

Hip and Thigh Bones, Joints, and Muscles

HIP REGION:

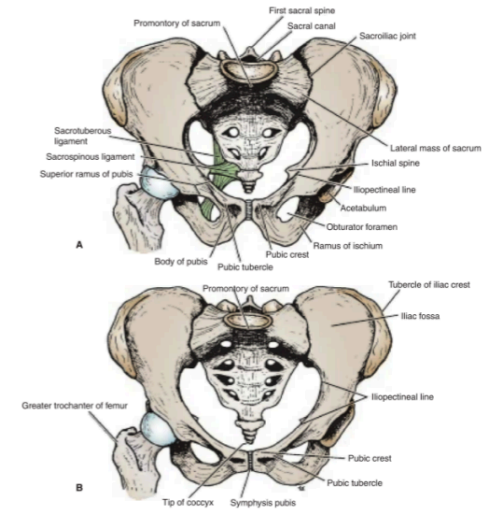
HIP AND THIGH - BONES AND JOINTS:

- **Anatomy of the hip and thigh:**
 - **Pelvic girdle - structure and function:**
 - **Pelvis (pelvic girdle):**
 - Supports and protects abdominal and pelvic organs.
 - Transmits forces from the head and trunk to the lower limbs.
 - Provides attachment sites for muscles and ligaments.
 - **Composed of:**
 - Two hip (innominate) bones (ilium, ischium, pubis).
 - Sacrum and coccyx (form a ring-like bony structure).
- **Articulations of the pelvis:**
 - **Sacroiliac joints (2) - posteriorly:**
 - Between the ilium of the hip bones and the sacrum.
 - Strong, weight-bearing joints.
 - **Sacrococcygeal symphysis:**
 - Between the sacrum and coccyx.
 - Allows slight movement, important in childbirth.
 - **Pubic symphysis - anteriorly:**
 - Between the pubic bones of both hip bones.
 - Contains fibrocartilaginous disc for shock absorption.
- **Divisions of the pelvis:**
 - **Greater pelvis (false pelvis):**
 - **Location:** superior to the pelvic brim.
 - **Function:** supports lower abdominal viscera (e.g., ileum and sigmoid colon) and provides little obstetric relevance.
 - **Boundaries:**
 - **Posterior:** lumbar vertebrae.
 - **Lateral:** iliac fossae and iliacus muscle.
 - **Anterior:** lower anterior abdominal wall.
 - **Clinical relevance:** supports abdominal contents and accommodates the gravid uterus during pregnancy.
 - **Lesser pelvis (true pelvis):**
 - **Location:** inferior to the pelvic brim.
 - **Function:** contains the pelvic cavity and viscera and provides obstetric relevance (which forms the birth canal).
 - **Boundaries:**
 - **Posterior:** sacrum and coccyx.

- **Lateral:** inner surface of the ischium and pubis.
- **Anterior:** small part of the ilium.
- **Clinical relevance:** protects the intestinal and urinary tracts, houses reproductive organs, and guides the fetus during labor.

- **Male Vs Female Pelvic Girdle:**

Characteristic	Female Pelvis	Male Pelvis
Thickness of Pelvis	Light and thin	Heavy and thick
Joint Surface Size	Small	Large
Greater Pelvis Depth	Shallow	Deep
Pelvic Inlet Size	Large	Small
Pelvic Inlet Shape	Oval-shaped	Heart-shaped
Pelvic Cavity Diameter	Greater diameter	Lesser diameter
Greater Pelvis Structure	Supports childbirth	Supports weight-bearing



- **Bones of the hip:**

- **Ilium:**

- **Location and structure:**

- The largest and superior-most part of the hip bone.
- Forms the superior part of the acetabulum (acetabular roof).

- **Key landmarks:**

- **Iliac crest:** located at the L4 level, extends from the ASIS to PSIS.
- **Auricular surface:** articulates with the sacrum at the sacroiliac joint.
- **Iliopectineal line (arcuate line):** divides the true pelvis from the false pelvis.
- **Posterior inferior iliac spine (PIIS):** located at the S2 level, marked externally by the dimple of Venus.
- **Greater sciatic notch:** located on the posterior aspect of the ilium, allows passage of the sciatic nerve.
- **Gluteal surface:** external (convex) surface providing attachment for gluteal muscles.
- **Wing of the ilium:**
 - **Inner surface:** concave, forms the iliac fossa (origin for iliacus)
 - **External surface (gluteal surface):** convex, provides attachment for gluteal muscles.

- **Pubis:**

- Reservoir for synovial fluid during heavy loading of the hip joint.
- **Proximal femur (thigh bone):**
 - The longest, largest, and heaviest bone in the human body.
 - Forms ¼ of an individual's height (45 cm/18 inches in average).
 - **Structural features:**
 - **Medially directed (oblique) in the anterior view:** aligns the hip joint with the knee joint.
 - **Slight anterior bowing in lateral view:** enhances resistance to stress and strain during ambulation.
- **Components of the proximal femur:**
 - **Head of femur:**
 - Articulates with the acetabulum of the hip bone.
 - **Orientation:** superior, anterior, and medial.
 - **Fovea capitis:**
 - Small central depression on the femoral head.
 - Contains the ligamentum teres femoris, which contributes to joint stability and blood supply.
 - **Neck of femur:**
 - Connects the head to the shaft.
 - Forms an angle of 135 degrees with the shaft.
 - **Anteverted:** directed upward, inward, and forward.
 - **Anatomical neck:** epiphyseal line between the head and intertrochanteric line/crest.
 - **Surgical neck:**
 - Located at the junction of the shaft and proximal extremity.
 - Common site of fractures, especially in elderly individuals.
 - **Trochanters:**
 - **Greater trochanter:**
 - Large protuberance at the posterolateral proximal femur.
 - **Serves as attachment sites for:**
 - Gluteal muscles (gluteus medius and minimus).
 - Vastus lateralis (part of the quadriceps).
 - **Lesser trochanter:**
 - Smaller protuberance at the posteromedial aspect of the femur.
 - Serves as an attachment site for the iliopsoas muscle (major hip flexor).
 - **Intertrochanteric structures:**
 - **Intertrochanteric line (anteriorly):**
 - Connects the greater and lesser trochanters.
 - **Provides an attachment site for** the iliofemoral ligament (the strongest ligament of the hip).

