The **gluteal muscles** (A, B, and C) are arranged in three layers, with the gluteus maximus being superficial-most, and the gluteus minimus buried deep to the gluteus medius. **Gluteus maximus** arises from the tendinous fibers of the erector spinae muscles (seen here as an impression under the skin), along the posterior gluteal line of the postero-superior aspect of the ilium (page 35, lateral view), from the sacrotuberous ligament, and the lateral edge of the sacrum and coccyx. This huge muscle covers most of the other two gluteal muscles, and covers all of the six lateral rotators of the hip joint as it courses inferiorly and laterally to insert along the upper *iliotibial tract* and the gluteal tuberosity of the femur. It lies just below the skin and superficial fascia that in some people abounds with adipose tissue. It is the most powerful hip extensor of the lot, and adducts and laterally rotates the hip joint. It is a tensor of the fasciae latae.

The large sciatic nerve (roughly the size of your thumb; see page 88) arises from the sacral plexus on the deep surface of the **piriformis muscle**, one of the lateral rotators of the hip joint. The nerve emerges from the greater sciatic foramen, under piriformis, and comes to lie deep to the gluteus maximus muscle in the lower medial quadrant of the buttock. The thickness of the gluteus maximus varies. Intramuscular injections are delivered to the upper and outer quadrant of the buttock.

The **gluteus medius** is a prime mover in abduction of the hip joint and an important stabilizer (leveler) of the pelvis when the opposite lower limb is lifted off the ground. The gluteus minimus is also a major contributor to the abduction effort of the hip joint.

The deepest layer of gluteal muscles includes the **gluteus minimus** and the **deep lateral rotators** of the hip joint. They cover up/fill the greater and lesser sciatic notches. These muscles generally insert at the posterior aspect of the greater trochanter of the femur. The gluteal muscles (less gluteus maximus) correspond to some degree with the rotator cuff of the shoulder joint: lateral rotators posteriorly, abductor (gluteus medius) superiorly, and medial rotators (gluteus medius and minimus, tensor fasciae latae) anteriorly. The identity of nerves and vessels that pass through the greater and lesser sciatic foramina (page 36) can be ascertained in the Glossary. See Foramen, greater and lesser sciatic.

The **iliotibial tract**, a thickening of the deep fascia (fascia lata) of the thigh, runs from ilium to tibia and helps stabilize the knee joint laterally. The **tensor fasciae latae** muscle, a frequently visible and palpable flexor and medial rotator of the hip joint, inserts into this fibrous band, tensing it.

MUSCLES OF THE GLUTEAL REGION

GN: In the posterior and lateral views of superficial dissections, the upper fibers of the iliotibial tract have been cut and pulled away, exposing gluteus medius. (1) Color the names and structures of the three gluteal muscles in all views. (2) Color the six deep lateral rotators and their names. Color the directional arrows. The origin of the piriformis, E, can be seen on page 50.

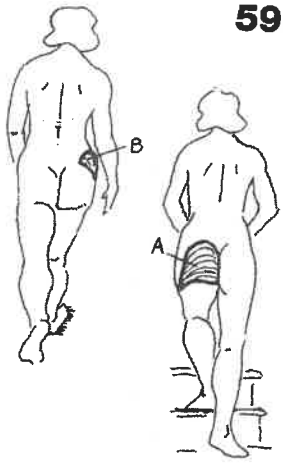
3 GLUTEAL MUSCLES

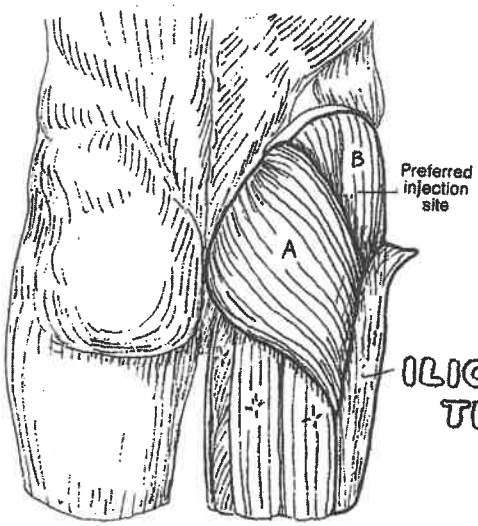
GLUTEUS MAXIMUS A
GLUTEUS MEDIUS B
GLUTEUS MINIMUS C

TENSOR FASCIAE LATAE D

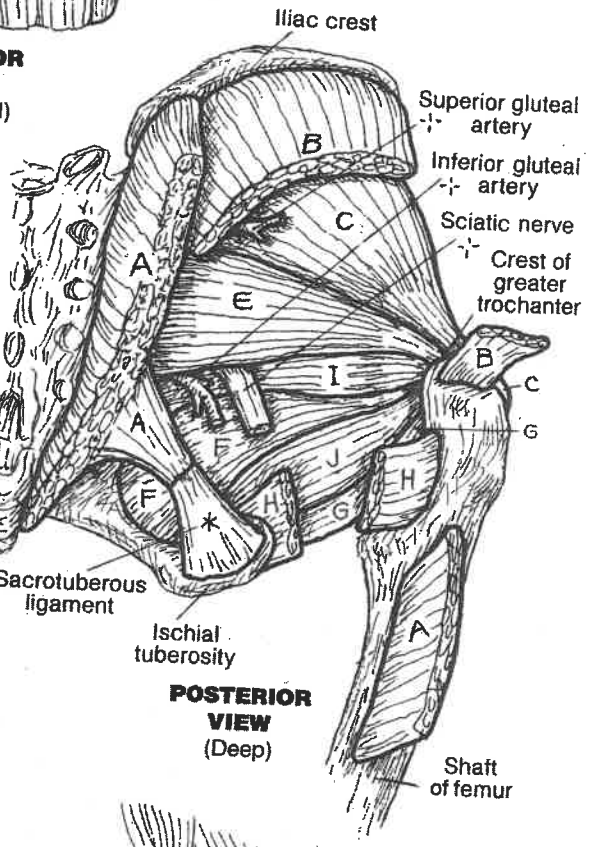
6 DEEP, LATERAL ROTATORS

PIRIFORMIS E
OBTURATOR INTERNUS F
OBTURATOR EXTERNUS G
QUADRATUS FEMORIS H
GEMELLUS SUPERIOR I
GEMELLUS INFERIOR J



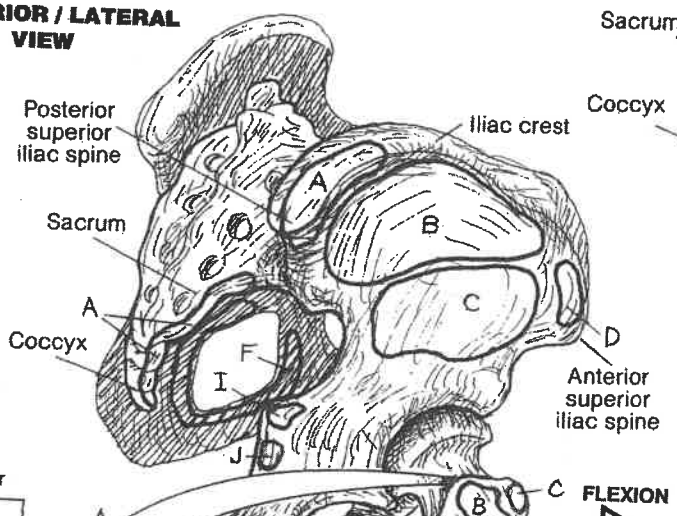


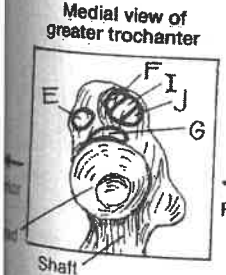
POSTERIOR VIEW (Superficial)

