Skeletal System-2

Bones of Lower Limb

Introduction to Anatomy and Embryology

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Bones of The Lower Limb

➢ Pelvic girdle:

Connects the lower limb to the trunk.

It is formed of 2 hip bones & sacrum

➢ Thigh:

Femur

➢ Forearm:

Tibia (*M*)

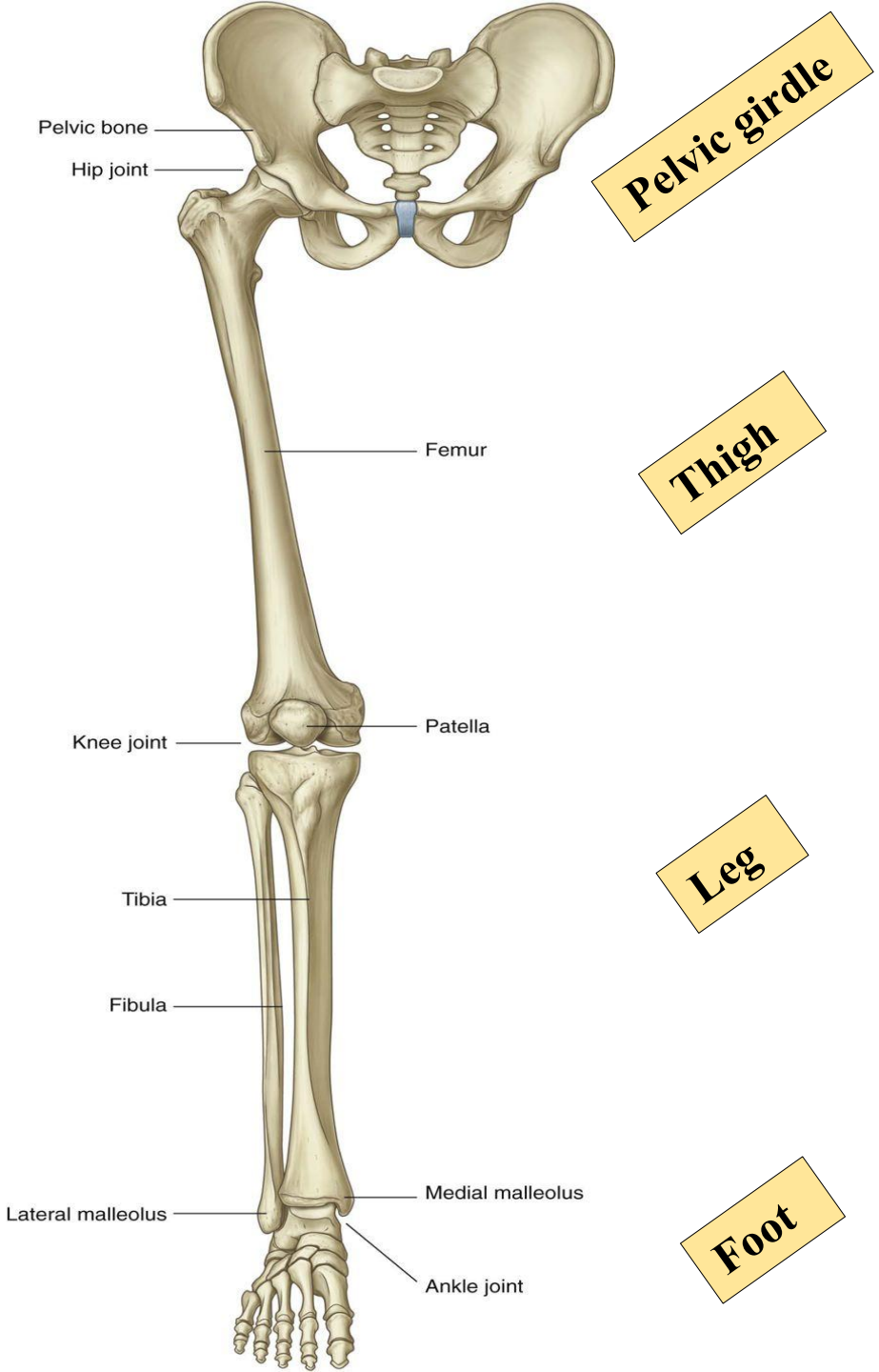
Fibula (*L*)

➢ Foot: (26 bones)

Tarsal bones (7)

Metatarsals (5)

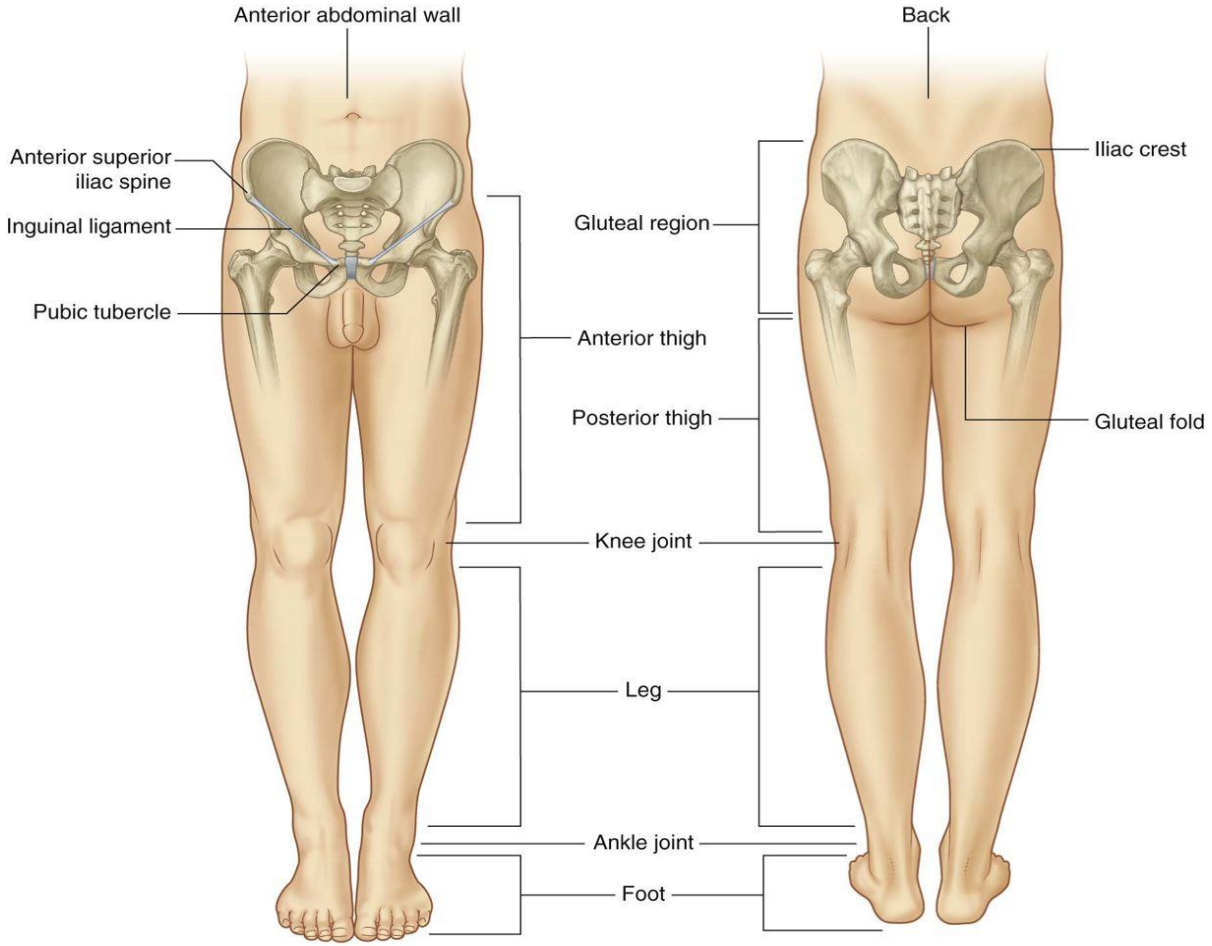
Phalanges (14)

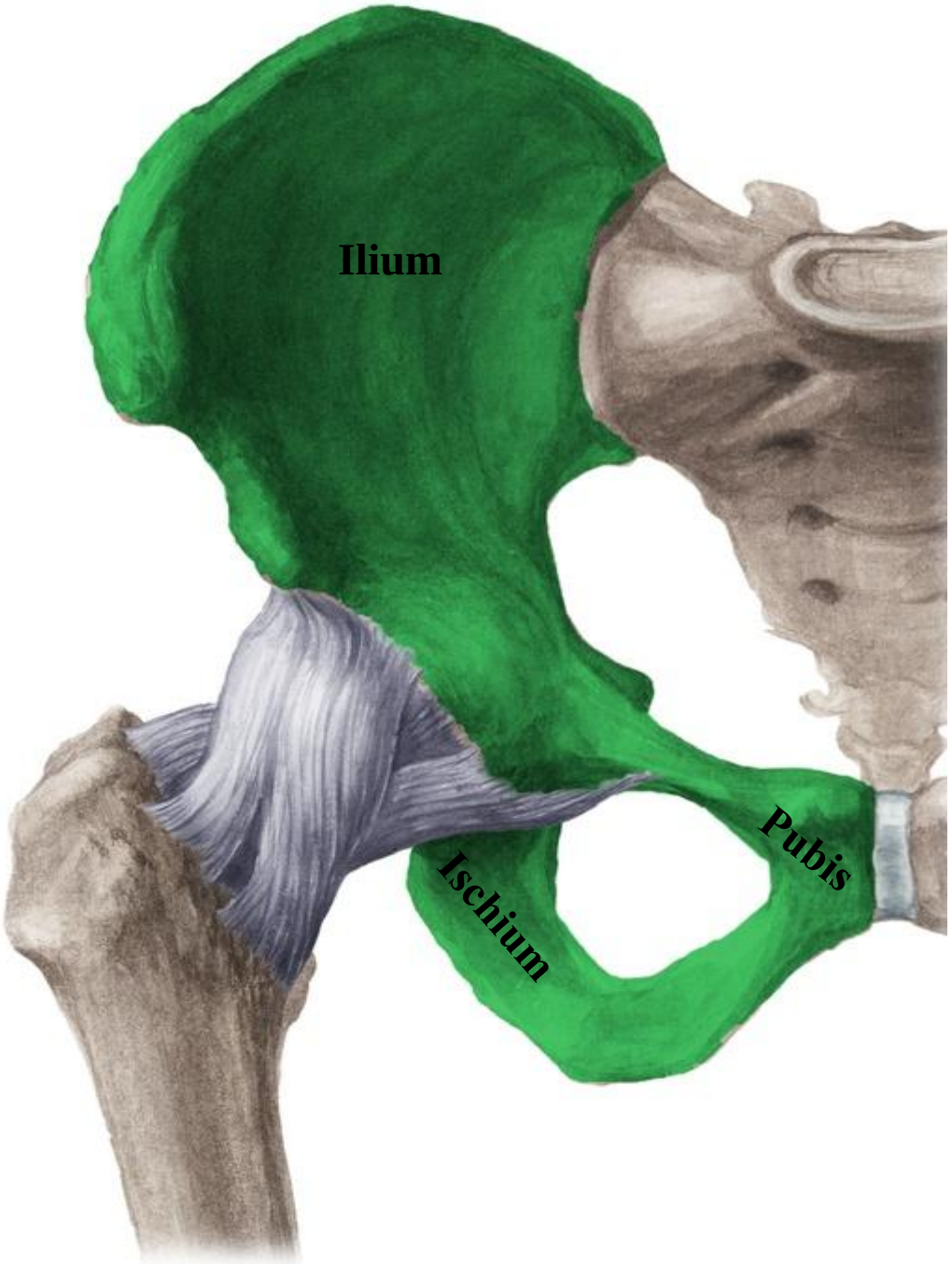


Hip bone

Made up of 3 bones:

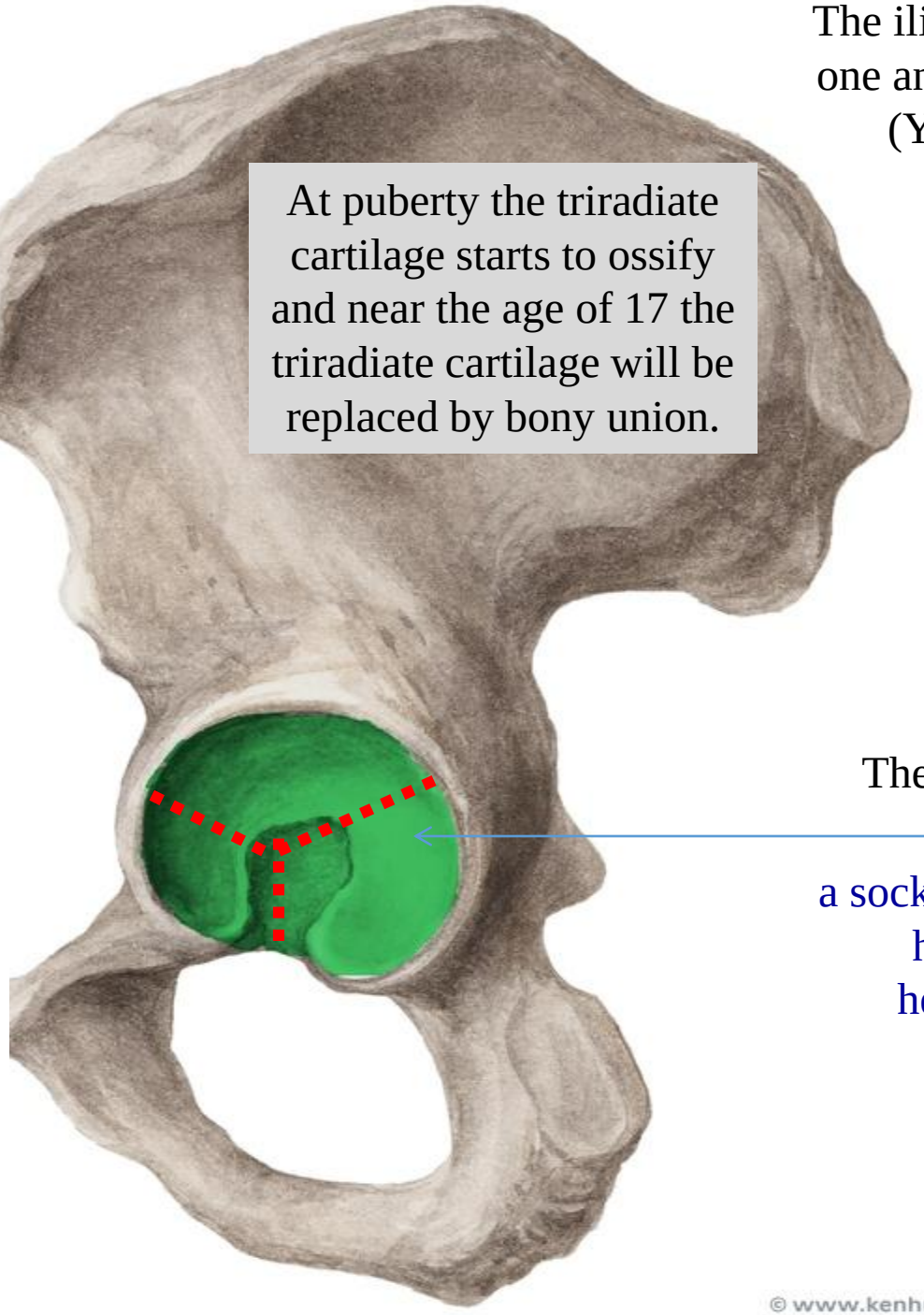
1) **Ilium** (flat), superior in position.
2) **Ischium** (L), postero-inferior in position.
3) **Pubis** (V), antero-inferior in position.





The ilium, ischium and pubis meet one another by means of triradiate (Y-shaped) cartilage at the acetabulum.

At puberty the triradiate cartilage starts to ossify and near the age of 17 the triradiate cartilage will be replaced by bony union.



The three bones meet at the

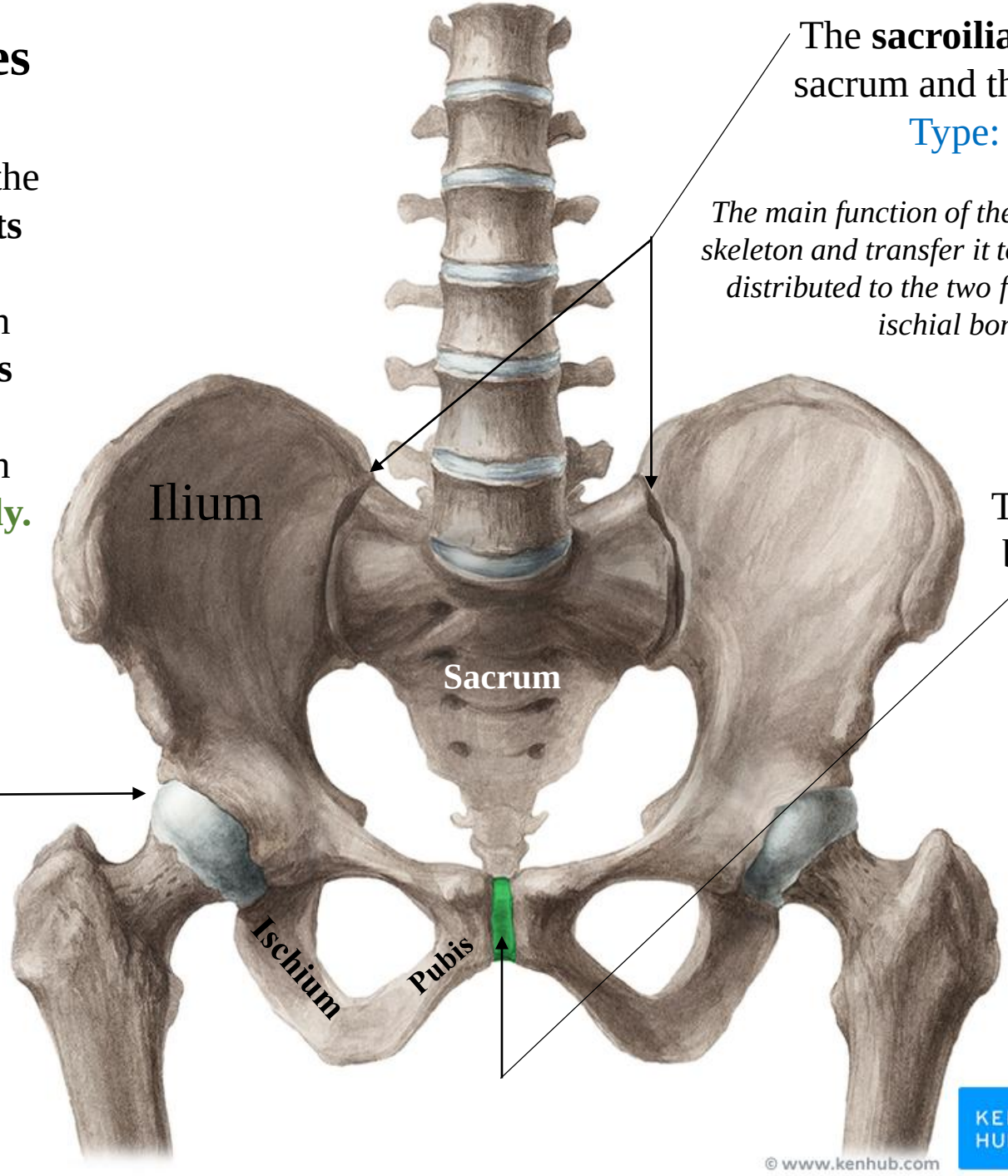
Acetabulum:

a socket on the lateral surface of hip bone where the femur head articulates to form the hip joint

Articulation of hip bones

1. The hip bones articulate with the sacrum at the **sacroiliac joints** **posteriorly.**
2. The hip bones articulate with one another at the **symphysis pubis** **anteriorly.**
3. The hip bone articulates with femur at the **hip joint** **laterally.**

The **hip joint** is the joint between the head of femur and acetabulum of the pelvis (Acetabulofemoral joint).
Type: Ball and socket synovial joint.
Movements: flexion, extension, abduction, adduction, medial & lateral rotation & circumduction.



The **sacroiliac joint** is the joint between sacrum and the ilium bones of the pelvis.
Type: plane synovial joint.

The main function of the joint is to bear the weight of the axial skeleton and transfer it to the hip bones. The weight can then be distributed to the two femurs in the standing position, or the ischial bones in the seated position.

The **symphysis pubis** is the joint between the left and right pubic bones.
Type: Secondary cartilaginous joint.

The movements in the pubic symphysis are very limited but very important for cushioning the stress related to physical activity particularly while walking and running. During pregnancy, circulating hormones (e.g. relaxin) cause structural changes in the pubic symphysis in order to increase its width and mobility to prepare the pelvis for childbirth.

