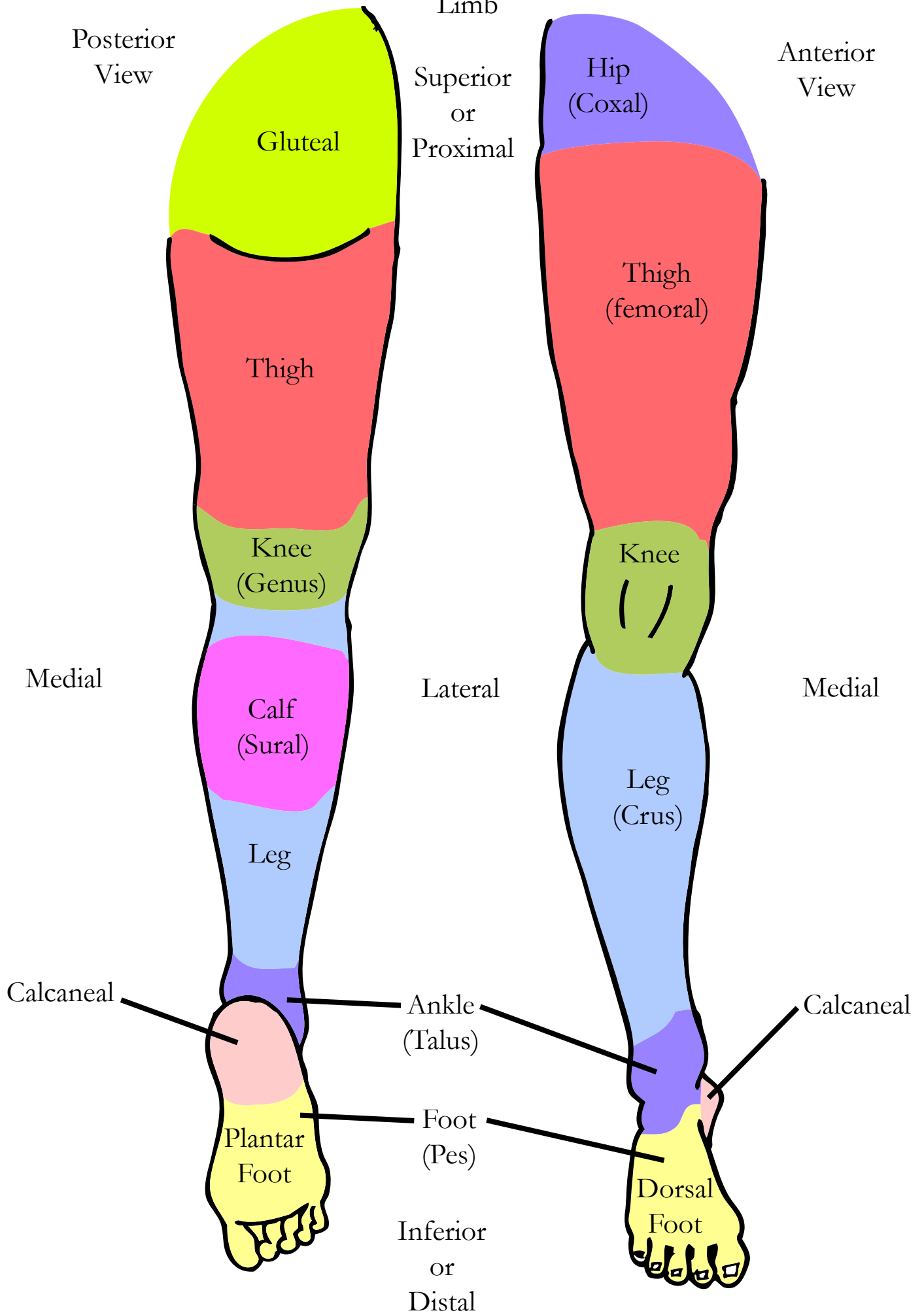




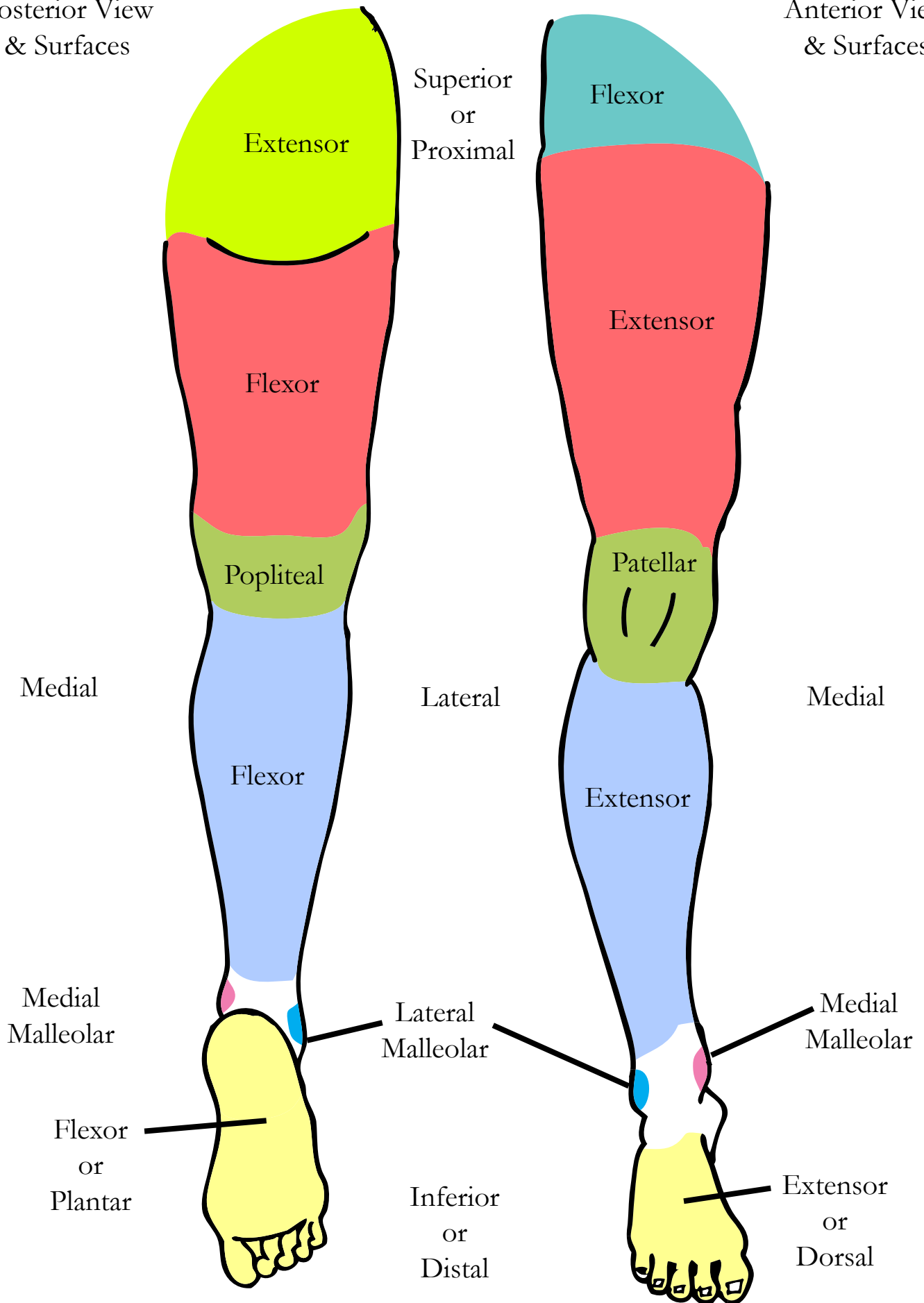
Regions - Lower Limb



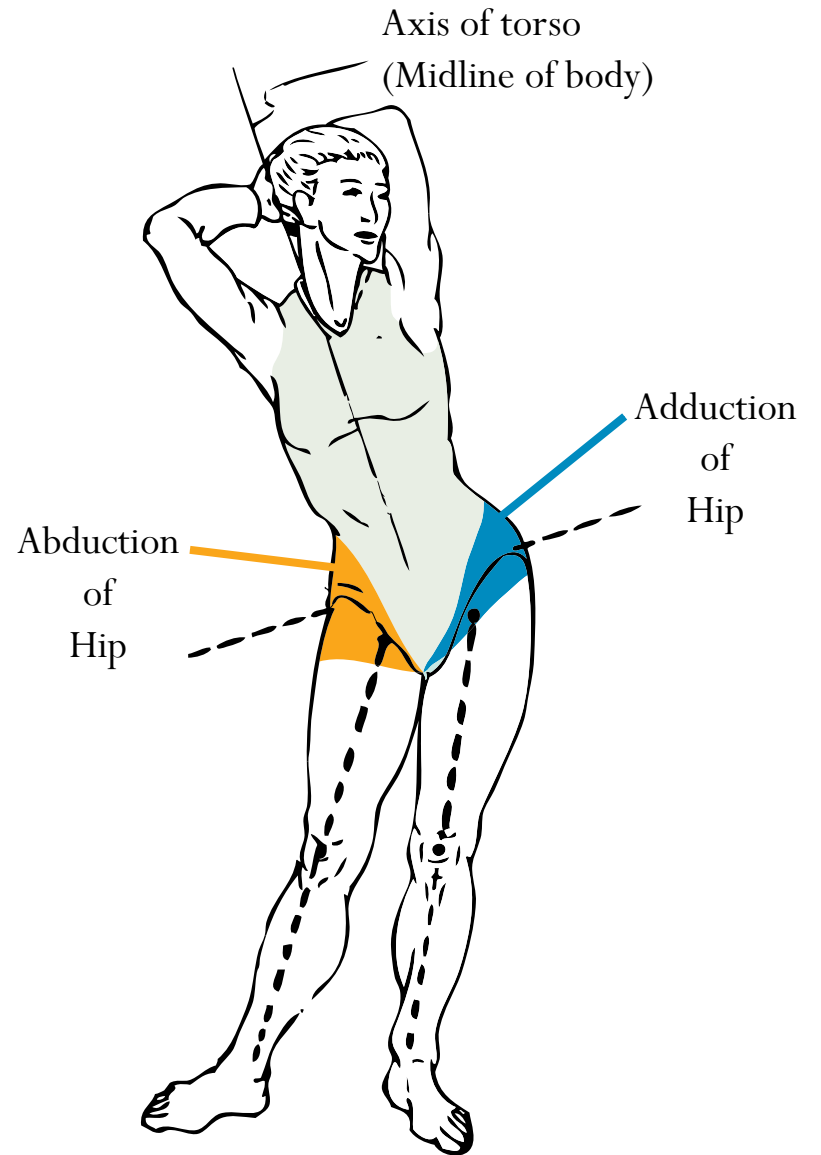
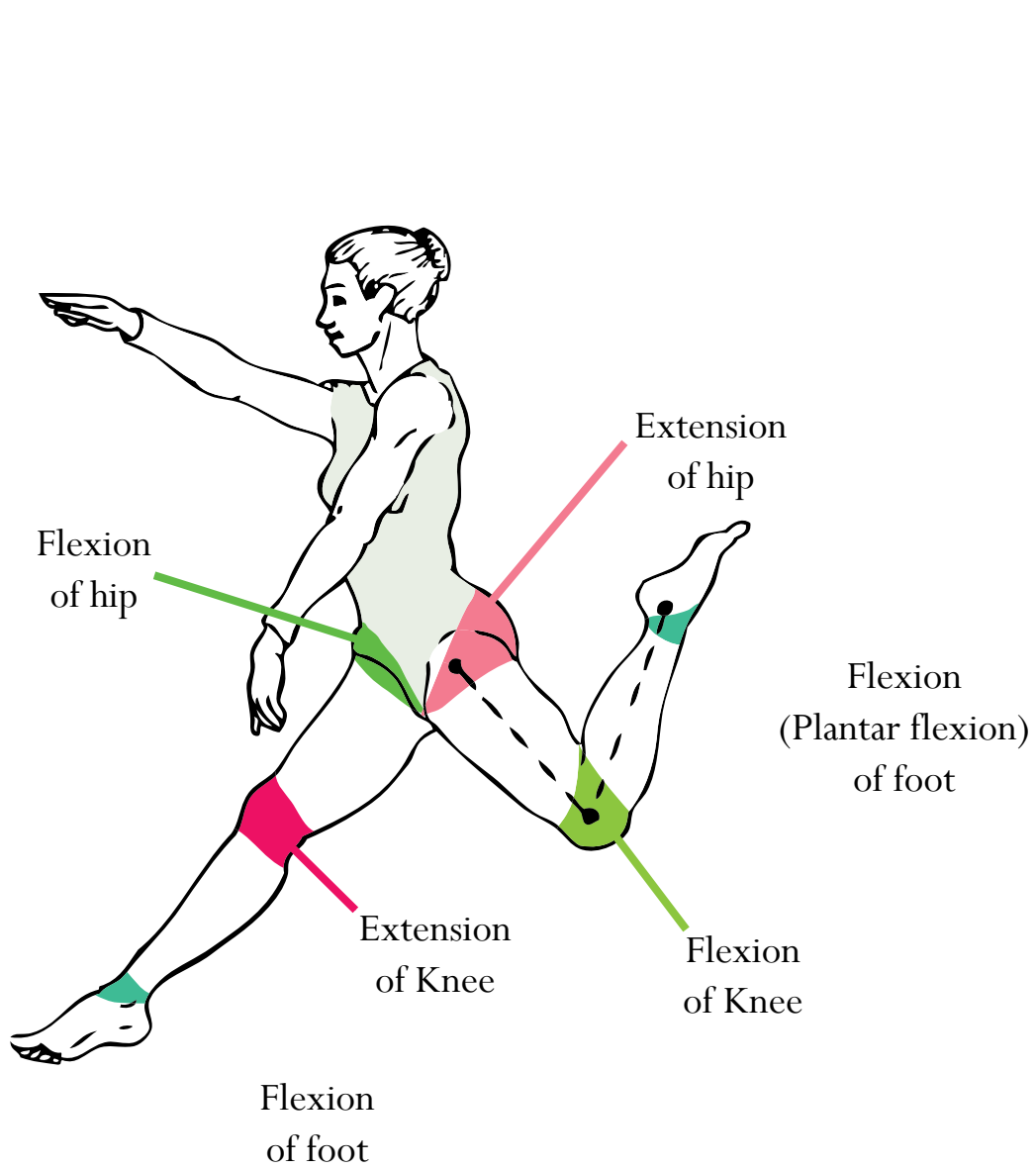
# Surfaces - Lower Limb

Posterior View  
& Surfaces

Anterior View  
& Surfaces



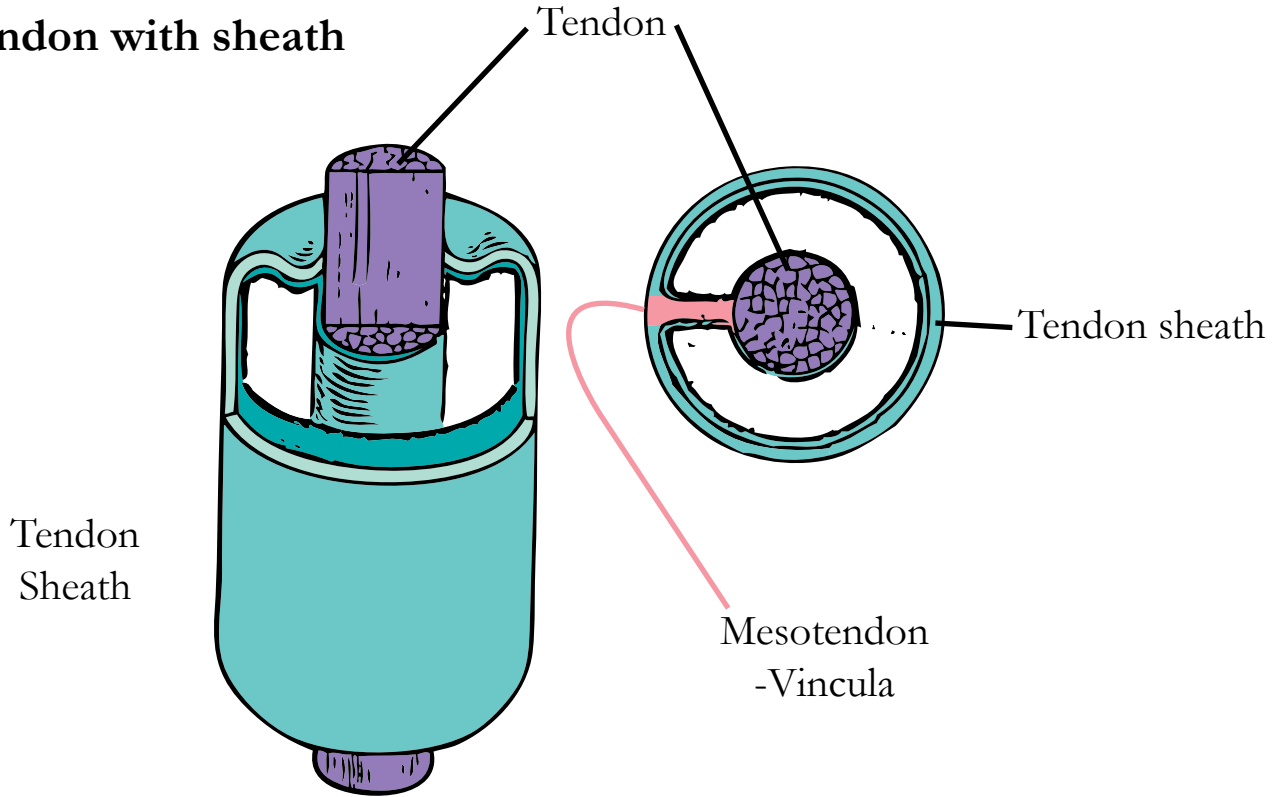
# Joint Motions



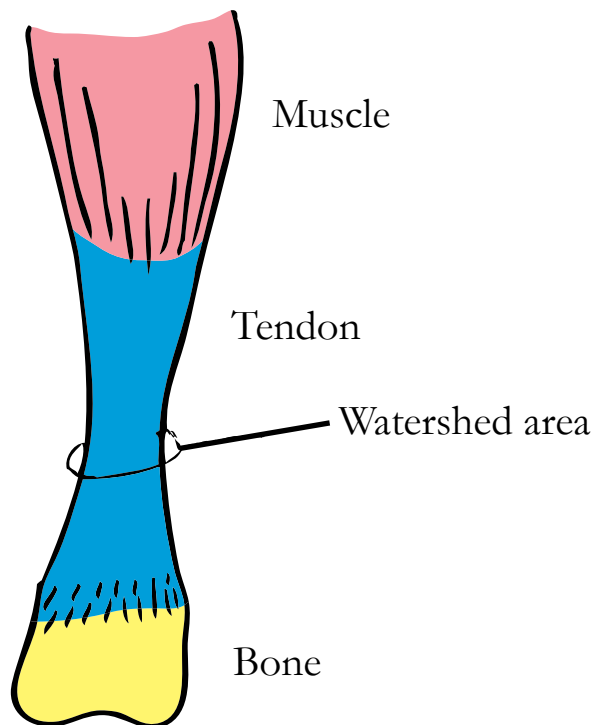


# Associated Muscle Structures

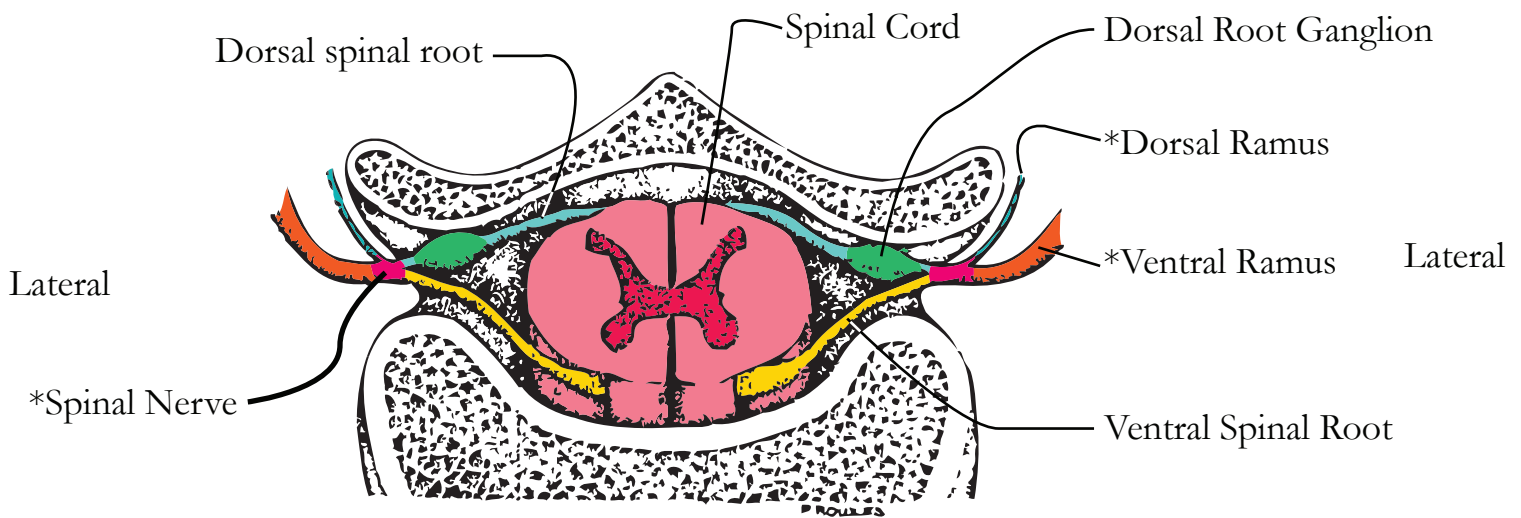
Tendon with sheath



Tendon without sheath



**Dorsal/Posterior**



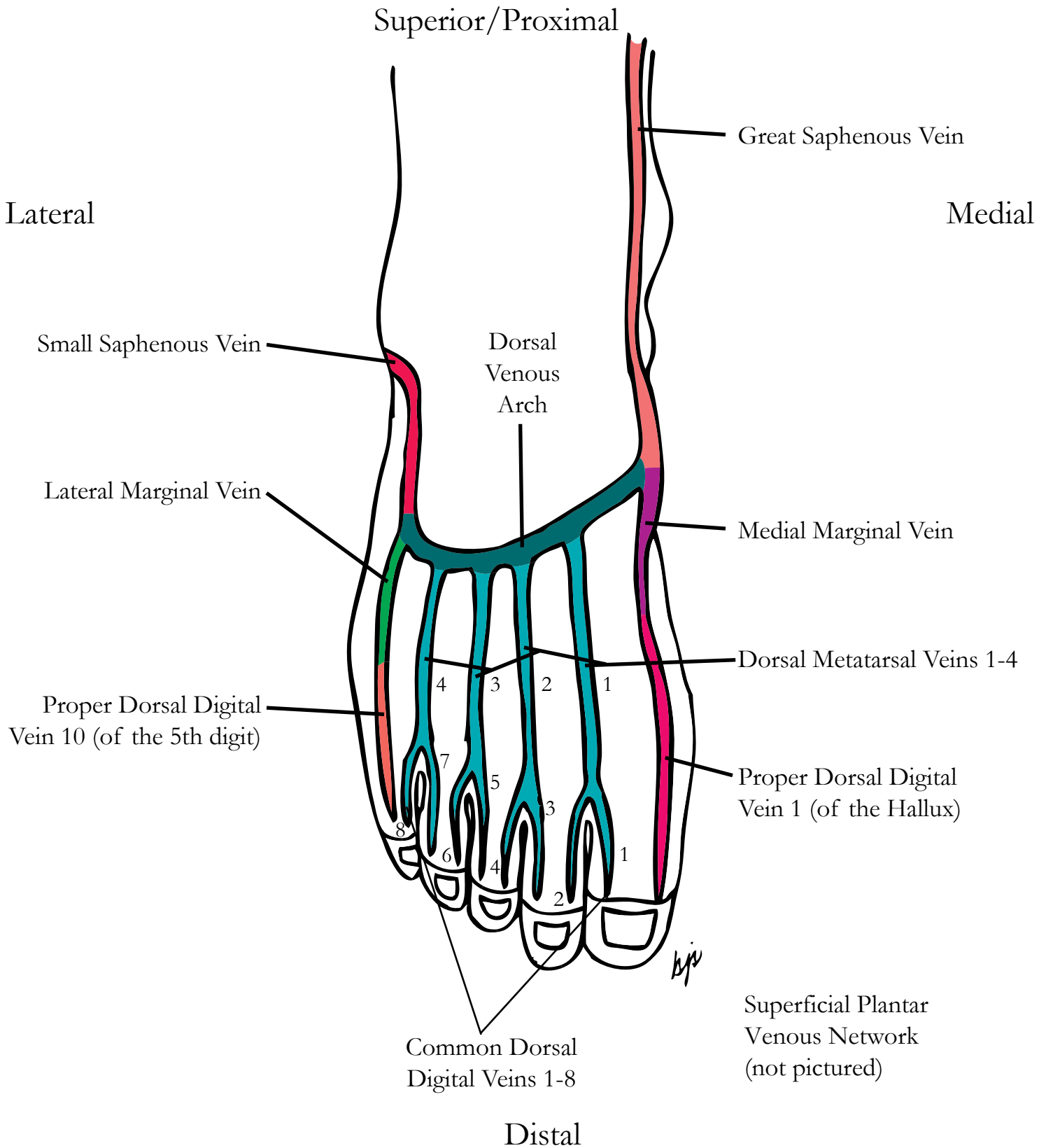
**Ventral/Anterior**

\*Peripheral Nervous System

# Anterior View - Ankle

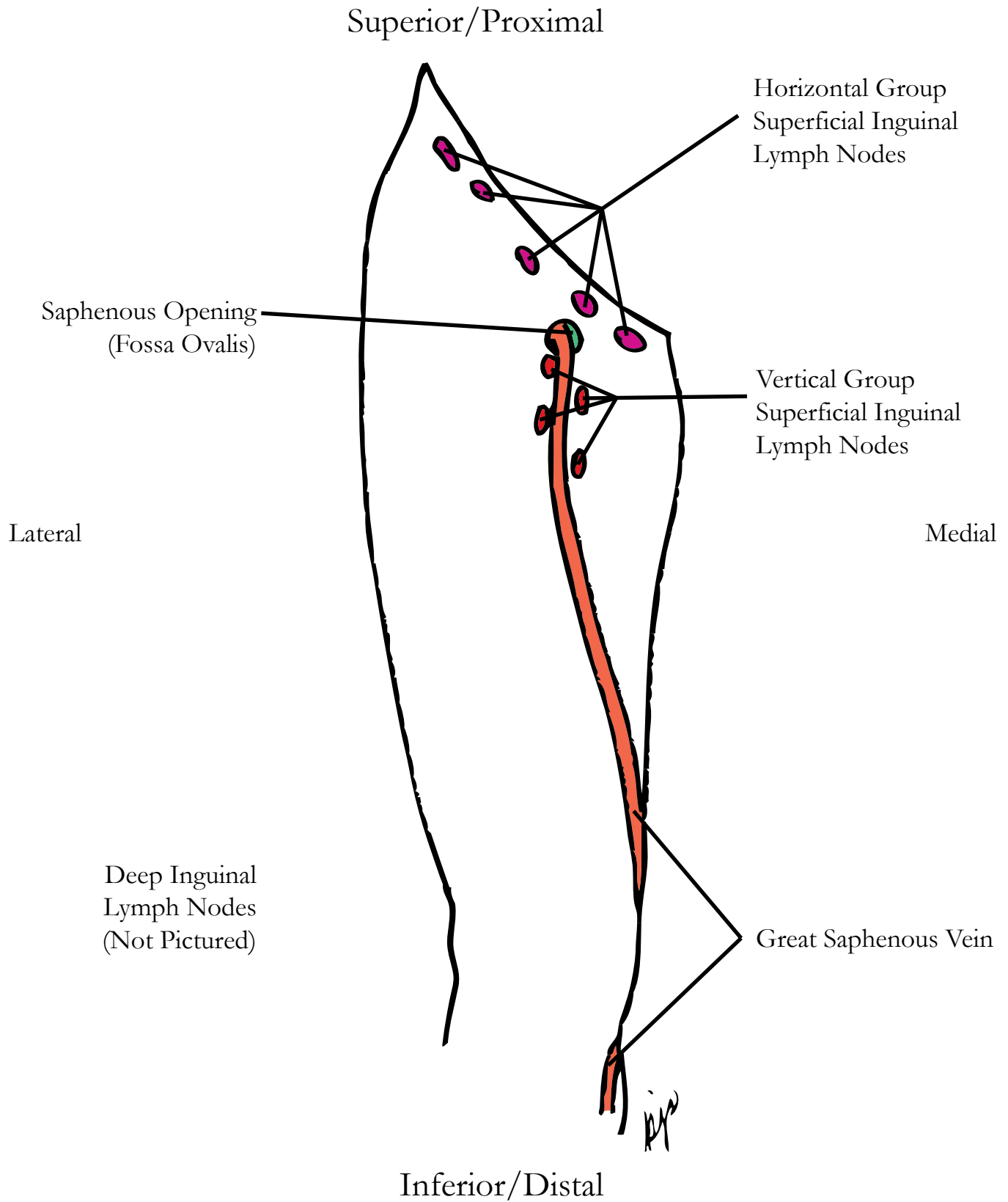
## Dorsal View Foot

### Superficial Veins



# Superficial Veins & Lymph Nodes

## Anterior View - Thigh & Knee

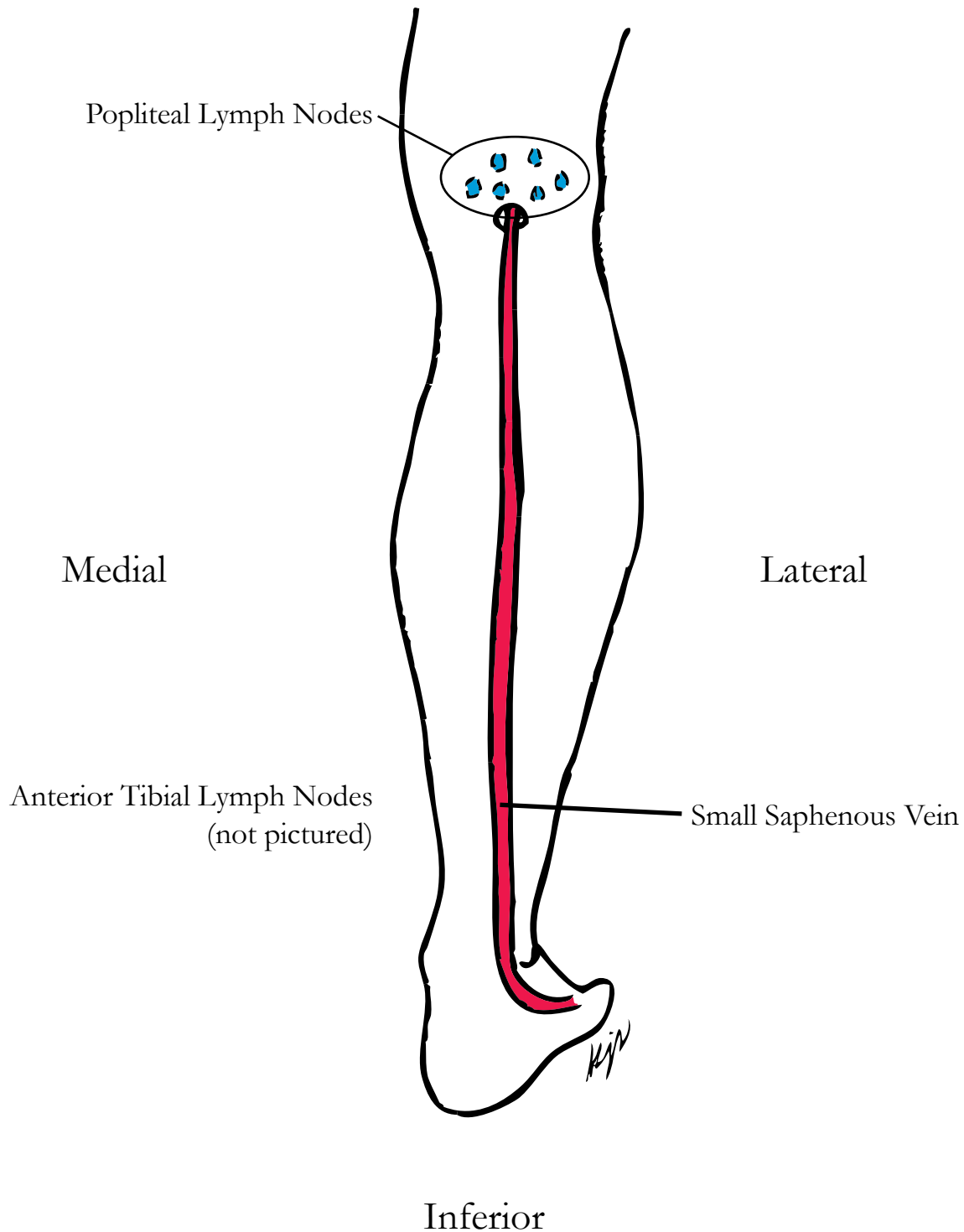


# Posterior View - Knee & Leg

## Superficial Veins

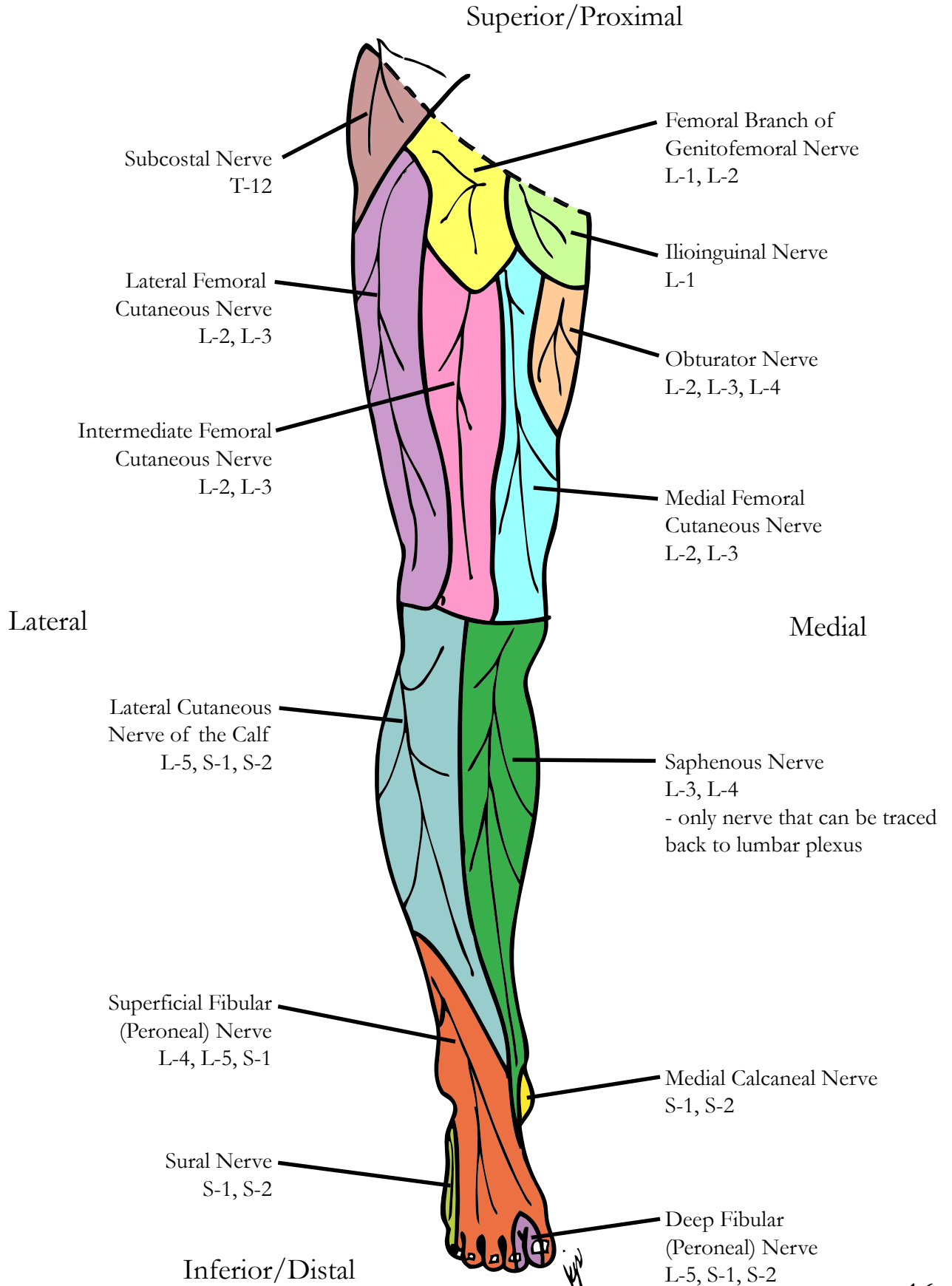
## Lymph Nodes

Superior/Proximal



# Cutaneous Nerves

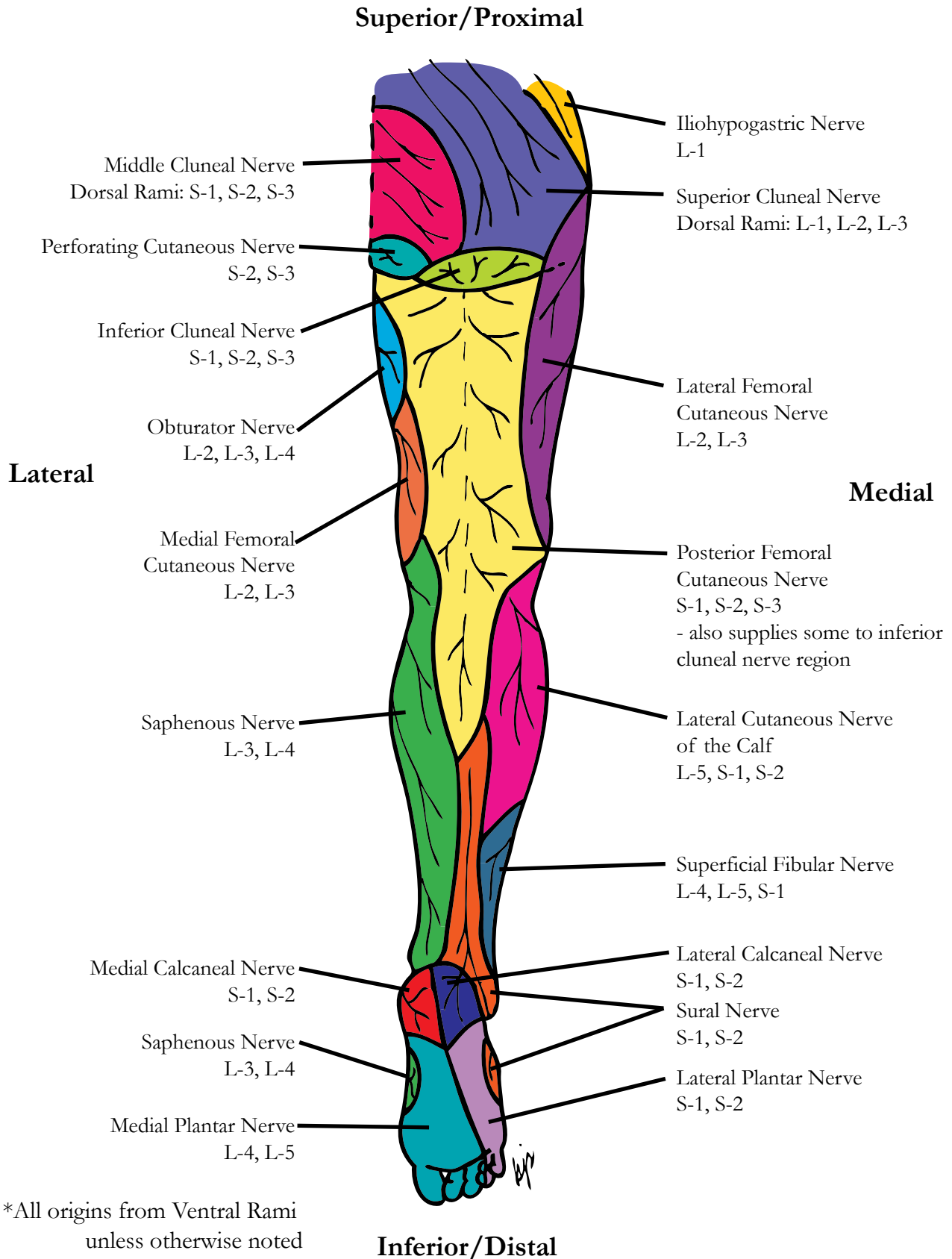
## Anterior View - Lower Limb





# Cutaneous Nerves

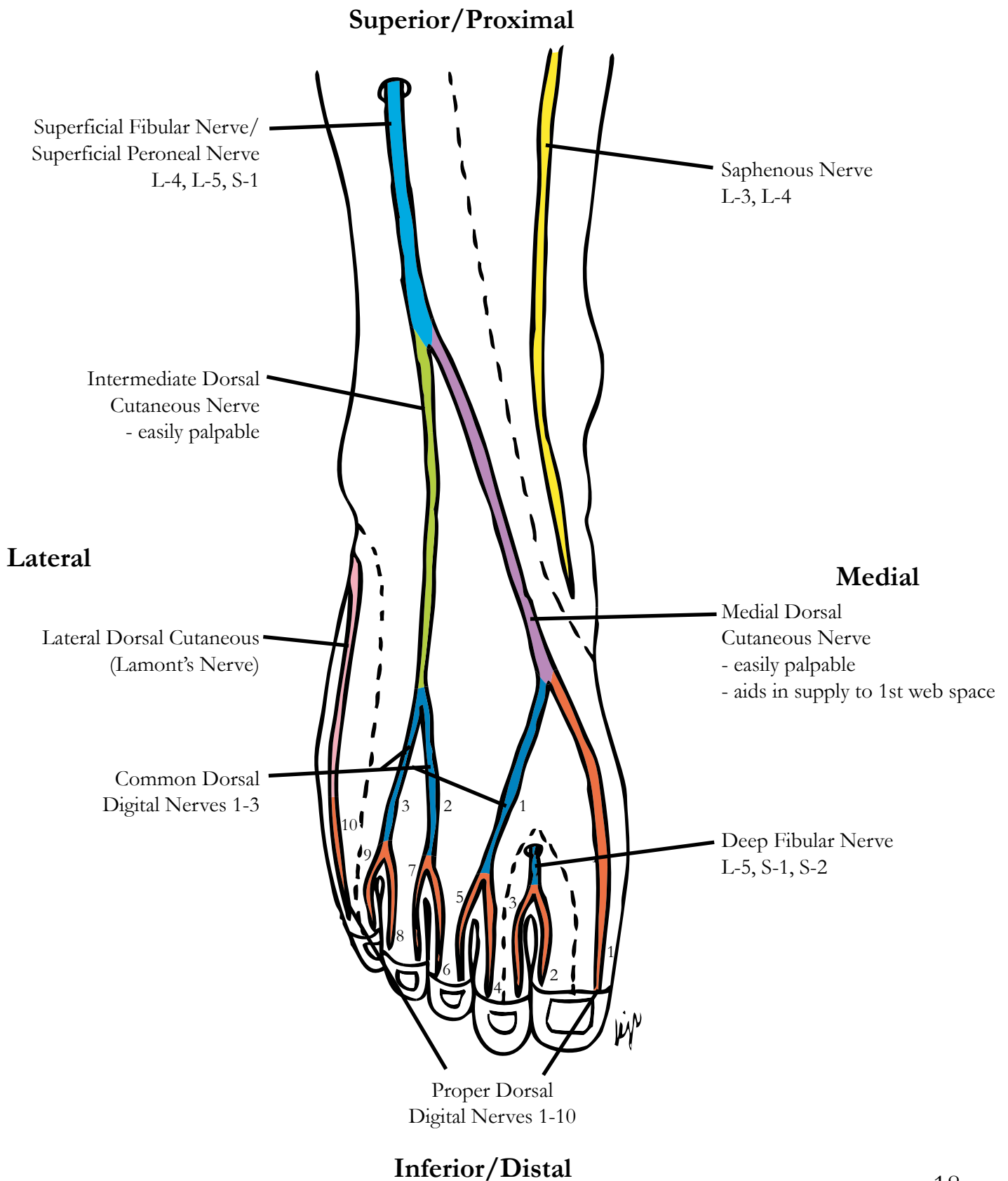
## Posterior View - Lower Limb



# Cutaneous Nerves

## Anterior View - Ankle

## Dorsal View - Foot

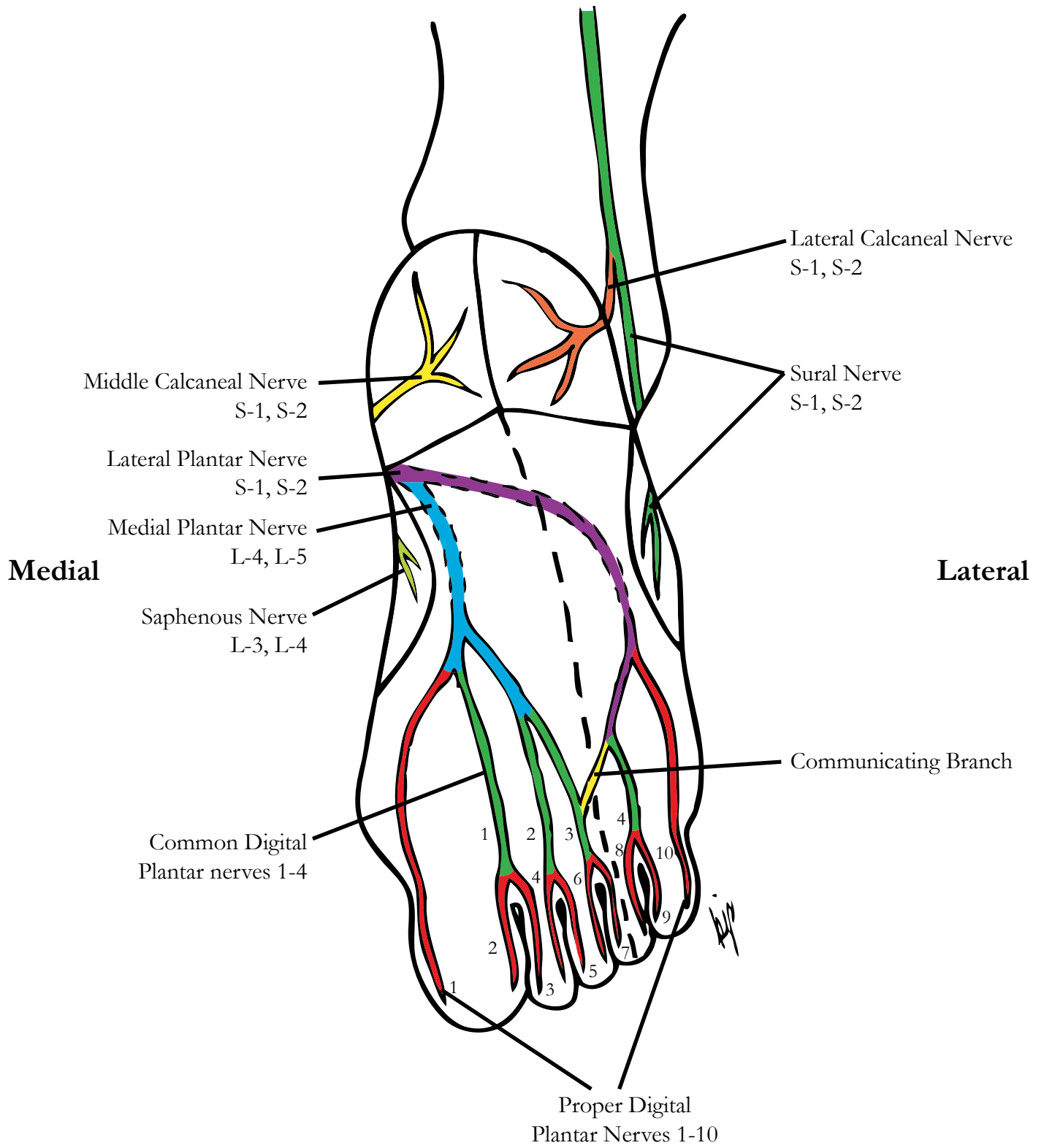


# Cutaneous Nerves

## Posterior View - Ankle

## Plantar View - Foot

Superior/Proximal



Inferior/Distal

# Retinacula

## Lateral View - Ankle

Superior/Proximal

Posterior

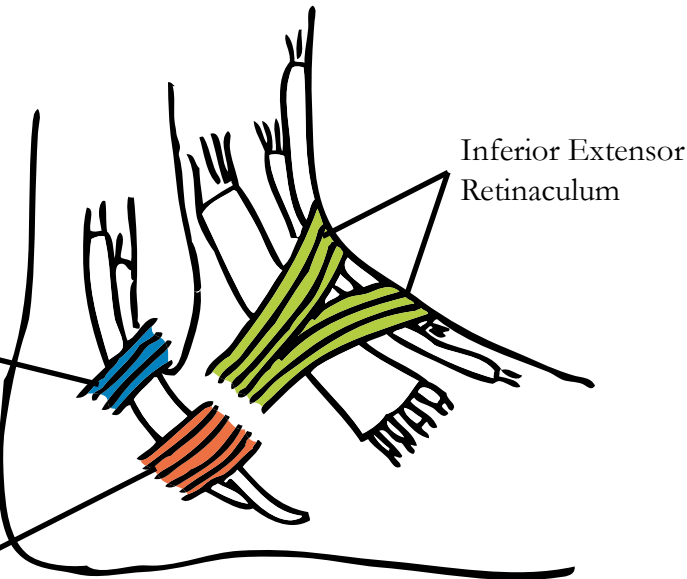
Fibular Retinaculum/  
Peroneal Retinaculum/  
External Annular Ligament

- Superior Fibular (Peroneal)  
Retinaculum

- formed by fascia cruris
- holds peroneal tendons and creates a pulley at the lateral malleolus
- both are in single tendon sheaths here and pass deep to retinaculum
- fibers are continuous with superior extensor retinaculum

- Inferior Fibular (Peroneal)  
Retinaculum

- formed by fascia dorsalis pedis
- holds peroneal tendons and creates pulley for fibularis longus tendon at the distoplantar calcaneus
- tendon sheath divides at this point and each tendon passes deep, separately
- fibers continuous with lateral root of frondiform ligament.

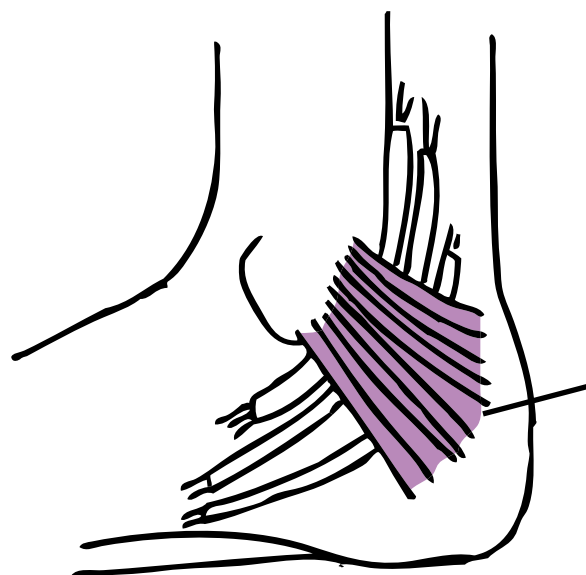


Inferior Extensor  
Retinaculum

Anterior

## Medial View - Ankle

Anterior



Flexor Retinaculum  
(Lacinate Ligament)

- thickening of fascia cruris, fascia dorsalis and plantar fascia
- holds flexor tendons of the foot and creates pulley to improve muscle function
- all tendons pass through the retinaculum and have separate tendon sheaths here.

Posterior

Inferior

# Retinacula

## Anterior View - Ankle

## Dorsal View - Foot

Superior/Proximal

### Superior Extensor Retinaculum (Transverse Crural Ligament)

- thickening of fascia cruris
- fiber continuous with flexor and superior fibular retinacula
- holds extensor tendons of the foot and maintains their position near the tibia
- only one tendon sheath at this level; for the tibialis anterior muscle
- all tendons pass deep to the retinaculum

### Frondiform Ligament

### Inferior Extensor Retinaculum (Cruciate Crural Ligament)

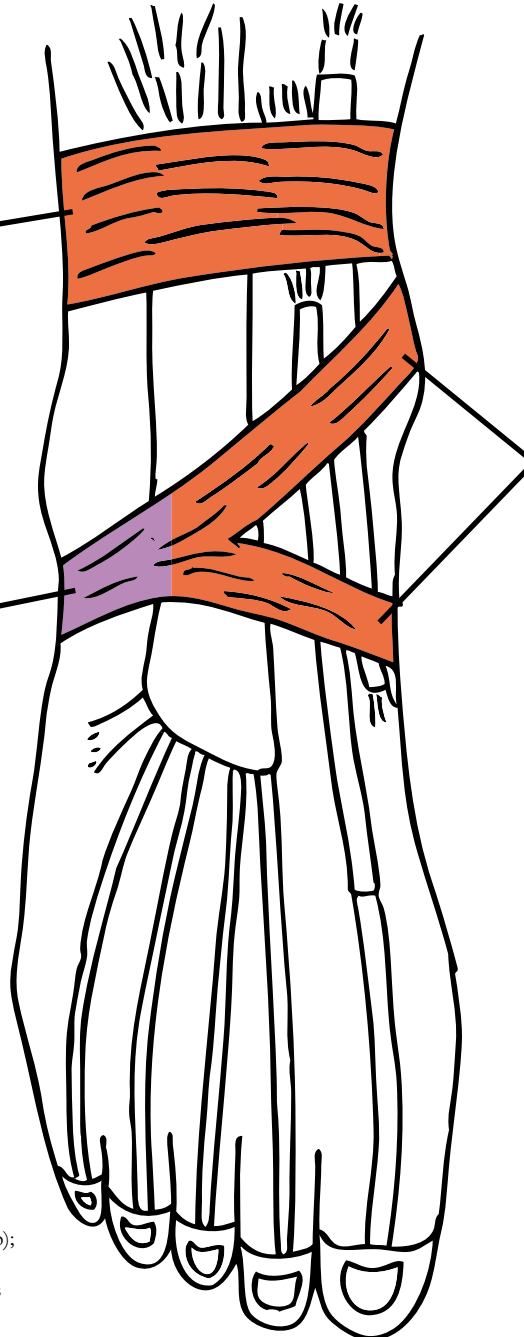
- thickening of fasciae cruris and dorsalis pedis
- described with 3 roots and 7 sinus tarsi
- continuous with the inferior fibular retinaculum
- all tendons have tendon sheaths at this level and pass through this retinaculum
- *frondiform ligament* - the stem of the inferior extensor retinaculum, attaches in the sinus tarsi.

Lateral

Medial

### Intermuscular Septae (not pictured)

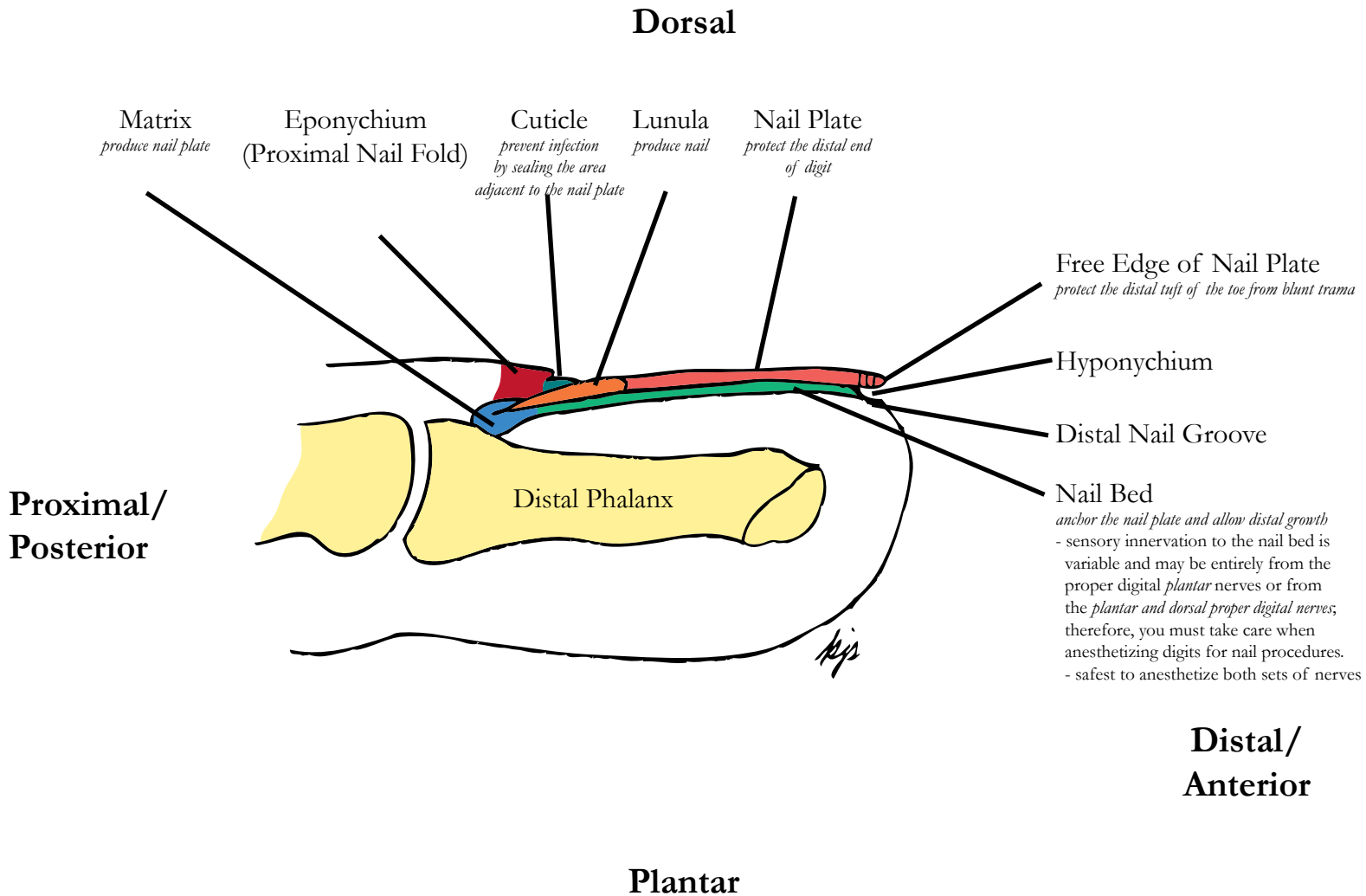
- extensions of deep fascia that attach to bone and separate muscles or groups of muscles
- muscles often take partial origin from or partially insert onto septae
- in the leg, these septae aid in venous return (venous pump); there is little elasticity of the septae and muscular action creates compression on the deep veins which forces fluids superiorly (the valves normally prevent inferior flow), the empty deep veins refill from the superficial veins and so on.



Distal

# Nail Anatomy

## Sagittal Plane View - Digit

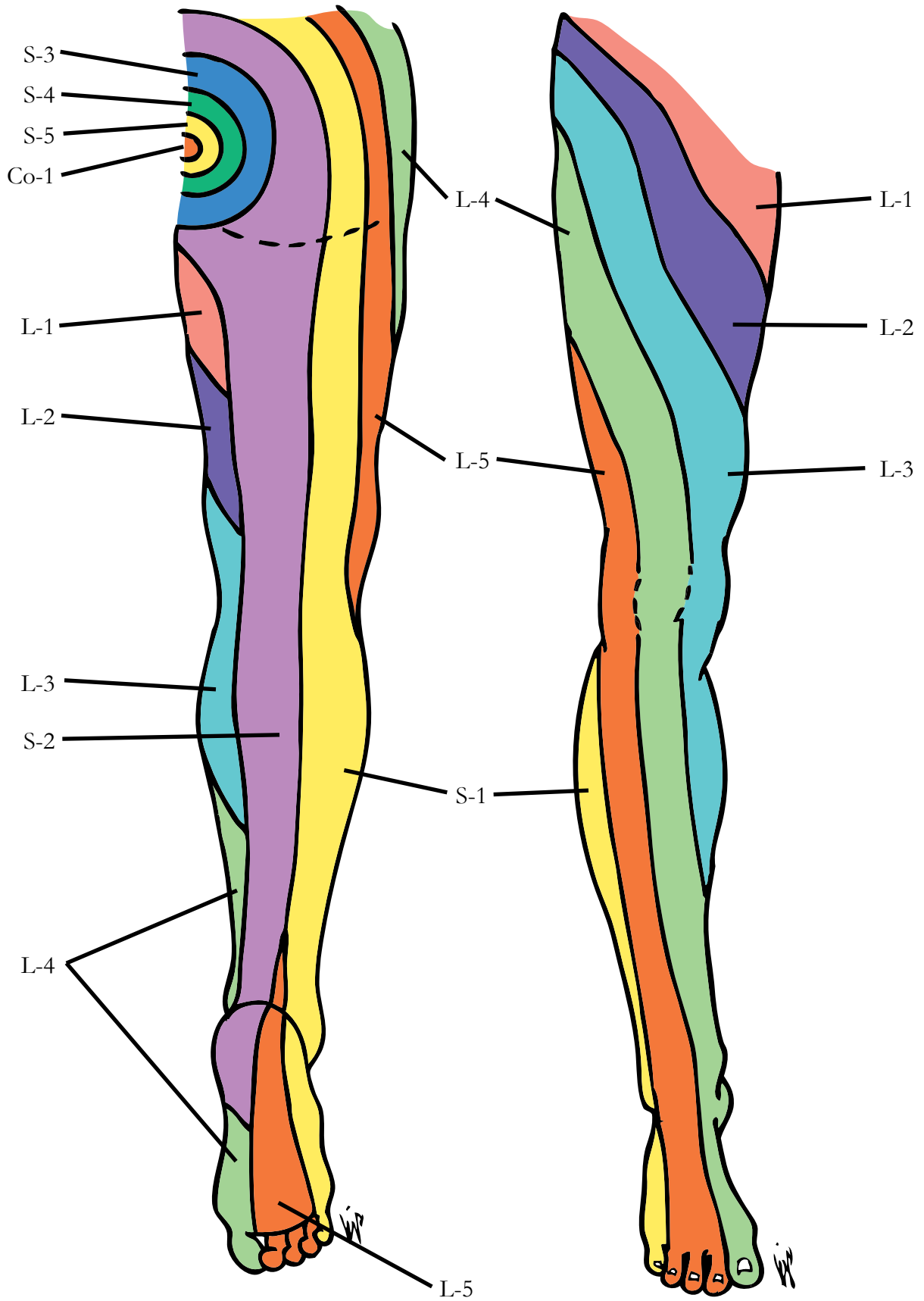




# Dermatomes

Posterior

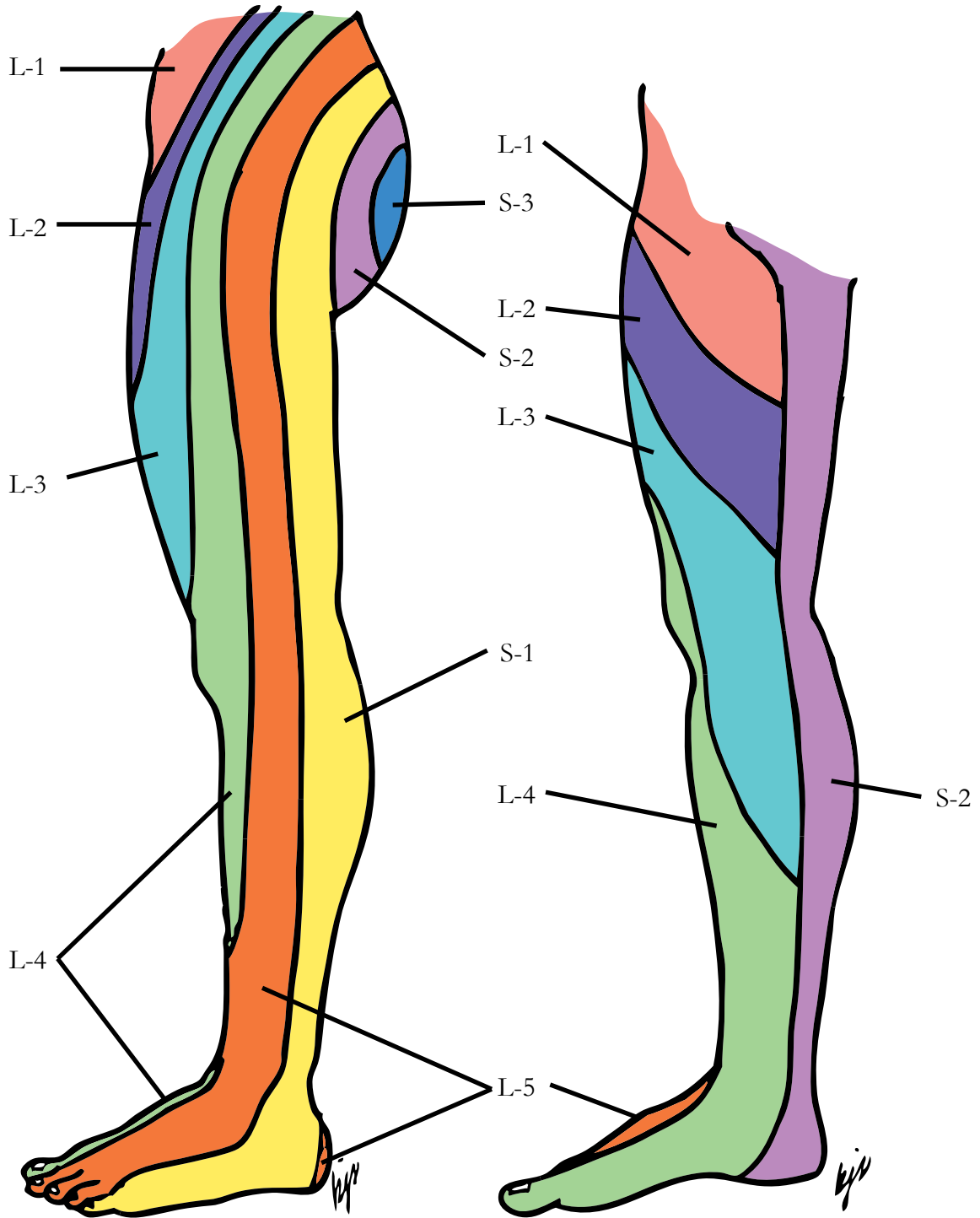
Anterior



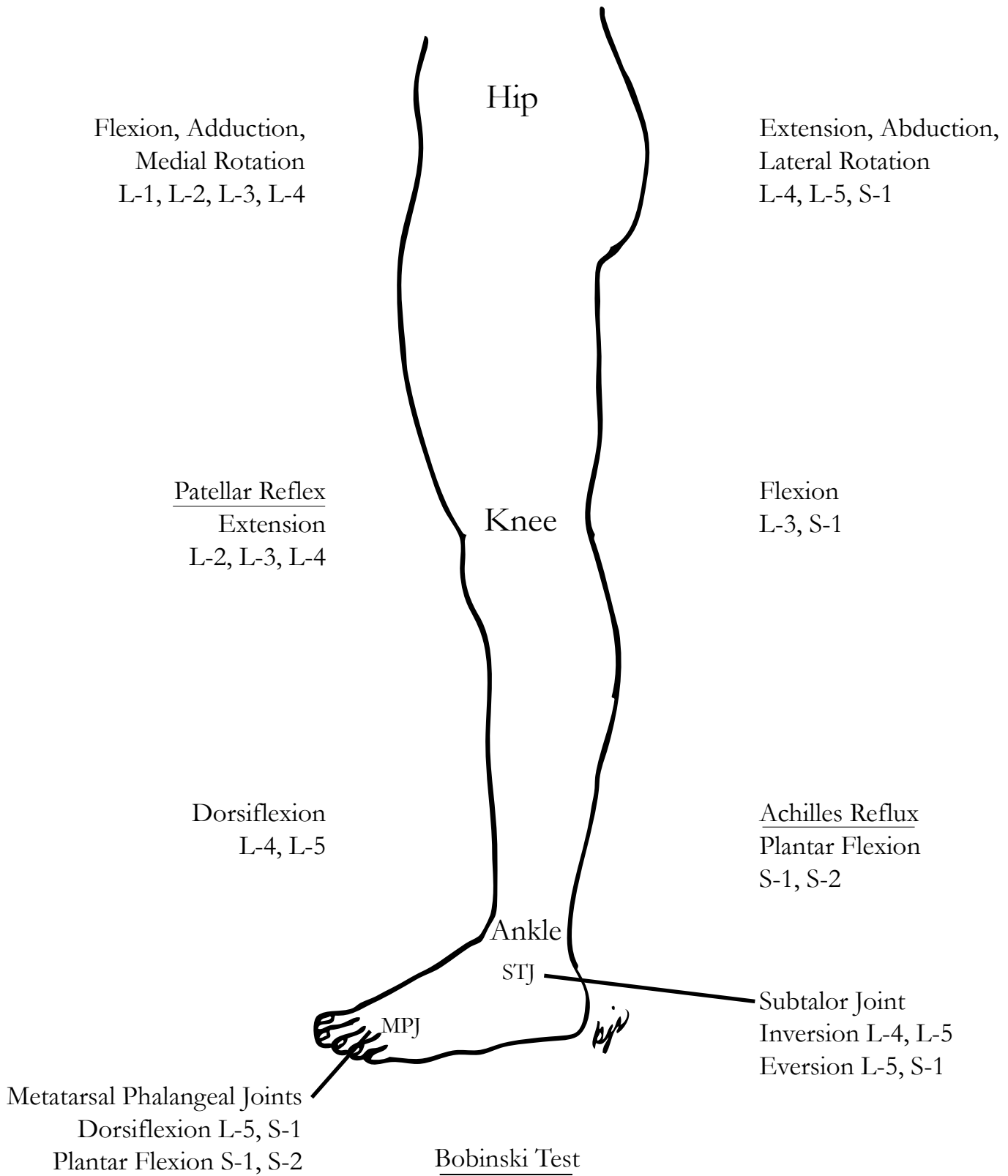
# Dermatomes

Lateral

Medial



# Myotomes



# **Topic 3**

## **Osteology Gluteal and Pelvic Regions**

# Sacrum and Coccyx

## Anterior View

Superior

Superior Articular Process

Articular  
Facet for  
5th Lumbar  
Vertebra

Sacrum

forms a primary curvature of spinal column

Sacral Ala

Sacral Ala

Sacral Promontory

Lateral

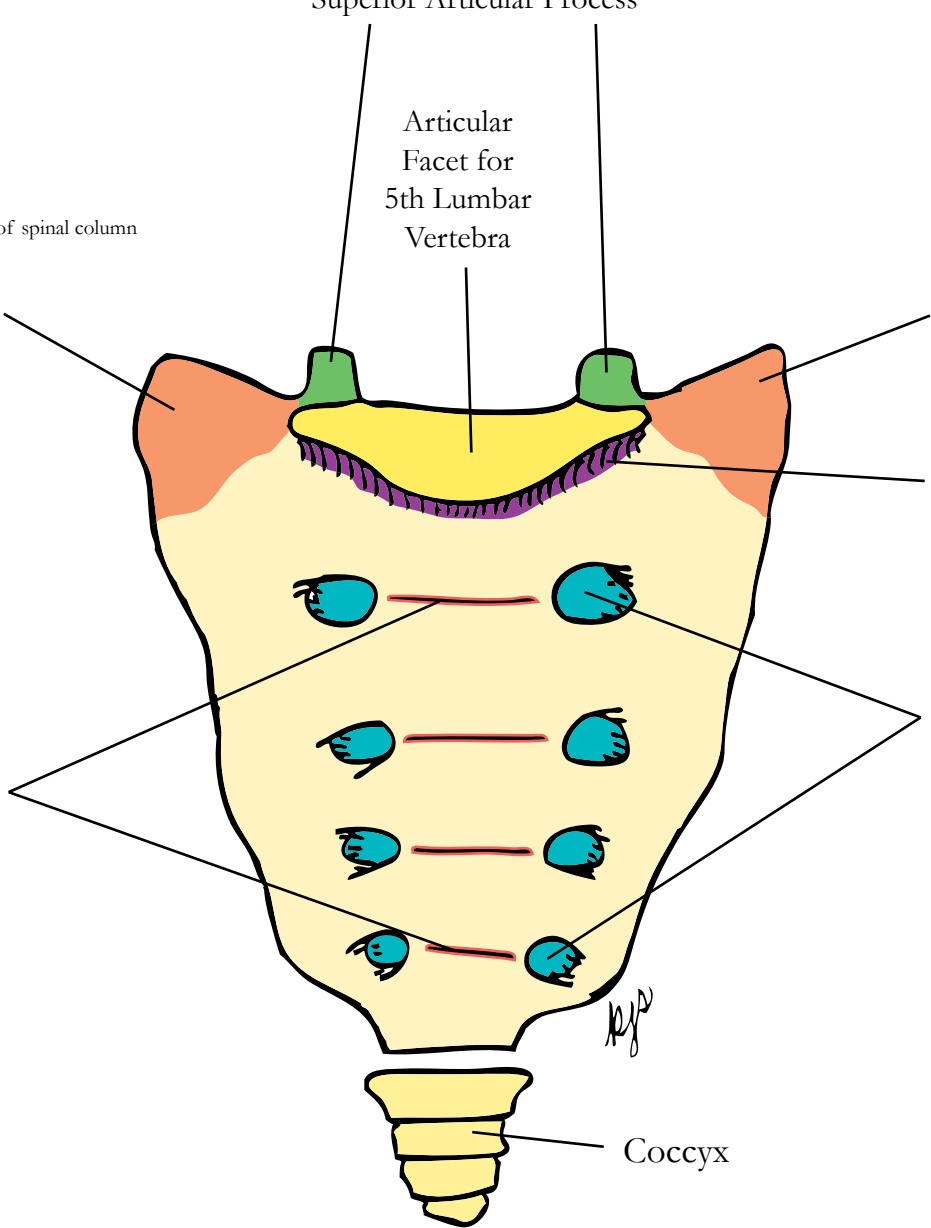
Lateral

Transverse Ridges  
last area in body to  
complete ossification

Anterior Sacral  
Foramina (4 pair)  
allow passage of *ventral rami*  
S-1 through S-4

Coccyx

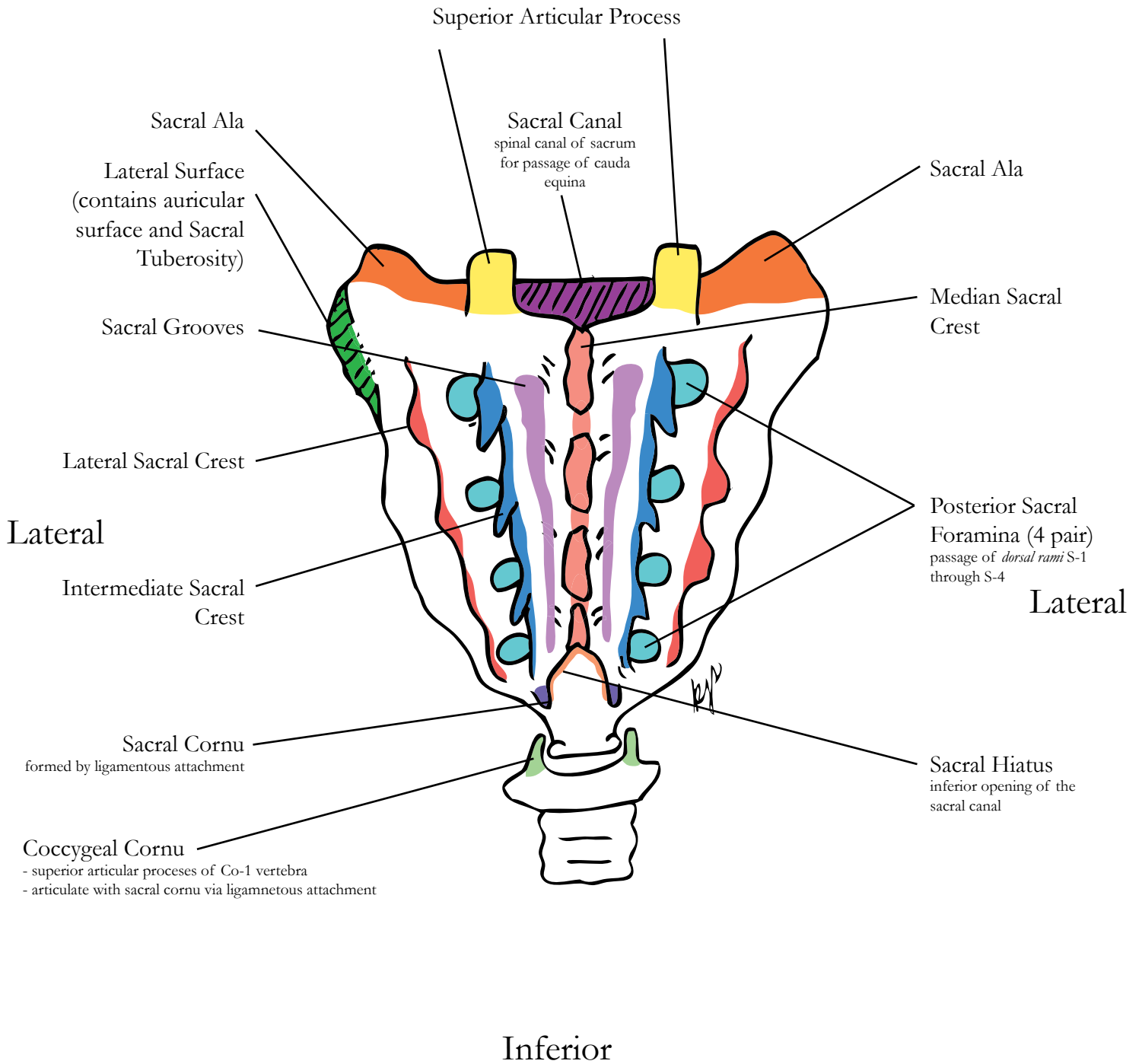
Inferior



# Sacrum and Coccyx

## Posterior View

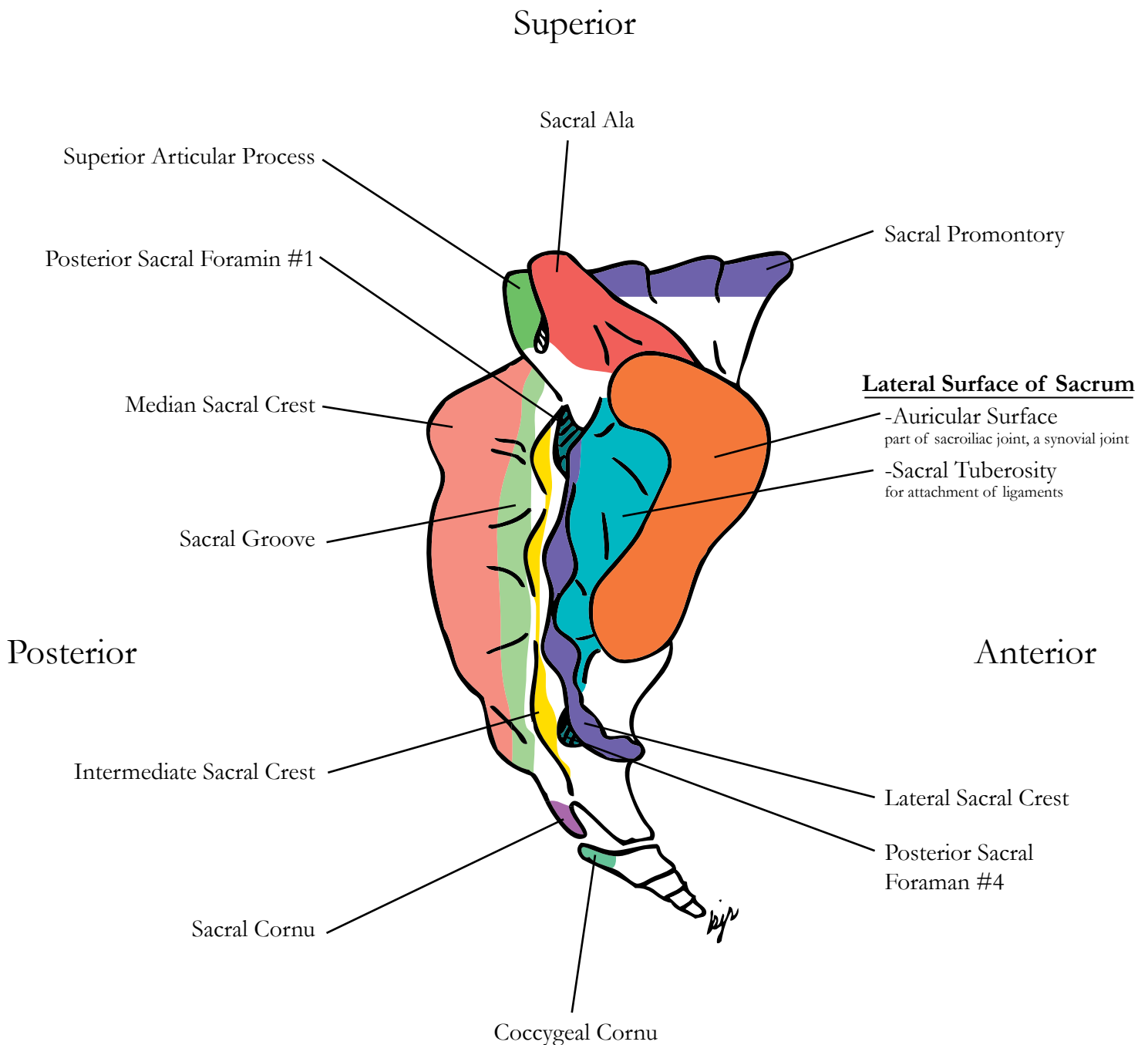
Superior





# Sacrum and Coccyx

## Lateral View



### Ossification of Sacrum

#### Primary Centers of Ossification

- all present at birth
- one in each vertebral body, one in each segment of the lateral masses, one in each of the lamina (around the sacral canal)

#### Secondary Centers of Ossification

- appear between puberty and age 20 years
- all fused by age 25 years except transverse ridges which take until middle age.