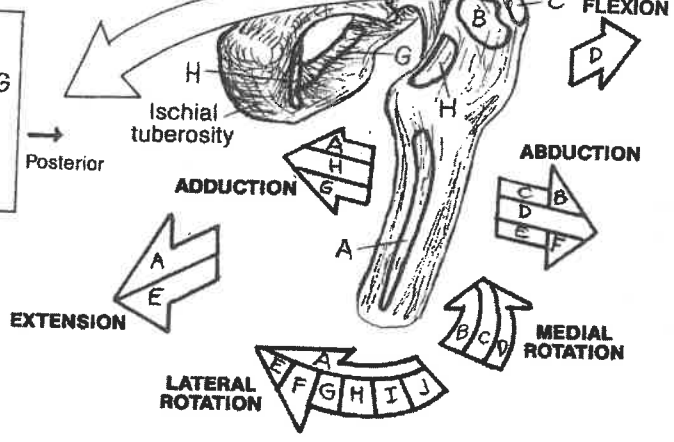


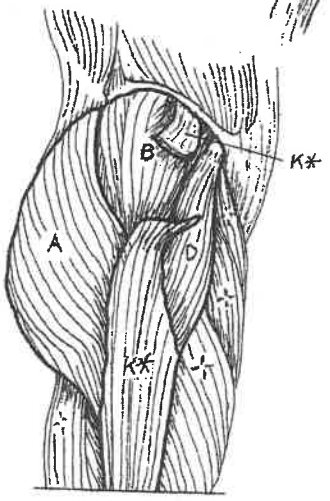
POSTERIOR VIEW (Deep)

POSTERIOR / LATERAL VIEW









LATERAL VIEW (Superficial)

The musculature of the **posterior thigh** consists of three muscles: **semimembranosus, semitendinosus**, and **biceps femoris**. They are often referred to as the **"hamstrings,"** the "ham" referring to the muscle/fat in the back of the porcine hindlimb, and the extraordinarily long (and vulnerable) related tendons ("strings").

Note the origins of these muscles. All three have at least one head that arise from the ischial tuberosity of the ilium. One of the muscles (biceps femoris) has a head that arises on the posterior thigh. See the illustration. Since these muscles cross the hip joint on the posterior aspect, they act on that joint by extending it. Check this on yourself.

Note that the tendons of these three muscles also cross the knee joint posterolaterally (biceps femoris) and posteromedially (semimembranosus and semitendinosus). The biceps inserts on the *lateral* aspect of the head of the fibula; the other two muscles insert on the posterior aspect of the medial tibial condyle and the medial aspect of the upper tibia. These muscles, therefore, flex the knee joint. The long tendons of the hamstrings can be palpated just above and behind the partially flexed knee on either side of the joint's midline. The knee joint is capable of a small degree of rotation. The semitendinosus and semimembranosus muscles can medially rotate the knee joint, and biceps femoris can laterally rotate it. The insertion of semitendinosus is intimately associated with the tendons of insertion of sartorius and gracilis (SGT). Part of this collection of tendons, shaped like a goose foot (*pes anserinus*), can be seen here on the medial aspect of the knee joint. (See also pages 61 and 62.)

Discomfort on stretching tight hamstrings can result from overuse to underuse (chronic couch potato syndrome). Test your own hamstrings from a standing posture. Bend forward without locking your knees; stop when you feel tension. It is written that most young people can touch their toes in this maneuver. Tight hamstrings, by their ischial origin, pull the posterior pelvis down, lengthening (stretching) the erector spinae muscles and flattening the lumbar lordosis, potentially contributing to limitation of lumbar movement and low back pain. Low back discomfort on stretching the hamstrings is common, and can usually be resolved simply by bending the knees, taking the tension off the tendons. Sharp low back pain radiating to the leg (below the knee) and/or foot while stretching the hamstrings can be something else again. Such pain suggests the sciatic nerve was stretched along with the tendons; in such a case, standing up and plantar flexing the ankle joint of the affected limb will often relieve the painful sensation.

MUSCULAR SYSTEM / LOWER LIMB
MUSCLES OF THE POSTERIOR THIGH

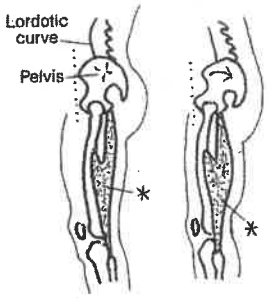
See 59, 61

CN: Use light colors. (1) Color each hamstring muscle in the deep view before going on to the superficial. Color the two smaller muscle diagrams with respect to flexion and extension of the hip and knee joints. (2) Color gray the two diagrams of stippled muscles at upper right.

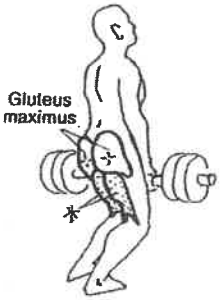
"HAMSTRINGS"

SEMIMEMBRANOSUS A
SEMITENDINOSUS B
BICEPS FEMORIS C

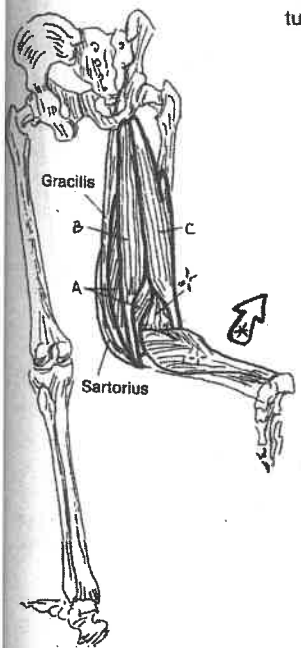
Tight hamstrings limit flexion of hip when knee joint is extended



Tight hamstrings (at right) tilt pelvis backward, flattening lordotic curve of lower back.

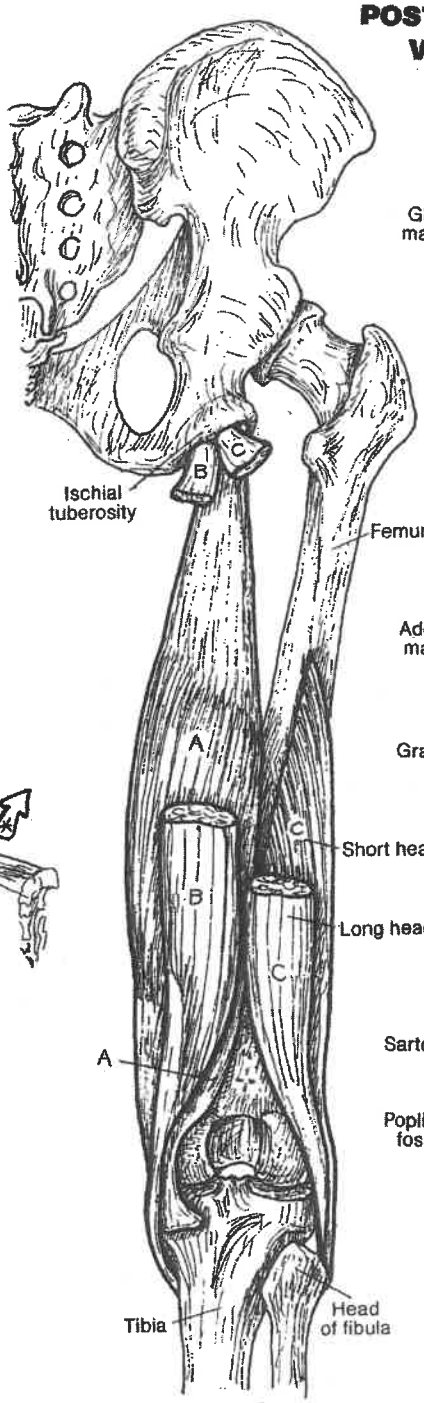


Powerful extensors of the hip joints.

