The Lower Extremity

The Knee

The knee is the most complicated joint in the body with very bad conditions of work. It is a joint that is stabilized mainly by ligaments

Bones: Femur, tibia, patella and fibula. Between these there are three joints.

Joints:

- **Tibio-femoral**: A hinge joint between the tibia and the femur; only flexion/extension. Any other movements here are effectively erroneous are from ligamentous laxity
- **Patello-femoral**: a saddle joint between the deep side of the patella and the femur allowing mainly superior/inferior
- **Superior tibio-fibular**: a gliding joint separate from the knee joint proper, it is situated inferior and lateral to it; allows mainly anterior/posterior shift gliding with some medial/lateral shift too.

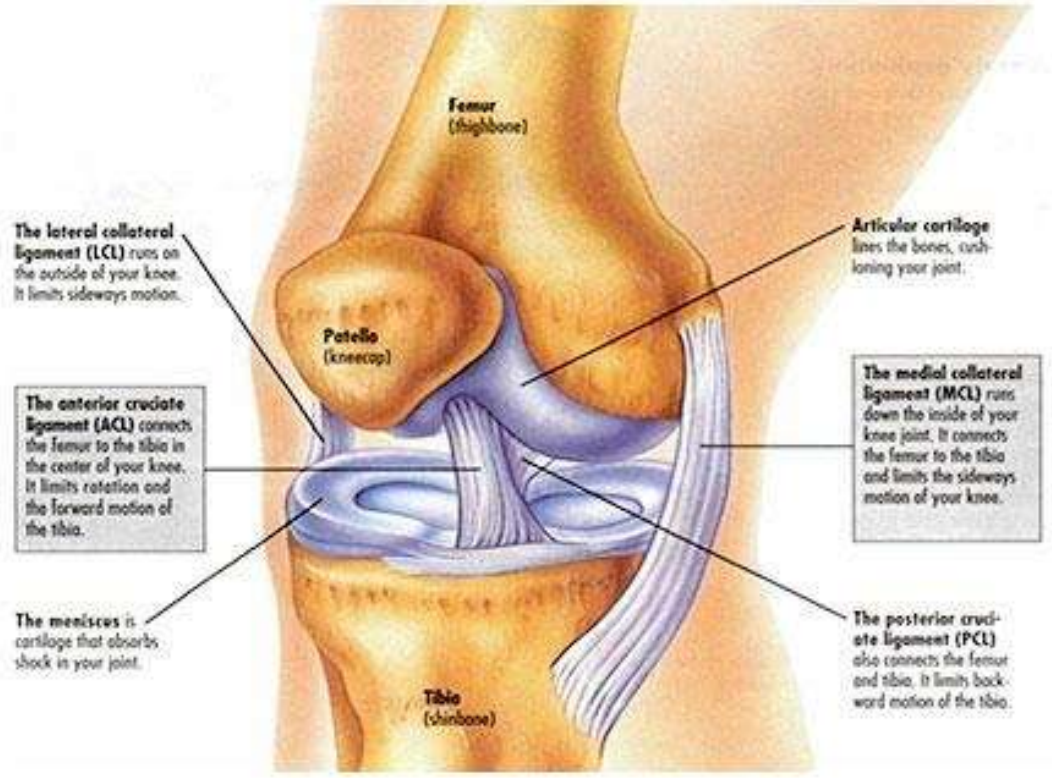


Figure 1 - Knee - Showing Ligaments and Menisci

Ligaments:

- **Medial/lateral Collaterals** (i.e. outside the joint)
- **Anterior/posterior Cruciates** (i.e. inside the joint)
- **Patellar** (between the patella and the tibia)

Movements of the knee:

Flexion/extension; any other movement (rotation, medial/lateral gapping, A/P shift) is from ligamentous laxity, but normal.

Menisci: these are semi-lunar shaped cartilaginous structures within the knee, between the femur and tibia; they are attached to the top of the tibia and have various functions:

- assist stability
- reduce wear and tear
- distributes forces and fluids with the knee

Bursae

Bursae are cushioning pads with a synovial outer lining; they are positioned between tendons and tendons and bone to reduce friction. There are about 12 in the knee, 4 on the front and 8 around the back:

Front:

- **Suprapatellar**: between the inferior end of the quadriceps and the femur; it reduces friction between the two especially with extreme flexion.
- **Prepatellar**: At front of inferior end of patellar; it cushions the patella with kneeling on all fours.
- **Infrapatellar superficial** and deep to inferior end of patellar ligament; reduces pressure on tibia with kneeling (prayer?) and with flexion.

