ВОЛГОГРАДСКИЙ
ГОСУДАРСТВЕННЫЙ
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УНИВЕРСИТЕТ

The lower extremity

Femoral region part I

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Bones of lower limb

The femur is the longest and heaviest bone in the body. The femur consists of a shaft (body) and superior or proximal and inferior or distal ends. Most of the shaft is smoothly rounded, except for a prominent double-edged ridge on its posterior aspect, the linea aspera, which diverges inferiorly. The proximal end of the femur consists of a head, neck, and greater and lesser trochanters.

Bones of lower limb

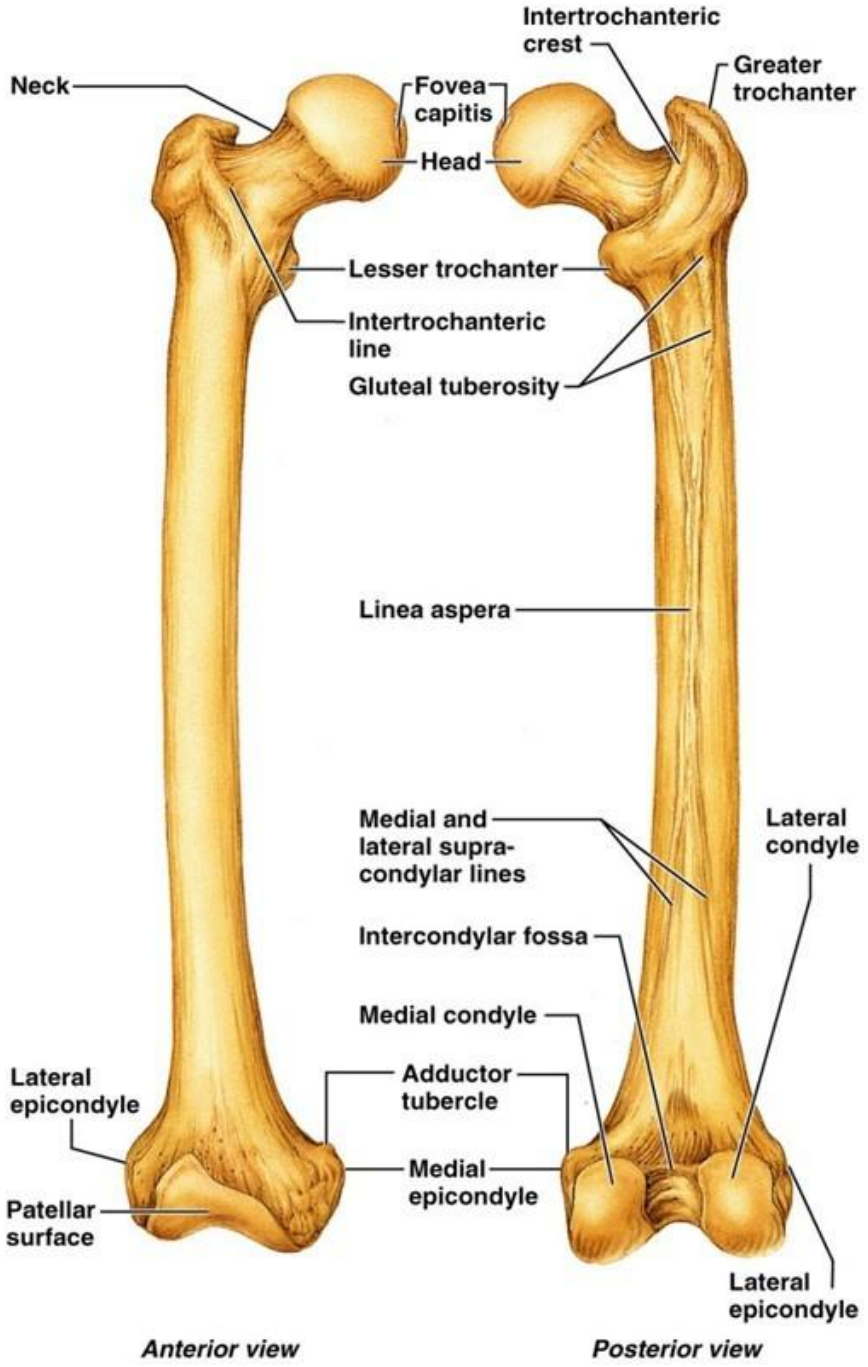
The head of the femur is covered with articular cartilage, except for a medially placed depression or pit, the fovea for the ligament of the head. The neck of the femur is trapezoidal; the narrow end supports the head and its broader base is continuous with the shaft. Where the neck joins the shaft are two large, blunt elevations— the trochanters.

Bones of lower limb

The **intertrochanteric line** is a roughened ridge running from the greater to the lesser trochanter. A similar but smoother ridge, the **intertrochanteric crest**, joins the trochanters posteriorly. The distal end of the femur ends in two spirally curved femoral condyles (medial and lateral). The femoral condyles articulate with the tibial condyles to form the knee joint.

Bones of lower limb

The femur



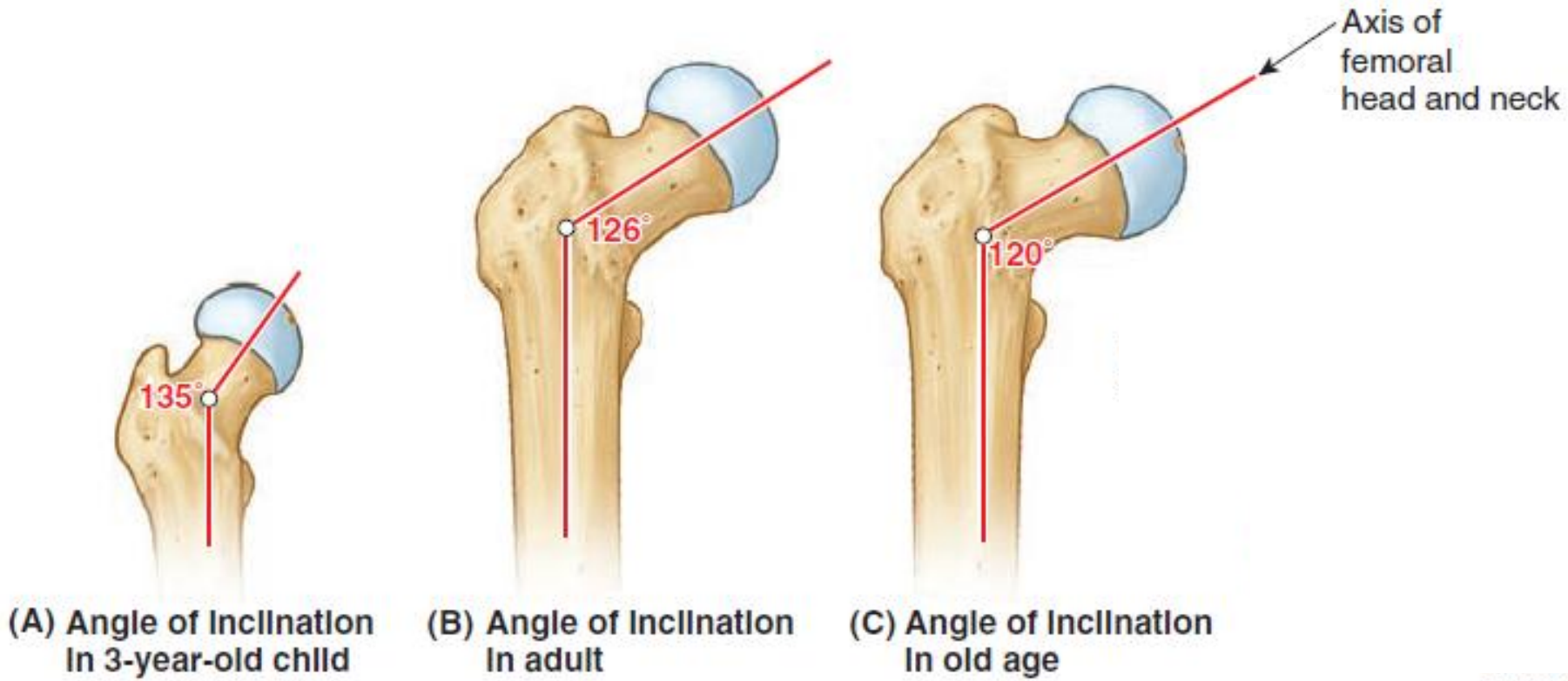
Bones of lower limb

The proximal femur is bent, making the femur L-shaped, so that the long axis of the head and neck project superomedially at an angle to that of the obliquely oriented shaft. This obtuse **angle of inclination** in the adult is 115 to 140 degrees, averaging 126 degrees. The angle is less in females because of the increased width between the acetabula and the greater obliquity of the shaft.

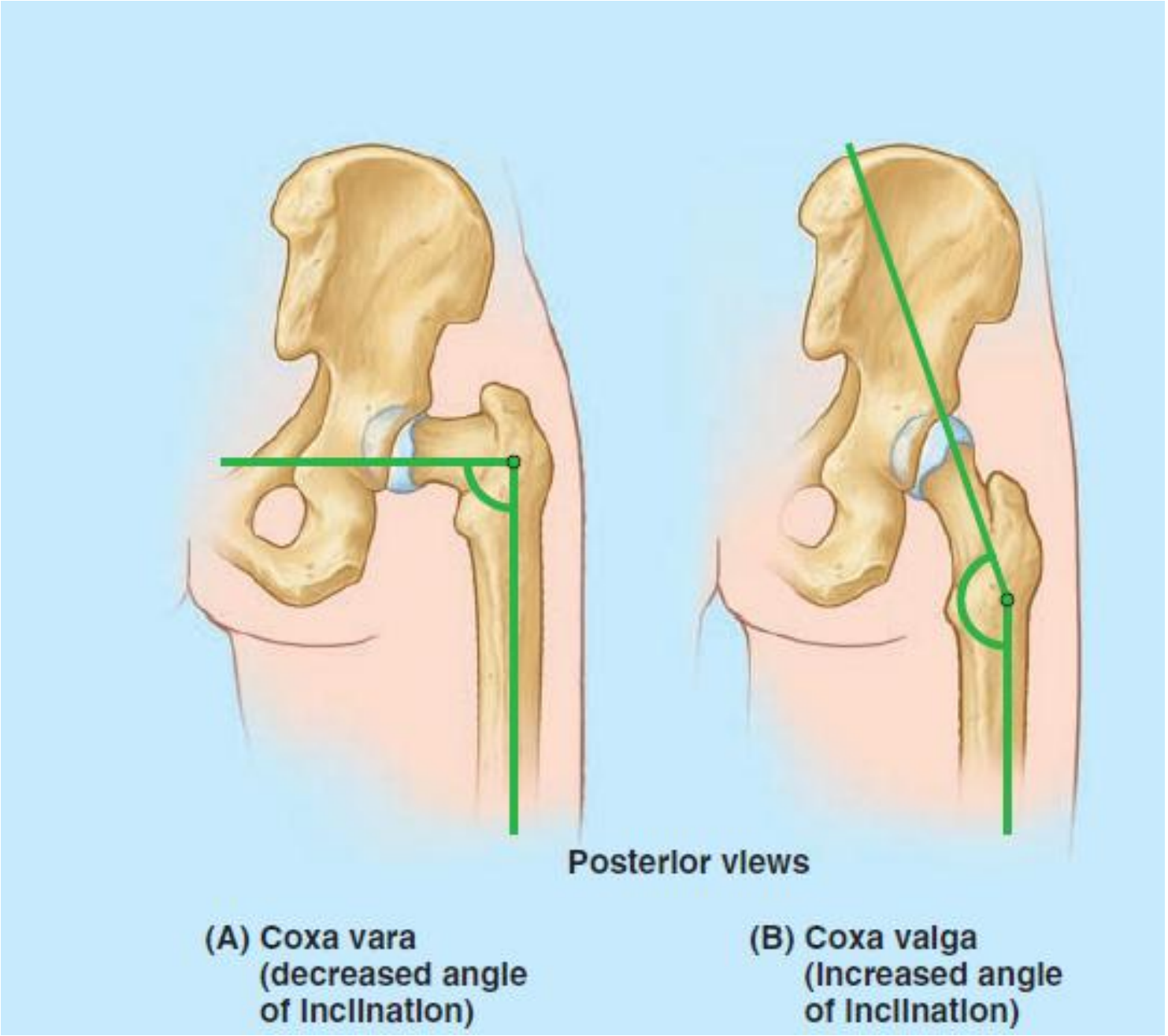
Bones of lower limb

The angle of inclination allows greater mobility of the femur at the hip joint because it places the head and neck more perpendicular to the acetabulum. This is advantageous for bipedal walking; however, it imposes considerable strain on the neck of the femur. Fractures of the neck may occur in older people as a result of a slight stumble if the neck has been weakened by osteoporosis.

The angle of inclination



The angle of inclination



The angle of inclination

The angle of inclination varies with age, sex, and development of the femur (e.g., consequent to a congenital defect in ossification of the femoral neck). It also may change with any pathological process that weakens the neck of the femur (e.g., rickets). When the angle of inclination is decreased, the condition is coxa vara; when it is increased, the condition is coxa valga. Coxa vara causes a mild passive abduction of the hip

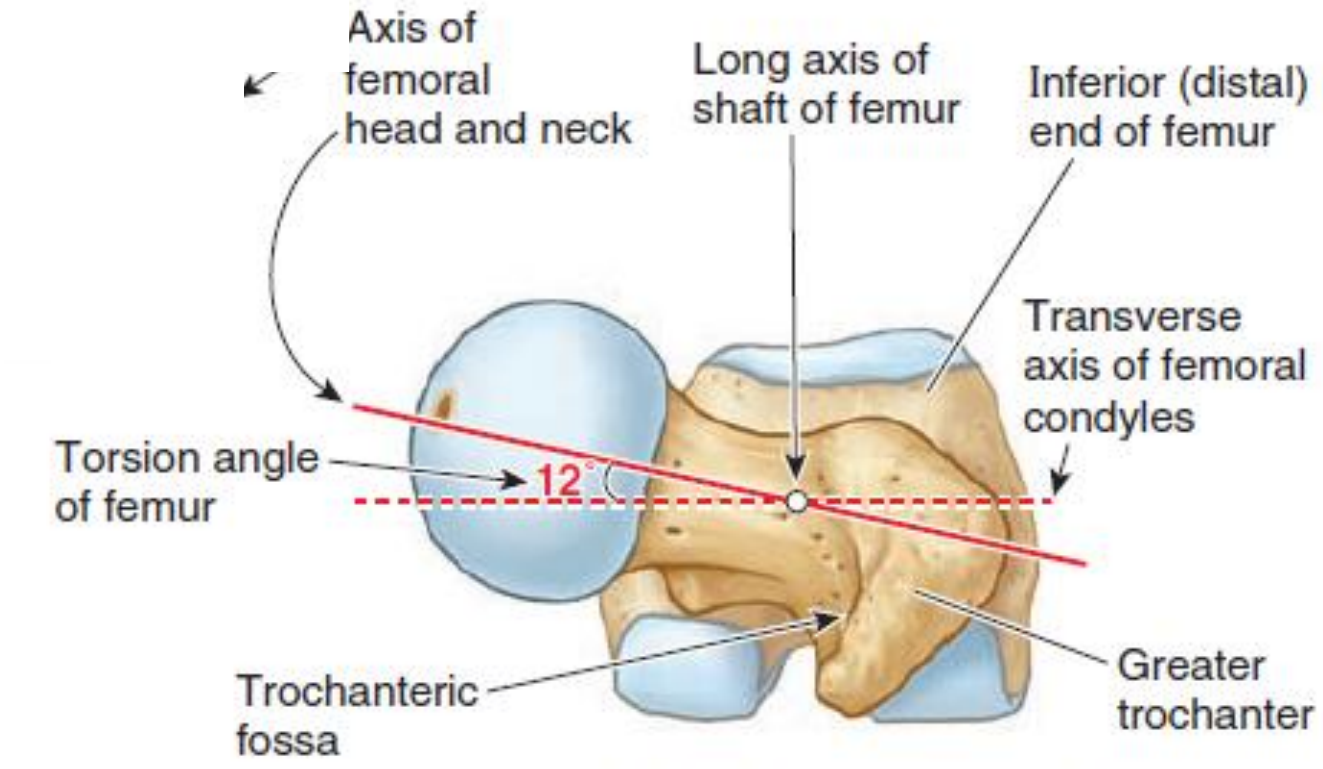
The torsion angle

When the femur is viewed superiorly, so that the proximal end is superimposed over the distal end, it can be seen that the axis of the head and neck of the femur and the transverse axis of the femoral condyles intersect at the long axis of the shaft of the femur, forming **the torsion angle,** or **angle of declination**. The mean torsion angle is 7 degrees in males and 12 degrees in females.

The torsion angle

The torsion angle, combined with the angle of inclination, allows rotatory movements of the femoral head within the obliquely placed acetabulum to convert into flexion and extension, abduction and adduction, and rotational movements of the thigh.

