GLUTEAL REGION, POSTERIOR THIGH, POPLITEAL FOSSA

I. OVERVIEW OF MUSCLE ACTIONS - Source of confusion: Flexion is anterior movement at hip but flexion is posterior movement at knee.

A. Hip joint - ball and socket; movements of femur

Flexion - Anterior
Extension - Posterior
Adduction - Medial
Abduction - Lateral
Rotation - movement about long axis of femur

B. Knee joint - condylar joint

Flexion - Posterior
Extension - Anterior
Rotation (some) - movement about long axis of leg (tibia)

II. GLUTEAL REGION - area between Iliac Crest (superior) and lower border of Gluteus maximus (inferior); dividing landmark is Piriformis muscle.

A. GLUTEAL MUSCLES AND TENSOR FASCIA LATA - originate above Piriformis; are innervated by Superior and Inferior Gluteal nerves.

1. Gluteus Maximus - largest extensor of hip; used in running, climbing stairs, rising up from stooped position; actions: extend hip, laterally rotate hip, extends trunk and maintains extension of leg via iliotibial tract; Innervation: Inferior Gluteal nerve. IMPORTANT IN WALKING AND RUNNING - Extends hip to provide forward propulsion

2. Gluteus Medius and Minimus - deep to Gluteus Maximus; Gluteus Minimus is deepest and separated from Gluteus Medius by Superior Gluteal nerves (landmark on practical exam); Action: abduct hip, rotate medially (rotation small); IMPORTANT IN STANDING AND WALKING - when foot is on ground, Gluteus Medius and Minimus support body weight and stabilize pelvis. Innervation: Superior Gluteal nerve.

Note: **Gluteal gait** - caused by injury to Superior Gluteal nerve or poliomyelitis (also congenital dislocation of hip joint). Paralyze Gluteus Medius and Minimus. Pelvis tilts in walking when lift foot of opposite, non-paralyzed leg. **PELVIS TILTS DOWN ON OPPOSITE (NON-PARALYZED) SIDE** (this is known as a Positive Trendelenburg sign).

3. Tensor Fascia Lata - inserts onto Iliotibial tract; in standing, abducts hip and maintains extension of leg; innervated by Superior Gluteal nerve.

B. BURSAE - function as shock absorbers, reduce friction of movement of muscle tendons against bones or other tendons

1. Trochanteral Bursa - separates Gluteus Maximus from Greater Trochanter of Femur and Vastus Lateralis.

2. Ischial Bursa - separates Gluteus Maximus from Ischial tuberosity.

Note: **Weaver's Bottom** - Inflammation of Ischial Bursae; when sitting, weight of body rests on Ischial tuberosities (Gluteus maximus covers Ischial tuberosities when standing, but not when sitting); Ischial bursae may become inflamed due to excess friction (Weavers used legs to power treadles by repeated leg extension, causing inflammation of Ischial bursae); may also become inflamed in paraplegics.

C. PIRIFORMIS AND MUSCLES BELOW PIRIFORMIS - Piriformis (=pear shaped), Quadratus Femoris, Obturator Internus, Superior Gemellus, Inferior Gemellus (from L. Gemini, twin)

1. Action - lateral rotation of femur (tendons posterior to hip joint) but also stabilize hip joint and hold head of femur in acetabulum.

2. Innervated by branches of lumbosacral plexus named for muscles (nerve to Obturator internus, nerve to Piriformis, nerve to Quadratus femoris).

III. ARTERIES AND NERVES - all leave pelvis by Greater Sciatic foramen.

A. ARTERIES - from Internal Iliac

1. Superior Gluteal Artery - courses above Piriformis, between Gluteus Medius and Gluteus Minimus..

2. Inferior Gluteal Artery - courses below Piriformis; branches join Cruciate anastomosis at hip joint.

B. NERVES- from Lumbosacral plexus

1. Superior Gluteal Nerve - innervates Gluteus Medius and Minimus, Tensor fascia lata.

2. Inferior Gluteal Nerve - innervates Gluteus maximus. .

3. Posterior Cutaneous nerve of hip - large sensory nerve to posterior hip and gluteal region, medial to Sciatic nerve

4. **Sciatic Nerve -** largest nerve body (from L45,S123); composed of Tibial and Peroneal parts; ends as Tibial and Common Peroneal nerves; courses deep to Gluteus maximus, found halfway between ischial tuberosity and greater trochanter; can be damaged in posterior dislocation of hip joint.

Clinical Note: Intramuscular Injection in Gluteal Region - need to avoid damage to Sciatic nerve; injection given in Upper Lateral Quadrant of Gluteal region.

Clinical Note: Early branching of Sciatic Nerve - Tibial and Peroneal parts normally branch in distal hip but can branch early; Sciatic nerve looks like two nerves; branches can sometimes be through Piriformis and get compressed (Piriformis syndrome).

IV. POSTERIOR HIP - muscles are called hamstrings because used by butchers for hanging hams of pigs.

A. Hamstring muscles - all originate from Ischial tuberosity; all cross hip and knee joint and most are Bifunctional (Extend hip and flex knee);

1. Semimbranosus (named for flattened tendon),

2. Semitendinosus (named for long tendon distally),

3. Biceps femoris (two heads, long head from Ischial tuberosity, short head from Linea aspera of femur),

4. Adductor magnus hamstring part takes origin from Ischial tuberosity.

B. Innervation of Hamstrings - all innervated by Tibial part of Sciatic Nerve except Short head of Biceps - innervated by Peroneal part of Sciatic Nerve.

Note: The Peroneal and Tibial parts occur as distinct, separate bundles within the Sciatic Nerve even before it has divided into the Tibial and Common Peroneal nerve.

Clinical note: Pulled Hamstrings - can tear or avulse (pull off) part of origin of muscles from Ischial tuberosity; can occur in running or when extend knee (contract Quadriceps) when hamstrings are not relaxed; extremely painful, person writhes in unbearable agony.

C. Arteries - Blood supply from perforating arteries (branches of Profunda femoris)

V. POPLITEAL FOSSA - diamond shaped region in back of knee; boundaries - Superior: Semimembranosus and Semitendinosus medial, Biceps femoris lateral; Interior - Medial and lateral heads of Gastrocnemius.

A. Fascia - forms roof over fossa; very strong and does not permit expansion; pain from abscess, aneurysm or tumor in fossa very painful.

B. Popliteus Muscle - small but functionally important; takes origin from inside knee joint (lateral condyle of femur, lateral meniscus); inserts to tibia; innervation - Tibial nerve.

Biomechanical note: Unlocking of Knee joint - Popliteus muscle unlocks knee joint; when extend leg, femur tends to rotate medially, pulling tendons and ligaments taut and 'locking' knee; Popliteus acts to rotate femur laterally when beginning to flex leg; this unlocks knee joint.

C. Nerves - Sciatic nerve branches into Tibial and Common Peroneal nerves in distal thigh.

1. Tibial nerve - located in midline, supplies posterior compartments of leg; cutaneous branch in Popliteal Fossa: Sural nerve (Medial Sural cutaneous nerve) - accompanies Small Saphenous vein; provides sensory innervation to posterior side of calf and lateral side of ankle and foot.

2. Common Peroneal Nerve - supplies anterior and lateral compartment of leg; cutaneous branch: Lateral Sural Cutaneous Nerve - sensory to skin of lateral calf.

Clinical Note: Damage to Common Peroneal Nerve - most commonly damaged nerve in lower extremity; very superficial when winds around neck of fibula; can be severed by fracture of fibula or damaged from tight plaster cast; clinical sign is Foot Drop.

VI. POPLITEAL ARTERY AND GENICULAR ANASTOMOSIS - Popliteal artery (continuation of Femoral Artery) courses deep in Popliteal fossa (deep to Popliteal vein); divides into Anterior and Posterior Tibial arteries distally; branches of Popliteal artery form Genicular Anastomosis at knee:

1. Superior Medial Genicular artery - anastomoses with Descending Genicular artery (from Femoral Artery)

2. Superior Lateral Genicular artery - anastomoses with Descending branch of Lateral Femoral Circumflex artery

3. Inferior Medial Genicular artery - anastomoses with Recurrent branch of Anterior Tibial artery

4. Inferior Lateral Genicular artery - anastomoses with Recurrent branch of Anterior Tibial artery

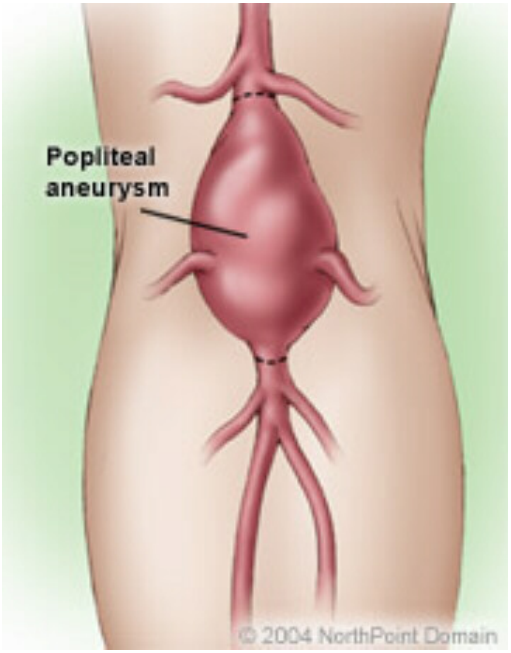
Clinical Note: Aneurysm of Popliteal artery - painful, due to toughness of fascia on back of knee, Femoral artery can be ligated above knee deep to Sartorius in Subsartorial canal (also called Hunter's canal for John Hunter, Scottish surgeon who invented operation); blood supply maintained by anastomoses around knee (Genicular anastomosis).

VII. POPLITEAL LYMPH NODES - lymph vessels follow venous drainage; receive lymph from deep leg that travel with anterior and posterior tibial vessels; also lymph from superifical leg and lateral foot from vessels with Small saphenous vein; drain superiorly to deep inguinal nodes.

GLUTEAL REGION, POSTERIOR THIGH, POPLITEAL FOSSA

OUTLINE

I. OVERVIEW MUSCLE ACTIONS
II. GLUTEAL REGION - muscles, bursae, Gluteal gait
III. ARTERIES AND NERVE OF GLUTEAL REGION - Sciatic nerve
IV. POSTERIOR THIGH - Pulled hamstrings
V. POPLITEAL FOSSA - Back of knee, aneurisms; mechanism unlock knee
VI. GENICULAR ANASTOMOSIS - permits prolonged flexion of knee without loss of blood supply
VII. POPLITEAL LYMPH NODES



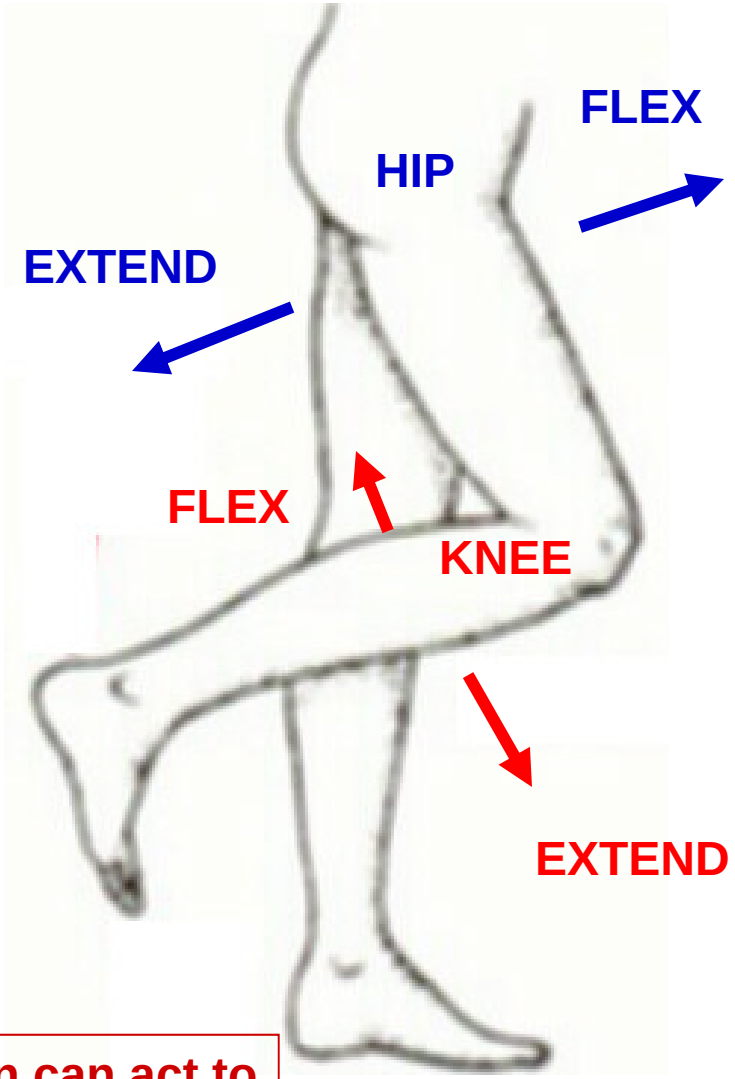
Popliteal aneurysm = dilation of vessel due to weakness of walls

WORD OF DAY (WORD ON THE STREET) - ANEURYSM - dilation (Gk.) (abnormal enlargement) of blood vessel due to weakness of walls

I. OVERVIEW OF MUSCLE ACTIONS

A. **Hip joint - ball and socket**
Flexion - Anterior
Extension - Posterior
Adduction - Medial
Abduction - Lateral
Rotation - movement about long axis of femur

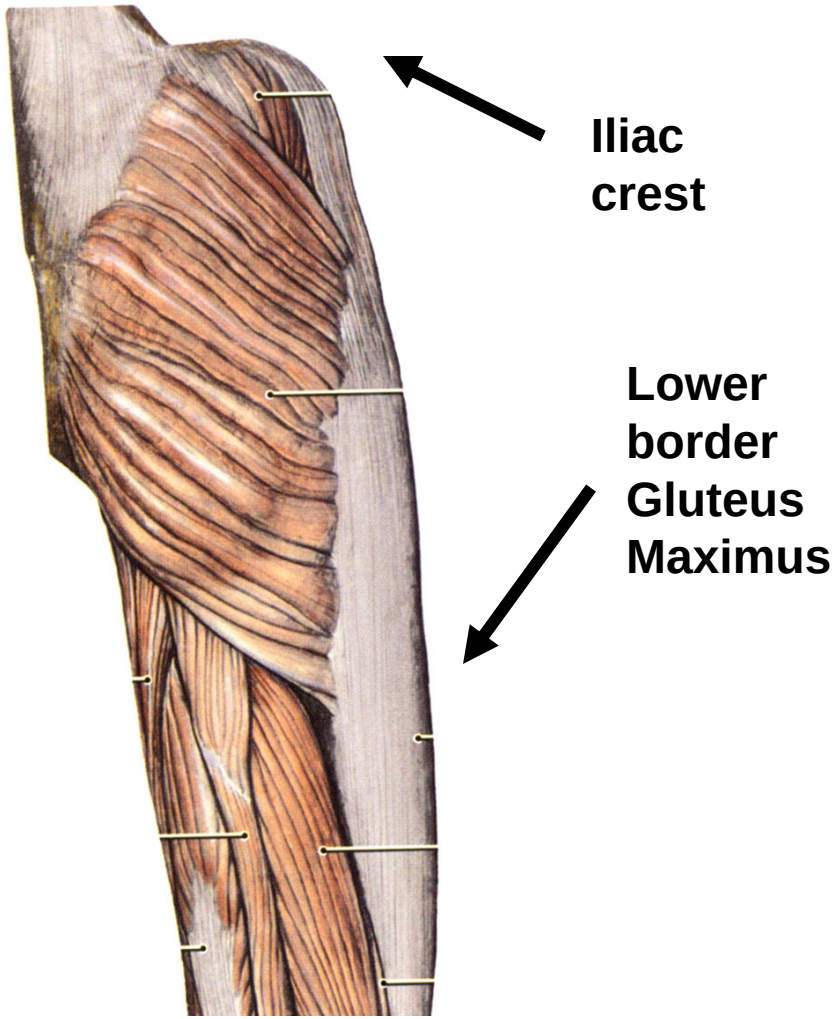
B. **Knee joint - condylar joint**
Flexion - Posterior
Extension - Anterior
Rotation (some) - movement about long axis of leg (tibia)

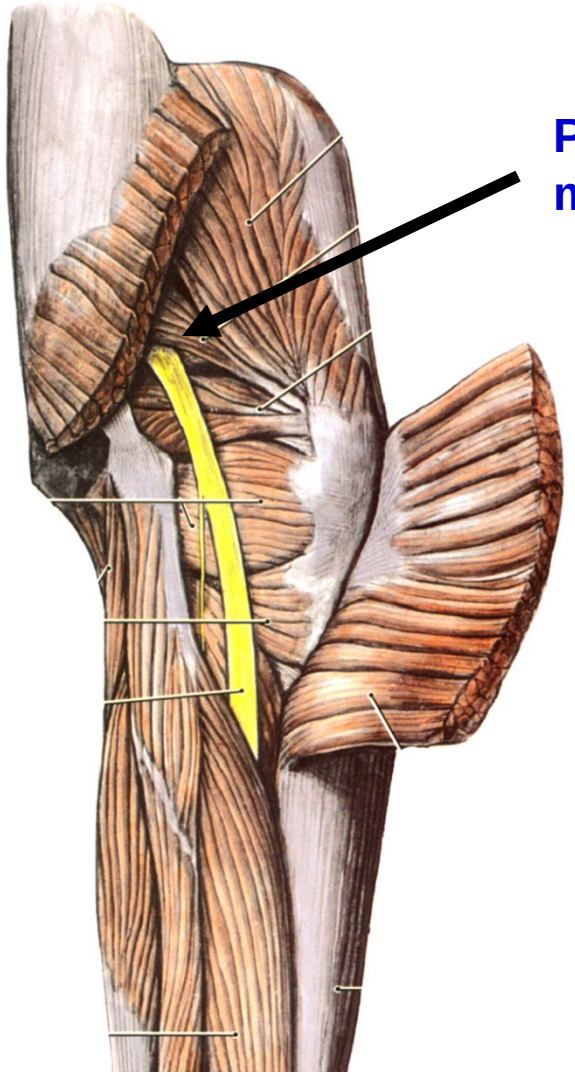


Note: muscles in Gluteal region can act to extend thigh (hip) and flex knee (leg)

II. GLUTEAL REGION

Area between **iliac crest (superior)** and **lower border of Gluteus maximus (inferior)**; dividing landmark is **Piriformis muscle**.





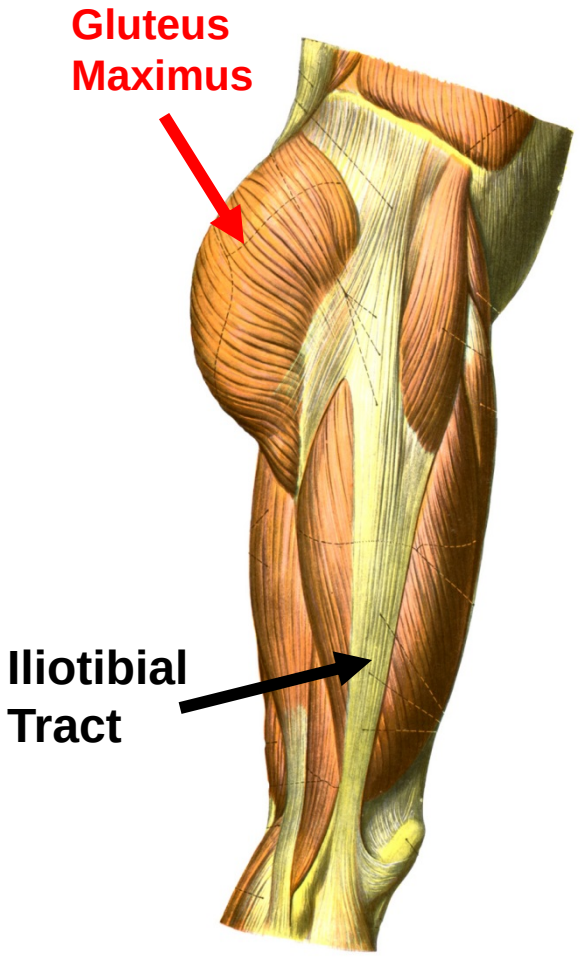
MUSCLES ARE ARRANGED IN LAYERS

A. GLUTEAL MUSCLES AND TENSOR FASCIA LATA

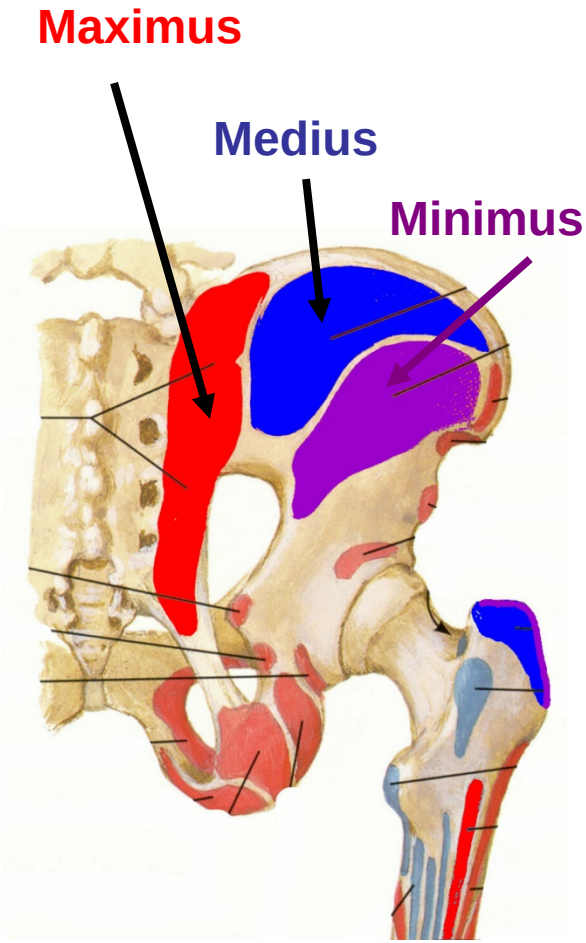
originate above Piriformis; are innervated by Superior and Inferior Gluteal nerves

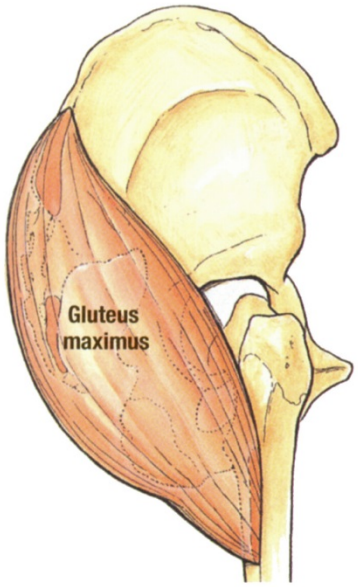
1. Gluteus Maximus - largest extensor of thigh; used in running, climbing stairs, rising up from stooped position; actions: extend, lateral rotate hip joint; keeps leg extended via iliotibial tract; Innervation - Inferior Gluteal nerve

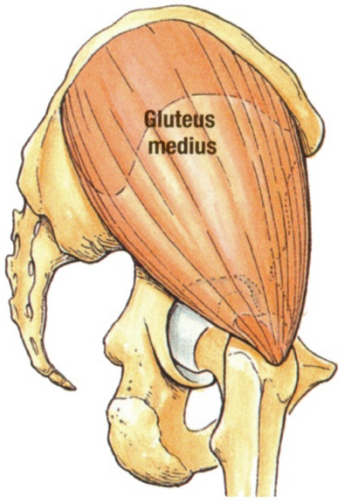
Gluteus = Latin for buttock

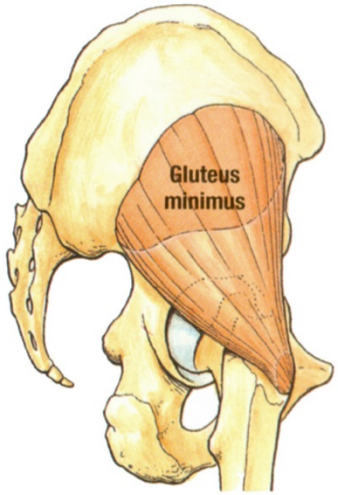


GLUTEAL MUSCLES: ORIGINS









Gluteus Maximus

O - Ilium, sacrum, coccyx, sacrotuberous lig.

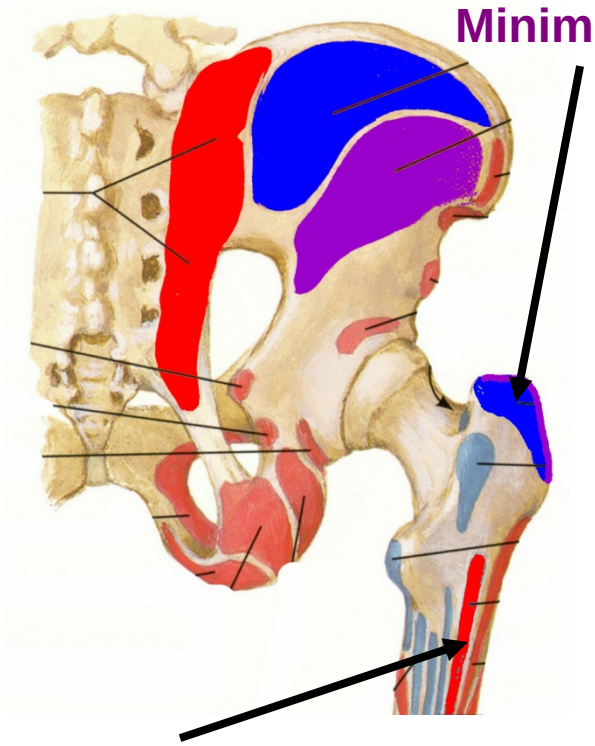
Gluteus Medius

O - Ilium

Gluteus Minimus

O - Ilium

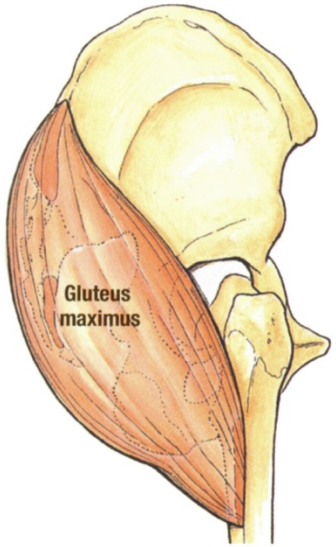
GLUTEAL MUSCLES: INSERTIONS, ACTIONS

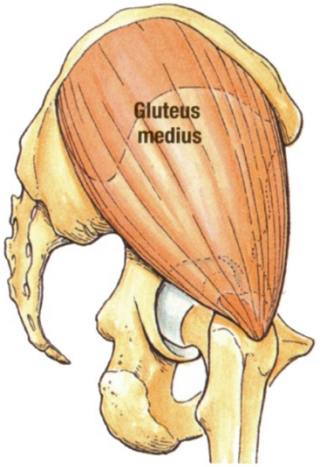


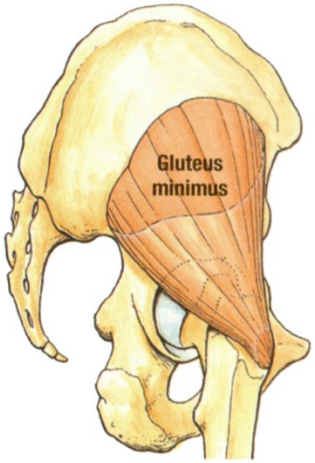
Medius +

Minimus

Maximus







Gluteus Maximus

I - Femur, IT tract

Act - Extend, Laterally rotate

Inn - Inferior Gluteal N.

Gluteus Medius

I - Femur (Greater Trochanter)

Act - Abduct, Medially rotate

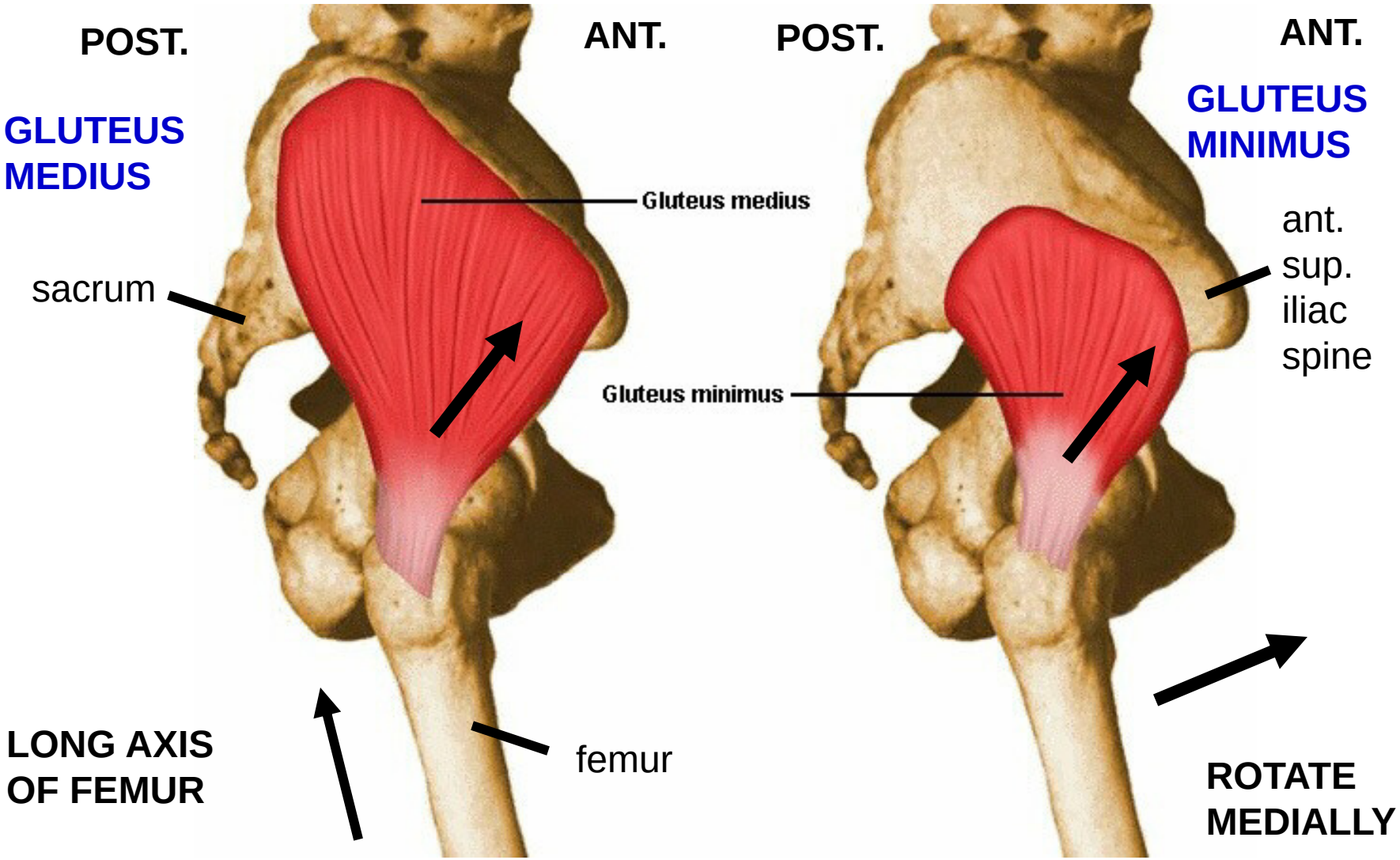
Gluteus Minimus

I - Femur (Greater Trochanter)

Act - Abduct, Medially rotate

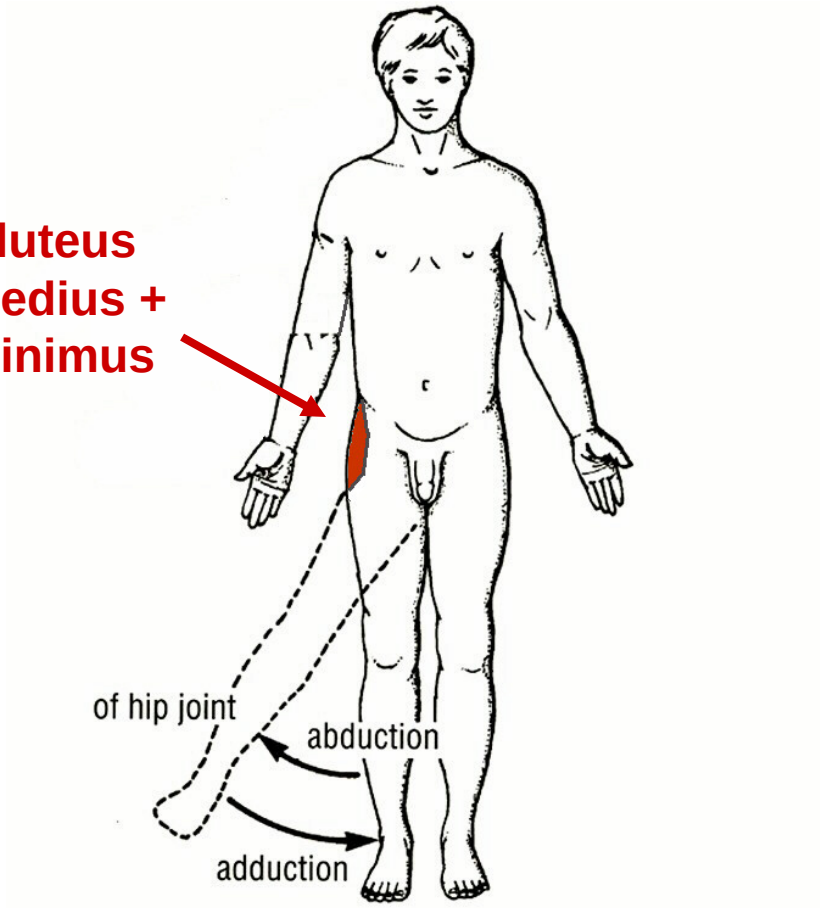
Inn both - Superior Gluteal N.

WHY DO GLUTEUS MEDIUS AND MINIMUM MEDIALLY ROTATE FEMUR?
LOOK AT LATERAL VIEW OF HIP (SURGICAL APPROACH)



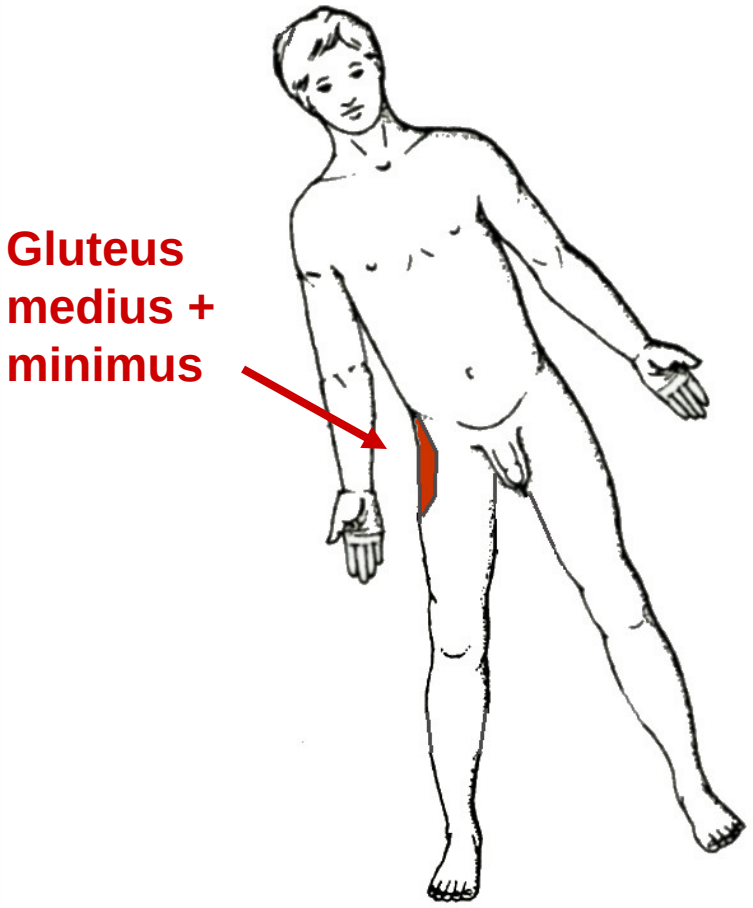
GLUTEUS MEDIUS AND MINIMUS TILT BODY WHEN FOOT IS KEPT ON GROUND

FOOT LIFTED FROM GROUND



ABDUCT LOWER EXTREMITY

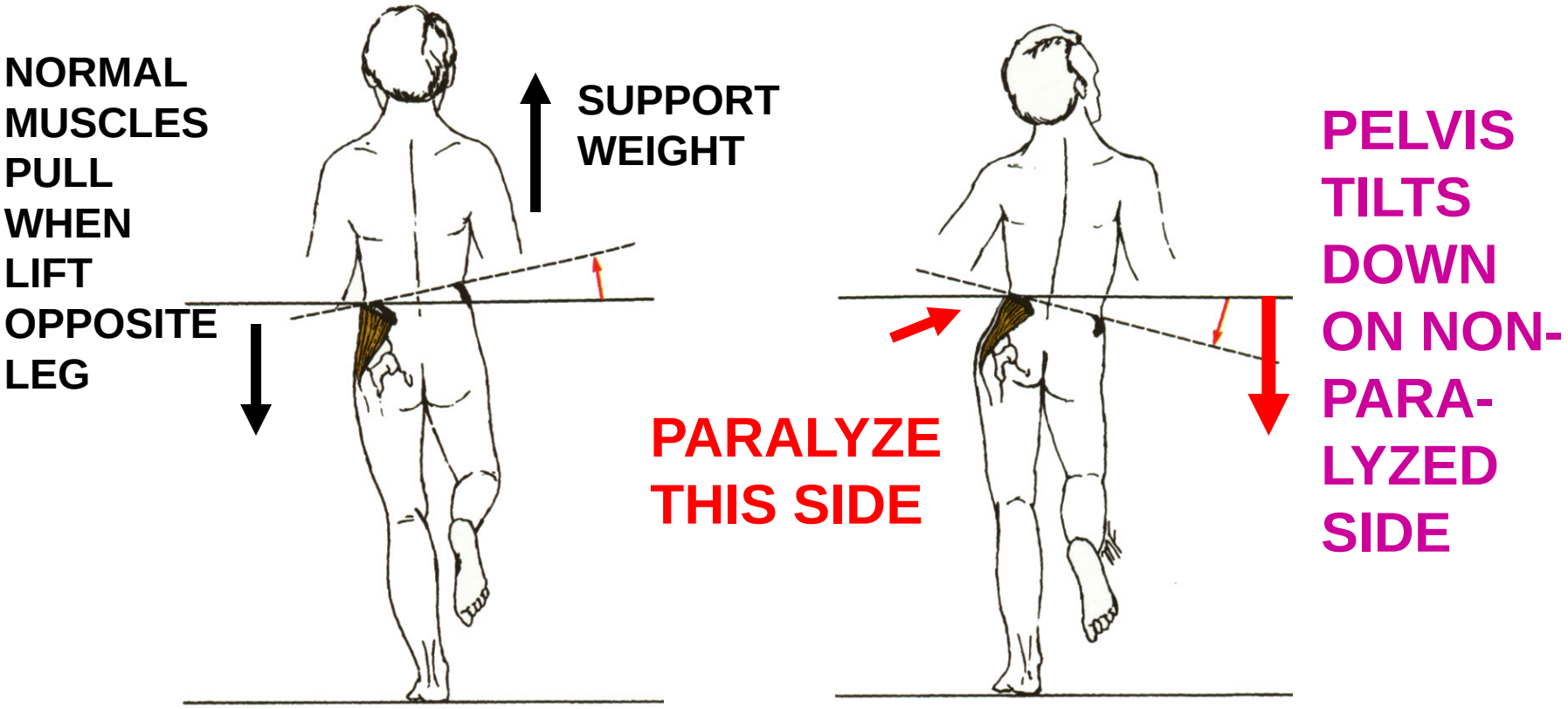
FOOT KEPT ON GROUND



TILT BODY TO SAME SIDE

GLUTEAL GAIT

Gluteal Gait - caused by injury to Superior Gluteal nerve or poliomyelitis (also congenital dislocation of hip joint). Paralyze Gluteus Medius and Minimus. In walking, pelvis tilts down on non-paralyzed side when lift foot of opposite, non-paralyzed leg.



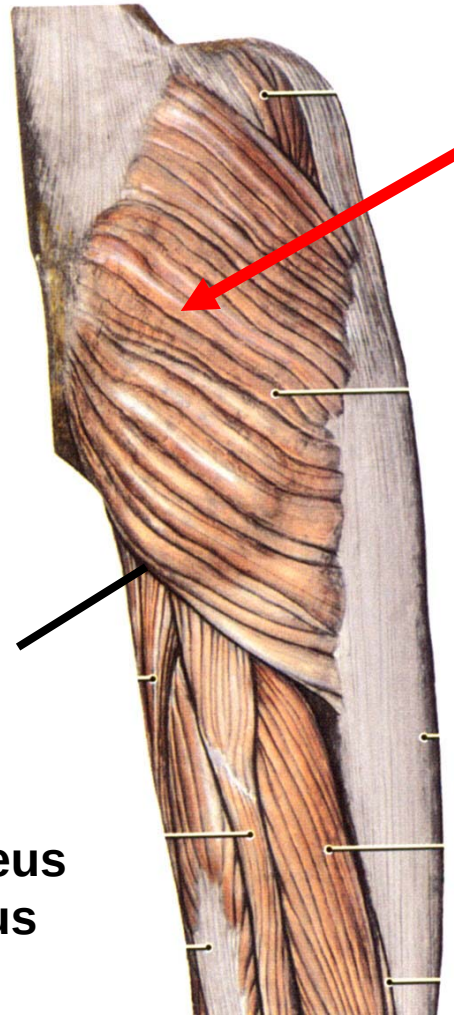
Positive Trendelenburg sign - WHEN LIFT OPPOSITE LEG, PELVIS TILTS DOWN ON (NON-PARALYZED) OPPOSITE SIDE.

Trendelenburg Gait

0:03 / 0:28

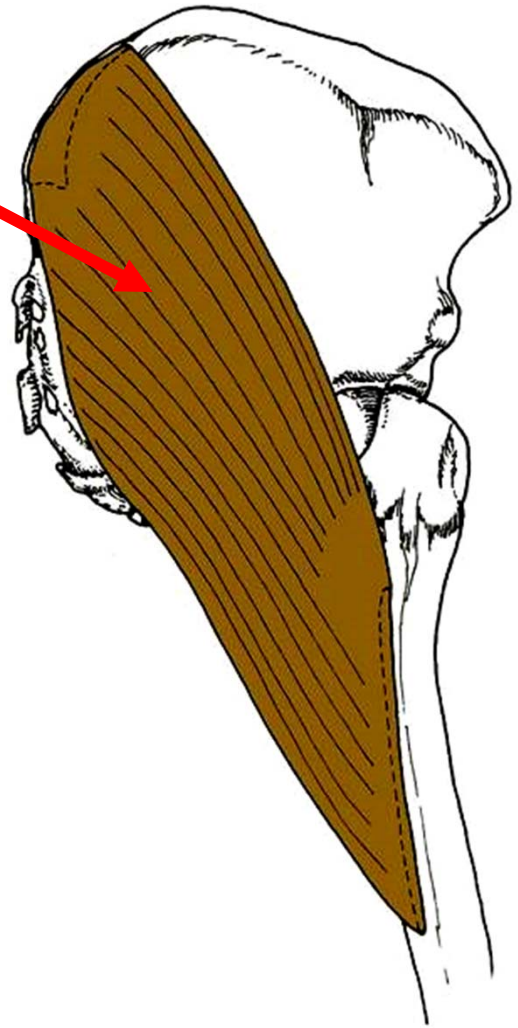
DISSECTION GLUTEAL REGION FROM POSTERIOR SIDE

Gluteus Maximus



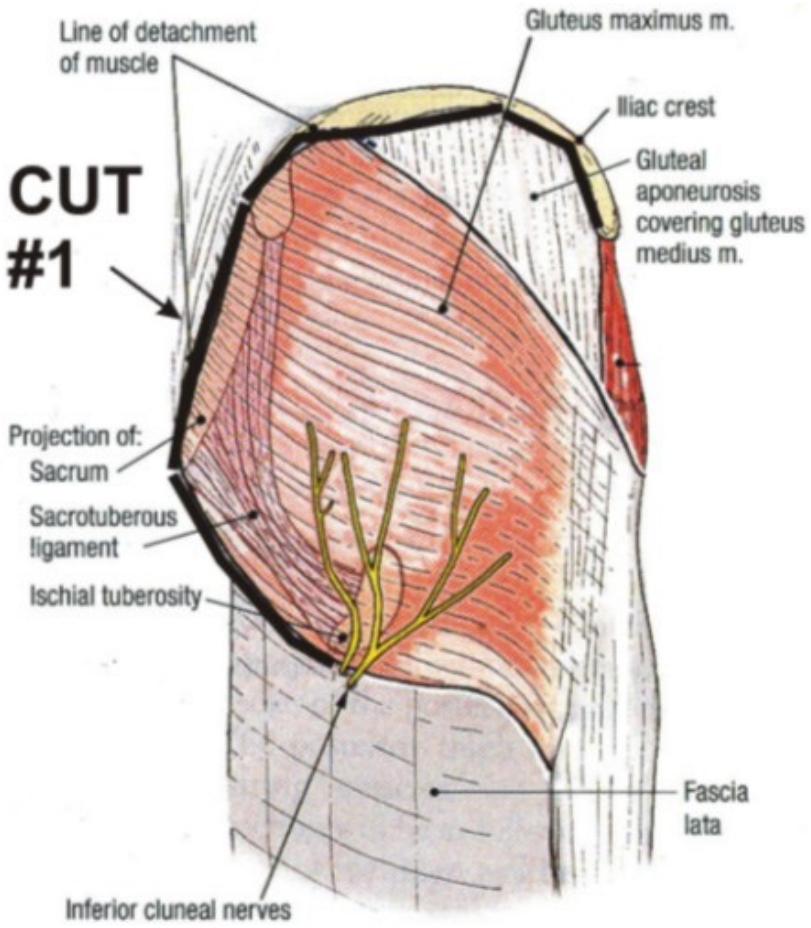
define lower margin of Gluteus maximus

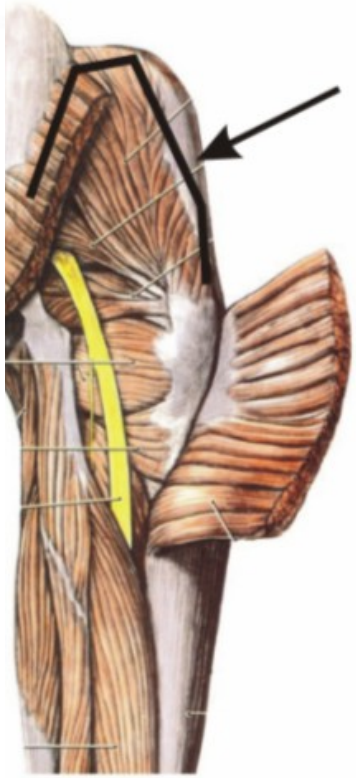
POSTERIOR



LATERAL

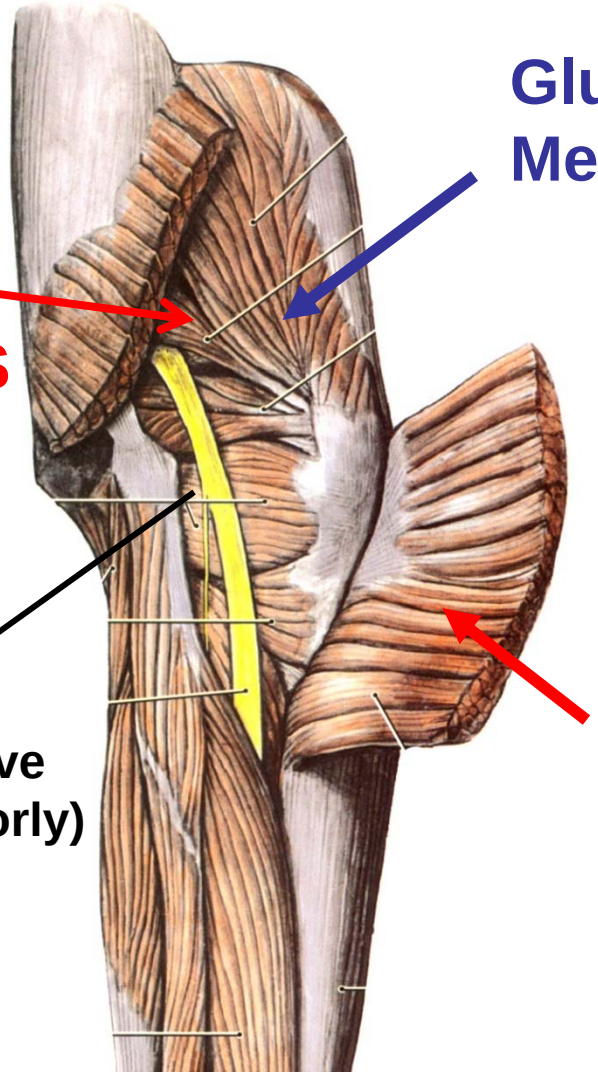
DISSECTION CUTS FOR GLUTEAL REGION LABORATORY





CUT #2 - Glut. Med.

DISSECTION GLUTEAL REGION FROM POSTERIOR SIDE

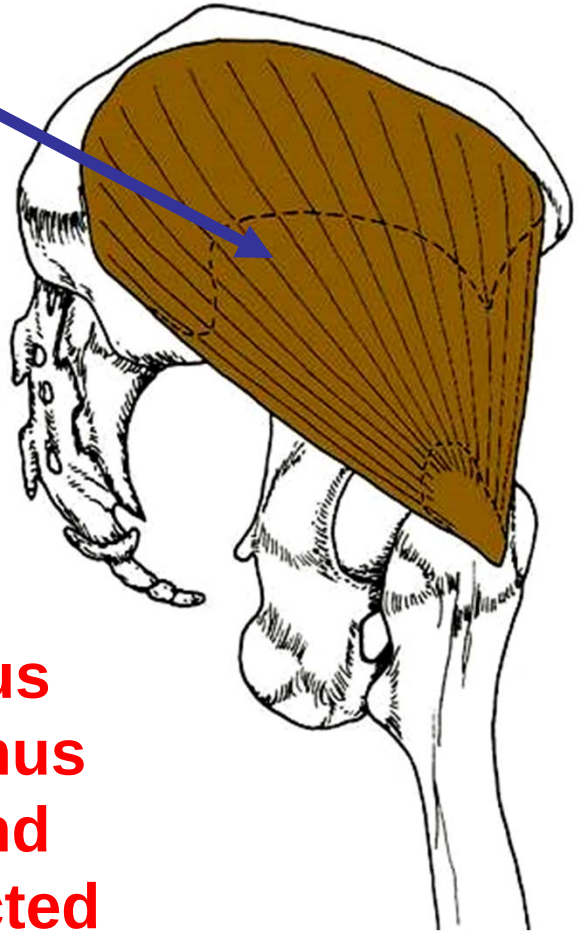


Gluteus Medius

IDENTIFY PIRIFORMIS MUSCLE

follow Sciatic nerve up (superiorly)

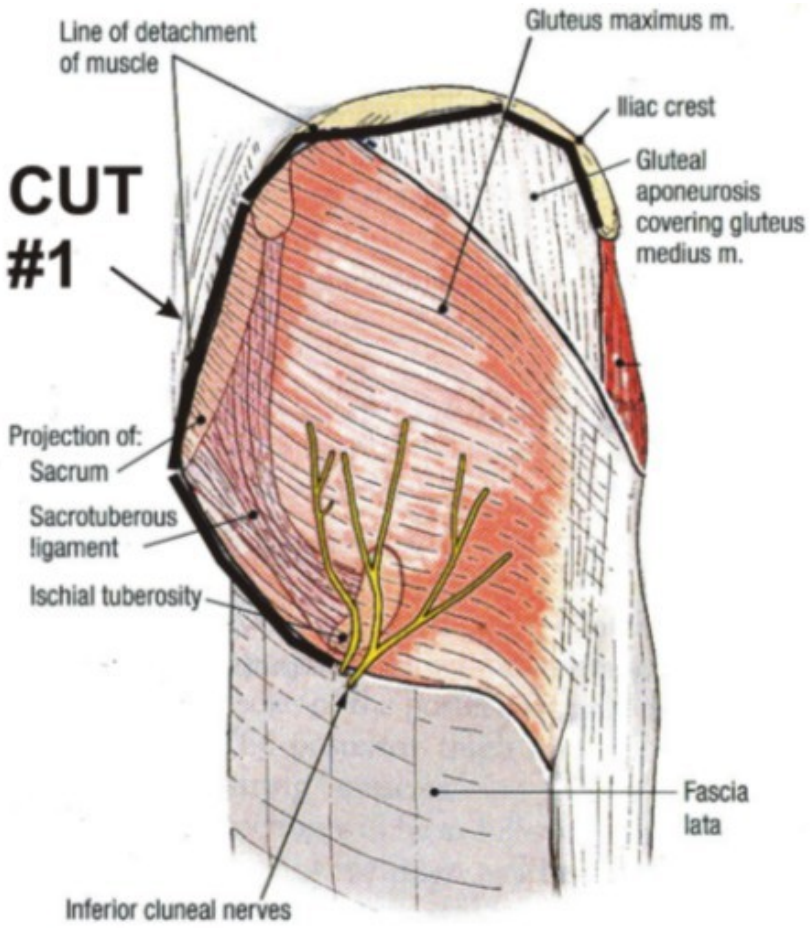
Gluteus Maximus Cut and Reflected

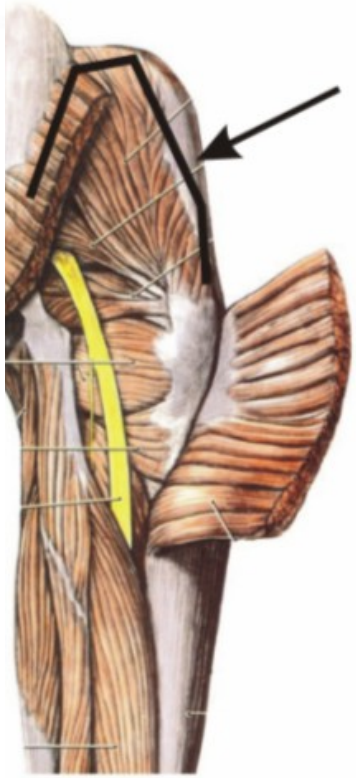


POSTERIOR

LATERAL

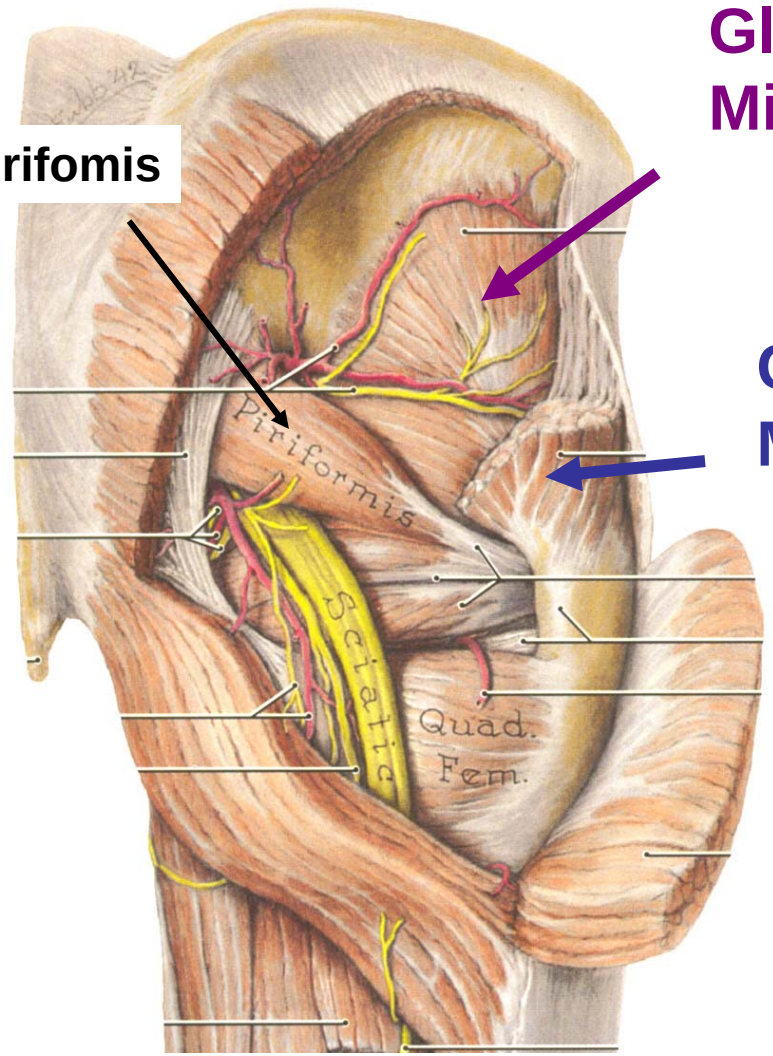
DISSECTION CUTS FOR GLUTEAL REGION LABORATORY



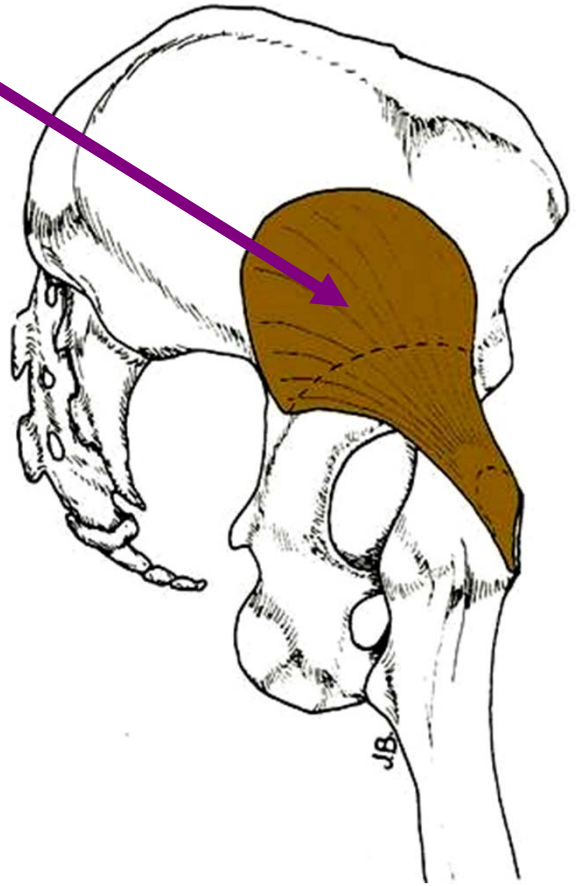


CUT #2 - Glut. Med.

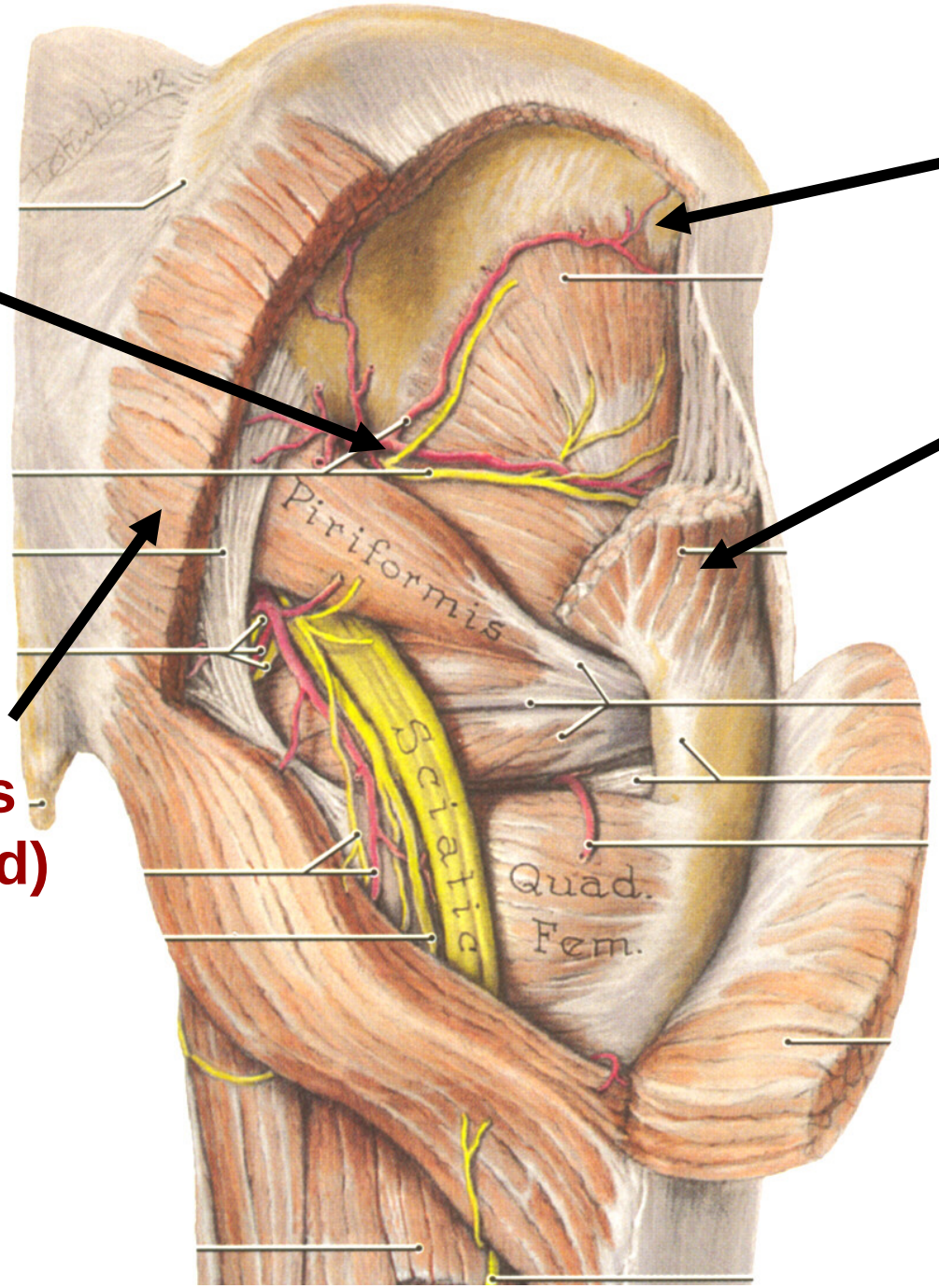
DISSECTION GLUTEAL REGION FROM POSTERIOR SIDE



POSTERIOR



LATERAL



Superior Gluteal Artery + Nerve

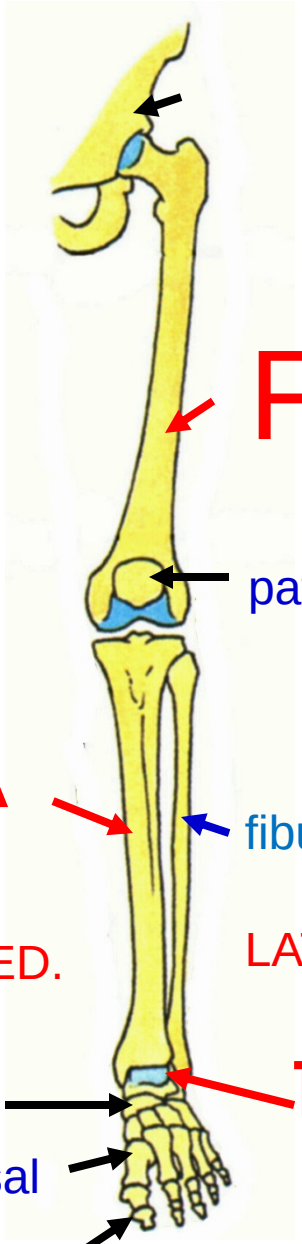
Gluteus Minimus

Gluteus Medius (reflected)

Gluteus Maximus (reflected)

Gluteus Medius and Minimus - located deep to Gluteus Maximus; Gluteus **Minimus is deepest and separated from Gluteus Medius by Superior Gluteal nerves and vessels (landmark on practical exam)**

BODY WEIGHT



calcaneus
first metatarsal

HEAD'S UP: STUDYING FILE: TABLE OF MUSCLES

TABLE OF MUSCLES OF LOWER EXTREMITY

ANTERIOR THIGH

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Iliopsoas	**Ilium, vertebra** (T12-L5)	**Femur**	Flex hip joint	Femoral nerve
Pectineus	**Pubis**	**Femur**	Flex hip joint	Femoral nerve
Sartorius	**Ilium** (Anterior superior iliac spine)	**Tibia**	Flex hip joint; Flex knee	Femoral nerve
Rectus femoris	**Ilium** (Anterior inferior iliac spine)	**Patella**	Flex hip joint, Extend knee	Femoral nerve
Vastus lateralis	**Femur**	**Patella**	Extend knee	Femoral nerve
Vastus medialis	**Femur**	**Patella**	Extend knee	Femoral nerve
Vastus intermedius	**Femur**	**Patella**	Extend knee	Femoral nerve

Note: Quadriceps inserts to Patella via Quadriceps tendon; Patella is linked to Tibia via Patellar Tendon.

MEDIAL THIGH

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Gracilis	**Pubis**	**Tibia**	1. Adduct hip joint 2. Flex knee	Obturator nerve
Adductor longus	**Pubis**	**Femur** (Linea aspera)	Adduct hip joint	Obturator nerve
Adductor brevis	**Pubis**	**Femur** (Linea aspera)	Adduct hip joint	Obturator nerve
Adductor magnus (adductor portion)	**Pubis, Ischium**	**Femur** (Linea aspera)	Adduct hip joint	Obturator nerve
Adductor magnus (hamstring portion)	**Ischial tuberosity**	**Femur** (Adductor tubercle)	Extend hip joint	Sciatic Nerve (Tibial part)
Obturator externus	**Obturator membrane**	**Femur**	Laterally rotate femur at hip joint	Obturator nerve

- Need to know: Origin, Insertion, Action, Innervation according to Table

QUESTIONS ON BOTH PRACTICAL AND WRITTEN EXAMS

MUSCLE OF FOOT: TABLE OF INTRINSIC MUSCLES OF SOLE OF FOOT: PAGE 4

SOLE OF FOOT - FIRST LAYER

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Abductor hallucis	Calcaneus	Proximal phalanx of big toe	Abduct and flex big toe	Medial plantar nerve
Abductor digiti minimi	Calcaneus	Proximal phalanx of little toe	Abduct and flex little toe	Lateral plantar nerve
Flexor digitorum brevis	Calcaneus	Middle phalanges of lateral four toes	Flex lateral four toes	Medial plantar nerve

SOLE OF FOOT - SECOND LAYER

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Quadratus plantae	Calcaneus	Common tendon of flexor digitorum longus	Assist in flexing lateral four toes	Lateral plantar nerve
Lumbricals	Tendons of flexor digitorum longus	1. Proximal phalanges of lateral four toes 2. Extensor expansions	1. Flex toes at metatarsophalangeal joint 2. Extend toes at interphalangeal joints	Lumbrical 1: Medial plantar nerve Lumbricals 2-4: Lateral plantar nerve

SOLE OF FOOT - THIRD LAYER

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Flexor hallucis brevis	Cuboid and lateral cuneiform bones	Proximal phalanx of big toe	Flex big toe	Medial plantar nerve
Flexor digiti minimi brevis	Fifth Metatarsal	Proximal phalanx of little toe	Flex little toe	Lateral plantar nerve
Adductor hallucis	1. Oblique head: Metatarsal bones 2. Transverse head: plantar ligaments of metatarsophalangeal joints	Proximal phalanx of big toe	Adduct and flex big toe	Lateral plantar nerve

SOLE OF FOOT - FOURTH LAYER

MUSCLE	ORIGIN	INSERTION	ACTION	NERVE
Plantar Interosseus	Metatarsals 3-5	Proximal	Adduct toes and flex	Lateral Plantar

NOTE: INTRINSIC MUSCLES OF FOOT FOR LOWER EXTREMITY EXAM

KNOW:
- IDENTIFY MUSCLES OF FOOT
- ACTIONS OF MUSCLES
- INNERVATION OF MUSCLES

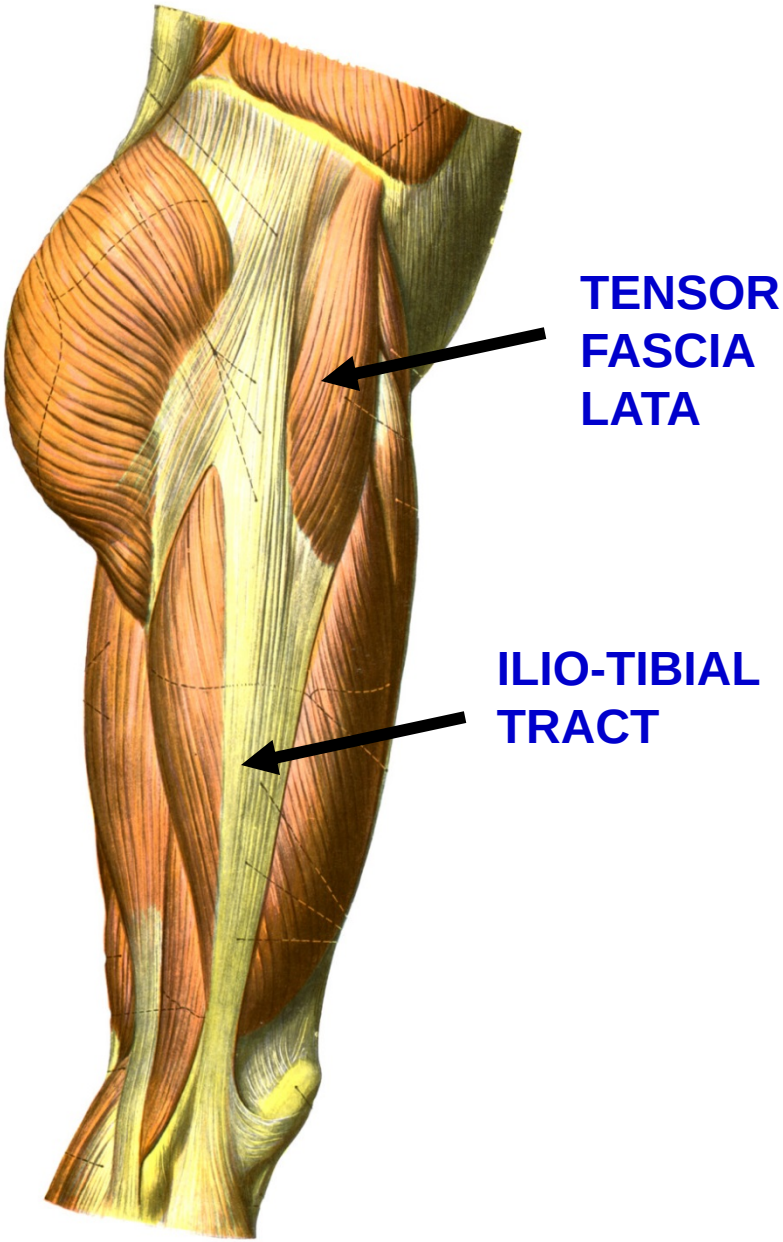
FOR INTRINSIC MUSCLES OF FOOT ONLY:

DO NOT NEED TO KNOW ORIGINS AND INSERTIONS

ALL OTHER MUSCLES NEED TO KNOW ORIGINS, INSERTIONS, ACTIONS, INNERVATION

TENSOR FASCIA LATA

3. Tensor Fascia Lata - O - Ant. Sup. Iliac spine **I - Iliotibial tract**; Act - Abducts HIP and maintains extension of leg Inn - Superior Gluteal nerve.



LOOK FOR MUSCLE ATTACHED TO FASCIA OF IT TRACT

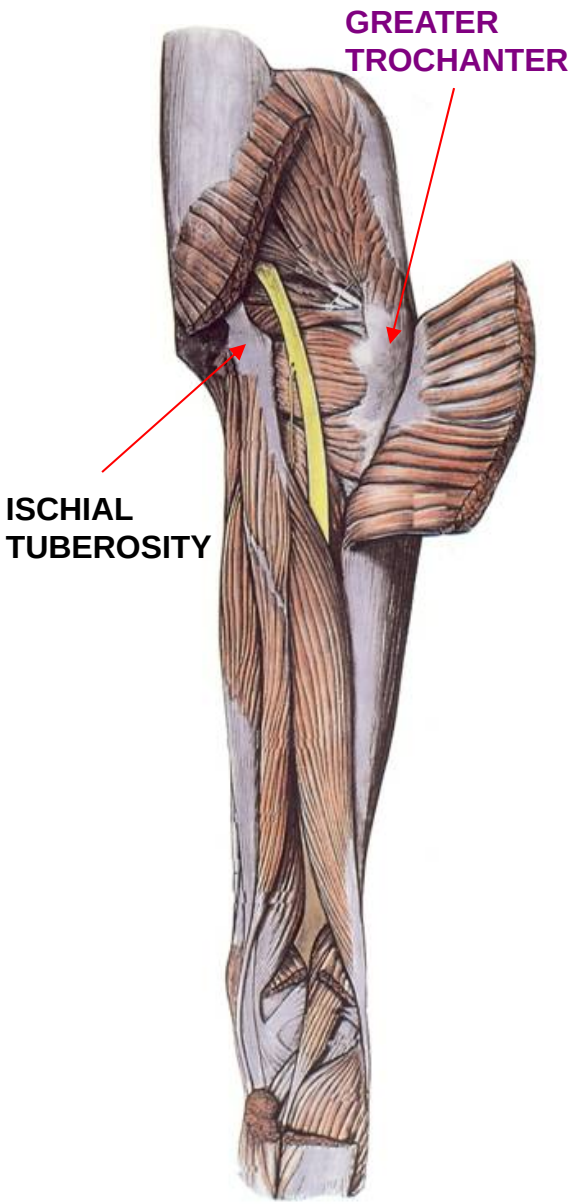
B. BURSAE

BURSAE - bags of fluid surrounded by connective tissue

Function as shock absorbers, reduce friction of movement of muscle tendons against bones or other tendons

Bursae are found adjacent to Ischial Tuberosity and Greater Trochanter

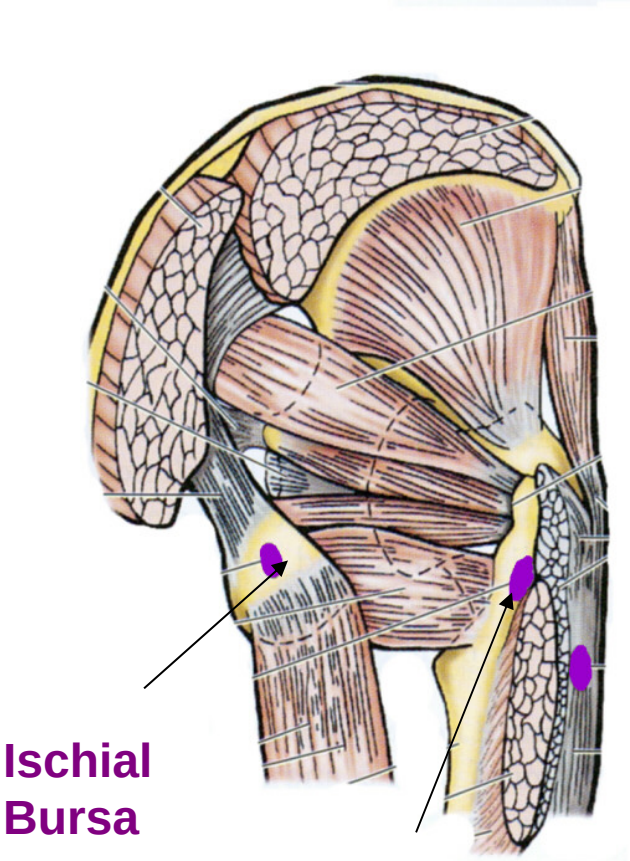
BURSA AT ELBOW JOINT

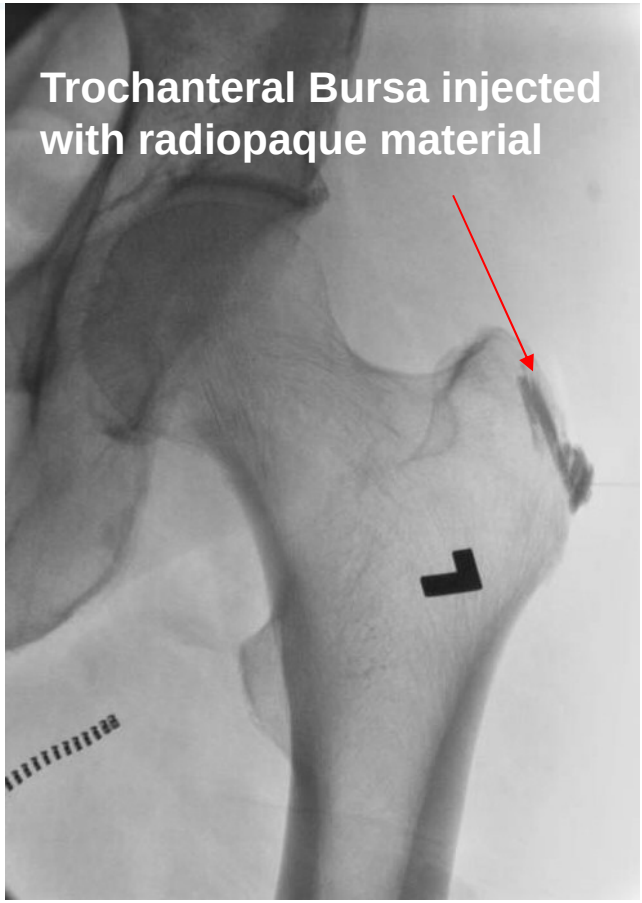


B. BURSAE

1. Trochanteral Bursa - separates Gluteus Maximus from Greater Trochanter of Femur and Vastus Lateralis.

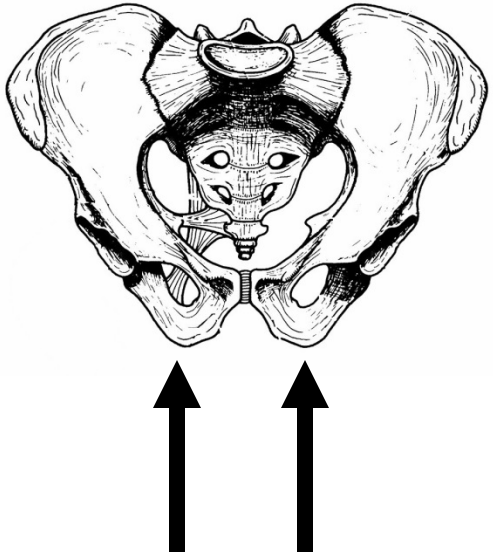
2. Ischial Bursa - separates Gluteus Maximus from Ischial tuberosity.



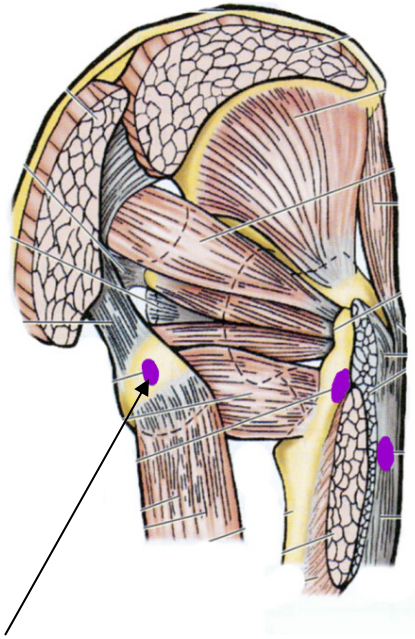


ISCHIAL BURSITIS CALLED WEAVER'S BOTTOM

Weaver on Treadle



Sit on Ischial Tuberosities



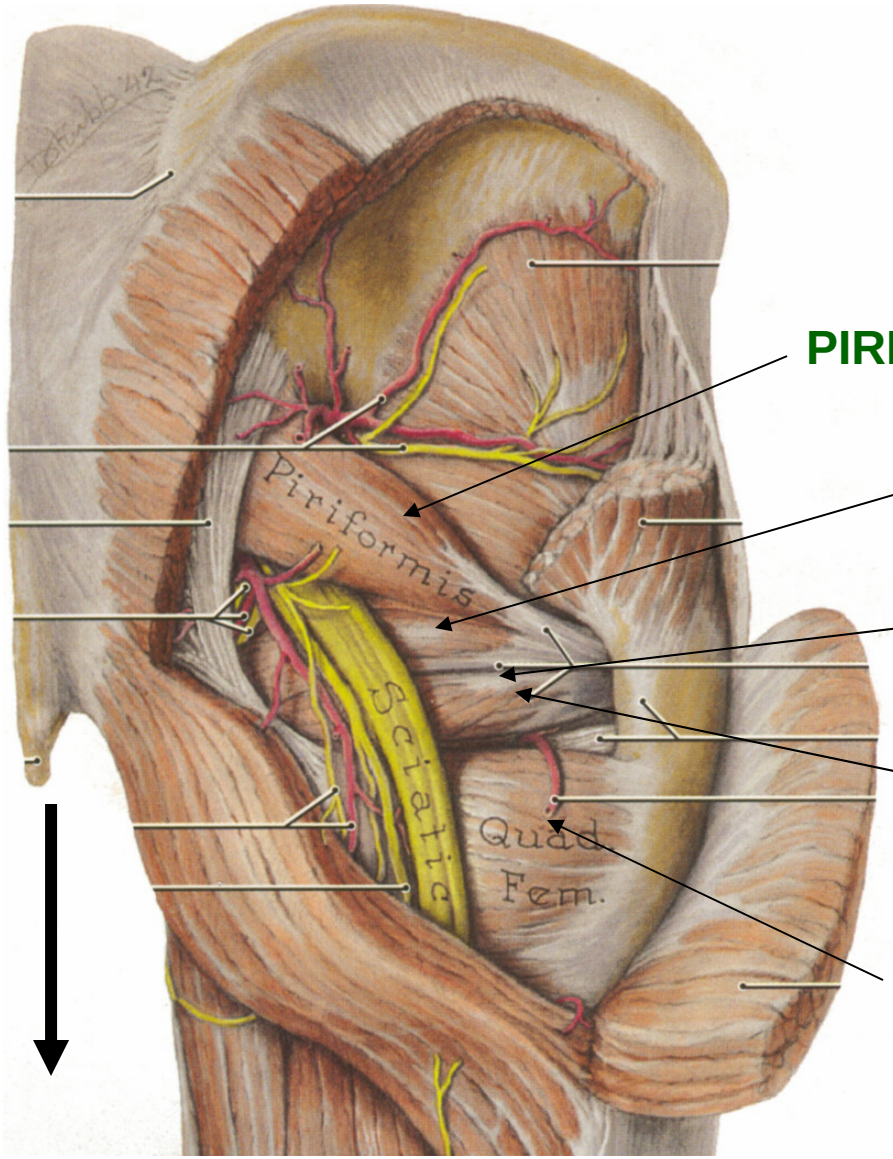
Movement Inflames Ischial Bursa

Note: Weaver's Bottom - Inflammation of Ischial Bursae; when sitting, weight of body rests on Ischial tuberosities (Gluteus maximus covers Ischial tuberosities when standing, but not when sitting); Ischial bursae may become inflamed due to excess friction (Weavers used legs to power treadles by repeated leg extension, causing inflammation of Ischial bursae); may also become inflamed in paraplegics (wheelchairs).

