

# Bones: Femur,Patella,Tibia,Fibula and bones of feet

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## Femur

### Introduction

- The **femur** (thigh bone) is the **longest and strongest bone** in the human body.
- It extends from the **hip joint** to the **knee joint** and transmits the **weight of the body** from the pelvis to the tibia.
- Its length is about **1/4 of the body height**.
- It forms the **upper segment of the lower limb skeleton** and participates in:
  - **Hip joint** (proximally)
  - **Knee joint** (distally)

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### Parts of the Femur

1. **Upper End**
2. **Shaft**
3. **Lower End**

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### Upper End

Consists of:

1. **Head** –

- Smooth, spherical structure forming **2/3 of a sphere**.
- Directed **medially, upward, and slightly forward**.
- Covered with **articular cartilage**, except at the **fovea capitis**, where the **ligament of head of femur** attaches.

2. **Neck** –

- Connects the head to the shaft.
- Forms an angle of **125°–130° with the shaft** (angle of inclination).
- In newborns, this angle is about **150°** and decreases with age.
- *Clinical correlation*: Decrease in angle ? **coxa vara**; Increase ? **coxa valga**.

3. **Greater Trochanter** –

- Large, quadrangular projection on the lateral side.
- Gives attachment to:
  - *Gluteus medius* (lateral surface)
  - *Gluteus minimus* (anterior surface)
  - *Piriformis* (superior border)
  - *Obturator internus and gemelli* (medial surface)

- *Vastus lateralis* (base)

- Palpable on lateral aspect of thigh; used to locate hip joint level.

#### 4. Lesser Trochanter –

- Small, conical projection on the **posteromedial surface**.
- Gives insertion to *psaos major* and *iliacus* muscles (as iliopsoas).

#### 5. Intertrochanteric Line –

- On anterior surface between the two trochanters.
- Gives attachment to *iliofemoral ligament* (of hip joint capsule).

#### 6. Intertrochanteric Crest –

- On posterior surface between trochanters.
- Has a rounded tubercle called **quadrate tubercle** for *quadratus femoris* muscle.

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### Shaft

- Long, cylindrical, and slightly bowed **forward (anterior convexity)**.
- Has **three surfaces** — anterior, medial, and lateral — separated by **three borders** — medial, lateral, and posterior.
- **Posterior border** forms a prominent **linea aspera**, which divides above into:
  - *Gluteal tuberosity* (for gluteus maximus)

- *Pectineal line* (for pectineus)
- *Spiral line* (leading to lesser trochanter)
- **Linea aspera** below divides into **medial and lateral supracondylar lines**.

### Attachments along Linea Aspera

- **Lateral lip:** Gluteus maximus, vastus lateralis, short head of biceps femoris.
  - **Medial lip:** Adductor longus, adductor magnus, vastus medialis.
  - **Between lips:** Adductor brevis and part of adductor magnus.
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### Lower End

- Expanded and articulates with the **tibia and patella**.
  - Has:
    1. **Two condyles (medial and lateral)** – separated by **intercondylar fossa (posteriorly)** and **patellar surface (anteriorly)**.
    2. **Patellar surface:** Smooth anterior area for articulation with patella.
    3. **Medial condyle:** Larger and projects lower; bears the **adductor tubercle** for insertion of *adductor magnus*.
    4. **Lateral condyle:** Provides attachment to *popliteus* tendon.
  - **Intercondylar fossa:** Lodges *cruciate ligaments* of the knee.
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## Ossification of Femur

### Primary Centres

- **Shaft** – appears in the **7th week of intrauterine life** (one of the earliest long bone centres).

### Secondary Centres

| PART                         | APPEARANCE                     | FUSION WITH SHAFT |
|------------------------------|--------------------------------|-------------------|
| Lower end (distal epiphysis) | 9th month of intrauterine life | 18–20 years       |
| Head                         | 1 year                         | 18 years          |
| Greater trochanter           | 4 years                        | 18 years          |
| Lesser trochanter            | 12–14 years                    | 18 years          |

**Note:** The **lower end** ossification centre appears **before birth** and is used in **determining fetal viability** in forensic medicine.

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### Sequence of Fusion

1. Lesser trochanter ? 18 years
2. Greater trochanter ? 18 years
3. Head ? 18 years
4. Lower end ? 20 years

**Complete fusion by about 20 years of age.**

### 1. Fractures

- **Neck of Femur**

- Common in **elderly osteoporotic females**.
- Classified as **intracapsular** or **extracapsular**.
- *Intracapsular fracture* ? poor healing due to interruption of **retinacular arteries** (branches of medial circumflex femoral artery).
- Leads to **avascular necrosis** of the femoral head.

- **Intertrochanteric Fracture**

- Between greater and lesser trochanters.
- Extracapsular ? heals well due to good blood supply.

- **Shaft Fracture**

- Common in young adults (motor accidents).
- Causes **shortening** due to muscle pull:
  - *Upper fragment* ? flexed, abducted, externally rotated (gluteus medius, iliopsoas).
  - *Lower fragment* ? pulled upward by *adductors*.

- **Supracondylar Fracture**

- May injure **popliteal artery**, leading to ischemia and gangrene.
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## 2. Developmental & Pathological Conditions

- **Coxa Vara** – Decrease in neck-shaft angle ( $<120^\circ$ ).
    - Causes limp and limited abduction.
    - May be congenital or post-traumatic.
  - **Coxa Valga** – Increase in neck-shaft angle ( $>135^\circ$ ).
    - Causes unstable hip joint.
  - **Slipped Capital Femoral Epiphysis** – Displacement of femoral head epiphysis in adolescence.
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## 3. Applied Surgical Importance

- **Intramedullary nailing** for shaft fractures – entry through **greater trochanter**.
  - **Bone marrow biopsy** rarely done in femur due to thick cortex.
  - **Femoral head vascularity**:
    - Mainly from *medial circumflex femoral artery* via **retinacular vessels**.
    - Damage leads to **avascular necrosis**.
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## 4. Radiological Importance

- **Centre of ossification of lower end** appears before birth — useful for determining **fetal maturity**.
  - **Neck-shaft angle measurement** helps in diagnosing deformities (coxa vara, valga).
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## 5. Forensic Importance

- **Length of femur** can be used to **estimate body height** using anthropometric formulas.

## Patella

### Introduction

- The **patella** is a **large sesamoid bone** developed within the **tendon of quadriceps femoris**.
- It is the **largest sesamoid bone** in the body.
- It is **triangular**, with:
  - **Apex** pointing **downward**.
  - **Base** directed **upward**.
  - **Anterior surface** convex and rough.
  - **Posterior surface** divided into **articular and non-articular areas**.