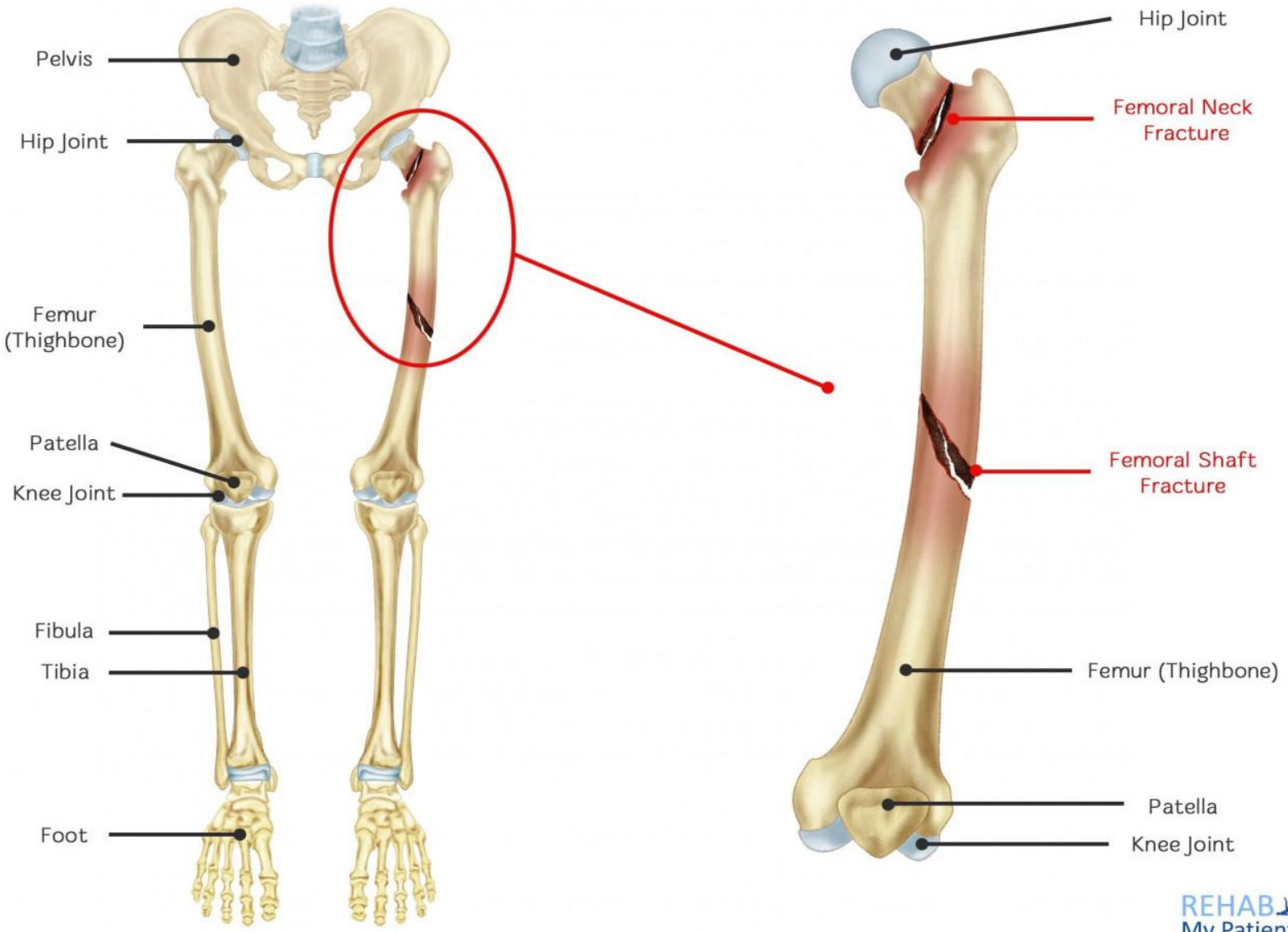
The torsion angle



clination

(D) Superior view demonstrating torsion angle of femur

Femoral Fracture



Femoral Fracture

The thighbone (femur) is the longest bone found in the body. Since the femur is so strong, it will take a great deal of force to break this bone. A car crash is one of the main causes of a femoral fracture. The straight, long part of the bone is referred to as the femoral shaft. Whenever a break occurs anywhere along the length of the bone, it is referred to as a femoral shaft fracture.

Femoral Fracture

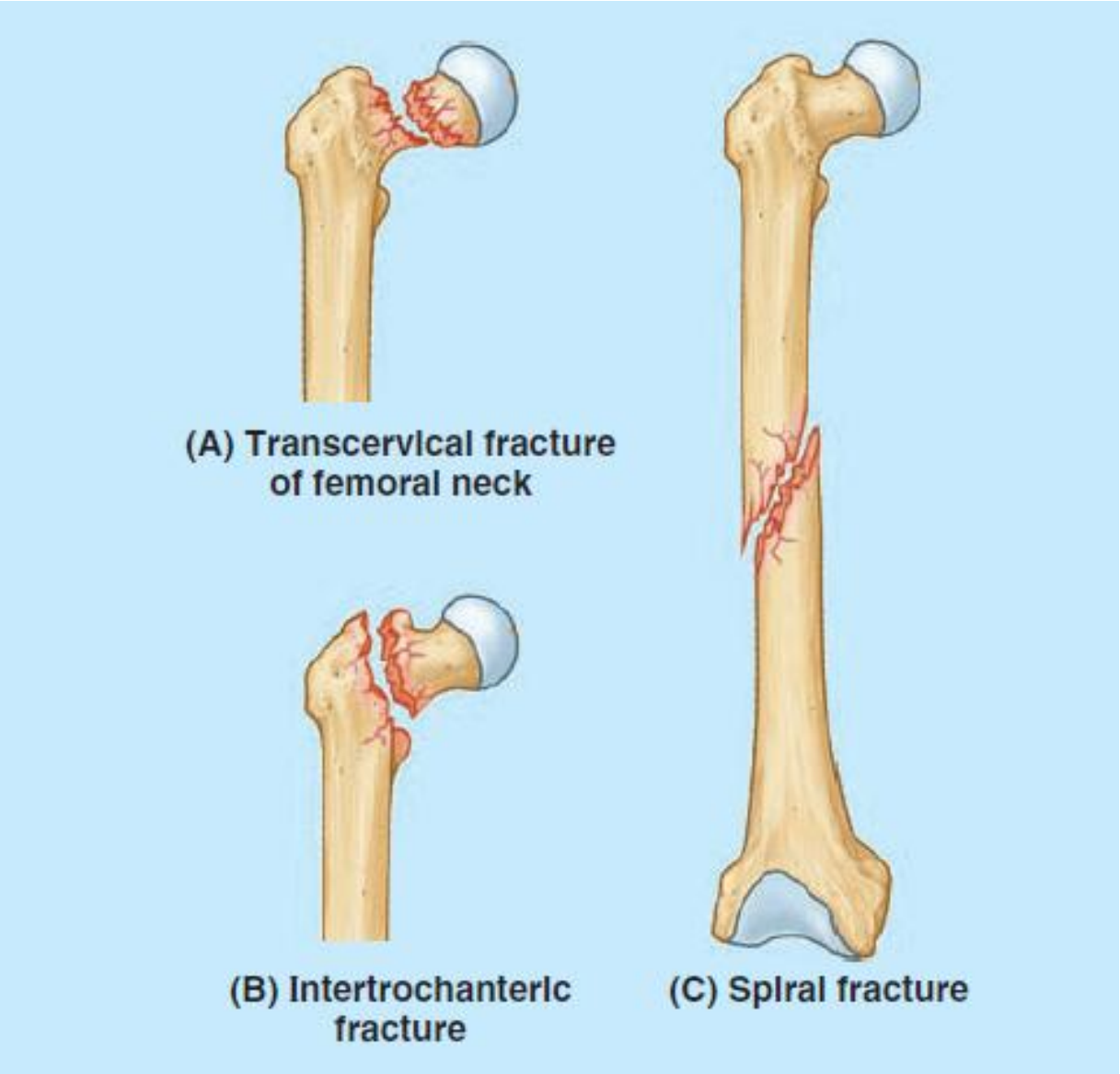
The femur has an exceptional supply of blood going to it. It is because of this and the protective surrounding muscle that the shaft doesn't easily fracture. When fracture does occur, sometimes the force can be excessive enough to cause displacement in which case the bone dislocates from its correct position.

Femoral Fracture

Femoral fractures are common in high trauma incidents such as car crashes or falling from a height. But the population most likely to suffer with femoral fractures are the elderly, especially elderly ladies. This is because the neck of the femur is prone to osteoporosis (bone thinning). A simple fall from tripping over a curb or pavement slab can be enough to cause a fall and fracture the femur.

Femoral Fracture

Fractures of the proximal femur can occur at several locations—for example, transcervical and intertrochant eric



Femoral Fracture

How to Treat a Femoral Fracture:

- **Intramedullary Nailing**

The method the majority of surgeons tend to use for treating fractures is that of intramedullary nailing. During the procedure, a metal rod that is specially designed will be inserted into the narrow femur canal. The rod passes along the fracture to make sure it stays in position.

Femoral Fracture

How to Treat a Femoral Fracture:

- **Intramedullary Nailing**

An intramedullary nail is inserted into canal at either the knee or the hip through a small incision. The nail will be screwed in at either end, which help to keep the nail and the bone where they need to be in the healing process. The nails are often made from titanium. They come in an array of different lengths and diameters to accommodate the majority of femur bones.

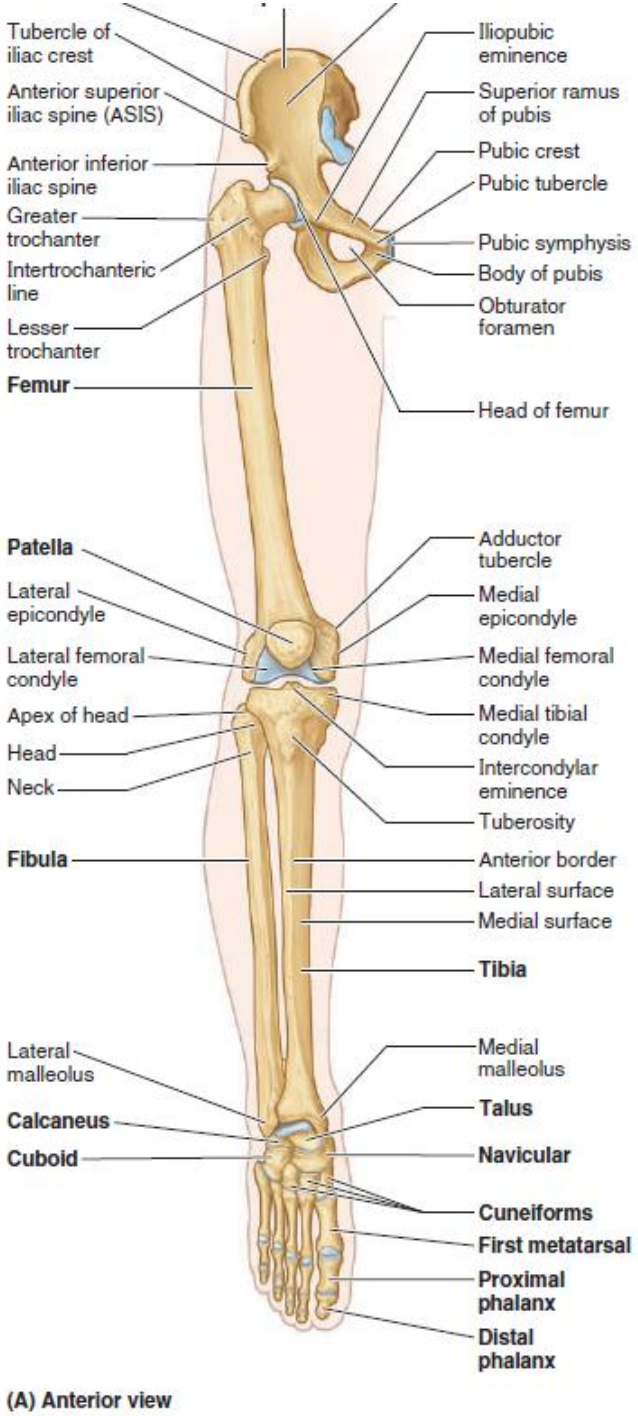
Femoral Fracture

How to Treat a Femoral Fracture:

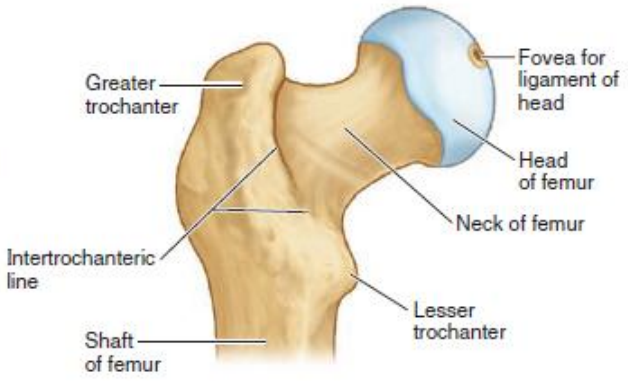
- **Plates and Screws**

During this particular operation, all of the bone fragments are repositioned back to where they are supposed to be. They are held in position with specialized screws and metal plates that affix to the outer part of the bone. Screws and plates are generally used when intramedullary nailing isn't possible, such as that of fractures extending into the knee and hip joints.

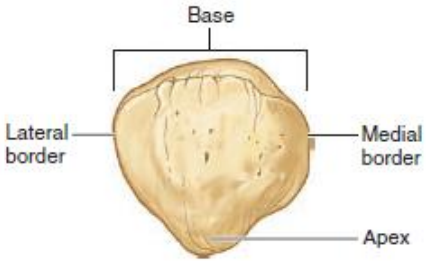
An overview of bones of the lower extremity



