Lecture 5

OSTEOLOGY
of the Lower Limb

Lecture 5 : Osteology of the Lower Limb

1. General Overview

The **lower limb** (inferior limb) is the region of the body adapted for **support, stability, and locomotion**. It bears the weight of the entire body and allows movement such as walking, running, jumping, and maintaining posture.

It is **divided into several regions**:

Region	Main Bones	Description
Hip (Pelvic region)	Hip bone (*os coxae*)	Connects the lower limb to the trunk through the sacroiliac joint.
Thigh (Femoral region)	Femur	The longest and strongest bone of the human body.
Knee (Genicular region)	Patella	A sesamoid bone embedded in the quadriceps tendon that protects the knee joint.
Leg (Crural region)	Tibia and Fibula	The tibia (medial) bears weight, while the fibula (lateral) provides muscle attachment and ankle stability.
Foot (Pedal region)	Tarsals, Metatarsals, Phalanges	Provides balance, propulsion, and adaptation to surfaces during locomotion.

Functions of the Lower Limb Bones

1. **Support:** They form the framework that supports the body's weight in standing posture.
2. **Movement:** They act as levers for muscles during locomotion.
3. **Protection:** They protect structures such as major blood vessels and nerves.
4. **Attachment:** Provide attachment for muscles, tendons, and ligaments.

2. The Hip Bone (Os Coxae)

General Description

The **hip bone**, also called the **coxal bone** or **innominate bone**, forms the **anterior and lateral walls of the pelvis**.
Each hip bone is a large, irregular bone formed by the **fusion of three parts**:

- **Ilium** (superior part)
- **Ischium** (posteroinferior part)
- **Pubis** (anteroinferior part)

These three parts meet in a deep cup-shaped cavity called the **acetabulum**, which articulates with the **head of the femur** to form the **hip joint** (*acetabulofemoral joint*).

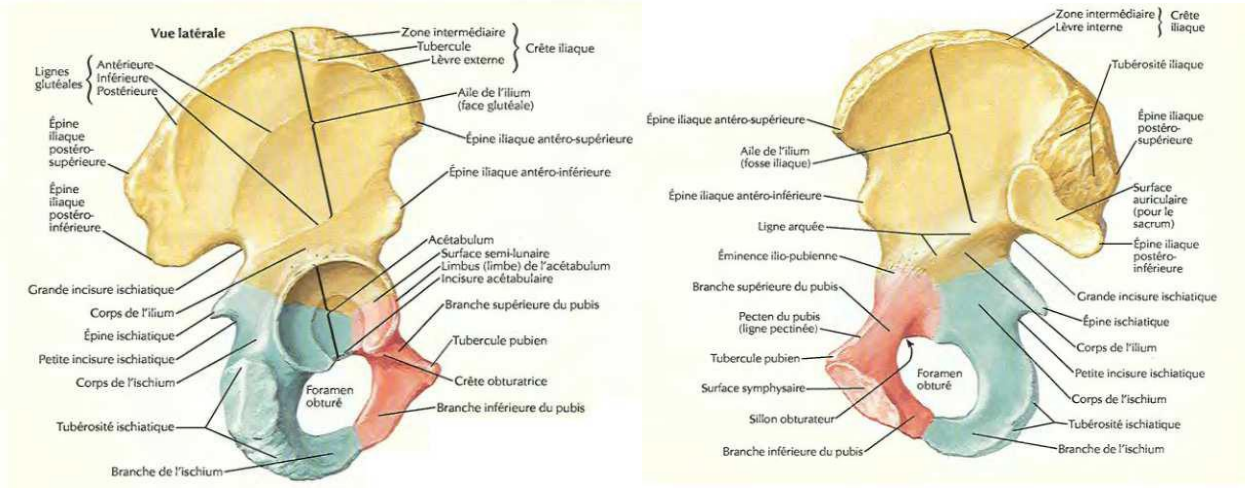
A. Parts of the Hip Bone

Part	Features	Function / Significance
1. Ilium	Upper, broad, and flaring portion forming the superior part of the hip bone.	Supports abdominal organs; provides attachment for gluteal muscles.
2. Ischium	Posterior and inferior portion; bears the weight when sitting.	Provides attachment for hamstring muscles; forms the ischial tuberosity.
3. Pubis	Anterior portion of the bone.	Contributes to the pubic symphysis joint; provides attachment for adductor muscles.

