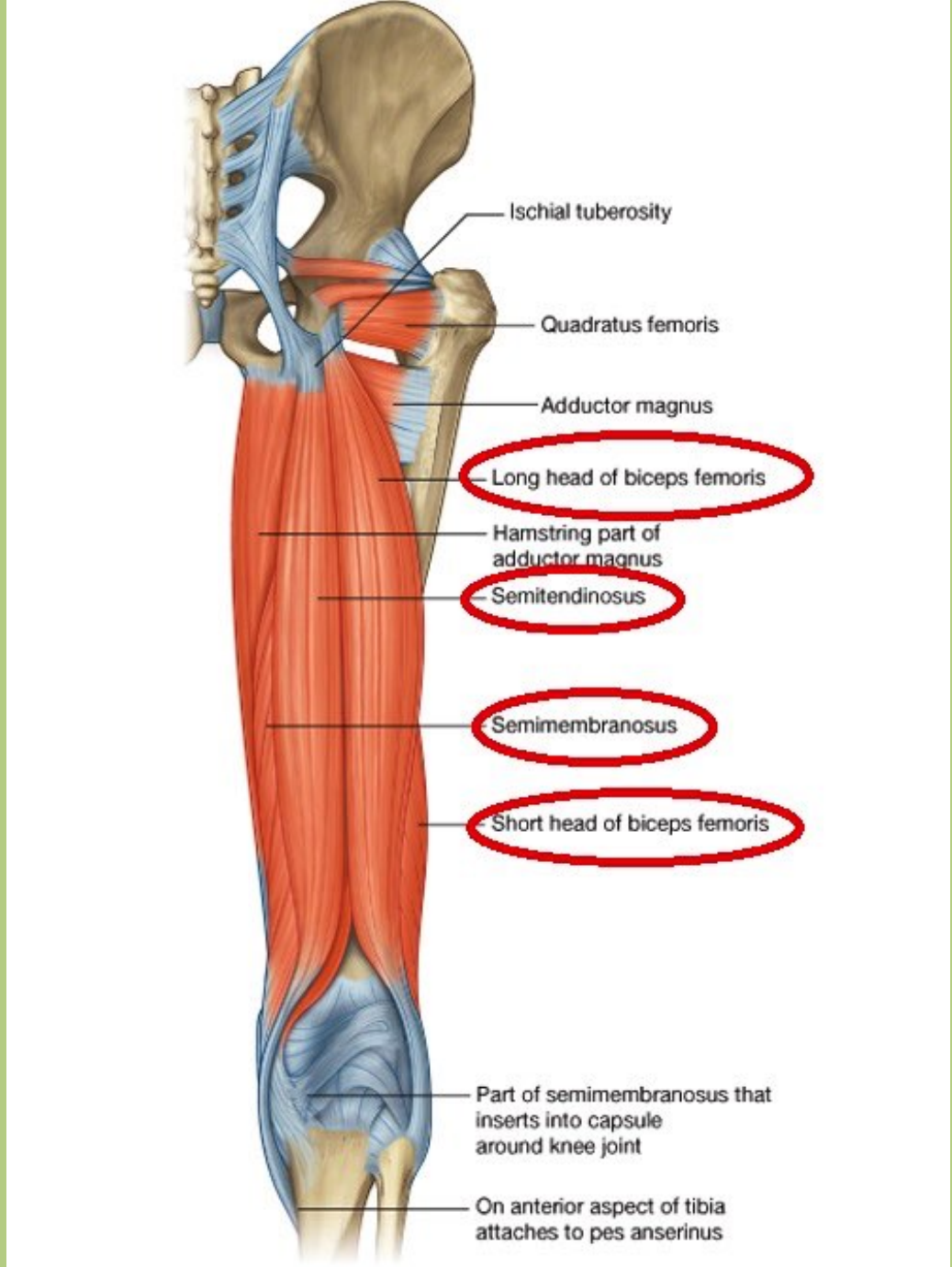
Muscles of the lower limb. Walking

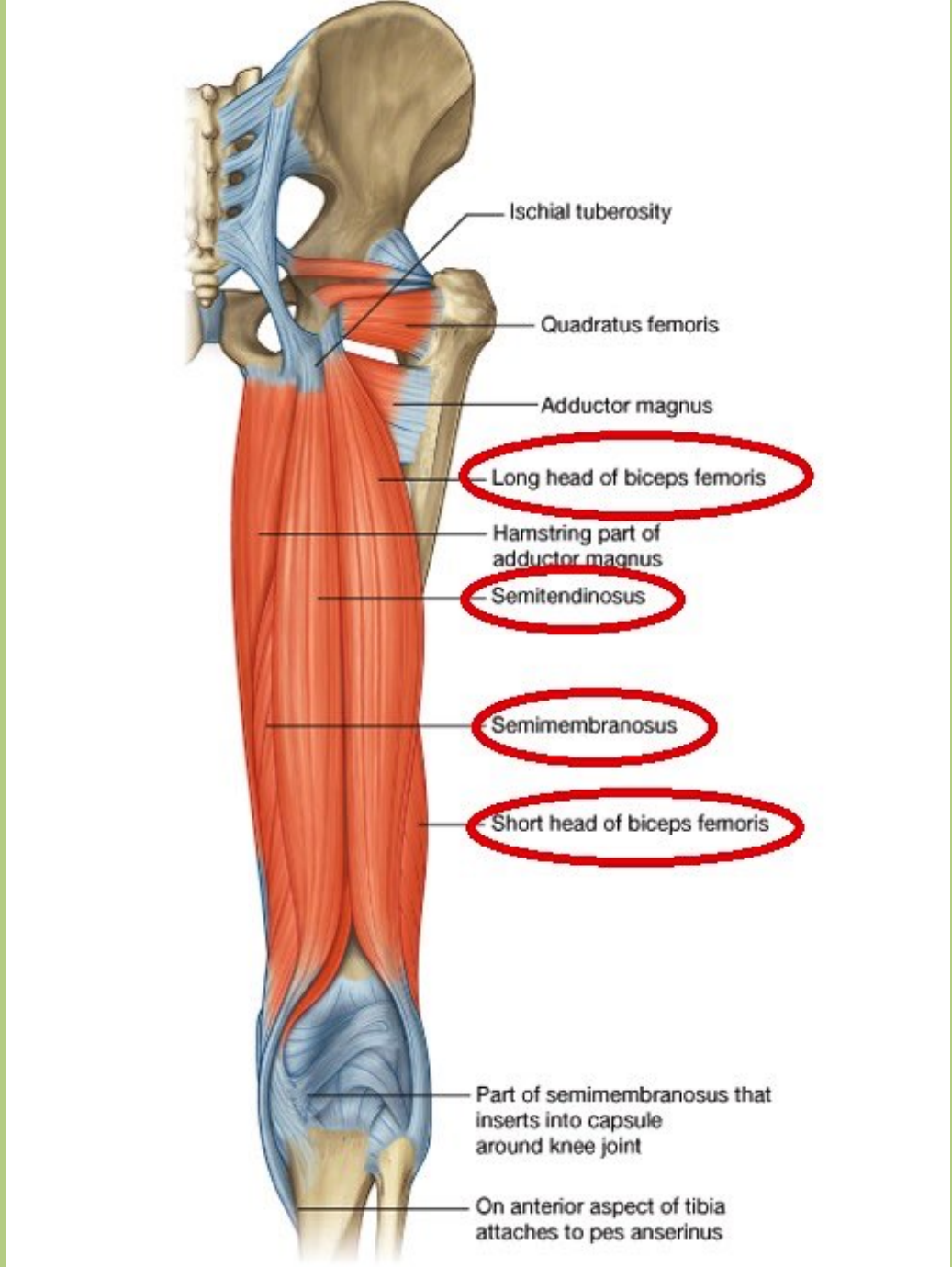
Sándor Katz M.D.,Ph.D.

Hip extensors - knee flexors



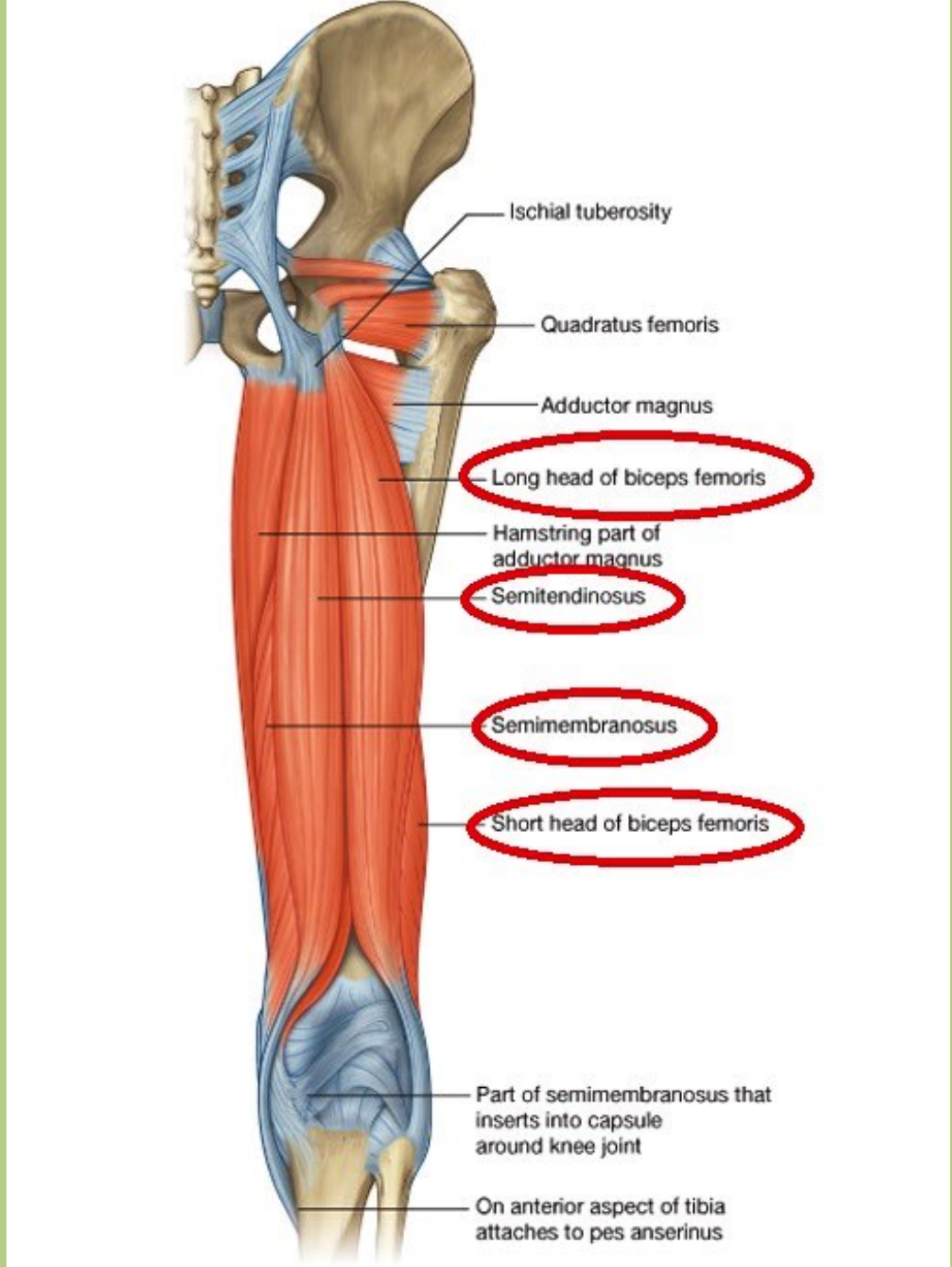
Biceps femoris

- **Origin:** long head: ischial tuberosity; short head: lateral lip of linea aspera
- **Insertion:** head of fibula
- **Action:** Hip joint: extension. Knee joint: flexion.
- **Innervation:** sciatic nerve



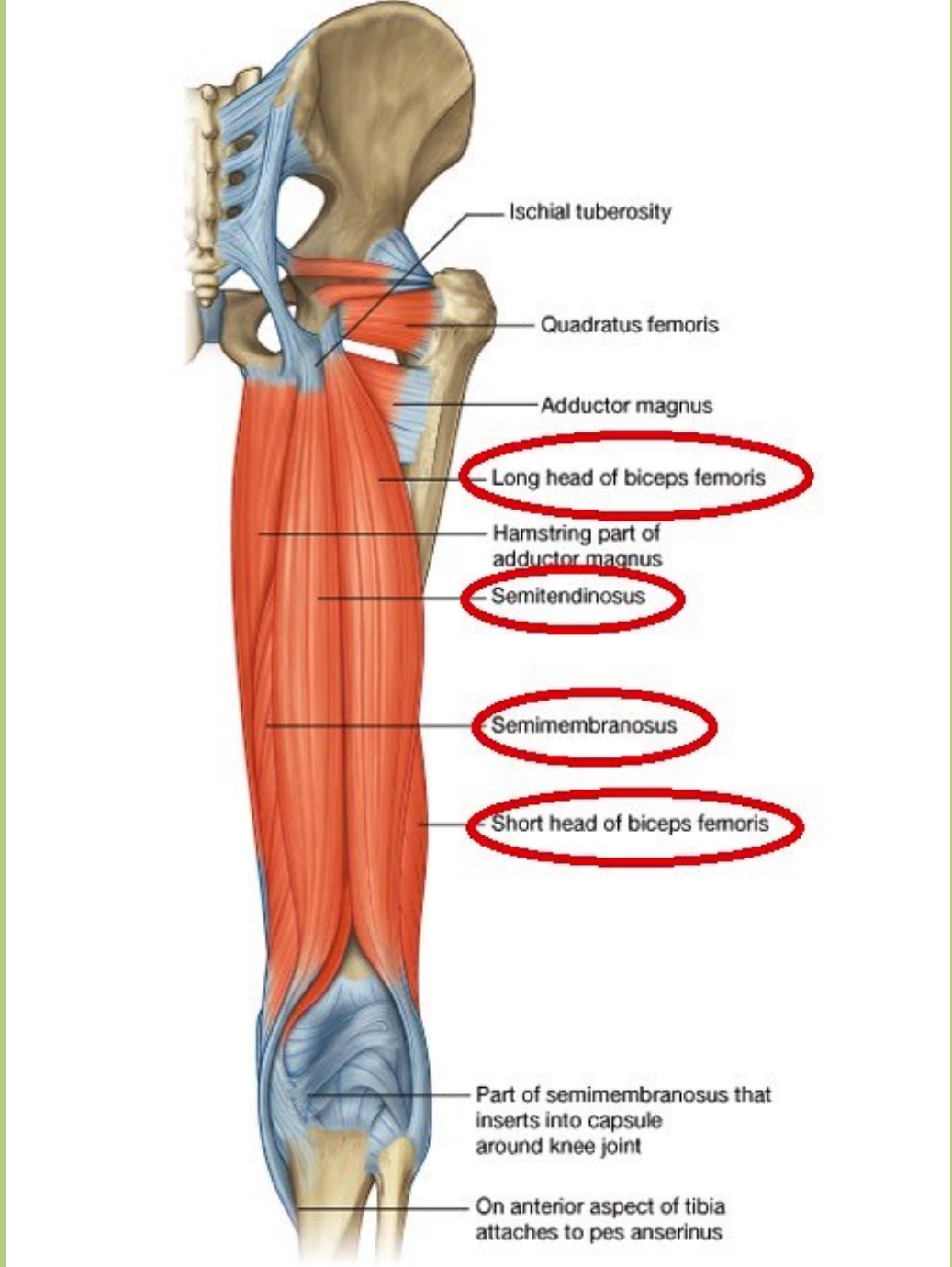
Semitendinosus

- **Origin:** ischial tuberosity
- **Insertion:** superficial pes anserinus (under the medial tibial condyle)
- **Action:** Hip joint: extension. Knee joint: flexion.
- **Innervation:** sciatic nerve

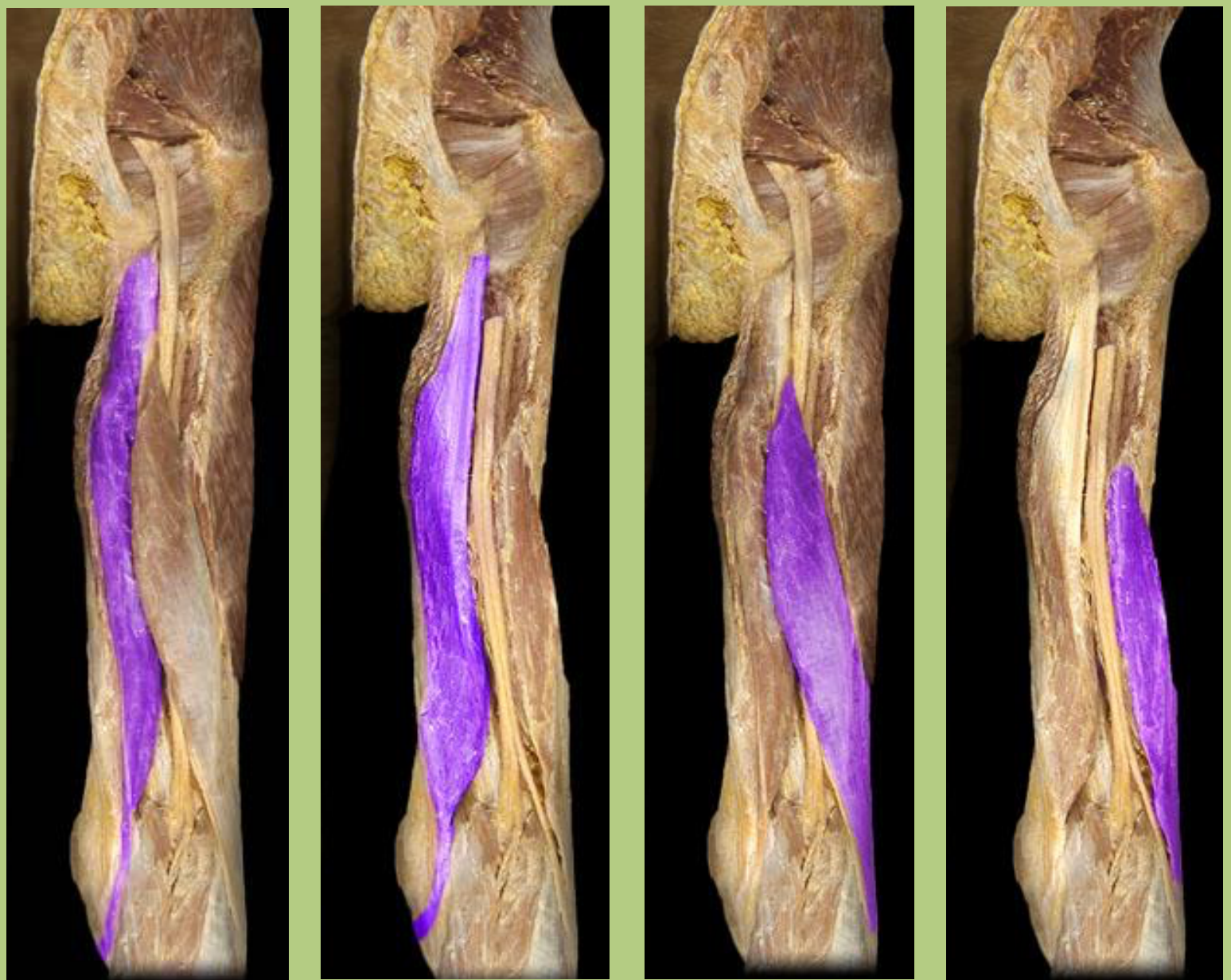


Semimembranosus

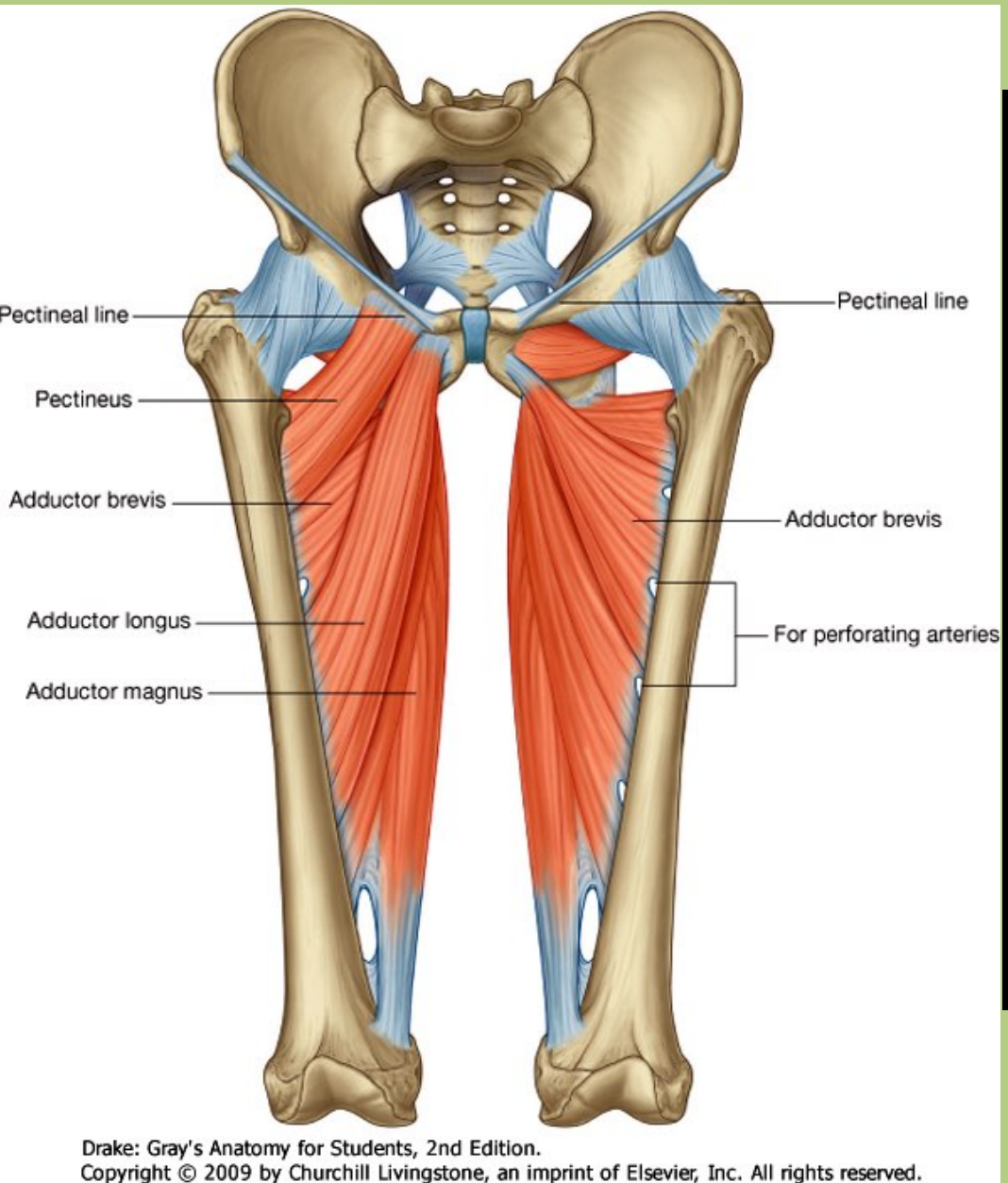
- **Origin:** ischial tuberosity
- **Insertion:** deep pes anserinus (under the superficial pes anserinus)
- **Action:** Hip joint: extension. Knee joint: flexion.
- **Innervation:** sciatic nerve



Hip extensors-knee flexors
(semitendinosus, semimembranosus, biceps femoris)

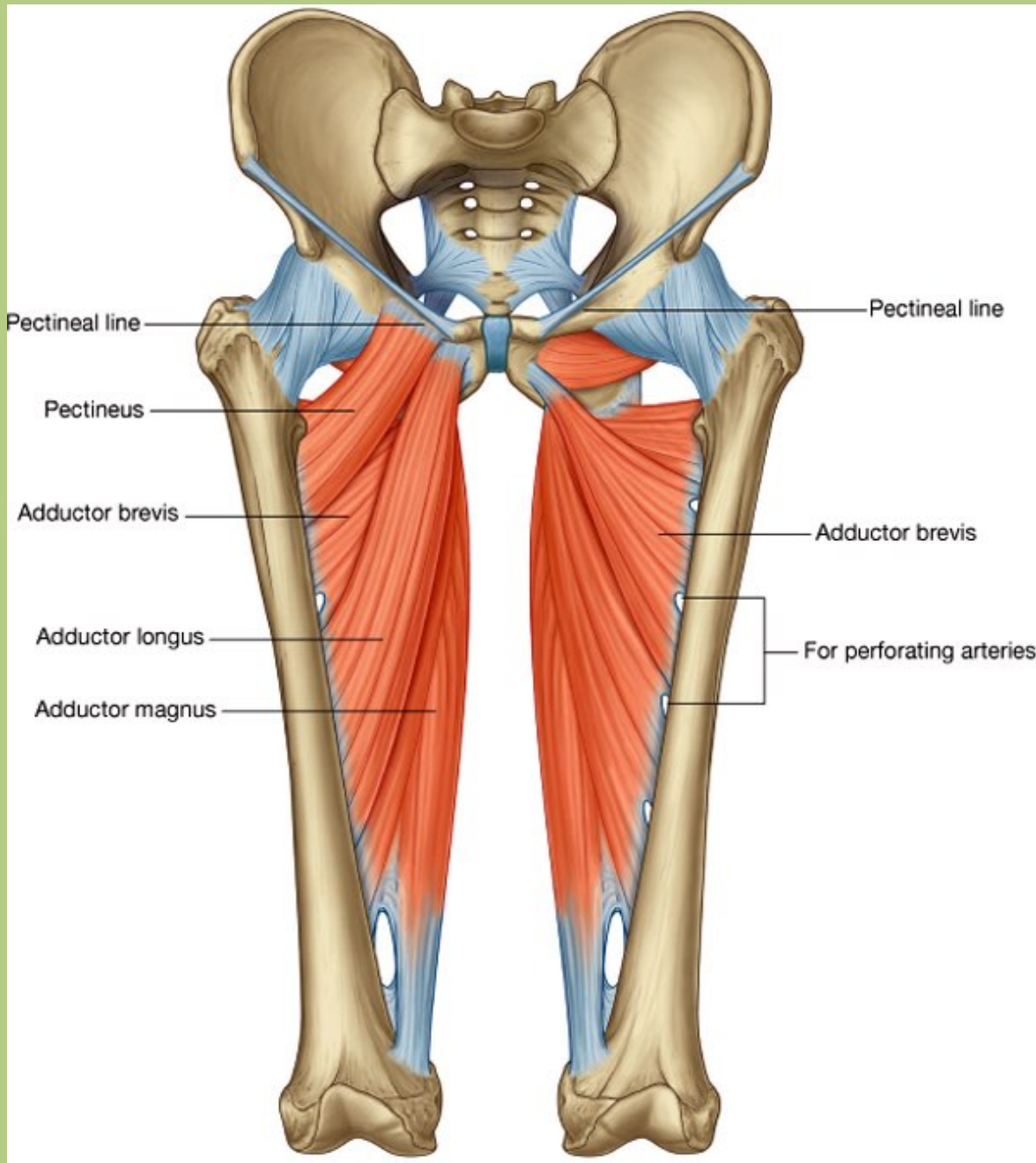


Adductors



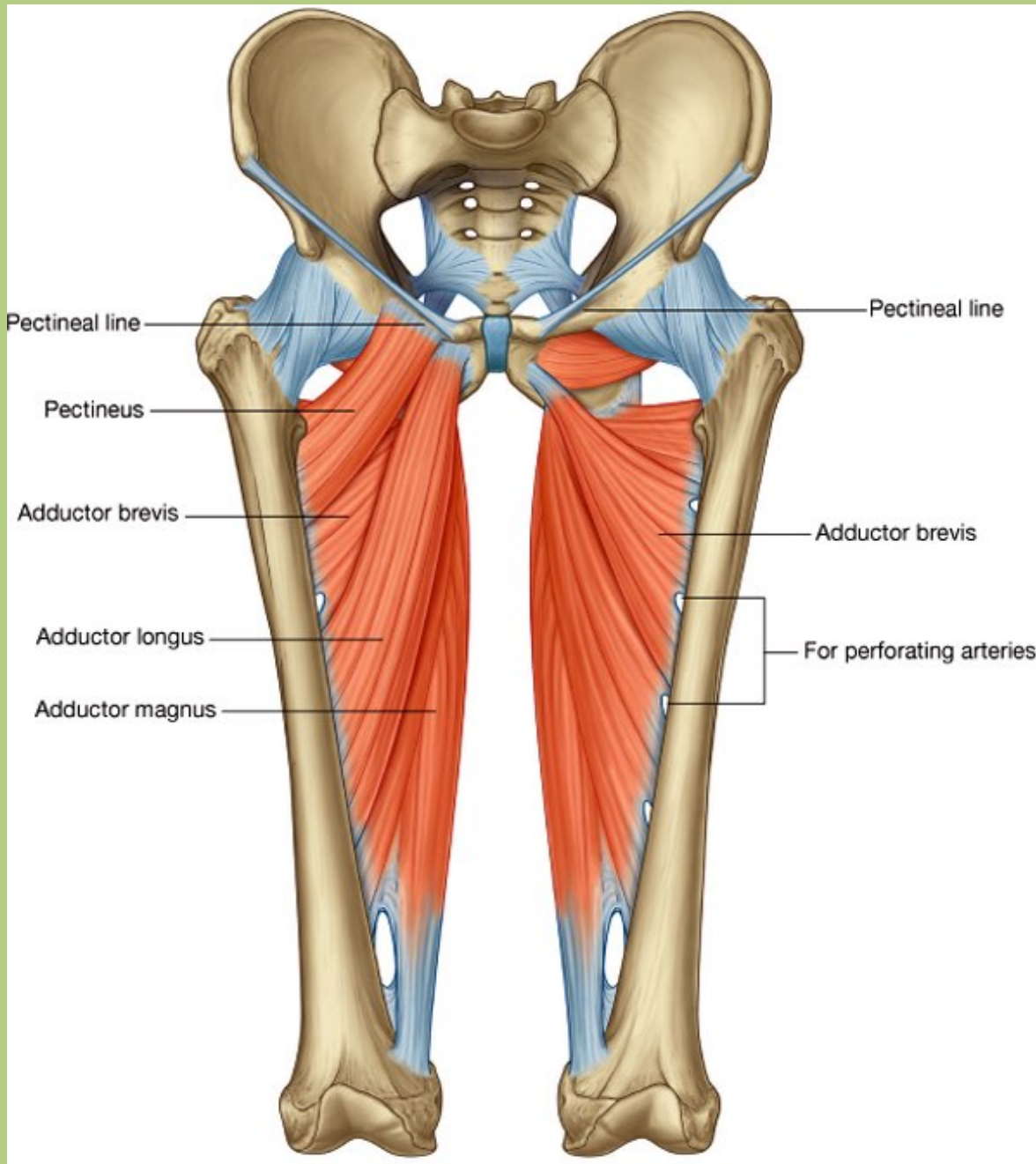
Gracilis

- **Origin:** inferior pubic ramus
- **Insertion:** superficial pes anserinus (under the medial tibial condyle)
- **Action:** Hip joint: adduction and flexion. Knee joint: flexion and medial rotation.
- **Innervation:** obturator nerve



