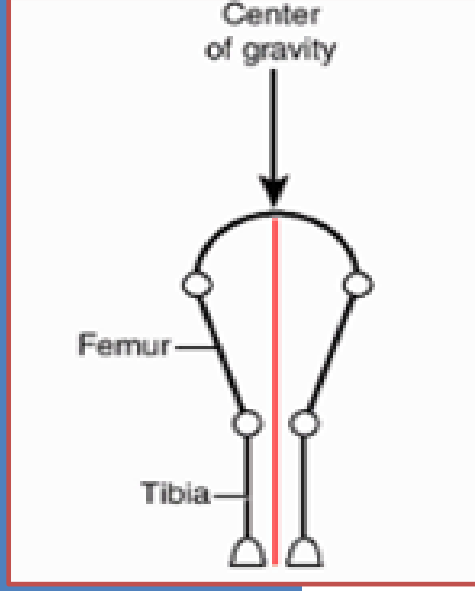


Chapter-3

Radiographic positioning of lower limb

By ***Samuel. B***

Contents

- Foot
- Ankle joint
- Leg
- Knee joint
- Femur
- Hip joint and pelvic

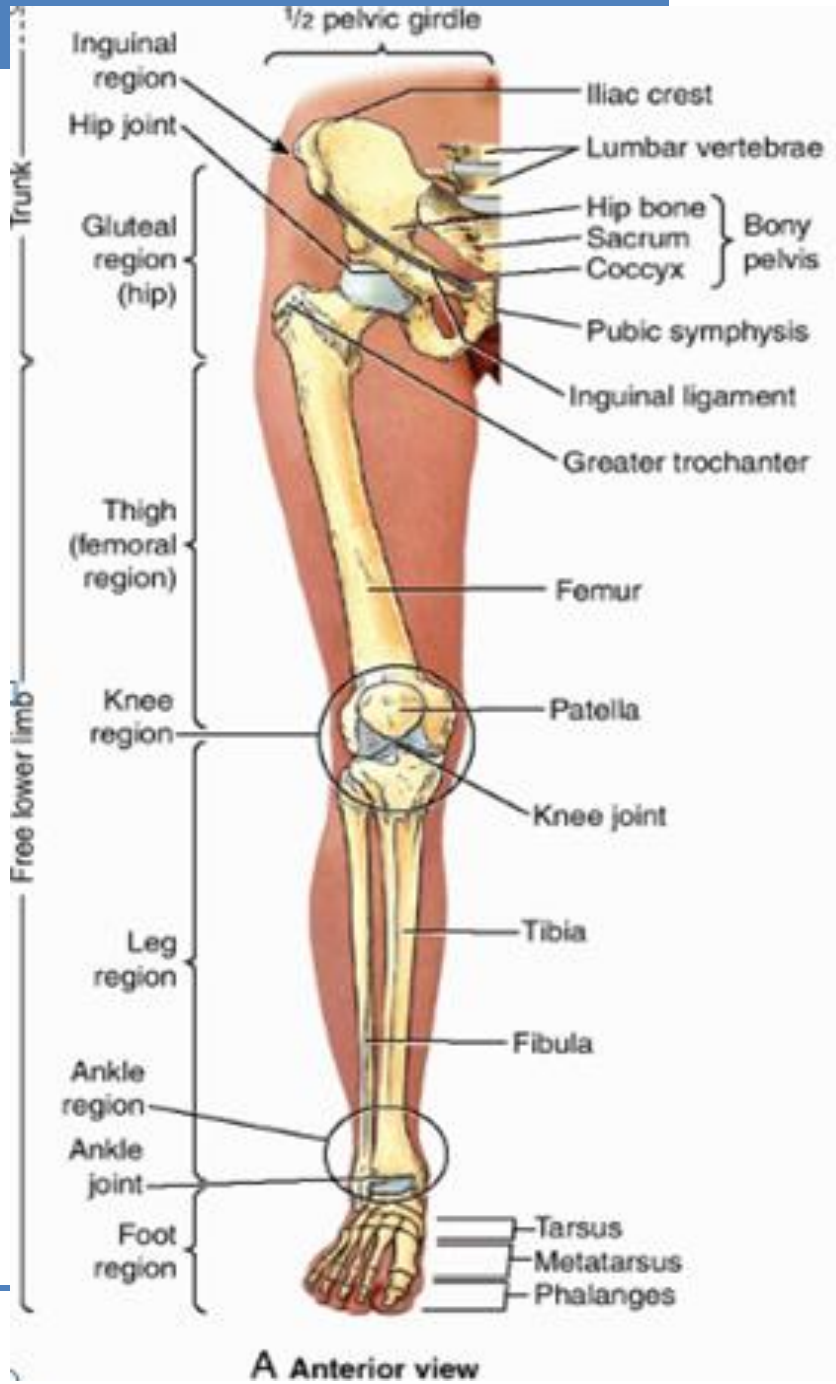
Objectives:-

At the end of this session you will be able to:-

- Identify ***anatomy of lower limb***
- Discuss ***basic and alternative projection*** of lower limb, with clinical indications.
- ***Evaluate radiographs*** upper limb in terms of positioning ,centering , image quality, radiographic anatomy and pathology.

Anatomy overview

- Lower limb has six regions:
  - ✓Gluteal region,
  - ✓Femoral region,
  - ✓Knee region,
  - ✓leg region,
  - ✓Ankle region, and
  - ✓Foot region.



❖FOOT

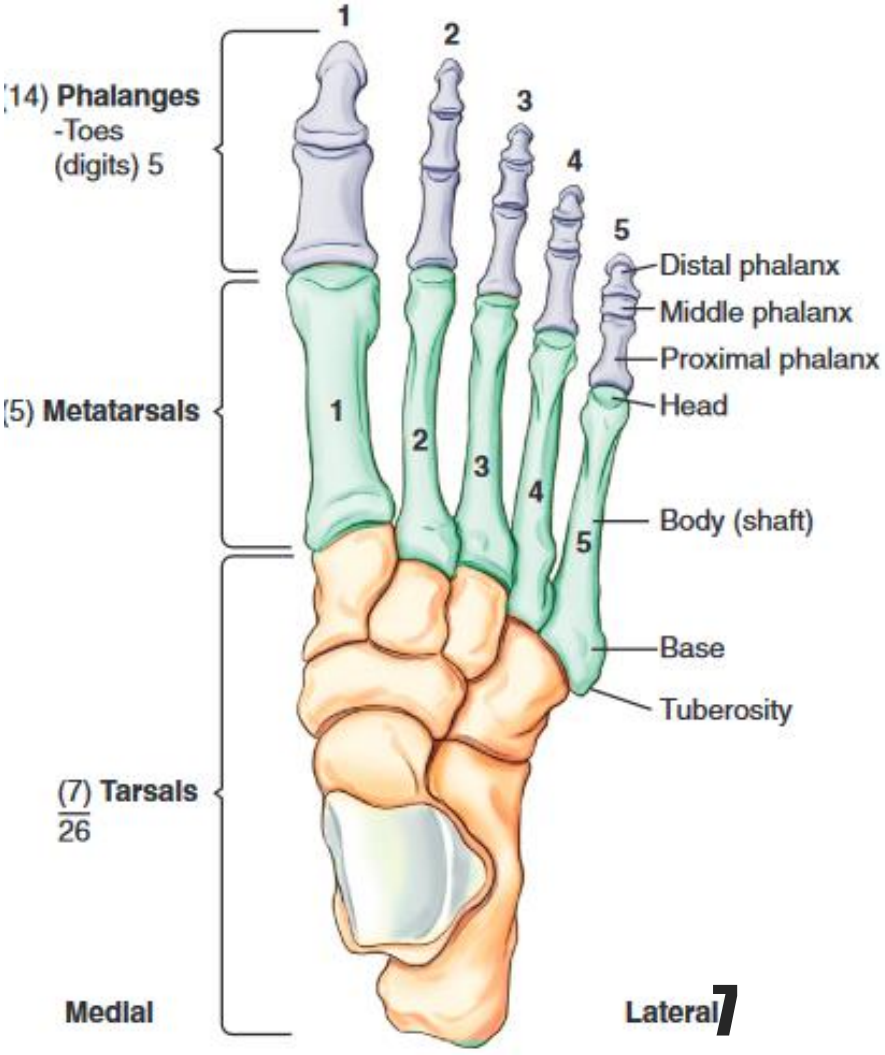
Radiographic Anatomy

- The 26 bones of one foot are divided into **three groups** as follows:-

1. ***Phalanges (toes or digits) 14,***
2. ***Metatarsals (instep) 5, and***
3. ***Tarsals 7.***

Anatomy…

- **Phalanges(toe):-**
  - **Hallux (big toe):-**
    1. Distal, &
    2. Proximal phalanges.
  - In each **other toes**:-
    a. Distal,
    b. Middle, &
    c. Proximal phalanges.
  - Each phalanx contain **body**, **base** and **head**.



❑TARSALS:-

- Proximal foot contain 7 tarsals:-
  I. Talus
  II. Calcaneus
  III. Navicular
  IV. Cuboid
  V. 3 Cunieforms:-
    1. Medial(1st)
    2. Intermediate(2nd)
    3. Lateral(3rd)

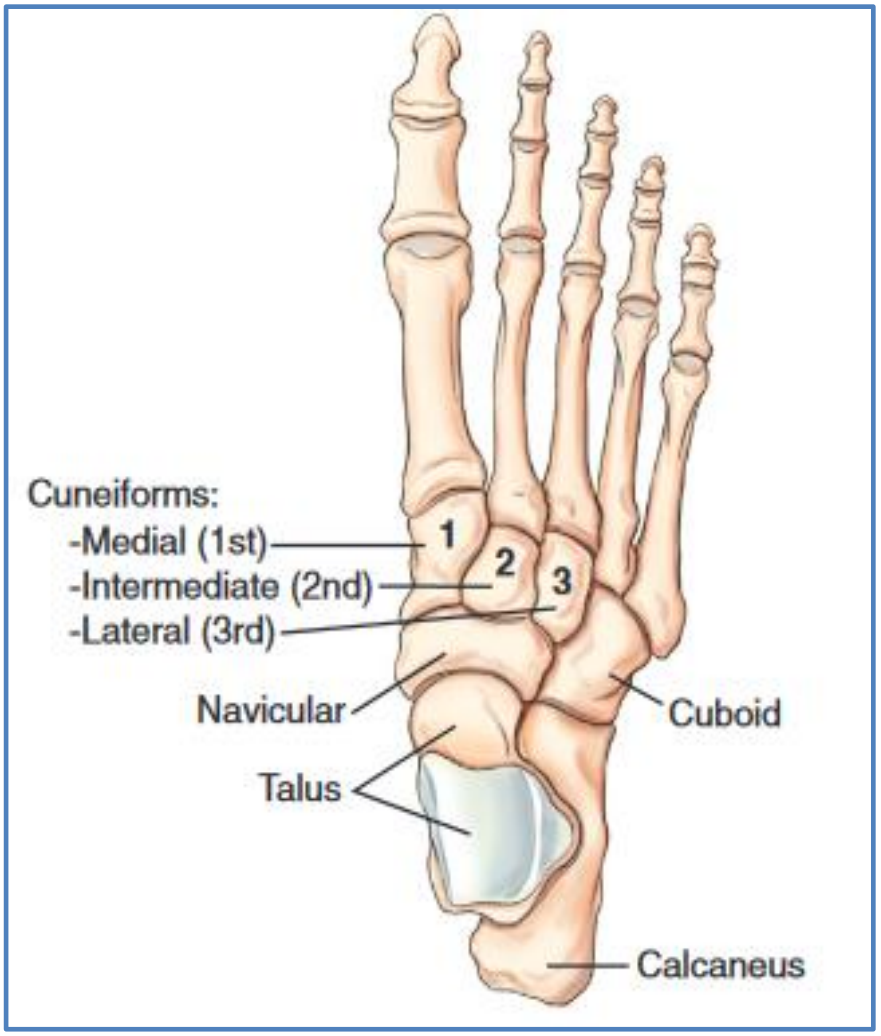
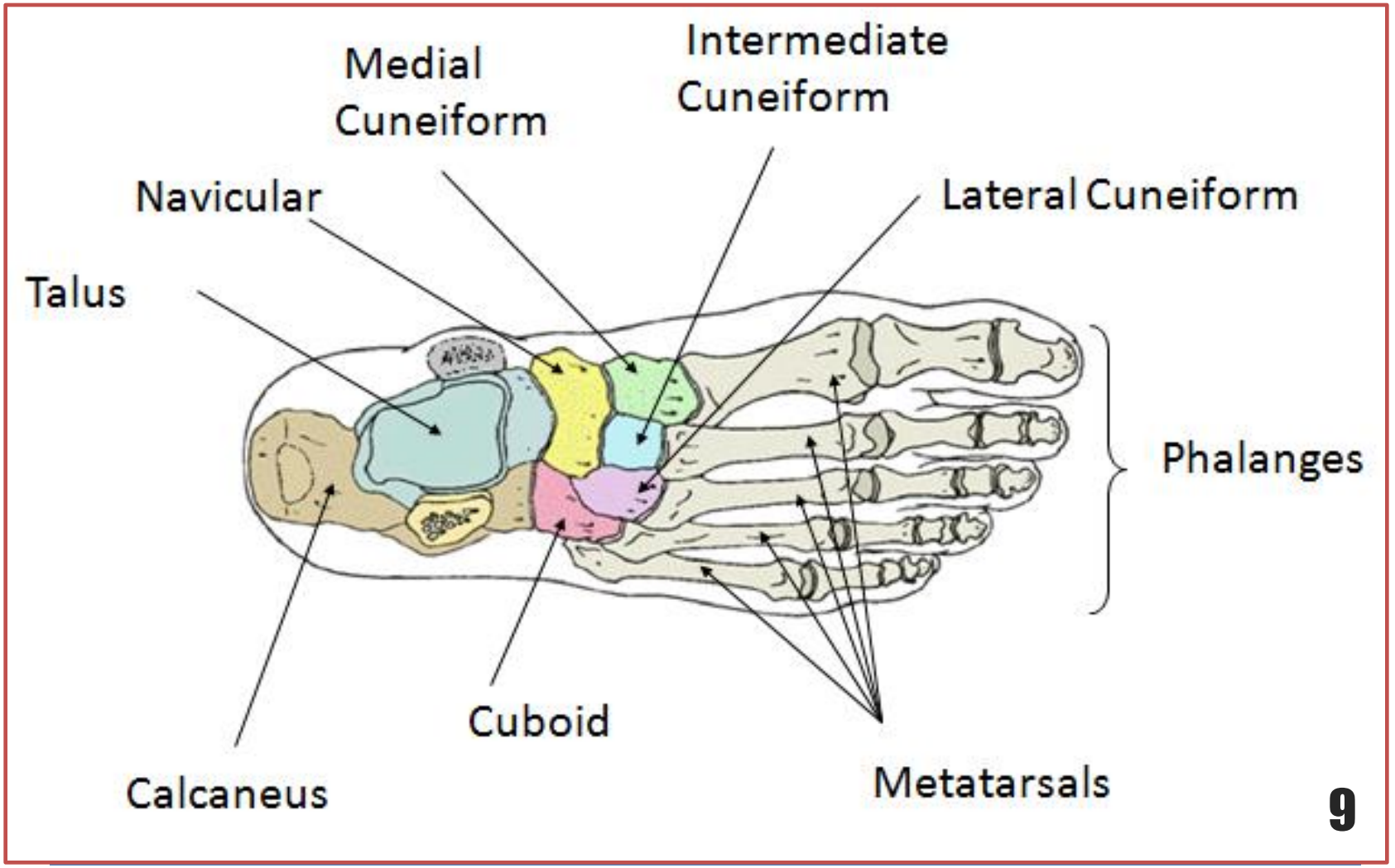
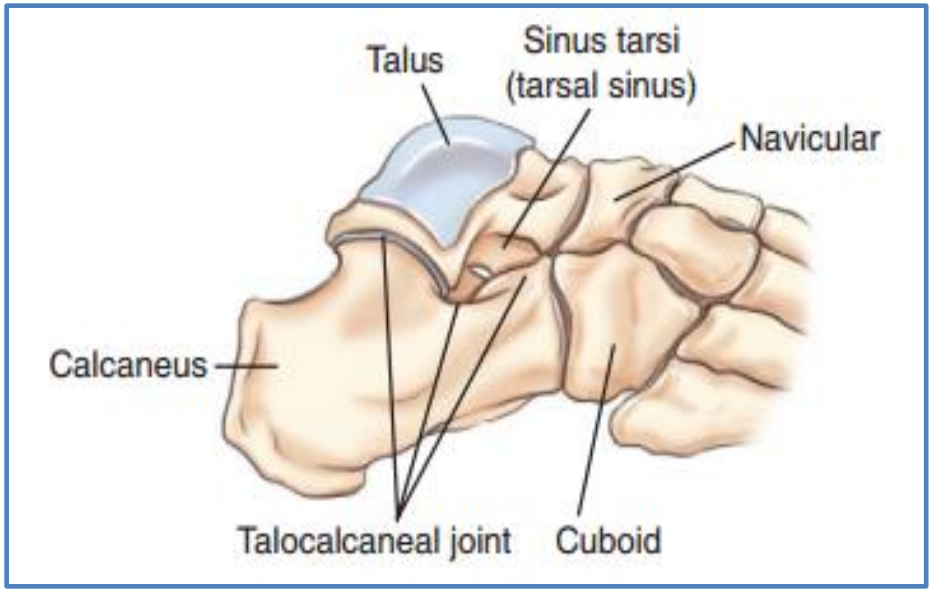