- Results in flattening of the lower back.
- Hips tilted backward.
- **Potential issues:**
 - Tight hamstrings and hip extensors.
 - Weak hip flexors.
 - Rounded posture.
- **Sacroiliac joint - Nutation vs Counternutation**

Bony Structures	Nutation	Counter-Nutation
Sacral Promontory	Anteriorly & Inferiorly	Posteriorly & Superiorly
Coccyx	Posteriorly	Anteriorly
Iliac Crest	Approximates	Separates
Ischial Tuberosity	Separates	Approximates
Pelvic Motion	ASIS higher than PSIS Posterior Pelvic Tilt	PSIS higher than ASIS Anterior Pelvic Tilt

- **Pelvic joints:**
 - **Symphysis pubis joint:**
 - **Articulation:** between the two pubic bones.
 - **Type of joint:** cartilaginous (amphiarthrodial).
 - **Motion:** minimal.
 - **Acetabulofemoral joint:**
 - **Type of joint:** synovial diarthrodial ball-and-socket joint.
 - **Multiaxial movement.**
 - **Acetabular head:** horseshoe-shaped.
 - **Lunate surface:** articulating surface of the acetabulum.
 - **Intercoccygeal joint:**
 - **Location:** between the coccygeal bones.
 - **Type of joint:** cartilaginous.
 - **Motion:** minimal.
- **Acetabulofemoral joint (hip joint) components:**
 - **Acetabulum:**
 - **Acetabular fossa:**
 - Non-articulating portion of the acetabulum.
 - Reservoir for synovial fluid.
 - Contains proprioceptive nerve endings.
 - Attachment site for the ligamentum teres.
 - **Ligamentum teres:** conduit for blood supply to the femoral head.
 - **Acetabular canal:** includes the acetabular notch and transverse acetabular ligament (“necklace”).
 - **Acetabular labrum (Cotyloid ligament):** deepens the joint for increased stability.
- **Ligaments of the hip joint:**
 - **Iliofemoral ligament (Y ligament of Bigelow):**

- **Appearance:** inverted Y-shaped, the strongest and thickest ligament of the hip.
- **Covers:** anterior and superior portions of the hip.
- **Functions:**
 - Prevents hip hyperextension.
 - Aids in maintaining an erect posture without constant muscle contraction.
 - Limits hip external rotation.
- **Attachments:**
 - **Proximal:** inferior part of the AIIS.
 - **Distal:** the intertrochanteric line of the femur.
- **Ischiofemoral ligament (ischiocapsular ligament):**
 - **Appearance:** Spiral-shaped, located posteriorly.
 - **Covers:** posterior and inferior portions of the hip.
 - **Functions:**
 - Limits internal rotation and adduction in the flexed position.
 - Prevents hyperextension of the hip.
 - Holds the femoral head in the acetabulum.
 - **Attachments:**
 - **Proximal:** ischium below the acetabulum.
 - **Distal:** joint capsule.
- **Pubofemoral ligament:**
 - **Appearance:** triangular-shaped ligament.
 - **Location:** medial and lower part of the joint capsule.
 - **Functions:**
 - Prevents excessive hip abduction.
 - Helps reinforce the posterior joint capsule.
- **Other hip ligaments:**
 - **Transverse acetabular ligament:**
 - Bridges the acetabular notch.
 - Converts the acetabular notch into the acetabular foramen.
 - Composed of strong fibrous bands.
 - **Ligamentum teres femoris (ligamentum capitis femoris/Ligament of the head of the femur):**
 - **Function:** secures the femoral head to the lower acetabulum.
 - **Attachments:**
 - **Base:** transverse ligament and acetabular margin.
 - **Apex:** fovea capitis.

HIP MUSCLES:

- **Classification of hip and thigh muscles:**
 - **Gluteal region muscles:**
 - Primarily responsible for pelvic stability, hip extension/abduction/rotation.
 - Organized into superficial and deep muscles.
 - **Anterior hip/thigh muscles (flexor group):** primarily responsible for hip flexion (important in swing phase of gait).
 - **Medial hip/thigh muscles (adductor group):** primarily responsible for adduction, stabilization of the pelvis in stance.
 - **Posterior hip/thigh muscles (hip extensors):** assist in hip extension, control the trunk/hip during bending and gait.
- **Gluteal region muscles:**
 - **Gluteal region - superficial muscles (overview):**
 - Forms the main bulk of the buttock region.
 - Function in mobility, stabilization, especially during walking and single-leg stance.
 - **Superficial group:**
 - Gluteus maximus
 - Gluteus medius
 - Gluteus minimus
 - Tensor fasciae latae (TFL)
 - **Gluteus maximus:**
 - **Shape:** thick, quadrangular muscle; forms most of the buttock mass.
 - **Actions:**
 - Hip extension (power movement).
 - Lateral rotation of the femur.
 - Assists stability via the IT tract.
 - **Innervation:** inferior gluteal nerve.
 - **Clinical note:** weakness affects rising from a chair, stair climbing, and running propulsion.
 - **Gluteus medius:**
 - **Shape:** fan-shaped; lateral ilium → greater trochanter.
 - **Actions:**
 - Hip abduction.
 - Assists in internal rotation (anterior fibers).
 - Pelvic stabilization in single-leg stance.
 - **Innervation:** superior gluteal nerve.
 - **Clinical note:** weakness → Trendelenburg sign/gait.
 - **Gluteus minimus:**
 - **Shape:** small, deep to the gluteus medius.
 - **Actions:**