- It articulates with the **patellar surface of the femur** to form the **patellofemoral part of the knee joint**.
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## Position and Orientation

To hold the bone in **anatomical position**:

- The **apex** should point downward.
  - The **base** should be above.
  - The **lateral articular surface** is **larger** than the medial one — this helps in identifying the side.
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## Features

### 1. Anterior Surface

- Convex and rough for attachment of:
  - *Fibres of quadriceps tendon* (above).
  - *Patellar retinacula* (sides).
- The **lower part** gives attachment to the **ligamentum patellae**, which connects the patella to the **tibial tuberosity**.

### 2. Posterior Surface

- **Upper three-fourths**: Articular and smooth — covered with **hyaline cartilage**.
  - Divided into **two facets** by a **vertical ridge**:

- **Lateral facet:** Larger and deeper; articulates with the lateral femoral condyle.
- **Medial facet:** Smaller and shallower; articulates with the medial femoral condyle.
- **Lower one-fourth:** Rough, non-articular area for attachment of **ligamentum patellae**.

### 3. Margins

- **Medial and lateral borders** give attachment to **medial and lateral patellar retinacula** (expansions of vastus medialis and vastus lateralis).

### 4. Apex

- The **apex** is the pointed inferior tip of the patella.
- Gives attachment to **ligamentum patellae**.

### 5. Base

- Broad superior margin.
- Gives attachment to the **rectus femoris** and **vastus intermedius** tendons.

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### Side Determination

1. Place the **apex downwards** and **anterior surface facing forward**.
2. The **larger articular facet** will be **lateral** ? this determines the side.

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### Muscular and Ligamentous Attachments

- **Base:** Tendon of *quadriceps femoris*.
- **Apex:** *Ligamentum patellae* (to tibial tuberosity).
- **Medial border:** *Vastus medialis* and *medial patellar retinaculum*.
- **Lateral border:** *Vastus lateralis* and *lateral patellar retinaculum*.

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## Ossification of Patella

- **Type:** Sesamoid bone ossifying in tendon.
- **Centre of ossification:**
  - Appears during the **3rd to 5th year** of life.
  - Sometimes appears as **two or more centres**, which may not unite — forming a **bipartite patella**.
- **Fusion:** Ossification is completed by **puberty** (around 14–16 years).

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## Summary Table

| STAGE                 | TIME OF APPEARANCE      | REMARKS                               |
|-----------------------|-------------------------|---------------------------------------|
| Primary centre        | 3rd–5th year            | Develops within quadriceps tendon     |
| Accessory centres     | May appear occasionally | Cause bipartite or tripartite patella |
| Complete ossification | By puberty              | Around 14–16 years                    |

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## Clinical Anatomy of Patella

### 1. Patellar Fractures

- **Transverse fractures** are common due to **direct blow or sudden quadriceps contraction**.
- The **upper fragment** is pulled upward by the *quadriceps femoris*; the **lower fragment** remains attached to *ligamentum patellae*.
- **Comminuted fractures** (multiple fragments) occur from severe trauma.
- **Treatment:** Tension-band wiring or open reduction fixation.

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### 2. Bipartite / Tripartite Patella

- Occurs when **ossification centres fail to unite**.
- Usually **asymptomatic**, discovered incidentally on X-ray.
- Commonly located at the **superolateral angle**.
- Must be differentiated from **fracture** (margins smooth, no pain).

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### 3. Chondromalacia Patellae

- Also called **runner's knee**.
- Softening and degeneration of **articular cartilage** on posterior surface of patella.
- Causes **anterior knee pain**, especially while climbing stairs.

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#### 4. Patellar Dislocation

- More common in **adolescent females**.
- Usually **lateral dislocation** due to:
  - Shallow trochlear groove.
  - Lateral pull of *vastus lateralis*.
  - Weakness of *vastus medialis oblique (VMO)*.
- Predisposing factors: genu valgum, high patella (patella alta).

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#### 5. Patellar Reflex (Knee Jerk)

- Tapping the **ligamentum patellae** causes **extension of the leg** via *quadriceps contraction*.
- Tests the integrity of **L2–L4 spinal segments** and the **femoral nerve**.

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#### 6. Patellar Tracking Disorders

- Abnormal movement of patella during knee flexion/extension.
- May cause **crepitus** or **pain** due to uneven cartilage wear.

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#### 7. Surgical Relevance

- **Patellectomy**: Surgical removal of patella, done rarely for comminuted fractures.

- Results in **loss of mechanical advantage** of quadriceps ? decreased extension strength.
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## 8. Radiological Uses

- The **shape and height** of patella used to assess **patellar alta** or **baja** (high-riding or low-riding patella).
- **Sunrise or skyline X-ray view** shows alignment of patella in femoral trochlea.

## Tibia

### Introduction

- The **tibia** (shin bone) is the **medial and larger bone of the leg**.
  - It is the **second longest bone** in the body, after the femur.
  - It bears the **weight of the body** from the femur and transmits it to the talus (ankle bone).
  - It articulates:
    - **Above** – with *femur* and *fibula* (at superior tibiofibular joint).
    - **Below** – with *talus* and *fibula* (at inferior tibiofibular joint).
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### General Features

The tibia has **two ends** and a **shaft**:

1. **Upper end**
  2. **Shaft**
  3. **Lower end**
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## Upper End

- Expanded for articulation with the **femoral condyles** and for the attachment of ligaments and muscles.

## Important Parts

### 1. Medial and Lateral Condyles

- Flattened articular surfaces separated by an **intercondylar area**.
- Covered with **hyaline cartilage** for articulation with femoral condyles.
- *Medial condyle* is larger and oval; *lateral condyle* is circular.

### 2. Intercondylar Area

- Between condyles, divided into:
  - *Anterior intercondylar area*
  - *Posterior intercondylar area*
- Gives attachment to *anterior and posterior cruciate ligaments* and *menisci* of the knee.

### 3. Intercondylar Eminence

- A raised bony ridge between the articular surfaces.
- Composed of:
  - *Medial intercondylar tubercle*
  - *Lateral intercondylar tubercle*
- Prevents lateral displacement of femoral condyles.

### 4. Tibial Tuberosity

- Prominent rough elevation below the condyles on anterior surface.
- *Upper smooth part* – attachment of *ligamentum patellae*.
- *Lower rough part* – for *patellar retinacula*.

### 5. Gerdy's Tubercle

- On lateral condyle, for insertion of *iliotibial tract*.

### 6. Articular Facet for Fibula

- Located on posteroinferior aspect of lateral condyle, for *head of fibula*.

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## Shaft

- **Triangular in cross-section**, with **three borders** and **three surfaces**.