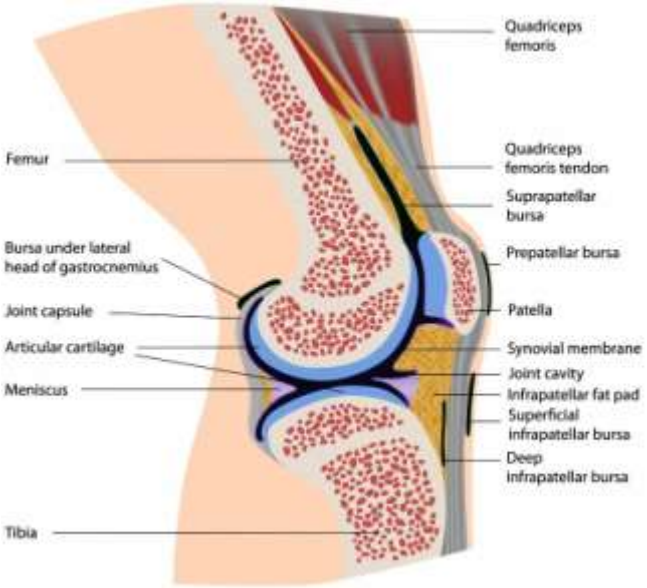
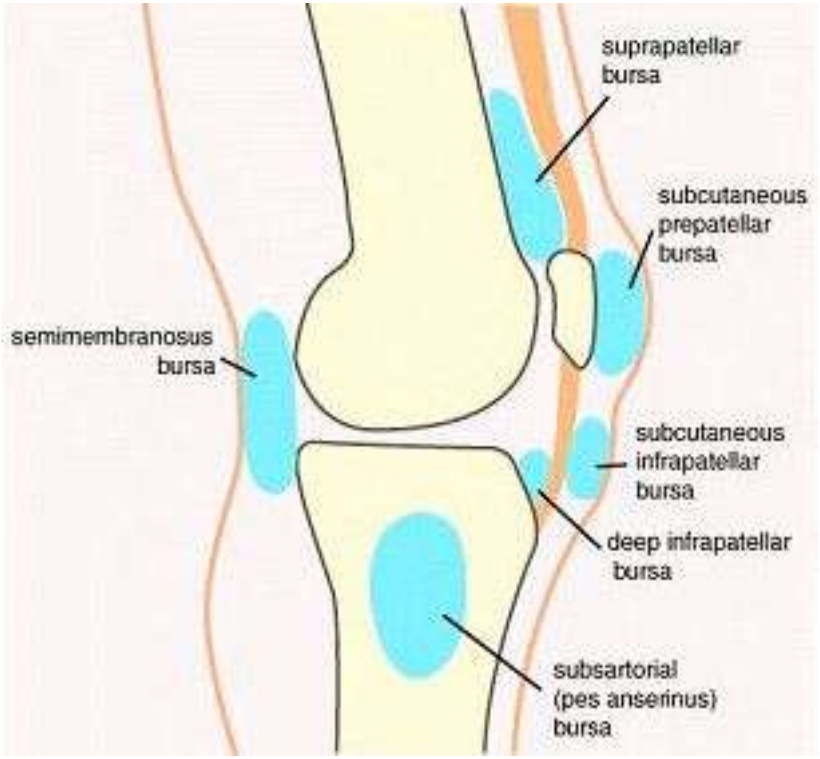


Figure 2 - Cross Section of Knee Showing Bursae



Muscles of the thigh

Anterior thigh:

- **Quadriceps**: effectively one muscle group, but the 4 heads are so big they are all named individually:
  - **Vastus Lateralis** (lateral aspect of femur)
  - **Vastus Medialis** (medial aspect of femur)
  - **Vastus intermedius** (anterior femur, between lateralis and medialis)
  - **Rectus Femoris** (anterior inferior iliac spine of front of pelvis)
- **Insertion**: These all attach (insert) onto the patella and from there to the tibia