- Hip abduction.
 - Internal rotation.
 - Assists in pelvic stabilization.
 - **Innervation:** superior gluteal nerve.
 - **Clinical note:** often works with the gluteus medius; **dysfunction contributes to pelvic drop.**
- **Tensor fasciae latae:**
 - **Shape:** small anterior-lateral hip muscle; blends into the IT tract.
 - **Actions:**
 - Assists hip abduction and medial rotation.
 - Helps stabilize the hip and knee via the IT band.
 - **Innervation:** superior gluteal nerve.
 - **Clinical note:** tightness → lateral hip/knee issues (ITB-related pain patterns).
- **Gluteal muscles - deep muscles (short lateral rotator):**
 - These muscles lie deep to the gluteus maximus and mainly stabilize the hip.
 - **Function:** keep the femoral head controlled within the acetabulum during movement.
 - **Deep group:**
 - Piriformis
 - Obturator internus
 - Gemellus superior/inferior
 - Quadratus femoris
 - **Piriformis:**
 - **Actions:** lateral rotation; assists abduction (especially when hip is flexed).
 - **Innervation:** nerve to piriformis.
 - **Clinical note (piriformis syndrome):** can irritate the sciatic nerve, causing buttock pain (radiating symptoms).
 - **Obturator internus and gemelli:**
 - **Actions:**
 - Primarily lateral rotation.
 - Assists hip stabilization (may assist in abduction depending on position).
 - **Innervation:**
 - **Obturator internus:** nerve to obturator internus.
 - **Gemelli:** commonly grouped with nearby deep rotator innervation patterns.
 - **Clinical note:** often acts as a functional unit to stabilize the femoral head.
 - **Quadratus femoris:**
 - **Shape:** flat, rectangular muscle inferior to the gemelli/obturator internus.

- **Action:** strong lateral rotation (and stabilization).
 - **Innervation:** nerve to quadratus femoris.
 - **Clinical note:** an important deep stabilizer during hip rotation tasks.
- **Gluteal region muscles - Clinical slides:**
 - **Trendelenburg sign (hip abductor weakness):**
 - **Cause:** weakness/paralysis of gluteus medius/minimus (often the superior gluteal nerve is involved).
 - **Sign:** pelvic drop on the unsupported side during single-leg stance.
 - **Gait compensation:** trunk leans toward the stance leg (Trendelenburg gait).
 - **Piriformis syndrome:**
 - **Cause:** compression/irritation of the sciatic nerve by the piriformis muscle.
 - **Sign:** pain and tingling sensation in the buttocks and up to the back of the leg.
 - **Functional problem:** patients have difficulty sitting on hard surfaces.

THIGH MUSCLES:

- **Anterior compartment of the thigh:** contains muscles involved in hip flexion and knee extension/flexion control.
 - **Important landmark muscle:**
 - Iliopsoas.
 - Sartorius (the longest muscle of the body).
 - **Femoral triangle:** a key passageway for major neurovascular structures.
- **Anterior hip muscles (hip flexor group):**
 - **Iliopsoas (primary hip flexor):**
 - **Actions:** strong hip flexion; assists trunk flexion when the femur is fixed.
 - **Innervation (simple):** femoral nerve (iliacus), lumbar plexus (psoas).
 - **Clinical note:** tight iliopsoas may increase anterior pelvic tilt and limit hip extension in gait.
 - **Sartorius (tailor's muscle):** longest muscle; thin; runs inferomedially across the thigh.
 - **Actions:**
 - **Hip joint:** flexion, abduction, lateral rotation.
 - **Knee joint:** flexion.
 - **Key anatomy note:** forms part of the femoral triangle border.
- **Medial thigh compartment:** hip adduction, stabilization during gait/stance.
 - **Key muscles:**
 - Pectineus

- Adductor longus
 - Adductor magnus
 - Adductor brevis
 - Gracilis
 - Obturator externus
- **Medial thigh muscles (adductor group):**
 - **Pectineus:** flat, quadrangular muscle (which contributes to the floor of the femoral triangle).
 - **Actions:** adduction and flexion at the hip joint.
 - **Adductor magnus:** the largest muscle in the medial thigh compartment.
 - **Two parts:**
 - **Adductor part:** adduction and flexion of the thigh.
 - **Hamstring part:** adduction and extension of the thigh.
 - **Innervation:**
 - **Adductor part:** obturator nerve (L2-4).
 - **Hamstring part:** tibial compartment of sciatic nerve (L4-S3).
 - **Adductor longus:**
 - A flat muscle that covers the adductor brevis and adductor magnus.
 - Forms the medial border of the femoral triangle.
 - **Clinical note:** most common cause of groin pain because it is a commonly strained adductor muscle.
 - **Adductor brevis:**
 - **Action:** adducts the thigh at the hip joint (may assist in external rotation).
 - **Obturator externus:**
 - **Actions:** adduction and lateral rotation of the thigh.
 - **Gracilis:**
 - Slender muscle.
 - Only a 2-jointed adductor muscle.
 - **Actions:**
 - **Hip:** adduction of the thigh.
 - **Knee:** flexion and internal rotation of the leg.
- **Posterior thigh muscles (extensor group):**
 - **Semitendinosus/Semimembranosus:** knee flexion, hip extension, medial thigh, and leg rotation.