B. Key Anatomical Landmarks

Structure	Description
Iliac crest	Upper curved border of the ilium; palpable in the flank region.
Anterior superior iliac spine (ASIS)	Prominent projection at the anterior end of the iliac crest; important landmark for surface anatomy.
Posterior superior iliac	Posterior end of the iliac crest; visible as dimples on the lower

spine (PSIS)	back.
Ischial tuberosity	Roughened area of the ischium; bears weight when sitting.
Pubic symphysis	Midline cartilaginous joint connecting the right and left pubic bones.
Obturator foramen	Large opening formed by pubis and ischium; covered by obturator membrane.
Acetabulum	Deep hemispherical cavity receiving the femoral head; forms the hip joint.



3. The Femur

General Description

The **femur**, commonly known as the **thigh bone**, is the **longest and strongest bone** in the human skeleton. It extends from the **hip joint** above to the **knee joint** below and serves as the main support for the body during standing, walking, and running. Its superior end articulates with the **acetabulum of the hip bone**, while the inferior end forms part of the **knee joint**, articulating with the **tibia** and **patella**.

The femur is slightly oblique, directed medially and downward, to align the knees under the body's center of gravity. This inclination provides both stability and efficient movement during locomotion.

A. Parts of the Femur

The femur is divided into three main parts:

Part	Description
Upper end	Composed of the head, neck, and two trochanters (greater and lesser).
Shaft	Long, slightly convex anteriorly, with a rough posterior border known as the *linea aspera*.
Lower end	Expanded to form the medial and lateral condyles, which articulate with the tibia.

B. Anatomical Features

1. Upper End

The **head** of the femur is a smooth, rounded structure that fits into the acetabulum, forming the **hip joint**. It bears a small depression called the **fovea capitis**, which serves as the attachment site for the **ligament of the head of the femur (ligamentum teres)**.

The **neck** of the femur connects the head to the shaft, forming an **angle of inclination** (approximately 125° in adults). This angle optimizes the alignment of the hip and knee joints, allowing efficient transmission of weight and movement. A decrease in this angle (coxa vara) or an increase (coxa valga) can affect gait and joint mechanics.

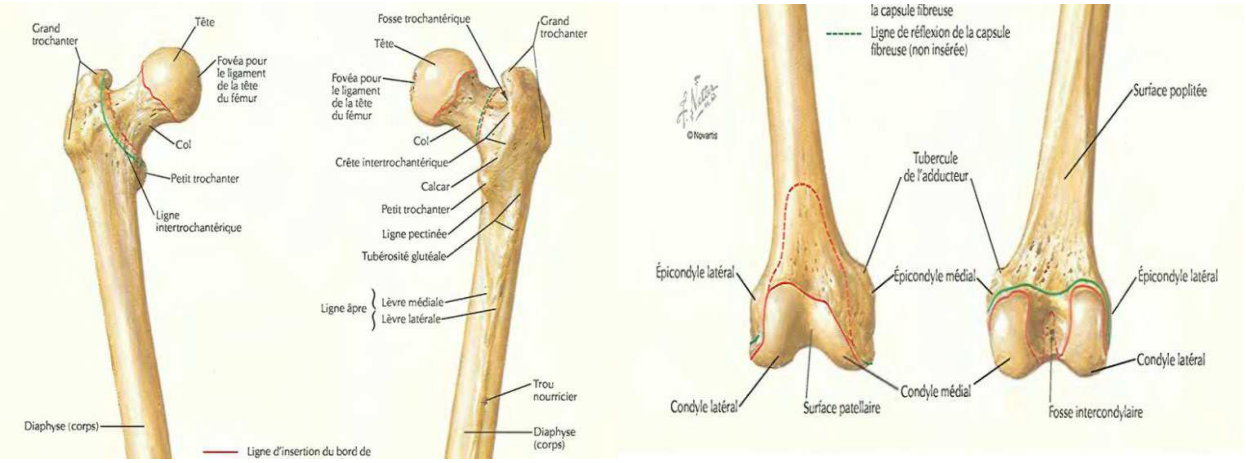
Two prominent projections, the **greater trochanter** (lateral) and the **lesser trochanter** (posteromedial), serve as attachment sites for major muscles of the hip. The **intertrochanteric line** (anterior) and **intertrochanteric crest** (posterior) mark the junction between the neck and the shaft.

