

Anatomy

Objectives

- Locate the bones, muscles, joints and tendons of the foot.
- Recognize the common footwear components.
- Recall the manufacturing methods and how they benefit the patient.
- State the benefits of therapeutic shoes to provide optimum benefits to the patient.



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It is important to be properly indentify the bones, muscles, joints and tendons of the foot, as well as be familiar with common footwear components.

Anatomy



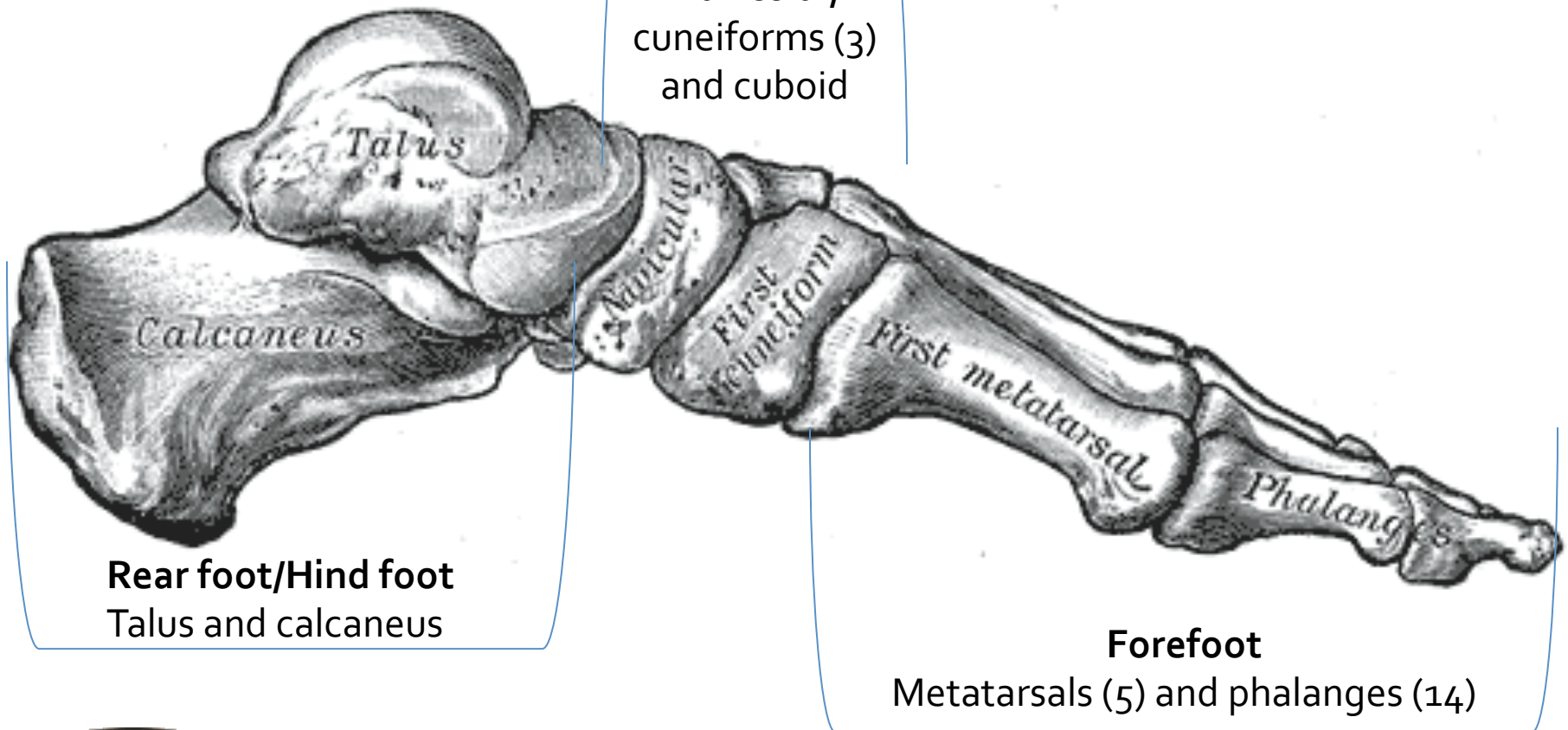
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Bones

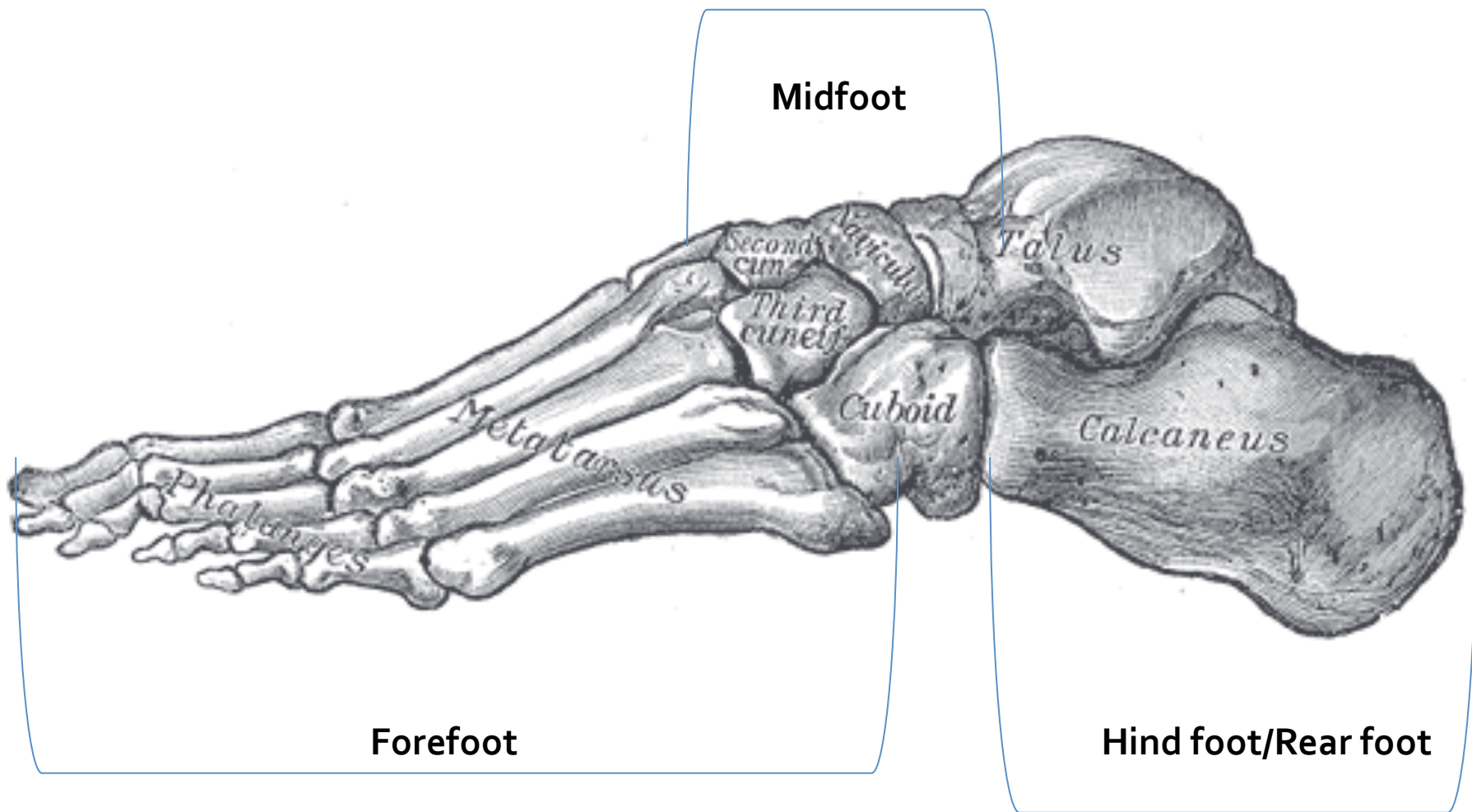
- There are 26 bones in each human foot. Makes up one quarter of the entire (206 bones) human body
- 2 in the hind foot or rear foot
- 5 in the midfoot
- 19 in the forefoot
- 2 ancillary bones underneath the first metatarsal head



