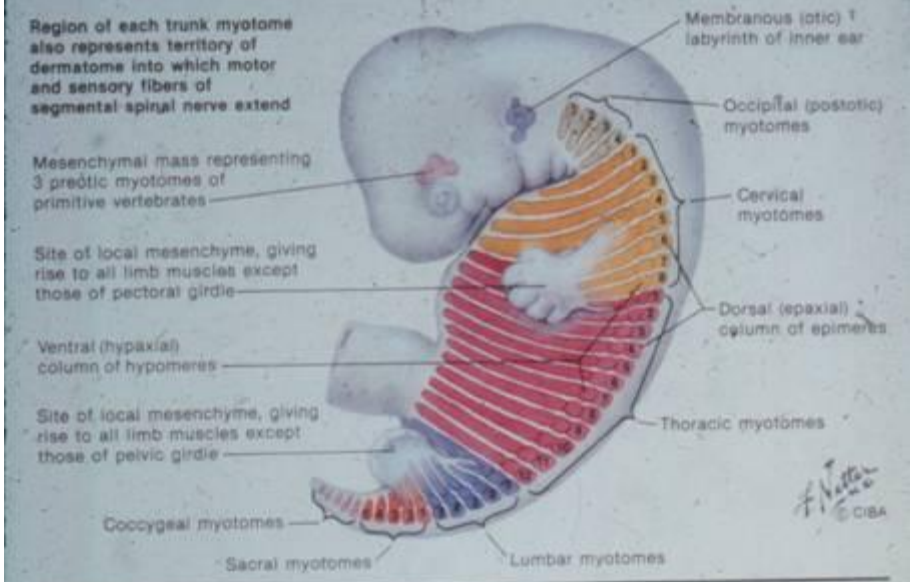
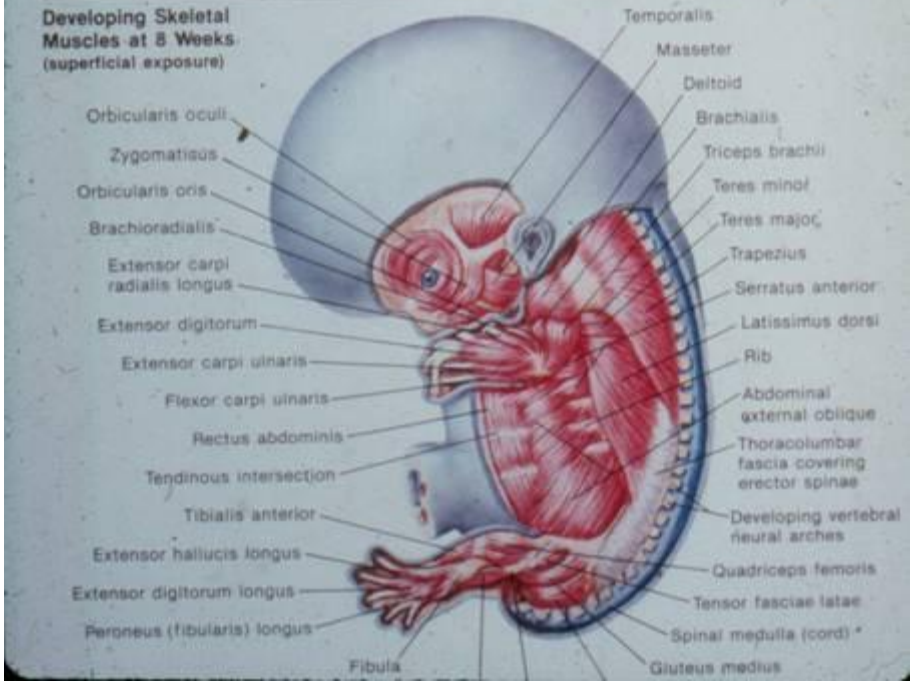
Biology 323
Human Anatomy for Biology Majors
Lecture 4
Dr. Stuart S. Sumida

Appendicular Skeleton

Segmental Distribution of Myotomes in Fetus of 6 Weeks



Developing Skeletal Muscles at 8 Weeks (superficial exposure)



Changes in Position of Limbs Before Birth

A. At 5 weeks. Upper and lower limbs have formed as finlike appendages pointing laterally and caudally

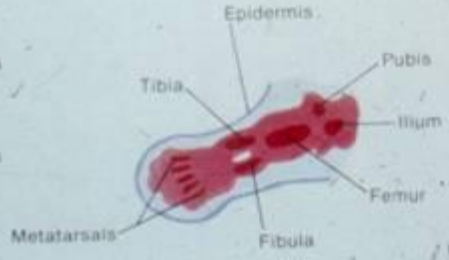
B. At 6 weeks. Limbs bend anteriorly, so elbows and knees point laterally, palms and soles face trunk

C. At 7 weeks. Upper and lower limbs have undergone 90° torsion about their long axes, but in opposite directions; so elbows point caudally and knees cranially

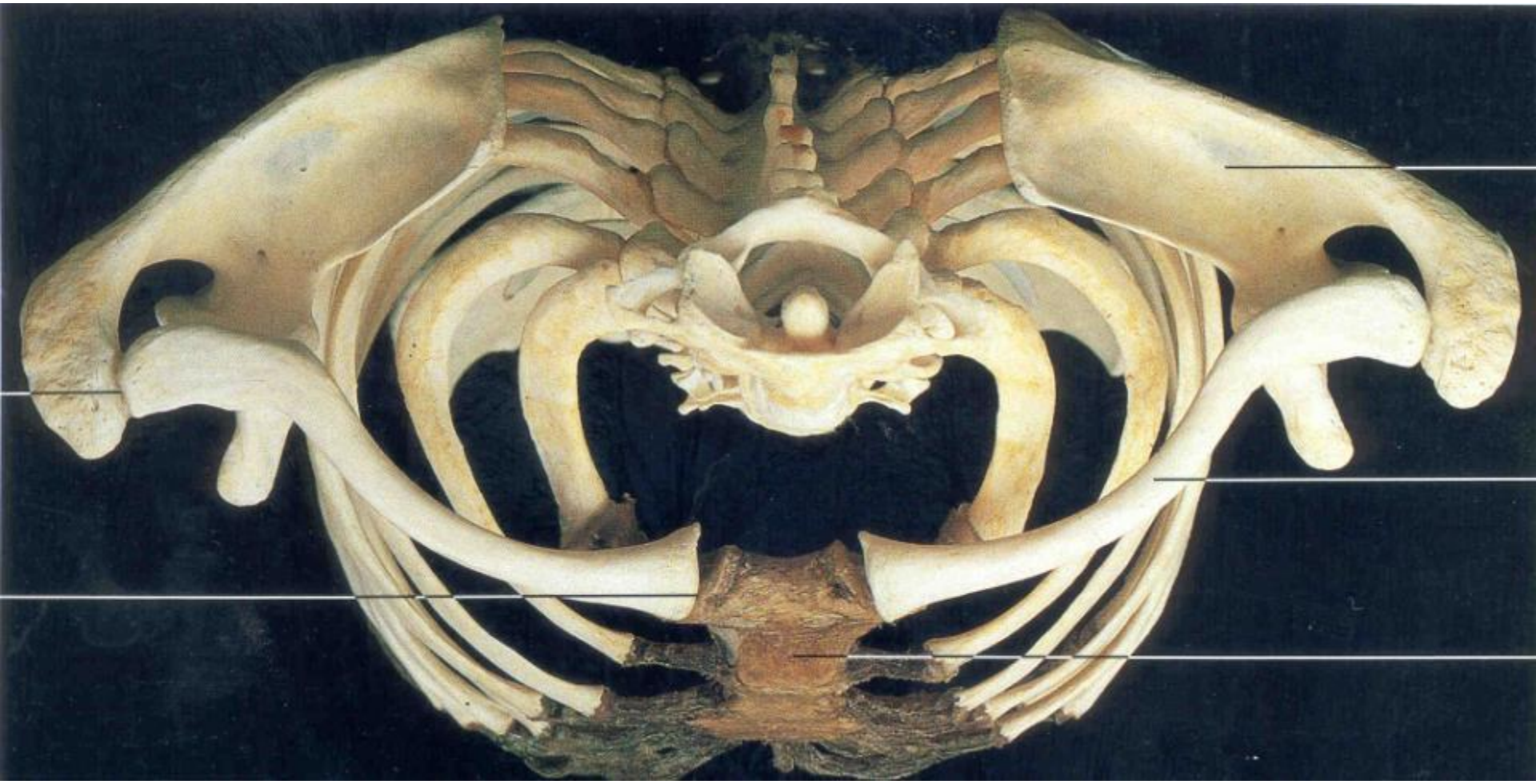
D. At 8 weeks. Torsion of lower limbs results in twisted or "barber pole" arrangement of their cutaneous innervation

Precartilage Mesenchymal Cell Concentrations of Appendicular Skeleton at 6th Week

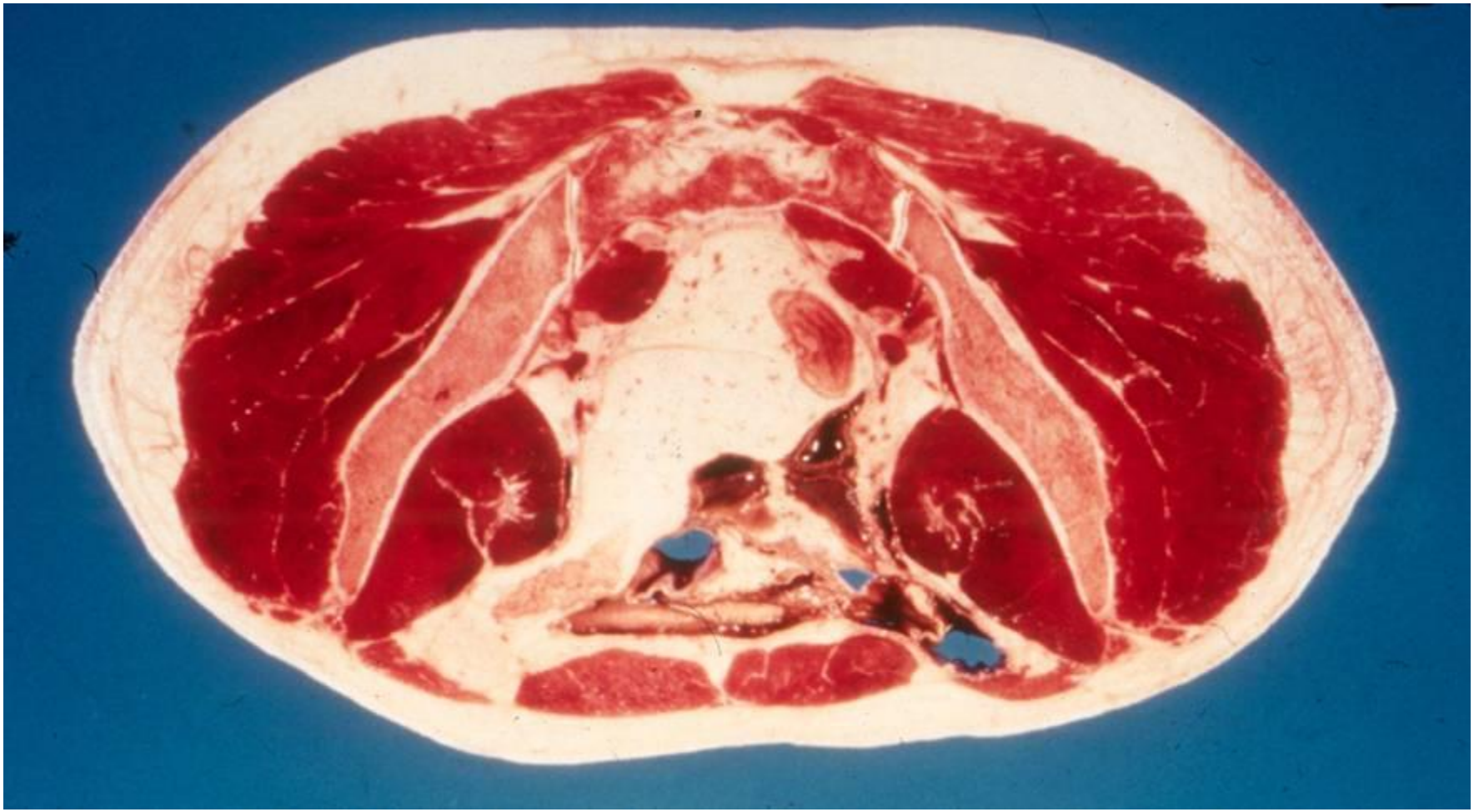
A. Upper limb

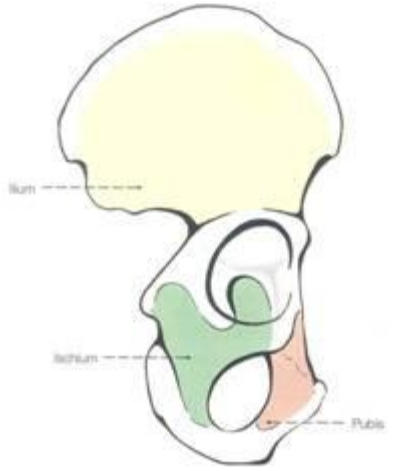


B. Lower limb




T3,4

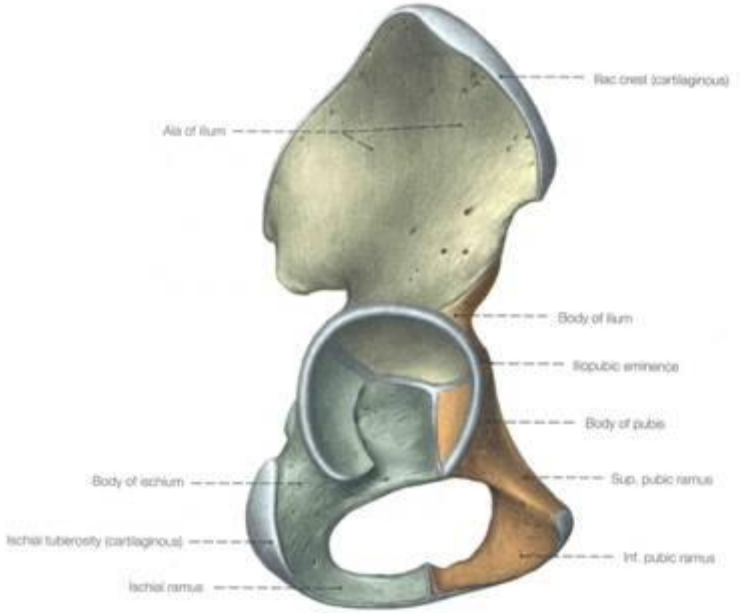




The right hip bone in a drawing showing the extent of its three osseous parts in a newborn, lateral aspect (110%).

The right hip bone in a drawing showing the extent of its three osseous parts at different ages, lateral aspect.

* At about 6 years of age



The right hip bone, developmental state in a 6-year-old child, lateral aspect (90%).

The three parts of the hip bone are connected with each other in the region of the acetabulum in a Y-shaped cartilaginous junction, which undergoes synostosis at about 13–18 years of age.

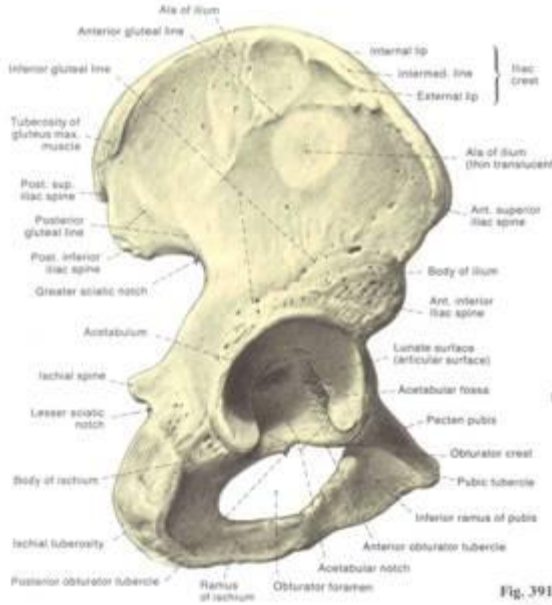


Fig. 389: Lateral View of the Adult Right Hip Bone

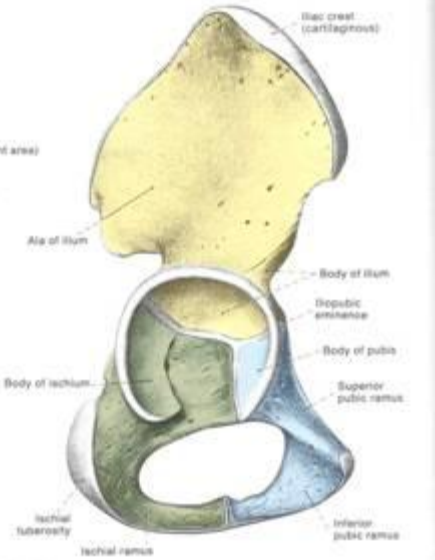


Fig. 391: Hip Bone of 5 Year Old Child: Lateral View

NOTE that the hip bone is formed by a fusion of the ilium (yellow), ischium (green) and pubis (blue). Although ossification of the inferior pubic ramus occurs during the 7th or 8th year, complete fusion of the three bones at the acetabulum occurs sometime between the 15th and 20th year.

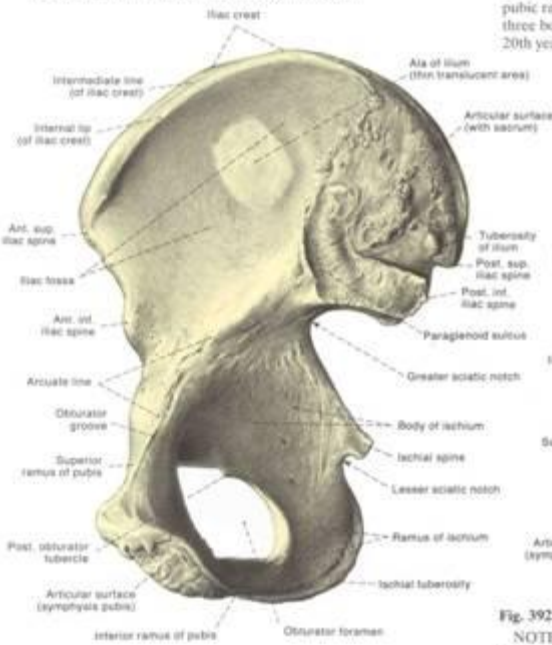


Fig. 390: Medial View of the Adult Right Hip Bone

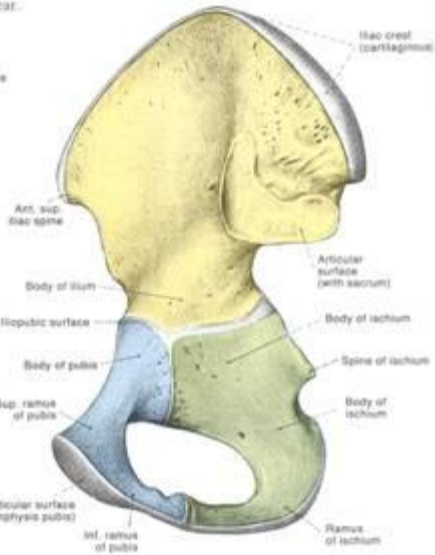
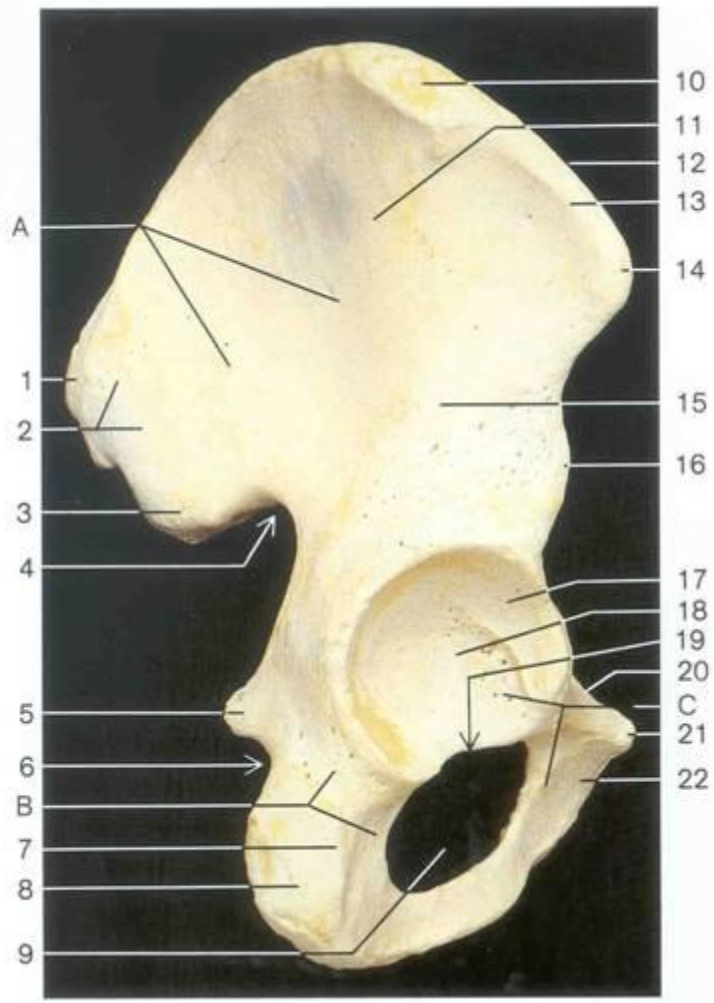
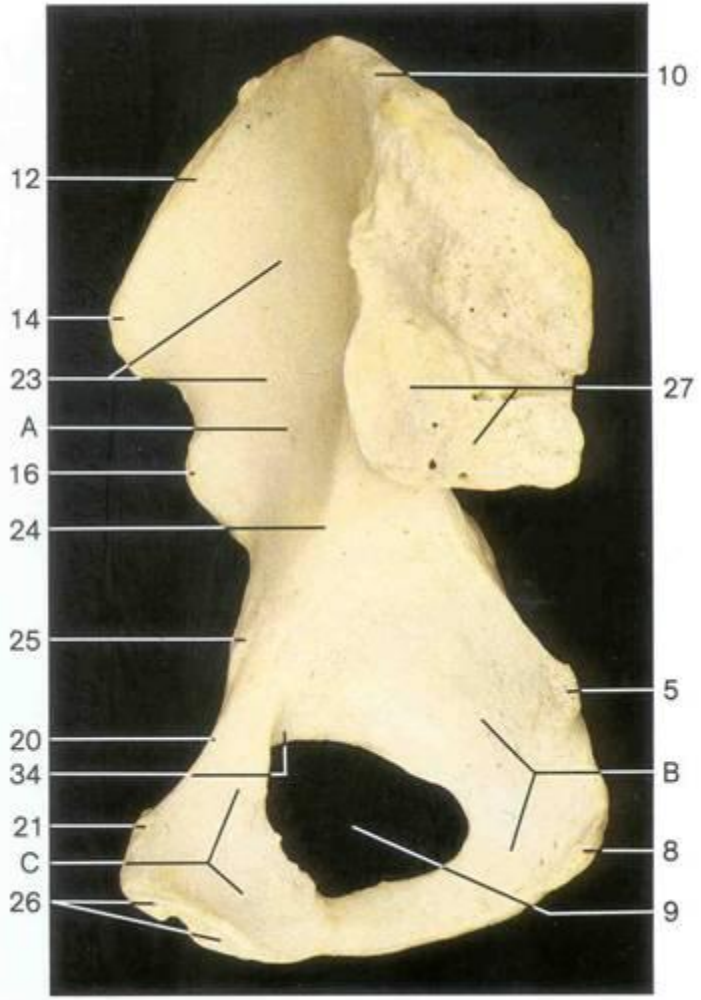
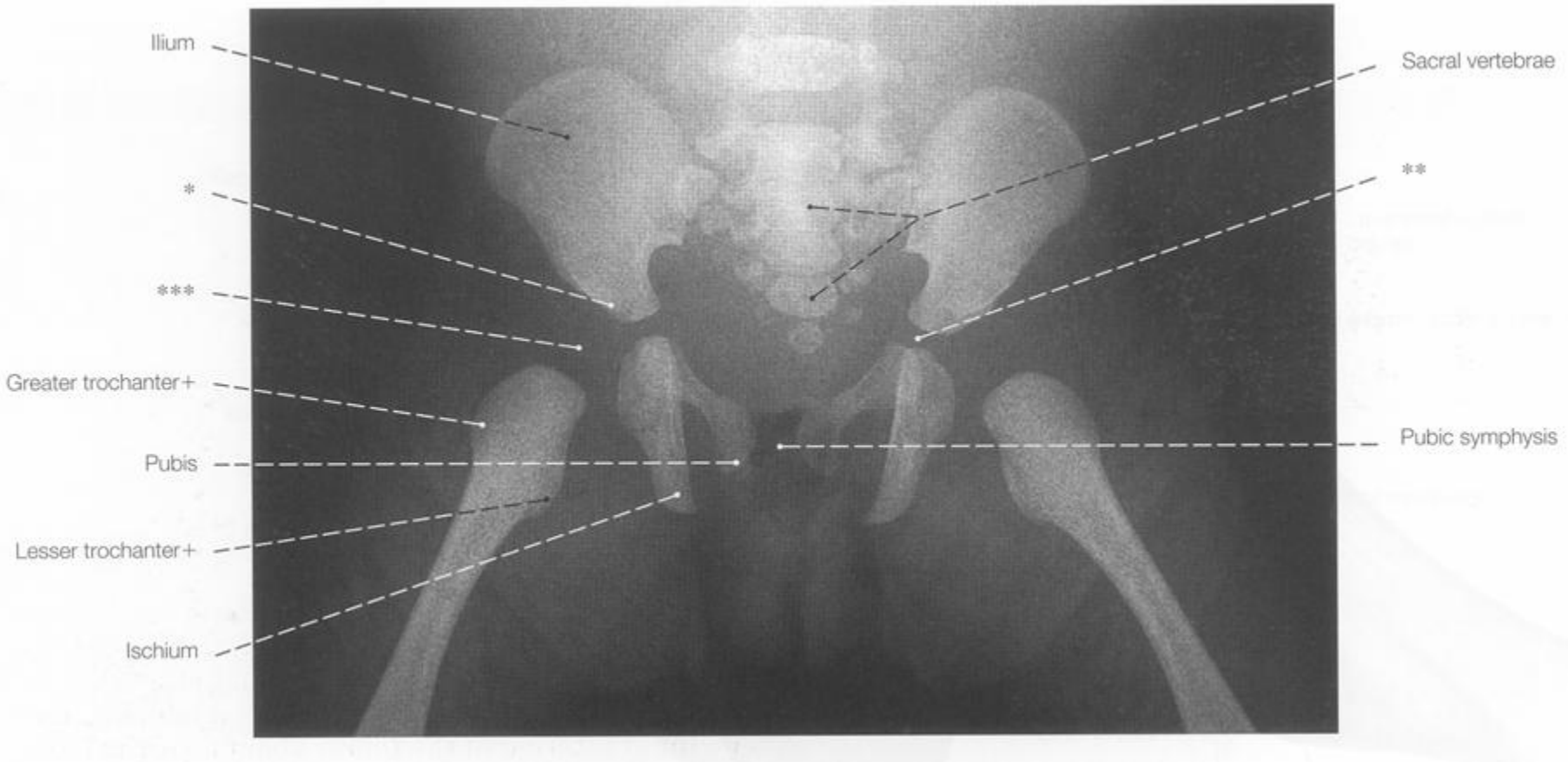


Fig. 392: Hip Bone of 5 Year Old Child: Medial View

NOTE the lines of fusion of the three bones above the obturator foramen and the fusion of the inferior pubic ramus and the ischial ramus below that foramen.