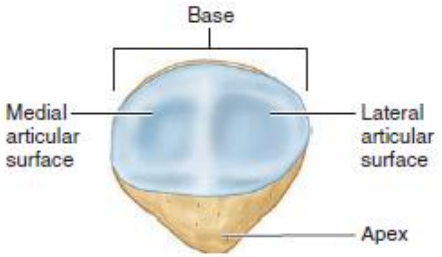
(A) Anterior view



(B) Anterior view of proximal femur

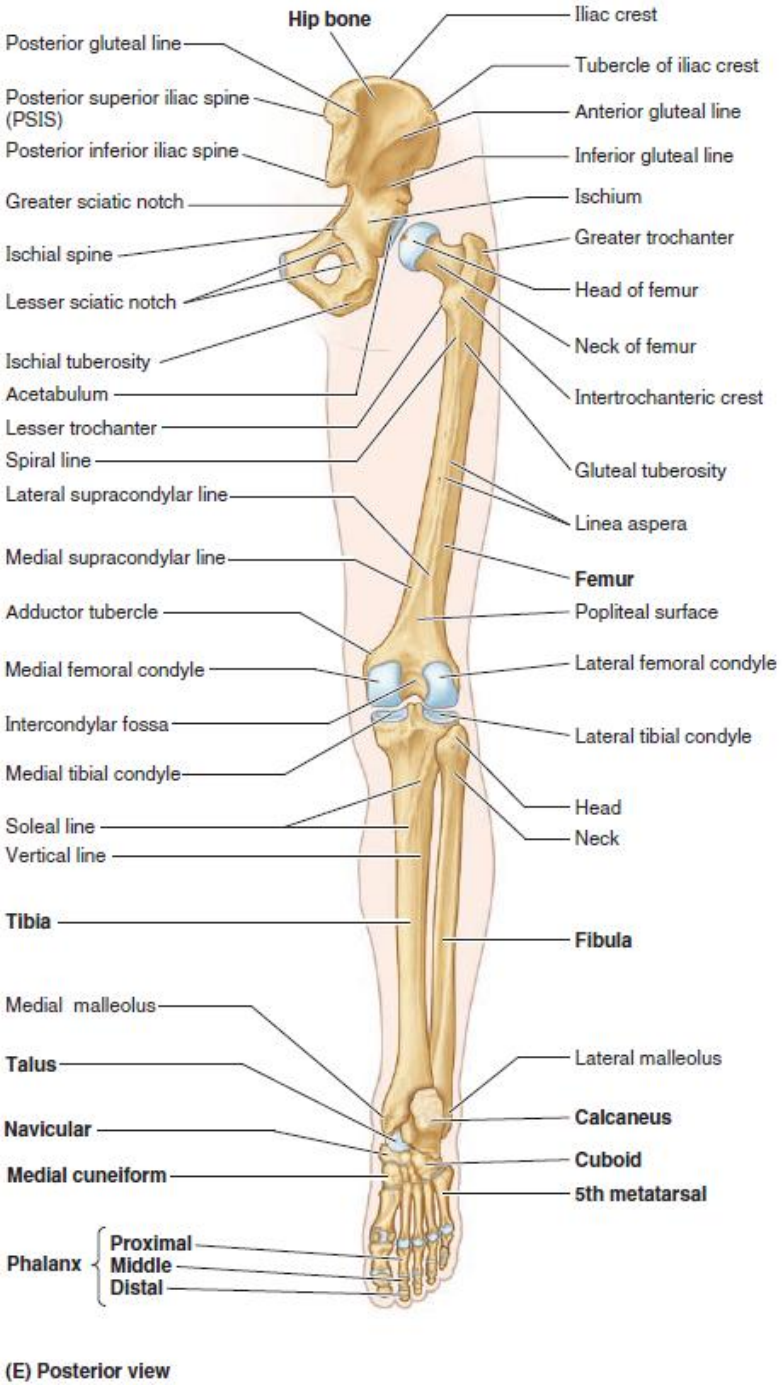


(C) Anterior view of patella



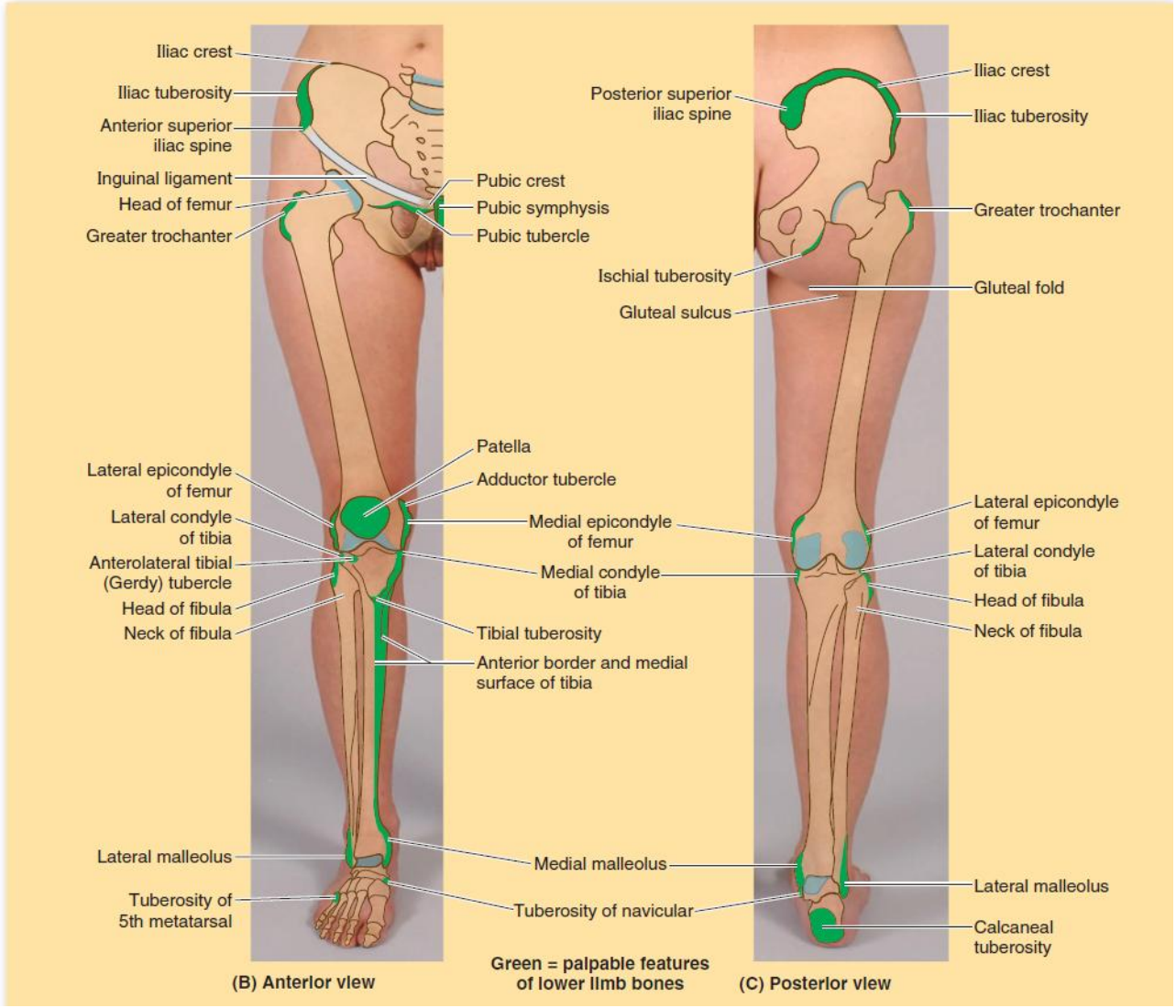
(D) Posterior view of patella

An overview of bones of the lower extremity

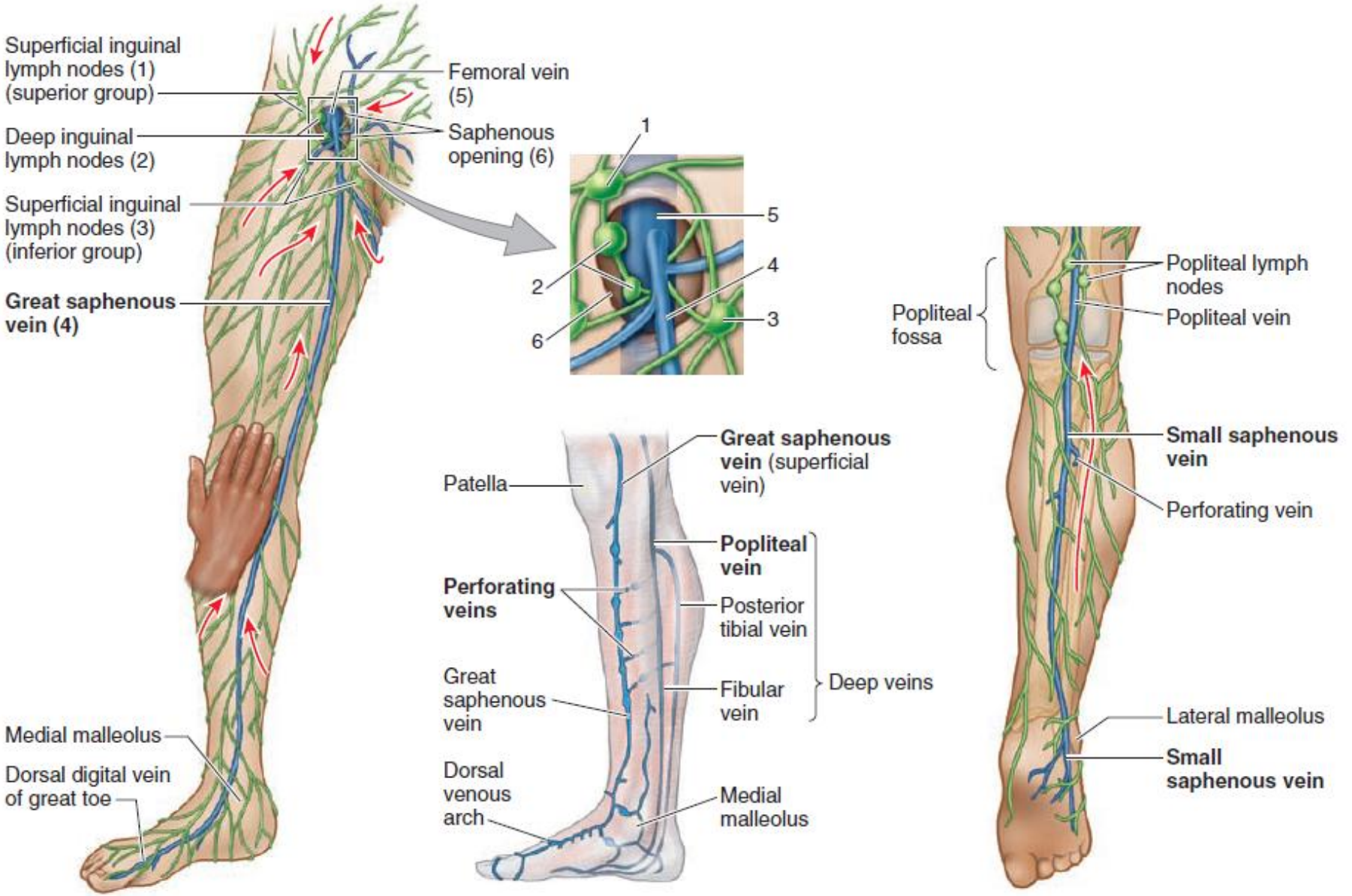


(E) Posterior view

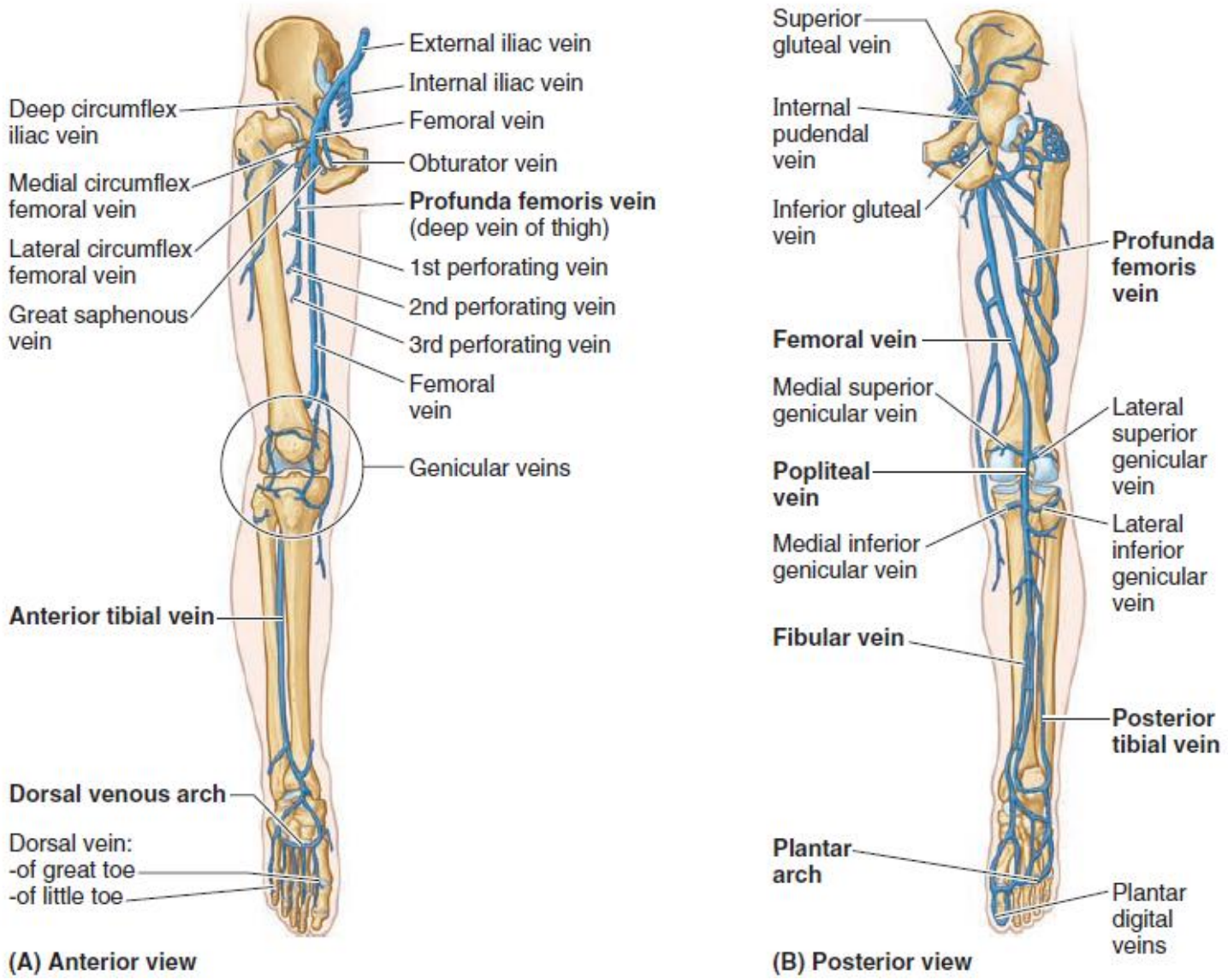
The landmarks of the lower extremity



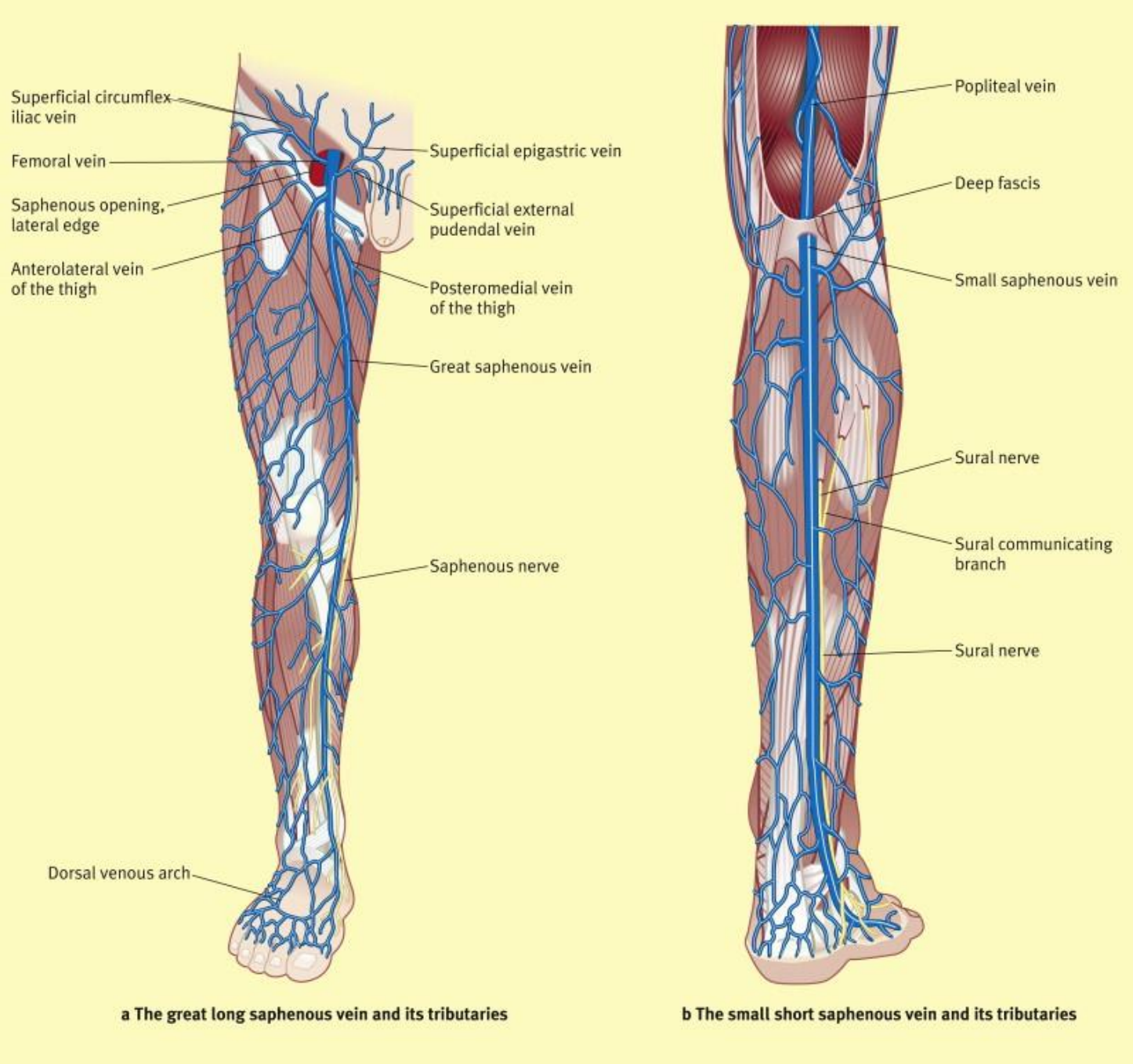
Venous and Lymphatic Drainage of Lower Limb