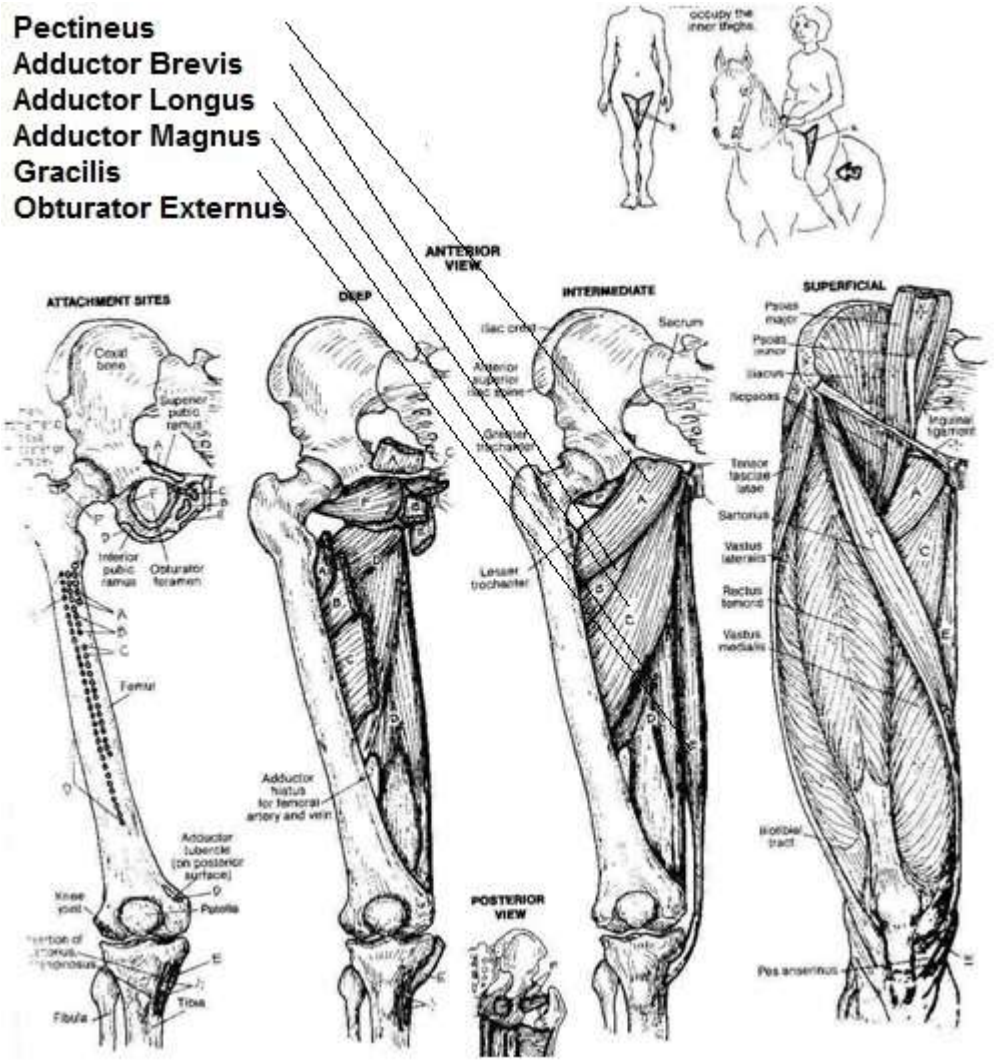


Figure 3 - Adductor Muscle Group of Hip

- **Action**: They all extend (straighten) the knee; rectus femoris also flexes the hip.

Sartorius:

Sartorius passes from the anterior superior iliac spine to the top of the medial aspect of the tibia.

Action: Flexes the knee (and externally rotates and flexes hip)

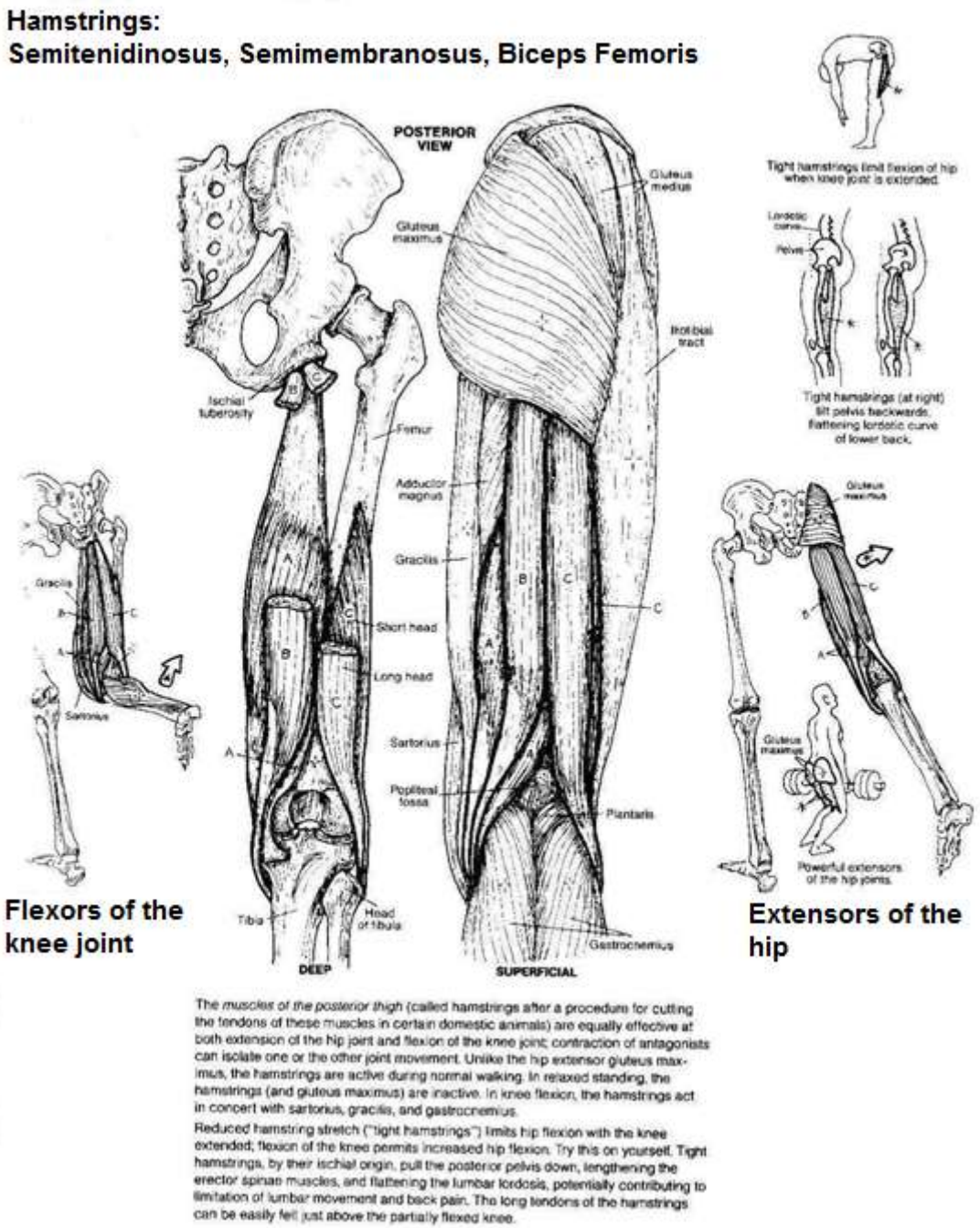
Posterior thigh:

