranial fossae.
- Formed by:
  - the orbital parts of the frontal bone
  - Cribriform plate of ethmoid bone
  - and the body and lesser wings of the sphenoid posteriorly
  - *Occupied by the inferior and anterior parts of the frontal lobes of the brain.*



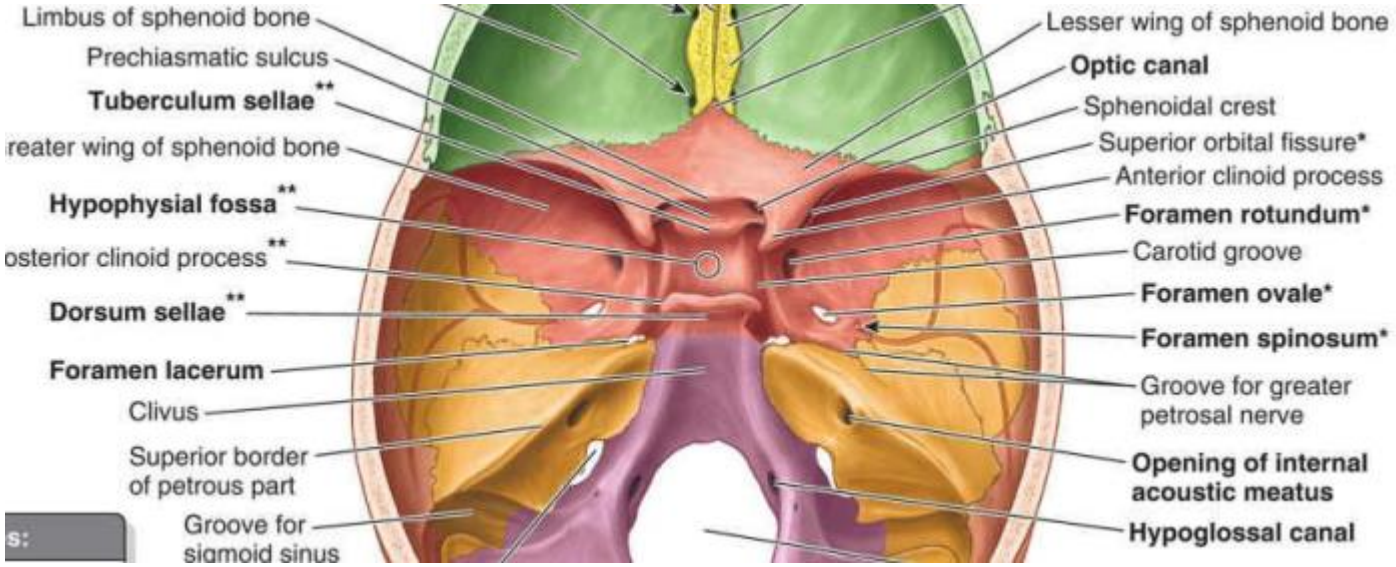
Ethmoid Bone

- **Forms:** medial walls of the orbit, nasal septum and the roof & lateral walls of the nasal cavity.
- **Cribriform plate**
  - **(1) Roof of nasal cavity and central floor of anterior cranial fossa**
  - **(2) Perforated by olfactory foramina for olfactory nerve fibers**
    - **The olfactory nerves traverse the cribriform plate to reach the nasal cavity.**
- **Perpendicular plate**
  - **Projects inferiorly from cribriform plate to contribute to nasal septum**
- **Ethmoidal labyrinth**
  - **Encloses posterior, middle, and anterior ethmoid air cells**
  - **Forms superior and middle nasal conchae on lateral wall of nasal cavity and orbital lamina on medial wall of orbit**



Middle Cranial Fossa

- Floor formed by
  - Median part: body of sphenoid bone
    - Sella turcica
  - Lateral concavities
    - greater wing of sphenoid, squamous and petrous parts of temporal bone.
  - Houses temporal lobe



Posterior Cranial Fossa

- The largest and deepest of the three cranial fossae
- Formed by:
  - Occipital bone,
  - Mastoid part & post. half of petrous temporal bone.
- Lodges the
  - **cerebellum, pons, and medulla oblongata.**

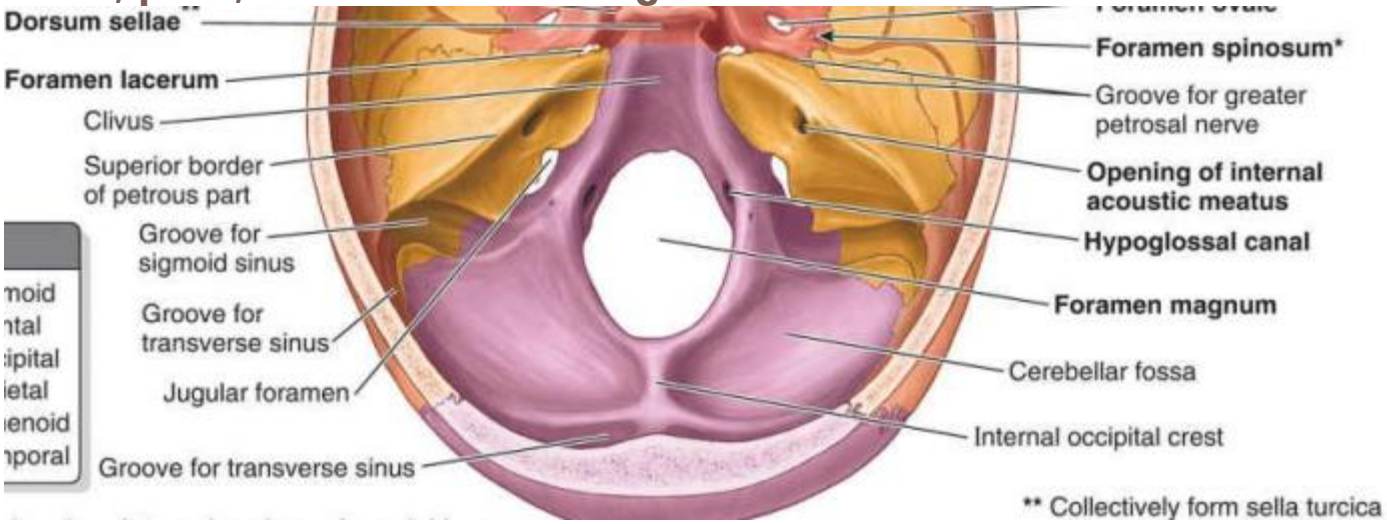
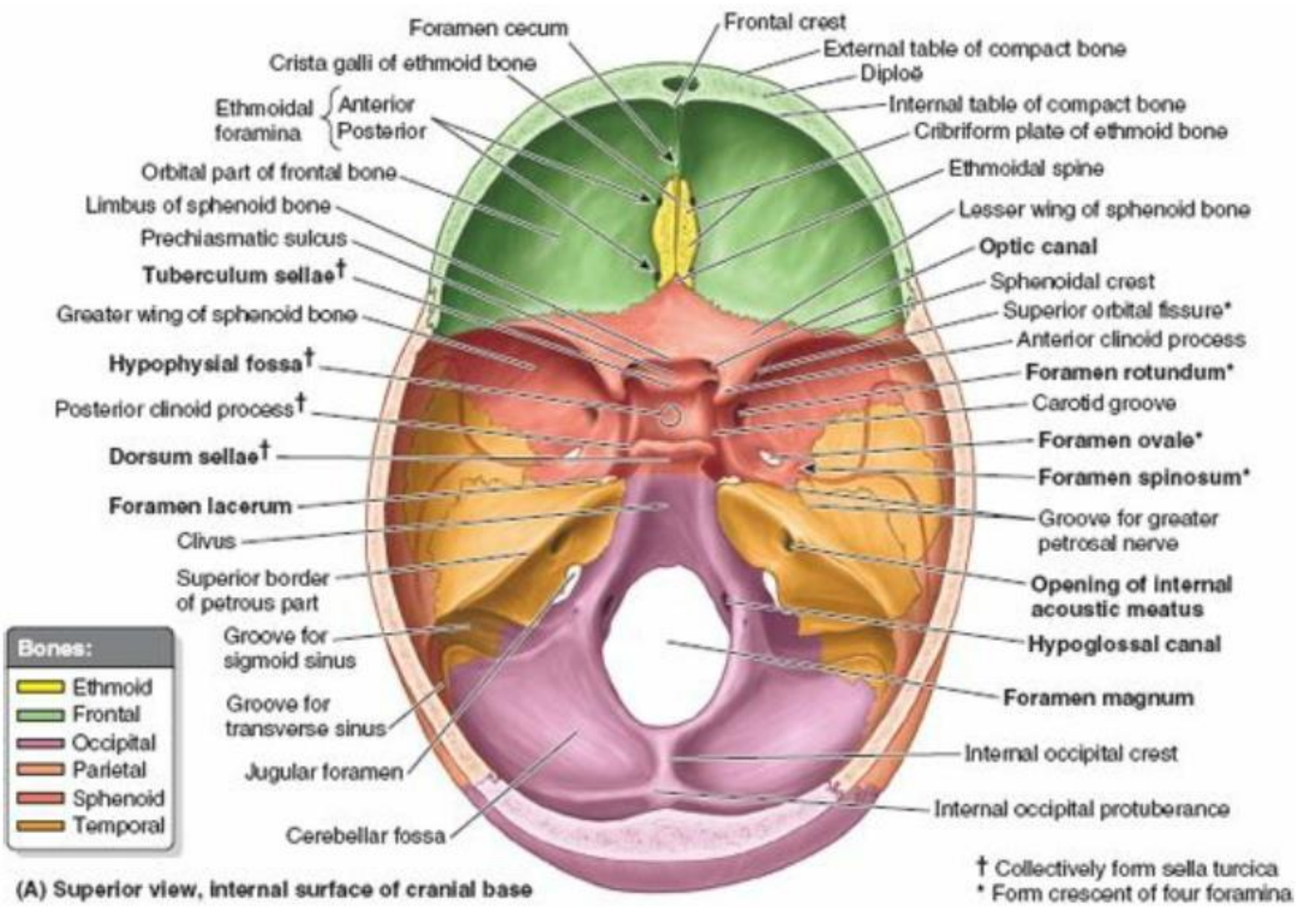


TABLE 7.2. FORAMINA AND OTHER APERTURES OF CRANIAL FOSSAE AND CONTENTS

Foramina/Apertures	Contents
Anterior cranial fossa	
Foramen cecum	Nasal emissary vein (1% of population)
Cribriform foramina in cribriform plate	Axons of olfactory cells in olfactory epithelium that form olfactory nerves
Anterior and posterior ethmoidal foramina	Vessels and nerves with same names
Middle cranial fossa	
Optic canals	Optic nerves (CN II) and ophthalmic arteries
Superior orbital fissure	Ophthalmic veins; ophthalmic nerve (CN V_1); CN III, IV, and VI; and sympathetic fibers
Foramen rotundum	Maxillary nerve (CN V_2)
Foramen ovale	Mandibular nerve (CN V_3) and accessory meningeal artery
Foramen spinosum	Middle meningeal artery and vein and meningeal branch of CN V_3
Foramen lacerum*	Deep petrosal nerve and some meningeal arterial branches and small veins
Groove or hiatus of greater petrosal nerve	Greater petrosal nerve and petrosal branch of middle meningeal artery
Posterior cranial fossa	
Foramen magnum	Medulla and meninges, vertebral arteries, CN XI, dural veins, anterior and posterior spinal arteries
Jugular foramen	CN IX, X, and XI; superior bulb of internal jugular vein; inferior petrosal and sigmoid sinuses; and meningeal branches of ascending pharyngeal and occipital arteries
Hypoglossal canal	Hypoglossal nerve (CN XII)
Condylar canal	Emissary vein that passes from sigmoid sinus to vertebral veins in neck
Mastoid foramen	Mastoid emissary vein from sigmoid sinus and meningeal branch of occipital artery

*The internal carotid artery and its accompanying sympathetic and venous plexuses actually pass horizontally *across* (rather than vertically through) the area of the foramen lacerum, an artifact of dry crania, which is closed by cartilage in life.



(A) Superior view, internal surface of cranial base

† Collectively form sella turcica
* Form crescent of four foramina

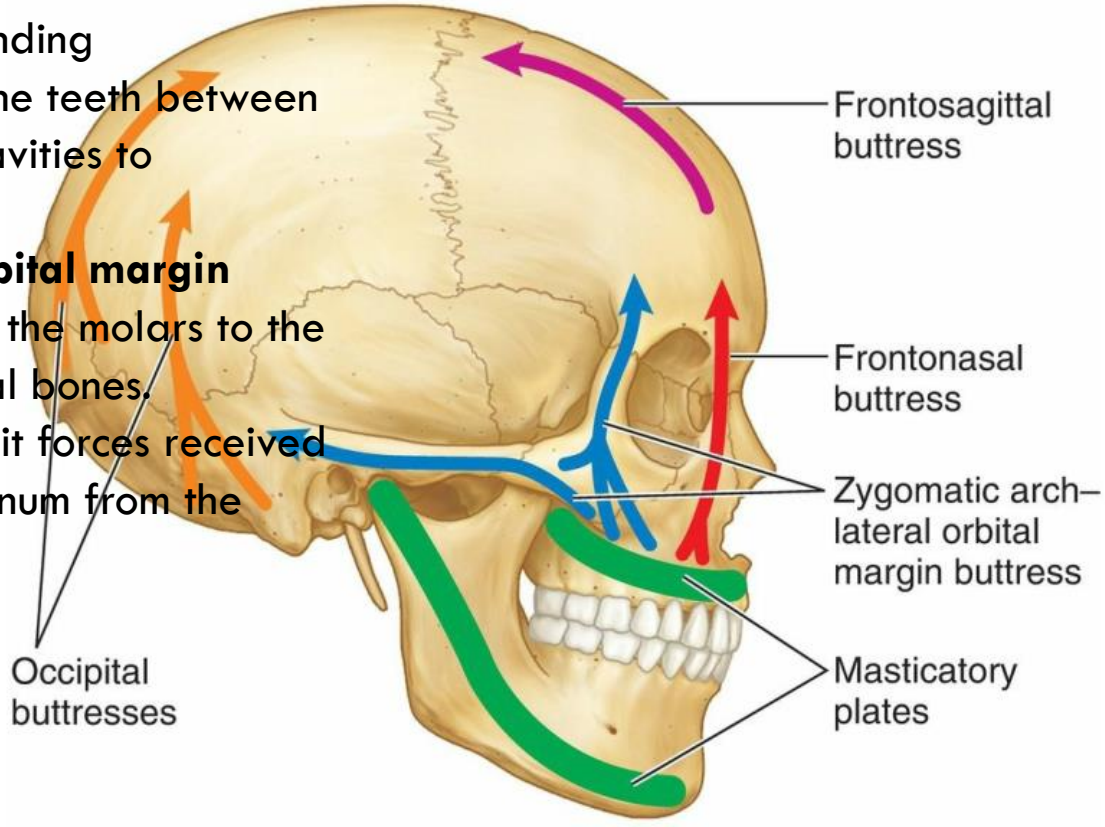
Walls of Cranial Cavity

- The walls of the cranial cavity vary in thickness in different regions.
- They are usually thinner in females than in males and are thinner in children and elderly people.
- The bones tend to be thinnest in areas that are well covered with muscles, such as the squamous part of the temporal bone.
- Thin areas of bone can be seen radiographically or by holding a dried cranium up to a bright light.

Buttresses of cranium

- The buttresses are thicker portions of cranial bone that transmit forces around weaker regions of the cranium.

- **Frontonasal buttress,** extending from the region of the canine teeth between the nasal and the orbital cavities to the central frontal bone.
- **zygomatic arch–lateral orbital margin buttress** from the region of the molars to the lateral frontal and temporal bones.
- **Occipital buttresses** transmit forces received lateral to the foramen magnum from the vertebral column.

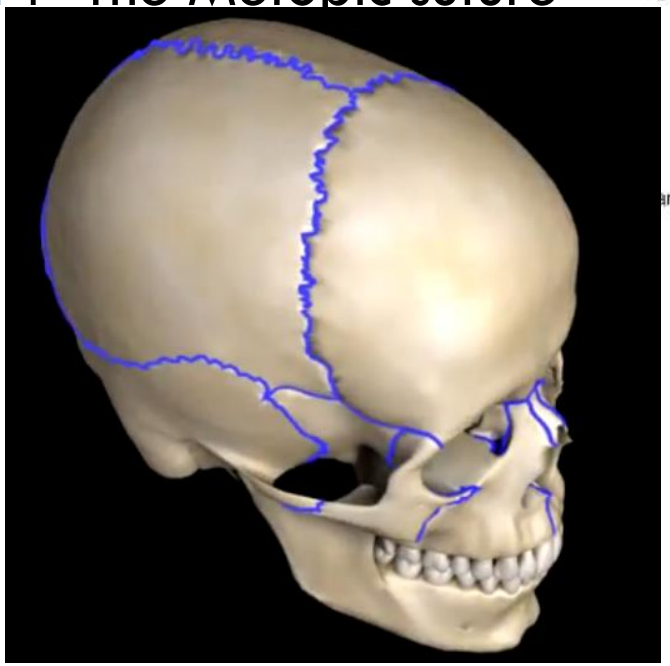


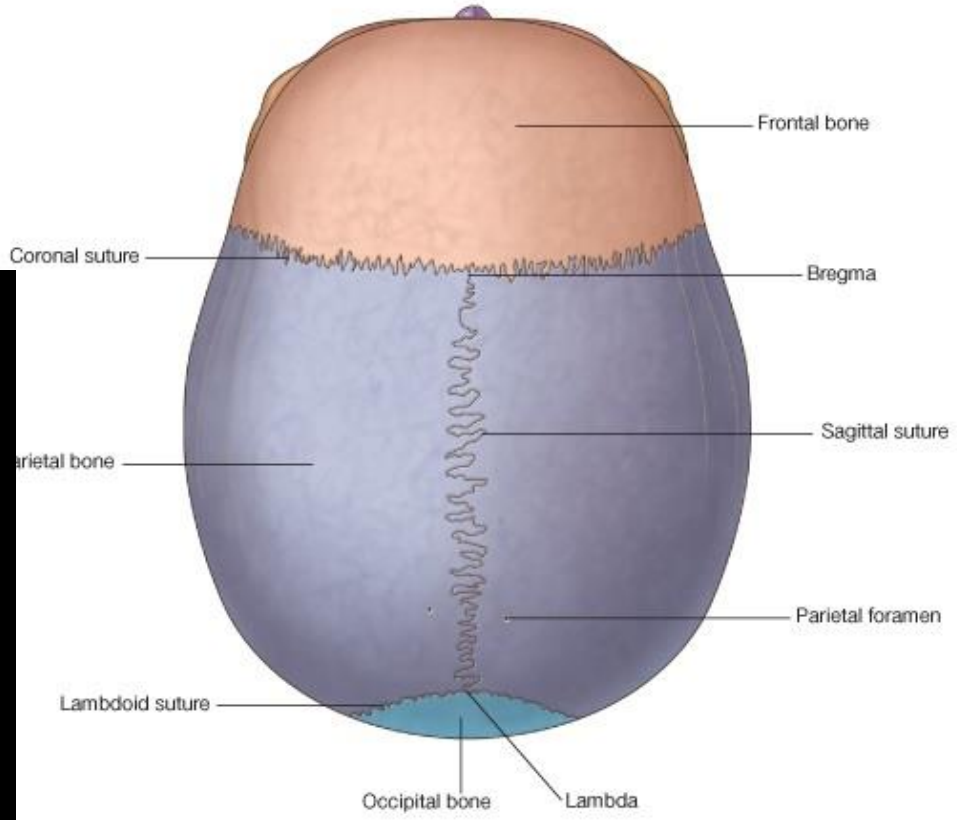
Cont.

- Perhaps to compensate for the denser bone required for these buttresses, some areas of the cranium not as mechanically stressed become pneumatized (air filled). What are this bones???

Sutures

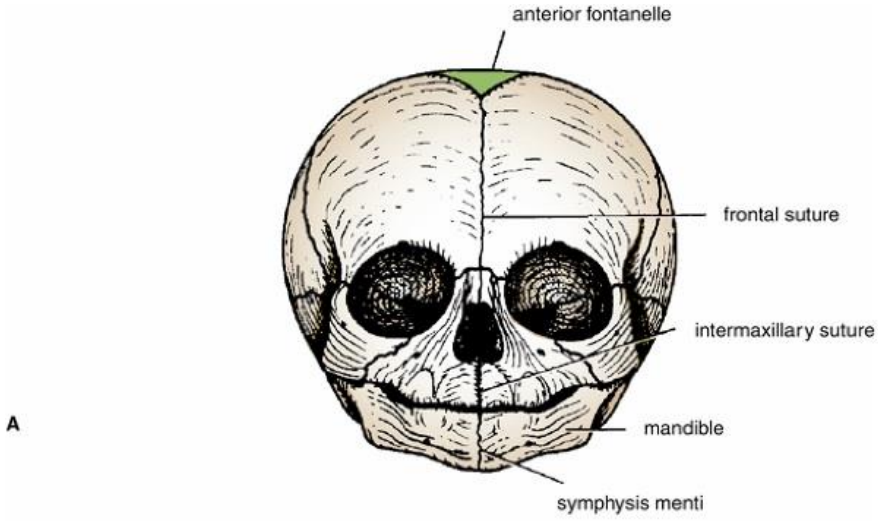
- The sutures are fibrous joints uniting the bones of the skull.
  - 1- The Coronal suture
  - 2- The Sagittal suture
  - 3- The Lambdoid suture
  - 4- The Metopic suture

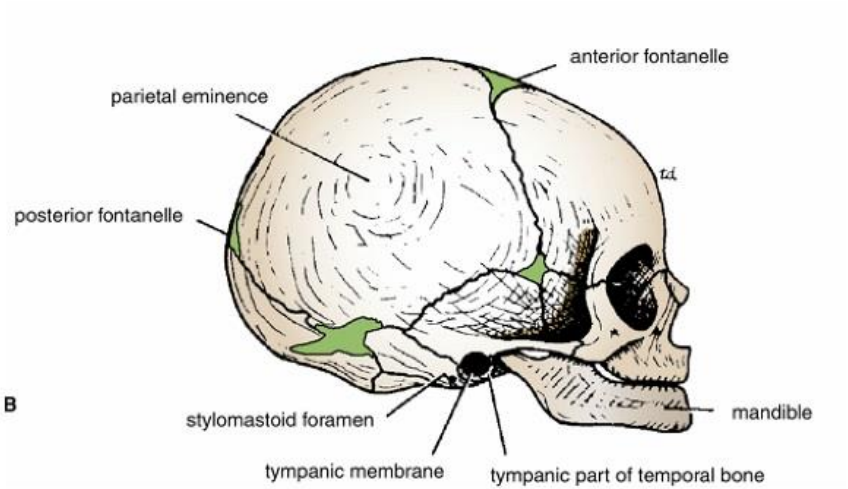




Neonate Skull

- **Anterior fontanelle** at the bregma (18 months)
- **Posterior fontanelle** at the Lambda site (3 months)
- **Sphenoidal fontanelle**
- **Mastoid fontanelle**





Age Changes in Face

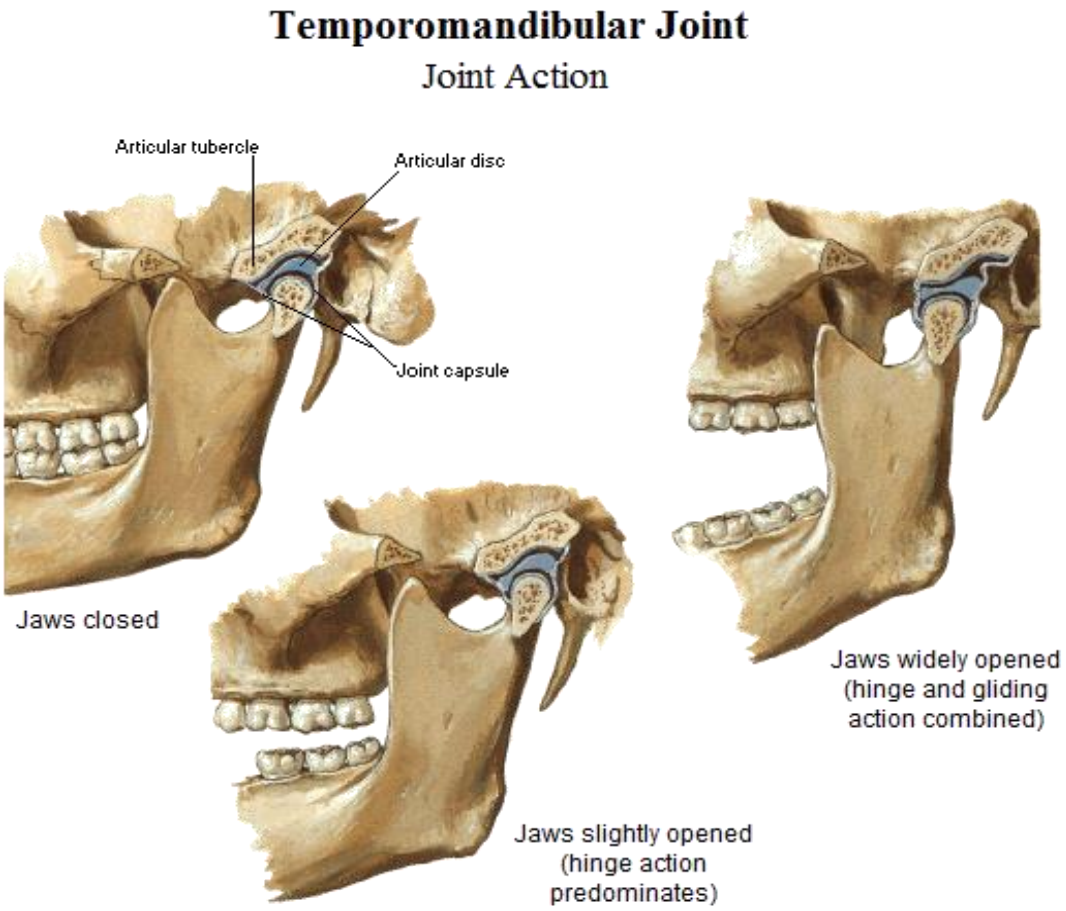
- The mandible is the most dynamic of our bones; its size and shape and the number of teeth it normally bears undergo considerable change with age.
- In the neonate, the mandible consists of two halves united in the median plane by a cartilaginous joint, the *mandibular symphysis*.
- Union between the halves of the mandible is effected by means of fibrocartilage.
- This union begins during the 1st year, and the halves are fused by the end of the 2nd year.

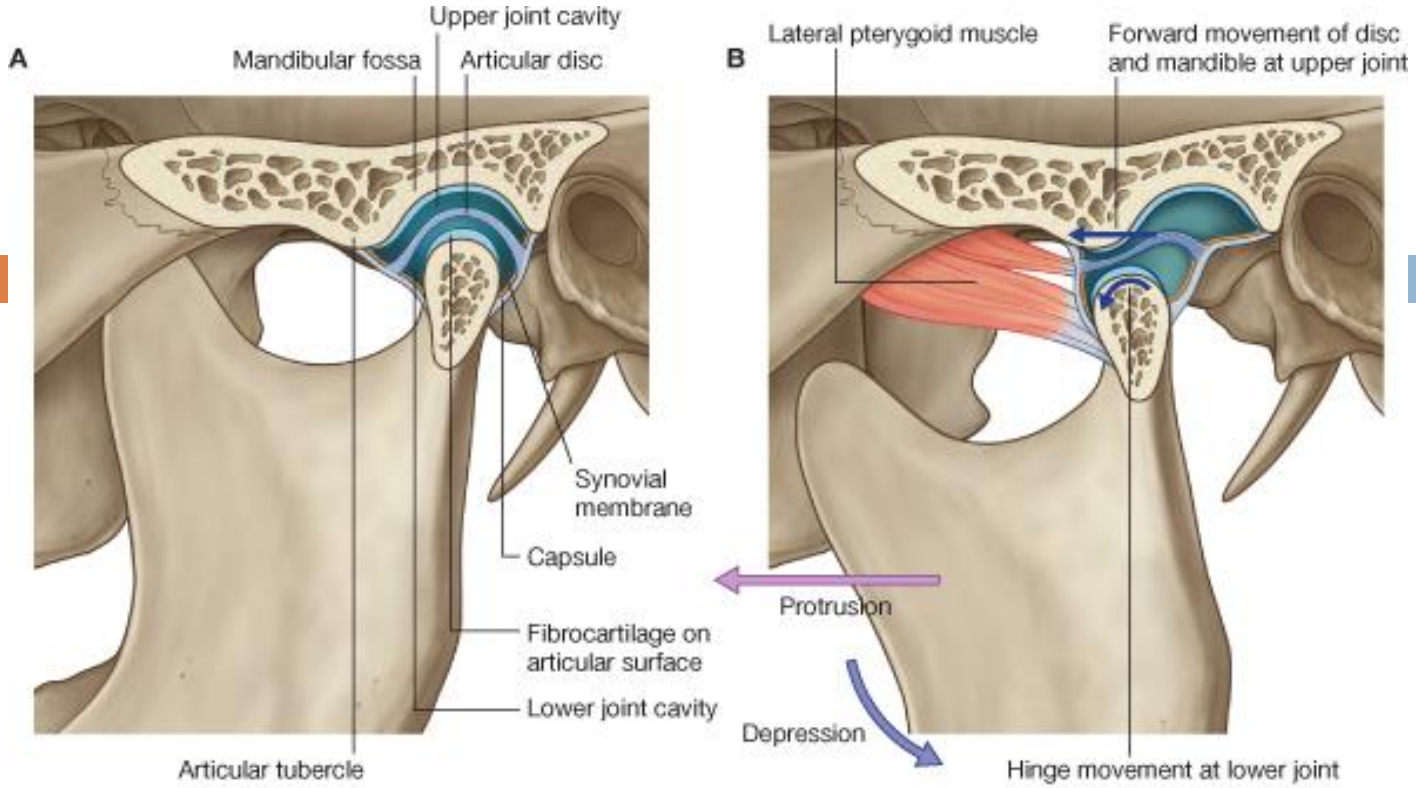
Cont.

- The body of the mandible in neonates is a mere shell lacking an alveolar part with each half enclosing five deciduous teeth.
- These teeth usually begin to erupt in infants at approximately 6 months of age.
- The body of the mandible elongates particularly posterior to the mental foramen, to accommodate this development.
- Later, eight permanent teeth begin to erupt during the 6th year of life.
- Eruption of the permanent teeth is not complete until early adulthood.

Temporomandibular Joint

- Synovial type joint b/n mandibular fossa & articular tubercle of zygomatic arch superiorly, & the condyle of mandible inferiorly.
- An articular disc separates the joint cavity into 2 cavities, an upper & lower compartments, each lined by a separate synovial membrane.

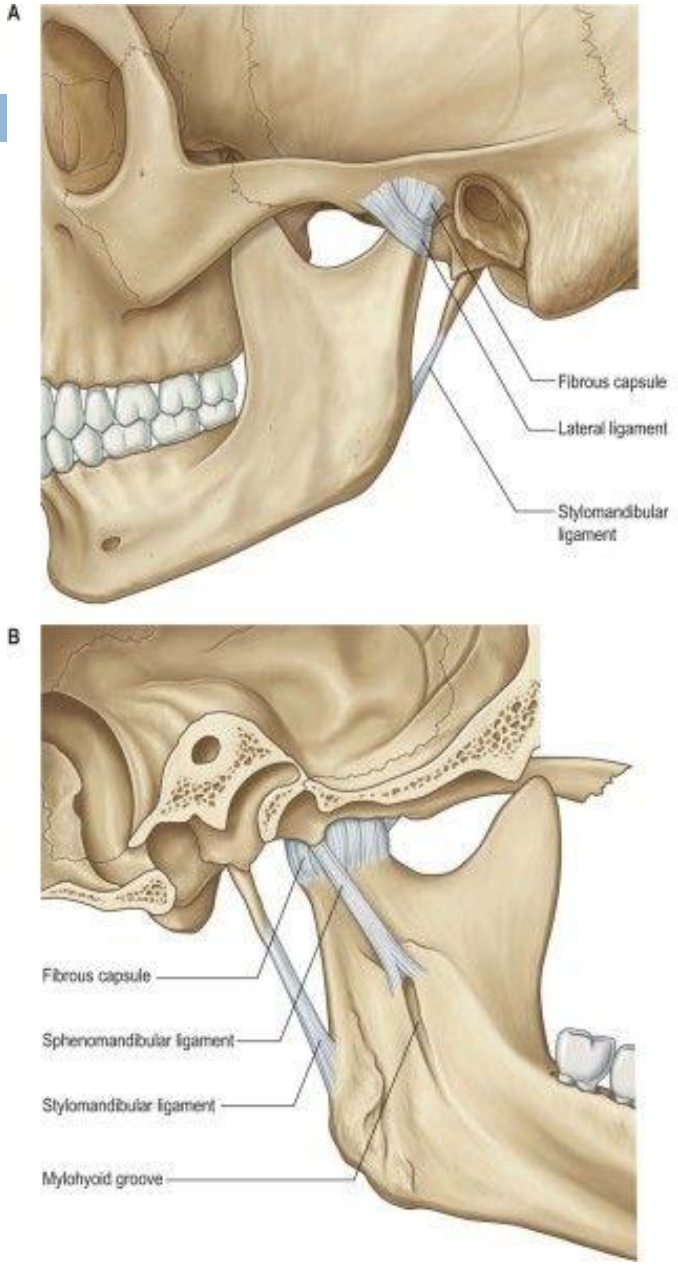




- The **upper joint:** is b/n ***mandibular (articular) fossa*** *of the temporal bone* & *the* ***articular disc*** ➔ *it* provides a ***sliding motion:***
  - ➔ ***Disc*** plus ***condyle*** *move forward onto articular tubercle* (***protrusion*** & ***retraction*** movements) when the ***lateral pterygoid*** contracts.
- The **lower joint:** is b/n ***articular disc & head of the condyle of mandible***:
  - ➔ the action here is a ***hinge-like action*** **:** ➔ Condyle rotates beneath disc (***depression & elevation*** movements), in which the mandible drops, thereby ***opening the mouth.***

TMJ - Ligaments

- 1- Lateral temporomandibular ligament:
  - Lateral to TMJ
  - Runs diagonally backwards from margin of the articular tubercle to the neck of mandible.
- 2- Sphenomandibular ligament:
  - Medial to TMJ
  - Runs from the spine of the sphenoid to Lingula on the ramus of mandible.
  - It is the primary passive support of mandible.
- 3- Stylomandibular ligament:
  - Posterior to the TMJ
  - Runs from styloid process of temporal bone to the posterior margin & angle of mandible.



Clinical Note

- ***Dislocation of jaw (mandible):***

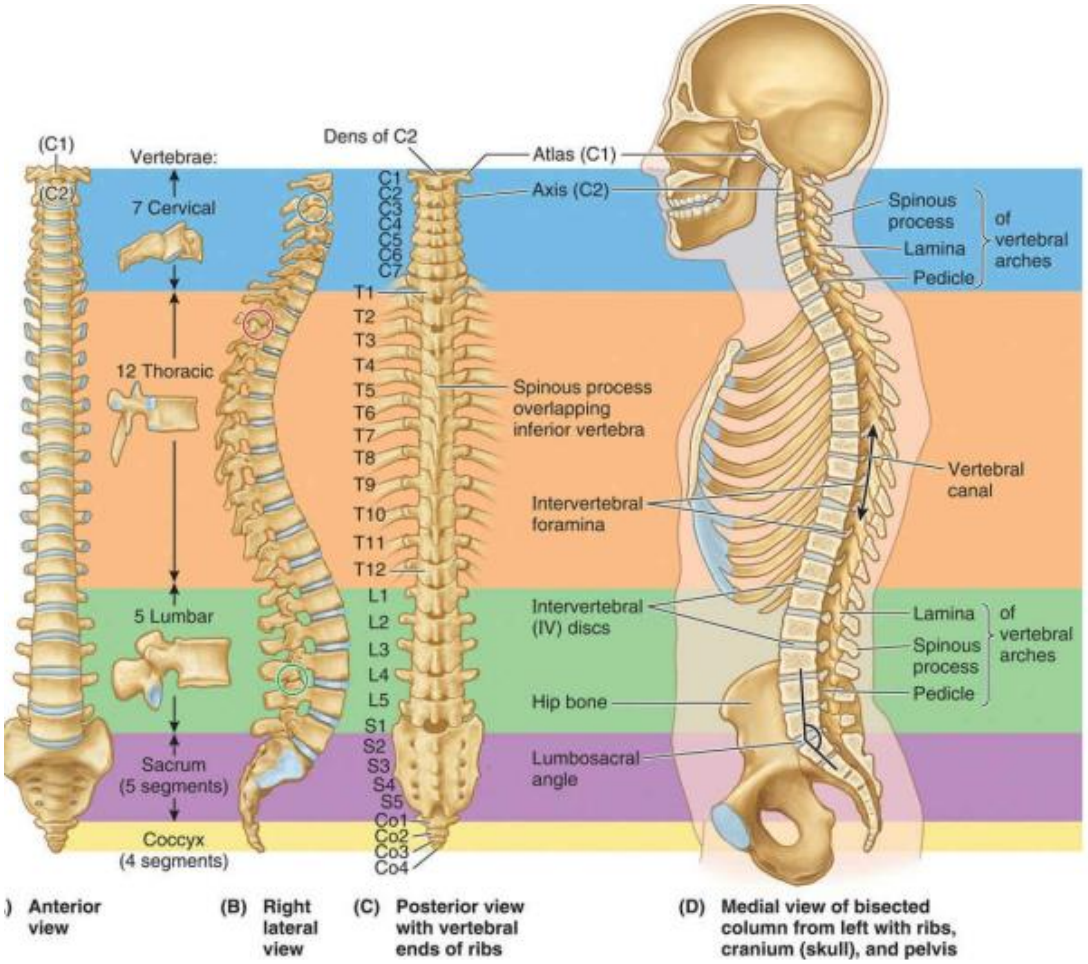
➔Usually an ***anterior dislocation:*** When the jaw is open, the disc and condyle have moved forward on to the articular tubercle.

- During yawning or a blow or when taking large bites, excessive contraction of the lateral pterygoids can cause the head of the mandible to dislocate (pass anterior to the articular tubercle): ➔ forward dislocation:

➔ In this position, the mouth remains wide open & the person cannot close it without manual distraction.

- **TREATMENT:** Press down on molar teeth with thumbs and at same time pull up chin.

VERTEBRAL COLUMN

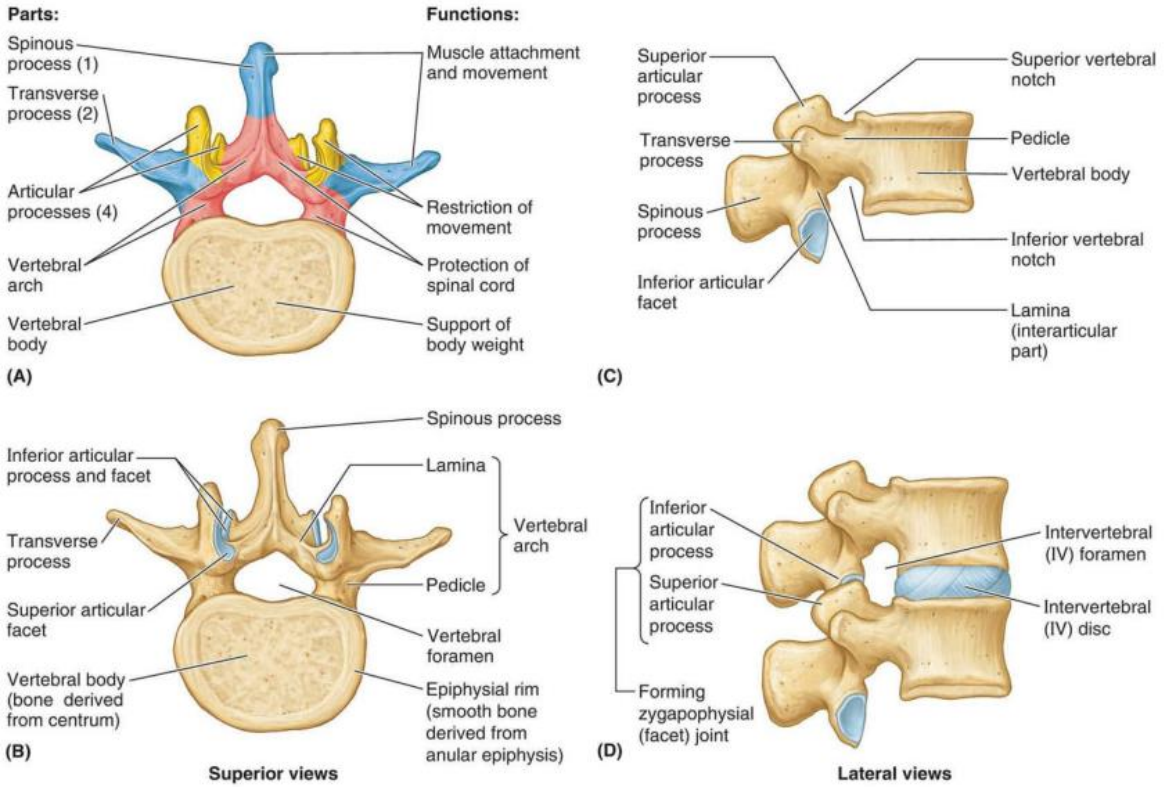


- Extends from the cranium (skull) to the apex of the coccyx.
- In adults, it is 72–75 cm long, of which approximately one quarter is formed by the IV discs
- Formed by the vertebrae and intervertebral (IV) discs.
- Comprises 33 vertebrae in normal adult: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, 4 coccygeal

FUNCTION

- Protects the spinal cord and spinal nerves.
- Supports the weight of the body superior to the level of the pelvis
- Provides a partly rigid and flexible axis for the body and an extended base on which the head is placed and pivots.
- Plays an important role in posture and *locomotion* (the movement from one place to another)

Structure and Function of Vertebrae



A **typical vertebra has:**

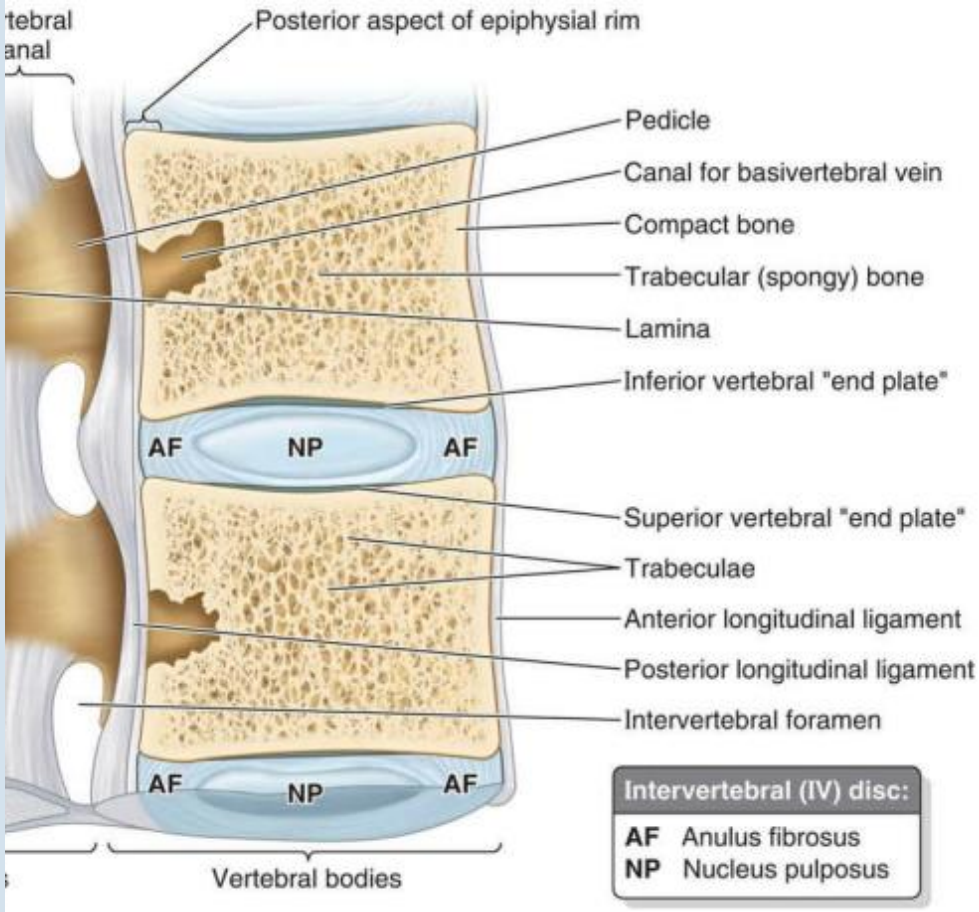
- the vertebral body
- a vertebral arch,
- and seven processes:
  - three for muscle attachment and leverage (*blue*) and
  - four that participate in synovial joints with adjacent vertebrae (*yellow*).

Cont.

- **Articular Processes**
  - **Superior** and **inferior articular processes** project from junction of pedicle and lamina separated by **pars interarticularis**
  - Form synovial **zygapophysial (facet) joints** with articular processes of adjacent vertebrae
  - Bear weight only temporarily, as when one rises from the flexed position, and unilaterally, when the cervical vertebrae are laterally flexed to their limit.
  - *However, the inferior articular processes of the L5 vertebra bear weight even in the erect posture.* Why???
- Vertebral Foramen
  - Space enclosed by vertebral arch and body
  - Collectively form **vertebral canal** for **spinal cord** and meninges
- **Intervertebral Foramina**
  - Formed between inferior and superior vertebral notches in pedicles of adjacent vertebrae
  - Transmit spinal nerves and related blood vessels

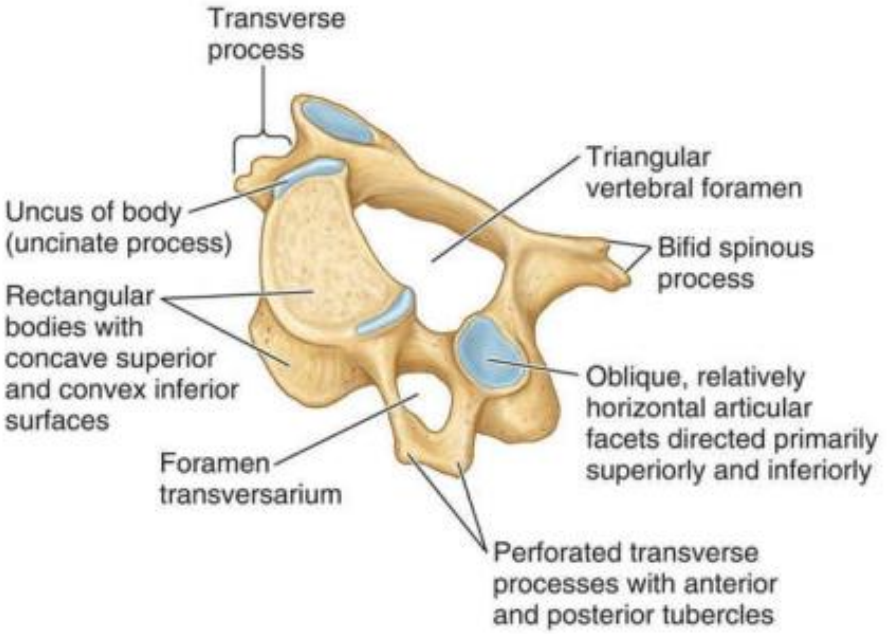
Internal aspects of vertebral bodies and vertebral canal

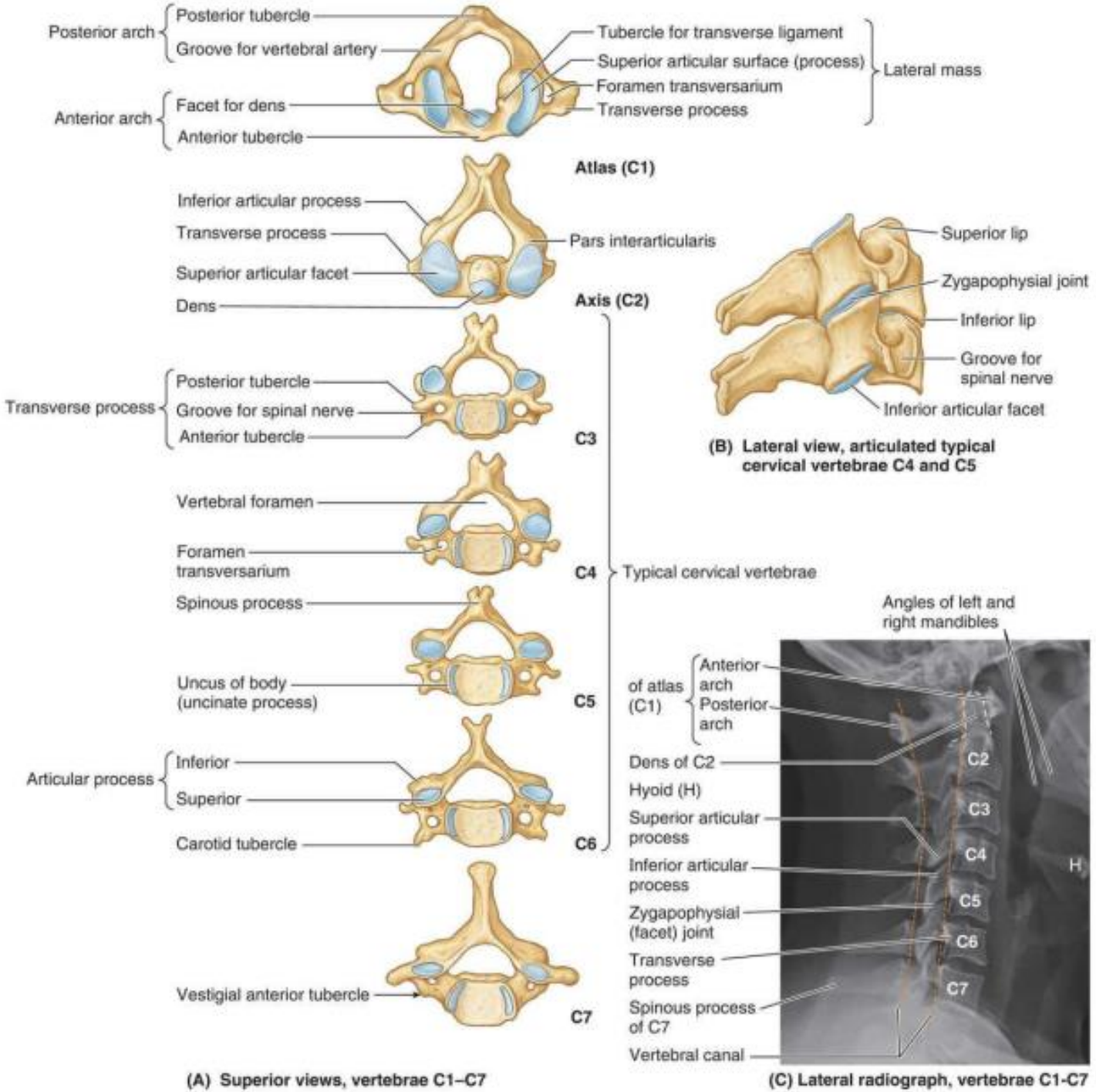
- The vertebral body consists of vascular, trabecular (spongy, cancellous) bone enclosed by a thin external layer of compact bone
- Has marrow
- One or more large foramina in the posterior surface of the vertebral body accommodate basivertebral veins that drain the marrow
- Hyaline cartilage “end plates” cover the superior and inferior surfaces of the bodies, surrounded by smooth bony epiphysial rims.



CERVICAL VERTEBRAE

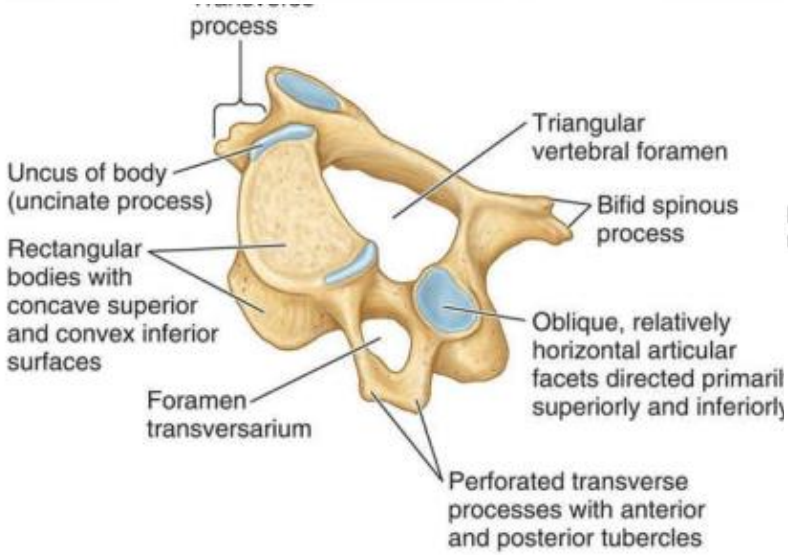
- The smallest of the 24 movable vertebrae
- bear less weight than do the larger inferior vertebrae.
- Although the cervical IV discs are thinner than those of inferior regions, they are relatively thick compared to the size of the vertebral bodies they connect.
- The relative thickness of the IV discs, the nearly horizontal orientation of the articular facets, and the small amount of surrounding body mass give the cervical region the greatest range and variety of movement of all the vertebral regions.

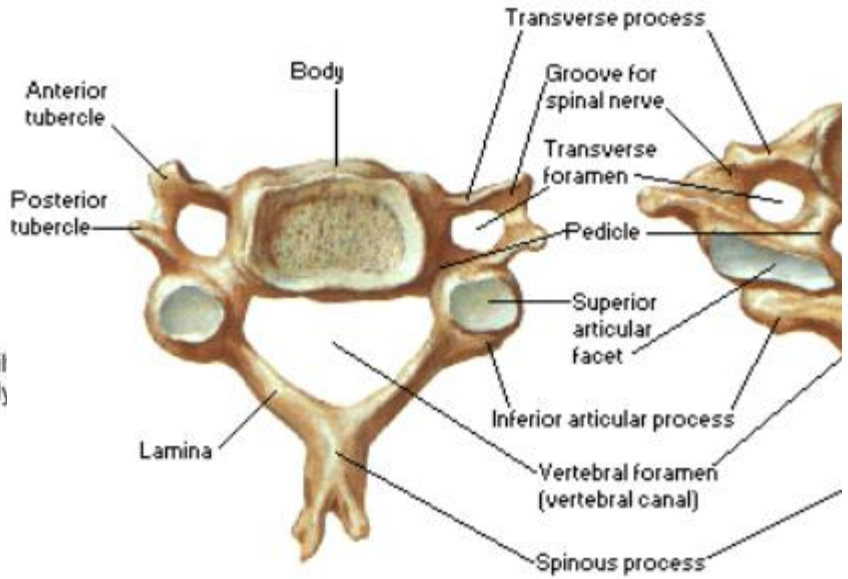



Posterior arch
Posterior tubercle
Groove for vertebral artery
Anterior arch
Facet for dens
Anterior tubercle
Tubercle for transverse ligament
Superior articular surface (process)
Foramen transversarium
Transverse process
Lateral mass
Atlas (C1)
Inferior articular process
Transverse process
Superior articular facet
Dens
Pars interarticularis
Axis (C2)
Transverse process
Posterior tubercle
Groove for spinal nerve
Anterior tubercle
C3
Vertebral foramen
Foramen transversarium
C4
Typical cervical vertebrae
Spinous process
Uncus of body (uncinate process)
C5
Articular process
Inferior
Superior
Carotid tubercle
C6
Vestigial anterior tubercle
C7
(A) Superior views, vertebrae C1–C7
Superior lip
Zygapophysial joint
Inferior lip
Groove for spinal nerve
Inferior articular facet
(B) Lateral view, articulated typical cervical vertebrae C4 and C5
Angles of left and right mandibles
of atlas (C1)
Anterior arch
Posterior arch
Dens of C2
Hyoid (H)
Superior articular process
Inferior articular process
Zygapophysial (facet) joint
Transverse process
Spinous process of C7
Vertebral canal
C2
C3
C4
C5
C6
C7
H
(C) Lateral radiograph, vertebrae C1-C7

Typical cervical vertebrae

Part	Characteristics
Vertebral body	Small and wider from side to side than anteroposteriorly; superior surface concave with uncus of body (uncinate process); inferior surface convex
Vertebral foramen	Large and triangular
Transverse processes	Foramina transversarii and anterior and posterior tubercles; vertebral arteries and accompanying venous and sympathetic plexuses pass through foramina transversarii of all cervical vertebrae except C7, which transmits only small accessory vertebral veins
Articular processes	Superior facets directed superoposteriorly; inferior facets directed infero-anteriorly; obliquely placed facets are most nearly horizontal in this region
Spinous processes	Short (C3–C5) and bifid (C3–C6); process of C6 long, that of C7 is longer (thus C7 is called "vertebra prominens")

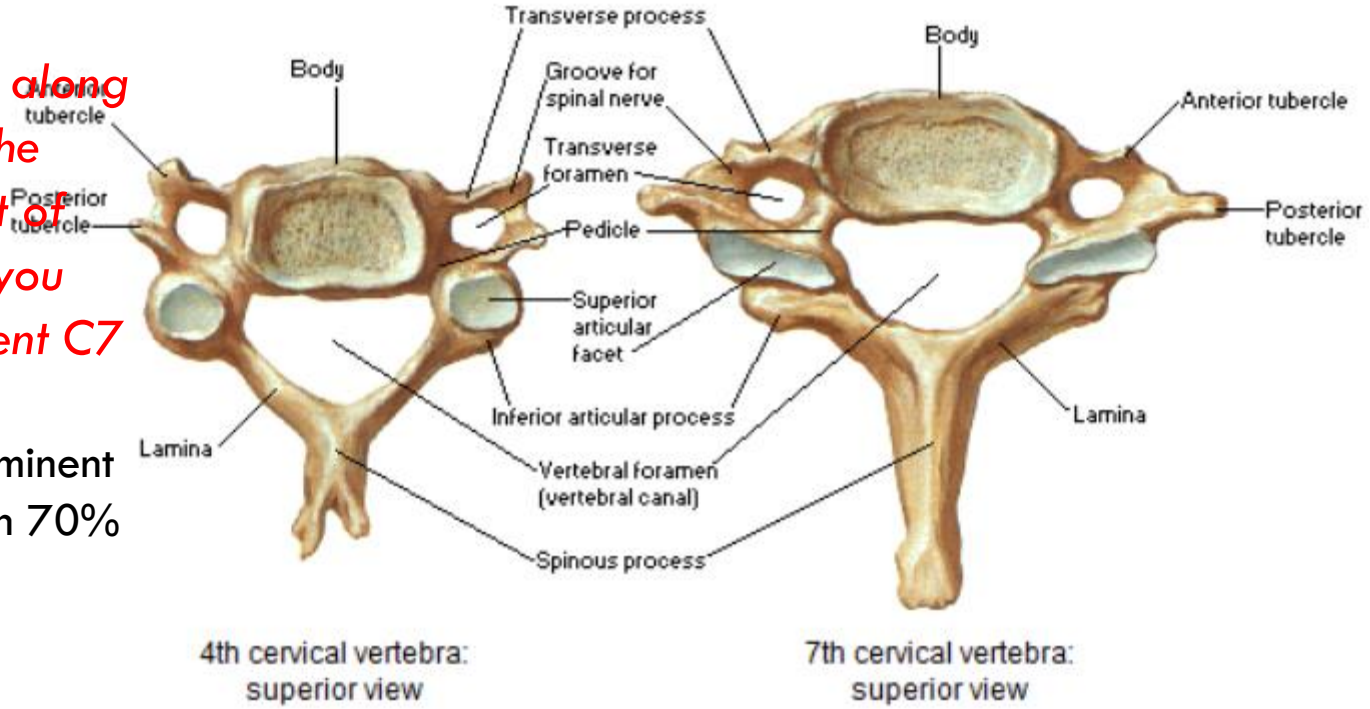




Cont.