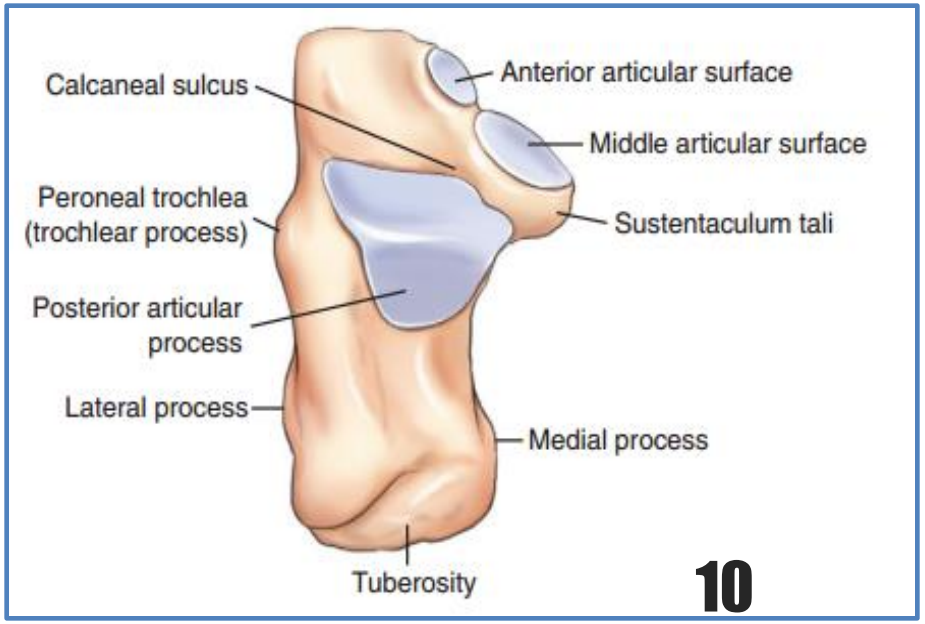
Fig. foot, dorsal aspect



❑ ***Calcaneus:-***

- The largest and strongest bone of the foot.
- Articulate, ***anteriorly with the cuboid*** *and* ***superiorly with the talus.***





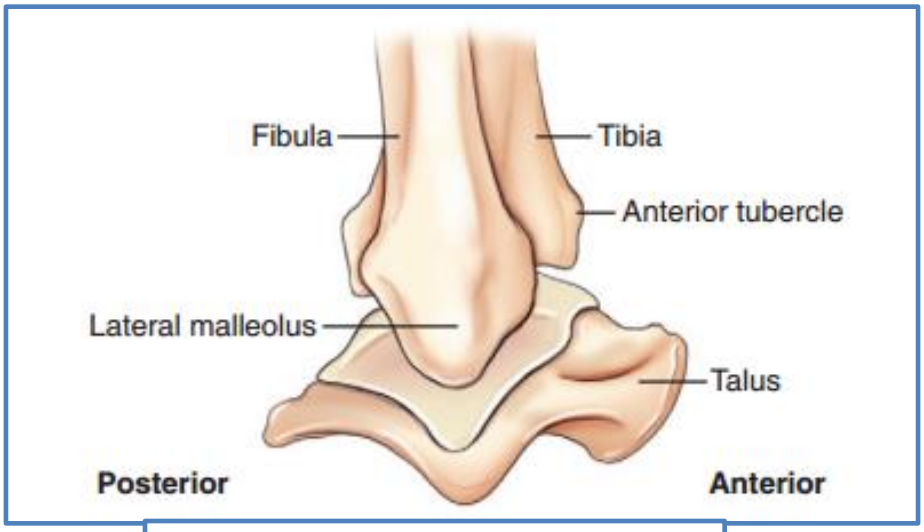
Cont'd…

- **Joints of the foot:-**

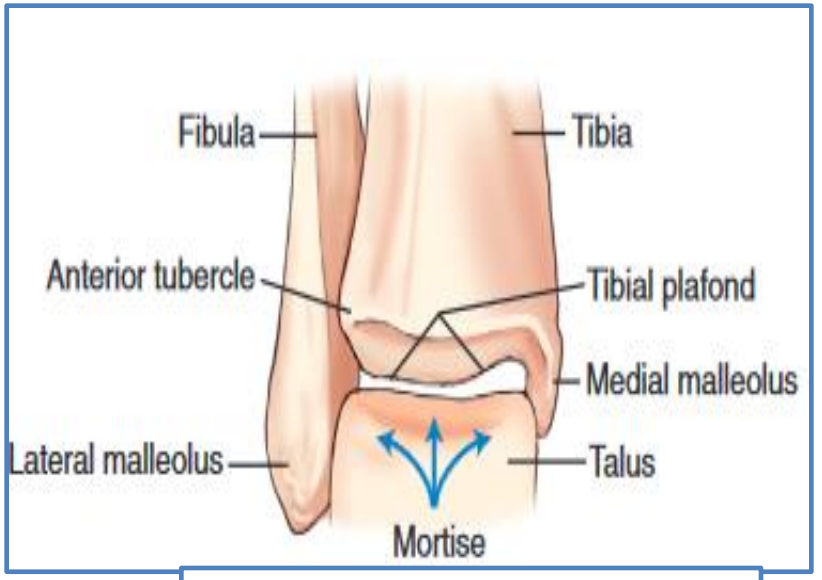
1. Ankle joint
2. Distal tibiofibular
3. Intertarsal
4. Metatarsophalangeal
5. Interphalangeal

Ankle joint:-

- The ankle joint is formed by three bones:-
  1. **Tibia,**
  2. **Fibula**, and
  3. One tarsal bone, the **talus.**



True lateral view



frontal view

RADIOGRAPHY

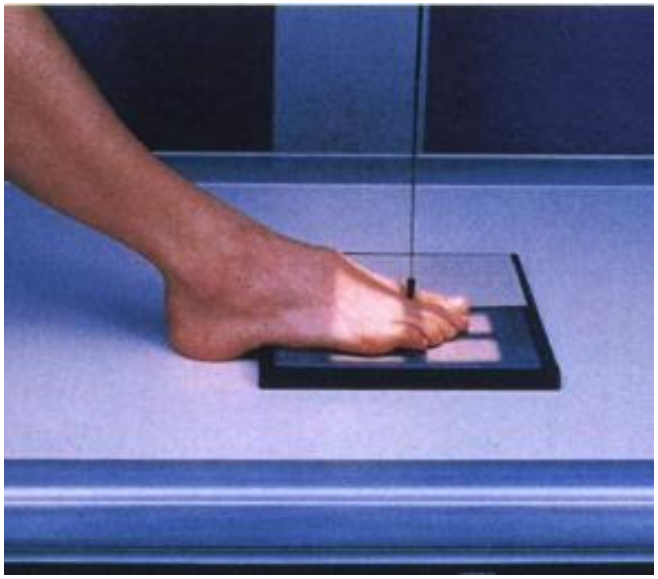
TOES

- ***Technical factors:***
  - ✓***Film size*** *:- 18x24cm(crosswise)*
  - ✓***Non grid***
  - ✓***kv selection****: –50-55kvp*
  - ✓***FFD****:- 100cm*
- ***Shielding -*** *use gonad shield for all pts.*
- ***Routine projections:-***
  1. ***AP,***
  2. ***oblique &***
  3. ***Lateral***

1. AP TOES

- ***Patient position:-***
  - Place patient supine or seated on table; knee should be flexed with plantar surface of foot resting on IR.
- ***Part position:***
  - Center and align long axis of digits to CR.
  - Center the toe over one half of the IR.
- ***CR:***
  - perpendicular to the ***3rd metatarsophalangeal*** joint.

fig, AP toe



- ***Image evaluation:-***
  - ✓No rotation of phalanges
  - ✓Toes separated from each other
  - ✓Distal ends of the metatarsals
  - ✓Soft tissue and bony trabeculation.

Fig, AP – axial ;Toe

- *CR, 10° to 15° posterior*

- *With wedge*

2. AP Oblique; Toe

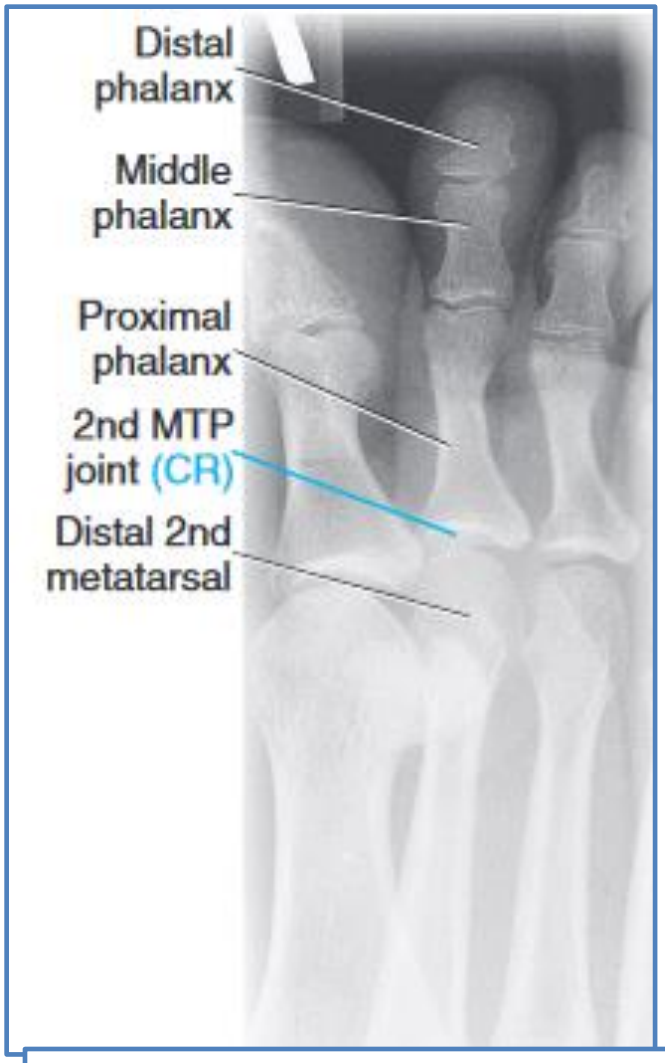
- ***Patient position:***
  - Place patient ***supine or seated*** on table; knee should be flexed with plantar surface of foot resting on IR.
- ***Part position:***
  - Rotate the leg and foot ***30° to 45°, medially*** for the **1st , 2nd** , and **3rd** digits and ***laterally for the 4th and 5th digits.***
  - Use 45° radiolucent support under elevated portion of foot.
- ***CR:-*** directed to ***MTP*** joint in question.

Fig, AP oblique .

- ✓ *Medial rotation for 1st digit*
- ✓ *Lateral rotation for 4th digit*

AP Oblique….

- ***Image evaluation:-***
  - Phalanges in question.
  - Open interphalageal and 2nd through 5th MTP joint.
  - Toes separated from each other.
  - Distal ends of metatarsals.



Oblique 2nd digit

3. LATERAL TOES

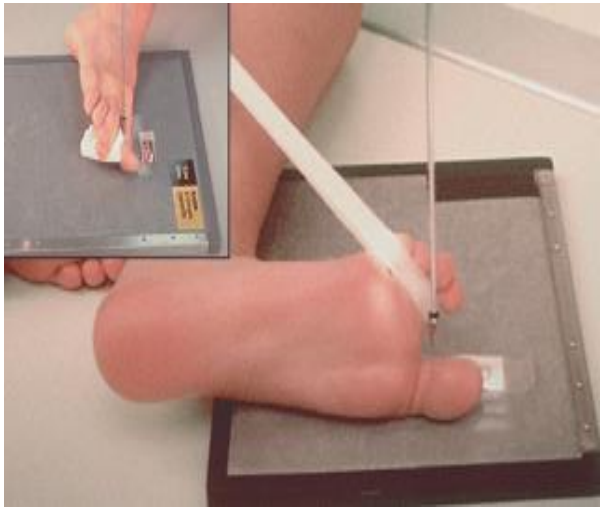
- ***Patient position:-***
  - Have the patient lie in the lateral recumbent position on the affected or unaffected side.
- ***Part position:-***
  - Rotate affected leg and foot ***medially for 1st , 2nd , and 3rd*** digits and ***laterally for 4th and 5th*** digits.
  - align long axis of toe in question to CR.
  - Use tape or gauze to flex and separate unaffected toes to prevent superimposition.

Lateral toes cont'd…

- ***CR:***
  - directed to ***IP joint for 1st digit and to PIP joint for second to fifth digits***
- ***Image evaluation:***
  - ✓Phalanges in profile
  - ✓**Phalanx**, without superimposition of adjacent toes..
  - ✓Open **IP** joint space.

Mediolateral-4th digit

lateromedial-1st digit



FOOT

- ***Technical factors:-***
  - ✓***Film size*** :- 24 x 30cm(lenghtwise)
  - ✓***Non grid***
  - ✓***kv selection***:– 55-65kvp
  - ✓***FFD***:- 100cm
  - ✓Collimate to include soft tissue structures of all toes and tarsals.
  - ✓***Shielding:-*** gonadal shield should be used on all pts
- ***Basic projections:-***
  1. ***AP,***
  2. ***AP Oblique, &***
  3. ***lateral***

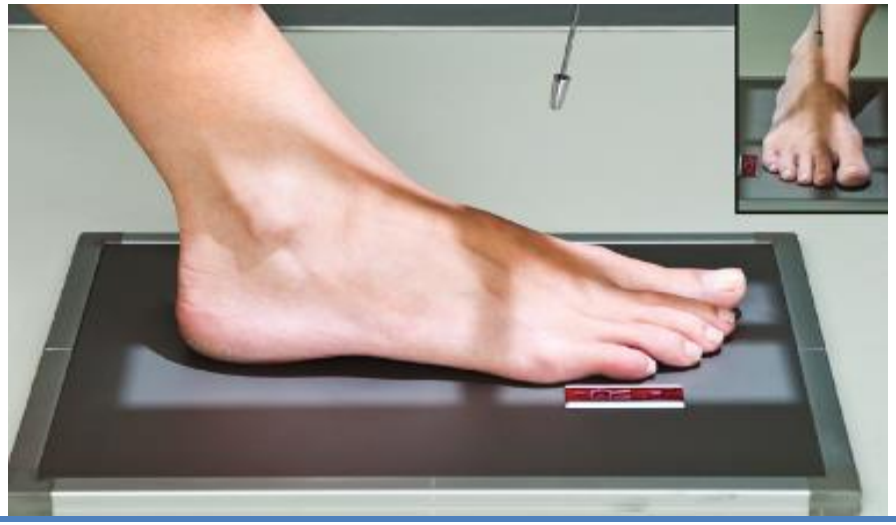
1. AP FOOT

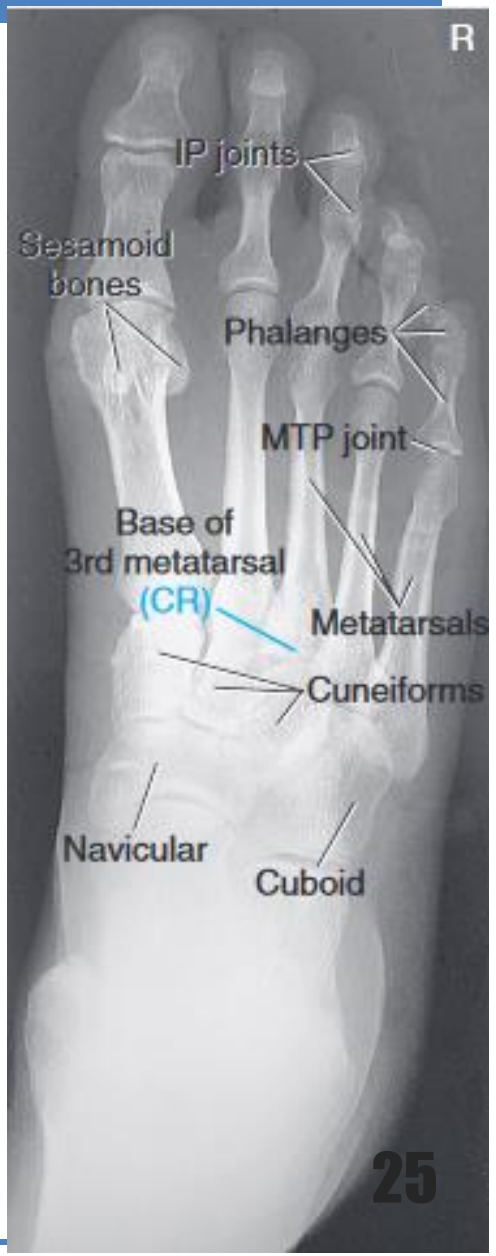
- ***Patient position:-***
  - Place patient seated/supine position on the radiographic table.
- ***Part position:-***
  - Flex the knee of the affected side until the plantar surface of the foot rests firmly on the table.
  - Center the foot to the unmask half of the cassette.
- ***CR:-***
  - Direct the CR ***10^{o} cephaled to the base of the 3^{rd} metatarsal.***

AP: foot…

Image evaluation:-

- ✓No rotation of the foot
- ✓Overlap of the 2nd through 5th metatarsal bases.
- ✓Phalanges and tarsals distal to the talus.