Hamstrings:

- **Semimembranosus**: from ischium (of innominate) to top, medial side tibia
- **Semitendinosus**: from ischium to top medial side of tibia
- **Biceps Femoris**: from ischium and linea aspera (line on back of femur; to top of fibula

Action: extends hip and flexes knee

Figure 4 - Hamstring Group of Muscles



The *muscles of the posterior thigh* (called hamstrings after a procedure for cutting the tendons of these muscles in certain domestic animals) are equally effective at both extension of the hip joint and flexion of the knee joint; contraction of antagonists can isolate one or the other joint movement. Unlike the hip extensor gluteus maximus, the hamstrings are active during normal walking. In relaxed standing, the hamstrings (and gluteus maximus) are inactive. In knee flexion, the hamstrings act in concert with sartorius, gracilis, and gastrocnemius.

Reduced hamstring stretch ("tight hamstrings") limits hip flexion with the knee extended; flexion of the knee permits increased hip flexion. Try this on yourself. Tight hamstrings, by their ischial origin, pull the posterior pelvis down, lengthening the erector spinae muscles, and flattening the lumbar lordosis, potentially contributing to limitation of lumbar movement and back pain. The long tendons of the hamstrings can be easily felt just above the partially flexed knee.

Common knee disorders:

- **Ligamentous strain**
- **Muscle strain**
- **Osgood Schlatter's** (only in growing children: excessive traction strain to epiphysis at insertion of quadriceps causing inflammation and pain). This X-Ray also shows the epiphyseal plate (indicating a young person, usually teenagers) and fragmentation of the tibial tubercle at the attachment of the patellar ligament.

Figure 5 - X-Ray Showing Osgood Schlatter's Disease of tibial tubercle

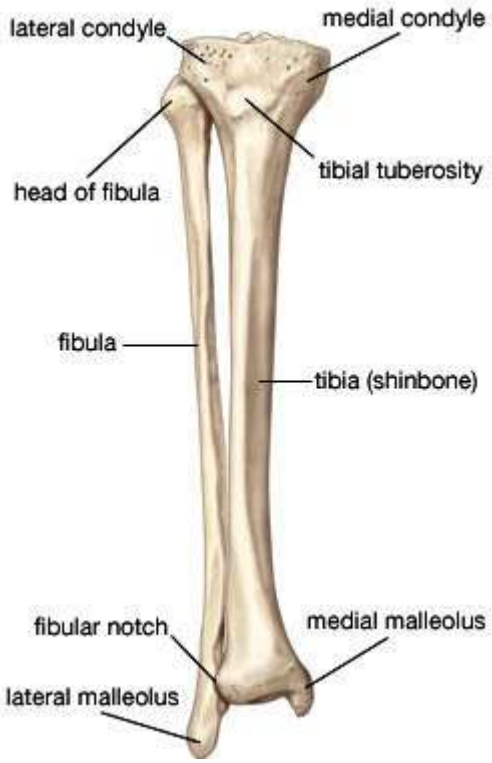
Bursitis: inflamed bursa; frequently from areas of increased, persistent tension in muscles (and hence tendons)

Osteoarthritis – usually under the patella, but can be between femur and tibia. This X-ray shows bony changes and deformation characteristic of advanced O/A

Lower leg and ankle

Bones

- **Tibia and fibula**. These are very strong and stable, having one joint at each end, a gliding joint at the top, and a fibrous joint at the bottom. The superior tibio-fibular joint is regarded as part of the knee, but is distinct and separate from it. The inferior tibio-fibular joint (a syndesmosis) is robust to help maintain the stability of the ankle. The distal ends of the tibia and fibula have an 'indent', creating a mortise cavity for the talus of the foot.



Muscles

The fascial structure of the lower leg is thick and robust, creating three distinct compartments: posterior, anterior and lateral; this robustness will help with the flow of venous blood up the leg (see later).