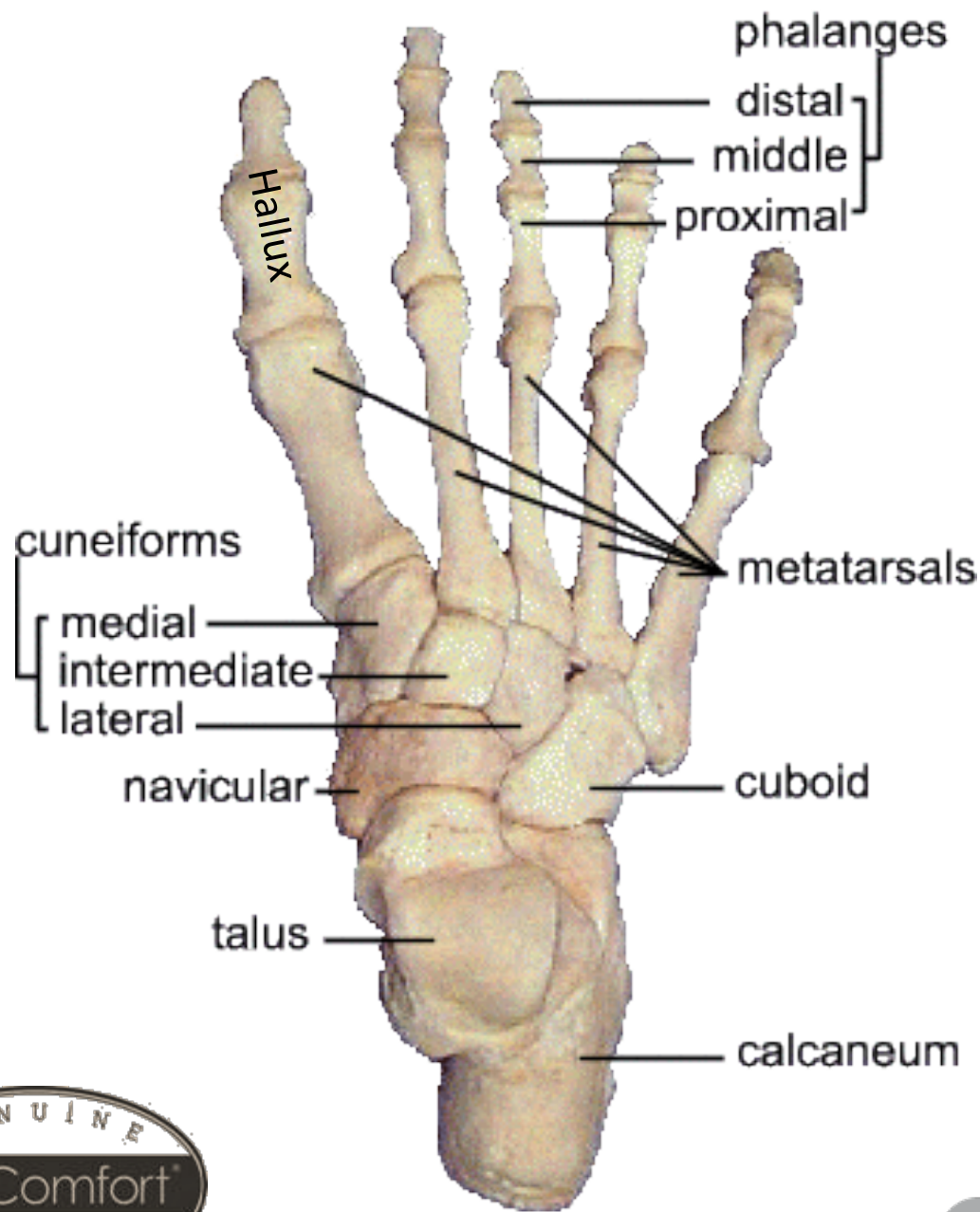
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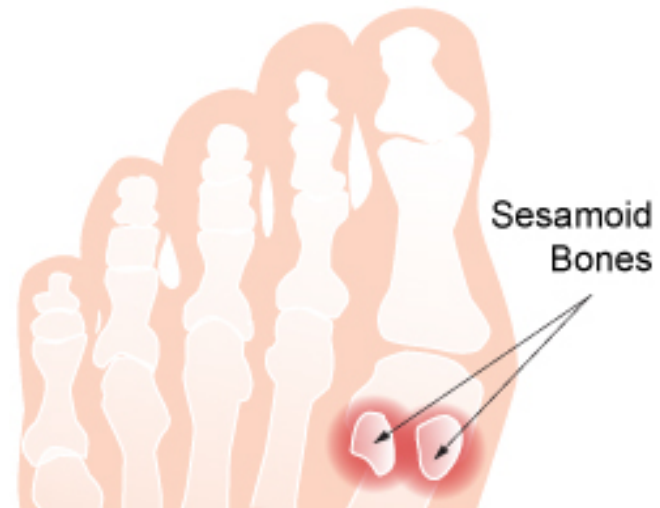
The metatarsals are numbered 1-5 beginning with the great toe, or hallux.

The 5 metatarsal bones are made up of three main parts—the base, the shaft and the head. The heads are the weight bearing portion of the foot.

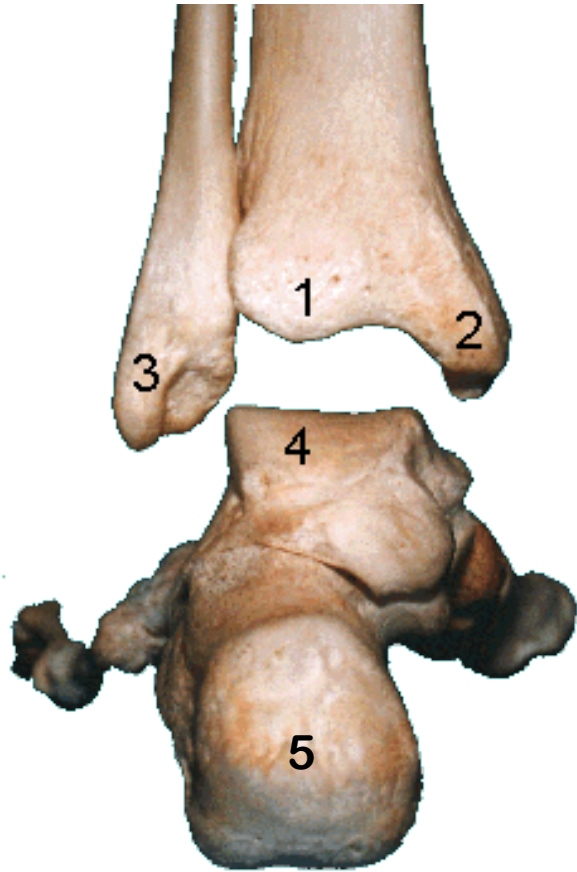


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- **Sesamoids:** Located on the plantar side of the great toe (hallux). Identified by the location on the foot-- tibial (medial) and fibular (lateral) sesamoids.
- The sesamoids are embedded within the medial and lateral slips of the flexore hallucis brevis.
- Act as the weightbearing surface of the 1st MTH



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Posterior view of ankle (left)