IMPORTANT STRUCTURES IN THE HIP AND THIGH:

- **Femoral triangle:**
 - **Definition and function:**
 - A wedge-shaped area in the superomedial aspect of the anterior thigh.
 - Acts as a conduit for structures entering and leaving the anterior thigh.
 - **Borders:**

- **Roof:** fascia lata.
 - **Floor:** pectineus, iliopsoas, and adductor longus.
 - **Superior border:** inguinal ligament.
 - **Lateral border:** medial border of the sartorius muscle.
 - **Medial border:** medial border of the adductor longus.
- **Contents:**
 - **NAVEL (lateral to medial):**
 - **N - Femoral nerve:** innervates the anterior thigh, provides sensory branches for the leg and foot.
 - **A - Femoral artery:** major arterial supply to the lower limb.
 - **V - Femoral vein:** receives the great saphenous vein drainage.
 - **E - Empty space (femoral canal)**
 - **L - Lymph nodes/vessels (deep)**
- **Femoral canal:**
 - **Location:** situated in the anterior thigh within the femoral triangle.
 - **Borders:**
 - **Medial:** lacunar ligament.
 - **Lateral:** femoral vein.
 - **Anterior:** inguinal ligament.
 - **Posterior:** pectineal ligament, superior ramus of pubic bone, and pectineus muscle.
 - **Contents:**
 - Lymphatic vessels draining the deep inguinal lymph nodes.
 - Deep lymph node (lacunar node).
 - Empty space and loose connective tissue allowing femoral vein distension.
- **Adductor canal (Hunter's/subsartorial canal):**
 - A narrow, conical tunnel in the thigh.
 - A passageway for structures between the anterior thigh and posterior leg.
 - **Borders:**
 - **Anteromedial:** sartorius
 - **Lateral:** vastus medialis
 - **Posterior:** adductor longus and adductor magnus
 - **Contents:**
 - Femoral artery
 - Femoral vein (posterior to artery)
 - Nerve to the vastus medialis
 - Saphenous nerve (the largest cutaneous branch of the femoral nerve).

Knee region - Bones, Joints, and Muscles

KNEE BONES:

- **Knee region:**
 - **Knee joint:** one of the most intricate joints in the human body, consisting of three bones: Femur, Tibia, Patella
 - **Two degrees of freedom:** allowing movement in multiple directions.
 - **Primary articulating surfaces:**
 - **Medial tibiofemoral joint:** between the **medial femoral condyle** and the **medial tibial plateau**.
 - **Lateral tibiofemoral joint:** between the **lateral femoral condyle** and the **lateral tibial plateau**.
 - **Patellofemoral joint:** between the **patella** and the **femur**, facilitating **smooth knee flexion and extension**.

- **Landmarks of the knee:**
 - **Bony landmarks of the distal femur:**
 - **Supracondylar lines:**
 - **Medial supracondylar line:** posterior continuation of the linea aspera, delineating the popliteal surface.
 - **Lateral supracondylar line:** defines the lateral aspect of the femur and serves as an attachment site for muscles.
 - **Femoral condyles:**
 - **Medial femoral condyle:** Forms the medial part of the knee joint, articulating with the medial tibial plateau.
 - **Role:** knee stability and weight distribution.
 - **Lateral femoral condyle:** Forms the lateral part of the knee joint, articulating with the lateral tibial plateau.
 - **Role:** knee function and movement.
 - **Epicondyles:**
 - **Medial epicondyle:** provides attachment for the medial collateral ligament (MCL), which stabilizes the knee.
 - **Lateral epicondyle:** helps identify the lateral aspect of the femur and provides attachment for the lateral collateral ligament (LCL), contributing to knee stability.
 - **Adductor tubercle:**
 - **Location:** posterosuperior to the medial epicondyle.
 - Serves as an attachment point for the adductor magnus muscle.
 - **Groove for the popliteus tendon:** Provides a pathway for the popliteus tendon.
 - **Popliteus muscle:** unlocks the knee joint by medially rotating the tibia during knee extension.

- A vertical ridge along the lateral aspect of the tibia.
 - Extends inferior to the articular facet for the fibula.
 - **Medial border:**
 - Indistinct superiorly, beginning at the anterior end of the groove on the posterior surface of the medial epicondyle.
 - Becomes sharp at midshaft.
 - **Surfaces of the tibia:**
 - **Lateral surface:**
 - **Location:** between the anterior and interosseous borders.
 - Smooth and unremarkable.
 - **Medial surface:**
 - **Location:** between the anterior and medial borders.
 - Just inferior to the tibial tuberosity is the attachment site for the **Pes Anserinus muscle:**
 - Sartorius
 - Gracilis
 - Semitendinosus
 - **Posterior surface:** located between the interosseous and medial borders (widest superiorly).
 - **Additional bony features:**
 - **Soleal/popliteal line:** a roughened oblique line on the posterior surface of the tibia.
 - **Articular facet for fibula:** the site where the fibular head articulates with the tibia.
 - **Groove for semimembranosus:** provides attachment for the semimembranosus.
 - **Impression for Iliotibial tract:** attachment site for the iliotibial (IT) band.
- **Patella (kneecap):**
 - The largest sesamoid bone in the body.
 - Triangular-shaped, embedded within the quadriceps tendon.
 - **Bony features of the patella:**
 - **Apex:** pointed inferiorly, connected to the tibial tuberosity via the patellar ligament.
 - **Base:** broad and thick, provides attachment for the quadriceps muscle and tendon.
 - **Facets for articulation with the femur:**
 - **Lateral facet:** Larger than the medial facet.
 - Articulates with the lateral condyle of the femur.
 - **Medial facet:** articulates with the medial condyle of the femur.

