University of Sheffield

School of Medicine

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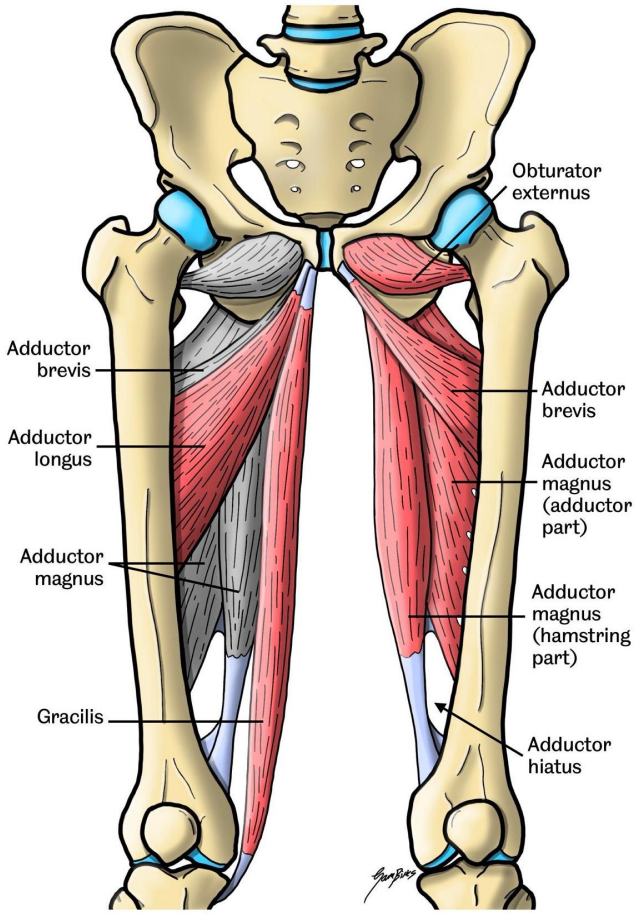
Anatomy of the Lower Limb



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Contents

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Acknowledgments

Special thanks are extended to Dr Sam Birks for the creation of original illustrations for this Handbook, which are reproduced here with permission.

Introduction to the Lower Limb

Why Study the Lower Limb?

We have studied the anatomy of the upper limb and some common presentations and causes of upper limb trauma and pathology. The same principles apply to our study of the lower limb. Traumatic injuries and chronic conditions are common. Lower limb musculoskeletal pain can be a symptom of sinister pathology, such as malignancy or deep infection.

Approach to the Muscles and Movements of the Lower Limb

There are lots of muscles in the lower limb. As with the upper limb, we will mostly talk about the **prime actions** of muscles; we will mention additional actions where they are important. We will look at muscles in terms of **compartments** and we will concentrate on the general actions of muscles located in the same compartments.

We will talk about muscle attachments in simple terms. Where it is important to understand specific muscle attachments, we will look at them in more detail.

Parts of the Lower Limb

Typically, patients will refer to the whole lower limb as the 'leg'. In anatomy and medicine, specific terms are used to describe the different regions of the lower limb.

- The **pelvis** – the two hip (innominate) bones and the sacrum.
- The **thigh** – between the hip and knee joints. The bone of the thigh is the femur. The thigh contains anterior, medial and posterior muscle compartments.
- The **leg** – between the knee and ankle joint. The bones of the leg are the tibia and fibula. It contains anterior, lateral and posterior muscle compartments.
- The **foot** – distal to the ankle. The plantar surface (sole) contains many small muscles (like the palm of the hand). The 'top' of the foot is the dorsum.

Joints of the Lower Limb

The lower limb contains large and small joints.

- **Hip joint** – allows flexion, extension, abduction, adduction and medial and lateral rotation of the lower limb. It is a synovial ball and socket joint formed by the

articulation between the acetabulum and the proximal femur. It is very stable but also quite mobile (not as mobile as the shoulder).

- **Knee joint** – allows flexion and extension of the leg. It is a synovial hinge joint formed by the articulation of the distal femur with the tibia.

- **Ankle joint** – allows flexion (plantarflexion) and extension (dorsiflexion) of the foot. It is a synovial hinge joint formed by the articulation between the distal ends of the tibia and fibula with the talus.

There are many **small joints** in the lower limb, for example, those between the bones of the foot and between the small bones of the digits (toes). We will look at these in due course.

Examination of the Lower Limb and Surface Anatomy

A sound understanding of the anatomy of the lower limb is vital for competent examination of a patient, interpretation of your findings and making an appropriate plan for investigation and further management.

Before your first lower limb session, review the following movements of the lower limb and we will go over them in the first practical session. **Make sure you can show the following movements on yourself** (refer to your Introduction to Anatomy Handbook – section "Actions of the Muscles'):

- **Hip joint** – flexion, extension, abduction, adduction, medial (internal) rotation, lateral (external) rotation, and circumduction.

- **Knee joint** – flexion and extension.

- **Ankle joint** – flexion and extension.

- **Toes** – flexion and extension, adduction and abduction.

Session 31: The Anterior and Medial Thigh.

- Dissection Video: Session 31
- Dissection Instructions: Available in the MTU and via Minerva in advance.

Aims and Objectives

1. Identify and demonstrate the **key anatomical landmarks** of the pelvis and femur.
2. Know and demonstrate the **movements** of the hip and knee joints.
3. Locate the anterior and medial compartments of the thigh; know the **nerve supply** and **general actions** of the muscles in these compartments.
4. Identify and name the muscles of the **anterior compartment**, their attachments, actions and innervation.
5. Identify and name the muscles of the **medial compartment**, their attachments, actions and innervation.
6. Know and describe the course of the **major vessels** and **nerves** of both compartments.
7. Identify the boundaries and contents of the **femoral triangle**. Understand the **clinical importance** of this region.

Clinical points

- Neck of femur fracture
- Neurovascular access
- Femoral hernia
- Obturator nerve irritation
- Patellar dislocation

In the MTU you will **dissect / study** the:

- muscles of the anterior thigh
- muscles of the medial thigh
- boundaries and contents of the femoral triangle
- key anatomical landmarks of the pelvis and femur

Part 1 - Key Anatomical Landmarks: the pelvis and femur

The pelvis

In the practical session you will identify the key **bony landmarks** of the pelvis and femur.

The pelvis is a bony ring formed by the articulation of the left and right innominate (hip) bones and the sacrum. The pelvis takes the weight of the body and transmits it to the lower limbs.

- Each hip bone is formed from three separate bones – the **pubic** bone, the **ilium** and **ischium**, which fuse at the **acetabulum** – the socket of the hip joint.

- The hip bones articulate anteriorly with each other at the **pubic symphysis** and posteriorly with the sacrum at the **sacroiliac joints**.

- The superior and inferior **pubic rami** surround the **obturator foramen.** In life, the obturator foramen is almost completely closed over by the obturator membrane and muscles attached to it. A small gap in the membrane and the muscles – **the obturator canal** – allows vessels and nerves to pass between the pelvis and thigh.

- The uppermost part of the ilium is the **iliac crest**. These are palpable.

- Anteriorly, the **anterior superior iliac spine** (ASIS) and **anterior inferior iliac spine** (AIIS) are prominent.

- Posteriorly, important landmarks are the **ischial tuberosity**, **ischial spine** and the greater and lesser **sciatic notches.**

The femur

The long bone of the thigh. Like the humerus, it has a head, neck and shaft, and its distal end is expanded.

- The **head** of the femur articulates with the **acetabulum** of the pelvis to form the hip joint.

- The **neck** of the femur extends from the head.

- The **greater** and **lesser trochanters** lie distal to the neck. They are sites of muscle attachment.

- The **intertrochanteric line** lies between the greater and lesser trochanters on the anterior surface of the femur.

- The **trochanteric fossa** is a small hollow on the medial aspect of the greater trochanter.

- The **linea aspera** is a bony vertical ridge on the posterior aspect of the **shaft** of the femur. It is a site of muscle attachment.

- The distal end of the femur is expanded to form the **medial** and **lateral femoral condyles**. These articulate with the proximal tibia at the knee joint.

- Just superior to the medial femoral condyle lies the small **adductor tubercle**.

- The **patella** lies anterior to the knee joint.

Part 2 – Movement of the Hip and Knee Joints

Although we will look at the joints in more detail in a later session, we need to look at the **movements** of the hip and knee joints now, as the muscles of the anterior, medial and posterior compartments of the thigh contribute to movement at both joints.

The movements possible at the **hip** joint are flexion, extension, abduction, adduction, medial (internal) and lateral (external) rotation and circumduction.

- Muscles in the **anterior** thigh **flex** the thigh at the hip joint.
- Muscles in the **medial** thigh **adduct** the thigh at the hip joint.
- Muscles in the **posterior** thigh **extend** the thigh at the hip joint.

The movements possible at the **knee** joint are flexion and extension.

- Muscles in the **anterior** thigh **extend** the leg at the knee joint.
- Muscles in the **posterior** thigh **flex** the leg at the knee joint.

Make sure you know what the movements of the hip and knee look like and that you can **demonstrate them on yourself**.

Part 3 - Anterior Thigh

The thigh lies between the hip and knee. Deep fascia - the **fascia lata** - surrounds the thigh like a sleeve. The **iliotibial band (**or **tract)** is a thickening of the lateral part of the fascia lata. It attaches to the lateral aspect of the proximal tibia and is important for stabilising the knee joint.

Intermuscular septa extend from the fascia lata to the linea aspera and separate the thigh into anterior, medial and posterior **compartments**.

Muscles

The anterior compartment of the thigh contains seven muscles. As a group they:

- primarily act as **extensors** of the knee. Some of them act upon the hip joint.
- are innervated by the **femoral** nerve (spinal nerves **L2-L4**).

The muscles are:

- Quadriceps femoris – a group of four large muscles.
- Sartorius
- Iliopsoas
- Pectineus

Quadriceps femoris

The prime **extensor** of the knee, this group forms the bulk of the anterior thigh:

- Rectus femoris
- Vastus lateralis
- Vastus medialis
- Vastus intermedius

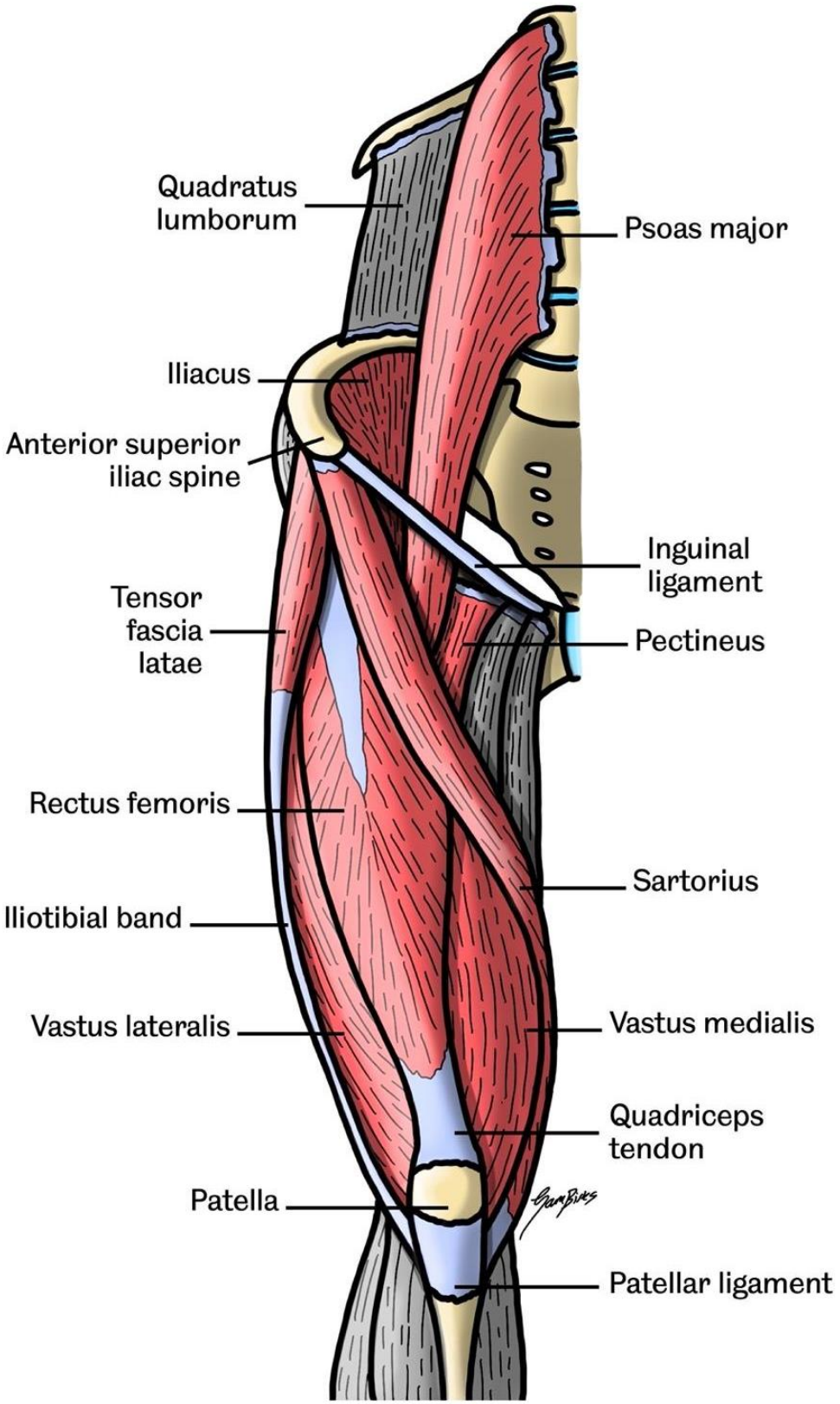
These muscles converge onto the **quadriceps tendon** which runs over the patella (kneecap) to insert onto the **tibial tuberosity** via the **patellar ligament**.

- **Rectus femoris** lies in the midline of the anterior thigh. It is attached to the **AIIS** proximally. Because it crosses the hip, it can contribute to **flexion** of the hip.

- **Vastus lateralis** lies lateral to rectus femoris. It attaches to the **linea aspera** on the **posterior** aspect of the femoral shaft.

- **Vastus medialis** lies medial to rectus femoris. It attaches to the **linea aspera**.

- **Vastus intermedius** lies deep to rectus femoris. It attaches to the **anterior** aspect of the femoral shaft.


Quadratus lumborum
Psoas major
Iliacus
Anterior superior iliac spine
Inguinal ligament
Tensor fascia latae
Pectineus
Rectus femoris
Sartorius
Iliotibial band
Vastus lateralis
Vastus medialis
Quadriceps tendon
Patella
Patellar ligament

Sartorius lies superficially in the anterior thigh.

- It attaches proximally at the **ASIS** and inserts on the **medial** aspect of the proximal tibia. It crosses both the hip and knee joints.
- It flexes and laterally rotates the hip joint and can flex the knee joint.
- Sartorius is not a prime mover, but rather contributes to these movements.

Iliopsoas lies proximally in the anterior thigh.

- Psoas major and iliacus converge via a common tendon onto the **lesser trochanter** of the femur.
- It is the prime **flexor** of the hip joint.

Pectineus lies in the proximal anterior thigh, medial to iliopsoas. Some consider it a muscle of the anterior thigh, whilst others consider it part of the medial thigh, because it has features of both – don't worry about this.

- It attaches proximally at the **superior pubic ramus** and distally on the femur, just inferior to the lesser trochanter.
- It flexes and adducts the hip joint.

