

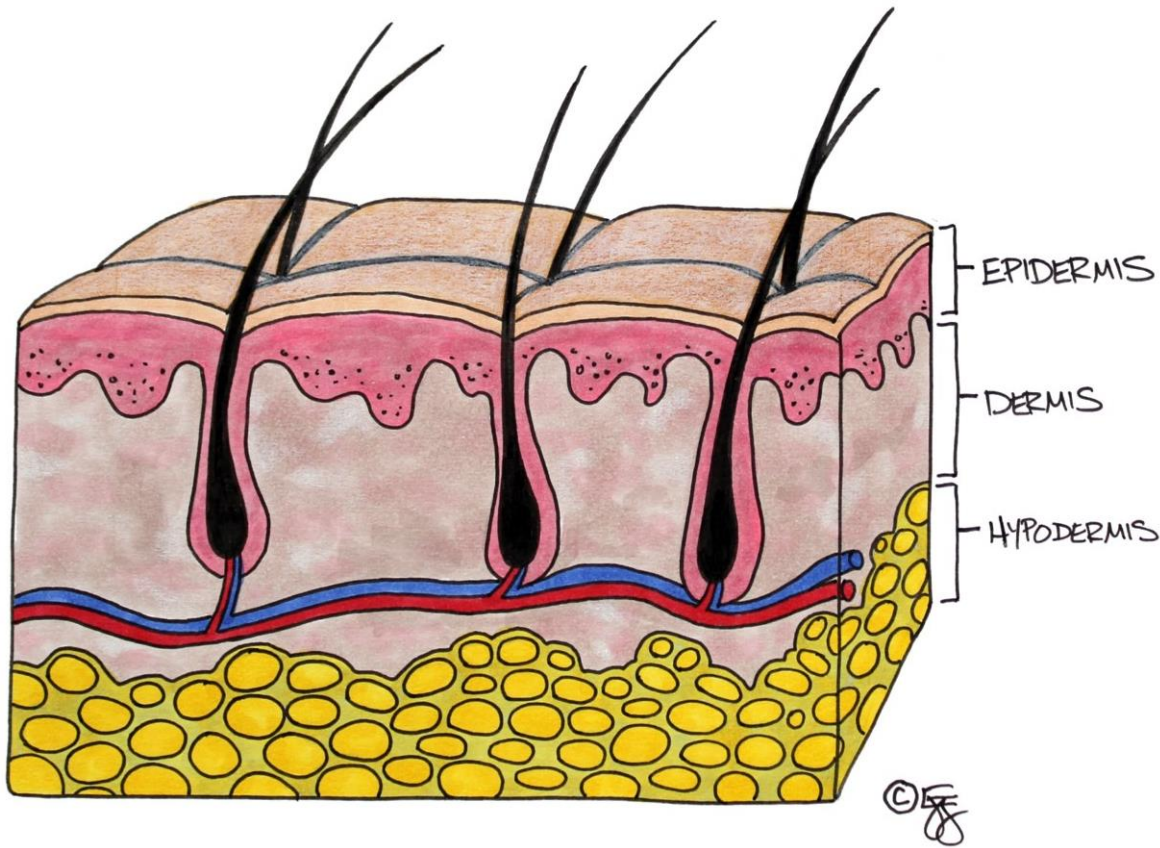
Anatomy: Blood Vessels and Nerves

Midwest School of Modern Pedorthics
Precertification Program in Pedorthics
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Skin





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

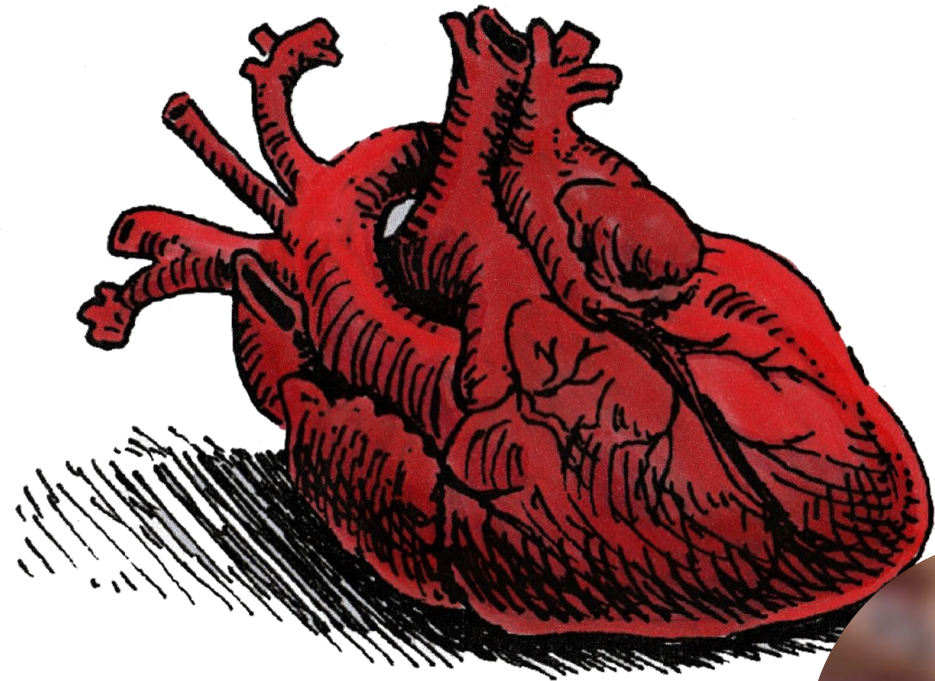


Circulatory System



Heart

- The adult heart beats over 100,000 times per day pumping blood through approximately 100,000 miles of blood vessels within the body.
- Blood makes a round trip through the body about 1,000 times every day.



Blood Vessels

- **Arteries**

Carries oxygen rich blood away from heart

- Must withstand great internal pressure

- **Capillaries**

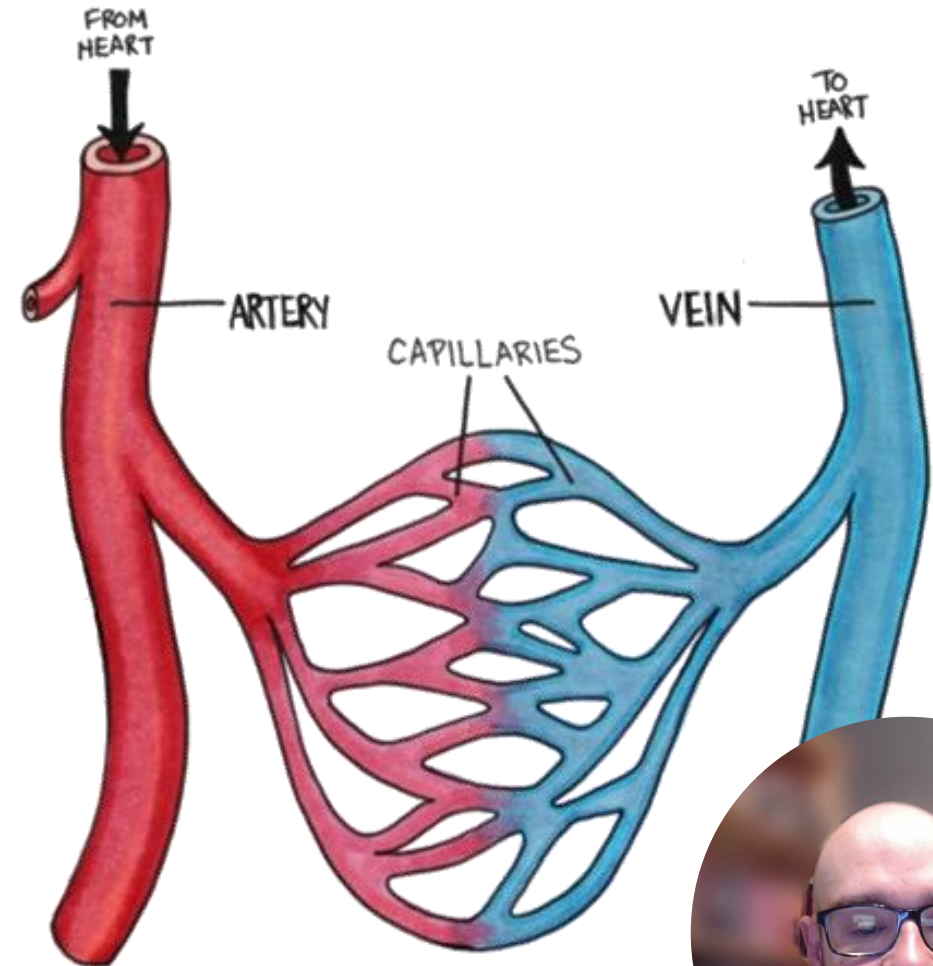
Communication point between arterioles and venules

- Exchange of substances between blood and cells

- **Veins**

Carry blood back to the heart

- Less elastic walls
- Contain valves, unlike arteries
- *Perforating veins* connect deep and superficial veins