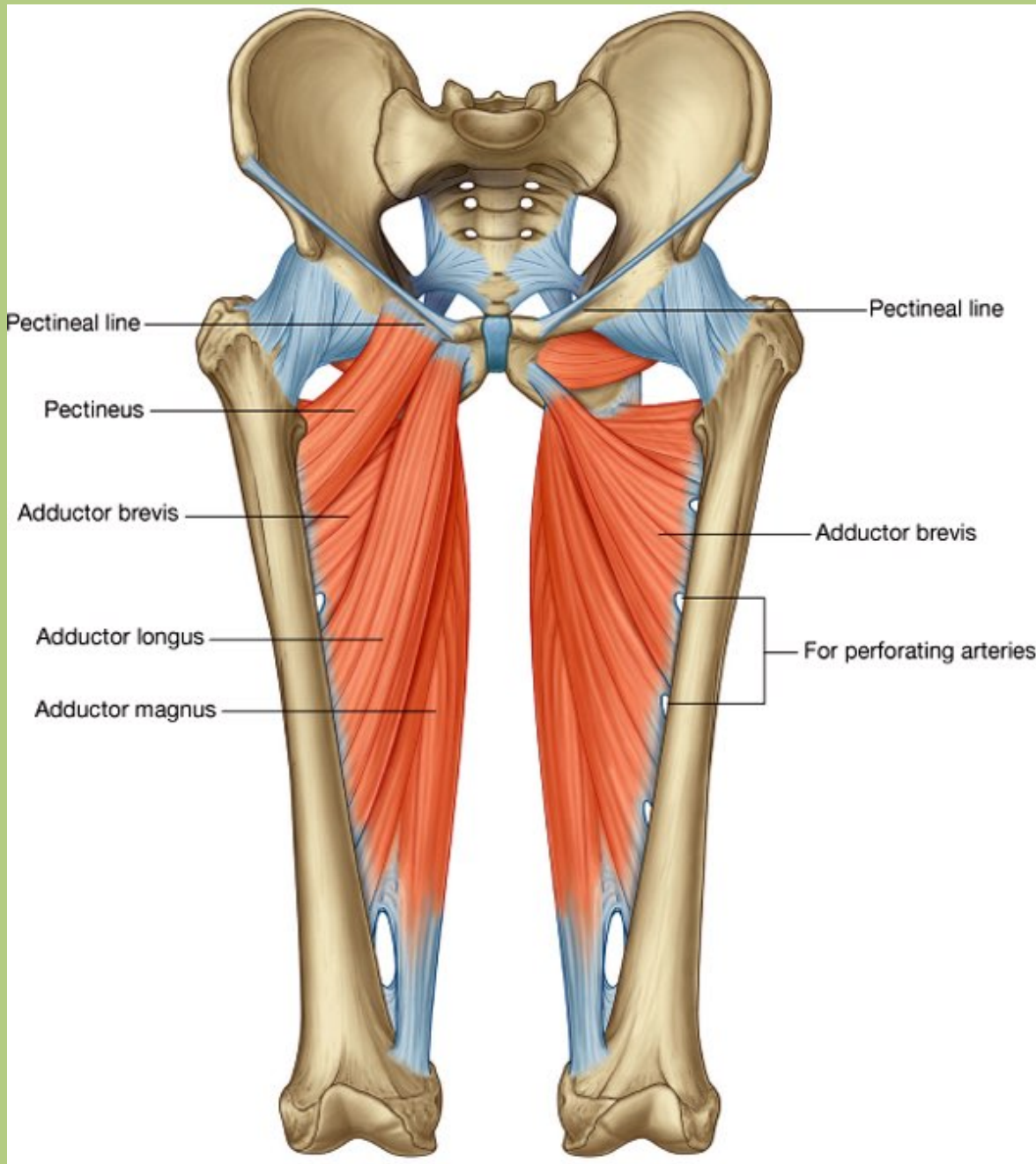
Adductor longus

- **Origin:** pubic bone, symphysis
- **Insertion:** medial lip of the linea aspera
- **Action:** Hip joint: adduction and flexion.
- **Innervation:** obturator nerve



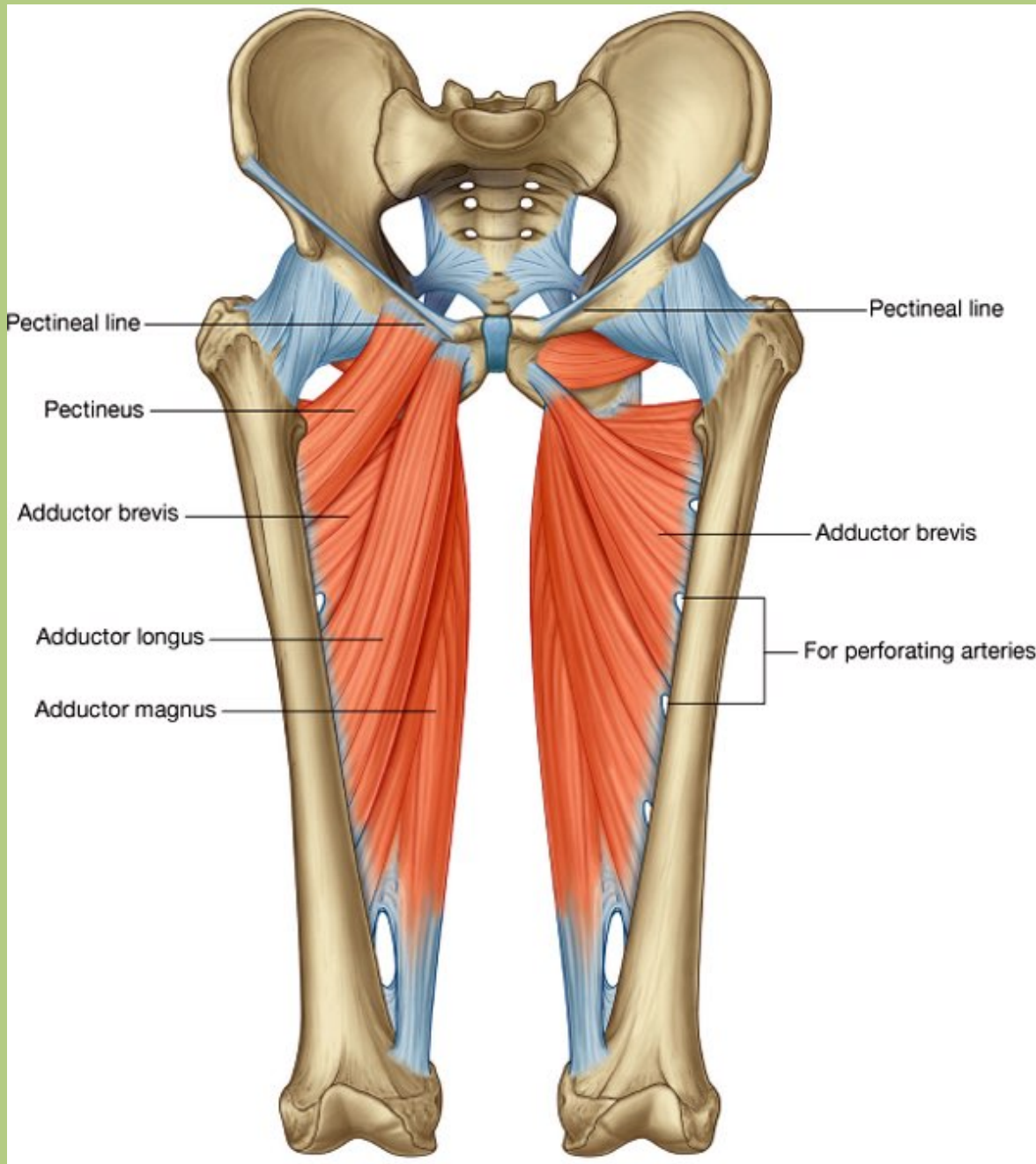
Adductor brevis

- **Origin:** inferior pubic ramus
- **Insertion:** medial lip of the linea aspera
- **Action:** Hip joint: adduction and flexion.
- **Innervation:** obturator nerve



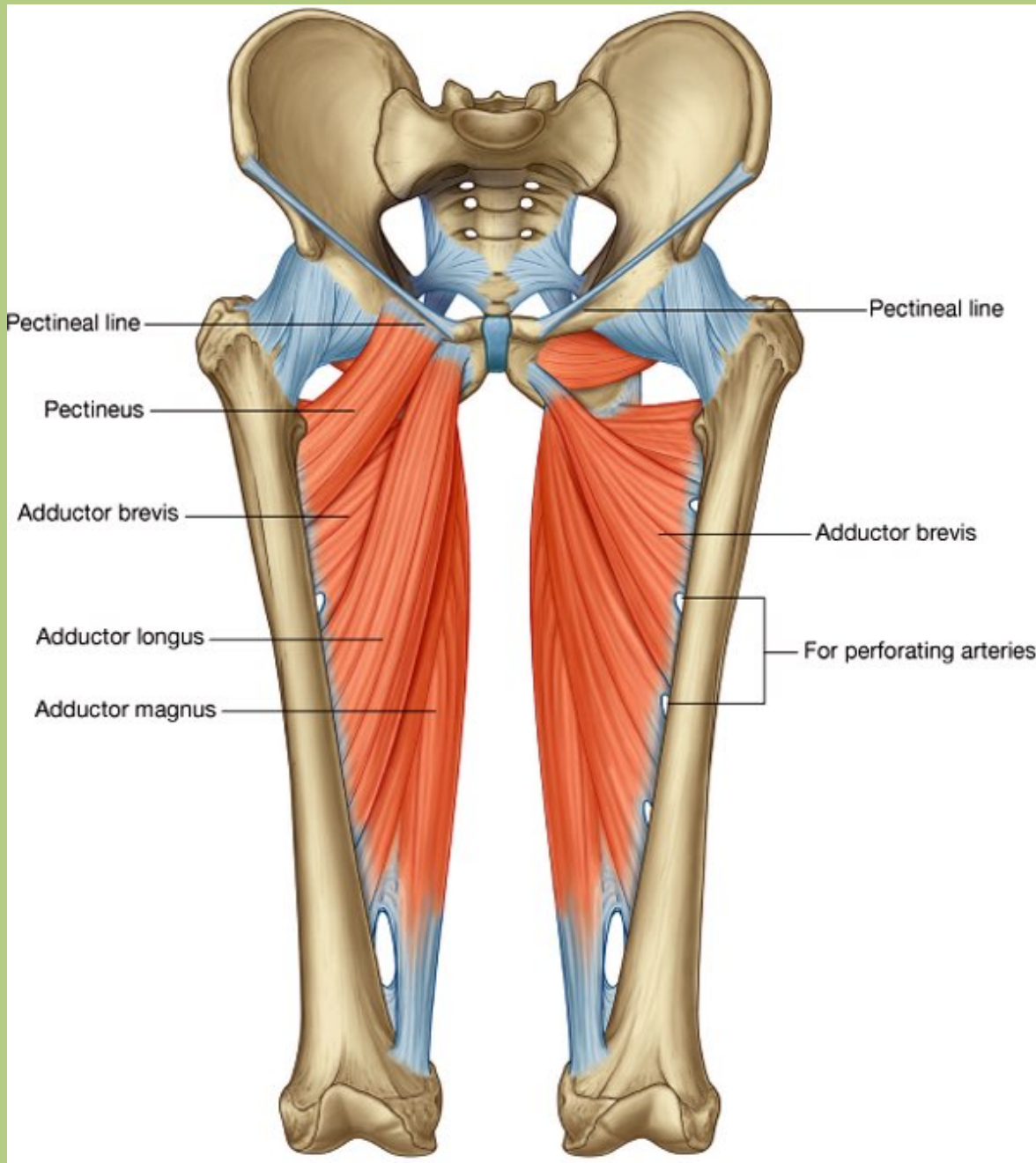
Adductor magnus

- **Origin:** inferior pubic ramus, ischial tuberosity
- **Insertion:** Fleshy part: medial lip of the linea aspera. Tendinous part: adductor tubercle.
- **Action:** Hip joint: adduction and flexion.
- **Innervation:** obturator nerve



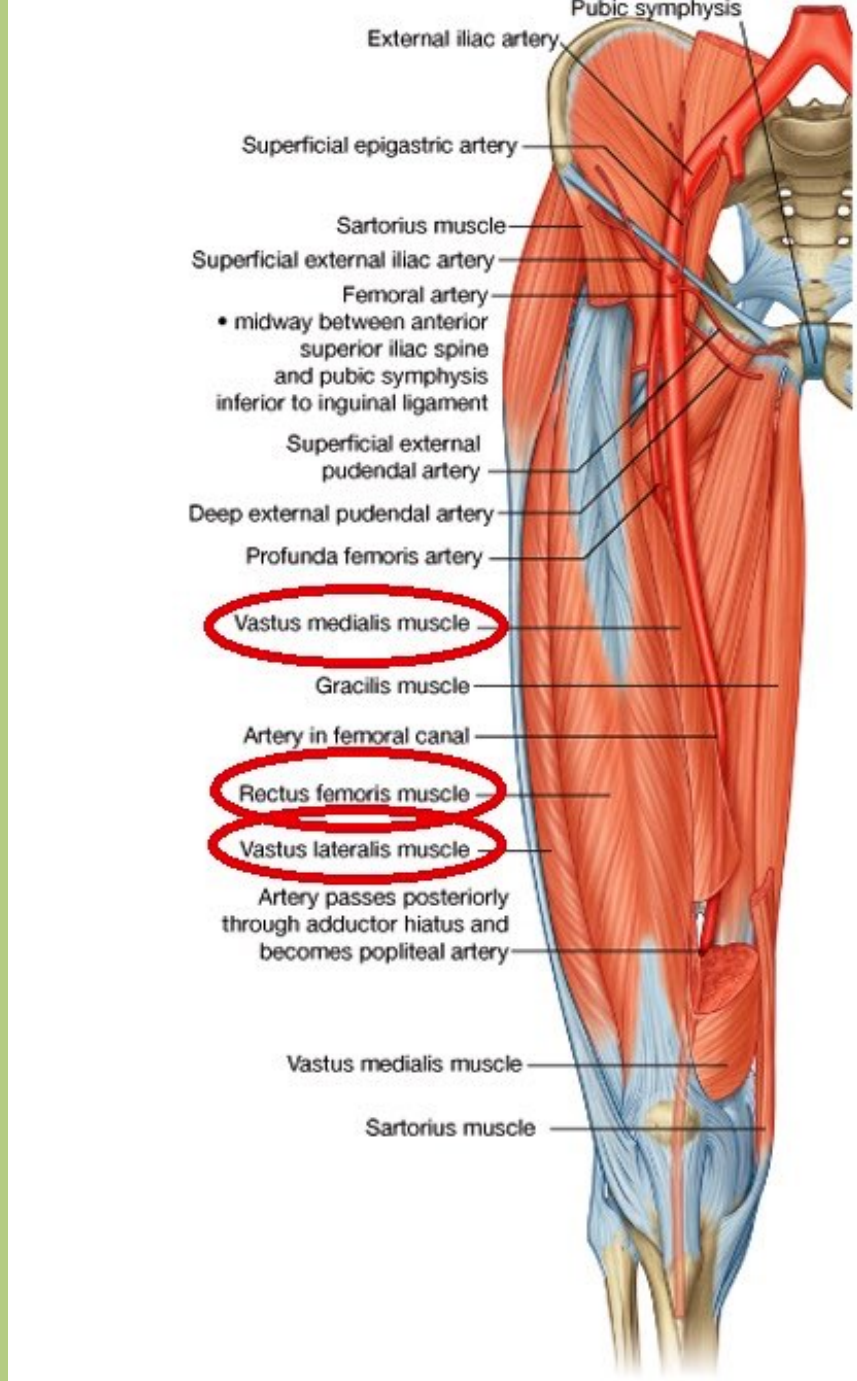
Pectineus

- **Origin:** pecten pubis
- **Insertion:** greater trochanter
- **Action:** Hip joint: adduction and flexion.
- **Innervation:** obturator and femoral nerves



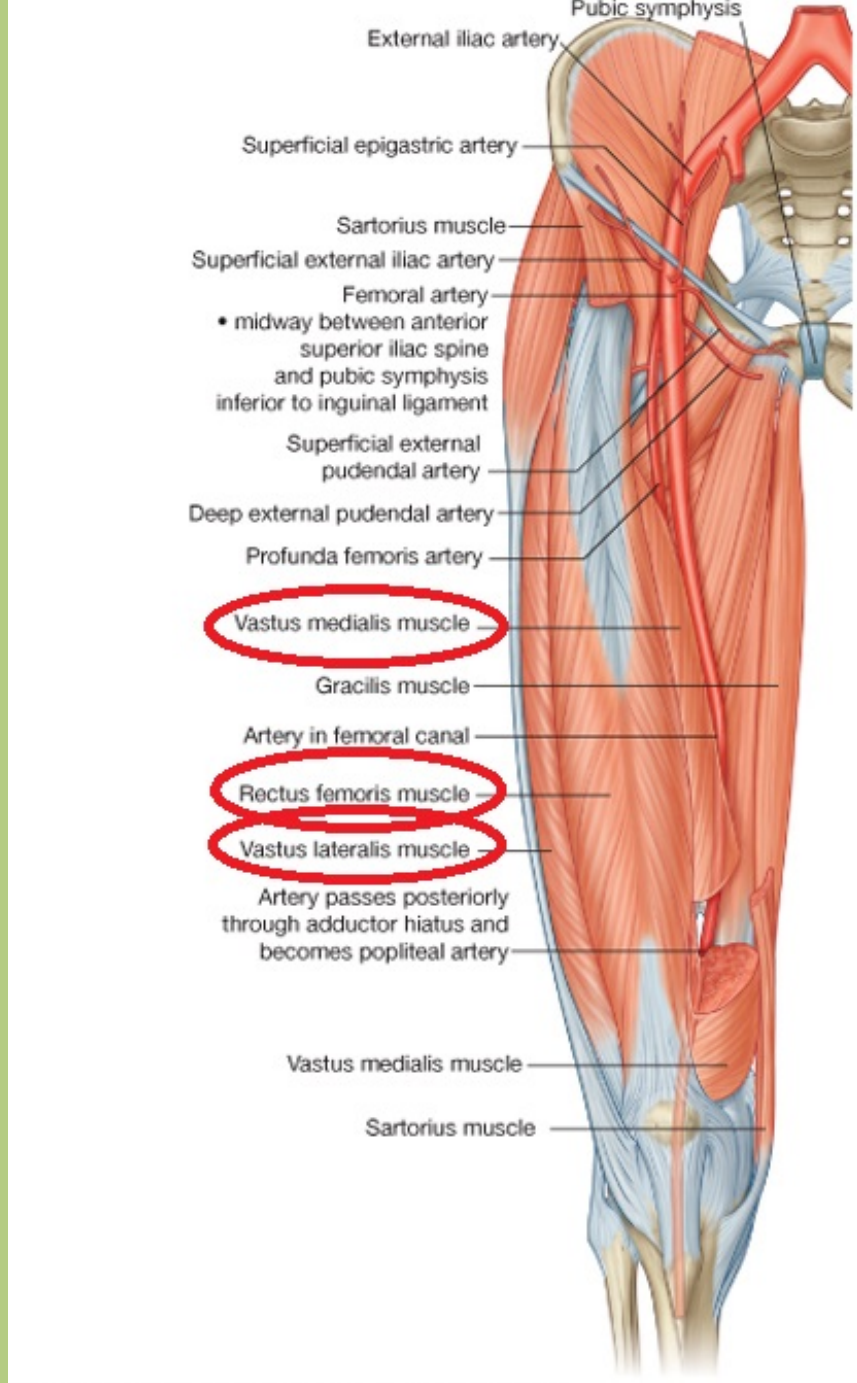
Adductor brevis, gracilis and pectineus

Hip flexors - knee extensors



Quadriceps femoris

- **Origin: rectus femoris:** inferior anterior iliac spine, **vastus medialis:** medial lip of the linea aspera, **vastus lateralis:** lateral lip of the linea aspera, **vastus intermedius:** shaft of the femur anteriorly
- **Insertion:** tibial tuberosity
- **Action:** Hip joint: flexion. Knee joint: extension.
- **Innervation:** femoral nerve

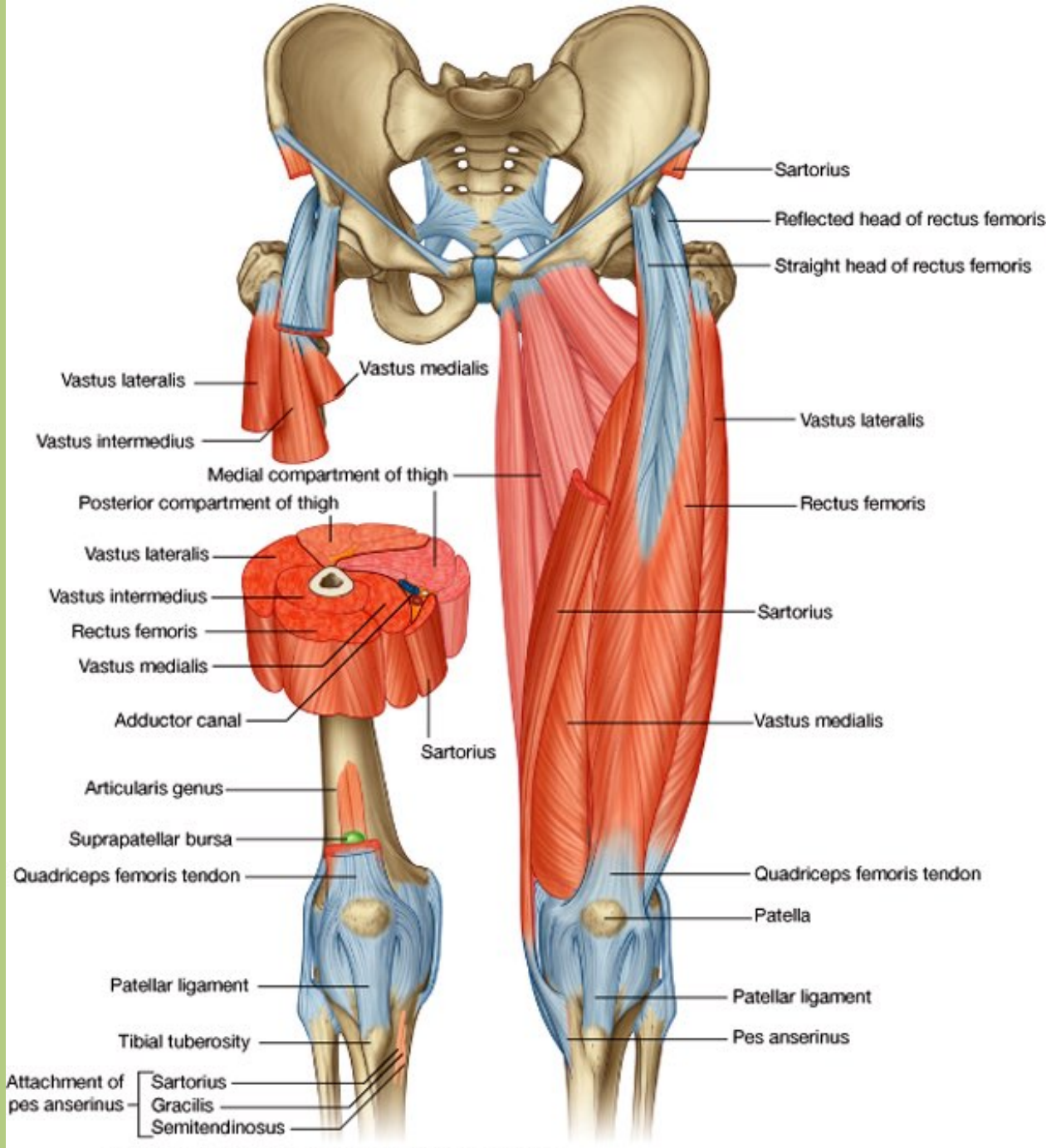


Hip flexors-knee extensors (quadriceps femoris)




Sartorius

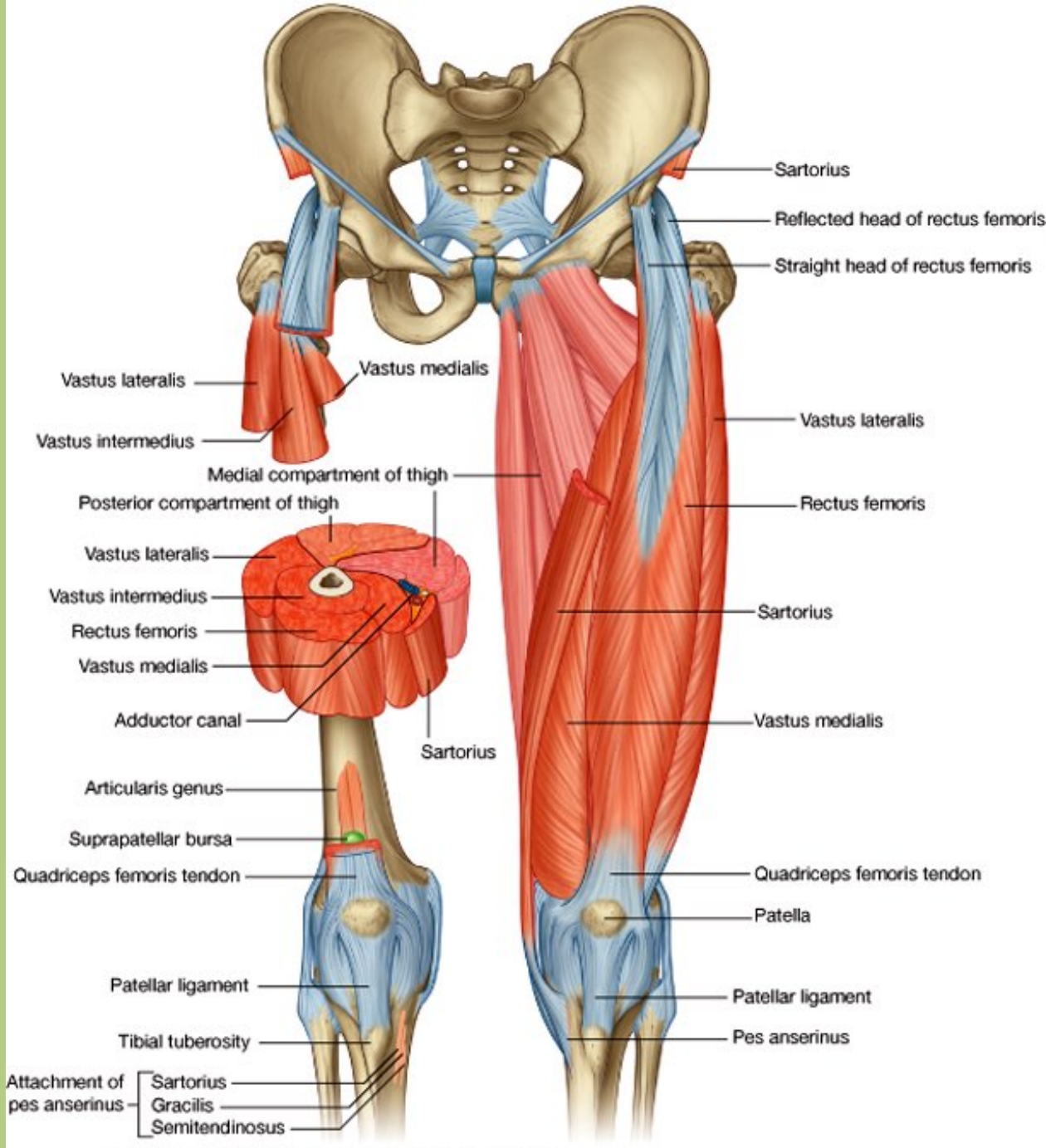
- **Origin:** anterior superior iliac spine
- **Insertion:** superficial pes anserinus
- **Action:** Hip joint: flexion and abduction. Knee joint: flexion.
- **Innervation:** femoral nerve



Drake: Gray's Anatomy for Students, 2nd Edition.

