

THE LOWER EXTREMITY

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MUSCULOSKELETAL DEVELOPMENT

MESENCHYME: Not the same thing as mesoderm. It means *loosely organized connective tissue that is pluripotential*. It is often derived from mesoderm but may also be derived from Ectoderm Neural Crest, as in (Conus area of heart, branchial arches, area around eyes).

MESODERM: The middle germ-layer.

SOMITES: They are on the dorsal (back) surface of the embryo.

- **Schlerotome:** Medial part, becomes the bone. At this stage it is pluripotential.
- **Dermamytome:** Lateral-Plate Mesoderm -- lateral part, divides into dermatome and myotome to become skin and muscle.

BONE DEVELOPMENT: From the pluripotential sclerotome.

- **Osteoblasts:** Form bone.
- **Osteoclasts:** Break down and reshape bone.
- **Osteocytes:** They are osteoblasts, once calcification has already formed around the bone.

INTRAMEMBRANOUS OSSIFICATION: Forming bone directly from mesenchymal cells, as they differentiate to osteoblasts with no cartilage intermediate. This happens with flat bones like the skull.

ENDOCHONDRAL OSSIFICATION: Forming bones with a Cartilage intermediate.

- The entry of a **periosteal bud** into the cartilage is the key stage -- this is what allows the avascular cartilage to form vascular bone.
- Increase in bone:
 - **WIDTH-INCREASES IN BONE:** Occurs by lateral bone-deposition, directly under the collar.
 - The name of this deposited bone is **periosteal bone**.
 - **LENGTH-INCREASES IN BONE:** Occurs by growth at the Metaphyseal Plate, by proliferation of chondrocytes.
- Ossification centers:
 - **PRIMARY OSSIFICATION CENTER:** Periosteal bone development occurs at the primary center prenatally. This is in the middle of a long bone -- the **diaphysis**.
 - **SECONDARY OSSIFICATION CENTER:** Develops at or after birth. These are located in the **epiphysis**, or near the ends of the bones.
- Pretty much all of the bones are present in a fetus already at 13-14 weeks, except for the sesamoid bones -- the tarsals and carpals.

AXIAL SKELETON: Spine, skull, sternum, ribs

APPENDICULAR SKELETON: Extremities, pectoral girdle (scapula), pelvic girdle

SKELETAL DISORDERS

- **SPINA BIFIDA:**
 - **Spina Bifida Occulta:** The vertebral arch doesn't form fully. It is innocuous as long as it is localized only to one vertebrae.
 - **Spina Bifida Occulta:** More serious. As well as having no closure of the vertebral arch, you have a cyst.
 - If it is just a little sac of meninges, it is called a **meningocele** and may not be a problem.
 - **Meningomyelocele** has both meninges and a piece of spinal chord in the cyst. This is a problem.
 - **MYELOSCHISIS** -- worst case scenario. The neural tube never closes.
- **ACHONDROPLASIA:** General failure in endochondral ossification, resulting in short bones and short person! Has a strong inherited component.
- **Congenital Dislocation of the Hip:** Also has an inherited component, as well as about 25% environmental component, or so it seems.
- **Osteogenesis Imperfecta:** Repeated fractures of the long bones. Inherited component with a defect in type I Collagen.
- **Talipes Equinovarus:** Have a flexion and inversion of the feet. Talipes refers to Talus. Again, seems to be both environmental and inherited components.

MUSCLE DEVELOPMENT:

- Myotomes divide into two divisions:
 - **Epaxial (Epimeric) Division:** Innervated by *dorsal primary rami*. These are the muscles of the neck, back, and spine.
 - **Hypaxial (Hypomeric) Division:** *Innervation by ventral primary rami*. Includes most of the trunk and all of the extremities.

LIMB ROTATION:

- Initially, the limbs extend caudally, then later they extend back ventrally. But initially they are both facing the same direction (bent and facing forward).
- Then rotation occurs, such that the *knees point cranially and the elbows point caudally*. **THE ROTATION IS IN OPPOSITE DIRECTIONS**. This creates the **fetal position**.
 - **The upper limbs rotate 90 laterally, so that the elbows point down.**
 - **The lower limbs rotate 90 medially, so that the knees point up.**
- This rotation explains the twisted dermatomal arrangement in the limbs -- due to the rotation of the limbs.