Part 4 - Medial Thigh

Muscles

The medial compartment of the thigh contains five muscles. As a group they:

- primarily act as **adductors** of the hip.
- are innervated by the **obturator** nerve (spinal nerves **L2-L4**).

The adductors play an important role in normal gait as they help to draw the leg back towards the midline as we walk.

The muscles of the medial thigh are:

- Adductor brevis
- Adductor longus
- Adductor magnus
- Gracilis
- Obturator externus

(As mentioned, some consider pectineus to be part of the medial compartment).

Adductor brevis and **adductor longus** have similar points of attachment to the pubic bone and the linea aspera. **Adductor brevis** lies deep to longus. The obturator nerve lies between them.

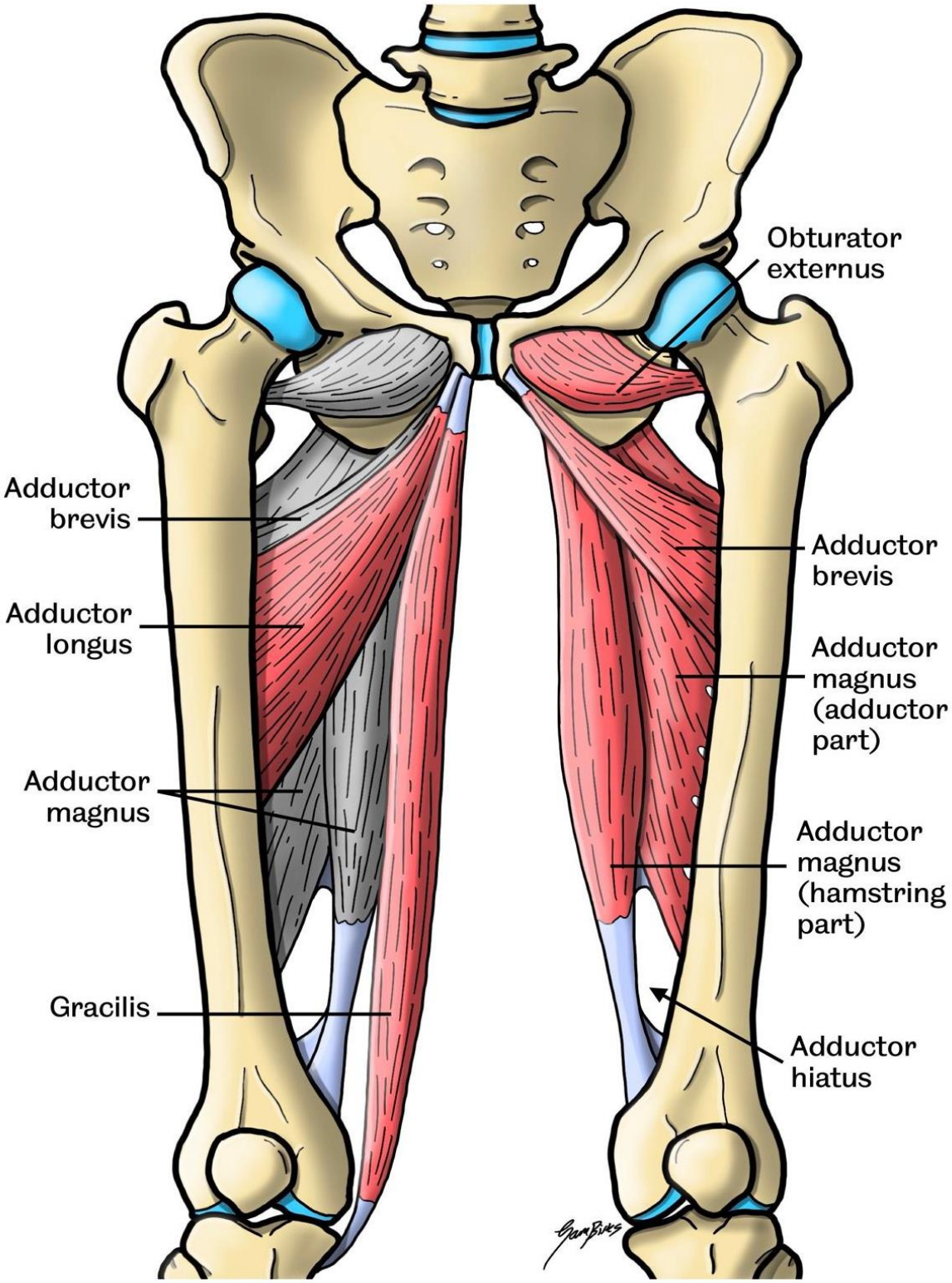
Adductor magnus is a large muscle that has an **adductor** part and a **hamstring** part. These two parts function differently and have different nerve supplies:

- The **adductor** part attaches to the inferior pubic ramus and the linea aspera. It acts as an adductor and is innervated by the obturator nerve.
- The **hamstring** part attaches to the ischial tuberosity and the adductor tubercle. We will come back to it when we look at the posterior thigh.

The **adductor hiatus** is a gap formed between the distal attachments of the two parts of adductor magnus. The femoral artery and vein travel through the adductor hiatus to enter the posterior thigh.

Gracilis is the most medial muscle. It attaches to the pubic bone and the medial aspect of the tibia. It is a weak adductor and flexor of the hip and a weak flexor of the knee. It is not a prime mover.

Obturator externus is attached to the external surface of the obturator membrane and inserts on the femur near the greater trochanter. It stabilises and laterally rotates the hip joint.


Obturator externus
Adductor brevis
Adductor longus
Adductor magnus
Gracilis
Adductor brevis
Adductor magnus (adductor part)
Adductor magnus (hamstring part)
Adductor hiatus

Part 5 - Major Vessels and Nerves

Arteries

The **femoral artery** is the continuation of the external iliac artery. It travels deep to the inguinal ligament to enter the proximal anterior thigh - it lies relatively superficially here and can be palpated. It gives a large branch called the **profunda femoris** (deep artery of the thigh) which travels deep into the thigh and supplies it. The femoral artery continues distally, traverses the adductor hiatus and enters the distal part of the posterior thigh (the popliteal fossa) where it becomes the **popliteal** artery.

The **obturator artery** is a branch of the **internal iliac** artery. It travels through the **obturator canal** into the medial compartment of the thigh. It anastomoses with branches from the femoral artery.

Veins

The **femoral vein** follows the course of the femoral artery. It lies medial to the femoral artery in the proximal thigh. It travels under the inguinal ligament and is continuous with the external iliac vein.

The **obturator vein** follows the course of the obturator artery. It travels through the obturator canal and joins the internal iliac vein in the pelvis.

Nerves

The **femoral nerve** is formed from the L2 - L4 spinal nerves. It travels deep to the inguinal ligament to enter the proximal anterior thigh lateral to the femoral artery. Branches innervate the anterior thigh muscles. The **saphenous** nerve is a sensory branch of the femoral nerve that innervates skin over the leg.

The **obturator nerve** is also formed from the L2 – L4 spinal nerves. It travels along the lateral wall of the pelvis and exits through the obturator canal. It emerges onto the superficial surface of adductor brevis and gives rise to branches that innervate the medial compartment muscles and skin over the medial thigh.

Part 6 – Femoral Triangle

The femoral triangle is a clinically important region of the proximal anterior thigh.

It has three boundaries:

- **lateral** - formed by the medial border of **sartorius**
- **medial** - formed by the lateral border of **adductor longus**
- **superior** - formed by the **inguinal ligament**

The **apex** is distal, where sartorius and adductor longus meet.

The **floor** of the triangle is formed by **iliopsoas** laterally and **pectineus** medially.

Contents of the femoral triangle

- The **femoral artery** can be palpated and accessed in the femoral triangle.

- The **femoral vein** lies medial to the femoral artery. It receives an important tributary in the femoral triangle – a superficial vein called the **great saphenous vein**.

- The **femoral nerve** lies lateral to the femoral vein. It travels deep to the inguinal ligament to enter the anterior thigh.

The femoral artery and vein lie superficially in the femoral triangle and are vulnerable to penetrating injuries.. Because of their superficial position, bleeding vessels can be compressed at the mid-inguinal point.

Part 7 - Clinical Relevance

Neck of femur fracture = 'broken hip' or 'hip fracture'

A 'fractured hip' refers to a fracture of the **femoral neck**. This is extremely common in the elderly population and can be caused even by a low energy fall. **Osteoporosis** is often a contributing factor. Patients typically have pain in the groin and struggle to walk. The typical finding on examination is **shortening** and **lateral rotation** of the affected limb compared to the uninjured limb. The fracture may tear the vessels that supply the femoral head and neck, leading to **avascular necrosis** of the femoral head.

Neurovascular access

The **femoral artery** can be accessed in the femoral triangle. This is very commonly undertaken for coronary angiography. The **femoral vein** lies medial to the femoral artery. It can be accessed for blood samples if they cannot be obtained from peripheral veins in an emergency. The **femoral nerve** can be blocked by infiltrating local anaesthetic around it. This is used to relieve pain in lower limb fractures.

Femoral hernia

This is an abnormal protrusion of intestine into the upper anterior thigh. It is more common in females. The intestine passes deep to the inguinal ligament and causes a lump to appear in the inguinal region or upper thigh. Strangulation of the herniated intestine leads to ischaemia and infarction of the tissue.

Obturator nerve irritation

Along its course on the lateral wall of the pelvis, the obturator nerve lies close to the ovary. Ovarian pathology, such as a cyst, may irritate the nerve. This typically results in sensory abnormalities (tingling, itching or pain) in the medial thigh.

Patellar dislocation

Dislocation of the patella is common. Dislocation is almost always lateral because the femur is angled obliquely relative to the tibia and so the angle of the pull of quadriceps is also oblique. The distal fibres of vastus medialis are arranged horizontally and these usually resist lateral movement of the patella.

Part 8 - Questions to Consolidate Learning

1. What is the surface marking of the femoral artery?
2. How do the femoral artery, vein and nerve lie relative to each other in the femoral triangle?
3. Which compartment and muscles are supplied by the femoral nerve? What is the general action of this muscle group?
4. Which regions of skin in the lower limb are innervated by the femoral nerve?
5. Which compartment and muscles are supplied by the obturator nerve? What is the general action of this muscle group?
6. A patient with a large right ovarian cyst develops paraesthesia in the skin over her medial thigh. Explain this finding.
7. Describe the course of the obturator nerve.
8. What forms the adductor hiatus and what passes through it?

Session 32: The Gluteal Region and Posterior Thigh.

- Dissection Video: Session 32
- Dissection Instructions: Available in the MTU and via Minerva in advance.

Aims and Objectives

1. Identify and demonstrate the **key anatomical landmarks** of the pelvis and femur.
2. Know the location of the greater and lesser **sciatic notches**, **foramina** and the **sacrotuberous** and **sacroiliac** ligaments. Know the key structures passing through both foramina.
3. Locate the gluteal region and distinguish between the superficial and deep gluteal muscles; know the **nerve supply** and **general actions** of both groups.
4. Identify and name the **superficial** muscles of the **gluteal region**. Know their attachments, actions and innervation.
5. Understand the importance of gluteus medius and minimus for **normal gait.**
6. Identify and name the **deep** muscles of the **gluteal region.** Know their attachments, actions and innervation.
7. Identify and name the muscles of the **posterior thigh.** Know their attachments, actions and innervation.
8. Name and identify the **major vessels** and **nerves** of the gluteal region and posterior thigh.
9. Identify the boundaries and contents of the **popliteal fossa**. Understand the **clinical importance** of this region.

Clinical points

- Gluteal IM injection
- Sciatica
- Popliteal aneurysm

In the MTU you will **dissect / study** the:

- superficial and deep gluteal muscles
- muscles of the posterior thigh
- popliteal fossa
- key anatomical landmarks of the pelvis and femur

Part 1 - Key Anatomical Landmarks: the pelvis and femur

We looked at these in the first lower limb session – recap them. Of importance in this session are the bony landmarks on the posterior aspect of the pelvis and femur.

The pelvis

- The posterior aspect of the **ilium** bears three ridges; the anterior, posterior and inferior **gluteal lines**.

- The posterior ilium and ischium bear two notches, the **greater** and **lesser sciatic notches**.

- The **sacrotuberous** and **sacrospinous ligaments** close these notches to form the greater and lesser sciatic **foramina**.

- The foramina allow structures to pass between the pelvis and the gluteal region and perineum. We will look at the notches, ligaments and foramina in the MTU.

- The **ischial spine** projects from the posterior ischium. The sacrospinous ligament attaches to it.

- The **ischial tuberosity** is a bulky prominence of bone at the posterior aspect of the ischium. We sit on this part of the pelvis. The muscles of the posterior thigh and the sacrotuberous ligament attach here.

The femur

- The **intertrochanteric crest** is a ridge of bone between the trochanters on the posterior aspect of the femur.

- The **gluteal tuberosity** lies just inferior to the trochanters on the posterior aspect of the femur. It is a site of muscle attachment.

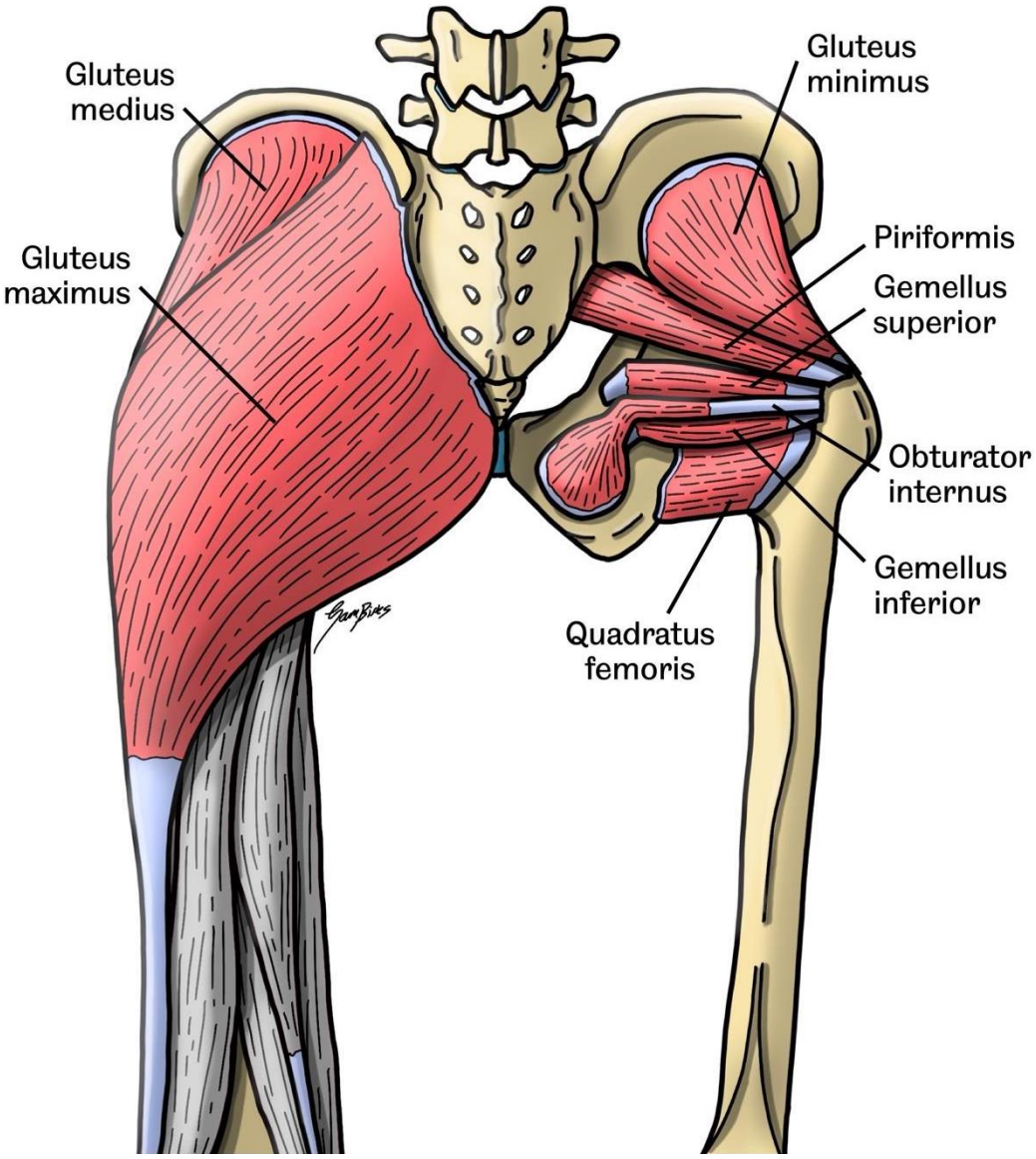
Part 2 – Gluteal Muscles

The gluteal region contains two groups of muscles, a superficial group and a deep group. We will look at these in turn.