2. Shaft

The **shaft** of the femur is cylindrical and slightly convex anteriorly. Its **posterior surface** features a prominent longitudinal ridge known as the **linea aspera**, which provides attachment for the adductor muscles of the thigh. The **medial and lateral lips** of the linea aspera diverge inferiorly to form the **supracondylar lines** that lead toward the lower end of the bone. A **nutrient foramen** is present on the posterior surface, directed upward, allowing passage of the nutrient artery to supply the bone.

3. Lower End

The **lower end** of the femur is expanded and consists of two large rounded prominences: the **medial** and **lateral condyles**. These articulate with the **tibial condyles** to form the **knee joint**. Between the condyles lies the **intercondylar fossa**, a deep depression that accommodates the **cruciate ligaments** of the knee. Anteriorly, the **patellar surface** forms a smooth area that articulates with the **patella**, facilitating the movement of the quadriceps tendon over the knee during flexion and extension.



4. The Patella

General Description

The **patella**, or **kneecap**, is the **largest sesamoid bone** in the human body. It is embedded within the **quadriceps femoris tendon** and lies anterior to the knee joint, where it plays a key biomechanical role in improving the efficiency of knee extension.
By increasing the **leverage** of the quadriceps muscle, the patella enhances the strength of knee extension while also protecting the anterior aspect of the joint.

A. Shape and Orientation

The patella is a **triangular bone** with:

- **Apex (inferior angle)** pointing downward,
- **Base (superior border)** broad and thick,
- **Anterior surface** convex and subcutaneous,
- **Posterior surface** smooth and divided into two articular facets (lateral and medial) for articulation with the femoral condyles.

Surface / Border	Description
Anterior surface	Convex, roughened for attachment of quadriceps tendon.
Posterior surface	Smooth, covered with articular cartilage; divided into lateral and medial facets that articulate with the femur.
Base	Broad superior border; receives the quadriceps tendon.
Apex	Pointed inferiorly; gives attachment to the ligamentum patellae.
Borders	Provide attachment to medial and lateral patellar retinacula.

Bones of the Leg (Tibia and Fibula)

The **leg** (also called the **crus**) is the segment of the lower limb located between the **knee** and the **ankle**.
It consists of two long bones: the **tibia** and the **fibula**, which are arranged **parallel** to each other and connected along their lengths by the **interosseous membrane**.

The **tibia**, situated on the **medial side**, is the **main weight-bearing bone** of the leg. It transfers the body's weight from the femur above to the talus below, playing a vital role in standing and locomotion.
The **fibula**, located on the **lateral side**, is **slender and non–weight-bearing**. Although it contributes little to weight transmission, it provides **important muscle attachments** and forms the **lateral malleolus**, which stabilizes the ankle joint.

Together, these bones form a **strong and stable framework** that supports the body during movement, protects neurovascular structures of the leg, and serves as an anchor for several muscles involved in walking and balance.

5. The Tibia

General Description

The **tibia**, or **shin bone**, is the **larger and stronger** of the two bones of the leg. It lies on the **medial side** and extends from the **knee to the ankle**, articulating superiorly with the **femur** and inferiorly with the **talus**.
It is a **major weight-bearing bone**, essential for transmitting body weight from the thigh to the foot.

A. Parts of the Tibia

Part	Description
Upper end	Expanded and bears two condyles (medial and lateral) that articulate with the femoral condyles.
Shaft	Triangular in cross-section; has three borders and three surfaces.
Lower end	Smaller; forms the medial malleolus and part of the ankle joint.

B. Anatomical Features

1. Upper End

- The **medial and lateral condyles** articulate with the femoral condyles to form the **knee joint**.
- The **intercondylar area**, located between them, serves as an attachment for the **cruciate ligaments** and **menisci**.
- The **tibial tuberosity**, located just below the condyles on the anterior surface, provides attachment for the **patellar ligament**.
- The **tibial plateau** (superior articular surface) is slightly concave to receive the femoral condyles.

2. Shaft

- **Triangular in cross-section**, with:
    - *Anterior border*: sharp and palpable, forming the "shin."
    - *Medial border*: separates the medial and posterior surfaces.
    - *Interosseous border*: attachment site for the interosseous membrane connecting the fibula.
- **Posterior surface**: marked by the **soleal line**, giving attachment to the *soleus muscle*.