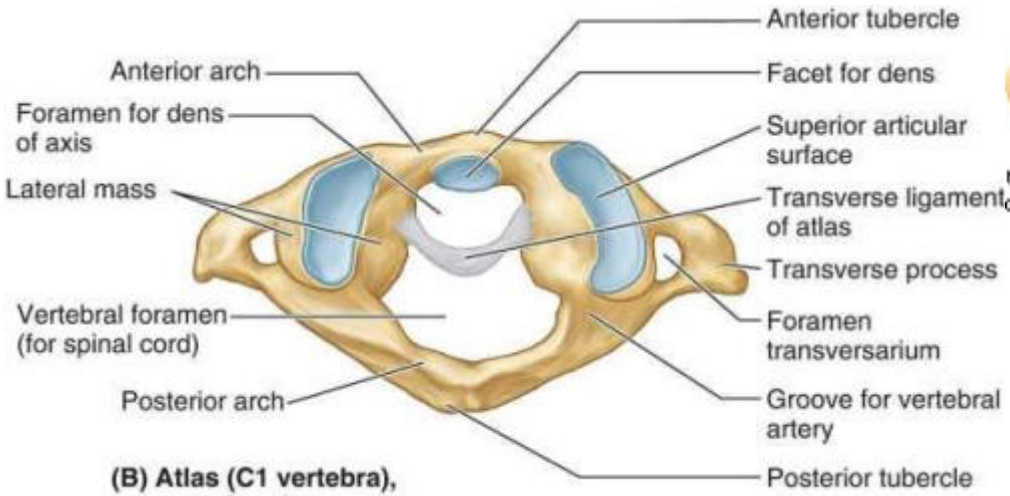
- The spinous processes of the C3–C6 vertebrae are short and usually bifid in white people, especially males, but usually not as commonly in people of African descent or in females.
- C7(**vertebra prominens**) has a long spinous process.

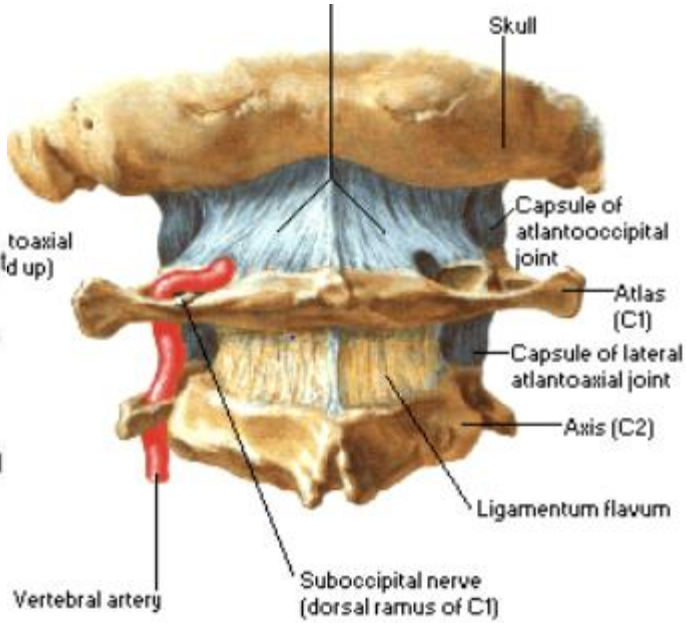
- *Run your finger along the midline of the posterior aspect of your neck until you feel the prominent C7 spinous* process.
- It is the most prominent spinous process in 70% of people



Atypical cervical vertebrae

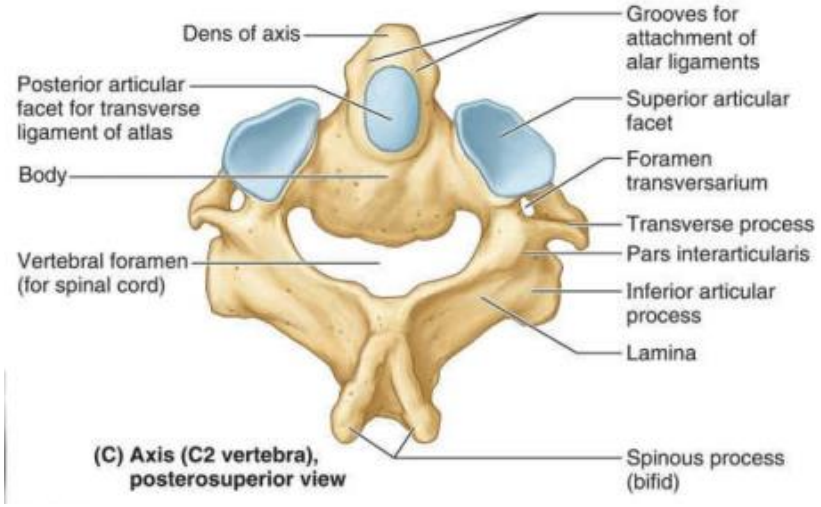
- **Vertebra C1, atlas,**
  - **It has neither a body nor a spinous process.**
  - Has anterior and posterior arches with paired lateral masses
  - Has Long and stout transverse process with foramen
  - Articulate with skull at atlanto-occipital joints and with axis at atlantoaxial joints

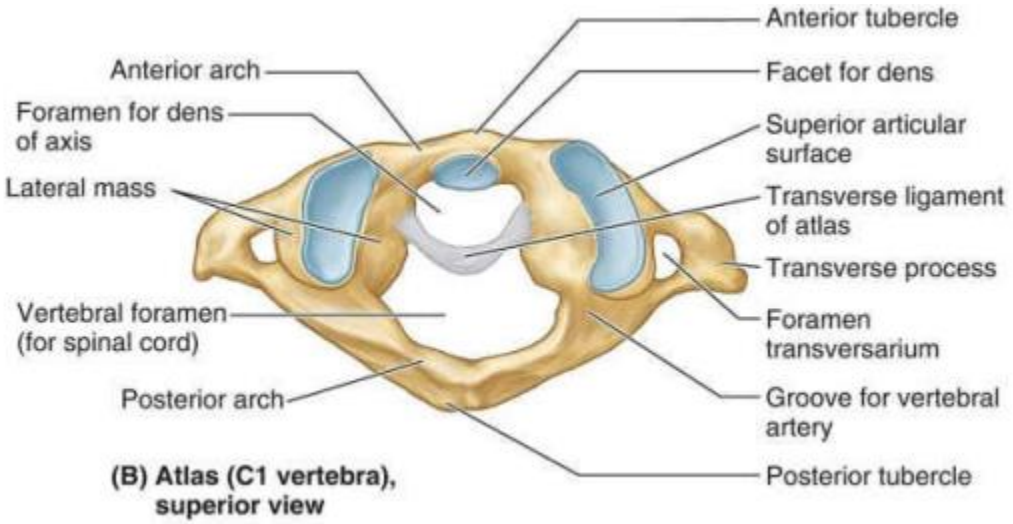




Atypical cervical vertebrae

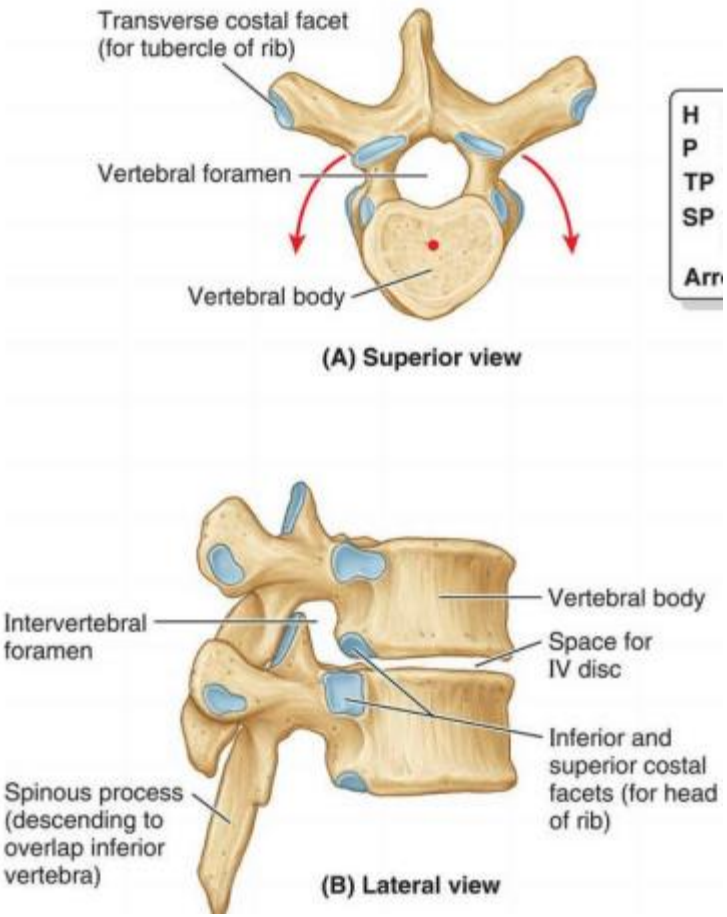
- **Vertebra C2 (axis)**
  - The strongest of the cervical vertebrae
  - The axis has two large, flat bearing surfaces, the superior articular facets, on which the atlas rotates.
  - Odontoid process is distinguishing feature of C2
  - The dens is held in position against the posterior aspect of the anterior arch of the atlas by the transverse ligament of the atlas.
  - Thus, it prevents posterior (horizontal) displacement of the dens and anterior displacement of the atlas.





THORACIC VERTEBRAE

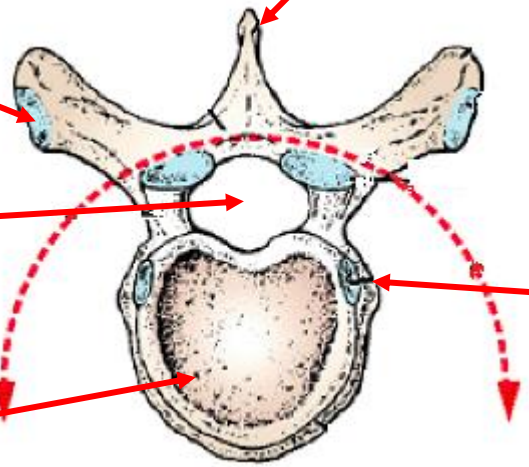
- The twelve thoracic vertebrae are all characterized by their articulation with ribs.
- A typical thoracic vertebra has two partial facets (superior and inferior costal facets) or each side of the vertebral body for articulation with the head of its own rib and the head of the rib below.
- The superior costal facet is much larger than the inferior costal facet.
- Each transverse process also has a facet (transverse costal facet) for articulation with the tubercle of its own rib.
- The vertebral body of the vertebra is somewhat heart-shaped when viewed from above, and the vertebral foramen is circular.



THORACIC VERTEBRAE

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).

The **spines** are long and inclined downward.



The **vertebral foramen** is small and circular

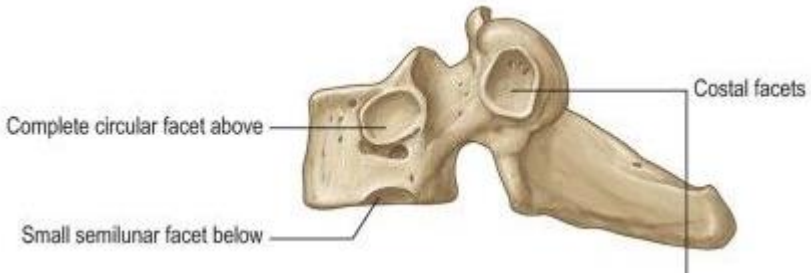
Costal facets are present on the sides of the bodies for articulation with the heads of the ribs.

The **body** is medium size and heart shaped.

The **superior articular processes** bear facets that face backward and laterally, whereas the facets on the **inferior articular processes** face forward and medially. The inferior articular processes of the 12th vertebra face laterally, as do those of the lumbar vertebrae.

Cont.

- The T1–T4 vertebrae share some features of cervical vertebrae.
- T1 is atypical of thoracic vertebrae
  - Has a long, almost horizontal spinous process that may be nearly as prominent as that of the vertebra prominens.
  - Has a complete costal facet on the superior edge of its body for the 1st rib and a demifacet on its inferior edge that contributes to the articular surface for the 2nd rib.

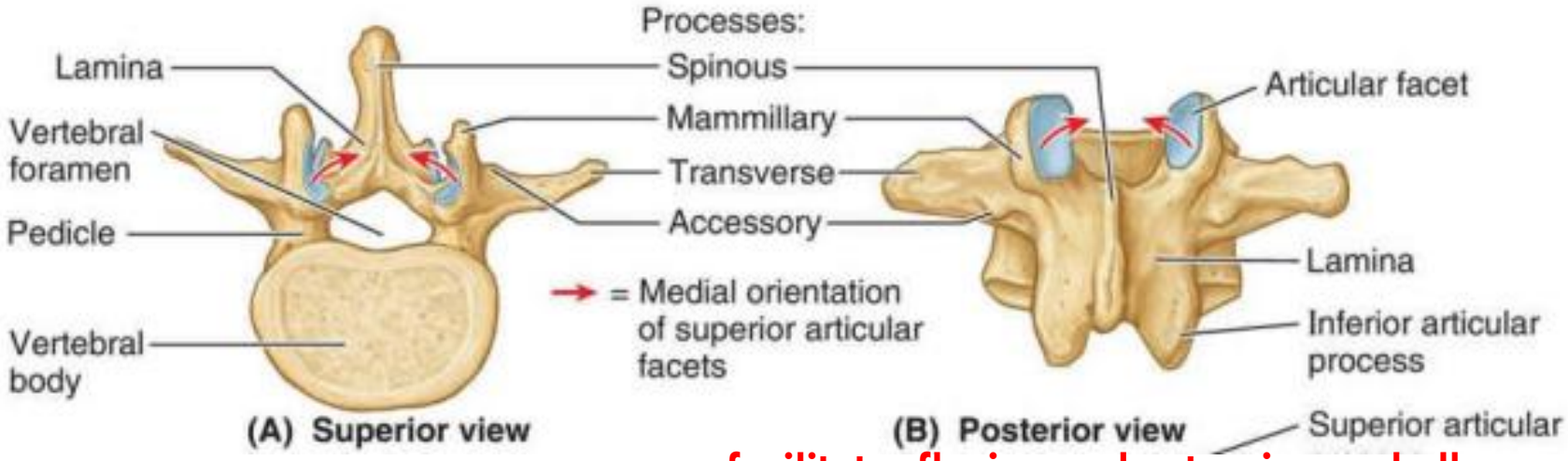


Cont.

- The T9–T12 vertebrae have some features of the lumbar vertebrae (e.g., tubercles are similar to the accessory processes).
  - Mammillary processes (small tubercles) also occur on vertebra T12.
- Vertebra T12
  - Most of the transition in characteristics of vertebrae from the thoracic to the lumbar region occurs over the length of T12.
  - Its superior half is thoracic in character, having costal facets and articular processes that permit primarily rotatory movement,
  - Its inferior half is lumbar in character, devoid of costal facets and having articular processes that permit only flexion and extension.
  - **Consequently, vertebra T12 is subject to transitional stresses that cause it to be the most commonly fractured vertebra.**

LUMBAR VERTEBRAE

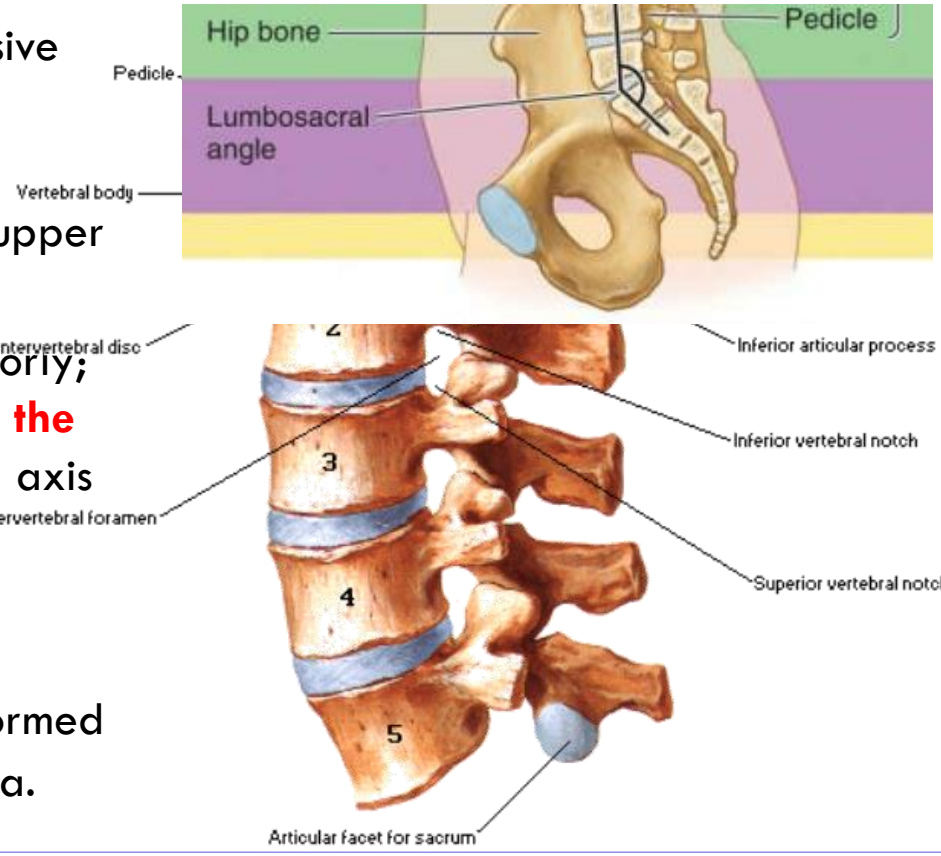
Part	Characteristics
Vertebral body	Massive; kidney shaped when viewed superiorly
Vertebral foramen	Triangular; larger than in thoracic vertebrae and smaller than in cervical vertebrae
Transverse processes	Long and slender; accessory process on posterior surface of the base of each process
Articular processes	Nearly vertical facets; superior facets directed posteromedially (or medially); inferior facets directed anterolaterally (or laterally); mammillary process on posterior surface of each superior articular process
Spinous processes	Short and sturdy; thick, broad, and hatchet shaped



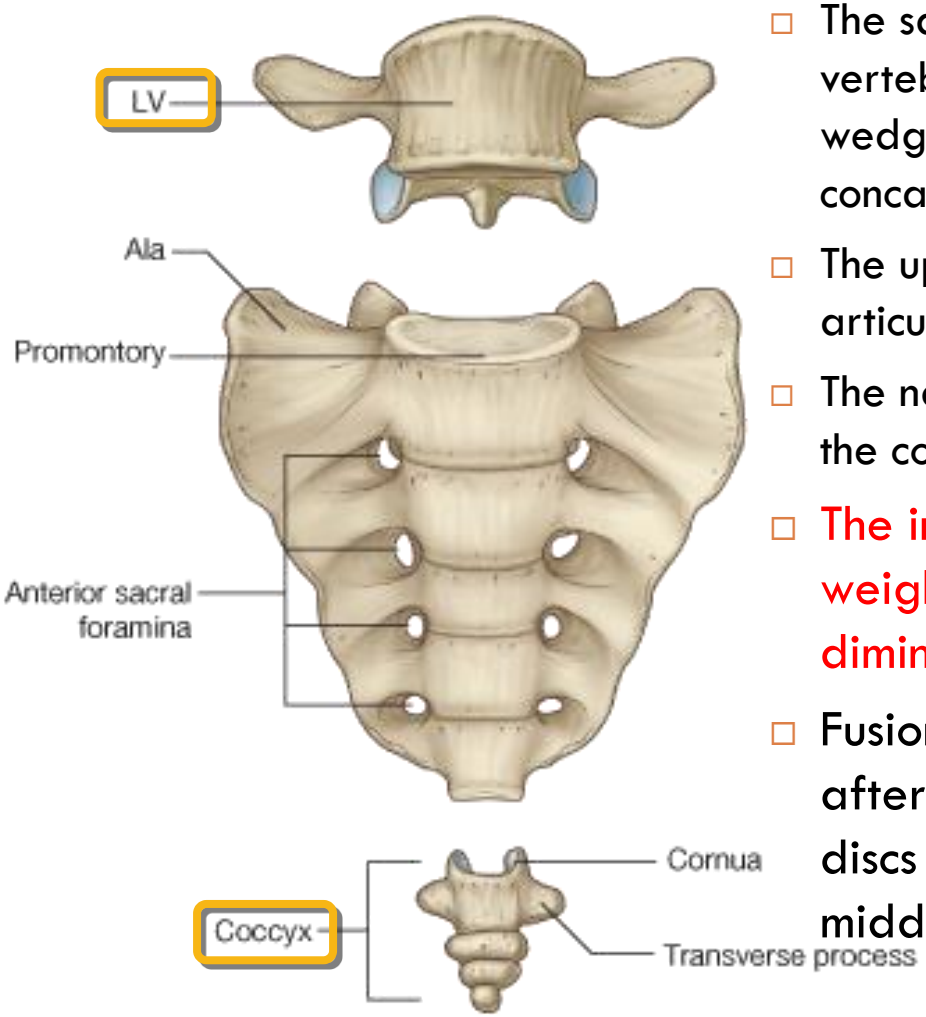
facilitates flexion and extension and allows lateral flexion but prohibits rotation.

Cont.

- Vertebra L5, distinguished by its massive body and transverse processes, is the largest of all movable vertebrae.
- It carries the weight of the complete upper body.
- The L5 body is markedly taller anteriorly; therefore, it is largely responsible for **the lumbosacral angle** between the long axis of the lumbar region of the vertebral column and that of the sacrum.
- Body weight is transmitted from L5 vertebra to the *base of the sacrum*, formed by the superior surface of S1 vertebra.



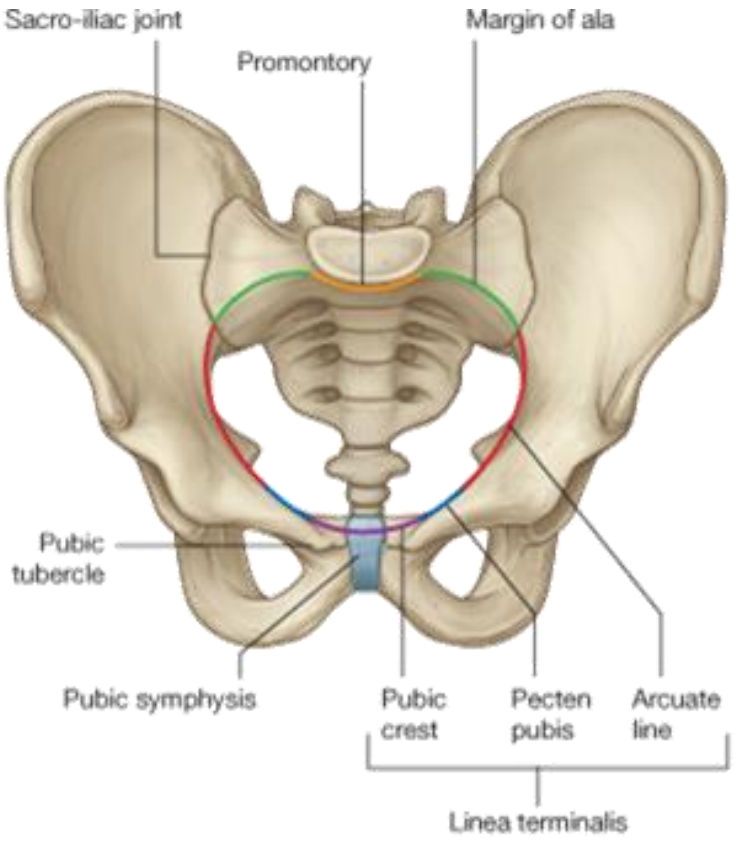
Sacrum



- The sacrum consists of five rudimentary vertebrae fused together to form a single wedge-shaped bone with a forward concavity.
- The upper border or base of the bone articulates with the fifth lumbar vertebra.
- The narrow inferior border articulates with the coccyx.
- The inferior half of the sacrum is not weight bearing; therefore, its bulk is diminished considerably. ????
- Fusion of the sacral vertebrae starts after age 20; however, most of the IV discs remain unossified up to or beyond middle life.

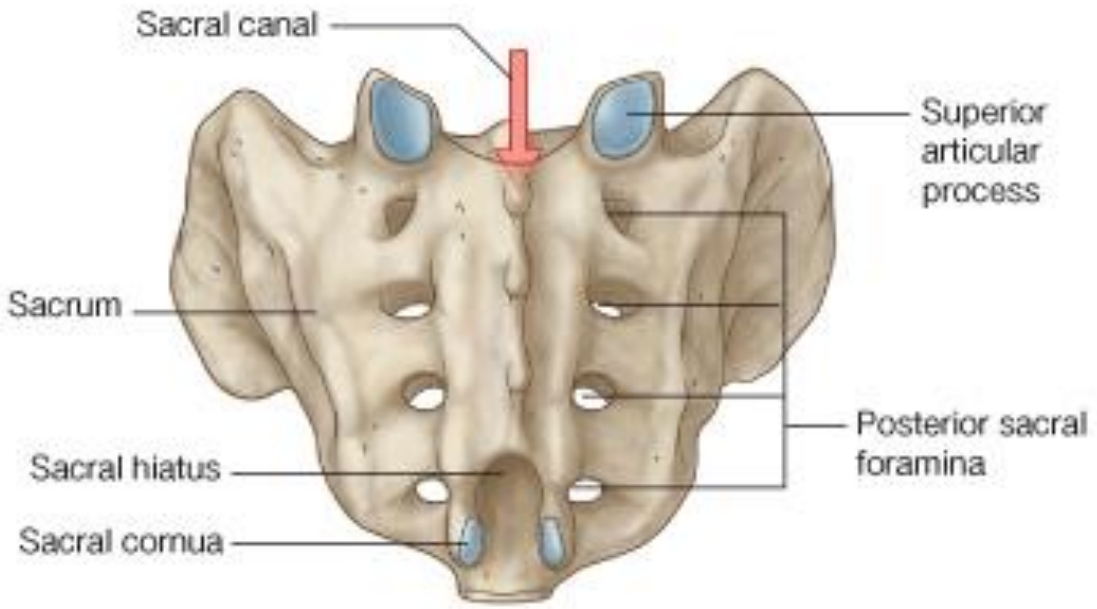
Cont.

- Laterally, the sacrum articulates with the two iliac bones to form the **sacroiliac joints.**
- The anterior and upper margins of the first sacral vertebra bulge forward as the posterior margin of the pelvic inlet—the **sacral promontory** —which is an *important obstetric landmark* used when measuring the size of the pelvis.



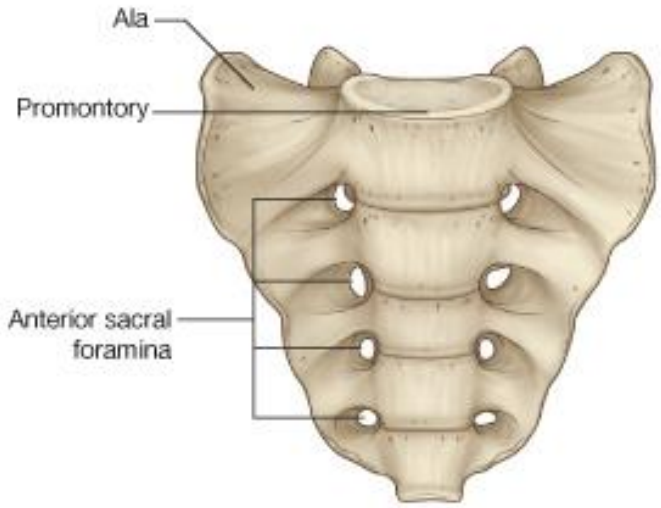
Cont.

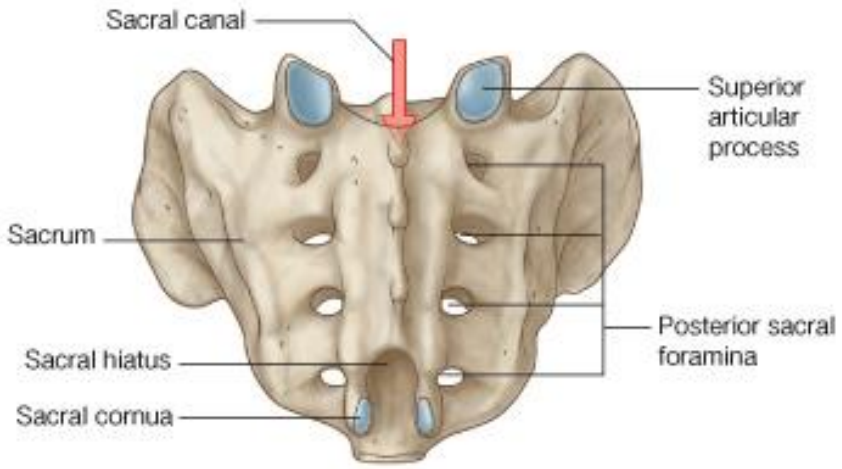
- The vertebral foramina together form the **sacral canal.**
- The laminae of the fifth sacral vertebra, and sometimes those of the fourth, fail to meet in the midline, forming the **sacral hiatus.**



Cont.

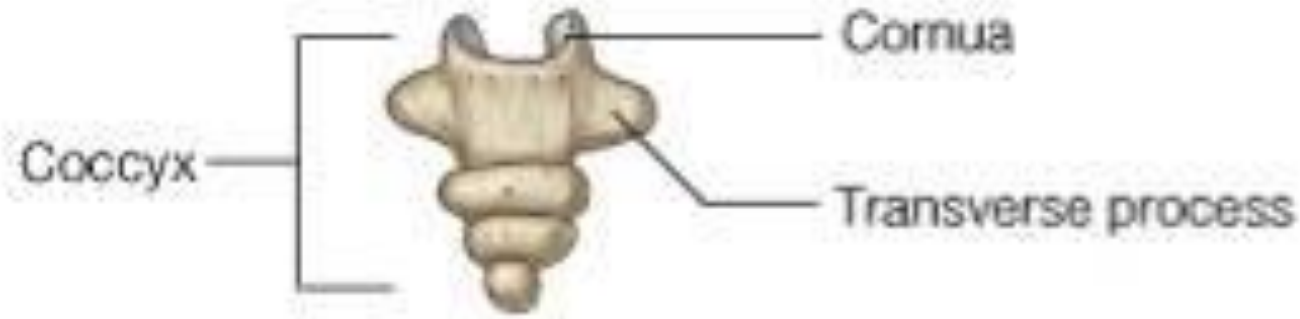
- The anterior and posterior surfaces of the sacrum possess on each side four **foramina** for the passage of the anterior and posterior rami of the upper four sacral nerves.
- The sacrum is usually wider in proportion to its length in the female than in the male.





The coccyx

- **The coccyx** consists of four vertebrae fused together to form a small triangular bone, which articulates at its base with the lower end of the sacrum.
- The coccygeal vertebrae consist of bodies only, but the first vertebra possesses a rudimentary **transverse process and cornua.**
- The cornua are the remains of the pedicles and superior articular processes and project upward to articulate with the sacral cornua.

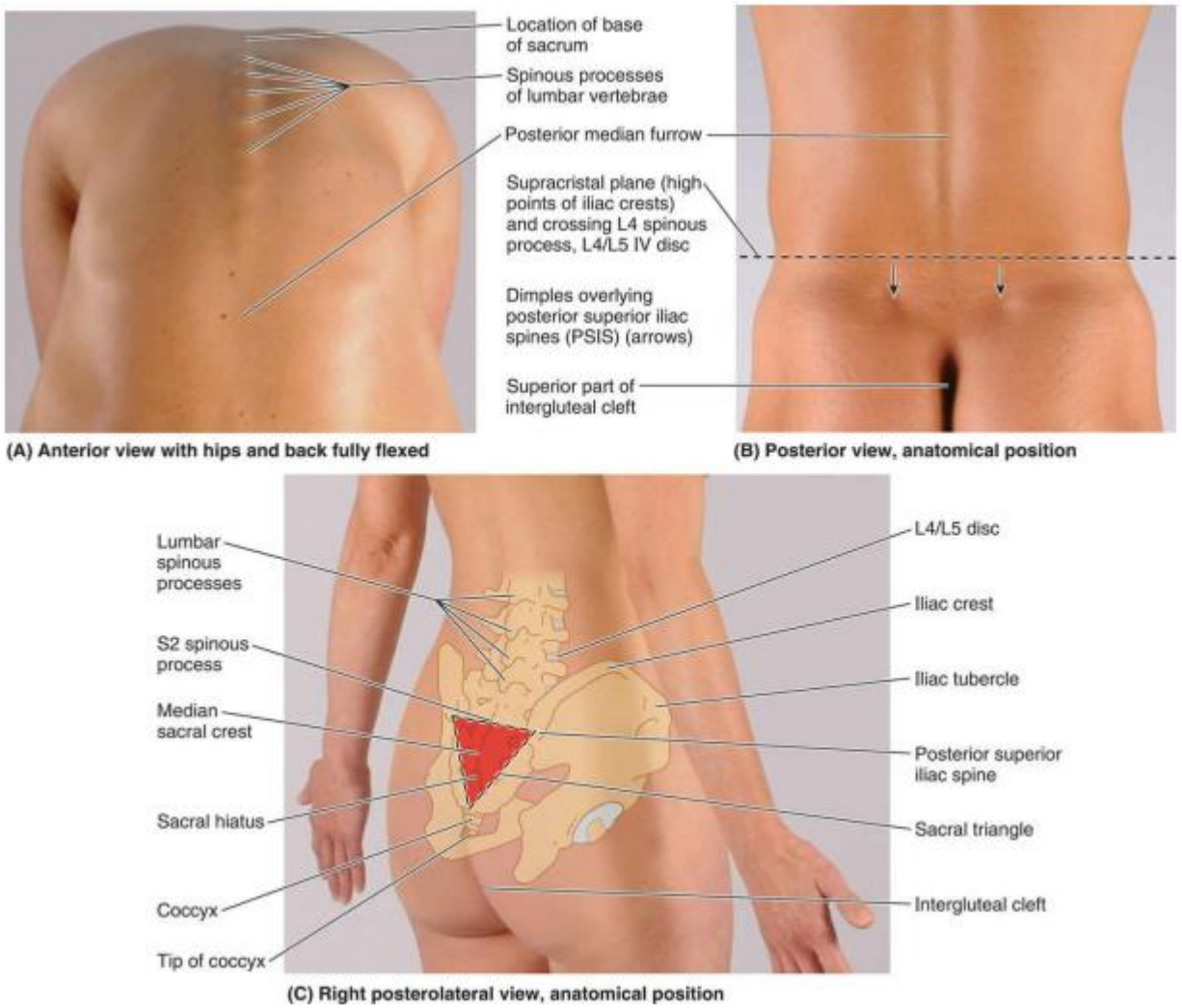


Cont.

- The coccyx does not participate with the other vertebrae in support of the body weight when standing; however, when sitting, it may flex anteriorly somewhat, indicating that it is receiving some weight.
- The coccyx provides attachments for parts of the gluteus maximus and coccygeus muscles and the *anococcygeal ligament*, the median fibrous band of the pubococcygeus muscles

Clinical significance

- L2
- L4
- IVD b/n L4 and L5



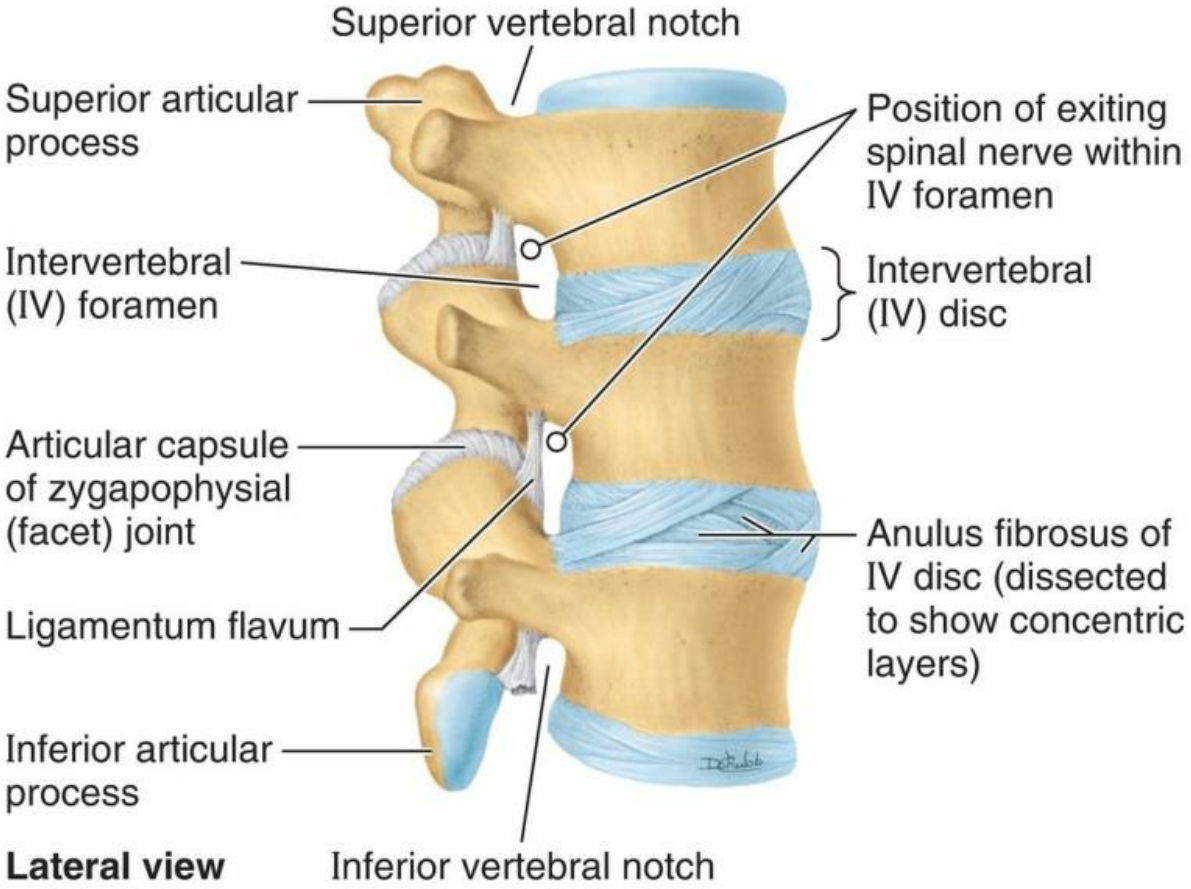
Variations in Vertebrae

- Variations in vertebrae are affected by race, gender, and developmental factors (genetic and environmental).
- An increased number of vertebrae occur more often in males and a reduced number occurs more frequently in females.
- Some races show more variation in the number of vertebrae.
- Variations in the number of vertebrae may be clinically important.
- An increased length of the presacral region of the vertebral column increases the strain on the inferior part of the lumbar region of the column owing to the increased leverage.
- However, most numerical variations are detected incidentally during diagnostic medical imaging studies being performed for other reasons and during dissections and autopsies of persons with no history of back problems.

Joints of Vertebral Column

- Joints of the vertebral bodies.
- Joints of the vertebral arches.
- Craniovertebral (atlanto-axial and atlanto-occipital) joints.
- Costovertebral joints
- Sacro-iliac joints

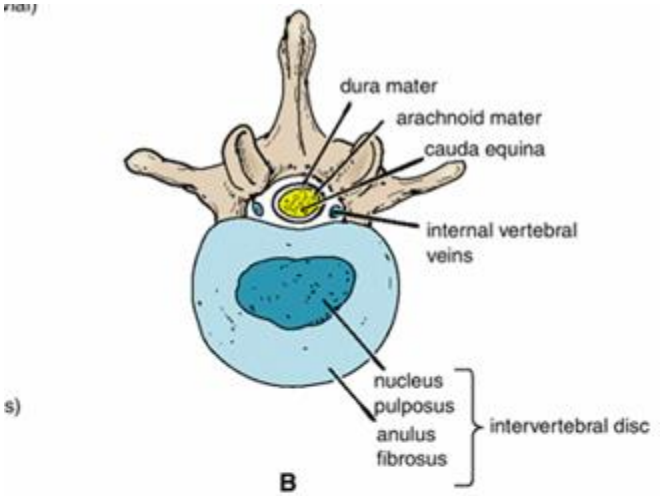
JOINTS OF VERTEBRAL BODIES

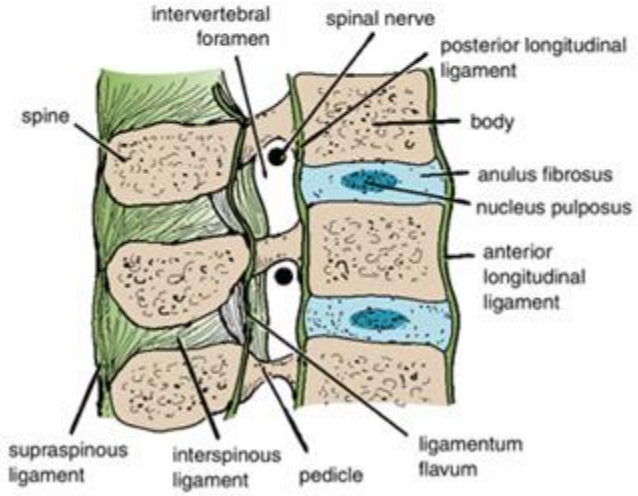


- The joints of the vertebral bodies are *symphyses (secondary cartilaginous joints)* designed for weight bearing and strength.
- The articulating surfaces of adjacent vertebrae are connected by IV discs and ligaments

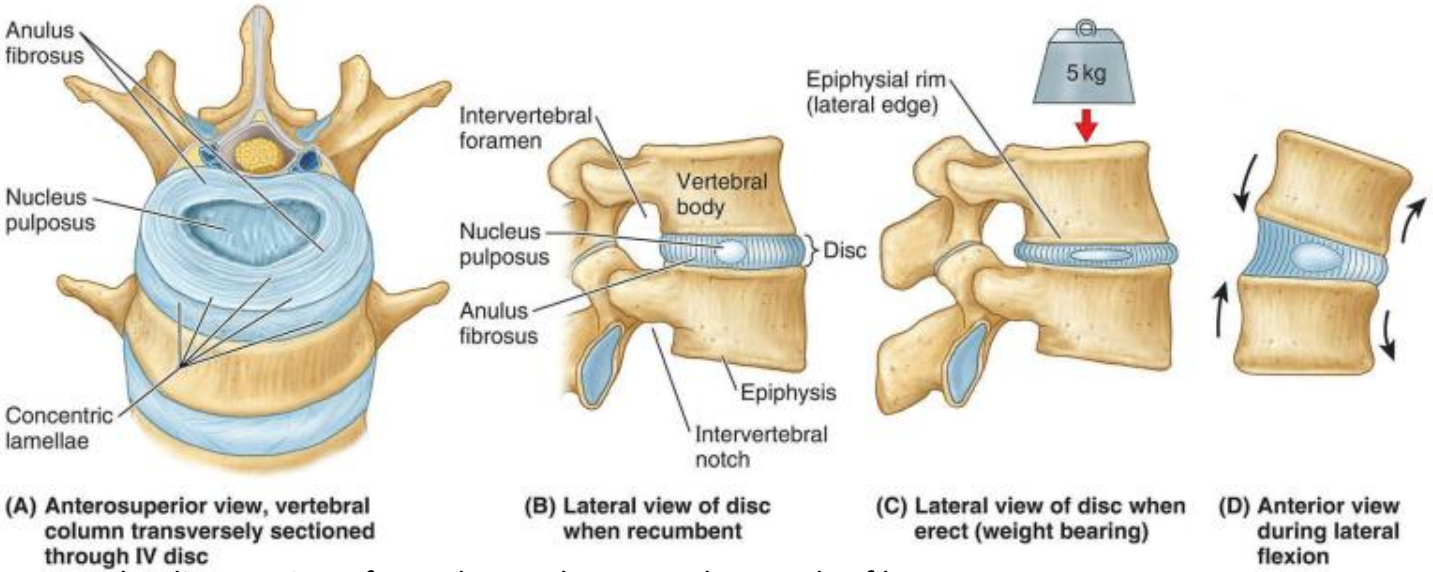
Intervertebral (IV) discs

- The intervertebral discs are responsible for one fourth of the length of the vertebral column
- They are thickest in the cervical and lumbar regions, where the movements of the vertebral column are greatest.
- Each disc consists of a:
  - Peripheral part, the anulus fibrosus, composed of fibrocartilage, which is thinner posteriorly and may be incomplete posteriorly in the adult in the cervical region
  - Central part, the nucleus pulposus, a mass of gelatinous material containing a large amount of water, a small number of collagen fibers, and a few cartilage cells.
- No discs are found between the first two cervical vertebrae or in the sacrum or coccyx.





Structure and function of IV discs



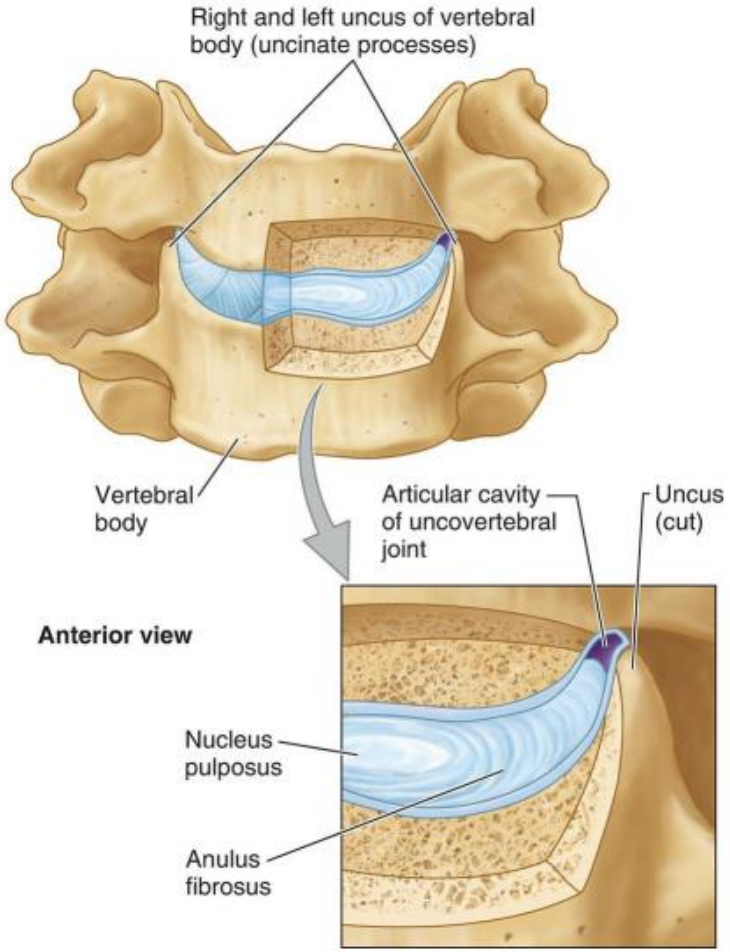
(A) Anterosuperior view, vertebral column transversely sectioned through IV disc **(B) Lateral view of disc when recumbent** **(C) Lateral view of disc when erect (weight bearing)** **(D) Anterior view during lateral flexion**

- A. The disc consists of a nucleus pulposus and an anulus fibrosus.
- The combined thickness of the rings of the anulus is diminished posteriorly that is, the anulus is thinner posteriorly.
- **B.** The fibrogelatinous nucleus pulposus occupies the center of the disc and acts as a cushion and shock-absorbing mechanism.
- **C.** The pulpy nucleus flattens and the anulus bulges when weight is applied, as occurs during standing and more so during lifting. **D.** During flexion and extension movements, the nucleus pulposus serves as a fulcrum.
- **The anulus becomes decreasingly vascularized centrally, and only the outer third of the anulus receives sensory innervation.**

Cont.

- There is no IV disc between C1 and C2 vertebrae; the most inferior functional disc is between L5 and S1 vertebrae.
- The discs vary in thickness in different regions.
- The thickness of the discs increases as the vertebral column descends.
- However, their thickness relative to the size of the bodies they connect is most clearly related to the range of movement, and relative thickness is greatest in the cervical and lumbar regions.
- Their thickness is most uniform in the thoracic region.
- The discs are thicker anteriorly in the cervical and lumbar regions, their varying shapes producing the secondary curvatures of the vertebral column

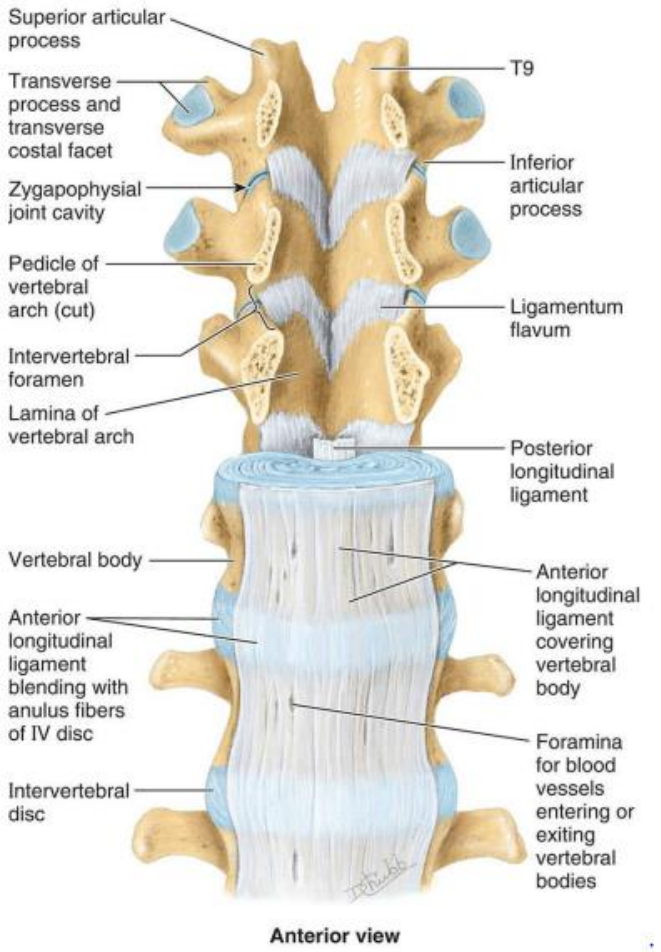
Uncovertebral joints (of Luschka)



- Joint like structures that can develop postnatally in cervical spine between lips of bodies of adjacent vertebrae.
- Commonly develop between the unci of the bodies of C3 or C4–C6 or C7 vertebrae and the beveled inferolateral surfaces of the vertebral bodies superior to them after 10 years of age
- These joints are at the posterolateral margins of the IV discs.

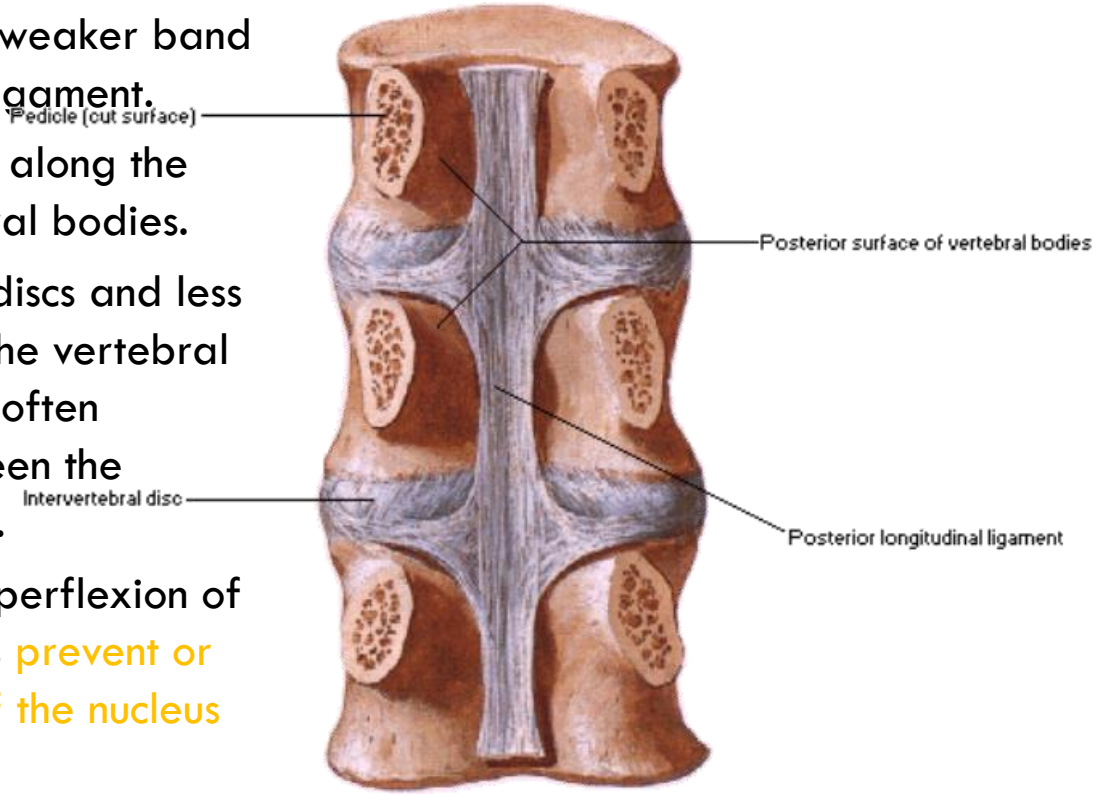
The anterior longitudinal ligament

- The ligament extends longitudinally from the pelvic surface of the sacrum to the anterior tubercle of vertebra C1 and the occipital bone anterior to the foramen magnum are the superiormost parts, the anterior atlanto-axial and atlanto-occipital ligaments.
- Although thickest on the anterior aspect of the vertebral bodies, the anterior longitudinal ligament also covers the lateral aspects of the bodies to the IV foramen.
- Prevents hyperextension of the vertebral column, maintaining stability of the joints between the vertebral bodies.



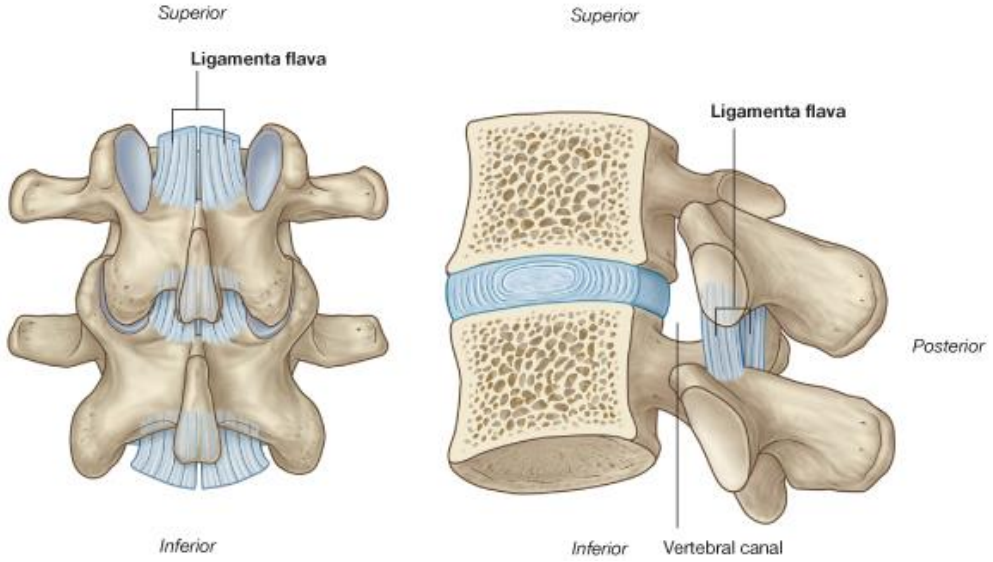
The **posterior longitudinal ligament**

- Is a much narrower, somewhat weaker band than the anterior longitudinal ligament.
- Runs within the vertebral canal along the posterior aspect of the vertebral bodies.
- It is attached mainly to the IV discs and less so to the posterior aspects of the vertebral bodies from C2 to the sacrum, often bridging fat and vessels between the ligament and the bony surface.
- This ligament weakly resists hyperflexion of the vertebral column and helps prevent or redirect posterior herniation of the nucleus pulposus.
- *It is well provided with nociceptive (pain) nerve endings.*



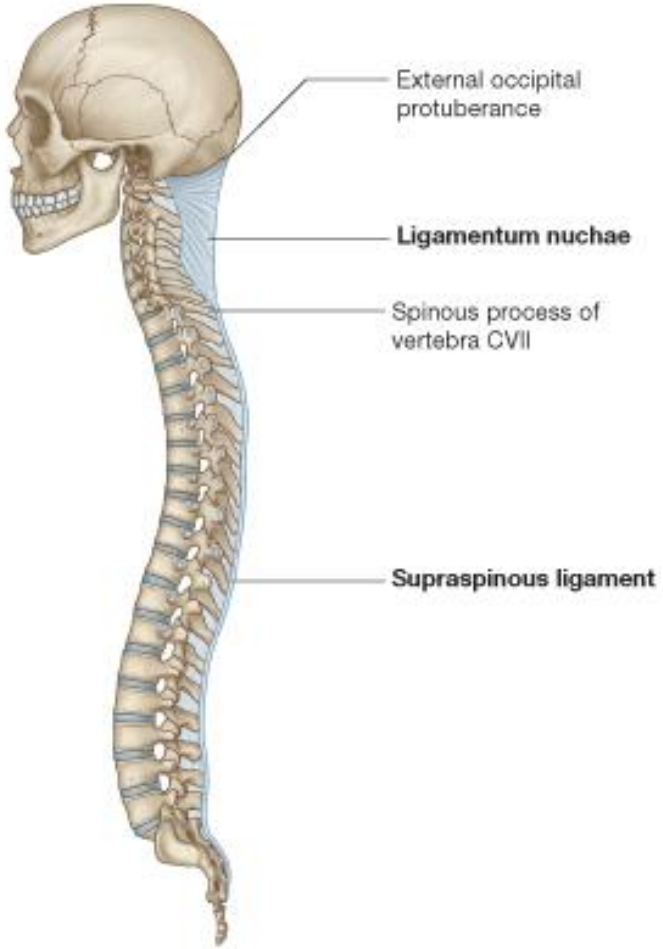
Ligamenta flava

- The **ligamenta flava**, on each side, pass between the laminae of adjacent vertebrae.
- These thin, broad ligaments consist predominantly of elastic tissue and form part of the posterior surface of the vertebral canal.
- Each ligamentum flavum runs between the posterior surface of the lamina on the vertebra below to the anterior surface of the lamina of the vertebra above.
- The ligamenta flava resist separation of the laminae in flexion and assist in extension back to the anatomic position.



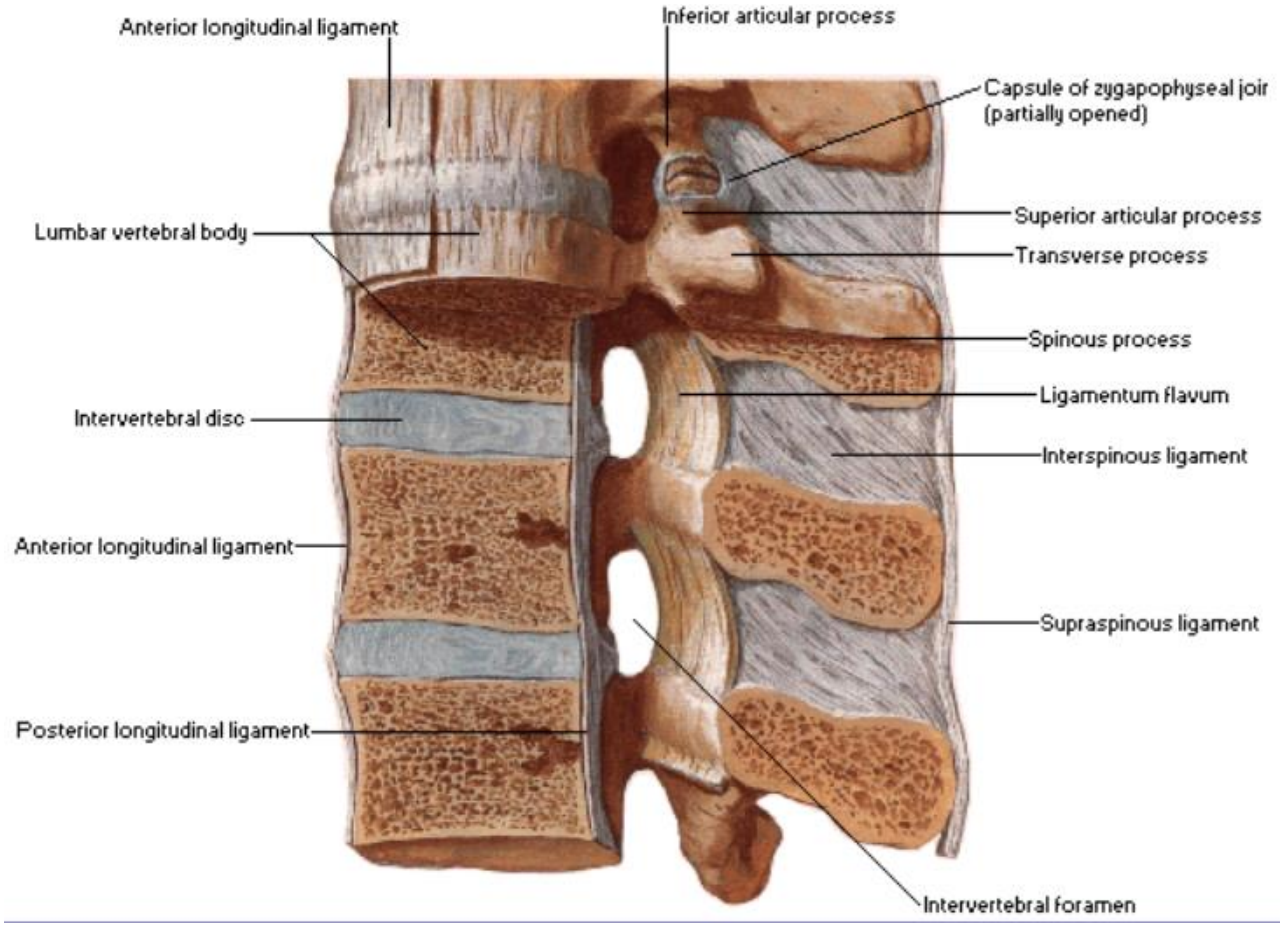
Supraspinous ligament and ligamentum nuchae

- The supraspinous ligament connects and passes along the tips of the vertebral spinous processes from vertebra CVII to the sacrum.
- From vertebra CVII to the skull, the ligament becomes structurally distinct from more caudal parts of the ligament and is called the ligamentum nuchae.
- The ligamentum nuchae is a triangular, sheet like structure in the median sagittal plane:
  - the base of the triangle is attached to the skull, from the external occipital protuberance to the foramen magnum;
  - the apex is attached to the tip of the spinous process of vertebra CVII;
  - the deep side of the triangle is attached to the posterior tubercle of vertebra CI and the spinous processes of the other cervical vertebrae.
- The ligamentum nuchae supports the head. It resists flexion and facilitates returning the head to the anatomic position. The broad lateral surfaces and the posterior edge of the ligament provide attachment for adjacent muscles.