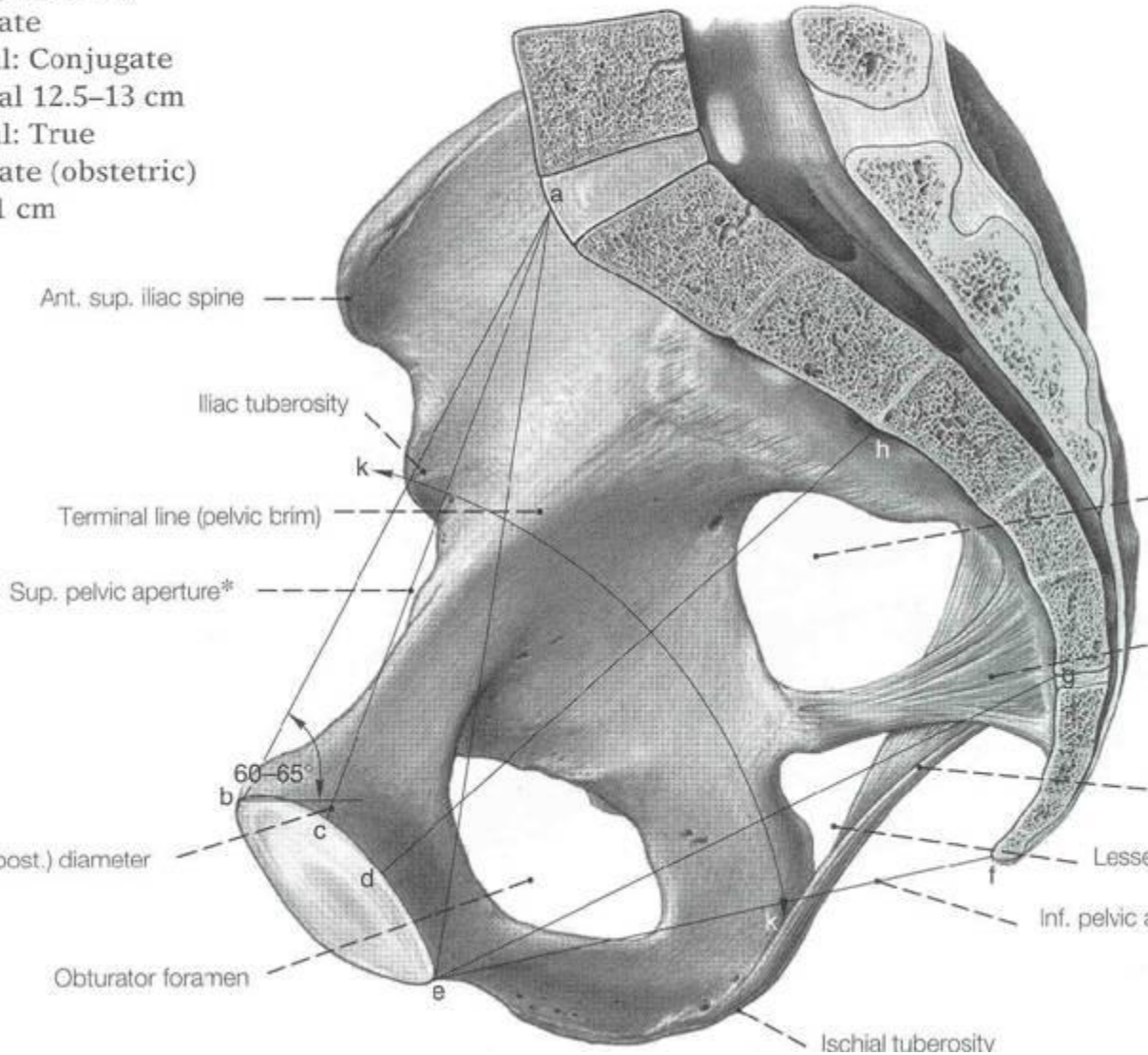

10
11
12
13
A
14
1
15
2
16
3
4
17
18
19
20
5
C
21
6
22
B
7
8
9

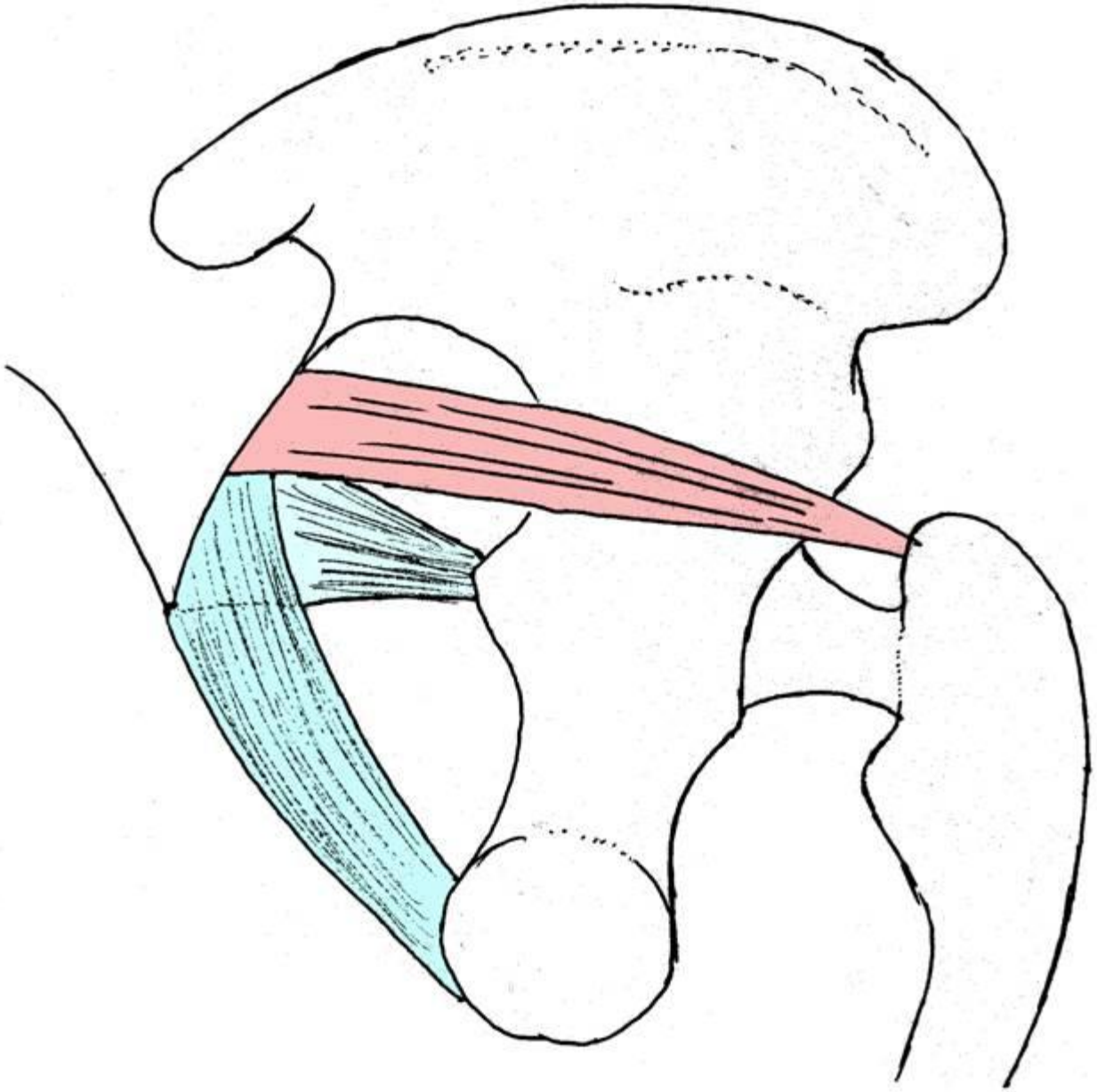

10
12
14
23
27
A
16
24
25
5
20
34
B
21
8
C
26
9

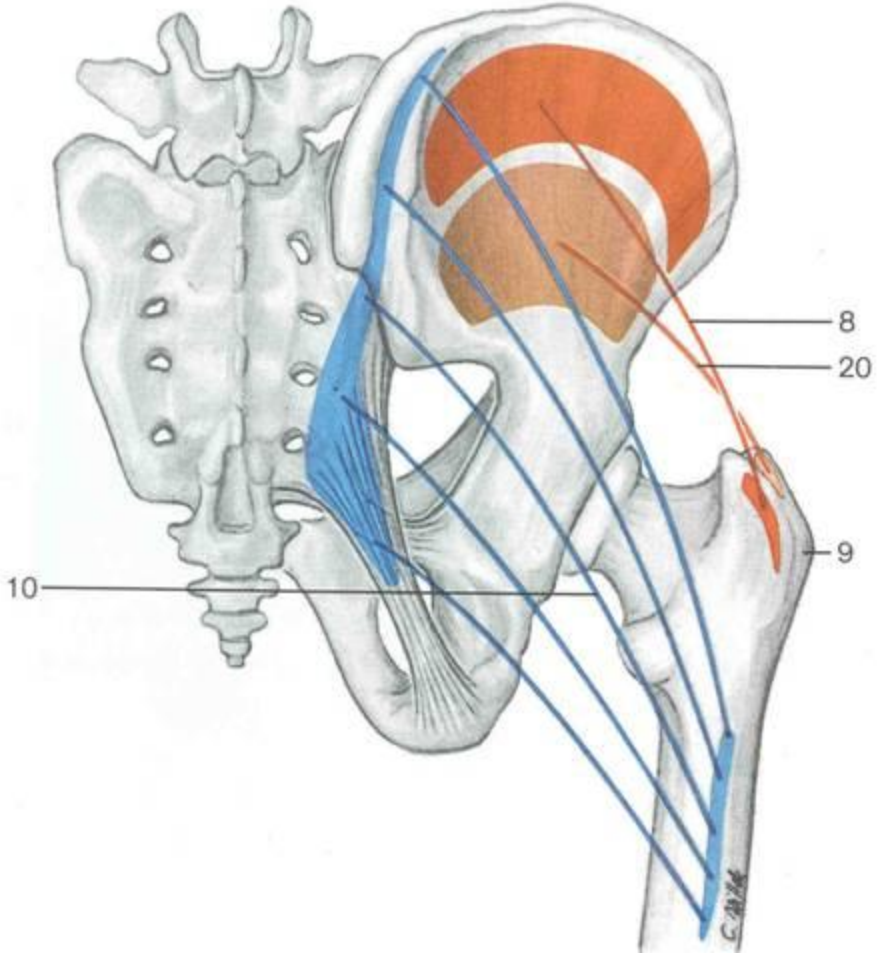

Ilium
*
***
Greater trochanter+
Pubis
Lesser trochanter+
Ischium
Sacral vertebrae
**
Pubic symphysis

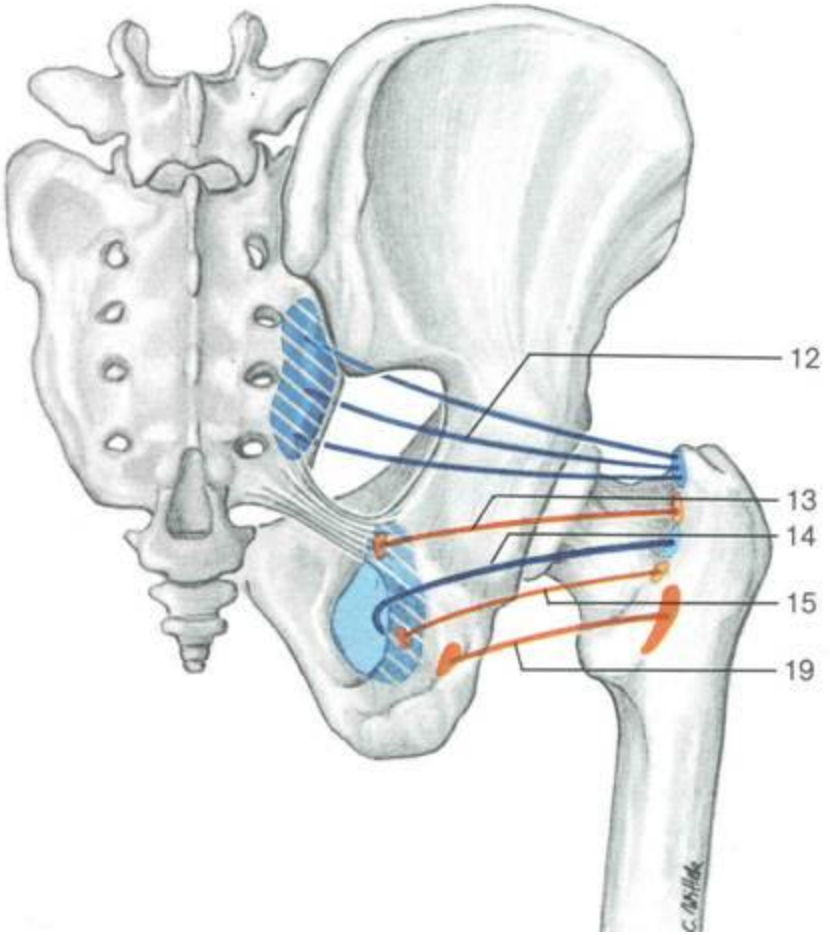
k–k = Pelvic axis
a–b = Clinical: Anatomical (true, anteroposterior) conjugate
a–e = Clinical: Conjugate diagonal 12.5–13 cm
a–c = Clinical: True conjugate (obstetric) 10.4–11 cm

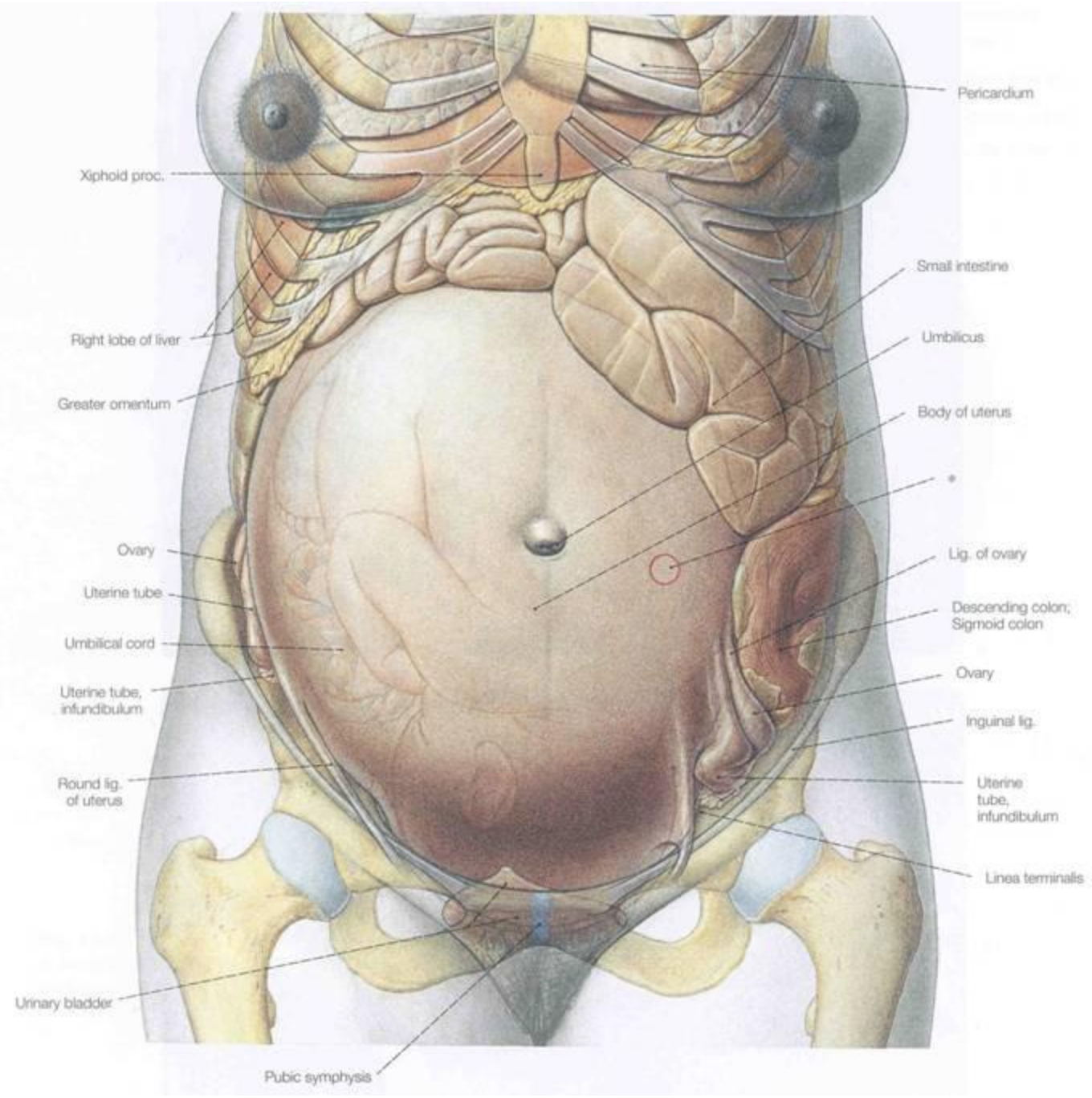
h–d = Clinical: Sagittal diameter of the pelvic brim 12–12.5 cm
e–g = Clinical: Sagittal diameter of the pelvic constriction 11–11.5 cm
e–f = Sagittal diameter of the inferior pelvic aperture (= pubococcygeal distance) 9–10 cm

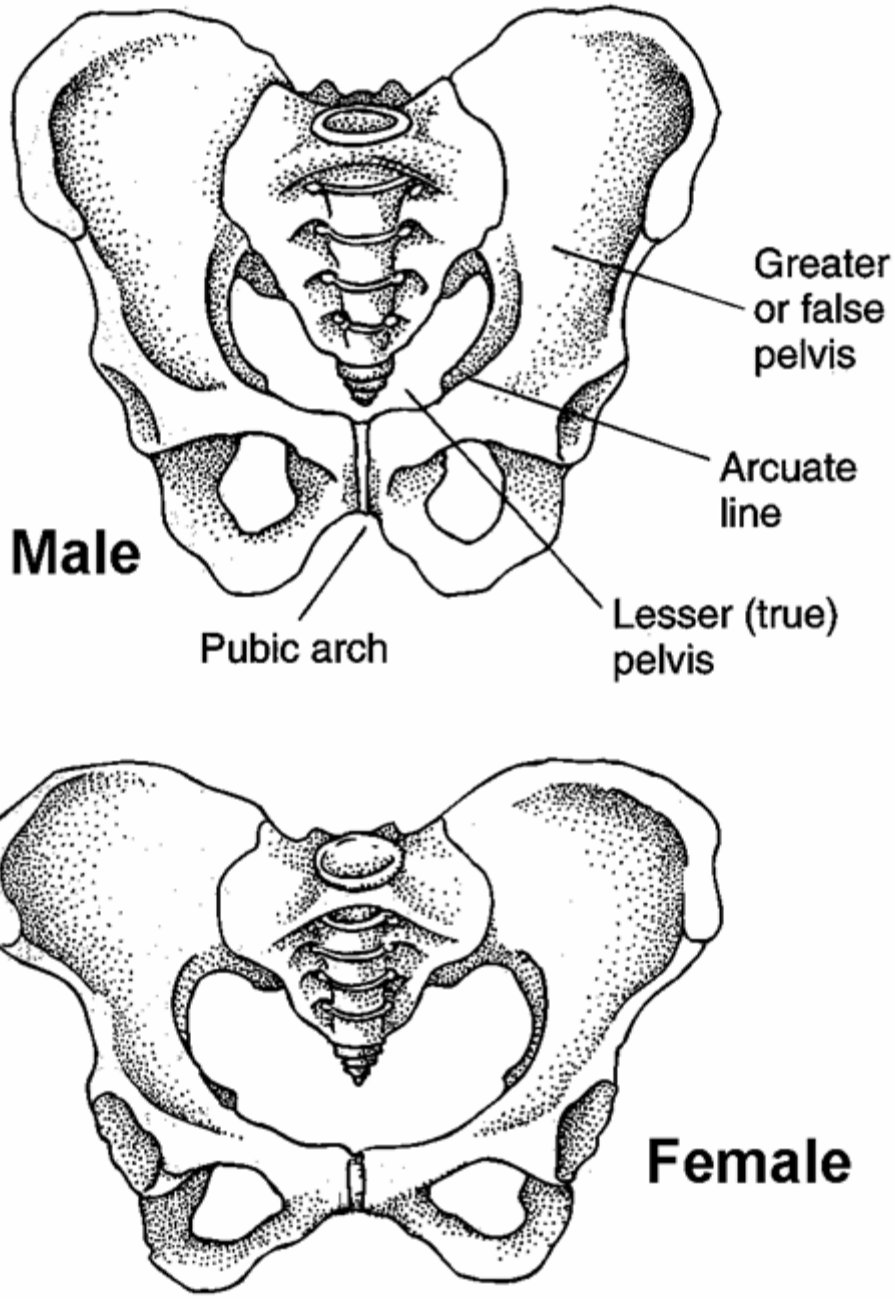




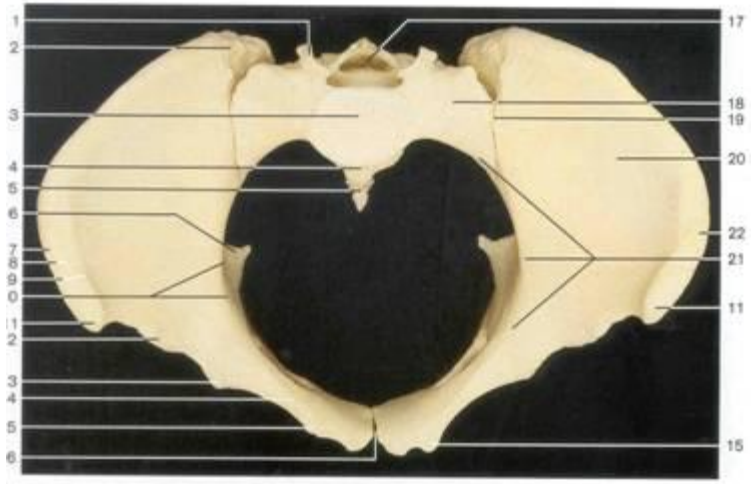

8
20
9
10


12
13
14
15
19

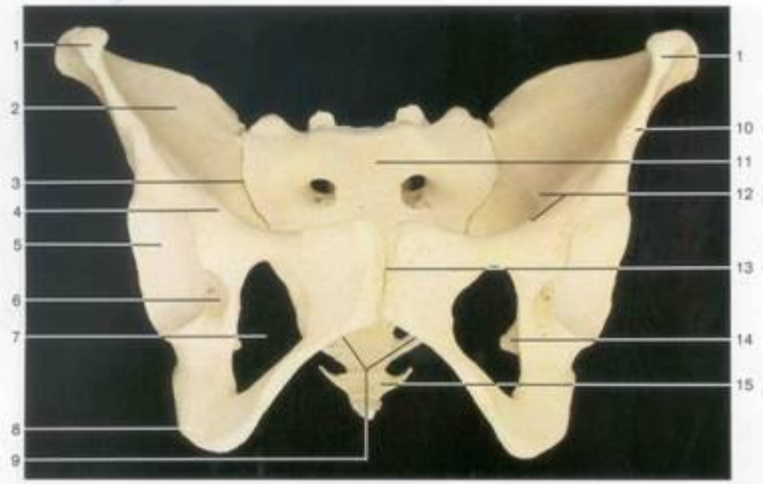

Pericardium
Xiphoid proc.
Small intestine
Right lobe of liver
Umbilicus
Greater omentum
Body of uterus
Ovary
Lig. of ovary
Uterine tube
Descending colon;
Sigmoid colon
Umbilical cord
Ovary
Uterine tube,
infundibulum
Inguinal lig.
Round lig.
of uterus
Uterine
tube,
infundibulum
Linea terminalis
Urinary bladder
Pubic symphysis


Greater or false pelvis
Arcuate line
Male
Lesser (true) pelvis
Pubic arch
Female

Female



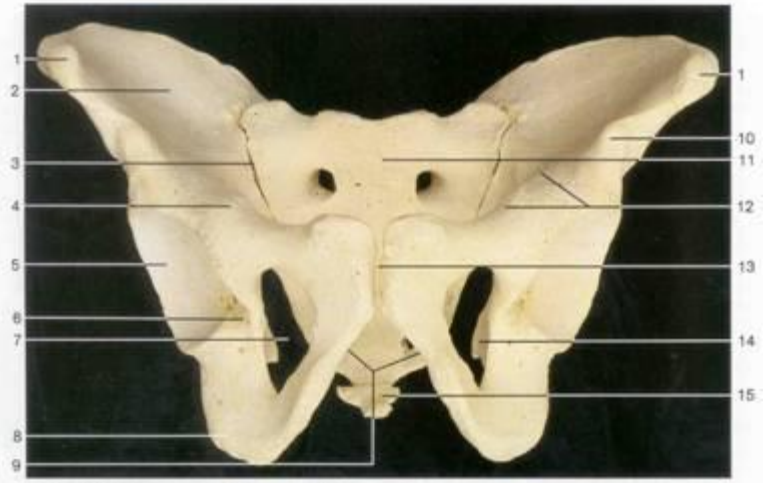
Female pelvis (superior aspect). Note the differences between the male and the female pelvis, predominantly in the form and dimensions of the sacrum, the superior and inferior apertures and the alae of the ilium.



Female pelvis (anterior aspect). Note the differences between the form and dimensions of the male and the female pelvis. The female pubic arch is wider than the male. The obturator foramen in the female pelvis is triangular, while that in the male pelvis is ovoid.

Male

Male pelvis (superior aspect). Compare with the female pelvis (depicted above).

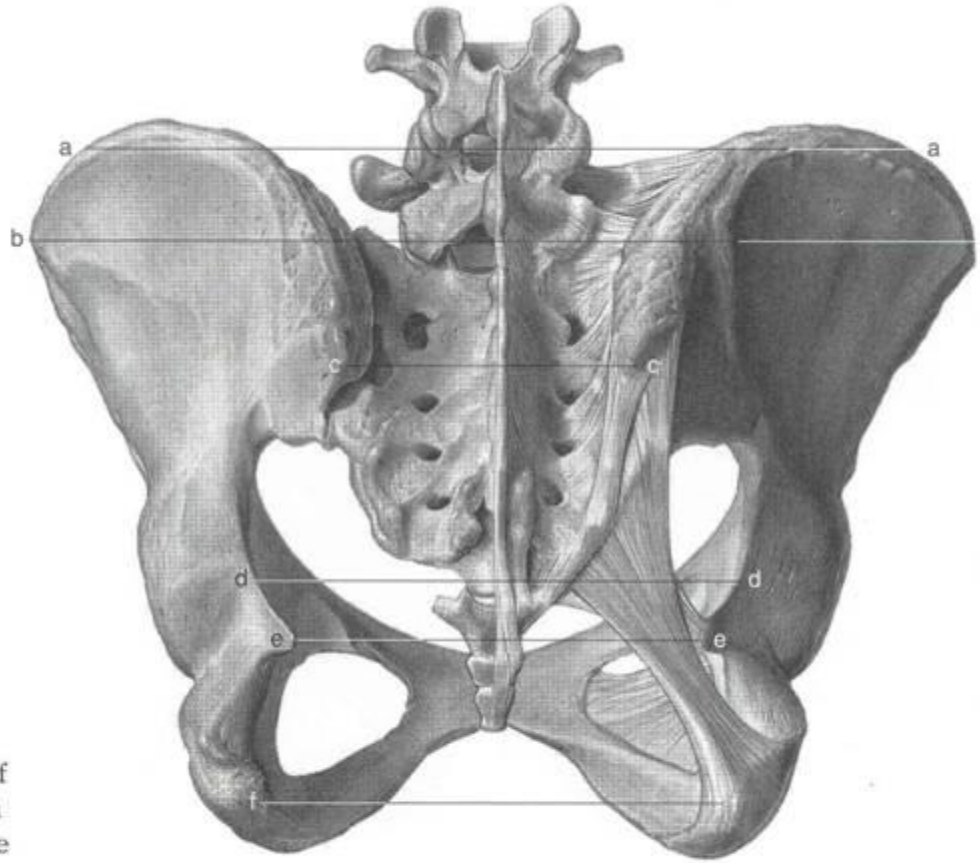


Male pelvis (anterior aspect). Compare with foregoing figure.