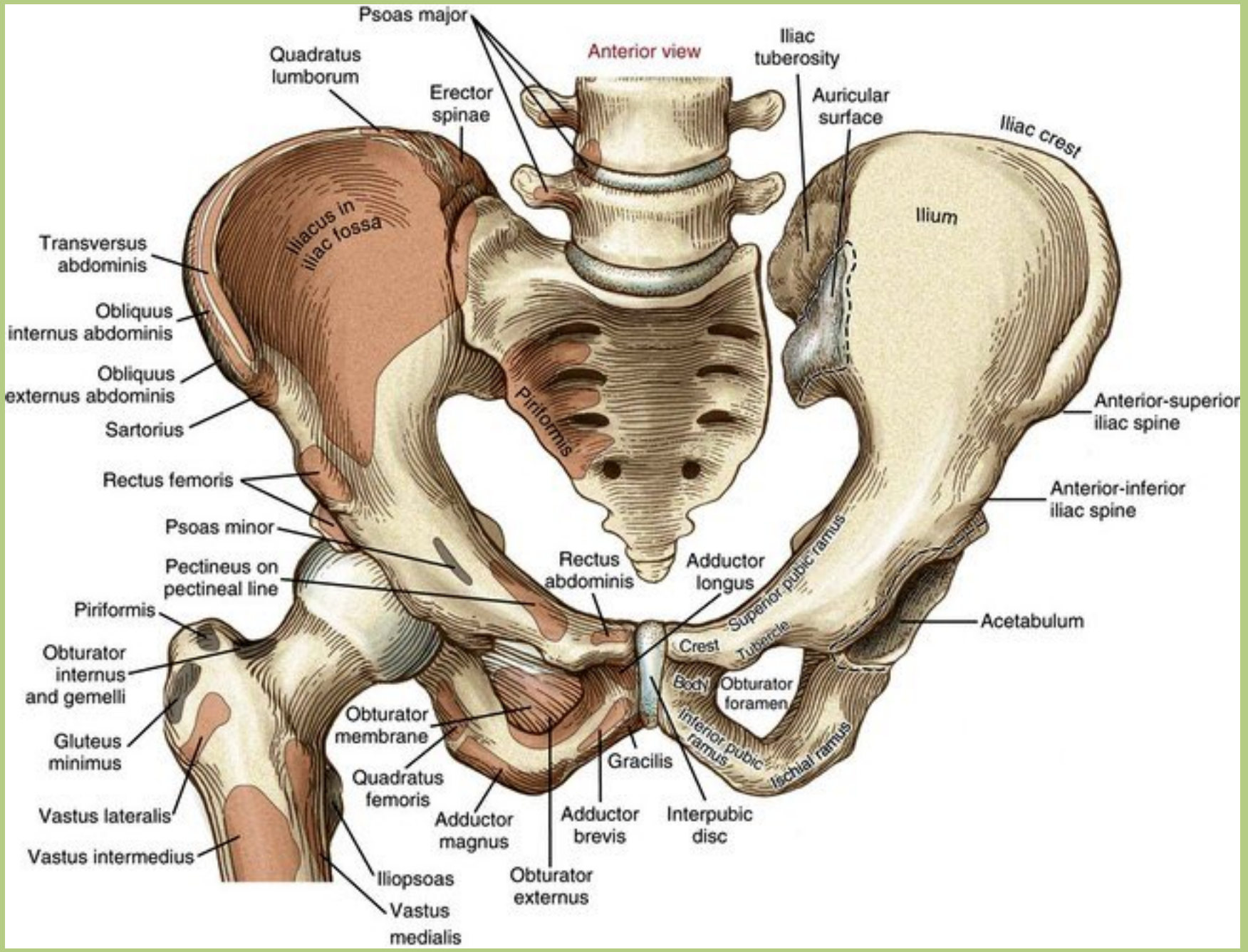
Tensor fasciae latae

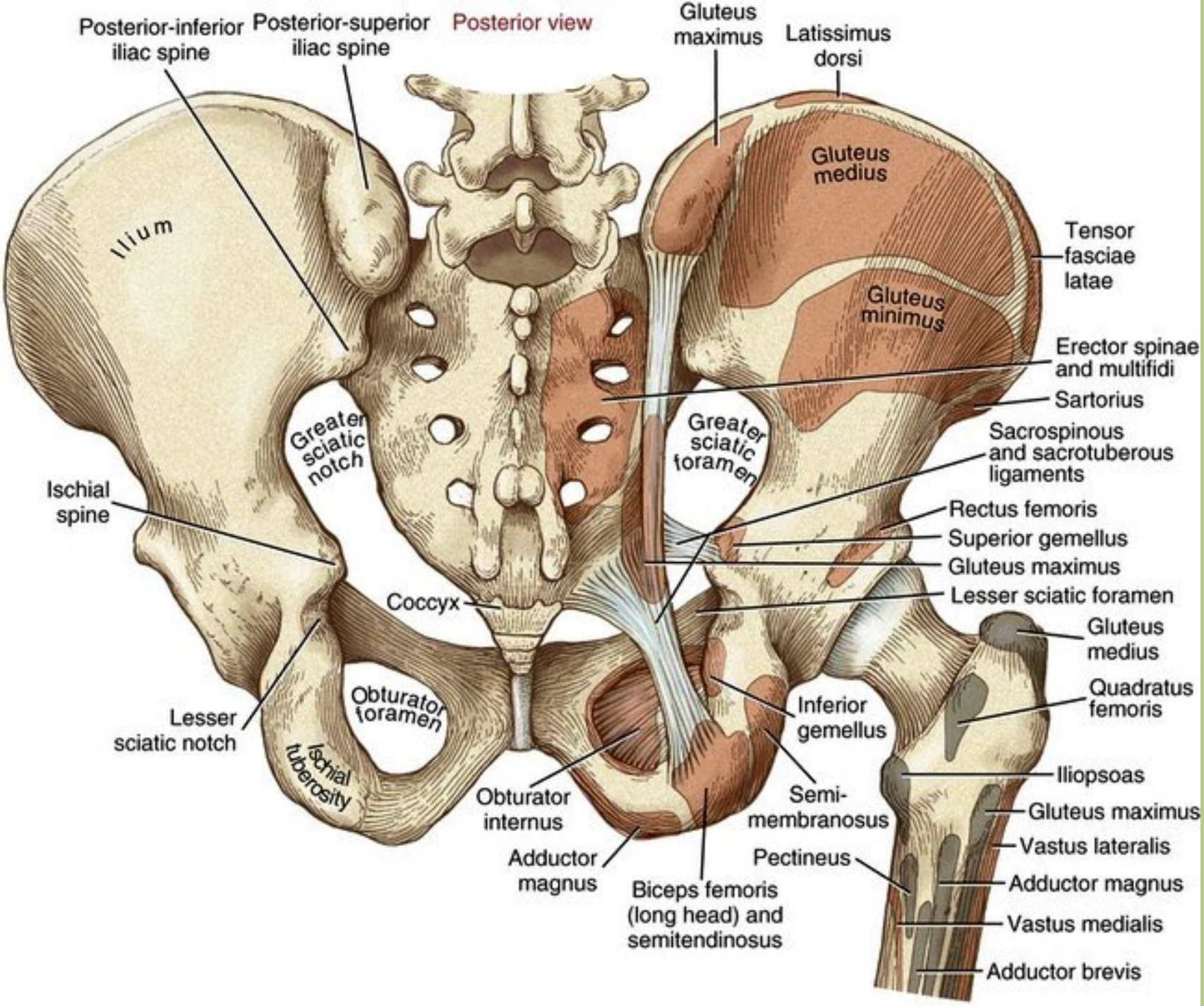
- **Origin:** anterior superior iliac spine
- **Insertion:** iliotibial tract
- **Action:** Hip joint: flexion and abduction. Knee joint: stabilisation.
- **Innervation:** superior gluteal nerve



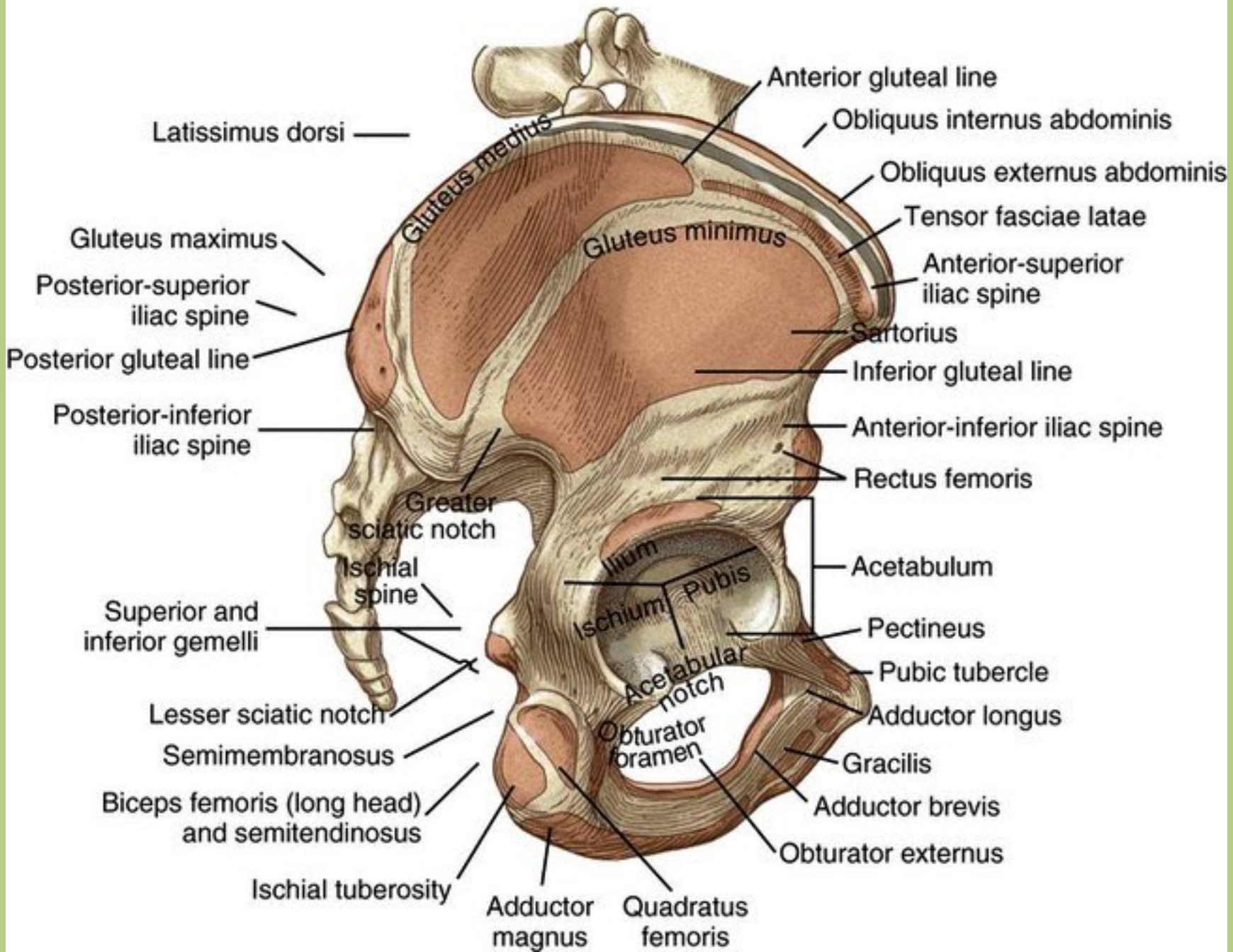
Drake: Gray's Anatomy for Students, 2nd Edition.

Tensor fasciae latae and sartorius

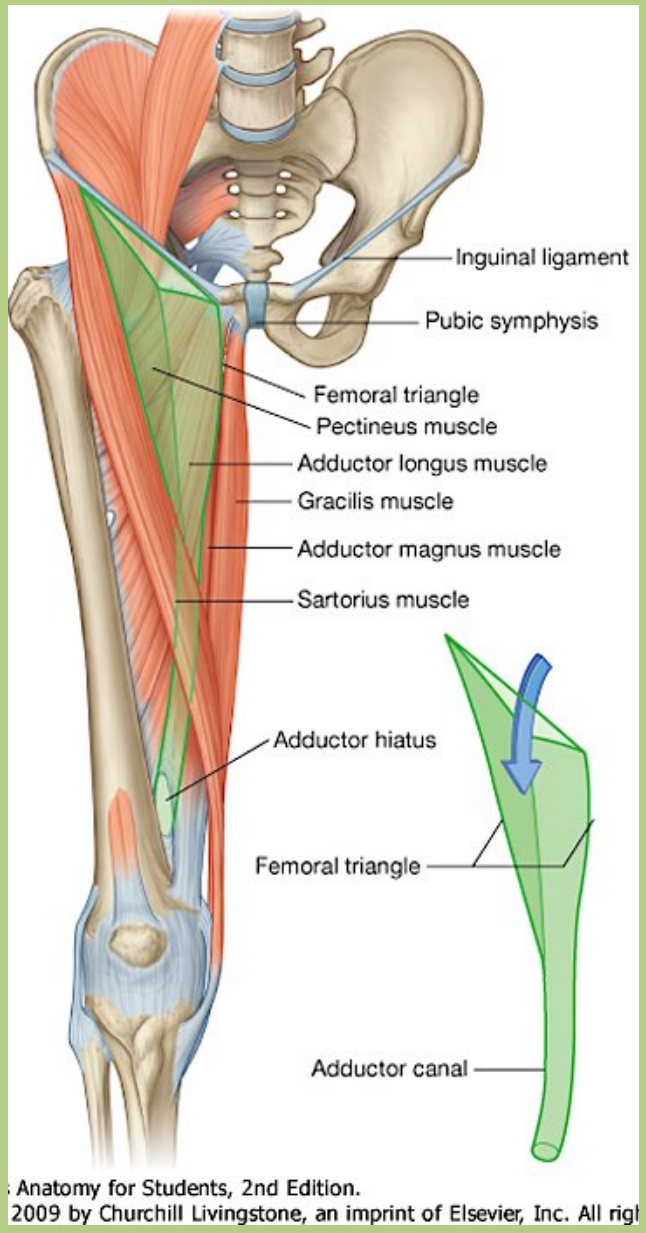

Psoas major
Anterior view
Iliac tuberosity
Quadratus lumborum
Erector spinae
Auricular surface
Iliac crest
Iliacus in iliac fossa
Ilium
Transversus abdominis
Obliquus internus abdominis
Obliquus externus abdominis
Piriformis
Sartorius
Anterior-superior iliac spine
Rectus femoris
Anterior-inferior iliac spine
Psoas minor
Rectus abdominis
Adductor longus
Pectineus on pectineal line
Superior pubic ramus
Piriformis
Acetabulum
Crest
Tubercle
Obturator internus and gemelli
Body
Obturator foramen
Inferior pubic ramus
Ischial ramus
Obturator membrane
Gracilis
Gluteus minimus
Quadratus femoris
Vastus lateralis
Adductor magnus
Adductor brevis
Interpubic disc
Vastus intermedius
Iliopsoas
Obturator externus
Vastus medialis

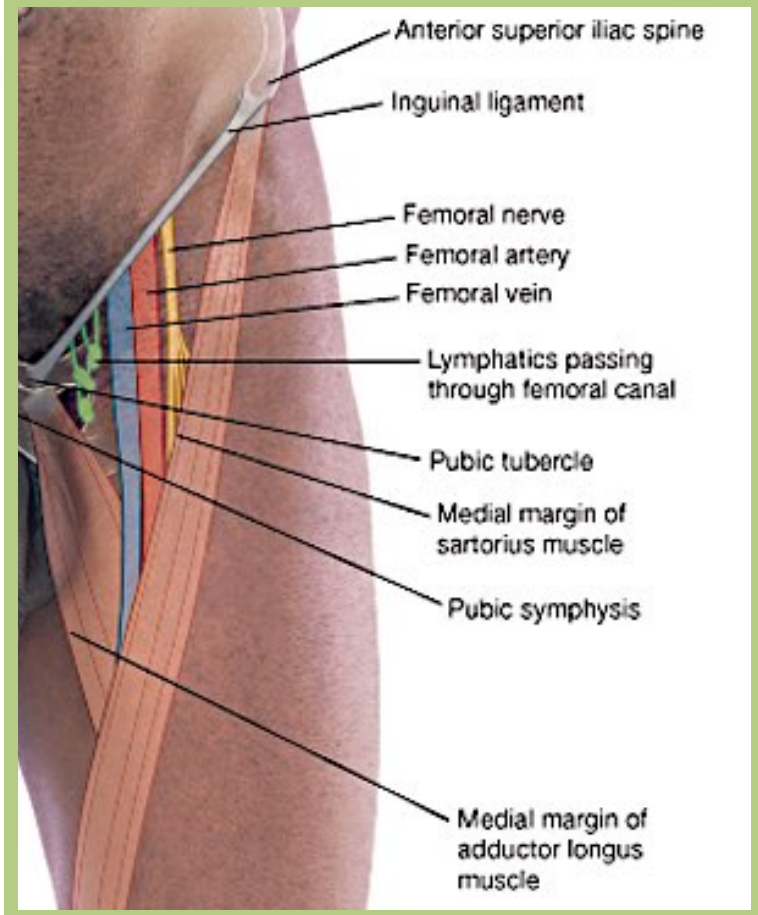

Posterior-inferior iliac spine
Posterior-superior iliac spine
Posterior view
Gluteus maximus
Latissimus dorsi
Gluteus medius
Ilium
Tensor fasciae latae
Gluteus minimus
Erector spinae and multifidi
Sartorius
Greater sciatic notch
Greater sciatic foramen
Sacrospinous and sacrotuberous ligaments
Ischial spine
Rectus femoris
Superior gemellus
Gluteus maximus
Coccyx
Lesser sciatic foramen
Gluteus medius
Obturator foramen
Quadratus femoris
Inferior gemellus
Lesser sciatic notch
Ischial tuberosity
Iliopsoas
Semi-membranosus
Gluteus maximus
Obturator internus
Vastus lateralis
Pectineus
Adductor magnus
Adductor magnus
Biceps femoris (long head) and semitendinosus
Vastus medialis
Adductor brevis

Lateral view



Femoral trigone





Base: inguinal lig.

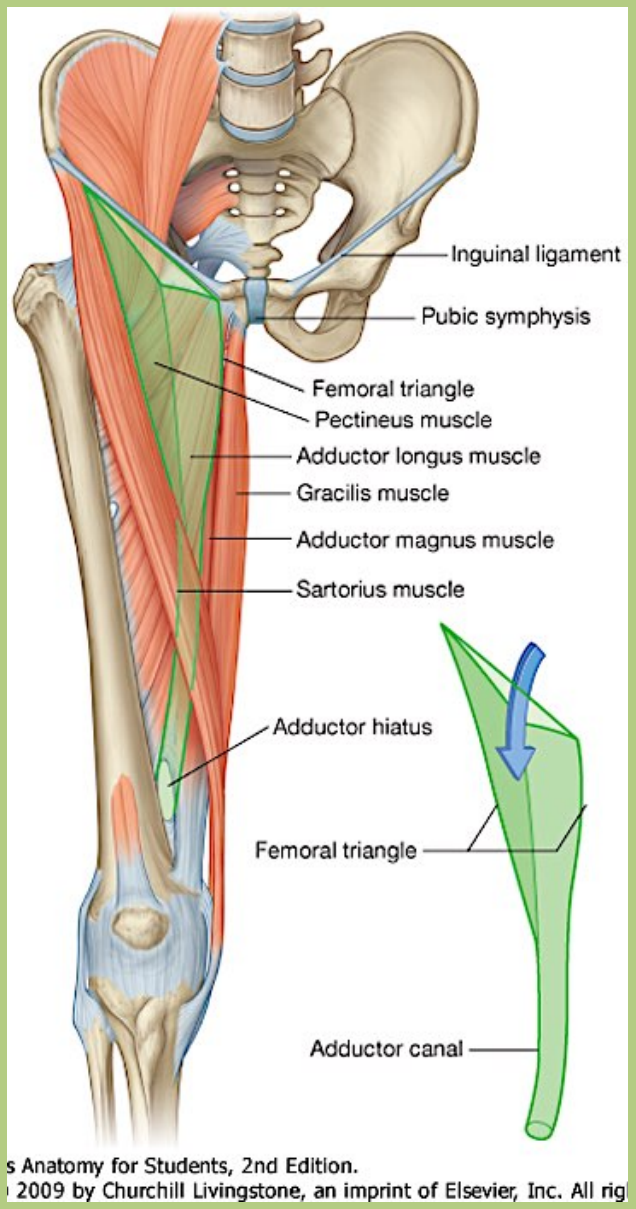
Medial wall: adductor longus

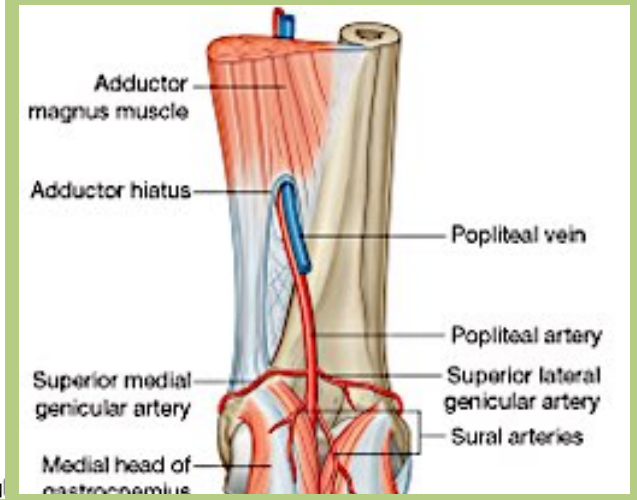
Lateral wall: sartorius

Floor: iliopsoas, pectineus

Componets:
Femoral artery / vein
Femoral nerve

Adductor canal





Superior wall: sartorius, vastoadductor membrane

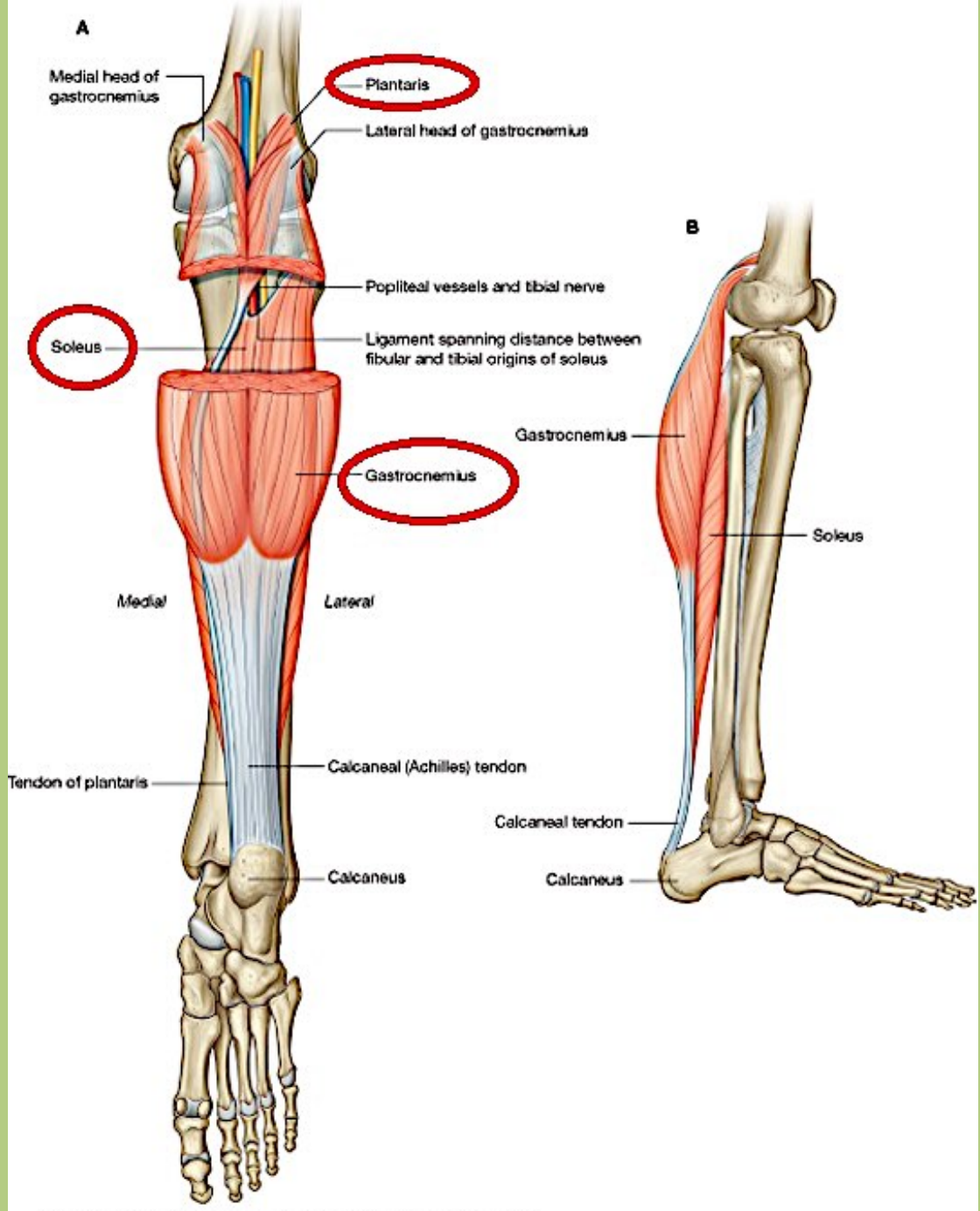
Medial wall: adductor longus, adductor magnus

Lateral wall: vastus medialis

Exit: adductor hiatus

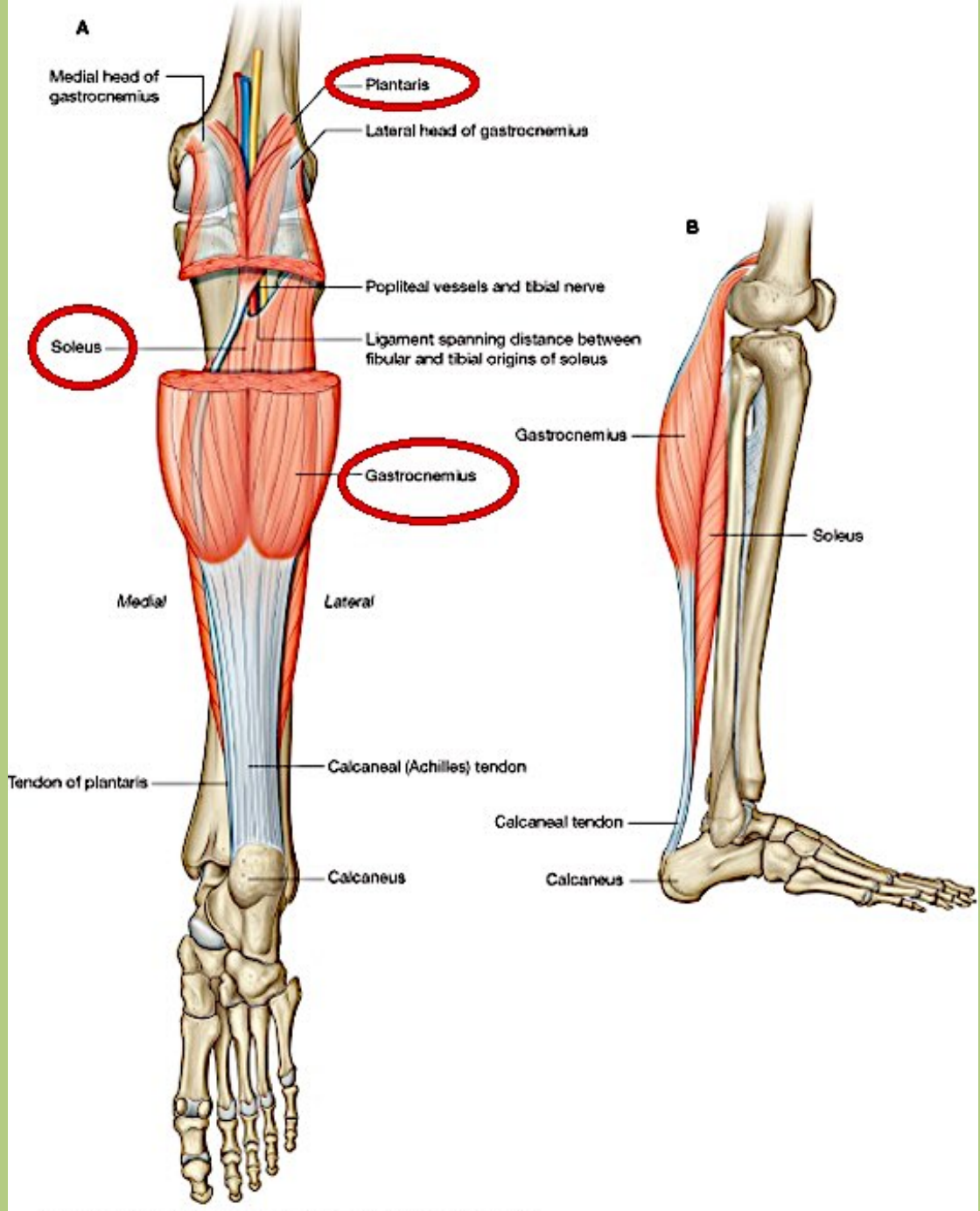
Contents:
Femoral vessels
Saphenus nerve
Descending genicular artery