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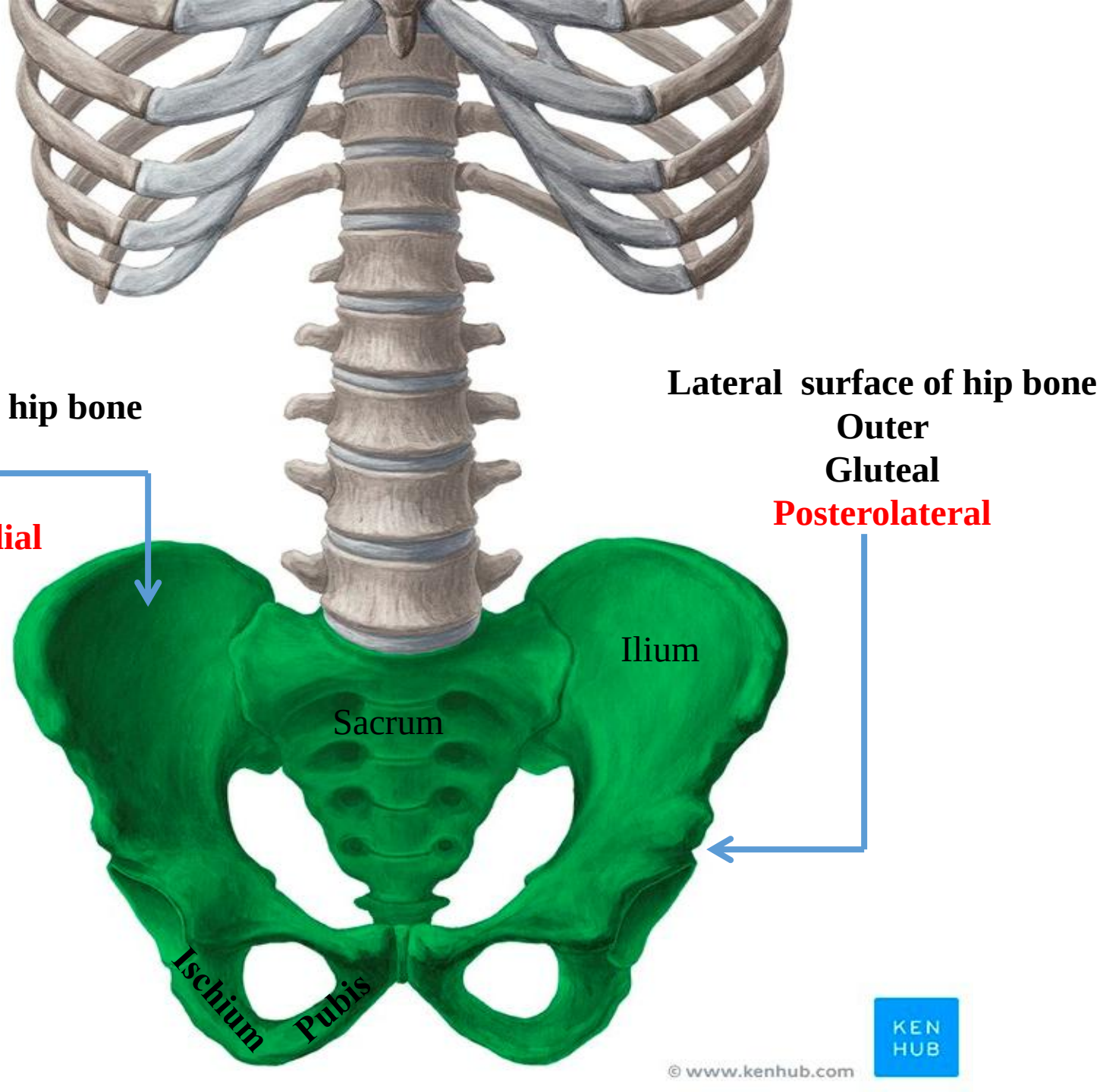
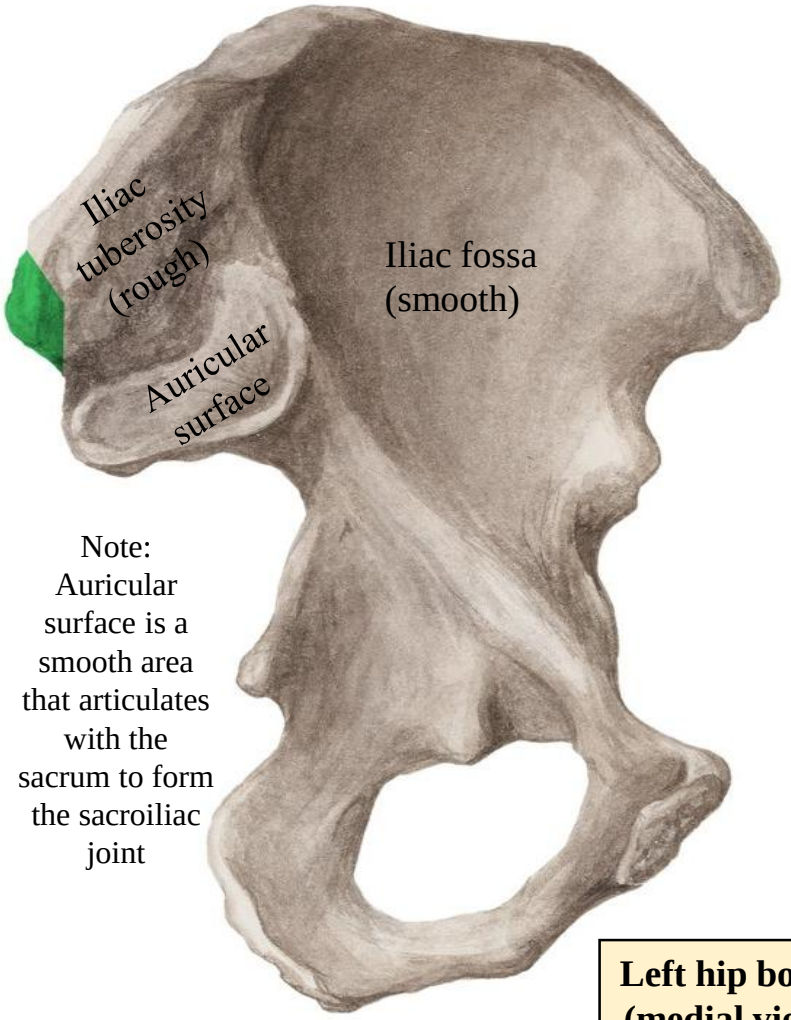


Inner or pelvic surface



Note: Auricular surface is a smooth area that articulates with the sacrum to form the sacroiliac joint

Left hip bone (medial view)

Hip bone is formed of 3 bones: Ilium, Pubis, Ischium

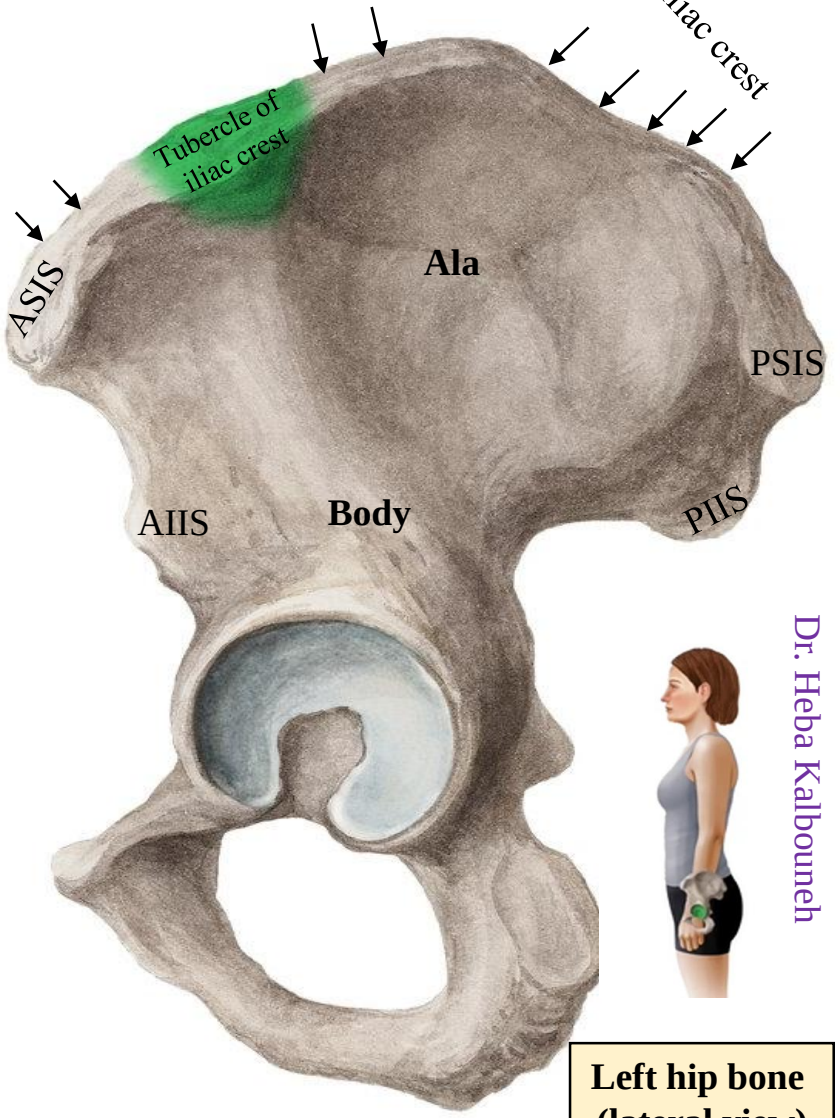
Ilium: is the upper part of hip bone.

It has 2 parts:
Body and ala (wing)

It has 3 borders:

- ✓ **Superior border:** called iliac crest (palpable). The iliac tubercle is located approximately 5 cm posterior to the ASIS on the iliac crest.
- ✓ **Anterior border** which presents the anterior superior iliac spine (ASIS) & anterior inferior iliac spine (AIIS).
- ✓ **Posterior border** which presents the posterior superior iliac spine (PSIS) & posterior inferior iliac spine (PIIS).

Outer or gluteal surface



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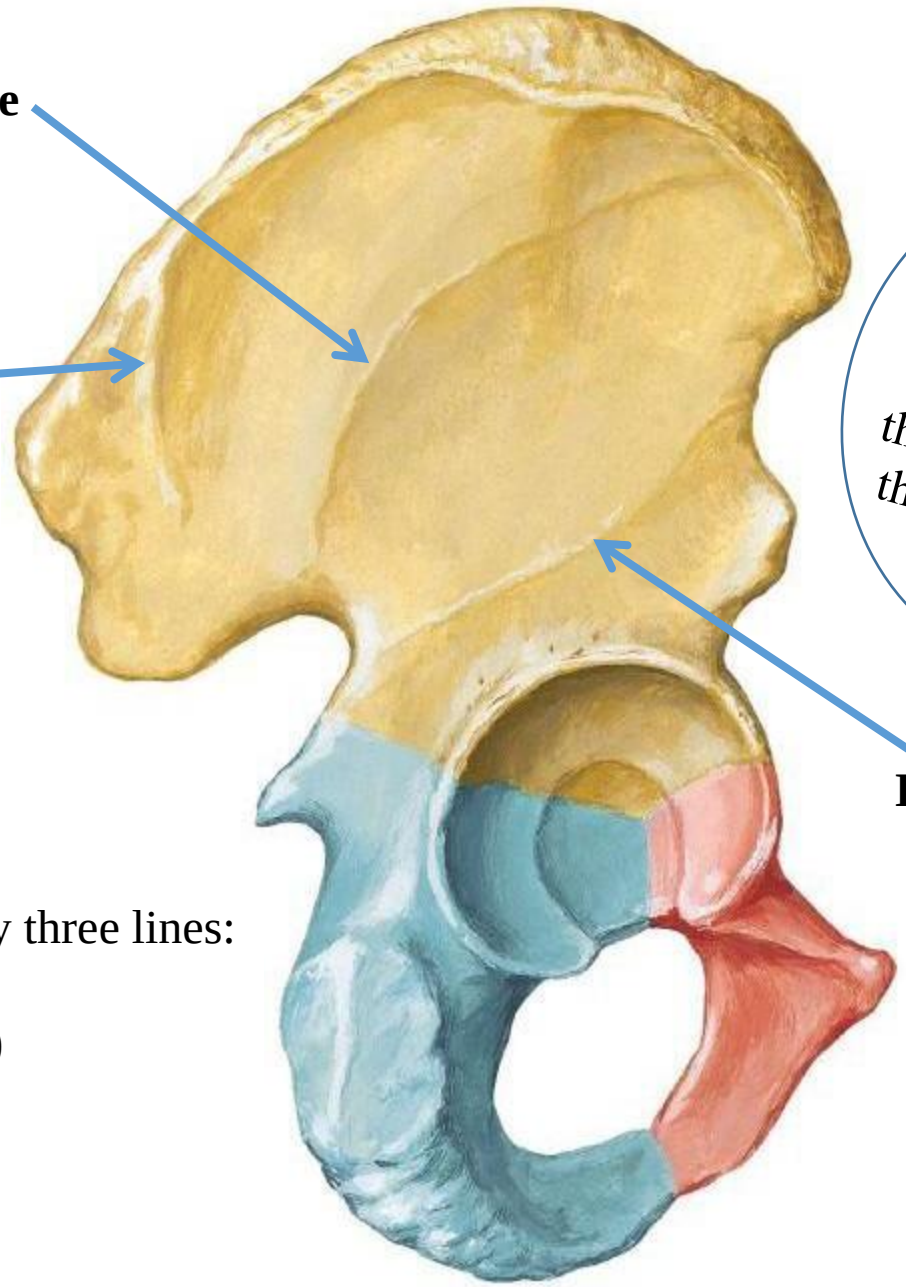
Left hip bone (lateral view)

It has 2 surfaces :

- ✓ **Outer or gluteal surface** which has 3 gluteal lines (posterior, middle & inferior).
- ✓ **Inner or pelvic surface** which shows iliac fossa, iliac tuberosity and auricular surface (which articulates with sacrum).

The gluteal surface



MAKE SURE you know the names of the muscles that are attached to the areas between these lines

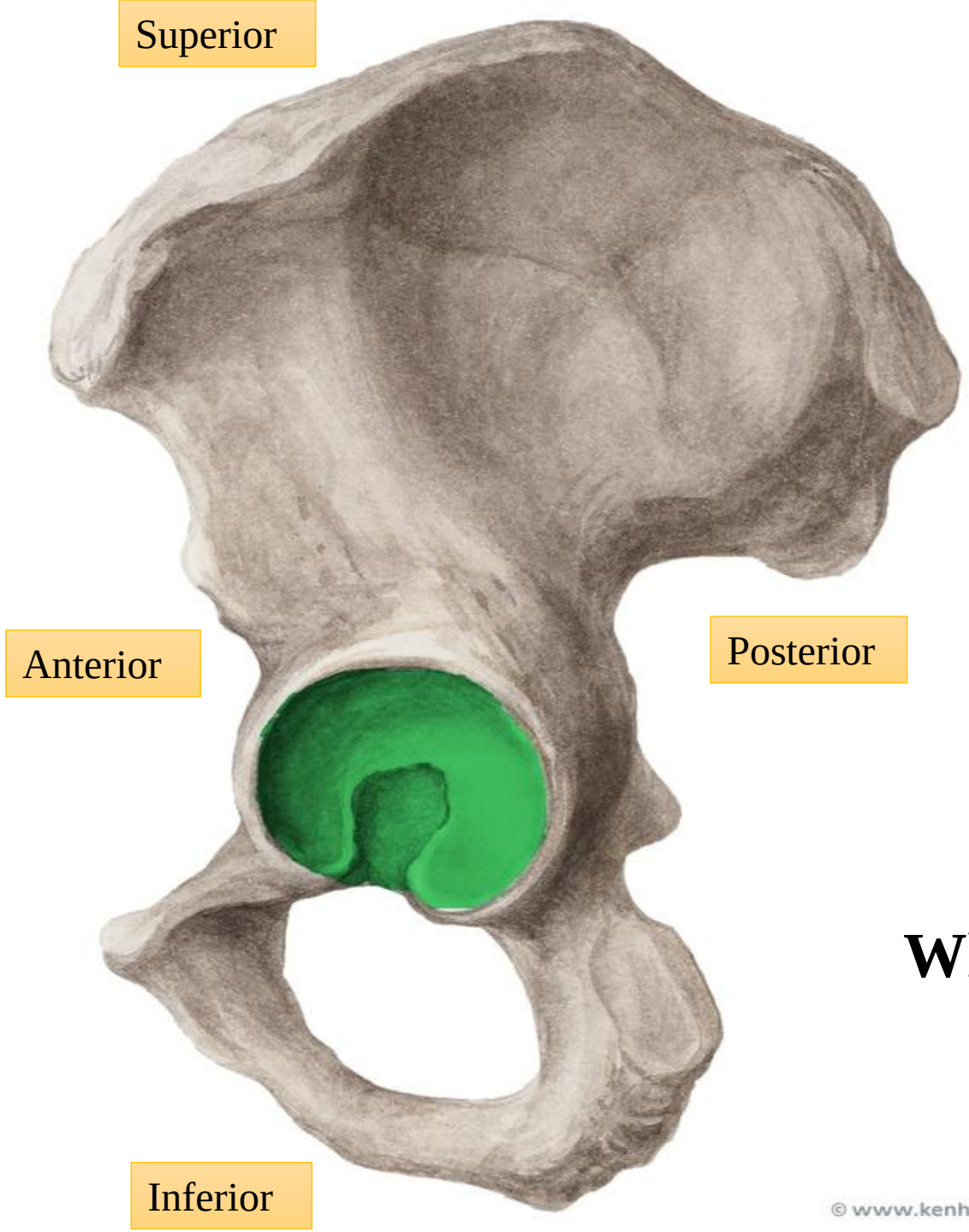
The gluteal surface is divided into 4 parts by three lines:

1- Posterior gluteal line

2- Anterior gluteal line (middle)

3- Inferior gluteal line

Outer surface Left hip bone



Which surface??? Which side???

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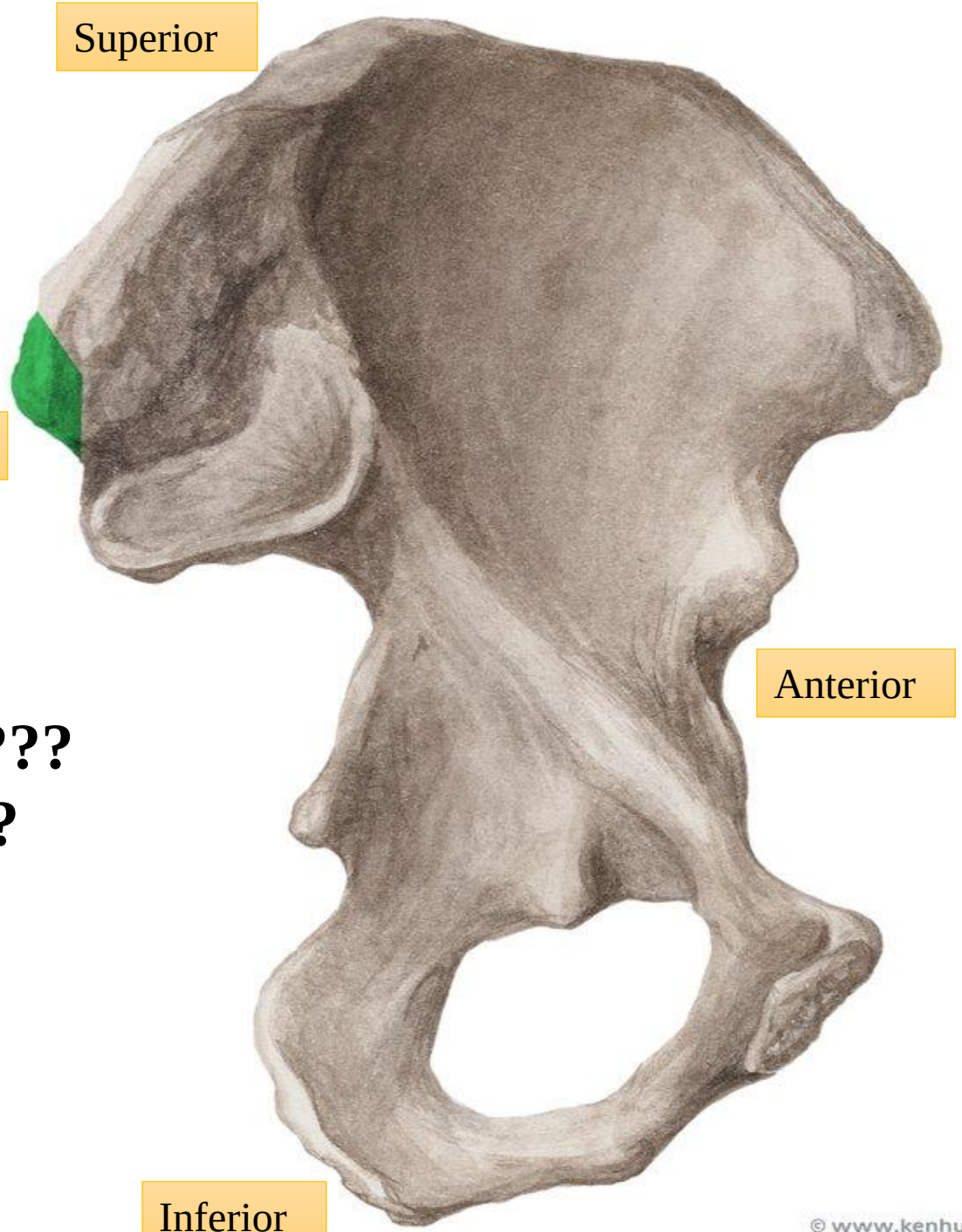
Inner surface Left hip bone

Superior

Posterior

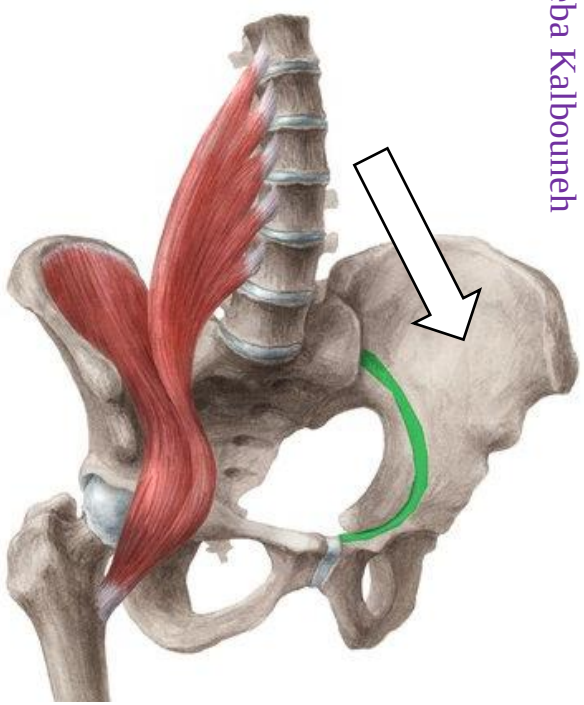
Anterior

Inferior



Which surface???
Which side???

Look at the hip bone from inner (medial) side



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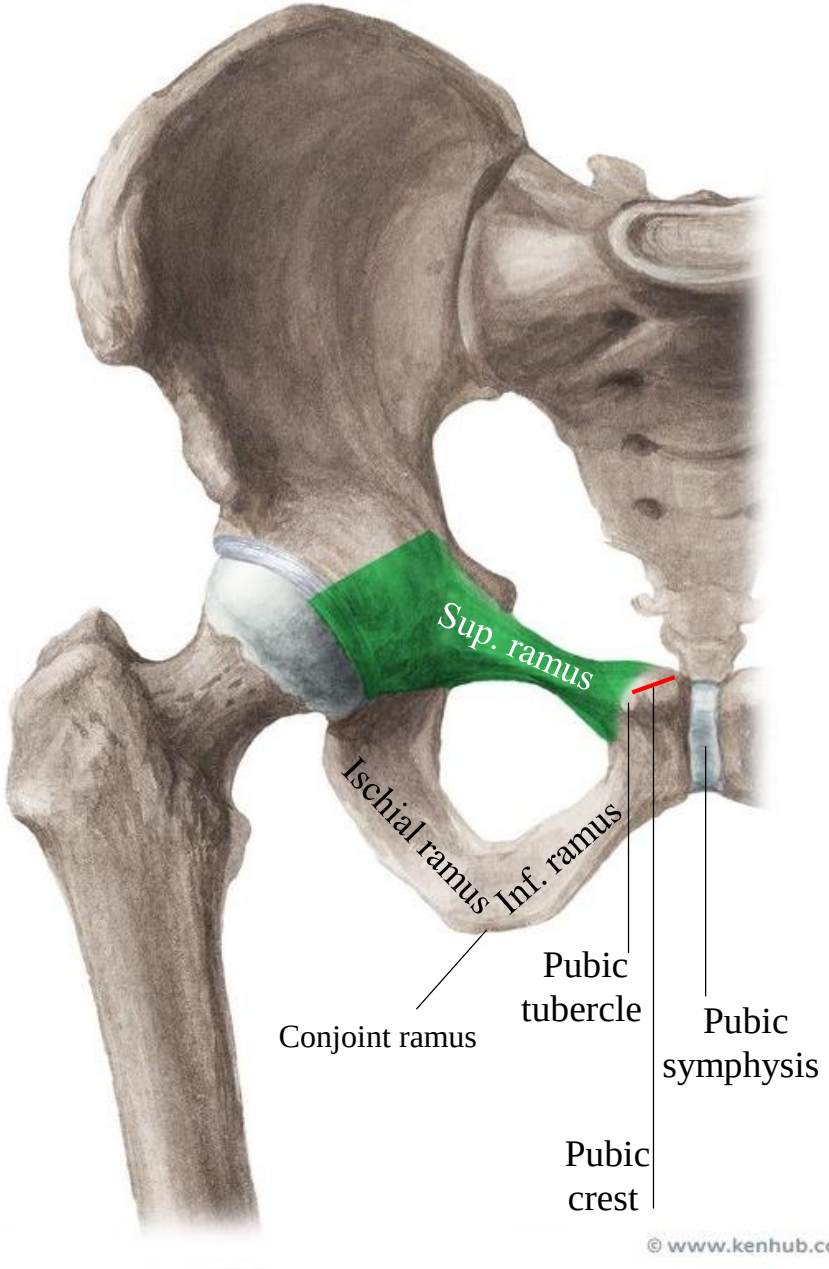
Pubis: is the anterior-inferior part of hip bone.