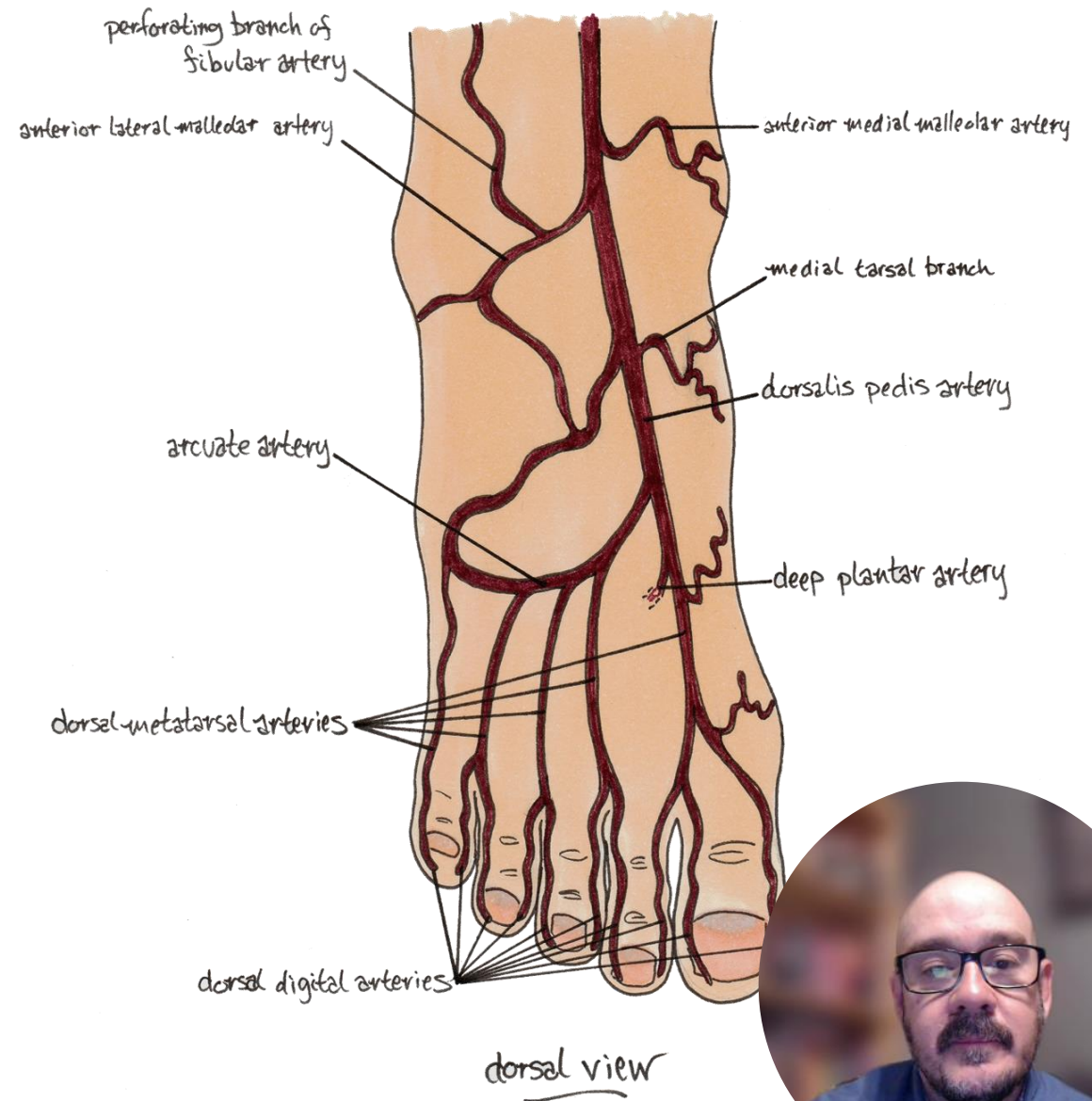


Arteries

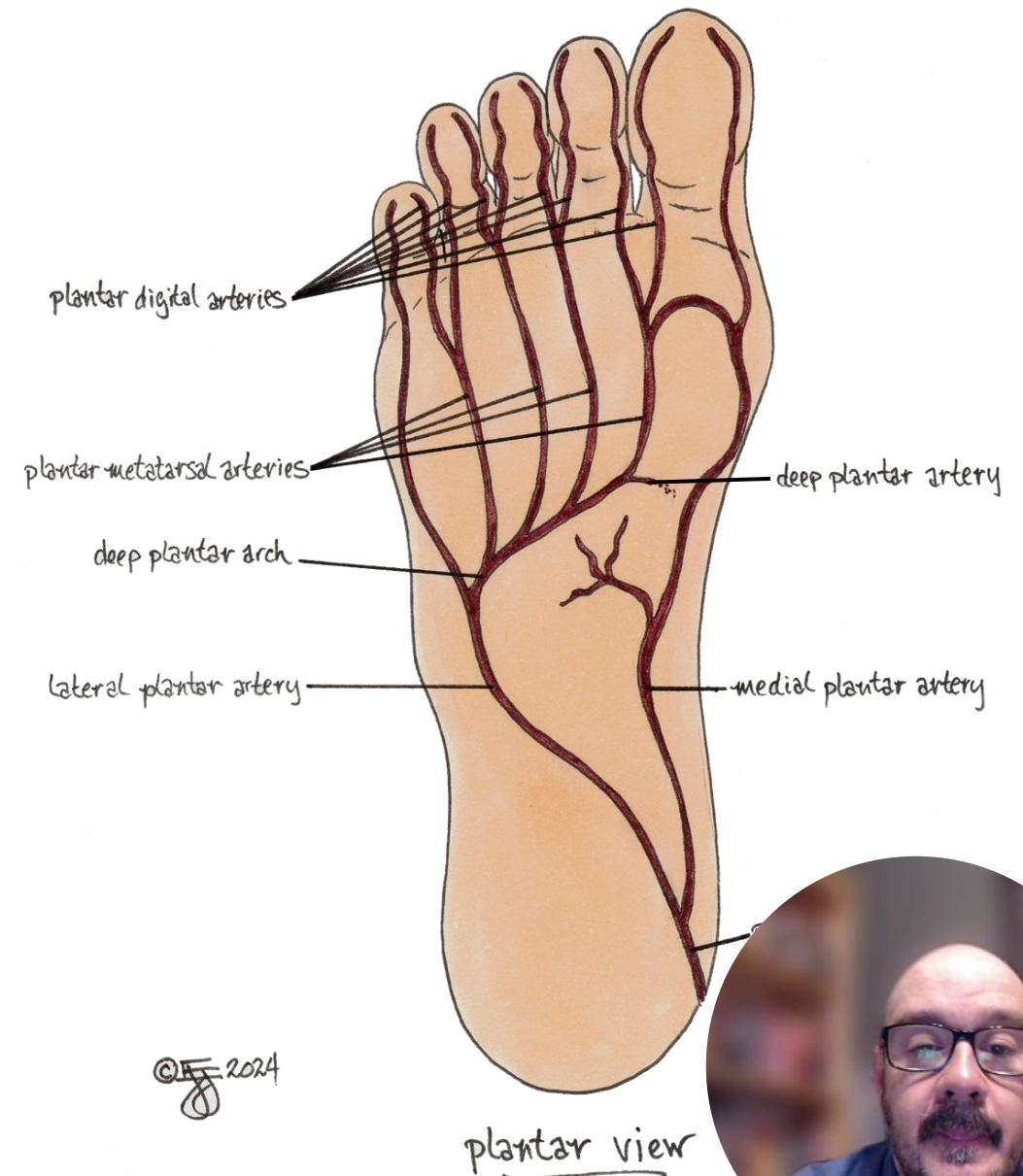
- The “Big Three” arteries that move blood to the foot are:
 - Posterior Tibial Artery
 - Fibular Artery (posterior, but perforating branch passes through tibiofibular interosseus membrane to the anterior aspect of the ankle.
 - Anterior Tibial Artery
- All three branch off of the femoral artery at or just below the knee.



- The *dorsalis pedis artery* is the main supplier to the dorsum of the foot.
- Originates at the level of the distal tibia between the medial and lateral malleoli, continuing on from the anterior tibial artery. Runs superficially on the dorsal surface of the forefoot, over the talus and navicular towards the first dorsal interosseous space, where it continues as the first dorsal metatarsal artery.
- The branches of the dorsalis pedis artery are:
 - Lateral tarsal artery
 - Medial tarsal artery
 - Arcuate artery
 - First dorsal metatarsal artery
 - Deep plantar artery