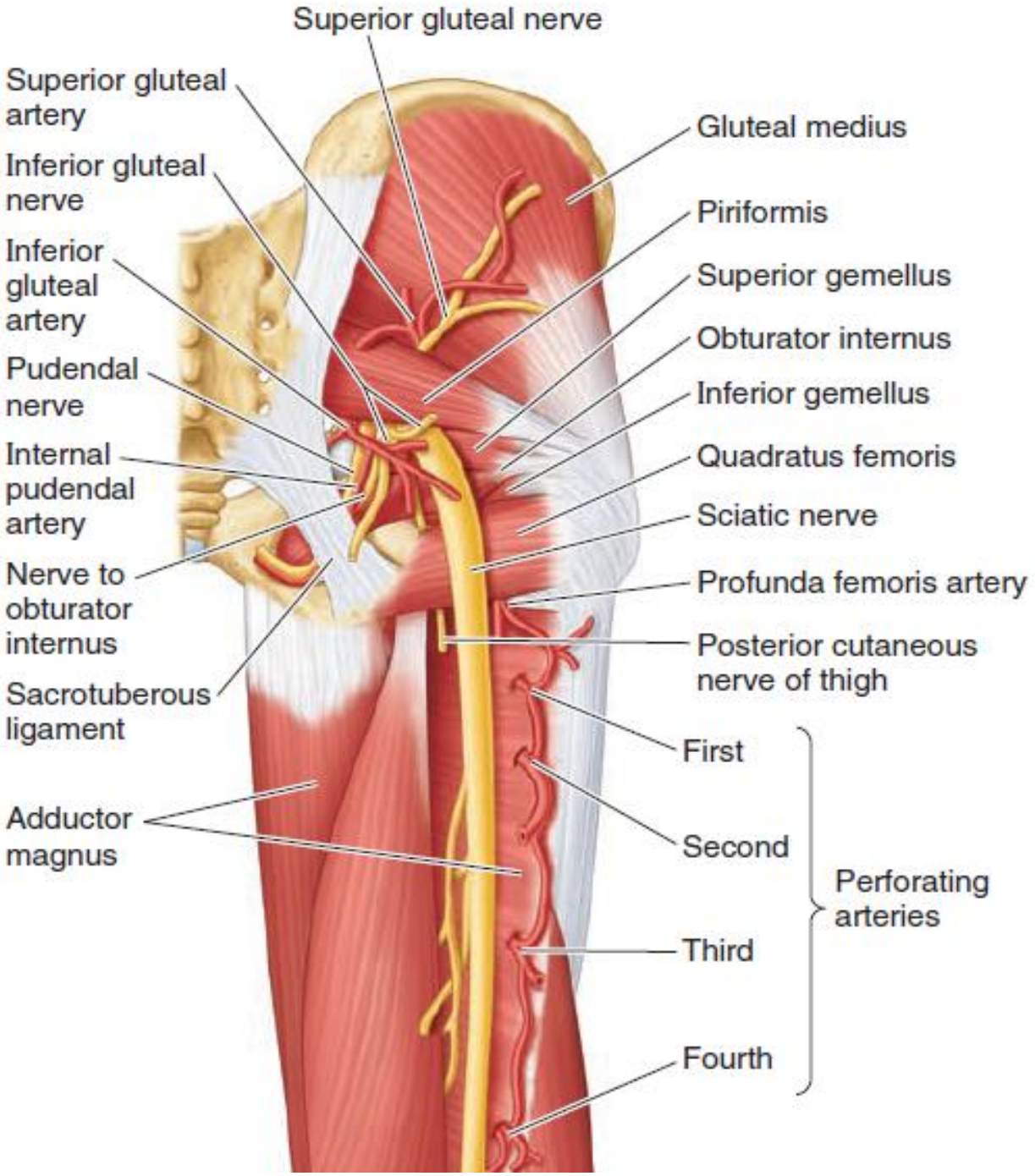
Deep Venous Drainage of Lower Limb



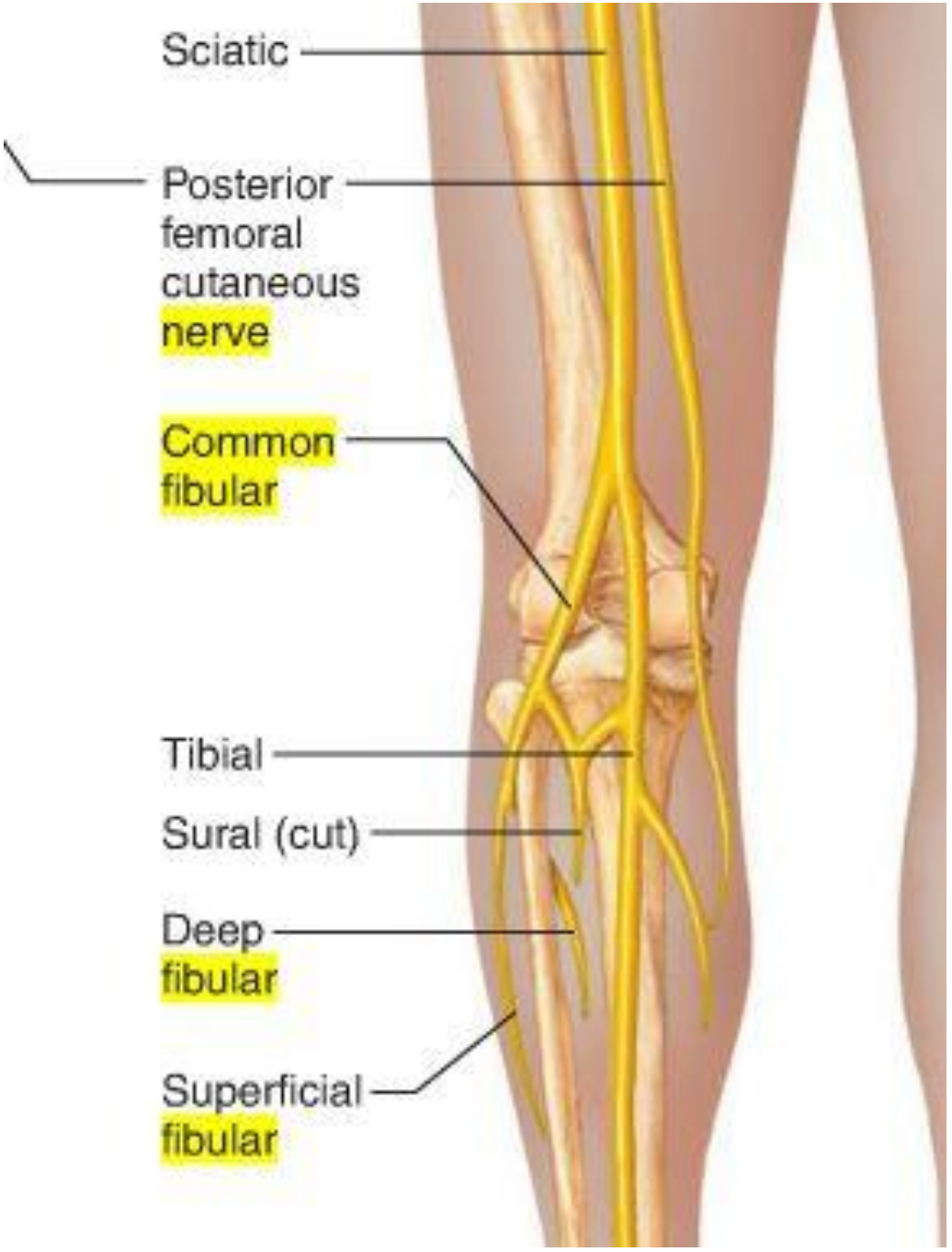
Superficial Venous Drainage of Lower Limb



Course of arteries and nerves in gluteal region and posterior thigh



The sciatic nerve usually ends at the superior angle of the popliteal fossa by dividing into the tibial and common fibular nerves



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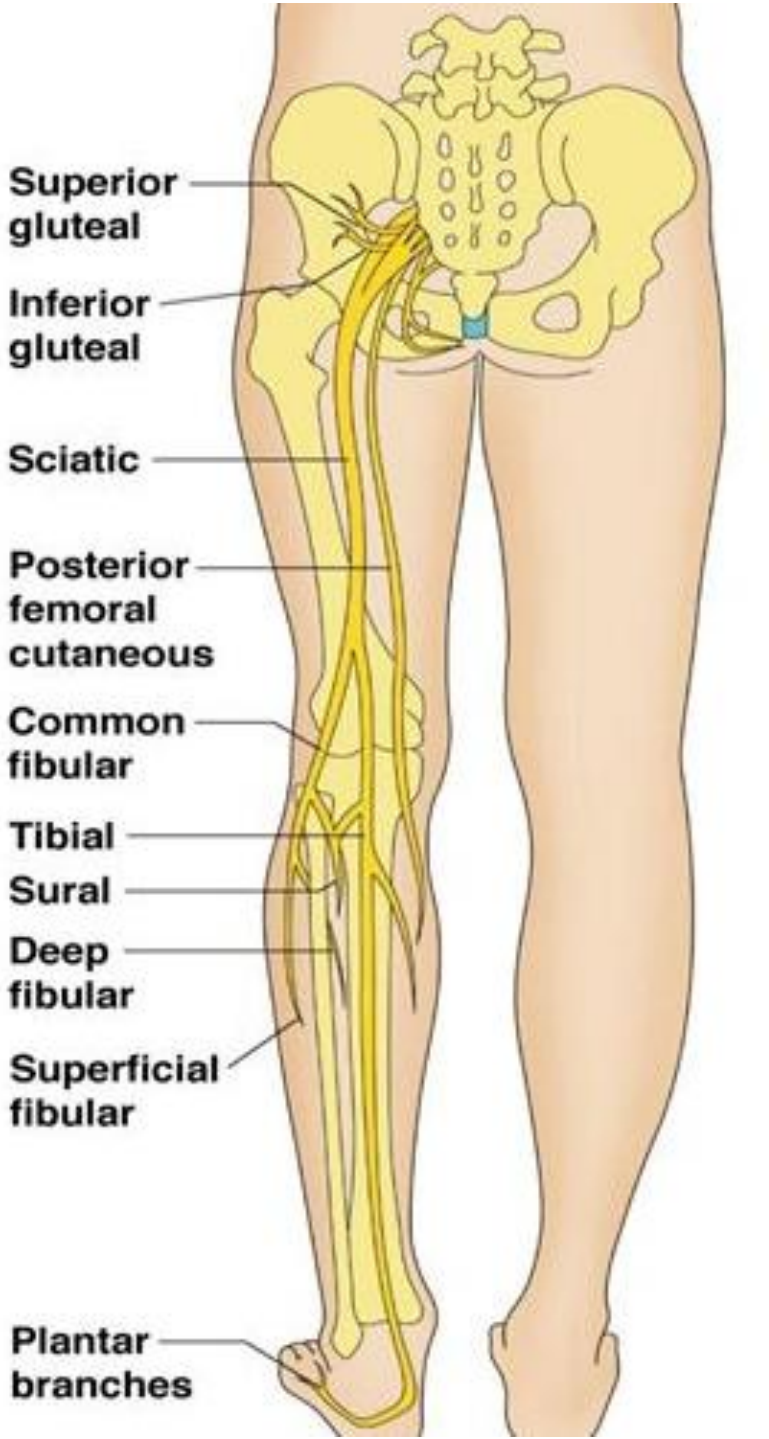
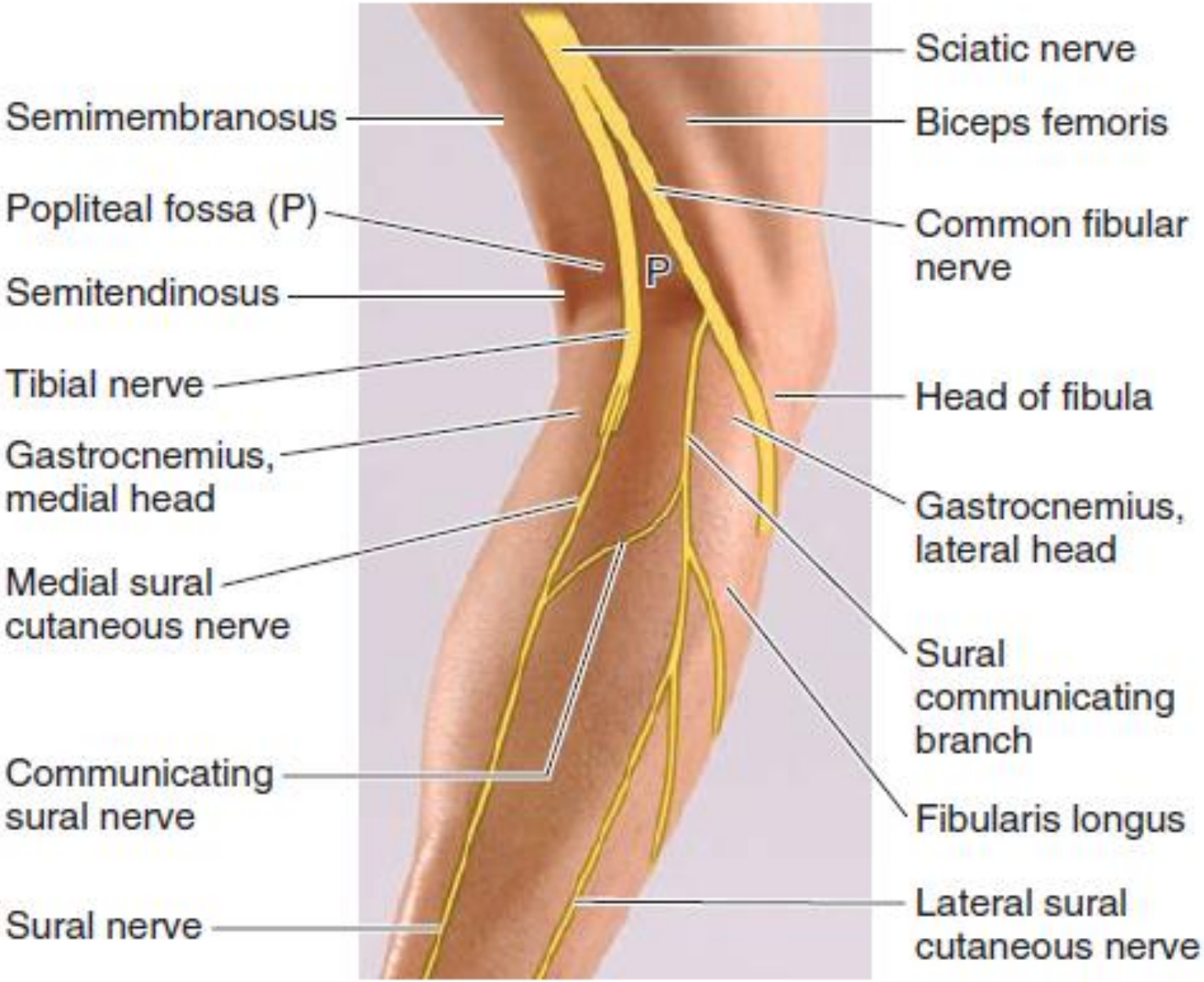
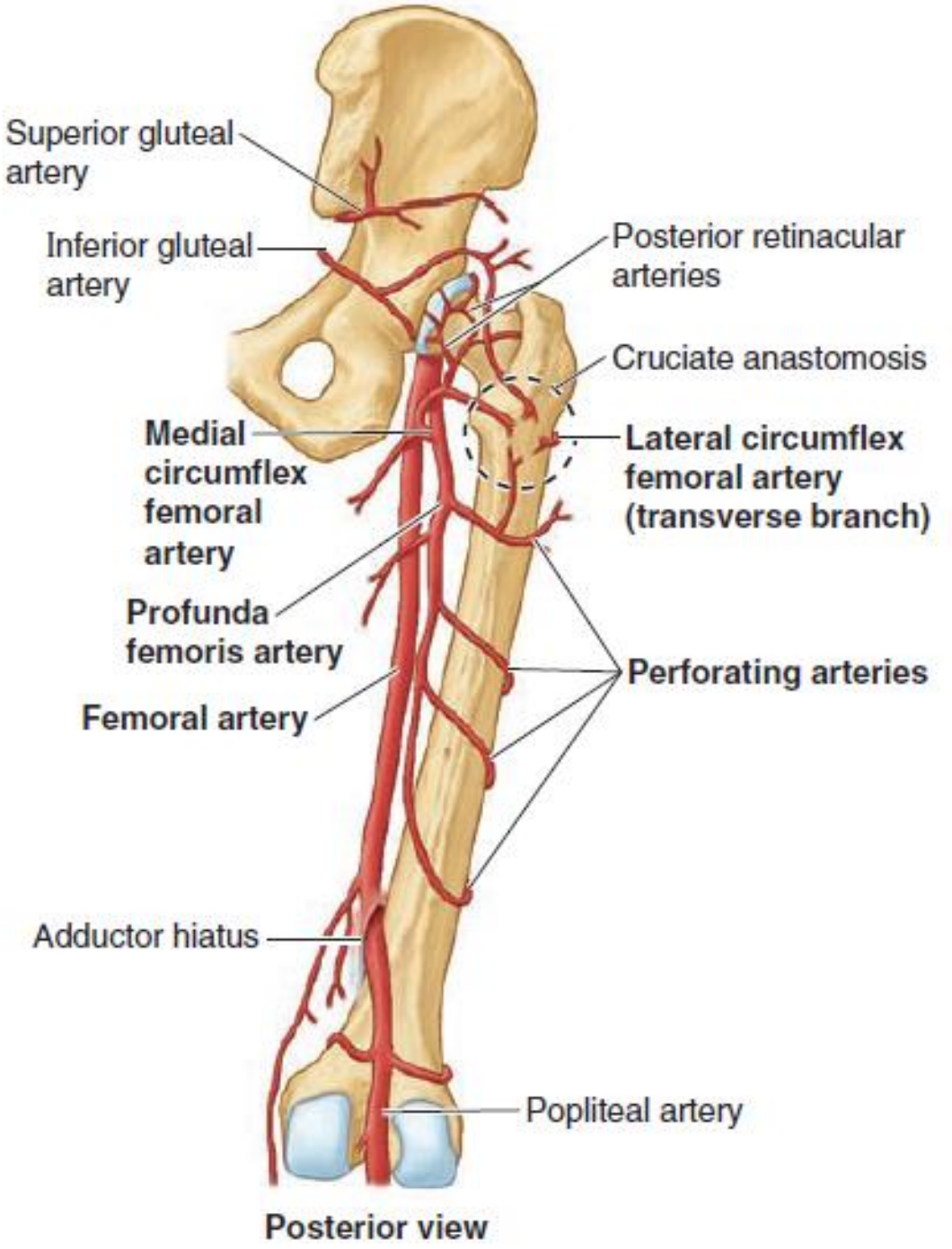



Sciatic nerve
Semimembranosus
Biceps femoris
Popliteal fossa (P)
P
Common fibular nerve
Semitendinosus
Tibial nerve
Head of fibula
Gastrocnemius, medial head
Gastrocnemius, lateral head
Medial sural cutaneous nerve
Sural communicating branch
Communicating sural nerve
Fibularis longus
Lateral sural cutaneous nerve
Sural nerve

Arteries of gluteal and posterior thigh regions



Femoral region

The thigh or femoral region is the most superior part of the free lower limbs. It lies between the gluteal, abdominal, and perineal regions proximally and the knee region distally. It contains a large percentage of the femur or thigh bone, which forms the bony connection between the hip region and knee region.

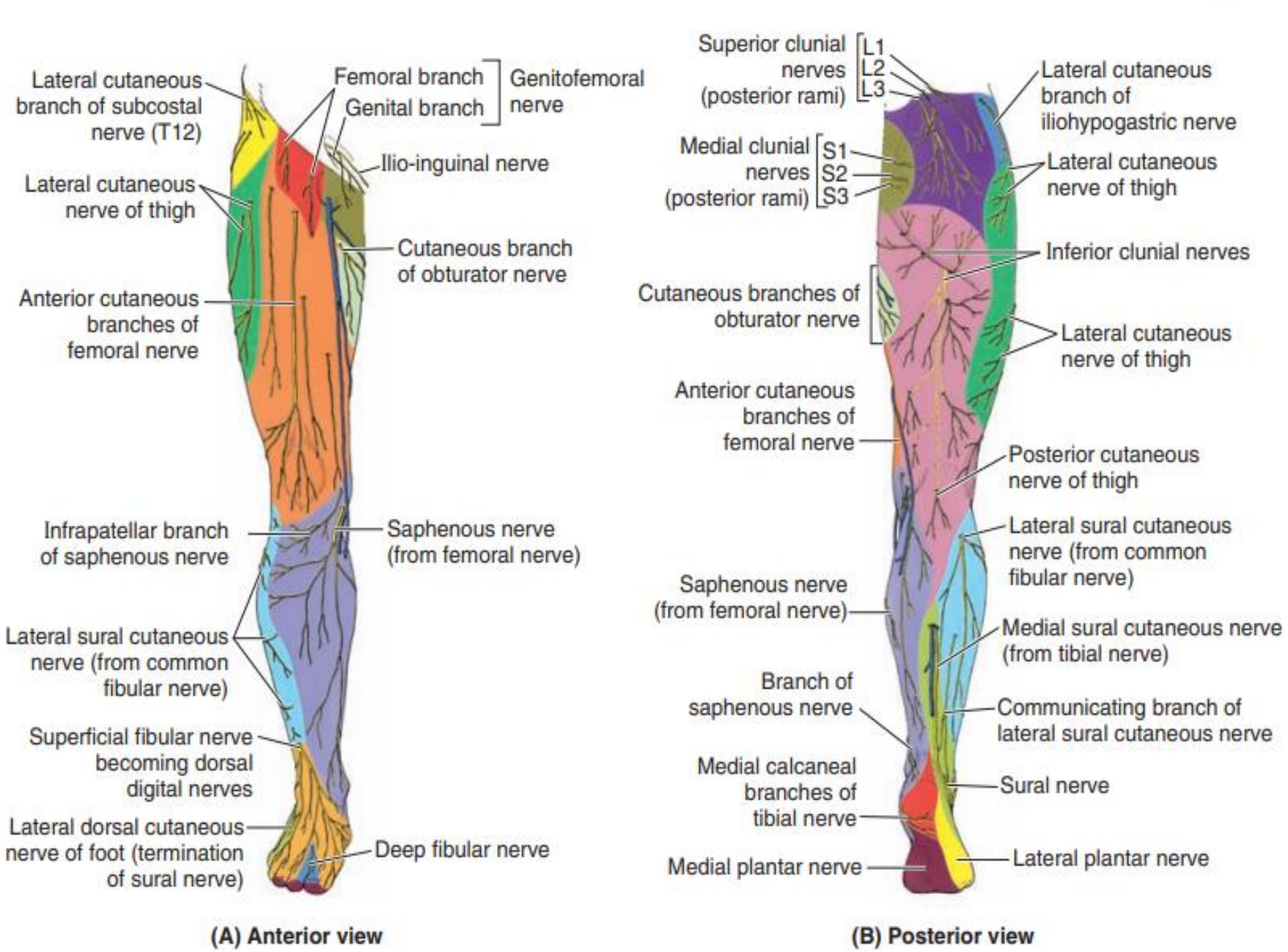
Femoral region

Posterior thigh region (posterior view)

Femoral region

- The transition between the trunk and the free lower limb is abrupt anteriorly and medially. The boundary between the thigh and abdominal regions is demarcated by the inguinal ligament anteriorly and the ischiopubic branch of the hip bone medially. The junction of these regions is the inguinal region or groin.

