# Lab 15: Anterior and Lateral Leg, Knee and Ankle Joints, and Dorsum of Foot
# 11/10/2022

## — Goals

1. Identify bony features associated with the knee, leg, and ankle.
2. Identify the muscles in the anterior and lateral compartments of the leg and discuss their actions, innervations, and blood supply.
3. Identify the muscles, nerves, and vessels on the dorsum of the foot.
4. Identify the bones, ligaments, and cartilages of the knee and ankle joints.

## Relevant Osteology



COMPLETE ANATOMY
OSTEOLOGY OF THE LEG

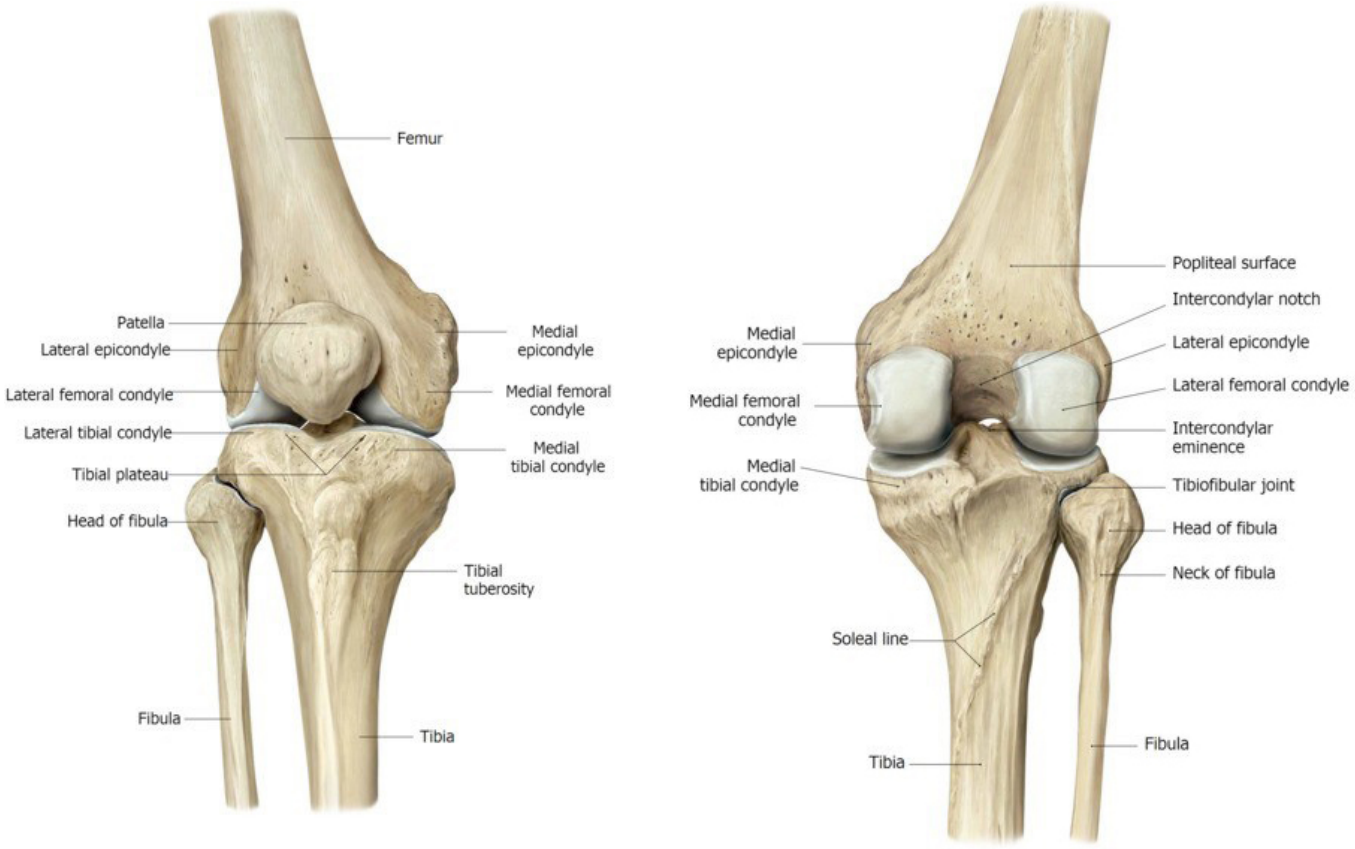



Figure 15.1. Distal femur and proximal tibia/fibula.

## Distal Femur

- **Medial and lateral condyles**
- **Medial and lateral epicondyles**
- **Intercondylar fossa (notch)**
- **Identify the spots on the femur where the anterior and posterior cruciate ligaments attach.**

## Tibia

- **Medial and lateral condyles**
- **Tibial plateau**
- **Intercondylar eminence**
- **Identify the spots on the tibial plateau where the anterior and posterior cruciate ligaments attach**
- **Tibial tuberosity—what structure attaches here?**
- **Anterolateral tubercle (Gerdy's tubercle)—what structure attaches here?**
- **Shaft of tibia**
- **Anterior border of tibia** (commonly known as the "shin")
- **Medial malleolus**

## Fibula

- **Head and neck**
- **Shaft of fibula**
- **Lateral malleolus**

## Ankle Joint

- **Mortise of the ankle joint**—this is the rectangular bony box for articulation with the **dome of the talus**. It is formed by the distal parts of the tibia and fibula, ***with the medial and lateral malleoli forming the sides of the box. See Figure 15.2.***

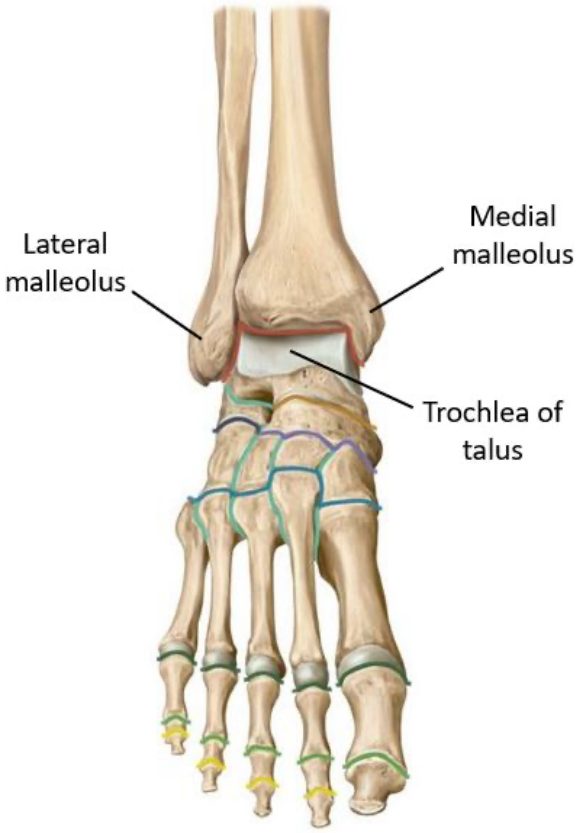



Figure 15.2. Bones of the ankle joint.

## Bones of the Foot

See Figure 15.3.

