



THE SKELETAL SYSTEM: THE APPENDICULAR SKELETON

APPENDICULAR SKELETON

- The primary function is movement
- It includes bones of the upper and lower limbs
- Girdles attach the limbs to the axial skeleton



SKELETON OF THE UPPER LIMB

- Each upper limb has 32 bones
- Two separate regions
- 1. The *pectoral (shoulder) girdle* (2 bones)
- 2. The *free part* (30 bones)



THE PECTORAL (OR SHOULDER) GIRDLE

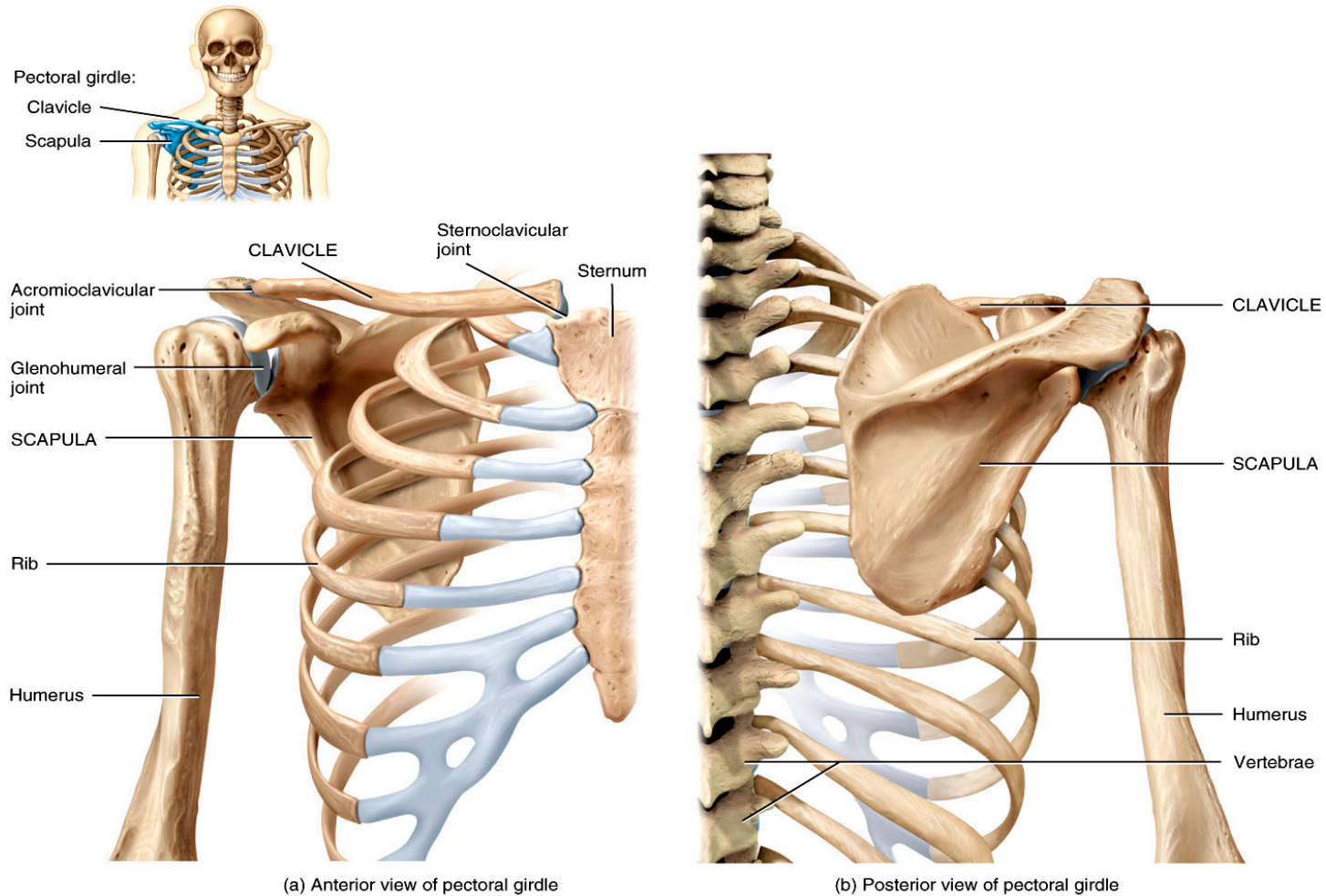


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UPPER LIMB

- The *pectoral girdle* consists of two bones, the scapula and the clavicle
- The *free part* has 30 bones
- 1 humerus (arm)
- 1 ulna (forearm)
- 1 radius (forearm)
- 8 carpals (wrist)
- 19 metacarpal and phalanges (hand)



PECTORAL GIRDLE - CLAVICLE

- The clavicle is “S” shaped
- The medial end articulates with the manubrium of the sternum forming the *sternoclavicular joint*
- The lateral end articulates with the acromion forming the *acromioclavicular joint*



THE CLAVICLE

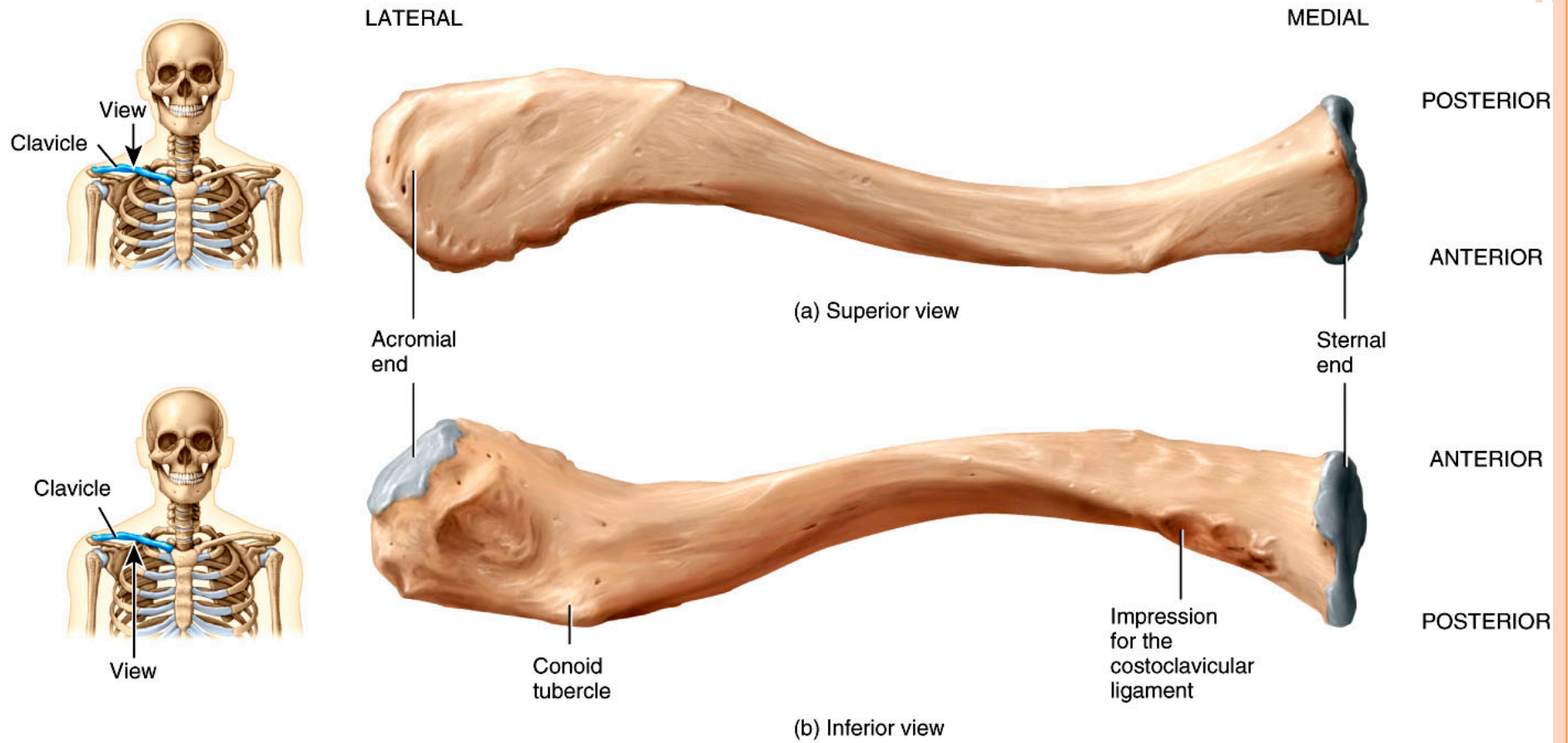


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PECTORAL GIRDLE - CLAVICLE

- The clavicle is convex in shape anteriorly near the sternal junction
- The clavicle is concave anteriorly on its lateral edge near the acromion



CLINICAL CONNECTION - FRACTURED CLAVICLE

- A fall on an outstretched arm (F.O.O.S.H.) injury can lead to a fractured clavicle
- The clavicle is weakest at the junction of the two curves
- Forces are generated through the upper limb to the trunk during a fall
- Therefore, most breaks occur approximately in the middle of the clavicle



PECTORAL GIRDLE - SCAPULA

- Also called the shoulder blade
- Triangular in shape
- Most notable features include the spine, acromion, coracoid process and the glenoid cavity