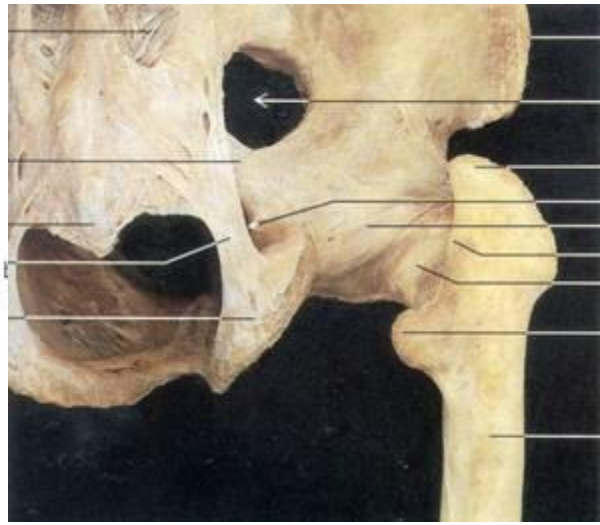
1 Superior articular process of sacrum
2 Posterior superior iliac spine
3 Base of sacrum
4 Sacral promontory
5 Coccyx
6 Ischial spine
7 External lip
8 Intermediate line
9 Internal lip
(of iliac crest)
10 Arcuate line
11 Anterior superior iliac spine
12 Anterior inferior iliac spine
13 Iliopubic eminence
14 Pecten pubis
15 Pubic tubercle
16 Pubic symphysis
17 Sacral canal
18 Ala of sacrum
19 Position of sacroiliac joint
20 Iliac fossa
21 Linea terminalis
22 Iliac crest

1 Anterior superior iliac spine
2 Iliac fossa
3 Position of sacroiliac joint
4 Iliopubic eminence
5 Lunate surface of acetabulum
6 Acetabular notch
7 Obturator foramen
8 Ischial tuberosity
9 Pubic arch
10 Anterior inferior iliac spine
11 Sacrum
12 Linea terminalis (at margin of superior aperture)
13 Pubic symphysis
14 Ischial spine
15 Coccyx

a–a = Crestal distance 28–29 cm*
b–b = Spinal distance 25–26 cm*
c–c = Post. spinal diameter (width of the sacrum) 10 cm
* In perspective, the crestal distance appears shorter than the spinal distance



The pelvis, dimensions in the female, dorsal aspect



d–d = Transverse diameter of the pelvic brim (= interacetabular line) 12–12.5 cm
e–e = Transverse diameter of the pelvic constriction (=interspinal line) 10.5 cm
f–f = Transverse diameter of the inferior pelvic aperture (= tuberal diameter) 11–12 cm

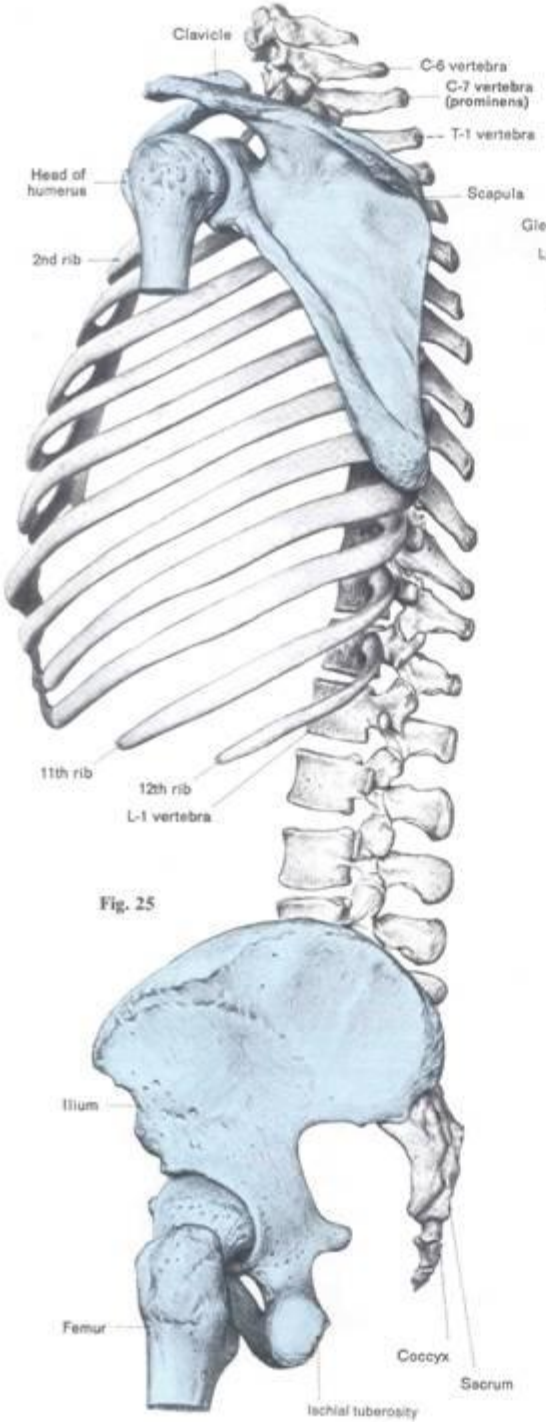


Fig. 25

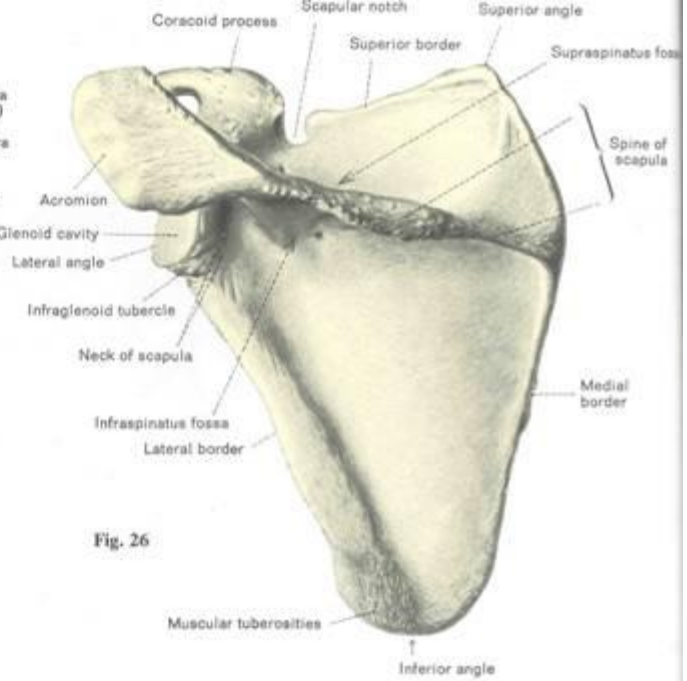


Fig. 26

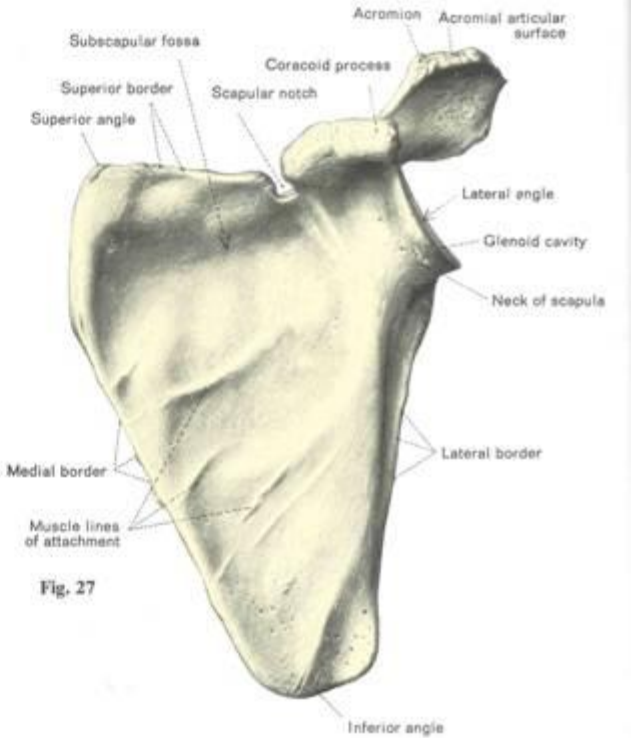
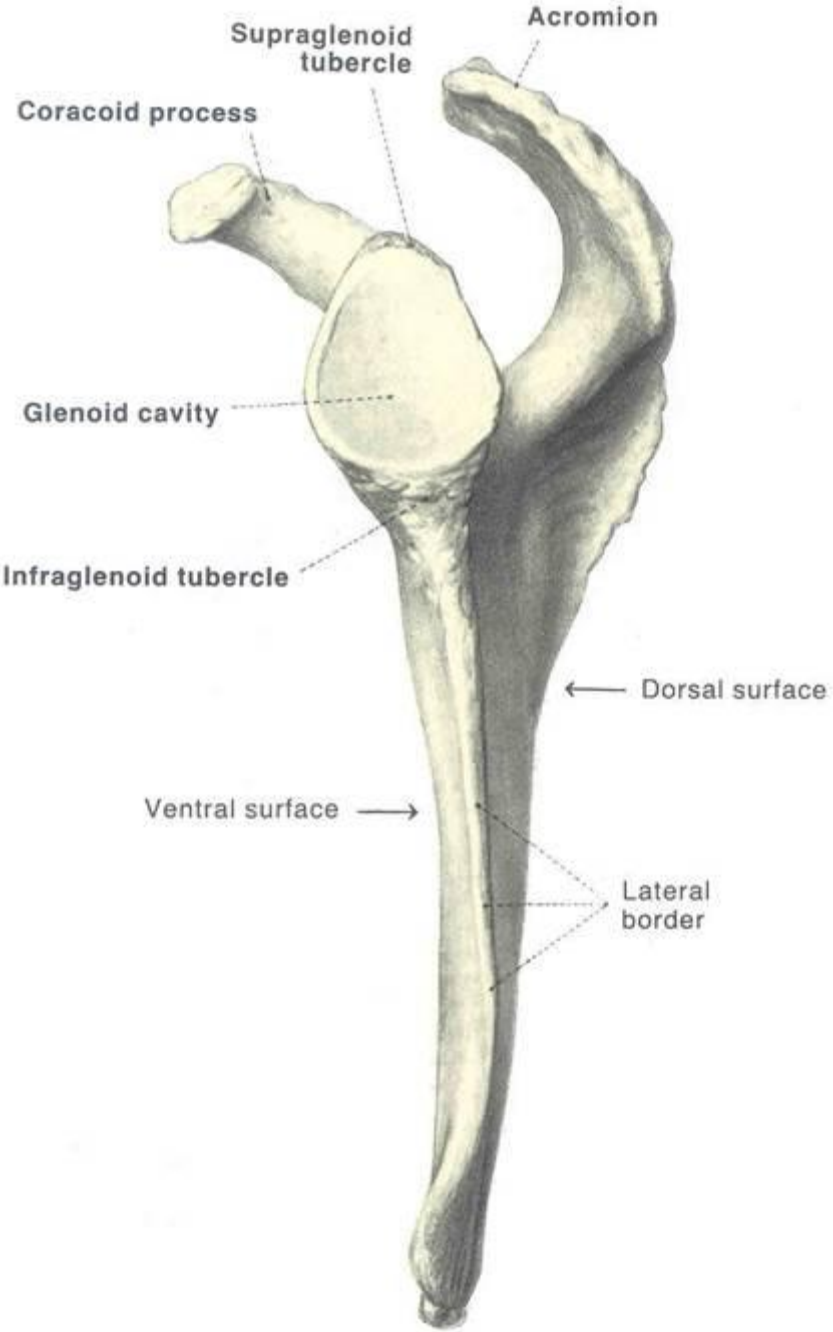
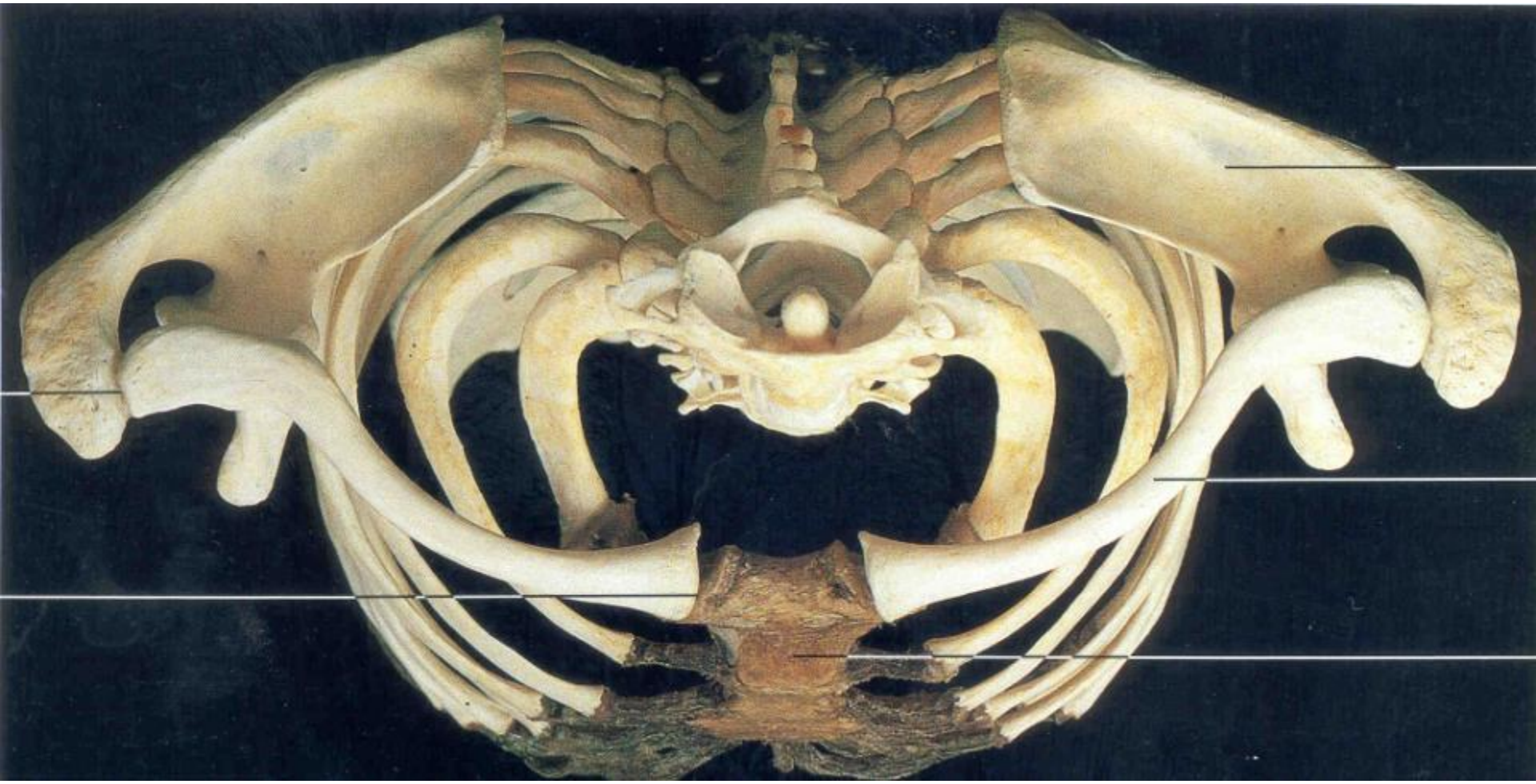
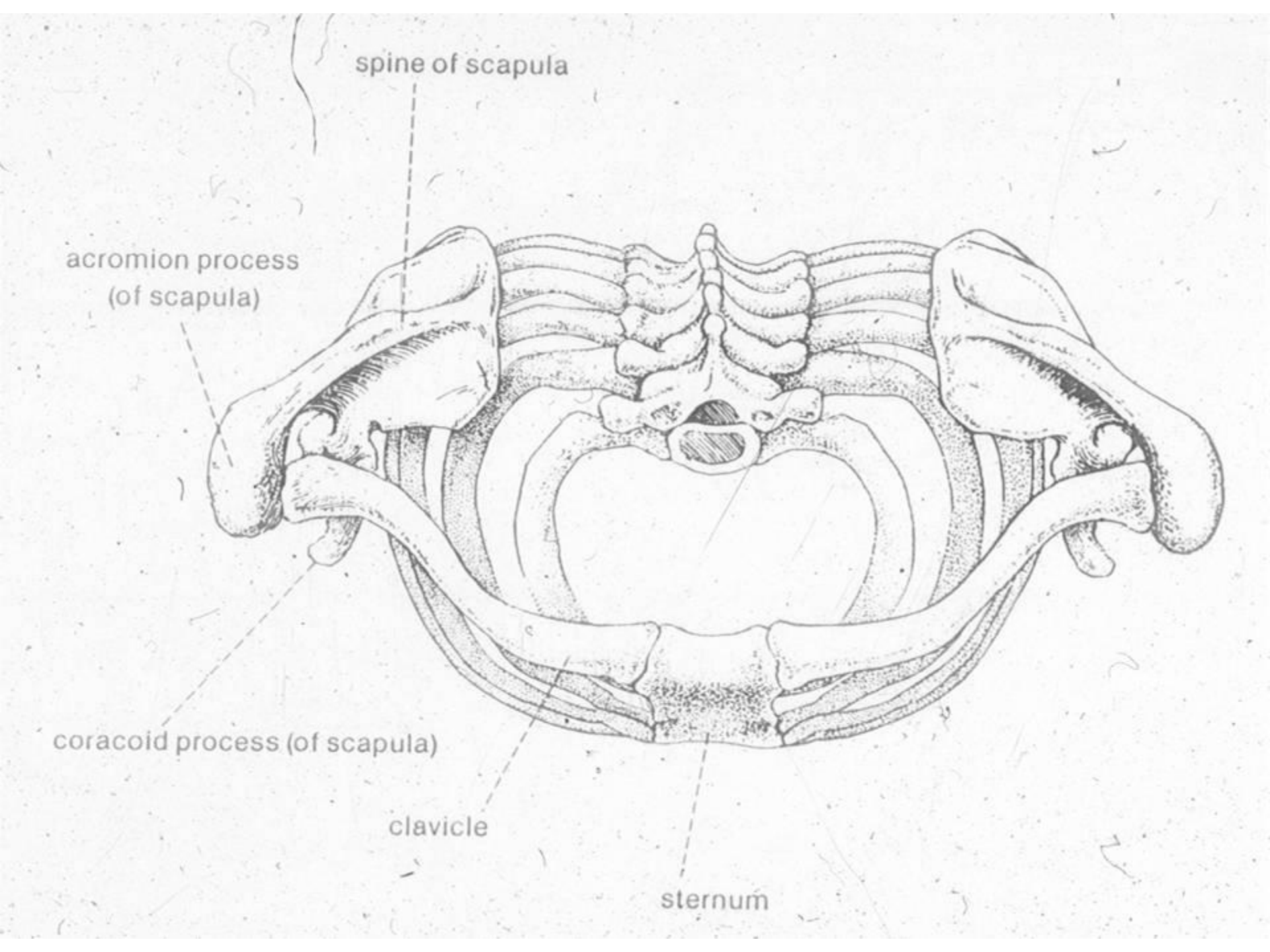
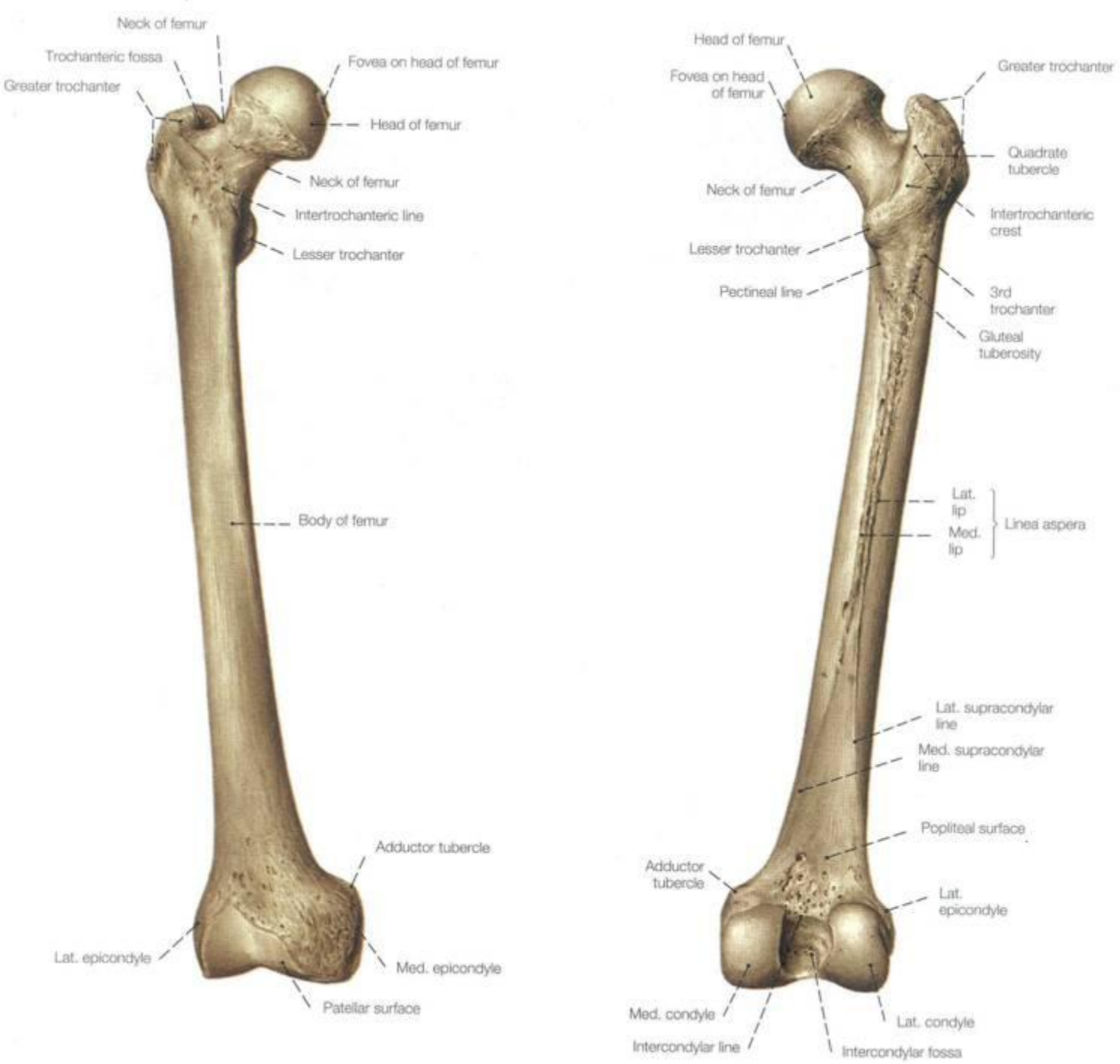


Fig. 27


Acromion
Supraglenoid tubercle
Coracoid process
Glenoid cavity
Infraglenoid tubercle
Dorsal surface
Ventral surface
Lateral border




spine of scapula
acromion process
(of scapula)
coracoid process (of scapula)
clavicle
sternum

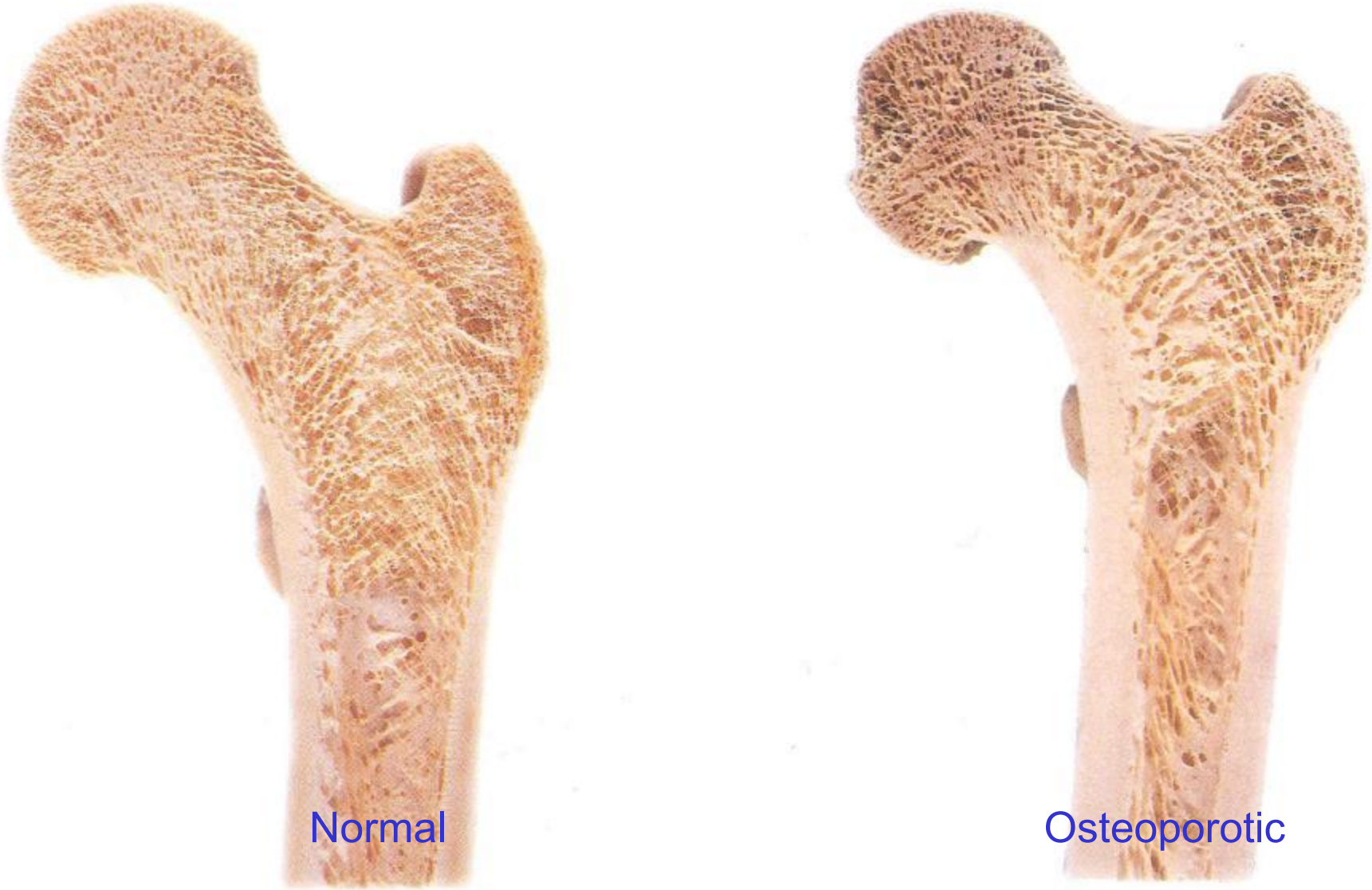

Neck of femur
Trochanteric fossa
Greater trochanter
Fovea on head of femur
Head of femur
Neck of femur
Intertrochanteric line
Lesser trochanter
Body of femur
Adductor tubercle
Lat. epicondyle
Med. epicondyle
Patellar surface
Head of femur
Fovea on head of femur
Greater trochanter
Quadrate tubercle
Neck of femur
Intertrochanteric crest
Lesser trochanter
Pectineal line
3rd trochanter
Gluteal tuberosity
Lat. lip
Med. lip
Linea aspera
Lat. supracondylar line
Med. supracondylar line
Popliteal surface
Adductor tubercle
Lat. epicondyle
Med. condyle
Intercondylar line
Intercondylar fossa
Lat. condyle

Right femur (anterior aspect).

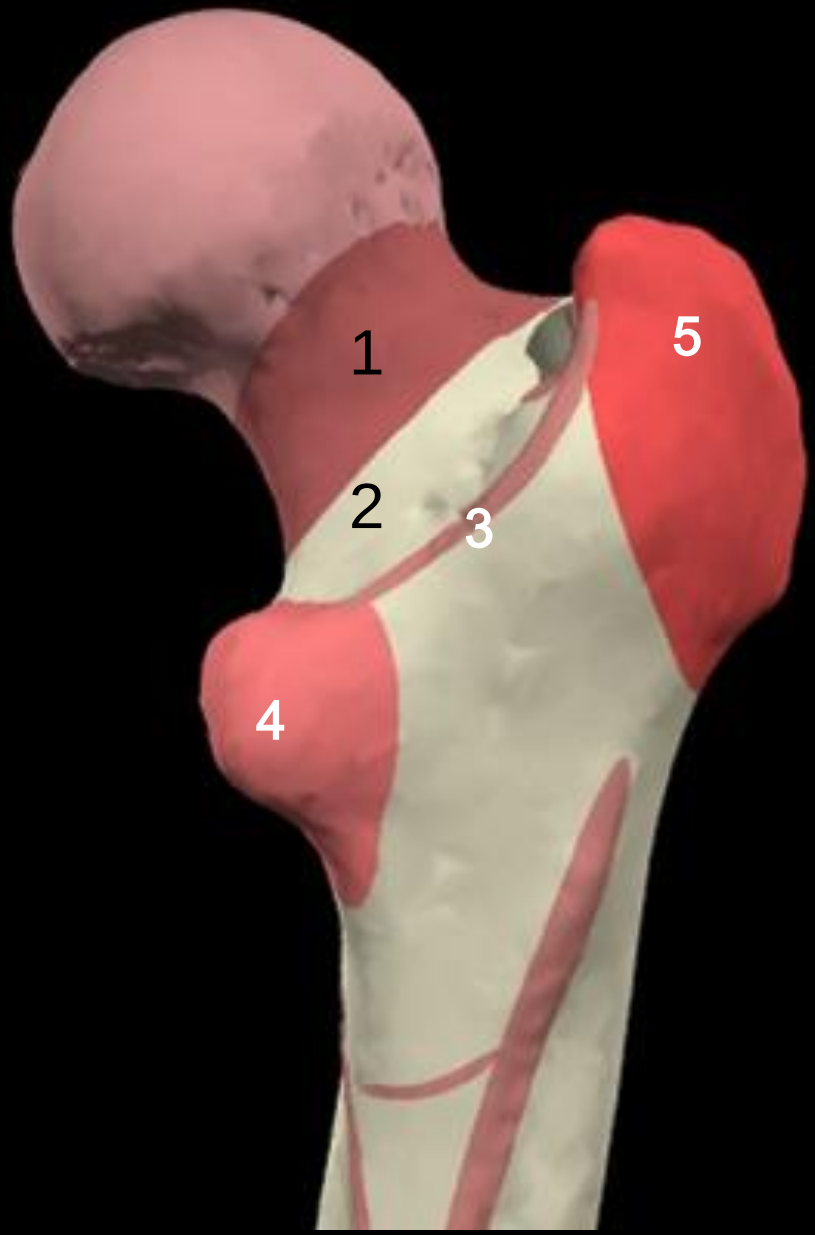
Right femur (medial aspect).

Right femur (posterior aspect).