2. AP Oblique: FOOT

- ***Patient position:***
  - Place patient supine or sitting; flex knee, with plantar surface of foot on table; turn body slightly away from side in question.
- ***Part position:***
  - Align and center long axis of foot to CR.
  - Rotate foot **medially** to place plantar surface **30° to 40°** to plane of IR.
  - Use 45° radiolucent support block to prevent motion.
- ***CR:***
  - directed to ***base of 3rd metatarsal.***

AP oblique…

- ***Image evaluation:-***
  - Lateral tarsals with less superimposition than **AP** projection**.**
  - lateral **TMT** and **intertarsal** joints.
  - Sinus tarsi
  - Tuberosity of the 5th metataesal.
  - Bases of the 1st and 2nd metatarsals

Fig, AP oblique

3. Lateral: foot

- ***Patient position:***
  - Place patient in lateral recumbent position on the table.
- ***Part position:***
  - **Externally rotate** the leg of the affected side until the patella is perpendicular to the film plane and the lateral aspect of the foot rests on the cassette.
  - Carefully dorsiflex foot, if possible, to form 90^{o} with lower leg.
- ***CR:***
  - directed to ***medial cuneiform*** (at level of base of third metatarsal).

Fig, Lateral: foot

Image evaluation:

- Entire foot, with ≈ 2.5cm of distal tibia & fibula.
- Metatarsals are nearly superimposed
- Fibula overlapping the posterior portion of the tibia
- Tibiotalar joint

CALCANEUS

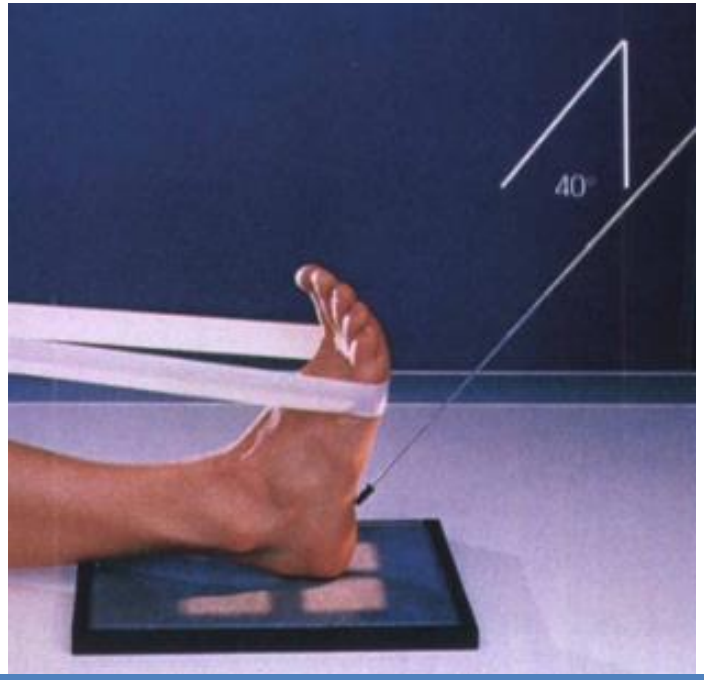
1. Axial: Calcaneus

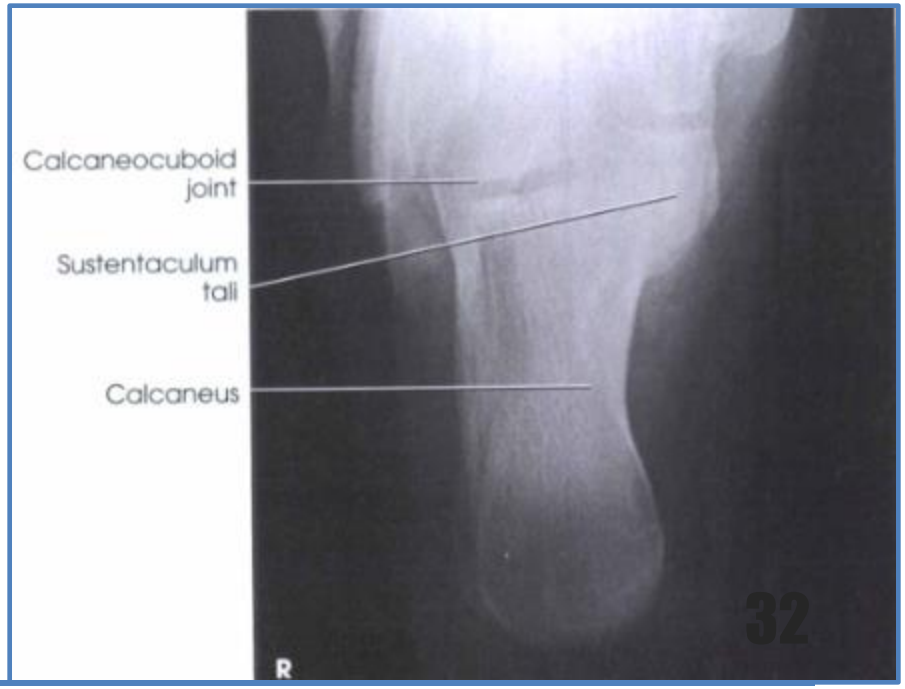
- ***Patient position:-***
  - Place patient supine or seated on table with leg fully extended.
- ***Part position:-***
  - Center and align ankle joint to the unmasked half of the cassette.
  - Dorsiflex foot using strip of tape.
- ***CR:-***
  - Direct the CR ***40^{o} Cephalad to the midplantar at the base of 3^{rd} metatarsal.***

Fig, Axial calcaneus

Image evaluation:-

- ✓Calcaneus and subtalar joint.
- ✓No rotation of the calcaneus





2. Lateral: Calcaneus

- ***Patient position:-***
  - Place patient in lateral recumbent position, affected side down.
- ***Part position:-***
  - Center calcaneus to CR and to unmasked portion of IR,
  - Position ankle and foot for a **true lateral**
  - Dorsiflex foot so that plantar surface is at right angle to leg.
- ***CR:-***
  - directed to a point ***1 inch (2.5cm) distal to medial malleolus.***

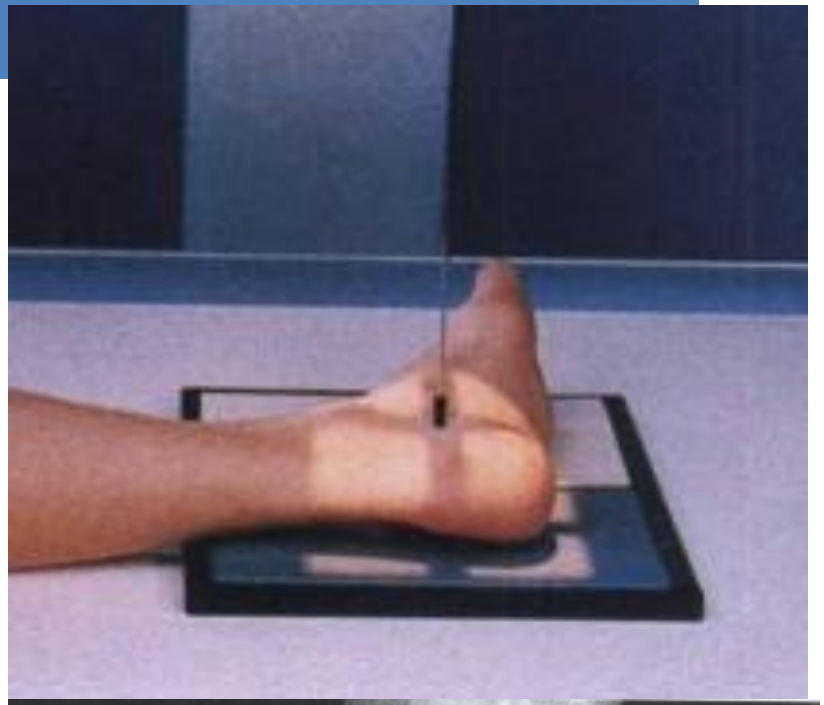
Fig, Lateral Calcaneus

- ***Image evaluation:-***

✓ No rotation of the calcaneus

✓ Sinus tarsi

✓ Ankle joint and adjacent tarsals.



ANKLE

1. AP: ankle

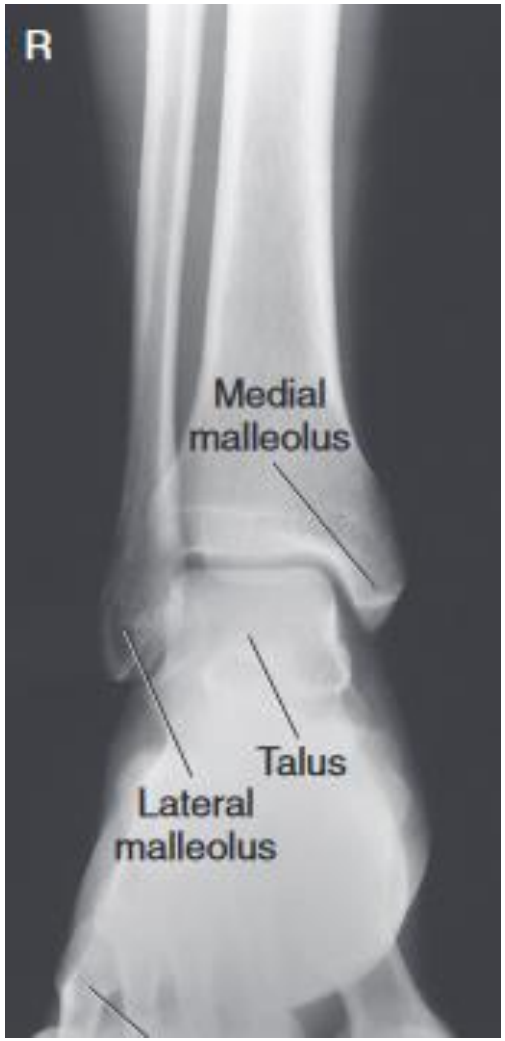
- ***Patient position:-***
  - Place patient in the supine/seated position, with the affected limb fully extended.
- ***Part position:-***
  - Center the affected ankle joint to the unmasked half of the cassette.
  - Dorsiflex the foot so the plantar surface forms 90 degree angle with the lower leg.
- ***CR:-***
  - directed to a point ***midway between malleoli.***

AP – ankle cont'd…

Image evaluation:-

- ✓Tibiotalar joint space
- ✓Talus slightly overlap over the distal fibula
- ✓No overlapping of medial talometalleolar articulation
- ✓Medial and lateral malleoli
- ✓Talus with proper density

Fig, AP - ANKLE



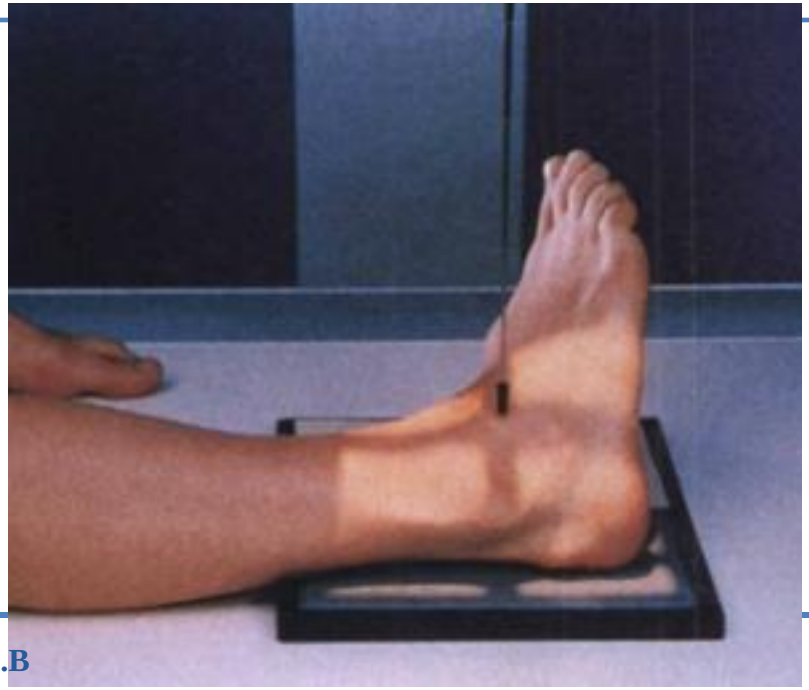
2. AP MORTISE(15º) - ankle

- ***Patient position:-***
  - Place patient in the supine/seated position, with the affected limb fully extended.
- ***Part position:-***
  - Center and align ankle joint to CR
  - Internally rotate entire leg and foot about **15° to 20°**until intermalleolar line is parallel to IR.
  - ***Do not dorsiflex foot.***
- ***CR:-***
  - Directed to point ***midway between malleoli.***

Fig, AP mortise - ankle

Image demonstrate:-

- ✓Entire ankle mortise joint
- ✓Talofibular joint space in profile



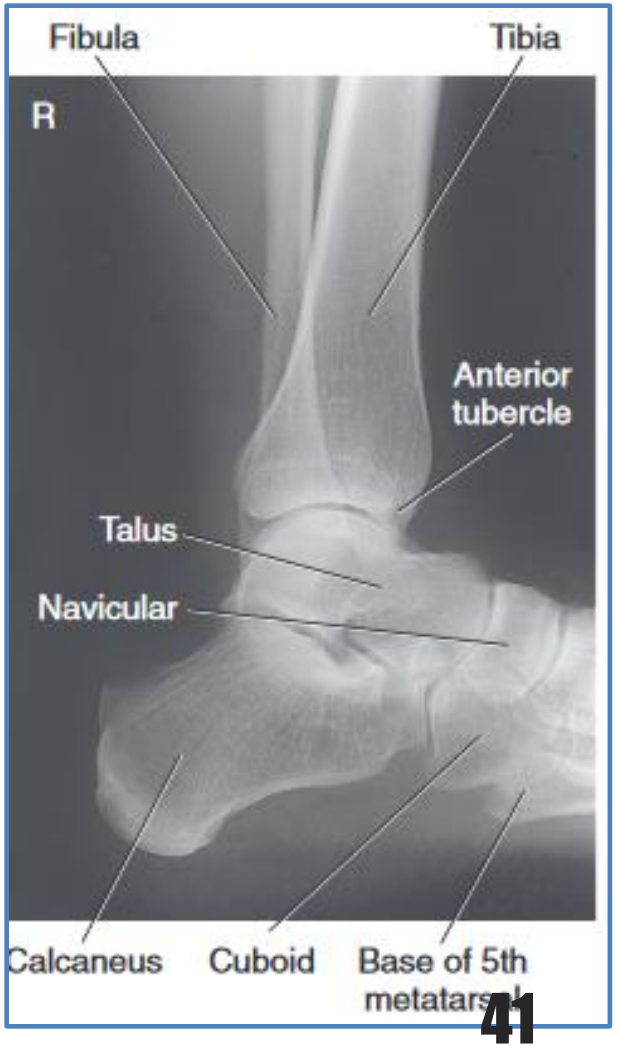
3. Lateral - ankle

- ***Patient position:-***
  - Place patient in the lateral recumbent position, affected side down; flex knee of affected limb about 45°
- ***Part position:-***
  - Center and align ankle joint to CR
  - Place support under knee, to place leg and foot in true lateral position.
  - Dorsiflex the foot so that the foot and leg form a 90 degree angle.
- ***CR:-*** directed to ***medial malleolus.***

Fig, lateral - ankle

Image demonstrate:-

- Tibiotalar joint well visualised
- Fibula over the posterior half of the tibia.
- Distal tibia and fibula, talus and adjacent tarsals.