- **Vertical ridge:** a rounded surface running longitudinally from top to bottom across the posterior surface of the patella.
- **Odd facet:** a third facet along the extreme medial border of the medial facet.
- **Functions of the patella:**
 - Enhances knee extension efficiency by acting as a fulcrum for the quadriceps tendon.
 - Provides bony protection for the femoral condyles during knee flexion.
 - Distributes forces along the femur.
 - Contributes to the aesthetic appearance of the knee joint.
 - Helps control capsular tension in the knee.
 - Acts as a guide for the quadriceps tendon during movement.

KNEE JOINTS AND LIGAMENTS:

- **Tibiofemoral joint:**
 - **Articulating surfaces:**
 - The medial and lateral condyles of the femur articulate with the medial and lateral tibial plateaus.
 - Primary weight-bearing component of the knee.
 - **Joint type:** synovial diarthrosis joint (modified hinge joint).
 - **Motions permitted:**
 - Flexion and extension of the knee.
 - Medial and lateral rotation of the tibia (when the knee is flexed).
- **Patellofemoral joint:**
 - **Articulating surfaces:** the anterior aspect of the distal femur articulates with the patella.
 - **Function:**
 - Increases the efficiency of the quadriceps femoris tendon by providing a fulcrum, improving knee extensor power.
 - Reduces frictional forces on the femoral condyles.
 - **Joint type:** synovial joint.
 - **Motions permitted:** patellar sliding as the knee joint moves.
- **Screw home mechanism:**
 - Locking mechanism of the knee.
 - Occurs in the last 20 degrees of knee extension.
 - Purely mechanical (involuntary).
 - **Locking:**
 - **Open kinetic chain (OKC):** tibia externally rotates.
 - **Closed kinetic chain (CKC):** femur internally rotates.
 - **Unlocking:**

- **OKC:** tibia internally rotates.
 - **CKC:** femur externally rotates.
- **Ligaments of the knee:**
 - **Collateral ligaments:**
 - **Medial collateral ligament (MCL):**
 - **Origin:** medial epicondyle of the femur.
 - **Insertion:** tibia.
 - **Function:** resists valgus stress and anterior tibial translation.
 - Taut in full extension and external tibial rotation.
 - **Lateral collateral ligament (LCL):**
 - **Origin:** lateral epicondyle of the femur.
 - **Insertion:** fibular head.
 - **Function:** resists varus stress.
 - Cord-like, extracapsular.
 - **Cruciate ligaments:**
 - **Anterior cruciate ligament (ACL):**
 - **Origin:** anterior intercondylar area of the tibia.
 - **Insertion:** lateral condyle of the femur.
 - **Function:** prevents anterior tibial translation.
 - **Common injuries:** **hyperextension**, landing on an extended knee.
 - **Posterior cruciate ligament (PCL):**
 - **Origin:** posterior intercondylar area of the tibia.
 - **Insertion:** medial condyle of the femur.
 - **Function:** prevents posterior tibial translation.
 - **Common injuries:** **dashboard injury**, falling on a flexed knee.
 - The unhappy triad:
 - **Involves injury to:**
 - **MCL**
 - **ACL**
 - **Medial meniscus**
 - **Oblique popliteal ligament:**
 - Strengthens the posterior knee capsule.
 - Helps limit hyperextension.
 - **Arcuate popliteal ligament:**
 - Reinforces the posterolateral capsule of the knee.
 - Provides stability in full knee extension.
 - **Patellar ligament (patellar tendon):**
 - Connects the patella to the tibial tuberosity.
 - Acts as a continuation of the quadriceps tendon, aiding in knee extension.
 - **Transverse ligament of the knee:** connects the anterior portions of the medial/lateral menisci, stabilizing them.

- **Coronary ligaments:** attach the menisci to the tibia, preventing excessive movement.
- **Menisci of the knee:** fibrocartilage structure at the tibia.
 - **Functions:**
 - Deepens the joint.
 - Adds lubrication.
 - Absorbs shock.
 - Prevents the capsule from intruding into the joint space.
 - **Blood supply:**
 - **Outer** $\frac{1}{3}$: Vascularized.
 - **Inner** $\frac{2}{3}$: Avascular.
 - **Innervation: Outer** $\frac{2}{3}$.
 - **Medial meniscus:**
 - C-shaped fibrocartilaginous structure located on the medial tibial plateau.
 - Larger and more firmly attached to the tibia than the lateral meniscus.
 - Attach to the MCL, making it more prone to injury.
 - **Functions:**
 -
 - Shock absorption by distributing loads across the joint.
 - Deepens the tibial articular surface, enhancing knee stability.
 - Aids in the lubrication and nutrition of the knee joint.
 - **Lateral meniscus:**
 - O-shaped fibrocartilaginous structure located on the lateral tibial plateau.
 - More mobile and less firmly attached to the tibia than the medial meniscus.
 - Not directly attached to the LCL, allowing greater movement and reducing injury risk.
 - **Functions:**
 - Absorbs shock and distributes weight-bearing forces.
 - Enhances joint congruency and stability.
 - Facilitates smooth articulation between the femur and tibia.

MUSCLES OF THE KNEE:

- **Knee extensors (anterior compartment of the thigh):** these muscles work to extend the knee joint and are primarily innervated by the femoral nerve (L2-4).
 - **Quadriceps femoris group:** the primary knee extensor, and consists of four muscles.
 - **Rectus femoris:** the only quadriceps muscle that crosses both the hip and knee joints.
 - **Function:** knee extension and assists in hip flexion.
 - **Vastus lateralis:** the largest of the quadriceps group.
 - **Function:** powerful knee extensor.