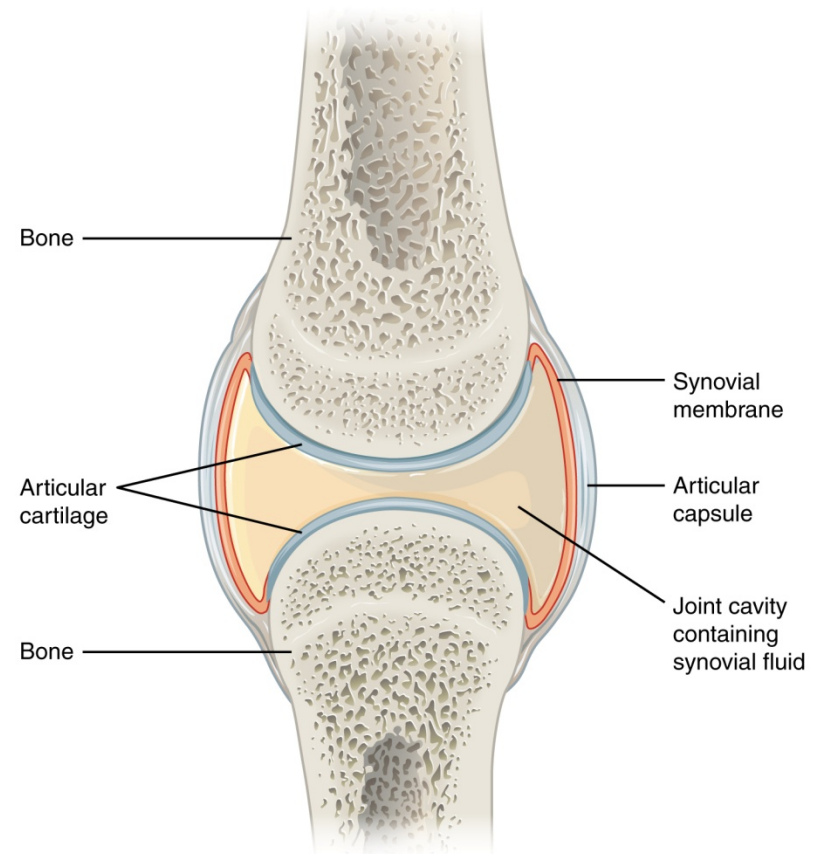
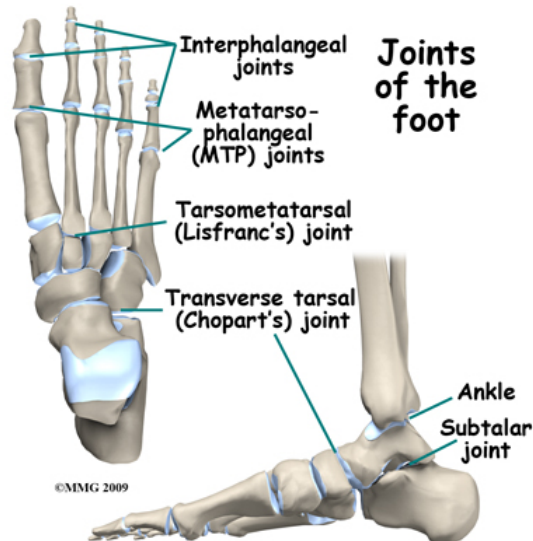
1. Tibia
2. Medial malleolus (tibia)
3. Lateral malleolus (fibula)
4. Talus (slightly displaced)
5. Calcaneus



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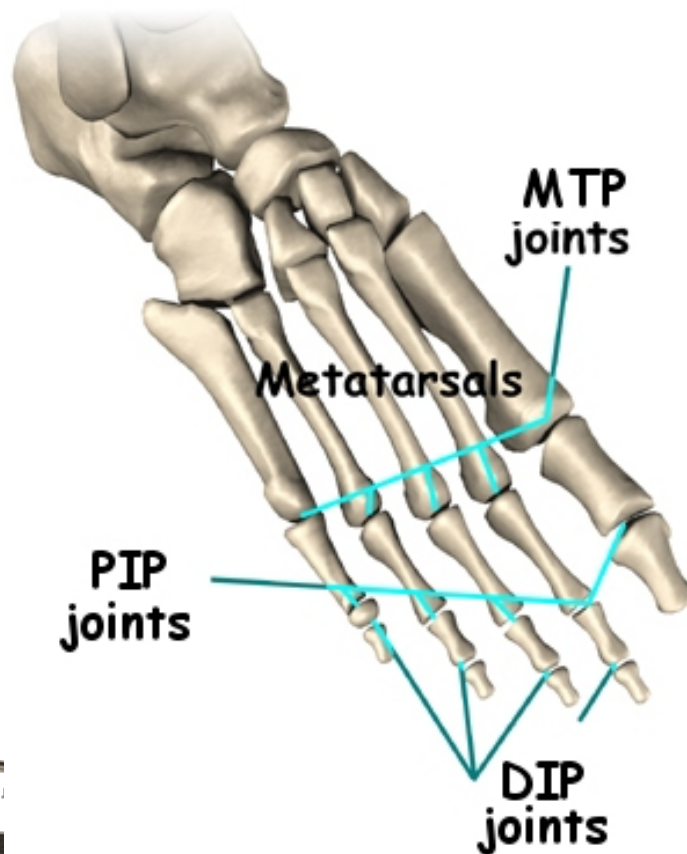
Joints

- The joints are shock absorbers.
- There are 33 joints in the human foot and they allow the foot to move in many directions and adapt to many surfaces.
- A joint is usually formed of fibrous connective tissue and cartilage.
- A joint is the area where two or more bones are attached for the purpose of motion of human body parts.
- They are named by the two bones which meet.



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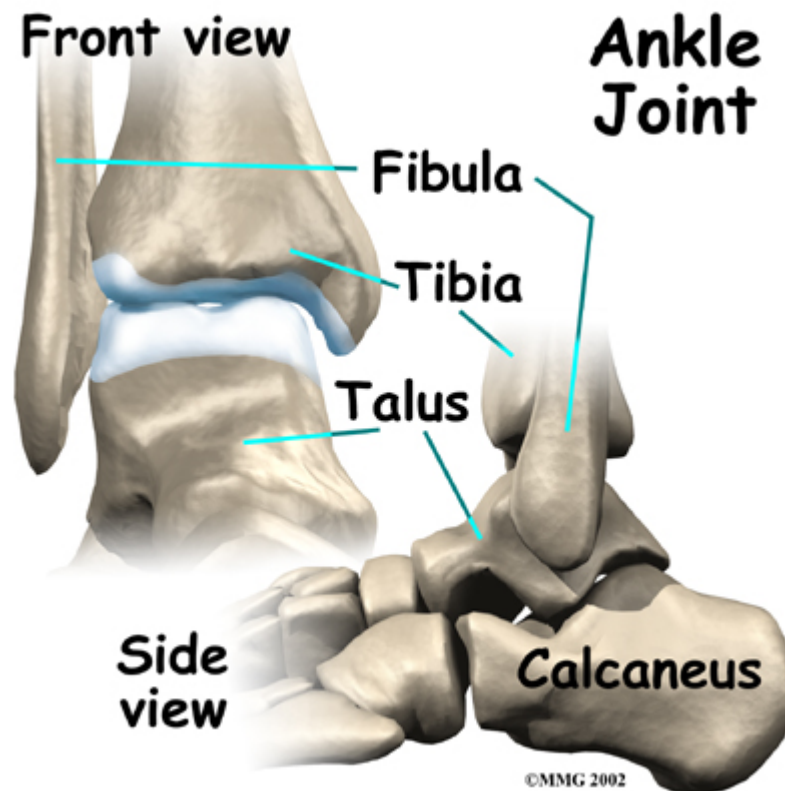
- The *metarso-phalangeal joint* (MTP or MTPJ) is between the metatarsals and the phalanges (toes).
- Hinge joints that allow mostly plantar and dorsiflexion and also allow the toes to maintain contact with the ground during push off.



The *proximal interphalangeal joint* (PIP) is between the proximal and middle phalanges.

The *distal interphalangeal joint* (DIP) is found only on phalanges 2-5.

- The *ankle joint* is composed of the fibula, tibia and talus.
- A hinge joint that allows the foot to pull up (dorsiflex) and move downward (plantarflex).