COMPLETE ANATOMY
OSTEOLOGY OF THE FOOT

### *Tarsal Bones*

- **Talus—**the **trochlea (dome)** of the talus is part of the ankle joint
- **Calcaneus—**note the **tuberosity of the calcaneus**, for attachment of the Achilles (calcaneal) tendon
- **Navicular**
- **Medial cuneiform**
- **Intermediate cuneiform**
- **Lateral cuneiform**
- **Cuboid**

### *Metatarsal Bones: Numbered 1 to 5 from medial to lateral*

- **Base (proximal end)**
- **Shaft**
- **Head (distal end)**
- **Tuberosity of the 5th metatarsal bone—** located at its base—for attachment of the fibularis brevis muscle

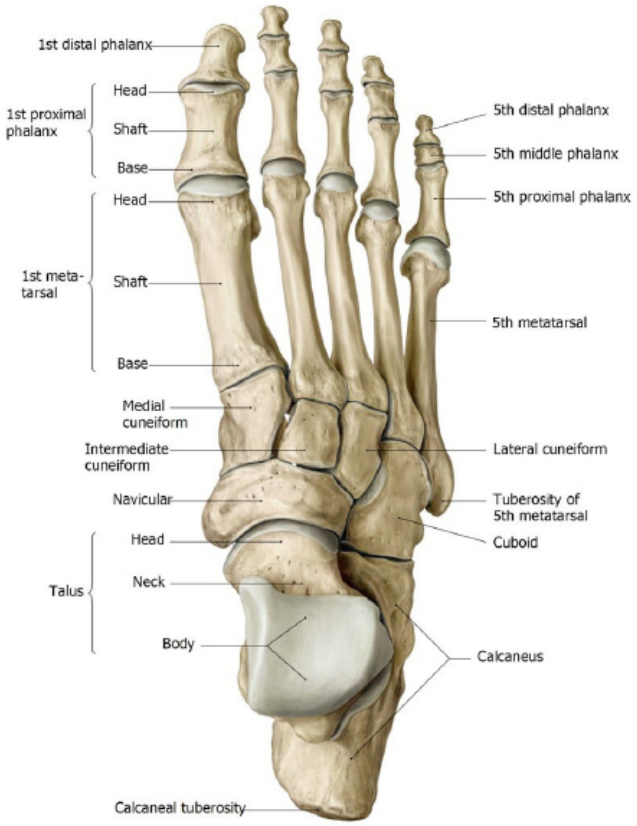



Figure 15.3. Bones of the foot.

### *Phalanges*

- Digits 2–5 have 3: **proximal**, **middle**, and **distal**
- Digit 1 (big toe or hallux): only **proximal and distal**

**Reflect the skin on both limbs (attached and detached limbs) as shown in Figure 15.4. Make shallow skin incisions and leave the superficial fascia on the leg.**

## Skin Flaps

- [ ] Reflect the skin on both limbs (attached and detached limbs)

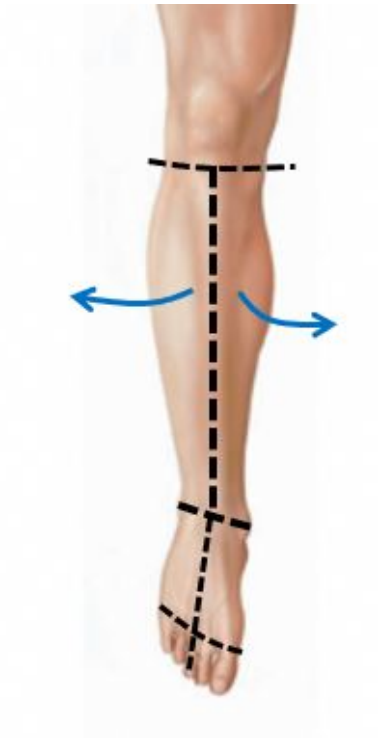


Figure 15.4. Skin incisions.

COMPLETE ANATOMY
**SUPERFICIAL STRUCTURE OF THE LEG**

- [ ] Probe through the superficial fascia on the medial side of the leg to find the **saphenous nerve** and the **great saphenous vein**. They travel together. Recall that the **saphenous nerve** is a sensory branch of the **femoral nerve. The great saphenous vein is a tributary of the femoral vein.**

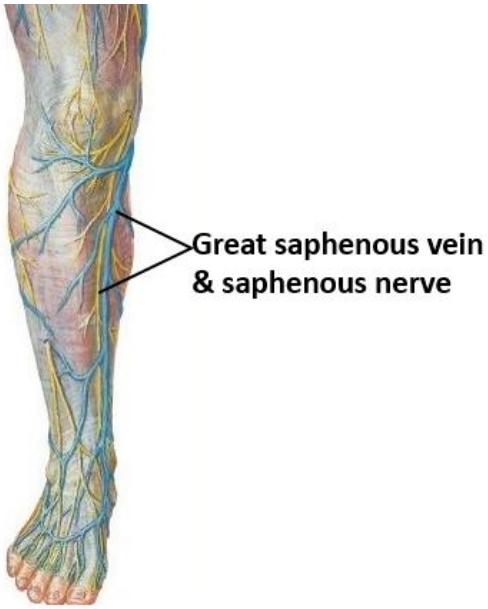



Figure 15.5. Great saphenous vein and saphenous nerve.

- [ ] Now clean away the superficial fascia. The anterior leg won't have much as it is very thin over the anterior border of the tibia ("shin bone"). Identity the **deep fascia of the leg (crural fascia)**. Like the fascia lata in the thigh, it fits the leg like a snug inelastic stocking.

- [ ] Identify the **extensor retinacula**, fascial thickenings of the deep (crural) fascia just above the ankle. There are two: **superior** and **inferior** extensor retinacula. See Figure 15.6.

What is a retinaculum? What is its function?

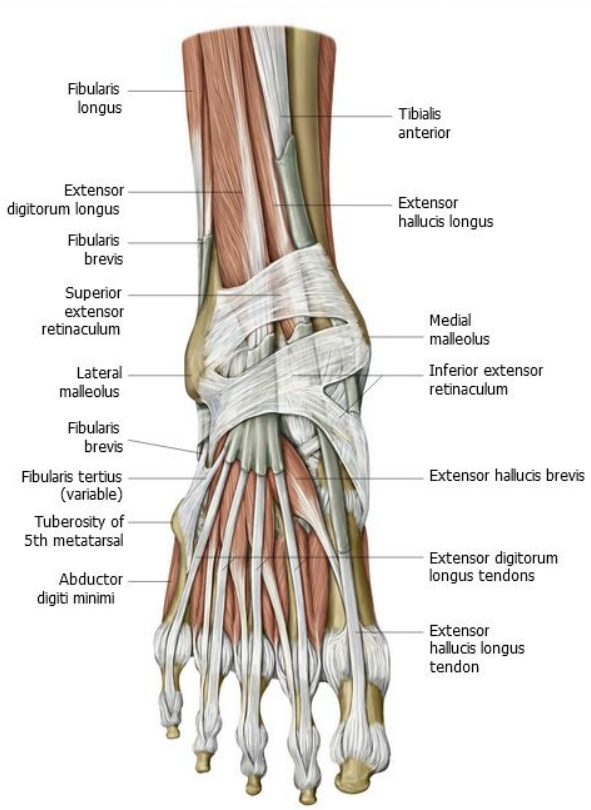



Figure 15.6. Extensor retinacula of leg.

☐ Once you have removed the skin and superficial fascia you will want to open the anterior compartment and identify the muscles within. Incise the robust deep fascia (crural fascia) from the anterior compartment of the leg. Use scissor and scalpel to remove it. **Remove the extensor retinacula from one limb.**

Review now the concept of compartments within the limbs. Which structures compose the boundaries of limb compartments?

**Clinical correlation**

The inelastic crural fascia would pose a problem if the tissue pressure within the anterior leg compartment were to rise—and if it were to exceed the perfusion pressure in the vessels within the compartment. This would produce a **Compartment Syndrome**.

**AFTER THE DEEP FASCIA HAS BEEN REMOVED, USE BLUNT DISSECTION TO SEPARATE THE MUSCLES OF THE ANTERIOR COMPARTMENT OF THE LEG.**

COMPLETE ANATOMY
MUSCLES OF THE ANTERIOR LEG

See Figure 15.7.

Follow their tendons onto the dorsal surface of the foot. Identify the following:

- **Tibialis anterior**
- **Extensor hallucis longus**
- **Extensor digitorum longus**
- **Fibularis tertius (if present)**

Tug on the tendons to verify their actions.