# Pelvic Bone (Os Coxa)

## Medial View

Superior

-articulates posteriorly with the lateral surface of the sacrum, anteriorly with the symphyseal surface of the other pelvic bone and laterally with the femoral head

Ilium

Iliac Ala

Anterior

Pubis

Superior Pubic Ramus

Obturator surface - anterior surface at the medial end which spirals to an inferior position at the lateral end and is the continuation of the femoral surface of the body  
Pectineal surface - superior surface - narrow medially, expands laterally

Pubic Body

Symphyseal surface - flattened medial surface  
- articulates with other symphyseal surface at pubic symphysis  
Femoral surface - anterior/external surface (not seen in picture)  
Pelvic surface - posterior/internal surface (not seen in picture)

\*Inferior Pubic Ramus

Iliac Body

Ischial Body

Ischial Body

Femoral surface - external surface (not seen in picture)  
Pelvic surface - internal surface  
Faces medially  
Dorsal surface - posterior surface (not seen in picture)

Posterior

\*Ischial Ramus

Ischium

Ischial Ramus

Anterior Surface - the external surface; faces laterally  
- rough from soft tissue attachment  
Posterior Surface - the internal surface; faces medially  
- smooth area

\*Conjoined Ramus or Ischiopubic Ramus

Inferior

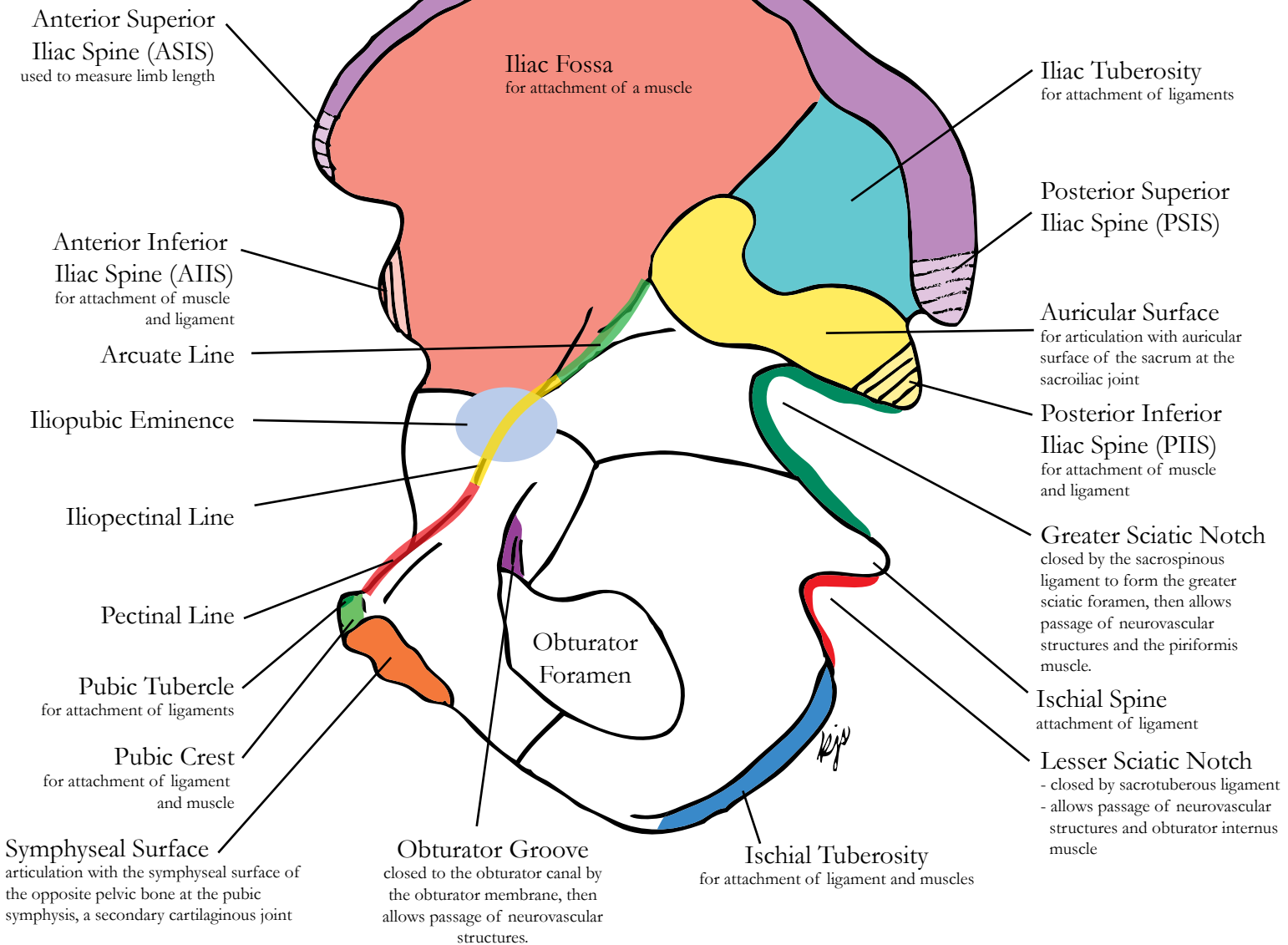
# Sacrum and Coccyx Medial View

Superior

Iliac Crest

Anterior

Posterior



## Linea Terminalis

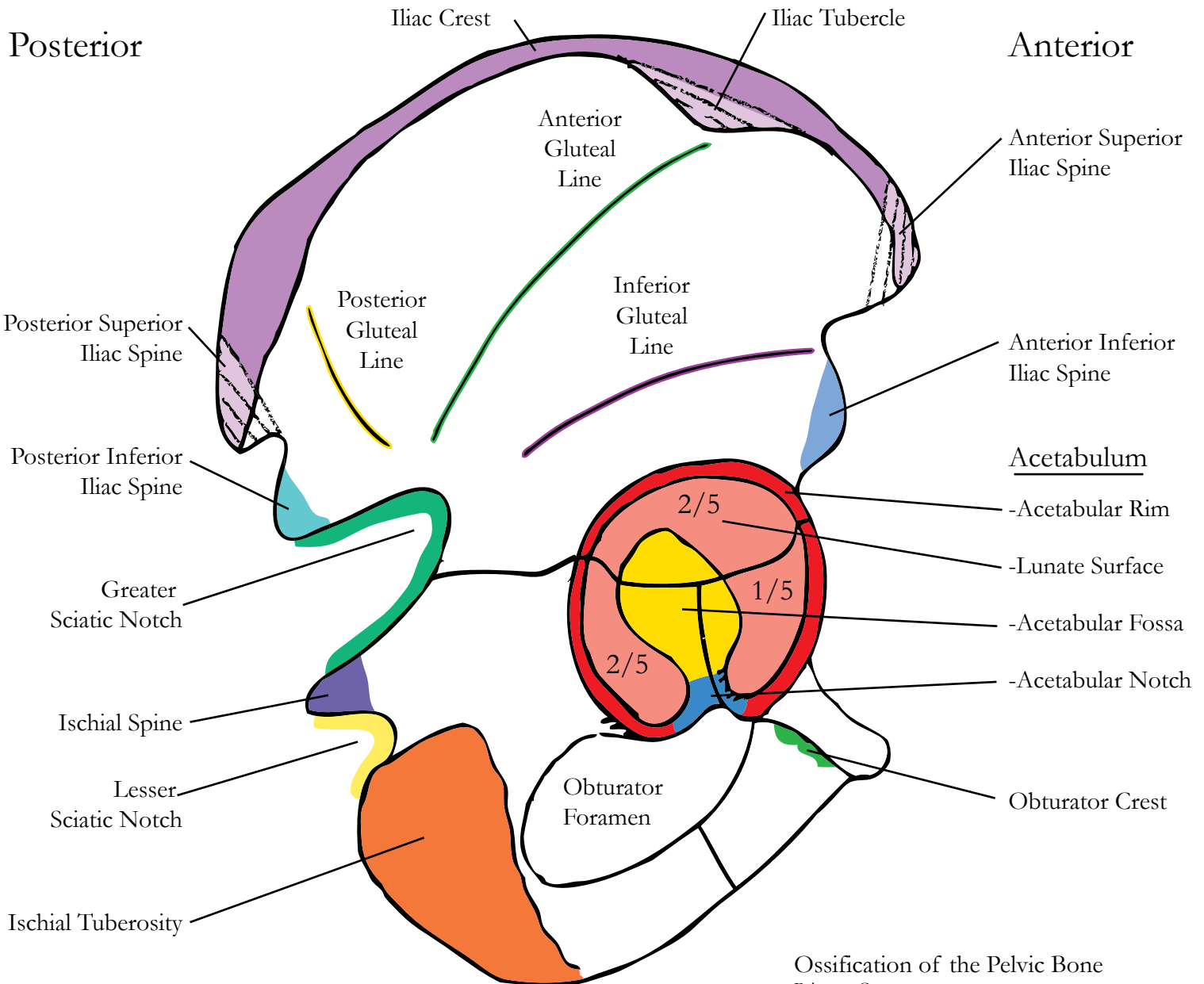
- continuous line of the lateral and anterior walls of the pelvis, internally
- formed by four separate structures that align end to end
  - Arcuate Line
  - Iliopectineal Line
  - Pectineal Line/Pecten Pubis
  - Pubic Crest

Inferior

# Os Coxa

## Lateral View

Superior



### Greater Pelvis / False Pelvis

- pelvic area superior to the pelvic brim
- formed primarily by the iliac alae

### Lesser Pelvis / True Pelvis

- pelvic area inferior to the pelvic brim
- formed by the pubic bones, ischial bones, iliac bodies, sacrum and coccyx

### Pelvic Outlet

- inferior opening (exit) of the true pelvis
- generally larger in females for childbirth

Inferior

### Ossification of the Pelvic Bone

#### Primary Centers

- Ilium - appears near **9th fetal week** in the iliac ala
- ischium - appears early **4th fetal month** in the ischial body
- pubis - appears late 4th fetal month in the superior pubic ramus

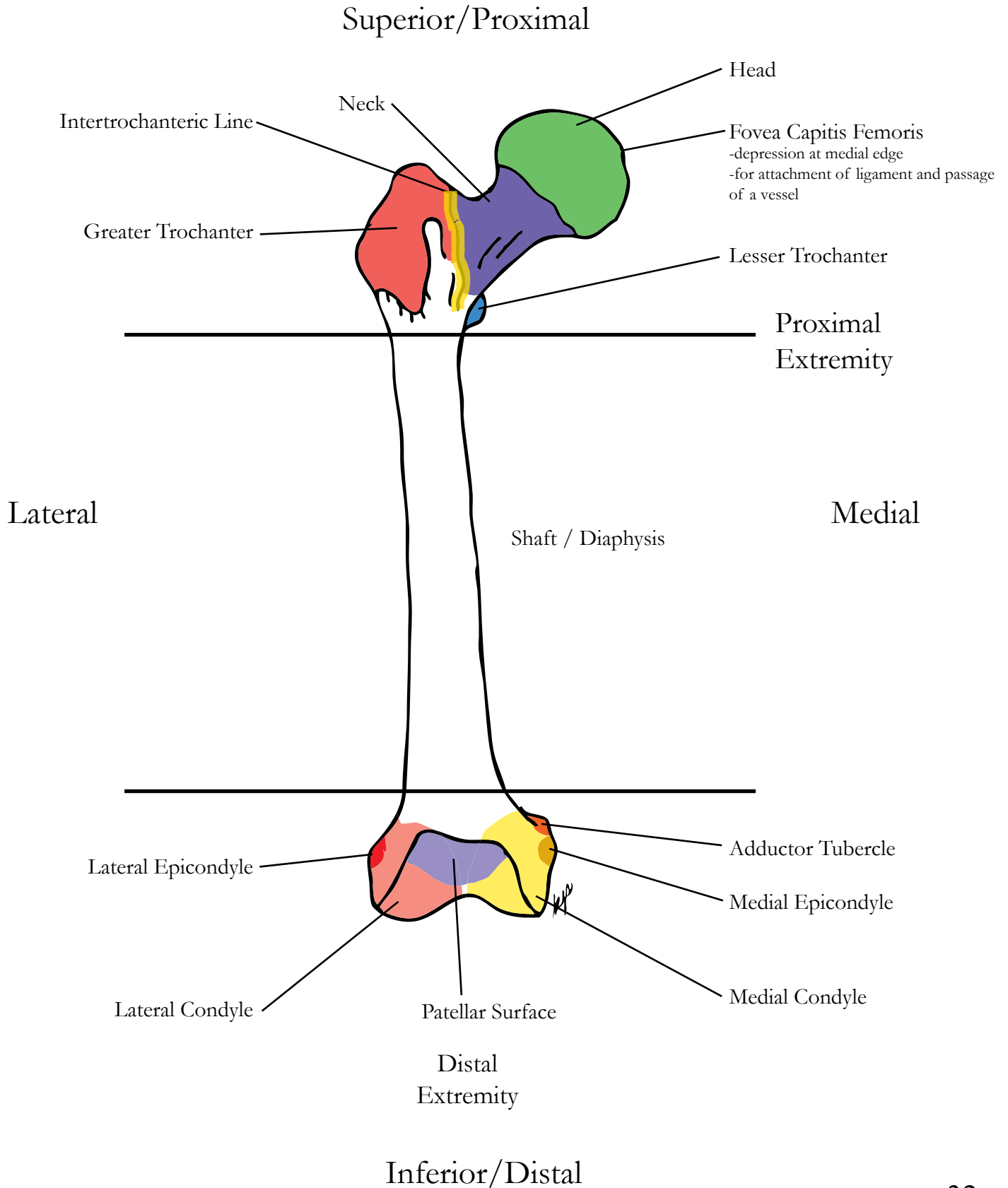
#### Secondary Centers

appear near puberty and fuse from ages 15 - 25 years

- iliac crest
- acetabulum
- pubic body
- ischial tuberosity

# Femur

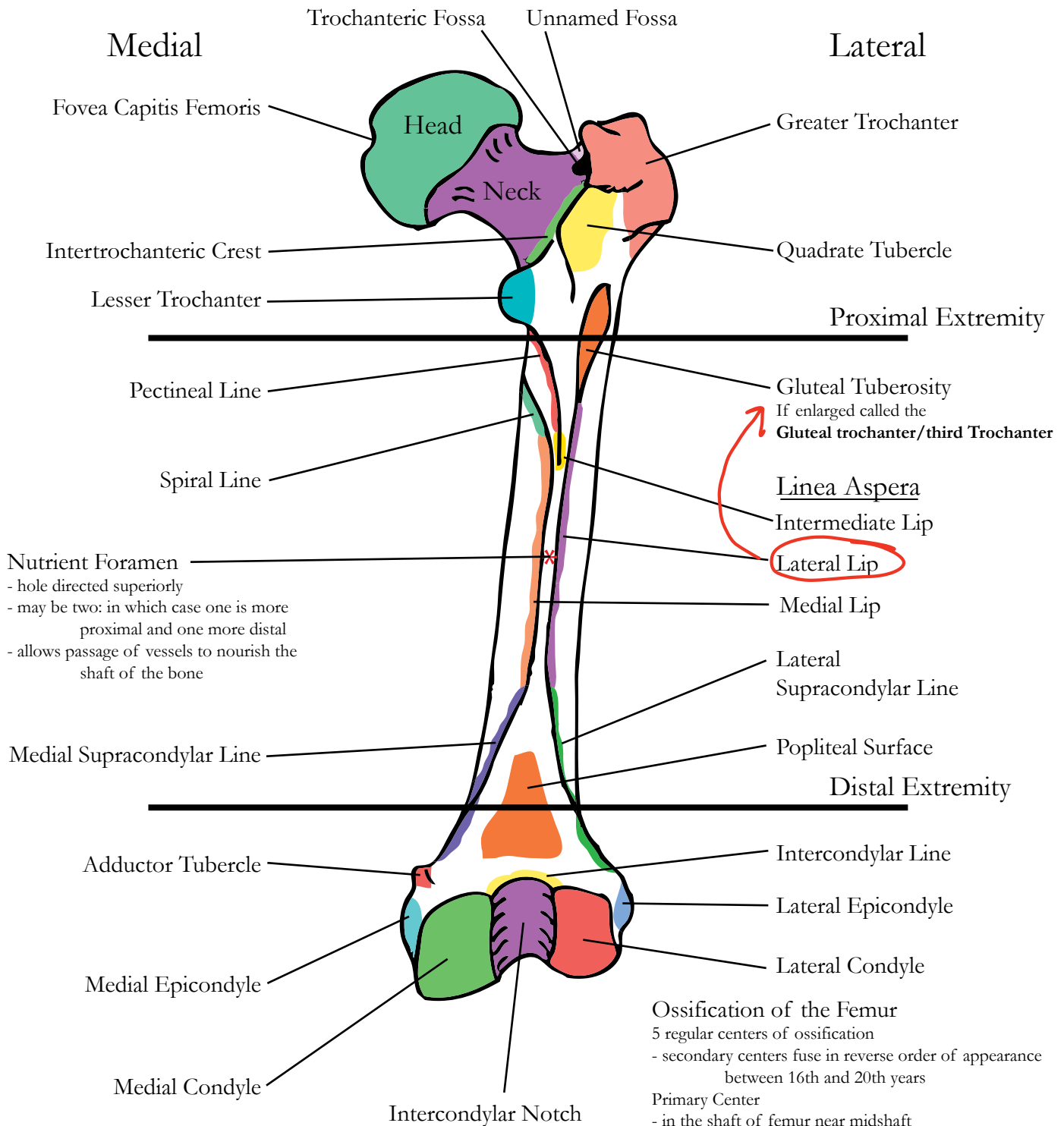
## Anterior View



# Femur

## Posterior View

### Superior/Proximal



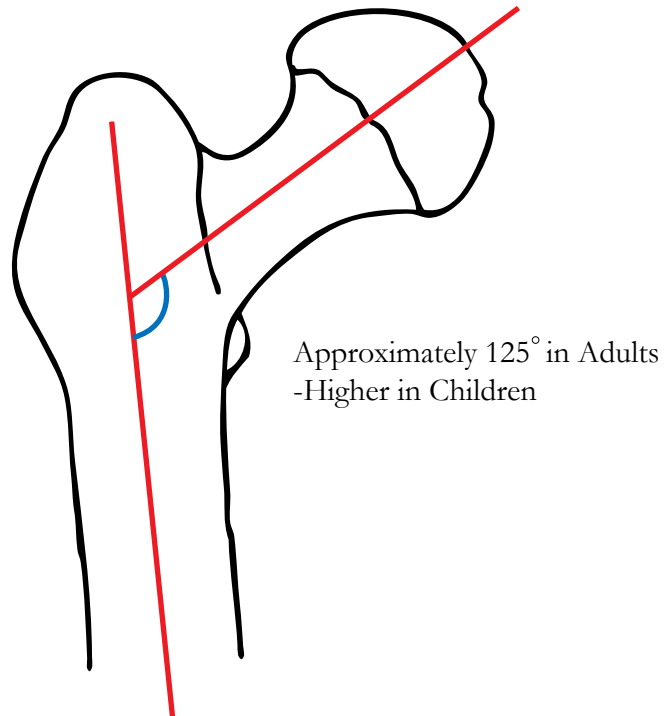
**Ossification of the Femur**  
 5 regular centers of ossification  
 - secondary centers fuse in reverse order of appearance between 16th and 20th years

**Primary Center**  
 - in the shaft of femur near midshaft  
 - appears during the 7th fetal week

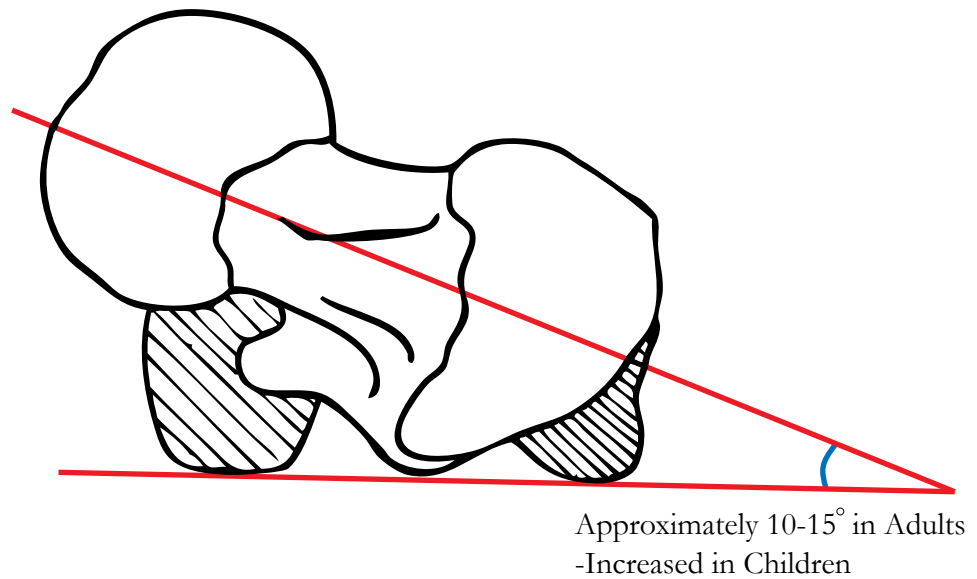
**Secondary Centers**  
 - femoral condyles - appears near birth, may be one or two  
 - head of the femur - appears by the 1st year  
 - greater trochanter - appears between the 4th and 5th years  
 - lesser trochanter - appears between the 12th and 14th years



## Angle of Inclination



## Angle of Declination (Angle of Femoral Torsion)

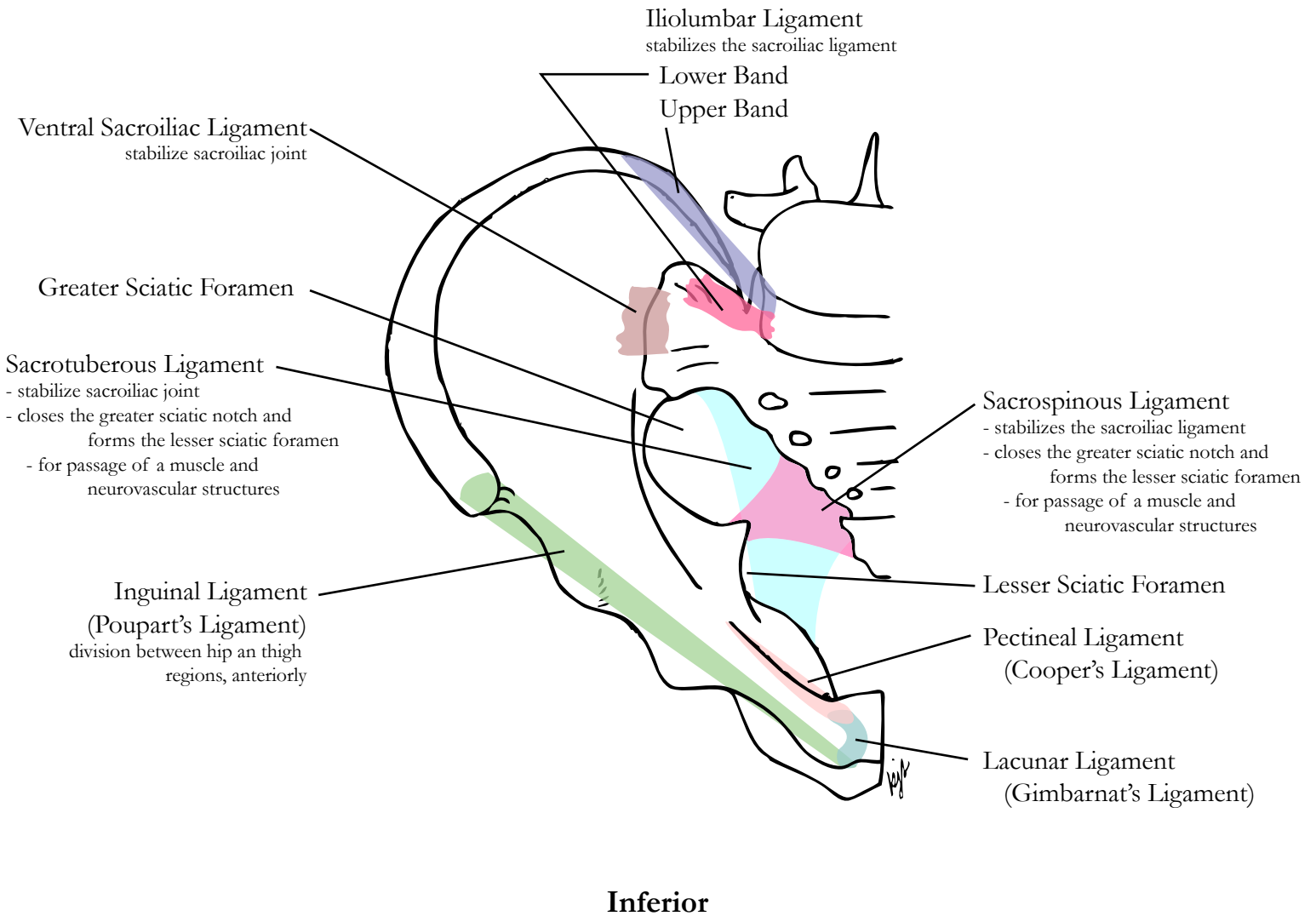


# Pelvis - Anterior View

Superior

Lateral

Medial



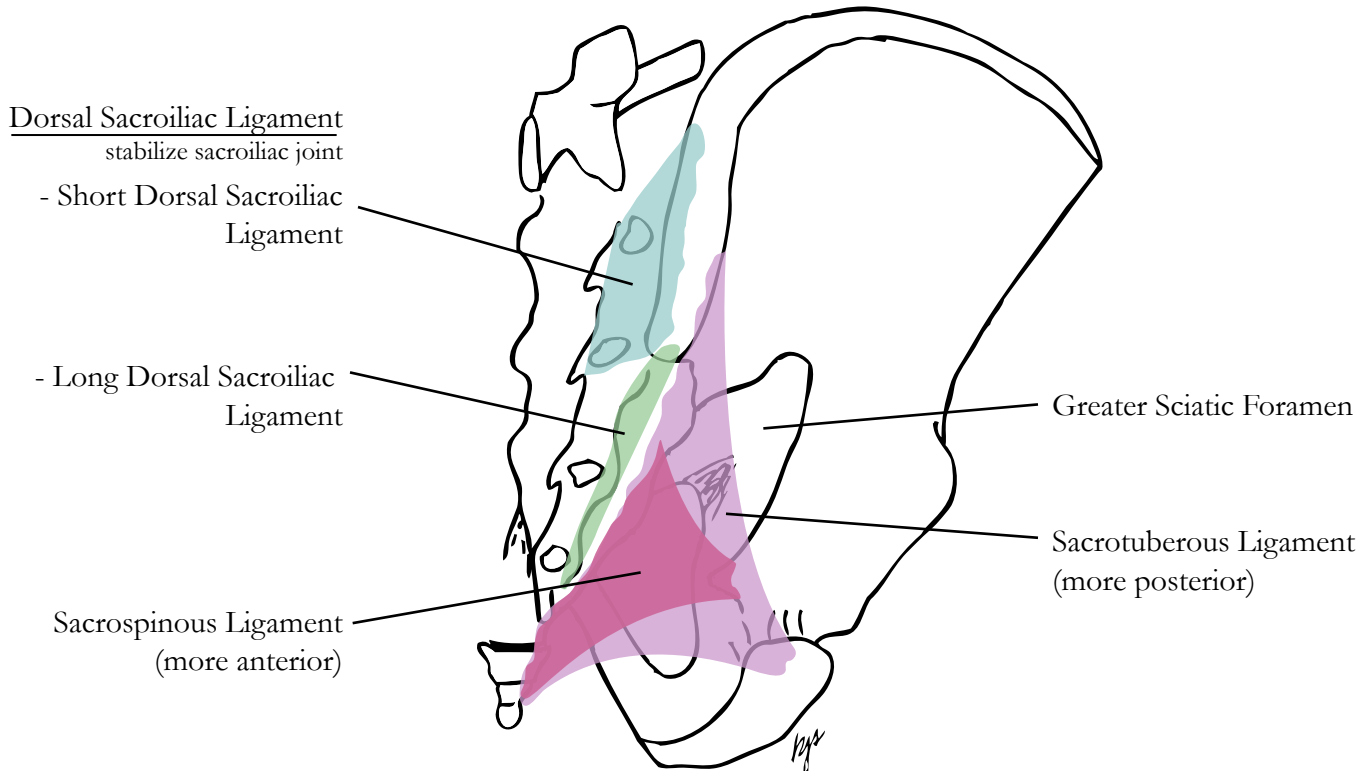
Inferior

# Pelvis - Posterior View

Superior

Medial

Lateral

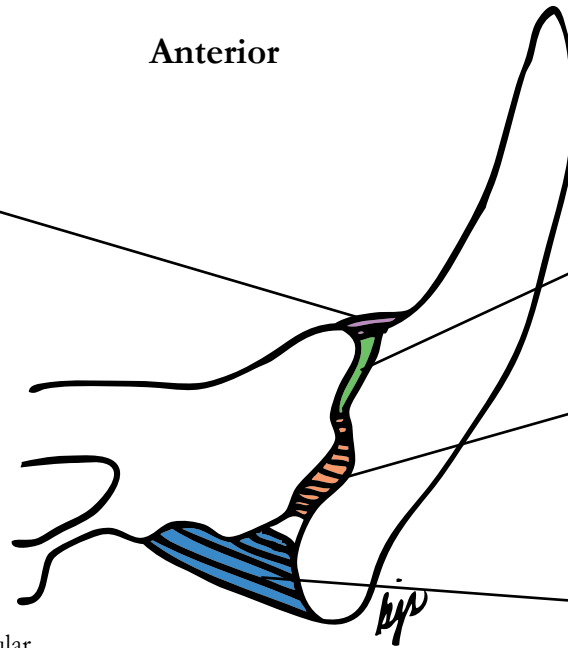


Inferior

# Sacroiliac Joint - Cross Section

Anterior

- Ventral Sacroiliac Ligament
- thickening of anterior joint capsule
  - reinforces joint anteriorly
  - intrinsic ligament



Sacroiliac Joint

Interosseous Sacroiliac Ligament

- very thick and strong ligament
- stabilizes sacroiliac joint
- extrinsic ligament

Dorsal Sacroiliac Ligament

- separated from joint capsule by interosseous ligament
- reinforces joint posteriorly
- extrinsic ligament

Sacroiliac Joint

- articulation between iliac and sacral auricular surfaces at vertebral levels S-1 through S-3
- articular surfaces covered by fibrocartilage (not hyaline), adhesions form with aging
- structural synovial planar joint
- functional diarthrosis

Posterior

# Pubic Symphysis - Anterior View

Superior

Superior Pubic Ligament

- stabilizes pubic symphysis superiorly

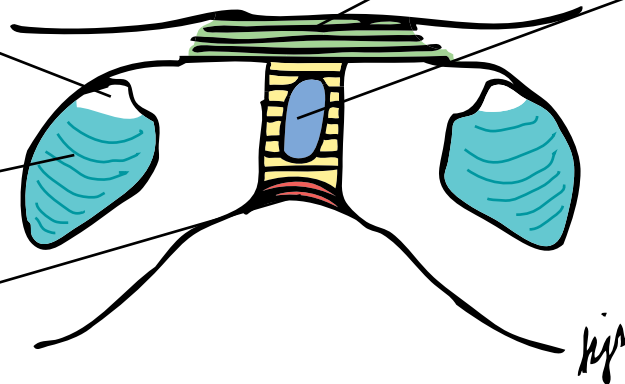
Interpubic Disc

- pad of fibrocartilage

Obturator Canal

Obturator Membrane

Arcuate Pubic Ligament  
stabilizes pubic symphysis



Pubic Symphysis / Symphysis Pubis

- articulation between symphyseal surfaces of pubic bodies
- symphyseal surfaces are covered with hyaline cartilage that blends with interpubic disc
- provides partial attachment for some thigh muscles
- structural fibrous syndesmosis
- functional amphiarthrosis

Inferior

# Pelvic Region Anterior View

## Psoas Major Muscle

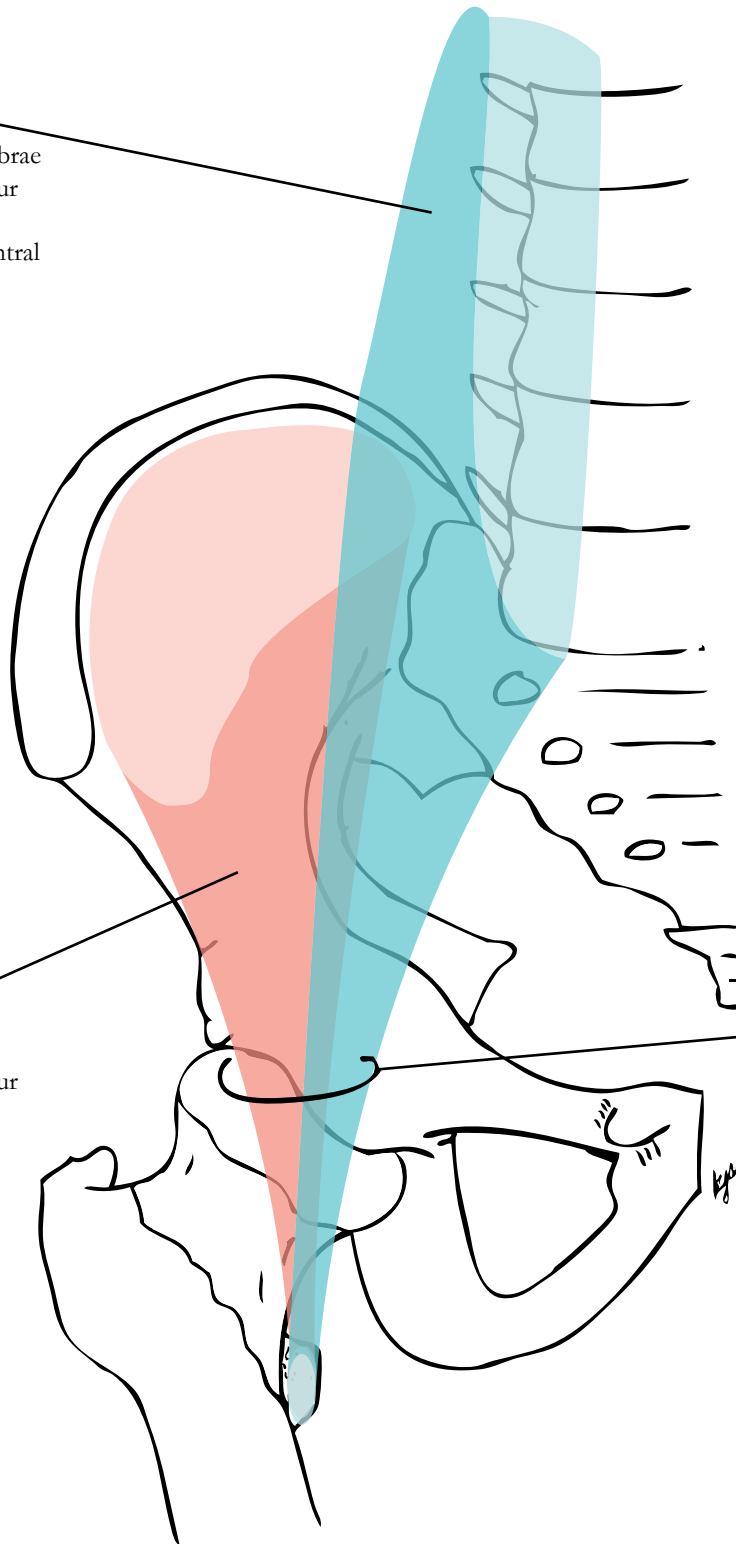
O: T-12 through L-5 vertebrae  
 I: lesser trochanter of femur  
 A: flexes thigh  
 NS: dorsal divisions of ventral rami L-2, L-3 & L-4  
 AS: common, internal and external iliac arteries

## Iliacus Muscle

O: superior iliac fossa  
 I: lesser trochanter of femur  
 A: flexes thigh  
 NS: femoral nerve; from dorsal divisions of ventral rami L-2, L-3 & L-4  
 AS: common, internal and external iliac arteries

## Iliopsoas Muscle

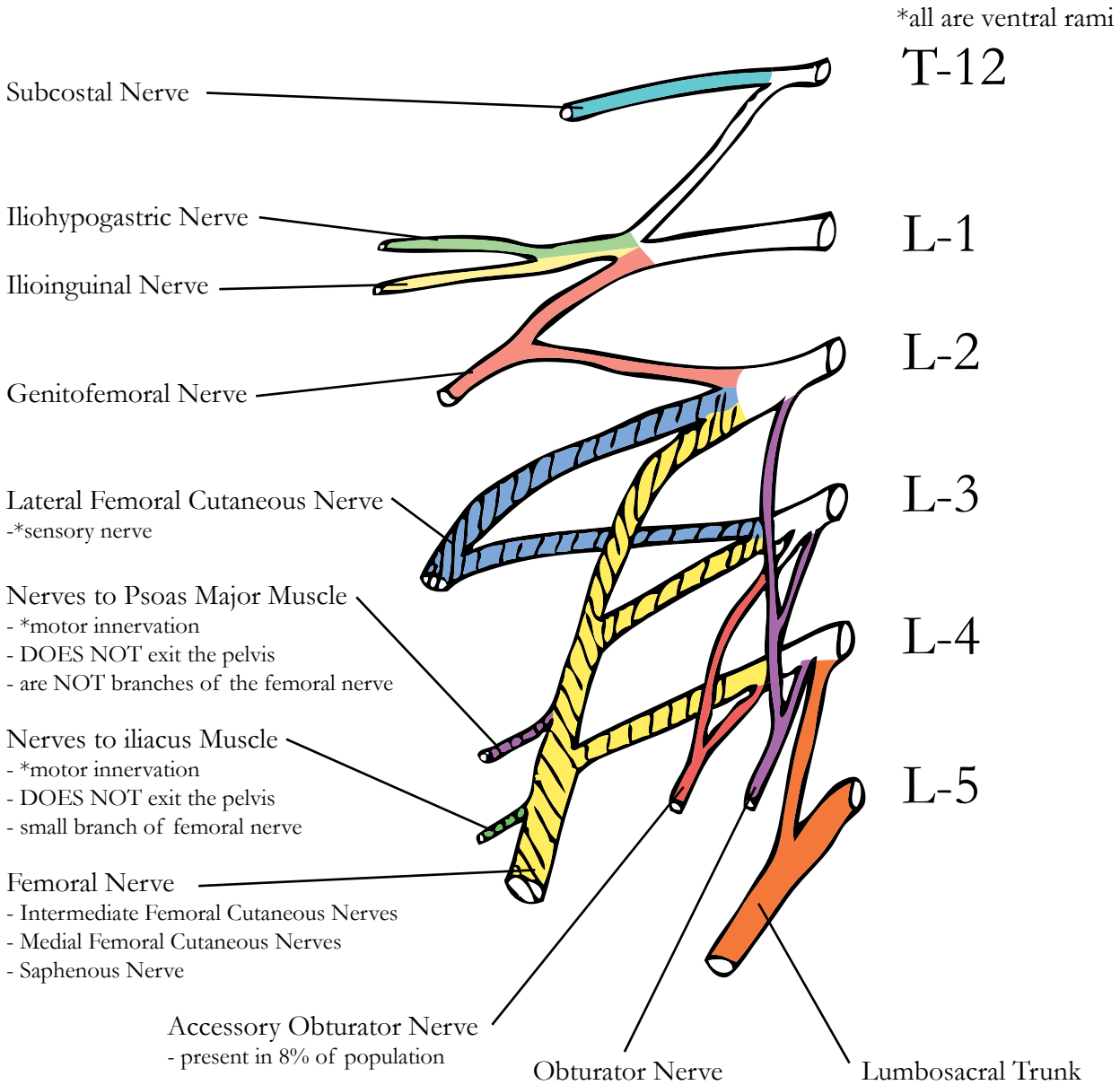
-combination of iliacus muscle and psoas major muscle



## **Unit 4**

# **Pelvic Regions**

# Lumbar Plexus



\*all are sensorimotor nerves unless otherwise noted.

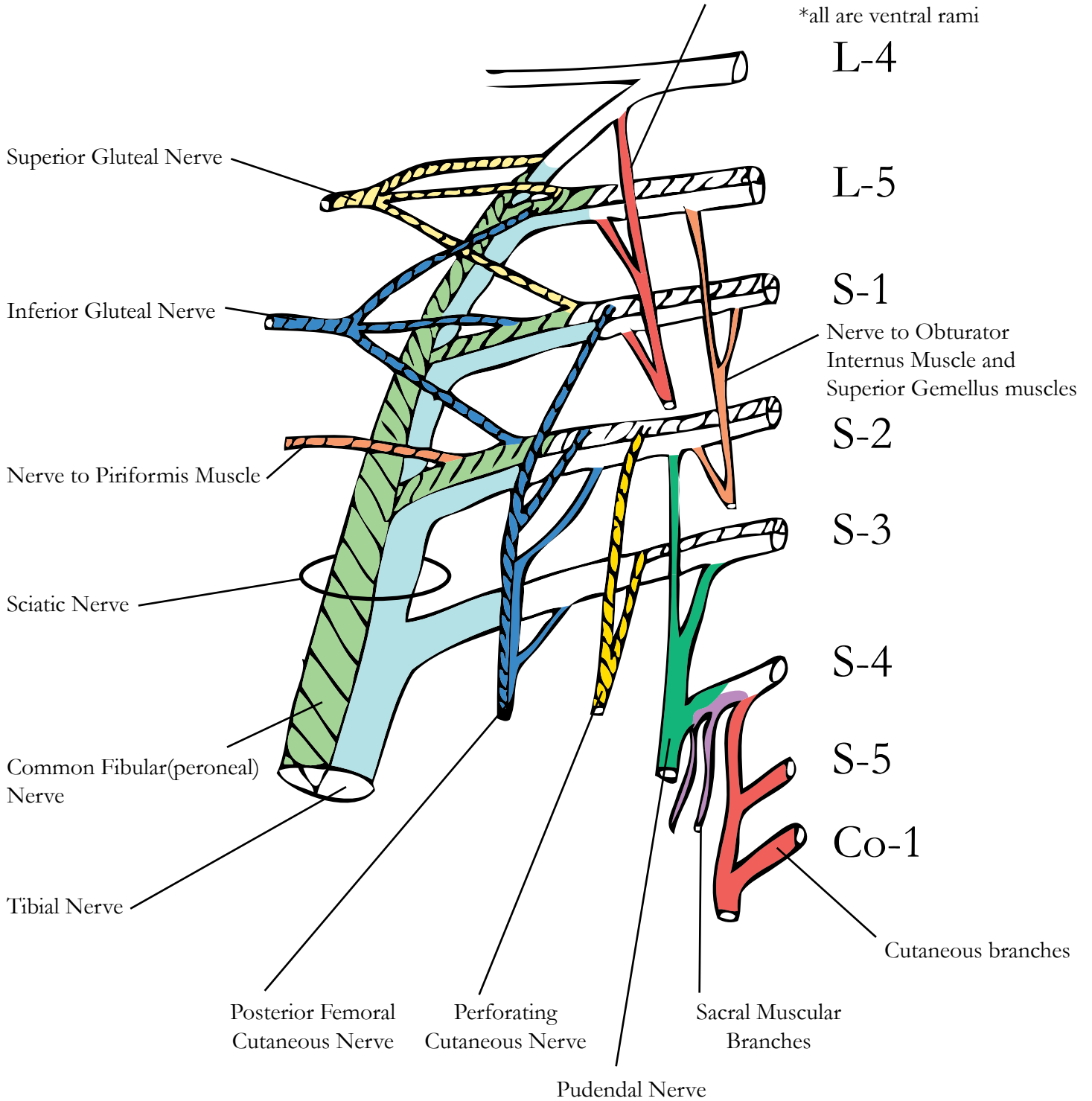
- Shaded - dorsal division

- Rami L-1 through L-3 with contributions from ventral rami of T-12 and L-4

- lies within the psoas major muscle just anterior to transverse processes of vertebral bodies

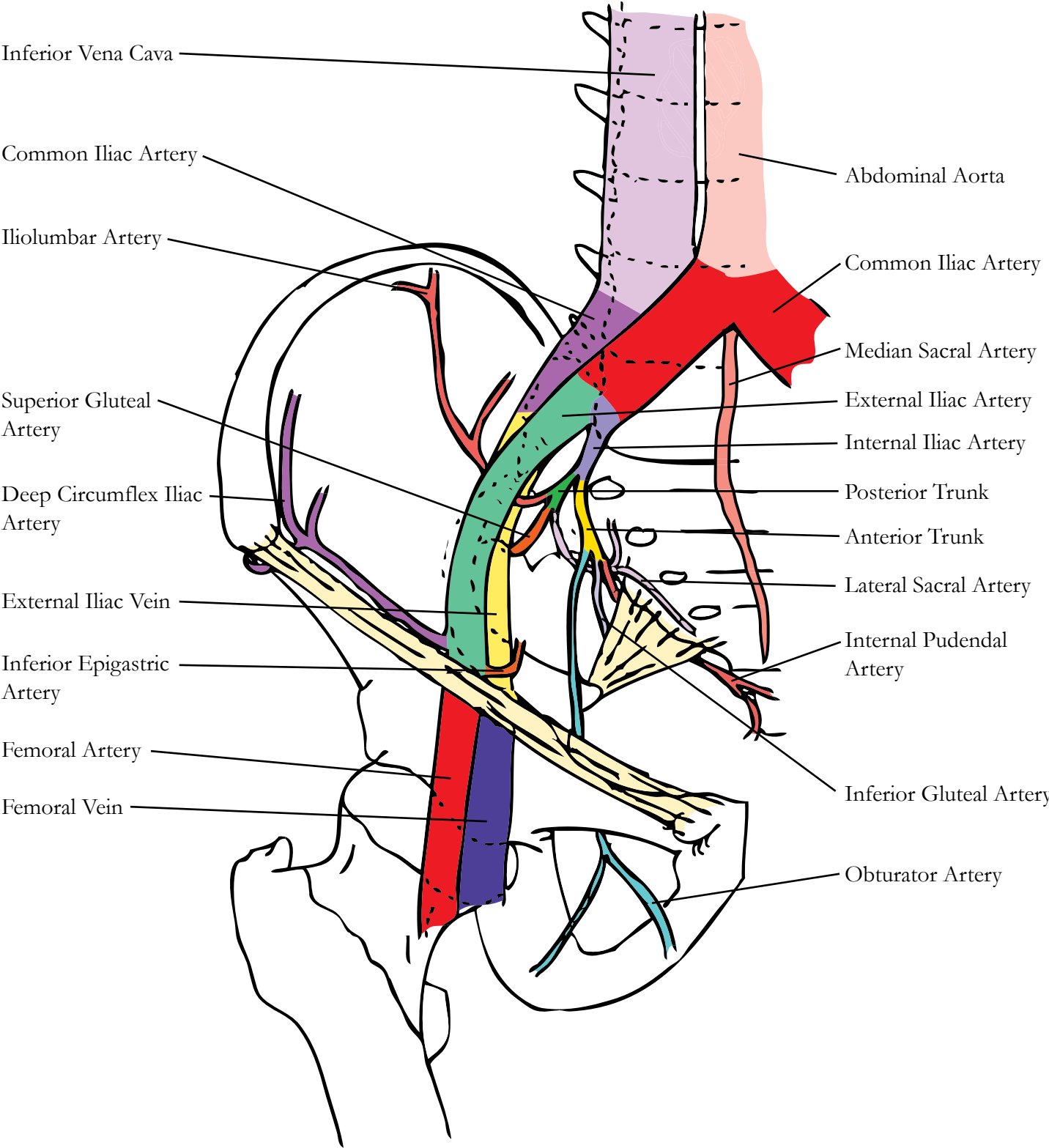
# Sacrococcygeal Plexus

Nerve to Quadratus Femoris  
and Inferior Gemellus Muscles

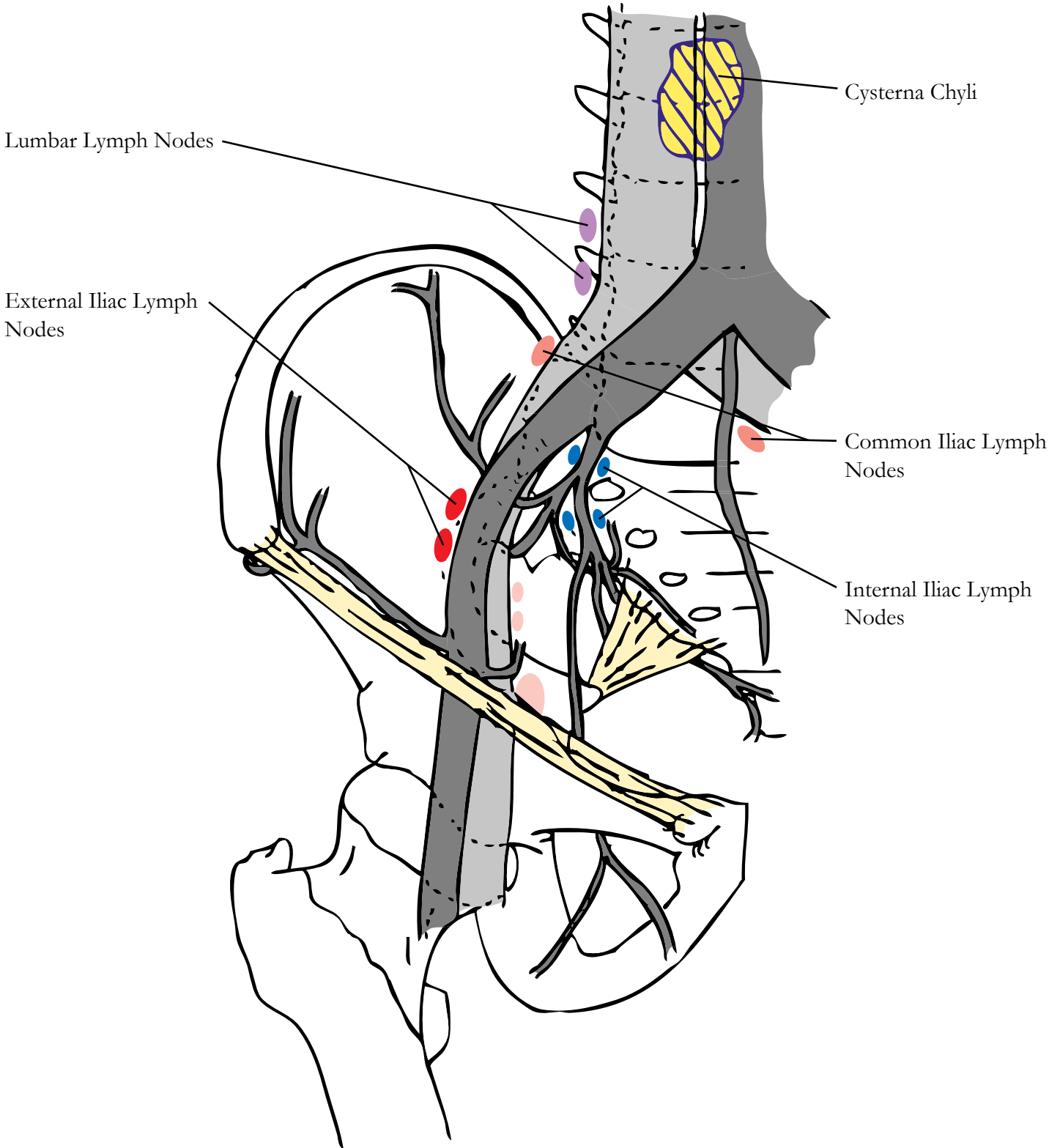




# Pelvic Vessels - Anterior View

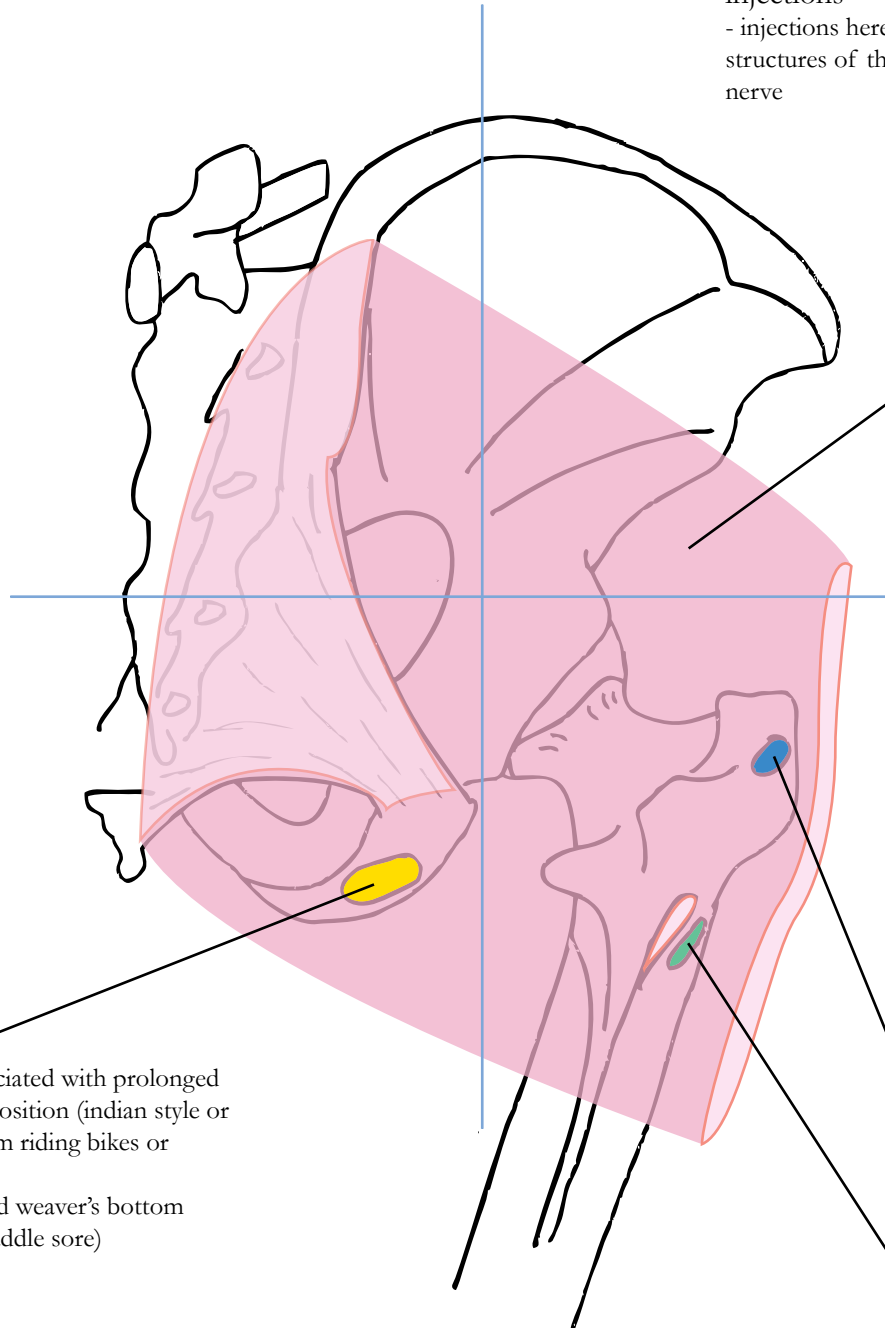


# Pelvic Lymph - Anterior View



# Gluteal Region - Posterior View

Quadrant for intramuscular Gluteal injections  
 - injections here to miss major neurovascular structures of this region, especially the Sciatic nerve



## Gluteus Maximus Muscle

O: external iliac ala posterior to posterior gluteal line, the poster crest, external surfaces of the sacrum and coccyx. sacrotuberous ligament  
 I: gluteal tuberosity of femur and posteriosuperior iliotibial tract  
 A: extends & laterally rotates thigh  
 NS: inferior gluteal nerve; dorsal divisions of ventral rami L-5, S-1 & S-2  
 AS: superior gluteal artery, inferior gluteal artery and the perforating branches of the profunda femoris artery

## Ischial Bursa

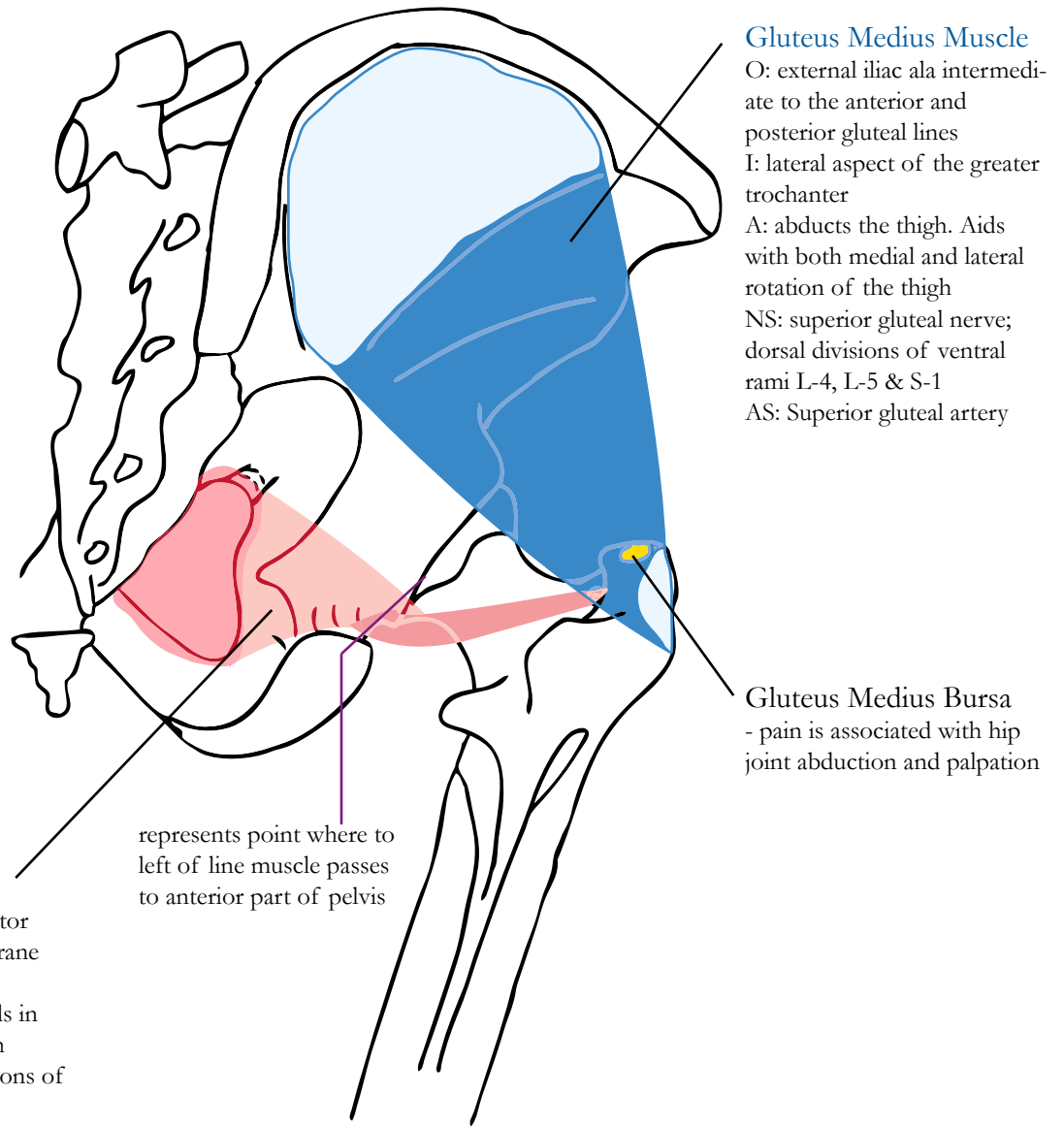
- inflammation associated with prolonged sitting in the tailor position (indian style or cross-legged) or from riding bikes or horses
- inflammation called weaver's bottom (sometimes called saddle sore)
- painful with sitting

## Trochanteric bursa

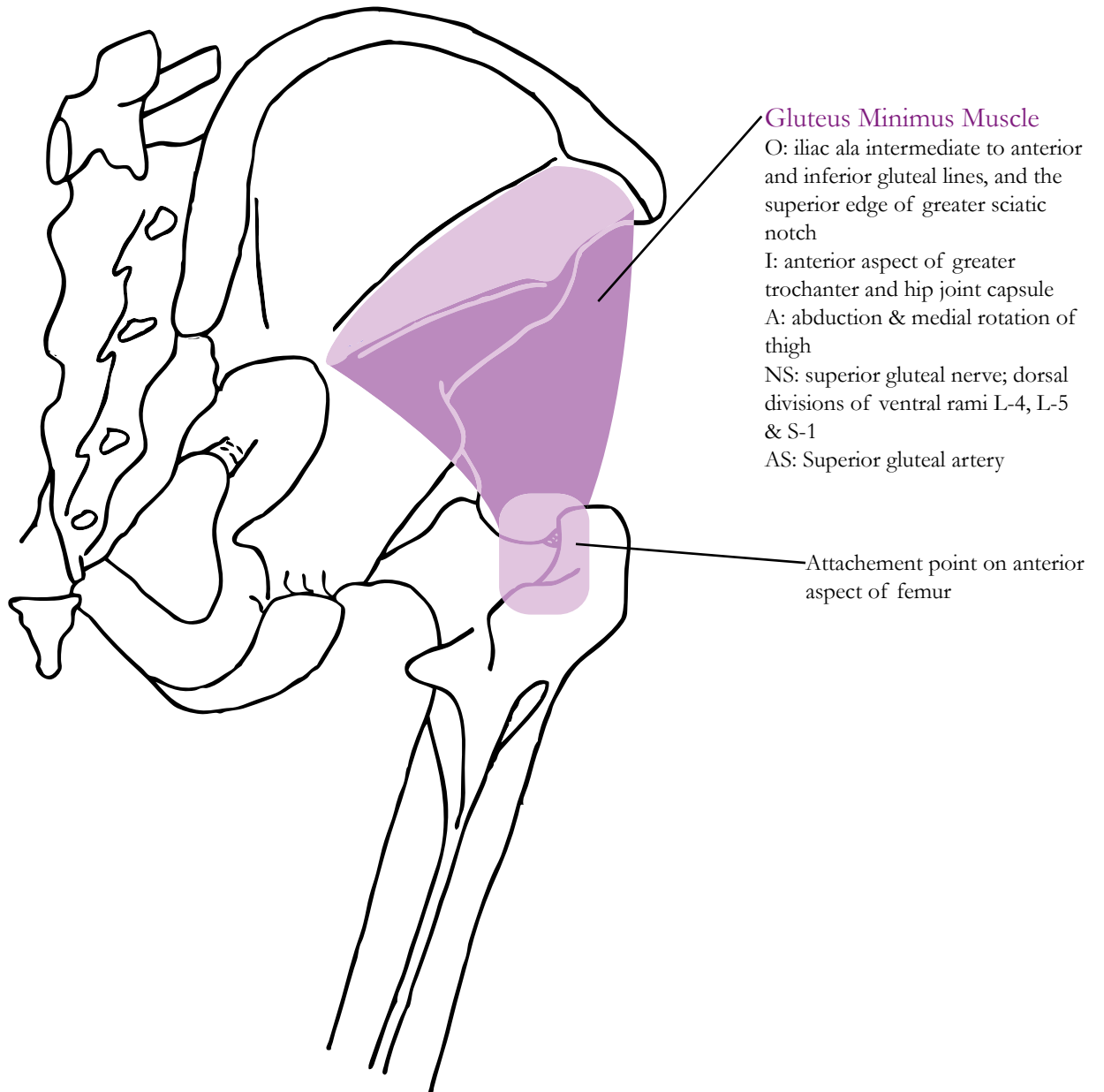
- inflammation called bursitis of the hip
- painful with extension or lateral rotation of thigh when inflamed

## Gluteofemoral bursa

# Gluteal Region - Posterior View



# Gluteal Region - Posterior View



# Gluteal Region Posterior View

## Piriformis Muscle

- O: pelvic surface of the sacrum (S-2, S-3, S-4)  
 I: superior aspect of the greater trochanter  
 - exits pelvis via greater sciatic foramen  
 A: lateral rotation of the thigh; assists in abduction and extension of the thigh  
 NS: **dorsal division** of S-2 ventral ramus (nerve to piriformis muscle)  
 AS: superior and inferior gluteal arteries

## Superior Gemellus Muscle

- O: ischial spine and superior edge of lesser sciatic notch  
 I: anterior fossa (unnamed)  
 A: lateral rotation of the thigh  
 NS: nerve to obturator internus & superior gemellus muscles  
 AS: inferior gluteal artery

## Inferior Gemellus Muscle

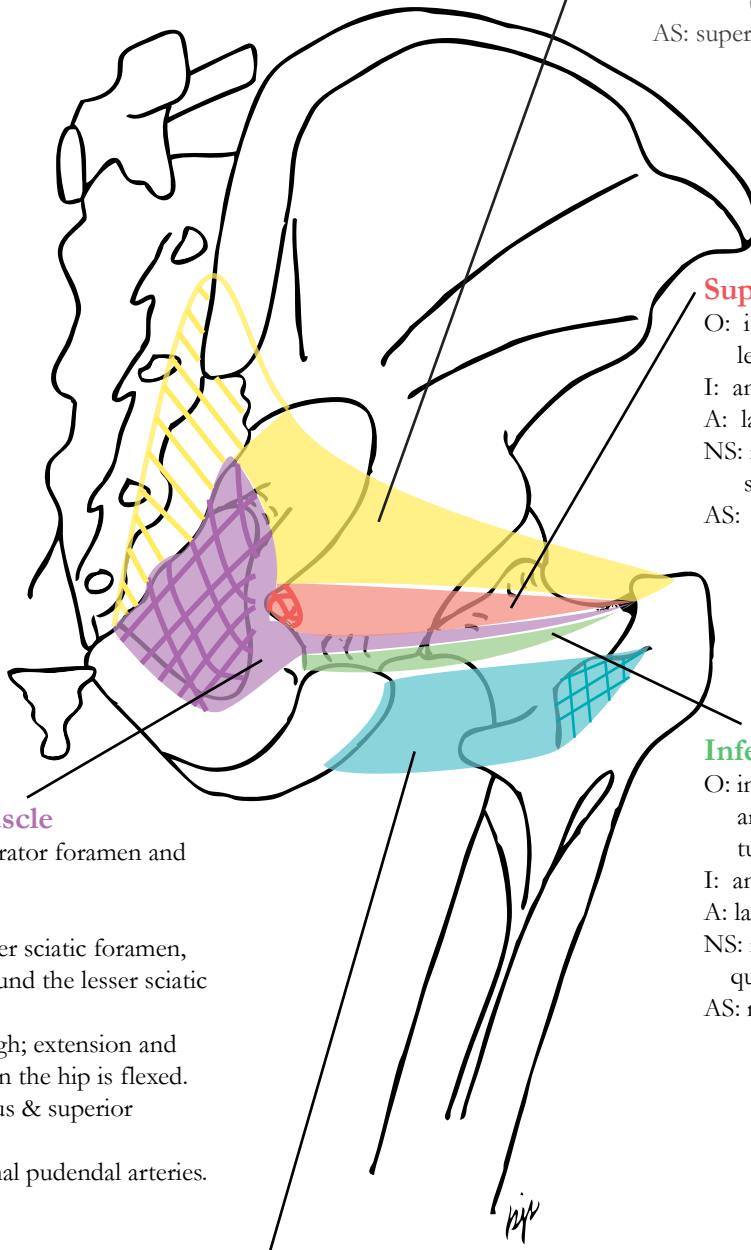
- O: inferior margin of lesser sciatic notch and superior border of ischial tuberosity  
 I: anterior fossa (unnamed)  
 A: lateral rotation of the thigh  
 NS: nerve to inferior gemellus & quadratus femoris muscles  
 AS: medial femoral circumflex artery

## Obturator Internus Muscle

- O: pelvic surfaces of the obturator foramen and obturator membrane  
 I: anterior fossa (unnamed)  
 - exit the pelvis via the lesser sciatic foramen, then angles anteriorly around the lesser sciatic notch.  
 A: external rotation of the thigh; extension and abduction of the thigh when the hip is flexed.  
 NS: nerve to obturator internus & superior gemellus muscles  
 AS: superior gluteal and internal pudendal arteries.

## Quadratus Femoris Muscle

- O: external border of the ischial tuberosity  
 I: quadrate tubercle of the femur  
 A: lateral rotation of the thigh  
 NS: nerve to inferior gemellus & quadratus femoris muscles  
 AS: medial femoral circumflex artery

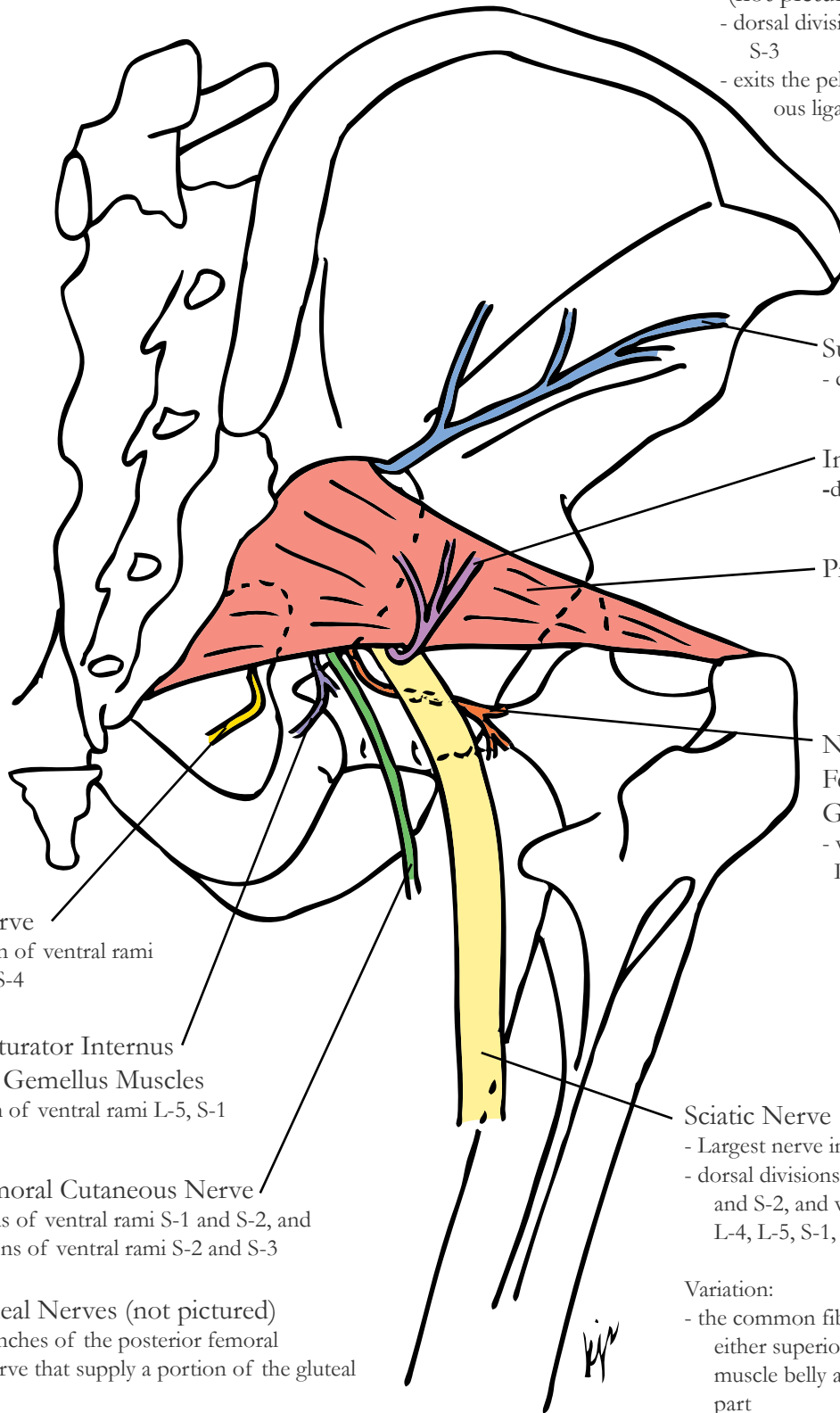


# Gluteal Region - Nerves

## Posterior View

Perforating Cutaneous Nerve  
(not pictured)

- dorsal divisions of ventral rami S-2 and S-3
- exits the pelvis by piercing the sacrotuberous ligament, usually near the sacrum
- refer to picture page 17



Superior Gluteal Nerve  
- dorsal divisions of ventral rami L-4, L-5 and S-1

Inferior Gluteal Nerve  
-dorsal division of ventral rami L-5, S-1, and S-2

Piriformis Muscle

Nerve to Quadratus Femoris and Inferior Gemellus Muscles  
- ventral divisions of ventral rami L-4, L-5 and S-1

Pudendal Nerve  
- ventral division of ventral rami S-2, S-3, and S-4

Nerve to Obturator Internus and Superior Gemellus Muscles  
- ventral division of ventral rami L-5, S-1 and S-2

Posterior Femoral Cutaneous Nerve  
- dorsal divisions of ventral rami S-1 and S-2, and ventral divisions of ventral rami S-2 and S-3

Inferior Cluneal Nerves (not pictured)  
- cutaneous branches of the posterior femoral cutaneous nerve that supply a portion of the gluteal region skin  
- arise near the proximal end and pass along the deep surface of the gluteus maximus muscle, then pass around its inferior edge to the skin.

