MEDICAL EDUCATION RESOURCE

Joints of Lower Limb

? Joints of Lower Limb – Hip Joint

Introduction

- The **hip joint** is a **ball-and-socket synovial joint** between the **head of femur** and the **acetabulum of hip bone**.
- It is designed for **stability and weight-bearing**, not excessive mobility like the shoulder.
- Functions: Supports body weight in standing, walking, and running; provides locomotion while maintaining equilibrium.

Type

- **Structural Type:** Synovial joint (ball and socket variety).
- **Functional Type:** Diarthrosis (freely movable).

Articular Surfaces

- **Acetabulum:**
  - Cup-shaped cavity on lateral surface of hip bone.

- Formed by ilium (2/5), ischium (2/5), and pubis (1/5).
- Articular surface covered with **hyaline cartilage**, horseshoe-shaped (lunate surface).
- Non-articular part is the **acetabular fossa** filled with fat and ligamentum teres.

- **Head of Femur:**
  - More than half a sphere covered with cartilage except at the **fovea capitis femoris**, where **ligament of head** attaches.

Ligaments of Hip Joint

The strength of the hip joint depends on **strong ligaments** and surrounding muscles.

1. Capsular Ligament

- Attached **above** to acetabular margin and **below** to neck of femur (anteriorly to intertrochanteric line, posteriorly above intertrochanteric crest).
- Encloses the joint completely.
- Very strong and dense, particularly anteriorly.

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2. Iliofemoral Ligament (Y-shaped ligament of Bigelow)

- **Strongest ligament of the body.**
- **Attachment:**

- Apex ? anterior inferior iliac spine.
- Base ? intertrochanteric line.

- **Function:**
  - Prevents **hyperextension** of hip during standing.
  - Maintains upright posture with minimal muscle effort.

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3. Pubofemoral Ligament

- **Attachment:**
  - From iliopubic eminence and obturator crest ? blends with capsule and iliofemoral ligament.
- **Function:**
  - Limits **over-abduction and extension**.

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4. Ischiofemoral Ligament

- **Attachment:**
  - From ischial part of acetabular rim ? spirals superolaterally to attach to greater trochanter.
- **Function:**
  - Limits **internal rotation** and **extension** of hip.

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5. Ligament of Head of Femur (Ligamentum Teres)

- **Attachment:**
  - Apex ? fovea on head of femur.
  - Base ? margins of acetabular notch and transverse acetabular ligament.
- **Contains:**
  - **Small artery to head of femur** (from obturator artery).
- **Function:**
  - Provides vascular supply and minimal mechanical support.

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6. Acetabular Labrum

- **Fibrocartilaginous rim** attached to acetabular margin, deepening the cavity and increasing stability.

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7. Transverse Acetabular Ligament

- Bridges the **acetabular notch**, converting it into a foramen for the **obturator vessels and nerves** to enter.

Relations of the Hip Joint

Anteriorly:

- Iliopsoas tendon and bursa.
- Femoral nerve, artery, and vein.
- Pectineus and rectus femoris.

Posteriorly:

- Obturator internus, gemelli, and quadratus femoris.
- Sciatic nerve.

Superiorly:

- Gluteus minimus and reflected head of rectus femoris.

Inferiorly:

- Obturator externus.

Blood Supply

- **Primary sources:**
  - **Medial circumflex femoral artery** — main supply to head and neck of femur.
  - **Lateral circumflex femoral artery.**
  - **Superior and inferior gluteal arteries.**
  - **Obturator artery** (via artery in ligamentum teres in children).

- **Clinical note:**
  - The **retinacular branches** from medial circumflex femoral artery are easily damaged in **neck of femur fractures**, causing **avascular necrosis** of the head.

Nerve Supply

- Supplied by **Hilton's Law** (nerves supplying muscles acting on joint also supply the joint):
  - **Femoral nerve** (anterior).
  - **Obturator nerve** (inferior).
  - **Nerve to quadratus femoris** (posterior).
  - **Superior gluteal nerve** (superior).

Movements of Hip Joint

MOVEMENT	MUSCLES INVOLVED	RANGE / NOTES
Flexion	Iliopsoas (chief), rectus femoris, sartorius	Up to 120°
Extension	Gluteus maximus, hamstrings	Up to 20°
Abduction	Gluteus medius, minimus, tensor fasciae latae	45°
Adduction	Adductor longus, brevis, magnus, gracilis	30°

MOVEMENT	MUSCLES INVOLVED	RANGE / NOTES
Medial rotation	Gluteus medius (anterior fibers), tensor fasciae latae	35°
Lateral rotation	Piriformis, obturator internus, gemelli, quadratus femoris	45°
Circumduction	Combination of all movements	Circular movement

Dissection Highlights

- Incision through gluteus maximus exposes the **capsule**.
- Removal of gluteus medius and minimus reveals **ligaments** and **joint capsule**.
- Synovial membrane lines capsule and reflects onto **neck of femur**.
- Note the **iliofemoral ligament** as thickened anterior part of capsule.

Clinical Anatomy

- **Congenital Dislocation of Hip:**
  - Present at birth; due to shallow acetabulum.
  - Limb appears shortened and externally rotated.

- Trendelenburg’s sign positive.

- **Traumatic Dislocation:**
  - Usually posterior, from dashboard injury.
  - Limb is shortened, flexed, adducted, and medially rotated.

- **Fracture Neck of Femur:**
  - Common in elderly (especially females).
  - Leads to avascular necrosis of head due to torn retinacular vessels.

- **Avascular Necrosis (AVN):**
  - Death of femoral head due to disrupted blood supply.
  - Presents with pain and limited motion.

- **Coxa Vara:**
  - Decrease in angle between neck and shaft (<125°).
  - Causes limb shortening and limp.

- **Coxa Valga:**
  - Increase in neck-shaft angle (>135°).
  - Associated with cerebral palsy or postural deformity.

- **Trendelenburg’s Sign:**

    - Positive when gluteus medius/minimus are weak (superior gluteal nerve palsy).
    - Pelvis drops on the opposite side when standing on one leg.
- **Referred Pain:**
    - Pain from hip joint felt in **knee joint** (via obturator and femoral nerves).

? Knee Joint

Type

- **Synovial joint** – *condylar variety*.
- Functionally a **complex joint** consisting of three joints in one:
    - **Lateral femorotibial joint**
    - **Medial femorotibial joint**
    - **Femoropatellar joint**
- **Cavity divided by menisci** (intra-articular fibrocartilaginous discs).

Articular Surfaces

- **Femur:** Medial and lateral condyles.
- **Tibia:** Medial and lateral condyles with intercondylar area.