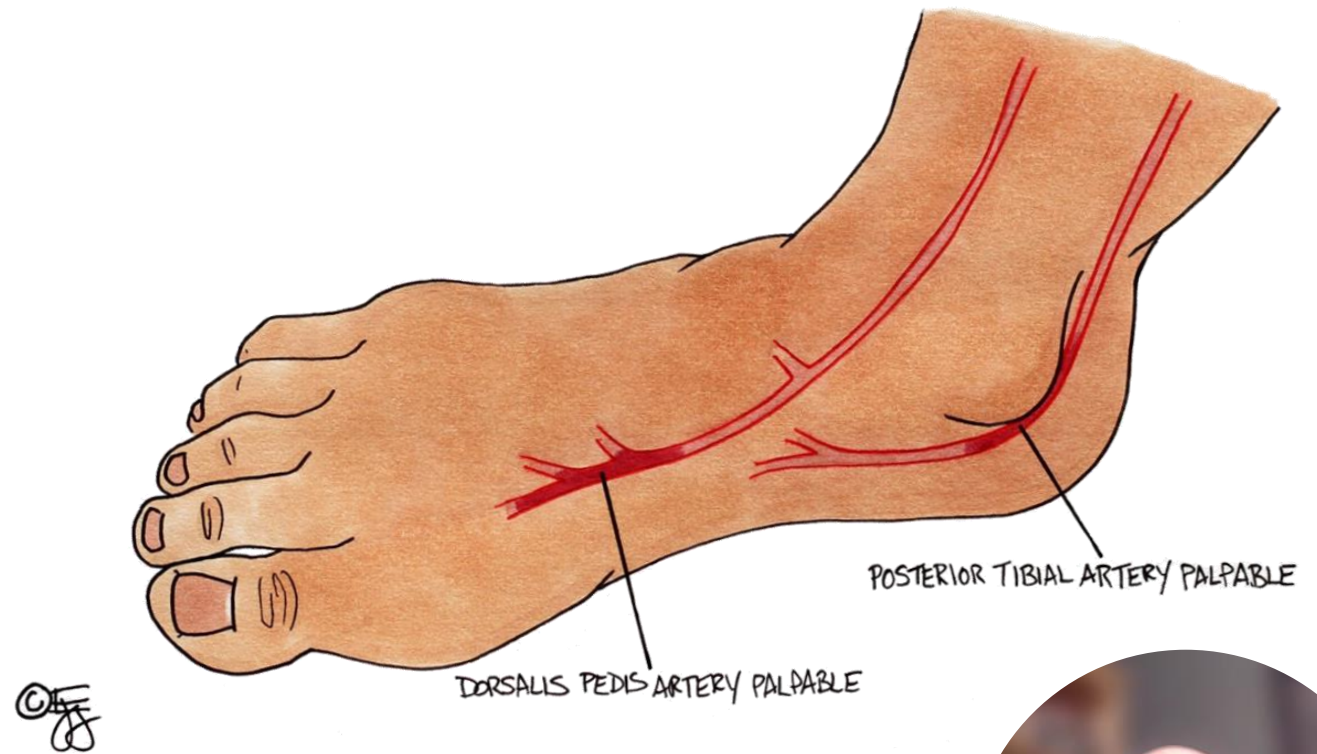


- The *posterior tibial artery* is the main supplier to the plantar aspect of the foot
- The posterior tibial artery arises from the popliteal artery in the popliteal fossa. It is accompanied by a deep vein, the posterior tibial vein, along its course. It passes just posterior to the medial malleolus of the tibia, but anterior to the Achilles tendon. It passes into the foot deep to the flexor retinaculum of the foot. It runs through the tarsal tunnel.
- The branches of the posterior tibial artery are:
 - Medial plantar artery
 - Lateral plantar artery
 - Fibular artery
 - Calcaneal branch to the medial aspect of the calcaneus.



Palpating Arteries/Pulses

- Dorsalis pedis is palpable on the dorsum of the foot between the first and second metatarsals close to their bases.
- Posterior tibial artery is palpable just behind and below the medial malleolus.

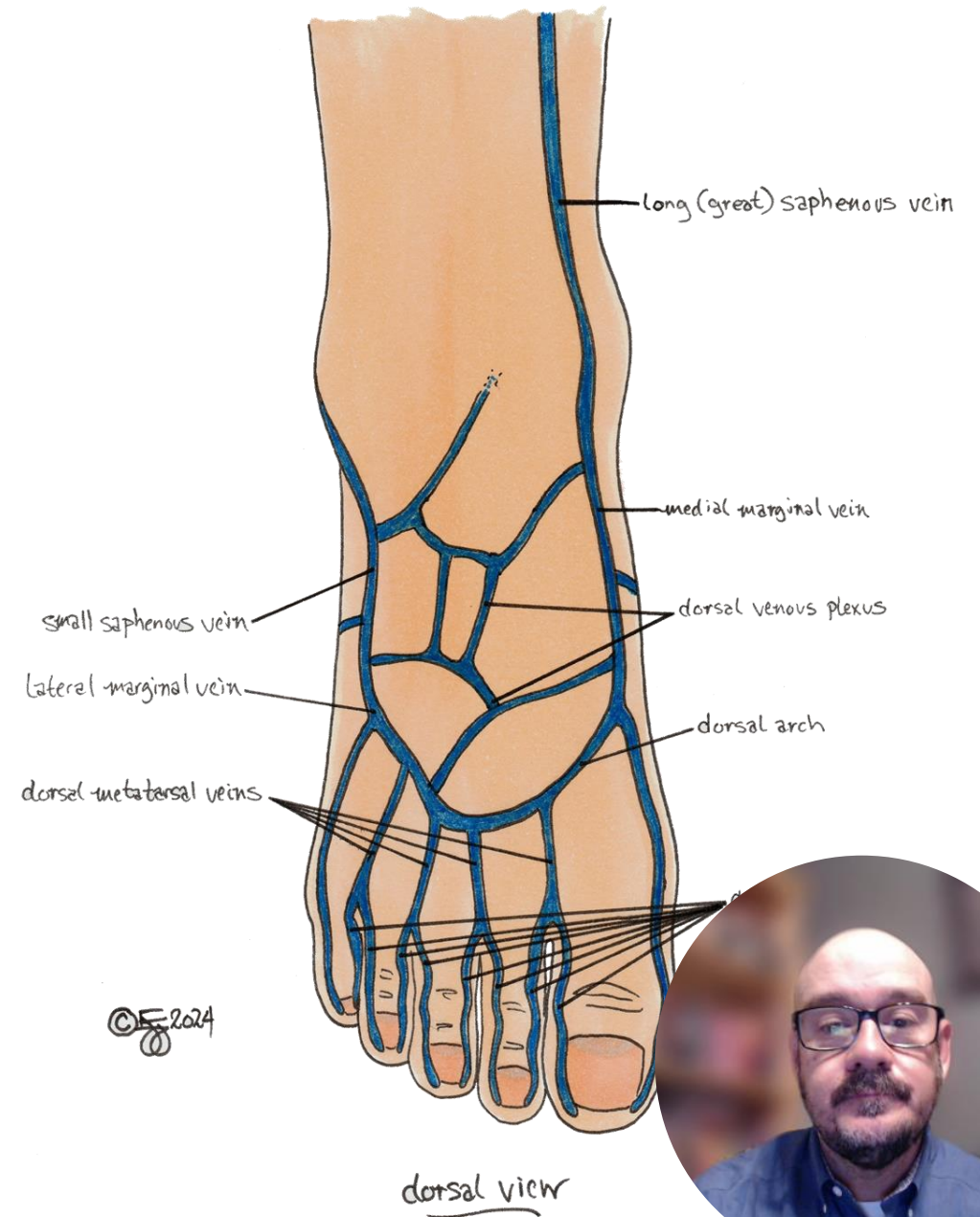


- *Long saphenous vein*

- Also called the great saphenous vein; it is a large, subcutaneous, superficial vein of the leg. It is the longest vein in the body, running along the length of the lower limb, returning blood from the foot, leg and thigh to the deep femoral vein at the femoral triangle.
- The long saphenous vein originates from where the dorsal vein of the great toe merges with the dorsal venous arch of the foot.

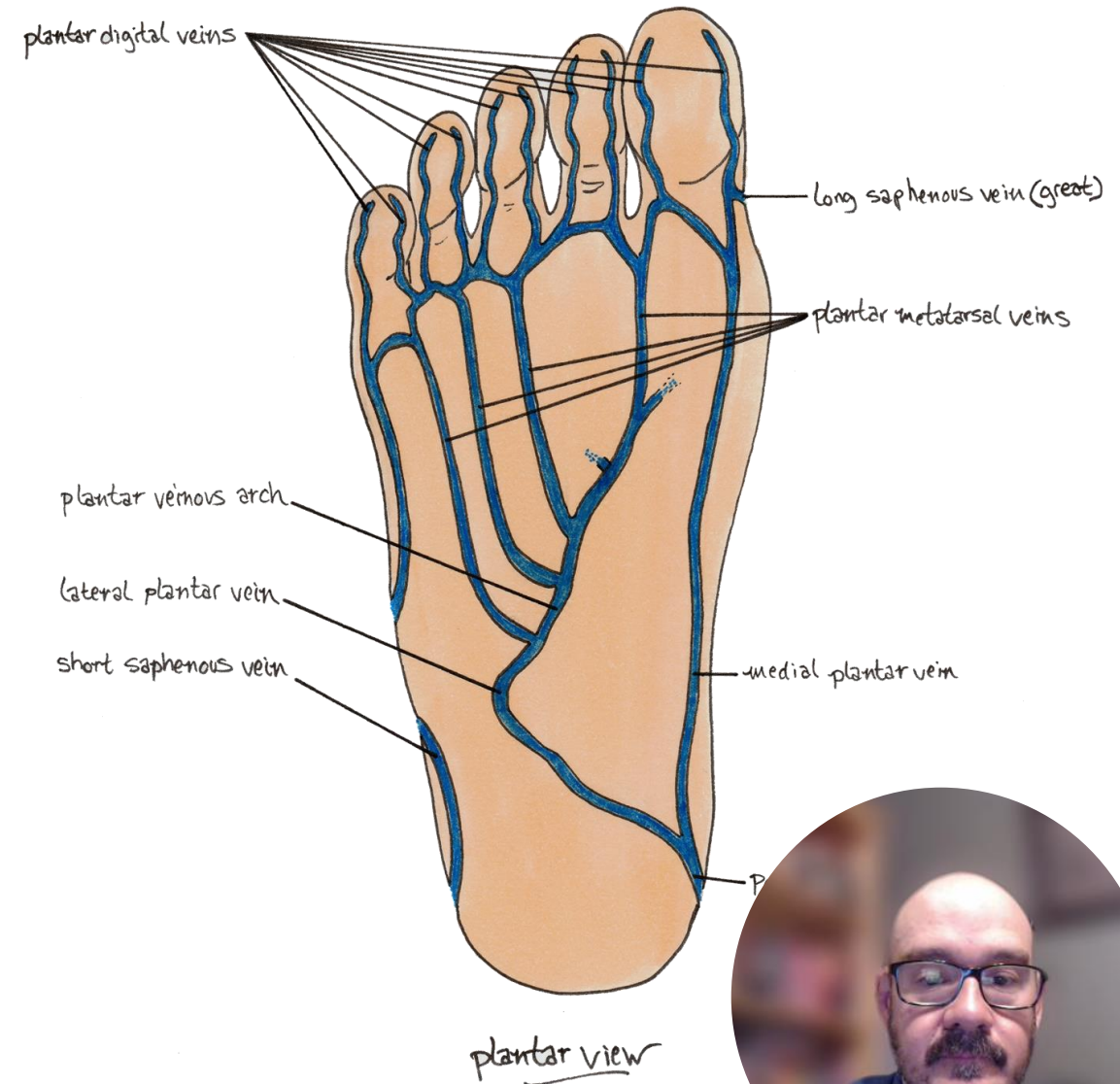
- *Small saphenous vein*

- Relatively large superficial vein of the posterior leg.
- The origin of the small saphenous vein, is where the dorsal vein from the fifth toe merges with the dorsal venous arch of the foot, which attaches to the long saphenous vein. It is a superficial subcutaneous vein.