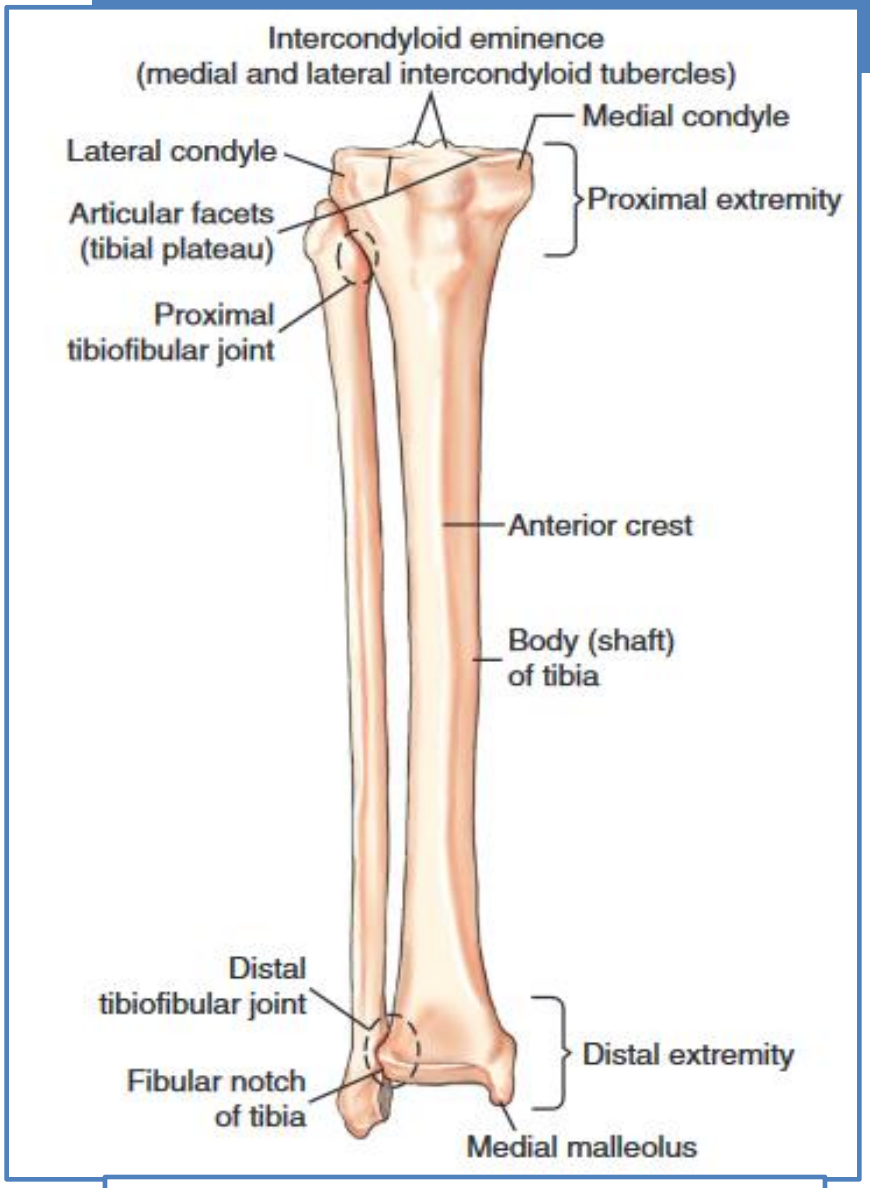


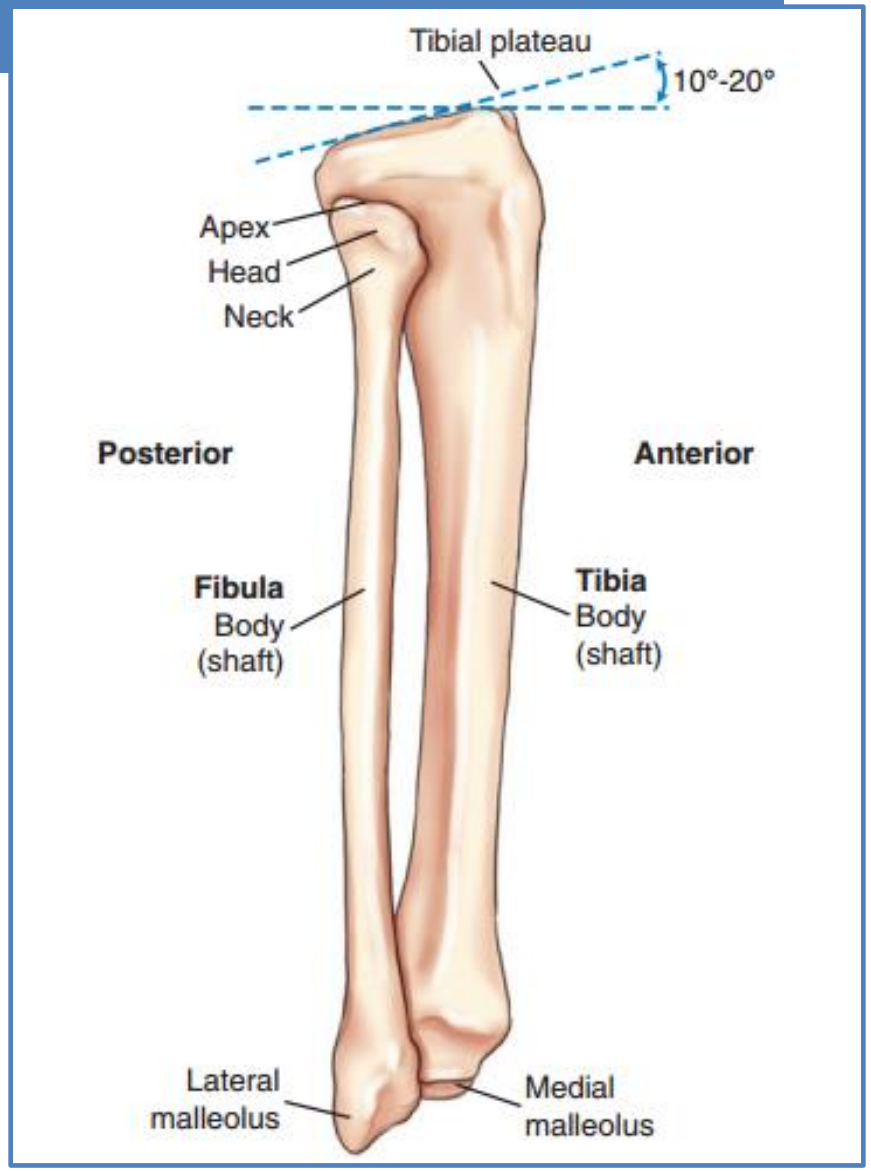
❖LOWER LEG

Anatomy

LEG:- Tibia & Fibula.

- ***Tibia*:** is the weight bearing bone, located anteromedialy.
- ***Fibula*:** smaller and located laterally and posterior to the tibia.
- The ***fibula*** articulates with the ***tibia proximally*** and the tibia and ***talus distally***



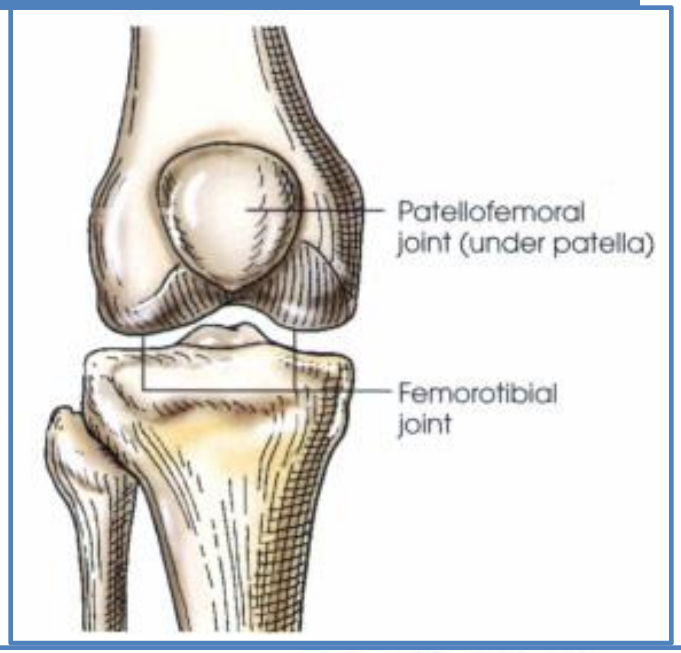


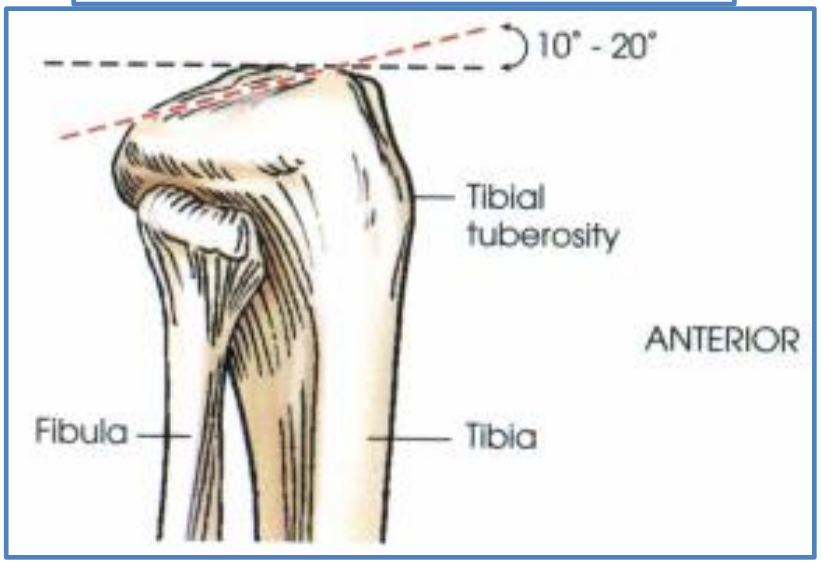
- ***Ant. view***

- ***lateral view***

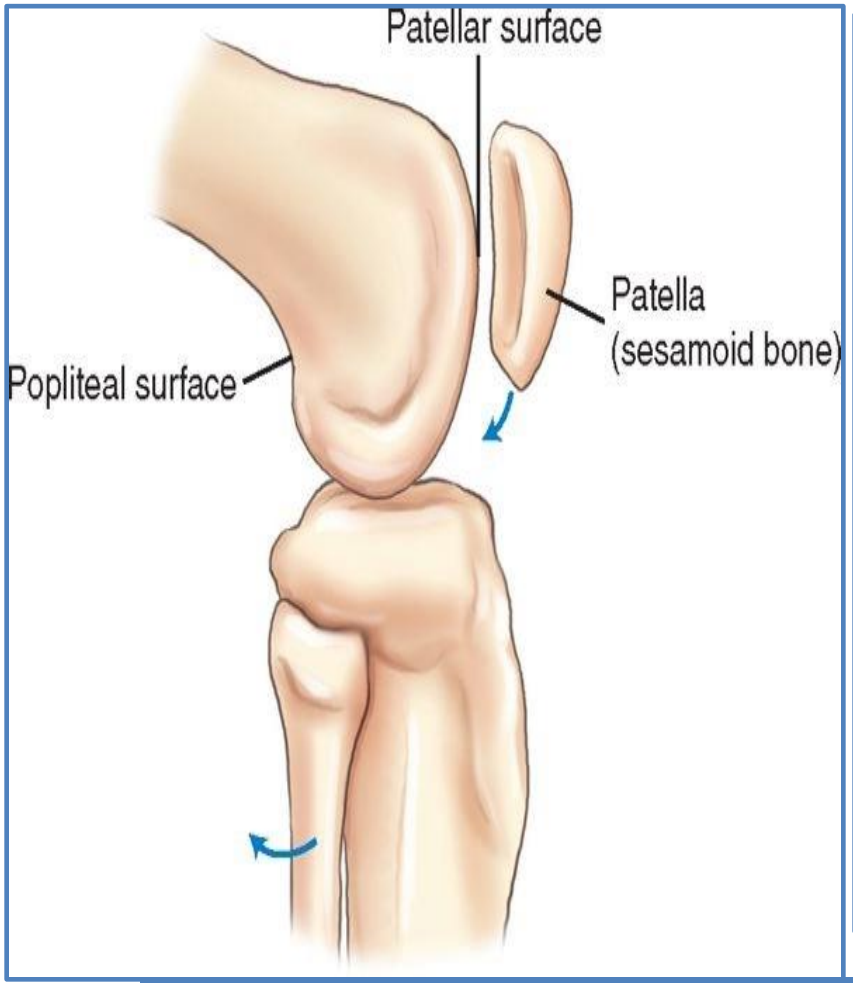
Anatomy…

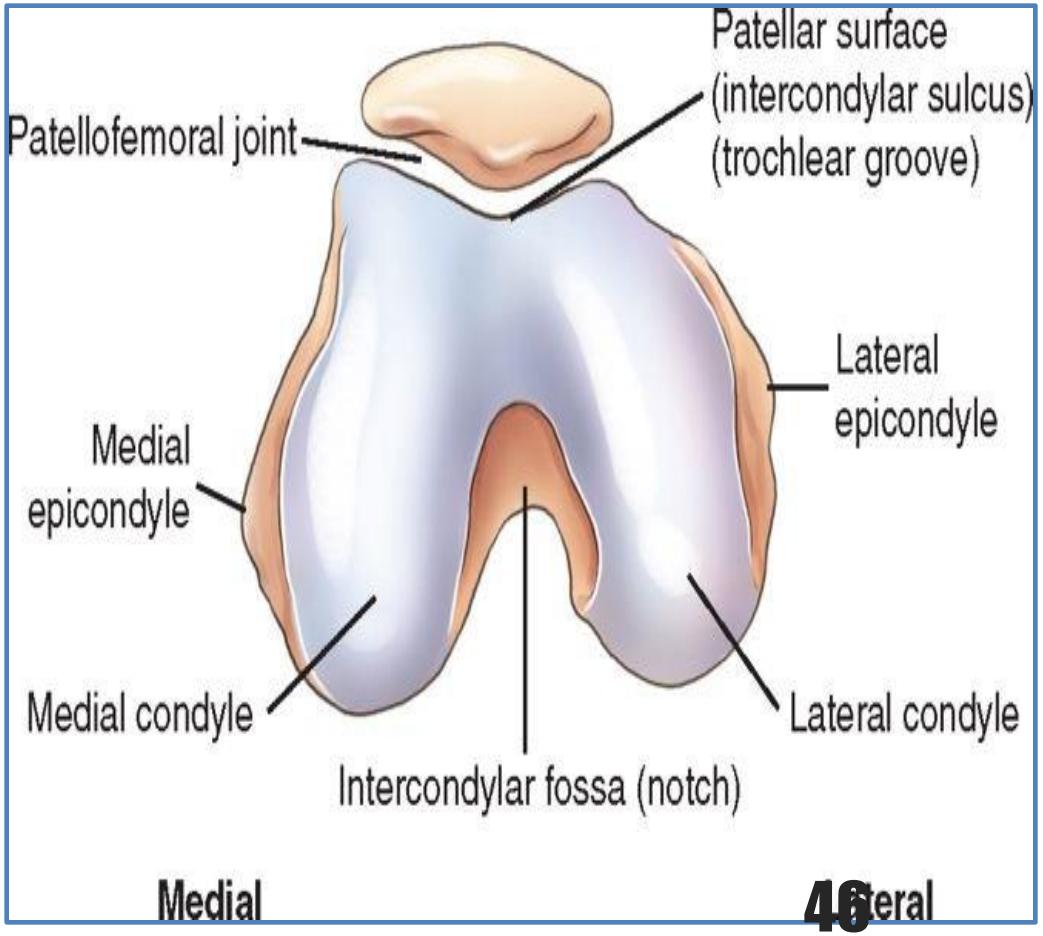
- **Knee joint:-** it involves 2 joints:-
  - ***Femorotibial:-*** b/n the 2 condyles of femur and condyles of the tibia.
  - ***Parellofemural:-*** b/n patella and anterior surface of distal femur





Knee anatomy….





Radiographic pos. of leg

- ***Clinical indication:-***
  - Fractures, foriegn bodies and lesions of the bones.
- ***Technical factors:-***
  - ✓**Film size** :- 30 x 40cm(lengthwise)
  - ✓**Non grid**
  - ✓**kv selection**: –60-70kvp
  - ✓**FFD**:- 100cm
  - ✓**Shielding** - use gonad shield for all pts
- ***Projections:- AP & lateral***

1. AP - leg

- ***Patient position:-***
  - Place patient in the supine/seated position on the table.
- ***Part position:-***
  - Adjust pelvis, knee, and leg into true AP with no rotation.
  - Adjust the leg so a line b/n the femoral condyles is parallel with the film plane.
  - Dorsiflex the foot to form a 90^{o} with the lower leg.
- ***CR:-*** perpendicular to the midpoint of the leg.