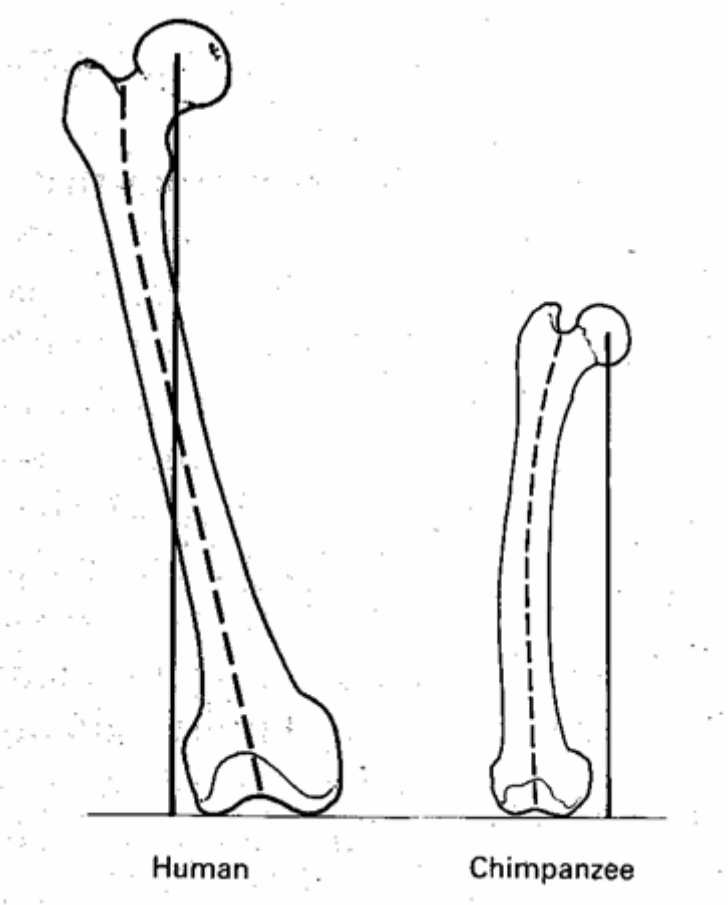
1 Greater trochanter
2 Intertrochanteric line
3 Nutrient foramina
4 Shaft of femur (diaphysis)
5 Lateral epicondyle
6 Patellar surface
7 Head
8 Fovea of head
9 Neck
10 Lesser trochanter
11 Medial epicondyle
12 Pectineal line
13 Linea aspera
14 Popliteal surface
15 Lateral condyle
16 Medial condyle
17 Intertrochanteric crest
18 Third trochanter
19 Medial lip of linea aspera
20 Lateral lip of linea aspera
21 Intercondylar fossa



Notice buttress-like trabecular orientation of proximal femur for transfer of weight through head of the femur to cortical bone of femoral shaft



1. NECK
2. INTERTROCHANTERIC LINE
3. INTERTROCHANTERIC CREST
4. LESSER TROCHANTER
5. GREATER TROCHANTER


Human
Chimpanzee

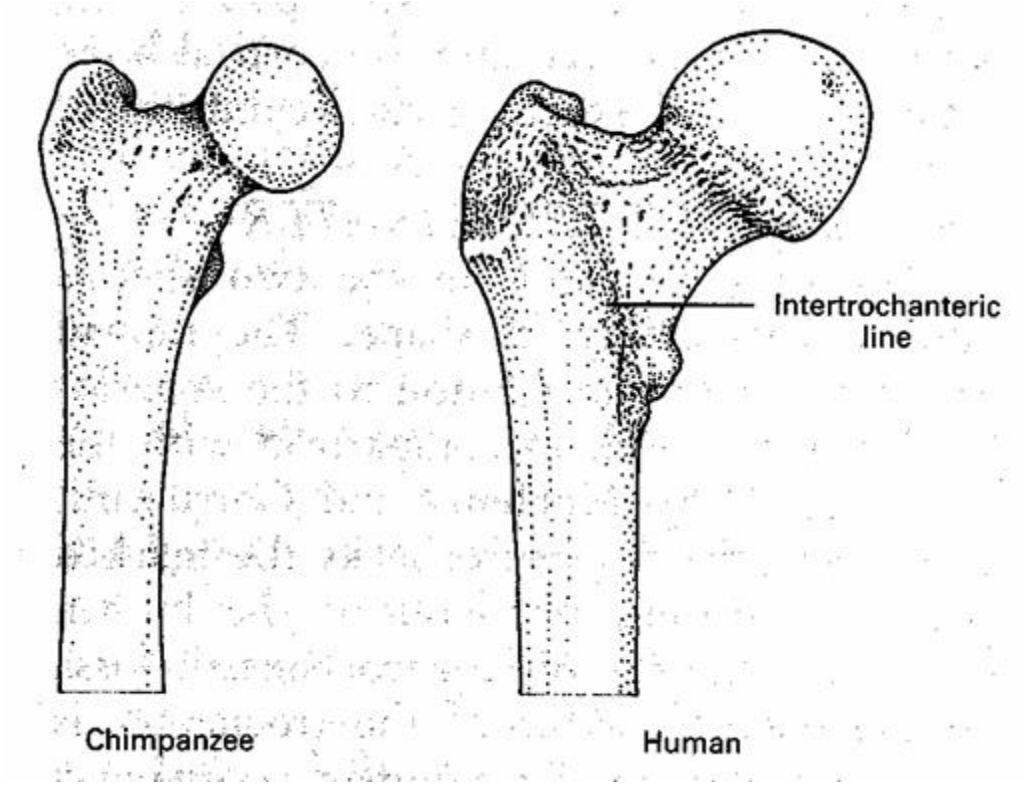

Intertrochanteric line
Chimpanzee
Human

Fig. 290 The left humerus, anterior view (45%).

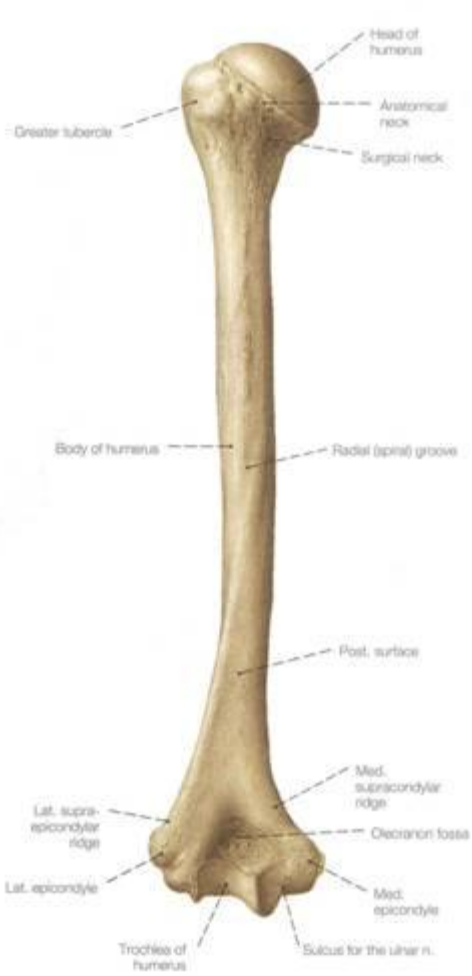
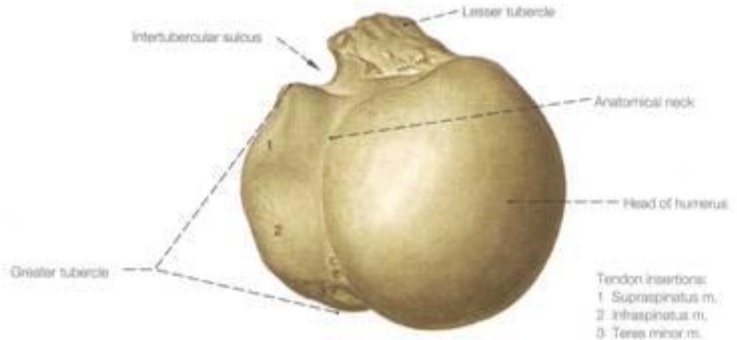
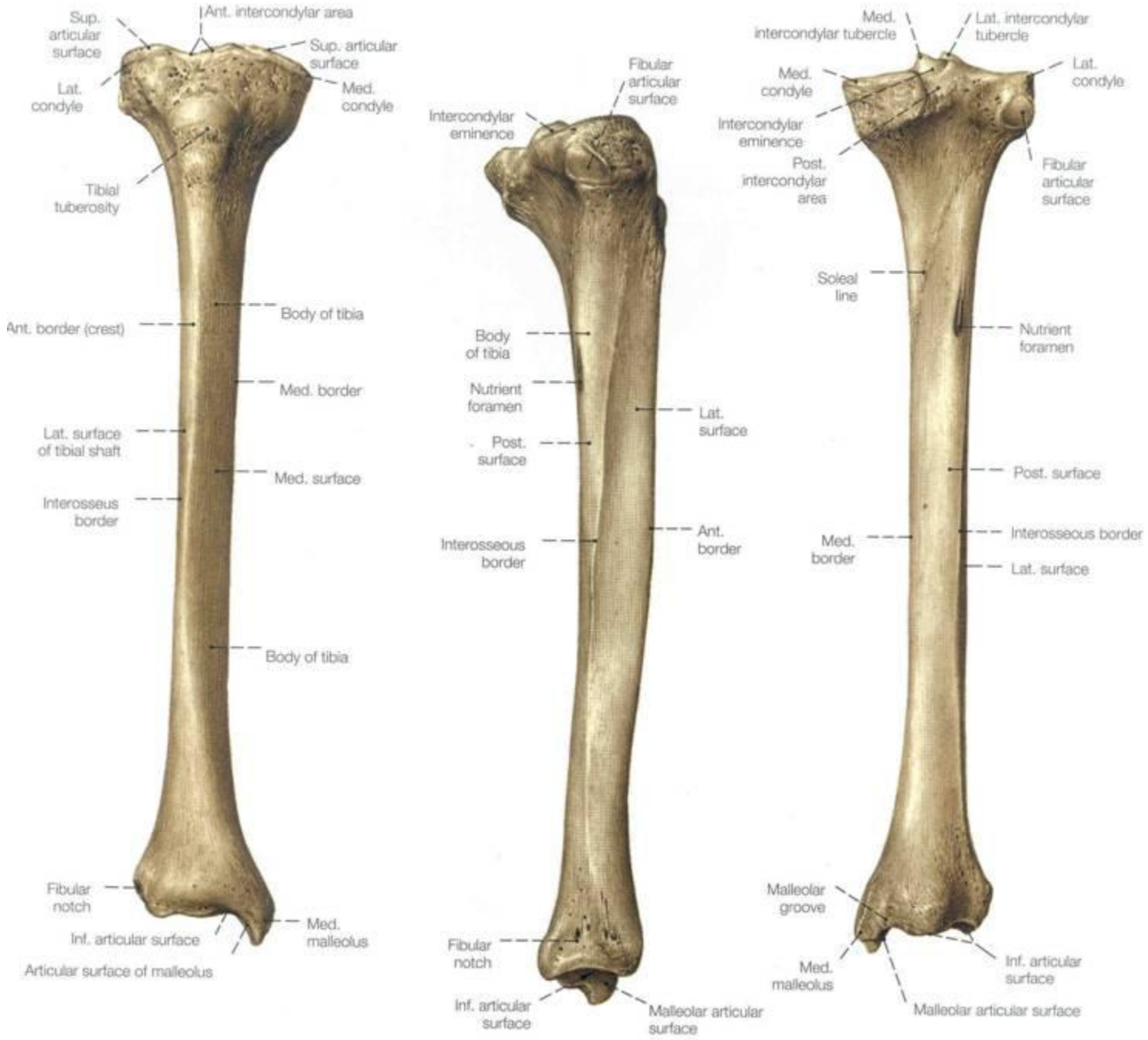
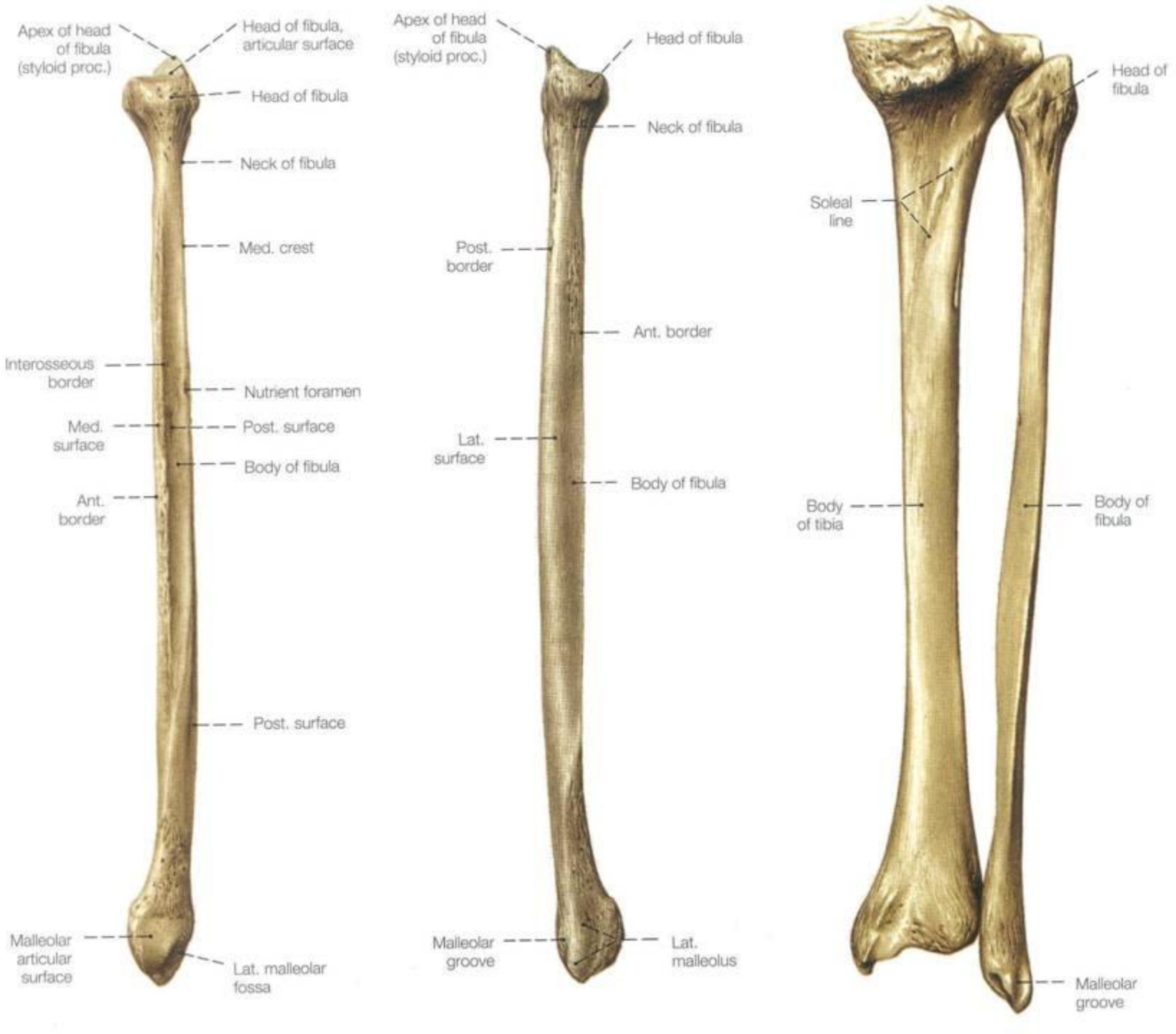
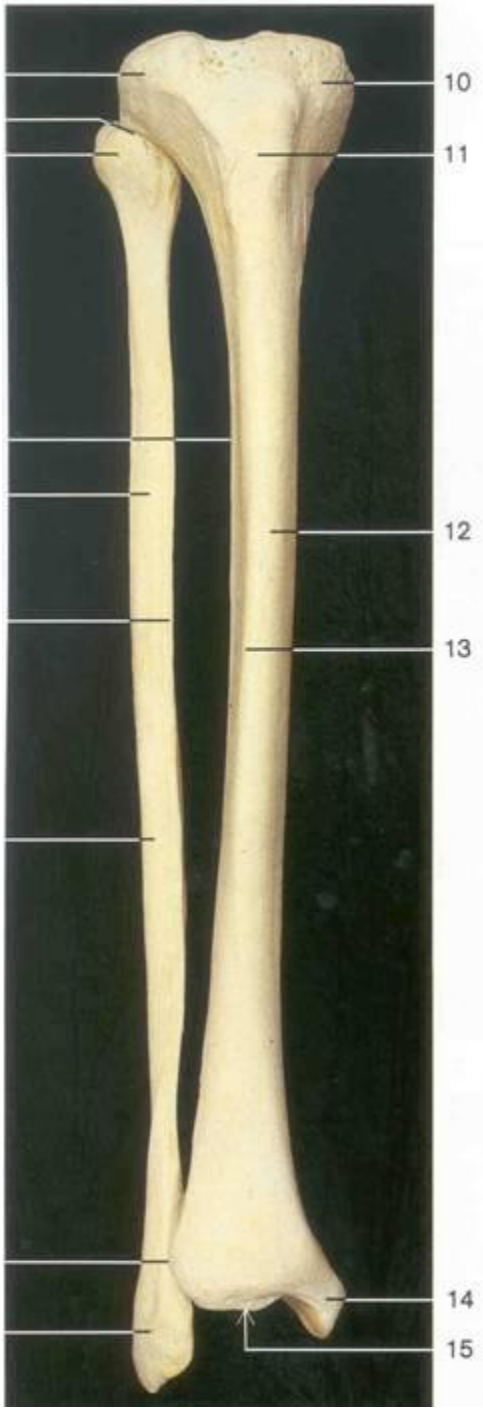


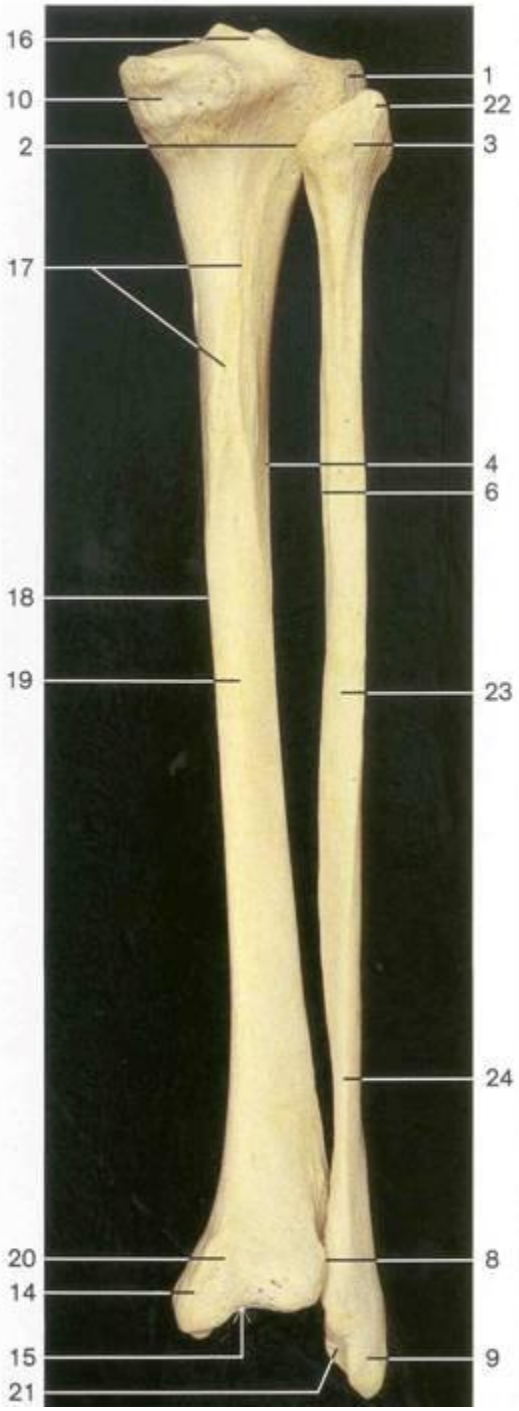
Fig. 291 The left humerus, posterior view (45%).




Sup. articular surface
Ant. intercondylar area
Sup. articular surface
Lat. condyle
Med. condyle
Tibial tuberosity
Body of tibia
Ant. border (crest)
Med. border
Lat. surface of tibial shaft
Med. surface
Interosseus border
Body of tibia
Fibular notch
Med. malleolus
Inf. articular surface
Articular surface of malleolus
Fibular articular surface
Intercondylar eminence
Body of tibia
Nutrient foramen
Lat. surface
Post. surface
Interosseous border
Ant. border
Fibular notch
Inf. articular surface
Malleolar articular surface
Med. intercondylar tubercle
Lat. intercondylar tubercle
Med. condyle
Lat. condyle
Intercondylar eminence
Post. intercondylar area
Fibular articular surface
Soleal line
Nutrient foramen
Post. surface
Med. border
Interosseous border
Lat. surface
Malleolar groove
Med. malleolus
Inf. articular surface
Malleolar articular surface


Apex of head of fibula (styloid proc.)
Head of fibula, articular surface
Head of fibula
Neck of fibula
Med. crest
Interosseous border
Nutrient foramen
Med. surface
Post. surface
Body of fibula
Ant. border
Post. surface
Malleolar articular surface
Lat. malleolar fossa
Apex of head of fibula (styloid proc.)
Head of fibula
Neck of fibula
Post. border
Ant. border
Lat. surface
Body of fibula
Malleolar groove
Lat. malleolus
Head of fibula
Soleal line
Body of tibia
Body of fibula
Malleolar groove





1 Lateral condyle of tibia
2 Position of tibiofibular joint
3 Head of fibula
4 Interosseous border of tibia
5 Shaft of fibula
6 Interosseous border of fibula
7 Lateral surface of fibula
8 Position of tibiofibular joint
9 Lateral malleolus
10 Medial condyle of tibia
11 Tuberosity of tibia
12 Shaft of tibia (diaphysis)
13 Anterior margin of tibia
14 Medial malleolus
15 Inferior articular surface of tibia
16 Intercondylar eminence
17 Soleal line
18 Medial border of tibia
19 Posterior surface of tibia
20 Malleolar sulcus of tibia
21 Malleolar articular surface of fibula
22 Apex of head of fibula
23 Posterior surface of fibula
24 Posterior border of fibula
25 Medial intercondylar tubercle
26 Posterior intercondylar area
27 Anterior intercondylar area
28 Lateral intercondylar tubercle

Fig. 304 The left radius, anterior view (50%).

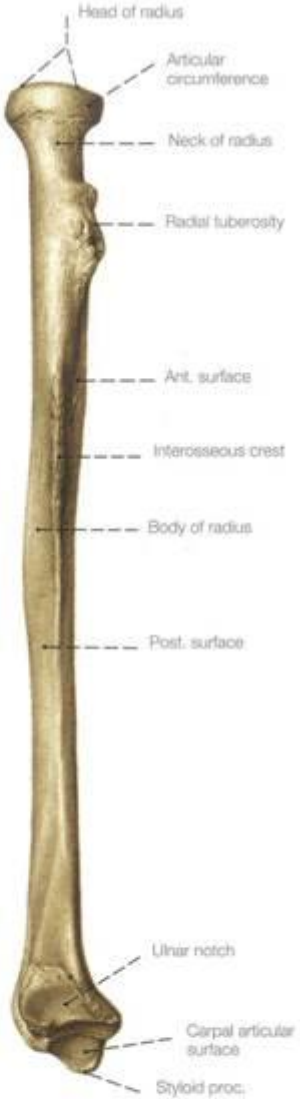


Fig. 306 The left radius, ulnar aspect (50%).

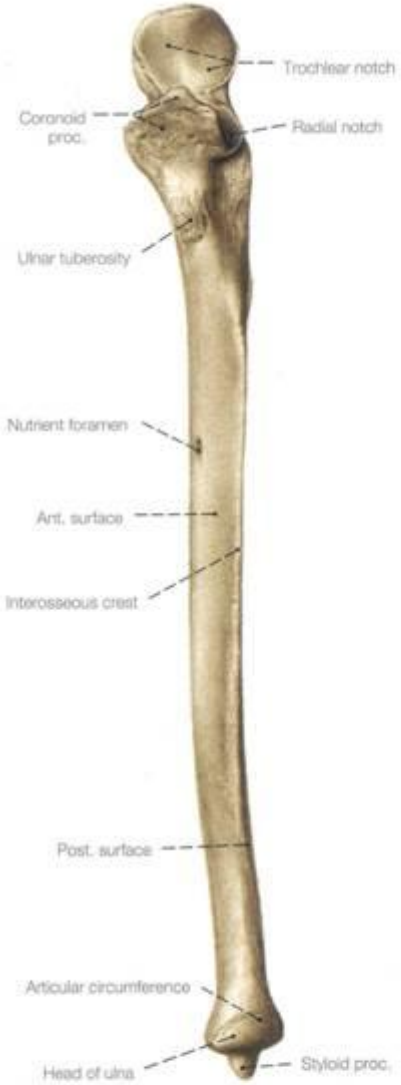
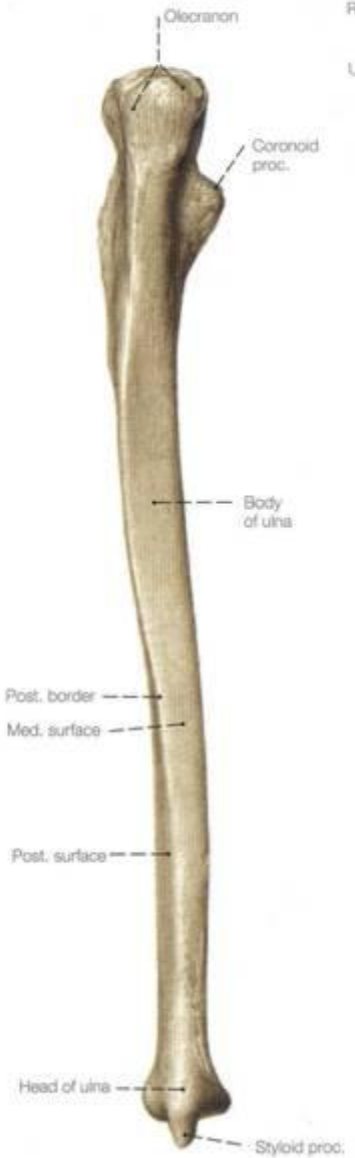


Fig. 301 The left ulna, anterior view (50%).