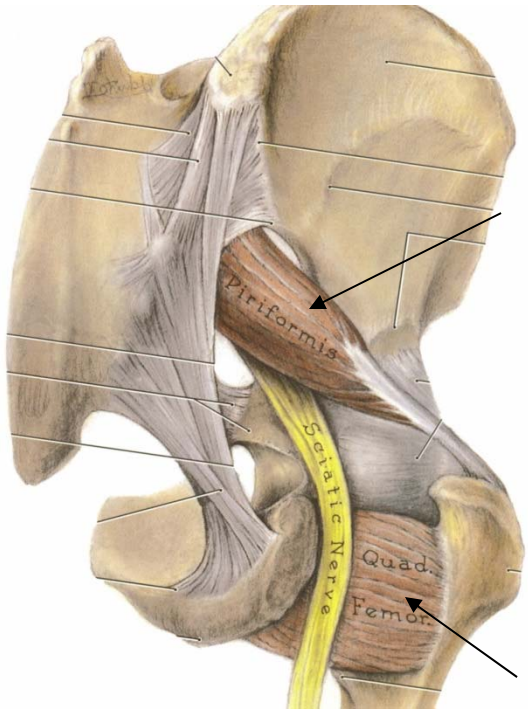
PIRIFORMIS AND MUSCLES BELOW PIRIFORMIS

C. **PIRIFORMIS AND MUSCLES BELOW PIRIFORMIS** - Piriformis (=pear shaped), Quadratus femoris, Obturator Internus, Gemellus superior, Gemellus inferior (from L. Gemini, twin; **pronounce Je-mel'-us)**

LEARN SEQUENCE

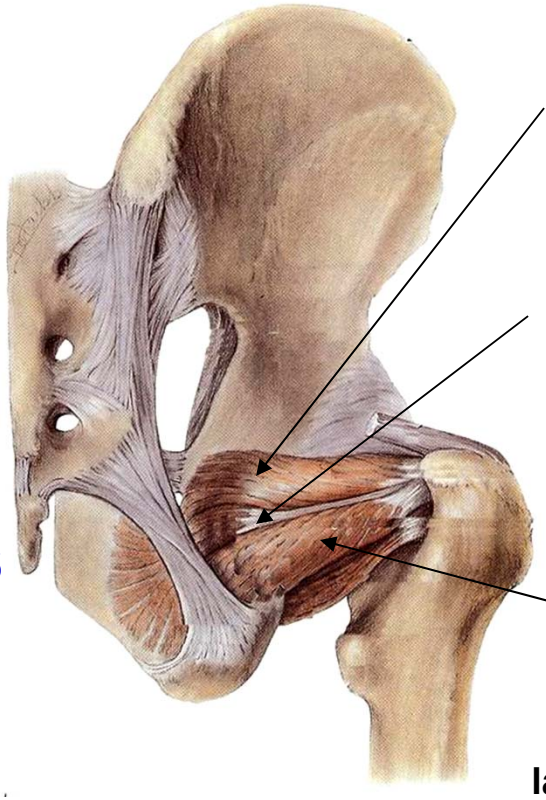


PIRIFORMIS AND MUSCLES BELOW PIRIFORMIS



PIRIFORMIS
O - Sacrum

QUADRATUS FEMORIS
O - Ischial Tuberosity



SUPERIOR GEMELLUS
O - Ischial spine

OBTURATOR INTERNUS
O - Obturator membrane

INFERIOR GEMELLUS
O - Ischial Tuberosity

laterally rotate femur

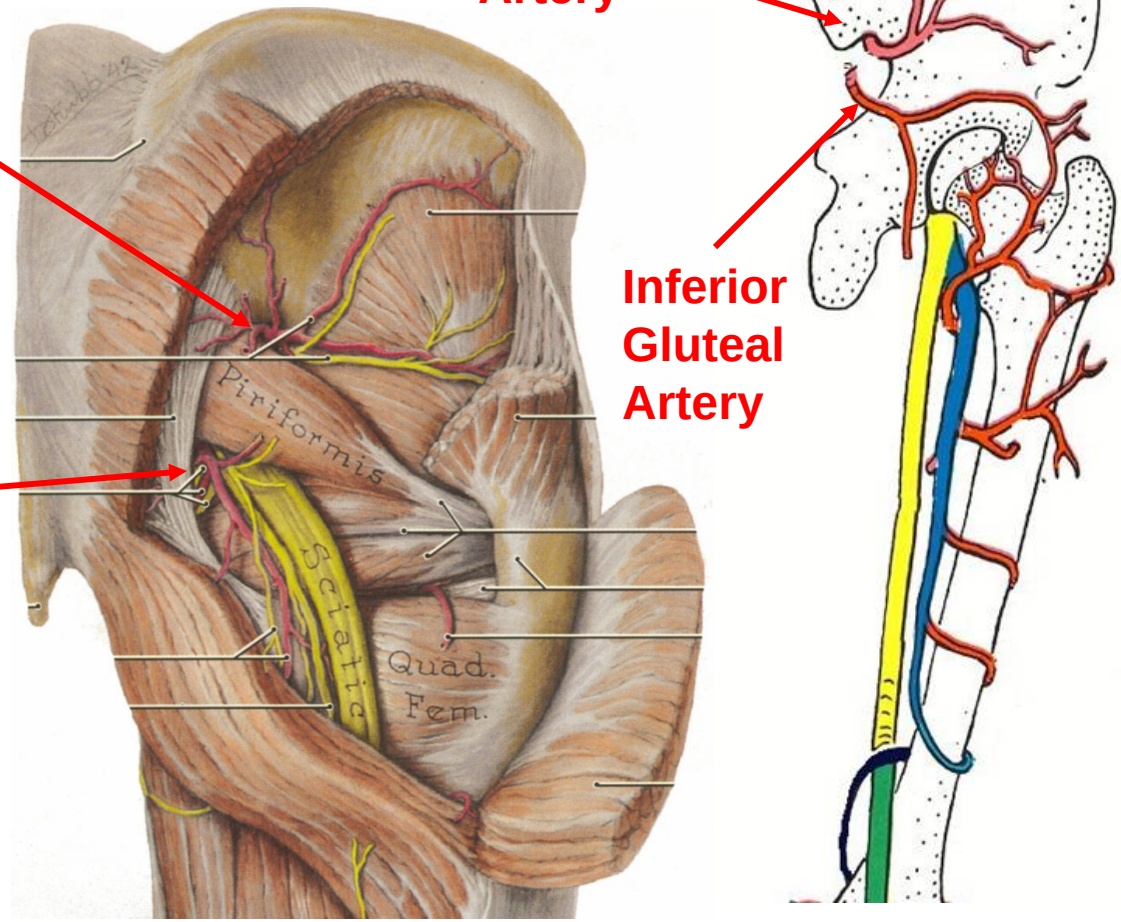
MOST INSERT - GREATER TROCHANTER
ACT - LATERALLY ROTATE FEMUR; ALSO ACT LIKE ROTATOR CUFF AND HOLD HEAD OF FEMUR IN ACETABULUM
INNERVATION - BRANCHES NAMED FOR MUSCLES

III. ARTERIES AND NERVES .

- Arteries are branches of Internal Iliac
- all leave pelvis by Greater Sciatic foramen

1. **Superior Gluteal Artery** - **above Piriformis**; courses between Gluteus Medius and Gluteus Minimus.

2. **Inferior Gluteal Artery** - **below Piriformis**; branches joint Cruciate anastomosis at hip joint.

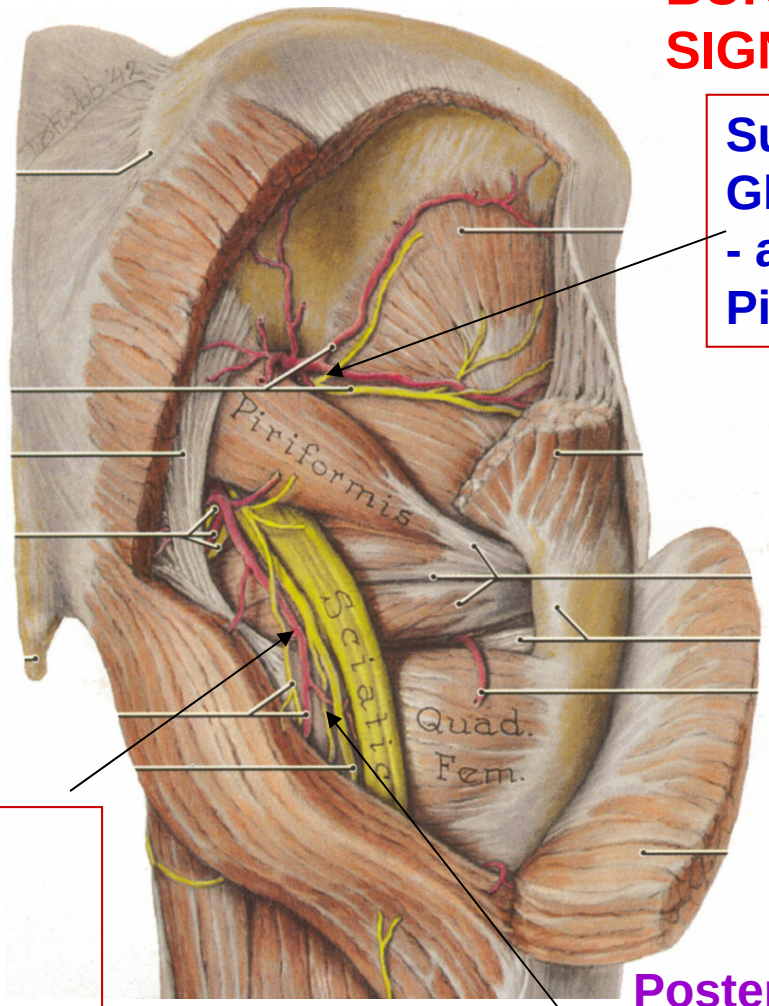


NERVES

B. NERVES- from Lumbosacral plexus

1. **Superior Gluteal Nerve** - innervates Gluteus Medius and Minimus, Tensor fascia lata.
2. **Inferior Gluteal Nerve** - innervates Gluteus Maximus.
3. **Posterior Cutaneous nerve of thigh** - large sensory nerve to posterior thigh and gluteal region, medial to Sciatic nerve

DAMAGE - TRENDELEN-BURG SIGN



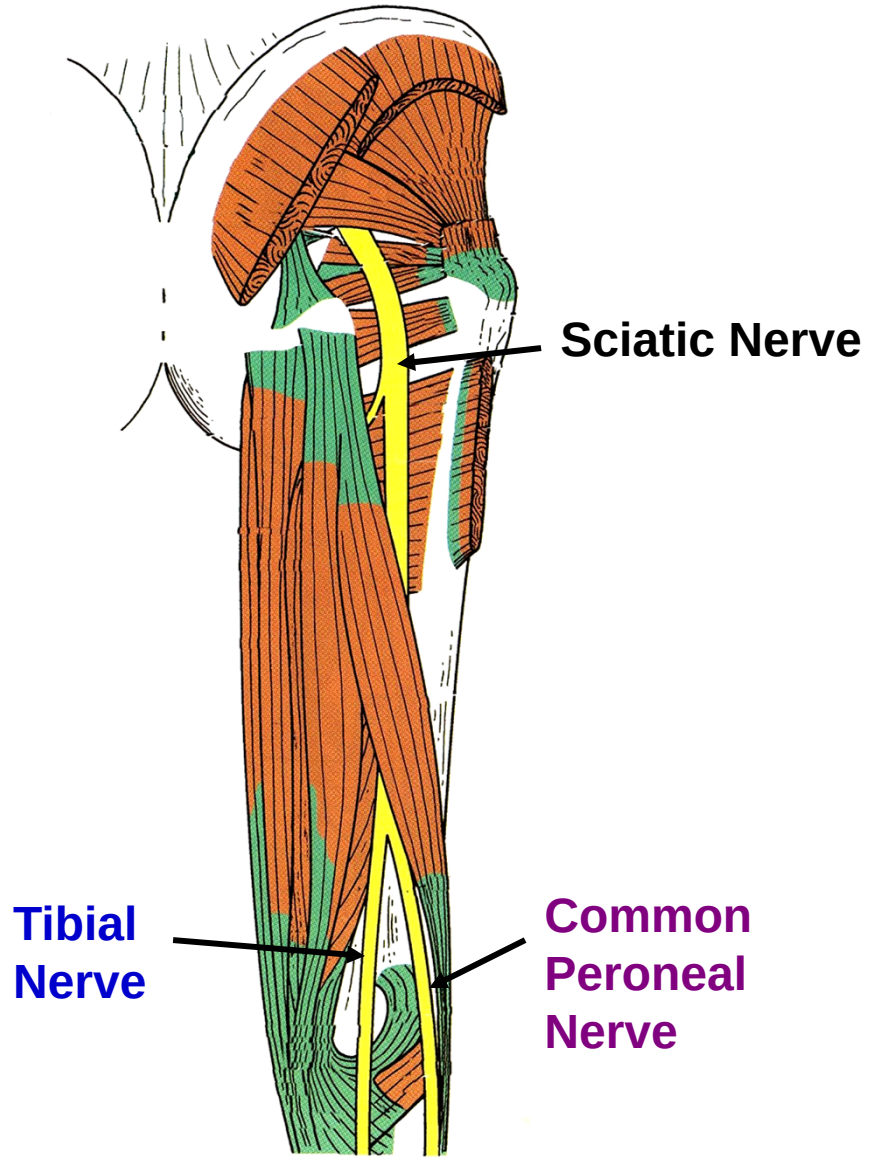
Superior Gluteal Nerve - above Piriformis

Inferior Gluteal Nerve - below Piriformis

Posterior Cutaneous nerve of thigh

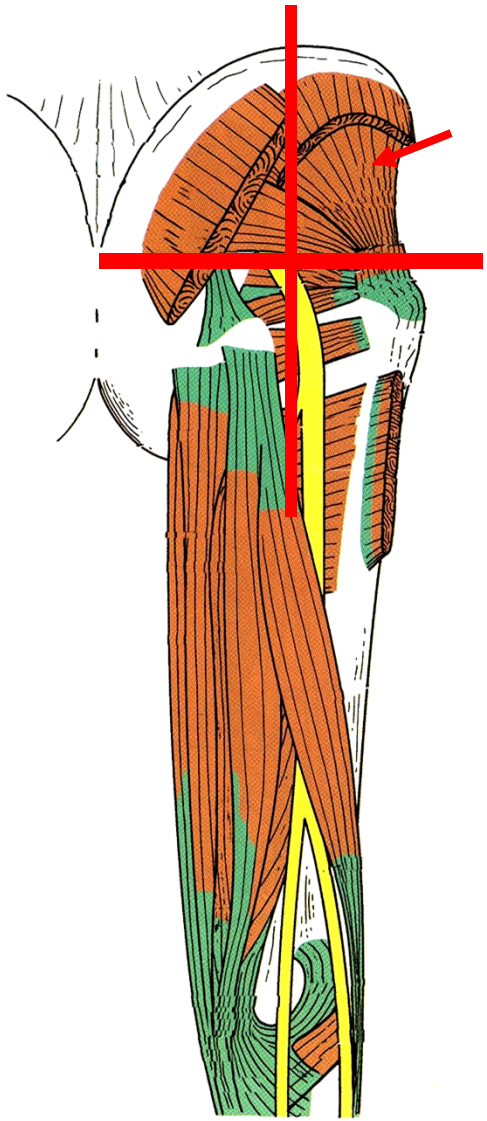
SCIATIC NERVE

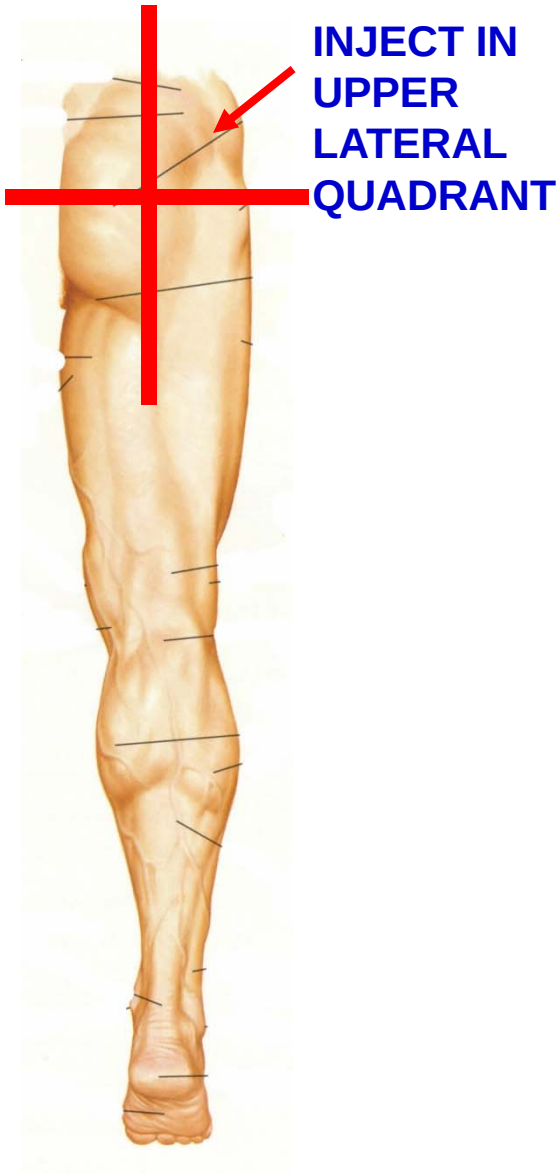
5. **Sciatic Nerve - largest nerve in body** (from L45,S123); composed of Tibial and Peroneal parts; ends as **Tibial Nerve** and **Common Peroneal Nerve**; courses first deep to Gluteus maximus, found halfway between ischial tuberosity and greater trochanter; can be **damaged in posterior dislocation of hip joint**.



INTRAMUSCULAR INJECTION IN GLUTEAL REGION - GIVE IN UPPER LATERAL QUADRANT TO AVOID SCIATIC NERVE

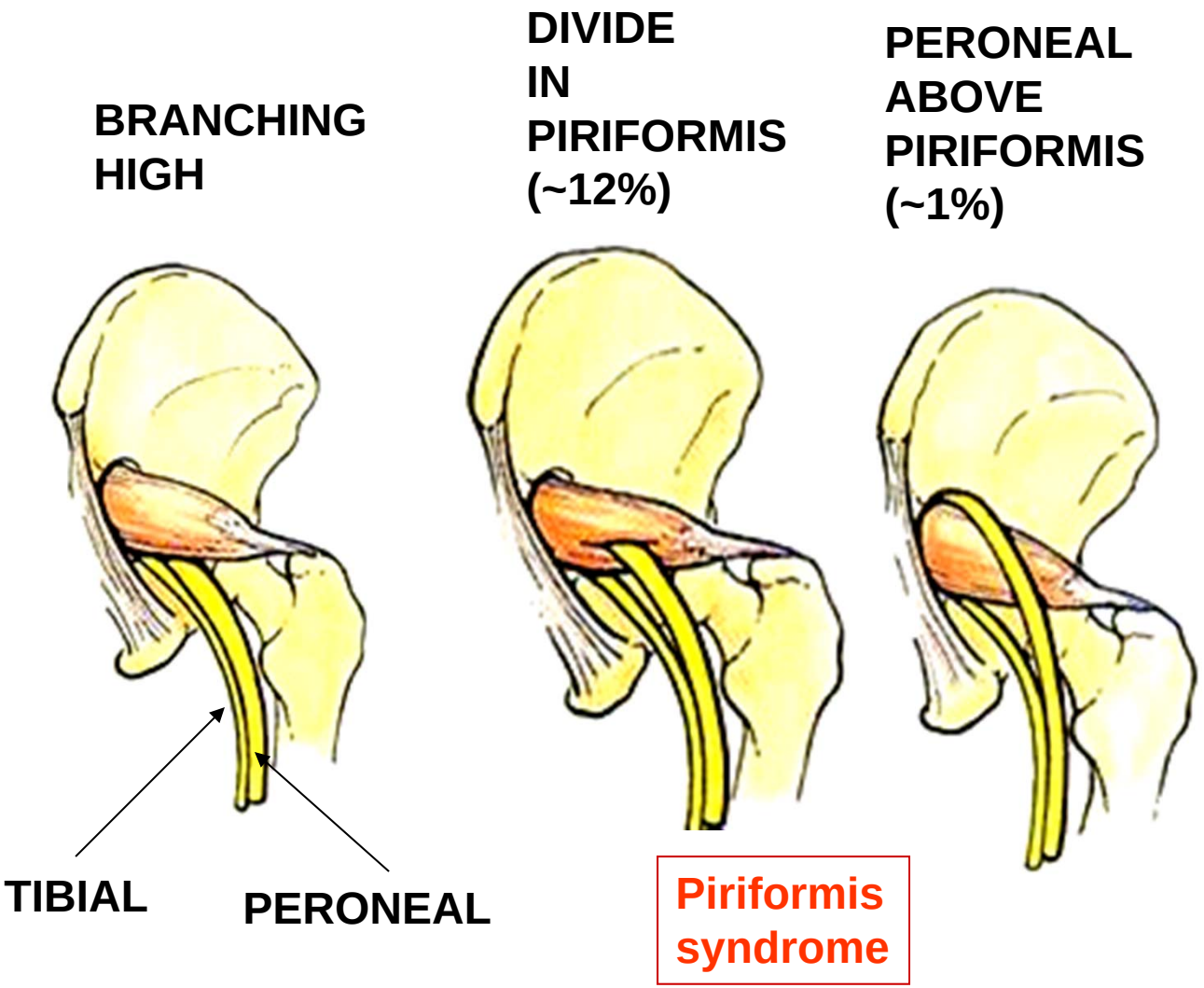
Clinical Note: Intramuscular Injection in Gluteal Region - need to **avoid damage to Sciatic nerve**; injection given in **Upper Lateral Quadrant of Gluteal region.**





EARLY BRANCHING OF SCIATIC NERVE

Clinical Note:
Early branching of Sciatic Nerve - Tibial and Peroneal parts normally branch in distal thigh but can branch early; Sciatic nerve looks like two nerves; **branches can sometimes be through Piriformis and get compressed**

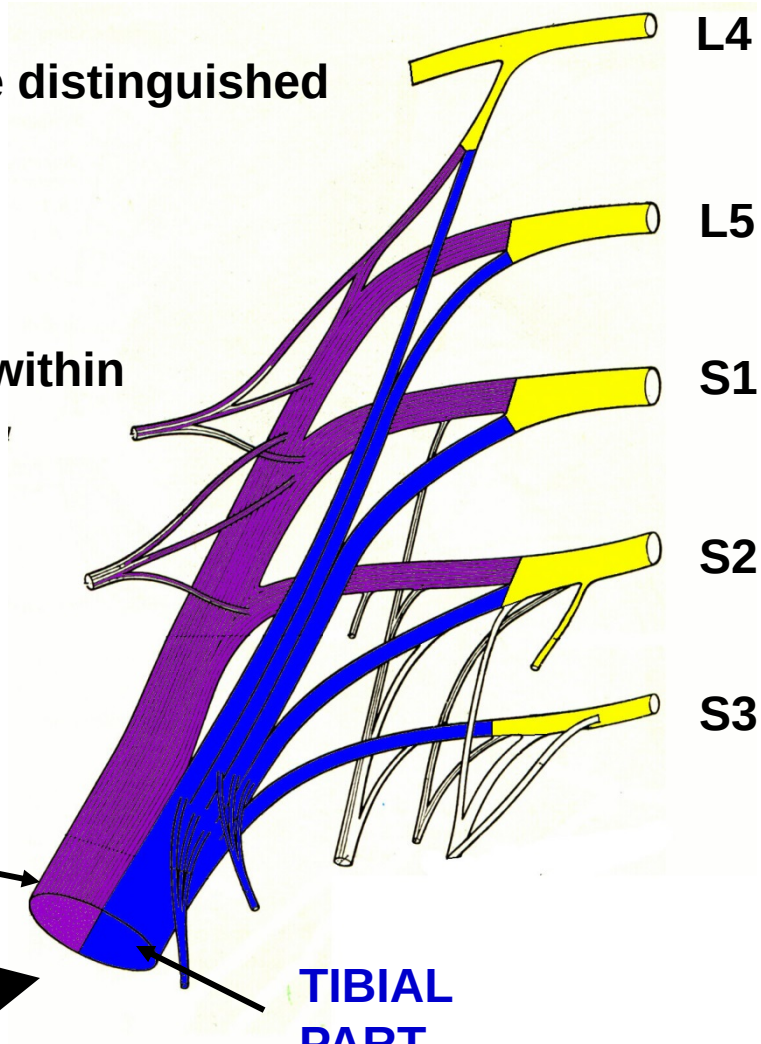


TIBIAL AND PERONEAL PARTS CAN BE DISTINGUISHED WITHIN SCIATIC NERVE

Tibial and peroneal parts can be distinguished in Sciatic nerve

1. Form from separate divisions

2. Remain as separate bundles within nerve



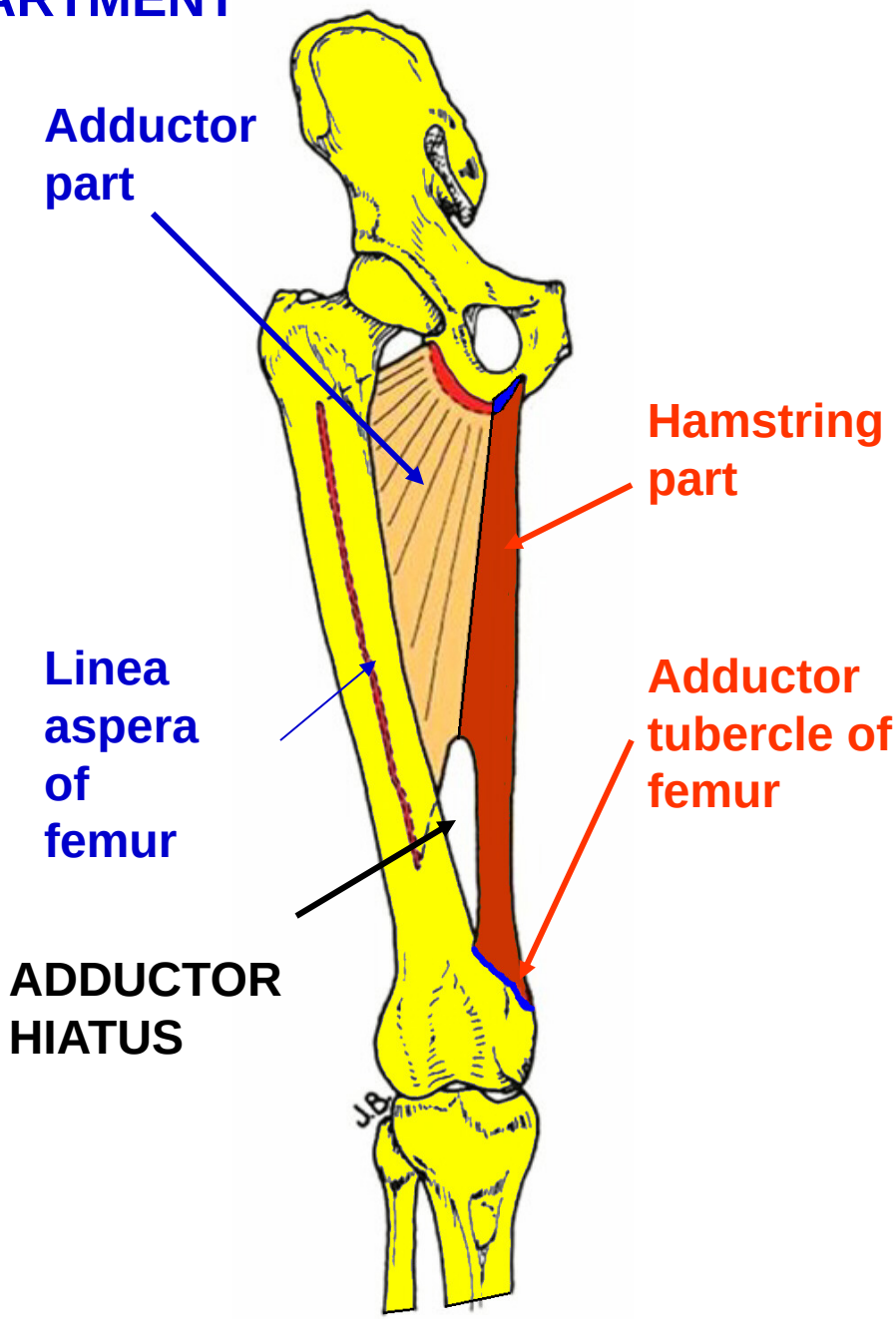
IV. MUSCLES OF MEDIAL COMPARTMENT

1. **Adductor Magnus** - has two parts;

a. **Adductor part** - origin: pubis and ischium, insert: **Linea aspera of femur**; action: Adduct thigh; innervation: **Obturator nerve**.

b. **Hamstring part** - origin Ischial tuberosity, inserts to **Adductor tubercle of femur**; action: Extends thigh (because of more posterior origin); **innervation: Tibial part of Sciatic nerve.**

Clinical Note: Tear or stretch of adductor group at pubis is called a Pulled Groin.

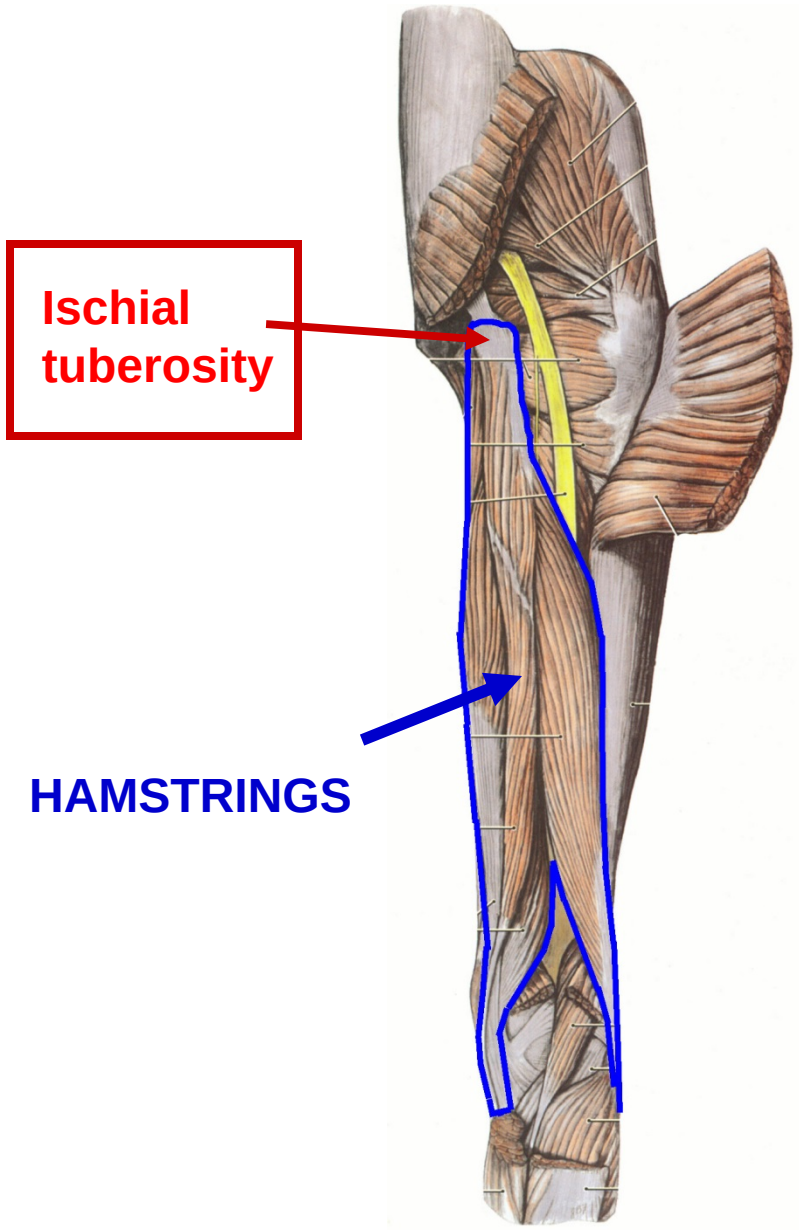


POSTERIOR THIGH - HAMSTRING MUSCLES

IV. POSTERIOR THIGH - muscles are called **hamstrings** **because used by butchers for hanging hams of pigs.**

A. **Hamstring muscles** - **all originate from Ischial tuberosity (except biceps short head);** all cross hip and knee joint and most are **Bifunctional (Extend thigh and flex leg);**

Adductor magnus - part of muscle taking origin from Ischial tuberosity is considered **hamstring part of Adductor magnus**.



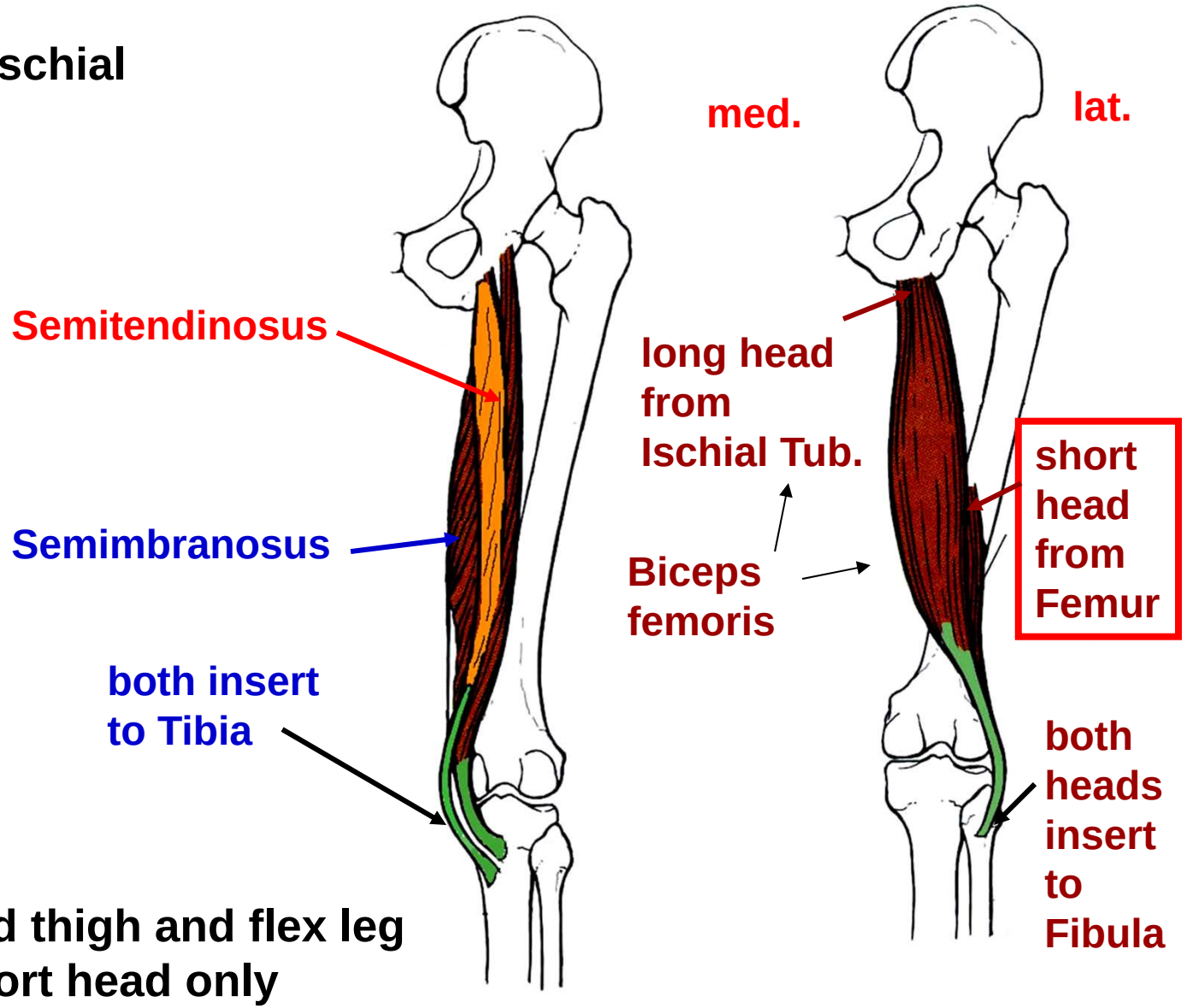
POSTERIOR THIGH - HAMSTRING MUSCLES

ORIGIN ALL - Ischial Tuberosity

1) **Semimbranosus** (named for flattened tendon),

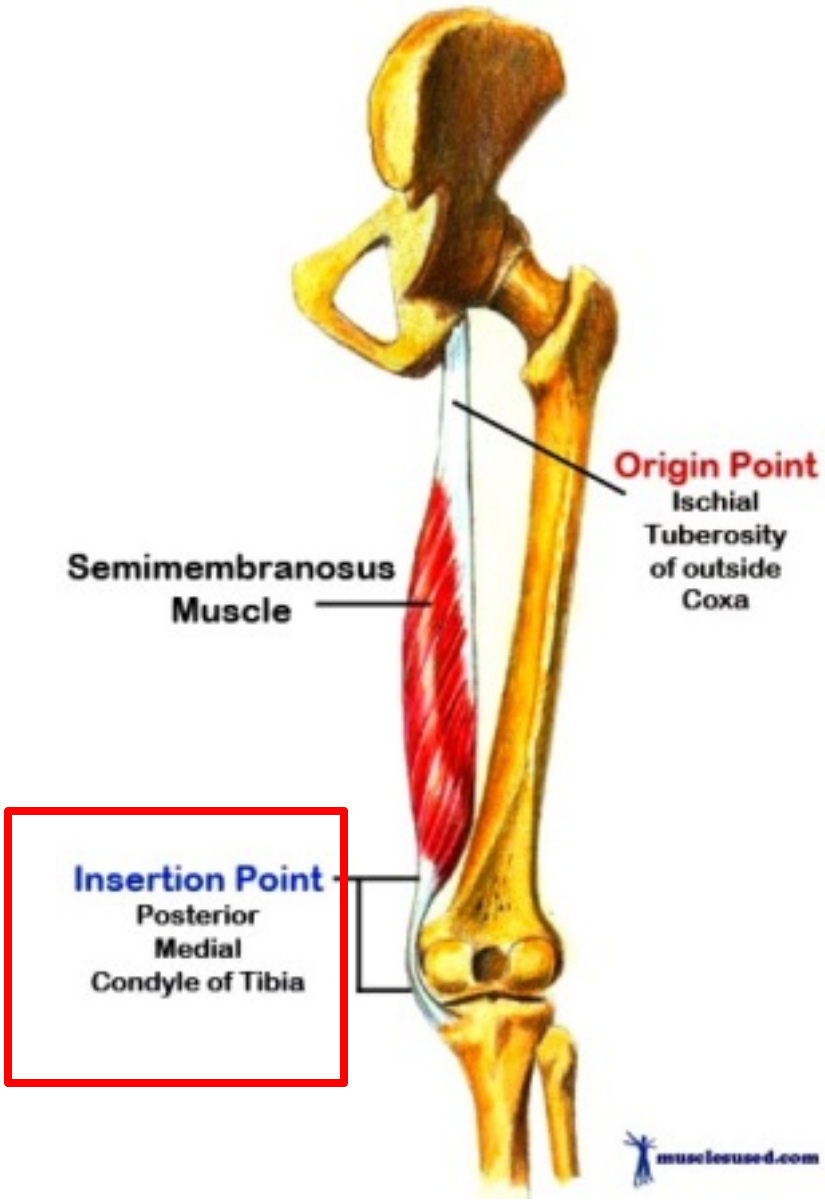
2) **Semitendinosus** (named for long tendon distally),

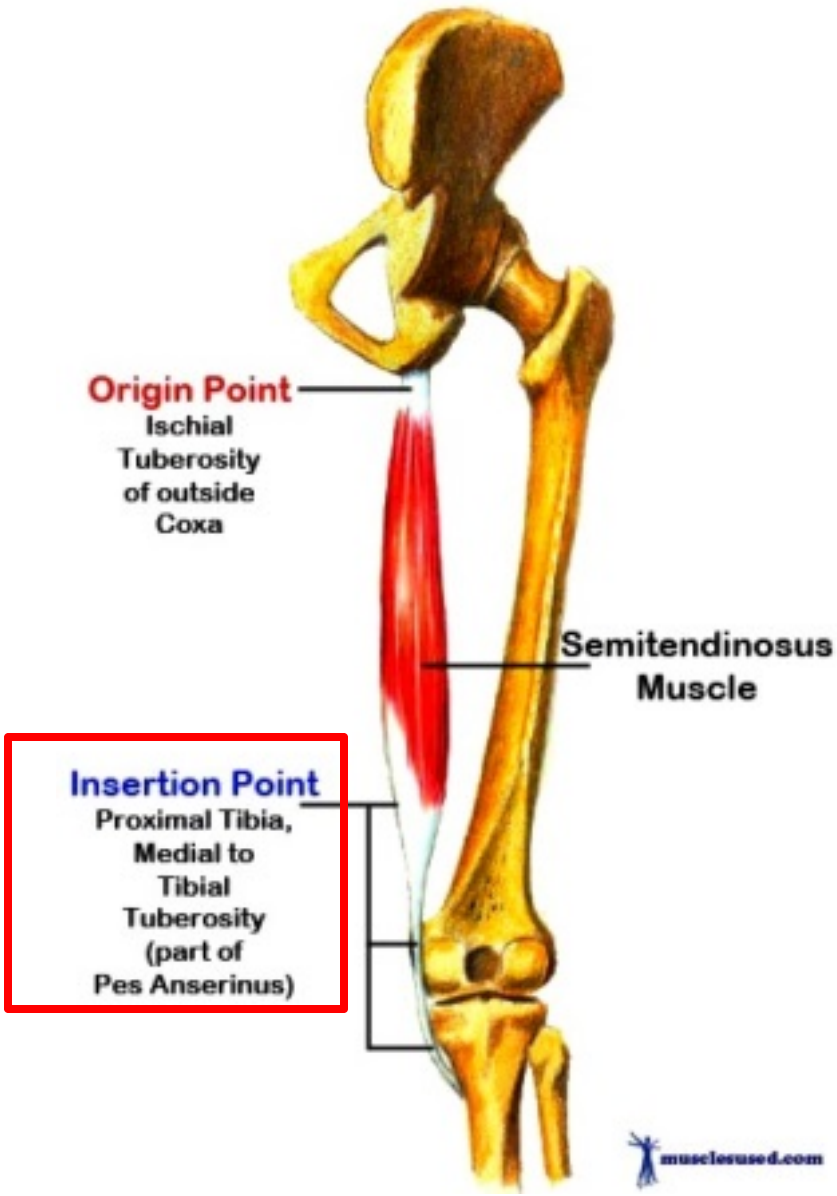
3) **Biceps femoris** (two heads, long head from Ischial tuberosity, short head from Linea aspera of femur),



Action - All Extend thigh and flex leg except Biceps Short head only flex leg

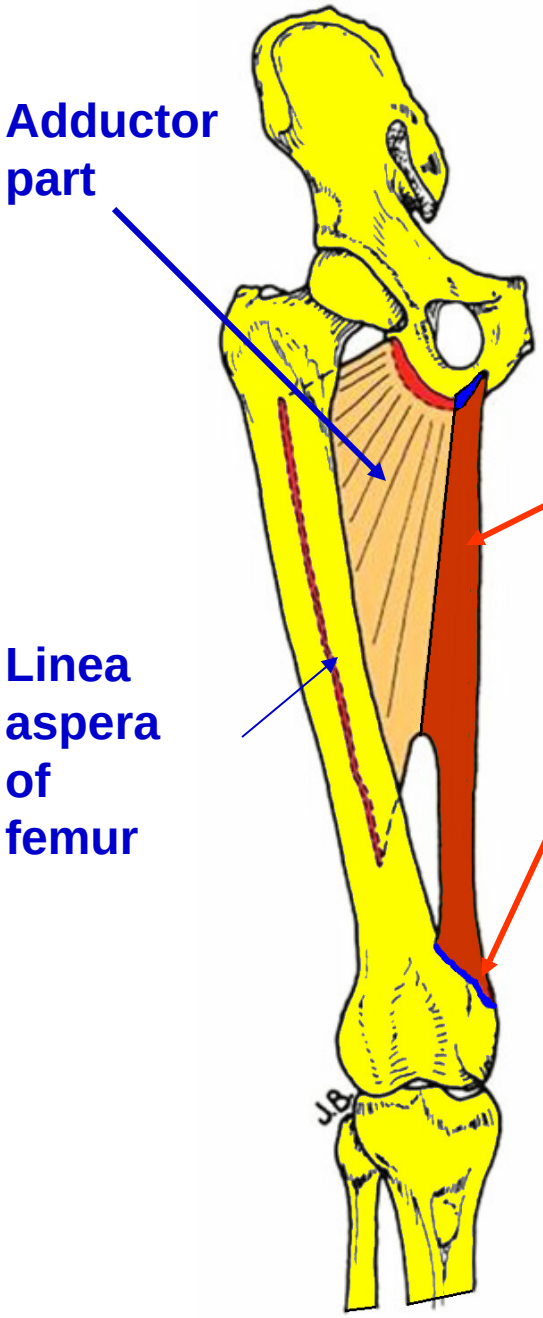
POSTERIOR THIGH - HAMSTRING MUSCLES





Adductor magnus - part of muscle taking origin from Ischial tuberosity is considered **hamstring part of Adductor magnus**.

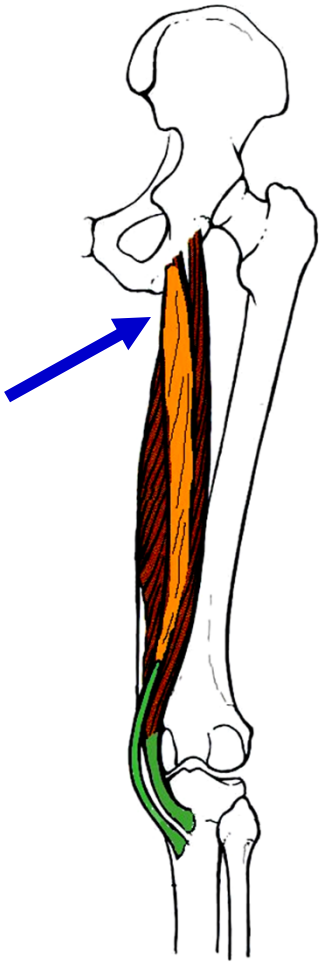
Innervation of Hamstrings - all innervated by Tibial part of Sciatic Nerve except Short head of Biceps - innervated by Peroneal part of Sciatic Nerve.



C. Arteries - Blood supply from perforating arteries (branches of Profunda femoris)

PULLED HAMSTRINGS - TEAR OR AVULSE FROM ISCHIAL TUBEROSITY

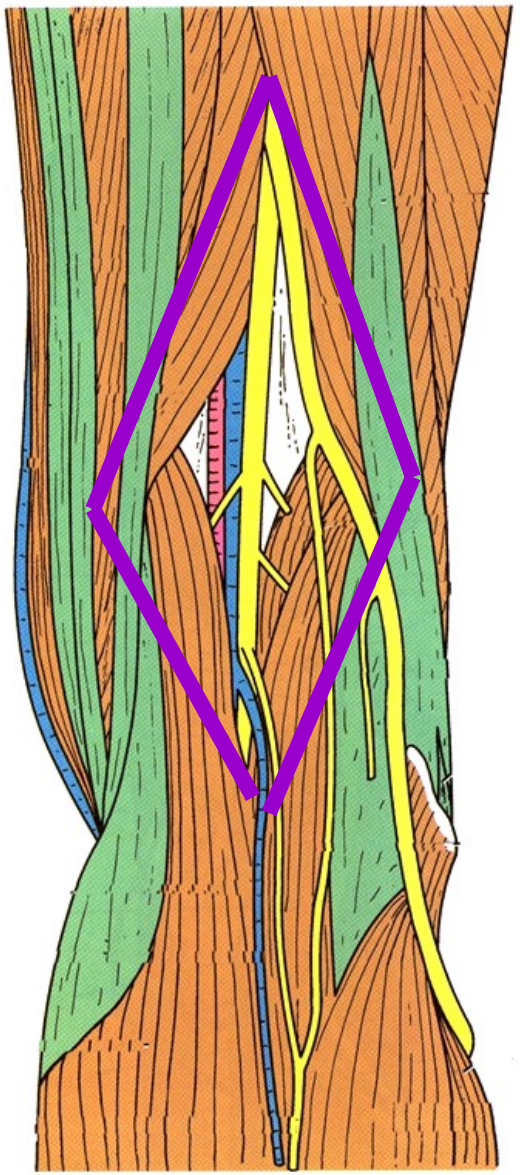
Clinical note:
Pulled Hamstrings - can tear or avulse (pull off) part of origin of muscles from Ischial tuberosity; can occur in **running** or when **extend knee (contract Quadriceps) when hamstrings are not relaxed**; extremely **painful**, **person writhes in unbearable agony.**



IN EXTREME CASES: AVULSION WITH FRACTURE OF ISCHIAL TUBEROSITY

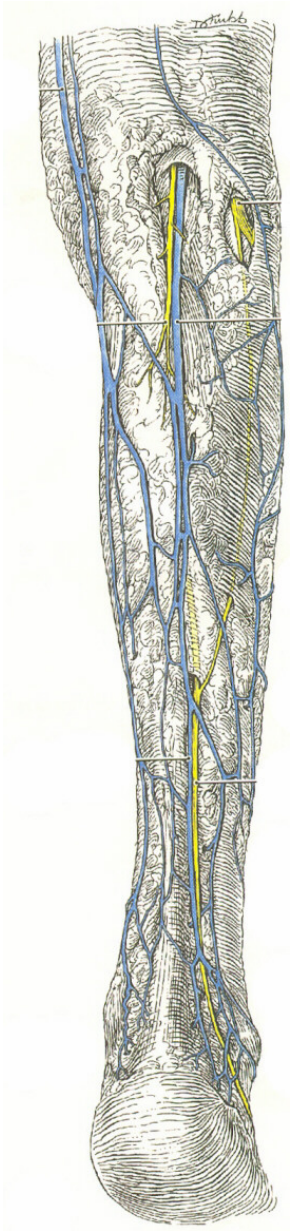
V. POPLITEAL FOSSA - diamond shaped region in back of knee; **boundaries** - **Superior: Semimembranosus and Semitendinosus** medial, **Biceps femoris** lateral; **Inferior** - Medial and lateral heads of **Gastrocnemius.**

V. POPLITEAL FOSSA

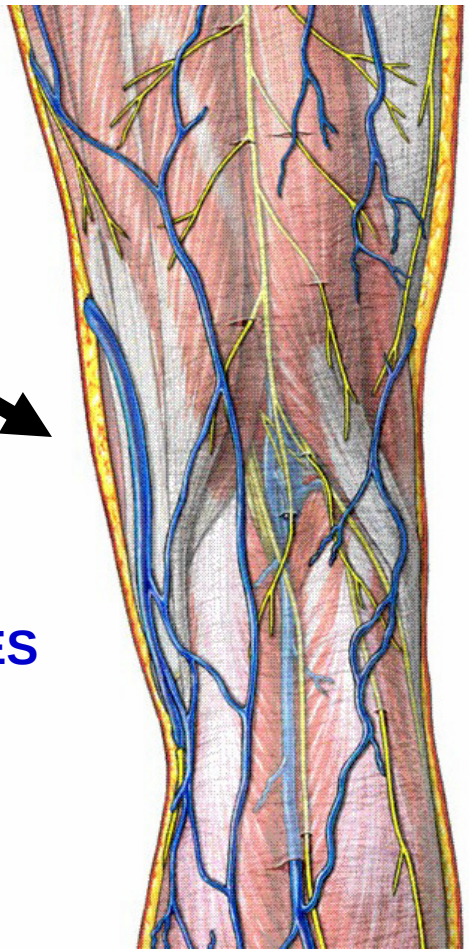


POPLITEAL FOSSA

A. **Fascia** - forms roof over fossa; **very strong and not permit expansion**; pain from abscess or tumor in fossa very painful.

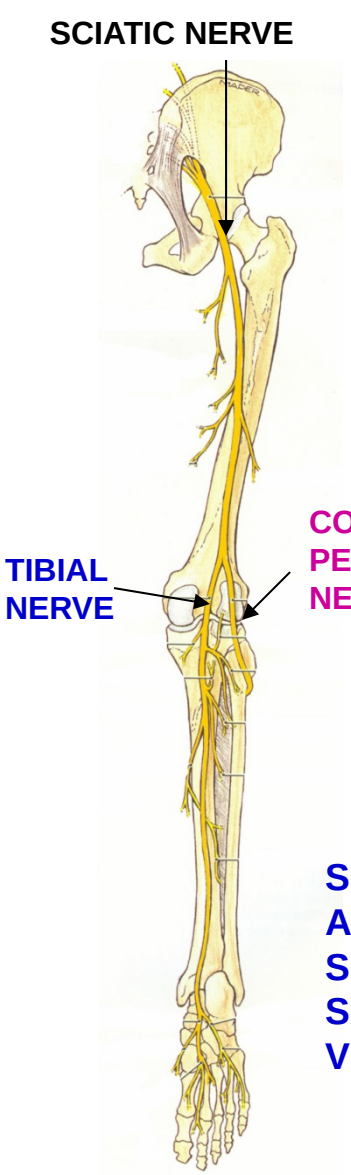


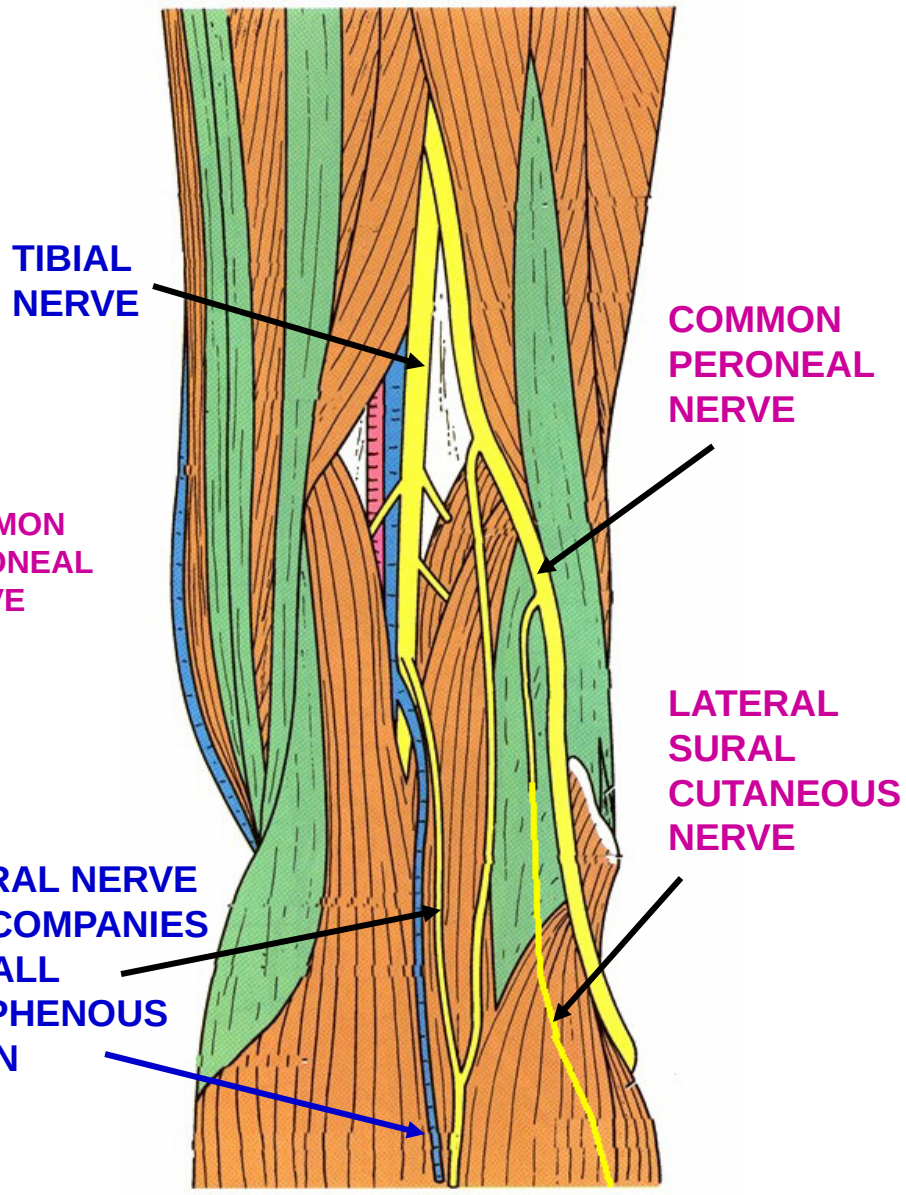
DENSE FASCIA OVERLIES FOSSA



SCIATIC NERVE BRANCHES TO TIBIAL AND COMMON PERONEAL NERVES

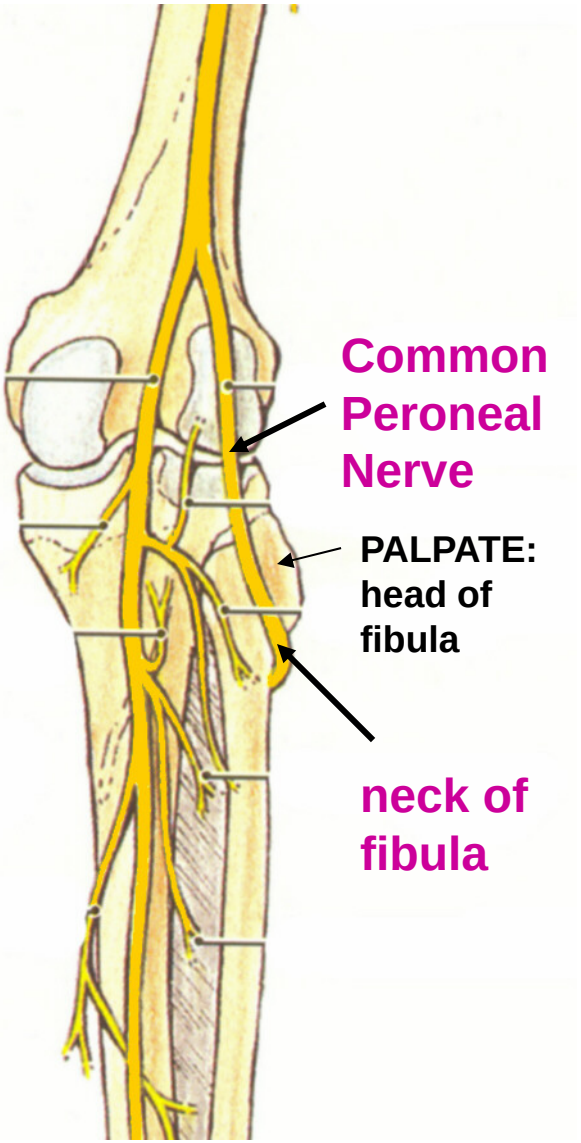
1. **Tibial nerve** - supplies posterior compartment of leg; branch:
Sural nerve (Medial Sural cutaneous nerve) accompanies Small Saphenous vein; **sensory to posterior side of calf** and lateral foot.
2. **Common Peroneal Nerve** - supplies lateral and anterior compartments of leg: branch:
Lateral Sural Cutaneous Nerve - sensory to **skin of lateral calf.**

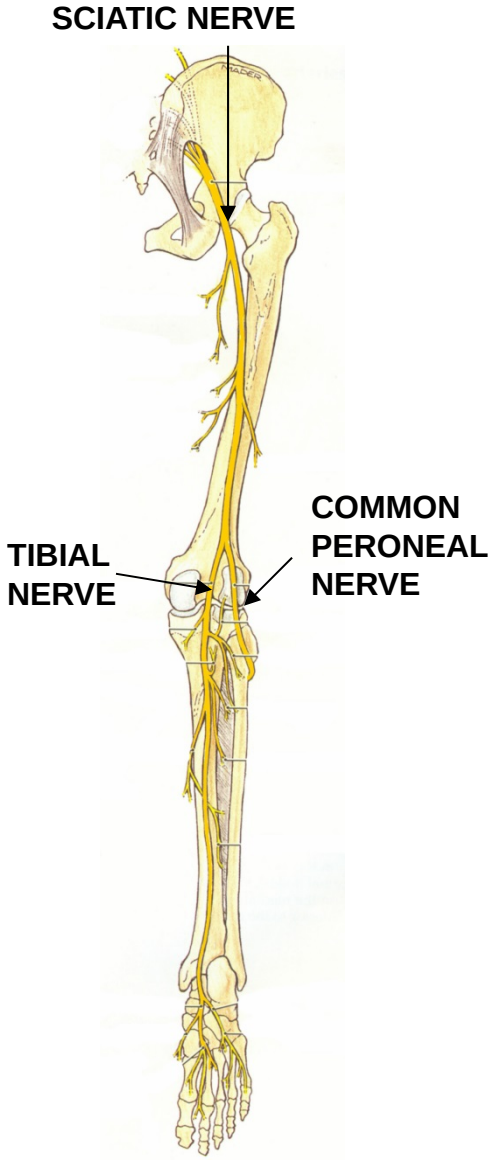




DAMAGE TO COMMON PERONEAL NERVE - FOOT DROP

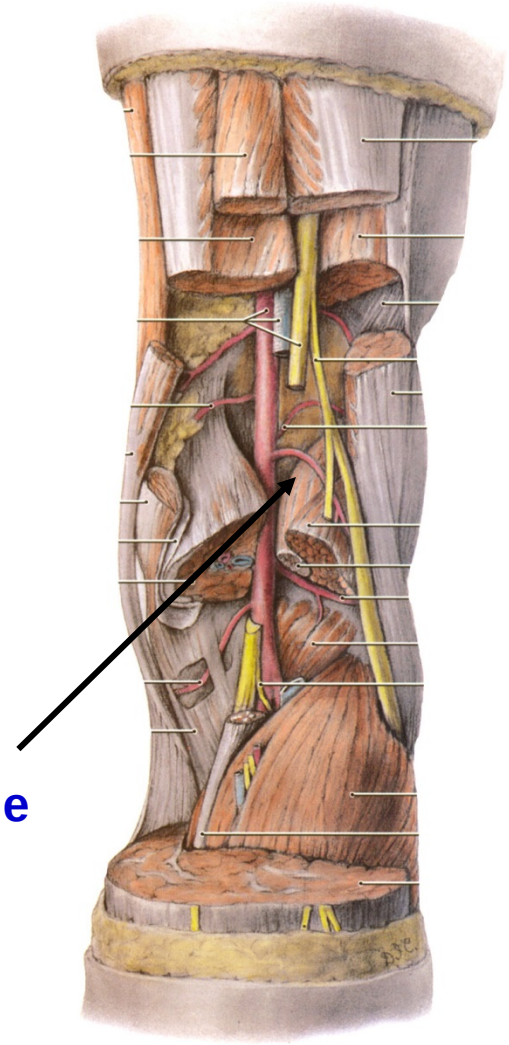
Clinical Note:
Damage to **Common Peroneal Nerve - most commonly damaged nerve** in lower extremity; very superficial when winds around **neck of fibula**; can be severed by fracture of fibula or damaged from tight plaster cast; sign is called **FOOT DROP**.



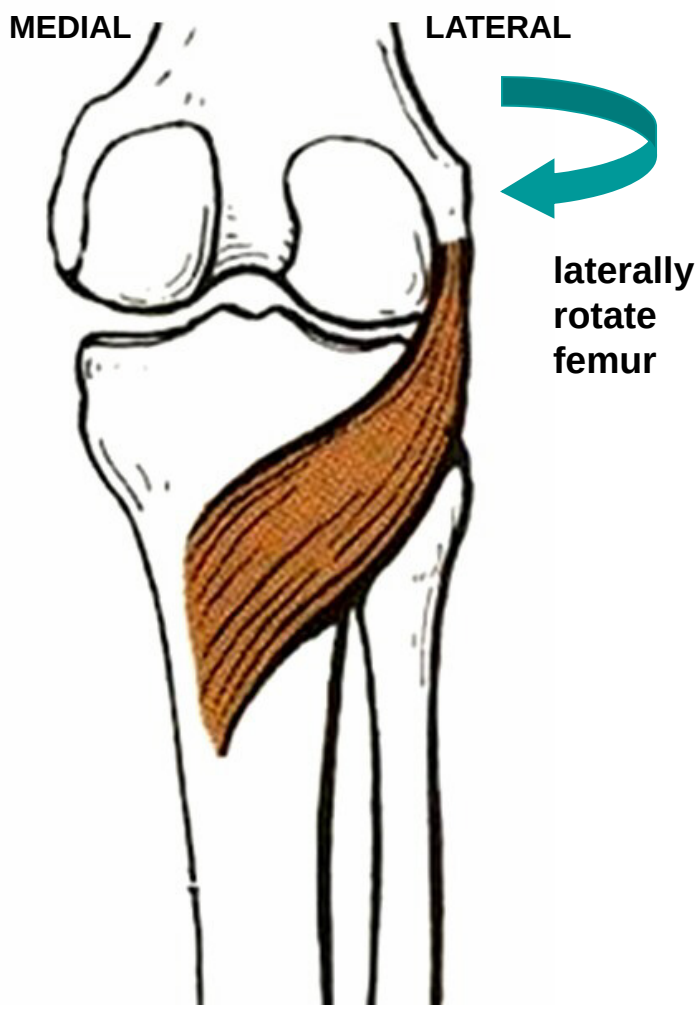


POPLITEUS MUSCLE

B. **Popliteus Muscle** - small but functionally important;
origin - femur, inside knee joint (**lateral condyle of femur**, lateral meniscus);
insert - tibia;
innervation - Tibial nerve

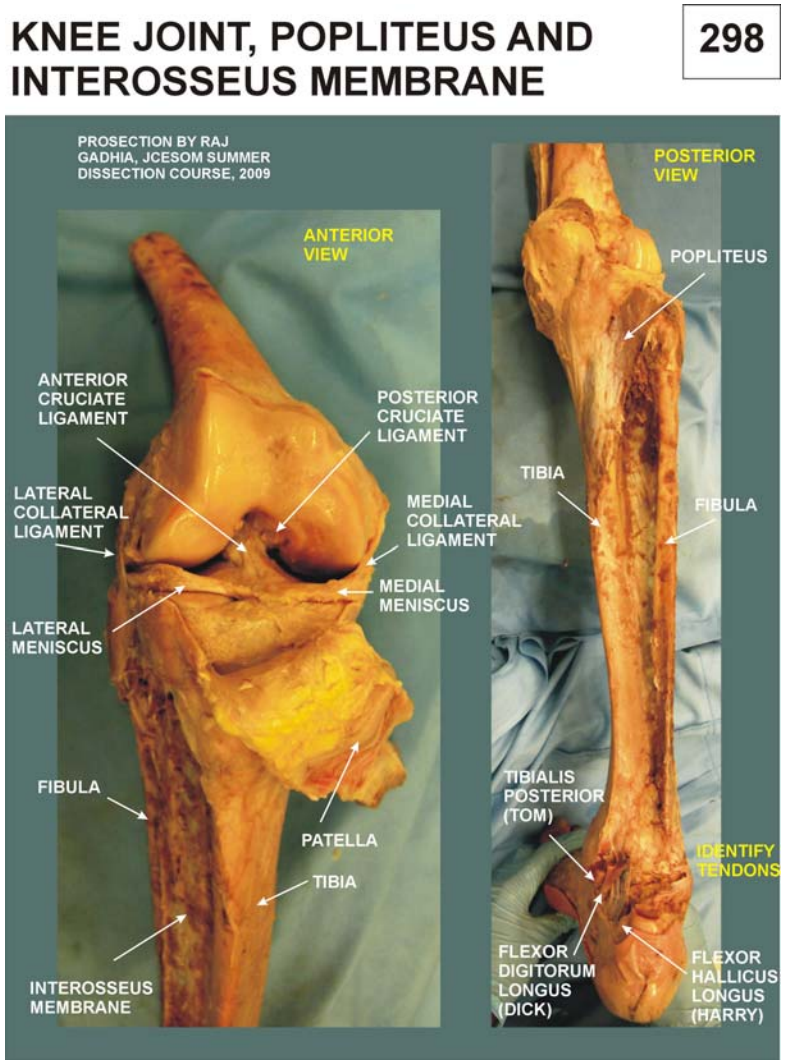


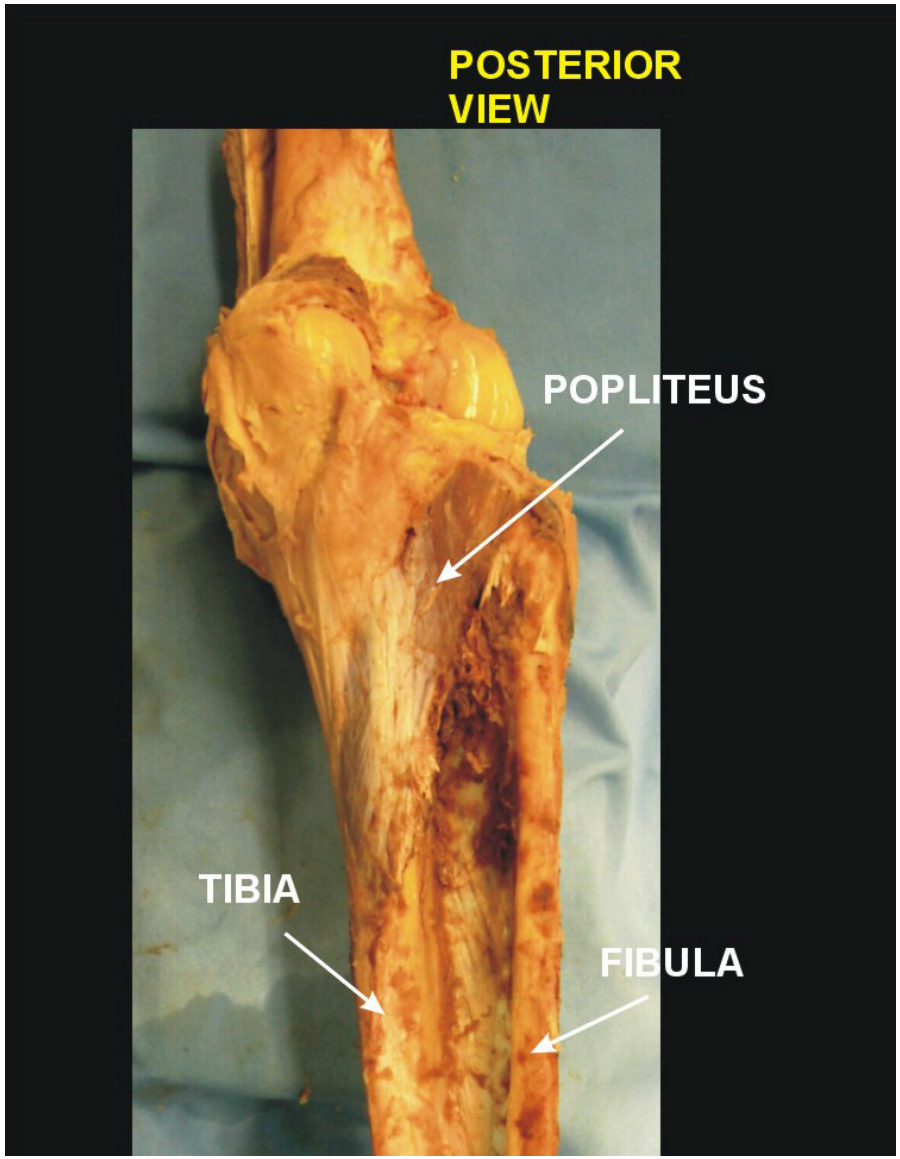
Popliteus Muscle



Biomechanical note: Popliteus muscle unlocks knee joint; when **extend leg, femur tends to rotate medially**, pulling tendons and ligaments taut and **'locking' knee**; **Popliteus acts to rotate femur laterally when beginning to flex leg; this unlocks knee joint.**

POPLITEUS MUSCLE - PROSECTION 298



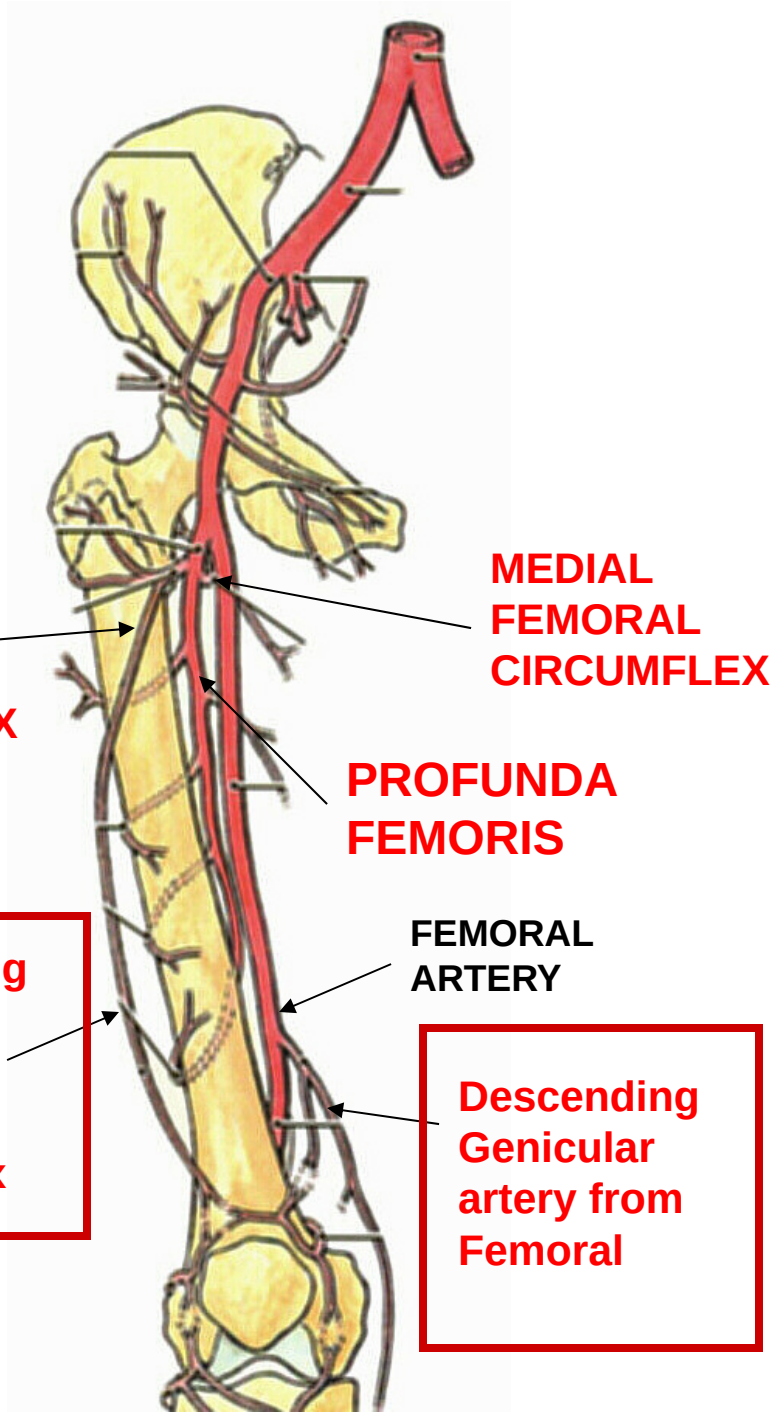


FEMORAL ARTERY

Profunda Femoris - largest branch of femoral; arises posteriorly in femoral triangle and passes between pectineus and adductor longus; branches:

a. Medial Femoral Circumflex - passes directly posteriorly **between pectineus and iliopsoas;** provides most of blood supply to head of femur.

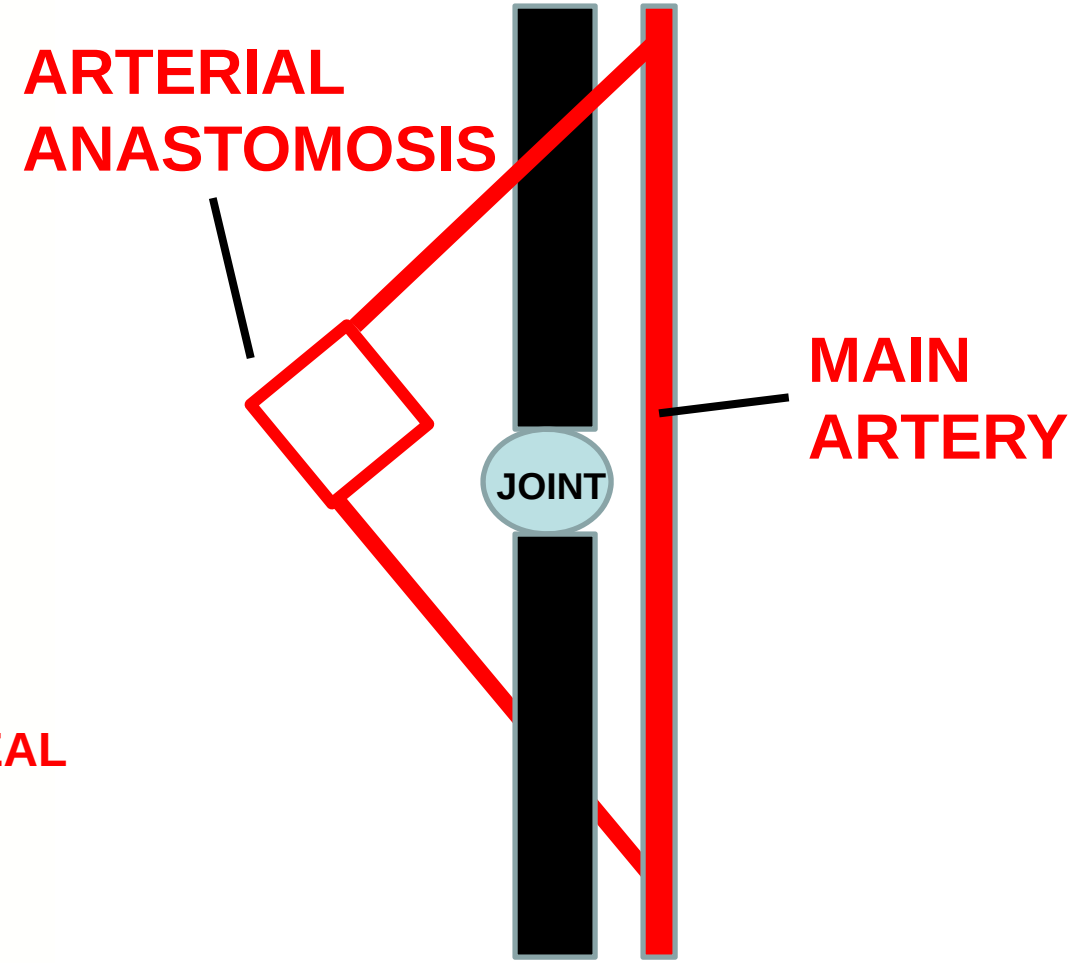
b. Lateral Femoral Circumflex - passes laterally**, deep to Rectus femoris**; supplies lateral side of thigh, neck of femur; has **Descending branch** that is part of Genicular anastomosis at knee joint.



ARTERIAL ANASTOMOSES AT JOINTS

KNEE JOINT

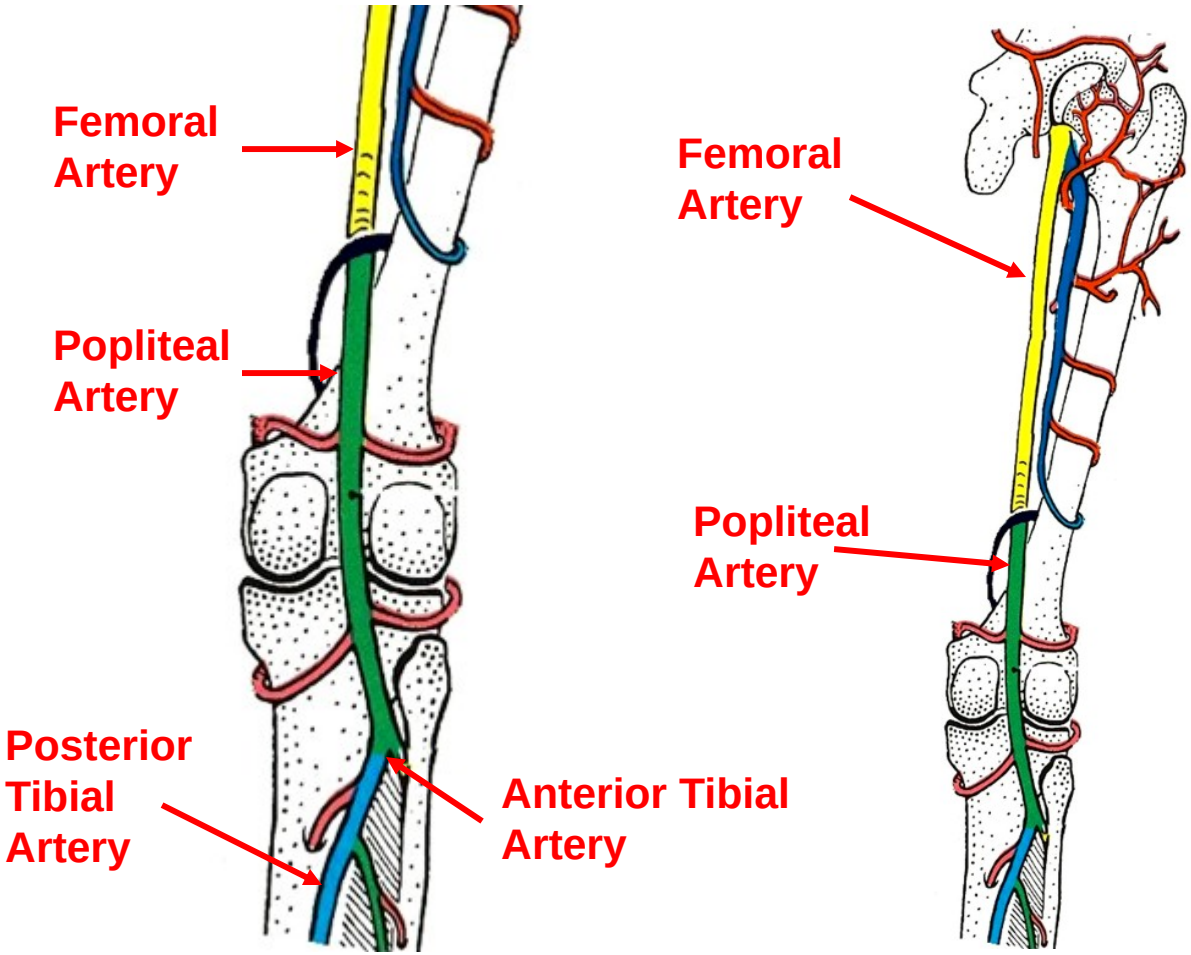
POPLITEAL ARTERY



(formally called Arterio-arterial anastomosis)

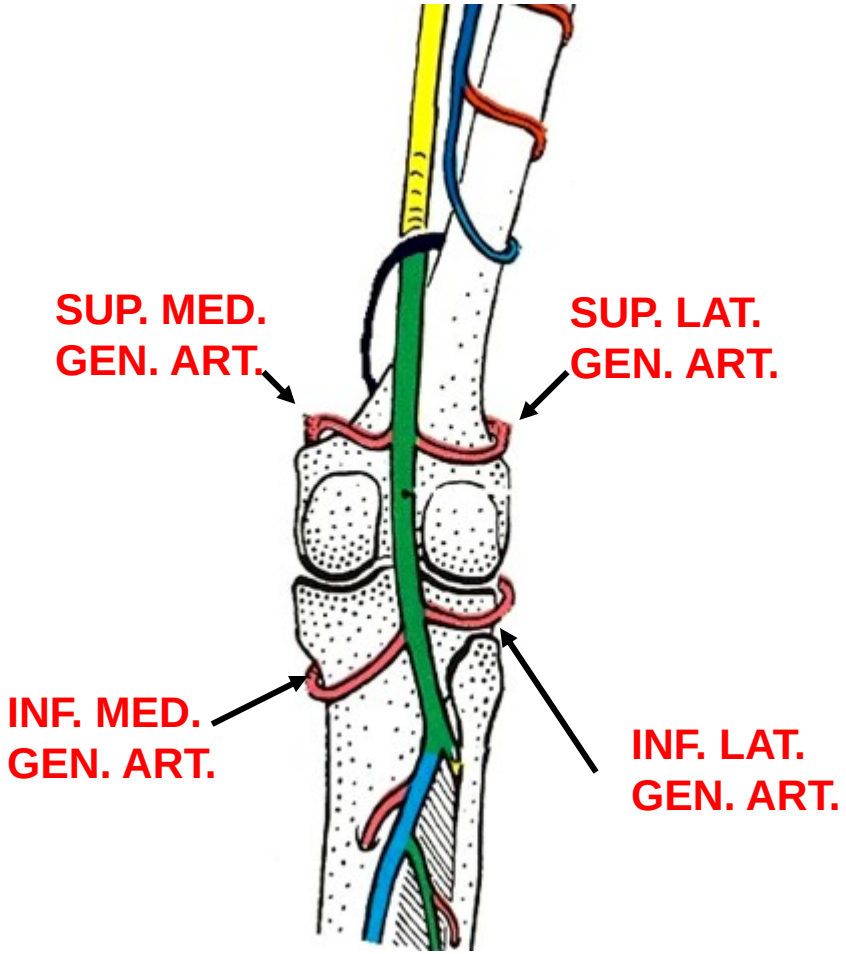
VI. POPLITEAL ARTERY AND GENICULAR ANASTOMOSIS

Popliteal artery (continuation of Femoral Artery) courses deep in Popliteal fossa (deep to vein); **divides into Anterior and Posterior Tibial arteries distally**;



GENICULAR ANASTOMOSIS

1. **Superior Medial Genicular artery** - anastomoses with Descending Genicular artery (from Femoral Artery)
2. **Superior Lateral Genicular artery** - anastomoses with Descending branch of Lateral femoral circumflex artery
3. **Inferior Medial Genicular artery** - anastomoses with Recurrent branch of Anterior Tibial artery
4. **Inferior Lateral Genicular artery** - anastomoses with Recurrent branch of Anterior Tibial artery



posterior view

GENICULAR ANASTOMOSIS

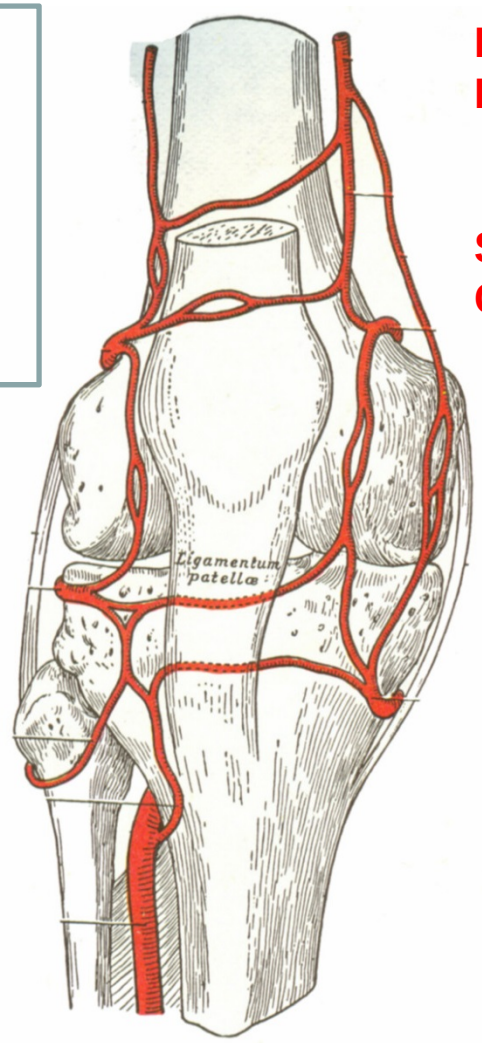
1. Superior Medial Genicular artery - anastomoses with Descending Genicular artery (from Femoral Artery)
2. Superior Lateral Genicular artery - anastomoses with Descending branch of Lateral femoral circumflex artery
3. Inferior Medial Genicular artery AND
4. Inferior Lateral Genicular artery - BOTH anastomose with Recurrent branch of Anterior Tibial artery

DESC. BR. LAT. FEM. CIRC. → SUP. LAT. GEN. ART.