Sciatic Nerve

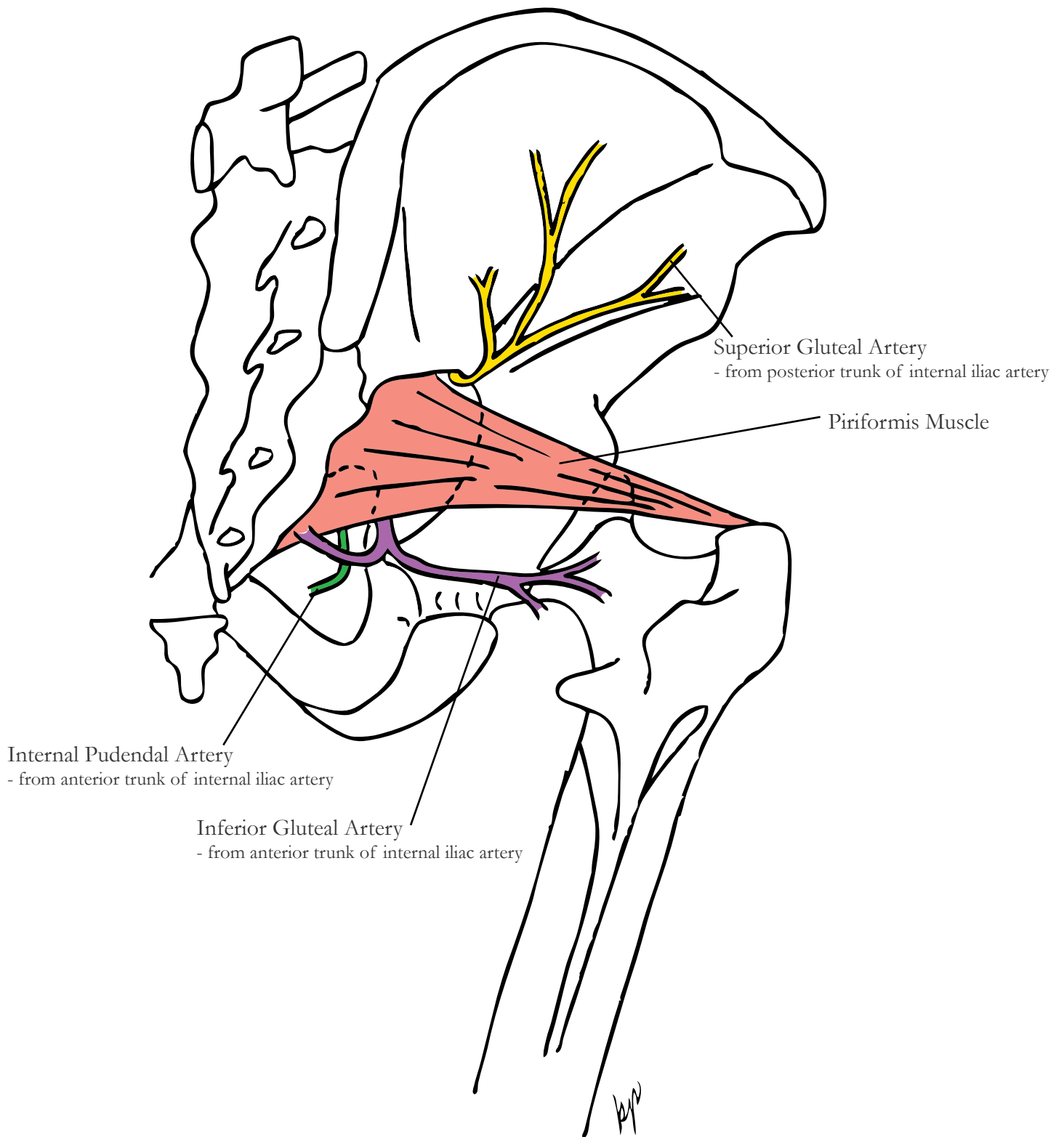
- Largest nerve in the body
- dorsal divisions of ventral rami L-4, L-5, S-1 and S-2, and ventral divisions of ventral rami L-4, L-5, S-1, S-2 and S-3

Variation:

- the common fibular part may exit the pelvis either superior to or through the piriformis muscle belly and the course with the tibial part
- when this occurs, the sciatic nerve has split into its component parts already

# Gluteal Region - Arteries

## Posterior View





# Hip Joint - Ligaments

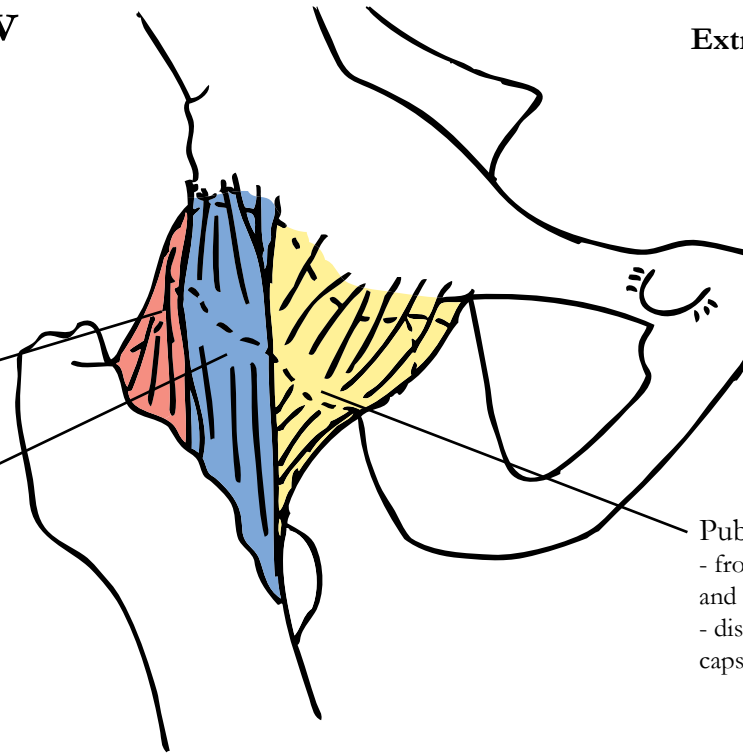
## Anterior View

Iliofemoral ligament  
(Ligament of Bigelow)  
- from inferior part anterior  
inferior iliac spine and iliac part of  
acetabular rim  
- one of strongest ligaments in  
body

- Upper Band
- to superior part femoral intertrochanteric line
- Lower Band
- to inferior part femoral intertrochanteric line

## Extracapsular Ligaments

Pubofemoral Ligament  
- from pubic part of acetabular rim  
and lateral superior pubic ramus  
- distally blends with hip joint  
capsule medially



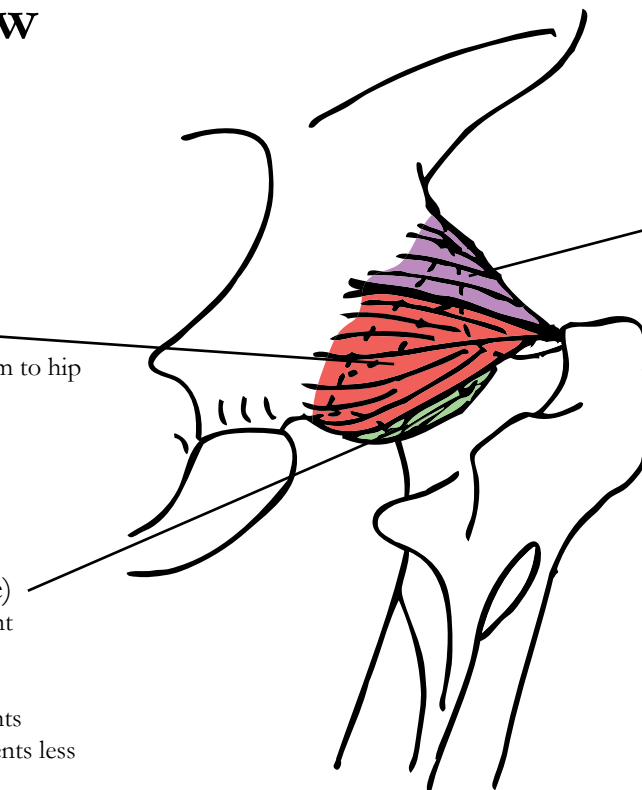
## Posterior View

Ischiofemoral Ligament  
- from ischial part of acetabular rim to hip  
joint capsule posteriorly

Iliofemoral Ligament  
- from the iliac part of acetabular  
rim to superior part of femoral  
intertrochanteric line

## Intracapsular Ligaments

Zona Orbicularis (of capsule)  
- thickened constricted area of joint  
around femoral neck  
- fibers pass circularly  
- ligament with no bony attachments  
- visible posteriorly because ligaments less  
prominent



# Hip Joint - Cross Section

## Acetabular Labrum

- pad of fibrocartilage attached to acetabular rim
- function - deepens the joint to allow better fit between the bone ends

## Fibrous Joint Capsule

- from exterior rim of acetabulum to femoral neck, anteriorly at intertrochanteric line

## Zona Orbicularis

- thickened circular fibers of joint capsule at neck of femur

## Retinacula

- longitudinal capsular fibers that reflect superiorly along the femoral neck
- allow passage of blood vessels from capsule and synovium to femoral head

## Synovium (dashed lines)

- lines all structures within joint capsule except bony articular surfaces
- part that lines retinacula are raised into folds and vessels pass through these

## Medial (*lateral*) Femoral Circumflex Artery (not pictured)

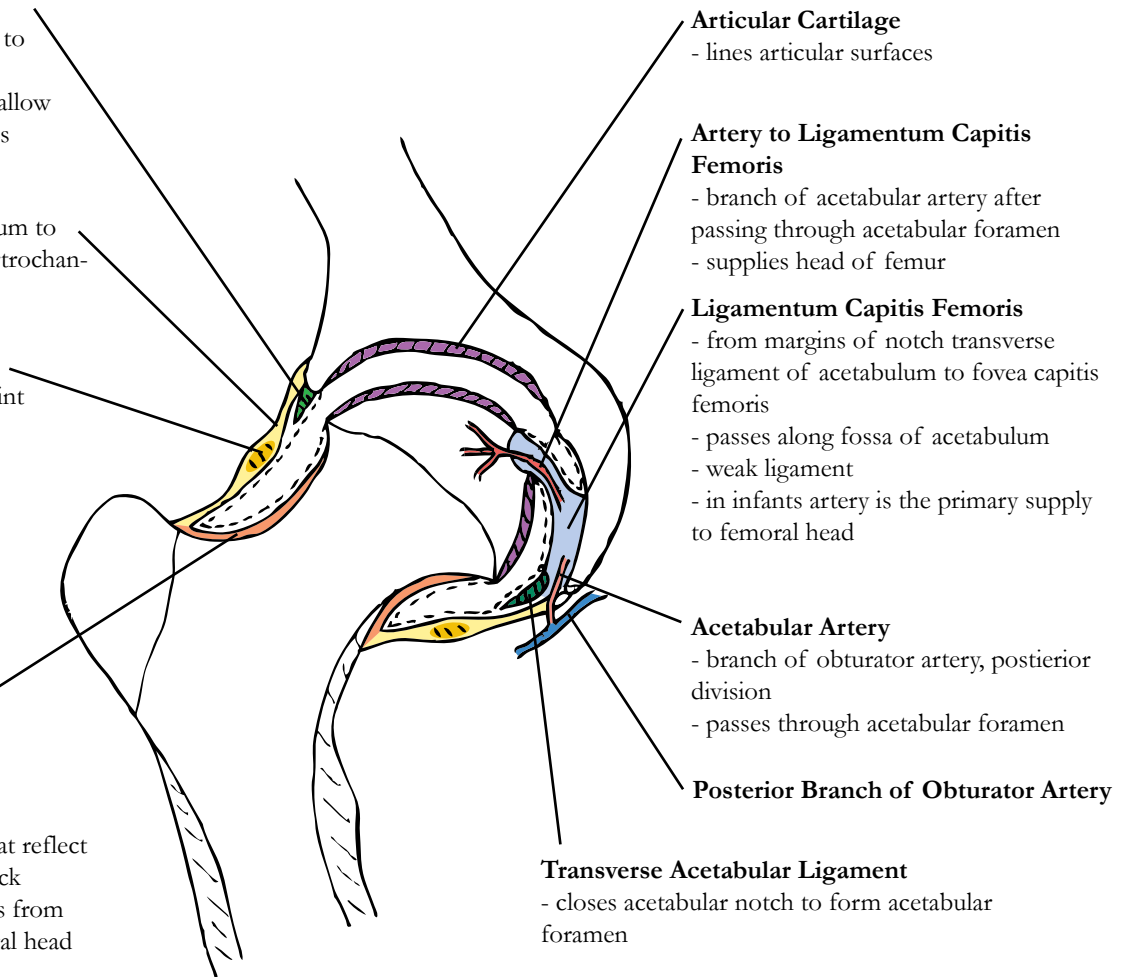
- ascending branch passes along the femoral intertrochanteric crest (*line*) and gives rise to branches which pass through the retinacula to supply the femoral head and neck
- anastomose with branches in the femoral head

## Superior Gluteal Artery (not pictured)

- branch that arise from the deep branch and continue laterally and inferiorly to supply the hip joint

## Inferior Gluteal Artery (not pictured)

- branch(es) which pass laterally and inferiorly to supply the piriformis and superior gemellus muscles then continue to the hip joint



## Articular Cartilage

- lines articular surfaces

## Artery to Ligamentum Capitis Femoris

- branch of acetabular artery after passing through acetabular foramen
- supplies head of femur

## Ligamentum Capitis Femoris

- from margins of notch transverse ligament of acetabulum to fovea capitis femoris
- passes along fossa of acetabulum
- weak ligament
- in infants artery is the primary supply to femoral head

## Acetabular Artery

- branch of obturator artery, posterior division
- passes through acetabular foramen

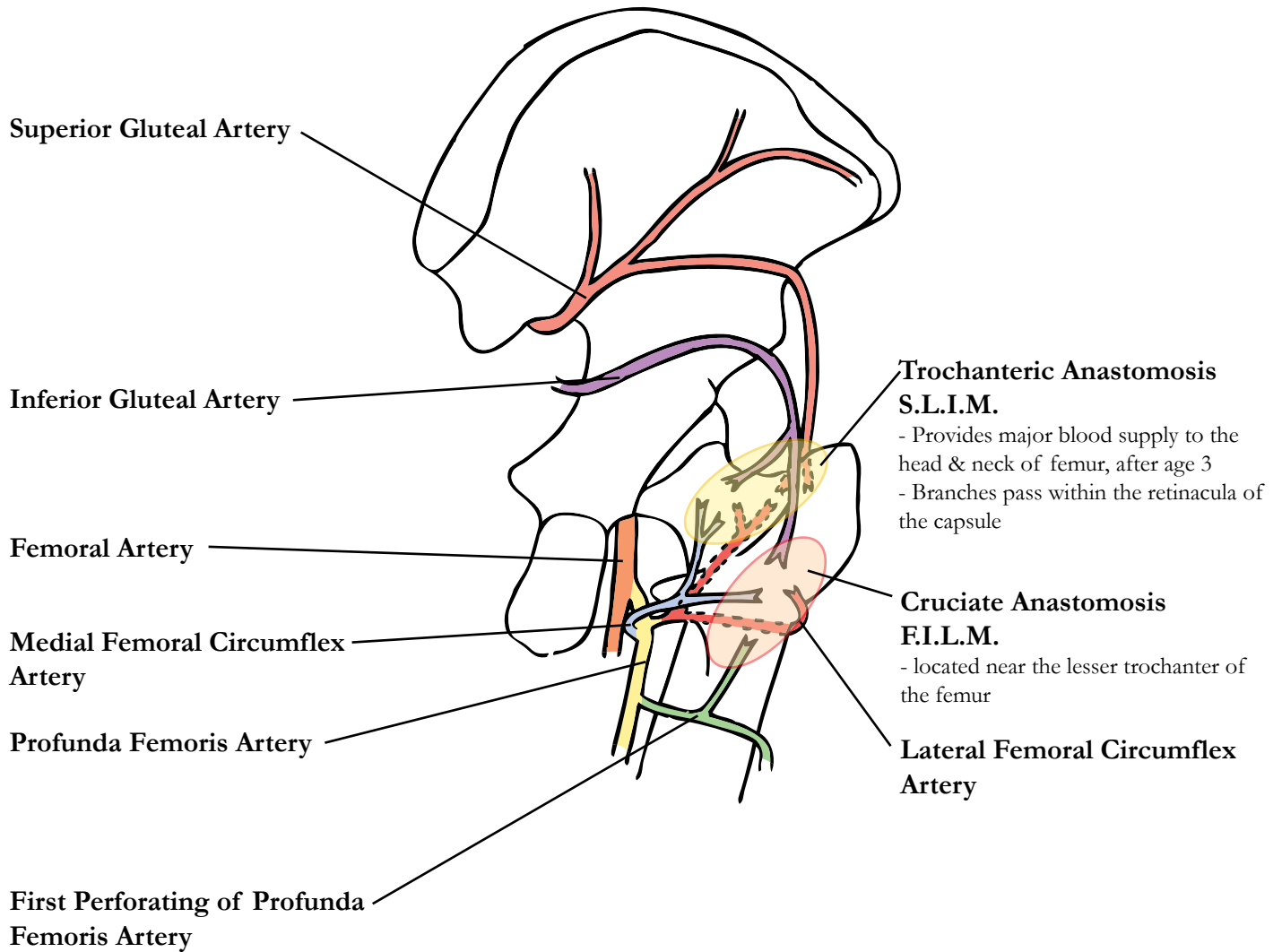
## Posterior Branch of Obturator Artery

## Transverse Acetabular Ligament

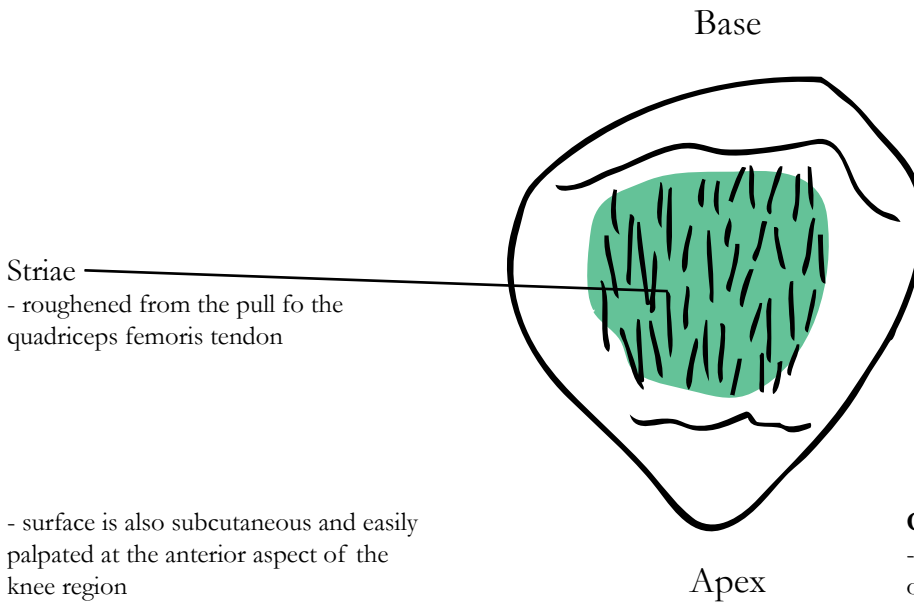
- closes acetabular notch to form acetabular foramen

# Hip Anastamoses

## Posterior View



# Patella - Anterior View



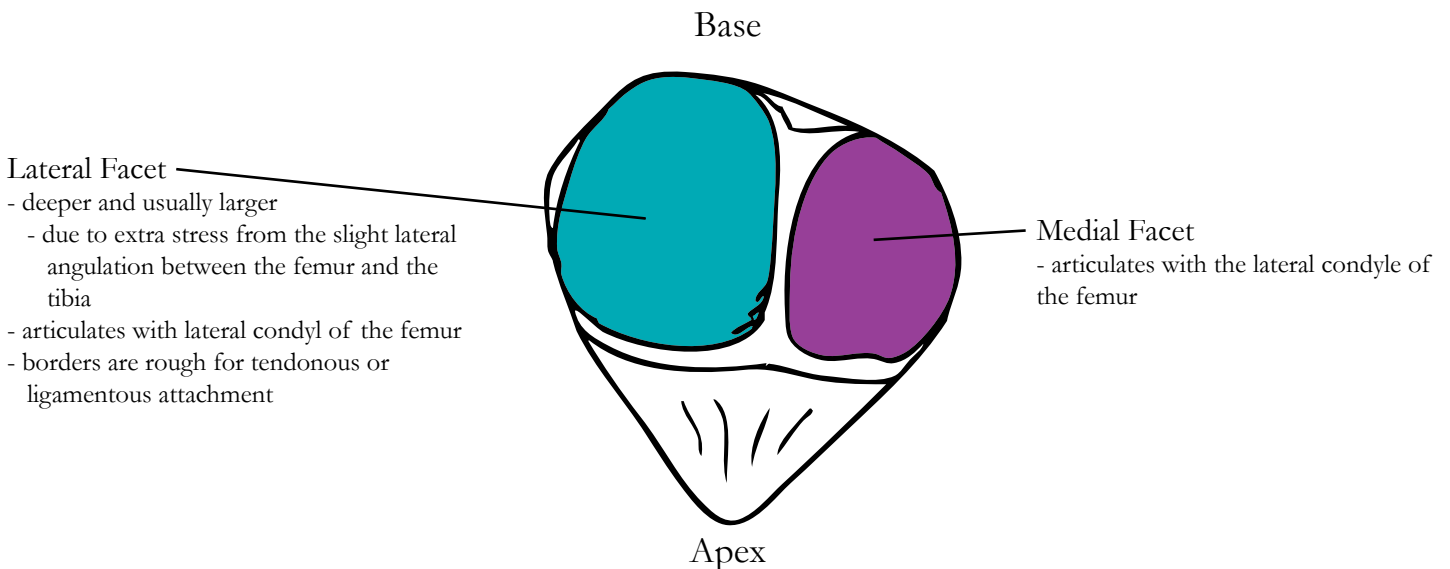
**Striae**  
 - roughened from the pull fo the quadriceps femoris tendon

- surface is also subcutaneous and easily palpated at the anterior aspect of the knee region  
 - subcutaneous means that the deep fascia attaches to this surface.

### Ossification of the Patella

- develops form a single or several centers of ossification  
 - center(s) appear between **3 and 6 years** and are fused by puberty  
 - if centers do not fuse, get a bipartite patella

# Patella - Posterior View



**Lateral Facet**  
 - deeper and usually larger  
 - due to extra stress from the slight lateral angulation between the femur and the tibia  
 - articulates with lateral condyl of the femur  
 - borders are rough for tendonous or ligamentous attachment

**Medial Facet**  
 - articulates with the lateral condyle of the femur

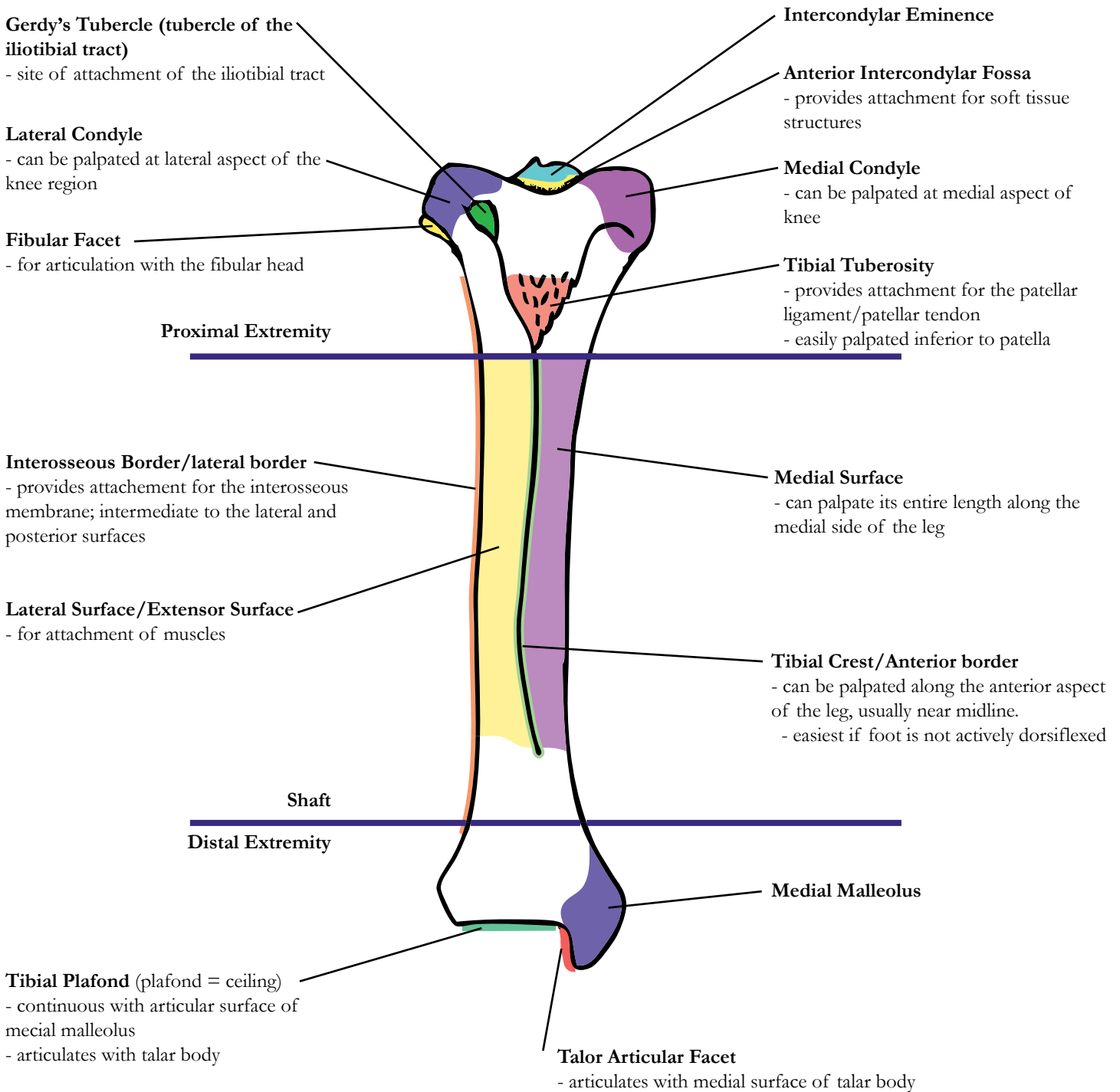
- most of this surface is smooth for articulation with the femoral condyles  
 - the medial, lateral and superior edges are rough for attachment of the quadriciceps femoris tendon

### Patella

- aka: knee cap  
 - largest sesmoid bone in the body  
 - articulates only with the femur  
 - provides leverage for the quadriciceps femoris muscle  
 - know left from right (this is left)

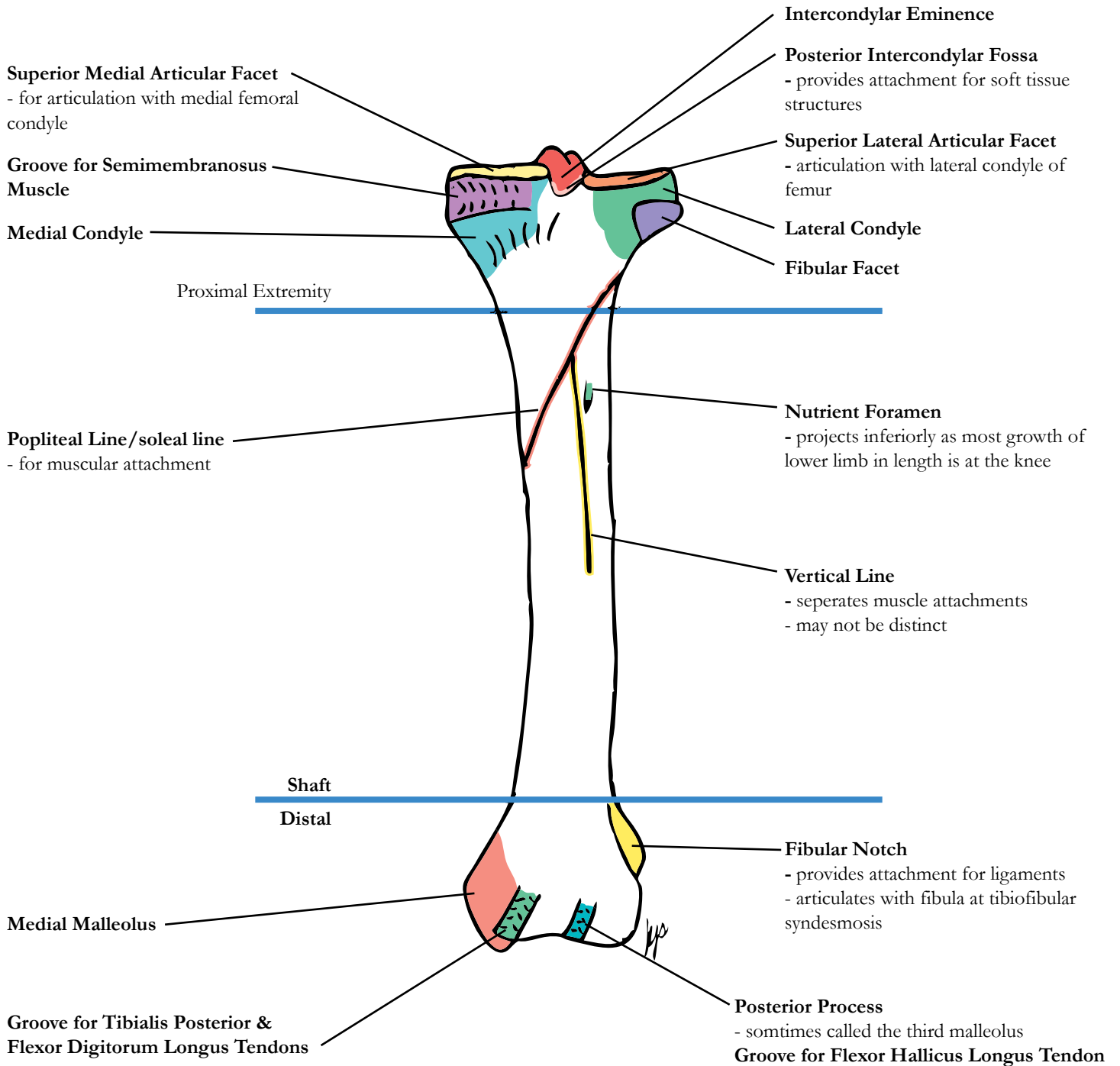
# Tibia

## Anterior View



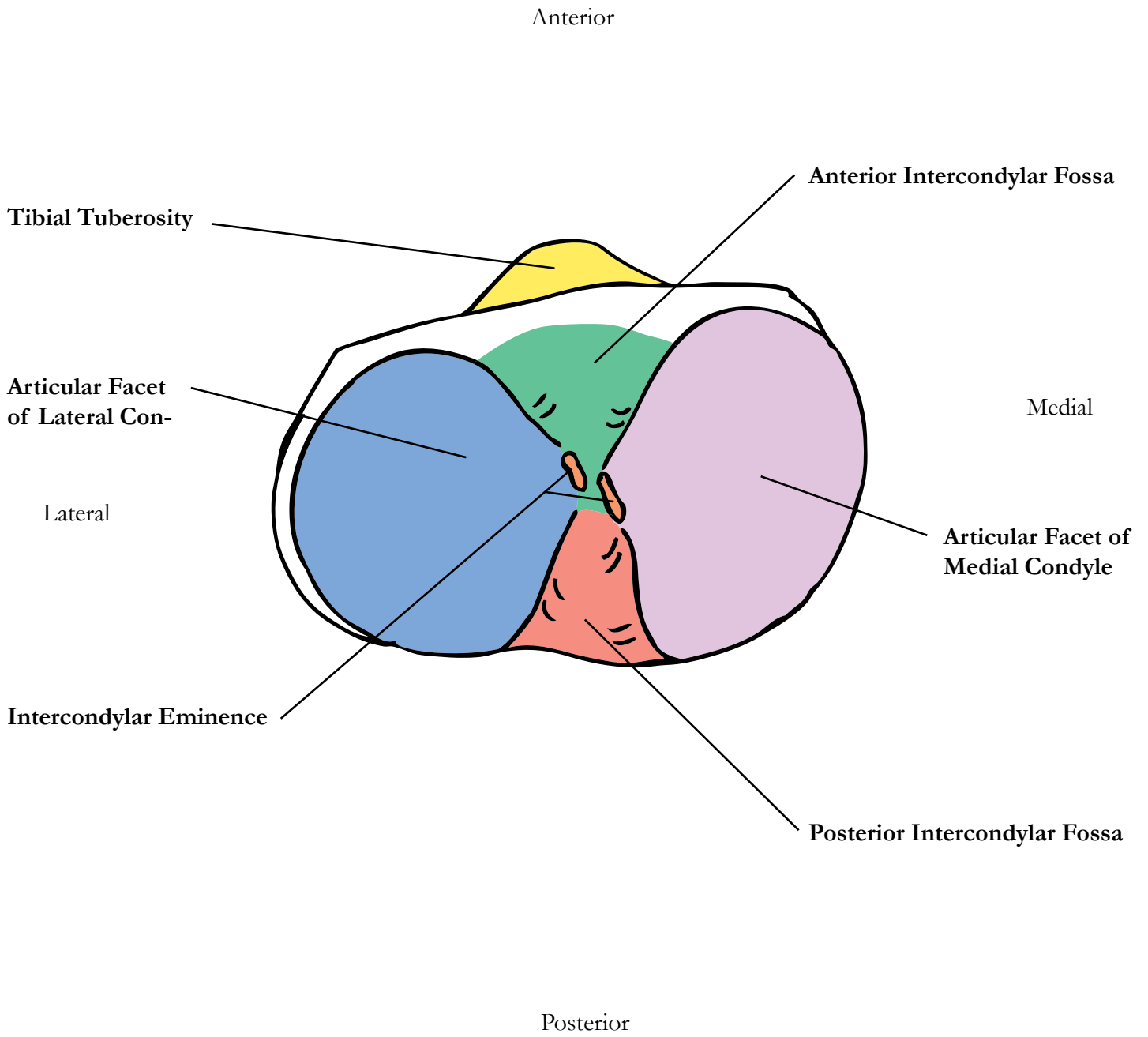
# Tibia

## Posterior View



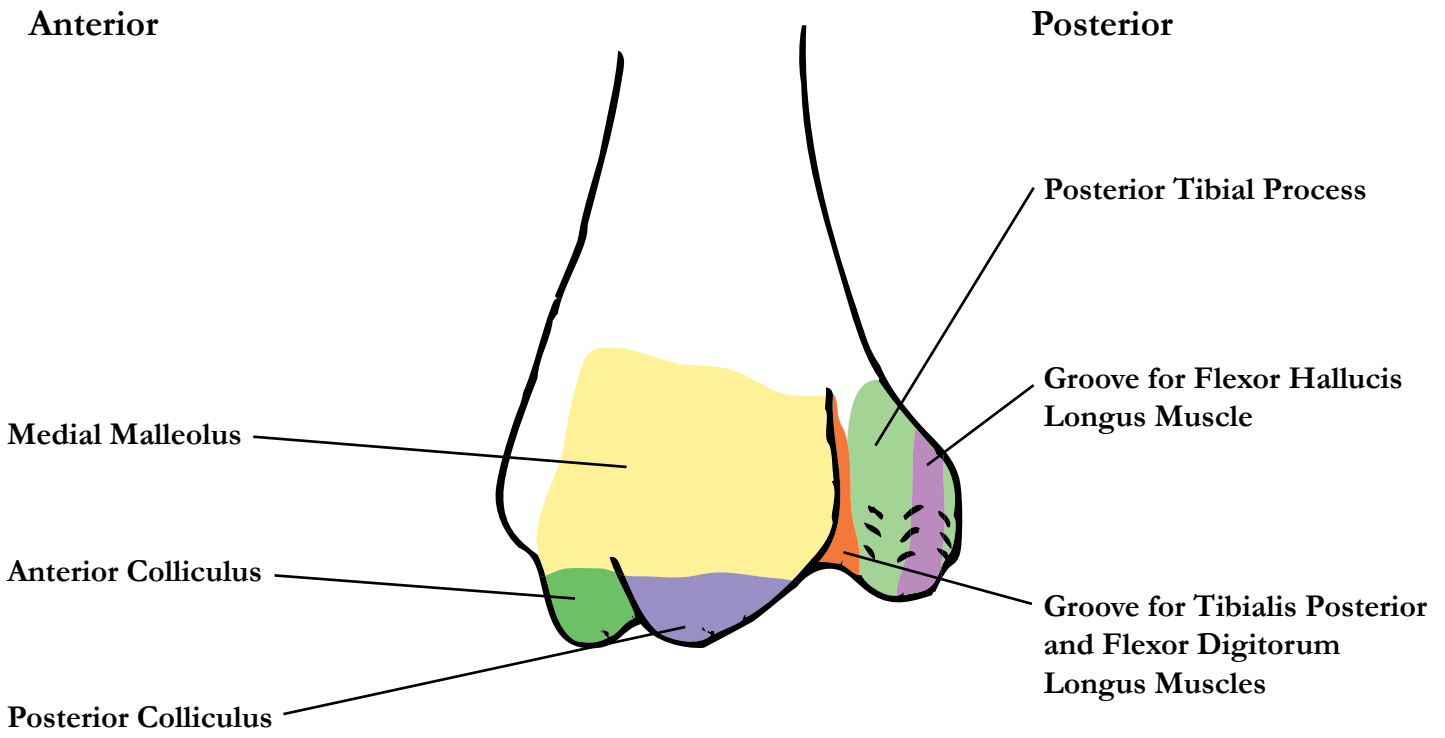
# Tibia

## Superior View

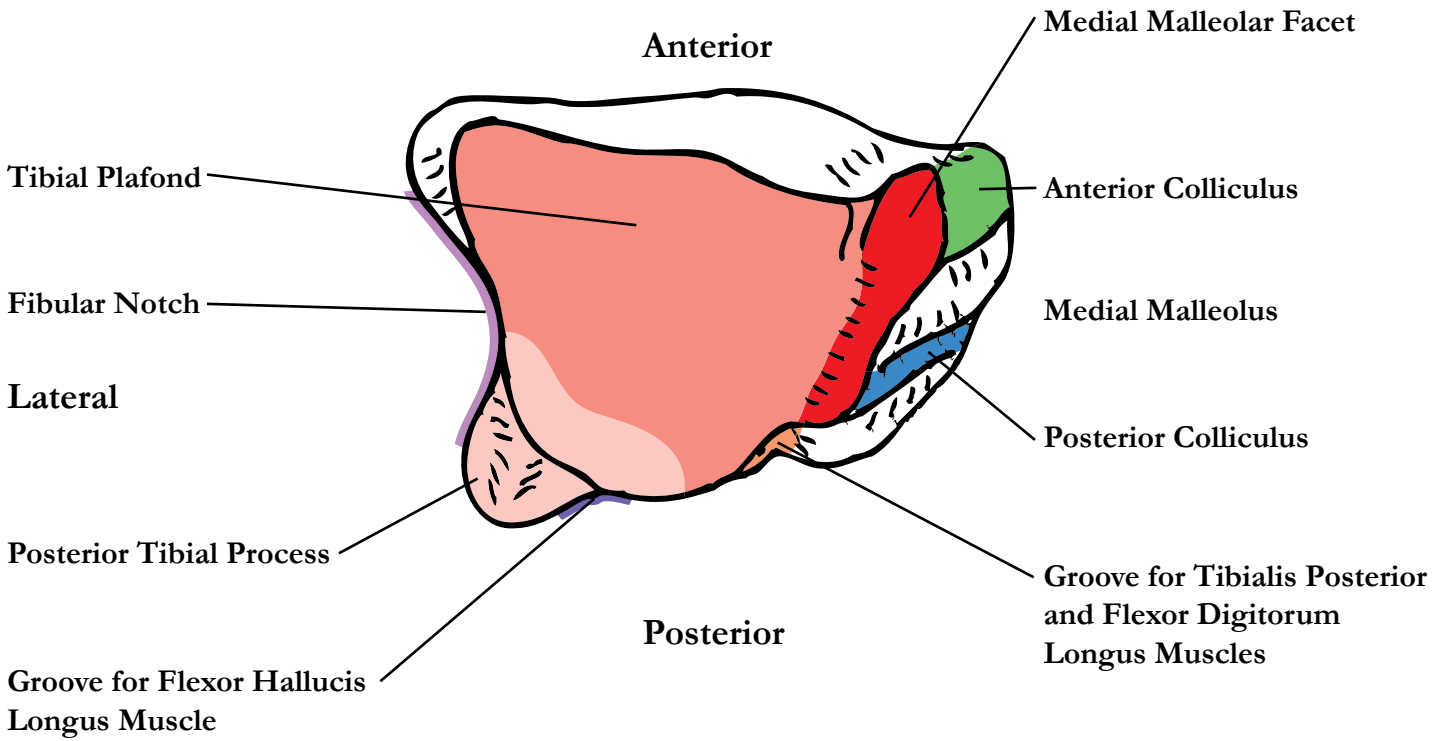


\*Left Tibia

# Tibia - Medial View



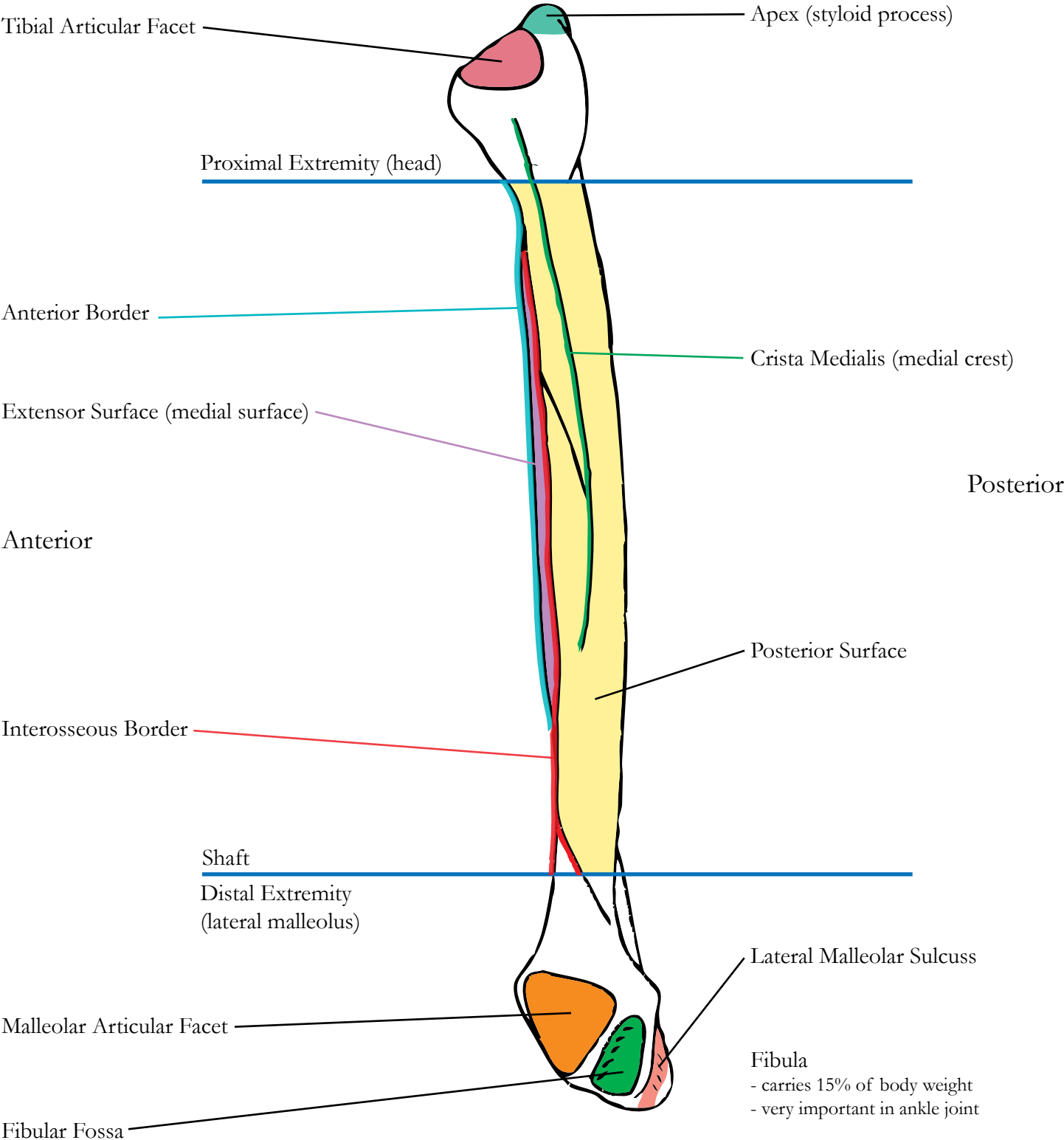
# Tibia - Inferior View





# Fibula

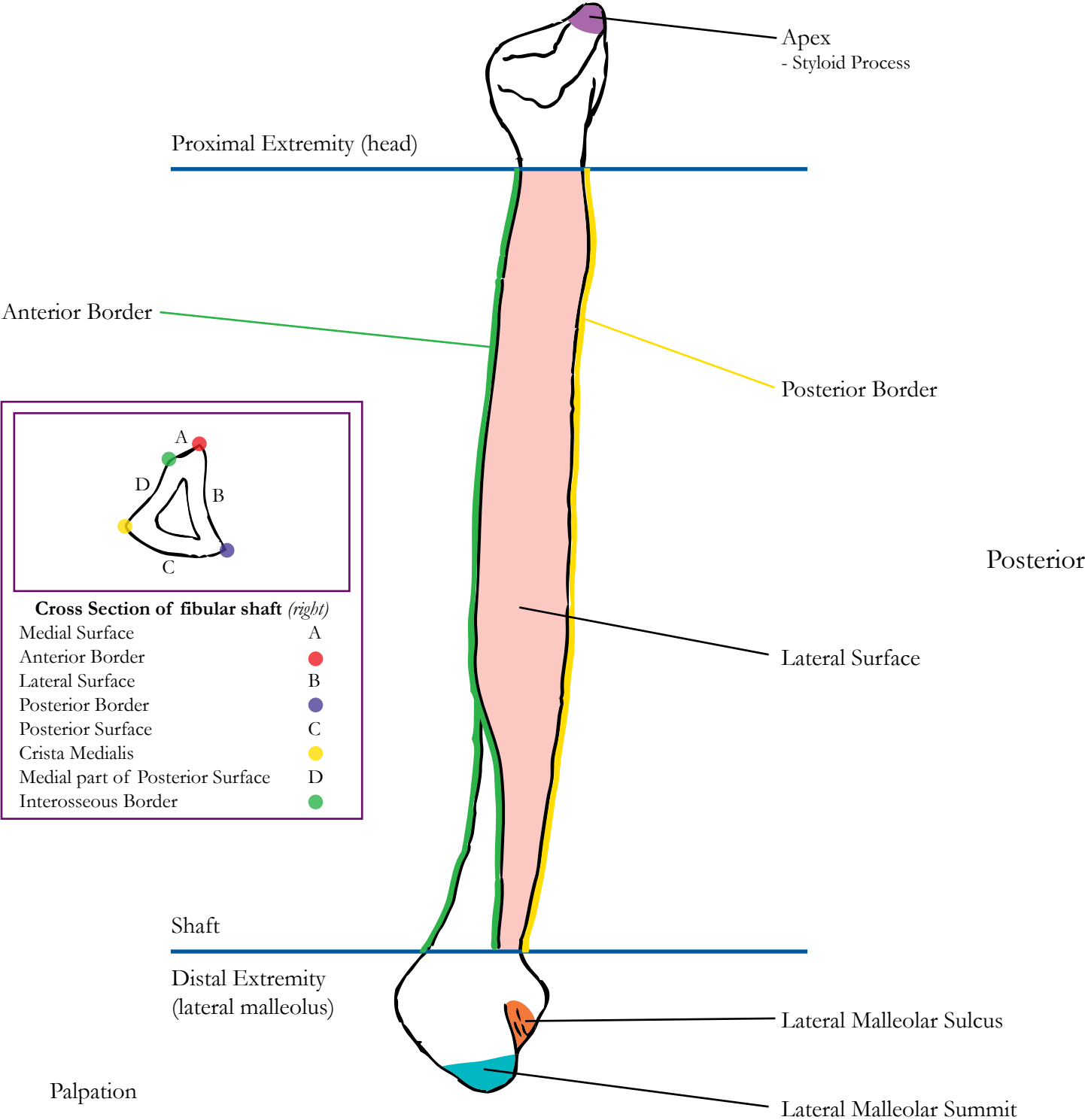
## Medial View



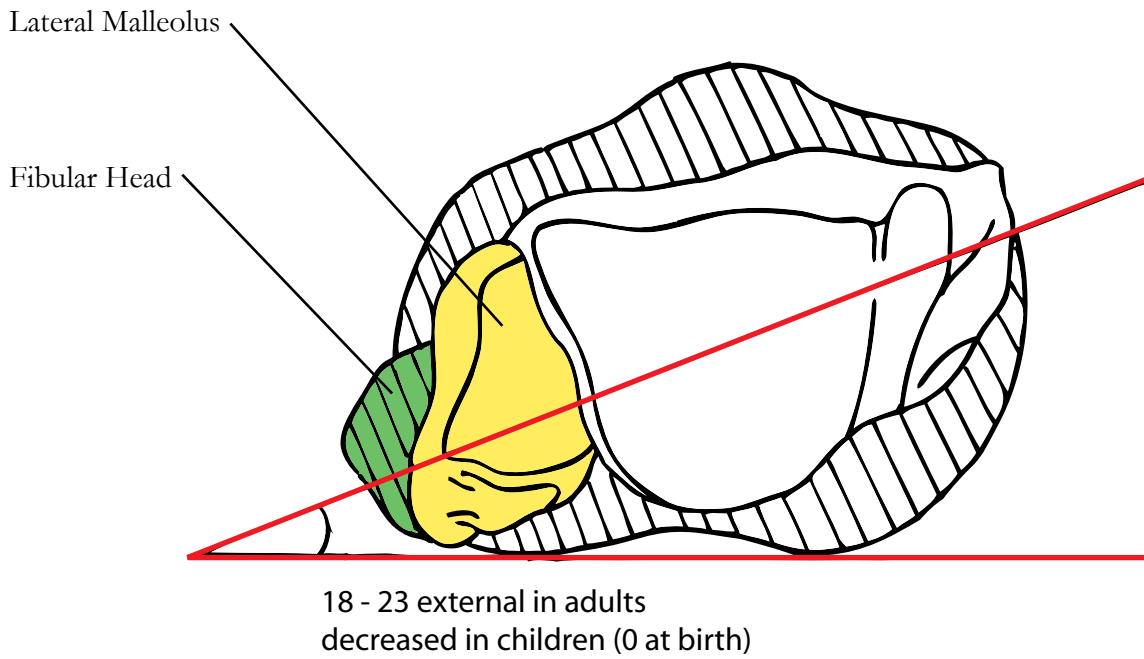
**Fibula**  
 - carries 15% of body weight  
 - very important in ankle joint

# Fibula

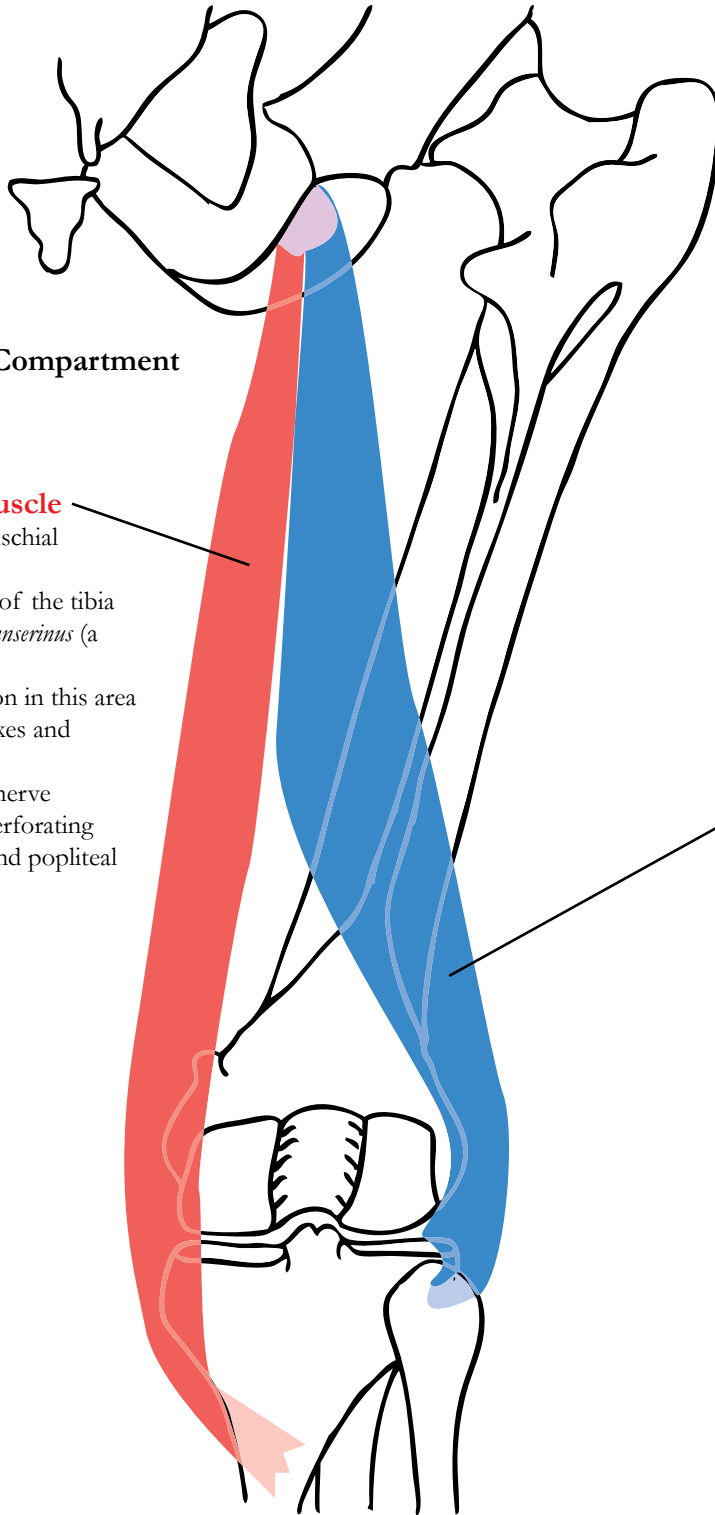
## Lateral View



# Tibiofibular Torsion



# Thigh - Posterior View



## Posterior Femoral Compartment Superficial layer

### Semitendinosus Muscle

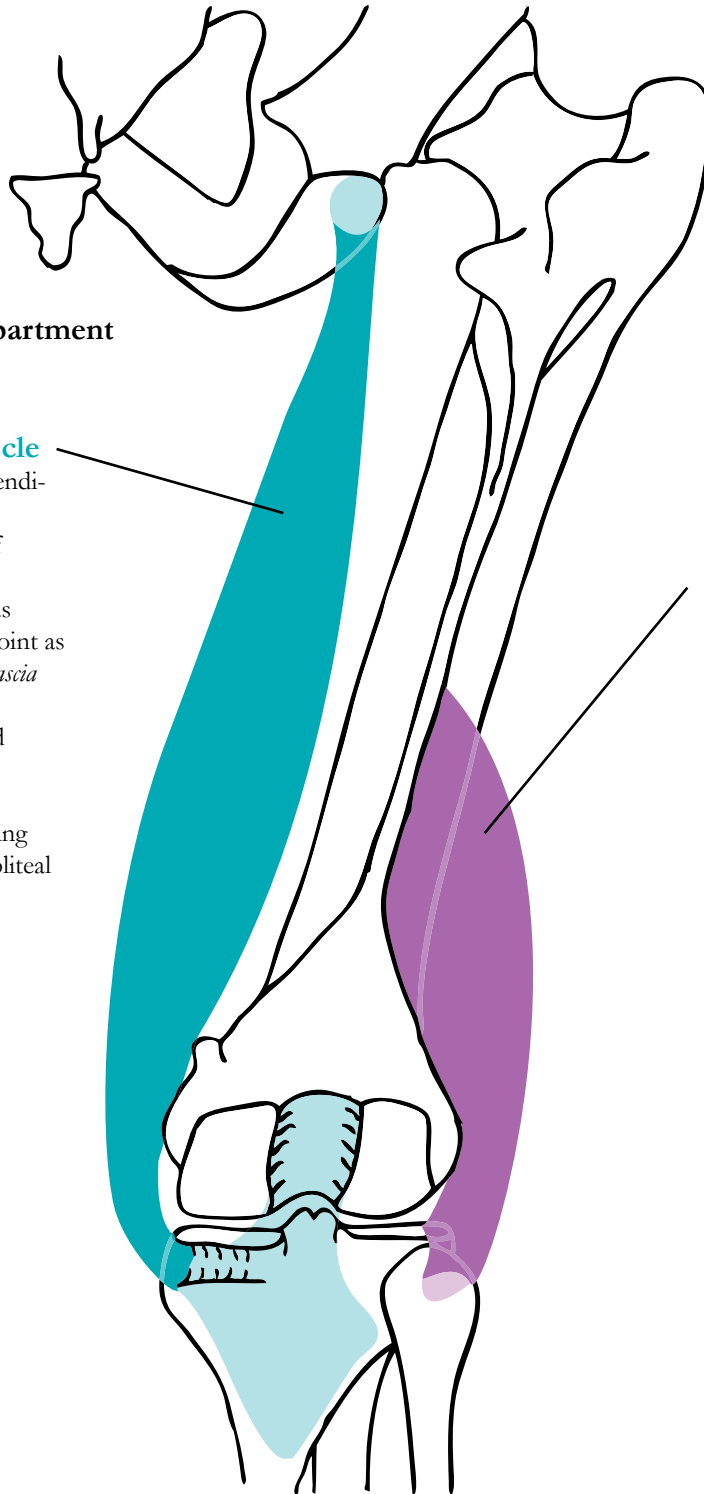
- O: posteroinferomedial ischial tuberosity
- I: proximal medial shaft of the tibia
  - forms part of the *pes anserinus* (a tendinous structure)
  - more prominent tendon in this area
- A: extends the thigh; flexes and **medially** rotates the leg
- NS: tibial part of sciatic nerve
- AS: profunda femoral perforating arteries, inferior gluteal and popliteal arteries

### Biceps Femoris Muscle

#### - long head

- O: posteroinferomedial ischial tuberosity (squared posterior part)
- I: Lateral aspect of the fibular head and the anterior edge of the lateral tibial condyle; shared with short head of biceps femoris muscle
- A: Extends the thigh; flexes and **laterally** rotates the leg
- NS: Tibial part of sciatic nerve
- AS: profunda femoral perforating arteries, inferior gluteal and popliteal arteries

# Thigh - Posterior View



## Posterior Femoral Compartment Deep Layer

### Semimembranosus Muscle

- located anteromedial to semitendinosus muscle

O: posterosuperolateral part of ischial tuberosity

I: groove for semimembranosus muscle and the posterior knee joint as the *oblique popliteal ligament* and *fascia over the popliteus muscle*

A: extends the thigh; flexes and **medially** rotates the leg

NS: tibial part of sciatic nerve

AS: profunda femoral perforating arteries, inferior gluteal and popliteal arteries

### Biceps Femoris Muscle

#### - short head

O: lateral lip of the linea aspera and lateral supracondylar line (also the posterior femoral intermuscular septum)

I: Lateral aspect of the fibular head and lateral tibial condyle; shared with long head of biceps femoris muscle

A: flexes and **laterally** rotates the leg

NS: common fibular part of sciatic nerve

AS: profunda femoral perforating arteries and popliteal arteries

### Hamstring Muscles

O: ischial tuberosity

A: extend the thigh and flex the leg

NS: sciatic nerve

1. Biceps femoris muscle
2. Semitendinosus muscle
3. Semimembranosus muscle

# Thigh - Anterior View

## Anterior Femoral Compartment Superficial Layer

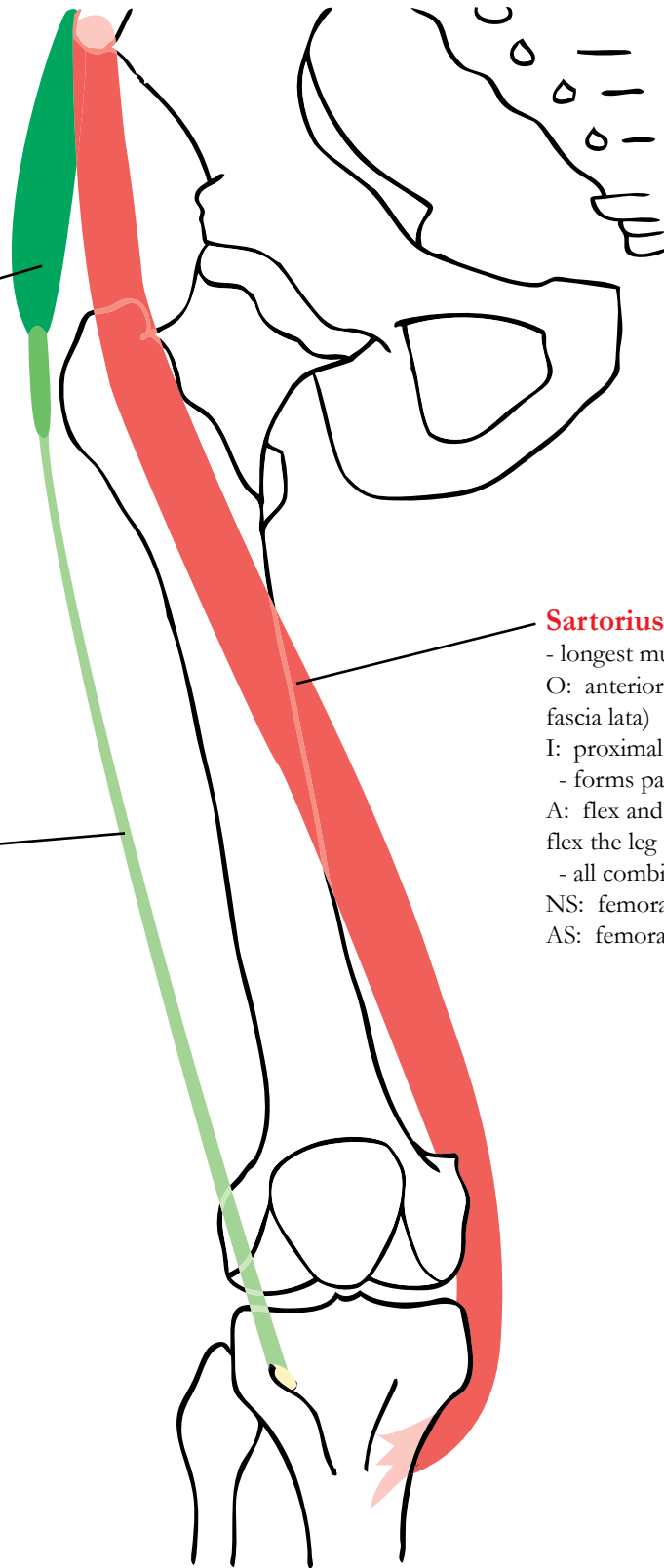
### Tensor Fascia Lata Muscle

O: Lateral lip of iliac crest, anterior to iliac tubercle (and fascia lata)  
 I: iliotibial band which attaches at Gerdy's tubercle  
 A: flex and abduct the thigh  
 - this stabilizes hip during gait;  
 extend the leg  
 - stabilizes the knee during gait  
 NS: superior gluteal nerve  
 AS: lateral femoral circumflex artery and superior gluteal artery

### Iliotibial band

### Sartorius Muscle

- longest muscle in body; strap-like  
 O: anterior superior iliac spine (and fascia lata)  
 I: proximal medial shaft of tibia  
 - forms part of the *pes anserinus*  
 A: flex and laterally rotate the thigh;  
 flex the leg  
 - all combined is the tailor position  
 NS: femoral nerve  
 AS: femoral artery



# Thigh - Anterior View

Anterior Femoral Compartment  
Intermediate Layer

## Rectus Femoris Muscle

O: *Straight Head/ Anterior Head*

- anterior inferior iliac spine

*Reflected Head/ Posterior Head*

- iliac part of acetabular rim, externally

I: base of patella forming part of the quadriceps tendon, and then to the tibial tuberosity via the patellar tendon

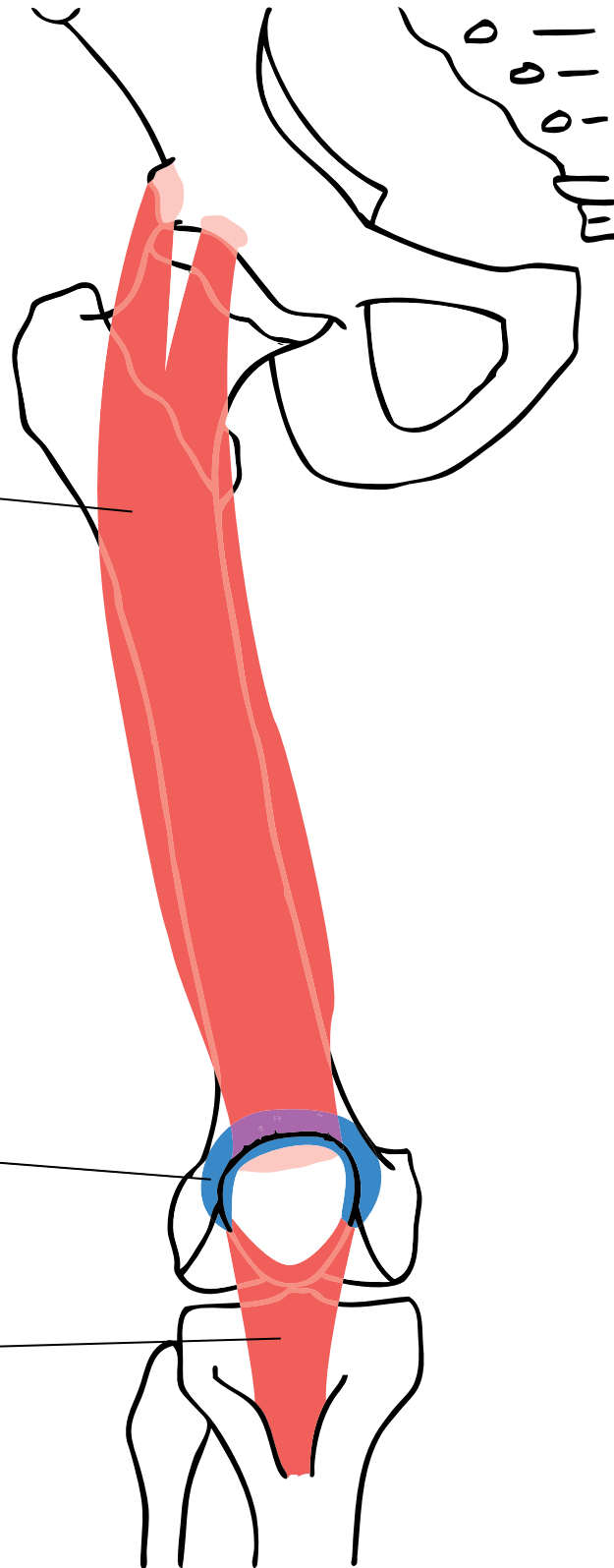
A: extend the knee; assist with flexion of the thigh

NS: femoral nerve

AS: descending branch of lateral femoral circumflex artery

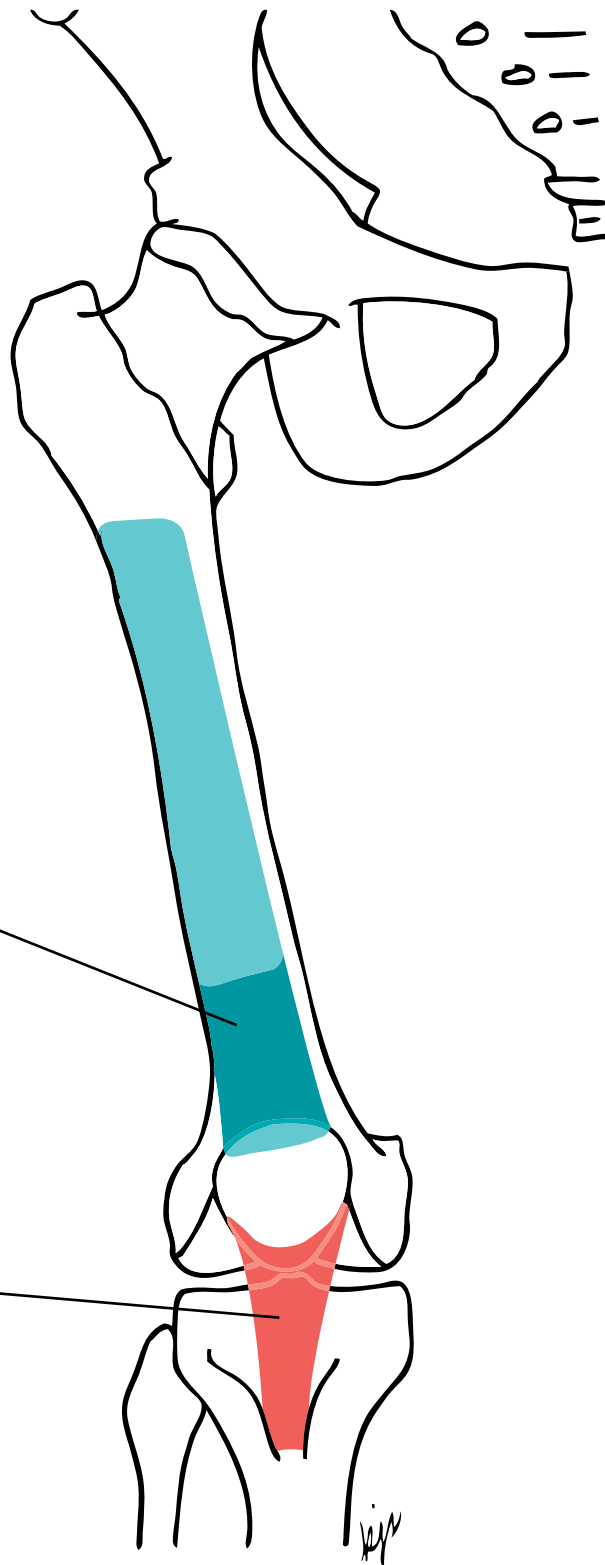
Quadriceps tendon

Patellar Tendon



# Thigh - Anterior View

## Anterior Femoral Compartment Deep Layer



### Vastus Intermedius Muscle

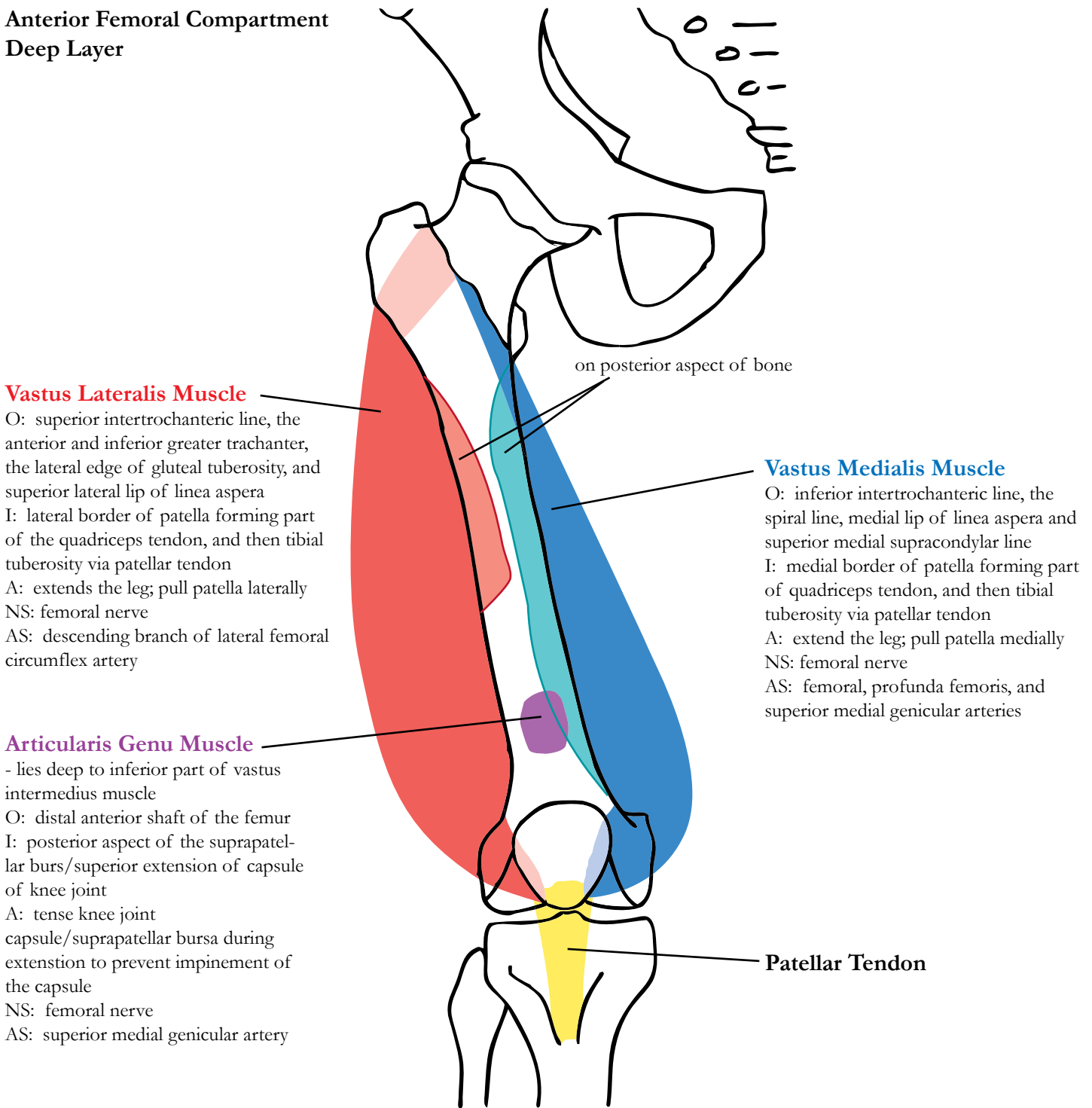
- directly deep to rectus femoris muscle
- O: superior 2/3 of the femoral shaft (anterior and lateral surfaces)
- I: base of the patella forming part of the quadriceps tendon, and the tibial tuberosity via the patellar tendon
- A: extends the leg
- NS: femoral nerve
- AS: descending branch of lateral femoral circumflex artery

### Patellar Tendon



# Thigh - Anterior View

## Anterior Femoral Compartment Deep Layer



### Vastus Lateralis Muscle

O: superior intertrochanteric line, the anterior and inferior greater trochanter, the lateral edge of gluteal tuberosity, and superior lateral lip of linea aspera  
 I: lateral border of patella forming part of the quadriceps tendon, and then tibial tuberosity via patellar tendon  
 A: extends the leg; pull patella laterally  
 NS: femoral nerve  
 AS: descending branch of lateral femoral circumflex artery

### Vastus Medialis Muscle

O: inferior intertrochanteric line, the spiral line, medial lip of linea aspera and superior medial supracondylar line  
 I: medial border of patella forming part of quadriceps tendon, and then tibial tuberosity via patellar tendon  
 A: extend the leg; pull patella medially  
 NS: femoral nerve  
 AS: femoral, profunda femoris, and superior medial genicular arteries

### Articularis Genu Muscle

- lies deep to inferior part of vastus intermedius muscle  
 O: distal anterior shaft of the femur  
 I: posterior aspect of the suprapatellar bursa/superior extension of capsule of knee joint  
 A: tense knee joint capsule/suprapatellar bursa during extension to prevent impingement of the capsule  
 NS: femoral nerve  
 AS: superior medial genicular artery

### Patellar Tendon

## Quadriceps Femoris Muscle

- four of the anterior compartment thigh muscles, considered as one - together they form the *quadriceps tendon*. The quadriceps tendon attaches the quadriceps femoris muscle to the patella. The quadriceps tendon also envelops the patella and forms the *patellar tendon* which inserts onto the tibial tuberosity. (the patellar tendon is also called the patellar ligament or ligamentum patellae

I: base of patella, then the tibial tuberosity through the patellar tendon

A: extend the leg; aid in flexion of the hip

NS: femoral nerve

1. Rectus Femoris Muscle

2. Vastus Medialis Muscle

3. Vastus Lateralis Muscle

4. Vastus Intermedius Muscle

# Thigh - Anterior View

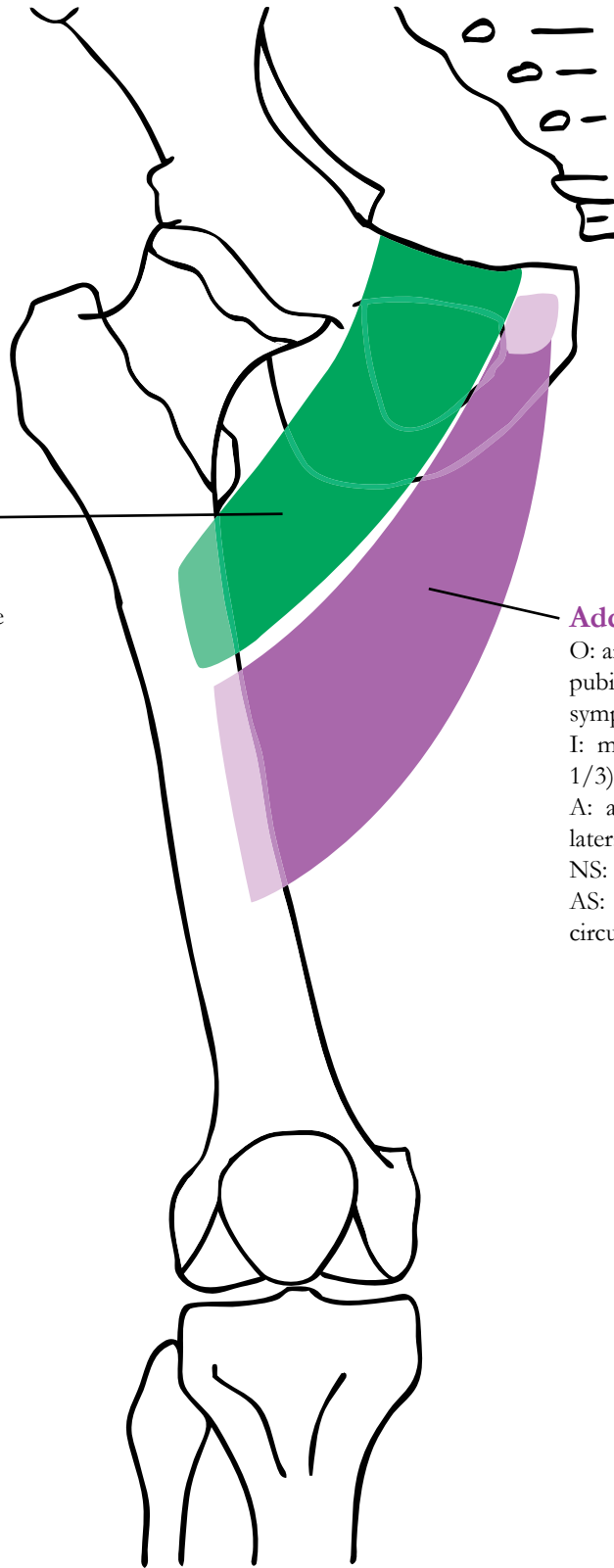
## Medial Femoral Compartment Anterior Layer

### Pectineus Muscle

- O: pecten pubis (from the pubic tubercle to the iliopectineal eminence)
- I: pectineal line of the femur (crosses the obturator externus muscle)
- A: adduct and flex the thigh
- NS: femoral nerve
- AS: obturator artery and medial femoral circumflex artery

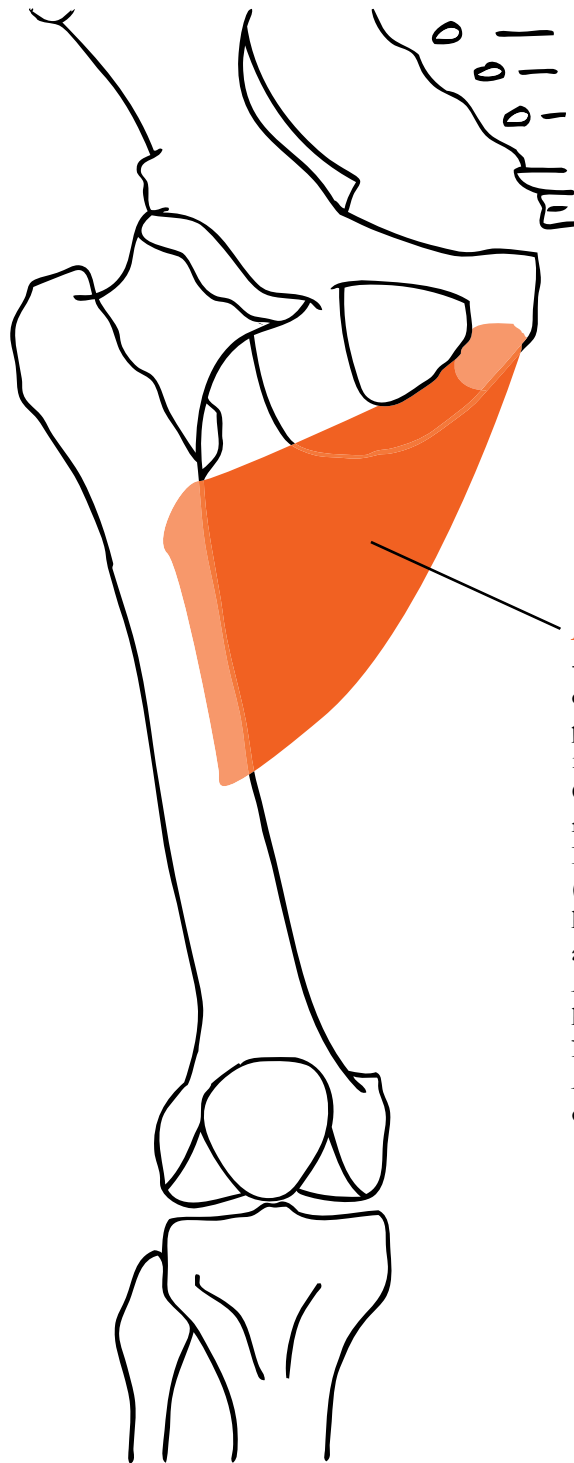
### Adductor Longus Muscle

- O: anterior pubic body (inferior to the pubic crest and lateral to the pubic symphysis)
- I: medial lip of the linea aspera (middle 1/3)
- A: adduct and flex the thigh; aids in lateral rotation of the thigh
- NS: obturator nerve
- AS: obturator artery and medial femoral circumflex artery



# Thigh - Anterior View

Medial Femoral Compartment  
Intermediate Layer



## Adductor Brevis Muscle

- landmark muscle for two main branches of obturator nerve and artery, and perforating branches of the profunda femoris artery

O: anterior surface of the inferior pubic ramus

I: pectineal line of the femur and (superior 1/2 of the) medial lip of the linea aspera; shared with pectineus and adductor longus muscles

A: adduct and flex the thigh; aids in lateral rotation of the thigh

NS: obturator nerve

AS: obturator artery and medial femoral circumflex artery

# Thigh - Anterior View

## Medial Femoral Compartment Posterior Layer

### Adductor Magnus Muscle

- largest adductor muscle

O: anterior to posterior orientation of fibers at origin

- a. inferior aspect of the inferior pubic ramus
- b. ischial ramus
- c. inferolateral part of the ischial tuberosity

I: superior to inferior orientation of fibers at insertion

- a. gluteal tuberosity (medial edge)
- b. medial lip of the linea aspera and medial supracondylar line
- c. medial supracondylar line and adductor tubercle

A: adduct the thigh; aid in flexion and extension of the thigh (due to rotation from origin to insertion)

NS: obturator nerve; all except hamstring part  
tibial part of sciatic nerve; hamstring part

AS: medial femoral circumflex artery, perforating arteries of the profunda femoris artery, obturator artery, and popliteal artery

- *superior fibers* of adductor magnus muscle are sometimes referred to as the *adductor minimus muscle*.
- the *inferior/vertical fibers* of the adductor magnus muscle are often termed the *hamstring part of the adductor magnus muscle*
- can palpate the tendon of the hamstring part of the adductor magnus muscle at the medial aspect of the knee region, anterior to gracilis and sartorius muscles, with resisted adduction of the thigh

### Adductor Hiatus

- opening formed by vertical fibers/ hamstring part of adductor magnus muscle as it passes to its insertion
- allows passage of femoral vessels to and popliteal vessels from the popliteal fossa

### Pes Anserinus (means goose's foot)

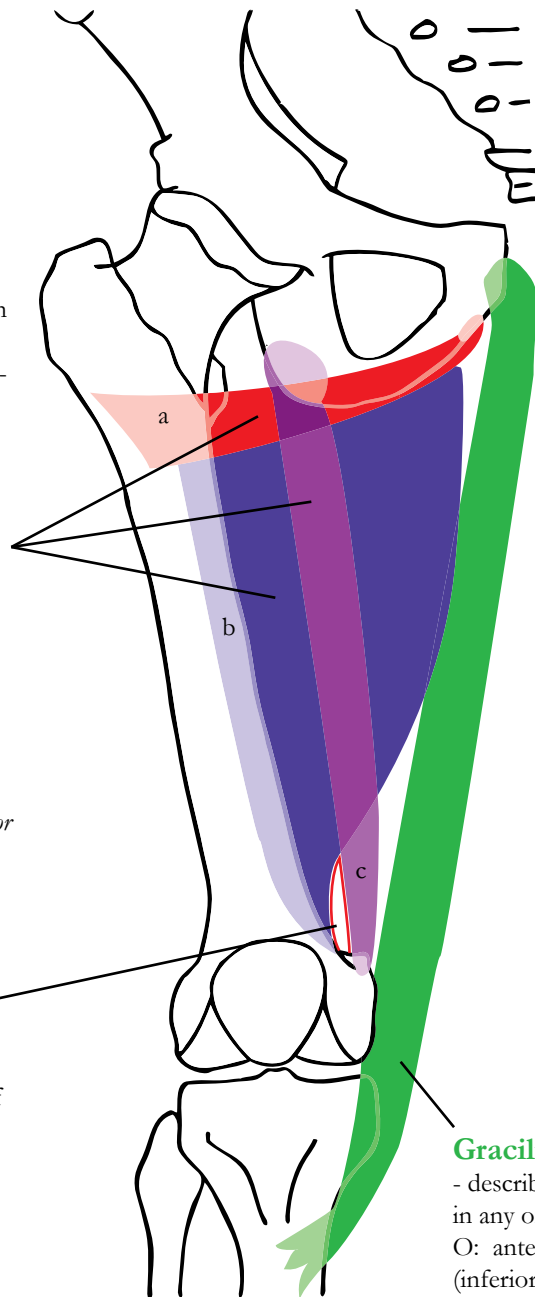
- 3 tendons that insert at the proximomedial aspect of the tibial shaft. One from each compartment

#### Muscles:

- Semitendinosus muscle (posteroinferior insertion)
- Sartorius muscle (anterosuperior insertion)
- Gracilis muscle (central insertion)

### Bursa Anserina / Anserine Bursa

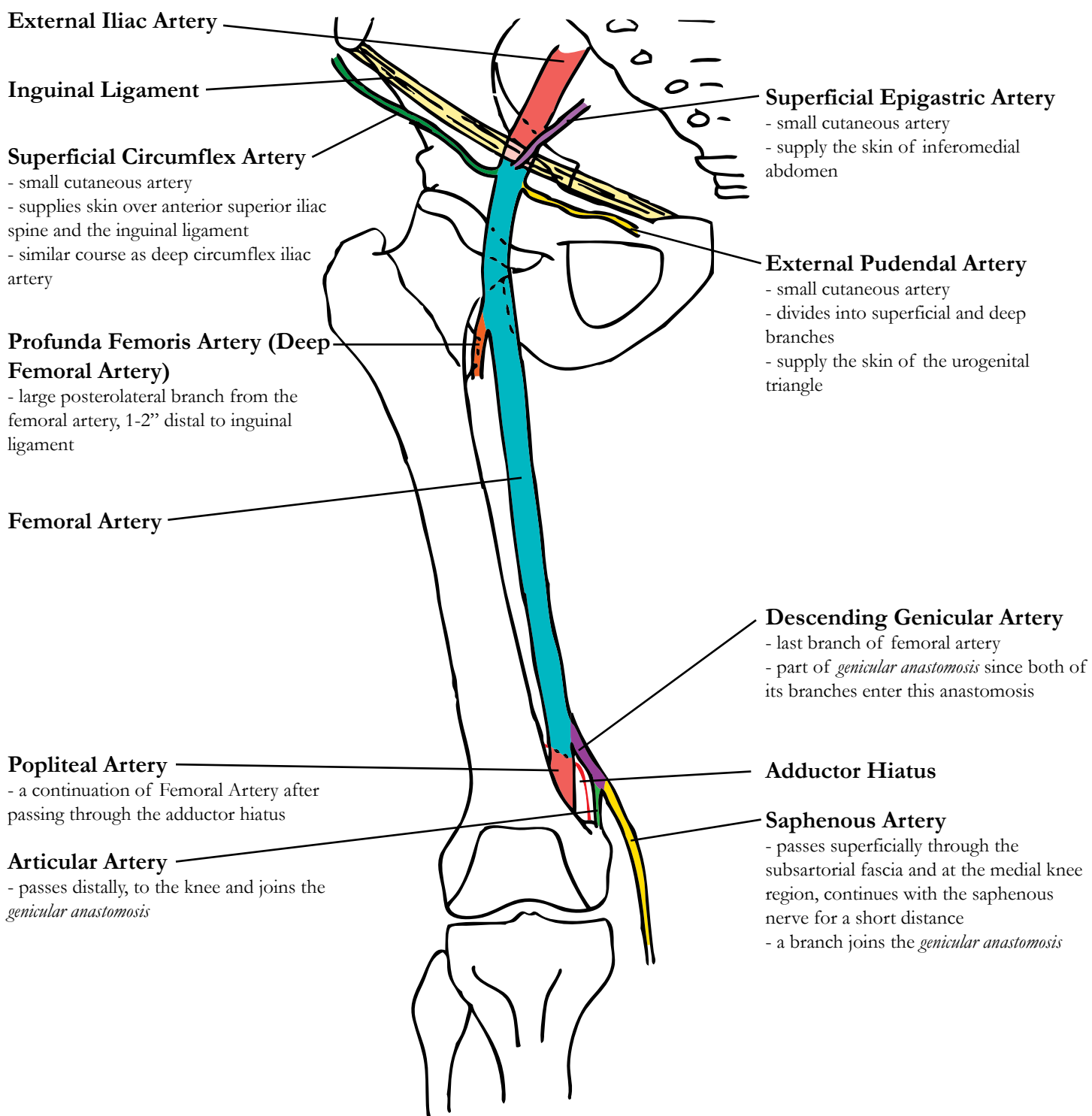
- separates the 3 tendons of Pes Anserinus from each other and from the bone
- it prevents rubbing friction between these structures
- may become irritated with repeated internal rotation of the leg at the knee



### Gracilis Muscle

- described with posterior layer, but not in any one layer
- O: anterior aspect of the pubic body (inferior part), inferior pubic ramus (medial part) and pubic symphysis (inferior aspect)
- I: proximal medial shaft of the tibia
  - forms part of the *pes anserinus*
  - passes posterior to the medial femoral condyle
- A: Adduct the thigh; flex the leg; aids in medial rotation of the leg (at the knee)
- NS: obturator nerve
- AS: medial femoral circumflex, obturator, and profunda femoris

# Arterial Supply of Thigh Anterior View



# Arterial Supply to Thigh

## Anterior View

Lateral

Medial

### Femoral Artery

#### Lateral Femoral Circumflex Artery

- typically branch from profunda femoris artery but occasionally from femoral artery

##### 1 - Ascending

- supplies greater trochanter and head and neck of the femur
- joins trochanteric anastomosis

##### 2 - Transverse

- provides muscular branches
- joins the cruciate anastomosis

##### 3 - Descending

- passes inferiorly in anterior compartment of thigh, intermediate to rectus femoris and vastus intermedius muscles at their lateral edges, near vastus lateralis muscle.
- provides muscular branches and joins the genicular anastomosis

### Perforating Arteries

- all pass posterolaterally and pierce adductor magnus near area of insertion
- adductor brevis is landmark for first, second and third.