It has 3 parts:
Body, superior ramus and inferior ramus.

Pubic crest is the upper border of the body of pubis.
Pubic crest ends laterally by the **pubic tubercle.**

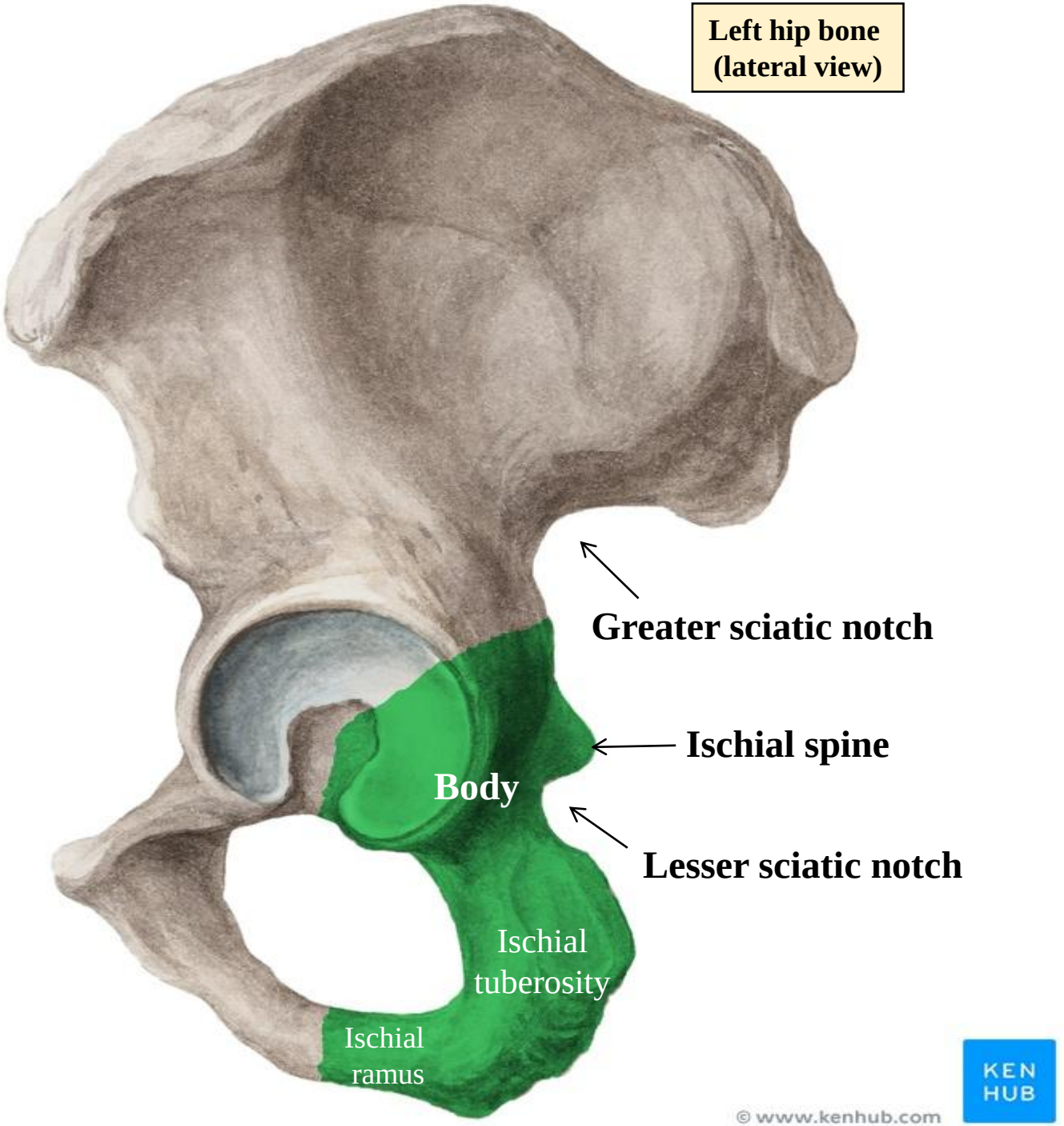
The medial surface of the body articulates with the opposite pubis to form the **pubic symphysis.**

The inferior ramus of the pubic bone joins the ischial ramus to form the **conjoint ramus (ischiopubic ramus)**.



Outer or gluteal surface

Left hip bone (lateral view)



Ischium: is the posterior-inferior part of hip bone.

It has 4 parts:

Body

Ischial tuberosity: (sitting bone) it is related to bursa to reduce friction during sitting.

Ischial spine: which separates the greater sciatic notch from the lesser sciatic notch.

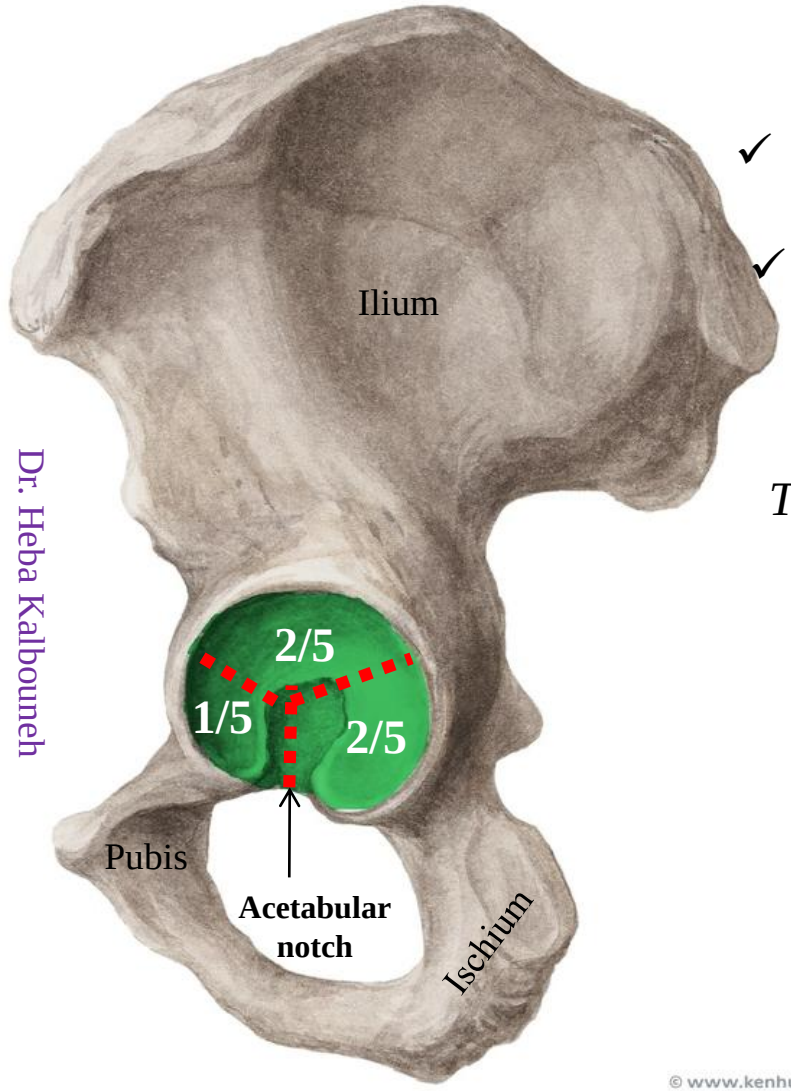
Ischial ramus: which joins the inferior pubic ramus to form ischiopubic (conjoint) ramus.

Acetabulum

- ✓ It is a hollow depression located on the lateral aspect of the hip bone.
- ✓ It is directed laterally, downwards and forwards.
- ✓ A fibrocartilaginous lip called **acetabular labrum**, is attached to the margin of the acetabulum to increase its depth.

Note:

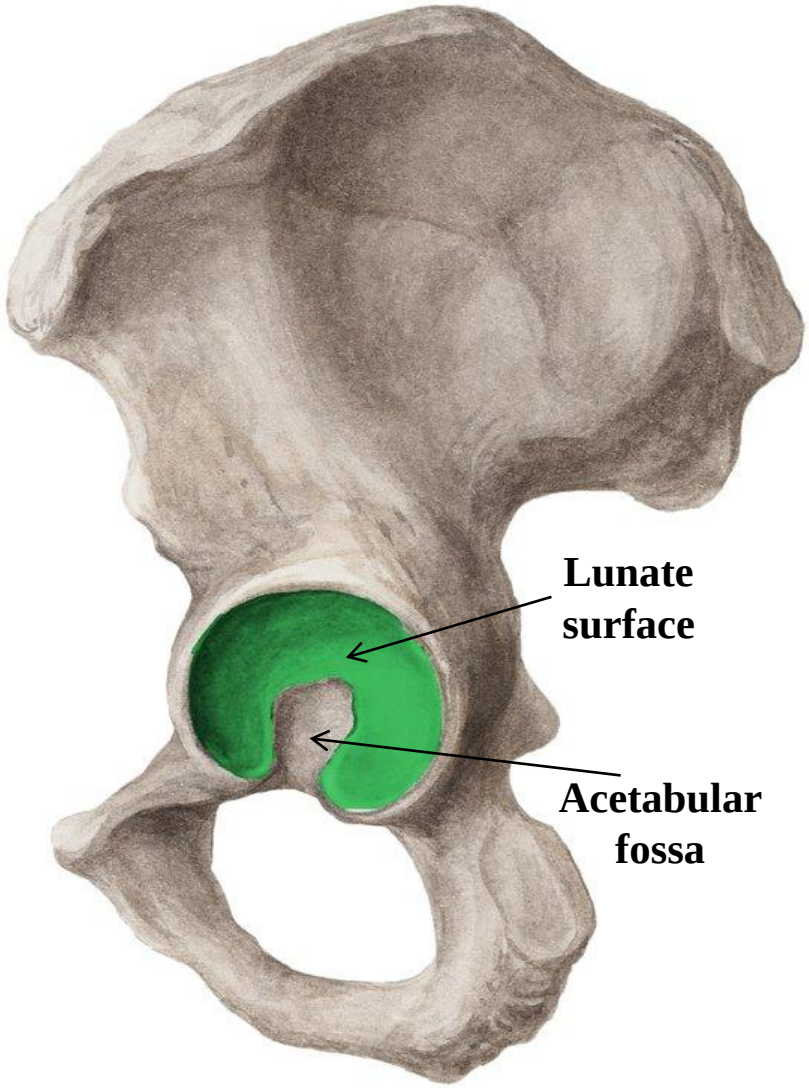
1. The ilium forms the superior 2/5 of the lunate surface.
2. The ischium forms the posterior 2/5 of the lunate surface.
3. The pubis forms the anterior 1/5 of the lunate surface.



- ✓ The acetabulum articulates with head of femur to form hip joint.
- ✓ It is notched inferiorly by the **acetabular notch** which is bridged by the **transverse acetabular ligament** (part of the acetabular labrum).

The acetabular ligament converts the acetabular notch into foramen.

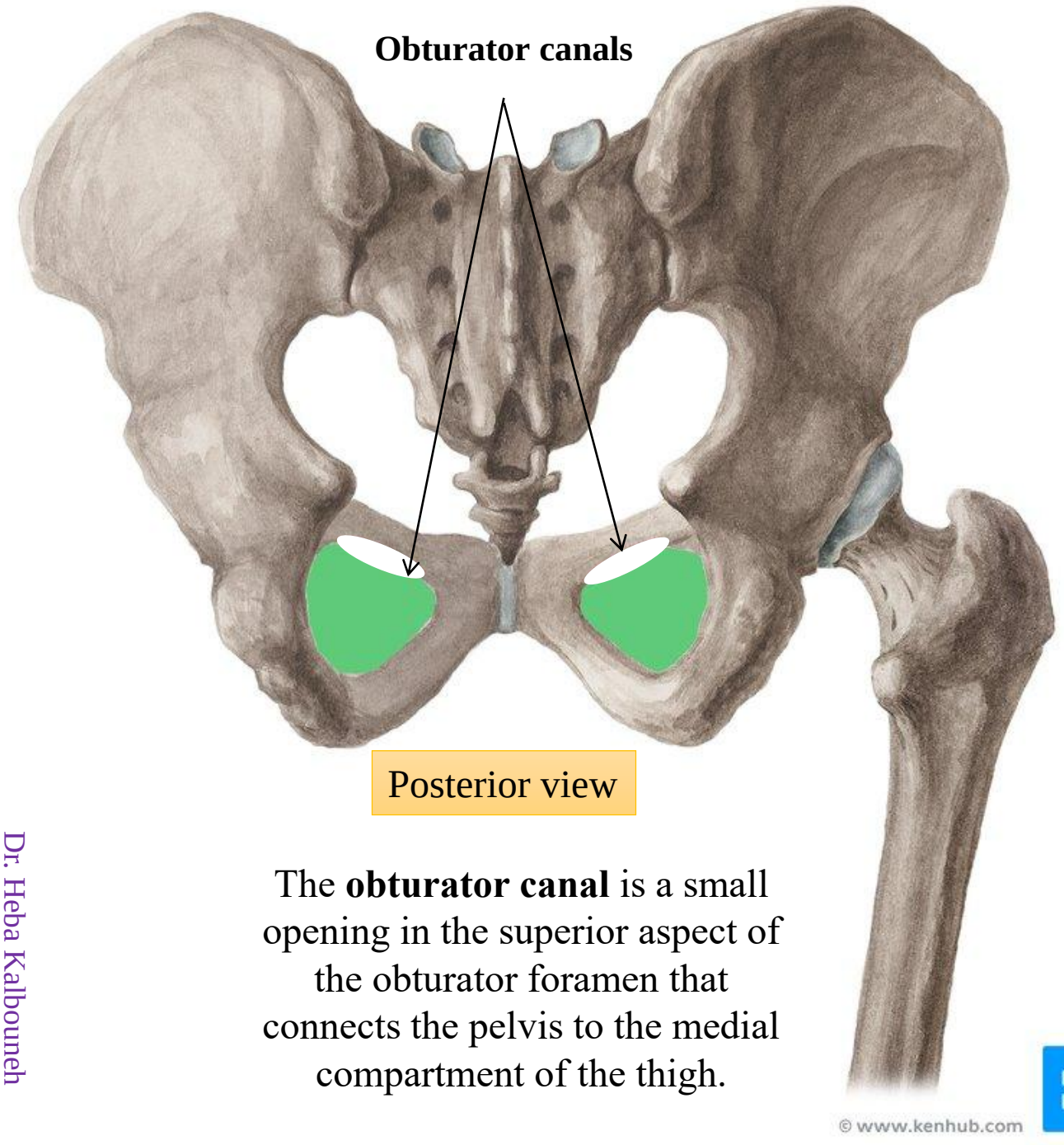
- ✓ Its cavity presents a horse-shoe shaped articular surface called **Lunate surface.**
- ✓ The lunate surface surrounds a non articular depression called **acetabular fossa** which is occupied by fat tissue in living subjects.



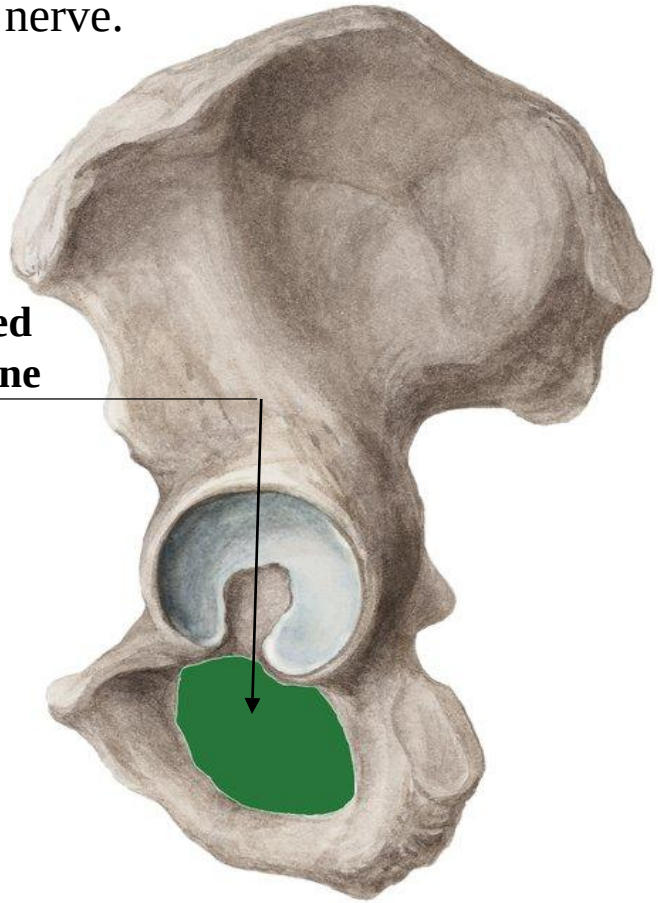
Obturator foramen

- ✓ A large opening below the acetabulum.
- ✓ In living subjects, it is filled with obturator membrane except superiorly

Obturator canal for the passage of obturator vessels and nerve.

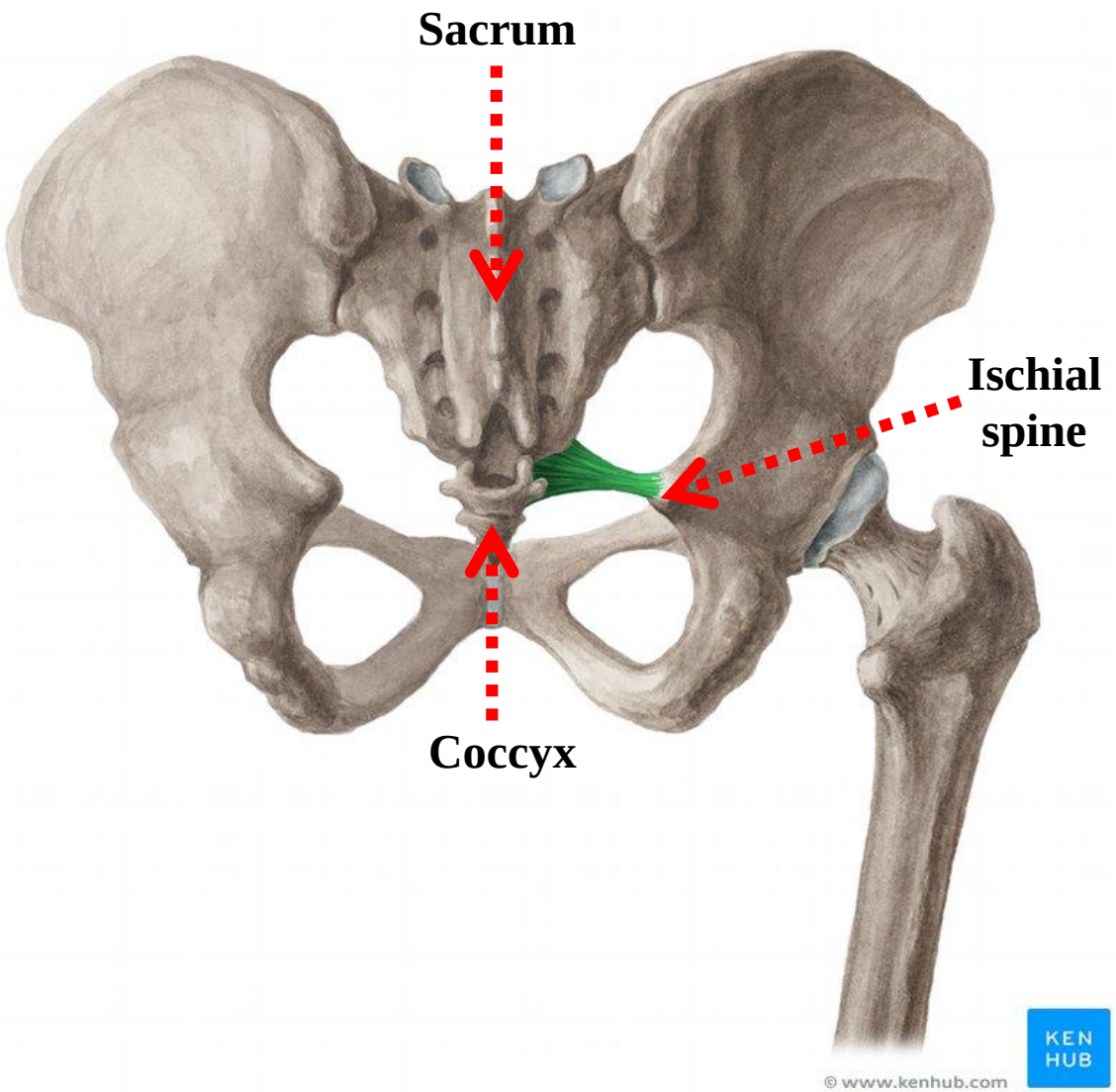


The **obturator canal** is a small opening in the superior aspect of the obturator foramen that connects the pelvis to the medial compartment of the thigh.