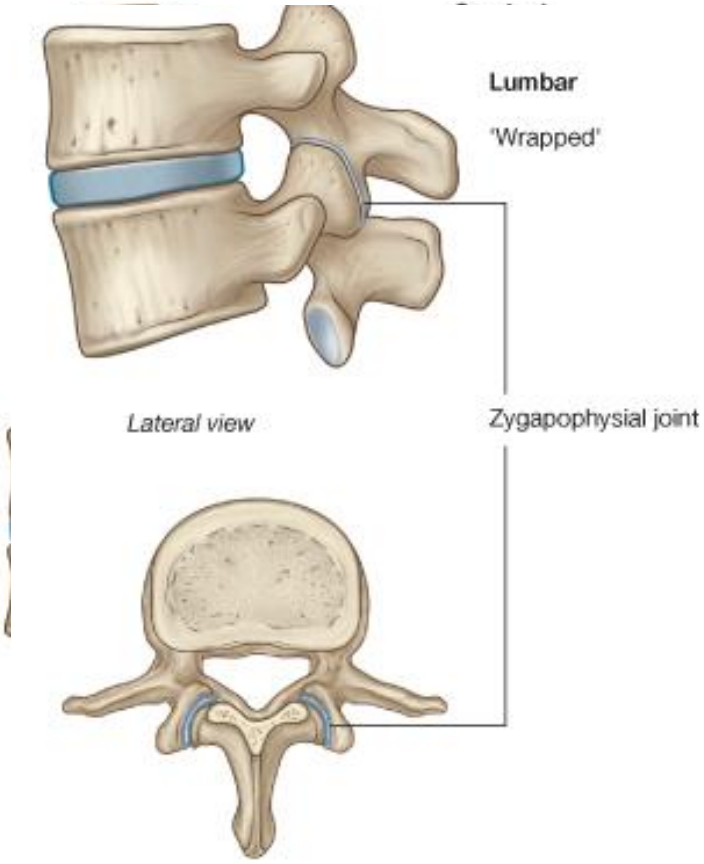
Interspinous ligaments

- Interspinous ligaments pass between adjacent vertebral spinous processes.
- They attach from the base to the apex of each spinous process and blend with the supraspinous ligament posteriorly and the ligamenta flava anteriorly on each side.



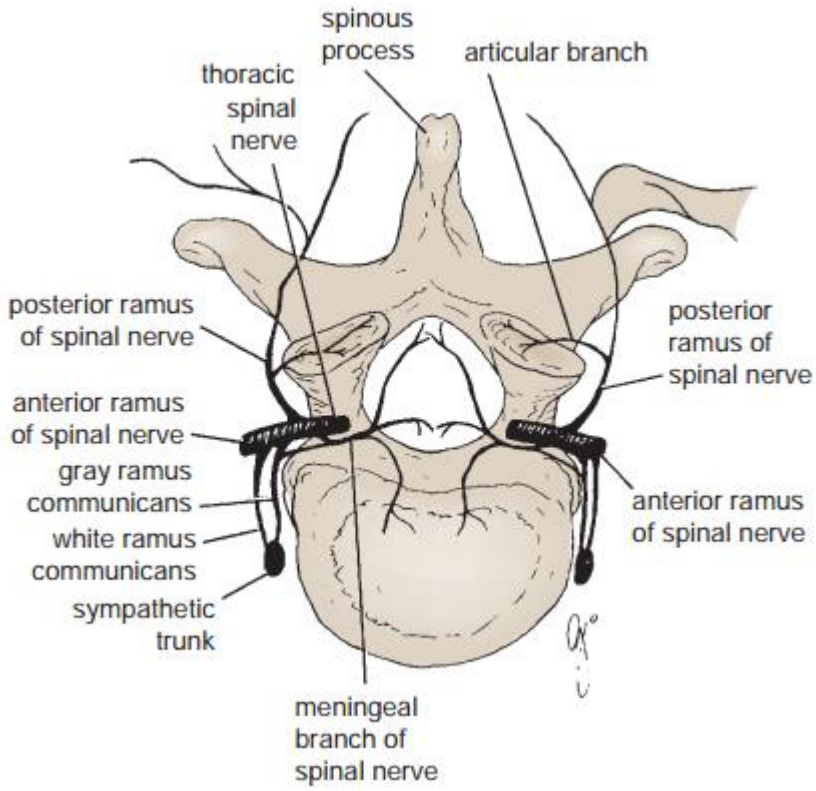
Facet joints (zygapophysial/zygapophyseal joints)

- The synovial joints between superior and inferior articular processes on adjacent vertebrae.
- A thin articular capsule attached to the margins of the articular facets encloses each joint.
- In cervical regions, 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.



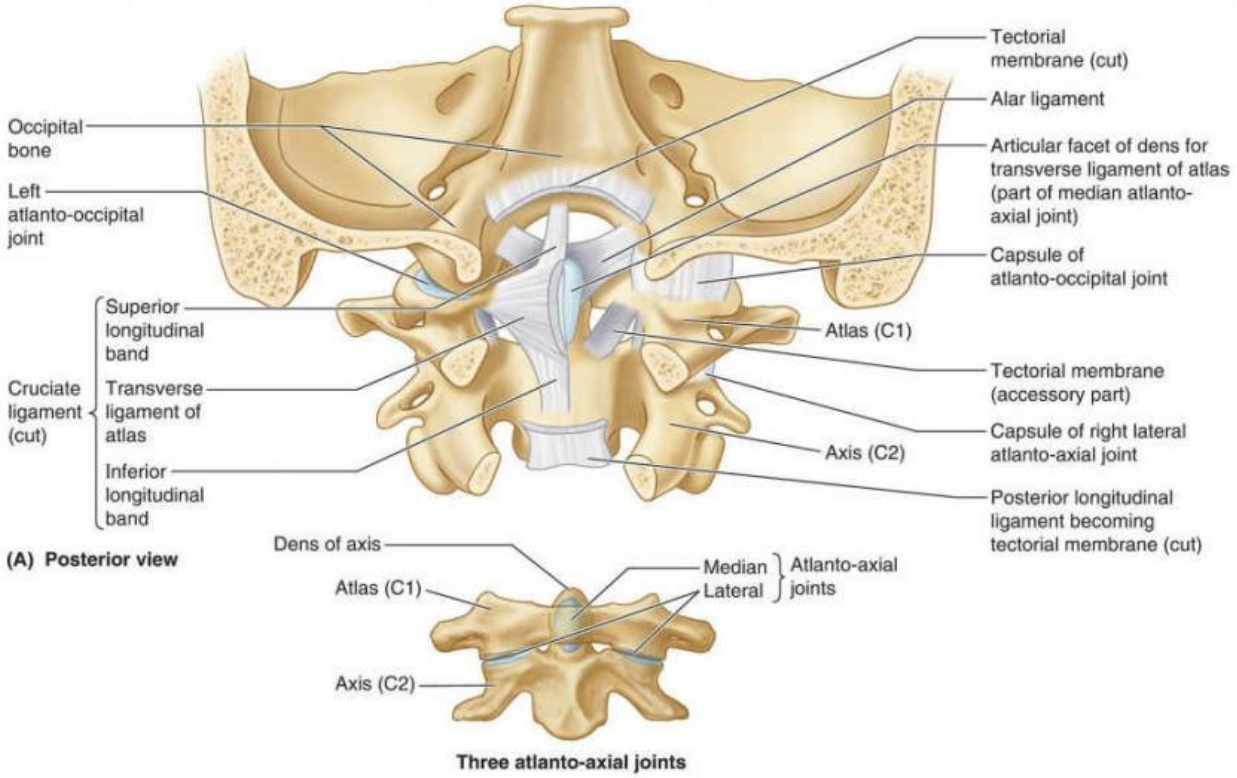
Nerve Supply of Vertebral Joints

- The joints between the vertebral bodies are innervated by the small meningeal branches of each spinal nerve.
- 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.
- It should be noted that the joints of any particular level receive nerve fibers from two adjacent spinal nerves.

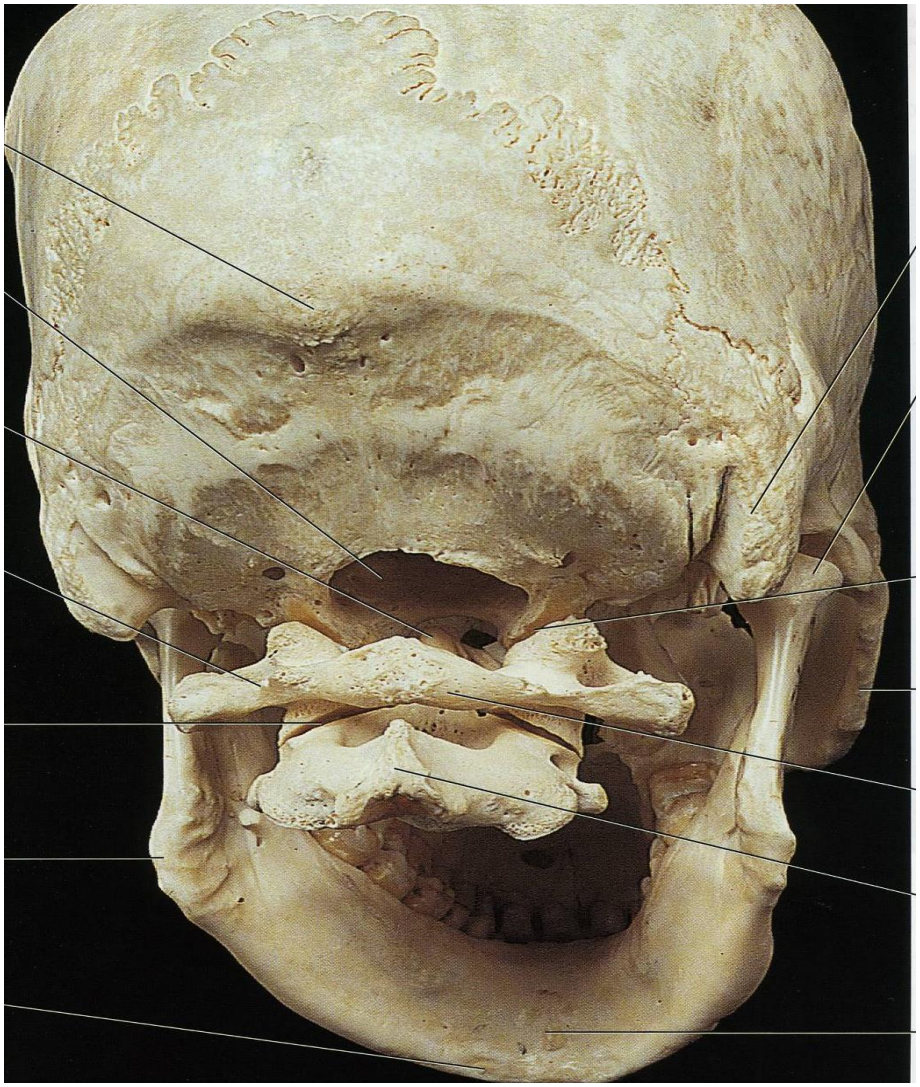


CRANIOVERTEBRAL JOINTS

- There are two sets of craniovertebral joints,
  - The *atlanto-occipital joints*, formed between the atlas (C1 vertebra) and the occipital bone of the cranium, and
  - The *atlanto-axial joints*, formed between the atlas and axis (C2 vertebra).



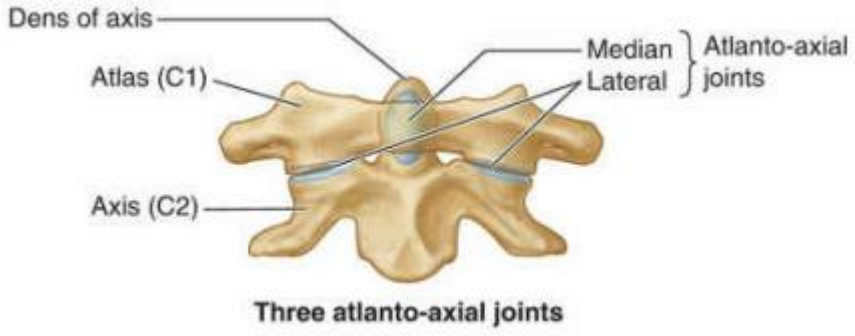
Atlanto-Occipital Joints



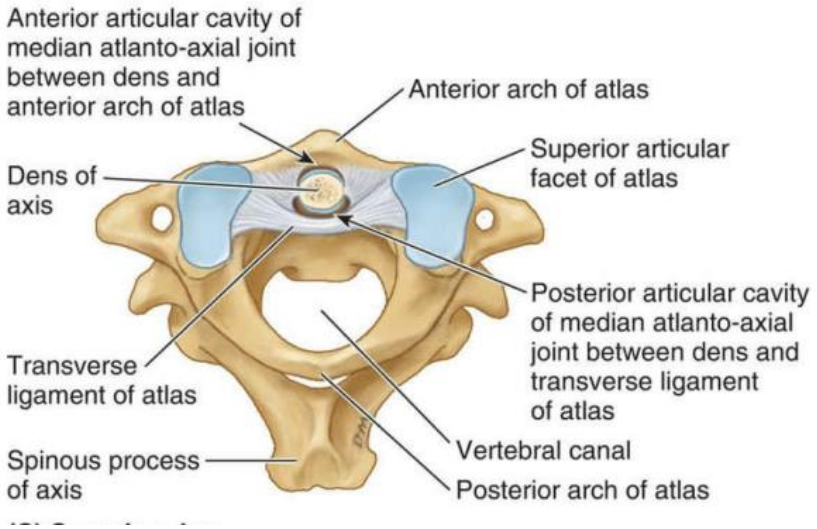
- Paired **synovial joint** between **occipital condyle** and **superior articular facet** of **atlas**
- Allows **flexion/extension** of head (nodding head "yes") and some lateral flexion but **no rotation**

Atlanto-Axial Joints

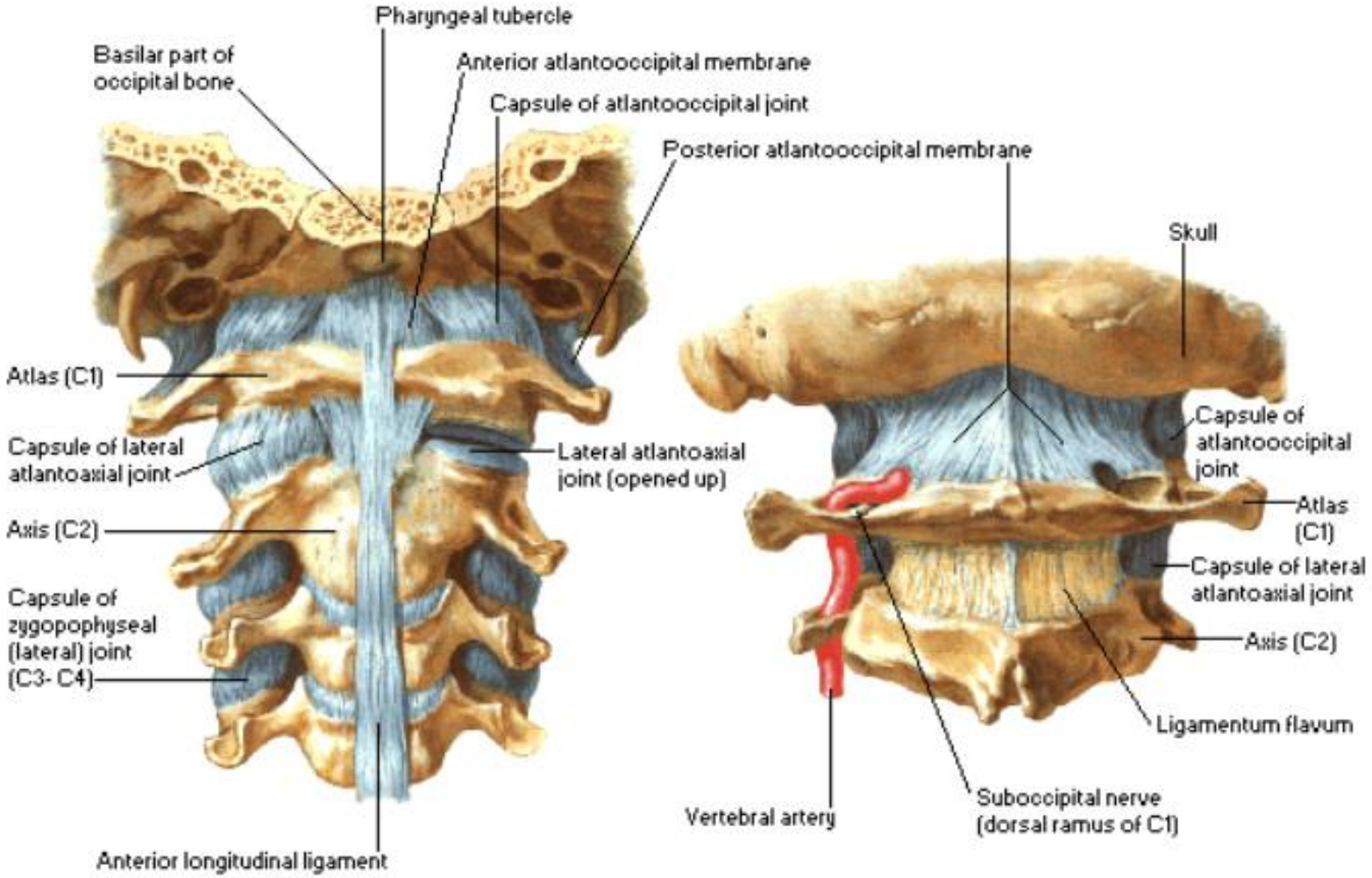
- There are three atlanto-axial articulations: two (right and left) **lateral atlanto-axial joints** (between the inferior facets of the lateral masses of C1 and the superior facets of C2) and one **median atlanto-axial joint** (between the dens of C2 and the anterior arch of the atlas).
- The lateral atlanto-axial joints are gliding-type synovial joints, whereas the median atlanto-axial joint is a pivot joint.



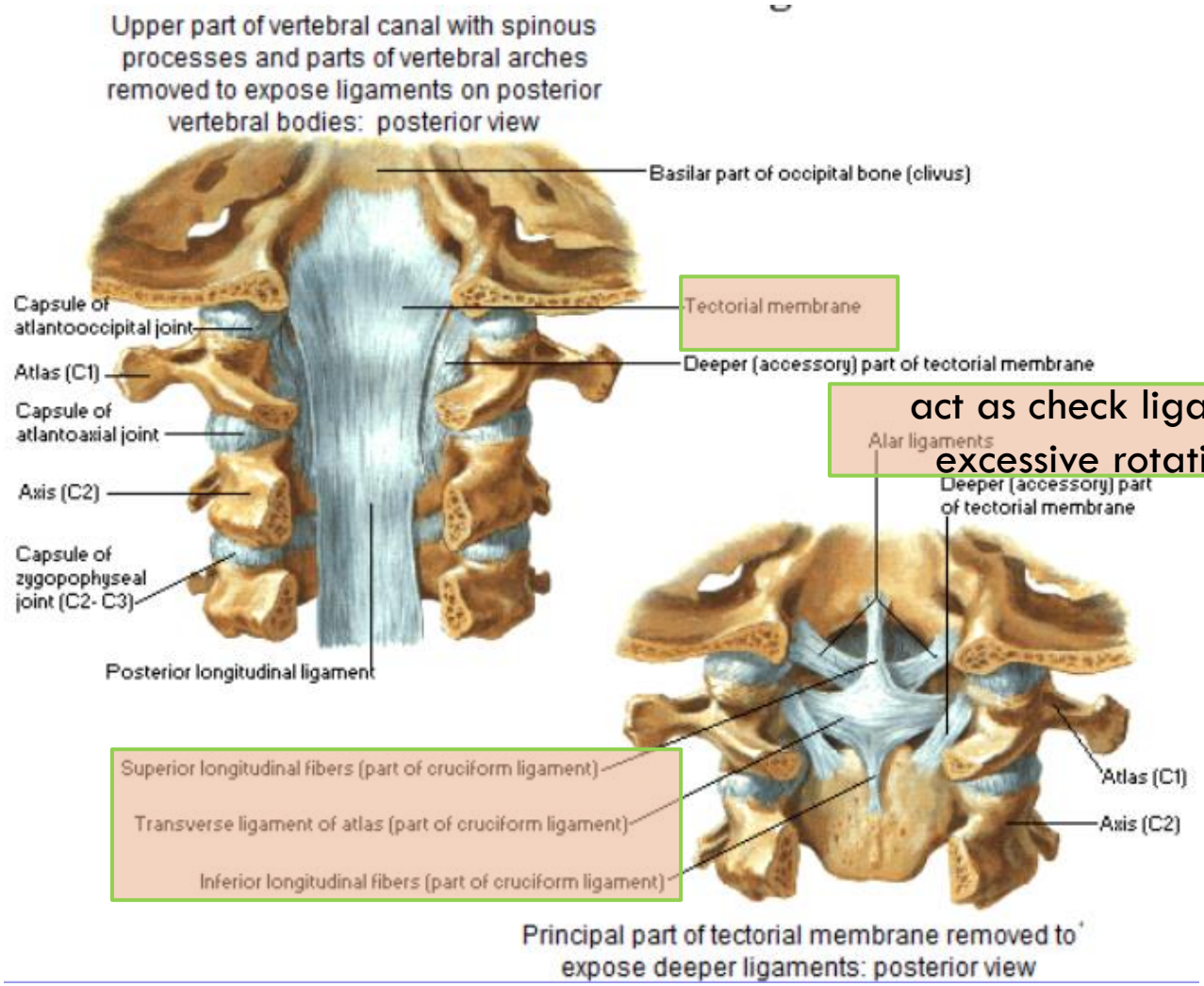
Three atlanto-axial joints



External Membranes of craniovertebral joints



Internal craniocervical ligaments



act as check ligaments in preventing excessive rotation at the joints.

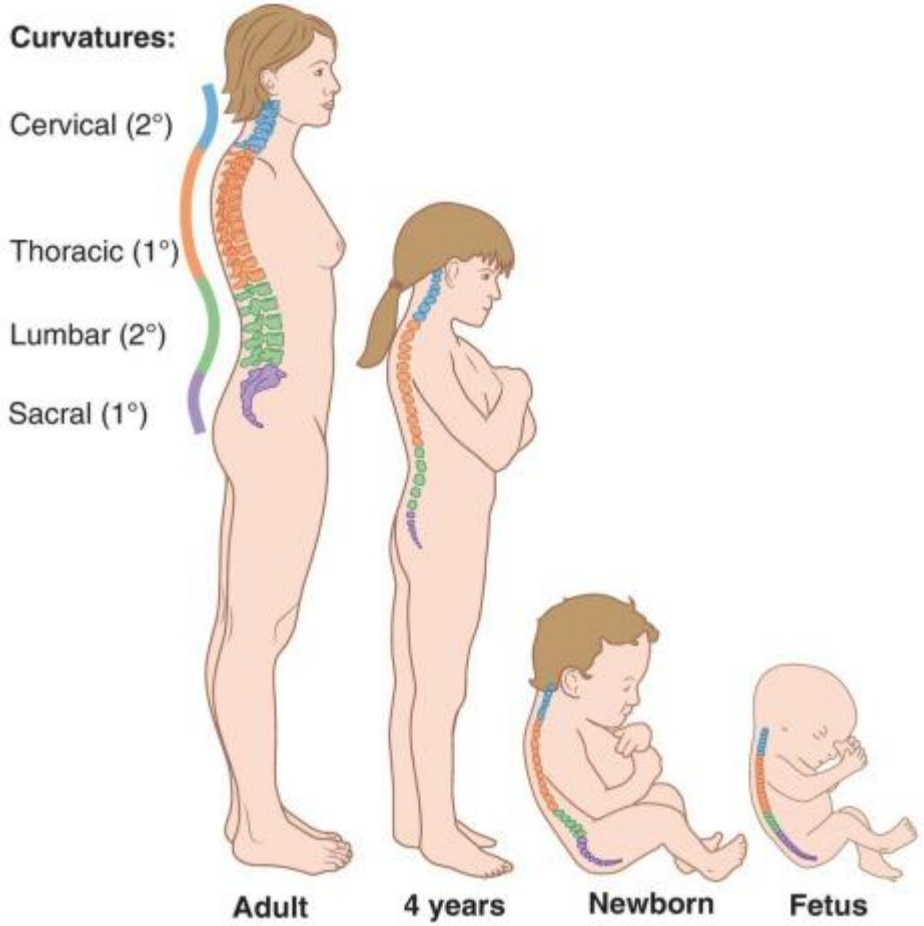
Movements of Vertebral Column

- The range of movement of the vertebral column varies according to the region and the individual.
- The mobility of the vertebral column results primarily from the compressibility and elasticity of the IV discs.
- The vertebral column is capable of flexion, extension, lateral flexion and extension, and rotation (torsion)

Cont.

- The range of movement of the vertebral column is limited by the
  - thickness, elasticity, and compressibility of the IV discs
  - shape and orientation of the zygapophysial joints.
  - tension of the joint capsules of the zygapophysial joints.
  - resistance of the back muscles and ligaments (e.g., the ligamenta flava and posterior longitudinal ligament).
  - attachment to the thoracic (rib) cage.
  - bulk of surrounding tissue.

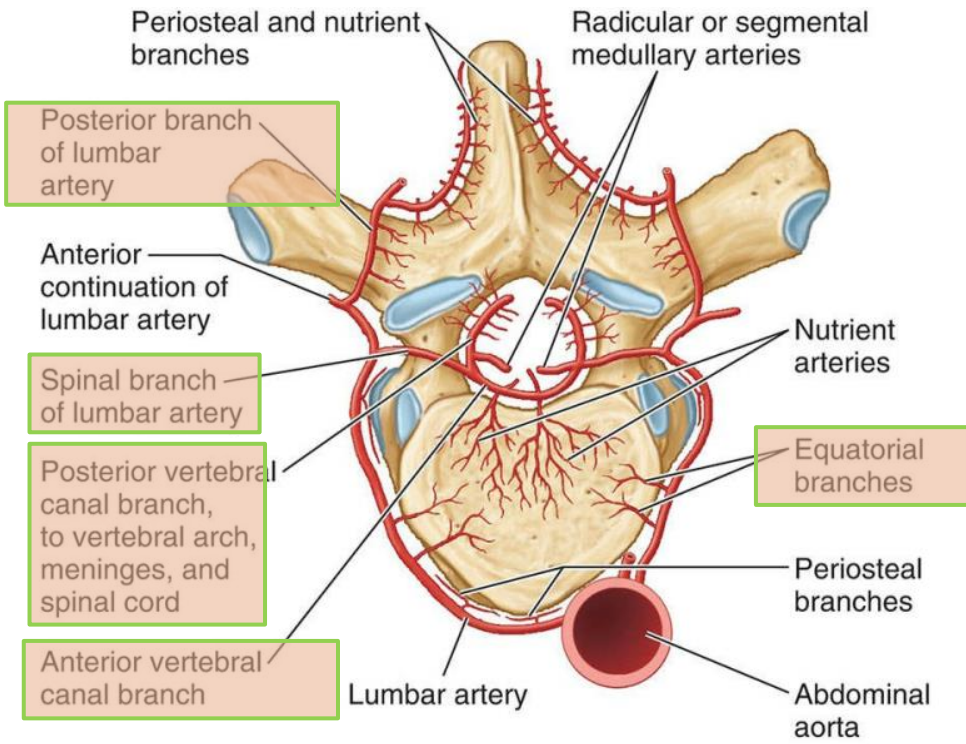
Curvatures of Vertebral Column



- The four curvatures of the adult vertebral column—cervical, thoracic, lumbar, and sacral—are contrasted with the C-shaped curvature of the column during fetal life, when only the primary (*1°*) curvatures exist.
- The secondary (*2°*) curvatures develop during infancy and childhood

Vasculature of Vertebral Column

- Vertebrae are supplied by *periosteal* and *equatorial branches* of the major cervical and *segmental arteries* and their spinal branches.
  - *Vertebral* and *ascending cervical arteries* in the neck
  - The major *segmental arteries* of the trunk:
    - *Posterior intercostal arteries* in the thoracic region
    - *Subcostal* and *lumbar arteries* in the abdomen
    - Iliolumbar and lateral and medial sacral arteries in the pelvis

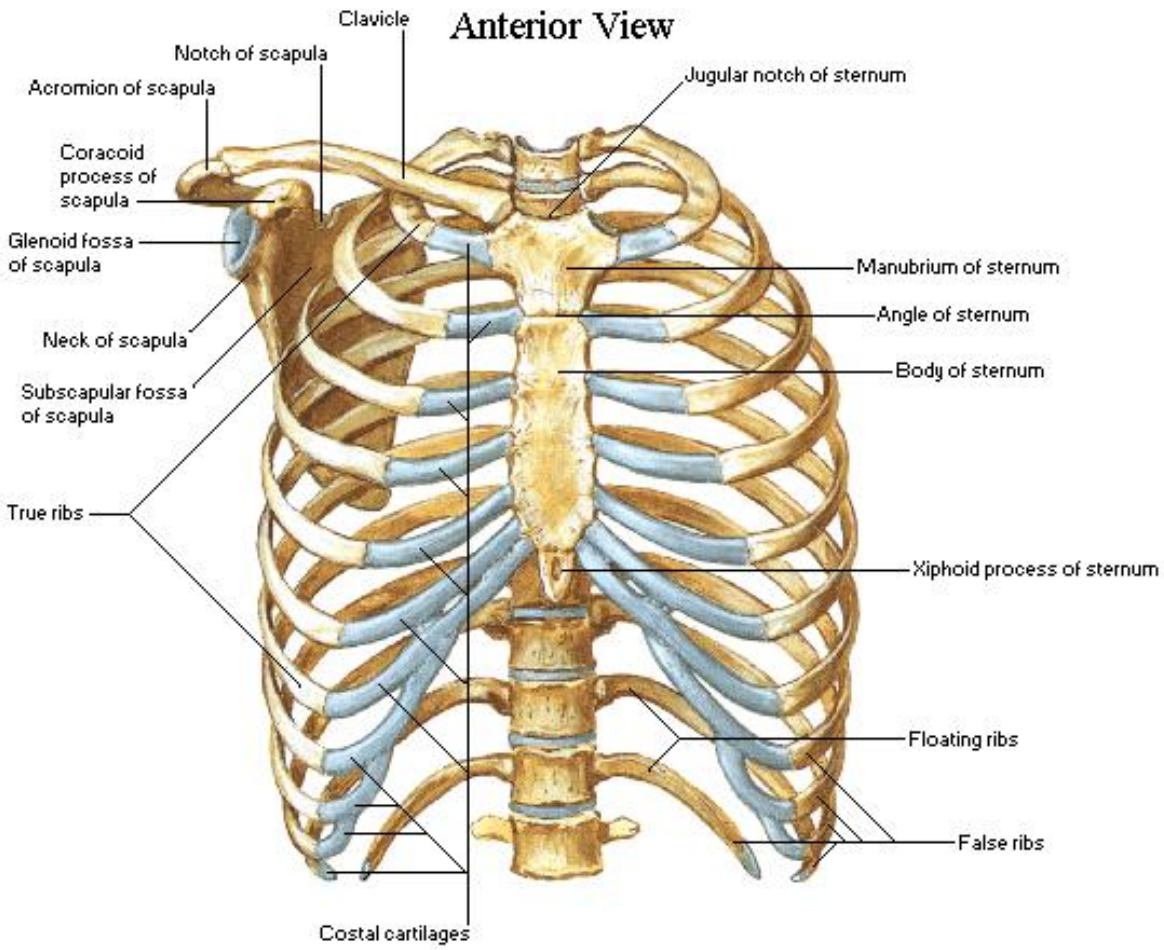


Skeleton of the Thoracic Wall

- The thoracic skeleton forms the osteocartilaginous thoracic cage, which protects the thoracic viscera and some abdominal organs.
- *It includes 12 pairs of ribs and associated costal cartilages, 12 thoracic vertebrae and the intervertebral (IV) discs interposed between them, and the sternum.*
- The ribs and costal cartilages form the largest part of the thoracic cage.

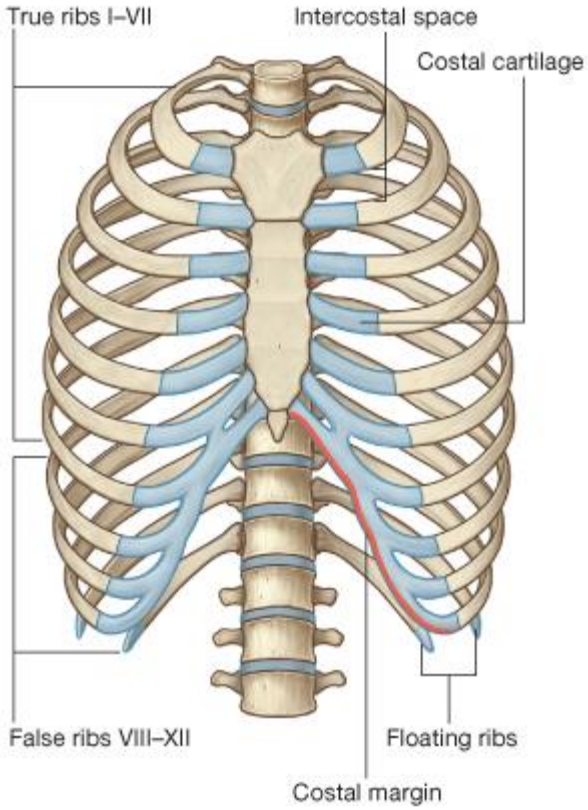
Ribs, Costal Cartilages, and Intercostal Spaces

- ***Ribs (L. costae)***
- are curved, flat bones that form most of the thoracic cage.
- They are remarkably light in weight yet highly resilient.
- Each rib has a spongy interior containing bone marrow (hematopoietic tissue), which forms blood cells.



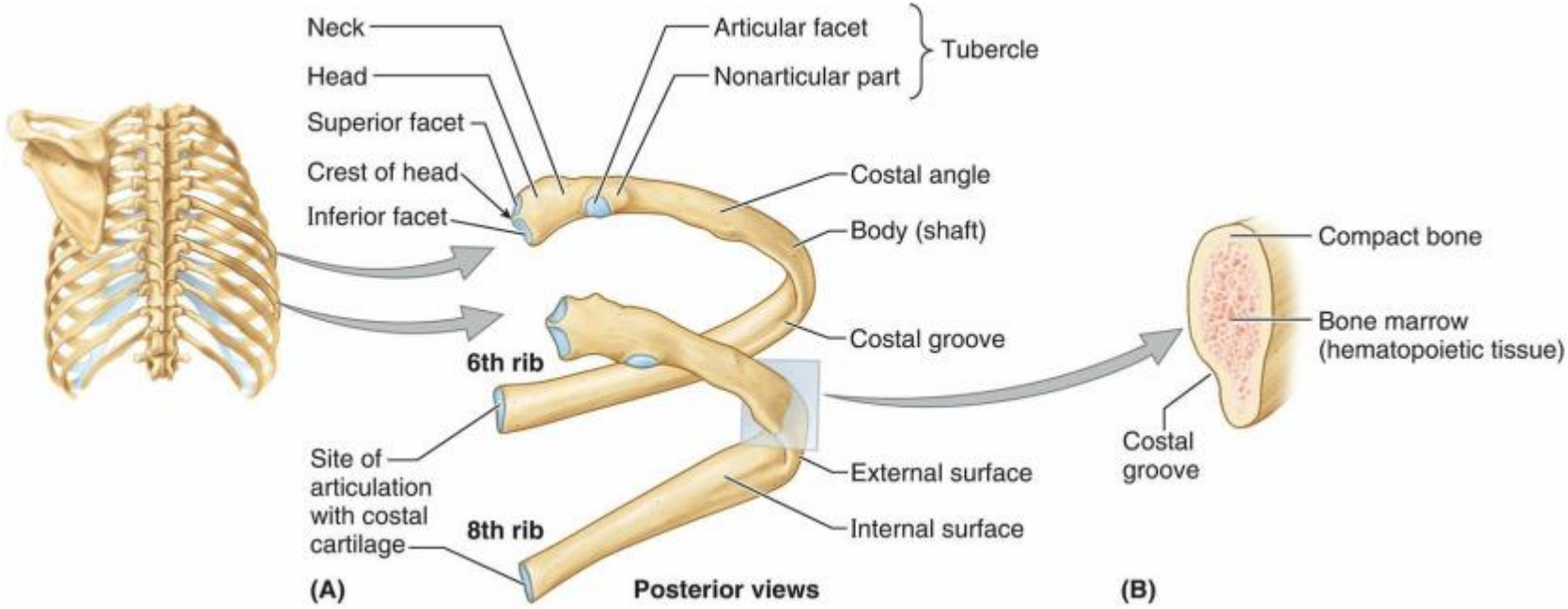
Cont.

- ***There are three types of rib:***
- **True (vertebrocostal) ribs** (1st to "7th ribs): They attach directly to the sternum through their own costal cartilages.
- **False (vertebrochondral) ribs** (8th, 9th, and usually 10th ribs):
- Their cartilages are connected to the cartilage of the rib above them; thus their connection with the sternum is indirect.
- **Floating (vertebral, free)** ribs (11th, 12th, and sometimes 10th ribs):
- The rudimentary cartilages of these ribs do not connect even indirectly with the sternum; instead they end in the posterior abdominal musculature.



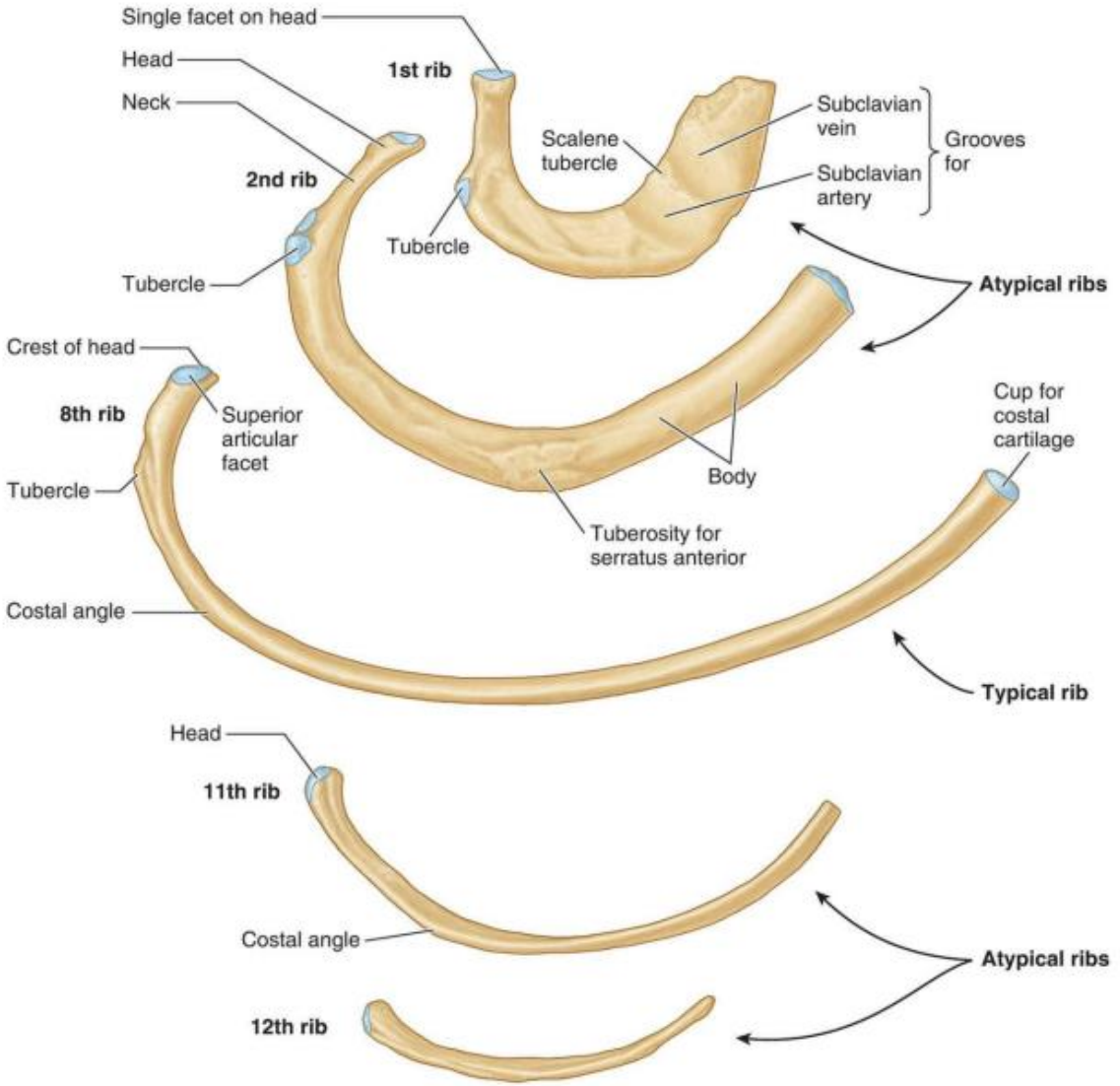
Features of typical ribs

- The 3rd–9th ribs have common characteristics.
  - Each rib has a head, neck, tubercle, and body (shaft)



Atypical ribs

- The atypical 1st, 2nd, 11th, and 12th ribs differ from typical ribs and dissimilar

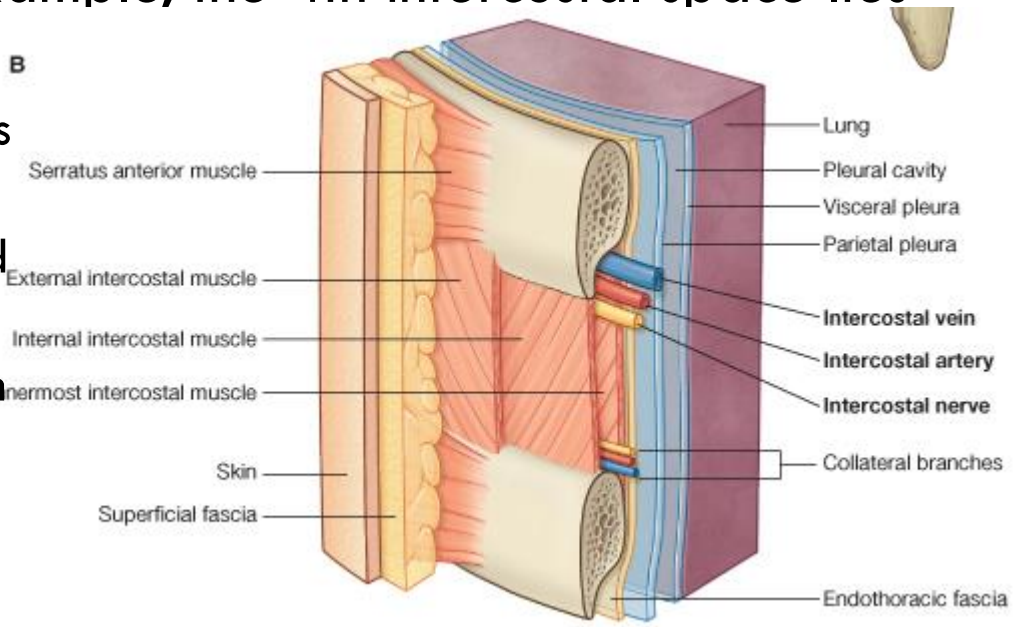


Cont.

- ***Costal cartilages***
- prolong the ribs anteriorly and contribute to the elasticity of the thoracic wall, providing a flexible attachment for their anterior or distal ends (tips).
- The cartilages increase in length through the first 7 and then gradually decrease.

Intercostal spaces

- Separate the ribs and their costal cartilages from one another.
- The spaces are named according to the rib forming the superior border of the space for example, the 4th intercostal space lies between rib 4 and rib 5.
  - There are 11 intercostal spaces and 11 intercostal nerves.
  - Intercostal spaces are occupied by intercostal muscles and membranes, and two sets (main and collateral) of intercostal blood vessels and nerves, identified by the same number assigned to the space.



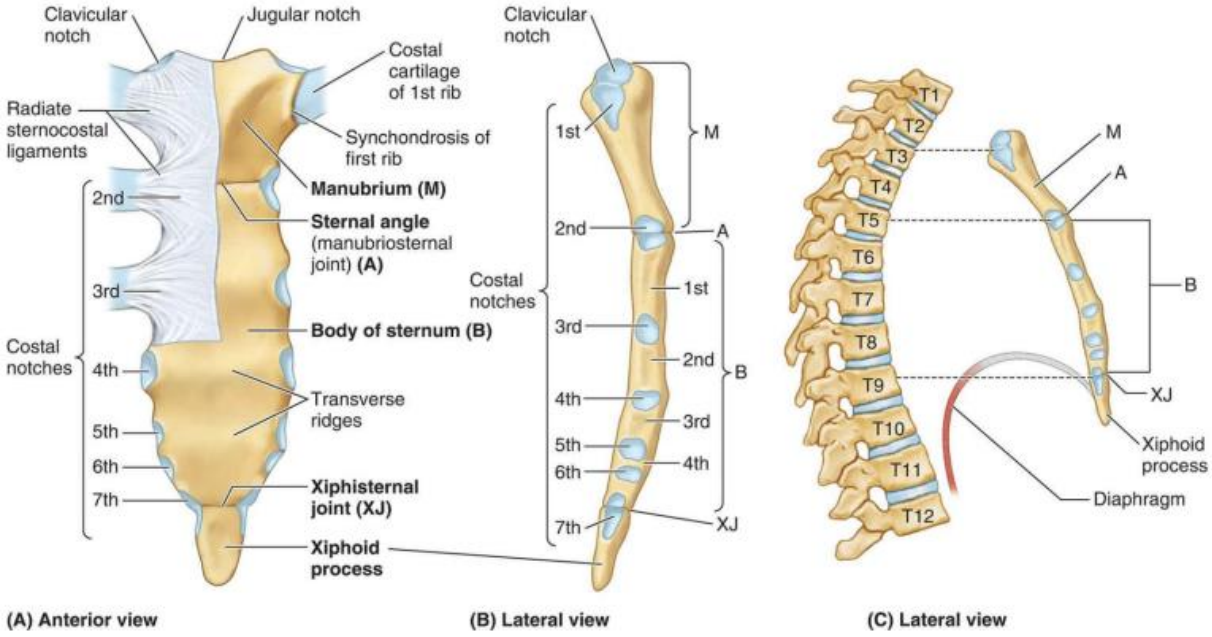
Cont.

- The space below the 12th rib does not lie between ribs and thus is referred to as the subcostal space, and the anterior ramus of spinal nerve T12 is the subcostal nerve.
- The intercostal spaces are widest anterolaterally, and they widen with inspiration.
- They can be further widened by extension and/or lateral flexion of the thoracic vertebral column to the contralateral side.

The Sternum

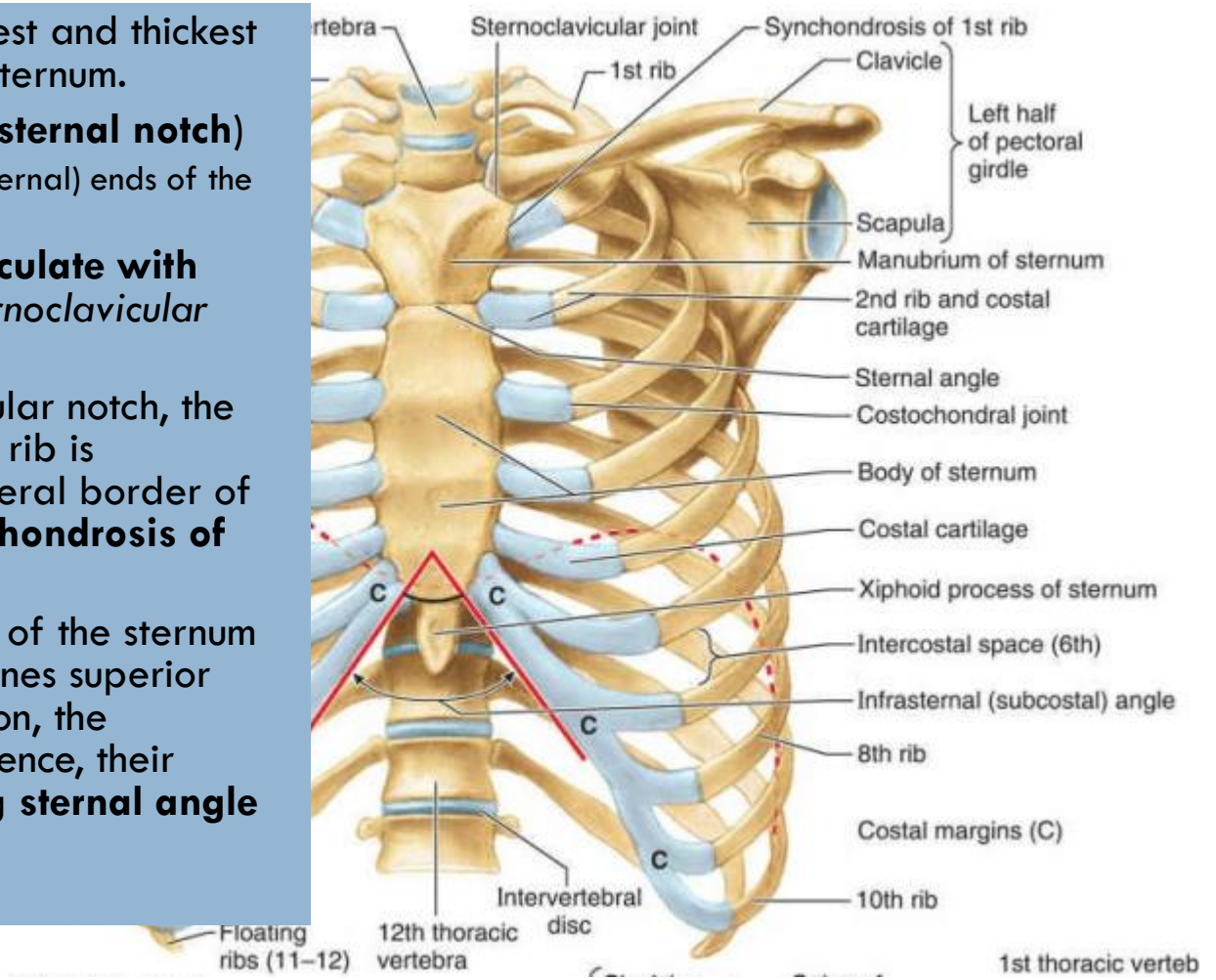
- The sternum (G. sternon, chest) is the flat, elongated bone that forms the middle of the anterior part of the thoracic cage.
- The sternum consists of three parts:
  - manubrium,
  - body, and
  - xiphoid process.

In adolescents and young adults, the three parts are connected together by cartilaginous joints (*synchondroses*) that ossify during middle to late adulthood.



Cont.

- The manubrium is the widest and thickest of the three parts of the sternum.
- **Has jugular notch (suprasternal notch)**
  deepened by the medial (sternal) ends of the clavicles
- **clavicular notches to articulate with clavicle and form** the *sternoclavicular (SC) joints.*
- Inferolateral to the clavicular notch, the costal cartilage of the 1st rib is tightly attached to the lateral border of the manubrium—the **synchondrosis of the first rib.**
- The manubrium and body of the sternum lie in slightly different planes superior and inferior to their junction, the **manubriosternal joint ;** hence, their junction forms a projecting **sternal angle** (of Louis).



Cont.

- The **body of the sternum** is longer, narrower, and thinner than the manubrium and is located at the level of the T5–T9 vertebrae.
  - Marked by **transverse ridges**
- The **xiphoid process,**
  - the smallest and most variable part of the sternum, is thin and elongated. Its inferior end lies at the level of T10 vertebra.
  - Although often pointed, the process may be blunt, bifid, curved, or deflected to one side or anteriorly.
  - It is cartilaginous in young people but more or less ossified in adults older than age 40. In elderly people, the xiphoid process may fuse with the sternal body
  - ***The xiphoid process is an important landmark in the median plane ????***

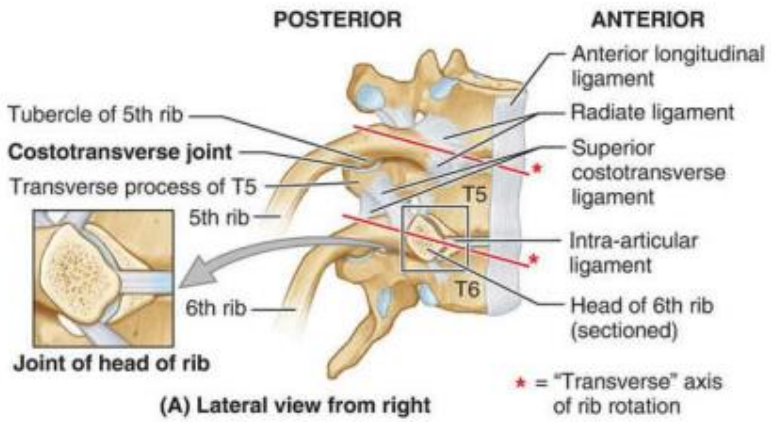
Joints of Thoracic Wall

- The range of movement at the individual joints is relatively small but frequent.
- Nonetheless, any disturbance that reduces the mobility of these joints interferes with respiration.
- During deep breathing, the excursions of the thoracic cage (anteriorly, superiorly, or laterally) are considerable.
- Extending the vertebral column further increases the anteroposterior (AP) diameter of the thorax.