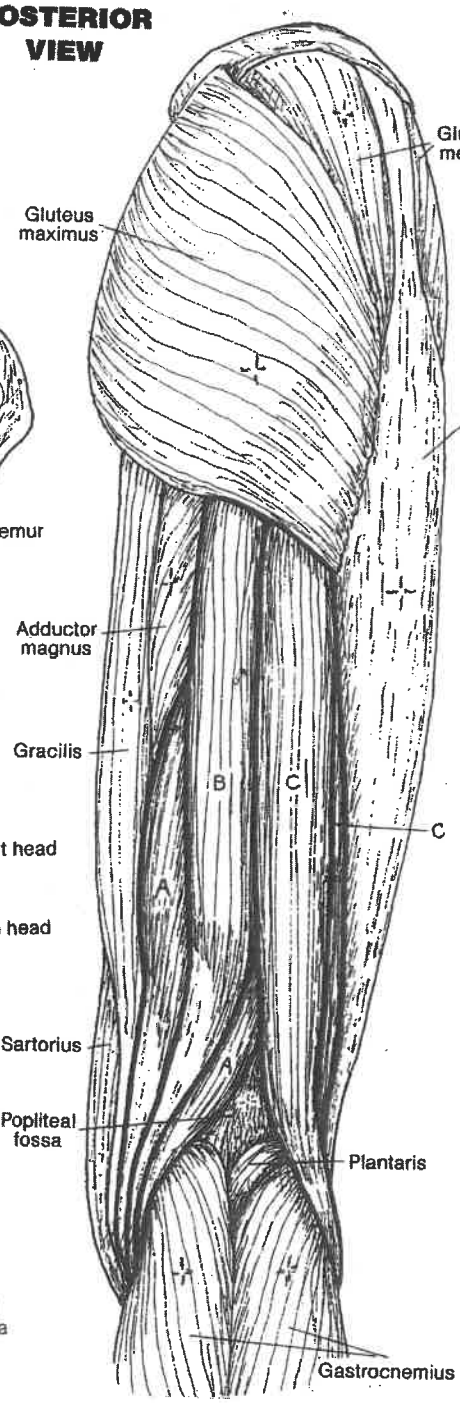


FLEXORS OF THE KNEE JOINT

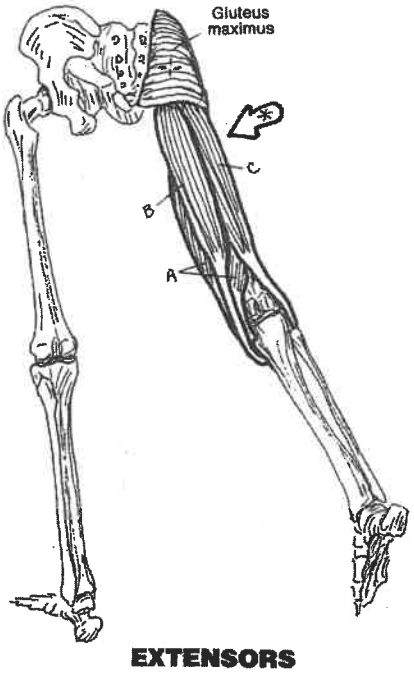
POSTERIOR VIEW



DEEP



SUPERFICIAL



EXTENSORS OF THE HIP JOINT

The **medial thigh muscles** consist of the hip joint *adductors* (**pectineus**, **adductor brevis**, **adductor longus**, *adductor magnus*, and *gracilis*) and the *obturator externus*, a lateral rotator of that joint. These can all be seen in the illustration, and their relationship to one another at their origin is a relationship you should spend some time with. They are a powerful set of muscles.

The **obturator externus** is part of the medial thigh group because of its location within the adductor group and because it is innervated by the obturator nerve which supplies the adductors. The insertion site of "externus" has a mechanically disadvantaged location to qualify as a hip adductor; it is more likely a lateral rotator of the hip (recall page 59). Unfortunately, electromyographic study of this muscle in the living does not seem to be currently possible. However, it is compartmentalized by fasciae in the medial thigh, covers the external surface of the obturator foramen in the deep upper medial thigh, and receives the same innervation as the adductors. Thus, it is considered by many authorities to be an adductor of the hip joint.

The **gracilis**, longest of the adductor group, crosses the medial knee (flexing it), and inserts only on the medial tibia (not the linea aspera); its tendon joins the tendons of the sartorius and semitendinosus to form its insertion, the *pes anserinus* (recall page 60).

The **adductor magnus** is the most massive of the group (see posterior view). In its lower half, adductor magnus fibers give way to passage of the femoral artery and vein through a separation of muscle fibers called the *adductor hiatus*. Passing through this canal within the muscle, the vessels enter the popliteal fossa above and behind the knee (see page 110).

Look carefully at the posterior view and focus on the medial aspect of the muscle adjacent to gracilis (E). Note the column of straight, descending fibers that reach down to the distal medial surface of the femur where it attaches to the adductor tubercle (see far left illustration just above the medial condyle). These fibers are not adductors; they are flexors of the knee joint, essentially a hamstring muscle! The more lateral fibers of the adductor magnus attach to the linea aspera and the supracondylar line of the femur and therefore function as an adductor of the hip joint.

This fact is worth repeating: all of the adductor muscles, except the gracilis, insert on the vertical rough line (linea aspera) on the posterior surface of the femur.

Innervation of the adductor muscles, for the most part, is by the obturator nerve (see page 88). The sciatic nerve innervates the "hamstring fibers" of the adductor magnus.

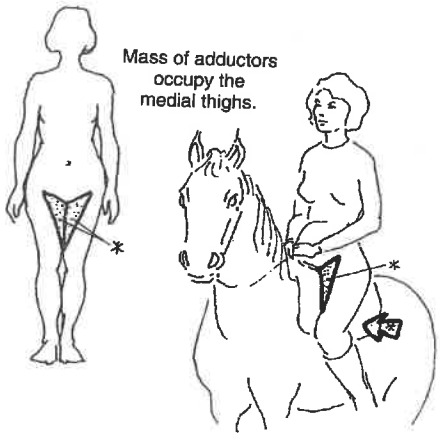
MUSCLES OF THE MEDIAL THIGH

See 60, 62

CN: (1) Color one muscle at a time through the five main views before going to the next one. (2) The dotted lines at far left represent the sites of insertion (linea aspera) for muscles A, B, C, and D on the *posterior* aspect of the femur.