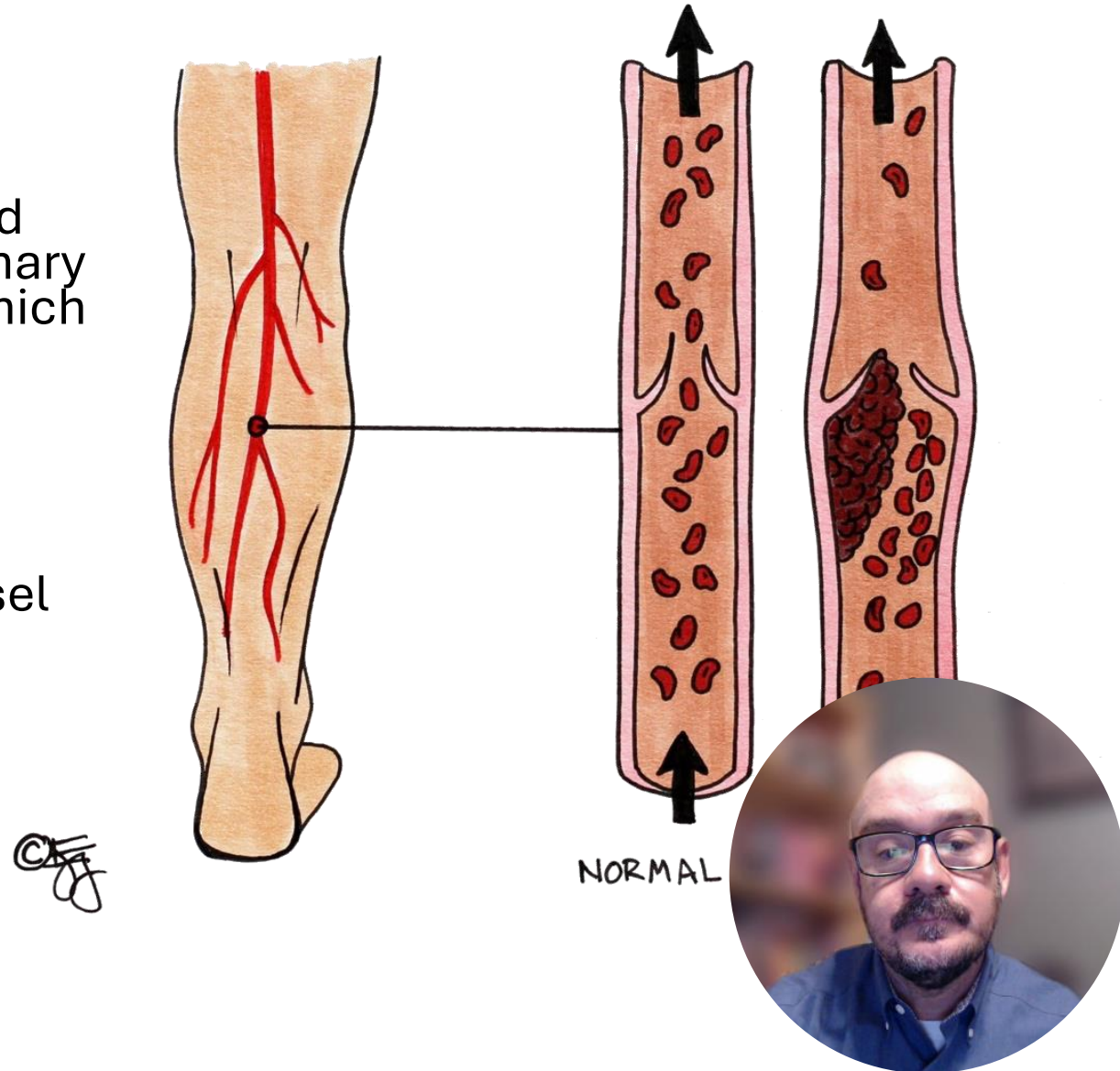
Deep Veins

- Below the knee, the leg has three types of deep veins. These three veins run next to each other, and all collect blood from the calves, ankles and certain portions of the feet:
 - ***Posterior tibial veins* collect blood from the sole of the foot. They run along the medial aspect of the calf.**
 - **Branches into the medial and lateral plantar veins**
 - *Anterior tibial veins* collect blood from the dorsum of the foot. They run along the lateral aspect of the calf.
 - *Peroneal tibial veins* collect blood from the lateral aspect of the foot. They run up the middle of the calves.



What's a DVT?

- **Deep Vein Thrombosis (DVT)**
- Formation of a blood clot in a deep vein and causes pain, swelling and redness; Pulmonary Embolism (PE) is a detachment of a clot which may result in death if it reaches the lung
- **Causes**
 - Venous stasis (slow blood)
 - Hypercoagulability (clotting)
 - Changes in the endothelial blood vessel lining
- **Treatments/Preventions**
 - Frequent walking
 - Calf exercises
 - Anticoagulants
 - Graduated compression stockings
 - Intermittent pneumatic compression



Doppler Ultrasound

- Uses sound waves to check for strength and direction of blood flow.
- Can be used to diagnosis:
 - Narrowed arteries or veins
 - Blood clots, including deep vein thrombosis
 - Blood vessel injuries
 - Chronic venous insufficiency
 - Evaluate blood supply to a transplant organ
 - Renal vascular causes of hypertension
 - Tumors in blood vessels
- Many different types
 - Color Doppler
 - Spectral Doppler
 - Duplex Doppler
 - Power Doppler



Nervous System



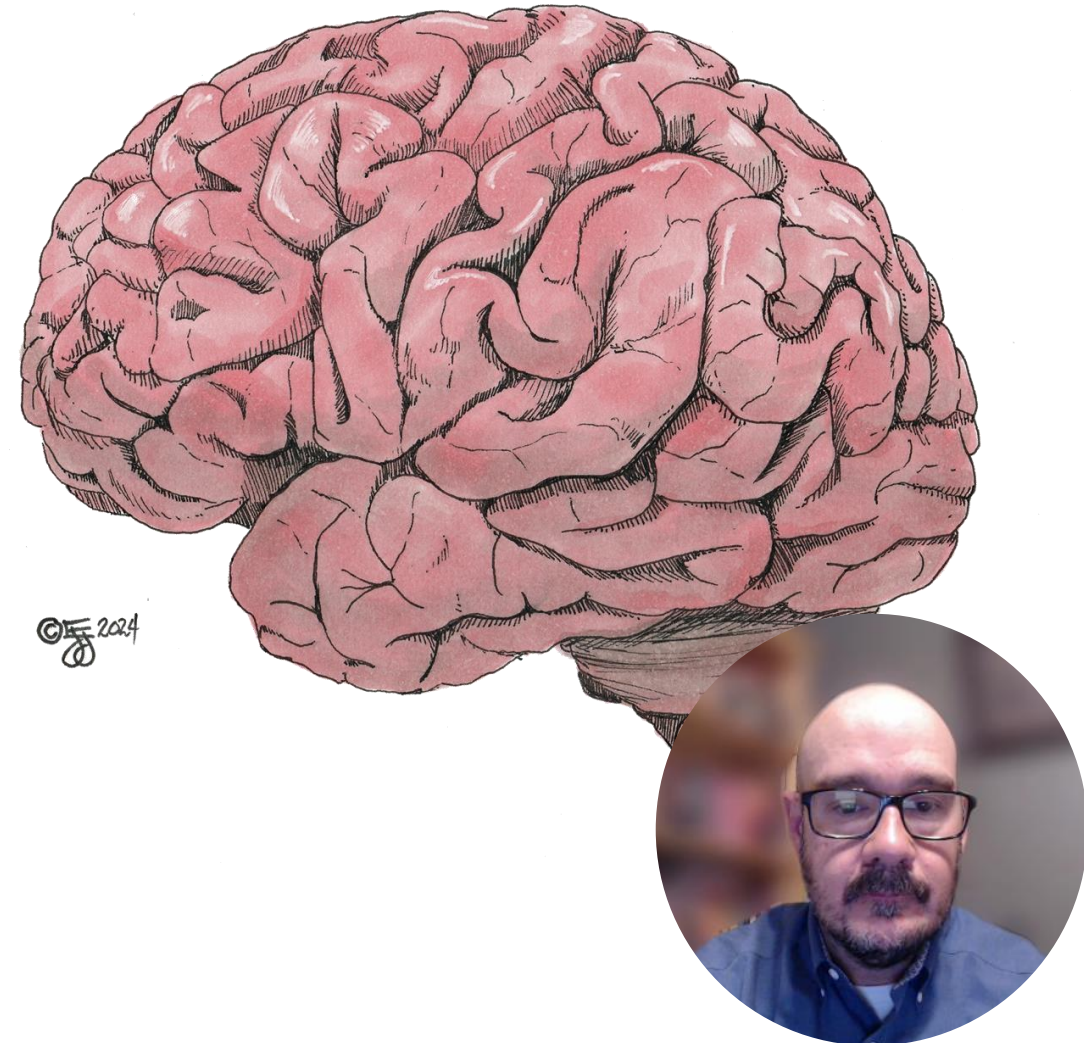
What is the Nervous System?