Calf

The bones of the lower leg are the tibia and fibula

They have two joints between them:

- **A synovial joint** (superior tibiofibular) at the top (part of the knee)
- **A fibrous joint** (a syndesmosis) between the two of them along their length, from top to bottom. The latter creating the primary stability between the two just above the ankle where the talus has the possible action of pushing them apart

Muscles:

There are three distinct compartments

Posterior compartment [From superficial to deep]:

- **Gastrocnaemius**: biggest and most obvious of all calf muscles. Passes down from the back of the two tibial condyles, the two heads converge and pass down to the calcaneum via the Achilles tendon; it plantar-flexes the foot
- **Soleus**: from the back of the tibia and the interosseous (I/O) membrane, it passes down and merges with Gastrocnaemius at inserts via the Achilles tendon
- **Flexor digitorum longus**: from the back of the tibia; it passes down to the distal phalanx of the toes; it flexes the toes and plantar flexes the foot
- **Flexor hallucis longus**: from the back of the fibula, it passes down and across medially to the ankle to the big toe (hallux)
- **Tibialis posterior**: from the I/O membrane, it passes down and crosses the medial ankle to attach to a number of bones of the foot it plantar flexes and inverts the foot.
- **Popliteus**: from the back of the tibia, passes up and across to the lateral side of the femur: it initiates flexion of the knee
- **Plantaris**: is a vestigial muscle from the back of the femur, it passes down and ultimately merges with the Achilles tendon; it flexes the knee and planter flexes the foot.

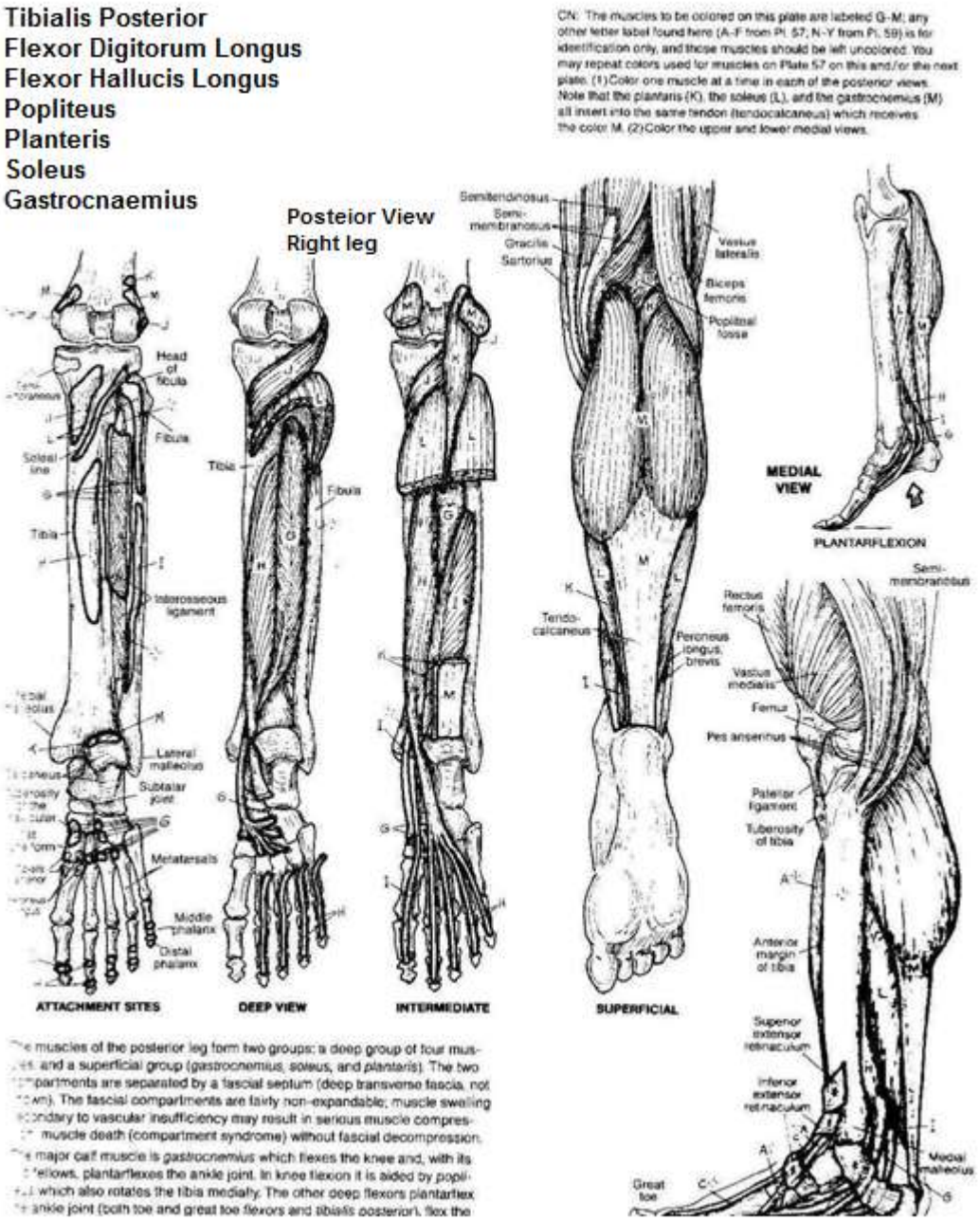


Figure 6 - Posterior Compartment Muscles

Anterior compartment

- **Tibialis anterior**: from anterior tibia and I/O membrane, passes down and medially across the front of the foot to the base of the first metatarsal; it dorsiflexes and inverts the foot.
- **Extensor digitorum longus**: from anterior tibia and I/O membrane, it passes down to the distal phalanges; it extends the toes and dorsiflexes the foot.
- **Extensor hallucis longus**: from the lower half of the I/O membrane, it passes down to the distal phalanx of the big toe; it extends the big toe and dorsiflexes the foot.
- **Peroneus tertius**: from the lower front of the fibula, it passes down to the base of the fifth metatarsal; it everts and dorsiflexes the foot

Lateral compartment:

- **Peroneus longus**: from the top outer edge of the fibula, it passes down, behind the lateral malleolus, to the base of the fifth metatarsal; it everts the foot
- **Peroneus brevis**: from the lower half of the fibula, it passes down behind the lateral malleolus to the base of the fifth metatarsal; it everts the foot.

