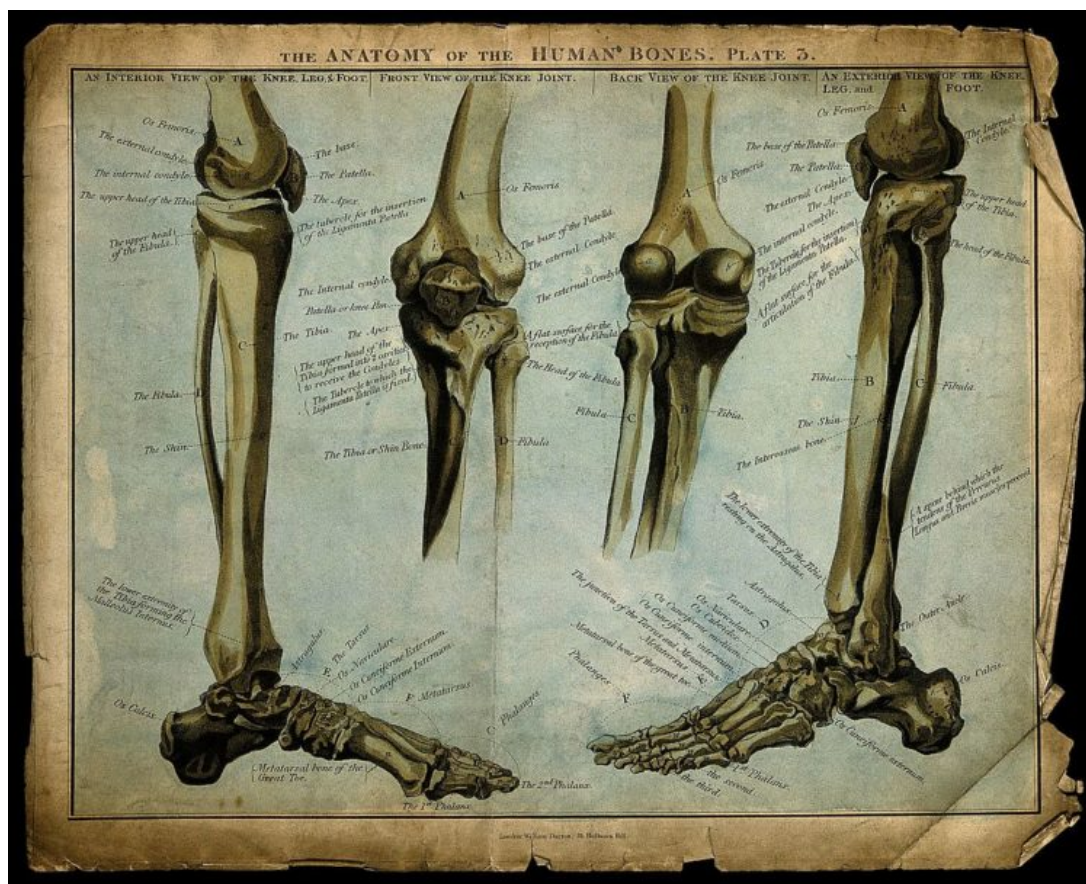


## Bones of the Lower Extremity — Femur, Tibia, Fibula, Phalanges and More

[See online here](#)

The lower limb connects the body to the foot. It bears the weight of the body when standing and during movement. Altogether, there are 32 bones in the lower limb; this includes the hip bone (with its three components: ilium, ischium, pubis), femur, tibia, fibula, patella, tarsal bones (8), the metatarsals (5) and the phalanges (5) on either side.



### General Arrangement of lower limb

The superior appendicular skeleton includes:

- Hip bone
- Femur
- Patella
- Tibia
- Fibula
- Tarsals

- Metatarsals
- Phalange

## Hip Bone

Along with the **sacrum**, the hip bone (or Innominate bone), the bone formed from the fusion of the ilium, ischium, and pubis forms a bony ring around the pelvic structures. The **Ilium**, **ischium**, and **pubis** are fused at the **acetabulum** anteriorly to form a single bone.

The hip bone articulates with the sacrum, the femur, and its opposite counterpart. It is responsible for movements in all three planes and is therefore prone to injury if its supporting structures fail to function.