DESC. GEN. FROM FEMORAL → SUP. MED. GEN. ART.

LATERAL

MEDIAL



INF. LAT. GEN. ART. ← RECURR. BR. ANT. TIB. A.

INF. MED. GEN. ART. ← RECURR. BR. ANT. TIB. A.

anterior view

Remember: Lateral goes to lateral:
Desc. Br. Lat. Fem. Circumflex joins Superior Lateral Genicular Artery

MIDDLE GENICULAR ARTERY VARIANT

1. Superior Medial Genicular artery - anastomoses with Descending Genicular artery
2. Superior Lateral Genicular artery - anastomoses with Descending branch of Lateral femoral circumflex artery
3. Inferior Medial Genicular artery AND
4. Inferior Lateral Genicular artery - BOTH anastomose with Recurrent branch of Anterior Tibial artery

5. Middle Genicular artery – when present, arises from Popliteal artery; courses anteriorly and anastomoses with Superior Lateral or Inferior Lateral Genicular arteries.

DESC. BR. LAT. FEM. CIRC.

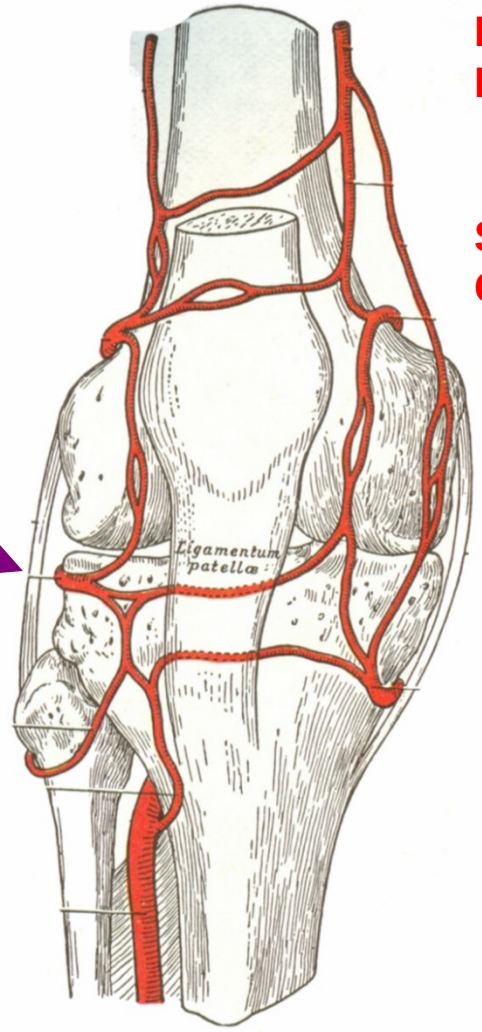
SUP. LAT. GEN. ART.

LATERAL

MIDDLE GENICULAR A.

INF. LAT. GEN. ART.

RECURR. BR. ANT. TIB. A.



anterior view

DESC. GEN. FROM FEMORAL

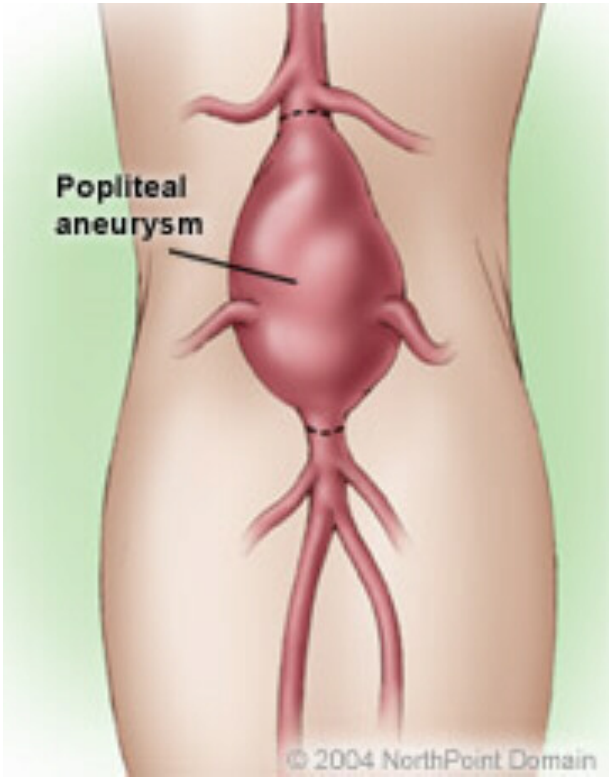
SUP. MED. GEN. ART.

MEDIAL

INF. MED. GEN. ART.

RECURR. BR. ANT. TIB. A.

ANEURYSM OF POPLITEAL ARTERY



WORD ON THE STREET - <u>ANEURYSM</u> - dilation (Gk.) (abnormal enlargement) of blood vessel due to weakness of walls

POPLITEAL ANEURYSM

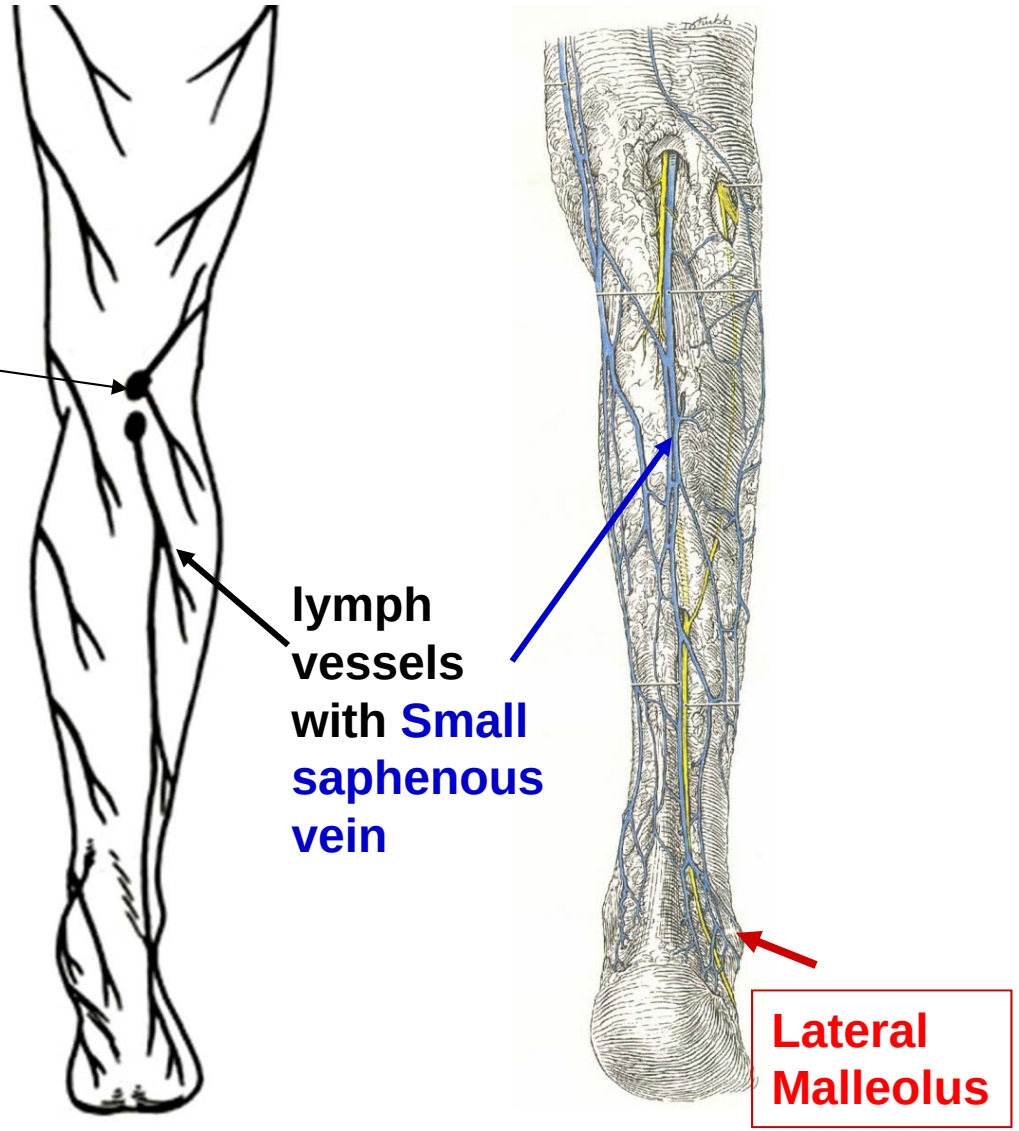
Clinical Note: **Aneurysm of Popliteal artery** - painful, due to toughness of fascia on back of knee, **Femoral artery can be ligated above knee deep to Sartorius in Subsartorial canal (also called Hunter's canal** for John Hunter, Scottish surgeon who invented operation); blood supply maintained by anastomoses around knee (Genicular anastomosis).

VII. POPLITEAL LYMPH NODES

- follow **venous drainage:** receive lymph from

1) **Deep leg** that travel with Anterior and Posterior tibial vessels; also lymph from

2) **Superifical leg and lateral foot from vessels with Small saphenous vein**; drain superiorly to deep inguinal nodes.



CHECK LIST FOR GLUTEAL REGION AND POSTERIOR THIGH LAB 2018

1) GLUTEAL REGION

MUSCLES
_____ GLUTEUS MAXIMUS
_____ GLUTEUS MEDIUS
_____ GLUTEUS MINIMUS
_____ PIRIFORMIS
_____ SUPERIOR GEMELLUS
_____ INFERIOR GEMELLUS
_____ OBTURATOR INTERNUS
_____ QUADRATUS FEMORIS

ARTERIES
_____ SUPERIOR GLUTEAL A.
_____ INFERIOR GLUTEAL A. (cut)

NERVES
_____ SCIATIC NERVE

2) POSTERIOR LEG AND POPLITEAL FOSSA
(NOTE: * STARRED STRUCTURES ARE OPTIONAL, FIND IF YOU CAN):

MUSCLES
_____ SEMIMEMBRANOSUS
_____ SEMITENDINOSUS
_____ ADDUCTOR MAGNUS
_____ LONG HEAD BICEPS FEMORIS M.
_____ SHORT HEAD BICEPS FEMORIS M.
_____ GASTROCNEMIUS (LAT HEAD)
_____ GASTROCNEMIUS (MED HEAD)
_____ POPLITEUS M.

ARTERIES
_____ POPLITEAL ARTERY
_____ *SUPERIOR LATERAL GENICULAR ARTERY
_____ *SUPERIOR MEDIAL GENICULAR A
_____ *INFERIOR MEDIAL GENICULAR A
_____ *INFERIOR LATERAL GENICULAR A

NERVES -
_____ SCIATIC NERVE
_____ TIBIAL NERVE
_____ COMMON PERONEAL N.

VEINS -
_____ POPLITEAL VEIN

JOINTS OF LOWER EXTREMITY

I. HIP JOINT - Synovial ball and socket articulation between head of femur and acetabulum; specialized for support of body weight but allows freedom of movement.

A. Articular surfaces - Articular surface of acetabulum is C shaped (Lunate Articular Surface) and has a gap inferiorly called the acetabular notch. Cavity of the acetabulum is deepened by a rim of fibrocartilage called the acetabular labrum. The labrum bridges the notch and is strengthened by the Transverse acetabular ligament. Both the articular surfaces of the acetabulum and femur are covered by hyaline cartilage.

B. Joint capsule - Strong fibrous layer that encloses joint; lined by a synovial membrane; has thickened regions (called intrinsic ligaments) that prevent excessive joint movement.

1. Iliofemoral ligament - strongest ligament in body; shaped like an inverted Y; attached above to ilium, below to intertrochanteric line; prevents overextension of hip.

2. Pubofemoral ligament - triangular ligament attached to superior ramus of pubis and intertrochanteric line; limits extension and abduction.

3. Ischiofemoral ligament - spiral shaped; attached to ischium and greater trochanter; limits extension.

C. Ligament of head of femur - inside joint capsule; attached to head of femur at fovea capitis and to transverse acetabular ligament; transmits artery of ligament of head of femur (branch of obturator artery).

Note: **Dislocation** - traumatic dislocation is rare due to strength of intrinsic ligaments; congenitally, upper lip of acetabulum may fail to form and head of femur may dislocate superiorly; leg is rotated medially; also appears to be shorter

Note: **Fracture of neck of femur** - common in the elderly; leg is rotated laterally due to action of gluteus maximus and short rotators of hip.

Note: **Avascular necrosis of head of femur after fracture of neck of femur** - Head and neck of femur receive blood from branches of obturator artery (through ligament of head) and branches of medial and lateral femoral circumflex arteries; after fracture, supply from circumflex arteries is disrupted; if obturator supply is inadequate, avascular necrosis may occur requiring artificial replacement of head and neck of femur.

II. KNEE JOINT - Anatomically a condyloid synovial joint between condyles of femur and tibia; functionally an amazing feat of bioengineering, acts like a hinge type joint which also permits limited rotation (note: fibula is not directly involved in knee articulation).

A. Articular Surfaces - femur simply against tibia; stability of knee joint dependent upon ligaments.

B. Capsule - surrounds posterior, medial and lateral sides of joint but is absent anteriorly; joint covered anteriorly by patellar ligament, patella, and quadriceps tendon.

C. Bursae - bags of synovial fluid with synovial lining; some connect to main synovial sac of knee joint; become inflamed with repeated contact with ground when kneeling.

1. Suprapatellar bursa - outpocketing of synovial cavity of knee joint posterior to quadriceps tendon.

2. **Prepatellar bursa** - in subcutaneous tissue between skin and patella; **inflammation is called HOUSEMAID'S KNEE**.

3. **Superficial Infrapatellar bursa** between skin and patellar ligament; **inflammation is called CLERGYMAN'S KNEE**.

D. Extracapsular ligaments

1. Patellar ligament - attached above to patella, below to tubercle of tibia.

2. Lateral (fibular) Collateral ligament - attached above to lateral condyle of femur, below to head of fibula (prevents movement of tibia medially). There is a space between the ligament and the lateral meniscus (posteriorly popliteus muscles is in this space).

3. Medial (tibial) Collateral ligament - attached above to medial condyle of femur, below to medial side of tibia; prevents movement of the tibia laterally.

Note: Unlike Lateral Collateral ligament, Medial Collateral ligament is firmly attached to medial meniscus. Both Medial and Lateral Collateral ligaments are taut in extension of knee joint and pull femur against tibia; joint is 'locked' when extended.

E. Intracapsular ligaments - are located deep in joint.

1. Anterior Cruciate ligament - attached between condyles of tibia, anterior to intercondylar eminence; passes upward, laterally, and posteriorly to attach to medial side of lateral femoral condyle; prevents movement of tibia anteriorly.

2. Posterior Cruciate ligament attached between condyles of tibia; attaches to lateral side of medial femoral condyle; prevents movement of tibia posteriorly

Note: Tests for tears in cruciate ligaments -

Tear Anterior Cruciate Ligament - can **draw tibia anteriorly**.
Tear Posterior Cruciate Ligament - can **push tibia posteriorly**

F. Menisci - "C" shaped cartilages that are attached to inner side of joint capsule

1. Medial Meniscus - attached between condyles; also firmly attached to Medial (tibial) Collateral ligament; relatively fixed in joint.

2. Lateral Meniscus - more movable than Medial Meniscus since it is not attached to Fibular Collateral ligament

Note: **LOCKING AND UNLOCKING KNEE JOINT** - When moving to full extension of knee joint, femur rotates medially during last 30 degrees of movement; this pulls all major ligaments of the knee joint taut, 'locking' the knee and making it very stable; to flex knee from full extension, joint must first be **unlocked by contracting the Popliteus muscle** which rotates the femur laterally (foot is firmly on ground) producing relaxation of ligaments.(**LOCK femur rotates MEDIALLY; UNLOCK femur rotates LATERALLY**)

Clinical Note: **Terrible Triad of the Knee joint**: Knee joint is stable in extension but ligaments are slackened by joint flexion; **blow to lateral side** of the knee when the leg is flexed (as can occur in football tackles) can tear **Tibial (Medial) Collateral ligament, Anterior Cruciate ligament and Medial Meniscus** (because it is firmly fixed to the medial collateral ligament).

III. JOINTS BETWEEN TIBIA AND FIBULA - bones linked by ligaments.

A. Interosseus membrane - broad sheet of connective tissue links shafts of tibia and fibula; has gap for Anterior Tibial artery and vein.

B. Inferior articulation - Anterior and Posterior Inferior Tibio-Fibular ligaments join bones above ankle joint.

IV. ANKLE JOINT - Uniaxial, synovial hinge type joint; permits dorsiflexion and plantar flexion (not inversion or eversion which occurs at joints between tarsal bones). Joint is between talus inferiorly and the tibia and fibula superiorly, capsule surrounds joint:

A. Ligaments

1. Medial (Deltoid) ligament - very strong triangular shaped ligament; attaches above to medial malleolus of tibia, below to medial surface of talus and calcaneus. Permits free dorsiflexion/plantar flexion but limits eversion of foot.

2. Lateral ligaments - weaker; all attach above to lateral malleolus of fibula; permit free dorsiflexion/plantar flexion but limit inversion of foot.

a. Anterior and Posterior Talofibular ligaments to talus.

b. Calcaneofibular ligament to calcaneus.

V. JOINT OF INVERSION-EVERSION OF FOOT

A. Inversion eversion movements occur at 1) subtalar joint (between talus and calcaneus) and at 2) transverse tarsal joint (between talus and navicular bones medially, calcaneus and cuboid bones laterally.

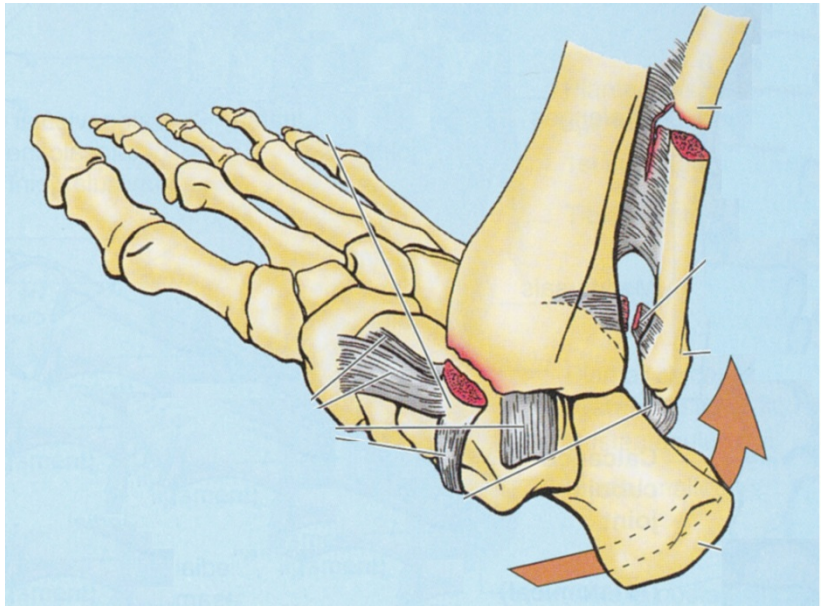
B. Movements - In inversion and eversion, the talus remains largely fixed at the ankle joint and the foot rotates about the inferior and anterior surfaces of the talus (the movement is augmented by movement between the calcaneus and cuboid bones).

Note: **Sprains** of ankle are usually caused by **excessive inversion**; **Anterior talofibular** and **Calcaneofibular ligaments** are commonly **stretched or partially torn**.

Note: **Pott's fractures** are caused by **excessive eversion**; strong **Deltoid ligament does not rupture** but **medial malleolus is fractured**; also **break shaft of fibula.**

JOINTS OF LOWER EXTREMITY

I. HIP JOINT
II. KNEE JOINT
III. JOINTS BETWEEN TIBIA FIBULA
IV. ANKLE JOINT
V. JOINTS OF INVERSION-EVERSION OF FOOT

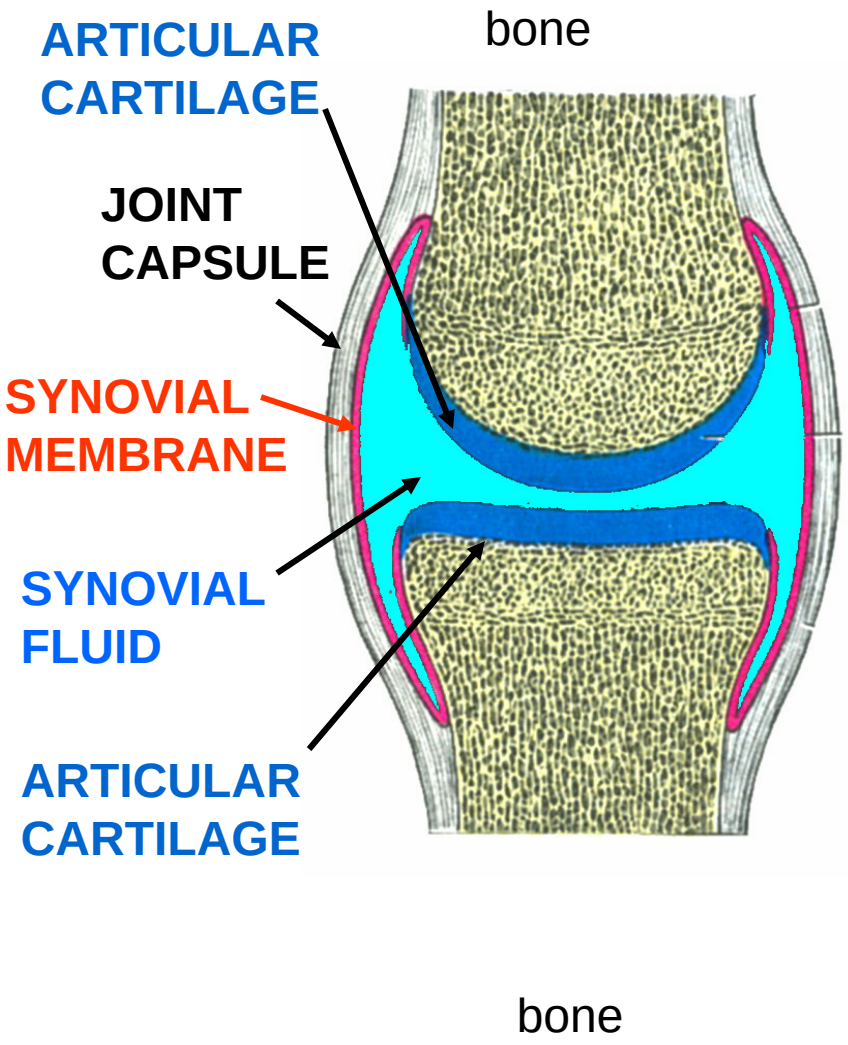


JOINT - Anatomical definition - region of contact/connection between two bones.

- classify joints 1) type of connective tissue; 2) shapes of regions of contact

All subject to dislocations, fractures, sprains

SYNOVIAL JOINTS



A joint = location where one bone contacts another bone; Synovial joints (hip, knee, ankle) are one class of joints.

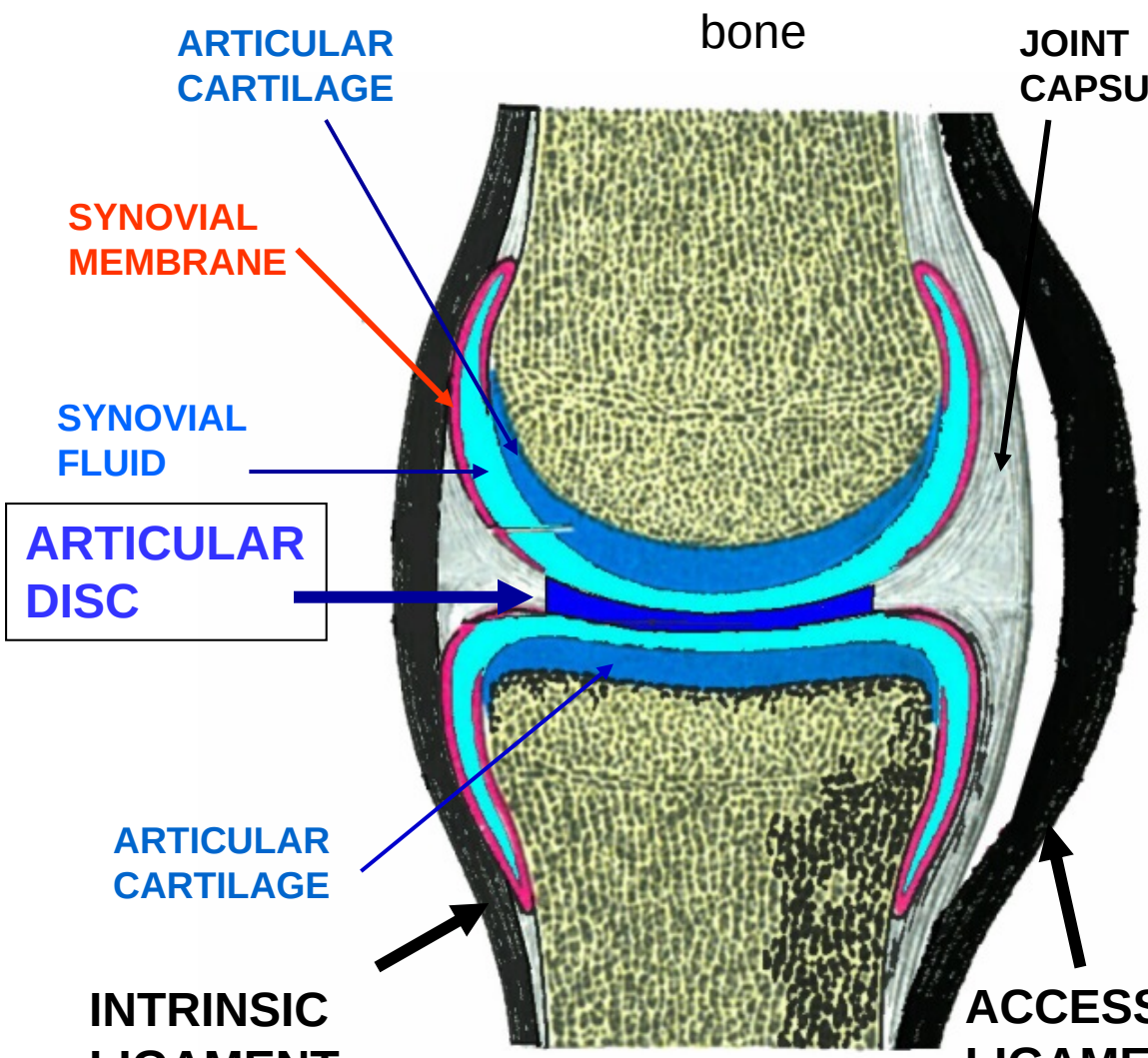
1) JOINT CAPSULE - joints have connective tissue surround the bones

2) SYNOVIAL MEMBRANE - a membrane inside the capsule that secretes synovial fluid (lubricating fluid)

3) ARTICULAR CARTILAGE - cartilage layer on the bones at the point of contact; serves as a shock absorber and reduces the effects of friction on the bones

OSTEOARTHRITIS - degenerate articular cartilage

SYNOVIAL JOINTS CAN HAVE ARTICULAR DISCS



4) ARTICULAR DISC - Some joints also have an articular disc interposed between the cartilages; greatly reduce friction wear

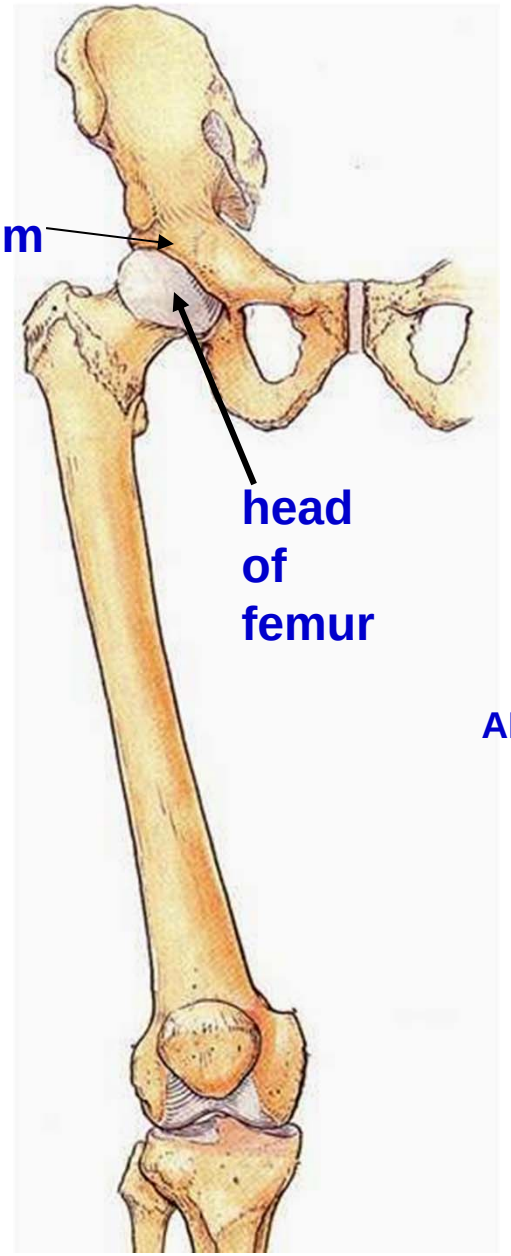
5) LIGAMENTS - connective tissue bands; strengthen joint and may limit movement

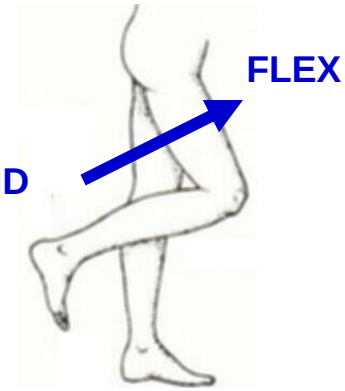
a. INTRINSIC LIGAMENTS = thickening of capsule - example Ligaments of Hip Joint

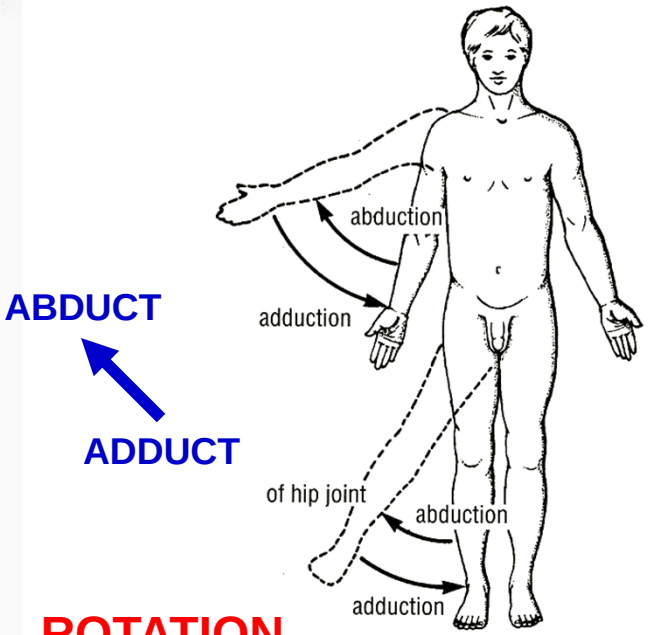
b. ACCESSORY LIGAMENTS - separate from capsule - example Collateral ligaments of knee

HIP JOINT

I. **HIP JOINT** - Synovial ball and socket articulation between **head of femur** and **acetabulum**; specialized for **support of body weight but allows freedom of movement.**







ROTATION

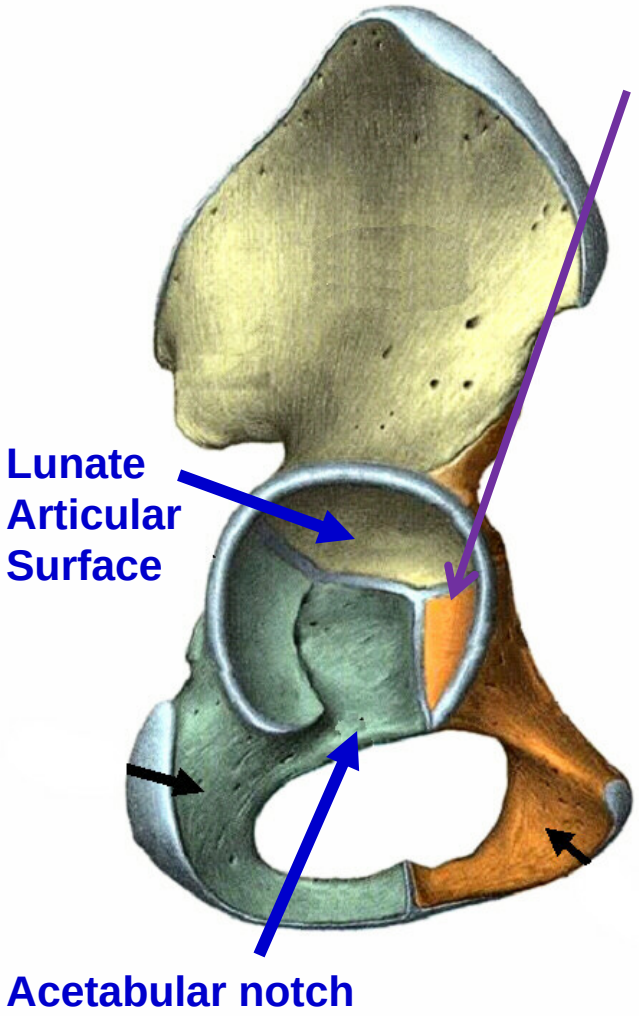
medial rotation

lateral rotation

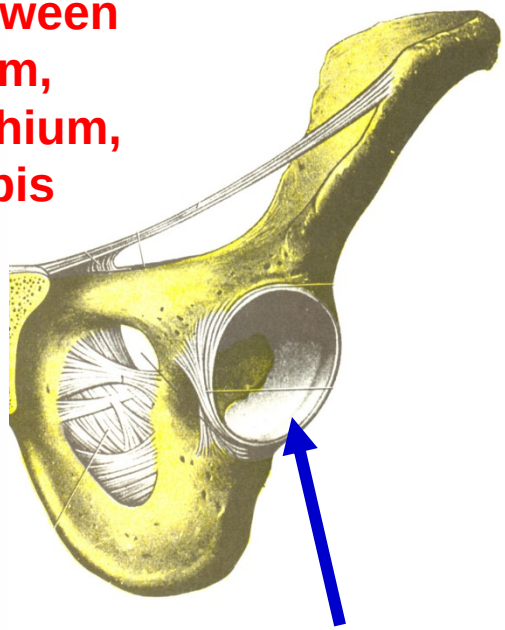
HIP JOINT - ACETABULUM AND LABRUM

Articular surface of acetabulum is **C shaped (Lunate Articular Surface)** and has a **gap** inferiorly called the **acetabular notch**. Cavity of the **acetabulum is deepened by a rim of fibrocartilage called the Acetabular labrum**. The labrum bridges the notch and is strengthened by the transverse acetabular ligament.

labrum = lip



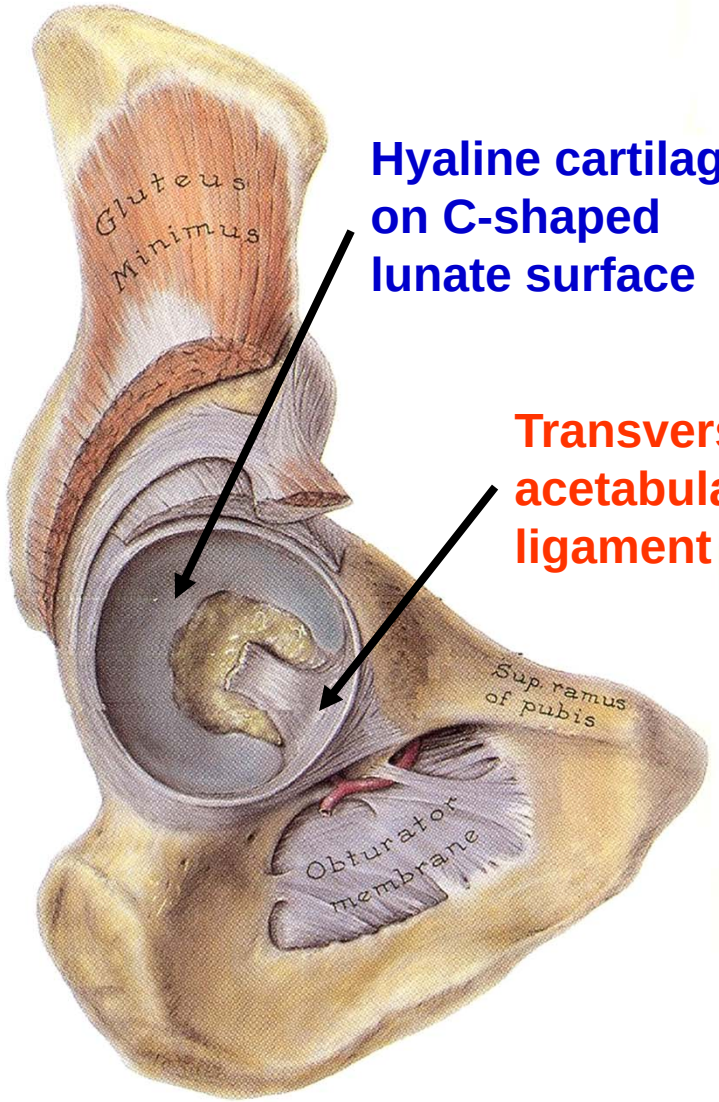
note: Triradial cartilage - Y shaped between ilium, ischium, pubis



like glenoid labrum of shoulder but deeper

HIP JOINT - ACETABULUM AND LABRUM

Acetabular labrum bridges the acetabular notch and is strengthened by the **Transverse acetabular ligament**. Both the articular surfaces of the acetabulum and femur are covered by **hyaline cartilage**.

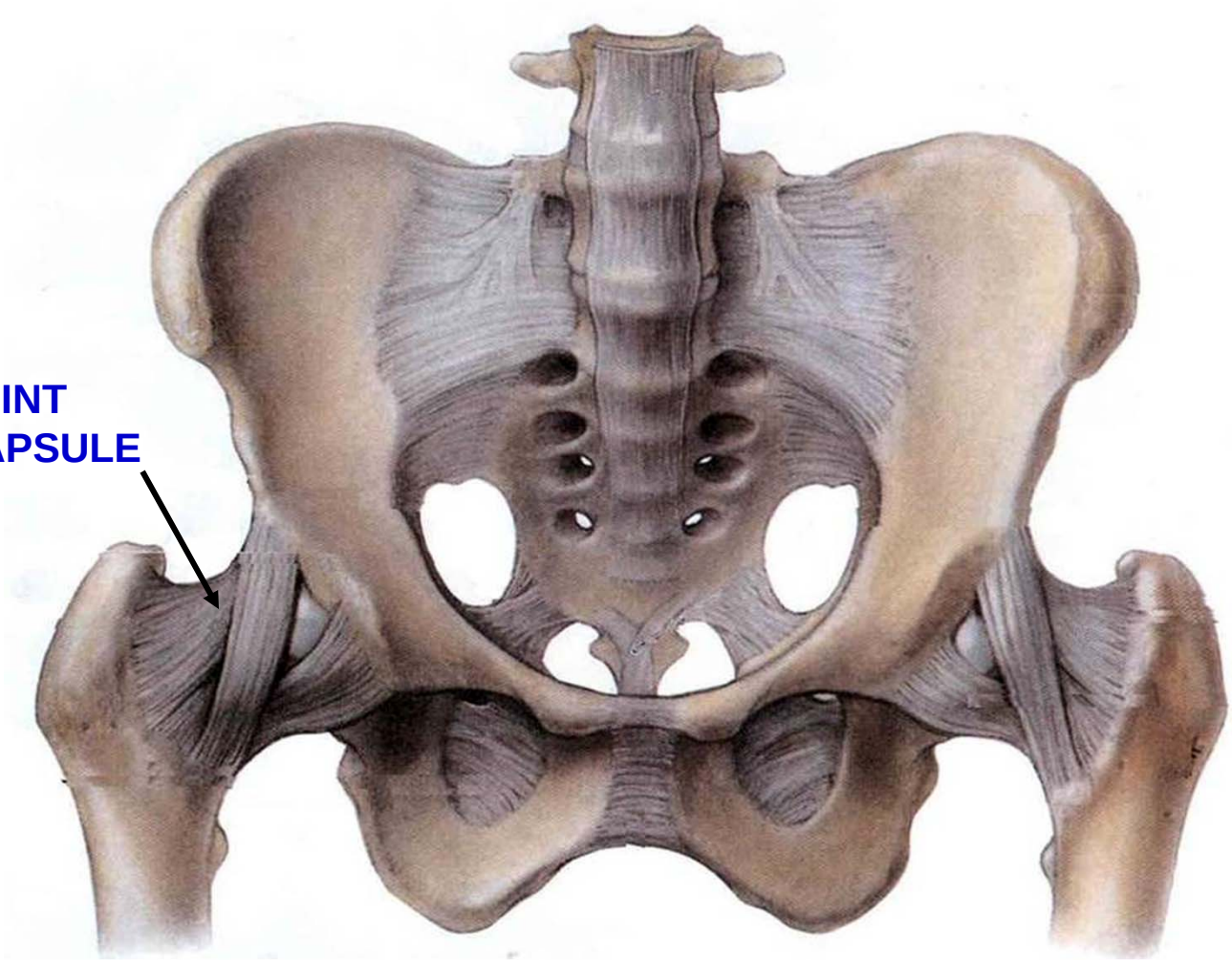


Hyaline cartilage on C-shaped lunate surface

Transverse acetabular ligament - over gap

JOINT CAPSULE

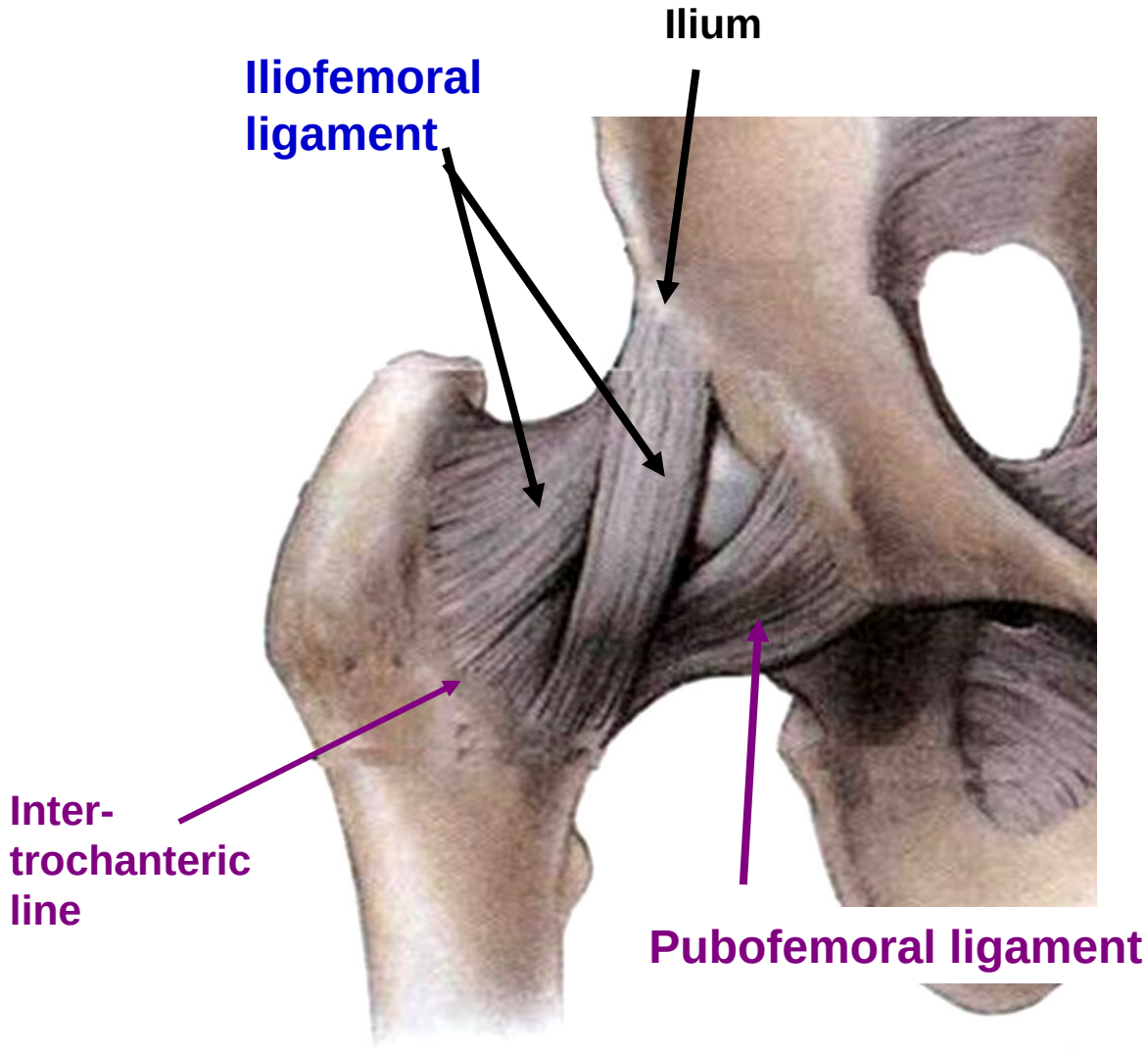
Strong fibrous layer encloses joint; lined by a synovial membrane; has thickened regions (called **Intrinsic ligaments**) that prevent excessive joint movement.



HIP JOINT - LIGAMENTS

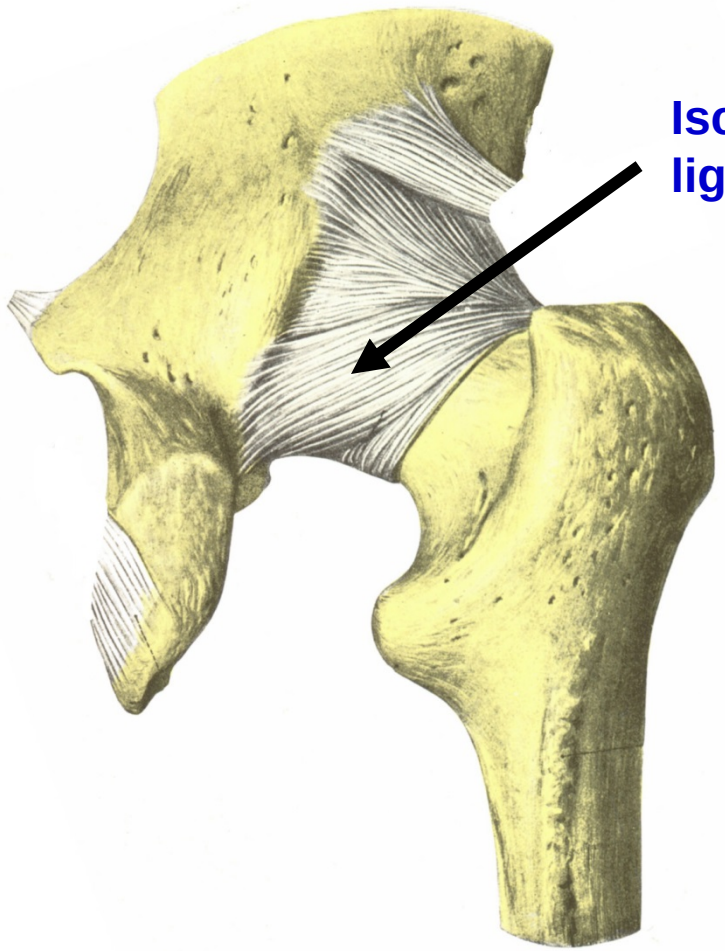
1. Iliofemoral ligament - **strongest ligament in body;** shaped like an inverted Y; attached above to **ilium**, below to **intertrochanteric line**; **prevents overextension** of hip.

2. Pubofemoral ligament - triangular ligament attached to **superior ramus of pubis** and lower part of **intertrochanteric line**; **limits extension and abduction**.



HIP JOINT - LIGAMENTS

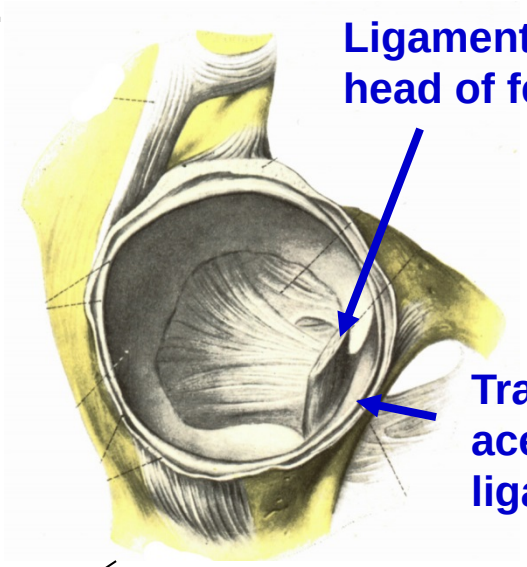
3. Ischiofemoral ligament - spiral shaped; attached to **ischium and greater trochanter**; **limits extension.**



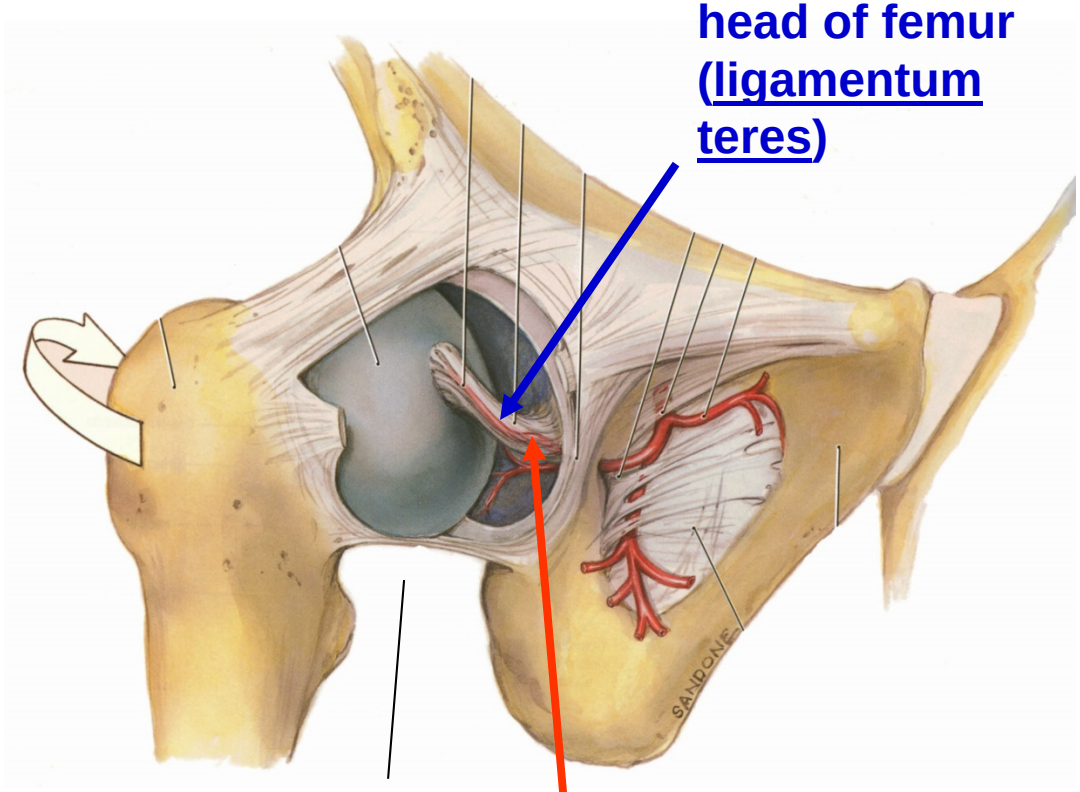
HIP JOINT - LIGAMENTS

C. **Ligament of head of femur** - inside joint capsule; attached to head of femur at **fovea capitis** and to transverse acetabular ligament; transmits **Artery of ligament of head of femur (branch of Obturator artery)**

.



look inside joint after remove femur

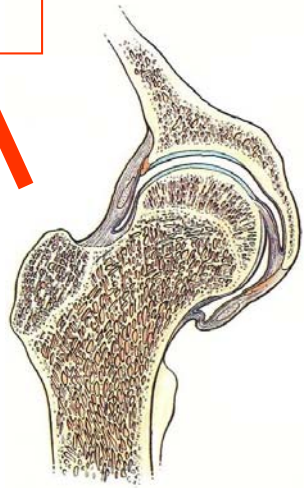


open joint capsule

Artery of ligament of head of femur (branch of Obturator artery)

DISLOCATE HIP JOINT

If congenital, dislocate superiorly

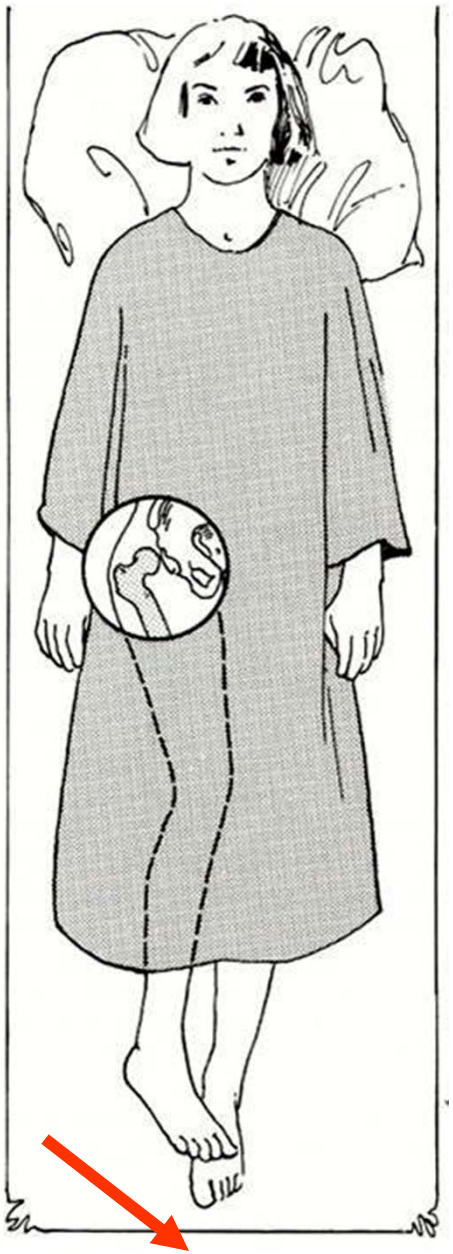


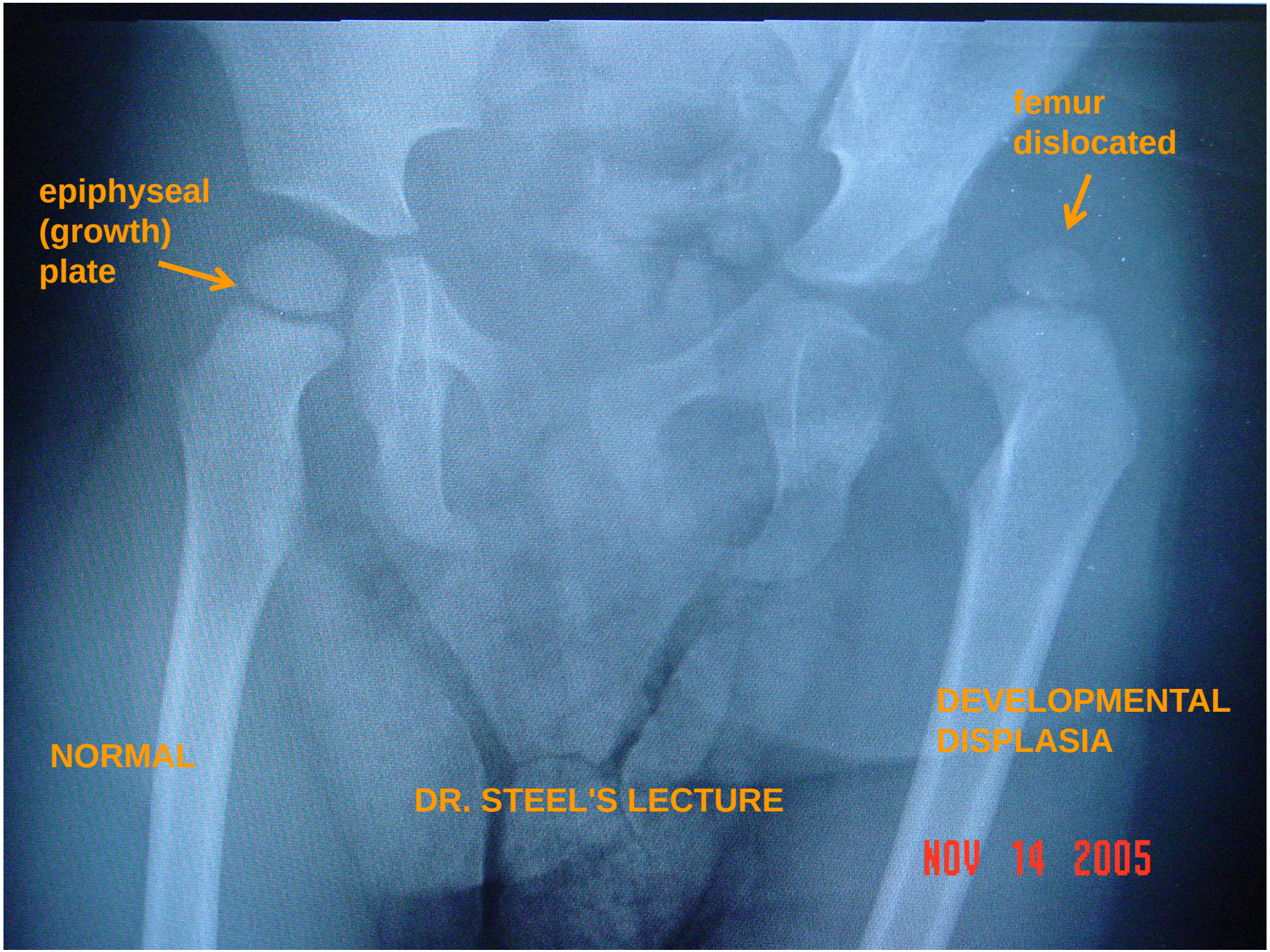
Note: **Dislocation** - traumatic dislocation is rare due to strength of intrinsic ligaments; **congenitally, upper lip of acetabulum may fail to form** and head of femur may **dislocate superiorly**; leg is **rotated medially** (**action gluteus medius and minimus**); also appears to be shorter

If traumatic, dislocate posteriorly

Leg is rotated medially and appears to be shorter

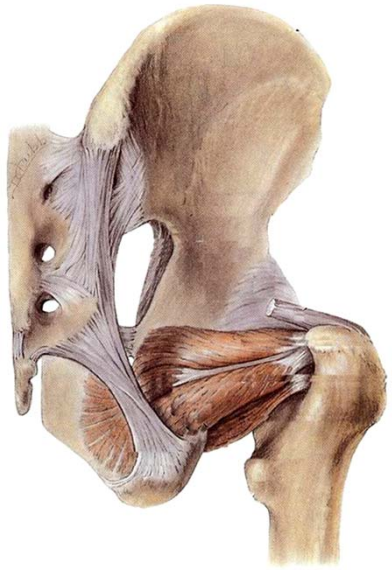
Congenital




epiphyseal
(growth)
plate
femur
dislocated
NORMAL
DEVELOPMENTAL
DISPLASIA
DR. STEEL'S LECTURE
NOV 14 2005

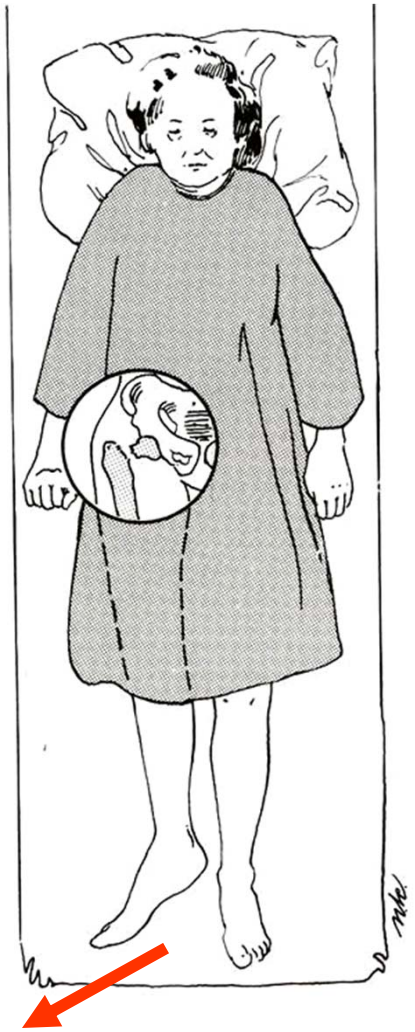
FRACTURE OF NECK OF FEMUR

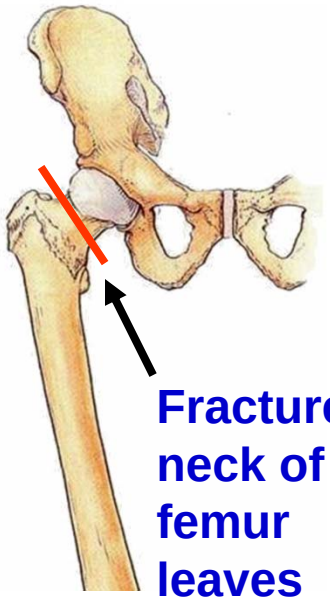
Note: **Fracture of neck of femur** - common in the elderly; **leg is rotated laterally** due to action of **gluteus maximus and short rotators of hip**.



Leg is rotated laterally

laterally rotate femur

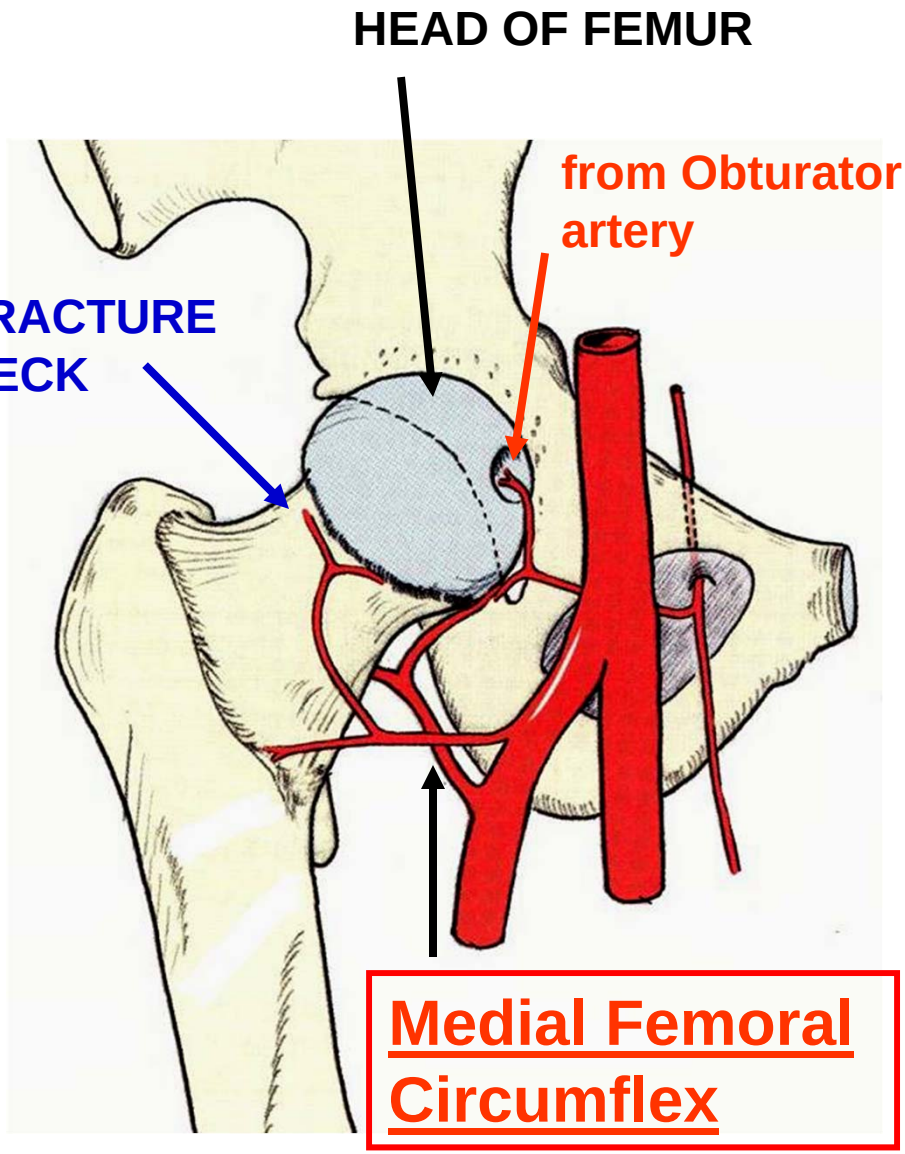




Fracture of neck of femur leaves Greater Trochanter attached to femur

FRACTURE CAN PRODUCE AVASCULAR NECROSIS OF HEAD OF FEMUR

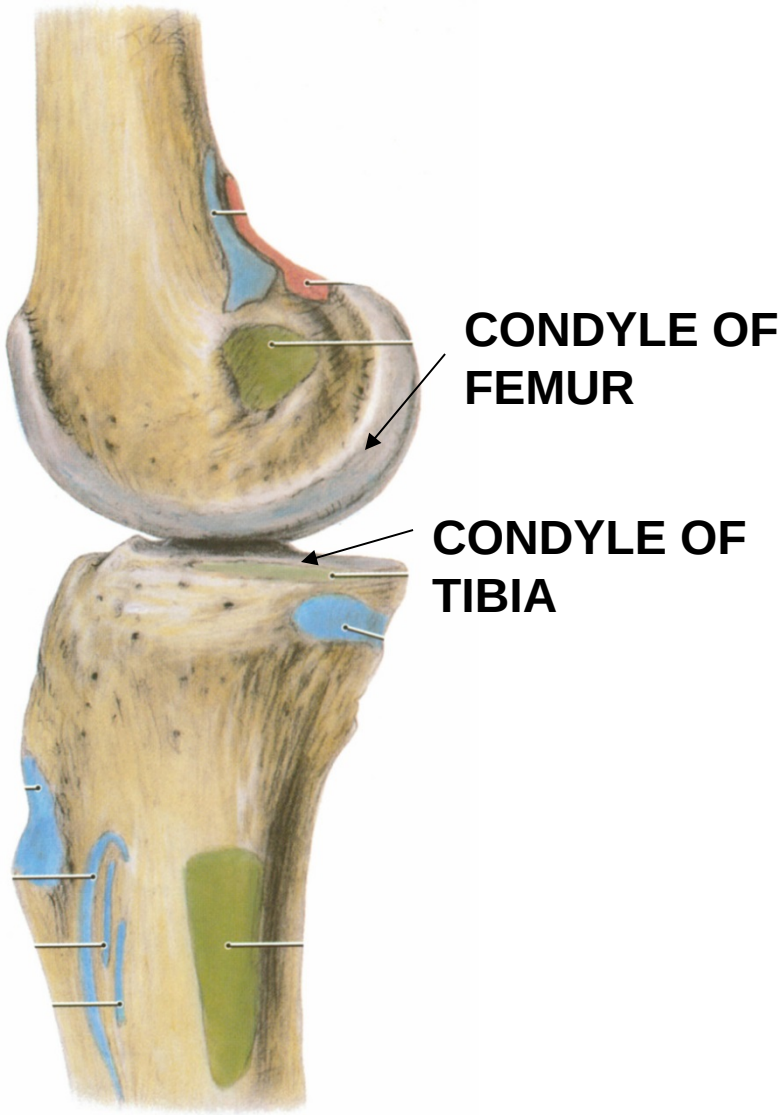
Note: **Fracture of neck of femur** - head and neck of femur receive blood from branches of **Obturator artery** (through ligament of head) and branches of **Medial and lateral femoral circumflex**; after fracture, supply from circumflex arteries is disrupted; if obturator supply is inadequate, **avascular necrosis may occur requiring artificial replacement of head and neck of femur**.



KNEE JOINT

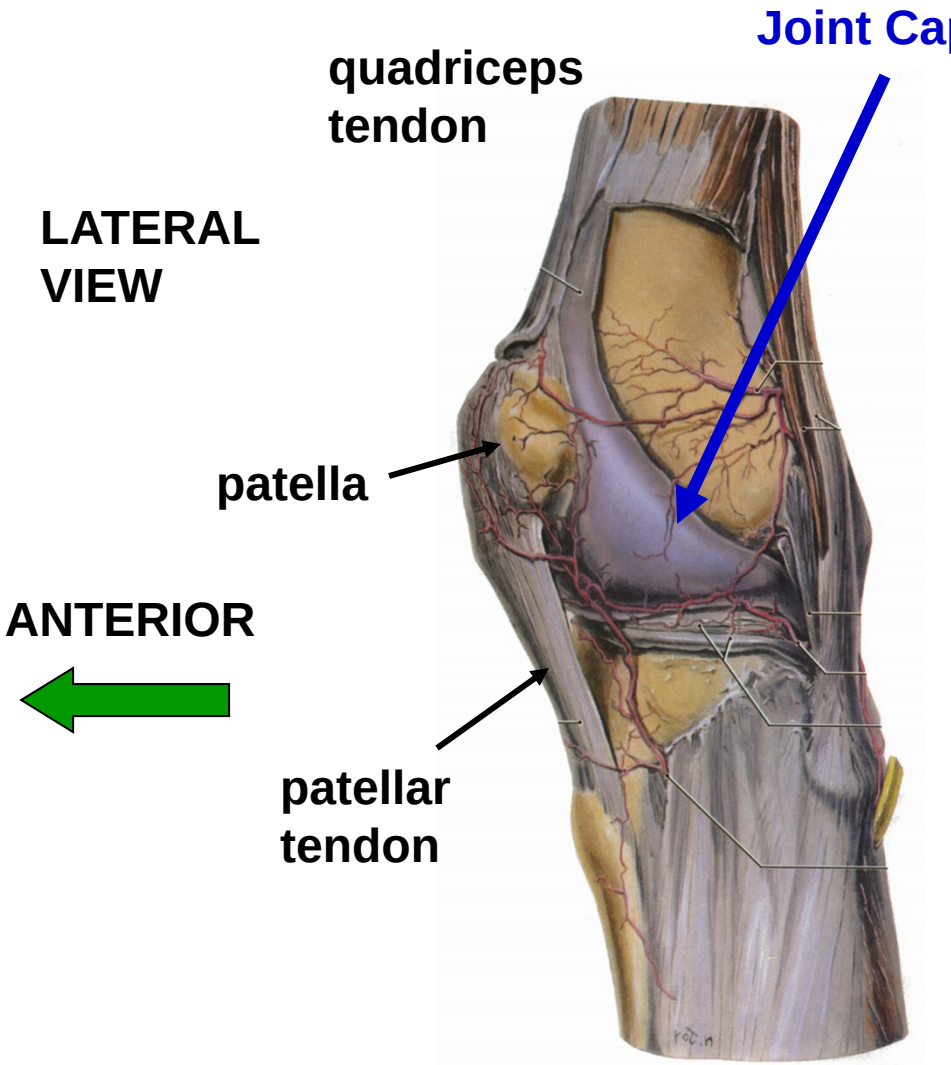
Anatomically a **condyloid synovial joint between condyles of femur and tibia**; functionally an **amazing feat of bioengineering**, acts like a **hinge type joint which also permits limited rotation** (note: fibula is not directly involved in knee articulation).

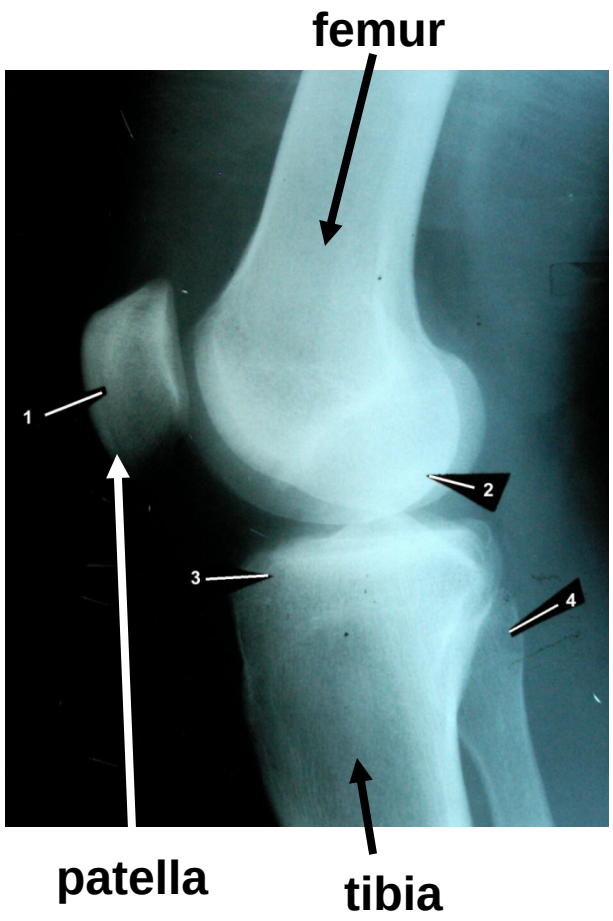
A. Articular Surfaces - **femur simply against tibia; stability of knee joint dependent upon ligaments**.



KNEE JOINT

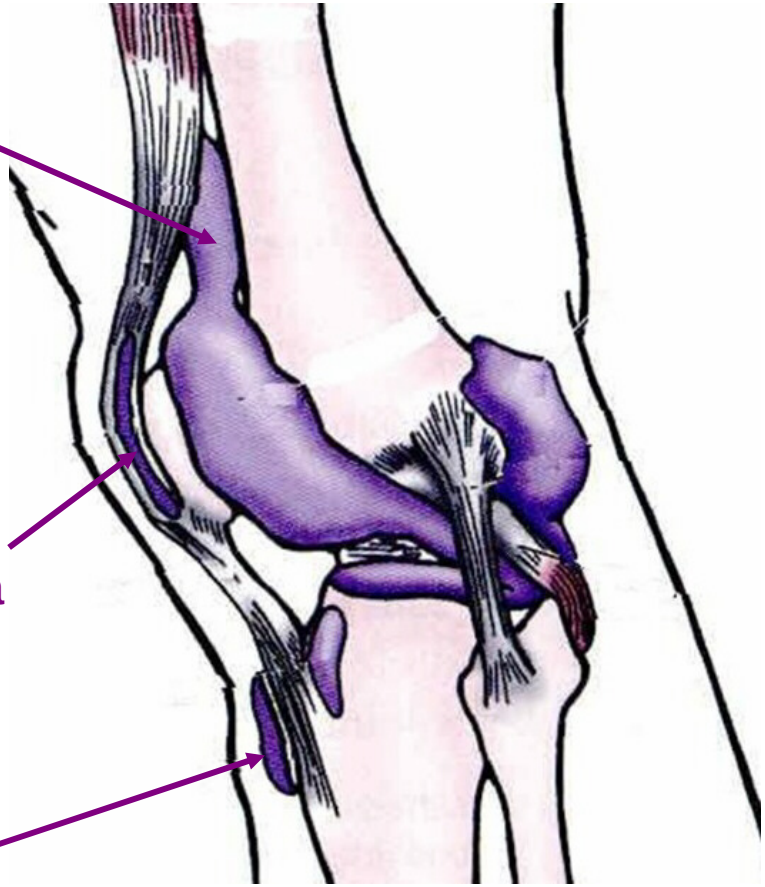
Joint Capsule - surrounds posterior, medial and lateral sides of joint but is absent anteriorly; joint covered anteriorly by patellar ligament, patella, and quadriceps tendon.





BURSAE OF KNEE

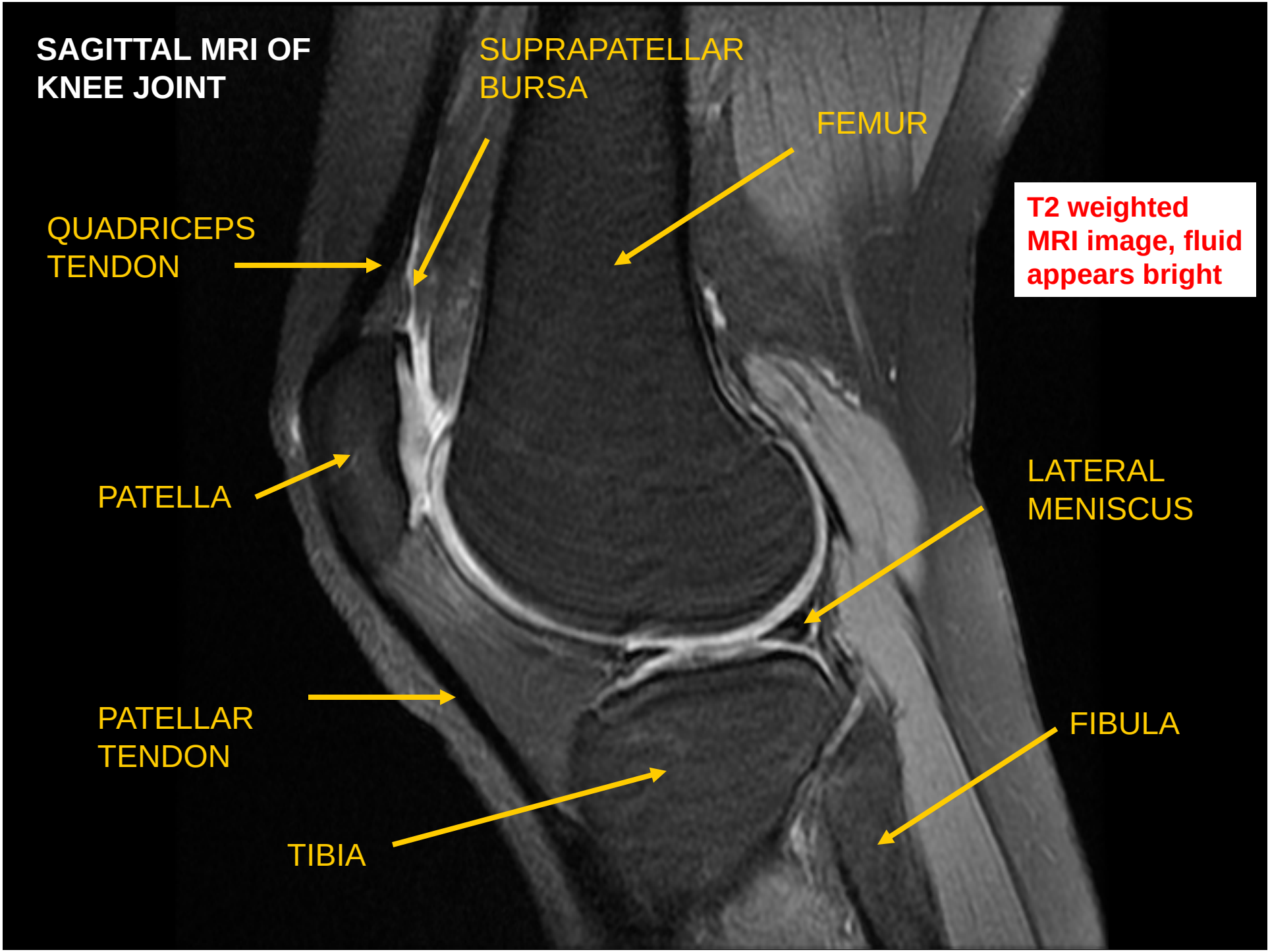
Bursae - bags of synovial fluid with synovial lining; some connect to main synovial sac of knee joint; become inflamed with repeated contact with ground when kneeling.



1.Suprapatellar bursa - **outpocketing of synovial cavity** of knee joint **posterior to quadriceps tendon.**

2.Prepatellar bursa - in subcutaneous tissue **between skin and patella**

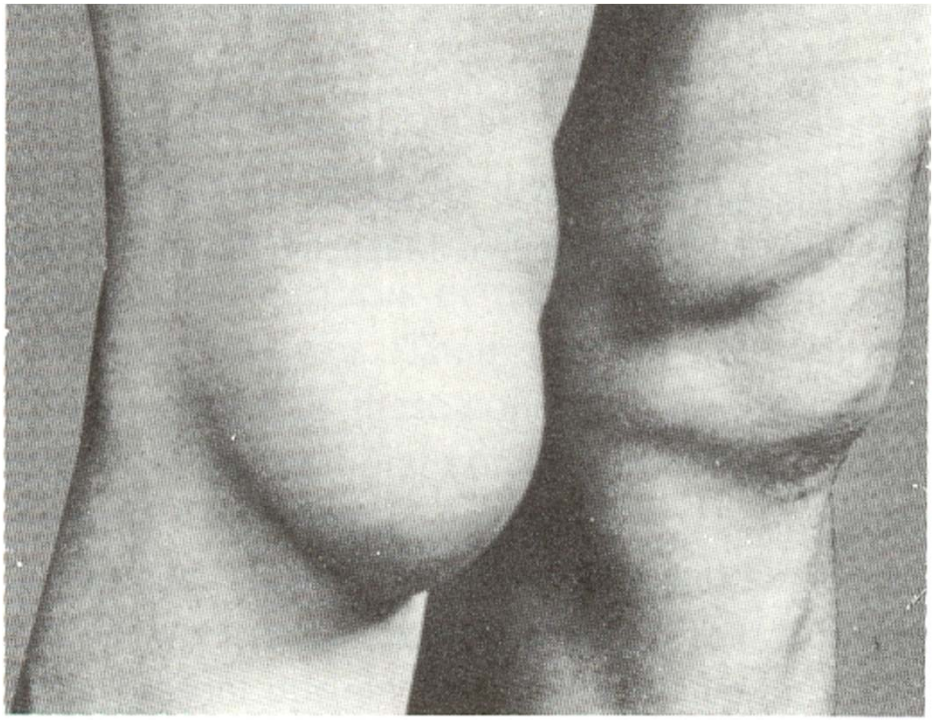
3.**Superficial infrapatellar bursa** - **between skin and patellar ligament**.


SAGITTAL MRI OF KNEE JOINT
SUPRAPATELLAR BURSA
FEMUR
QUADRICEPS TENDON
T2 weighted MRI image, fluid appears bright
PATELLA
LATERAL MENISCUS
PATELLAR TENDON
FIBULA
TIBIA

BURSAE OF KNEE CAN BECOME INFLAMMED

2. **Prepatellar bursa** in subcutaneous tissue between skin and patella; **inflammation is called HOUSEMAID'S KNEE**.

3. **Superficial infrapatellar bursa** between skin and patellar ligament; **inflammation is called CLERGYMAN'S KNEE**.