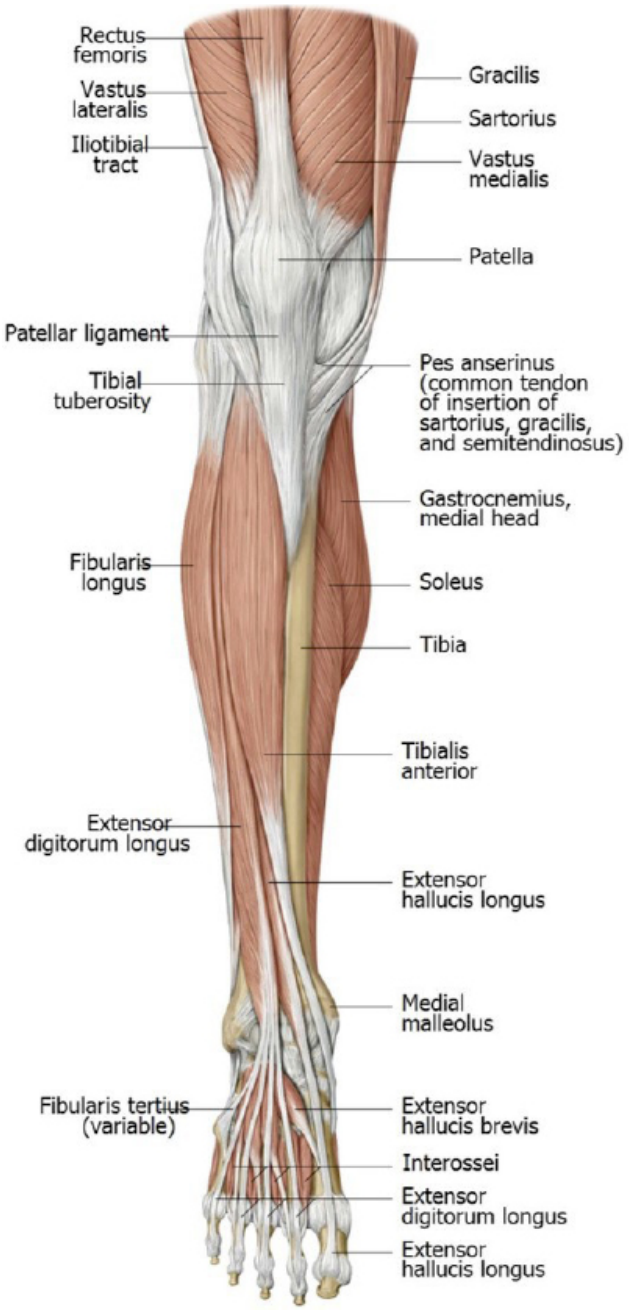



Figure 15.7. Muscles of the anterior leg.

**Note**

The fibularis tertius appears to be the "5th tendon" of the extensor digitorum longus (EDL) since it blends proximally with the fleshy part of EDL. However, it is considered to be a separate muscle because its distal attachment is to the 5th metatarsal, and not to a toe like the tendons of the EDL. Fibularis tertius functions to weakly dorsiflex and evert the foot. It might be a proprioceptive muscle that can sense sudden inversion of the foot and reflexively evert to help prevent ankle sprains. The utility of this muscle is unclear, because it may be absent in up to 10% of individuals and studies have shown that subjects without a fibularis tertius are not at higher risk for ankle injuries.

- [ ] Move the tibialis anterior slightly to one side and separate it from the adjacent extensor hallucis longus and extensor digitorum longus muscles. Clean the fascia in this neurovascular plane and identify the following (Figure 15.8):
  - **Anterior tibial artery**
  - **Anterior tibial veins (2)**
  - **Deep fibular nerve**

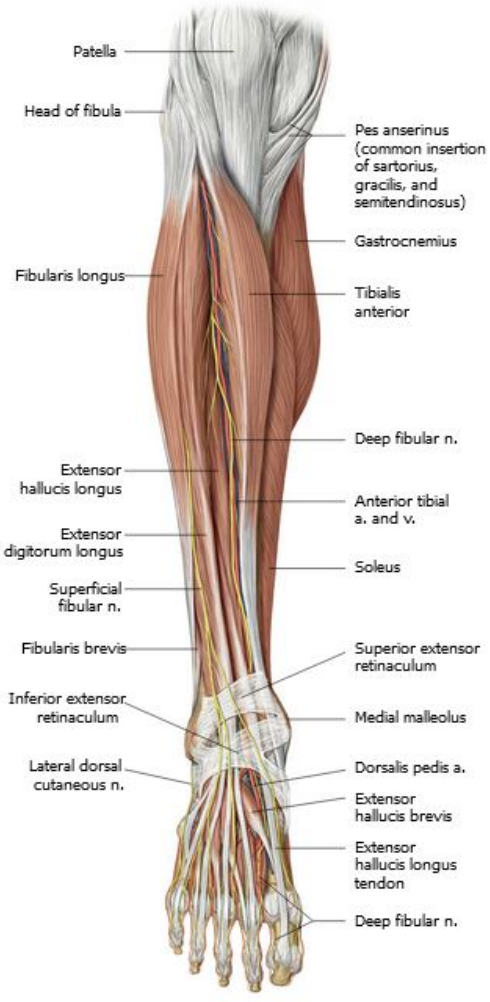



Figure 15.8. Nerves and vessels of anterior leg.

COMPLETE ANATOMY

## ARTERIES AND NERVES OF THE LEG

Where does the anterior tibial artery arise?

Where do the anterior tibial veins drain?

Where does the deep fibular nerve arise?

The **deep fibular nerve** is the motor nerve of the anterior compartment of the leg.

What physical signs would present if the deep fibular nerve were damaged?

Discuss the concept of "foot drop."

- [ ] Identify the **superficial fibular nerve** as it moves on to the dorsum of the foot from the lateral compartment of the leg. It appears from the midportion of the lateral leg, just lateral to the extensor digitorum longus. See Figure 15.8.
- [ ] The superficial fibular nerve is the motor nerve of the lateral compartment of the leg, and it is sensory to most of the dorsum of the foot.
- [ ] The deep and superficial fibular nerves are branches of the **common fibular nerve.**

COMPLETE ANATOMY
## DORSUM OF THE FOOT

## Clean and trace the long tendons, nerves, and vessels from the anterior compartment of the leg onto the dorsum of the foot.

- ☐ Identify the tendons of the **extensor digitorum longus**.
- ☐ On the dorsal surface of the foot, identify the small **extensor digitorum brevis** and **extensor hallucis brevis muscles**, deep to the long extensor tendons.
- ☐ These two small muscles both arise and insert from the bones and fascia within the foot—***so they are intrinsic muscles of the foot***. These muscles are innervated by the deep fibular nerve.
- ☐ Between the metatarsal bones, identify the **dorsal interosseus muscles** of the foot.
- ☐ Trace the **anterior tibial artery** from the anterior leg onto the dorsum of the foot—it changes its name here to the **dorsalis pedis artery**.

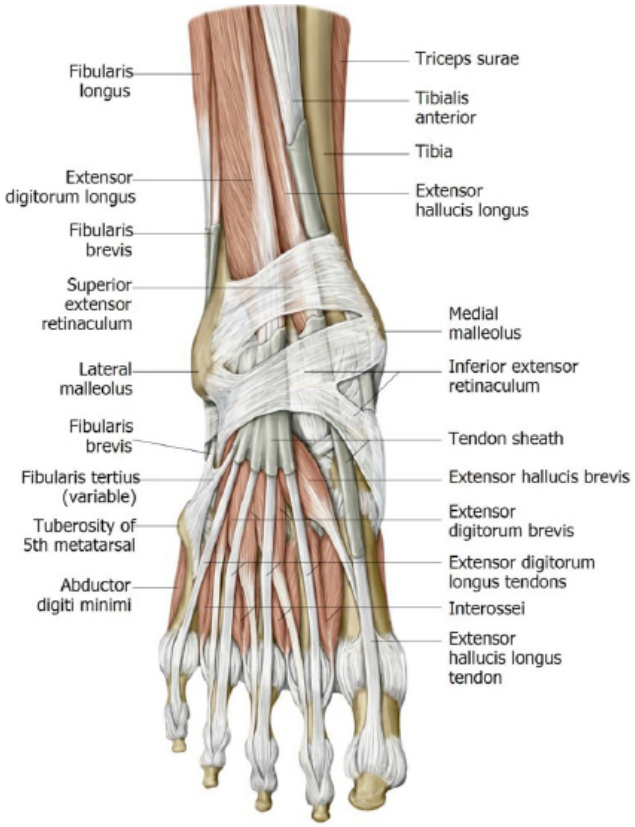



Figure 15.9. Muscles and tendons on dorsal foot.