Fig, AP - leg

Image evaluation:-

- ✓ Ankle and knee joints without rotation
- ✓ Tibia and fibular articulations are moderately overlapped.
- ✓ Trabecular detail and soft tissue

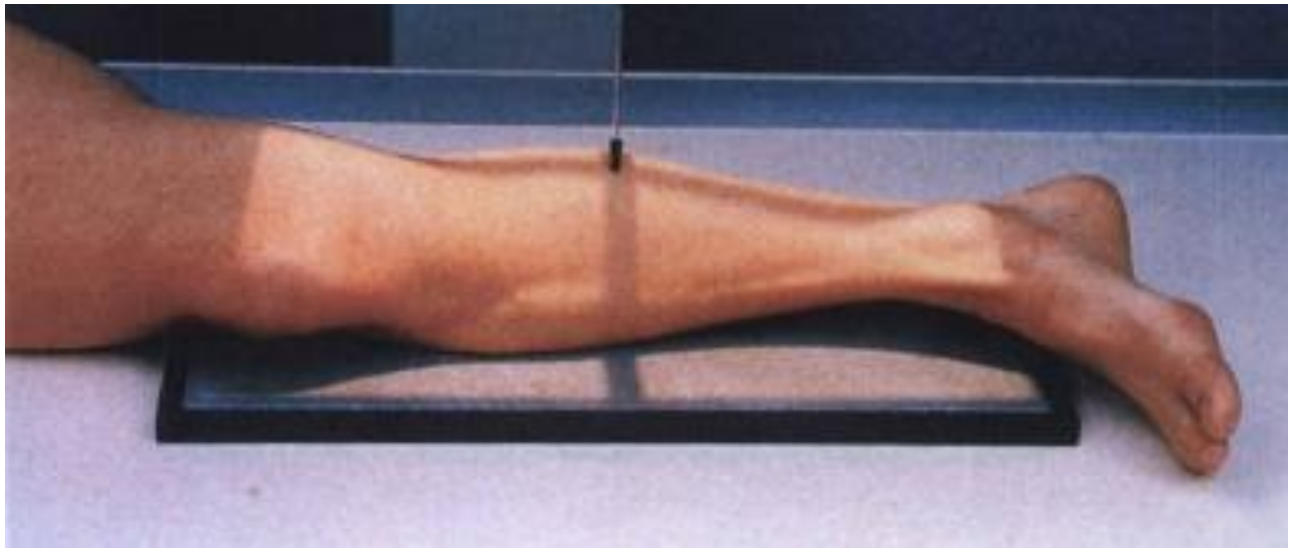
2. Lateral : leg

- ***Patient position:-***
  - Place patient in the lateral recumbent position, injured side down.
- ***Part position:-***
  - Adjust the body to place the patella perpendicular to the IR.
  - Ensure that a line drawn b/n femoral condyles is also perpendicular IR.
- ***CR:-***
  - perpendicular to the ***midpoint of the leg.***

Fig, Lateral - leg

Image evaluation:-

- ✓ Distal fibula lying over the posterior half of the tibia
- ✓ Slight overlap of tibia on posterior fibular head
- ✓ Ankle and knee joint with no rotation



KNEE

- ***Technical factors:***
  - ✓***Film size*** :- 24 x 30cm(crosswise)
  - ✓***KV selection***:- 65-70kvp
  - ✓***FFD***:- 100cm
  - ✓***Shielding :-*** use gonad shield for all pts
- ***Routine projections:-***
  - ❖***AP, &***
  - ❖***Lateral.***

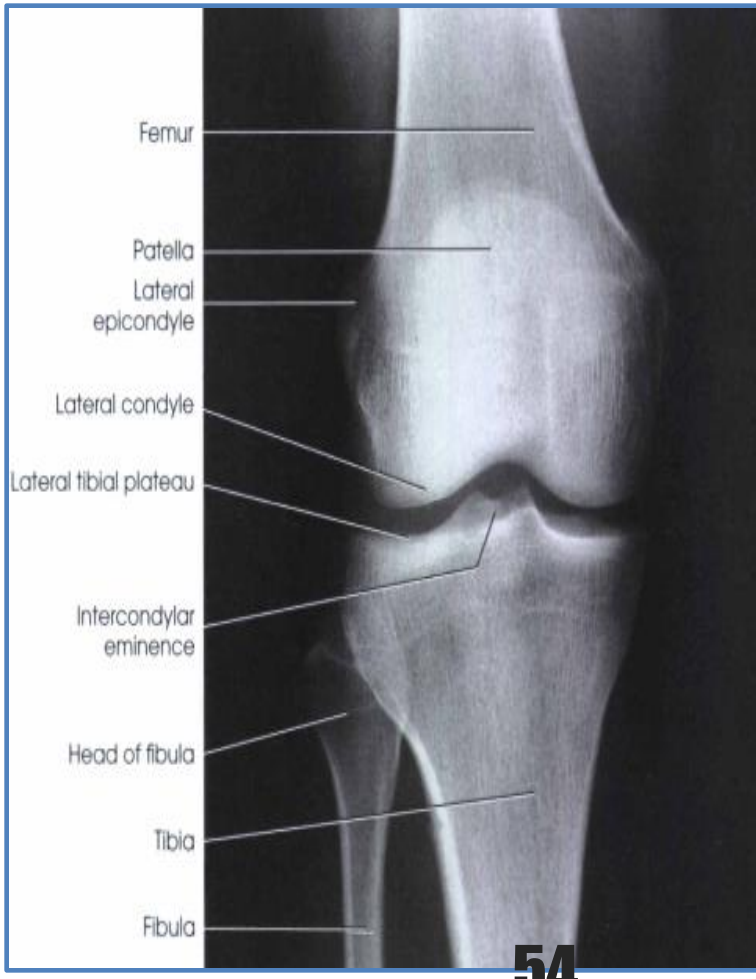
1. AP KNEE

- ***Patient position:-***
  - Place patient in supine/seated position on the table; leg should be fully extended.
- ***Part position:-***
  - Align and center knee to CR and IR.
  - Rotate leg **internally 3º to 5º** for true AP knee.
- ***CR:-***
  - Direct the ***CR 5^0 cephaled*** *to pt* ***0.5inch(1.25cm) distal to the apex*** of the patella.

Fig, AP knee

Image evaluation:-

- Distal femur and proximal tibia and fibula are shown.
- ***Femorotibial joint space*** should be open.



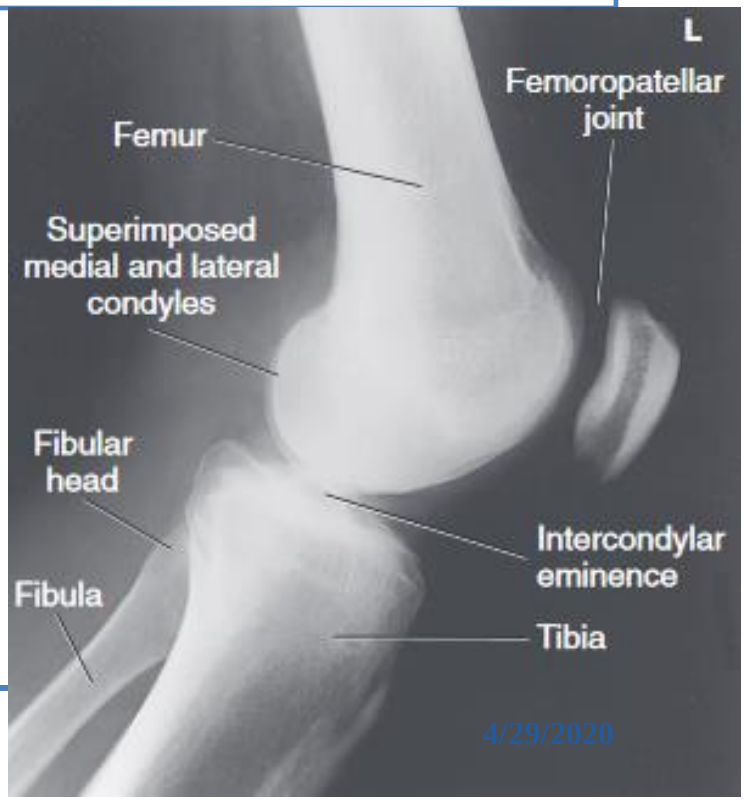
2. Lateral - knee

- ***Patient position:-***
  - Assist the pt to the lateral recumbent position on the table with the affected side down.
- ***Part position:-***
  - Flex the ***affected knee 20 -30 degree***.
  - Place a support under the ankle
  - Align and center leg and knee to CR and midline of IR.
- ***CR:- 5^0 cephaled*** to the point ***1inch(2.5cm) below the medial condyle of the femur.***

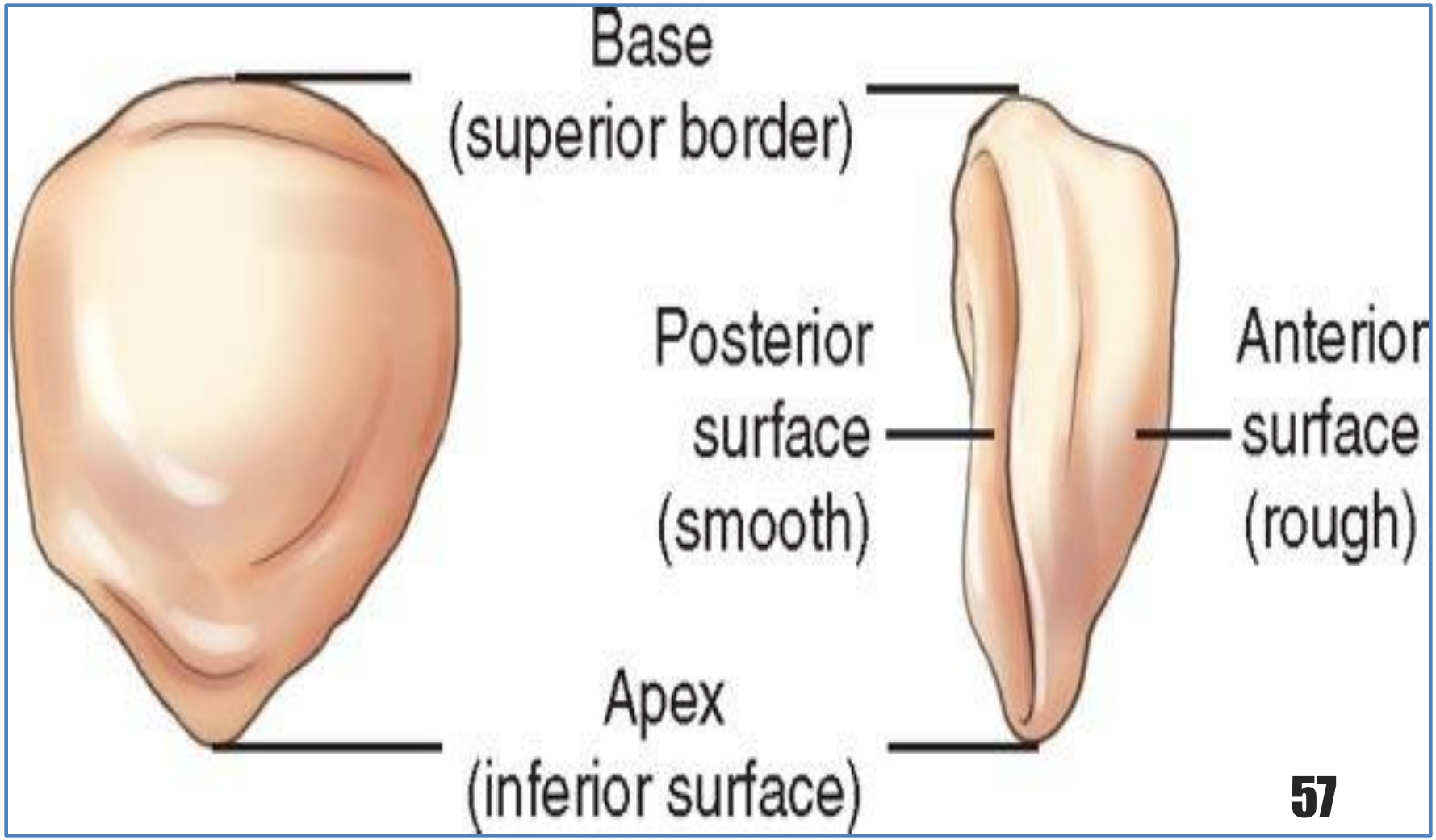
Fig, Lateral - knee

Image evaluation:-

- Distal femur, proximal tibia and fibula, and patella are shown in lateral profile.
- ***Femoropatellar & knee joints should be open***



PATELLA (Knee cap)



1. PA - Patella

- ***Patient position:-***
  - Place patient in **prone position**, legs extended.
  - Place foam pads under the ankle and thigh for the support.
- ***Part position:-***
  - Align and center long axis of leg and knee to midline of IR.
  - Align interepicondylar line parallel to plane of IR, by using ***5° internal rotation of anterior knee***.
- ***CR:-***
  - Direct CR to ***midpatella area*** (which is ≈ the ***mid-popliteal area***).

Image evaluation:-

- ✓Knee joint and patella are shown,
- ✓Patella completely superimposed by the femur.

Fig, PA - Patella

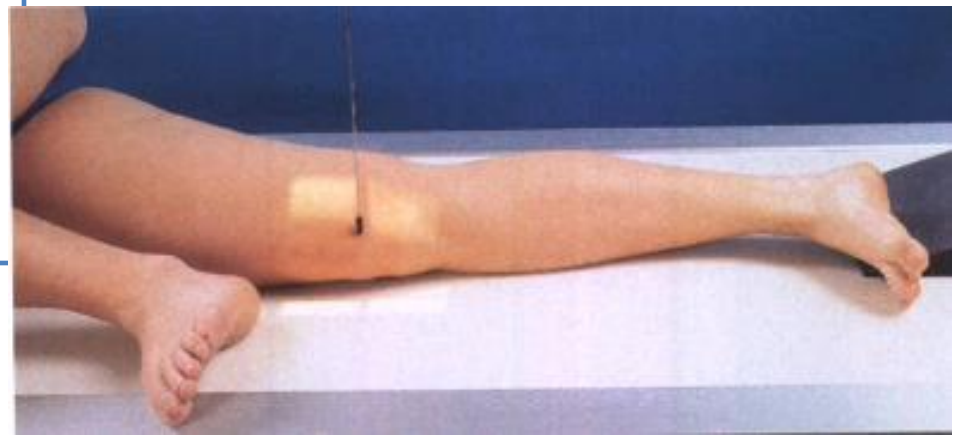
2. Lateral: Patella

- ***Patient position:-***
  - Place patient in lateral recumbent position, with the affected side down, provide support for knee of opposite limb.
- ***Part position:-***
  - Flex the affected knee ***only 5° or 10°.***
  - Adjust the knee so that the ***femoral epicondyles directly superimposed*** *and* ***plane of patella perpendicular to plane of IR.***
- **CR:-**
  - Direct CR to ***midfemoropatellar joint.***

Image evaluation:-

- ✓Open patellofemural joint space.
- ✓Profile image of patella.