- **Patella:** Articulates with patellar surface of femur.

Ligaments of the Knee Joint

The knee joint is stabilized by **five extracapsular** and **two intracapsular ligaments**, along with **menisci**.

1. Fibrous Capsule

- Surrounds the joint completely except anteriorly (where replaced by patella and ligamentum patellae).
- Attached above to the margins of the articular surfaces of the femoral condyles and below to the tibial condyles.
- Strengthened posteriorly by **oblique popliteal ligament** and laterally by **arcuate popliteal ligament**.

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2. Ligamentum Patellae

- Continuation of **quadriceps tendon** below the patella to the **tibial tuberosity**.
- Acts as an anterior reinforcement of the capsule.
- **Patellar retinacula** on both sides support it, formed by expansions of vasti.

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3. Tibial (Medial) Collateral Ligament

- Broad, flat band from **medial femoral epicondyle** to **medial tibial condyle**.

- Firmly attached to **medial meniscus**.
- **Function:** Resists valgus (abduction) stress.

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4. Fibular (Lateral) Collateral Ligament

- Cord-like structure from **lateral femoral epicondyle** to **head of fibula**.
- Separated from **lateral meniscus** by **tendon of popliteus**.
- **Function:** Resists varus (adduction) stress.

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5. Oblique Popliteal Ligament

- Expansion from **semimembranosus tendon**, reinforces posterior capsule.

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6. Arcuate Popliteal Ligament

- Y-shaped; arises from **fibular head** and spreads upward to strengthen the posterolateral part of the capsule.

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7. Cruciate Ligaments

- **Anterior Cruciate Ligament (ACL):**
  - From anterior intercondylar area of tibia ? posterior part of inner surface of lateral femoral condyle.
  - Prevents **anterior displacement of tibia** on femur.

- **Posterior Cruciate Ligament (PCL):**
  - From posterior intercondylar area of tibia ? anterior part of medial femoral condyle.
  - Prevents **posterior displacement of tibia** on femur.
- **Both are intracapsular but extrasynovial.**

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8. Menisci (Semilunar Cartilages)

- **Medial meniscus:** C-shaped, less mobile, attached to tibial collateral ligament ? prone to injury.
- **Lateral meniscus:** Circular, more mobile, separated from fibular collateral ligament by **popliteus tendon**.
- **Functions:**
  - Increase congruence of articular surfaces.
  - Absorb shock.
  - Aid in joint lubrication and proprioception.

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9. Transverse Ligament

- Connects anterior horns of medial and lateral menisci.

Synovial Membrane

- Lines the capsule except posteriorly where reflected by cruciate ligaments.
- **Extensions:**
  - **Suprapatellar bursa** (extends upward for 5 cm or more).
  - **Infrapatellar pad of fat** (separates it from ligamentum patellae).
  - **Infrapatellar synovial fold** extends backward to intercondylar fossa.
  - **Alar folds** on either side of the patella.

Bursae Around the Knee

There are **12 bursae** around the joint — 4 anterior, 4 medial, and 4 lateral.

Anterior:

1. **Subcutaneous prepatellar bursa**
2. **Subcutaneous infrapatellar bursa**
3. **Deep infrapatellar bursa**
4. **Suprapatellar bursa**

Lateral:

1. Bursa beneath **lateral head of gastrocnemius**

2. Between **fibular collateral ligament** and **biceps femoris**
3. Between **fibular collateral ligament** and **popliteus tendon**
4. Between **popliteus tendon** and **lateral tibial condyle**

Medial:

1. Bursa beneath **medial head of gastrocnemius**
2. **Anserine bursa** (between sartorius, gracilis, semitendinosus, tibia, and tibial collateral ligament)
3. Beneath **tibial collateral ligament**
4. Beneath **semimembranosus tendon**

Relations of the Knee Joint

Anteriorly

- Ligamentum patellae and anterior bursae.
- Patellar plexus of nerves.

Posteriorly

1. **Middle:** Popliteal artery and vein, tibial nerve.
2. **Posterolateral:** Lateral head of gastrocnemius, plantaris, and common peroneal nerve.

3. **Posteromedial:** Medial head of gastrocnemius, semimembranosus, semitendinosus, gracilis, and popliteus.

Medially

- Sartorius, gracilis, semitendinosus, great saphenous vein, saphenous nerve.

Laterally

- Biceps femoris, popliteus tendon.

Blood Supply

- **Genicular branches** of:
  - Femoral artery
  - Popliteal artery
  - Lateral circumflex femoral artery
  - Recurrent branches from anterior and posterior tibial arteries
- Together form the **genicular anastomosis**.

Nerve Supply

- Derived from:

- **Femoral nerve** (via saphenous branch)
- **Tibial nerve**
- **Common peroneal nerve**
- **Obturator nerve**

- Follows **Hilton's law** (nerves supplying muscles acting on the joint also supply the joint).

Dissection Notes

- Strip surrounding structures to display capsule, collateral, cruciate, and popliteal ligaments.
- Observe menisci, synovial folds, and bursae during deep dissection.

? Movements at the Knee Joint

Types of Movements

The knee is primarily a **hinge joint with slight rotation**, allowing:

- **Flexion**
- **Extension**

- **Slight medial and lateral rotation** (only when the joint is flexed)

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1. Flexion

- **Range:** Up to 135°
- **Muscles producing flexion:**
  - Biceps femoris
  - Semitendinosus
  - Semimembranosus
  - Sartorius
  - Gracilis
  - Gastrocnemius (weak flexor)
- **Limitation:** By tension of quadriceps tendon and anterior cruciate ligament.

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2. Extension

- **Range:** Up to 0° (full extension)
- **Muscles producing extension:**
  - Quadriceps femoris (chief extensor)
  - Assisted by tensor fasciae latae

- **Limitation:** By posterior capsule, oblique popliteal ligament, and cruciate ligaments.

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3. Medial Rotation (when knee is flexed)

- **Range:** About 10°
- **Muscles producing medial rotation:**
  - Popliteus
  - Semitendinosus
  - Semimembranosus
  - Gracilis
  - Sartorius

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4. Lateral Rotation (when knee is flexed)

- **Range:** About 30°
- **Muscle producing lateral rotation:**
  - Biceps femoris

Note:

When the knee is extended, rotation is **prevented by tightness of ligaments**, especially the **cruciate** and **collateral** ligaments.