#### First Perforating of Profunda Femoris Artery

- passes proximal to the superior border of adductor brevis muscle

#### Second Perforating of Profunda Femoris Artery

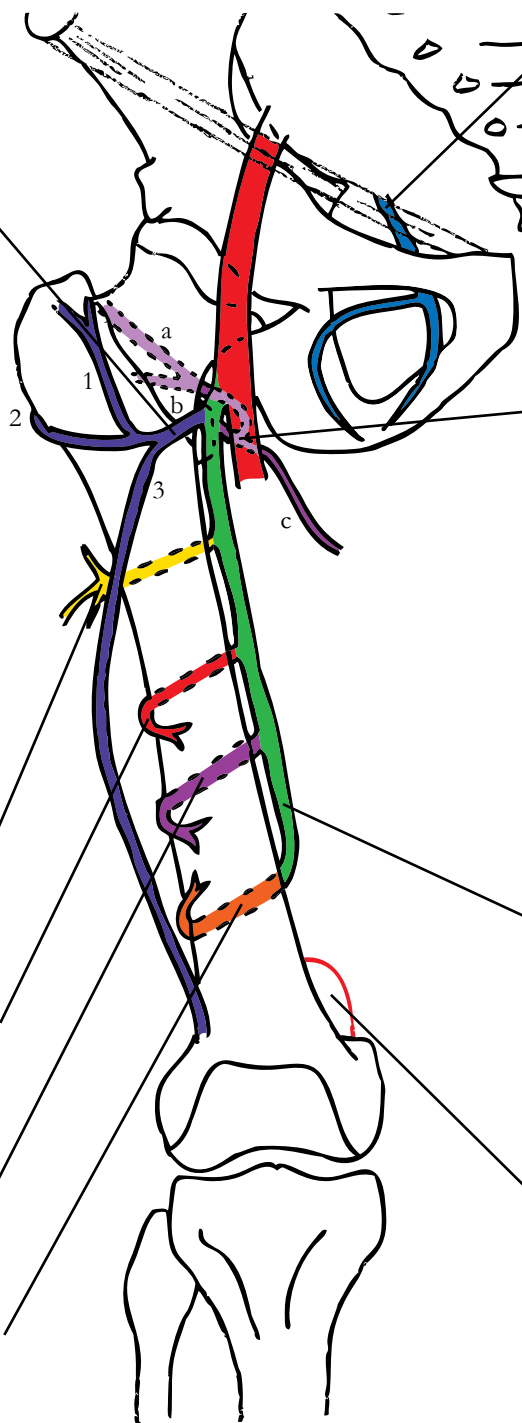
- pierces adductor brevis muscle, usually near the midportion of muscle belly
- supplies the nutrient artery to the femur

#### Third Perforating of Profunda Femoris Artery

- passes distal to inferior border of adductor brevis muscle

#### Fourth Perforating of Profunda Femoris Artery

- termination of profunda femoris artery
- located just proximal to adductor hiatus
- anastomosis with branches of the popliteal artery



### Obturator Artery

- artery of medial femoral compartment;
- has anterior and posterior branches which pass to anterior and posterior aspects of adductor brevis muscle.

### Acetabular Artery

- from posterior branch of obturator artery
- enters hip joint via acetabular foramen
- gives rise to *artery to ligamentum capitis femoris*

### Medial Femoral Circumflex Artery

- branch typically from medial side of profunda femoris artery but occasionally from the femoral artery

##### a - Ascending

- supplies greater trochanter and head and neck of the femur

- joins the trochanteric anastomosis

##### b - Transverse

- provides muscular branches
- joins cruciate anastomosis

##### c - Descending

- in medial compartment of thigh
- provides muscular branches

### Profunda Femoris Artery

- major branch of femoral artery passes posterior, intermediate to the pectineus muscle and the adductor longus muscle; it then passes inferiorly, anterior to both the adductor brevis and adductor magnus muscles, to its termination.

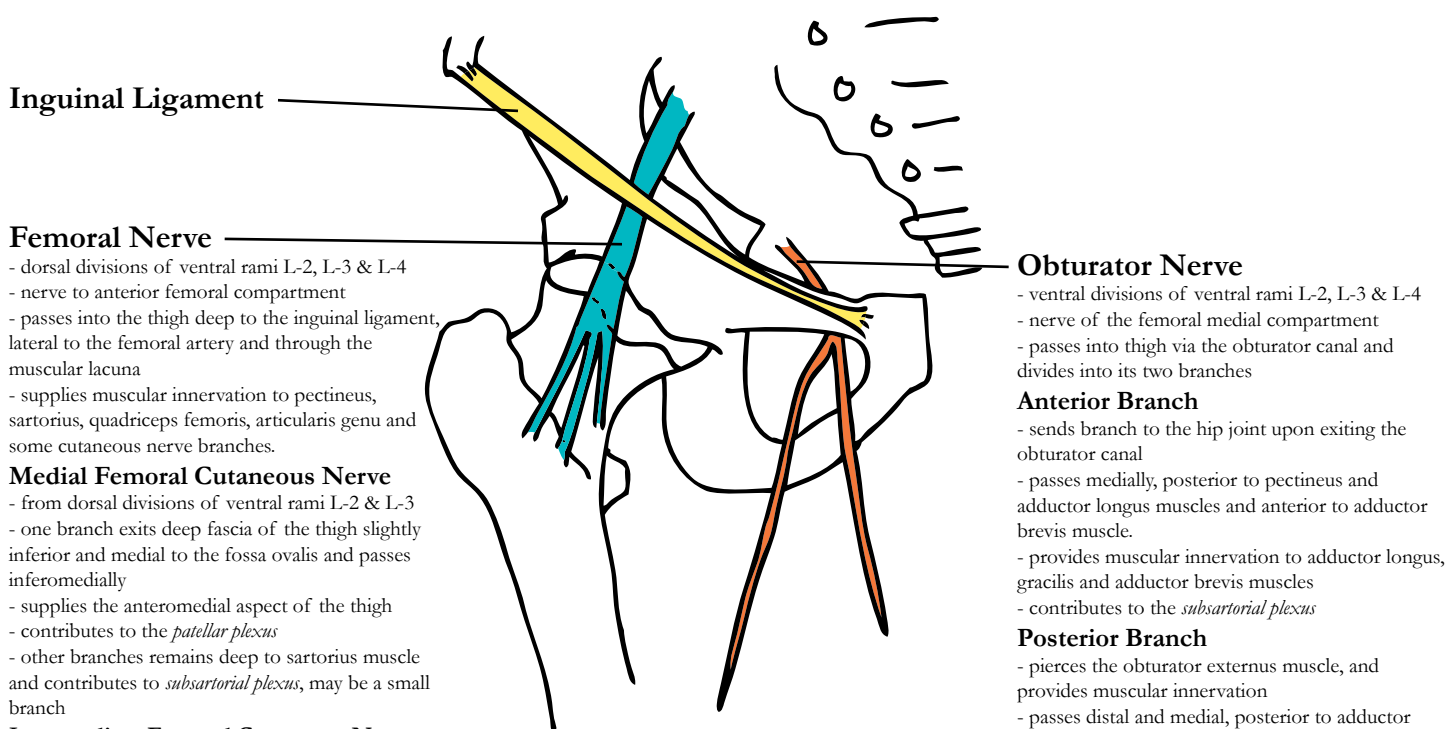
### Adductor Hiatus

# Nerve Supply of Hip

## Anterior View

Lateral

Medial



**Inguinal Ligament**

**Femoral Nerve**

- dorsal divisions of ventral rami L-2, L-3 & L-4
- nerve to anterior femoral compartment
- passes into the thigh deep to the inguinal ligament, lateral to the femoral artery and through the muscular lacuna
- supplies muscular innervation to pectineus, sartorius, quadriceps femoris, articularis genu and some cutaneous nerve branches.

**Medial Femoral Cutaneous Nerve**

- from dorsal divisions of ventral rami L-2 & L-3
- one branch exits deep fascia of the thigh slightly inferior and medial to the fossa ovalis and passes inferomedially
- supplies the anteromedial aspect of the thigh
- contributes to the *patellar plexus*
- other branches remains deep to sartorius muscle and contributes to *subsartorial plexus*, may be a small branch

**Intermediate Femoral Cutaneous Nerve**

- dorsal divisions of ventral rami L-2 & L-3
- exits fascia lata near the fossa ovalis and passes inferiorly, usually over the rectus femoris muscle
- often pierces sartorius muscle prior to exiting fascia lata
- supplies the central part of the anterior aspect of the thigh
- contributes to *patellar plexus*

**Saphenous Nerve**

- dorsal divisions of ventral rami L-3 & L-4
- travels with the femoral artery and vein in the adductor canal
- exits the deep fascia at the posteroinferomedial aspect of the thigh or superoanteromedial aspect of the leg
- supplies the skin of medial 1/2 of the leg and patellar surface
- contributes to the *subsartorial plexus*
- infrapatellar branch contributes to the *patellar plexus*

**Obturator Nerve**

- ventral divisions of ventral rami L-2, L-3 & L-4
- nerve of the femoral medial compartment
- passes into thigh via the obturator canal and divides into its two branches

**Anterior Branch**

- sends branch to the hip joint upon exiting the obturator canal
- passes medially, posterior to pectineus and adductor longus muscles and anterior to adductor brevis muscle.
- provides muscular innervation to adductor longus, gracilis and adductor brevis muscles
- contributes to the *subsartorial plexus*

**Posterior Branch**

- pierces the obturator externus muscle, and provides muscular innervation
- passes distal and medial, posterior to adductor brevis muscle and anterior to adductor magnus muscle
- supplies obturator externus and adductor magnus, except hamstring part
- provides a branch to the knee joint which pierces the oblique popliteal ligament (this branch follows the femoral and popliteal arteries)

**Subsartorial Plexus**

- branches of 3 nerves join near the distal edge of adductor longus muscle and deep to sartorius muscle in lower thigh
- provide cutaneous innervation at the thigh, medially

1. obturator nerve, anterior branch
2. medial femoral cutaneous nerve
3. saphenous nerve

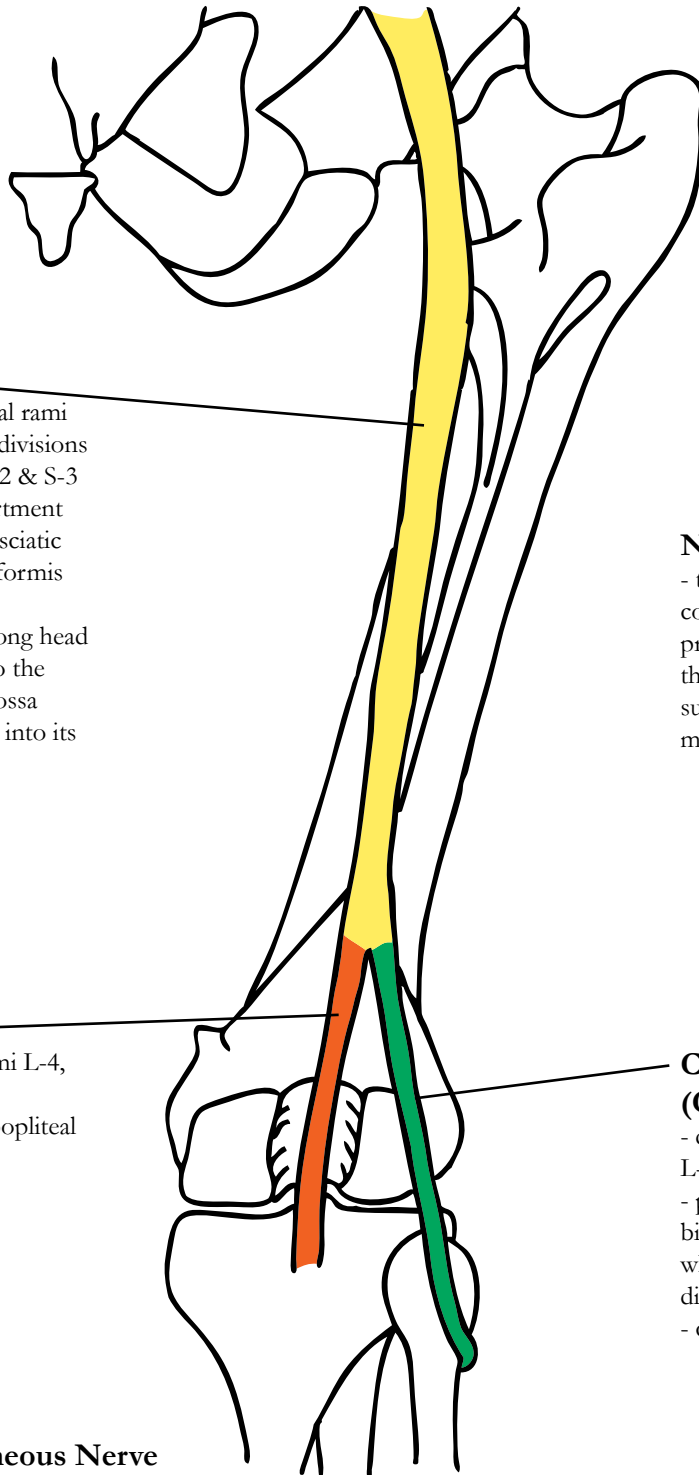
**Patellar Plexus**

- around the patella
  - formed by branches of 4 nerves
  - provides cutaneous innervation to the patellar surface
1. medial femoral cutaneous nerve
  2. intermediate femoral cutaneous nerve
  3. saphenous nerve, infrapatellar branch
  4. lateral femoral cutaneous nerve

# Nerve Supply to Thigh Posterior View

Medial

Lateral



## Sciatic Nerve

- from dorsal divisions of ventral rami L-4, L-5, S-1 & S-2 and ventral divisions of ventral rami L-4, L-5, S-1, S-2 & S-3
- nerve of the posterior compartment
- exits the pelvis via the greater sciatic foramen, usually inferior to piriformis muscle
- travels inferiorly, deep to the long head of the biceps femoris muscle, to the superior edge of the popliteal fossa
- at the popliteal fossa it divides into its two component parts.

## Note:

- the sciatic nerve may split into its component nerves at any level including prior to exiting the pelvis. In this case the common fibular nerve usually passes superior to or through the piriformis muscle when exiting the pelvis

## Tibial Nerve

- ventral divisions of ventral rami L-4, L-5, S-1, S-2 & S-3
- passes inferiorly through the popliteal fossa into the leg

## Common Fibular Nerve (Common Peroneal Nerve)

- dorsal divisions of ventral rami L-4, L-5, S-1 & S-2
- passes along the inferior edge of the biceps femoris tendon to the fibula where it passes in an anteroinferior direction around the head of the fibula
- can palpate the nerve at the fibular head

## Posterior Femoral Cutaneous Nerve

(not pictured)

- dorsal division of ventral rami S-1 & S-2 and ventral divisions of ventral rami S-2 & S-3
- sensory nerve in posterior femoral compart-

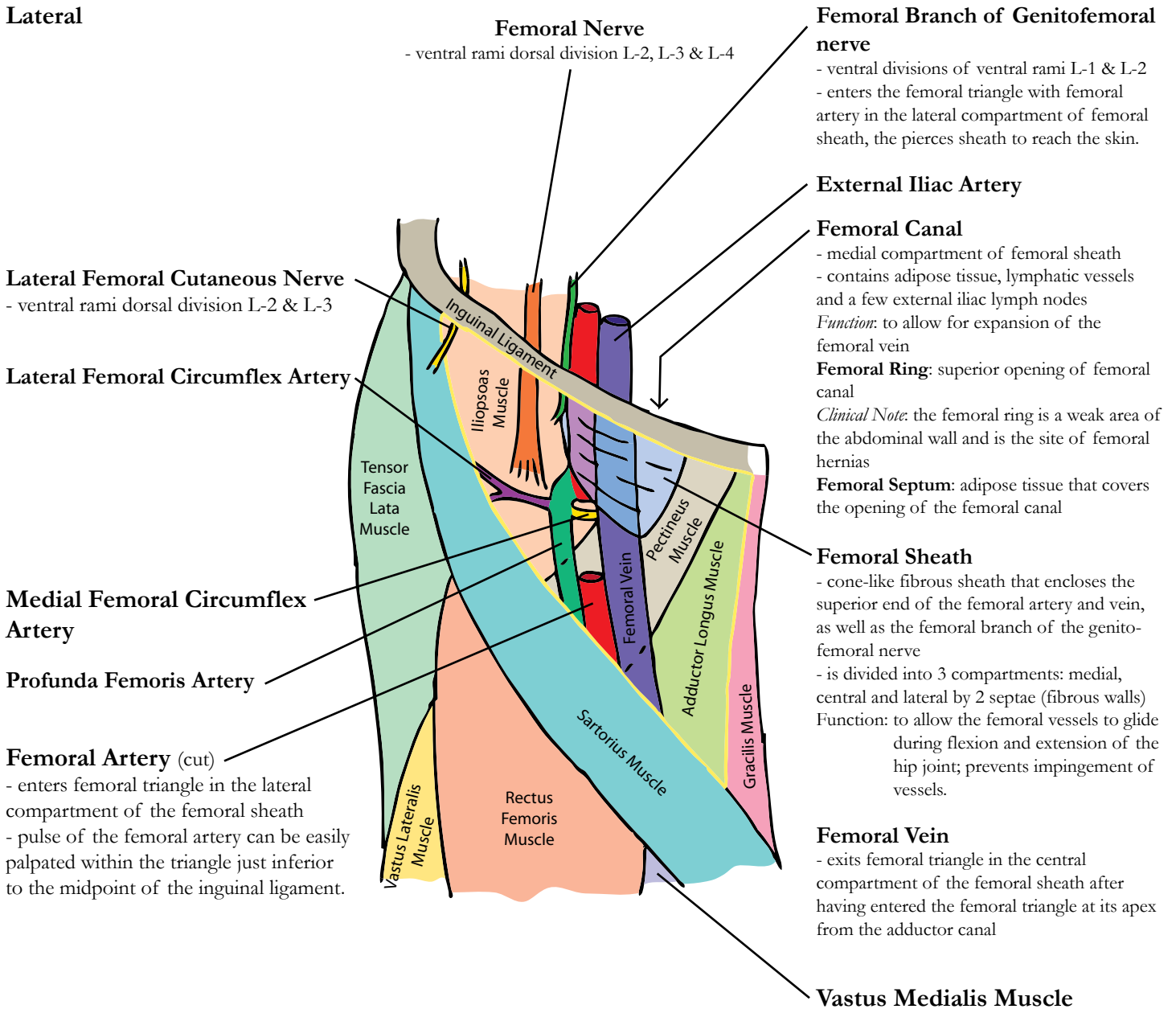


# Femoral Triangle - Hip Region

## Anterior View

Medial

Lateral



**Femoral Nerve**  
- ventral rami dorsal division L-2, L-3 & L-4

**Femoral Branch of Genitofemoral nerve**

- ventral divisions of ventral rami L-1 & L-2  
- enters the femoral triangle with femoral artery in the lateral compartment of femoral sheath, the pierces sheath to reach the skin.

**External Iliac Artery**

**Femoral Canal**

- medial compartment of femoral sheath  
- contains adipose tissue, lymphatic vessels and a few external iliac lymph nodes  
*Function:* to allow for expansion of the femoral vein

**Femoral Ring:** superior opening of femoral canal

*Clinical Note:* the femoral ring is a weak area of the abdominal wall and is the site of femoral hernias

**Femoral Septum:** adipose tissue that covers the opening of the femoral canal

**Femoral Sheath**

- cone-like fibrous sheath that encloses the superior end of the femoral artery and vein, as well as the femoral branch of the genitofemoral nerve  
- is divided into 3 compartments: medial, central and lateral by 2 septae (fibrous walls)  
*Function:* to allow the femoral vessels to glide during flexion and extension of the hip joint; prevents impingement of vessels.

**Femoral Vein**

- exits femoral triangle in the central compartment of the femoral sheath after having entered the femoral triangle at its apex from the adductor canal

**Lateral Femoral Cutaneous Nerve**  
- ventral rami dorsal division L-2 & L-3

**Lateral Femoral Circumflex Artery**

**Medial Femoral Circumflex Artery**

**Profunda Femoris Artery**

**Femoral Artery (cut)**  
- enters femoral triangle in the lateral compartment of the femoral sheath  
- pulse of the femoral artery can be easily palpated within the triangle just inferior to the midpoint of the inguinal ligament.

### Femoral Triangle

- triangular space deep to the fascia lata at the superior medial aspect of the thigh
- an important clinical space as many neurovascular structures pass through it
- the base is superior and the apex is inferior
- apex extends to the adductor canal
- Floor - pectineus, adductor longus and iliopsoas muscles
- Roof - fascia lata, includes the cribriform fascia

# Base of Femoral Triangle

## Superior View

Lateral

Medial

Muscular Lacuna/Lacuna Musculorum

Vascular Lacuna/Lacuna Vasculorum

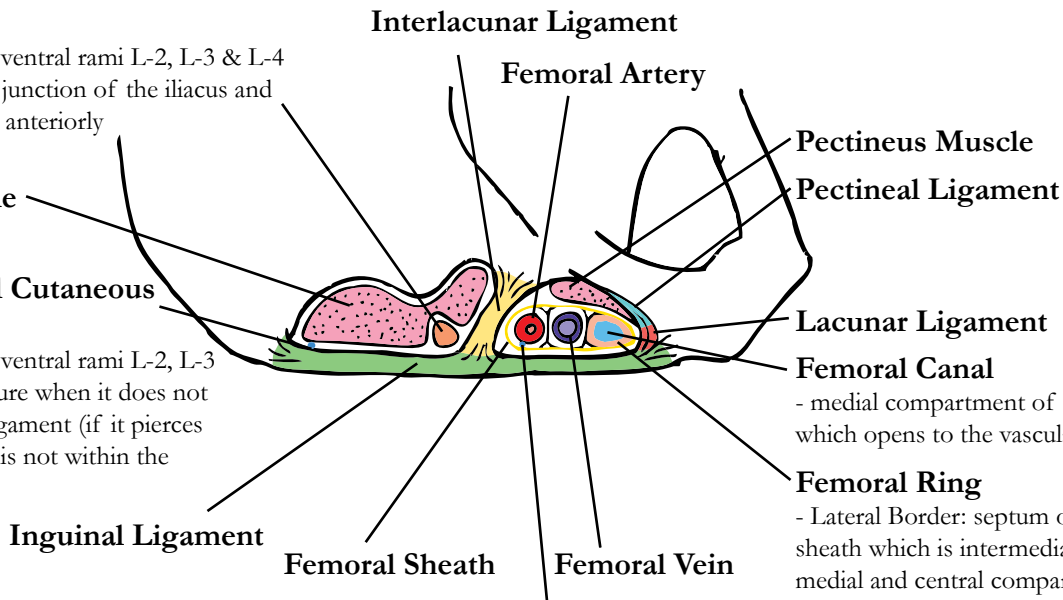
### Femoral Nerve

- dorsal divisions of ventral rami L-2, L-3 & L-4
- passes through the junction of the iliacus and psoas major muscles anteriorly

### Iliopsoas Muscle

### Lateral Femoral Cutaneous Nerve

- dorsal divisions of ventral rami L-2, L-3
- anterolateral structure when it does not pierce the inguinal ligament (if it pierces the ligament, then it is not within the femoral triangle)



### Femoral Branch of Genitofemoral Nerve

- ventral divisions of ventral rami L-1, L-2

### Pectineus Muscle

### Pectineal Ligament

### Lacunar Ligament

### Femoral Canal

- medial compartment of femoral sheath which opens to the vascular lacuna

### Femoral Ring

- Lateral Border: septum of the femoral sheath which is intermediate to the medial and central compartments
- Medial Border: lacunar or Gimbernat's ligament
- Anterior Border: inguinal or Poupart's ligament
- Posterior Border: pectineus muscle and pectineal ligament or Cooper's ligament

# Muscular & Vascular Lacunae

## Inferior View

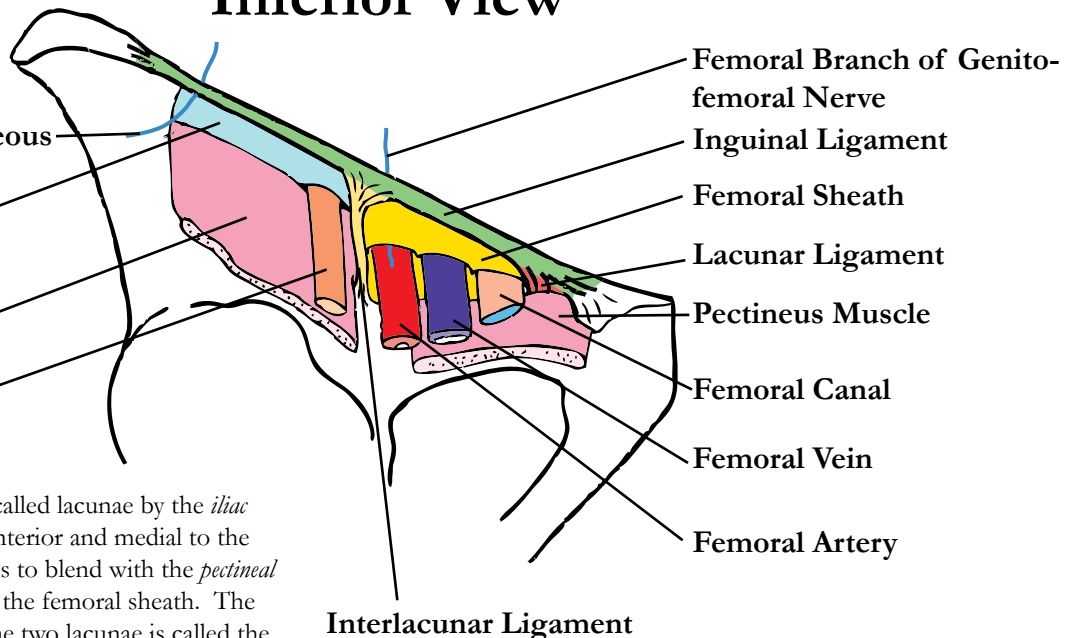
### Lateral Femoral Cutaneous Nerve

### Iliac Fascia

### Iliopsoas Muscle

### Femoral Nerve

- area is divided into 2 spaces called lacunae by the *iliac fascia/fascia iliaca* as it passes anterior and medial to the iliacus and psoas major muscles to blend with the *pectineal fascia* and the posterior wall of the femoral sheath. The thickening at the division of the two lacunae is called the *interlacunar ligament*



### Femoral Branch of Genitofemoral Nerve

### Inguinal Ligament

### Femoral Sheath

### Lacunar Ligament

### Pectineus Muscle

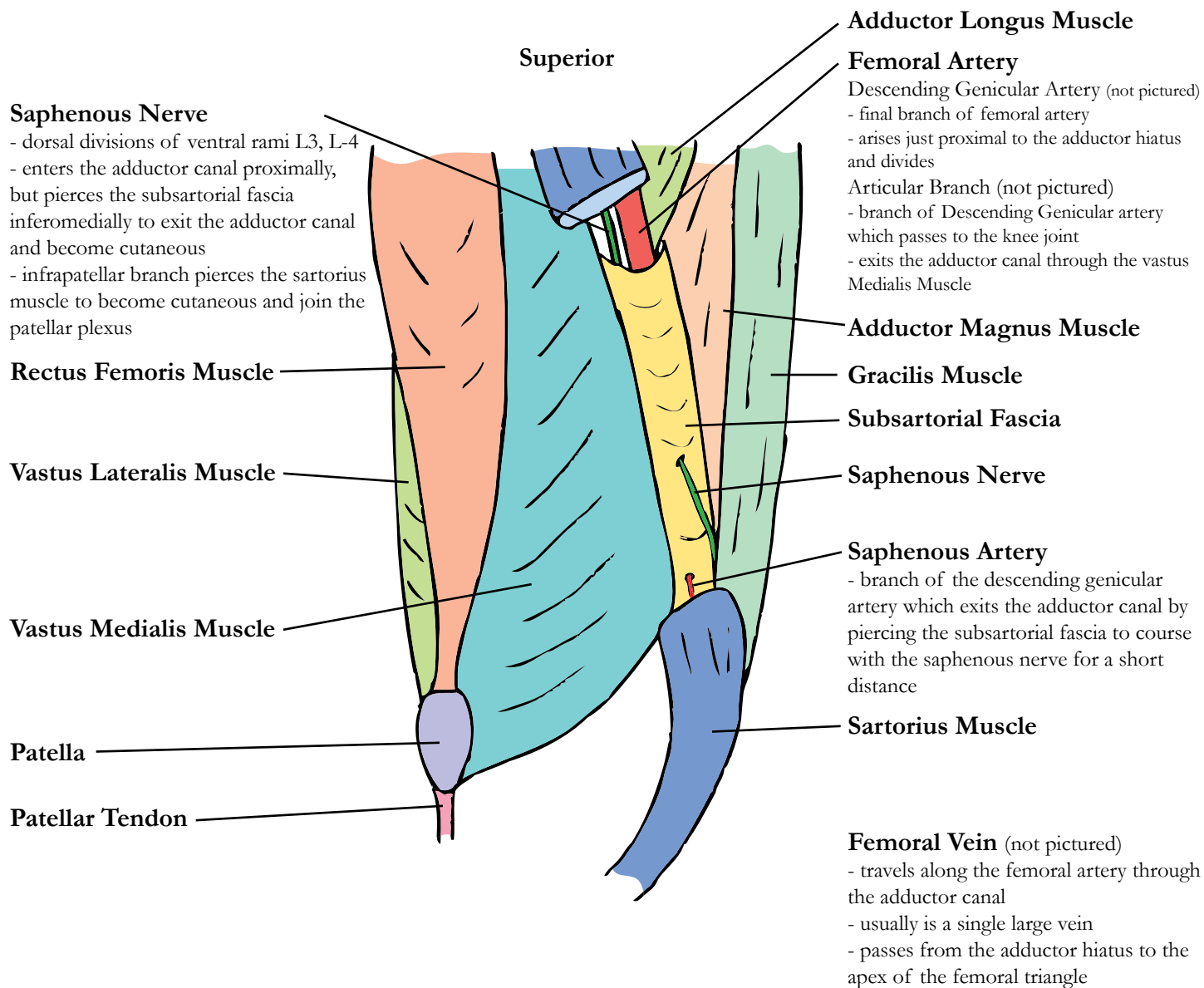
### Femoral Canal

### Femoral Vein

### Femoral Artery

### Interlacunar Ligament

# Adductor Canal - Thigh Anteromedial View



The adductor canal is also called the subsartorial canal or Hunter's canal. It is a narrow fascial tunnel in the thigh which is located deep to the sartorius muscle and extends from the apex of the femoral triangle to the adductor hiatus. The adductor canal is roughly triangular on a cross-section view.

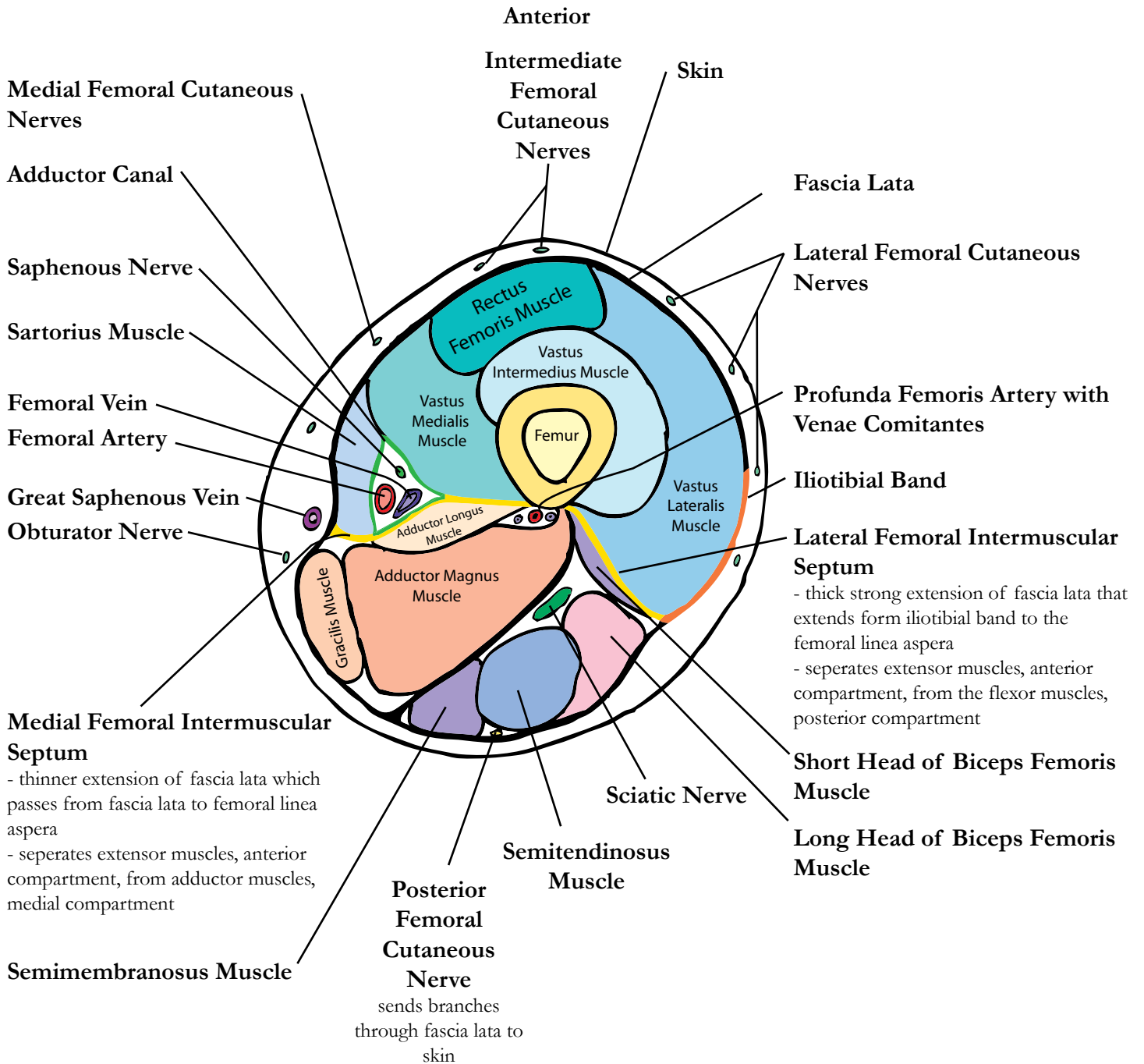
Posterior: adductor longus and adductor magnus muscle

Anteromedial: subsartorial fascia which is very thick and lies on the deep surface of the sartorius muscle

Anterolateral: vastus medialis muscle

# Thigh - Cross Section

## Anteromedial View



Deep fascia/ Fascia lata  
 - thicker anteriorly and laterally  
 - laterally it forms the iliotibial band  
 - fascia lata surrounds all muscles and compartments, but is not named in all areas

# Popliteal Fossa - Knee

## Posterior View

Medial

Lateral

Sciatic Nerve

Adductor Magnus Muscle

Biceps Femoris Muscle

Gracilis Muscle

Vastus Lateralis Muscle

Semimembranosus Muscle

Tibial Nerve

- ventral division of ventral rami L-4, L-5, S-1, S-2 & S-3

- enters posterior compartment of the leg via the fibrous arch of soleus muscle

Semitendinosus Muscle

Common Fibular Nerve

- dorsal division of ventral rami L-4, L-5, S-1 & S-2  
- passes along the superior lateral border of the popliteal fossa at the edge of the biceps femoris muscle to course around the fibular head and neck  
- enters lateral compartment of the leg by piercing the posterior intermuscular septum of the leg where it divides into its two terminal branches; superficial and deep fibular nerves

Sartorius Muscle

Popliteal Artery

- passes through the popliteal fossa and enters the posterior compartment of the leg by passing through the fibrous arch of soleus muscle  
- passes from a superomedial position to an inferocentral position within the popliteal fossa  
- situated deep to both the popliteal vein and the tibial nerve within the popliteal fossa  
- pulse can be palpated in this region; easiest superiorly, just medial to the midline with the knee slightly flexed

Lateral Cutaneous Nerve of the Calf

- dorsal division of ventral rami L-5, S-1 & S-2  
- arises in the popliteal fossa and passes into the superficial fascia over the lateral calf region to supply the superior part of the lateral aspect of the leg

Popliteal Vein

- drains into the femoral vein, superiorly; formed by the union of the venae comitantes of the posterior tibial and the anterior tibial arteries  
- enters the popliteal fossa via the fibrous arch of soleus muscle and exits the popliteal via the adductor hiatus  
- drains the small saphenous vein  
- crosses popliteal artery from posteromedial to posterolateral as it passes superiorly

Fibular Communicating Nerve/  
Lateral Sural Cutaneous Nerve

- dorsal division of ventral rami S-1 & S-2  
- arises in the popliteal fossa from the common fibular nerve or in the leg from the lateral cutaneous nerve of the calf and passes inferomedially to join the sural nerve, in the inferior 1/2 of the leg.

Gastrocnemius Muscle

- plantaris muscle is immediately deep to the gastrocnemius muscle

Medial Sural Cutaneous Nerve/  
Sural Nerve

- ventral division of ventral rami S-1 & S-2  
- branch of tibial nerve that passes into the superficial fascia at the inferior aspect of the popliteal fossa, travels inferiorly through the leg region and passes posterior to the lateral malleolus to reach the lateral aspect of the foot.

Small Saphenous Vein

The fossa bulges posteriorly when the knee is extended and becomes depressed when the knee is flexed. Clinically, this is an important area as the pulse of the popliteal artery can be palpated here and the popliteal lymph nodes are located here.

There is much adipose tissue in the popliteal fossa to protect all of the neurovascular structures.

Floor:

Popliteal surface of the femur - superior

Oblique popliteal ligament - central

Popliteus muscle and its fascial covering - inferior

Roof: formed by skin and fasciae

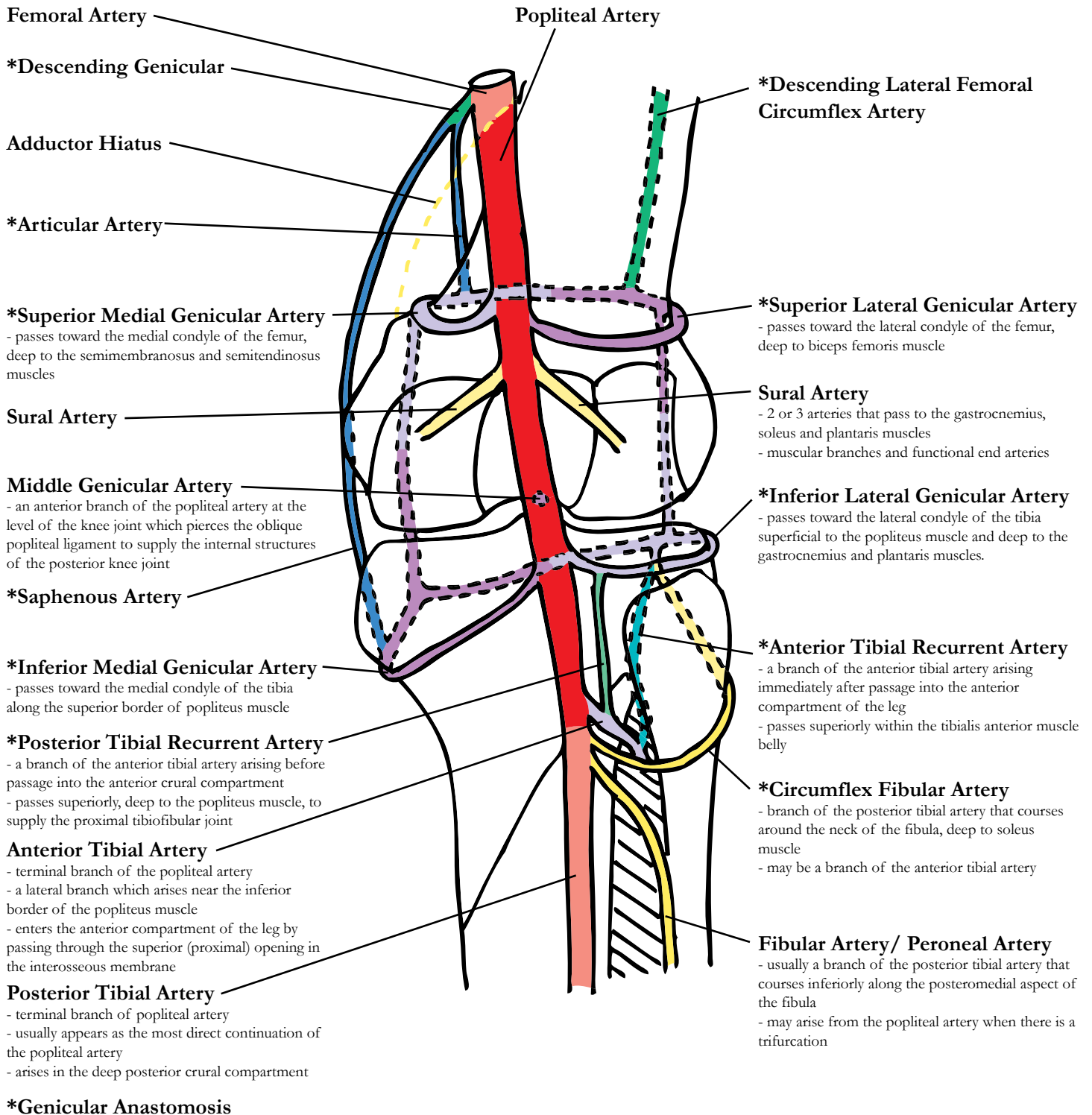
Superficial Fascia - contains fat, terminal end of the small saphenous vein, and cutaneous nerves

Deep Fascia/popliteal fascia - thin, strong fascial covering that holds the borders together and connects the fascia lata to the fascia cruris

# Vascular Supply - Knee Joint

## Posterior View

note: Dashed lines are anterior





# Knee Joint

## Posterior View

Medial

Lateral

### Extracapsular Ligaments/Extrinsic Ligaments

- these ligaments are located outside of or are part of the knee joint capsule

#### Adductor Tubercle

#### Capsule

- knee joint capsule is well defined and reinforced by ligaments medially, laterally and posteriorly  
 - knee joint capsule is deficient anteriorly where it is replaced by the patellar tendon, the medial patellar retinaculum and the lateral patellar retinaculum

#### Medial Patellar Retinaculum

- a fascial extension from the vastus medialis muscle to the patella and patellar ligament  
 - reinforces the knee joint anteromedially

#### Lateral Patellar Retinaculum

- fascial extension from the vastus lateralis muscle to the patella and patellar ligament  
 - reinforces the knee joint anterolaterally

#### Medial Genual Collateral Ligament/ Tibial Genual Collateral Ligament

- a broad ligament that extends from the medial epicondyle of the femur to the medial surface of the tibia  
 - its deep surface attaches to the medial surface of the medial meniscus so if the ligament is damaged, the medial meniscus is generally also damaged  
 - reinforces the knee joint capsule, medially  
 - blends with the capsule

#### Semimembranosus Tendon

#### Fascia over Popliteus Muscle

#### Oblique Popliteal Ligament

- an extension of the semimembranosus tendon that attaches at the margins of the femoral intercondylar notch  
 - the fascia over the popliteus muscle is not considered to be a ligament and it is inferior to the knee joint  
 - reinforces the knee joint capsule, posteriorly  
 - blends with the capsule  
 - forms part of the floor of the popliteal fossa

#### Arcuate Popliteal Ligament/ Arcuate ligament of the Knee

- a Y-shaped ligament that attaches to the lateral epicondyle of the femur, the posterior tibial intercondylar fossa and the apex of the fibula  
 - reinforces the knee joint capsule, posteriorly

#### Lateral Genual Collateral Ligament/ Fibular Genual Collateral Ligament

- a relatively narrow, round ligament that extends from the lateral epicondyle of the femur to the apex of the fibula  
 - does not attach to the lateral meniscus  
 - reinforces the knee joint capsule, laterally

#### Biceps Femoris Tendon

#### Popliteus Muscle



- knee joint is often described as a ginglymus (hinge) type of joint, which only allows flexion and extension. However a small amount of rotation normally occurs at the knee joint as well. There is usually some medial rotation of the leg with the knee joint flexion and some lateral rotation of the leg with knee joint extension. This is most easily demonstrated by slowly flexing and extending the leg with the foot planted on the floor. As the knee flexes, the malleoli will internally rotate. As the knee extends, the malleoli will externally rotate. The knee joint is a structural synovial ginglymus or synovial bicondylar joint and a functional diarthrosis.

- arterial supply is from the *genicular anastomosis* and the *middle genicular artery*.

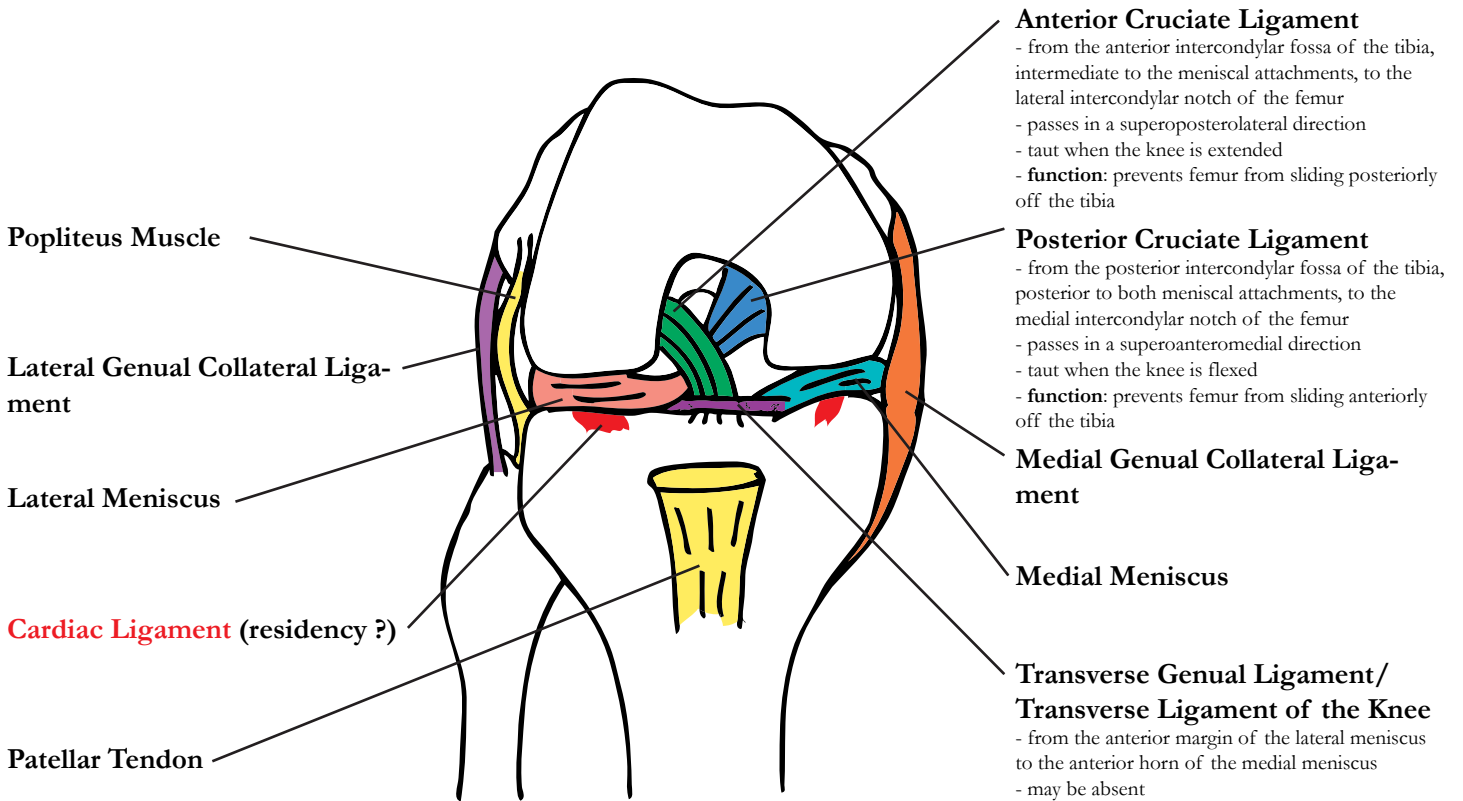
- innervation to the knee joint is supplied by branches of the *obturator, femoral, tibial and common fibular nerves*. The posterior branch of the obturator nerve generally sends a branch that enters the joint posteriorly with the middle genicular artery. The tibial nerve sends two or three branches that generally follow the medial and middle genicular arteries. The common fibular nerve sends branches that follow the lateral genicular arteries, and the anterior tibial recurrent artery. The anterior tibial recurrent branch innervates the infrapatellar fat pad. The saphenous nerve, and muscular branches to the vasti muscles from the femoral nerve supply the knee joint from the medial, anterior and lateral aspects.

# Flexed Knee Joint

## Anterior View

Lateral

Medial



### Anterior Cruciate Ligament

- from the anterior intercondylar fossa of the tibia, intermediate to the meniscal attachments, to the lateral intercondylar notch of the femur
- passes in a superoposterolateral direction
- taut when the knee is extended
- **function:** prevents femur from sliding posteriorly off the tibia

### Posterior Cruciate Ligament

- from the posterior intercondylar fossa of the tibia, posterior to both meniscal attachments, to the medial intercondylar notch of the femur
- passes in a superoanteromedial direction
- taut when the knee is flexed
- **function:** prevents femur from sliding anteriorly off the tibia

### Medial Genual Collateral Ligament

### Medial Meniscus

### Transverse Genual Ligament/ Transverse Ligament of the Knee

- from the anterior margin of the lateral meniscus to the anterior horn of the medial meniscus
- may be absent

### Popliteus Muscle

### Lateral Genual Collateral Ligament

### Lateral Meniscus

### Cardiac Ligament (residency ?)

### Patellar Tendon

### Menisci of the Knee joint

- crescent-shaped pads of fibrocartilage that produce a better fit between the tibia and the femur
- thicker at the external edge and very thin centrally
- surrounded by synovial fluid except at external surfaces
- may help to lubricate joint surfaces properly, so are intrasynovial and intracapsular
- sometimes regenerate after excision

### Medial Meniscus

- semi-circular (C-shaped) pad that covers part of the superior articular surface of the medial condyle of the tibia
- attached to the medial genual collateral ligament, medially to maintain position

### Anterior Horn of Medial Meniscus

- the anterior ligamentous part
- attaches to the anteromedial aspect of the *anterior intercondylar fossa* of the tibia, anterior to the attachments of the anterior cruciate ligament and the anterior horn of the lateral meniscus

### Posterior Horn of Medial Meniscus

- the posterior ligamentous part
- attaches to the medial aspect of the *posterior intercondylar fossa* of the tibia, anterior to the attachment of the posterior cruciate ligament and posterior to the attachment of the posterior horn of the lateral meniscus

### Lateral Meniscus

- an almost circular-shaped pad that covers the majority of the superior articular surface of the lateral condyle of the tibia
- its posterolateral edge attaches to the popliteus muscle which helps maintain its articular position

### Anterior Horn of Lateral Meniscus

- the anterior ligamentous part
- attaches to the posterolateral aspect of the *tibial anterior intercondylar fossa*, immediately anterior to the intercondylar eminence and posterior to the attachment of the anterior cruciate ligament

### Posterior Horn of Lateral Meniscus

- the posterior ligamentous part
- attaches to the anterolateral aspect of the *tibial posterior intercondylar fossa*, immediately posterior to the intercondylar eminence and anterior to the attachments of the posterior horn of the medial meniscus and the posterior cruciate ligament



# Knee Joint

## Posterior View

- capsule removed -

Medial

Lateral

### Posterior Cruciate Ligament

### Posterior Menisofemoral

#### Ligament/ Ligament of Wrisberg

- from the posterior edge of the lateral meniscus to the lateral surface of the medial femoral condyle/ medial femoral intercondylar notch
- passes along the posterior aspect of the posterior cruciate ligament

### Medial Meniscus

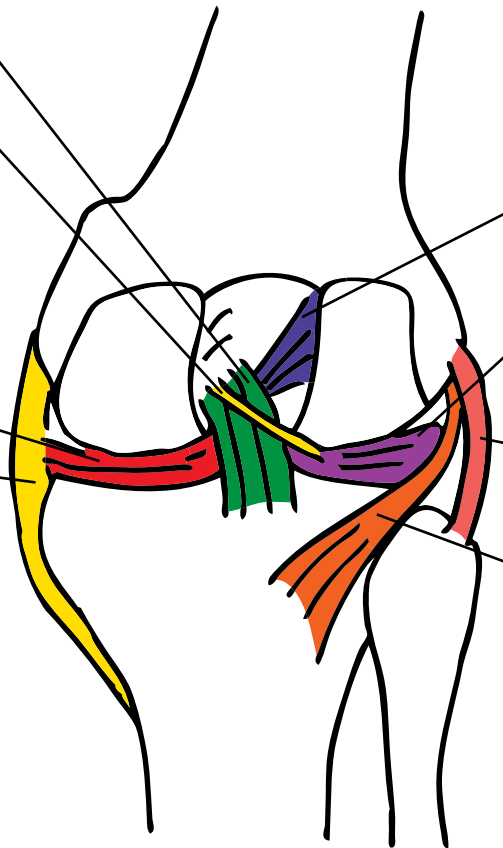
### Medial Genual Collateral Ligament

### Anterior Cruciate Ligament

### Lateral Meniscus

### Lateral Genual Collateral Ligament

### Popliteus Muscle



### Anterior Menisofemoral Ligament/ Ligament of Humphry

- From the posterior edge of the lateral meniscus to the lateral surface of the medial femoral condyle / medial femoral intercondylar notch
- passes along the anterior aspect of the posterior cruciate ligament
- may be absent

### Muscle

- the popliteus muscle is closely associated with the knee joint; its origin is intracapsular and it becomes extracapsular as it passes distal to the medial edge of the arcuate popliteal ligament
- it is an intracapsular and extrasynovial structure of the knee
- attaches to the posterolateral edge of the lateral meniscus which helps maintain the meniscal position

### Tibia

- attaches along the margins of the articular cartilage on the superior surface; it invaginates along the anterior and posterior intercondylar sulci

### Anterior Intercondylar Sulcus

- the synovial membrane invaginates slightly from the anterior edge to line the posterior aspect of the *infrapatellar fat pad*
- passes superiorly to the patella from the central area or to the menisci from the articular margins

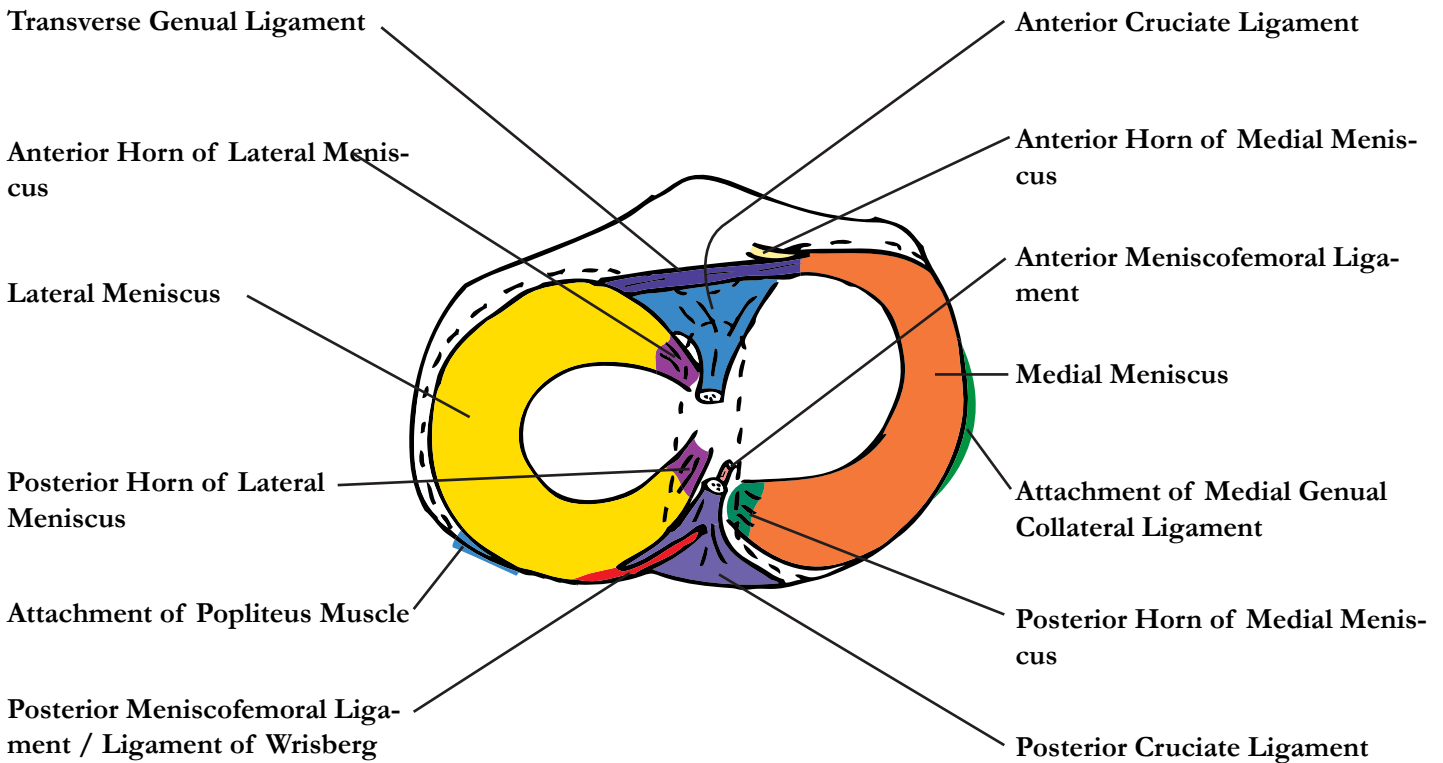
### Posterior Intercondylar Sulcus

- the synovial membrane invaginates to line the anterior, medial and lateral aspects of both cruciate ligaments, so the posterior aspect of the capsule is not lined by synovium
- this part of the synovial membrane passes to the inferior edge of the intercondylar notch of the femur from the margins of the sulcus or to the inferior meniscal edges from the posterior articular margins of the sulcus.

# Cross Section of Knee Joint Superior View

Lateral

Medial



## Synovial Membrane (dashed lines)

- all structures in knee are extrasynovial
- synovial cavity of the knee is the largest in the body

## Femur

- attaches along the margins of the articular cartilage of the distal femur; medially, anteriorly, laterally and posteriorly
- are two attachments at the inferior edge of the intercondylar notch; one from the apex of the patella and one from the anterior edge of the posterior intercondylar sulcus of the tibia.

## Menisci

- the synovium attaches to the external edges of the menisci and passes to the margins of the articular cartilage of the femoral and tibial condyles and the patella

## Patella

- attaches along the margins of the articular cartilage on the posterior surface
- from the superior border of the patella to the superior edge of the patellar surface of the femur
- here it forms the *suprapatellar bursa* which extends superiorly, deep to the quadriceps femoris muscle

## Patella cont.

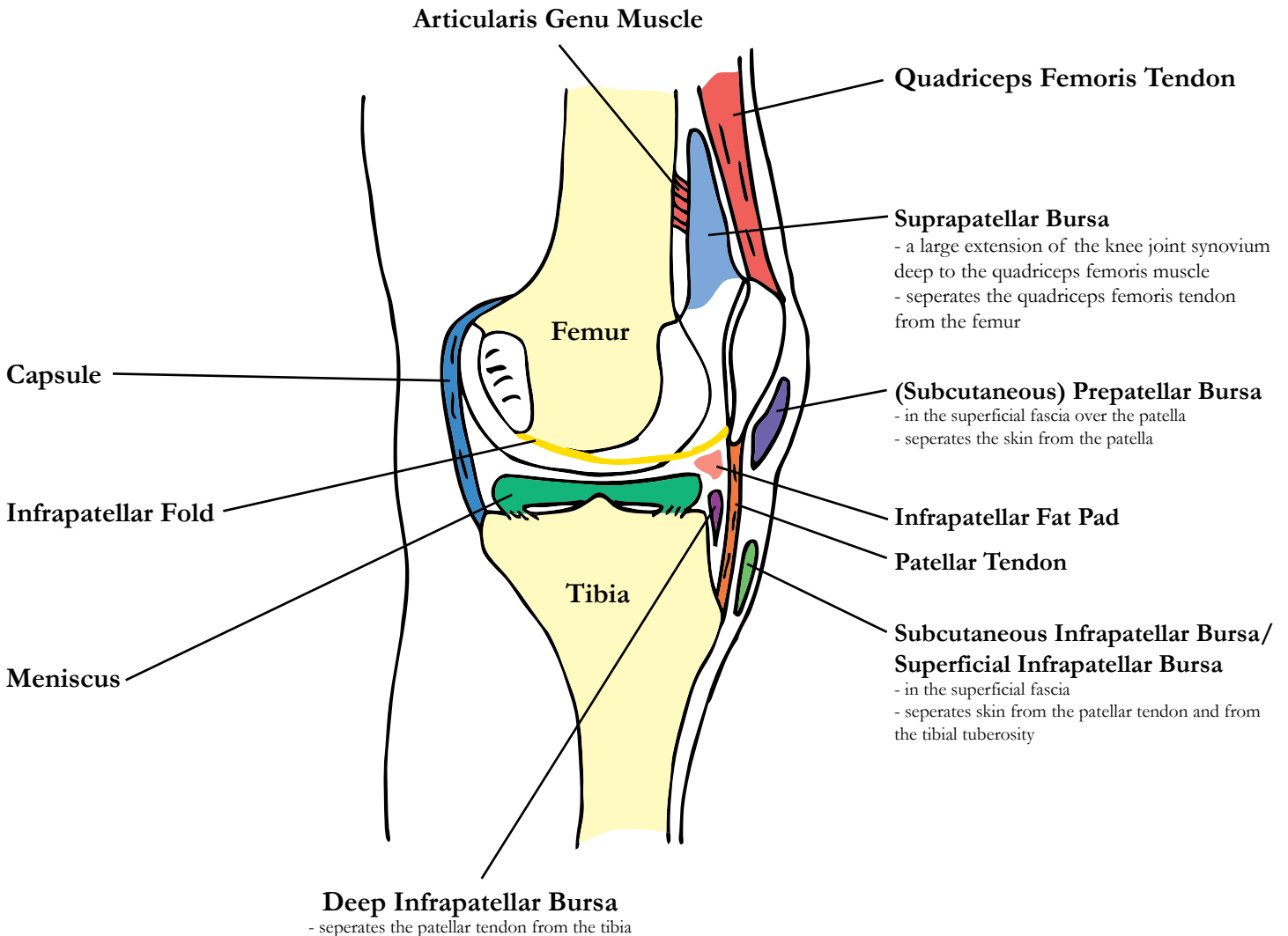
- from the inferior edge / apex of the patella to the inferior edge of the intercondylar fossa of the femur, the synovium passes inferoposteriorly
  - here it forms the *infrapatellar fold*
- from the medial and lateral margins of the patella, the synovium passes superiorly to the corresponding edges of the patellar surface of the femur, and inferiorly to the anterior superior edges of the menisci and the anterior intercondylar sulcus of the tibia (where menisci are not present)

# Knee Joint

## Midsagittal View

Posterior

Anterior



### Bursae of the knee

- function: allow free movement of the structures that are separated anterior side and projects posteriorly in doing this

#### Anserine Bursa / Bursa Anserina (not pictured)

- located between the medial collateral ligament of the knee and the pes anserinus, also around the individual tendons of the pes anserinus as they insert at the proximal medial tibial shaft  
- separates the patellar tendon from the tibia

#### Semimembranosus Bursa (not pictured)

- located between the semimembranosus muscle and the medial head of the gastrocnemius muscle at the area of the medial condyle of the femur

#### Popliteus Bursa (not pictured)

- located between the popliteus tendon and the lateral condyle of the tibia  
- continuous with the knee joint inferior to the lateral meniscus

(not pictured)

- located between the medial head of gastrocnemius muscle and the knee joint

- often communicates with the semimembranosus bursa

- may communicate with the knee joint

### Infrapatellar Fat Pad

- adipose tissue which separates the synovium from the patellar ligament  
- the synovium lines this fat pad on its posterior side and projects posteriorly in doing this

#### Alar Folds

- two fringe-like structures that meet in the center, at the infrapatellar fold  
- formed by the synovium as it lines the infrapatellar fat pad and passes from the patella to the menisci and tibia

#### Infrapatellar Fold

- extends from the apex of the patella to the inferior margin of the intercondylar fossa of the femur

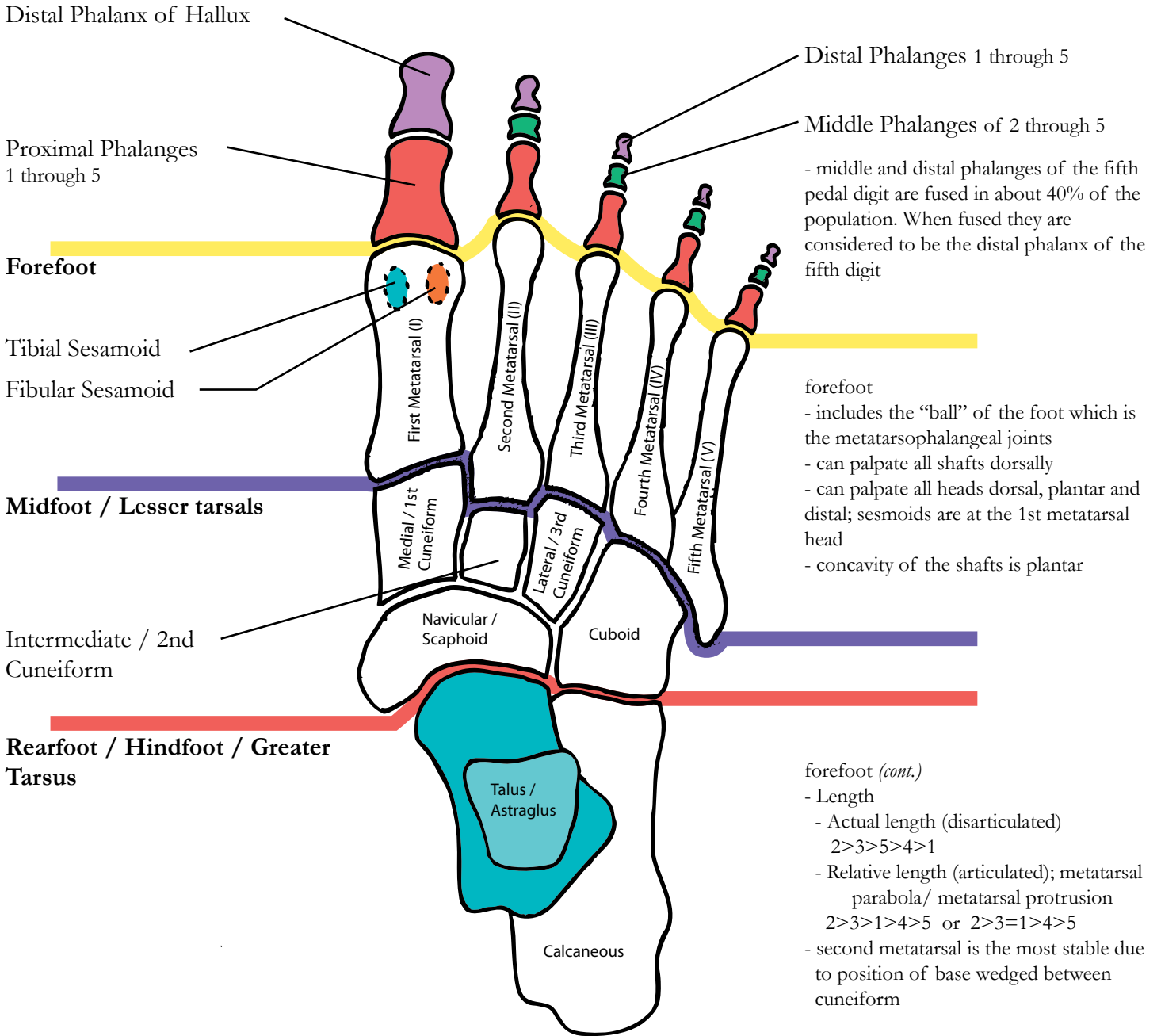
- where the alar folds meet (centrally)

# Osteology of the Foot

## Dorsal View

Medial

Lateral

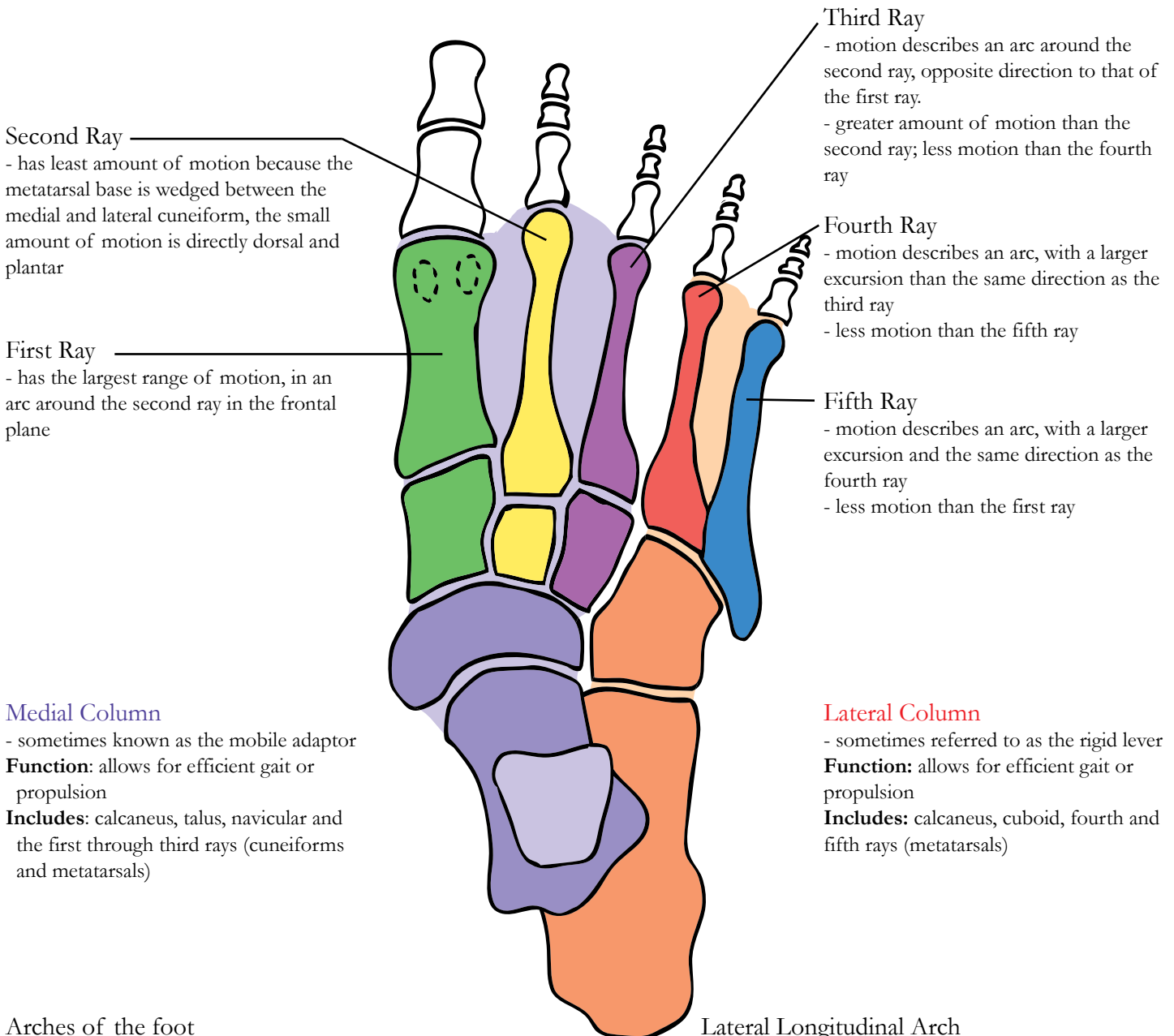


# Functional Units - Foot

## Dorsal View

Medial

Lateral



**Second Ray**  
- has least amount of motion because the metatarsal base is wedged between the medial and lateral cuneiform, the small amount of motion is directly dorsal and plantar

**First Ray**  
- has the largest range of motion, in an arc around the second ray in the frontal plane

**Third Ray**  
- motion describes an arc around the second ray, opposite direction to that of the first ray.  
- greater amount of motion than the second ray; less motion than the fourth ray

**Fourth Ray**  
- motion describes an arc, with a larger excursion than the same direction as the third ray  
- less motion than the fifth ray

**Fifth Ray**  
- motion describes an arc, with a larger excursion and the same direction as the fourth ray  
- less motion than the first ray

### Medial Column

- sometimes known as the mobile adaptor  
**Function:** allows for efficient gait or propulsion  
**Includes:** calcaneus, talus, navicular and the first through third rays (cuneiforms and metatarsals)

### Lateral Column

- sometimes referred to as the rigid lever  
**Function:** allows for efficient gait or propulsion  
**Includes:** calcaneus, cuboid, fourth and fifth rays (metatarsals)

### Arches of the foot

- **function:** allow the foot to absorb shock

#### Medial Longitudinal Arch

- layman's arch  
- formed by the medial column of the foot  
- from the heel to the first through third metatarsal heads, plantarly  
- normally is a smooth curve of variable height, but higher than the lateral longitudinal arch

#### Lateral Longitudinal Arch

- formed by the lateral column of the foot  
- from the heel to the fourth and fifth metatarsal heads, plantarly  
- normally is a smooth curve of low height