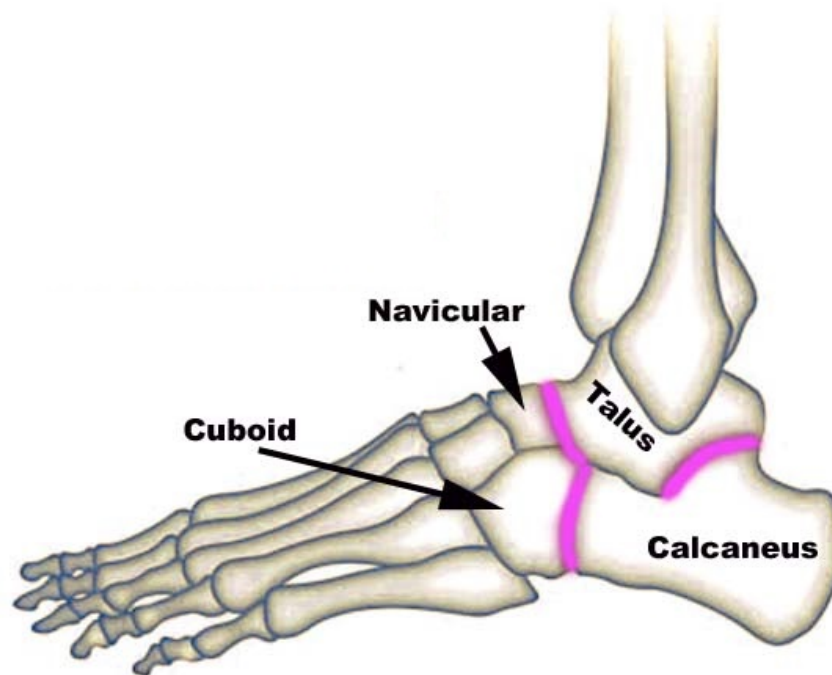


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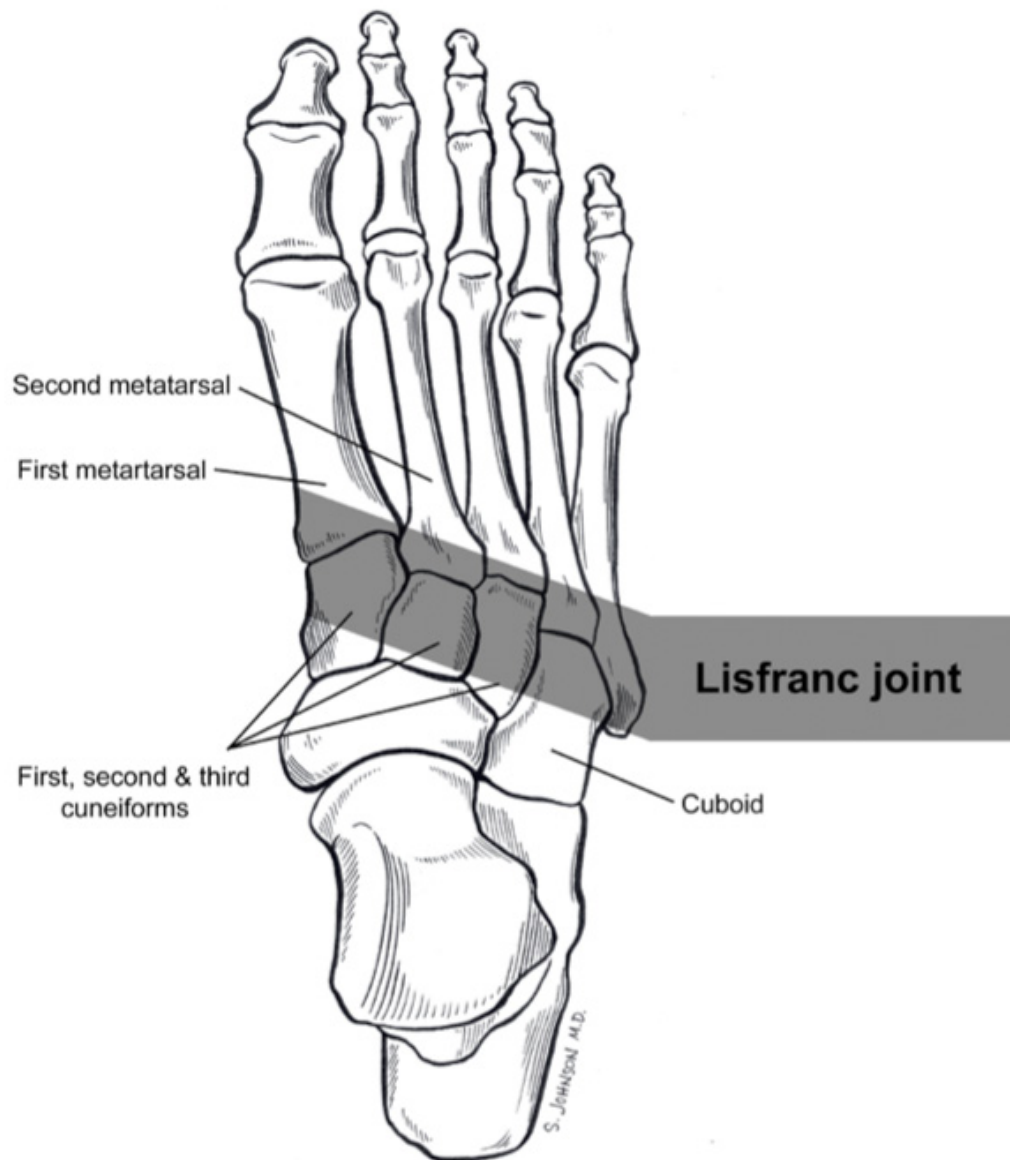


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- The *transverse tarsal joint* is comprised of two joints—the talonavicular and calcaneocuboid (TNCC joint).
- Also known as the midtarsal or Chopart's joint

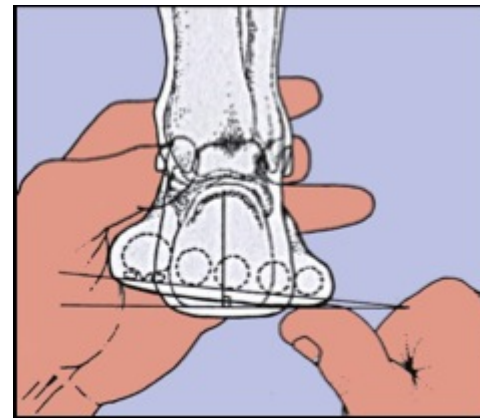
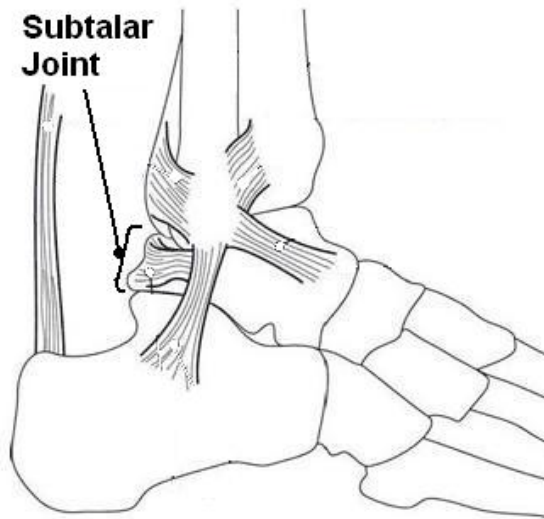


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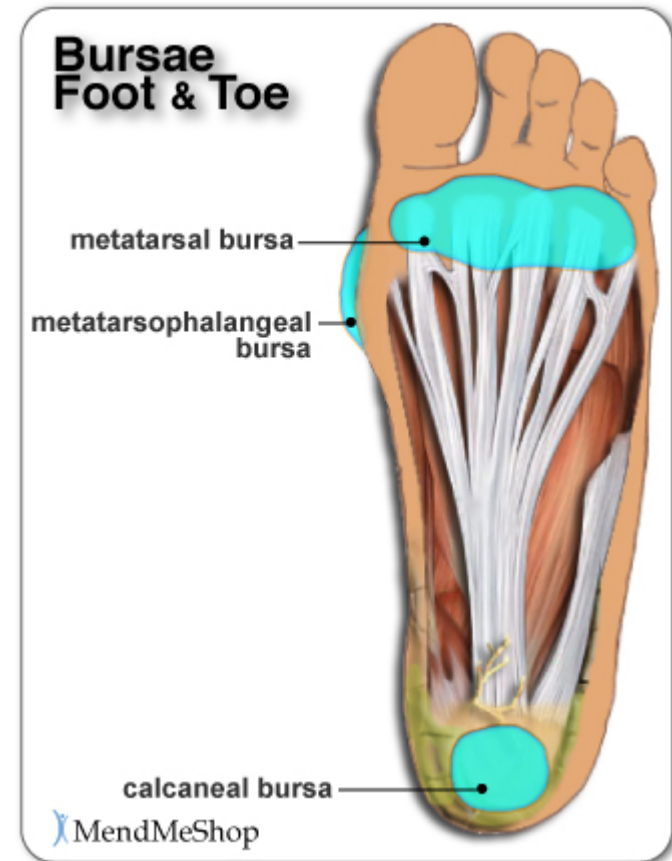
- The *tarsometatarsal joint* is made up of the tarsals and metatarsals.
- Also known as the Lisfranc Joint.