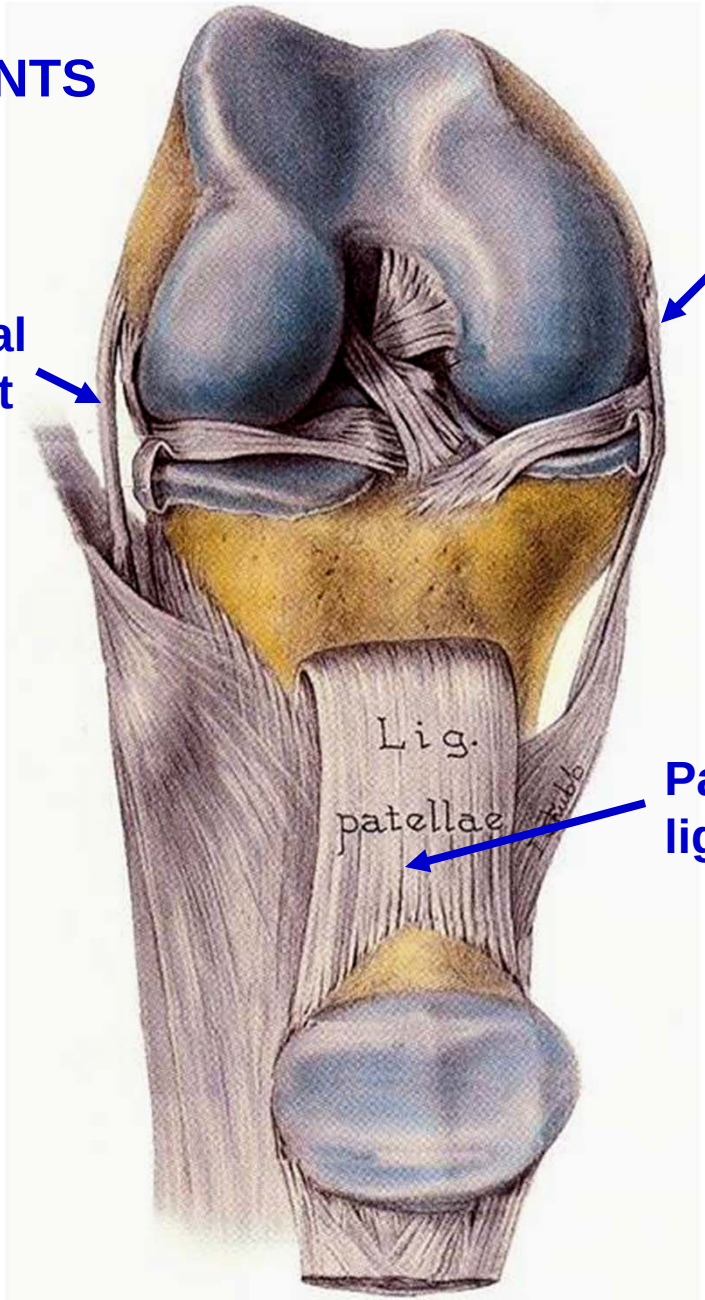
Inflammation of Prepatellar bursa - HOUSEMAIDS KNEE

EXTRACAPSULAR LIGAMENTS

1. **Patellar ligament** - attached above to patella, below to tubercle of tibia.

2. **Lateral (fibular) collateral ligament** - attached above to **lateral condyle of femur**, below to **head of fibula** (**prevents movement of tibia medially**). There is a **space between the ligament and the lateral meniscus** (posteriorly, popliteus is in this space)

3. **Medial (tibial) collateral ligament** - attached above to **medial condyle of femur**, below to **medial side of tibia**; **prevents movement of the tibia laterally**.



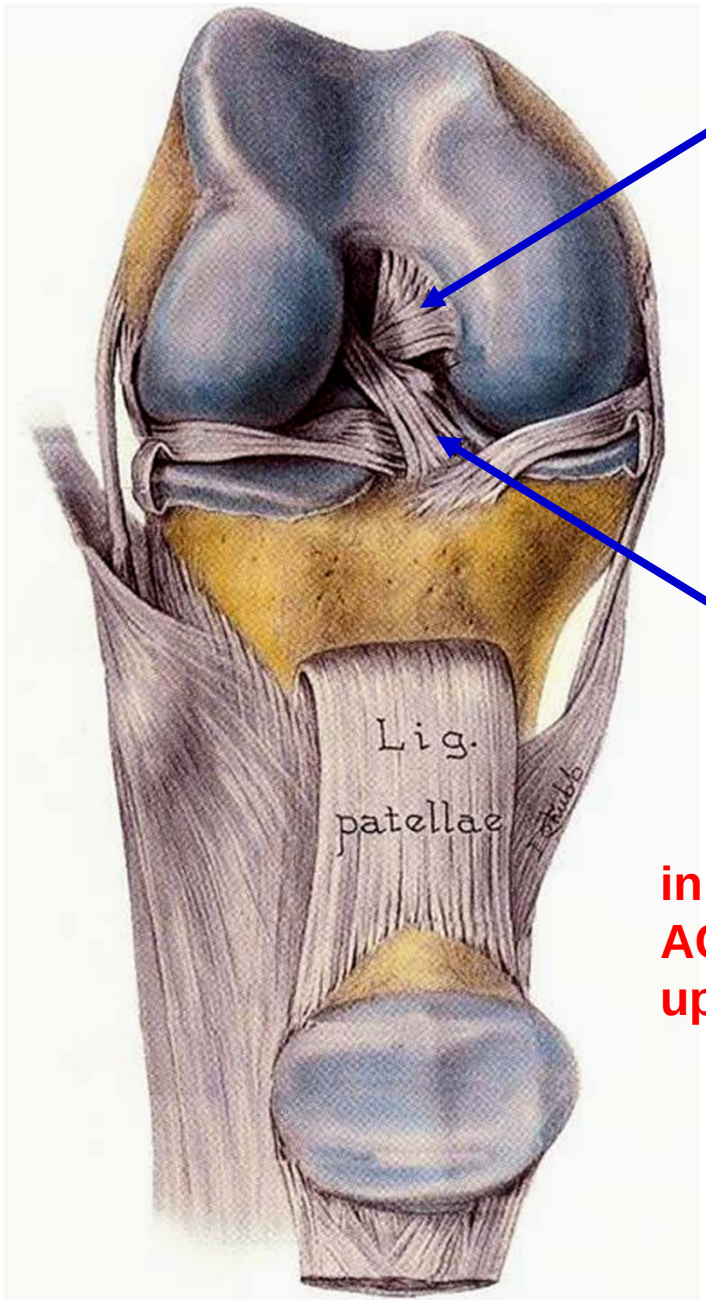
VIEW RIGHT JOINT ANTERIORLY WITH QUADRICEPS TENDON CUT AND PATELLA REFLECTED DOWN

INTRACAPSULAR LIGAMENTS

located deep in joint.

1. **Anterior cruciate ligament** - attached between condyles of tibia, anterior to intercondylar eminence; **passes upward, laterally, and posteriorly to attach to medial side of lateral femoral condyle**; **prevents movement of tibia anteriorly.**

2. **Posterior cruciate ligament** attached between condyles of tibia; attaches to **lateral side of medial femoral condyle**; **prevents movement of tibia posteriorly**

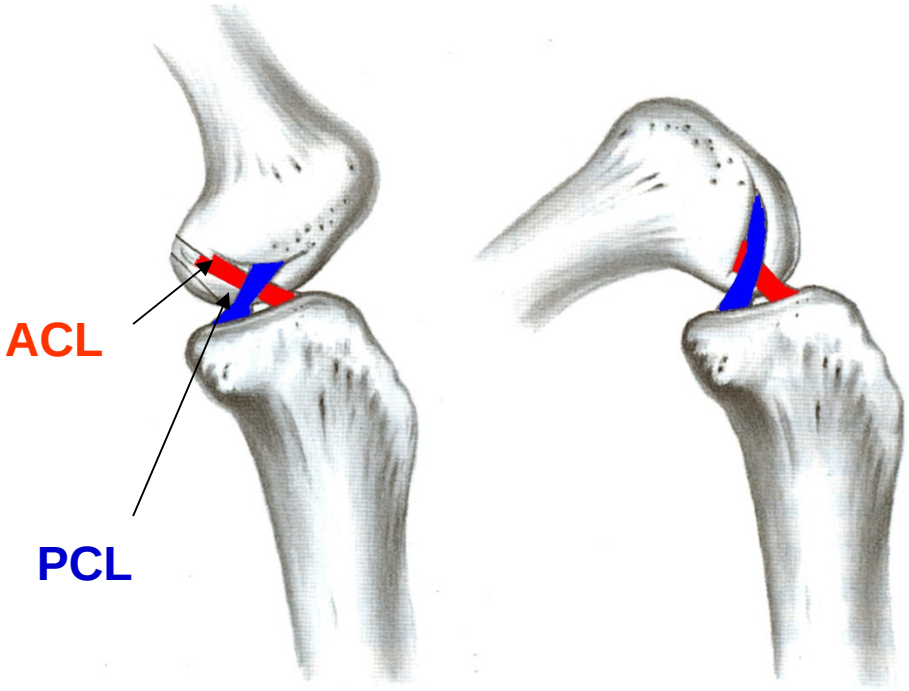


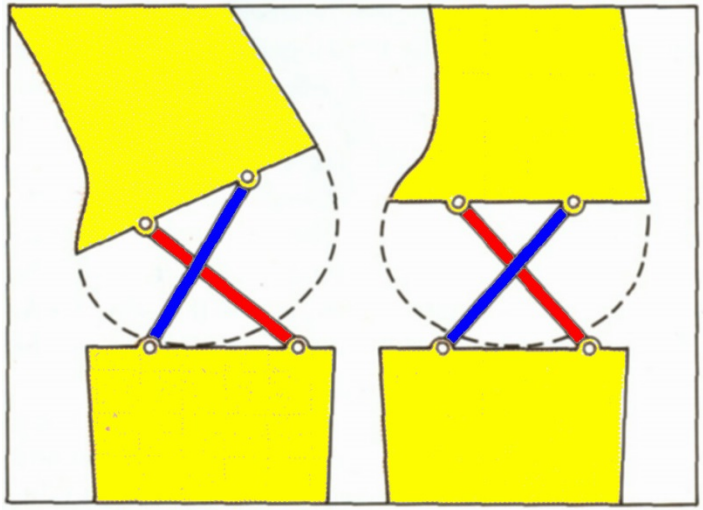
Posterior cruciate ligament

Anterior cruciate ligament

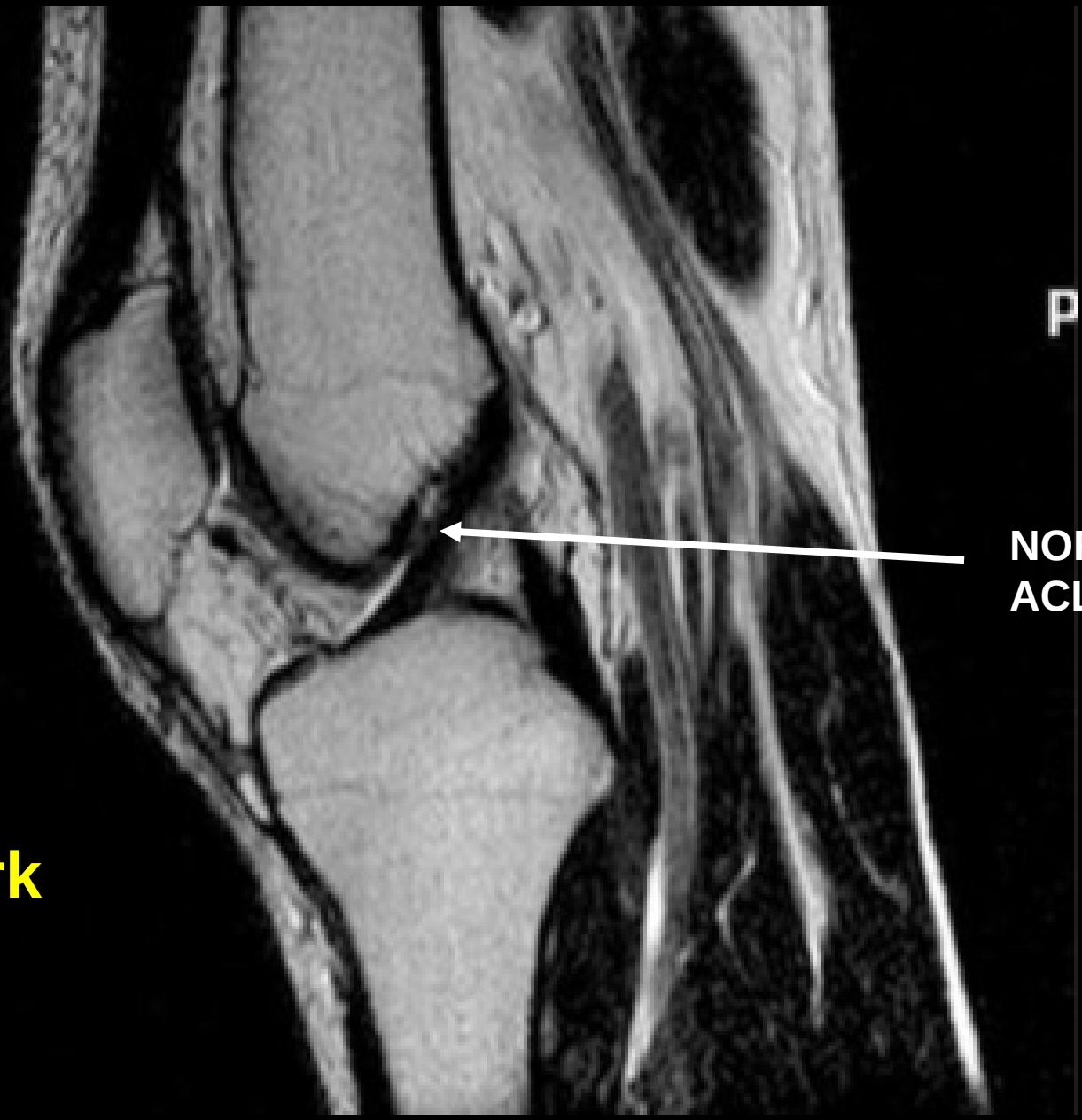
in anterior view, ACL passes up and back

ANTERIOR AND POSTERIOR CRUCIATE LIGAMENTS ALLOW FOR FREE FLEXION AND EXTENSION OF KNEE





MRI OF KNEE JOINT: NORMAL



What landmark helps identify ACL?

MRI OF KNEE JOINT: ACL TEAR

LAURA WILSON, MUSOM 2015
PEDIATRIC RESIDENT

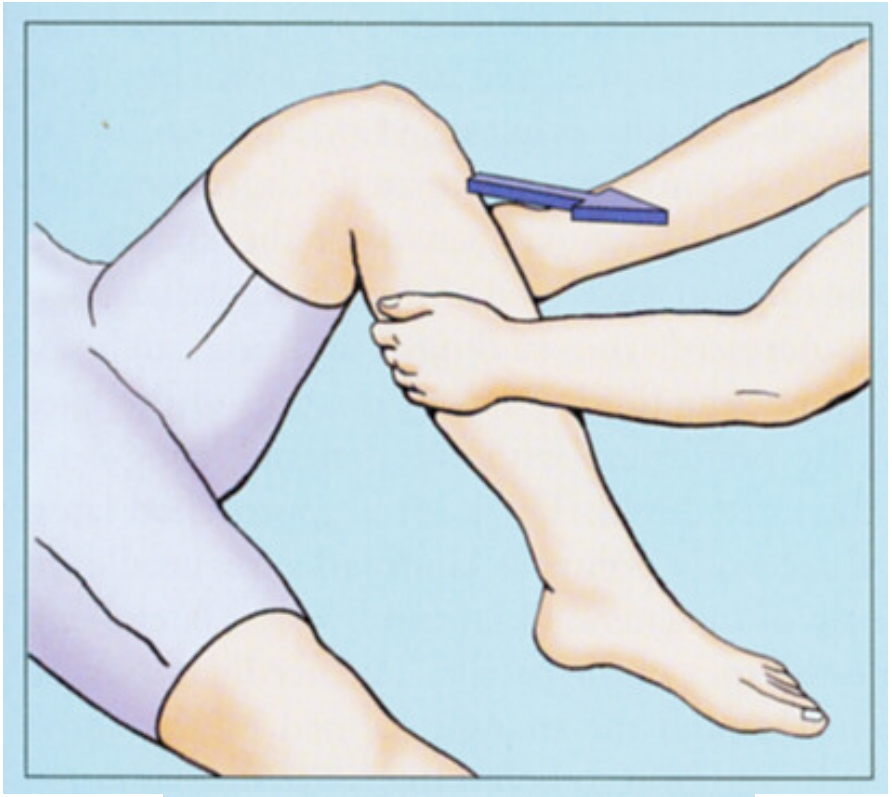
NORMAL ACL

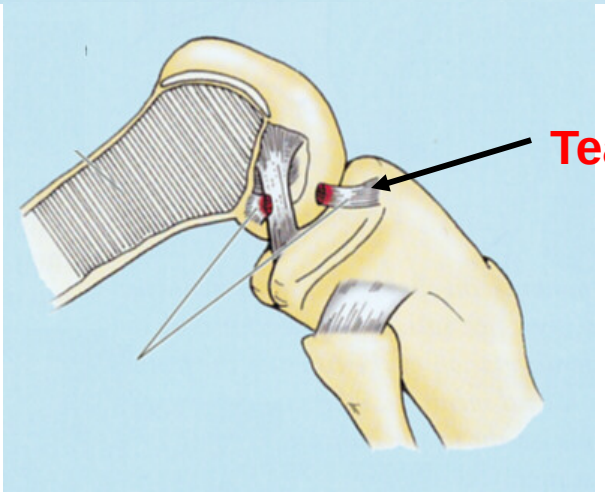
TORN ACL

TESTS FOR TEARS IN CRUCIATE LIGAMENTS

ANTERIOR DRAWER SIGN

Tear Anterior Cruciate Ligament - can **draw tibia anteriorly**.



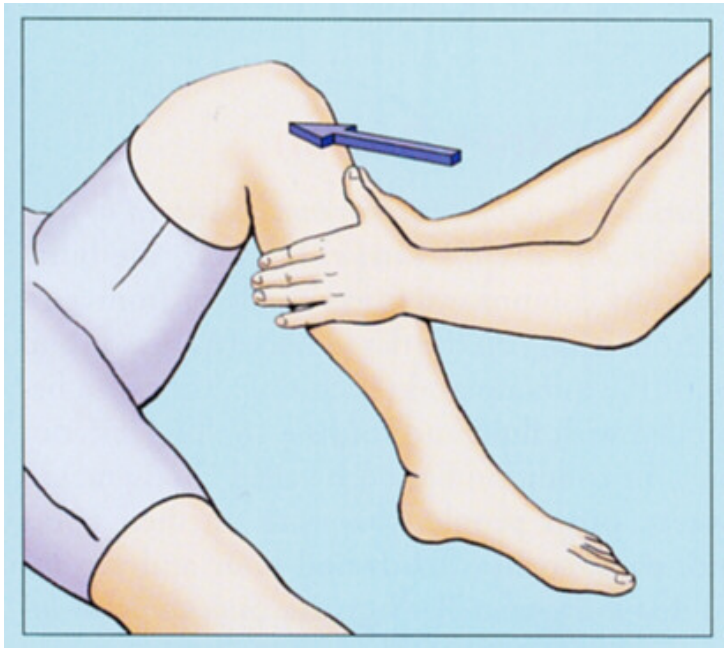


Tear Anterior Cruciate

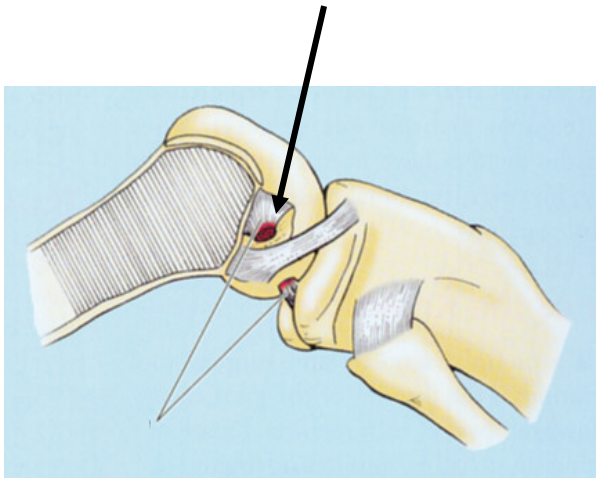
TESTS FOR TEARS IN CRUCIATE LIGAMENTS

POSTERIOR DRAWER SIGN

Tear Posterior Cruciate Ligament - can **push tibia posteriorly**



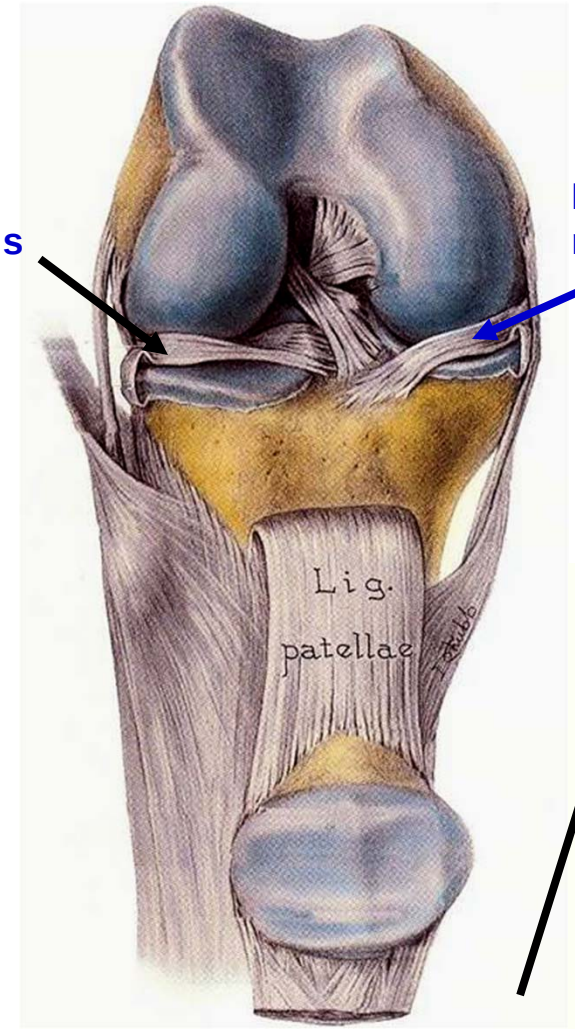
Tear Posterior Cruciate

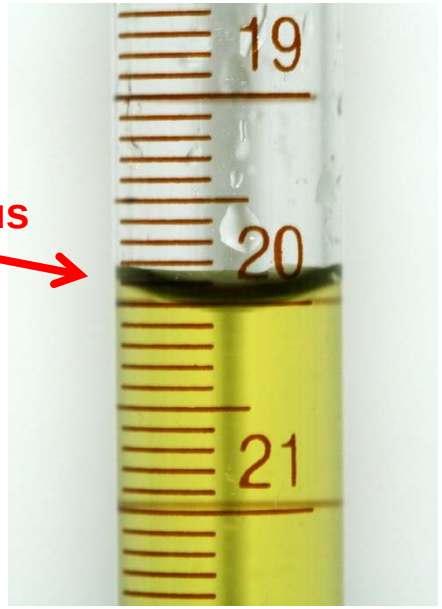


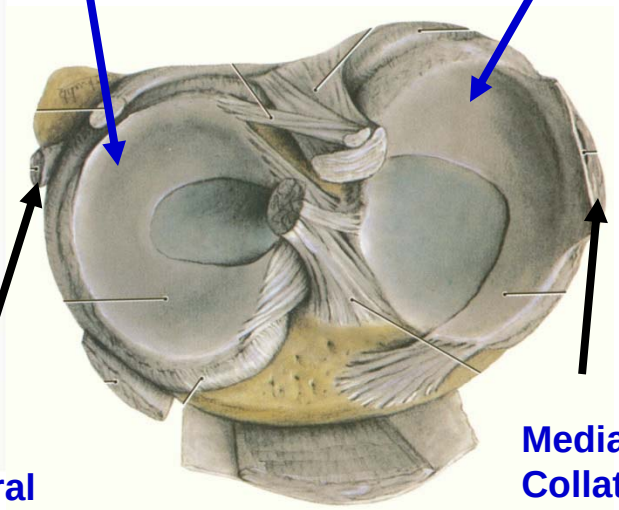
KNEE JOINT - MENISCI

Menisci - "C" shaped cartilages that are attached to inner side of joint capsule

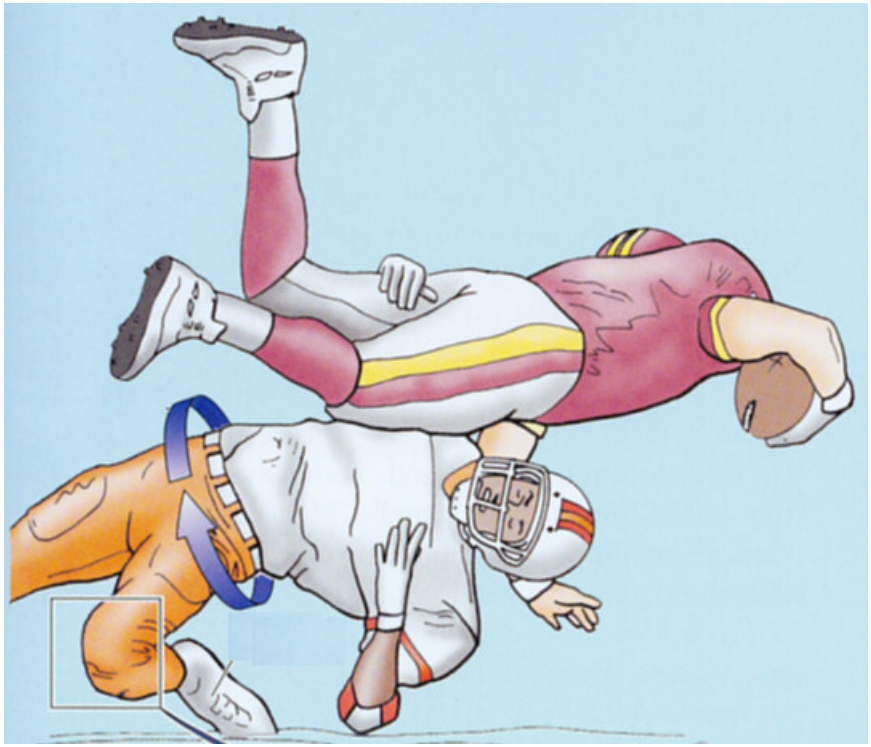
1. **Medial meniscus** - attached between condyles; also firmly **attached to medial (tibial) collateral ligament**; relatively fixed in joint.
2. **Lateral meniscus** - more movable than medial meniscus since it is **NOT attached to fibular collateral ligament**

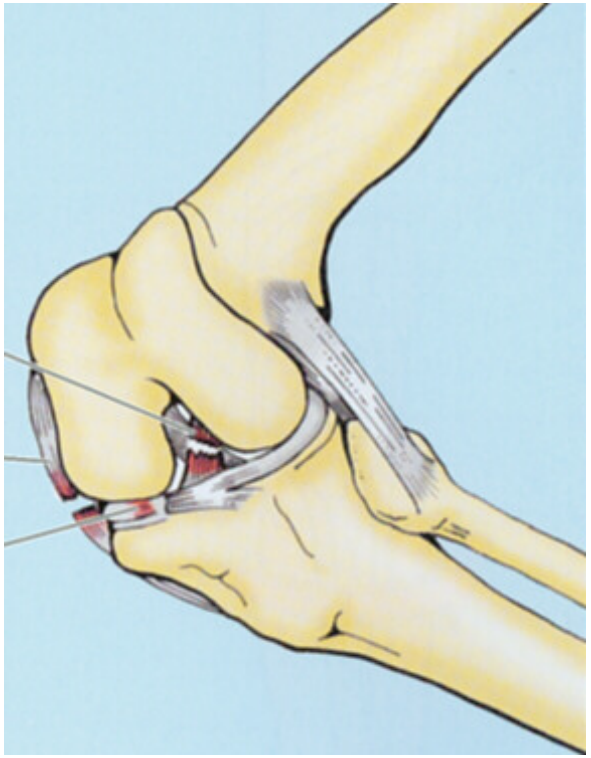






TERRIBLE TRIAD OF KNEE JOINT



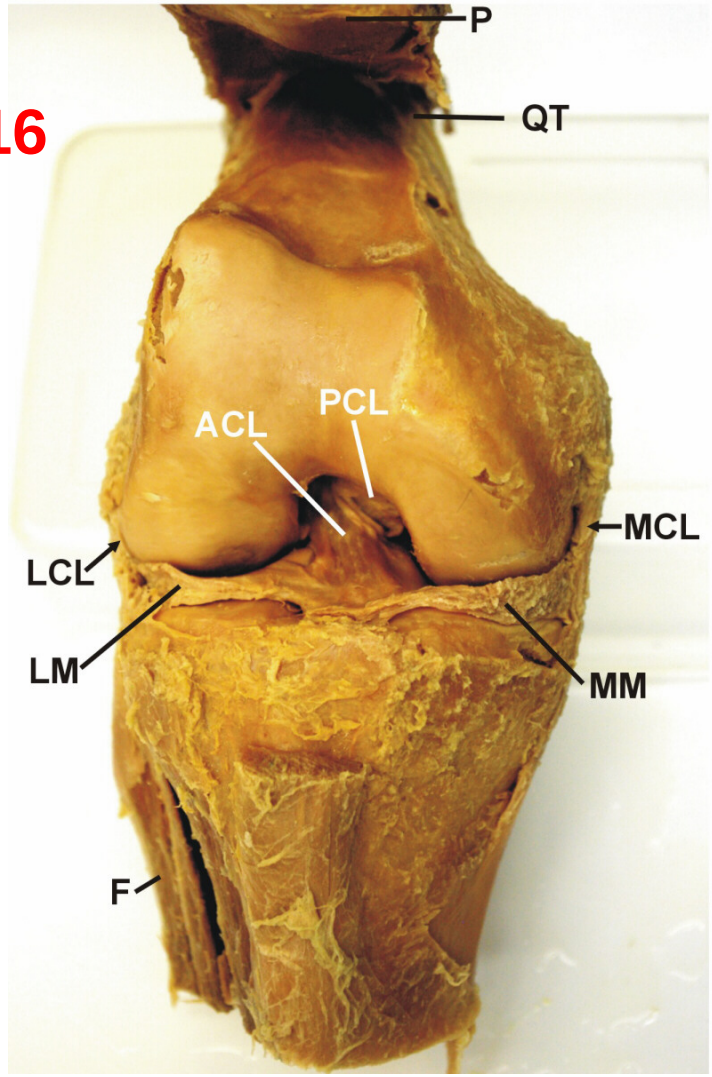


Clinical Note: **Terrible Triad of the Knee joint**: Knee joint is stable in extension but ligaments are slackened by joint flexion; **blow to lateral side** of the knee when the leg is flexed (as can occur in football tackles) or rotate and force lateral movement of body; can tear **Tibial (Medial) collateral ligament, Anterior cruciate ligament and Medial meniscus** (because it is firmly fixed to the medial collateral ligament).

PROSECTIONS OF KNEE JOINT

DISSECT KNEE JOINT

216



ARTHROPLASTY: ARTIFICAL KNEE

218

DR. ALI OLIASHIRAZI: TOTAL KNEE REPLACEMENT

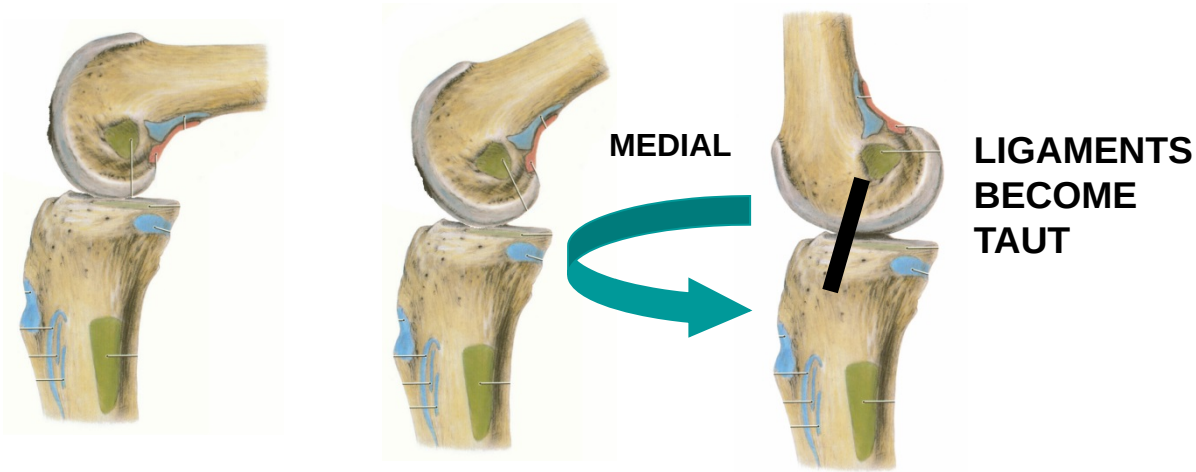
BEFORE

AFTER

LOCKING AND UNLOCKING KNEE JOINT

Note: **LOCKING AND UNLOCKING KNEE JOINT**
- When **moving to full extension of knee joint, femur rotates medially during last 30 degrees of movement**; this pulls all major ligaments of the knee joint taut, **'locking' the knee and making it very stable**; to flex knee from full extension, joint must first be **unlocked** by contracting the **popliteus muscle** which **rotates the femur laterally (foot is firmly on ground)** producing relaxation of ligaments. (LOCK femur rotates MEDIALLY; UNLOCK femur rotates LATERALLY)

Femur rotates medially during last 30 degrees of extension, due to shape of condyles

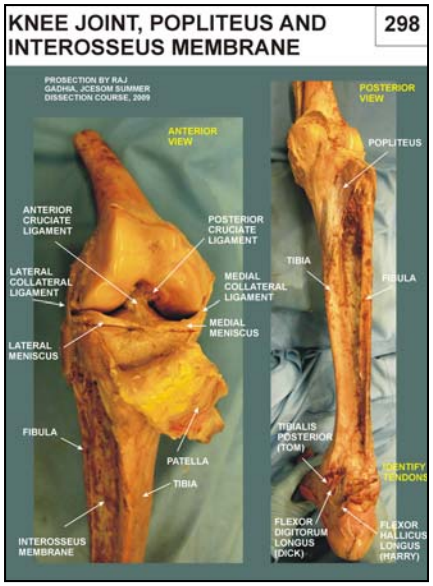


POPLITEUS ROTATES FEMUR LATERALLY

LATERAL

POP-LIT'-EUS UNLOCKS KNEE WHEN FLEX KNEE

JOINTS BETWEEN TIBIA AND FIBULA

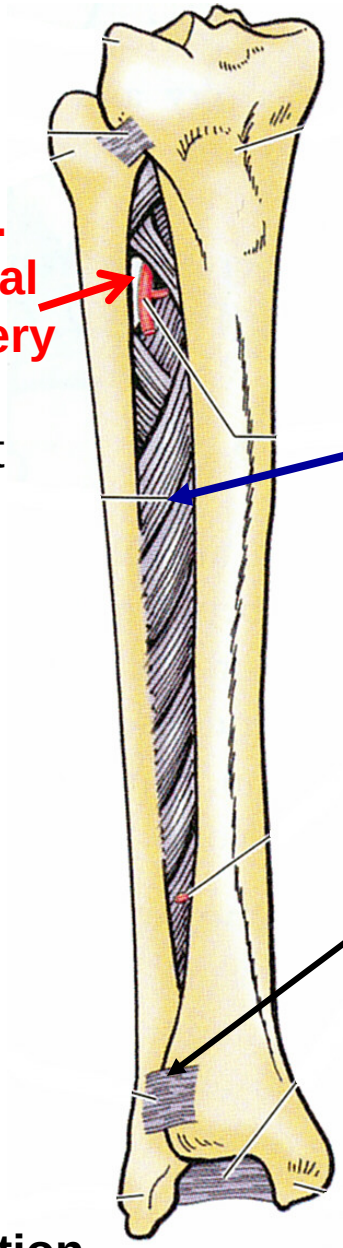


SEE PROSECTION 298

Bones linked by ligaments.

A. **Interosseus membrane** - broad sheet of **connective tissue links shafts of tibia and fibula**; has gap for Anterior Tibial artery and vein.

B. **Inferior articulation - Anterior and Posterior Inferior tibio-fibular ligaments** join bones above ankle joint.



type of joint = SYNDESMOSIS - sheet of connective tissue between bones

Interosseus membrane - CT fibers oriented to pull up on fibula

Anterior Inferior tibio-fibular ligaments

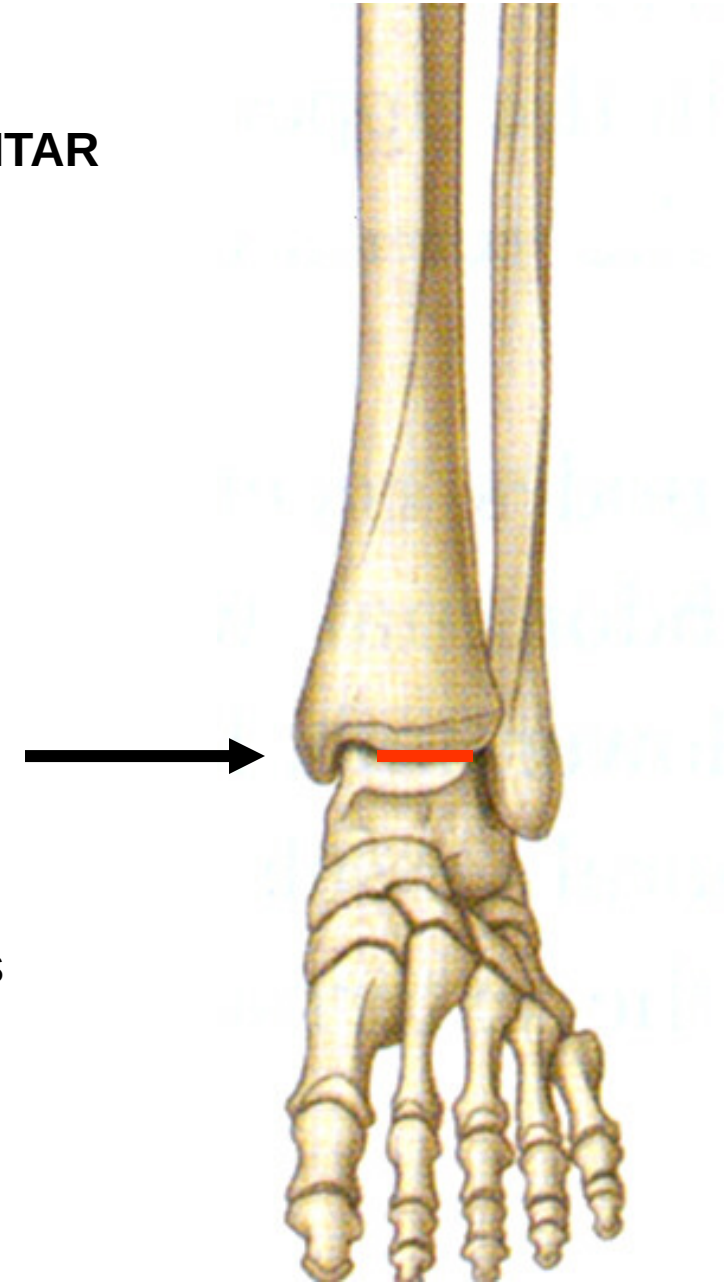
HIGH ANKLE SPRAIN

High ankle sprain - cause usually foot rotation

ANKLE JOINT: DORSIFLEXION/PLANTAR FLEXION

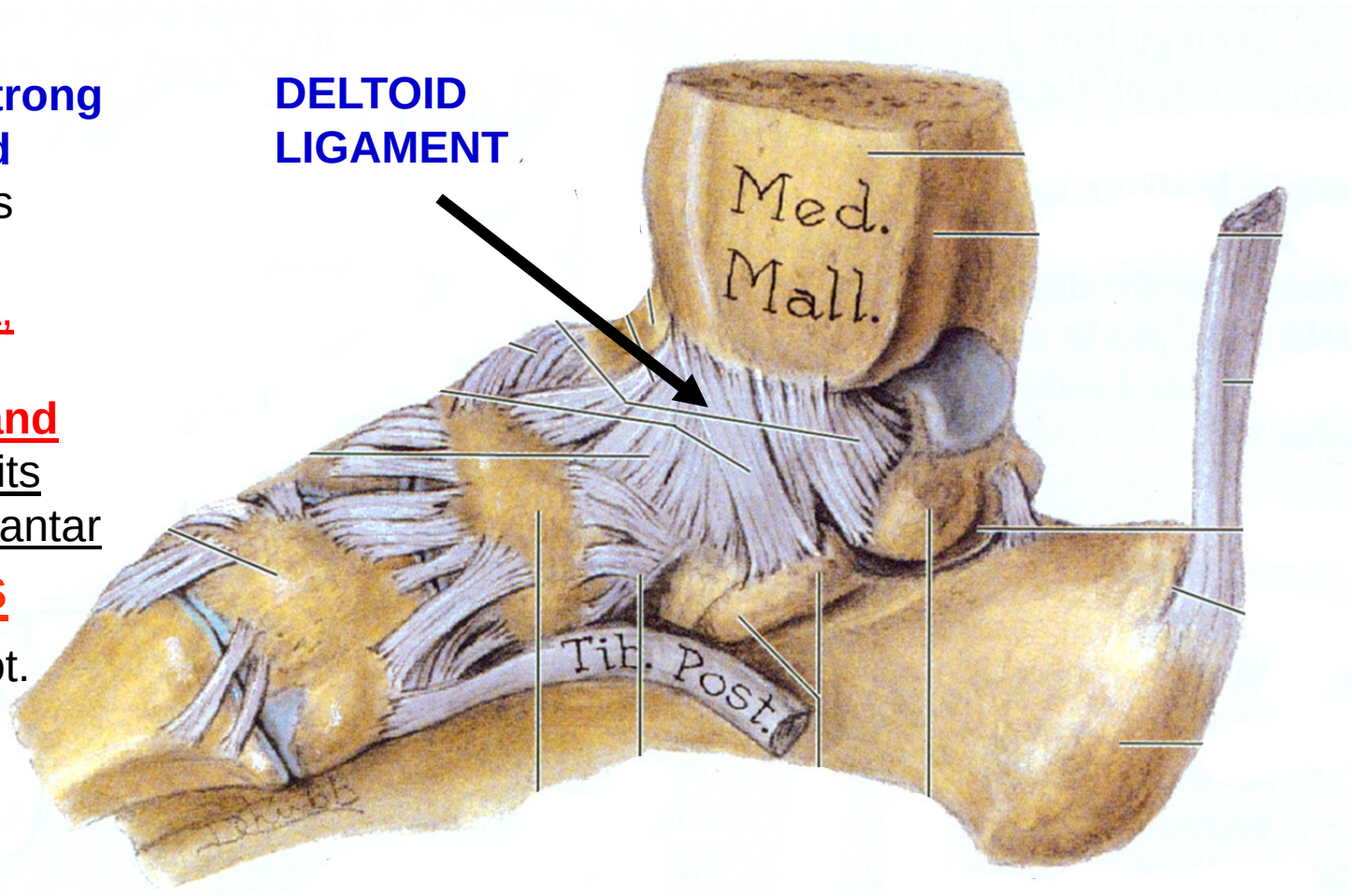
Joint is between talus inferiorly and the tibia and fibula superiorly, capsule surrounds joint:

Uniaxial, synovial **hinge type joint; permits dorsiflexion and plantar flexion (not inversion or eversion** which occurs at joints between tarsal bones).



ANKLE JOINT: LIGAMENTS

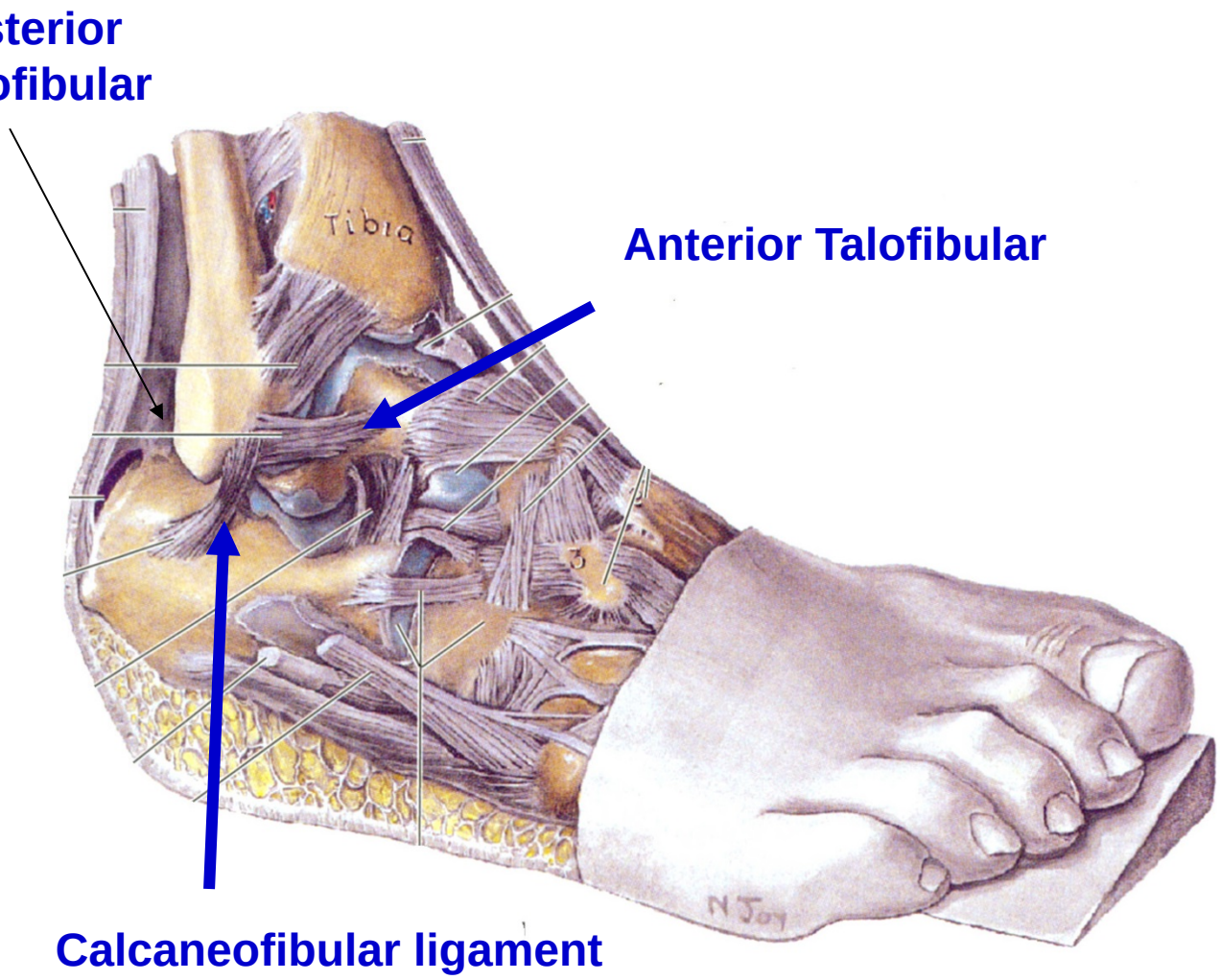
Medial (Deltoid) ligament - very strong triangular shaped ligament; attaches above to **medial malleolus of tibia**, below to **medial surface of talus and calcaneus**. Permits free dorsiflexion/plantar flexion but **limits eversion** of foot.



ANKLE JOINT: LIGAMENTS

Lateral ligaments - weaker; all attach above to **lateral malleolus of fibula**; permit free dorsiflexion/plantar flexion but **limit inversion** of foot.

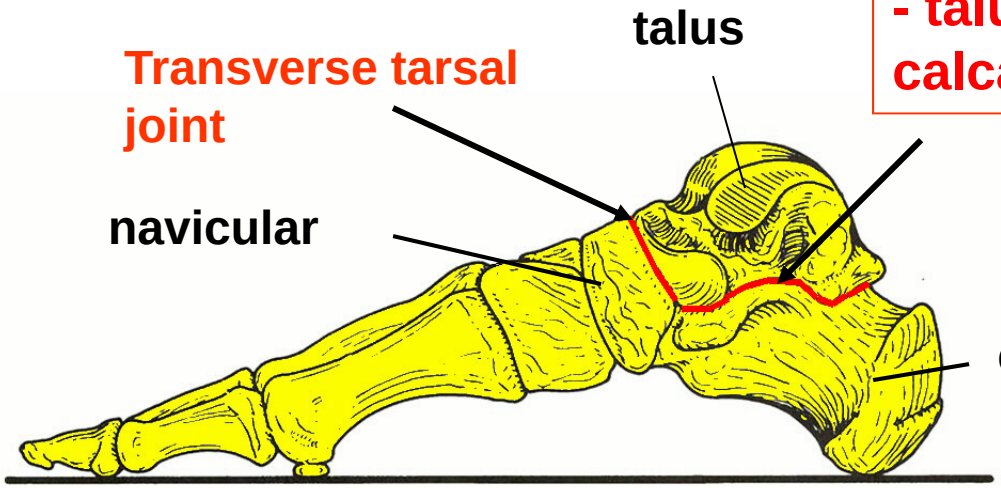
a. **Anterior and Posterior Talofibular** ligaments to talus.
b. **Calcaneofibular ligament** to calcaneus.



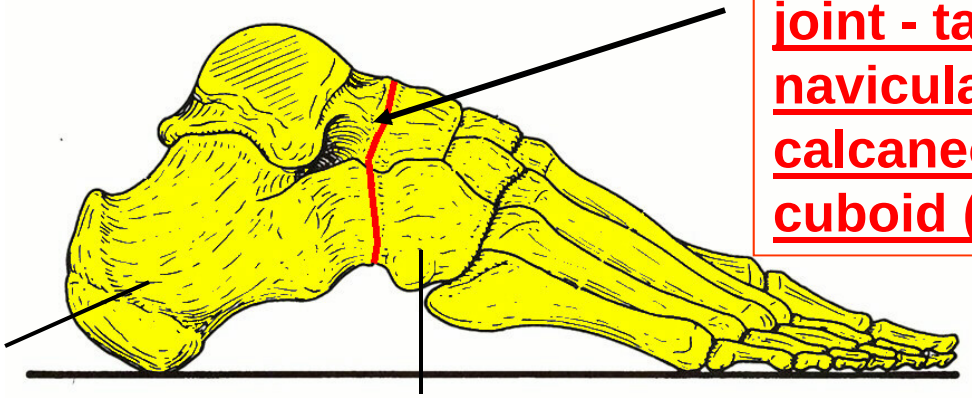
JOINTS OF INVERSION/EVERSION OF FOOT

Inversion eversion movements occur at
1) **Subtalar joint** (between **talus and calcaneus**) and at
2) **Transverse tarsal joint** (between **talus and navicular** bones medially, **calcaneus and cuboid bones** laterally.

Subtalar joint - talus, calcaneous



Transverse tarsal joint - talus, navicular (med), calcaneous, cuboid (lat)



MOVEMENTS OF LOWER LIMB

D. Inversion-Eversion -

Inversion - turn foot so sole faces medially

Eversion - turn foot so sole faces laterally

Inversion - sole faces medially

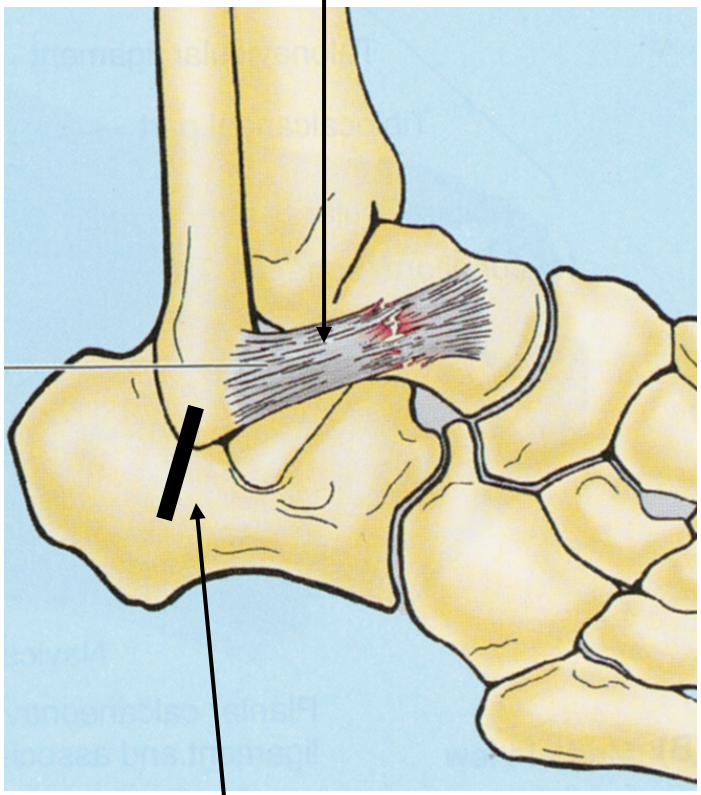
Eversion - sole faces laterally

big toe raised

big toe turned down

SPRAINED ANKLE: EXCESSIVE INVERSION

Note: **Sprains** of ankle are usually caused by **excessive inversion**; **Anterior talofibular** and **Calcaneofibular ligaments** are commonly **stretched or partially torn**.

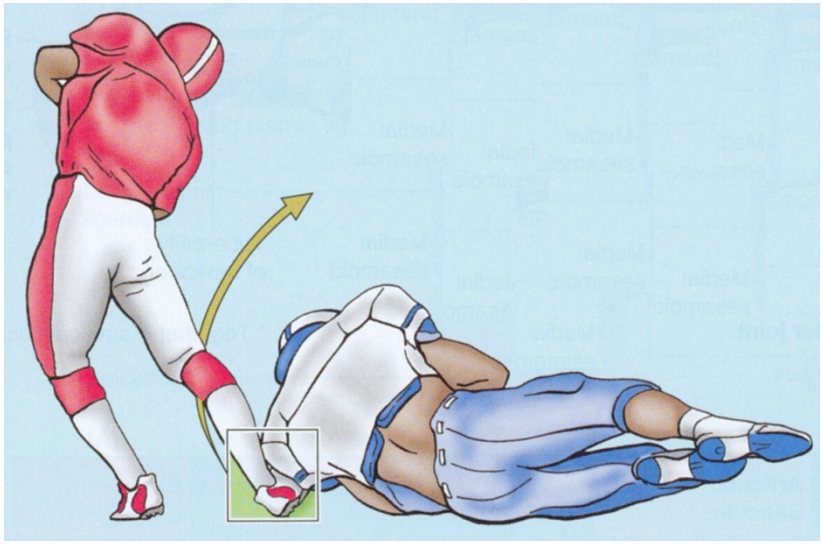


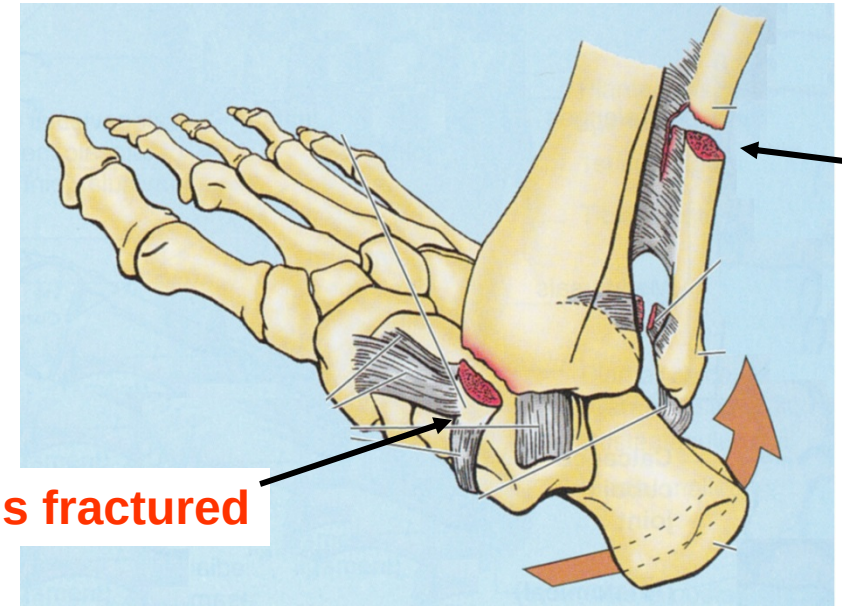
Anterior talofibular

Calcaneofibular ligaments

POTT'S FRACTURE: EXCESSIVE EVERSION

Note: **Pott's fractures** are caused by **excessive eversion**; strong **Deltoid ligament does not rupture** but 1) **medial malleolus is fractured**; also 2) **break shaft of fibula.**



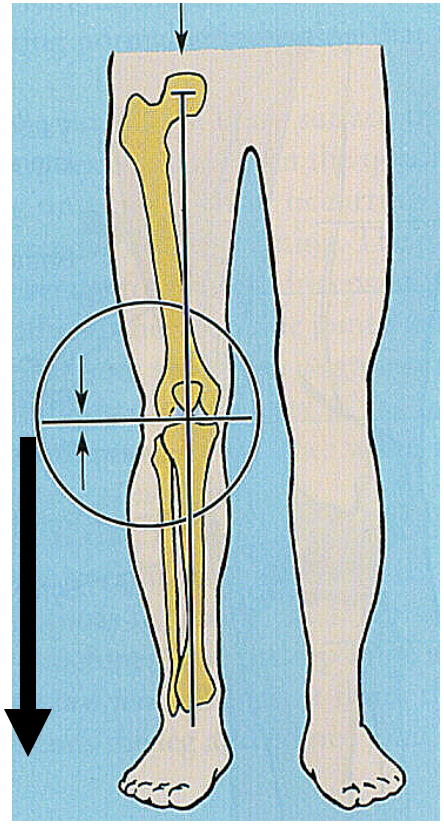


Fibula is fractured

Medial malleolus is fractured

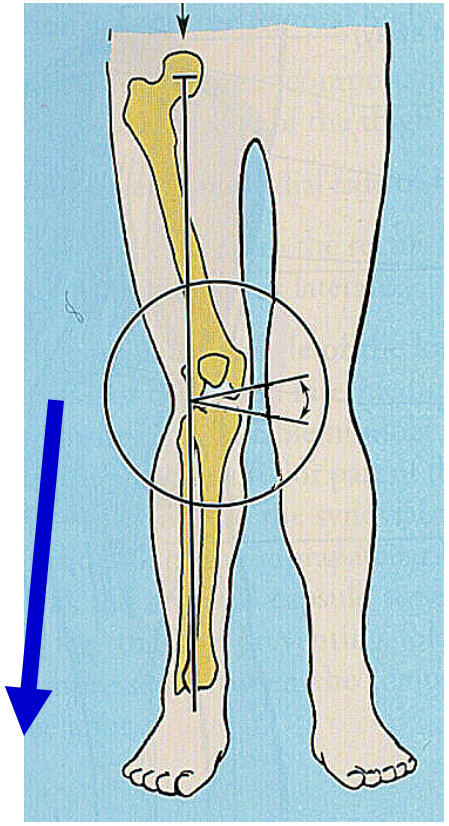
X. DEFORMITIES OF LOWER LIMB: TERMINOLOGY – Valgus and Varus

Normal - Distal bone in joint is parallel to midline



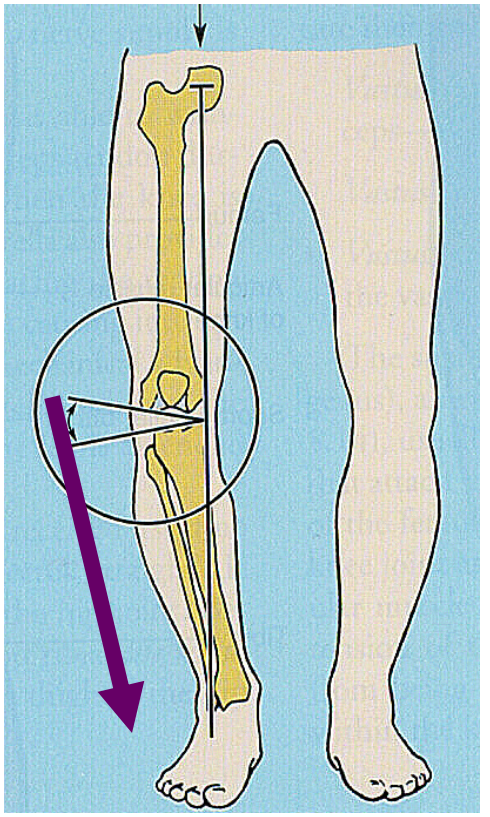
(It's vulgar to be knock-kneed) →

Valgus - Distal bone at a joint is deviated laterally away from midline of body



Genu valgus = knock-kneed;
normal in infants 3-5

Varus - Distal bone at a joint is deviate toward midline



Genu varus = bow-legged;
normal in infants to age 3

CAUSES GENU VARUS (BOWLEGGED)

Blount's disease - a condition of severe bowleg that occurs more frequently in black children; disease is progressive, and may require surgery.

Growth disturbance - or epiphyseal dysplasia, which may be a part of a generalized bone growth disturbance.

Post-trauma - where injury to the knee causes damage to the growth plate (also called the epiphyseal plate) and abnormal growth around the knee.

Rickets - Lack of vitamin D intake, or inability to metabolize Vitamin D due to kidney disease can cause growth disturbance of the bones in the body, including the knee.

LEG AND DORSUM OF FOOT

I. DESIGN OF LEG AND FOOT - foot is specialized for

A. **Supporting weight of body at heel and toes**; tendons of muscles of lower leg enter foot on medial and lateral sides without being compressed by body weight; tendons use medial malleolus, lateral malleolus as pulleys; support of body is produced by pushing foot and toes on ground (plantar flexion of foot, flexion of toes).

B. **Walking on surfaces that are not flat** (i.e. walking across a hill side) - joint between calcaneus and talus allows foot to be tilted from side to side; inversion - sole up medially, eversion - sole up laterally; this is very useful but can cause clinical problems (i.e. sprained ankle is excessive inversion).

II. REVIEW BONES OF LEG - Weight of body is transmitted to tibia; tibia and fibula joined by interosseus membrane.

A. Tibia - medial bone, subcutaneous; proximally is large with flat condyles for articulation with femur at knee joint; distally is small and forms medial malleolus (little hammer) on medial side of ankle joint (tibia articulates with talus).

B. Fibula - much smaller bone located laterally; proximally does not form part of knee joint but head of fibula (proximal end) is palpable laterally below knee; distally forms lateral malleolus and articulates with talus at ankle joint.

Note: Hallux is big toe in Latin.

III. COMPARTMENTS OF LEG - separated by 1) septa derived from deep fascia of leg and 2) interosseus membrane

COMPARTMENT	MUSCLE ACTION	NERVE	ARTERY
Posterior	Plantar flex foot, flex toes; Invert foot	Tibial nerve	Posterior tibial artery
Lateral	Evert foot	Superficial Peroneal Nerve	Posterior tibial artery (lateral branch)
Anterior	Dorsiflex foot, extend toes; Invert foot	Deep Peroneal Nerve	Anterior tibial artery

IV. POSTERIOR COMPARTMENT - composed of superficial and deep subgroups; Tibial nerve courses between subgroups with Posterior Tibial artery

A. Superficial group - large muscles of posterior calf that support weight of body and provide propulsion in walking and running by plantar flexion of foot, insert onto Calcaneus

1. Gastrocnemius (gastr - belly, cnem - leg) has medial and lateral heads that insert to tendo calcaneus (Achilles tendon); Tendo calcaneus is largest tendon in body.

Clinical note: Lateral head of Gastrocnemius sometimes contains sesamoid bone, called the Fabella (L. faba, bean). Why do you have to know this? Fabella can be mistaken for a fracture on x-ray

2. Soleus (named for resemblance to flat fish called sole) - deep to Gastrocnemius, also inserts on Tendo calcaneus.

3. Plantaris - sometimes absent; very small belly but long thin tendon that is used for tendon grafts; tendon resembles a nerve; Plantaris is called 'freshman's nerve'.

Note: Rupture of tendo calcaneus - All superficial muscles insert onto tendo calcaneus. Tendon can rupture, accompanied by tearing of muscles and bleeding.

Clinical note: **Achilles tendon refle**x - tap on tendo calcaneus results in plantar flexion of foot; tests **S1 and S2.**

Clinical note: A bursa is located between tendon and calcaneus; can become inflamed.

B. Deep group - muscles that plantar flex and invert foot, flex toes; muscles enter foot on medial side of ankle

ORDER OF STRUCTURES ON MEDIAL SIDE OF ANKLE - **TOM, DICK AND HARRY** - **T**ibialis posterior (tendon), Flexor **D**igitorum Longus, Posterior Tibial **A**rtery, Tibial **N**erve and Flexor **H**allucis Longus.

Note: Order is important as accidents can happen that sever tendons (i.e. ax strikes ankle when chopping wood).

Note: Muscles bellies are apparently backward in leg - Flexor of big toe (hallucis) is lateral; flexor other toes is medial; tendons cross in foot.

1. Flexor hallucis longus - tendon passes deep on medial ankle beneath projection from calcaneus (sustentaculum tali); crosses over other tendons to reach distal phalanx of big toe.
2. Tibialis posterior - located deep between flexor hallucis longus and flexor digitorum longus; tendon crosses to medial side at ankle joint and passes directly beneath medial malleolus.
3. Flexor digitorum longus - located medially in leg; single tendon passes medial to ankle beneath medial malleolus then expands to four tendons that pass to distal phalanges in foot.

Note: Flexor Retinaculum (L. retaining band) - tendons of deep muscles pass beneath flexor reticulum (thickened of deep fascia) on medial side of ankle joint. Each tendon is covered by a synovial sheath, which lubricates tendon.

Clinical Note: **Tarsal Tunnel Syndrome** - Tarsal Tunnel is area beneath flexor retinaculum; Tarsal Tunnel Syndrome results from swelling of synovial sheaths; can compress Tibial Nerve; symptoms are numbness of sole of foot, toes and weakened flexion of toes (intrinsic muscles of foot).

V. LATERAL COMPARTMENT OF LEG - muscles act to evert foot; tendons pass beneath lateral malleolus (acts as pulley) beneath Superior and Inferior Peroneal retinacula; Innervated by Superficial Peroneal Nerve.

A. Peroneus Longus - starts laterally in leg and ends on medial side of foot; tendon passes beneath lateral malleolus then crosses in deepest layer of foot to first metatarsal and cuneiform bone; major everter of foot.

B. Peroneus Brevis - starts laterally and ends laterally; inserts to fifth metatarsal.

VI. ANTERIOR COMPARTMENT OF LEG - muscle bellies in anterior leg, tightly covered by dense fascia; tendons pass beneath extensor retinacula to dorsum of foot and toes; Innervated by Deep Peroneal Nerve.

A. Retinacula - on anterior side of leg: Superior Extensor Retinaculum - extends from tibia to fibula; Inferior Extensor Retinaculum - Y-shaped, extends from calcaneus to medial malleolus.

B. Muscles

1. Tibialis Anterior - major Inverter of foot and antagonist to Peroneus Longus; ends on same bones (medial cuneiform and first metatarsal) as Peroneus Longus.

2. Extensor Hallucis Longus - inserts to distal phalanx of big toe;

3. Extensor Digitorum Longus - insert to Extensor expansions of phalanges of lateral four toes.

4. Peroneus Tertius - the 'third peroneal muscle', part of Extensor Digitorum Longus that ends on fifth metatarsal.

Clinical Note: **Anterior Leg Syndrome** - fascia surrounding anterior leg muscles is very tough and tight; muscles can swell in compartment due to exercise or fracture of tibia; symptom is FOOT DROP (= loss of dorsiflexion of foot) due to compression of Deep Peroneal Nerve; treated by fasciotomy (surgically splitting fascia).

VII. DORSUM OF FOOT

A. Extensor Digitorum Brevis - origin: calcaneus; insert to extensor expansions of digits 2, 3, and 4. If present, can extend to big toe and then is called Extensor Hallucis Brevis; innervation - Deep peroneal nerve; Action - Extend toes.

VIII. SUMMARY OF MUSCLES THAT ACT IN INVERSION OR EVERSION

1. Muscles that course and insert medially can produce **INVERSION - MAIN INVERTERS, TIBIALIS ANTERIOR AND TIBIALIS POSTERIOR**
2. Muscles that course laterally can produce **EVERSION - MAIN EVERTERS, PERONEUS LONGUS, PERONEUS BREVIS,** (PERONEUS TERTIUS)

IX. NERVES AND ARTERIES

A. Nerves - Sciatic nerve divides into Tibial and Common Peroneal Nerves

1- Common Peroneal Nerve - leaves Popliteal fossa and winds around neck of fibula; very exposed and subject to damage; symptom is FOOT DROP; divides to

a. Deep Peroneal Nerve - innervates muscles of anterior compartment; sensory innervation to dorsum of foot.

b. Superficial Peroneal Nerve - supplies muscles of lateral compartment; main sensory innervation to dorsum of foot.

2- Tibial nerve - innervates muscles of posterior compartment; enters foot and divides into Medial and Lateral Plantar nerves.

B. Arteries - Popliteal artery divides into Anterior and Posterior Tibial arteries:

1. Posterior Tibial Artery - enter posterior compartment and courses with Tibial nerve; in foot divides into Medial and Lateral Plantar arteries; branch in leg:

a. Peroneal Artery - descends in lateral part of posterior compartment; branches to muscles of lateral and posterior compartment.

Note: **Intermittent Claudication** (from L. claudico, limping) - Narrowing of Posterior Tibial artery due to arteriosclerosis; produces ischemia; patients have painful cramps when walking but pain subsides after rest.

Note: **Pulse of Posterior Tibial Artery** - taken between medial malleolus and tendo calcaneus.

2. Anterior Tibial Artery - passes through Interosseus membrane to anterior compartment; descends with Deep Peroneal Nerve; branches;

a. Anterior Tibial Recurrent Artery - part of anastomosis at knee.
b. Medial and Lateral Malleolar Arteries - form anastomosis at ankle.
c. Dorsalis pedis - continuation of Anterior Tibial artery
d. Arcuate artery - branch of Dorsalis pedis; gives rise to Dorsal Digital arteries to toes.

Note: **Pulse of Dorsalis pedis artery** - taken on dorsum of foot between medial and lateral malleoli.

X. DEFORMITIES OF LOWER LIMB: TERMINOLOGY – Valgus and Varus – terms clinically important

A. **Valgus** - Distal bone at a joint is deviated laterally away from midline of body; ex. **Genu valgus = knock-kneed** (**distal tibia tilts away from midline)** (Remember: It's **vulgar** to be knock-kneed)

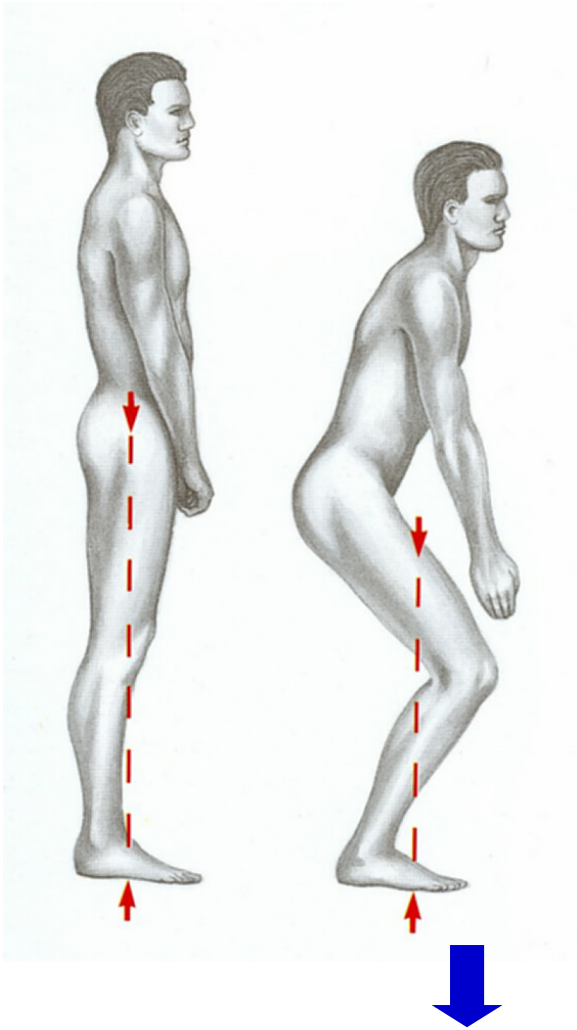
B. **Varus** - Distal part of bone at joint is deviate toward midline; ex. **Genu varus = bow-legged (leg is bowed out and distal tibia tilts toward midline)**

LEG AND DORSUM OF FOOT

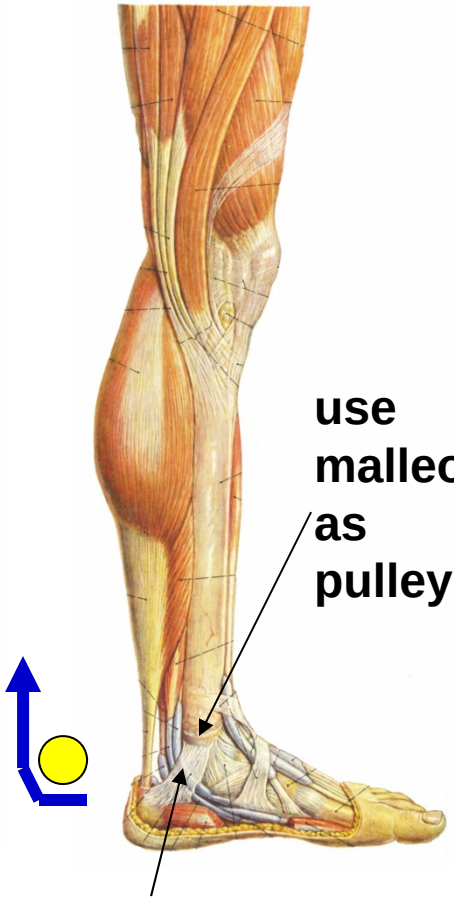
OUTLINE

I. DESIGN OF LEG AND FOOT
II. BONES OF LEG
III. COMPARMENTS
IV. POSTERIOR COMPARTMENT - Tom, Dick and Harry, standing and walking
V. LATERAL COMPARTMENT - eversion of foot
VI. ANTERIOR COMPARTMENT - lift foot, anterior compartment syndrome, shin splints
VI. NERVES AND ARTERIES

I. DESIGN OF LEG AND FOOT



Support body weight
by plantar flex foot



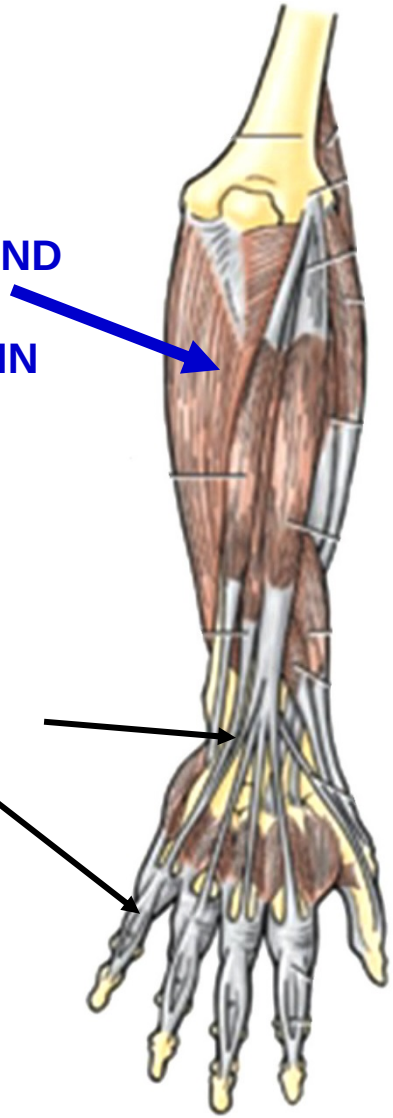
tendons of
muscles enter foot on
lateral, medial and anterior sides

Foot is specialized for:
1) Supporting weight of body at heel and toes; tendons of muscles of lower leg enter foot on medial and lateral sides without being compressed by body weight; tendons use medial malleolus, lateral malleolus as pulleys; support of body is produced by pushing foot and toes on ground (plantar flexion of foot, flexion of toes).

COMMON DESIGN OF UPPER AND LOWER EXTREMITIES

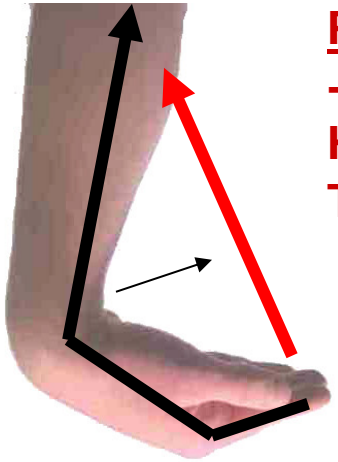
RETINACULUM - L. Restrain

IN ARM, POWERFUL MUSCLES THAT MOVE HAND AND FINGERS ARE LOCATED IN FOREARM



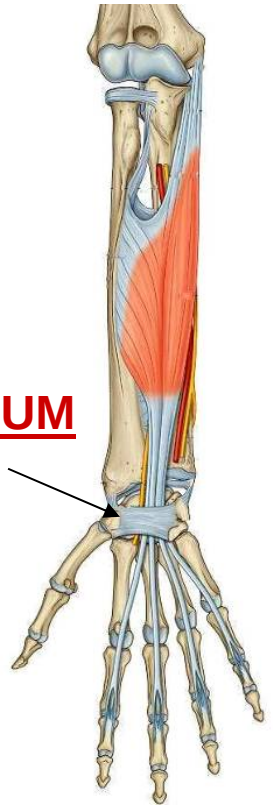
TENDONS OF MUSCLES EXTEND INTO HAND AND FINGERS

FLEX WRIST AND FINGERS BY CONTRACT MUSCLES IN FOREARM



TENDONS WOULD PULL OUT IF NOT HELD TO WRIST - 'BOWSTRINGING'

RETINACULUM - CT BAND - HOLDS IN TENDONS



WRIST IS A TUNNEL = 'CARPAL' TUNNEL

I. DESIGN OF LEG AND FOOT

2) **Walking on surfaces that are not flat** (i.e. walking across a hill side) - joint between calcaneus and talus allows foot to be tilted from side to side; inversion - sole up medially, eversion - sole up laterally; this is very useful but can cause clinical problems (i.e. **sprained ankle is excessive inversion**).

SPRAINED ANKLE - EXCESSIVE INVERSION

Inversion - turn foot so sole faces **medially**

Eversion - turn foot so sole faces **laterally**

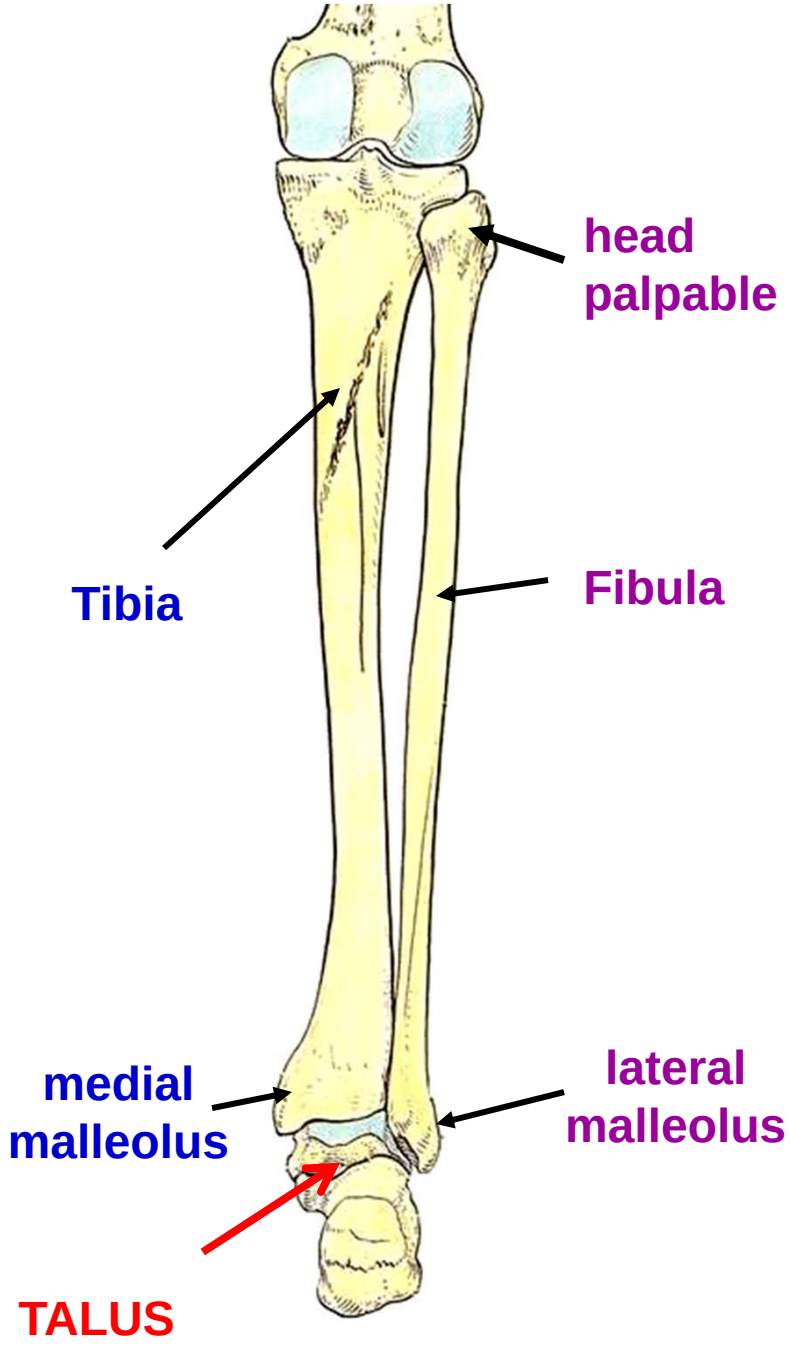
II. REVIEW BONES OF LEG

- Weight of body is transmitted to tibia; tibia and fibula joined by interosseus membrane.

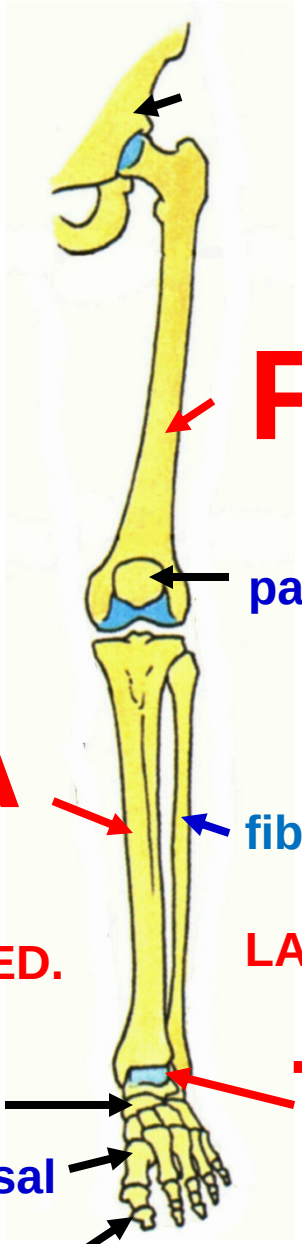
A. **Tibia** - medial bone, **subcutaneous**; proximally is large with flat condyles for articulation with femur at knee joint; distally is small and forms **medial malleolus** (little hammer) on medial side of ankle joint (tibia articulates with talus).

B. **Fibula** - much smaller bone located laterally; proximally does not form part of knee joint but **head of fibula (proximal end) is palpable below laterally below knee**; distally forms **lateral malleolus** and articulates with talus at ankle joint.

Note: Hallux is big toe in Latin.