#### Transverse Arch

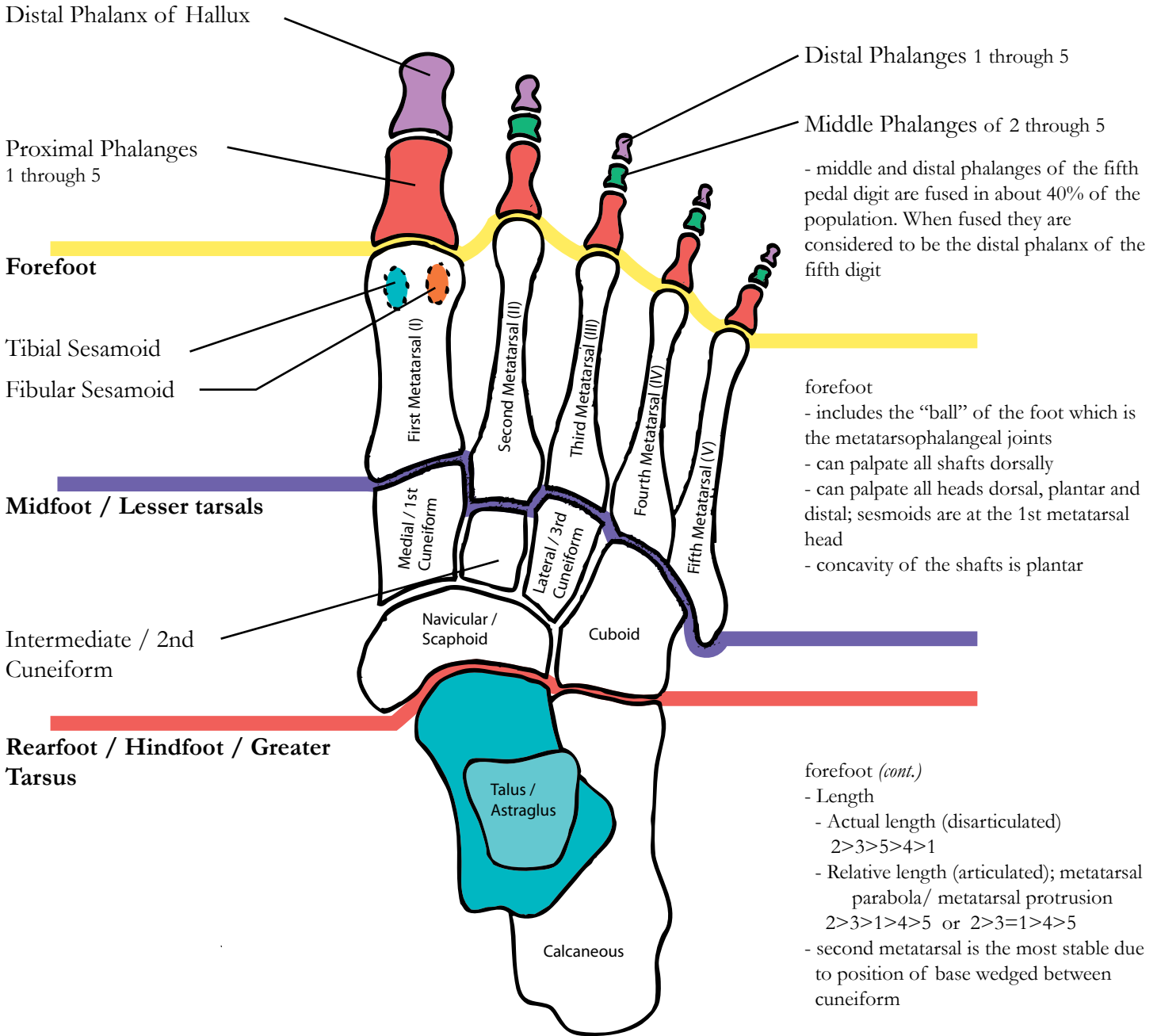
- formed by the plantar aspect of the cuneiforms and the cuboids; 1/2 of this arch is in each foot  
- some consider more than one transverse arch  
- also at the metatarsal heads, one in each foot  
- also at the metatarsal bases, 1/2 in each foot

# Osteology of the Foot

## Dorsal View

Medial

Lateral

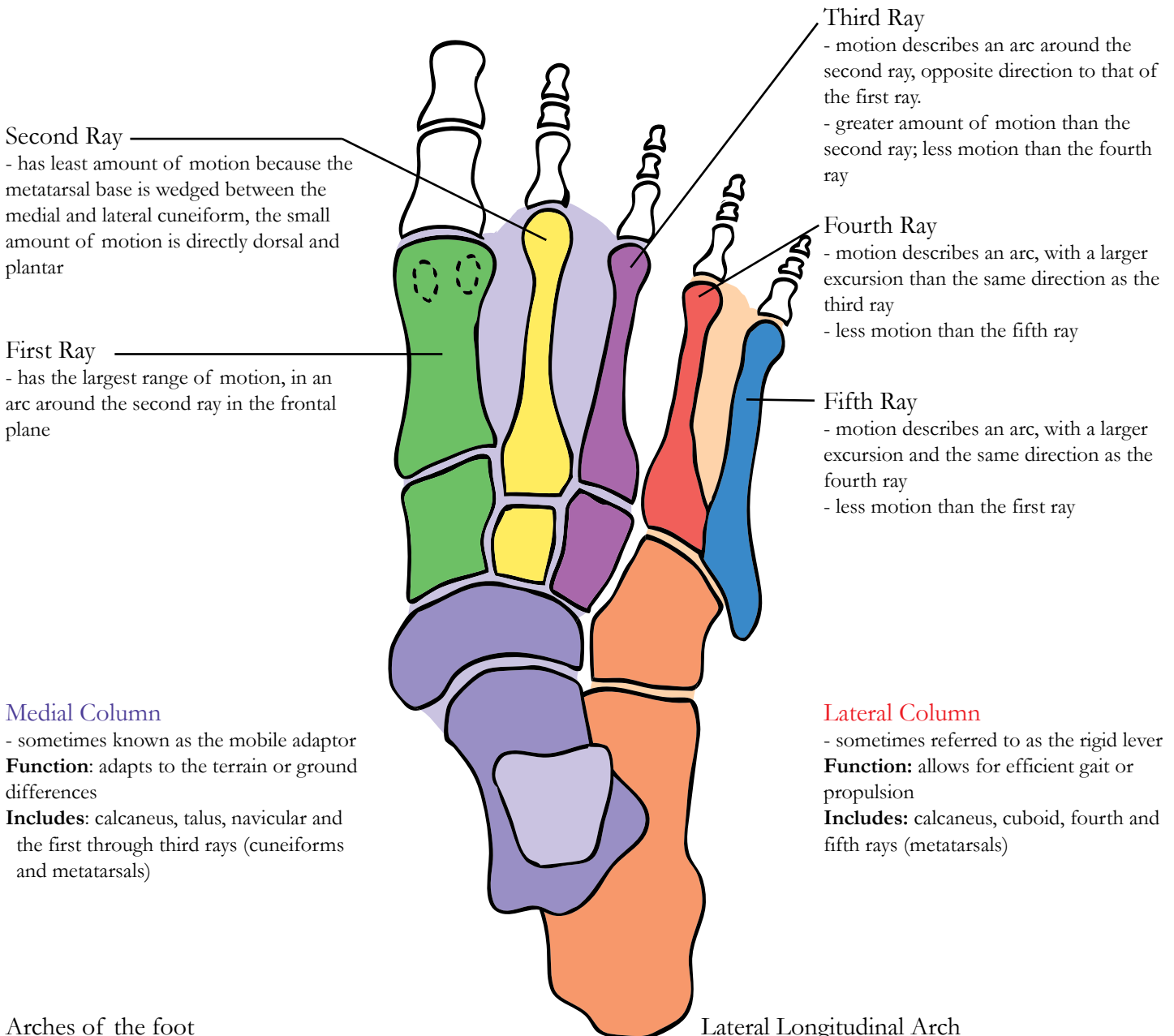


# Functional Units - Foot

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Lateral



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 - less motion than the fifth ray

**Fifth Ray**  
 - motion describes an arc, with a larger excursion and the same direction as the fourth ray  
 - less motion than the first ray

### Medial Column

- sometimes known as the mobile adaptor  
**Function:** adapts to the terrain or ground differences

**Includes:** calcaneus, talus, navicular and the first through third rays (cuneiforms and metatarsals)

### Lateral Column

- sometimes referred to as the rigid lever  
**Function:** allows for efficient gait or propulsion

**Includes:** calcaneus, cuboid, fourth and fifth rays (metatarsals)

### Arches of the foot

- **function:** allow the foot to absorb shock

#### Medial Longitudinal Arch

- layman's arch

- formed by the medial column of the foot

- from the heel to the first through third metatarsal heads, plantarly

- normally is a smooth curve of variable height, but higher than the lateral longitudinal arch

#### Lateral Longitudinal Arch

- formed by the lateral column of the foot

- from the heel to the fourth and fifth metatarsal heads, plantarly

- normally is a smooth curve of low height

#### Transverse Arch

- formed by the plantar aspect of the cuneiforms and the cuboids; 1/2 of this arch is in each foot

- some consider more than one transverse arch

- also at the metatarsal heads, one in each foot

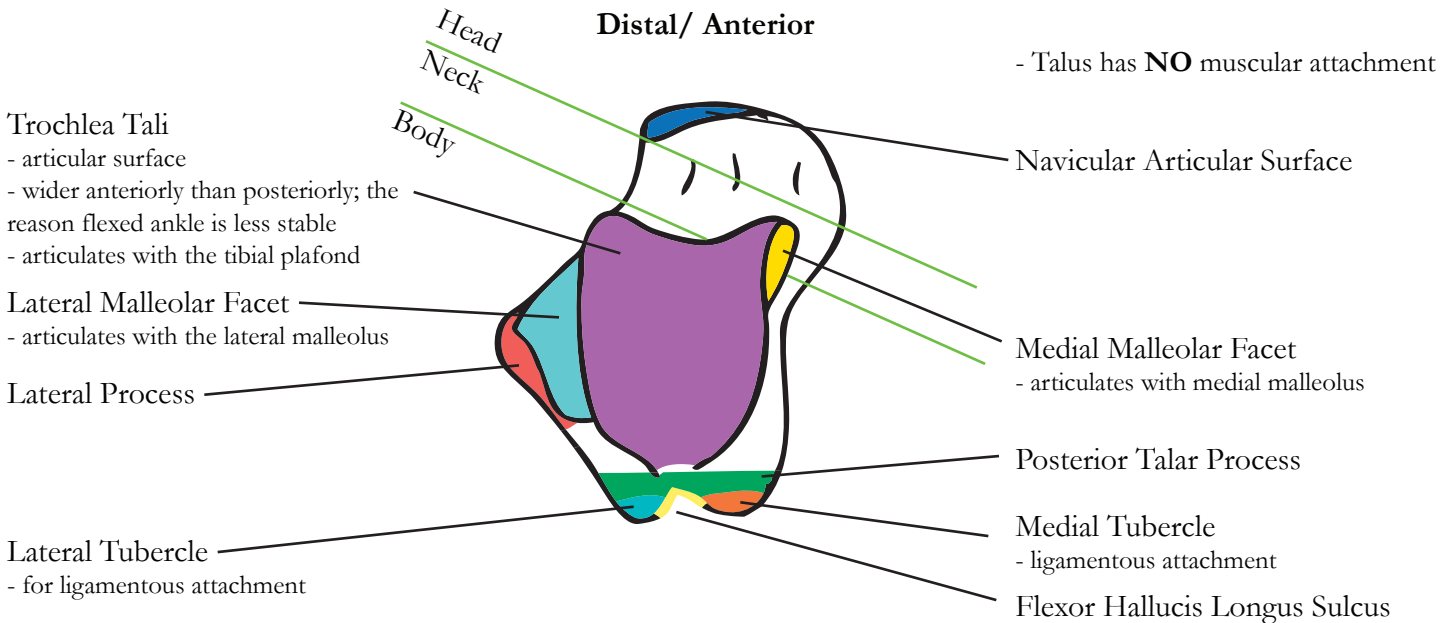
- also at the metatarsal bases, 1/2 in each foot

# Talus

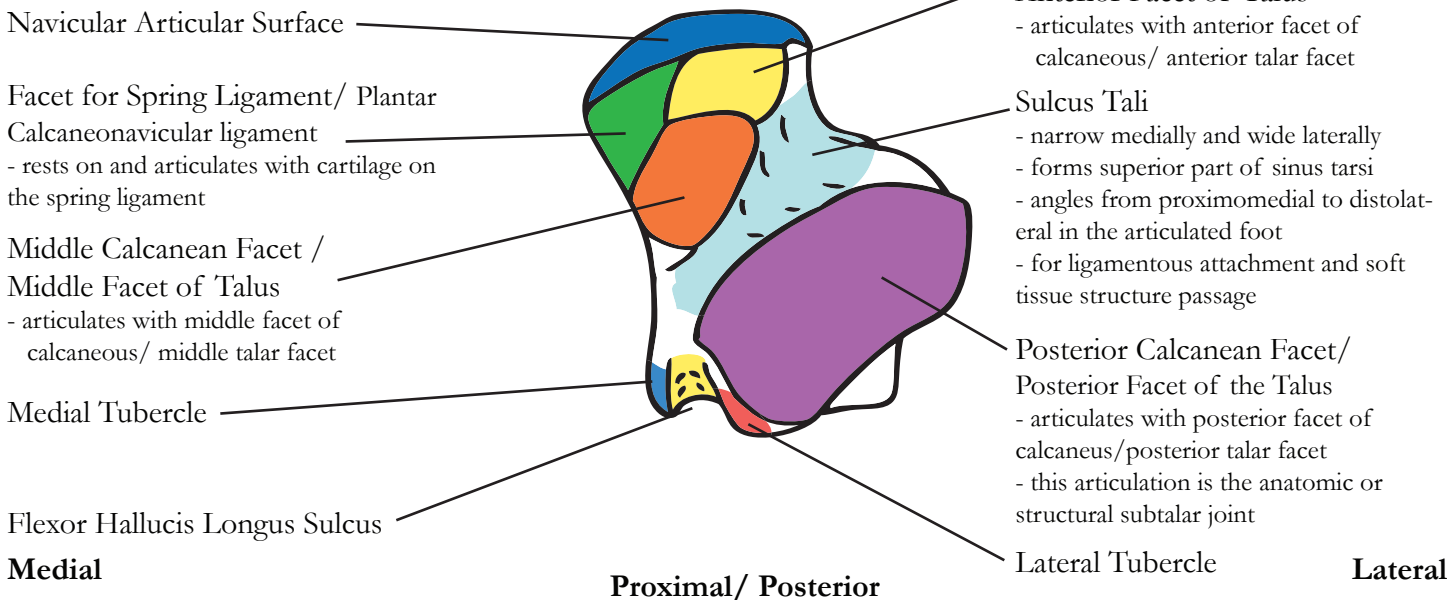
## Dorsal View

**Lateral**

**Medial**



## Plantar View



**Primary Center of Ossification**  
 - normally a single center in body of talus  
 - appears by **6th fetal month**

**Secondary Center of Ossification**  
 - occasionally Present  
 - in the lateral tubercle of the posterior process of talus

*Os Trigonum* - accessory ossicle usually present when secondary ossification center did not fuse to primary ossification center.

### Morphologic Changes

- talus normally undergoes torsional changes during development that change the relative position of its parts  
 - when these do not occur, have persistent talor torsion and get flatfoot.

*Frontal Plane* - changes from infancy to adulthood (adult 40)

- due to external rotation of head and neck which raises the talor head relative to the floor.

*Transverse Plane* - decreases from infancy (35) to adulthood (15) moves laterally

- considered to be a result of the torsional change within the neck of the talus



# Talus

## Morphologic Changes

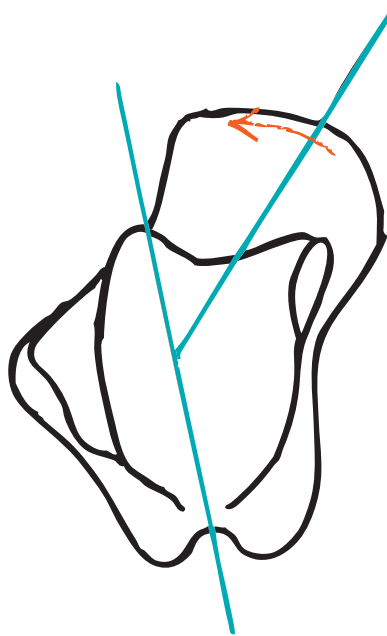
Lateral

Distal/ Anterior

Medial

### Transverse Plane Dorsal View

- longitudinal bisection of the body to the longitudinal bisection of the head and neck
- decreases from infancy (near 35) to adulthood (near 15)
- moves laterally
- this is considered to be a result of the torsional change within the neck of the talus



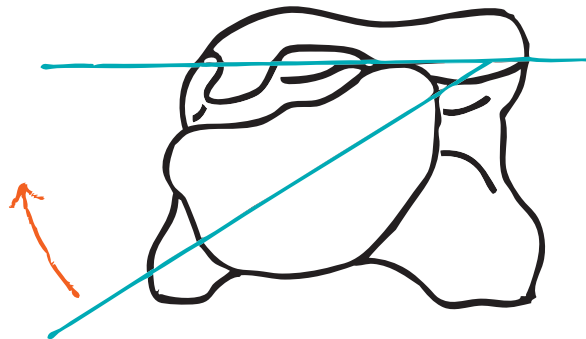
Navicular Articular Surface

Proximal/ Posterior

### Frontal Plane Anterior View

Superior

Medial



Lateral

Inferior

- talus normally undergoes torsional changes during development that change the relative position of its parts
- When these do not occur, have persistent talar torsion and get flatfoot

- the horizontal bisection of the head to the horizontal plane of the talar body
- changes from infancy to adulthood (adult 40)
- due to external rotation of the head and neck which raises the talar head relative to the floor.

# Calcaneus

Largest bone of the foot

## Dorsal View

Lateral

Medial

Dorsal / Anterior

### Anterior Process

- best viewed on lateral radiograph of foot/ankle

### Sulcus Calcanei

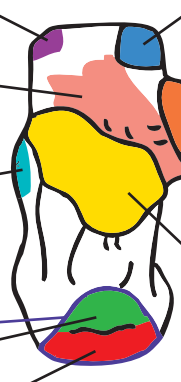
- wider laterally than medially  
 - forms the inferior part of the sinus tarsi  
 - for ligamentous attachment and passage of soft tissue structures

### Peroneal Tubercle or Trochlea / Fibular Trochlea or Tubercle

- for attachment of the inferior fibular retinaculum/ inferior peroneal retinaculum

### Posterior Calcaneal Surface

- Superior 1/3 / Trigonum Achilleum  
 - smooth area where a bursa is located  
 - called bursal projection of calcaneus  
 - Middle 1/3  
 - Roughened area for insertion of Achilles Tendon



### Anterior Talar Facet / Anterior Facet of Calcaneus

- smallest of 3 articular facets  
 - articulates with anterior facet of talus

### Middle Talar Facet / Middle Facet of Calcaneus

- articulates with middle facet of the talus

### Sustentaculum Tali

- medial shelf like projection of calcaneus  
 - provides pulley type advantage for some muscles and attachment for ligaments

### Posterior Talar Facet/ Posterior Facet of Calcaneus

- largest of articular facets on superior surface  
 - articulates with posterior facet of the talus

## Plantar View

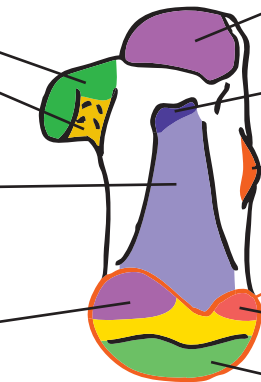
### Sustentaculum Tali

### Groove for Flexor Hallucis Longus Tendon

### Trigonum Plantare

- roughened triangular area which extends from the anterior tubercle of the calcaneus to the calcaneal tuberosity  
 - provides ligamentous and muscular attachment

### Medial Tubercle



### Cuboid Articular Facet

- convex from medial to lateral and concave from superior to inferior

### Anterior Tubercle

- ligamentous attachment

### Fibular Tubercle or Trochlea

### Calcaneal Tuberosity

- for muscular and fascial attachments  
 - weight-bearing prominence

Medial Tubercle - larger inferior medial

Lateral Tubercle - smaller inferior lateral

### Inferior 1/3 of the posterior surface

- weight-bearing area which is continuous with calcaneal tuberosity

Proximal / Posterior

### Sinus Tarsi

- tunnel formed by the sulcus tali and the sulcus calcanei  
 - includes the straight narrow medial parts and funnel-shaped lateral parts  
 - can palpate the lateral opening anterior to the lateral malleolar summit  
 - provides attachment and passage of soft tissue structures

*Canalis Tarsi* - the narrow medial part of the sinus tarsi  
 - provides attachment for a ligament

**Development** - only tarsal bone that regularly develops from two ossification centers

Primary Center of Ossification - center of the bone  
 - appears during the 3rd fetal month

Secondary Center of Ossification - inferior 2/3 of posterior surface and calcaneal tuberosity  
 - appears between ages 6 and 8 years at posterior inferior border of calcaneus  
 - called the *calcaneal apophysis*

### Internal Structure

- trabeculae of calcaneus are arranged such that weight is transferred to the forefoot and to the ground from its superior articular facets  
 - Neutral Triangle - roughly triangular area with few trabeculae  
 - created by weight-bearing forces through the bone  
 - visible on a lateral radiograph of the foot/ankle

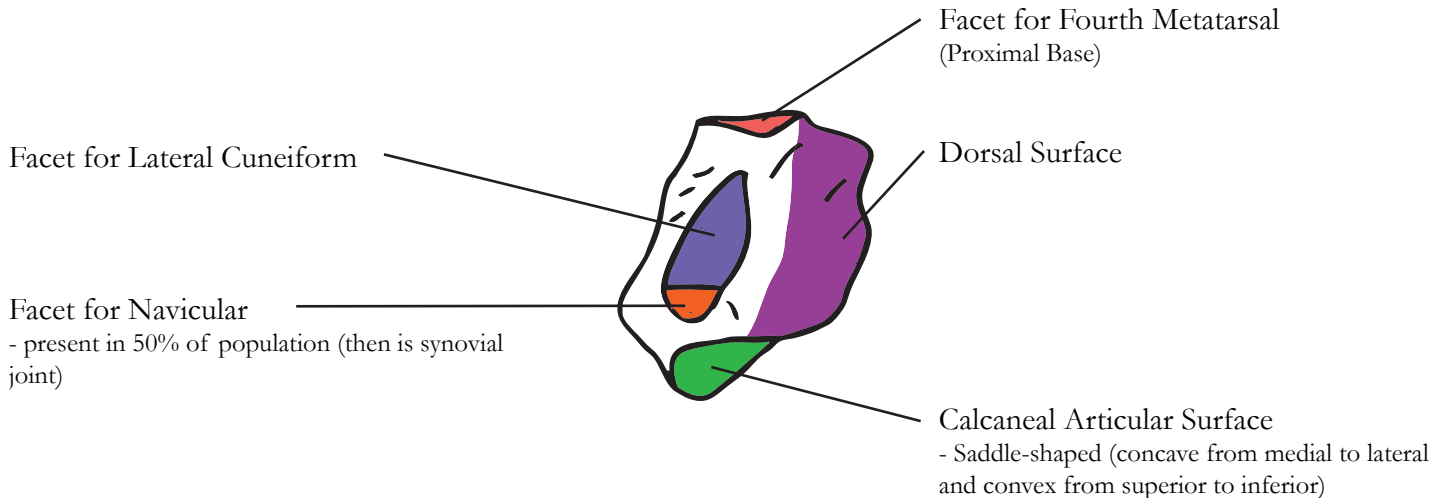
# Cuboid

## Dorsomedial View

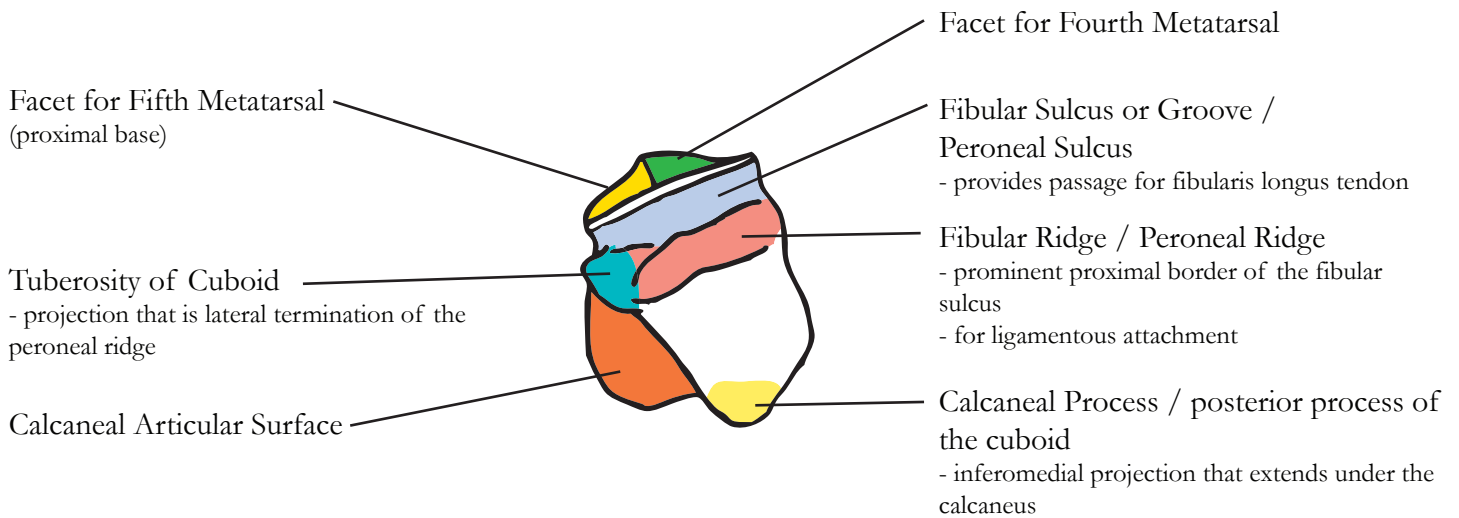
Plantar medial

Distal / Anterior

Dorsolateral



## Plantar View



Proximal/ Posterior

- Cuboid's entire superior surface is roughened for capsular / ligamentous attachment
  - this surface faces laterally in the articulated foot

### Development

Primary center of ossification

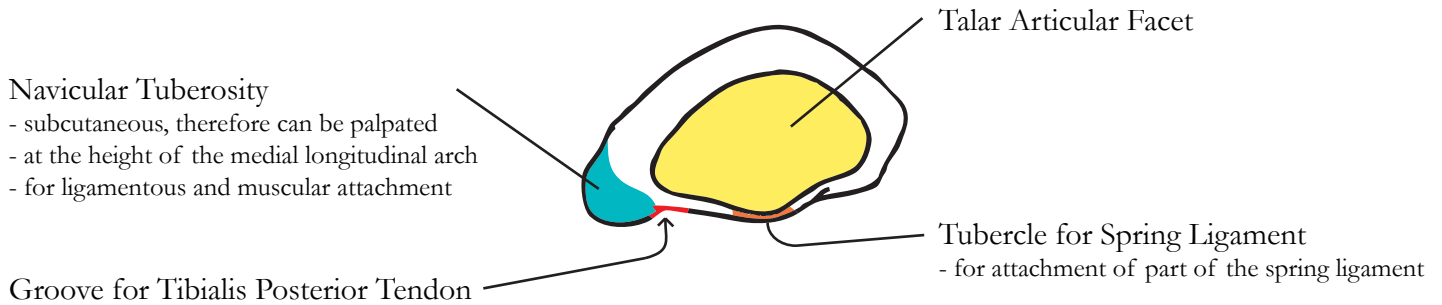
- single central center
- appears **near the time of birth**, usually present at birth

# Navicular Proximal View

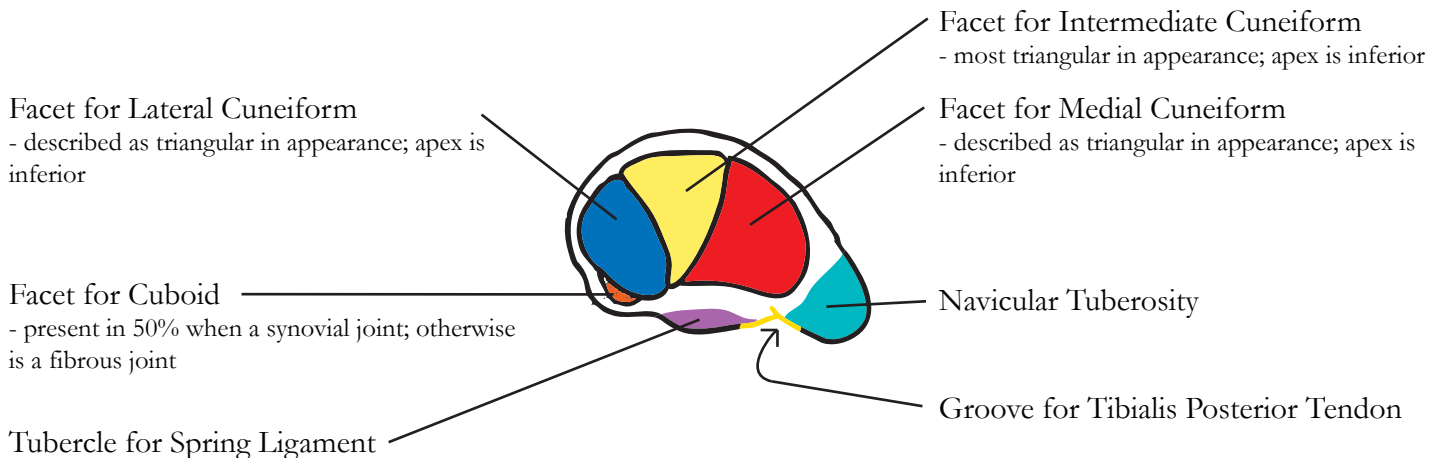
Medial

Dorsal / Superior

Lateral



## Distal View



Plantar / Inferior

### Development

- the navicular is last bone of the foot to begin ossification.  
Bones begin ossification at their primary centers. It may be used as an indicator of age from pediatric pedal radiographs

#### Primary Center of Ossification

- appears in center of bone near **age 3 years**

#### Secondary Center of Ossification

- occasionally present, in the medial part of the bone  
- if it does not fuse, results in a bipartite navicular

# Medial Cuneiform

## First Cuneiform

### Dorsal View

Proximal / Posterior

Superior / Dorsal

Lateral

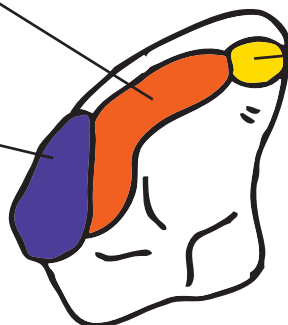
Facet for Intermediate Cuneiform

- an inverted "L" shape, along the superior and proximal borders

Posterior Articular Facet

- slightly concave facet  
- articulates with the medial facet on the anterior surface of the navicular  
- roughly triangular with apex superior and base inferior

Facet for Second Metatarsal Base



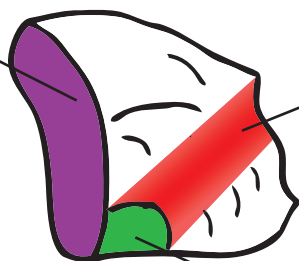
### Medial View

Facet for First Metatarsal Base (proximal)

- Larger than the posterior surface

Groove from tibialis Anterior Tendon

Smooth Surface for Accessory Sesamoid or Tibialis Anterior Tendon



Inferior / Plantar

- Largest of the cuneiform bones
- dorsal, plantar and medial surfaces are roughened for ligamentous and muscular attachment.
- situated in the body with its apex superior and base inferior

#### Development

**Primary Center of Ossification** - Center of bone near age 1.5 to 2 years

**Secondary Center of Ossification** - occasionally will have one center of ossification located plantar to the primary ossification center.

# Intermediate Cuneiform

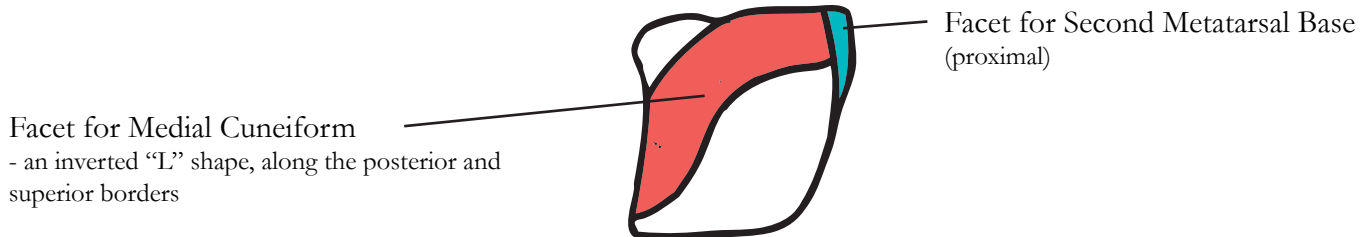
## Second Cuneiform

### Medial View

Proximal / Posterior

Superior / Dorsal

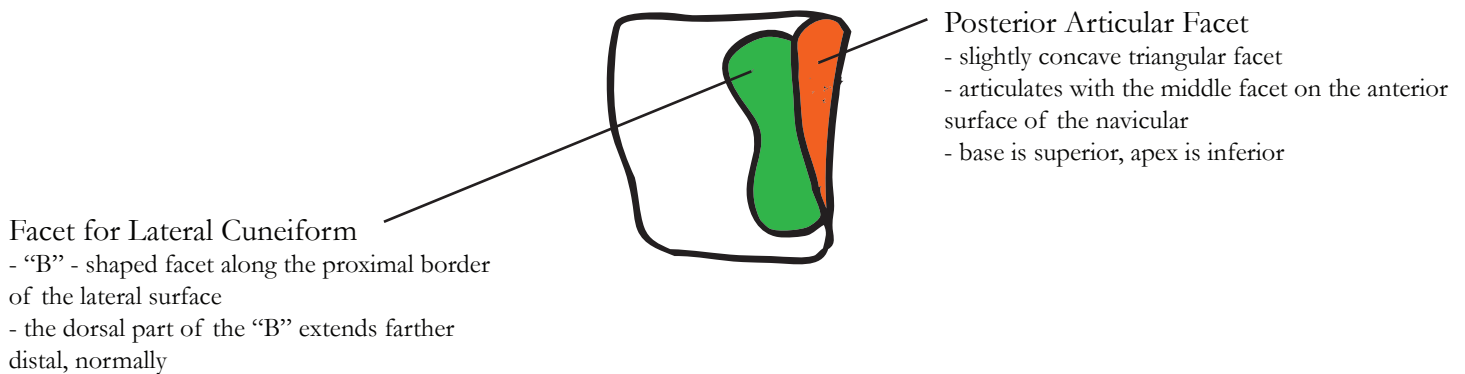
Distal / Anterior



### Lateral View

Distal / Anterior

Proximal / Posterior



### Inferior / Plantar

- smallest of the cuneiform bones
- wedge shaped with apex inferior and base superior
- dorsal / superior and plantar / inferior surfaces are roughened for ligamentous and muscular attachment
- Recognized by its wedge shape, a large inverted "L" - shaped facet is on its medial surface and a "B" - shaped facet is on its lateral surface.

### Development

#### Primary Center of Ossification

- appears in the center of the bone near **age 2.5 years**

# Lateral Cuneiform

## Third Cuneiform

### Medial View

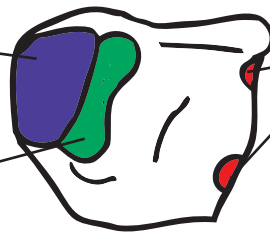
Proximal / Posterior

Superior / Dorsal

Distal / Anterior

Posterior Articular Facet  
- articulates with lateral facet on anterior surface of navicular

Facet for Intermediate Cuneiform  
- "B" - shaped facet



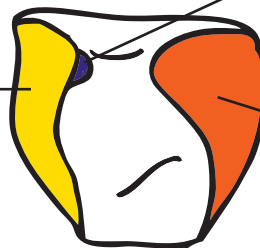
Facet for Second Metatarsal Base (proximolateral)  
- usually two demi-facets  
- dorsal or superior facet usually larger while the inferior may be absent

Distal / Anterior

## Lateral View

Distal / Anterior

Facet for Third Metatarsal Base (proximal)  
- triangular with base superior and apex inferior  
- covers the anterior surface



Facet for Fourth Metatarsal Base (proximomedial)

Facet for Cuboid

Plantar / Inferior

### Development

#### Primary Center of Ossification

- appears in center of bone near age 1 year

# First Metatarsal

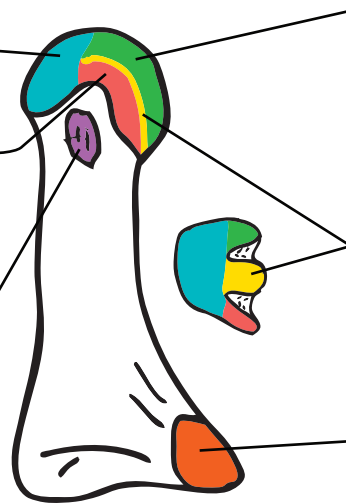
## Lateral View

**Dorsal / Superior**

**Distal / Anterior**

**Plantar / Inferior**

- Distal Articular Facet**  
- articulates with hallucal proximal phalangeal base
- Lateral Condyle**  
- weight-bearing projection  
- contains groove for articulation with lateral sesamoid  
- weight is transferred from the lateral sesamoid to lateral condyle of the head of first metatarsal
- Lateral Tubercle**  
- for ligamentous attachment



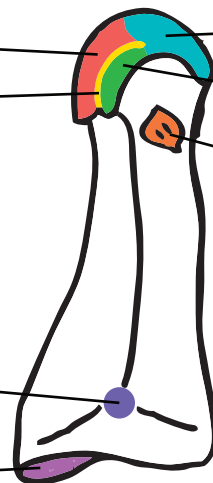
- Medial Condyle**  
- weight-bearing projection  
- contains groove for articulation with medial sesamoid  
- weight is transferred from the medial sesamoid to the medial condyle of the head of the first metatarsal
- Crista**  
- ridge at center of head plantarly  
- separates two grooves which articulate with sesamoid bones
- First Metatarsal tuberosity**  
- for insertion of peroneus longus muscle

## Medial View

**Plantar / Inferior**

**Dorsal / Superior**

- Lateral Condyle**
- Crista**
- First Metatarsal Tubercle**  
- for insertion of tibialis anterior muscle
- Posterior Articular Facet**  
- articulates with the medial cuneiform



- Distal Articular Facet**
- Medial Condyle**
- Medial Tubercle**  
- for ligamentous attachment

**Proximal / Posterior**

- shortest, thickest and heaviest metatarsal bone
- easy to palpate the shaft, base and head - dorsal and medial
- nutrient forament is located on the lateral surface of the shaft and generally in the proximal 1/2 or may be at the distal end
- nutrient artery is from dorsal metatarsal artery 1, usually
  - there may be dual supply from both the dorsal and plantar metatarsal arteries 1

### Development

#### Primary Center of Ossification

- appears in the shaft during **10th intrauterine week**

#### Secondary Center of Ossification

- appears in the base near **age 3 years**
  - fuses near 18 years of age
- this places the growth plate proximal between the base and the shaft
- occasionally a secondary center is also present in the head



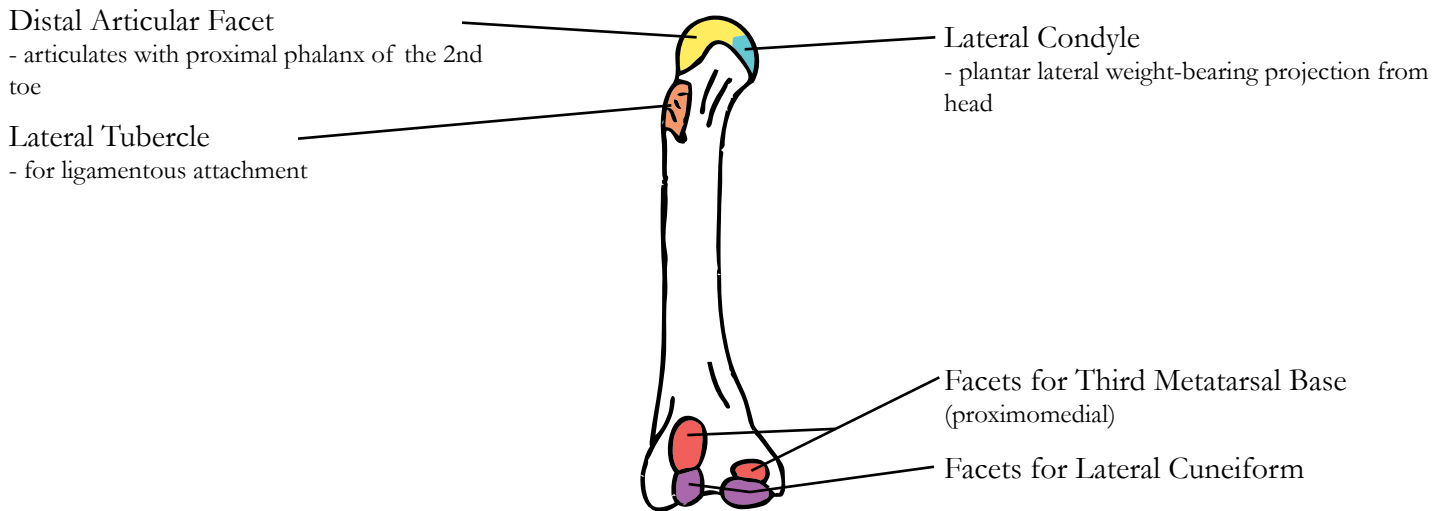
# Second Metatarsal

## Lateral View

Dorsal / Superior

Distal / Anterior

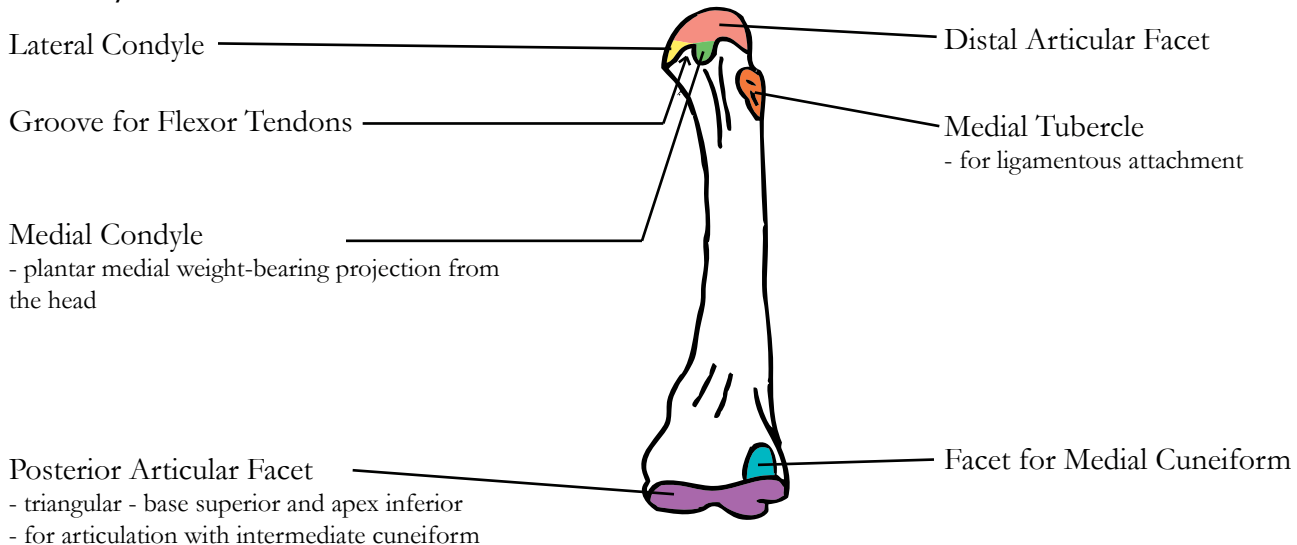
Plantar / Inferior



## Medial View

Plantar / Inferior

Dorsal / Superior



Proximal / Posterior

- longest metatarsal bone
- easy to palpate parts of the head, shaft and base
- nutrient foramen is located on the lateral surface of the shaft and generally in the proximal 1/3
- nutrient artery is from dorsal metatarsal artery 2, generally plantar

### Development

#### Primary Center of Ossification

- appears in the shaft during **9th intrauterine week**

#### Secondary Center of Ossification

- appears in the head between **ages 3 and 4 years**  
- fuses near 18 years of age

- this places the growth plate distally between the head and the shaft

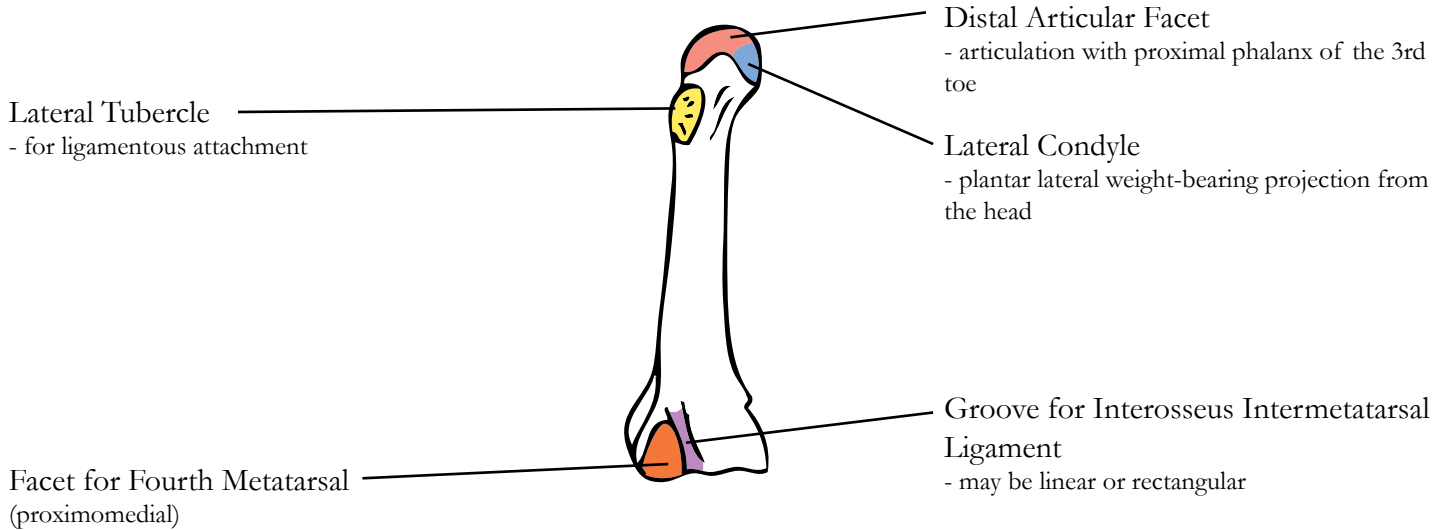
# Third Metatarsal

## Lateral View

**Dorsal / Superior**

**Distal / Anterior**

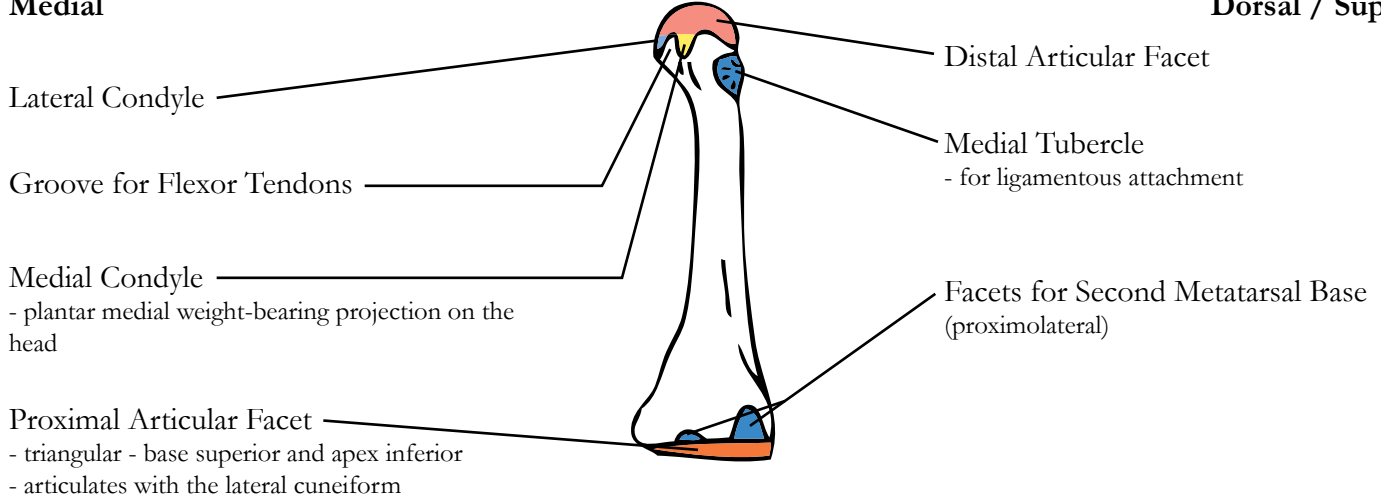
**Plantar / Inferior**



## Dorsal View

**Medial**

**Dorsal / Superior**



**Proximal / Posterior**

- easy to palpate parts of the head, shaft and base
- nutrient foramen is located on the lateral surface of the shaft in the proximal 1/3
- nutrient artery is from dorsal or plantar metatarsal artery 3, generally plantar

### Development

#### Primary Center of Ossification

- appears in the shaft during **9th fetal week**

#### Secondary Center of Ossification

- appears in the head between **ages 3 and 4 years**
  - fuses near 18 years of age
- this places the growth plate distally between the head and the shaft

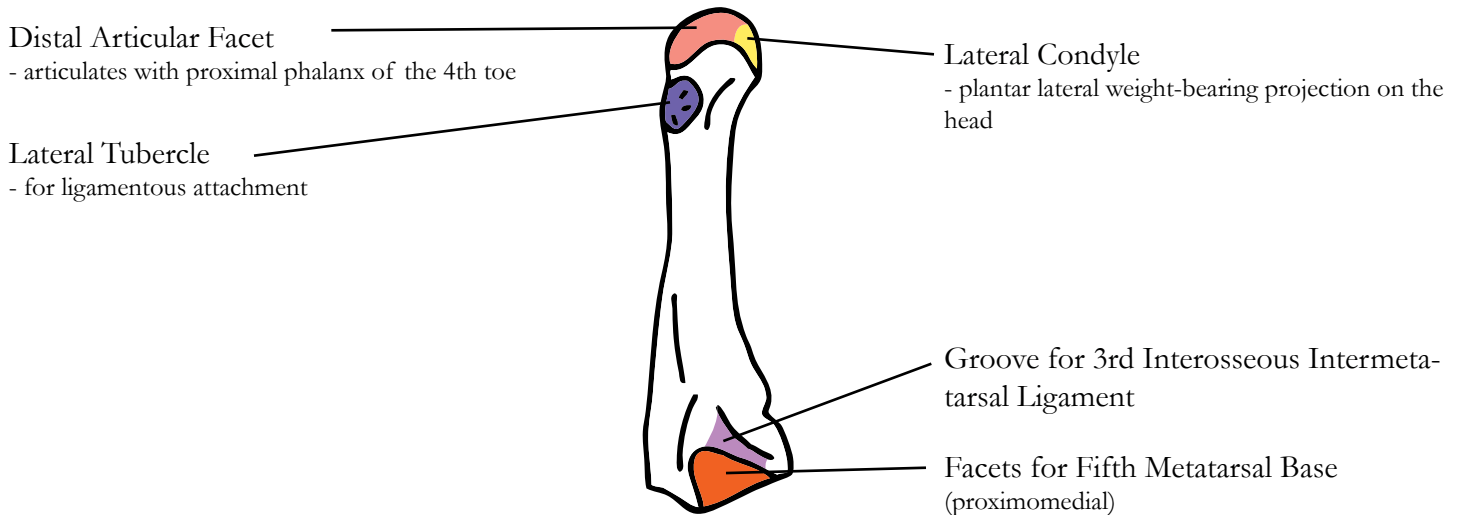
# Fourth Metatarsal

## Lateral View

**Dorsal / Superior**

**Distal / Anterior**

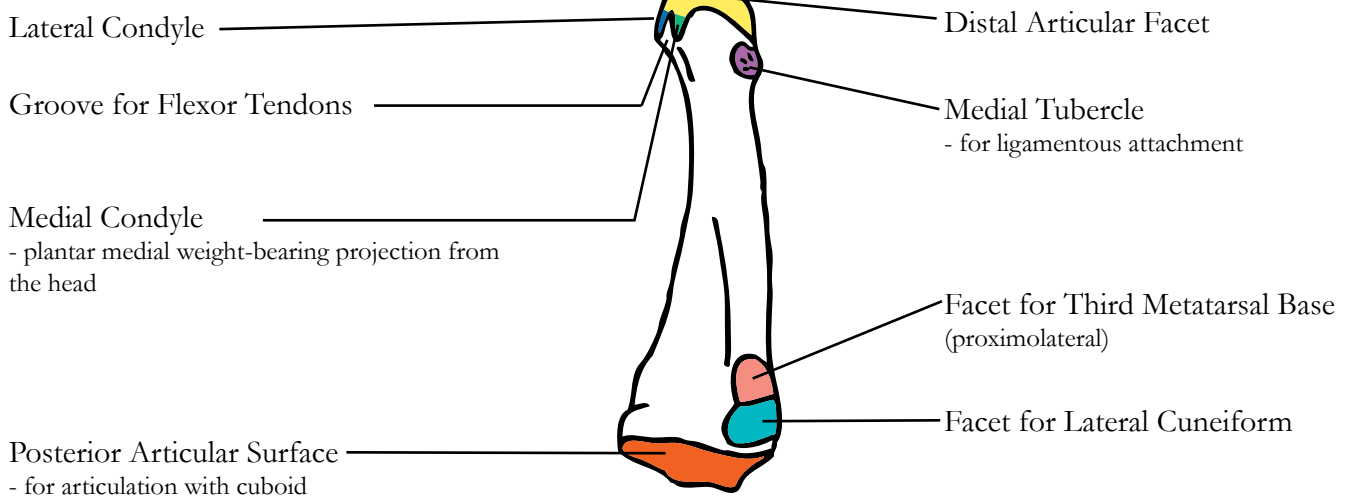
**Plantar / Inferior**



## Medial View

**Plantar / Inferior**

**Dorsal / Superior**



**Proximal / Posterior**

- easy to palpate parts of the head, shaft and base
- base is usually cube shaped
- nutrient foramen is located on the lateral surface of the shaft in the proximal 1/3
- nutrient artery is from dorsal metatarsal artery 4, generally plantar

### Development

#### Primary Center of Ossification

- appears in the shaft during **9th fetal week**

#### Secondary Center of Ossification

- appears in the head between **ages 3 and 4 years**
- fuses near 18 years of age

- this places the growth plate distally between the head and the shaft

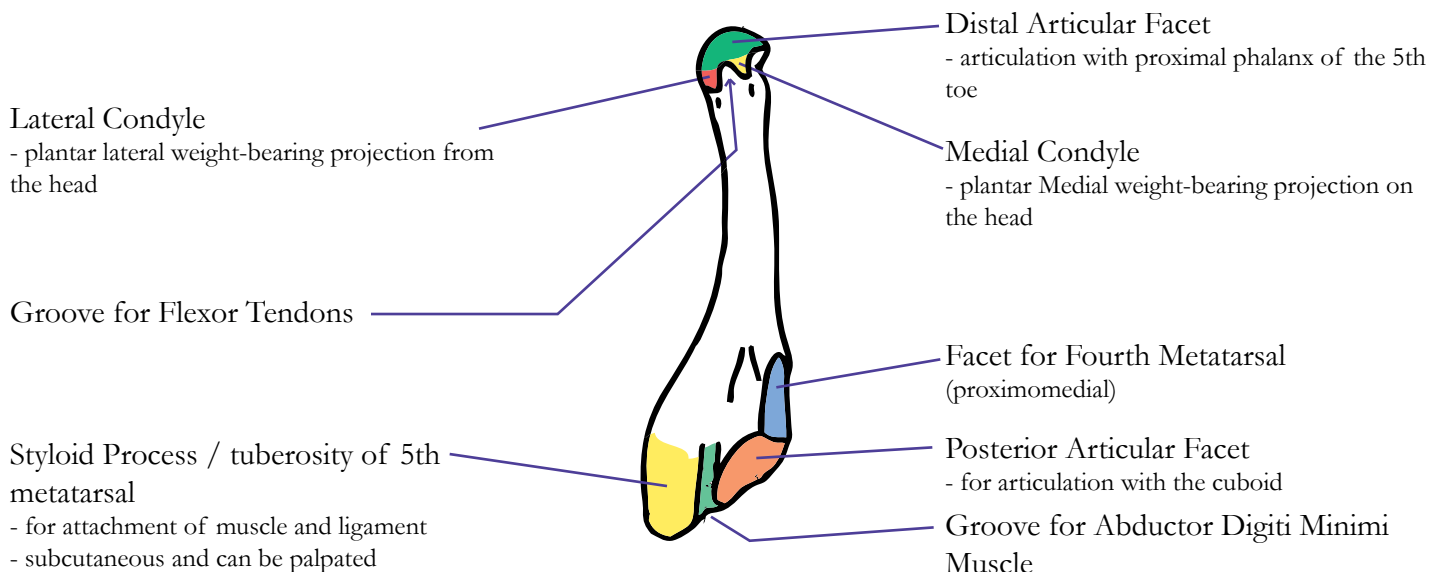
# Fifth Metatarsal

## Plantar View

Lateral

Distal / Anterior

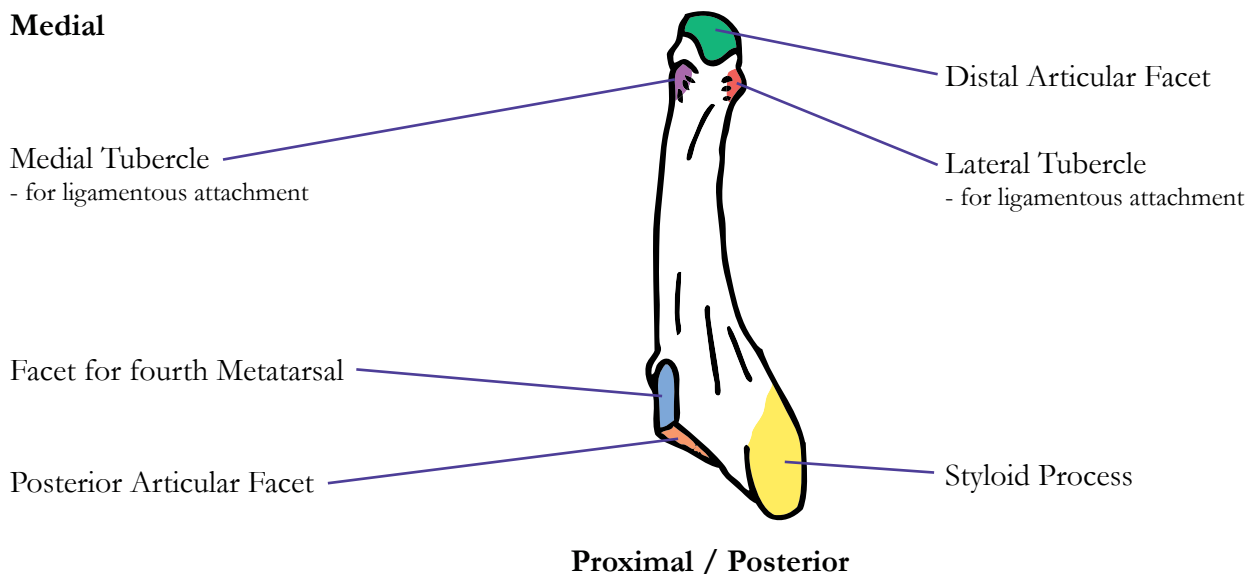
Medial



## Dorsal View

Medial

Lateral



- easy to palpate parts of the head, shaft and base
- nutrient foramen is located on the medial surface of the shaft at the junction of proximal and middle thirds
- nutrient artery is from plantar metatarsal artery 4, usually

### Development

#### Primary Center of Ossification

- appears in the shaft during **10th fetal week**

#### Secondary Center of Ossification

- appears in the head between **ages 3 and 4 years**
  - fuses near 18 years of age
- this places the growth plate distally between the head and the shaft
- may be an additional secondary center in the styloid process of the bone
  - when present and does not fuse is called a *Vesalianum*

# Phalanges

Distal/Anterior

Dorsal Views

Plantar Views

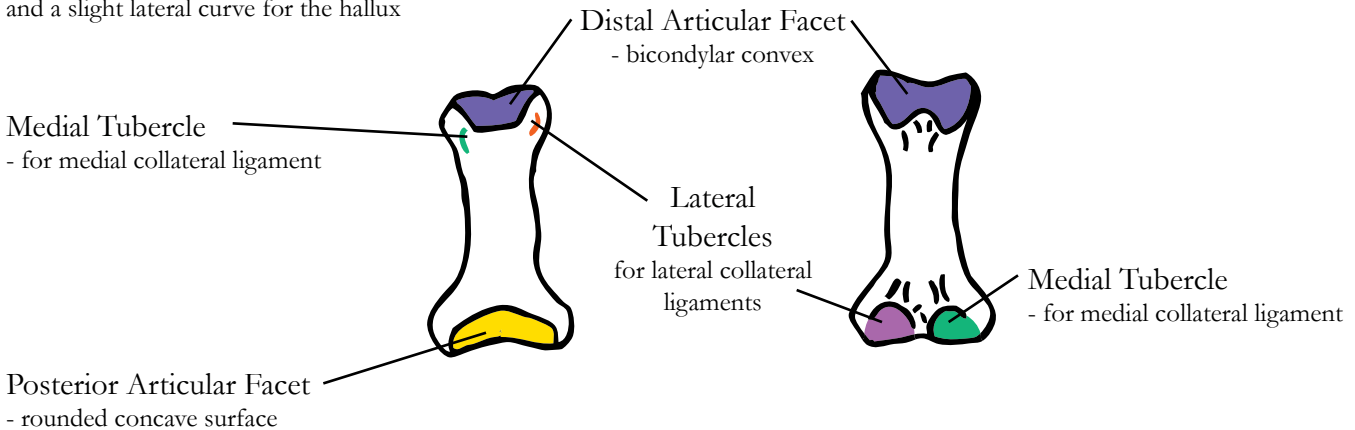
Medial

Lateral

Medial

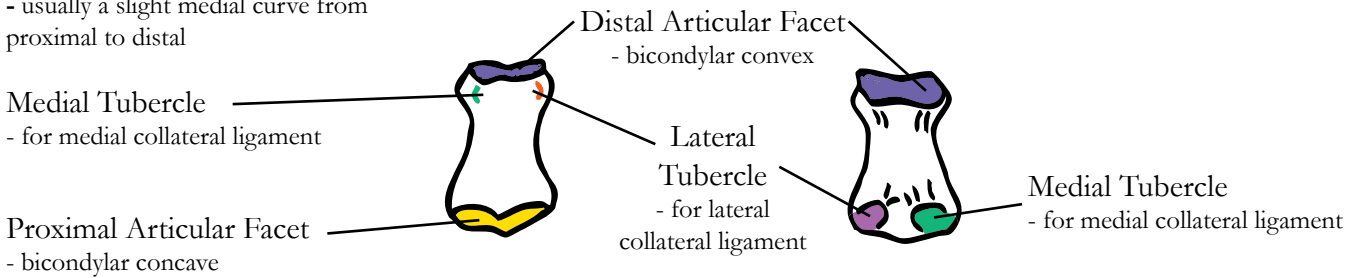
## Proximal

- usually have a slight medial curve from proximal to distal for lesser digits and a slight lateral curve for the hallux



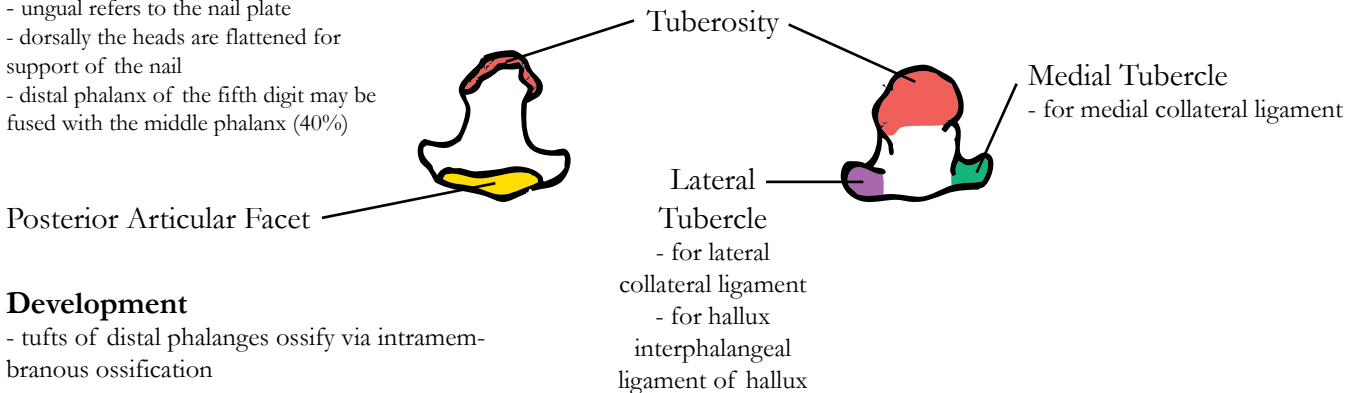
## Middle

- usually a slight medial curve from proximal to distal



## Distal/Ungual

- unguis refers to the nail plate  
 - dorsally the heads are flattened for support of the nail  
 - distal phalanx of the fifth digit may be fused with the middle phalanx (40%)



## Development

- tufts of distal phalanges ossify via intramembranous ossification

### Primary Center of Ossification

- in shafts
- distal - 9th to 12 fetal weeks
- proximal - 11th to 15th fetal weeks
- middle - after 15th fetal week

### Secondary Center of Ossification

- bases between ages 2 and 8 years, fuse by 18 yrs

Proximal / Posterior

# Muscles of Leg

## Anterior Crural Compartment

### Anterior View

Lateral

Proximal

Medial

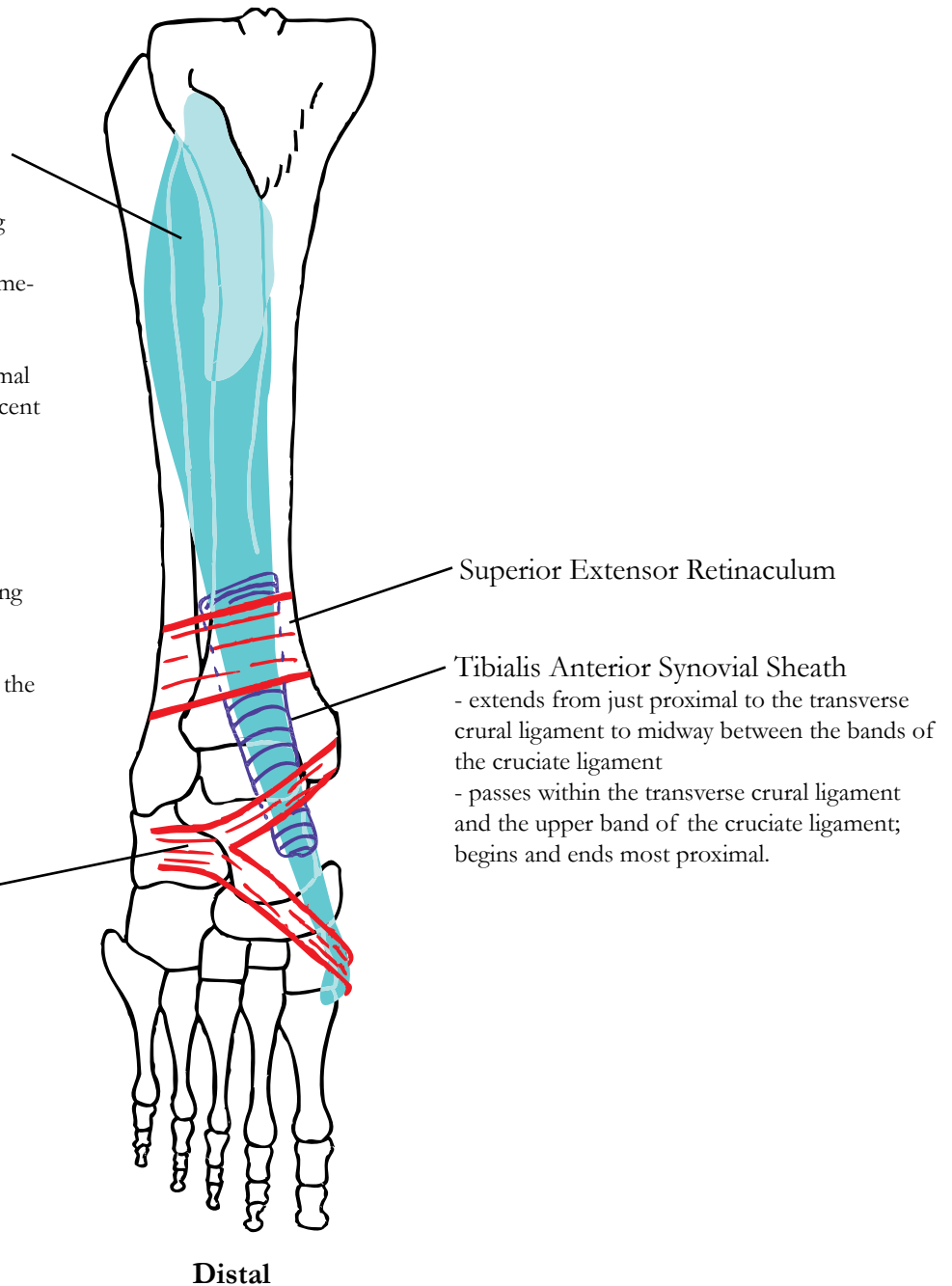
#### Tibialis Anterior Muscle

- largest and most superficial of anterior compartment
- muscle belly easily visible and palpable at proximal part of anterior aspect of leg during muscular contraction.
- tendon easily visible and palpable at antero-medial ankle region during muscular contraction
- primary extensor of the foot
- O:** tibial lateral condyle, anteriorly, the proximal lateral surface of the tibial shaft, and the adjacent interosseous membrane
- I:** medial and plantar surfaces of the medial cuneiform, and the first metatarsal tubercle
  - its tendon passes distally over the anteromedial ankle, within the superior and inferior extensor retinacula and is visible during much of this course during active ankle joint dorsiflexion.
- A:** dorsiflexes and inverts the foot (inverting the foot supinates the subtalar joint)
- NS:** deep fibular/ deep peroneal nerve
- AS:** anterior tibial artery

#### Inferior Extensor Retinaculum

#### Anterior Crural Compartment

- 4 muscles
- innervation from deep fibular/peroneal nerve
- arterial supply from anterior tibial artery
- in general, these muscles are dorsiflexors or extensors of the foot and ankle joint
  - when can't do this - drop foot.



Superior Extensor Retinaculum

Tibialis Anterior Synovial Sheath  
 - extends from just proximal to the transverse crural ligament to midway between the bands of the cruciate ligament  
 - passes within the transverse crural ligament and the upper band of the cruciate ligament; begins and ends most proximal.

Distal

# Muscles of Leg

## Anterior Crural Compartment

### Anterior View

Lateral

Proximal

Medial

#### Extensor Digitorum Longus Muscle

- spindle-shaped muscle that lies lateral to tibialis muscle and superficial to extensor hallucis longus muscle

- its tendon is often visible over the anterolateral ankle/ dorsal foot during muscular contraction

**O:** tibial lateral condyle, the superior medial surface of the fibular shaft, and the adjacent interosseus membrane (also the fascia cruris)

**I:** dorsal surface of the middle phalangeal base of the 2nd, 3rd, 4th and 5th pedal digits, its part of the extensor hood apparatus

- its tendon passes inferiorly over the anterolateral ankle and dorsolateral foot, within the superior and inferior extensor retinacula, where the tendon divides into four slips; one for each lesser digit

**A:** dorsiflexes/ extends the lesser digits; aids in dorsiflexion and eversion of the foot (eversion of the foot causes pronation of the subtalar joint)

**NS:** deep fibular/ deep peroneal nerve

**AS:** anterior tibial artery

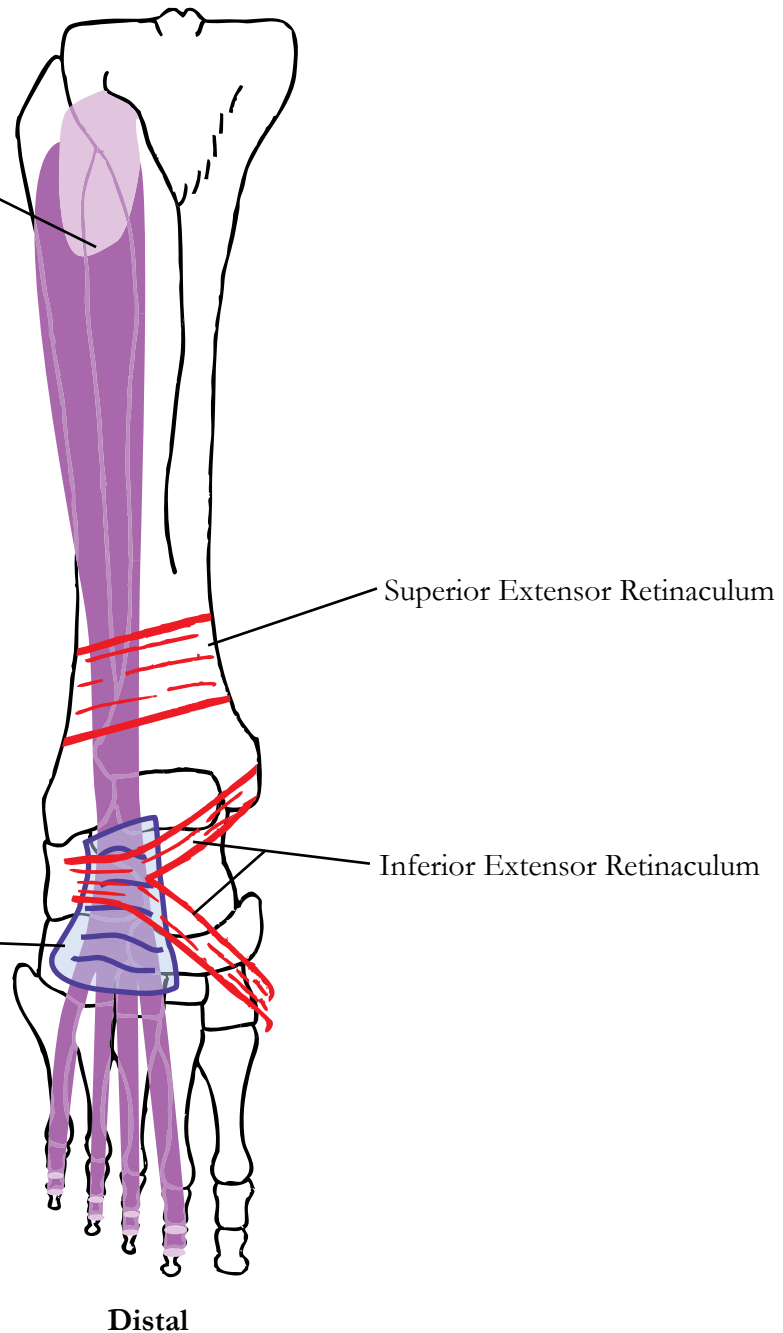
#### Extensor Digitorum Longus and Fibularis Tertius / Peroneus Tertius Synovial Sheath

- includes the 4 slips of the extensor digitorum longus tendon and the tendon of the peroneus tertius muscle

- short when compared to other two synovial sheaths

- extends from just proximal to the upper band of the inferior extensor retinaculum (the level of the malleoli) to the level of the base of the fifth metatarsal

- passes within the cruciate crural ligament



# Muscles of Leg

## Anterior Crural Compartment

### Anterior View

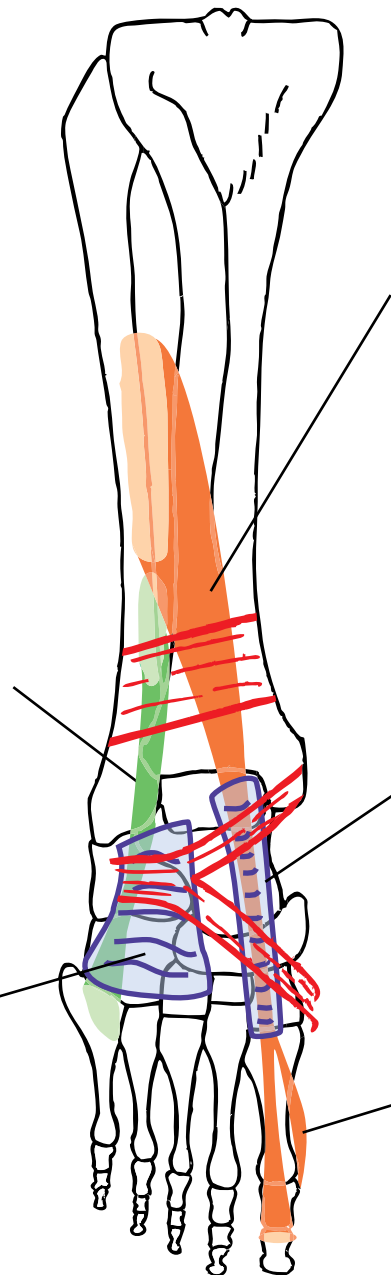
Lateral

Proximal

Medial

**Fibularis (Peroneus) Tertius Muscle**  
 - small muscle located deep and distal to the extensor digitorum longus muscle  
 - may be part of the extensor digitorum longus muscle or may be absent  
**O:** inferior part (1/4) of the medial surface of the fibular shaft and adjacent interosseous membrane  
**I:** dorsal surface of the base and proximal shaft of the fifth metatarsal; NOT the styloid process  
 - its tendon passes inferiorly with the extensor digitorum longus tendon deep to the superior extensor retinaculum and within the inferior extensor retinaculum  
**A:** dorsiflexion of the foot; aids in eversion of the foot (pronating the subtalar joint)  
**NS:** deep fibular/ deep peroneal nerve  
**AS:** anterior tibial artery

**Extensor Digitorum Longus and Fibularis (Peroneus) Tertius Synovial Sheath**



Distal

**Extensor Hallucis Longus Muscle**  
 - Located deep to tibialis anterior and extensor digitorum longus muscles superiorly; it becomes superficial at the level of the middle leg.  
 - is often visible over the anterior ankle, dorsomedial foot and first metatarsophalangeal joint during muscular contraction  
**O:** middle 1/2 of the medial/extensor surface of the fibular shaft and the adjacent interosseous membrane  
**I:** dorsal surface of the base of the distal phalanx of the hallux  
 - its tendon passes inferomedially across the anterior ankle and dorsal foot; at this level it lies intermediate to the tendons of extensor digitorum longus and tibialis anterior muscles, passes deep to the superior extensor retinaculum and within the inferior extensor retinaculum  
**A:** dorsiflexes /extends the hallux at both the interphalangeal and metatarsophalangeal joints; aids in dorsiflexion of the ankle  
**NS:** deep fibular/ deep peroneal nerve  
**AS:** anterior tibial artery

**Extensor Hallucis Longus Synovial Sheath**  
 - extends from just proximal to the upper band of the cruciate crural ligament (near the level of the malleoli) to the base of the first metatarsal  
 - begins and ends more distally than the synovial sheath of the tibialis anterior tendon  
 - passes within the cruciate crural ligament

**Extensor Hallucis Capsularis Muscle**  
 - a tendinous slip from the medial aspect of extensor hallucis longus muscle tendon; occasionally may be from the tibialis anterior muscle  
 - arises at the level of the midfoot  
**I:** medial aspect of the capsule of the first metatarsophalangeal joint  
**A:** tenses the capsule of the first metatarsophalangeal joint during extension which prevents impingement of the capsule



# Muscles of Leg

## Lateral Crural Compartment

### Lateral View

Proximal

#### Fibularis (Peroneus) Longus Muscle

- the muscle belly fills the superior part of the lateral crural compartment
- its tendon is often visible and palpable along the lateral calcaneus during muscular contraction

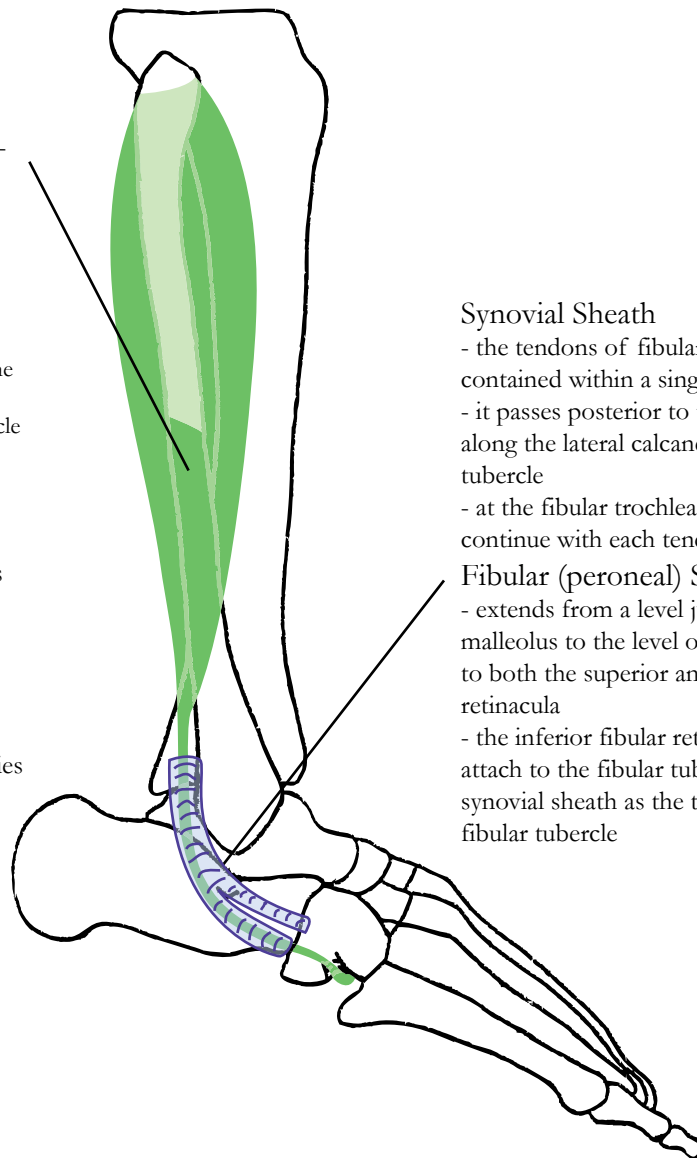
**O:** the fibular head and proximal 1/2 of the lateral surface of the fibular shaft (also fascia cruris)

**I:** lateral and plantar aspects of the medial cuneiform and the first metatarsal tuberosity  
 - its tendon passes distally, posterior to the lateral malleolus, deep to the superior fibular (peroneal) retinaculum, inferior to the fibular tubercle of the calcaneus as it passes deep to the inferior fibular retinaculum, then turns medially and passes along the fibular sulcus of the cuboid to the medial cuneiform and first metatarsal base.