- The *subtalar joint* is between the talus and calcaneus.
- Also known as the talocalcaneal joint.
- Acts as a screw-shaped joint and is the primary joint that allows the foot to turn in (inversion) or turn outward (eversion)
- Triplanar motion



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- *Bursae*, or singular *bursa*, are fluid filled sacs (synovial fluid) commonly located just proximal to insertion of tendon into bone; reduce friction that would otherwise occur as tendon moves against bone



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Muscles

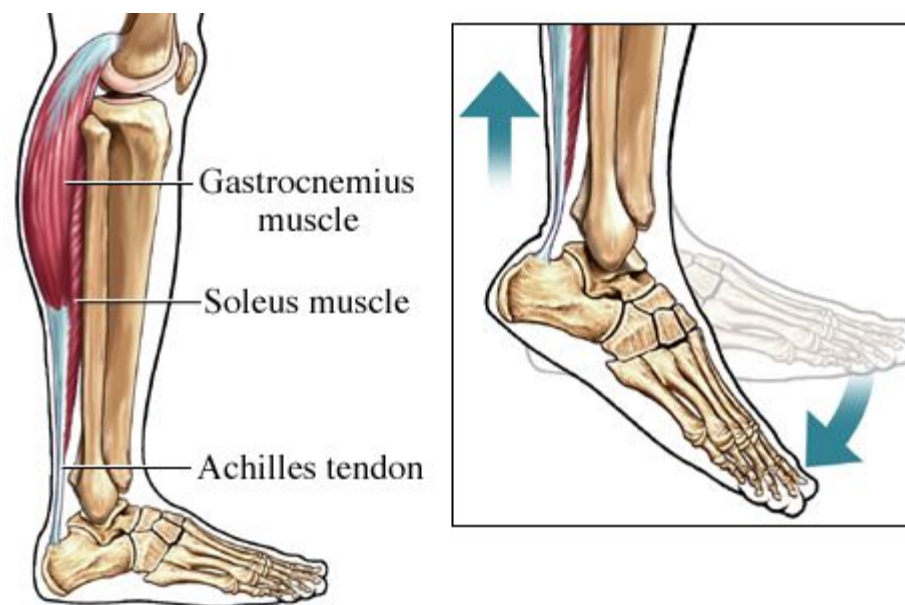
- **Muscles** are attached to tendons which insert to the bones of the foot and toes.
- Most muscles that move the foot originate from the calf (posterior) or shin (anterior) area.



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Gastrocnemius-Soleus Muscles and the Achilles Tendon

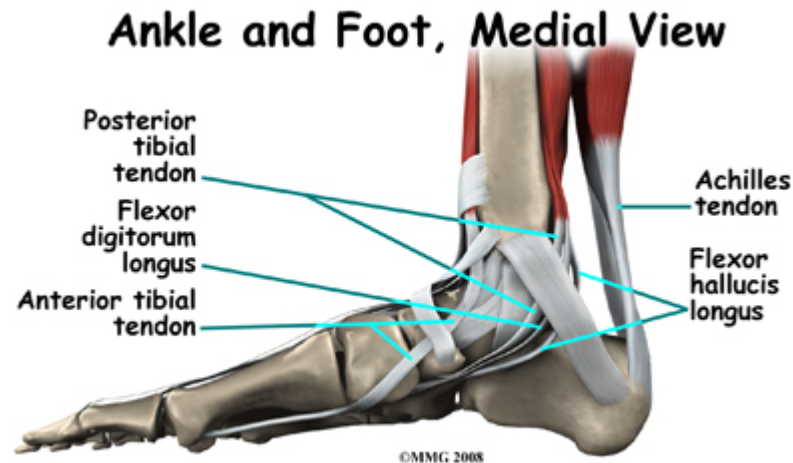
- Gastroc-Soleus complex is the primary ankle plantar flexor
- Attaches to calcaneus on the plantar half of the posterior aspect of calcaneus via the Achilles tendon
- Provides push-off from stance phase, active from heel-off to toe-off.



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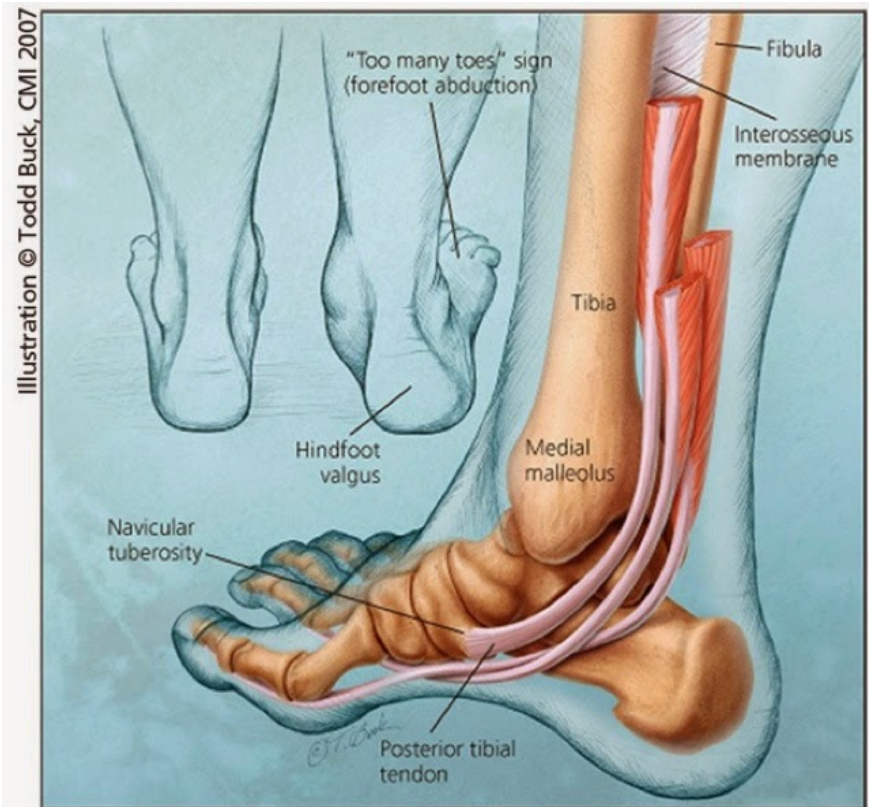
Tendons

- Tendons are a band of fibrous tissue that attach muscles to the bones.
- When a muscle contracts, it pulls on the tendon.
- One of the most prominent tendons is the Achilles tendon, which can be felt on the back of the foot, just above the heel.
- Tendons can be torn or ruptured and inflammation is the most prevalent.



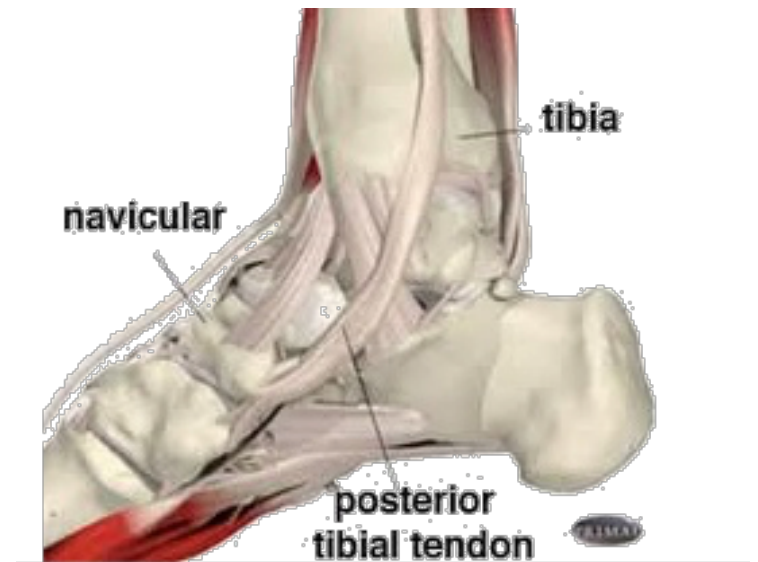
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- **Tibialis Posterior Tendon**
- In normal gait, PTT is most active in stance phase to prevent foot from everting past neutral.
- When tendon undergoes degenerative changes it lengthens. Lengthening creates weakness and muscle imbalance.
- Posterior tibialis is opposed by peroneus brevis. When both are functioning normally at full strength, the foot is normally aligned.