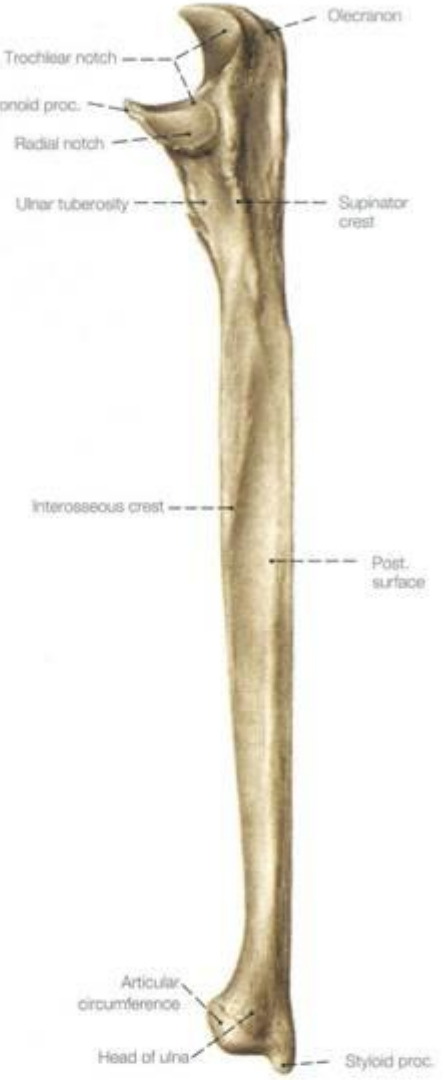
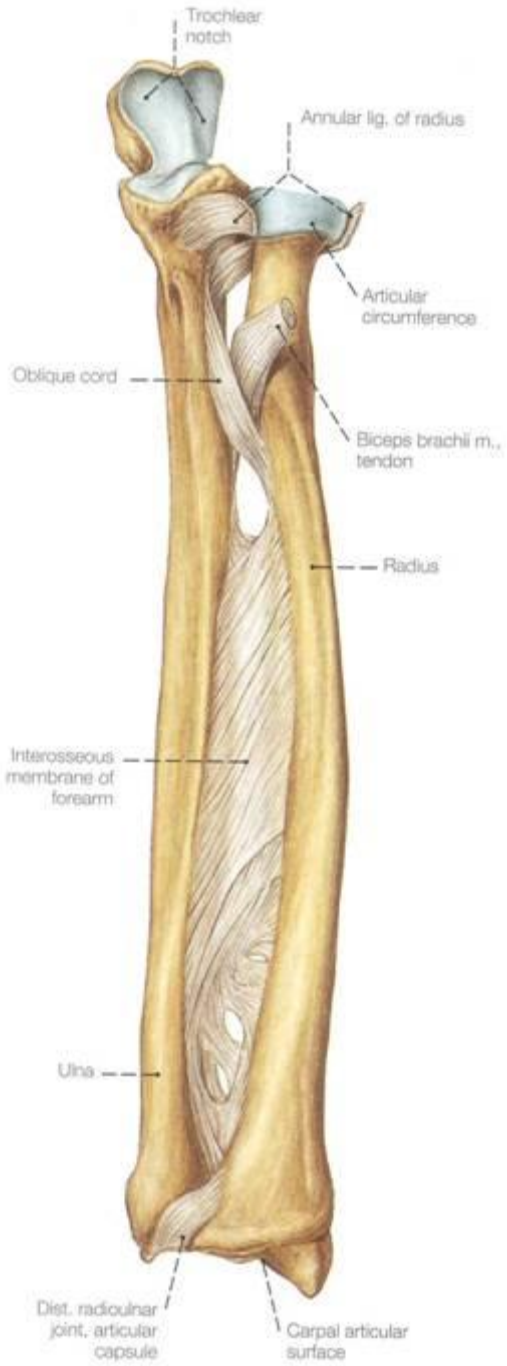
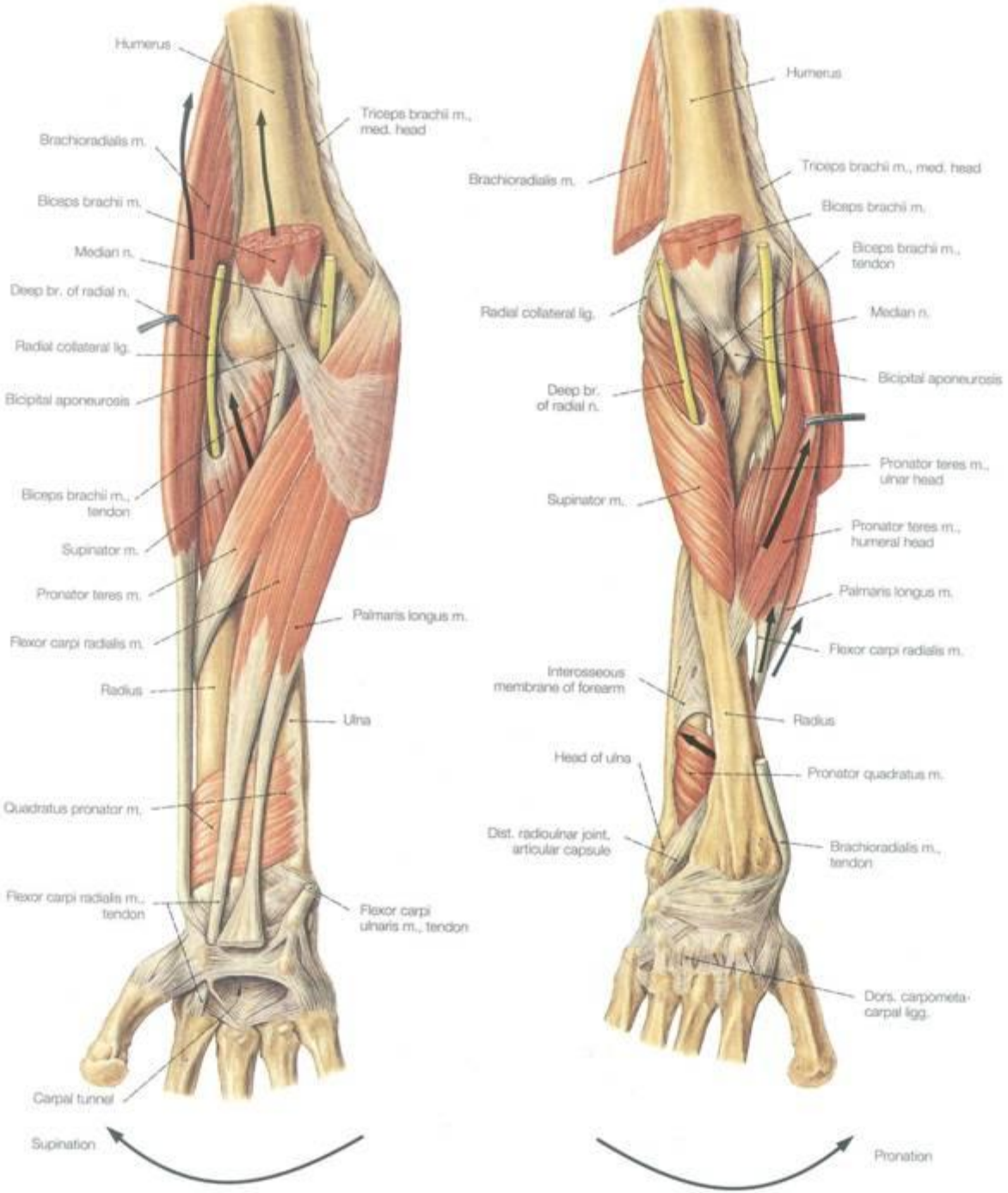
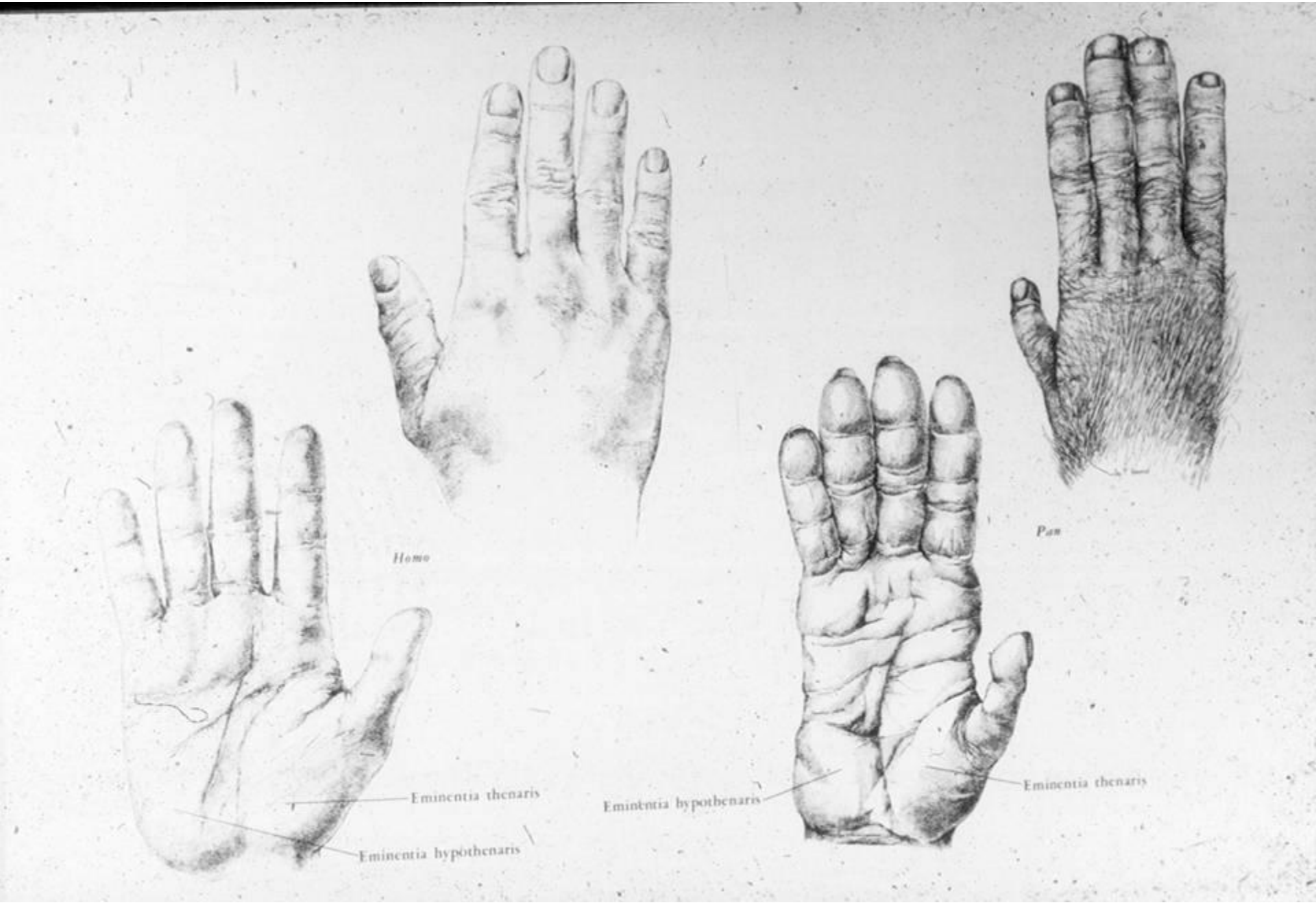


Fig. 303 The left ulna, radial aspect (50%).


Trochlear notch
Annular lig. of radius
Articular circumference
Oblique cord
Biceps brachii m., tendon
Radius
Interosseous membrane of forearm
Ulna
Dist. radioulnar joint, articular capsule
Carpal articular surface


Humerus
Triceps brachii m., med. head
Brachioradialis m.
Biceps brachii m.
Median n.
Deep br. of radial n.
Radial collateral lig.
Bicipital aponeurosis
Biceps brachii m., tendon
Supinator m.
Pronator teres m.
Flexor carpi radialis m.
Radius
Palmaris longus m.
Ulna
Quadratus pronator m.
Flexor carpi radialis m., tendon
Flexor carpi ulnaris m., tendon
Carpal tunnel
Supination
Humerus
Brachioradialis m.
Triceps brachii m., med. head
Biceps brachii m.
Biceps brachii m., tendon
Radial collateral lig.
Median n.
Bicipital aponeurosis
Deep br. of radial n.
Pronator teres m., ulnar head
Supinator m.
Pronator teres m., humeral head
Palmaris longus m.
Flexor carpi radialis m.
Interosseous membrane of forearm
Radius
Head of ulna
Pronator quadratus m.
Dist. radioulnar joint, articular capsule
Brachioradialis m., tendon
Dors. carpometacarpal ligg.
Pronation


Homo
Eminentia thenaris
Eminentia hypothenaris
Pan
Eminentia hypothenaris
Eminentia thenaris

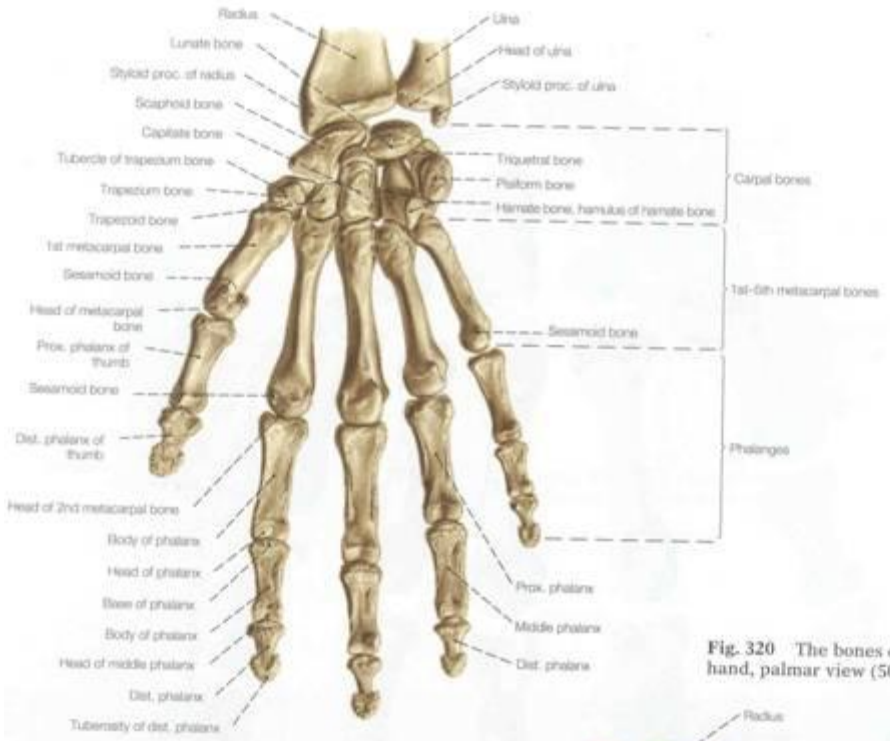


Fig. 320 The bones of the right hand, palmar view (50%).

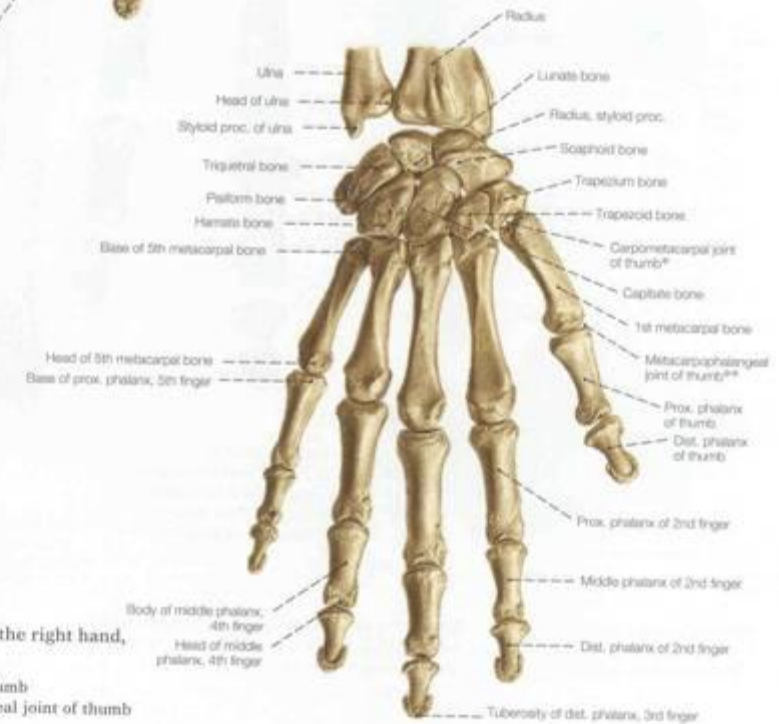


Fig. 321 The bones of the right hand, dorsal view (50%).

* Also: Saddle joint of thumb
** Also: Proximal phalangeal joint of thumb

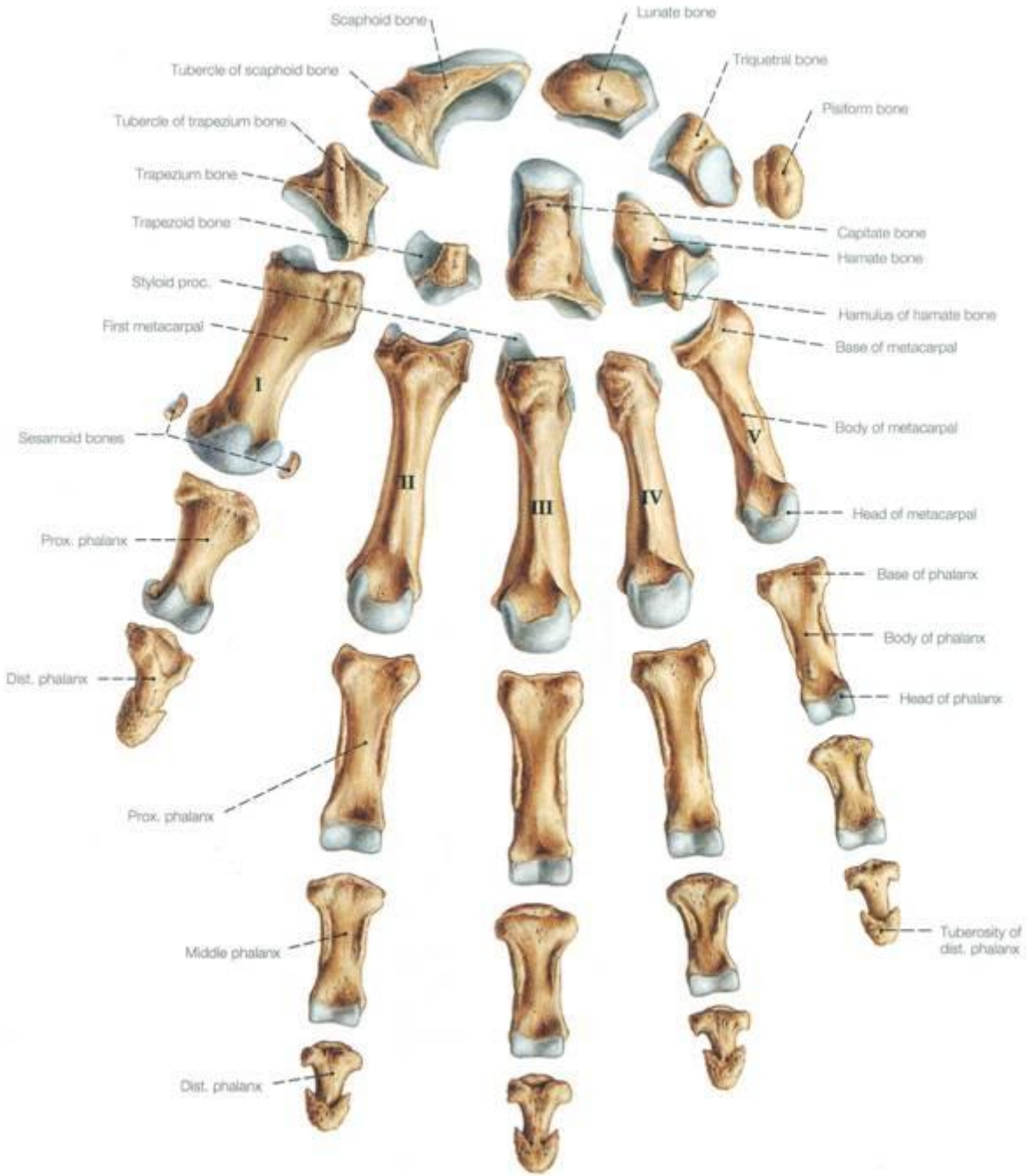

Scaphoid bone
Lunate bone
Triquetral bone
Pisiform bone
Tubercle of scaphoid bone
Tubercle of trapezium bone
Trapezium bone
Trapezoid bone
Capitate bone
Hamate bone
Styloid proc.
Hamulus of hamate bone
First metacarpal
Base of metacarpal
I
II
III
IV
V
Sesamoid bones
Body of metacarpal
Head of metacarpal
Prox. phalanx
Base of phalanx
Body of phalanx
Dist. phalanx
Head of phalanx
Prox. phalanx
Middle phalanx
Tuberosity of dist. phalanx
Dist. phalanx

Fig. 1208 Bones of the right foot, dorsal aspect (50%).

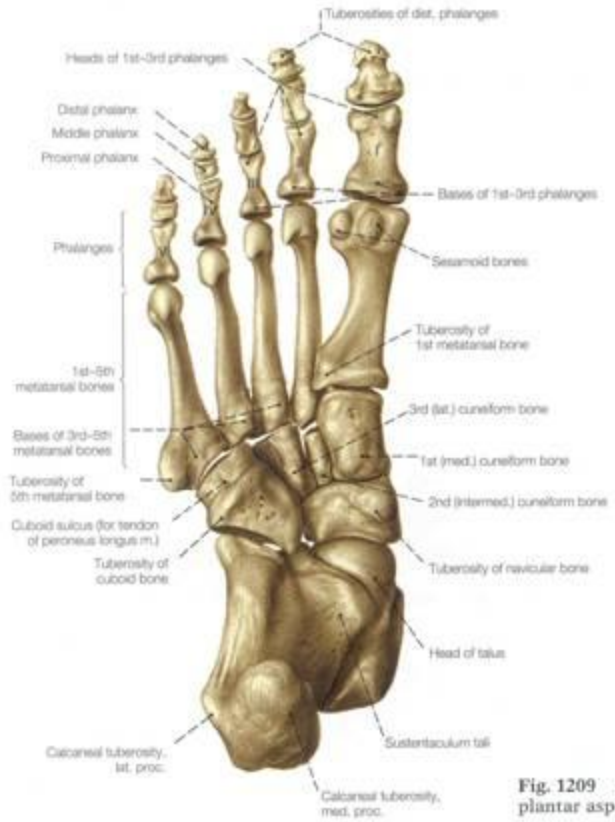
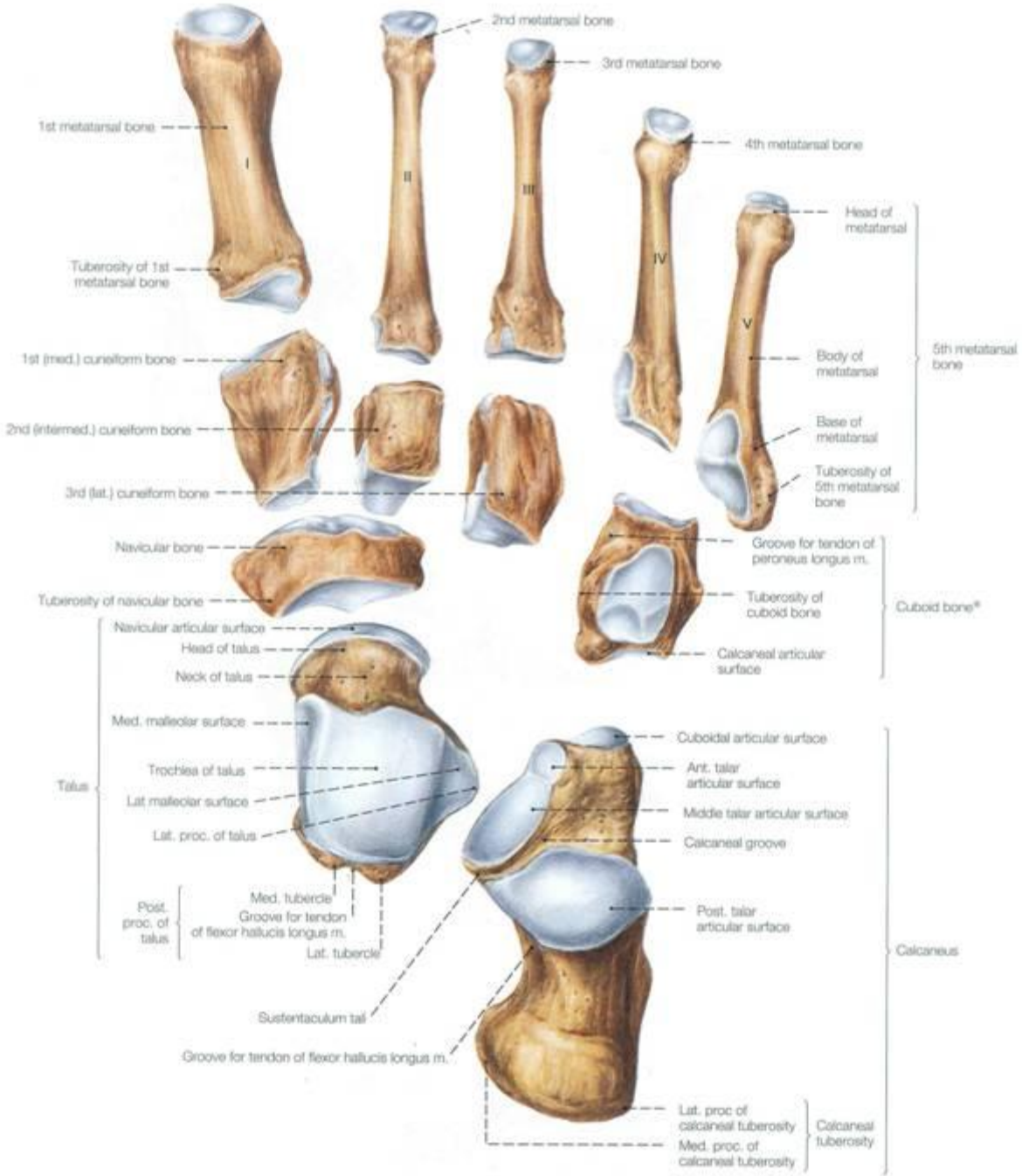


Fig. 1209 Bones of the right foot, plantar aspect (50%).

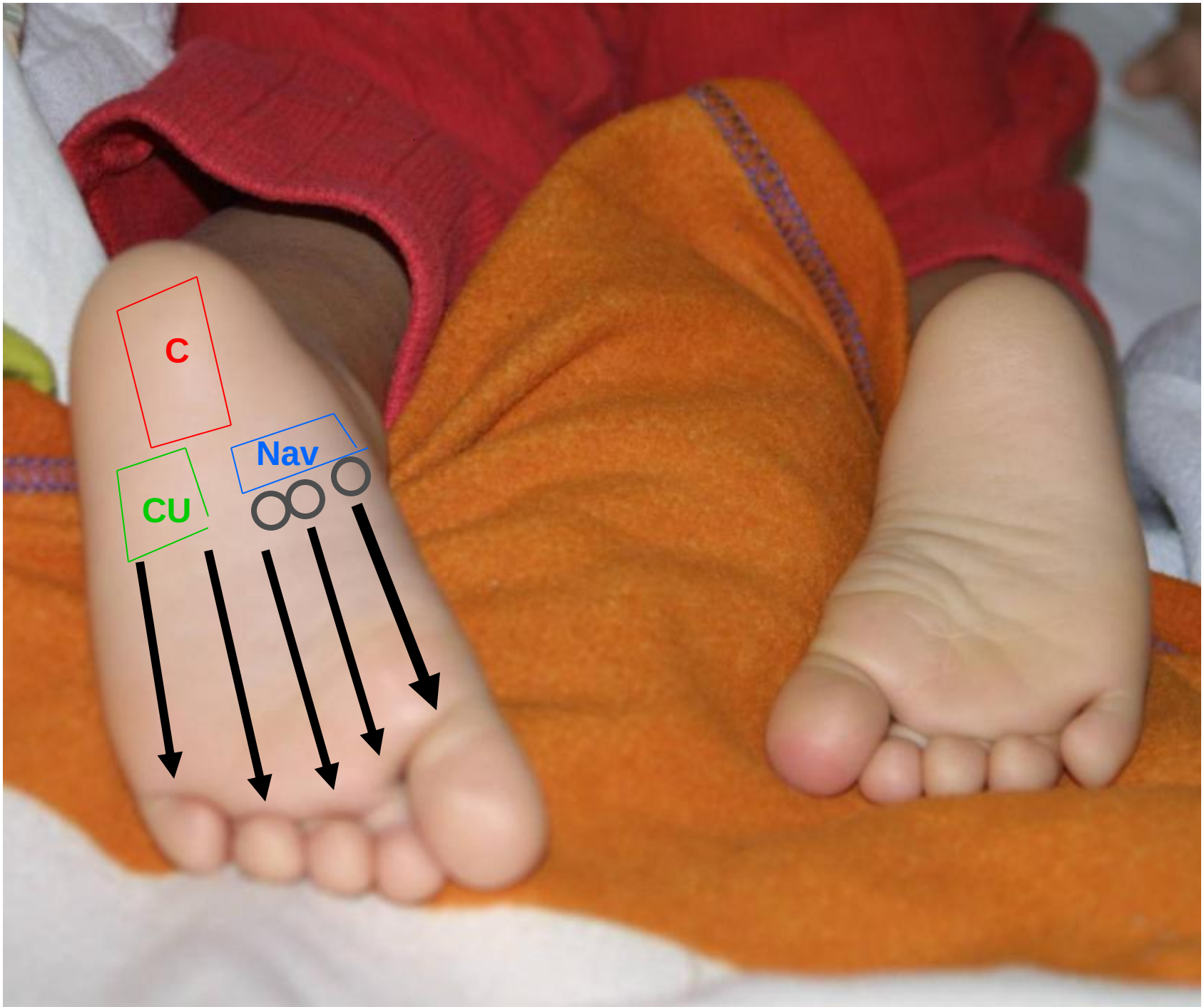

2nd metatarsal bone
3rd metatarsal bone
1st metatarsal bone
4th metatarsal bone
I
II
III
IV
V
Head of metatarsal
Tuberosity of 1st metatarsal bone
Body of metatarsal
5th metatarsal bone
1st (med.) cuneiform bone
Base of metatarsal
2nd (intermed.) cuneiform bone
Tuberosity of 5th metatarsal bone
3rd (lat.) cuneiform bone
Groove for tendon of peroneus longus m.
Navicular bone
Tuberosity of cuboid bone
Cuboid bone*
Tuberosity of navicular bone
Calcaneal articular surface
Navicular articular surface
Head of talus
Neck of talus
Med. malleolar surface
Cuboidal articular surface
Trochlea of talus
Ant. talar articular surface
Talus
Lat. malleolar surface
Middle talar articular surface
Lat. proc. of talus
Calcaneal groove
Med. tubercle
Post. talar articular surface
Post. proc. of talus
Groove for tendon of flexor hallucis longus m.
Lat. tubercle
Calcaneus
Sustentaculum tali
Groove for tendon of flexor hallucis longus m.
Lat. proc of calcaneal tuberosity
Calcaneal tuberosity
Med. proc. of calcaneal tuberosity

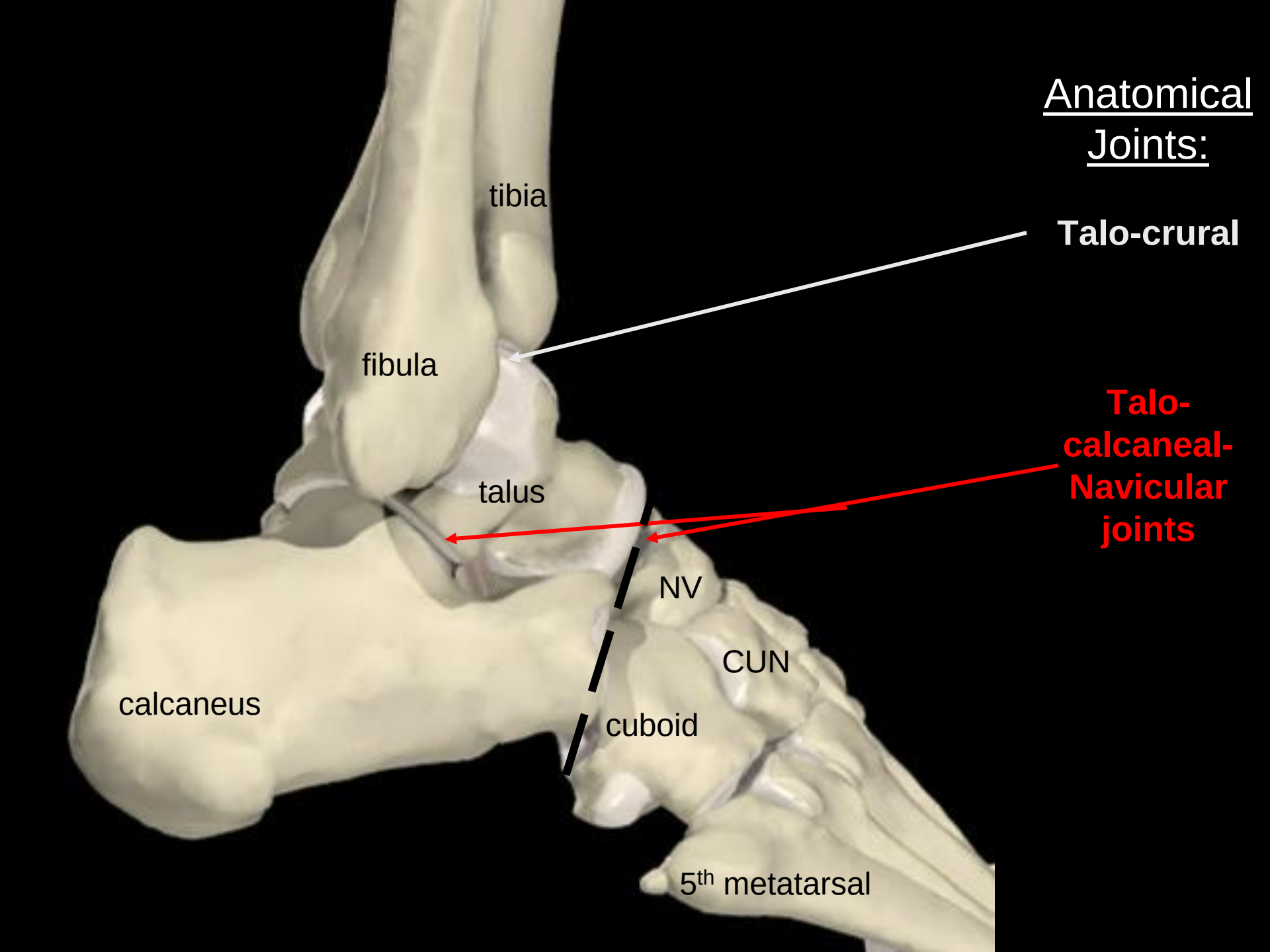
Bones of right foot (dorsal aspect).