3. Lower End

- Forms the **medial malleolus**, a palpable prominence on the inner side of the ankle.
- The **inferior surface** articulates with the **talus** to form part of the **ankle joint**.
- The **fibular notch**, on the lateral side, articulates with the distal fibula, forming the **inferior tibiofibular joint**.

6. The Fibula

General Description

The **fibula** is the **slender lateral bone** of the leg, located parallel to the tibia. Unlike the tibia, it **does not bear body weight**, but it provides **attachment for several muscles** and forms the **lateral malleolus**, which contributes to ankle stability.
It articulates with the **tibia** at both ends and with the **talus** below, and is connected to the tibia by the **interosseous membrane**.

A. Parts of the Fibula

Part	Description
Head (upper end)	Enlarged and irregular; articulates with the lateral condyle of the tibia.
Shaft	Long, slender, and twisted; provides extensive muscle attachment.
Lower end	Forms the **lateral malleolus**, contributing to the ankle joint.

B. Anatomical Features

1. Head

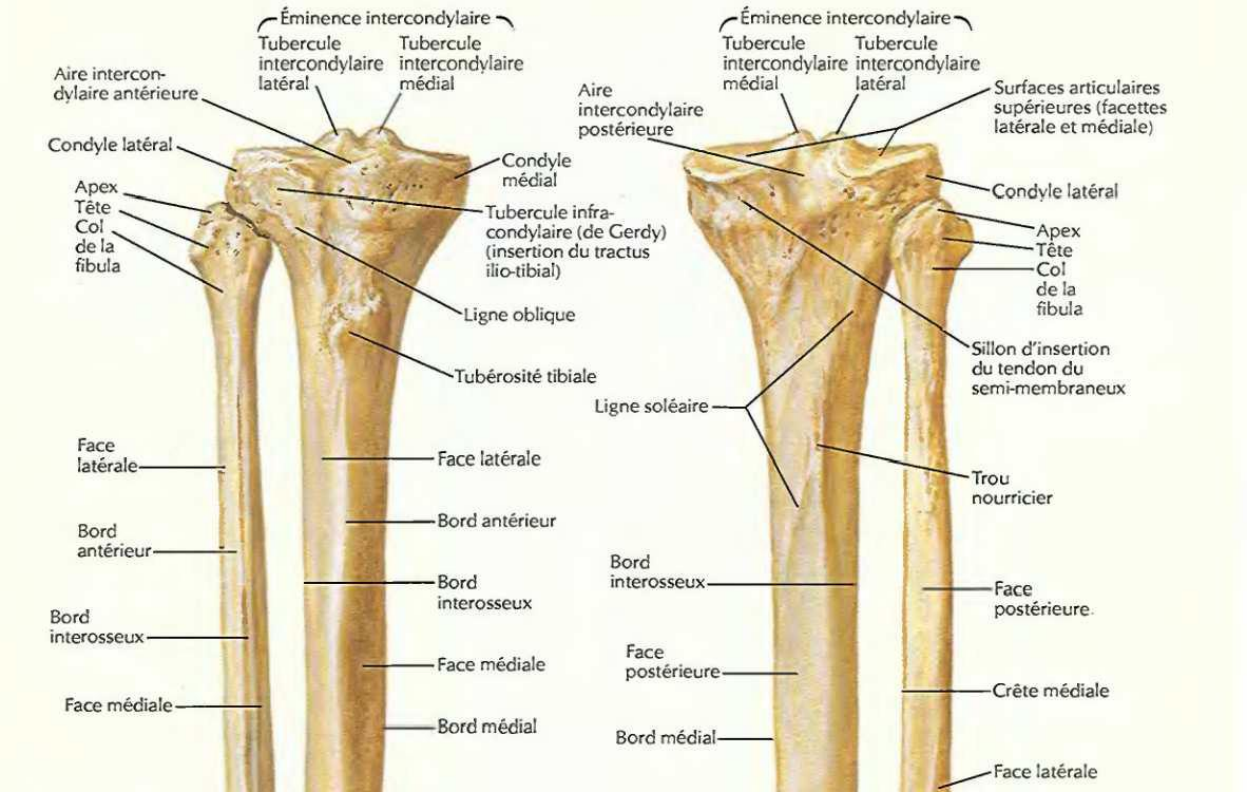
- Rounded upper part of the fibula with a **facet** that articulates with the **lateral condyle of the tibia** (forming the superior tibiofibular joint).
- Possesses a **styloid process** projecting upward, giving attachment to the **fibular collateral ligament (LCL)** of the knee.