GENERAL DERMATOMAL PATTERN OF UPPER LIMB: You move down the lateral surface and back up the medial surface, as you go from C4 to T2.

GENERAL DERMATOMAL PATTERN OF THE LOWER LIMB: More or less, you move down the anterior surface and back up the posterior surface, as you go from L2 to S4.

Vernix Caseosa: The encomium of the fetus as it is born, made of **peridermal tissue** that is sloughed off of the fetus' ectoderm prenatally.

VEINS, NERVES, MISCELLANY

SUPERFICIAL VEINS OF LOWER LIMB (N512, N513)

- **Great Saphenous Vein**
 - On the anterior thigh, it travels through the **Fossa Ovalis**, after which it merges with the Femoral Vein.
 - As you go down the leg, it wraps medially around to the posterior aspect of the knee.
 - Then it comes back anteriorly to the medial malleolus of the ankle, where it anastomoses with the Lesser Saphenous Vein.

- **Lesser Saphenous Vein:** Runs up the posterior leg.
 - It anastomoses with the Great Saphenous Vein around the ankle.

DEEP VEINS OF LOWER LIMB:

- For the most part, the deep veins run with the deep arteries.
- **(N485) Popliteal Vein:** Around the back of the knee, this vein is very important clinically.
 - BLOOD CLOT in POPLITEAL VEIN -----> *Femoral Vein* -----> *External Iliac* -----> *IVC* -----> *Right Heart* -----> *Lungs* -----> *Pulmonary Embolism!* -- not good.
 - The Lesser Saphenous Vein feeds into the Popliteal Vein around the posterior aspect of the thigh.
 - The Popliteal Vein feeds into the Femoral Vein.

SCIATIC NERVE and Branches (N508): Largest peripheral nerve in body.

- Innervates the posterior thigh. Divides into two principle branches at the *Popliteal Fossa usually, but may occur a foot proximal to it.*
- **Common Peroneal Nerve**, which divides into
 - **Deep Peroneal Nerve** -- Motor to medial leg
 - **Superficial Peroneal Nerve** -- Motor to lateral leg
 - **Lateral Sural Cutaneous** -- Cutaneous innervation to lateral leg.
- **Tibial Nerve** (N509) -- Posterior leg
- It may arise above, through, or below the Piriformis muscle in the hip.

FEMORAL NERVE and Branches:

- **Anterior Cutaneous Branches** -- Anterior Cutaneous innervation of thigh
- **Saphenous Nerve** -- Anteromedial innervation of leg

LUMBAR PLEXUS (N468): L2, L3, L4 primarily.

- Lateral Femoral Cutaneous Nerve
- Femoral Nerve
- Obturator Nerve

SACRAL PLEXUS (N469): L4, L5, S1, S2, S3 primarily.

- Superior and Inferior Gluteal Nerves
- Sciatic Nerve
 - Tibial
 - Common Peroneal
- Nerve to the Piriformis

MULTIPLE SPINAL LEVELS: Generally we should know that *different movements of the same limb utilize different spinal levels.*

- Generally the anterior compartment has a slightly higher spinal level than the posterior compartment, in the lower limb.

DERMATOME PATTERN OF LOWER LIMB (N511):

- We almost get a *Barber-Pole Effect* with the different spinal levels as you travel down the lower limb.
- LUMBAR generally covers the anterior leg.
- SACRAL generally covers the posterior leg.

CUTANEOUS INNERVATION OF THIGH and LEG:

- **Posterior Femoral Cutaneous Nerve** innervates the posterior thigh.
 - It comes directly off the Sacral Plexus.
- **Branches of the Femoral** innervate the anterior thigh.
- **Saphenous Nerve:** Innervates the medial part of the leg and foot.
 - It comes off the Femoral Nerve.
 - **It only travels with the Saphenous Vein in the Leg -- not in the thigh!!** In the thigh, the Saphenous Nerve has a different path than the corresponding vein.
 - It gives *residual innervation to the foot*. If you lose the Tibial Nerve (from the Sciatic), you *won't lose all of your sensation in the foot -- because of the Saphenous*.