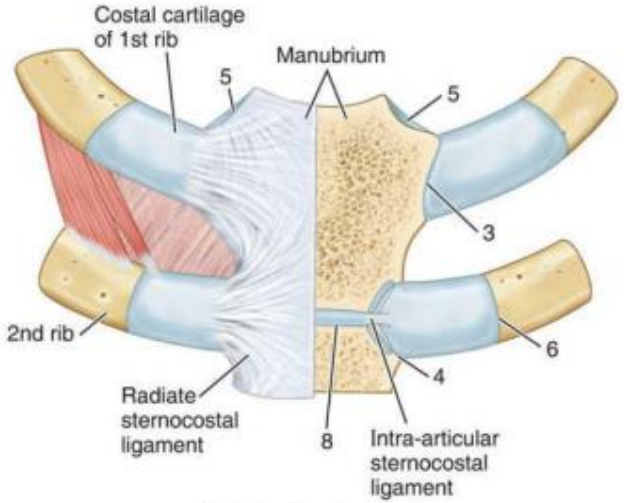
Joints of Thoracic Wall

Joint	Type	Articulation	Ligaments	Comments
Intervertebral (of vertebrae T1–T12)	Symphysis (secondary cartilaginous)	Adjacent vertebral bodies bound together by IV disc	Anterior and posterior longitudinal	Movement mostly limited to small degrees of rotation
Costovertebral Joints of head of rib	Synovial plane joint	Head of each rib with superior demi- or costal facet of vertebral body of same number and inferior demi- or costal facet of vertebral body superior to it and IV disc between them	Radiate and intra-articular ligaments of head of rib	Heads of 1st, 11th, and 12th ribs (sometimes 10th) articulate only with vertebral body of same number.
Costotransverse		Tubercle of rib with transverse process of vertebra of same number	Costotransverse; lateral and superior costotransverse	11th and 12th ribs do not articulate with transverse process of vertebrae of same number.
Costochondral	Primary (hyaline) cartilaginous joint	Lateral end of costal cartilage with sternal end of rib	Cartilage and bone bound together by periosteum	No movement normally occurs at this joint; costal cartilage provides flexibility.
Interchondral	Synovial plane joint	Between costal cartilages of 6th and 7th, 7th and 8th, and 8th and 9th ribs	Interchondral ligaments	Articulation between costal cartilages of 9th and 10th ribs is fibrous.
Sternocostal	1st: primary cartilaginous joint (synchondrosis) 2nd–7th: synovial plane joint	Articulation of 1st costal cartilages with manubrium of sternum Articulation of the 2nd–7th pairs of costal cartilages with sternum	Anterior and posterior radiate sternocostal; intra-articular	Articular cavities often absent; fibrocartilage covers articular surfaces.
Sternoclavicular	Saddle type of synovial joint	Sternal end of clavicle with manubrium of sternum and 1st costal cartilage	Anterior and posterior sternoclavicular; costoclavicular	This joint is divided into two compartments by an articular disc.
Manubriosternal	Secondary cartilaginous joint (symphysis)	Articulation between manubrium and body of sternum		These joints often fuse and become synostoses in older individuals.
Xiphisternal	Primary cartilaginous joint (synchondrosis)	Articulation between xiphoid process and body of sternum		

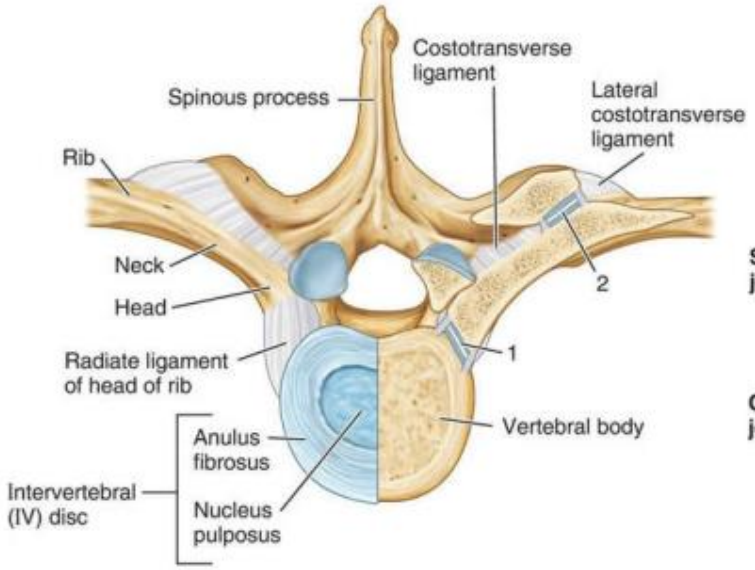
Joints of Thoracic Wall



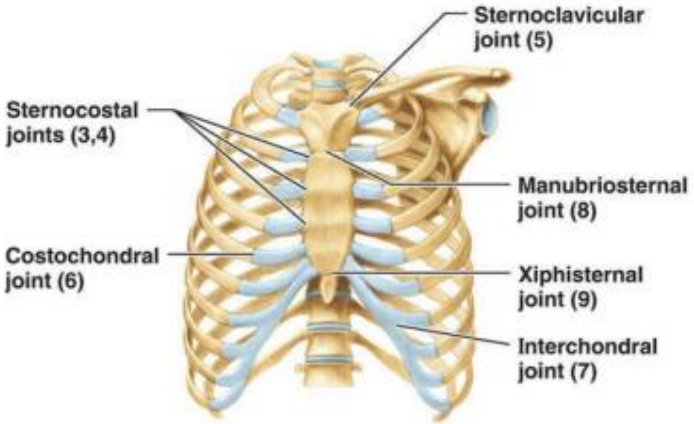
(A) Lateral view from right



(C) Anterior view

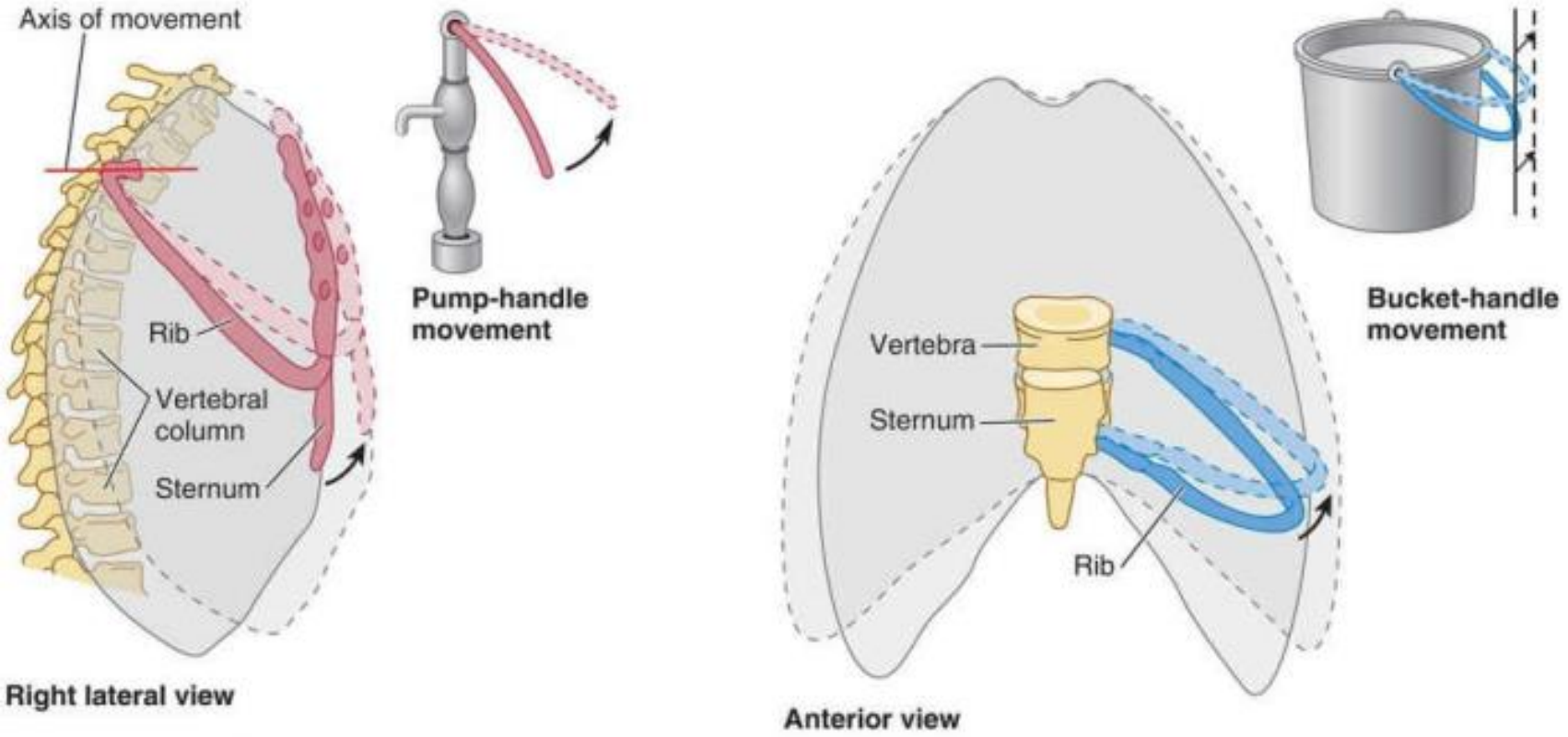


(B) Superior view



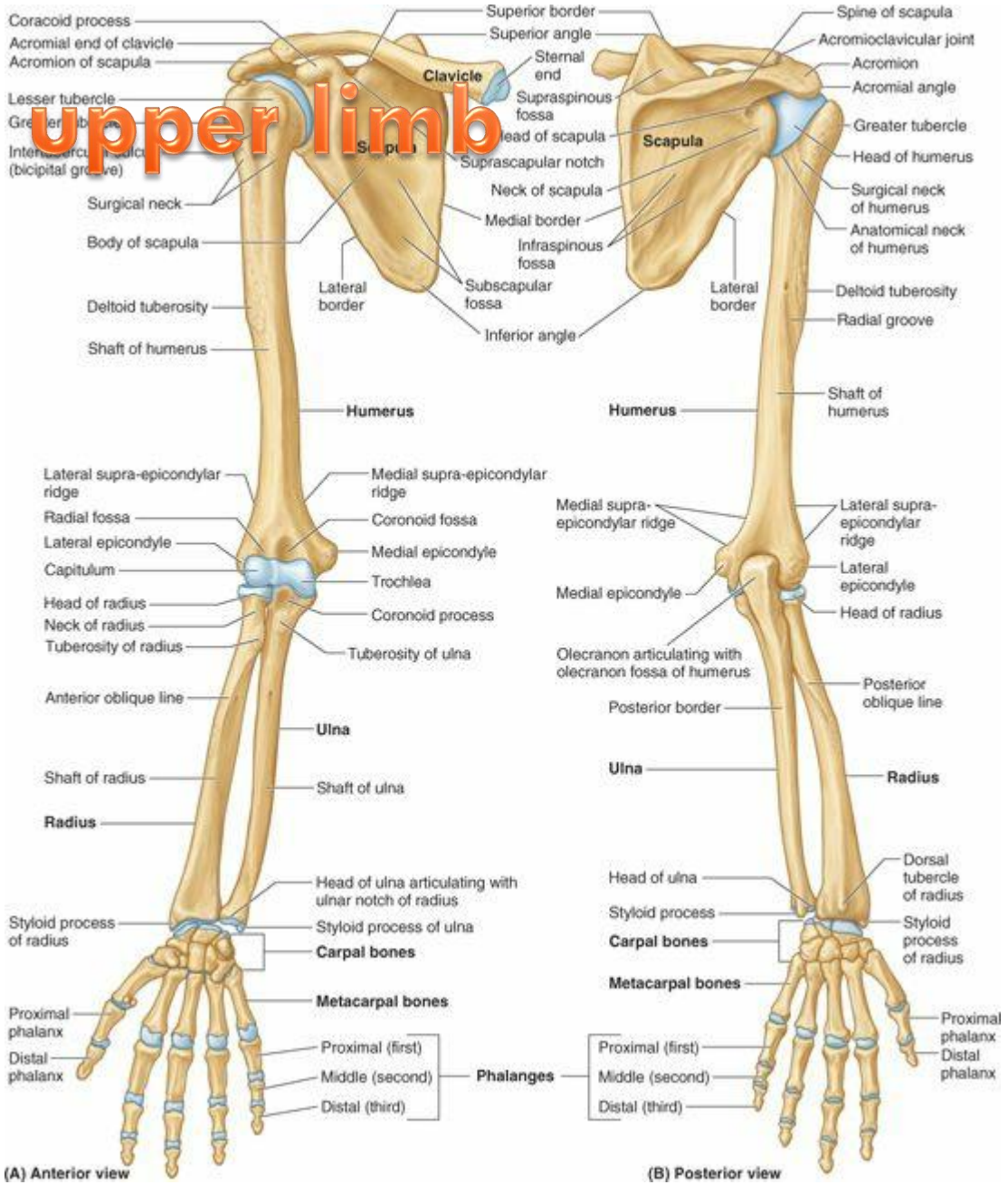
(D) Anterior view

Movements of thoracic wall



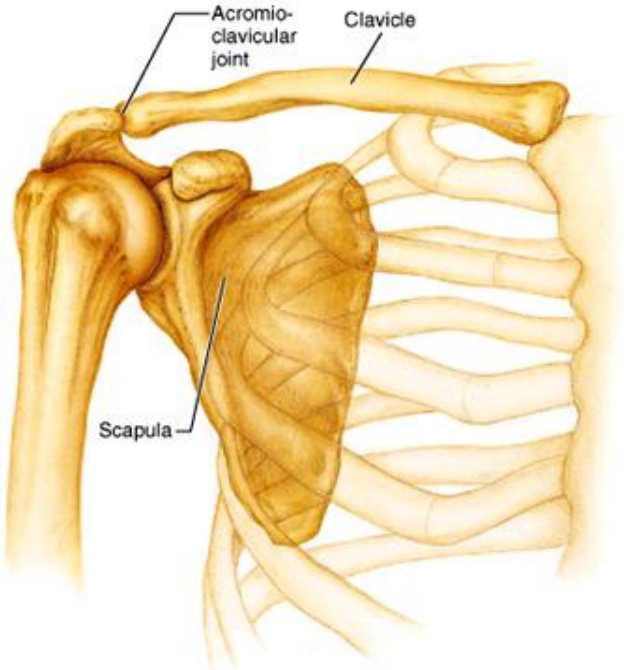
Bones of the upper limb

- The superior appendicular skeleton
  - Composed of
    - pectoral girdle
    - bones of the free part of the upper limb
  - Articulates with the axial skeleton only at the sternoclavicular joint
    - allows great mobility



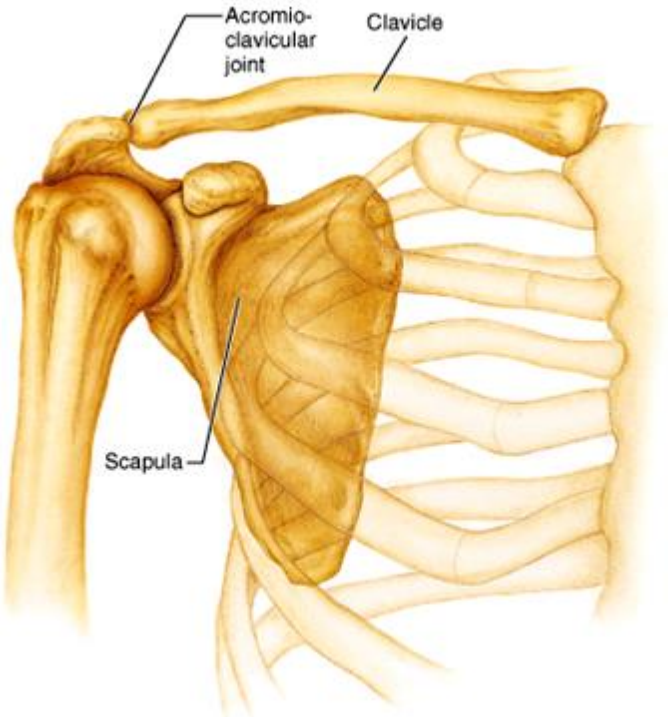
Pectoral (Shoulder) Girdle

- Consists of two bones: clavicle and scapula
- Loosely attached, held in place largely by musculature attached to the thorax and the vertebral column
- Frees girdle to move over the thorax

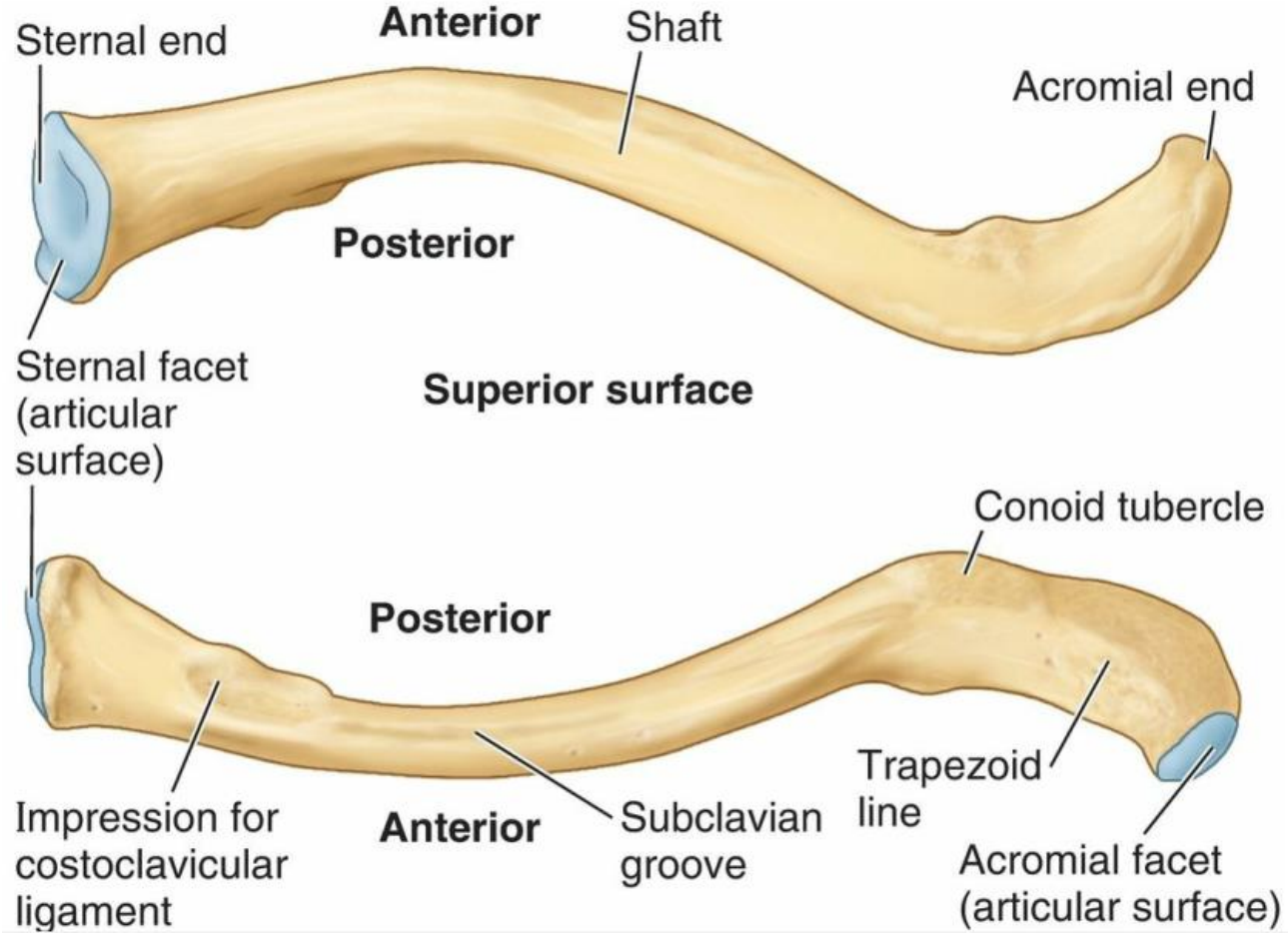


Clavicle

- Double curved bones extending along the superior thorax
- Its sternal end articulates with manubrium of the sternum at the sternoclavicular (SC) joint
- Its acromial end articulates with the acromion of the scapula at the acromioclavicular (AC) joint
- Function
  - Serves as a rigid support from which the scapula and free upper limb are suspended
  - Transmits forces from the upper limb to the axial skeleton.
  - Provides attachment for muscles.
  - It forms a boundary of the cervicoaxillary canal for protection of the neurovascular bundle of the UL.



Cont.



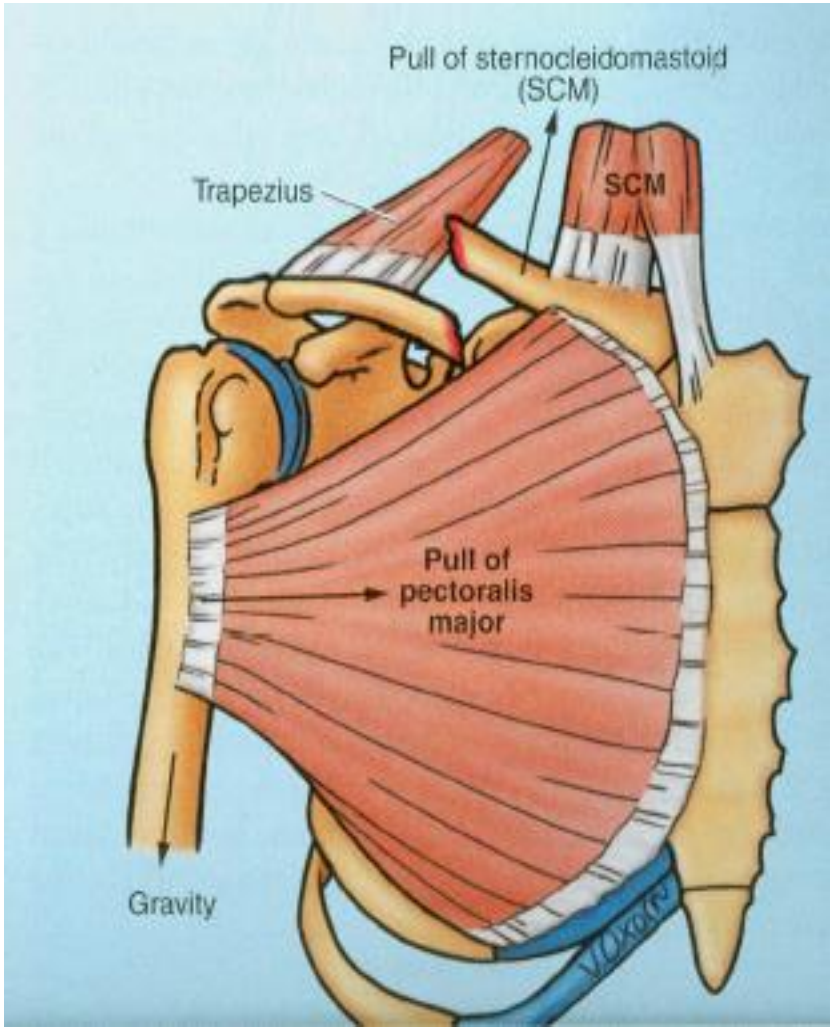
- The clavicle is subcutaneous and palpable throughout its length and is often used as a landmark for clinical procedures.

Cont.

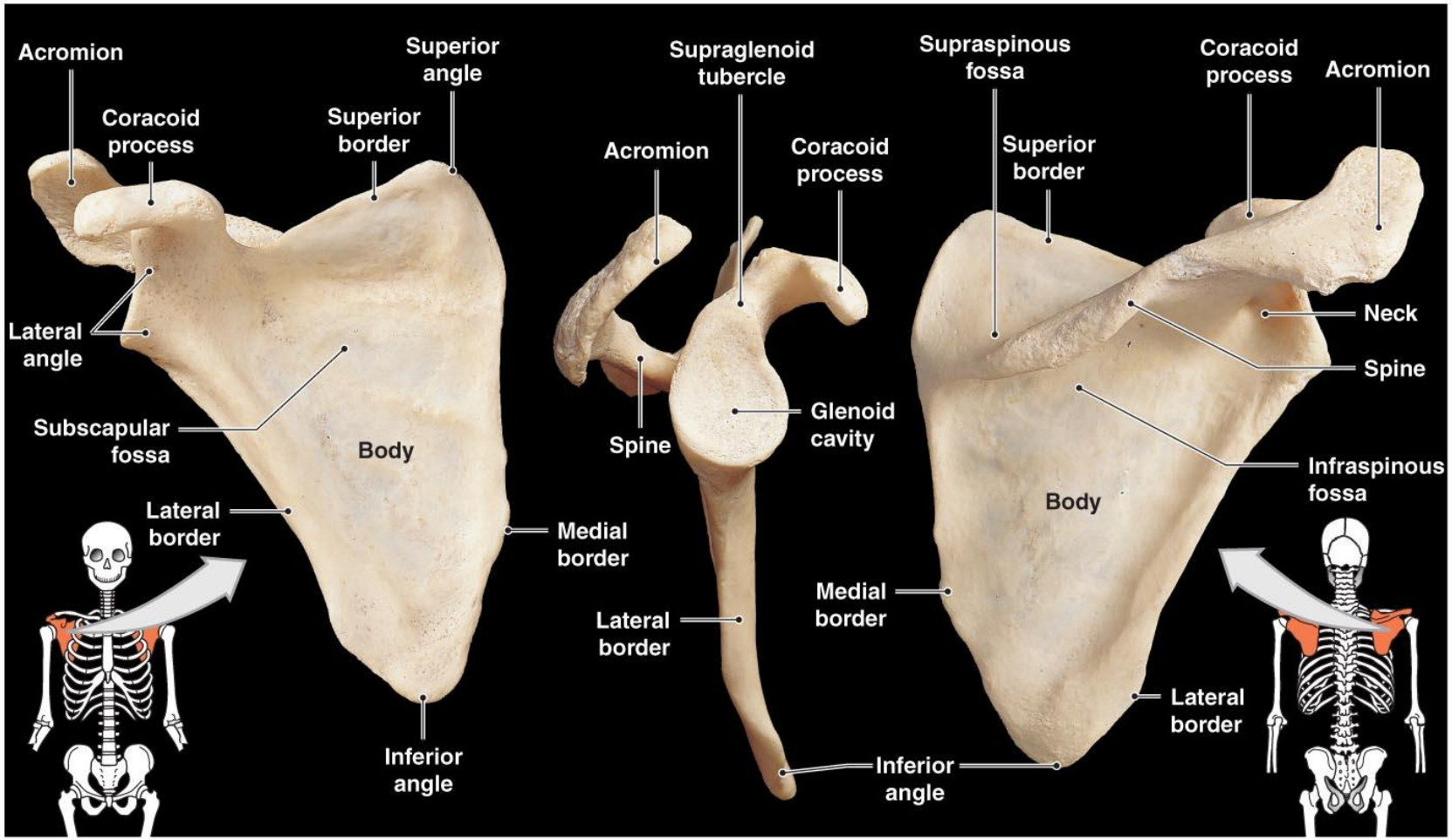
- The **superior surface of the clavicle**, lying just deep to the skin and platysma (G. flat plate) muscle in the subcutaneous tissue, is smooth.
- The **inferior surface of the clavicle** is rough because strong ligaments bind it to the 1st rib near its sternal end and suspend the scapula from its acromial end.
- The **conoid tubercle**, near the acromial end of the clavicle, gives attachment to the *conoid ligament*, the medial part of the *coracoclavicular ligament* by which the remainder of the upper limb is passively suspended from the clavicle.
- Also, near the acromial end of the clavicle is the **trapezoid line**, to which the *trapezoid ligament* attaches; it is the lateral part of the coracoclavicular ligament.
- The **subclavian groove** (groove for the subclavius) in the medial third of the shaft of the clavicle is the site of attachment of the subclavius muscle.
- More medially is the **impression for the costoclavicular ligament**, a rough, often depressed, oval area that gives attachment to the ligament binding the 1st rib (L. *costa*) to the clavicle, limiting elevation of the shoulder.

Fractures of the Clavicle

- The clavicle is commonly fractured especially in children as forces are impacted to the outstretched hand during falling.
- The weakest part of the clavicle is the junction of the middle and lateral thirds.
- After fracture, the medial fragment is elevated (by the *sternocleidomastoid muscle*), the lateral fragment drops because of the weight of the UL.
- It may be pulled medially by the adductors of the arm.
- The sagging limb is supported by the other.

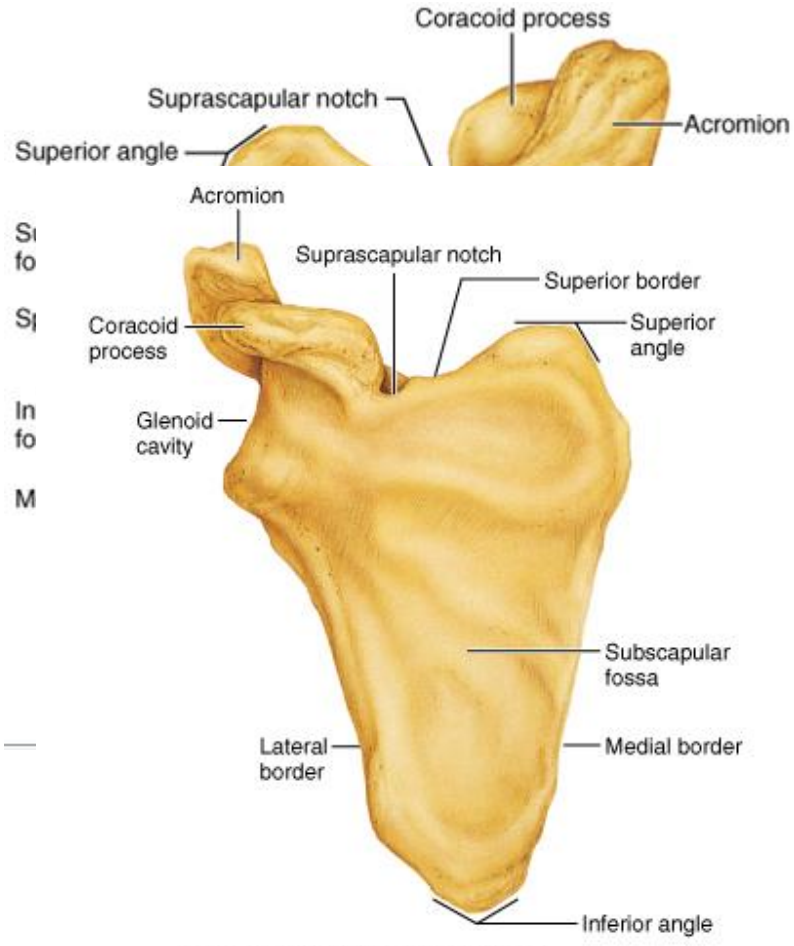


Scapula (Shoulder Blade)



Cont.

- Triangular flat bone
- Lies on the posterolateral aspect of the thorax, overlying the 2nd-7th ribs
- Two Surfaces:
  - 1. Convex Posterior : divided by the spine of the scapula into the
    - Smaller supraspinous Fossa (above the spine) and the
    - larger Infraspinous Fossa (below the spine).
  - 2.Concave Anterior (Costal) : it forms the large subscapular fossa.
- Three Borders:
  - Superior,
  - Medial (Vertebral) &
  - Lateral (Axillary) (the thickest) part of the bone, it terminates at the lateral angle .



(d) Right scapula, anterior aspect

Cont.

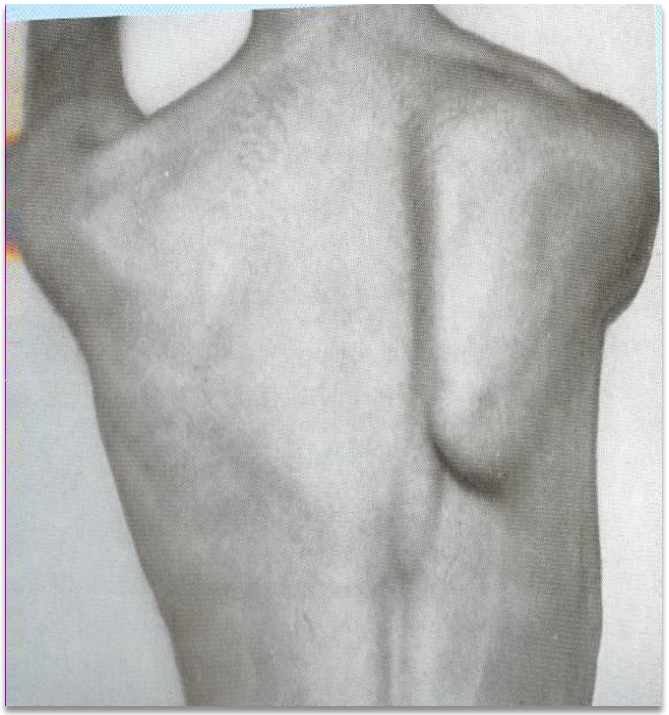
- It has three Processes:
  - (1)Spine: a thick projecting ridge of bone that continues laterally.
  - (2) Acromion : forms the subcutaneous point of the shoulder.
  - (3) Coracoid: a beaklike process, resembles in size, shape and direction a bent finger pointing to the shoulder.

Function

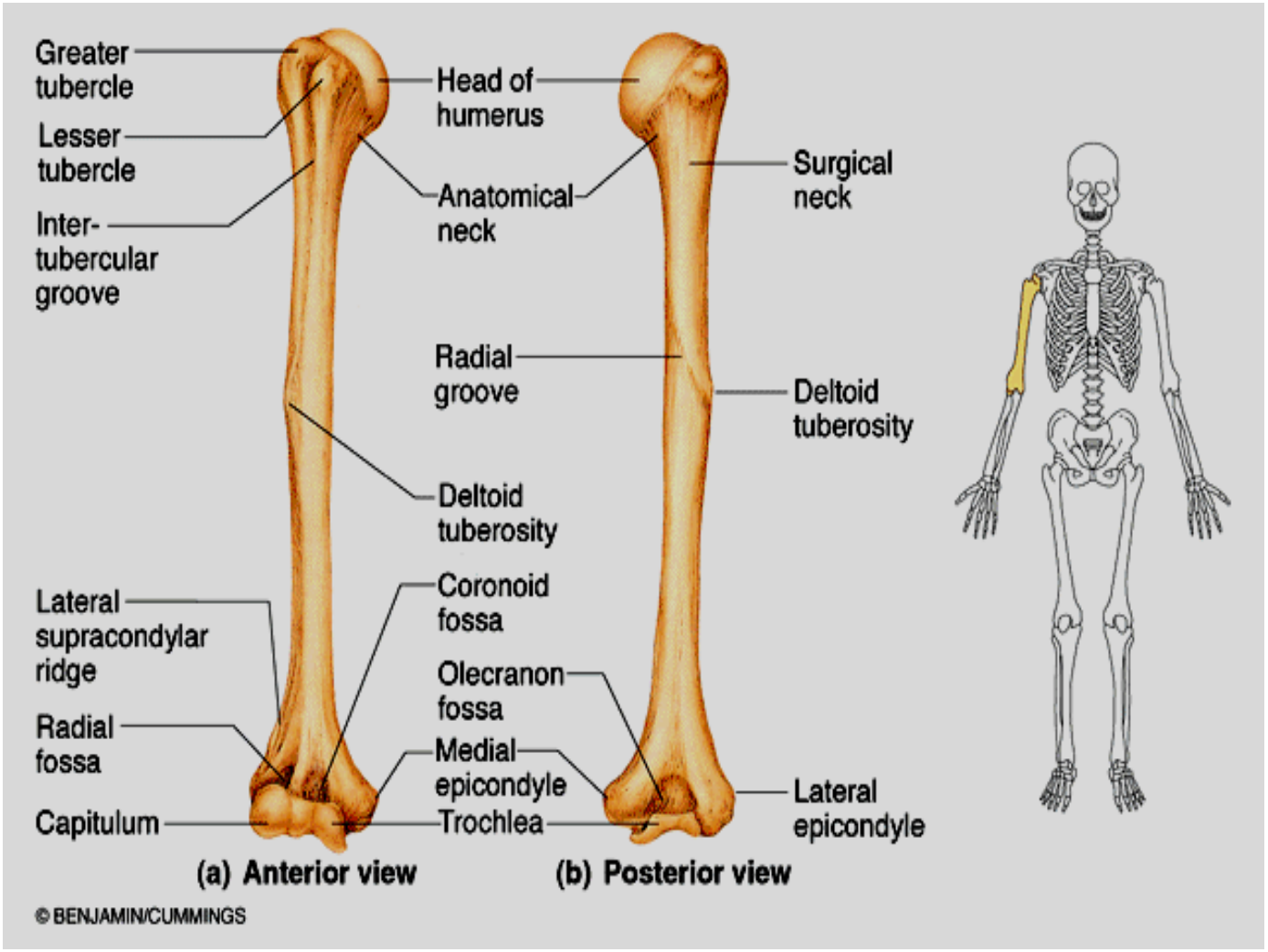
- Gives attachment to muscles.
- Has a considerable degree of movement on the thoracic wall to enable the arm to move freely.
- The glenoid cavity forms the socket of the shoulder joint.
- Because most of the scapula is well protected by muscles and by its association with the thoracic wall , most of its fractures involve the protruding subcutaneous acromion.

Winged scapula

- It will protrude posteriorly.
- The patient has difficulty in raising the arm above the head (difficult in rotation of the scapula).
- It is due to injury of the long thoracic nerve (as in radical mastectomy) which causes paralysis of serratus anterior muscle
- The medial border and inferior angle of the scapula will no longer be kept closely applied to the chest wall

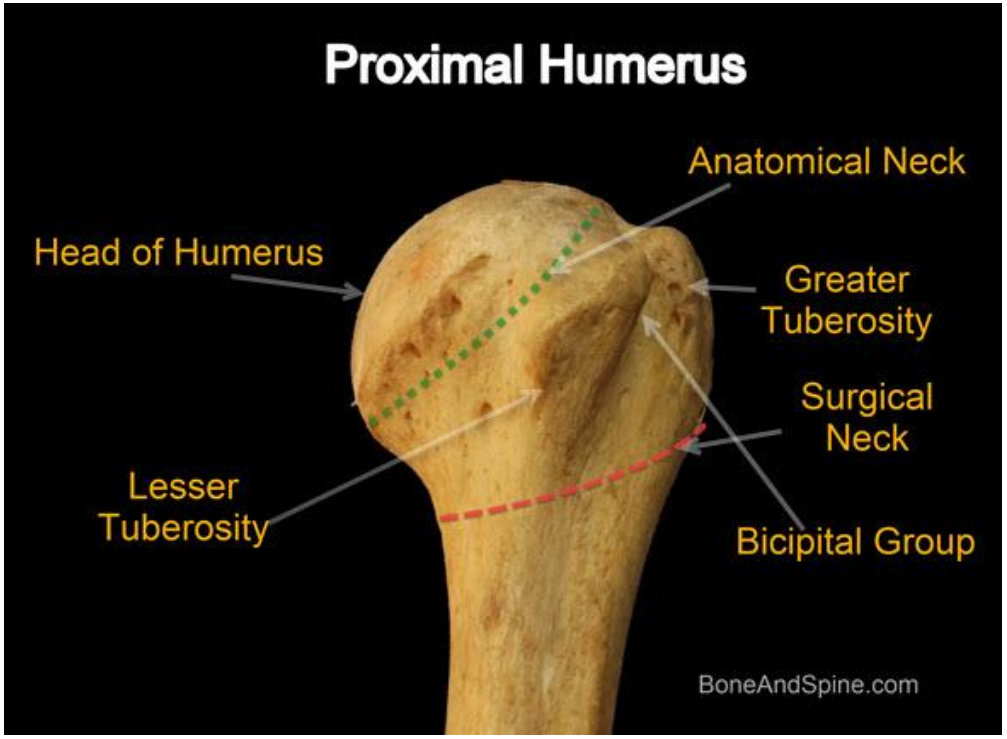


Humerus


Greater tubercle
Lesser tubercle
Inter-tubercular groove
Head of humerus
Anatomical neck
Surgical neck
Radial groove
Deltoid tuberosity
Deltoid tuberosity
Lateral supracondylar ridge
Radial fossa
Capitulum
Coronoid fossa
Olecranon fossa
Medial epicondyle
Trochlea
Lateral epicondyle
(a) Anterior view
(b) Posterior view
© BENJAMIN/CUMMINGS

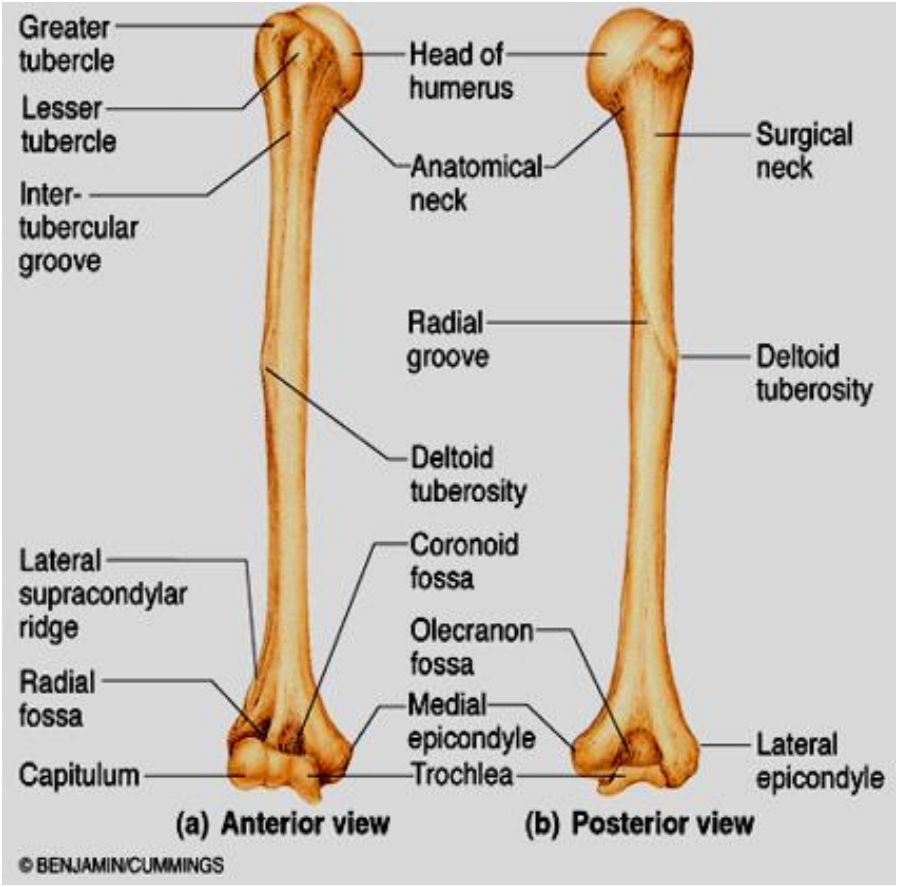
Cont.

- It is the largest bone in the UL
- Proximal End :
  - Head, Neck, Greater & Lesser Tubercles.
  - Head: Smooth
    - it forms 1/3 of a sphere, it articulates with the glenoid cavity of the scapula.
  - Greater tubercle: at the lateral margin of the humerus.
  - Lesser tubercle: projects anteriorly.
    - The two tubercles are separated by intertubercular Groove.
  - Anatomical neck: formed by a groove separating the head from the tubercles
  - Surgical Neck: a narrow part distal to the tubercles.



Cont.

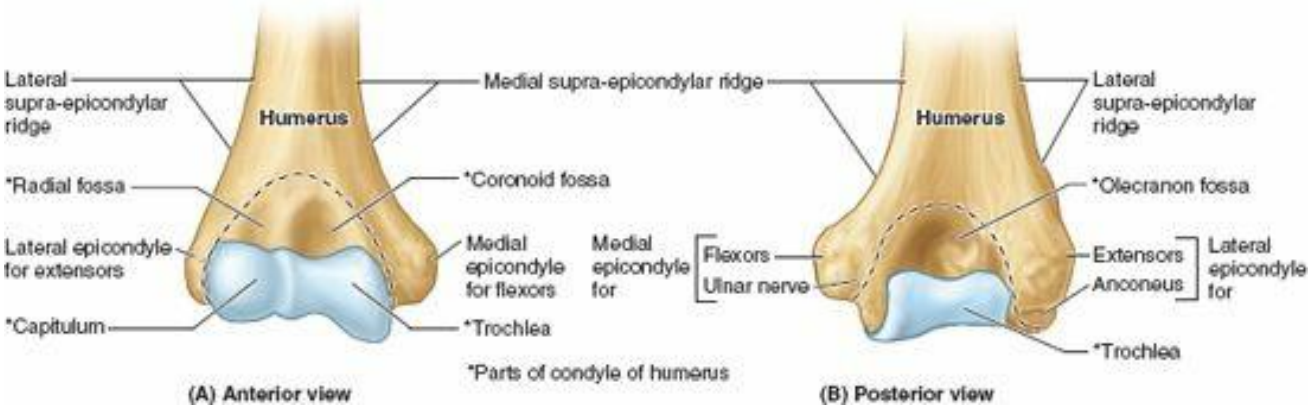
- The Humerus
  - The Shaft
    - **Deltoid tuberosity:**
      - a bulge in the shaft laterally
      - attaches deltoid muscle
    - **Radial groove:**
      - for radial nerve
      - posterior to deltoid tuberosity



Cont.

- The Humerus
  - The distal epiphysis
    - **Medial** and **lateral epicondyles:**
      - for muscle attachment
    - **Condyle** of the humerus:
      - articulates with *ulna* and *radius*

- Articular regions of the condyle
  - **Trochlea:**
    - **coronoid fossa** and **olecranon fossa**
    - articulates with ulna
  - **Capitulum:**
    - **radial fossa**
    - articulates with radius

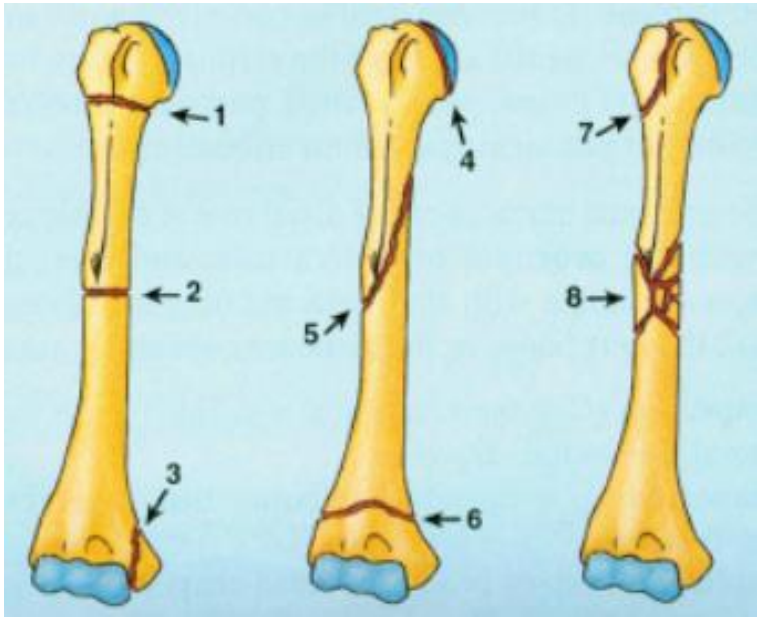


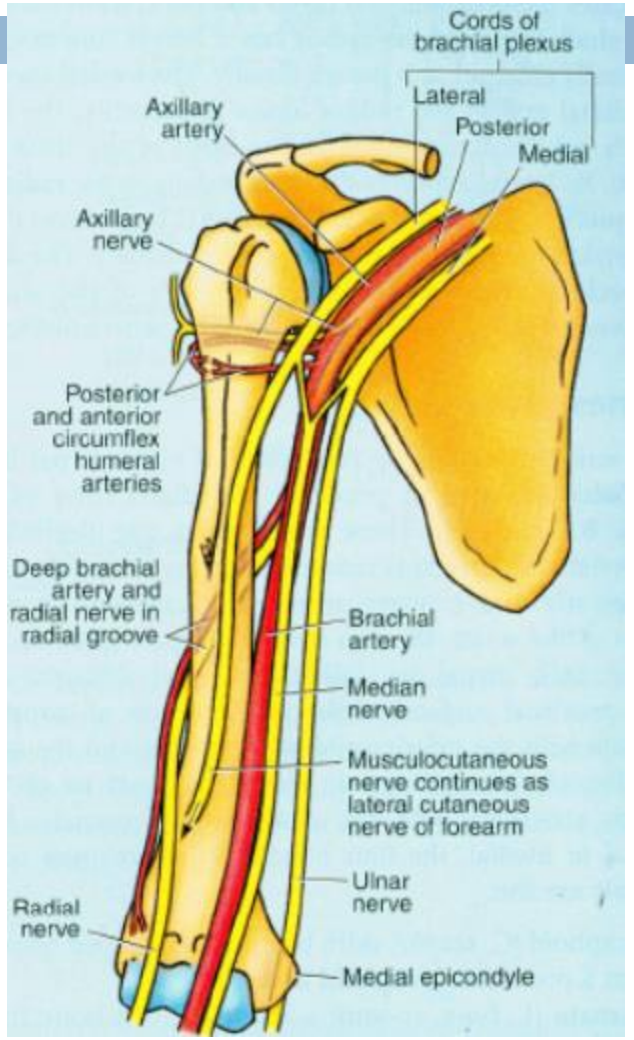
Fractures of Humerus

- Most common fractures are of the **Surgical Neck** especially in **elder people with osteoporosis.**
- The fracture results from falling on the hand (transition of force through the bones of forearm of the extended limb).
- In younger people, fractures of the **greater tubercle** results from falling on the hand when the arm is abducted .
- The **body of the humerus** can be fractured by a direct blow to the arm or by indirect injury as falling on the out stretched hand.

Nerves affected in fractures of humerus

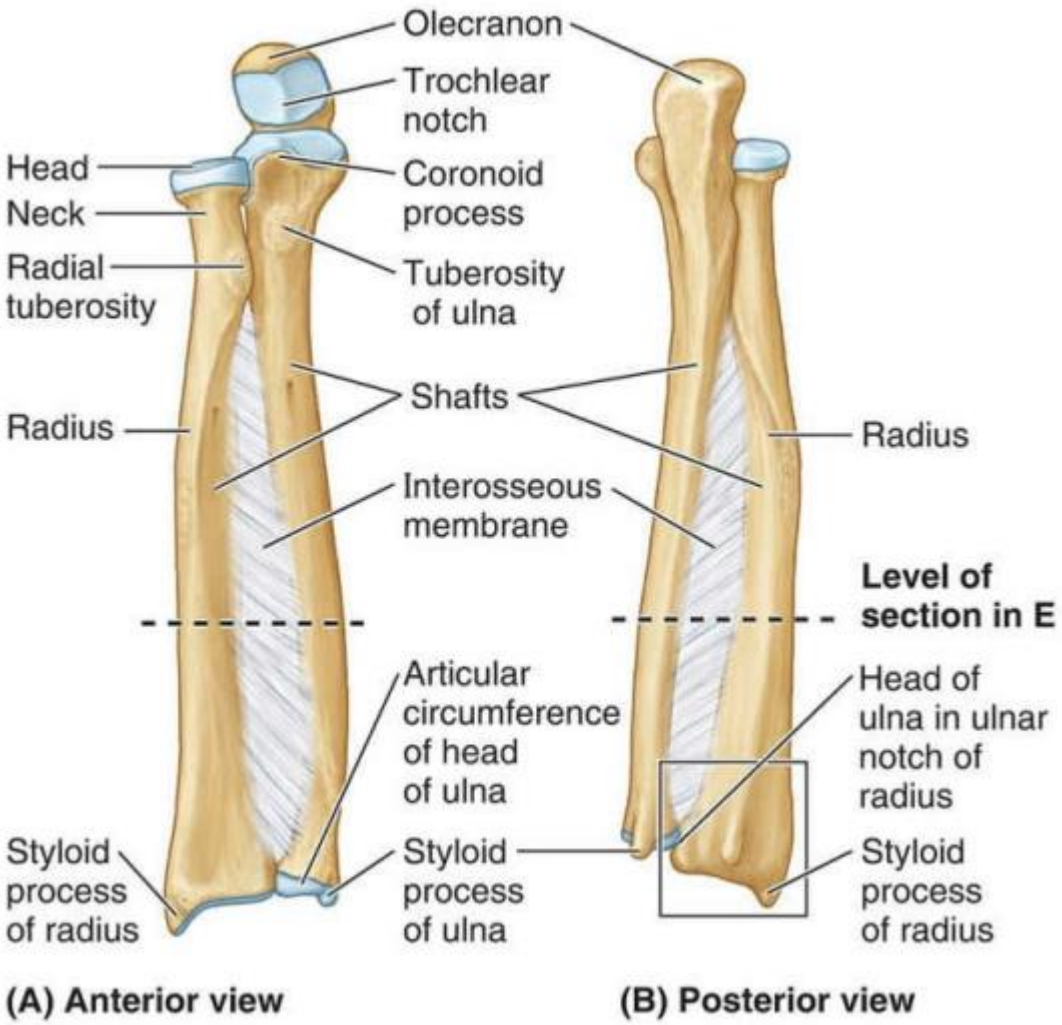
- Surgical neck: Axillary nerve
- Radial groove: Radial nerve and brachial aa.
- Distal end of humerus: Median nerve.
- Medial epicondyle : Ulnar nerve.



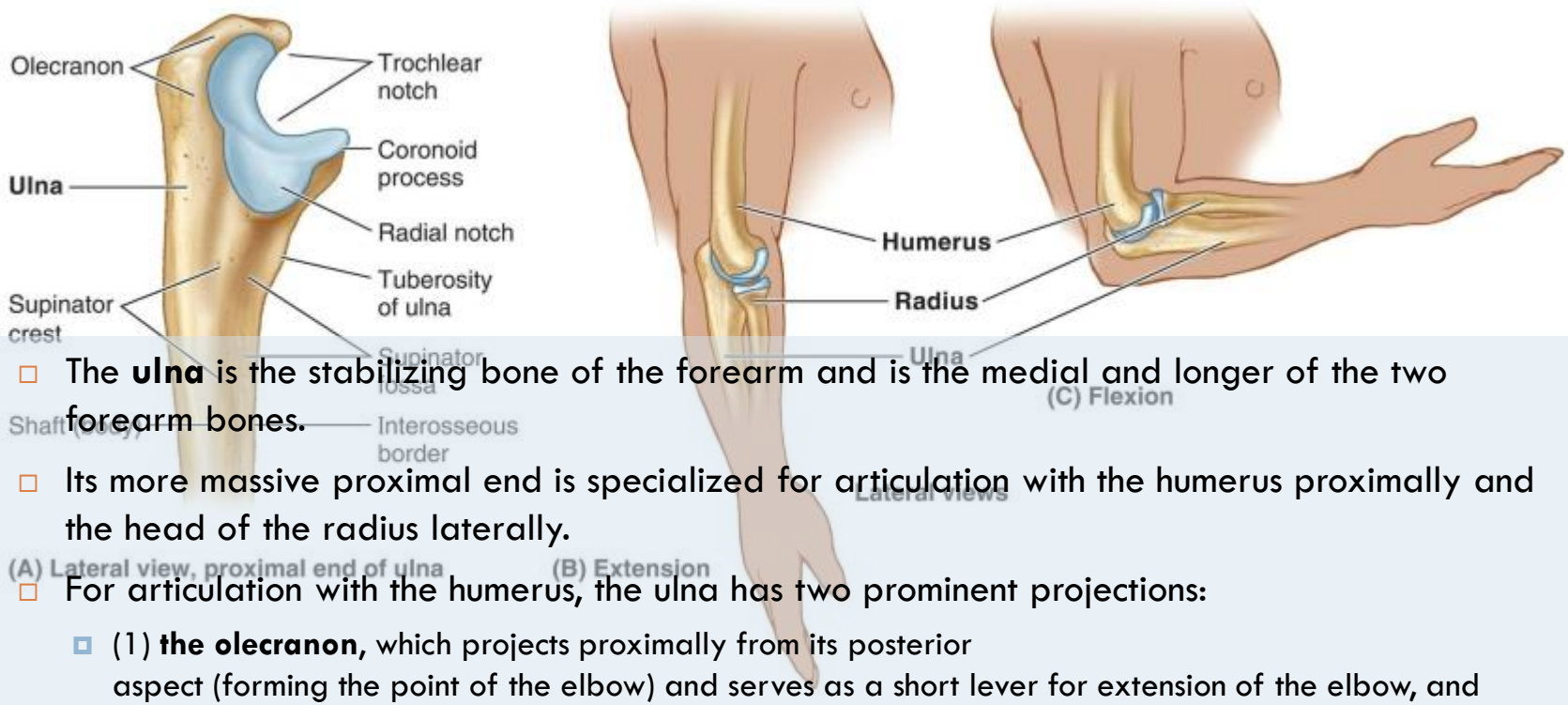


Ulna and radius

- Proximally, the larger medial ulna forms the primary articulation with the humerus, whereas distally, the shorter lateral radius forms the primary articulation with the hand via the wrist.
- Because the ulna does not reach the wrist, forces received by the hand are transmitted from the radius to the ulna via the interosseous membrane.



ULNA



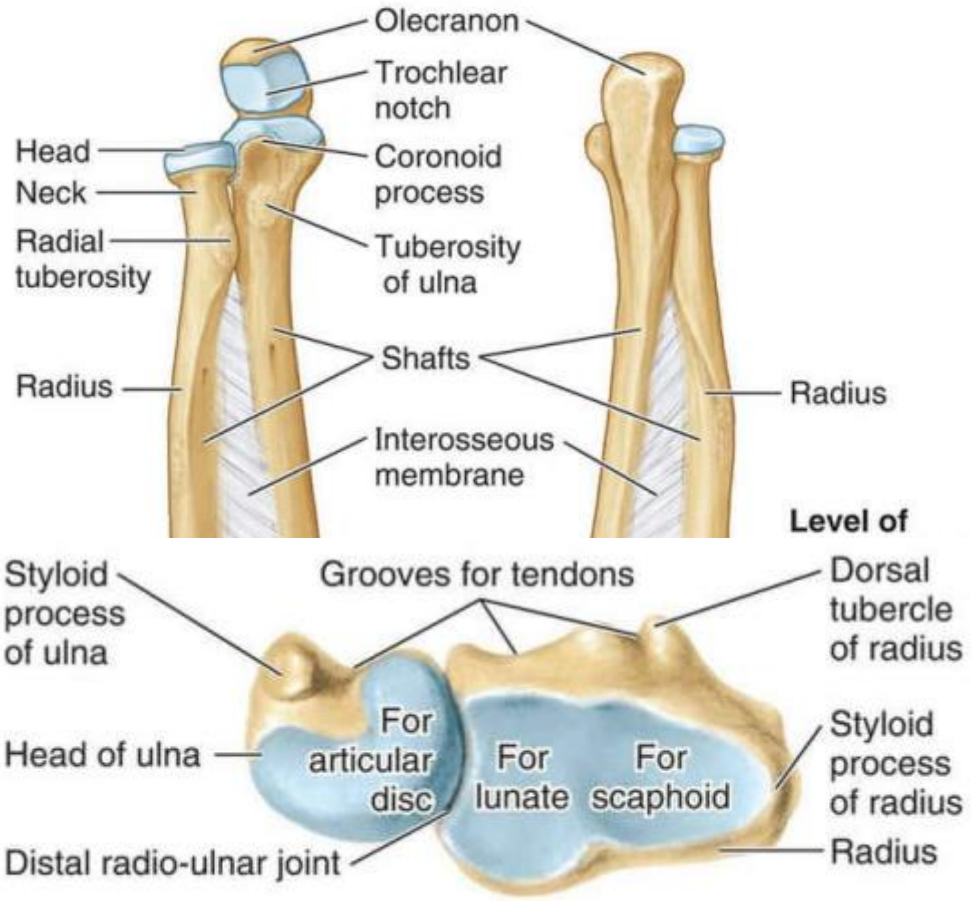
- The **ulna** is the stabilizing bone of the forearm and is the medial and longer of the two forearm bones.
- Its more massive proximal end is specialized for articulation with the humerus proximally and the head of the radius laterally.
- For articulation with the humerus, the ulna has two prominent projections:
  - (1) **the olecranon,** which projects proximally from its posterior aspect (forming the point of the elbow) and serves as a short lever for extension of the elbow, and
  - (2) the **coronoid process,** which projects anteriorly.
- The articulation between the ulna and humerus primarily allows only flexion and extension of the elbow joint although a small amount of abduction and adduction occurs during pronation and supination of the forearm.

Cont.

- Proximal end
  - The **trochlear notch**
    - **formed by** olecranon and coronoid processes
  - **tuberosity of the ulna**
    - Inferior to the coronoid process for attachment of the tendon of the brachialis muscle
  - **radial notch**
    - receives the broad periphery of the head of the radius
  - **supinator crest and supinator fossa**
    - deep part of the supinator muscle attaches

Cont.

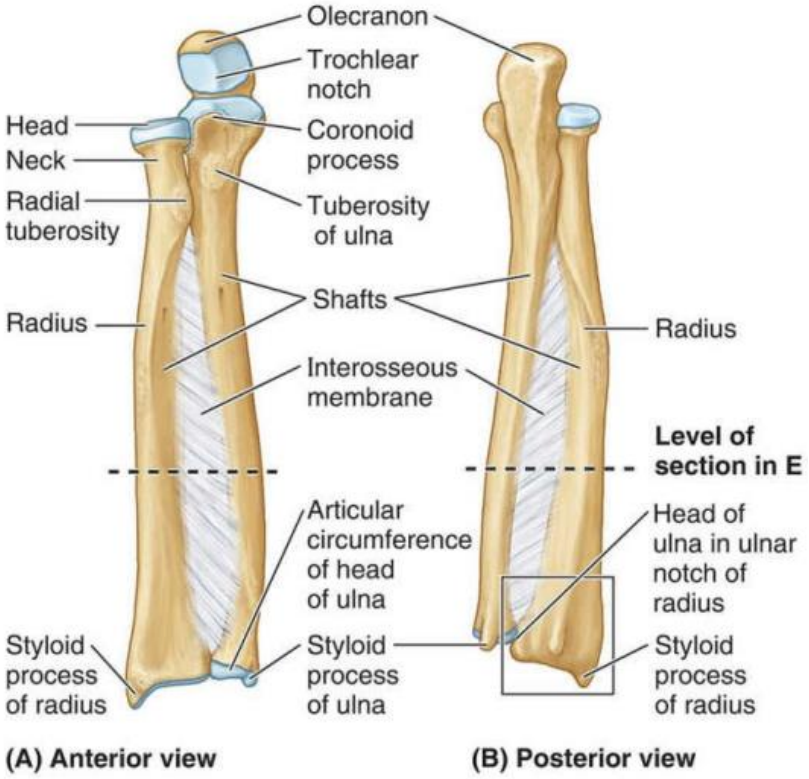
- The **shaft of the ulna** is thick and cylindrical proximally, but it tapers, diminishing in diameter, as it continues distally.
- At the narrow distal end of the ulna is a small but abrupt enlargement, the disc-like **head of the ulna** with a small, conical **ulnar styloid process.**
- The ulna does not reach—and therefore does not participate in—the wrist (radiocarpal) joint



(D) Inferior view of distal ends of ulna and radius

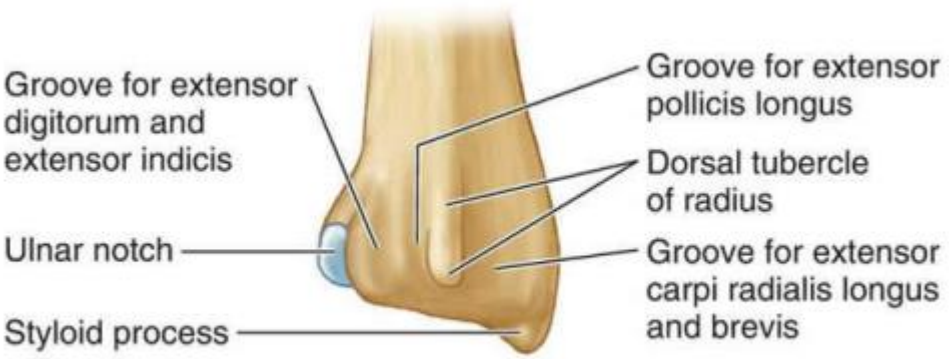
RADIUS

- The **radius** is the lateral and shorter of the two forearm bones.
  - **Head**
    - (1) **Articulates proximally** with **capitulum** and **medially** with **radial notch of ulna at proximal radioulnar joint**
    - (2) Encircled by strong **anular ligament** except at radial notch of ulna
  - **Neck**
    - Related to **deep radial nerve** as it pierces supinator muscle
  - **Tuberosity**
    - Insertion of **biceps brachii tendon,** just lateral to brachial artery
- The **shaft of the radius,** in contrast to that of the ulna, gradually enlarges as it passes distally.

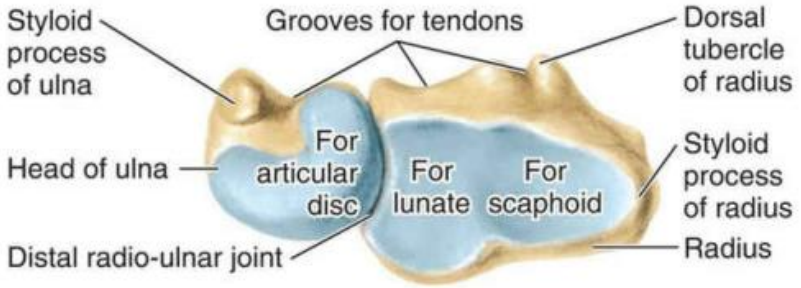


Cont.

- **Distal radius**
  - Concave for articulation with carpal bones at **radiocarpal joint**
  - **Ulnar notch**
    - Medial facet for **head of ulna** at **distal radioulnar joint**
  - **Styloid process**
    - Lateral prolongation of radius **palpable in anatomical snuffbox**
  - **Dorsal tubercle of the radius** lies between otherwise shallow grooves for the passage of the tendons of forearm muscles.