## Ossification of the hip bone

It is ossified from **eight ossification centers**: three primary and five secondary centers. The three primary centers - one each for the Ilium, ischium and the pubic bone - unite around a Y- shaped tri-radiate cartilage around puberty. Around this time, secondary centers or **epiphyses** appear in that cartilage and also in the **anterior inferior iliac spine**, the **iliac crest**, **ischial tuberosity**, and the **pubic symphysis**. These eventually unite about the twenty-fifth year.

## Ilium

Ilium consists of a **body** and an **ala** (or **wing**) which is demarcated internally by the curved arcuate line and externally by the acetabular margin. The body of the Ilium forms the superior two-fifths of the **acetabular fossa** and fuses with the ischium and the pubis.

The inner surface of the body forms the wall of the lesser pelvis and provides attachment to the **obturator internus muscle** fibers. The superior border of the body is called the **iliac crest** and is easily palpable. The **anterior superior iliac spine** forms the anterior limit of the iliac crest, while the **posterior superior iliac spine** forms the posterior limit.

The **ilioinguinal ligament** connects the anterior superior iliac spine to the pubic symphysis and separates the thigh from the anterior abdominal wall. The iliac crest has an outer and an inner lip which provides attachment to several muscles.

The **ala of the ilium** is an expanded wing-like part with an internal or medial, external or lateral surface, the **sacropelvic surface**, a crest, and an anterior and posterior border. The external or lateral or gluteal surface is concave posteriorly and convex anteriorly. It is bounded by the crest above and by the upper border of the acetabulum below. The external surface has the anterior, posterior and inferior **gluteal lines**.

The **gluteus maximus muscle** is attached to a semilunar surface behind the posterior gluteal line; the **gluteus medius** is attached to the intervening space between the anterior and posterior gluteal lines, while the **gluteus minimus** is attached to the surface of the bone between the anterior and inferior gluteal lines.

The internal or medial surface has the **iliac fossa**, which forms a part of the lateral pelvic wall. The sacropelvic surface, posterior to the iliac fossa, has a rough ligamentous area, the **iliac tuberosity** and the **auricular surface** which forms the **sacroiliac joint**.

The anterior superior **iliac spine** is the site where the anterior border of the ilium begins,

then continues to the anterior inferior spine located superior to the **acetabulum** and ends at the junction of the ilium and the pubis forming the **iliopubic eminence**. The posterior border, on the other hand, starts at the posterior superior iliac spine and then continues to form the **greater sciatic notch**.

## Ischium

This bone forms the posteroinferior aspect of the hip bone. It consists of two **rami** (the superior and inferior) and a body. **The body forms more than two-fifths of the acetabulum** and has an internal and an external surface. The internal surface forms a part of the pelvic wall and the **obturator externus muscle** originates from it.

Along its posterior border, there is a triangular, pointed eminence called the **ischial spine**, which provides attachment to the **gemellus superior**, the **coccygeus**, **levator ani**, and the **pelvic fascia**. The **sacrospinous ligament** is attached to the pointed tip of the ischial spine.

Superior to the spine is the greater sciatic notch through which passes the **piriformis muscle**, the superior and the inferior **gluteal vessels, nerves**, the **sciatic and posterior femoral cutaneous nerves**, the **internal pudendal vessels and nerve** and the **nerves to the obturator internus and quadratus femoris**.

The **lesser sciatic notch** lies inferior to the **ischial spine** and is converted into a **foramen** by the **sacrospinous and sacrotuberous ligaments**. It transmits the obturator internus, its nerve, and the internal pudendal vessels and nerve.

The gluteus maximus muscle obscures the **ischial tuberosity** on hip extension, but the tuberosity is palpable when the thigh is flexed. The two rami of the ischium and the pubis form the inferior aspect of the **obturator foramen**. The external surface of the superior ramus provides attachment to the **obturator externus**, the **quadratus femoris**, and the **adductor magnus**.

The internal surface of the superior ramus provides attachment to the **transversus perinaei** and the **ischiocavernosus muscles**. The inferior aspect of the superior ramus has the ischial tuberosity which provides attachment to the **semimembranosus**, the long head of the **biceps femoris** and the **semitendinosus**.