**A:** everts and plantar flexes the foot (pronates the subtalar and midtarsal joints and plantar flexes the ankle joint); Stabilizes the first metatarsal during the propulsive phase of gait (rising on the toes and pushing forward)

**NS:** superficial fibular (peroneal) nerve

**AS:** fibular (peroneal) and anterior tibial arteries



#### Synovial Sheath

- the tendons of fibularis longus and brevis are contained within a single sheath proximally
- it passes posterior to the lateral malleolus and along the lateral calcaneus to the fibular tubercle
- at the fibular trochlea, the sheath divides to continue with each tendon.

#### Fibular (peroneal) Synovial Sheath

- extends from a level just superior to the lateral malleolus to the level of the cuboid; passes deep to both the superior and inferior fibular retinacula
- the inferior fibular retinaculum has fibers that attach to the fibular tubercle and splits the synovial sheath as the tendons pass around the fibular tubercle

#### Lateral Crural Compartment

- contains the fibularis (peroneal) muscles
- these muscles originate from the lateral surface of the fibular shaft
- receive innervation from the superficial fibular (peroneal) nerve
- receive majority of blood supply from the fibular (peroneal) artery
- in general these muscles are foot everters.

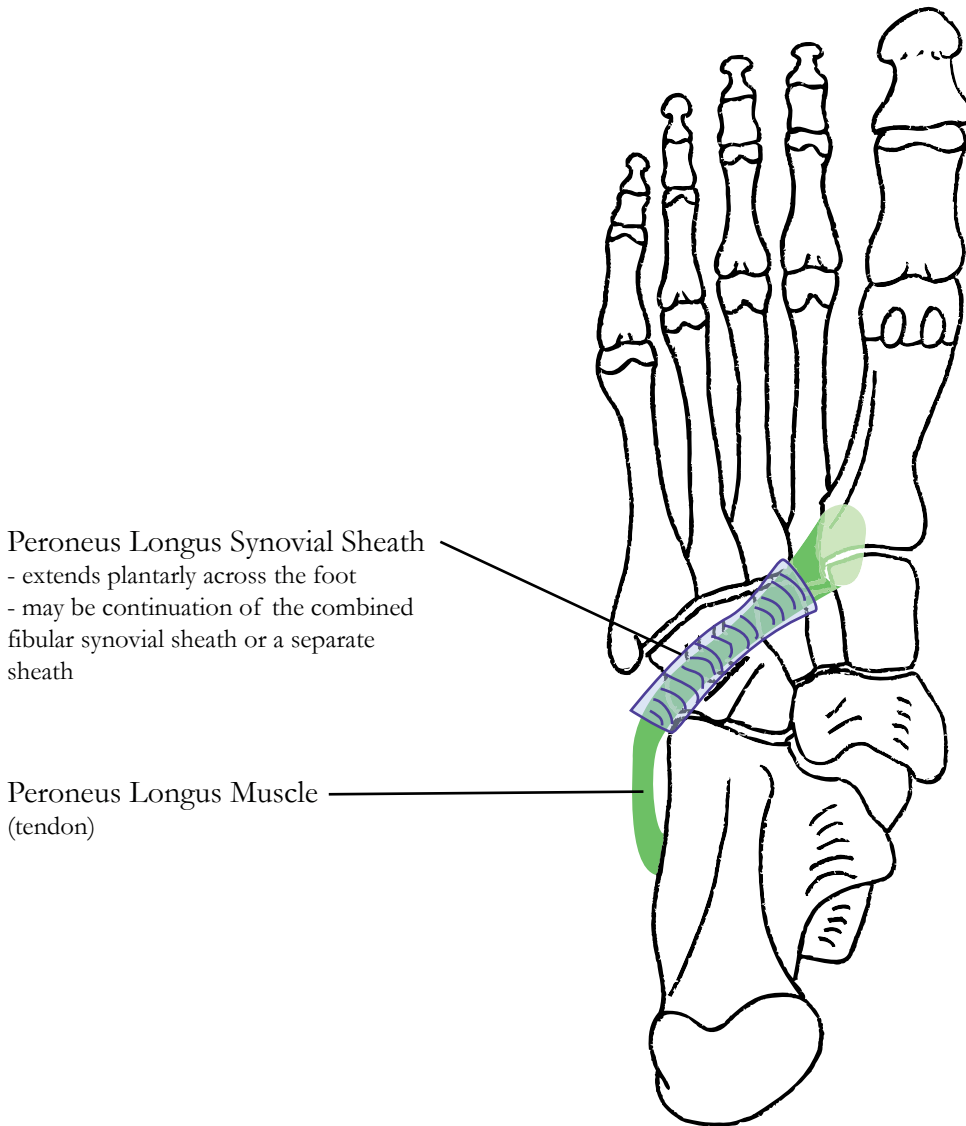
Distal

# Muscles of Leg

## Lateral Crural Compartment

### Dorsal View

Proximal



Peroneus Longus Synovial Sheath  
- extends plantarly across the foot  
- may be continuation of the combined  
fibular synovial sheath or a separate  
sheath

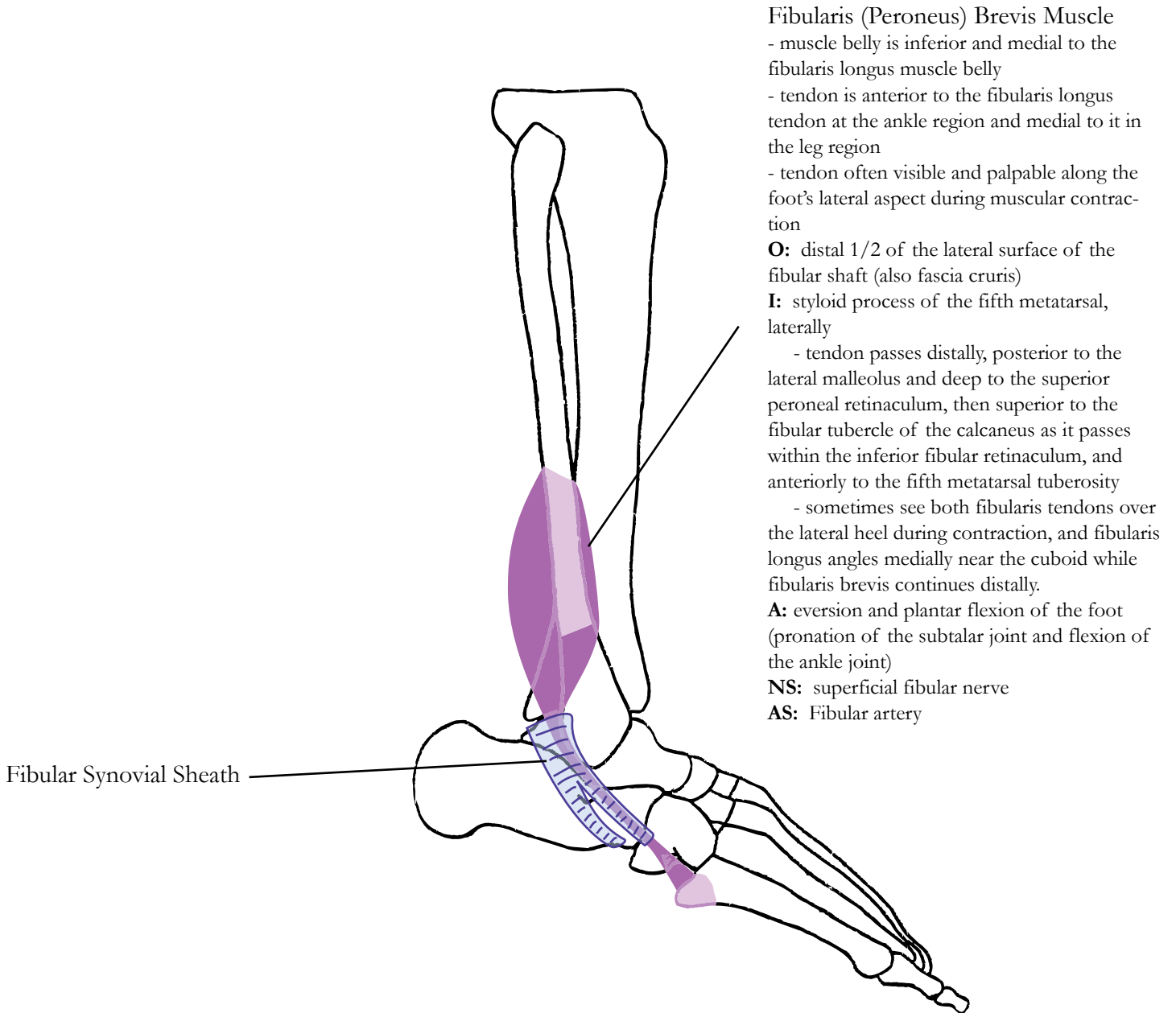
Peroneus Longus Muscle  
(tendon)

Distal

# Muscles of Leg

## Lateral Crural Compartment

### Lateral View



**Fibularis (Peroneus) Brevis Muscle**

- muscle belly is inferior and medial to the fibularis longus muscle belly
- tendon is anterior to the fibularis longus tendon at the ankle region and medial to it in the leg region
- tendon often visible and palpable along the foot's lateral aspect during muscular contraction

**O:** distal 1/2 of the lateral surface of the fibular shaft (also fascia cruris)

**I:** styloid process of the fifth metatarsal, laterally

- tendon passes distally, posterior to the lateral malleolus and deep to the superior peroneal retinaculum, then superior to the fibular tubercle of the calcaneus as it passes within the inferior fibular retinaculum, and anteriorly to the fifth metatarsal tuberosity
- sometimes see both fibularis tendons over the lateral heel during contraction, and fibularis longus angles medially near the cuboid while fibularis brevis continues distally.

**A:** eversion and plantar flexion of the foot (pronation of the subtalar joint and flexion of the ankle joint)

**NS:** superficial fibular nerve

**AS:** Fibular artery

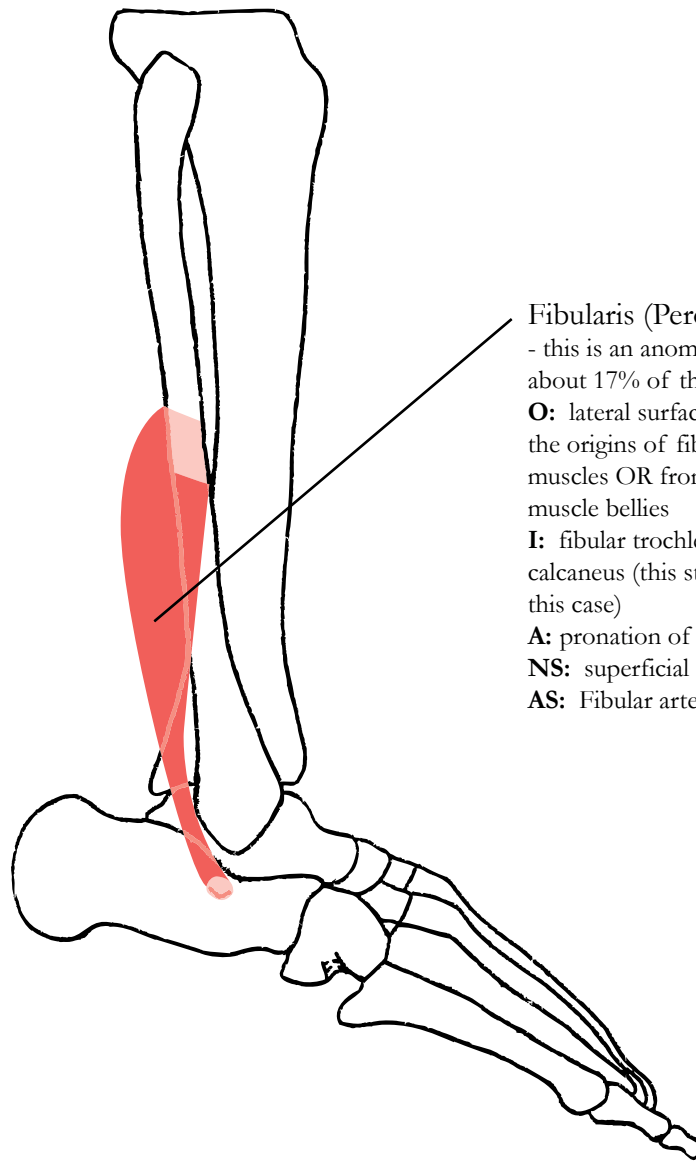
Fibular Synovial Sheath

# Muscles of Leg

## Lateral Crural Compartment

### Lateral View

Proximal



**Fibularis (Peroneus) Quartus Muscle**  
- this is an anomalous muscle which is found in about 17% of the population

**O:** lateral surface of the fibula intermediate to the origins of fibularis longus and brevis muscles OR from fibularis longus and brevis muscle bellies

**I:** fibular trochlea (peroneal tubercle) of the calcaneus (this structure is usually enlarged, in this case)

**A:** pronation of the subtalar joint

**NS:** superficial fibular nerve

**AS:** Fibular artery

Distal

# Muscles of Leg

## Posterior Crural Compartment

### Posterior View

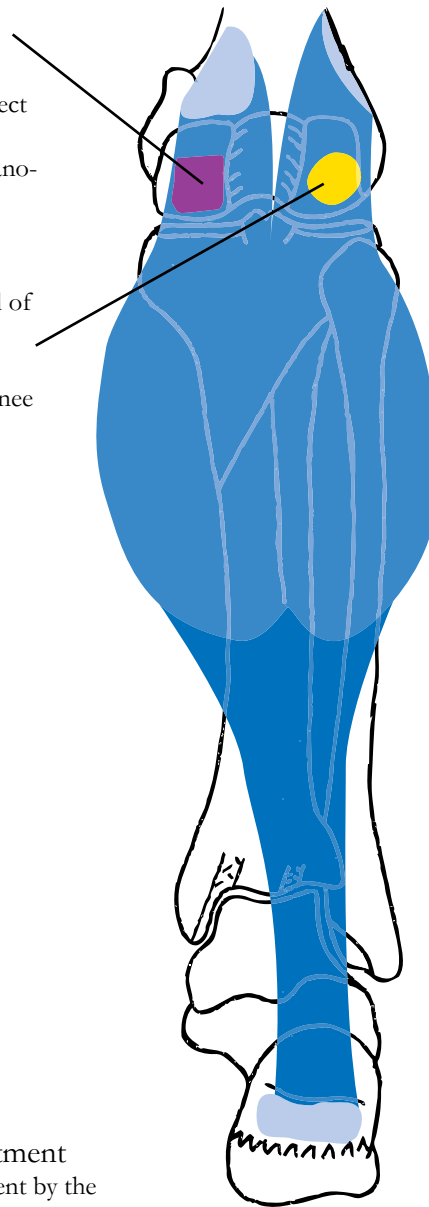
**Medial**

**Proximal**

**Lateral**

**Bursa of the Gastrocnemius muscle**  
 - intermediate to the medial head of the gastrocnemius muscle and the posterior aspect of the knee joint  
 - often communicates with the semimembranosus bursa

**Fabella**  
 - a sesamoid bone located in the lateral head of the gastrocnemius muscle  
 - present in about 30% of the population  
 - easily seen on a lateral radiograph of the knee



#### Gastrocnemius Muscle

- the most superficial muscle of the posterior compartment
- has 2 heads of origin (the medial head is larger) and crosses 2 joints
- often visible and generally palpable at the calf region during muscular contraction

**O:** *medial head:* proximal posterior aspect of the femoral medial supracondylar line and the medial part of the popliteal surface of the femur (also fascia cruris)

*lateral head:* posterolateral surface of the lateral condyle of the femur and the inferior part of the lateral femoral supracondylar line (also the fascia cruris)

**I:** (lateral part of the) middle 1/3 of the posterior surface of the calcaneus via the tendo calcaneus/ calcaneal tendon/ Achilles tendon

- the two heads attach to the gastrocnemius aponeurosis which is also attached to the superficial surface of the soleus muscle

**A:** plantar flexion of the foot; flexion of the leg (can not effectively do both at the same time)

**NS:** tibial nerve

**AS:** one sural artery to each head;

these are branches of the popliteal artery and are functional end arteries

- major supply of blood, without them the structure will die;

- minor supply - posterior tibial and fibular arteries

#### Superficial Posterior Crural Compartment

- separated from deep posterior compartment by the *deep transverse crural intermuscular septum (deep transverse fascial septum of the leg)* which attaches proximally to the soleal line/ popliteal line of the tibia and distally to the interosseus tibiofibular ligament of the distal tibiofibular joint

- these muscles give the calf region its shape

- these muscles are powerful plantar flexors of the ankle joint.

**Distal**

#### Posterior Crural Compartment

- also known as the flexor compartment

- subdivided into superficial and deep groups

- deep receive innervation from tibial nerve and some arterial supply from the posterior tibial artery

- superficial receive some arterial supply from the sural arteries

- in general muscles of this compartment are flexors / plantar flexors of the foot.

# Muscles of Leg

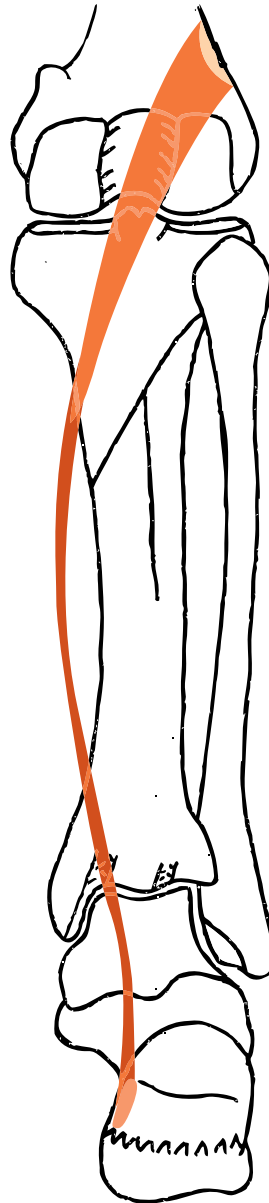
## Posterior Crural Compartment

### Posterior View

Medial

Proximal

Lateral



#### Plantaris Muscle

- a small muscle with a very long tendon that is found deep to the lateral head of gastrocnemius muscle
- its tendon is located intermediate to the gastrocnemius and soleus muscle
- occasionally is absent

**O:** distal part of the lateral supracondylar line of the femur

**I:** medial edge of the middle 1/3 of the posterior surface of the calcaneus

- its tendon passes inferomedially, intermediate to the gastrocnemius and soleus muscles

**A:** aids in plantar flexion of the ankle joint; aids in flexion of the knee joint

**NS:** tibial nerve

**AS:** sural artery (branch of popliteal artery)

Distal

# Muscles of Leg

## Posterior Crural Compartment

### Posterior View

**Medial**

**Proximal**

**Lateral**

#### Triceps Surae

- sometimes referred to as the gastrosoleus muscle or gastroc-soleus group
- considered a single muscle with three heads of origin and a single insertion (shoe shaped origin)

- **A:** plantar flex the foot
- aids in flexion of the leg

#### Gastrocnemius Muscle

- two heads of origin and part of insertion

#### Soleus Muscle

- one head of origin and part of insertion

#### Tendo Calcaneus

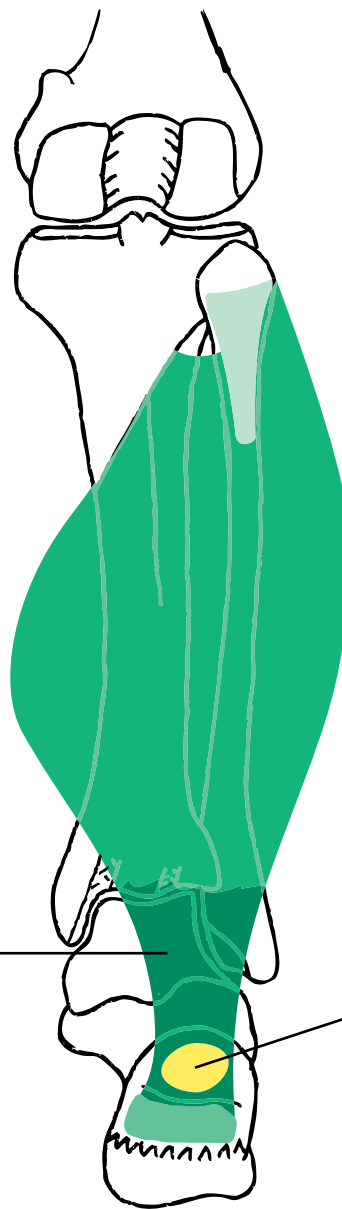
- the large structure that attaches the soleus and gastrocnemius muscles to the calcaneus
- twists internally from proximal to distal; thus the fibers from the gastrocnemius muscle are more laterally placed on the calcaneus and the fibers of the soleus muscle are more medially placed on the calcaneus

#### Watershed area

- an area of decreased blood supply within the tendon
- tendon receives blood from muscle bellies above and from below
- approximately 1.5 inches superior of the insertion, where the tendon is very round (to palpation)

#### Paratendon

- the thin fascial covering of the tendo Achilles which aids in decreasing friction and provides some blood supply
- this tendon has no tendon sheath



#### Soleus Muscle

- a broad flat muscle (named for the fish - sole)
- contractions are slower than gastrocnemius muscle
- often visible at the calf region during muscular contraction

**O:** the middle 1/3 of the medial border of the tibia, the soleal line of the tibia, the tendinous arch of the soleus muscle between the tibia and the fibula that allows the passage of neurovascular structures to the leg, the posterior aspect of the fibular head, and the proximal 1/3 of the posterior surface of the fibula, (a horse-shoe shaped origin)

**I:** the (medial part of the) middle 1/3 of the posterior surface of the calcaneus via the tendo calcaneus; the combined tendon of gastrocnemius and soleus muscles

**A:** plantar flexion of the ankle joint

**NS:** tibial nerve

**AS:** posterior tibial artery, fibular artery, and sural artery

#### Bursae of the tendo calcaneus

- two associated with the tendo calcaneus
- Deep Retrocalcaneal Bursa
  - located between the tendo calcaneus and the trigonum achilleum
- Superficial Retrocalcaneal Bursa
  - located between the tendo calcaneus and the skin at the level of the junction of the superior and middle thirds of the posterior surface of the calcaneus

**Distal**

# Muscles of Leg

## Deep Posterior Compartment

### Posterior View

**Medial**

#### Flexor Digitorum Longus Muscle

- the most medial and superficial of the 3 long muscles of the deep posterior crural compartment

- can often palpate the tendon posterior to the medial malleolus during contraction

**O:** posterior surface of the tibia, inferior to the soleal line (popliteal line) and medial to the vertical line

**I:** plantar aspect of the bases of the distal phalanges of the lesser digits (2 through 5)

- its tendon passes inferiorly along the tibial groove for tibialis posterior and flexor digitorum longus muscles, the medial (flattened) edge of the sustentaculum tali where it lies within the flexor retinaculum, then into the plantar foot under the talus, the tendon splits into four slips near the level of the cuneiform bones and one slip passes plantarly along each of the four lesser metatarsals, along the groove for the flexor tendons on the head of each of the lesser metatarsal bones, and along the plantar surface of the proximal and middle phalanges of each lesser digit

**A:** plantar flexes the lesser digits

- begins at the distal interphalangeal joints, then the proximal interphalangeal joints and then the metatarsophalangeal joints

aids in plantar flexing the ankle joint

**NS:** tibial nerve

**AS:** posterior tibial artery

#### Flexor Digitorum Longus Synovial Sheath

Proximal Sheath

- surrounds the flexor digitorum longus tendon as it courses posterior to the ankle joint and into the plantar foot

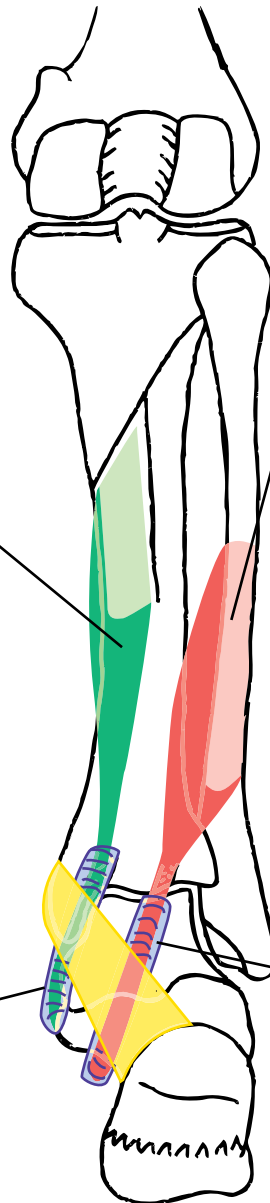
- begins posterior to the medial malleolus and ends proximal to the knot of Henry

- passes within the lacinate ligament

Distal Sheaths

- a second sheath is present and surrounds each of the four tendons as they pass along the plantar aspects of the lesser digits from the metatarsophalangeal joints to the middle phalanges

**Proximal**



**Distal**

**Lateral**

#### Deep Posterior Crural Compartment

- separated from the superficial posterior crural compartment by the deep transverse crural intermuscular septum / deep transverse fascial septum of the leg

- attachments of fascial septum:

- proximal – tibial popliteal line

- distal – distal posterior tibiofibular ligament

- medial – medial tibial border and fascia cruris

- lateral – crista medialis and posterior crural

intermuscular septum

#### Flexor Hallucis Longus Muscle

- the most lateral of the long muscles of the deep posterior crural compartment

**O:** inferior 2/3 of the posterior fibular surface

**I:** plantar aspect of the base of the distal phalanx of the hallux

- its tendon passes along the groove for flexor hallucis longus tendon at the posteroinferior aspect of the tibia, the groove for flexor hallucis longus tendon on the posterior process of the talus, along the inferior surface of the sustentaculum tali where it lies within the flexor retinaculum, and then along the plantar aspect of the first ray, between the tibial and fibular sesamoids of the first metatarsal bone, and along the plantar aspect of the proximal phalanx of the hallux

**A:** plantar flexes the hallux;

- begins at the interphalangeal joint and with continued contraction, also plantar flexes the hallux at the metatarsophalangeal joint

aids in inversion of the foot;

aids in plantar flexion of the ankle joint

**NS:** tibial nerve

**AS:** posterior tibial and fibular arteries

#### Flexor Hallucis Longus Synovial Sheaths

Proximal Sheath

- surrounds the flexor hallucis longus tendon as it courses posterior to the medial malleolus and inferior to the sustentaculum tali

- begins at the distal end of the tibia and ends at the knot of Henry

- begins and ends most distally

- passes within the flexor retinaculum

Distal Sheath

- surrounds the flexor hallucis longus tendon as it passes along the plantar aspect of the hallux from the metatarsal head to the central proximal phalanx



# Muscles of Leg

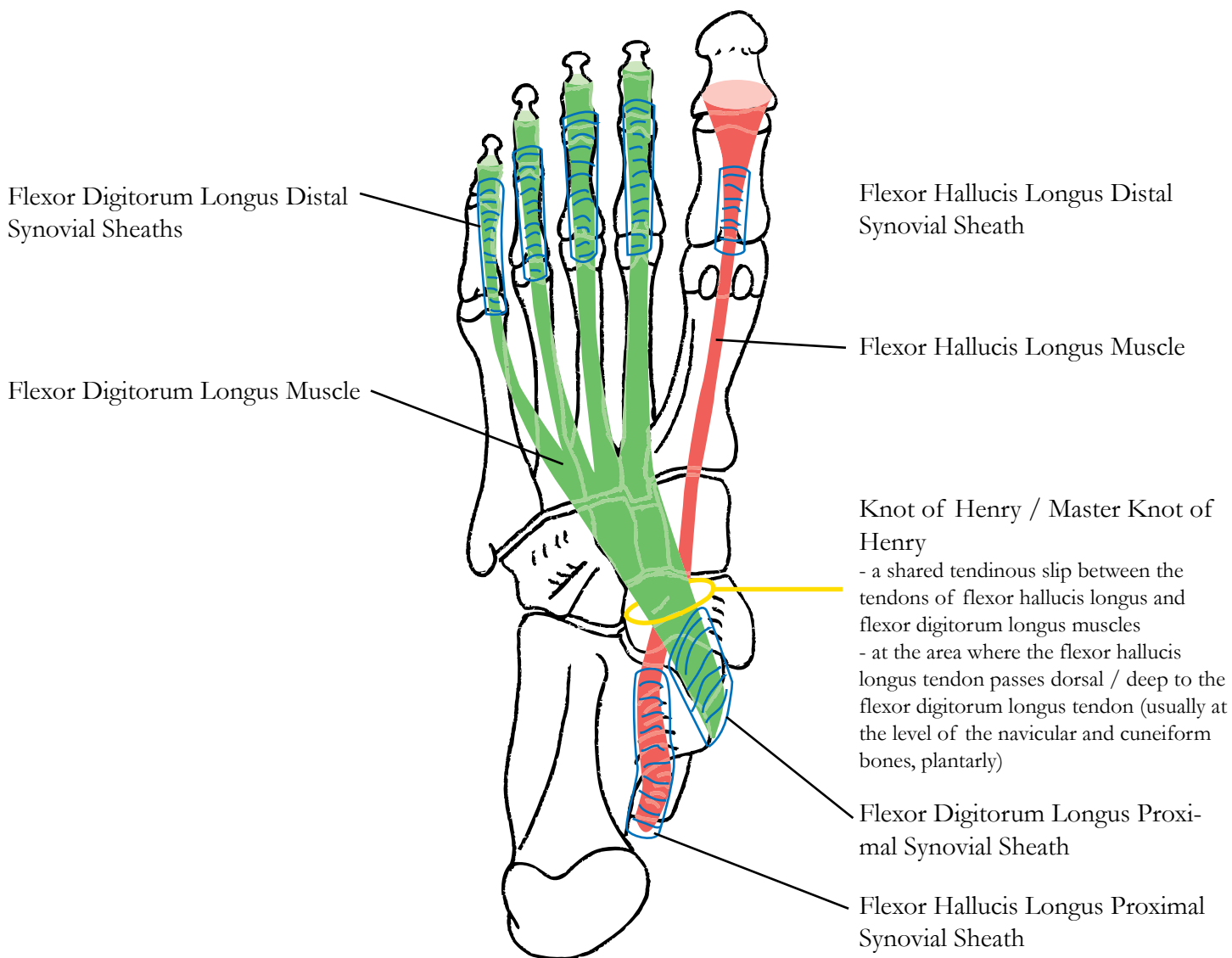
## Deep Posterior Compartment

### Plantar View

Lateral

Distal

Medial



Proximal

# Muscles of Leg

## Deep Posterior Compartment

### Posterior View

Medial

Proximal

Lateral

#### Tibialis Posterior Muscle

- the deepest of the long muscles of the deep posterior compartment of the leg
- can palpate tendon at posteromedial edge of medial malleolus; sometimes is visible during contraction between medial malleolus and navicular tuberosity

**O:** interosseous membrane, the posterior tibial shaft inferior to the soleal line and lateral to the vertical line, and the medial part of the posterior surface of the fibular shaft (anterior to the crista medialis)

**I:** navicular tuberosity, the plantar aspect of the intermediate cuneiform, and the plantar aspect of the bases of the 2nd, 3rd and 4th metatarsals

- may also insert plantarly on the medial cuneiform, cuboid, lateral cuneiform, 1st metatarsal base, 5th metatarsal base and sustentaculum tali

- its tendon passes inferiorly and slightly medial to emerge from deep to the tendon of flexor digitorum longus muscle, then along the tibial groove for tibialis posterior and flexor digitorum longus muscles and inferiorly along the medial malleolus and within the flexor retinaculum to the plantar foot

**A:** inverts and adducts the foot (inverting the foot supinates the subtalar and midtarsal joints); aids in plantar flexing the ankle joint

**NS:** tibial nerve

**AS:** posterior tibial and fibular arteries

#### Tibialis Posterior Synovial Sheath

- surrounds the tibialis posterior tendon as it courses posterior to the ankle joint
- begins at the proximal posterior medial malleolus and ends after passing through the porta pedis
- begins and ends most proximally
- passes within the laciniated ligament



#### Popliteus Muscle

- a short flat muscle located at the posterior aspect of the knee

- an intracapsular structure, which becomes extracapsular before its insertion
- covered by fascia over popliteus muscle from semimembranosus muscle

**O:** (popliteal groove of the) lateral aspect of the lateral condyle of the femur and the posterior edge of the lateral meniscus

**I:** superior to the soleal line / popliteal line on the posterior surface of the tibial shaft

**A:** medially rotates the leg (on the thigh); flexes the leg

- these occur simultaneously when the knee is extended and is called *unlocking the knee*

**NS:** tibial nerve

**AS:** posterior tibial artery and medial inferior genicular artery

Distal

# Muscles of Leg

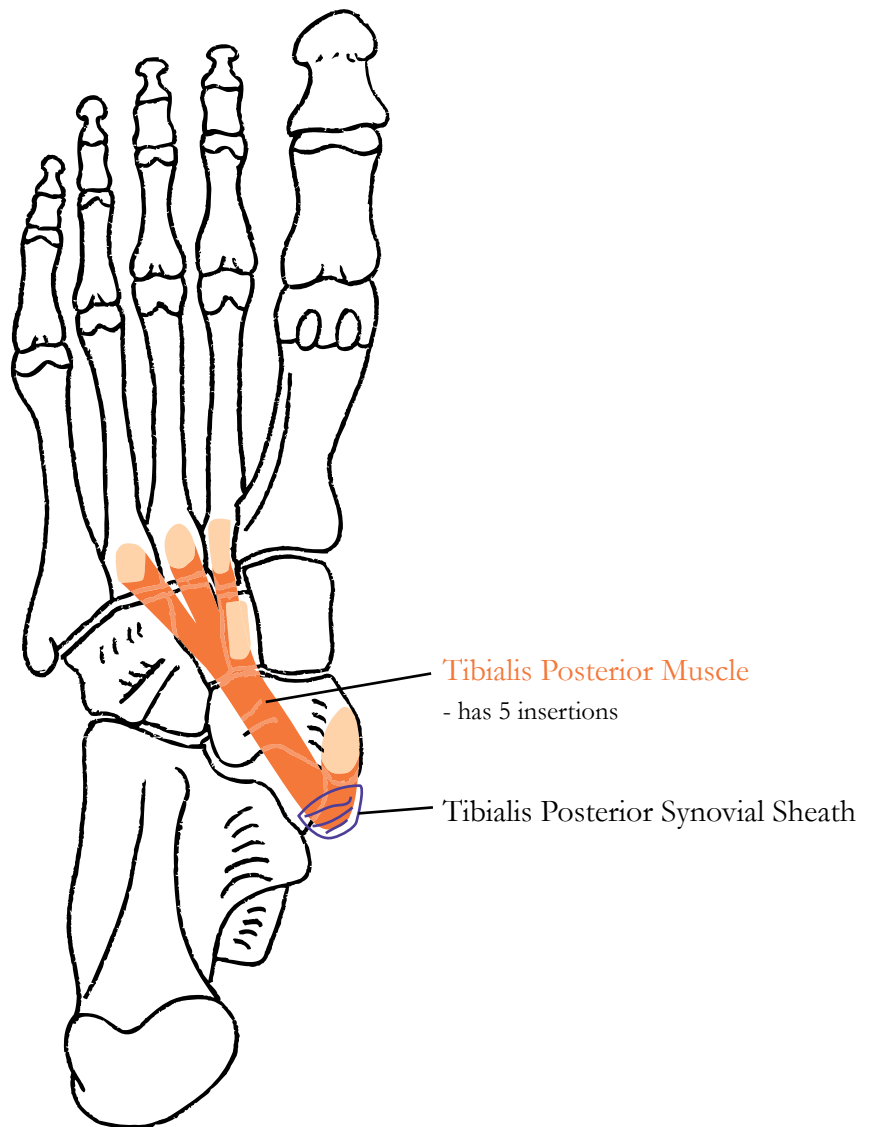
## Deep Posterior Compartment

### Plantar View

Lateral

Distal

Medial



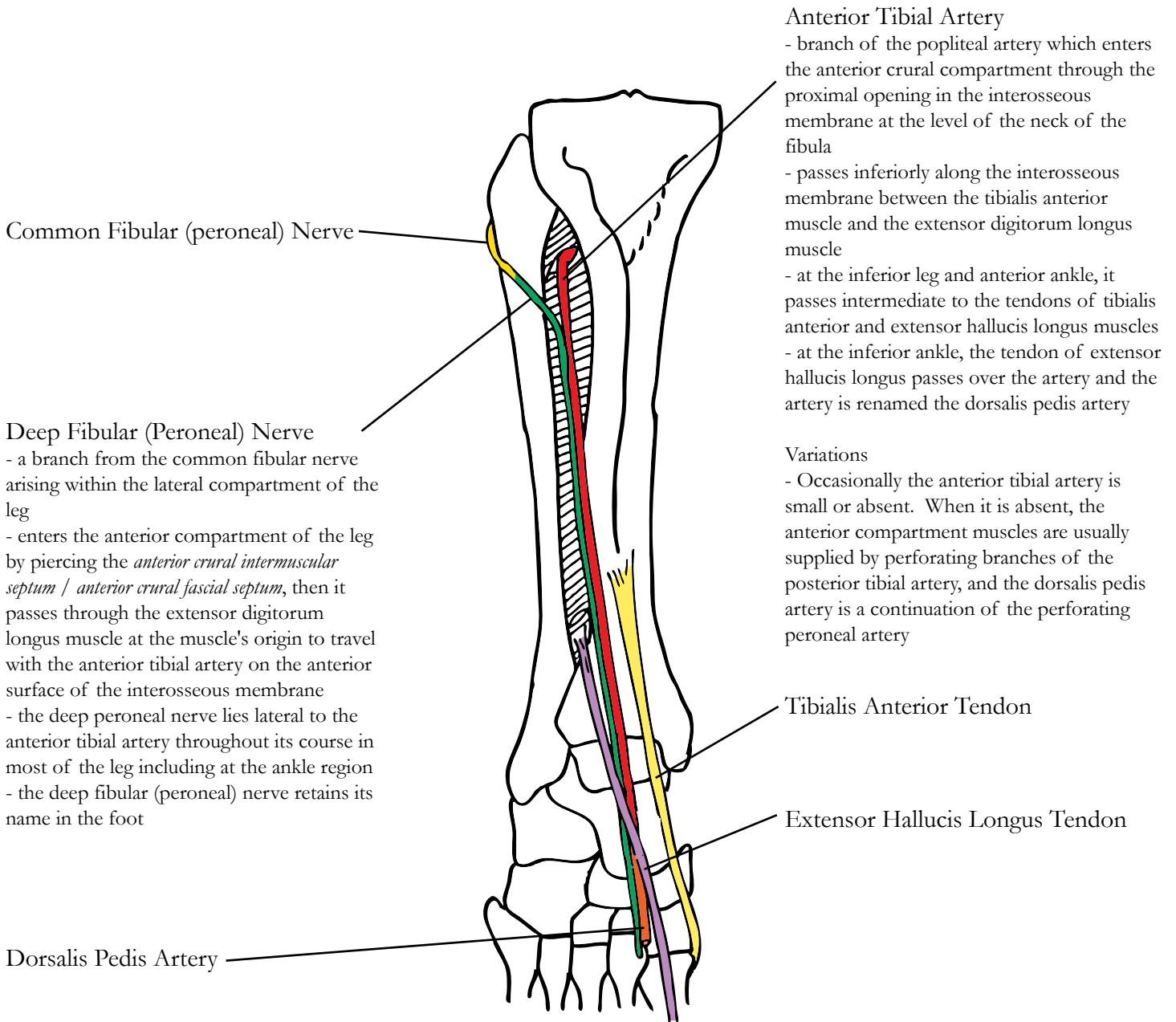
Proximal

# Neurovasculature of Anterior Crural Compartment Anterior View

Lateral

Proximal

Medial



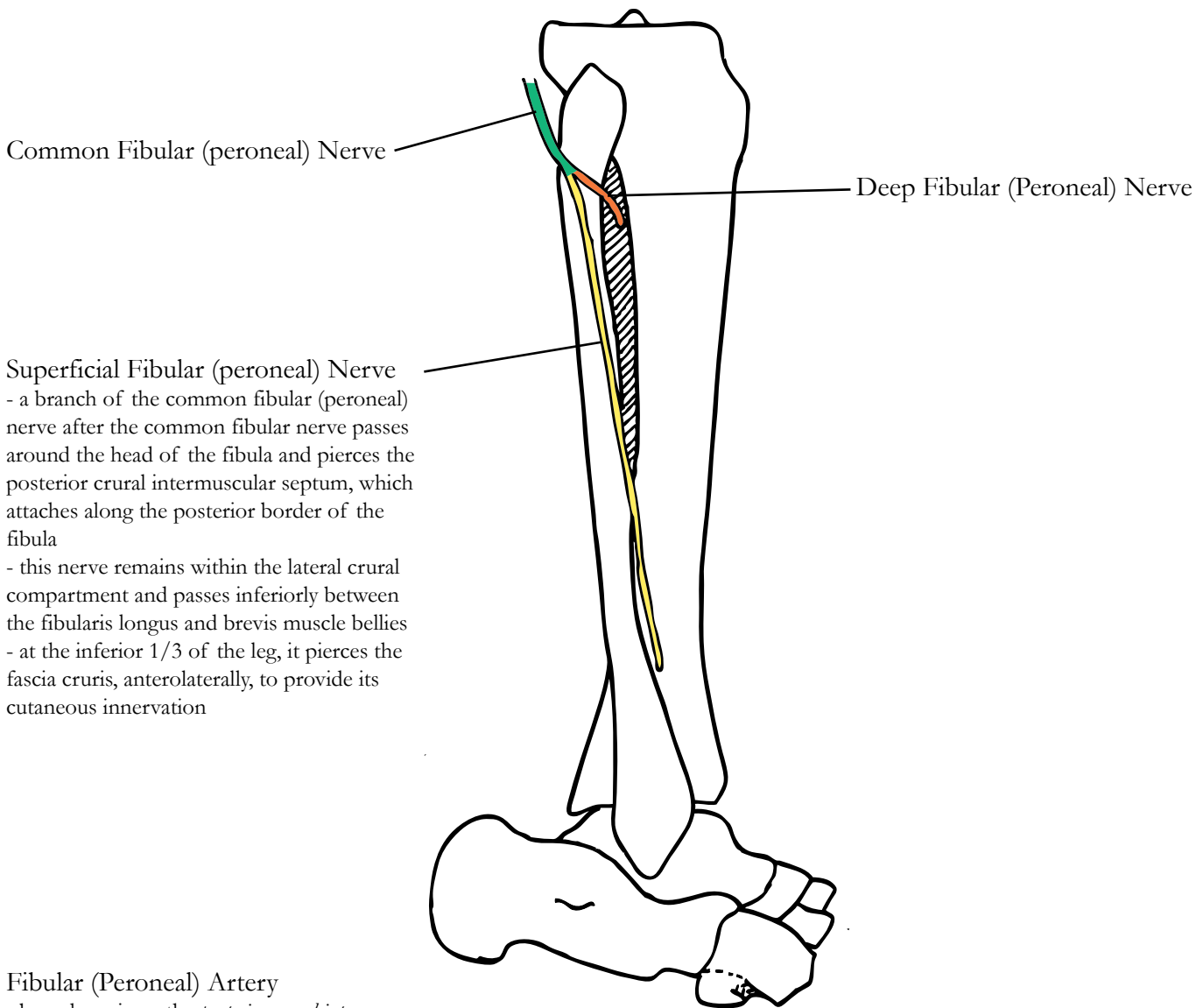
Distal

# Neurovasculature of Lateral Crural Compartment Lateral View

Posterior

Proximal

Anterior



Common Fibular (peroneal) Nerve

Deep Fibular (Peroneal) Nerve

Superficial Fibular (peroneal) Nerve  
- a branch of the common fibular (peroneal) nerve after the common fibular nerve passes around the head of the fibula and pierces the posterior crural intermuscular septum, which attaches along the posterior border of the fibula

- this nerve remains within the lateral crural compartment and passes inferiorly between the fibularis longus and brevis muscle bellies  
- at the inferior 1/3 of the leg, it pierces the fascia cruris, anterolaterally, to provide its cutaneous innervation

Fibular (Peroneal) Artery

- branches pierce the *posterior crural intermuscular (fascial) septum* to supply the fibularis muscles

- the artery DOES NOT lie within the lateral compartment of the leg

- the artery is within the posterior compartment

Distal

# Neurovasculature of Posterior Crural Compartment Posterior View

Medial

Proximal

Lateral

## Tibial Nerve

- passes through the popliteal fossa, enters the leg by passing through the *tendinous arch of the soleus muscle* and follows the course of the posterior tibial artery
- it divides to form the medial and lateral plantar nerves near the level of the ankle joint prior to entering the foot
- at the ankle region, it gives rise to the medial calcaneal nerve which pierces the lacinate ligament

## Posterior Tibial Artery

- usually appears to be the continuation of the popliteal artery
- it arises within the posterior crural compartment and passes distally along the superficial / posterior surface of the tibialis posterior muscle, intermediate to the flexor hallucis longus and flexor digitorum longus muscle bellies, then posterior to the medial malleolus where it divides to form the medial and lateral plantar arteries
- its pulse is palpated posterior to the medial malleolus

## Nutrient Artery to the Tibia

- usually arises deep to the soleus muscle (at its proximal end)

## Popliteal Artery

## Tendinous arch of the soleus muscle

## Anterior Tibial Artery

- branches supply the proximal part of the fibularis (peroneus) longus muscle at its origin on the lateral tibial condyle

## Fibular (Peroneal) Artery

- a branch of the posterior tibial artery arising near the inferior edge of the popliteus muscle
- it passes inferiorly deep to the soleus muscle, it then continues intermediate to the flexor hallucis longus and tibialis posterior muscles, at the ankle it lies posterior to the lateral malleolus (near the peroneal tendons) where it divides to form the *lateral calcaneal arteries*

### Nutrient Artery to the Fibula

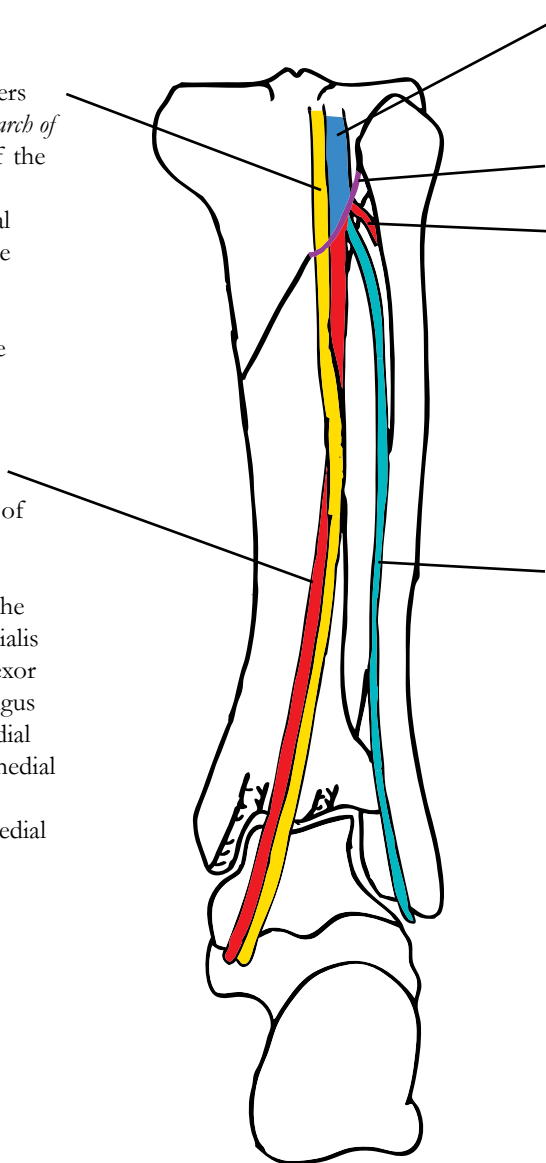
- a branch usually arising near midshaft and entering the fibula in the proximal 1/2 of the posterior surface

### Perforating Fibular (peroneal) Artery

- passes into the anterior ankle region through the inferior opening in the interosseous membrane

### Fibular (peroneal) Communicating Artery

- a transverse branch which anastomoses with the posterior tibial artery (in the inferior 1/3 of the leg, posteriorly)

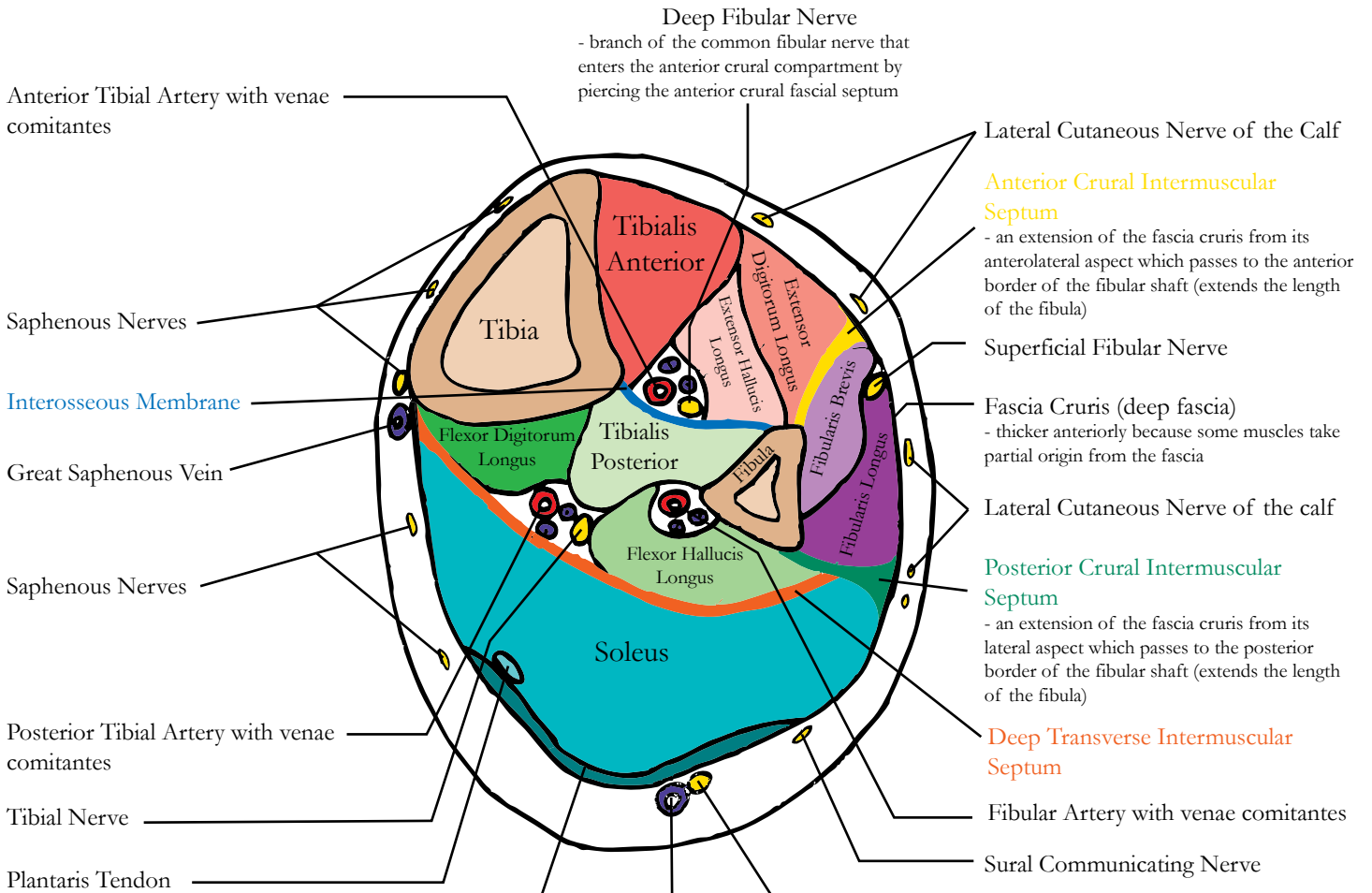


Distal

# Cross Section of Leg

## Mid-level

### Superior View



**Deep Fibular Nerve**  
- branch of the common fibular nerve that enters the anterior crural compartment by piercing the anterior crural fascial septum

Anterior Tibial Artery with venae comitantes

Lateral Cutaneous Nerve of the Calf

**Anterior Crural Intermuscular Septum**

- an extension of the fascia cruris from its anterolateral aspect which passes to the anterior border of the fibular shaft (extends the length of the fibula)

Saphenous Nerves

Superficial Fibular Nerve

**Interosseous Membrane**

Fascia Cruris (deep fascia)

- thicker anteriorly because some muscles take partial origin from the fascia

Great Saphenous Vein

Lateral Cutaneous Nerve of the calf

Saphenous Nerves

**Posterior Crural Intermuscular Septum**

- an extension of the fascia cruris from its lateral aspect which passes to the posterior border of the fibular shaft (extends the length of the fibula)

Posterior Tibial Artery with venae comitantes

**Deep Transverse Intermuscular Septum**

Tibial Nerve

Fibular Artery with venae comitantes

Plantaris Tendon

Sural Communicating Nerve

Gastrocnemius Aponeurosis

Sural Nerve

Small Saphenous Vein

**Interosseous Membrane**

- a sheet of fibrous tissue connecting the tibia and fibula at their interosseous borders  
- fibers pass from superior medial to inferior lateral which allows the fibula to glide slightly proximal with respect to the tibia  
- a superior opening pierces the membrane at the level of the neck of the fibula; allows passage of the anterior tibial artery  
- an inferior opening pierces the membrane near the tibiofibular syndesmosis; allows passage of the perforating fibular artery

**Posterior Compartment**

**Deep Posterior Compartment**

**Borders**

Anterior Border - Interosseous Membrane and Medial Part of Posterior Fibular Surface

Lateral Border - Posterior Fibular Surface and Posterior Crural Intermuscular Septum

Medial Border - Posterior Tibial Surface

Posterior Border - Deep Transverse Crural Intermuscular Septum

**Superficial Posterior Compartment**

**Borders**

Anterior Border - Deep Transverse Crural Intermuscular Septum

Medial Border - Fascia Cruris

Lateral Border - Fascia Cruris

Posterior Border - Fascia Cruris

**Anterior Compartment**

**Borders**

Medial Border - Tibial lateral surface

Anterior Border - Fascia Cruris

Lateral Border - Anterior Crural Intermuscular Septum

**Septum**

Posterior Border - Interosseous Membrane and Medial Fibular Surface

**Deep Transverse Intermuscular Septum**

- an extension of the fascia cruris from posteromedial to posterolateral near the posterior crural intermuscular septum; deep to soleus muscle

- attaches to the medial tibial border, the tibial soleal line, the crista medialis, the posterior border of the fibular shaft, and the distal posterior tibiofibular ligament

- separates the superficial posterior crural compartment from the deep posterior crural compartment

- usually covers the posterior surface of the tibial nerve & posterior tibial artery

**Lateral Compartment**

**Borders**

Anterior Border - Anterior Crural Fascial Septum

Lateral Border - Fascia Cruris

Posterior Border - Posterior Crural Fascial Septum

**Septum**

Medial Border - Lateral Fibular Surface

## Anterior Compartment

### Muscles

- a. Tibialis Anterior Muscle
  - located medially, the largest muscle mass at this level (for this compartment)
- b. Extensor Hallucis Longus Muscle
  - centrally located and deep to the other 2
- c. Extensor Digitorum Longus Muscle
  - located laterally
- d. Fibularis Tertius Muscle
  - distal to this level so it is not seen

### Neurovasculature

- a. Anterior Tibial Artery and venae comitantes
  - located anterior to the interosseous membrane and intermediate to tibialis anterior and extensor hallucis longus muscles
- b. Deep Fibular Nerve / Deep Peroneal Nerve
  - usually lies just lateral to the vessels in the same fascial space
  - branch of the common fibular nerve that enters the anterior crural compartment by piercing the anterior crural fascial septum

## Lateral Compartment

### Muscles

- a. Fibularis Longus Muscle / Peroneus Longus Muscle
  - more posteriorly located; proximally, it is the only muscle present and distally, it is present only as a tendon
- b. Fibularis Brevis Muscle / Peroneus Brevis Muscle
  - more anteriorly located; proximally, it is not present and distally, its muscle belly is present with the peroneus longus tendon
- c. Fibularis Quartus Muscle / Peroneus Quartus Muscle
  - when present, is seen as a muscle belly at midlevel and as a third tendon distally; intermediate to fibularis longus and brevis tendons or deep to both tendons
  - not pictured

### Neurovasculature

- there are no vessels within the compartment
  - arterial supply is from the fibular artery
1. Superficial Fibular Nerve / Superficial Peroneal Nerve
    - near the superficial junction of the fibularis longus and brevis muscles
    - proximally, it is more posterior and deep (near the fibula deep to the peroneus longus muscle)
    - distally, it pierces the fascia cruris to supply the skin

## Posterior Compartment

### Deep Posterior Compartment

#### Muscles

- i. Flexor Digitorum Longus Muscle
  - most medially located
- ii. Tibialis Posterior Muscle
  - most centrally located and deepest (most anterior)
- iii. Flexor Hallucis Longus Muscle
  - most laterally located
- iv. Popliteus Muscle
  - is proximal to this level so it is not seen
  - is also proximal to the attachment of the deep transverse crural



intermuscular septum

Neurovasculature

i. Posterior Tibial Artery

- and its venae comitantes
- somewhat medially located, just deep to the deep transverse crural intermuscular septum

ii. Tibial Nerve

- same fascial compartment as posterior tibial artery, usually just lateral to the vessels

iii. Fibular Artery / Peroneal Artery

- and its venae comitantes
- somewhat laterally located, often at the posterior surface of the fibula between tibialis posterior muscle and flexor hallucis longus muscle

**Superficial Posterior Compartment**

Muscles

i. Soleus Muscle

- usually the only muscle belly present at this level, fills the compartment, located anteriorly

ii. Gastrocnemius Aponeurosis

- the tendinous part of gastrocnemius muscle before it becomes the tendo calcaneus, located posteriorly

iii. Plantaris Tendon

- at the medial side, just deep to the gastrocnemius aponeurosis

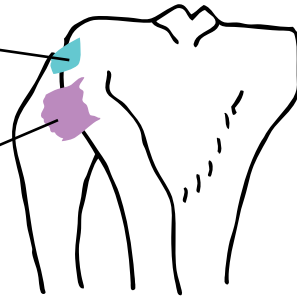
# Tibiofibular Joint

## Proximal Tibiofibular Joint

### Anterior View

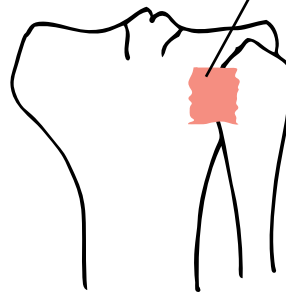
Lateral Tibiofibular Ligament  
- reinforces its lateral aspect

Proximal Anterior Tibiofibular Ligament  
- reinforces its anterior aspect



### Posterior View

Proximal Posterior Tibiofibular Ligament  
- reinforces its posterior aspect

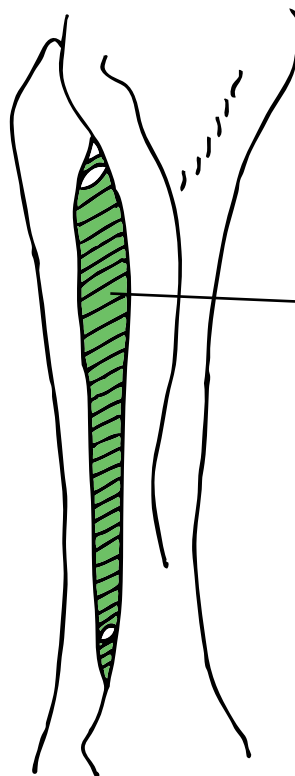


- The proximal tibiofibular joint is located between the head of the fibula and lateral condyle of the tibia.
- Structurally it is a planar or gliding synovial joint.
- Functionally, it is a diarthrosis.
- It is reinforced by ligaments.
- This articulation undergoes rotational moments and gliding movements when the distal tibiofibular joint separates.
- receives arterial supply from the inferior lateral genicular and anterior tibial recurrent arteries
- innervation from the common peroneal nerve and the nerve to popliteus muscle

## Middle Tibiofibular Joint

### Anterior View

- The middle tibiofibular joint is formed by the interosseous membrane as it attaches to the interosseous borders of both the tibia and fibula.
- The fibers of the interosseous membrane pass from proximal medial to distal lateral which allows the fibula to slide slightly proximal on the tibia.
- This sliding accompanies a slight separation of the fibula from the tibia at their distal extremities.

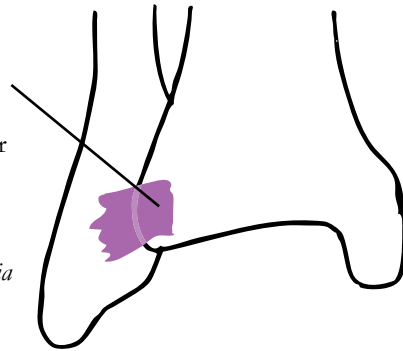


Interosseus Membrane

# Distal Tibiofibular Joint

## Anterior View

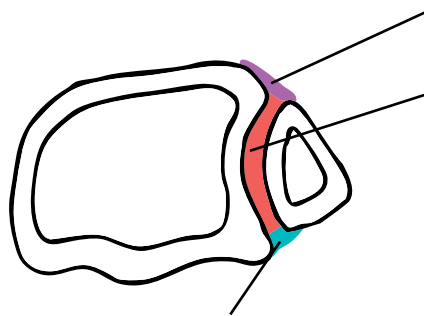
**Distal Anterior Tibiofibular Ligament**  
 - extends from the anterior border of the fibular notch of the tibia to the anterior border of the fibula and the anterior edge of the triangular area on the distal extremity of the fibula  
 - helps to prevent separation of the fibula from the tibia



## Superior View

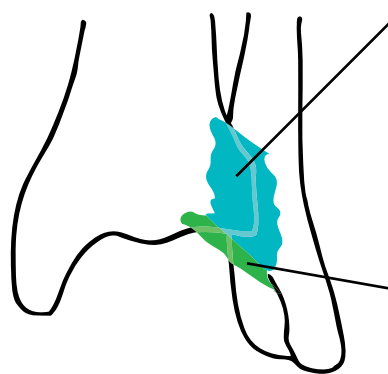
**Distal Anterior Tibiofibular Ligament**  
**Interosseous Tibiofibular Ligament**  
 - inferior continuation of the interosseous membrane  
 - extends from the central part of the fibular notch of the tibia to the central part of the rough triangular area on the fibular distal extremity  
 - strongest of the ligaments at this joint  
 - often is a small synovial extension of the ankle joint within this ligament  
 - prevents the talus from wedging between the tibia and fibula by preventing separation of the fibula from the tibia

**Distal Posterior Tibiofibular Ligament**



## Posterior View

- The distal tibiofibular joint / tibiofibular syndesmosis is located between the fibular notch of the tibia and the roughened triangular area on the medial aspect of the fibular distal extremity.
- structurally a syndesmototic fibrous joint
- functionally an amphiarthrotic joint
- The motion usually accompanies inversion and eversion of the foot during closed kinetic chain motion, when the foot is fixed on the ground.
- It is reinforced by several ligaments
- The distal tibiofibular joint receives arterial supply from the perforating peroneal, anterior medial malleolar and posterior lateral malleolar arteries
- it receives innervation from the deep peroneal, tibial and saphenous nerves.



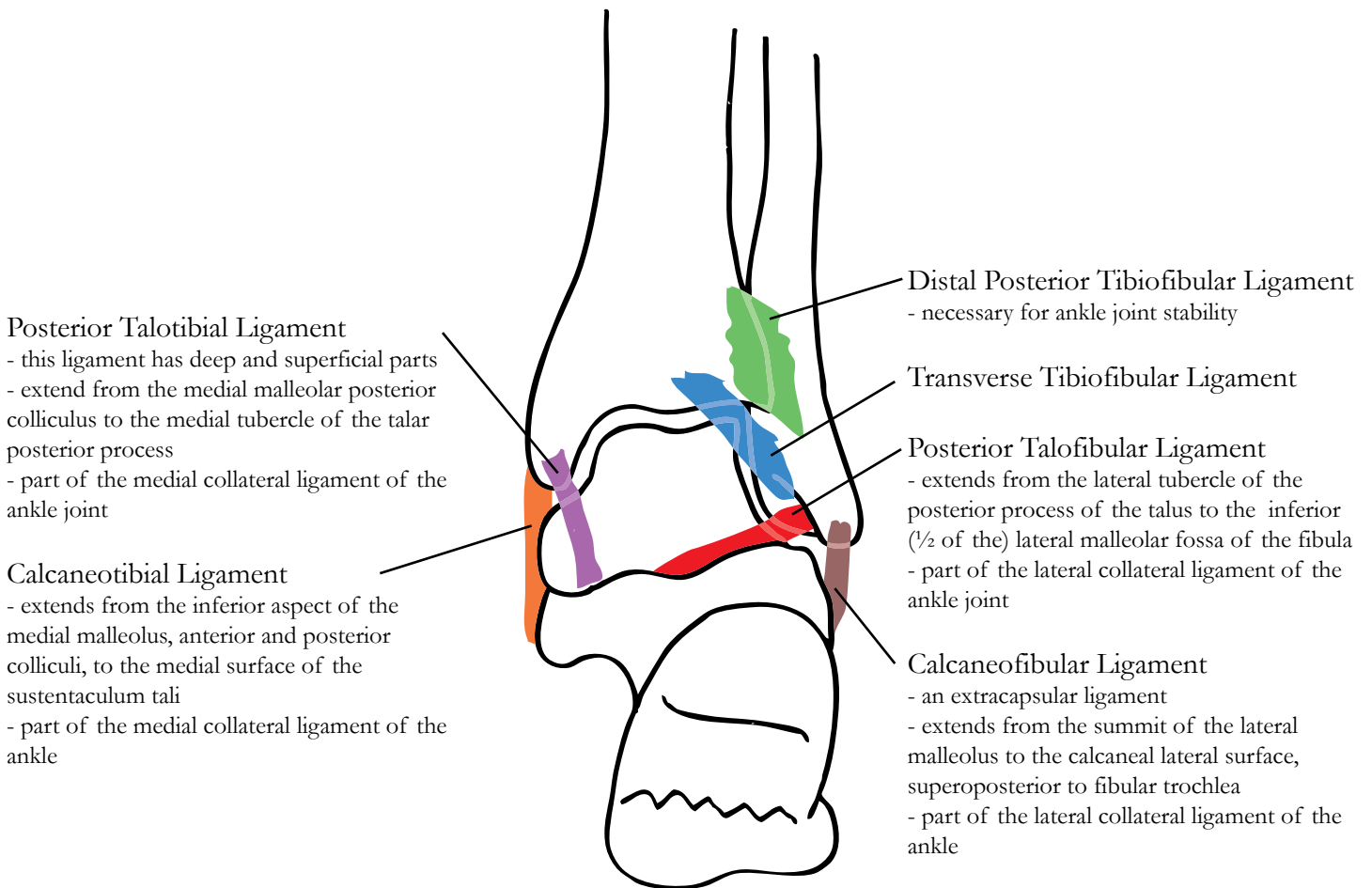
**Distal Posterior Tibiofibular Ligament**  
 - extends from the posterior border of the fibular notch and the posterior process of the tibia to the posterior edge of the triangular area on the medial aspect of the distal fibula  
 - very broad ligament which decreases the posterior movement of the talus within the ankle mortise and prevents separation of the fibula from the tibia

**Transverse Inferior Posterior Tibiofibular Ligament**  
 - the inferior part of the posterior tibiofibular ligament which blends with the fibrous capsule of the ankle joint  
 - has articular cartilage on its deep surface for articulation with the posterior aspect of the trochlea tali so it forms part of the ankle mortise (ankle joint)  
 - passes from the posterior process of the tibia to the superior (1/2 of the) lateral malleolar fossa of the fibula

# Ankle Ligaments

## Posterior View

- aid in providing stability to the ankle joint



## ANKLE JOINT / TALOCRURAL JOINT

The ankle joint is the articulation between the talus and the tibia and between the talus and the fibula. It is classified, structurally, as a synovial, ginglymus (hinge) joint and functionally, as a diarthrosis. The ankle joint primarily moves in dorsiflexion and plantar flexion; however a small amount of adduction/abduction and inversion/eversion are allowed. This is mainly due to the shape of the articular surfaces. The tibial plafond and the trochlea tali are both wider anteriorly than posteriorly, but the trochlea of the talus is narrower posteriorly than the tibial plafond. This makes the ankle joint more mobile laterally when it is in a plantar flexed position. In addition, the interosseous membrane allows a small amount of separation between the tibia and the fibula. Also, the ankle joint axis is not perpendicular to the sagittal plane and as such the motion is sometimes described as triplanar, biomechanically.

### A. Terminology

#### 1. Ankle Mortise

- the concavity formed by the tibia, the fibula and the transverse tibiofibular ligament
- the talus fits into this concavity

### B. Capsule

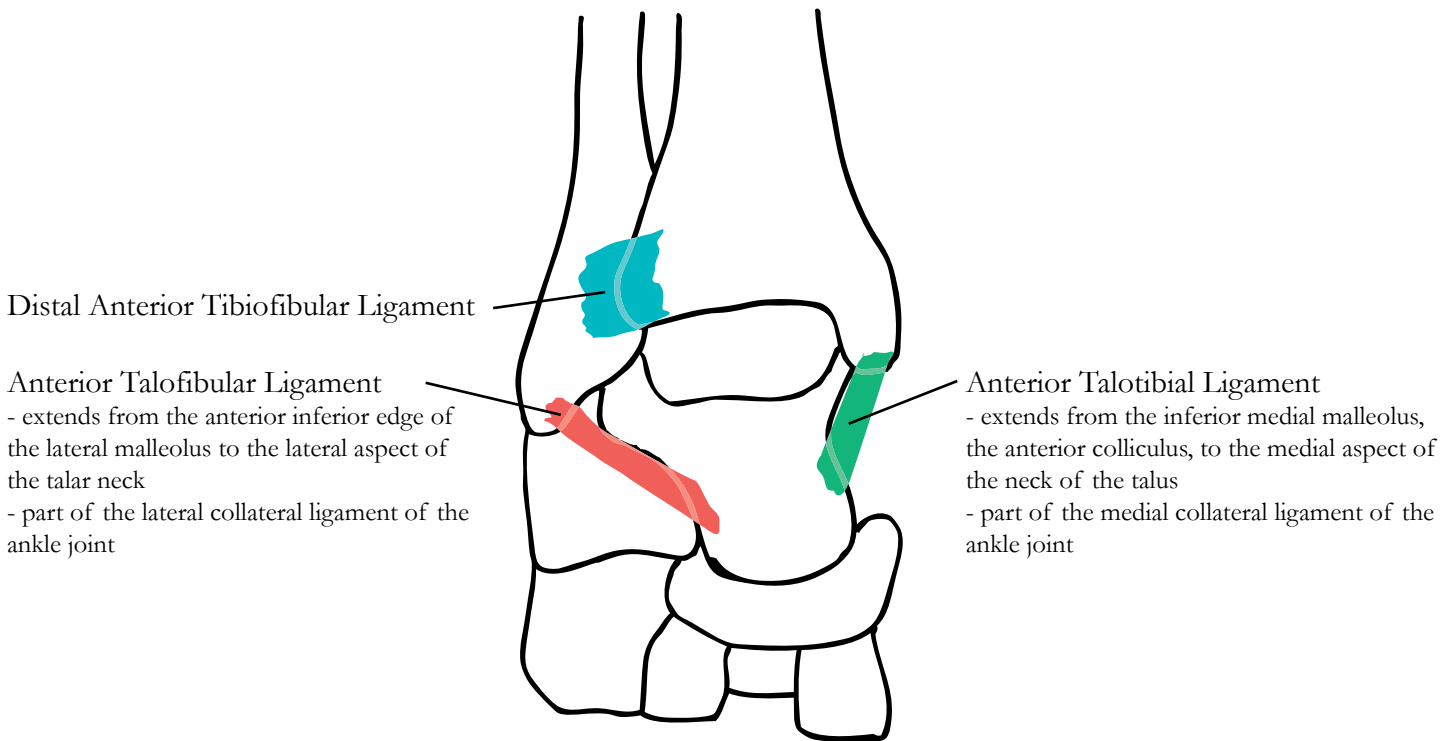
- the capsule of the ankle joint attaches at the articular margins of all surfaces of the ankle joint except the anterior trochlea tali; here it extends to the neck of the talus to allow ankle plantar flexion
- reinforced by ligaments

### C. Synovial Membrane

- lines all areas of the capsule
- at the junction of the tibia and fibula inferiorly (in the syndesmosis), it extends slightly proximal to form a small recess in the interosseous tibiofibular ligament
- occasionally this recess is large enough to create a synovial joint between the distal tibia and fibula

# Ankle Ligaments

## Anterior View



# Ankle Ligaments

## Lateral Collateral Ligaments of the Ankle

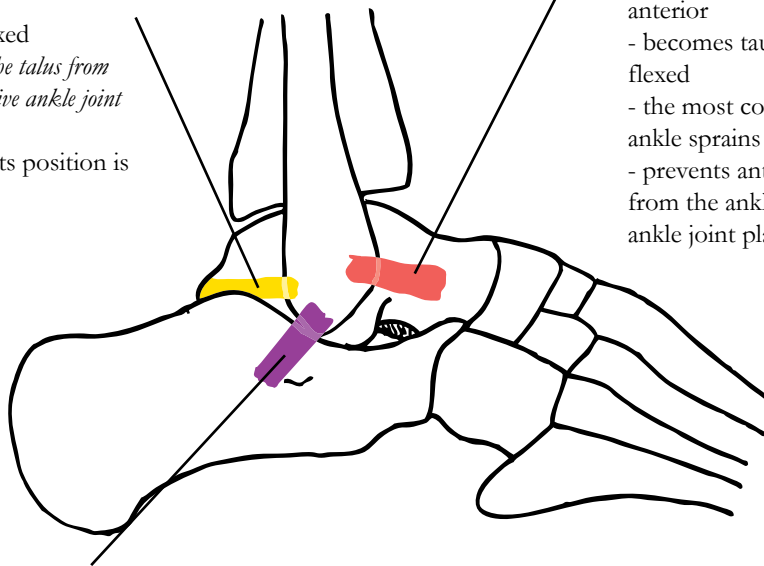
### Lateral View

#### Posterior Talofibular Ligament

- from the posterior lateral malleolus to the lateral tubercle of the posterior process of the talus
- taut when the ankle is dorsiflexed
- *prevents posterior displacement of the talus from the ankle mortise and prevents excessive ankle joint dorsiflexion*
- rarely torn in ankle sprains as its position is almost horizontal

#### Anterior Talofibular Ligament

- from the anterior inferior edge of the lateral malleolus to the lateral aspect of the talar neck; passes primarily medial and slightly anterior
- becomes taut when the ankle joint is plantar flexed
- the most commonly injured ligament in ankle sprains
- prevents anterior displacement of the talus from the ankle mortise and prevents excessive ankle joint plantar flexion



#### Calcaneofibular Ligament

- extends from the summit of the lateral malleolus to the lateral aspect of the calcaneus, just proximal and superior to the peroneal trochlea
- an extracapsular ligament which lies deep to the peroneal tendons
- becomes taut when the ankle joint is dorsiflexed
- forms an angle of approximately  $105^\circ$  with the anterior talofibular ligament
- *limits inversion of the rearfoot and prevents excessive ankle joint dorsiflexion*

# Ankle Ligaments

## Medial Collateral Ligaments of the Ankle (Deltoid ligament)

### Medial View

#### Deep Deltoid Ligaments

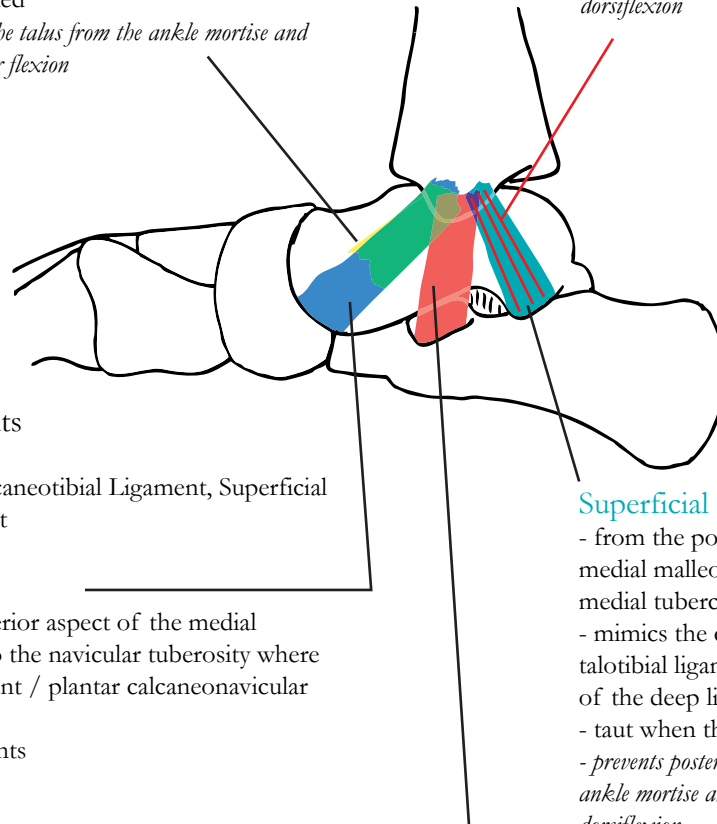
- are 2 of them
  - Anterior Talotibial Ligament & Deep Posterior Talotibial Ligament

#### Anterior Talotibial Ligament

- from the anterior colliculus of the medial malleolus to the medial aspect of the talar neck
- its fibers often blend with the fibers of the tibionavicular ligament
- may be absent
- taut when ankle is plantar flexed
- prevents anterior displacement of the talus from the ankle mortise and prevents excessive ankle joint plantar flexion

#### Deep Posterior Talotibial Ligament

- from the posterior colliculus of the medial malleolus to the medial tubercle of the posterior process of the talus
- a strong thick ligament
- taut when the ankle is dorsiflexed
- prevents posterior displacement of the talus from the ankle mortise and prevents excessive ankle joint dorsiflexion



#### Superficial Deltoid Ligaments

- are 3 of them
  - Tibionavicular Ligament, Calcaneotibial Ligament, Superficial Posterior Talotibial Ligament

#### Tibionavicular Ligament

- extends from the anterior inferior aspect of the medial malleolus, anterior colliculus, to the navicular tuberosity where it blends with the spring ligament / plantar calcaneonavicular ligament
- weakest of the deltoid ligaments

#### Superficial Posterior Talotibial Ligament

- from the posterior inferior aspect of the medial malleolus, posterior colliculus, to the medial tubercle of the posterior talar process
- mimics the course of the deep posterior talotibial ligament and may blend with the fibers of the deep ligament or may be absent
- taut when the ankle is dorsiflexed
- prevents posterior displacement of the talus from the ankle mortise and prevents excessive ankle joint dorsiflexion

#### Medial Collateral Ligament of the Ankle

- also called the Deltoid Ligament
- very thick strong ligament; rarely injured
- reinforces the ankle joint medially
- limits eversion of the rearfoot
- consists of superficial and deep parts
- descriptions vary from three to five ligaments present, two may be absent or blended with others
- the common clinical description is 3 ligaments

#### Calcaneotibial Ligament

- extends from the medial malleolar colliculi to the medial surface of the sustentaculum tali
- lies deep to the tendon of flexor digitorum longus as it passes along the sustentaculum tali
- strongest of the deltoid ligaments
- limits eversion of the calcaneus



# Arterial Supply

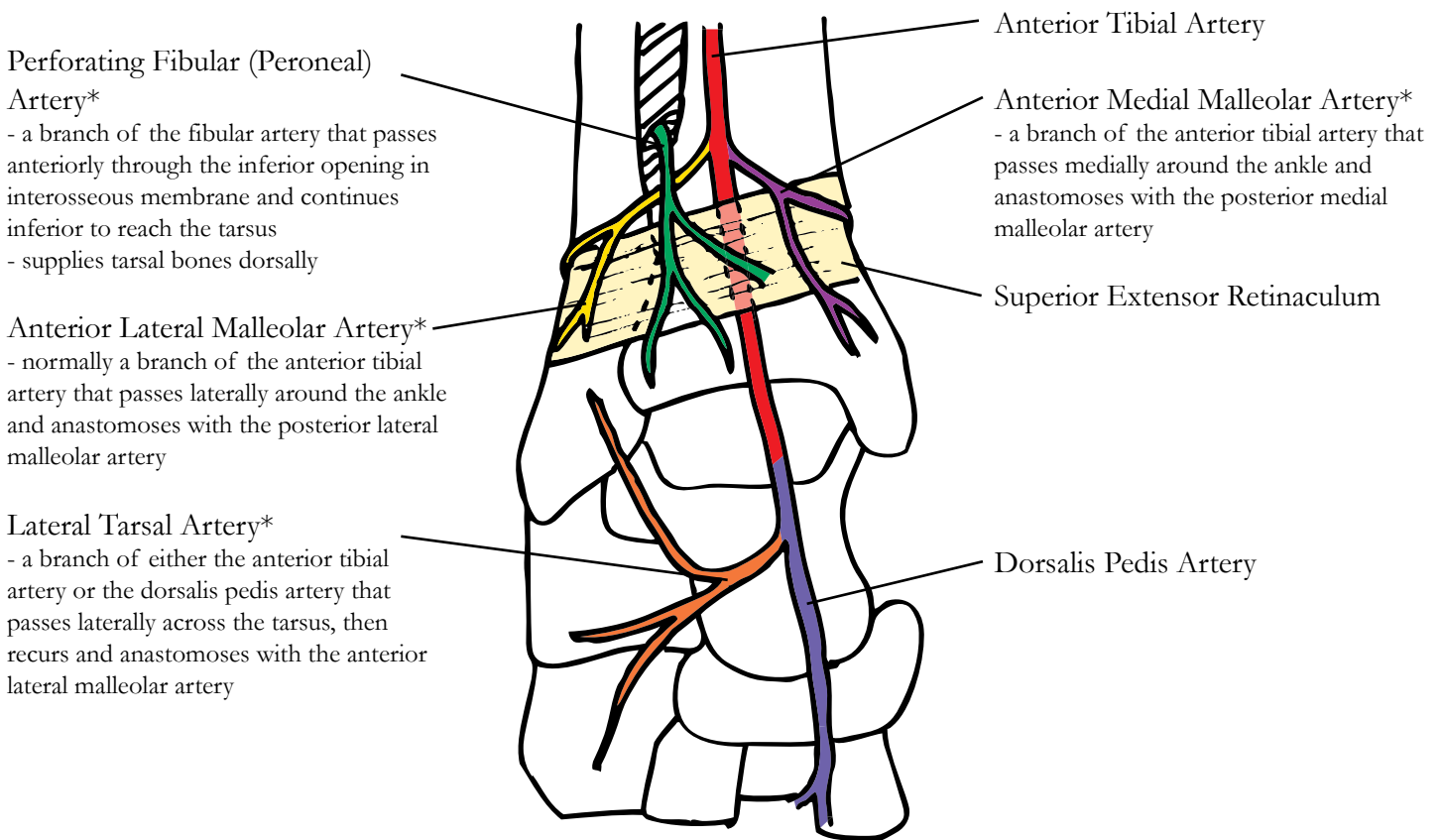
## Malleolar Arterial Network\*

### Anterior View

Lateral

Proximal

Medial



The arterial supply to the ankle region is extensive and includes branches from the anterior tibial, posterior tibial, fibular and dorsalis pedis arteries. This includes the malleolar arterial network and the arterial supply to the talus. This extensive supply makes it rare to have necrosis of the bones from severe ankle injuries.