CLINICAL (N510B) -- Cutaneous innervation of the *Deep Peroneal Nerve* is assessed at the *web of skin between the first and second toes*. This is a common way to assess lower-damage from an injury.

HERNIATED SPINAL DISKS: Pinching a nerve in the nerve-root of the spinal chord, due to an outward herniation of the **nucleus pulposus** in the spinal column.

- To see which Lumbar Spinal Level is compromised, you can use various tests:

	L4 COMPROMISE	L5 COMPROMISE	S1 COMPROMISE
Area of Pain:	Shooting pain along the lower extremity	Shooting pain on lateral leg	Posterior thigh and leg, and lateral foot
Area of Numbness:	Anteromedial Thigh	Lateral leg	Posterior leg and sole of foot
Motor Weakness:	Loss of Quadriceps -- weak flexion of thigh and extension of leg	No Dorsiflexion of Great Toe and Foot	No Plantarflexion of foot
Screening Exam:	Squat&Rise -- This requires the quads, i.e. thigh-flexion and leg-extension	Cannot walk on heels , due to inability to dorsiflex the foot.	Cannot walk on toes , due to inability to plantar flex foot.
Reflex-Tests:	No Knee-Jerk Reflex -- because the Quads insert on the Patellar Ligament	None	No Ankle-Jerk Reflex , due to lost innervation of the Calcaneus (Achilles) Tendon

THE HIP AND THIGH

THE ILIUM:

- External surface of Ilium has three Gluteal lines for the Gluteus muscles, from superior to inferior in the following order:
 - **Posterior Gluteal Line**
 - **Anterior Gluteal Line**
 - **Inferior Gluteal Line**

THE FEMUR (N459):

- **Linea Aspera:** Important ridge on the *posterior surface* of the femur, while the anterior surface is smooth. Hence this is a good way to tell the difference between the two surfaces.
- Greater and Less Trochanter:
 - **Intertrochanteric Line** connects them *anteriorly*.
 - **Intertrochanteric Spine** connects them *posteriorly*.

COLLATERAL CIRCULATION AROUND THE NECK OF THE FEMUR (N474a):

- **Lateral and Medial Circumflex Femoral Arteries** -- supply the head and neck of the femur.
 - As well they supply the **intertrochanteric region**, regions between the greater and lesser trochanter.
- **INTERTROCHANTERIC FRACTURE:** Fracture right across the intertrochanteric line, at the bottom of the neck.
 - You retain blood supply to the head and the neck of the femur, so this has a good chance of healing.
 - Head Blood Supply: **Retinacular Arteries**
 - Neck Blood Supply: Circumflex Femoral Arteries
- **SUBCAPITAL FRACTURE:** Fracture right beneath the head, at the top of the neck.
 - You LOSE BLOOD SUPPLY TO THE HEAD, resulting in **Avascular Necrosis (AVN) of the head of the femur!** Bad news dude.
- **Cruciate Anastomosis:** In a significant percentage of the population, anastomoses between the following vessels:
 - Inferior Gluteals
 - 1st perforating branch of the Femoral Profunda artery
 - Medial and Lateral Femoral Circumflex.
- In the event of a Femoral Artery Occlusion, there will still be some blood supply to the leg, because of this collateral circulation.

ISCHIAL SPINE: Is the bony protuberance that marks the separation between the Greater and Less Sciatic Foramina.

ANTERIOR COMPARTMENT OF THE THIGH:

- Action = flexion of thigh and extension of leg.
- Innervation = Femoral Nerve

POSTERIOR COMPARTMENT OF THE THIGH:

- Action = Extension of thigh and flexion of leg
- Innervation = Sciatic Nerve
- **CLINICAL -- WHERE TO GIVE A SHOT:** The **Upper Outer Quadrant**, which is an *intramuscular injection* into the Gluteus Medius and Minimus.
 - The object: *avoid the Sciatic nerve*, which is in the lower medial quadrant.
- **CLINICAL -- PULLED HAMSTRINGS** -- A common injury to this area.
 - Can occur at common origin (ischial tuberosity) or common tendon (medial condyle of tibia, or head of fibula for biceps femoris)

MEDIAL (ADDUCTOR) COMPARTMENT OF THE THIGH:

- Action = Adduction of thigh
- Innervation = Obturator Nerve

QUADRICEPS: These four muscles, which insert on the Quadriceps tendon on the Patella, have a crucial role in knee stability.