BODY WEIGHT



calcaneus

first metatarsal

III. COMPARTMENTS OF LEG - separated by 1) septae derived from deep fascia of leg and 2) interosseus membrane

COMPARTMENT	MUSCLE ACTION	NERVE	ARTERY
Posterior	Plantar flex foot, flex toes; Invert foot	Tibial nerve	Posterior tibial artery
Lateral	Evert foot	Superficial Peroneal Nerve	Posterior tibial artery (lateral branch)
Anterior	Dorsiflex foot, extend toes; Invert foot	Deep Peroneal Nerve	Anterior tibial artery

- NOTE: ALL NERVES TO MUSCLES IN LEG AND FOOT ARE BRANCHES OF THE SCIATIC NERVE
- SCIATIC NERVE DIVIDES INTO TIBIAL NERVE AND COMMON PERONEAL NERVE IN POPLITEAL FOSSA
- COMMON PERONEAL NERVE DIVIDES INTO SUPERFICIAL AND DEEP PERONEAL NERVES

DEEP PERONEAL NERVE

SUPERFICIAL PERONEAL NERVE

ANTERIOR

DORSIFLEX FOOT

medial

Tibia

Fibula

LATERAL

EVERT FOOT

BIG TOE

POSTERIOR

PLANTAR FLEX FOOT

TIBIAL NERVE

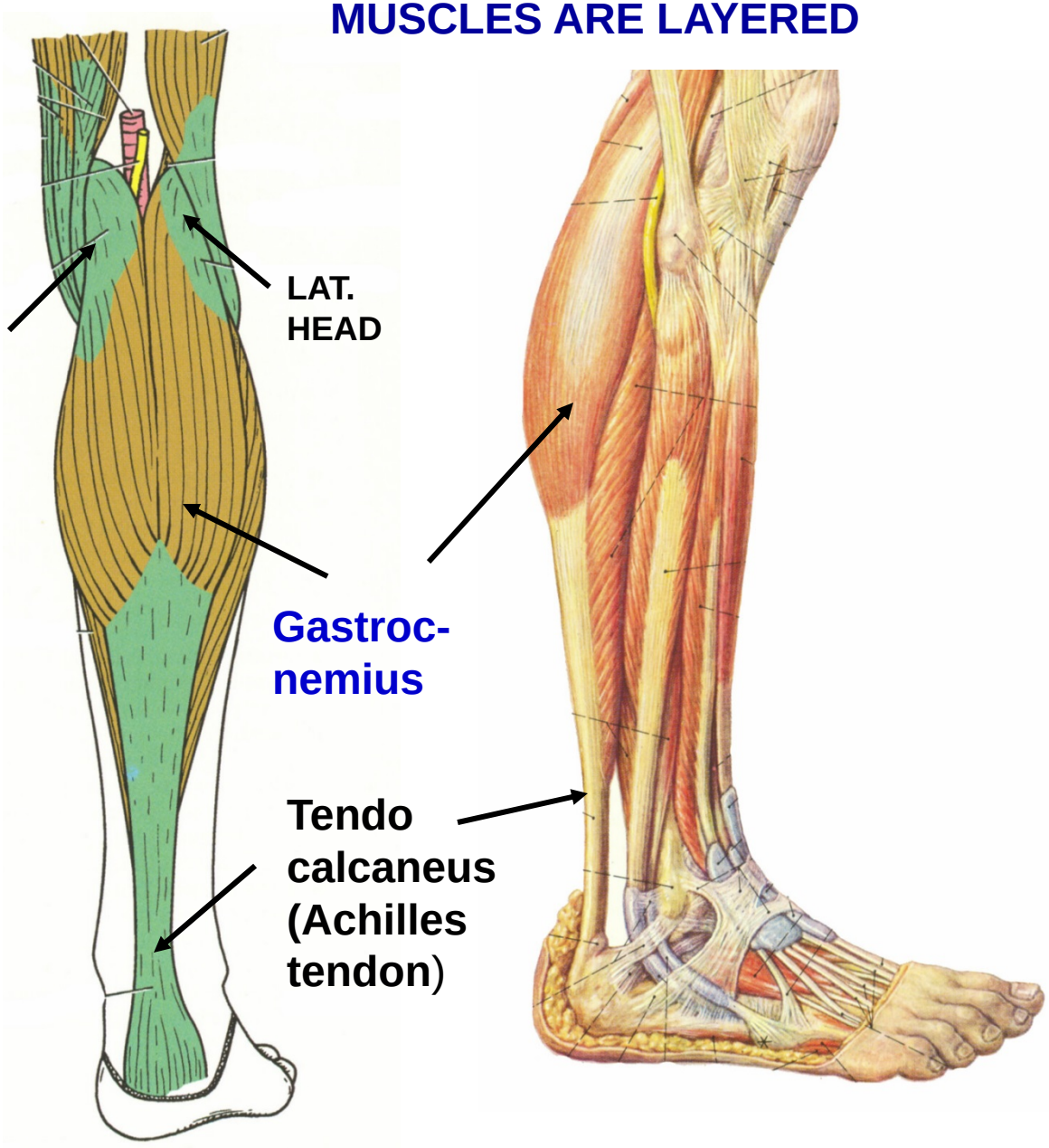
NOTE: MUSCLES OF ANT. AND POST. COMPART-MENTS ALSO INVERT FOOT

IV. POSTERIOR COMPARTMENT MUSCLES - SUPERFICIAL GROUP

A. **Superficial group** - large muscles of posterior calf that **support weight of body** and provide propulsion in walking and running by plantar flexion of foot, insert onto **Calcaneus**

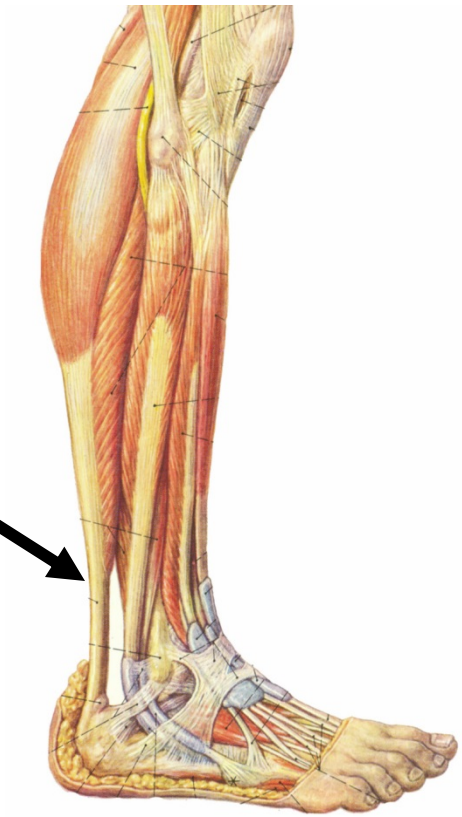
1. **Gastrocnemius** (gastr - belly, cnem - leg) has medial and lateral heads
O - **Femur**
I - to tendo calcaneus **(Achilles tendon**) which attaches to calcaneus; **Tendo calcaneus is largest tendon in body**.
A **- Plantar flex foot**

MUSCLES ARE LAYERED



RUPTURE OF ACHILLES TENDON

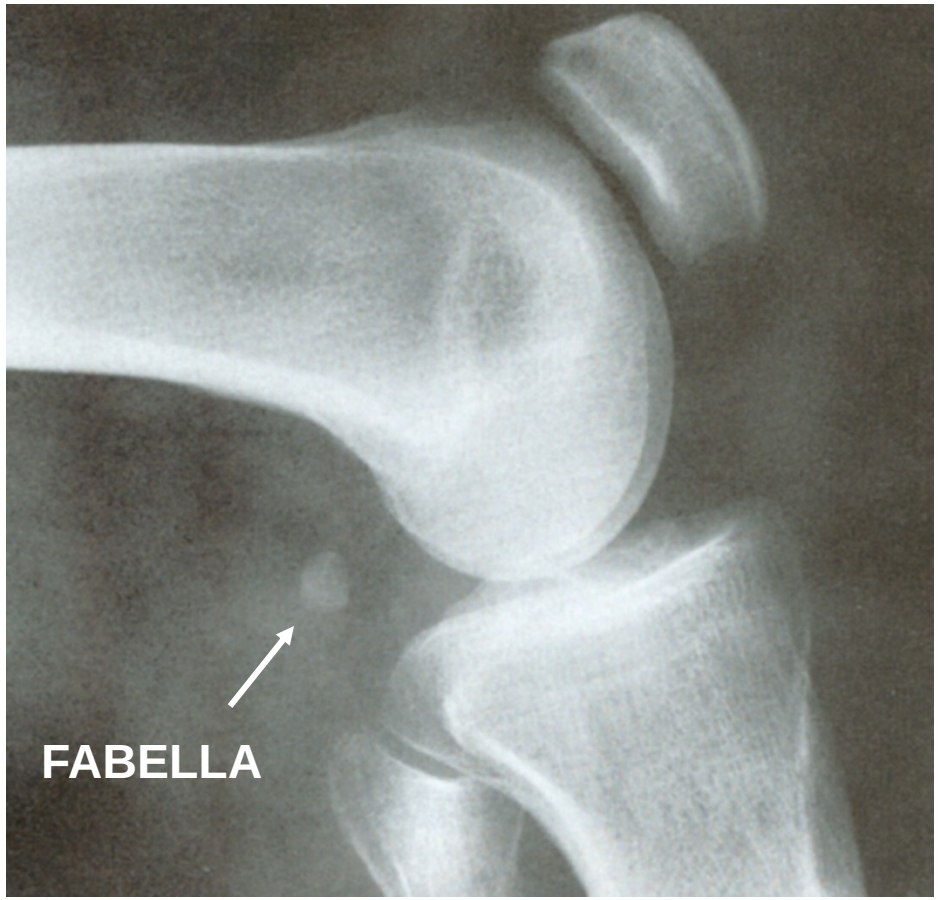
ALL SUPERFICIAL ANKLE PLANTAR FLEXORS INSERT TO ACHILLES TENDON



Tendon can rupture, accompanied by tearing of muscles and bleeding.

FABELLA

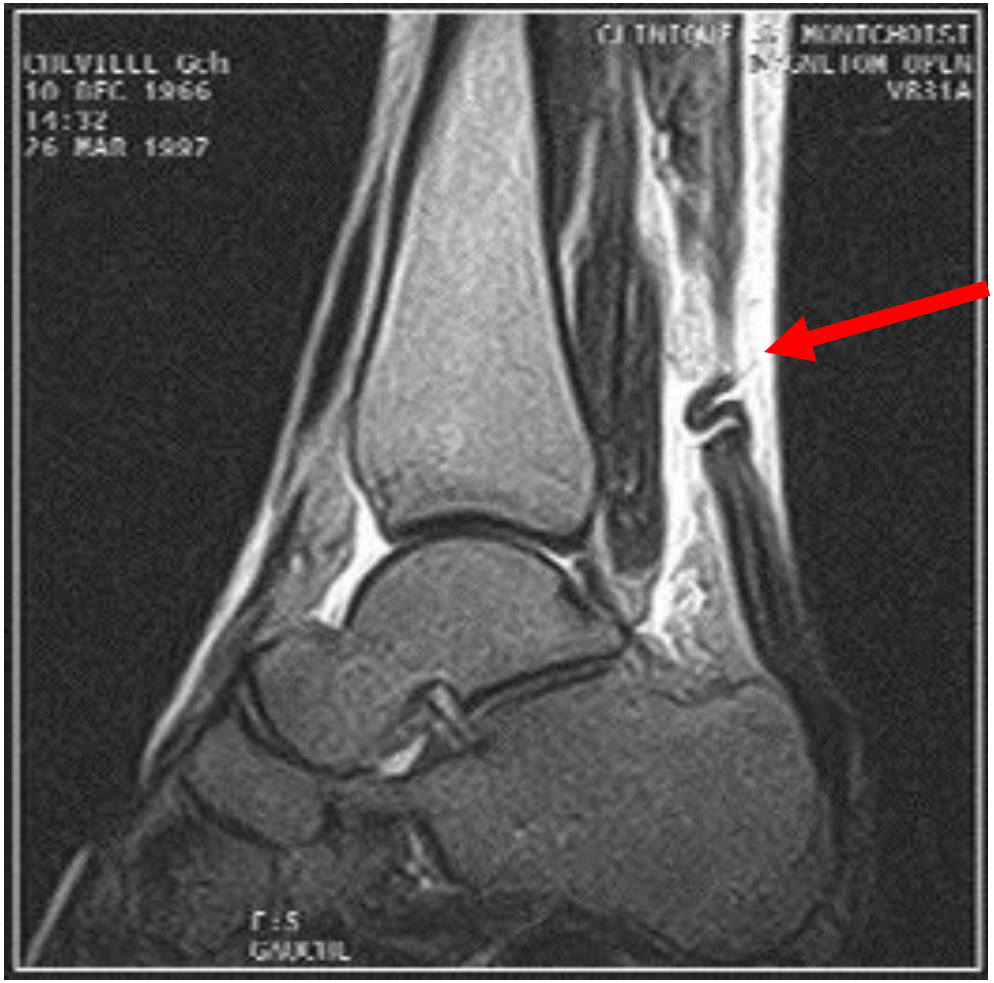
Clinical note: Lateral head of Gastrocnemius sometimes contains sesamoid bone, called the Fabella (L. bean). Fabella can be mistaken for a fracture on x-ray



RUPTURE OF ACHILLES TENDON

ACHILLES HEEL

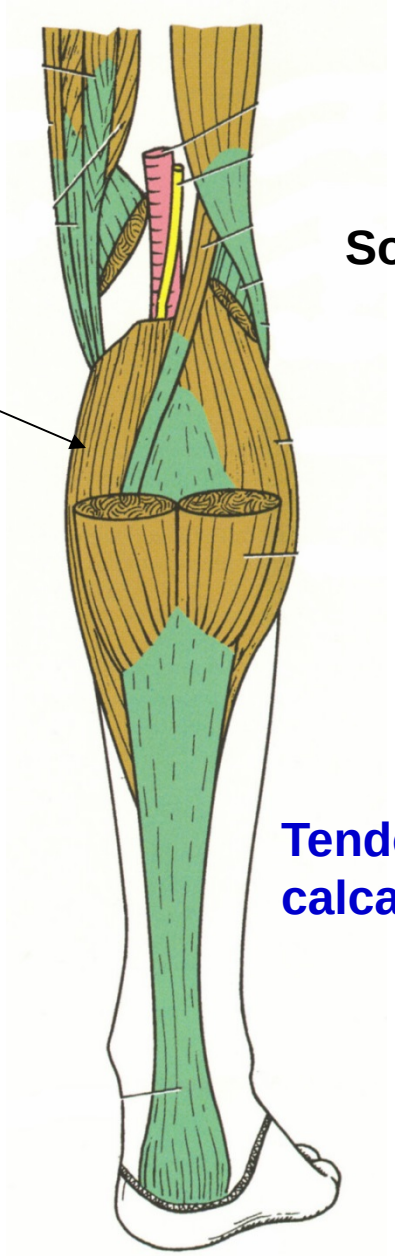
Achilles - hero of Trojan war; as child, dipped by his mother in river Styx; she neglected to dip his heel



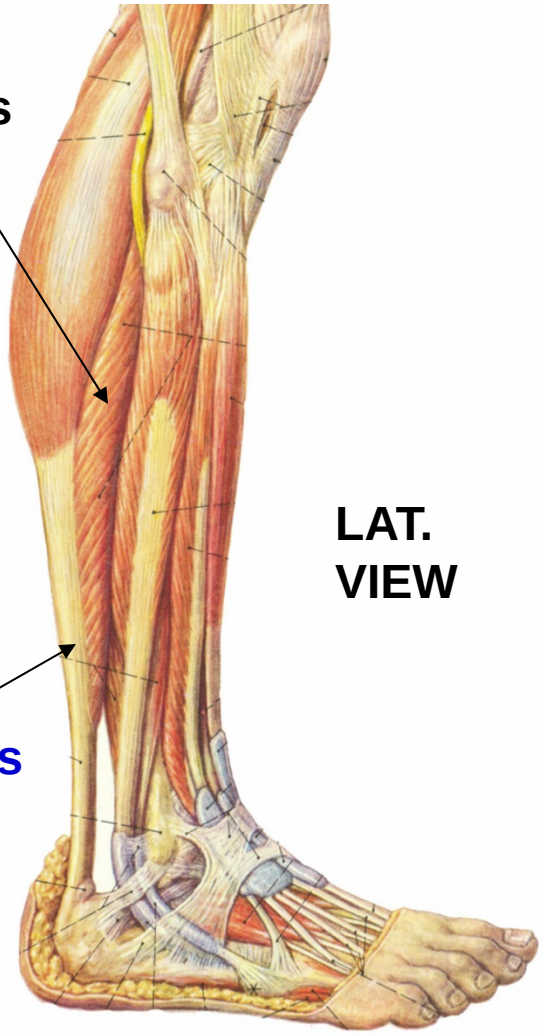
POSTERIOR COMPARTMENT
MUSCLES - SUPERFICIAL GROUP

2. **Soleus** (named for resemblance to flat fish called sole) - deep to Gastrocnemius, also inserts on **Tendo calcaneus.**

ORIGIN -
TIBIA (Soleal line)
FIBULA



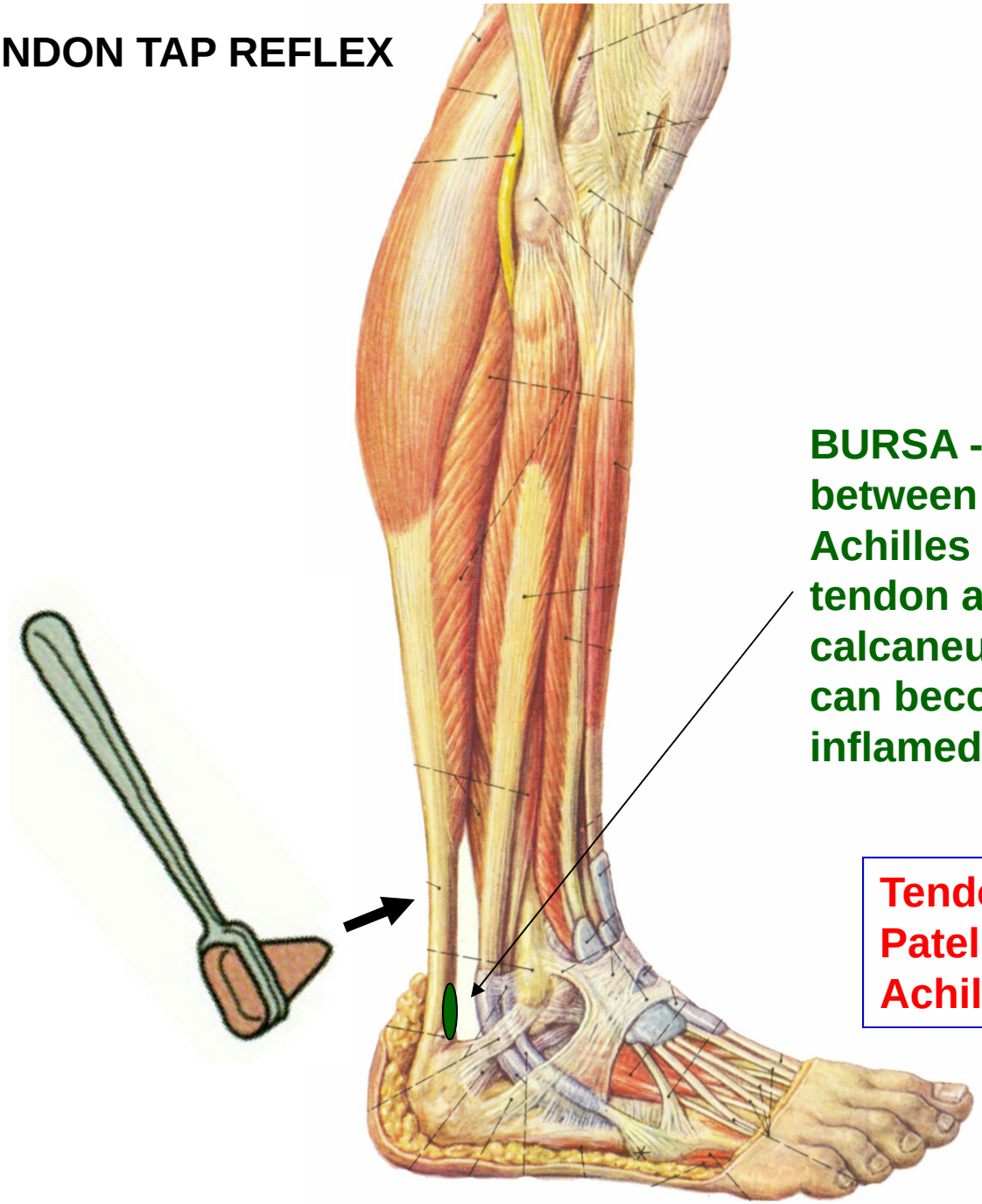
POST. VIEW



LAT. VIEW

ACHILLES TENDON TAP REFLEX IS S1-S2

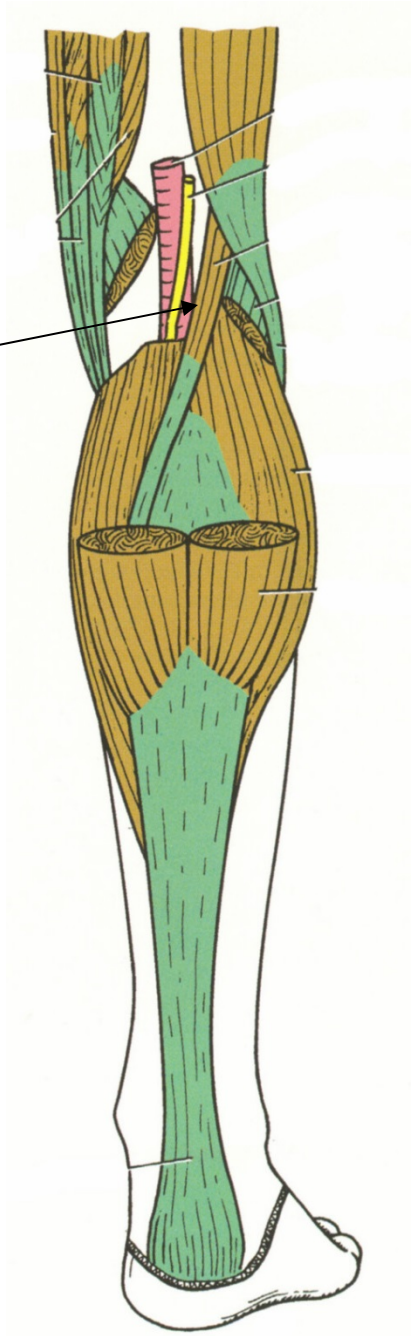
Clinical note: Achilles tendon reflex - tap on tendo calcaneus results in plantar flexion of foot; tests **S1 and S2.**



BURSA - between Achilles tendon and calcaneus; can become inflamed

Tendon reflexes
Patellar - L234
Achilles tendon - S12

POSTERIOR COMPARTMENT MUSCLES - SUPERFICIAL GROUP



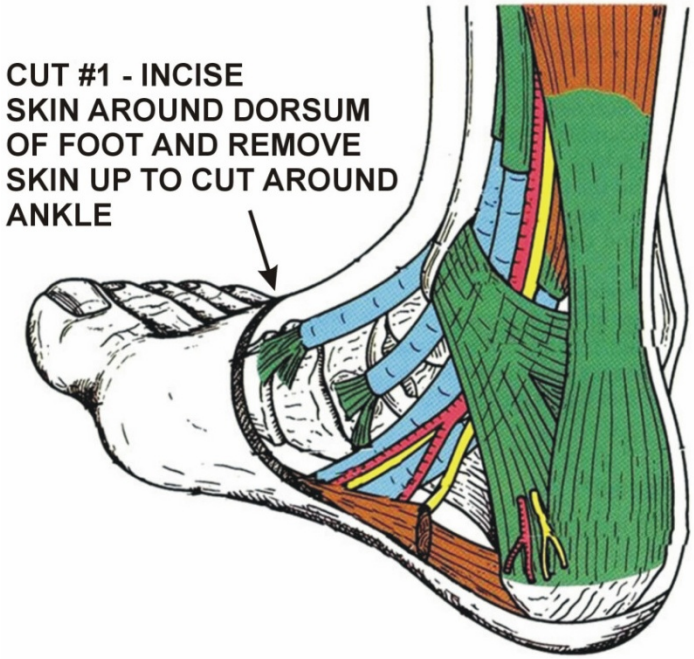
ORIGIN - FEMUR
INSERT - TENDO CALCANEUS

3. **Plantaris** - sometimes absent; very small belly but long thin tendon that is used **for tendon grafts**; tendon resembles nerves and Plantaris is **called 'freshman's** nerve'.

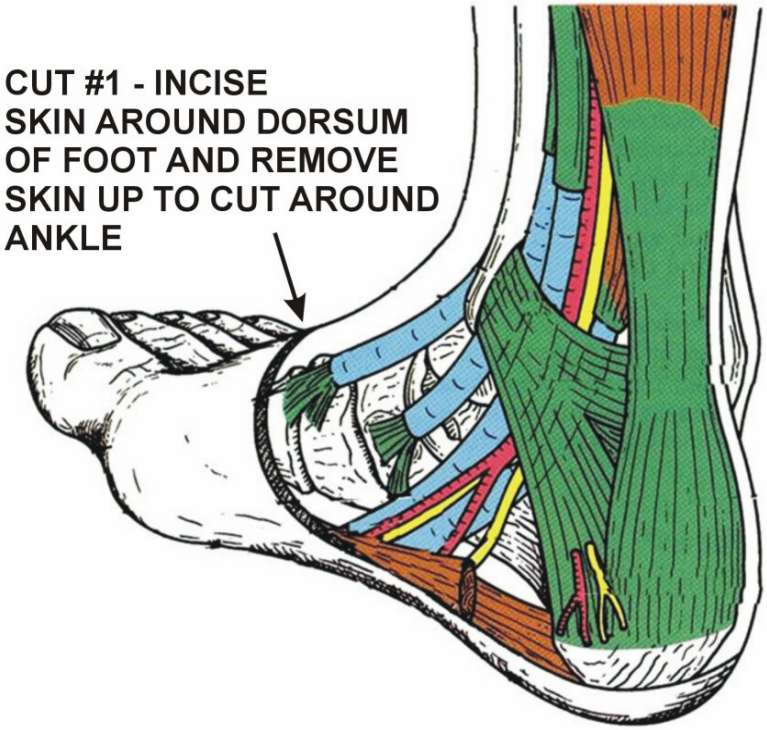
Vestige - structure that has become reduced (or functionless) in course of evolution

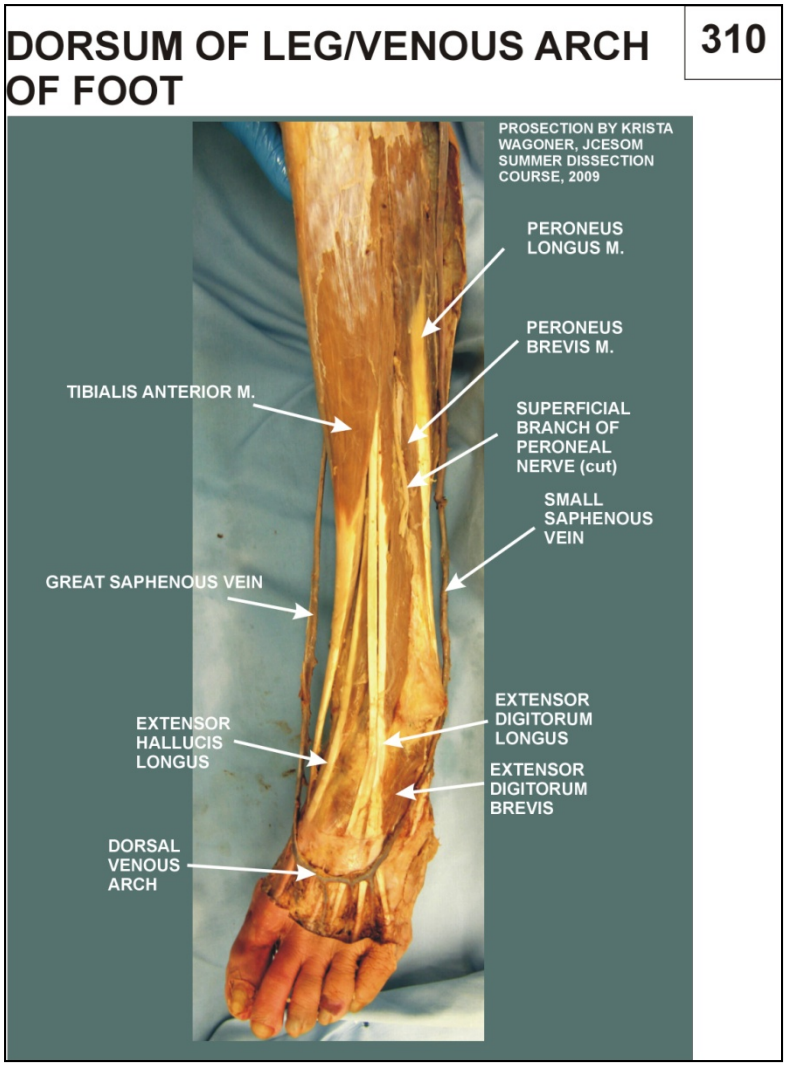
DISSECTION INSTRUCTIONS LEG: FIRST REMOVE SKIN FROM ANKLE AND DORSUM OF FOOT

Fig. 1 - Incise skin as in diagram at right: remove all skin around ankle and dorsum of foot (extend skinning to some individual toes); this exposes Tom, Dick and Harry, Peroneal muscle tendons and tendons of muscles of Anterior Compartment.



SIMILAR TO PROSECTION 310: FIRST REMOVE SKIN FROM ANKLE AND DORSUM OF FOOT





Also skin one or two toes to see tendons

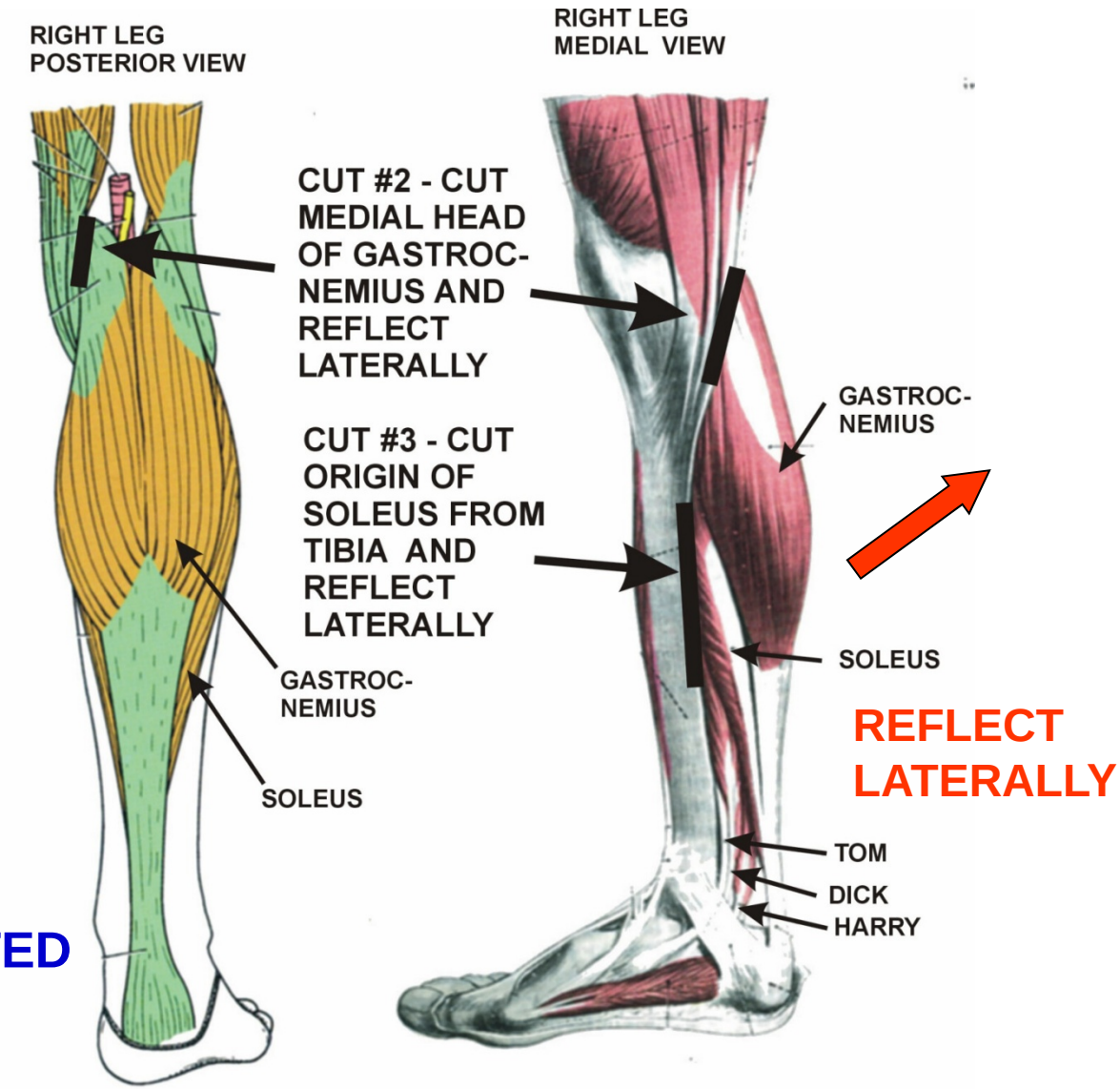
TURN CADAVER OVER TO PRONE (FACE DOWN) POSITION

TWO CUTS:

1) CUT MEDIAL HEAD OF GASTROCNEMIUS AT FEMUR

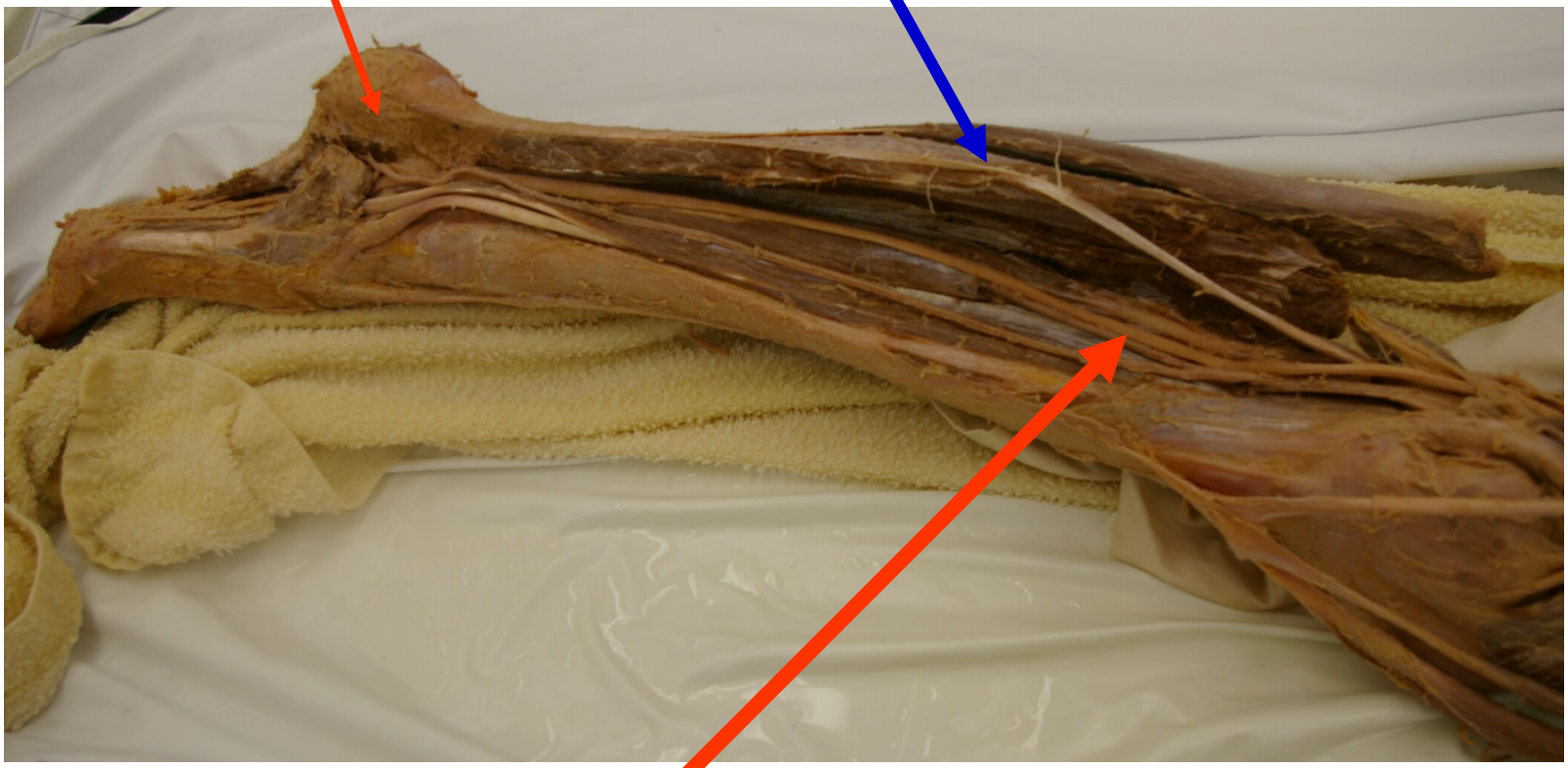
2) PUT FINGER UNDER SOLEUS; THEN CUT ORIGIN FROM TIBIA

3) MUSCLES OF POSTERIOR COMPARTMENT (SUPERFICIAL) CAN THEN BE REFLECTED LATERALLY



REFLECT GASTROCNEMIUS, SOLEUS, PLANTARIS LATERALLY

MEDIAL SIDE OF ANKLE OF LEFT LEG

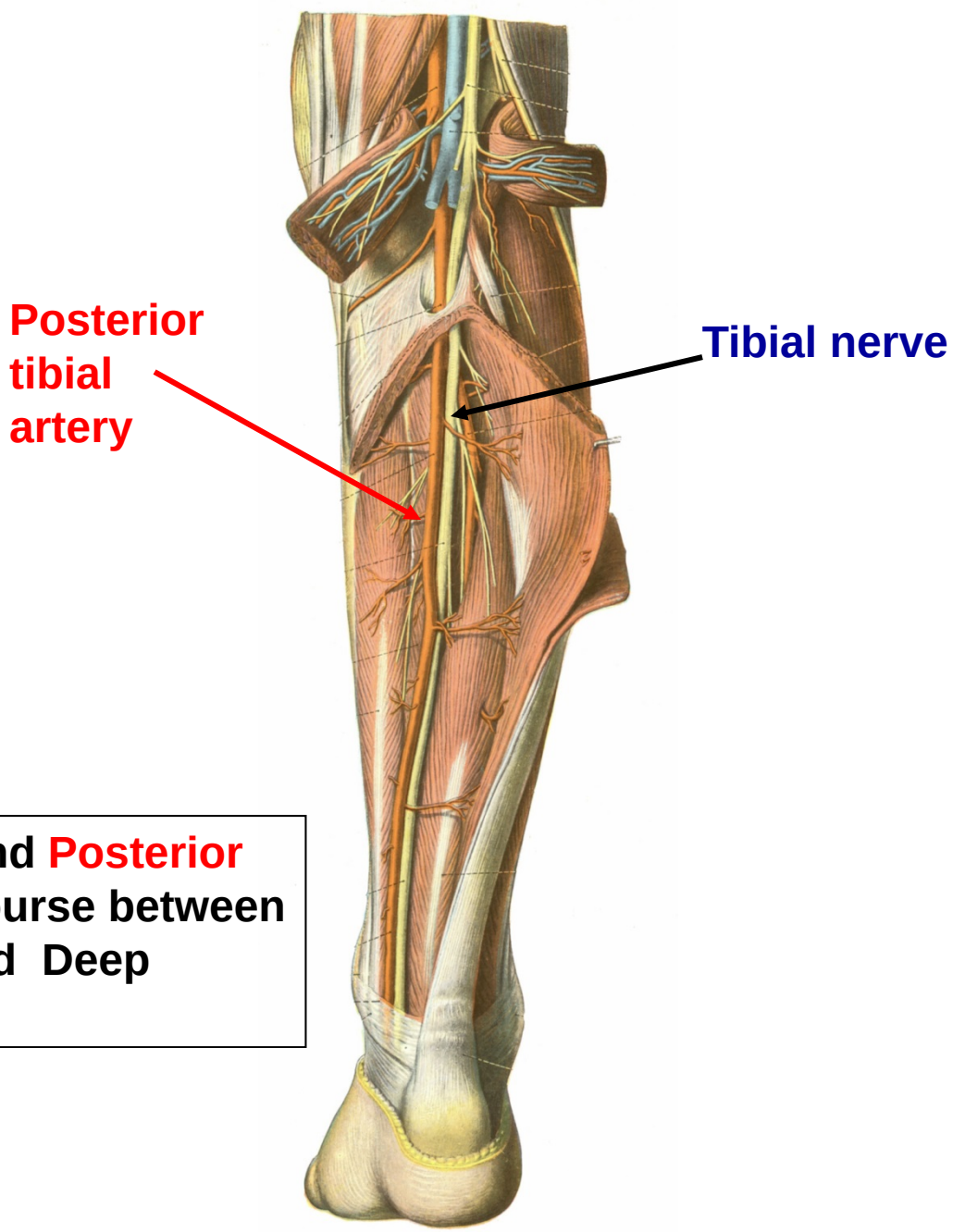


NERVES AND ARTERIES COURSE IN POSTERIOR COMPARTMENT BETWEEN SUPERFICIAL AND DEEP GROUPS OF MUSCLES

POSTERIOR COMPARTMENT MUSCLES - DEEP GROUP

B. **Deep group** - muscles that **plantar flex and invert foot, flex toes**; muscles enter foot on medial side of ankle

Note: **Muscles bellies are backward in leg** - **Flexor of big toe (hallucis) is lateral; flexor other toes is medial; tendons cross in foot.**



Tibial nerve and Posterior tibial artery course between Superficial and Deep Groups

POSTERIOR COMPARTMENT MUSCLES - DEEP GROUP

1. **Flexor hallucis longus** -

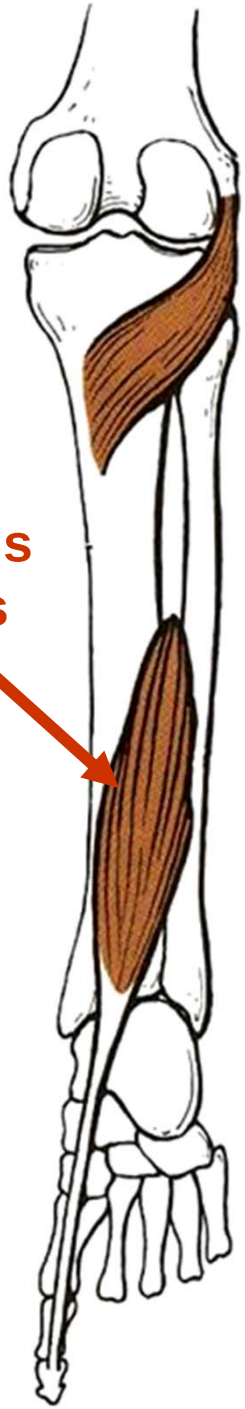
O - Fibula

I - Distal phalanx of Big Toe

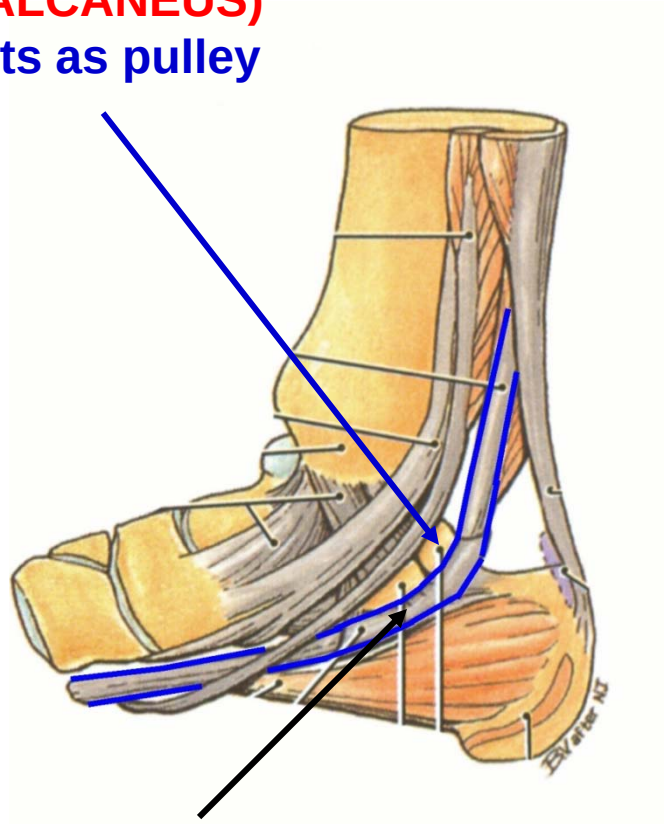
ORIGIN IS LATERAL IN POST. COMPARTMENT

tendon passes deep on medial ankle **beneath projection from CALCANEUS (sustentaculum tali)**; crosses over other tendons to reach distal phalanx of big toe.

ACT - PLANTAR FLEX BIG TOE
- PLANTAR FLEX FOOT



Sustentaculum tali
(projection from CALCANEUS)
acts as pulley



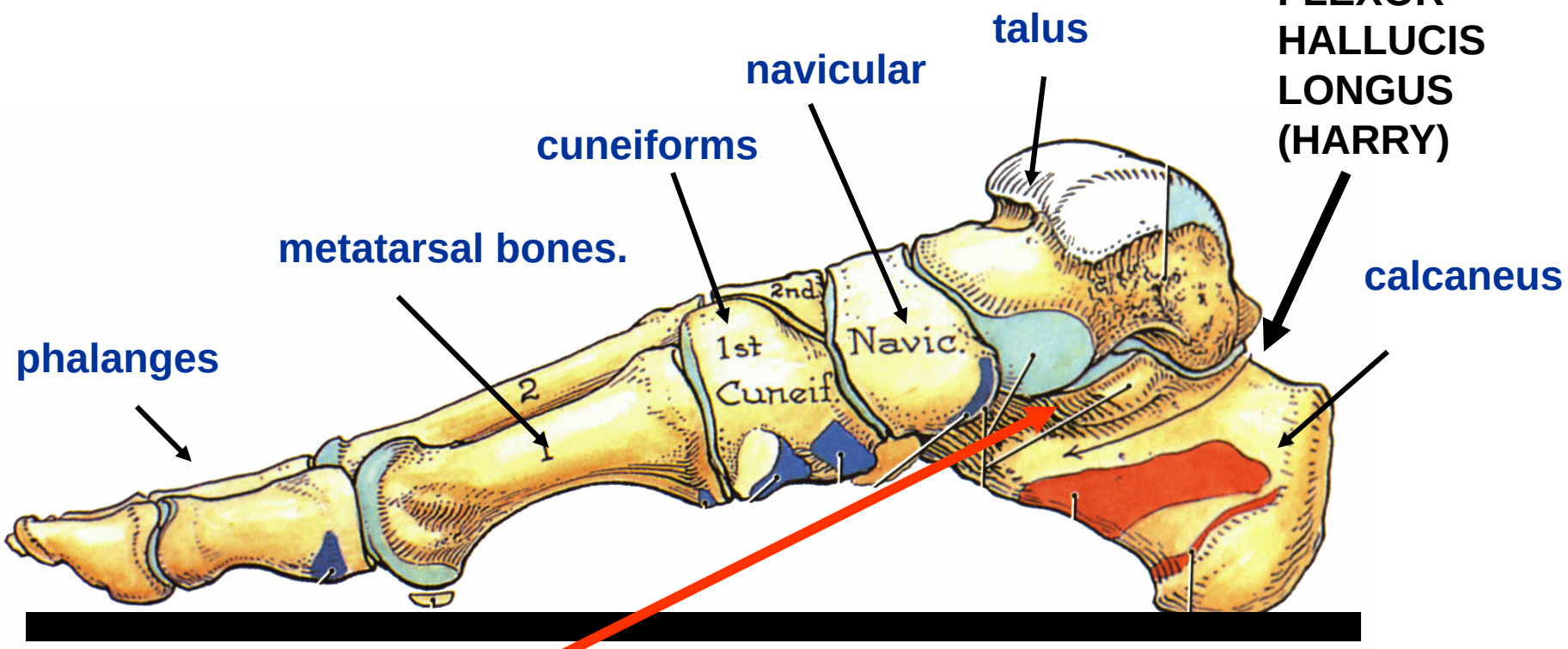
Flexor hallucis longus tendon

Sustentaculum = L. prop, support

TARSAL BONES, METATARSALS AND PHALANGES

Talus sits above calcaneus;
Foot has arch

PATH OF TENDON OF FLEXOR HALLUCIS LONGUS (HARRY)



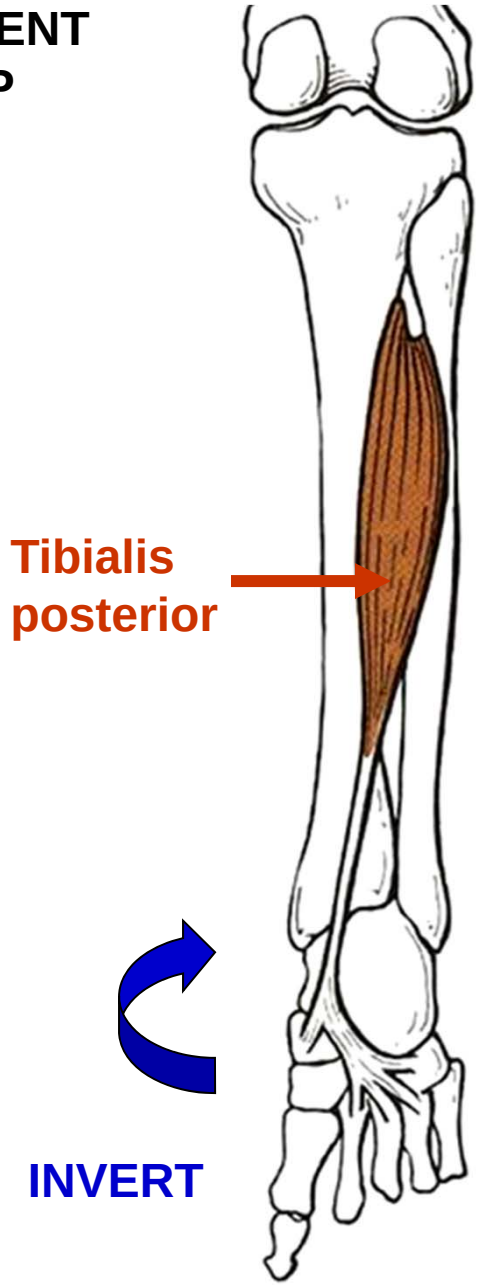
SUSTENTACULUM TALI - (L. support of talus) - part of CALCANEUS; ACTS AS PULLEY FOR FLEXOR HALLUCIS LONGUS

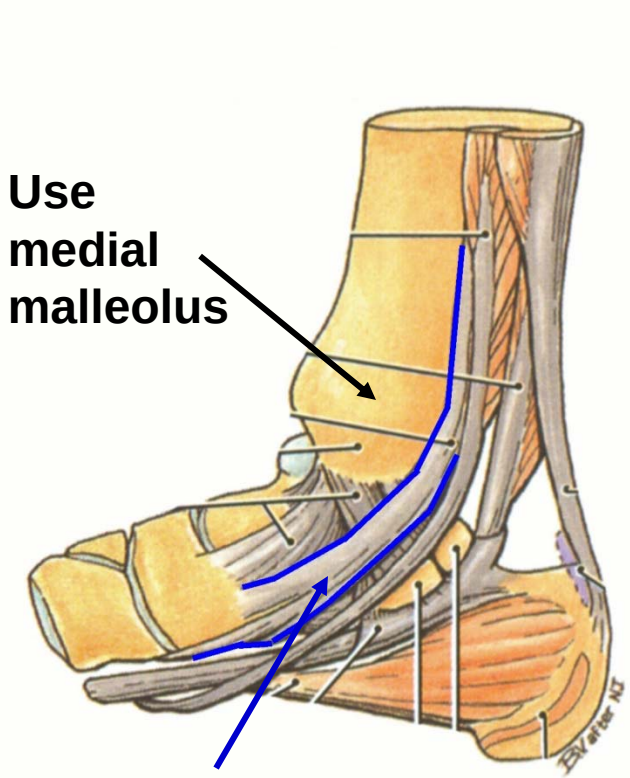
POSTERIOR COMPARTMENT MUSCLES - DEEP GROUP

2. **Tibialis posterior** -
O - Tibia, Fibula, Interosseus membrane
I - Navicular bone, cuneiform, cuboid, metatarsals 2-4

located deep in between flexor hallucis longus and flexor digitorum longus; tendon crosses to medial side at ankle joint and passes directly beneath medial malleolus.

ACT - MAJOR INVERTER OF FOOT

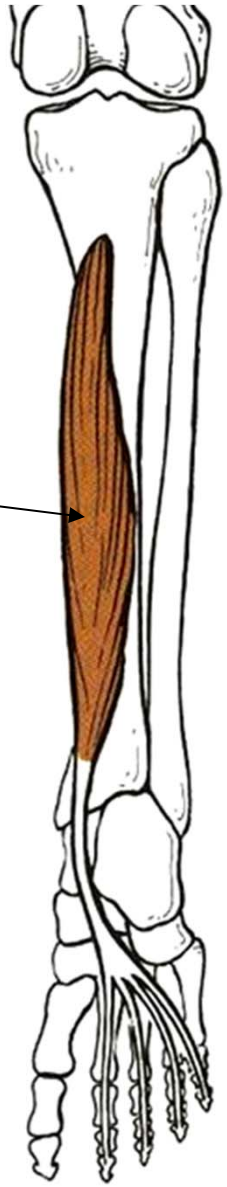


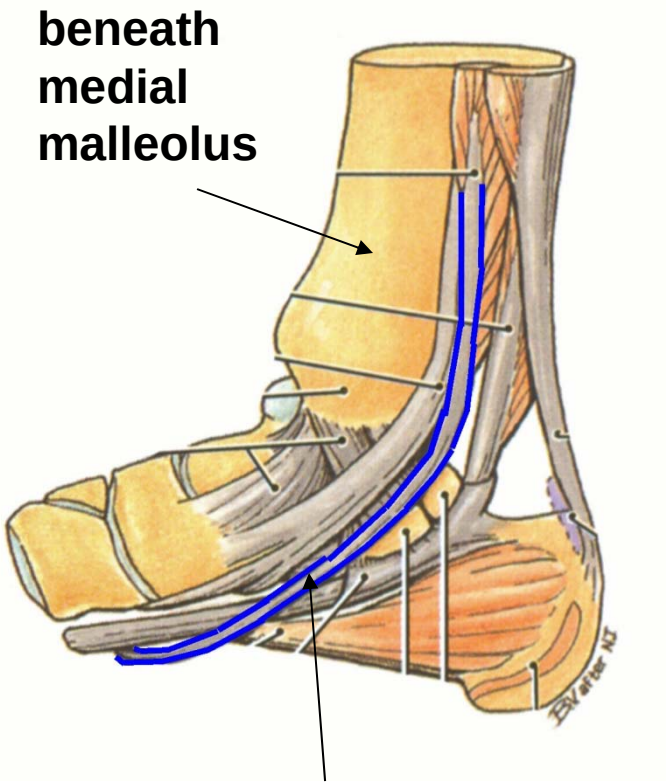


POSTERIOR COMPARTMENT MUSCLES - DEEP GROUP

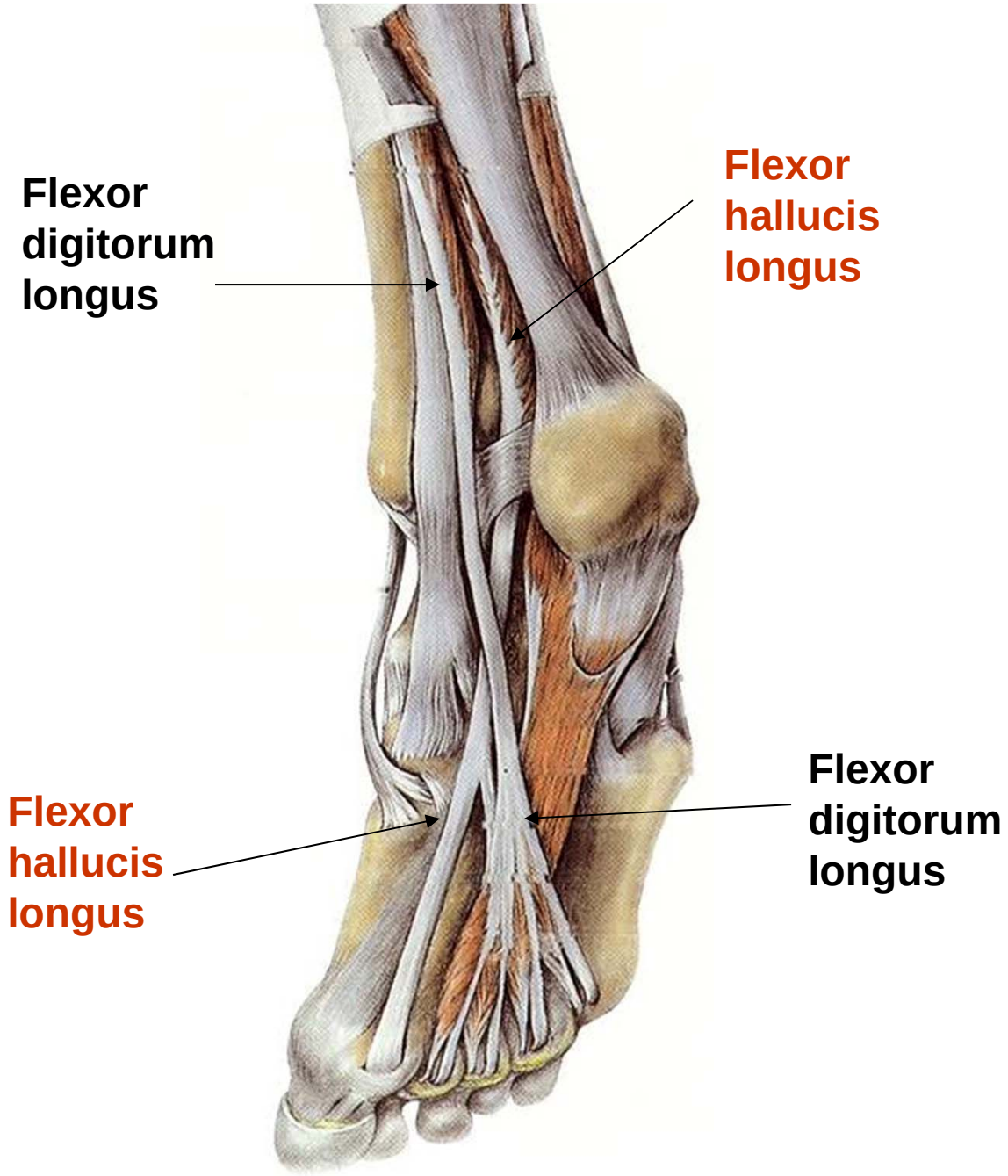
3. **Flexor digitorum longus** -
O - Tibia
I - Distal phalanges lateral four toes
ORIGIN IS MEDIAL IN POST. COMPARTMENT
single tendon passes medial to ankle beneath medial malleolus then expands to four tendons that pass to distal phalanges in foot.

ACT - PLANTAR FLEX LATERAL FOUR TOES,
PLANTAR FLEX FOOT



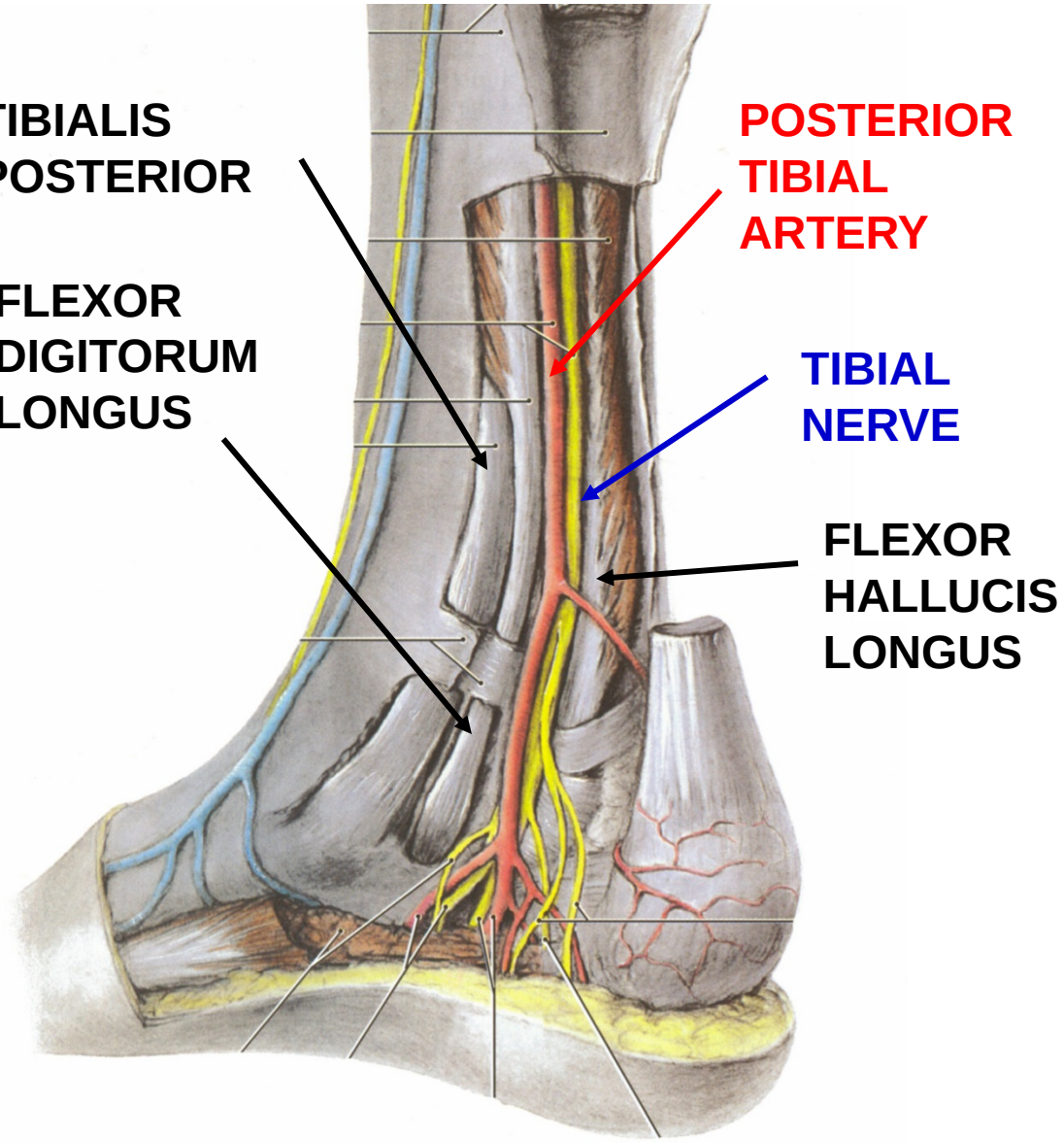


TENDONS CROSS IN FOOT - BRINGS PULL ON BIG TOE (HALLUX) MEDIALLY AND IN LINE WITH TENDON



TOM, DICK AND HARRY

ORDER OF STRUCTURES ON MEDIAL SIDE OF ANKLE - TOM, DICK AND HARRY - Tibialis posterior (tendon), Flexion Digitorum Longus, Posterior Tibial Artery, Tibial Nerve and Flexor Hallucis Longus.

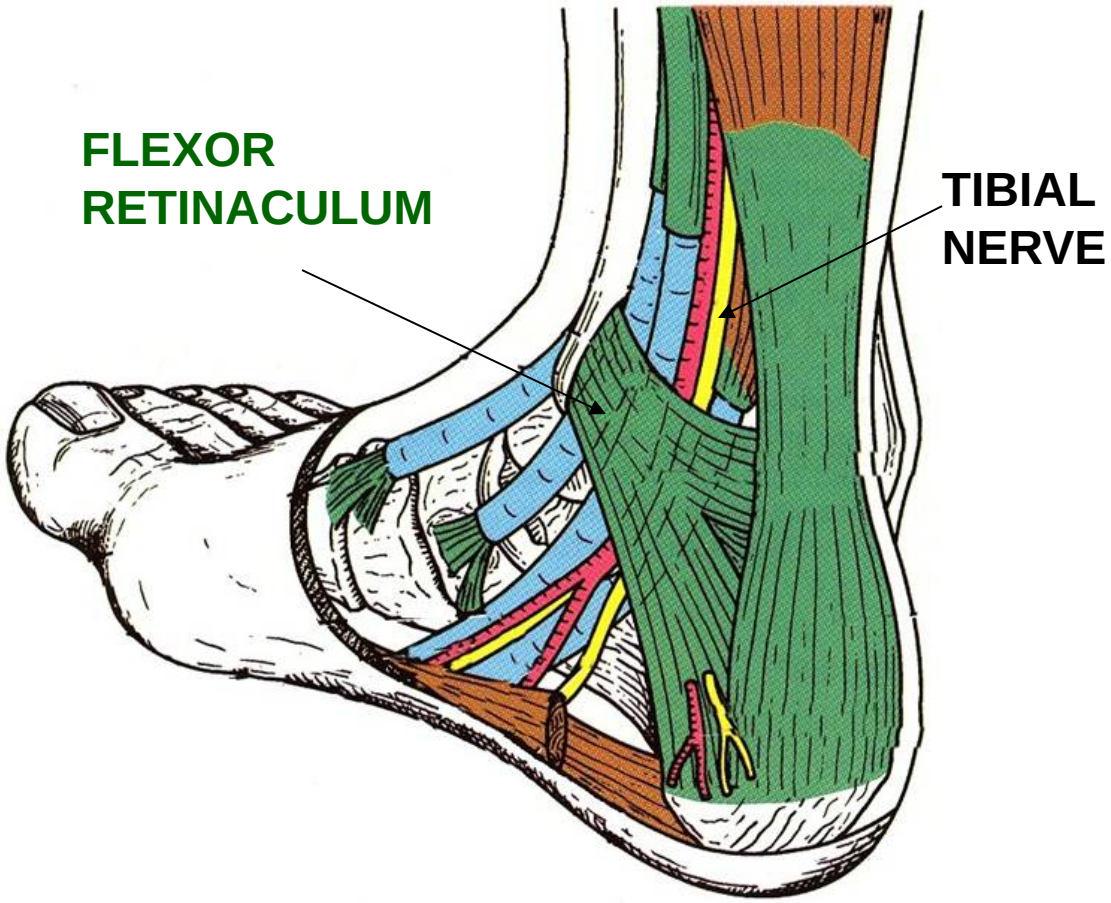


Note: Order is important as accidents can happen that sever tendons (i.e. ax strikes ankle when chopping wood).

FLEXOR RETINACULUM AND TARSAL TUNNEL SYNDROME

retinaculum - L. restrain

Note: **Flexor Retinaculum** - tendons of deep muscles pass beneath flexor reticulum on medial side of ankle joint; muscle tendons are covered by **synovial sheaths** under retinaculum



Clinical Note: **Tarsal Tunnel Syndrome** - Tarsal Tunnel is area beneath flexor retinaculum; Tarsal Tunnel Syndrome results from **swelling of synovial sheaths**, can compress **Tibial Nerve**; symptoms are **numbness of sole of foot, toes and weakened flexion of toes** (intrinsic muscles of foot).

DEEP PERONEAL NERVE

ANTERIOR

DORSIFLEX FOOT

SUPERFICIAL PE-RON'-EAL NERVE

LATERAL

EVERT FOOT

BIG TOE

Tibia

Fibula

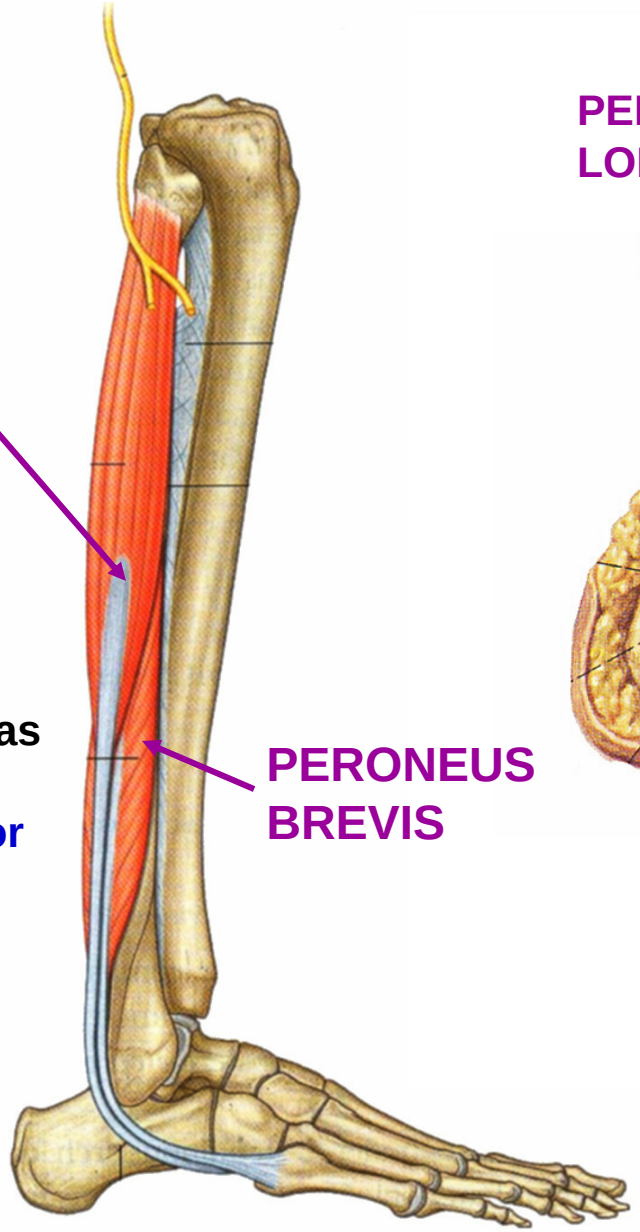
POSTERIOR

PLANTAR FLEX FOOT

TIBIAL NERVE

NOTE: MUSCLES OF ANT. AND POST. COMPART-MENTS ALSO INVERT FOOT

V. LATERAL COMPARTMENT



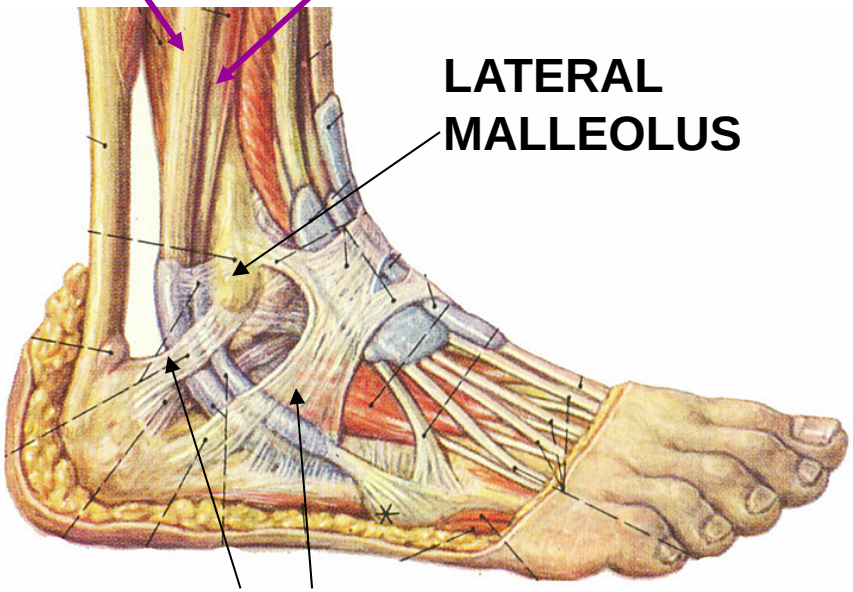
PE-RON'-EUS LONGUS

PERONEUS BREVIS

Muscles act to evert foot; tendons pass beneath lateral malleolus (acts as pulley) and beneath Superior and Inferior Peroneal retinacula; Innervated by Superficial Peroneal Nerve.

PERONEUS LONGUS

PERONEUS BREVIS



LATERAL MALLEOLUS

Superior and Inferior Peroneal retinacula

ORIGIN - FIBULA

PERONEUS LONGUS AND PERONEUS BREVIS

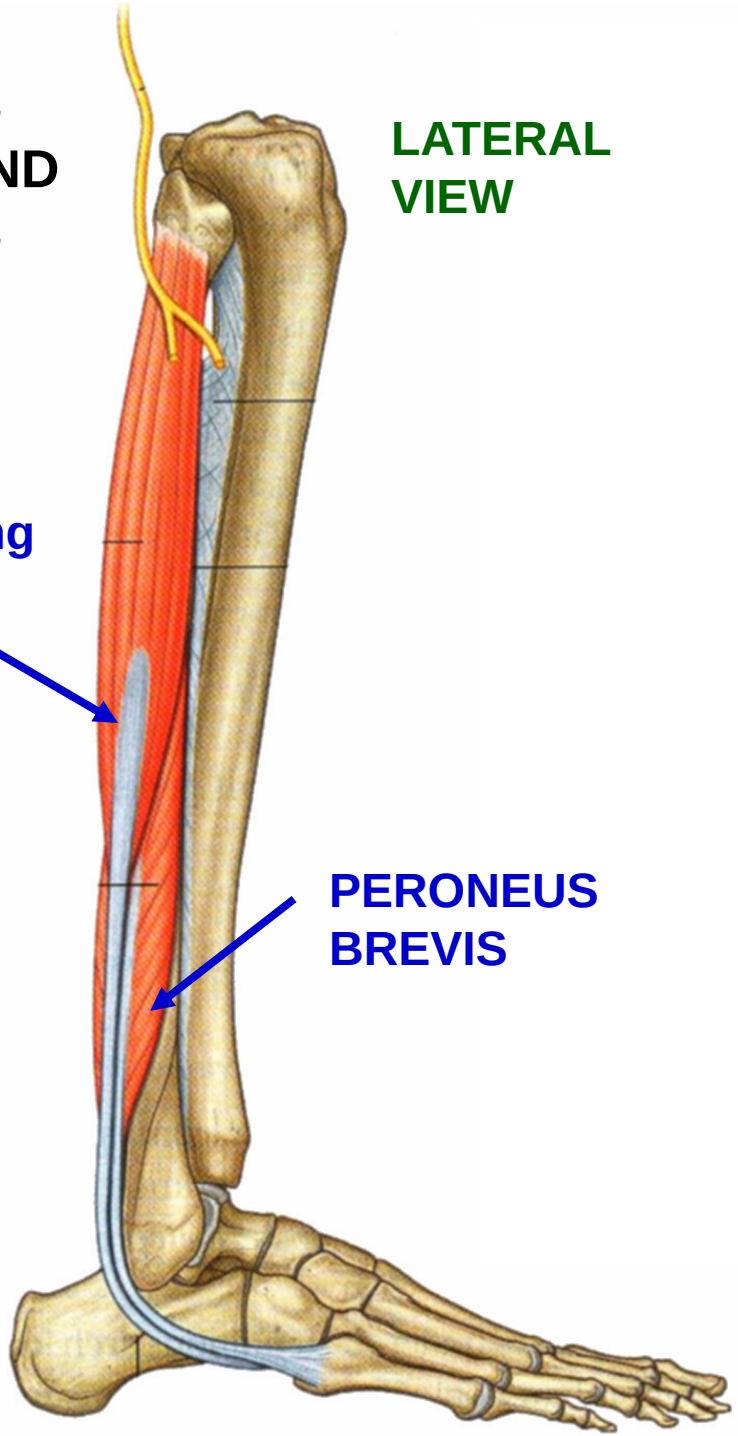
LATERAL VIEW

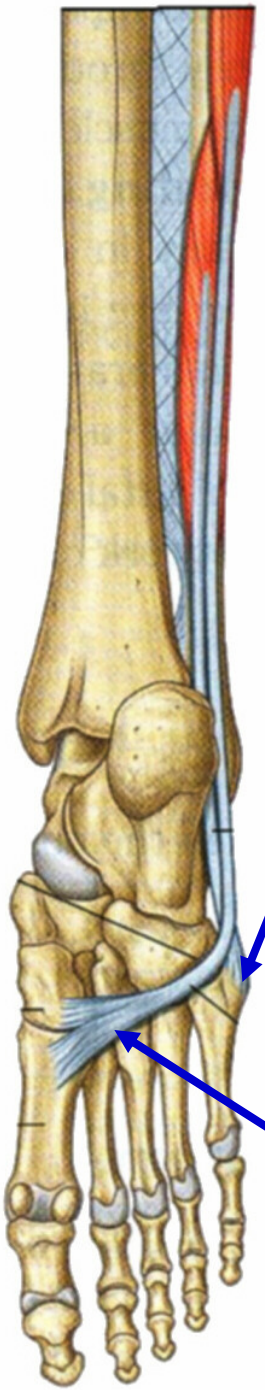
POST., INF. VIEW

PERONEUS LONGUS - long tendon superficial

ORIGIN BOTH MUSCLES - FIBULA

PERONEUS BREVIS





PERONEUS BREVIS - FIFTH METATARSAL

PERONEUS LONGUS - FIRST METATARSAL, MEDIAL CUNEIFORM

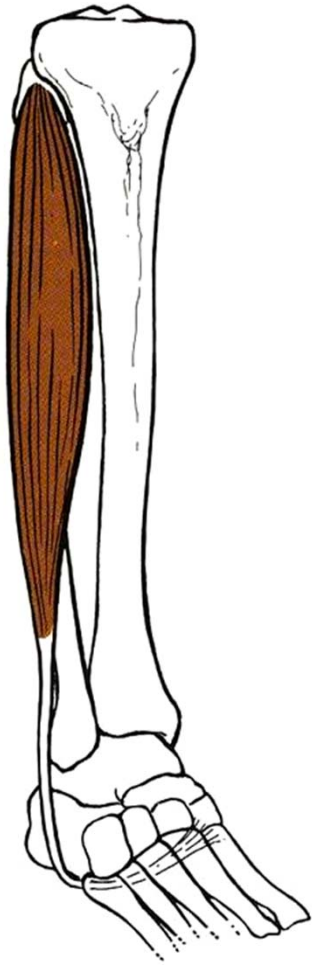
LATERAL COMPARTMENT

O - both originate on fibula

A. **Peroneus Longus - starts laterally and ends on medial side of foot;** crosses in deepest layer of foot; I - first metatarsal and cuneiform bone

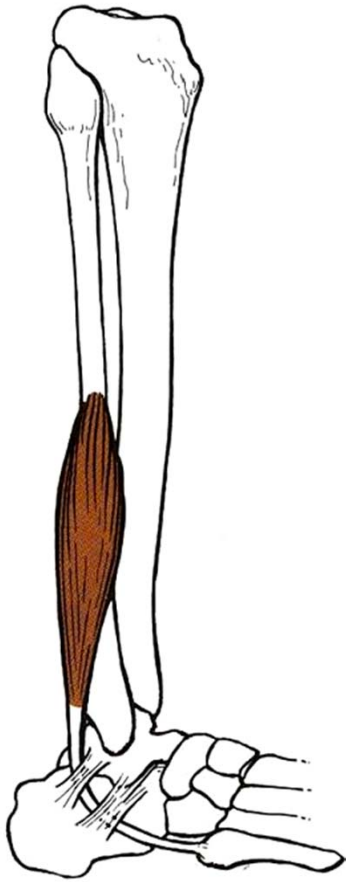
B. **Peroneus Brevis - starts and ends laterally;** I - fifth metatarsal.

Peroneus Longus



first metatarsal, medial cuneiform

Peroneus Brevis



fifth metatarsal

ACTION - BOTH EVERT FOOT

DEEP PERONEAL NERVE

SUPERFICIAL PERONEAL NERVE

ANTERIOR

DORSIFLEX FOOT

Tibia

Fibula

LATERAL

EVERT FOOT

BIG TOE

POSTERIOR

PLANTAR FLEX FOOT

TIBIAL NERVE

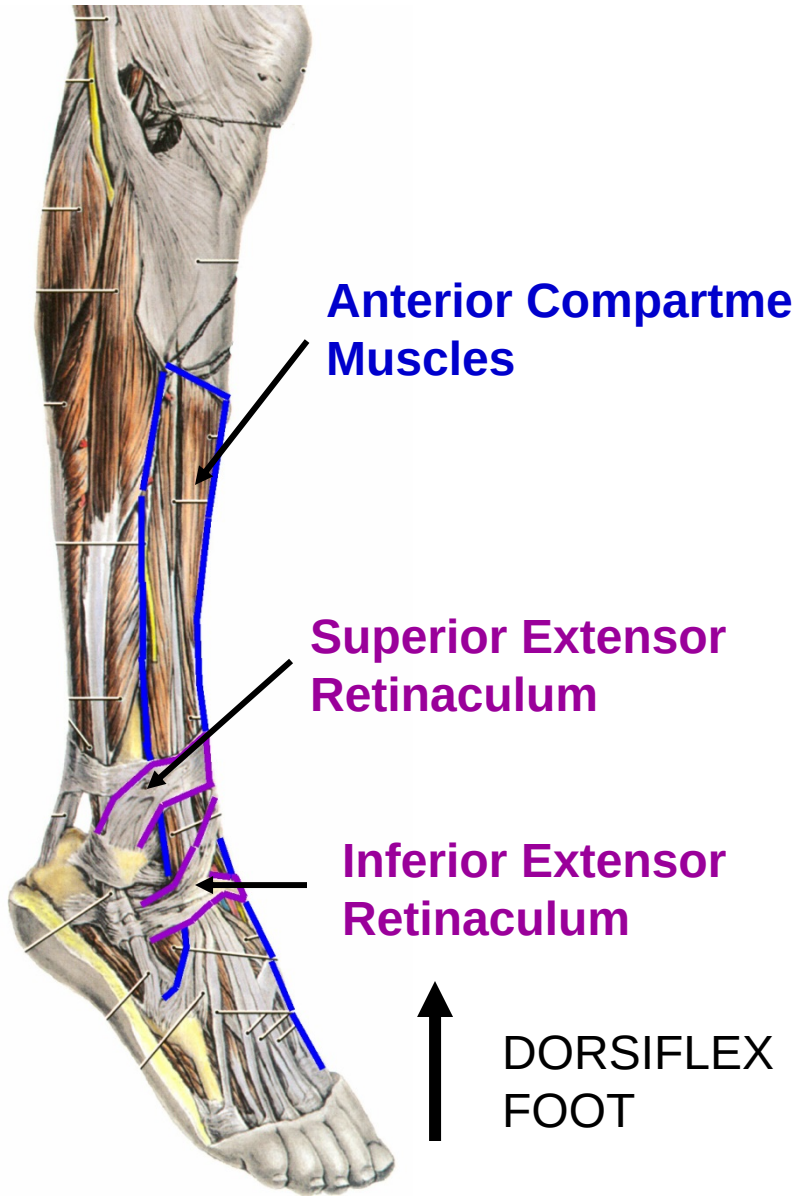
NOTE: MUSCLES OF ANT. AND POST. COMPART-MENTS ALSO INVERT FOOT

VI. ANTERIOR COMPARTMENT

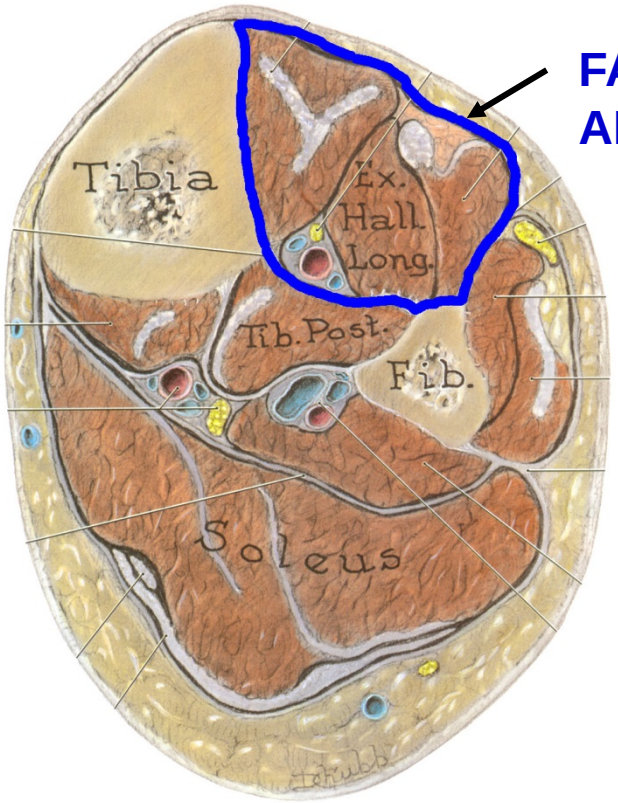
muscle bellies in anterior leg, tightly covered by dense fascia; tendons pass beneath extensor retinacula to dorsum of foot and toes; Innervated by Deep Peroneal Nerve.

ALL ACT - TO DORSIFLEX ANKLE

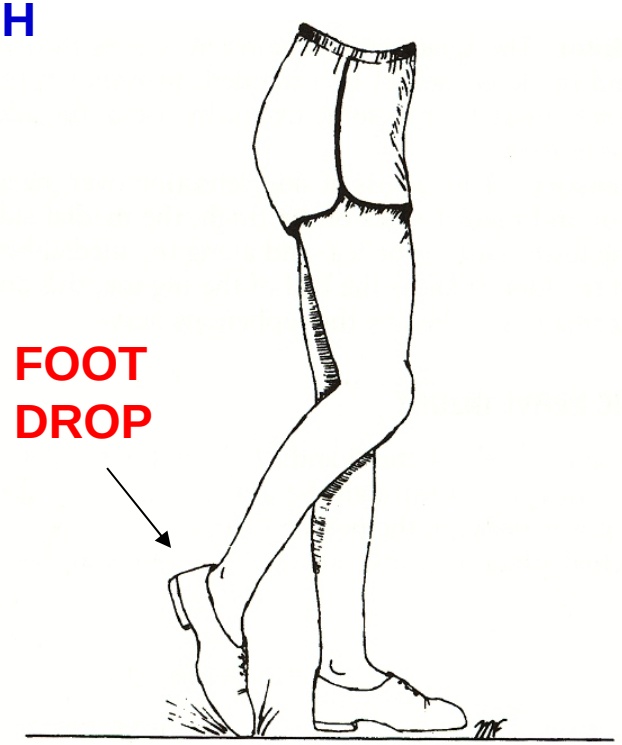
A. Retinacula - <u>Superior and Inferior Extensor Retinacula</u> on Anterior Side of Ankle and Foot



ANTERIOR COMPARTMENT



FASCIA IS TOUGH AND TIGHT



FOOT DROP

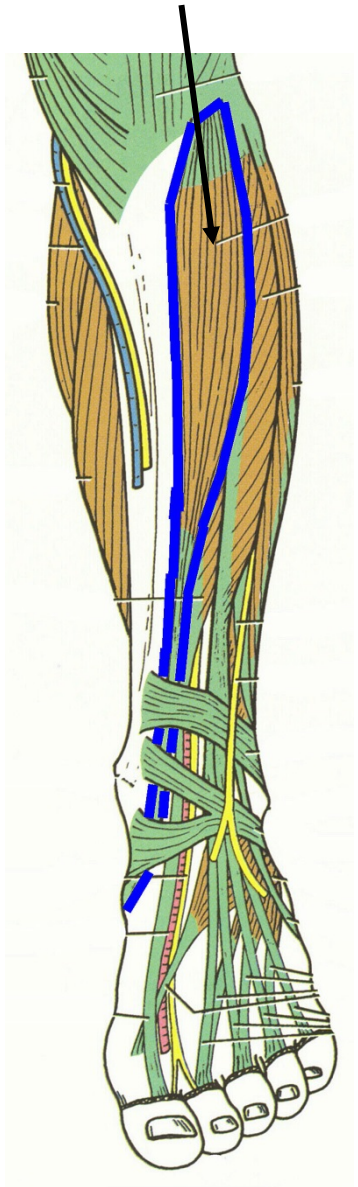
Clinical Note: **Anterior Leg Syndrome** - fascia surrounding anterior leg muscles is very tough and tight; muscles can swell in compartment due to exercise or when fracture tibia; symptom **is FOOT DROP (=loss of dorsiflexion of foot) due to compression of Deep Peroneal Nerve;** treated by **fasciotomy (surgically splitting fascia**). (Note: 'shin splints' is different term, inflammation of the periosteum of the tibia)

ANTERIOR COMPARTMENT

1. **Tibialis anterior** -
major Inverter of foot and antagonist to Peroneus longus (ends on same bones, medial cuneiform and first metatarsal).