Triceps surae: superficial flexor of the leg - knee flexor

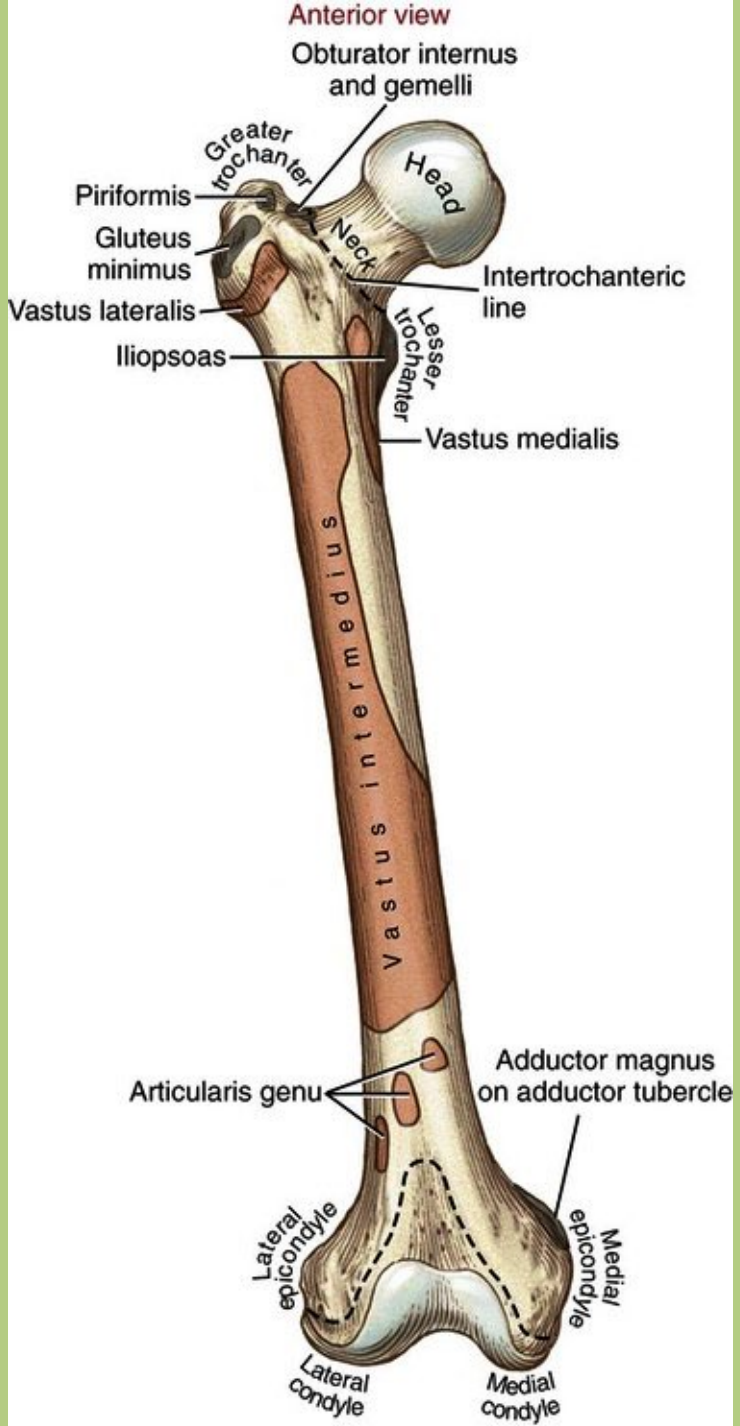


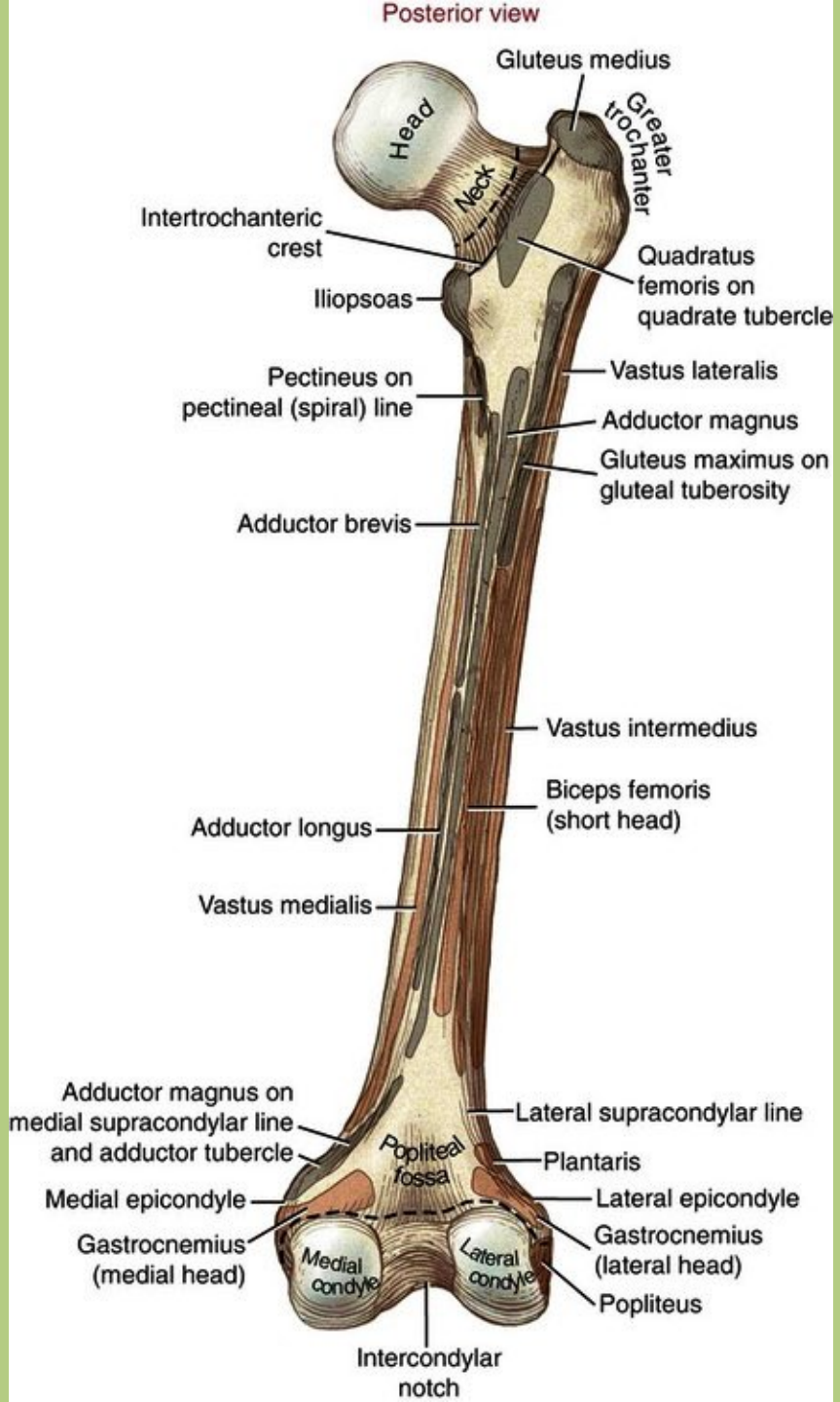
Triceps surae

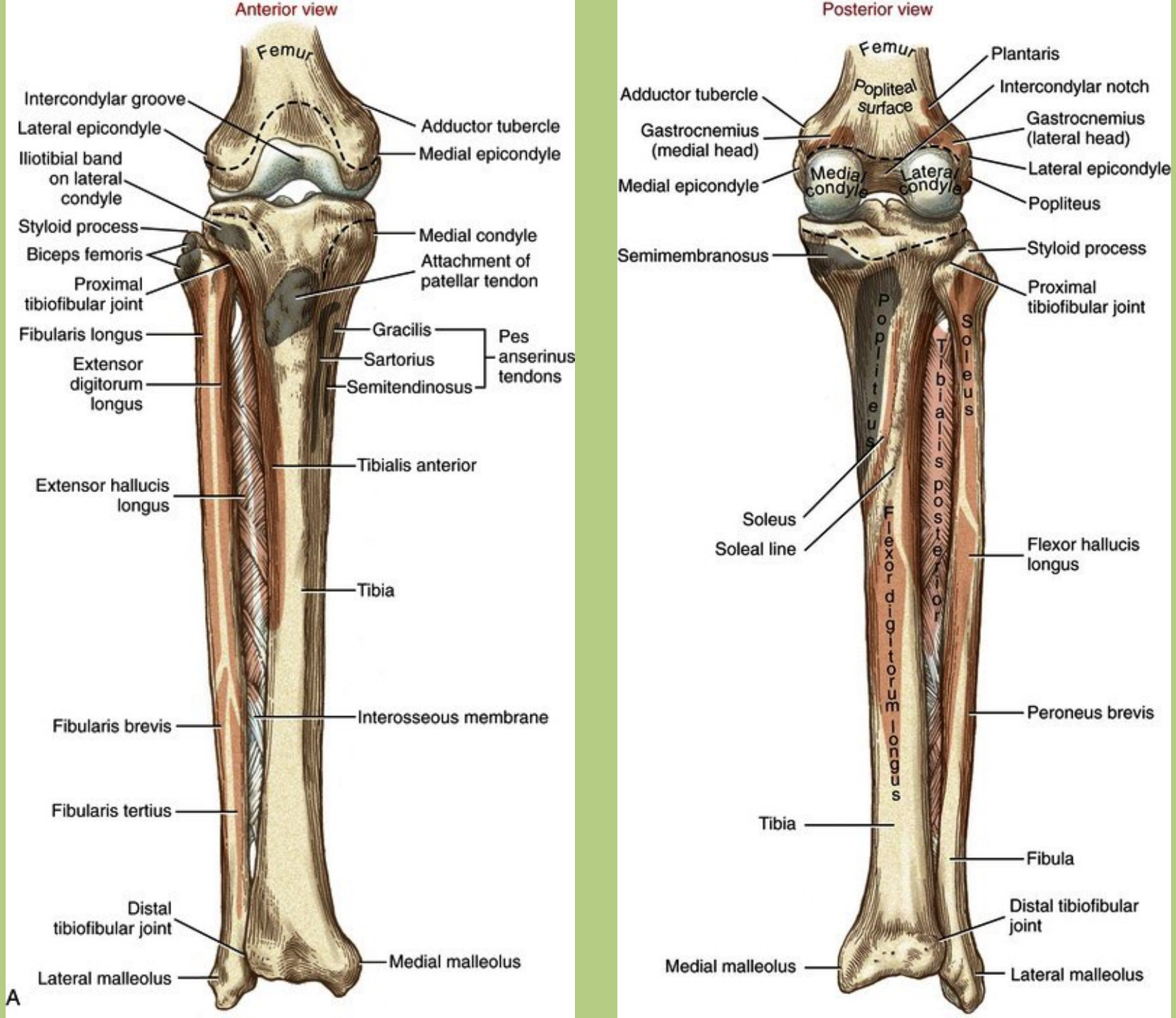
- **Origin: gastrocnemius:** femoral condyles, **soleus:** soleal line and fibula, **plantaris:** lateral femoral condyle
- **Insertion:** calcaneal tuberosity
- **Action:** Knee joint: flexion. Talocrural joint: plantarflexion. Talocalcaneonavicular joint: supination.
- **Innervation:** tibial nerve



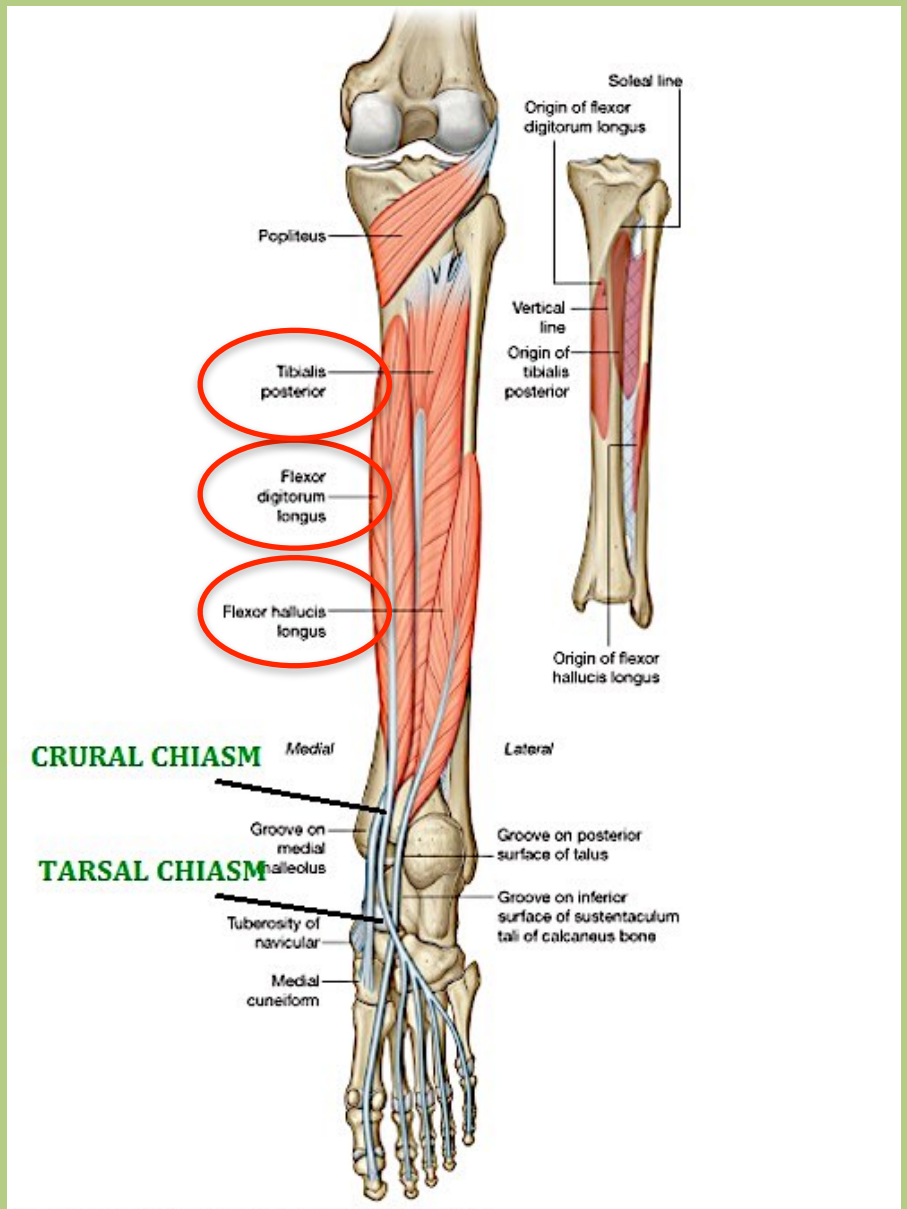
Triceps surae


Anterior view
Obturator internus and gemelli
Greater trochanter
Head
Piriformis
Neck
Gluteus minimus
Intertrochanteric line
Vastus lateralis
Lesser trochanter
Iliopsoas
Vastus medialis
Vastus intermedius
Articularis genu
Adductor magnus on adductor tubercle
Lateral epicondyle
Medial epicondyle
Lateral condyle
Medial condyle


Posterior view
Gluteus medius
Head
Greater trochanter
Neck
Intertrochanteric crest
Quadratus femoris on quadrate tubercle
Iliopsoas
Vastus lateralis
Pectineus on pectineal (spiral) line
Adductor magnus
Gluteus maximus on gluteal tuberosity
Adductor brevis
Vastus intermedius
Biceps femoris (short head)
Adductor longus
Vastus medialis
Adductor magnus on medial supracondylar line and adductor tubercle
Lateral supracondylar line
Popliteal fossa
Plantaris
Medial epicondyle
Lateral epicondyle
Gastrocnemius (medial head)
Gastrocnemius (lateral head)
Medial condyle
Lateral condyle
Popliteus
Intercondylar notch

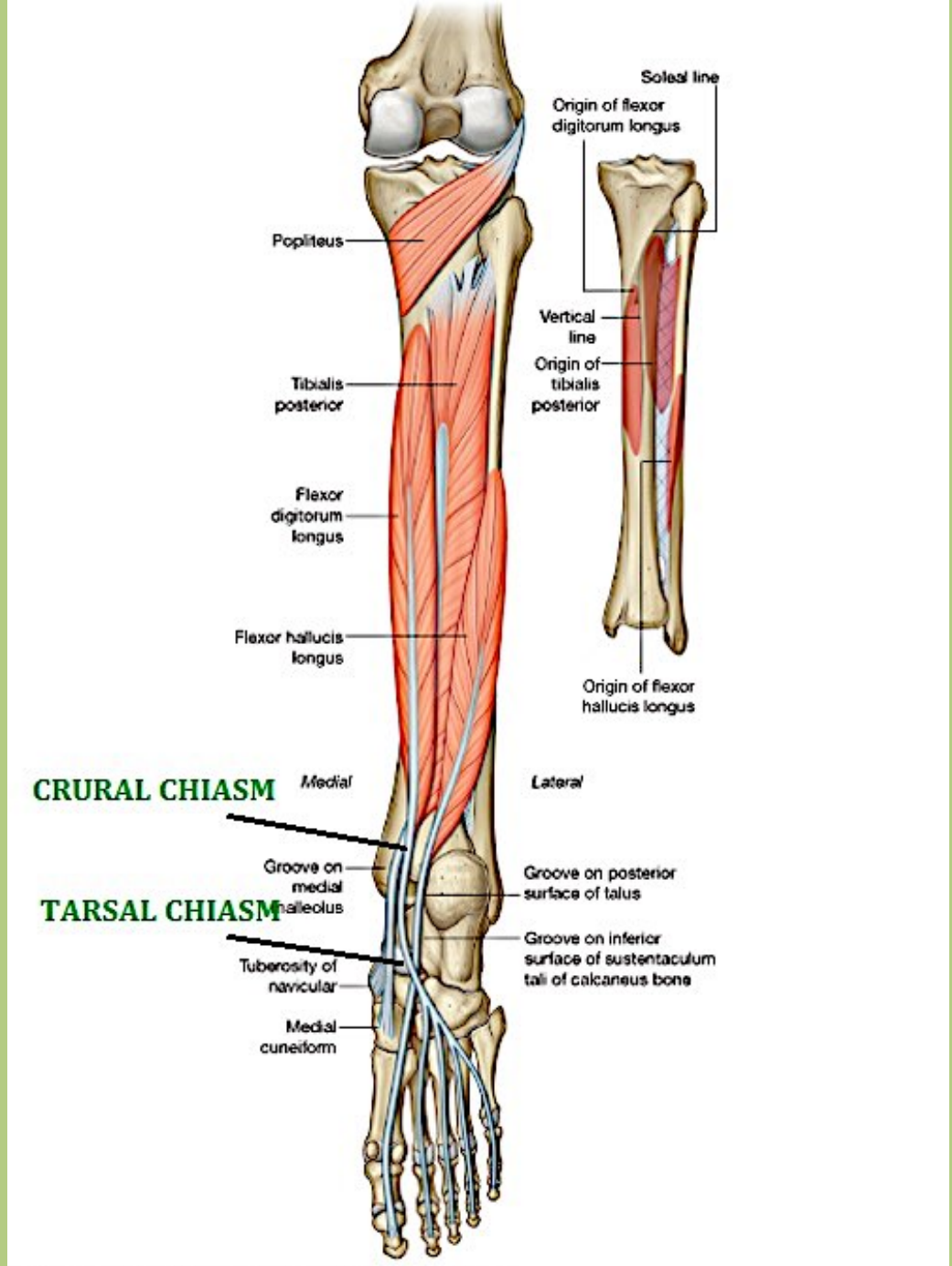

Anterior view
Femur
Intercondylar groove
Lateral epicondyle
Iliotibial band on lateral condyle
Styloid process
Biceps femoris
Proximal tibiofibular joint
Fibularis longus
Extensor digitorum longus
Adductor tubercle
Medial epicondyle
Medial condyle
Attachment of patellar tendon
Gracilis
Sartorius
Semitendinosus
Pes anserinus tendons
Tibialis anterior
Extensor hallucis longus
Tibia
Interosseous membrane
Fibularis brevis
Fibularis tertius
Distal tibiofibular joint
Lateral malleolus
Medial malleolus
A
Posterior view
Femur
Popliteal surface
Adductor tubercle
Gastrocnemius (medial head)
Medial epicondyle
Medial condyle
Lateral condyle
Plantaris
Intercondylar notch
Gastrocnemius (lateral head)
Lateral epicondyle
Popliteus
Semimembranosus
Styloid process
Proximal tibiofibular joint
Popliteus
Soleus
Tibialis posterior
Flexor digitorum longus
Soleus
Soleal line
Flexor hallucis longus
Peroneus brevis
Tibia
Fibula
Distal tibiofibular joint
Medial malleolus
Lateral malleolus

Deep flexors on the posterior side



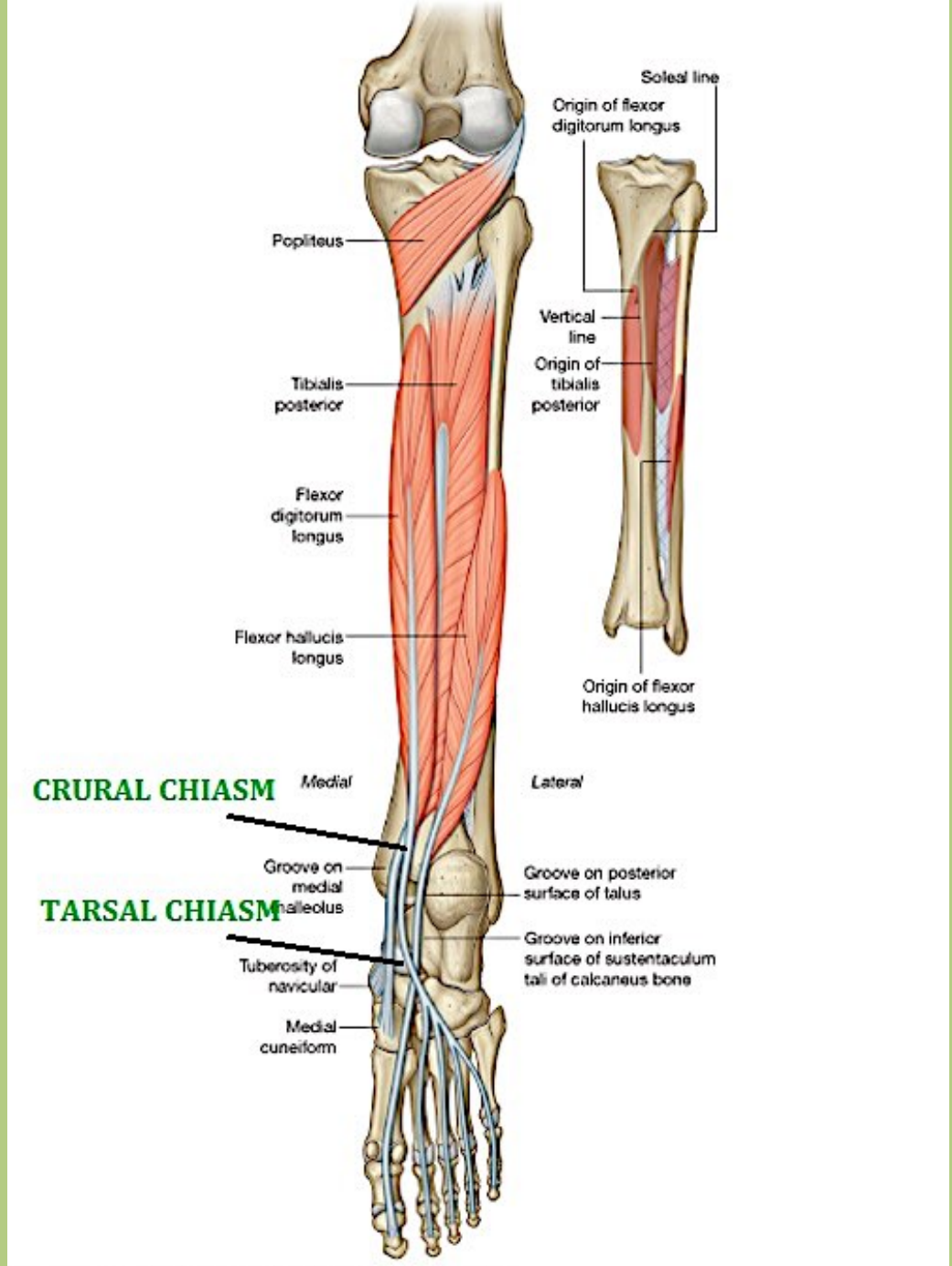
Tibialis posterior

- **Origin:** interosseous membrane, tibia and fibula
- **Insertion:** navicular
- **Action:** Talocrural joint: plantarflexion. Talocalcaneonavicular joint: supination.
- **Innervation:** tibial nerve



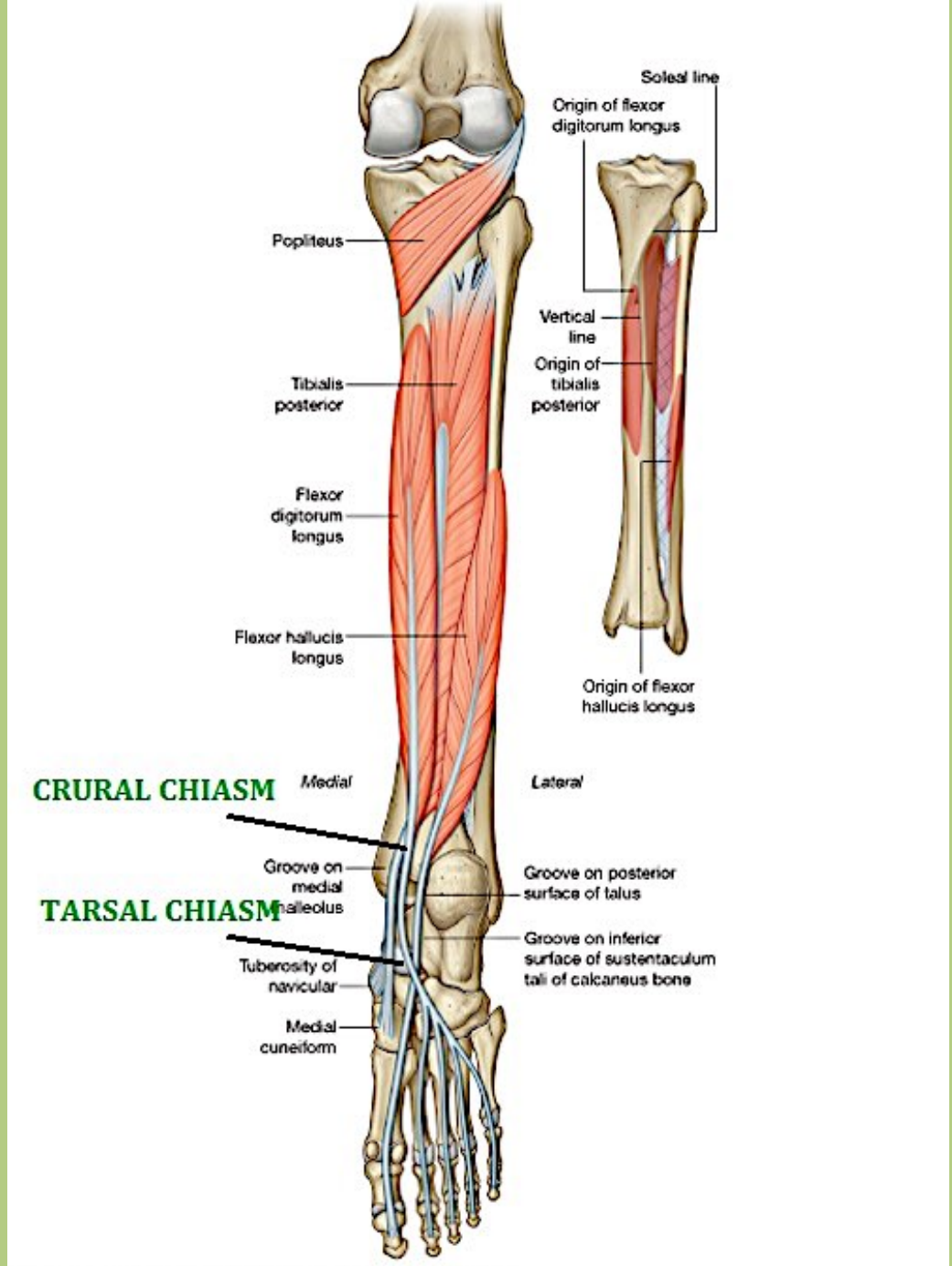
Flexor hallucis longus

- **Origin:** interosseous membrane and fibula
- **Insertion:** distal phalanx of the 1st toe
- **Action:** Talocrural joint: plantarflexion. Talocalcaneonavicular joint: supination. Flexion of the 1st toe.
- **Innervation:** tibial nerve