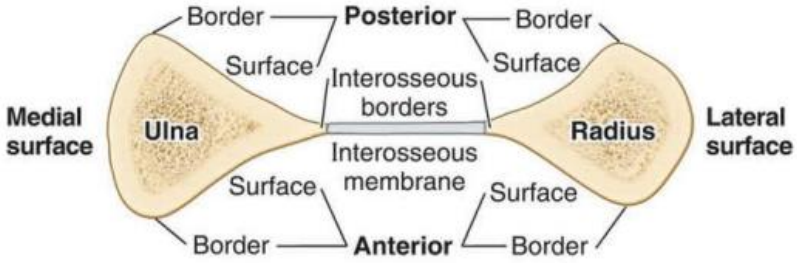
(C) Posterior view, distal end of radius



(D) Inferior view of distal ends of ulna and radius

Cont.

- Most of the length of the shafts of the radius and ulna is essentially triangular in cross section, with a rounded, superficially directed base and an acute, deeply directed apex.
- The apex is formed by a section of the sharp **interosseous border of the radius or ulna** that connects to the thin, fibrous **interosseous membrane of the forearm.**
- The majority of fibers of the interosseous membrane run an oblique course, passing inferiorly from the radius as they extend medially to the ulna.
- Thus, they are positioned to transmit forces received by the radius (via the hands) to the ulna for transmission to the humerus.



(E) Inferior view of cross section through shafts of the ulna and radius and interosseous membrane

Fractures of radius & ulna

- Because the radius & ulna are firmly bound by the interosseous membrane, a fracture of one bone is commonly associated with dislocation of the nearest joint.
- Colle' s Fracture (fracture of the distal end of radius) is the most common fracture of the forearm.
  - It is more common in women after middle age because of osteoporosis.
  - It causes dinner fork deformity.
  - It results from forced dorsiflexion of the hand as a result to ease a fall by outstretching the upper limb.
  - Because of the rich blood supply to the distal end of the radius, bony union is usually good.

Colle' s Fracture

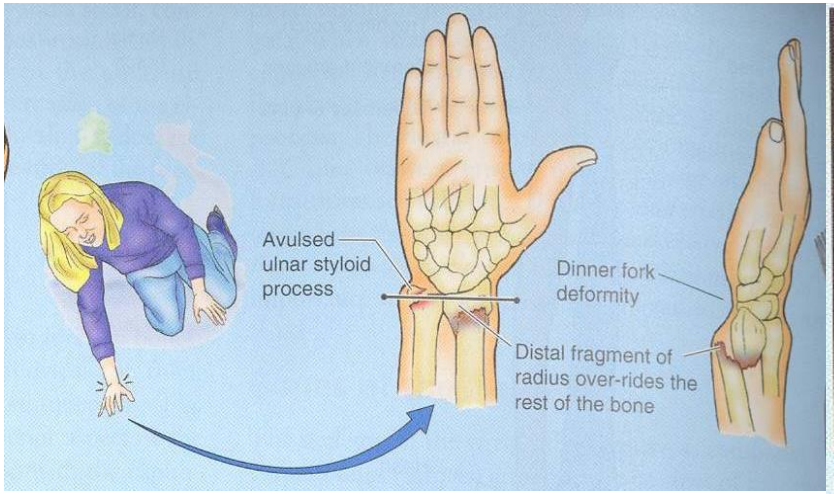


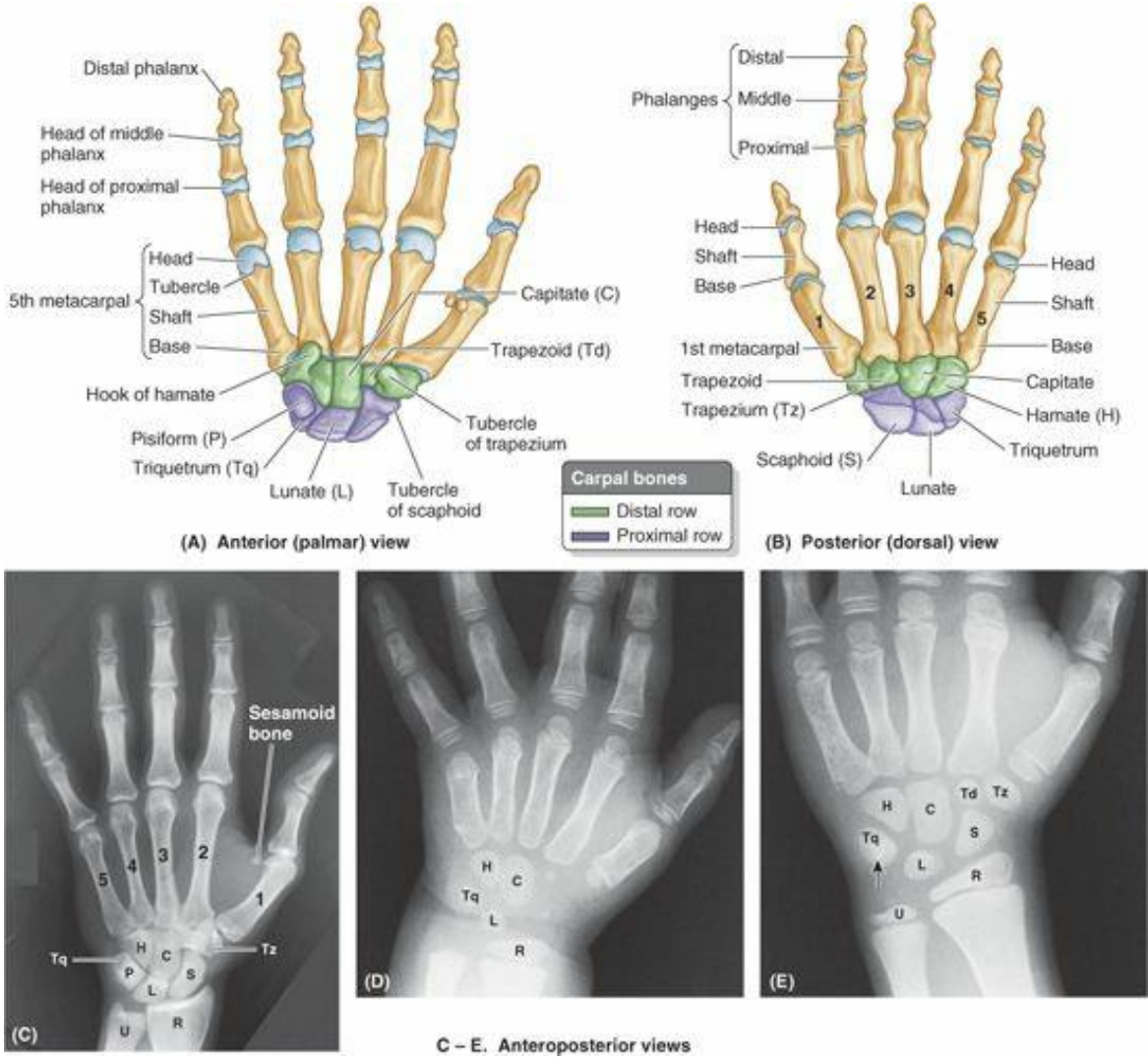
Figure 14.4 (a) Scaphoid fracture (arrow). (b) Colles' fr
showing 'dinner fork' deformity. (c) Colles' fracture, X

Bones of Hand

- The wrist, or carpus, is composed of eight carpal bones, arranged in proximal and distal rows of four.
- These small bones give flexibility to the wrist.
- The carpus is markedly convex from side to side posteriorly, and concave anteriorly.
- Augmenting movement at the wrist joint, the two rows of carpal bones glide on each other; in addition, each bone glides on those adjacent to it.

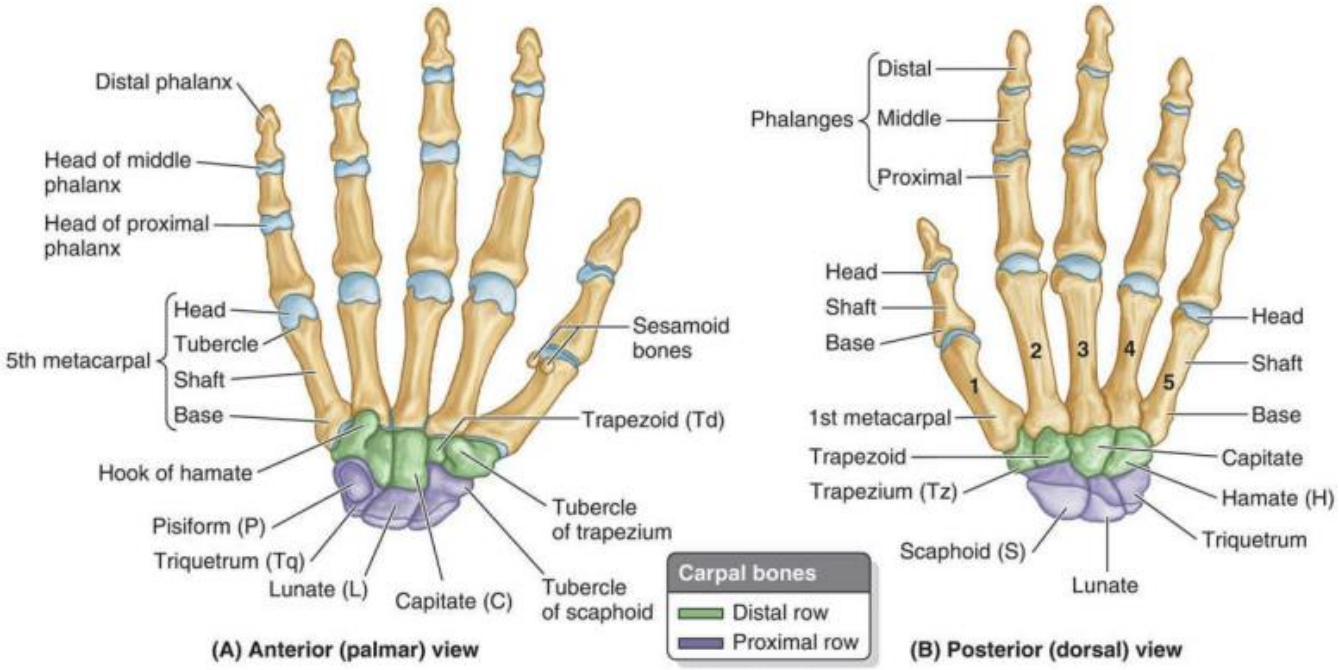
Carpal bones

- **Proximal row**
  - (1) Lateral to medial: **scaphoid, lunate, triquetrum,** and **pisiform**
  - (2) Articulates at **radiocarpal joint** except for pisiform
- **Distal row**
  - (1) Lateral to medial: **trapezium, trapezoid, capitate,** and **hamate**
  - (2) Articulates with **proximal row of carpal bones** at **midcarpal joint** and with **metacarpal bones** at **metacarpophalangeal joints**



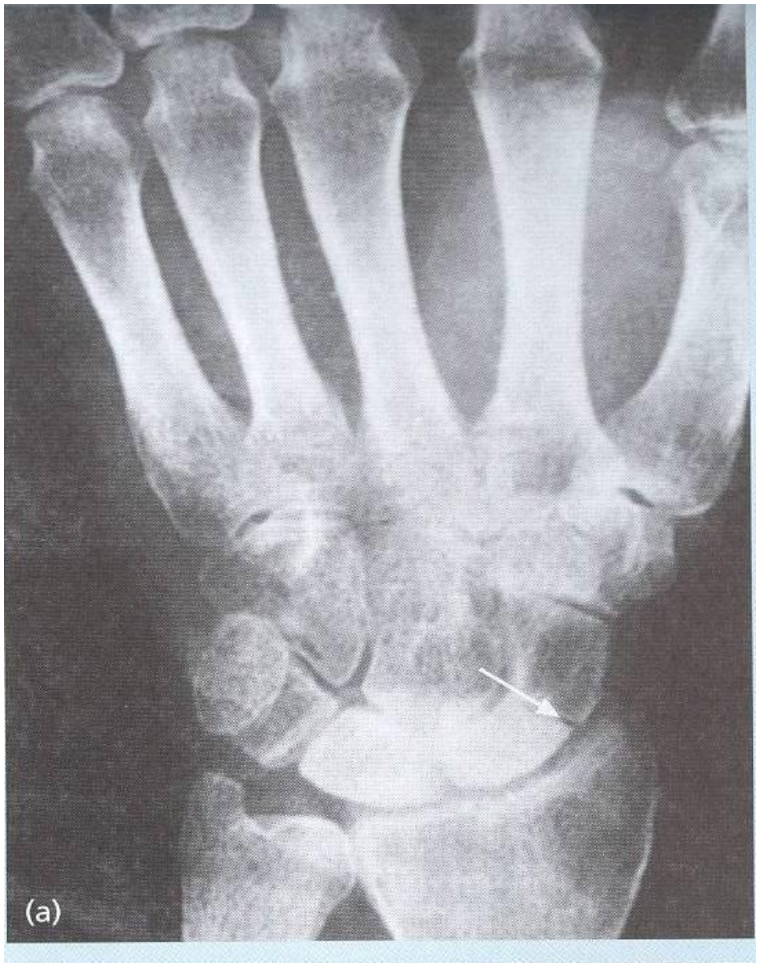
Cont.

- **Scaphoid** (navicular)
  - Lies in floor of **anatomical snuffbox**
- **Lunate**
- **Pisiform**
  - Palpable **sesamoid bone** in tendon of flexor carpi ulnaris muscle
- **Trapezium**
  - Forms a saddle joint with **first metacarpal bone**
- **Hamate**
  - On its palmar surface has prominent **hook of hamate**



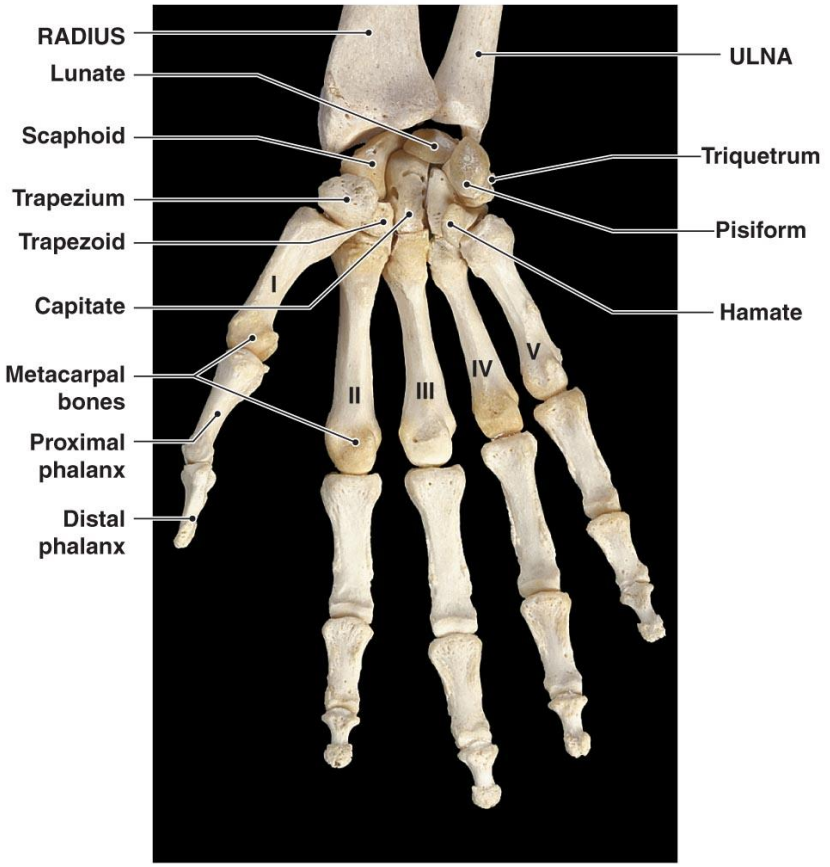
Fracture of Scaphoid

- **It is the most commonly fractured carpal bone and it is the most common injury of the wrist.**
- It is the result of a fall onto the palm when the hand is abducted.
- Pain occurs along the lateral side of the wrist especially during dorsiflexion and abduction of the hand.
- **Union of the bone may take several months because of poor blood supply to the proximal part of the scaphoid.**



Metacarpus

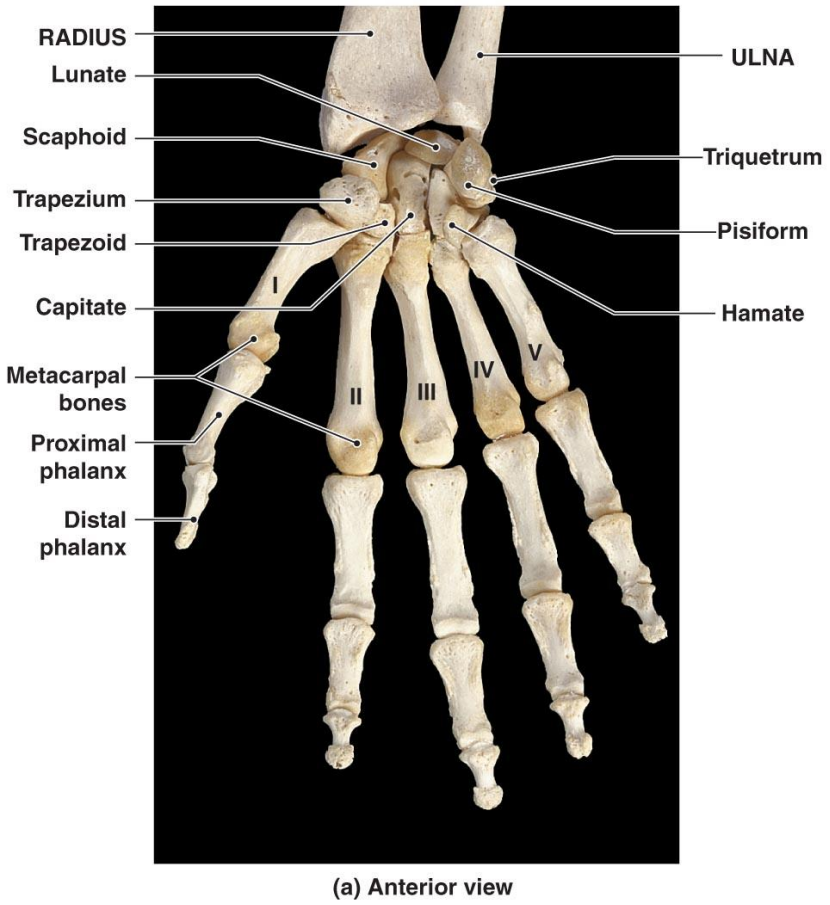
- It is the skeleton of the hand between the carpus and phalanges.
- It is composed of Five Metacarpal bones, each has a Base, Shaft, and a Head.
- They are numbered 1-5 from the thumb.
- The distal ends (Heads) articulate with the proximal phalanges to form the Knuckles of the fist.
- The Bases of the metacarpals articulate with the carpal bones.
- The 1st metacarpal is the shortest and most mobile.



(a) Anterior view

Digits

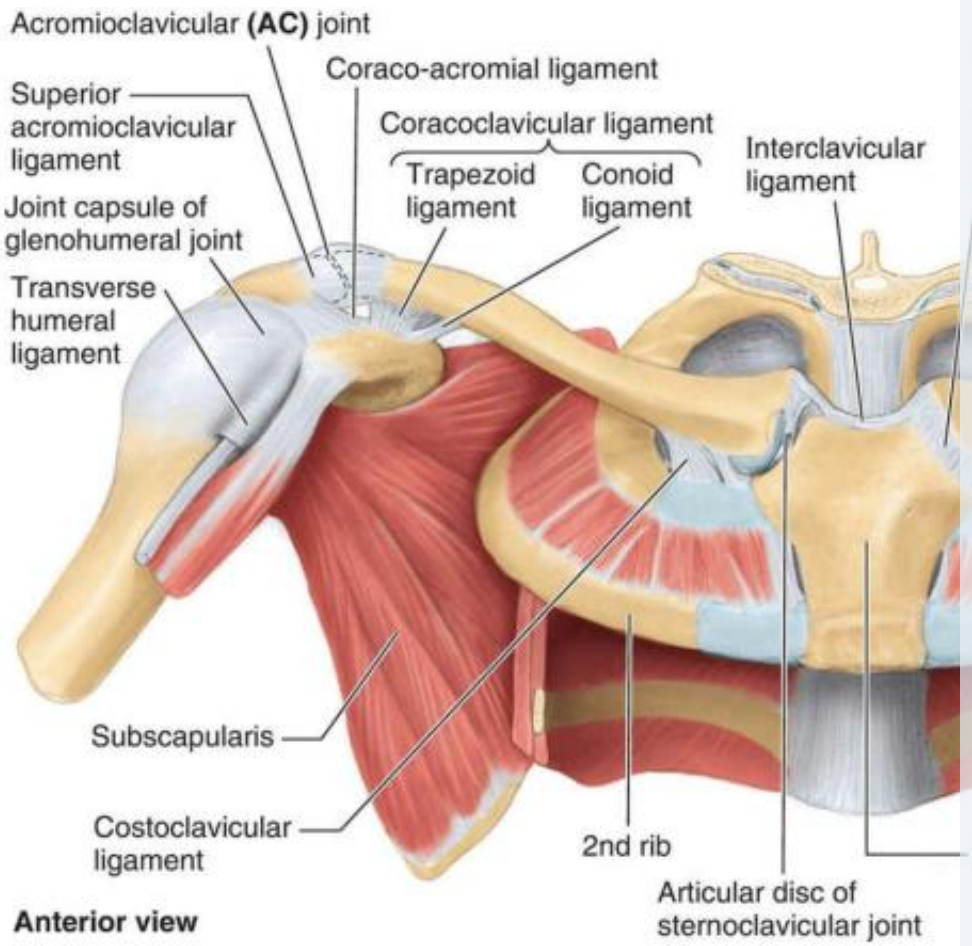
- Each digit has three Phalanges
- Except the thumb which has only two
- Each phalanx has a base Proximally, a head distally and a body between the base and the head.
- The proximal phalanx is the largest.
- The middle ones are intermediate in size.
- The distal ones are the smallest, its distal ends are flattened and expanded distally to form the nail beds.



(a) Anterior view

Joints of Upper Limb

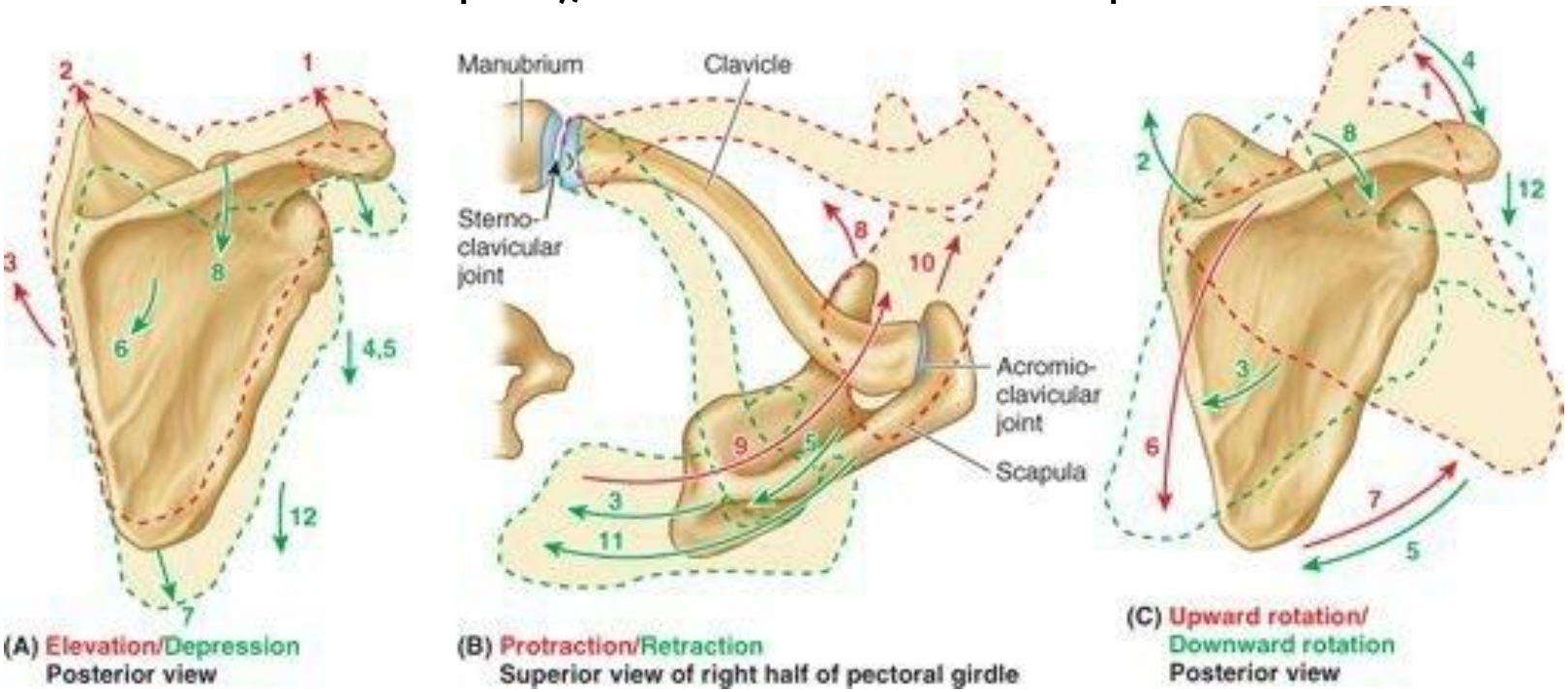
Pectoral girdle and associated tendons and ligaments



- The pectoral girdle is a partial bony ring (incomplete posteriorly) formed by the manubrium of the sternum, the clavicle, and the scapulae.
- Joints associated with these bones are the sternoclavicular, acromioclavicular, and glenohumeral.
- The girdle provides for attachment of the superior appendicular skeleton to the axial skeleton and provides the mobile base from which the upper limb operates.

Functional Scapulothoracic Joint

- The important movements of the pectoral girdle are scapular movements : elevation and depression, protraction (lateral or forward movement of the scapula) and retraction (medial or backward movement of the scapula), and rotation of the scapula.

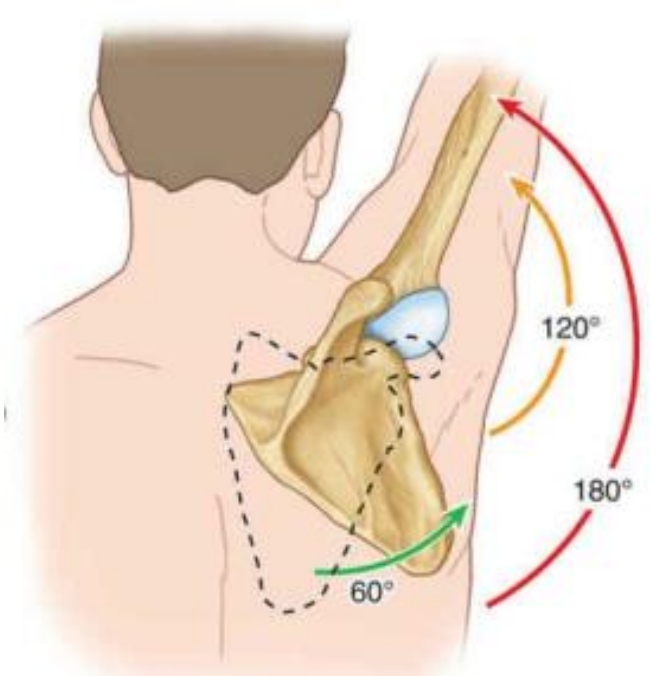


Functional Scapulothoracic Joint

- Movements of scapula on thoracic wall function like a joint
  - **Elevation:** trapezius (upper fibers) and levator scapulae muscles
  - **Depression:** gravity, trapezius (lower fibers), and serratus anterior (lower fibers) muscles
  - **Superior rotation:** serratus anterior and trapezius muscles (upper and lower fibers together)
  - **Inferior rotation:** levator scapulae, rhomboid major and minor muscles
  - **Protraction:** serratus anterior and pectoralis minor muscles
  - **Retraction:** trapezius (middle fibers), rhomboid major and minor muscles

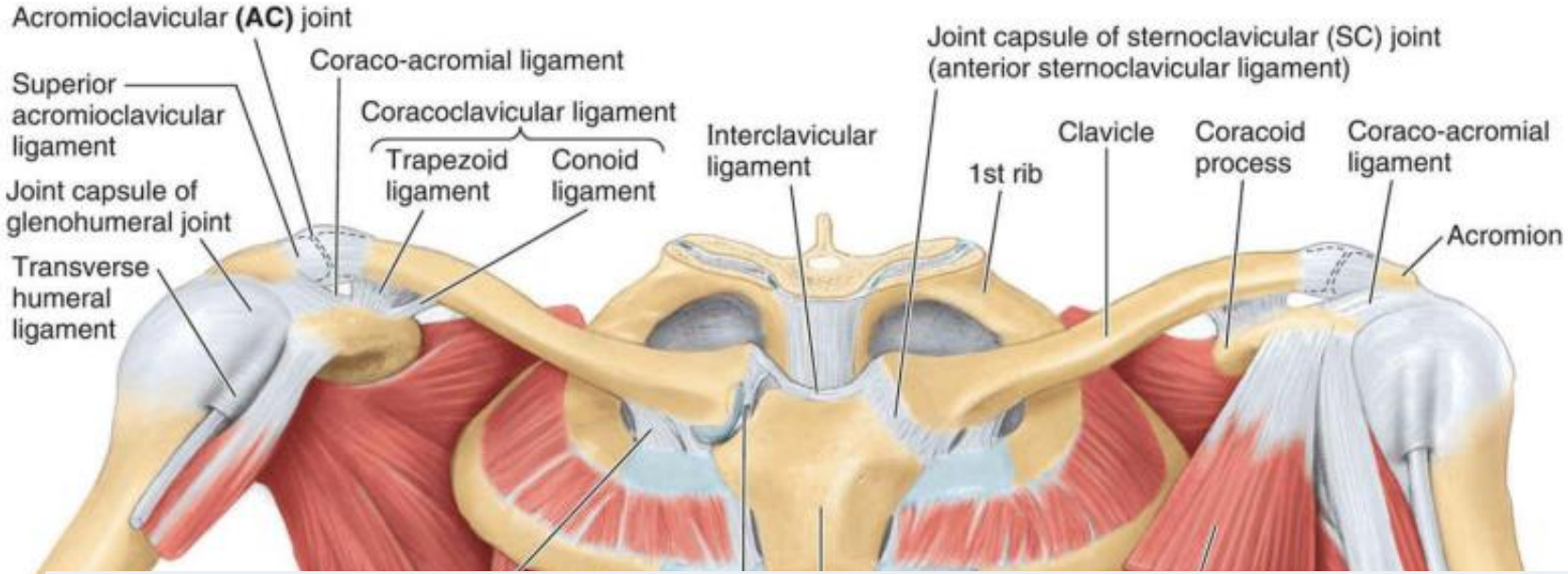
Cont.

- Although the initial 30° of abduction may occur without scapular motion, in the overall movement of fully elevating the arm, the movement occurs in a 2:1 ratio: For every 3° of elevation, approximately 2° occurs at the glenohumeral joint and 1° at the physiological scapulothoracic joint.
- When the upper limb has been elevated so that the arm is vertical at the side of the head (180° of arm abduction or flexion), 120° occurred at the glenohumeral joint and 60° occurred at the scapulothoracic joint; known as **scapulohumeral rhythm**.



(C) Scapulohumeral rhythm. The scapula and humerus move in 1:2 ratio. When the arm is abducted 180°, 60° occurs by rotation of the scapula, and 120° by rotation of the humerus at the shoulder joint.

Sternoclavicular Joint



- Formed between **clavicle** laterally and **manubrium and first costal cartilage** medially as only true joint between **upper extremity** and **axial skeletons**
- Contains two joint cavities separated by **articular disc**
- Fibrous **capsule** reinforced by **anterior and posterior sternoclavicular ligaments** and superiorly by **interclavicular ligament**
- Stabilized mainly by strong **costoclavicular ligament,** which anchors medial end of clavicle to rib 1 and its costal cartilage

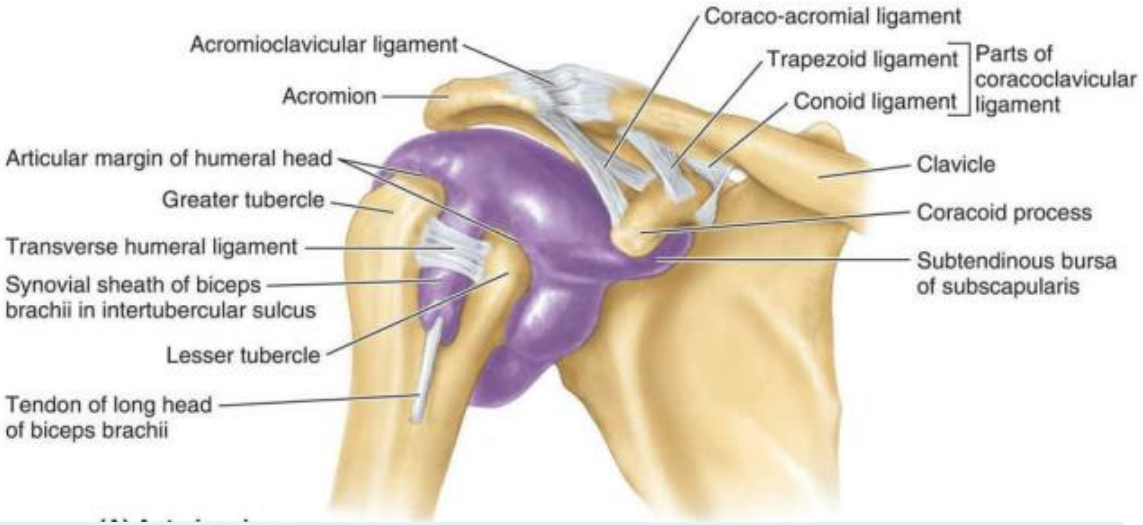
Cont.

- The **sternoclavicular joint** is so stable that the clavicle usually will fracture before the joint dislocates.
- If the joint dislocates, it is usually anteriorly.
- In a rare **posterior dislocation,** however, the medial end of the clavicle may **compress the trachea** or **major blood vessels.**

Acromioclavicular Joint

- A plane type of synovial joint, which is located 2–3 cm from the "point" of the shoulder formed by the lateral part of the acromion
- Formed between **acromion** and **lateral end of clavicle**
- The acromion of the scapula rotates on the acromial end of the clavicle.

- No muscles connect the articulating bones to move the AC joint; the axio-appendicular muscles that attach to and move the scapula cause the acromion to move on the clavicle.



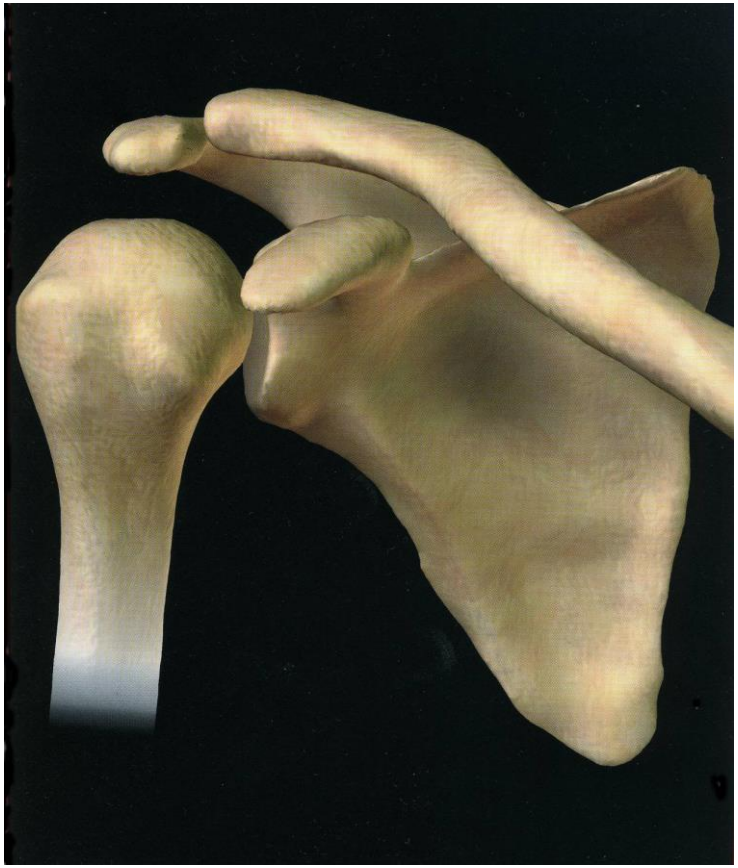
The 15–20° of movement at the AC joint permits positioning of the glenoid cavity that is necessary for arm movements.

Ligaments

- The acromioclavicular ligament
  - is a fibrous band extending from the acromion to the clavicle that strengthens the AC joint superiorly
- The **coracoclavicular ligament**
  - Is a strong pair of bands that unite the coracoid process of the scapula to the clavicle, anchoring the clavicle to the coracoid process.
  - Consists of two ligaments, the conoid and trapezoid ligaments, which are often separated by a bursa related to the lateral end of the subclavius muscle.

Glenohumeral Joint

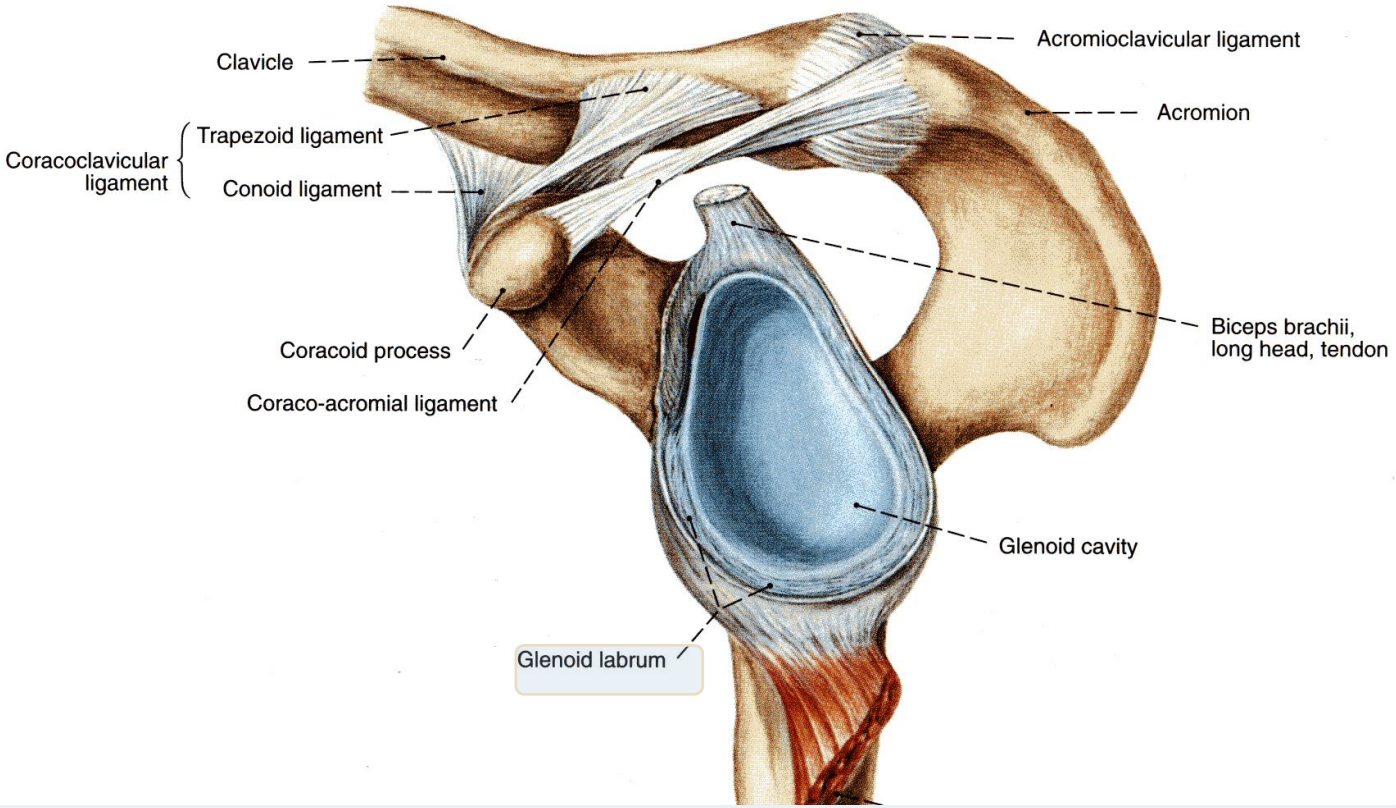
- The glenohumeral (shoulder) joint is a ball-and-socket type of synovial joint that permits a wide range of movement; however, its mobility makes the joint relatively unstable.



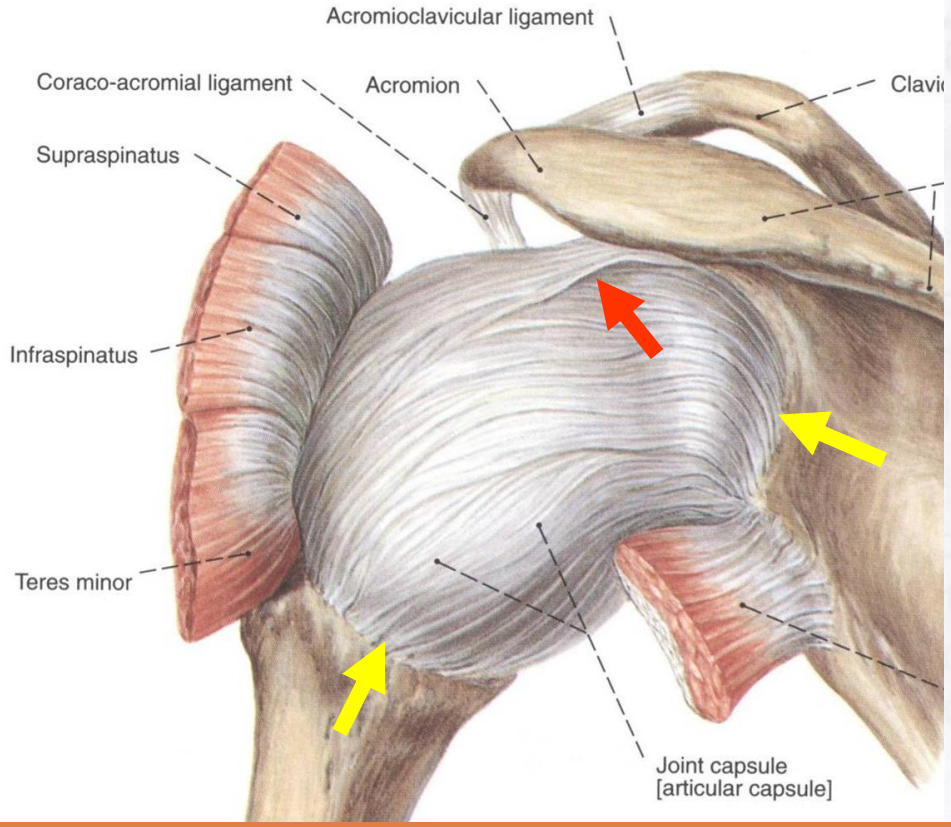
The articulation is between:

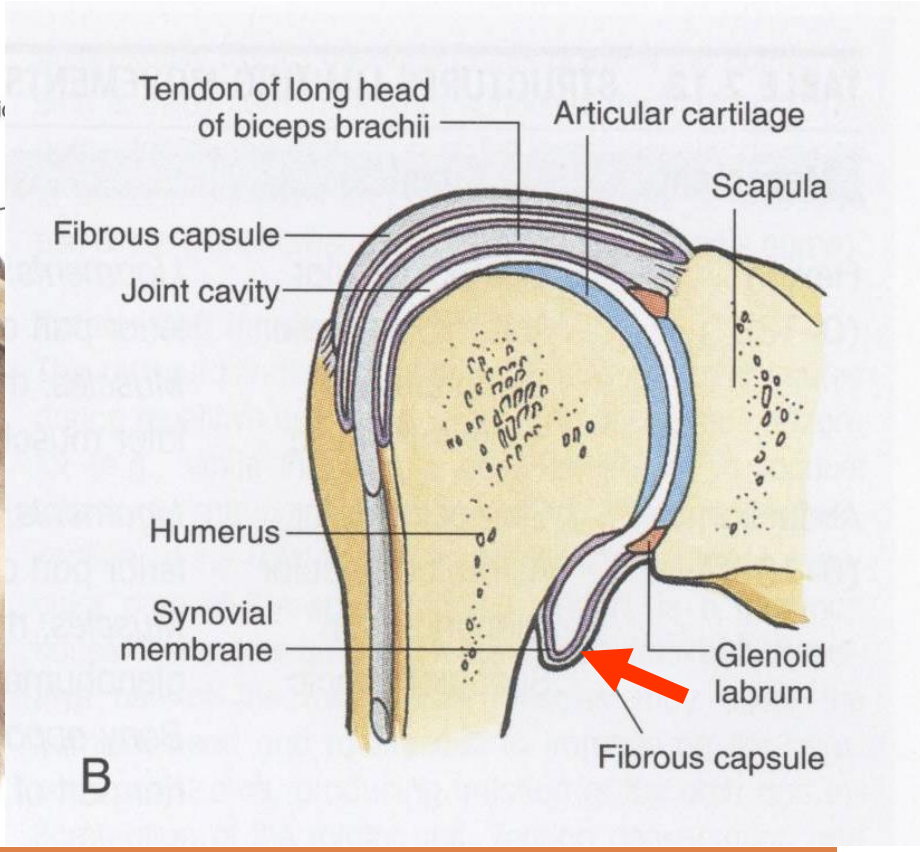
- the rounded **head of the humerus** and
- the shallow, pear-shaped **glenoid cavity** of the scapula.

Cont.



- The articular surfaces are covered by *hyaline articular cartilage.*
- The glenoid cavity is deepened by the presence of a *fibrocartilaginous rim* called the **glenoid labrum.**



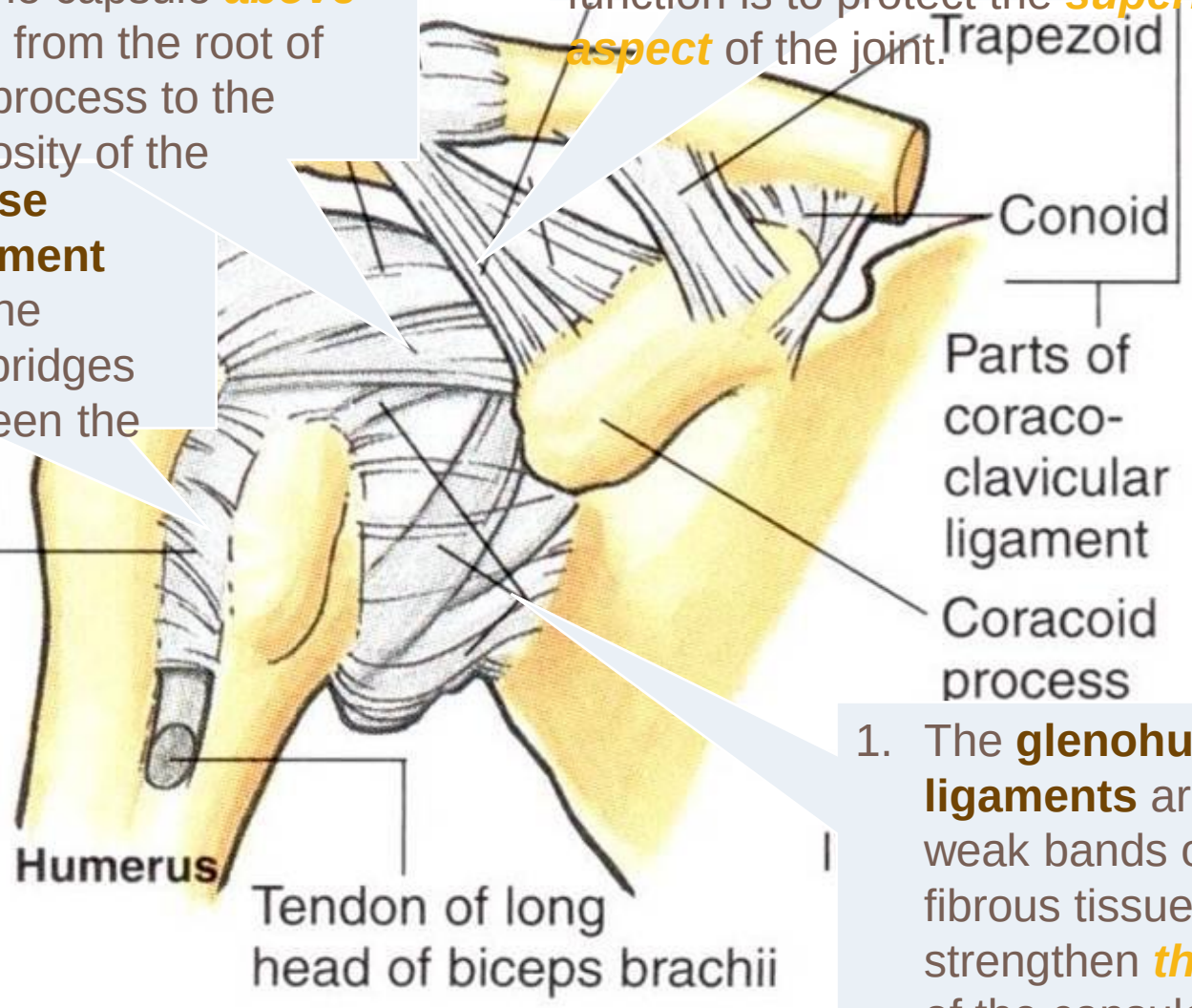


- The fibrous capsule surrounds the joint and is attached:
  - *medially* to the margin of the glenoid cavity outside the labrum;
  - *laterally* to the anatomic neck of the humerus.
- The capsule is **thin and lax**, allowing a wide range of movement.
- It is **strengthened by fibrous slips** from the tendons of the rotator cuff muscles (subscapularis, supraspinatus, infraspinatus and teres minor)

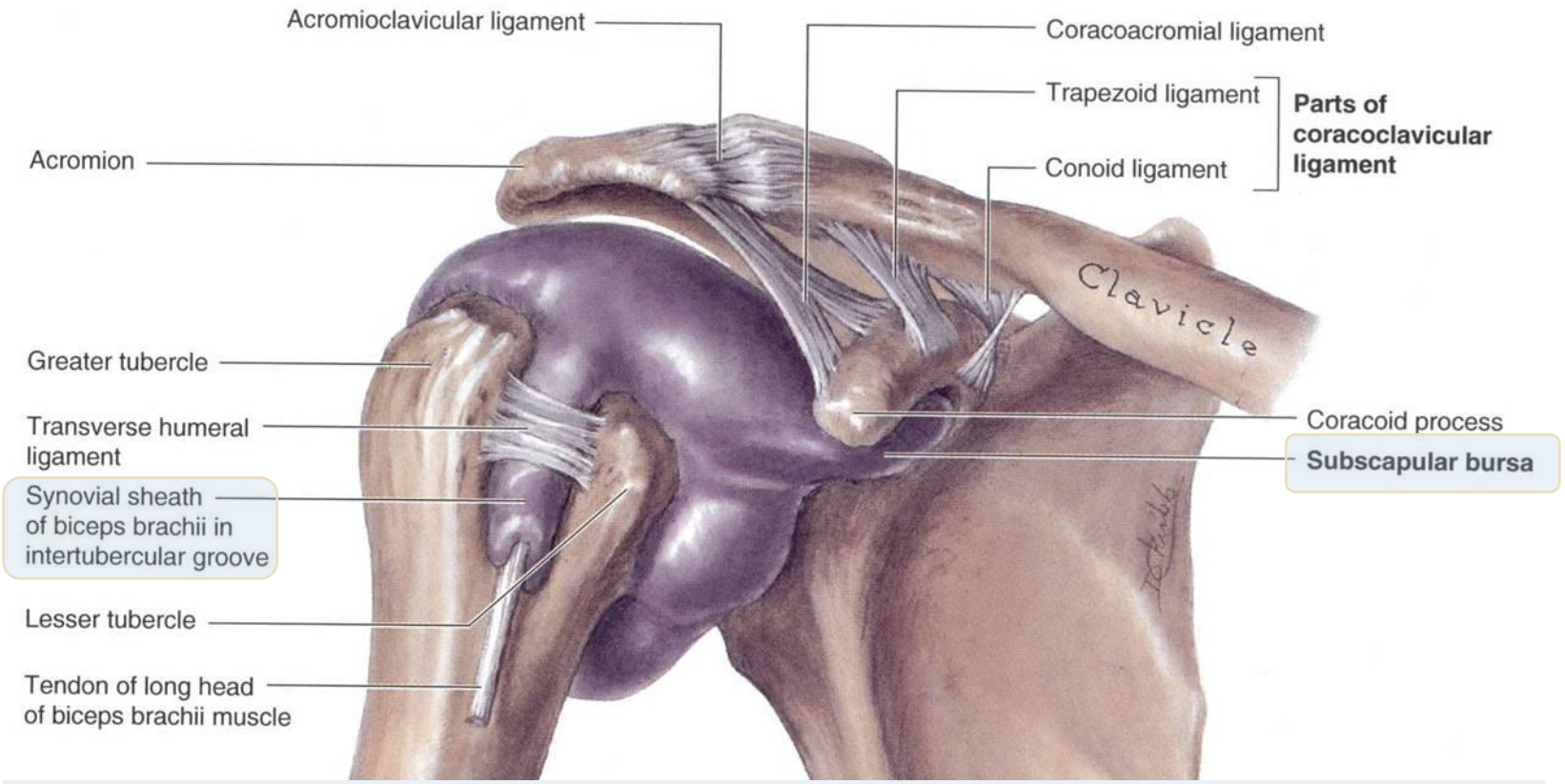
Accessory ligaments:
The **coracoacromial ligament** extends between the coracoid process and the acromion. Its function is to protect the ***superior aspect*** of the joint.

3. The **coracohumeral ligament** strengthens the capsule ***above*** and stretches from the root of the coracoid process to the greater tuberosity of the humerus.

2. The **transverse humeral ligament** strengthens the capsule and bridges the gap between the two humeral tuberosities.

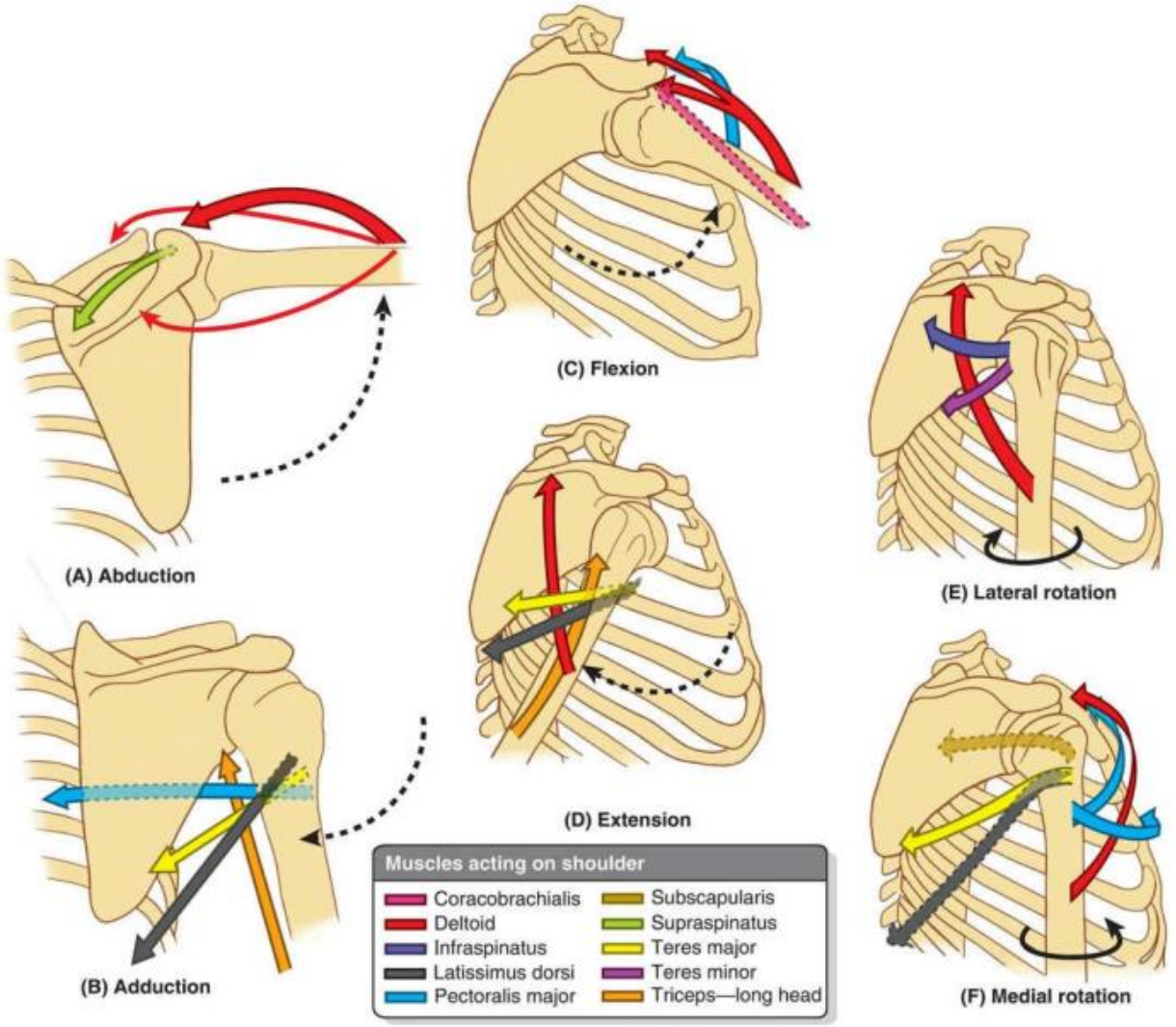


1. The **glenohumeral ligaments** are three weak bands of fibrous tissue that strengthen ***the front*** of the capsule.

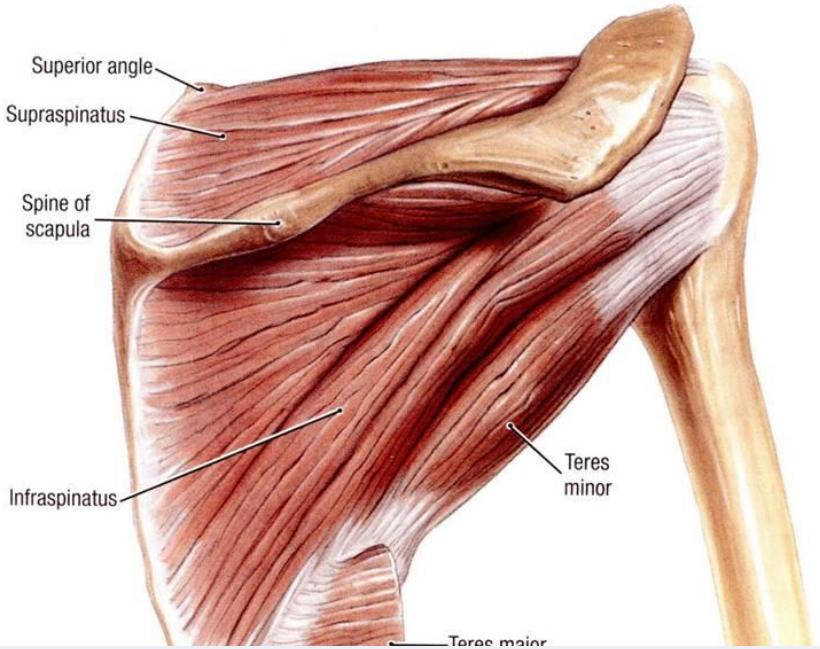


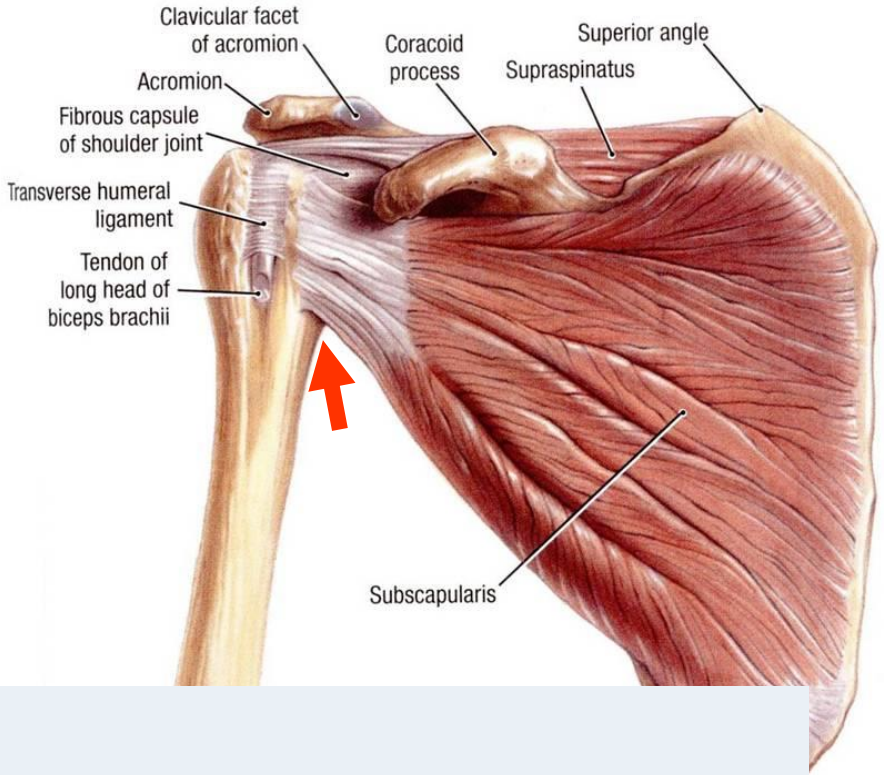
- It lines the fibrous capsule.
- ***It is attached to the margins of the cartilage*** covering the articular surfaces.
- It forms a **tubular sheath** around the tendon of the long head of the biceps brachii.
- ***It extends through the anterior wall of the capsule*** to form the **subscapularis bursa** beneath the subscapularis muscle.