- Sartorius
 - Popliteus (helps unlock the knee)
- Lateral rotation of the tibia (when the knee is flexed):
 - Biceps femoris

POPLITEAL FOSSA:

- A diamond-shaped depression is located at the posterior aspect of the knee joint.
- Serves as a passageway for neurovascular structures travelling between the thigh and leg.
- **Boundaries of the popliteal fossa:**
 - **Superior boundaries:**
 - **Superolateral:** biceps femoris.
 - **Superomedial:** semimembranosus
 - **Inferior boundaries:**
 - **Inferolateral:** lateral head of gastrocnemius.
 - **Inferomedial:** medial head of gastrocnemius.
 - **Roof (superficial boundary):**
 - Formed by **skin, superficial fascia, and deep popliteal fascia.**
 - The small saphenous vein runs superficially before draining into the popliteal vein.
 - **Nerve:** posterior cutaneous nerve of the thigh, providing sensation to the area.
 - **Floor (deep boundary):**
 - Popliteal surface of the femur.
 - Joint capsule of the knee.
 - Popliteus muscle.
- **Contents of the popliteal fossa (superficial to deep):**
 - **Tibial nerve (most superficial):**
 - The **largest branch of the sciatic nerve.**
 - Runs vertically through the fossa, providing motor innervation to the posterior leg muscles.
 - Gives rise to the medial sural cutaneous nerve, which contributes to the sural nerve (cutaneous innervation of the posterior leg).
 - **Common fibular (peroneal) nerve:**
 - **Smaller lateral branch of the sciatic nerve.**
 - Travels along the biceps femoris tendon before wrapping around the neck of the fibula.
 - Divides into superficial and deep fibular nerves, innervating muscles of the lateral and anterior compartments of the leg.
 - **Popliteal vein (intermediate depth):**
 - Continuation of the posterior tibial vein.
 - Receives the small saphenous vein.
 - Becomes the femoral vein at the adductor hiatus.
 - **Popliteal artery (deepest structure):**

- Continuation of the femoral artery after it passes through the adductor hiatus.
- Supplies blood to the knee joint and surrounding muscles via genicular branches.
- Divides into anterior and posterior tibial arteries at the lower border of the popliteus muscle.

Ankle and Foot - Bones, Joints, and Muscles

ANKLE BONES:

- **Tibia (shin bone):**
 - **Articulations and structure:**
 - The lower end forms a saddle-shaped articular surface for the talus, creating the ankle joint.
 - Extends downward to form the medial malleolus, which articulates with the talus and interacts with tarsal bones.
 - **Distal end:** widens for weight-bearing support.
 - **Notable features:**
 - **Lateral surface:** contains a wide, rough depression for fibular articulation.
 - **Posterior surface:** has a groove for the passage of the tibilis posterior tendon.
 - **Fibular notch:** binds the fibula to the tibia, forming the distal tibiofibular joint, crucial for ankle stability.
- **Fibula (lateral leg bone):**
 - **Lower-end features:**
 - Forms the triangular lateral malleolus, more prominent than the medial malleolus.
 - **Medial surface of the lateral malleolus:** contains a triangular articular facet, articulating with the lateral talus.
 - Below and behind this facet is the malleolar fossa.
 - **Lateral malleolus:** palpable on the lateral side of the ankle.
- **Talus (ankle bone):**
 - **Function:**
 - Transmits forces from the tibia to the calcaneus.
 - Ensures ankle stability, with a wider anterior structure.
 - Articulates with the tibia, fibula, calcaneus, and navicular bone.
 - **Key regions:**
 - **Head:** features an oval convex surface for articulation with the navicular bone, extending inferiorly.
 - **Neck:** slightly narrowed, with roughened upper and grooved lower surfaces.

- **Midfoot joints:**
 - **Transverse tarsal joints:** talonavicular and calcaneocuboid (midfoot movement)
 - **Distal intertarsal joints:** cuneonavicular, cuboideonavicular, intercuneiform, and cuneocuboid (midfoot flexibility and stability).

- **Forefoot:**
 - **Metatarsals (1-5, medial to lateral):**
 - Long bones between tarsals and phalanges.
 - Each has a head, neck, shaft, and base.
 - **Key metatarsals:**
 - **1st metatarsal:** largest, shortest, strongest.
 - **2nd metatarsal:** longest.
 - **5th metatarsal:** attachment site for the peroneus brevis.
 - **Phalanges (toe bones):**
 - **Toes 2-5:** have proximal, middle, and distal phalanges.
 - **Great toe (hallux):** has only proximal and distal phalanges.
 - **Each phalanx has a base, shaft, and head.**
 - **Forefoot joints:**
 - Tarsometatarsal (TMT) joints.
 - Intermetatarsal joints.
 - Metatarsophalangeal (MTP) joints.
 - Interphalangeal (IP) joints.
 - **Forefoot morphology (toe length patterns):**
 - **Index plus (Egyptian foot):** 1st metatarsal is longest.
 - **Index minus (Morton's/Greek foot):** 2nd metatarsal is longest.
 - **Index plus-minus (Squared foot):** The 1st and 2nd metatarsals are equal.

ANKLE AND FOOT JOINTS AND LIGAMENTS:

- **Ankle joint (talocrural joint):**
 - **Type:** synovial hinge joint.
 - **Function:** enables dorsiflexion/plantarflexion, crucial for walking and running.
 - **Articulations:**
 - **Superiorly:** tibia and fibula form a mortise (deep socket).
 - **Inferiorly:** the talus fits within the mortise, allowing controlled movement.
 - **Movements:**
 - **Dorsiflexion (toes up):**
 - **Muscles involved:** tibialis anterior, extensor digitorum longus, and extensor hallucis longus.
 - **Limited by:** posterior ligaments, Achilles tendon, and posterior muscles.
 - **Plantarflexion (toes down):**

- **Muscles involved:** gastrocnemius, soleus, plantaris, tibialis posterior.
 - **Limited by:** anterior structures such as the anterior talofibular ligament and dorsiflexor muscles.