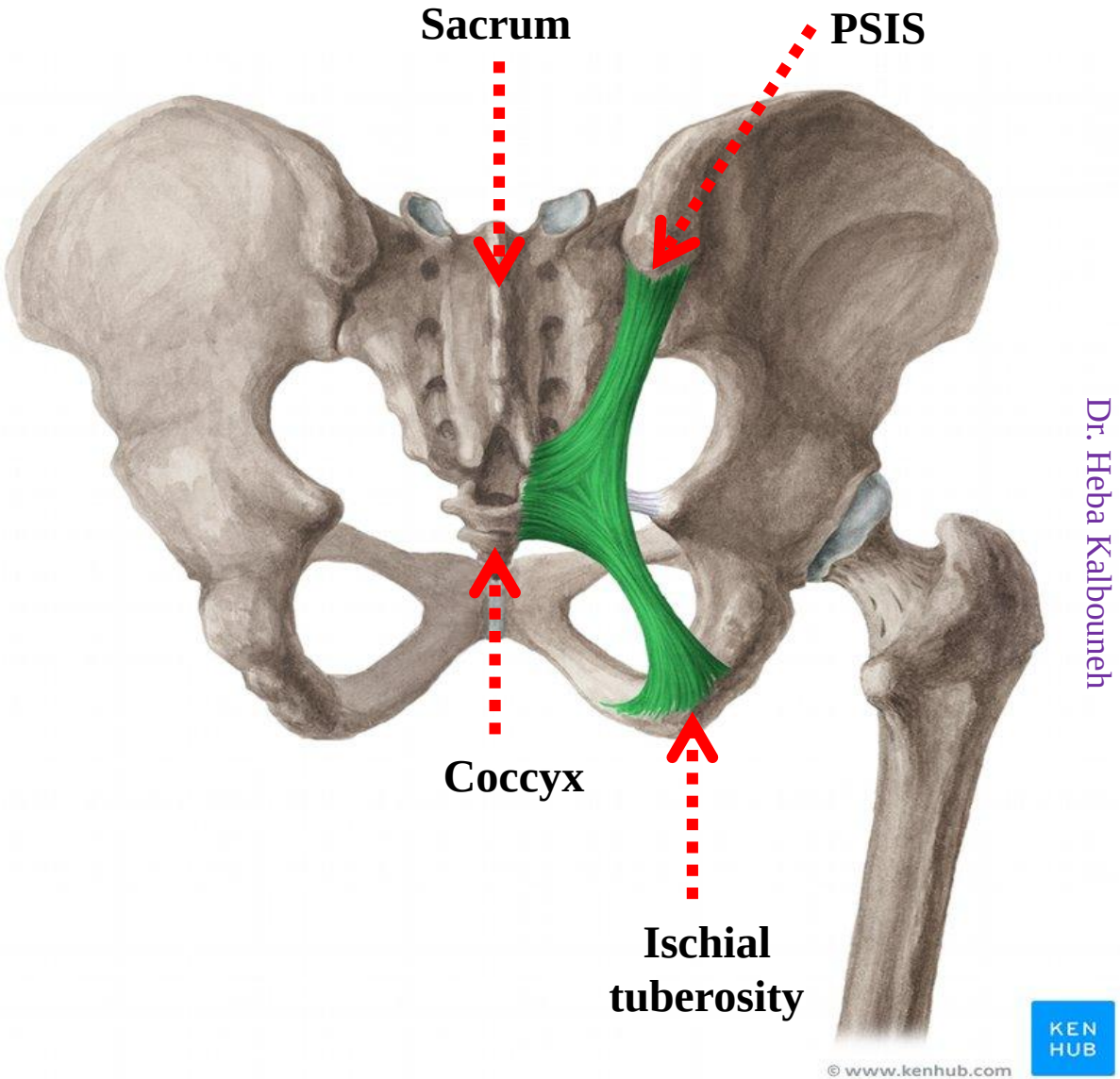


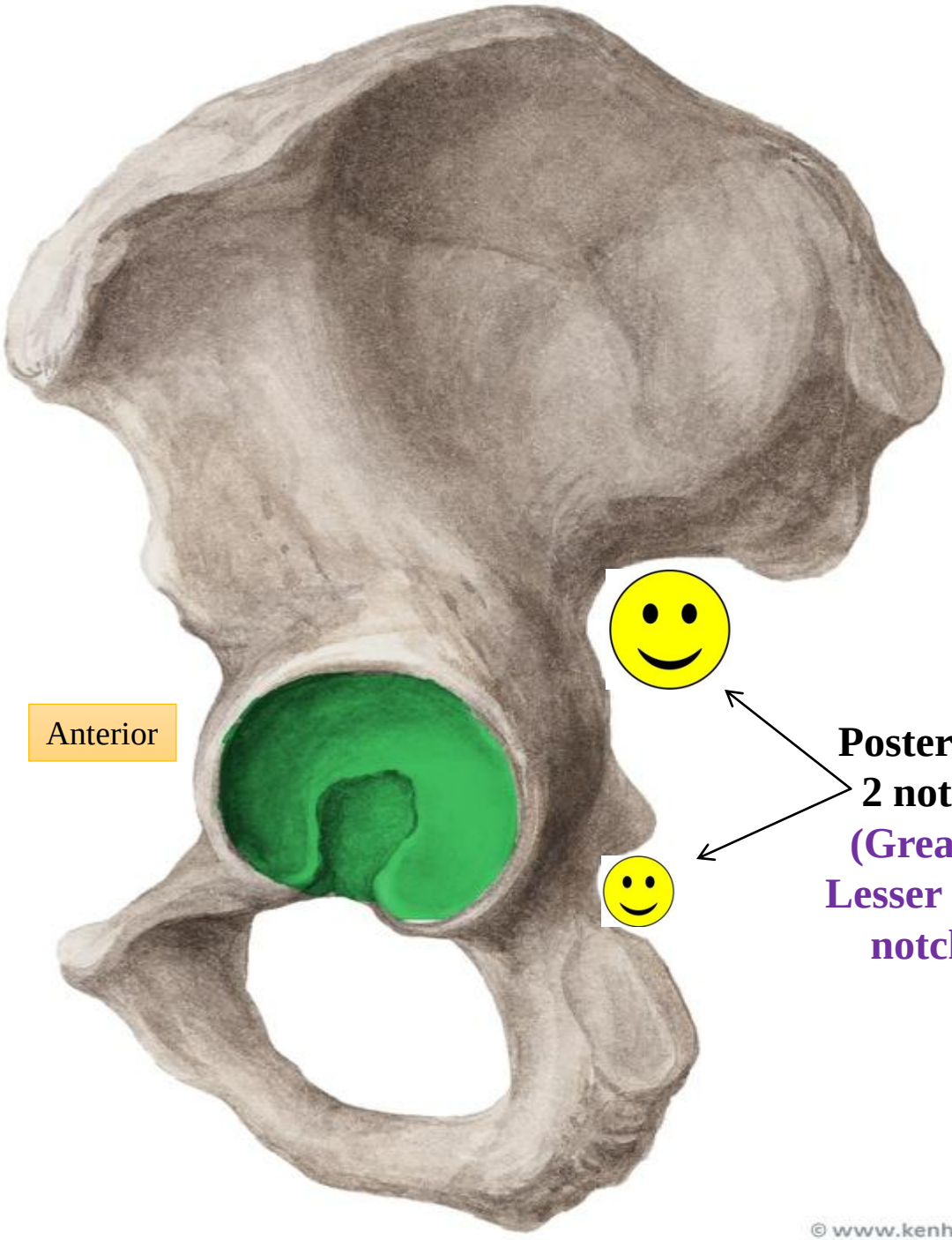
Posterior view

The **sacrospinous ligament** is a thin, triangular ligament. The base of the ligament is attached to the sacrum and coccyx, and the tip attaches to the ischial spine.



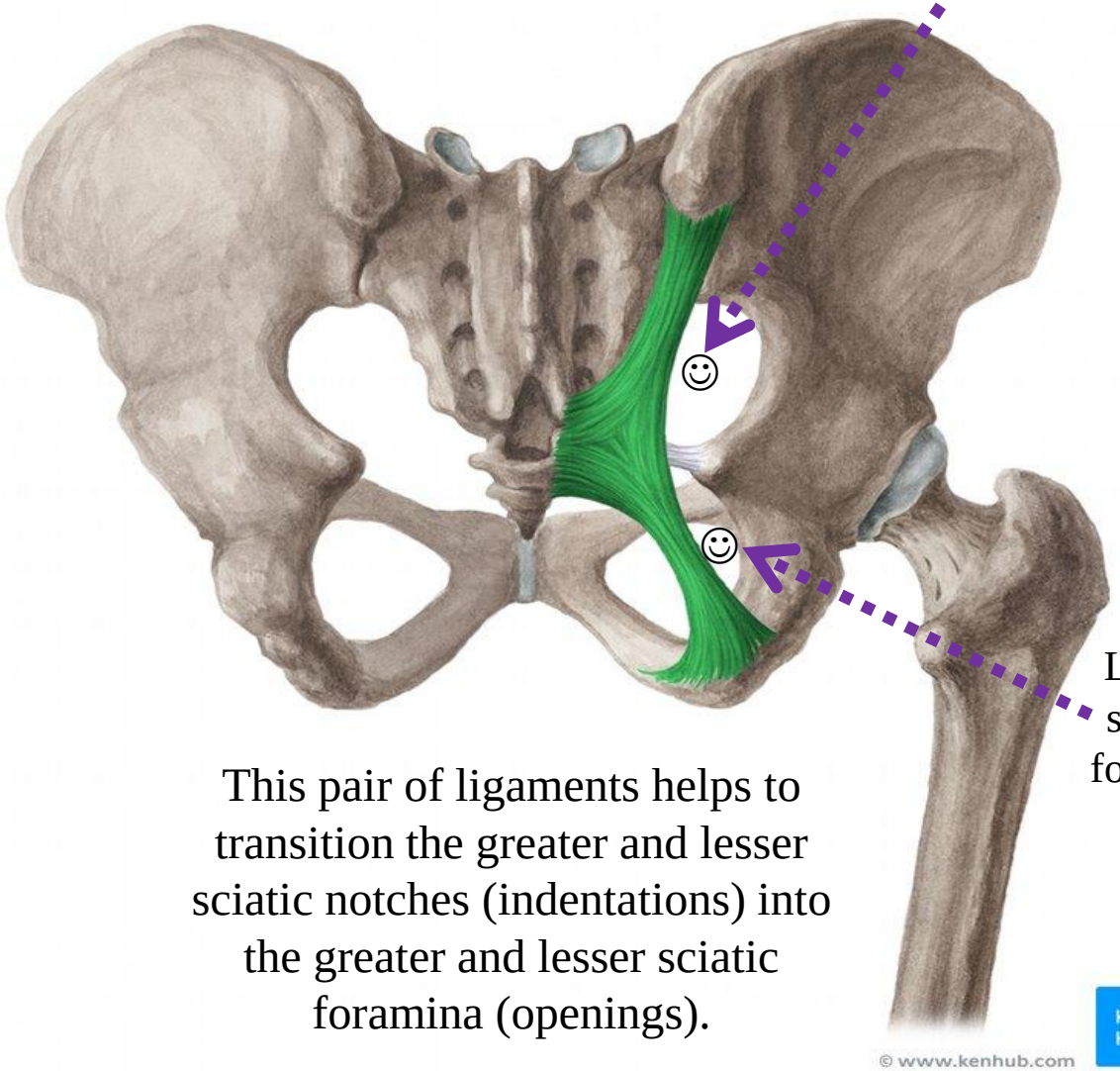
Sacrotuberous ligament runs from the sacrum, coccyx and PSIS to the ischial tuberosity.





Posteriorly:
2 notches
(Greater & Lesser sciatic notches)

Posterior view



This pair of ligaments helps to transition the greater and lesser sciatic notches (indentations) into the greater and lesser sciatic foramina (openings).

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Anatomical position of the hip bone

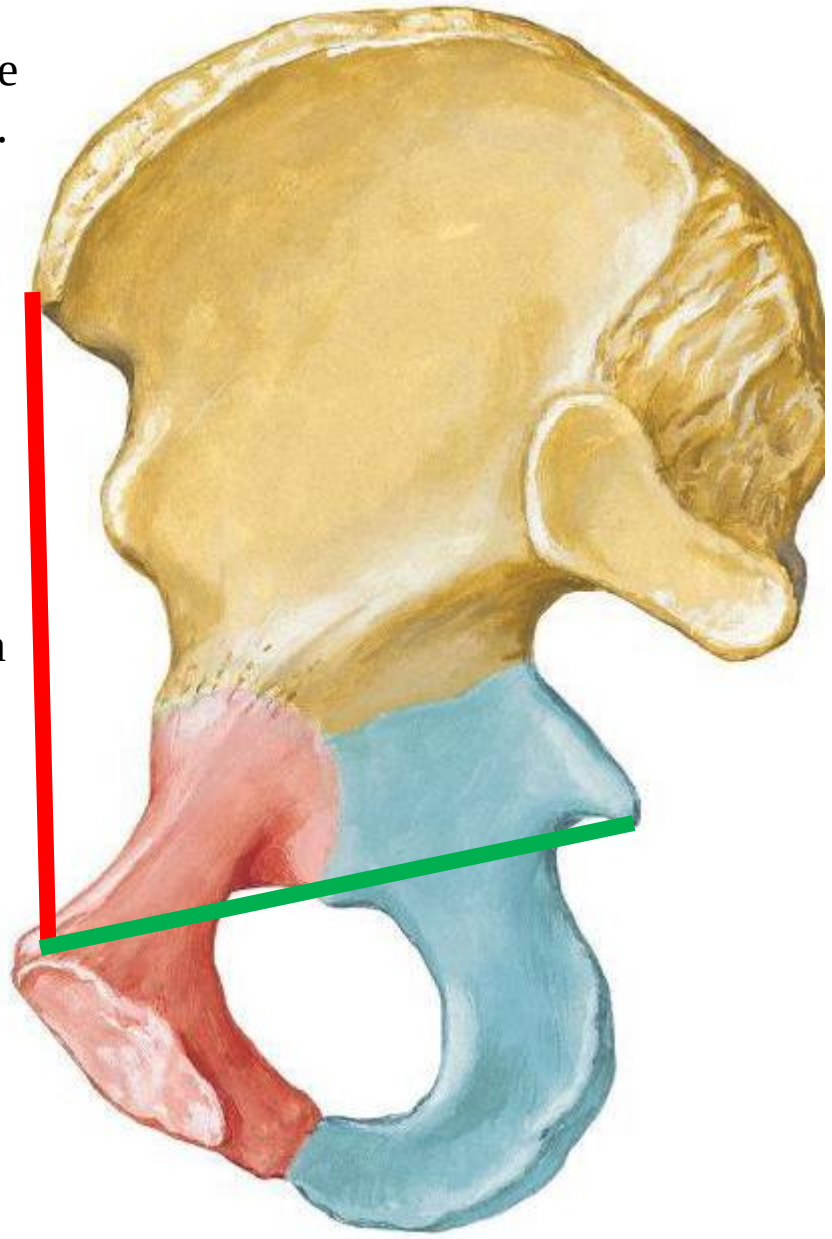
It is very important to understand the anatomical position of the hip bone.

In anatomical position:

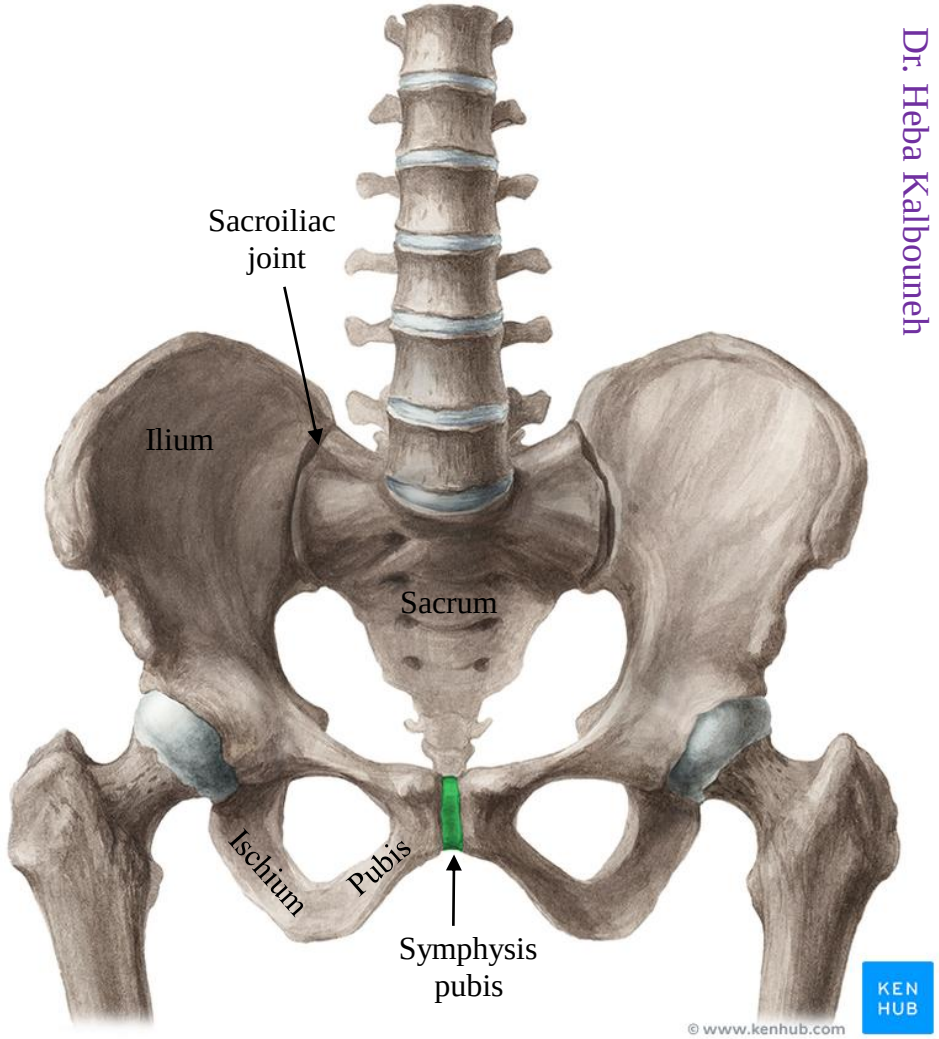
1-The Anterior superior iliac spine and the pubic tubercle lie in the **same vertical plane.**

2-The ischial spine and the upper border of the symphysis pubis lie in the **same horizontal plane.**

It means that the pelvis is looking forward in the anatomical position



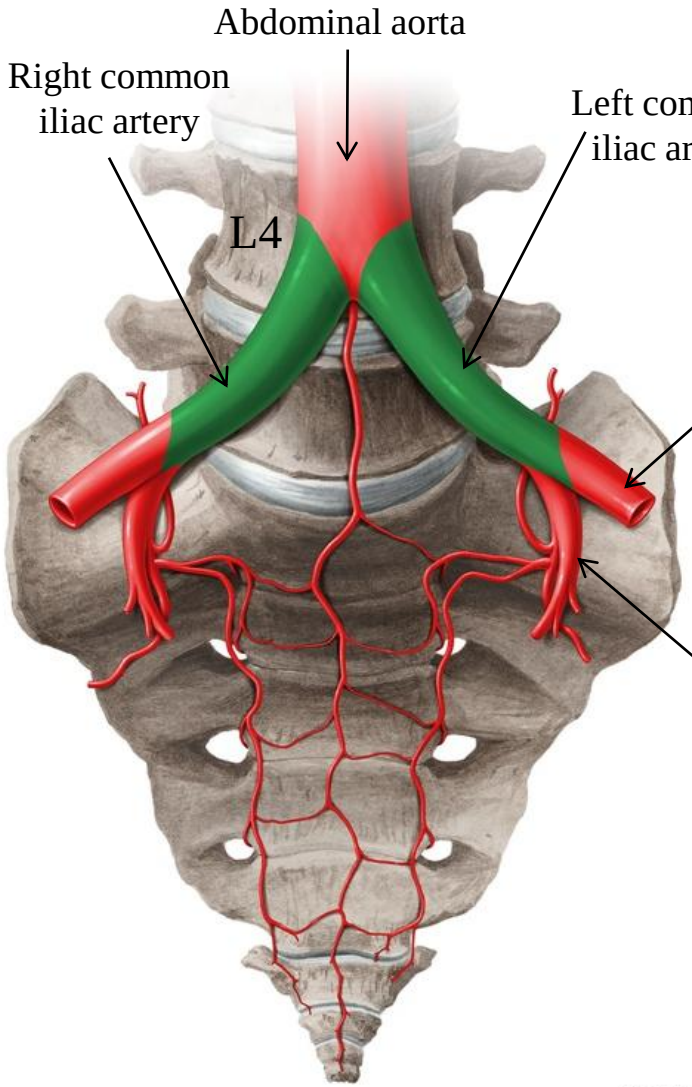
The 2 hip bones with the sacrum form the pelvis



Now look! where does the pelvis look? It is looking right at you! Never upwards

During your first practical session, make sure to have a look at the anatomical position of the pelvis

- ✓ Abdominal aorta bifurcates into the **left and right common iliac arteries.**
- ✓ Aortic bifurcation is at the level of the **fourth lumbar vertebra L4**



Bifurcation *refers to a division into two branches.*

Each common iliac artery divides into ***external*** *and* ***internal*** *iliac arteries.*

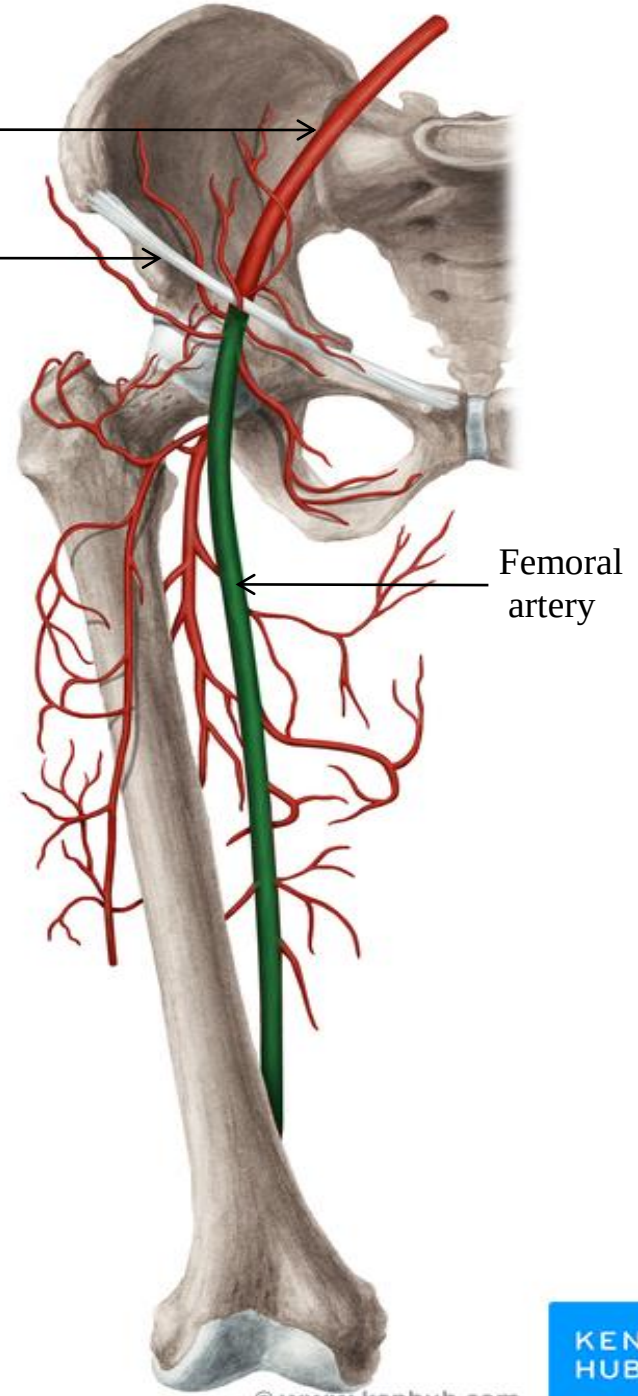
External iliac artery

Inguinal ligament

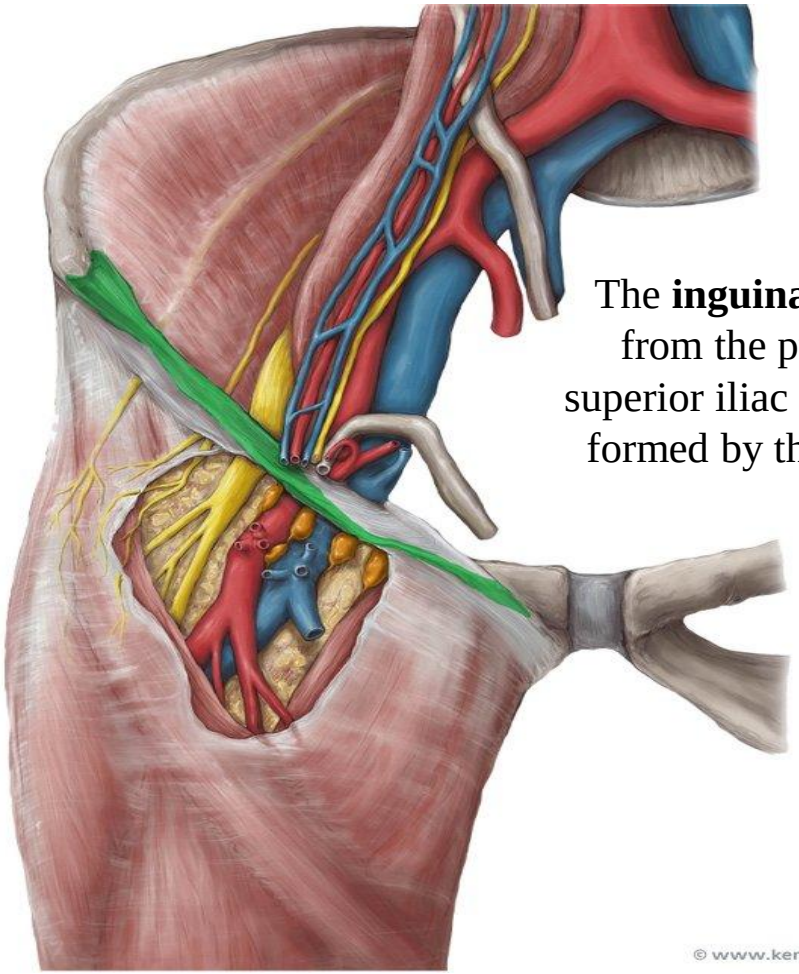
The fact that the pelvis is facing (looking) forward is important to understand how structures passing from the pelvis smoothly to join the thigh.