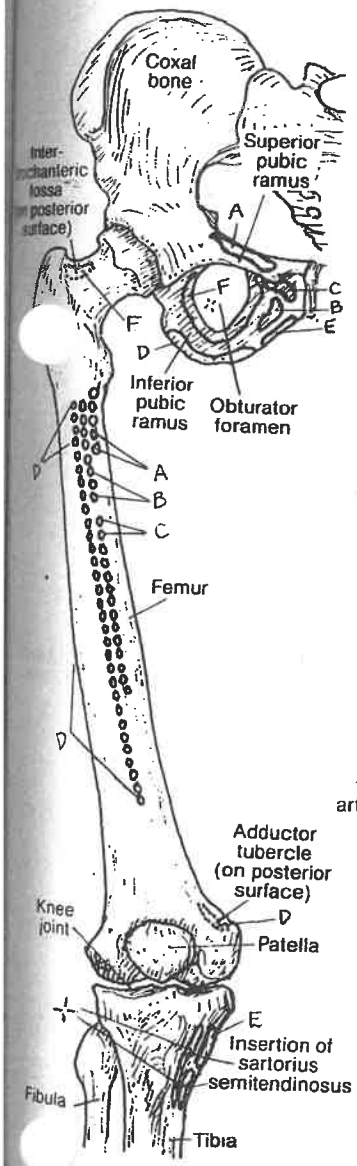
MUSCLES

PECTINEUS$_A$
ADDUCTOR BREVIS$_B$
ADDUCTOR LONGUS$_C$
ADDUCTOR MAGNUS$_D$
GRACILIS$_E$
OBTURATOR EXTERNUS$_F$

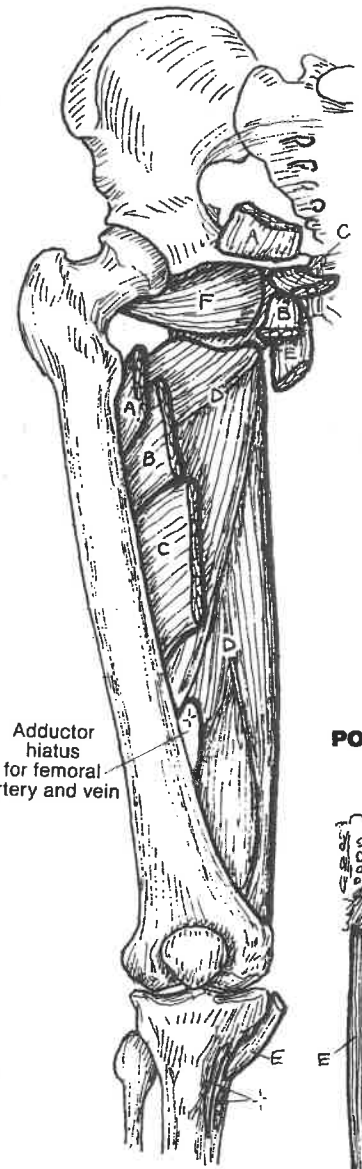


ANTERIOR VIEW

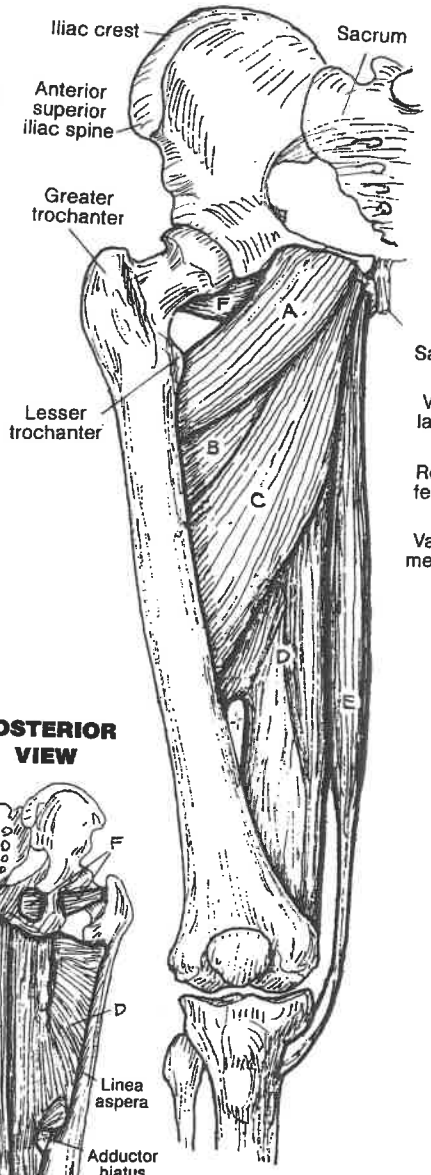
ATTACHMENT SITES



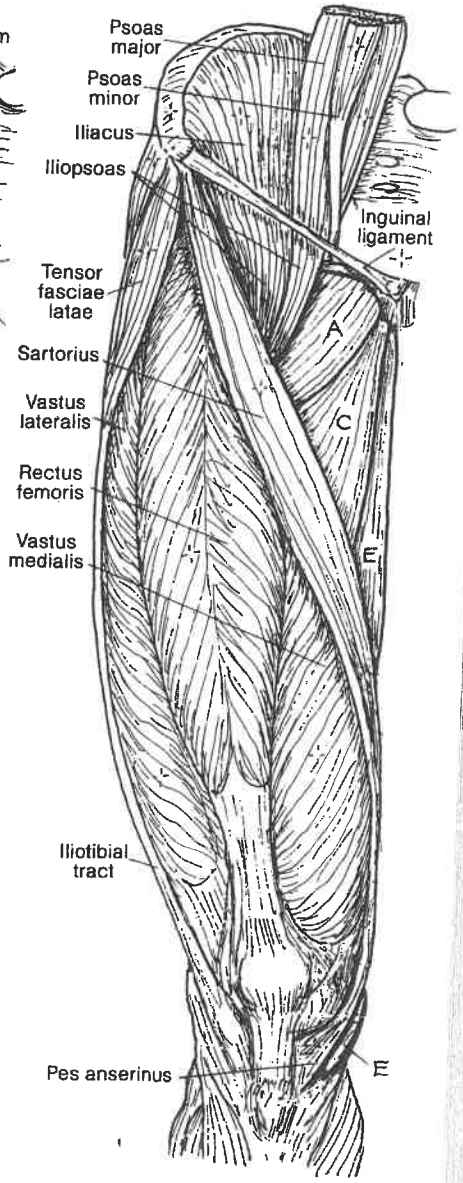
DEEP



INTERMEDIATE



SUPERFICAL



POSTERIOR VIEW

What we have here in the **anterior muscles of the thigh** is a very powerful and fascinating group of muscles. They are all innervated by branches of the lumbar plexus (L1–4), most often in the form of the femoral nerve (L2, 3, 4) and its branches.

The **sartorius**, called the "tailor's muscle" for its role in enabling a crossed-legs sitting posture, one used for centuries to sit and be able to create a posture that takes up little room and so readily facilitates hand work, as in sewing, drawing, etc. The muscle arises from the anterior superior iliac spine, and crosses obliquely medially as it descends to insert on the superior medial surface of the tibia. It is a flexor and lateral rotator of the hip joint and a flexor of the knee joint, as you can infer from its illustrated attachments. It is innervated by the femoral nerve.

The **quadriceps femoris** muscle arises from four heads. The **rectus femoris** arises from the anterior inferior iliac spine. The **vastus medialis** and **lateralis** each arise from the linea aspera on the posterior aspect of the femur; the **vastus intermedius** arises from the anterior and lateral femoral shaft. The four tendons converge at the patella as the tendon of quadriceps femoris.

The **patella** is the largest sesamoid bone in the body. It developed as a cartilaginous body in the tendon of quadriceps femoris as it passed over the anterior inferior surface of the femur and anterior superior surface of the tibia. Absent the patella, the tendon of quadriceps femoris would be subjected to serious abrasive forces when the tendon is brought into contact with the femur over which it is passing during flexion and extension of the knee joint. The patella thus incorporates the tendon of quadriceps in its bony structure. At the inferior aspect (apex) of the patella, the tendinous fibers of quadriceps continue to the tibial tuberosity as the **patellar ligament**.

The rectus femoris, a strong hip joint flexor, is the only member of the quadriceps to cross the hip joint. The four heads of the quadriceps femoris are the only knee extensors. The significance of the role of quadriceps becomes clear to those having experienced a knee injury; the muscles tend to atrophy and weaken rapidly with disuse, and "quad" exercises are essential to maintain structural stability of the joint. The muscle also suffers from insufficient stretching, except by athletes who depend on it. A "tight quad" can be a real pain, not to mention subtracting from a fully functioning and powerful knee extensor

The **iliopsoas** is the most powerful flexor of the hip, having a broad origin from the iliac fossa, iliac crest and the sacrum and sacroiliac ligaments (in the form of iliacus), as well as the narrow triangular psoas major and the much more slender psoas minor (see page 48). These muscles all attach at the lesser trochanter at the proximal end of the femoral shaft.