**Clinical correlation**

Clinically, the dorsalis pedis artery is used to obtain a pulse to check on peripheral vascular health in the lower limb. However, the dorsalis pedis is variable and even sometimes missing, so it is not as reliable as the posterior tibial artery for checking pulses and evaluating peripheral vascular blood flow.

- From the dorsalis pedis artery, the **arcuate artery** of the foot is given off—it crosses the foot transversely, along the bases of the metatarsal bones. **Dorsal metatarsal arteries** are given off from the arcuate artery to the digits. See Figure 15.10.
- Between the 1st and 2nd metatarsals, identify the **deep plantar artery**, a branch of the dorsalis pedis artery. It anastomoses with the lateral plantar artery in the sole of the foot to form the ***plantar arch***.
- Identify the **deep fibular nerve** as it passes from the leg onto the dorsum of the foot, accompanying the dorsalis pedis artery.

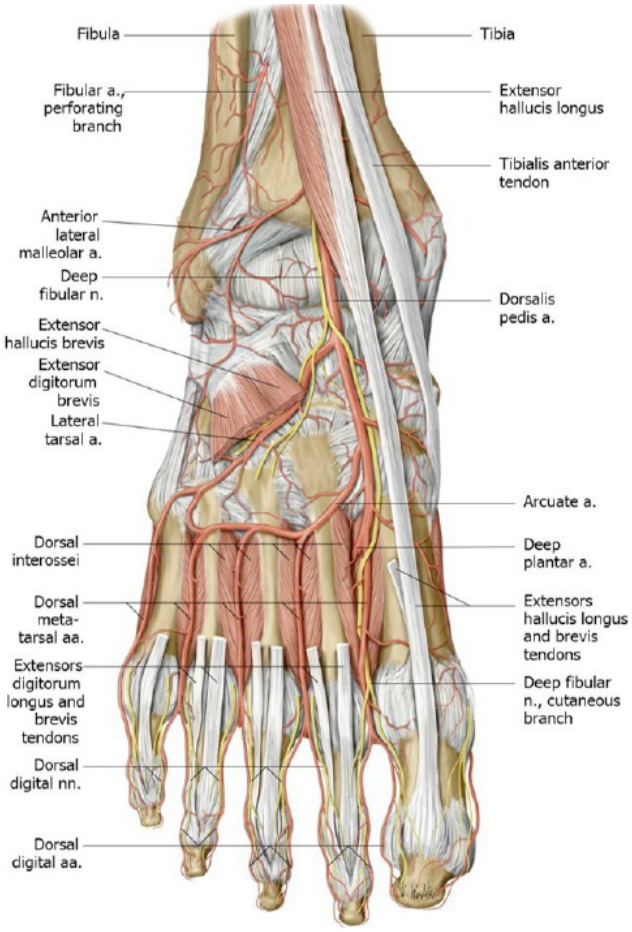



Figure 15.10. Nerves and vessels on the dorsal foot.

- [ ] Most of the skin on the dorsal foot is innervated by the **superficial fibular nerve**. The webspace between the first and second toes receives sensory innervation from the **deep fibular nerve**. See Figure 15.11.

Where do the superficial and deep fibular nerves arise?

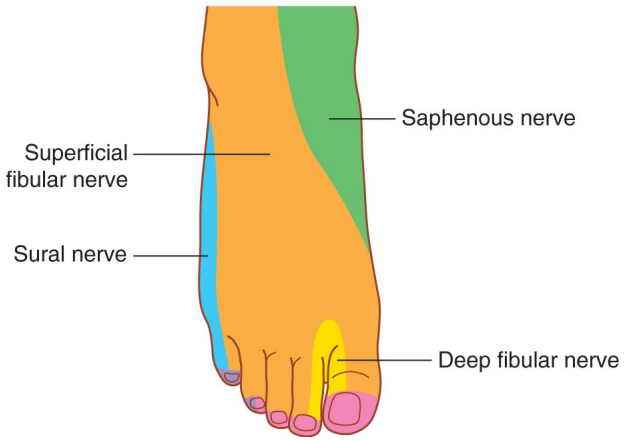



Figure 15.11. Sensory innervation of dorsal foot.

## Remove the skin and deep fascia from the lateral leg.

- ☐ Palpate the **head of the fibula.** The shaft of the fibula is hidden by the **fibularis longus** and **fibularis brevis muscles.**

> **Note**
>
> Clinicians often refer to these muscles by their alternate names = the **peroneus longus** and **peroneus brevis**. Do you see how using the term "peroneal" here might be topographically confusing?

- ☐ Locate the **common fibular nerve** looping around the **neck of the fibula** (the neck is just below the fibular head). ***This large nerve is superficial here, so it is vulnerable to trauma***.

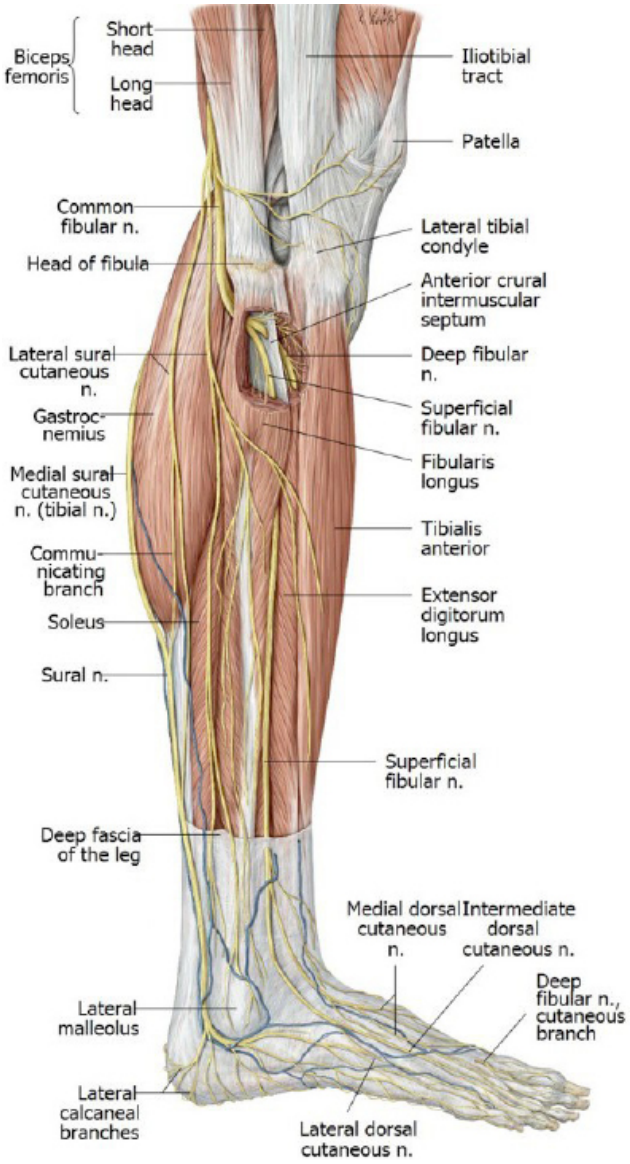



Figure 15.12. Lateral leg.

**Clinical correlation**

Damage to the common fibular nerve can cause weakness to muscles in the anterior compartment (supplied by the deep fibular nerve), producing a condition called **foot drop**.