- The nervous system is your body's "command center." It's comprised of the brain, spinal cord and nerves. It works by sending electrical signals back and forth between the brain and the rest of the body. These signals, or impulses, tell the other body systems to breathe, move, speak, see, etc. The nervous system monitors what's going on internally and externally decides how to respond.
- The nervous system regulates complicated processes like thoughts and memory. It also plays an essential role in the things the body does without thinking, like blinking, swallowing and breathing, as well as things one can't control like digesting and regulating the body's temperature.



Central Nervous System

- Brain and Spinal Cord
- The brain reads signals from the nerves to regulate how to think, act, react, move and feel.
- There are over 100 billion neurons (nerve cells) in your brain alone.
- There are another 20 billion (or so) in the spinal cord.



Peripheral Nervous System

- The peripheral nervous system is made up of a massive network of nerves. The nerves branch out from the spinal cord. This system relays information to and from the brain and spinal cord to the internal organs, muscles, face, arms, legs, fingers, toes, etc.
- There are two parts to your peripheral nervous system:
 - The *somatic* nervous system guides voluntary movements.
 - The *autonomic* nervous system regulates the activities done without having to (or being able to) think about them (involuntary movements).
- About 15 billion neurons make up the peripheral nervous system.



Involuntary Nervous System

- Both the central and peripheral nervous systems have voluntary and involuntary parts. These two parts are closely linked in the central nervous system. They are usually quite separate in other areas of the body.
- The involuntary nervous system is made up of three parts:
 - The *sympathetic* nervous system
 - Prepares your body for physical and mental activity.
 - The *parasympathetic* nervous system
 - Responsible for bodily functions when we are at rest.
 - The *enteric* (gastrointestinal) nervous system
 - A separate nervous system for the bowel.



Cranial and Spinal Nerves



- There are two main groups of nerves branching out from your brain and spinal cord:
 - Cranial nerves: These 12 nerve pairs originate in the brain and extend through the face, head and neck. Cranial nerves can have sensory functions, motor functions or both. For example, cranial nerves help make facial expressions, move the eyes and process smells.
 - Spinal nerves: There are 31 pairs of spinal nerves branching out from the spinal cord. These nerves can provide sensory function, motor function or both. For example, spinal nerves may carry sensations from the joints and muscles to the spinal cord. Spinal nerves also control some reflexes or involuntary responses, such as one pulling their hand away quickly from a hot stove.

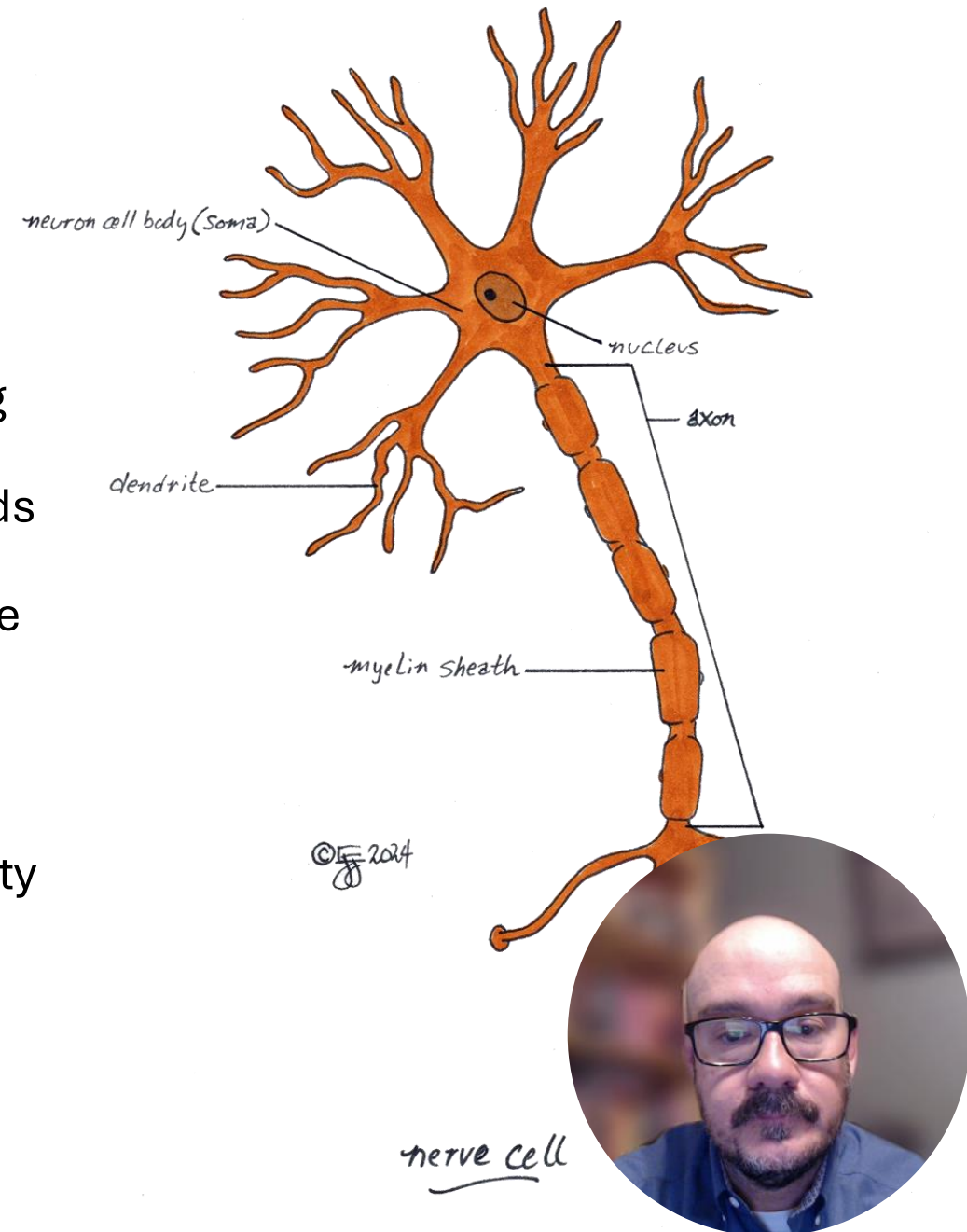
Neurons

- Neurons (Nerve cells)
 - **Motor neurons** take signals from the brain and spinal cord to the muscles. They help a body to move. They also assist with breathing, swallowing and speaking.
 - **Sensory neurons** take information gathered from the five senses (sight, touch, sound, taste and smell) to the brain for processing. These neurons are also responsible for proprioception.
 - **Interneurons** communicate between motor and sensory neurons. These neurons regulate movement in response to sensory information (like moving away from a hot surface) and play a role in how one learns and remembers.



Anatomy of a Nerve

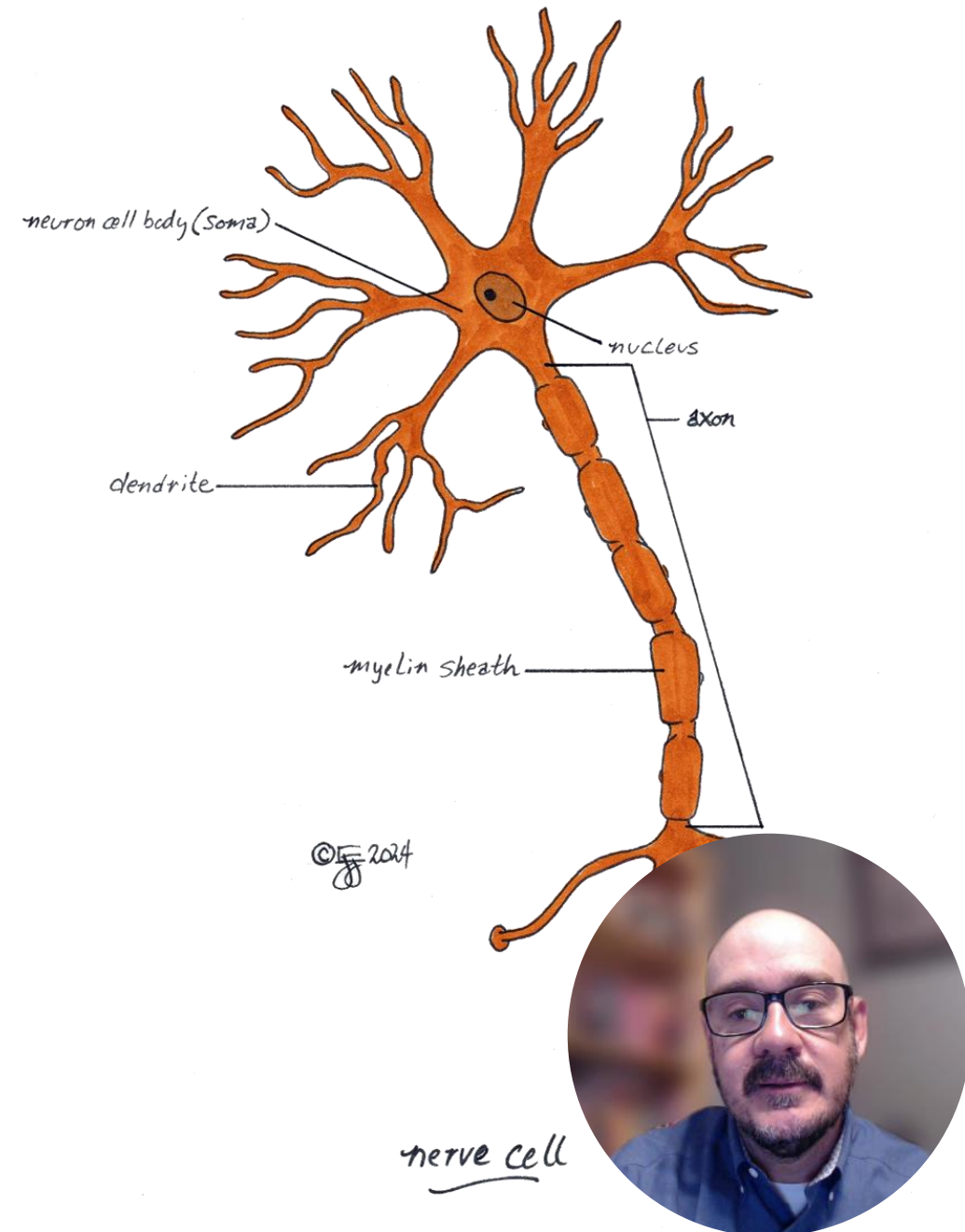
- **Axons**, cord-like groups of fibers in the center of the nerve.
- **Dendrites**, branches that carry electrical impulses.
- **Endoneurium**, a layer of connective tissue surrounding axons.
- **Perineurium**, a layer of connective tissue that surrounds groups of axons called fascicles.
- **Epineurium**, a layer of connective tissue that covers the outer surface of your nerve.
- In the brain, cells called oligodendrocytes surround axons. In the peripheral nervous system, cells called Schwann cells surround the axons.
- Both oligodendrocytes and Schwann cells contain a fatty tissue called myelin. Myelin surrounds the axons in a layered sheath (coating). The myelin sheath is like the insulation around electrical wiring. If it gets damaged, the nerves can't send electrical signals as quickly. Sometimes, they stop sending electrical signals completely.