Movements of glenohumeral joint



STABILITY OF THE SHOULDER JOINT

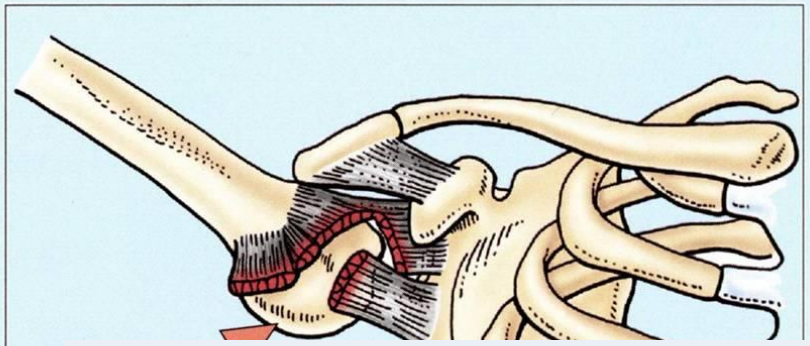


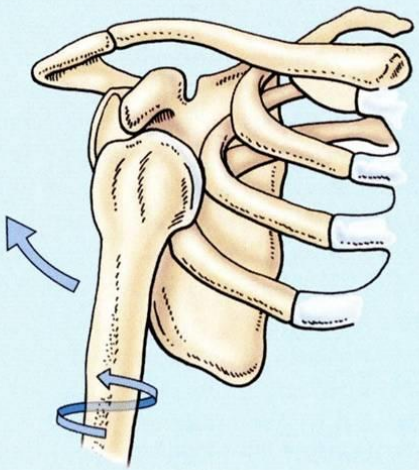


- This joint is **unstable** because of the:
  - ***shallowness*** of the glenoid fossa
  - ***weak ligaments***
- Its strength almost entirely depends on the **tone** of the rotator cuff muscles.
- The tendons of these muscles are fused to the underlying capsule of the shoulder joint.
- ***The least supported part of the joint*** lies in the **inferior** location, where it is unprotected by muscles.

DISLOCATIONS OF THE SHOULDER JOINT

The shoulder joint is the most commonly dislocated large joint.





Anterior-Inferior Dislocation

- Sudden violence applied to the humerus with the joint fully abducted tilts the humeral head downward onto the inferior weak part of the capsule, which tears, and the humeral head comes to lie inferior to the glenoid fossa.
- During this movement the acromion has acted as a fulcrum.
- The strong flexors and adductors of the shoulder joint now usually pull the humeral head forward and upward into the subcoracoid position.

Posterior Dislocations

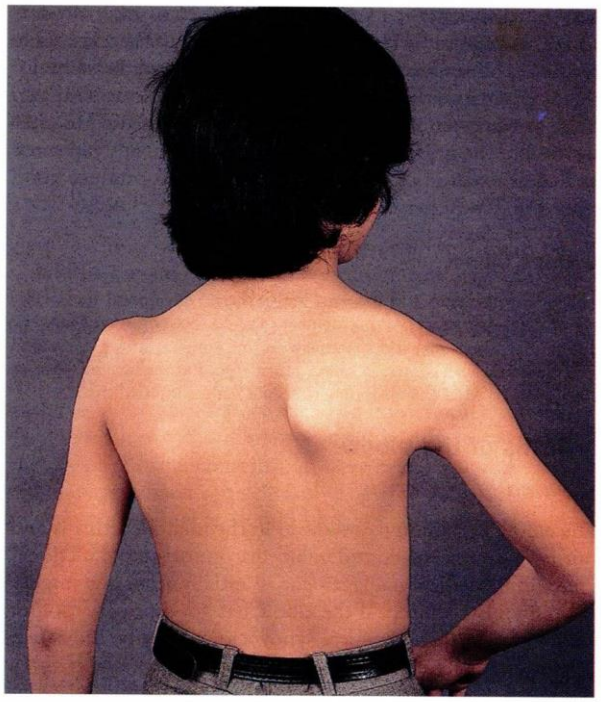
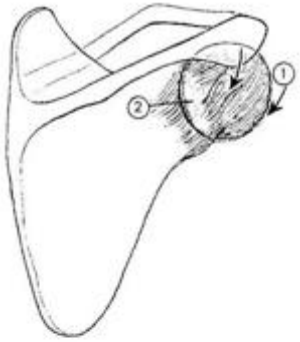
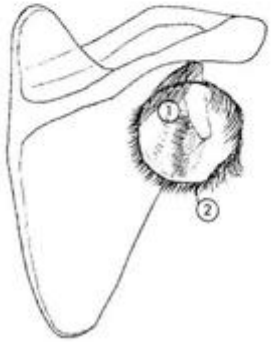


Fig. 22.15 Multidirectional voluntary dislocation of the shoulder. This 9-year-old boy can voluntarily dislocate his shoulder posteriorly.

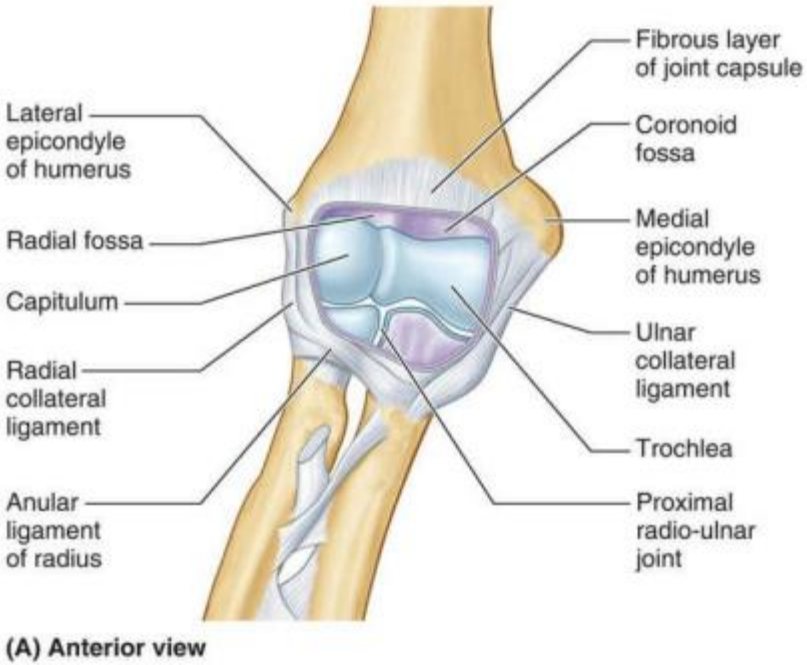




- Posterior dislocations are rare and are usually caused by direct violence ***to the front of the joint.***
- On inspection of the patient with shoulder dislocation ***the rounded appearance of the shoulder is seen to be lost*** because the greater tuberosity of the humerus is no longer bulging laterally beneath the deltoid muscle.

Elbow Joint

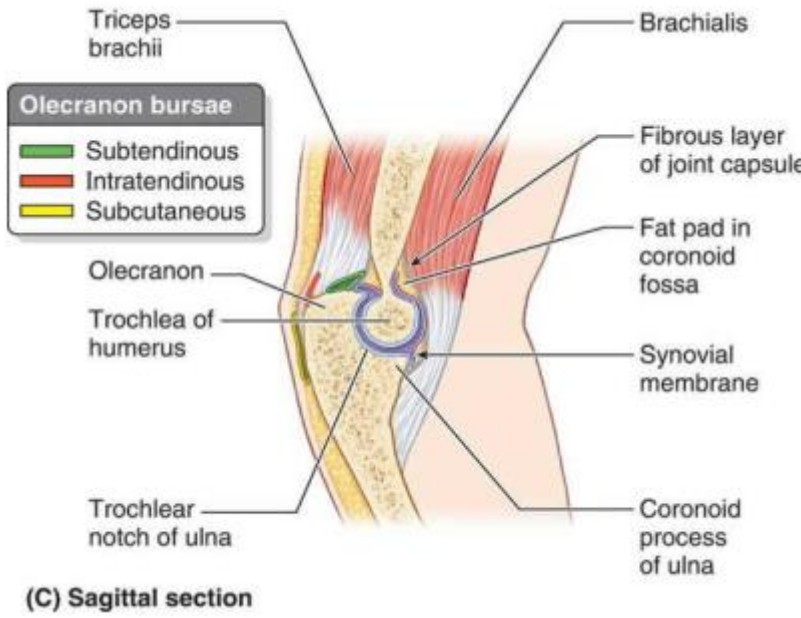
- The **elbow joint,** a hinge type of synovial joint, is located 2–3 cm inferior to the epicondyles of the humerus
- The spool-shaped *trochlea* and spheroidal *capitulum* of the humerus articulate with the *trochlear notch* of the ulna and the slightly concave superior aspect of the *head of the radius*, respectively; therefore there are humero-ulnar and humeroradial articulations.
- *The articular surfaces, covered with hyaline cartilage, are most fully congruent (in contact) when the forearm is in a position midway between pronation and supination and is flexed to a right angle.*



(A) Anterior view

JOINT CAPSULE OF ELBOW JOINT

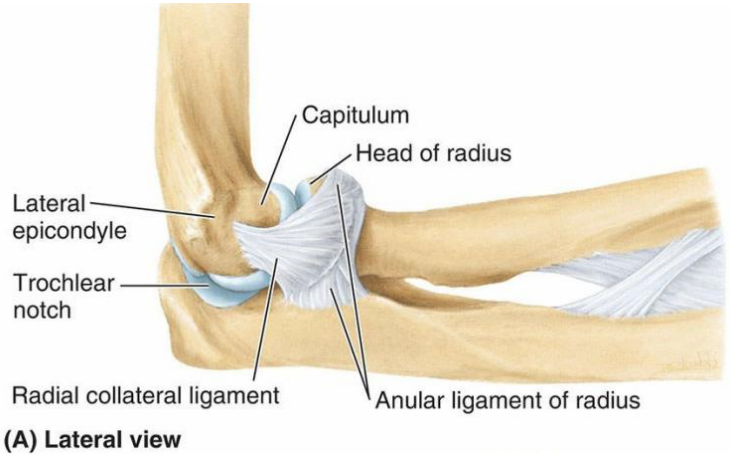
- The *fibrous layer of the joint capsule* surrounds the elbow joint.
- It is attached to the humerus at the margins of th lateral and medial ends of the articular surfaces of the capitulum and trochlea. Anteriorly and posteriorly, it is carried superiorly, proximal to th coronoid and olecranon fossae.
- The *synovial membrane* lines the internal surface of the fibrous layer of the capsule and the intracapsular non articular parts of the humerus.
- It is also continuous inferiorly with the synovial membrane of the proximal radio-ulnar joint.
- The joint capsule is weak anteriorly and posteriorly but is strengthened on each side by collateral ligaments.



(C) Sagittal section

LIGAMENTS OF ELBOW JOINT

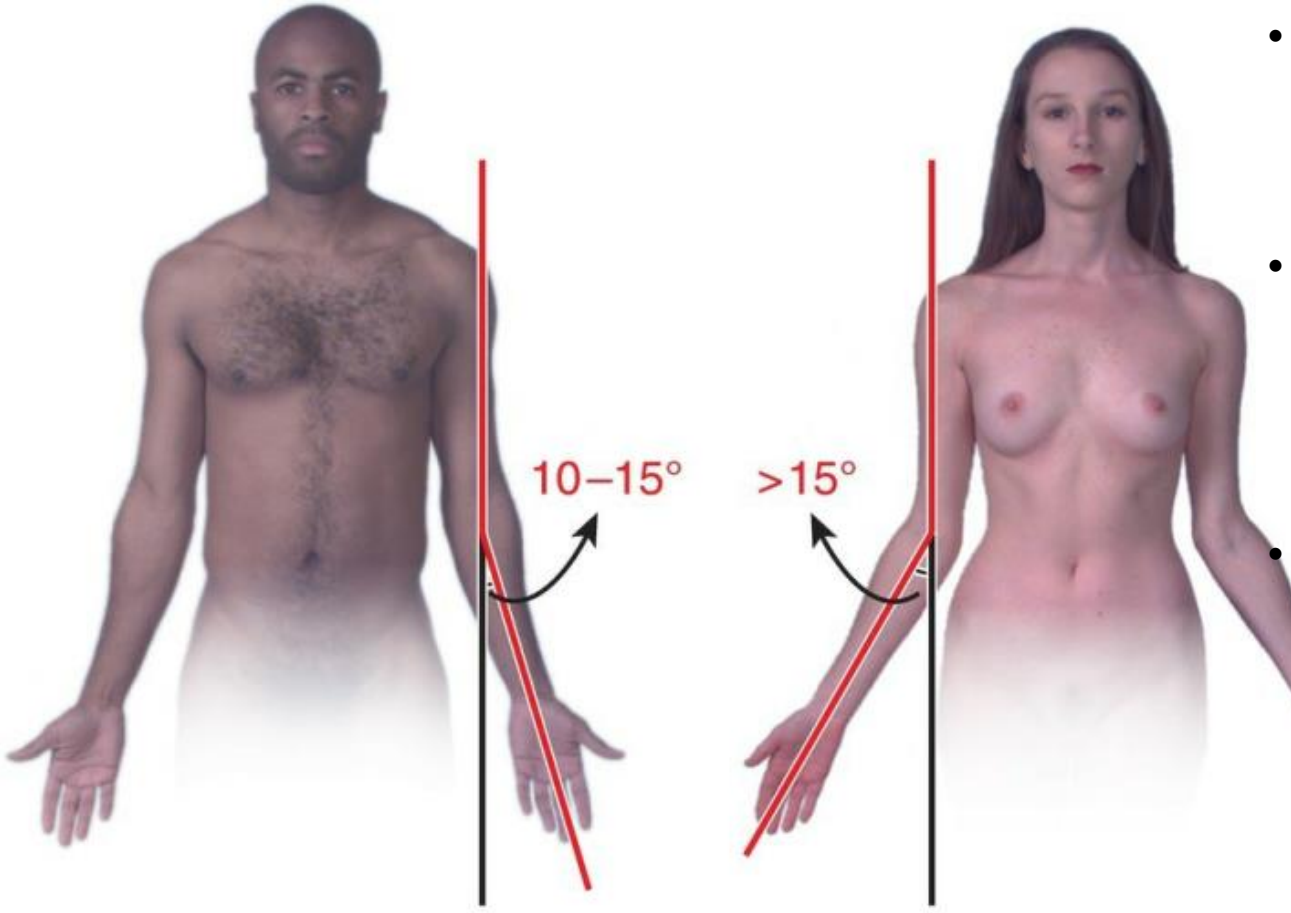
- The collateral ligaments of the elbow joint are strong triangular bands that are medial and lateral thickenings of the fibrous layer of the joint capsule.
  - **radial collateral ligament** extends from the lateral epicondyle of the humerus and blends distally with the **anular ligament of the radius.**
  - **ulnar collateral ligament** extends from the medial epicondyle of the humerus to the coronoid process and olecranon of the ulna and consists of three bands:
    - (1) the *anterior cord-like band* is the strongest,
    - (2) the *posterior fan-like band* is the weakest, and
    - (3) the slender *oblique band* deepens the socket for the trochlea of the humerus.



MOVEMENTS OF ELBOW JOINT

- Flexion and extension occur at the elbow joint. The long axis of the fully extended ulna makes an angle of approximately 170° with the long axis of the humerus.
- This **carrying angle** is named for the way the forearm angles away from the body when something is carried, such as a pail of water.
- The obliquity of the ulna and thus of the carrying angle is more pronounced (the angle is approximately 10° more acute) in women than in men.
- It is said to enable the swinging limbs to clear the wide female pelvis when walking.
- In the anatomical position, the elbow is against the waist. The carrying angle disappears when the forearm is pronated.

Carrying angle of elbow joint

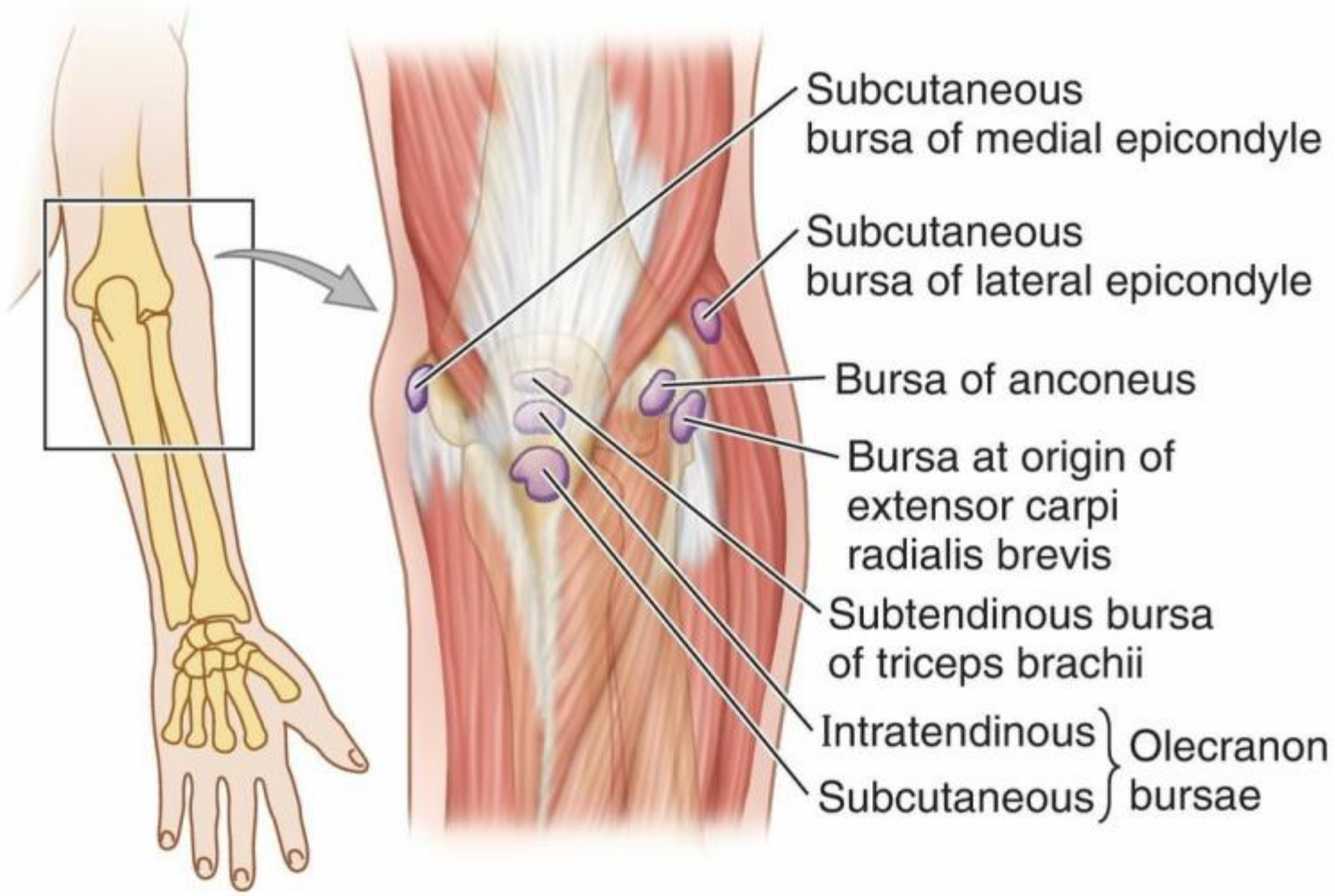


- This angle is made by the axes of the arm and forearm when the elbow is fully extended.
- Note that the forearm diverges laterally, forming an angle that is greater in the woman.
- This is said to allow for clearance of the wider female pelvis as the limbs swing during walking; however, no significant difference exists regarding the function of the elbow.

BURSAE AROUND ELBOW JOINT

- Only some of the bursae around the elbow joint are clinically important.
- The three olecranon bursae are:
  - **Intratendinous olecranon bursa,** which is sometimes present in the tendon of triceps brachii.
  - **Subtendinous olecranon bursa,** which is located between the olecranon and the triceps tendon, just proximal to its attachment to the olecranon.
  - **Subcutaneous olecranon bursa,** which is located in the subcutaneous connective tissue over the olecranon.

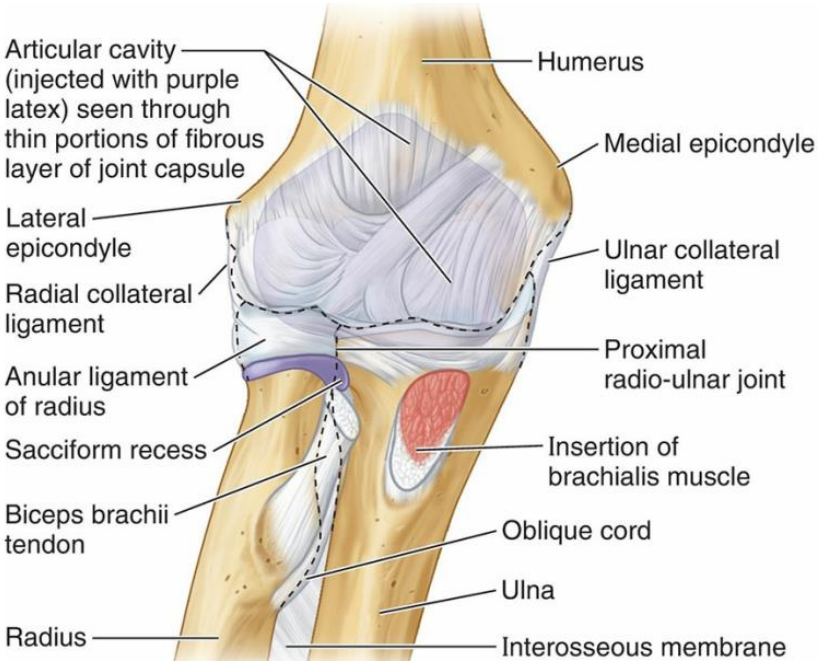
BURSAE AROUND ELBOW JOINT



- Of the several bursae around the elbow joint, the olecranon bursae are most important clinically.
- Trauma of these bursae may produce bursitis.

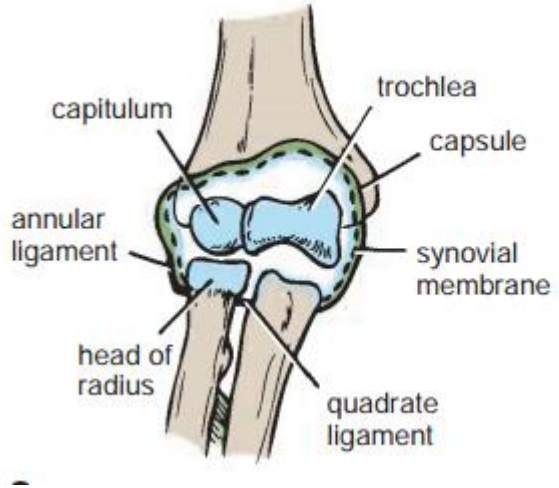
Proximal Radio-Ulnar Joint

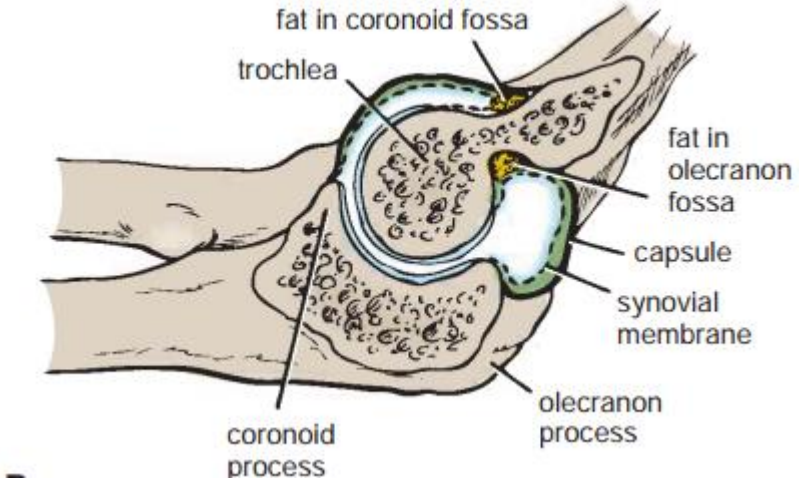
- The **proximal (superior)** radio-ulnar joint is a pivot type of synovial joint that allows **head of radius to rotate** in ring formed by **radial notch of ulna** and **anular ligament,** its main stabilizer
  - Shares **articular cavity** with elbow joint
- • The anular ligament attaches to the radial notch of the ulna, forming a collar around the head of the radius and creating a pivot type of synovial joint.
  - The articular cavity of the joint is continuous with that of the elbow joint, as demonstrated by the blue latex injected into that space and seen through the thin parts of the fibrous layer of the capsule, including a small area distal to the anular ligament.



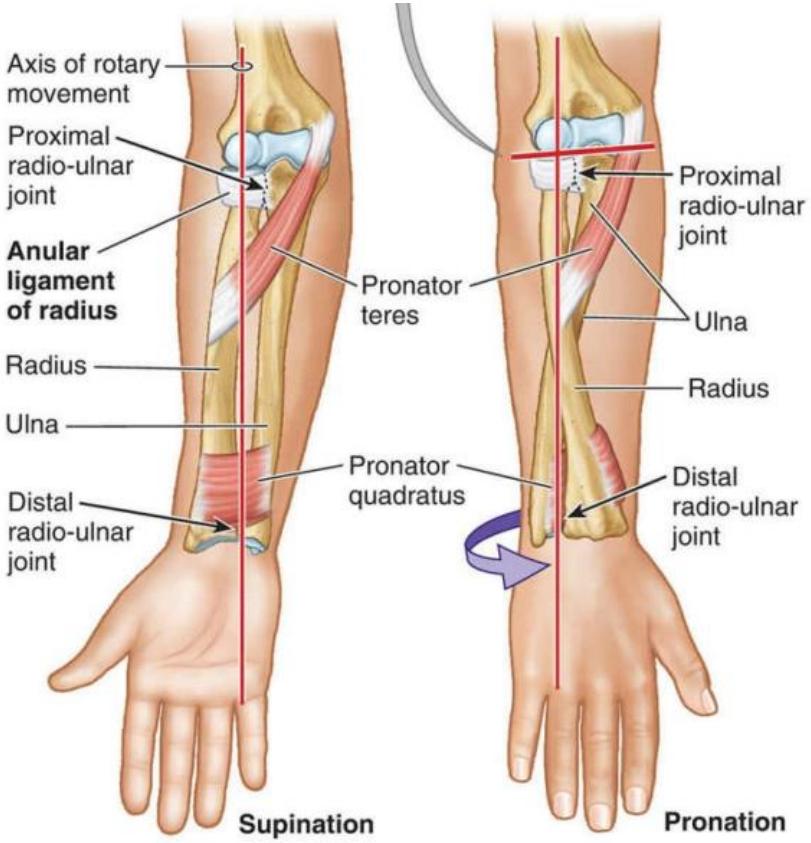
Cont.

- The strong *anular ligament*, attached to the ulna anterior and posterior to its radial notch, surrounds the articulating bony surfaces and forms a collar that, with the radial notch, creates a ring that completely encircles the head of the radius.
- The deep surface of the anular ligament is lined with synovial membrane, which continues distally as a **sacciform recess of the proximal radio-ulnar joint** on the neck of the radius.
- This arrangement allows the radius to rotate within the anular ligament without binding, stretching, or tearing the synovial membrane.





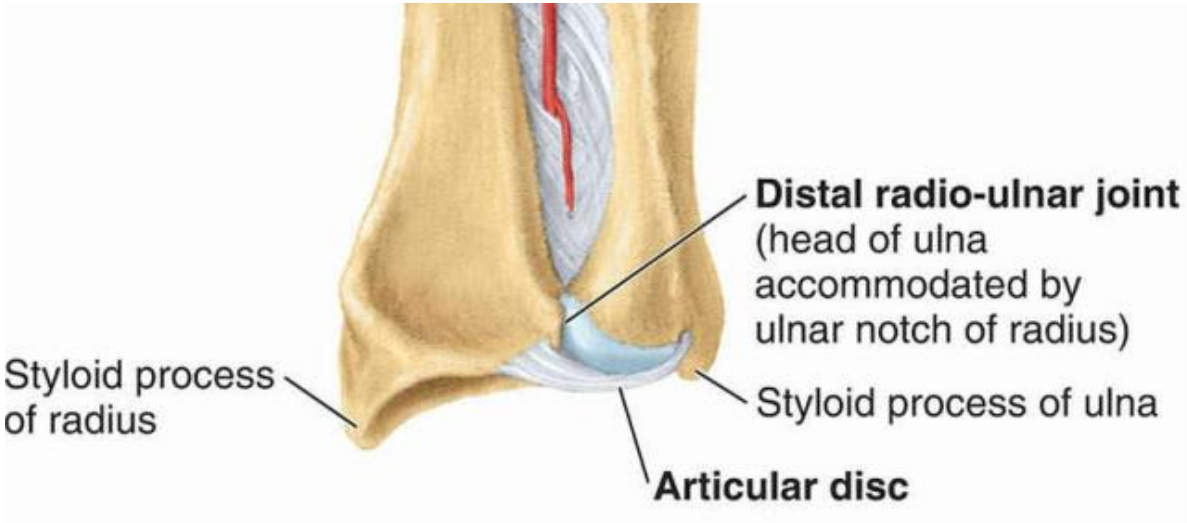
MOVEMENTS OF PROXIMAL RADIO-ULNAR JOINT



- Supination is the movement of the forearm that rotates the radius laterally around its longitudinal axis
- Pronation is the movement of the forearm, produced by pronators teres and quadratus, that rotates the radius medially around its longitudinal axis

Distal Radio-Ulnar Joint

- The **distal (inferior) radio-ulnar joint** is a pivot type of synovial joint.
- The radius moves around the relatively fixed distal end of the ulna.
- **Pivot joint** between **head of ulna** and **ulnar notch of radius**
- Fibrocartilaginous **articular disc** (triangular ligament) separating it from radiocarpal joint.
- The articular disc separates the cavity of the distal radio-ulnar joint from the cavity of the wrist joint.



Distal Radio-Ulnar Joint

- **Articulation:** Between the rounded head of the ulna and the ulnar notch on the radius
- **Type:** Synovial pivot joint
- **Capsule:** The capsule encloses the joint but is deficient superiorly.
- **Ligaments:** Weak **anterior** and **posterior** ligaments strengthen the capsule.
- **Articular disc:** This is triangular and composed of fibrocartilage. It is attached by its apex to the lateral side of the base of the styloid process of the ulna and by its base to the lower border of the ulnar notch of the radius. It shuts off the distal radioulnar joint from the wrist and strongly unites the radius to the ulna.
- **Synovial membrane:** This lines the capsule passing from the edge of one articular surface to that of the other.

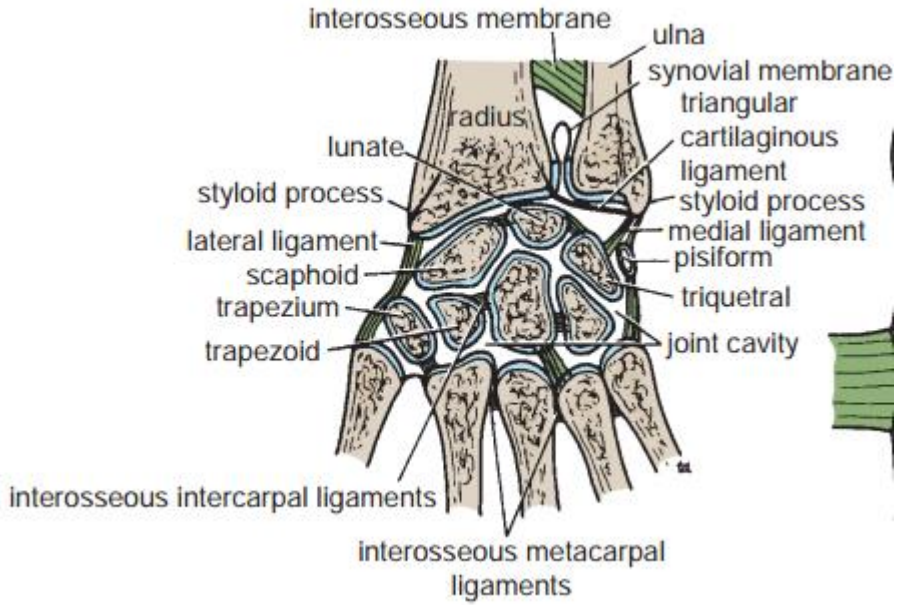
- Supination is the more powerful of the two movements because of the strength of the biceps muscle.
- Because supination is the more powerful movement, screw threads and the spiral of corkscrews are made so that the screw and corkscrews are driven inward by the movement of supination in right-handed people.

Wrist Joint (Radiocarpal Joint)

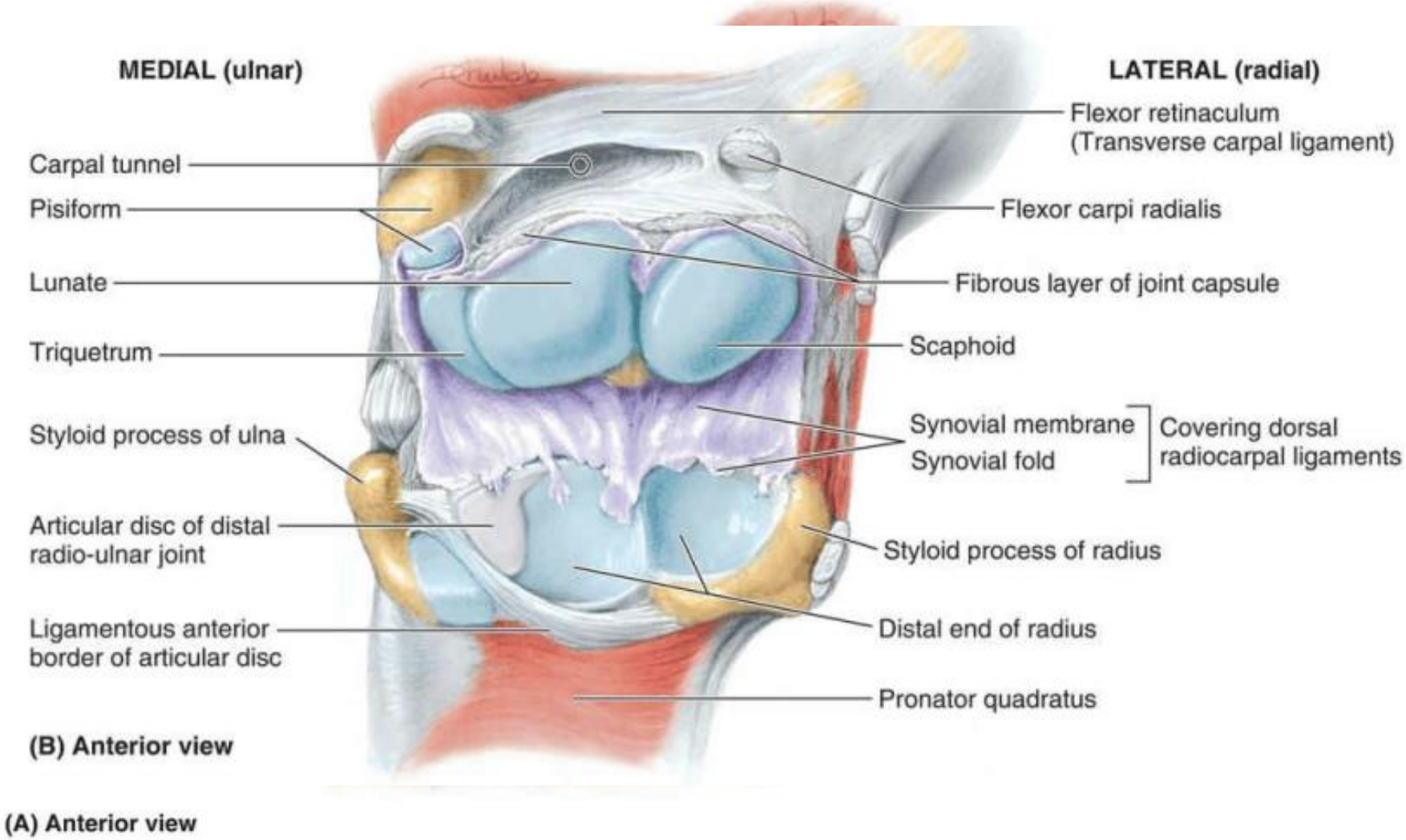
- **Articulation:** Between the distal end of the radius and the articular disc above and the scaphoid, lunate, and triquetral bones below.
- The proximal articular surface forms an ellipsoid concave surface, which is adapted to the distal ellipsoid convex surface.
- **Type:** Synovial ellipsoid joint

Cont.

- **Capsule:** The capsule encloses the joint and is attached above to the distal ends of the radius and ulna and below to the proximal row of carpal bones.
- The **medial ligament** is attached to the styloid process of the ulna and to the triquetral bone.
- The **lateral ligament** is attached to the styloid process of the radius and to the scaphoid bone.



Dissection of distal radio-ulnar, radiocarpal, and intercarpal joints



MOVEMENTS OF WRIST JOINT

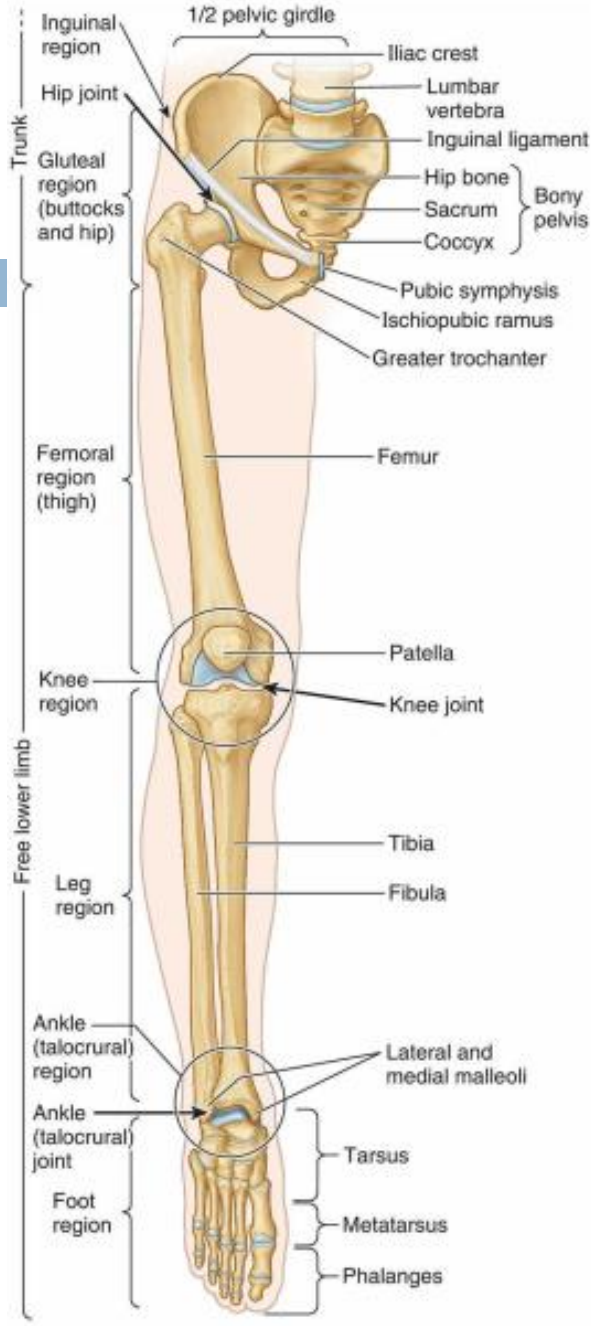
- The movements at the wrist joint may be augmented by additional smaller movements at the intercarpal and midcarpal joints.
- The movements are *flexion–extension, abduction–adduction* (radial deviation–ulnar deviation), and *circumduction*.
- The hand can be flexed on the forearm more than it can be extended.
- These movements are accompanied (actually, are initiated) by similar movements at the midcarpal joint between the proximal and distal rows of carpal bones.
- Adduction of the hand is greater than abduction. Most adduction occurs at the wrist joint. Abduction from the neutral position occurs at the midcarpal joint. Circumduction of the hand consists of successive flexion, adduction, extension, and abduction.

Assignment

- Joints of carpal and phalangeal bones??????????????

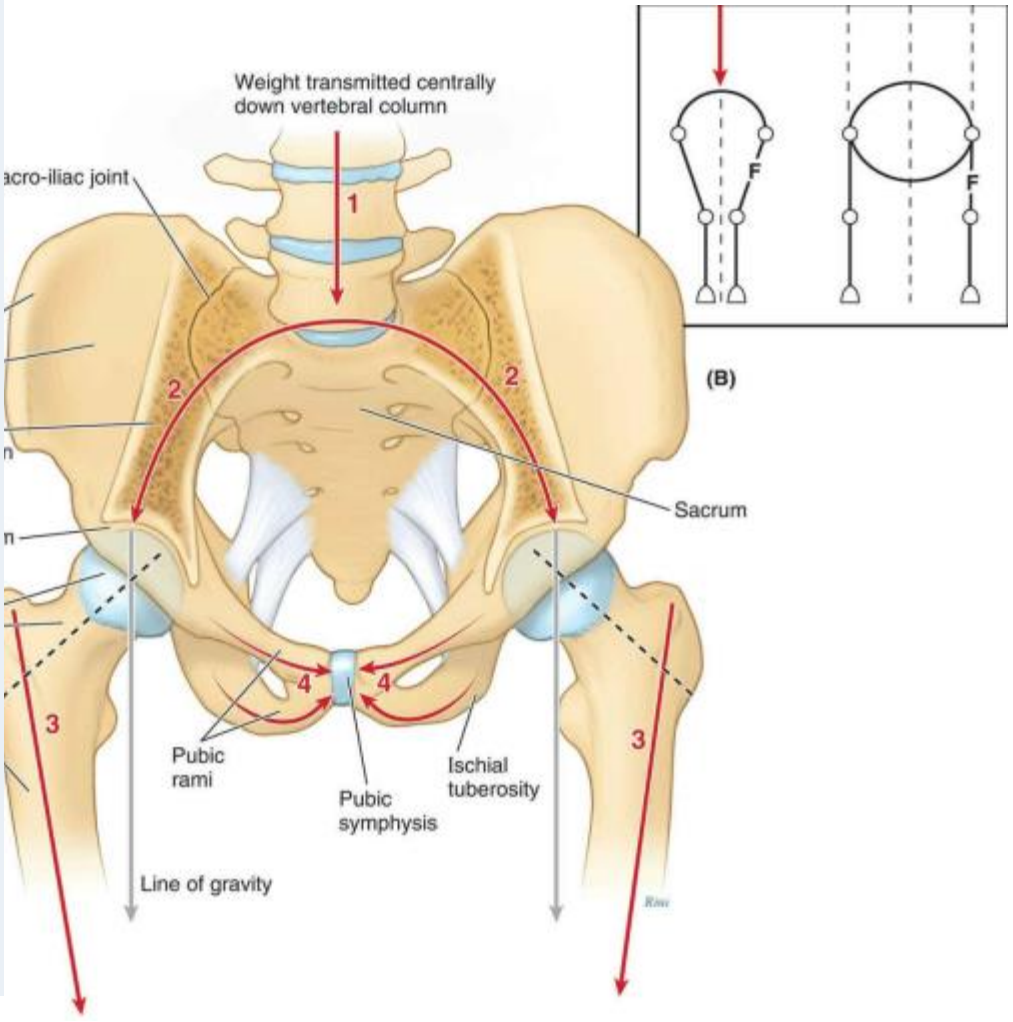
BONES OF LOWER LIMB

- The skeleton of the lower limb (inferior appendicular skeleton) may be divided into two functional components:
  - The pelvic girdle and
    - The **pelvic girdle** (bony pelvis) is a bony ring composed of the sacrum and right and left hip bones joined anteriorly at the pubic symphysis.
    - The pelvic girdle attaches the free lower limb to the axial skeleton
  - The bones of the free lower limb
    - The *bones of the free lower limb* are contained within and specifically serve that part of the limb.



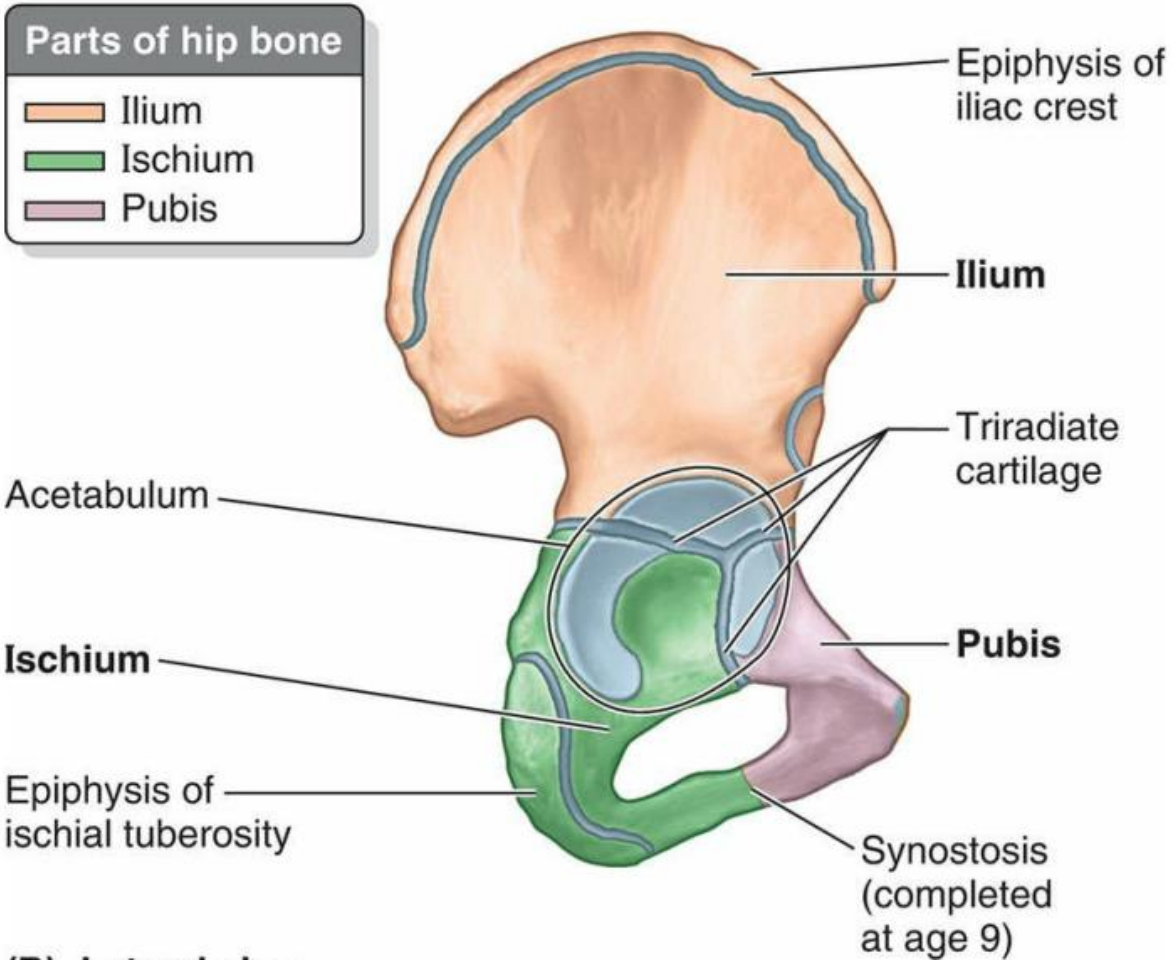
Arrangement of Lower Limb Bones

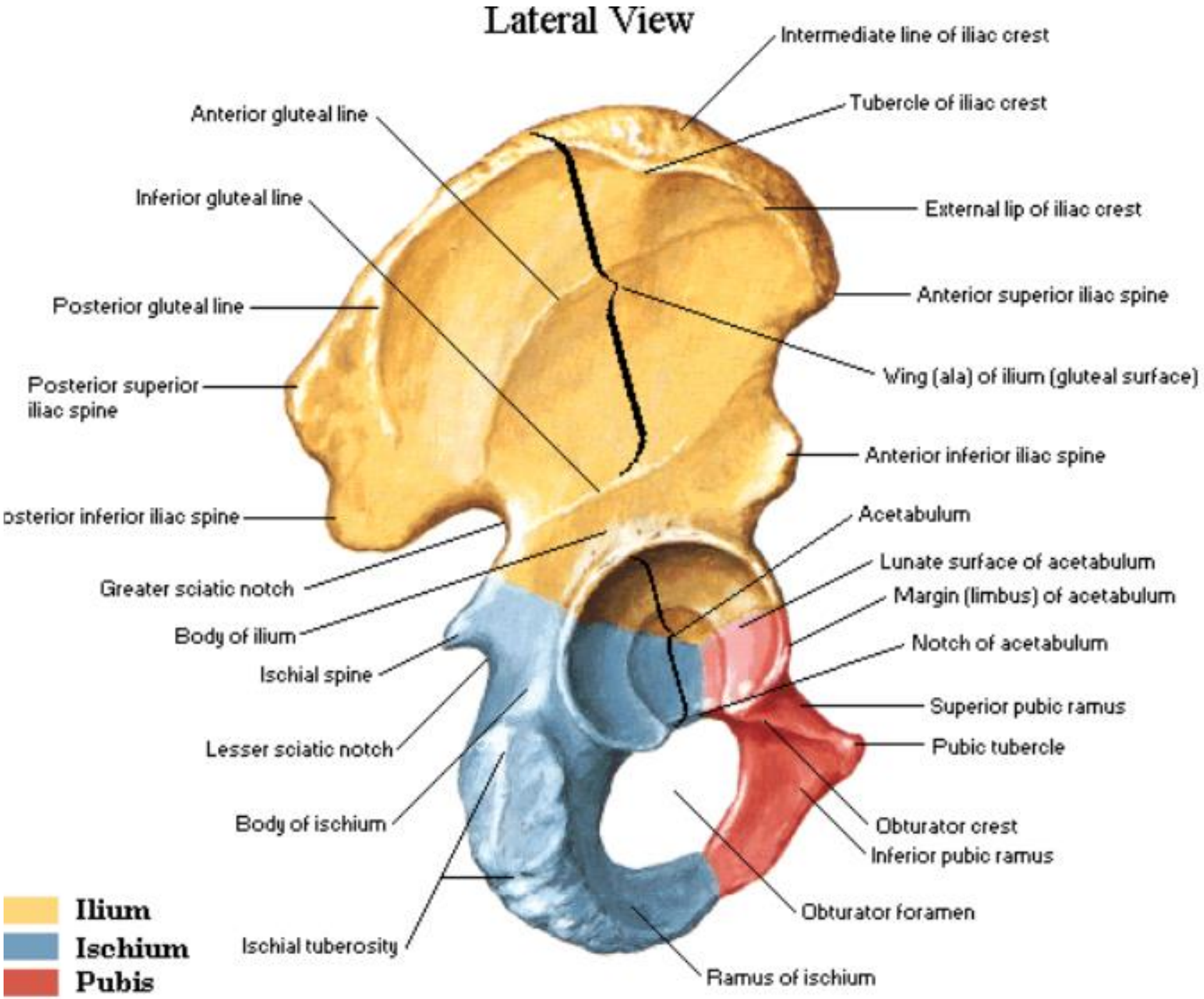
- Body weight is transferred from the vertebral column through the *sacro-iliac joints* to the pelvic girdle and from the pelvic girdle through the hip joints to the femurs.
- To support the erect bipedal posture better, the femurs are oblique (directed inferomedially) within the thighs so that when standing, the knees are adjacent and placed directly inferior to the trunk, returning the center of gravity to the vertical lines of the supporting legs and feet.
- Compare this oblique position of the femurs with that of quadrupeds, in which the femurs are vertical and the knees are apart, with the trunk mass suspended between the limbs



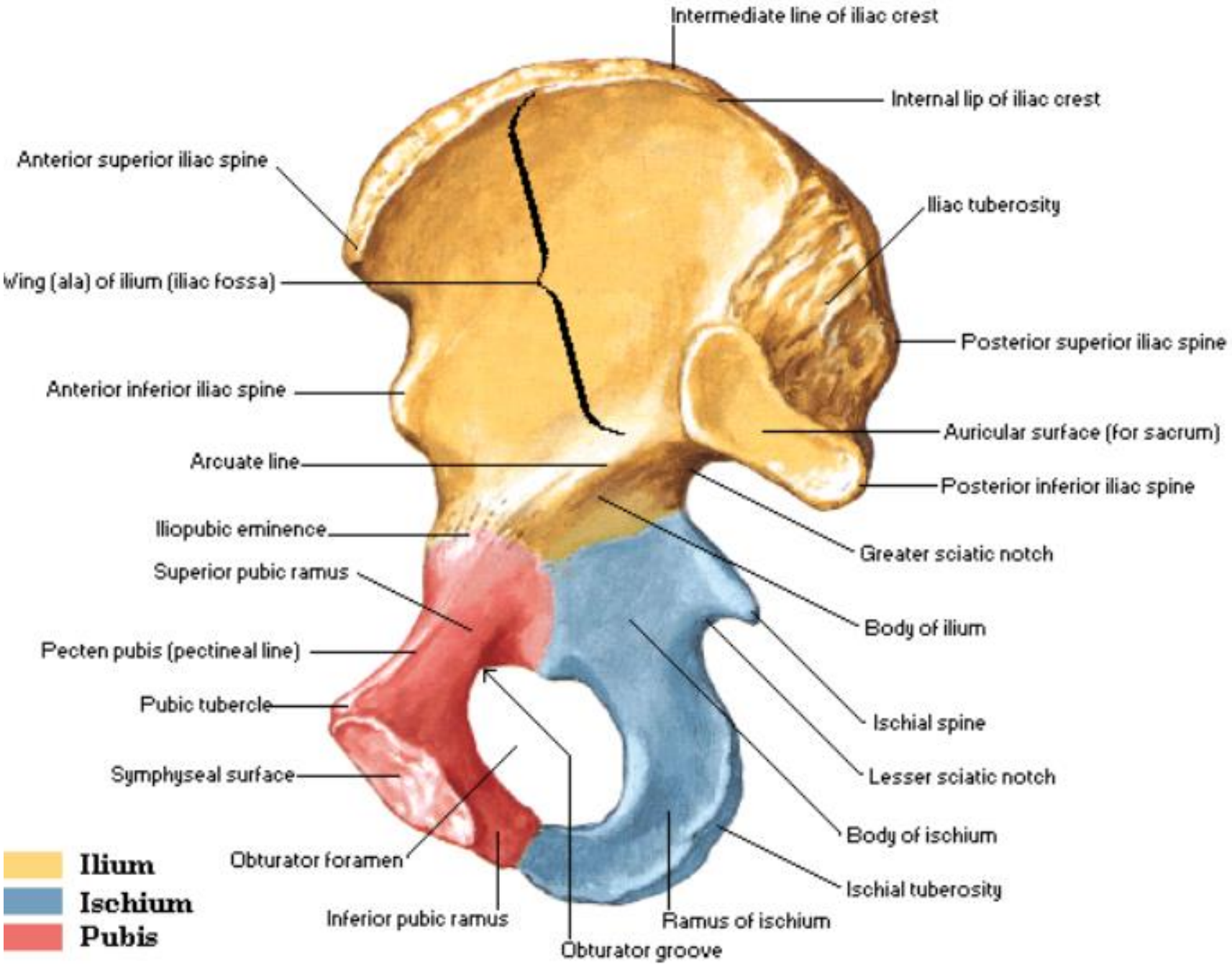
Hip Bone

- Each hip bone (c
  at the acetabulu
  lateral aspect fc
  shaped cartilage
- Begin to fuse at
  years of age
- The 3 bones are
  - Ilium
  - Ischium
  - Pubis



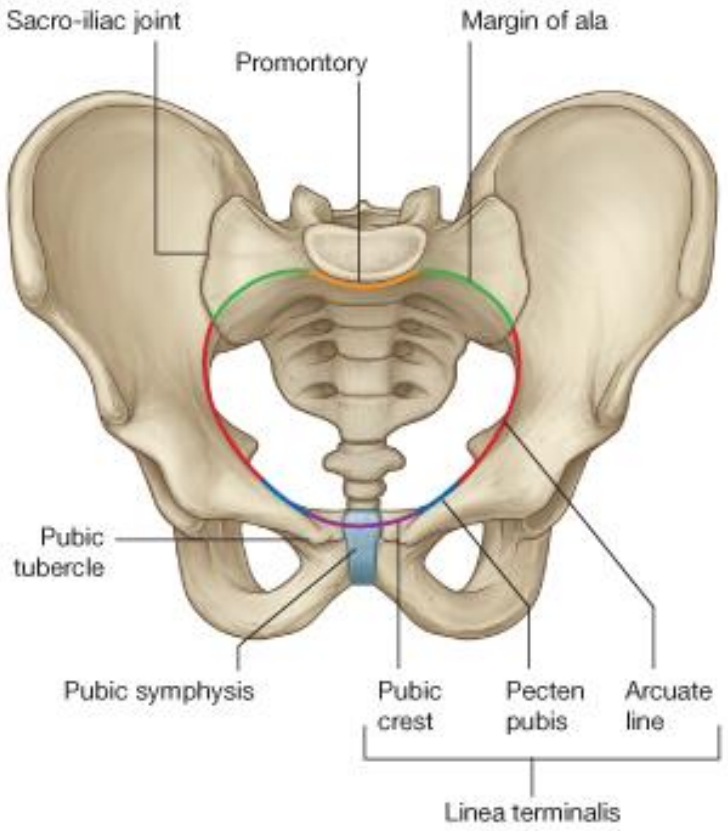

Lateral View
Intermediate line of iliac crest
Tubercle of iliac crest
Anterior gluteal line
Inferior gluteal line
External lip of iliac crest
Posterior gluteal line
Anterior superior iliac spine
Wing (ala) of ilium (gluteal surface)
Posterior superior iliac spine
Anterior inferior iliac spine
Posterior inferior iliac spine
Acetabulum
Lunate surface of acetabulum
Greater sciatic notch
Margin (limbus) of acetabulum
Body of ilium
Notch of acetabulum
Ischial spine
Superior pubic ramus
Lesser sciatic notch
Pubic tubercle
Body of ischium
Obturator crest
Inferior pubic ramus
Obturator foramen
Ischial tuberosity
Ramus of ischium
Ilium
Ischium
Pubis

Medial View


Intermediate line of iliac crest
Internal lip of iliac crest
Anterior superior iliac spine
Iliac tuberosity
Wing (ala) of ilium (iliac fossa)
Posterior superior iliac spine
Anterior inferior iliac spine
Auricular surface (for sacrum)
Arcuate line
Posterior inferior iliac spine
Iliopubic eminence
Greater sciatic notch
Superior pubic ramus
Body of ilium
Pecten pubis (pectineal line)
Pubic tubercle
Ischial spine
Lesser sciatic notch
Symphyseal surface
Body of ischium
Obturator foramen
Ischial tuberosity
Inferior pubic ramus
Ramus of ischium
Obturator groove
Ilium
Ischium
Pubis

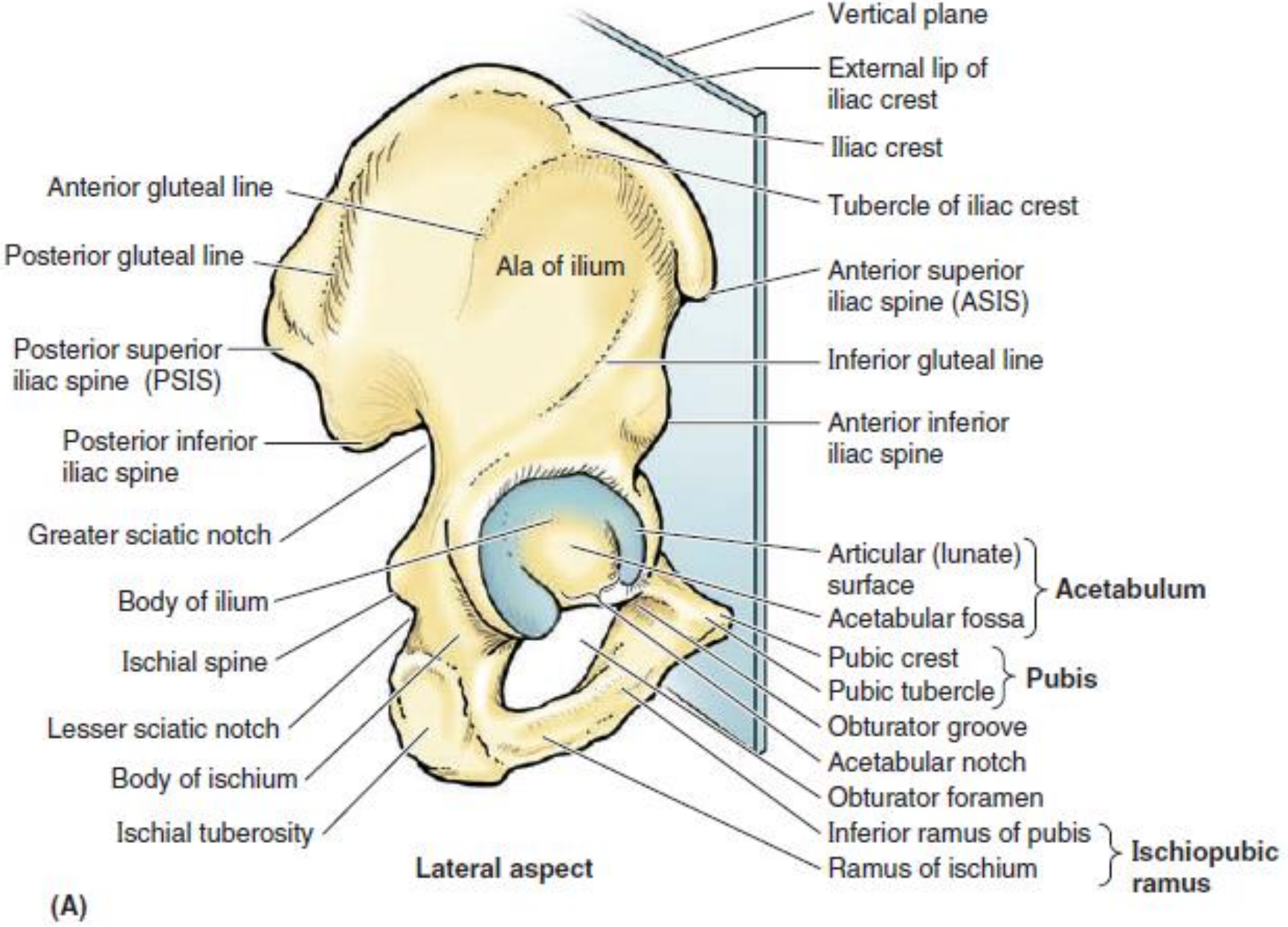
Cont.