GAIT / WALKING / PELVIC TILT:

- When walking, you have to tilt up your pelvis on the side of the body not planted. This involved contraction of *Gluteus Minimus and Medius* muscles.
 - Slightly Abducting the thigh and medially rotating it.
- **CLINICAL -- GLUTEAL GAIT:** If you lose the superior gluteal nerve, you will no longer be able to lift the hip. When walking, this looks like a gluteal gait.
 - To compensate for this, the leg swings out laterally so that the foot can move forward, so walking kind of looks like a shuffle.
 - This can be caused by loss of two different nerves:
 - **Superior Gluteal Nerve** (no abduction of thigh)
 - **Obturator Nerve** (no adduction of thigh)

SUPERIOR GLUTEALS (N473): The vein, artery, and nerve travel:

- Superior to the Piriformis muscle.
- Then *between the gluteus minimus and medius muscles.*

FASCIA LATA (N470, N464): The fascia on the thigh is very dense.

- Superior Limit: The Inguinal Ligament and Iliac Crest, it is a continuation of the Transversus Abdominis.
- Inferior Limit: It merges with the Iliotibial Tract, which is around the lateral of the leg.

ILIOTIBIAL TRACT (N464): Inserts onto the tibia, around the lateral aspect of the knee. It is continuous superomedially with the fascia lata.

- When standing upright, it holds the knee in place.

GRACILIS MUSCLE: A GOOD SPARE PART. This weak adductor has a nice nerve and artery that are dispensable and can be grafted to other locations.

N.A.V.E.L.: The order of femoral vessels entering through the obturator foramen into the medial thigh, starting from the ASIS and working inferomedially to the pubic tubercle.

- N: Nerve
- A: Artery
- V: Vein -- *the femoral nerve is not a part of the femoral sheath, while the others are.*
- E: Empty Space
- L: Lacunar Ligament

FEMORAL TRIANGLE: Region of medial thigh, where the **Femoral Sheath** ends and lets out the Femoral Artery and Vein.

- Floor of the Femoral Triangle is composed of the following muscles:
 - **Iliopsoas**
 - **Pectineus**
 - **Adductor Longus**
- Borders of Femoral Triangle:
 - **Sartorius:** Inferior base of triangle
 - **Inguinal Ligament:** Superior limit of triangle
 - **Adductor Longus:** More or less the lateral limit
- **CLINICAL -- FEMORAL HERNIA:** Abdominal contents can spill through the Femoral Sheath into the Femoral Triangle.
 - How to distinguish it from inguinal hernias: A femoral hernia is completely inferior to the inguinal ligament and lateral to the pubic tubercle.

Femoral Vessels (N470): Travel through the thigh between the anterior and medial compartments in the upper thigh.

Femoral Nerve: Enters the thigh by traveling just deep to the **Inguinal Ligament**, on the anterior surface of the **Psoas Muscle**. This creates a nerve-sandwich!

- This entry-point is just medial to that of the lateral femoral cutaneous nerve.
- **Nerve Entrapment** can occur between the Psoas Muscle and the Inguinal Ligament.

Lateral Femoral Cutaneous Nerve: Enters the thigh by traveling under the **Inguinal Ligament** at the very lateral aspect of the Inguinal Ligament.

- **Nerve Entrapment:** Hence the nerve can get pinched, especially in overweight folks.
- That would result in paresthesia in the lateral region of the thigh.

FEMORAL ARTERY (N471, N481): The continuation of the External Iliac Artery, beyond the Inguinal Ligament.