O - Tibia
I - First metatarsal, medial cuneiform
Act - Dorsiflex ankle, Invert foot

Tibialis anterior

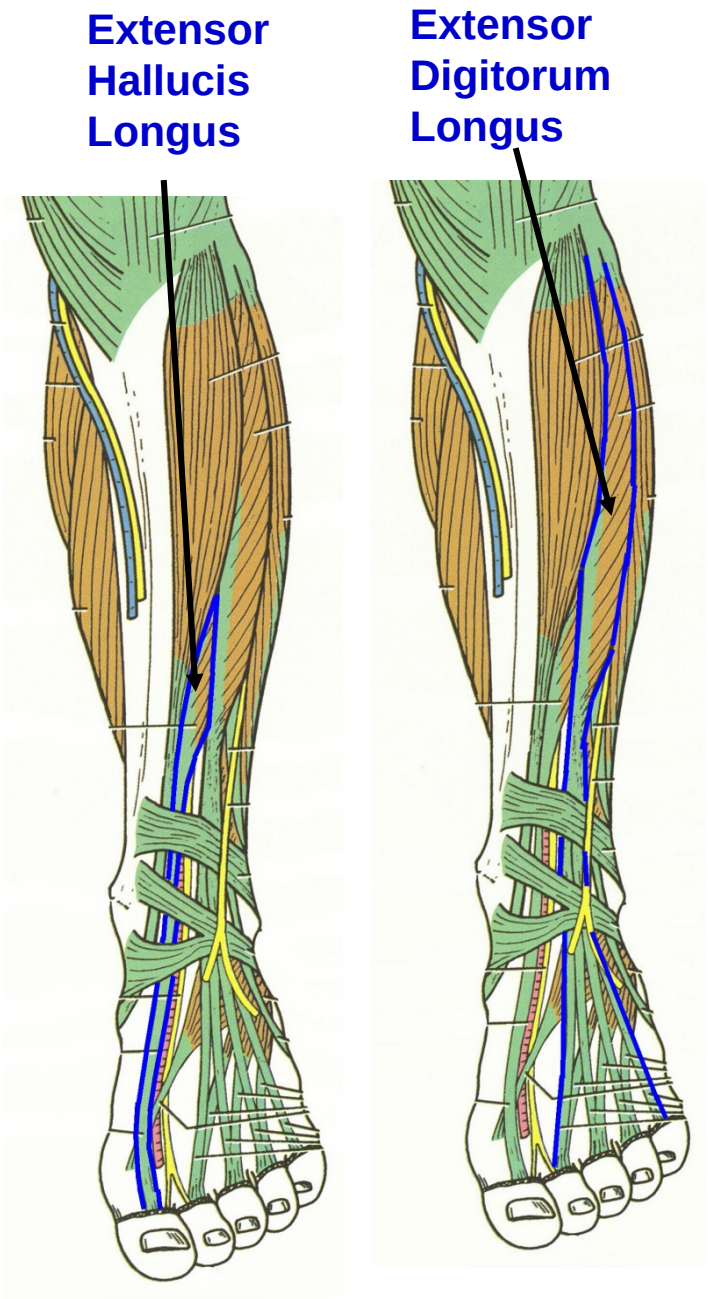


ANTERIOR COMPARTMENT

2. **Extensor Hallucis Longus** and 3. **Extensor digitorum longus** - end on extensor expansions, which pass to middle and distal phalanges.

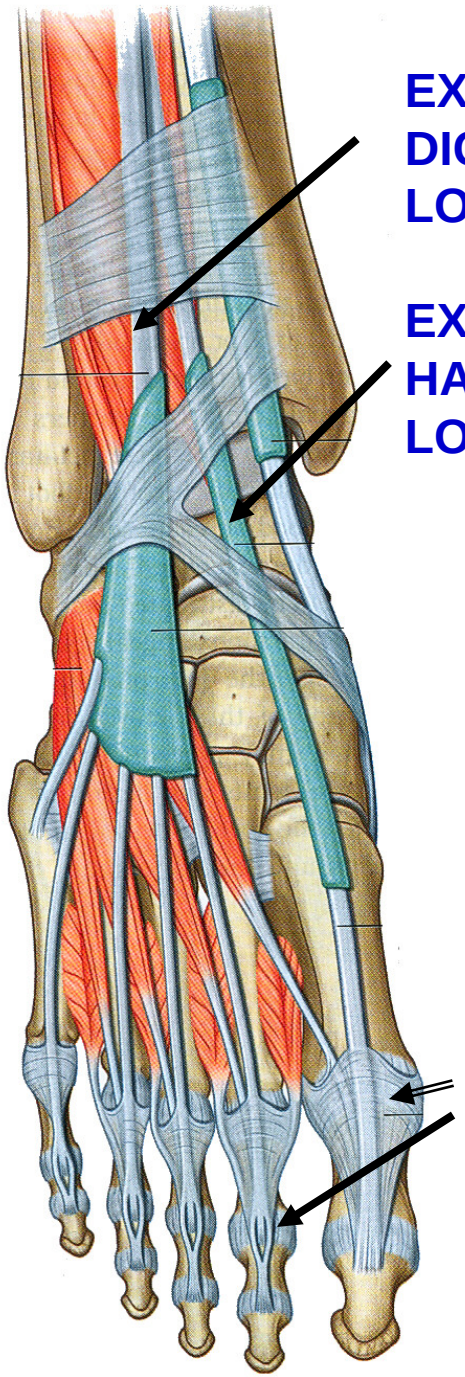
Extensor Hallucis Longus
O - **Fibula and Interosseus Membrane**
I - **Distal Phalanx** Big Toe
Act - **Dorsiflex Ankle, Extend Big Toe**

Extensor Digitorum Longus
O - **Tibia and Interosseus Membrane**
I - **Distal Phalanges** Other Toes
Act - **Dorsiflex ankle, Extend Toes**



EXTENSOR EXPANSIONS

tendons of Externsor Digitorum Longus and Extensor Hallucis Longus attach to distal phalanges and Extensor Expansions



These muscles also attach to <u>Extensor Expansions</u>

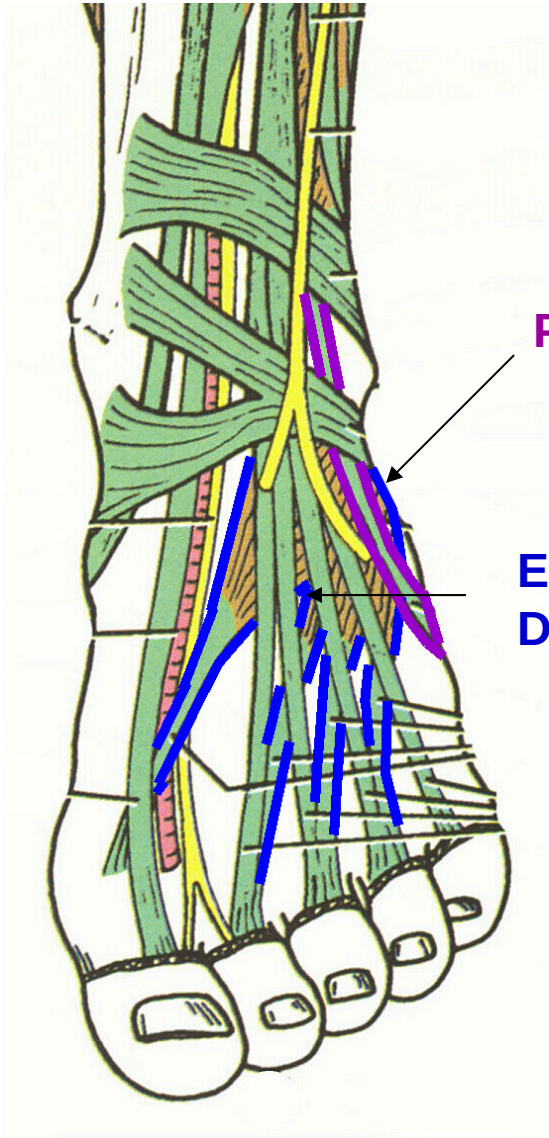
<u>Extensor Expansions</u> - connective tissue that spreads over dorsal surface of toes; forms 'hood' that attaches proximal, middle and distal phalanges and functions like a retinacum (prevents bowstringing)

ANTERIOR COMPARTMENT AND DORSUM OF FOOT

4. **Peroneus Tertius** - the 'third peroneal muscle', part **of Extensor Digitorum Longus that ends on fifth metatarsal.**

VII. DORSUM OF FOOT

A. **Extensor Digitorum Brevis** -
O - Calcaneus
I - **Phalanges toes 2-4**
Innervation - Deep peroneal nerve;
Action - Extend toes.



Peroneus Tertius *

Extensor Digitorum Brevis *

SUMMARY OF MUSCLE ACTIONS IN INVERSION AND EVERSION

Muscles that course and end medially invert foot (turn sole medially)

Muscles that course laterally evert foot (turn sole laterally)

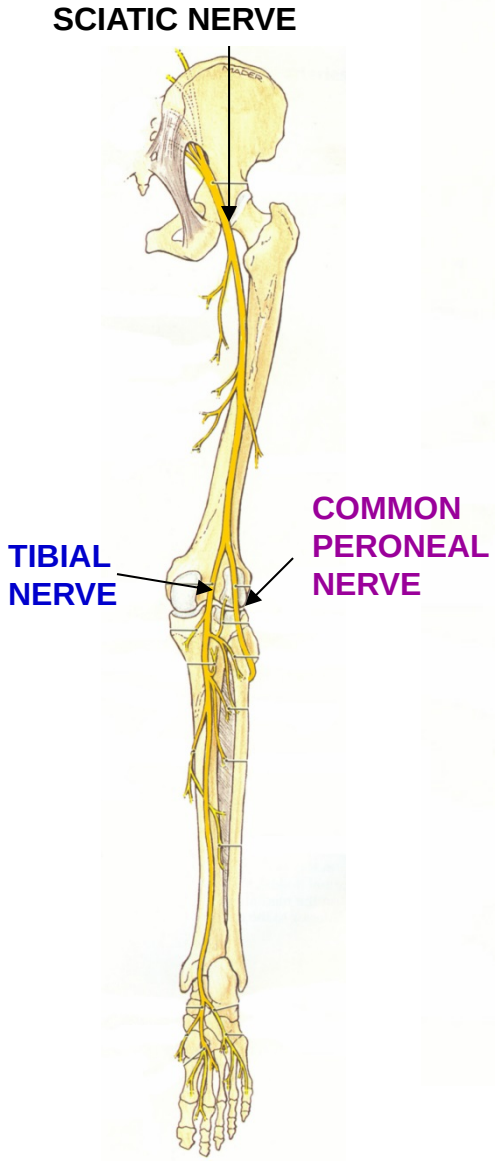
MAIN INVERTERS:
1) TIBIALIS ANTERIOR
2) TIBIALIS POSTERIOR

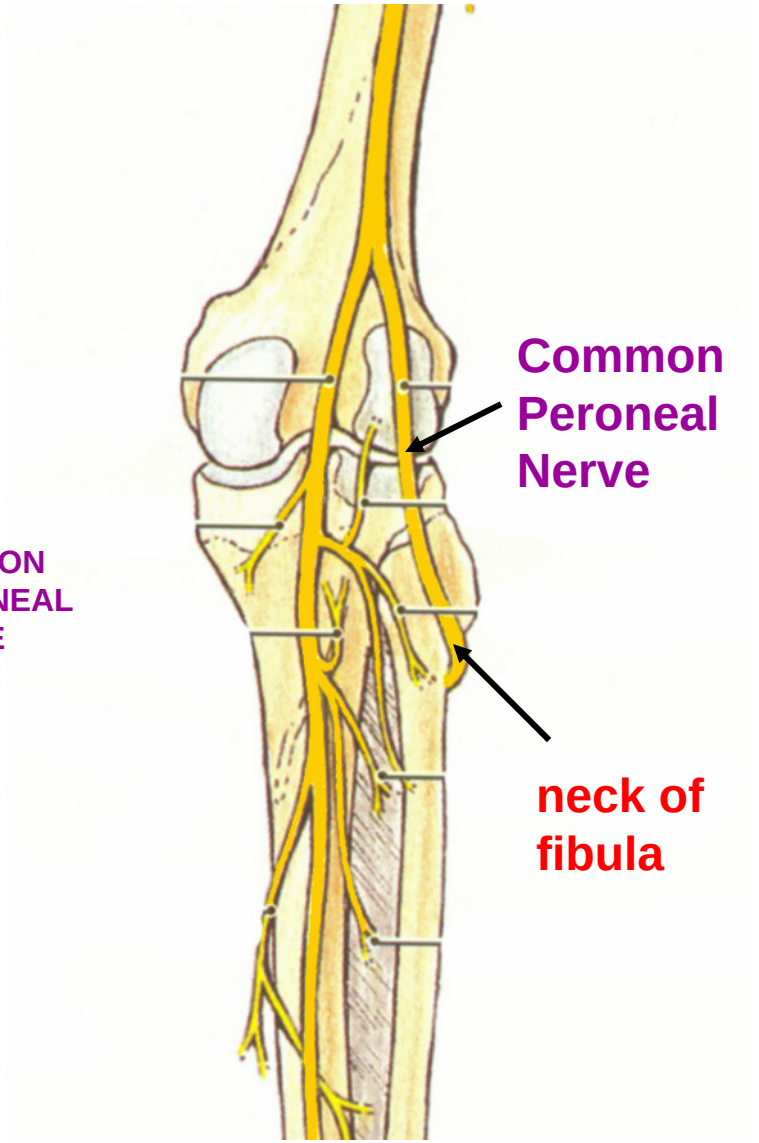
MAIN EVERTERS:
1) PERONEUS LONGUS
2) PERONEUS BREVIS
(PERONEUS TERTIUS)

IX. NERVES AND ARTERIES

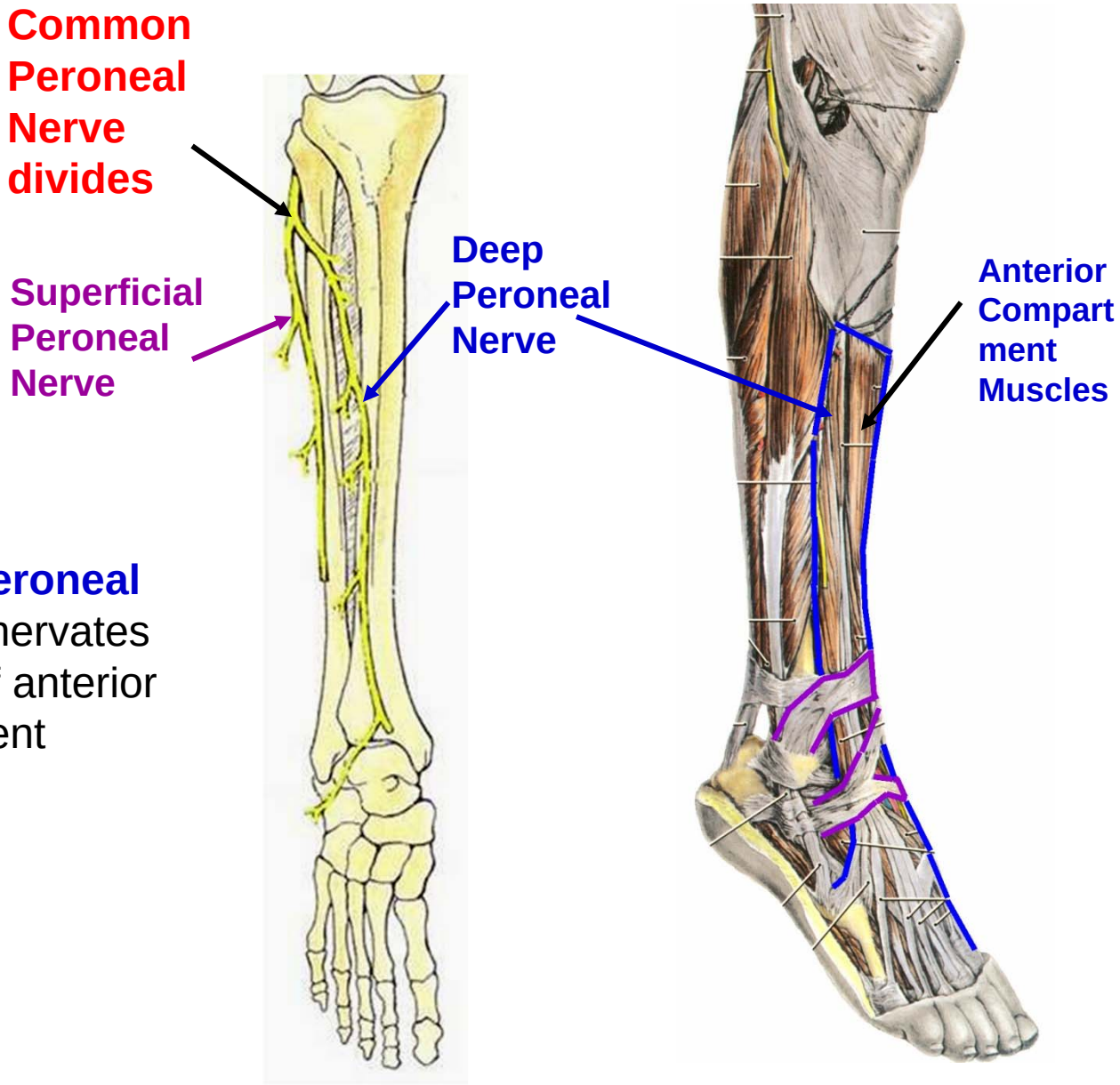
A. Nerves - **Sciatic nerve** divides into **Tibial** and **Common Peroneal** Nerves.

1- **Common Peroneal Nerve** - leaves Popliteal fossa and **winds around neck of fibula; very exposed and subject to damage; symptom is FOOT DROP**.



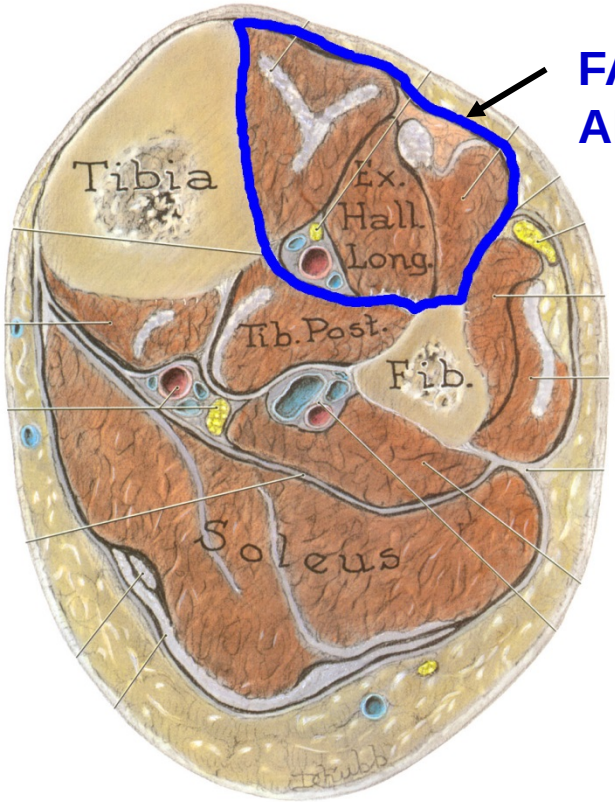


COMMON PERONEAL NERVE DIVIDES TO SUPERFICIAL AND DEEP PERONEAL NERVES



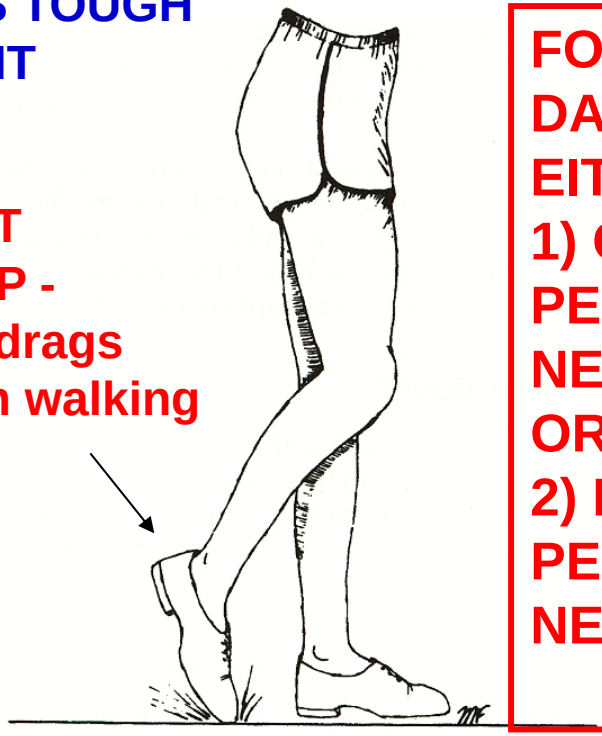
a. **Deep Peroneal Nerve** - innervates muscles of anterior compartment

ANTERIOR COMPARTMENT



FASCIA IS TOUGH AND TIGHT

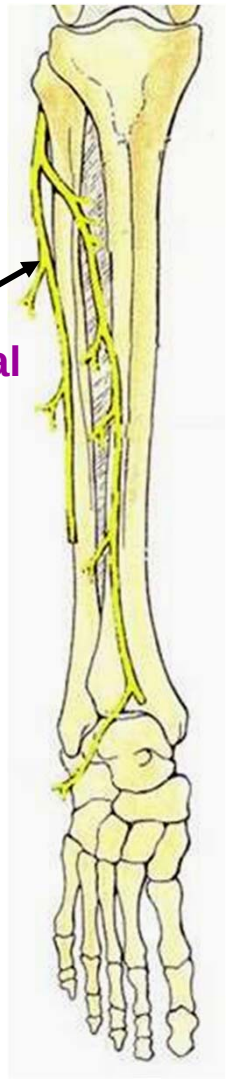
FOOT DROP - foot drags when walking

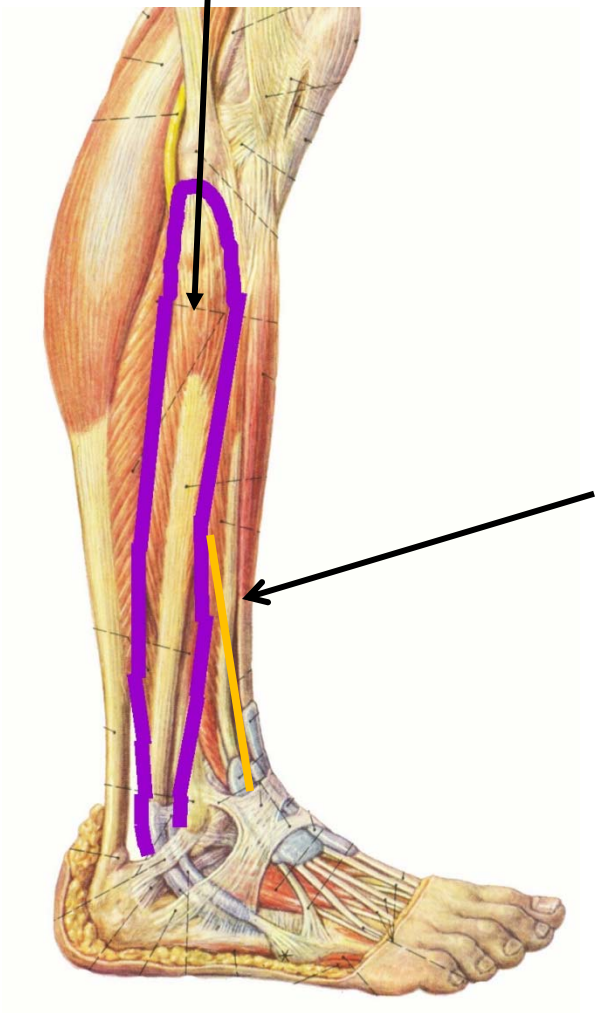


FOOT DROP: DAMAGE EITHER
1) COMMON PERONEAL NERVE
OR
2) DEEP PERONEAL NERVE

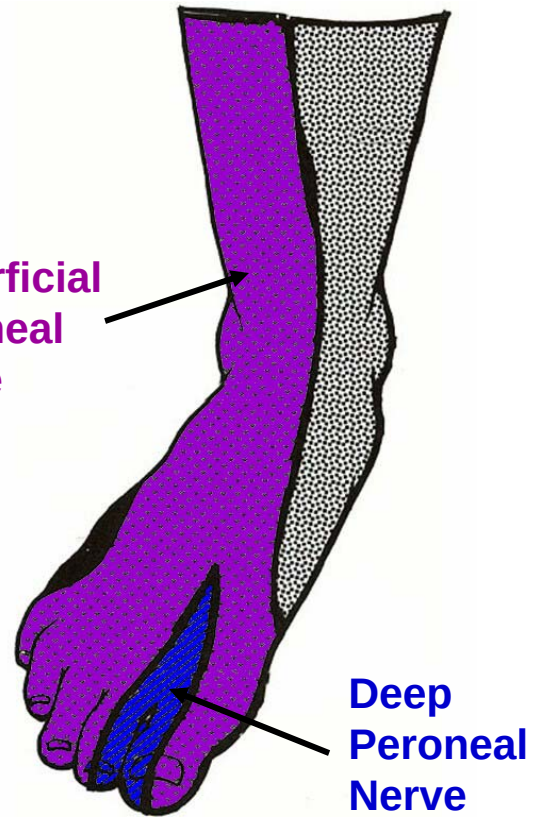
Clinical Note: **Anterior Leg Syndrome** - fascia surrounding anterior leg muscles is very tough and tight; muscles can swell in compartment due to exercise or when fracture tibia; symptom is **FOOT DROP** (=loss of dorsiflexion of foot) due to compression of Deep Peroneal Nerve; treated by fasciotomy (surgically splitting fascia). (Note: 'shin splints' is different term, inflammation of the periosteum of the tibia)

b. **Superficial Peroneal Nerve** - **supplies muscles of lateral compartment;**



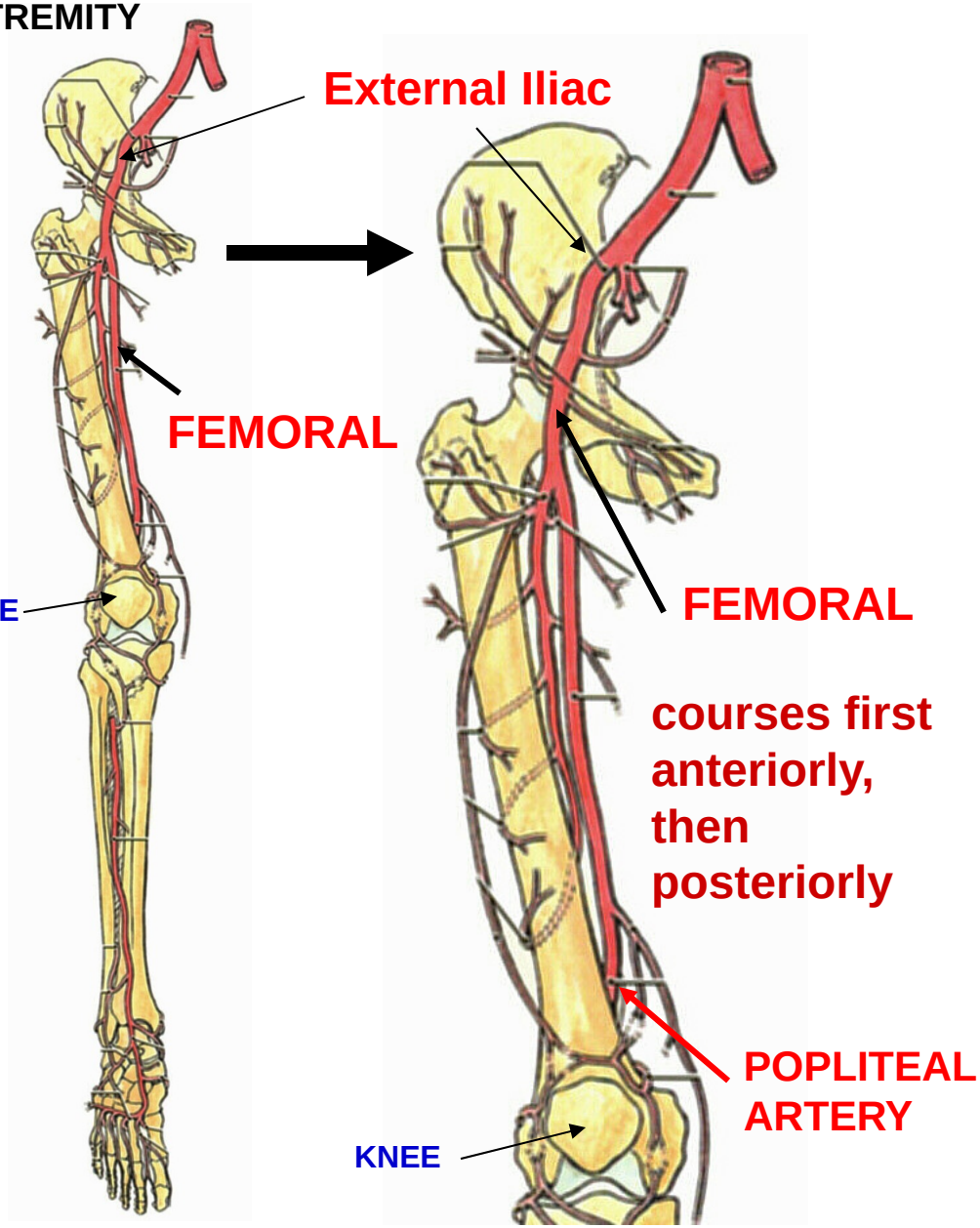


Superficial and Deep Peroneal Nerves provide sensory innervation to dorsum of Foot



OVERVIEW OF ARTERIAL SUPPLY

ANT. VIEW OF LOWER EXTREMITY



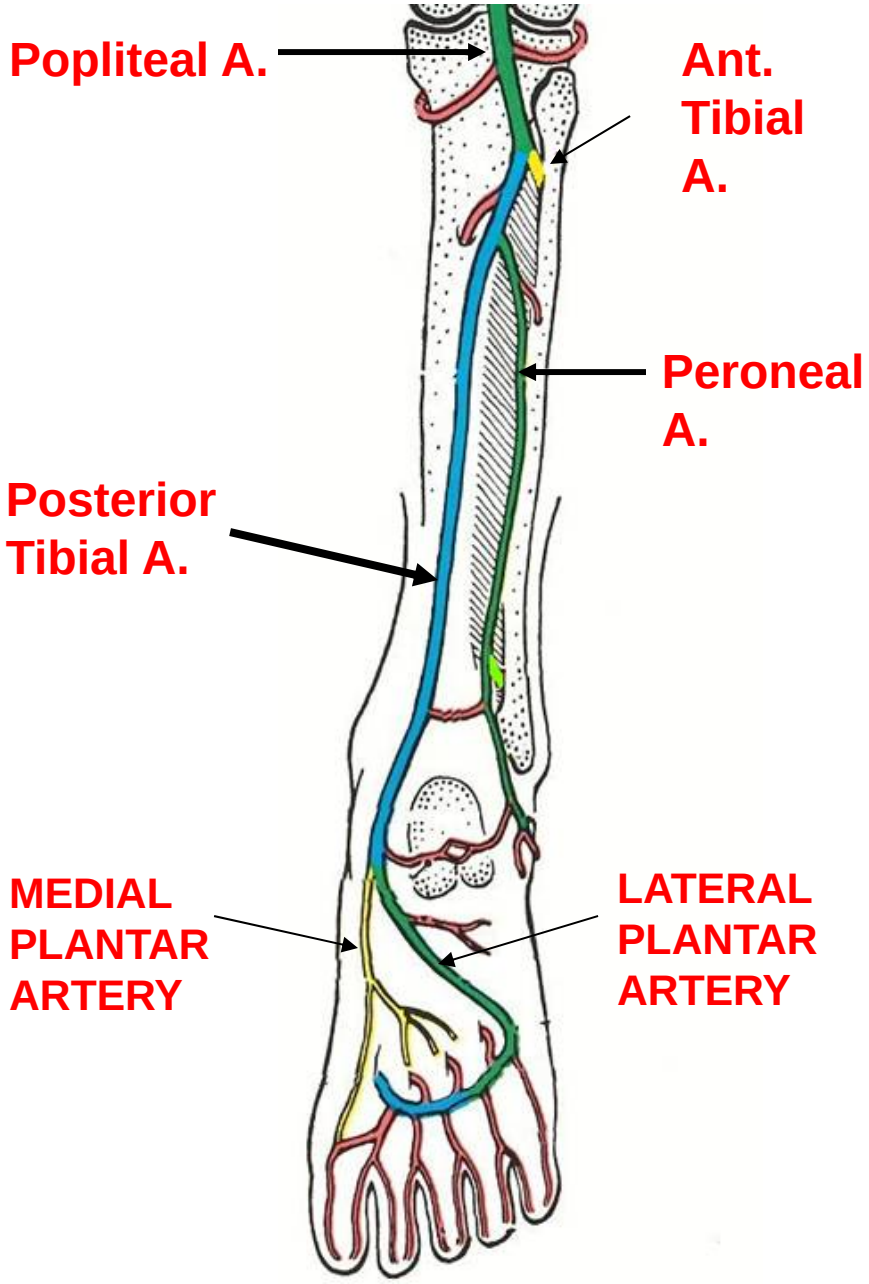
External Iliac becomes **Femoral Artery** (boundary is **inguinal ligament**); Femoral artery courses first anteriorly, then posteriorly (because of medial rotation of lower extremity in development); at **Adductor hiatus**, **Femoral artery changes name to Popliteal artery** and courses behind knee.

ARTERIES

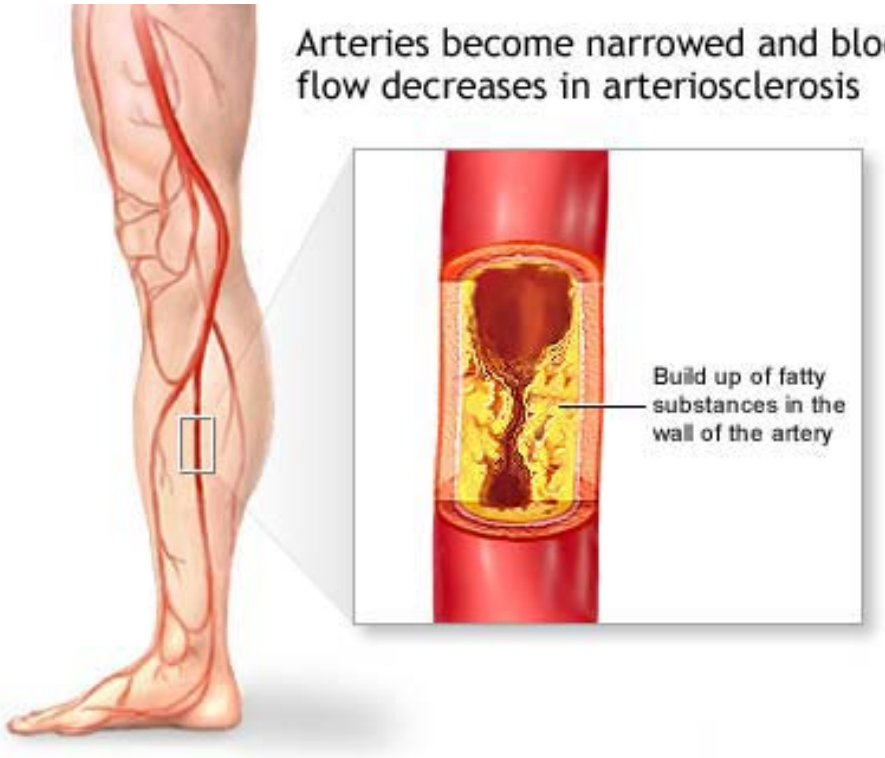
B. Arteries - **Popliteal artery ENDS BY dividing into Anterior and Posterior Tibial arteries**

1. **Posterior Tibial Artery** - enter **posterior compartment and courses with Tibial nerve**; in foot divides into **Medial and Lateral plantar** arteries.
branch:

a. **Peroneal Artery** - descends in **lateral part of posterior compartment**; branches to muscles of lateral and posterior compartment.

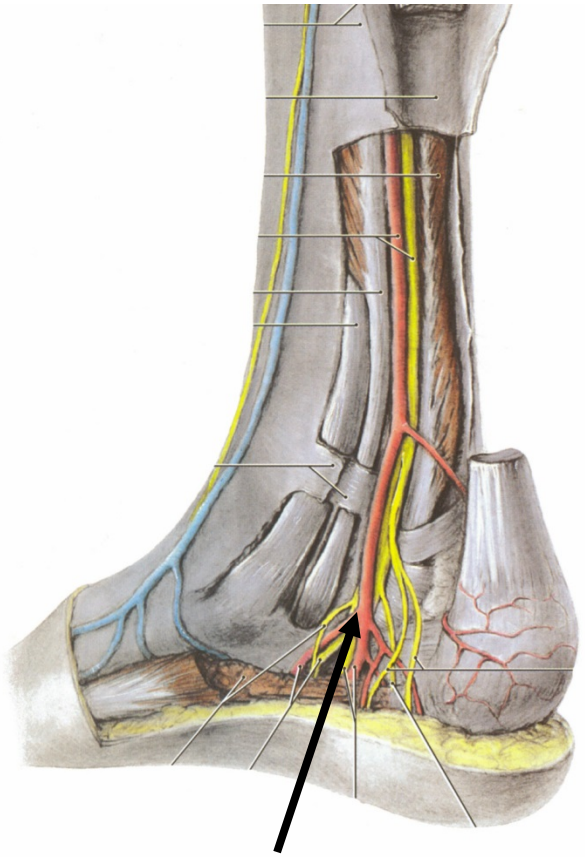


INTERMITTENT CLAUDICATION



Note: **Intermittent Claudication** (L. claudico, limping) - Narrowing of **posterior tibial artery due to arteriosclerosis**; produces ischemia; patients have painful cramps when walking but subsides after rest.

ARTERIES

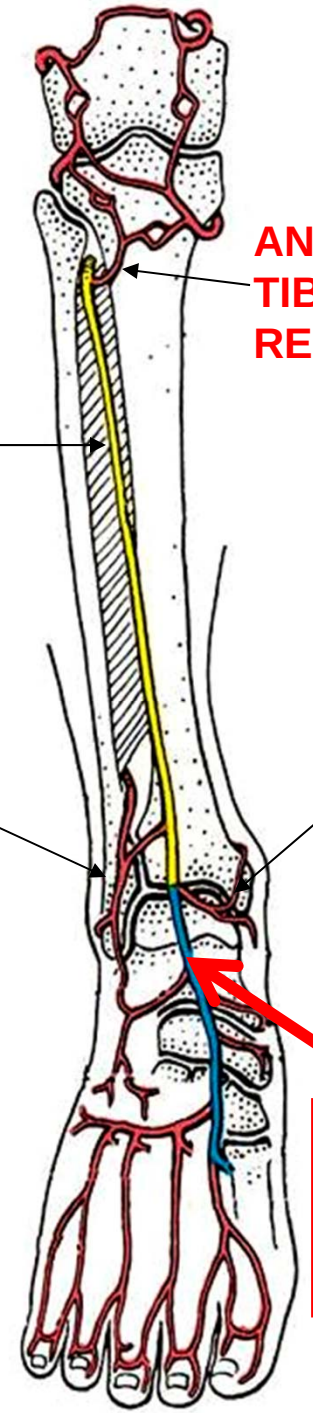


Note: **Pulse of Posterior Tibial Artery** - **taken between medial malleolus and tendo calcaneus.**

ARTERIES

2. **Anterior Tibial Artery** - passes through Interosseus membrane to anterior compartment; descends with Deep Peroneal Nerve; branches;

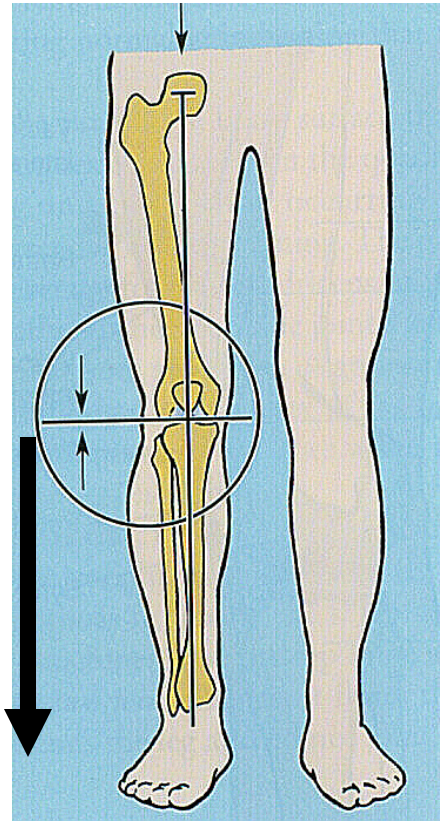
a. **Anterior Tibial Recurrent Artery -** part of **anastomosis at knee.**
b. **Medial and Lateral Malleolar Arteries -** form anastomosis at ankle.
c. **Dorsalis pedis** - continuation of Anterior Tibial artery
d. **Arcuate artery** - branch of Dorsalis pedis; gives rise to Dorsal Digital arteries to toes.



Note: **Pulse of Dorsalis pedis artery** - taken on dorsum of foot **between medial and lateral malleoli.**

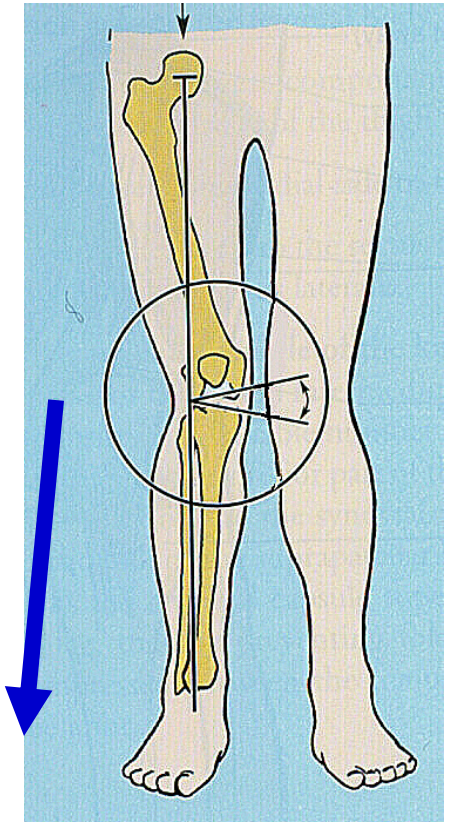
X. DEFORMITIES OF LOWER LIMB: TERMINOLOGY – Valgus and Varus

Normal - Distal bone in joint is parallel to midline



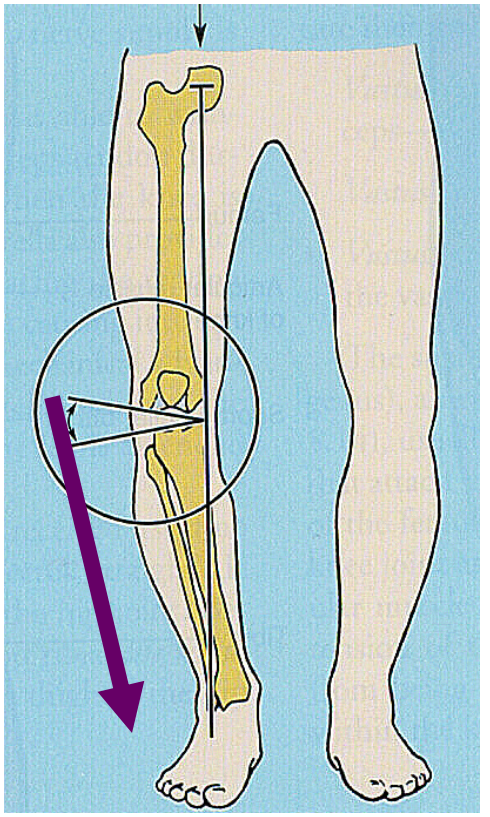
(It's vulgar to be knock-kneed) →

Valgus - Distal bone at a joint is deviated laterally away from midline of body



Genu valgus = knock-kneed;
normal in infants 3-5

Varus - Distal bone at a joint is deviate toward midline



Genu varus = bow-legged;
normal in infants to age 3

CAUSES GENU VARUS (BOWLEGGED)

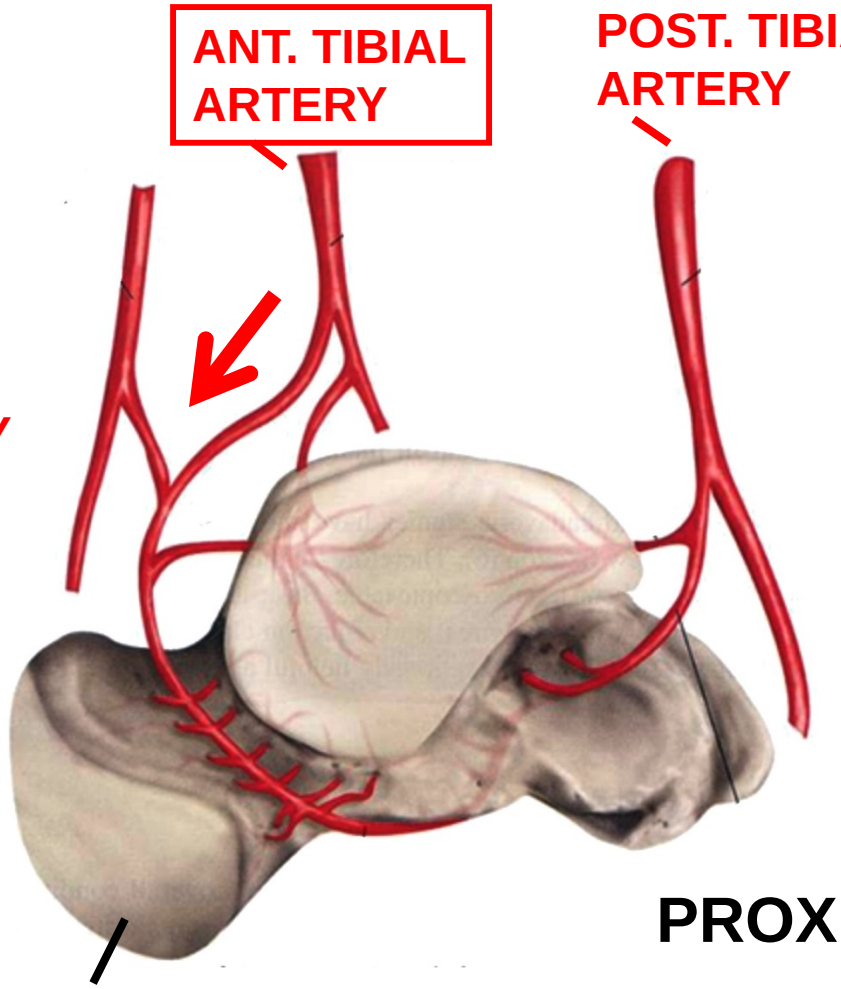
Blount's disease - a condition of severe bowleg that occurs more frequently in black children; disease is progressive, and may require surgery.

Growth disturbance - or epiphyseal dysplasia, which may be a part of a generalized bone growth disturbance.

Post-trauma - where injury to the knee causes damage to the growth plate (also called the epiphyseal plate) and abnormal growth around the knee.

Rickets - Lack of vitamin D intake, or inability to metabolize Vitamin D due to kidney disease can cause growth disturbance of the bones in the body, including the knee.

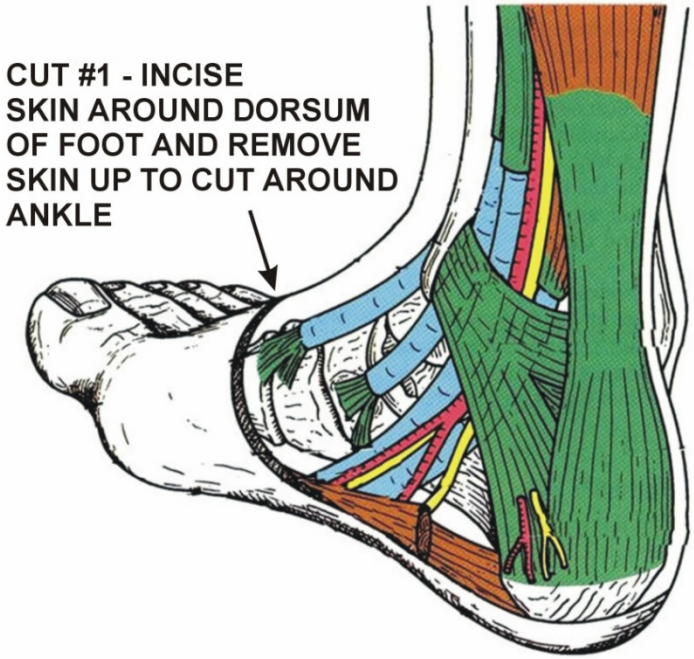
BLOOD SUPPLY TO TALUS



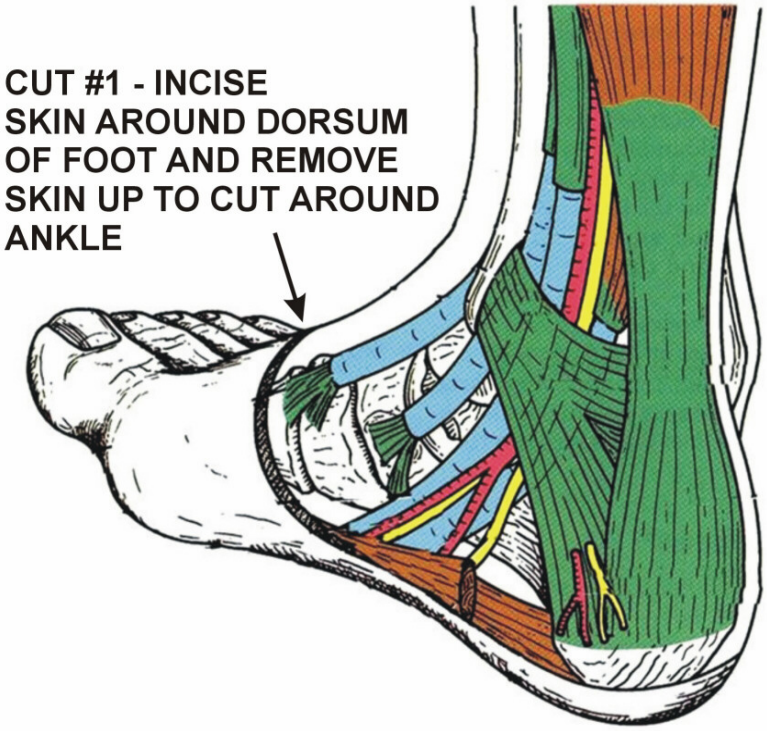
- In most bones, major blood supply is derived from branches at proximal end of bone
- in Talus (and Scaphoid bone in hand) <u>blood supply enters bone distally</u>
- Fracture of Talus can interrupt blood supply and produce necrosis of Talus

DISSECTION INSTRUCTIONS LEG: FIRST REMOVE SKIN FROM ANKLE AND DORSUM OF FOOT

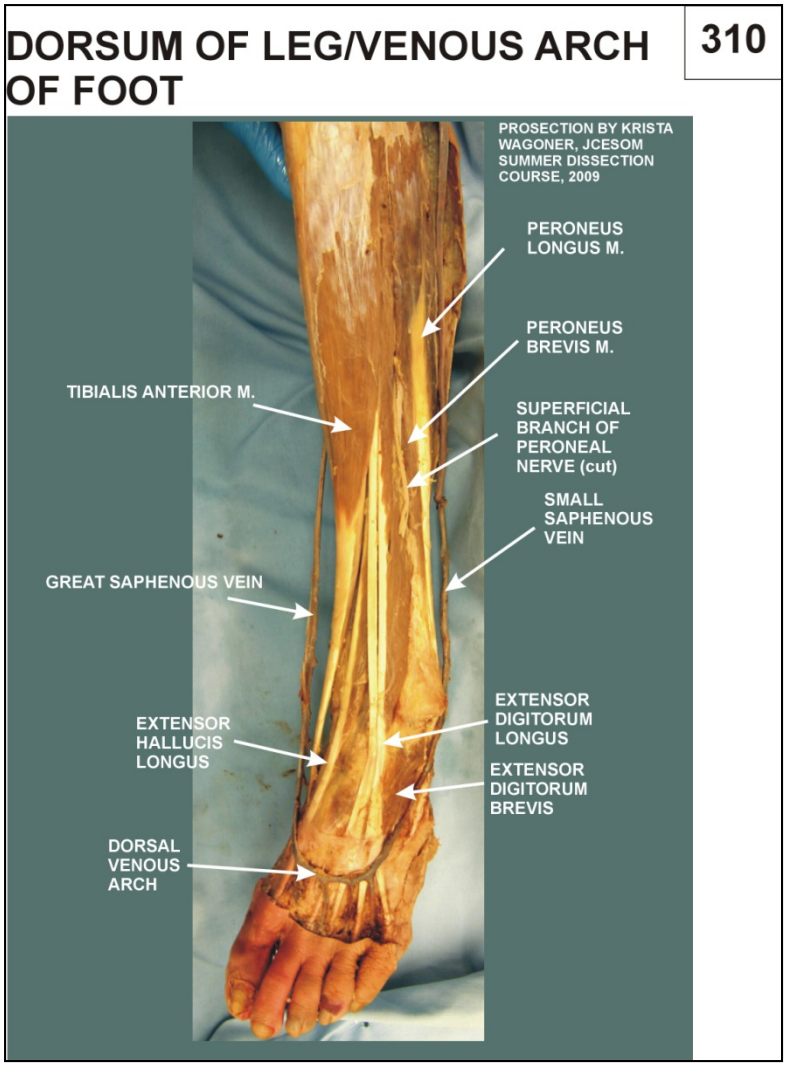
Fig. 1 - Incise skin as in diagram at right: remove all skin around ankle and dorsum of foot (extend skinning to some individual toes); this exposes Tom, Dick and Harry, Peroneal muscle tendons and tendons of muscles of Anterior Compartment.



SIMILAR TO PROSECTION 310: FIRST REMOVE SKIN FROM ANKLE AND DORSUM OF FOOT



LOOK AT 310



Also skin one or two toes to see tendons

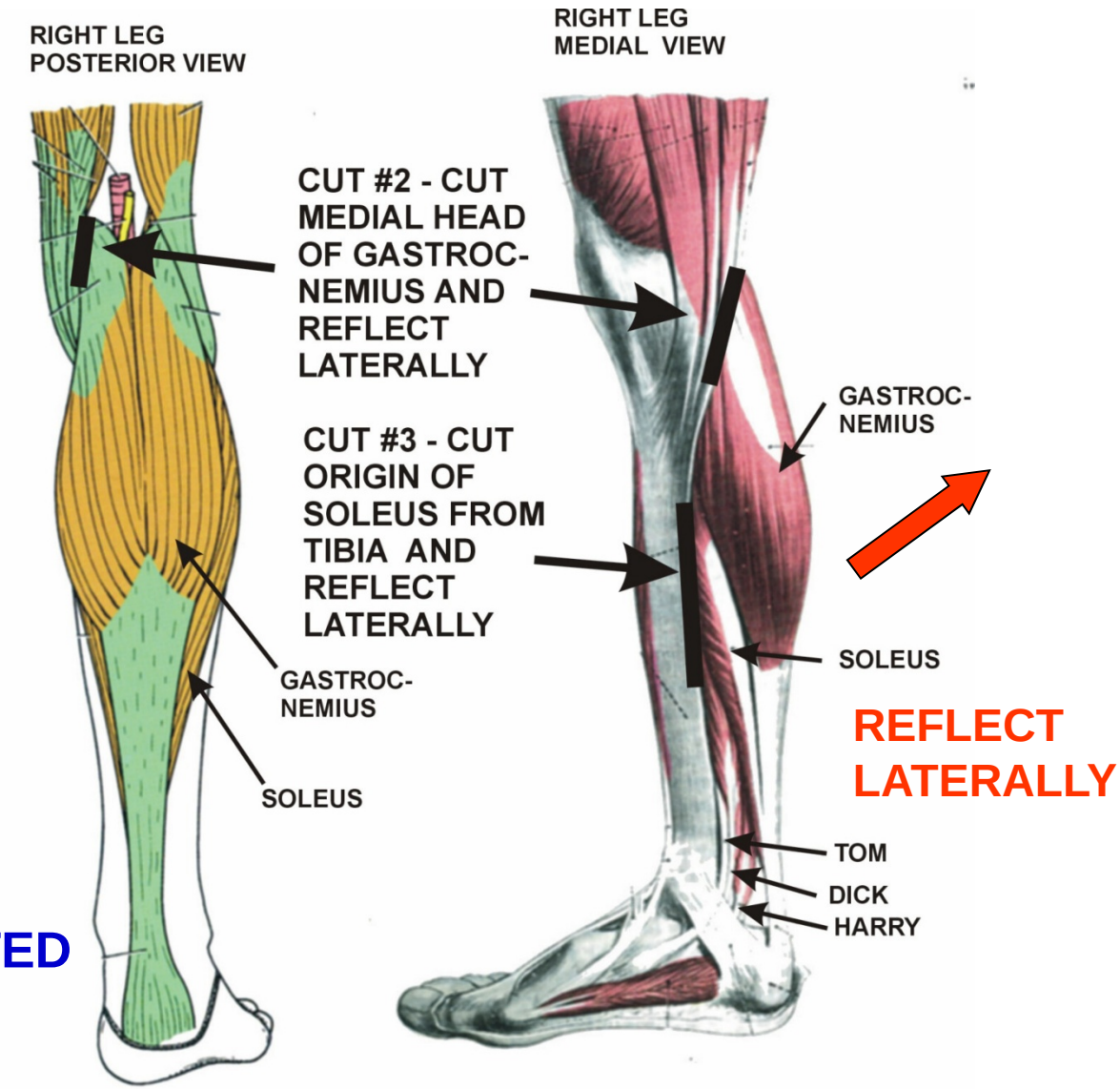
TURN CADAVER OVER TO PRONE (FACE DOWN) POSITION

TWO CUTS:

1) CUT MEDIAL HEAD OF GASTROCNEMIUS AT FEMUR

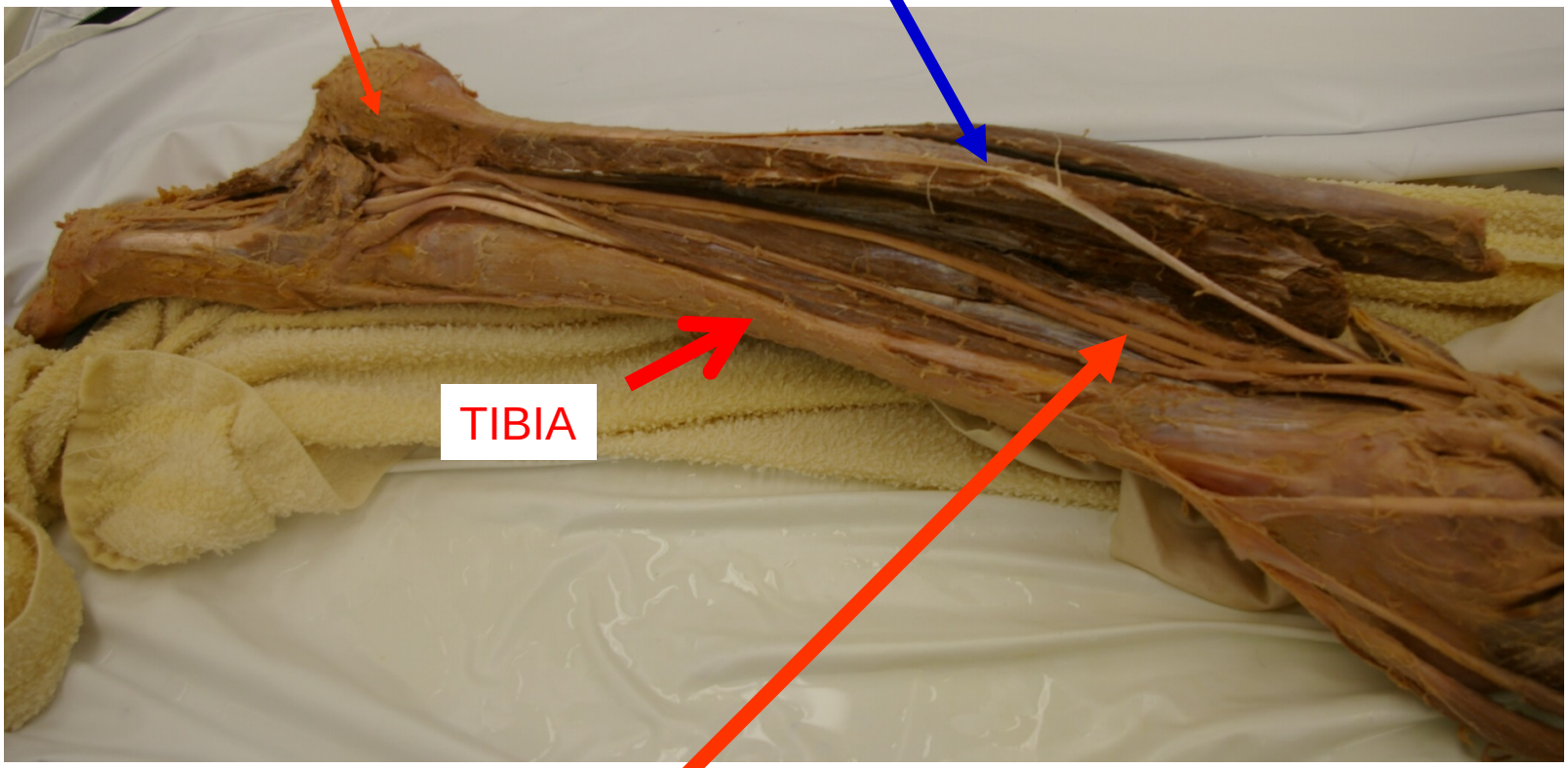
2) PUT FINGER UNDER SOLEUS; THEN CUT ORIGIN FROM TIBIA

3) MUSCLES OF POSTERIOR COMPARTMENT (SUPERFICIAL) CAN THEN BE REFLECTED LATERALLY



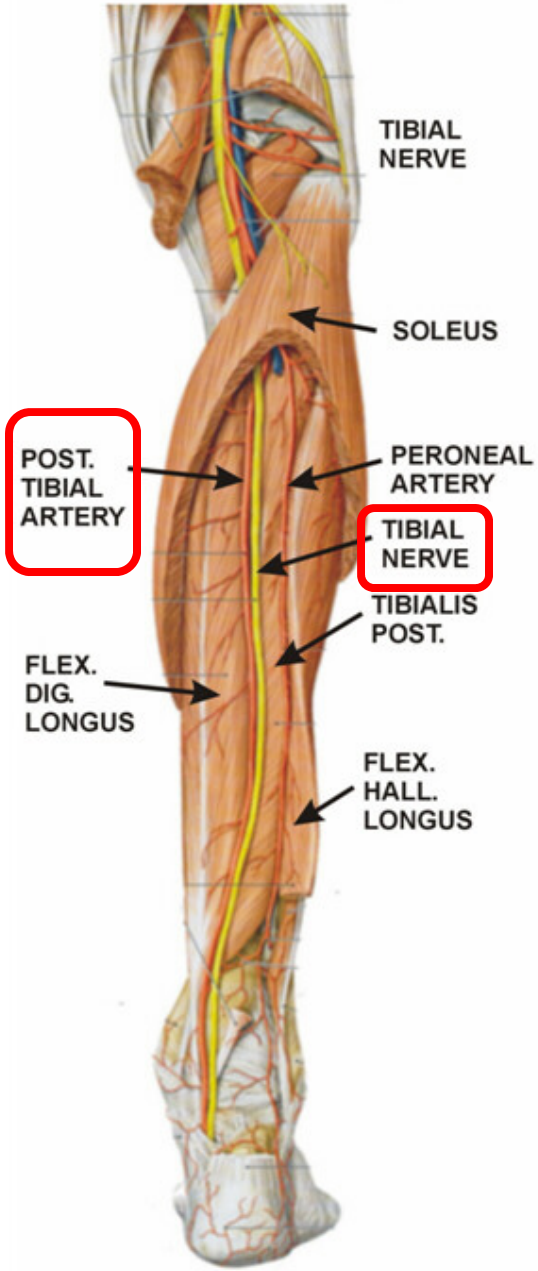
REFLECT GASTROCNEMIUS, SOLEUS, PLANTARIS LATERALLY

MEDIAL SIDE OF ANKLE OF LEFT LEG



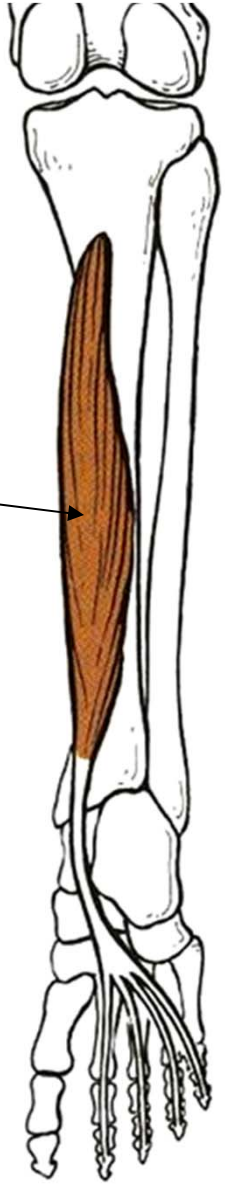
NERVES AND ARTERIES COURSE IN POSTERIOR COMPARTMENT BETWEEN SUPERFICIAL AND DEEP GROUPS OF MUSCLES

POST. SIDE
RIGHT LEG
DEEP MUSCLES

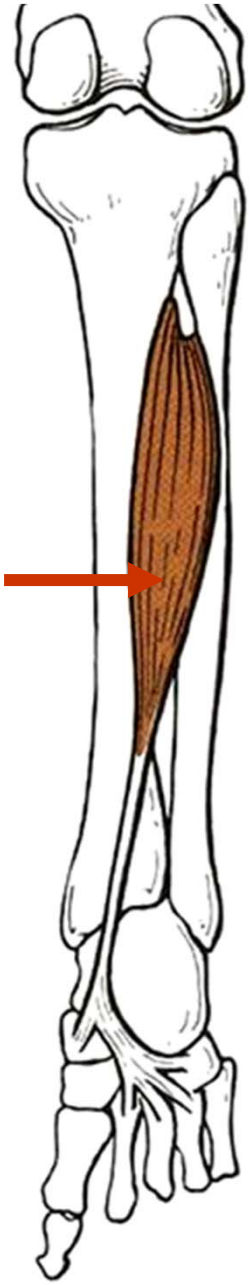


DEEP MUSCLES: ORDER IS BACKWARD LATERAL TO MEDIAL

Flexor digitorum longus

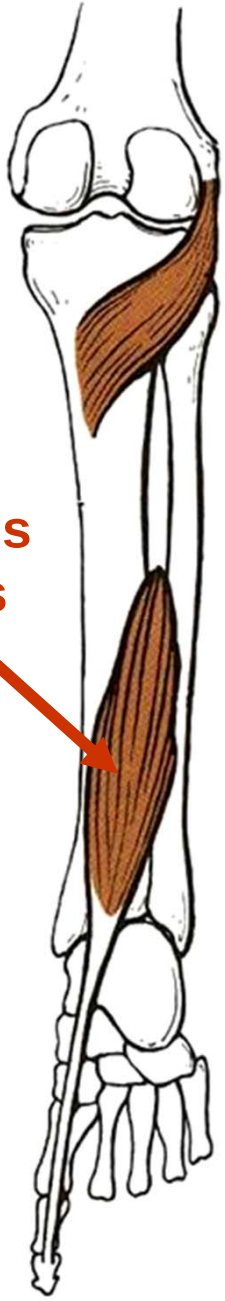


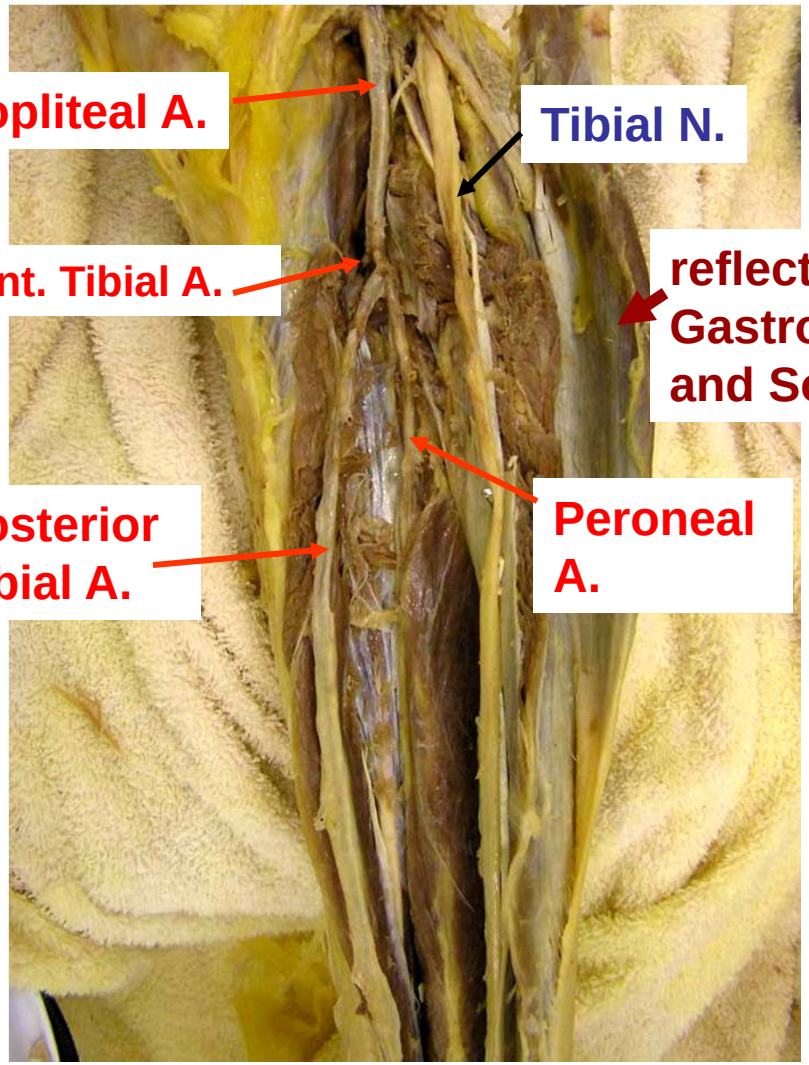
Tibialis posterior

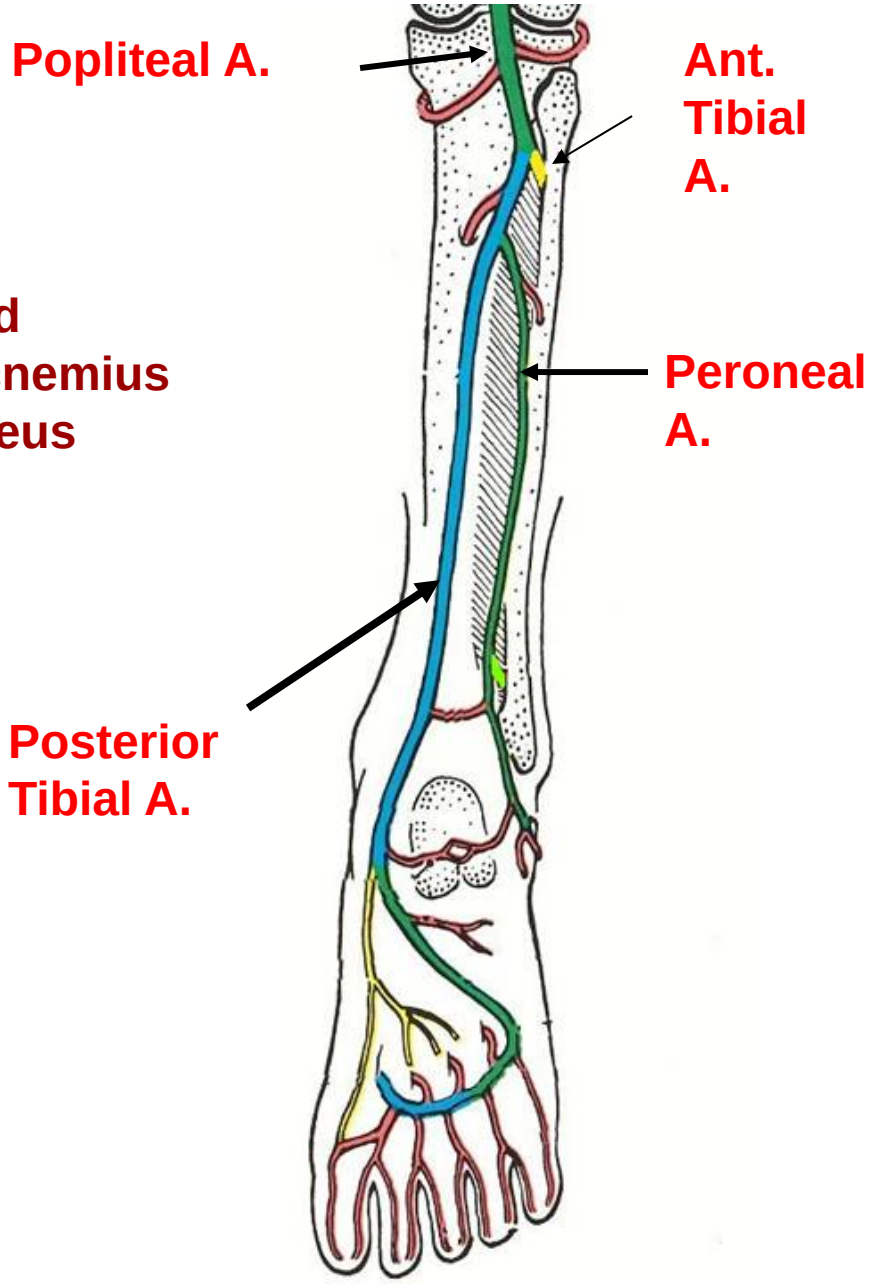


INVERT

Flexor hallucis longus



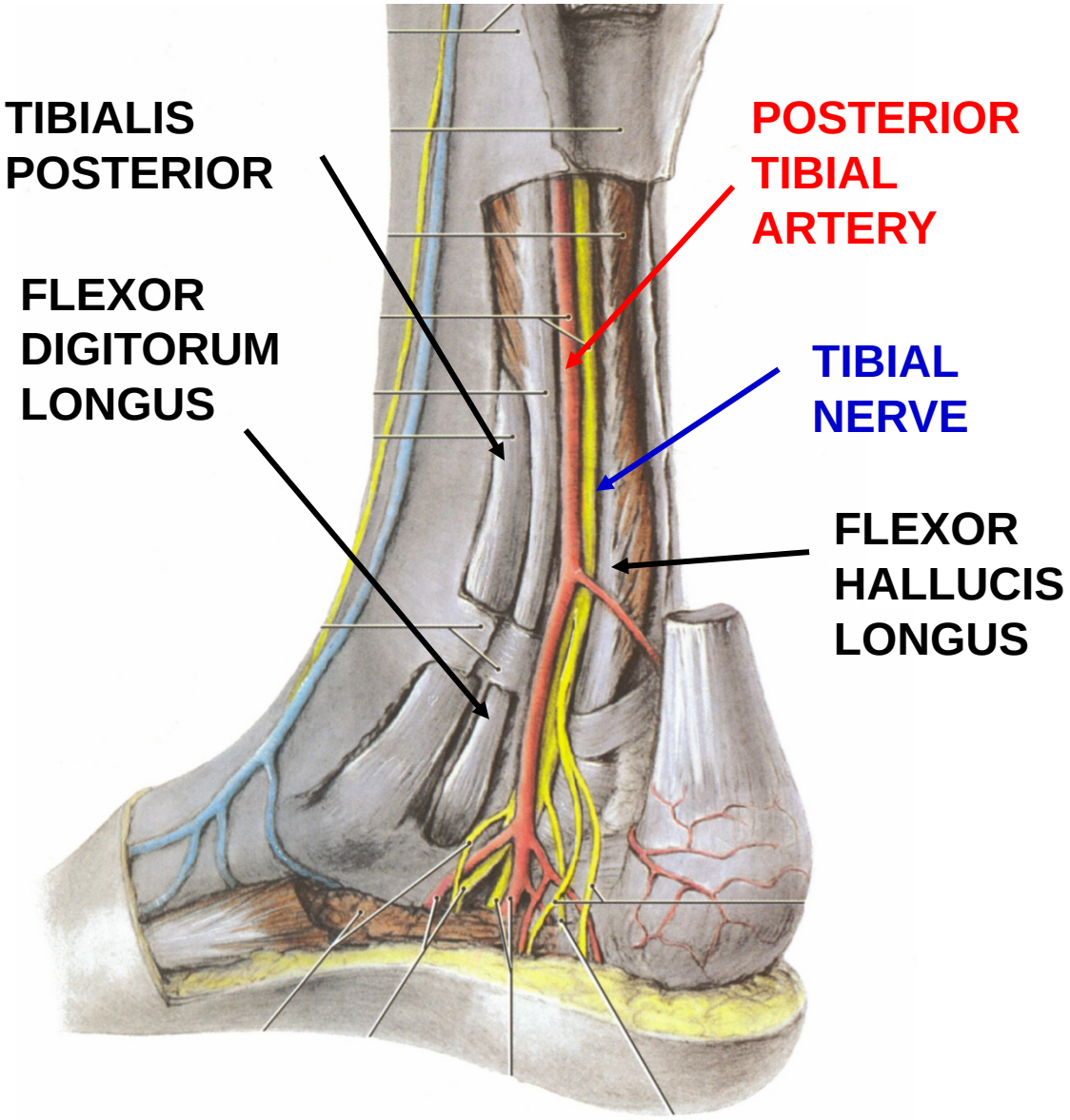

Popliteal A.
Tibial N.
Ant. Tibial A.
reflected Gastrocnemius and Soleus
Posterior Tibial A.
Peroneal A.


Popliteal A.
Ant. Tibial A.
Peroneal A.
Posterior Tibial A.

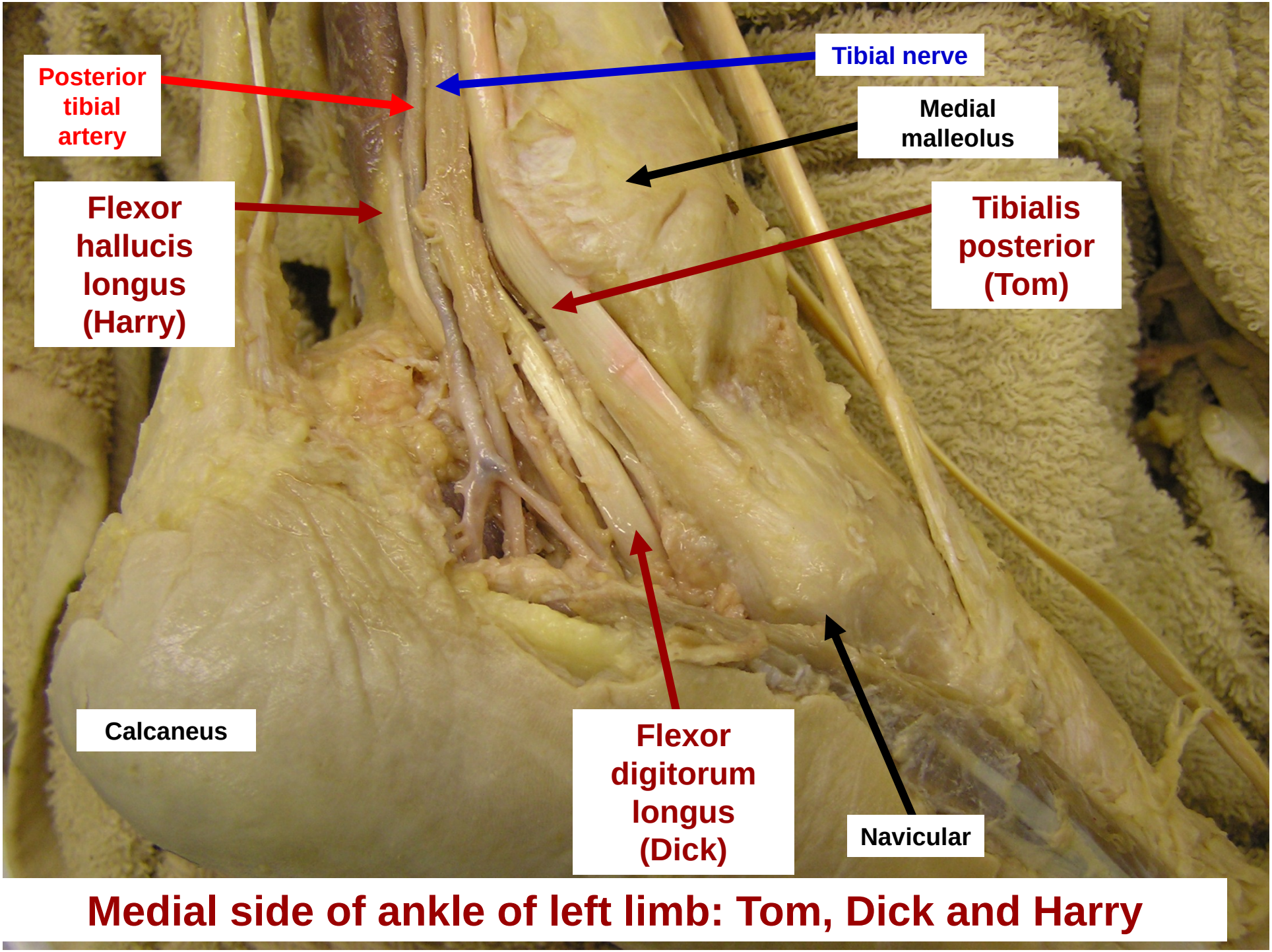
TOM, DICK AND HARRY

ORDER OF STRUCTURES ON MEDIAL SIDE OF ANKLE - TOM, DICK AND HARRY - Tibialis posterior (tendon), Flexion Digitorum Longus, Posterior Tibial Artery, Tibial Nerve and Flexor Hallucis Longus.

LOOK FOR TENDONS AT MEDIAL ANKLE THEN FOLLOW UP INTO POST. LEG



Note: Order is important as accidents can happen that sever tendons (i.e. ax strikes ankle when chopping wood).