Superficial gluteal muscles

This group comprises four muscles:

- Gluteus maximus
- Gluteus medius
- Gluteus minimus
- Tensor fascia latae



Gluteus maximus is the most superficial muscle. It has several proximal attachments – it is attached to the most posterior parts of the **posterior** surface of the **ilium**, the sacrotuberous ligament and the **sacrum**. Distally, most fibres insert into the **iliotibial tract**, with a smaller proportion attaching onto the gluteal tuberosity (not the greater trochanter!). It is an **extensor** of the hip and is important for standing from a sitting position. It also acts as a lateral rotator of the hip. Because it inserts into the iliotibial tract, it stabilises the knee joint.

Gluteus medius lies deep to maximus. **Gluteus minimus** lies deep to medius. These muscles have similar points of attachment to the posterior ilium - they both attach to **anterior** parts of the posterior surface of the ilium. They both insert onto the **greater trochanter**. Because of their similar bony attachments, they move the hip in the same way – they **abduct** and **medially rotate** it.

Gluteus medius and **minimus** play an important role in normal gait. When we walk or run, for much of the time we have only one leg in contact with the ground and the other is off the ground.

- When we stand on one leg, gluteus medius and minimus in the limb that we are standing on contract and hold the pelvis 'level', so that it does not tilt to the side that is unsupported (i.e. the side with the leg off the ground).
- If gluteus medius and minimus are weak or paralysed in one limb, the pelvis tilts to the contralateral side every time the contralateral leg is off the ground, resulting in a limp.

Tensor fascia latae (TFL, tensor of the fascia lata) is attached to the **ASIS** and inserts into the **iliotibial band**, which itself inserts onto the lateral part of the proximal **tibia**. It acts as its name suggests – contraction of the muscle tenses the fascia lata and the iliotibial band. It stabilises the knee when it is extended and it also flexes the hip joint, but is not a prime mover.

The superficial gluteal muscles are innervated by the **gluteal nerves** which leave the sacral plexus in the pelvis via the greater sciatic foramen:

- Gluteus **maximus** is innervated by the **inferior** gluteal nerve.
- Gluteus **medius** and **minimus**, and **TFL**, are innervated by the **superior** gluteal nerve.

Deep gluteal muscles

The deep gluteal muscles are small muscles that primarily **stabilise** and **laterally rotate** the hip joint. They are:

- Piriformis
- The superior and inferior gemelli
- Obturator internus
- Quadratus femoris

They all insert onto, or close to, the greater trochanter.

Piriformis is a key landmark. It attaches to the **anterior** surface of the sacrum, passes through the **greater sciatic foramen** and inserts on the **greater trochanter**. The nerves of the sacral plexus lie over it in the pelvis. The **sciatic nerve** emerges below its inferior border in the gluteal region. The sciatic nerve divides into the **tibial** and **common peroneal** (common fibular) **nerves** in the posterior thigh. We will come back to these nerves. The other deep gluteal muscles arise from the ischium, except for obturator internus, which arises from the obturator membrane. Its tendon passes through the lesser sciatic foramen.

Part 3 – Posterior Thigh

The posterior compartment of the thigh contains four muscles. These are:

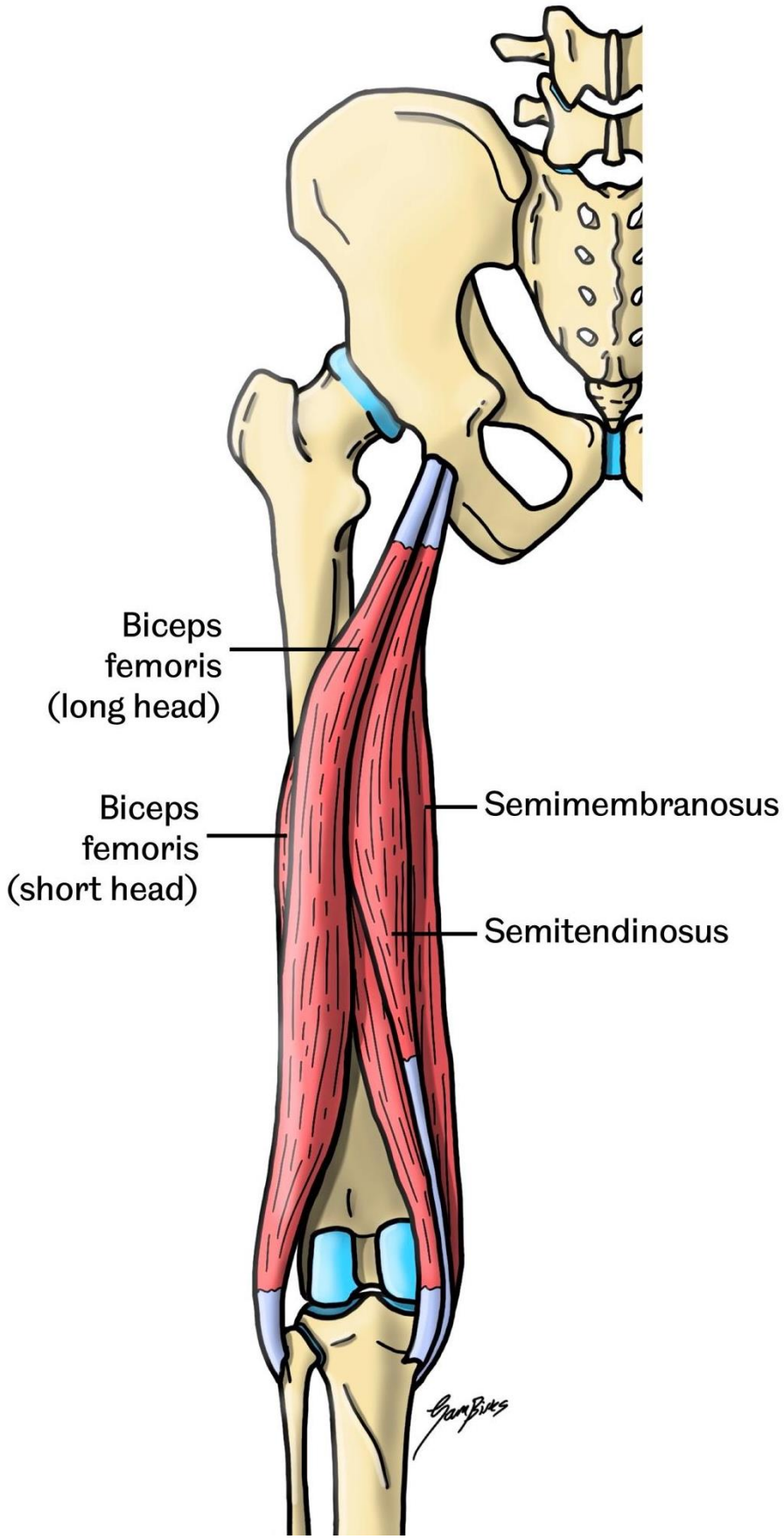
- semimembranosus
- semitendinosus
- biceps femoris (a long and a short head)
- hamstring part of adductor magnus

Three of these muscles - semimembranosus, semitendinosus and the long head of biceps femoris - span both the hip and knee joints and are referred to as the 'hamstrings'. As a group, these muscles are attached proximally to the ischial tuberosity, extend the hip, flex the knee and are innervated by the tibial nerve

Semimembranosus and semitendinosus insert on the **medial** aspect of the proximal **tibia**. The long head of biceps femoris forms a common tendon with the short head, which inserts onto the **head of the fibula**. The **short head** of biceps femoris arises from the linea aspera, therefore it flexes the knee, but does not move the hip joint. It is innervated by the **common peroneal nerve**.

The **hamstring part** of **adductor magnus** arises from the ischial tuberosity and inserts into the adductor tubercle of the femur, therefore it extends the hip but does not move the knee joint. It is innervated by the **tibial nerve**. These movements and innervations are summarised below:

Muscle	**Action**	**Innervation**
Semimembranosus	Extension of the hip Flexion of the knee	Tibial
Semitendinosus	Extension of the hip Flexion of the knee	Tibial
Biceps femoris - long head	Extension of the hip Flexion of the knee	Tibial
Biceps femoris - short head	Flexion of the knee	Common peroneal
Adductor magnus - hamstring part	Extension of the hip	Tibial
Adductor magnus - adductor part	Adduction of the hip	Obturator


Biceps
femoris
(long head)
Biceps
femoris
(short head)
Semimembranosus
Semitendinosus

Part 4 – Major Vessels and Nerves

Arteries

The gluteal muscles are supplied by the **superior** and **inferior gluteal arteries**, which are branches of the **internal iliac** artery. They leave the pelvis via the greater sciatic foramen to enter the gluteal region.

There is no large artery in the upper posterior thigh. The hamstring muscles are supplied by three or four **perforating arteries** that arise from the **profunda femoris.** These perforating arteries travel through small apertures in the adductor magnus to reach the posterior compartment.

In the lower thigh, the **femoral artery** traverses the **adductor hiatus** to enter the region behind the knee. This region is the popliteal fossa and the artery is now called the **popliteal artery**.

Veins

Superior and **inferior gluteal veins** follow the corresponding arteries through the greater sciatic foramen into the pelvis. They drain into the internal iliac vein.

The **popliteal vein** in the popliteal fossa enters the anterior thigh via the adductor hiatus. The vessel – now the **femoral vein** – ascends through the anterior thigh. It receives the **great saphenous** vein in the femoral triangle before travelling under the inguinal ligament to become continuous with the **external iliac** vein.

Nerves

The gluteal muscles are innervated by the **superior** and **inferior gluteal nerves**. These nerves leave the sacral plexus in the pelvis and travel through the greater sciatic foramen to enter the gluteal region.

The **sciatic nerve** is a very large nerve composed of fibres from the **L4 – S3** spinal nerves. It leaves the pelvis via the greater sciatic foramen and enters the gluteal region inferior to the lower border of piriformis. The nerve is really composed of two separate nerves bound together – the **tibial** nerve and the **common peroneal** (common fibular) nerve.

The **tibial** nerve innervates the muscles of the **posterior thigh** and **posterior leg.** The **common peroneal** (common fibular) nerve innervates the muscles of the **anterior** and **lateral leg**. Thus a lesion of the sciatic nerve can result in severe functional deficits.

Both nerves innervate regions of **skin** of the lower limb.

Part 5 – Popliteal Fossa

Boundaries

This is a diamond-shaped depression behind the knee joint. The two **superior** boundaries (or borders) are formed by:

- semimembranosus and semitendinosus **medially** ('superomedial')
- biceps femoris **laterally** ('superolateral')

The inferomedial and inferolateral borders are formed by the two heads of **gastrocnemius**, a superficial muscle in the posterior leg. We will learn more about this muscle later.

Contents

The popliteal fossa contains important structures:

- **Popliteal artery** - the continuation of the femoral artery. It travesrses the adductor hiatus to enter the popliteal fossa. It is possible to palpate the popliteal pulse in the fossa but it can be difficult - flexing the patient's knee gives the best chance of palpating the artery. It bifurcates into the anterior and posterior tibial arteries, which supply the leg. We will look at these in the next session.

- **Popliteal vein** - formed by the deep veins of the leg. It traverses the adductor hiatus and continues as the femoral vein.

- **Tibial nerve** - it descends through the midline of the fossa and innervates the muscles of the **posterior leg**.

- **Common peroneal (fibular) nerve** – it travels along the superolateral border of the popliteal fossa, alongside the tendon of biceps femoris. It wraps around the neck of the fibula and then splits into a superficial and a deep branch. The **superficial peroneal nerve** innervates the muscles of the **lateral** leg and the **deep peroneal nerve** innervates the muscles of the **anterior** leg.

Part 6 – Clinical Relevance

Gluteal IM injection

Gluteus maximus is a common site for **intramuscular** injection, but the sciatic nerve must be avoided. Given the position of the nerve deep to the gluteal muscles, the **only** safe place to give an injection is into the **upper outer quadrant** of the buttock. The upper medial quadrant and both lower quadrants are not safe and so avoided.

Sciatica

This term is in common use and describes pain that is felt in the posterior thigh and leg due to compression of nerve roots that contribute to the sciatic nerve (L4 - S3). Most commonly it is the result of a prolapsed ('slipped') intervertebral disc between L5 and S1.

Popliteal aneurysm

An aneurysm of the popliteal artery may rupture, causing significant bleeding. In some cases, clot forms within it, occluding blood flow to the leg. The tissues of the leg become ischaemic and tissue death occurs if flow in the artery is not quickly restored.

Part 7 - Questions to Consolidate Learning

1. Which muscles extend the hip?
2. Which muscles are the prime abductors of the hip joint? Explain why abduction is important for normal gait.
3. What structures pass:
    a. through the greater sciatic foramen?
    b. through the lesser sciatic foramen?
    c. through the obturator canal?
    d. deep to the inguinal ligament?
4. Which muscles attach to the ischial tuberosity?
5. Where should an IM gluteal injection be given and why?
6. Which arteries supply the gluteal region? What larger vessel do they arise from?
7. Which vessel supplies the posterior compartment of the thigh?

Session 33: The Anterior Leg and Dorsum of the Foot.

- Dissection Video: Session 33.
- Dissection Instructions: Available in the MTU and via Minerva in advance.

Aims and Objectives

1. Identify and demonstrate the **key anatomical landmarks** of the tibia and fibula.
2. Identify and name the **bones** and **joints** of the foot and digits; understand the **movements** that occur at these joints.
3. Locate the anterior and lateral compartments of the leg; know the **nerve supply** and **general actions** of the muscles in these compartments.
4. Identify and name the muscles of the **anterior compartment**. Know their attachments, actions and innervation.
5. Identify and name the muscles of the **lateral compartment.** Know their attachments, actions and innervation.
6. Identify and trace the tendons of the anterior and lateral leg muscles to their insertions in the foot.
7. Identify extensor digitorum brevis.
8. Name and identify the **major vessels** and **nerves** of the leg and dorsum of the foot.