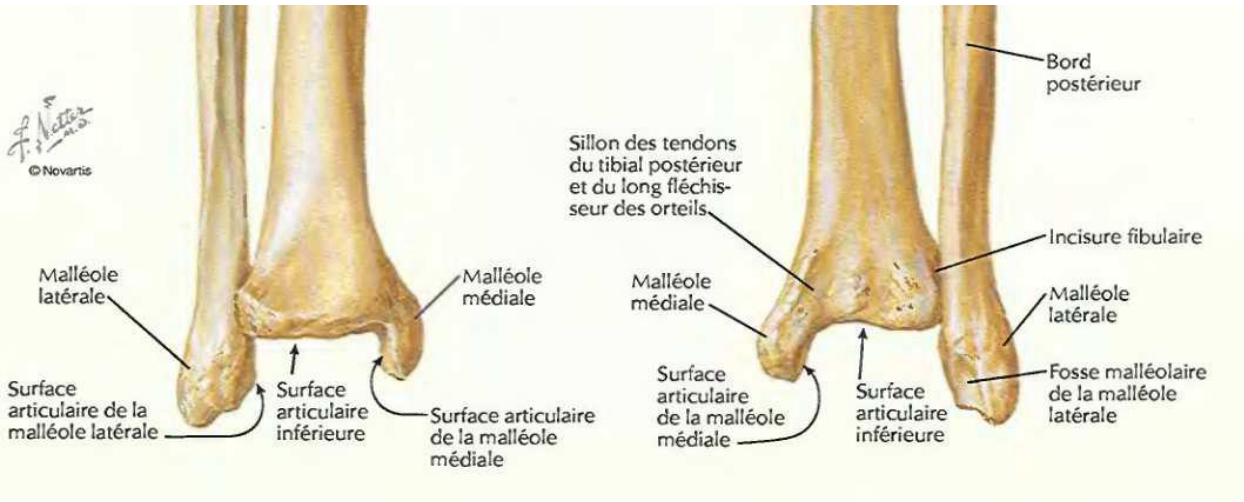
2. Shaft

- **Four borders** and **four surfaces**:
  - *Medial (interosseous) border*: attachment for the interosseous membrane.
  - *Posterior surface*: origin of the *flexor hallucis longus* muscle.
  - *Lateral surface*: attachment for the *peroneus longus* and *brevis* muscles (foot evertors).
  - *Anterior border*: separates the lateral and anterior surfaces, where *extensor muscles* arise.

3. Lower End

- Expanded to form the **lateral malleolus**, the outer ankle prominence.
- The **medial surface** bears a facet for articulation with the **talus**.
- The **posterior border** contains a groove for the **tendons of peroneus longus and brevis**.
- It extends slightly lower than the medial malleolus, adding **lateral stability** to the ankle joint.





6. Bones of the Foot

The **foot** forms the terminal part of the lower limb and serves as a strong yet flexible platform that supports the body's weight during standing, walking, and running.
It is composed of **26 bones**, arranged in **three groups**: the **tarsus**, the **metatarsus**, and the **phalanges**.

1. The Tarsus

The **tarsus** consists of **seven irregularly shaped bones** arranged in two rows — **proximal and distal**.
These bones form the posterior half of the foot and articulate with the tibia and fibula above and with the metatarsals in front.

Tarsal Bone	Description and Function
Talus	Articulates with the tibia and fibula to form the ankle joint (talocrural joint). It transmits body weight from the leg to the foot.
Calcaneus	The largest tarsal bone; forms the heel and serves as the insertion of the Achilles tendon. Supports body weight and acts as a lever for the calf muscles.
Navicular	Boat-shaped bone located medially; articulates with the talus posteriorly and the three cuneiforms anteriorly.

Cuboid	Lies on the lateral side of the foot; articulates with the calcaneus and the fourth and fifth metatarsals.
Medial Cuneiform	The largest of the three cuneiforms; articulates with the first metatarsal.
Intermediate Cuneiform	The smallest cuneiform; articulates with the second metatarsal.
Lateral Cuneiform	Lies between the intermediate cuneiform and the cuboid; articulates with the third metatarsal.

2. The Metatarsus

The **metatarsus** comprises **five metatarsal bones**, numbered from **medial to lateral (I–V)**. They form the **anterior part of the foot** and play a major role in balance and propulsion.