Femoral region: cutaneous innervation



Femoral region

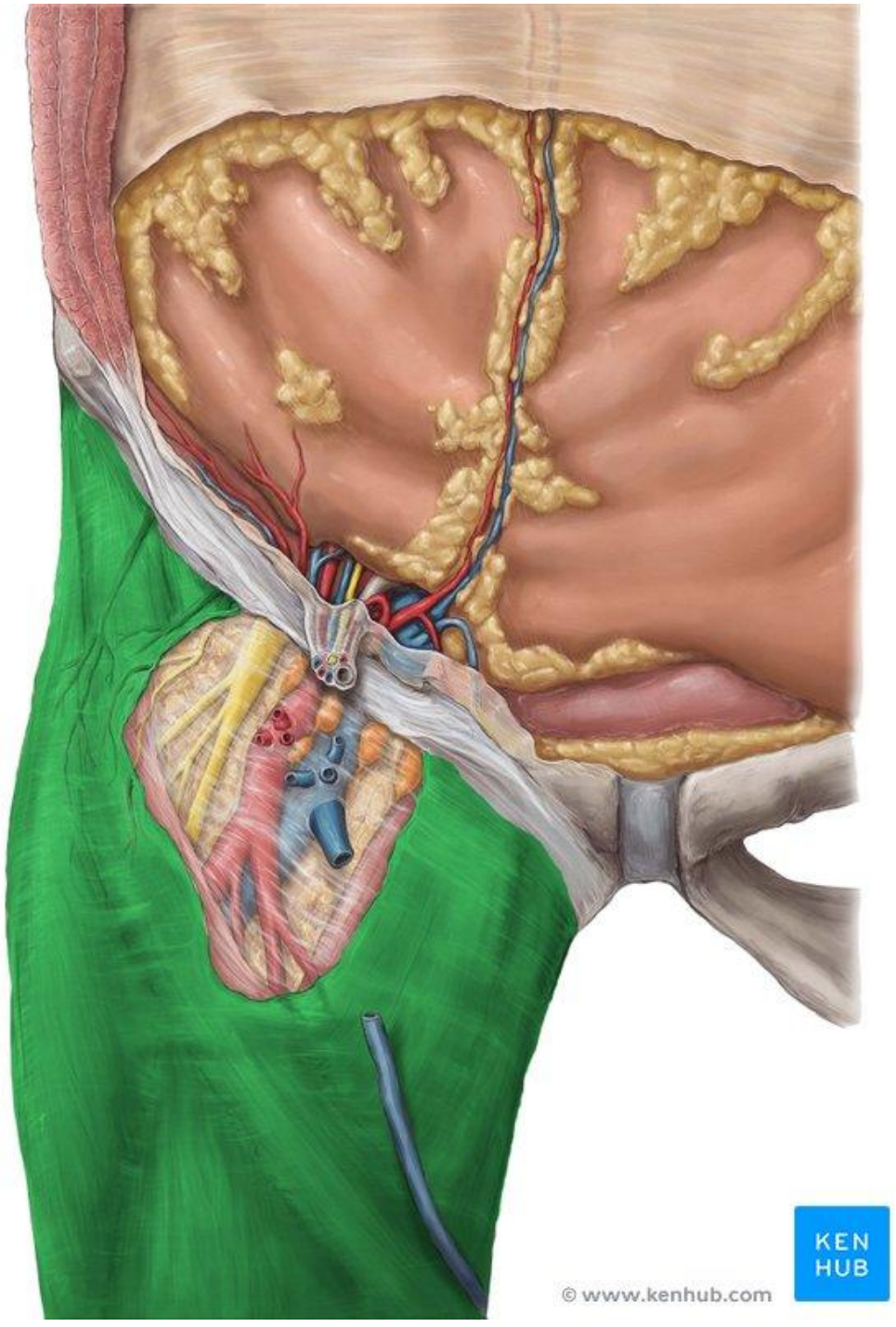
- Although this region is named according to the bone femur, the bulk of structures it contains are muscles, which are grouped by fasciae and intermuscular septa into compartments.

Femoral region

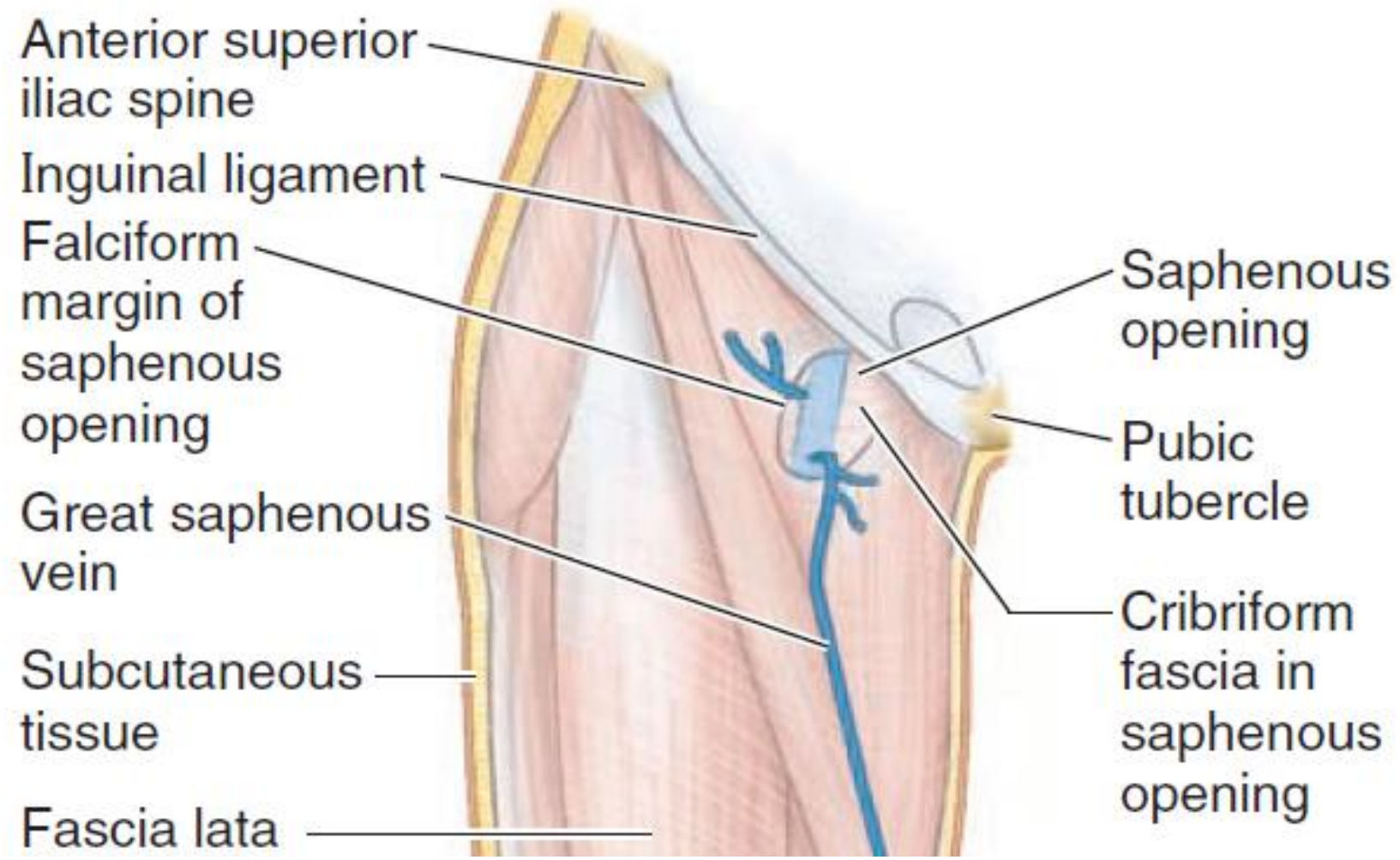
The **deep fascia** is especially strong, investing the limb like an elastic stocking. This fascia limits outward extension of contracting muscles, making muscular contraction more efficient in compressing the veins to push blood toward the heart. The deep fascia of the thigh is called fascia lata (L. lata, broad).

Femoral region

Fascia lata (anterior view)



Femoral region



The **saphenous opening** is a gap or hiatus in the fascia lata inferior to the medial part of the inguinal ligament

Femoral region

The **saphenous opening** is a gap or hiatus in the fascia lata inferior to the medial part of the inguinal ligament. Its medial margin is smooth, but its superior, lateral, and inferior margins form a sharp edge, the **falciform margin**. The sieve-like **cribriform fascia** (L. *cribrum*, sieve) is a localized membranous layer of subcutaneous tissue over the saphenous opening, enclosing it. The **great** saphenous vein and some lymphatics pass through the saphenous opening and cribriform fascia to enter the femoral vein and the deep inguinal lymph nodes, respectively.

Femoral region

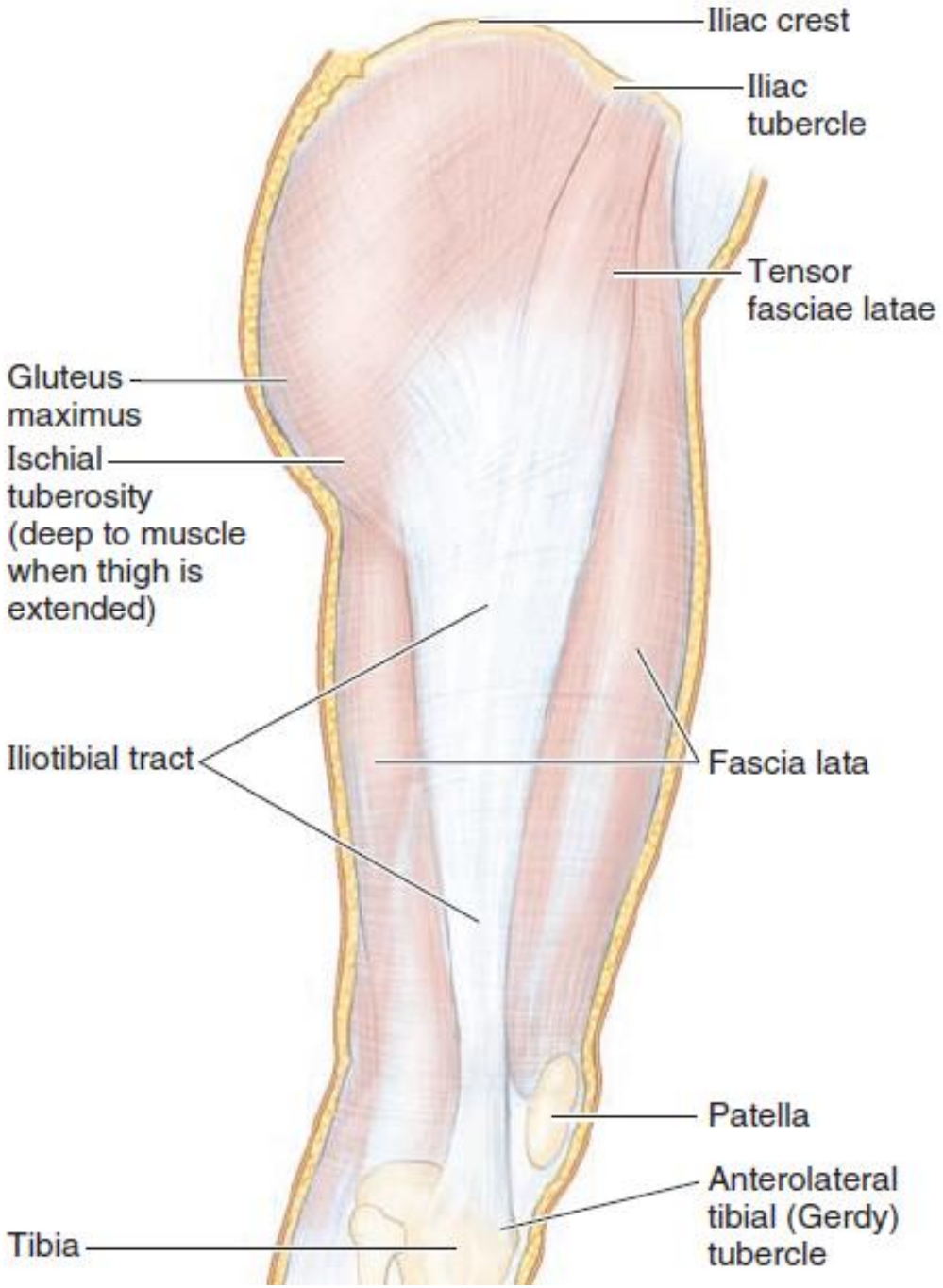
The fascia lata is substantial because it encloses the large thigh muscles, especially laterally where it is thickened to form the **iliotibial tract**. This broad band of fibers is also the aponeurosis of the *tensor fasciae latae* and *gluteus maximus* muscles. The iliotibial tract extends from the iliac tubercle to the anterolateral tibial tubercle (Gerdy tubercle) on the lateral condyle of the tibia

Femoral region

The thigh muscles are separated into three fascial compartments: anterior, medial, and posterior. The walls of these compartments are formed by the fascia lata and three fascial intermuscular septa that arise from the deep aspect of the fascia lata and attach to the linea aspera on the posterior aspect of the femur

Femoral region

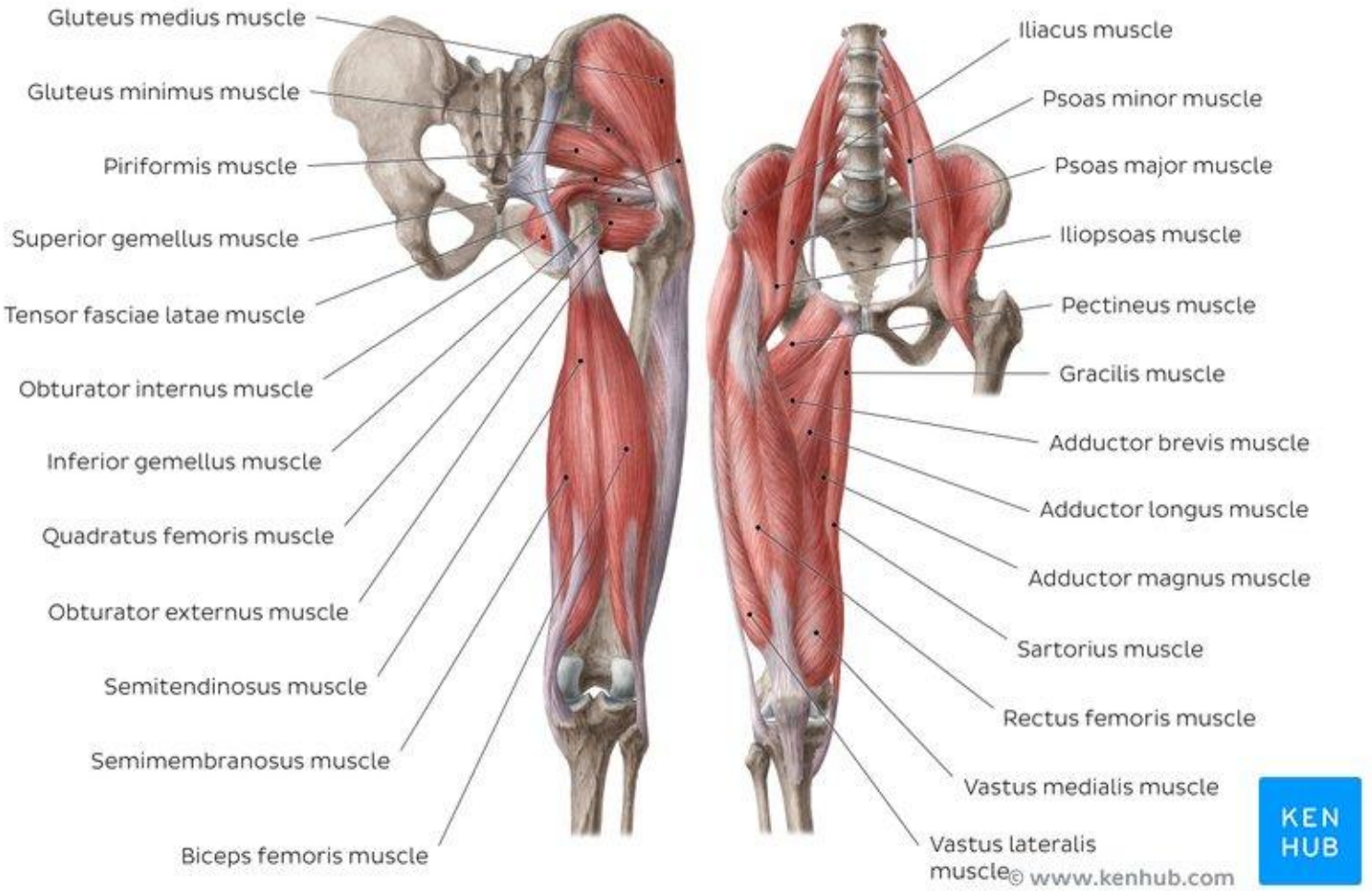
The lateral intermuscular septum is strong; the other two septa are relatively weak. The iliotibial tract is continuous with the lateral intermuscular septum.