? Locking and Unlocking of the Knee Joint

Locking

- **Definition:** A mechanism that **converts the knee into a rigid, weight-bearing joint** during the last stage of extension.
- **Mechanism:**
  - During the last 10°–15° of extension, the **medial femoral condyle continues to glide**, while the **lateral condyle stops early** due to its shorter articular surface.
  - This results in **medial rotation of the femur on the tibia** (in fixed tibia position).
  - The joint becomes *locked* — stable for weight-bearing with minimal muscular effort.
- **Muscle responsible:** *Quadriceps femoris* (especially vastus medialis) brings the joint into the locked position.
- **Ligaments involved:** Cruciate and collateral ligaments become taut, adding passive stability.

Unlocking

- **Definition:** The process of **initiating flexion by undoing the locking**.
- **Mechanism:**
  - Brought about by **popliteus muscle**.
  - It **laterally rotates the femur on the tibia** (or medially rotates tibia when non-weight bearing), thus freeing the joint for flexion.

- **Popliteus is called the "key of the knee joint."**

Functional Importance

- Locking saves energy during prolonged standing by maintaining joint stability with minimal muscle effort.
- Unlocking is necessary for walking, squatting, and all flexion activities.

? Dissection Highlights

- Identify **menisci**, **cruciate ligaments**, and **collateral ligaments** within the joint cavity.
- Observe the **popliteus tendon** entering the posterior capsule below the lateral condyle.
- Trace the **suprapatellar bursa** and **infrapatellar pad of fat** for clinical correlations (bursitis, effusion).

?? Clinical Anatomy

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1. Ligament Injuries

- **ACL tear:** Common in athletes; occurs with sudden deceleration or pivoting.
  - **Clinical sign:** *Anterior drawer test positive* — tibia moves anteriorly.
- **PCL tear:** Due to dashboard injury; tibia displaced posteriorly.

- **Clinical sign:** *Posterior drawer test positive.*

- **Collateral ligament injury:**
  - *Medial collateral ligament (MCL)* more frequently injured (often with ACL and medial meniscus — *"unhappy triad"*).

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2. Meniscus Injury

- **Medial meniscus tear** more common due to its firm attachment to MCL.
- **Symptoms:** Locking of knee, pain, clicking, and swelling.
- **Diagnosis:** MRI or McMurray's test.
- **Treatment:** Arthroscopic repair or meniscectomy.

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3. Housemaid's Knee

- Inflammation of **prepatellar bursa** due to chronic kneeling.
- Presents with anterior knee swelling.

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4. Clergyman's Knee

- Inflammation of **subcutaneous infrapatellar bursa**, seen in people who kneel frequently.

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5. Baker's Cyst (Popliteal Cyst)

- Fluid-filled swelling in the popliteal fossa due to herniation of synovial membrane through posterior capsule.
- Common in chronic arthritis.

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6. Genu Valgum (Knock Knee)

- Increased Q-angle; knees close together and ankles apart.
- Due to rickets or ligament weakness.

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7. Genu Varum (Bow Leg)

- Decreased Q-angle; knees apart and ankles close together.
- Seen in children with vitamin D deficiency.

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8. Effusion of Knee Joint

- Excess synovial fluid collects in suprapatellar pouch ? causes swelling above the patella.
- Seen in traumatic or inflammatory arthritis.

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9. Referred Pain

- Pain from hip or spine may be felt in the knee due to shared nerve pathways (obturator and femoral nerves).

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10. Total Knee Replacement

- Surgical substitution of articular surfaces in severe osteoarthritis; restores mobility and relieves pain.

? Ankle Joint

Type

- **Synovial hinge joint** (ginglymus variety).
- Formed between **lower ends of tibia and fibula** and the **superior (trochlear) surface of talus**.
- Allows movements only in one plane: **dorsiflexion and plantar flexion**.

Articular Surfaces

- **Tibia and fibula** form a **deep socket** or **mortise** that grips the **trochlea of talus**.
- **Tibia:** Inferior surface and medial malleolus.
- **Fibula:** Medial surface of lateral malleolus.
- **Talus:** Superior, medial, and lateral surfaces of the body of talus.

Ligaments of the Ankle Joint

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1. Capsule

- Encloses the joint, thin in front and behind, strong on sides.
- **Anteriorly:** Attached close to articular margins.
- **Posteriorly:** Attached above articular margins of tibia and below to talus.

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2. Medial (Deltoid) Ligament

- **Strong, triangular ligament** on the medial side.
- **Apex:** Attached to tip of **medial malleolus**.
- **Base:** Spreads downward to talus, calcaneus, and navicular bone.
- **Superficial part:** Tibionavicular and tibiocalcanean fibers.
- **Deep part:** Anterior and posterior tibiotalar fibers.
- Crossed by **tendons of tibialis posterior and flexor digitorum longus**.
- **Function:** Prevents over-eversion; very strong, so usually causes **avulsion fracture** rather than rupture.

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3. Lateral Ligament

- Consists of **three distinct bands:**
    1. **Anterior talofibular ligament:** From anterior margin of lateral malleolus ? neck of talus.
    2. **Posterior talofibular ligament:** From posterior aspect of lateral malleolus ? posterior process of talus.

3. **Calcaneofibular ligament:** From tip of lateral malleolus ? lateral surface of calcaneus.

- **Function:** Prevents inversion; weaker than the deltoid ligament.

Relations of the Ankle Joint

- **Anteriorly:**
  - Tendons of tibialis anterior, extensor hallucis longus, and extensor digitorum longus.
  - Anterior tibial vessels and deep peroneal nerve.
- **Posteriorly:**
  - Tendons of gastrocnemius (via Achilles), tibialis posterior, flexor digitorum longus, and flexor hallucis longus.
  - Posterior tibial vessels and tibial nerve.
- **Medially:** Deltoid ligament, posterior tibial tendons, and vessels.
- **Laterally:** Lateral ligament, peroneal tendons, and peroneal retinacula.

Movements

MOVEMENT	RANGE / AXIS	MUSCLES INVOLVED
Dorsiflexion	20°	Tibialis anterior (chief), Extensor hallucis longus, Extensor digitorum longus, Peroneus tertius
Plantar flexion	50°	Gastrocnemius, Soleus, Plantaris, Tibialis posterior, Flexor hallucis longus, Flexor digitorum longus

- **Axis:** Passes transversely through the malleoli.
- **Stability:** Maximum in **dorsiflexion** due to the wider anterior part of talus fitting tightly in the mortise.

Blood Supply

- Derived from:
    - **Anterior tibial artery**
    - **Posterior tibial artery**
    - **Peroneal artery**

These arteries form **periarticular anastomoses** around the joint

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Nerve Supply

- From **deep peroneal nerve** (anterior) and **tibial nerve** (posterior)

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- According to **Hilton's law**, these are the same nerves that supply muscles moving the joint.