Part	Description
Base	Proximal end; articulates with the tarsal bones.
Shaft	Long and slightly curved portion.
Head	Distal end; articulates with the proximal phalanges.

Each metatarsal supports part of the body weight, with the **first metatarsal** being the thickest and strongest, supporting most of the load during walking.

3. The Phalanges

The **phalanges** form the **toes** and resemble the phalanges of the hand. Each toe has **three phalanges** (proximal, middle, distal), except the **great toe (hallux)**, which has **two** (proximal and distal).

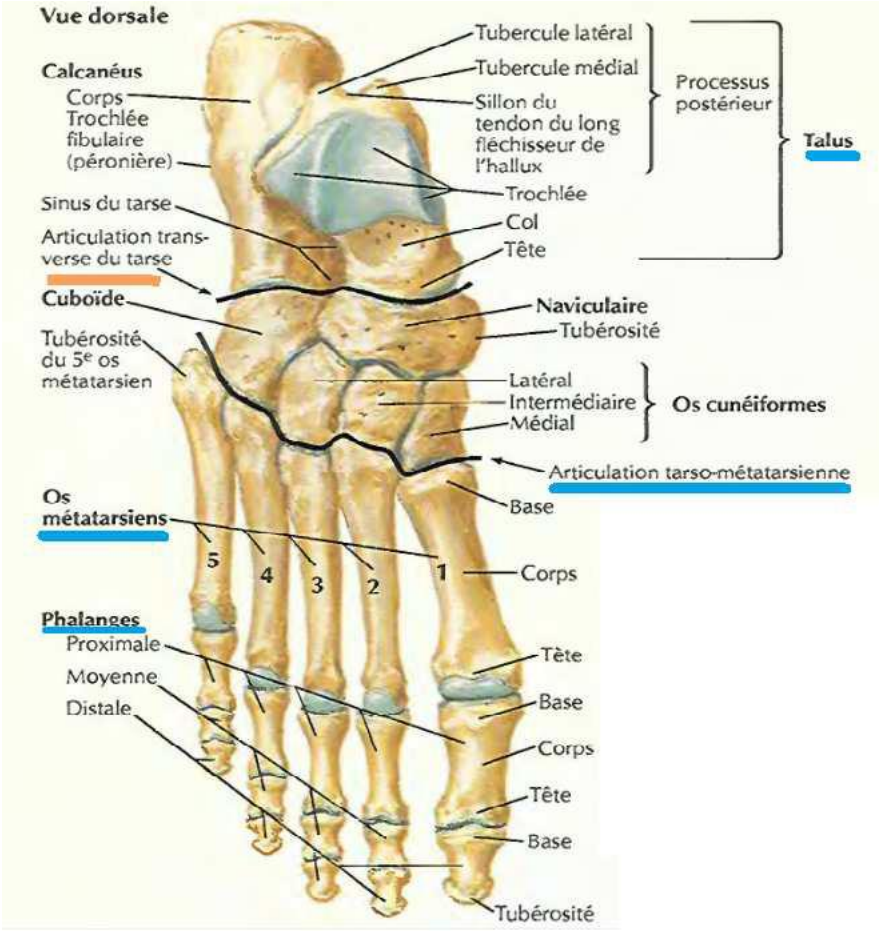
The phalanges provide leverage during walking and help maintain balance, especially during the push-off phase.

4. Arches of the Foot (Brief Overview)

The bones of the foot are arranged to form **arches** that distribute body weight and absorb shock:

- **Longitudinal arches** (medial and lateral)
- **Transverse arch**

These arches are supported by **ligaments, tendons, and muscles**, ensuring flexibility and stability during movement.



Conclusion

The **lower limb skeleton** forms the strong and stable framework that supports the entire body during standing, walking, and running.
Its bones — organized into the **hip bone**, **femur**, **patella**, **tibia**, **fibula**, and **bones of the foot** — work in close coordination to provide both **strength and mobility**.

The **pelvic girdle** ensures firm attachment of the limb to the axial skeleton, while the **femur** and **tibia** bear the body's weight.
The **fibula**, though non–weight-bearing, contributes to ankle stability, and the **foot bones** are ingeniously arranged to form **arches** that absorb shocks and maintain balance on uneven surfaces.

Together, this complex bony structure enables **efficient locomotion**, **shock absorption**, and **postural control**, illustrating the perfect adaptation of the lower limb to its primary function: **support and movement**.