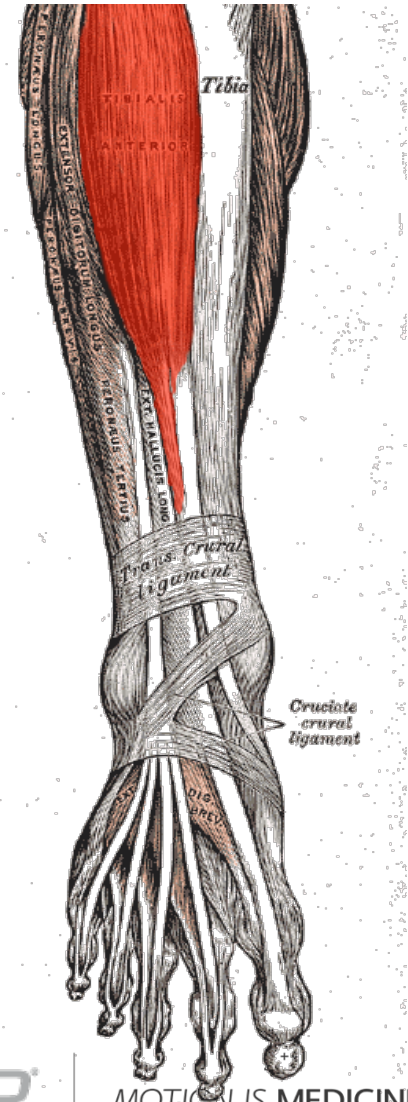
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- **Tibialis Posterior Tendon**
- Originates in the deep calf from the posterior tibia.
- Primary attachment is at the navicular but additional slips insert into the plantar aspects of several tarsal bones.
- Generally speaking, the PTT inverts and plantarflexes the foot.
- Specifically, it adducts transverse tarsal joint and inverts the subtalar joint.



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- **Tibialis Anterior Tendon**
- Originating in the anterior leg, the tib ant crosses the anteriomedial ankle and inserts into the medial cuneiform and base of 1st MT.
- It is the primary foot and ankle dorsiflexor
- Activity is biphasic
 - Toe-off to allow foot to clear the floor in swing phase
 - Heel strike to decelerate the foot
- Compromised tib ant = foot drop



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Ligament:

A short band of tough, flexible, fibrous connective tissue that connects two bones or cartilages or holds together a joint.



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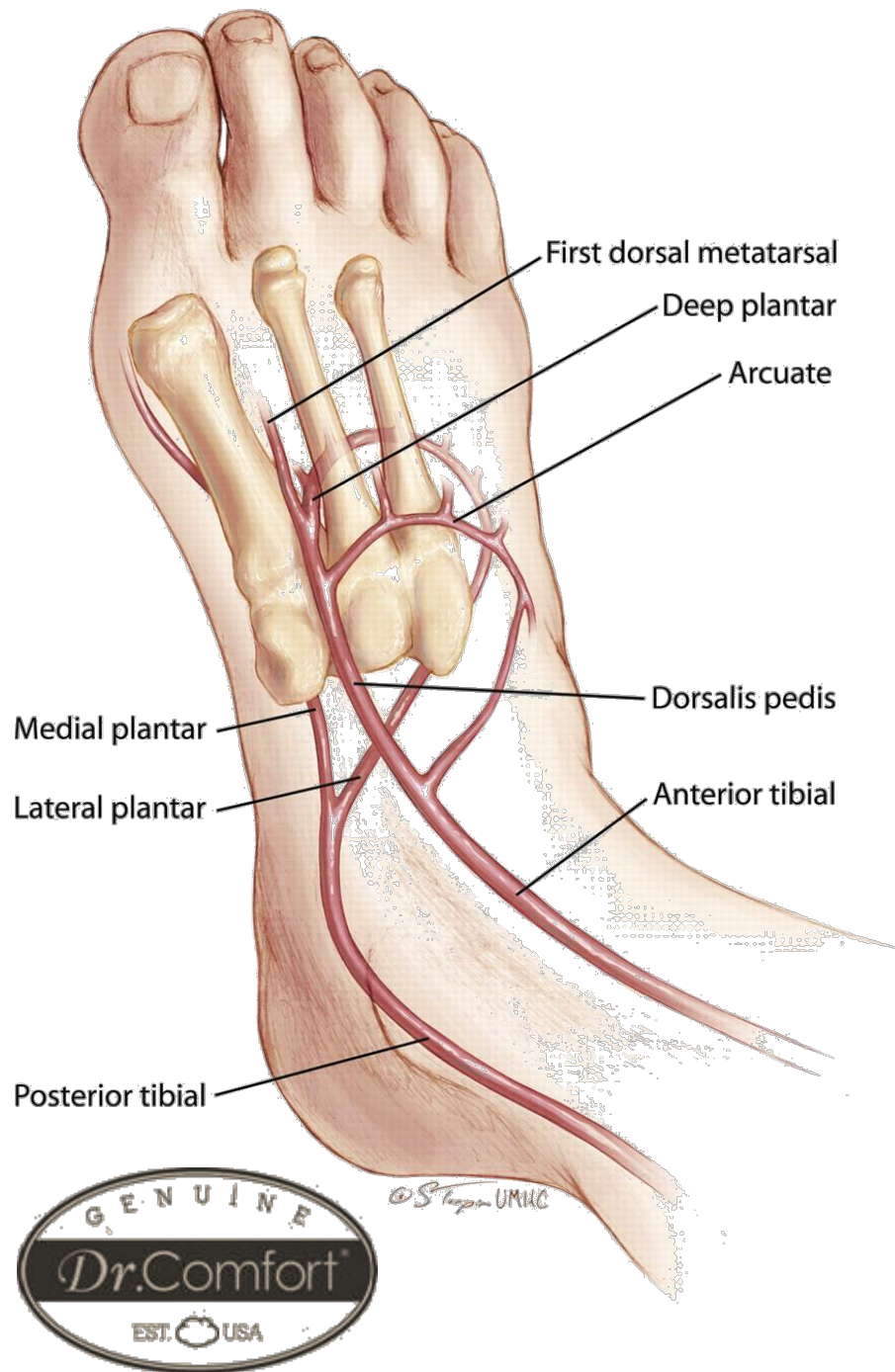
Circulatory System

There are three types of blood vessels:

1. Arteries-carries blood away from the heart
2. Veins-transfers blood back to the heart from the capillaries
3. Capillaries-connect arteries to veins



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The **dorsalis pedis artery** can be palpated on the dorsum of the foot between the first and second ray.

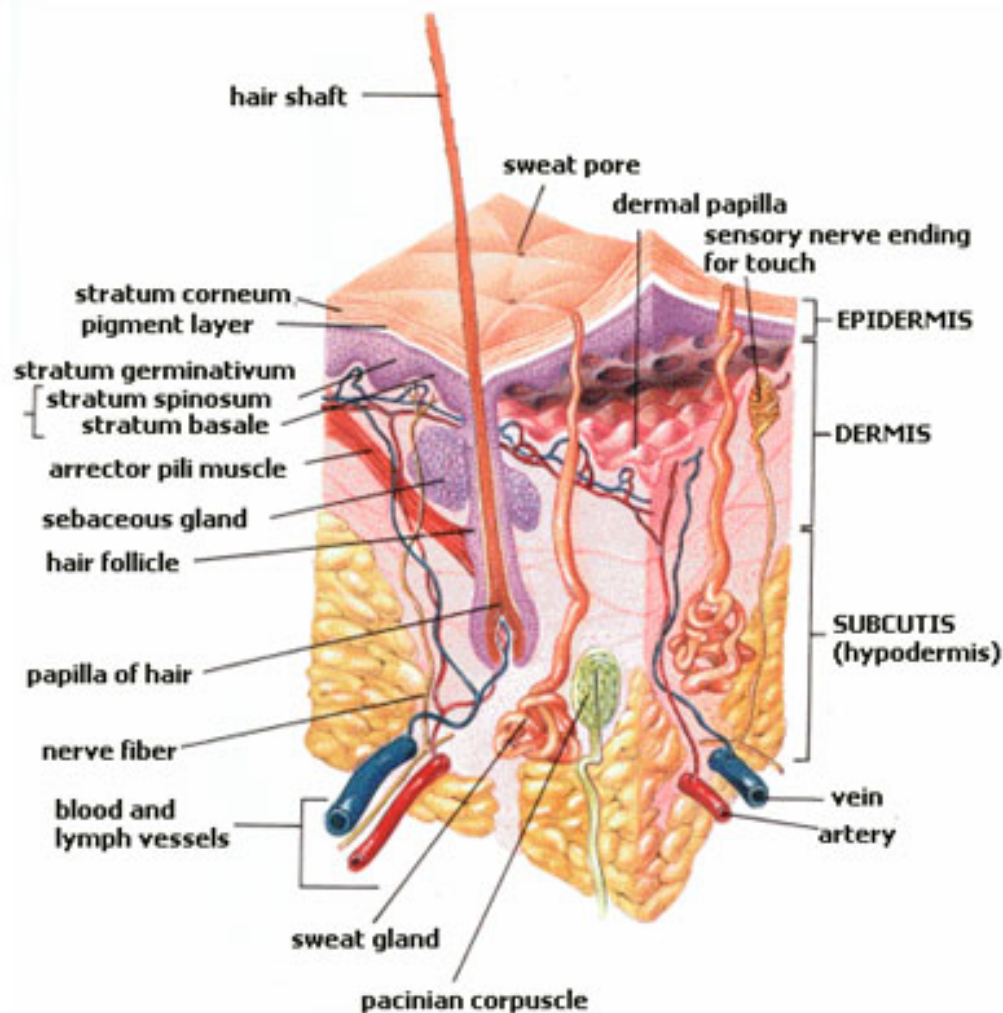
The **posterior tibial artery** is found on the medial side of the ankle and can be palpated.