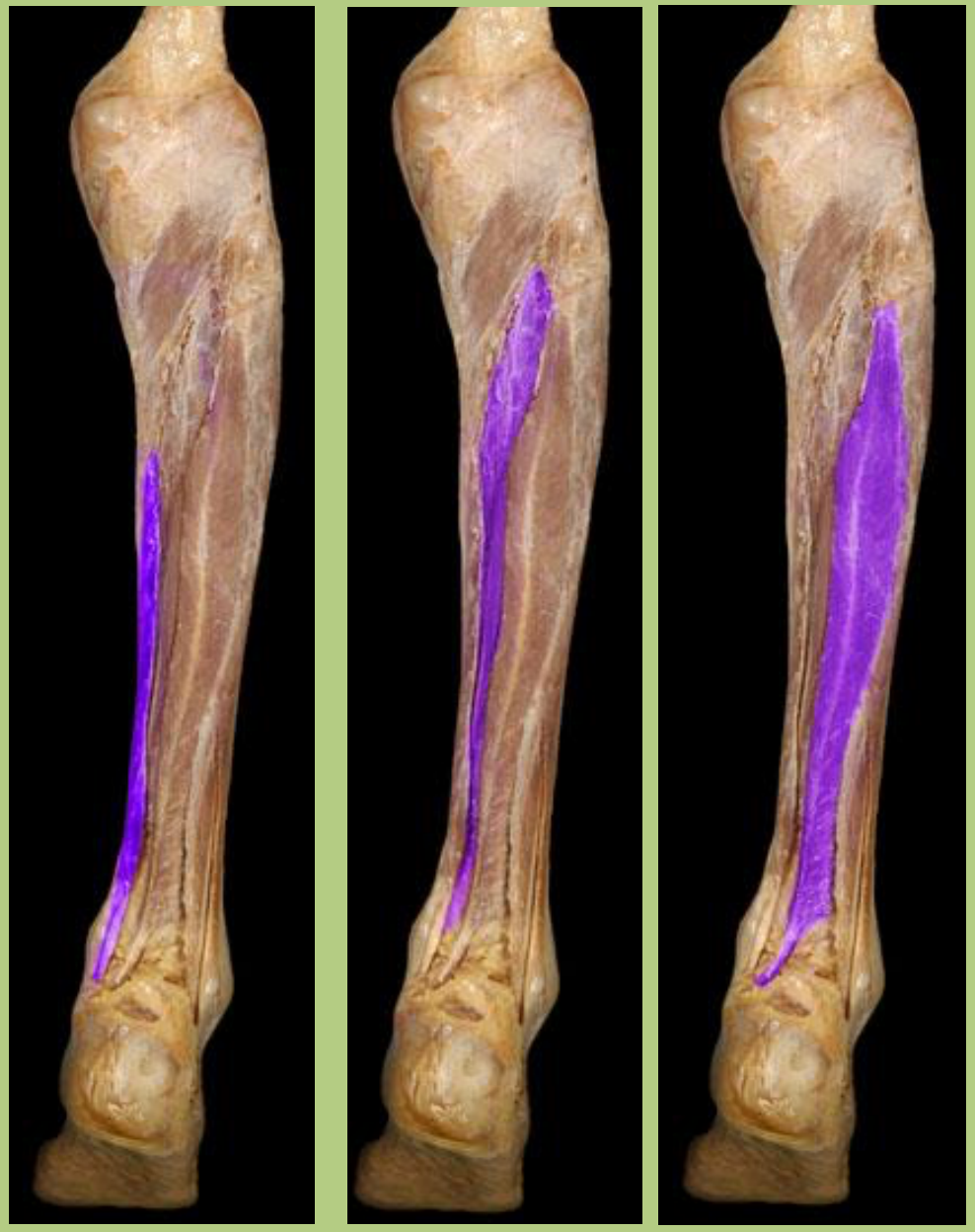


Flexor digitorum longus

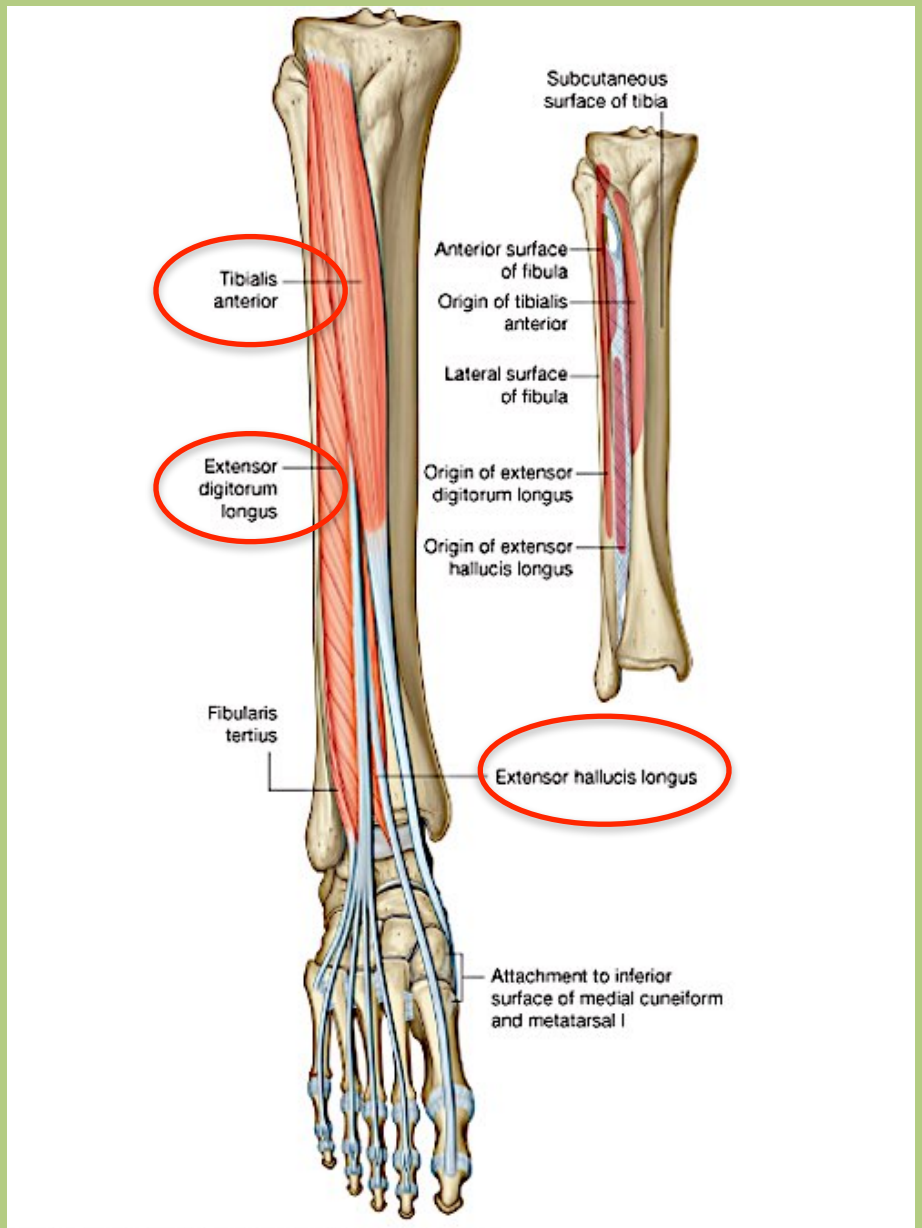
- **Origin:** tibia and fibula
- **Insertion:** distal phalanx of the 2nd-5th toes
- **Action:** Talocrural joint: plantarflexion. Talocalcaneonavicular joint: supination. Flexion of the 2nd-5th toes.
- **Innervation:** tibial nerve



Deep flexors

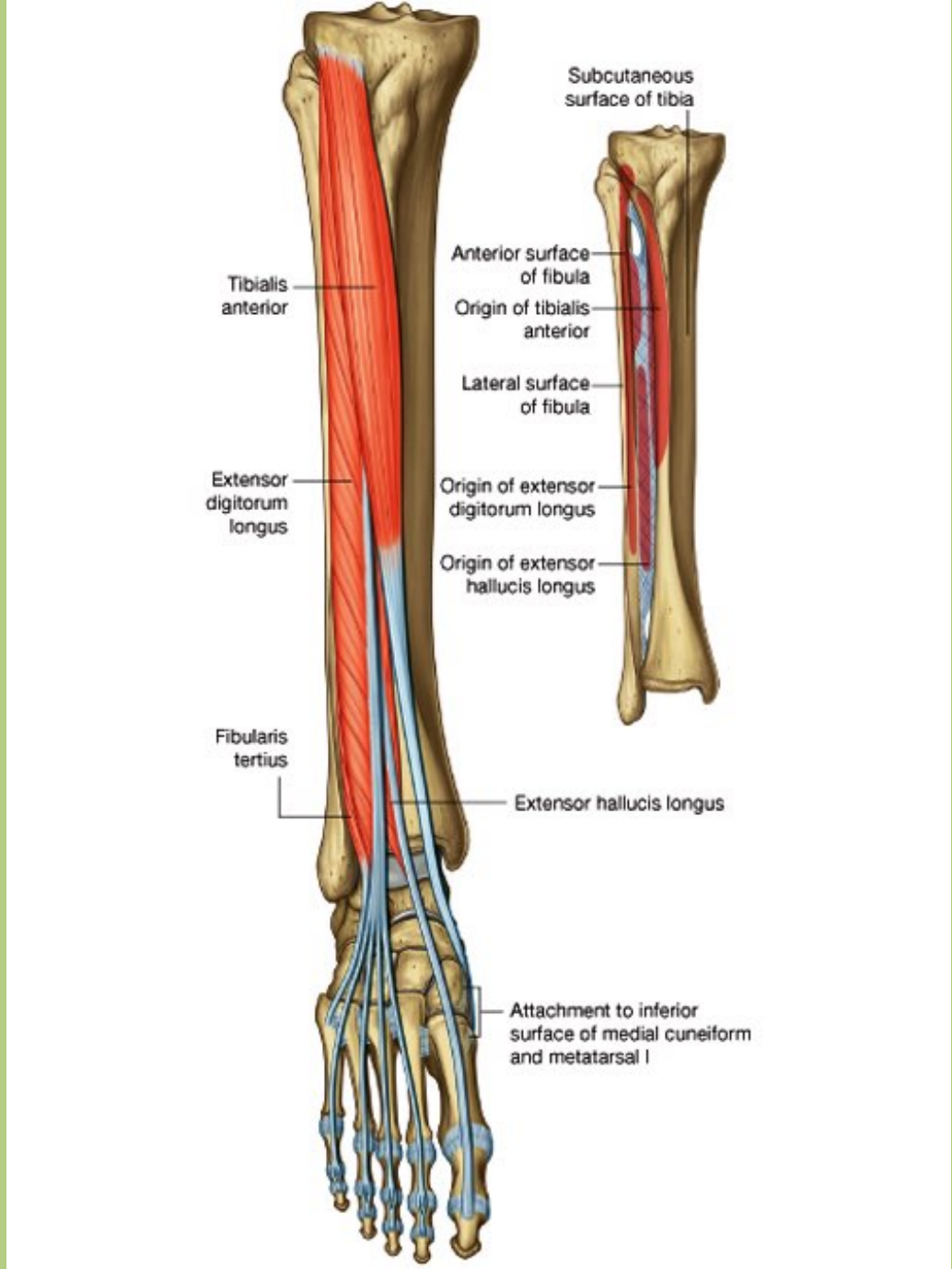


Extensors on the anterior side



Tibialis anterior

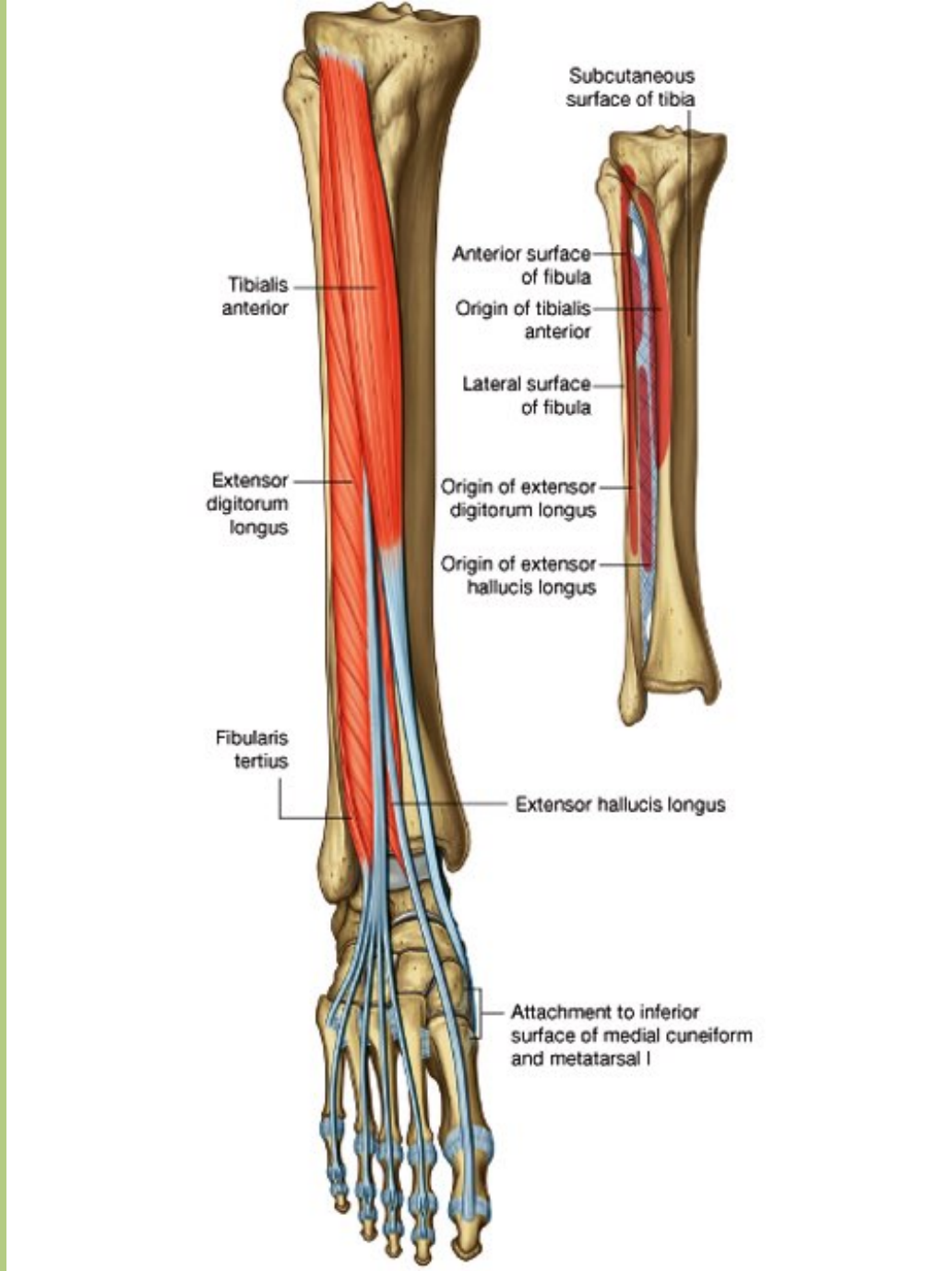
- **Origin:** interosseous membrane and tibia
- **Insertion:** 1st metatarsal and medial cuneiform
- **Action:** Talocrural joint: dorsiflexion. Talocalcaneonavicular joint: supination.
- **Innervation:** deep fibular nerve



Drake: Gray's Anatomy for Students, 2nd Edition.

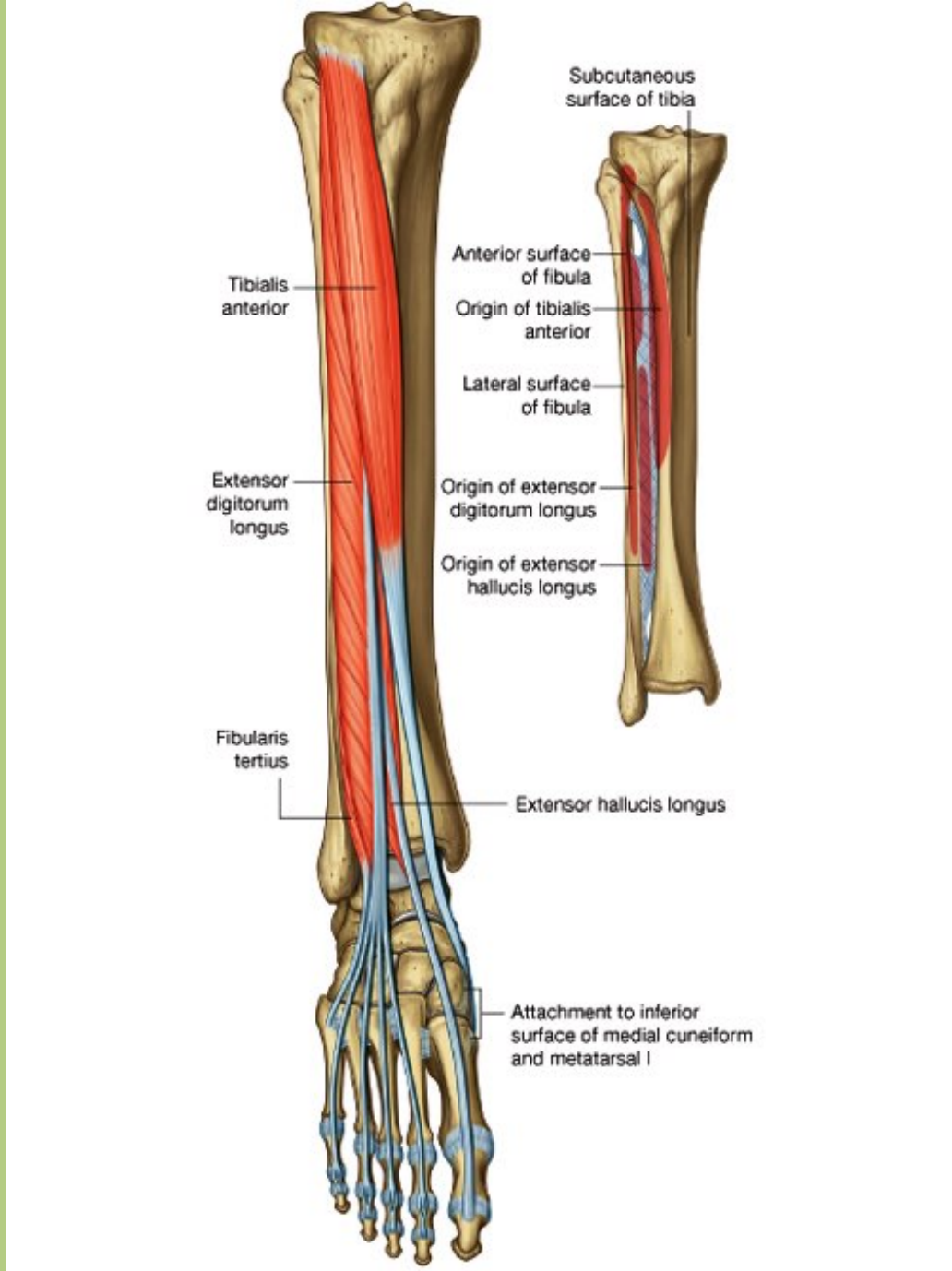
Extensor hallucis longus

- **Origin:** interosseous membrane and tibia
- **Insertion:** distal phalanx of the 1st toe
- **Action:** Talocrural joint: dorsiflexion. Talocalcaneonavicular joint: pronation. Extension of the hallux.
- **Innervation:** deep fibular nerve



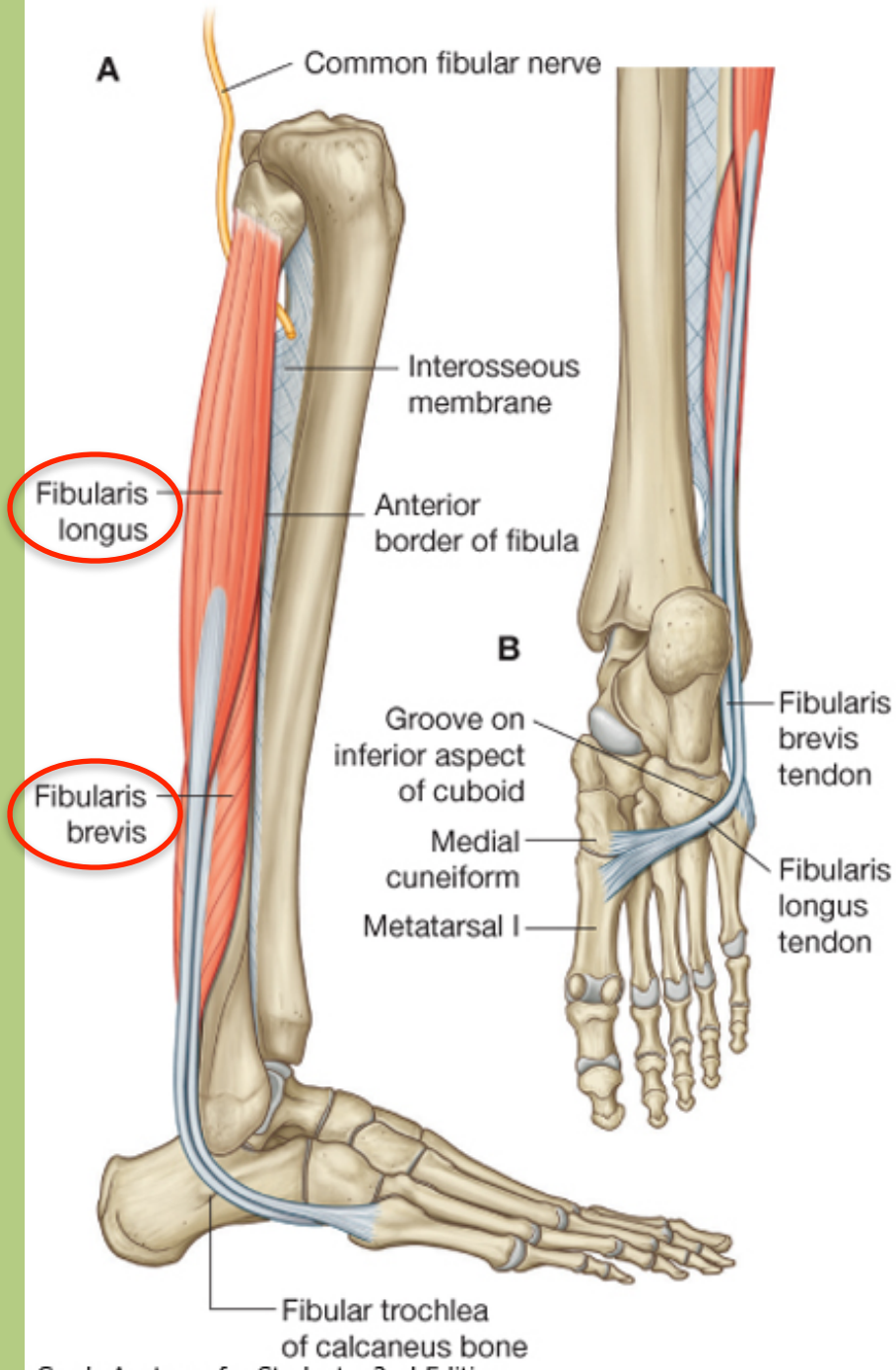
Extensor digitorum longus

- **Origin:** interosseous membrane, tibia and fibula
- **Insertion:** distal phalanx of the 2nd-5th toes
- **Action:** Talocrural joint: dorsiflexion. Talocalcaneonavicular joint: pronation. Extension of the 2nd-5th toes.
- **Innervation:** deep fibular nerve



Extensors

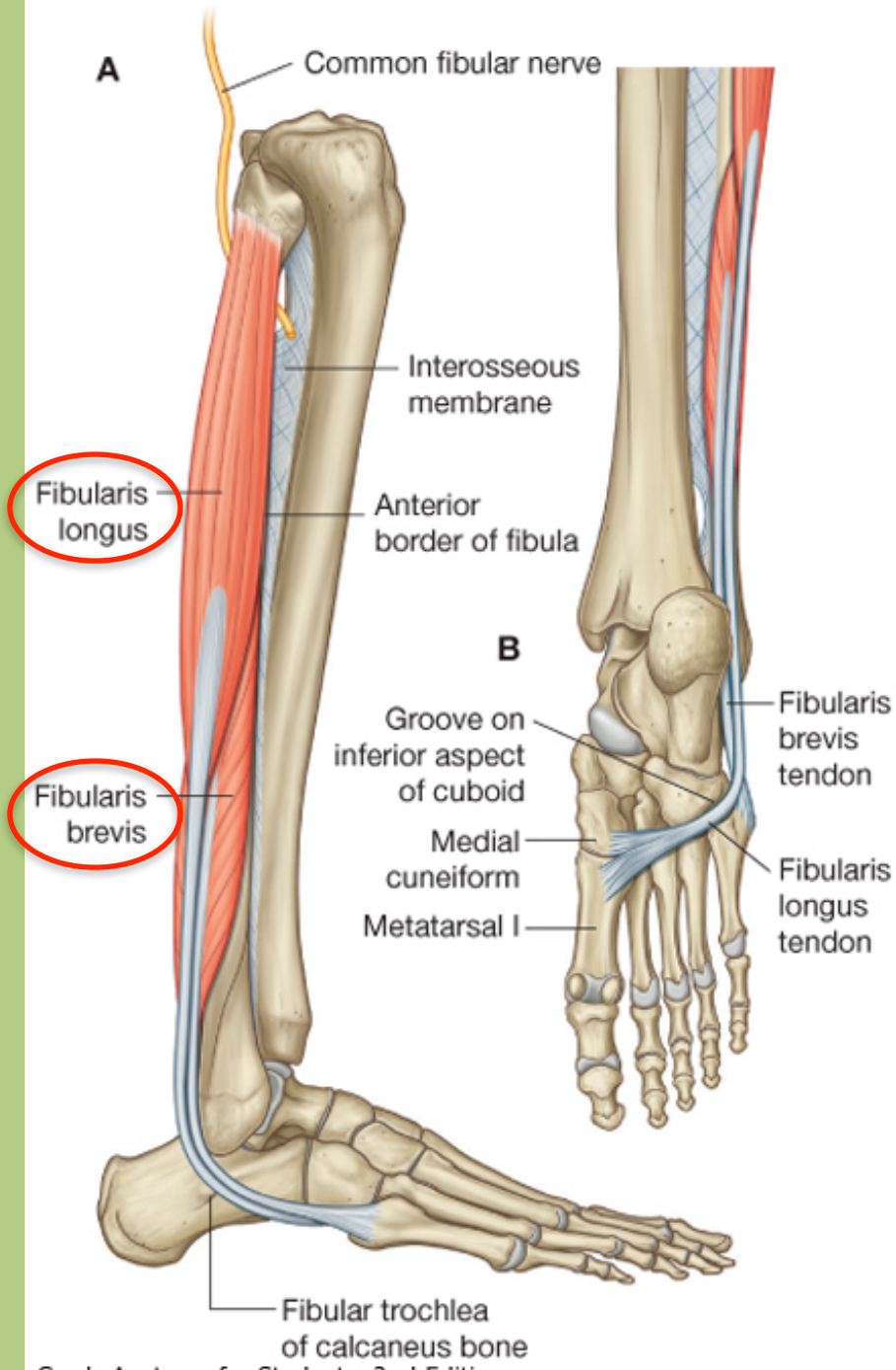
Pronators



Gray's Anatomy for Students, 2nd Edition.

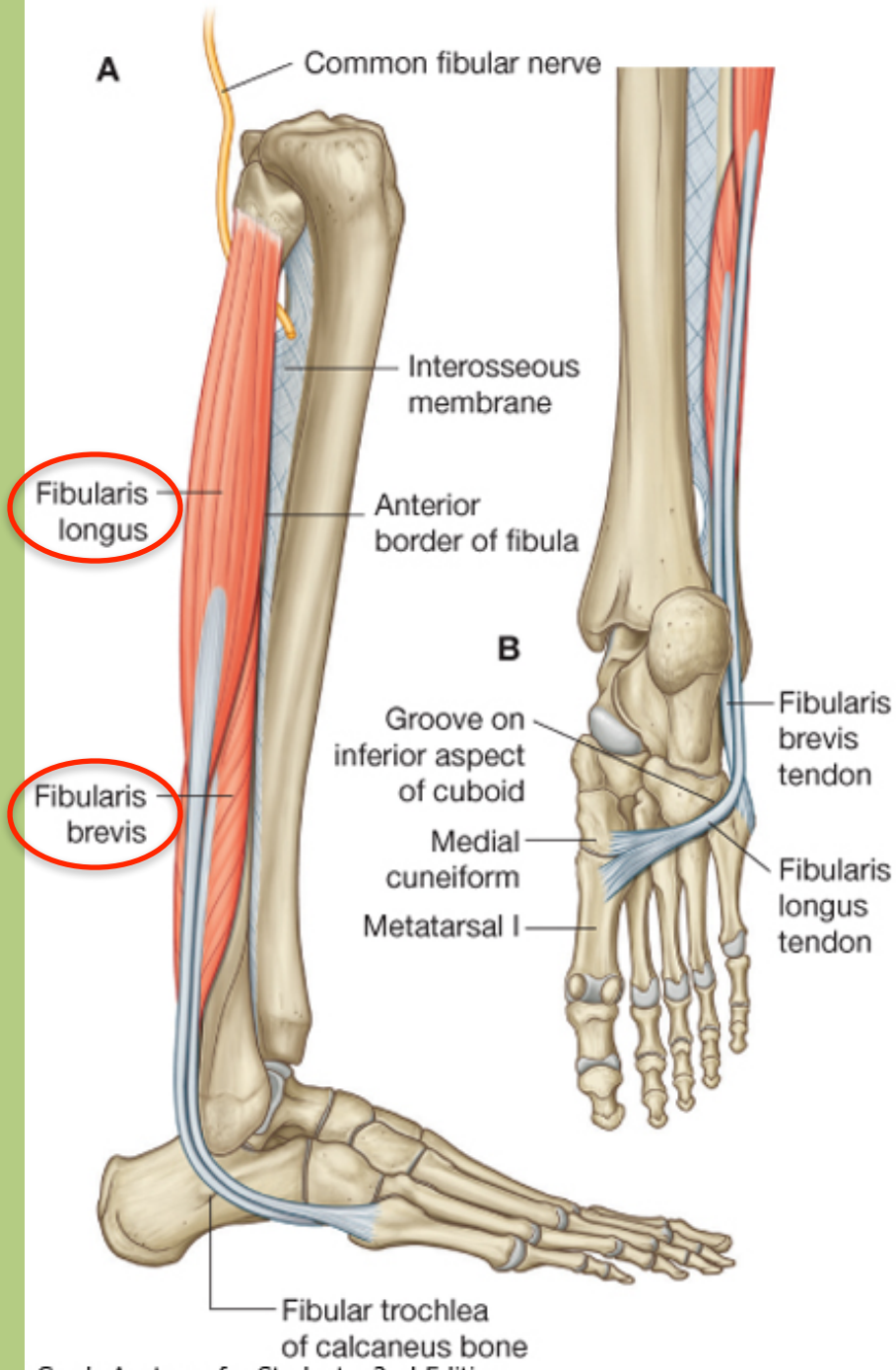
Fibularis longus

- **Origin:** fibula and head of fibula
- **Insertion:** 1st metatarsal and medial cuneiform
- **Action:** Talocrural joint: plantarflexion. Talocalcaneonavicular joint: pronation.
- **Innervation:** superficial fibular nerve