How Nerves Work...

When a nerve sends an electrical impulse:

1. The signal travels down the axon, the “wiring” connection of the nerve.
2. The message converts to a chemical signal at the end of the nerve called the axon hillock.
3. The chemical releases molecules called neurotransmitters, into a space that bridges the space between one neuron to another. These bridges are called synapses.
4. The neurotransmitter binds to a receptor on the muscle or connecting neuron and converts to another electrical signal.
5. Electrical signals travel up the length of that next neuron.
6. The process repeats until the message reaches its target.



What is Peripheral Neuropathy?

- Neuropathy is, essentially, anytime, anywhere in the body, when the nerve impulse does not arrive at its intended target in the manner or composition in which it was intended to arrive.
- The signals can be:
 - Interrupted
 - Distorted
 - Weakened
 - Altogether absent
- There can also be inappropriate signaling at times when no should be being sent.

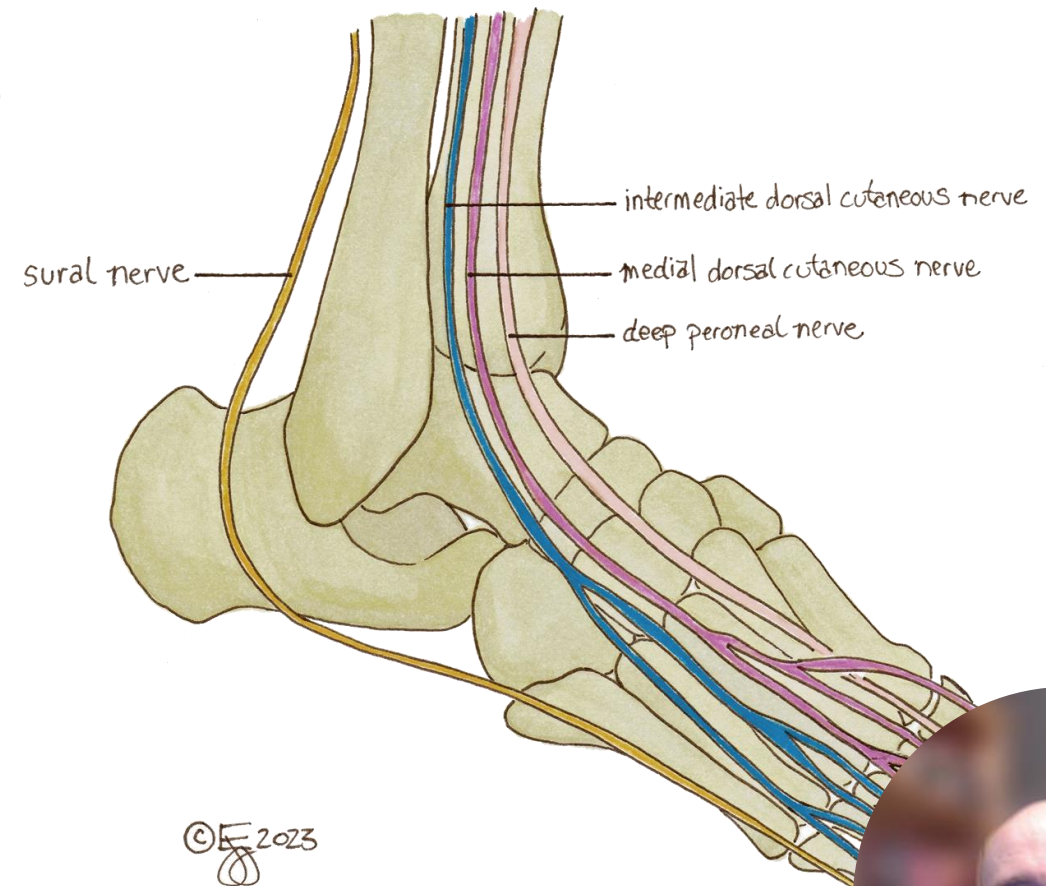


- Sural Nerve

- A purely sensory cutaneous nerve, providing sensation to the posterolateral aspect of the distal third of the leg and the lateral aspect of the foot, heel, and ankle. It is formed by terminal branches of the tibial and common peroneal nerves that join together in the superficial aspect of the distal third of the leg.

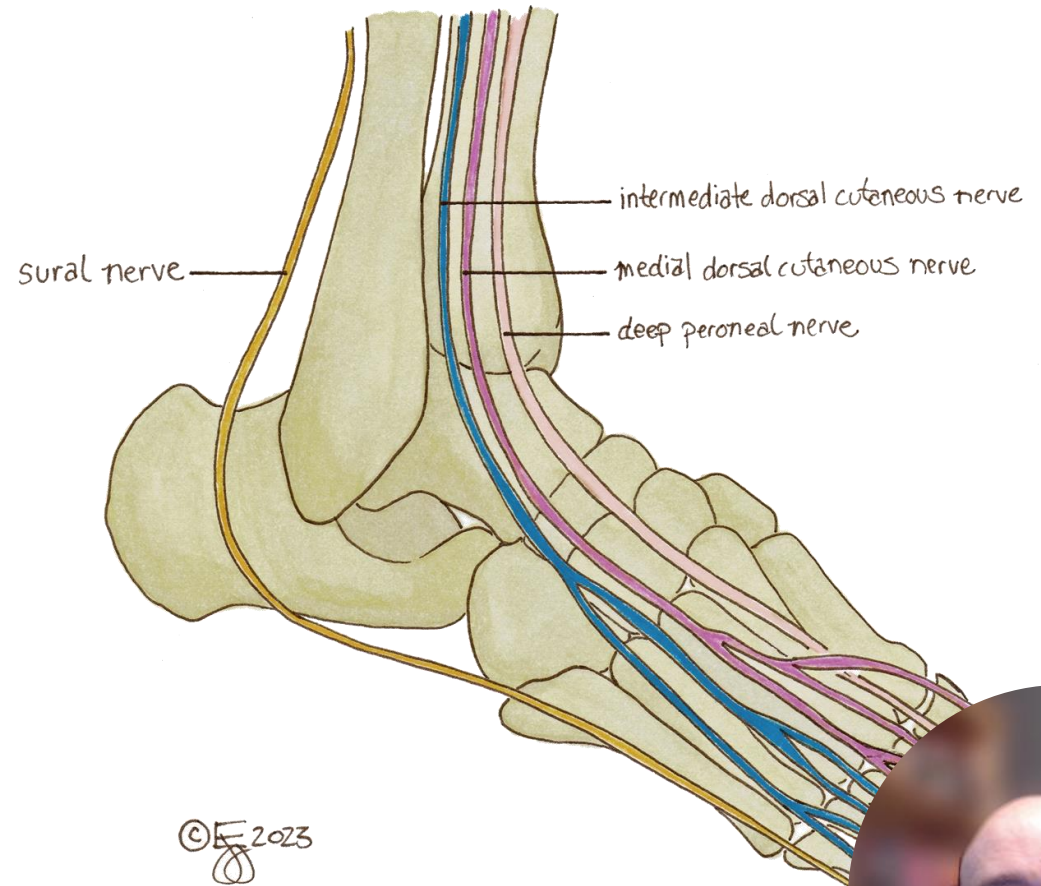
- Intermediate Dorsal Cutaneous Nerve

- Passes along the lateral part of the dorsum of the foot, and divides into dorsal digital branches, which supply the contiguous sides of the third and fourth, and of the fourth and fifth toes. It also supplies the skin of the lateral side of the foot and ankle and communicates with the sural nerve.