Bones of right foot (plantar aspect).

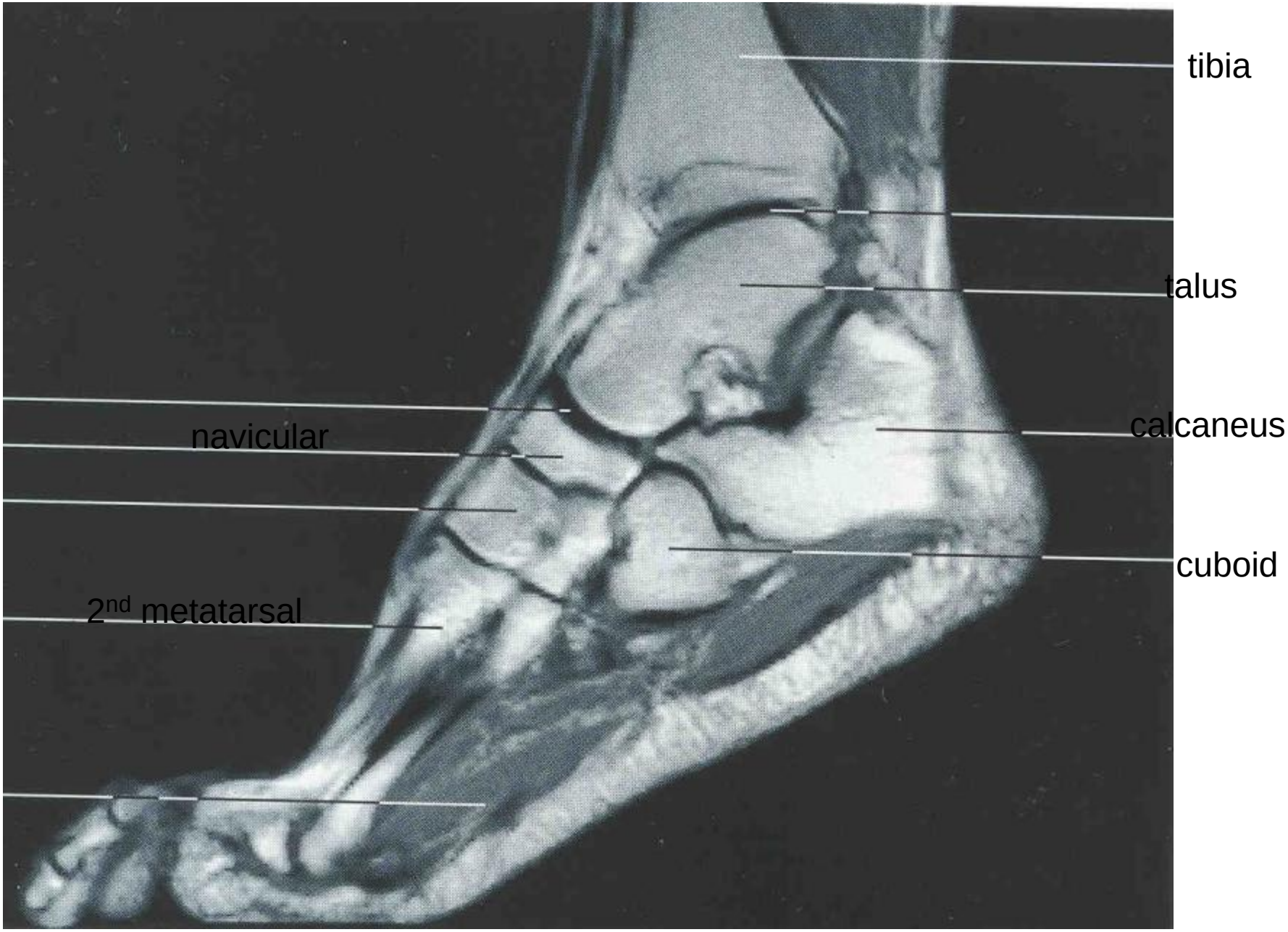
Bones of right foot together with tibia and fibula (posterior aspect).

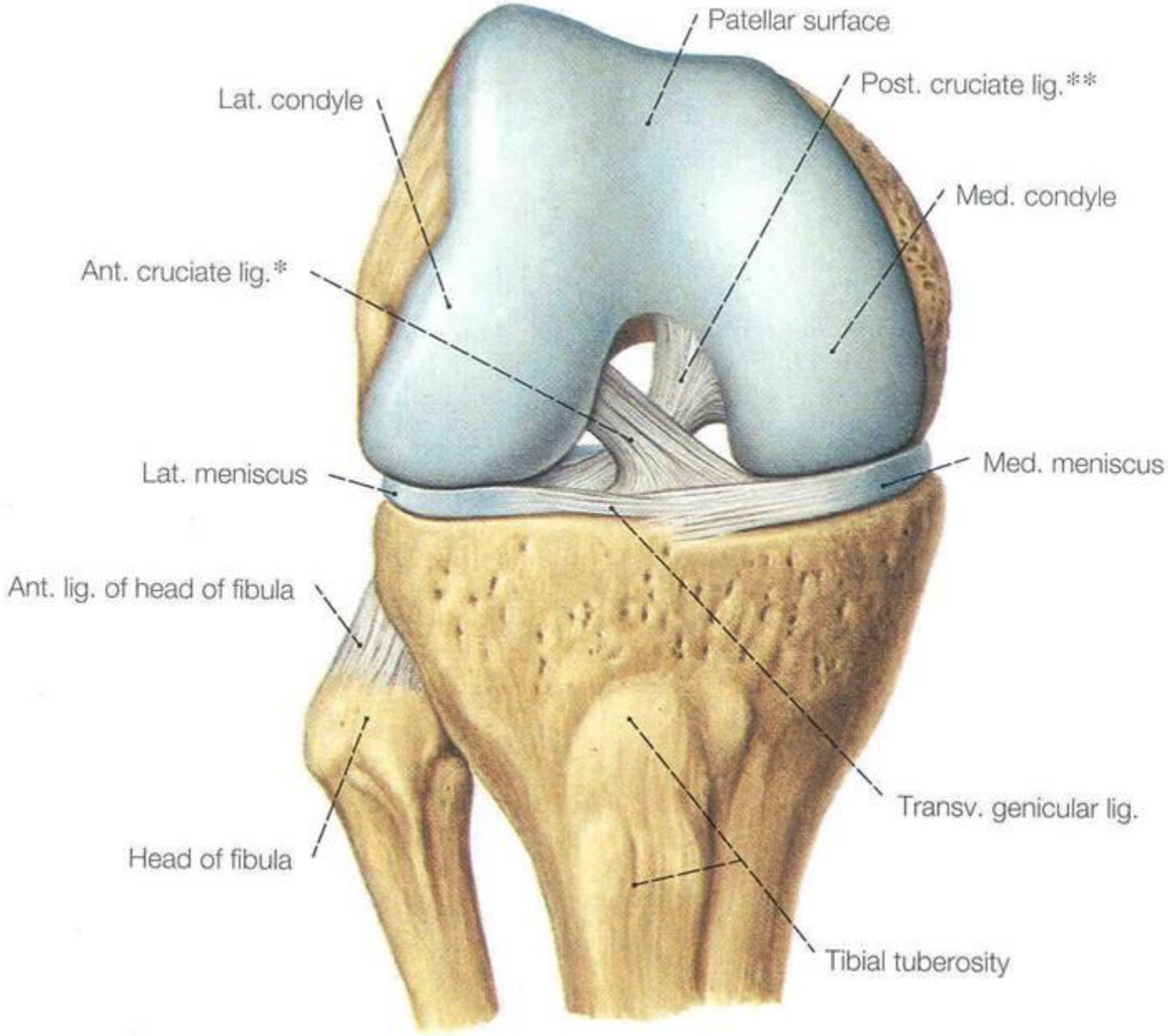
1 Tuberosity of distal phalanx of great toe
2 Distal phalanx of great toe
3 Proximal phalanx of great toe
4 Head of first metatarsal bone
5 First metatarsal bone
6 Base of first metatarsal bone
7 Medial cuneiform bone
8 Intermediate cuneiform bone
9 Position of **cuneonavicular joint**
10 Navicular bone

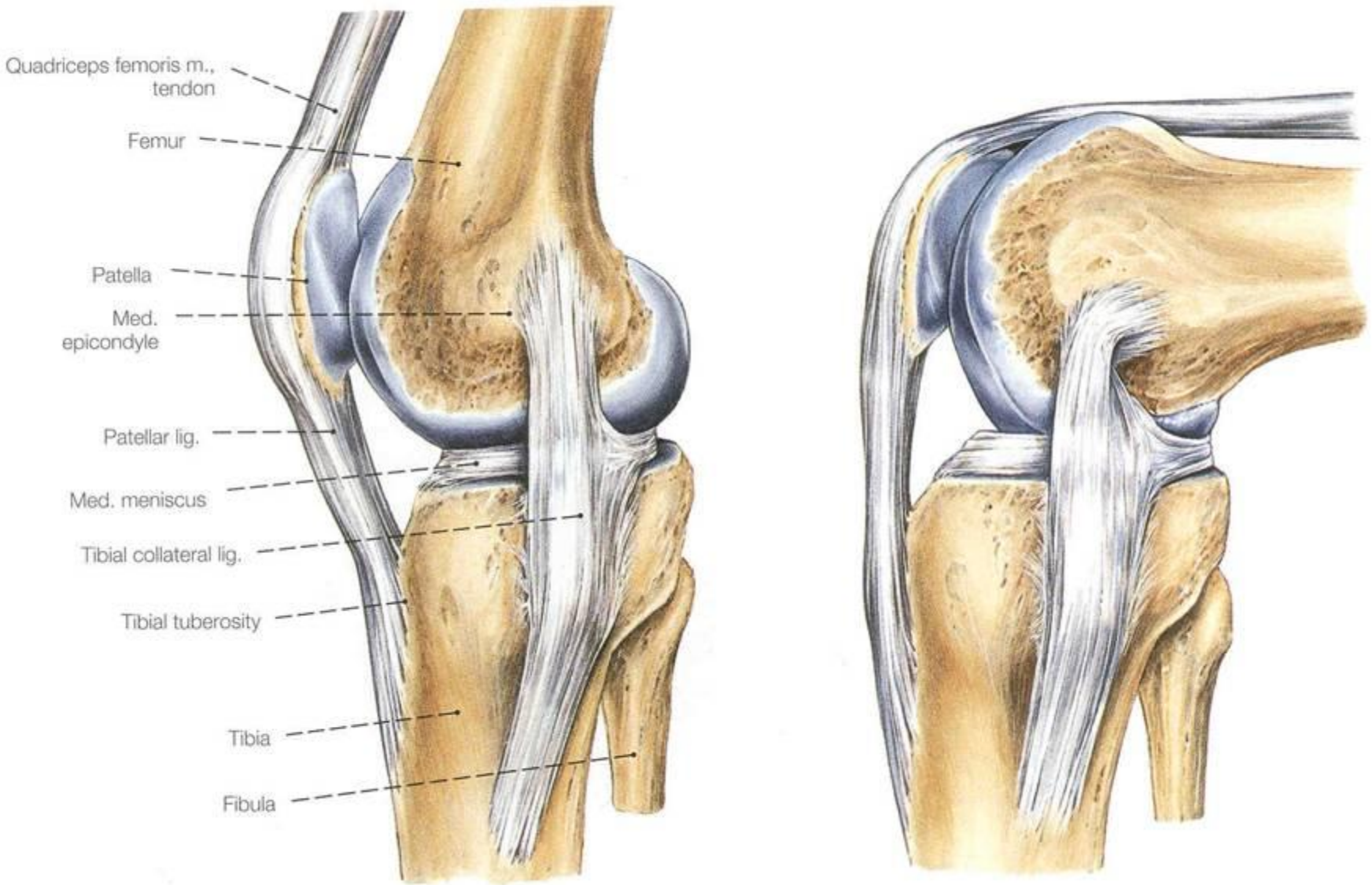

C
Nav
CU


Anatomical Joints:
Talo-crural
Talo-calcaneal-Navicular joints
tibia
fibula
talus
NV
CUN
calcaneus
cuboid
5th metatarsal

Objective 3: **JOINTS and LIGAMENTS OF THE FOOT & ANKLE/ Parasagittal MRI**




Patellar surface
Lat. condyle
Post. cruciate lig.**
Med. condyle
Ant. cruciate lig.*
Lat. meniscus
Med. meniscus
Ant. lig. of head of fibula
Transv. genicular lig.
Head of fibula
Tibial tuberosity


Quadriceps femoris m., tendon
Femur
Patella
Med. epicondyle
Patellar lig.
Med. meniscus
Tibial collateral lig.
Tibial tuberosity
Tibia
Fibula

Note interosseus membrane

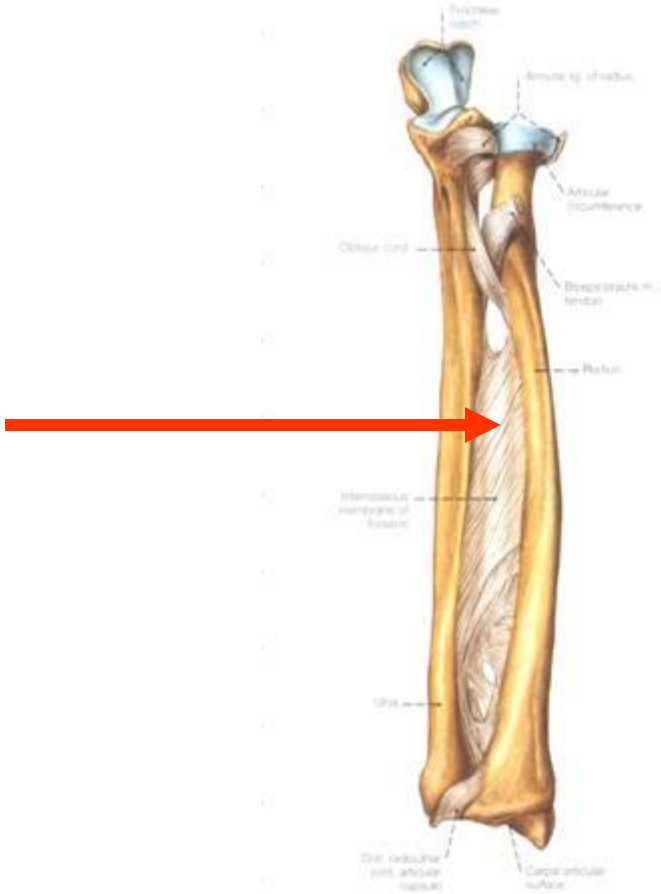


Fig. 315 Ligaments of the bones of the left forearm, anterior view (50%). The annular ligament has been cut.

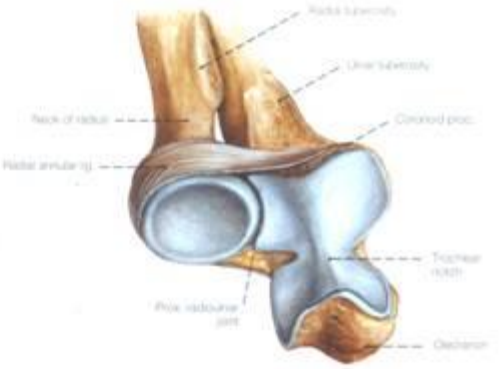


Fig. 316 The right proximal radioulnar joint, anterior view of the proximal end (85%).

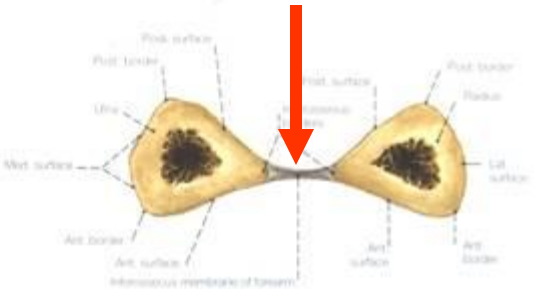


Fig. 317 Cross section through the bones of the left forearm, viewed from the distal end (115%).

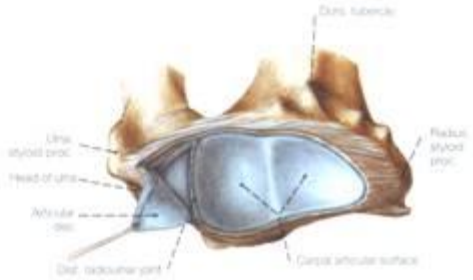
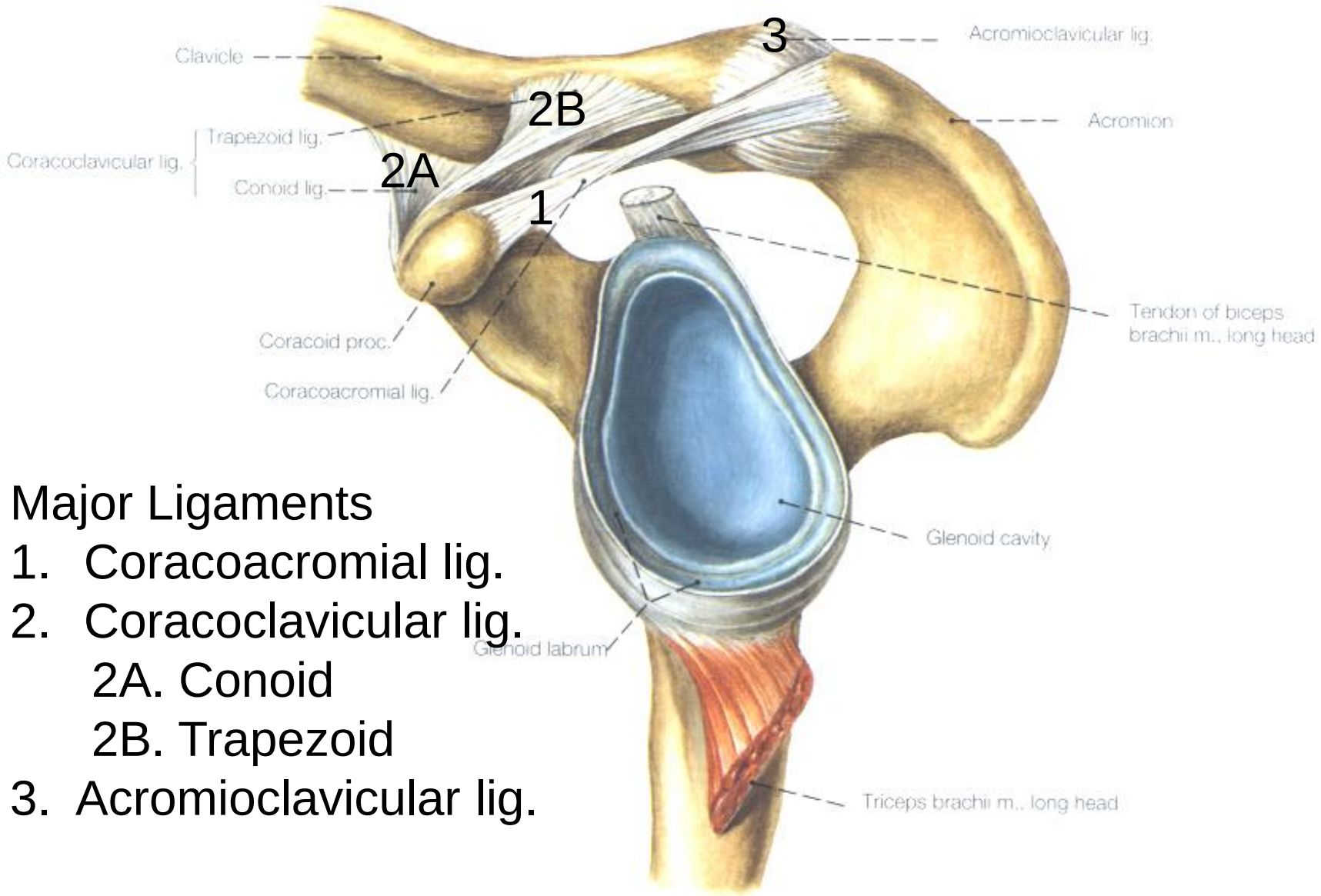
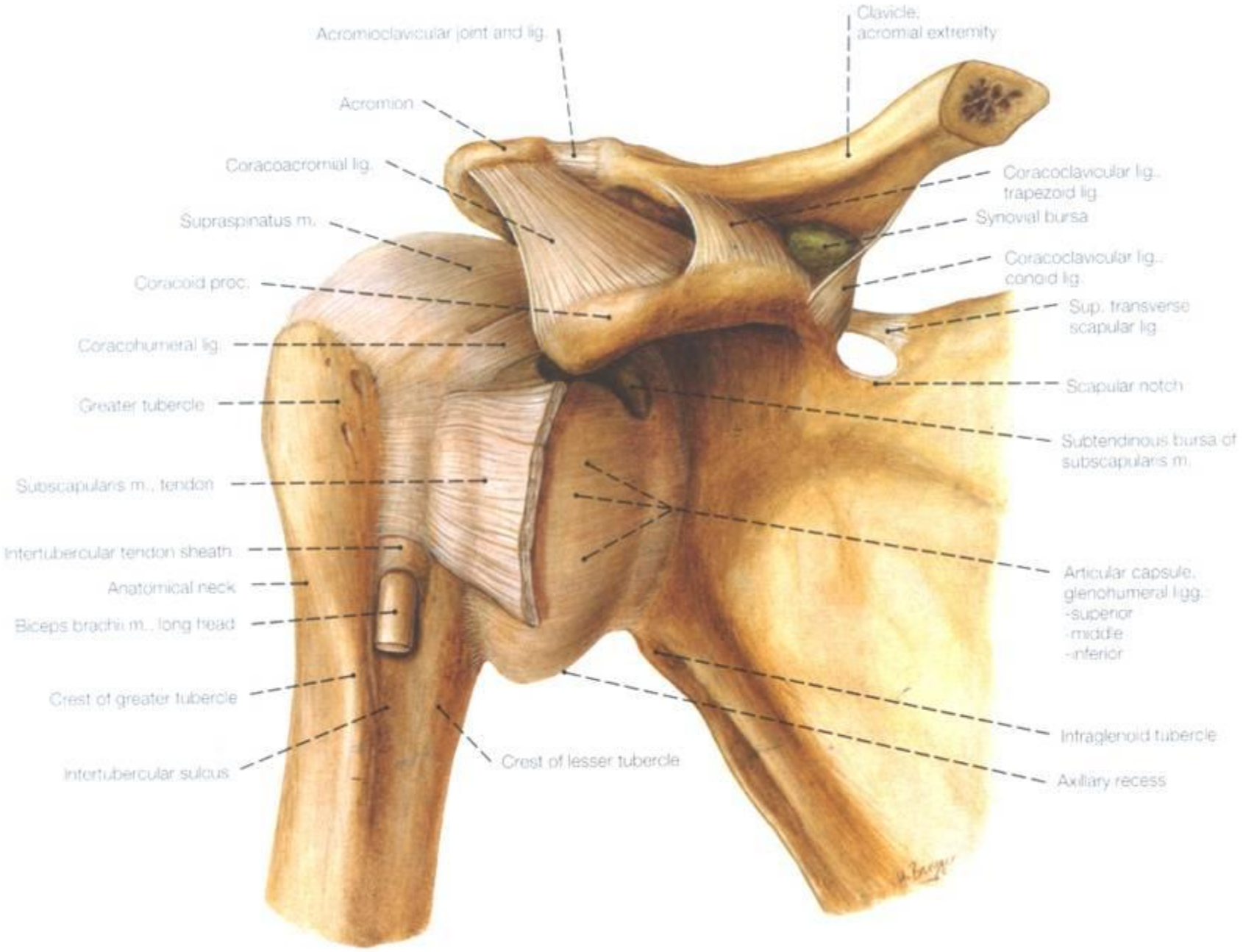


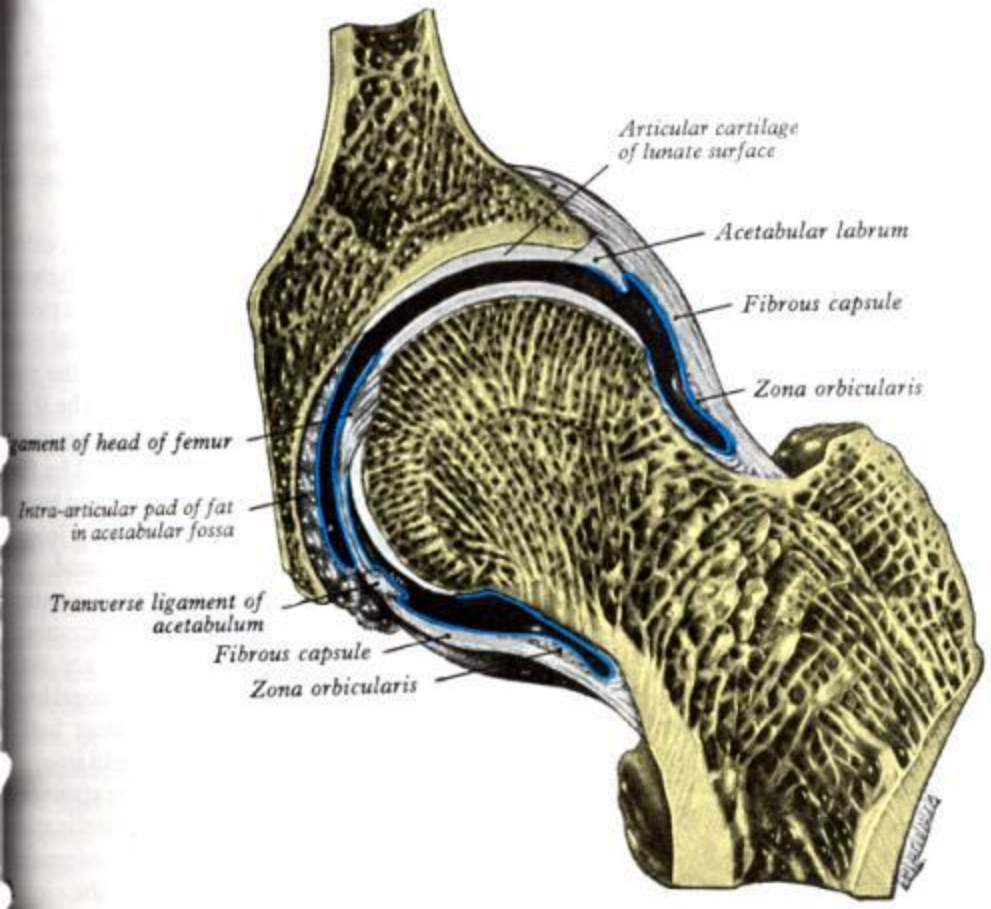
Fig. 318 The left distal radioulnar joint, posterior view of the distal end (85%). The articular disc has been separated from the radius and reflected toward the ulnar side.