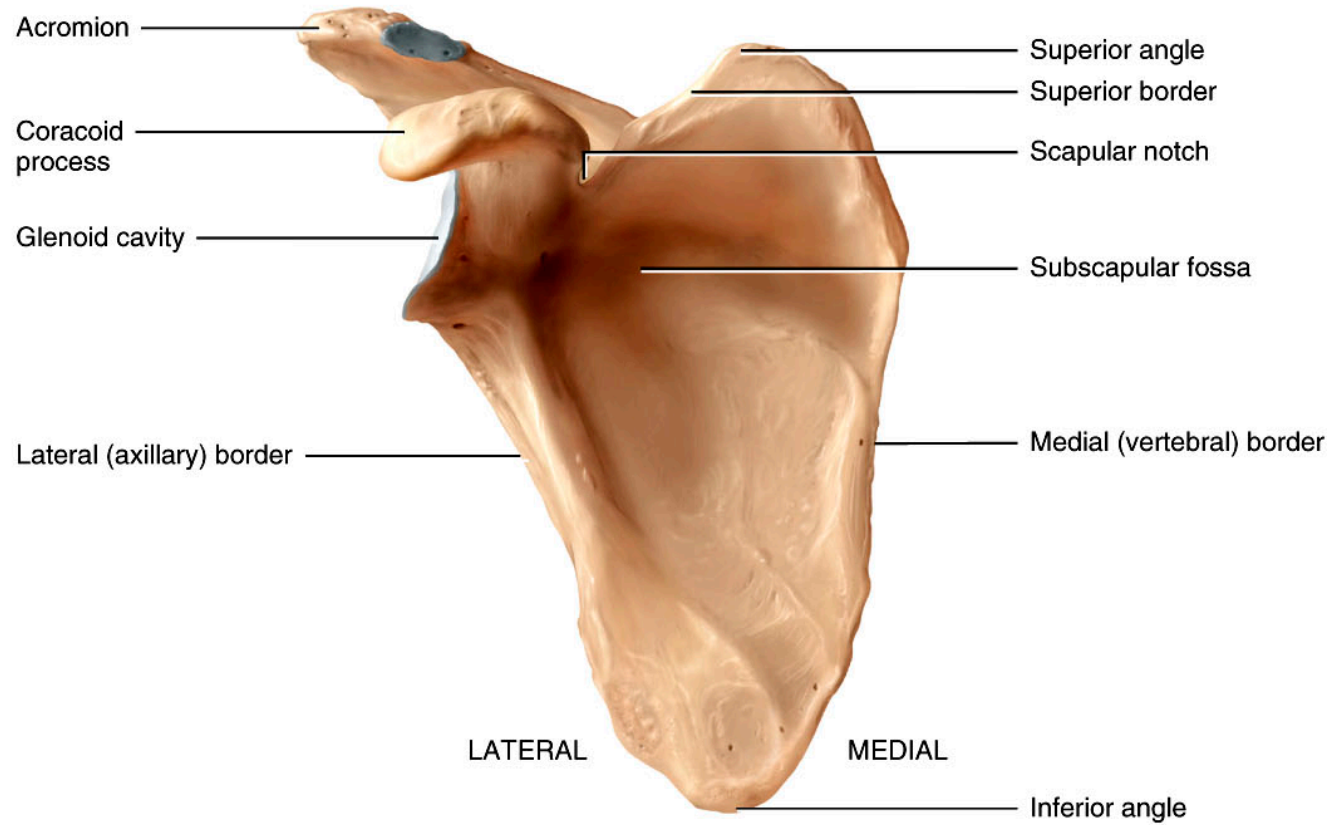
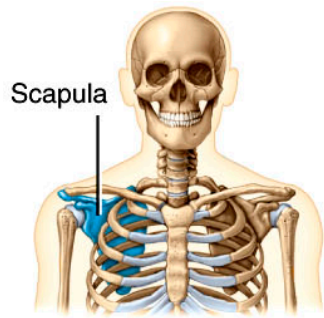


FEATURES ON THE SCAPULA

- Spine - a large process on the posterior of the scapula that ends laterally as the acromion
- Acromion - the flattened lateral portion of the spine of the scapula
- Coracoid process - a protruding projection on the anterior surface just inferior to the lateral aspect of the clavicle
- Glenoid cavity - shallow concavity that articulates with the head of the humerus



SCAPULA



(a) Anterior view

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SCAPULA

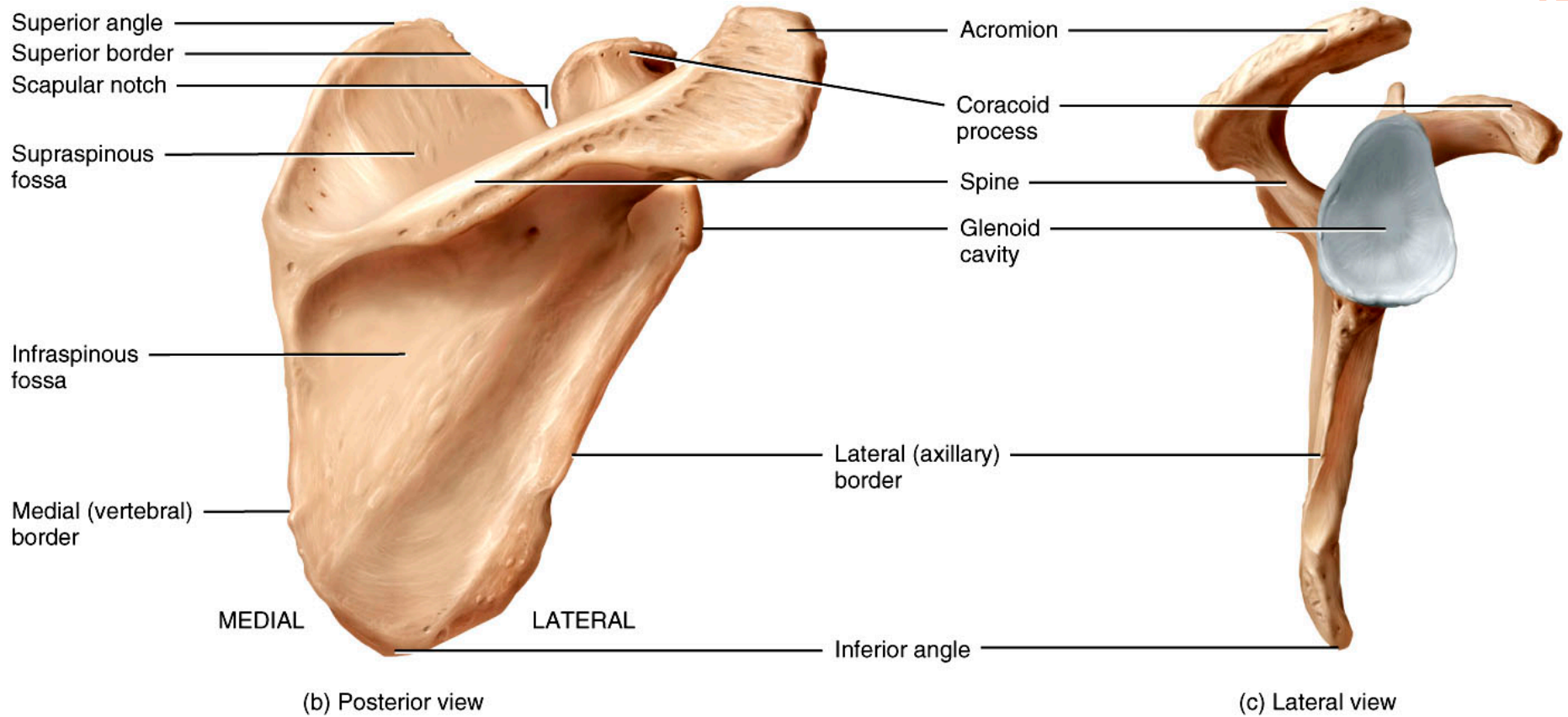


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SCAPULA - FEATURES

- The medial (vertebral) border - closest to the vertebral spine
- Lateral border - closest to the arm
- Superior border - superior edge
- Inferior angle - where medial and lateral borders meet inferiorly
- Superior angle - uppermost aspect of scapula where medial border meets superior border



SCAPULA - FEATURES

- Subscapular fossa - anterior concavity where the subscapularis muscle attaches
- Supraspinous fossa - posterior concavity superior to the scapular spine, attachment site for supraspinatus muscle
- Infraspinous fossa - posterior concavity inferior to the scapular spine, site of infraspinatus muscle



SKELETON OF THE ARM - HUMERUS

- Longest and largest bone of the free part of the upper limb
- The proximal ball-shaped end articulates with the glenoid cavity of the scapula
- The distal end articulates at the elbow with the radius and ulna



HUMERUS - SURFACE FEATURES

- The head of the humerus has two unequal-sized projections
- The greater tubercle lies more laterally
- The lesser tubercle lies more anteriorly
- Between the tubercles lies the intertubercular groove or sulcus (bicipital groove) where the long head of the biceps brachii tendon is located



HUMERUS - SURFACE FEATURES

- Just distal to the head is the *anatomical neck*
- The *surgical neck* is where the tubular shaft begins and is a common area of fracture
- About mid-shaft on the lateral aspect is a roughened area, the *deltoid tuberosity* where the deltoid tendon attaches
- Capitulum - a round knob-like process on the lateral distal humerus
- Trochlea - medial to the capitulum, is a spool-shaped projection on the distal humerus



HUMERUS - SURFACE FEATURES

- *Coronoid fossa* - anterior depression that receives the coronoid process of the ulna during forearm flexion
- *Olecranon fossa* - posterior depression that receives the olecranon of the ulna during forearm extension
- The *medial* and *lateral epicondyles* are bony projections to which the forearm muscles attach



HUMERUS AND GLENOHUMERAL JOINT

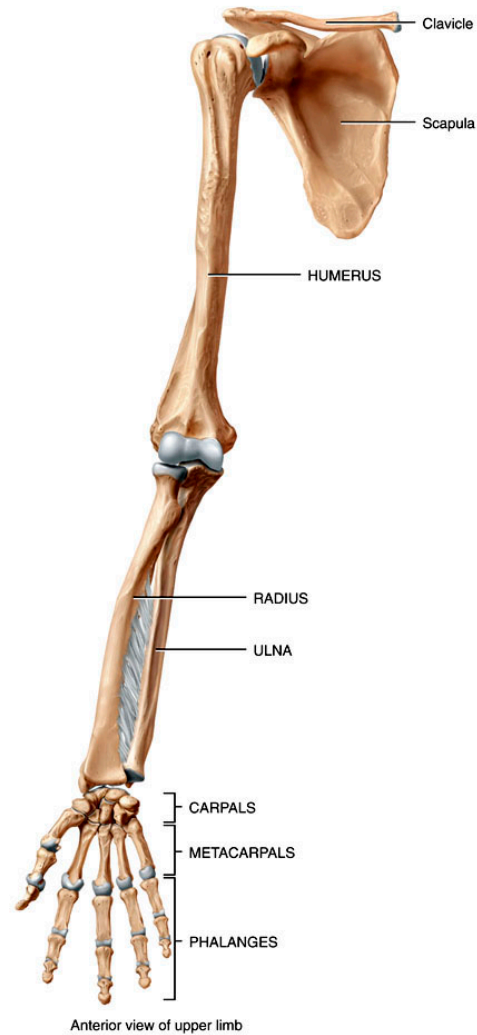


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SKELETON OF THE FOREARM - ULNA

- The longer of the two forearm bones
- Located medial to the radius
- *Olecranon* - the large, prominent proximal end, the “tip of your elbow”
- *Coronoid process* - the anterior “lip” of the proximal ulna
- *Trochlear notch* - the deep fossa that receives the trochlea of the humerus during elbow flexion
- *Styloid process* - the thin cylindrical projection on the posterior side of the ulna’s head