Notice, the **external iliac artery** as it passes from the pelvis into thigh to become the **femoral artery**

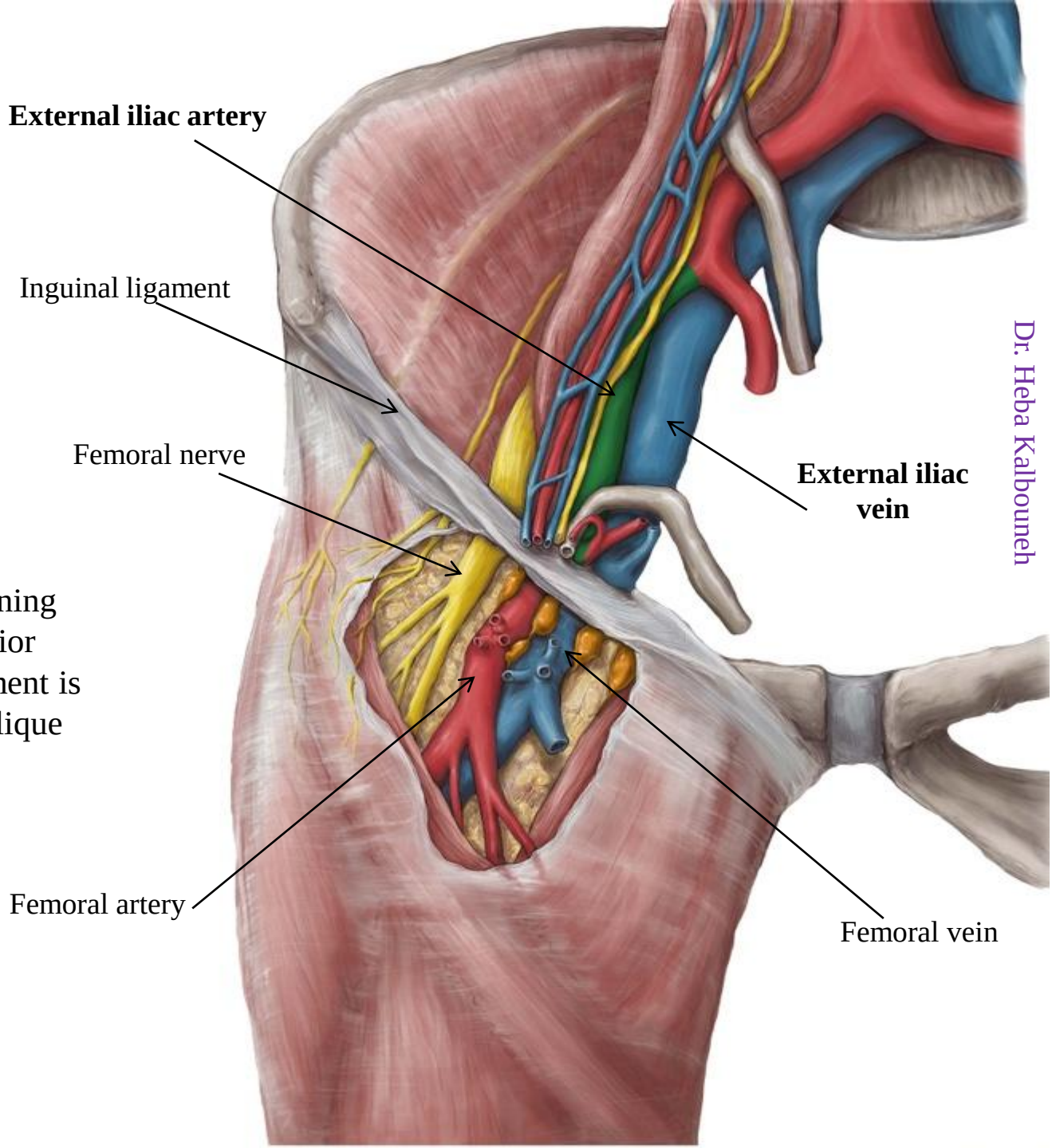
What do you think about the femoral nerve and vein?

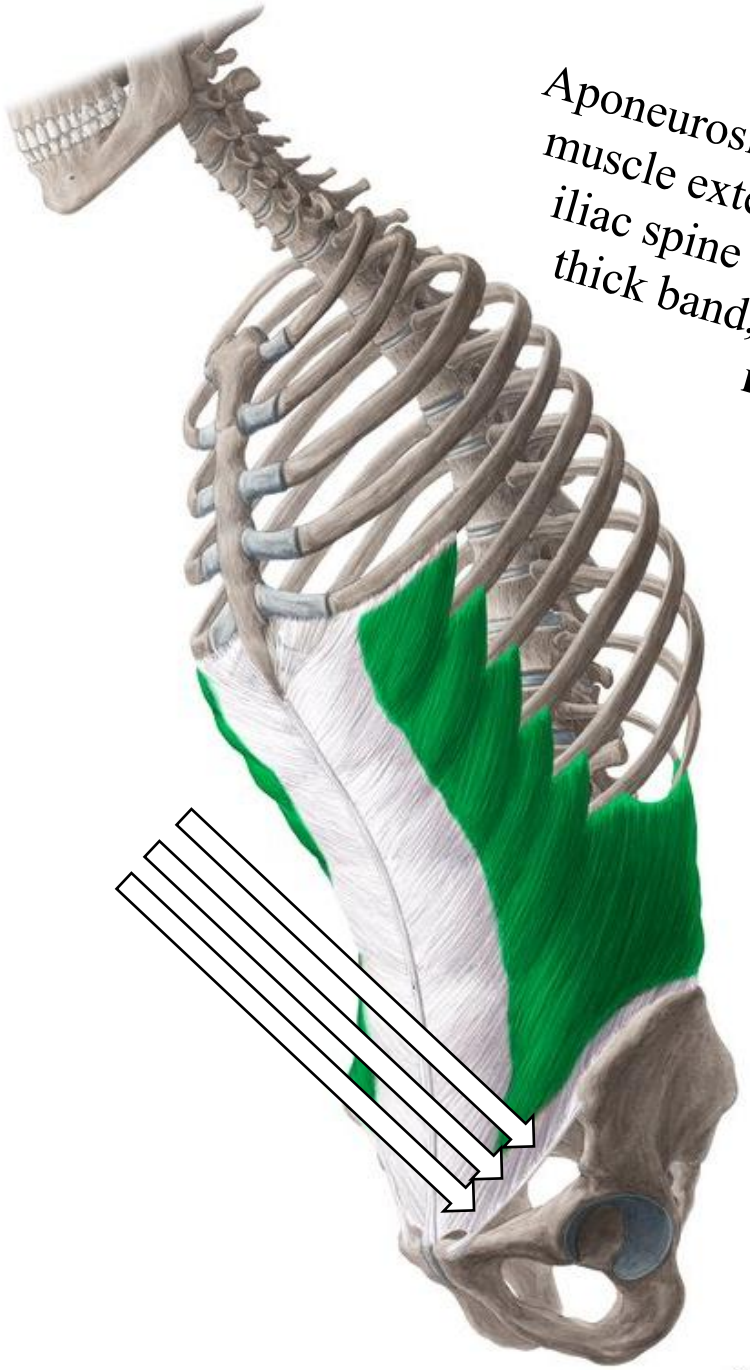


External iliac artery continues as **femoral artery**
It enters the thigh from behind the inguinal ligament.
Femoral vein continues as **External iliac vein**
It leaves the thigh from behind the inguinal ligament.



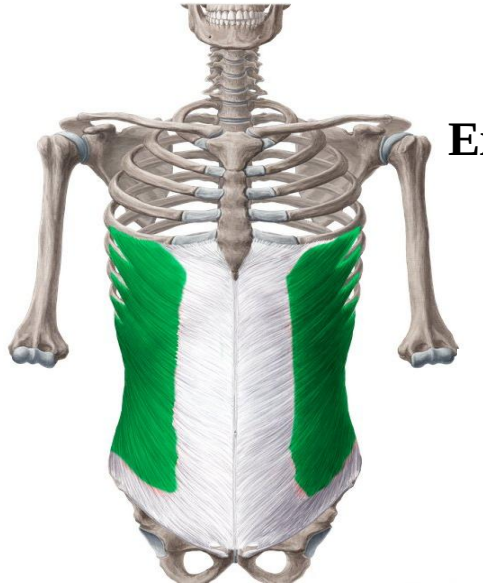
The **inguinal ligament** is a band running from the pubic tubercle to the anterior superior iliac spine. The inguinal ligament is formed by the external abdominal oblique aponeurosis.



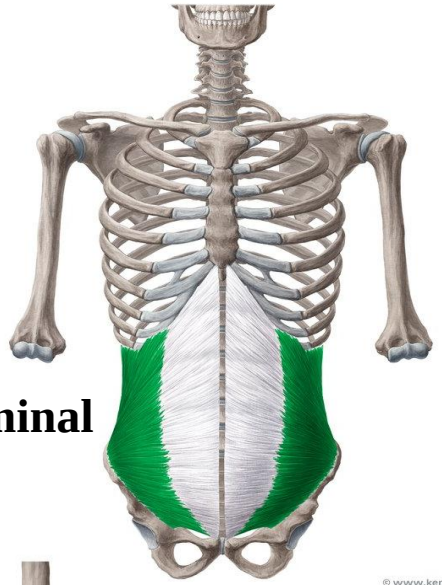


Aponeurosis of the abdominal external oblique muscle extends between the anterior superior iliac spine and the pubic tubercle to form a thick band, folded inward, it is called the **inguinal ligament**

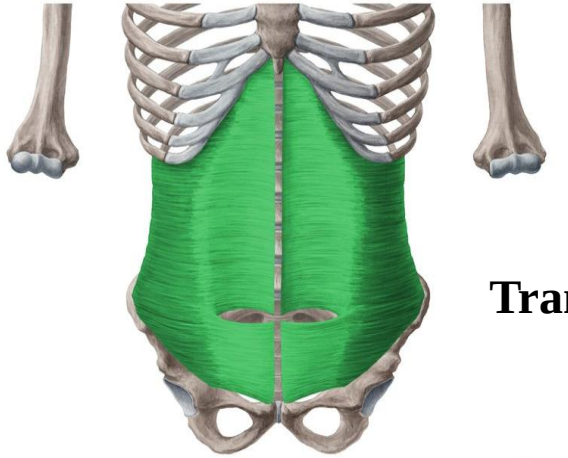
Aponeurosis means flattened tendon



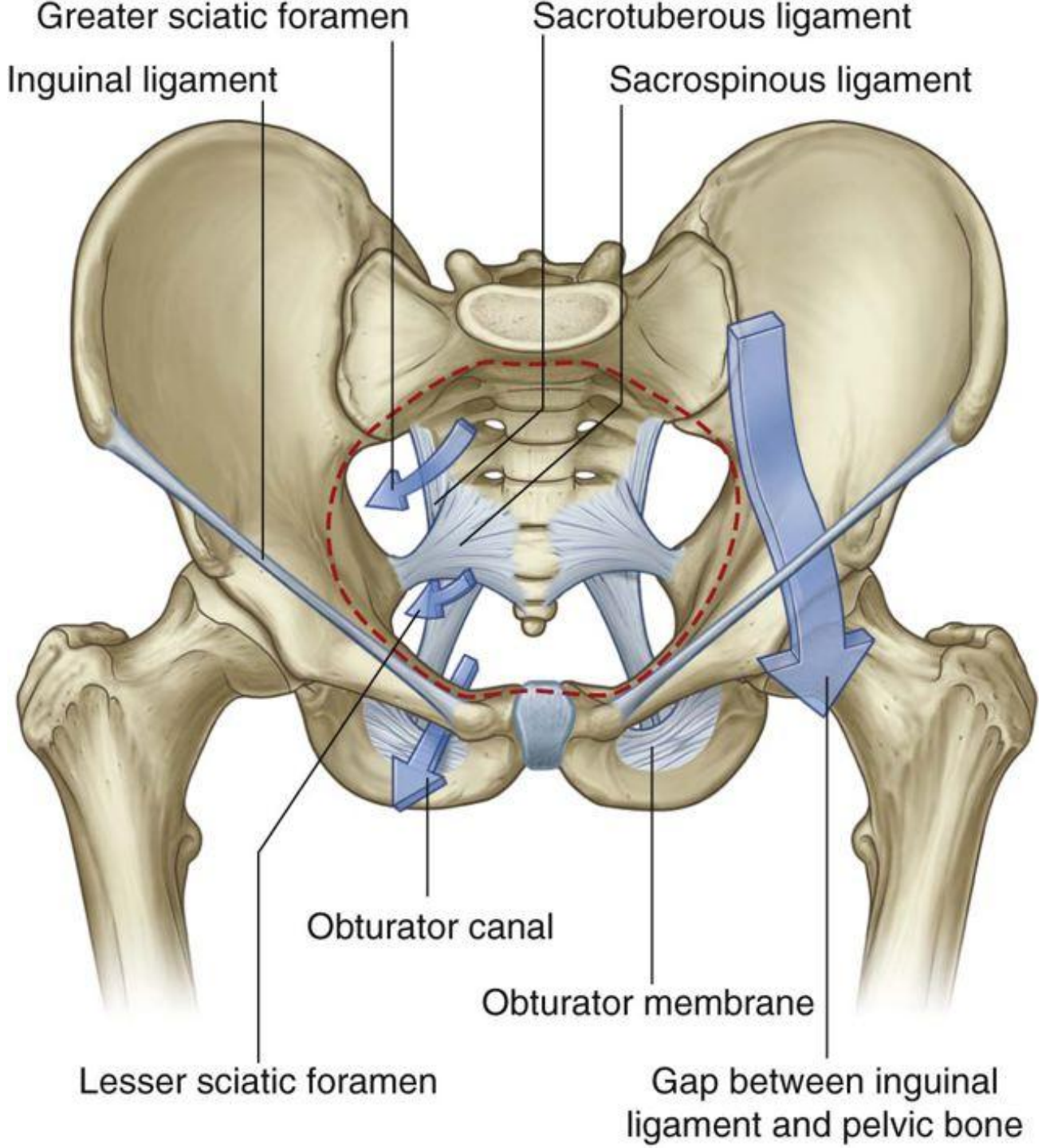
External abdominal oblique



Internal abdominal oblique



Transversus abdominus


Greater sciatic foramen
Sacrotuberous ligament
Inguinal ligament
Sacrospinous ligament
Obturator canal
Obturator membrane
Lesser sciatic foramen
Gap between inguinal ligament and pelvic bone

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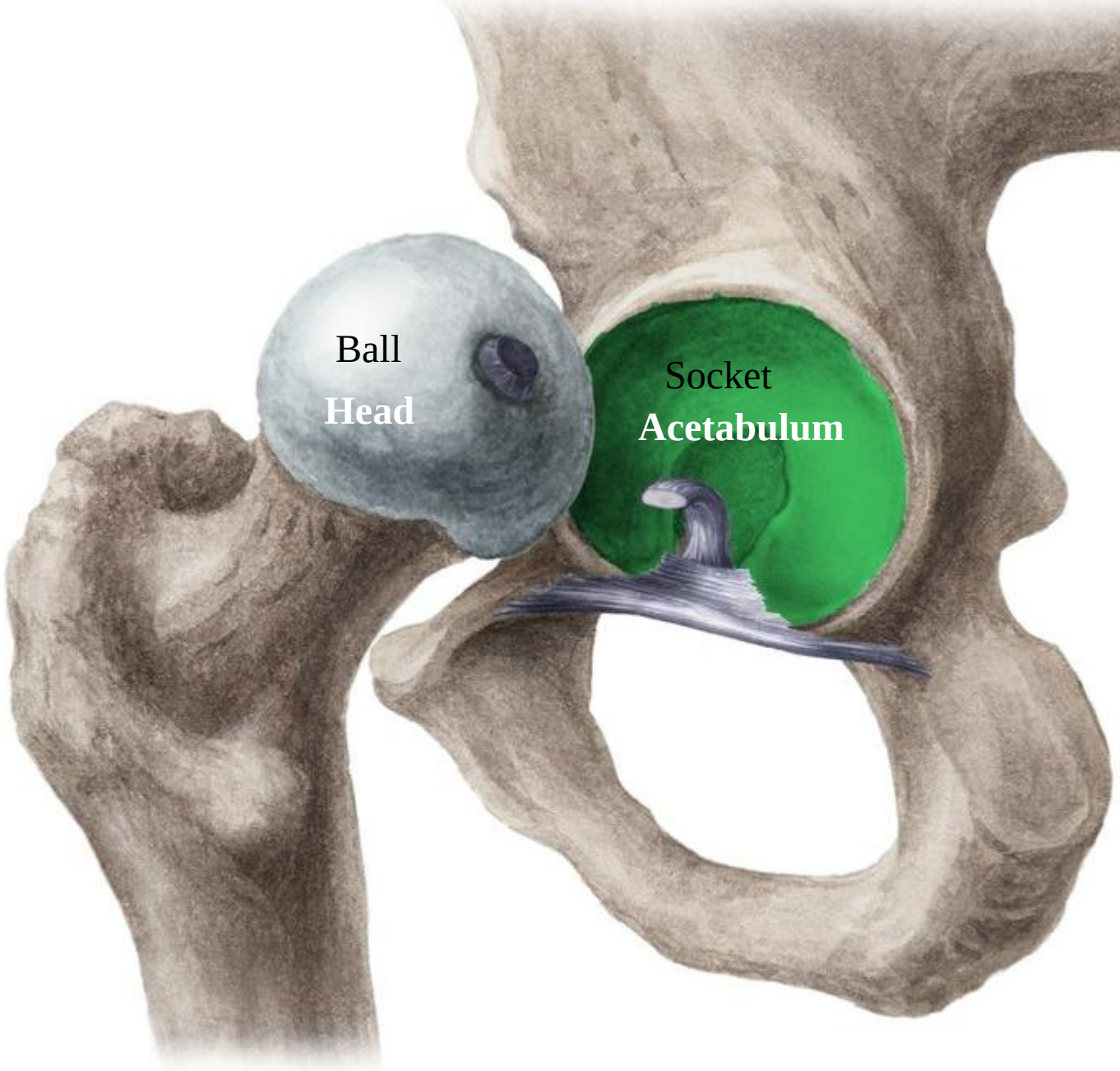
Hip joint



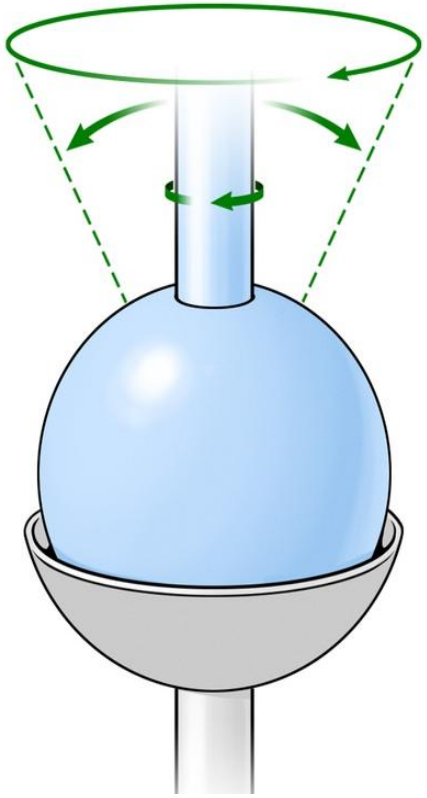
Articular surfaces:

1. Head of femur
2. Lunate surface of acetabulum

Type: Ball and socket synovial joint.

Movements:

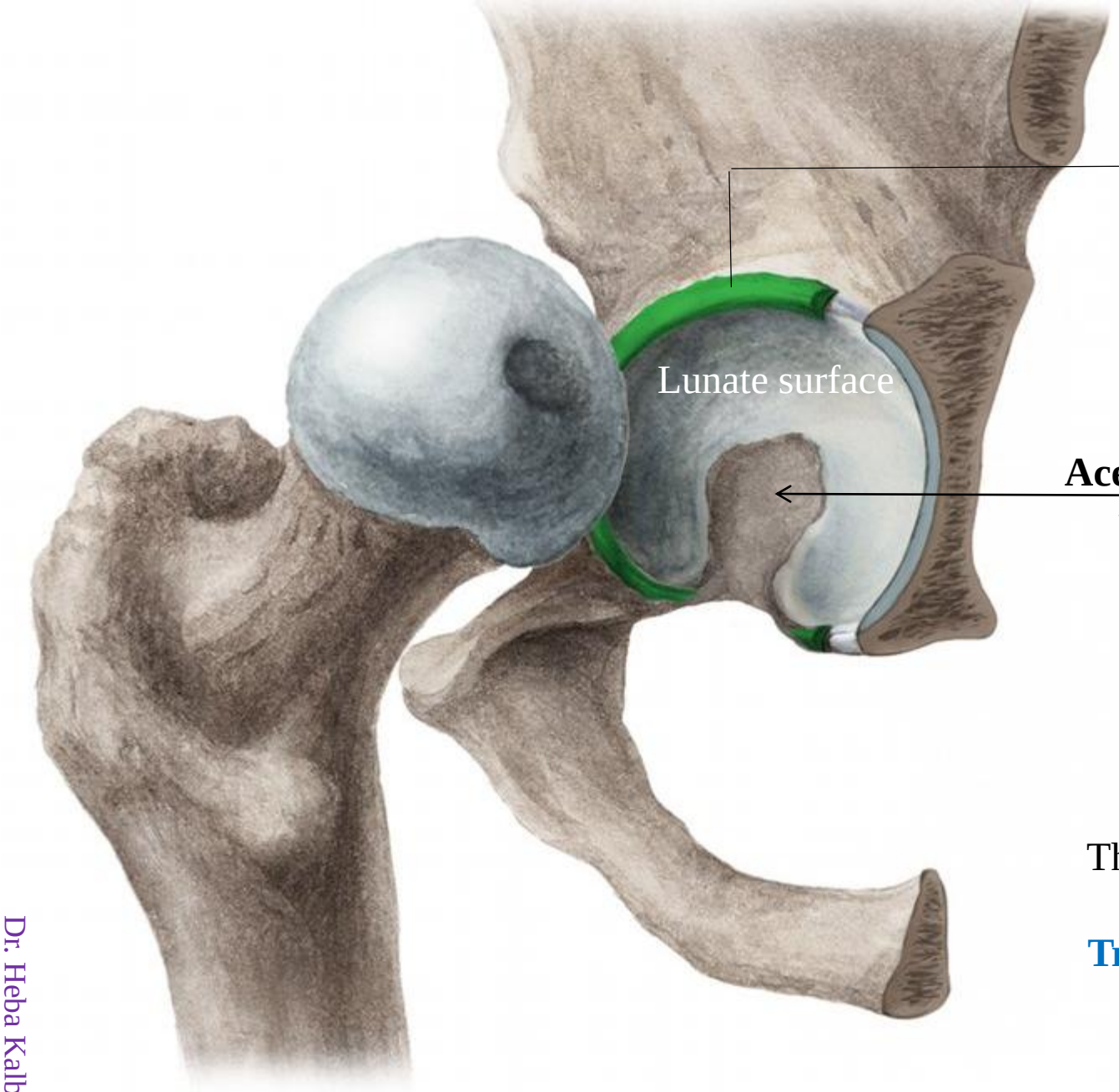
1. Flexion and extension
2. Abduction and adduction
3. Medial and lateral rotation
4. Circumduction



Ligaments:

Extracapsular: Iliofemoral, pubofemoral, ischiofemoral ligaments

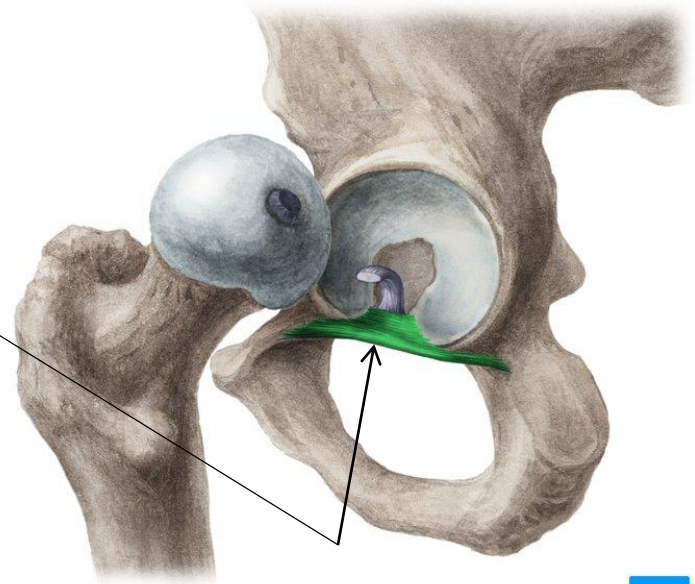
Intracapsular: Ligament of head of femur, transverse ligament of acetabulum.