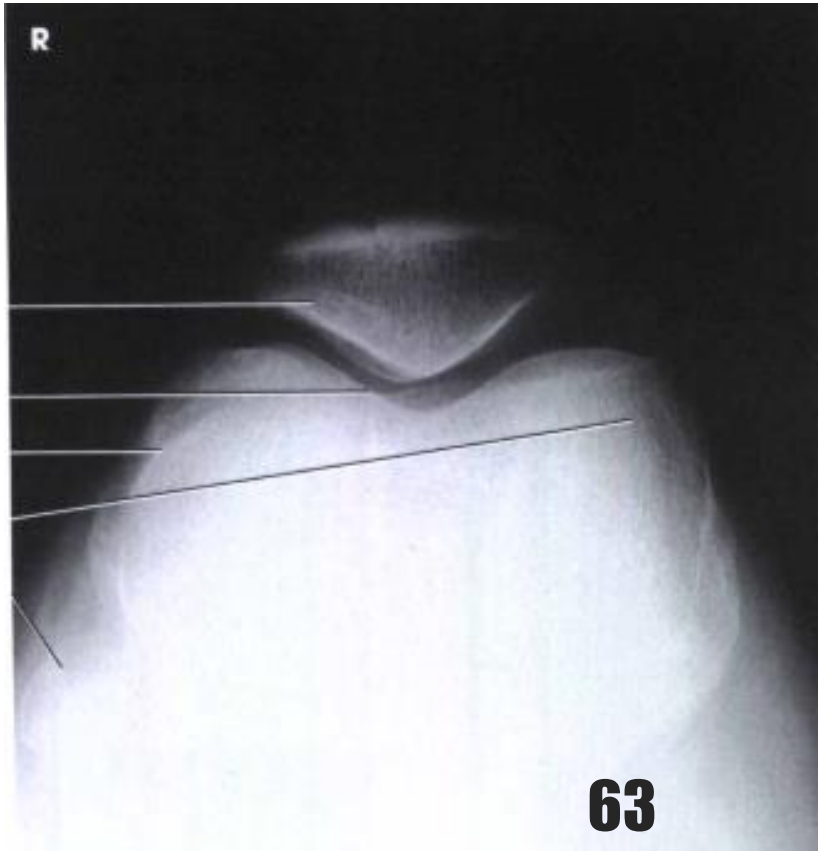
Fig, Lateral - patella



Tangential(Skyline) projection; patella (Settegast method)

- ***Patient position:-***
  - Place the pt in seated position on the table.
- ***Part position:-***
  - The affected knee flexed to 90^{o} .
  - A cassette is held by the pt against the anterior distal femur, which rests on the anterior aspect of the thigh.
- ***CR:-***
  - Directed to the **joint space** with ***CR angled 15^{o}-20^{o} cephalad.***

Fig, Tangential(Skyline) projection



Tangential(Skyline) projections …

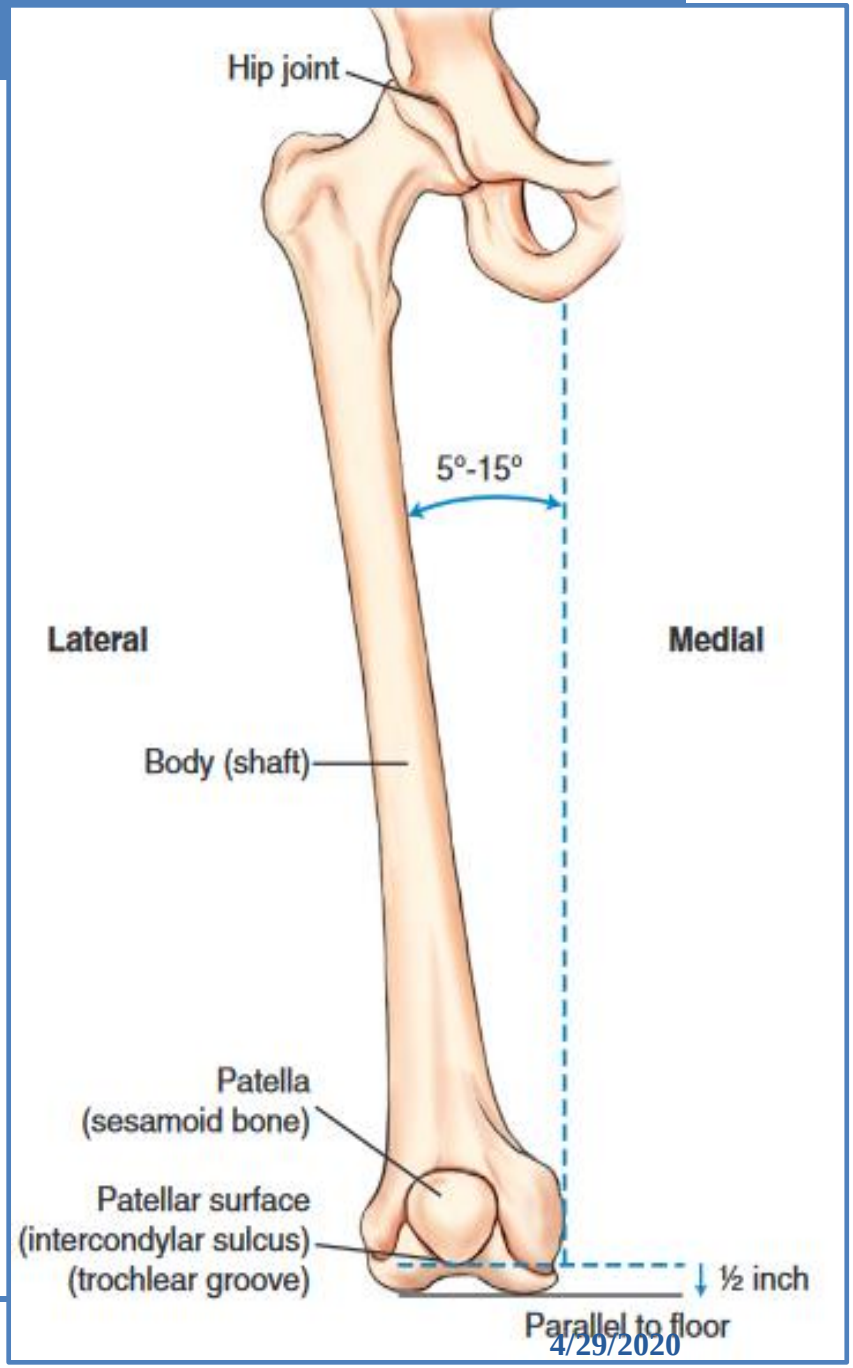
1. inferosuperior projection (patient supine, 45° knee flexion),

2. hughston method (patient prone, 55° knee flexion),

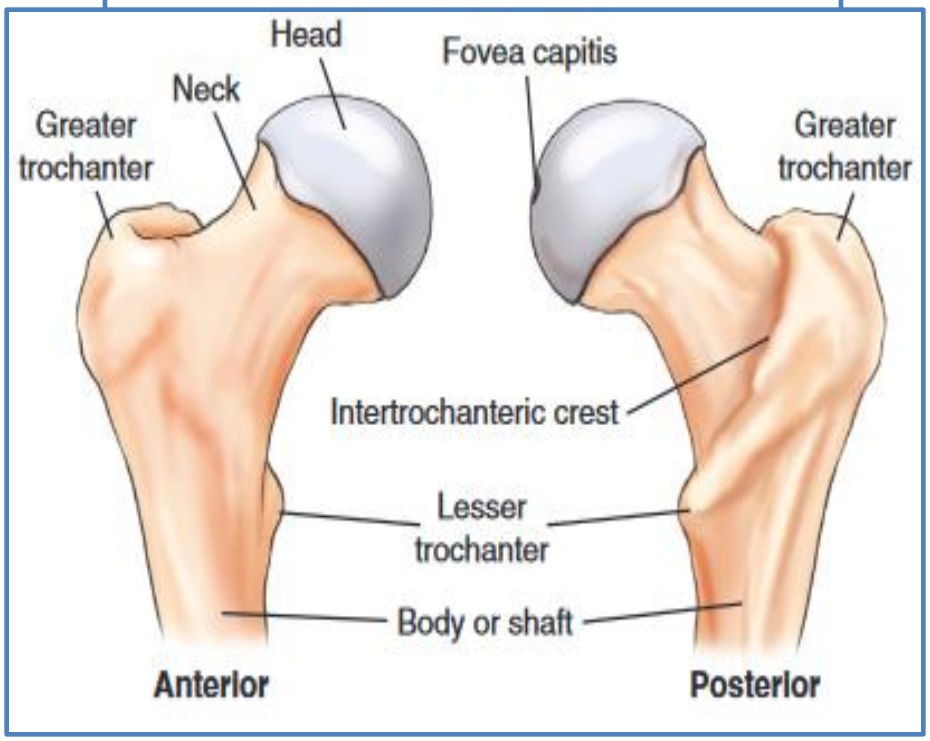
❖FEMUR

Anatomy

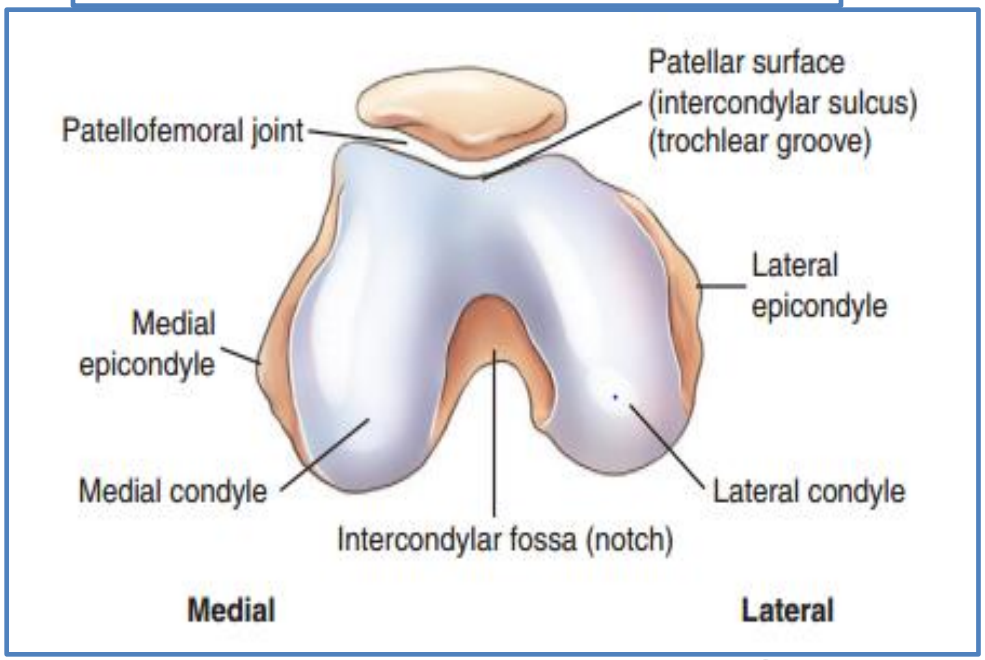
- **Femur:-** is the ***longest and strongest*** bone in our body.
  - ✓ Proximally, articulate with hip bone making the ***hip joint.***
  - ✓ ***Distally***, articulate with proximal tibia making the ***femorotibial joint.***
  - ✓ ***Ant. surface of distal femur*** articulate with patella to make ***patellofemural joint.***



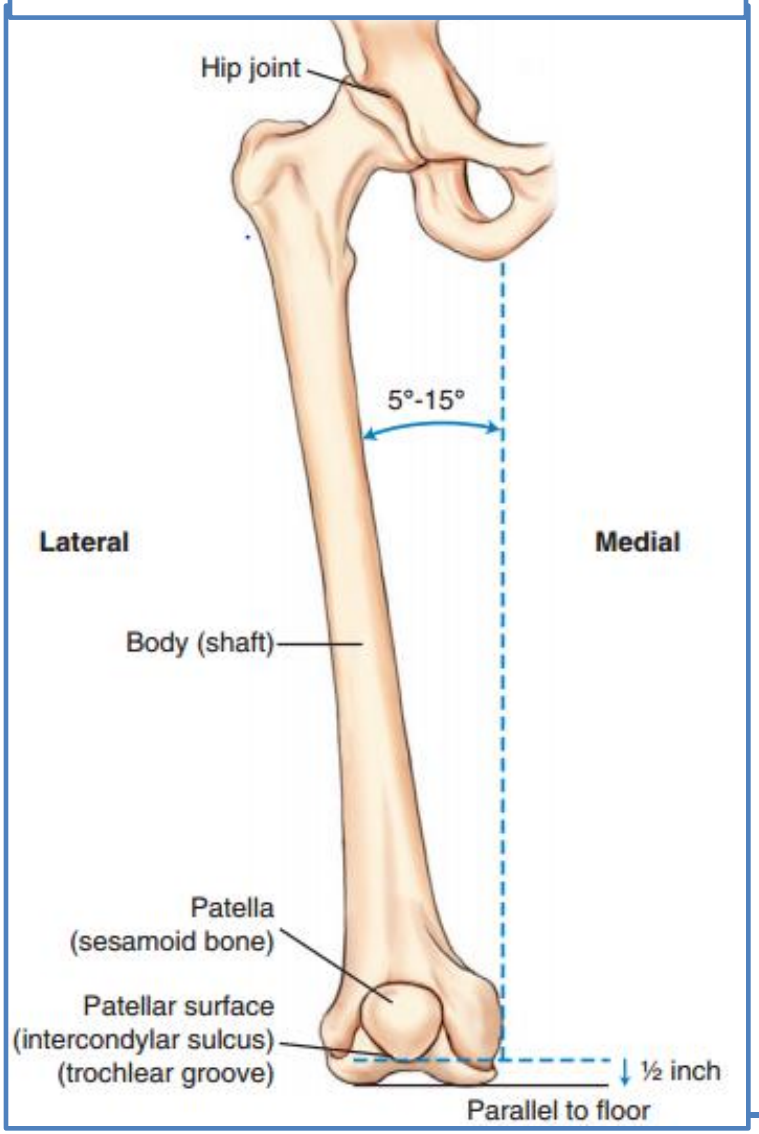
- ***Proximal femur***



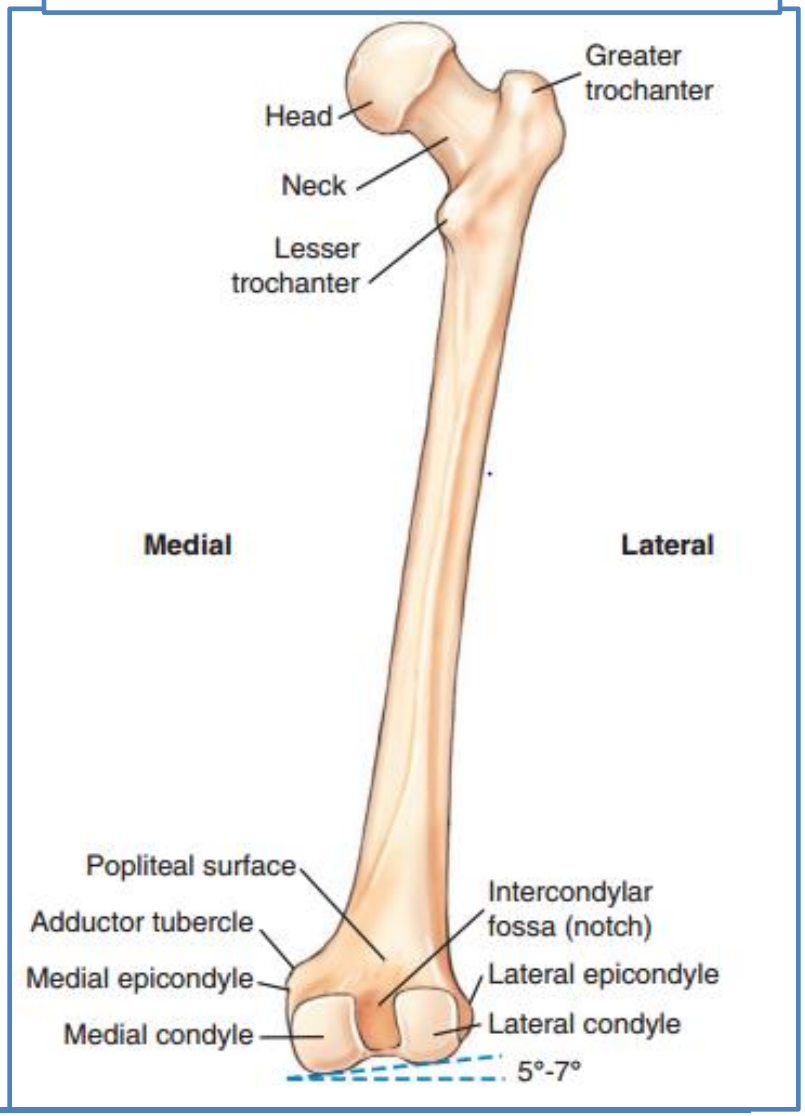
- ***Distal, femur(axial view)***



Ant. view



Post. view



Radiographic pos. of femur

- ***Technical consideration:-***
  - **FFD**- 100cm
  - **Film size** -30x40cm(length wise orientation)
  - **Grid** is recommended
  - **Kv** selection –75-85kvp
  - Collimate area of interest
- ***Shielding:-***
  - Apply gonad for all patient. especial children and adult in reproductive age.

1. AP; femur

- ***Patient position:-***
  - Place patient in the supine position, with femur centered to midline of table.
- ***Part position:-***
  - Center the affected thigh to midline of IR.
  - Rotate the affected ***leg internally about 5°*** for a true AP.
  - Ensure that the ***epicondyles are parallel*** with the **IR.**
- ***CR:-***
  - Direct CR to ***midpoint of IR.***

AP; femur…

Image evaluation:-

- ✓Majority of femur and joint nearest to the pathologic condition.
- ✓Femoral neck is not foreshortened on the proximal femur.
- ✓Knee joint without rotation on the distal femur.
- ✓Trabecular detail on the femoral shaft.