Dissection Highlights

- Identify **extensor and peroneal retinacula**, **flexor retinaculum**, and the **tendons within synovial sheaths**.

- Define **medial and lateral ligaments**, and note the thin **anterior and posterior capsule**

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Clinical Anatomy

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1. Sprains

- **Commonest injury:** Lateral ankle sprain.

- **Mechanism:** Forced inversion during plantar flexion.

- **Ligaments involved:** Anterior talofibular and calcaneofibular ligaments.
- **Medial sprains:** Rare; occur during over-eversion causing tear of deltoid ligament

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2. Dislocation

- Rare due to the **deep socket-like mortise** formed by tibia and fibula.
- Usually associated with **fracture of malleoli**.

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3. Fractures

- **Pott's fracture:** Twisting injury causing fracture of both malleoli with dislocation of foot.

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4. Injection of Ankle Joint

- Performed **between tendons of extensor hallucis longus and tibialis anterior**, with the ankle **slightly plantar-flexed**

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5. Optimal Position for Immobilization

- **Slight plantar flexion** prevents ankylosis (joint stiffness)

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6. Functional Role in Walking

- **Dorsiflexors** lift the foot during the swing phase to clear the ground.
- **Plantar flexors** raise the heel during push-off, propelling the body forward.
- The ankle’s hinge action is essential for smooth gait

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7. Stability Factors

- **Bony mortise** (tibia and fibula gripping talus).
- **Ligaments:** Deltoid, lateral ligaments, interosseous tibiofibular ligament.
- **Retinacula:** Inferior extensor and peroneal retinacula

> ### ? Tibiofibular Joints

The tibia and fibula articulate at **three joints**:

- **Superior tibiofibular joint**
- **Middle tibiofibular joint**
- **Inferior tibiofibular joint**

These joints together maintain the **stability and alignment** of the leg and ankle during locomotion.

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1. Superior Tibiofibular Joint

Type

- **Synovial joint (plane type).**

Articular Surfaces

- **Head of fibula** ? small, flat facet.
- **Lateral condyle of tibia** ? corresponding flat facet.

Ligaments

- **Fibrous capsule** enclosing the joint.
- Strengthened by **anterior and posterior tibiofibular ligaments**, directed *forwards and laterally.*

Movements

- **Slight gliding or rotatory movements**, aiding **adjustment of lateral malleolus** during ankle motion.

Communication

- Occasionally communicates with **knee joint cavity** through the **popliteal bursa**.

Blood Supply

- **Inferior lateral genicular branch** of the popliteal artery.

Nerve Supply

- **Nerve to popliteus**
- **Recurrent genicular nerve**

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2. Middle Tibiofibular Joint

Type

- **Fibrous joint** formed by the **interosseous membrane** connecting tibia and fibula shafts.

Attachments

- Extends between the **interosseous borders** of both bones.
- Fibers directed **downwards and laterally**.

Openings

- **Upper large opening** ? for *anterior tibial vessels.*
- **Lower small opening** ? for *perforating branch of peroneal artery.*

Relations

- **Anteriorly:** Tibialis anterior, extensor digitorum longus, extensor hallucis longus, peroneus tertius, deep peroneal nerve, anterior tibial vessels.

- **Posteriorly:** Tibialis posterior, flexor hallucis longus.

Blood Supply

- **Anterior and posterior tibial arteries.**

Nerve Supply

- **Nerve to popliteus.**

Functions

1. Provides **muscle attachment surface**.
2. **Binds tibia and fibula** firmly.
3. **Resists downward pull** on fibula by attached muscles (except **biceps femoris**, which pulls fibula upward).

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3. Inferior Tibiofibular Joint

Type

- **Syndesmosis** (fibrous joint) between the lower ends of tibia and fibula.

Ligaments

1. **Interosseous tibiofibular ligament** — main bond of union.
2. **Anterior tibiofibular ligament** — fibers directed *downward and laterally.*

3. **Posterior tibiofibular ligament** — stronger than the anterior; lower part forms the **inferior transverse tibiofibular ligament**, a thick band extending from the **malleolar fossa of fibula** to the **posterior border of tibia**.

Blood Supply

- **Perforating branch of peroneal artery**
- **Malleolar branches** of anterior and posterior tibial arteries.

Nerve Supply

- **Deep peroneal**, **tibial**, and **saphenous nerves.**

Movements

- Slight gliding and **lateral rotation of the fibula** during **dorsiflexion** of the ankle.

Dissection

- **Superior joint:** Remove muscles around head of fibula; define popliteus tendon; open the joint.
- **Middle joint:** Remove anterior and posterior muscles from interosseous membrane; examine its surface and openings.
- **Inferior joint:** Identify anterior, posterior, and inferior transverse ligaments; expose interosseous ligament using articulated bones.

Clinical Anatomy

- The **inferior tibiofibular joint** provides critical support to the **ankle mortise**.
- **Ligament rupture** at this joint can cause **widening of ankle mortise** ? instability and chronic pain.
- **Syndesmotic injuries (“high ankle sprains”)** result from forced dorsiflexion with external rotation.
- The **strength of the interosseous and tibiofibular ligaments** is vital for maintaining **ankle joint integrity**

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? Joints of the Foot

The joints of the foot form a **complex interlocking system** that allows both stability for weight-bearing and flexibility for locomotion. The **main functional joints** are the **subtalar (talocalcanean)** and **talocalcaneonavicular** joints.

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1. Talocalcanean (Subtalar) Joint

Type

- **Synovial plane joint** between the **talus** and **calcaneus**.

Articular Surfaces

- **Concave facet** on the **inferior surface of the talus**.

- **Convex facet** on the **superior surface of calcaneus** (middle one-third).

Ligaments

1. **Fibrous capsule** enclosing the joint.
2. **Lateral and medial talocalcanean ligaments** — reinforce the sides.
3. **Interosseous talocalcanean ligament** — thick and strong, occupies the **sinus tarsi**; it is the **chief bond of union** between the two bones.
4. **Cervical ligament** — located lateral to the sinus tarsi, passes **upward and medially** from the calcaneus to the neck of the talus.

Special Note

- The **sinus tarsi** (tarsal canal) separates the **posterior talocalcanean articulation** from the **anterior and medial** ones.
- Functionally, the **talocalcanean joint** and the **talocalcaneonavicular joint** act together and are often referred to as the **subtalar joint complex**.