RIGHT HUMERUS IN RELATION TO SCAPULA, ULNA, AND RADIUS

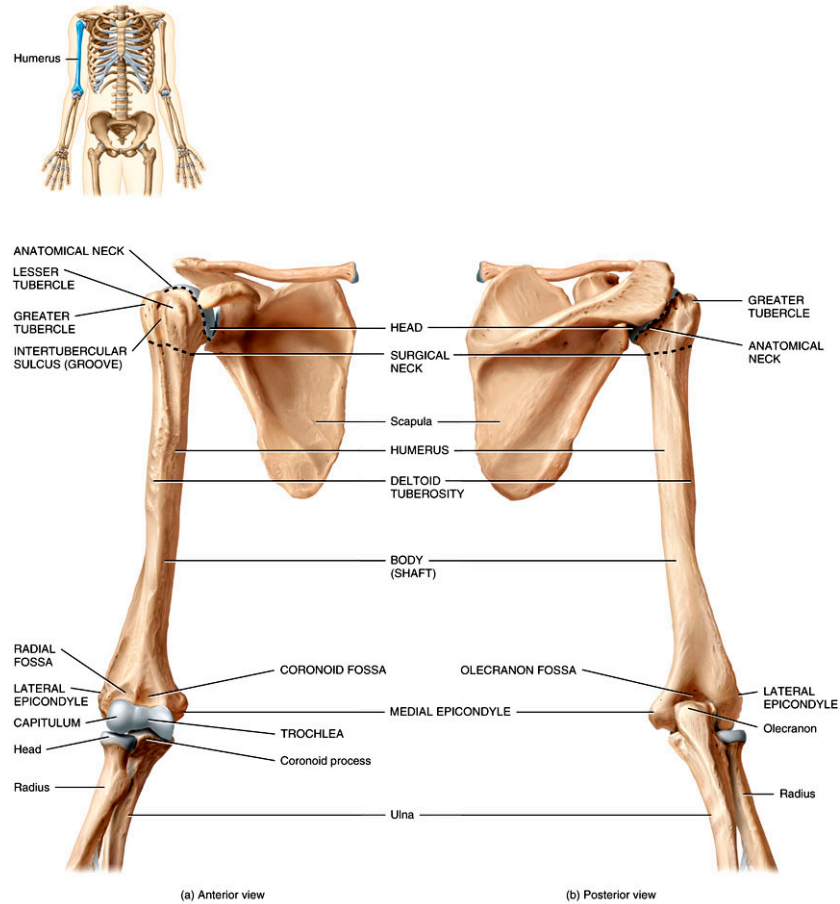


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RADIUS

- Lies lateral to the ulna (thumb side of the forearm)
- The head (disc-shaped) and neck are at the proximal end
- The head articulates with the capitulum of the humerus and the radial notch of the ulna
- Radial tuberosity - medial and inferior to neck, attachment site for biceps brachii muscle
- Styloid process - large distal projection on lateral side of radius



ULNA AND RADIUS

- The shaft of these bones are connected by an interosseus membrane
- There is a proximal radioulnar joint and a distal radioulnar joint
- Proximally, the head of the radius articulates with the radial notch of the ulna
- Distally, the head of the ulna articulates with the ulnar notch of the radius



RIGHT ULNA AND RADIUS IN RELATION TO THE HUMERUS AND CARPALS

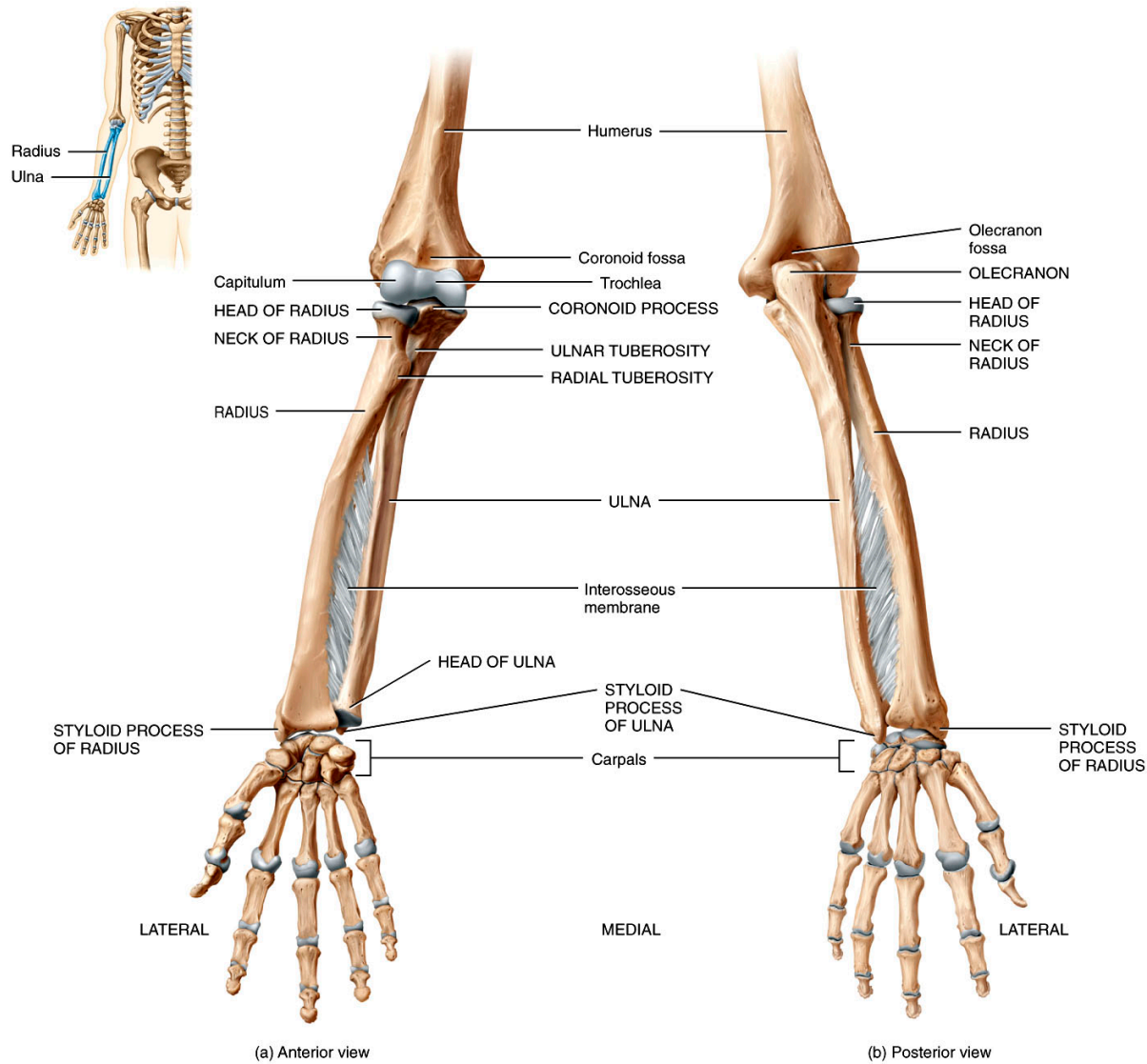


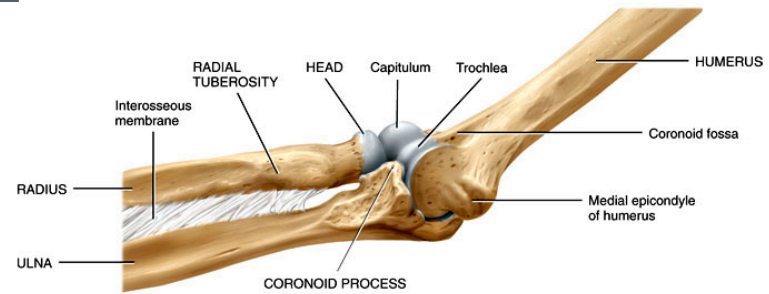
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SKELETON OF THE HAND

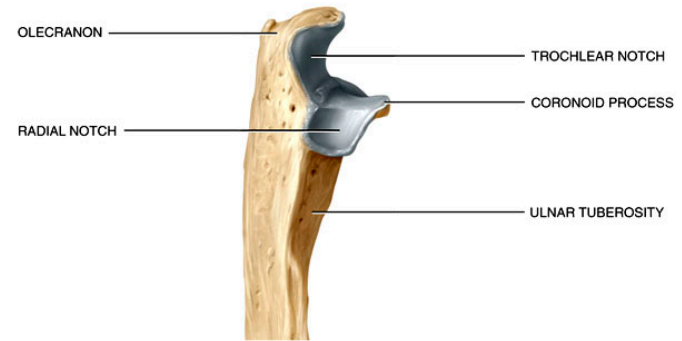
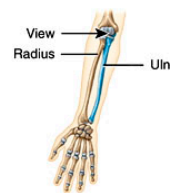
- The carpus (wrist) consists of 8 small bones (carpals)
- Two rows of carpal bones
- Proximal row - scaphoid, lunate, triquetrum, pisiform
- Distal row - trapezium, trapezoid, capitate, hamate
- Scaphoid - most commonly fractured
- Carpal tunnel - space between carpal bones and flexor retinaculum



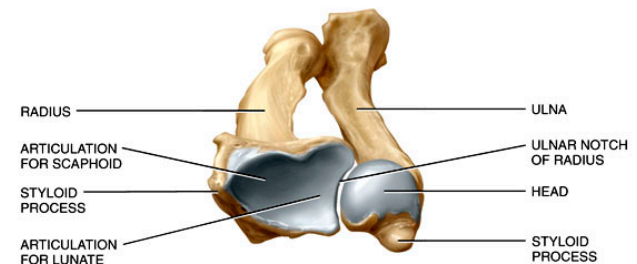
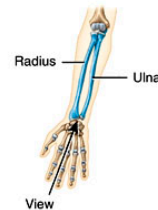
ARTICULATIONS FORMED BY THE ULNA AND RADIUS -