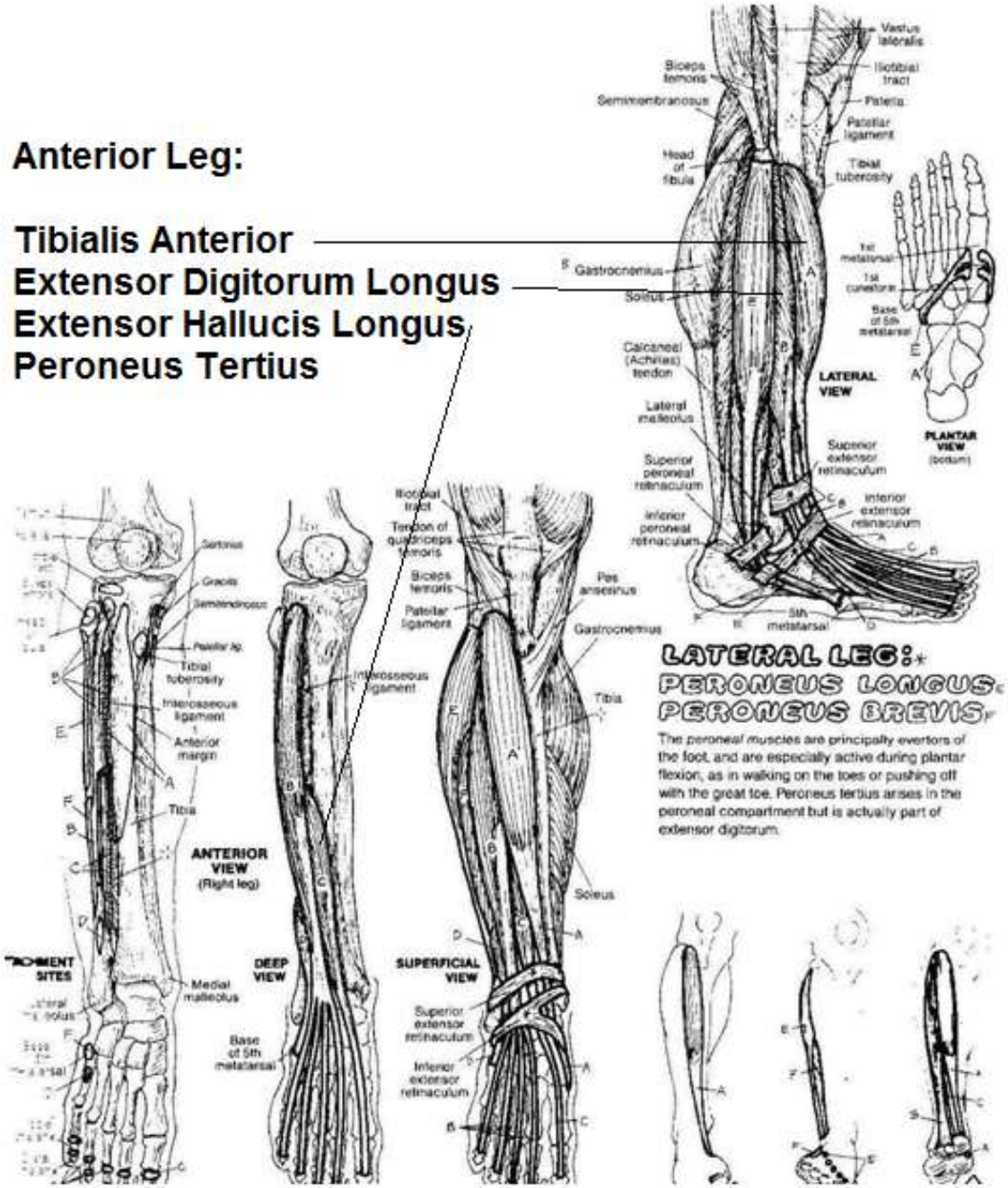


Figure 7 - Anterior and Lateral Compartment Muscles

Problems affecting the lower leg and ankle

Sprains and strains

Inversion – the commonest injury of the ankle; when the ankle is forced 'inwards', leading to a sprain of the lateral ligaments of the ankle

Eversion – can be the cause of a Potts fracture

Fractures

Potts Fracture – an eversion injury of the ankle leading to a fracture of the fibula and/or tibia