Clinical points

- Tibial fracture and osteomyelitis
- Common peroneal nerve injury and foot drop
- Pulses around the ankle

In the MTU you will **dissect / study** the:

- anterior muscles of the leg
- lateral muscles of the leg
- dorsum of the foot

Part 1 - Key Anatomical Landmarks: the tibia, fibula and talus

The leg contains two bones, the tibia and fibula. They are connected via two joints and a strong interosseous membrane. The distal ends of both bones articulate with the talus at the ankle joint.

The tibia

The tibia is a thick and strong bone. Its expanded proximal end articulates with the femur to form the knee joint. Its distal end is tapered and articulates with the talus and fibula.

- The proximal part of the tibia forms medial and lateral **tibial condyles**.
- The superior surfaces of the condyles, the **medial** and **lateral tibial plateaus**, are flattened. They articulate with the femoral condyles to form the knee joint.
- The **intercondylar tubercles** lie between the tibial plateaus.
- The **tibial tuberosity** projects from the upper anterior surface of the tibia and is palpable. The patellar ligament inserts here.
- The sharp **anterior border** of the **shaft** of the tibia is palpable.
- The **soleal line** is an oblique ridge of bone on the posterior surface of the tibia.
- The **medial malleolus** projects medially from the distal end of the bone and forms part of the 'socket' for the talus.

The fibula

The fibula is a slender bone. Its proximal end does not contribute to the knee joint.

- The proximal part of the fibula is expanded and forms the **head**, which is palpable.
- The **neck** lies just distal to the head and is also palpable. The common peroneal (fibular) nerve lies close to the bone here.
- The **shaft** of the fibula is slender and is an attachment site for muscles.
- The **lateral malleolus** projects from the distal end of the bone and forms part of the 'socket' for the talus.

Part 2 – Bones and Movements of the Foot and Toes

As the muscles of the leg insert into the foot, we will look at the bones, joints and movements of the foot and toes now.

- The human foot carries the weight of the body and is adapted for bipedal gait.
- The **small joints** of the foot allow it to **deform** and **absorb shock** when walking over uneven ground.
- Part of the sole of the foot does not make contact with the ground when we stand, but is raised by the longitudinal and transverse **arches** of the foot. These are formed by the arrangement of the bones of the foot and allow shock absorption. The arches are supported by ligaments and tendons in the foot.

Bones and joints

Like the hand, the foot is composed of many small bones and joints.

- The **tarsal bones** comprise the following: the **talus**, **calcaneus** (heel bone), **navicular**, **cuboid** and three **cuneiforms** (medial, intermediate and lateral). The **talus** articulates with the tibia and fibula at the ankle joint.

- The talus and calcaneus are referred to as the **hindfoot**. The navicular, cuboid and cuneiforms comprise the **midfoot.**

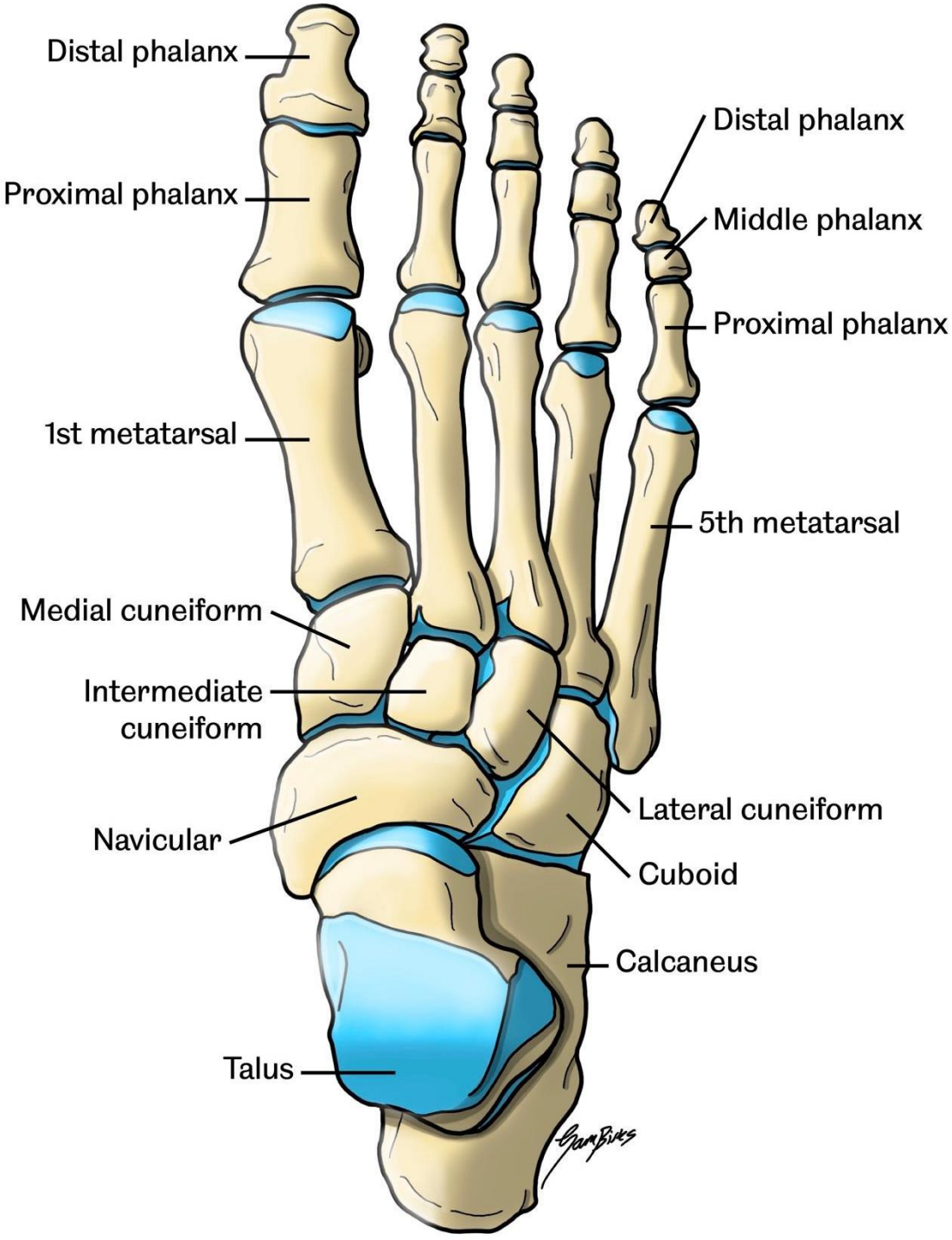
- The metatarsals and phalanges comprise the **forefoot.**

- The **metatarsals** are numbered 1 – 5 from the medial (big toe) side to the lateral (little toe) side.

- The bones of the digits (toes) are **phalanges** (singular = **phalanx**). There are three phalanges in toes 2-5 and two phalanges in the big toe (digit 1).

- The three phalanges of the toes are named proximal, middle and distal.

- The two phalanges of the big toe are named proximal and distal.



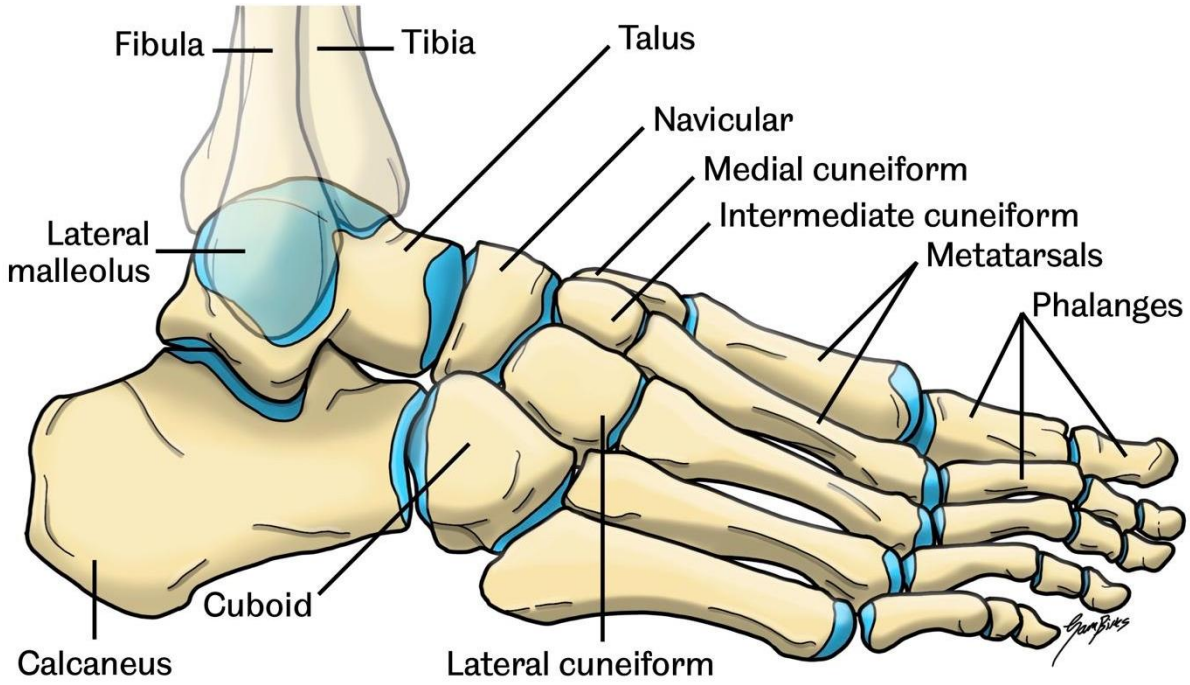
Small joints lie between the bones of the foot. We will concentrate on the joints between the metatarsals and phalanges.

- **Metatarsophalangeal** joints (MTPJ) – lie between the metatarsals and the proximal phalanges.

- **Interphalangeal** joints (IPJ) – lie between the phalanges.

- The **big toe** contains only **two phalanges** and so there is only **one joint** between them – this is the **interphalangeal joint of the big toe** (IPJ)

- Toes 2-5 contain **three phalanges** and so there are **two joints** between them:
  - the **proximal** interphalangeal joint lies between the proximal and middle phalanx (PIPJ)
  - the **distal** interphalangeal joint lies between the middle and distal phalanx (DIPJ)



Movements

Movements of the foot and toes are similar to those of the hand, but the range of movement is less extensive. The human hand is extremely dextrous, but the human foot is adapted for weight-bearing and bipedal gait, rather than fine, skilled movement.

The **foot** can move in the following ways:

- Dorsiflexion (extension) - at the ankle joint. Positions the foot so the toes point upwards.
- Plantarflexion - at the ankle joint. Positions the foot so the toes point to the floor.
- Inversion - at the **subtalar** joint. Inversion brings the sole of the foot medially.
- Eversion - at the **subtalar** joint. Eversion brings the lateral border and sole of the foot laterally.

The **subtalar joint** is formed by the articulation of the talus with the calcaneum and navicular. We will look the subtalar joint later when we look at the joints in more detail.

The **toes** move in the following ways:

- Flexion
- Extension
- Abduction (moving the toes apart)
- Adduction (bringing the toes together)

Plantarflexion at the MTP joints, especially the MTP joint of the big toe, is extremely important for pushing the foot off the ground and forward propulsion during walking and running.

Make sure you can **demonstrate** the movements of the foot and toes on yourself. We will cover these in the practical session.

Part 3 – Anterior Compartment of the Leg

The leg lies between the knee and ankle joint. Deep fascia surrounds the leg like a sleeve. Intermuscular septa extend from the deep fascia and separate the leg into anterior, lateral and posterior **compartments**.

The anterior compartment of the leg contains three muscles.

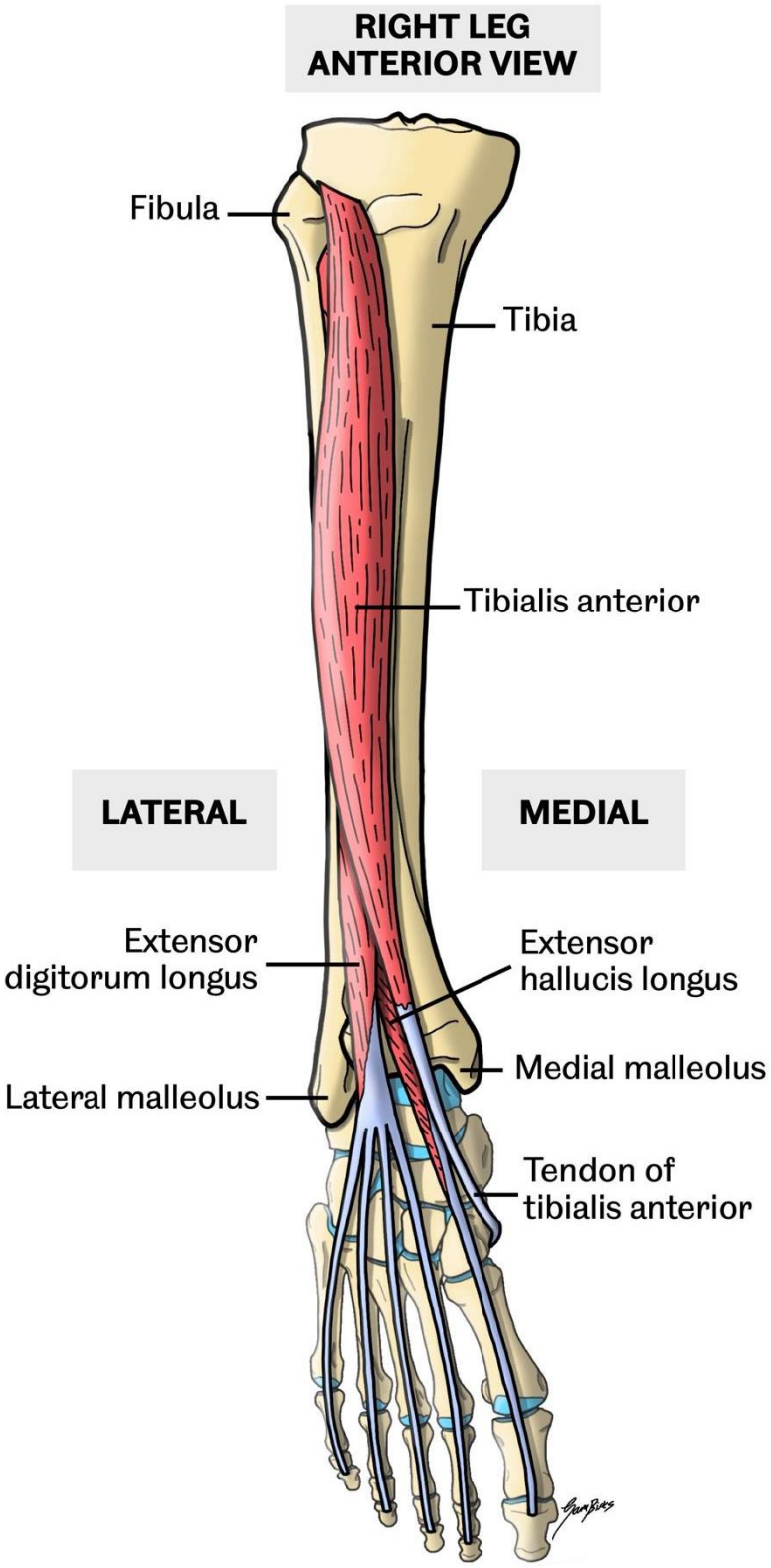
- They arise from the tibia, fibula and interosseous membrane.
- They primarily act as **dorsiflexors** (extensors) of the **foot** at the ankle joint and **extensors** of the **toes**.
- They are innervated by the **deep peroneal** nerve.

