Understanding Leg Anatomy and Function

THE UPPER LEG

- The long thigh bone is the femur. It connects to the pelvis to form the hip joint and then extends down to meet the tibia (shin bone) at the knee joint.
- The hip is a ball-and-socket joint where the head of the femur (ball) fits deeply and snugly into the acetabulum (socket) of the pelvis. This perfect fit gives the hip joint a great degree of stability. Because it is such a large and stable joint, it helps dissipate the forces that come from weight-bearing activities.
- The hip muscles can flex (bring the leg up toward the body), extend (move the leg backward away from the body), abduct (move the leg out to the side of the body), adduct (move the leg toward the midline of the body), and internally and externally rotate the leg.
- The knee joint consists of the femur, the tibia, and the patella (kneecap).
- Patellofemoral refers to the union between the patella and the femur.
- The primary muscles surrounding the knee joint are the quadriceps muscles on the front of the thigh, the adductor muscles on the inside of the thigh, the hamstring muscles on the back of the thigh, and the tensor fasciae latae and iliotibial band on the outside of the thigh.
- The patella is located inside the tendon of the rectus femoris muscle, which connects the femur to the tibia. The femur has a concavity or groove where the patella rides up during extension (knee straightening) and down during flexion (knee bending). The underside of the patella has many ridges that are covered with protective cartilage. The patella's function is to give the quadriceps muscles increased efficiency and to protect the front of the femur.
- Muscles of the upper leg will bring the other parts of the lower leg upward. The skeletal components of the knee joint are the protective patella, or kneecap, the femur, or thigh bone, connected at the joint to the tibia, the shin bone, and the fibula, which are the long bones of the lower leg. The integrity of the knee joint is secured by the sets of ligaments connecting the three bones, as well as through the stabilizing effect of knee cartilage.
The lower-leg bones, the tibia and fibula, also help to form the ankle joint. The tibia sits on top of the talus (an ankle bone), which fits into the calcaneus (heel bone).

The fibula forms the lateral malleolus (the bony projection on the outside of your ankle).

The lower-leg muscles can act on the ankle and either dorsiflex (bring the toes towards the nose) or plantarflex (point the toes down). They can also act at the foot and either invert (move the foot toward midline) or evert (move the foot away from the body).

The foot’s bony and muscular anatomy is very similar to that of the hand. There are tarsals, metatarsals, and phalanges, and the muscles can flex, extend, abduct, and adduct the toes.

The lower leg is a remarkable structure, where each of its sophisticated components must work in harmony with the adjacent mechanisms to achieve support for the body or movement. No portion of the lower leg anatomy is capable of independent physical action.

The lower leg anatomy is composed of five distinct parts: the knee joint, the shin, the calf, the ankle, and the foot. In terms of the general functions of the lower leg, all movement is initiated by either a flexion or an extension of the knee joint. Either movement will stimulate a corresponding action on the part of the calf muscles and the attached Achilles tendon. These structures are themselves attached to the flexor and extension muscles of the ankle and the foot, which govern how the foot will be moved. The entire process of knee action to foot position is not a continuum, progressing down the lower leg. It is an integrated, system-wide response to a stimulus transmitted by the brain to the central nervous system and simultaneously received at the nerve endings in the muscles of the lower leg.

When the lower leg components respond in harmony to the direction of the nervous system to achieve the desired physical movement, all components must be functioning properly. When one of the lower leg anatomical parts is not capable of a proper response, the entire structure is compromised.

The knee joint is the hinge mechanism that initiates the propulsion of the lower leg. A flex of the hinge, powered by the hamstring and quadriceps, when one of the lower leg anatomical parts is not capable of a proper response, the entire structure is compromised.

The tibia and the fibula are commonly treated as a single skeletal structure. While neither bone is capable of independent movement, the chief function of these bones is in the formation of the knee and the various ankle joints, as well as providing support over a significant anatomical distance the tibia (the shin bone), relative to the overall body height, can range in length from approximately 10 in to over 20 in (25-50 cm) in healthy adults.

The shin is covered with a very thin tissue that represents the limited cushion between the surface of the tibia and the skin. The most common ailment involving the shin is medial tibial stress syndrome, or shin splints, caused by the stresses of either poor running mechanics or overuse directed into the tissue adjacent to the tibia.