The **acetabular labrum** is a ring of fibrocartilage that surrounds the acetabulum of the hip.

The labrum deepens this cavity and effectively increases the surface and strength of the hip joint.

The acetabular notch is bridged by the **Transverse acetabular ligament**



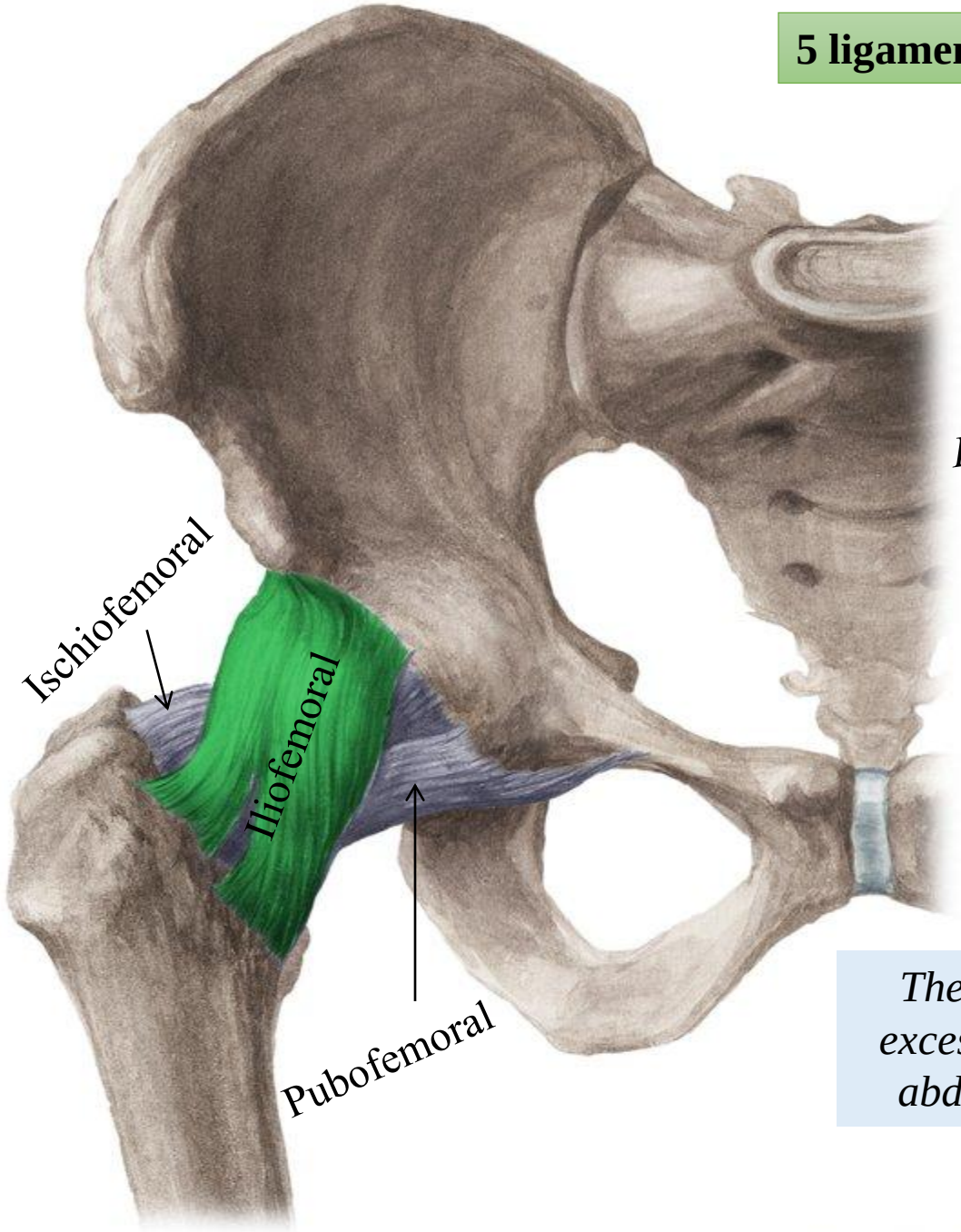
5 ligaments

Main ligaments of the hip joint

Iliofemoral ligament

Pubofemoral ligament

Ischiofemoral ligament



Note:
Iliofemoral ligament is the strongest ligament in the body

All three ligaments are oriented in a spiral fashion around the hip joint so that they become taut when the joint is extended

This stabilizes the joint and reduces the amount of energy required to maintain a standing position.

These ligaments limit excessive extension and abduction of hip joint

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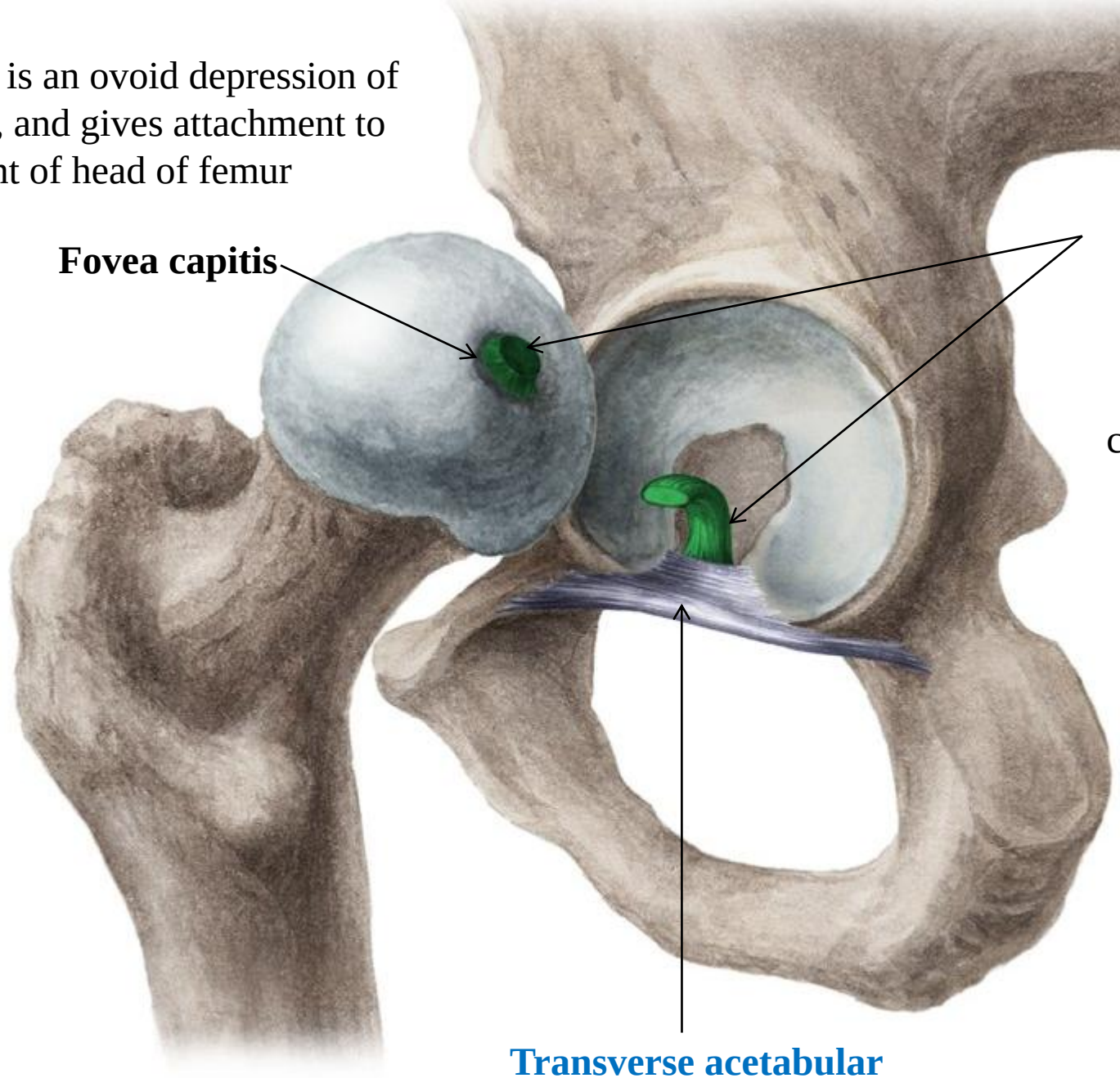
The **fovea capitis** is an ovoid depression of the femoral head, and gives attachment to the ligament of head of femur



The ligament of head of femur
(ligamentum teres)
is weak and of little importance in strengthening
the hip joint. Usually, the ligament contains a small artery to the head of the femur.

Femur (thigh bone)

It is the longest & strongest bone in the body. It has:

Upper end, consists of:

Head (shows fovea) and **neck**.

Greater trochanter (Its medial surface shows **trochanteric fossa**)

Lesser trochanter

Intertrochanteric line (anterior) & **intertrochanteric crest** (posterior) between greater and lesser trochanters.

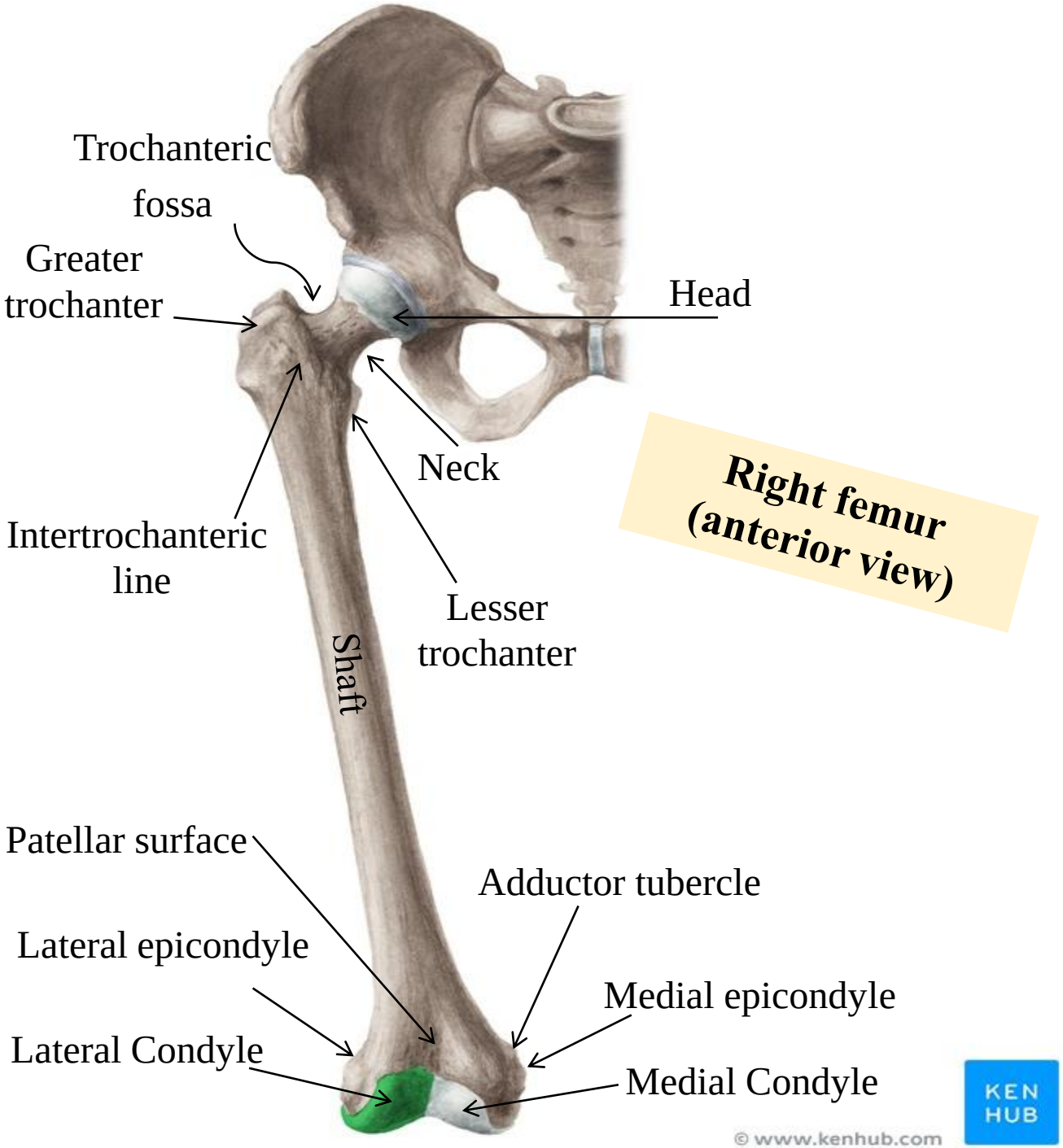
Lower end, consists of:

Medial and lateral condyles: The lateral condyle is more prominent.

The two condyles are fused anteriorly to form a **patellar surface** and separated posteriorly to form an **intercondylar fossa.**

Medial and lateral epicondyles

Adductor tubercle is a prominence present at the lower end of the medial supracondylar line.



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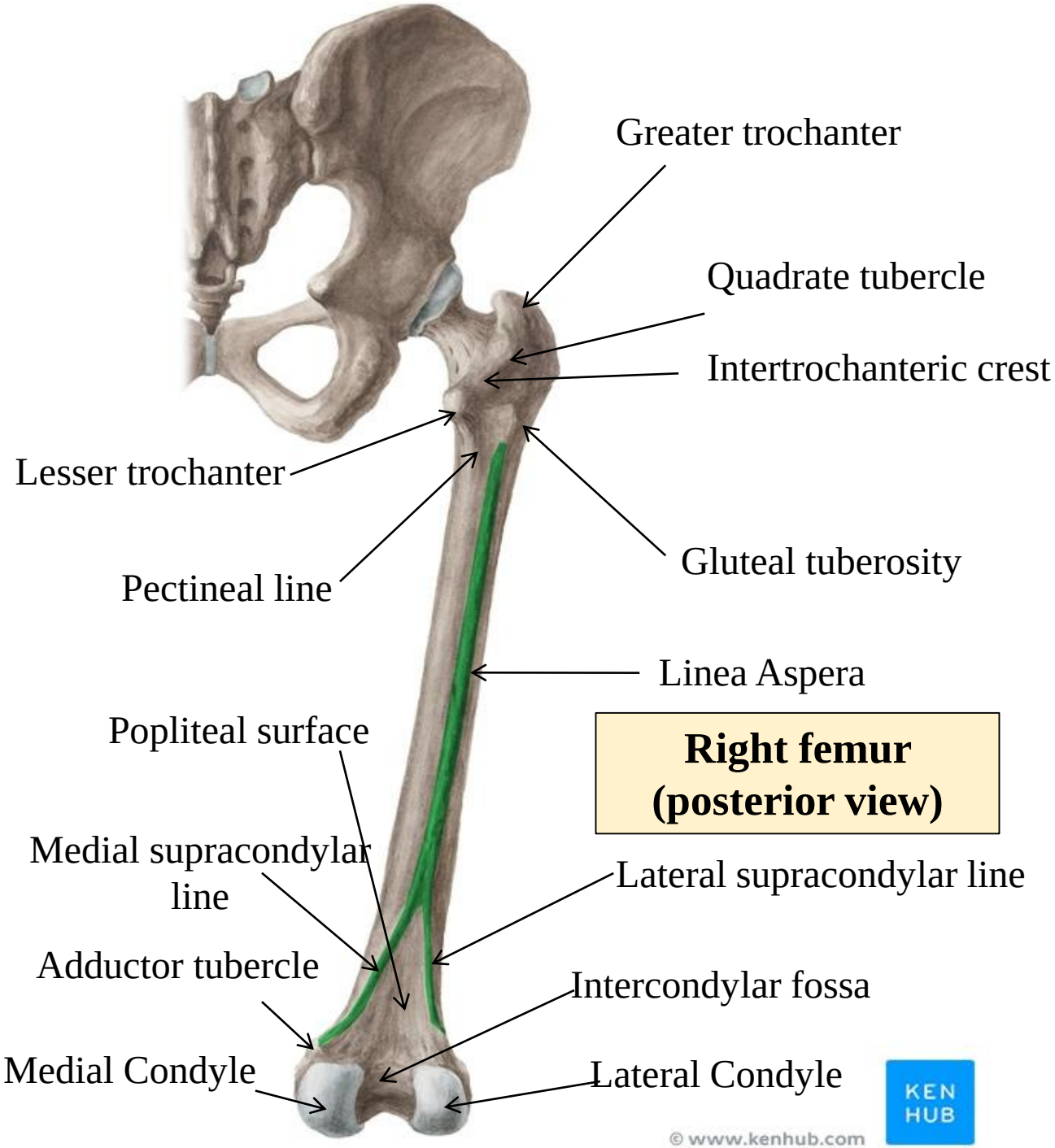


Shaft: It presents

Anterior surface convex smooth anteriorly.

Posterior surface shows:

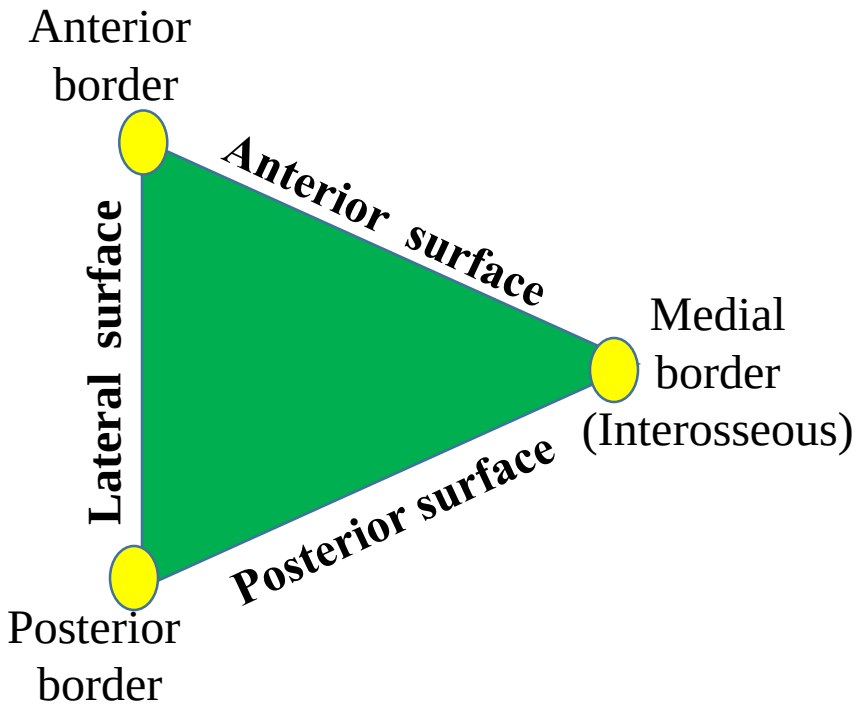
- **Intertrochanteric crest**
- **Quadrate tubercle** is a small tubercle found on intertrochanteric crest.
- **Gluteal tuberosity** (lateral)
- **Pectineal line** (medial)
- **Linea aspera** (has a medial & lateral lips)
- **Medial & lateral supracondylar ridges**
- **Popliteal surface** of femur.

Fibula

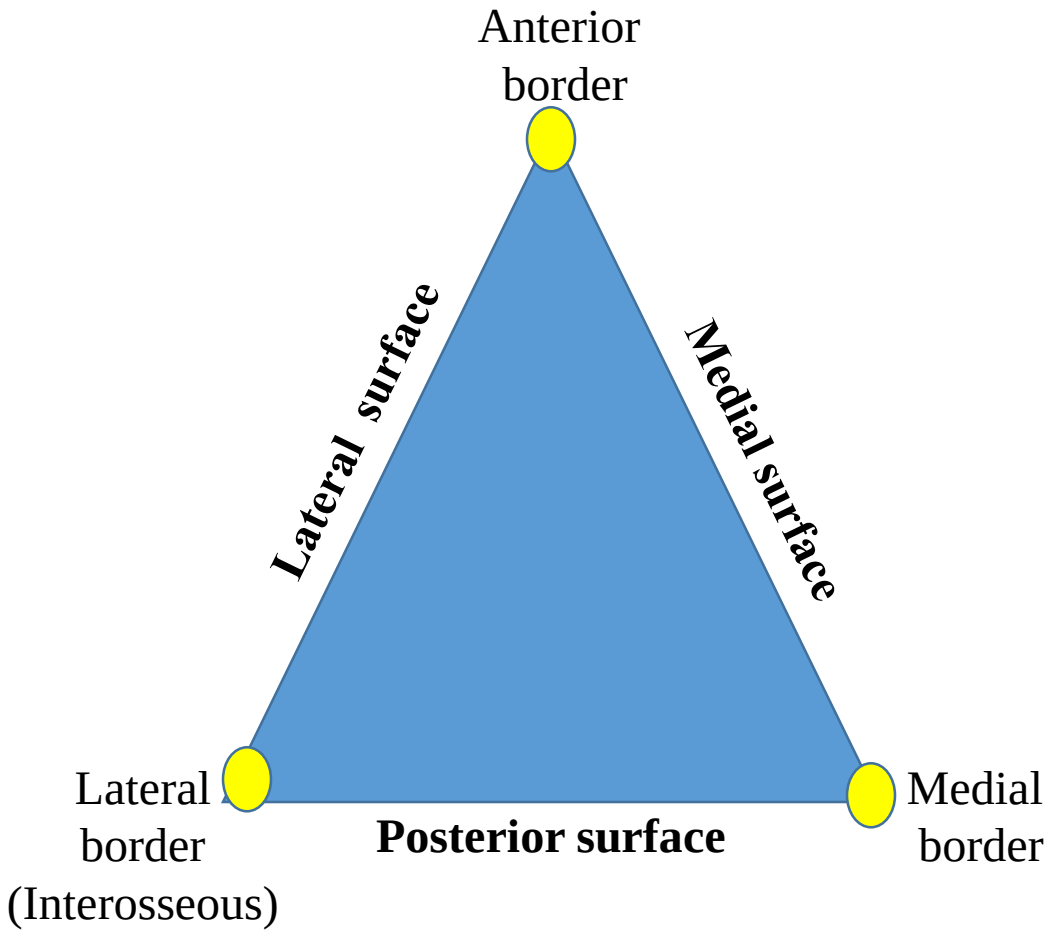
The lateral bone of the leg.