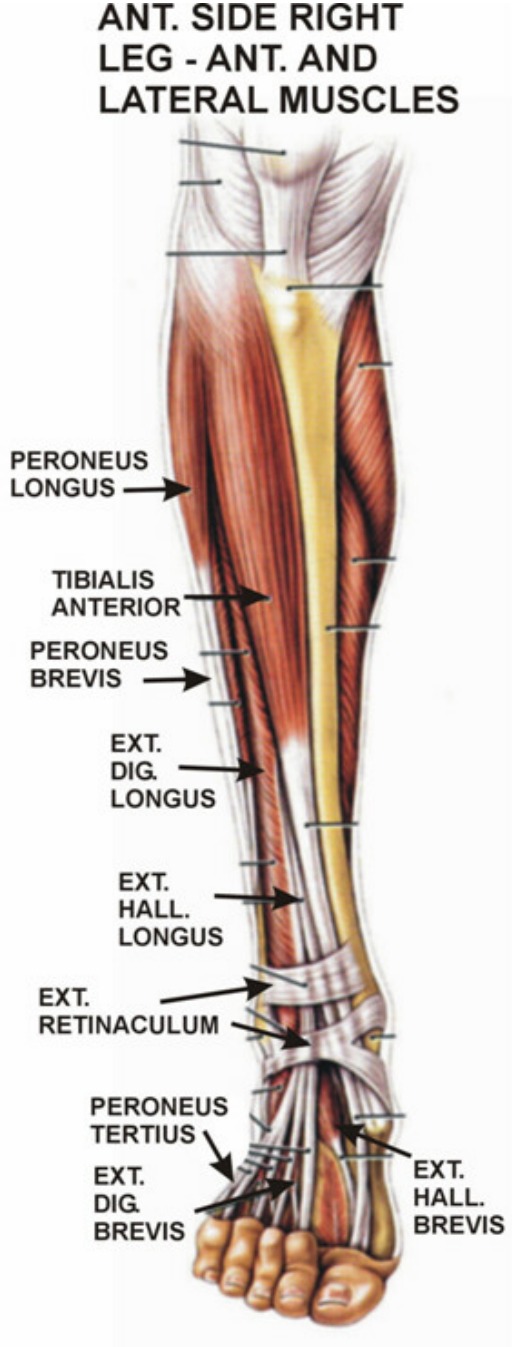
Medial side of ankle of left limb: Tom, Dick and Harry

TURN CADAVER OVER TO SUPINE (FACE UP) POSITION

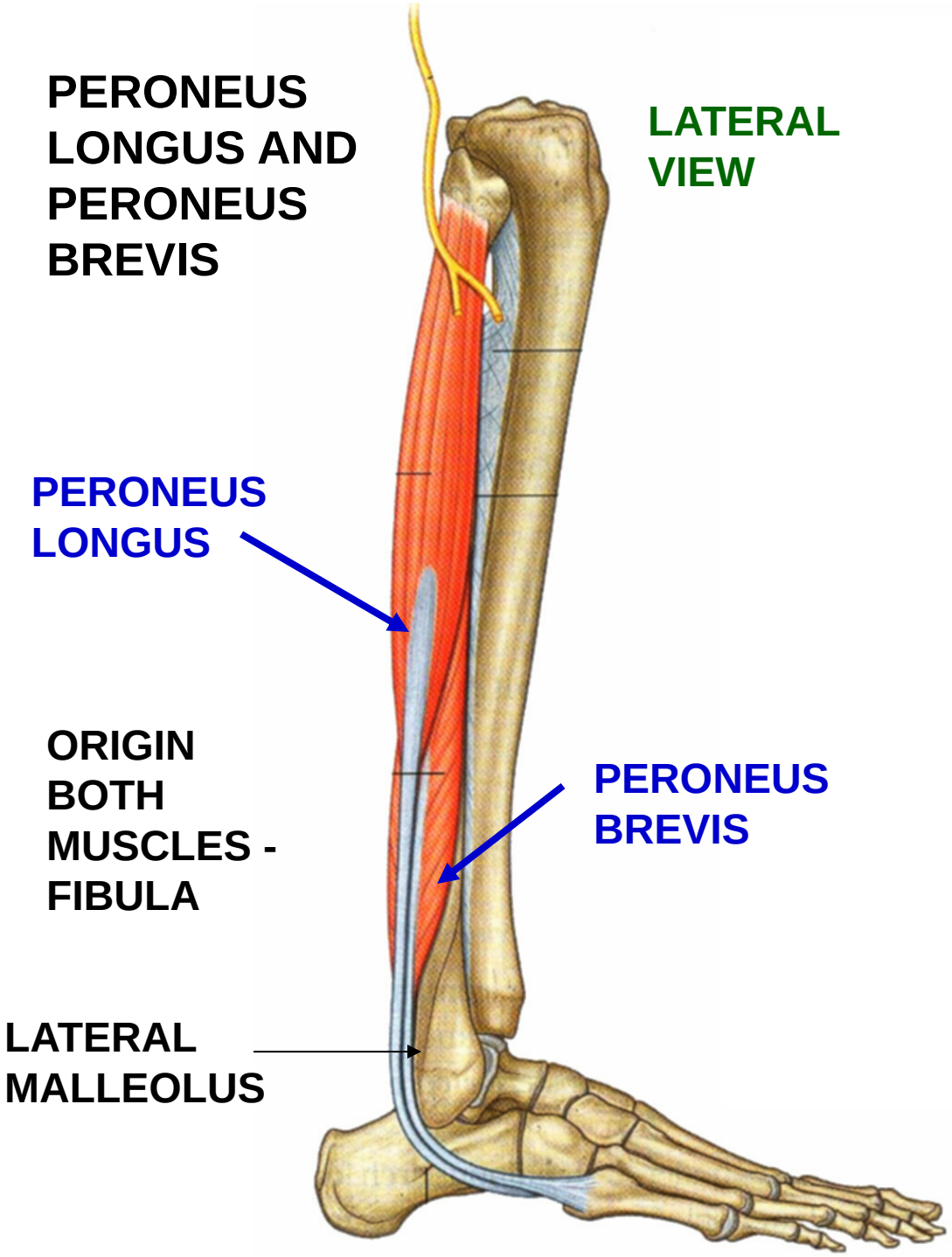
ANTERIOR AND LATERAL COMPARTMENTS OF LEG -

Muscles are in a single layer

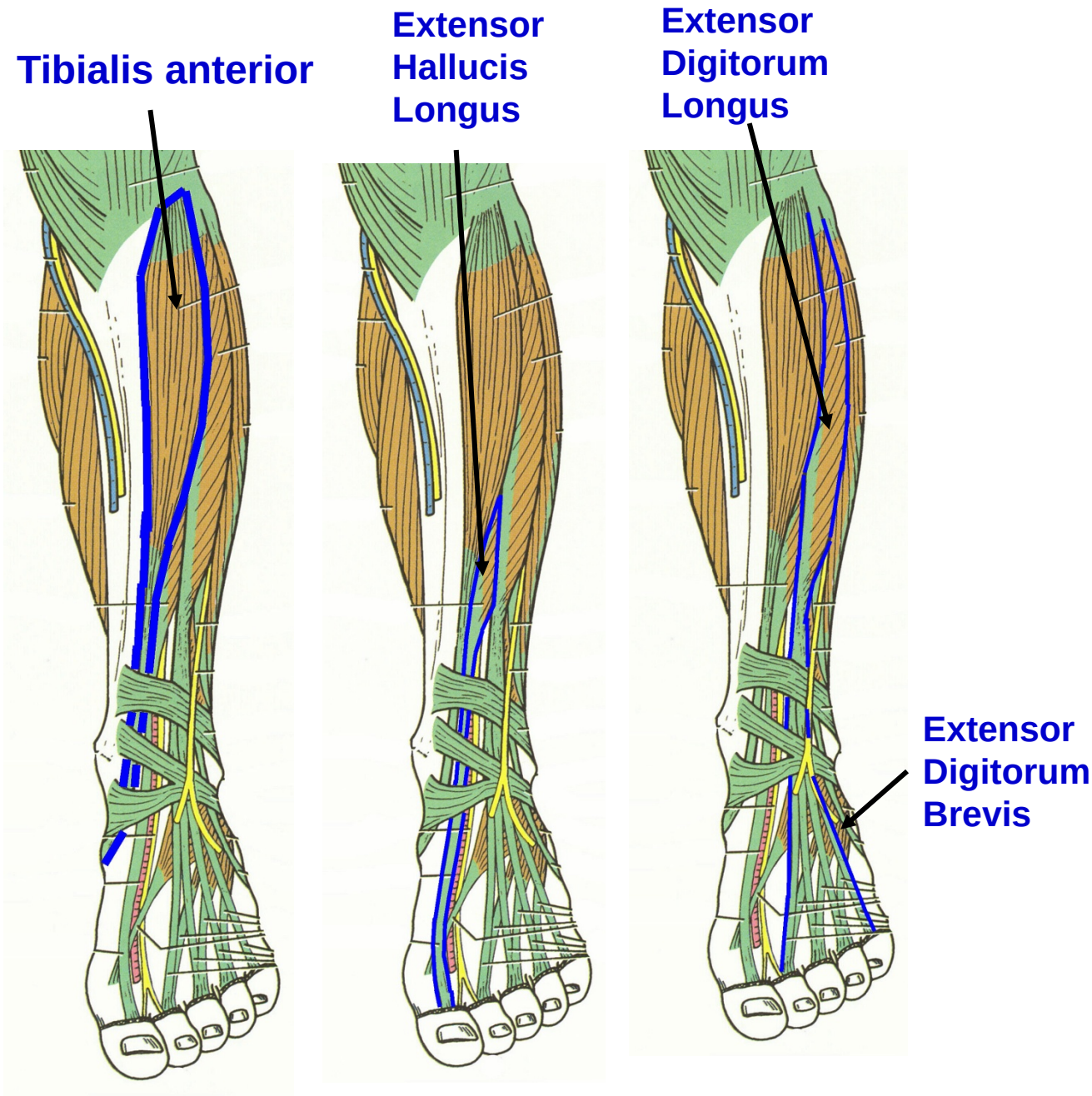
- **Remove deep fascia** overlying anterior and lateral compartments. Fascia is particularly tough and may need to be removed in pieces.
- **NO CUTS.** Dissection should only require scissors technique and **separation of muscles**. Follow tendons into the foot and identify retinacula (if possible).



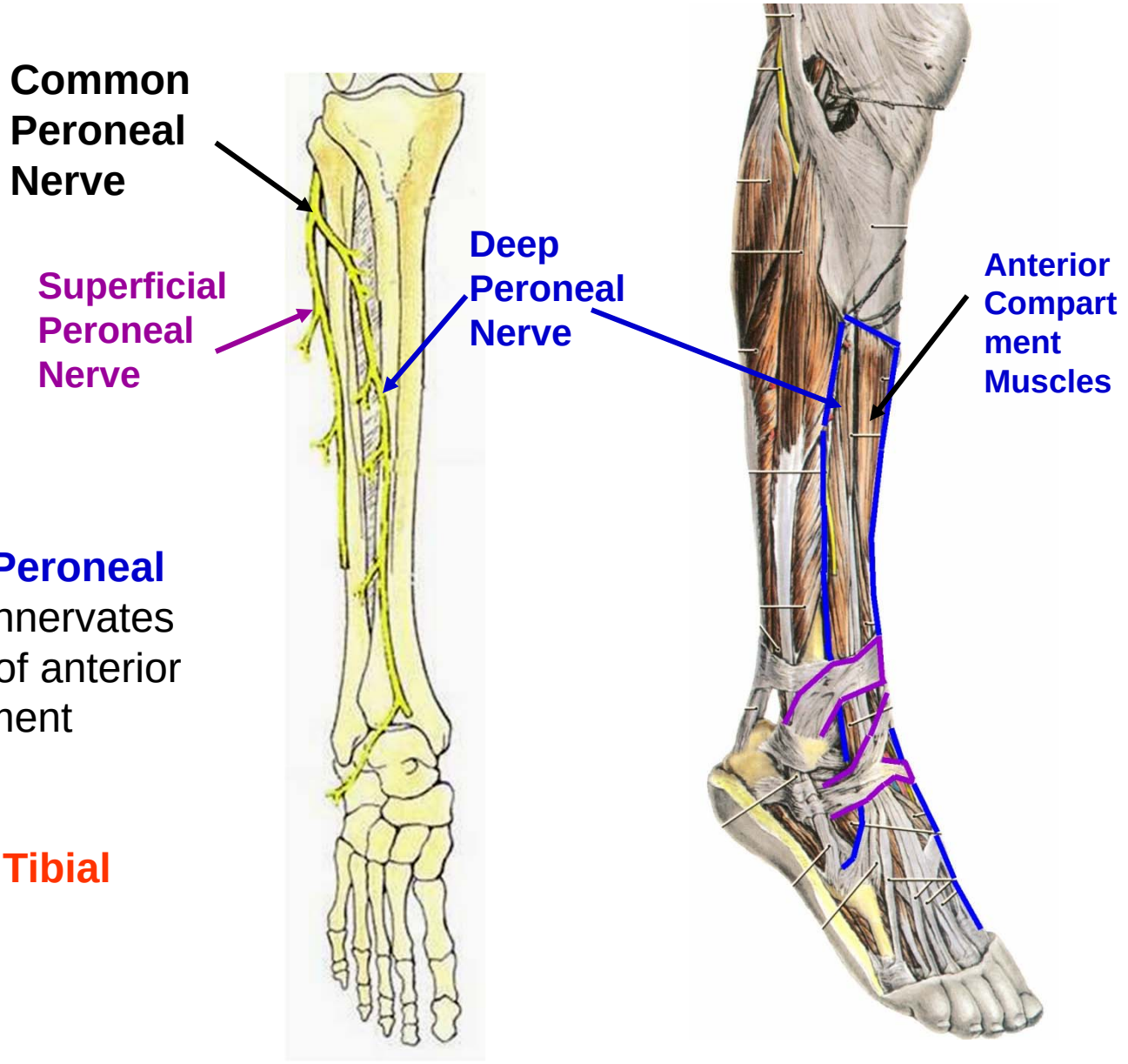
LATERAL COMPART-MENT OF LEG - 2 Muscles



ANTERIOR COMPART-MENT OF LEG - Muscles in a single layer

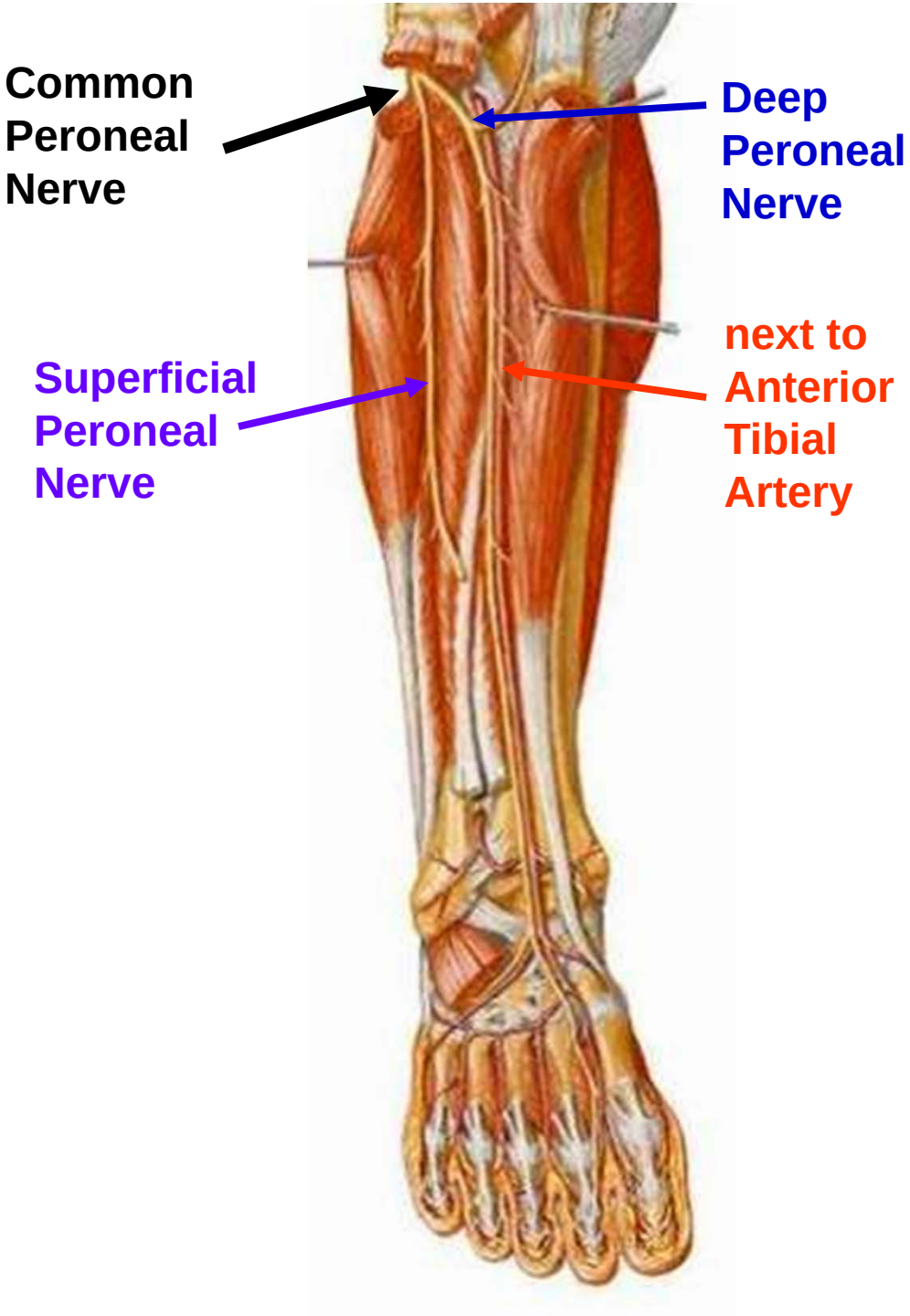


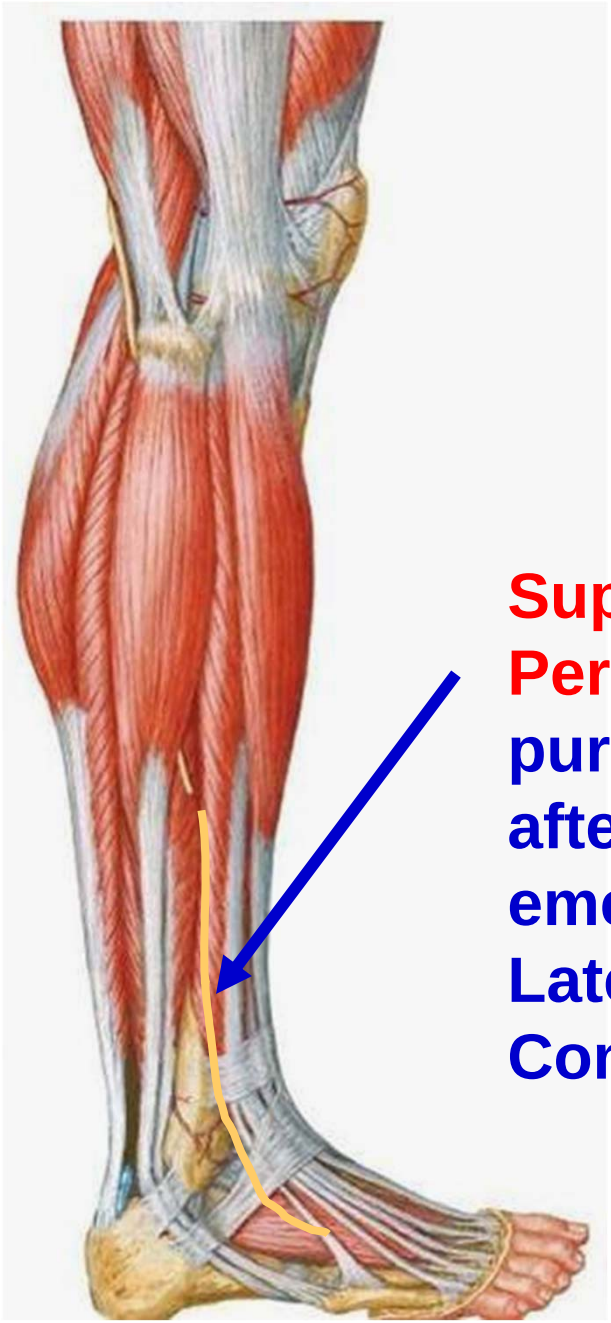
COMMON PERONEAL NERVE DIVIDES TO SUPERFICIAL AND DEEP PERONEAL NERVES



a. **Deep Peroneal Nerve** - innervates muscles of anterior compartment **courses with Anterior Tibial Artery**

COMMON PERONEAL NERVE DIVIDES - in substance of Peroneus Longus Muscle (hard to see) - to Superficial and Deep Peroneal nerves





Superficial Peroneal Nerve - purely sensory after emerges from Lateral Compartment

CHECK LIST FOR LEG AND DORSUM OF FOOT LAB 2018

1) POSTERIOR COMPARTMENT OF LEG

MUSCLES -
_____ GASTROCNEMIUS
_____ SOLEUS
_____ PLANTARIS
_____ TENDO CALCANEUS
_____ TIBIALIS POSTERIOR
_____ FLEXOR DIGITORUM LONGUS
_____ FLEXOR HALLUCIS LONGUS

ARTERIES -
_____ POPLITEAL ARTERY
_____ POSTERIOR TIBIAL ARTERY
_____ PERONEAL ARTERY
_____ ANTERIOR TIBIAL ARTERY

NERVES -
_____ COMMON PERONEAL NERVE
_____ TIBIAL NERVE

FASCIA AND OTHER STRUCTURES -
_____ *FLEXOR RETINACULUM

2) ANTERIOR AND LATERAL COMPARTMENTS OF LEG

MUSCLES -
_____ TIBIALIS ANTERIOR
_____ EXTENSOR DIGITORUM LONGUS
_____ EXTENSOR HALLUCIS LONGUS
_____ PERONEUS BREVIS
_____ PERONEUS LONGUS
_____ PERONEUS TERTIUS
_____ EXTENSOR DIGITORUM BREVIS
_____ EXTENSOR HALLUCIS BREVIS

ARTERIES -
_____ ANTERIOR TIBIAL ARTERY

NERVES -
_____ SUPERFICIAL PERONEAL NERVE
_____ DEEP PERONEAL NERVE

FASCIA AND OTHER STRUCTURES -
_____ *EXTENSOR RETINACULUM

(NOTE: * STARRED STRUCTURES ARE OPTIONAL, FIND IF YOU CAN):

SOLE OF FOOT

I. DESIGN OF FOOT – the foot is specialized for supporting weight and walking: 1) foot acts like a lever in generating forces for walking and running; 2) weight is supported at specific points on sole of foot: 3) ligaments and arches of foot function like springs that store energy in walking (important in design of prosthetics).

II. SKIN AND FASCIA

A. Skin - specialized for standing and walking on foot; very thick and hairless on sole of foot, tightly bound to fascia.

B. Plantar Aponeurosis - thickened, tough band of deep fascia on sole of foot; extends from calcaneus; distally divides into connective tissue bands for all five toes; protects underlying structures and helps support arch (Lateral longitudinal arch) of foot (see below).

C. Fibrous digital sheaths - thickened bands attached to side of phalanges; form tunnels for passage of long tendons to toes (ex., flexor digitorum longus) and prevents bowstringing (tendons popping out when muscles contract).

III. MUSCLES OF FOOT - arranged in four layers.

A. Layer 1 - Flexor Digitorum Brevis, Abductor Hallucis, Abductor Digiti Minimi

Note: Flexor Digitorum Brevis tendons end on middle phalanges; tendon splits to allow passage of Flexor Digitorum Longus to distal phalanges.

B. Layer 2 - Quadratus Plantae and Lumbricals (also tendons of Flexor Digitorum Longus and Flexor Hallucis Longus)

1. Tendon of Flexor Digitorum Longus = DICK of TOM, DICK and Harry; tendon passes deep to Abductor Hallucis; branches to 4 tendons that end in distal phalanges of toes; have Lumbricals attached.

2. Lumbricals - attach to tendons of Flexor Digitorum Longus and extend to 1) proximal phalanges of toes and 2) extensor expansions; Lumbricals act to flex metatarsophalangeal joint and extend interphalangeal joints.

3. Quadratus Plantae - attaches from calcaneus to Flexor Digitorum Longus.

Note: Quadratus Plantae is biomechanically elegant - If only Flexor Digitorum longus contracted, it would pull toes toward medial side; instead, Quadratus Plantae pulls on Flexor tendon to redirect flexor pull toward calcaneus, i.e. direct flexion of toes.

4. tendon of Flexor Hallucis Longus - (= HARRY) - Tendon passes to distal phalanx of big toe; tendon passes between two sesamoid bones under the head of the first metatarsal; this prevents weight of body from resting on tendon; weight presses on sesamoids, allowing movement of flexor tendon.

C. Layer 3 - Small muscles to big toe and little toe.

1. Flexor hallucis brevis - has two tendons that insert to proximal phalanx; sesamoid bones present in each tendon.

2. Adductor hallucis - two heads of origin and one common tendon.

3. Flexor digiti minimi brevis - small muscle to little toe.

D. Layer 4 - Interosseus muscles (between metatarsal bones) and tendons of long muscles.

1. Dorsal interossei - 4 muscles - DAB - (dorsal abduct)

2. Plantar interossei - 3 muscles, toes 3-5 - PAD - (plantar adduct)
Note: Axis of abduction/adduction is second toe. Interossei also hold metatarsal bones together in bearing weight.

3. Tendon of Peroneus longus - crosses from lateral to medial to insert on first metatarsal and medial cuneiform bones.

4. Tendon of Tibialis posterior - inserts to navicular and sends slips to cuneiforms.

IV. ARTERIES AND NERVES OF SOLE OF FOOT

A. Posterior Tibial Artery - divides into Medial and Lateral Plantar arteries

1. Lateral Plantar artery - gives rise to Plantar Arterial arch, located deep in foot; Plantar Arch gives rise to Plantar Metatarsal arteries which branch to sides of toes as Plantar Digital arteries.

2. Medial Plantar artery - smaller branch to medial foot.

B. Tibial Nerve - branches to Medial and Lateral plantar nerves.

1. Medial Plantar nerve -
Sensory branches to medial 3 1/2 digits and medial part of sole
Motor branches - muscles of big toe (Flexor Hallucis Brevis, Abductor Hallucis), Flexor Digitorum Brevis, first Lumbrical.

2. Lateral Plantar nerve -
Sensory branches to lateral 1 1/2 digits and lateral sole
Motor branches to remaining intrinsic muscles of sole of foot

V. ARCHES OF FOOT AND SUPPORT OF BODY WEIGHT

A. Arches of foot - foot is not flat but has arches that allow ligaments to act like springs; foot contacts ground anteriorly at heads of metatarsals and sesamoid bones under first metatarsal ; posteriorly at calcaneus.

1. Medial Longitudinal arch - highest arch, responsible for 'fallen arches'

a. formed by - calcaneus, talus, navicular, cuneiforms and medial three metatarsal bones; talus is highest point of arch.

b. supported by ligaments and muscles

i. Plantar Calcaneonavicular Ligament - 'Spring' ligament, most important ligament, keeps head of talus high off ground.

ii. Tibialis Posterior and Tibialis Anterior - insert to medial side of foot and support arch.

Note: 'Flat' Feet - weakening of Medal Longitudinal arch - associated with stretching of Plantar Calcaneonavicular ligament.

2. Lateral Longitudinal arch - smaller

a. formed by - calcaneus, cuboid and lateral two metatarsals; cuboid is highest point of arch.

b. supported by

i. Long Plantar Ligament and Plantar Aponeurosis

ii. Peroneal tendons

3. Transverse arch

a. formed by cuneiform and cuboid bones and metatarsals

b. supported by Interosseus muscles and Peroneus longus tendon (courses across sole of foot).

B. Support of body weight - primarily by muscles that attach to tendo calcaneus (gastrocnemius and soleus); pull up on calcaneus and prevent body from falling forward (anteriorly); also, muscles with long tendons to toes (ex. Flexor digitorum longus) use bones of foot and malleoli as pulleys.

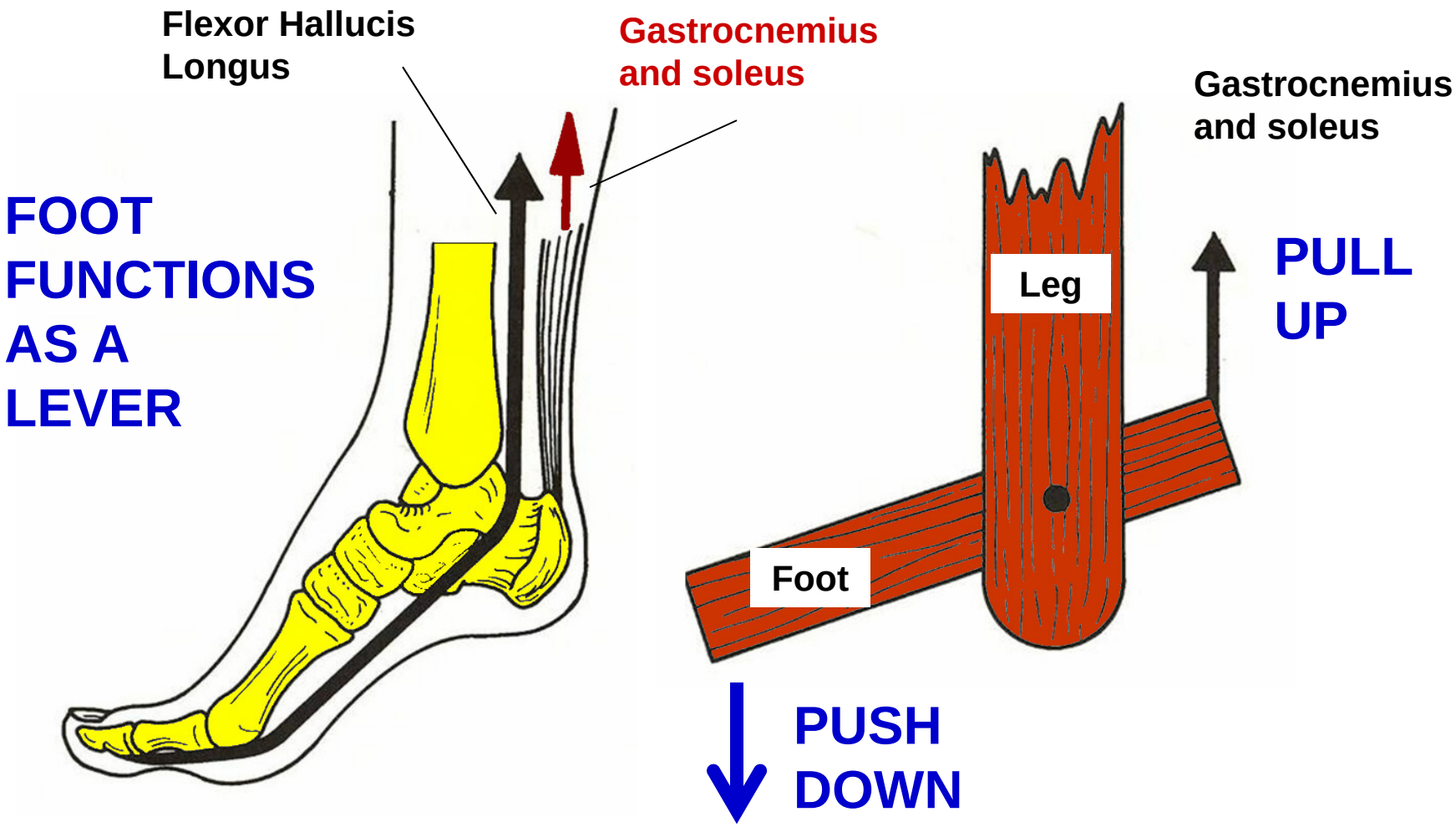
SOLE OF FOOT

I. DESIGN OF FOOT –
specialized to support and propel body
II. SKIN AND FASCIA
III. MUSCLES OF FOOT
IV. ARTERIES AND NERVES OF SOLE OF FOOT
V. ARCHES OF FOOT AND SUPPORT OF BODY WEIGHT
- smart prosthetics: match prosthesis to size, weight

Sarah Reinertsen - first female above knee leg amputee to complete the Ironman World Championship in Hawaii, 2005

I. DESIGN OF FOOT

1) foot acts like a lever in generating forces for walking and running



I. DESIGN OF FOOT

2) weight is supported and forces are exerted at specific points on sole of foot

base of big toe (most at first metatarsal)

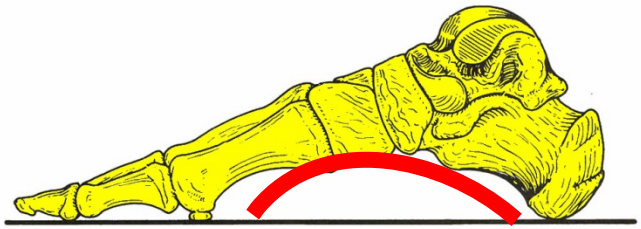
WEIGHT BEARING OF FOOT - weight is not evenly distributed on sole of foot

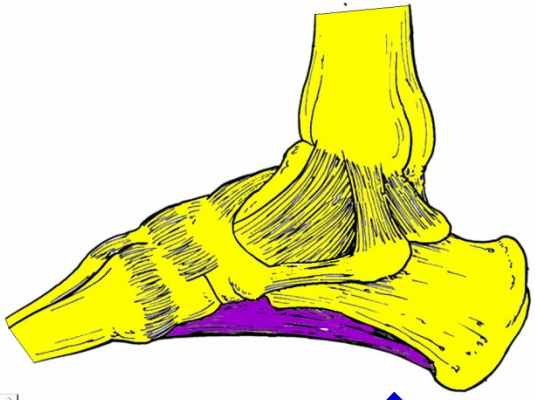
Weight distribution reflects arch of foot

heel - calcaneus

I. DESIGN OF FOOT

3) ligaments and arches of foot function like springs that store energy in walking (important in design of prosthetics).





FOOT NOT FLAT BUT HAS
ARCHES (lateral and medial)

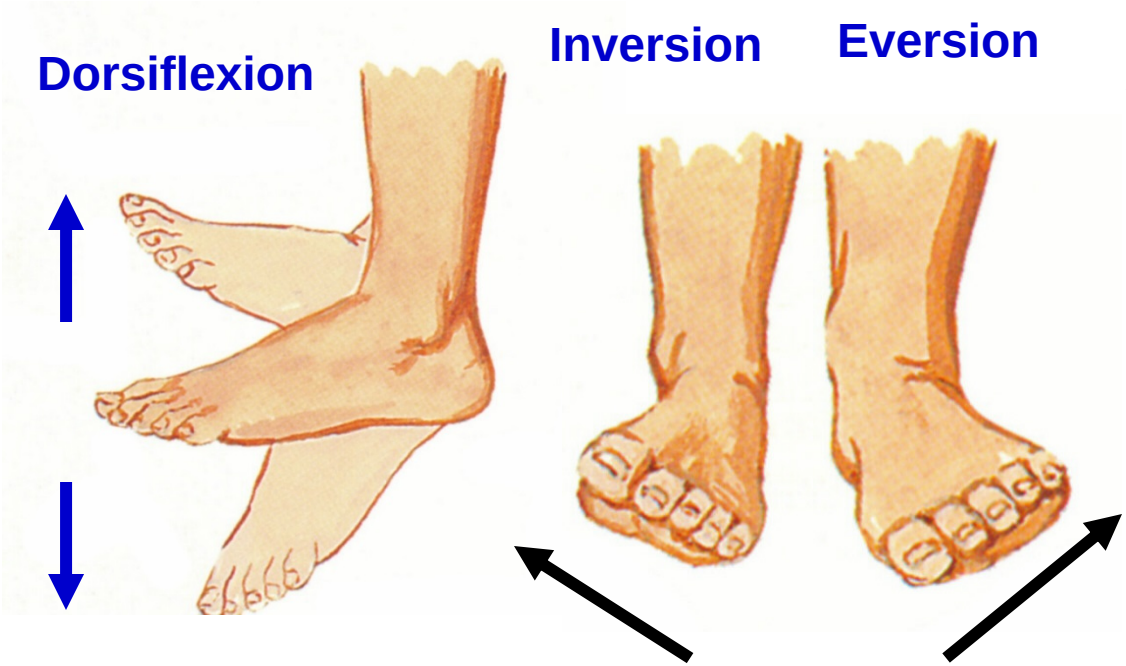
LIGAMENTS OF FOOT ACT LIKE SPRINGS

Biomechanically designed feet and legs

Sarah Reinertsen

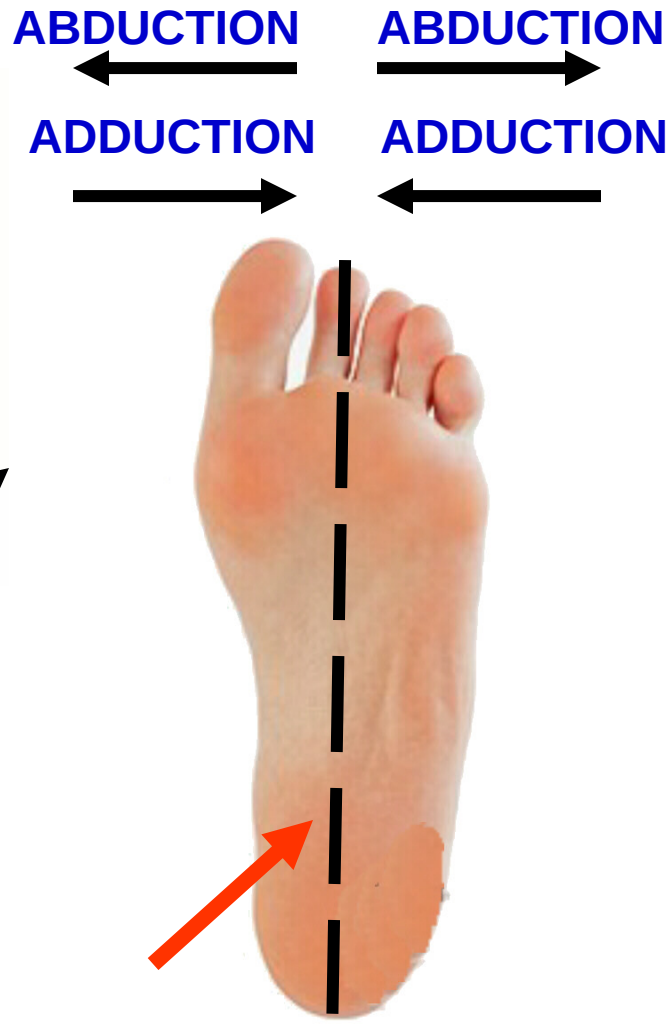
Clinical correlate: Problems
Pes Planus ('Flat feet')

MOVEMENTS OF FOOT



Note: Abduction/Adduction is movement <u>relative to second toe</u>; movements of second toe away from its own midline are Abduction

ABDUCTION/ADDUCTION MOVEMENTS OF TOES

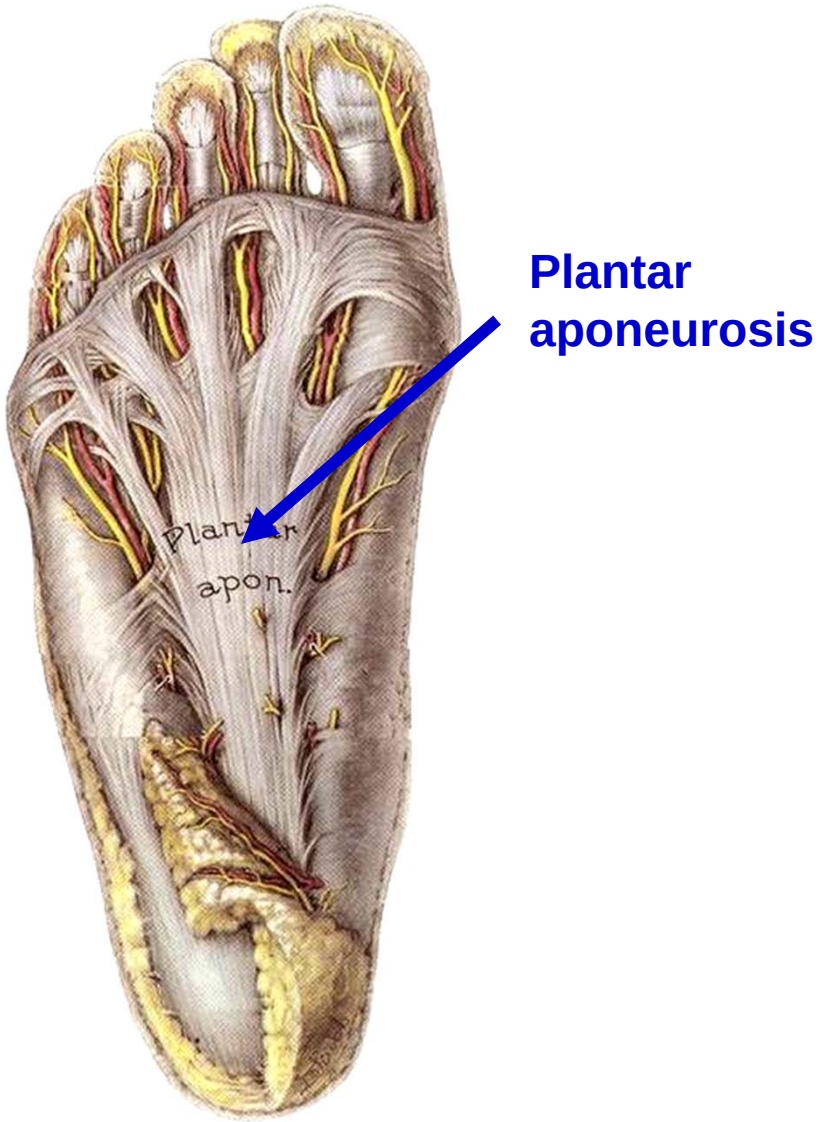


<u>AXIS IS LINE THROUGH SECOND TOE</u>

II. SKIN AND FASCIA

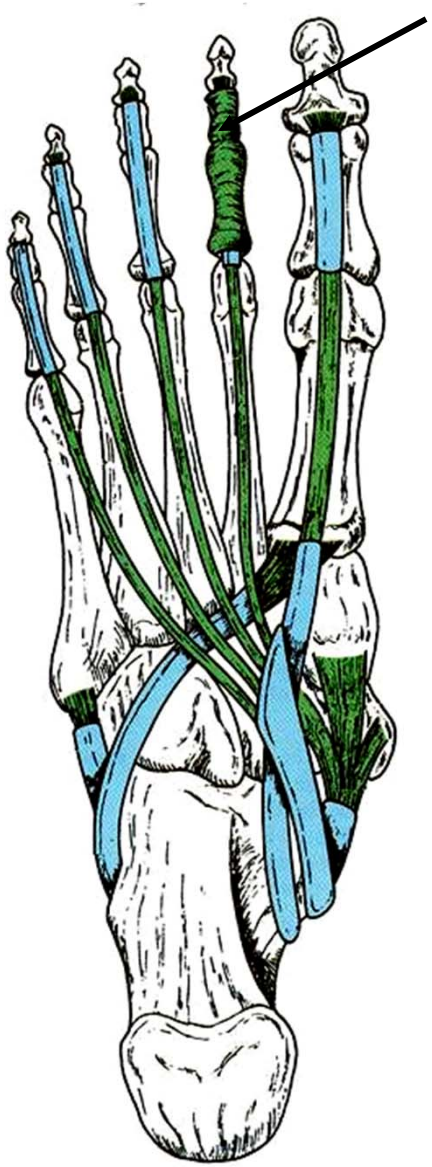
A. **Skin** - **specialized for standing and walking on foot;** very thick and hairless on sole of foot, tightly bound to fascia

B. **Plantar aponeurosis** - **tough band of deep fascia on sole of foot; extends from calcaneus**; distally divides into connective tissue **bands for all five toes**; **protects underlying structures and helps support Lateral arch (Lateral longitudinal arch)** of foot.



II. SKIN AND FASCIA

C. **Fibrous digital sheaths**
- thickened **fascial bands attached to side of phalanges**; form tunnels for passage of long tendons to toes (ex., flexor digitorum longus) and **prevents bowstringing (tendons popping out when muscles contract).**



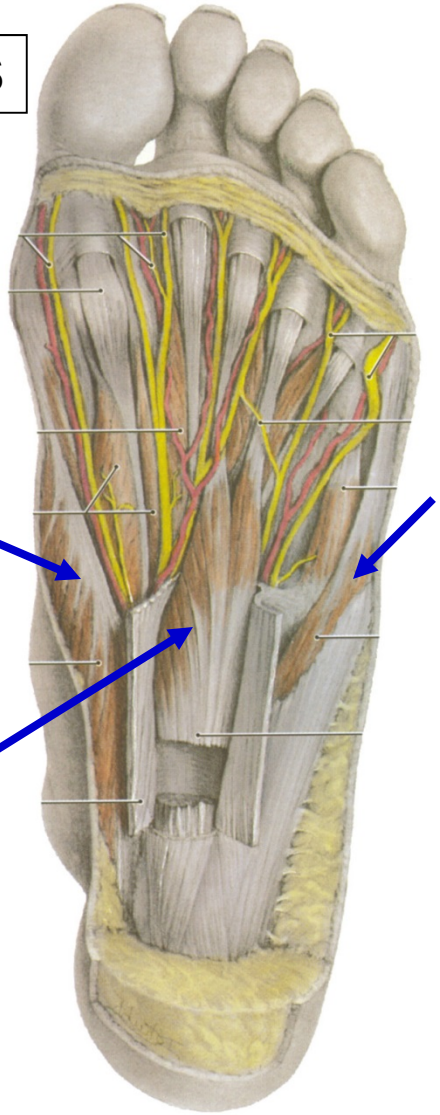
Fibrous digital sheaths - like retinacula for toes

FOUND ON FLEXOR (PLANTAR) SIDE OF TOES

MUSCLES OF FOOT - ARRANGED IN FOUR LAYERS

Layer 1 - Flexor Digitorum Brevis, Abductor Hallucis, Abductor Digiti Minimi - all take origin from Calcaneus; ACT FLEX TOES, ABDUCTORS ABDUCT

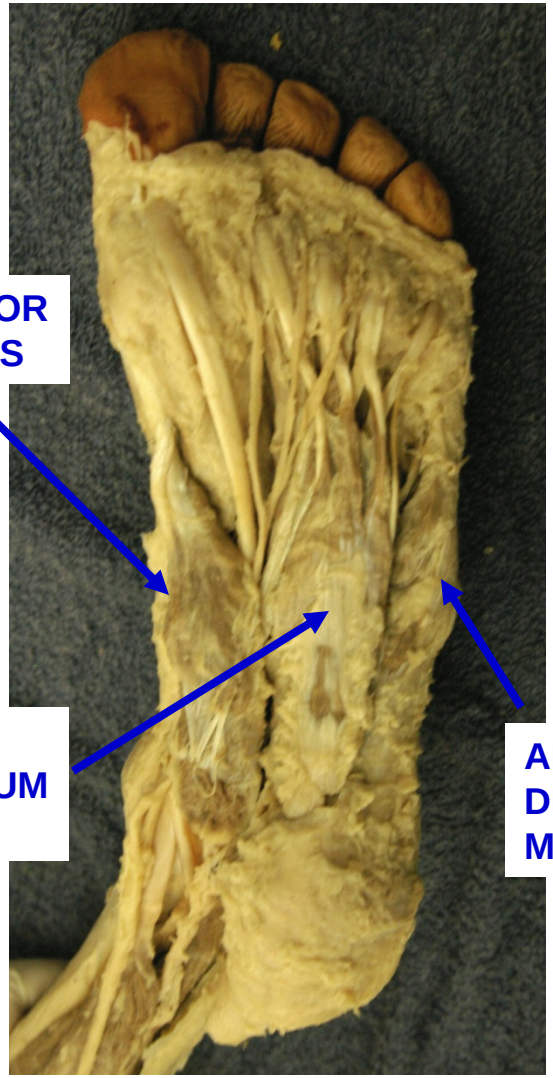
3 MUSCLES



ABDUCTOR HALLUCIS - I - proximal phalanx big toe

FLEXOR DIGITORUM BREVIS - i - middle phalanges lateral four toes

ABDUCTOR DIGITI MINIMI - i - proximal phalanx little toe



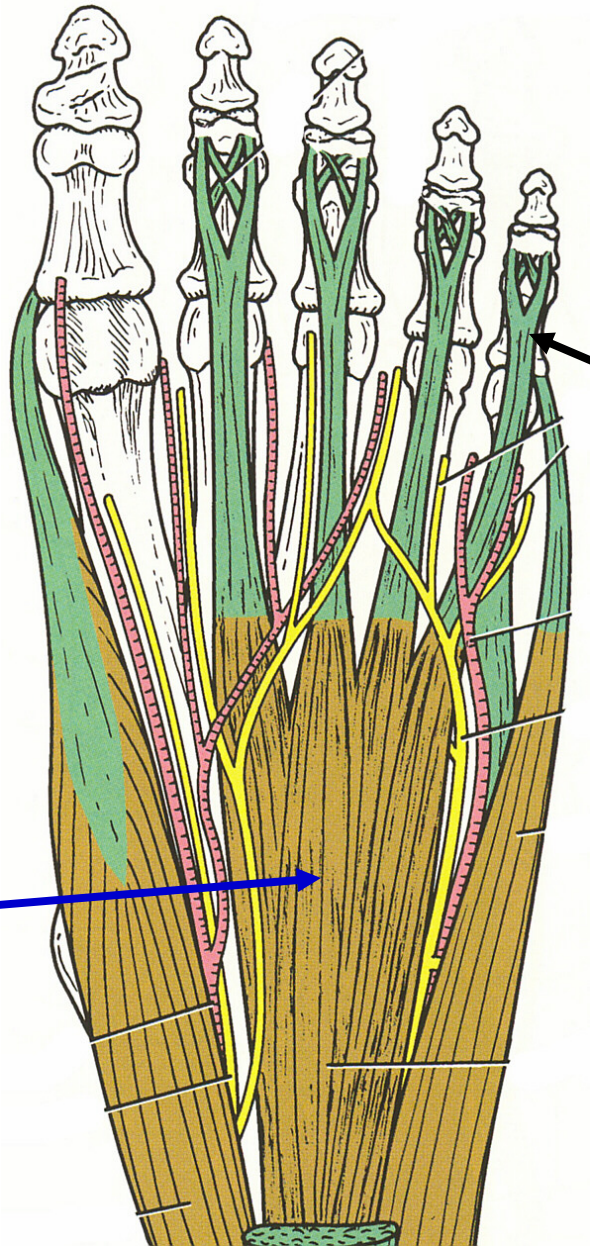
ABDUCTOR HALLUCIS

FLEXOR DIGITORUM BREVIS

ABDUCTOR DIGITI MINIMI

MUSCLES OF FOOT - Layer 1

Note: **Flexor Digitorum Brevis** tendons end on **middle phalanges**; **tendons split to allow passage of Flexor Digitorum Longus to distal phalanges**



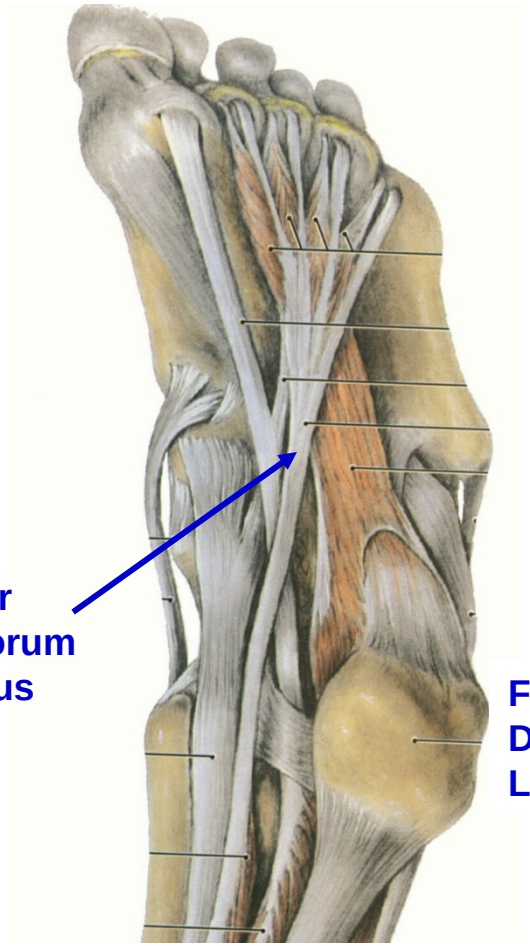
FLEXOR DIGITORUM BREVIS

TENDONS INSERT TO MIDDLE PHALANGES - SPLIT TO ALLOW PASSAGE OF FLEXOR DIGITORUM LONGUS

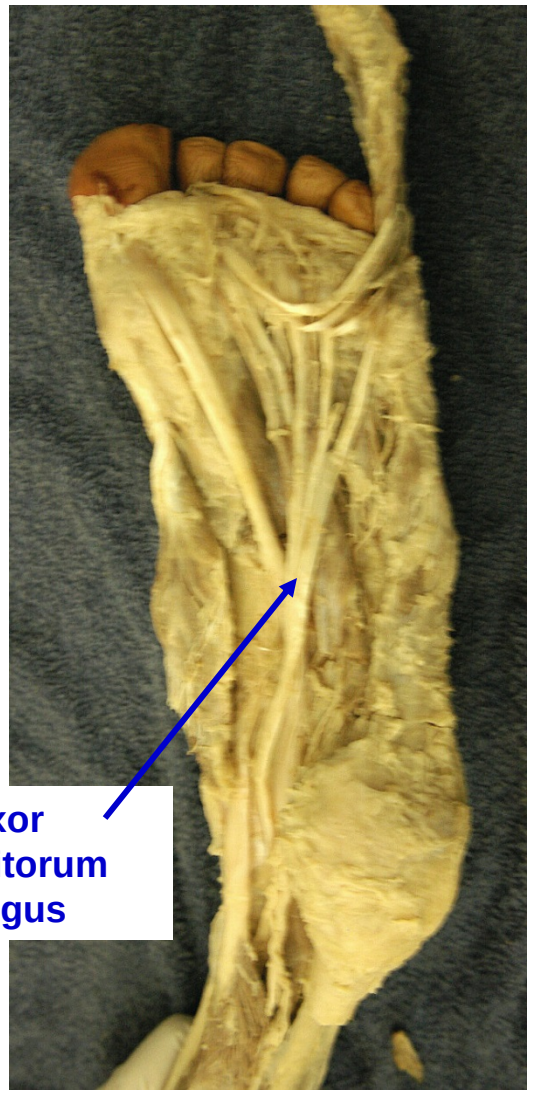
MUSCLES OF FOOT - Layer 2

1. **tendon of Flexor Digitorum Longus** = **DICK of TOM, DICK and Harry**;
O - Tibia
tendon passes deep to Abductor Hallucis; branches to 4 tendons that end in **distal phalanges of toes**; have **Lumbricals attached**.

Tendons pass to toes between split Flexor Digitorum Brevis tendons



Flexor Digitorum Brevis reflected



Layer 2 - 2 MUSCLES IN FOOT + TENDONS OF DICK AND HARRY

MUSCLES OF FOOT - Layer 2

2. **Lumbricals - attach to tendons of Flexor Digitorum Longus** and extend to 1) **proximal phalanges of toes** and 2) **extensor expansions**.

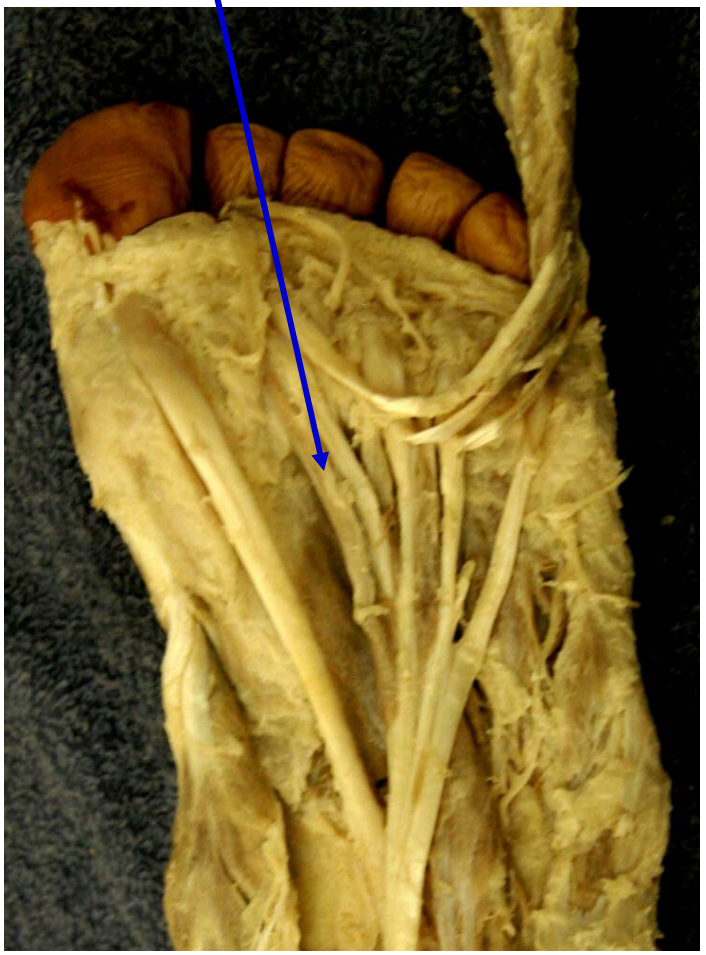
Lumbricals act to flex metatarsophalangeal joints and extend interphalangeal joints.

EXTENSORS

extend

flex

LUMBRICALS

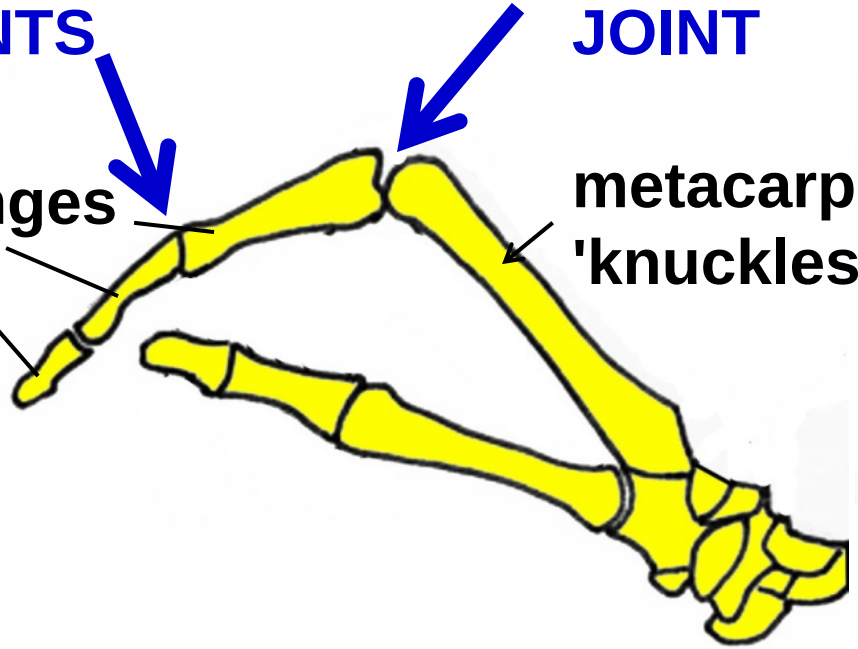


LUMBRICAL = worm-like

LUMBRICALS ALSO FOUND IN HAND: HAVE SAME ACTION

EXTEND INTER-PHALANGEAL JOINTS

FLEX METACARPO-PHALANGEAL JOINT



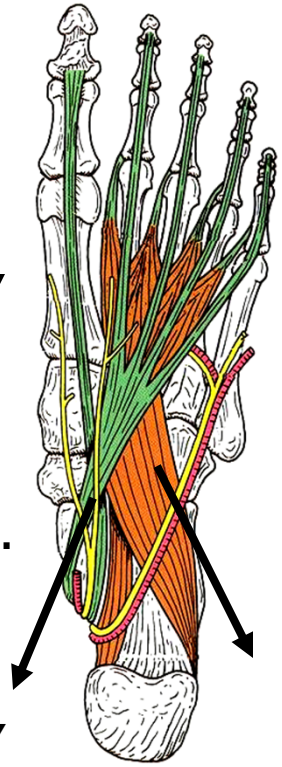
LUMBRICALS USED IN FINE MOVEMENTS

HOLD PEN IN HAND BY FLEXING METACARPO-PHALANGEAL JOINT AND EXTENDING INTERPHALANGEAL JOINTS

MUSCLES OF FOOT - Layer 2

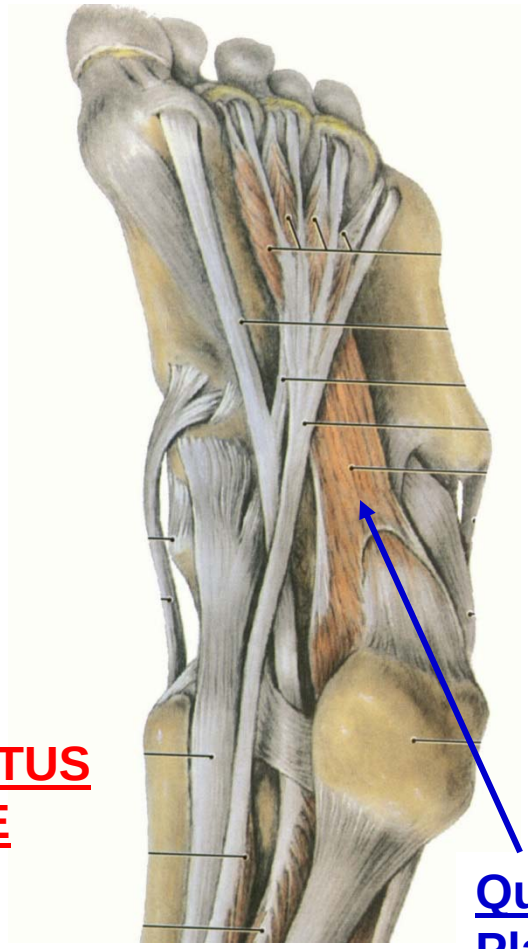
3. Quadratus Plantae - attaches from **calcaneus to Flexor Digitorum Longus.**

FLEX TOES



FLEX. DIG. LONGUS PULL TENDON MEDIALLY

QUADRATUS PLANTAE PULL TENDON LATERALLY

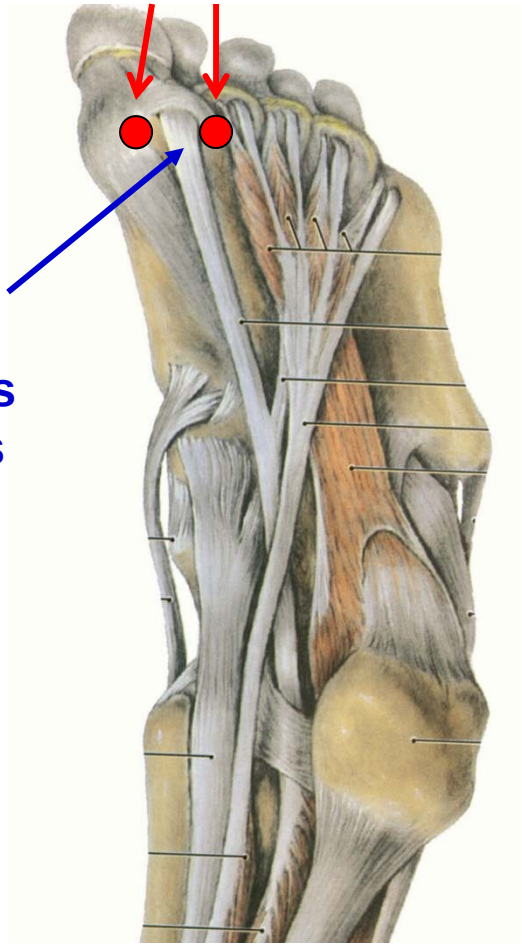


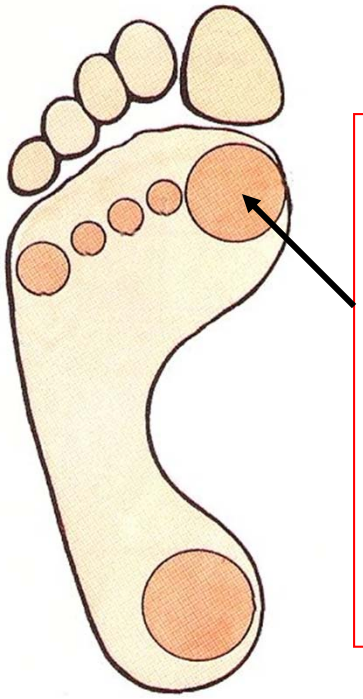
Quadratus Plantae

Note: Quadratus Plantae is biomechanically elegant - If only Flexor Digitorum longus contracted, it would pull toes toward medial side; instead, Quadratus Plantae pulls on Flexor tendon to redirect flexor pull toward calcaneus, i.e. direct flexion of toes.

MUSCLES OF FOOT - Layer 2

4. tendon of **Flexor Hallucis Longus** - (= HARRY) - Tendon passes to **distal phalanx** of big toe; tendon passes **between two sesamoid bones under the head of the first metatarsal**; this prevents weight of body from resting on tendon; weight presses on sesamoids, allowing movement of flexor tendon.



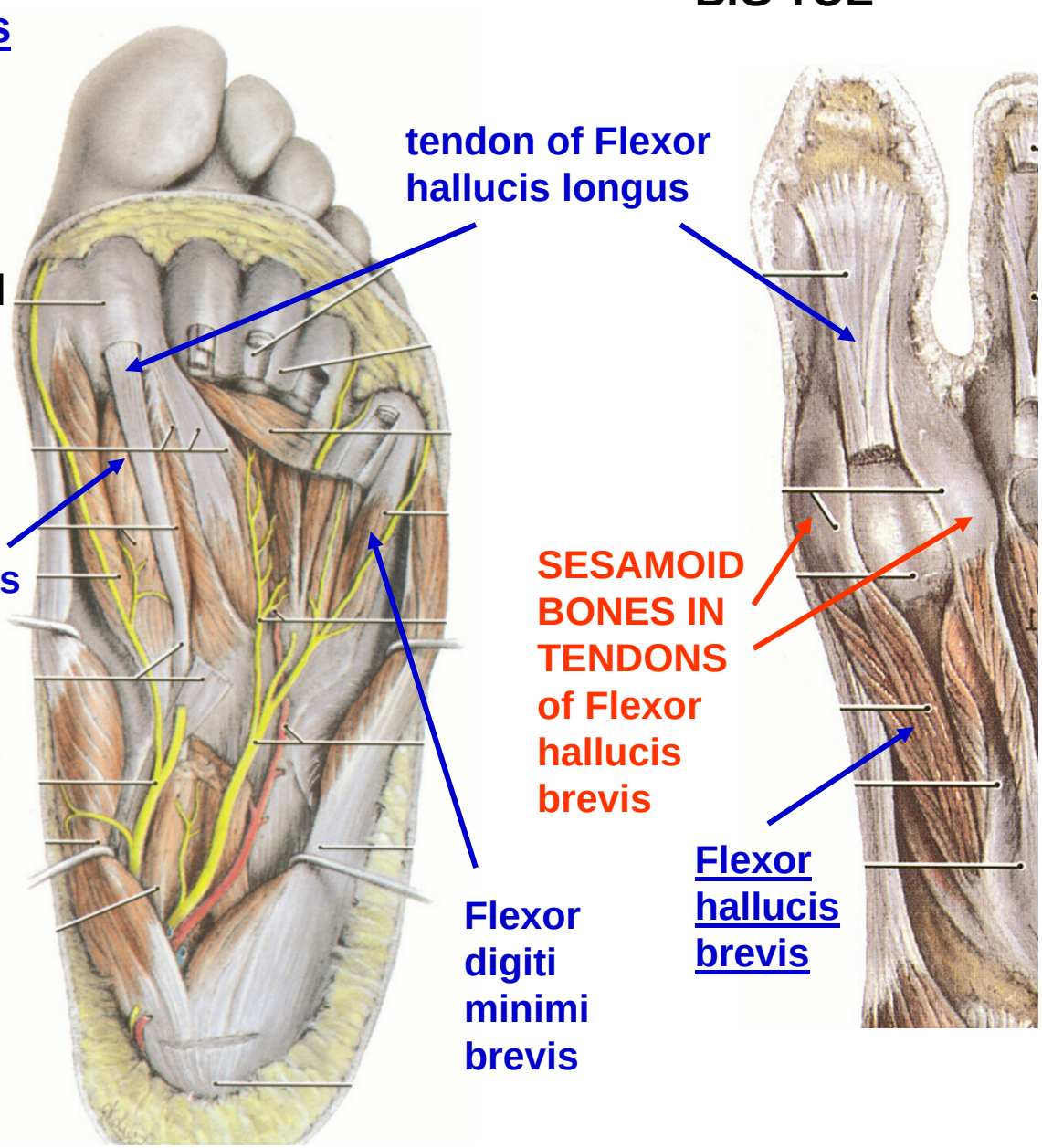


PROBLEM - LARGE PART OF BODY WEIGHT RESTS ON FIRST METATARSAL; FLEXOR HALLUCIS LONGUS TENDON PASSES BELOW FIRST METATARSAL

MUSCLES OF FOOT - Layer 3 - 3 MUSCLES

1. **Flexor hallucis brevis** - has two tendons that insert **to proximal phalanx**; **sesamoid bones** present in each tendon; insert to proximal phalanx big toe
3. **Flexor digiti minimi brevis** - small muscle to **proximal phalanx** little toe.

Weight presses on sesamoids, allowing movement of Flexor hallucis longus tendon

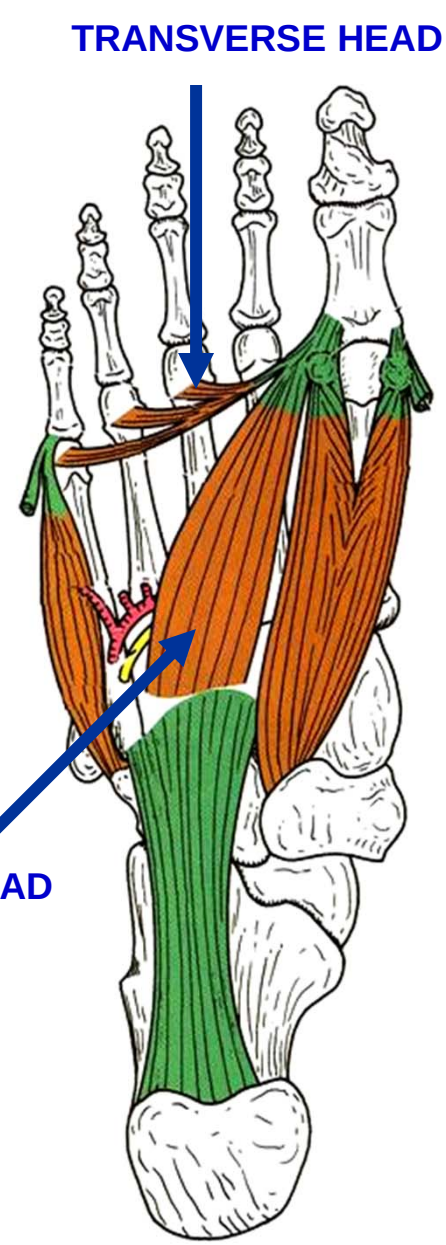


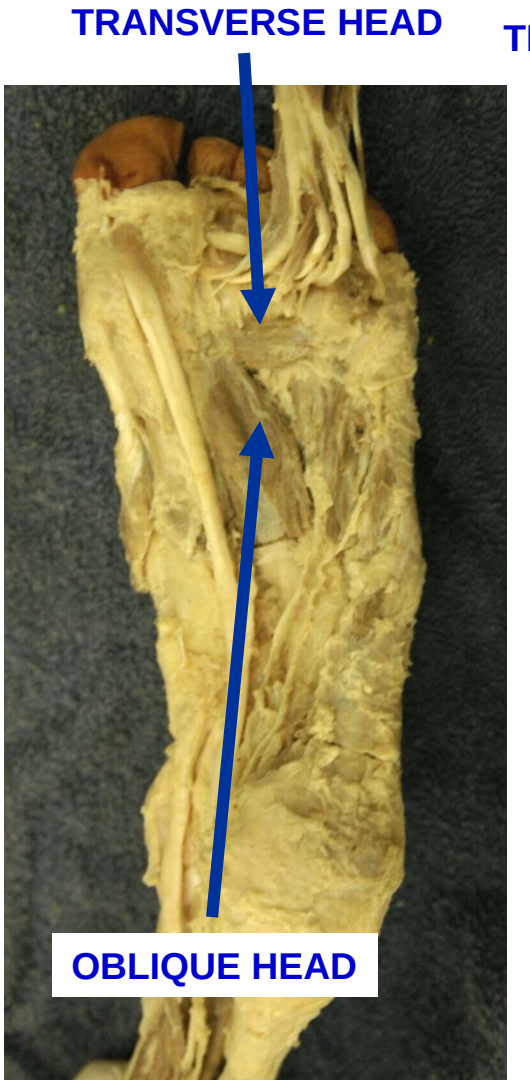

SESAMOID
BONES IN
TENDONS
of Flexor Hallucis
Brevis muscle
SUPPORT BODY
WEIGHT

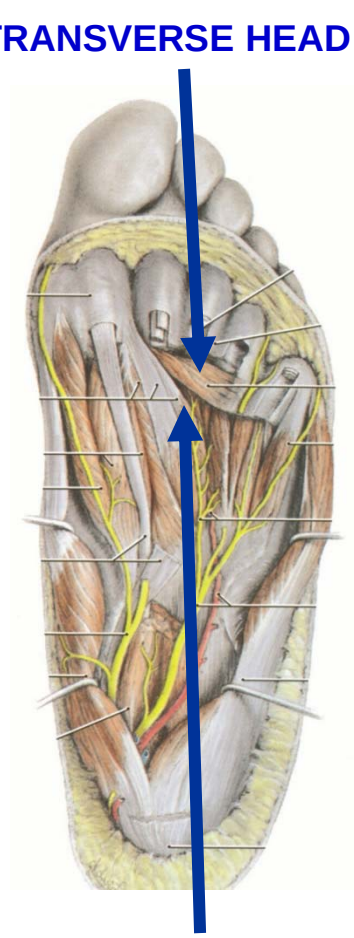
MUSCLES OF FOOT - Layer 3

C. Layer 3

2. **Adductor hallucis** - two heads of origin (**OBLIQUE and TRANSVERSE**) and one common tendon.
I - proximal phalanx big toe







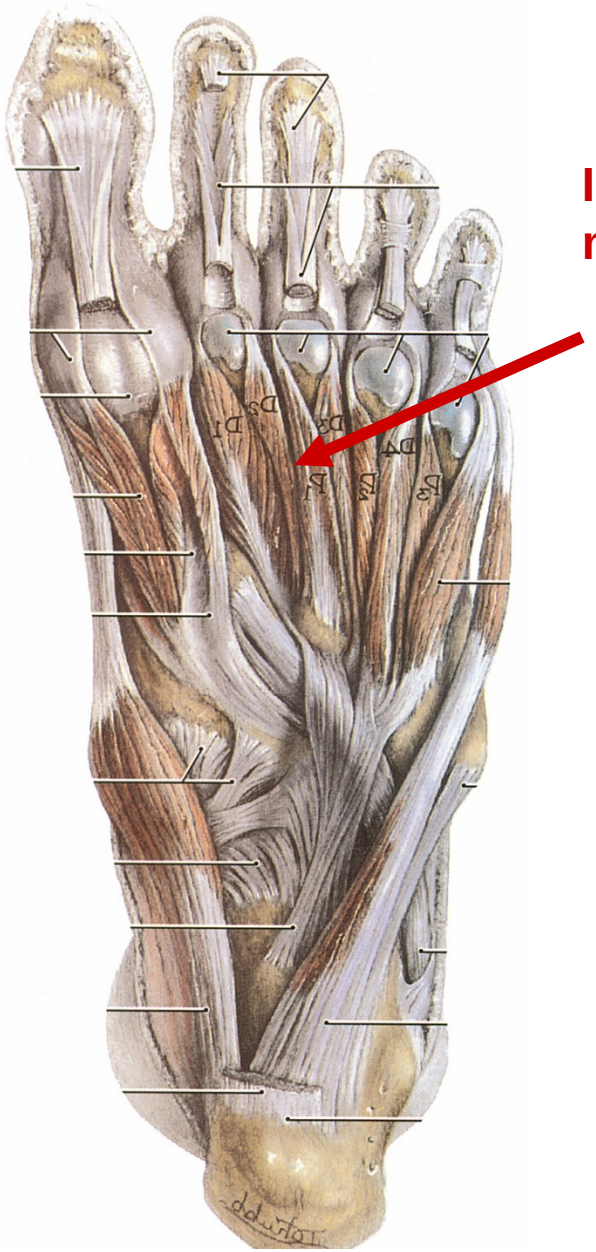
TWO HEADS OF ADDUCTOR

MUSCLES OF FOOT - Layer 4

D. Layer 4 - Interosseus muscles (between metatarsal bones) and tendons of long muscles.

1. Dorsal interossei - DAB
2. Plantar interossei - PAD

Interossei also hold metatarsal bones together in bearing weight.

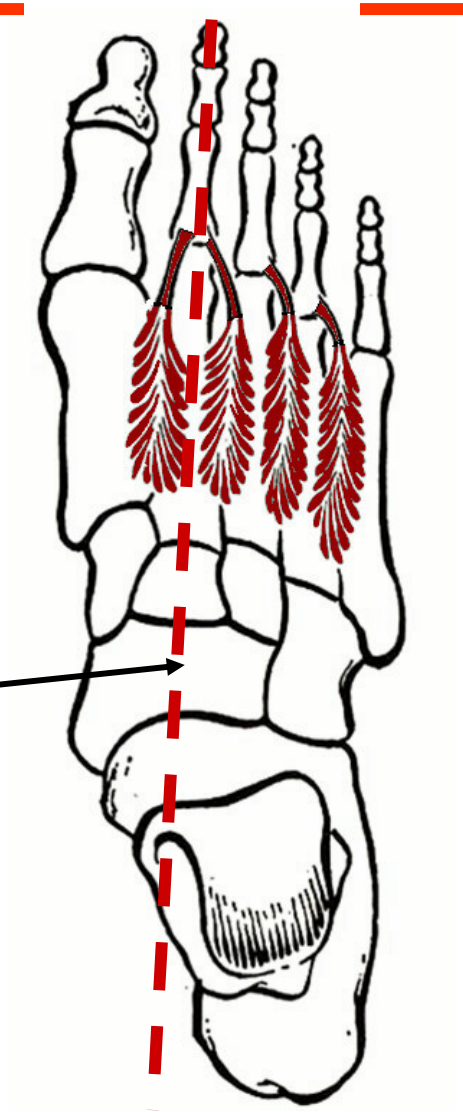


Interosseus muscles

MUSCLES OF FOOT - Layer 4 - DORSAL INTEROSSEUS MUSCLES

ABDUCTION ABDUCTION

1. **Dorsal interossei** - 4 muscles - **DAB - (dorsal abduct)**



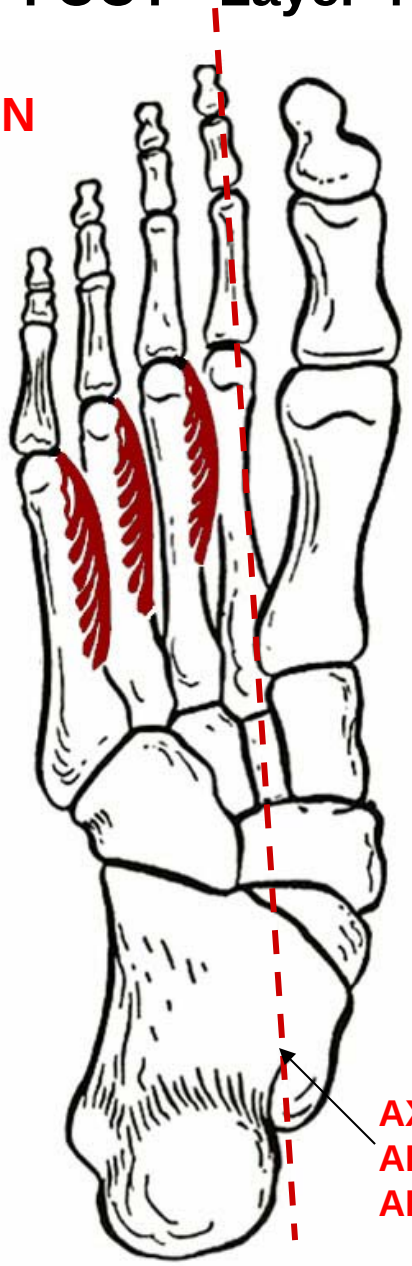
Note: Axis of abduction/ adduction in FOOT is <u>SECOND TOE</u>.

Movements of second toe away from its own midline are Abduction

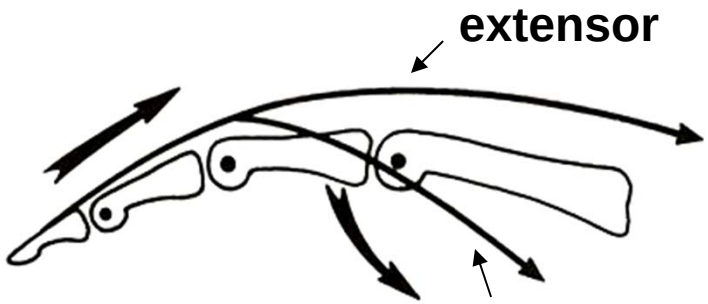
MUSCLES OF FOOT - Layer 4 - PLANTAR INTEROSSEUS

ADDUCTION

2. Plantar interossei - 3 muscles,
toes 3-5 -
PAD - (plantar adduct)



Note: interossei also insert to Extensor Expansions; flex metatarsophalanageal joints and (extend interphalangeal joints)



ACTION OF INTEROSSEUS MUSCLES AND LUMBRICALS

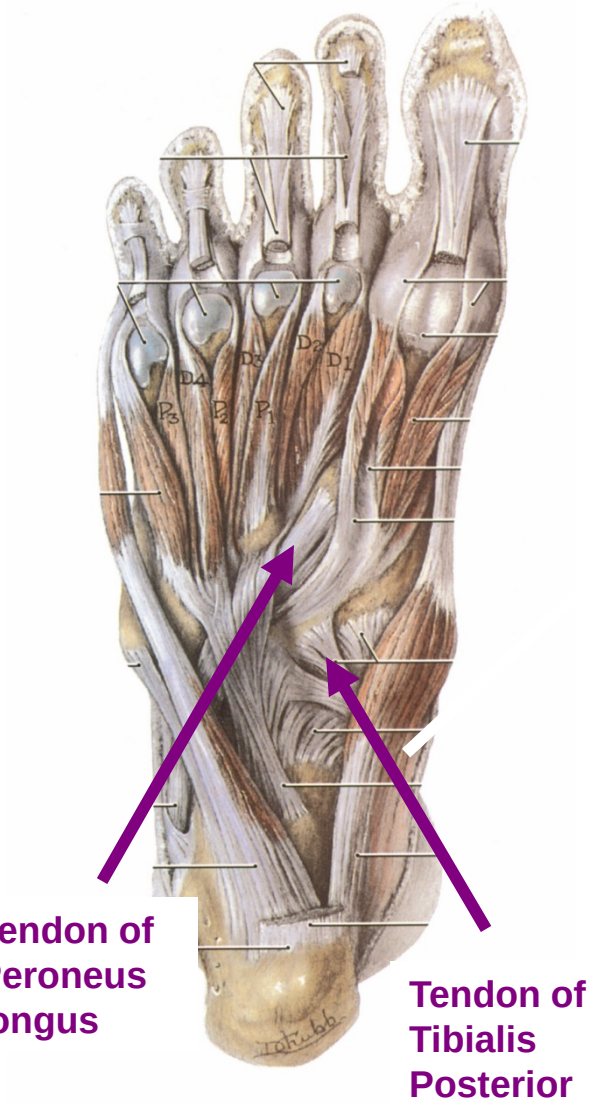
MUSCLES OF FOOT - Layer 4 - DEEP TENDONS

D. Layer 4 -

3. **Tendon of Peroneus longus** - crosses from lateral to medial to insert on **first metatarsal and medial cuneiform bones**.