Movements

- The talocalcanean joint participates in:
    - **Inversion of foot** – turning sole medially.
    - **Eversion of foot** – turning sole laterally.
- **Limiting factors:**
    - *Eversion* limited by **interosseous ligament** (taut during eversion).

- *Inversion* limited by **cervical ligament** (taut during inversion).

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2. Talocalcaneonavicular Joint

Type

- Modified **ball-and-socket synovial joint**.

Articular Surfaces

- **Head of talus** ? spherical and forms the *ball*.
- **Socket** ? formed by:
  1. **Posterior surface of navicular bone.**
  2. **Upper surface of spring ligament** (plantar calcaneonavicular ligament).
  3. **Anterior articular surface of calcaneus.**
  4. **Medial limb of bifurcate ligament** (laterally).

Ligaments

1. **Spring ligament (plantar calcaneonavicular ligament):**
   - Extends from sustentaculum tali to navicular bone.
   - Supports the head of the talus, forming part of the socket.
   - Contains **elastic fibers** ? acts as a “spring” maintaining medial longitudinal arch.

2. **Dorsal talonavicular ligament:** Supports the joint dorsally.
3. **Interosseous talocalcanean ligament:** Supports it posteriorly.
4. **Medial limb of bifurcate ligament:** Supports the joint laterally.

Movements

- **Inversion and eversion** of the foot (along with subtalar joint).
- During these movements:
    - The **talus acts as a pivot**, remaining relatively fixed within the ankle mortise.
    - The **calcaneus and navicular bones** move around the head of talus.
- These joints together permit complex "**supination and pronation**" movements essential for walking on uneven ground.

Functional Note

- The combined **talocalcanean** and **talocalcaneonavicular joints** allow the foot to:
    - Adapt to uneven surfaces.
    - Maintain balance during locomotion.
    - Absorb shocks during heel strike and propulsion.

Clinical Anatomy

- **Subtalar dislocation:** Rare; occurs due to severe inversion or eversion injury.

- **Flat foot (pes planus):** Weakening of the **spring ligament** causes depression of medial arch and downward displacement of talar head.
- **Sinus tarsi syndrome:** Pain and tenderness due to inflammation in the interosseous ligament area.

? Calcaneocuboid Joint

Type

- **Synovial saddle-type joint**, but functionally behaves as a **plane joint**.

Articular Surfaces

- **Anterior surface of calcaneus** – slightly convex.
- **Posterior surface of cuboid** – slightly concave.
- Together form a stable but flexible articulation forming the **lateral part** of the transverse tarsal joint.

Ligaments

1. **Fibrous capsule** – completely encloses the joint.
2. **Dorsal calcaneocuboid ligament** – strengthens dorsum.
3. **Plantar calcaneocuboid ligament (short plantar ligament)** – very strong, lies deep to long plantar ligament.

4. **Long plantar ligament** – extends from calcaneus to bases of 2nd–4th metatarsals, forming a tunnel for the tendon of **peroneus longus**.

Movements

- Gliding movements occur, contributing to **inversion and eversion** of the foot.
- Motion occurs around an **oblique axis**, continuous with that of the talocalcaneonavicular joint.

Blood Supply

- From **peroneal** and **dorsalis pedis arteries**.

Nerve Supply

- **Lateral plantar nerve** and **superficial peroneal nerve**.

Transverse Tarsal (Midtarsal) Joint

Definition

- Formed by the combination of:
  - **Talocalcaneonavicular joint (medially)** and
  - **Calcaneocuboid joint (laterally)**.
- Functionally acts as **one continuous joint line**, providing rotational mobility of the foot.

Type

- **Compound synovial joint.**

Ligaments

- Derived from the **two constituent joints** (same as above).
- The **interosseous talocalcanean ligament** and **bifurcate ligament** (connecting calcaneus to cuboid and navicular) are key stabilizers.

Movements

- The main site for **inversion and eversion** of the foot.
- Acts as a **transverse hinge** between hindfoot and forefoot, adjusting the foot to uneven ground.
- Movement occurs about an **oblique axis** passing from the back of the heel to the front of the foot.

Inversion and Eversion of the Foot

Axis of Movement

- Passes obliquely from the **posterolateral calcaneus** through the **sinus tarsi** to the **dorsum of the navicular bone**.

Inversion

- Sole faces **medially and upward**.
- **Associated movements:**
    - Adduction of forefoot.
    - Supination (raising of medial border).
- **Joints involved:**
    - Talocalcanean joint.
    - Talocalcaneonavicular joint.
    - Calcaneocuboid joint.

Muscles producing inversion:

- **Tibialis anterior** – chief muscle during dorsiflexion.
- **Tibialis posterior** – chief muscle during plantar flexion.
- Assisted by **flexor hallucis longus** and **flexor digitorum longus.**

Eversion

- Sole faces **laterally and upward**.
- **Associated movements:**
    - Abduction of forefoot.

    - Pronation (raising of lateral border).

- **Joints involved:**
    - Talocalcanean joint.
    - Talocalcaneonavicular joint.
    - Calcaneocuboid joint.

Muscles producing eversion:

- **Peroneus longus**
- **Peroneus brevis**
- **Peroneus tertius**

Functional Importance

- **Inversion** helps lift the medial side during walking on uneven surfaces.
- **Eversion** stabilizes the foot on lateral tilt and prevents ankle inversion injuries.
- Together, these movements give the foot its **adaptive and spring-like quality**.

Dissection Highlights

- Remove extensor tendons on dorsum to expose the **talonavicular and calcaneocuboid joints.**

- Identify **bifurcate ligament** dividing into:
    - **Calcaneonavicular limb** (medial).
    - **Calcaneocuboid limb** (lateral).
- Display **short and long plantar ligaments** and **peroneus longus tendon tunnel** beneath them.
- Observe **spring ligament** beneath the head of talus, supporting the medial arch.
- Note movement demonstration: passive inversion and eversion by manipulating calcaneus.

Clinical Anatomy

- **Flat Foot (Pes Planus):**
    - Collapse of medial arch due to weakness of **spring ligament** or **tibialis posterior**.
- **Club Foot (Talipes Equinovarus):**
    - Congenital inversion and adduction deformity of foot.
- **Eversion Injury:**
    - May rupture **deltoid ligament** or fracture medial malleolus.
- **Inversion Injury:**
    - Commonest ankle trauma; damages **lateral ligament complex**.

? Smaller Joints of the Forefoot

Overview

The forefoot contains numerous small synovial joints between the **tarsal**, **metatarsal**, and **phalangeal bones**.
Together, they provide flexibility, stability, and shock absorption during walking.