Femoral region

The muscles of the thigh are organized into three compartments (or can be divided into three groups) — *anterior* or *extensor*, *medial* or *adductor*, and *posterior* or *flexor*—by intermuscular septa. Generally, the anterior group is innervated by the femoral nerve, the medial group by the obturator nerve, and the posterior group by the tibial portion of the sciatic nerve.

Muscles of the hip and thigh (anterior and posterior views)



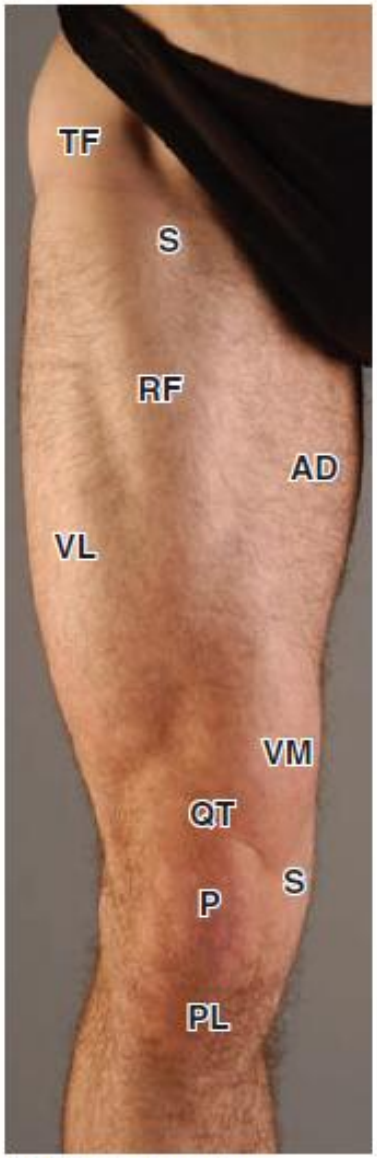
Muscles of the hip and thigh	
Iliopsoas muscles	Psoas minor, iliopsoas (psoas major + iliacus)
Gluteal muscles	- Superficial group: gluteus maximus, gluteus medius, gluteus minimus, tensor fasciae latae - Deep group: piriformis, obturator internus, obturator externus, superior gemellus, inferior gemellus, quadratus femoris
Thigh muscles	- Anterior thigh muscles: sartorius, quadriceps femoris (rectus femoris, vastus lateralis, vastus intermedius, vastus medialis) - Medial thigh muscles: pectineus, adductor longus, adductor brevis, adductor magnus, gracilis - Posterior thigh muscles: biceps femoris, semimembranosus, semitendinosus

Femoral region

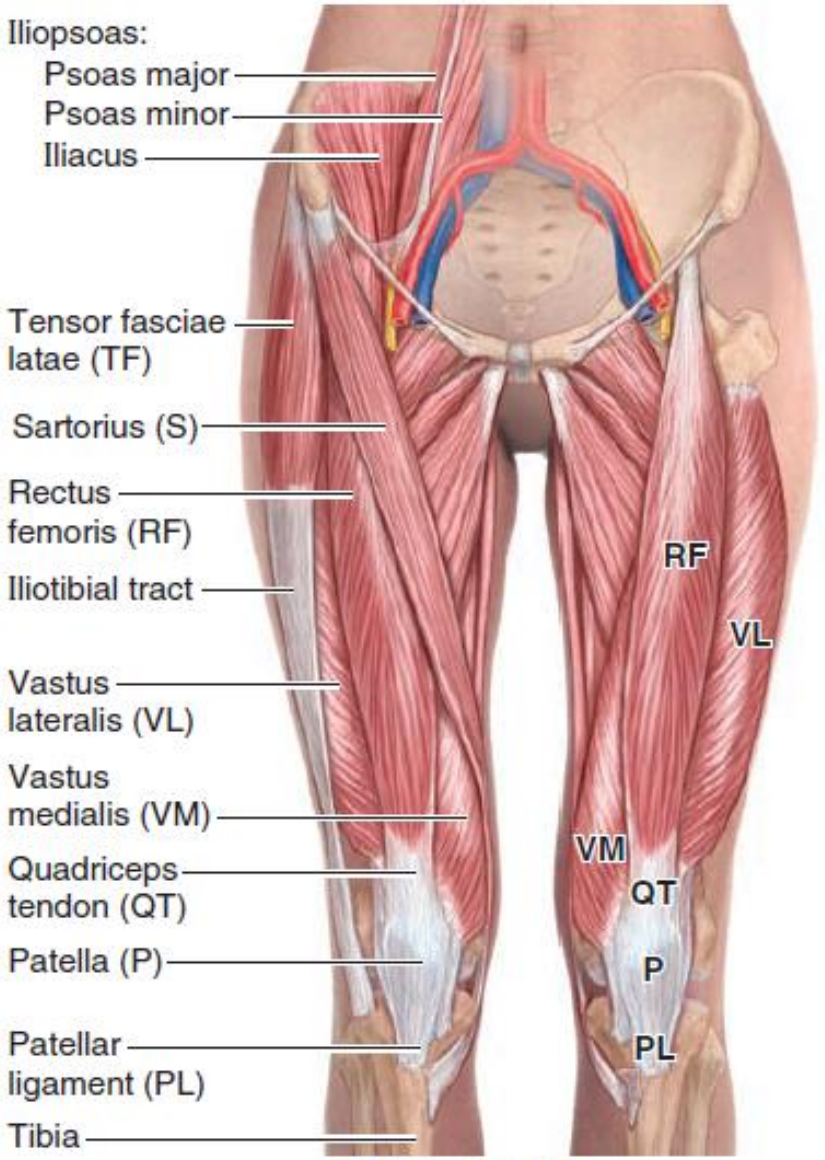
The anterior group of the thigh muscles occupies the anterior compartment situated at the front of the thigh, and includes the sartorius and quadriceps femoris. The latter is, in fact, one large muscle composed of four smaller ones called rectus femoris, vastus medialis, vastus lateralis, and vastus intermedius.

Femoral region

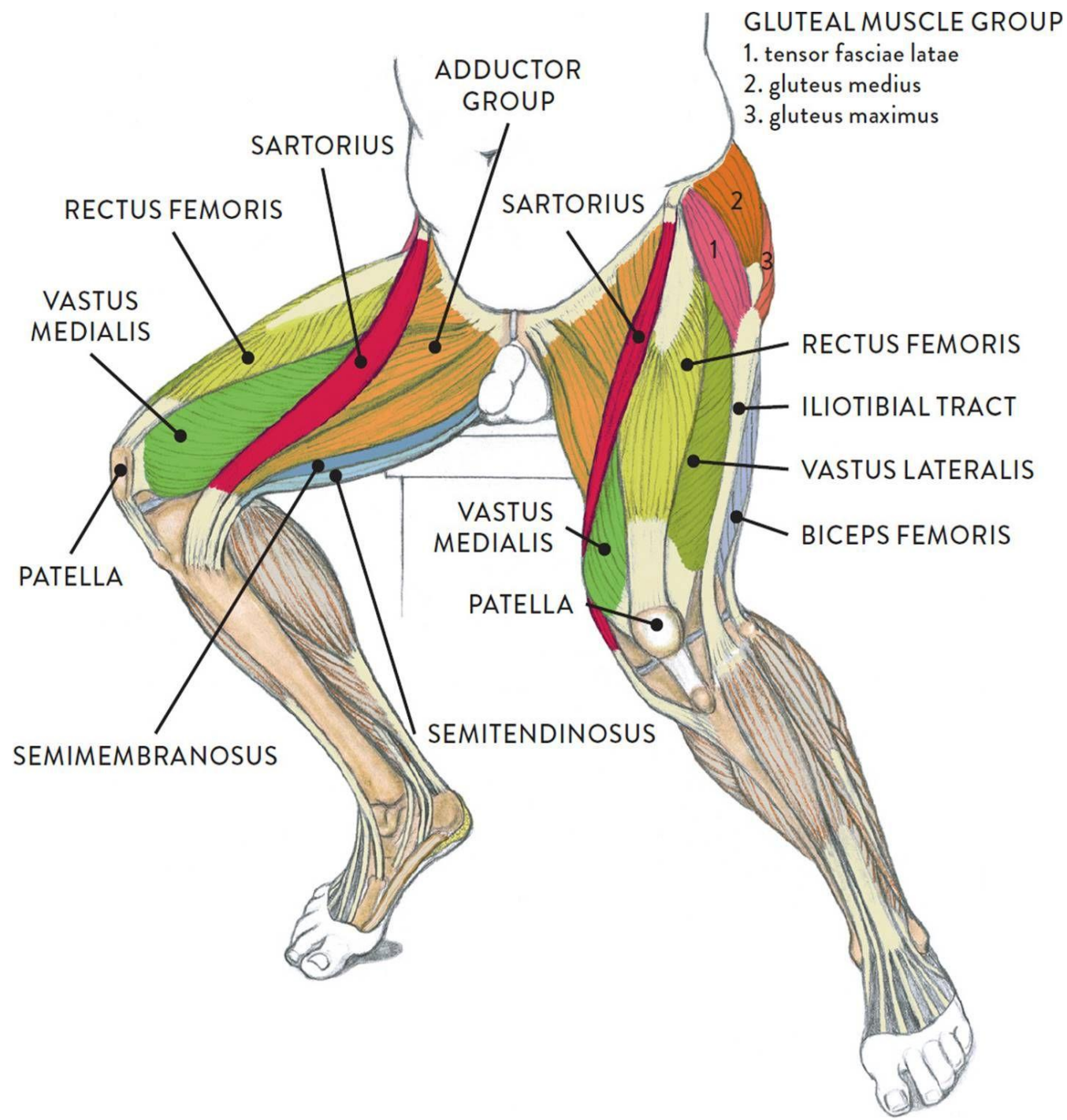
Anterior and medial thigh muscles. Surface anatomy of the thigh.



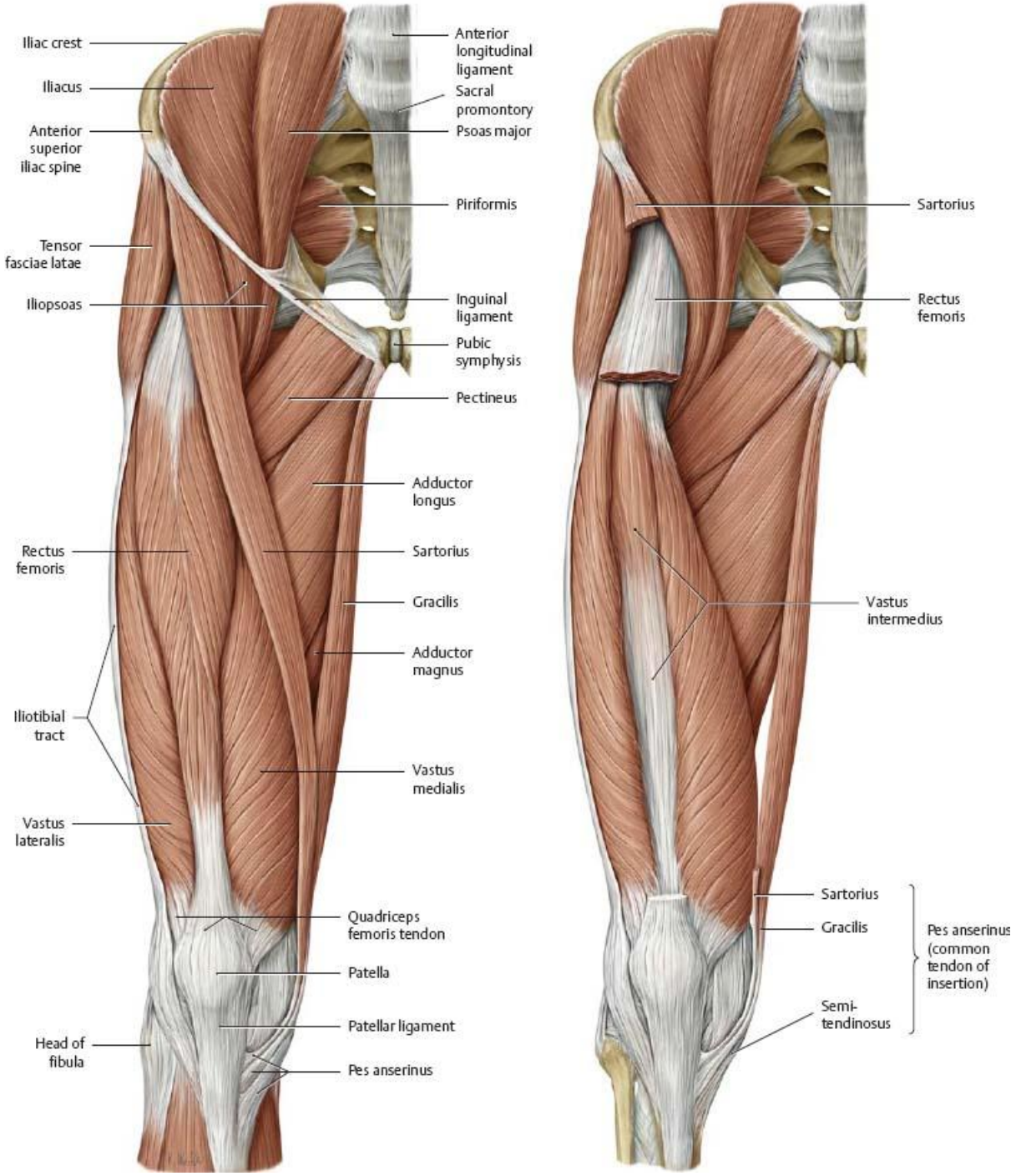
(A) Anterior view



(B) Anterior view



Muscles of the the anterior compartment of the thigh



Muscles of the the anterior compartment of the thigh

Femoral region

- **Sartorius**, the tailor's muscle (L. sart, a tailor): a long, ribbon-like muscle that is the most superficial muscle in the anterior thigh; it passes obliquely (lateral to medial) across the supero-anterior part of the thigh. It acts across both the hip and knee joints, and when acting bilaterally, the muscles bring the lower limbs into the cross-legged sitting position. None of the actions is strong; therefore, it is mainly a synergist, acting with other thigh muscles that produce these movements.

Femoral region

- **Rectus femoris**, the “kicking muscle” (L. *rectus*, straight): it crosses the hip joint and helps the iliopsoas flex this joint. Its ability to extend the knee is compromised during hip flexion
- **Vastus lateralis**: the largest component of the quadriceps, located on the lateral aspect of the full length of the thigh
- **Vastus intermedius**: lies deep to the rectus femoris between the vastus medialis and the vastus lateralis
- **Vastus medialis**: covers the medial aspect of the distal two thirds of the thigh

Femoral region

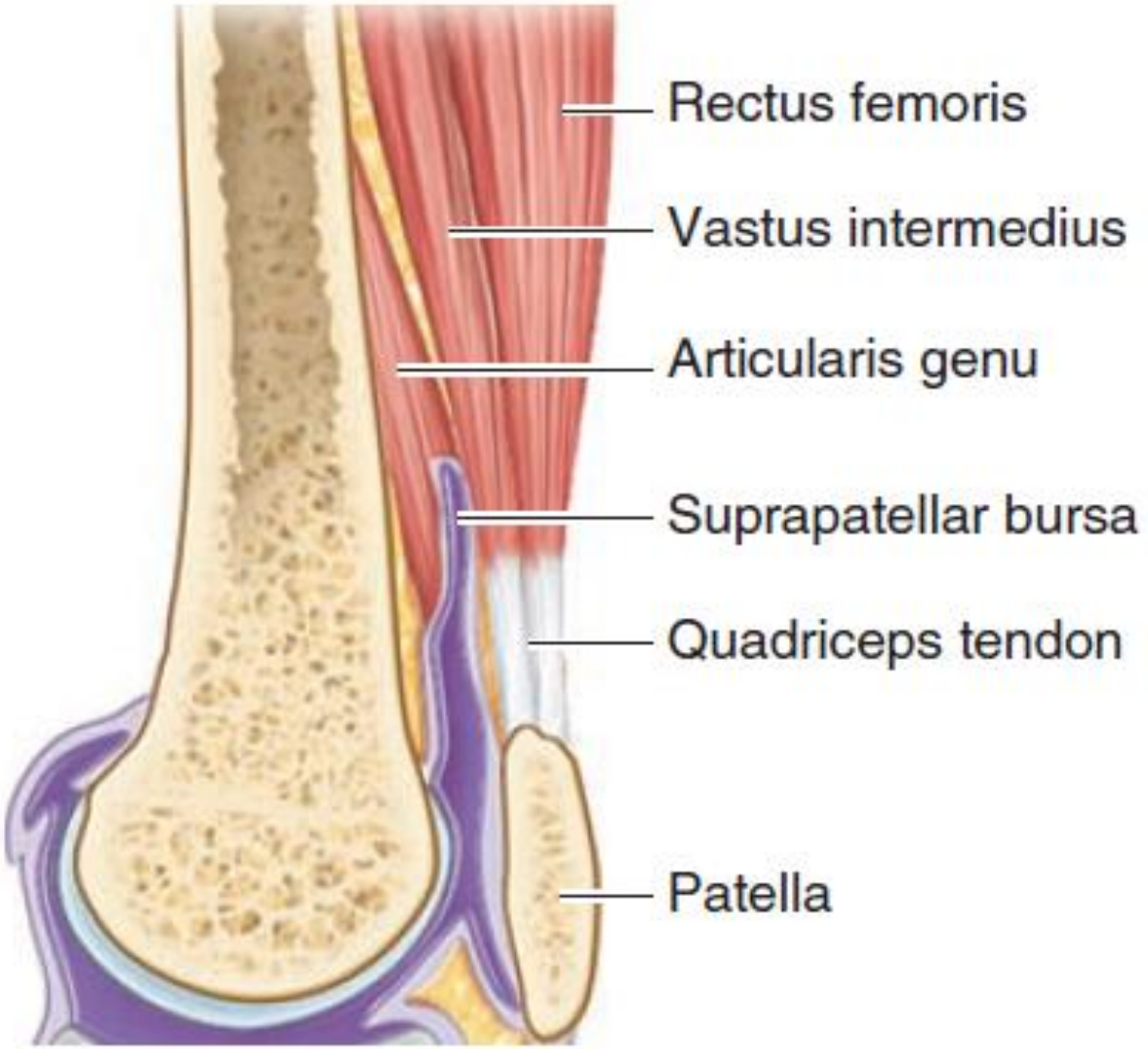
The tendons of the four parts of the quadriceps unite in the distal part of the thigh to form the **quadriceps tendon**. The **patellar ligament** (L. *ligamentum patellae*), attached to the tibial tuberosity, is the continuation of the quadriceps tendon in which the patella is embedded.