AP; femur…

- Fig. A(1,2)-distal femur
- Fig. B-proximal femur

Fig. A(1)

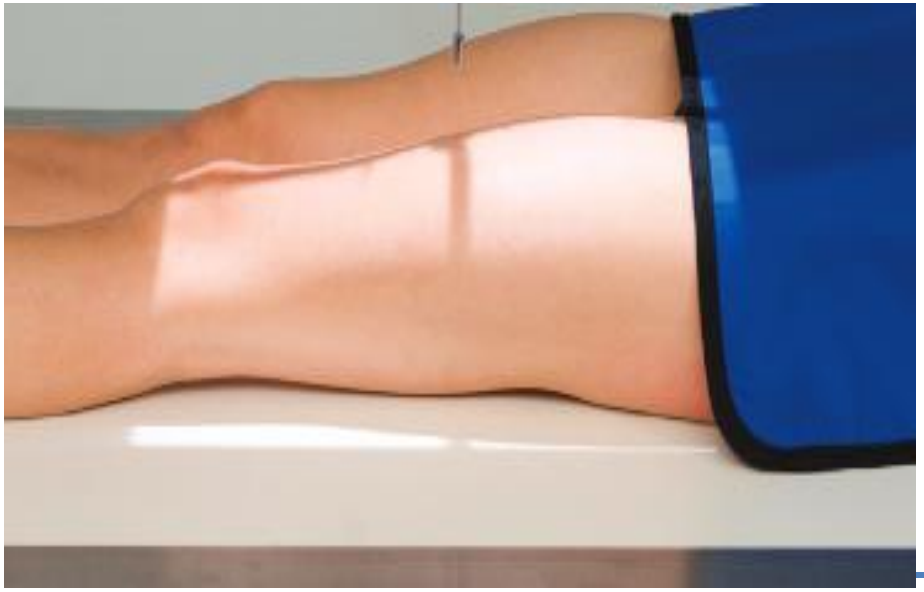


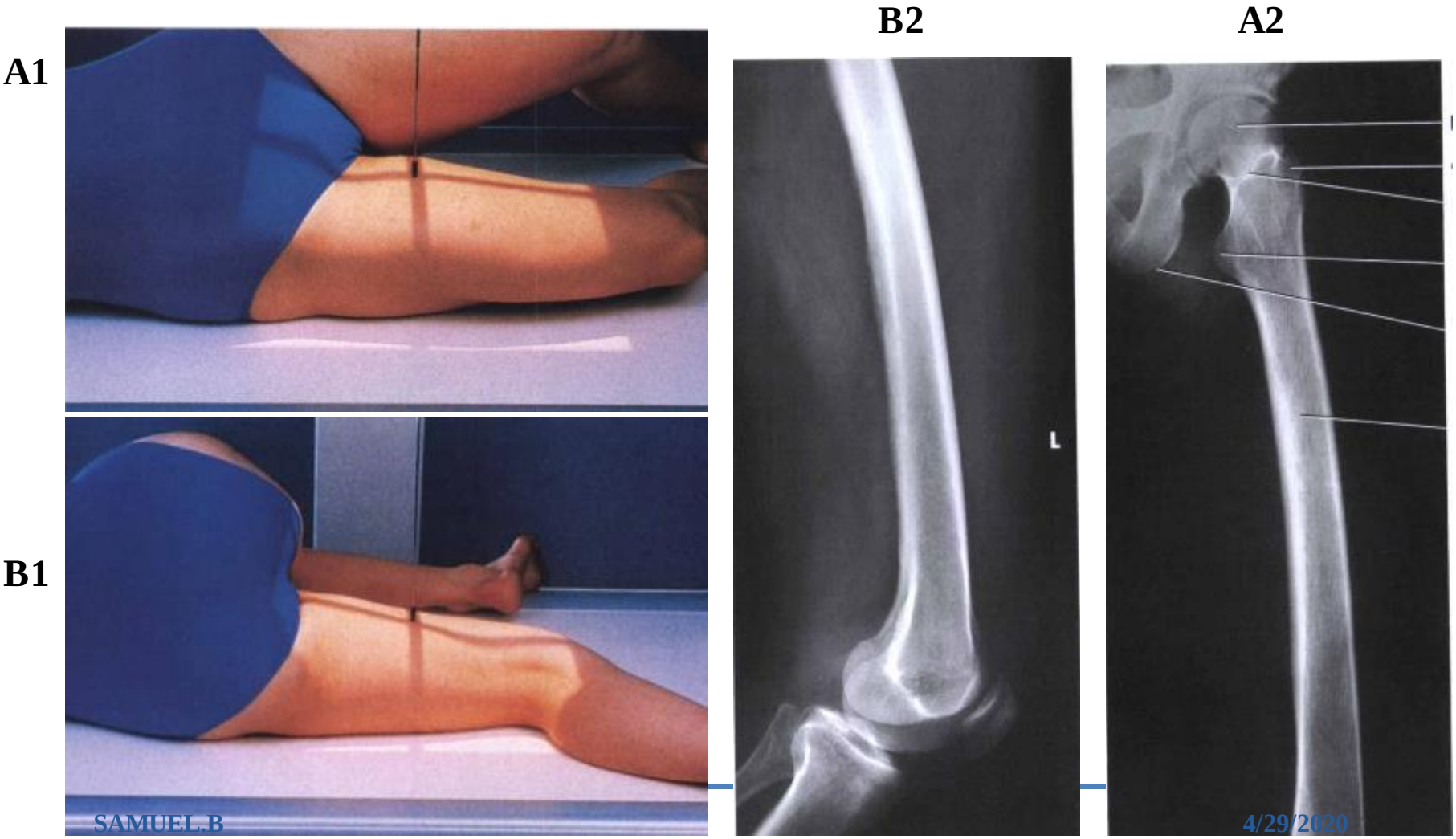
Fig. A(2)

Fig. B

2. Lateral; femur

- ***Patient position:***
  - Place patient in the lateral recumbent position, with affected side down.
- ***Part position:***
  - Flex affected knee about 45° and align femur to midline of IR.
  - For proximal femur, place unaffected leg behind affected knee and have patient roll back (posteriorly) about 15°.
  - For distal femur, draw the patient's uppermost limb forward.
- ***CR:-***
  - perpendicular to ***midfemur***

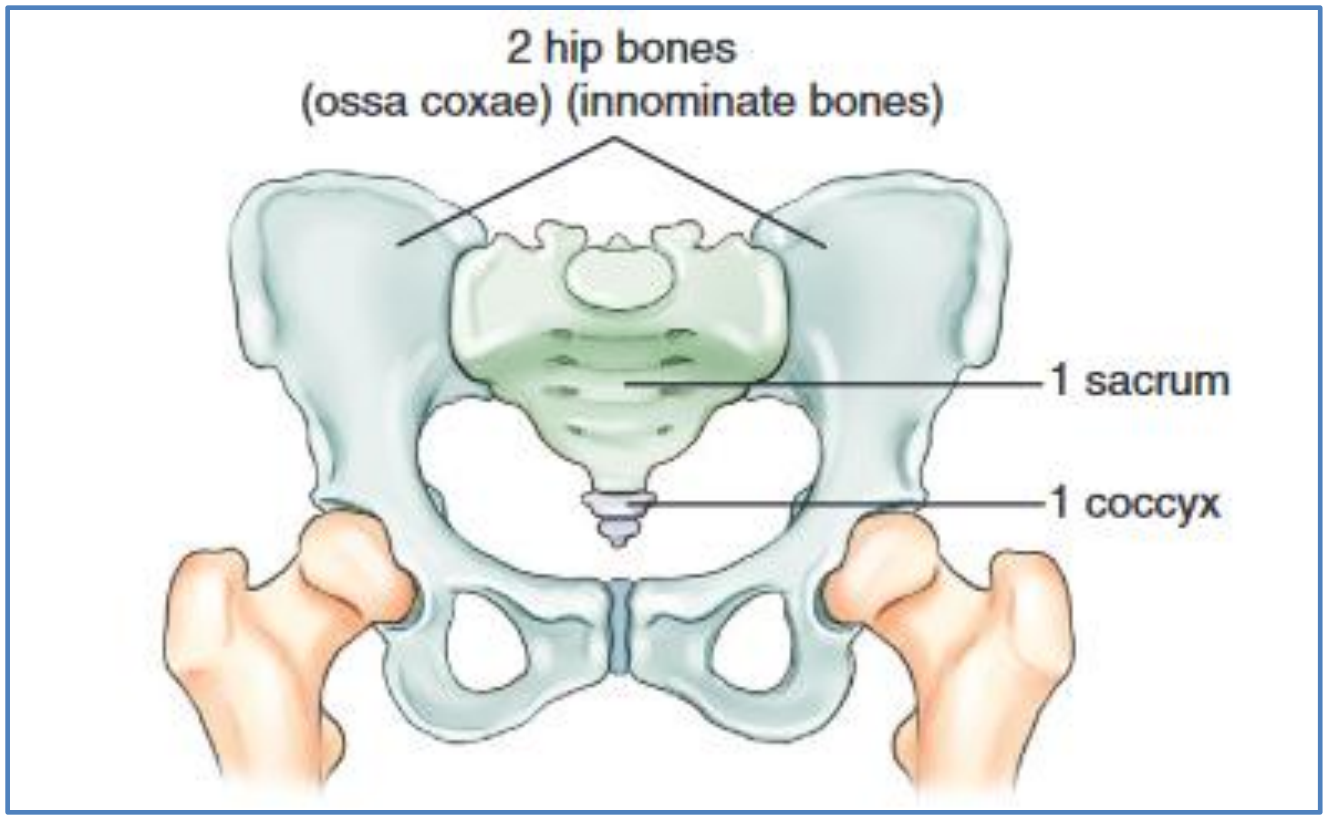
Fig, Lateral; femur; A(1,2)-proximal, Fig. B(1,2)-distal femur.



❖PELVIS

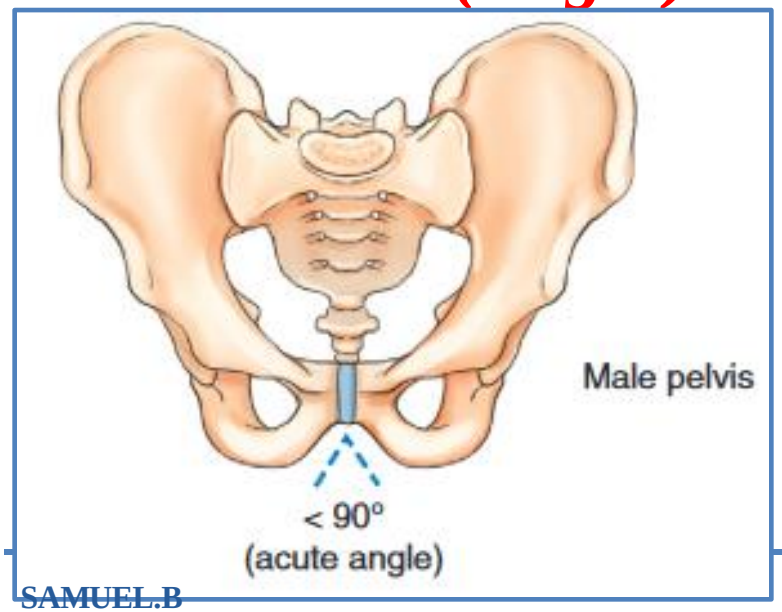
Anatomy overview

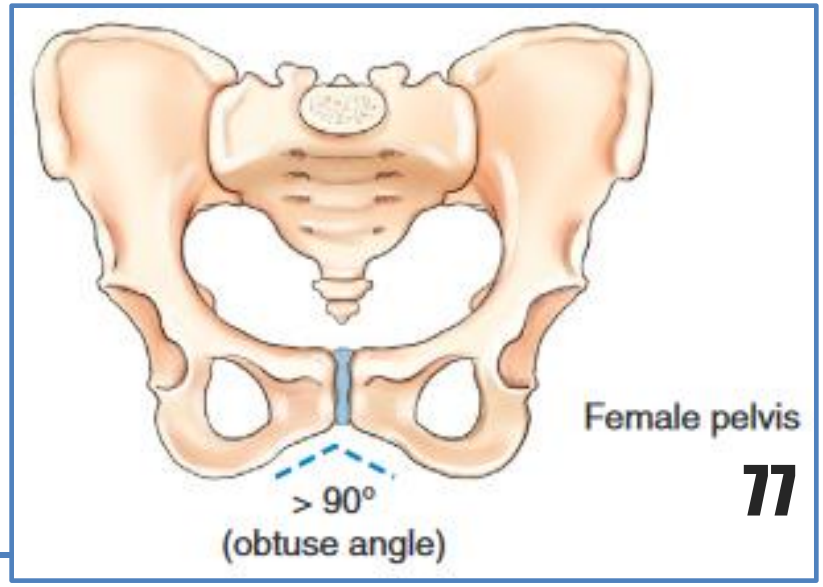
- The pelvis consists of four bones; **two hip bones**, **one sacrum** and **one coccyx.**



Anatomy…

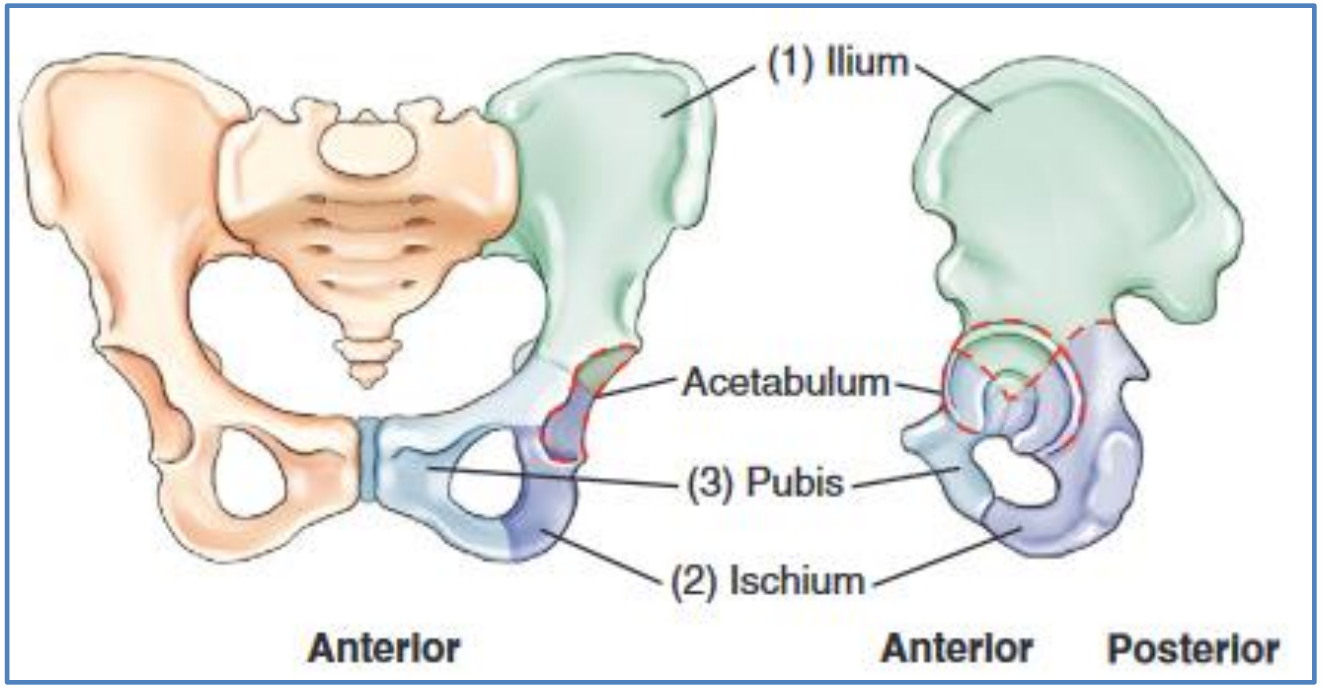
- There is considerable variation in shape of pelvis based on gender;
  - ✓**Male pelvis** *is* ***narrower, deeper, less flared, and oval inlet.***
  - ✓**Female pelvis** is ***wider, more shallow***, more flared, and ***rounded(larger) inlet***.





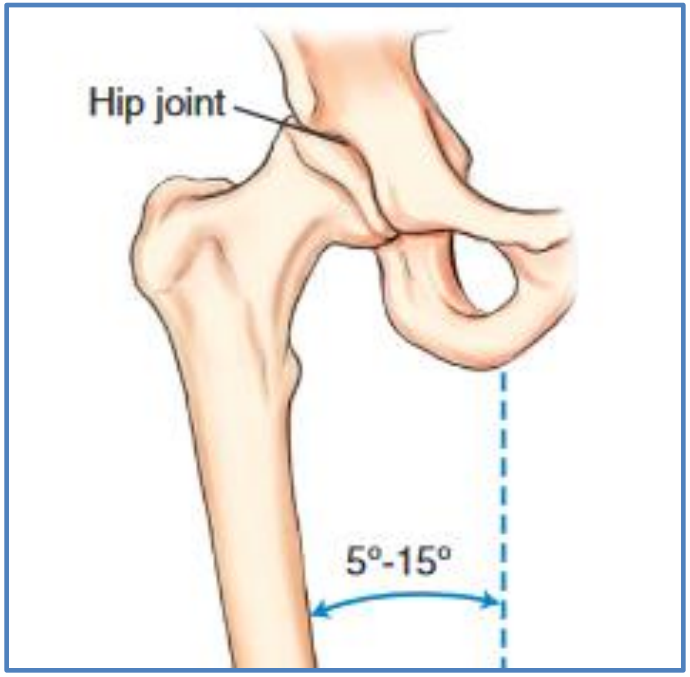
HIP BONE

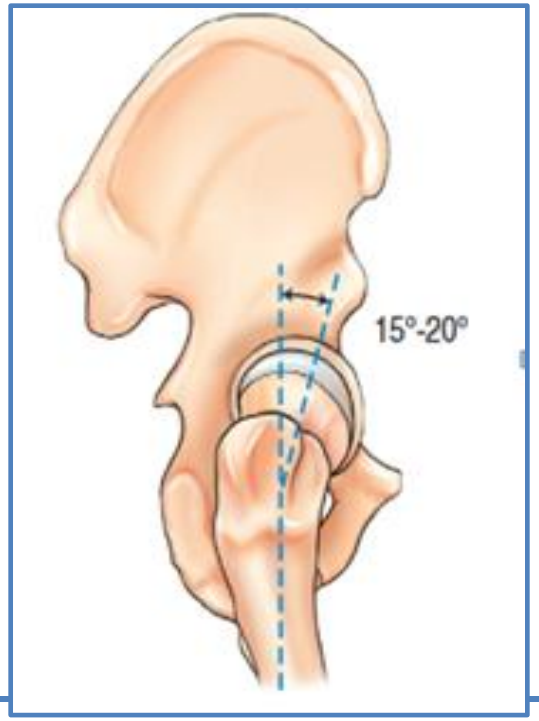
- Each hip bone is composed of three divisions: **ilium**, **ischium** & **pubis**.
- Their fusion occurs in the area of the ***acetabulum.***



HIP JOINT

- Is a ***synovial ball and socket*** joint b/n the acetabulum and head of femur.
- Permits free movement **in all directions.**





Radiography hip joint

Technical consideration:

- **Film size-**24x30cm(length wise cassette orientation)
- **FFD-** 100cm
- **grid** is recommended
- **KV** selection – 85-90kvp
- collimate area of interest

Shielding:

- Apply gonad shield for all patient, especial children and adult in reproductive age.