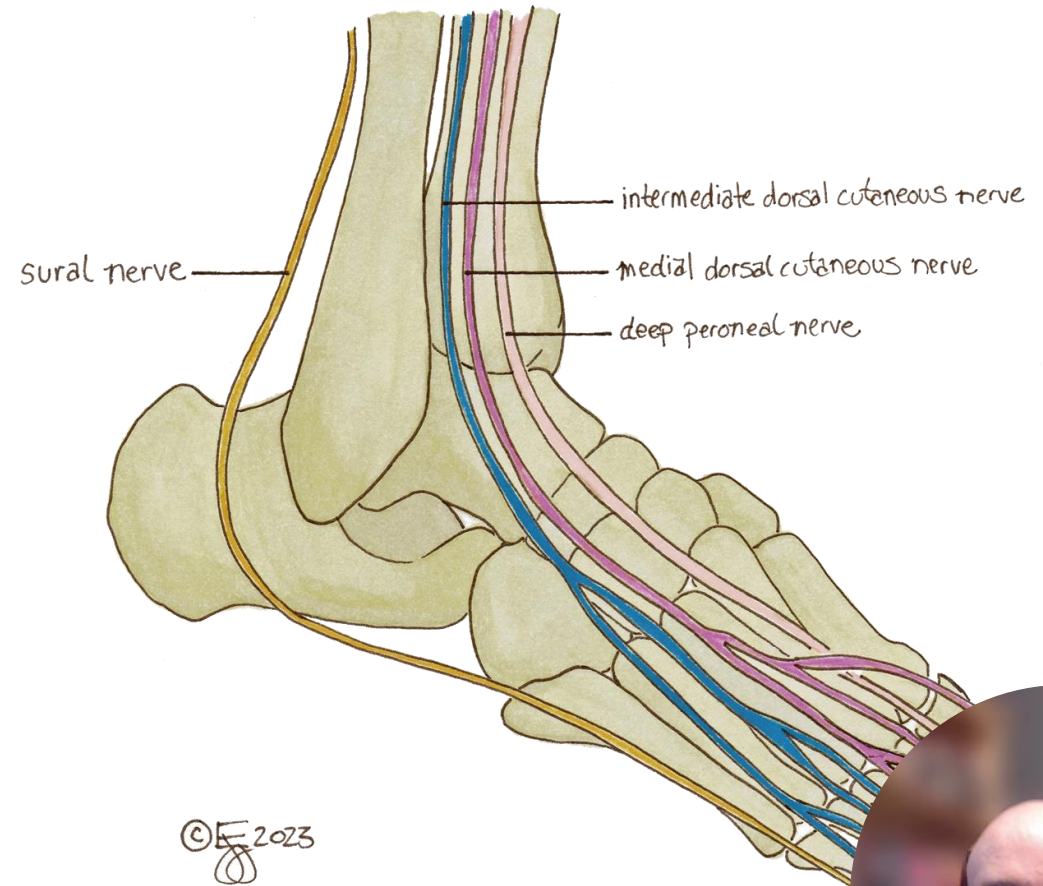


- Medial Dorsal Cutaneous Nerve

- Typically passes in front of the ankle joint, dividing into two dorsal digital branches, with one branch supplying the medial side of the hallux and the other supplying the adjacent side of the second and third toes. This nerve communicates with the saphenous and deep fibular nerves.

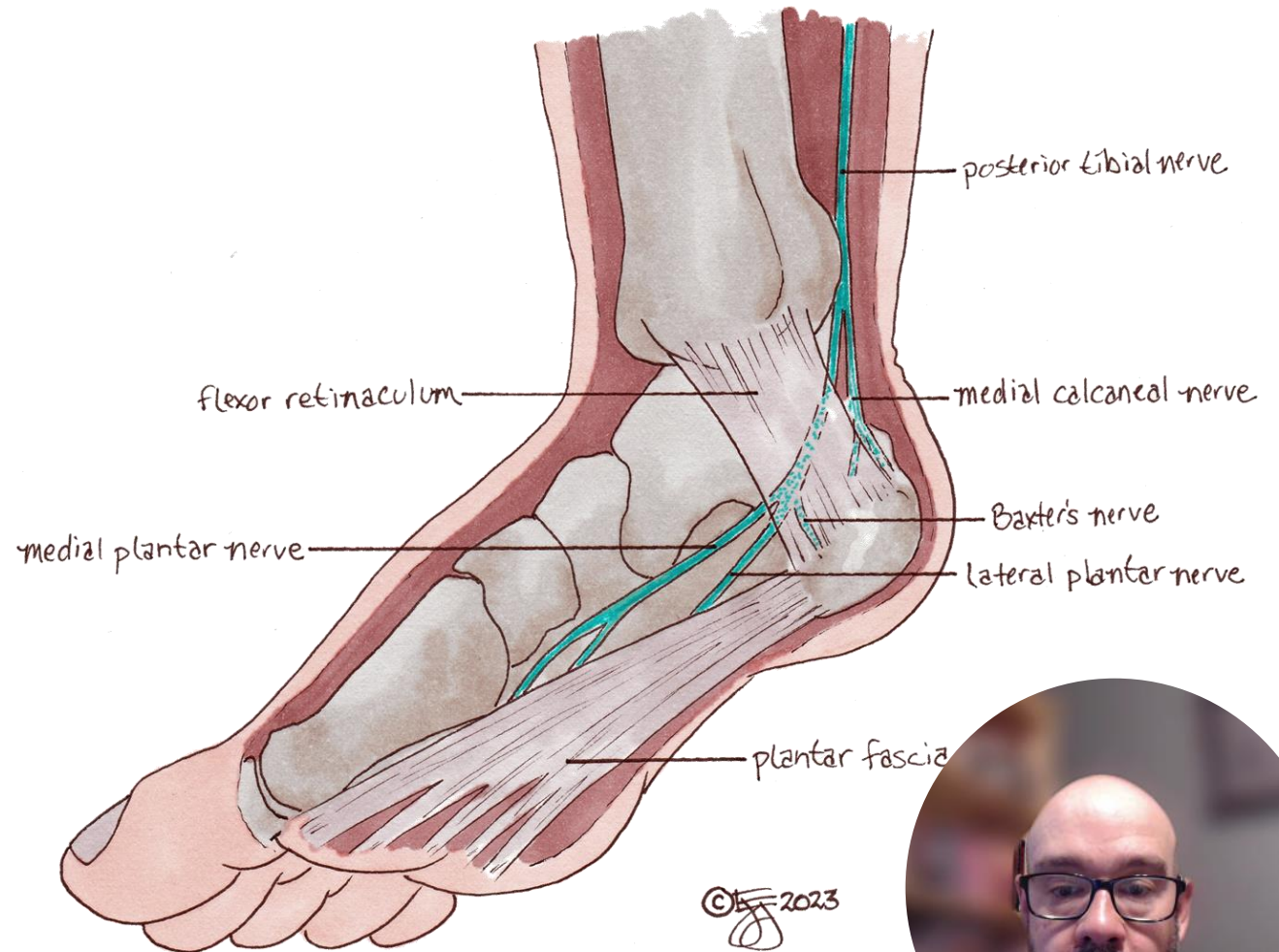


- Deep Peroneal (Fibular) Nerve
 - Terminal division of the common peroneal nerve.
 - In the anterior compartment of the leg:
 - Innervates the tibialis anterior muscle
 - In the foot:
 - Lateral branch – motor branch innervates the extensor digitorum brevis and extensor hallucis brevis muscles
 - Medial branch – sensory branch innervates the skin of the webbed space between the 1st and 2nd toes.



Posterior Tibial Nerve

- The tibial nerve is the larger terminal branch of the two main muscular branches of the sciatic nerve.
- The tibial nerve provides innervation to the muscles of the lower leg and foot. Specifically: triceps surae, plantaris, popliteus, tibialis posterior, flexor digitorum longus and flexor hallucis longus. It also has articular and cutaneous branches.

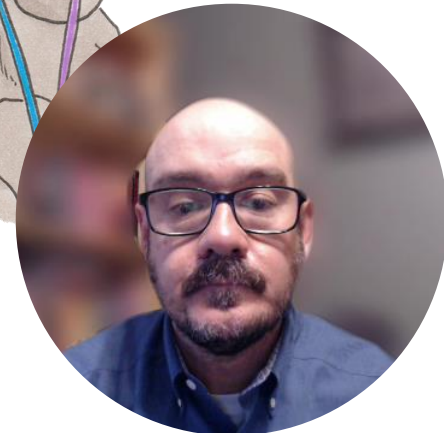
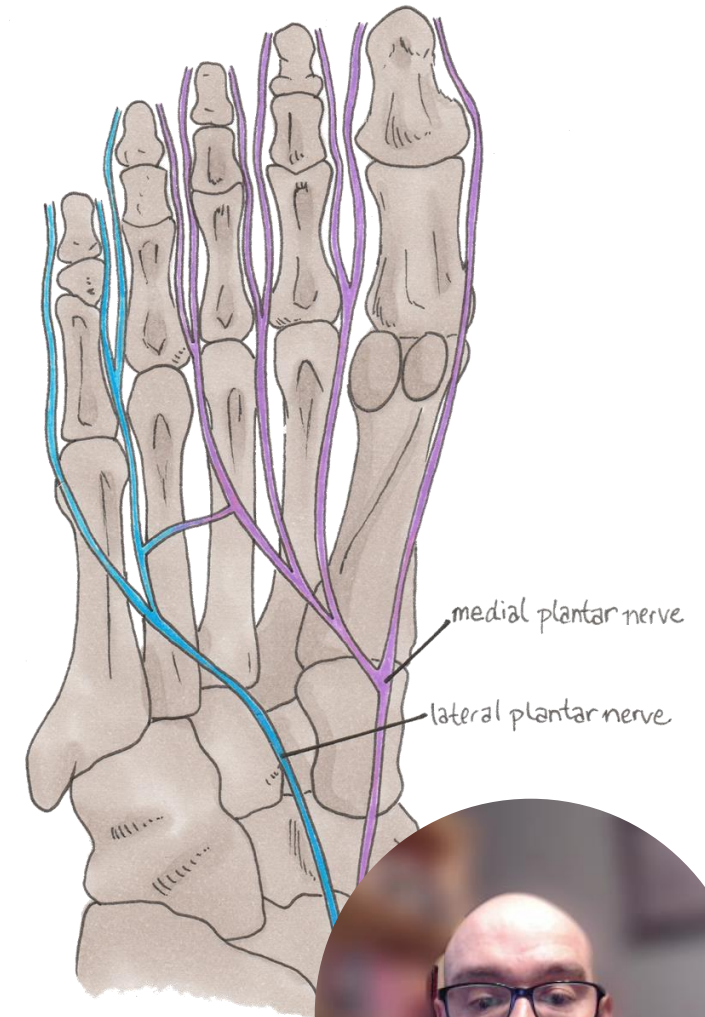


- **Medial Plantar Nerve**

- The larger one of the two terminal branches of the tibial nerve, it covers most of the sole of the foot and supplies multiple intrinsic muscles of foot.
- Cutaneous branches supply most of the skin on the anterior two-thirds of the sole as well as the adjacent surfaces of the medial three and one-half toes, including the big toe.
- Muscular branches supply the abductor hallucis, flexor hallucis brevis, flexor digitorum brevis and first lumbrical muscles.
- Articular branches supply the articulations of the tarsus and metatarsus.