- ☐ The **superficial fibular nerve** emerges below the fibularis muscles in the distal leg and passes onto the dorsum of the foot. The superficial fibular nerve is motor to the fibularis longus and brevis muscles, and sensory to the distal leg and dorsum of the foot.
- ☐ Follow the tendons of the **fibularis longus and brevis muscles** distally. Note how they curve around the posterior margin of the **lateral malleolus.** Here they are held down by a **fibular retinaculum**.
- ☐ You won't see the insertion of the **fibularis longus muscle** right now because it attaches to the **base of the first metatarsal** and **medial cuneiform** on the plantar aspect of the foot.
- ☐ The tendon of the **fibularis brevis attaches distally to the tubercle of the fifth metatarsal**. See Figure 15.13.

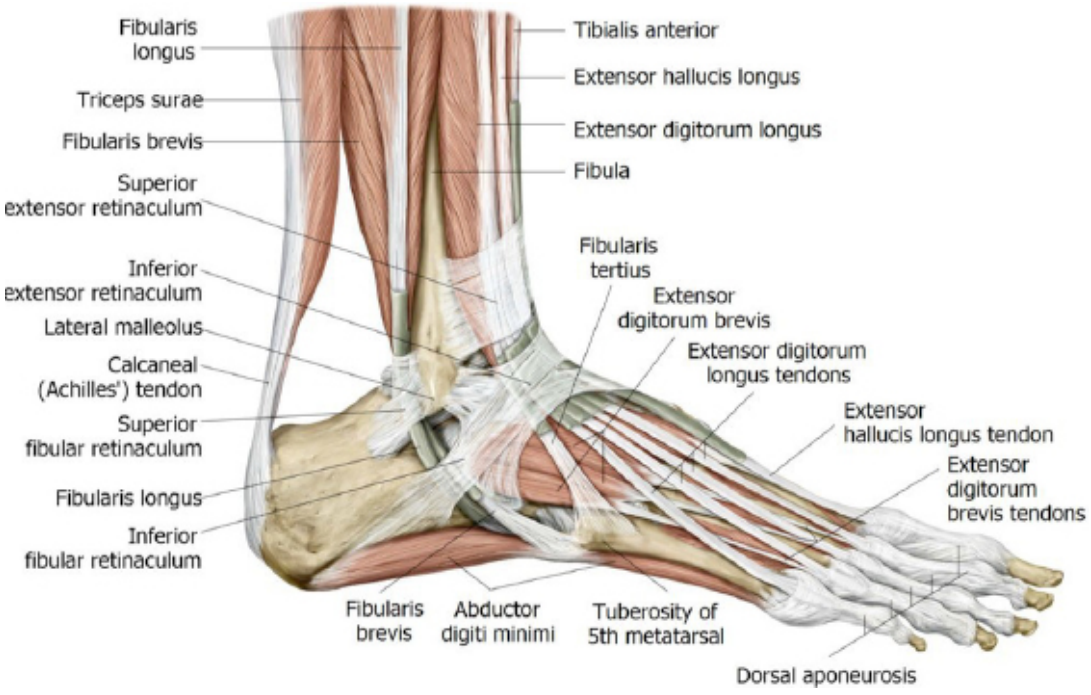



Figure 15.13.

**Clinical correlation**

An avulsion fracture of the tuberosity of the fifth metatarsal bone, where the tendon of the fibularis brevis pulls off a chunk of bone is called a **Pseudo-Jones fracture**. See Figure 15.14.



Figure 15.14. Avulsion fracture of tuberosity of 5th metatarsal.

## Knee Joint

COMPLETE ANATOMY
KNEE JOINT

! Do this dissection on one side only.

**Before you cut, review the osteology relevant to the knee joint (Figures 15.15–15.17).**

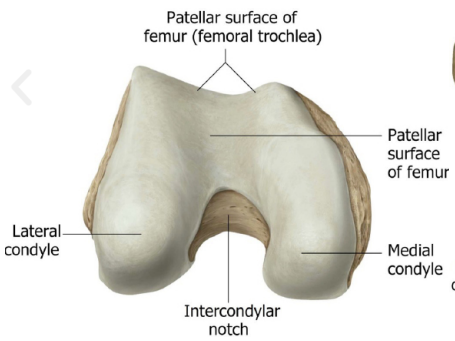



Figure 15.15.

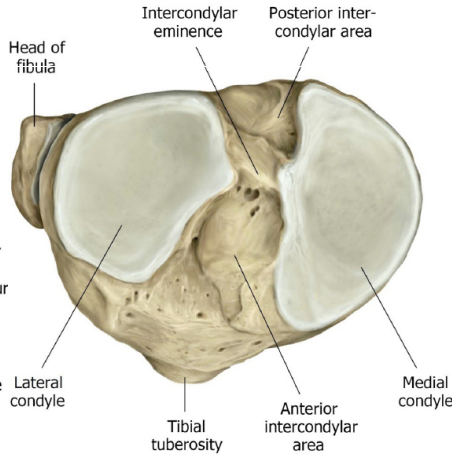



Figure 15.16.

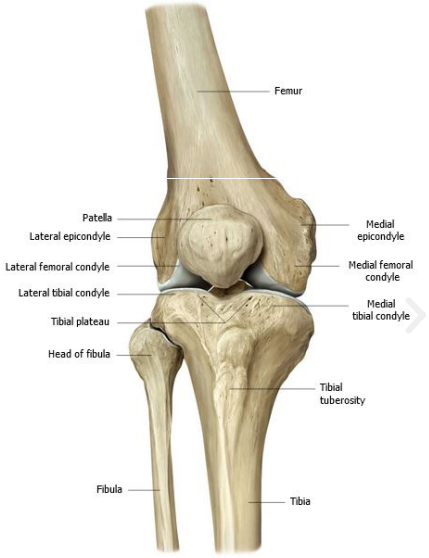



Figure 15.17.

## Femur

- **Medial and lateral condyles**
- **Intercondylar fossa (notch)**

## Tibia

- **Intercondylar eminence**
- **Tibial plateau**
- **Medial and lateral condyles**

The knee has three articulations:

- **Medial and lateral tibiofemoral articulations**
- **Patellofemoral articulation**

## One side only: Open the knee joint to see the structures inside.

- [ ] **Make an inverted U-shaped cut in the quadriceps tendon** that goes around the top and sides of the patella (see Figure 15.18).

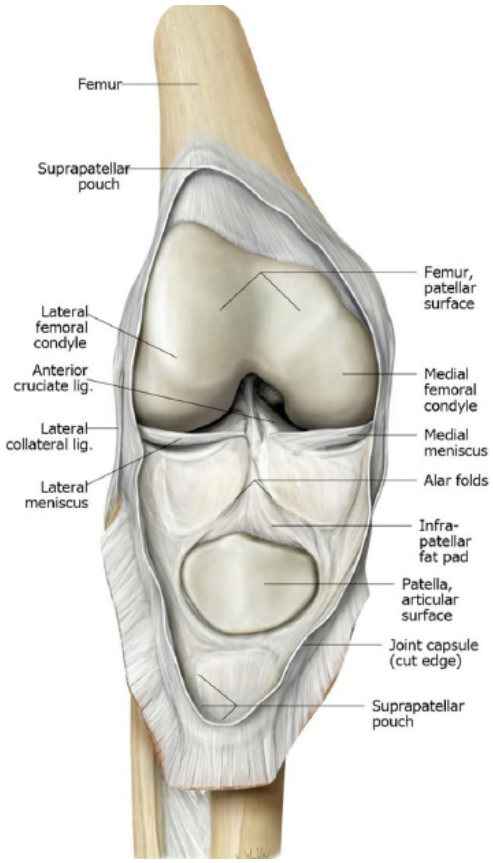



Figure 15.18.

## Reflect the patella and patellar ligament inferiorly.

- [ ] Locate the **anterior cruciate ligament** and **medial and lateral menisci.**

- [ ] Trace the joint cavity upwards and place your fingers deep to the cut quadriceps tendon. Your fingers are extending into the **suprapatellar bursa (suprapatellar pouch),** an extension of the joint cavity deep to the quadriceps tendon and vastus intermedius.