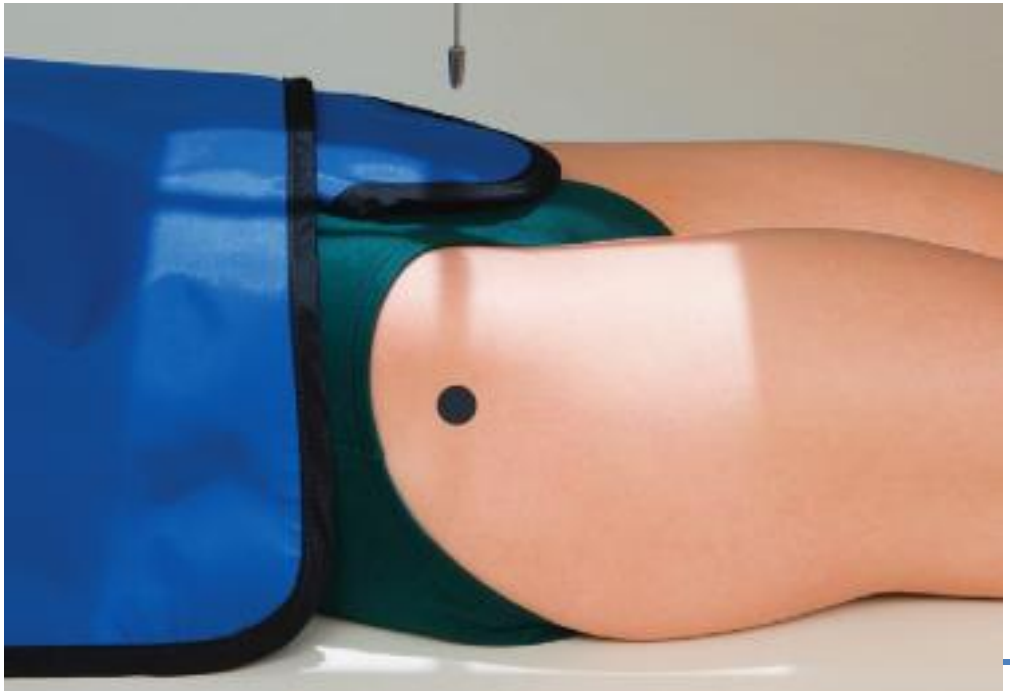
1. AP: hip joint

- ***Patient position:-***
  - The patient lies supine and symmetrical on the x-ray table.
- ***Part position:-***
  - Ensure that pelvis is not rotated; distance from tabletop to each ASIS should be equal.
  - The ***affected limb is internally rotated(15^0-20^0)*** to bring the neck of the femur parallel to the table top and supported by sandbags.
- ***CR:-***
  - Directed to ***1 to 2 inches (2.5 to 5 cm)*** *distal to* ***mid-femoral neck.***

Fig, AP: hip joint

Image evaluation:-

- ✓proximal one-third of the femur,
- ✓the acetabulum and adjacent parts of the pubis, ischium, and ilium.



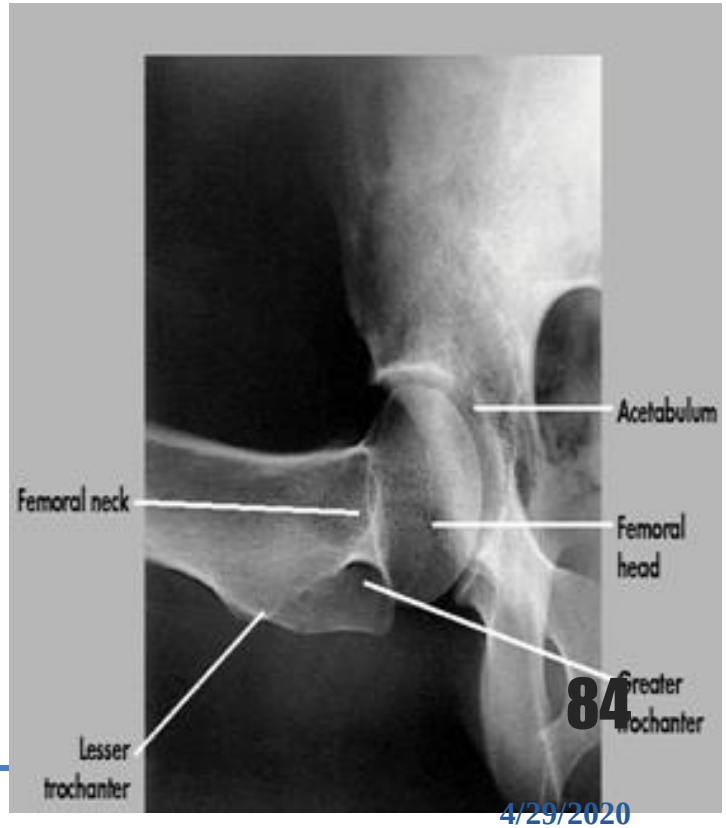
2. Lateral; hip joint

- ***Patient position:-***
  - Assist the patient to the supine position.
- ***Part position:-***
  - Rotate the patient slightly toward the side of interest, flex unaffected leg, use a sponge to support the elevated side.
  - Flex the affected knee and draw the thigh up to nearly a right angle to the hip joint.
- ***CR:-***
  - ***Perpendicular to hip joint(midway b/n ASIS and pubic symphysis).***

Fig, Lateral; hip joint

Image evaluation:-

- ✓Hip joint, acetabulum, and femoral head.
- ✓Femoral neck overlapped by greater trochanter



Lateral-both hip("frog-leg")

❖ ***Clinical Indications:-***

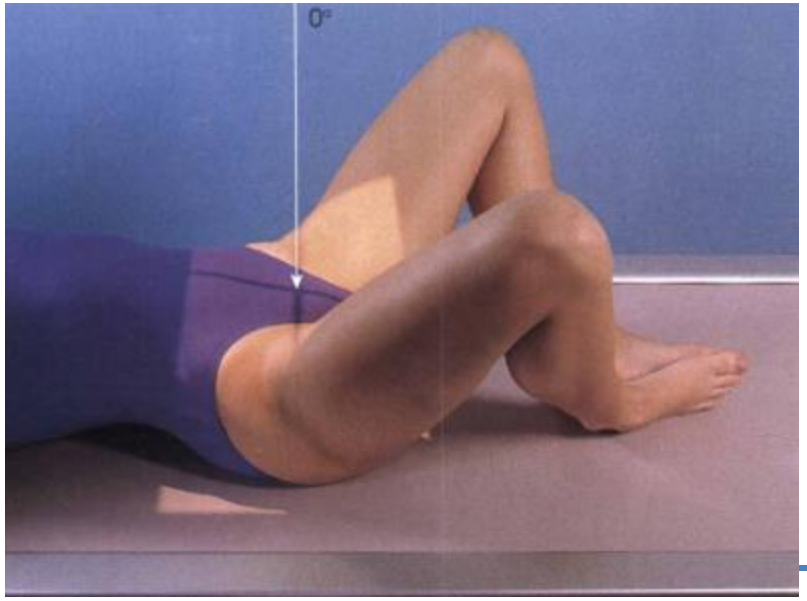
- Demonstration of a nontrauma hip
- Developmental dysplasia of hip **(DDH),** also known as **congenital hip dislocation (CHD).**

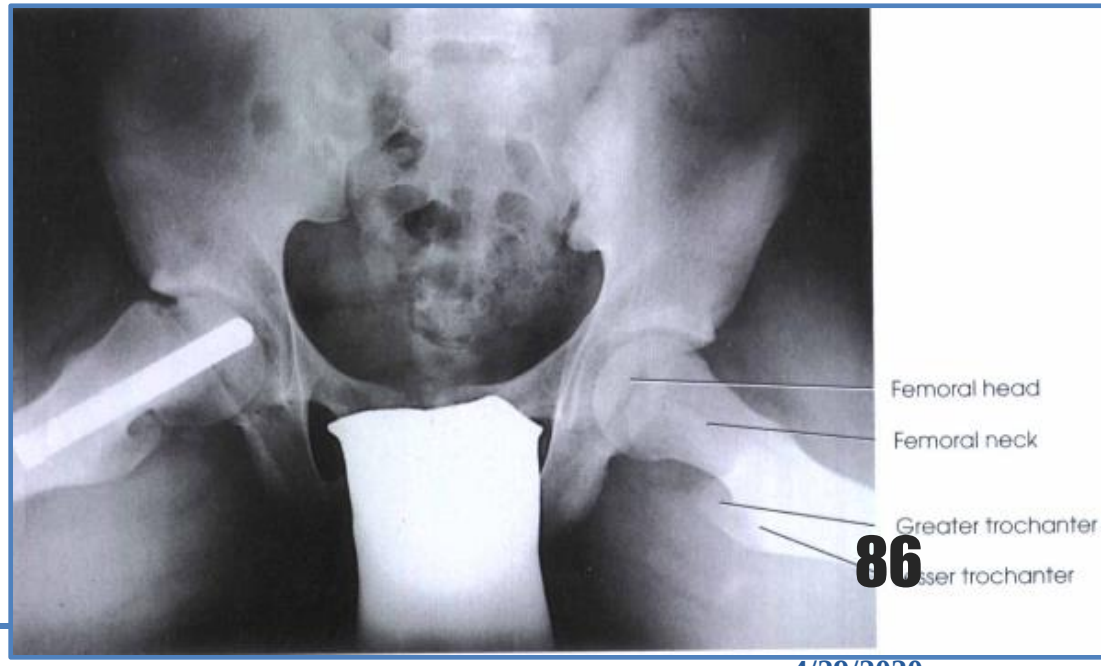
- ***Patient position:***
  - ➢ Assist the patient to the supine position.
- ***Part position:***
  - ➢ Flex the hips and knees and draw the feet up as much as possible.
  - ➢ Abduct thighs as much as possible, and place the plantar surface of feet together
- ***CR:-***
  - ❑ directed to a point **3 inches (7.5cm) below level of ASIS (1 inch [2.5cm] above symphysis pubis).**

Fig, Lateral-both hip("frog-leg")

Image evaluation:-

- No rotation of pelvis
- Acetabulum, femoral head and femoral neck.
- Lesser trochanter on the medial side of femur
- Femoral neck without superimposition by greater trochanter.





PELVIS

- ***Technical consideration:-***
  - **Film size-**30x40cm(crosswise)
  - **FFD-** 100cm
  - **Grid** is recommended
  - **KV** selection – 85-95kvp
  - Collimate area of interest
- ***Shielding:***
  - ✓Shield gonads on all male patient. Ovarian shield is, however, not possible.

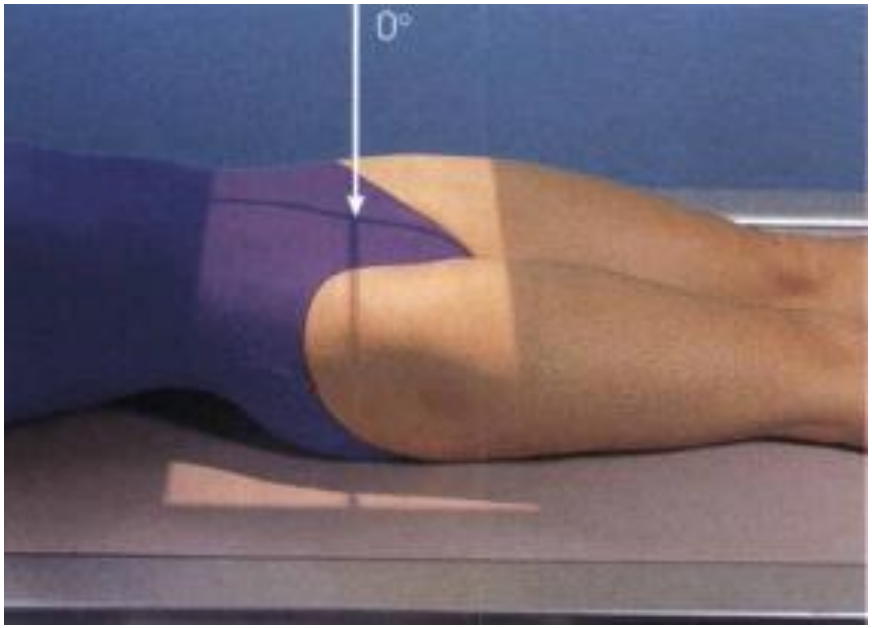
AP: PELVIS

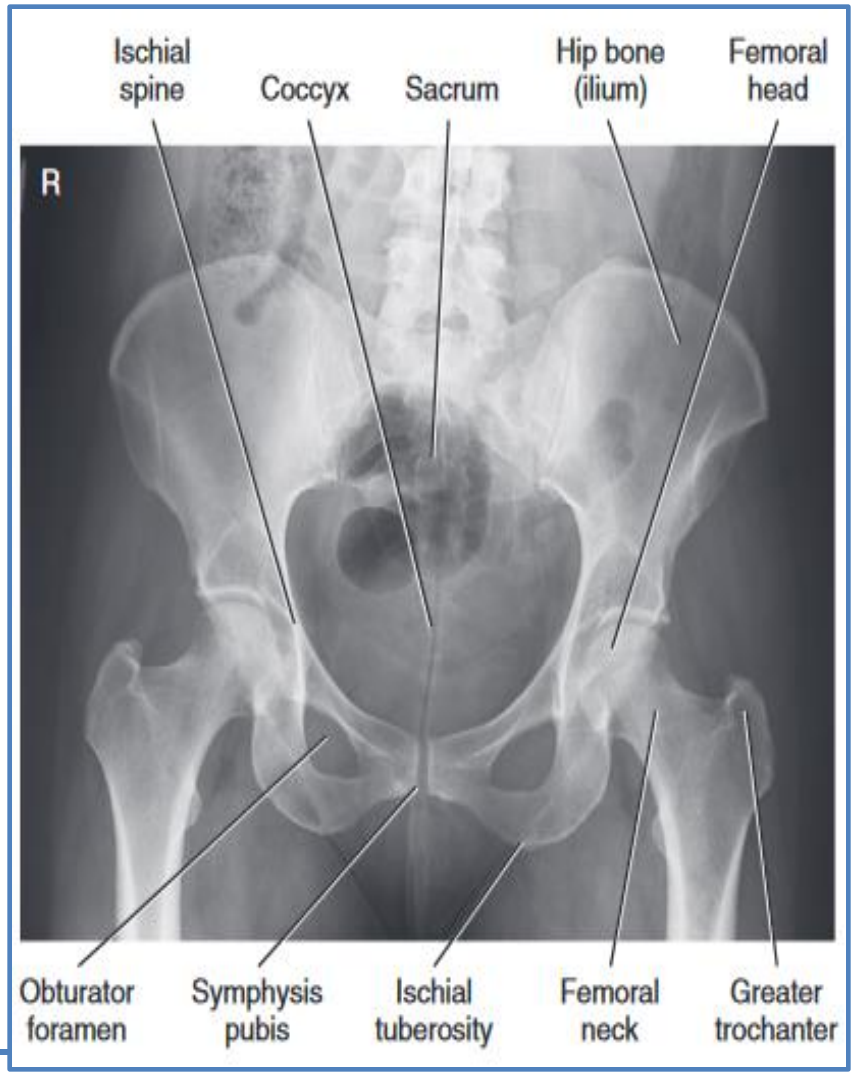
- ***Patient position:***
  - The patient lies supine, with the midsagittal plane perpendicular to the tabletop.
- ***Part position:***
  - Separate legs and feet, then internally rotate long axes of feet and lower limbs**(15° -20°)** to bring femoral neck parallel to the **IR.**
  - Sandbags and pads are placed against the ankle region.
- ***CR:***
  - ***Directed to a point 2inch above symphysis pubis.***

Fig, AP: Pelvis

Image evaluation:-

- ✓ Entire pelvis, L5, sacrum and coccyx, femoral heads and neck, and greater trochanters are visible.
- ✓ ***Lesser trochanters not visible at all.***





The end…