(a) Medial view in relation to humerus



(b) Lateral view of proximal end of ulna



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

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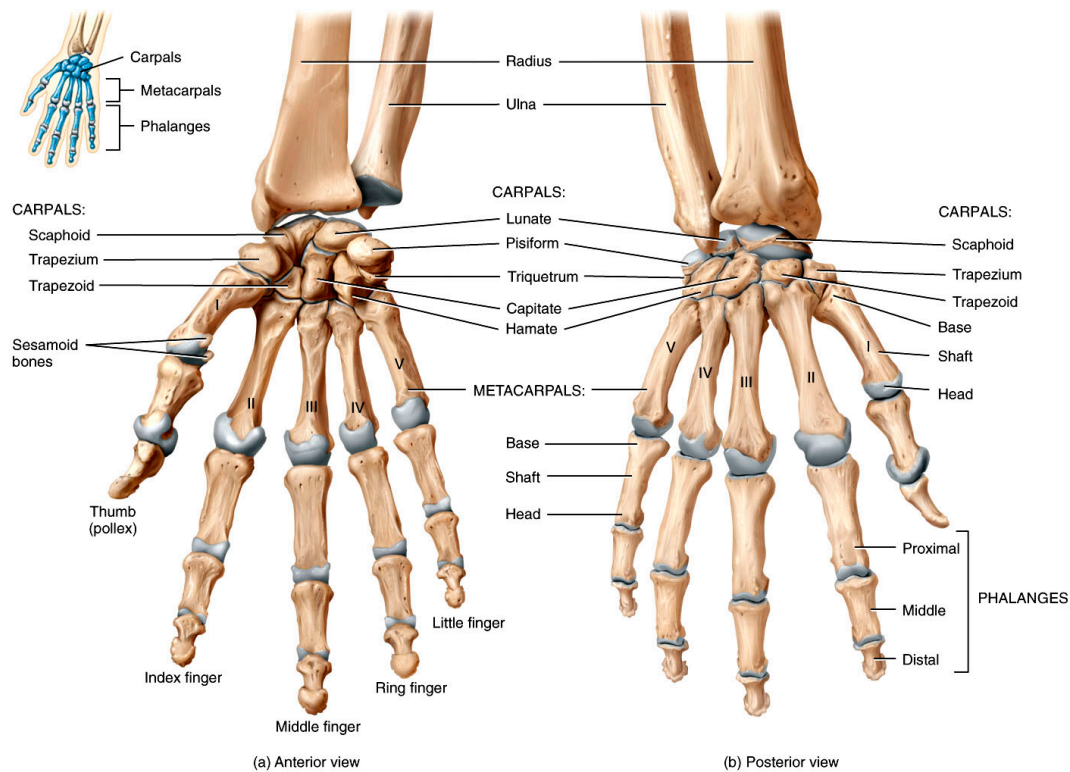


METACARPALS AND PHALANGES

- Five metacarpals - numbered I-V, lateral to medial
- 14 phalanges - two in the thumb (pollex) and three in each of the other fingers
- Each phalanx has a base, shaft, and head
- Joints - carpometacarpal, metacarpophalangeal, interphalangeal

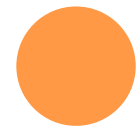


RIGHT WRIST AND HAND IN RELATION TO ULNA AND RADIUS



MNEMONIC for carpal bones*:
Stop Letting Those People Touch The Cadaver's Hand.
 Scaphoid Lunate Triquetrum Pisiform Trapezium Trapezoid Capitate Hamate
 Proximal row Distal row
 Lateral → Medial Lateral → Medial

* Edward Tanner, University of Alabama, SOM



SKELETON OF THE LOWER LIMB

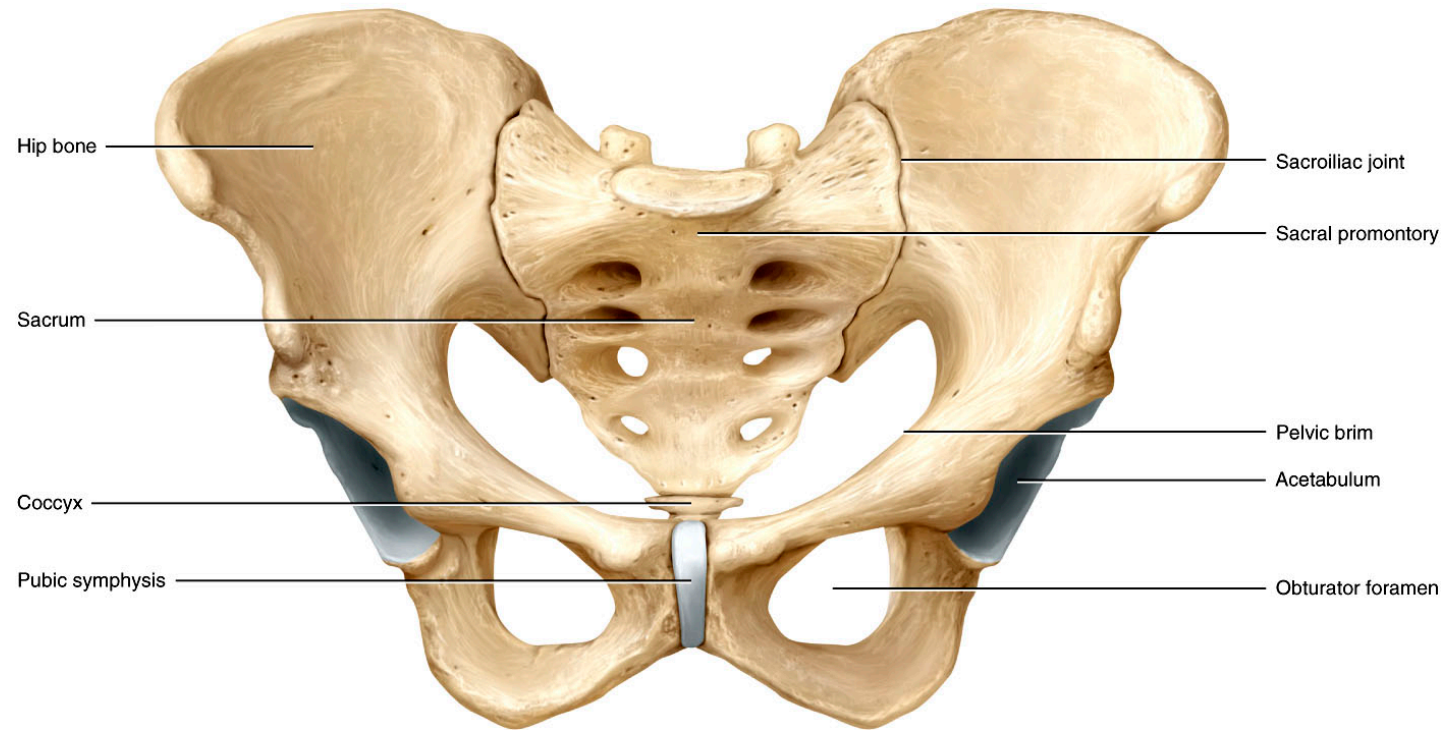
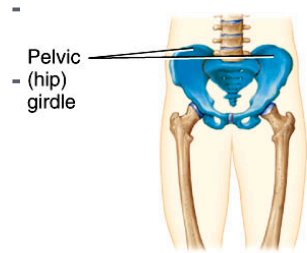
- Skeleton of the Lower Limb
- Two separate regions
- 1. A single *pelvic girdle* (2 bones)
- 2. The *free part* (30 bones)



PELVIC (HIP) GIRDLE

- Each coxal (hip) bone consists of three bones that fuse together: ilium, pubis, and ischium
- The two coxal bones are joined anteriorly by the pubic symphysis (fibrocartilage)
- Joined posteriorly by the sacrum forming the sacroiliac joints (Fig 8.9)





Anterosuperior view of pelvic girdle

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THE ILIUM

- Largest of the three hip bones
- Ilium is the superior part of the hip bone
- Consists of a superior *ala* and inferior *body* which forms the acetabulum (the socket for the head of the femur)
- Superior border - iliac crest
- *Hip pointer* - occurs at anterior superior iliac spine
- Greater sciatic notch - allows passage of sciatic nerve

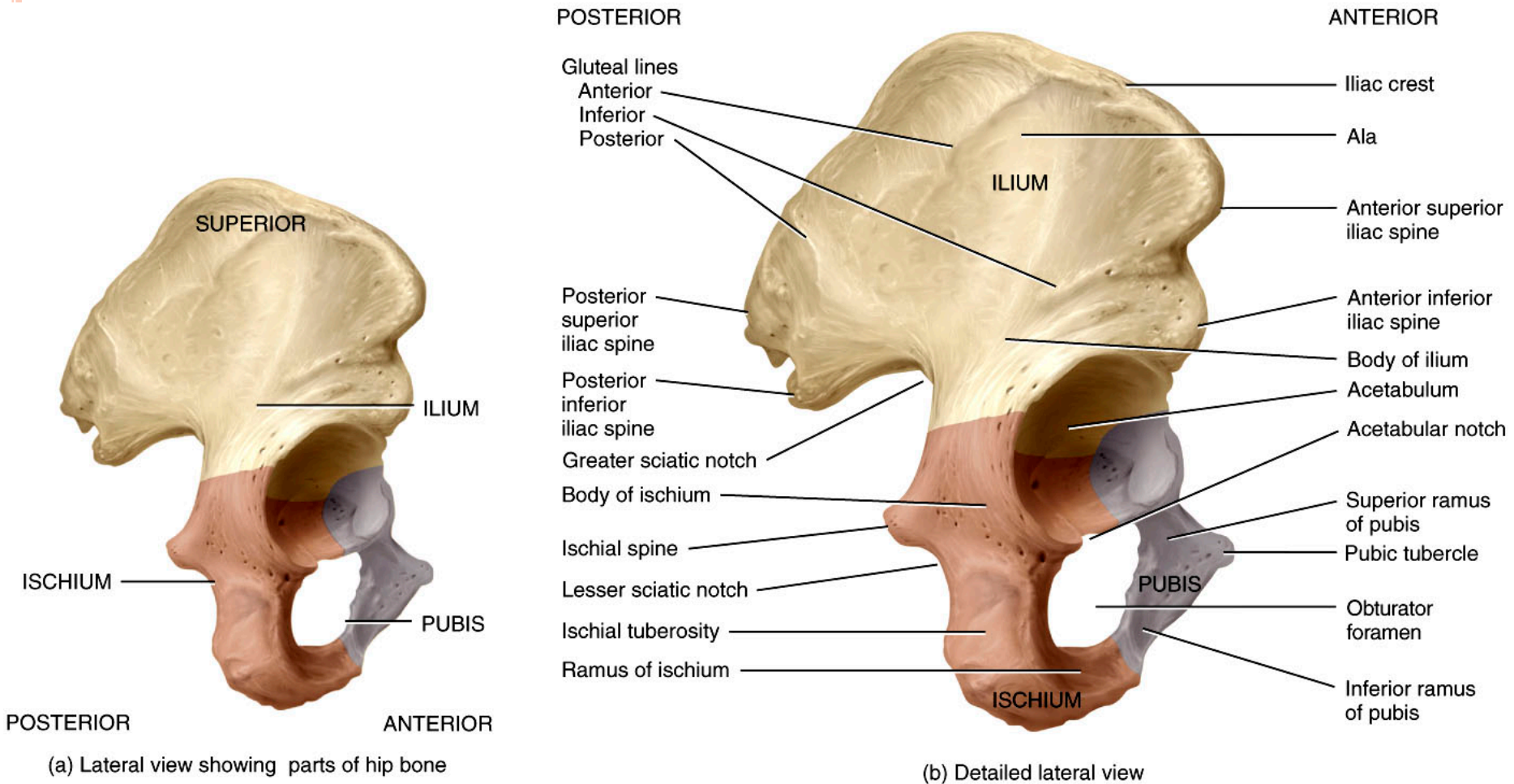


ISCHIUM AND PUBIS

- Ischium - inferior and posterior part of the hip bone
- Most prominent feature is the ischial tuberosity, it is the part that meets the chair when you are sitting
- Pubis - inferior and anterior part of the hip bone
- Superior and inferior rami and body