Arteries to the ankle joint arise from malleolar branches of the anterior tibial and peroneal arteries.

# Arterial Supply

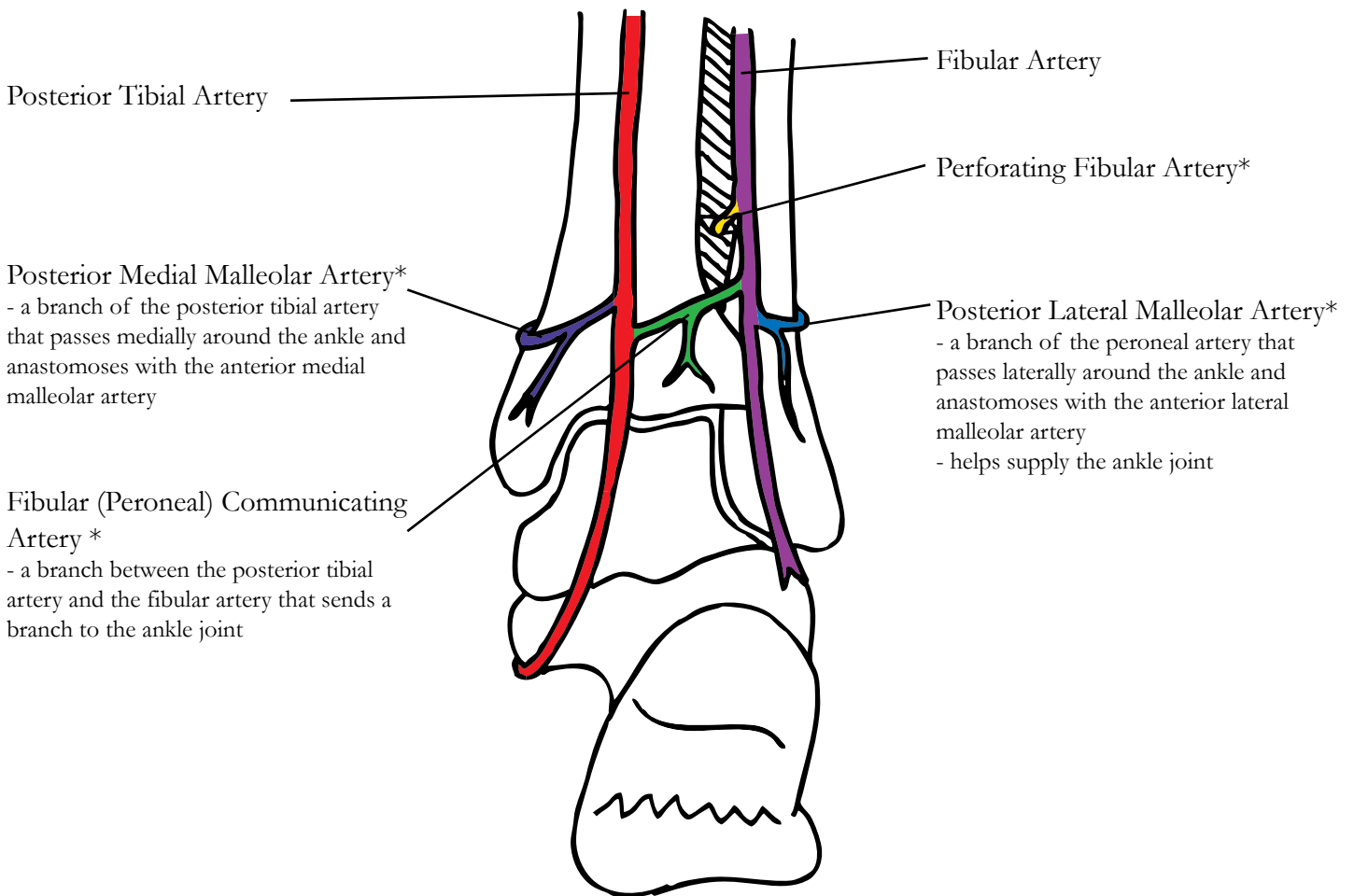
## Malleolar Arterial Network\*

### Posterior View

Medial

Proximal

Lateral



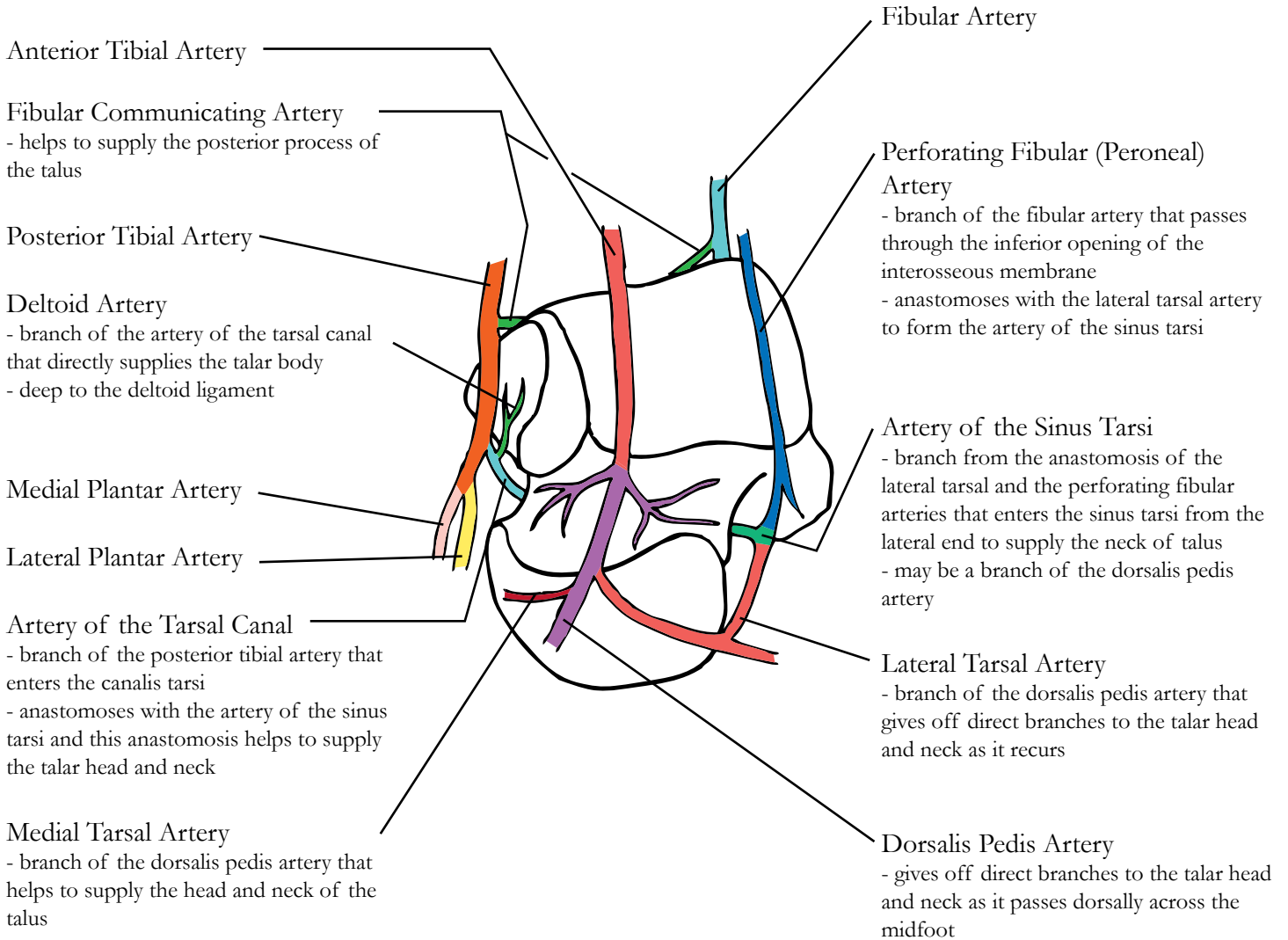
# Arterial Supply to the Talus

## Anterior View

**Medial**

**Proximal**

**Lateral**



### Innervation to the Ankle Joint

Innervation to the ankle joint is supplied by branches from four nerves that pass superficial to the ankle joint. In general, the branches arise at the ankle joint (the level of the malleoli).

#### Tibial Nerve

- sends branches to the ankle joint as it passes along the postero-medial aspect; it is deep to the fascia cruris

#### Deep Fibular (Peroneal) Nerve

- sends branches to the ankle joint as it passes along the anterior aspect; it is deep to the fascia cruris at this level

#### Sural Nerve

- sends branches to the ankle joint as it passes over the posterior lateral aspect; it is in the superficial fascia

#### Saphenous Nerve

- sends branches to the ankle joint as it passes over the anterior medial aspect; it is in the superficial fascia

#### Superficial Fibular (Peroneal) Nerve

- crosses the ankle joint at the anterior lateral aspect, but normally does not provide innervation to the ankle joint (probably because it would be easily injured from an inversion ankle sprain)

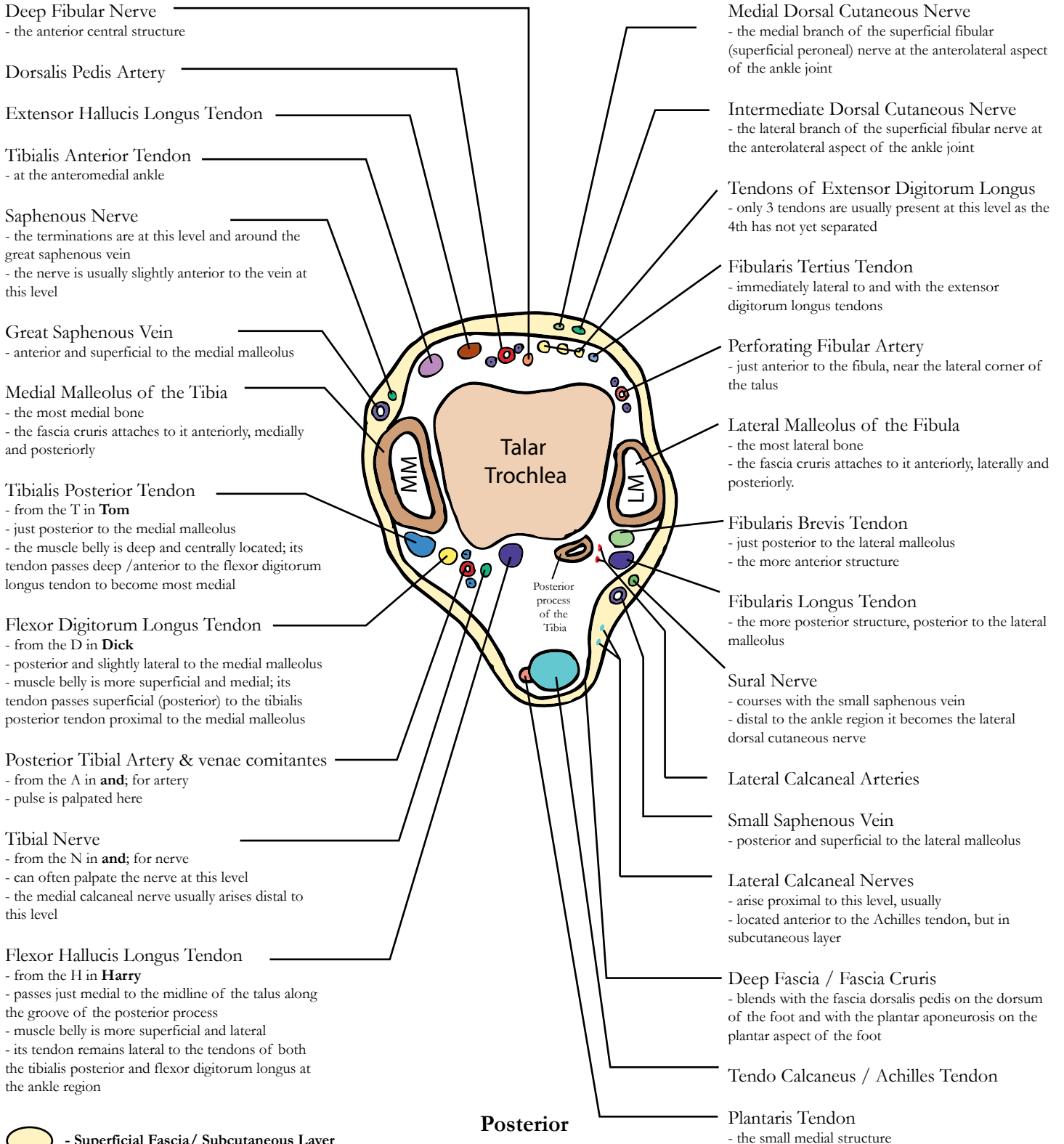
# Ankle Cross Section at the Trochlea Tali

## Superior View

**Medial**

**Anterior**

**Lateral**



**Posterior**

## **Topic 6**

### **Foot Region**

The foot is a complex unit which functions to support body weight during standing and movement. Improper foot function can affect the function of the lower limbs. Improper foot function can create pain in the foot, ankle, leg, knee, thigh, hip or back. Improper function in any region proximal to the foot can create improper foot function or foot pain, also.

Pictures and notes used from Dr. Kathy Siesel's lecture note packet and lecture materials

# Tarsal Tunnel

## Ankle, Rearfoot, and Medial Column

### Medial View

**Anterior**

**Superior**

**Posterior**

#### Borders:

Medial / Superficial \*

- the lacinate ligament / flexor retinaculum, proximal
- the abductor hallucis muscle belly, distal

#### Anterior

- the medial malleolus
- the posterior process of talus
- the sustentaculum tali

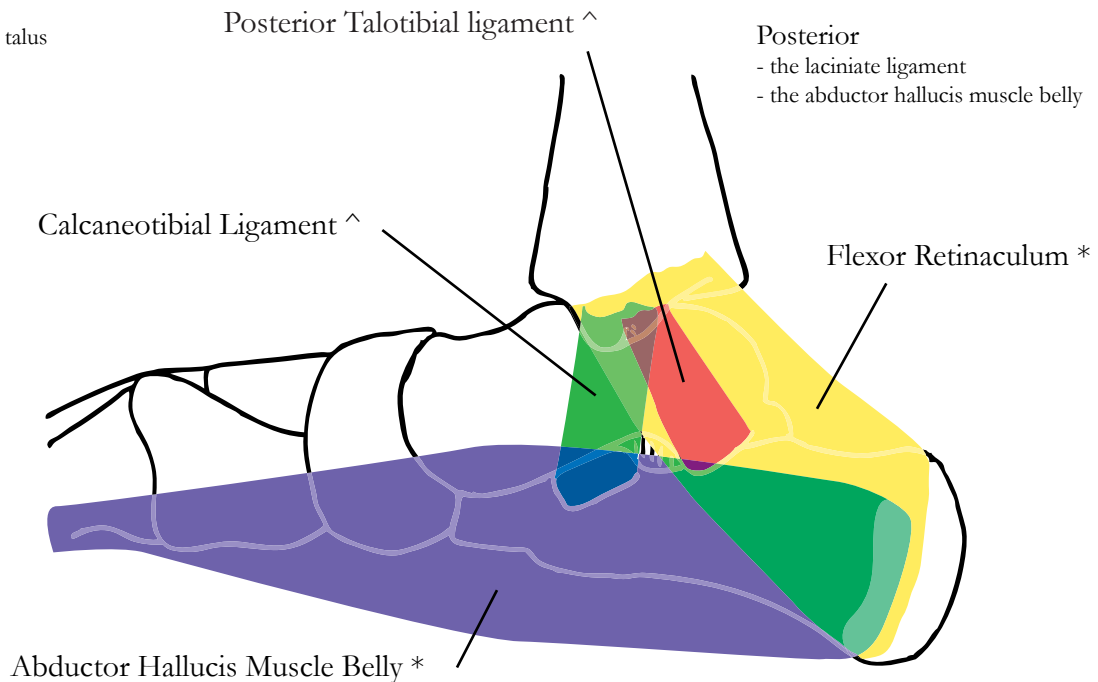
#### Borders:

Lateral / Deep ^

- the posterior talotibial ligaments, proximal
- the calcaneotibial ligament with the ankle joint capsule, superior and distal
- the medial surface of the calcaneus, inferior and distal

#### Posterior

- the lacinate ligament
- the abductor hallucis muscle belly



**Inferior**

The tarsal tunnel is an anatomic area at the posteromedial aspect of the ankle. It extends from the proximal edge of the flexor retinaculum to the distal edge of the porta pedis. It is an osseofibrous tunnel and several structures that pass into the plantar region of the foot also pass through the tarsal tunnel.

#### Contents

- Several soft tissue structures traverse the tarsal tunnel, each in its own compartment. They are listed from anterior to posterior. This is the site of tarsal tunnel syndrome.
- Tibialis Posterior Tendon
- Flexor Digitorum Longus Tendon
- Posterior Tibial Artery & its venae comitantes
  - becomes the medial and lateral plantar arteries within the tarsal tunnel, usually near the porta pedis
- Medial Calcaneal Arteries
  - arise within the tarsal tunnel
  - normally exit by piercing the flexor retinaculum
  - may also continue through the tarsal tunnel

#### - Tibial Nerve

- becomes the medial and lateral plantar nerves within the tarsal tunnel, usually at the proximal end
- Medial Calcaneal Nerve
  - arises within the tarsal tunnel
  - exits by piercing the flexor retinaculum

#### - Flexor Hallucis Longus Tendon

- passes along the inferior aspect of the sustentaculum tali

#### Variation – Anomalous Muscle

#### Flexor Digitorum Accessorius Longus Muscle

- occasionally present (7%) and may cause tibial nerve entrapment
- passes through the tarsal tunnel with the tibial nerve

O: may arise at any level in the posterior crural compartment, from soft tissue or osseous structures

I: inserts into the flexor digitorum longus tendon with the quadratus plantae muscle, normally

A: supinates the subtalar joint

NS: tibial nerve

AS: posterior tibial artery and fibular artery

# Dorsum of the Foot Intrinsic Muscles

## Dorsal View

Medial

Distal

Lateral

### Extensor Hallucis Brevis Muscle

- the distinct medial belly and tendon of the extensor digitorum brevis muscle

O: (anterolateral) floor of the sinus tarsi and the anterior process of the calcaneus  
I: dorsal aspect of the base of the proximal phalanx of the hallux

- the muscle belly passes distomedially and is longer than the extensor digitorum brevis muscle belly; the tendon passes over the dorsal aspect of the first metatarsal head to its insertion

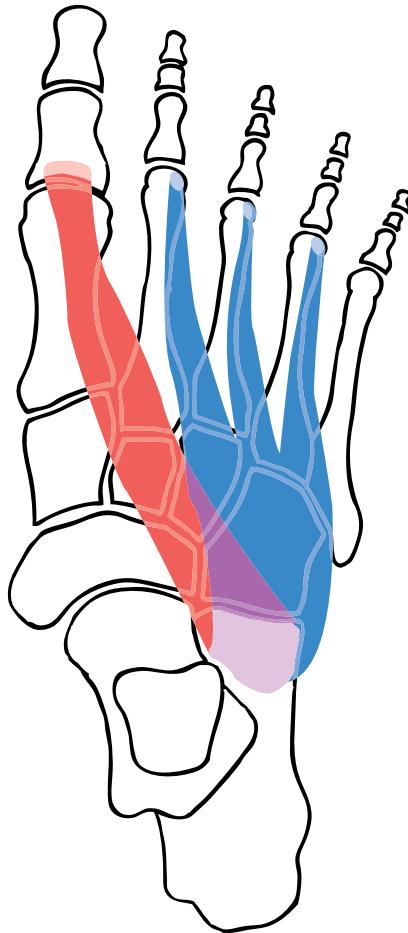
- its tendon passes superficially over the dorsalis pedis artery

- its tendon is often palpable during contraction and sometimes visible over the forefoot

A: dorsiflex the hallux at the metatarsophalangeal joint

NS: lateral terminal branch of the deep fibular nerve

AS: lateral tarsal artery



### Extensor Digitorum Brevis Muscle

- a small muscle located over the dorsolateral aspect of the foot

O: (anterolateral) floor of the sinus tarsi and the anterior process of the calcaneus  
I: lateral aspect of the extensor digitorum longus tendons 2, 3, 4, within the extensor expansion

- the muscle belly passes in a distomedial direction and is relatively short; the tendons then pass to the dorsolateral aspect of the respective digit

- can palpate the muscle belly during contraction; in some individuals can see the muscle belly and tendons during contraction

A: dorsiflex digits 2, 3 and 4 at the metatarsophalangeal joints

NS: lateral terminal branch of the deep fibular nerve / deep peroneal nerve

AS: lateral tarsal artery

### Variations:

- an additional tendon to the 5th digit
- fewer than 3 tendons

Proximal

The dorsum of the foot has one intrinsic muscle with two distinct parts. An intrinsic muscle has both its origin and its insertion in the foot. We have already discussed the extrinsic muscles of the foot. The tendons of the extrinsic muscles are superficial or dorsal to the bellies of the intrinsic muscle. The muscle of the dorsum of the foot receives innervation from the lateral terminal branch of the deep fibular nerve / deep peroneal nerve and nourishment from the lateral tarsal artery. The muscle functions to dorsiflex digits one through four.



# Neurovascular - Foot

## Dorsal View

### Arterial Supply

- arteries lie deep to the muscles and tendons
- often confusing because there is very little subcutaneous soft tissue in this area

### Deep Fibular Nerve ①

### Lateral Tarsal Artery ②

- branch of the dorsalis pedis artery which passes distolaterally, deep to the extensor digitorum brevis and extensor hallucis brevis muscle bellies and supplies them
- anastomoses with the arcuate artery, the lateral plantar artery and the perforating fibular artery
- supplies tarsal bones, extensor digitorum brevis and extensor hallucis brevis muscles, and deep soft tissue structures
- its pulse can be palpated near the proximomedial edge of the extensor digitorum brevis muscle belly

### Lateral Terminal Deep Fibular Nerve ③

- similar course as the arcuate artery or the lateral tarsal artery
- passes deep to and innervates the extensor digitorum brevis and extensor hallucis brevis muscle bellies
- sends minute branches into the 2nd through 4th interspaces which supply the intertarsal, tarsometatarsal and metatarsophalangeal joints of these toes

### Arcuate Artery ④

- a branch of the dorsalis pedis artery near the base of the 2nd metatarsal which passes laterally across the bases of the metatarsal bones 2 through 5
- anastomoses with the lateral tarsal artery
- gives rise to 3 dorsal metatarsal arteries

#### Variations:

- if the arcuate artery is absent, the dorsal metatarsal arteries arise from either the lateral tarsal artery or the proximal perforating arteries (between the dorsal and plantar metatarsal arteries at the proximal end of the intermetatarsal space)
- when the dorsal metatarsal arteries arise from the lateral tarsal artery, then the lateral tarsal artery is in a more distal position
- the lateral tarsal artery position can be normal when the dorsal metatarsal arteries arise from the proximal perforating arteries

### Dorsal Metatarsal Arteries 2, 3, 4 ⑤

- arises between the metatarsal bases and passes distally within the intermetatarsal space, dorsally
- rests on the belly of the (2,3,4) dorsal interosseous muscle

### Proximal Perforating Arteries 2, 3, 4 ⑥

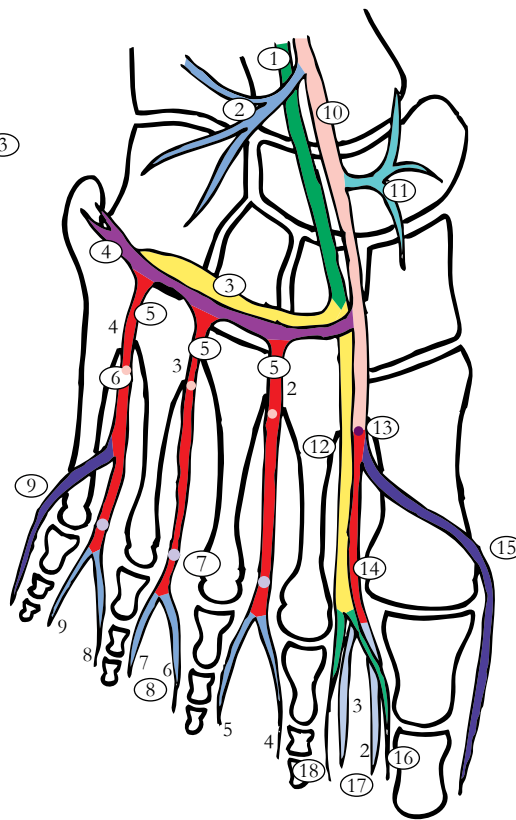
- a branch of the (2,3,4) dorsal metatarsal artery that passes plantarly at the (2,3,4) proximal intermetatarsal space
- provides anastomosis between the (2,3,4) dorsal metatarsal artery and the (2,3,4) plantar metatarsal artery

### Nutrient Artery to the First Metatarsal

- passes into the lateral aspect of the metatarsal shaft near the center

### Nerve Supply

- The other proper dorsal digital nerves are branches from the medial, intermediate and lateral dorsal cutaneous nerves of the foot. These are branches of the superficial fibular and sural nerves. Along the dorsum of the foot, these nerves are superficial to the muscles and are found within the subcutaneous layer. The proper dorsal digital nerves are also deep to the superficial veins.



### Distal Perforating Arteries 1, 2, 3, 4 ⑦

- a branch of the (1,2,3,4) dorsal metatarsal artery which passes plantarly at the distal interspace
- provides anastomosis between the (1,2,3,4) dorsal metatarsal artery and the (1,2,3,4) plantar metatarsal artery

### Common Dorsal Digital Artery 4 thru 9 ⑧

- terminations of the dorsal metatarsal artery; one ⑧ supplies the lateral side of the toe and another supplies the medial side of the toe

### Proper Dorsal Digital Artery 10 ⑨

- branch of the 4th dorsal metatarsal artery, courses dorsally over the 5th metatarsal and supplies the dorsolateral side of the 5th toe
- may be a branch of the arcuate artery

### Dorsalis Pedis Artery ⑩

- continuation of the anterior tibial artery, courses dorsally over the medial midfoot (usually the navicular and intermediate cuneiform)
- its pulse can be palpated at this level, intermediate to the extensor hallucis longus and extensor digitorum longus muscle tendons
- it lies deep to the muscle bellies at the transverse crural ligament and passes deep to the cruciate crural ligament

#### Variation:

- if the anterior tibial artery is absent, the dorsalis pedis artery arises from the perforating fibular artery

### Medial Tarsal Artery ⑪

- anastomoses with the medial part of the malleolar arterial network and the medial plantar artery
- supplies medial tarsal bones and deep soft tissue structures

### Medial Terminal Deep Fibular Nerve ⑫

#### Nerve

- at the 1st web space it pierces the fascia dorsalis pedis and becomes subcutaneous
- innervates 1st metatarsal-medial cuneiform joint and the 1st metatarsophalangeal joint
- innervates part of the 1st dorsal interosseous muscle

### Deep Plantar Artery Medial ⑬

- (first proximal perforating artery)
- terminal branch of the dorsalis pedis artery
- arises at the proximal end of the 1st interspace and passes plantarly to anastomose with the 1st plantar metatarsal artery

### First Dorsal Metatarsal Artery ⑭

- terminal branch of the dorsalis pedis artery
- passes distally within the 1st interspace, dorsally
- rests on the dorsal surface of the 1st dorsal interosseous muscle

### Proper Dorsal Digital Artery 1 ⑮

- branch of first dorsal metatarsal artery, courses dorsally over the first metatarsal and supplies the medial side of the hallux

### Proper Dorsal Digital Nerve 2 ⑯

- the medial branch of the nerve after it exits the deep fascia
- innervates the lateral aspect of the hallux

### Common Dorsal Digital Artery 2 & 3 ⑰

- terminations of the 1st dorsal metatarsal artery ⑰
- two supplies the lateral side of the hallux and three supplies the medial side of the 2nd toe

### Proper Dorsal Digital Nerve 3 ⑱

- the lateral branch of the nerve after it exits the deep fascia
- innervates the medial aspect of the 2nd toe

# Plantar Aponeurosis

## Dorsal Foot

## Plantar View

**Lateral**

**Distal**

**Medial**

### Deep Fascia

The deep fascia of the plantar aspect of the foot is the plantar fascia or plantar aponeurosis. It is a very strong, thick layer of tissue that attaches to the plantar skin and provides partial attachment for some of the muscles of the plantar aspect of the foot.

### Superficial Transverse Metatarsal Ligament

### Lateral Band (slip, part)

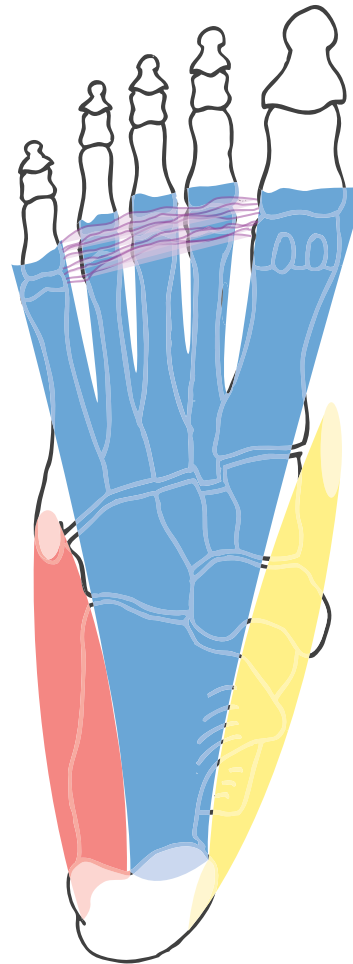
#### Distal Attachment

- the styloid process of the 5th metatarsal
- it blends with fascia dorsalis pedis laterally, and with the central band of plantar fascia medially
- attaches bone to bone
- septae pass to skin along this course and contain the fat pad

#### Proximal attachment

- the lateral tubercle of the calcaneal tuberosity

The plantar aspect of the foot is covered with a thick cutaneous layer / skin as well as a thick subcutaneous layer of adipose tissue called the plantar fat pad. The layer of adipose tissue is generally less thick in the area of the medial longitudinal arch. The plantar fat pad is generally kept in place by fibers of the plantar aponeurosis called septae. The septae pass to the skin and create small compartments to contain the adipose tissue. The fat pad is thickest in weight-bearing areas: the metatarsophalangeal joints, the lateral column and the calcaneus. The subcutaneous layer provides shock absorption and cushioning for osseous and soft tissue structures.



**Proximal**

### Central Band (part, slip)

#### Distal Attachment

- divides into 5 bands (one for each metatarsal) and then into superficial and deep layers before attaching near the metatarsal heads

#### Superficial Layer

- most plantar, septae pass to skin along course and contain the fat pad
- attaches bone to skin

#### Longitudinal Fibers

- the skin of the sulcus between the digits and the forefoot

#### Transverse Fibers

- transverse fibers arise near the attachment at the sulcus and course from one digital band to another forming the metatarsal ligament at the level of the metatarsophalangeal joints

#### Proximal Attachment

- the medial tubercle of the calcaneal tuberosity, plantar aspect
- the thickest and strongest part

### Medial Band (slip, part)

#### Distal Attachment

- thinnest part of the plantar fascia
- no true bony attachments distally
- it blends with the fascia dorsalis pedis and the lower band of the inferior extensor retinaculum medially, and with the central band of the plantar laterally
- attaches bone to deep fascia
- septae pass to skin along this course and contain the fat pad

#### Proximal Attachment

- the medial tubercle of the tuberosity of the calcaneus, medial aspect
- the thinnest part

# Deep Layer of Central Band of Plantar Fascia

## Plantar View

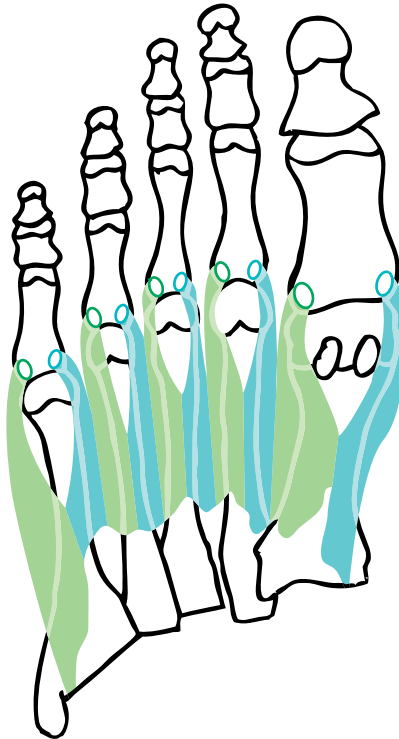
**Lateral**

**Distal**

**Medial**

### Deep Layer of Central Band

- splits into medial and lateral slips that pass along either side of the long and short flexor tendons and attach to the proximal phalangeal bases
- at the 1st metatarsophalangeal joint, these slips attach to the respective sesamoid, too
- attaches bone to bone
- creates the *flexor sheaths*



### Central Band - Lateral Slip

- attaches to the lateral aspect of the base of the proximal phalanx of the respective digit, ex. the 3rd band attaches to the lateral proximal phalangeal base of the 3rd toe

### Central Band - Medial Slip

- attaches to the medial aspect of the base of the proximal phalanx of the respective digit, ex. the 2nd band attaches to the medial proximal phalangeal base of the 2nd toe

**Proximal**

### Flexor Sheaths

- fibrous tunnels that protect the long and short flexor tendons
- formed as the slips blend with surrounding structures
- *Dorsal Border* – deep transverse metatarsal ligament
- *Medial Border* – medial slip of deep layer of central band of plantar aponeurosis for the respective toe
- *Plantar Border* – superficial transverse metatarsal ligament
- *Lateral Border* – lateral slip of deep layer of central band of plantar fascia for the respective toe

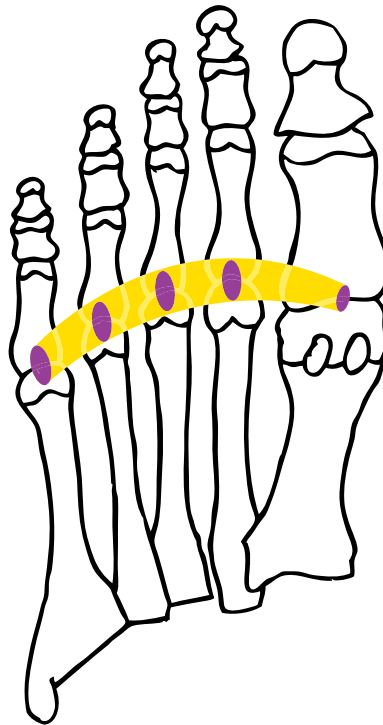
# Deep Transverse Metatarsal Ligament

## Plantar View

Lateral

Distal

Medial



### Plantar (Volar) Plate

- a thickening of the plantar aspect of the capsule and the plantar metatarsophalangeal ligament of the metatarsophalangeal joints that serves as a site of attachment for the deep transverse metatarsal ligament
- 1st metatarsophalangeal joint plate is less thick due to the presence of sesamoids

### Deep Transverse Metatarsal Ligament

- a relatively firm ligament that connects one metatarsal head to another at the volar plate
- the ligament between the 1st and 2nd metatarsal heads is often thinner and occasionally absent

Proximal

# First Plantar Layer Muscles

## Plantar View

First Layer is the most superficial/plantar and contains 3 muscles

Lateral

Distal

Medial

### Abductor Digiti Minimi (Quinti) Muscle

- the lateral muscle of the 1st layer
- lies deep to and takes partial origin from the lateral band of the plantar fascia

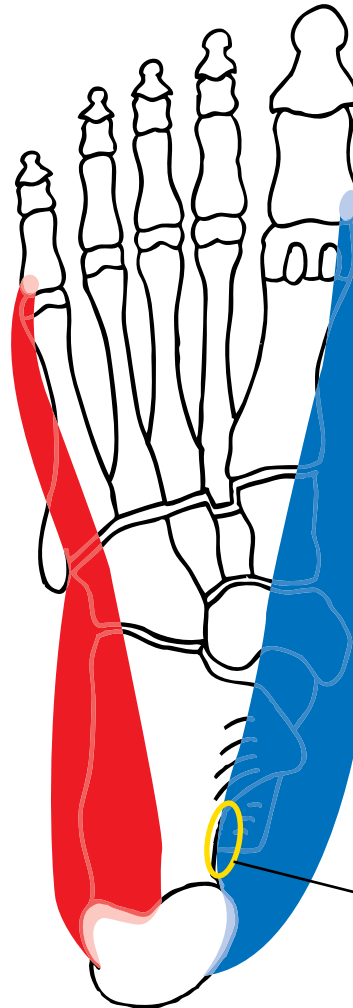
**O:** the lateral tubercle of the calcaneal tuberosity and the lateral edge of the medial tubercle of the calcaneal tuberosity

**I:** plantar lateral tubercle of the base of the proximal phalanx of the 5th toe  
 - the muscle belly passes along the lateral longitudinal arch and the groove on the plantar surface of the 5th metatarsal base, it becomes tendinous near midshaft and passes along the plantar lateral aspect of the 5th metatarsophalangeal joint

**A:** abducts the 5th toe; aids in plantar flexion of the 5th toe

**NS:** lateral plantar nerve

**AS:** lateral plantar artery



Proximal

### Abductor Hallucis Muscle

- the medial muscle of the 1st layer
- lies deep to and takes partial origin from the medial band of the plantar fascia
- often a visible bulge on the medial side of the foot during weight bearing (near the calcaneus)

**O:** medial tubercle (medial aspect) of the calcaneal tuberosity and the lacinate ligament

**I:** plantar medial tubercle of the base of the proximal phalanx of the hallux and some fibers insert onto the medial (tibial) sesamoid

- the muscle belly passes along the medial longitudinal arch of the foot and becomes tendinous at the midshaft of the 1st metatarsal bone and passes along the plantar medial aspect of the 1st metatarsophalangeal joint

**A:** abducts the hallux (moves it away from the midline of the foot); aids in plantar flexion of the hallux

**NS:** medial plantar nerve

**AS:** medial plantar artery

### Porta Pedis

- the "door of the foot"
- the area (space) between the medial surface of the calcaneus and the abductor hallucis muscle belly
- the distal extent of the tarsal tunnel
- many neurovascular structures to the planta of the foot pass through this area

The muscles of the plantar aspect of the foot are arranged in layers with the neurovascular supply generally passing between these layers. There are four layers of muscles on the plantar aspect of the foot. The muscles of the first and second layers traverse the length of the foot. The muscles of the third and fourth layers are muscles of the forefoot. These muscles, in general terms, receive arterial supply and innervation from the medial and lateral plantar arteries and nerves.

# First Plantar Layer Muscles

## Plantar View

First Layer is the most superficial/plantar and contains 3 muscles

**Lateral**

**Distal**

**Medial**

### Flexor Digitorum Brevis Muscle

- the central muscle of the 1st layer
- lies deep to and takes partial origin from the central band of the plantar fascia

**O:** plantar aponeurosis, central band and medial calcaneal tubercle, plantar aspect

**I:** plantar aspect of the bases of the middle phalanges of digits 2 through 5  
 - the tendons course with the flexor digitorum longus tendons, lying superficial or plantar to the flexor digitorum longus tendons; near the middle of the proximal phalanges the flexor digitorum brevis tendons divide, to allow passage of the flexor digitorum longus tendons, and reunite deep to the flexor digitorum longus tendons prior to inserting on the middle phalangeal bases.

The flexor digitorum longus tendons have a more distal insertion and must pass from a more dorsal to a more plantar position.

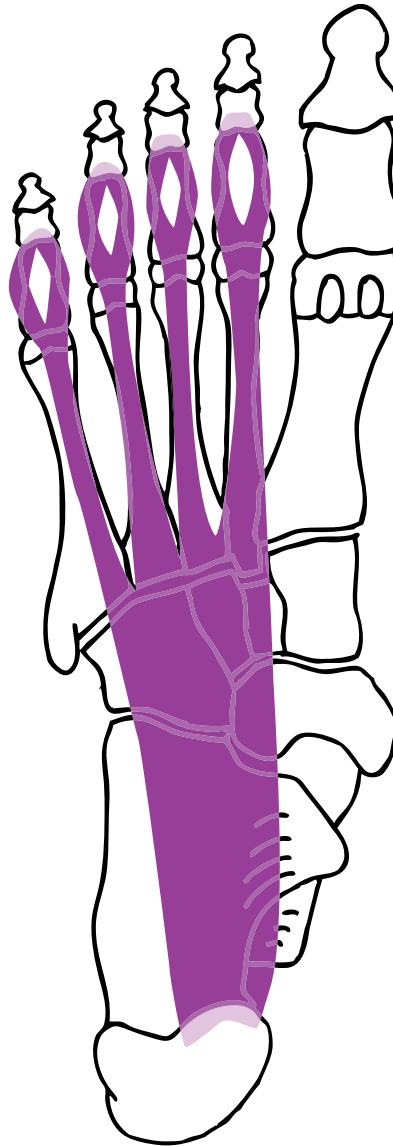
**A:** plantar flex the lesser digits, begins at the proximal interphalangeal joints then the metatarsophalangeal joints

**NS:** medial plantar nerve

**AS:** medial plantar artery

#### *Variations:*

- absence of the tendon to the 5th toe
- an extra tendon to the 5th toe
- very small tendon to the 5th toe that seems to arise from the deep surface of the muscle belly.



**Proximal**

# Second Plantar Layer Muscles

## Plantar View

- consists of 5 muscles
- all muscles are associated with the flexor digitorum longus tendon(s)
- flexor digitorum longus and flexor hallucis longus tendons pass in this layer

**Lateral**

**Distal**

**Medial**

### Quadratus Plantae Muscle

- sometimes called flexor accessorius muscle
- proximal muscle of the 2nd layer
- lies deep to flexor digitorum brevis muscle belly
- has 2 heads of origin which are separated by the long plantar ligament

**O:** medial head - medial surface of the calcaneus (inferior to the groove for flexor hallucis longus tendon)

- the larger and more muscular part lateral head – trigonum plantare of calcaneus, proximolaterally (inferior aspect of the calcaneus, distal to the calcaneal lateral tubercle)

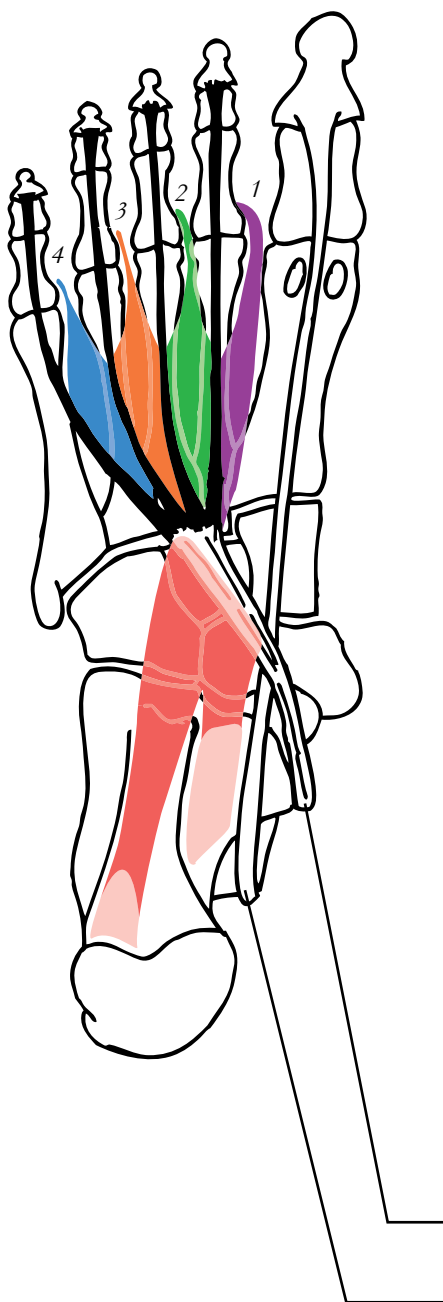
**I:** the tendon of flexor digitorum longus muscle

- the 2 heads unite and pass to the insertion

**A:** modifies the direction of pull of the flexor digitorum longus muscle (modifies the action of the flexor digitorum longus muscle); the flexor digitorum longus muscle will pull in a more posterior direction instead of a medial posterior direction

**NS:** lateral plantar nerve

**AS:** medial plantar and lateral plantar arteries



### Lumbricale Muscles (1, 2, 3 and 4)

- distal muscles of the 2nd layer (at the forefoot)
- there are 4 lumbrical muscles
- one muscle for each intermetatarsal space

**O:** first - medial side of 1st tendon of flexor digitorum longus muscle

- second, third and fourth - adjacent sides of the tendons of flexor digitorum longus muscle; one between each two tendons
  - ex. the 2nd lumbricale originates from the lateral side of the 1st tendon and the medial side of the 2nd tendon of flexor digitorum longus muscle, etc.

**I:** the medial aspect of the extensor wing portion of the extensor expansion/ extensor hood apparatus at the proximal phalangeal base; the 1st lumbrical muscle inserts into the extensor wing of the 2nd metatarsophalangeal joint (MTPJ), etc.

- the tendons pass along the medial side of the respective metatarsals, then pass plantar to the deep transverse metatarsal ligament before inserting

**A:** plantar flex / flex the metatarsophalangeal joints and dorsiflex / extend the proximal and distal interphalangeal joints (PIPJs and DIPJs) of the lesser toes, simultaneously (the bye-bye muscles); ex. 1st lumbrical muscle acts upon the 2nd toe, etc.

**NS:** first - medial plantar nerve

- second, third and fourth - deep branch of the lateral plantar nerve

**AS:** plantar metatarsal arteries, respectively; ex. the 1st plantar metatarsal artery supplies the 1st lumbrical muscle, etc.

*Variations:*

- absence of one or more of the lumbricales
- the second lumbricale is rarely absent

Flexor Digitorum Longus Muscle

Flexor Hallucis Longus Muscle

**Proximal**



# Third Plantar Layer Muscles

## Plantar View

deep / dorsal to the 2nd layer  
 - contains 3 muscles

- tendons of peroneus longus and tibialis posterior muscles pass in this layer

**Lateral**

**Distal**

**Medial**

### Flexor Digiti Minimi (Quinti) Brevis Muscle

- small muscle located at the plantar lateral aspect of the forefoot

**O:** plantar medial aspect of the base of 5th metatarsal and fibularis longus tendon sheath / fibular canal

**I:** plantar lateral aspect of the base of the proximal phalanx of 5th digit, with abductor digiti minimi muscle  
 - passes directly along the metatarsal shaft

**A:** plantar flexion (flexion) of the 5th digit at the metatarsophalangeal joint; some abduction of the 5th digit often occurs

**NS:** superficial branch of the lateral plantar nerve

**AS:** lateral plantar artery

#### Variation:

**Opponens Digiti Minimi (Quinti) Muscle**  
 - an insertion of the flexor digiti minimi brevis muscle on the plantar aspect of the 5th metatarsal head  
 - functions to plantar flex and adduct the 5th metatarsal  
 - to oppose the 1st metatarsal

Fibularis Longus Muscle

### Flexor Hallucis Brevis Muscle

- the medial muscle of the 3rd layer  
 - this muscle has a Y-shaped tendinous origin

**O:** lateral part – adjacent plantar aspects of the cuboid (medial edge of the peroneal ridge) and the lateral cuneiform (adjacent plantar area)

medial part - tendon of tibialis posterior muscle (near the cuneiforms)

**I:** plantar medial and plantar lateral tubercles of the base of the hallux proximal phalanx

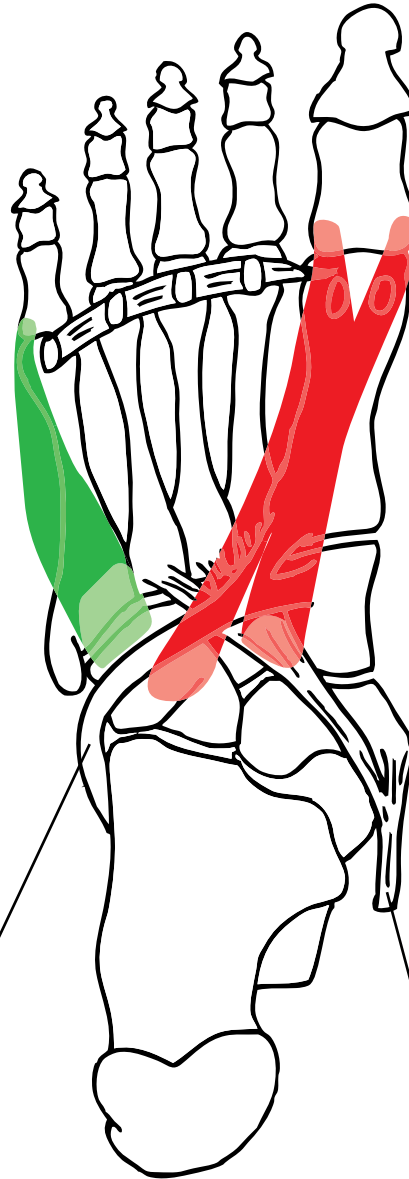
- the muscle fibers blend as they pass distally then separate into 2 tendons, each tendon surrounds a sesamoid bone before inserting onto the proximal phalanx;

ex. the medial tendon encloses the medial or tibial sesamoid then inserts onto the plantar medial aspect of the base of the proximal phalanx of the hallux, etc.

**A:** plantar flexes / flexes the hallux at the metatarsophalangeal joint

**NS:** medial plantar nerve

**AS:** first plantar metatarsal artery (from the plantar arch artery)



Tibialis Posterior Muscle

**Proximal**



# Third Plantar Layer Muscles

## Plantar View

deep / dorsal to the 2nd layer

- contains 3 muscles

- tendons of peroneus longus and tibialis posterior muscles pass in this layer

**Lateral**

**Distal**

**Medial**

### Adductor Hallucis Muscle

- the central muscle of the 3rd layer
- sometimes called the transverse pedis muscle
- has 2 heads of origin; transverse and oblique

**O:** transverse head - the 3rd through 5th plantar plates and the deep transverse metatarsal ligament, plantarly

oblique head - plantar aspect of the bases of 2nd through 4th metatarsals and the fibularis longus tendon sheath / fibular canal

**I:** lateral / fibular sesamoid and lateral tubercle of the 1st proximal phalangeal base

- the part of the tendon that attaches to the proximal phalanx passes dorsal to the deep transverse metatarsal ligament

**A:** adducts the hallux (toward the midline of the foot); aids in plantar flexion of the hallux

**NS:** deep branch of the lateral plantar nerve

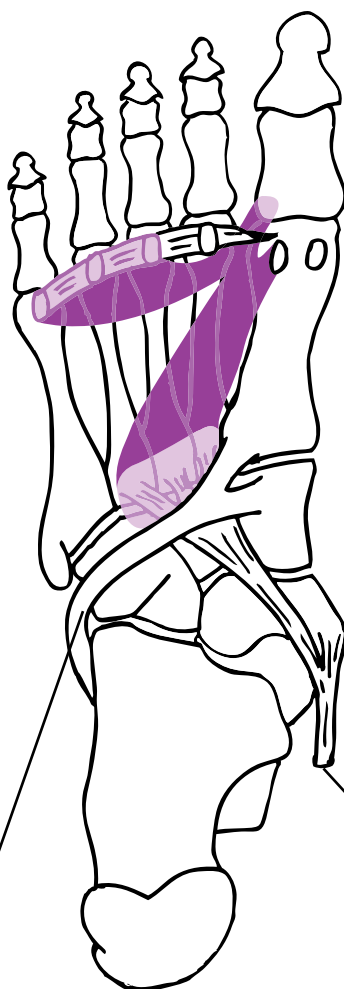
**AS:** plantar metatarsal arteries (all 4)

#### *Variation:*

Opponens Hallucis Muscle

- an insertion of the adductor hallucis muscle on the plantar aspect of the 1st metatarsal head
- functions to adduct and plantar flex the first metatarsal
- to oppose the 5th metatarsal

Fibularis Longus Muscle



Tibialis Posterior Muscle

**Proximal**

# Fourth Plantar Layer Muscles

## Plantar View

- the deepest, most dorsal, layer of plantar muscles, the interossei
- located in the intermetatarsal spaces
- associated with the lesser digits only
- all tendons pass dorsal to the deep transverse metatarsal ligament

### Lateral

#### Plantar Interossei Muscles (1, 2 and 3)

- 3 plantar interossei muscles
- none to 2nd digit
- are unipennate (muscle fibers all pass in the same manner from the origin to the same side of the muscle tendon)

**O:** plantar aspect of the bases and medial aspect of the shafts of the 3rd, 4th and 5th metatarsals;

- ex. the 1st plantar interosseous muscle arises from the plantar base and medial shaft of the 3rd metatarsal, the 2nd plantar interosseous muscle arises from the plantar base and medial shaft of the 4th metatarsal and the 3rd plantar interosseous muscle arises from the plantar base and medial shaft of the 5th metatarsal

**I:** medial aspect of the base of the proximal phalanx and extensor expansion of the respective digit;

- ex. the 3rd plantar interosseous muscle inserts medially onto the proximal phalanx and laterally to the extensor expansion of the 5th toe, the 2nd plantar interosseous muscle inserts medially onto the proximal phalanx and laterally to the extensor expansion of the 4th digit, and the 1st plantar interosseous muscle inserts medially onto the proximal phalanx and laterally to the extensor expansion of the 3rd toe

- the tendons pass dorsal (deep) to the extensor expansion

**A:** adduct digits 3, 4 and 5, respectively (toward the midline of the foot)

- ex. the 1st plantar interosseous muscle adducts the 3rd toe, the 2nd plantar interosseous muscle adducts the 4th toe and the 3rd plantar interosseous muscle adducts the 5th toe

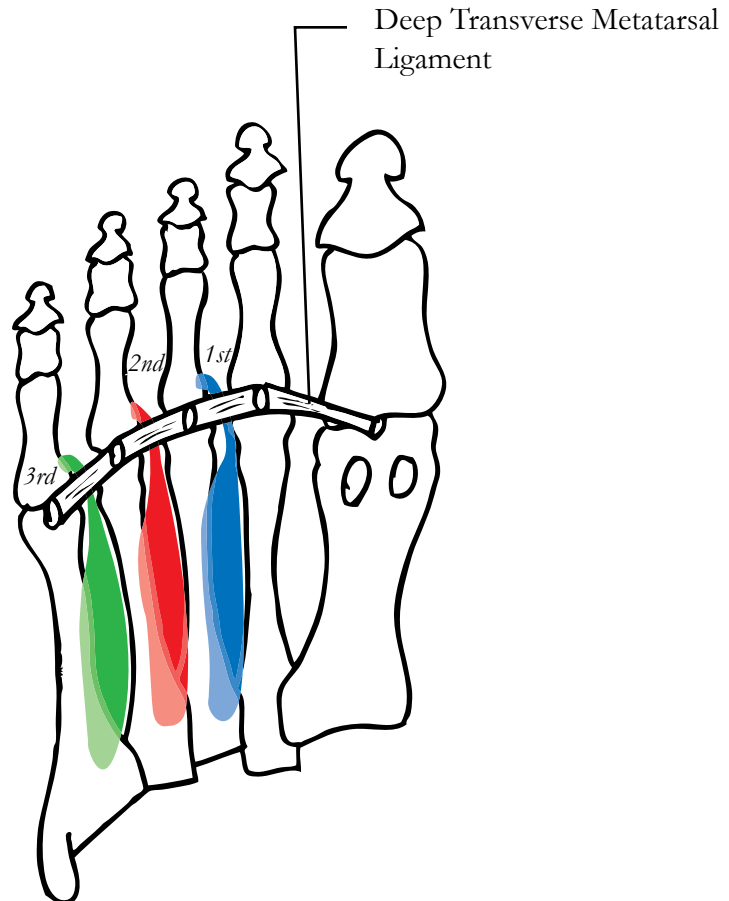
**NS:** lateral plantar nerve; superficial branch for the 3rd plantar interosseous, and deep branch for 1st and 2nd plantar interosseous muscles

**AS:** second, third and fourth plantar metatarsal arteries, respectively;

- ex. the 1st plantar interosseous muscle is supplied by the 2nd plantar metatarsal artery, the 2nd plantar interosseous muscle is supplied by the 3rd plantar metatarsal artery, and the 3rd plantar interosseous muscle is supplied by the 4th plantar metatarsal artery

### Distal

### Medial



### Proximal

# Fourth Plantar Layer Muscles

## Plantar View

- the deepest, most dorsal, layer of plantar muscles, the interossei
- located in the intermetatarsal spaces
- associated with the lesser digits only
- all tendons pass dorsal to the deep transverse metatarsal ligament

### Lateral

#### Dorsal Interossei Muscles (1, 2, 3 and 4)

- 4 dorsal interossei muscles
- none to 5th toe
- are bipennate (muscle fibers converge upon the central tendon from 2 sides)
- lie dorsal (deep) to the plantar interossei muscles
- in lab, often visible from the dorsum of the foot (between metatarsal bones) also

**O:** adjacent areas of the metatarsal shafts (one muscle is located in each intermetatarsal space),

ex. the 1st dorsal interosseous muscle originates from the lateral aspect of the 1st metatarsal shaft and the medial aspect of the 2nd metatarsal shaft, the 2nd dorsal interosseous muscle originates from the lateral shaft of the 2nd metatarsal and the medial shaft of the 3rd metatarsal, the 3rd dorsal interosseous muscle originates from adjacent aspects of the 3rd and 4th metatarsal shafts, and the 4th dorsal interosseous muscle originates from adjacent surfaces of the 4th and 5th metatarsal shafts

**I:** first - medial aspect of the 2nd proximal phalangeal base

second, third and fourth - lateral aspect of the base of the proximal phalanx of the respective toe

ex. the 2nd dorsal interosseous muscle inserts onto the lateral aspect of the 2nd proximal phalangeal base, the 3rd dorsal interosseous muscle inserts onto the lateral aspect of the proximal phalangeal base of the of the 3rd digit, and the 4th dorsal interosseous muscle inserts onto the lateral aspect of the base of the proximal phalanx of the 4th toe

- tendons pass within the extensor expansion

**A:** abduct toes 2, 3 and 4 (from the midline of the foot), 1st and 2nd abduct the 2nd toe, 3rd abducts the 3rd toe and 4th abducts the 4th toe

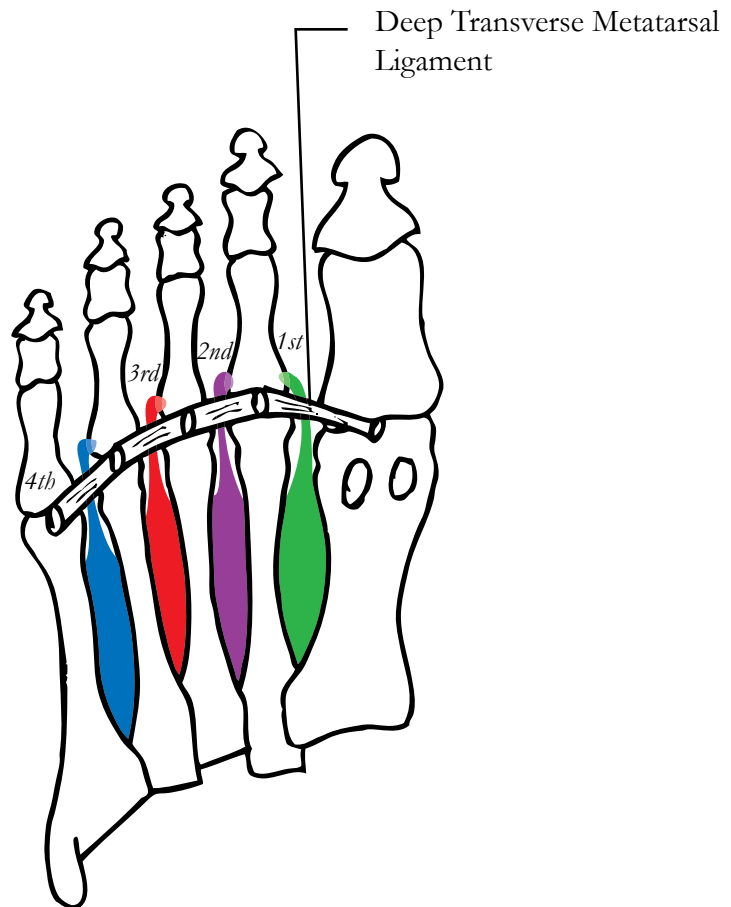
**NS:** lateral plantar nerve, 1st, 2nd and 3rd from the deep branch and 4th from the superficial branch; 1st and 2nd also receive some supply from the deep fibular / deep peroneal nerve

**AS:** the respective dorsal metatarsal artery

ex. the 4th dorsal interosseous muscle is supplied by the 4th dorsal metatarsal artery, the 3rd dorsal interosseous muscle is supplied by the 3rd dorsal metatarsal artery, the 2nd dorsal interosseous muscle is supplied by the 2nd dorsal metatarsal artery, and the 1st dorsal interosseous muscle is supplied by the 1st dorsal metatarsal artery

### Distal

### Medial



### Proximal

The functions of the muscles in the fourth layer are most easily remembered by the mnemonic **PAD & DAB**. The first letter represents the interossei muscles; **P** for plantar and **D** for dorsal. The other letters represent the action (function) of the respective interossei; **AD** for adduct and **AB** for abduct. So PAD represents plantar interossei muscles adduct and DAB represents dorsal interossei muscles abduct

# Arterial Supply Plantar View

**Lateral**

**Distal**

**Medial**

**Common Digital Plantar Arteries 2 thru 9**  
- terminal divisions of the plantar metatarsal artery  
- generally arise distal to the deep transverse metatarsal ligament

**Proper Digital Plantar Artery 10 (of Fifth Digit)**  
- a small lateral branch from the lateral plantar artery as the course turns sharply medial near the 5th metatarsal base  
- passes distally intermediate to the abductor digiti minimi muscle (plantar lateral) and flexor digiti minimi brevis muscle (dorsomedial); becomes more superficial near midshaft of the 5th metatarsal  
- terminates in the 5th toe where it supplies the toe's plantar lateral aspect

**First thru Fourth Distal Perforating Artery**  
- arises at the (1st, 2nd, 3rd or 4th) distal interspace and connects the (1st, 2nd, 3rd or 4th) dorsal and plantar metatarsal arteries

**First thru Fourth Plantar Metatarsal Artery**  
- 1st arises at the anastomosis of the deep plantar artery / 1st proximal perforating artery and the plantar arterial arch  
- passes distally in the (1st, 2nd, 3rd or 4th) intermetatarsal space; passes dorsal to the deep transverse metatarsal ligament

**Second thru Fourth Proximal Perforating Artery**  
- arises at the (2nd, 3rd or 4th) proximal interspace and connects the (2nd, 3rd or 4th) dorsal and plantar metatarsal arteries

**Plantar Arterial Arch (Arch Artery)**  
- the medially directed continuation of the lateral plantar artery  
- passes medially at the metatarsal bases, dorsal to the oblique head of adductor hallucis muscle and plantar to the interossei muscles; intermediate to layers 3 and 4  
- gives rise to 4 plantar metatarsal arteries and anastomoses with the deep plantar artery

**Lateral Plantar Artery**  
- the posterior branch of the posterior tibial artery  
- usually larger than the medial plantar artery  
- passes anterolaterally toward the 5th metatarsal styloid process; dorsal to the flexor digitorum brevis muscle and plantar to the quadratus plantae muscle, intermediate to layers 1 and 2

**Proper Digital Plantar Artery 1 (of hallux)**  
- the medial division of the superficial branch of the medial plantar artery  
- supplies the medial plantar aspect of the hallux

**Digital Branch of First Plantar Metatarsal Artery**  
- passes medially to anastomose with the proper digital plantar artery 1 (of the hallux)

**First Proximal Perforating Artery (Deep Plantar Artery)**  
- arises at the First proximal interspace and connects the First dorsal and plantar metatarsal arteries

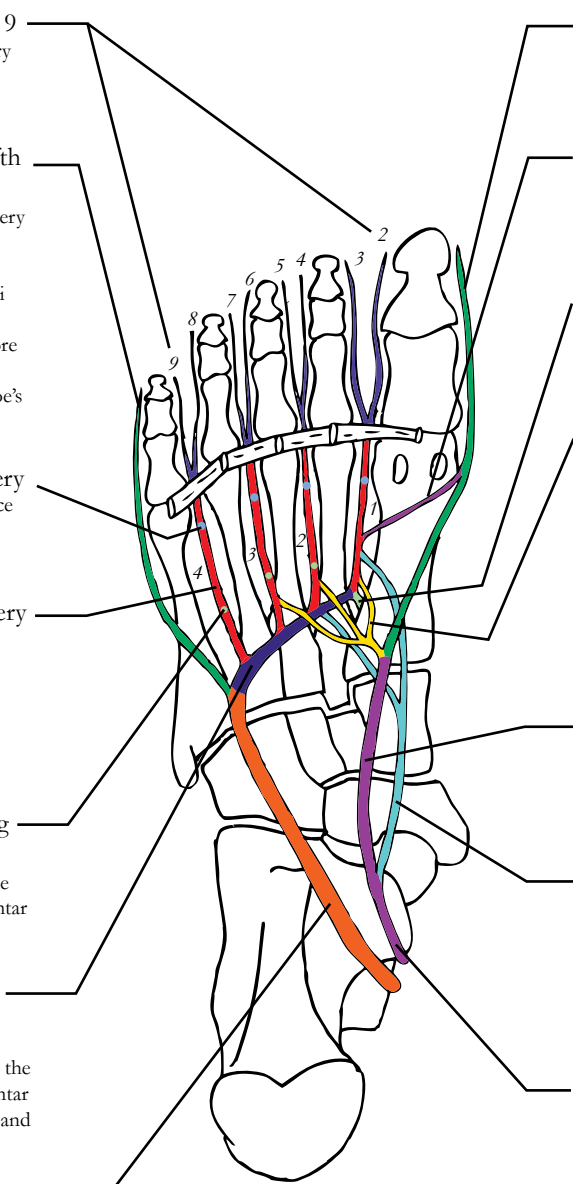
**Superficial Digital Branch**  
- the lateral division of the superficial branch of the medial plantar artery  
- anastomoses with the 1st, 2nd and 3rd plantar metatarsal arteries  
- occasionally provides small common digital plantar arteries which pass plantar to the deep transverse metatarsal ligament in addition to the normal metatarsal arteries and common digital plantar arteries

**Superficial Branch**  
- appears as the direct continuation of the medial plantar artery and passes distally intermediate to the abductor hallucis (medial) and the flexor digitorum brevis (lateral) muscles; within the 1st layer

**Deep Branch / ramus profundus**  
- usually arises near the origin of the medial plantar artery  
- passes along the plantar aspect of the medial foot bones and supplies them  
- anastomoses with the plantar arch artery and the 1st plantar metatarsal artery

**Medial Plantar Artery**  
- the anterior branch of the posterior tibial artery  
- usually smaller than the lateral plantar artery  
- enters the foot through the porta pedis intermediate to plantar layers 1 and 2  
- the passes along the medial aspect of the foot intermediate to the abductor hallucis and flexor digitorum brevis muscles; within the 1st layer

**Nutrient Artery to the 5th Metatarsal**  
- passes to the medial aspect of the 5th metatarsal shaft and pierces it in its proximal one-third



**Proximal**

The arterial supply to the plantar aspect of the foot is via the medial and lateral plantar arteries. These are the terminal branches of the posterior tibial artery.

These branches usually arise deep to the flexor retinaculum and pass into the foot via the tarsal tunnel and the porta pedis. Several small medial calcaneal arteries usually arise from the posterior tibial artery prior to this division and pierce the flexor retinaculum.

The lateral calcaneal arteries are terminal divisions of the peroneal artery, posterior to the lateral malleolus

# Nerve Supply Plantar View

## Lateral

### Proper Digital Plantar Nerves 2 thru 9

- cutaneous branches which are terminal divisions of common digital plantar nerve 1 thru 4 and arise near the deep transverse metatarsal ligament
- one supplies the plantar lateral aspect of the digit while the other supplies the plantar medial aspect of the neighboring digit

### Proper Digital Plantar Nerve 10 (of 5th digit)

- a cutaneous branch that supplies the plantar lateral aspect of the 5th toe
- becomes cutaneous near the 5th metatarsal midshaft

### Communicating Branch

- from the superficial lateral plantar nerve
- joins the 3rd common digital plantar nerve, a branch of the medial plantar n.

### Superficial Branch of Lateral Plantar Nerve

- arises near the base of the 5th metatarsal
- provides cutaneous, articular and muscular branches along its course
- provides muscular innervation to the flexor digiti minimi brevis muscle, 3rd plantar interosseous muscle, and the 4th dorsal interosseous muscle

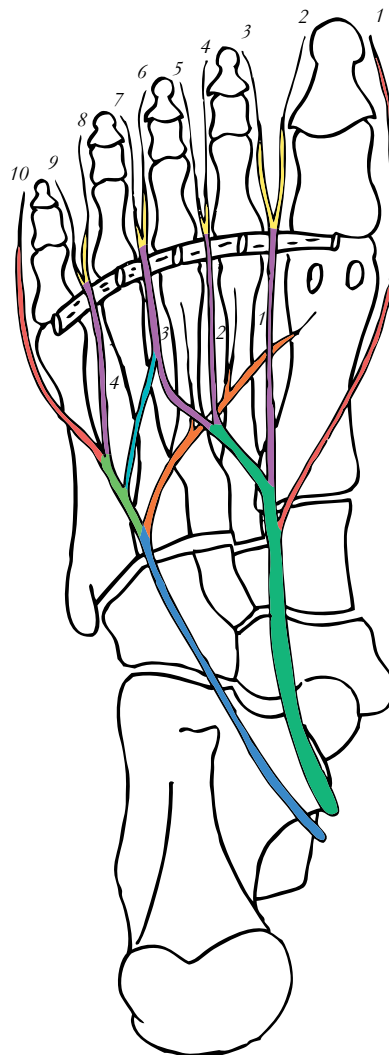
### Deep Branch of Lateral Plantar Nerve

- passes medially from near the base of the 5th metatarsal with the plantar arterial arch
- passes intermediate to layers 3 and 4
- provides articular and muscular branches along its course
- provides muscular innervation to the 2nd, 3rd and 4th lumbrical muscles; adductor hallucis muscle; 1st and 2nd plantar interosseous muscles; and 1st, 2nd and 3rd dorsal interosseous muscles

### Lateral Plantar Nerve

- the smaller posterior branch of the tibial nerve
- courses with the lateral plantar artery; deep to the flexor digitorum brevis muscle and superficial to the quadratus plantae muscle; intermediate to layers 1 and 2, lying just anterior (distal) to the lateral plantar artery in the foot, normally
- provides muscular innervation to the following: abductor digiti minimi muscle; quadratus plantae muscle; 2nd, 3rd and 4th lumbrical muscles; adductor hallucis muscle (transverse and oblique heads); flexor digiti minimi brevis muscle; opponens digiti minimi muscle (when present); the plantar interosseous muscles; the dorsal interosseous muscles;
- provides cutaneous innervation, plantarly to the lateral 1½ toes, and the lateral 1/3 of the midfoot and forefoot

## Distal



## Proximal

Innervation to the plantar aspect of the foot is via the medial and lateral plantar nerves. These are branches of the tibial nerve and arise deep to the laciniate ligament. These nerves enter the foot deep to the abductor hallucis muscle belly through the tarsal tunnel and the porta pedis.

The medial calcaneal nerve arises in this area and pierces the laciniate ligament / flexor retinaculum to reach its area of innervation. This nerve supplies cutaneous innervation to the medial ½ of the calcaneal region. This may be a site of entrapment for the medial calcaneal nerve as it passes through the laciniate ligament. There may be more than one medial calcaneal nerve branch.

The lateral calcaneal nerves arise from the sural nerve, in the superficial fascia, approximately 1" proximal to the lateral malleolus. These branches pass inferiorly to supply the lateral ½ of the calcaneal region.