- BRANCHES
 - **Deep Femoral Artery** -- goes around the posterior side of the knee and hugs the back of the knee joint.
 - Sends 3 **Perforating Branches** to posterior compartment.
 - Gives off **Lateral Circumflex Artery** that anastomoses both at the head of the femur and at the knee (via lateral superior genicular)
 - **Popliteal Artery** -- around posterior of knee, gives off three branches:
 - **Anterior Tibial Artery** -- main blood supply down anterior leg
 - **Posterior Tibial Artery** -- main blood supply down posterior leg.
 - **Peroneal Artery** -- it may play a significant role if one of the above is absent or damaged.
 - CLINICAL -- a knee injury around the back of the knee can injure the popliteal artery, but that usually doesn't happen because the popliteal is very deep.
- The Femoral Artery becomes the Popliteal after it has traveled through the **Adductor Hiatus** on the medial distal thigh.
 - At the same time it *pierces the Adductor Magnus tendon.*
- CLINICAL -- **FEMORAL CATHETER.** *The Femoral Artery lies halfway in-between the ASIS and the Pubic Tubercle, as it runs beneath the Inguinal Ligament.*
 - This is the location where you would put a catheter into the Femoral Artery. This is a common place to inject dye for arteriographs.
- CLINICAL -- **FEMORAL ARTERY OCCLUSION:**
 - Commonly occurs at two points:
 - Just as the Femoral Artery enters anterior thigh under the Inguinal Ligament., at the Femoral Triangle.
 - As the Femoral Artery goes through the Adductor Hiatus, going back into the Popliteal Fossa.

GLUTEAL MUSCLES: The order of muscles below the gluteus maximum and minimum, going from superior to inferior:

- Piriformis
 - *Sciatic Nerve comes out right below the Piriformis*
- Superior Gemellus
- Obturator Internus
- Inferior Gemellus
- Quadratus Femoris

THE KNEE AND LEG

FIBULA: Lateral, smaller bone.

- The proximal part can be used as a spare part for bone grafts. The Fibula has no articulation at the knee but some articulation at the ankle joint.

TIBIA: Medial, larger bone.

- The anterior part of the tibia has almost no tissue associated with it. So it is the most common place to see an open fracture.

THE KNEE-JOINT (N479): Three groups of ligaments.

- Collateral Ligaments
 - **Fibular (lateral) Collateral Ligament** -- longitudinal ligament on lateral aspect of Patella.
 - **Tibial (medial) Collateral Ligament**
- Cruciate Ligaments: They span the **Intercondylar Fossa** and insert onto the **Intercondylar Eminence** of the Tibia. They are crucial to knee stability.
 - **Anterior Cruciate Ligament**
 - **Posterior Cruciate Ligament**

- Cartilaginous Ligaments: They provide more articulation space for the condyles of the femur.
 - **Medial Meniscus does connect to the Tibial (medial) Collateral Ligament**
 - So if the Tibial Collateral Ligament is damaged, the Medial Meniscus could easily be damaged with it.
 - **Lateral Meniscus does not connect to the Fibular (lateral) Collateral Ligament**
- *The LATERAL MENISCUS IS MORE MOBILE THAN THE MEDIAL MENISCUS.*
 - The **Popliteus Muscle** (posterior leg) has an insertion between the lateral meniscus and the joint, creating more room on the lateral side.

COLLATERAL CIRCULATION AROUND THE KNEE (N481):

- **Superolateral Genicular Artery**
 - Anastomoses with the **Lateral Circumflex Artery**, all the way from the femur.
- **Inferolateral Genicular Artery**
- **Superomedial Genicular Artery**
- **Inferomedial Genicular Artery**

POPLITEAL ARTERY (N487): Posterior artery around the knee, the continuation of the Femoral Artery, right after it passes through the Adductor Hiatus. It is the *basic blood supply to everything below the knee.*