## Borders

1. **Anterior border (shin)** – sharp and prominent; palpable under skin.
2. **Medial border** – smooth and rounded.
3. **Interosseous border (lateral)** – sharp ridge for attachment of *interosseous membrane* connecting tibia and fibula.

## Surfaces

1. **Medial surface** – subcutaneous and easily palpable (skin over the shin).
  2. **Lateral surface** – between anterior and interosseous borders; origin of *tibialis anterior*.
  3. **Posterior surface** – marked by *soleal line* (oblique ridge) giving attachment to *soleus*; below it lies the *nutrient foramen* (directed downward).
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## Lower End

- Smaller and quadrangular; forms part of the ankle joint.

## Parts

1. **Medial Malleolus**
  - Prominent downward projection on medial side; subcutaneous and palpable.
  - Lateral surface articulates with *talus*.
  - Medial surface gives attachment to *deltoid ligament*.
2. **Fibular Notch**

- On lateral aspect for *inferior tibiofibular articulation*.

### 3. Inferior Articular Surface

- Quadrilateral surface articulating with the *superior surface of talus*.

### 4. Groove for Tendons

- Posterior aspect has grooves for *tibialis posterior* and *flexor digitorum longus* tendons.

## Side Determination

1. Medial malleolus points downward and medially.
2. Tibial tuberosity is anterior.
3. Smooth articular surface for fibula lies laterally.  
? The bone belongs to the side of the medial malleolus.

## Muscular Attachments

| STRUCTURE                       | MUSCLES ATTACHED                                           |
|---------------------------------|------------------------------------------------------------|
| Upper anterior surface of tibia | <i>Sartorius, gracilis, semitendinosus</i> (Pes anserinus) |
| Upper lateral surface           | <i>Tibialis anterior</i>                                   |
| Soleal line (posterior surface) | <i>Soleus</i>                                              |
| Below soleal line               | <i>Tibialis posterior, Flexor digitorum longus</i>         |

| STRUCTURE                          | MUSCLES ATTACHED                 |
|------------------------------------|----------------------------------|
| Lateral surface (upper two-thirds) | <i>Tibialis anterior</i>         |
| Lateral surface (lower third)      | <i>Extensor digitorum longus</i> |
| Medial surface (subcutaneous)      | No muscle attached               |

## Ossification of Tibia

| CENTRE                                        | TIME OF APPEARANCE         | FUSION                                   |
|-----------------------------------------------|----------------------------|------------------------------------------|
| <b>Primary centre (shaft)</b>                 | 7th week intrauterine life | —                                        |
| <b>Secondary centre for upper end</b>         | At birth                   | 20–22 years                              |
| <b>Secondary centre for lower end</b>         | 1–2 years                  | 18–20 years                              |
| <b>Secondary centre for tibial tuberosity</b> | 12–14 years                | 18 years (may fuse with upper epiphysis) |

## Sequence

1. Shaft – prenatal (7th week IU)
2. Upper end – at birth (contains an epiphysis with a large tibial tubercle)

3. Lower end – 1 to 2 years
  4. Tibial tuberosity (accessory) – 12 to 14 years  
? All unite with shaft by **20–22 years**.
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### Special Note

- **Upper epiphyseal centre** appears before birth ? used in **determining neonatal maturity**.
  - The **tibial tuberosity** may ossify separately and later unite with the upper epiphysis.
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## Clinical Anatomy of Tibia

### 1. Fractures

- **Shaft fractures** are common due to its subcutaneous position (especially lower third).
    - Usually **open fractures** because of poor soft-tissue cover.
  - **Union is slow** because of poor blood supply.
  - **Upper end fractures** may extend into **knee joint (tibial plateau fractures)**, causing joint effusion and instability.
  - **Lower end fractures** (near medial malleolus) may involve the **ankle joint**, producing *Pott's fracture*.
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### 2. Osgood–Schlatter Disease

- Occurs in adolescents due to **avulsion or microfracture at the tibial tuberosity** (site of patellar ligament attachment).
  - Caused by repetitive strain from *quadriceps contraction*.
  - Presents with localized **pain and swelling** over tibial tuberosity.
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### 3. Compound (Open) Fractures

- The **subcutaneous anterior surface** of tibia predisposes to *compound fractures* with risk of infection, delayed union, or osteomyelitis.
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### 4. Stress Fractures

- Seen in athletes and military recruits due to **repeated microtrauma**.
  - Typically in the **lower third of shaft**; visible on bone scan or MRI before X-ray.
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### 5. Nutrient Artery Importance

- The **nutrient artery** (from posterior tibial artery) enters the bone **below the soleal line** and runs **downward** — “to the elbow I go, from the knee I flee.”
  - Injury to this artery may delay healing.
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### 6. Flatfoot and Tibial Deformities

- **Medial malleolus** serves as attachment for the *deltoid ligament*, maintaining the **medial arch** of foot.

- Malalignment (e.g., **tibia vara** or **tibia valga**) may alter gait and foot mechanics.
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## 7. Surgical and Radiological Relevance

- **Tibial crest** and **medial surface** used for bone graft harvesting.
  - **Intraosseous infusion** in emergencies (children) given in **upper medial tibial surface** below tibial tuberosity.
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## 8. Forensic Relevance

- Length of tibia used for **stature estimation** in skeletal remains.

## Fibula

### Introduction

- The **fibula** is the **lateral and smaller bone of the leg**.
  - It lies **parallel to the tibia** and is connected to it by an **interosseous membrane**.
  - It **does not bear body weight**; its main role is to provide **muscle attachment** and form the **lateral wall of the leg**.
  - The lower end forms the **lateral malleolus**, which takes part in forming the **ankle joint**.
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### Parts of the Fibula

Like other long bones, it has:

1. **Upper end (Head)**
  2. **Shaft**
  3. **Lower end (Lateral malleolus)**
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## Upper End

- Expanded into a **head**, with a rounded apex called the **styloid process**.
  - **Articular facet** on the upper surface of the head ? articulates with the *lateral condyle of tibia* (superior tibiofibular joint).
  - **Neck of fibula** – constricted part below the head.
    - *Common peroneal (fibular) nerve* winds around it ? vulnerable to injury.
  - **Styloid process** – projects upward from the head; gives attachment to:
    - *Fibular collateral ligament* (of knee joint).
    - *Biceps femoris* tendon.
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## Shaft

- Long, slender, and twisted.
- Has **three borders** (anterior, posterior, interosseous) and **three surfaces** (medial, lateral, posterior).

## Borders

1. **Anterior border** – begins below the anterior aspect of head and continues to anterior border of lateral malleolus.
2. **Posterior border** – extends from the back of head to the posterior border of lateral malleolus.
3. **Interosseous border (medial)** – for attachment of *interosseous membrane*.