The tibia and the fibula provide support for both the calf muscles and the Achilles tendon. The calf muscles are a two-part structure, the larger gastrocnemius and the underlying soleus muscle. These are connected to the knee joint at one end, and through the Achilles tendon are joined to the calcaneus, the heel bone. The calf muscles and the Achilles working in concert link the flexing and extending motions of the knee to the movements of the ankle and the foot.
THE ANKLE AND THE FOOT

The ankle joint is created at the junction of the tibia, fibula, and the talus, the ankle bone. There are three separate joints formed by these three bones, all of which are secured by a protective structure known as the synovial capsule, which encloses the joint in a fluid that both protects and lubricates the joint. The three bones are connected by way of three separate sets of ankle ligaments. The structure of the joint and the manner in which its ligaments are arranged permits the ankle to be rotated, flexed, and extended in all directions.

The ankle is attached to the bones of the foot at the talus, which is positioned above the calcaneus, the largest of the bones of the foot. It is the heel that absorbs a significant degree of force in every movement made through the lower leg. The ankle and the foot skeleton are comprised of 26 different bones, many of which are small, but are secured through the sophisticated structure of the foot anatomy. In addition to its bone structure, the arch of the foot is secured through the plantar, which extends from the heel to the forefoot, often referred to as the ball of the foot. The metatarsal bones are the five structures extending from the ankle to the toes, or phalanges, which extend from the base of the metatarsalphalangeal joint. Each toe is secured by its own set of ligaments; movement of the toes in relation to the rest of the structure of the foot is achieved through a complex system of tendons and small muscles on the top, the sole, and the sides of each foot.

Tendons and Muscles in the Foot and Ankle

In the foot diagram to the right, the main tendons on the top of the foot are labeled. In the foot diagram at the bottom, the tendons on the lateral aspect of the foot are labeled.

A. **Extensor hallucis longus**: dorsiflexes the big toe and dorsiflexes the foot (pulls up the big toe and the foot).
B. **Extensor digitorum longus**: dorsiflexes the small toes and dorsiflexes the foot (pulls the little toes up and pulls the foot up).
C. **Extensor digitorum brevis**: dorsiflexes the small toes (pulls the small toes up).

**Peroneus longus**: Everts and plantar flexes the foot (rotates the foot out and down). Stabilizes the arch when walking.
**Peroneus brevis**: Everts and plantar flexes the foot and stabilizes the foot when walking. The brevis tendon is a more powerful everter than the peroneus longus tendon.
In the foot diagram to the right, the main tendons on the bottom of the foot are labeled.
A. Flexor hallucis longus: plantar flexes the hallux and the foot (brings the big toe down and flexes the foot down).
B. Flexor hallucis brevis: plantar flexes the hallux (brings the big toe down).
C. Flexor digitorum longus: plantar flexes the toes and the foot (brings the little toes down and flexes the foot down).
D. Posterior tibialis: inverts and plantar flexes the foot (brings the foot in and down).

The images on the left and below show the tendons, muscles and plantar fascia on the inside, back and bottom of the foot.

- Posterior tibialis: inverts and plantar flexes the foot (brings the foot in and down). Posterior tibial tendonitis
- Achilles tendon: plantar flexes the foot (brings the foot down and assists in "push off" when walking). The largest and strongest tendon in the body.
- Plantar fascia: long ligament-type structure which supports the longitudinal arch when walking. There are three bands, the medial, central and lateral band.
Ankle Ligaments

In the ankle image on the right, the medial ankle ligaments are shown. There are four ligaments which make up the deltoid ligament:

- posterior tibiotalar ligament
- tibiocalcaneal ligament
- tibionavicular ligament
- anterior tibiotalar ligament

These ligaments give support to the inside of the ankle (medial ankle joint).

In the ankle image on the left is a diagram of the lateral ankle ligaments. There are three ligaments on the lateral aspect of the ankle joint:

- anterior talofibular ligament
- calcaneofibular ligament
- posterior talofibular ligament

The posterior talofibular ligament is not visible in this diagram. The ligament sits under the peroneal tendons. It attaches to the fibula and extends to the back of the ankle and attaches to the talus.

Neurovascular Structures in the Foot

"Neuro" refers to nerve and "vascular" refers to the veins and arteries, hence the term neurovascular.

In the foot diagram on the right the nerves are represented by the yellow structures, the arteries are represented by the red structures and the veins are represented by the blue structures.

- Nerves carry sensory and movement information to and from the brain.
- Arteries carry blood with oxygen and nutrients from the heart to the feet.
- Veins carry blood without oxygen or nutrients and with CO2 and byproducts from the feet back to the heart.
The foot diagram to the left shows the sensory nerves in the foot. The main nerves which control movement in the foot, branch much higher in the leg. The three nerves shown here are:

- superficial peroneal nerve
- dorsal intermediate cutaneous nerve
- dorsal medial cutaneous nerve

The superficial peroneal nerve branches off the common peroneal nerve which wraps around the knee. The common peroneal nerve is a branch off the sciatic nerve.