RIGHT HIP BONE



(a) Lateral view showing parts of hip bone

(b) Detailed lateral view



FALSE AND TRUE PELVES

- Pelvic brim - a line from the sacral promontory to the upper part of the pubic symphysis
- False pelvis - lies above this line (Fig 8.9b)
- Contains no pelvic organs except urinary bladder (when full) and uterus during pregnancy
- True pelvis - the bony pelvis inferior to the pelvic brim, has an inlet, an outlet and a cavity
- Pelvic axis - path of baby during birth



TRUE AND FALSE Pelves FIGURE

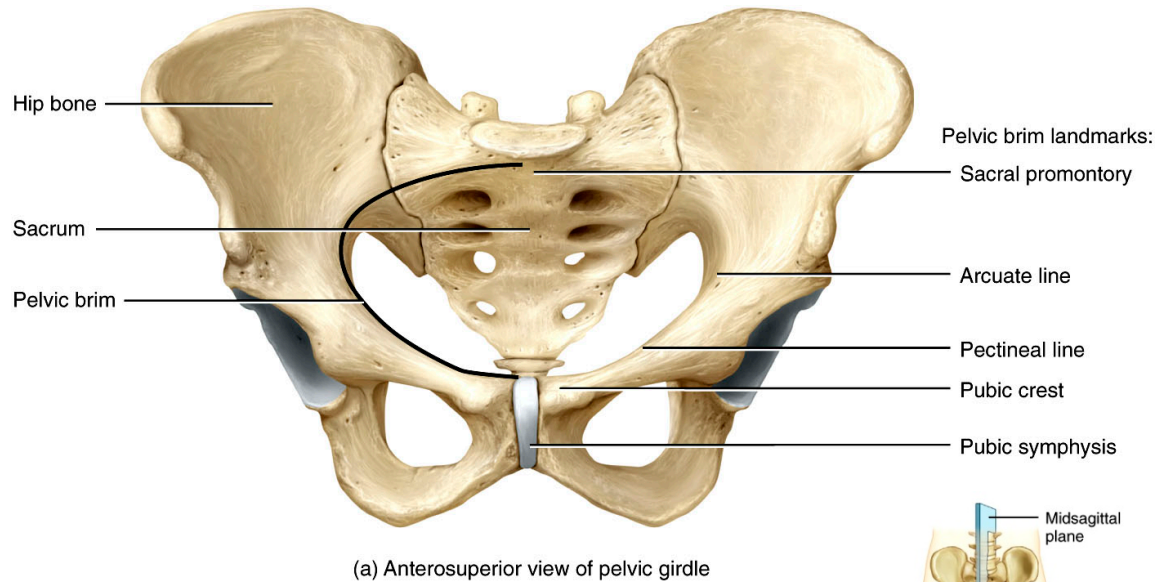


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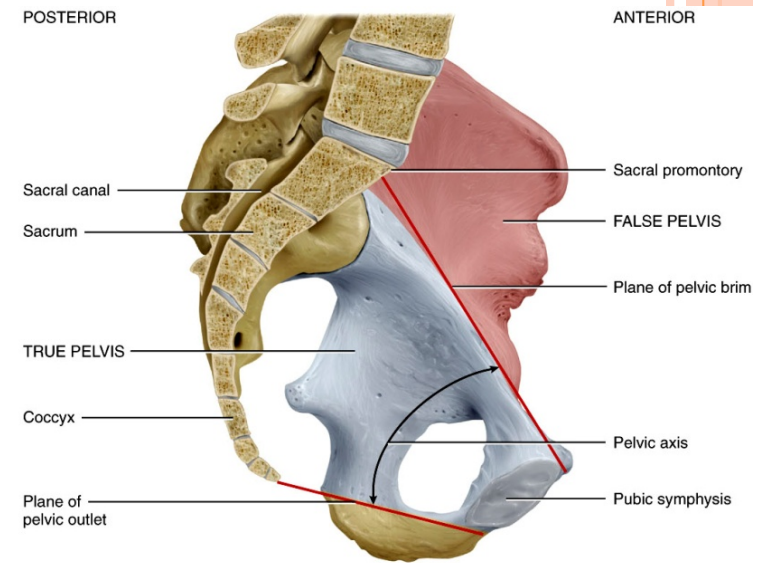


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COMPARING MALE AND FEMALE PELVES

- Males - bones are larger and heavier
- Pelvic inlet is smaller and heart shaped
- Pubic arch is less than 90°
- Female - wider and shallower
- Pubic arch is greater than 90°
- More space in the true pelvis (Table 8.1)

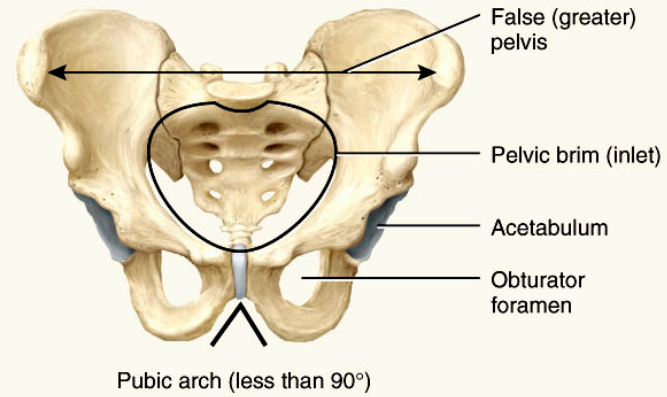
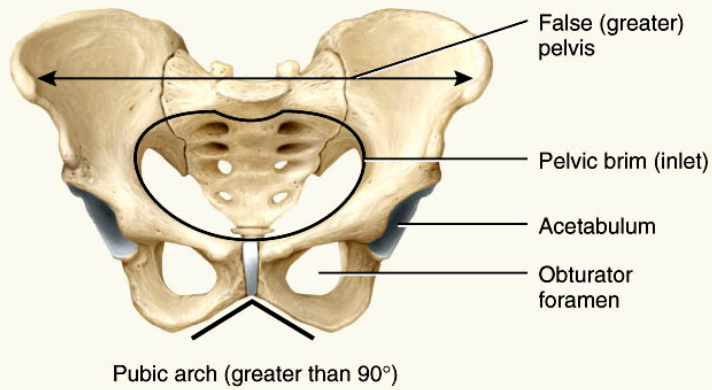


COMPARING MALE AND FEMALE PELVES

TABLE 8.1

Comparison of Female and Male Pelves

POINT OF COMPARISON	FEMALE	MALE
General structure	Light and thin.	Heavy and thick.
False (greater) pelvis	Shallow.	Deep.
Pelvic brim (inlet)	Larger and more oval.	Smaller and heart-shaped.
Acetabulum	Small and faces anteriorly.	Large and faces laterally.
Obturator foramen	Oval.	Round.
Pubic arch	Greater than 90° angle.	Less than 90° angle.



Anterior views

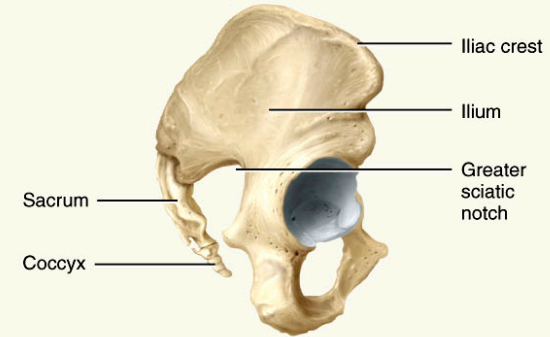
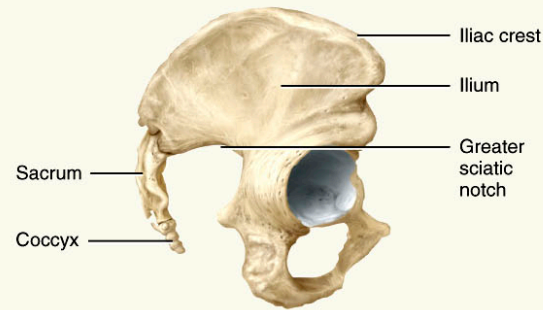
TABLE 8.1 CONTINUES



COMPARING MALE AND FEMALE PELVES

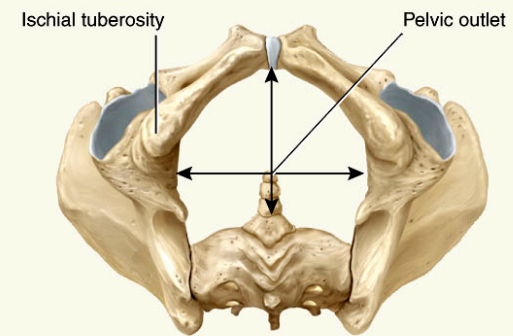
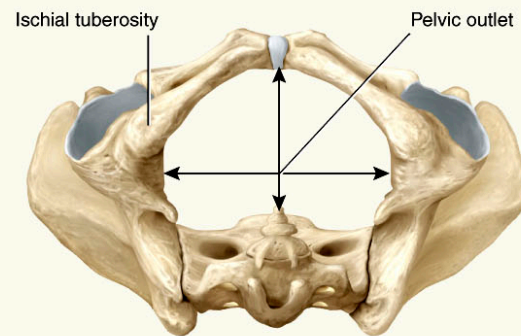
TABLE 8.1 CONTINUED

POINT OF COMPARISON	FEMALE	MALE
Iliac crest	Less curved.	More curved.
Ilium	Less vertical.	More vertical.
Greater sciatic notch	Wide.	Narrow.
Coccyx	More movable and more curved anteriorly.	Less movable and less curved anteriorly.
Sacrum	Shorter, wider (see anterior views), and less curved anteriorly.	Longer, narrower (see anterior views), and more curved anteriorly.