- BRANCHES
 - **Posterior Tibial Artery:** Comes around the *medial malleolus* (ankle) and perfuses the sole of the foot.
 - CLINICAL -- you can test the integrity of the posterior tibial by palpating for a pulse on the sole of the foot.
 - **Anterior Tibial Artery:** Comes down through the anterior leg and onto the dorsum of the foot.
 - **Dorsalis Pedis Artery** is the continuation of the Anterior Tibial onto the dorsum of the foot.
 - **Common Peroneal Artery**
 - **Sural Artery:** Terminal branches of the Popliteal Artery, supplying the heads of the gastrocs. They are *the exclusive supplier of the Gastrocnemius.*
 - **It contains no collateral circulation.** If you lose your blood supply there, a lot of cramping of the leg will result.
 - It can be affected by a femoral artery occlusion, and it is not necessarily fixed by bypass surgery.
- CLINICAL -- **SUPRACONDYLAR FRACTURE** of the distal femur can harm the popliteal artery.
 - **Gastrocnemius Muscle** can threaten the popliteal artery at its origin, where it flexes the distal femur. Tearing of the artery would cut blood supply to entire leg essentially.
 - *A Cast for this fracture should be made with the leg in the flexed position*, so pull from the Gastrocnemius on the femur is minimal.

POPLITEAL VEIN: May **thrombose**, for example, during pregnancy, when the External Iliacs are pinched. The thrombus has potential to break loose and make its way back to the lungs. Not good as usual.

POPLITEAL FOSSA (N472): The area behind the knee.

- Borders:
 - Lateral border: Biceps Femoris
 - Medial border: Semimembranosus and semitendinosus muscles.
 - Inferior border: The lateral and medial head of the gastrocnemius.
- CONTENTS:
 - The origin of the **Popliteal Artery** and terminus of the **Popliteal Vein**
 - The **Lesser Saphenous Vein** dumps into the popliteal vein at the Popliteal Fossa.
 - **Sciatic Nerve** can bifurcate into the Tibial and Common Peroneal as far inferiorly as the popliteal fossa.
- The order of things going through Popliteal Fossa, from medial to lateral
 - ARTERY (popliteal artery)
 - VEIN (popliteal vein)
 - NERVE (sciatic or tibial nerve)

ANTERIOR COMPARTMENT OF THE LEG:

- Action = Dorsiflexion of foot and some extension of digits
- Innervation = Deep Peroneal Nerve

COMMON PERONEAL NERVE:

- You can feel it over the head and neck of the fibula.
- It divides into:
 - **Deep Peroneal Nerve** -- Anterior leg
 - **Superficial Peroneal Nerve** -- Lateral leg
- **CLINICAL** -- IT CAN BE INJURED where it lies against the head of the fibula (a fracture of the proximal fibula) or around the lateral knee (the lateral collateral ligament).
 - The telling sign for this injury is "**foot drop**", resulting from damage to the Deep Peroneal Nerve (anterior compartment -- no dorsiflexion of foot).
 - You will also **Varus** with this injury, due to injury to the Superficial Peroneal Nerve (lateral compartment -- no eversion of foot)

POSTERIOR COMPARTMENT OF THE LEG:

- Action = Flexion of knee, plantarflexion of foot, some flexion of digits.
- Innervation = Tibial Nerve.
- **Sural artery**: Sole supplier of the Gastrocnemius, and it has no collateral circulation.
- **Sural nerve**: A SPARE PART. It does *not innervate* the gastrocs -- the Tibial Nerve does.
- **Transverse Intermuscular Septum**: Separates the superficial and deep compartments of the posterior leg.
- **Gastrocnemius and Soleus**: Both of these muscles are essential for you to push off when you walk, and to change direction.
 - They are the primary plantar flexors of the foot -- let you stand on your toes.

LATERAL COMPARTMENT OF THE LEG:

- Action = eversion of foot
- Innervation = Superficial Peroneal Nerve.
- **JONES' FRACTURE**: Pulling off or breaking a piece of the fibula distally, as often occurs with a sprained ankle.
 - This often results in damage to the **Peroneus Brevis** muscle, as its origin is on the fibula, which in turn means no eversion of the leg.

THE ANKLE AND FOOT

THE ANKLE LIGAMENTS (N494, N495)

- *Lateral Collateral Ligament*
 - **Anterior and Posterior Talofibular Ligaments** (Talus <====> Fibula)
 - **Calcaneofibular Ligament** (Calcaneus <====> Fibula) -- it crosses the Subtalar joint to help support it.
- **SPRAINED ANKLE**:
 - Often happens by an *inversion* injury, where the foot is inverted, placing too much pressure on the **Anterior Talofibular Ligament**, which you can sometimes see ball up.
- **Deltoid (Medial) Ligament**: Group of four ligaments composing the medial ankle. Various tibiotarsal ligaments.
- **Transverse Tarsal Joint / Ligament**: aka **Chopart's Joint**. Allows for pronation and supination of the foot. A common point of amputation.