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1. Joint Cavities of the Foot

There are **five main synovial cavities** in the foot:

1. **Ankle joint cavity** — communicates freely with the **superior tibiofibular joint** in some individuals.
2. **Subtalar (talocalcanean) joint cavity** — separate from others, lies between talus and calcaneus.
3. **Talocalcaneonavicular + anterior intertarsal joints** — continuous with **midtarsal (transverse tarsal)** joint cavity.
4. **Tarsometatarsal + intermetatarsal joints** — interconnected, allowing limited gliding movement.
5. **Metatarsophalangeal + interphalangeal joints** — independent small synovial cavities.

Note: All cavities are lined by synovial membrane and surrounded by strong fibrous capsules.

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2. Metatarsophalangeal (MTP) Joints

Type

- **Synovial condyloid joints.**

Articular Surfaces

- **Heads of metatarsals** ? convex.
- **Bases of proximal phalanges** ? concave.

Ligaments

1. **Capsular ligament** — encloses the joint.
2. **Plantar ligament (plate)** — thick fibrocartilaginous structure on plantar side, limits hyperextension.
3. **Collateral ligaments** — strong, on either side of the joint.
4. **Deep transverse metatarsal ligament** — connects the plantar ligaments of all MTP joints (except first), maintaining the **transverse arch**.

Movements

- **Flexion and extension** (chief).
- **Abduction and adduction** (slight).
- Range greatest at the **first MTP joint** (for push-off during walking).

Muscles Acting

- **Flexion:** Flexor digitorum longus, flexor digitorum brevis, lumbricals, interossei.
- **Extension:** Extensor digitorum longus and brevis.
- **Abduction:** Dorsal interossei (away from 2nd toe).
- **Adduction:** Plantar interossei (toward 2nd toe).

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3. Interphalangeal (IP) Joints

Type

- **Synovial hinge joints.**

Articular Surfaces

- **Head of proximal phalanx** ? pulley-shaped.
- **Base of distal phalanx** ? correspondingly concave.

Ligaments

1. **Capsular ligament** — encloses the joint.
2. **Collateral ligaments** — strong, stabilize laterally.
3. **Plantar ligament** — fibrocartilaginous thickening that limits hyperextension.

Movements

- Only **flexion and extension**.
- **Flexion** more extensive than extension.

Muscles Acting

- **Flexion:** Flexor digitorum longus, flexor digitorum brevis, flexor hallucis longus (for great toe).
- **Extension:** Extensor digitorum longus, extensor digitorum brevis, extensor hallucis longus.

Clinical Note

- **Hammer Toe:** Hyperextension at MTP and flexion at PIP joint due to imbalance between flexors and extensors.
- **Claw Toe:** Hyperextension at MTP and flexion at both IP joints, commonly in neuropathic foot.
- **Hallux Valgus:** Lateral deviation of great toe at the first MTP joint with medial deviation of first metatarsal.
- **Bunion:** Inflammation and swelling of the bursa over the first MTP joint in hallux valgus.

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4. Dissection Highlights

- Remove skin and superficial fascia from the **dorsum and sole of forefoot**.
- Identify **tendons of long and short flexors and extensors** entering toes.

- Note **fibrous flexor sheaths** enclosing tendons on plantar side.
- Observe **deep transverse metatarsal ligament** connecting plantar plates.
- Demonstrate **MTP and IP joints** by gently flexing and extending the toes.
- Display **bursa and synovial sheaths** to understand friction-reducing mechanisms.

Functional Importance

- MTP and IP joints maintain **foot grip**, adapt to terrain, and ensure **smooth toe-off** in walking and running.
- Their coordinated motion supports the **longitudinal and transverse arches** of the foot.

???? Gait / Walking

Definition

- **Gait** is the *rhythmic, alternating movement* of the limbs and trunk that results in forward progression of the body.
- Each complete sequence of limb movement is called a **gait cycle** or **stride**.

Phases of Gait

Each gait cycle has **two main phases**:

1. Stance Phase (?60%)

- Period when the **foot is on the ground** bearing body weight.
- **Sub-phases:**
    1. **Heel strike (initial contact):**
        - Heel touches the ground.
        - **Muscles:** Tibialis anterior (controls foot lowering).
    2. **Foot flat (loading response):**
        - Entire foot contacts ground; weight transferred to limb.
        - **Muscles:** Quadriceps stabilize knee; gluteus medius prevents pelvic drop.
    3. **Mid-stance:**
        - Body passes over supporting limb; opposite limb in swing.
        - **Muscles:** Soleus and gastrocnemius control forward tibial movement.
    4. **Heel off (terminal stance):**
        - Heel rises as body moves forward.
        - **Muscles:** Gastrocnemius and soleus (plantar flexors) propel body.
    5. **Toe off (pre-swing):**
        - Toes push off; limb prepares for swing.
        - **Muscles:** Flexor hallucis longus, flexor digitorum longus.

2. Swing Phase (?40%)

- Period when **foot is off the ground** and limb moves forward.
    1. **Acceleration (initial swing):**
        - Hip flexors (iliopsoas) and knee flexors (hamstrings) advance limb.
    2. **Mid-swing:**
        - Foot clears ground; dorsiflexors (tibialis anterior) lift forefoot.
    3. **Deceleration (terminal swing):**
        - Hamstrings slow down limb before heel strike.

Cycle Repetition

- One gait cycle = time between **two successive heel strikes of the same foot.**
- The alternating pattern of stance and swing ensures continuous movement.

> ### ? Clinical Anatomy of Gait

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1. Antalgic Gait

- Seen in **painful conditions** (arthritis, fracture, soft-tissue injury).
- **Shortened stance phase** on affected side to reduce pain.

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2. Trendelenburg Gait

- **Cause:** Paralysis of **gluteus medius/minimus** (superior gluteal nerve).
- **Sign:** Pelvis drops on the *opposite side* when standing on affected limb.
- Person lurches toward affected side to maintain balance.

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3. Foot Drop (Steppage Gait)

- **Cause:** Paralysis of **dorsiflexors** (deep peroneal nerve lesion).
- **Sign:** Toes drag during swing; patient lifts knee high to clear foot.

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4. Waddling Gait

- **Cause:** Bilateral hip abductor weakness or congenital hip dislocation.
- **Sign:** Side-to-side trunk movement, resembling duck walk.

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5. Hemiplegic (Circumduction) Gait

- **Cause:** Upper motor neuron lesion.
- **Sign:** Affected limb stiff; swung outward in semicircle during walking.