### Clinical correlation

This pouch extends about one hands-breadth above the base of the patella. It normally contains a small amount of synovial fluid—enough to lubricate the space between the quadriceps tendon and the femur, so that no friction occurs here when the quads contract. In cases of knee trauma, this pouch can fill with bloody exudate, creating a dramatically large knee joint effusion.

### Clinical correlation

The **medial meniscus attaches to the medial collateral ligament (MCL)**, whereas the lateral meniscus does not attach to the lateral collateral ligament (LCL). See Figure 15.19. Therefore, an **MCL injury may affect the medial meniscus as well**.

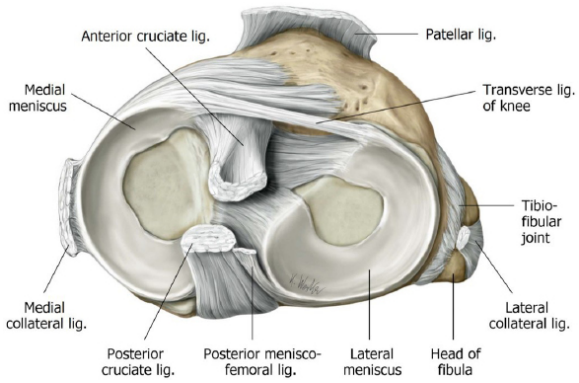



Figure 15.19. Menisci on tibial plateau.

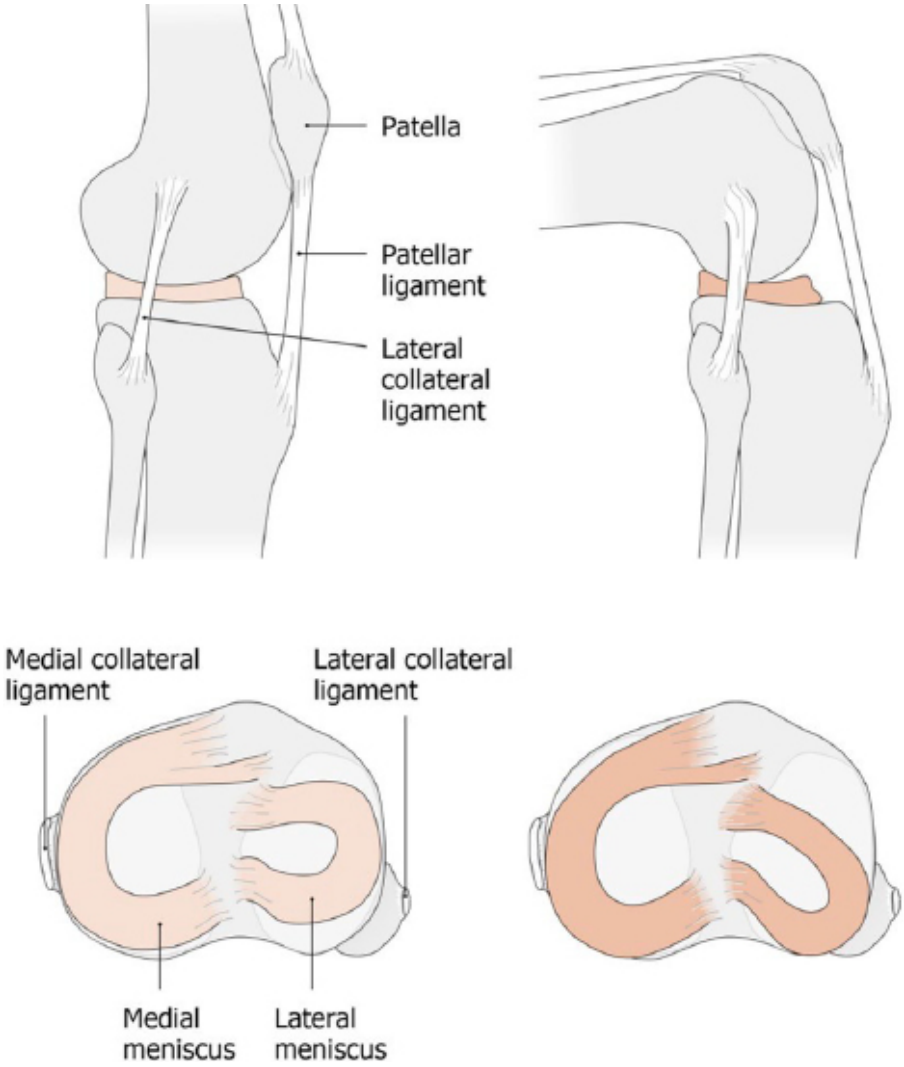



Figure 15.20. Menisci and ligaments of knee.

## On the other leg, that does not have the open knee joint:

- ☐ Clean and identify the **iliotibial tract** and the **pes anserinus tendons**. The iliotibial tract attaches distally to the anterolateral tubercle of the tibia (Gerdy's tubercle).
- ☐ The pes anserinus ("goose's foot") is a tendinous expansion on the proximal tibia, just below the medial condyle.
- ☐ The IT tract and pes anserinus tendons reinforce the lateral and medial sides of the knee joint, respectively.

> ? What are the three tendons that make up the pes anserinus?

> ? What are the innervations of the 3 muscles contributing to the pes anserinus? Remember SGT FOS?

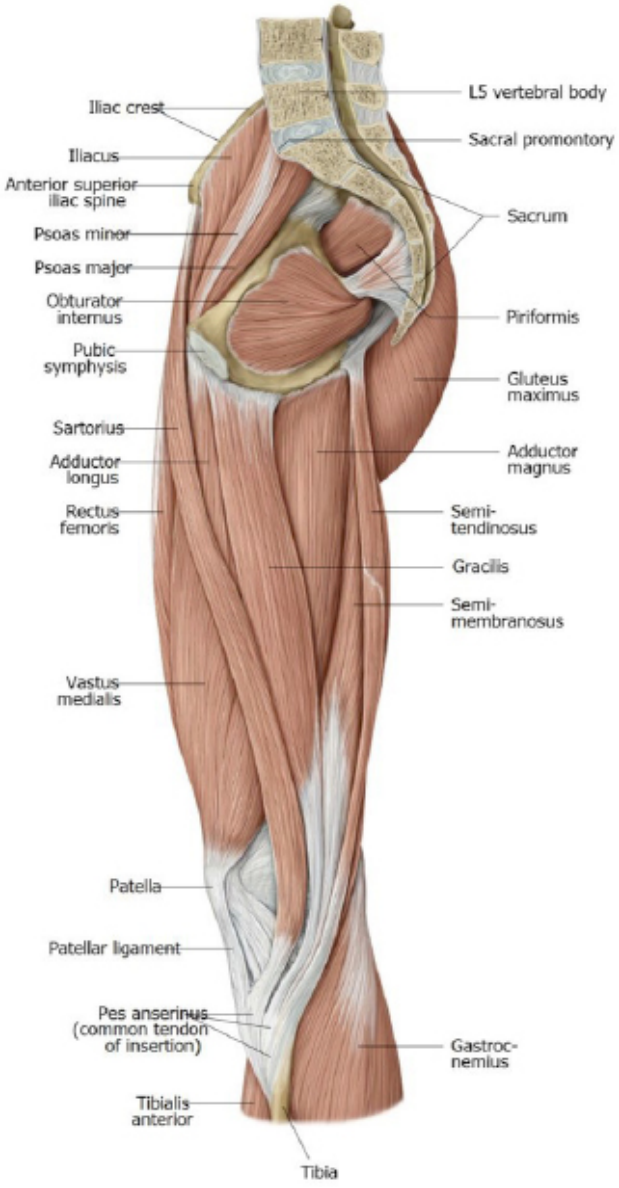



Figure 15.21. Pes anserinus.