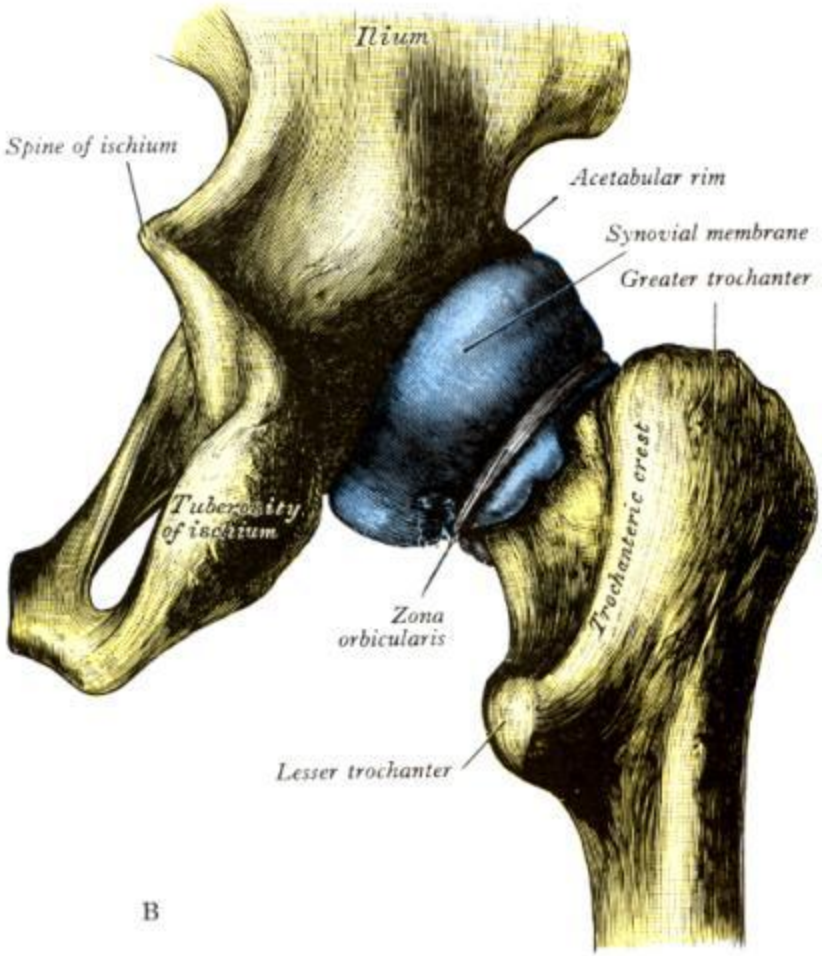


Major Ligaments

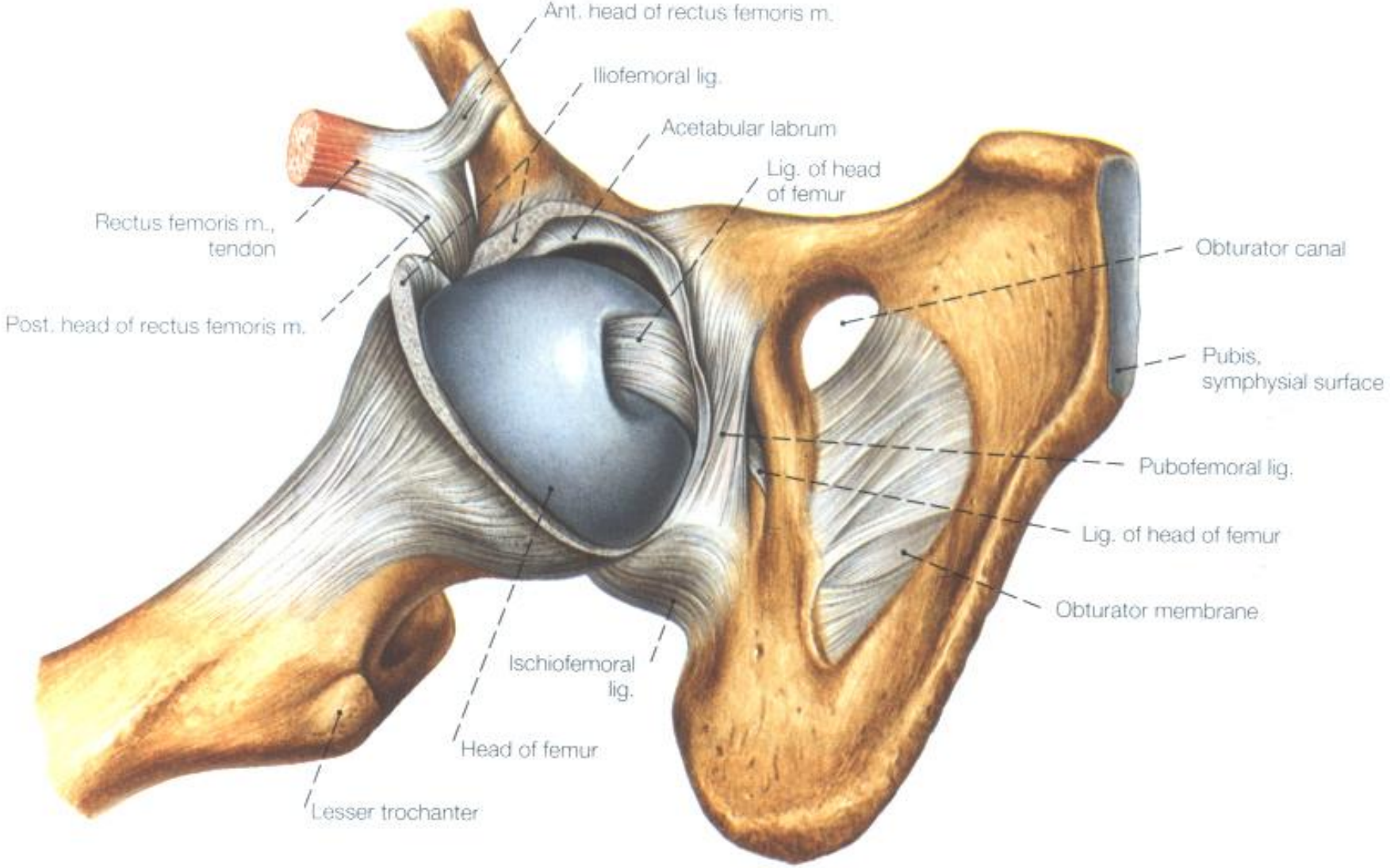
1. Coracoacromial lig.
2. Coracoclavicular lig.
   - 2A. Conoid
   - 2B. Trapezoid
3. Acromioclavicular lig.


Acromioclavicular joint and lig.
Clavicle, acromial extremity
Acromion
Coracoacromial lig.
Coracoclavicular lig., trapezoid lig.
Supraspinatus m.
Synovial bursa
Coracoclavicular lig., conoid lig.
Coracoid proc.
Sup. transverse scapular lig.
Coracohumeral lig.
Scapular notch
Greater tubercle
Subtendinous bursa of subscapularis m.
Subscapularis m., tendon
Intertubercular tendon sheath
Articular capsule, glenohumeral ligg.: -superior -middle -inferior
Anatomical neck
Biceps brachii m., long head
Crest of greater tubercle
Infraglenoid tubercle
Intertubercular sulcus
Crest of lesser tubercle
Axillary recess


Articular cartilage of lunate surface
Acetabular labrum
Fibrous capsule
Zona orbicularis
ament of head of femur
Intra-articular pad of fat in acetabular fossa
Transverse ligament of acetabulum
Fibrous capsule
Zona orbicularis


Ilium
Spine of ischium
Acetabular rim
Synovial membrane
Greater trochanter
Tuberosity of ischium
Zona orbicularis
Trochanteric crest
Lesser trochanter

B

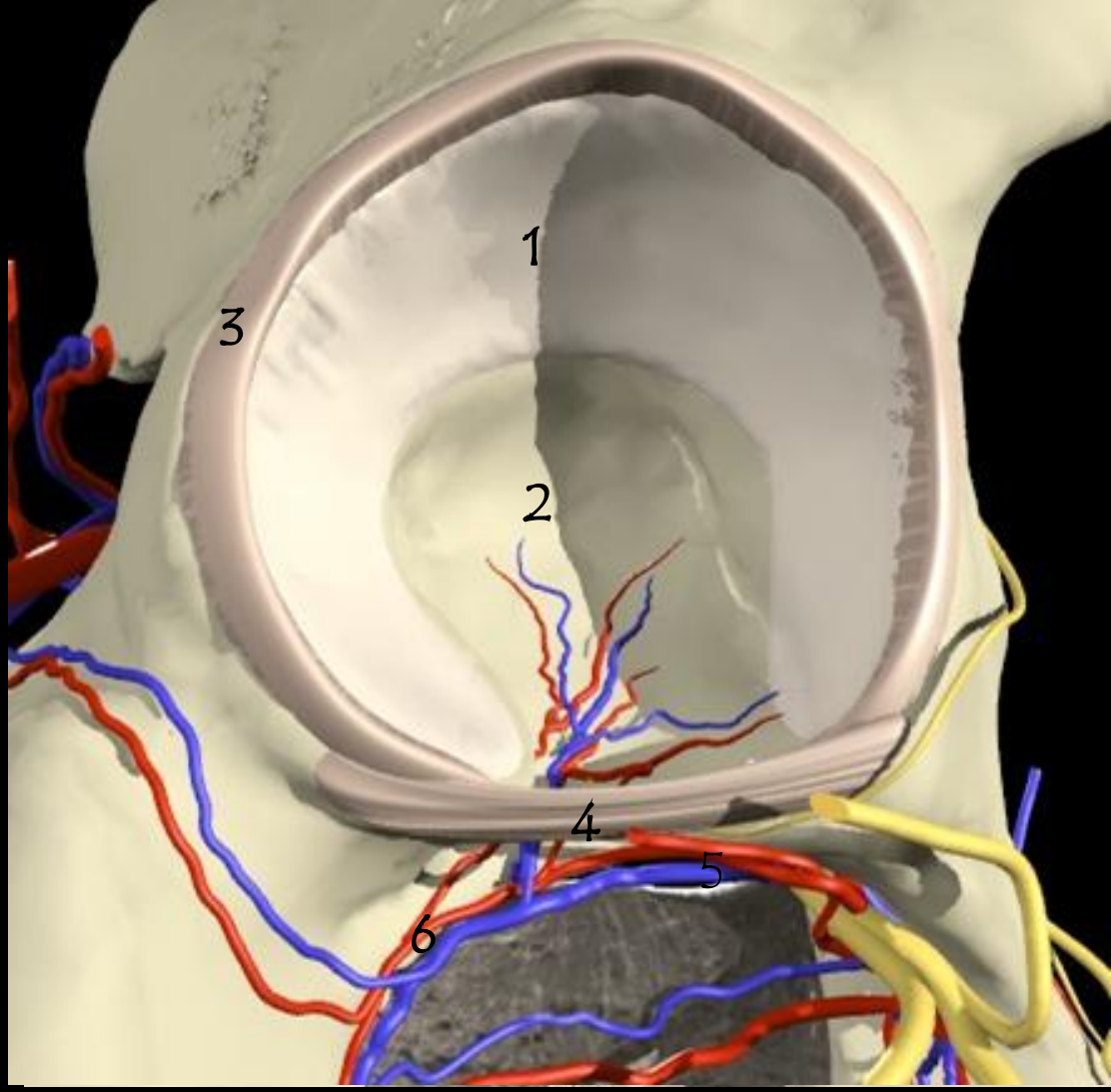

Ant. head of rectus femoris m.
Iliofemoral lig.
Acetabular labrum
Lig. of head of femur
Rectus femoris m., tendon
Post. head of rectus femoris m.
Obturator canal
Pubis, symphysial surface
Pubofemoral lig.
Lig. of head of femur
Obturator membrane
Ischiofemoral lig.
Head of femur
Lesser trochanter

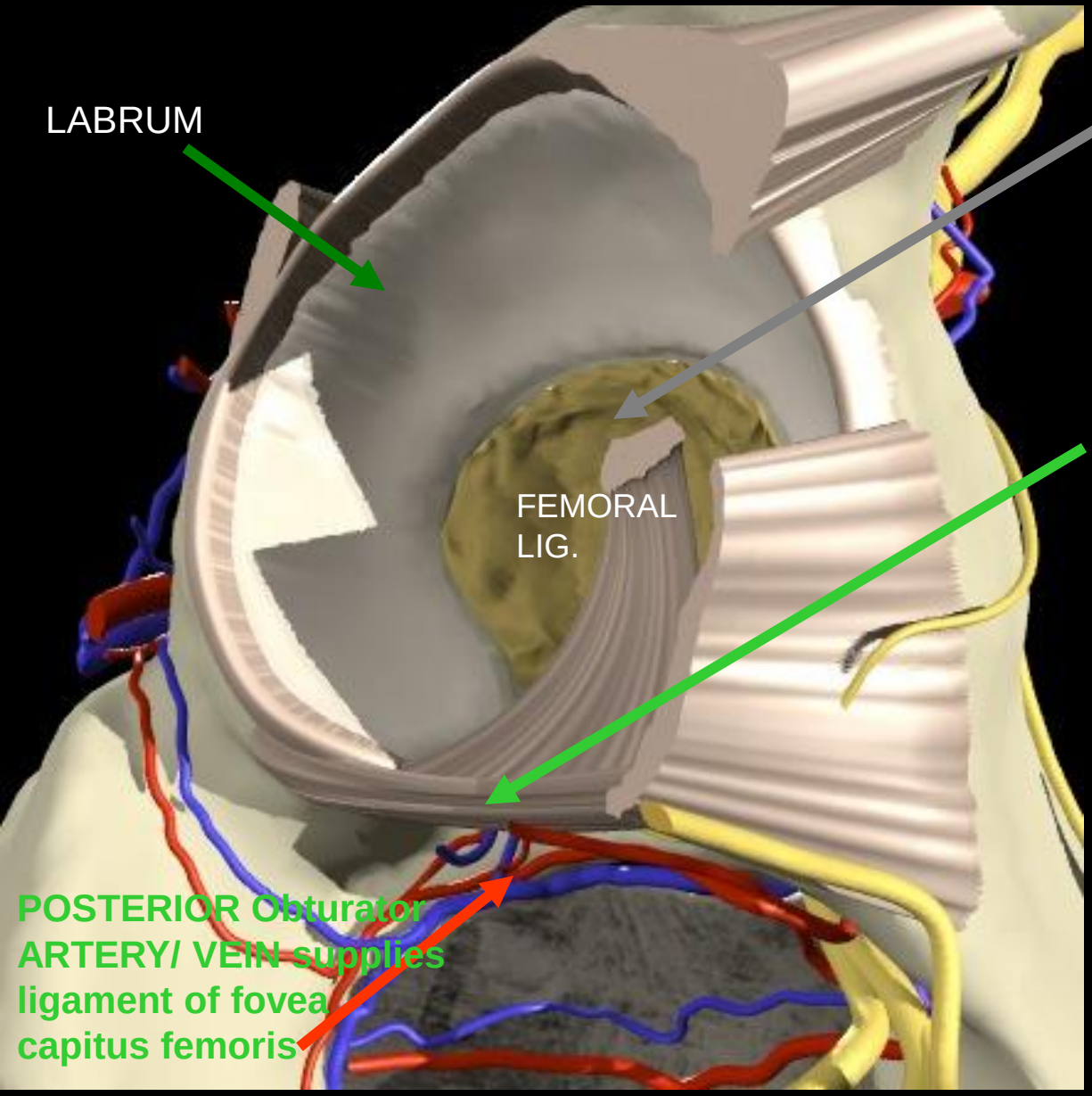

Tensor m. of fascia lata
Gluteus medius m.
Gluteus minimus m.
Trochanteric fossa
Greater trochanter
Gluteus maximus m., tendon*
Trochanteric bursa of gluteus maximus m.
Trochanteric bursa of gluteus medius m.
Iliotibial tract
Vastus lateralis m.
Lunate surface
Articular cavity
Head of femur
Acetabular fossa
Lig. of head of femur
Fovea on head of femur
Obturator internus m.
Neck of femur
Acetabular labrum
Obturator externus m.
Iliopsoas m., tendon
Lesser trochanter

ACETABULUM

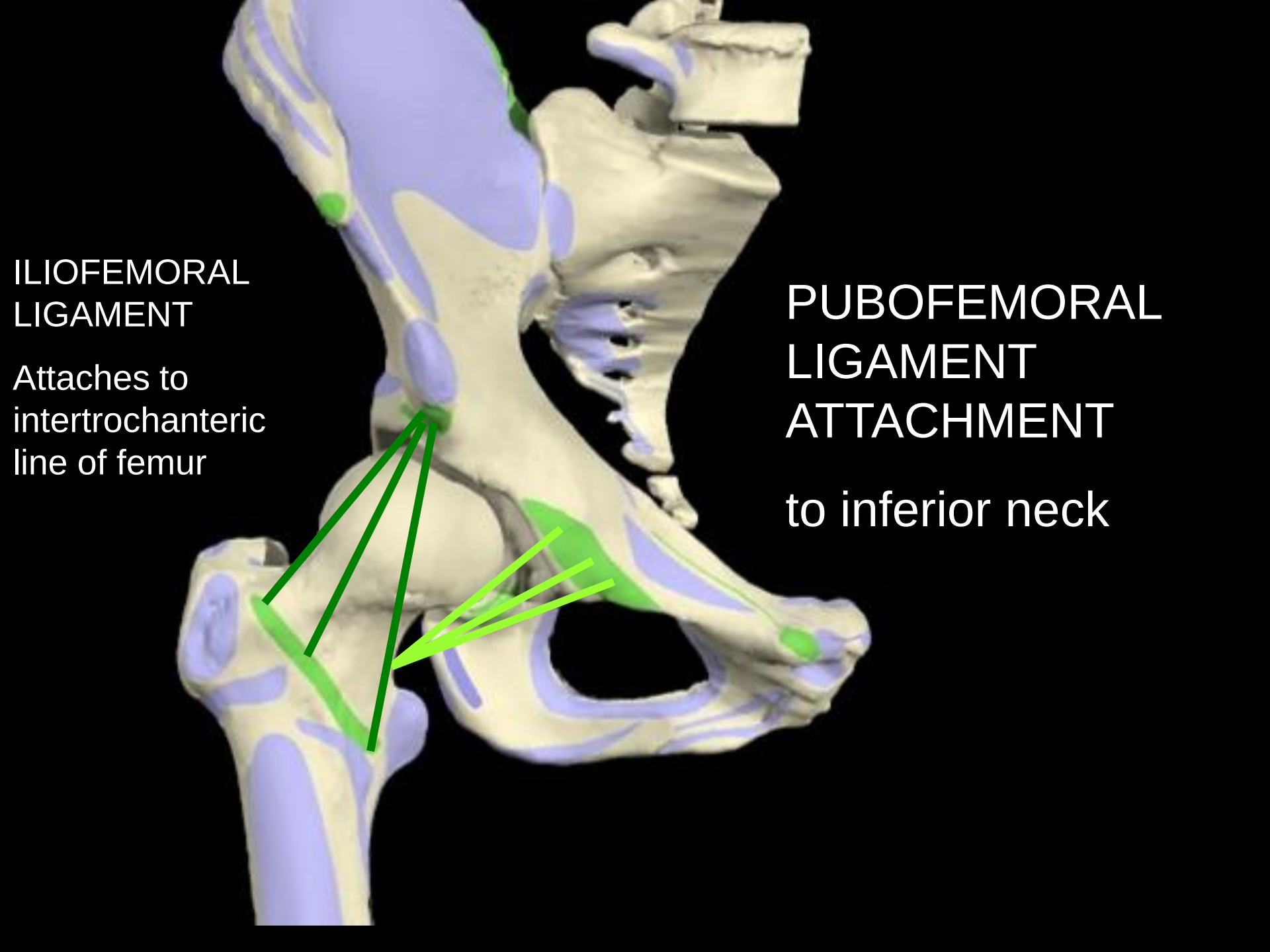
INCOMPLETE RING OF BONE

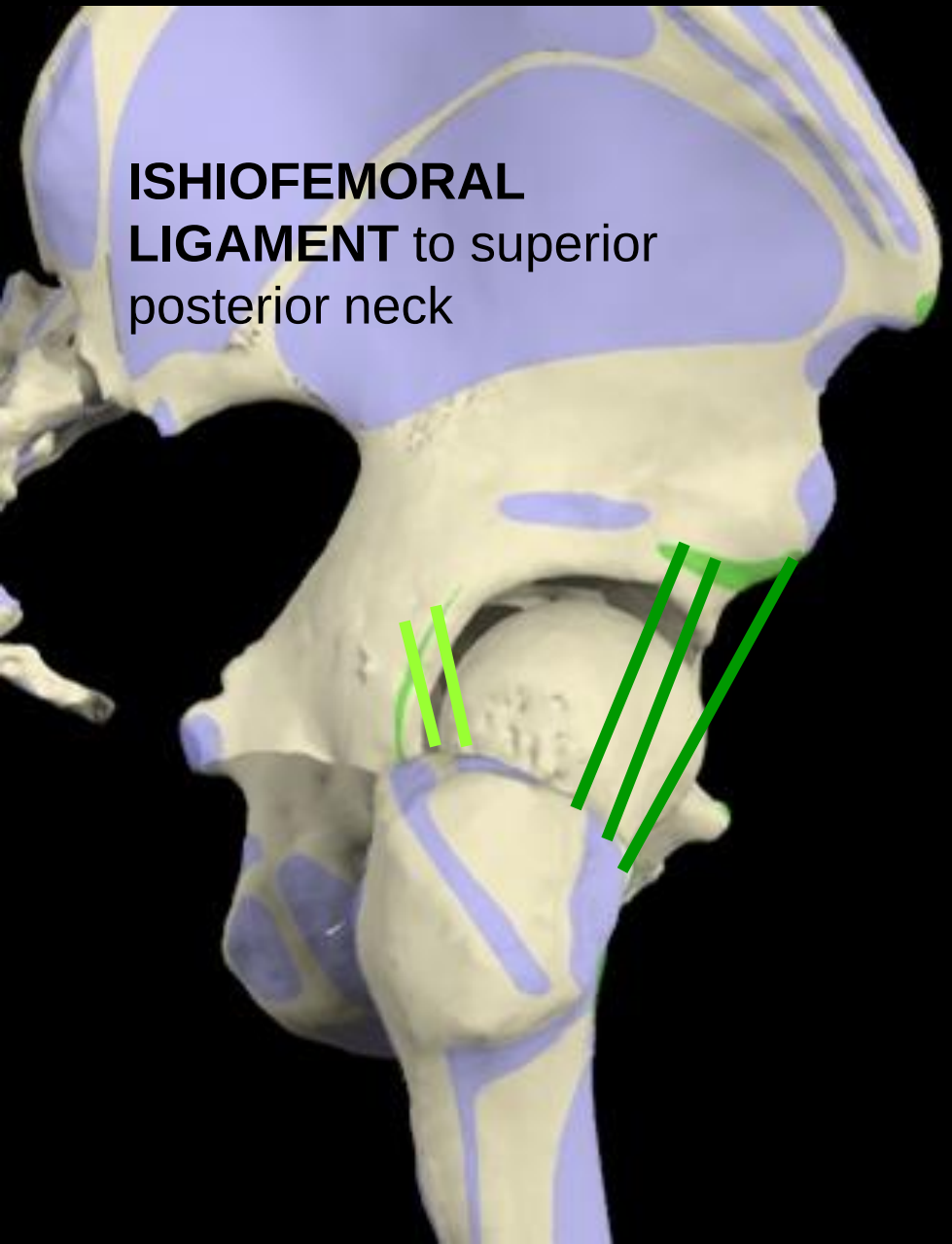
1. LUNATE (ARTICULAR) CRESCENT
2. ACETABULAR FOSSA WITH INTRA-ARTICULAR FAT PAD
3. LABRUM – FIBROCARTILAGENOUS
4. TRANSVERSE ARTICULAR LIGAMENT (DEMARCATING FORAMEN FOR COMMUNICATION OF NERVES, VESSELS.
5. Ant. Obturator ARTERY/VEIN
6. Posterior Obturator ARTERY/VEIN source of acetabular vessels





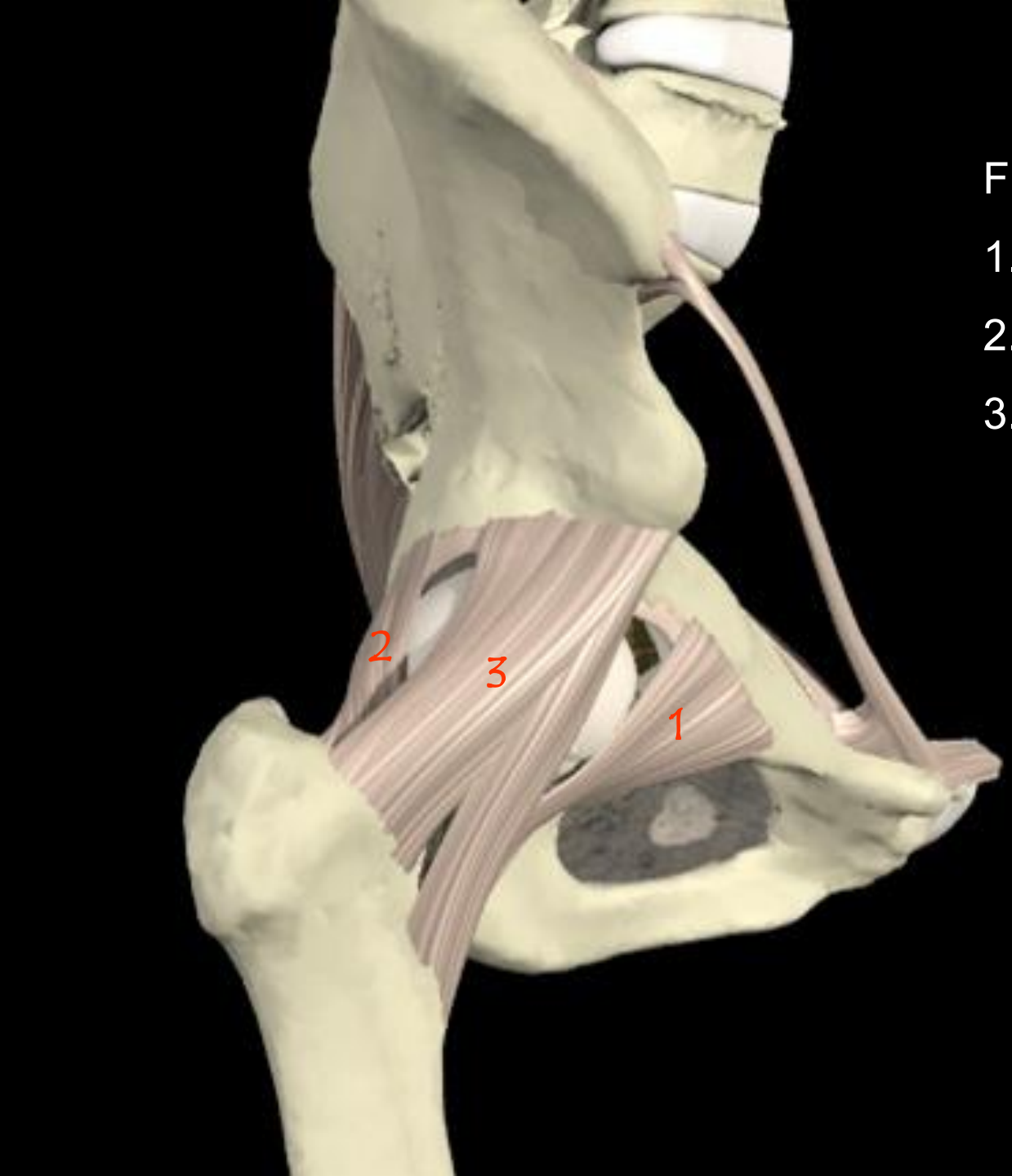
FEMORAL LIGAMENT DOES NOT PREVENT DISLOCATION OF FEMURAL HEAD


ILIOFEMORAL LIGAMENT
Attaches to intertrochanteric line of femur
PUBOFEMORAL LIGAMENT ATTACHMENT
to inferior neck