The outer surface of the inferior ramus is uneven and provides attachment to the **obturator externus** and the **adductor magnus**. The medial border of its inner surface is everted and rough to form the **pelvic outlet**, and provides attachment to the **inferior fascia of the urogenital diaphragm** and the deep layer of the **superficial perineal fascia**.

## Pubis

This forms the anterior part of the hip bone and consists of the body, a superior and an inferior ramus. **The body of the pubis forms one-fifth of the acetabulum**. The bodies of the two sides meet at the pubic symphysis in the median plane. The symphyseal surface of the body is covered by cartilage, while the pelvic surface supports the bladder.

The rough femoral surface of the body provides attachment to muscles. The **pubic tubercle** on the anterior aspect of the body is an important anatomical landmark which can be found 3 cm from the median plane by tracing the tendon of the **adductor longus muscle** superiorly.

The **spermatic cord** crosses the pubic tubercle, which is a guide to the **superficial inguinal ring**, the **femoral ring**, and the **saphenous opening**. The **pectineal line** extends from the pubic tubercles along the **superior pubic ramus** to the **iliopubic eminence**.

The pubic tubercle and the pectineal line together form a part of the **linea terminalis**. The superior ramus has a pelvic surface, an obturator surface and the **obturator crest** on its inferior aspect. The obturator surface has an **obturator groove** conveying the obturator nerve and vessels. The **inferior pubic ramus** joins the **ischial ramus**.

## Acetabulum and obturator foramen

Ilium, ischium, and pubis together form the **acetabulum** which forms the **socket for the femoral head**. Its articular surface is called the **lunate surface**, while its non-articular surface is called the **acetabular fossa**. The rim of the acetabulum, that is deficient inferiorly, provides attachment to the **acetabular labrum**, which deepens the hip socket. The ischium, the pubis, and their rami form boundaries of the **obturator foramen** which is closed by the **obturator membrane** except at the **obturator groove**. The obturator foramen contains the obturator nerve that innervates the skin of the inner thigh and the adductor muscles of the thigh, the obturator artery and vein.

## Femur

This is also known as the **thigh bone** and is the longest and the strongest bone in the human body. Extremely strong forces are required to cause femur fractures. The femur connects the hip to the [knee](#). It has a diaphysis and two epiphyses. The superior epiphysis consists of the **head**, a **neck**, a greater and lesser **trochanter**, while the **inferior epiphysis** consists of the **patellar surface**, and the **medial and the lateral condyle**.

The **head of the femur** articulates with the **innominate** or hip bone at the acetabulum to form the [hip joint](#). The greater and lesser trochanters are bony projections near the superior aspect of the head. Several **hip and groin muscles** like the **iliopsoas**, the **gluteus medius**, and the **adductor longus**, are attached to the greater and lesser trochanters of the femur.

The **body of the femur** is cylindrical, convex anteriorly and concave posteriorly. The **linea aspera** is a longitudinal ridge on its concave posterior aspect.

The inferior epiphysis **of the femur** has the **medial and lateral condyles**, which articulate with the **tibia** to form the knee joint. The **intercondylar fossa** is a small depression between the two condyles, which provides attachment to the **anterior and posterior cruciate ligaments**. These ligaments stabilize the knee joint in the anterior-posterior axis. The patellar surface of the femur adjoins the **patella**.

## Tibia

Tibia or the **shin bone** is a long bone which forms the knee joint and connects the femur to the **ankle bones**. The tibia takes part in forming four joints – the knee joint, the ankle joint and the superior and inferior **tibiofibular joints**. Its parts include its upper extremity, the body, and its lower extremity.

The **upper extremity of the tibia** has the **medial and lateral condyle**. The superior,

flat surfaces of the condyles articulate with the femur to form the weight-bearing part of the tibiofemoral or knee joint. The **cruciate ligaments** and the **menisci** are attached in the **intercondylar area** between the two condyles. The **patellar ligament** is attached to the **tibial tuberosity**, which is a bony prominence inferior to the condyles.

The **body of the tibia** is triangular and has three borders. The **lower extremity of the tibia** is narrower than its upper extremity. It forms the ankle joint along with the **fibula** and the **talus**.

## Fibula

This is the thin bone on the lateral aspect of the leg, parallel to the tibia. It stabilizes the ankle. The **fibular head** articulates with the tibia to form the **proximal tibiofibular joint**.