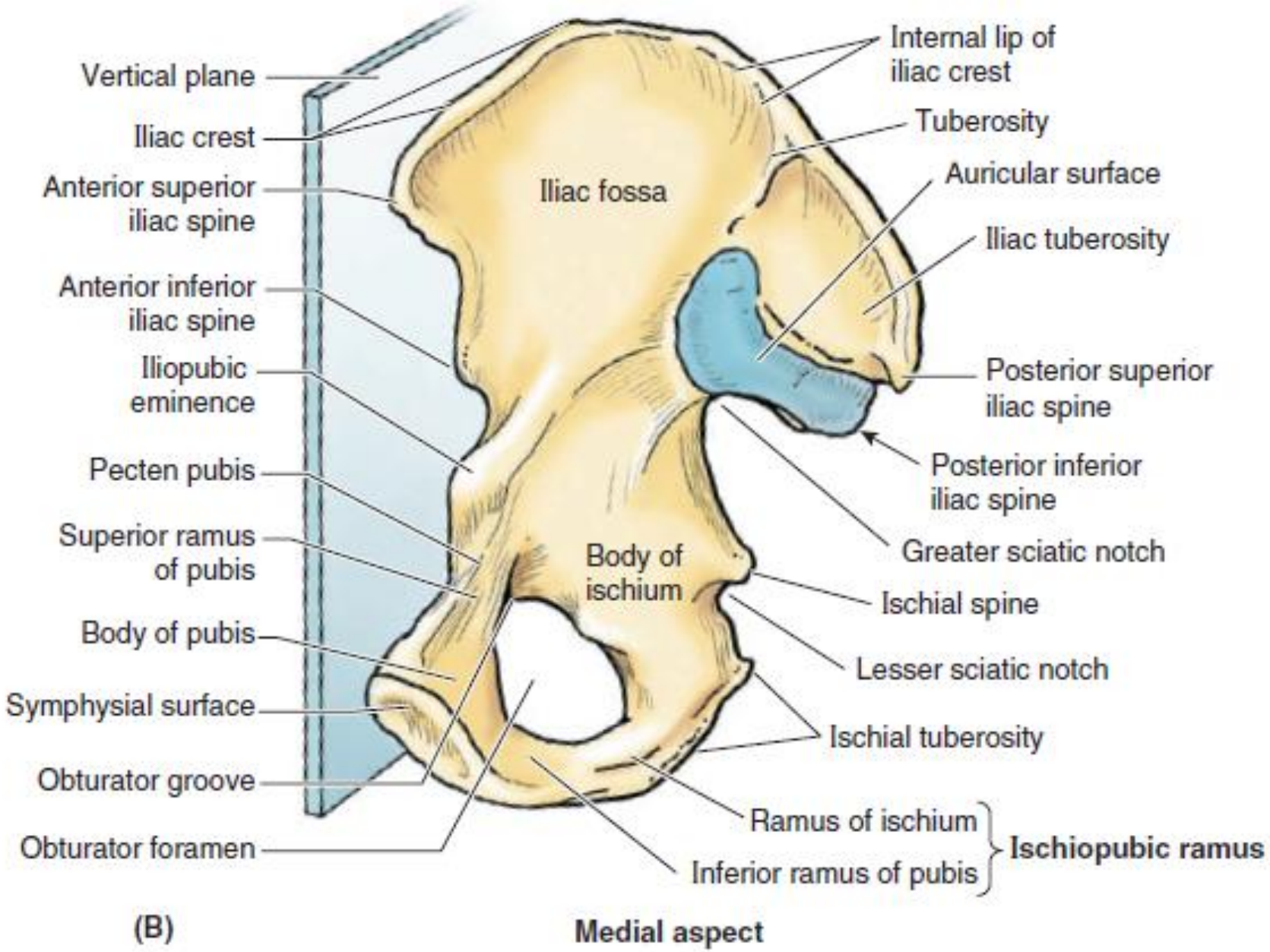
- Pubic arch (sub pubic angle)
  - formed by the ischiopubic rami (conjoined inferior rami of the pubis and ischium) of the two sides
  - these rami meet at the pubic symphysis
  - their inferior borders define the subpubic angle
    - the distance between right and left ischial tuberosities
    - measured with the fingers in the vagina during a pelvic examination



Hip bone in anatomical position

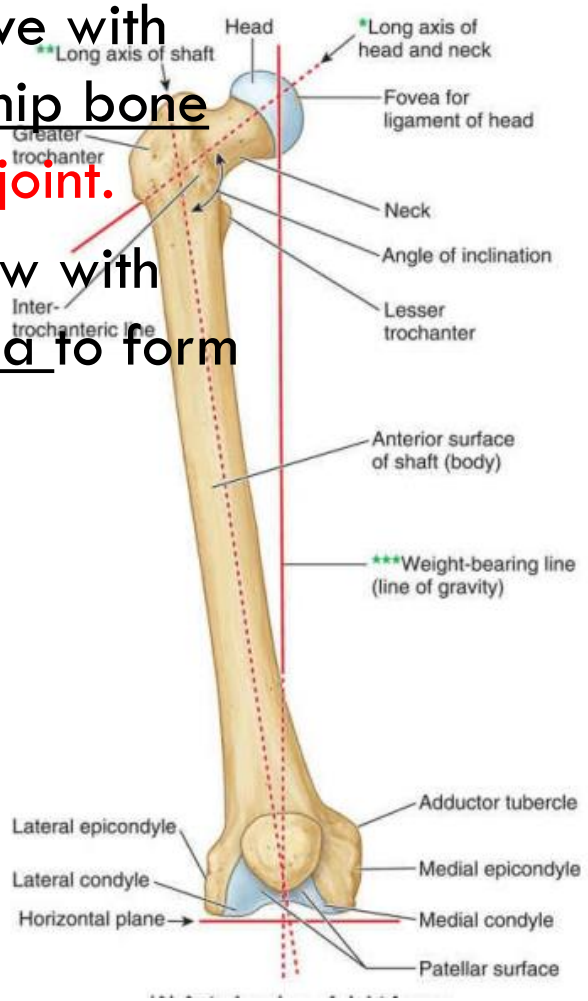
- To place the hip bone in the anatomical position, manipulate it so that the acetabulum faces laterally and slightly anteriorly
- When the hip bone is in the anatomical position:
  - Anterior superior iliac spine (ASIS) and anterosuperior aspect of the pubis lie in the same coronal plane
  - Symphysial surface of the pubis is vertical, parallel to the median plane
  - Internal aspect of the body of the pubis faces almost directly superiorly
  - Acetabulum faces inferolaterally, with the acetabular notch directed inferiorly
  - Obturator foramen lies inferomedial to the acetabulum

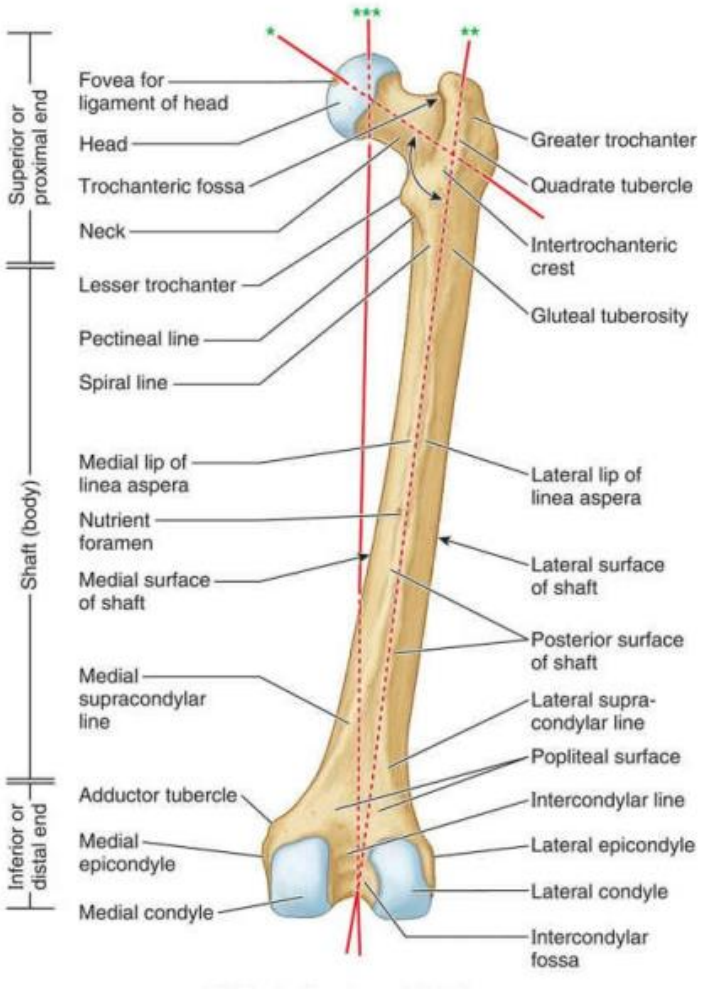

Vertical plane
External lip of iliac crest
Iliac crest
Tubercle of iliac crest
Anterior gluteal line
Posterior gluteal line
Ala of ilium
Anterior superior iliac spine (ASIS)
Posterior superior iliac spine (PSIS)
Inferior gluteal line
Anterior inferior iliac spine
Posterior inferior iliac spine
Greater sciatic notch
Articular (lunate) surface
Acetabular fossa
Acetabulum
Body of ilium
Ischial spine
Pubic crest
Pubic tubercle
Pubis
Lesser sciatic notch
Obturator groove
Acetabular notch
Body of ischium
Obturator foramen
Ischial tuberosity
Inferior ramus of pubis
Ramus of ischium
Ischiopubic ramus
Lateral aspect
(A)


Vertical plane
Iliac crest
Anterior superior iliac spine
Anterior inferior iliac spine
Iliopubic eminence
Pecten pubis
Superior ramus of pubis
Body of pubis
Symphysial surface
Obturator groove
Obturator foramen
Internal lip of iliac crest
Tuberosity
Auricular surface
Iliac fossa
Iliac tuberosity
Posterior superior iliac spine
Posterior inferior iliac spine
Greater sciatic notch
Body of ischium
Ischial spine
Lesser sciatic notch
Ischial tuberosity
Ramus of ischium
Inferior ramus of pubis
Ischiopubic ramus
(B)
Medial aspect

Femur

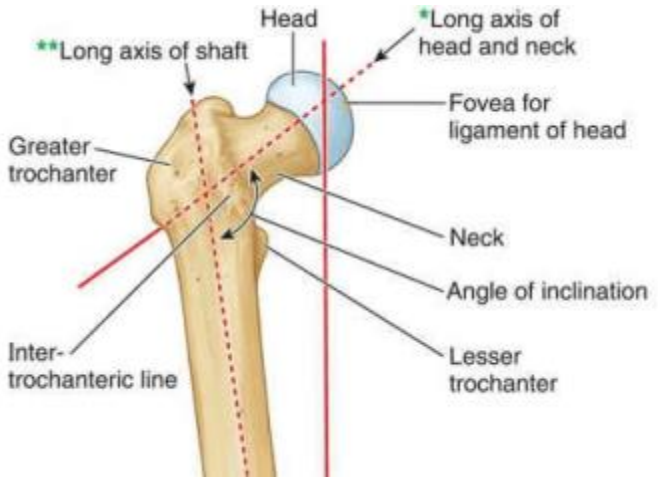
- Articulates above with <u>acetabulum of hip bone</u> to form the hip joint.
- Articulates below with <u>tibia and patella</u> to form the knee joint.
- **<u>Consists of :</u>**
  - **Upper end**
  - **Shaft**
  - **Lower end**

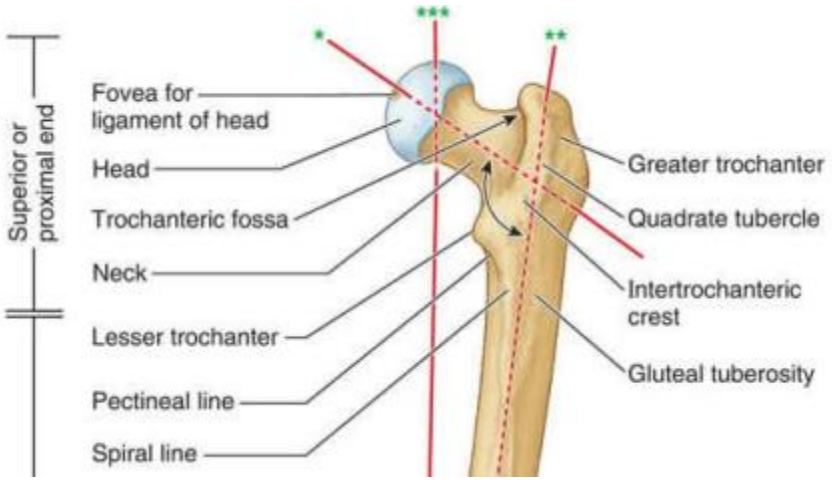




Upper end

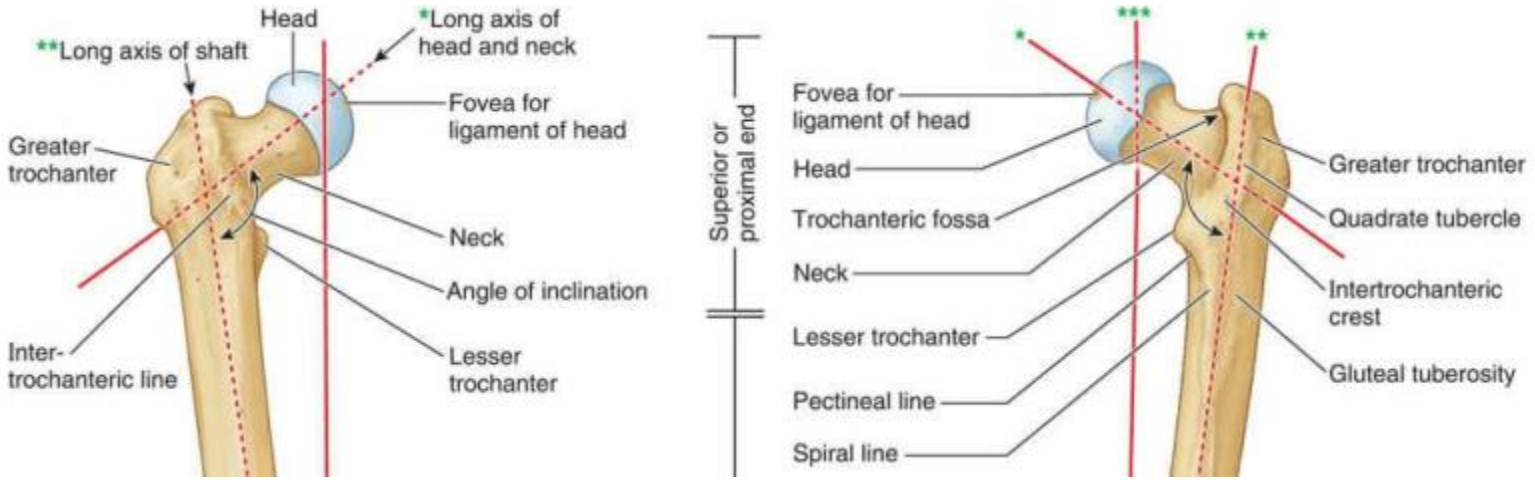
- **Head**
  - Articulates with acetabulum
- **Neck**
  - Typically forms **angle of inclination** of about 125° with shaft
- **Junction of neck and shaft**
  - **Greater trochanter**
    - Insertions for **hip abductors and rotators**
  - **Lesser trochanter**
    - Insertion for **iliopsoas muscle**



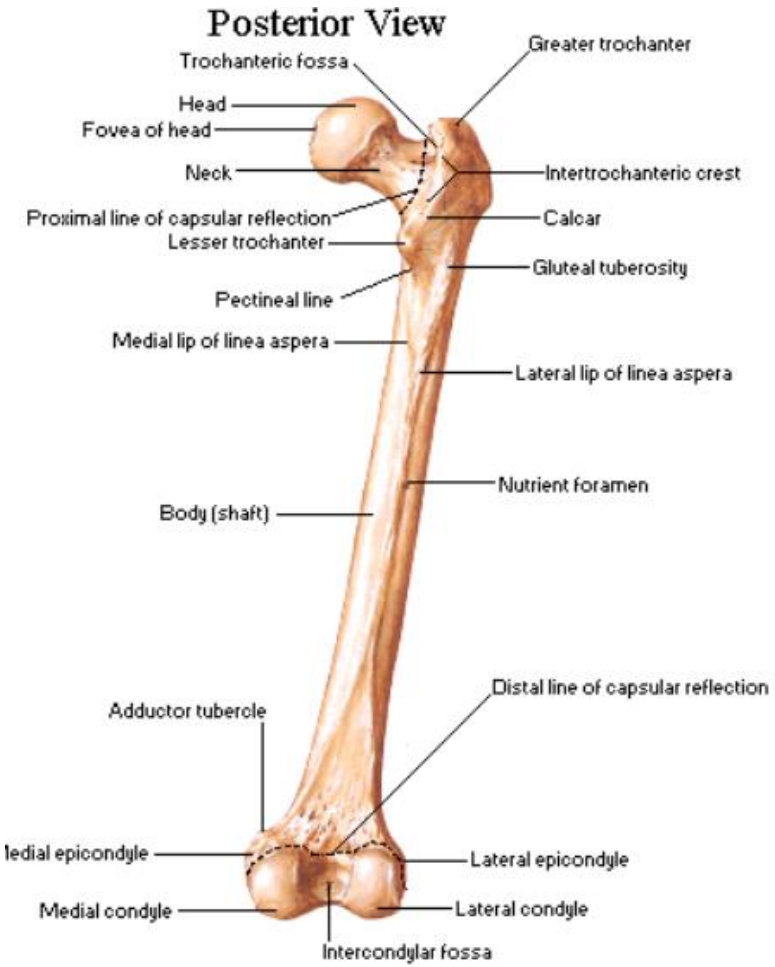


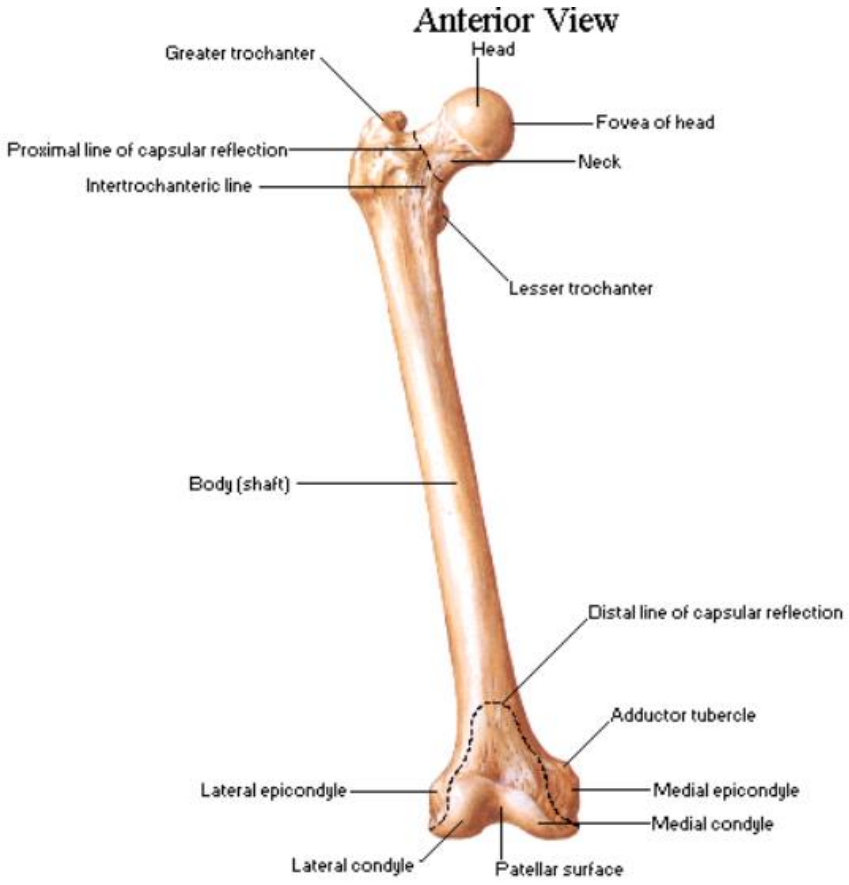
Cont.

- **Greater & lesser trochanters :**
  - Anteriorly, connecting the 2 trochanters, the inter-trochanteric line, where the iliofemoral ligament is attached.
  - Posteriorly, the inter-trochanteric crest, on which is the quadrate tubercle.



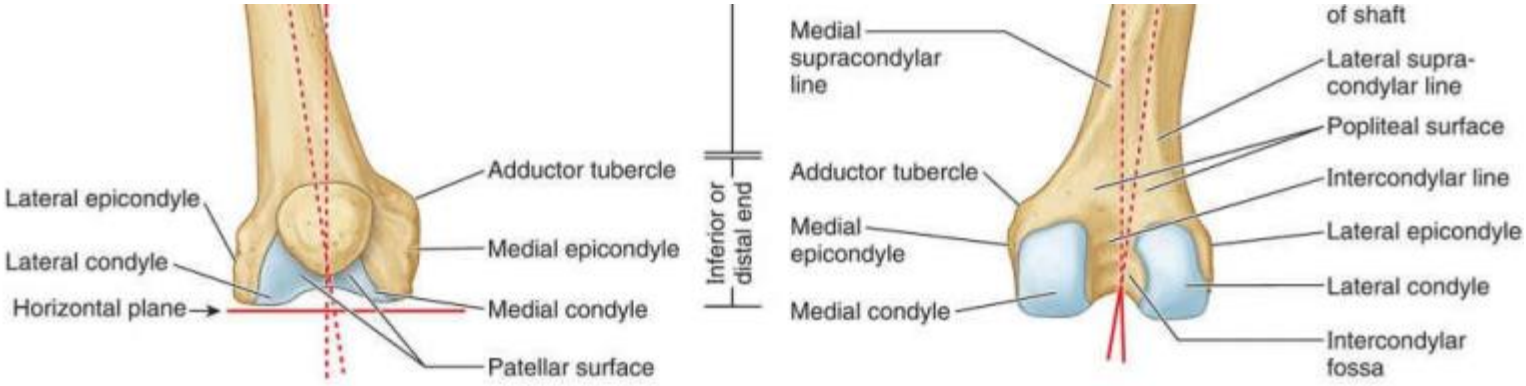
Shaft of Femur





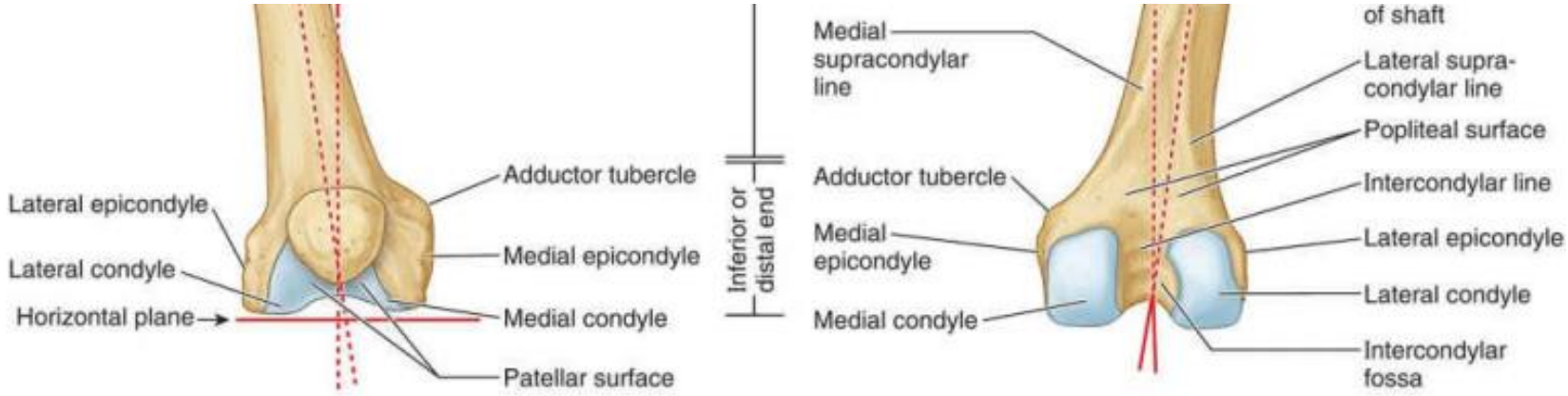
Lower End of Femur

- The **medial** and **lateral femoral condyles** make up nearly the entire inferior (distal) end of the femur.
- The femoral shaft will assume the same oblique position it occupies in the living body (about 9° from vertical in males and slightly greater in females).
- The condyles are separated posteriorly and inferiorly by an **intercondylar fossa** but merge anteriorly, forming a shallow longitudinal depression, the **patellar surface**



Cont.

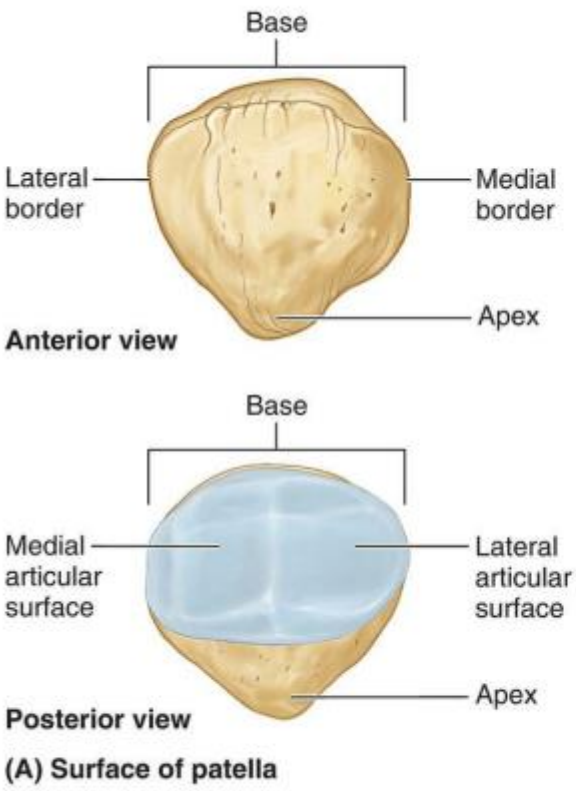
- The lateral surface of the lateral condyle has a central projection called the *lateral epicondyle*.
- The medial surface of the medial condyle has a larger and more prominent *medial epicondyle*, superior to which another elevation, the **adductor tubercle**, forms in relation to a tendon attachment.
- The epicondyles provide proximal attachment for the medial and lateral collateral ligaments of the knee joint.



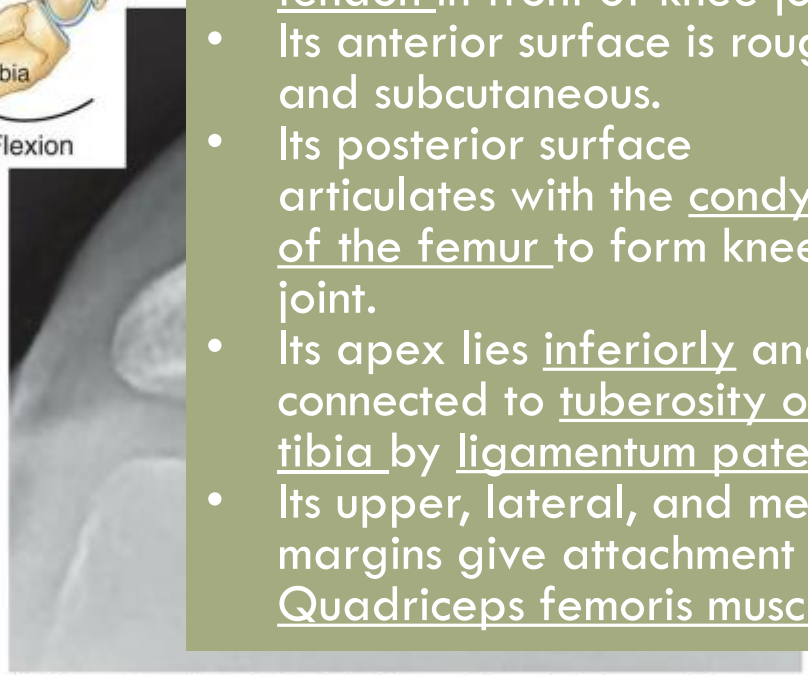
Cont.

- When the femur is viewed superiorly (so that one is looking along the long axis of the shaft), it is apparent that the two axes lie at an angle (the **torsion angle** or **angle of declination**), the mean of which is 7° in males and 12° in females.
- The torsion angle, combined with the angle of inclination, allows rotatory movements of the femoral head within the obliquely placed acetabulum to convert into ***flexion and extension, abduction and adduction, and rotational movements of the thigh.***

Patella



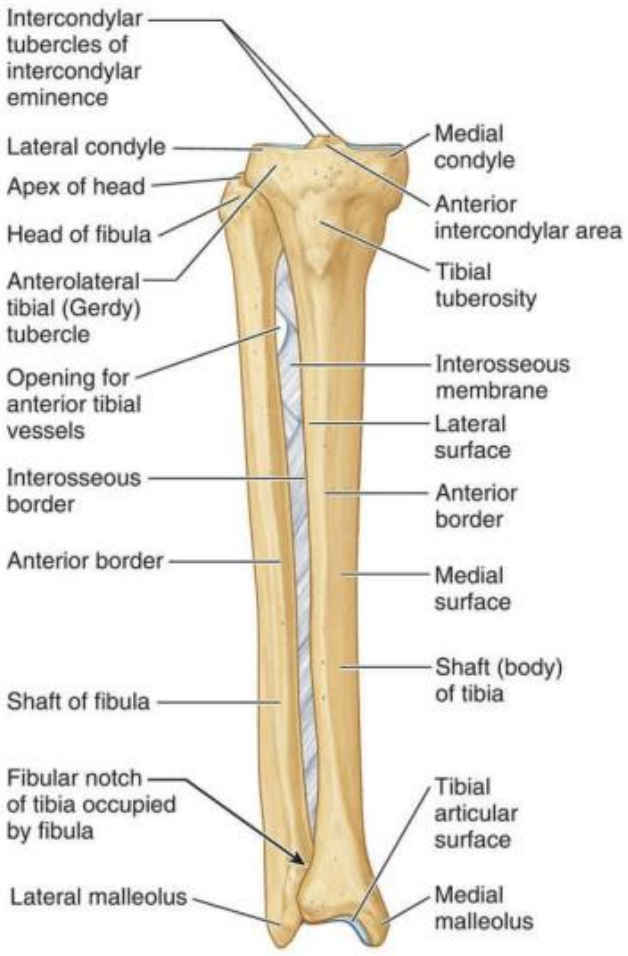
(A) Surface of patella



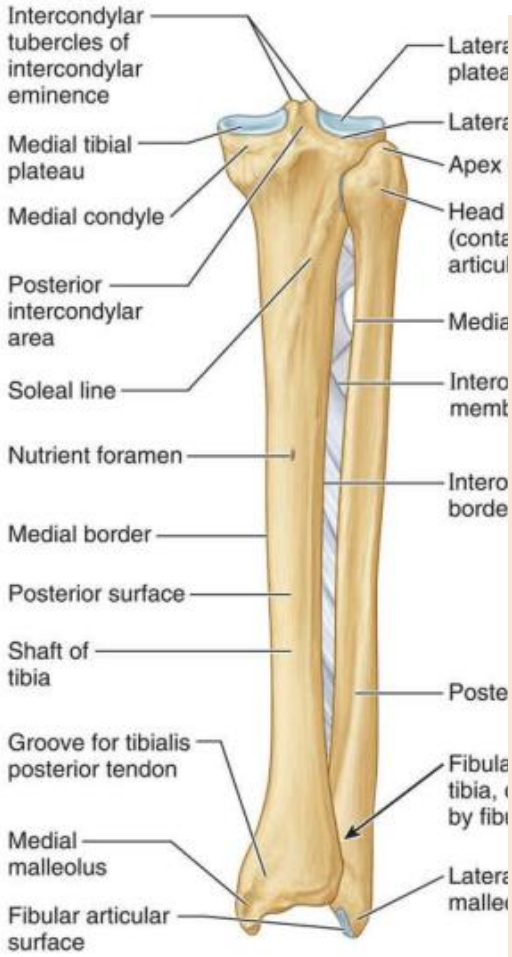
(B) Superior view of partially flexed knee (Skyline or Merchant view). P, patella; FE, femur; PH, patellofemoral "joint space" (actually thick articular cartilage on posterior patella).

- It is a largest sesamoid bone (lying inside the Quadriceps tendon in front of knee joint).
- Its anterior surface is rough and subcutaneous.
- Its posterior surface articulates with the condyles of the femur to form knee joint.
- Its apex lies inferiorly and is connected to tuberosity of tibia by ligamentum patellae.
- Its upper, lateral, and medial margins give attachment to Quadriceps femoris muscles.

Tibia and Fibula



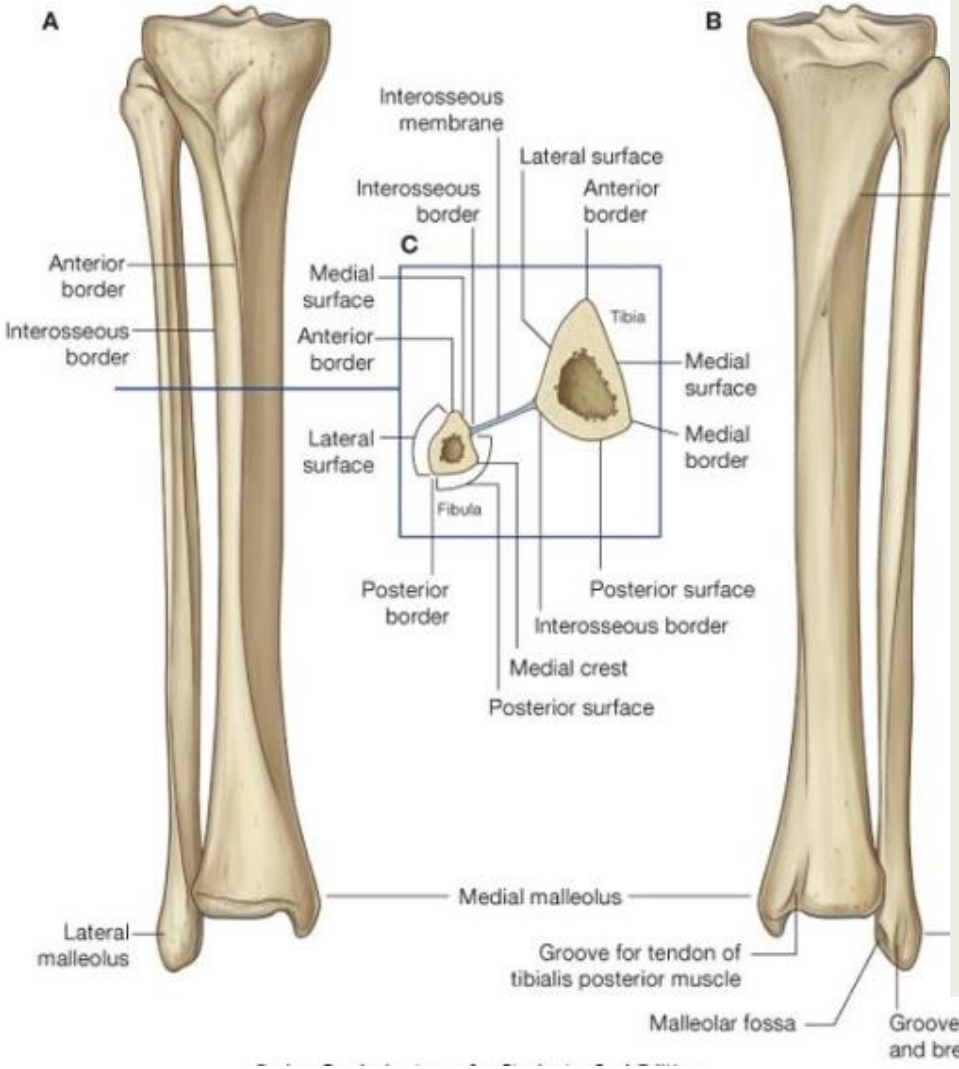
(A) Anterior view (right side)



(B) Posterior view (right side)

- **Tibia :**
  - It is the medial bone of leg.
- **Fibula :**
  - It is the lateral bone of leg.
  - Each of them has upper end, shaft, and lower end.
  - The shafts of the tibia and fibula are connected by a dense **interosseous membrane** composed of strong oblique fibers descending from the tibia to the fibula.

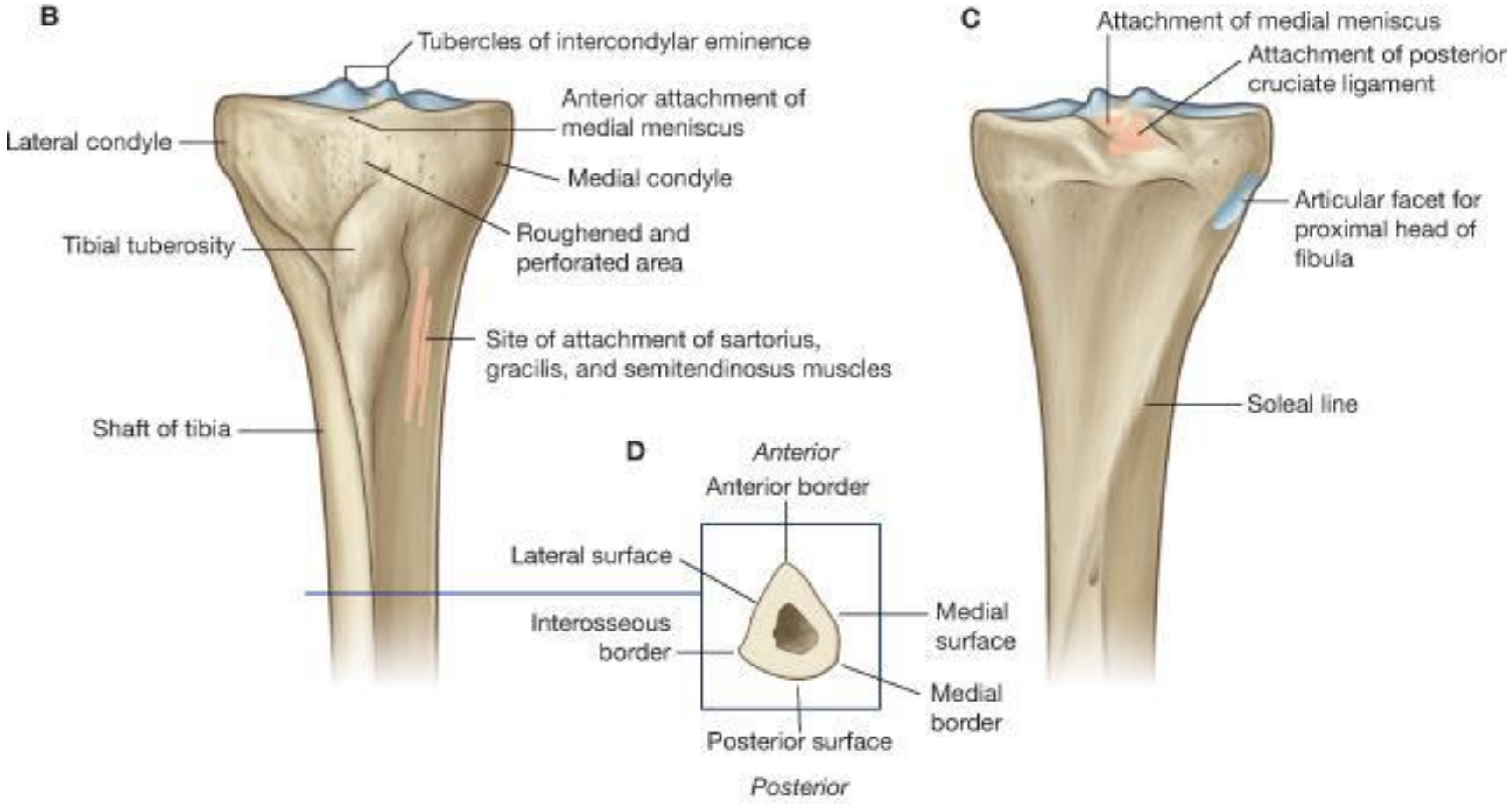
Cont.



Shaft has:

- Tibial tuberosity :
- Its upper smooth part gives attachment to ligamentum patellae.
- Its lower rough part is subcutaneous.
- 3 borders :
- Anterior boder : sharp and subcutaneous.
- Medial border.
- Lateral border interosseous border.
- 3 surfaces :
- Medial : subcutaneous.
- Lateral
- Posterior has oblique line, soleal line for attachment of soleus muscle

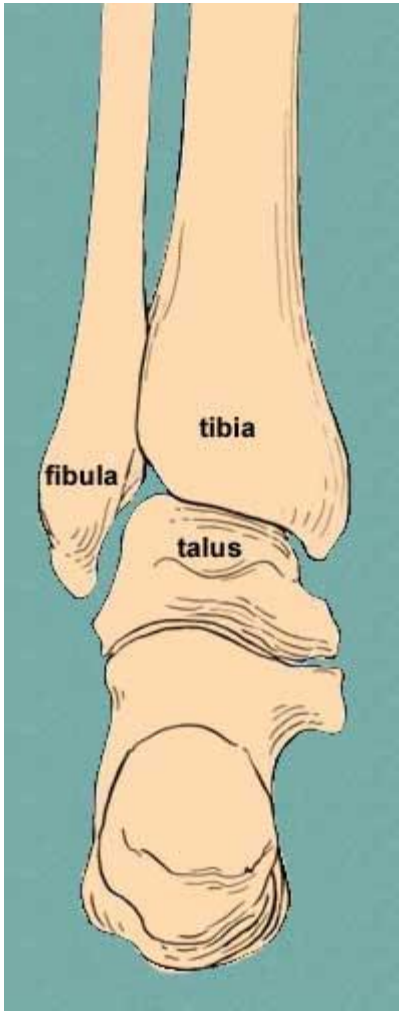
Cont.



Cont.

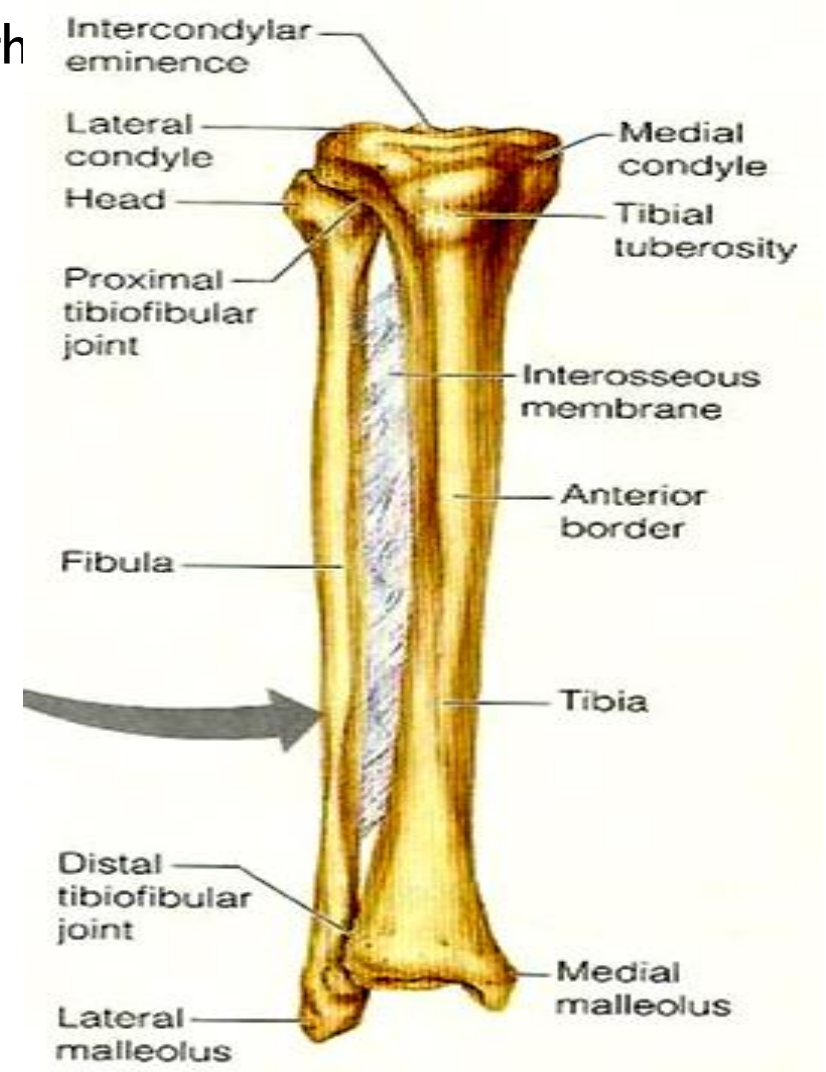
Lowe end:

- Articulates with talus for formation of ankle joint.
- Medial malleolus:
  - Its medial surface is subcutaneous.
  - Its lateral surface articulate with talus.
- Fibular notch: lies on its lateral surface of lower end to form distal tibiofibular joint.

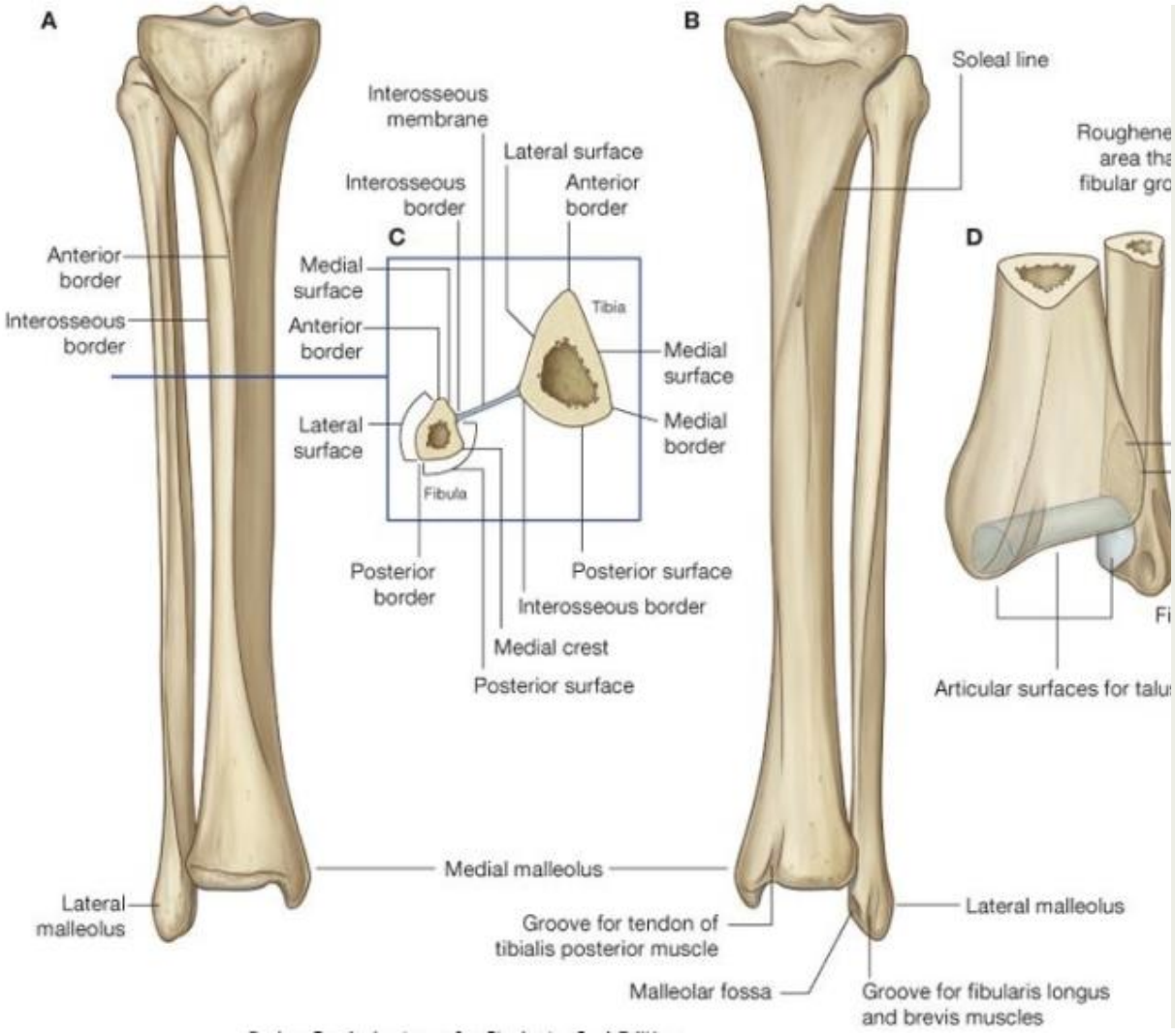


FIBULA

- It is the slender lateral bone of th leg.
- It takes no part in articulation of knee joint.
- **Its upper end has :**
  - Head : articulates with lateral condyle of tibia.
  - Styloid process.
  - Neck.



Cont.



Shaft has :

- 4 borders : its medial 'interosseous border gives attachment to <u>interosseous membrane.</u>
- 4 surfaces.

Lower end forms :

- Lateral malleolus :
- is subcutaneous.
- <u>Its medial surface</u> is smooth for articulation with <u>talus</u> to form <u>ankle joint</u>.

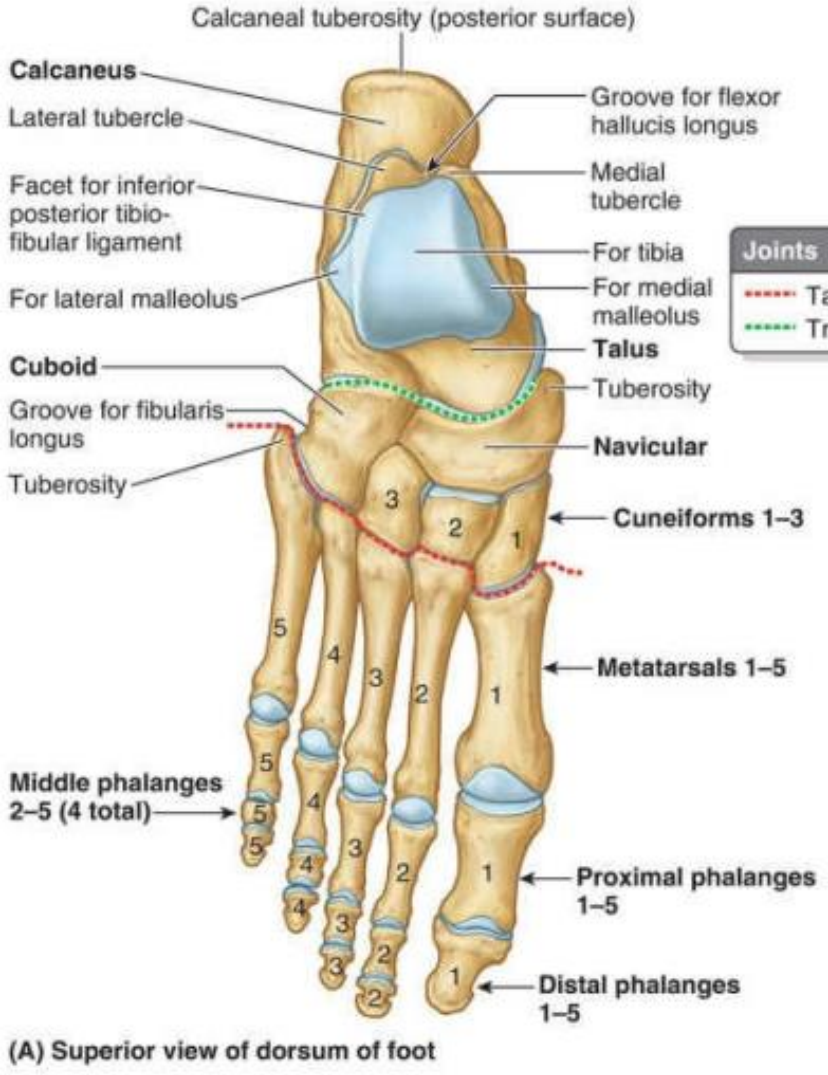
Bones of Foot

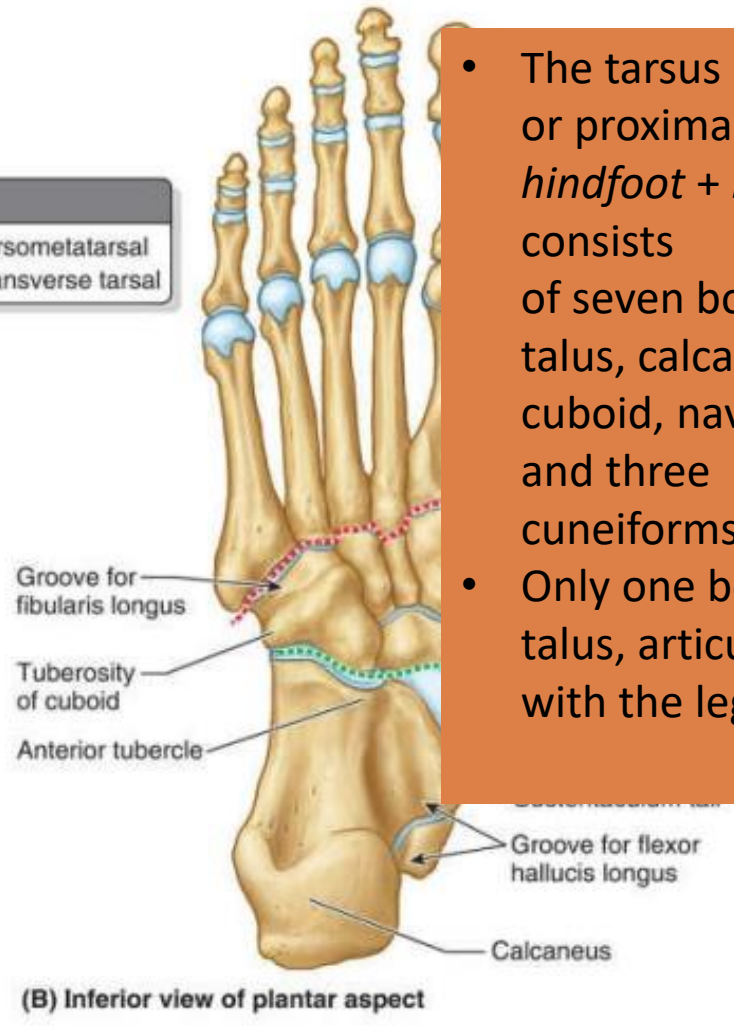
- The bones of the foot include the *tarsus, metatarsus*, and *phalanges*.
- There are 7tarsal bones, 5 metatarsal bones, and 14 phalanges
- Although knowledge of the characteristics of individual bones is necessary for an understanding of the structure of the foot,
- *it is important to study the skeleton of the foot as a whole and to identify its principal bony landmarks in the living foot.*

Cont.

- The foot and its bones may be considered in terms of three anatomical and functional zones
  - The **hindfoot:** talus and calcaneus.
  - The **midfoot:** navicular, cuboid, and cuneiforms.
  - The **forefoot:** metatarsals and phalanges.