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6. Ataxic Gait

- **Cause:** Cerebellar or sensory pathway lesions.
- **Sign:** Unsteady, broad-based, irregular steps (“drunken gait”).

7. Parkinsonian Gait

- **Cause:** Basal ganglia disorder (Parkinson’s disease).
- **Sign:** Short, shuffling steps, stooped posture, reduced arm swing, difficulty starting or stopping.

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8. High Stepping Gait

- **Cause:** Tabes dorsalis or sensory neuropathy.
- **Sign:** Patient stamps feet to know ground contact (loss of proprioception).

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9. Equinus Gait

- **Cause:** Tight Achilles tendon or spastic plantar flexors.
- **Sign:** Walking on toes with heels elevated.

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10. Short Leg Gait

- **Cause:** True or apparent limb shortening.
- **Sign:** Pelvic dip on shorter side; compensatory circumduction of long limb.

> **? Mnemonics: Locking and Unlocking of the Knee Joint**

Locking of Knee

Mnemonic: ? **“MAP Tightens Joint”**

- **M** – *Medial condyle* of femur continues to glide (longer surface).
- **A** – *Anterior cruciate ligament* becomes taut.
- **P** – *Posterior cruciate ligament* tightens too.
- **Tightens Joint** – Collateral ligaments also tense up ? knee becomes stable.

Key Point:
During final stage of **extension**, femur **medially rotates** on tibia (or tibia laterally rotates when foot is free), producing the *locked* position.

Purpose:
Allows the body to stand erect without continuous quadriceps contraction.

Unlocking of Knee

Mnemonic: ?? **“POP Laterally”**

- **POP** – *Popliteus* muscle initiates movement.
- **Laterally** – Causes **lateral rotation of femur** (or medial rotation of tibia).

Key Point:
Popliteus “unlocks” the knee by releasing tension in cruciate and collateral ligaments so **flexion** can begin.

Functional Summary

PROCESS	MOVEMENT	MUSCLE	EFFECT

Locking	Medial rotation of femur	Quadriceps (esp. vastus medialis)	Stability in extension
Unlocking	Lateral rotation of femur	Popliteus	Initiates flexion

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Clinical Relevance

- **Inability to lock** ? quadriceps weakness.
- **Inability to unlock** ? popliteus paralysis (posterior knee injury).
- Locking mechanism provides **energy-efficient standing posture**; essential for erect bipedal gait.

Hip Joint

- **Type:** Ball-and-socket synovial joint.
- **Strongest ligament:** *Iliofemoral ligament (of Bigelow)* — prevents hyperextension.
- **Chief flexor:** *Iliopsoas.*
- **Chief extensor:** *Gluteus maximus.*
- **Chief abductor:** *Gluteus medius.*
- **Chief adductor:** *Adductor longus.*
- **Main blood supply:** *Medial circumflex femoral artery.*

- **Nerve supply:** Femoral, obturator, and nerve to quadratus femoris.
- **Clinical note:** *Fracture neck of femur ? avascular necrosis of femoral head.*

Knee Joint

- **Type:** Condylar synovial joint (modified hinge).
- **Ligaments:** Two cruciate (ACL, PCL) and two collateral (MCL, LCL).
- **Strongest ligament:** *Posterior cruciate ligament.*
- **Weakest part:** Anterior aspect (no capsule).
- **Menisci:** Fibrocartilaginous; medial meniscus fixed (commonly torn).
- **Locking mechanism:** Medial rotation of femur during final extension.
- **Unlocking muscle:** *Popliteus.*
- **Blood supply:** Genicular anastomosis.
- **Nerve supply:** Femoral, tibial, common peroneal, obturator nerves.
- **Clinical note:** *"Unhappy triad"* — injury to ACL, MCL, and medial meniscus.

Ankle Joint

- **Type:** Synovial hinge joint.
- **Axis:** Transverse line joining tips of malleoli.

- **Movements:** Dorsiflexion and plantar flexion.
- **Stable position:** Dorsiflexion (wider anterior talar surface engaged).
- **Strong ligament:** Deltoid (medial) ligament.
- **Common injury:** Lateral ligament sprain due to inversion.
- **Main stabilizer:** Inferior transverse tibiofibular ligament.
- **Clinical note:** *Pott's fracture* — twisting injury causing bimalleolar fracture.

Tibiofibular Joints

- **Superior:** Plane synovial joint (slight gliding).
- **Middle:** Fibrous interosseous membrane (no movement).
- **Inferior:** Syndesmosis (strong fibrous joint).
- **Main ligament:** Interosseous tibiofibular ligament.
- **Function:** Maintains ankle mortise stability.
- **Clinical note:** High ankle sprain = injury to inferior tibiofibular ligaments.

Joints of Foot

- **Subtalar joint:** Between talus and calcaneus — for inversion/eversion.
- **Talocalcaneonavicular joint:** Modified ball-and-socket type.

- **Calcaneocuboid joint:** Saddle-type; forms lateral part of transverse tarsal joint.
- **Plantar calcaneonavicular (spring) ligament:** Supports medial arch; maintains talar head position.
- **Long and short plantar ligaments:** Support lateral arch.
- **Movements:** Inversion (tibialis anterior & posterior) and eversion (peronei).

Forefoot Joints

- **MTP joints:** Condyloid type ? flexion, extension, slight abduction/adduction.
- **IP joints:** Hinge type ? flexion and extension.
- **Deep transverse metatarsal ligament:** Maintains transverse arch.
- **Clinical note:**
    - *Hallux valgus* ? lateral deviation of great toe.
    - *Hammer/claw toe* ? imbalance of long flexors and extensors.

Arches of Foot

- **Medial longitudinal arch:** Higher and more elastic.
    - Bones: Calcaneus, talus, navicular, 3 cuneiforms, medial 3 metatarsals.
    - Key ligament: *Spring ligament.*
    - Key muscle: *Tibialis posterior.*

- **Lateral longitudinal arch:** Flatter, more rigid.
    - Bones: Calcaneus, cuboid, 4th & 5th metatarsals.
    - Key ligament: *Long plantar ligament.*
- **Transverse arch:** Across metatarsal bases; maintained by *peroneus longus tendon.*

Gait and Walking

- **Stance phase:** 60% of cycle (foot in contact with ground).
- **Swing phase:** 40% (foot in air).
- **Locking of knee:** Medial rotation of femur during last phase of extension.
- **Unlocking:** Lateral rotation of femur by *popliteus.*
- **Trendelenburg gait:** Superior gluteal nerve lesion.
- **Foot drop:** Deep peroneal nerve lesion.
- **Waddling gait:** Bilateral abductor weakness.
- **Ataxic gait:** Cerebellar disorder.
- **Parkinsonian gait:** Short, shuffling steps.