## Surfaces

1. **Medial surface (anterior)** – origin for *extensor digitorum longus* and *extensor hallucis longus*.
2. **Lateral surface** – origin for *peroneus longus* and *peroneus brevis*.
3. **Posterior surface** – has a vertical *nutrient foramen* directed upward;
  - Above: *Soleus* and *Flexor hallucis longus*.
  - Below: *Peroneus longus*.

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## Lower End

- Expanded to form the **lateral malleolus**, which extends lower and posterior to the medial malleolus of the tibia.

## Features

1. **Medial surface** – has a triangular articular facet for *lateral surface of talus*.
2. **Anterior border** – attachment to *anterior talofibular ligament*.

3. **Posterior border** – has a shallow *groove for tendons of peroneus longus and peroneus brevis*.
  4. **Lateral surface** – subcutaneous, easily palpable.
  5. **Tip of lateral malleolus** – attachment for *calcaneofibular ligament*.
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### Side Determination

1. **Head upward, lateral malleolus downward.**
  2. Smooth *articular facet* faces medially.
  3. The *groove for peroneal tendons* lies posteriorly.  
? The side corresponds to the position of the lateral malleolus.
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### Muscular Attachments of Fibula

| REGION                            | MUSCLES ATTACHED                                           |
|-----------------------------------|------------------------------------------------------------|
| Head                              | <i>Biceps femoris, fibular collateral ligament</i>         |
| Upper two-thirds anterior surface | <i>Extensor digitorum longus, Extensor hallucis longus</i> |
| Lateral surface                   | <i>Peroneus longus, Peroneus brevis</i>                    |
| Posterior surface                 | <i>Soleus, Flexor hallucis longus</i>                      |
| Lower fourth medial surface       | <i>Peroneus tertius</i>                                    |
| Interosseous border               | <i>Interosseous membrane</i>                               |

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## Ossification of Fibula

| CENTRE                       | TIME OF APPEARANCE         | FUSION WITH SHAFT |
|------------------------------|----------------------------|-------------------|
| Primary centre (shaft)       | 8th week intrauterine life | —                 |
| Secondary centre (lower end) | 1st year                   | 18–20 years       |
| Secondary centre (upper end) | 3–4 years                  | 20–25 years       |

### Key Points

- **Lower end ossifies first but fuses later.**
- **Upper end ossifies later but fuses first.**
  - ? This is the reverse of the pattern seen in the tibia.

### Mnemonic

**“Lower first, upper last — but upper joins first, lower joins last.”**

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## Clinical Anatomy of Fibula

### 1. Fractures

- **Fibular neck fracture** – may injure **common peroneal nerve**, leading to:
  - *Foot drop* (loss of dorsiflexion and eversion).
  - Sensory loss over dorsum of foot.

- **Fibular shaft fracture** – usually accompanies tibial fracture; rarely isolated because it's non-weight-bearing.
  - **Avulsion fractures** – at the **lateral malleolus**, due to pull of *lateral ligaments* of ankle.
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## 2. Pott's Fracture

- A **bimalleolar fracture** involving **lateral and medial malleoli**.
  - Occurs due to **forcible eversion of foot**.
  - The **lateral malleolus** is fractured due to tension of the *deltoid ligament* pulling the medial malleolus and pushing the talus laterally.
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## 3. Surgical and Orthopedic Importance

- **Fibular grafts:**
    - Commonly used for **bone grafting**, since fibula is expendable and non-weight-bearing.
    - Middle third is preferred for graft harvest.
  - **Free vascularized fibular grafts** are used in reconstructive surgery of long bones and mandible.
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## 4. Relation to Common Peroneal Nerve

- The **common peroneal nerve winds around the neck** of fibula, making it vulnerable in:
    - Fibular head fractures.
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- Plaster casts or tight bandages.
  - Injury causes **foot drop** and loss of eversion.
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## 5. Ankle Joint Relevance

- **Lateral malleolus** extends **lower and posterior** to medial malleolus ? stabilizes ankle joint and prevents *lateral displacement* of talus.
  - Provides attachment for the **lateral ligament complex**:
    - *Anterior talofibular ligament*
    - *Posterior talofibular ligament*
    - *Calcaneofibular ligament*
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## 6. Radiological and Forensic Uses

- Length of fibula is used for **height estimation** in anthropology.
  - *Epiphyseal union timing* helps in **age estimation** in forensic medicine.
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## 7. Clinical Palpation Points

- **Head of fibula** – palpable below lateral side of knee joint; landmark for nerve block.
  - **Lateral malleolus** – forms the outer prominence of ankle; used in assessing malleolar fractures.
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## 8. Deformities

- **Fibular hemimelia** – congenital absence or underdevelopment of fibula, leading to shortening of limb and foot deformities.
- **Fibular malunion** – improper healing can cause rotational deformities affecting gait.

## Bones of the Foot

### Introduction

- The **skeleton of the foot** is formed by **26 bones**, arranged to provide **support, balance, and locomotion**.
- These bones are grouped into three parts:
  1. **Tarsus (Tarsal bones)** – 7 bones
  2. **Metatarsus (Metatarsal bones)** – 5 bones
  3. **Phalanges (Toes)** – 14 bones
- The tarsal bones form the **posterior half of the foot** and are responsible for **forming the arches** and **bearing body weight**.

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## Tarsus / Tarsal Bones

### Names of Tarsal Bones (7)

1. **Talus**

2. **Calcaneus**
  3. **Navicular**
  4. **Cuboid**
  5. **Medial cuneiform**
  6. **Intermediate cuneiform**
  7. **Lateral cuneiform**
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## Arrangement

- **Proximal row** ? *Talus and Calcaneus*
  - **Intermediate row** ? *Navicular*
  - **Distal row** ? *Three cuneiforms and Cuboid*
  - **Mnemonic: “Tiger Cubs Need MILC”**  
(*Talus, Calcaneus, Navicular, Medial–Intermediate–Lateral cuneiforms, Cuboid*)
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## Key Features

- The **talus** articulates with tibia and fibula to form the **ankle joint**.
- The **calcaneus** forms the **heel** and articulates with talus and cuboid.
- The **navicular** lies in front of talus, behind the cuneiforms.
- The **cuboid** lies lateral, articulating with calcaneus and 4th–5th metatarsals.