The muscles of the anterior compartment are:

- Tibialis anterior
- Extensor hallucis longus (EHL)
- Extensor digitorum longus (EDL)

Tibialis anterior crosses the anterior aspect of the ankle and inserts onto the medial cuneiform. It dorsiflexes and inverts the foot.

Extensor hallucis longus extends the big toe. Its tendon crosses the anterior aspect of the ankle and inserts onto the distal phalanx of the big toe. It also dorsiflexes the foot at the ankle.



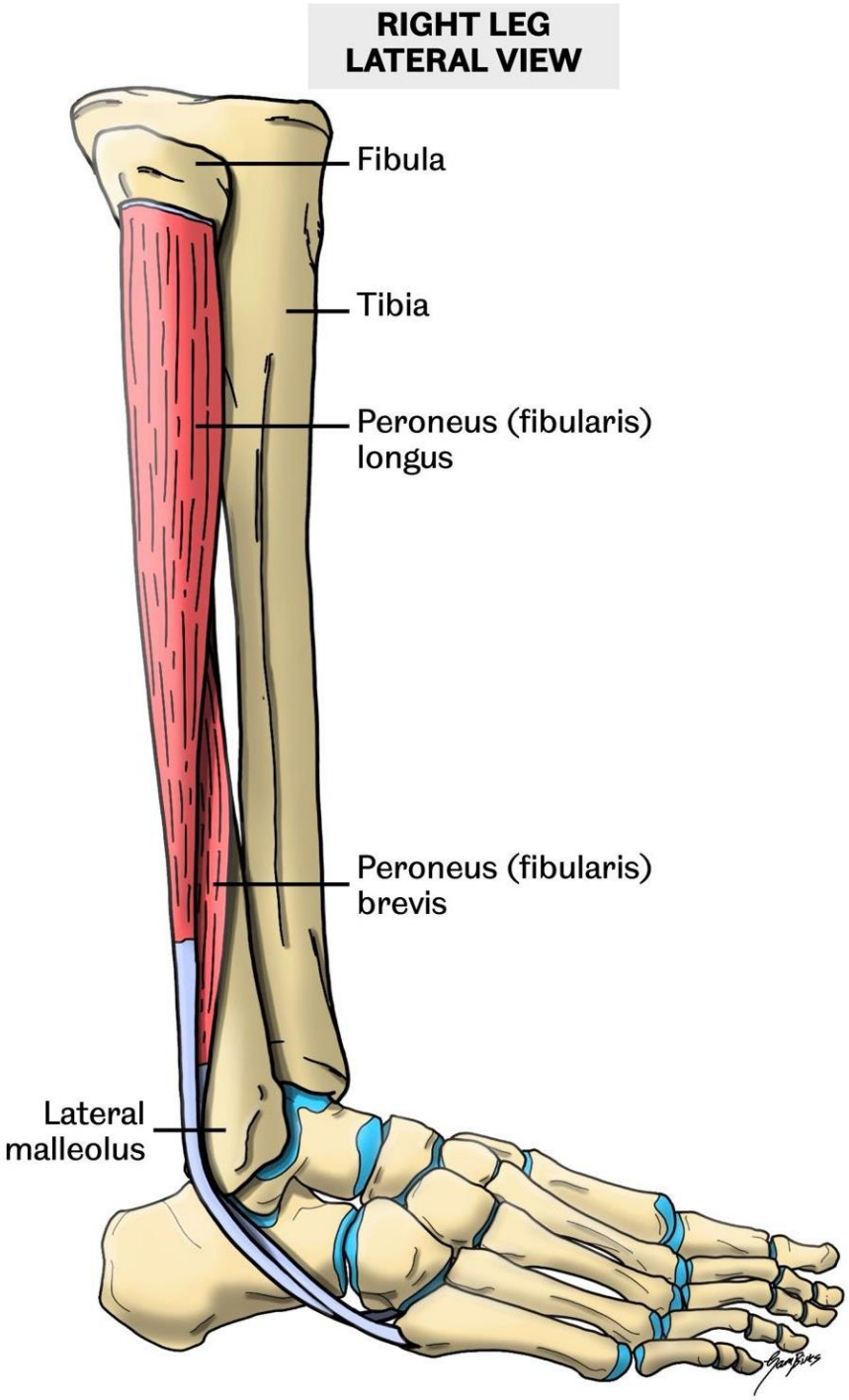
Extensor digitorum longus gives rise to four tendons. They cross the anterior aspect of the ankle and insert onto the distal phalanges of toes 2-5, extending them. It also dorsiflexes the foot at the ankle joint.

Extensor retinacula overlie the extensor tendons at the ankle joint.

Part 4 – Lateral Compartment of the Leg

The lateral compartment of the leg contains two muscles that:

- attach to the fibula
- **evert** the foot at the **subtalar** joint
- are innervated by the **superficial peroneal** nerve



The muscles of the lateral compartment are:

- Peroneus longus (fibularis longus)
- Peroneus brevis (fibularis brevis)

(In some textbooks these muscles are called fibularis longus and brevis).

Peroneus longus is the more superficial muscle. It inserts onto the plantar surface of the medial cuneiform bone.

Peroneus brevis is the deeper muscle of the two. It inserts onto the base of the 5th metatarsal.

The tendons of both muscles travel **posterior** the **lateral malleolus** to their insertions in the foot.

Part 5 – Major Vessels and Nerves

Arteries

The popliteal artery bifurcates in the popliteal fossa into **anterior** and **posterior tibial arteries.**

- The **anterior tibial** pierces the interosseous membrane to enter the anterior compartment of the leg, which it supplies.
- It crosses the anterior aspect of the ankle joint and enters the dorsum of the foot. Here, the artery is called the **dorsalis pedis** artery, and is palpable in the foot **lateral** to the tendon of extensor hallucis longus.
- The dorsalis pedis artery gives rise to branches that travel between the metatarsals and anastomose with arteries in the plantar aspect of the foot.
- The lateral compartment of the leg is supplied by the **fibular** artery, which is a branch of the **posterior** tibial artery.

Veins

There are two major **superficial veins** in the leg which drain the foot.

The **great saphenous** vein travels anterior to the medial malleolus and courses all the way up the medial aspect of the lower limb to its termination at the femoral vein in the femoral triangle.

The **small saphenous** vein travels posterior to the lateral malleolus and courses up the posterior aspect of the leg to its termination at the **popliteal vein** in the popliteal fossa.

Deep veins follow the arteries.

Nerves

The common peroneal nerve wraps around the neck of the fibula and divides into two branches – the **superficial** and **deep peroneal nerves**.

- The **superficial** peroneal nerve innervates the muscles of the **lateral** leg.
- The **deep** peroneal nerve innervates the muscles of the **anterior** leg.
- Both branches innervate regions of skin of the leg.

Part 6 – Dorsum of the Foot

The dorsum of the foot is similar to the hand in that superficial veins and extensor tendons are usually visible under the skin.

The dorsum of the foot also contains a small muscle called **extensor digitorum brevis**. It lies laterally and gives rise to four slender tendons that insert into toes 2 – 5. It is innervated by the **deep peroneal nerve**.

Part 7 – Clinical Relevance

Tibial fracture and osteomyelitis

High energy forces are required to fracture a healthy tibia. When the tibia fractures, the broken ends of the bone may break through the skin because there is little subcutaneous tissue between the anterior surface of the tibia and skin. **Open fractures** must be managed carefully to prevent infection from entering the exposed bone. Bone infection is called **osteomyelitis** and can be difficult to treat.

Common peroneal nerve injury and foot drop

The common peroneal nerve lies relatively superficially as it wraps around the neck of the fibula. Fractures of the fibular neck, caused by a lateral blow to the leg, can injure the nerve. This leads to weakness of the anterior and lateral leg muscles. The foot cannot be dorsiflexed and the toes will drag on the ground when walking. This condition is called **foot drop**. Patients compensate either by lifting the leg (by flexing the hip and knee to a greater degree) or by swinging the affected leg out – both allow the toes to clear the ground.

Pulses around the ankle

The pulsation of the **dorsalis pedis** artery is usually easily palpable over the dorsum of the foot, just lateral to the tendon of extensor hallucis longus, between the first

and second metatarsals. The pulse of the **posterior tibial** artery is palpable posterior to the medial malleolus. Because it travels behind the medial malleolus with other structures, it can be tricky to palpate.

Part 8 - Questions to Consolidate Learning

1. Which nerves supply the anterior and lateral compartments of the leg?
2. Where is the common peroneal nerve vulnerable to injury? What would be the result of an injury to it?
3. Which artery supplies the anterior compartment of the leg? Where does this artery arise from?
4. Which muscles extend the toes? Which nerves innervate them?
5. Where are pulses palpable in the leg? Give the name of the arteries and the locations where they can be palpated.
6. What complications can arise from an open fracture of the tibial shaft?
7. What movements take place at the ankle joint?
8. What movements occur at the subtalar joint?

Session 34: The Posterior Leg and Sole of the Foot.

- Dissection Video: Session 34
- Dissection Instructions: Available in the MTU and via Minerva in advance

Aims and Objectives

1. Identify and demonstrate the **key anatomical landmarks** of the ankle and foot.
2. Locate the posterior compartment of the leg; know the **nerve supply** and **general actions** of the muscles in this compartment.
3. Identify and name the superficial and deep muscles of the **posterior compartment**. Know their attachments, actions and innervation.
4. Appreciate that the foot contains **four layers** of muscles.
5. Name and identify the **major vessels** and **nerves** of the posterior leg and sole of the foot.
6. Know the **cutaneous innervation** of the lower limb.

Clinical points

- Deep vein thrombosis (DVT)
- Compartment syndrome
- Achilles tendon rupture
- Gout
- Penetrating injuries in the sole of the foot
- Plantar fasciitis

In the MTU you will **dissect / study** the:

- posterior muscles of the leg
- sole of the foot
- bones of the foot

Part 1 – Posterior Compartment of the Leg

The posterior compartment of the leg contains a superficial and a deep group of muscles.

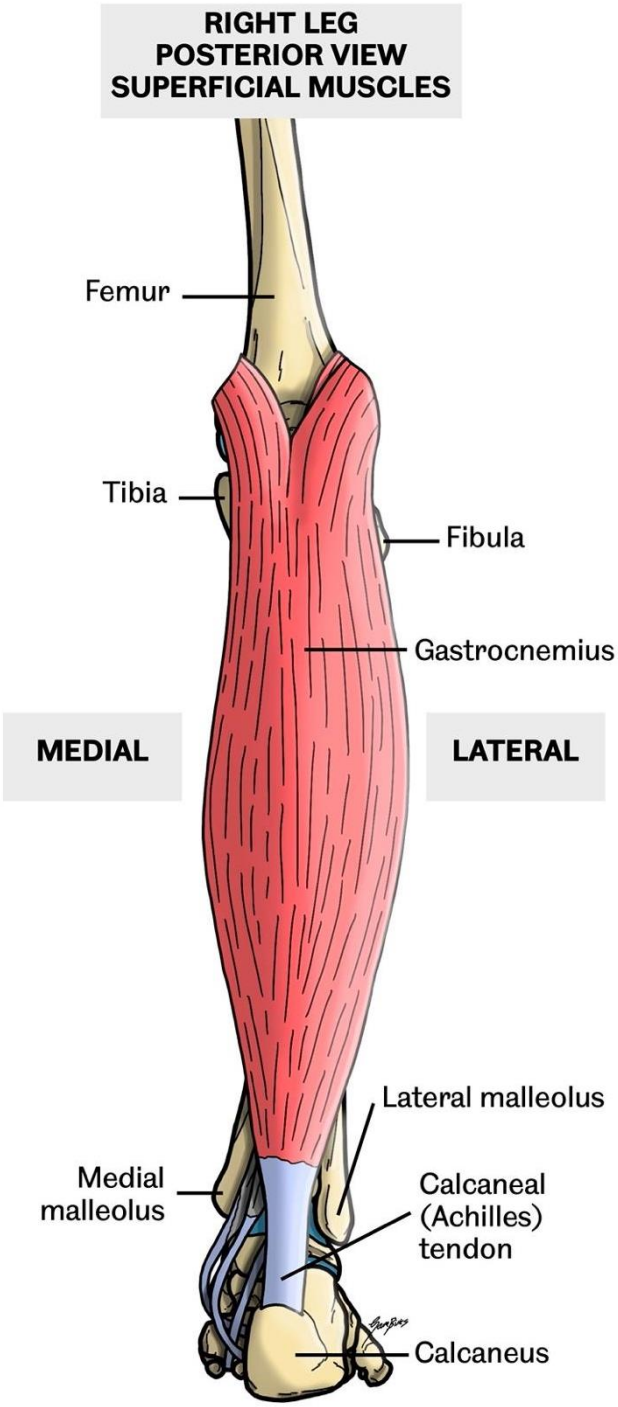
- They primarily act as **plantarflexors** of the foot at the ankle joint and flexors of the toes.
- They are innervated by the **tibial** nerve.

Superficial muscles

There are three superficial muscles;

- Gastrocnemius
- Soleus
- Plantaris

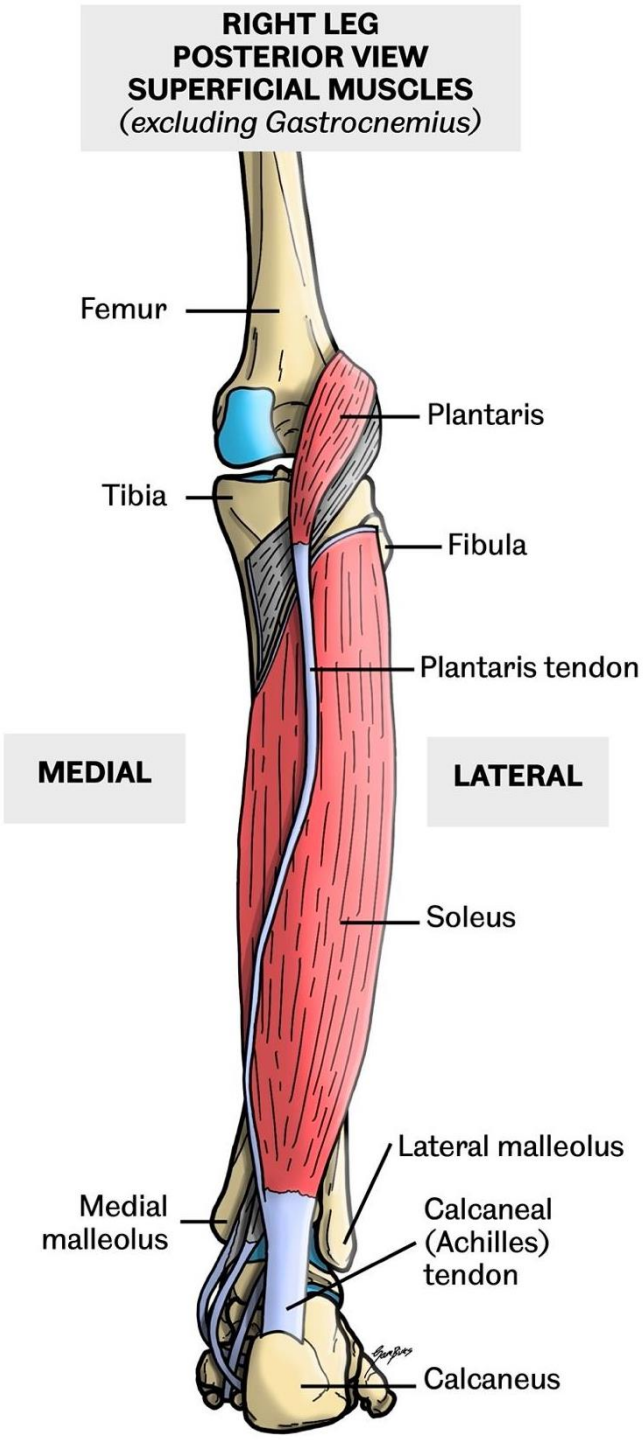
The tendons of all three muscles insert into the **calcaneus** via the calcaneal (**Achilles**) tendon.