Skin

- The human skin is the body's largest organ and made up of multiple layers.
- The top layer of skin, called the epidermis, plays a very important role in protecting the body against the environment.
- Functions include insulation, temperature regulation and sensation.



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Skin is divided into 3 main layers:
Epidermis-outermost layer; visible
Dermis-layer underneath epidermis
Hypodermis- also called the subcutaneous tissue, used for fat storage.



The thickness of the skin at the soles is 1.5 mm at the epidermis layer.



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Shoes—Basic Facts

- The U.S. imports more than 90% of shoes* Source: The New York Times
- The U.S. no longer has the infrastructure to fully manufacture shoes
- \$20B spent on shoes per year in the U.S.
- Average American man owns 12 pairs of shoes
- Average American woman owns 27 pairs of shoes
- Several manufacturing methods—Goodyear Welt (stitch down), Strobel (force lasting), Moccasin style
- Worldwide Manufacturing Shoes: China (12.6 billion pairs year); India (2.1 billion/year); Brazil (895 million/year); Vietnam (760 million/year)



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What is a Diabetic Shoe?

- PDAC (Pricing Data Analysis and Coding)—formerly SADMERC
- Long description: FOR DIABETICS ONLY, FITTING (INCLUDING FOLLOW-UP), CUSTOM PREPARATION AND SUPPLY OF OFF-THE-SHELF DEPTH-INLAY SHOE MANUFACTURED TO ACCOMMODATE MULTI- DENSITY INSERT(S), PER SHOE



PDAC

Medicare Pricing, Data Analysis and Coding

Mission Statement: Pricing, Data Analysis and Coding (PDAC) contractor is committed to quality and accurate results, within time frames that exceed our customers' expectations and is of great value to CMS.



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What is a Diabetic Shoe?

- 4 main criteria:

1. Has a full length, heel-to-toe liner that when removed provides a minimum of 3/16" of additional depth used to accommodate inserts
 2. Made from leather or other suitable material of equal quality
 3. Form of shoe closure
 4. Available in full and half sizes with a minimum of three widths so that the sole is graded to the size and width of the upper portions of the shoe according to the American standard last sizing schedule or its equivalent. (The American last sizing schedule is the numerical shoe sizing system used for shoes in the United States.)
- The shoe may or may not have an internally seamless toe.



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Knowledge of the components of footwear are important to aid in the selection of the shoes to provide optimum therapeutic benefits to the patient.

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Shoes are made over a “last.” The last is the generic foot model produced to the specifications of the manufacturer. The last determines the shape and profile of the shoe.



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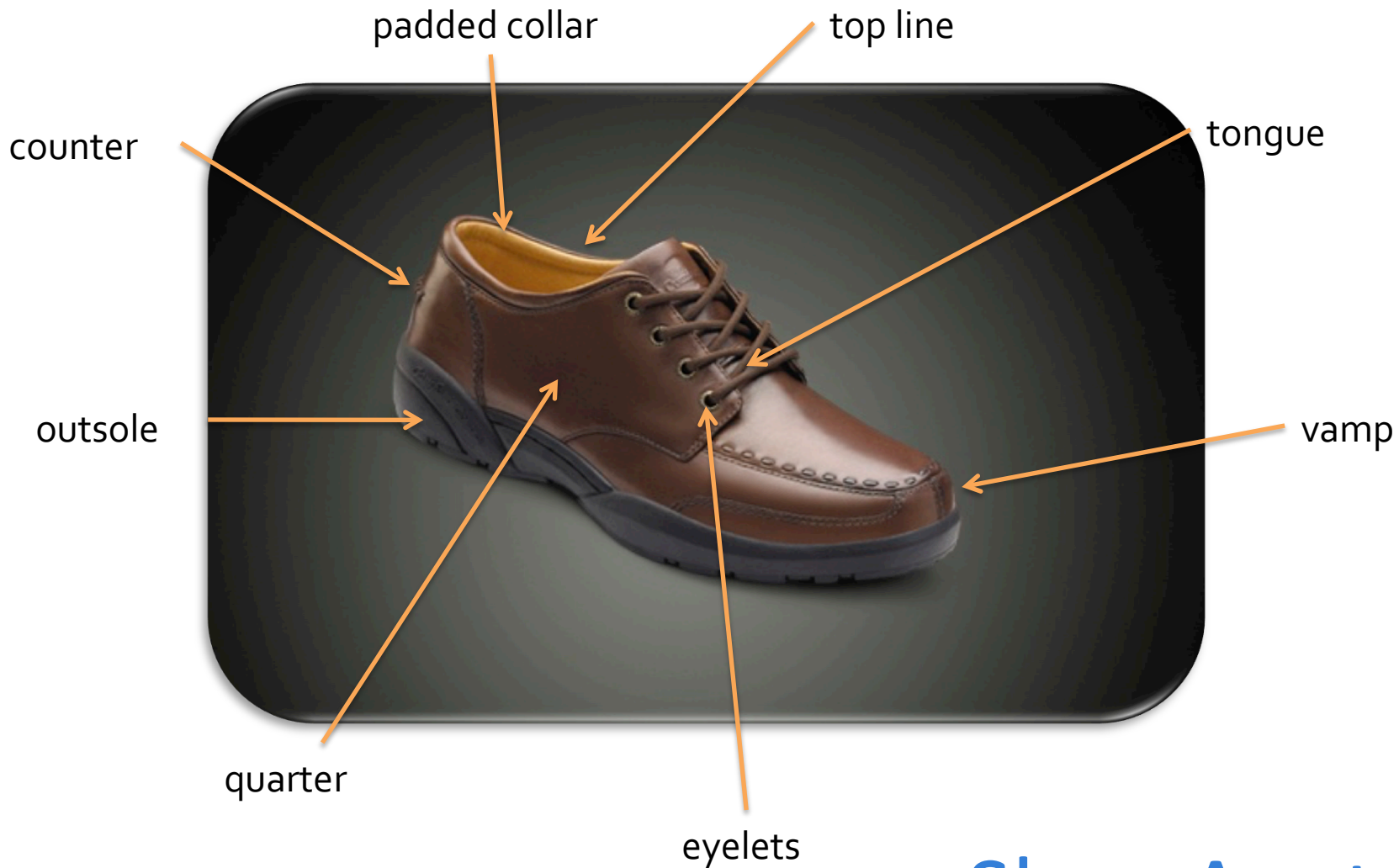
A variety of measurements are taken into consideration beyond the ones we are able to measure including waist, ball, instep girth, throat opening and the last break point.



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Uppers: portion of the shoe that covers the top of the foot; includes vamp, tongue, quarters, etc.; area that is seen



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Uppers before attached to sole. This material is lycra.