MUSCULAR SYSTEM / LOWER LIMB
MUSCLES OF THE ANTERIOR THIGH

See 60, 61

CN: The patellar ligament, G*, is colored gray but the patella is left uncolored. (1) Begin with the deep view of the thigh and then complete the superficial view. (2) On the far left, color the visualized portions of the quadriceps that are antagonists to the hamstring group. (3) Complete the action diagrams along the right margin.

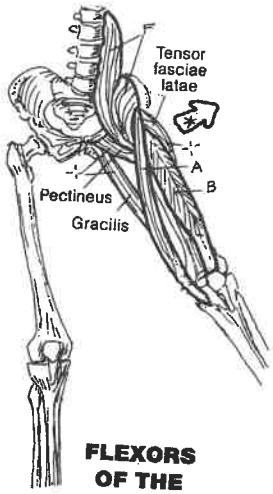
MUSCLES

SARTORIUS A

QUADRICEPS FEMORIS ⊹
- RECTUS FEMORIS B
- VASTUS LATERALIS C
- VASTUS INTERMEDIUS D
- VASTUS MEDIALIS E

ILIOPSOAS F

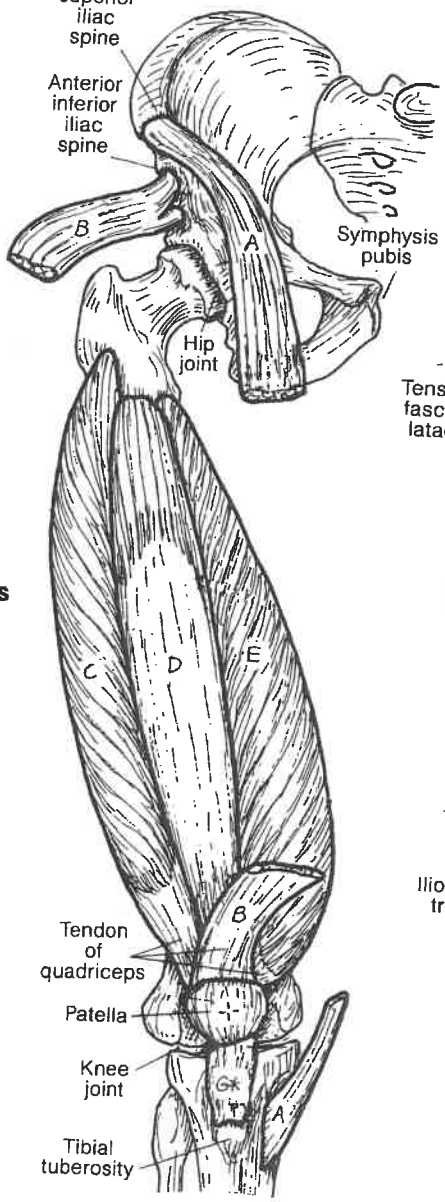
PATELLAR LIGAMENT G*



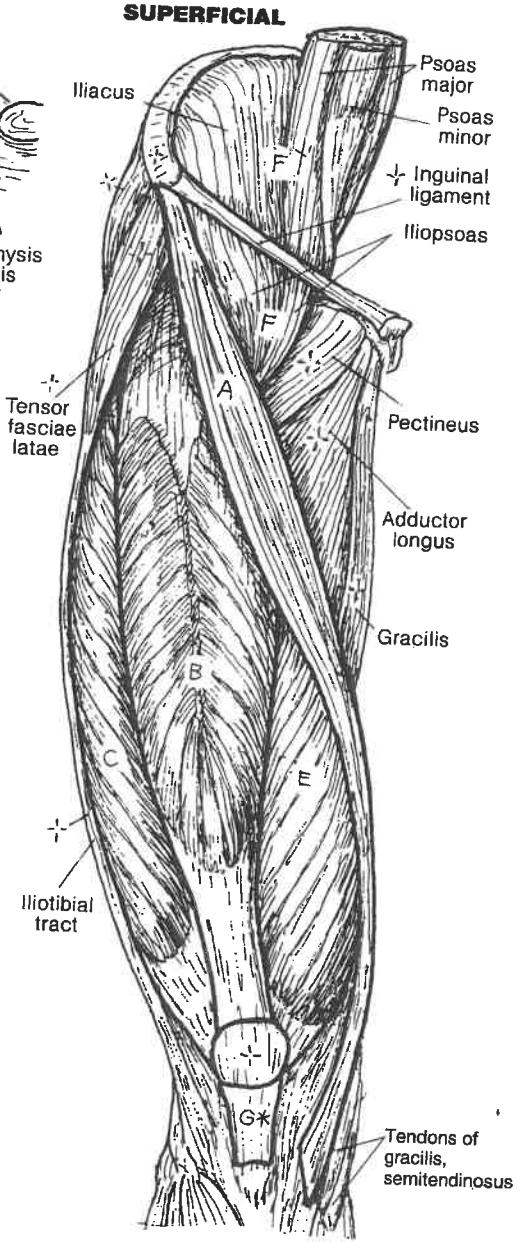
FLEXORS OF THE HIP JOINT

ANTERIOR VIEW

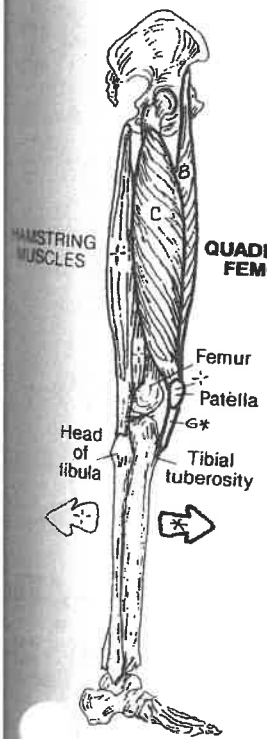
DEEP

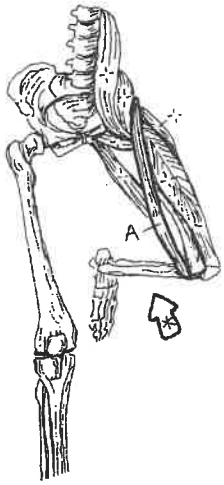


SUPERFICIAL

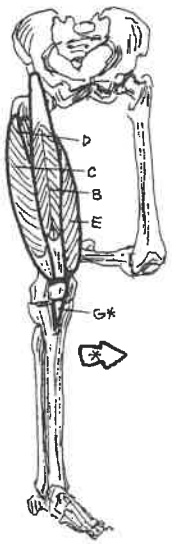


LATERAL VIEW





FLEXOR OF THE KNEE JOINT



EXTENSORS OF THE KNEE JOINT

The **muscles of the leg** are arranged into anterolateral, lateral, and posterior compartments. These muscles attached to the anterolateral surface of the tibia, the anterior aspect of the fibula; and the intervening interosseous membrane/ligament. The anteromedial surface of the tibia is bare of muscle attachments (as you can feel on yourself). The muscles of the posterior compartment (page 64) arise from the fibula, tibia, and the interosseous membrane. Insertions of these muscles are discussed below.

Three muscles arise in the anterolateral compartment: the **tibialis anterior** largely originates on the tibia, and its fellows the **extensor hallucis longus** and **extensor digitorum longus** arise from the interosseous membrane and the fibula. All of the anterior leg muscles are dorsiflexors (extensors) of the ankle; the extensors hallucis and digitorum longus are toe extensors; the tibialis anterior is an invertor of the subtalar joint as well, and the **fibularis tertius** (the fifth tendon of the extensor digitorum) is an evertor of the subtalar joint. Due to rotation of the lower limb during embryonic development, these extensors are anterior to the bones of attachment in the anatomical position (unlike the upper limb wrist extensors, which are posterior). In walking, the three anterolateral muscles of the leg are particularly helpful in lifting the foot up (plantar flexion) during the swing phase and avoiding "stubbing" of the toes.