Fibularis brevis

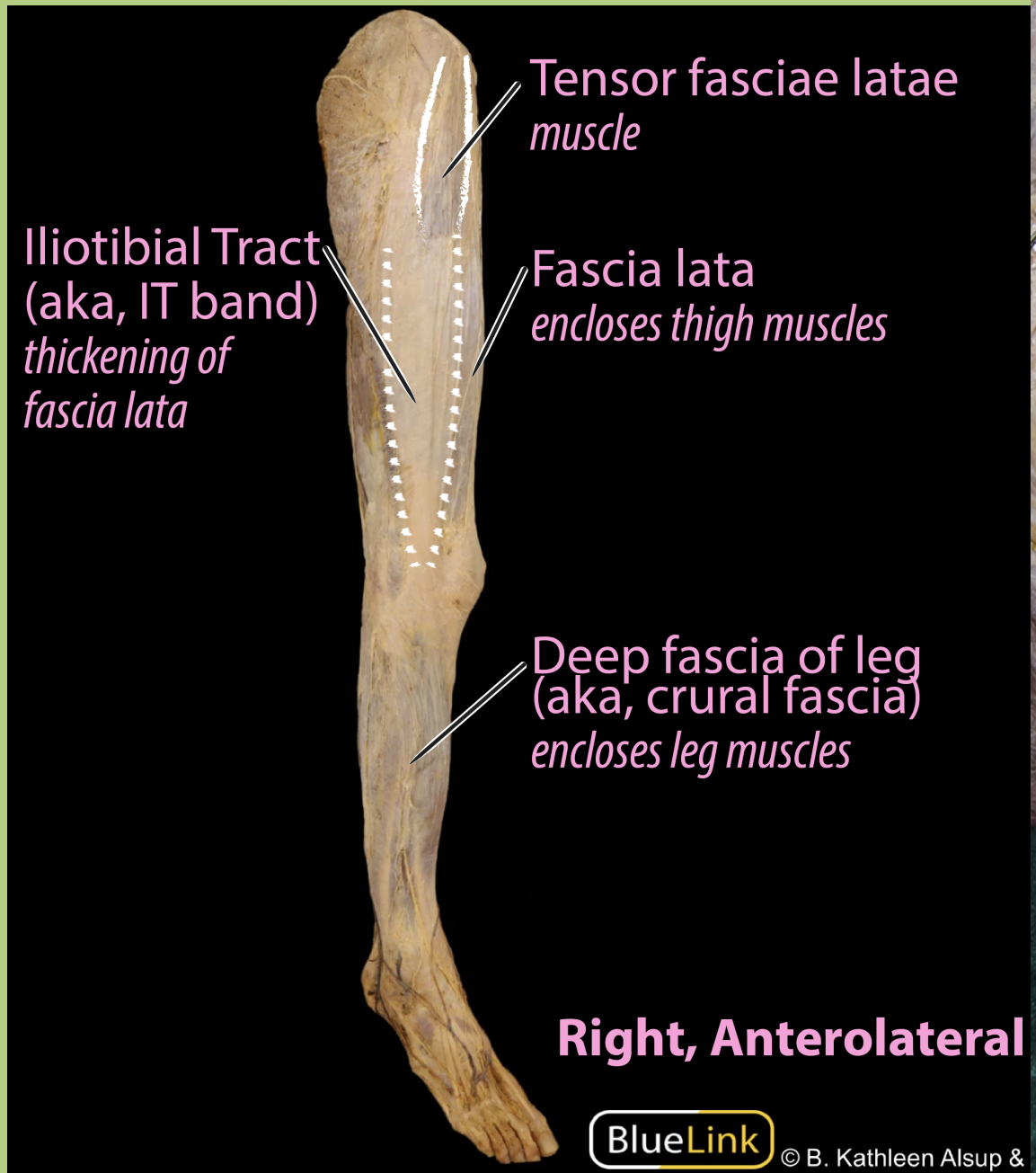
- **Origin:** distal half of the fibula
- **Insertion:** 5th metatarsal
- **Action:** Talocrural joint: plantarflexion. Talocalcaneonavicular joint: pronation.
- **Innervation:** superficial fibular nerve



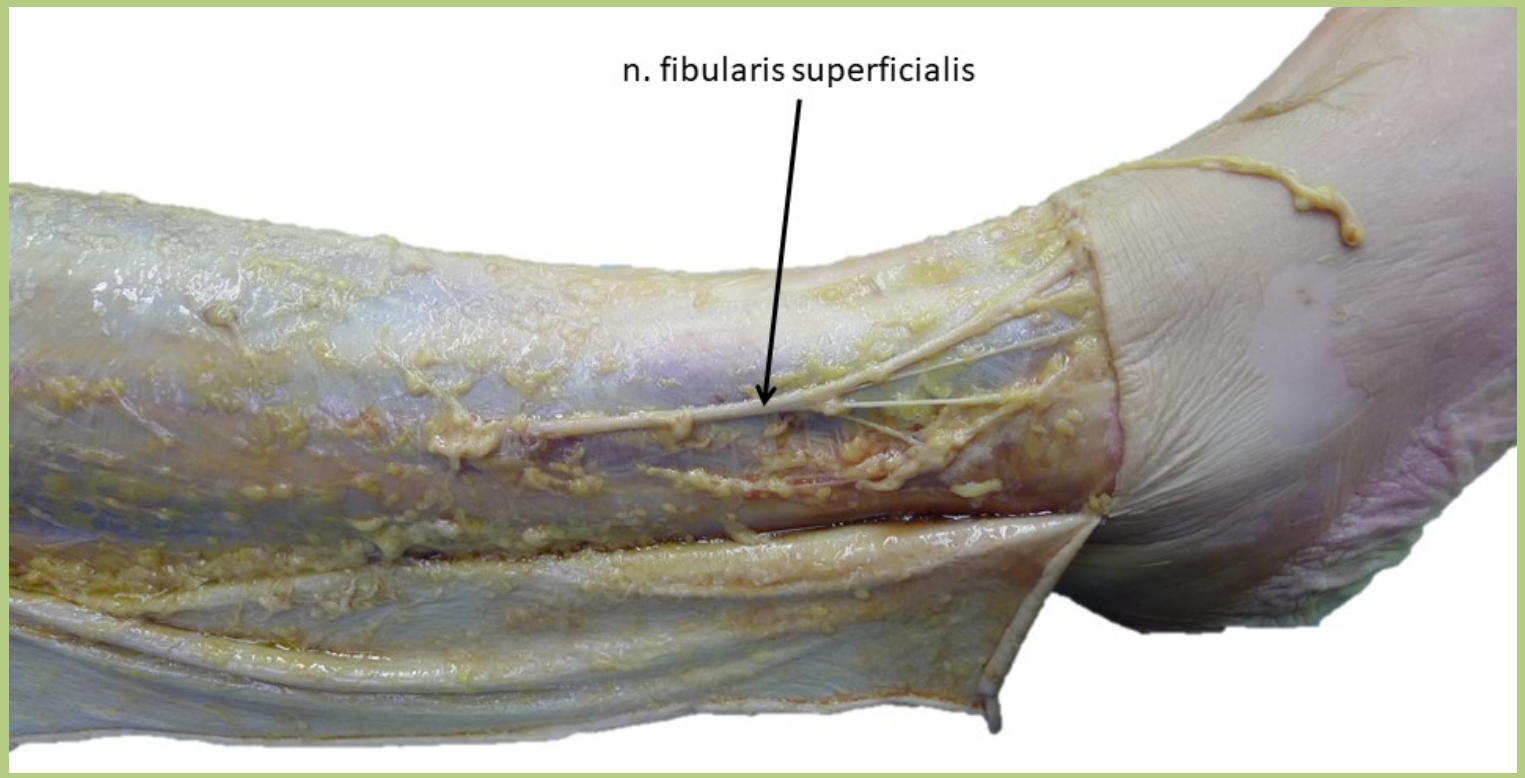
Gray's Anatomy for Students, 2nd Edition.

Pronators

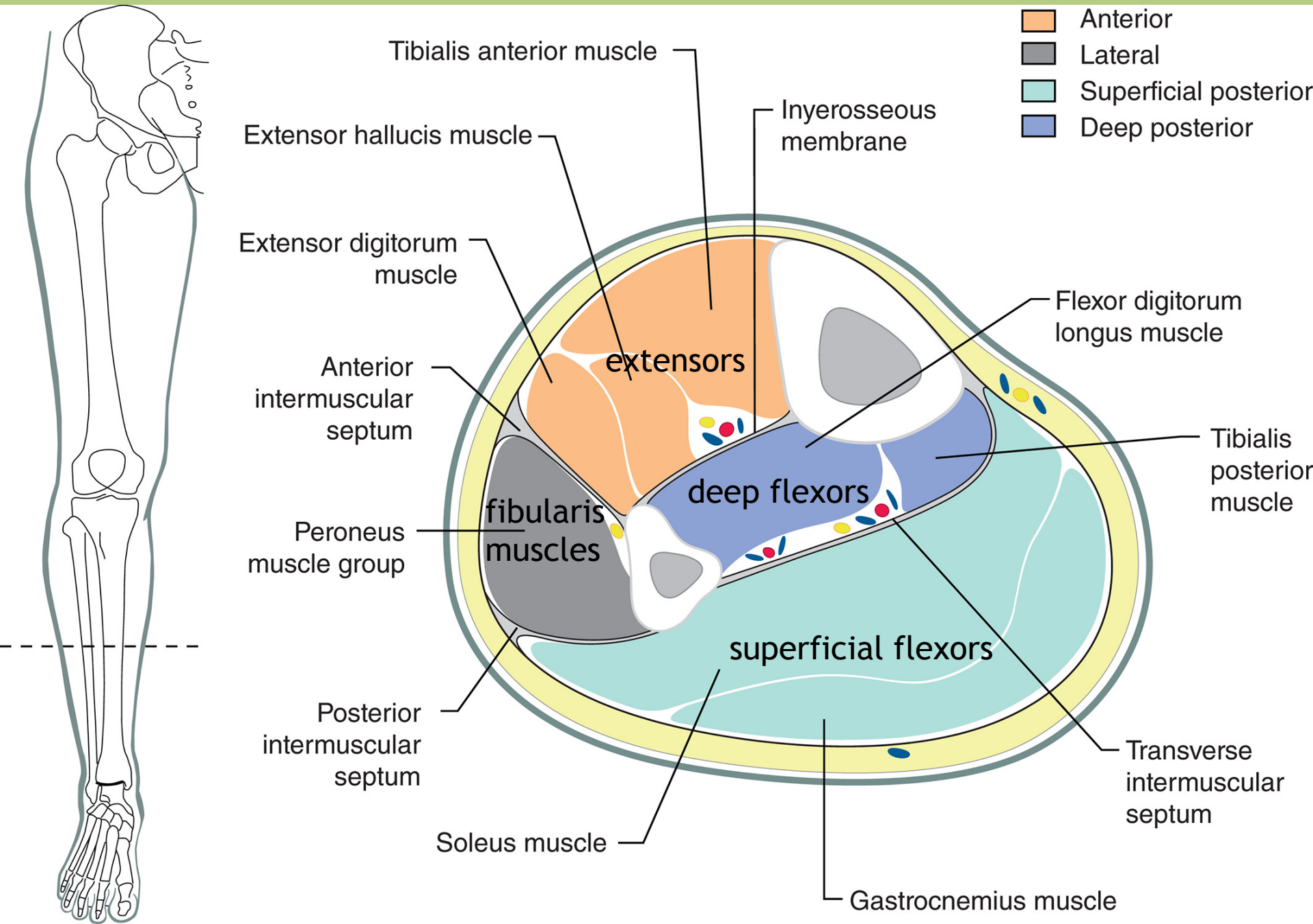
Fasciae of the lower limb



Crural fascia

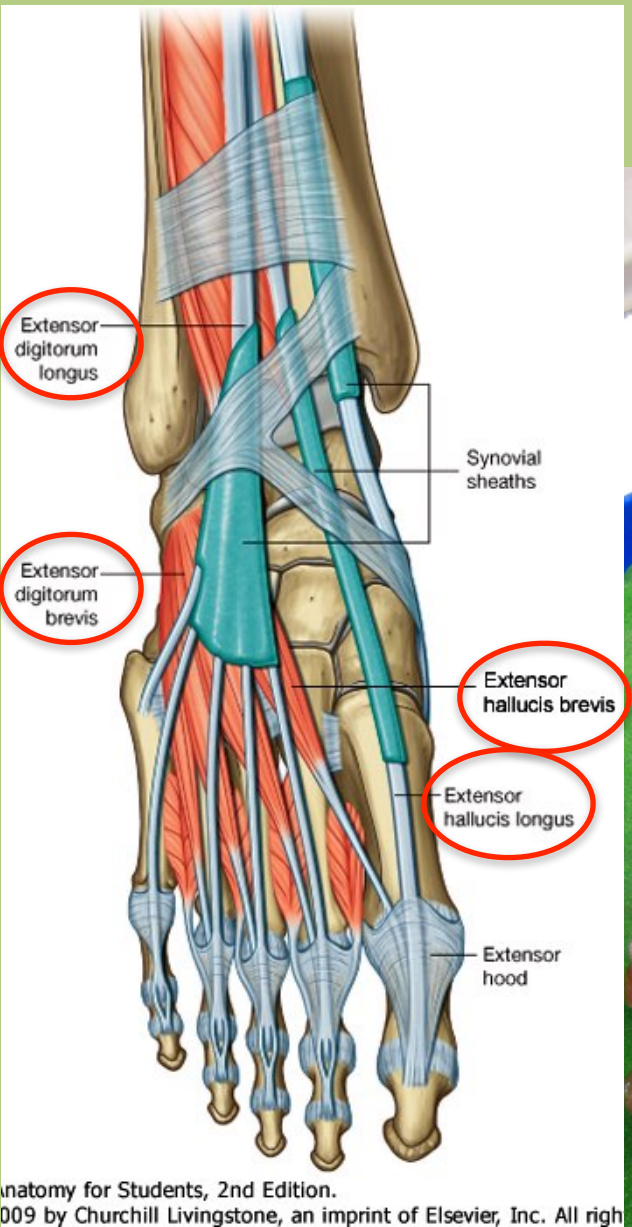


Compartments of the crural fascia



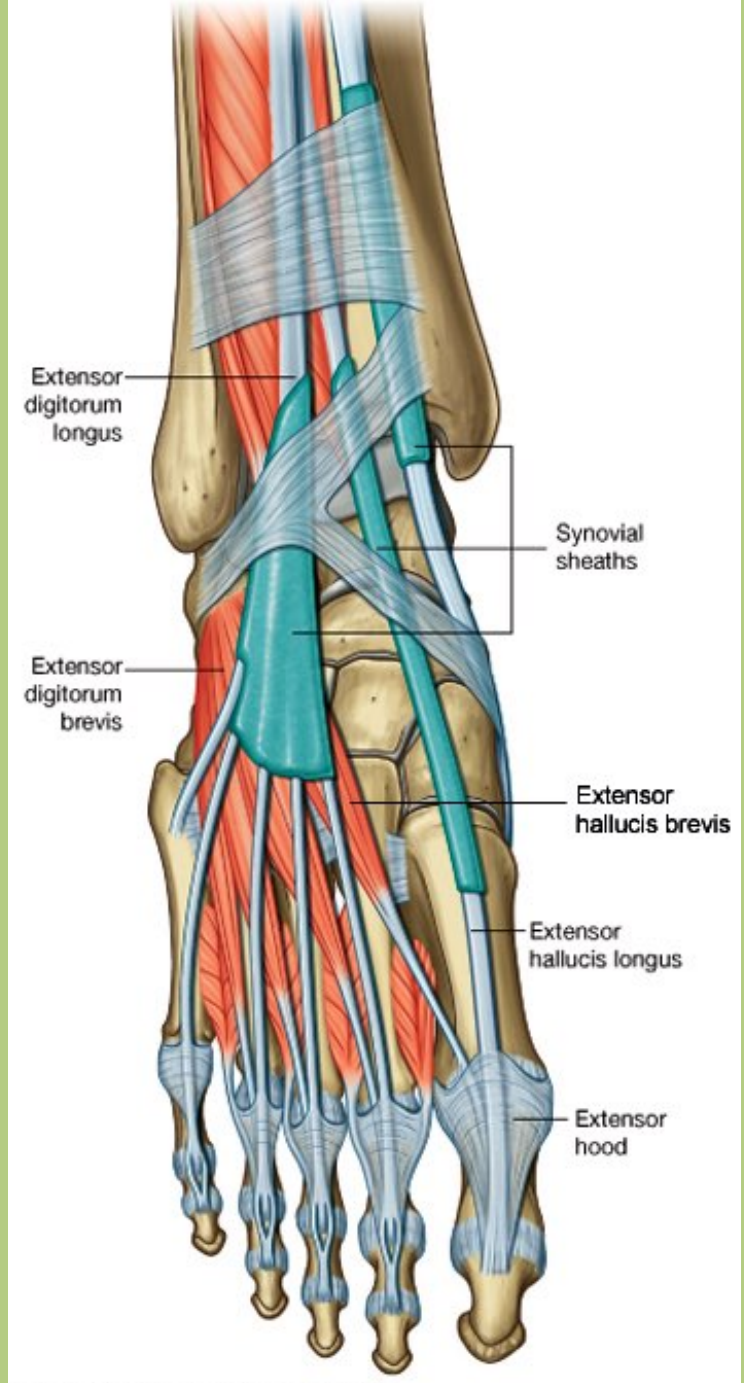
Compartment syndrome and fasciotomy

Foot muscles - dorsal side extensors



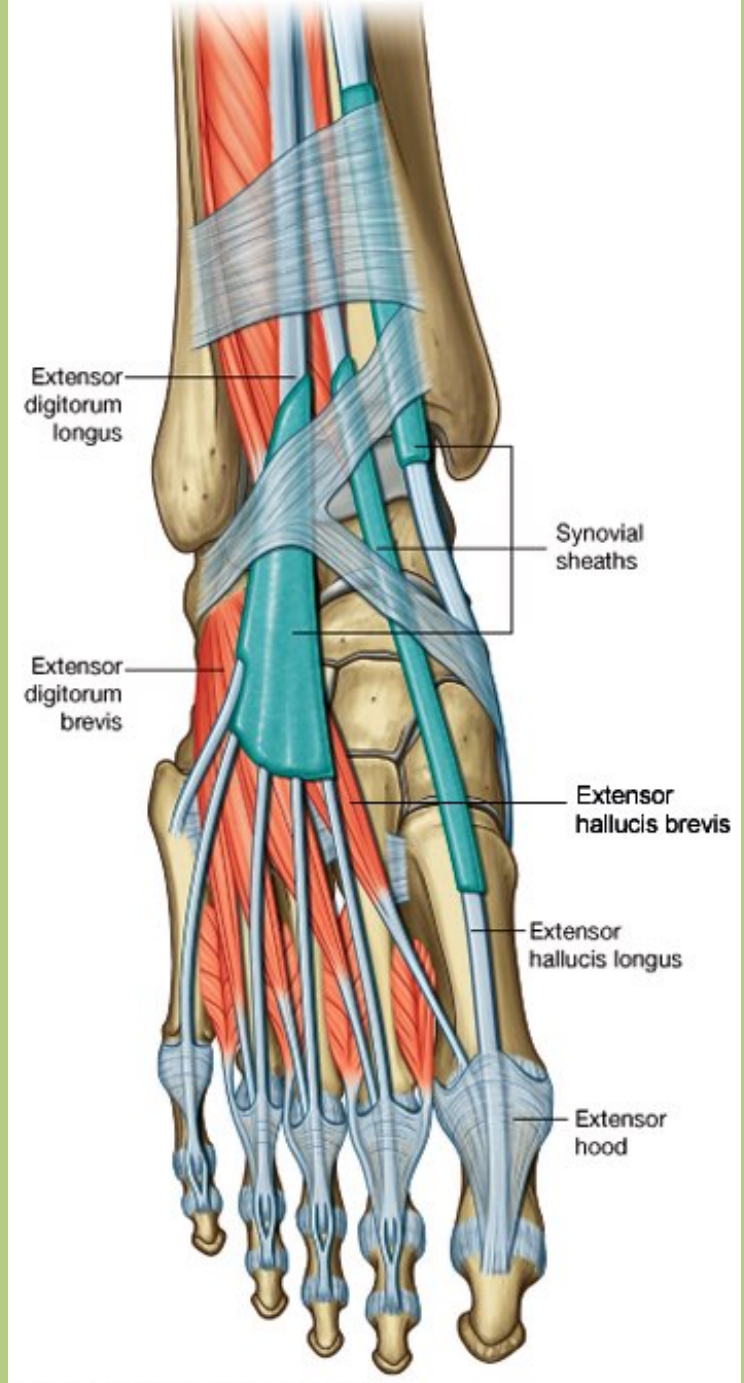
Extensor digitorum brevis

- **Origin:** calcaneus
- **Insertion:** middle phalanx of the 2nd-4th toes
- **Action:** Extension of the 2nd-4th toes.
- **Innervation:** deep fibular nerve

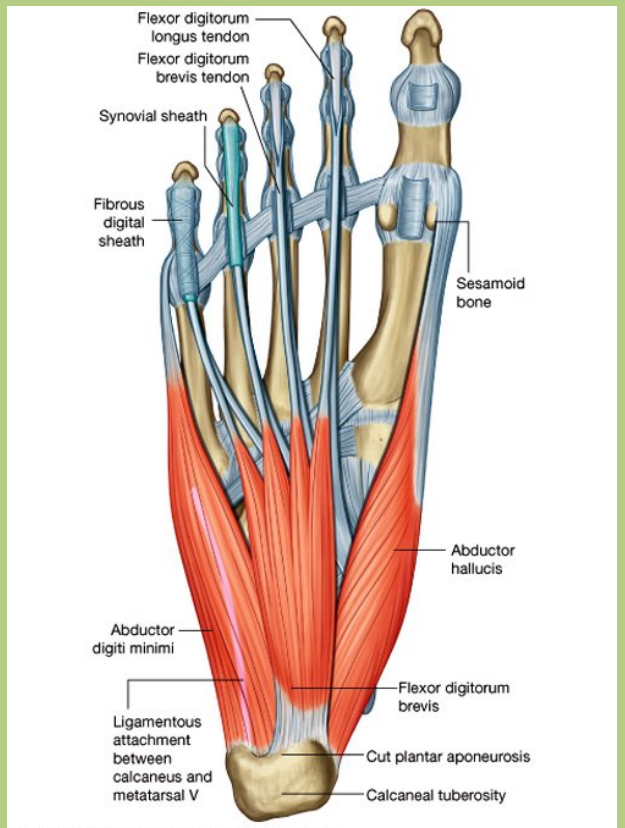


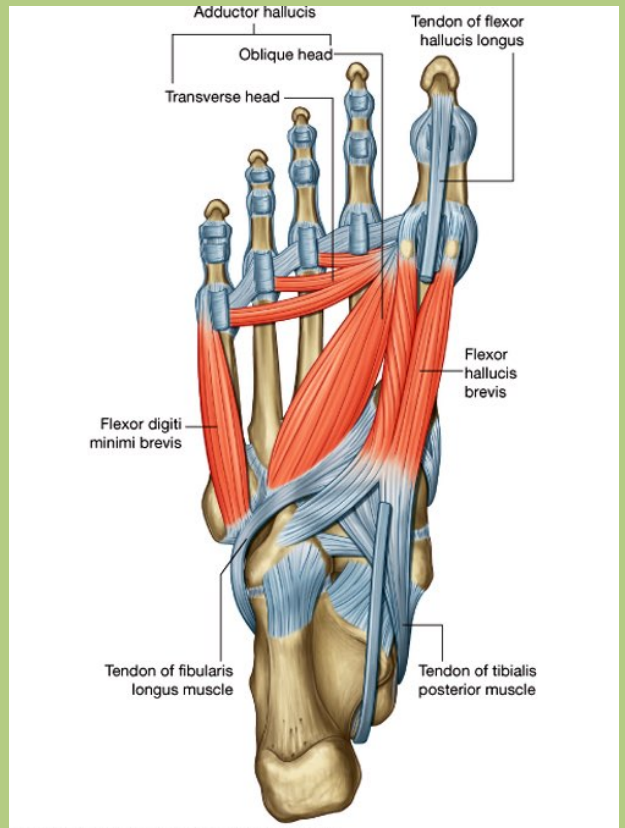
Extensor hallucis brevis

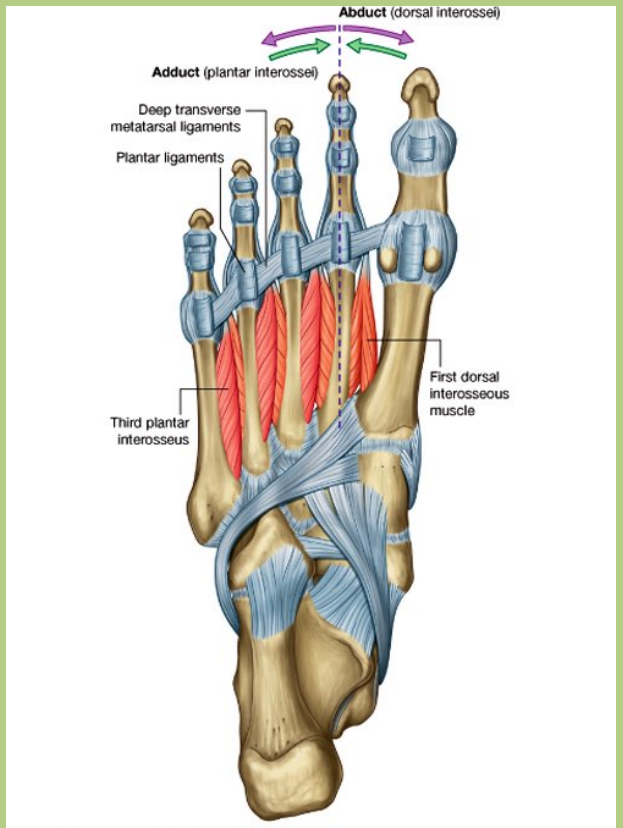
- **Origin:** calcaneus
- **Insertion:** proximal phalanx of the 1st toe
- **Action:** Extension of the 1st toe.
- **Innervation:** deep fibular nerve