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Vamp: covers the toes and a portion of the instep; the front portion of the shoe; all closed toe shoes have a vamp



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Uppers

Quarter: the back portion of a shoe or boot; meets the vamp to form a majority of the uppers

Quarters



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Tongue: several types of tongues; can protect from debris; sewn in shoe or as one with the vamp



This tongue is one with the vamp.



The bellows tongue is a stitched-in tongue, giving protection from the elements and the ingress of debris.



The apron tongue or kiltie are popular on golf shoes and help keep grass out.

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Balmoral (Bal): A type of shoe where the tongue is stitched at the throat of the vamp.

Although sometimes more appealing and stylish, this particular opening does not offer much adjustability in fit or fluctuation for the foot.



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Blucher: The quarters overlap the vamp and creates a wider opening shoe

This style makes donning and doffing easier. It is often chosen for patients with limited dorsiflexion, high insteps, swelling, and/or internal braces



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Achilles notch: area usually found in athletic shoes which accommodates for the Achilles tendon.



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Heel foxing: covering the quarter; sometimes will have perforations or a different color creating a two tone shoe. Foxing can also be over the quarters or the quarters can be cut away and the foxing in its place.



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Toe caps: normally go over the vamp, but the vamp can be cut away and the toe cap in place of it.



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Saddles: materials that go over the instep; can be the same color as the shoe but it is normally a contrasting color.



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Internal Stiffener:

Counter: Located in the heel area; Retains the shape of the shoe; also provides additional stability, especially when extended



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Internal Stiffener:

Toe Box: located in the toe of the shoe; retains the shape of the shoe; provides protection for the toes



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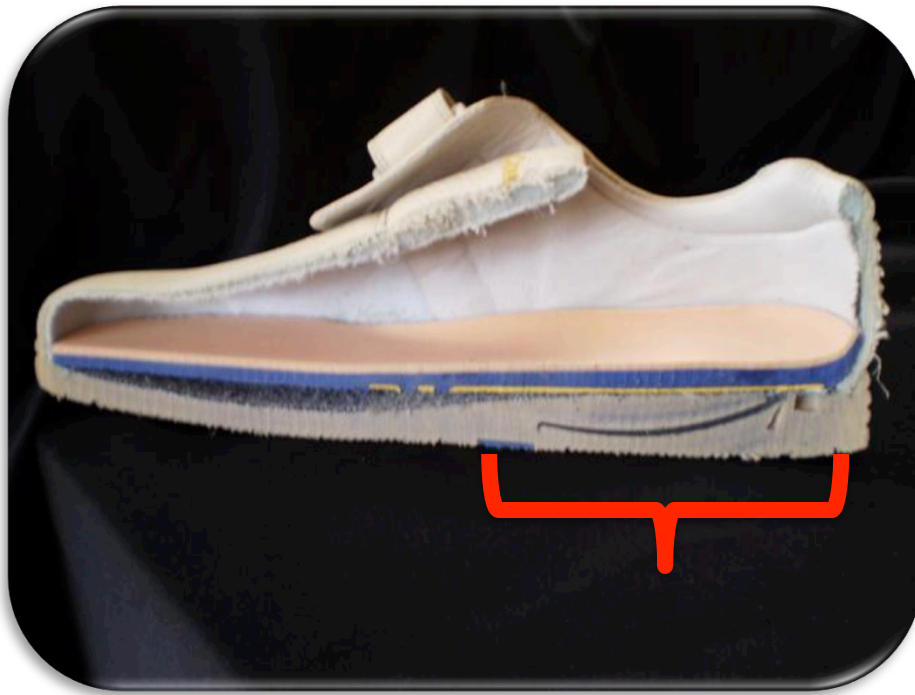


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Internal Stiffener:

Shankpiece: Material placed within the sole that is a bridge between the heel and front of shoe.

Allows for a mild spring effect on weight bearing.



The shank can be made of wood, plastic, *nylon*, steel or other materials

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Sole: Bottom portion of the shoe; includes outsole, midsole and insole; usually made from a durable material, such as, rubber or leather



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Irons: Sole thickness is measured in “irons.”
One iron equals $\frac{1}{48}^{\text{th}}$ inch.

A sole that measures 12 irons is $\frac{1}{4}$ inch thick.



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Outsole: Portion of the sole which comes into contact with the ground; Provides traction and can be made with rockers or rollers.

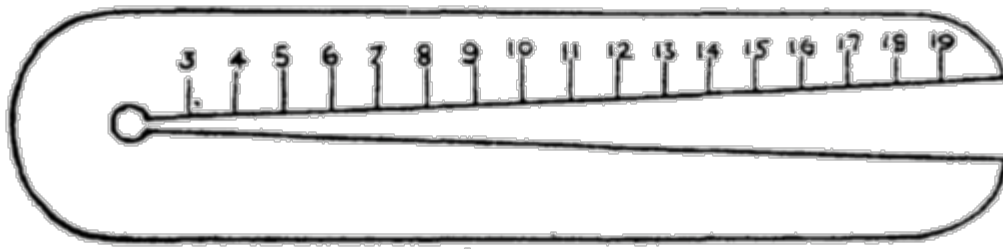
The outsole has a variety of functional properties, such as, flexibility, durability, traction, insulation, and dimensional stability



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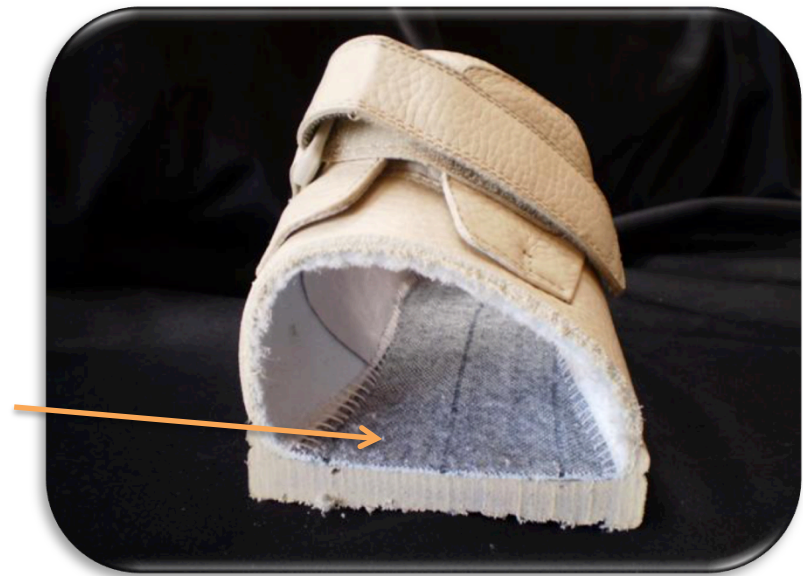
- **Irons:** Sole thickness is measured in “irons.” One iron equals $\frac{1}{48}^{\text{th}}$ inch. Ex: A sole that measures 12 irons is $\frac{1}{4}$ inch thick



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Midsole: additional soling placed between outsole and insole; sometimes used to give the shoe more heft or a sturdier, more rugged look

Insole: “hidden component of the shoe”; attaches to the outsole, vamp and quarter—anchors the shoe together; different from an insert



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Insoles vs. inlays

The **insole** is glued, stapled or sewn into place in a shoe.

The **inlay** goes on top of the insole and is removable.

The inlay will be the portion which comes into contact with the foot.

The inlay will be removed in a diabetic shoe and replaced with an insert.

An **insert** can accommodate or assist with correcting during ambulation.

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Rocker Sole: This therapeutic shoe has a mild rocker sole which promotes proper gait.



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Three tests can be done to check the stability of shoes:

Flex Test—by pushing down on the shoe, the breakpoint, should be firm but not provide significant resistance. The breakpoint of the shoe is under the met heads.

Torsion Test—by twisting the shoe in opposite directions, this will check the stability of the soling. If the shoe twists over on itself, inadequate support.

Counter Test—by grasping the heel of the shoe, apply pressure to the heel counter with you finger. If the counter collapses with little/no resistance, the shoe is not supporting the heel.



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Don't forget Style, Comfort and Cost

Style—If the shoes are accommodating AND appealing, the patient is more apt to wear the shoes.

Comfort—it also does not matter how many tests it passes, if the shoe is not comfortable, then nobody will wear them.

Cost—a lot of times a determining factor of why a patient chose a particular pair of shoes

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THANK YOU!



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