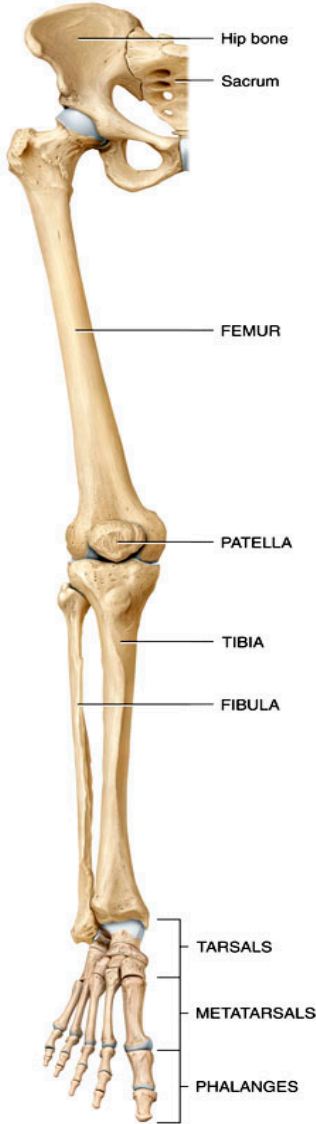
Right lateral views

Pelvic outlet	Wider.	Narrower.
Ischial tuberosity	Shorter, farther apart, and more medially projecting.	Longer, closer together, and more laterally projecting.



Inferior views

RIGHT LOWER LIMB



Anterior view of lower limb

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SKELETON OF THE THIGH - FEMUR AND PATELLA

- Femur - longest, heaviest, and strongest bone in the body
- Proximally, the head articulates with the acetabulum of the hip bone forming the hip (coxal) joint
- Neck - distal to head, common site of fracture
- Distally, the medial and lateral condyles articulate with the condyles of the tibia forming the knee joint
- Also articulates with patella



FEMUR

- Greater and lesser trochanters are projections where large muscles attach
- Gluteal tuberosity and linea aspera - attachment sites for the large hip muscles
- Intercondylar fossa - depression between the condyles
- Medial and lateral epicondyles - muscle site attachments for the knee muscles



RIGHT FEMUR

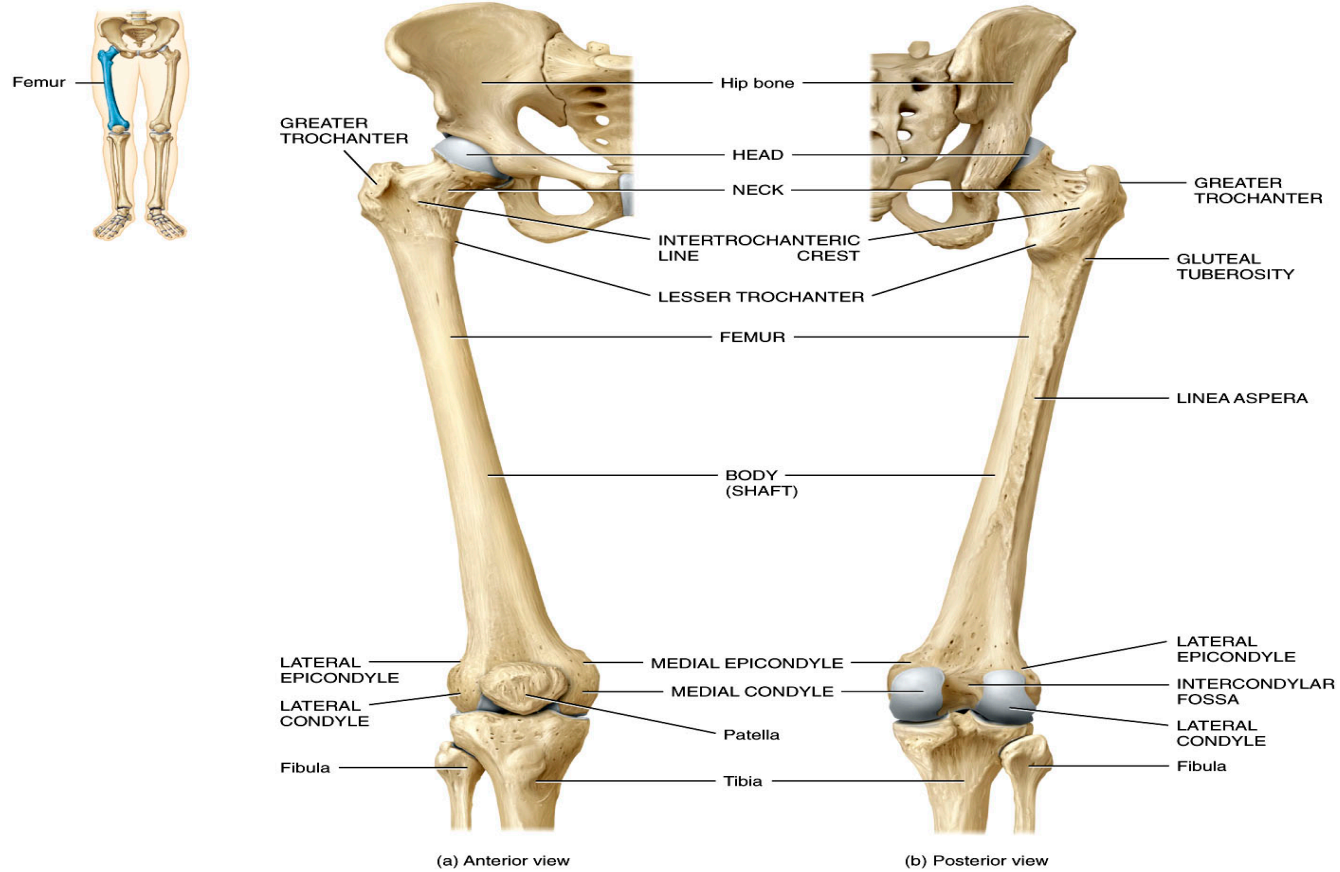


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PATELLA

- Largest sesamoid bone in the body
- Forms the patellofemoral joint
- Superior surface is the base
- Inferior, narrower surface is the apex
- Thick articular cartilage lines the posterior surface
- Increases the leverage of the quadriceps femoris muscle
- Patellofemoral stress syndrome - “runner’s knee”



PATELLA

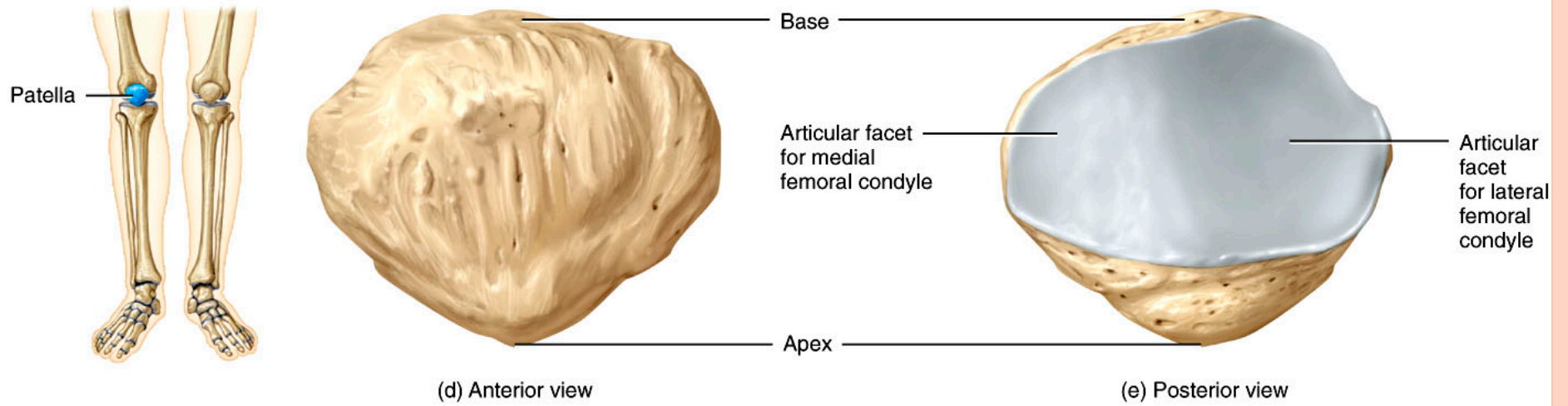


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TIBIA (SHIN BONE)

- The larger, medial weight-bearing bone of the leg
- The lateral and medial condyles at the proximal end articulate with the femur
- It articulates distally with the talus and fibula
- Tibial tuberosity - attachment site for the patellar ligament
- Medial malleolus - medial surface of distal end (medial surface of ankle joint)

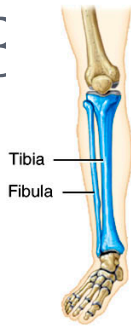


FIBULA

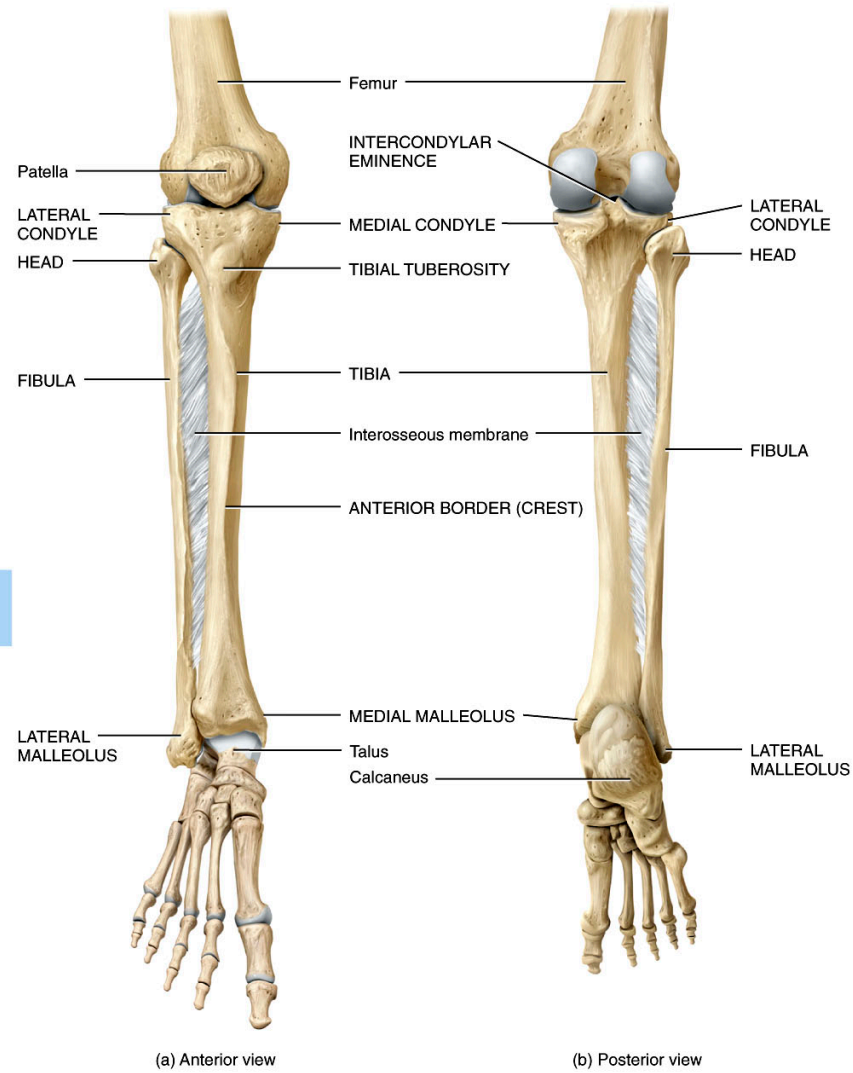
- The smaller, laterally placed bone of the leg
- Non-weight bearing
- The head forms the proximal tibiofibular joint
- Lateral malleolus - distal end, articulates with the tibia and the talus at the ankle