Femoral region

A small, flat muscle, the **articularis genu** (articular muscle of knee), a derivative of the vastus intermedius, attaches superiorly to the inferior part of the anterior aspect of the femur and inferiorly to the synovial membrane of the knee joint and the wall of the *suprapatellar bursa*.

Femoral region

The articularis genu muscle pulls the synovial membrane superiorly during extension of the knee, thereby preventing folds of the membrane from being compressed between the femur and the patella within the knee joint.



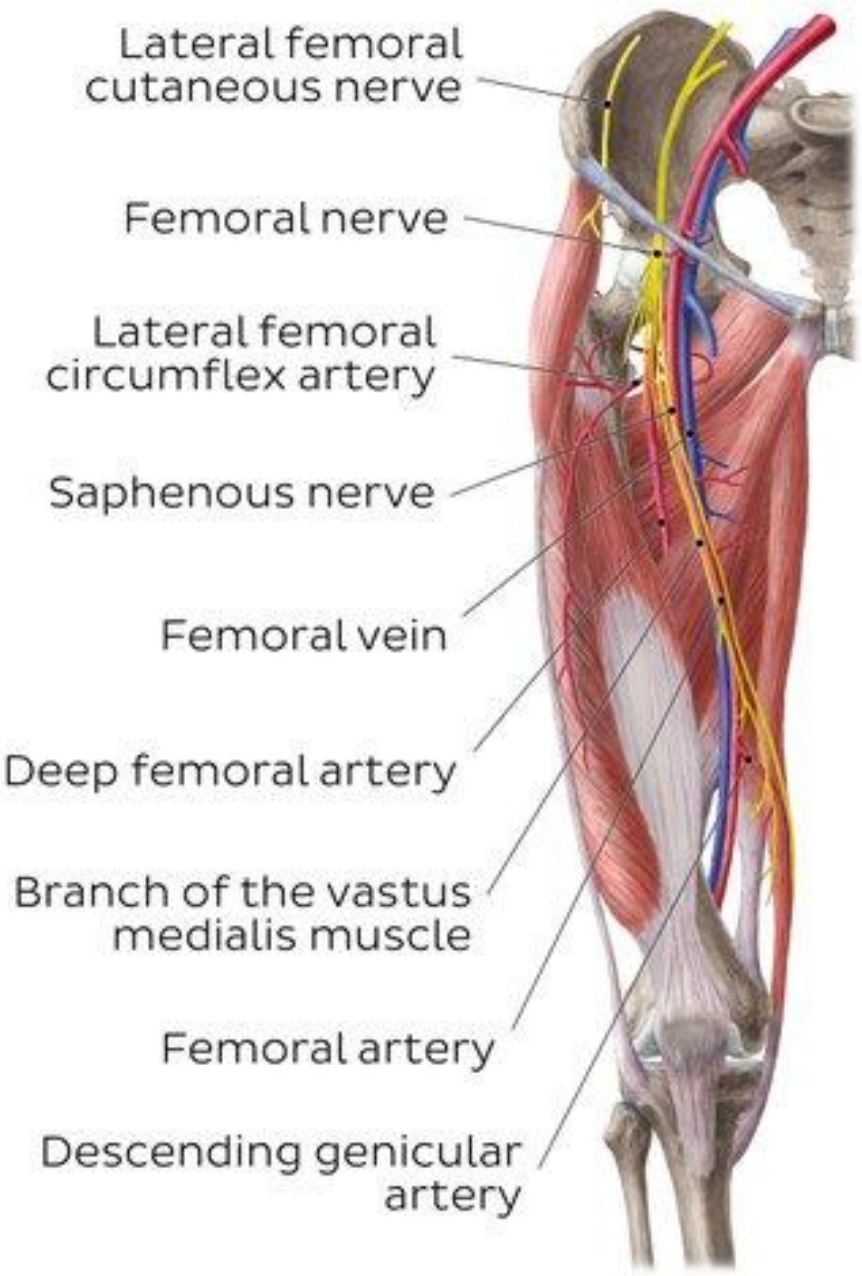
Neurovascular structures and relationships in anteromedial thigh

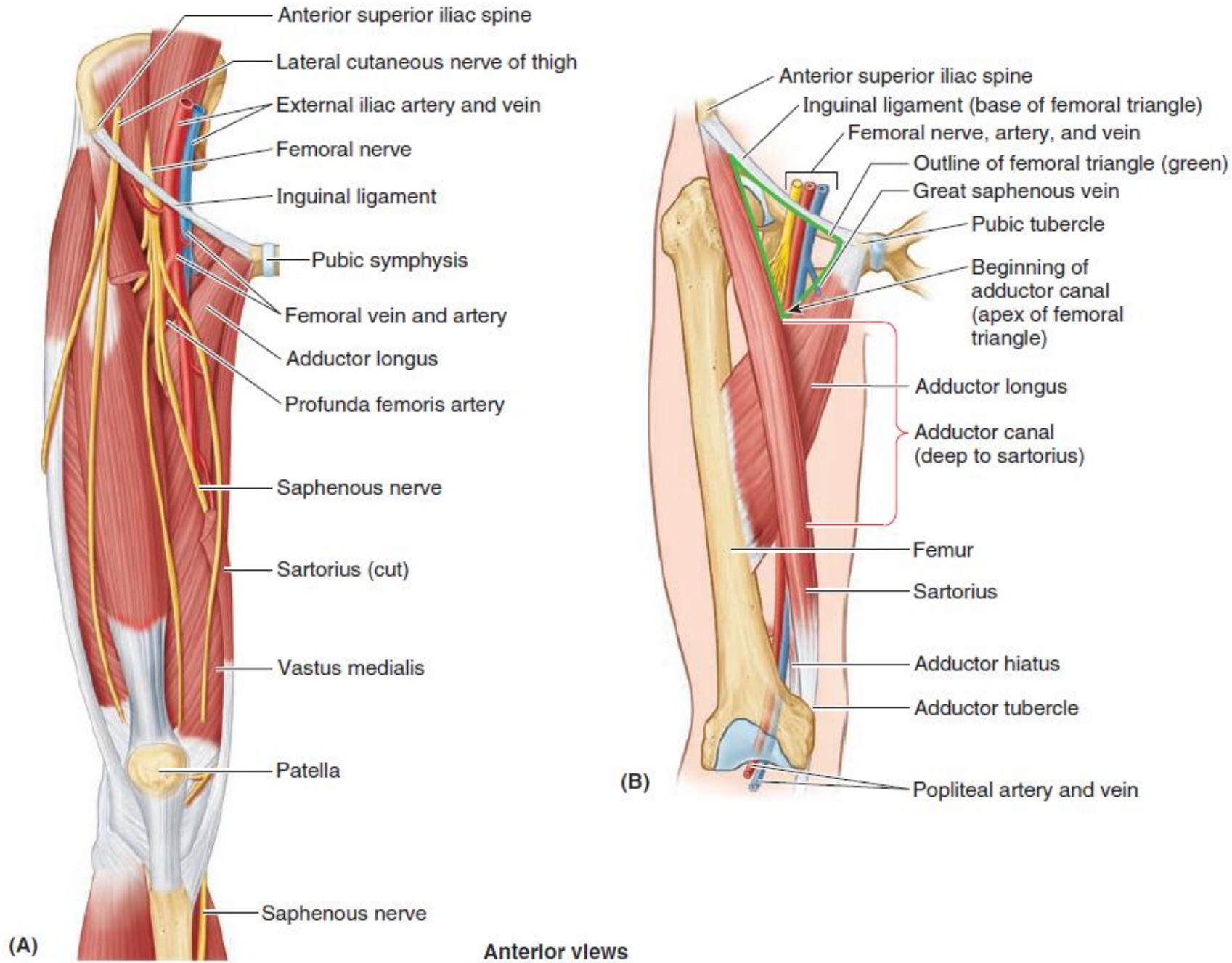
The femoral triangle is a subfascial space in the anterosuperior third of the thigh. It appears as a triangular depression inferior to the inguinal ligament when the thigh is flexed, abducted, and laterally rotated. The femoral triangle is bounded

- Superiorly by the inguinal ligament, which forms the *base of the femoral triangle*
- Medially by the adductor longus
- Laterally by the sartorius; the apex is where the medial border of the sartorius crosses the lateral border of the adductor longus.

Femoral region

Arteries and nerves of the thigh (anterior view)



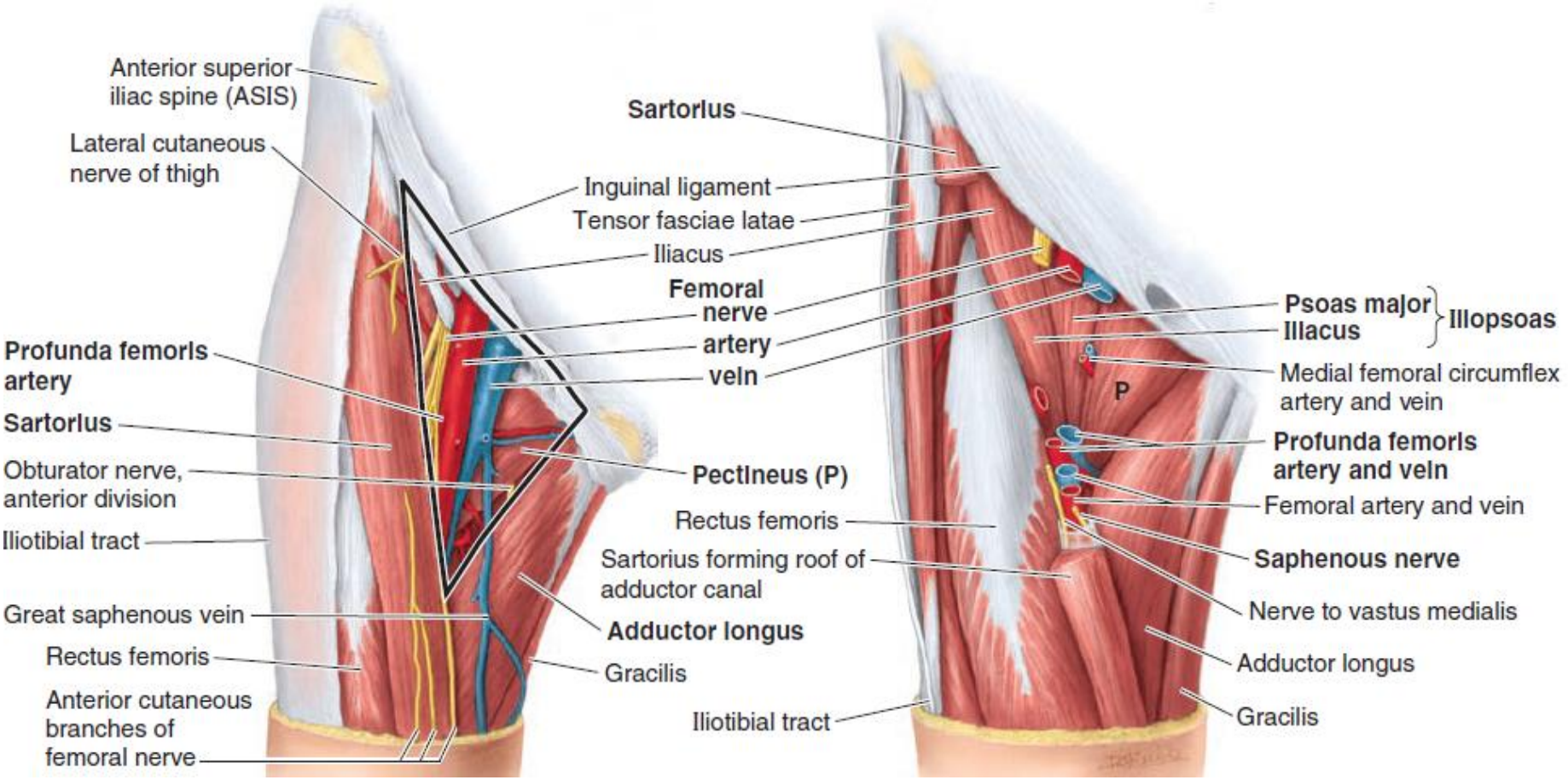


Anterior views

Neurovascular structures and relationships in anteromedial thigh

The muscular *floor of the femoral triangle* is formed by the iliopsoas laterally and pectineus medially. The *roof of the femoral triangle* is formed by fascia lata, cribriform fascia, subcutaneous tissue, and skin. Deep to the inguinal ligament, the retro-inguinal space is an important passageway connecting the trunk/abdominopelvic cavity to the lower limb. It is created as the inguinal ligament spans the gap between the ASIS and the pubic tubercle.

Boundaries and contents of femoral triangle. Floor of femoral triangle.



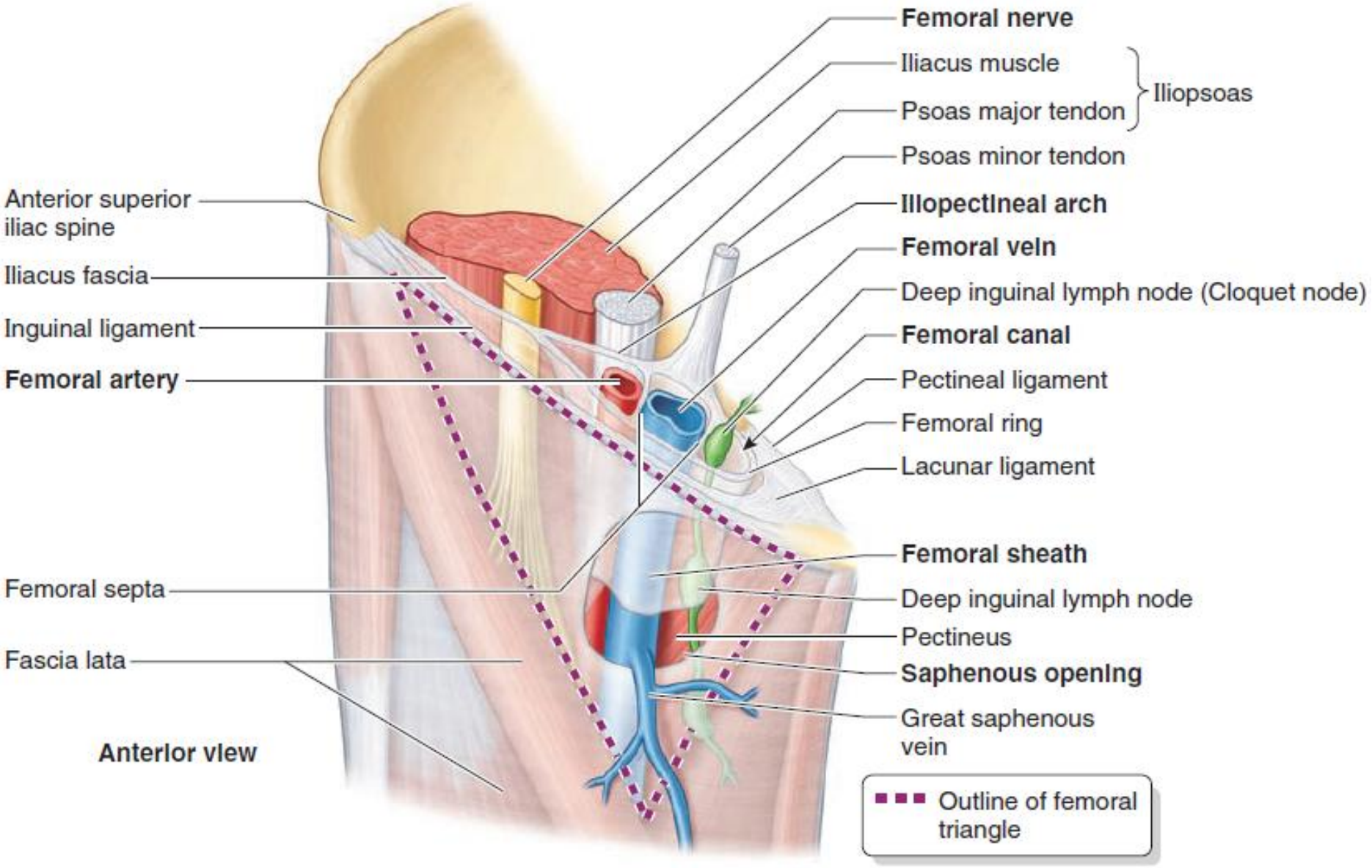
Neurovascular structures and relationships in anteromedial thigh

The retro-inguinal space is divided into two compartments by the iliopsoas fascia. The lateral compartment is the muscular compartment through which the iliopsoas muscle and femoral nerve pass; the medial compartment allows the passage of the veins, arteries, and lymphatics between the greater pelvis and the femoral triangle.