- The **cuneiforms** (medial, intermediate, lateral) articulate with navicular and first three metatarsals.
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## Talus

### Introduction

- The **talus** is the **second largest tarsal bone** and the **only bone connecting the foot to the leg**.
  - It transmits **body weight** from the tibia to the calcaneus and forefoot.
  - Unique feature: **no muscular attachments** ? entirely covered by **articular cartilage and ligaments**.
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### Parts

1. **Head**
  2. **Neck**
  3. **Body**
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### 1. Head

- Rounded and directed **forward and slightly downward and medial**.
  - Articulates:
    - **Anteriorly** ? with *navicular bone* (forming talonavicular joint).
-

- **Inferiorly** ? with *calcaneus* via *anterior subtalar facet*.
  - The head supports the **spring ligament (plantar calcaneonavicular ligament)**.
- 

## 2. Neck

- Narrow constricted part between head and body.
  - Upper surface ? *groove for dorsalis pedis artery*.
  - Inferior surface ? *sulcus tali*, forming **tarsal sinus** with *sulcus calcanei*.
  - Ligament attachments:
    - *Cervical ligament* and *interosseous talocalcaneal ligament* in the sinus tarsi.
- 

## 3. Body

- Largest part, cuboidal in shape, with **five surfaces**:

| SURFACE         | FEATURES / ARTICULATIONS                                            |
|-----------------|---------------------------------------------------------------------|
| <b>Superior</b> | Trochlear surface articulates with tibia ? forms <b>ankle joint</b> |
| <b>Inferior</b> | Three facets for calcaneus (posterior, middle, anterior)            |
| <b>Medial</b>   | Comma-shaped facet for <i>medial malleolus</i>                      |
| <b>Lateral</b>  | Triangular facet for <i>lateral malleolus</i>                       |

| SURFACE          | FEATURES / ARTICULATIONS                                                                     |
|------------------|----------------------------------------------------------------------------------------------|
| <b>Posterior</b> | Groove for <i>flexor hallucis longus</i> tendon; lateral and medial tubercles on either side |

- **Posterior process:**

- *Lateral tubercle* – attachment for *posterior talofibular ligament*.
- *Medial tubercle* – attachment for *posterior talocalcaneal ligament*.
- Between them: *groove for flexor hallucis longus*.

---

## Side Determination

1. Head faces **forward, medially, and downward**.
2. Larger facet on **lateral side** for fibula.
3. Groove on posterior surface runs **obliquely downward and medially**.  
? Bone belongs to that side.

---

## Articulations of Talus

1. **Superiorly** – with *tibia* (ankle joint)
2. **Laterally** – with *fibula* (ankle joint)
3. **Inferiorly** – with *calcaneus* (subtalar joint)
4. **Anteriorly** – with *navicular* (talonavicular joint)

---

## Ossification of Talus

| CENTRE                                  | TIME OF APPEARANCE          | FUSION / REMARKS                             |
|-----------------------------------------|-----------------------------|----------------------------------------------|
| Primary centre                          | 7th month intrauterine life | —                                            |
| Secondary centre (for lateral tubercle) | 8–10 years                  | May fail to fuse, forming os <i>trigonum</i> |

- The **talus ossifies from a single centre**, but occasionally a separate secondary centre appears for the **lateral tubercle** of posterior process.
- Ossification complete by **20 years**.

---

## Clinical Anatomy of Talus (and Tarsal Region)

### 1. Fractures of Talus

- **Common sites:** Neck and body.
- **Mechanism:** Fall from height or forced dorsiflexion of foot.
- **Complication:** High risk of **avascular necrosis (AVN)** of body due to disrupted blood supply (mostly from posterior tibial and dorsalis pedis arteries).
- *Hawkins classification* used for neck fractures.

## 2. Os Trigonum Syndrome

- Occurs when the **secondary ossification centre of lateral tubercle** fails to fuse ? accessory bone (*os trigonum*).
  - May cause posterior ankle pain, especially in ballet dancers and footballers due to repetitive plantar flexion.
- 

## 3. Congenital and Developmental Anomalies

- **Tarsal coalition:** Fusion between talus and calcaneus or navicular ? restricted inversion/eversion, flatfoot.
  - **Talipes equinovarus (clubfoot):** Medial rotation of talus leads to inward-turned foot.
- 

## 4. Flatfoot (Pes Planus)

- Collapse of the **medial longitudinal arch**, commonly due to stretching of the **spring ligament** beneath the talar head.
  - The **head of talus** moves downward and medially ? foot appears flat on the ground.
- 

## 5. Dislocations

- **Subtalar dislocation:** Talus remains in ankle mortise, but calcaneus and navicular are displaced medially or laterally.
  - **Total dislocation of talus:** Rare but serious; disrupts all articular connections, often causing necrosis.
- 

## 6. Blood Supply Significance

- Blood supply mainly from:
    - *Posterior tibial artery* ? via tarsal canal branch.
    - *Dorsalis pedis artery* ? via sinus tarsi branch.
    - *Perforating peroneal artery*.
  - Because of poor anastomosis, talar fractures are prone to **avascular necrosis**.
- 

## 7. Radiological Importance

- **Lateral view (Harris-Beath view)** helps assess tarsal coalition and talar fractures.
  - **Ossification pattern** aids in **fetal maturity estimation**.
- 

## 8. Surgical Note

- **Talectomy** (excision of talus) may be performed in severe clubfoot unresponsive to correction.
- **Talar replacement** prosthesis is rarely used due to complex blood supply.

## Calcaneus (Calcaneum)

### Introduction

- The **calcaneus** (or **heel bone**) is the **largest tarsal bone** and forms the **prominence of the heel**.
  - It lies **below the talus** and **behind the cuboid**.
  - Functionally, it **transmits the weight of the body** from the talus to the ground.
  - It forms part of both:
    - **Subtalar joint** (with talus above)
    - **Calcaneocuboid joint** (with cuboid in front)
- 

## Position and Orientation

To hold the bone in **anatomical position**:

1. The **posterior surface** (for Achilles tendon) faces backward.
  2. The **anterior articular facet** faces forward.
  3. The **sustentaculum tali** projects medially.
    - ? The bone belongs to the side of the **sustentaculum tali**.
- 

## Parts and Surfaces

The calcaneus has **six surfaces**: superior, inferior, anterior, posterior, medial, and lateral.

---

### 1. Superior Surface

Divided into **three areas** (from behind forward):

- **Posterior area**: Rough, for attachment of **calcaneal (Achilles) tendon** and **bursa**.