The **distal tibiofibular joint** is formed at the **medial malleolus** with the tibia and the lower end of the fibula. It also forms the **ankle joint** with the tibia and the talus. Several muscles are attached to the fibula – the **peroneus muscles**, the **soleus**, **flexors**, and **extensors of the toes** at its distal end, while the **biceps femoris** is inserted on its head.

The fibula is often a **source for bone grafts** to reconstruct bone defects in other parts of the body.

## Tarsus

The tarsus consists of seven bones: the **talus**, **navicular** and the **three cuneiforms** medially, the **calcaneus** and the **cuboid** laterally. In addition, several **sesamoid bones** may exist e.g. the **os trigonum** at the posterior aspect of the talus, the **os tibiale externum** near the navicular tuberosity and the **fibular sesamoid**.

The talus and the calcaneus start to [ossify in fetal life](#), while the ossification of the cuboid starts immediately after birth. During childhood, **epiphyseal centers** begin to appear for the calcaneal tuberosity and the talar posterior tubercle.

The talus does not have muscular attachments. It has a superior projection called the **trochlea** which articulates with the **medial malleolus of the tibia** and the **lateral malleolus of the fibula** to form the **ankle joint**. The talus articulates inferiorly with the calcaneus or the heel bone.

There are several **tubercles**, of which the lateral tubercle is called the **os trigonum**. The **tarsal sinus** is a deep depression inferior to the neck of the talus and above the calcaneus. The talus and the calcaneus together form the posterior aspect of the **transverse tarsal joint**.

The calcaneus is responsible for transmitting the body weight from the talus to the ground. It has a prominent bony extension medially called the **sustentaculum tali**, which supports the talus medially. The **calcaneal tuberosity** provides attachment to the **calcaneal tendon** posteriorly and to the short muscles of the sole and the **plantar aponeurosis** inferiorly. On its anterior aspect, the calcaneus articulates with the **cuboid**.

The **cuboid bone** articulates with the calcaneus anteriorly, with the fourth and the fifth **metatarsals** posteriorly and with the lateral **cuneiform** and occasionally with the **navicular** laterally. A groove on its inferior surface may be occupied by the **fibularis**

**longus.**

The **navicular bone** lies between the talus and the three cuneiform bones. The **tuberosity of the navicular bone** provides insertion for the **tibialis posterior tendon** and its posterior aspect forms the medial part of the **transverse tarsal joint**.

The three wedge-shaped **cuneiform bones** (medial, intermediate and the lateral cuneiform) are located between the navicular bone anteriorly and the first three metatarsals posteriorly. The cuneiforms together form the **transverse curvature of the foot**.

## Metatarsals

The **metatarsus** connects the **tarsus** to the **phalanges**. Medial to laterally, the metatarsals are numbered 1 to 5. Each metatarsal bone consists of a base, a shaft, a head and has its own individual feature e.g. the first metatarsal is short and thick, while the fifth metatarsal bone has a palpable lateral tuberosity.

Unlike the [metacarpals](#), the metatarsal bones are thinner and longer. The metatarsal bones articulate with the proximal phalanx of each toe forming the **metatarsophalangeal joint**. The anterior **ball of the foot** is formed by the heads of the metatarsal bones.

During fetal life, the shaft of the metatarsal bones begins to **ossify**. Postnatally, ossification centers for the heads of the metatarsal bones begin to appear. While the first metatarsal may have separate ossification centers for its head and base, the fifth metatarsal may have its own separate ossification center which fails to fuse and can be confused with a fracture.

## Phalanges

There are five phalanges: the proximal, middle and the distal. Each phalanx consists of a base, a shaft, and a head. Often, the great toe (or **hallux**) and the little toe have two phalanges each, while the others have one each. The joint between two adjacent phalangeal bones is called the **interphalangeal joint**.

In the little toe, the middle and the distal phalanges are often fused. During fetal life, the phalanges begin to ossify and postnatally ossification centers appear at their bases.

## Joint Movements

### Hip joint

Flexion and extension, internal and external rotation, abduction/adduction and circumduction. Movements are limited compared to those at the [shoulder](#).

### Knee joint

This is a synovial joint which permits flexion, extension and some medial and lateral rotation.



# Ankle joint

The ankle joint is a simple hinge joint and is capable of dorsiflexion, plantar flexion, eversion, and inversion.

## References

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