Tibia

The medial bone of the leg.



Cross section in the shaft of fibula



Cross section in the shaft of tibia

Tibia

- The medial bone of the leg.
- Weight-bearing bone of the leg.

Medial malleolus
(articulates with talus)

The Malleolus (Latin: "small hammer") is the bony prominence on each side of the ankle.

Medial malleolus is at the distal end of tibia

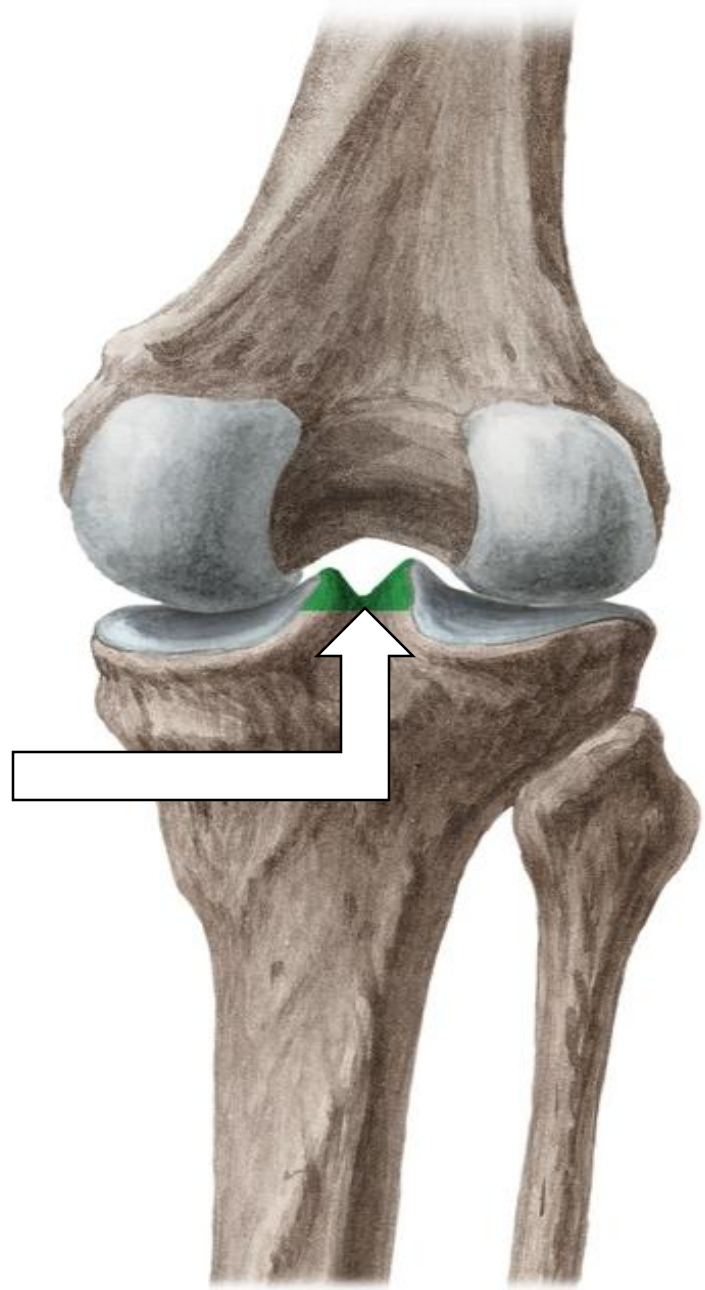
Lateral malleolus is at the distal end of fibula

Anterior

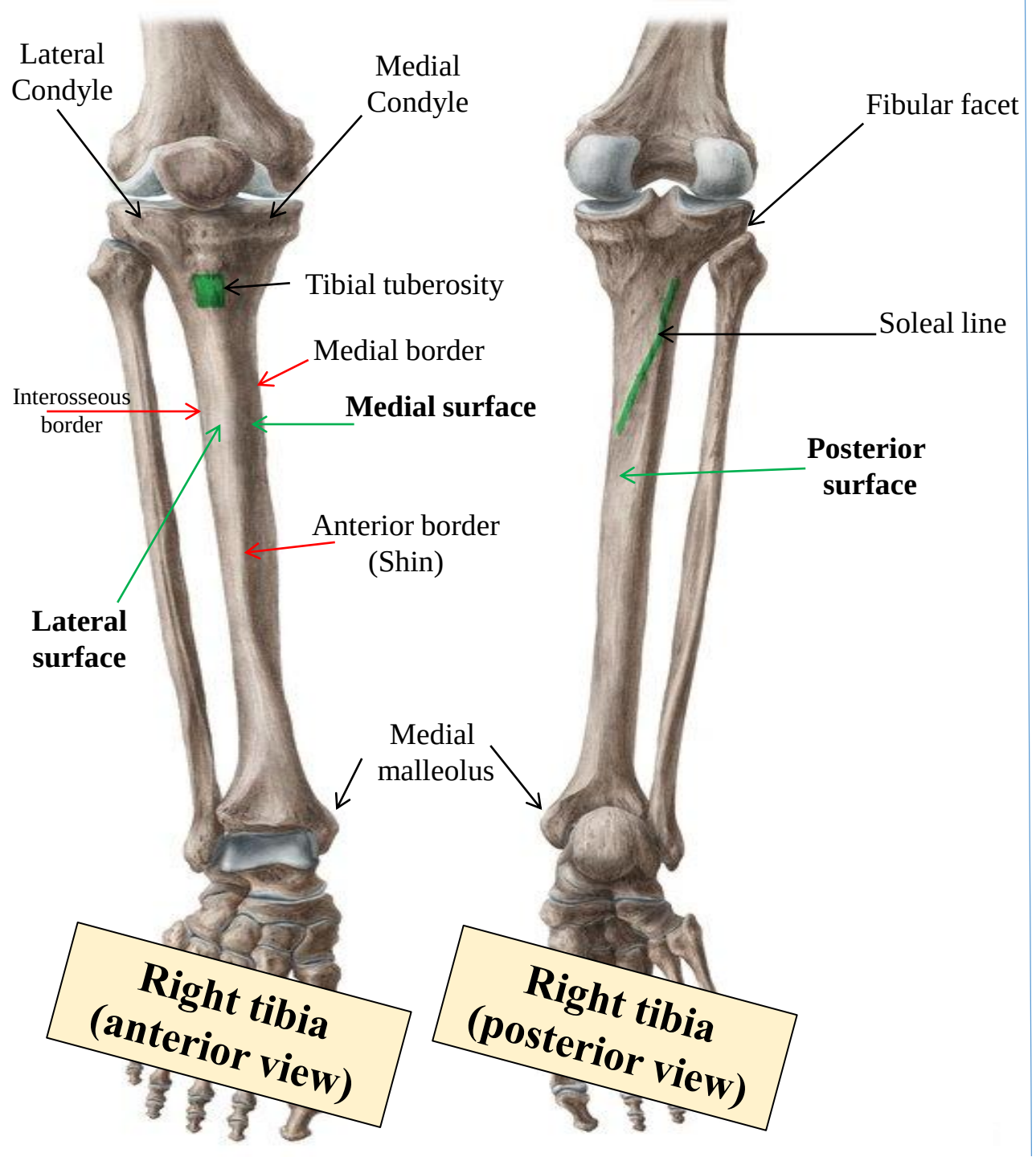
Lateral Condyle

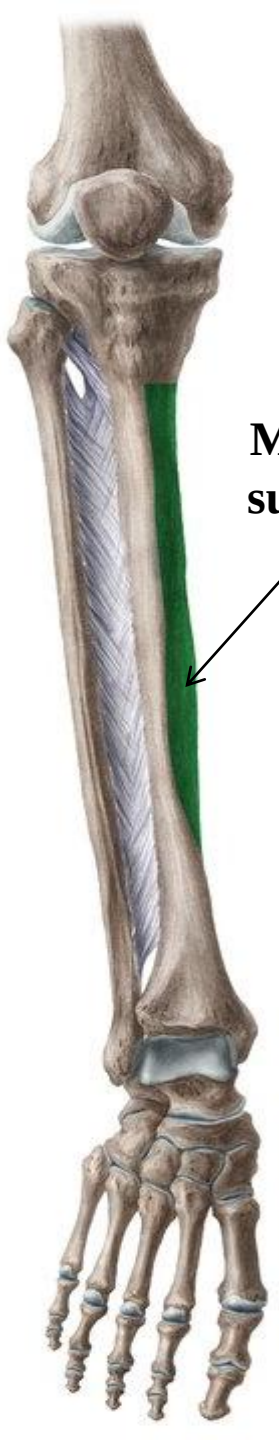
Medial Condyle

Tibial tuberosity

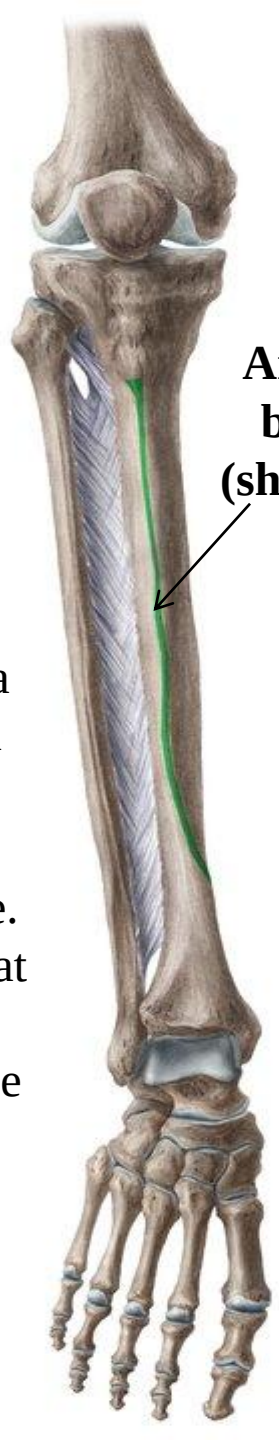


Intercondylar area and eminence



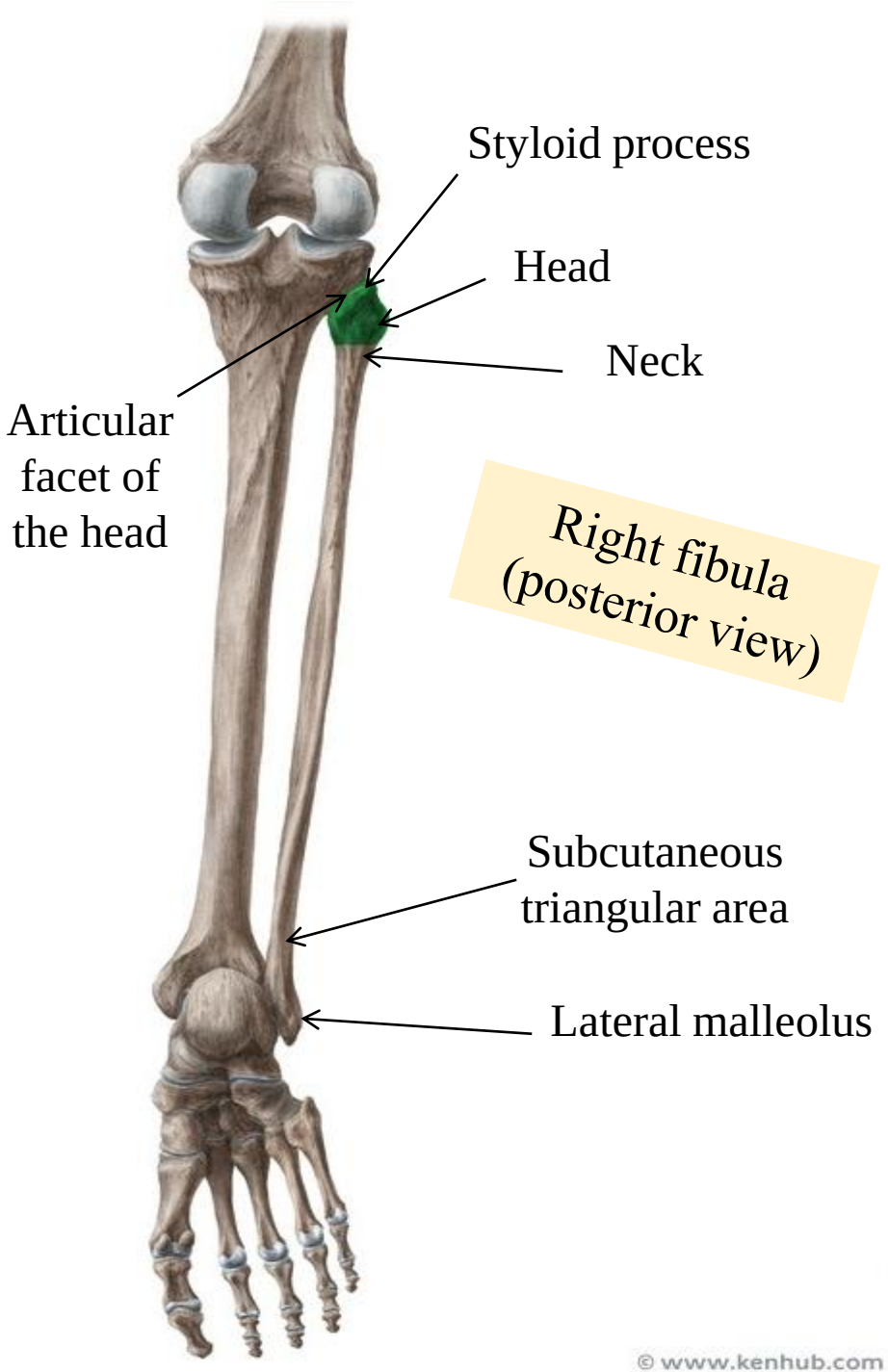


The shaft of the tibia is subcutaneous and unprotected anteromedially throughout its course. It is not surprising that the tibia is the commonest long bone to be fractured.



Fibula

- The lateral bone of the leg.
- Slender bone, smaller than tibia (No articulation with femur).



Right fibula (posterior view)

Patella

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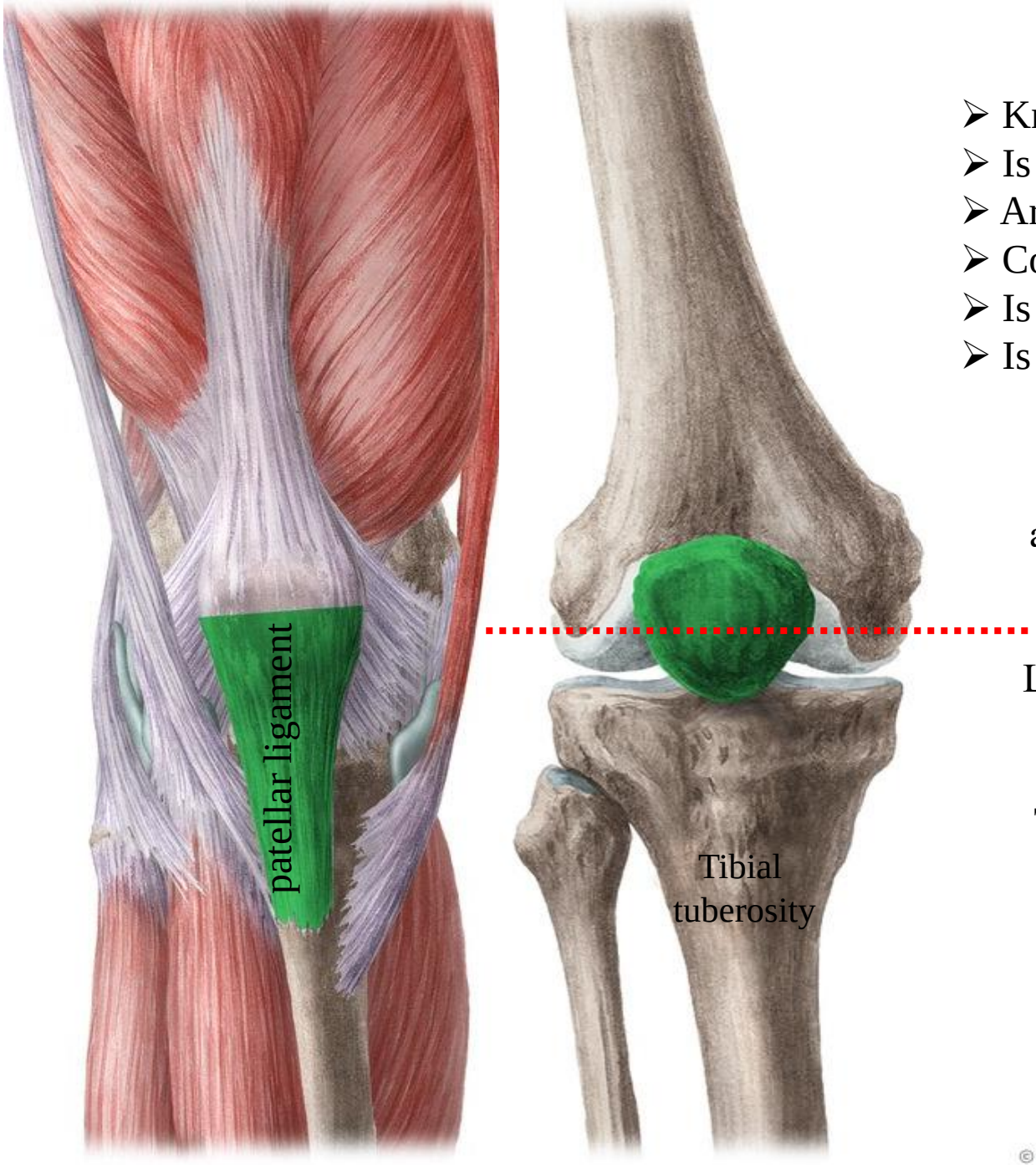
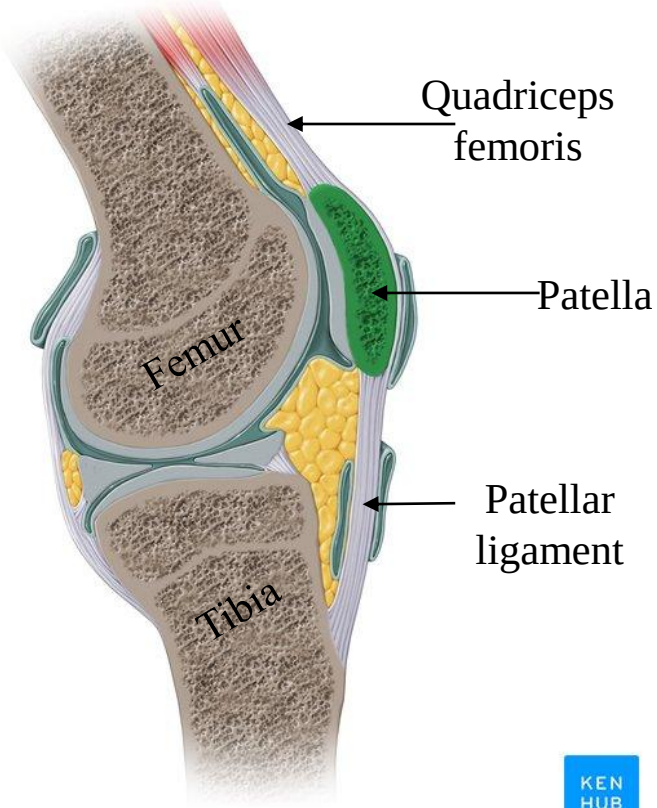
- Known as the **kneecap**
- Is triangular
- Articulates with the femur
- Covers and protects the anterior articular surface of the knee joint
- Is the largest sesamoid bone in the body
- Is embedded in the quadriceps femoris tendon