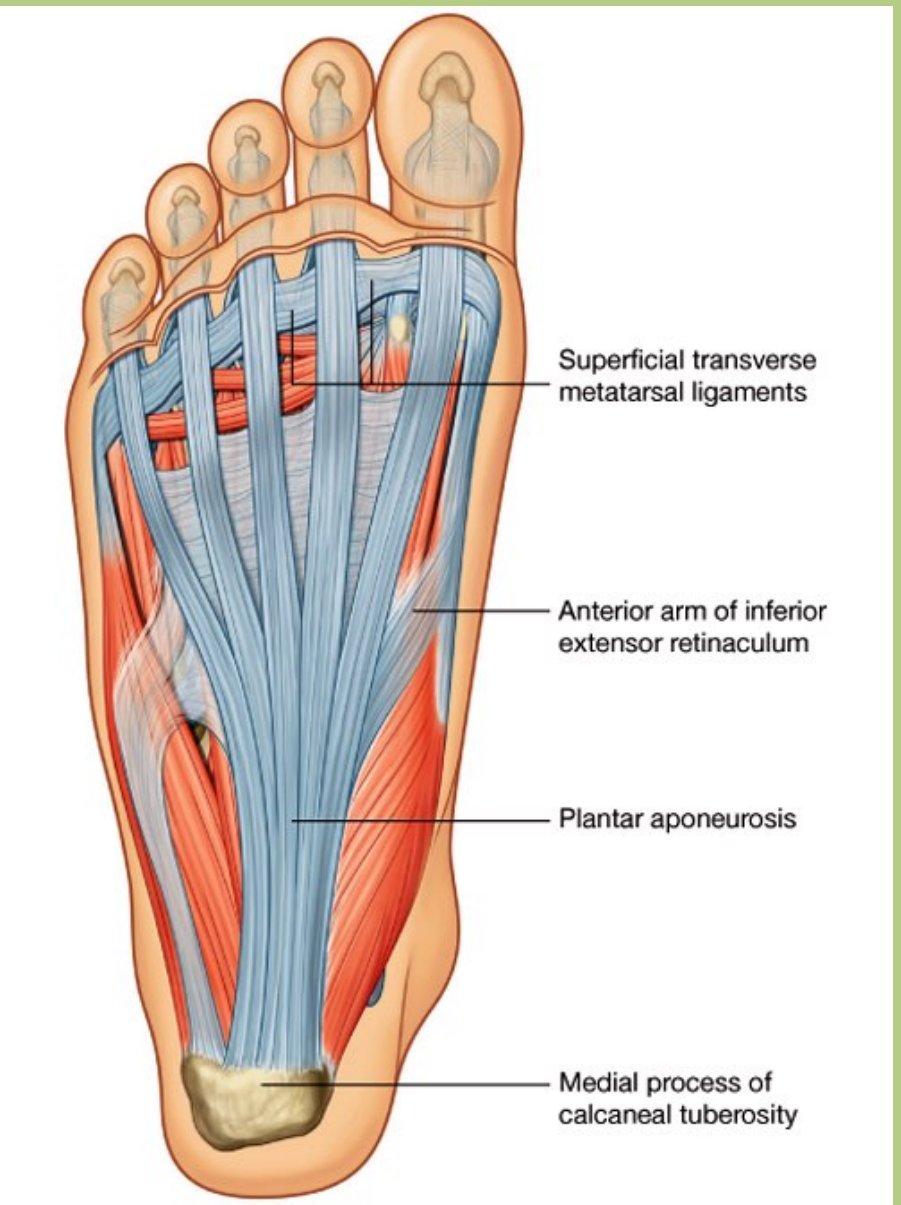
Foot muscles

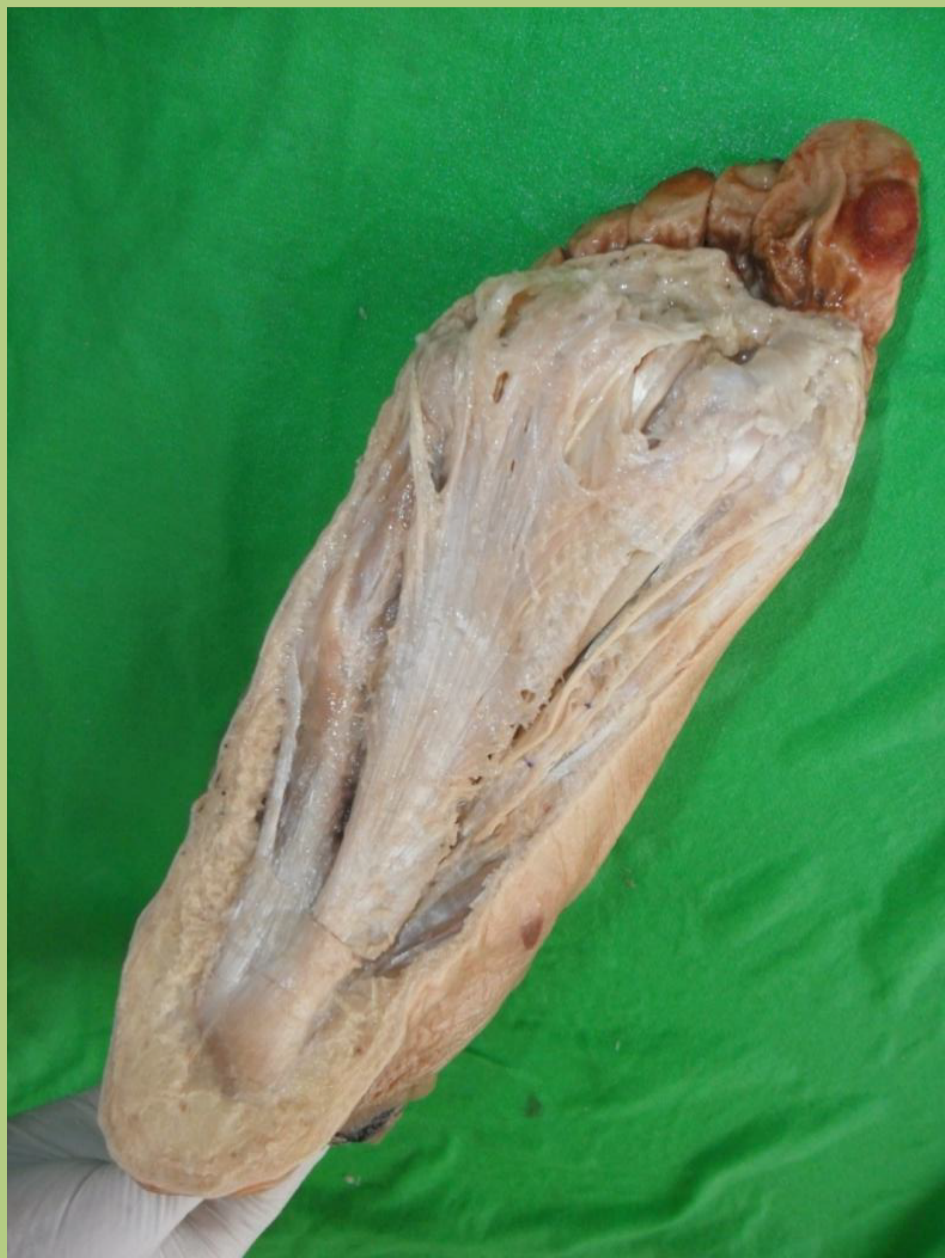




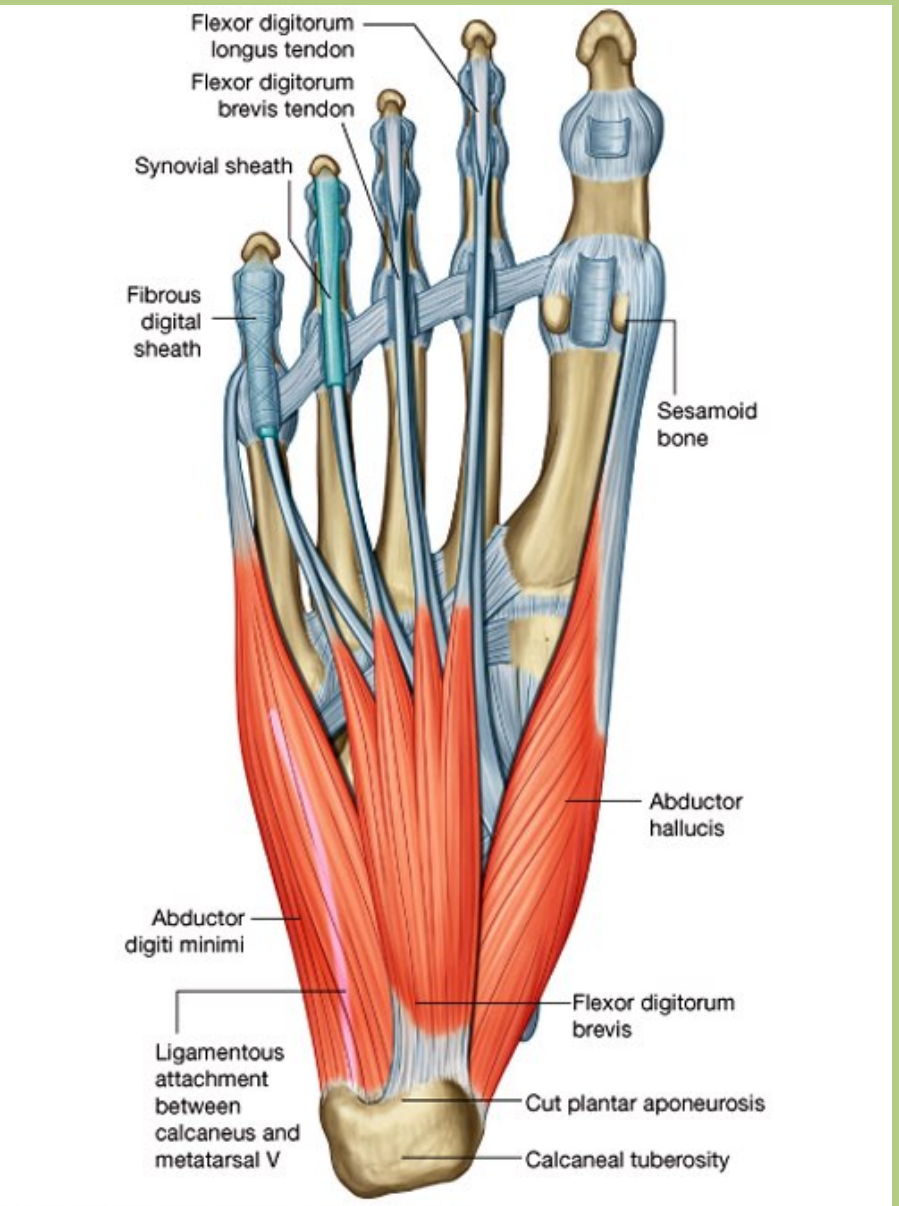


Foot muscles - plantar side





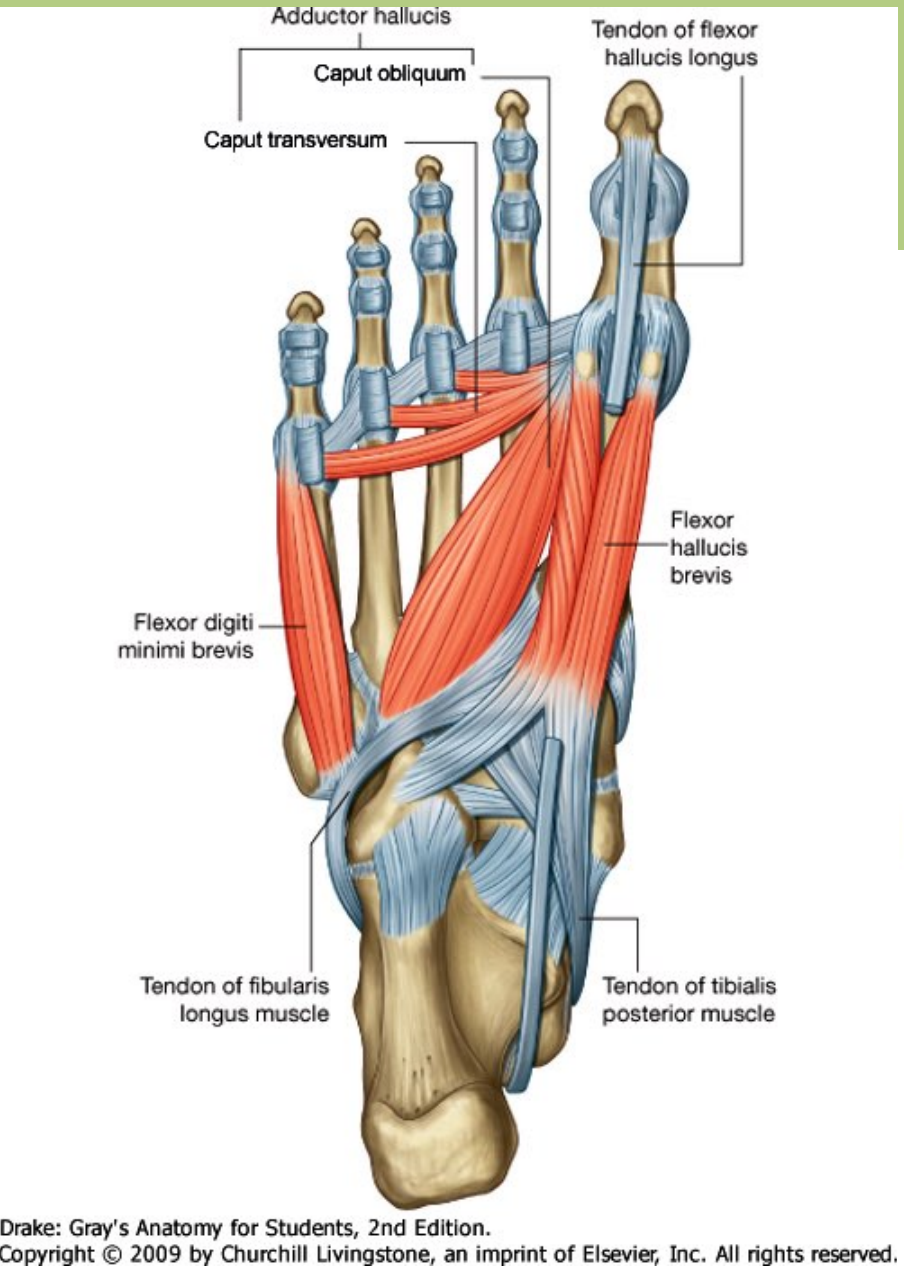
Foot muscles - plantar side



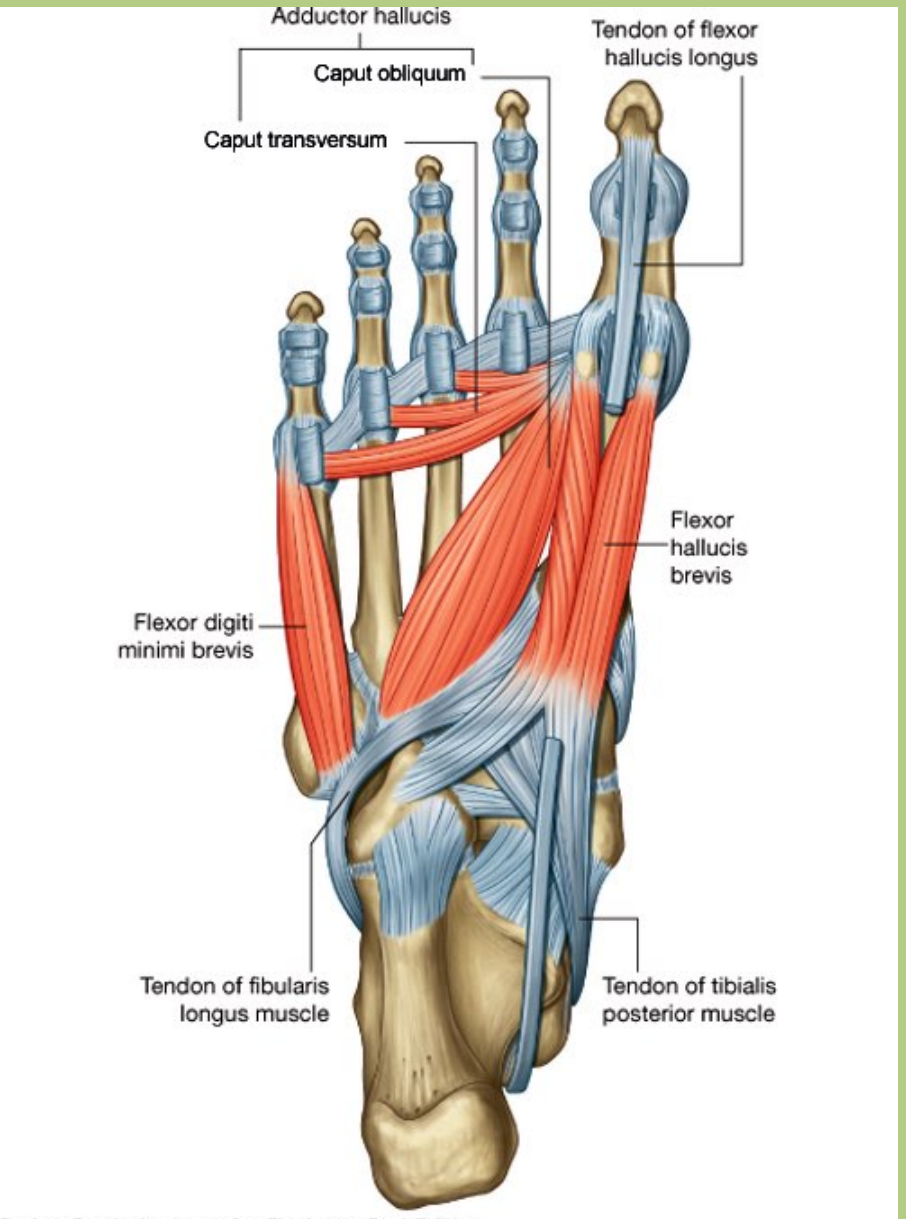
A: Medial plantar eminence: abductor, flexor and adductor muscles.

B: Lateral plantar eminence: abductor, flexor and opponens muscles.

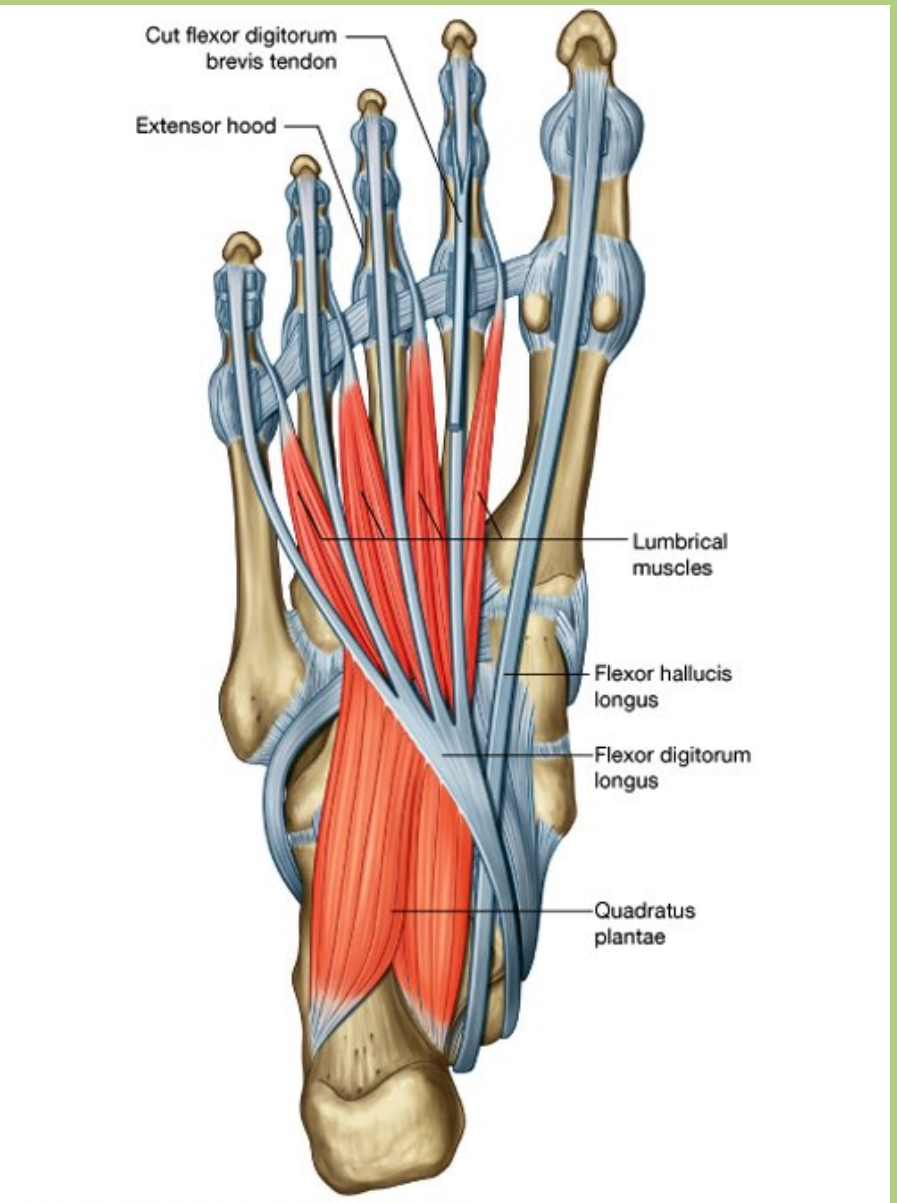
Foot muscles - plantar side



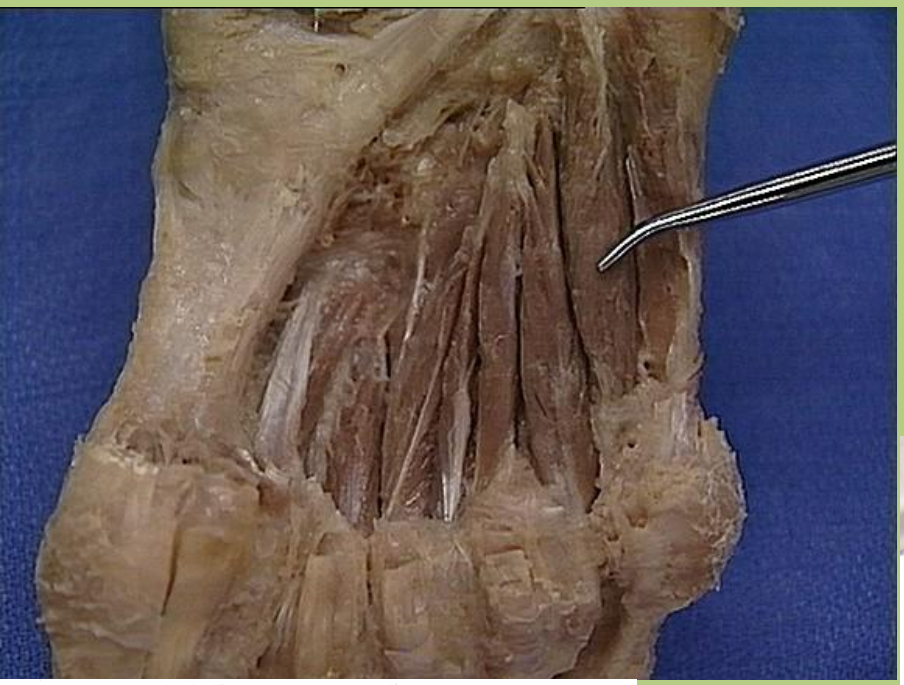
Foot muscles - plantar side

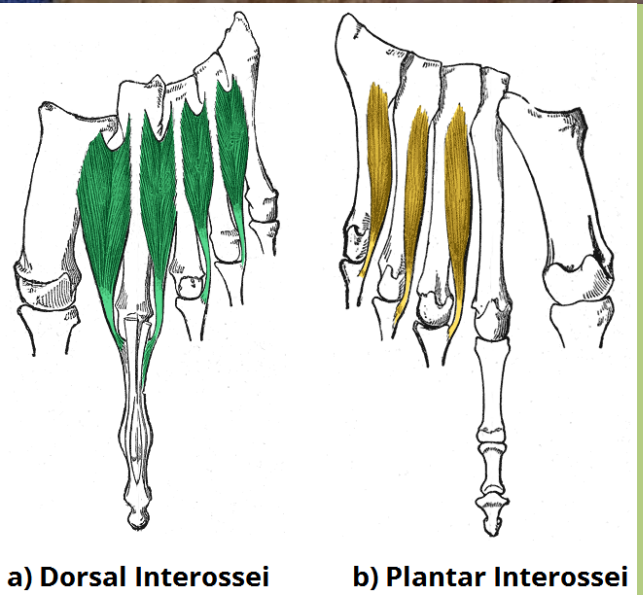


Foot muscles - plantar side



Foot muscles - interossei

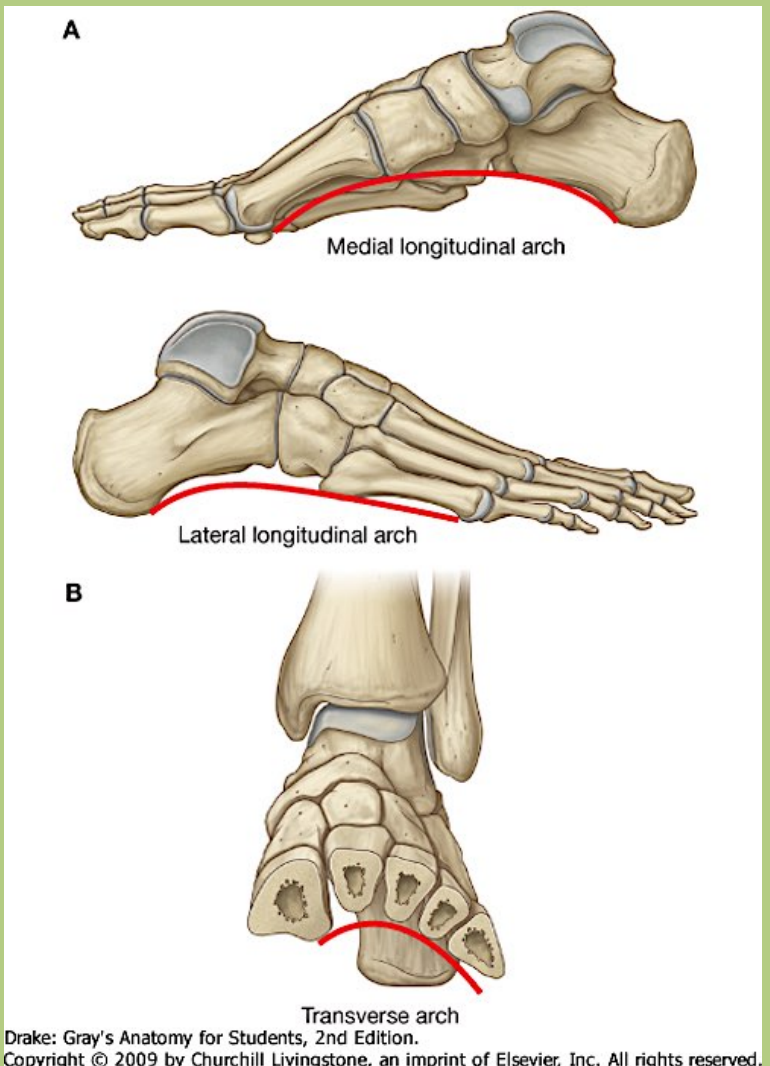




a) Dorsal Interossei

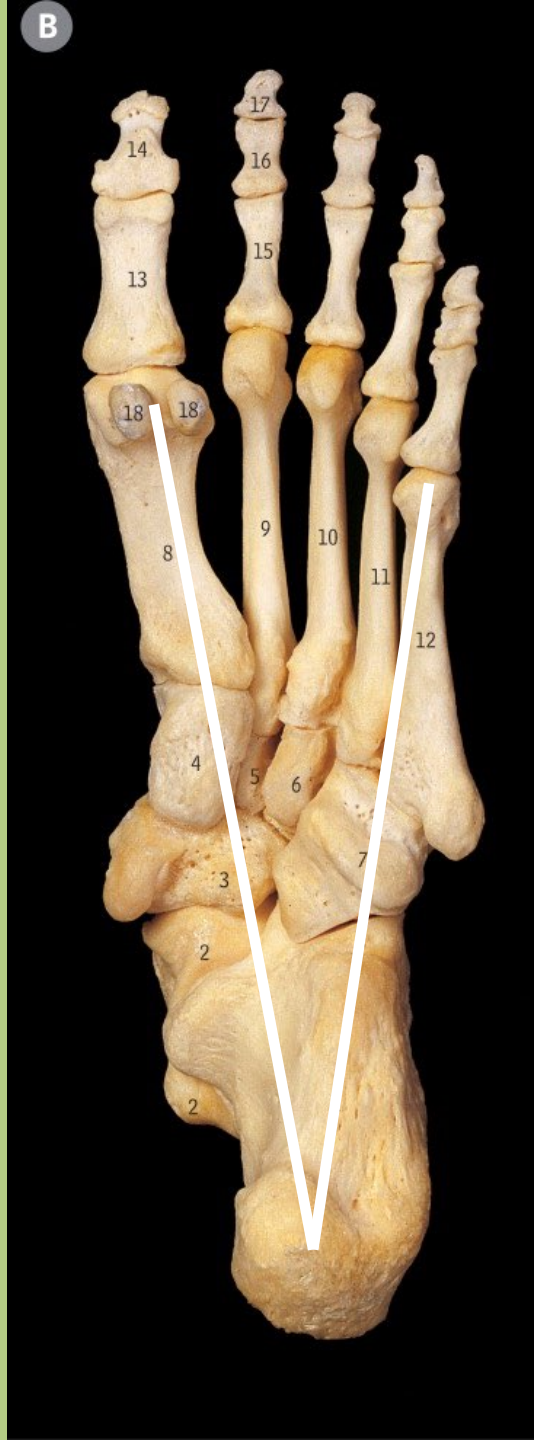
b) Plantar Interossei

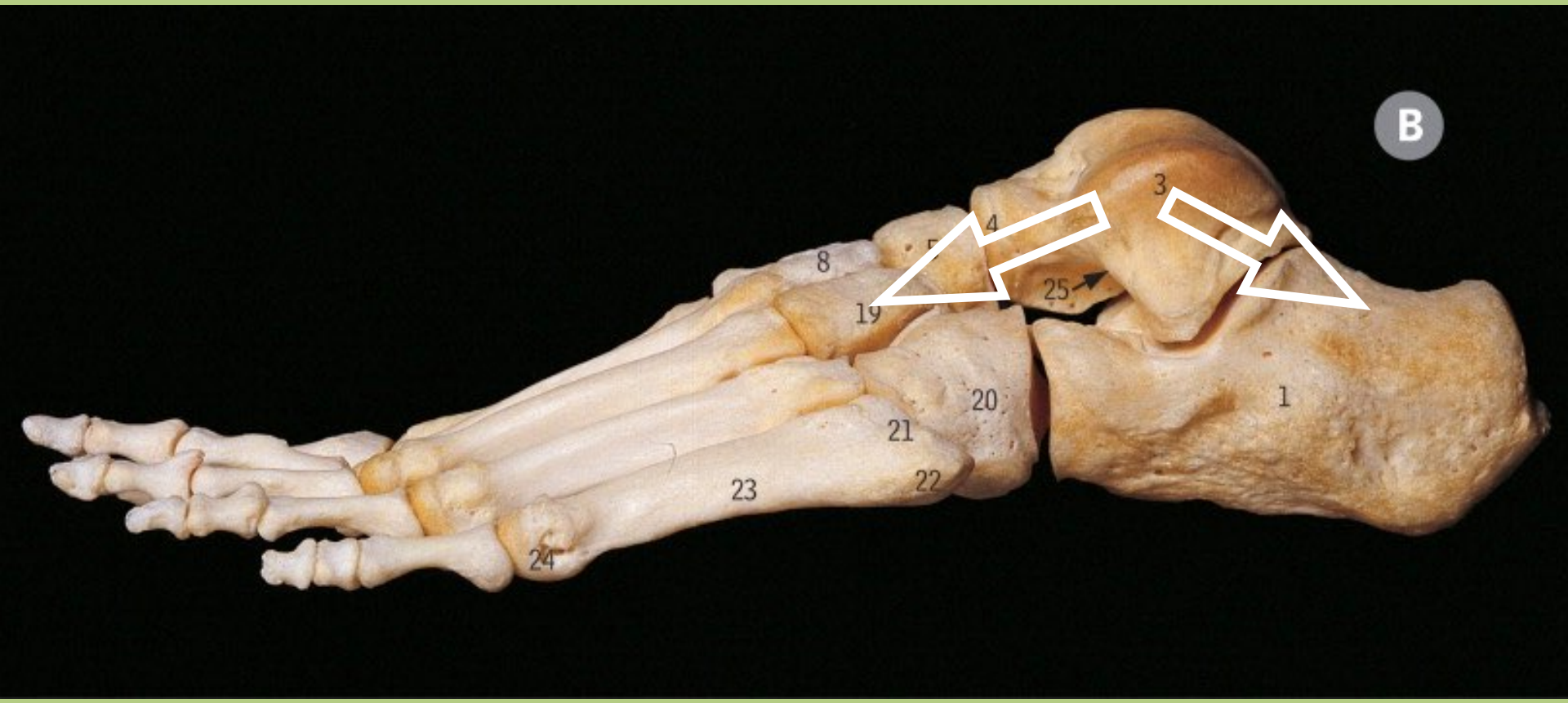
Plantar architecture



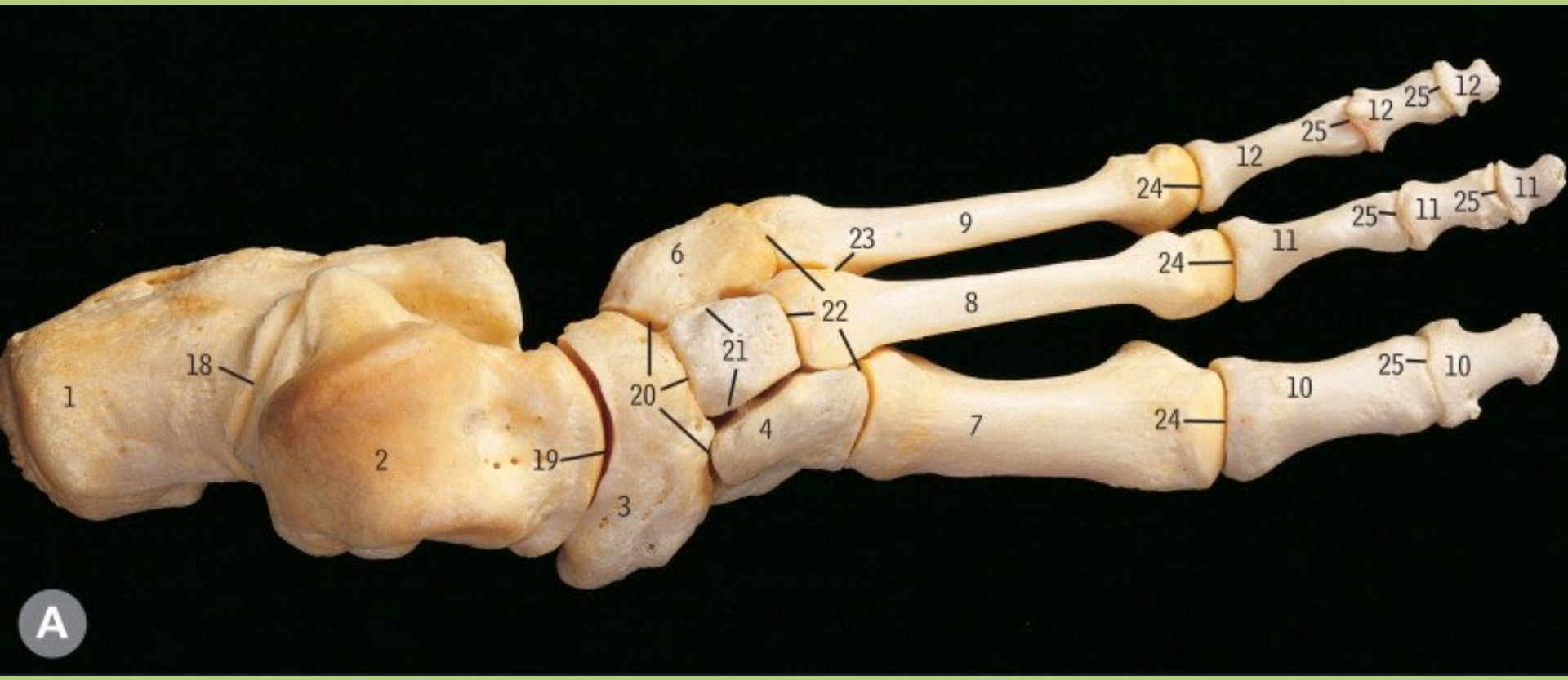
The weight of the body is transmitted to the talus from the tibia. Then it is transmitted posteriorly to the **calcaneal tubercle** and anteriorly to the **heads of the 1st-5th metatarsals.**

The cuneiforms and the bases of the metatarsals together form the **transverse arch.** Its uppermost point is the intermediate cuneiform.