- **LISFRANC'S JOINT: TARSMETATARSAL JOINT** -- very important joint. Injuries to this area are common.
 - *Fractures of the 2nd metatarsal are common*, because the 2nd metatarsal is less mobile because it is inset from the 2nd cuneiform.
- **Cervical Ligament**
- **Bifurcate Ligament**
- **Long Planter Ligament:** Helps maintain the arch of the foot.
- **Calcaneonavicular (Spring) Ligament:** Helps maintain the arch of the foot.

PLANTAR APONEUROSIS: Similar to the palmar aponeurosis, it keeps the skin on the sole of your foot immobile, so you can walk on it.

- Origin from Calcaneous Tuberosity.
- Inserts on much of the skin of the sole of the foot.

RETINACULA:

- **PERONEAL RETINACULUM:** Lateral side of foot
 - Contents: Peroneus Longus and Peroneus Brevis tendons.
 - Continuous with the inferior part of the extensor retinaculum
- **EXTENSOR RETINACULUM:** Along dorsum of foot
 - It is Y-Shaped, dividing into a superior and inferior portion on the lateral side of the foot. The stem of the Y is on the medial side and is continuous with the Peroneal Retinaculum.
 - Contents:
 - Extensor Digitorum Longus tendon
 - Extensor Hallucis Longus tendon
 - Peroneus Tertius tendon
 - **Dorsalis Pedis Artery and Deep Peroneal Nerve** pass underneath.
- **FLEXOR RETINACULUM:** On the medial side of the foot, from the medial malleolus to the calcaneus. All of the flexor tendons pass through it as they wrap around to the plantar aspect of the foot.
 - Contents: Tom Dick AND Harry
 - **Tibialis Posterior** tendon
 - **Flexor Digitorum Longus** tendon
 - **Posterior Tibial Artery**
 - **Posterior Tibial Nerve**
 - **Flexor Hallucis Longus** tendon

TARSAL TUNNEL SYNDROME: Similar to Carpal Tunnel syndrome, compression of the **tibial nerve** under the **flexor retinaculum**.

BONES OF THE FOOT (N492, N493):

- **Calcaneous:** The heel. The inferior-most aspect of the foot.
 - Made primarily of cancellous bone
 - Has three articular surfaces that articulate with the Talus at the Subtalar joint.
 - Posterior Articular Surface
 - Middle Articular Surface
 - Anterior Articular Surface
- **Talus:** The ankle-region, which articulates with the Tibia.
 - Articulates with the Tibia, the Fibula, and the Navicular bone.
 - *There are no blood vessels going to the Talus. There are no muscle attachments to the Talus.*
 - A lot of the Talus blood supply comes from the **Sinus Tarsi**.
 - Has three facets that articulate with the Calcaneous
 - **Posterior Facet**
 - **Middle Facet**
 - **Anterior Facet**

- **Tarsal Bones:** The analog to the carpal bones in the wrist:
 - **Cuboid Bone:** Most lateral, near the 5th digit
 - **Navicular Bone:** Most medial and proximal, articulating with the Talus and Calcaneus.
 - Most prominent of the Tarsal bones.
 - It has a palpable **Navicular Tuberosity**.
 - **Lateral, Intermediate, Medial Cuneiform Bones:** Most distal and on the lateral side, articulating with the metatarsals.
- **Metatarsal Bones**
- **Proximal, Middle, Distal Phalanges**

ARCHES OF THE FOOT (N495, N496):

- The arches:
 - **Medial Longitudinal Arch:** Talus is primary connection here.
 - **Lateral Longitudinal Arch:**
 - **Transverse Arch:** The **Peroneus Longus Tendon** helps support the Transverse arch of the foot (on the lateral side of the foot).
- What keeps the foot arched?
 - Shape of the bones
 - Ligaments
 - Some muscular support
- Three Plantar Ligaments help to maintain the **Longitudinal Arch:**
 - **Calcaneonavicular (Spring) Ligament:** Connect navicular bone to the Calcaneus.
 - **Long and Short Plantar Ligaments:** Along bottom of foot, help to maintain its arch.
- Muscles that help the arch: *Flexor Hallucis Longus Tendon* connects from the heel to the big toe, holding the two ends of the Medial Arch together.
- **Flat-Foot Deformity:**
 - The longitudinal arch is lost in some flat-foot deformities.