Gastrocnemius is the most superficial muscle of the leg. It attaches via two heads to the distal femur. This means it can flex the knee in addition to plantarflexing the ankle.

Soleus is a large, flat muscle that lies deep to gastrocnemius. It is attached to the soleal line. Contraction of soleus compresses the deep veins of the leg and is important for venous return.

Plantaris is a very small muscle that lies close to the popliteal fossa. It gives rise to a very long, thin tendon which merges with the Achilles tendon.



Deep muscles

There are four deep muscles:

- popliteus
- tibialis posterior
- flexor hallucis longus (FHL)
- flexor digitorum longus (FDL)

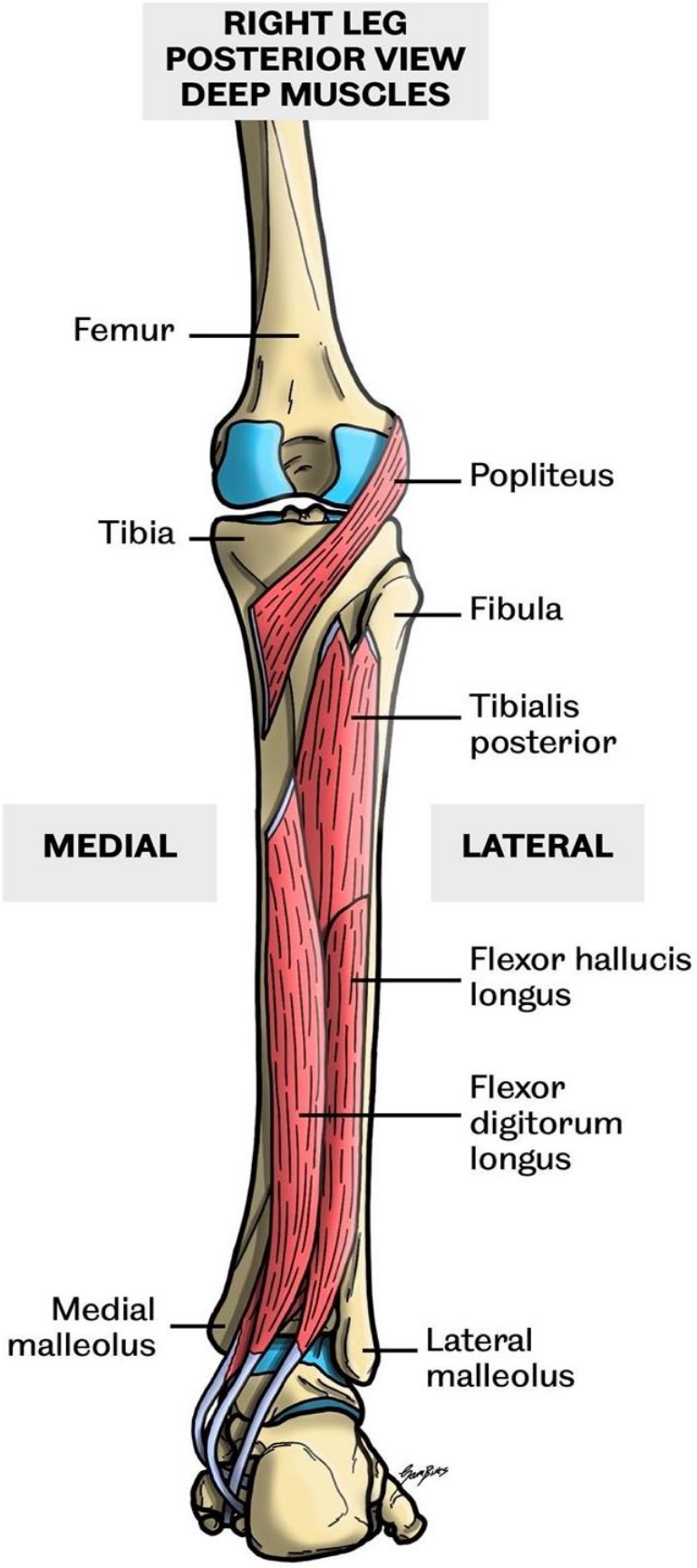
The tendons of the latter three muscles all travel **posterior to the medial malleolus** and insert into the plantar surface of the bones of the foot.

Popliteus lies in the popliteal fossa. It is attached to the tibia and the femur. It allows for a small degree of rotation of the knee. When the knee is flexed from full extension, popliteus slightly rotates the knee before flexion begins.

Tibialis posterior plantarflexes and inverts the foot. Its tendon attaches to multiple bones in the foot.

Flexor hallucis longus (FHL) flexes the big toe via its insertion into the distal phalanx. It also plantarflexes the foot.

Flexor digitorum longus (FDL) gives rise to four tendons that insert into the distal phalanges of toes 2-5. Its primary action is flexion of the toes, but it also plantarflexes the foot.


RIGHT LEG
POSTERIOR VIEW
DEEP MUSCLES
Femur
Popliteus
Tibia
Fibula
Tibialis posterior
MEDIAL
LATERAL
Flexor hallucis longus
Flexor digitorum longus
Medial malleolus
Lateral malleolus

Part 2 – The Sole of the Foot

The plantar aspect of the foot contains numerous intrinsic muscles, much like the palm of the hand.

- They are arranged in **four layers** and mirror those of the palm.
- They include abductors of the big and little toes, flexors of the toes, an adductor of the big toe, lumbricals and interossei.
- They are innervated by the **medial** and **lateral plantar nerves**, which are the terminal branches of the **tibial nerve.**

We are not going to name the muscles here. It is important to appreciate that the most important function of the muscles is that they work as a **group** to support the foot. We will try to identify as many of them as possible when we dissect them in the MTU. Dissection of the sole of the foot is challenging because of the thick skin and subcutaneous tissue, including the **plantar aponeurosis**, which lie superficial to the muscles - these structures are protective.

Part 3 – Major Vessels and Nerves

Arteries

The **popliteal artery** bifurcates into the **anterior** and **posterior tibial arteries**. The course of the anterior tibial artery has been described in the previous session.

The **posterior** tibial artery supplies the **posterior** compartment of the leg and sole of the foot.

- It gives rise to the **fibular** artery, which supplies the lateral compartment.
- The **posterior tibial** artery travels **posterior to the medial malleolus,** along with the tendons of tibialis posterior, FHL and FDL to enter the plantar aspect of the foot. The artery is palpable here, but it is not as easy to palpate as the dorsalis pedis artery.
- In the foot, the posterior tibial artery bifurcates into **medial** and **lateral plantar** arteries, which supply the sole of the foot.

Branches of the **dorsalis pedis** artery, which enter the sole of the foot from the dorsum, anastomose with branches of the **plantar** arteries. The **deep plantar arch** is an important vessel formed by the lateral plantar artery and a branch of the dorsalis pedis.

Metatarsal and digital arteries supply the forefoot and toes.

Veins

The posterior tibial, anterior tibial and fibular arteries are accompanied by **deep veins**. These veins unite to form the **popliteal** vein.

Superficial veins drain most of the blood from the foot. Superficial veins can usually be seen over the dorsum of the foot. The **dorsal venous network** drains medially to the **great saphenous vein** and laterally to the **small saphenous vein**. The small saphenous enters the popliteal vein in the popliteal fossa. The great saphenous meets the femoral vein in the femoral triangle.

Nerves

The **tibial** nerve innervates all the muscles in the posterior compartment of the leg and plantar surface of the foot.

- It travels **posterior** to the **medial malleolus** along with the tendons of tibialis posterior, FHL and FDL.
- It enters the sole of the foot and divides into two branches; the **medial** and **lateral plantar nerves**, which course along the medial and lateral aspects of the sole of the foot, respectively, alongside the corresponding arteries of the same name.
- These nerves innervate all the intrinsic muscles in the plantar aspect of the foot.
- Digital nerves enter the toes.

Both the tibial nerve and the common peroneal (fibular) nerve innervate the **skin** of the foot.

- The **tibial** nerve innervates **most** of the skin on the **plantar** surface of the foot.
- The **common peroneal** (fibular) nerve and its branches innervate the skin over the **anterolateral leg** and **dorsum of the foot**.

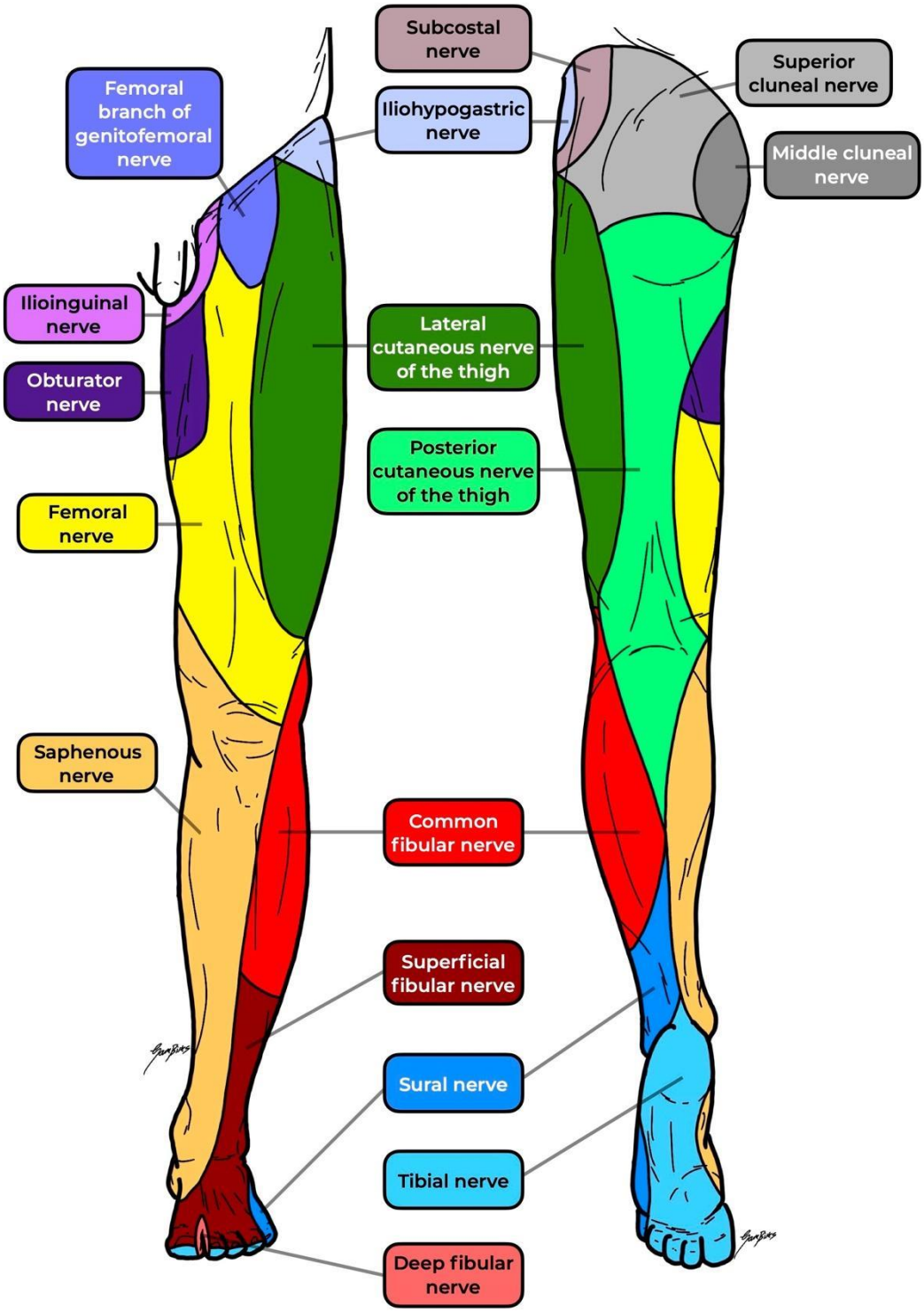
Part 4 – The Cutaneous Innervation of the Lower Limb

Understanding the pattern of innervation of the skin of the lower limb is important for clinical examination. Sensation can be assessed by examining:

- the territories of the peripheral nerves
- the dermatomes

Peripheral nerves

The territories of skin supplied by the **peripheral nerves** of the lower limb are illustrated on the following image:



- **Femoral**: anterior thigh and anteromedial leg (via the saphenous nerve)
- **Obturator**: medial thigh
- **Common peroneal:** anterolateral leg and dorsum of the foot
    - **Superficial peroneal**: lower anterolateral leg, most of the dorsum of the foot
    - **Deep peroneal**: 1st interdigital cleft
- **Tibial nerve**: sole of the foot

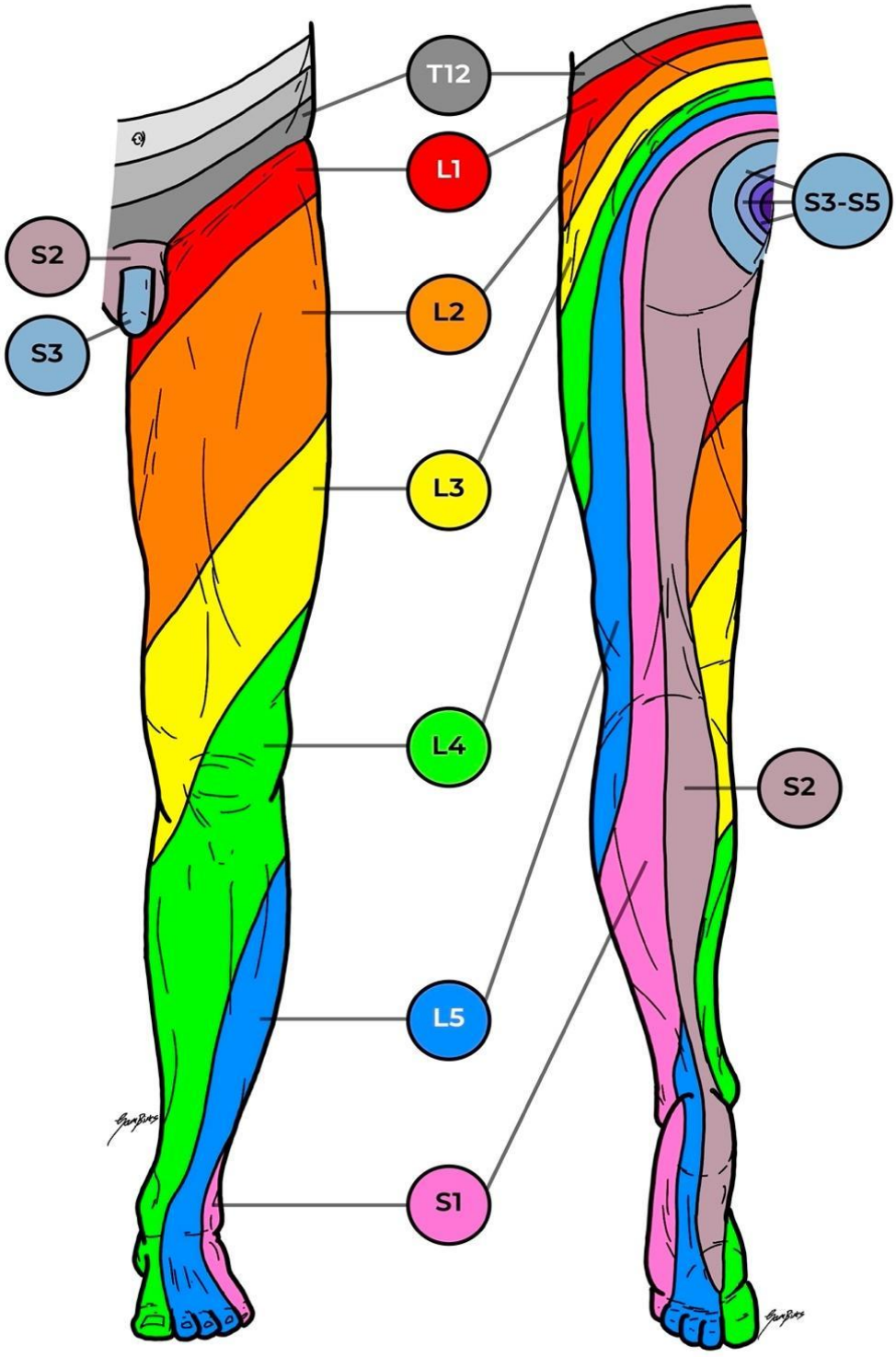
Just as in the upper limb, the these are the **approximate** territories of each nerve and there is some variation between individuals. However, testing sensation over these areas of skin should allow us to assess the integrity of the corresponding nerves.