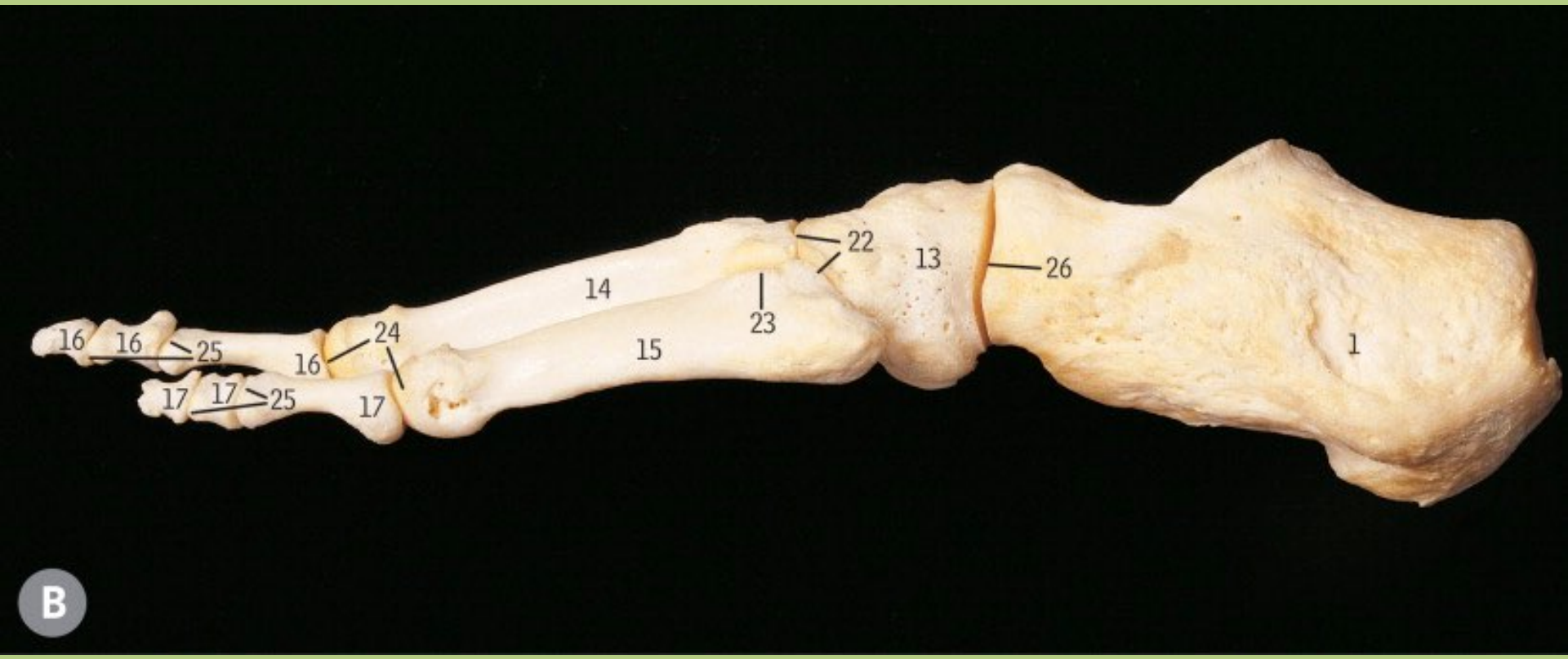

B
3
4
8
25
19
20
1
21
22
23
24

Medial longitudinal arch



calcaneus, talus, navicular, cuneiforms, metatarsals: I-III.

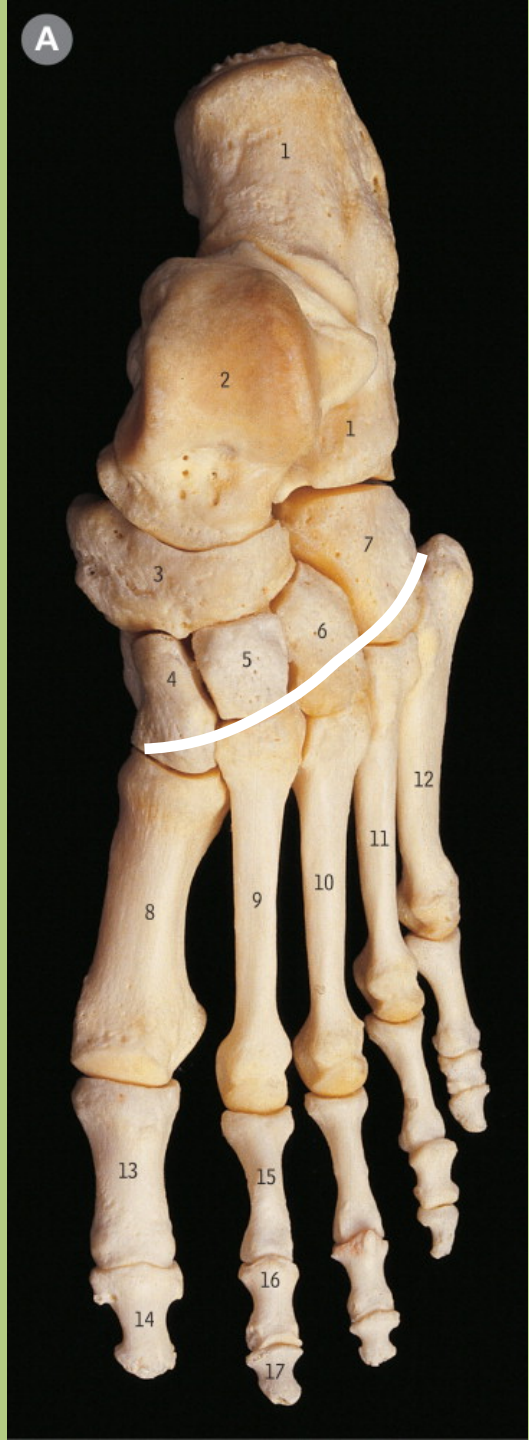
Lateral longitudinal arch



calcaneus, cuboid, metatarsals: IV-V.

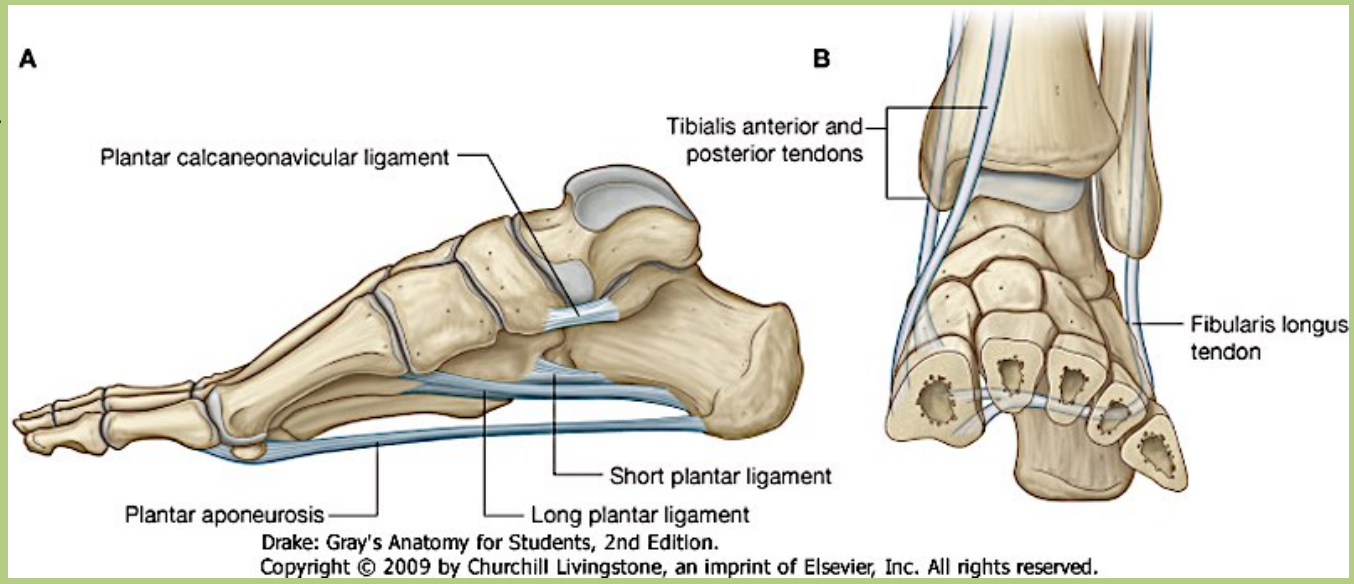
Transverse arch

cuneiforms, cuboid, bases of metatarsals



Arches of the foot - ligaments

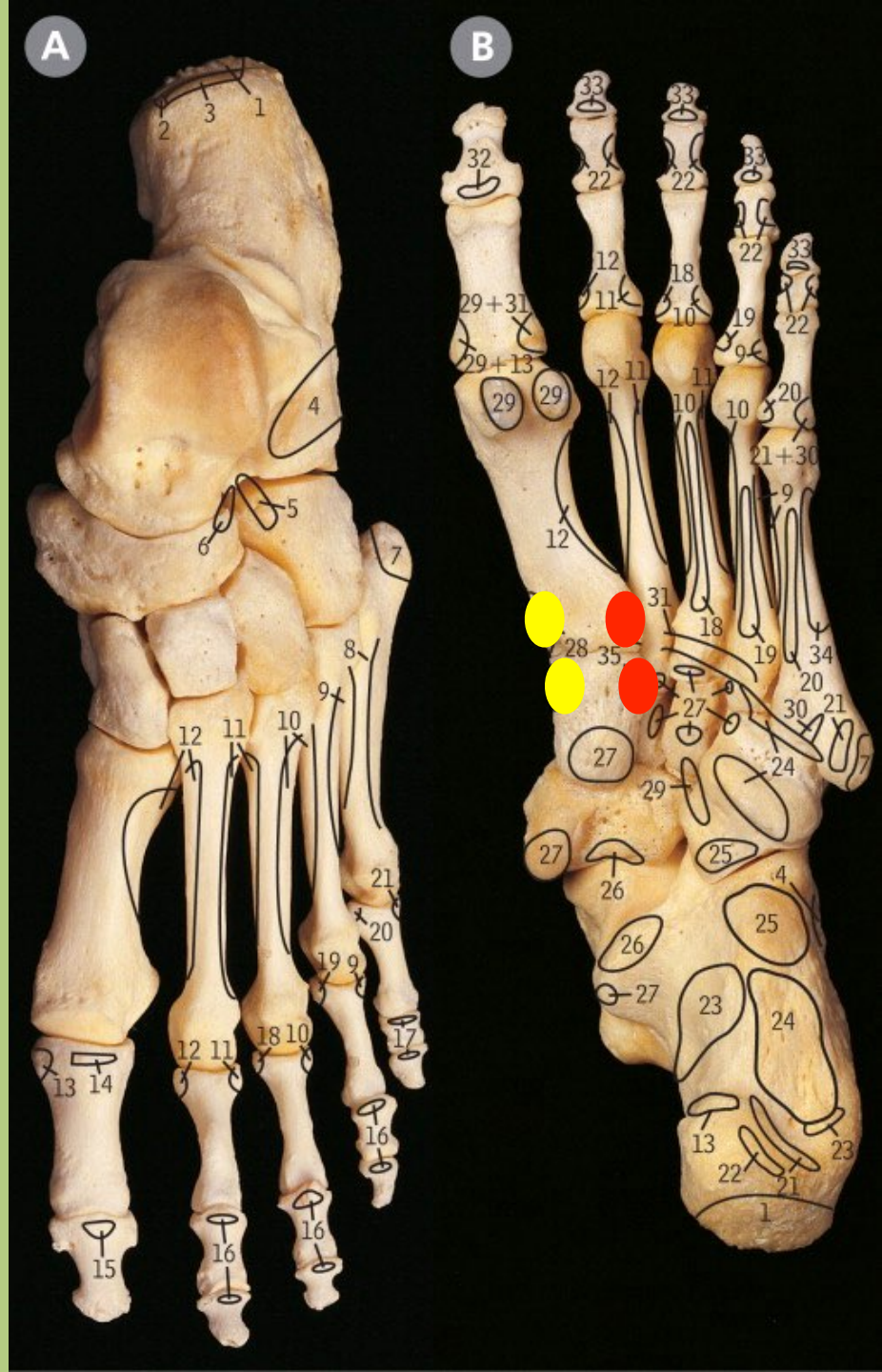
- **Plantar aponeurosis:** from calcaneal tubercle to the plantar surfaces of toes. ***Works when the body is standing; stabilizes the transverse arch as well.***
- **Long plantar ligament:** from calcaneus to the bases of metatarsals. ***Stabilizes the longitudinal arches.***
- **Plantar calcaneocuboid ligament:** from calcaneus to the cuboid bone. ***Stabilizes the bones at the lateral side.***
- **Plantar calcaneonavicular ligament:** extends the articular surface for the head of talus. ***Stabilizes the bones at the medial side.***



Stabilizers of the medial arch

Active stabilizers:

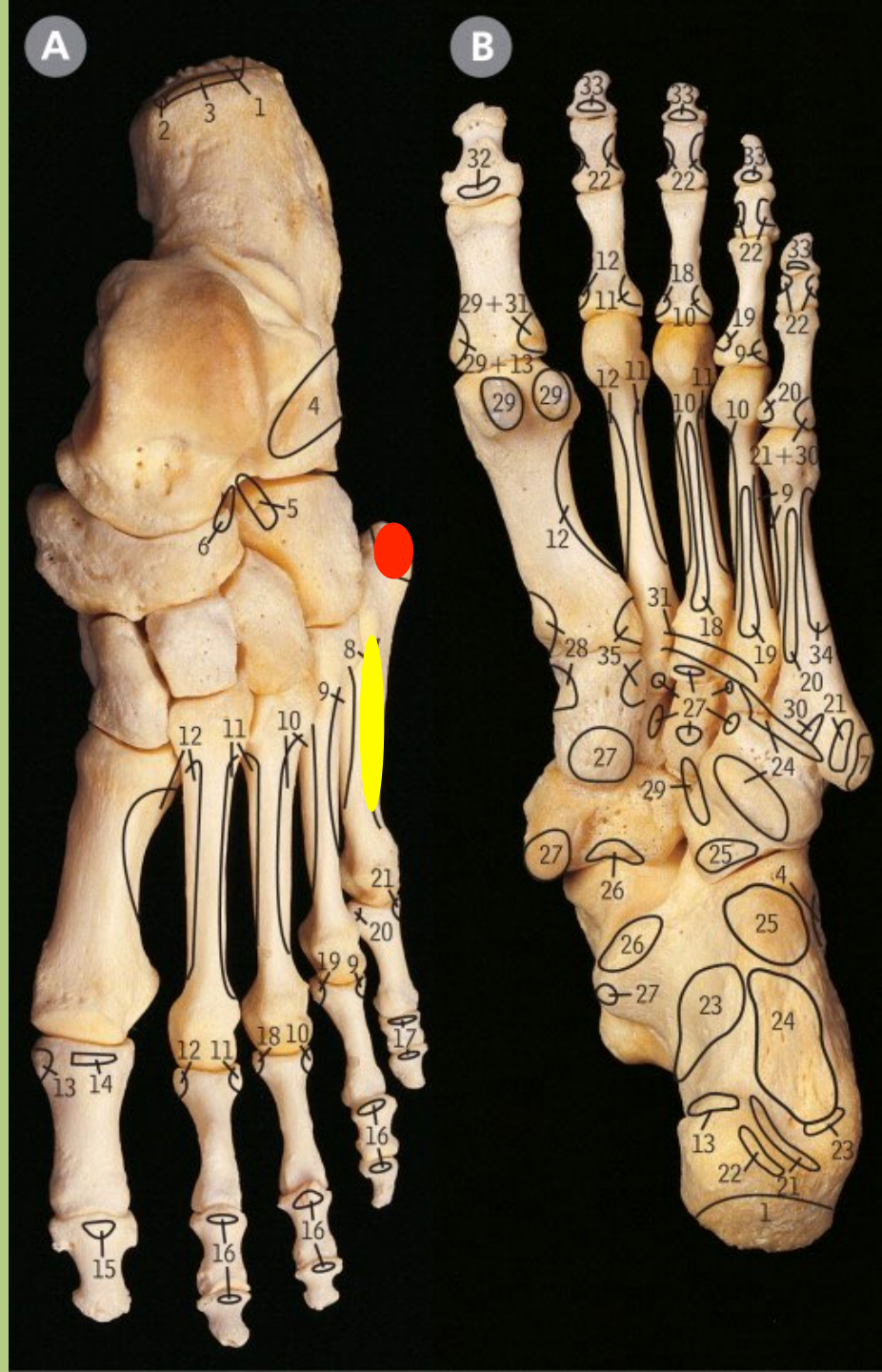
- tibialis anterior
- peroneus longus



Stabilizers of the lateral arch

Active stabilizers:

- peroneus tertius
- peroneus/fibularis brevis



Stabilizers of the longitudinal arch

Other active stabilizers:

- abductor hallucis (13)
- flexor hallucis brevis (29)
- flexor digitorum brevis (22)
- quadratus plantae (23)
- abductor digiti minimi (21)

Passive stabilizers:

- plantar aponeurosis
- longum plantar lig. (24)
- plantar calcaneonavicular lig. (26)
- plantar calcaneocuboid lig. (25)

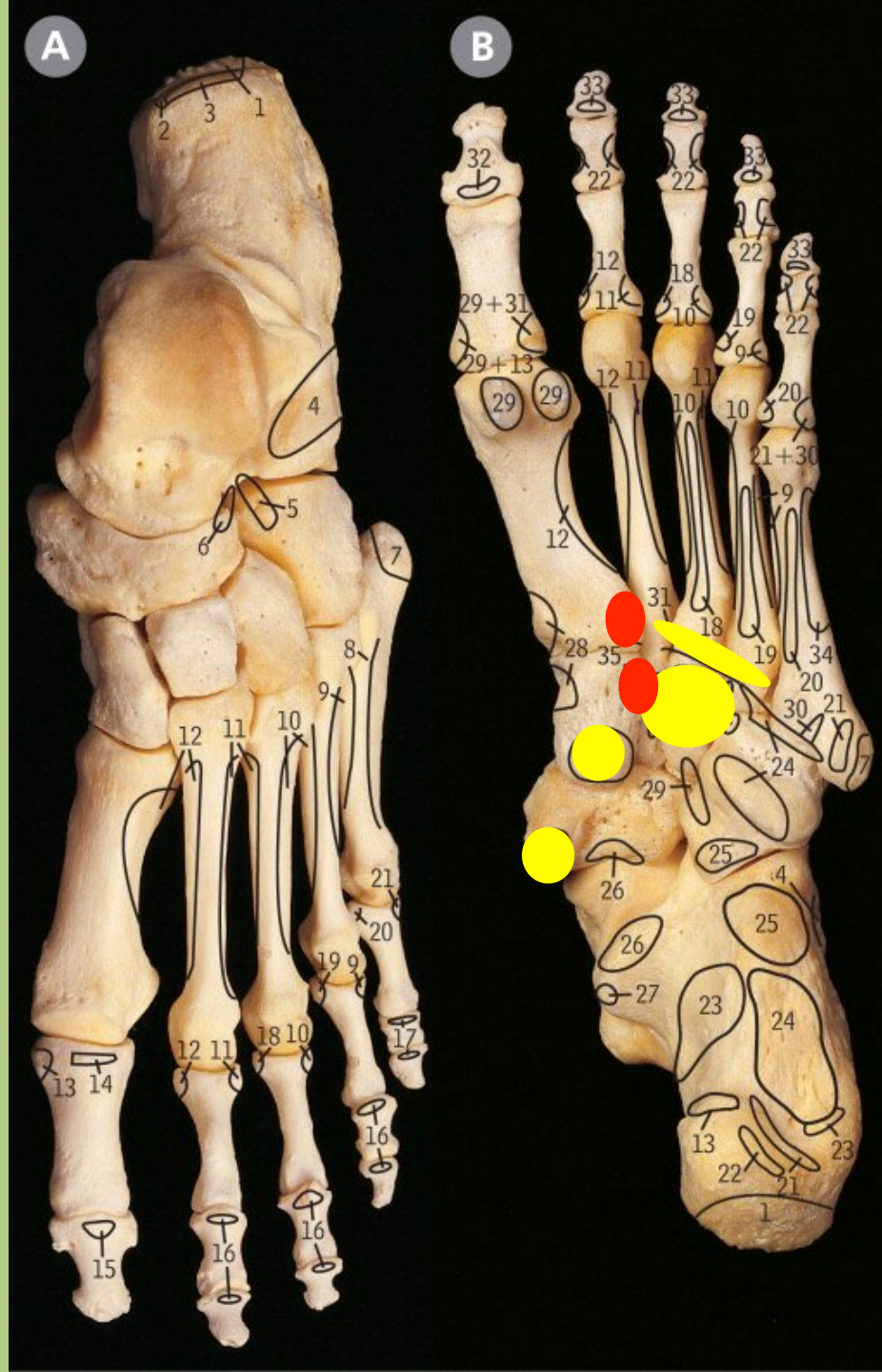
Stabilizers of the transverse arch

Passive stabilizers:

deep transverse metatarsal lig.

Active stabilizers:

- fibularis longus
- tibialis posterior

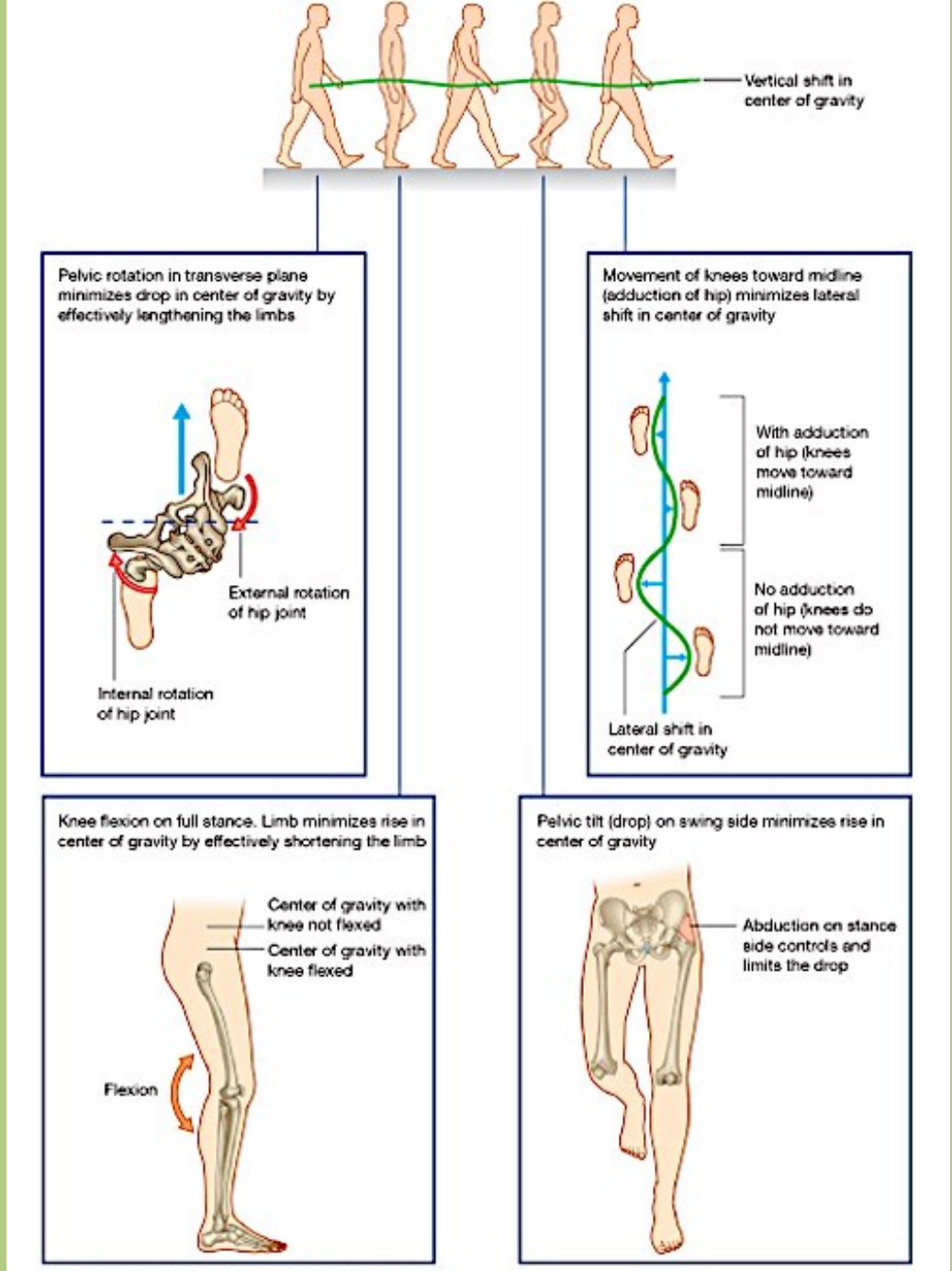


Walking

During walking, many anatomical features of the lower limbs contribute to **minimizing fluctuations in the body's center of gravity** and thereby reduce the amount of energy needed to maintain locomotion and produce a smooth, efficient gait.

They ***include pelvic tilt in the coronal plane, pelvic rotation in the transverse plane, movement of the knees toward the midline , flexion of the knees, and complex interactions between the hip, knee, and ankle.***

As a result, during walking the body's center of gravity normally fluctuates only 5cm in both vertical and lateral directions.



Orthopedic disorders

Pes planus (flatfoot): With ***collapse of the longitudinal arch***, marked by downward displacement of the talus and navicular, weight bearing often incites a diffuse foot pain that is most intense in the area of the ***stretched plantar calcaneonavicular ligament***.

A flat foot is normal in infants and toddlers, because the foot's arch hasn't yet developed.

Case courtesy of Dr Tim Luijkx, Radiopaedia.org, rID: 34737

Case courtesy of Dr Henry Knipe, Radiopaedia.org, rID: 30407

Orthopedic disorders

Pes transversoplanus (splayfoot): The ***collapse of the transverse arch*** results in a broadened forefoot with ***greater pressure acting on the heads of the second through fourth metatarsals*** and the associated metatarsophalangeal joints.

Orthopedic disorders

Hallux valgus:

- lateral deviation of the great toe
- first and second toes rub against each other
- displaced sesamoid bones
- causes: pes planus, high heels, genetic background

Case courtesy of Dr Benoudina Samir, Radiopaedia.org, rID: 42447

Orthopedic disorders

Hammer toes:

- proximal phalanges are in dorsiflexion
- middle phalanges are in plantarflexion
- distal phalanges are usually in dorsiflexion
- causes: defect of the lumbricals and interossei, high heels, genetic background

Case courtesy of Dr Usman Bashir, Radiopaedia.org, rID: 19010

Thank you for your attention.

References: Drake: Gray's Anatomy for Students, 2nd ed.
Standring: Gray's Anatomy, 39th ed.
Radiopaedia.org
Thieme Atlas of Anatomy, General Anatomy and Musculoskeletal System, 2nd ed.
musculoskeletalkey.com