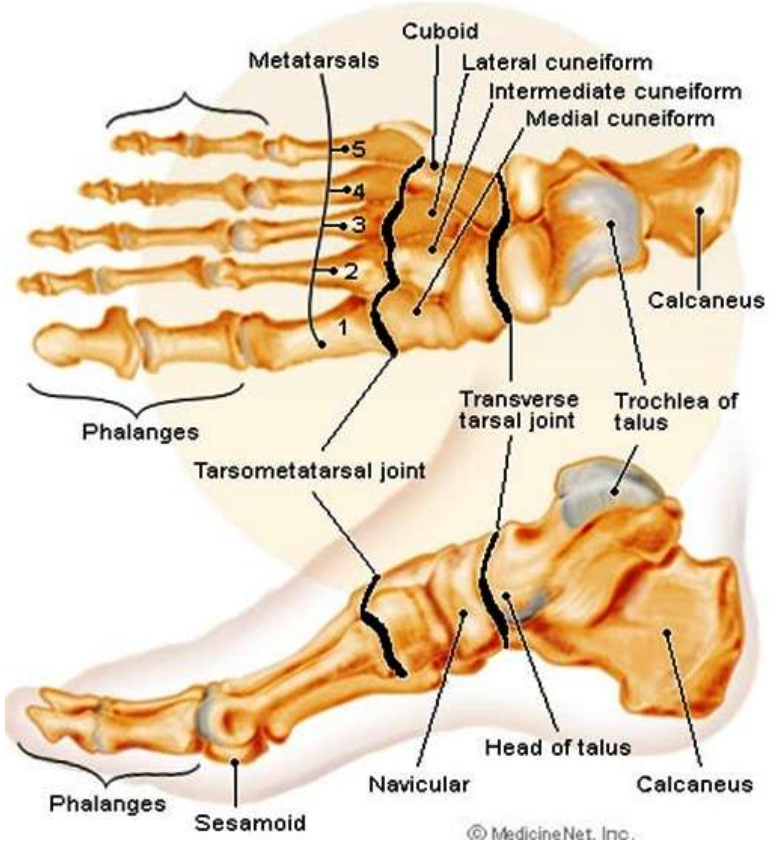
Figure 8 - Potts Fracture

Figure 9 - Achilles Tendinitis and Rupture

Ruptured Achilles tendon - can occur from running and having forced dorsiflexion of the ankle along with contraction of the gastrocnaemuis

The Foot

Figure 10 - Foot - Showing bones



The foot is a complex of bones, joints, fascial structures and muscles that allow it to be stable, yet relatively mobile and springy. These structures create and maintain the arches, the collective function of which is to protect the vessels, nerves and muscles on the planter (sole) aspect of the foot.

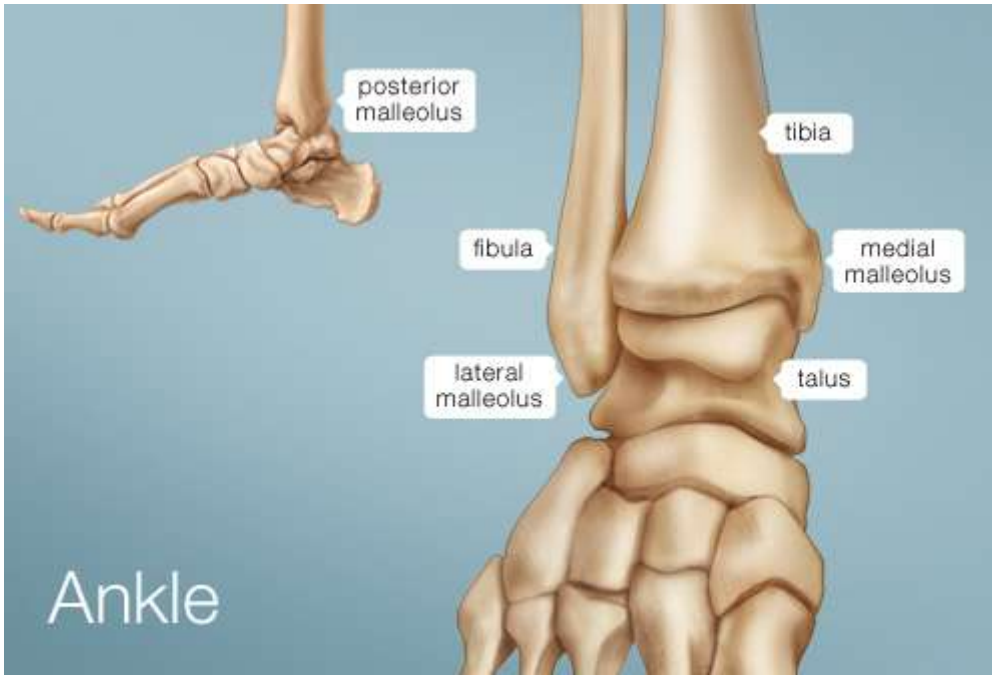


Figure 11 - Ankle joint

The lower end of the tibia and fibula form a joint shaped like a 'mortice', into which fit the 'tenon' of the talus