Dermatomes

Just as in the upper limb, the territories of skin supplied by the peripheral nerves are different to those innervated by spinal nerves. The **dermatomes** of the lower limb are illustrated below. On the **anterior** surface of the lower limb the dermatomes are arranged in roughly oblique 'strips', running inferiorly from the lateral aspect of the lower limb to the medial aspect. On the **posterior** aspect of the lower limb, the dermatomes are arranged more vertically.

The approximate regions innervated by L1 to S2 are:

- **L1:** the region over the inguinal ligament
- **L2:** the upper half of the anterior thigh
- **L3:** the lower anterior thigh and the medial aspect of the knee
- **L4:** on the anterior surface of the lower limb, the lateral aspect of the lower thigh, knee and upper leg. The dermatome extends obliquely, inferiorly and medially, to cover the anterior knee, the anteromedial leg, the dorsum of the medial aspect of the foot and the skin over the dorsum and plantar surface of the big toe.
- **L5:** On the anterior surface of the lower limb, laterally the dermatome covers the lower two-thirds of the leg, excluding the skin over the lateral ankle. The dermatome extends obliquely, inferiorly and medially to cover the dorsum of the middle of the foot and the dorsum of toes 2-4. The nerve innervates a corresponding region of skin on the sole of the foot (the skin in the middle of the foot and over the plantar surface of toes 2-4). Posteriorly, the nerve innervates a vertical strip of skin laterally, extending from the buttock to the upper leg.
- **S1:** Posteriorly, the nerve innervates a vertical strip of skin in the middle of the thigh, extending over the lateral part of the posterior leg, the lateral aspect of the ankle, the lateral aspect of the dorsum and sole of the foot and the skin over the dorsum and plantar aspect of the little toe.
- **S2:** Posteriorly the nerve innervates a vertical strip of skin over the medial thigh and leg, extending onto the medial aspect of the sole of the foot, but excluding the plantar surface of the big toe (which is innervated by L4).



To test the dermatomes, sensation is tested over the following areas:

- **L1**: region over the inguinal ligament
- **L2**: upper anterior thigh
- **L3**: medial aspect of the knee
- **L4**: anteromedial leg
- **L5**: anterolateral leg
- **S1**: 5th digit / lateral side of the foot

Part 5 – Clinical Relevance

Deep vein thrombosis (DVT)

Thrombus, or clot, can develop in the deep veins of the leg. Venous return from the leg is impaired, causing swelling, pain, redness and warmth of the affected leg. It is important to recognise and treat DVT, as the clot may migrate proximally and enter the pulmonary circulation, causing pulmonary embolism – a potentially fatal condition.

Compartment syndrome

Because the deep fascia and intermuscular septa do not stretch, swelling in one of the compartments of the leg (e.g., oedema, bleeding) increases pressure in the compartment and compresses muscles, nerves and blood vessels. Once the pressure exceeds capillary perfusion pressure, ischaemia and infarction of the tissues occurs if not treated promptly by releasing the fascia (fasciotomy).

Achilles tendon rupture

The typical mechanism of injury is a sudden, forceful plantarflexion of the ankle, such as pushing off from the ground to jump or run. Patients present with pain and altered gait, as they cannot plantarflex the foot to push-off from the ground when walking. On examination, they cannot plantarflex the foot against resistance.

Gout

Gout can affect any joint, but typically first presents at the first metatarsophalangeal joint. The joint becomes swollen, red and warm, and is extremely painful.

Penetrating injuries in the sole of the foot

It is not uncommon for patients to present with puncture wounds or lacerations to the sole of the foot. The deep plantar arch may bleed heavily if involved.

Plantar fasciitis

This is inflammation of the plantar aponeurosis and is associated with high-impact activity, such as running. It causes pain on the plantar surface of the foot.

Part 6 - Questions to Consolidate Learning

1. A patient sustained a traumatic injury which severed his sciatic nerve in his gluteal region. What functional deficits would you expect him to have?
2. Which muscles attach to the Achilles tendon? If a patient ruptured the tendon, what function deficit would result?
3. Where is the great saphenous vein formed? Describe its course from its distal origin to its proximal termination.
4. Which muscles flex the toes?
5. How many muscle layers are in the sole of the foot?
6. What are the key nerves and arteries of the sole of the foot? From which nerves and arteries do they arise? How to they enter the sole of the foot?
7. A patient presents with an aching, swollen, red and warm leg. What is the likely diagnosis? Which muscles of the leg are key in preventing this condition?

Session 35: The Joints of the Lower Limb.

- Dissection Video: Session 35
- Dissection Instructions: Available in the MTU and via Minerva in advance

Aims and Objectives

1. Identify and demonstrate the **key anatomical landmarks** of the bones of the lower limb.
2. Know the **movements** that occur at the hip, knee and ankle joints and be able to demonstrate these. Know which muscle groups are responsible for the movements of these joints.
3. Understand how the anatomy of these joints is adapted to their function.
4. Identify the key **ligaments, tendons and cartilages of the hip, knee and ankle joints.** Understand how they function.
5. Understand how the **menisci and ligaments** of the knee may be injured and the consequences of such injuries.
6. Understand how the **ankle ligaments** may be injured by inversion and eversion injuries.
7. Identify the **subtalar joint** and know that inversion and eversion of the ankle occur here. Be able to demonstrate these movements. Know which muscle groups are responsible for the movements of this joint.

Clinical points

- Arthritis of the hip, knee and ankle joints
- Posterior dislocation of the hip
- Meniscal and ligament injuries at the knee
- Ankle sprains

In the MTU you will **dissect / study** the:

- hip joint
- knee joint
- ankle joint
- joint prostheses

Part 1 – Key Anatomical Landmarks of the Bones of the Lower Limb.

Throughout the course we have looked at the bones and bony landmarks of the lower limb, so do refer back to the lower limb sessions in this Handbook.

In the sessions so far, we have looked at the movements of the lower limb joints and the muscle groups responsible. Your **IMMS Anatomy** Handbook contains a general overview of the different types of joints and the movements that occur at them – **refer back to this**. Here we will summarise key points.

Part 2 – The Hip Joint

Overview

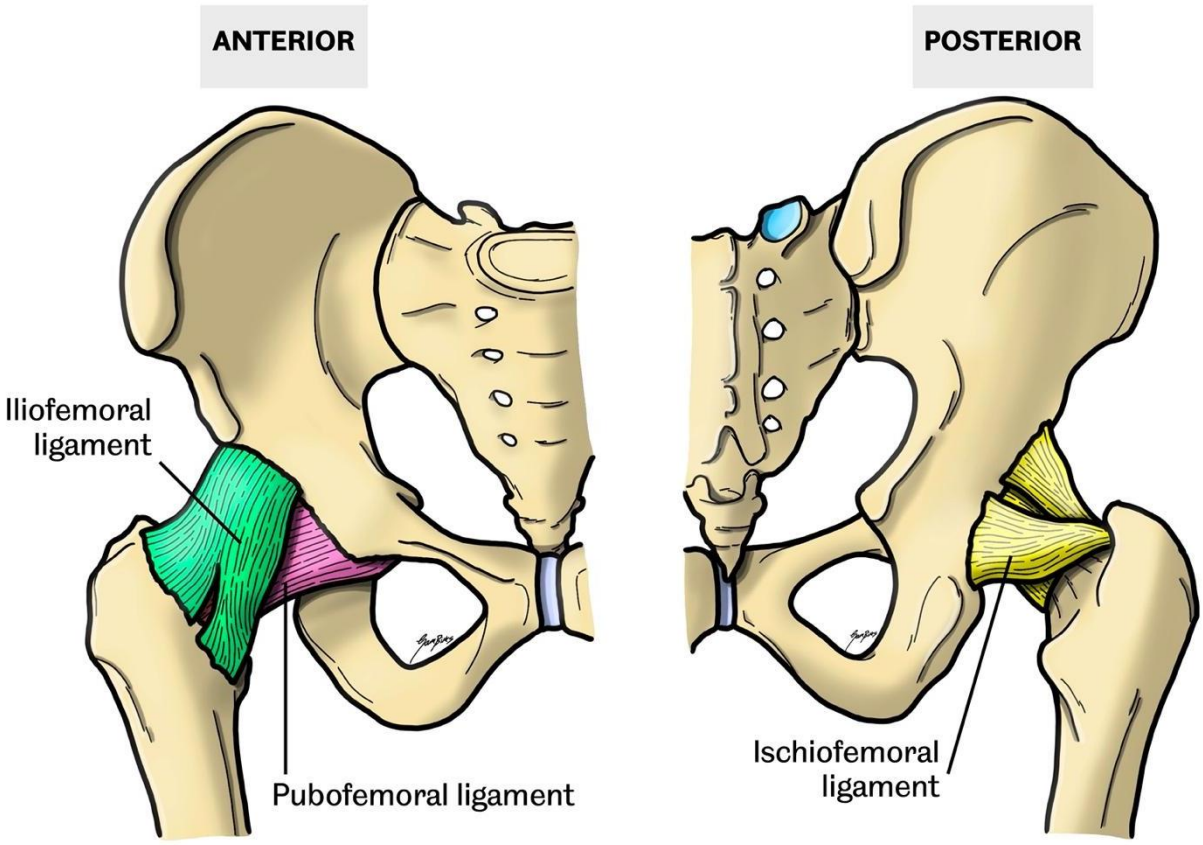
The hip is a synovial, **ball and socket** joint formed by the articulation between the **acetabulum** of the hip (innominate) **bone** and the **femoral head.**

- The weight of the body is transmitted through the lumbar vertebrae and the sacroiliac joints to the hip joints.
- The hip is a stable joint as the acetabulum is deep and there is a good fit between it and the femoral head.
- A rim of fibrocartilage - the **acetabular labrum** – deepens the acetabulum.
- The **ligament of the head of the femur** is a weak ligament that attaches the femoral head to the acetabulum.
- The joint capsule is reinforced by strong ligaments.
- The **arteries** to the hip joint arise mainly from the **profunda femoris.** They give rise to retinacular arteries that run along the neck of the femur to supply the femoral head. They can be torn by fractures of the femoral neck.

Ligaments

The hip joint is stabilised by three ligaments - the **iliofemoral, pubofemoral** and **ischiofemoral** ligaments.

Identify these on the image. Note the iliofemoral and pubofemoral are anterior ligaments, whilst the ischiofemoral lies posterior to the joint. As the hip is extended, these ligaments become taut and hold the femoral head more tightly. The hip is therefore most stable in extension.



Muscles and Movements

Using the knowledge you have developed over the course of the lower limb sessions, complete the following table:

Movement of the hip	**Muscles involved**
Flexion	
Extension	
Abduction	
Adduction	
Lateral rotation	
Medial rotation	

Part 3 – The Knee Joint

Overview

The knee is a synovial **hinge joint** formed by the articulation between the **femoral condyles** and the **tibial condyles.**

- The tibial plateaus are flat and do not provide a good fit for the femoral condyles.
- The femur and tibia achieve their 'best fit' with each other when the knee is extended, hence the knee is most stable in extension.
- The muscles, tendons, cartilage and ligaments of the knee joint provide stability.
- The iliotibial tract attaches to the lateral aspect of the tibia and stabilises the knee.

Muscles and Movements

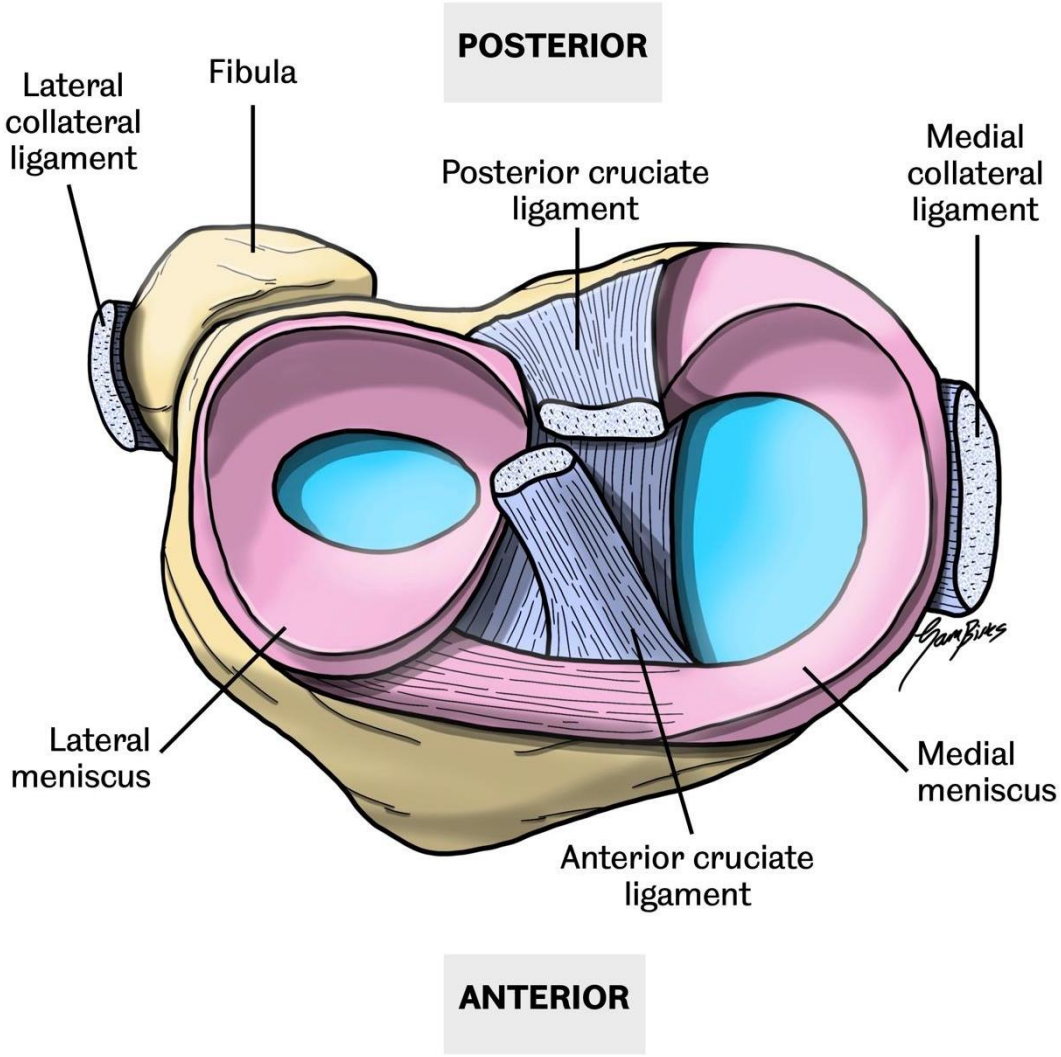
Using the knowledge you have developed over the course of the lower limb sessions, complete the following table:

Movement of the knee	**Muscles involved**
Flexion	
Extension	

Menisci

The menisci (singular = meniscus) are C-shaped cartilages that lie on the tibial plateaus. They are wedge-shaped, with the thickest part lying peripherally and the thinnest part lying centrally. They deepen the tibial condyles for articulation with the femoral condyles.