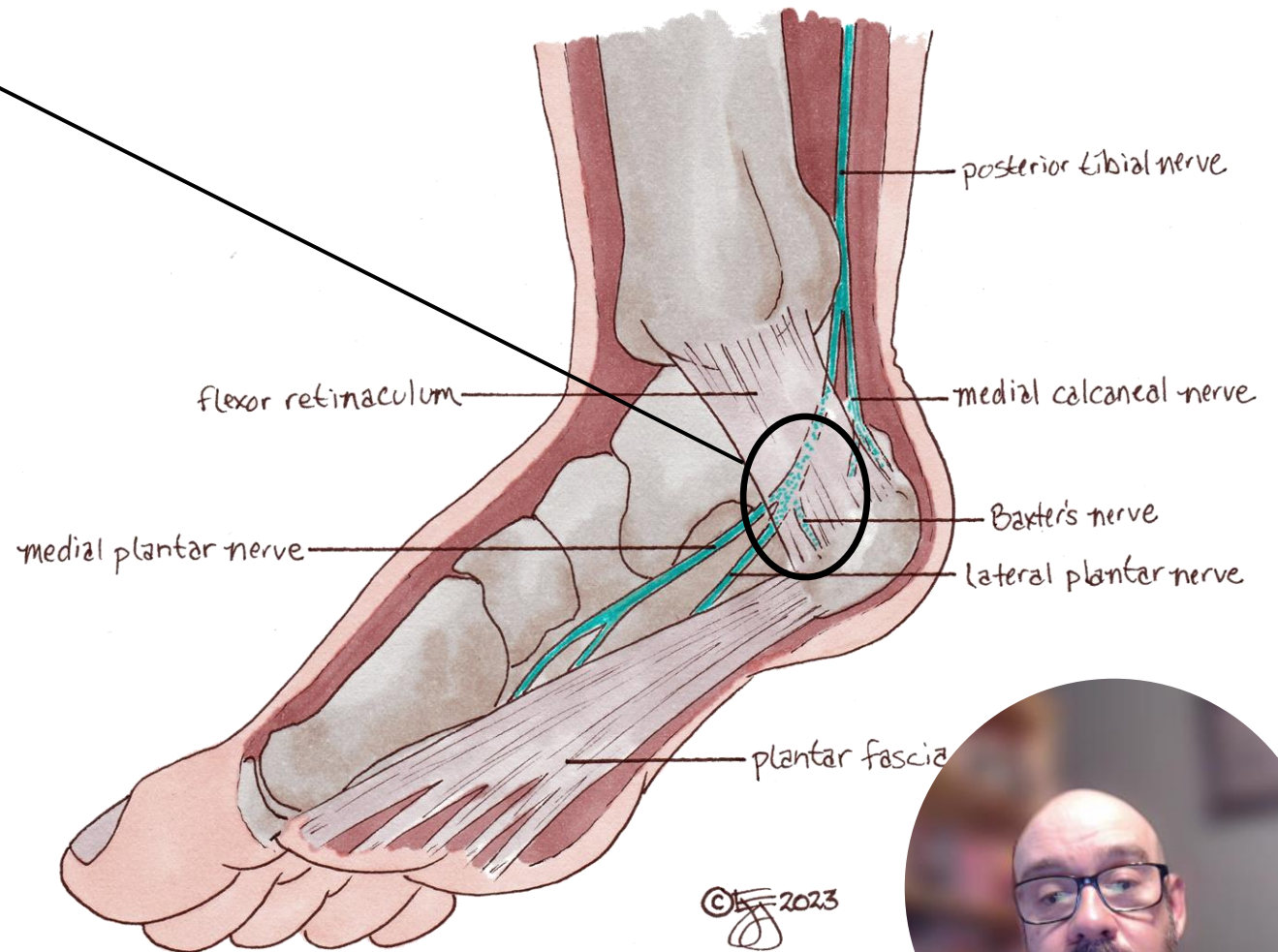
- **Lateral Plantar Nerve**

- The smaller terminal branch of the tibial nerve.
- It is a motor nerve that innervates all the intrinsic muscles from the sole with the exception of abductor hallucis, flexor digitorum brevis, the flexor hallucis brevis, and the first lumbrical muscle innervated by the medial plantar nerve.
- Also a sensory nerve that provides sensory information from the two anterior thirds of the lateral sole of the foot, as well as the plantar surfaces for the 5th and half of the 4th toe.



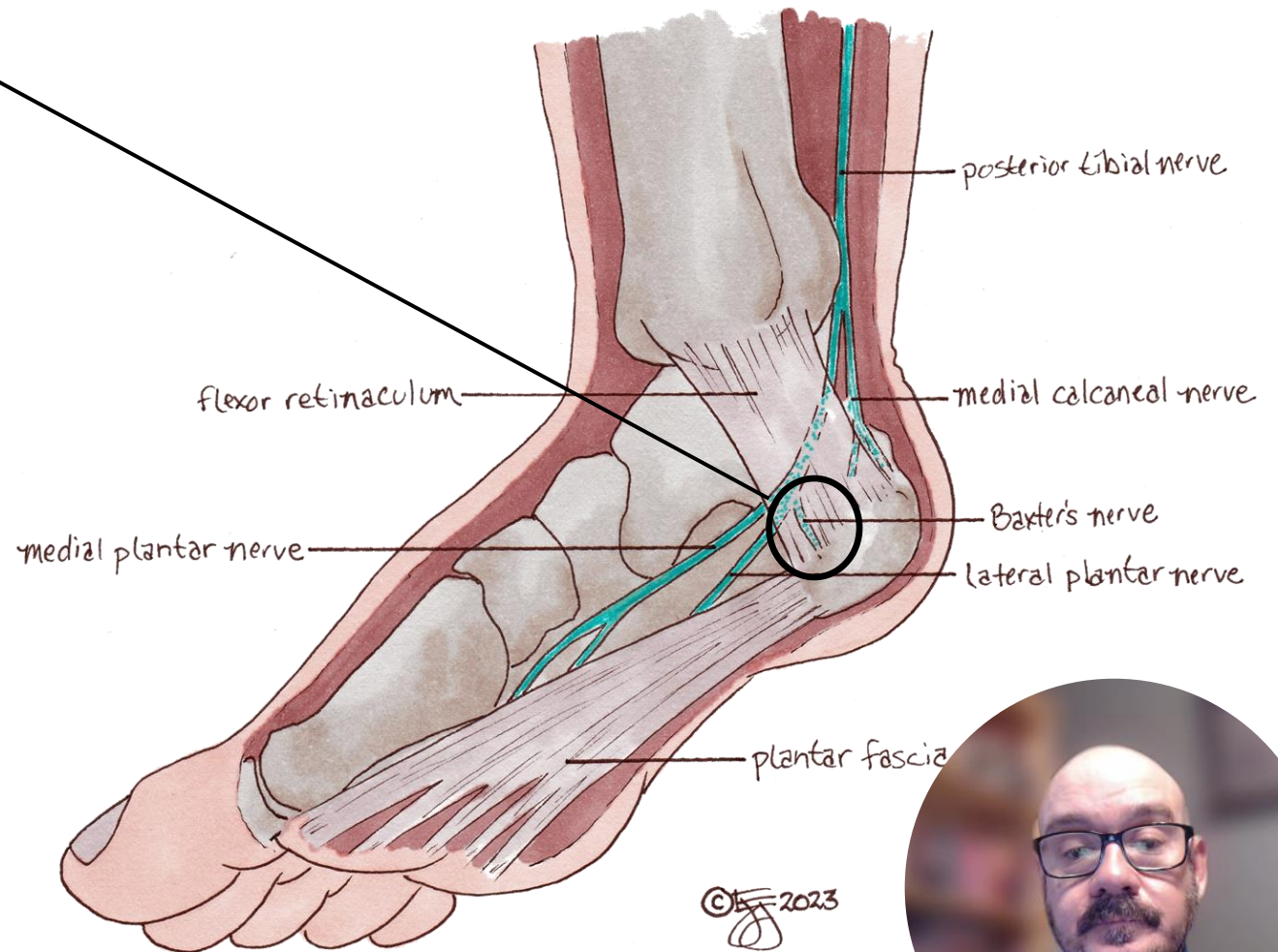
Tarsal Tunnel

- A narrow fibro-osseous space that runs behind and inferior to the medial malleolus.
- Bounded by the medial malleolus anterosuperiorly, by the posterior talus and calcaneus laterally, and is held against the bone by the flexor retinaculum which extends from the medial malleolus to the medial calcaneus and prevents medial displacement of its contents.
- Compression of the posterior tibial nerve in this area is called *tarsal tunnel syndrome*.



Baxter's Nerve

- The entrapment of the lateral plantar nerve first branch (inferior calcaneal nerve), also known as Baxter's nerve, produces pain on the inside of the ankle and heel and can mimic plantar fasciitis and tarsal tunnel syndrome.



Nerve Distribution



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The End