4. **Tendon of Tibialis posterior** - inserts to **navicular and sends slips to cuneiforms, cuboid, metatarsals 2-4**

Note: Tibialis anterior is the antagonist of Peroneus longus - both insert to first metatarsal and medial cuneiform

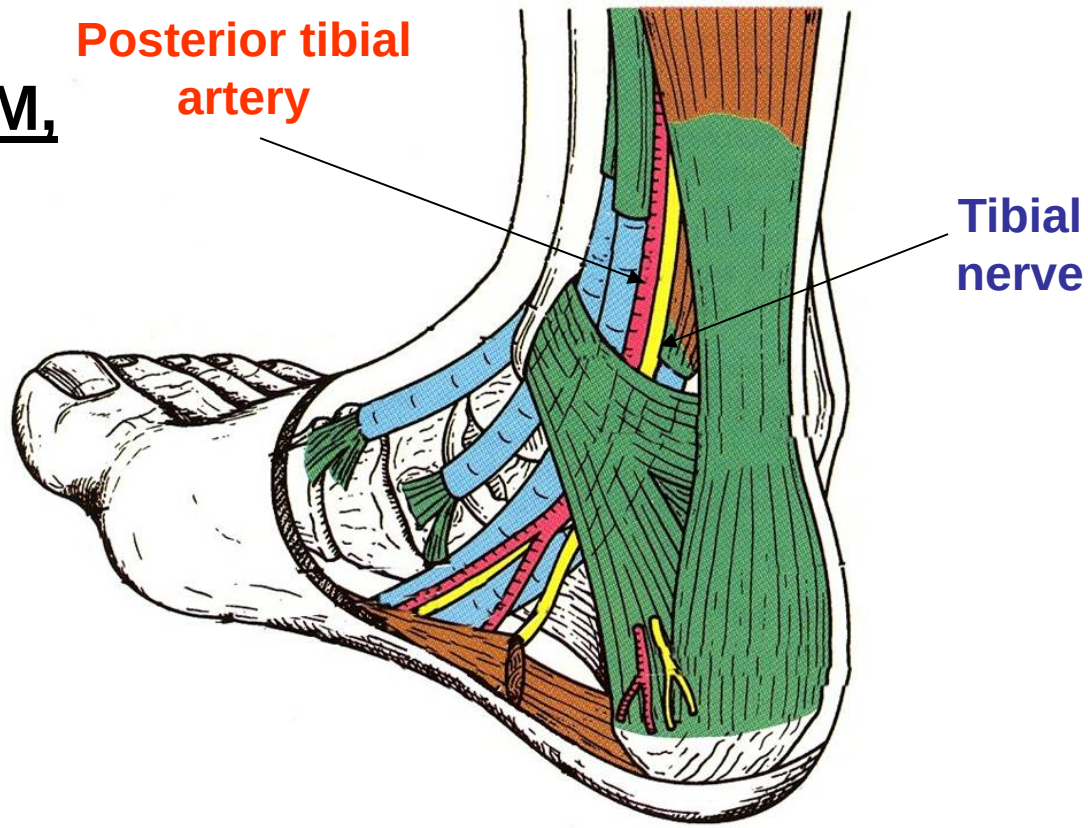


IV. NERVES AND ARTERIES OF SOLE OF FOOT

FROM 'AND' OF TOM, DICK AND HARRY

A - Posterior Tibial Artery

N - Tibial Nerve

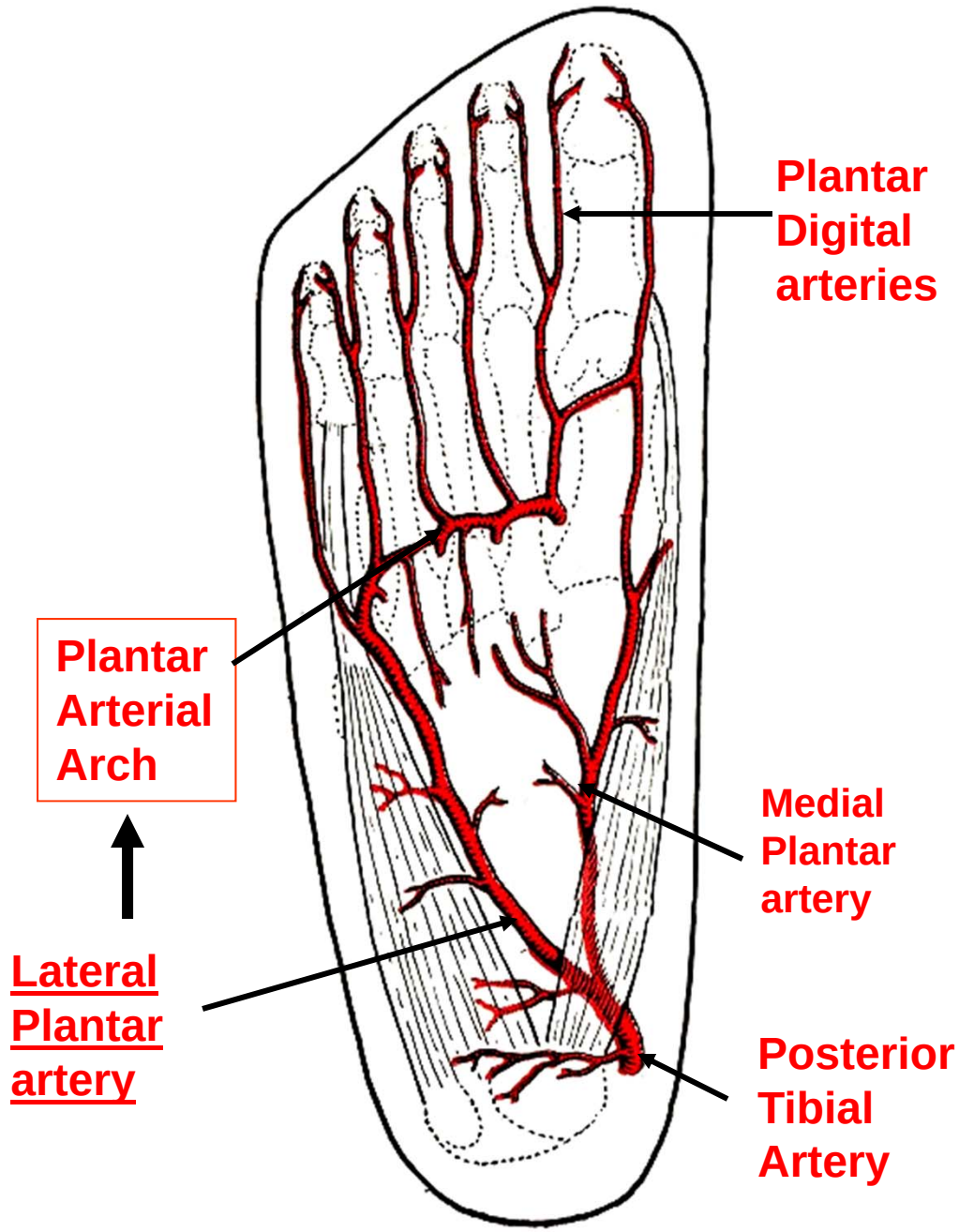


ARTERIES OF SOLE OF FOOT

Posterior Tibial Artery divides:

1. **Lateral Plantar artery** - gives rise to **Plantar Arterial arch**, located deep in foot; **Plantar Arterial Arch** gives rise to arteries sides of toes (**Plantar Digital arteries**)

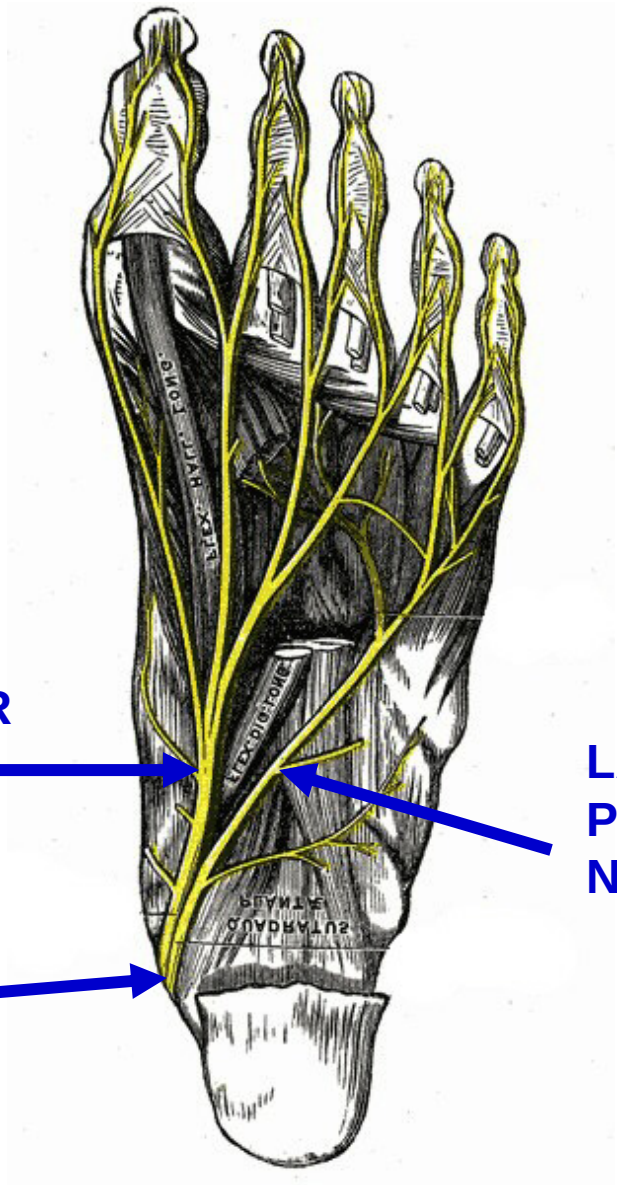
2. **Medial Plantar artery** - smaller branch **to medial foot**



NERVES OF SOLE OF FOOT

TIBIAL NERVE DIVIDES INTO MEDIAL AND LATERAL PLANTAR NERVES

BOTH NERVES ARE SENSORY AND MOTOR



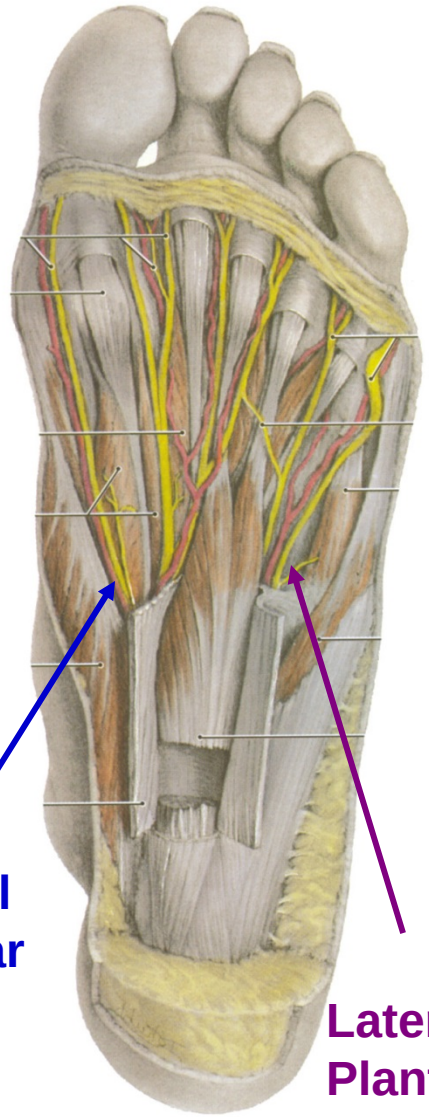
NERVES OF SOLE OF FOOT

SENSORY

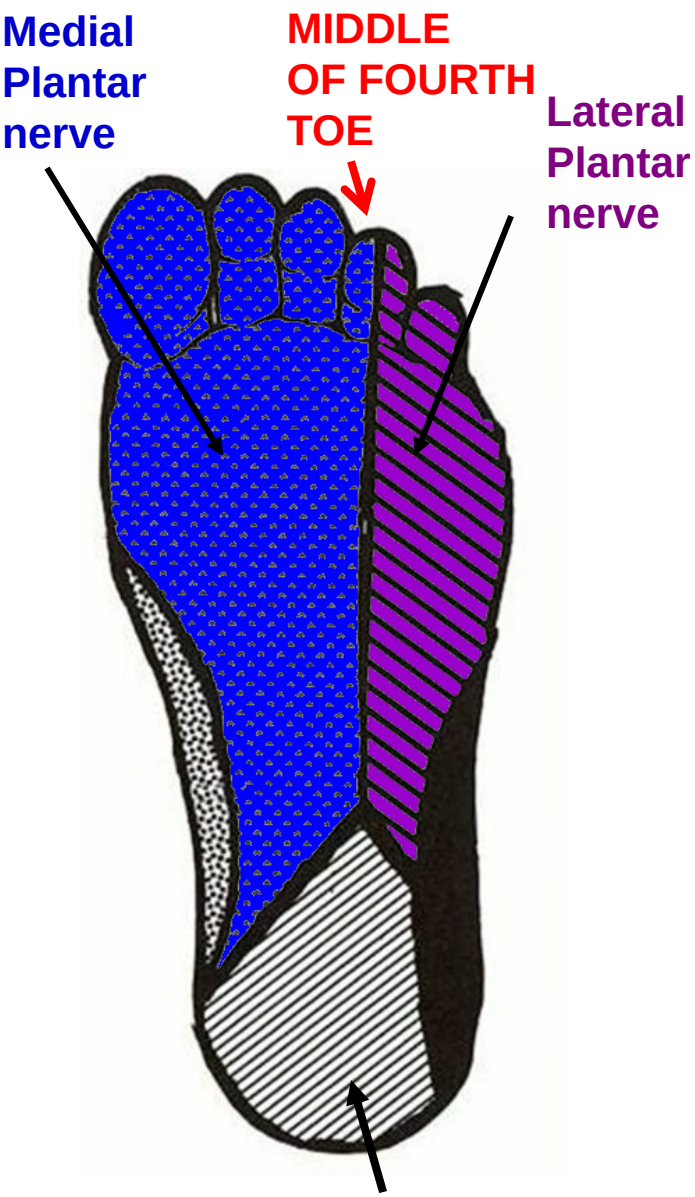
Tibial Nerve - branches:

1. **Medial Plantar nerve** - sensory branches to **medial 3 1/2 digits and medial part of sole**

2. **Lateral Plantar nerve** - sensory branches to **lateral 1 1/2 digits and lateral sole**



sensory innervation of sole of foot



NERVES OF SOLE OF FOOT

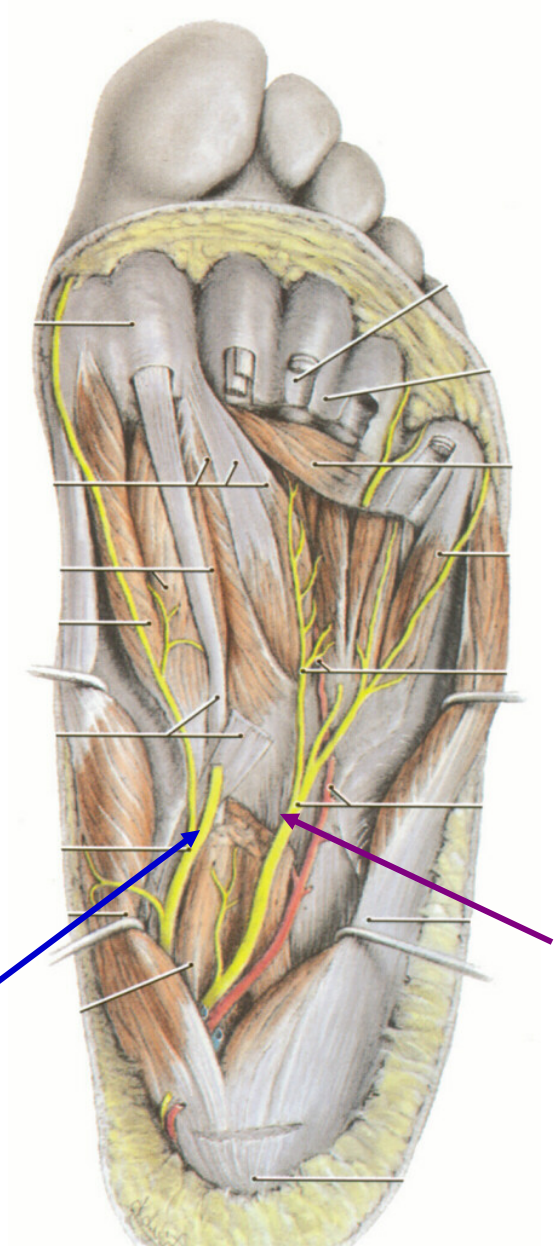
INNERVATION ALL MUSCLES

Tibial Nerve - branches:

1. **Medial Plantar nerve** - motor branches - **4 muscles**

1) 2 muscles of big toe (Flexor hallucis brevis, Abductor hallucis),
2) Flexor Digitorum brevis,
3) First Lumbrical.

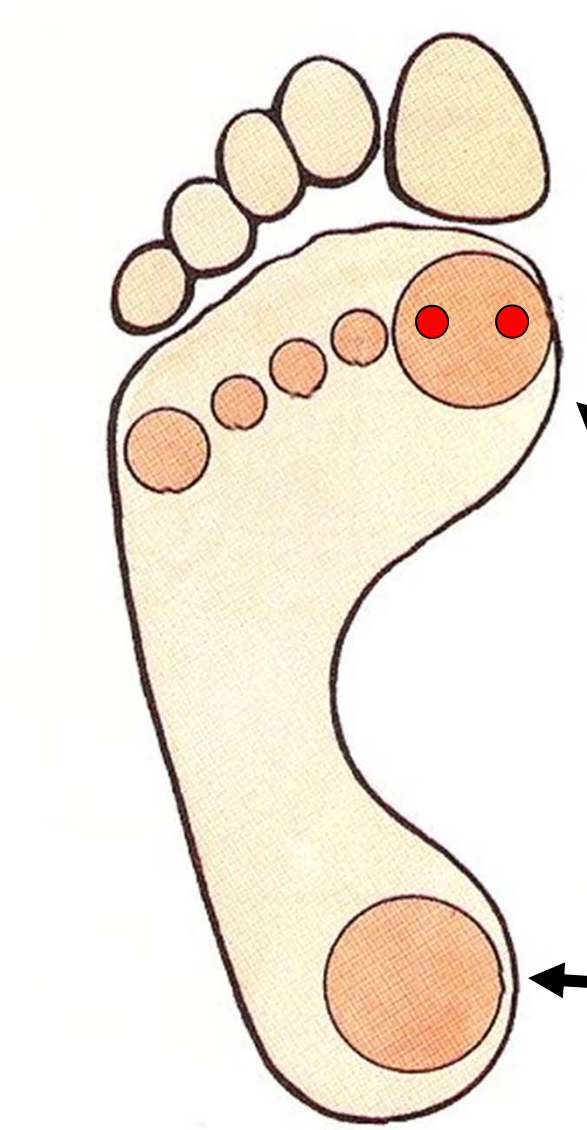
2. **Lateral Plantar nerve** - motor branches to **all remaining intrinsic muscles of sole of foot**



Medial Plantar nerve

Lateral Plantar nerve

V. ARCHES OF FOOT AND SUPPORT OF BODY WEIGHT



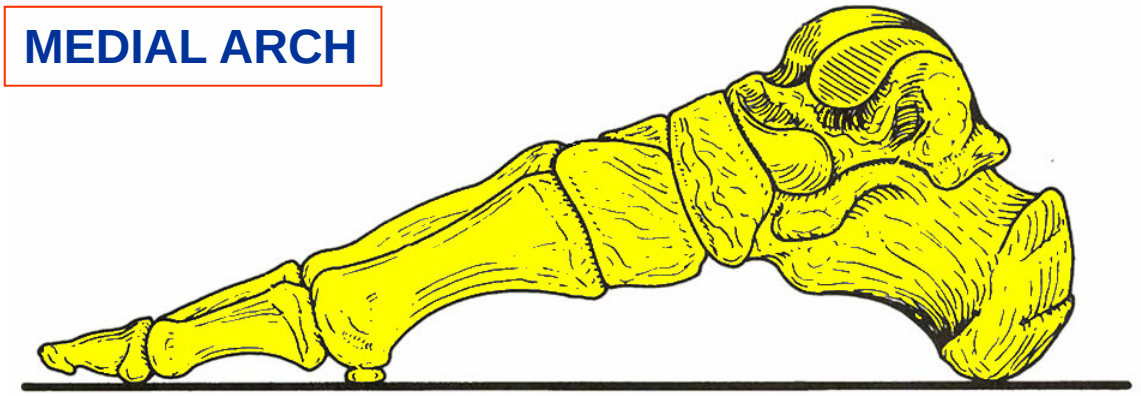
WEIGHT BEARING OF FOOT - weight is not evenly distributed on sole of foot

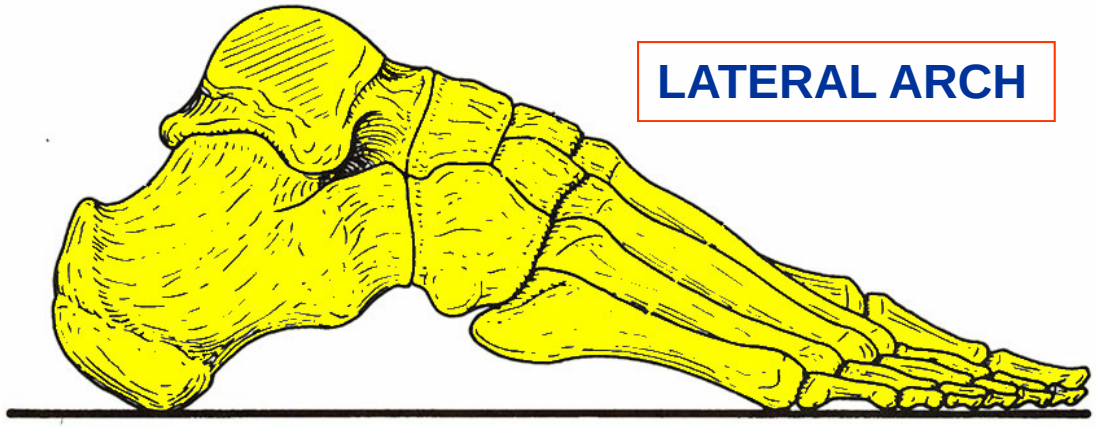
1. Anteriorly: Heads of the metatarsals (2-5) and two sesamoid bones inferior to the head of the first metatarsal forms six points of contact with ground

2. Posteriorly: calcaneus

V. ARCHES OF FOOT AND SUPPORT OF BODY WEIGHT

A. Arches of foot - foot is not flat but has **arches that allow ligaments to act like springs**; foot contacts ground anteriorly at **heads of metatarsals** and **sesamoid bones** under first metatarsal ; posteriorly at **calcaneus**.

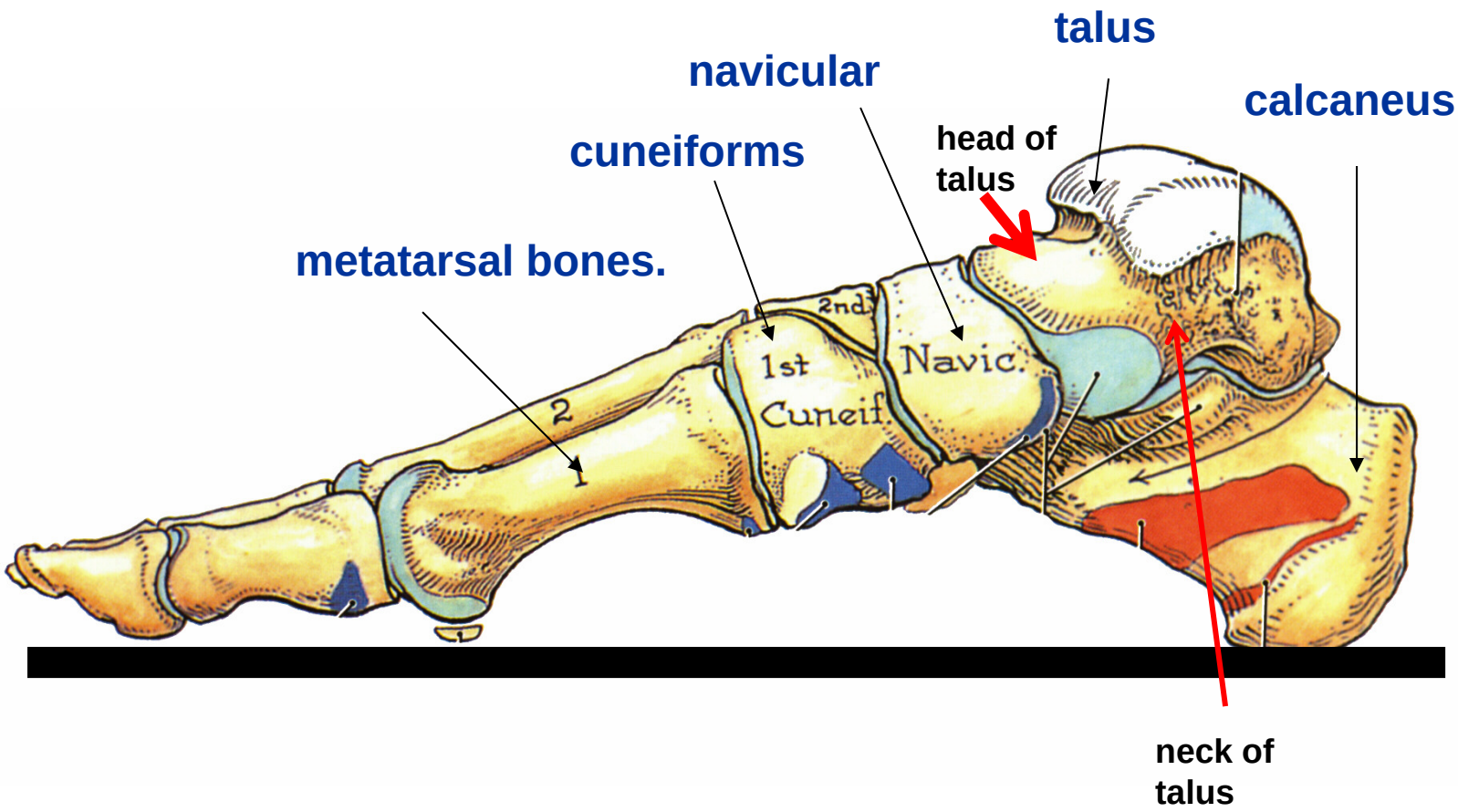




MEDIAL ARCH

1. **Medial Longitudinal arch** - highest arch, responsible for **'fallen arches' = PES PLANUS**

a. formed by - **calcaneus, talus, navicular, cuneiforms and medial three metatarsal bones.**

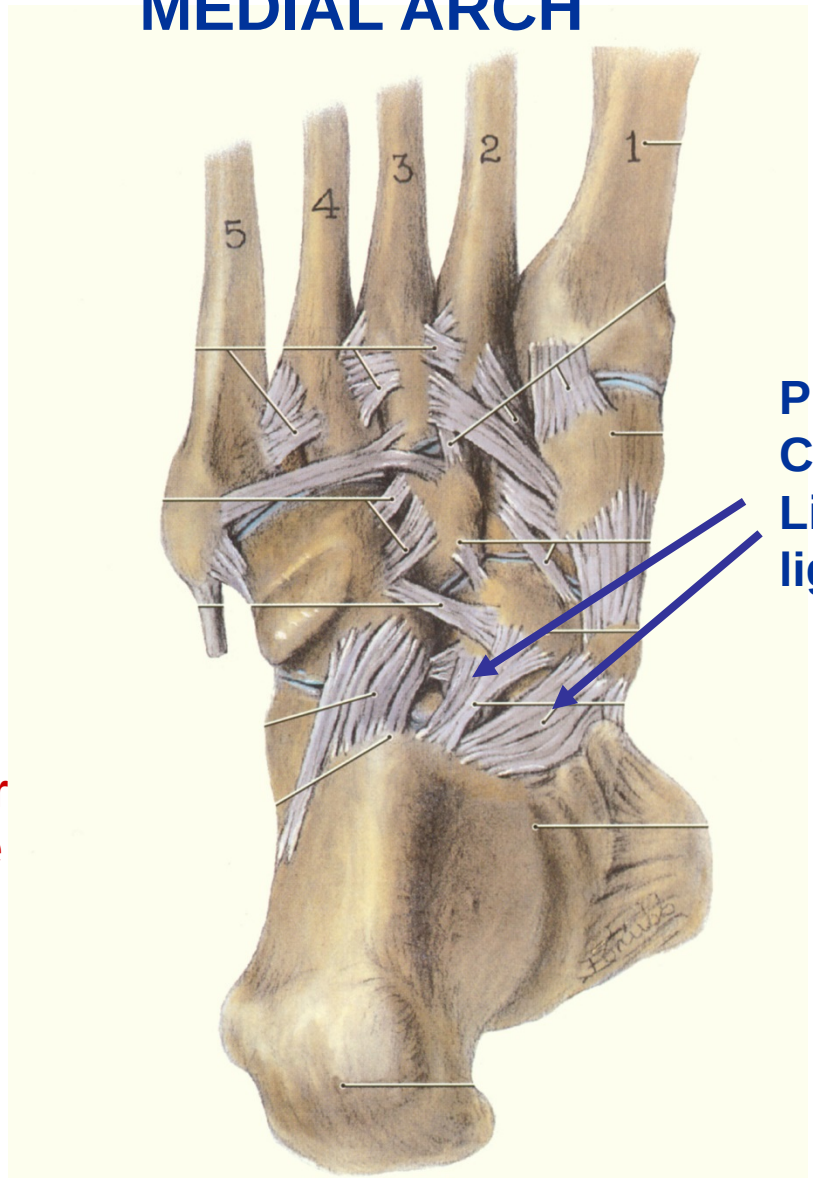


MEDIAL ARCH

b. supported by ligaments and muscles

i. **Plantar Calcaneonavicular Ligament - 'Spring' ligament,** most important ligament, keeps head of talus high off ground.

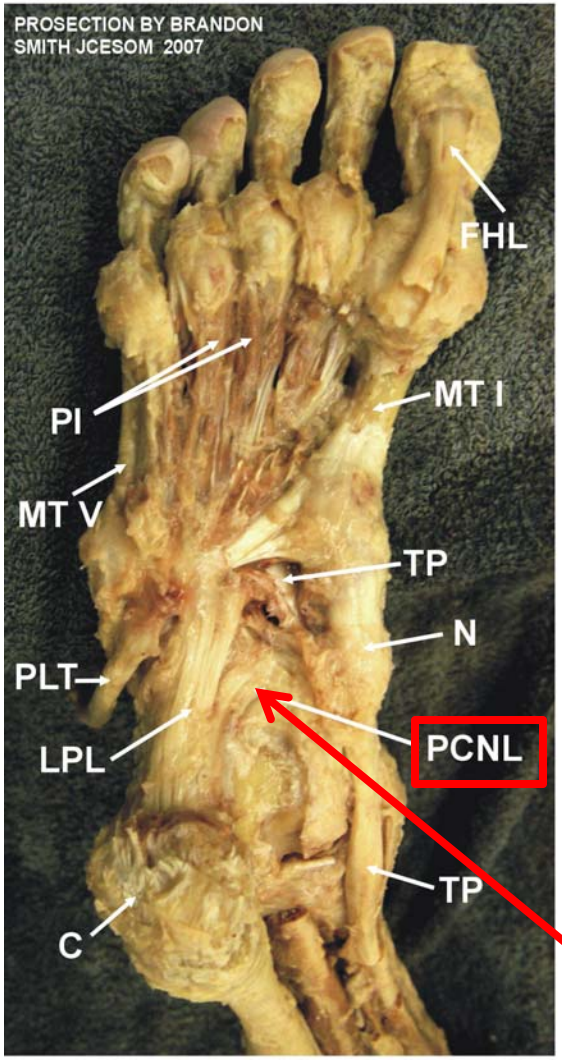
ii. **Tibialis Posterior and Tibialis Anterior** - insert to medial side of foot and support arch.

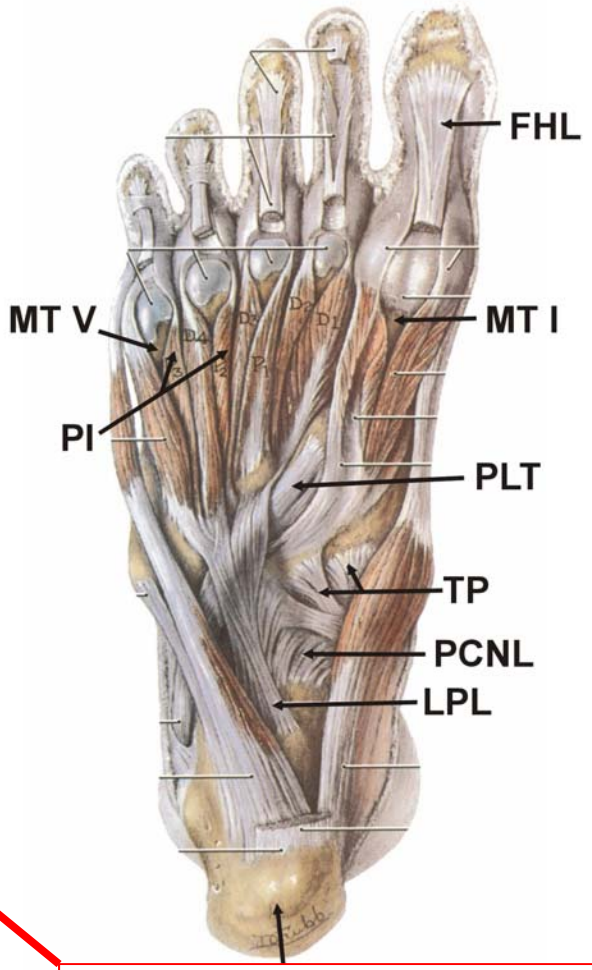


Plantar Calcaneonavicular Ligament - 'Spring' ligament,

Note: **'Flat' Feet - PES PLANUS - weakening of Medial Longitudinal arch** - associated with **stretching of Plantar Calcaneonavicular ligament**.

DEEP FOOT: PERONEUS LONGUS TENDON





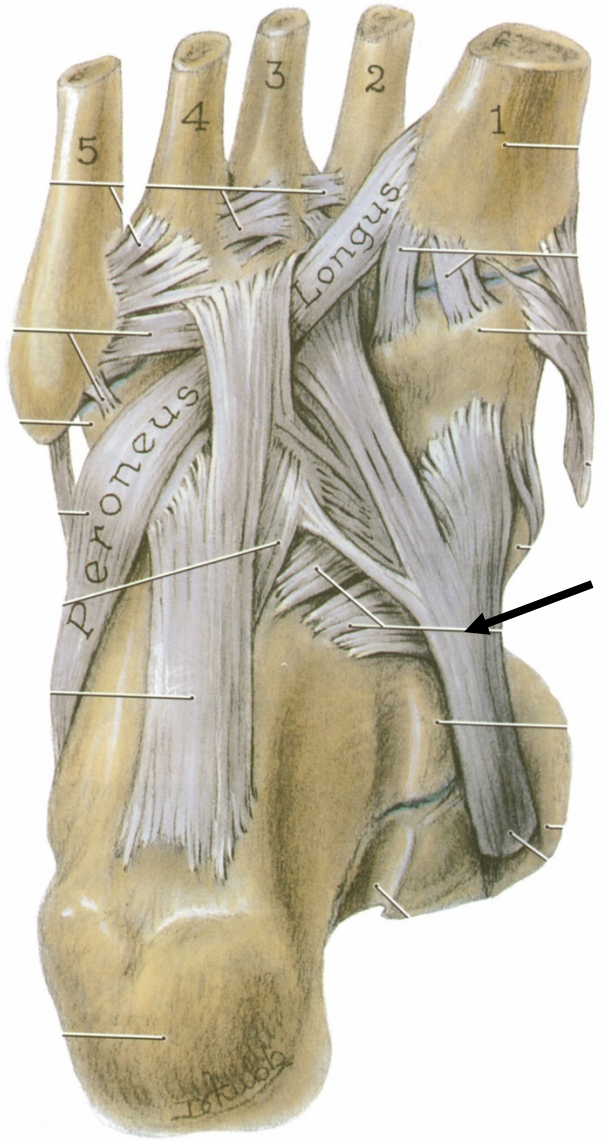
MT I - 1st METATARSAL
MT V - 5th METATARSAL
C - CALCANEUS
FHL - FLEXOR HALLUCIS LONGUS TENDON
LPL - LONG PLANTAR LIGAMENT
N - NAVICULAR BONE
PLT - PERONEUS LONGUS TENDON
PCNL - PLANTAR CALCANEONAVICULAR LIGAMENT
NTPLT - PERONEUS LONGUS TENDON

Plantar Calcaneonavicular Ligament - 'Spring' ligament - FLAT FEET - PES PLANUS

MEDIAL ARCH

b. supported by ligaments and muscles
i. **Plantar Calcaneonavicular Ligament - 'Spring' ligament,** most important ligament, keeps head of talus high off ground.
ii. **Tibialis Posterior and Tibialis Anterior** - insert to medial side of foot and support arch.

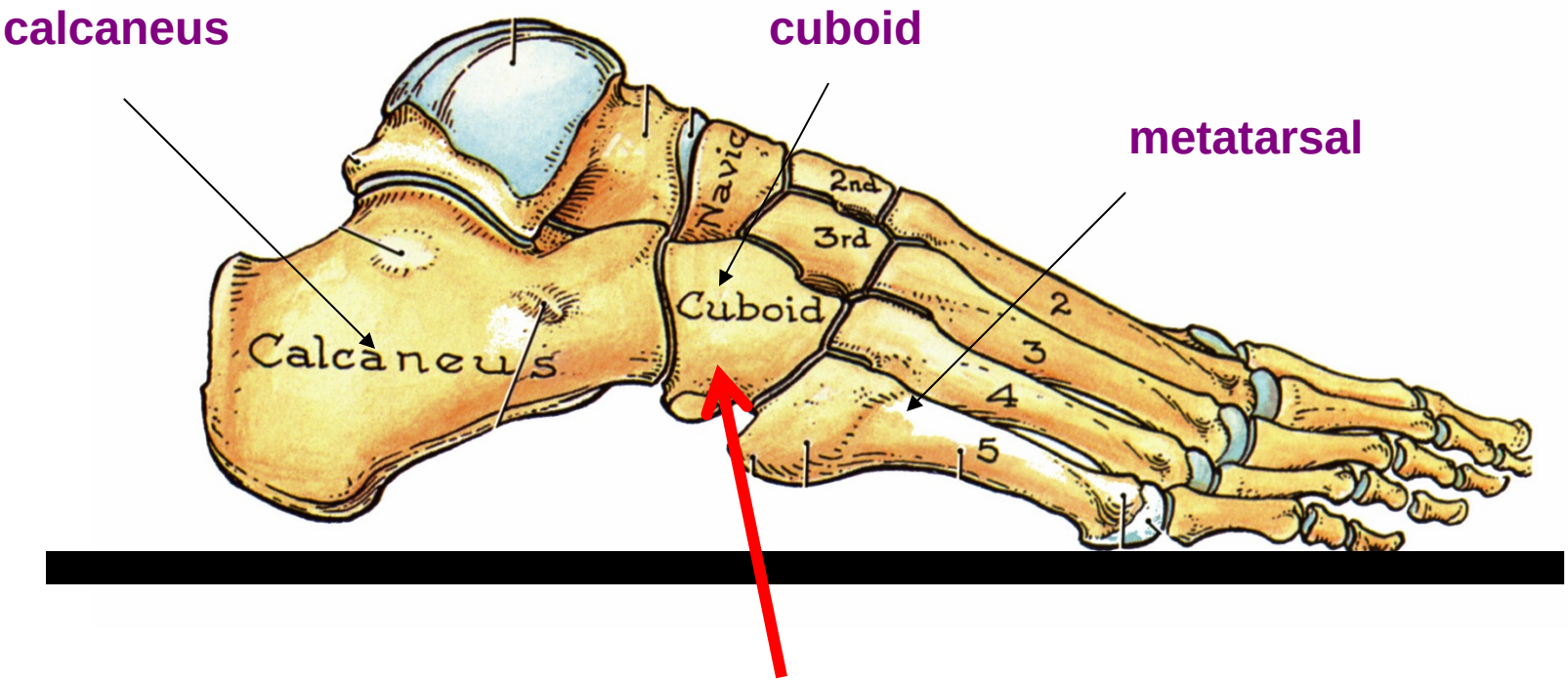
MUSCLES THAT INVERT FOOT SUPPORT MEDIAL ARCH



Tibialis Posterior

LATERAL ARCH

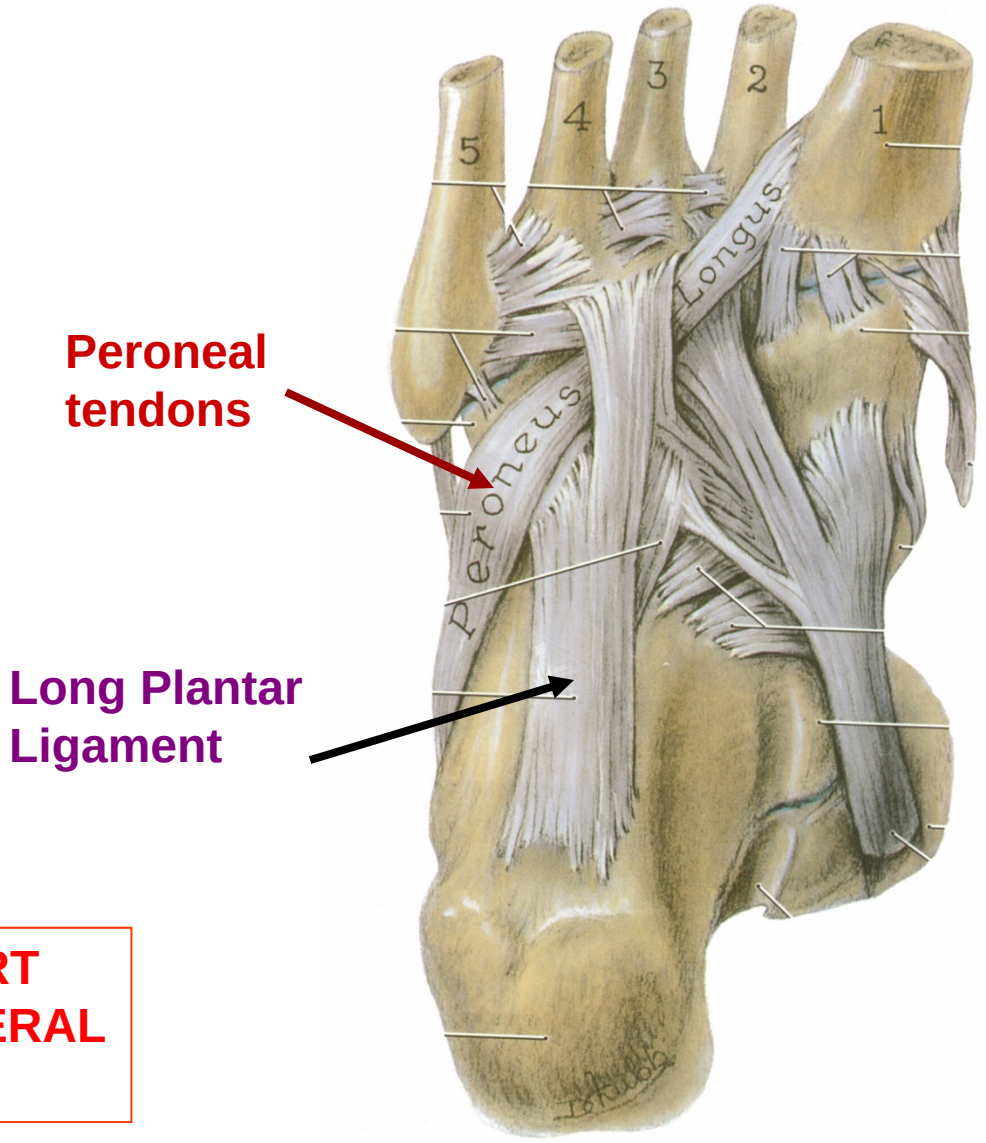
2. **Lateral Longitudinal arch** - smaller
a. formed by - **calcaneus, cuboid and lateral two metatarsals**
b. supported by
i. Long Plantar Ligament and Plantar Aponeurosis
ii. Peroneal tendons



CUBOID IS MOST INFERIOR IN LATERAL X-RAY

LATERAL ARCH

b. supported by
i. **Long Plantar Ligament** (calcaneus to cuboid) and Plantar Aponeurosis
ii. **Peroneal tendons**

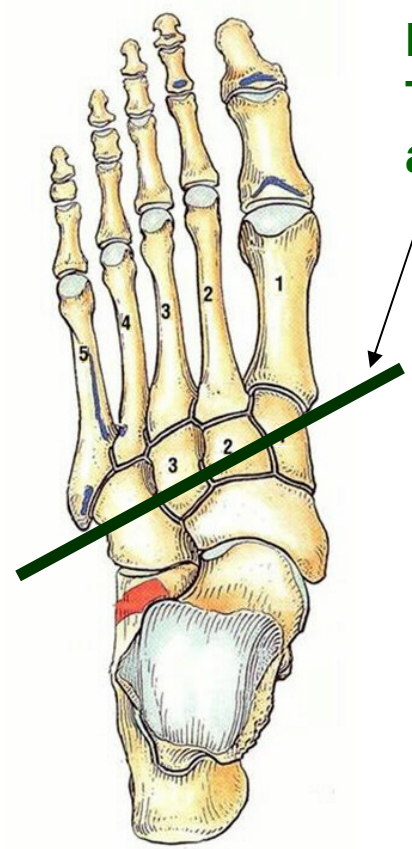


MUSCLES THAT EVERT FOOT SUPPORT LATERAL ARCH

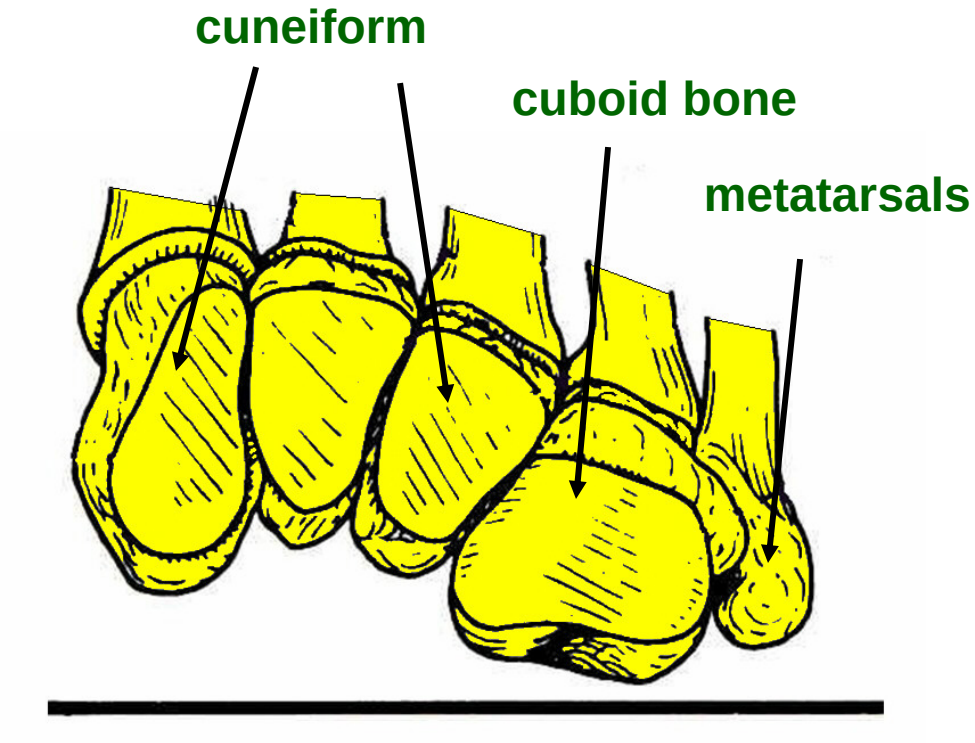
TRANSVERSE ARCH

3. **Transverse arch**

a. formed by **cuneiform** and **cuboid bones** and **metatarsals**



Plane of Transverse arch

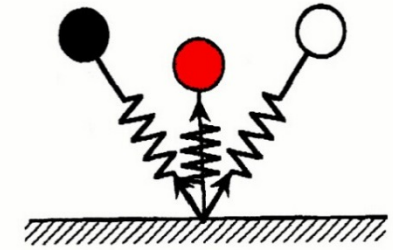


supported by Interosseus muscles and Peroneus longus tendon

PROSTHETIC FEET MADE OF SPRINGS FOR AMPUTEE RUNNERS

PHYSICS OF BOUNCING BALL DESCRIBES RUNNING

$$F = k*x$$



F = force
x = vertical displacement
k = spring constant

Load springs when put weight on foot on ground

OSSUR PROSTHETIC LEG IS A LEAF SPRING

PROSTHETIC FEET MADE OF SPRINGS FOR AMPUTEE RUNNERS

New design facilitates use of foot without tiring.

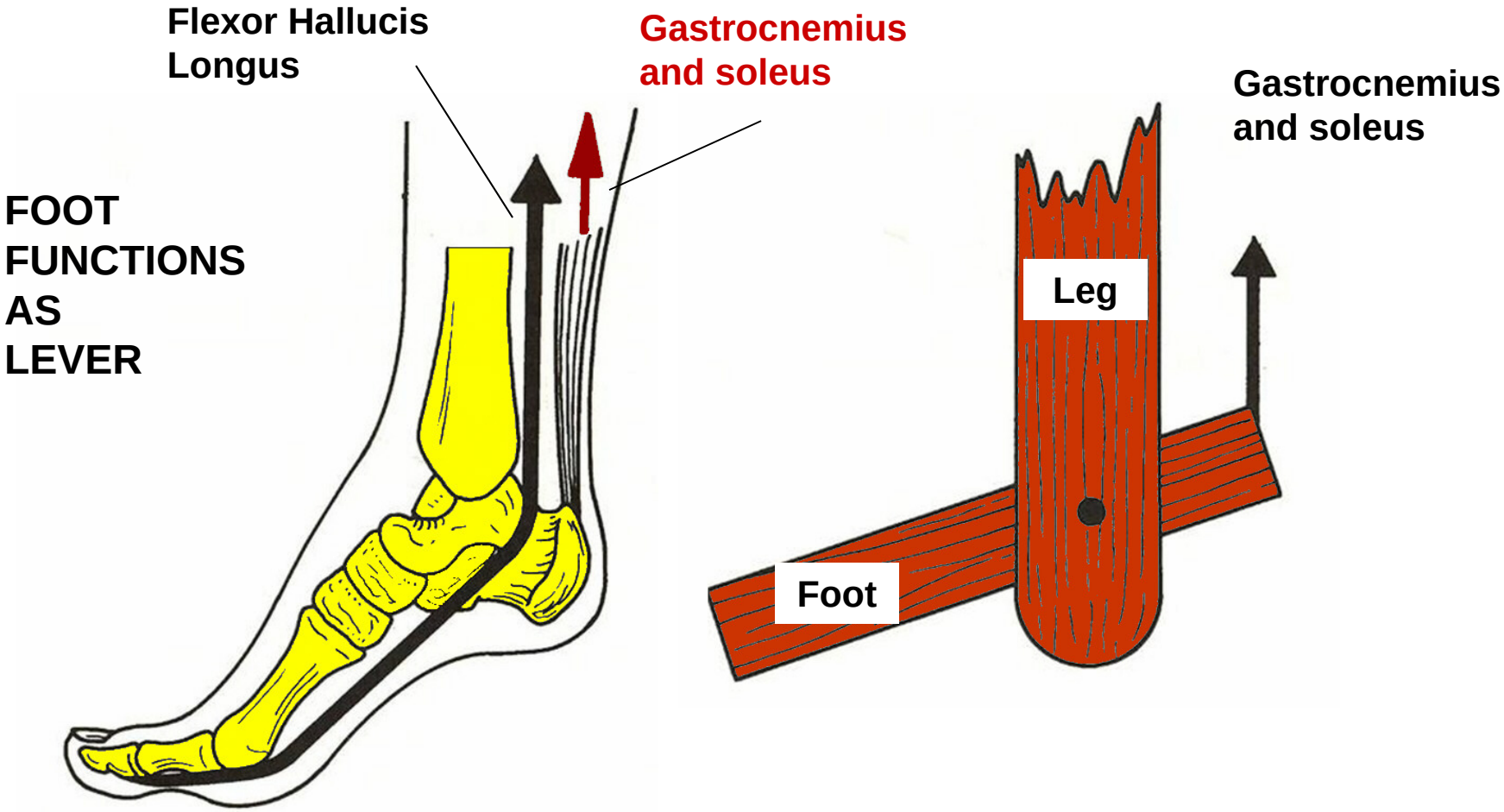
Sarah Reinertsen

carbon fiber - stiffness matches mass of runner

The first woman to swim 2.4 miles, bike 112 miles, and run 26.2 miles on a prosthetic leg at the Ironman World Championships (Kona, Hawaii) in 15 hours 5 minutes. (Oscar Pistorius - competed in Olympics; famous trial)

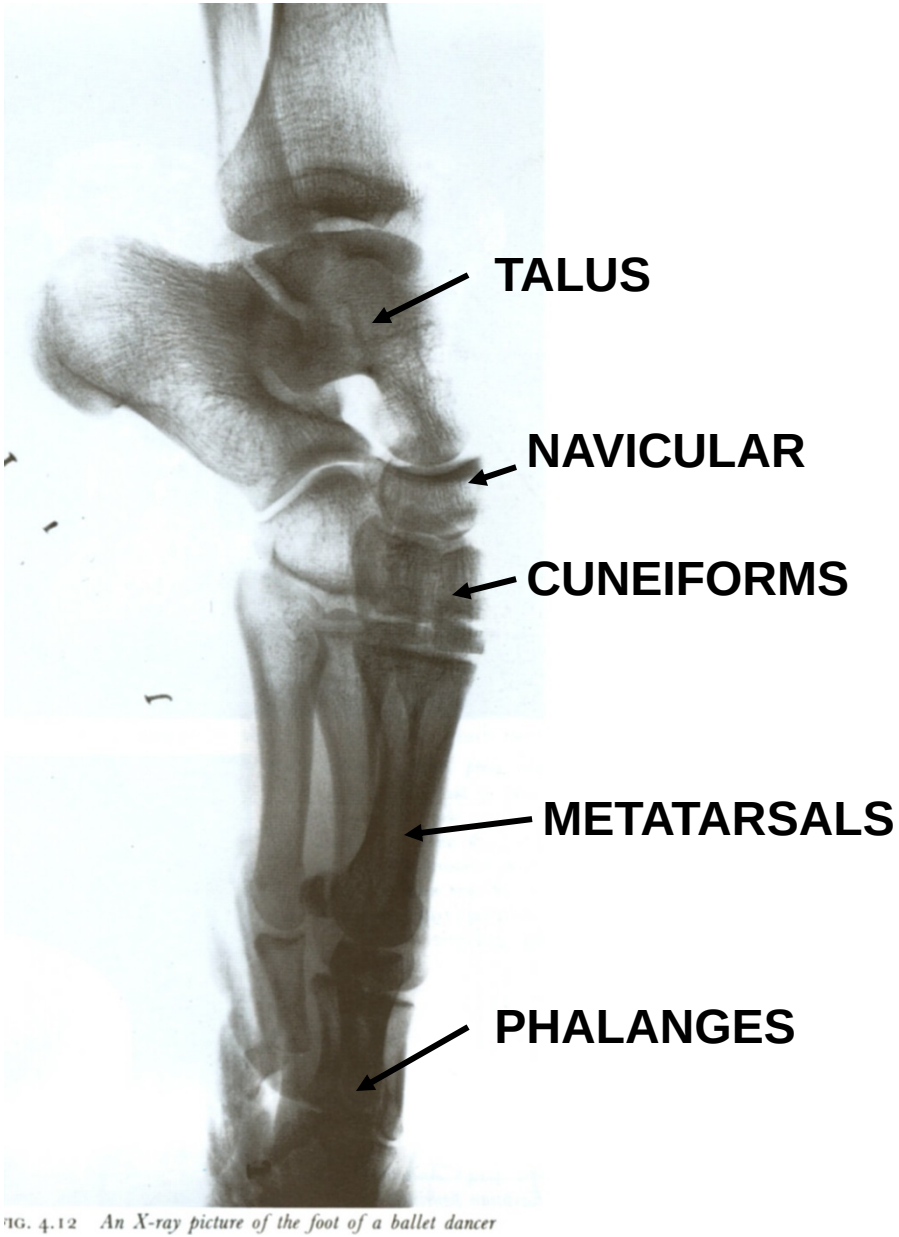
I. DESIGN OF FOOT

1) foot acts like a lever in generating forces for walking and running



Support of body weight - primarily by muscles that attach to tendo calcaneus (gastrocnemius and soleus); gastrocnemius and soleus pull up on calcaneus and prevent body from falling forward (anteriorly); also muscles with long tendons to toes (ex. flexor hallucis longus) that use bones of foot and malleoli as pulleys.

WHY BALLET DANCERS ARE GENERALLY SMALL AND LIGHT

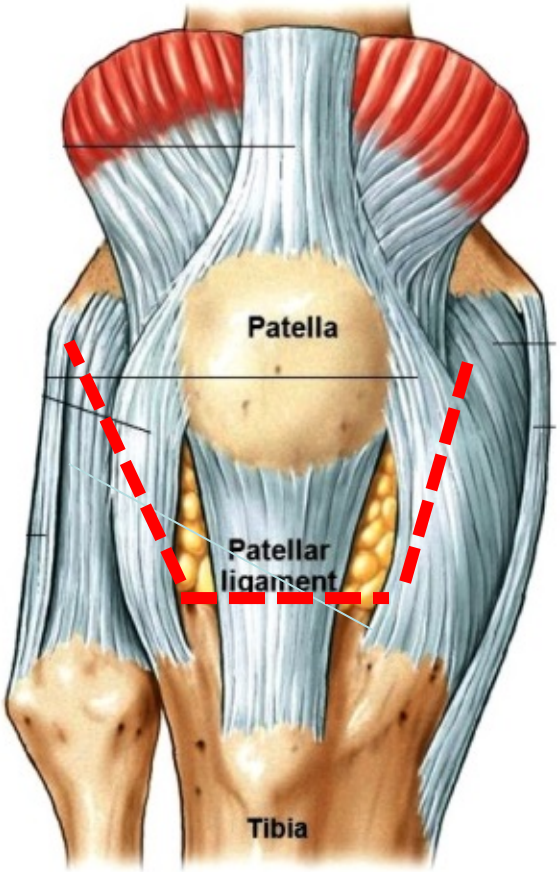


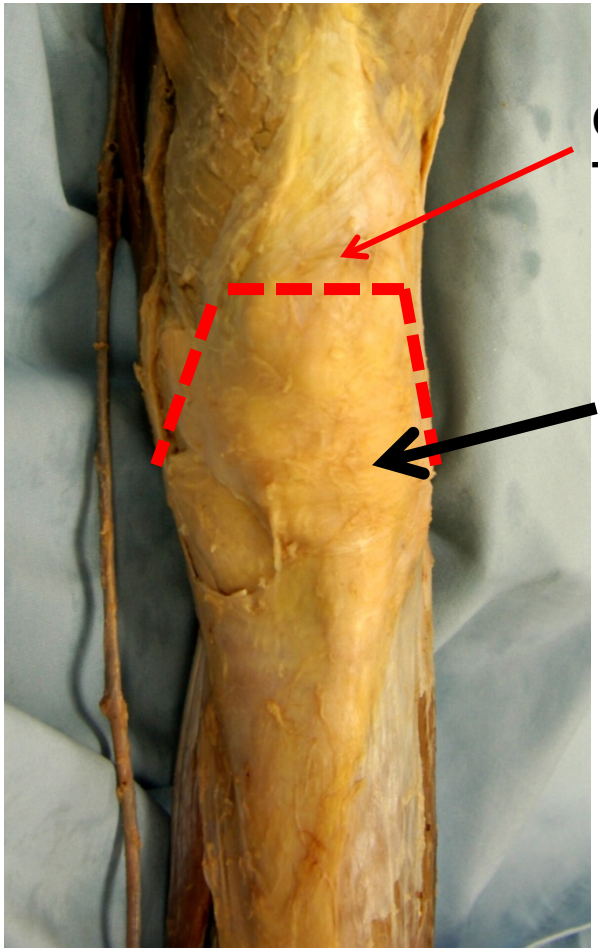
IG. 4.12 *An X-ray picture of the foot of a ballet dancer*

XRAY OF BALLERINA'S FOOT EN POINT
- body weight supported by phalanges

XRAY OF FOOT IN HIGH-HEELED SHOE - body weight transmitted along leg of metatarsal

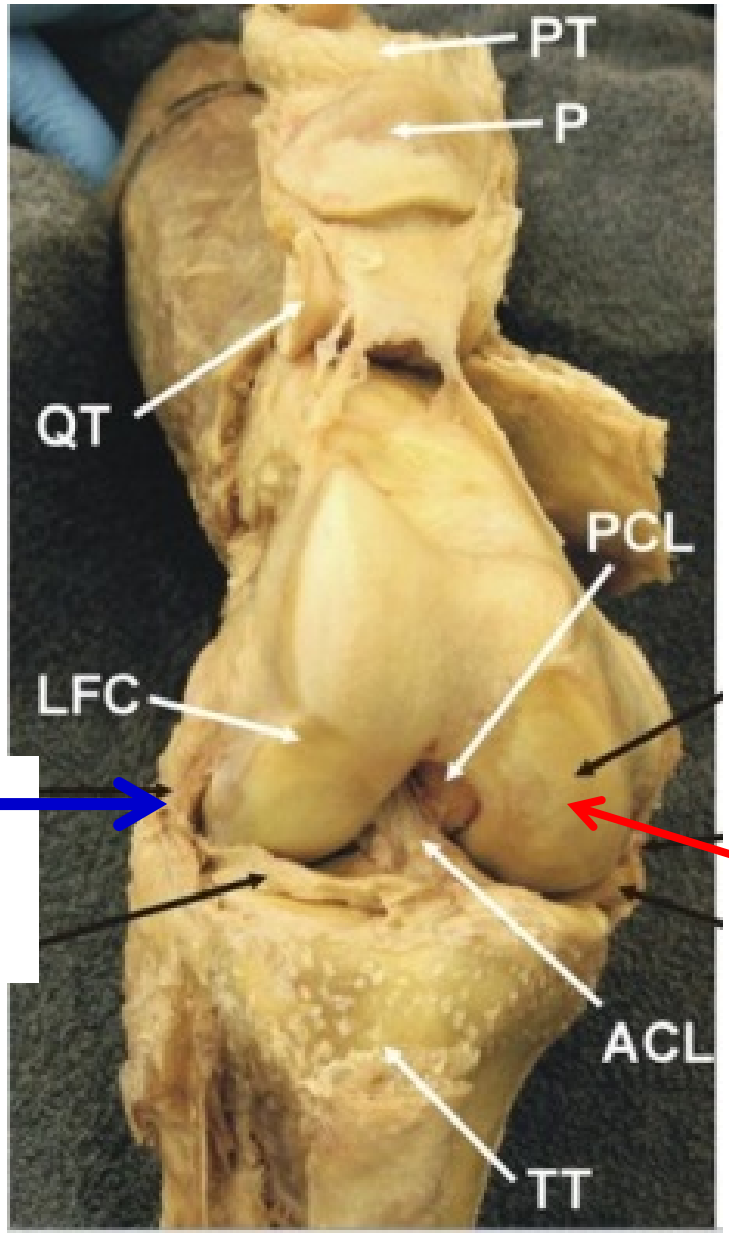
EXPOSE INTERIOR OF KNEE JOINT





1 - CUT ACROSS PATELLAR LIGAMENT OR QUADRICEPS TENDON; EXTEND CUT UP ON BOTH SIDES TOWARD SIDES OF KNEE JOINT.

EXPOSE INTERIOR OF KNEE JOINT



LATERAL COLLATERAL LIGAMENT

2 - LOOK INSIDE KNEE JOINT.
ACL (ANTERIOR CRUCIATE LIGAMENT) IS POINTING TOWARD YOU.

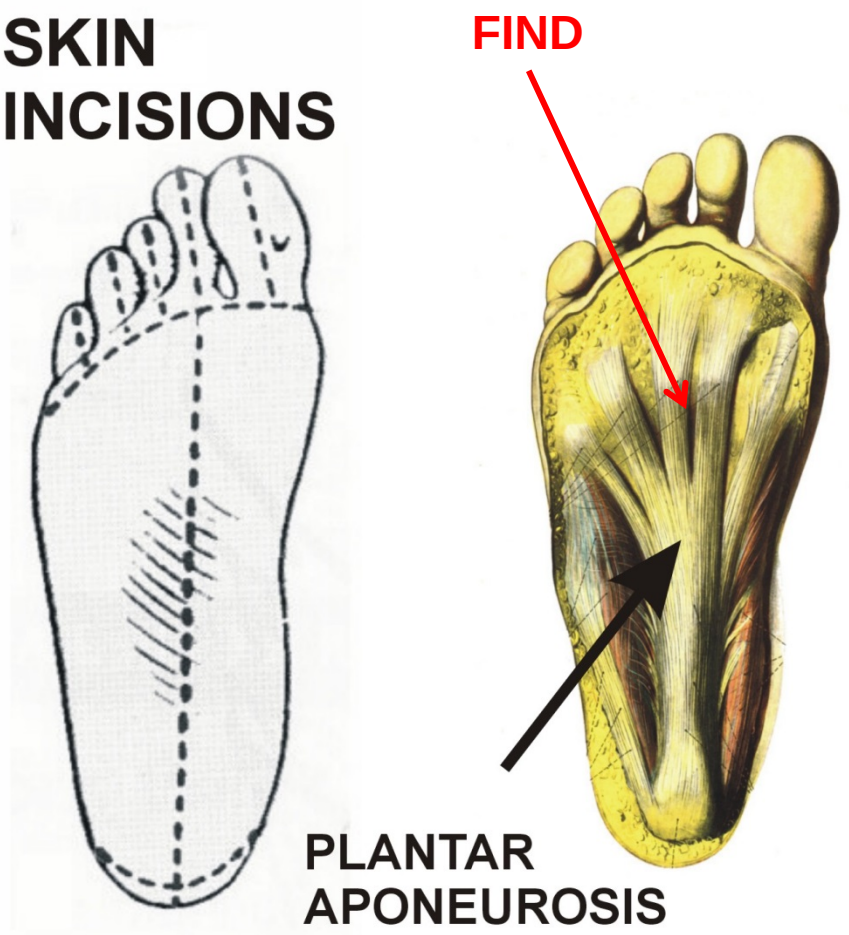
3- IDENTIFY: ACL, PCL, MENISCI
ALSO:
LATERAL COLLATERAL LIGAMENT

4- LOOK AT ARTICULAR CARTILAGE ON FEMUR FOR EVIDENCE OF OSTEOARTHRITIS (LOOKS LIKE SURFACE OF THE MOON INSTEAD OF SMOOTH)

DISSECTION INSTRUCTIONS: FOOT

FIRST: REMOVE SKIN FROM SOLE OF FOOT

Skin of the sole is very thick: just remove all tissues superficial to the Plantar Aponeurosis (a very thick, white layer). If you start removing muscles (appear red), stay a little more superficial. It is not necessary to skin all the toes.



1) COMPLETELY REMOVE THE PLANTAR APONEUROSIS - the white connective tissue layer

LAYER 1 FOOT MUSCLES, NERVES, ARTERIES

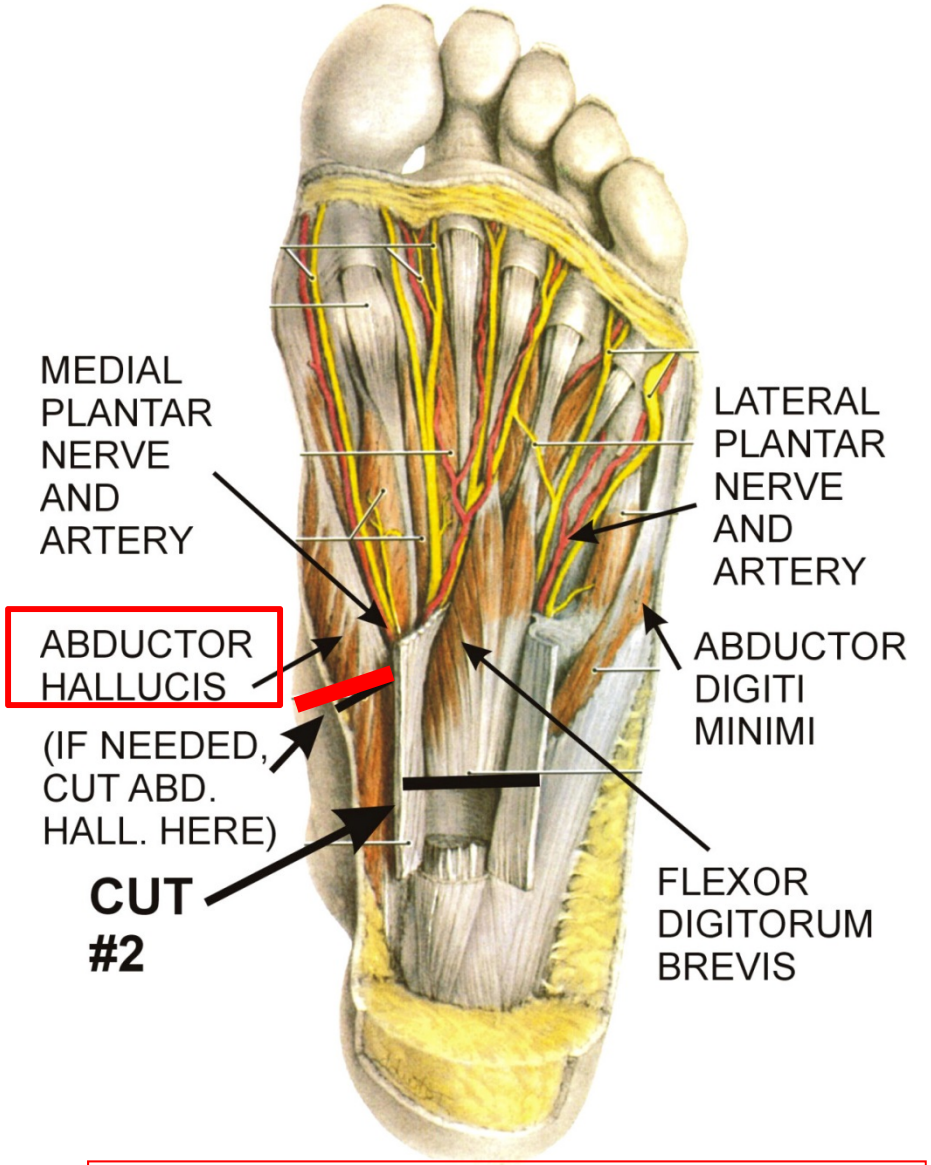
2. IDENTIFY NO CUTS EXCEPT ABD. HALL.

a. Identify the muscles ABDUCTOR HALLUCIS, FLEXOR DIGITORUM BREVIS, ABDUCTOR DIGITI MINIMI.

b. Then **REVIEW TOM, DICK and HARRY (TIBIALIS POSTERIOR, FLEXOR DIGITORUM LONGUS, POSTERIOR TIBIAL ARTERY, TIBIAL NERVE, FLEXOR HALLUCIS LONGUS) on the medial side of the foot (FOLLOW STRUCTURES INTO FOOT).**

c. Find the branches of the POSTERIOR TIBIAL ARTERY (**LATERAL PLANTAR ARTERY, MEDIAL PLANTAR ARTERY**) AND THE TIBIAL NERVE (**LATERAL PLANTAR NERVE, MEDIAL PLANTAR NERVE)**

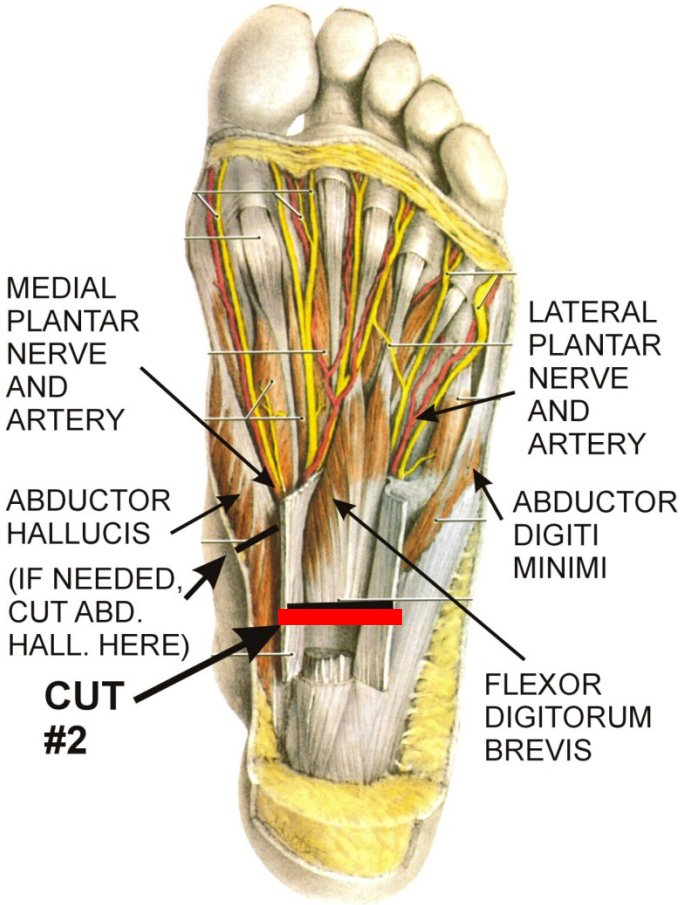
NOTE: THIS MAY BE EASIER IF YOU CUT THE ABDUCTOR HALLUCIS ACROSS THE MIDDLE OF THE MUSCLE



FOLLOW STRUCTURES FROM MEDIAL SIDE OF ANKLE TO FOOT

EXPOSE LAYER 2 FOOT MUSCLES

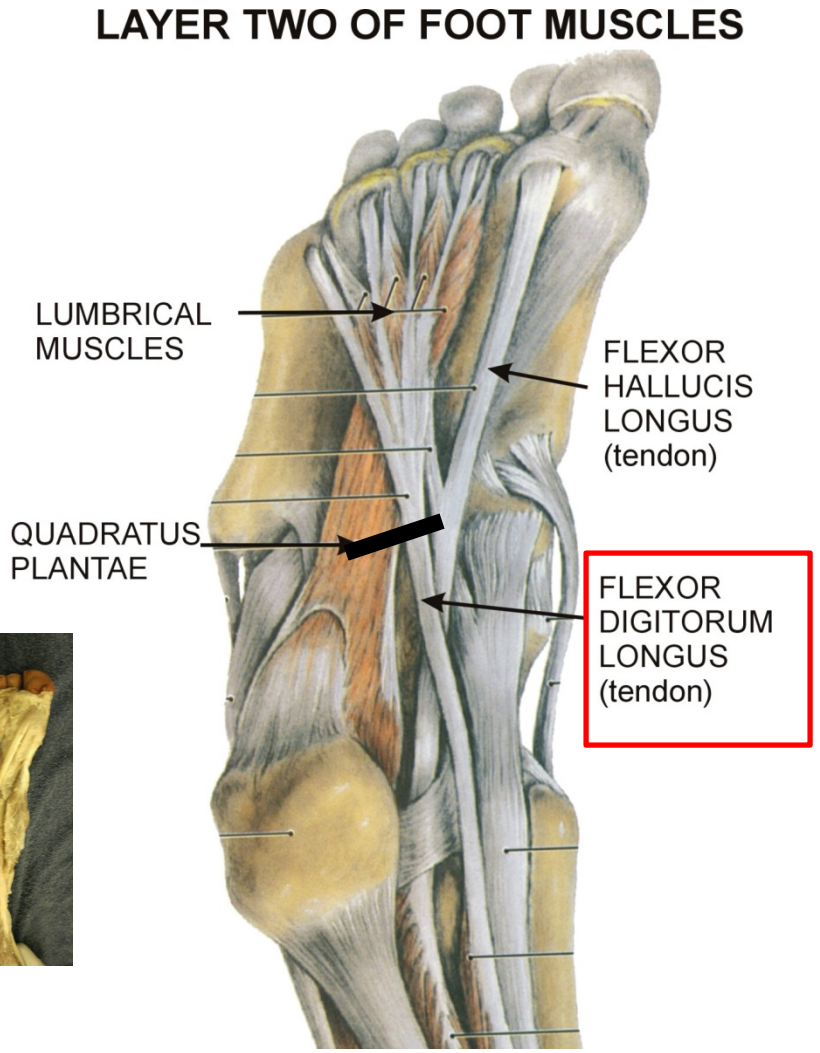
3) CUT THE ATTACHMENT OF THE FLEXOR DIGITORUM BREVIS FROM THE CALCANEUS AND REFLECT IT TOWARD THE TOES



FLEXOR DIGITORUM BREVIS

LAYER 2 FOOT MUSCLES

Identify:
FLEXOR DIGITORUM LONGUS,
LUMBRICALS,
QUADRATUS PLANTAE,
FLEXOR HALLUCIS LONGUS

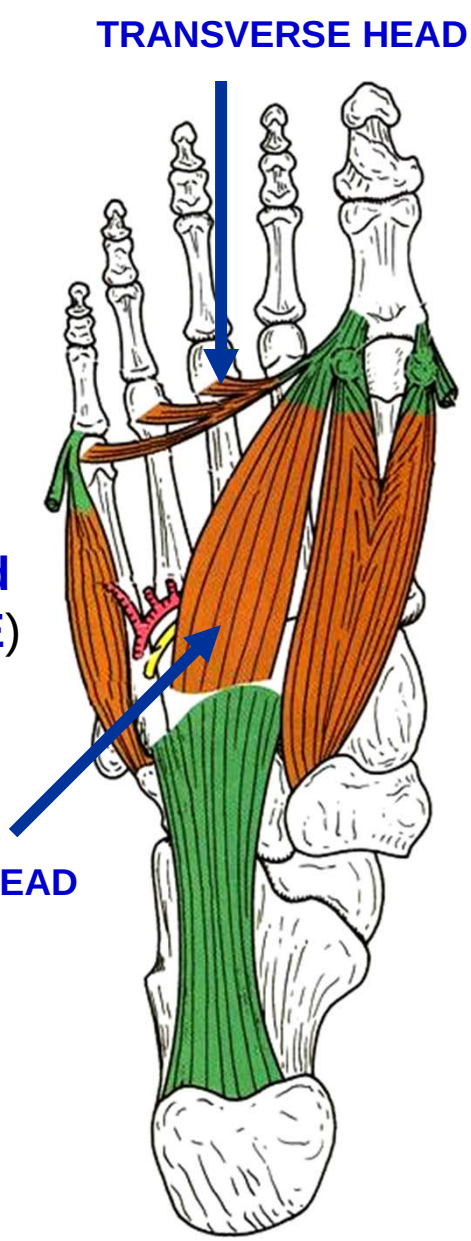


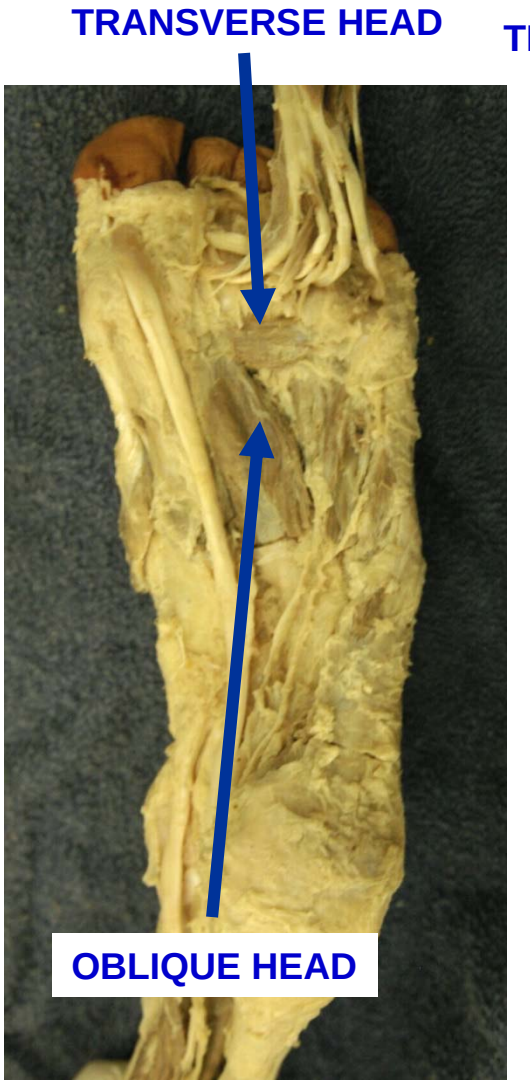
Can stop here or cut through tendon of Flexor Digitorum Longus

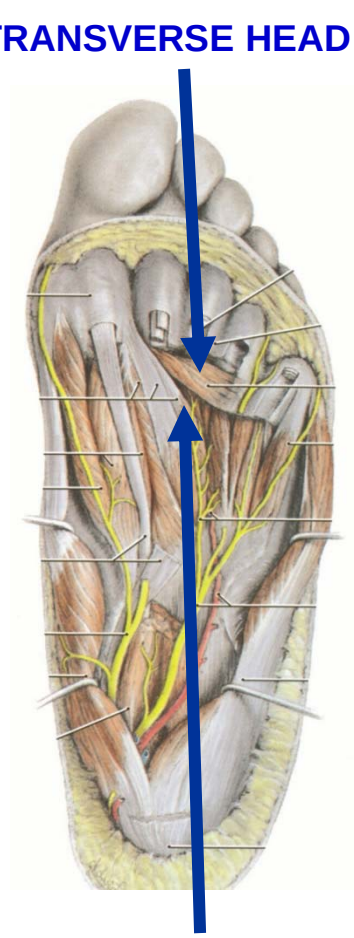
MUSCLES OF FOOT - Layer 3

C. Layer 3 - Small muscles to big toe and little toe.

2. **Adductor hallucis -** two heads of origin (**OBLIQUE and TRANSVERSE**) and one common tendon.



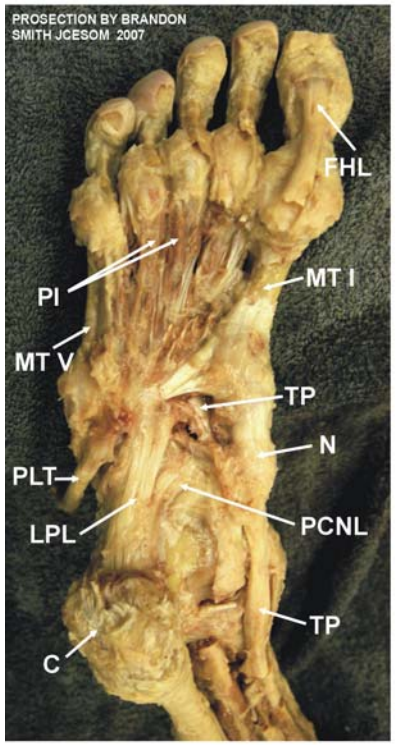


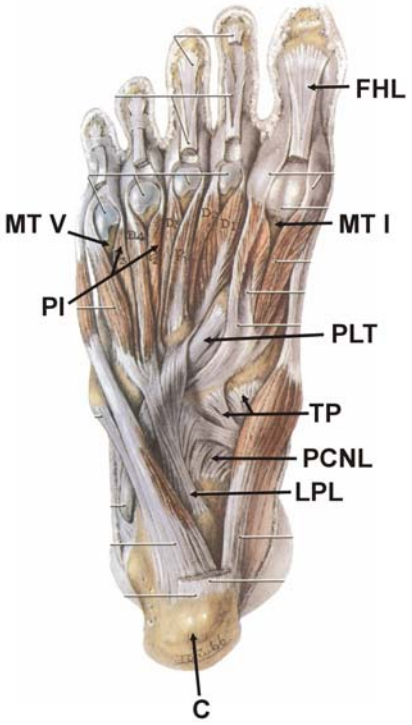


SEE ADDUCTOR HALLUCIS

STUDY MUSCLES OF FOOT - Layer 4
ON PROSECTIONS 220, 215

DEEP FOOT: PERONEUS LONGUS TENDON 220

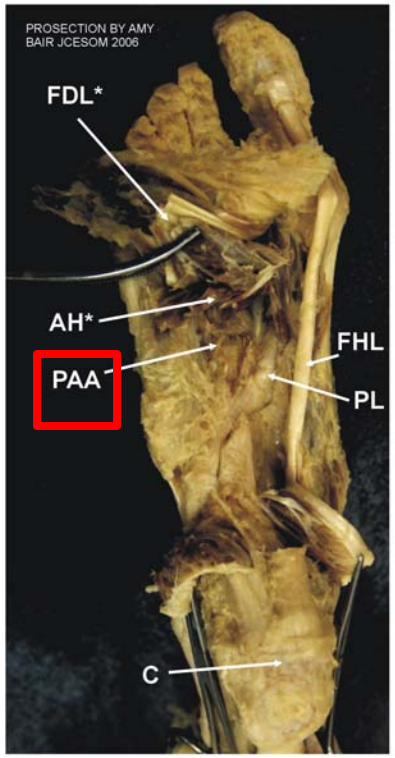




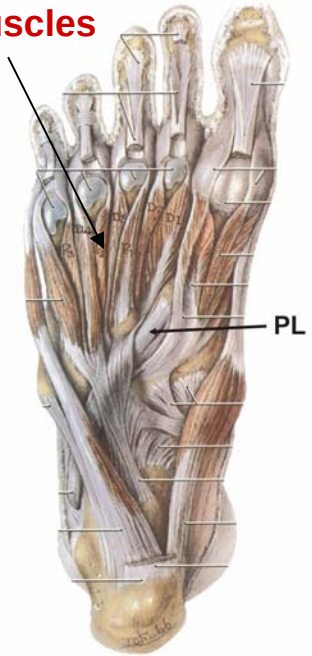
MT I - 1st METATARSAL
MT V - 5th METATARSAL
C - CALCANEUS
FHL - FLEXOR HALLUCIS LONGUS TENDON
LPL - LONG PLANTAR LIGAMENT
N - NAVICULAR BONE
PLT - PERONEUS LONGUS TENDON
PCNL - PLANTAR CALCANEONAVICULAR LIGAMENT
NTPLT - PERONEUS LONGUS TENDON

PI - PLANTAR INTEROSSEUS MM.
TP - TIBIALIS POSTERIOR

DEEP FOOT: PERONEUS LONGUS TENDON 215



Interosseus muscles



FDL* - FLEXOR DIGITORUM LONGUS (REFLECTED)
AH* - ADDUCTOR HALLICUS (REFLECTED)
PAA - PLANTAR ARTERIAL ARCH
PL - PERONEUS LONGUS TENDON
C - CALCANEUS
FHL - FLEXOR HALLUCIS LONGUS

also Plantar arterial arch*

CHECK LIST FOR SOLE OF FOOT LAB 2018

1) LAYER ONE

MUSCLES -

_____ ABDUCTOR HALLUCIS
_____ FLEXOR DIGITORUM BREVIS
_____ ABDUCTOR DIGITI MINIMI
_____ FLEXOR HALLUCIS LONGUS (tendon)
_____ FLEXOR DIGITORUM LONGUS (tendon)

ARTERIES -

_____ POSTERIOR TIBIAL ARTERY
_____ LATERAL PLANTAR ARTERY
_____ MEDIAL PLANTAR ARTERY

NERVES -

_____ TIBIAL NERVE
_____ LATERAL PLANTAR NERVE
_____ MEDIAL PLANTAR NERVE

2) LAYER TWO

MUSCLES -

_____ FLEXOR HALLUCIS LONGUS (tendon)
_____ FLEXOR DIGITORUM LONGUS (tendon)
_____ LUMBRICALS
_____ QUADRATUS PLANTAE

SEE REMAINING STRUCTURES ON PROSECTIONS