SUBTALAR JOINT: The joint between the Talus and Calcaneus.

- This joint helps you walk on unlevel ground. It accommodates with eversion and inversion of the hindfoot.
- **Subtalar Arthritis** would prevent a person from being able to walk on unlevel ground easily -- no eversion and inversion of hindfoot.

QUADRATUS PLANTAR MUSCLE (2nd layer): **CLAW-TOE** Deformity results from scarring of this muscle. The Flexor Digitorum longus tendons are just superficial to this muscle, and they will contract with scarring of this muscle.

- This is a common symptom of a *compartment syndrome* in this compartment in the foot.

Master's Knot of Henry (N497): The crossing of the Flexor Digitorum Longus and Flexor Hallucis Longus tendons, on the medial side of the foot.

- The two run together down the medial leg, behind the medial malleolus. After they pass the medial malleolus, they cross.

BUNION: Over-pull and contraction of the Adductor Hallucis (3rd layer) Muscle.'

- First toe bends in medially (in valgus)
- In surgery, bunions are often fixed by releasing the muscle in the first web-space.

ARTERIES OF THE FOOT

- **POSTERIOR TIBIAL ARTERY:** Follows the posterior tibial nerve, to supply the plantar aspect of the foot
 - **Medial Plantar Artery**
 - **Lateral Plantar Artery**
 - **PLANTAR ARCH:** Is formed by the medial and lateral plantar arteries.

- **Perforating Branches** are sent up *between first and second metatarsals*, to provide anastomosis between posterior tibial and dorsalis pedis arteries.
 - If one of the above arteries is cut off, therefore, you can still get blood supply to the foot.
- ANTERIOR TIBIAL ARTERY: Turns into the Dorsalis Pedis
 - **Dorsalis Pedis Artery** -- supplies the dorsum of the foot. It passes underneath the extensor retinaculum.
 - This is a good place to feel for pulses, as the artery is very superficial.
 - Gives off an **Arcuate Artery** which forms a **Dorsal Superficial Arch** and in turn gives off **Dorsal Metatarsal Arteries**.
- PERONEAL ARTERY: Normally small, unless one of the above is absent. It normally tapers out on top of the calcaneus.

NERVES OF THE FOOT:

- TIBIAL NERVE -- Divides into
 - **Medial and Lateral Plantar Nerves** -- the primary motor innervation of the foot.
- SAPHENOUS NERVE
- DEEP PERONEAL NERVE
- SUPERFICIAL PERONEAL NERVE
- SURAL NERVE

COMPARTMENTS OF THE FOOT:

- Medial Compartment
- Central Compartment
- Lateral Compartment
- Interosseus Compartment

CLINICAL -- **CALCANEUS FRACTURES** are common with falls.

- The calcaneus is largely cancellous rather than cortical bone, which makes it subject to breaking.
- Common mode of action: The Talus gets driven inferiorly into the calcaneus.
 - **Boehler's Angle** = the angle between the calcaneus and talus. It becomes flattened.
 - Fractures are most common through the Posterior Facet of the Talus.
- If you don't operate you can lose the *height of the foot*, making it so shoes don't fit very well!

LISFRANC (TARSOMETATARSAL) JOINT FRACTURES -- most commonly occur at the 2nd metatarsal bone, because it is inset next to the 2nd cuneiform.

- This is the location of the transverse arch of the foot.
- You can get pain in this fracture because the superficial peroneal nerve is directly dorsal to the joint, too.
- Chronic pain and arthritis is common with this, and the joint must be fixated to restore anatomical normality.

STRESS FRACTURE: A fracture that doesn't result from trauma, but results from fatigue in a bone. The fracture is usually small and/or diffuse.