Upper part: Serves for the attachment of the tendon of the quadriceps muscle

Lower part: Serves as the origin of the patellar ligament

The patellar ligament inserts into tibial tuberosity

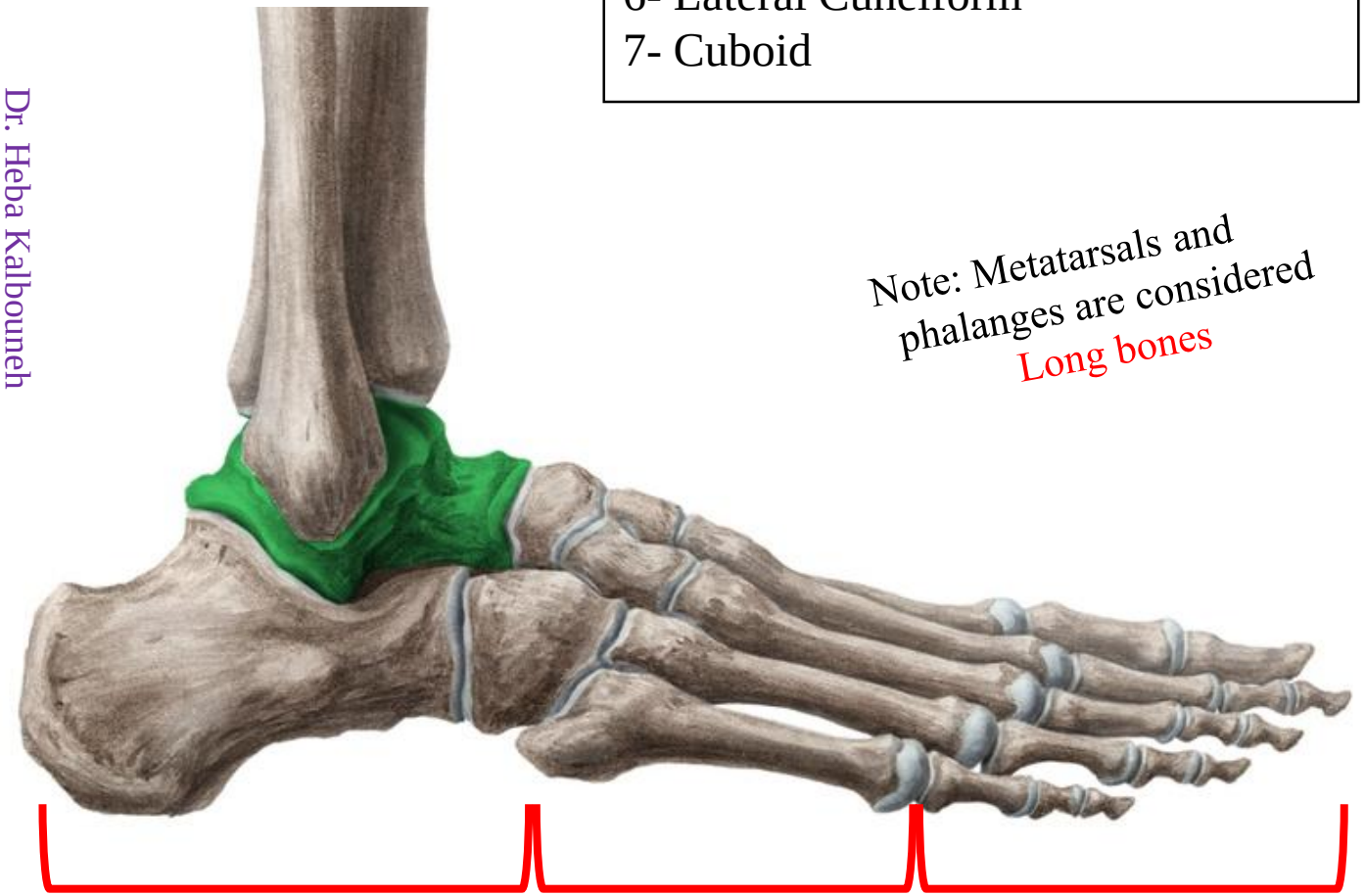


Bones of the foot

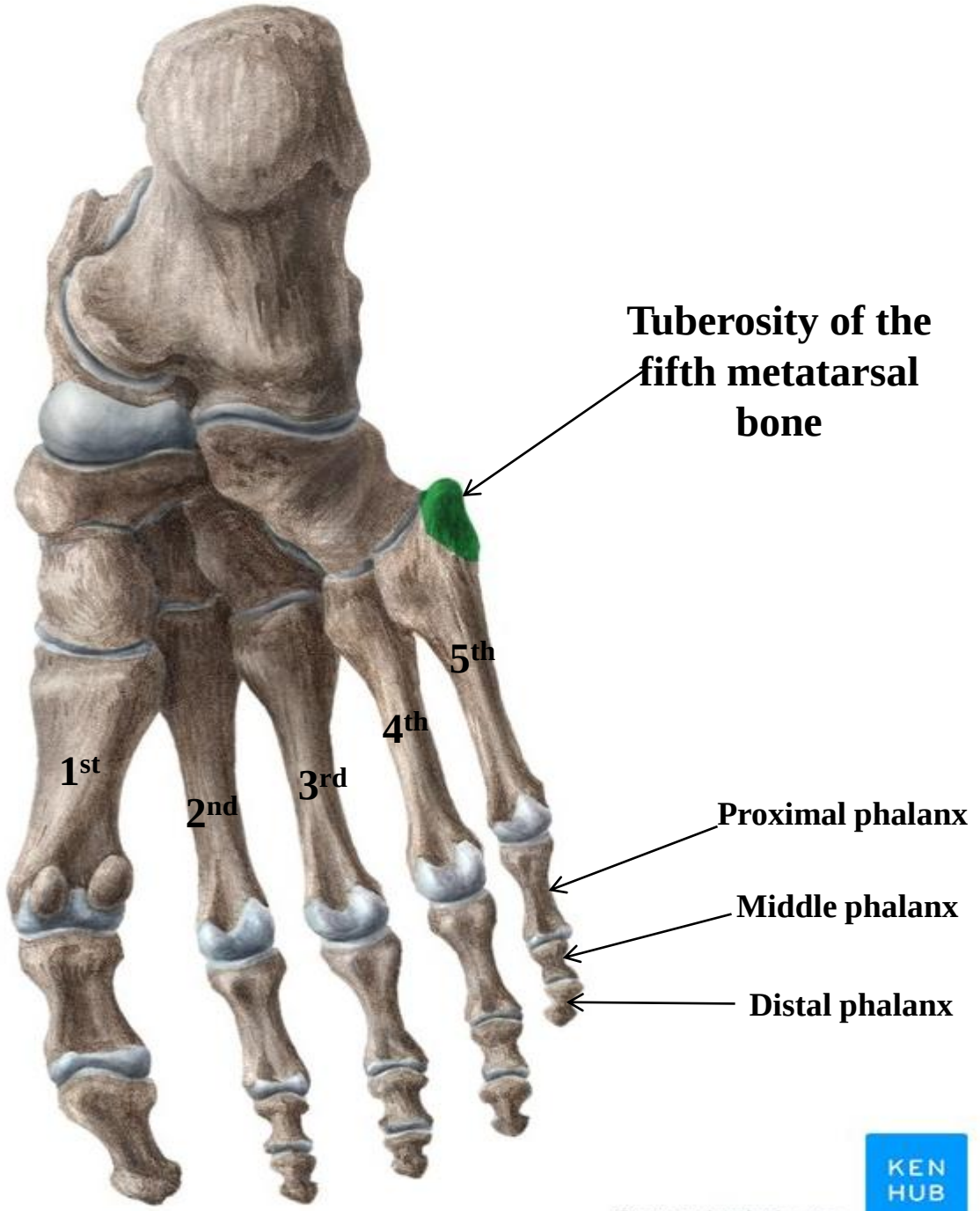
Tarsals (7)
Metatarsals (5)
Phalanges (14)

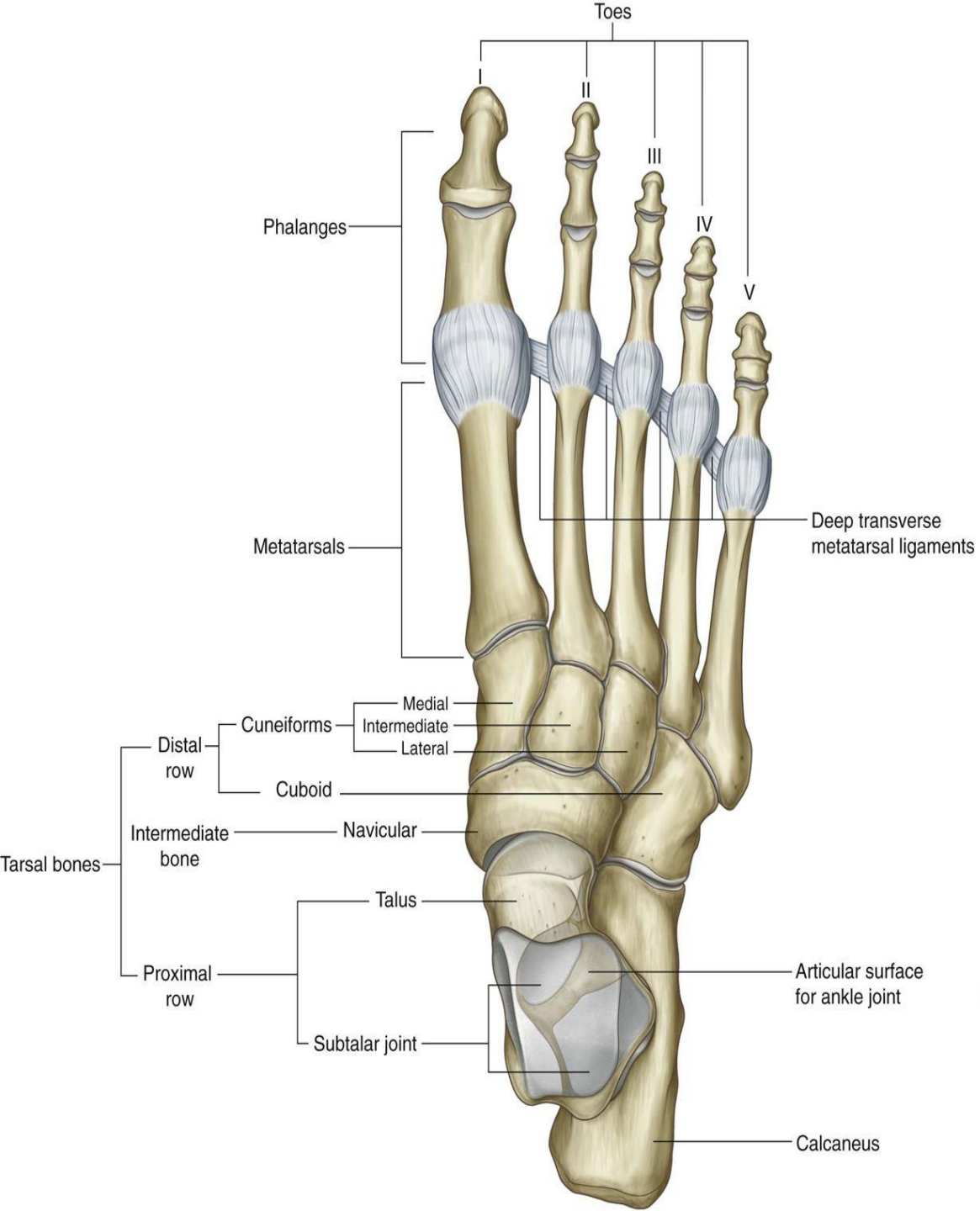
Tarsal bones
1- Talus (ankle= كاحل)
2- Calcaneus (heel= كعب)
3- Navicular (*little boat*)
4- Medial Cuneiform (*wedge-shape*)
5- Intermediate Cuneiform
6- Lateral Cuneiform
7- Cuboid

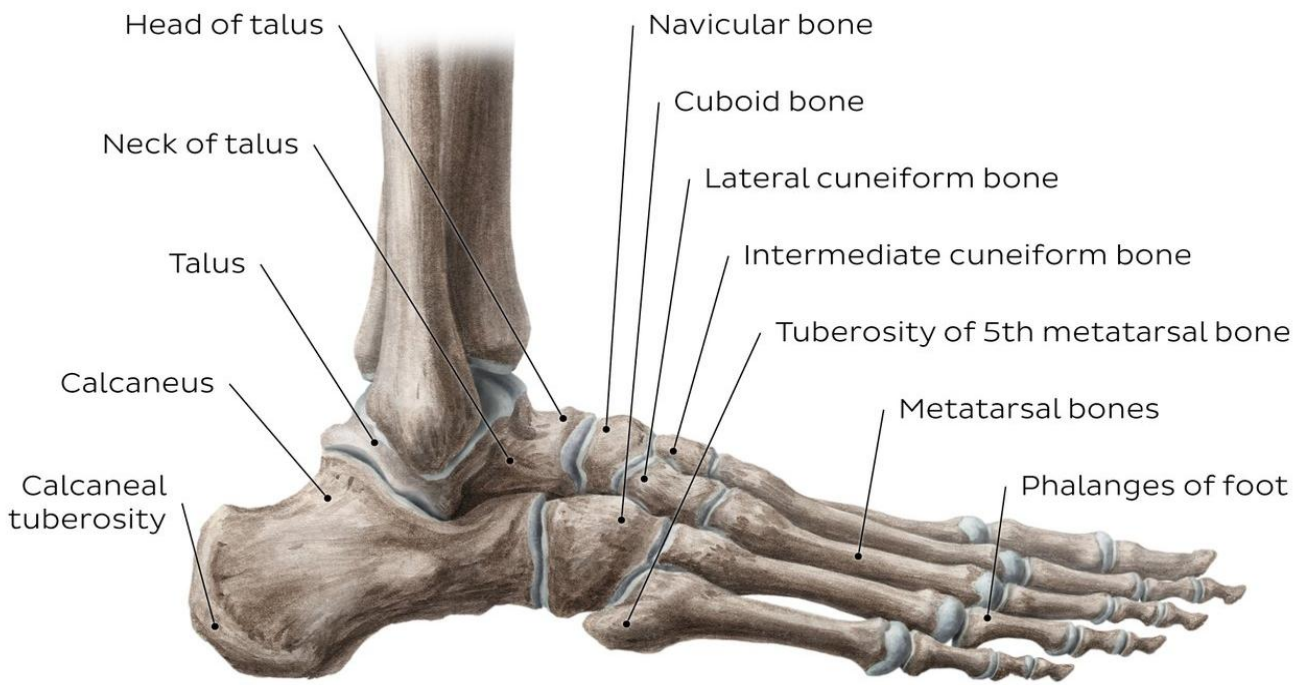
Dr. Heba Kalbouneh



Note: Metatarsals and phalanges are considered Long bones







The **knee joint** is a complex synovial joint that connects three bones (the femur, tibia and patella) which together form a pair of articulations:
Tibiofemoral joint, formed between the tibia and the femur.
Patellofemoral joint, formed between the patella and the femur.

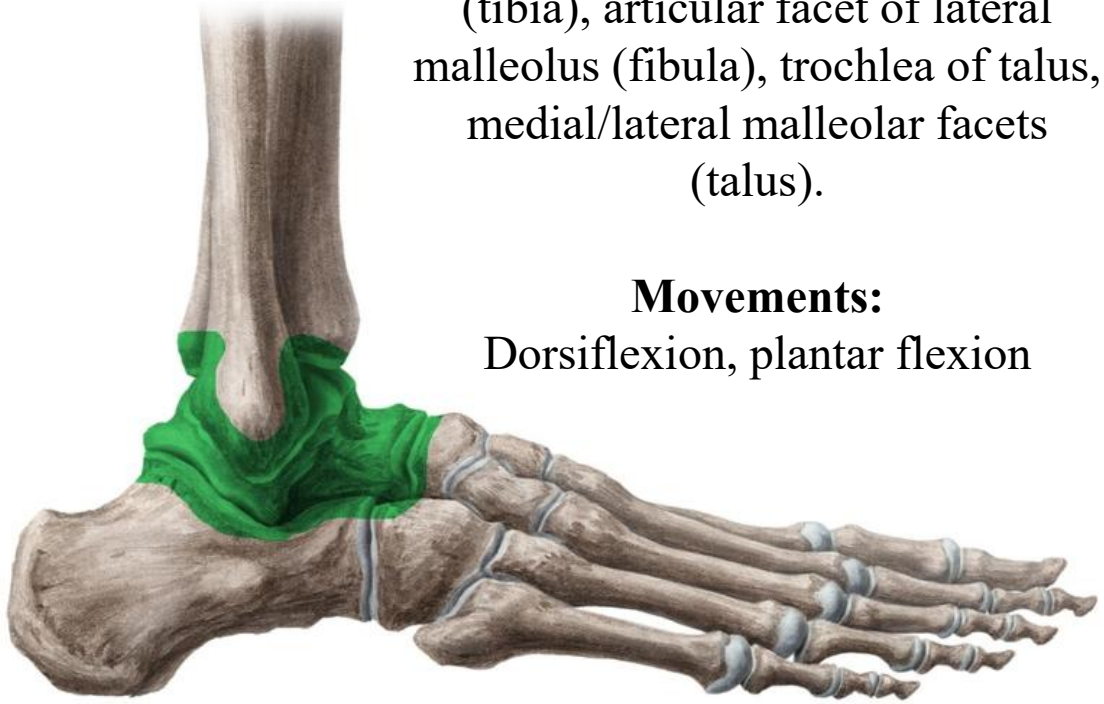
Type:
Tibiofemoral joint: Synovial hinge joint
Patellofemoral joint: Synovial plane joint

Articular surfaces:
Tibiofemoral joint: Lateral and medial condyles of femur, tibial plateau
Patellofemoral joint: Patellar surface of femur articular surface of patella

Movements:
Extension, flexion, internal/medial rotation, external/lateral rotation

The **ankle joint** is the joint between the talus and the distal ends of tibia and fibula.
Type: Synovial hinge joint.

Articular surfaces:
Articular facet of medial malleolus (tibia), articular facet of lateral malleolus (fibula), trochlea of talus, medial/lateral malleolar facets (talus).

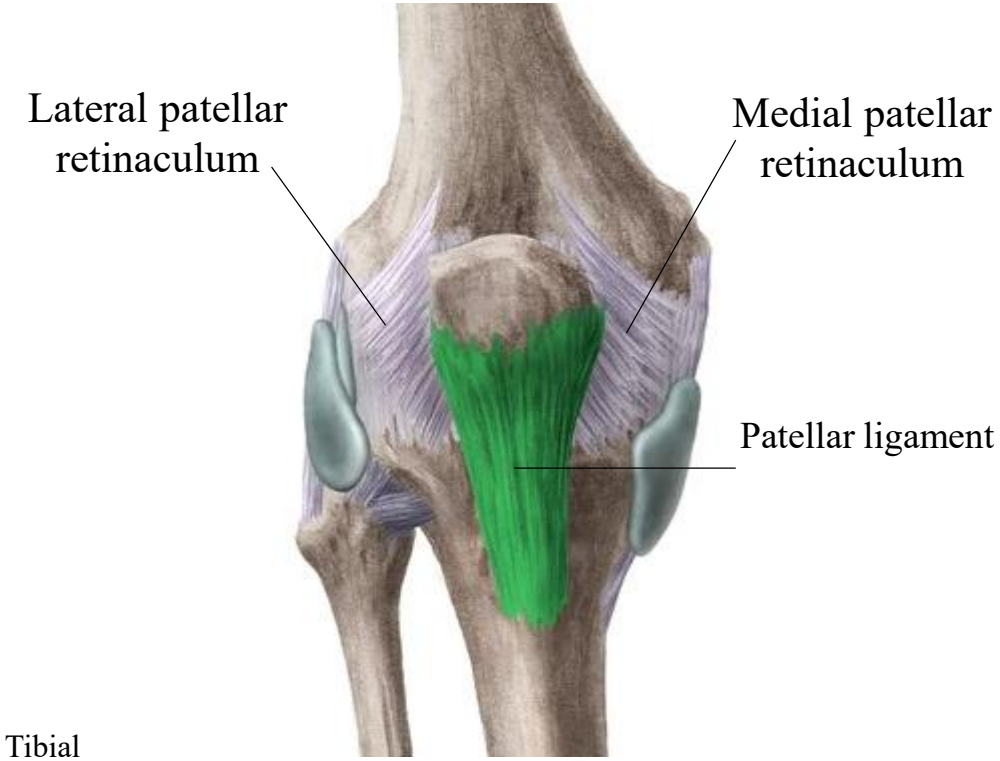


Movements:
Dorsiflexion, plantar flexion

Dr. Heba Kalbouneh

Note:

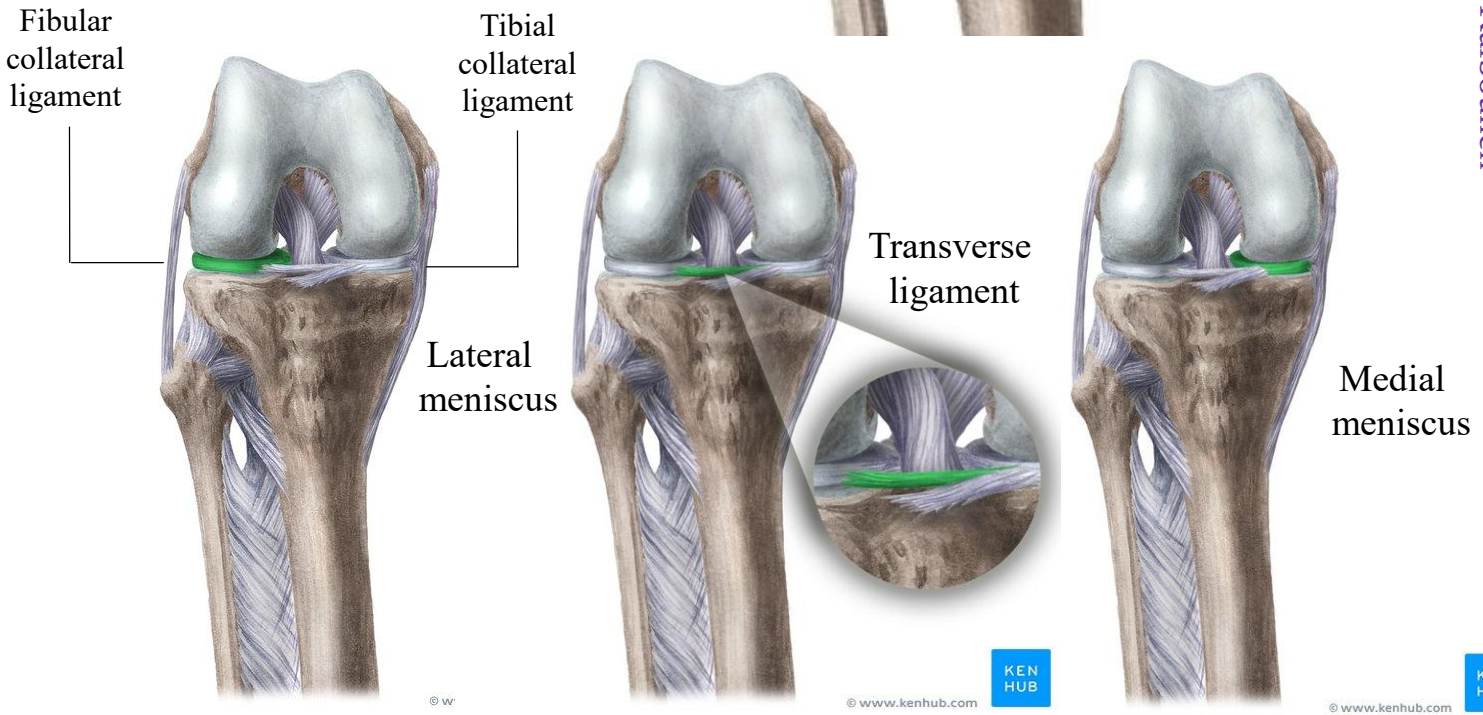
The knee joint is the largest joint of the body, responsible for bearing a considerable amount of biomechanical stress every time we stand or walk. Its integrity is supported by many extracapsular and intracapsular ligaments, menisci, as well as surrounding muscles that provide the knee joint with the stability needed to bear the weight of the whole body.

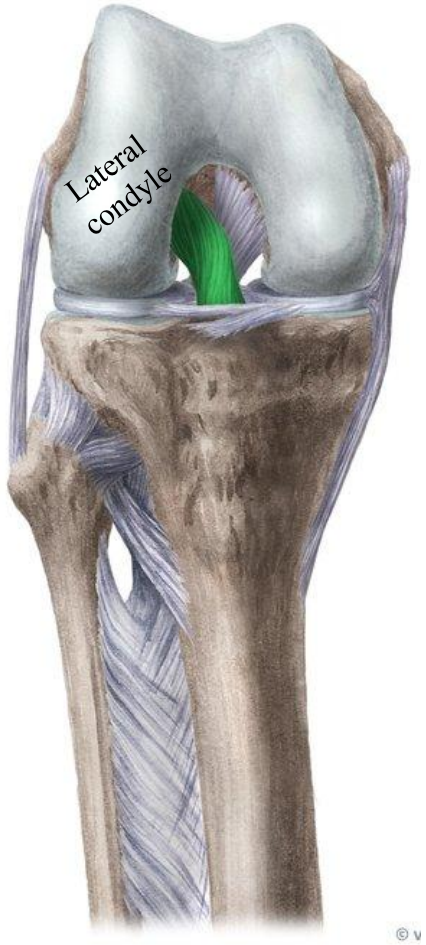


Ligaments and menisci:

Extracapsular ligaments: Patellar ligament, medial and lateral patellar retinacula, tibial (medial) collateral ligament, fibular (lateral) collateral ligament.

Intracapsular ligaments/menisci: Anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial meniscus, lateral meniscus, transverse ligament of the knee.





Cruciate ligaments are pairs of ligaments that cross each other like the limbs of an X.

ACL: The primary function of the ACL is to prevent the **tibia from sliding forward** relative to the femur.
(Anterior displacement of the tibia on the femur)
PCL: The primary function is to prevent the **tibia from sliding backward** relative to the femur.
(Posterior displacement of the tibia on the femur)

Clinical anatomy:
ACL injuries are more common, especially in sports that involve quick turns, jumps, or changes in direction.

Anterior cruciate ligament (ACL)
runs between the anterior aspect of intercondylar area of tibia and lateral condyle of femur

They are named for their insertion into the tibia: the ACL attaches to the anterior aspect of the intercondylar area, the PCL to the posterior aspect.

Posterior cruciate ligament (PCL)
runs between the posterior aspect of intercondylar area of tibia and medial condyle of femur

The femoral triangle
The popliteal fossa
The posteromedial side of the ankle (Tarsal tunnel)

are important areas of transition through which structures pass between regions

The **femoral triangle** is a pyramid-shaped depression formed by muscles in the proximal regions of the thigh and by the inguinal ligament. The major blood supply and one of the nerves of the limb (femoral nerve) enter into the thigh from the abdomen by passing under the inguinal ligament and into the femoral triangle.

The **popliteal fossa** is posterior to the knee joint and is a diamond-shaped region formed by muscles of the thigh and leg. Major vessels and nerves pass between the thigh and leg through the popliteal fossa.

The **posteromedial side of the ankle:** Most nerves, vessels, and flexor tendons that pass between the leg and foot pass through a series of canals (tarsal tunnel) on the posteromedial side of the ankle. The canals are formed by adjacent bones and a flexor retinaculum, which holds the tendons in position