The **medial meniscus** is attached to the joint capsule along its peripheral margin and is attached to the medial (tibial) collateral ligament. These attachments make it prone to injury if the knee is twisted. The **lateral meniscus** is not attached to the lateral (fibular) collateral ligament; it can move more freely, so is less prone to injury.



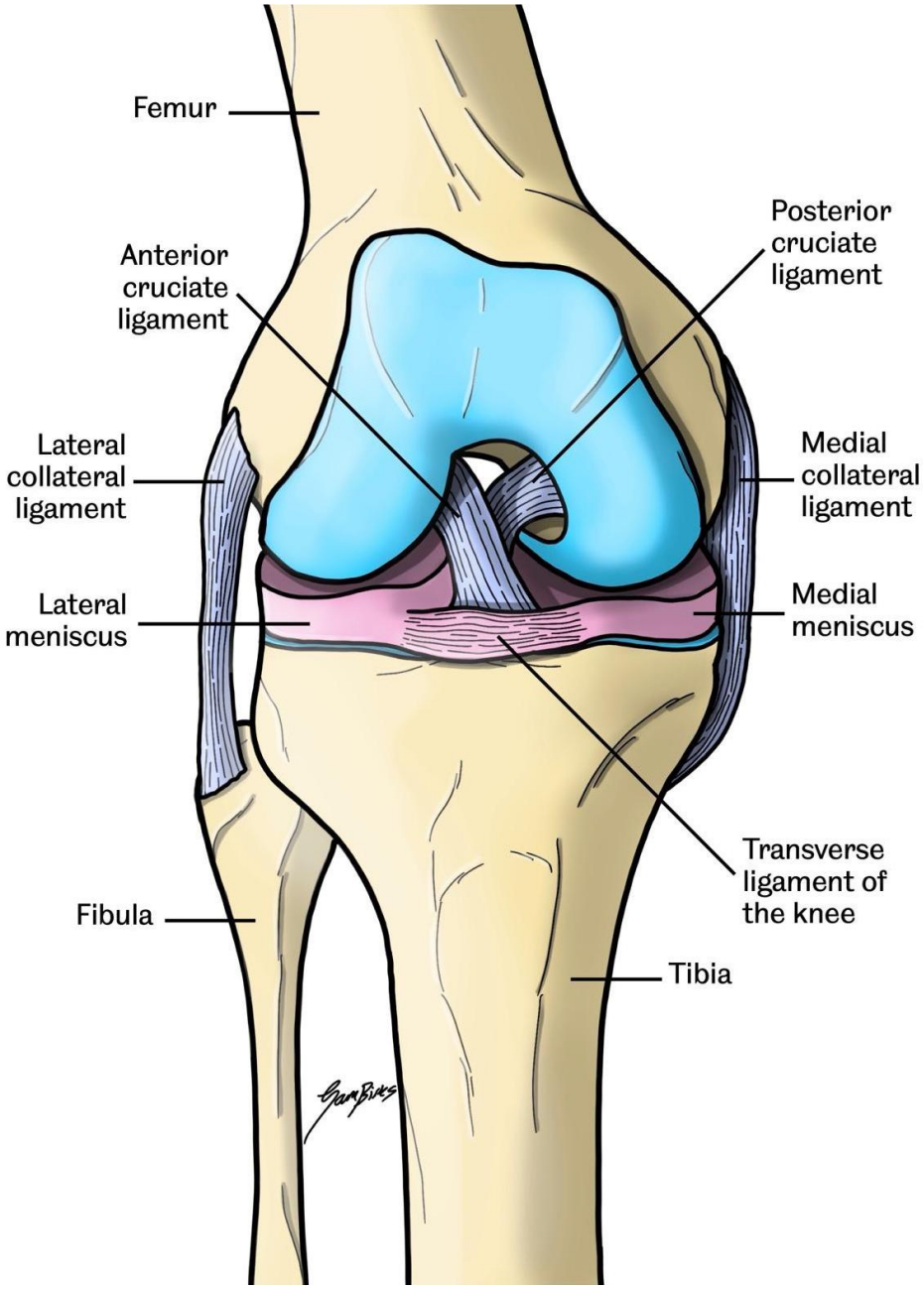
Ligaments

There are several important ligaments at the knee joint, but we will focus on two important pairs. These are the collateral ligaments and the cruciate ligaments.

The medial (tibial) and lateral (fibular) **collateral ligaments** support the knee and resist sideways movement of the tibia on the femur.

- The medial connects the femur to the tibia and the lateral connects the femur to the fibula.
- The medial (tibial) collateral ligament is attached to the medial meniscus; the lateral (fibular) collateral is not attached to the lateral meniscus – this arrangement has clinical implications.
- They are loose when the knee is flexed but taut in extension.

The **anterior** and **posterior cruciate ligaments** connect the tibia to the femur and are named according to their attachments to the tibia. The cruciate ligaments are lax when the knee is flexed, but taut when the knee is extended.



The **anterior cruciate ligament** is attached to the anterior part of the intercondylar area of the tibia. It attaches to the medial aspect of the lateral condyle of the femur. It prevents the tibia moving anteriorly relative to the femur (or, to think of it another way, it prevents the femur moving posteriorly relative to the tibia). Being able to pull the tibia anteriorly indicates ACL injury.

The **posterior cruciate ligament** is attached to the posterior part of the intercondylar area of the tibia. It attaches to the lateral aspect of the medial condyle of the femur. It prevents the tibia moving posteriorly relative to the femur (or, to think of it another way, it prevents the femur moving anteriorly relative to the tibia). This ligament is therefore crucial for stability of the knee when walking downhill or downstairs. Being able to push the tibia posteriorly indicates PCL injury.

Part 4 – The Ankle Joint

Overview

The ankle is a synovial hinge joint formed by the articulation between the distal **tibia,** distal **fibula** and the **talus.**

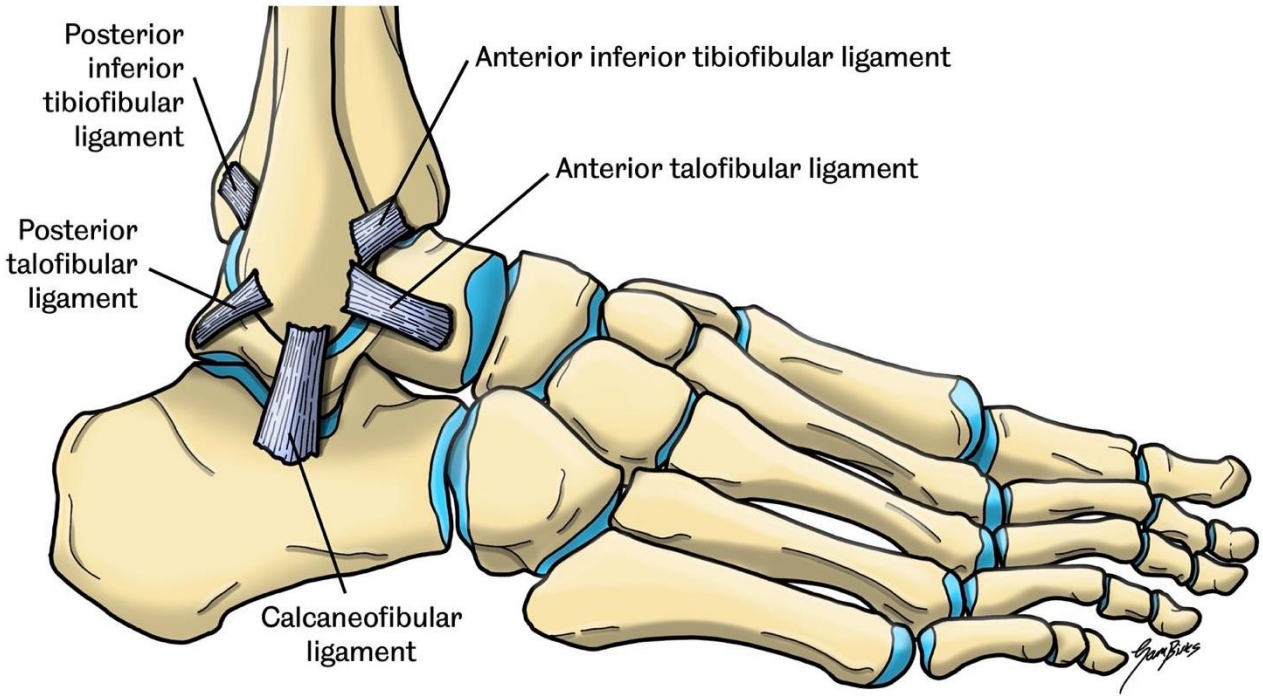
- The socket formed by the tibia and fibula for the talus is called the ankle **mortise**
- The malleoli 'grip' the talus. The joint is most stable in dorsiflexion.
- The joint is stable and supported by strong medial and lateral **ligaments.**

Ligaments

Many ligaments support the ankle joint. We will summarise them here.

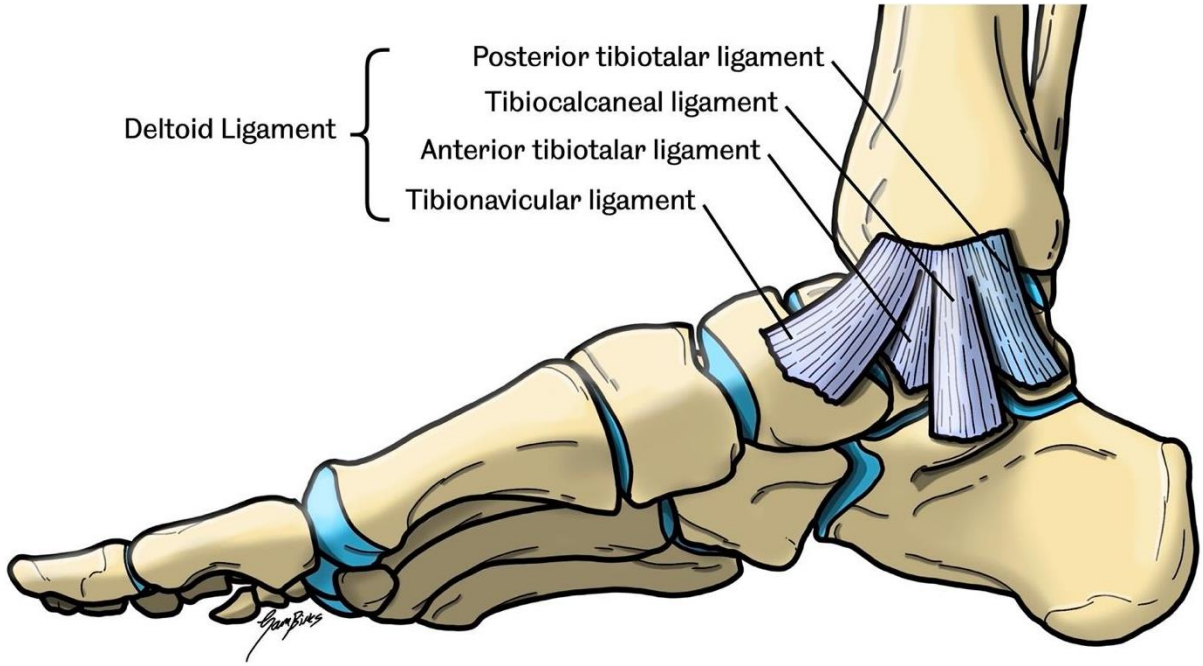
Three key ligaments support the **lateral aspect** of the ankle joint.

- They attach to the lateral malleolus.
- They are the anterior talofibular, posterior talofibular and the calcaneofibular.
- However, we will simply think of them as the **lateral ligament** of the ankle.



Several ligaments support the **medial aspect** of the ankle joint.

- They attach to the **medial malleolus**
- We can think of them simply as the **medial ligament** of the ankle; this is often also referred to as the **deltoid ligament**, because of the overall shape of the ligaments as a group.



The subtalar joint

This joint is formed by the articulation of the talus with the calcaneum and navicular. It is at this joint that **inversion** and **eversion** of the foot take place. Inversion and eversion are important in allowing us to walk on uneven ground.

- **Inversion** brings the sole of the foot medially.
- **Eversion** raises the lateral border of the foot and brings the sole of the foot laterally.
- Forced inversion and eversion sprain the ligaments of the ankle.

Muscle and Movements

Using the knowledge you have developed over the course of the lower limb sessions, complete the following table:

Movement of the foot	**Muscles involved**
Plantarflexion (at the ankle)	
Dorsiflexion (at the ankle)	
Inversion (subtalar joint)	
Eversion (subtalar joint)	

Part 5 – Clinical Relevance

Arthritis of the hip, knee and ankle joints

Osteoarthritis of the hip joint and knee joint is very common. It causes progressive pain and limited mobility. Hip and knee replacement are two of the commonest surgical procedures undertaken in the UK. Arthritis at the ankle also occurs.

Posterior dislocation of the hip

Dislocation of the hip requires significant force because the joint is stable. Posterior dislocation of the femoral head tends to occur in car accidents, when the knee forcibly impacts the dashboard. The force is transmitted along the femur and the head is forced posteriorly. The acetabulum may fracture. A posterior dislocation risks injury to the sciatic nerve, which lies just behind the hip joint.

Meniscal and ligament injuries at the knee

The menisci can be torn by twisting injuries of the knee. Tears of the **medial** (tibial) **collateral ligament** result from a lateral blow to the knee or twisting injuries. Because it is attached to the medial meniscus, the meniscus may also tear.

Anterior cruciate injury is typically caused when a flexed knee is twisted. It is a fairly common sporting injury, particularly amongst footballers. The **posterior cruciate** is stronger than the ACL, but it can also be injured. Ligament injuries cause instability of the joint.

Ankle sprains

Ankle sprains are very common and almost always result from a forced **inversion** of the foot. Forced inversion stretches and tears the **lateral** ligament of the ankle, resulting in pain and swelling over the lateral aspect of the ankle and foot. Forced **eversion** sprains the **deltoid** (medial) ligament.

Part 6 - Questions to Consolidate Learning

1. At which joint does inversion and eversion of the foot occur?
2. Which vessels supply blood to the head of the femur? What results if these vessels are disrupted by a fracture of the femoral neck?
3. What are the functions of the cruciate ligaments?
4. What mechanisms resist dislocation of the patella? Why does it tend to dislocate laterally?
5. What type of injuries sprain the medial and lateral ankle ligaments?