**Collateral ligaments of knee**: The knee is a modified hinge joint—and all hinge joints have collateral ligaments to resist varus and valgus forces on the joints, remember?

- ☐ On both knee joints, clean and identify the collateral ligaments.
- ☐ The **medial (tibial) collateral ligament (MCL)** is a capsular ligament, meaning that it is a thickening of the knee joint capsule itself. It will appear as a wide vertical band of tissue stretching from the medial epicondyle of the femur above to the medial condyle of the tibia below (see the Figure 15.22 —this is an exaggeration, however, since the MCL does not stand alone as depicted in the figure). To verify the ligament, try placing a valgus force on the leg (move the distal part of the leg laterally) while palpating the joint capsule in the area of the MCL— you will feel this area tighten up.

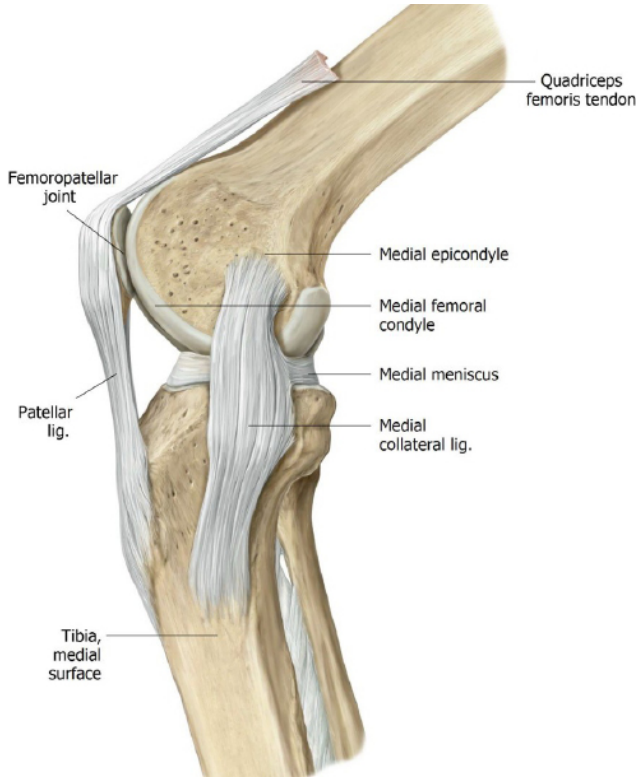



Figure 15.22. Medial collateral ligament.

- [ ] The lateral (fibular) collateral ligament (LCL) is an extracapsular ligament, meaning it stands alone outside the capsule of the knee joint. The lateral collateral is a narrow, but robust, band of tissue extending from the lateral epicondyle of the femur above to the head of the fibula below. See Figure 15.23. To find it, clean the area between the distal attachment of the iliotibial tract to Gerdy's tubercle and the attachment of the tendon of biceps femoris to the head of the fibula. See Figure 15.24. You may need to trim away some of the IT tract to see the LCL. To verify it, try placing a varus force on the leg (move the distal part of the leg medially) while palpating the LCL—you will feel it become taut.

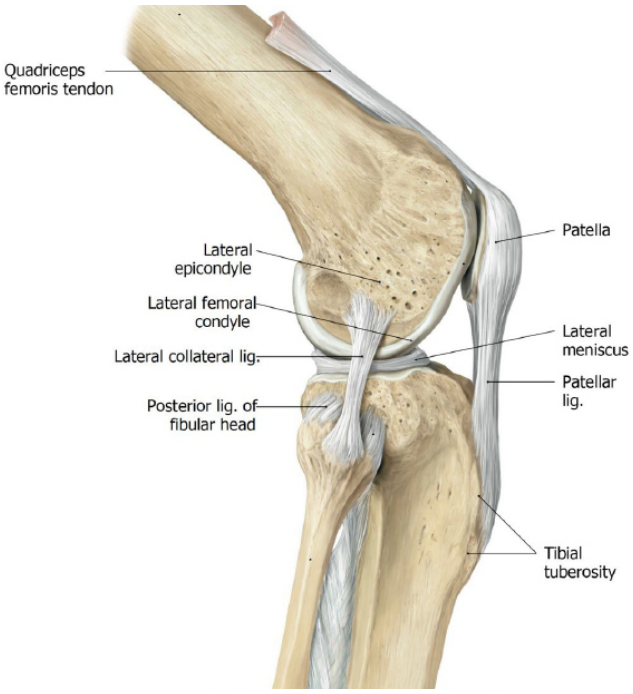



Figure 15.24.

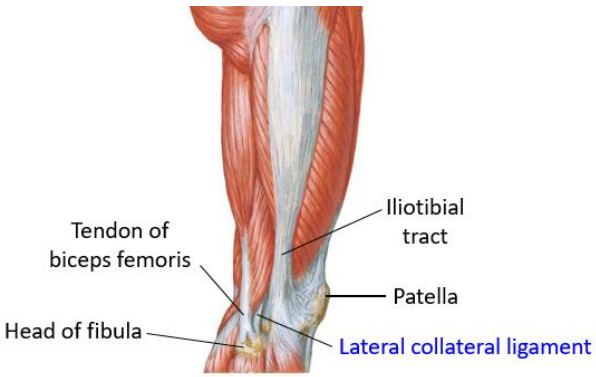



Figure 15.24.

## Ankle Ligaments: Prosection

**Go to a prosection and model and study the ankle ligaments.**

- [ ] Compound structures made of multiple ligaments brace the medial and lateral aspects of the ankle joint—***these are modified collateral ligaments***.

- [ ] The **medial ligament complex** (aka = **Deltoid ligament**) has four parts that together resemble the Greek letter delta (△). It is very stout. See Figure 15.25. Sprained deltoid ligaments are due to excessive or forced eversion movements of the foot. Because of their strength, deltoid ligament injuries are less common than injuries to the **lateral ligament complex** of the ankle. Examine the deltoid ligament on a model. We will not see it on the prosection.