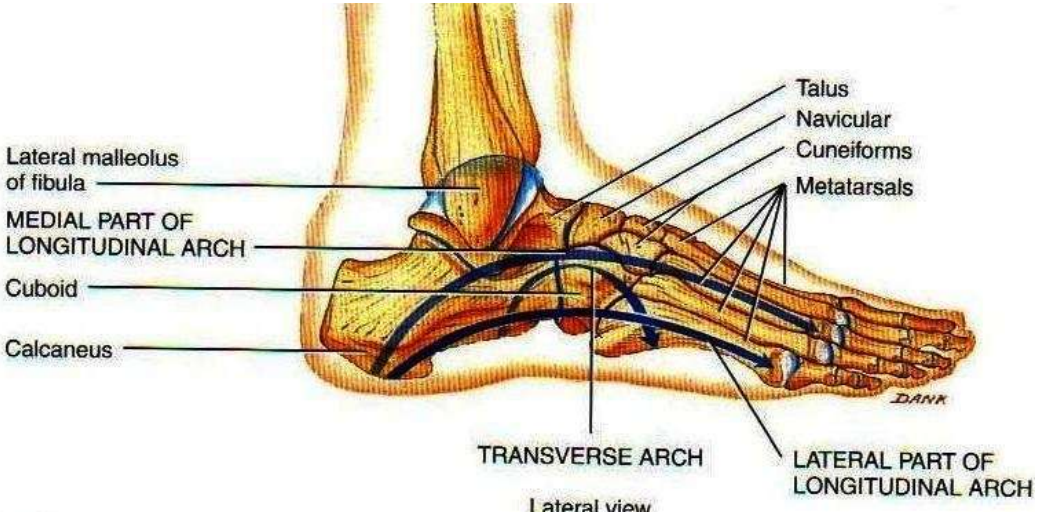
Bones of the foot (from proximal to distal):

Talus – the 'tenon' that fits in the mortise joint at the inferior end of the tibia and fibula (a hinge joint).
Calcaneum – the 'heel' bone, directly under the talus, navicular, which articulates with the talus (the joints talus, Calcaneum and navicular bones summate to a ball and socket joint, allowing circumduction of the ankle).
Three **cuneiforms** directly distal to the navicular, the cuboid is lateral, and has an articulation with, the navicular and cuneiforms, also with the Calcaneum (a saddle and the 4th and 5th metatarsals distal to it; and metatarsals 1 - 3 articulating with the cuneiforms. Are the rest of the joints are gliding, except the metatarsal-phalangeal and toes, which are hinge joints.

Ligaments: these are primarily medial and lateral across the ankle to stabilise the ankle in inversion and eversion.

Movements – As the foot works at right angles to the leg, there i no flexion/extension, per se; these movements are called:

- **Planter flexion**: pushing the foot distally
- **Dorsiflexion**: pulling the foot up, proximally
- **Inversion**: pulling the sole of the foot in medially (some books say supination)
- **Eversion**: pulling the sole of the foot out laterally (pronation)



The Arches of the Foot

There are three arches:

Longitudinal - medial side
Longitudinal – lateral side
Transverse – across the foot

Figure 12 - Arches of Foot

These arches are supported by 5 factors:

1. **Bony configuration** (the bones form an arch)
2. **Ligaments** holding the bones together
3. **Plantar fascia** – a band of fascia from the heel to the complex at the base of the toes
4. **Long muscles** (e.g. Tibialis anterior and posterior)
5. **Short muscles**

Problems affecting the ankles and feet:

Inversion strains – 'going over' on your ankle

Planter fasciitis – pain on the planter aspect of the foot, focussing at the heel

Calcaneal spur – a potential knock on of an ignored planter fasciitis, the body endeavours to heal the strain by calcifying the heel mend of the planter fascia, resulting in a bony spur on the heel; causing pain with weight-bearing.

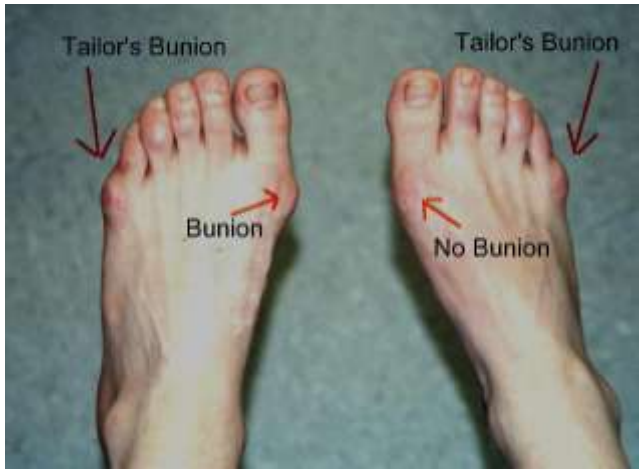
Figure 13 - Calcaneal Spur

March fractures – a stress fracture of the metatarsals, possibly not seen on X-ray
Frequently they are only seen later after some healing and callous formation have taken place

Figure 14 - Stress (March) Fractures

Bunions – a lateral deviation of the big toe possibly leading to deformation over/under the adjacent toes.

Figure 15 - Bunions



Pes planus (flat feet)

Figure 16 - Flat Feet - Pes Planus

Pes cavus (high arches)

Figure 17 - High Arches - Flat Feet

Talipes Equinus – club foot, though there are several varieties

Figure 18 - Club Foot