The **fibular (peroneal) muscles** (*longus* and *brevis*) make up the lateral compartment of the leg. They arise largely from the fibula and interosseous membrane. They are principally evertors of the foot, and are especially active during plantar flexion (walking on the toes or pushing off with the great toe).

Look now at the diagram of foot movements at lower right and the plantar view above of the foot with muscle attachments. Tendons from certain anterior, lateral, and posterior muscle groups come around the side of the foot to attach to the plantar surfaces of certain tarsal and metatarsal bones. When these muscles contract, they pull up the side of the foot to which they are attached. Simply defined, these movements are **inversion** if the great-toe side of the foot is lifted, and **eversion** if the little-toe side of the foot is lifted. Clearly, then, the muscles inverting the foot will pass around the medial aspect of the foot; muscles everting the foot will pass around the lateral aspect of the foot. Remember: the muscles from the lateral leg compartment of the foot (fibularis longus and brevis) are both evertors of the subtalar joint.

MUSCLES OF THE ANTERIOR & LATERAL LEG

CN: The interosseous ligament (site of origin) has been left out of the attachment-sites illustration for simplification. Insertion sites on the plantar surface of the foot are shown at upper right. (1) Color the anterior muscles and related names, starting with the attachment sites (with a sharp pencil!). Note the insertion of tibialis anterior at the plantar surface of the foot in the small upper drawing. (2) Color the muscles in the lateral view and the plantar view. (3) Color the "Movements of the Foot" diagram and related muscles and arrows.

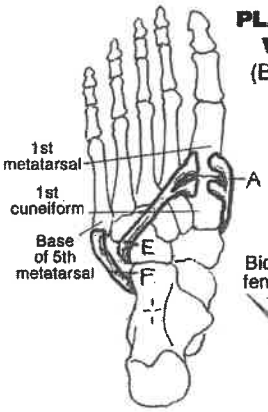
LATERAL LEG

FIBULARIS LONGUS E
FIBULARIS BREVIS F

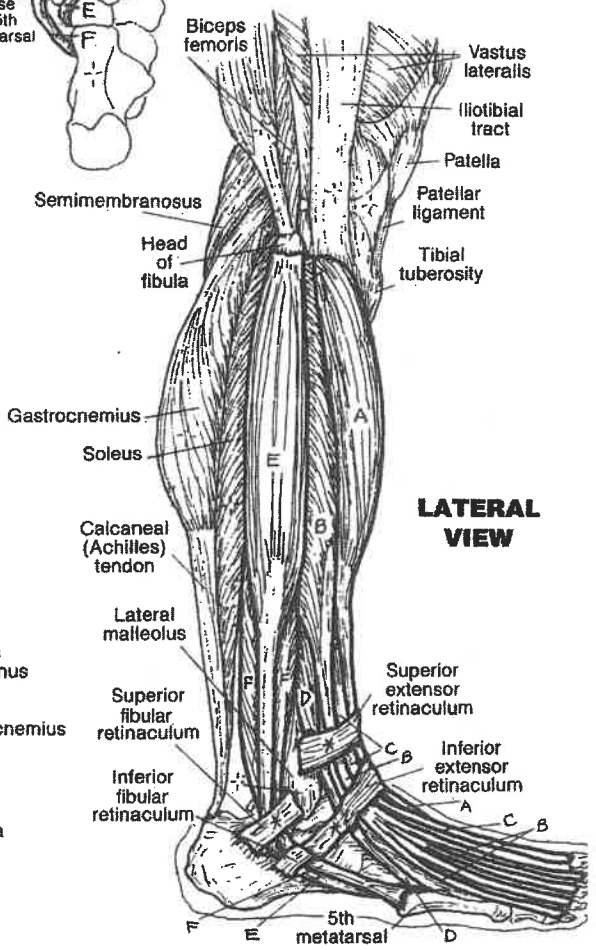
ANTERIOR LEG

TIBIALIS ANTERIOR A
EXTENSOR DIGITORUM LONGUS B
EXTENSOR HALLUCIS LONGUS C
FIBULARIS TERTIUS D

PLANTAR VIEW (Bottom)

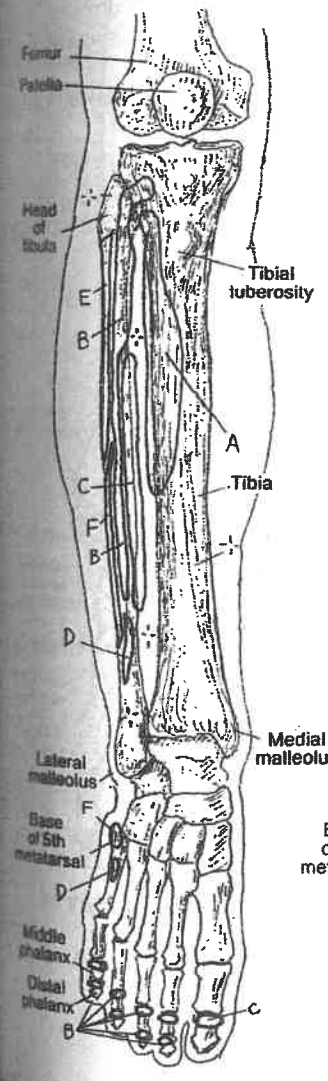


LATERAL VIEW

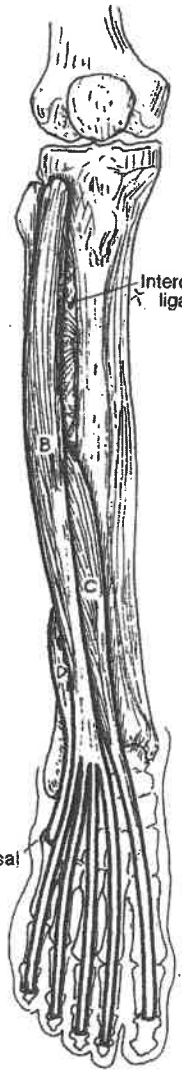


ANTERIOR VIEW (Right leg)