TIE



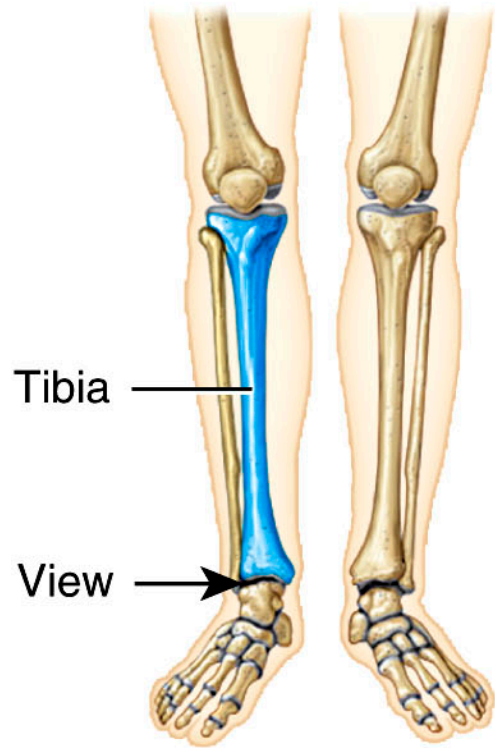
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MNEMONIC for location of tibia and fibula:
The fibu**LA** is **LA**teral.

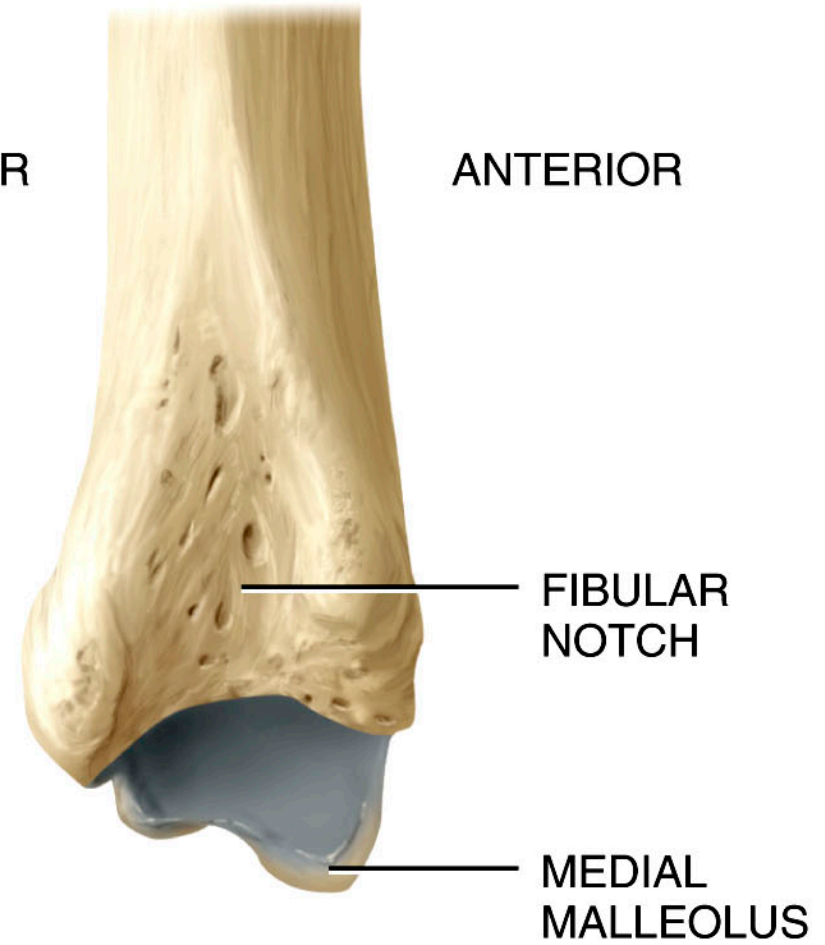
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POSTERIOR

ANTERIOR



(c) Lateral view of distal end of tibia

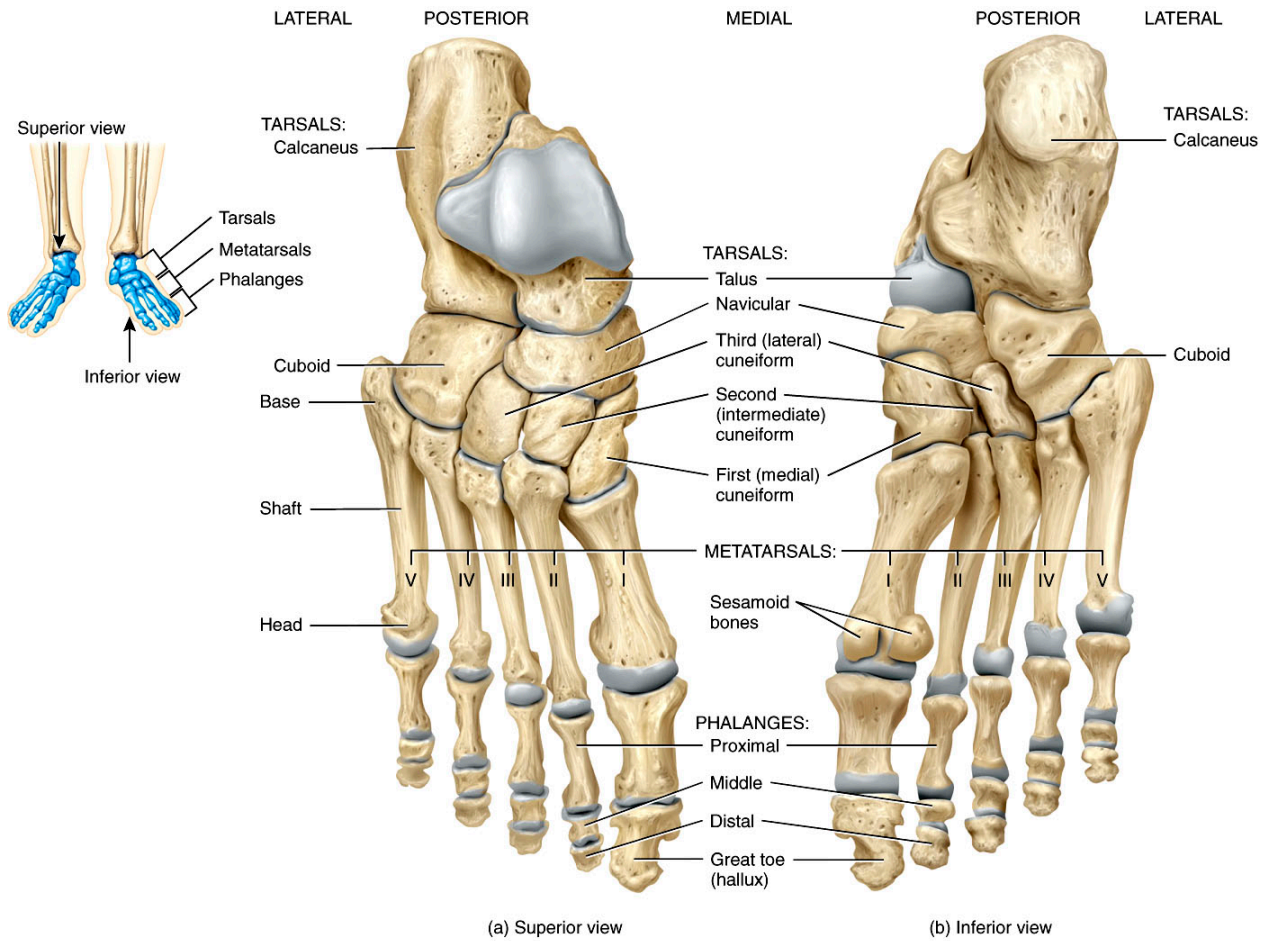


SKELETON OF THE FOOT - TARSALS, METATARSALS, AND PHALANGES

- Seven tarsal bones - talus (articulates with tibia and fibula), calcaneus (the heel bone, the largest and strongest), navicular, cuboid and three cuneiforms
- Five metatarsals - (I-V) base, shaft, head
- 14 phalanges (big toe is the hallux)
- Tarsus = ankle



RIG



MNEMONIC for tarsal bones:

Tall	Centers	Never	Take	Shots	From	Corners.
Talus	Calcaneus	Navicular	Third cuneiform	Second cuneiform	First cuneiform	Cuboid

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ARCHES OF THE FOOT

- Two arches support the weight of the body
- Provide spring and leverage to the foot when walking
- The arches flex when body weight applied
- Flatfoot - the arches decrease or “fall”
- Clawfoot - too much arch occurs due to various pathologies