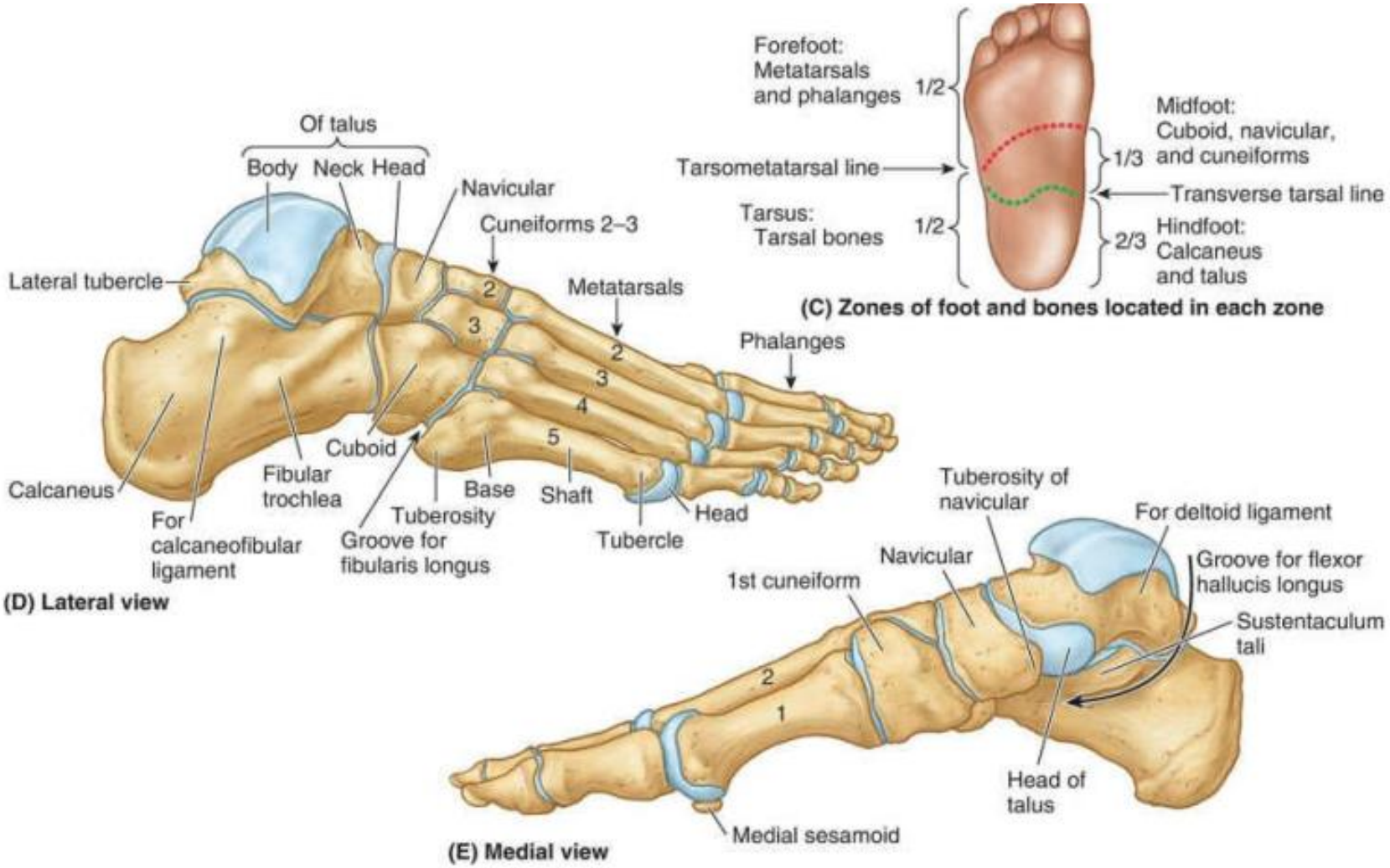
Cont.





- The tarsus (posterior or proximal foot; *hindfoot* + *midfoot* consists of seven bones: talus, calcaneus, cuboid, navicular, and three cuneiforms.
- Only one bone, the talus, articulates with the leg bones.

Cont.


Forefoot:
Metatarsals
and phalanges
1/2
Midfoot:
Cuboid, navicular,
and cuneiforms
1/3
Tarsometatarsal line
Transverse tarsal line
Tarsus:
Tarsal bones
1/2
2/3
Hindfoot:
Calcaneus
and talus
(C) Zones of foot and bones located in each zone
Of talus
Body
Neck
Head
Navicular
Cuneiforms 2–3
Lateral tubercle
Metatarsals
Phalanges
Cuboid
Calcaneus
Fibular
trochlea
Base
Shaft
Tuberosity
Groove for
fibularis longus
For
calcaneofibular
ligament
Tubercle
Head
(D) Lateral view
Tuberosity of
navicular
For deltoid ligament
Navicular
Groove for flexor
hallucis longus
1st cuneiform
Sustentaculum
tali
Head of
talus
Medial sesamoid
(E) Medial view

Cont.

- **Talus**
  - (1) Transmits weight of body from leg to foot
  - (2) Articulates with tibia, fibula, calcaneus, and navicular bones
  - (3) Head is supported by **plantar calcaneonavicular** (spring) **ligament** in medial longitudinal arch of foot
  - **Calcaneus**
    - (1) Largest and strongest bone of foot
    - (2) **Tuberosity gives attachment to calcaneal tendon** and forms posterior end of longitudinal arch of foot, where it **transmits 50% of weight on that extremity to ground**
  - **Navicular**
    - Palpable medial **tuberosity** for **tibialis posterior tendon**
  - **Cuboid**
    - **Grooved** on plantar surface by **sulcus for fibularis longus tendon**
  - **Cuneiforms**
    - Medial, intermediate, and lateral

METATARSUS

- Overview
  - (1) Numbered from one to five from great toe to small toe
    - The toes are numbered 1 to 5 starting with the great toe.
  - (2) Proximal base, curved shaft (convex dorsally), and distal head
  - (3) Heads collectively form anterior end of longitudinal arch of foot, transmitting 50% of weight on that extremity to ground
- First metatarsal
  - (1) Shorter and stouter than other metatarsals because its head bears twice the weight of any other metatarsal bone
  - (2) Tuberosity on plantar surface of base for attachment of fibularis longus tendon
- Fifth metatarsal
  - Prominent tuberosity for attachment of fibularis brevis
  - Fibularis brevis may avulse tuberosity of the fifth metatarsal in forced inversion.

PHALANGES

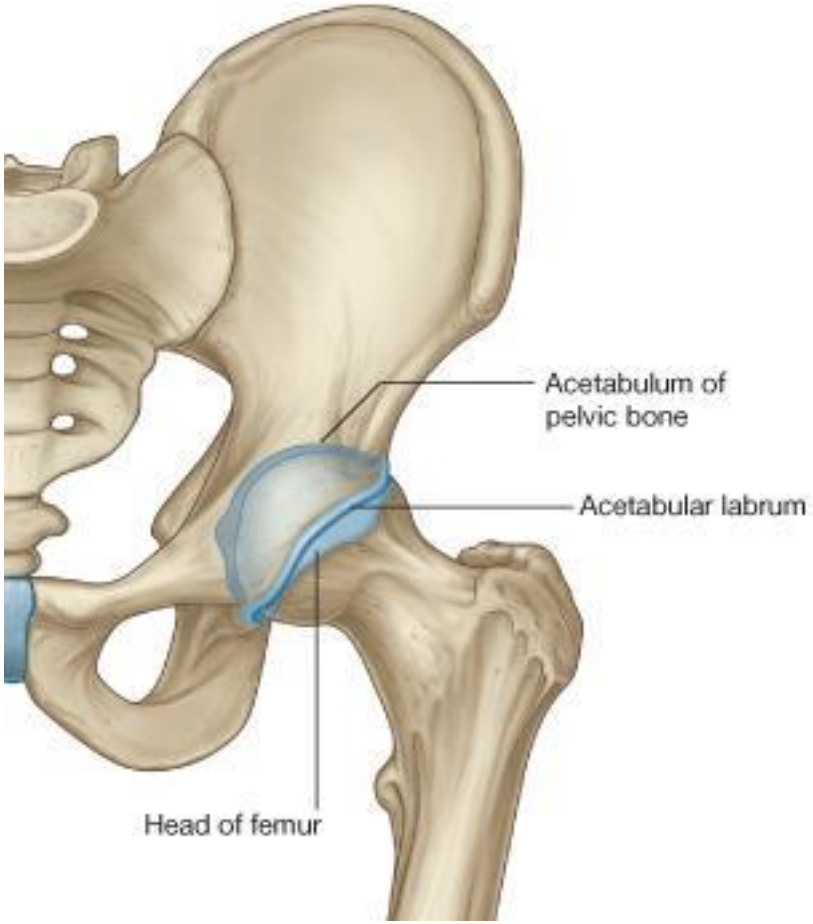
- The 14 **phalanges** of the lower limb are as follows: the 1st digit (great toe) has 2 phalanges (proximal and distal); the other four digits have 3 phalanges each:
  - proximal, middle, and distal.
- Each **phalanx** has a **base** (proximally), a **shaft**, and a **head** (distally).
- The phalanges of the 1st digit are short, broad, and strong.
- The middle and distal phalanges of the 5th digit may be fused in elderly people.

Joints of lower limb

- Hip Joint
- Knee Joint
- Tibiofibular Joints
- Ankle Joint
- Foot Joints

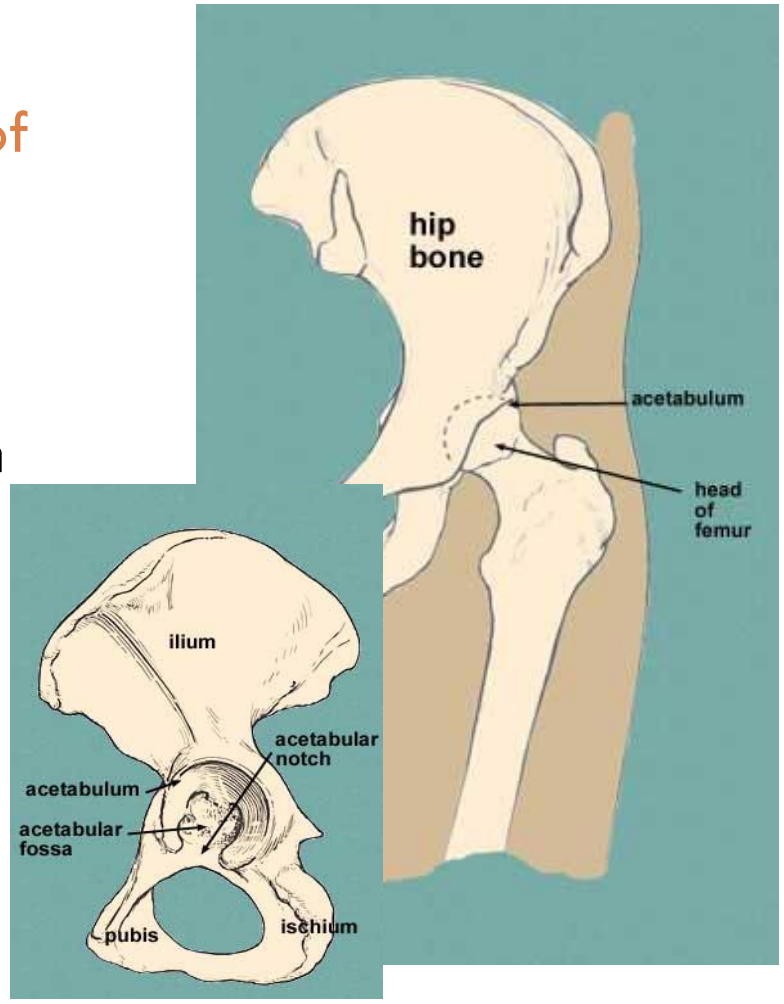
Hip Joint

- TYPE:
  - It is a synovial, ball & socket joint.
- ARTICULAR SURFACES:
  - Acetabulum of hip (pelvic) bone and Head of femur



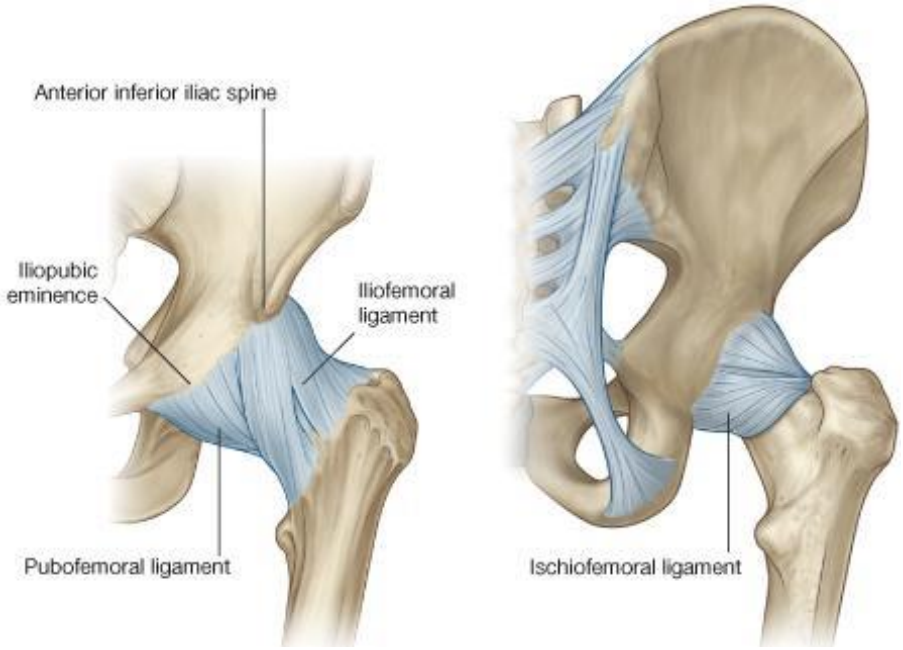
Cont.

- The hip joint is an articulation b/n the hemispherical head of the femur & the cup-shaped acetabulum of the hip bone.
- The acetabular notch at the lower part of the acetabulum is bridged by the **transverse ligament** of acetabulum.



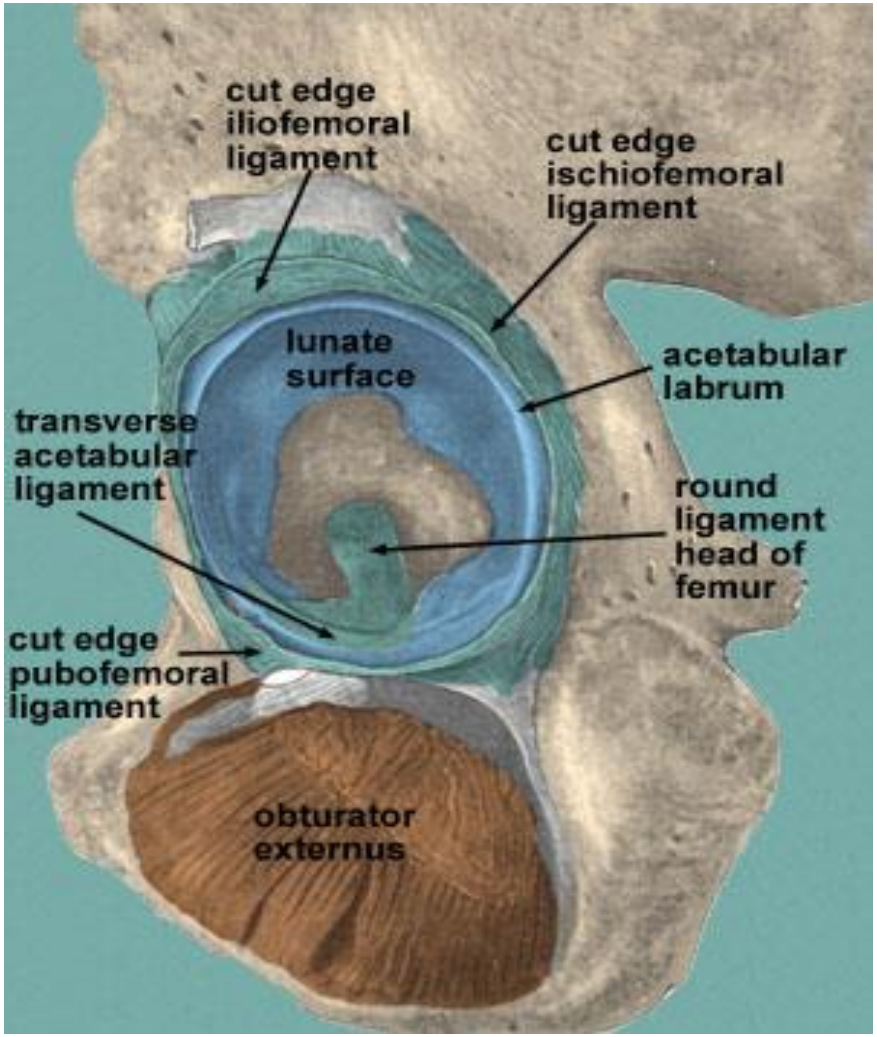
LIGAMENTS (3 Extracapsular)

- Iliofemoral ligament: Y-shaped, anterior to joint, limits extension
- Pubofemoral ligament: antero-inferior to joint, limits abduction & lateral rotation
- Ischiofemoral ligament: posterior to joint, limits medial rotation



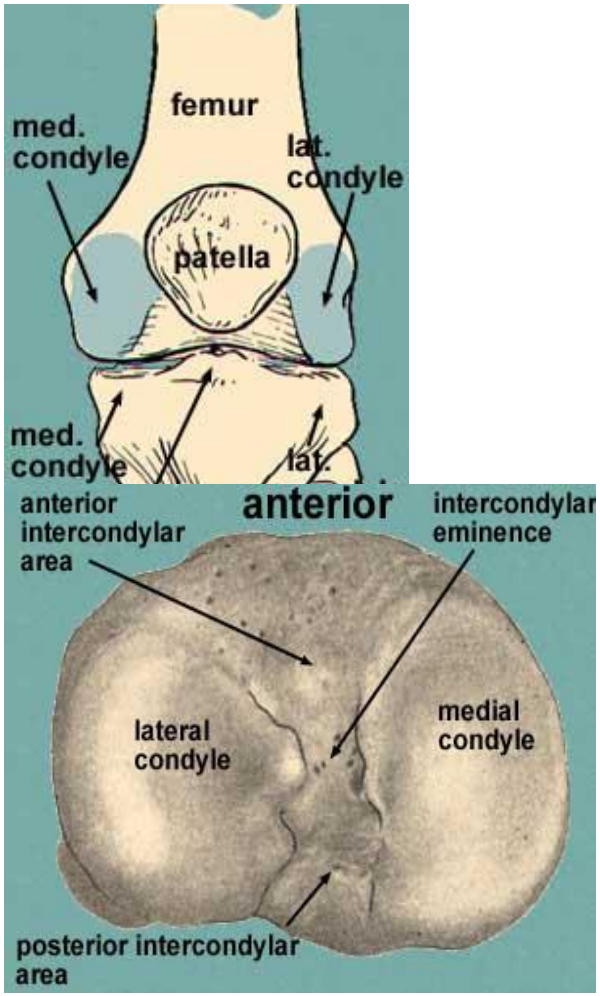
LIGAMENTS (3 Intracapsular)

- **Acetabular labrum:**
  - fibro-cartilaginous collar attached to margins of acetabulum to increase its depth for better retaining of head of femur.
- **Transverse acetabular ligament:**
  - converts acetabular notch into foramen through which pass acetabular vessels
- **Ligament of femoral head:**
  - carries vessels to head of femur



Knee Joint

- The knee joint is an articulation b/n condyles of femur & of tibia as well as the lower end of the femur & the patella.
- It is a synovial joint
- articulation b/n femur & tibia is a hinge joint with a very small amount of rotation possible.
- articulation b/n femur & patella is a synovial plane joint where the patella glides on the femur.



Cont.

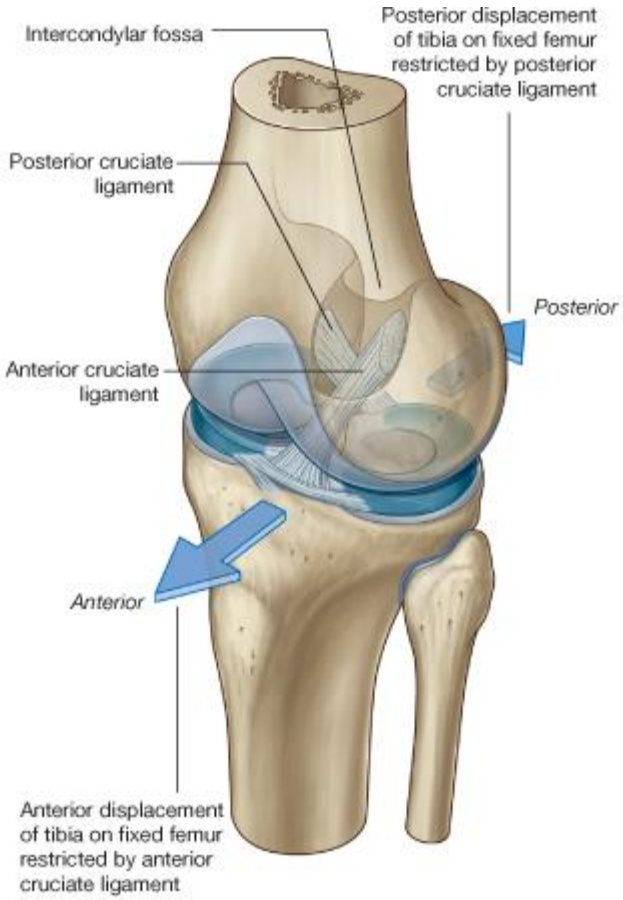
- The knee joint is relatively weak mechanically because of the incongruence of its articular surfaces.
- The stability of the knee joint depends on
  - (1) the strength and actions of the surrounding muscles and their tendons and
  - (2) the ligaments that connect the femur and tibia.
  - Of these supports, the muscles are most important; therefore, many sport injuries are preventable through appropriate conditioning and training.
- *The erect, extended position is the most stable position of the knee joint. In this position, the articular surfaces are most congruent (contact is minimized in all other positions); the primary ligaments of the joint (collateral and cruciate ligaments) are taut, and the many tendons surrounding the joint provide a splinting effect.*

Ligaments of the knee joint

Intra Capsular Ligaments:

I. ***Cruciate Ligaments:***

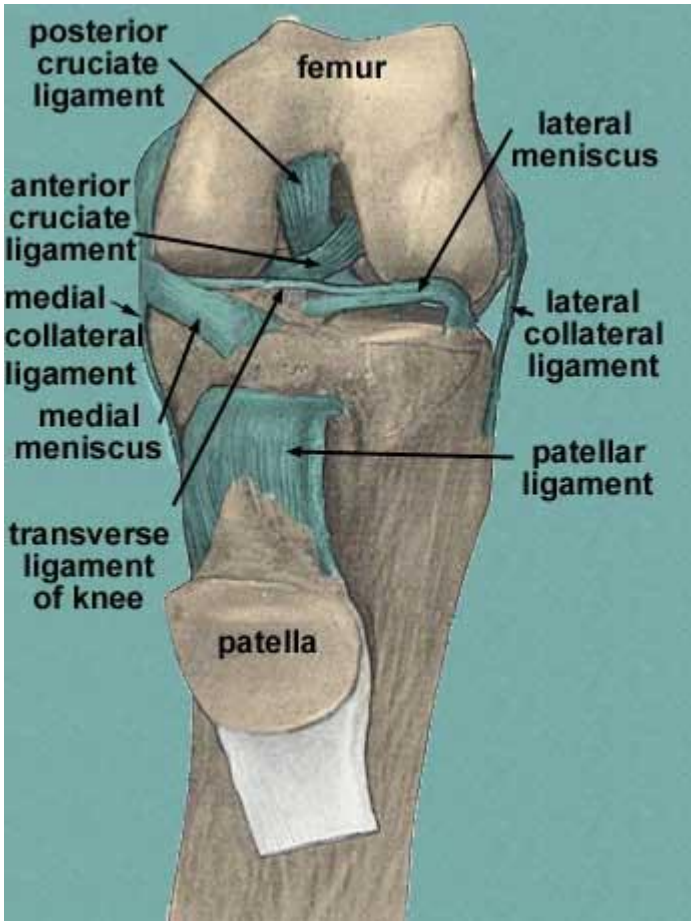
- Two very strong intracapsular ligaments, which cross each other within joint cavity.
- They are named ***Anterior & Posterior*** according to their Tibial attachments
- They are the main bond b/n femur & tibia



Cont.

Anterior Cruciate Ligament:

- Attached to ***anterior intercondylar area*** of Tibia
- Passes upward, backward & laterally to be attached to posterior part of medial surface of lateral condyle of femur.
- It is slack when knee is flexed but taut when knee is fully extended
- prevents ***posterior displacement of femur on Tibia.***
- With knee joint flexed, anterior cruciate ligament prevents tibia from being pulled anteriorly



Cont.

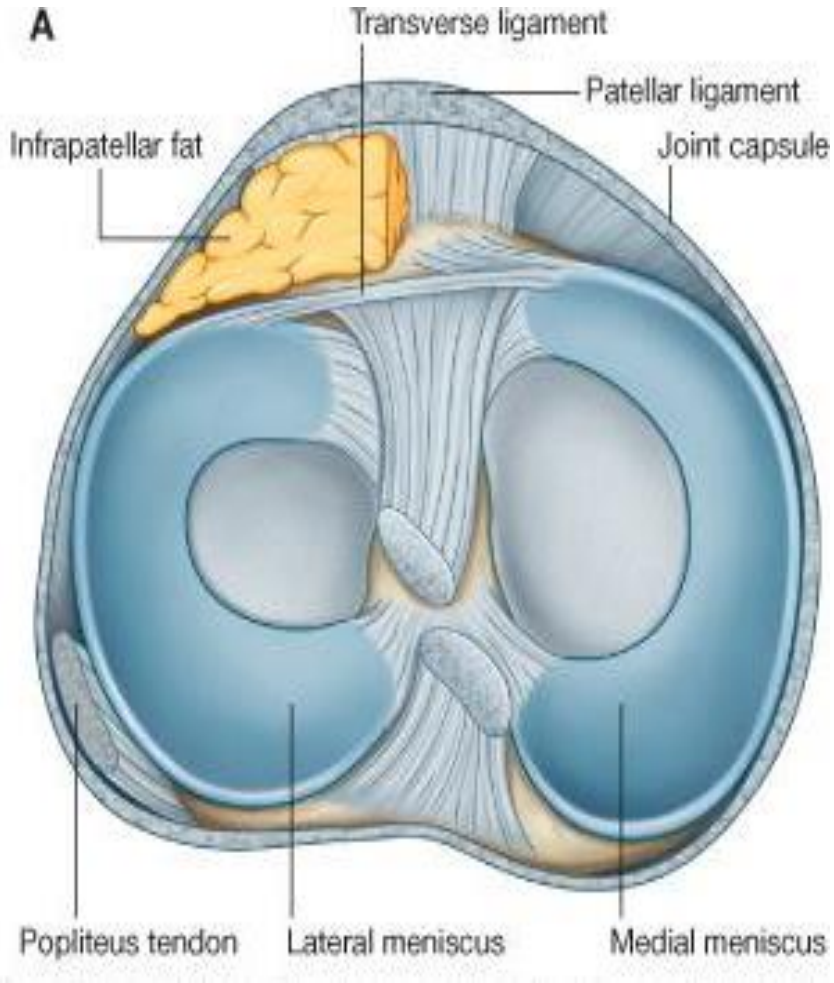
Posterior Cruciate Ligament:

- Attached to **posterior intercondylar area** of Tibia
- Passes upward, forward & medially to be attached to anterior part of lateral surface of medial condyle of femur.
- Anterior fibers become slack when knee is extended, but become taut in flexion
- Posterior fibers are taut in extension.
- **Posterior Cruciate Ligament** prevents anterior displacement of Femur on Tibia
- With knee joint flexed, Posterior Cruciate Ligament prevents the Tibia from being pulled posteriorly

Cont.

Menisci (Semilunar Cartilages):

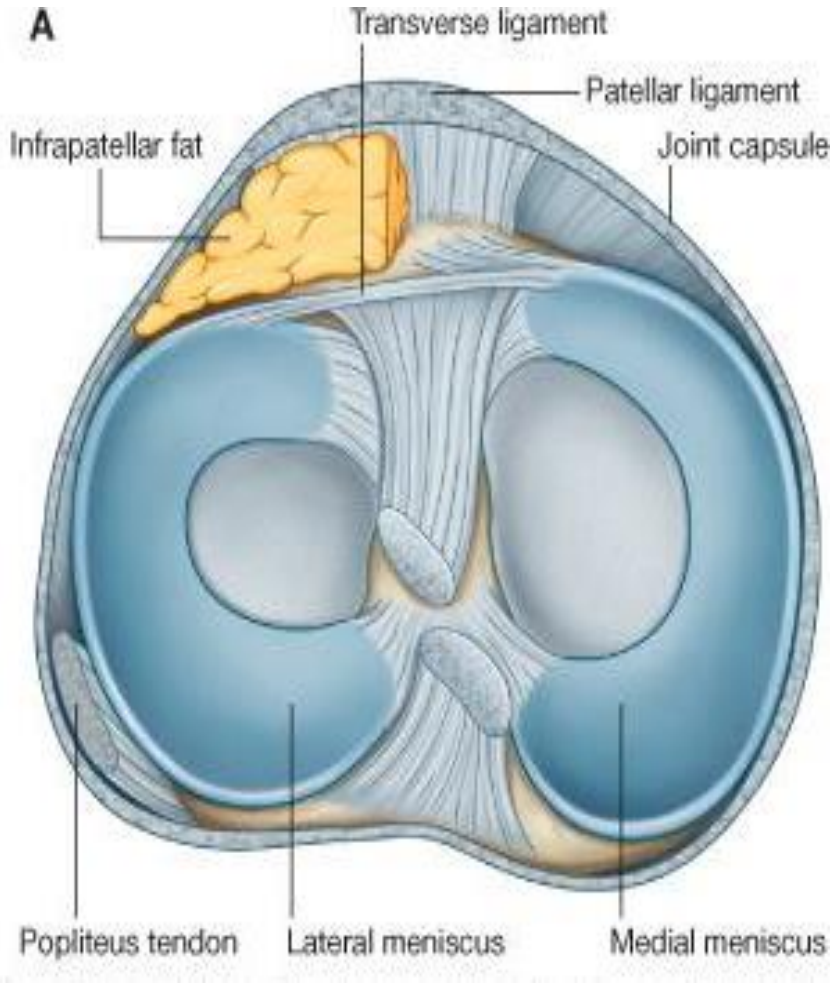
- C-shaped fibrocartilage
- Peripheral border is thick & convex & attached to the capsule
- Inner border is thin & concave and forms a free edge.
- Menisci's function is to deepen the articular surfaces of Tibial condyles to receive the convex Femoral condyles
- They also serve as cushions b/n Tibia & Femur



Cont.

Medial Meniscus:

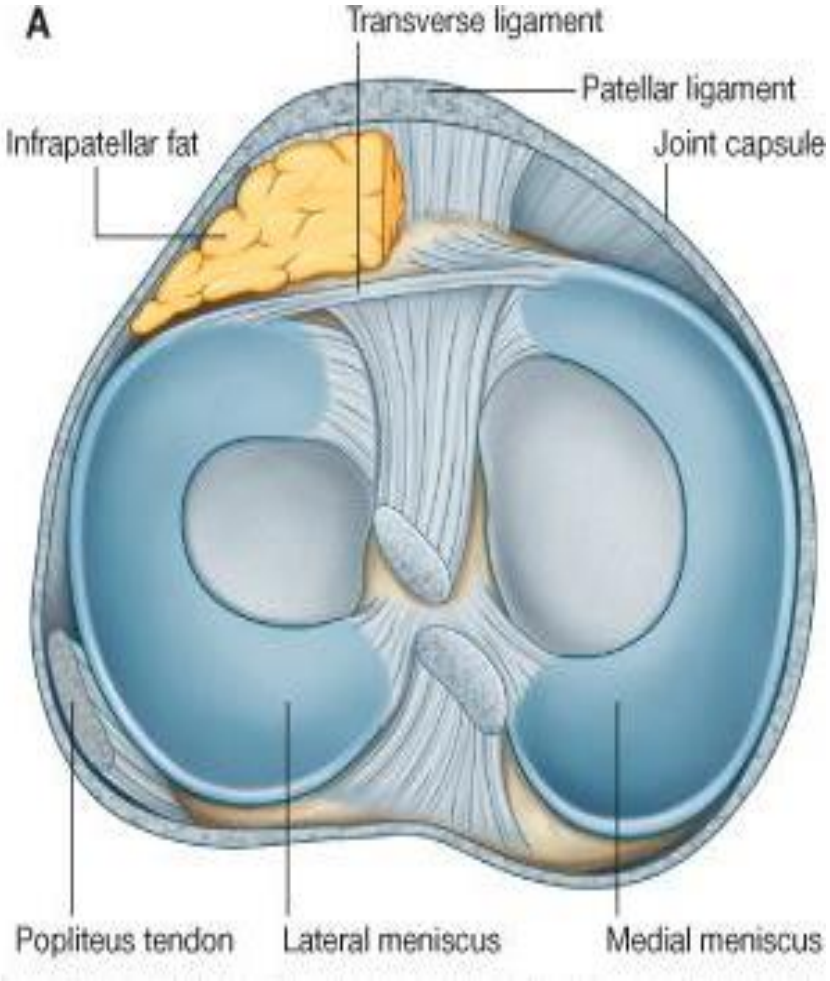
- Nearly semicircular
- ***Anterior horn*** attached to ***anterior intercondylar area*** of Tibia & ***Posterior horn*** attached to ***posterior intercondylar area***
- Also connected to ***lateral meniscus*** by ***Transverse Ligament***
- ***Peripheral border*** attached to the Capsule & to ***Medial Collateral Lig.***
- ➔because of this, ***Medial Meniscus*** is relatively fixed ➔ mobility limited ➔ more prone to injury



Cont.

Lateral Meniscus:

- Nearly circular
- ***Anterior horn*** attached to ***anterior intercondylar area*** of Tibia & ***Posterior horn*** attached to ***posterior intercondylar area***
- ***Peripheral border*** is separated from the ***Lateral Collateral Ligament*** by ***popliteus tendon***
- ➔because of this, ***Lateral Meniscus*** is less fixed than Medial Meniscus ➔ mobility unlimited ➔ less prone to injury

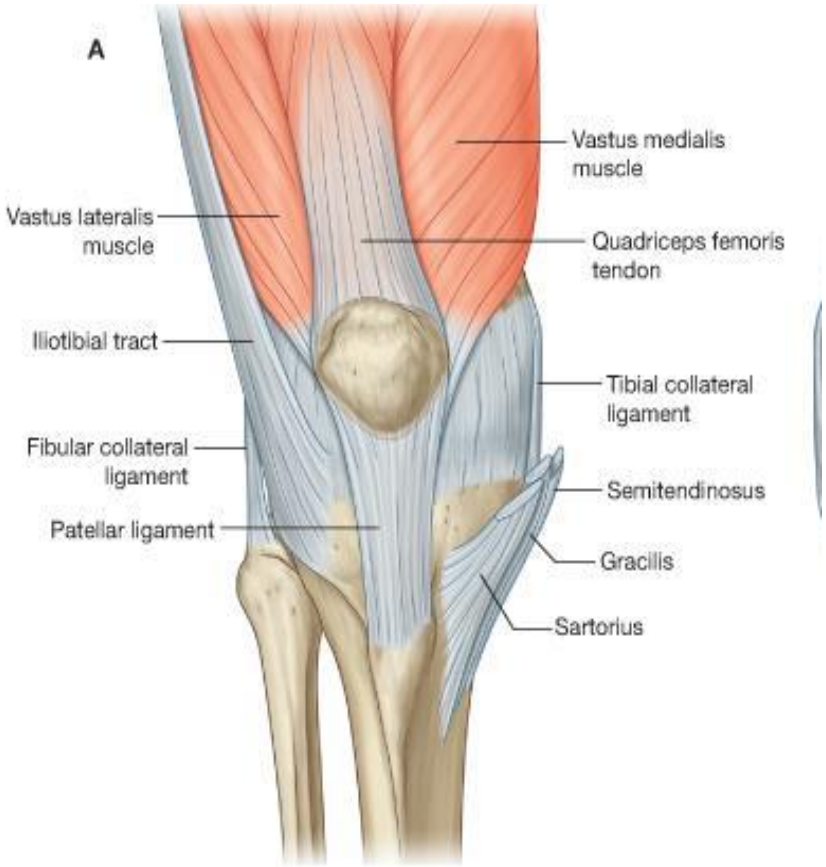


Cont.

Extra Capsular Ligaments:

Patellar Ligament:

- Attached to lower border of patella (above) & to tuberosity of tibia (below)
- Is a continuation of common tendon of ***quadriceps femoris m***
- Separated from the synovial membrane by intrapatellar fat pad



Cont.

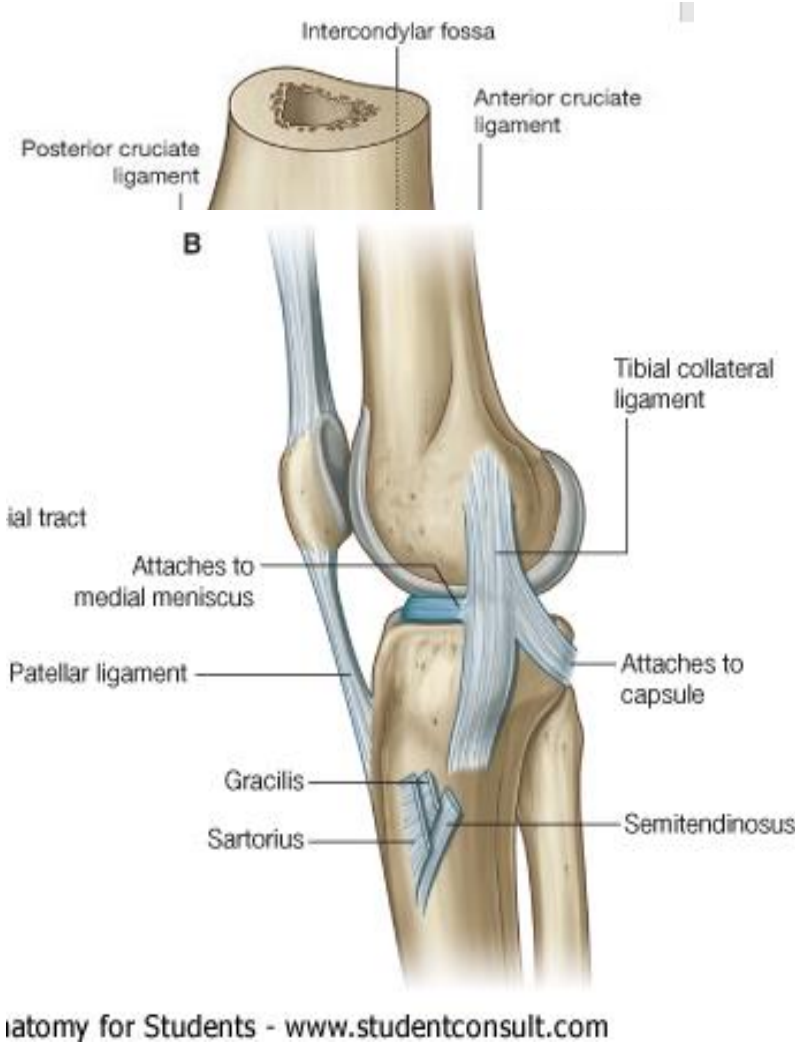
Lateral collateral ligament:

- Attached above to lateral condyle of ***femur*** & below to head of ***fibula***
- ***Popliteus tendon*** intervene b/n it & ***lateral meniscus***

➔ Not tightly held to lateral meniscus➔ mobility not limited.

Medial Collateral Ligament:

- Attached to medial condyle of ***femur*** & to medial surface of shaft of Tibia
- Firmly attached to edge of ***medial meniscus*** ➔ mobility limited



Cont.

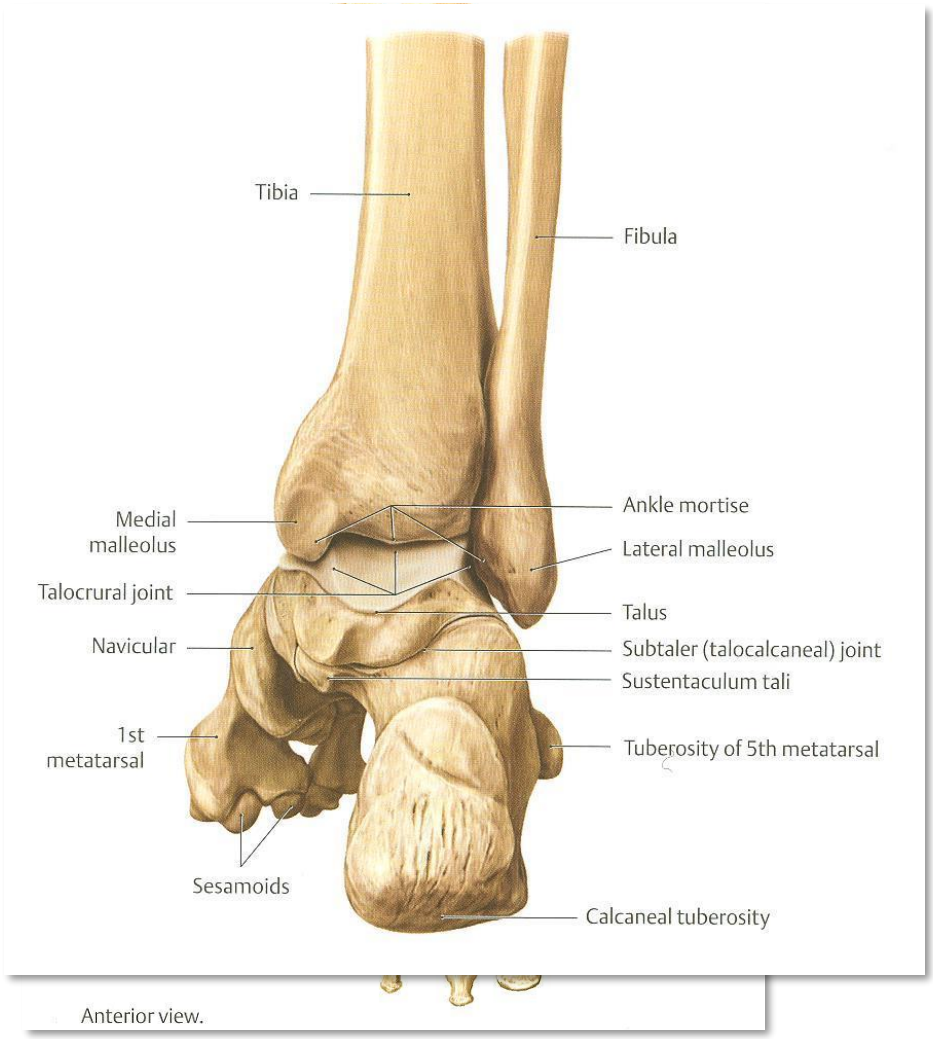
- ***Oblique popliteal ligament:***
  - Derived from ***semitendinosus m.***
  - Strengthens posterior aspect of the capsule
- The **arcuate popliteal ligament**
  - strengthens the joint capsule posterolaterally.
  - It arises from the posterior aspect of the fibular head, passes superomedially over the tendon of the popliteus, and spreads over the posterior surface of the knee joint.

Cont.

- The *collateral ligaments of the knee* are taut when the knee is fully extended, contributing to stability while standing.
- As flexion proceeds, they become increasingly slack, permitting and limiting (serving as check ligaments for) rotation at the knee.

ANKLE JOINT

- TYPE
  - It is synovial, hinge joint
- ARTICULAR SURFACES
  - UPPER:
    - A socket formed by the lower end of tibia, medial malleolus, lateral malleolus & transverse tibiofibular ligament
  - LOWER
    - Body of talus



LIGAMENTS

MEDIAL (DELTOID) LIGAMENT:

- A strong **triangular** ligament.
- **Apex:** attached to medial malleolus.
- Its base is attached to: navicular bone, plantar calcaneo-navicular ligament, neck of talus, sustentaculum tali, body of talus
- **Base:** subdivided into 4 parts:
  - Anterior tibiotalar part.
  - Tibionavicular part.
  - Tibiocalcaneal part.
  - Posterior tibiotalar part.

- **LATERAL LIGAMENT:**
  - **Composed of 3 separate ligaments (WHY?).**

Formed of 3 separate bands:

ANTERIOR TALOFIBULAR

- **From anterior border of lateral malleolus to neck of talus**

POSTERIOR TALOFIBULAR

- **From malleolar fossa to posterior tubercle of talus**

CALCANEOFIBULAR

- **From tip of lateral malleolus to lateral surface of calcaneus**

MOVEMENTS

DORSIFLEXION

- **Muscles of anterior compartment of leg**

PLANTERFLEXION

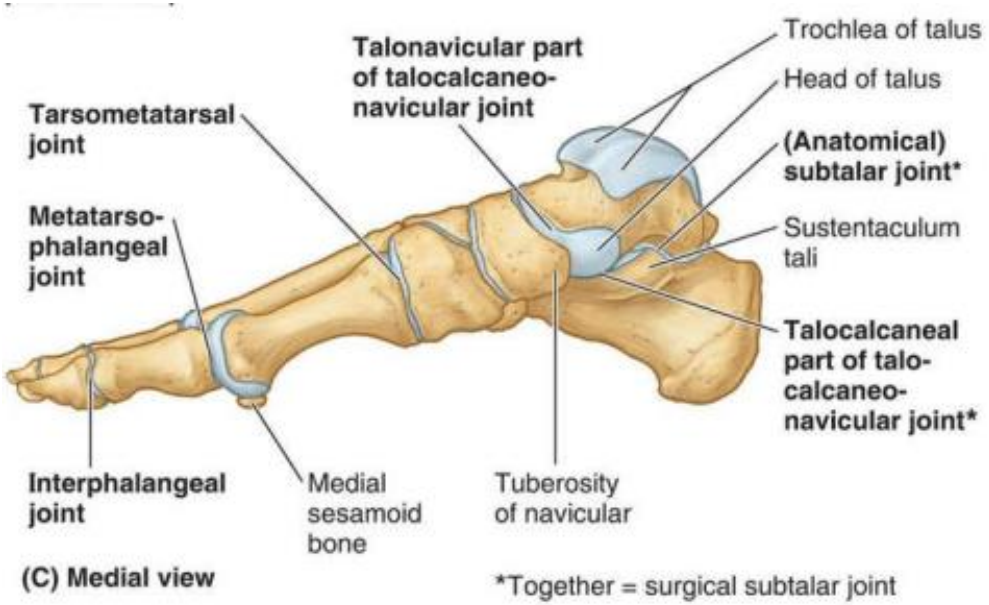
- **Initiated by soleus**
- **Maintained by gastrocnemius**
- **Helped by other muscles of posterior compartment of leg**

Cont.

- N.B.:
- THE MOVEMENT OF INVERSION & EVERSION IS PERFORMED AT SUBTALAR JOINTS AND NOT AT ANKLE JOINT
- INVERTORS: TIBIALIS ANTERIOR & POSTERIOR (helped by flexor digitroum longus & flexor hallucis longus)
- EVERTORS: PERONEUS LONGUS, BREVIS & TERTIUS

Foot Joints

- The many joints of the foot involve the tarsals, metatarsals, and phalanges.
- The important intertarsal joints are the subtalar (talocalcaneal) joint and the transverse tarsal joint (calcaneocuboid and talonavicular joints).
- Inversion and eversion of the foot are the main movements involving these joints.
- The other intertarsal joints (e.g., intercuneiform joints) and the tarsometatarsal and intermetatarsal joints are relatively small and are so tightly joined by ligaments that only slight movement occurs between them.



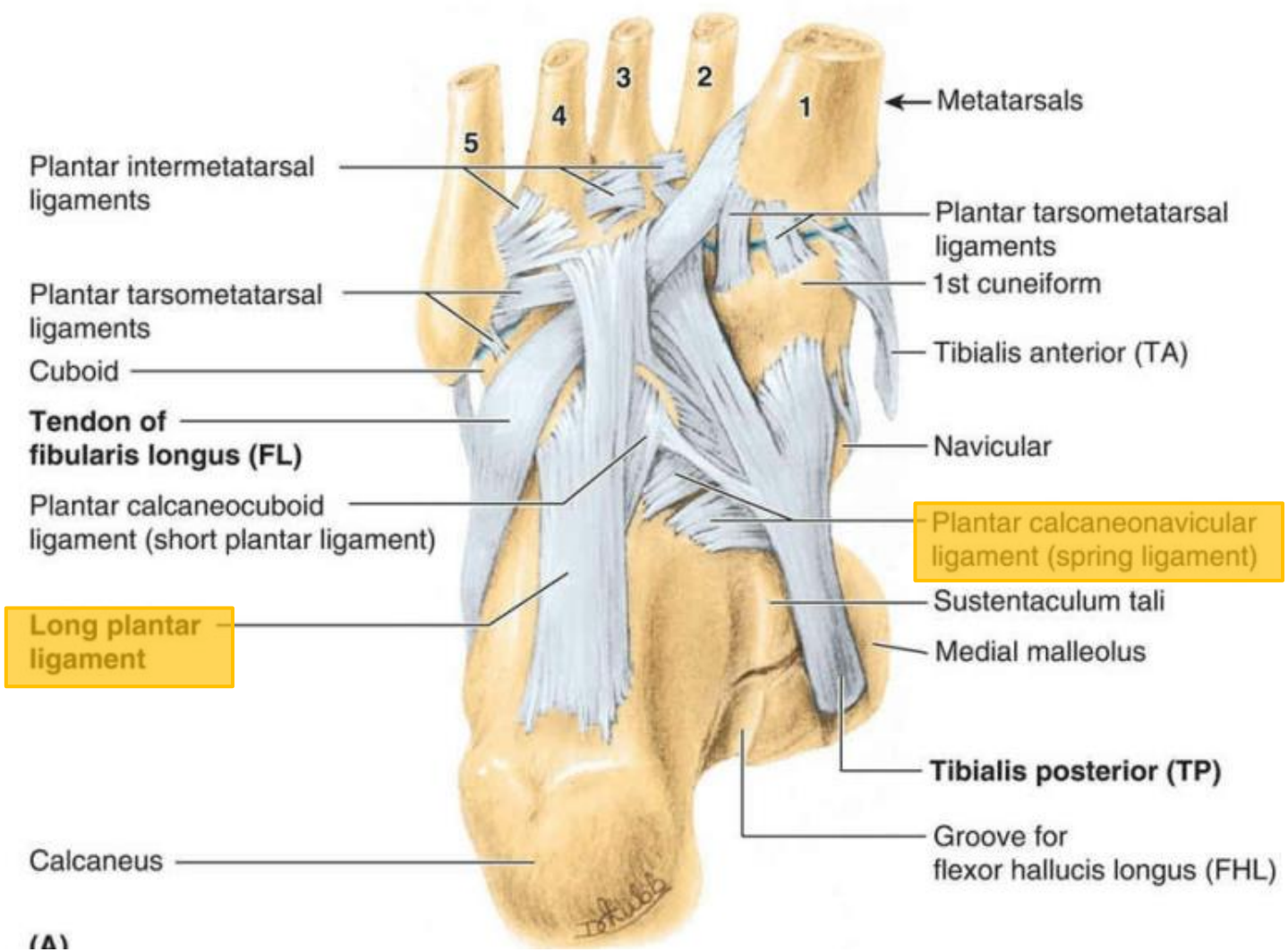
Cont.

- Functionally, there are three compound joints in the foot:
  - (1) the clinical subtalar joint between the talus and the calcaneus, where inversion and eversion occur about an oblique axis;
  - (2) the transverse tarsal joint, where the midfoot and forefoot rotate as a unit on the hindfoot around a longitudinal axis, augmenting inversion and eversion; and
  - (3) the remaining joints of the foot, which allow the pedal platform (foot) to form dynamic longitudinal and transverse arches. •

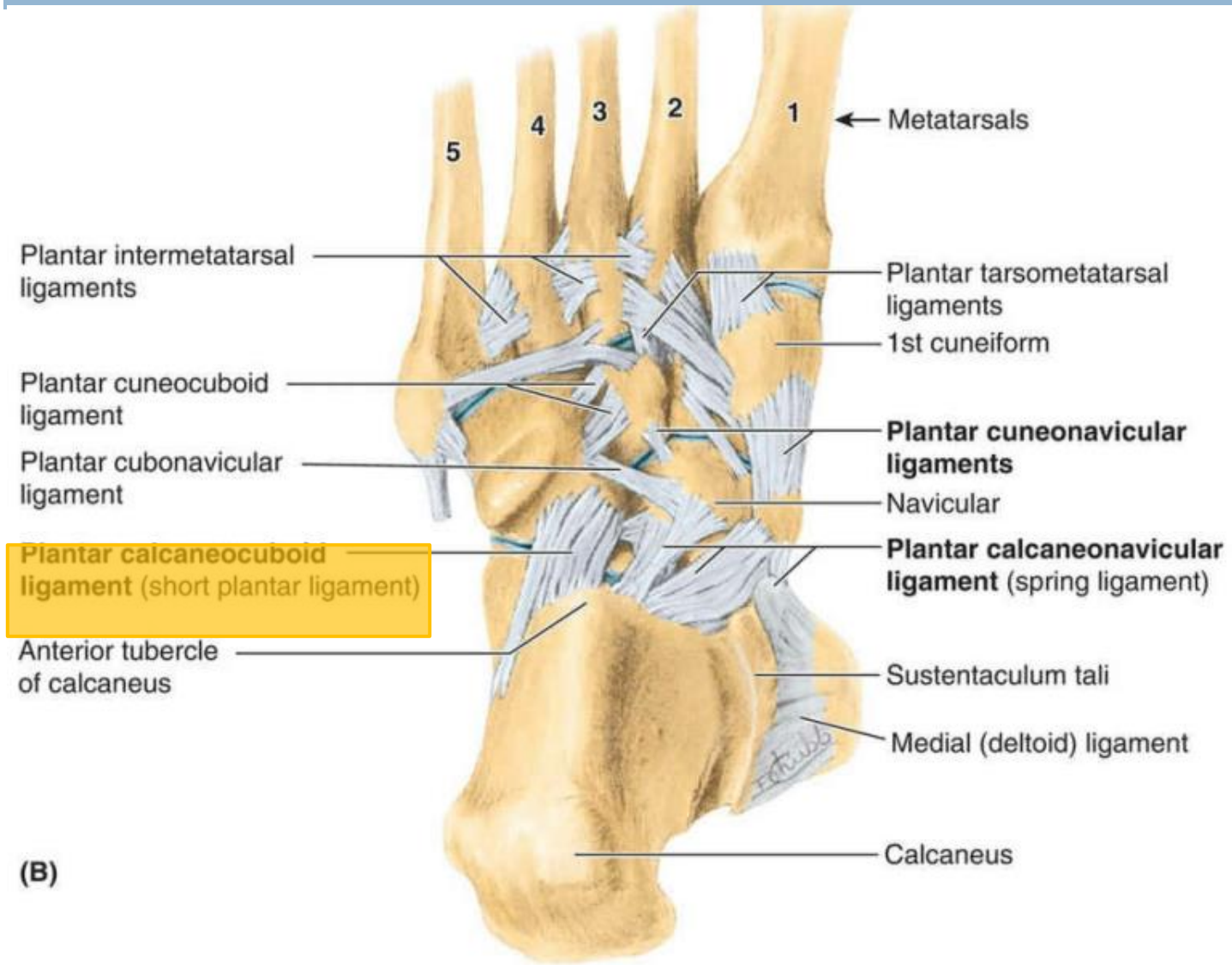
Cont.

- In the foot, flexion and extension occur in the forefoot at the metatarsophalangeal and interphalangeal joints.
- Inversion is augmented by flexion of the toes (especially the great and 2nd toes), and eversion by their extension (especially of the lateral toes).
- *All bones of the foot proximal to the metatarsophalangeal joints are united by dorsal and plantar ligaments.*
- The bones of the metatarsophalangeal and interphalangeal joints are united by lateral and medial collateral ligaments.

Plantar ligaments



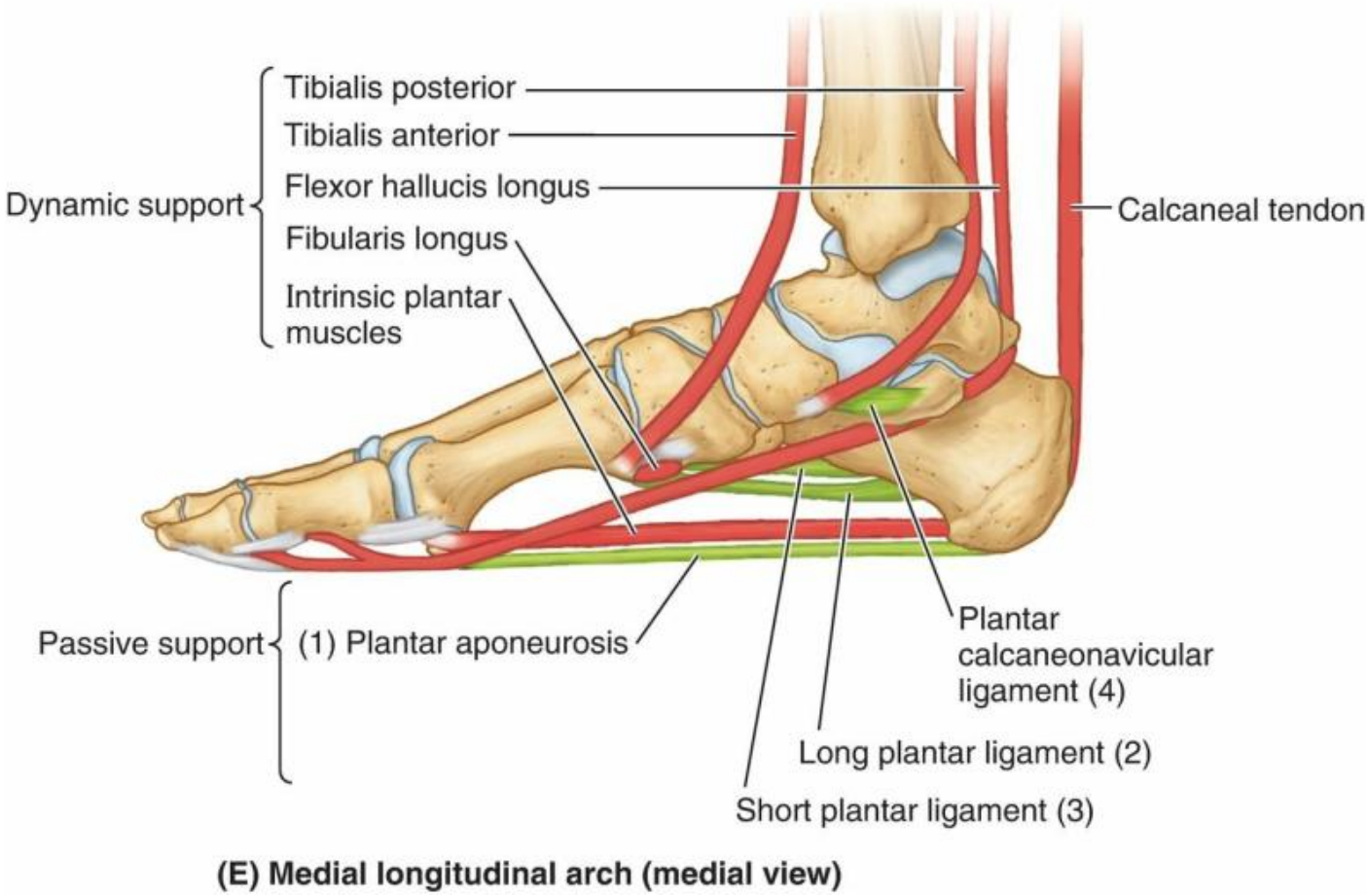
Cont.


5
4
3
2
1
Metatarsals
Plantar intermetatarsal ligaments
Plantar tarsometatarsal ligaments
1st cuneiform
Plantar cuneocuboid ligament
Plantar cuneonavicular ligaments
Plantar cubonavicular ligament
Navicular
Plantar calcaneocuboid ligament (short plantar ligament)
Plantar calcaneonavicular ligament (spring ligament)
Anterior tubercle of calcaneus
Sustentaculum tali
Medial (deltoid) ligament
Calcaneus
(B)

ARCHES OF FOOT

- Function in weight distribution, support, and forward propulsion
  - Weight is transferred from the foot to the ground only at the **calcaneal tuberosity and metatarsal heads.**
- Stability depends on
  - bony conformation,
  - plantar ligaments,
  - short plantar muscles, and
  - long leg muscles.
- *Plantar aponeurosis functions as ligament, helping support longitudinal arches*

Cont.



(E) Medial longitudinal arch (medial view)

Cont.

- **Medial longitudinal arch**
  - Formed by calcaneus, talus, navicular, cuneiform bones, and first three metatarsal bones
  - Highest at head of talus, which receives support from **plantar calcaneonavicular** (spring) **ligament**
- **Lateral longitudinal arch**
  - Formed by calcaneus, cuboid, and lateral two metatarsal bones
  - Receives support from **long plantar** and **short plantar ligaments**
- **Transverse arch**
  - Formed by bases of metatarsal bones, cuboid, and three cuneiform bones
  - Is actually a **half arch** formed in each foot when feet are planted and parallel

Clinical box

- Pes planus is a flat foot.
- Pes cavus is a high-arched foot.

Cont.

- Passive factors involved in forming and maintaining the arches of the foot include:
  - The shape of the united bones (both arches, but especially the transverse arch).
  - Four successive layers of fibrous tissue that bowstring the longitudinal arch(superficial to deep):
    1. Plantar aponeurosis.
    2. Long plantar ligament.
    3. Plantar calcaneocuboid (short plantar) ligament.
    4. Plantar calcaneonavicular (spring) ligament.

Cont.

- Dynamic supports involved in maintaining the arches of the foot include:
  - Active (reflexive) bracing action of intrinsic muscles of foot (longitudinal arch).
  - Active and tonic contraction of muscles with long tendons extending into foot:
    - Flexors hallucis and digitorum longus for the longitudinal arch.
    - Fibularis longus and tibialis posterior for the transverse arch.
    - Of these factors, the plantar ligaments and the plantar aponeurosis bear the greatest stress and are most important in maintaining the arches of the foot.


Thank u