- **Middle area:** Bears the **posterior articular facet** for talus (forming part of subtalar joint).
  - **Anterior area:** Bears the **middle and anterior articular facets** for talus, separated by *sulcus calcanei* (forms *tarsal sinus* with *sulcus tali* of talus).
- 

## 2. Inferior Surface

- Rough, with **three tubercles**:
    - **Medial process of tuberosity:** Large, for origin of *abductor hallucis* and *flexor digitorum brevis*.
    - **Lateral process:** Smaller, for origin of *abductor digiti minimi*.
    - **Anterior tubercle:** For attachment of *long plantar ligament*.
- 

## 3. Anterior Surface

- Bears a **saddle-shaped facet** for articulation with the **cuboid bone** (calcaneocuboid joint).
- 

## 4. Posterior Surface

- Divided into three parts:
    - **Upper smooth area:** For *retrocalcaneal bursa*.
    - **Middle rough area:** For insertion of *tendo calcaneus* (*Achilles tendon*).
    - **Lower rough area:** For origin of *plantar aponeurosis* and *abductor digiti minimi*.
-

## 5. Medial Surface

- Shelf-like projection called **sustentaculum tali**, which:
    - Supports the *head of talus*.
    - Has a **groove below it** for *flexor hallucis longus tendon*.
    - Gives attachment to *spring ligament* (plantar calcaneonavicular ligament).
    - Provides surface for *tibialis posterior* tendon attachment.
- 

## 6. Lateral Surface

- Marked by:
    - *Peroneal trochlea (fibular trochlea)* between the tendons of *peroneus longus* (below) and *peroneus brevis* (above).
    - *Peroneal tubercle* acts as pulley for peroneal tendons.
    - Smooth area for *retinaculum* attachment.
- 

## Articulations of Calcaneus

1. **Superiorly** – with *talus* (subtalar joint).
  2. **Anteriorly** – with *cuboid* (calcaneocuboid joint).
- 

## Attachments on Calcaneus

| REGION             | STRUCTURES ATTACHED                                                       |
|--------------------|---------------------------------------------------------------------------|
| Posterior surface  | <i>Tendo calcaneus, plantar aponeurosis</i>                               |
| Inferior surface   | <i>Abductor hallucis, Flexor digitorum brevis, Abductor digiti minimi</i> |
| Medial surface     | <i>Spring ligament, Flexor retinaculum</i>                                |
| Lateral surface    | <i>Peroneal retinacula, Peroneal trochlea</i>                             |
| Anterior surface   | <i>Long plantar ligament</i>                                              |
| Sustentaculum tali | <i>Spring ligament, Tibialis posterior tendon</i>                         |

### Ossification of Calcaneus

| CENTRE                                             | TIME OF APPEARANCE          | FUSION      |
|----------------------------------------------------|-----------------------------|-------------|
| <b>Primary centre</b>                              | 6th month intrauterine life | —           |
| <b>Secondary centre (for calcaneal tuberosity)</b> | 6–8 years                   | 14–16 years |

- The calcaneus ossifies from **two centres**:
  - Primary centre** – forms most of the bone.
  - Secondary centre** – appears for the **posterior tuberosity** (insertion of Achilles tendon).
- Failure of fusion of the secondary centre may form an accessory bone called **os calcaneus secundarius**.

---

## Clinical Anatomy of Calcaneus

### 1. Fractures

- **Commonest tarsal bone to fracture.**
- **Mechanism:** Fall from height landing on heel (axial compression).
- **Fracture types:**
  - **Comminuted fracture:** Disruption of *subtalar joint* and *calcaneal body*.
  - **Avulsion fracture:** At the *posterior tuberosity* (due to violent pull of Achilles tendon).
- **Radiological feature:** Decrease in *Böhler's angle* (normally 20°–40°) indicates collapse of calcaneus.

---

### 2. Calcaneal Spur

- Chronic traction on the **medial process of calcaneal tuberosity** ? formation of **bony outgrowth (spur)** at plantar fascia attachment.
- Causes **heel pain (plantar fasciitis)**, especially during first steps in the morning.

---

### 3. Tendo Calcaneus (Achilles Tendon) Rupture

- Sudden, forceful dorsiflexion (in athletes) can rupture the tendon at its insertion on the **posterior surface of calcaneus**.
- Causes inability to stand on toes.

- Treated by surgical repair or immobilization.
- 

#### 4. Flatfoot (Pes Planus)

- Weakness or stretching of the **spring ligament** under the **sustentaculum tali** leads to descent of talar head, flattening the **medial longitudinal arch**.
  - Pain occurs along medial side of heel.
- 

#### 5. Clubfoot (Talipes Equinovarus)

- Deformity due to **inversion and adduction** of calcaneus with medial rotation of talus.
  - Leads to inward turning of sole and heel.
- 

#### 6. Sever's Disease (Calcaneal Apophysitis)

- Seen in growing children (8–14 years).
  - Due to **inflammation of secondary ossification centre** of calcaneal tuberosity from overuse.
  - Presents with **heel pain** during activity.
- 

#### 7. Surgical and Radiological Notes

- **Böhler's angle** and **Gissane's angle** on X-ray help evaluate calcaneal fractures.
  - **Calcaneal bone grafts** are used in reconstructive foot surgery.
-

- **Peroneal tubercle** serves as an important surgical landmark for lateral foot incisions.

## Navicular Bone

### Introduction

- The **navicular bone** is a **boat-shaped tarsal bone** located in the **medial side of the foot**, between the **head of the talus** (behind) and the **three cuneiform bones** (in front).
- It forms part of the **medial longitudinal arch** and helps in **weight transmission** from the talus to the forefoot.

---

### Surfaces and Features

#### 1. Posterior Surface

- Concave and oval.
- Articulates with the **head of the talus** (forming the *talonavicular joint*).

#### 2. Anterior Surface

- Convex, divided into **three facets** for articulation with the **medial, intermediate, and lateral cuneiform bones**.

#### 3. Medial Surface

- Prominent **tuberosity** projects downward and medially.

- Gives insertion to the **tibialis posterior tendon** — key structure maintaining the **medial arch** of the foot.

#### 4. **Lateral Surface**

- Small facet for articulation with the **cuboid bone** (variable).

#### 5. **Superior Surface**

- Rough and narrow; for *ligament attachment*.

#### 6. **Inferior Surface**

- Rough for attachment of *plantar calcaneonavicular (spring) ligament* and part of *tibialis posterior tendon*.

---

### **Side Determination**

- Concave surface faces **posteriorly**, convex surface **anteriorly**.
- **Tuberosity** projects **medially**.
  - ? The bone belongs to the side of the projecting tuberosity.

---

### **Articulations**

1. **Posteriorly** – *Talus*
2. **Anteriorly** – *Three cuneiforms*
3. **Laterally** – *Cuboid (occasionally)*

## Ossification of Navicular Bone

| CENTRE                                  | TIME OF APPEARANCE                      | REMARKS                                    |
|-----------------------------------------|-----------------------------------------|--------------------------------------------|
| Primary centre                          | 3rd year (in girls), 4th year (in boys) | Single centre forms entire bone            |
| Accessory centre (Navicular tuberosity) | Occasionally present                    | Failure to fuse ? Accessory navicular bone |

- The **navicular** is the **last tarsal bone to ossify**.
- Ossification completes around **12–14 years**.