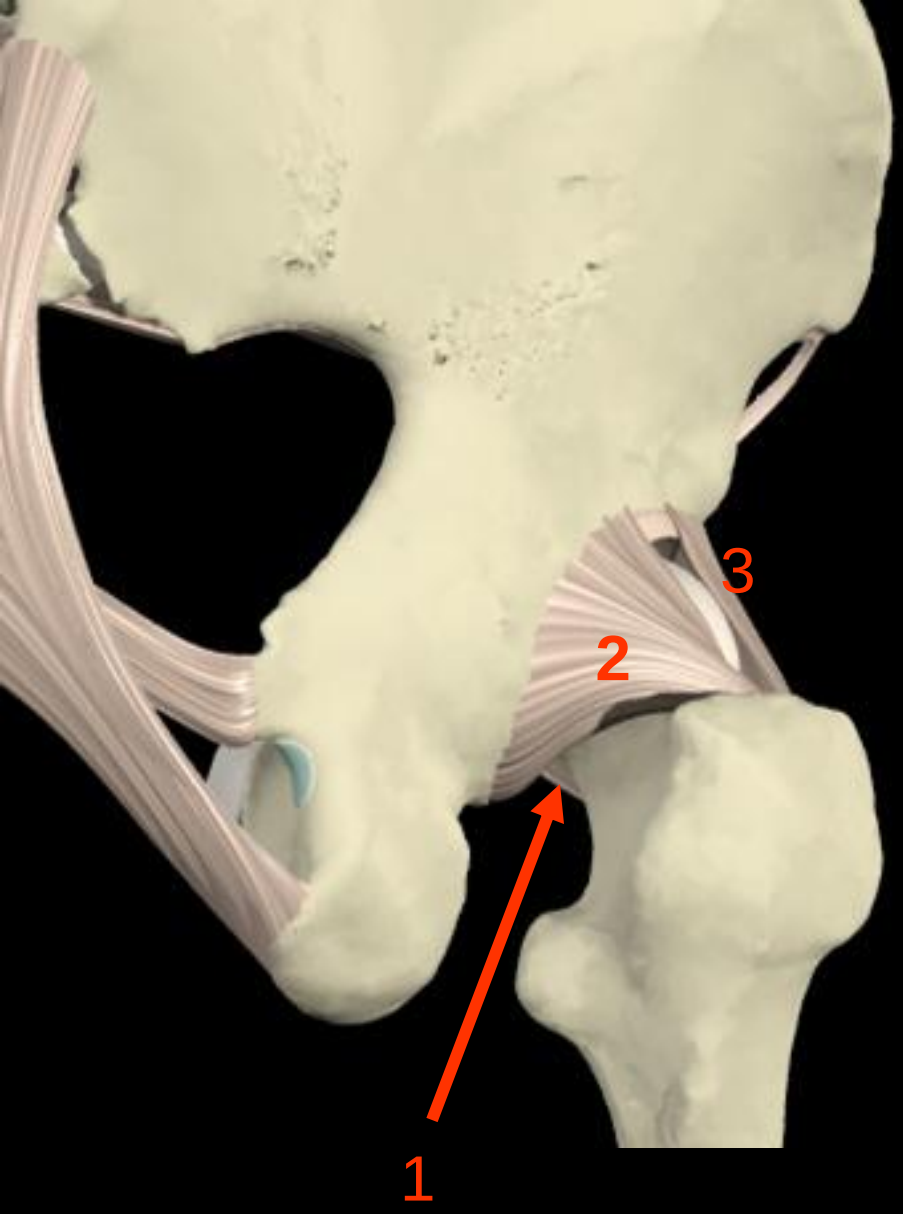
ILIOFEMORAL LIGAMENT

Attaches to intertrochanteric line of femur



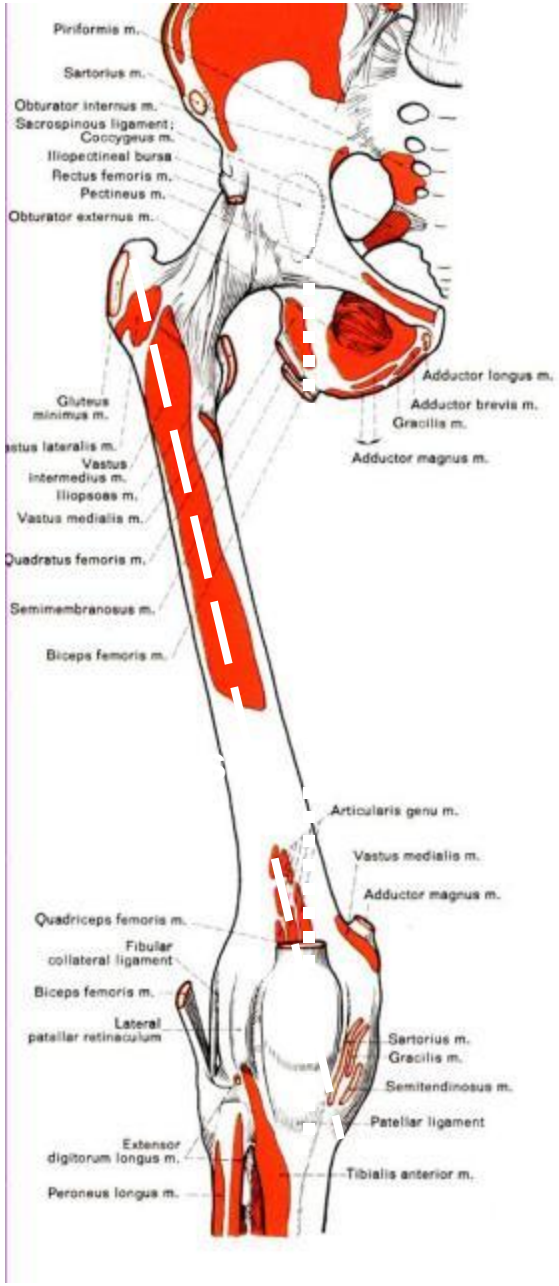
FEMORAL LIGAMENTS

1. PUBOFEMORAL
2. ISHIOFEMORAL
3. ILIOFEMORAL



FEMORAL LIGAMENTS

1. PUBOFEMORAL
2. ISHIOFEMORAL
3. ILIOFEMORAL



Note that the articulation of the femur at the tibia is not straight (180 degrees)

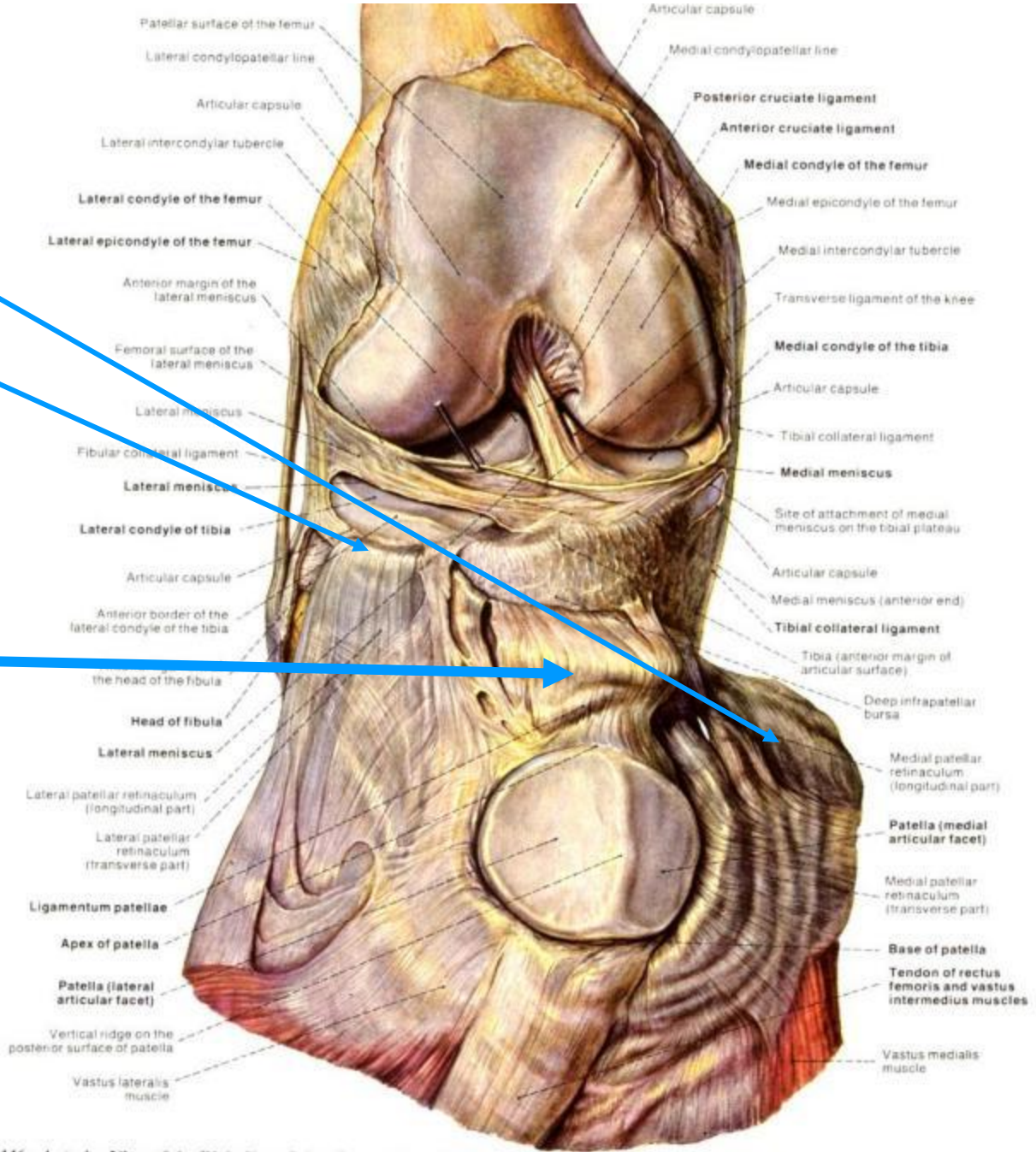
This angle is know as the VALGUS angle. Typically 170-175 degrees but …

It is more often greater in women because of the more widely-spaced acetabula.

Additional attachments

(patellar retinaculum)

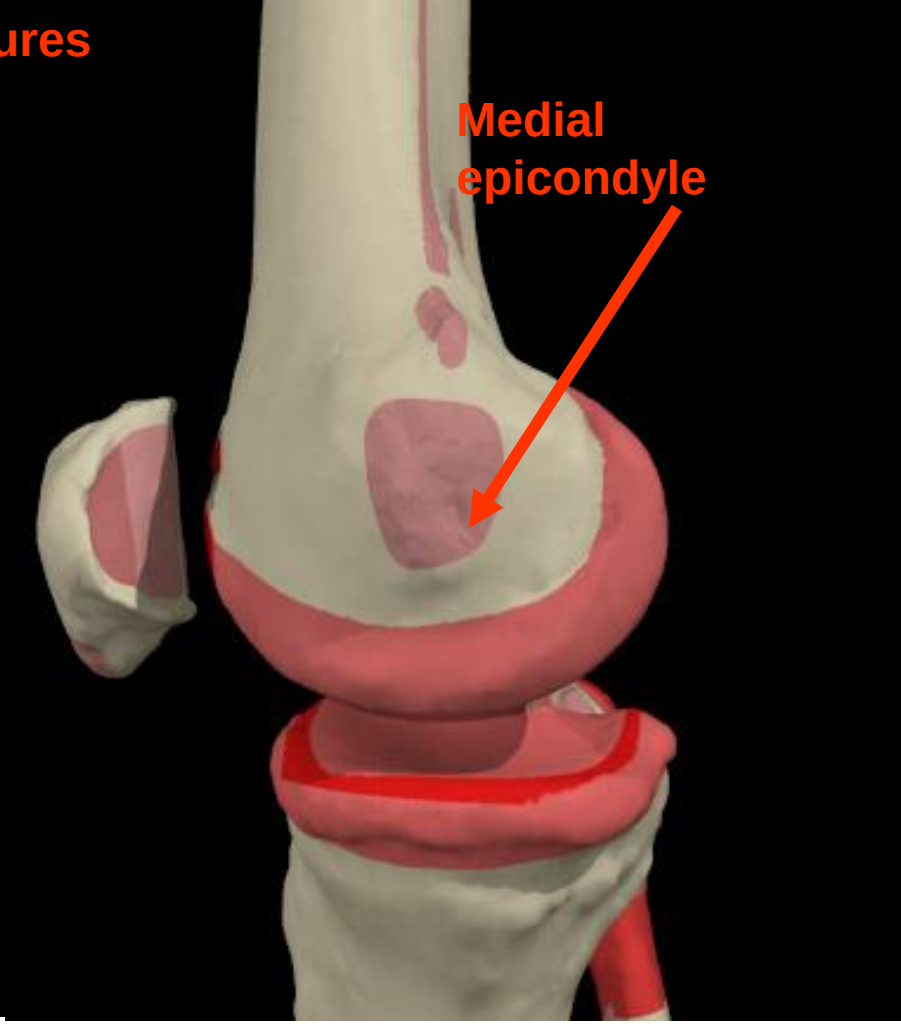
Patellar ligament



g. 446: Anterior View of the Right Knee Joint, Opened from the Front to Expose the Ligaments and Menisci

Knee Joint/ ARCHITECTURE / Osseous features

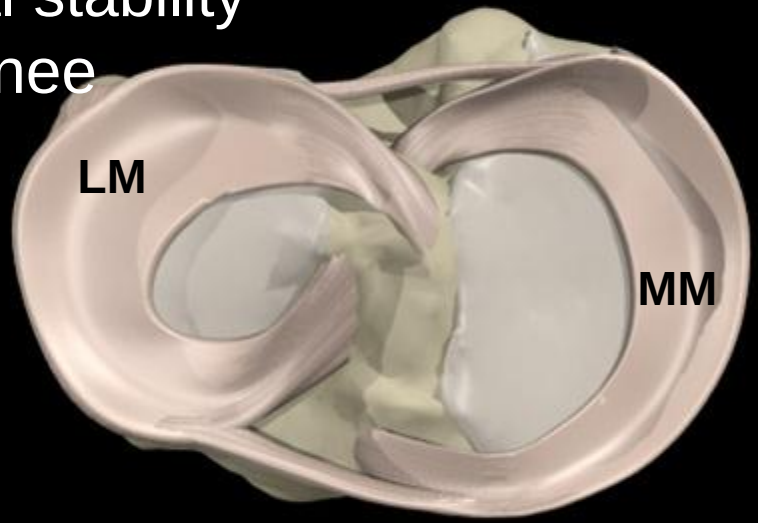
POSTERIOR VIEW

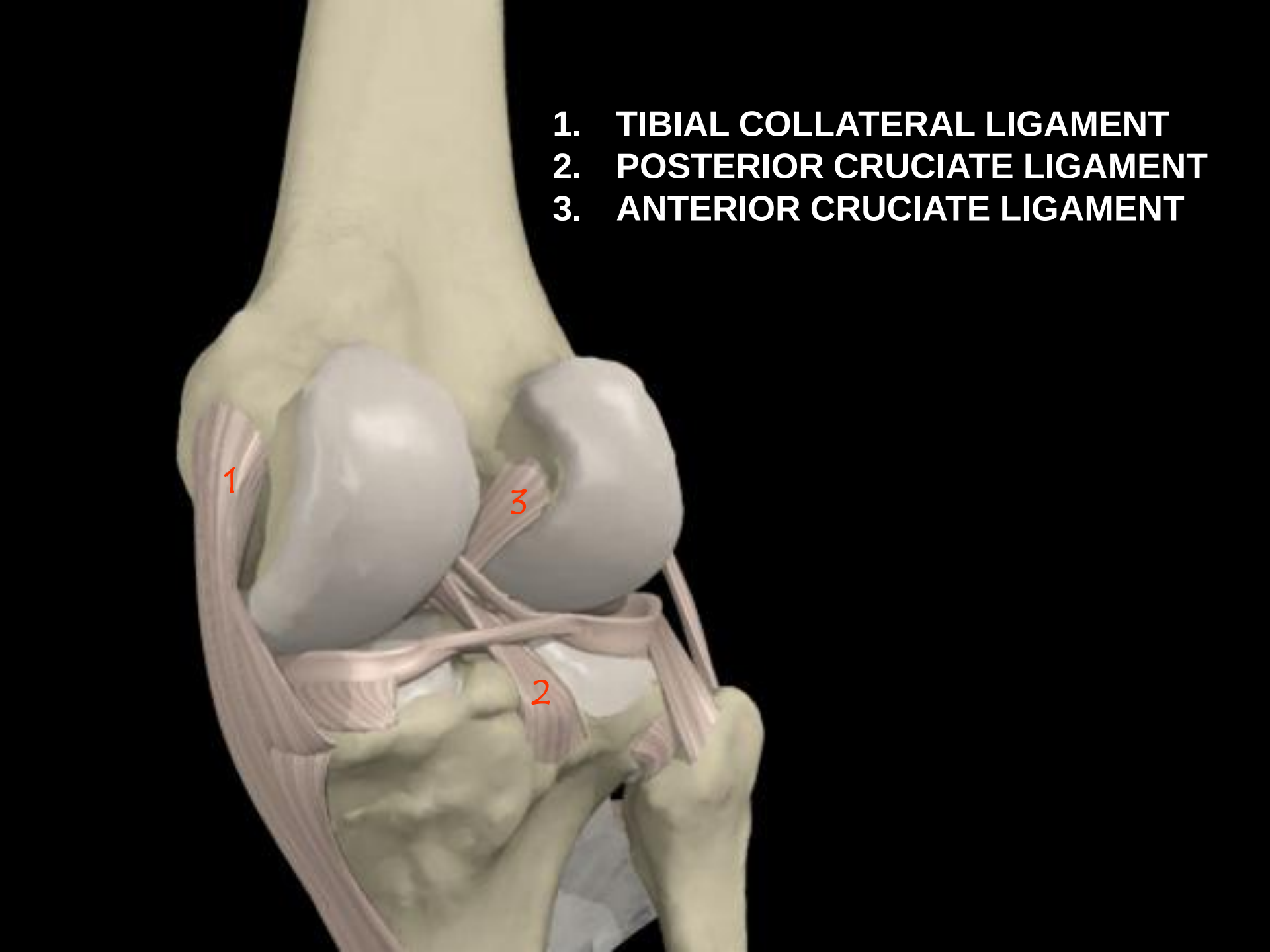


MEDIAL VIEW

Mensici – increase joint congruence

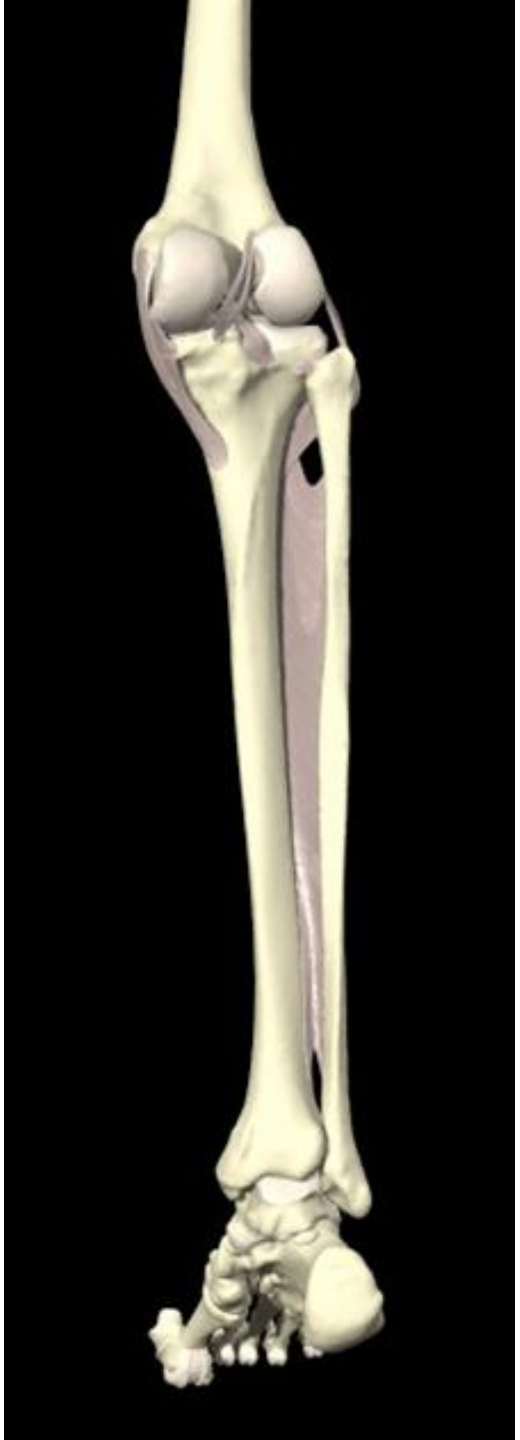
Collateral ligaments – increase lateral stability and promote knee locking




1. TIBIAL COLLATERAL LIGAMENT
2. POSTERIOR CRUCIATE LIGAMENT
3. ANTERIOR CRUCIATE LIGAMENT
1
3
2

Structures to be identified in your bone boxes

- **Distal femur**: lateral and medial condyles (articular and attachment surfaces), patellar surface, intercondylar fossa, epicondyles.
- **Fibula**: head, shaft, lateral malleolus, interosseus membrane attachment
- **Tibia**: condyles, intercondylar notch, patellar (tibial) tuberosity, medial malleolus, facet for fibular head, fibular notch, attachment of soleus muscle, interosseus membrane attachment;
- Patella



Posterior view

3 FUNCTIONAL JOINTS in foot

Functional joint = unit of movement

1. TALOCRURAL
2. SUBTALAR (incl. Talo-calcaneal of TCN)
3. TRANSVERSE TARSAL (incl. Talo-navicular of TCN)

Medial: medial collateral ligament (MCL); very strong, trauma by means of avulsion rather than material failure.

"deltoid ligament" superficial

- **posterior tibio-talar**
- **tibiocalcaneal**
- **tibionavicular.**

deep ligaments

- *anterior talotibial ligament*
- *posterior talotibial ligament*

Lateral: lateral collateral ligament (LCL)

- *anterior talofibular ligament*
- *posterior talofibular ligament* -- resists ANTERIOR displacement, allows fibular rotation
- *calcaneofibular ligament* – resist posterior displacement

Anterior:

- *anterior tibiofibular ligament*

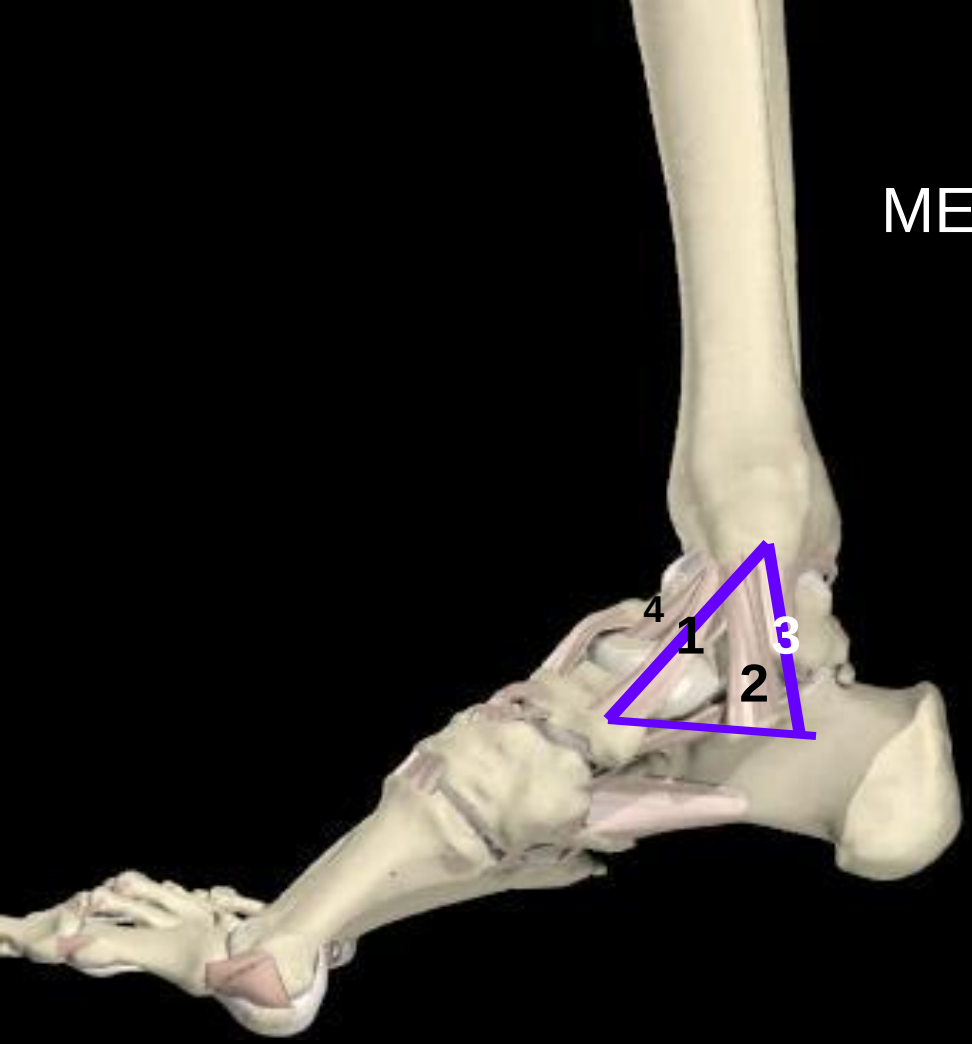
Posterior:

- *posterior tibiofibular ligament*
- *inferior transverse tibio-fibular ligament.*

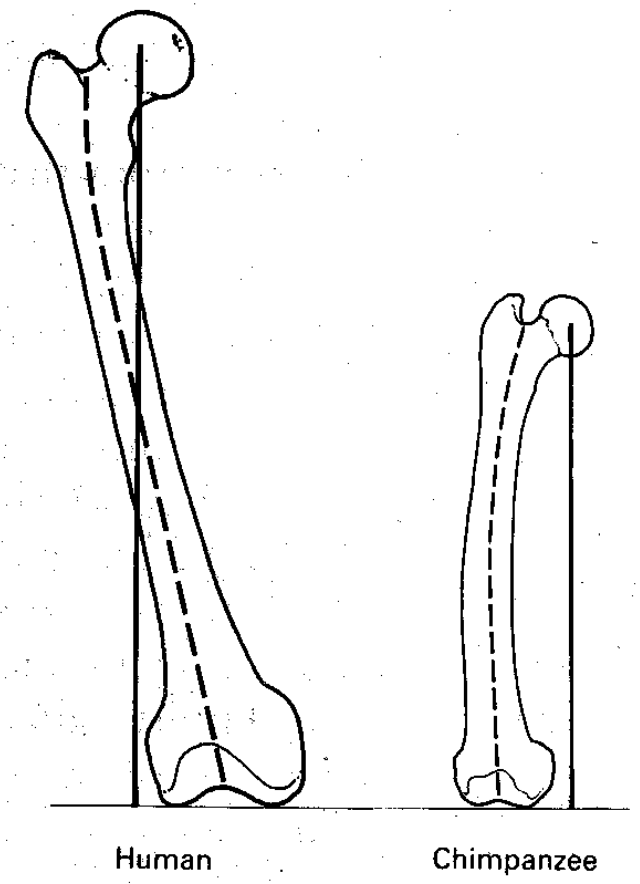
Superior:

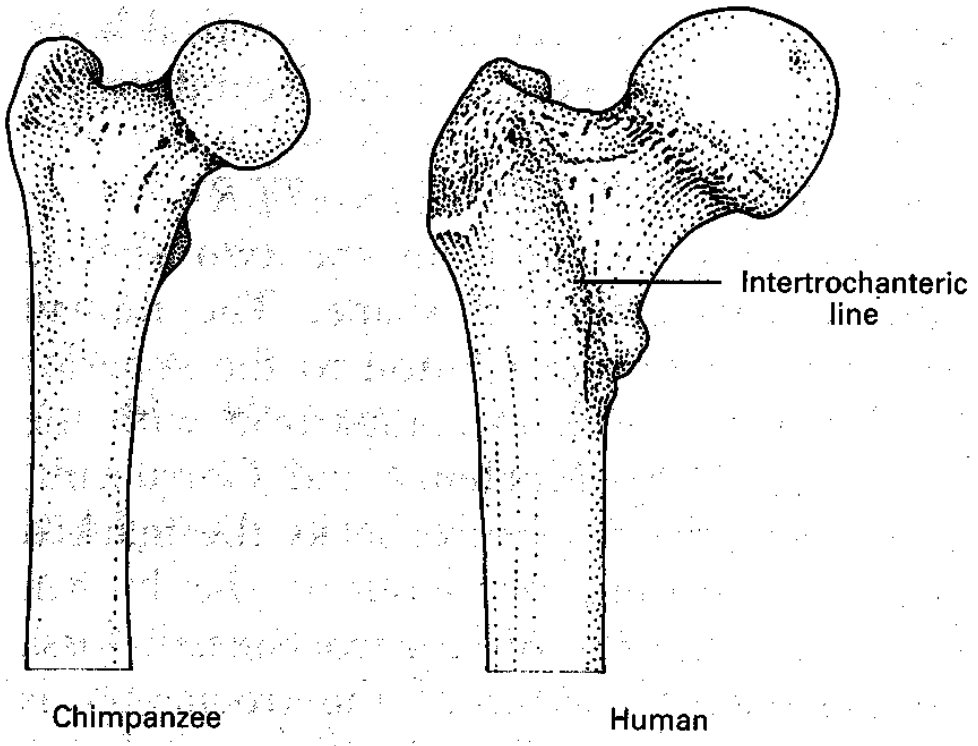
- *interosseous membrane & ligament*

MEDIAL COLLATERAL LIGAMENT (MCL)



1. TIBIONAVICULAR PART
2. TIBIOCALCANEAL PART
3. POSTERIOR TIBIO-TALAR PART
4. ANTERIOR TIBIO-TALAR PART


Human
Chimpanzee


Intertrochanteric line
Chimpanzee
Human

The Skeleton, Nutrition, Sex, and Growth

SEX	NUTRITION	
	Good	Poor
Male	Continued Growth, Greater Height	Reduced Growth SHORTER than normal height
Female	Energy to Reproduction & Supporting Fat Reserves	Delayed onset of reproductive ability; Continued bone growth; TALLER