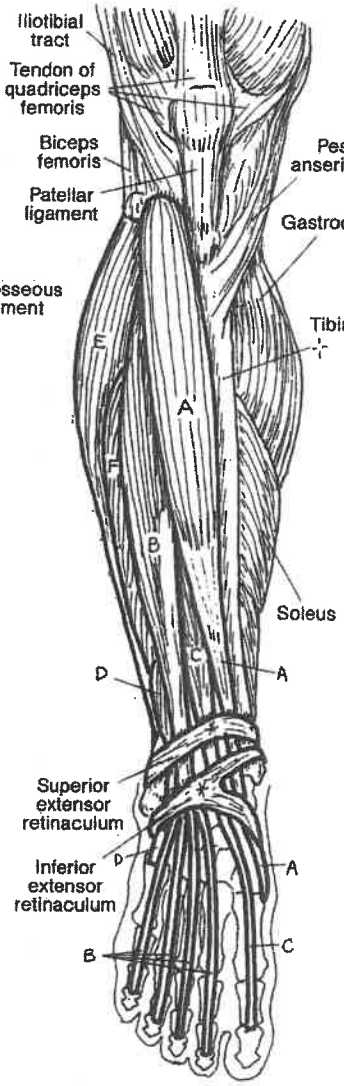
ATTACHMENT SITES

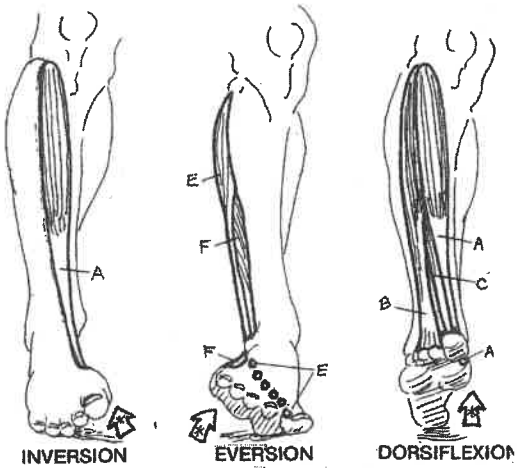


DEEP



SUPERFICIAL





MOVEMENTS OF THE FOOT

The **muscles of the posterior leg** (calf) are arranged into deep and superficial compartments between which is a fascial septum (barrier): the deep transverse fascia (not shown). The four muscles of the deep compartment arise from the tibia, the fibula, and/or the intervening interosseous membrane (see the "Deep View" and the "Attachment Sites"). The **popliteus** is all by itself in the upper part of the deep compartment, where it flexes the knee joint and rotates the tibia. The **tibialis posterior** occupies the center position in the deep compartment. Its tendon swings to the big-toe side, wraps around the medial aspect of the foot, and inserts on a host of bones on the plantar surface of the foot (cuboid, cuneiforms, navicular, and the base of the metatarsals). It flexes and inverts the foot. The tendons of **flexors hallucis longus** and **digitorum longus** wrap around the medial arch to reach the plantar surface of the great toe and the plantar surface of the bones of the forefoot. The deep fascial compartments of the posterior leg muscles are fairly inelastic. Muscle swelling secondary to vascular insufficiency can result in serious muscle compression with loss of the muscles (compartment syndrome) in the absence of fascial (surgical) decompression.

You might want to spend some time with the illustrations on pages 63–65 and work to fully understand the disposition of these tendons that arise from anterior, lateral, and posterior leg muscles to insert on the plantar aspect of the foot. It can be confusing if you don't.

The superficial group (**gastrocnemius, soleus**) of muscles insert on the calcaneus by way of a common tendon, the tendocalcaneus (Achilles tendon; see Glossary). These muscles collectively lift the posterior calcaneus (heel) up in plantar flexion of the foot, leaving the toes to carry the weight of the body. The gastrocnemius crosses the knee joint and is therefore a flexor of that joint.

Plantaris is a small muscle that arises just above the lateral femoral condyle and continues distally as a variably narrow, thin, pencil-size tendon to insert in the tendocalcaneus just above the latter's insertion on the calcaneus. Players of court games (tennis, racquetball, squash, etc.) may become familiar with the tendon of this muscle when it "snaps" (more like "pops") under excessive tension during dorsiflexion (extension) of the ankle joint. Its loss is of no significant consequence.

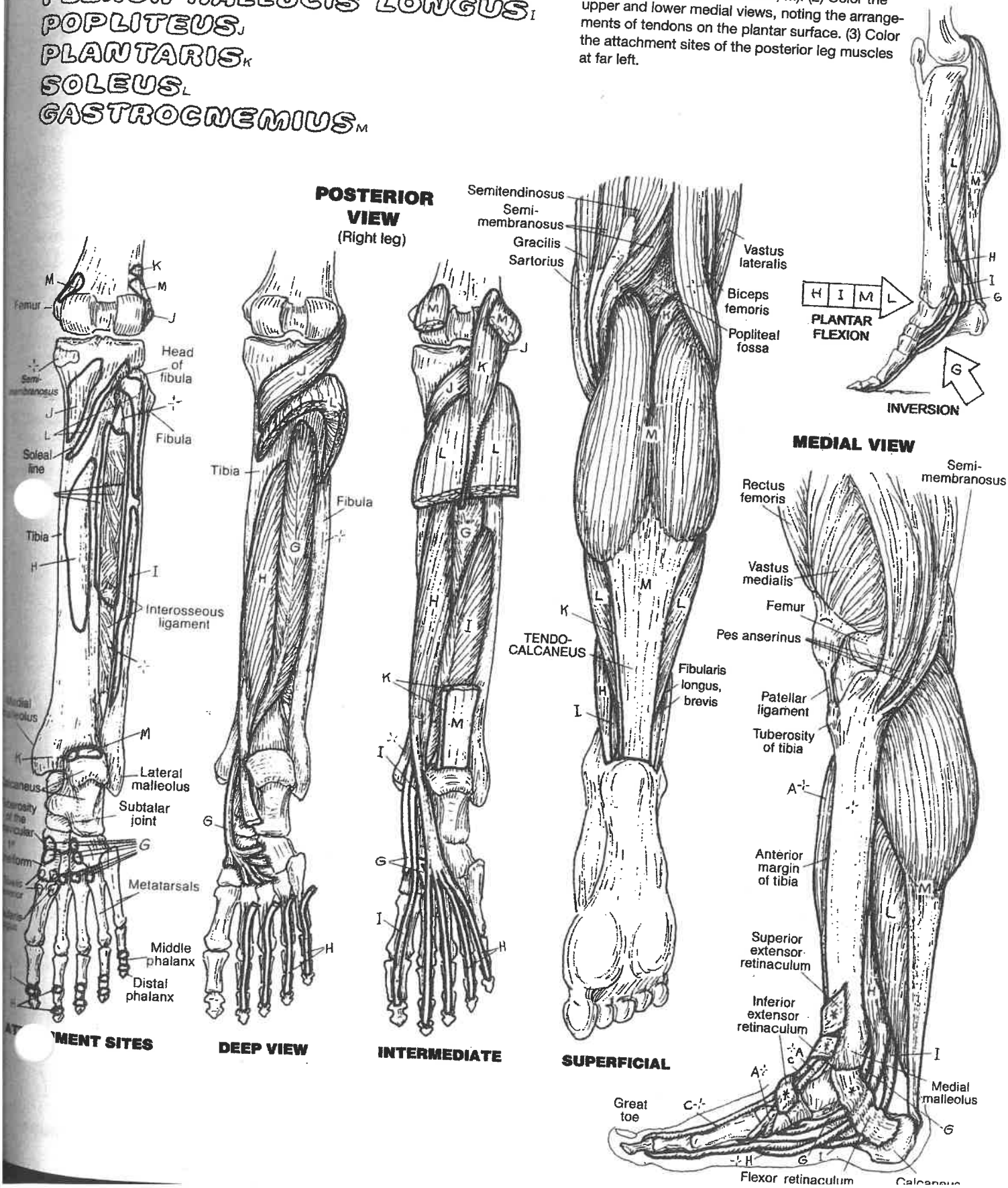
MUSCLES OF THE POSTERIOR LEG

See 63, 65

MUSCLES

TIBIALIS POSTERIOR G
FLEXOR DIGITORUM LONGUS H
FLEXOR HALLUCIS LONGUS I
POPLITEUS J
PLANTARIS K
SOLEUS L
GASTROCNEMIUS M

CN: Use light colors different from those used on page 63. (1) Color one muscle at a time, from deep to superficial, in each of the posterior views. Note that, soleus, L, and gastrocnemius, M, share the same tendon (tendocalcaneus, M). (2) Color the upper and lower medial views, noting the arrangements of tendons on the plantar surface. (3) Color the attachment sites of the posterior leg muscles at far left.



The dorsal intrinsic **muscles of the foot** (those that arise and insert within the dorsum of the foot) are limited to two small extensors of the toes (the **extensor digitorum brevis** and the **extensor hallucis brevis**), shown at right. Most of the extensor function is derived from extrinsic extensors.

The intrinsic muscles of the plantar region of the foot are shown here in four layers. The **plantar interossei**, wedged between the metatarsal bones, constitute the deepest (**fourth**) **layer**. They adduct toes 3–5, flex the metatarsophalangeal (MP) joints of these toes, and contribute to extension of the interphalangeal (IP) joints of these toes through the mechanism of the extensor expansion. The **dorsal interossei** abduct toes 3–5 and facilitate the other actions of the plantar interossei.