## Medial

### Proper Digital Plantar Nerve 1 (of the Hallux)

- provides cutaneous innervation to the plantar medial aspect of the hallux
- becomes cutaneous near the 1st metatarsal midshaft

### Common Digital Plantar Nerve 1, 2, 3 & 4

- passes distally in the (1st, 2nd, 3rd or 4th) interspace (respectively), passes plantar to the deep transverse metatarsal ligament then divides
- becomes cutaneous near the (1st, 2nd, 3rd or 4th; respectively) metatarsal head
- 3 is joined by the communicating branch of the lateral plantar nerve

### Medial Plantar Nerve

- the larger anterior branch of the tibial nerve
- courses with the medial plantar artery; intermediate to the abductor hallucis muscle (medial) and the flexor digitorum brevis muscle (lateral); within layer 1, lying anterior (distal) to the artery
- provides muscular innervation to the following: abductor hallucis muscle, flexor digitorum brevis muscle, flexor hallucis brevis muscle, and 1st lumbrical muscle
- provides cutaneous innervation, plantarly, to the medial 3½ toes, and the medial 2/3 of the midfoot and forefoot

# Anatomic Joints

## Dorsal View

- defined by a joint cavity  
 - all bones of a structural joint share the same synovial fluid

**Medial**

**Distal**

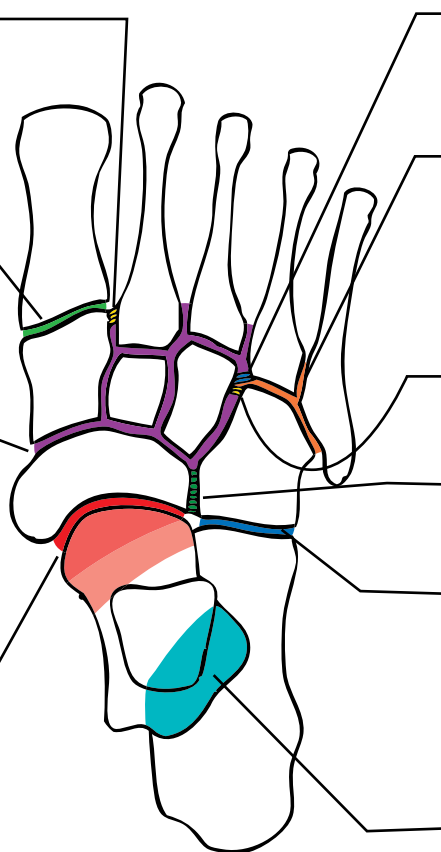
**Lateral**

**Lisfranc's Ligament / Medial Interosseous Tarsometatarsal Ligament**  
 - separates the great tarsal joint from the medial tarsometatarsal joint

**First Cuneometatarsal Joint / Medial Tarsometatarsal Joint**  
 - articulation between the medial cuneiform and the 1st metatarsal  
 - capsule attaches at the articular margins and is lined with synovium  
 - a synovial planar (gliding) joint  
 - a functional diarthrosis joint

**Great Tarsal Joint**  
 - also called the great tarsal synovial cavity  
 - articulation of most bones of the midfoot  
 - the joint capsule is continuous for all surfaces participating in the great tarsal joint, is lined with synovium, and reinforced by many ligaments  
 - synovial planar (gliding) joint  
 - a functional diarthrosis  
 - separated from other structural joints by 4 interosseous ligaments

**Talocalcaneonavicular Joint (TCN joint)**  
 - articulation of the talus with the navicular, the anterior and middle facets of the talus with the anterior and middle facets of the calcaneus, and the talus with the plantar calcaneonavicular ligament / spring ligament; all articulations with the head of the talus  
 - the joint capsule is irregular and strengthened by many ligaments  
 - a multi-axial synovial joint  
 - functional diarthrosis joint



**Lateral Interosseous Tarsometatarsal Ligament**  
 - separates the great tarsal joint from the lateral tarsometatarsal joint

**Lateral Tarsometatarsal Joint / Cuboideometatarsals 4 and 5 Joint**  
 - articulations between the cuboid and the 4th metatarsal, the cuboid and the 5th metatarsal, and the 4th and 5th metatarsal bases  
 - synovial planar (gliding) articulations  
 - a functional diarthrosis joint

**Interosseous Cuneocuboid Ligament**  
 - separates the great tarsal joint from the lateral tarsometatarsal joint

**Interosseous Cuboideonavicular Ligament**  
 - separates the great tarsal joint from the functional midtarsal joint

**Calcaneocuboid Joint (CC joint)**  
 - articulation between the calcaneus and the cuboid  
 - the joint capsule attaches near the articular margins of both surfaces, is lined with synovium, and reinforced by ligaments  
 - a synovial sellar (saddle) joint so it allows adduction and abduction or flexion and extension  
 - a functional diarthrosis

**Subtalar Joint (STJ)**  
 - articulation between the posterior facet of the talus and the posterior facet of the calcaneus  
 - the joint capsule attaches near the articular margins of both facets, is lined with synovium, and reinforced by several ligaments  
 - a synovial, planar (gliding) joint, structurally  
 - a diarthrotic joint, functionally

**Proximal**

**Cuneonavicular joints**  
 - proximal facets of the 3 cuneiforms with the distal surface of the navicular  
 - planar synovial articulations

**Intercuneiform joints**  
 - between the (lateral surface of the) medial cuneiform and the (medial surface of the) intermediate cuneiform, and between the (lateral surface of the) intermediate cuneiform and the (medial surface of the) lateral cuneiform  
 - planar synovial articulations

**Cuneocuboid joint**  
 - between the (lateral surface of the) lateral cuneiform and the (medial surface of the) cuboid  
 - planar synovial articulation

**Intermetatarsal joint 2 / Second intermetatarsal joint**  
 - between the bases of the 2nd metatarsal (laterally) and the 3rd metatarsal (medially)  
 - planar synovial articulation

**Second and Third cuneometatarsal joints / Intermediate tarsometatarsal joint**  
 - between the medial cuneiform and the base of the 2nd metatarsal, between the intermediate cuneiform and the base of the 2nd metatarsal, between the lateral cuneiform and the base of the 2nd metatarsal, and between the lateral cuneiform and the base of the 3rd metatarsal  
 - planar synovial articulations

**Cuboideonavicular joint (50% present)**  
 - between the cuboid and the navicular  
 - when present as a planar synovial articulation is part of the great tarsal joint  
 - is often a fibrous syndesmosic joint; joined by a very strong interosseous ligament

**Third Intermetatarsal Joint / Intermetatarsal joint of the 3rd and 4th**  
 - between the base of the 3rd metatarsal and the 4th metatarsal base  
 - often communicates with the great tarsal joint  
 - planar synovial articulation



# Functional Joints

## Plantar View

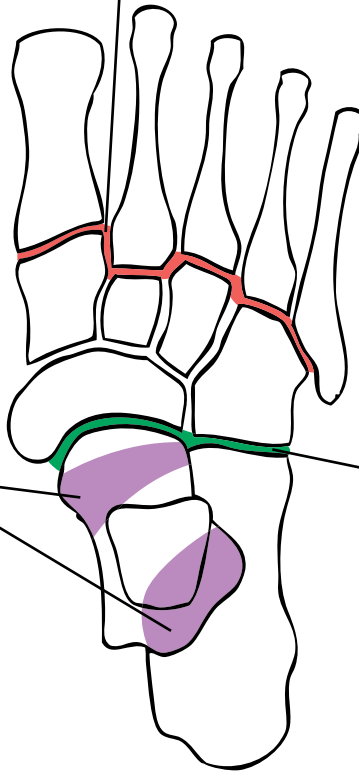
Lateral

Distal

Medial

### Tarsometatarsal Joint / Lisfranc's Joint

- includes the articulation of each metatarsal proximally with a cuneiform or the cuboid (the medial, intermediate and lateral tarsometatarsal joints)
- a biplanar joint
- little motion present normally
- **movement:** adduction/abduction and dorsiflexion/plantar flexion



### Subtalar Joint (STJ)

- includes the anatomic subtalar joint, and the talocalcaneal part of the talocalcaneonavicular joint (the inferior aspect of the head of the talus with the anterosuperior aspect of the calcaneus and with the spring ligament)
- a tri-planar joint (has movement in all 3 cardinal body planes)
- **Movement:** *pronation* (eversion, dorsiflexion and abduction of the foot) and *supination* (inversion, plantar flexion and adduction of the foot)

### Midtarsal Joint (MTJ) / Transverse Tarsal Joint or Chopart's Joint

- includes the calcaneocuboid joint and the talonavicular part of the talocalcaneonavicular joint (the head of the talus with the navicular)
- forms the Cyma line on lateral view radiographs
- normally a single smooth S-shaped curve
- a tri-planar joint
- **movement:** pronation and supination

Proximal

- anatomic joints that work together as a unit
- the clinical classification

# Interosseous Foot Ligaments

## Dorsal View

- interosseous ligaments are the strongest of the foot ligaments

**Medial**

**Distal**

**Lateral**

**Interosseous Tarsometatarsal Ligaments**  
- 3 ligaments that prevent separation of the bones united by each

**Lisfranc's Ligament / Medial (First) interosseous tarsometatarsal ligament**  
- the strongest of these three  
- passes from the non-articular part of the lateral surface of the medial cuneiform to the non-articular medial surface of the base of the 2nd metatarsal  
- lies plantar to the 2nd dorsal tarsometatarsal ligament  
- an important ligament  
- provides stability to Lisfranc's joint  
- forms a boundary for the great tarsal joint  
- severe functional problems are possible with an undiagnosed rupture

**Second (Intermediate) interosseous tarsometatarsal ligament**  
- passes from the non-articular part of the medial surface of the lateral cuneiform to the non-articular lateral aspect of the 2nd metatarsal base

**Interosseous Intercuneiform Ligaments**  
- both strong ligaments to prevent separation of the bones united by each  
- support the transverse arch of the foot

**First interosseous intercuneiform ligament**  
- from the non-articular lateral surface of the medial cuneiform to the non-articular medial surface of the intermediate cuneiform

**Second interosseous intercuneiform ligament**  
- from the non-articular lateral surface of the intermediate cuneiform to the non-articular medial surface of the lateral cuneiform

**Interosseous Intermetatarsal Ligaments**  
- 3 ligaments that prevent separation of the bones united by each  
- pass from the groove on the lateral aspect of the base of one metatarsal to the non-articular part of the medial aspect of the base of the adjacent metatarsal  
- the strongest intermetatarsal ligaments

**First interosseous intermetatarsal ligament**  
- from the groove of the 2nd metatarsal base, laterally, to the non-articular part of the 3rd metatarsal base, medially

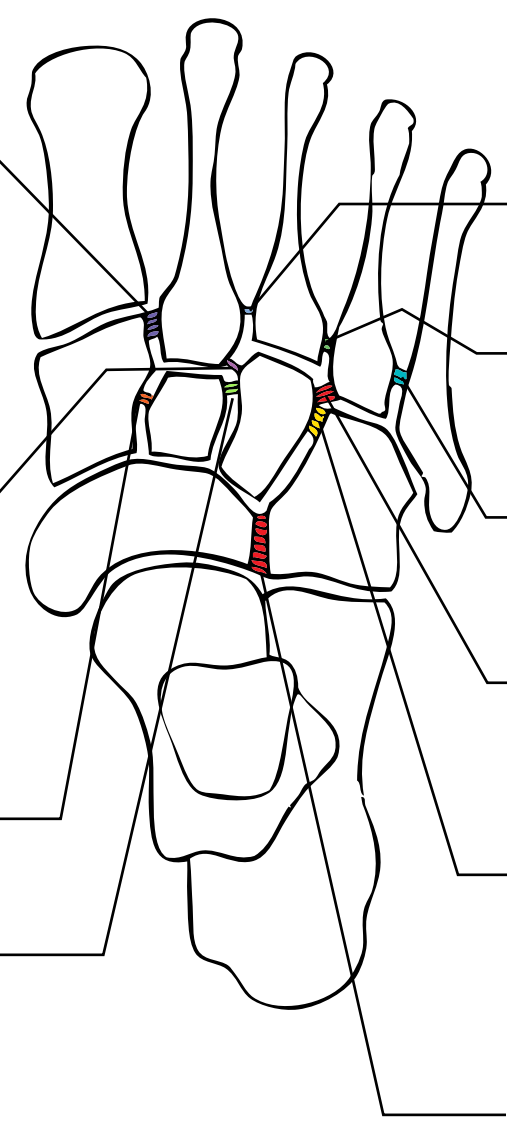
**Second interosseous intermetatarsal ligament**  
- from the groove of the 3rd metatarsal base, laterally, to the non-articular part of the 4th metatarsal base, medially

**Third interosseous intermetatarsal ligament**  
- from the groove of the 4th metatarsal base, laterally, to the non-articular part of the 5th metatarsal base, medially

**Lateral (Third) interosseous tarsometatarsal ligament**  
- passes from the non-articular lateral surface of the lateral cuneiform to the non-articular medial aspect of the 4th metatarsal base  
- is a boundary for the great tarsal joint

**Interosseous Cuneocuboid Ligament**  
- from the non-articular lateral surface of the lateral cuneiform to the non-articular medial surface of the cuboid (distal placement)  
- prevents separation of the lateral cuneiform and cuboid bones  
- supports the transverse arch of the foot  
- forms a boundary for the great tarsal joint

**Interosseous Cuboideonavicular Ligament**  
- from the lateral surface of the navicular to the medial surface of the cuboid  
- present when this joint is fibrous, not present or partially present when this joint is synovial  
- very strong, short ligament to prevent separation of the cuboid and navicular  
- forms a boundary of the great tarsal joint



**Proximal**

Many ligaments support the structural and functional joints of the foot. Without these ligaments, the foot would be a poor supportive mechanism for even the muscles. These ligaments are very important in preventing/reducing injury caused by moderate forces.



# Dorsal Foot Ligaments

## Dorsal View

### Medial

#### Dorsal Intercuneiform Ligaments

- reinforce these parts of the great tarsal joint, dorsally

**First** - from the lateral dorsal surface of the medial cuneiform to the medial dorsal surface of the intermediate cuneiform

**Second** - from the lateral dorsal surface of the intermediate cuneiform to the medial dorsal surface of the lateral cuneiform

#### Dorsal Cuneonavicular Ligaments

- reinforce their respective parts of the great tarsal joint, medial and/or dorsal

**Medial** - from the proximal dorsomedial surface of the medial cuneiform to the distal dorsomedial surface of the navicular

**Intermediate** - from the proximal dorsal surface of the intermediate cuneiform to the distal dorsal surface of the navicular

**Lateral** - from the proximal dorsal surface of the lateral cuneiform to the distal dorsal surface of the navicular

#### (Dorsal) Talonavicular Ligament

- from the superior aspect of the navicular to the superior aspect of the neck of the talus  
- reinforces the talonavicular part of the talocalcaneonavicular joint

#### Bifurcate Ligament / Chopart's Ligament

- located in the sinus tarsi

##### Calcaneonavicular part

- from the anterior process of the calcaneus to the dorsolateral edge of the navicular  
- reinforces the calcaneonavicular part of the talocalcaneonavicular joint, laterally

##### Calcaneocuboid part

- from the anterior process of the calcaneus to the dorsomedial aspect of the cuboid  
- reinforces the calcaneocuboid joint, medially

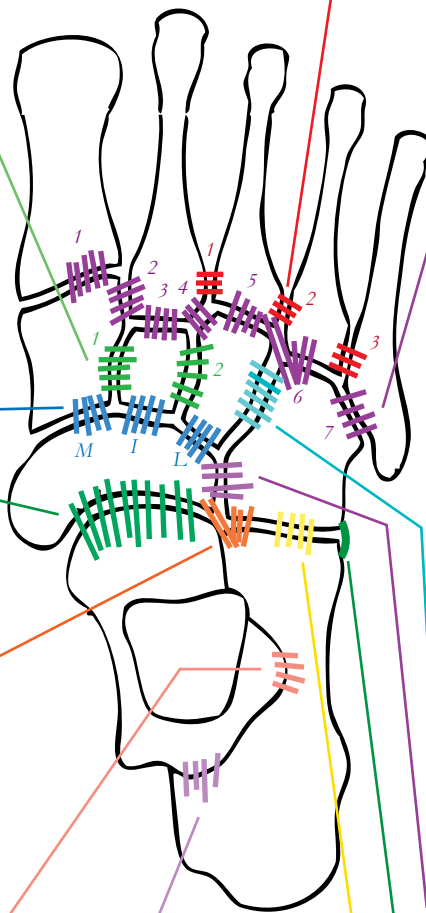
#### Lateral Talocalcaneal Ligament

- from the lateral process of the talus to the lateral surface of the calcaneus  
- reinforces the subtalar joint, laterally

#### Posterior Talocalcaneal Ligament

- from the posterior process of the talus (usually the lateral tubercle) to the superior surface of the calcaneus  
- reinforces the subtalar joint, posteriorly

### Distal



### Lateral

#### Dorsal Intermetatarsal Ligaments

- 3 ligaments

- reinforce these joints, dorsally

- fibers blend with the interosseous intermetatarsal ligament fibers

**First** - from the dorsolateral 2nd metatarsal base to the dorsomedial 3rd metatarsal base

**Second** - from the dorsolateral 3rd metatarsal base to the dorsomedial 4th the dorsomedial 4th metatarsal base

**Third** - from the dorsolateral 4th metatarsal base to the dorsomedial 5th metatarsal base

#### Dorsal Tarsometatarsal Ligaments (1 thru 7)

- all ligaments pass from the dorsum of one of the lesser tarsal bones to the dorsum of one or two of the metatarsal bases

- all reinforce the tarsometatarsal joint (Lisfranc's joint), dorsally

**First** - medial cuneiform to 1st metatarsal base

**Second** - medial cuneiform to 2nd metatarsal base

- fibers blend with Lisfranc's ligament

**Third** - intermediate cuneiform to 2nd metatarsal base

**Fourth** - lateral cuneiform to 2nd metatarsal base  
- fibers blend with 2nd interosseous tarsometatarsal ligament

**Fifth** - lateral cuneiform to 3rd metatarsal base

**Sixth** - dorsomedial cuboid to 3rd and 4th metatarsal bases

**Seventh** - dorsolateral cuboid to 5th metatarsal base

#### Dorsal Cuneocuboid Ligament

- from the lateral dorsal surface of the lateral cuneiform to the medial dorsal surface of the cuboid  
- reinforces this part of the great tarsal joint, dorsally

#### Dorsal Cuboideonavicular Ligament

- from the lateral dorsal surface of the navicular to the medial dorsal surface of the cuboid  
- reinforces this area of the great tarsal joint if this articulation is synovial  
- blends with the fibers of the interosseous cuboideonavicular ligament when this joint is a fibrous joint

#### Lateral Calcaneocuboid Ligament

- from the distal lateral surface of the calcaneus to the proximal lateral surface of the cuboid  
- reinforces the calcaneocuboid joint, laterally

#### Dorsal Calcaneocuboid Ligament

- from the distal dorsal calcaneal surface to the proximal dorsal surface of the cuboid  
- reinforces the calcaneocuboid joint, dorsally

### Proximal

# Foot Ligaments Medial View

Anterior

Superior

Posterior

## Spring Ligament / Plantar Calcaneonavicular Ligament

- passes from the distal aspect of the sustentaculum tali to the navicular tuberosity and the tubercle for the spring ligament on the plantar navicular
- very strong
- forms a joint surface of the talocalcaneonavicular joint; There is articular cartilage on the dorsal surface of this ligament.
- supports the head of the talus
- helps support the medial longitudinal arch of the foot
- blends with the tibionavicular ligament distomedially; these fibers are called the tibiospring ligament

## Medial Dorsal Cuneonavicular Ligament

## Medial Plantar Cuneonavicular Ligament

- passes from the plantar medial aspect of the navicular to the plantar medial aspect of the medial cuneiform
- the most medial (superior) fibers blend with those of the medial dorsal cuneonavicular ligament
- stronger than the dorsal ligament
- reinforces this part of the great tarsal joint

## Long Plantar Ligament (Long Plantar Calcaneocuboid Ligament)

- passes from the calcaneal trigonum plantare to the peroneal ridge of the cuboid and to the bases of the 4 lesser metatarsals (all plantar)
- the proximal attachment separates the heads of the quadratus plantae muscle
- reinforces the calcaneocuboid joint, plantarly
- helps maintain the lateral longitudinal arch

## Fibular canal / peroneal canal

- an osseofibrous tunnel for passage of the peroneus longus muscle tendon
- formed by the attachment between the peroneal ridge of the cuboid and the metatarsal bases

## Interosseous Talocalcaneal Ligament (Ligament of the Tarsal Canal)

- passes from the sulcus tali to the sulcus calcanei, fibers directed inferolaterally
- located within the canalis tarsi, therefore is within the sinus tarsi
- forms the border between the capsules of the anatomic subtalar joint and the talocalcaneonavicular joints
- very strong to prevent separation of the talus and calcaneus
- limits eversion of the calcaneus

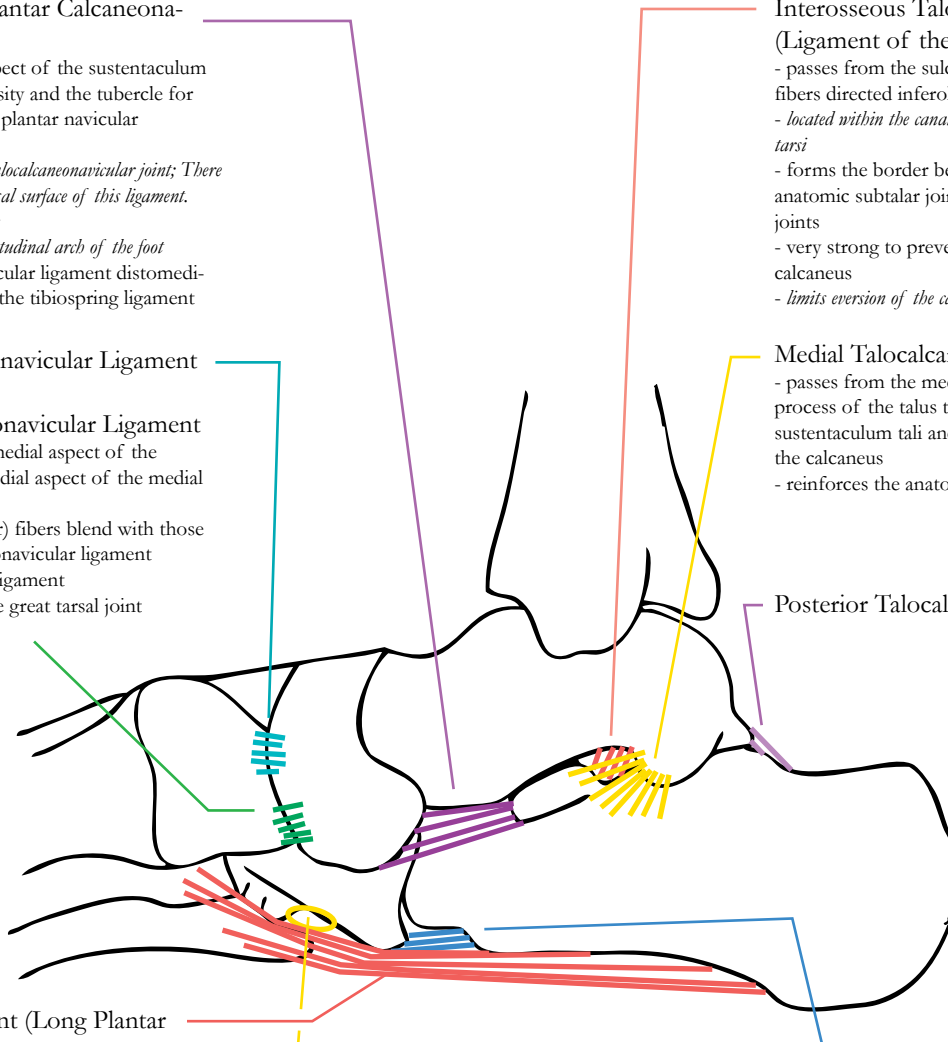
## Medial Talocalcaneal Ligament

- passes from the medial tubercle of the posterior process of the talus to the posterior edge of the sustentaculum tali and the adjacent medial surface of the calcaneus
- reinforces the anatomic subtalar joint, medially

## Posterior Talocalcaneal Ligament

## Short Plantar Ligament / Plantar Calcaneocuboid Ligament

- passes from the calcaneal anterior tubercle to the calcaneal process and the posterior edge of the cuboid
- reinforces the calcaneocuboid joint, plantarly
- helps maintain the lateral longitudinal arch



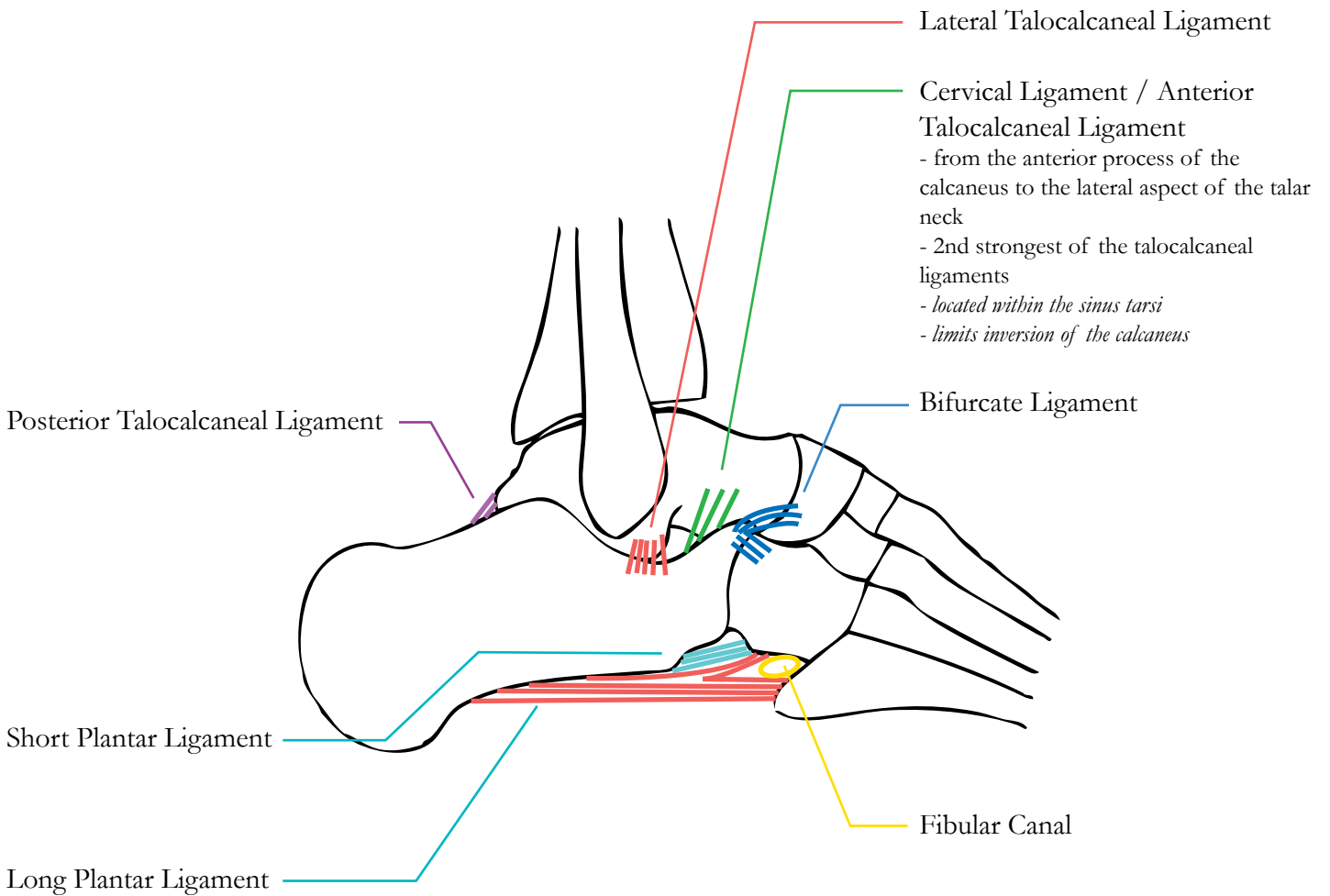
Inferior

# Foot Ligaments Lateral View

Posterior

Superior

Anterior



Inferior

# Plantar Foot Ligaments

## Plantar View

- plantar ligaments are stronger than dorsal ligaments, generally

Lateral

Distal

Medial

### Plantar Intermetatarsal Ligaments

- 3 ligaments
- stronger than dorsal intermetatarsal ligaments
- fibers blend with fibers of the interosseous intermetatarsal ligaments

**First** - from the plantar 2nd metatarsal base to the plantar 3rd metatarsal base

**Second** - from the plantar 3rd metatarsal base to the plantar 4th metatarsal base

**Third** - from the plantar 4th metatarsal base to the plantar 5th metatarsal base

### Plantar Tarsometatarsal Ligaments

- 5 ligaments
- generally, stronger than the dorsal tarsometatarsal ligaments
- none to the intermediate cuneiform

**First** - from the distoplantar medial cuneiform to the proximoplantar 1st metatarsal base

**Second** - from the distoplantar medial cuneiform to the proximoplantar 2nd and 3rd metatarsal bases

- fibers to the 2nd metatarsal base follow the course of and blend with Lisfranc's ligament

**Third** - from the distoplantar lateral cuneiform to the proximoplantar 3rd metatarsal base

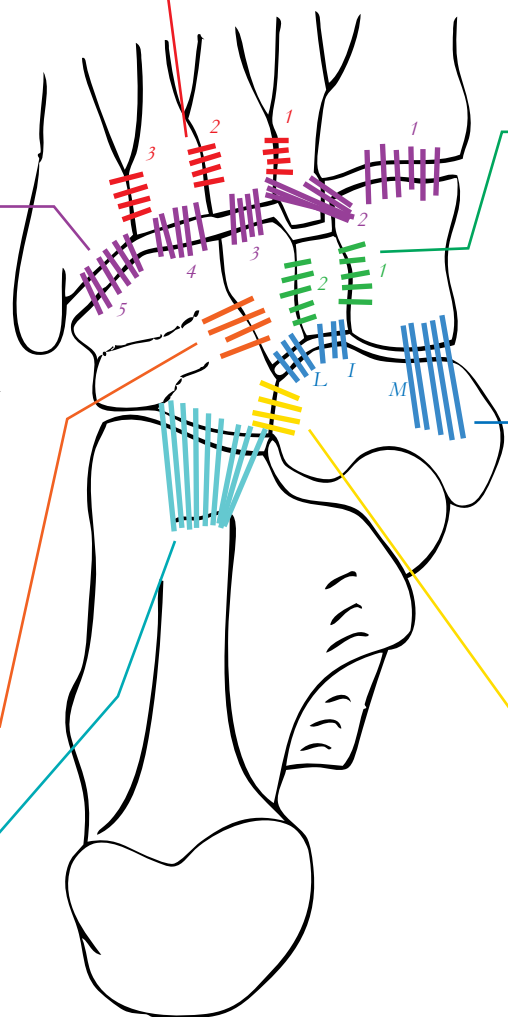
**Fourth** - from the distoplantar cuboid, medially to the proximoplantar 4th metatarsal base

**Fifth** - from the distoplantar cuboid laterally to the proximoplantar 5th metatarsal base

### Plantar Cuneocuboid Ligament

- from the posterior apex of the lateral cuneiform to the medial edge of the fibular ridge of the cuboid
- helps to support the transverse arch of the foot
- fibers blend with fibers of the interosseous cuneocuboid ligament

### Short Plantar Ligament



### Plantar Intercuneiform Ligaments

- help to support the transverse arch of the foot
- fibers blend with the fibers of the interosseous intercuneiform ligaments

**First** - from the lateral plantar aspect of the medial cuneiform to the medial plantar aspect of the intermediate cuneiform

**Second** - from the lateral plantar aspect of the intermediate cuneiform to the medial plantar aspect of the lateral cuneiform

### Plantar Cuneonavicular Ligaments

- stronger than dorsal cuneonavicular ligaments
- all help reinforce the great tarsal joint

**medial (first)**

**intermediate (second)** - from the plantar navicular surface to the plantar aspect of the intermediate cuneiform

**lateral (third)** plantar cuneonavicular ligament - from the plantar aspect of the navicular to the plantar aspect of the lateral cuneiform

### Plantar Cuboideonavicular Ligament

- from the lateral plantar aspect of the navicular to the medial plantar aspect of the cuboid
- blends with fibers of the interosseous cuboideonavicular ligament when this is a syndesmosis

Proximal

# Plantar Foot Ligaments

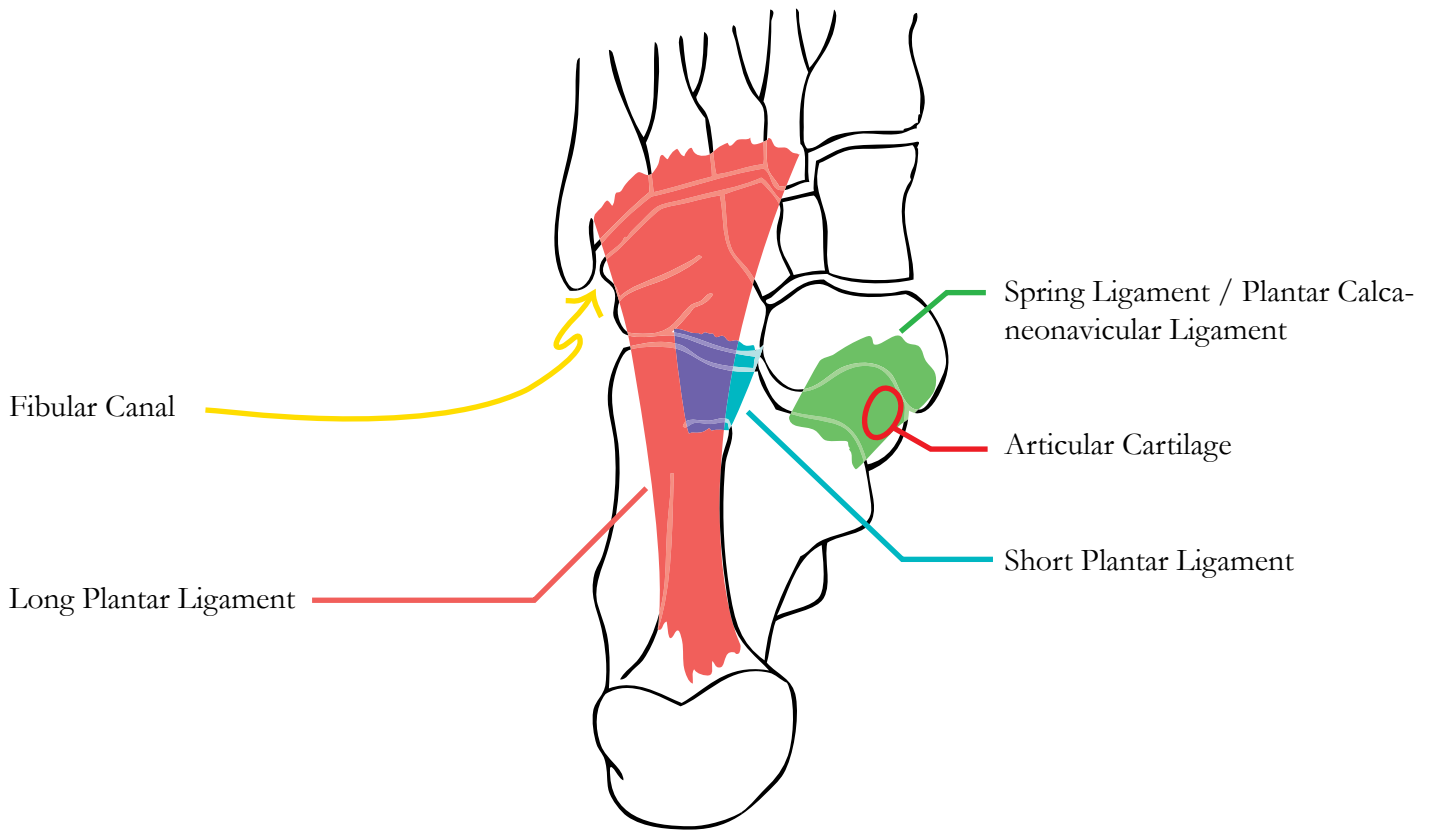
## Plantar View

- plantar ligaments are stronger than dorsal ligaments, generally

Lateral

Distal

Medial



Proximal

## ARTHROLOGY/SYNDESMOLOGY of the FOREFOOT

It is important to know the joint structure and ligamentous support for distal forefoot joints. This is where the majority of podiatrists perform surgery. An understanding of these joints and the soft tissue structures that surround them will provide a basis for selection and performance of surgical procedures.

### I. ARTHROLOGY

#### A. Metatarsophalangeal Joints (MTPJs)

- articulation of a rounded metatarsal head with the respective concave base of a proximal phalanx, ex. The 2<sup>nd</sup> metatarsal head articulates with the 2<sup>nd</sup> proximal phalangeal base, etc.
- the sesamoids are included for the 1<sup>st</sup> metatarsophalangeal joint
  - they allow posterior gliding of the 1<sup>st</sup> metatarsal head during propulsion (more effective lever)
- each is a separate anatomic and functional joint
- structural synovial ellipsoid joints
- functional diarthrotic joints
- **movement:** allow *abduction/adduction, flexion/extension and circumduction*

##### 1. Capsule

- attaches near the articular margins (encloses most of the metatarsal head)
- lined with synovium
- supported by ligaments

#### B. Interphalangeal Joints (IPJs)

- proximal and distal interphalangeal joints are identical
- capsules attach at the articular margins, are lined with synovium, and supported by ligaments
- all are anatomic and functional joints
- structural synovial ginglymus (hinge) joints
- functional diarthrotic joints
- **movement:** allow *plantar flexion and dorsiflexion*

##### 1. Proximal Interphalangeal Joints (PIPJs)

- articulation of the bicondylar convex head of a proximal phalanx with the respective bicondylar concave base of a middle phalanx, ex. the 3<sup>rd</sup> proximal phalangeal head articulates with the middle phalangeal base of the 3<sup>rd</sup> toe, etc.

##### 2. Distal Interphalangeal Joints (DIPJs)

- articulation of the bicondylar convex head of a middle phalanx with the bicondylar concave base of a distal phalanx, ex. the middle phalangeal head of the 5<sup>th</sup> toe articulates with the base of the distal phalanx of the 5<sup>th</sup> toe, etc.

##### 3. Interphalangeal Joint of the Hallux

- articulation of the bicondylar convex head of the hallucal proximal phalanx with the bicondylar concave base of the 1<sup>st</sup> distal phalanx

# First Metatarsal and Hallux

## Lateral View

### Dorsal

#### Metatarsosesamoid (Suspensory)

##### Ligaments

- pass from a sesamoid to the tubercle near the head of the first metatarsal

#### Lateral metatarsosesamoid (suspensory) ligament

- passes from the lateral aspect of the lateral sesamoid / fibular sesamoid to the 1st metatarsal head's lateral tubercle

#### Collateral Ligaments

- pass from a tubercle near the dorsal aspect of the metatarsal head to the plantar aspect of the proximal phalangeal base

#### Lateral collateral ligament of 1st metatarsophalangeal joint (1st lateral metatarsophalangeal ligament)

- passes from the lateral tubercle of the 1st metatarsal head to the lateral tubercle of the base of the proximal phalanx

#### Medial collateral ligament of 1st metatarsophalangeal joint / 1st medial metatarsophalangeal ligament

- passes from the medial tubercle of the 1st metatarsal head to the medial tubercle of the base of the proximal phalanx

#### Lateral Collateral Ligament of the Hallucal Interphalangeal Joint

- pass from the lateral tubercle of a phalangeal head, dorsally, to the lateral tubercle of the articulating phalangeal base, plantarly

#### Sesamophalangeal Ligaments

- pass from a sesamoid to the base of the proximal phalanx (plantarly)

#### Lateral Sesamophalangeal Ligament

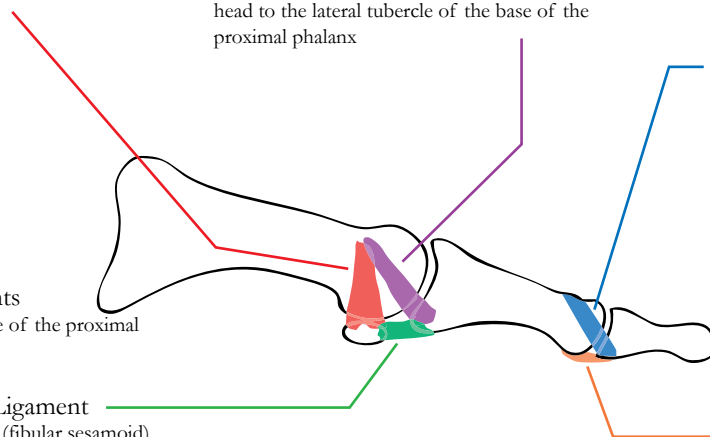
- passes from the lateral sesamoid (fibular sesamoid) to the lateral tubercle of the proximal phalangeal base

#### Medial Sesamophalangeal Ligament

- passes from the medial sesamoid (tibial sesamoid) to the medial tubercle of the base of the proximal phalanx

#### Plantar Interphalangeal Ligament of the Hallucal (1st) Interphalangeal Joint

- pass from the head of one phalanx, plantarly, to the base of the articulating phalanx, plantarly



## Cross Section

### Lateral

### Medial

#### Lateral metatarsosesamoid (suspensory) ligament

#### Intersesamoid Ligament

- passes from the lateral surface of the tibial sesamoid to the medial surface of the fibular sesamoid

#### Medial metatarsosesamoid ligament (suspensory) ligament

- passes from the medial aspect of the medial sesamoid / tibial sesamoid to the medial tubercle of the 1st metatarsal head

### Plantar

The metatarsophalangeal joint of the hallux has more ligaments than those of the lesser pedal digits due to the presence of sesamoids.

## **Lesser Digit**

### a. Plantar Metatarsophalangeal Ligaments

- passes from the metatarsal head, plantarly, to the plantar aspect of the base of the respective proximal phalanx, ex. the 4<sup>th</sup> plantar metatarsophalangeal ligament passes from the 4<sup>th</sup> proximoplantar metatarsal head to the plantar 4<sup>th</sup> proximal phalangeal base, etc.
- replaces the sesamophalangeal ligaments

### b. Collateral Ligaments / Metatarsophalangeal Ligaments

- pass from the tubercle near the head of a metatarsal to the tubercle of the base of the respective proximal phalanx

#### i. Medial Collateral Ligament of the ? Metatarsophalangeal Joint

- pass from the medial tubercle of the head of a metatarsal, dorsally, to the medial tubercle of a proximal phalangeal base, plantarly; ex. the 2<sup>nd</sup> medial metatarsophalangeal ligament passes from the medial tubercle of the 2<sup>nd</sup> metatarsal head to the medial tubercle of the 2<sup>nd</sup> proximal phalangeal base, etc.

#### ii. Lateral Collateral Ligament of the ? Metatarsophalangeal Joint

- pass from the lateral tubercle of the head of a metatarsal, dorsally, to the lateral tubercle of a proximal phalangeal base, plantarly; ex. the 4<sup>th</sup> lateral metatarsophalangeal ligament passes from the lateral tubercle of the 4<sup>th</sup> metatarsal head to the lateral tubercle of the 4<sup>th</sup> proximal phalangeal base, etc.

## **Interphalangeal Joints**

- proximal and distal interphalangeal joints have the same ligaments with slightly different names

### 1. Collateral Ligaments / Interphalangeal Ligaments

- from the tubercle near one phalangeal head (dorsally) to the tubercle of the articulating phalangeal base (plantarly)

#### a. Medial Collateral Ligament of the ? ? Interphalangeal Joint

- pass from the medial tubercle of a phalangeal head, dorsally, to the medial tubercle of the articulating phalangeal base, plantarly; ex. the 5<sup>th</sup> medial proximal interphalangeal ligament passes from the medial tubercle of the 5<sup>th</sup> proximal phalangeal head to the medial tubercle of the middle phalangeal base of the 5<sup>th</sup> toe, etc.

#### b. Lateral Collateral Ligament of the ? ? Interphalangeal Joint

- pass from the lateral tubercle of a phalangeal head, dorsally, to the lateral tubercle of the articulating phalangeal base, plantarly; ex. the 2<sup>nd</sup> lateral distal interphalangeal ligament passes from the lateral tubercle of the middle phalangeal head of the 2<sup>nd</sup> toe to the lateral tubercle of the 2<sup>nd</sup> distal phalangeal base, etc.

### 2. Plantar Interphalangeal Ligament of the ? Interphalangeal Joint

- pass from the head of one phalanx, plantarly, to the base of the articulating phalanx, plantarly; ex. the 3<sup>rd</sup> plantar distal interphalangeal ligament passes from the plantar middle phalangeal base of the 3<sup>rd</sup> toe to the 3<sup>rd</sup> plantar distal phalangeal base, etc.



# Extensor Expansion - Metatarsal and Digit

## Dorsal View

- Metatarsal 3 or 4

Medial

### Plantar Interossei Tendons

- pass deep to the medial aspect of the sling portion of the extensor expansion to insert onto the deep side of the extensor sling and the medial aspect of the proximal phalangeal bases of the 3rd through 5th pedal digits

### Extensor Digitorum Longus Tendon

- passes into the extensor sling just lateral to the extensor digitorum longus tendon before inserting into the lateral aspect of the extensor digitorum longus tendon

### Extensor Digitorum Brevis Tendon

- passes into the extensor sling just lateral to the extensor digitorum longus tendon before inserting into the lateral aspect of the extensor digitorum longus tendon

### Dorsal Interossei Tendons (removed on

*Medial side this drawing*)

- pass within the extensor sling
- 1st dorsal interosseous tendon passes within the medial aspect of the sling portion of the extensor hood of the 2nd toe and inserts onto the medial aspect of 2nd proximal phalangeal base
- 2nd, 3rd and 4th dorsal interosseous tendons pass within the lateral aspect of the sling portion of the extensor hood and insert onto the lateral aspect of the proximal phalangeal bases of the 2nd, 3rd and 4th toes, respectively

### Extensor Sling

- the sling portion of the extensor expansion
- the proximal part
- transversely arranged fibers that pass around the metatarsophalangeal joint and attach to the deep transverse metatarsal ligament

### Extensor Wing

- the wing portion of the extensor expansion
- the distal part
- obliquely oriented fibers that attach to the distal aspect of the sling portion and encase the extensor tendons at the dorsal aspect of the shaft of the proximal phalanx

Dorsal Interosseous Muscle

Lateral

## Medial View

- digit 3, 4 or 5

Dorsal

### Dorsal Interosseous Muscle (attachment)

- *only present from this view if second digit*
- passes within the extensor sling to insert onto the medial aspect of the base of the proximal phalanx of the second digit

### Plantar Interosseous Muscle

- only digits 3 through 5
- passes from its origin on the shaft and base of the metatarsal to its insertion on the base of the proximal phalanx and the deep part of the extensor sling
- the tendon passes deep to the extensor sling

### Lumbricale Muscle

- passes from its origin on the flexor digitorum longus tendon to its insertion into the wing portion (along the distal edge) of the extensor expansion
- the tendon passes plantar to the deep transverse metatarsal ligament

### Extensor Sling

### Extensor Wing

### Extensor Digitorum Longus Tendon

- passes into the extensor sling at the dorsal central aspect, exits the extensor wing at the head of the proximal phalanx and splits into 3 slips
- the central slip inserts onto the base of the middle phalanx
- the 2 lateral slips pass distally then merge and insert on the base of the distal phalanx
- passes dorsally along the bones and within the extensor expansion

Plantar

The extensor expansion is a fibrous sheath that encloses several tendons that pass across the metatarsophalangeal joints. The extensor expansion has 2 parts that together cover the metatarsophalangeal joint and extend to the proximal interphalangeal joint. The extensor expansion is sometimes referred to the extensor hood or the extensor hood apparatus. The extensor expansion may be absent at the 1st metatarsophalangeal joint.

# Extensor Expansion - Head of Metatarsal

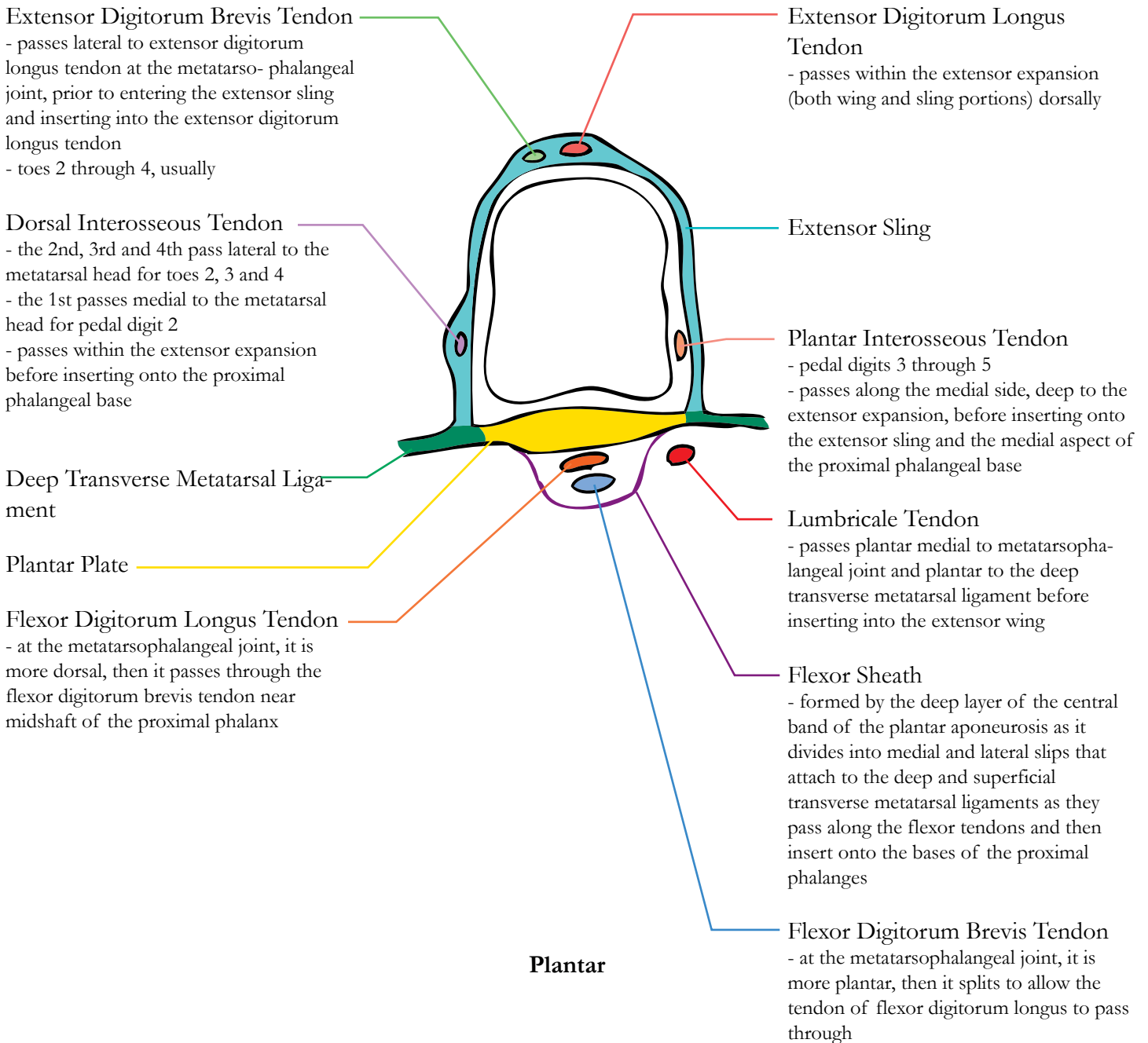
## Cross Section

- Metatarsal 3 or 4

Lateral

Dorsal

Medial



# Foot - Superficial and Deep Fascia

## Cross Section

This is a cross section of the foot at the level of the metatarsal shafts.

**Medial**

**Dorsal**

**Lateral**

### Proper Dorsal Digital Nerve 1

- a branch of the medial dorsal cutaneous nerve from the superficial peroneal (superficial fibular) nerve
- often just dorsomedial to the 1st metatarsal

### Medial Marginal Vein

- along the dorsal aspect of the 1st metatarsal
- arises at the junction of the proper dorsal digital vein of the hallux and the dorsal venous arch

### Fascia Dorsalis Pedis

- the deep fascia of the dorsum of the foot
- attaches to the dorsal surface of each metatarsal bone, the medial surface of the 1st metatarsal bone and the lateral surface of the 5th metatarsal bone
- splits to surround each of the structures and creates four layers of structures on the dorsum of the foot

### Common Dorsal Digital Nerves 1 through 3

- from branches of the superficial fibular (superficial peroneal) nerve

### First common dorsal digital nerve

- from the **medial** dorsal cutaneous nerve
- near the 2nd intermetatarsal space

### Second common dorsal digital nerve

- from the **intermediate** dorsal cutaneous nerve
- near the 3rd intermetatarsal space

### Third common dorsal digital nerve

- from the **intermediate** dorsal cutaneous nerve
- near the 4th intermetatarsal space

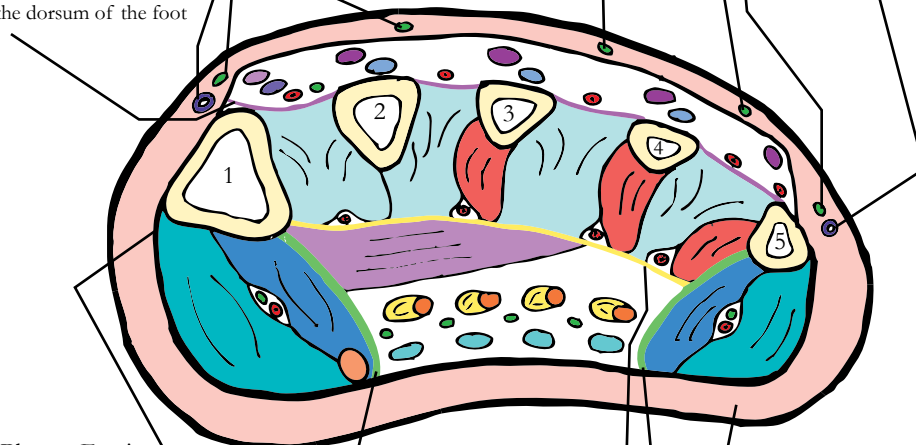
### Lateral Dorsal Cutaneous Nerve

- continuation of the sural nerve as it passes along the lateral aspect of the forefoot, lateral to the 5th metatarsal

### Proper Dorsal Digital Nerve 10

### Lateral Marginal Vein

- along the dorsolateral aspect of the 5th metatarsal
- arises at the junction of the proper dorsal digital vein of the 5th digit and the dorsal venous arch



### Plantar Aponeurosis / Plantar Fascia

- the deep fascia of the planta of the foot
- attaches to the metatarsal shafts 1 and 5, the proximal phalangeal bases 1 through 5, the calcaneal tuberosity and the skin of the sulcus
- sends vertical fibers to the skin at all levels

### Septae

- extensions of the plantar aponeurosis which divide the plantar aspect of the foot into 3 or 4 compartments

### Medial Pedal Intermuscular Septum (of the foot)

- an extension of plantar fascia which lies intermediate to abductor hallucis and flexor digitorum brevis muscle bellies and attaches to the calcaneus, navicular, medial cuneiform and first metatarsal base

### SUPERFICIAL FASCIA

- contains mostly adipose tissue
- is very dense plantarly and difficult to locate branches of nerves and arteries due to septae of plantar aponeurosis
- will look at dorsal contents here

### Lateral (Pedal) Intermuscular Septum of the Foot

- an extension of plantar fascia which lies intermediate to abductor digiti minimi and flexor digitorum brevis muscle bellies and attaches to the calcaneus, cuboid and fifth metatarsal base

### Interosseous Fascia

- an extension of the deep fascia which passes from the medial intermuscular septum of the foot or the first metatarsal to the lateral pedal intermuscular septum
- lies intermediate to the third and fourth plantar muscle layers

**Plantar**

# Foot - Dorsum Cross Section

This is a cross section of the foot at the level of the metatarsal shafts.

## Medial

- the fascia dorsalis pedis divides to surround the deeper structures of the dorsum of the foot

**Extensor Digitorum Brevis Tendons [1]**  
- 3 tendons just deep and lateral to the extensor digitorum longus tendons for digits 2 through 4  
- may have a tendon to the 5th digit

**Extensor Digitorum Longus Tendons [2]**  
- other 4 superficial tendons

**Deep Fibular (Peroneal) Nerve [3]**  
- the medial terminal branch

**Extensor Hallucis Brevis Tendon [4]**

**Extensor Hallucis Longus Tendon [5]**

## Dorsal

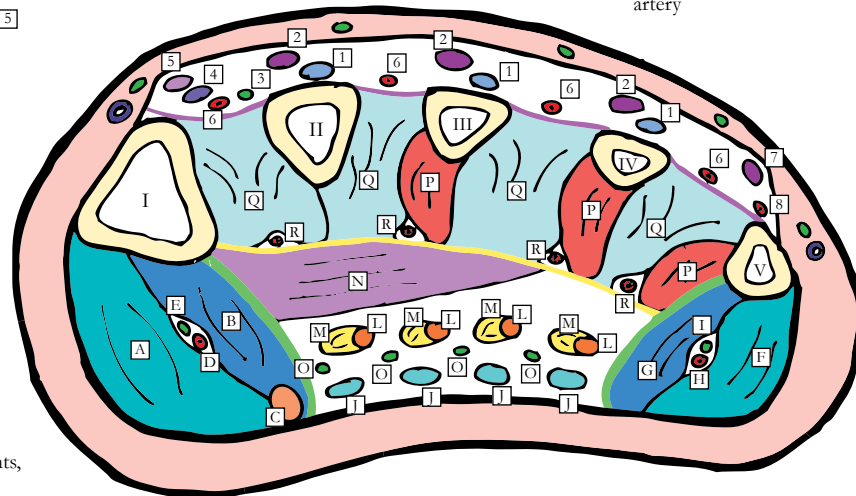
## Lateral

**Proper Dorsal Digital Artery 1**  
- not visible at this level as we are still, generally proximal to it

**[6] Dorsal Metatarsal Arteries 1 through 4**  
- one for each intermetatarsal space  
- each has venae comitantes

**[7] Extensor digitorum longus tendon (4) and Peroneus Tertius Tendon (not visible at this level as we are already distal to it)**

**[8] Proper Dorsal Digital Artery 10**  
- near where it arises from the 4th dorsal metatarsal artery



## Plantar

### Compartments

- the foot is divided into 3 or 4 compartments, plantarly which contain muscles  
- important because infections usually spread within the compartment of origin

### Medial Pedal Compartment

- flexor digitorum longus and tibialis posterior tendons along with the lateral plantar nerve and artery pass through the medial compartment's proximal end

**[A] Abductor Hallucis Muscle**

**[B] Flexor Hallucis Brevis Muscle**

**[C] Flexor Hallucis Longus Muscle Tendon**

**[D] Proper Digital Plantar Artery 1**

**[E] Proper Digital Plantar Nerve 1**

### Lateral Pedal Compartment

- fibularis longus tendon passes through the lateral compartment proximal to this level

**[F] Abductor Digiti Minimi (Quinti) Muscle**

**[G] Flexor Digiti Minimi (Quinti) Brevis Muscle**

**[H] Proper Digital Plantar Artery 10**

**[I] Proper Digital Plantar Nerve 10**

### Central Pedal Compartment

- tibialis posterior muscle inserts proximal to this level and fibularis longus muscle passes through proximal to this level

**[J] Flexor Digitorum Brevis Muscle**  
- present at this level as tendons

### Quadratus Plantae Muscle

- located proximal to this cut, but is part of the central compartment

**[L] Flexor Digitorum Longus Muscle Tendons**

**[M] Lumbricale Muscles 1 through 4**

**[N] Adductor Hallucis Muscle**

- the oblique head is seen more medially at this level and is deep to the flexor digitorum longus tendons  
- the transverse head is distal to this level

**[O] Common Digital Plantar Nerves 1 through 4**

### Interosseous Compartment

- the 4th compartment  
- a subcompartment of the central compartment  
- separated from components of the central compartment by the interosseous fascia

**[P] Plantar Interossei Muscles 1 through 3**  
- none with the 2nd metatarsal

**[Q] Dorsal Interossei Muscles 1 through 4**

**[R] Plantar Metatarsal Arteries 1 through 4**

# Accessory Bones

## Dorsal View

**Medial**

**Distal**

**Lateral**

There are several frequently occurring accessory bones in the foot. It is important to be able to distinguish between an accessory bone and a fracture.

Accessory sesamoids are also found in the foot. An accessory sesamoid is located within a muscle tendon or joint capsule.

### Os Intermetatarsaeum I

- an accessory bone located between the bases of 2 adjacent metatarsal bones
- most common are os intermetatarsaeum I (between the bases of the 1st and 2nd metatarsal bones) and os intermetatarsaeum IV (between the bases of the 4th and 5th metatarsal bones)

### Os Intercuneiforme

- an accessory bone located dorsally between adjacent cuneiforms
- usually between the medial and intermediate cuneiform bones; os intercuneiforme I

### Os Tibiale Externum

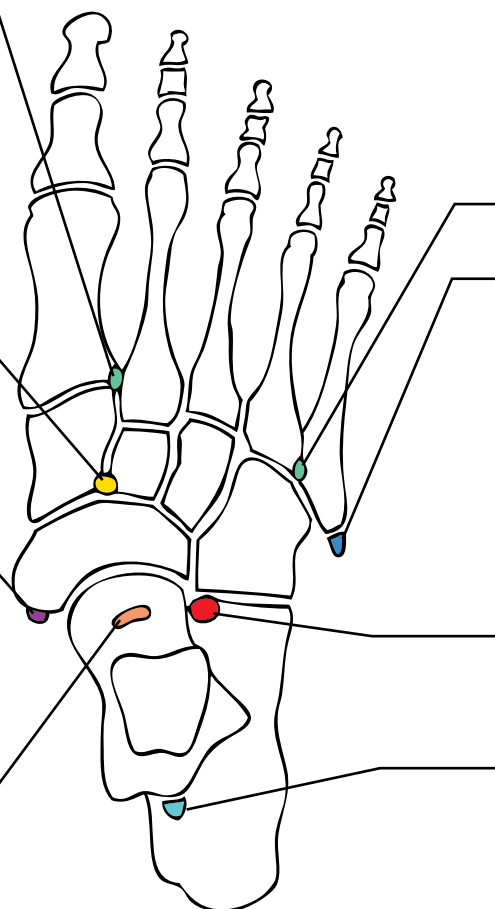
- an accessory sesamoid located within the tibialis posterior tendon at the plantar aspect of the navicular tuberosity
- best viewed on a lateral oblique radiograph of the foot
- generally also seen on a lateral radiograph of the foot

### Os Supratallare

- an accessory bone located dorsal to the talar neck

### Accessory Navicular

- an accessory bone located near the navicular tuberosity, usually large and often a visible prominence clinically
- may appear to articulate with the navicular tuberosity or as if it was a secondary center of ossification
- easily viewed on anteroposterior, lateral and lateral oblique radiographic views of the foot



### Os Intermetatarsaeum V

### Os Vesalianum

- an accessory sesamoid located within the tendon of peroneus brevis at its insertion on the 5th metatarsal tuberosity
- often is a secondary ossification center of the 5th metatarsal tuberosity that did not fuse
- most easily viewed on anteroposterior or medial oblique radiographic views of the foot

### Secondary Calcaneus

- an accessory bone located dorsally at the anterior process of the calcaneus

### Os Trigonum

- an accessory bone located at the posterior aspect of the talus
- often a secondary ossification center of the lateral tubercle of the talar posterior process that did not fuse
- most easily viewed on a lateral view radiograph of the foot or ankle

**Proximal**

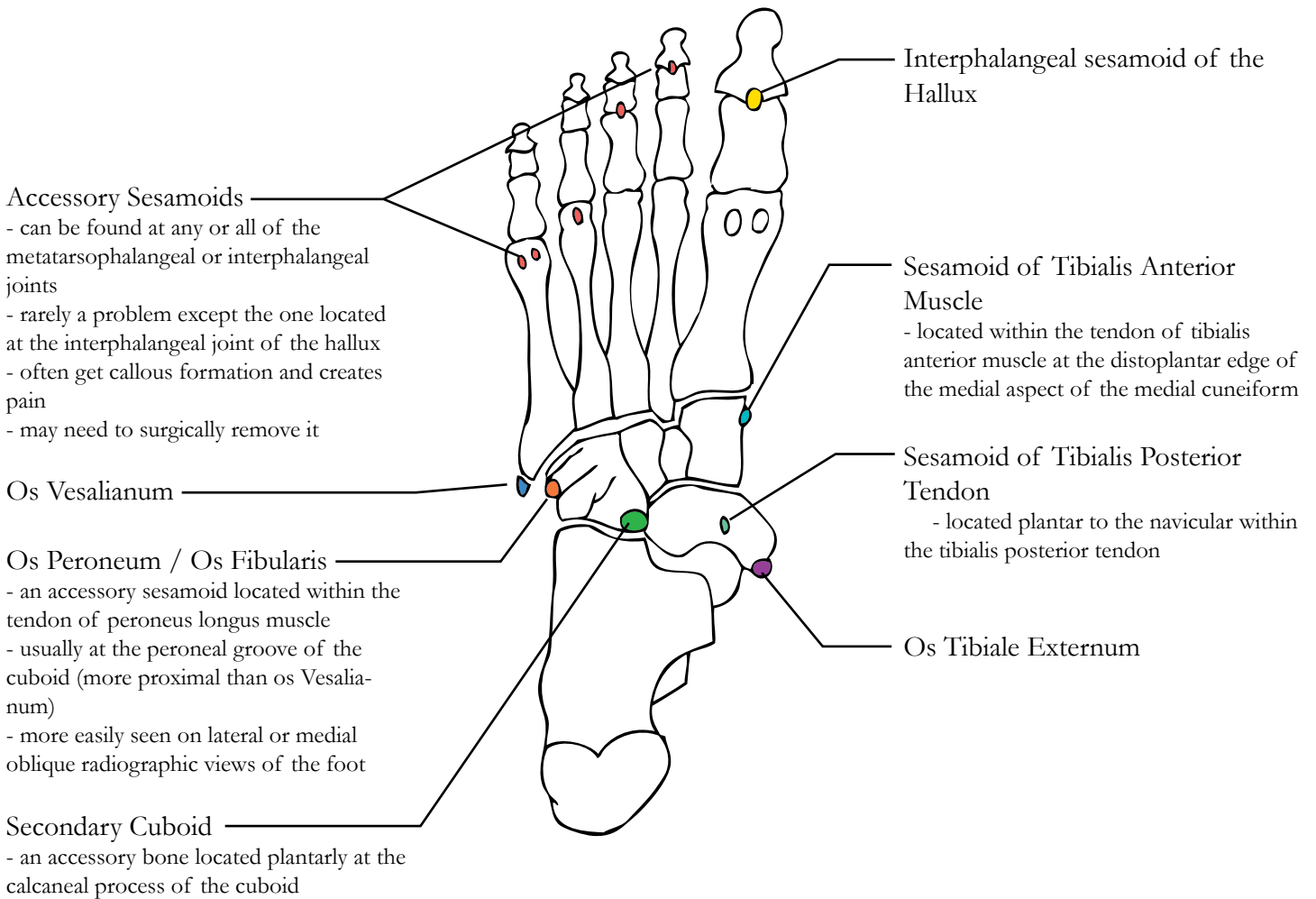
# Accessory Bones

## Plantar View

Lateral

Distal

Medial



Proximal

# Limb Development

## Embryonic Period (2 to 8 weeks in utero)

- Period of rapid development

### Limb Buds

- Limb buds develop in a proximal to distal manner. The upper limb buds precede the lower limb buds in all areas of development by several days. This corresponds to the major development of the embryo which is from cephalad / proximal / superior to caudad / distal / inferior.

### 4th Intrauterine Week

#### Limb Buds Appear

- upper and lower limb buds appear on the ventrolateral aspect of the embryo
- develop initially in a lateral direction
- upper limb buds precede lower limb buds
- early and late 4th week, respectively
- small flipper-like projections
- pre-axial border is cephalad and post-axial border is caudad
- small masses of mesenchyme derived from mesoderm covered by ectoderm
- mesenchyme contains the developmental information or "blueprints" for the limb

#### Apical Ectodermal Ridge

- a longitudinal ridge of tissue on the distal end of each limb bud
- induces continued development of the limb (causes the limb to continue forming) by interaction with the mesenchyme in the limb buds
- if defective, limb may not develop or may develop partially

### 6th Intrauterine Week

#### Elbow, Wrist, Knee and Ankle become recognizable

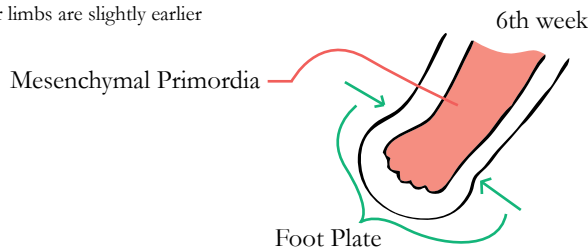
- upper limb regions are slightly earlier limb development, embryonic development, 6th week, con't

#### Digital Rays of the Hand Plate Develop

- condensations of mesenchyme which are ridges that become digits
- each digital ray retains part of the apical ectodermal ridge which induces further development
- pollex (thumb) is at the pre-axial border

#### Limbs Extend Ventrally (Adduct)

- move from a more lateral position to a more anterior position late in this week
- hands and feet move to near each other at the ventral aspect
- upper limbs are slightly earlier



### 8th Intrauterine Week

- limb rotations continue through the 8th week

#### Fetal Position is attained

- occurs by the end of the eighth week
- limb rotations continue through the 8th week and end in the fetal position
- planta of feet approximate each other
- pre-axial (tibial) borders of leg and foot are cephalad and post-axial (fibular) borders are caudad
- lower limb is externally rotated and foot is plantar flexed
- pedal digits are splayed

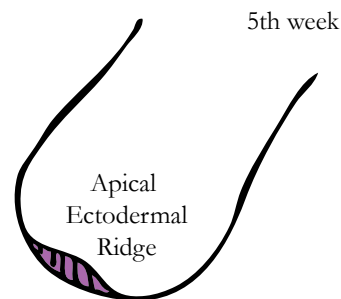
#### Digits become free

- separated from each other as the mesenchyme between them degenerates
- still occurs sooner in the hand

### 5th Intrauterine Week

#### Hand and Foot Plates Develop

- are flattened, paddle-shaped areas at the distal end of the limb buds which are marked by a proximal constriction
- apical ectodermal ridge is present at end of each hand/foot plate
- hand plate develops slightly earlier



### 7th Intrauterine Week

#### Digital Rays of the Foot Plate Develop

- condensations of mesenchyme which are ridges that become toes
- each digital ray retains part of the apical ectodermal ridge which induces further development
- hallux is at the pre-axial border

#### Limb Rotation Begins

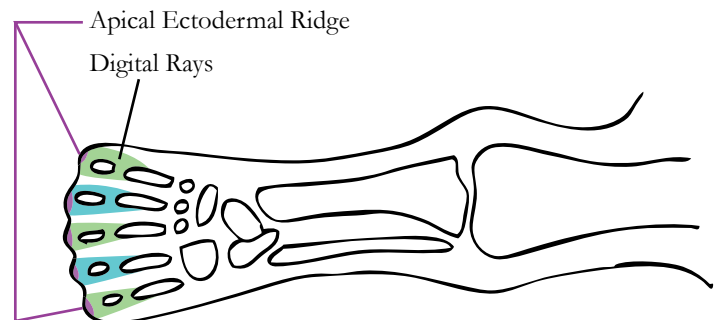
- knee and elbow both initially face laterally
- upper and lower limbs rotate in opposite directions
- upper limbs are slightly earlier

#### Upper Limb Rotation

- rotates laterally / externally so that the elbow moves from a laterally directed position to an inferiorly directed or caudal position

#### Lower Limb Rotation

- rotates medially / internally so that the knee moves from a laterally directed position to a superiorly directed or cephalic position





## Limb Development

### B. Skeletal Formation

- begins in the 4<sup>th</sup> to 5<sup>th</sup> intrauterine week
- bones develop in mesenchyme or cartilage
- intramembranous ossification occurs in mesenchyme; tufts of distal phalanges
- intracartilaginous ossification occurs in cartilage after chondrification
- also occurs in a proximal to distal fashion and as the limb bud is forming
- continues throughout intrauterine development into adulthood when the last skeletal elements fuse

#### 1. Mesenchymal Stage

- apical ectodermal ridge promotes growth and differentiation of the limb bud mesenchyme
- the mesenchymal models of the limb bones form

##### a. Mesenchymal Primordia

- condensations of mesenchyme in the limb bud
- begins as a solid mass of tissue in the center of the developing limb, then differentiates
- will become the bones and joints of the limb

#### 2. Cartilaginous Stage

- the mesenchymal models of most limb bones undergo chondrification to become the cartilage templates of the bones
- navicular is the last tarsal bone to condryfy
- order is different than for ossification

##### a. Joint Formation Begins

- in the areas between the newly chondrified bone models
- appear as areas where the mesenchymal primordia did not differentiate
- differentiation of this portion of the mesenchymal primordia depends upon the type of joint being formed

##### i. Fibrous Joint / Synfibrosis

- becomes collagen

##### ii. Cartilaginous Joint / Synchrondrosis

- becomes modified hyaline cartilage

##### iii. Synovial Joint

- becomes trilaminar (an intermediate zone between 2 dense zones)
- the model for the joint space and the epiphyses which will form the various structures

#### 3. Osseous Stage

- the chondrified bone models begin ossification at the area of the primary centers
- this is the point when bones begin to show up on radiographs
- many morphologic changes occur as the bones continue to ossify and positional changes occur



### C. Muscular Formation and Innervation

- both occur in a proximal to distal manner

#### 1. Limb Muscles Masses Develop

- from the mesenchyme around the developing bones
- during the 4<sup>th</sup> through 7<sup>th</sup> intrauterine weeks as the limbs are forming
- muscle masses enlarge by mitosis (adding new cells) until the mid-fetal period (near 22 weeks gestation) after which the fibers only increase in size
- 2 muscle masses per limb

##### a. Ventral Mass / Flexor Mass

- located ventrally / anteriorly before limb rotation in all 4 limbs
- located anteriorly in the upper limb after limb rotation (anatomic position)
- located posteriorly in the lower limb after limb rotation; in the lower limb girdle, it is still anterior

##### b. Dorsal Mass / Extensor Mass

- located dorsally / posteriorly before limb rotation in all 4 limbs
- located posteriorly in the upper limb after limb rotation
- located anteriorly in the lower limb after limb rotation; in the lower limb girdle, it is still posterior

#### 2. Innervation of the Limbs

- begins near 4 weeks gestation, prior to limb rotations; so dermatomes spiral
- nerves arise from ectoderm
- ventral rami from the spinal cord segments adjacent to the limb buds grow into the limb bud mesenchyme and migrate along the developing limbs
- T-12 through S-4 for the lower limb
- as a muscle group becomes discernible, the nerves send branches to supply them

# Limb Development

## Vascular Supply

- large vessels of the embryo begin as capillary plexuses
- blood flow causes vessels to enlarge or degenerate
- causes constant change
- supply and demand system can cause anomalies
- adult pattern is reached by the end of the 8th intrauterine week

### Axis Artery

- begins as a capillary plexus from the umbilical artery
- main supply to the developing limb
- passes along dorsal (posterior) aspect of the developing limb and forms a plantar network
- several branches pass into the mesenchymal skeleton, one forms a dorsal network

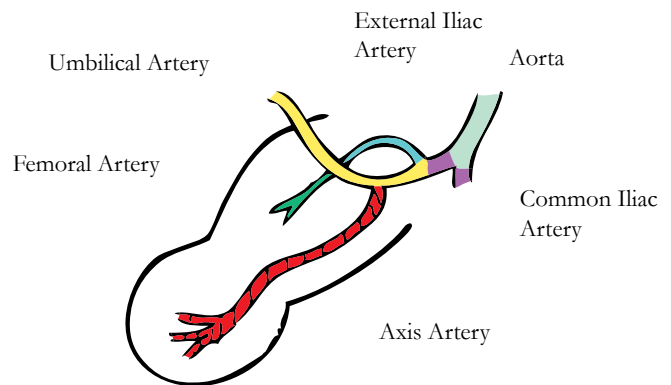
### Remnants of the Axis Artery

- in the adult
  - internal iliac artery
  - popliteal artery
  - peroneal artery

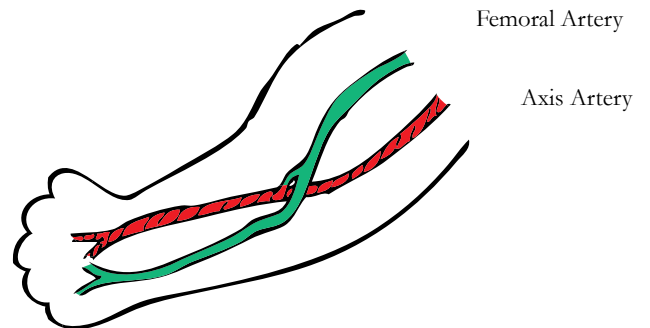
### Femoral Artery

- an extension of the newly formed external iliac artery
- passes down the anterior aspect of the lower limb and ends on the dorsum of the foot
- many points of communication with axis artery

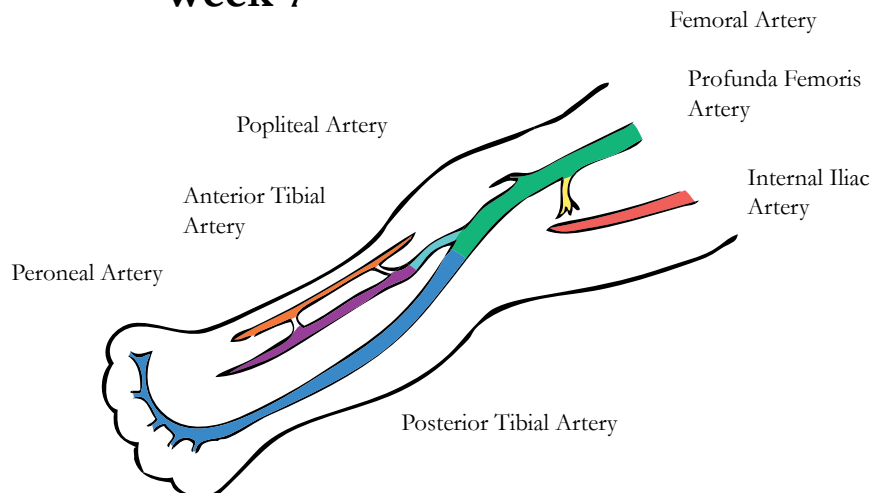
### Week 5



### Week 6-7



### Week 7



## FETAL DEVELOPMENT; 9 weeks in utero to birth

### A. Primary Centers of Ossification

- continue to appear

### B. Circulation Pattern Changes

- arteries become larger to meet the demand

### C. Nail Formation

- nails of the toes begin forming in the 9<sup>th</sup> fetal or intrauterine week and are completely formed by the 12<sup>th</sup> fetal week
- hands still precede feet

## III. INFANCY; birth to 1.5 or 2 years

- lower limb positional (soft tissue) changes occur
- hips begin internally rotating, in part due to muscular control
- overall development is monitored by motor milestones
  - ie: rolling, sitting, standing, walking, talking

## IV. CHILDHOOD; 1.5 or 2 years to 13 years

- significant changes in lower limb positions (due to soft tissue control) occur until 6 years of age
- torsional changes in the bones occur until about 13 years of age

	birth	6 years
<b><u>hips</u></b>	60 degrees external	10 degrees external
	- internally rotating, many soft tissue changes, some osseous changes in the femoral head and neck	
<b><u>knees</u></b>	external	on frontal plane
	- due to hip rotation initially, and then femoral torsion (angle of declination)	
<b><u>ankles</u></b>	0 degrees	~15 degrees external
	- (tibiofibular torsion) knee with respect to the ankle, due to external tibial torsion	
<b><u>heel</u></b>	7 degrees everted	vertical
	- vertical bisection of the heel with respect to the floor	
	- due to torsional changes in the head and neck of the talus as well as to increased ossification of the pedal bones	
<b><u>angle of gait</u></b>	45 degrees abducted	~15 degrees abducted
	- foot bisection with respect to the line of progression	
	- due to hip rotations, femoral torsion, tibial torsion and talar torsion	
<b><u>base of gait</u></b>	shoulder width	1.5 to 3 inches
	- distance between the medial malleoli	
	- due to higher center of gravity in infancy;	
	adult - just anterior to S-2 vertebra	
	infant - near the umbilicus (T-12 - L-2)	

## V. DISTURBANCES in limb development

- can occur at any time during the development of the limbs, may be hereditary or environmental

### A. Failure to Differentiate

#### 1. Synostosis

- failure of mesenchymal primordia to differentiate
- several possibilities in the foot
- most frequent talus and calcaneus
- not treated unless symptomatic
- may be treated conservatively or surgically

#### 2. Syndactyly

##### a. Cutaneous Syndactyly

- failure of mesenchyme between digits to degenerate
- causes webbed digits, complete or partial
- surgically separated if problematic
- usually a problem in the hand as fingers have much independent motion and are more used
- usually a cosmetic problem only for feet (little functional problem)

##### b. Osseous Syndactyly

- failure of mesenchymal primordia to differentiate
- notches between digital rays do not form

### B. Failure to Form

#### 1. Amelia

- low incidence
- failure of limb to develop
- may be one or more limbs
- absence of all limbs seen most often when pregnant women took thalidomide for nausea; no longer used for this, but is being used for parkinson's disease
- upper limb involvement, may use prostheses
- lower limb involvement, usually use prostheses

#### 2. Meromelia

- low incidence; old term hemimelia
- limb(s) partially absent
- can occur at any level from digits to parts of limbs
- upper limb involvement, may use prostheses
- lower limb involvement, usually use prostheses

##### a. Congenital Absence of Bones

- usually are genetic factors

##### i. Fifth Metatarsal

- low incidence

- often no functional problems

- ii. Fibula

- low incidence
- problem with ankle stability
- could probably use a knee-ankle-foot orthosis or fuse the ankle joint or perform a below-the-knee amputation

- b. Cleft Hand / Cleft Foot (Lobster Claw Hand/Foot)

- low incidence; old term ectrodactyly
- usually surgically corrected due to associated functional problems
- very difficult surgery, often done in stages (2-3 separate surgeries)
- depends upon which bones or other structures are absent

### C. Duplication of Parts

- often hereditary conditions

- 1. Polydactyly

- formation of extra digits/parts of digits
- more common in cultures with less genetic diversity (limited number of people in the community with no outside marriages)
- usually surgically corrected
  - even for feet is a problem due to fit of shoes
- may also have extra metatarsal bones (polymetatarsia)
- in upper limb, usually medial or lateral (pre-axial or post-axial)
- in lower limb, usually lateral (post-axial)

### D. Enlargement of Parts

- 1. Macroductyly

- enlargement of a digit or digits
- possibly due to vascular excess in a localized area (supply and demand failed)