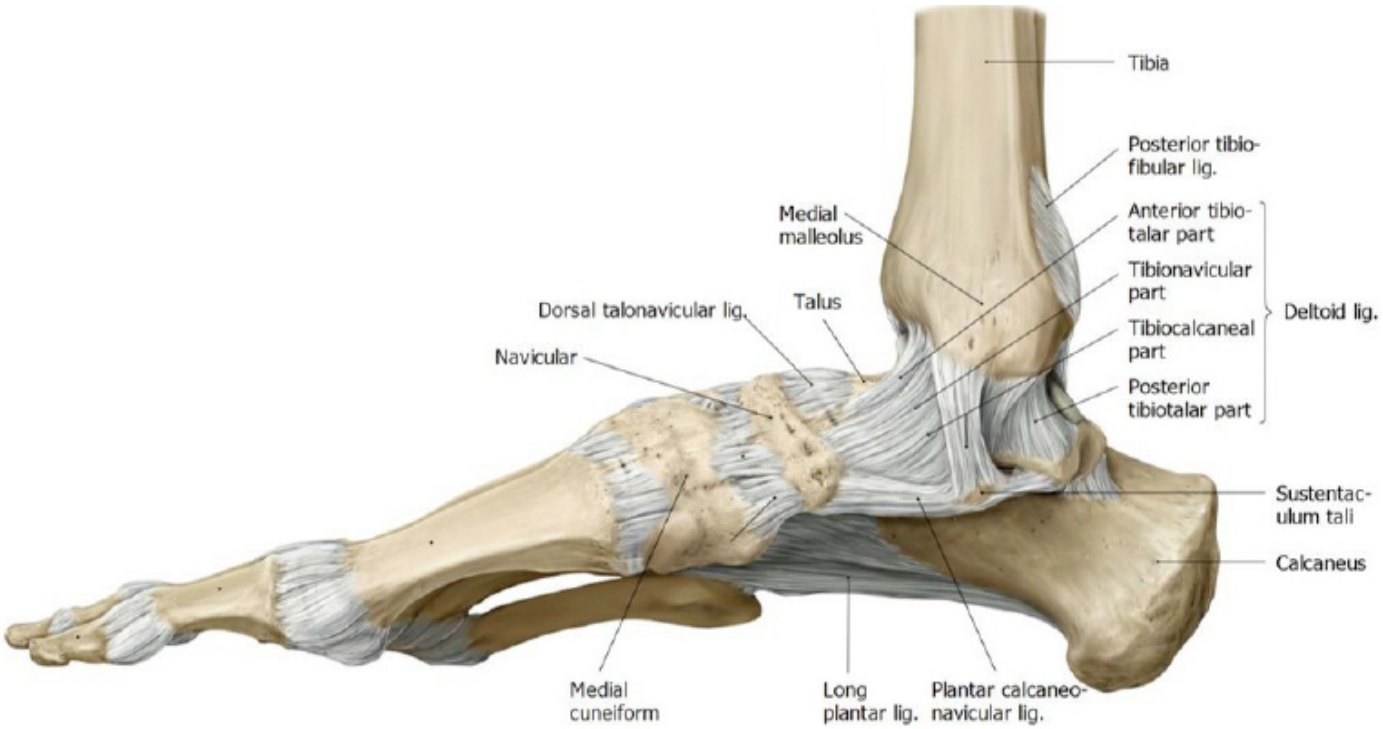



Figure 15.25. Deltoid ligament of medial ankle.

- [ ] Examine the **lateral ligament complex of the ankle** on the prosection. To see it, the tendons of the **fibularis longus** and **fibularis brevis** have been cut and the **fibular retinaculum** has been removed.

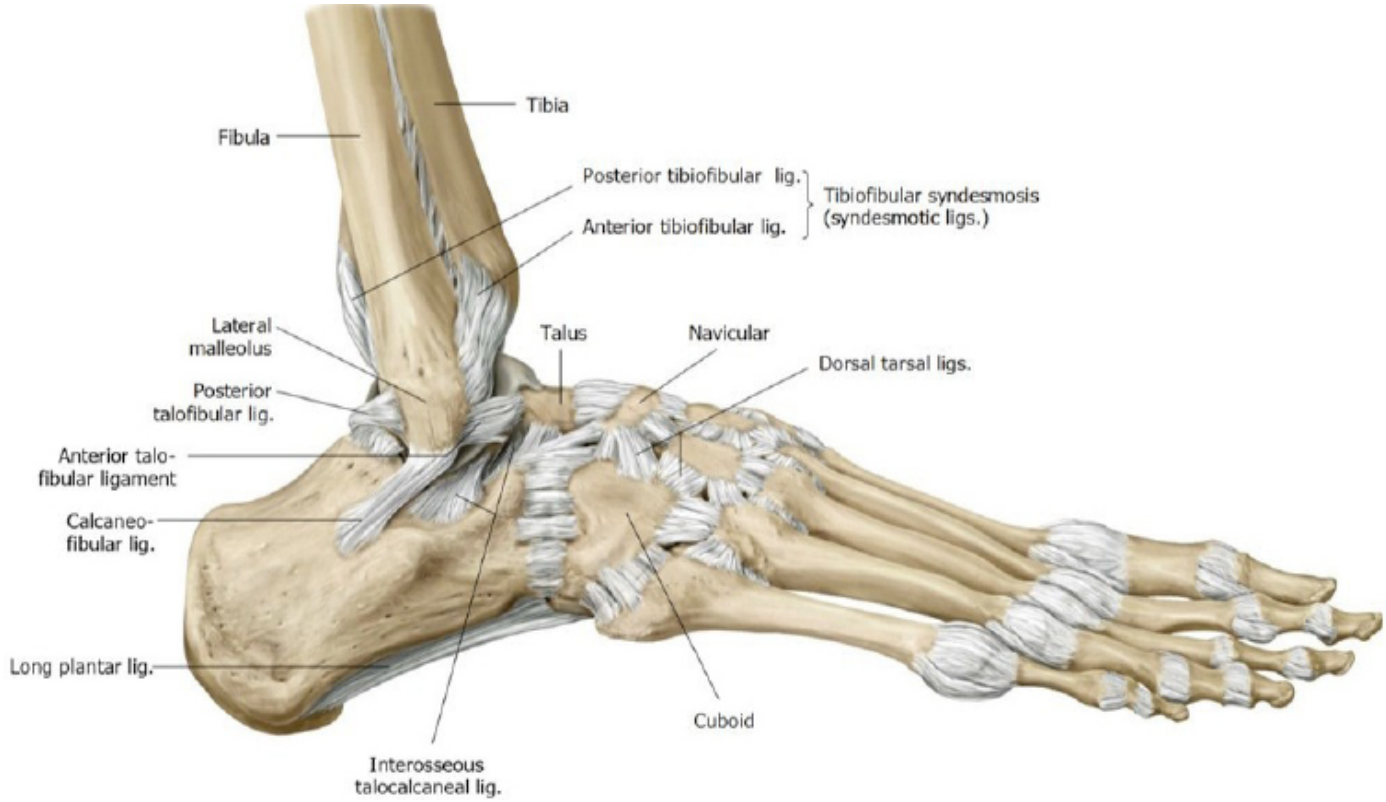



Figure 15.26. Lateral ligament complex of ankle.

***Three ligaments make up the lateral ligament complex of the ankle***. Identify these on the prosection (Figure 15.26):

- **Anterior talofibular ligament**
- **Calcaneofibular ligament**
- **Posterior talofibular ligament**

! The most important of these to learn about is the anterior talofibular ligament. It holds the distinction of being the most commonly sprained ligament in the body.

## CHECKLIST, LAB #15

REVIEW AND MAKE SURE YOU HAVE IDENTIFIED EACH OF THE STRUCTURES BELOW.

### BONES

- [ ] See the list of bony items above in the Dissection instructions

### JOINTS (IDENTIFY THESE ON A SKELETON)

- [ ] **Superior tibiofibular joint** (a synovial joint = articulation between the head of the fibula and the lateral condyle of the tibia)
- [ ] **Inferior tibiofibular joint** (not a synovial joint = a **syndesmosis**—what is this?) Clinical: Damage to this joint is referred to as a "high ankle sprain."
- [ ] **Ankle joint (talocrural joint)**: identify the "mortise" of the ankle joint and the trochlea of the talus
- [ ] **Subtalar joint** (articulation of the talus and calcaneus = inversion and eversion movements of the foot occur at this joint)
- [ ] **Tarsometatarsal joints**
- [ ] **Metatarsophalangeal joints**
- [ ] **Proximal** and **distal interphalangeal joints** (in toes 2–5)

### MUSCLES

- [ ] **Tibialis anterior**
- [ ] **Extensor hallucis longus**
- [ ] **Extensor digitorum longus**
- [ ] **Fibularis tertius**
- [ ] **Extensor digitorum brevis**

- [ ] **Extensor hallucis brevis**
- [ ] **Fibularis longus and brevis**

### NERVES AND VESSELS

- [ ] **Common fibular nerve**
- [ ] **Superficial** and **deep fibular nerves**
- [ ] **Anterior tibial artery**—becomes **dorsalis pedis artery** on the dorsum of the foot

### OTHER

- [ ] **Extensor retinacula**

### KNEE JOINT

- [ ] **Quadriceps tendon** and **patellar ligament**
- [ ] **Patella**
- [ ] **Tibial plateau**
- [ ] **Medial** and **lateral menisci**
- [ ] **Anterior** and **posterior cruciate ligaments**
- [ ] **Medial** (tibial) and **lateral** (fibular) **collateral ligaments**
- [ ] **Suprapatellar bursa**—superior extension of the knee joint cavity

### ANKLE JOINT

- [ ] **Lateral ligament of ankle**—compound structure consisting of three ligaments: **anterior talofibular**, **posterior talofibular**, and **calcaneofibular**. The Anterior talofibular ligament is the most important clinically.
- [ ] **Deltoid ligament** (medial ligament of ankle)—compound structure consisting of four ligaments.