General Summary

- **Hilton’s Law:** Nerves supplying muscles acting on a joint also supply the joint.

- **Menisci:** Absorb shock, improve congruence.
- **Spring ligament:** Supports talar head and medial arch.
- **Popliteus:** “Key of the knee joint.”
- **Iliofemoral ligament:** “Y-shaped ligament of Bigelow.”
- **Locking–Unlocking Mnemonics:**
    - *Locking ? MAP tightens joint*
    - *Unlocking ? POP laterally (popliteus)*

?? Clinicoanatomical Problems — Joints and Gait

1.

Case: A 65-year-old woman falls and cannot stand; her limb appears shortened and laterally rotated.
Diagnosis: *Fracture of the neck of femur.*
Explanation: Fracture disrupts retinacular branches of the medial circumflex femoral artery ? **avascular necrosis** of femoral head; lateral rotation by short lateral rotators.

2.

Case: A young athlete experiences pain in the groin after excessive kicking.
Diagnosis: *Strain of iliopsoas or rectus femoris.*
Explanation: These are primary **hip flexors**; sudden contraction during kicking leads to muscle strain near origin.

3.

Case: Patient with posterior dislocation of the hip has loss of dorsiflexion and extension of knee.
Diagnosis: *Injury to sciatic nerve.*
Explanation: Hip dislocation may stretch or tear the sciatic nerve ? paralysis of hamstrings and all muscles below knee.

4.

Case: A patient complains of pain and locking of the knee while walking.
Diagnosis: *Medial meniscus tear.*
Explanation: Medial meniscus is fixed to MCL and less mobile ? prone to tear during rotation when flexed.

5.

Case: After a football tackle, a player shows valgus strain with swelling in knee.
Diagnosis: *Unhappy Triad Injury.*
Explanation: Simultaneous rupture of **ACL, MCL, and medial meniscus** from lateral impact on flexed knee.

6.

Case: A person cannot initiate knee flexion after posterior knee trauma.
Diagnosis: *Injury to popliteus muscle.*
Explanation: Popliteus unlocks the knee by laterally rotating femur; injury prevents initiation of flexion.

7.

Case: Elderly patient has pain behind knee after walking; swelling in popliteal fossa.
Diagnosis: *Baker's cyst (popliteal cyst).*
Explanation: Herniation of knee joint synovial membrane through posterior capsule.

8.

Case: A patient complains of knee instability when descending stairs.
Diagnosis: *Tear of anterior cruciate ligament (ACL).*
Explanation: ACL prevents forward displacement of tibia; tear causes “anterior drawer sign” positive.

9.

Case: Following a dashboard injury, the tibia moves backward abnormally.
Diagnosis: *PCL tear.*
Explanation: Posterior cruciate ligament prevents posterior tibial displacement; “posterior drawer sign” positive.

10.

Case: A runner complains of pain below the patella; swelling over front of knee.
Diagnosis: *Prepatellar bursitis (Housemaid’s knee).*
Explanation: Inflammation of subcutaneous prepatellar bursa due to prolonged kneeling.

11.

Case: Pain over medial ankle with swelling after eversion injury.
Diagnosis: *Deltoid ligament tear or avulsion fracture.*
Explanation: Deltoid ligament is very strong; excessive eversion avulses medial malleolus.

12.

Case: Severe pain on outer ankle after inversion injury.
Diagnosis: *Lateral ligament sprain (ankle sprain).*
Explanation: Inversion strain tears anterior talofibular and calcaneofibular ligaments.

13.

Case: Patient complains of pain and tenderness over lateral malleolus after a twisting fall.
Diagnosis: *Pott’s fracture.*

Explanation: External rotation of foot fractures

14.

Case: A person walking on uneven surface twists ankle repeatedly with pain at ankle joint.
Diagnosis: *Syndesmotic injury (high ankle sprain).*
Explanation: Tear of interosseous tibiofibular ligament ? widening of ankle mortise and instability.

15.

Case: A person complains of chronic pain in heel, worse after rest.
Diagnosis: *Plantar fasciitis.*
Explanation: Inflammation of plantar aponeurosis at calcaneal attachment; causes “first step” heel pain.

16.

Case: A shopkeeper develops a bony spur at calcaneal tuberosity.
Diagnosis: *Calcaneal spur.*
Explanation: Chronic traction by plantar aponeurosis ? ossification at attachment.

17.

Case: A patient develops flattening of the medial border of foot.
Diagnosis: *Flat foot (pes planus).*
Explanation: Weakness of spring ligament and tibialis posterior ? collapse of medial arch.

18.

Case: Newborn presents with plantar flexed, inverted, and adducted foot.
Diagnosis: *Congenital talipes equinovarus (clubfoot).*
Explanation: Deformity due to abnormal intrauterine positioning or muscle imbalance.

19.

Case: Pain and tenderness over lateral side of foot after eversion sprain.
Diagnosis: *Peroneal tendon strain.*
Explanation: Overuse of peroneus longus and brevis during excessive eversion.

20.

Case: A person has high-stepping gait with inability to dorsiflex foot.
Diagnosis: *Common peroneal nerve injury at fibular neck.*
Explanation: Paralysis of dorsiflexors ? foot drop; compensated by exaggerated hip and knee flexion.

21.

Case: Patient shows pelvis drooping on one side while walking.
Diagnosis: *Positive Trendelenburg sign.*
Explanation: Weakness of gluteus medius/minimus (superior gluteal nerve palsy).

22.

Case: A child walks on toes with heels off the ground.
Diagnosis: *Equinus gait.*
Explanation: Spastic contraction or contracture of calf muscles (gastrocnemius, soleus).

23.

Case: A diabetic patient develops ulcer on ball of foot with clawing of toes.
Diagnosis: *Neuropathic foot (Charcot foot).*
Explanation: Loss of protective sensation and muscle imbalance ? deformity and pressure ulcers.

24.

Case: Elderly patient complains of instability while walking in dark.
Diagnosis: *Sensory ataxia.*
Explanation: Loss of proprioceptive input from posterior columns ? stamping gait.

25.

Case: Elderly woman with osteoarthritis reports difficulty rising from sitting.
Diagnosis: *Quadriceps weakness.*
Explanation: Quadriceps extend the knee and stabilize patella; weakness prevents smooth standing.

These **25 clinicoanatomical cases** comprehensively integrate the applied anatomy of hip, knee, ankle, and foot — ideal for viva and theory discussion.