- **Medial (deltoid) ligament:**
 - Strong, triangular ligament.
 - Prevents excessive eversion (foot rolling outward).
 - **Attachments:**
 - **Medial malleolus:** talus, calcaneus, navicular.
 - **Components:**
 - **Tibionavicular ligament:** stabilizes the connection with the navicular.
 - **Tibiocalcaneal ligament:** supports the calcaneus.
 - **Anterior tibiotalar ligament:** limits anterior movement of the talus.
 - **Posterior tibiotalar ligament:** limits posterior movement of the talus.

- **Lateral ligaments (weaker and more injury-prone):**
 - Prevents excessive inversion (foot rolling inward).
 - **Attachments:**
 - **Lateral malleolus:** talus, calcaneus.
 - **Components:**
 - **Anterior talofibular ligament (ATFL):**
 - The most commonly injured ligament in ankle sprains.
 - Restricts excessive anterior translation of the talus.
 - **Calcaneofibular ligament (CFL):** resists inversion stress at the subtalar joint.
 - **Posterior talofibular ligament (PTFL):** provides posterior ankle stability, the strongest of the lateral ligaments.

- **Subtalar joint (talocalcaneal joint):**
 - **Type:** synovial plane joint.
 - **Function:** allows the foot to adapt to uneven terrain by controlling inversion/eversion.
 - **Articulation:**
 - **Superiorly:** talus
 - **Inferiorly:** calcaneus
 - **Movements:**
 - **Inversion:** sole turns inward.
 - **Eversion:** sole turns outward.
 - **Subtalar joint ligaments:**
 - **Interosseous talocalcaneal ligament:** the strongest stabilizer, prevents excessive movement.
 - **Medial talocalcaneal ligament:** reinforces the joint medially.
 - **Lateral talocalcaneal ligament:** provides lateral support.

- Prevents excessive movement between metatarsals and tarsal bones.
 - **Clinical relevance:**
 - **Lisfranc injury (fracture-dislocation):**
 - Caused by high-impact trauma or twisting forces.
 - Leads to instability and midfoot pain.
 - Often requires surgical fixation.
- **Metatarsophalangeal joints (MTP):**
 - **Type:** synovial condyloid joints.
 - **Function:**
 - Important for the push-off phase in gait,
 - Controls weight transfer during walking and running.
 - **Articulations:**
 - **Between:**
 - Metatarsal heads.
 - Proximal phalanges.
 - **Movements:**
 - **Flexion and extension:** essential for walking and running.
 - **Abduction and adduction:** adjust toe positioning for balance.
 - **Supporting structures:**
 - **Collateral ligaments:** prevent excessive side movement and provide joint stability.
 - **Plantar plates:**
 - Fibrocartilaginous structures beneath MTP joints.
 - Prevent hyperextension and support foot arches.
- **Intermetatarsal joints:**
 - Synovial plane joints between the bases of the lateral four metatarsals (2-5).
 - Allow small gliding movements for foot flexibility.
 - **Articulations:**
 - Between adjacent bases of the 2nd-5th metatarsal bones.
 - **1st metatarsal:** independent and does not participate in these joints.
 - **Ligaments (stabilizers):**
 - **Dorsal intermetatarsal ligaments:** reinforce the joint from the top.
 - **Plantar intermetatarsal ligaments:** strengthen the sole side.
 - **Interosseous intermetatarsal ligaments:** strongest, bind metatarsal bases together.
 - **Function:**
 - Maintains foot stability by linking metatarsals.
 - Contributes to arch integrity and foot shock absorption.
 - Allows slight movement to adapt to uneven surfaces.

- **Interphalangeal joints (IP):**
 - **Type:** synovial hinge joints.
 - **Function:**
 - Controls toe bending and grip.
 - Aids in balance and propulsion.
 - **Articulations:**
 - **Between:** proximal, middle, and distal phalanges.
 - **In the hallux:** only one IP joint (proximal and distal phalanges).
 - **In toes 2-5:** PIP joint and DIP joint.
 - **Movements:**
 - **Flexion:** toes curl downward.
 - **Extension:** toes straighten.
 - **Ligaments:**
 - **Collateral ligaments:** stabilize the sides of each joint.
 - **Plantar ligaments:** reinforce the plantar surface, preventing hyperextension.

MUSCLES OF THE LEG AND SOLE OF THE FOOT:

- **Muscles of the anterior compartment of the leg:**
 - **Function:** dorsiflexion, inversion of the foot, and extension of the toe.
 - **Innervation:** deep fibular (peroneal) nerve.
 - **Blood supply:** anterior tibial artery.
 - **Muscles and actions:**
 - **Tibialis anterior:**
 - **Actions:** dorsiflexes and inverts the foot.
 - **Clinical relevance:** weakness leads to foot drop.
 - **Extensor hallucis longus:**
 - **Actions:** extends the big toe and assists in dorsiflexion.
 - **Extensor digitorum longus:**
 - **Actions:** extend the lateral four toes and assist in dorsiflexion.
 - **Fibularis (peroneus) tertius:**
 - **Actions:** assists in dorsiflexion and eversion.
- **Muscles of the posterior compartment of the leg:**
 - **Function:** plantarflexion and inversion of the foot, and flexion of the toes.
 - **Innervation:** tibial nerve.
 - **Blood supply:** posterior tibial artery.
 - **Superficial group (primary plantarflexors):**
 - **Gastrocnemius:**
 - **Action:** plantarflexion of the foot assists in knee flexion.
 - **Clinical relevance:** Achilles tendon rupture affects plantarflexion.
 - **Soleus:**
 - **Action:** plantarflexes the foot, key for postural stability.