---

## Clinical Anatomy of Navicular

### 1. Accessory Navicular Bone (Os Tibiale Externum)

- Results from non-fusion of the accessory centre at the tuberosity.
- Causes **pain and tenderness on medial side of foot**, may mimic fracture.

### 2. Navicular Fracture

- Occurs due to **indirect trauma or stress** (e.g., in runners).
- May cause **collapse of medial arch**.

### 3. Flatfoot (Pes Planus)

- Displacement of **talus head** downward stretches the **spring ligament**, pressing against the navicular, producing flat appearance.

#### 4. Tarsal Coalition

- Fusion between navicular and calcaneus (*calcaneonavicular coalition*) ? restricted inversion/eversion.

## Cuneiform Bones (Medial, Intermediate, and Lateral)

### Introduction

- The **three cuneiform bones** are **wedge-shaped tarsal bones** lying in the **distal row** of tarsus, between the **navicular bone (behind)** and the **first three metatarsals (in front)**.
- They form part of the **medial longitudinal** and **transverse arches** of the foot.

### General Arrangement

| BONE                          | POSITION                                  | ARTICULATES ANTERIORLY WITH |
|-------------------------------|-------------------------------------------|-----------------------------|
| <b>Medial cuneiform</b>       | Largest, most medial                      | 1st metatarsal              |
| <b>Intermediate cuneiform</b> | Smallest, between the other two           | 2nd metatarsal              |
| <b>Lateral cuneiform</b>      | Between intermediate cuneiform and cuboid | 3rd metatarsal              |

## Medial Cuneiform

### Features

- **Largest** of the three and **wedge-shaped**, base directed downward.
- **Medial surface** is subcutaneous and easily palpable.
- **Anterior surface** – articulates with *base of 1st metatarsal*.
- **Posterior surface** – articulates with *navicular bone*.
- **Lateral surface** – articulates with *intermediate cuneiform* and *base of 2nd metatarsal*.
- **Inferior surface** – rough for *tibialis posterior* and *peroneus longus* attachments.

### Attachments

- **Medial surface:** *Tibialis anterior* insertion.
- **Lateral surface:** *Peroneus longus* tendon crosses inferiorly.
- **Inferior surface:** Partly gives origin to *flexor hallucis brevis*.

---

## Intermediate Cuneiform

### Features

- **Smallest** of the three.
- **Wedge-shaped**, with base directed **upward**.

- **Posterior surface:** Articulates with *navicular bone*.
- **Anterior surface:** Articulates with *2nd metatarsal base*.
- **Medial surface:** Articulates with *medial cuneiform*.
- **Lateral surface:** Articulates with *lateral cuneiform*.
- **Superior and inferior surfaces:** Rough for ligament attachment.

---

## Lateral Cuneiform

### Features

- Lies between *intermediate cuneiform (medial)* and *cuboid (lateral)*.
- **Posterior surface:** Articulates with *navicular*.
- **Anterior surface:** Articulates with *3rd metatarsal*.
- **Medial surface:** Articulates with *intermediate cuneiform* and *2nd metatarsal*.
- **Lateral surface:** Articulates with *cuboid* and *4th metatarsal*.
- Gives partial origin to *flexor hallucis brevis*.

---

## Ossification of Cuneiform Bones

| BONE | CENTRE APPEARANCE | FUSION COMPLETED |
|------|-------------------|------------------|
|      |                   |                  |

|                               |          |          |
|-------------------------------|----------|----------|
| <b>Lateral cuneiform</b>      | 1st year | 12 years |
| <b>Medial cuneiform</b>       | 2nd year | 12 years |
| <b>Intermediate cuneiform</b> | 3rd year | 12 years |

- Occasionally, the **medial cuneiform** may have **two ossification centres** that later fuse.
- Ossification usually completes by **12 years of age**.

---

## Clinical Anatomy of Cuneiform Bones

### 1. Fractures

- Rare, due to protection by surrounding bones and strong ligaments.
- Usually part of complex **Lisfranc fracture-dislocation** (at tarsometatarsal joint).

### 2. Cuneiform Coalition

- Fusion between cuneiforms may lead to *restricted midfoot movement and foot stiffness*.

### 3. Flatfoot (Pes Planus)

- Collapse of **medial arch** involves downward displacement of medial cuneiform; weight-bearing line shifts medially.

### 4. Accessory Cuneiforms

- Occasionally found as small separate ossicles near normal bones (harmless, but may mimic fracture on X-ray).

## 5. Palpation

- The **medial cuneiform** is palpable just anterior to the *navicular tuberosity* — a surface landmark in medial foot.

## Cuboid

### Introduction

- The **cuboid** is the **most lateral bone of the distal row of tarsus**.
- It is **cube-shaped**, forming the **lateral part of the foot's skeleton**.
- It lies **in front of the calcaneus** and **behind the 4th and 5th metatarsal bones**.
- It participates in forming the **lateral longitudinal arch** of the foot.

---

### Surfaces and Features

#### 1. Anterior Surface

- Divided into **two facets** for articulation with the **bases of the 4th and 5th metatarsals**.

#### 2. Posterior Surface

- Saddle-shaped facet articulates with the **calcaneus** (calcaneocuboid joint).

#### 3. Medial Surface

- Articulates with the **lateral cuneiform** and **navicular** (occasionally).

#### 4. **Lateral Surface**

- Smooth and forms the outer border of the foot.

#### 5. **Inferior (Plantar) Surface**

- Prominent **tuberosity** near its posterior part for attachment of the **long plantar ligament**.
- Has a **groove for peroneus longus tendon**, obliquely directed forward and medially.
- Medial end of the groove shows a **ridge (peroneal ridge)** and a **small sesamoid bone** within the tendon.

#### 6. **Superior Surface**

- Rough, non-articular area for ligament attachment.

---

### **Articulations**

1. **Posteriorly** – *Calcaneus*
  2. **Medially** – *Lateral cuneiform* and sometimes *navicular*
  3. **Anteriorly** – *4th and 5th metatarsals*
-

## Ossification of Cuboid

| CENTRE         | TIME OF APPEARANCE                              | FUSION COMPLETED |
|----------------|-------------------------------------------------|------------------|
| Primary centre | 9th month intrauterine life (just before birth) | 12 years         |

- The **cuboid** is the **first tarsal bone to ossify after birth** and is used in **determining full-term maturity of the newborn**.

---

## Clinical Anatomy of Cuboid

### 1. Cuboid Syndrome

- Partial subluxation or malalignment of cuboid bone due to *peroneus longus* traction.
- Causes *lateral foot pain* and *difficulty in weight bearing*.
- Common in athletes and ballet dancers.