The **third layer** of muscles acts on the great toe (hallux) and fifth digit (digiti minimi).

The **second layer** includes the **quadratus plantae**, which inserts into the lateral border of the common tendon (H) of the flexor digitorum longus (FDL). It assists that muscle in flexion of the toes. The **lumbricals** arise from the individual tendons of the FDL and insert into the medial aspect of the extensor expansion (dorsal aspect). They flex the MP joints and extend the IP joints of toes 2–5 via the extensor expansion.

The superficial **(first) layer** consists of the abductors (**abductor hallucis** and **abductor digiti minimi**) of the first and fifth digits and the **flexor digitorum brevis**. The plantar muscles are covered by the thickened deep fascia of the sole and the plantar aponeurosis, extending from the calcaneus to the fibrous sheath of the flexor tendons.

It seems an injustice to only know these complex, critical muscle layers by virtue of walking on them under all sorts of difficult conditions. When they work, you work. When they don't, you don't...and you may soon make friends with your podiatrist or other appropriate health care provider.

MUSCULAR SYSTEM / LOWER LIMB
MUSCLES OF THE FOOT (Intrinsics)

CN: Only color the muscles whose names are listed on this page. Letter labels taken from the previous page are for identification purposes only. You may have to the same color more than once. (1) Attachment sites of extrinsic foot muscles found on the two preceding pages. (2) Begin with the fourth (deepest) layer complete each illustration before going on to the next.

MUSCLES

FOURTH LAYER

3 PLANTAR INTEROSSEI P
4 DORSAL INTEROSSEI Q

THIRD LAYER

FLEXOR HALLUCIS BREVIS R
ADDUCTOR HALLUCIS S
FLEXOR DIGITI MINIMI BREVIS T

SECOND LAYER

QUADRATUS PLANTAE U
4 LUMBRICALS V

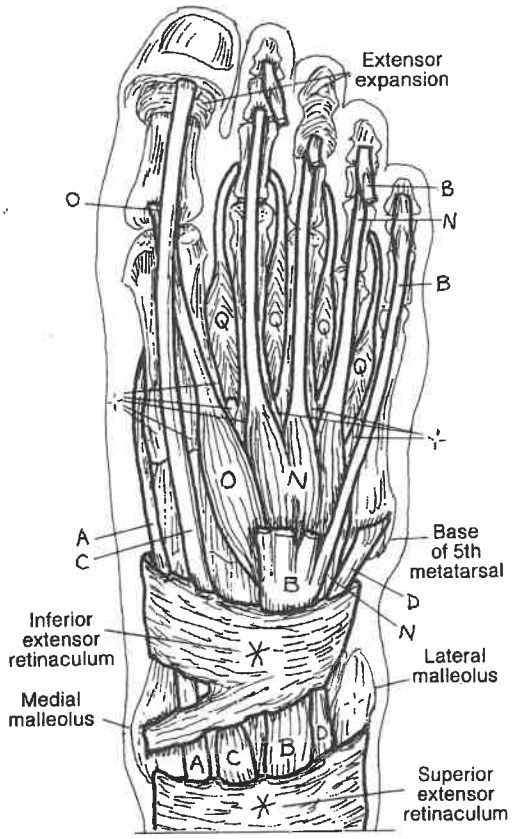
FIRST LAYER

ABDUCTOR HALLUCIS W
ABDUCTOR DIGITI MINIMI X
FLEXOR DIGITORUM BREVIS Y

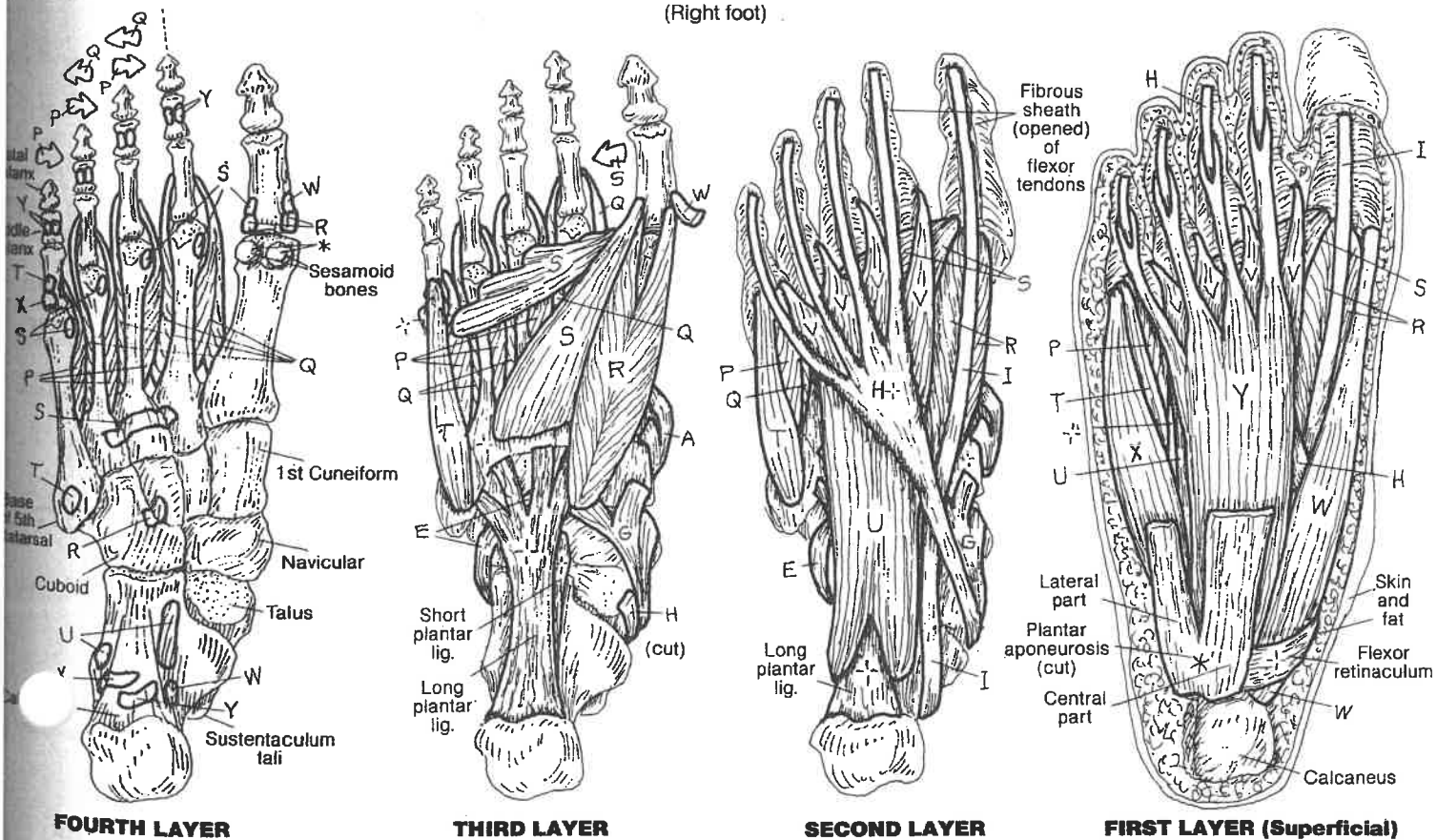
DORSAL SURFACE

EXTENSOR DIGITORUM BREVIS N
EXTENSOR HALLUCIS BREVIS O

DORSAL SURFACE
(Right foot)



PLANTAR SURFACE
(Right foot)



FOURTH LAYER | **THIRD LAYER** | **SECOND LAYER** | **FIRST LAYER (Superficial)**