- **Fourth layer (deepest):** toe adduction and stabilization. **PADDAB**
 - **Plantar interossei (3 muscles):** adduct toes.
 - **Dorsal interossei (4 muscles):** abduct toes.

ARCHES OF THE FOOT, MECHANISM OF ARCH SUPPORT, AND TARSAL TUNNEL:

- **Arches of the foot:**
 - **Function of the arches:**
 - Provide shock absorption during weight-bearing.
 - Enable efficient walking/running.
 - Acts as springs for propulsion.
 - Distribute body weight evenly across the foot.
 - **Medial longitudinal arch:**
 - Talus, calcaneus, cuneiforms, navicular.
 - 2 medial metatarsals.
 - **Lateral longitudinal arch:**
 - Calcaneus, cuboid.
 - 4th & 5th metatarsals
 - **Transverse arch:**
 - Cuboid, 3 cuneiforms.
 - Bases of the metatarsals.
 - **Mechanism of arch support:** the arches of the foot are supported by a combination of bone structure, ligaments, and muscles, working together to maintain stability and function.
 - **Passive support (structural and ligamentous support):**
 - **Shape of stone mechanism:**
 - The wedge shape of bones (especially cuneiforms) forms a stable structure.
 - The keystone (e.g., talus in the medial arch, cuboid in the lateral arch) acts as the central point, preventing collapse.
 - **Inferior edge of stone ties together:**
 - The interlocking of bones prevents separation under weight-bearing forces.
 - Strengthened by ligaments that act as passive stabilizers
 - **Ligamentous support (staples):**
 - **Plantar aponeurosis:** strong connective tissue that reinforces the arches.
 - **Spring ligament (plantar calcaneonavicular ligament):** essential for the medial arch.
 - **Long and short plantar ligaments:** support the lateral arch.
 - **Interosseous ligaments:** prevent excessive movement between bones.
 - **Active support (muscular support):**

- **Tie beam mechanism:** muscles act like tie beams, connecting the ends of the arch to prevent spreading.
 - **Key muscles acting as tie beams:**
 - **Plantar aponeurosis:** major stabilizer.
 - **Flexor digitorum longus (FDL):** assists in toe grip.
 - **Flexor hallucis longus (FHL):** provides medial arch support.
 - **Abductor hallucis (AH):** reinforces the medial arch.
 - **Flexor digitorum brevis (FDB):** supports the longitudinal arches.
- **Suspension bridge mechanism:** muscles act like suspension cables to maintain arch height.
 - **Key muscles acting as suspension bridges:**
 - **Tibialis anterior/posterior:** supports the medial longitudinal arch.
 - **Fibularis longus/brevis:** support the lateral longitudinal and transverse arches.
- **Types of foot arches:**
 - **Medial longitudinal arch (higher and more elastic):**
 - **Function:** absorbs shock and supports weight distribution.
 - **Bones involved:** calcaneus, talus, navicular, three cuneiforms, first three metatarsals.
 - **Keystone:** talus (acts as the peak of the arch).
 - **Support structures:**
 - **Staples (ligaments for structural stability):** spring ligament (plantar calcaneonavicular ligament).
 - **Tie beams (dynamic muscle supports):**
 - **Plantar aponeurosis**
 - **Flexor digitorum longus (FDL)**
 - **Flexor hallucis longus (FHL)**
 - **Abductor hallucis (AH)**
 - **Flexor digitorum brevis (FDB)**
 - **Flexor hallucis brevis (FHB)**
 - **Suspension bridge (muscles supporting from above):**
 - **Tibialis anterior**
 - **Tibialis posterior**
 - **Lateral longitudinal arch (lower, more rigid):**
 - **Function:** provides lateral foot stability and weight-bearing support.
 - **Bones involved:** calcaneus, cuboid, 4th and 5th metatarsals.
 - **Keystone:** cuboid (acts as a central stabilizer).
 - **Support structures:**

- **Staples (ligaments for structural stability):**
 - Long plantar ligament
 - Short plantar ligament
 - **Tie beams (dynamic muscle supports):**
 - Plantar aponeurosis
 - Abductor digiti minimi (ADM)
 - Flexor digitorum longus (FDL)
 - Flexor hallucis brevis (FHB)
 - **Suspension bridge (muscles supporting from above):**
 - Fibularis longus
 - Fibularis brevis

- **Tarsal tunnel:**
 - A fibro-osseous tunnel is located on the medial side of the ankle.
 - Allows passage of tendons, blood vessels, and nerves from the leg to the foot.
 - **Boundaries:**
 - **Roof:** flexor retinaculum (thick connective tissue).
 - **Floor:** medial malleolus, talus, calcaneus.
 - **Content (Tom, Dick, And Very Nervous Harry):**
 - **T:** tibialis posterior tendon
 - **D:** flexor digitorum longus tendon
 - **A:** posterior tibial artery
 - **V:** posterior tibial vein
 - **N:** tibial nerve
 - **H:** flexor hallucis longus tendon
 - **Clinical relevance:** tarsal tunnel syndrome
 - **Cause:** compression of the tibial nerve in the tunnel.
 - **Symptoms:**
 - Pain and numbness in the medial ankle and sole.
 - Weakness of the intrinsic foot muscles.
 - **Risk factors:** flat feet, swelling, trauma.