### 2. Fractures

- Usually due to **crush injuries** or **forced inversion** of the foot.
- May cause collapse of the **lateral longitudinal arch**.

### 3. Accessory Ossicles

- *Os peroneum* – small sesamoid bone sometimes found within the *peroneus longus* tendon near the cuboid groove.

### Introduction

- The **metatarsus** consists of **five metatarsal bones**, numbered **I to V** from medial to lateral side.
- They form the **skeleton of the forefoot** and connect the tarsus with the phalanges.
- Each metatarsal is a **miniature long bone** with:
  1. **Base** – proximal, articulating with tarsal bones
  2. **Shaft** – body
  3. **Head** – distal, articulating with proximal phalanges

### Special Features

| METATARSAL | SPECIAL CHARACTERISTICS                                                                                                  |
|------------|--------------------------------------------------------------------------------------------------------------------------|
| 1st        | Shortest, thickest, bears body weight; base has <i>facet for medial cuneiform</i> and <i>sesamoid bones under head</i> . |
| 2nd        | Longest; base wedged between medial and lateral cuneiforms (least mobile).                                               |
| 3rd        | Base articulates with <i>lateral cuneiform</i> .                                                                         |
| 4th        | Base articulates with <i>cuboid</i> and <i>lateral cuneiform</i> .                                                       |
| 5th        | Has prominent <i>tuberosity (styloid process)</i> on base for <i>peroneus brevis</i> tendon insertion.                   |

## Articulations Summary

| BONE | POSTERIORLY                              | ANTERIORLY           | LATERALLY /<br>MEDIALY  |
|------|------------------------------------------|----------------------|-------------------------|
| 1st  | Medial cuneiform                         | 1st proximal phalanx | —                       |
| 2nd  | Medial, intermediate, lateral cuneiforms | 2nd proximal phalanx | 1st and 3rd metatarsals |
| 3rd  | Lateral cuneiform                        | 3rd proximal phalanx | 2nd and 4th metatarsals |
| 4th  | Cuboid and lateral cuneiform             | 4th proximal phalanx | 3rd and 5th metatarsals |
| 5th  | Cuboid                                   | 5th proximal phalanx | 4th metatarsal          |

### Ossification of Metatarsals

| CENTRE                  | TIME OF APPEARANCE         | FUSION   |
|-------------------------|----------------------------|----------|
| Primary centre (shaft)  | 9th week intrauterine life | —        |
| Secondary centre (head) | 3rd year (1st – base)      | 18 years |

- **1st metatarsal** – secondary centre appears at the **base**.

- **2nd to 5th metatarsals** – secondary centres appear at the **heads**.
  - All fuse with shaft by **18 years**.
- 

## Clinical Anatomy of Metatarsals

### 1. March Fracture

- Stress fracture of **2nd or 3rd metatarsal** from repetitive stress (common in soldiers, dancers).
- Causes dorsal foot pain and swelling.

### 2. Jones Fracture

- Transverse fracture at the **base of 5th metatarsal**, due to *peroneus brevis* pull during inversion injury.
- Pain and tenderness at lateral midfoot.

### 3. Hallux Valgus (Bunion)

- Lateral deviation of *1st metatarsophalangeal joint*, often with *medial bony prominence (bunion)*.

### 4. Metatarsalgia

- Pain in forefoot due to *collapsed transverse arch*; involves *heads of 2nd and 3rd metatarsals*.
-

### Introduction

- There are **14 phalanges** in the foot:
    - **2 in the great toe (hallux)**
    - **3 in each of the other four toes**
  - Arranged as: **proximal, middle, and distal phalanges** (except great toe).
  - Each phalanx has:
    - **Base** – proximal, articulates with metatarsal or preceding phalanx
    - **Shaft** – middle part
    - **Head** – distal, small and rounded (or expanded distally in distal phalanges)
- 

### Features

- **Proximal phalanges:** Longest; articulate with metatarsal heads.
  - **Middle phalanges:** Absent in great toe.
  - **Distal phalanges:** Flattened distal ends supporting the nail bed.
  - The **distal phalanx of the great toe** is thick and strong, bearing much of the push-off weight in walking.
-

## Ossification of Phalanges

| CENTRE                  | TIME OF APPEARANCE              | FUSION   |
|-------------------------|---------------------------------|----------|
| Primary centre (shaft)  | 9th–10th week intrauterine life | —        |
| Secondary centre (base) | 3rd year                        | 18 years |

- Each phalanx ossifies from **two centres** — one for the **shaft**, and one for the **base** (which appears later).
- Ossification completes by **18 years of age**.

## Clinical Anatomy of Foot Bones

### 1. Flatfoot (Pes Planus)

- Collapse of **medial longitudinal arch** due to ligament or muscle weakness.
- Navicular, talus, and cuneiform bones sink downward.

### 2. High Arch (Pes Cavus)

- Exaggerated medial arch due to contracture of intrinsic foot muscles or neurological disorders.

### 3. Claw Toes / Hammer Toes

- Deformities of phalanges due to *imbalance between long and short toe muscles*.

#### 4. Metatarsalgia

- Pain under metatarsal heads due to **loss of transverse arch** or fat pad atrophy.

#### 5. Accessory Ossicles

- Common small extra bones: *os peroneum*, *os trigonum*, *accessory navicular* — may mimic fractures radiologically.

---

### Sesamoid Bones

#### Introduction

- **Sesamoid bones** are small nodules of bone embedded within tendons where they pass over joints or pressure points.
- They reduce friction, protect tendons, and improve the mechanical efficiency of muscles.

---

#### Sesamoid Bones in the Foot

1. **Two constant sesamoid bones** under the **head of 1st metatarsal**:
  - *Medial (tibial) sesamoid* ? in tendon of **flexor hallucis brevis (medial head)**
  - *Lateral (fibular) sesamoid* ? in tendon of **flexor hallucis brevis (lateral head)**
2. **Occasional sesamoids** may be present in tendons of:
  - *Peroneus longus* (near cuboid groove)
  - *Tibialis anterior* or *posterior*

- *Flexor digitorum longus* in toes
- 

## Clinical Anatomy of Sesamoid Bones

### 1. Sesamoiditis

- Inflammation due to repetitive pressure on *1st metatarsal sesamoids* (common in runners and dancers).
- Causes forefoot pain and tenderness beneath the great toe.

### 2. Fracture of Sesamoids

- May mimic bipartite sesamoid (which has smooth margins).
- Pain aggravated by toe dorsiflexion.

### 3. Bipartite Sesamoid

- Congenital division into two parts; usually painless unless traumatized.

### 4. Functionally Important

- Protect tendons from wear.
- Increase leverage of *flexor hallucis brevis* during toe-off in walking.