ARCHES OF THE FOOT - FIGURE

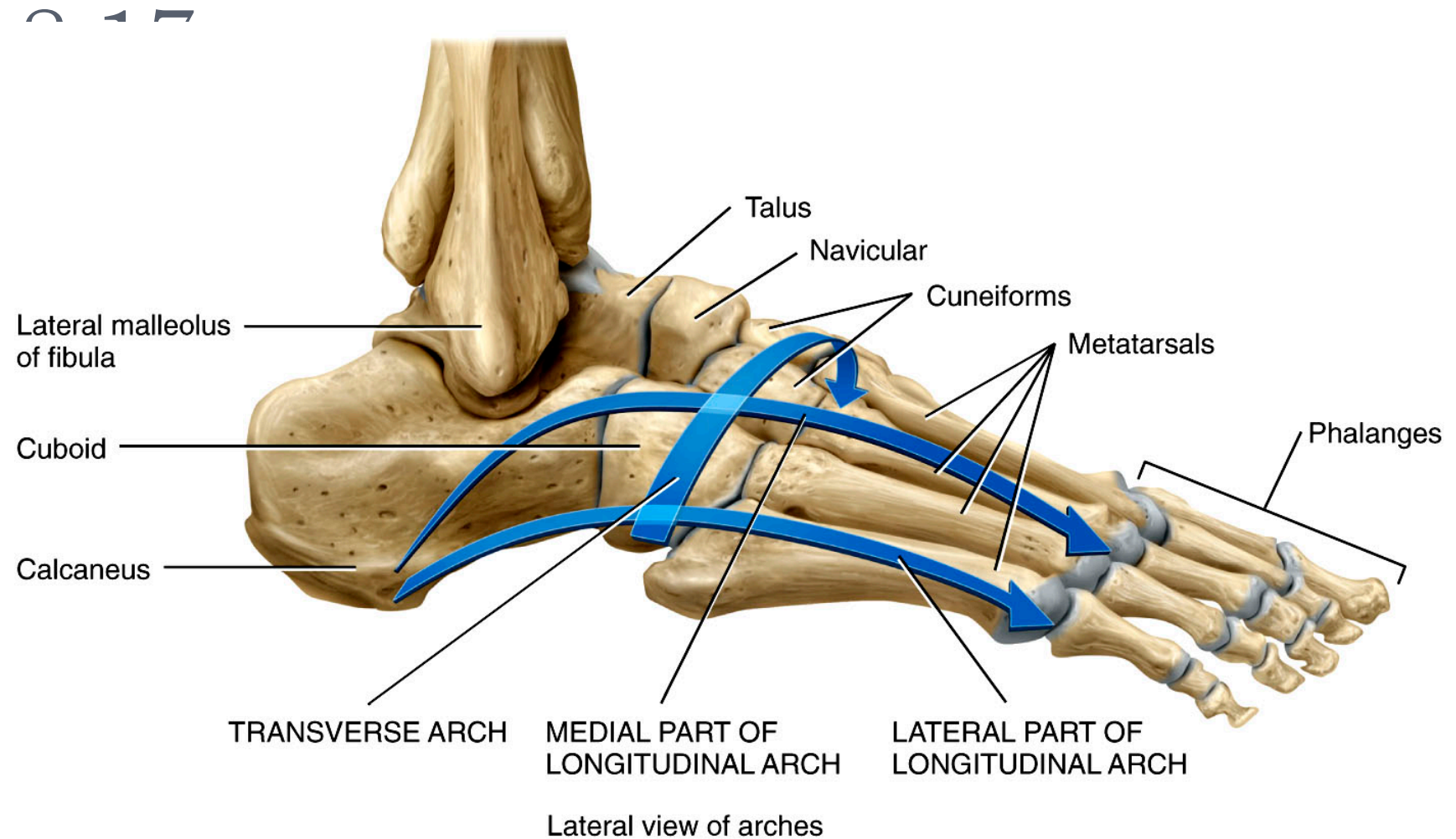


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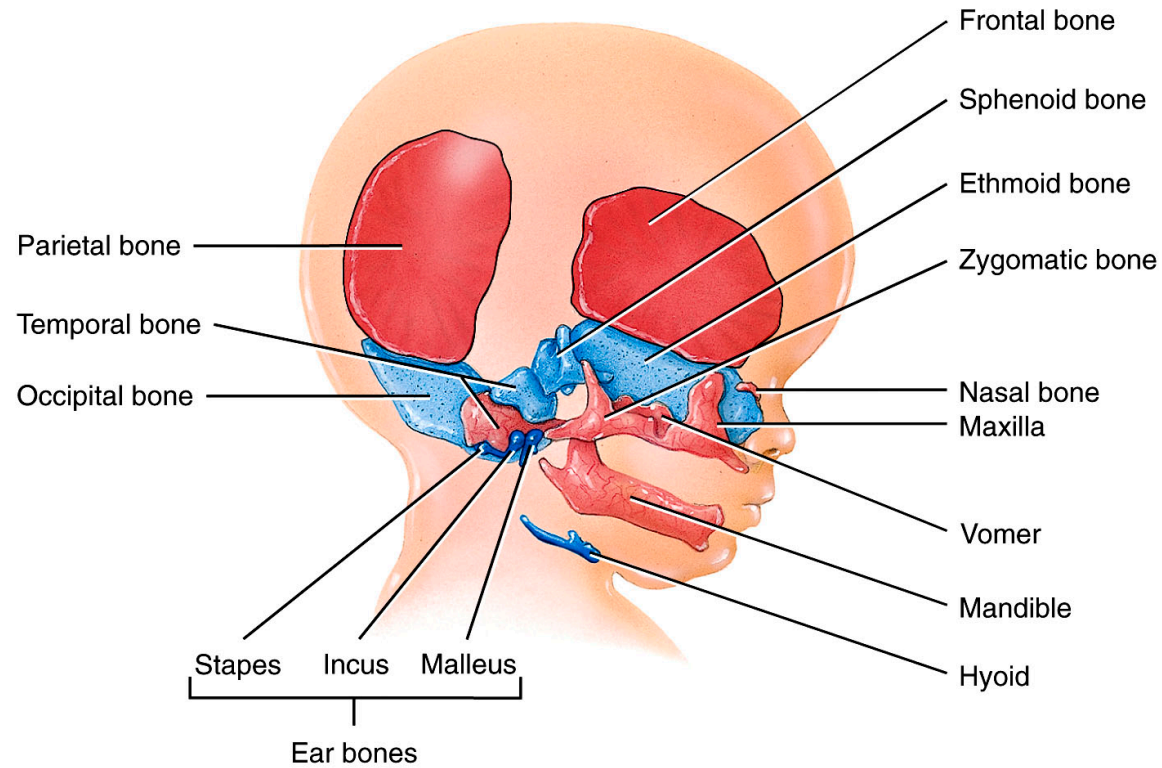


DEVELOPMENT OF THE SKELETAL SYSTEM

- Most skeletal tissue arises from mesenchymal cells
- The skull develops during the fourth week after fertilization
- Fontanelles are the spaces between the skull bones during fetal life and infancy
- Upper limb buds form during the fourth week after fertilization followed by the lower limb buds
- During the sixth week, hand plates and foot plates form
- Vertebrae and ribs are formed from sclerotomes of somites
- Failure of proper development of the vertebral arches leads to *spina bifida*



DEVELOPMENT OF THE SKELETAL SYSTEM

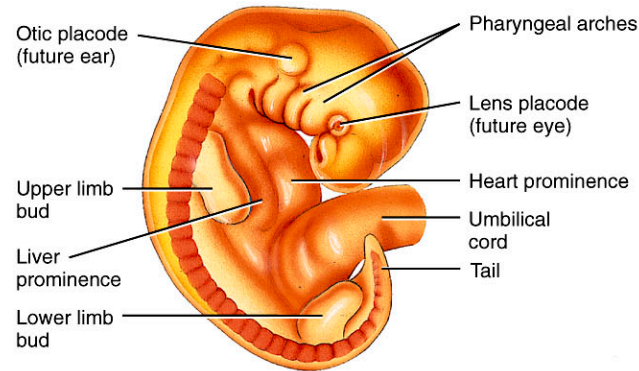


(a) Development of the skull

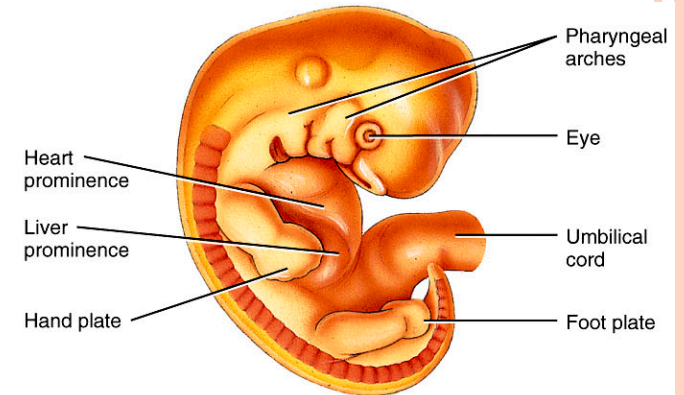
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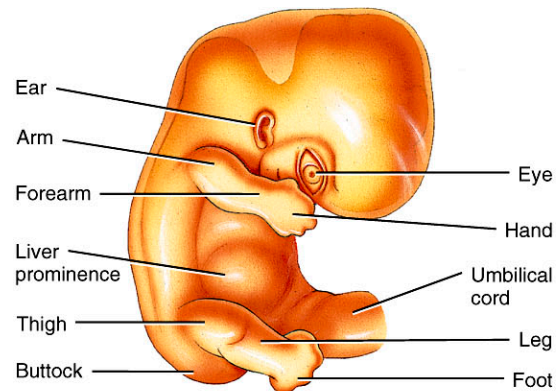
DEVELOPMENT OF THE SKELETAL SYSTEM



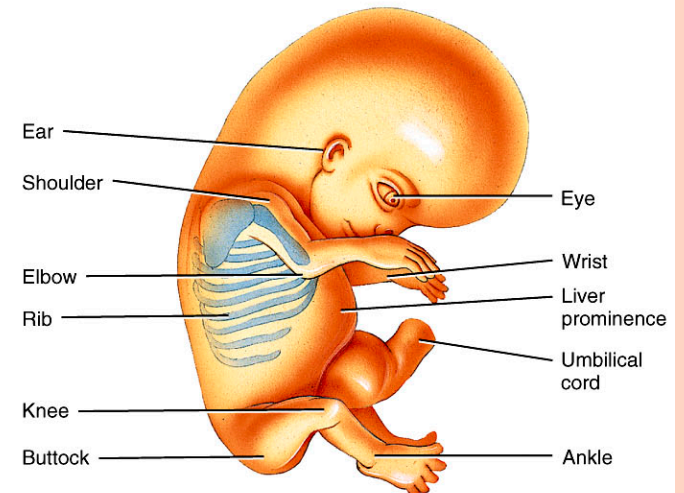
(b) Four-week embryo showing development of limb buds



(c) Six-week embryo showing development of hand and foot plates



(d) Seven-week embryo showing development of arm, forearm, and hand in upper limb bud and thigh, leg, and foot in lower limb bud



(e) Eight-week embryo in which limb buds have developed into upper and lower limbs

KEY CLINICAL TERMS

- **Osteoarthritis:** A localized degeneration of articular cartilage. It is not really considered true arthritis since inflammation is not the primary symptom.
- **Slipped Discs:** Herniation of the *nucleus pulposus* of an intervertebral disc.
- **Dislocation:** Displacement of bone away from its natural articulation with another.
- **Arthritis:** An inflammatory joint disease, usually associated with the synovial membrane and the articular cartilage. In certain types of arthritis, mineral deposits may form.
- **Sprain:** Straining or tearing of the ligaments and/or tendons of a joint.



KEY CLINICAL TERMS

- **Kyphosis:** Also known as “humpback” is an abnormal posterior convexity of the lower vertebral column.
- **Lordosis:** Excessive anteroposterior curvature of the vertebral column, generally in the lumbar region, resulting in a “hollow back” or “saddle back.”
- **Scoliosis:** Excessive lateral deviation of the vertebral column.





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