Neurovascular structures and relationships in anteromedial thigh

The contents of the femoral triangle, from lateral to medial, are the

- Femoral nerve and its (terminal) branches
- Femoral artery and several of its branches
- Femoral vein and its proximal tributaries (e.g., the great saphenous vein and profunda femoris vein)
- Femoral canal
- Deep inguinal lymph nodes and associated lymphatic vessels


Femoral nerve
Iliacus muscle
Psoas major tendon
Iliopsoas
Psoas minor tendon
Anterior superior iliac spine
Iliopectineal arch
Femoral vein
Iliacus fascia
Deep inguinal lymph node (Cloquet node)
Inguinal ligament
Femoral canal
Femoral artery
Pectineal ligament
Femoral ring
Lacunar ligament
Femoral sheath
Femoral septa
Deep inguinal lymph node
Pectineus
Fascia lata
Saphenous opening
Great saphenous vein
Anterior view
Outline of femoral triangle

Neurovascular structures and relationships in anteromedial thigh

The **femoral sheath** is a funnel-shaped, fascial tube of varying length (usually 3 to 4 cm) that passes deep to the inguinal ligament and encloses proximal parts of the femoral vessels and creates the femoral canal medial to them. The femoral sheath is subdivided into three compartments by vertical septa of extraperitoneal connective tissue that extend from the abdomen along the femoral vessels. The compartments of the femoral sheath are the lateral compartment for the femoral artery; intermediate compartment for the femoral vein; and medial compartment, which constitutes the femoral canal.

Neurovascular structures and relationships in anteromedial thigh

The femoral canal is the smallest of the three compartments. It is short and conical and lies between the medial wall of the femoral sheath and the femoral vein. The femoral canal

- Extends distally to the level of the proximal edge of the saphenous opening
- Allows the femoral vein to expand when venous return from the lower limb is increased or when increased intraabdominal pressure causes a temporary stasis in the vein
- Contains loose connective tissue, fat, a few lymphatic vessels, and sometimes a deep inguinal lymph node (Cloquet node)

Neurovascular structures and relationships in anteromedial thigh

The base of the femoral canal, formed by the small

(approximately 1 cm in diameter) proximal opening at its abdominal end, is the **femoral ring**. The boundaries of the femoral ring are as follows:

laterally, a **femoral septum** between the femoral canal and the femoral vein;

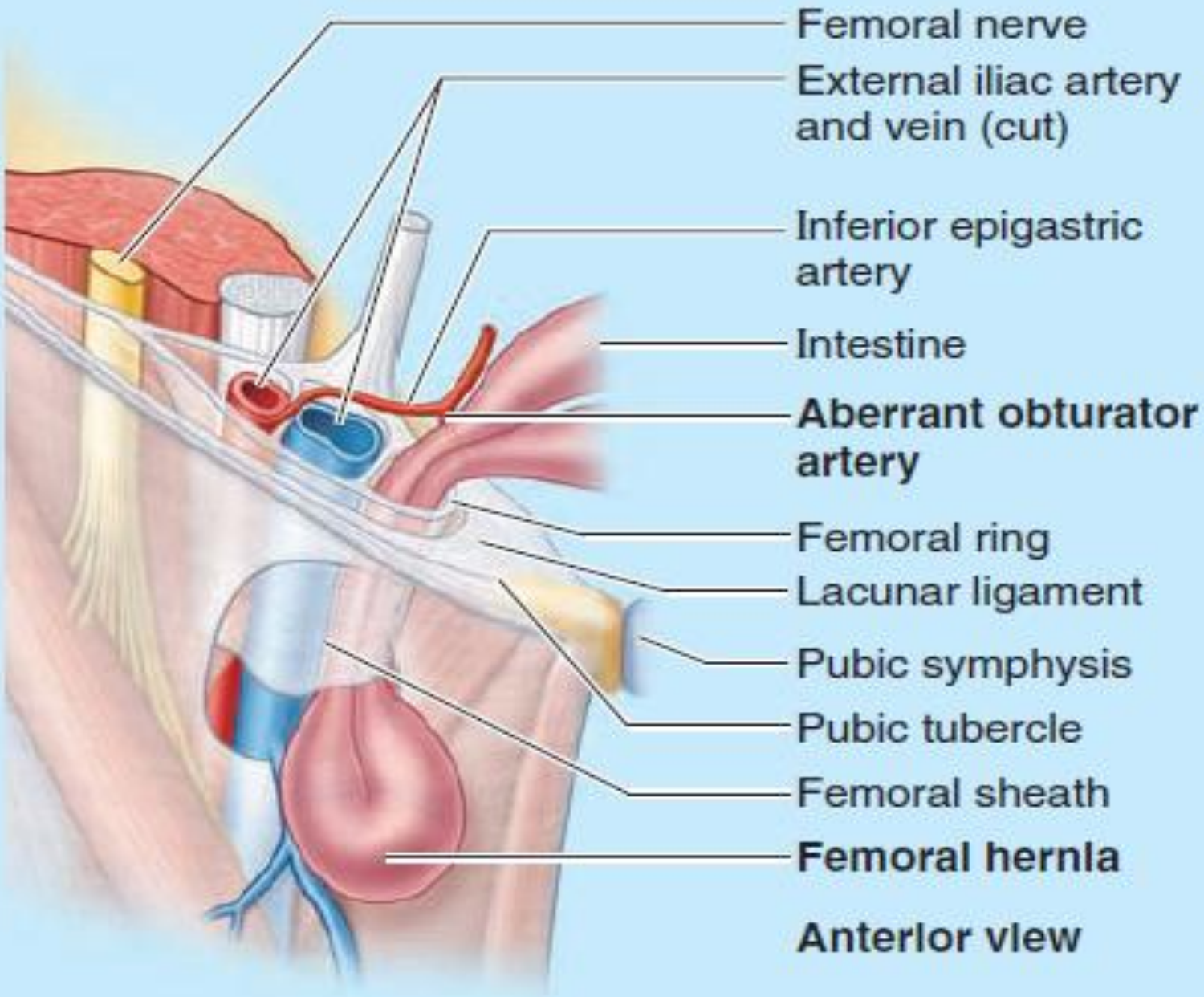
posteriorly, the superior ramus of the pubis covered by the pectineal ligament;

medially, the lacunar ligament; and

anteriorly, the medial part of the inguinal ligament.

Femoral hernia

The femoral ring is a weak area in the lower anterior abdominal wall that is the site of a *femoral hernia*, a protrusion of abdominal viscera (often a loop of small intestine) through the femoral ring into the femoral canal. A femoral hernia is more common in women than in men (in whom inguinal hernias are more common).



Late stage femoral hernia

Femoral hernia

The hernial sac displaces the contents of the femoral canal and distends its wall. Initially, the hernia is relatively small because it is contained within the femoral canal, but it can enlarge by passing through the saphenous opening into the subcutaneous tissue of the thigh. *Strangulation of a femoral hernia* may occur and interfere with the blood supply to the herniated intestine, and vascular impairment may result in death of the tissues.

Femoral artery

The femoral artery, the chief artery to the lower limb, is the continuation of the external iliac artery distal to the inguinal ligament. The femoral artery enters the femoral triangle deep to the midpoint of the inguinal ligament (midway between the ASIS and the pubic tubercle), lateral to the femoral vein

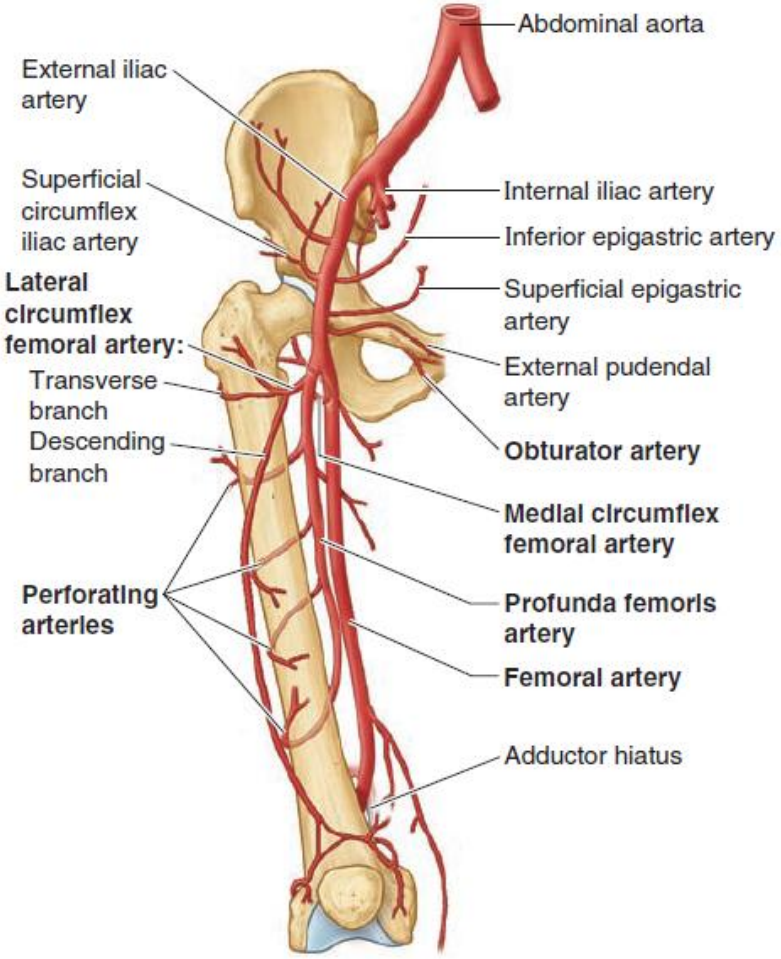
Femoral artery

The profunda femoris artery (deep artery of thigh) is the largest branch of the femoral artery and the chief artery to the thigh. It arises from the femoral artery in the femoral triangle. In the middle third of the thigh, it is separated from the femoral artery and vein by the adductor longus. It gives off three or four perforating arteries that wrap around the posterior aspect of the femur and supply the adductor magnus, hamstring, and vastus lateralis muscles.

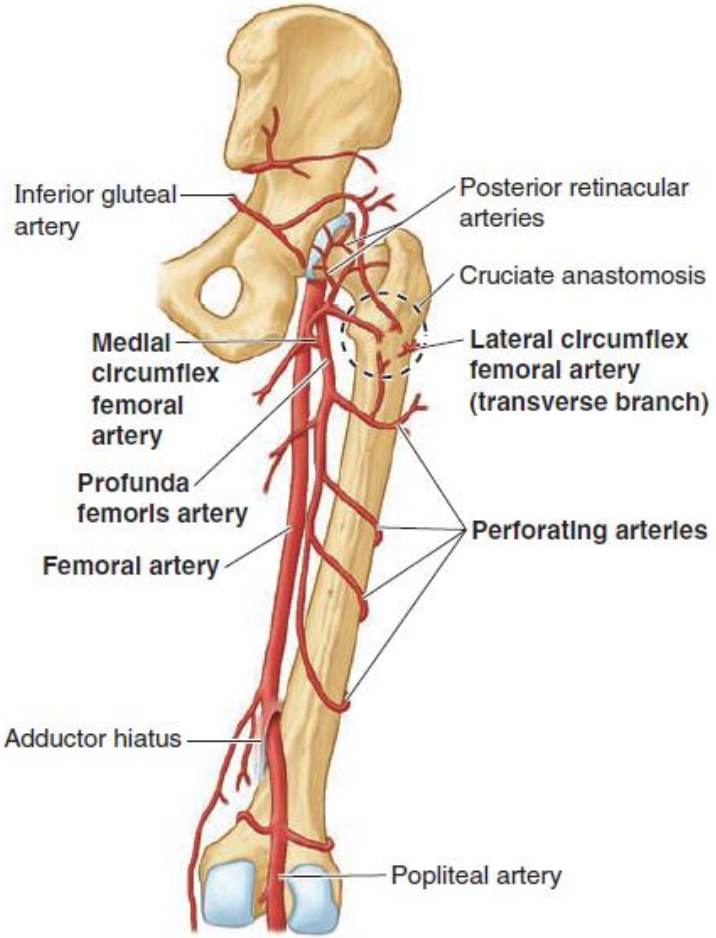
Femoral artery

The circumflex femoral arteries are usually branches of the profundus femoris artery, but they may arise from the femoral artery. They encircle the thigh, anastomose with each other and other arteries, and supply the thigh muscles and the proximal end of the femur.

Arteries of anterior and medial thigh

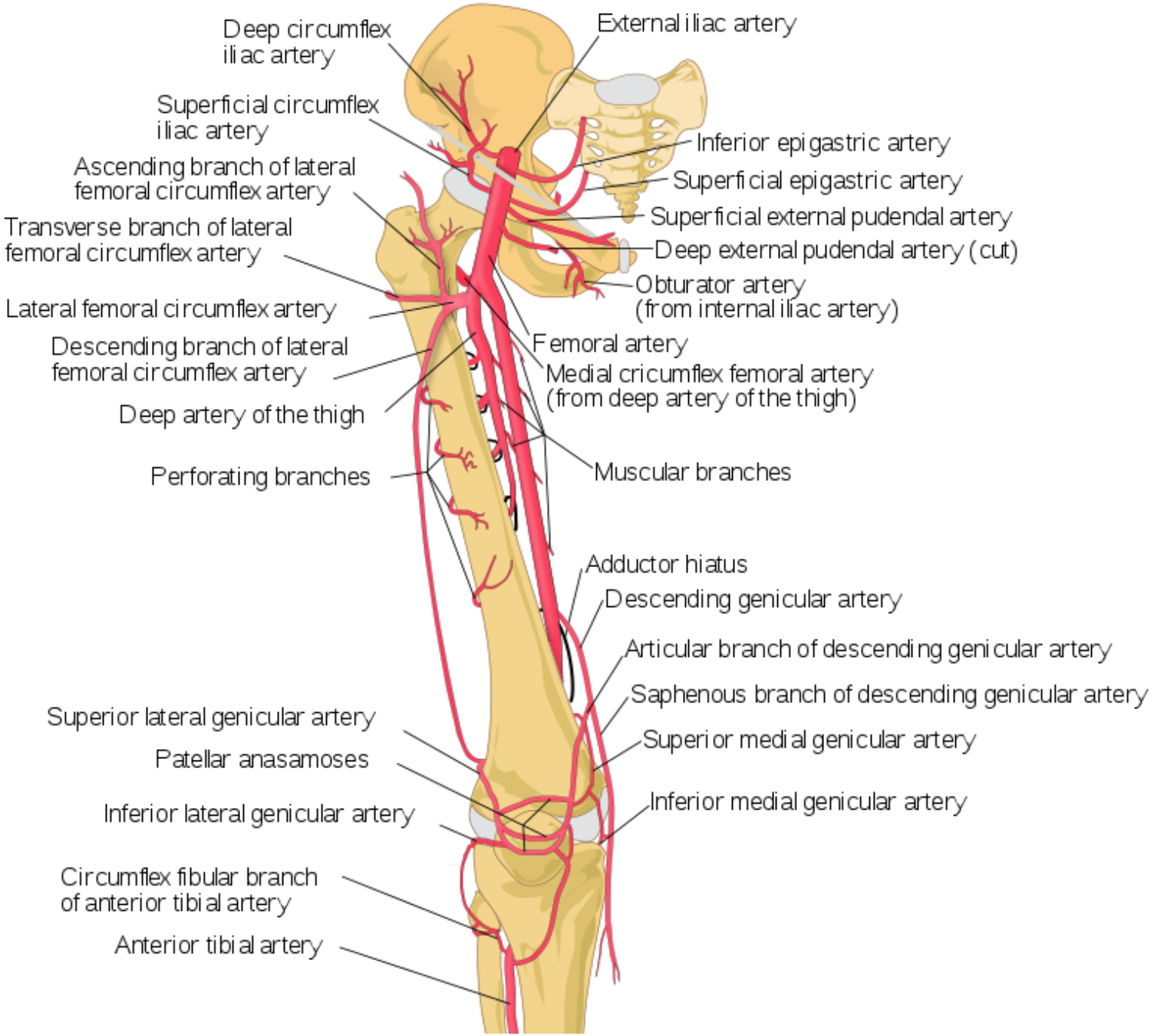


(A) Anterior view

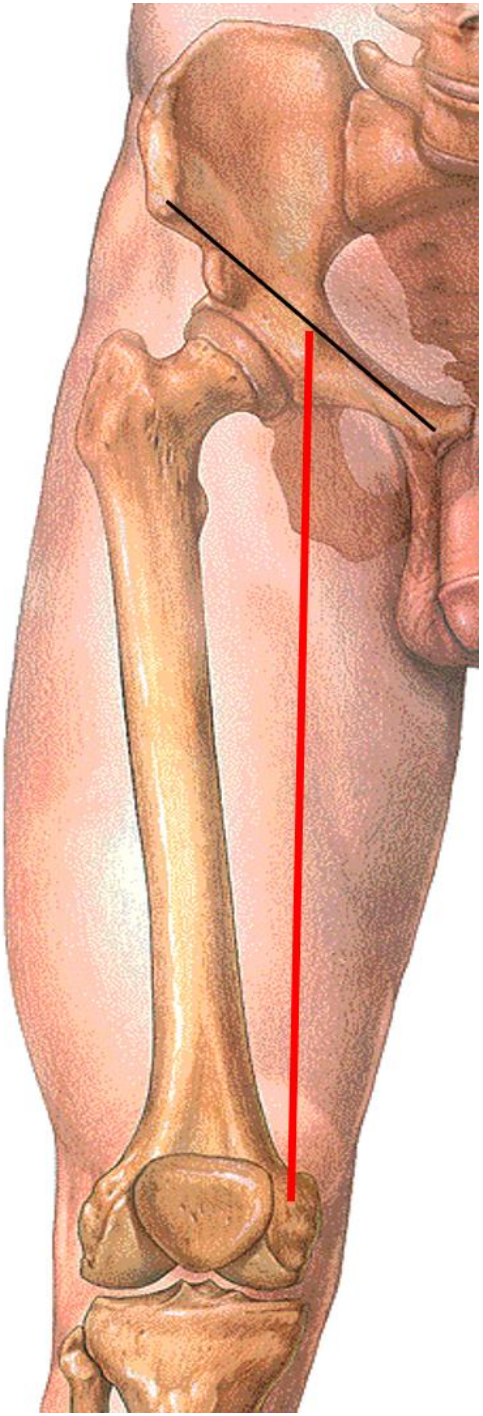


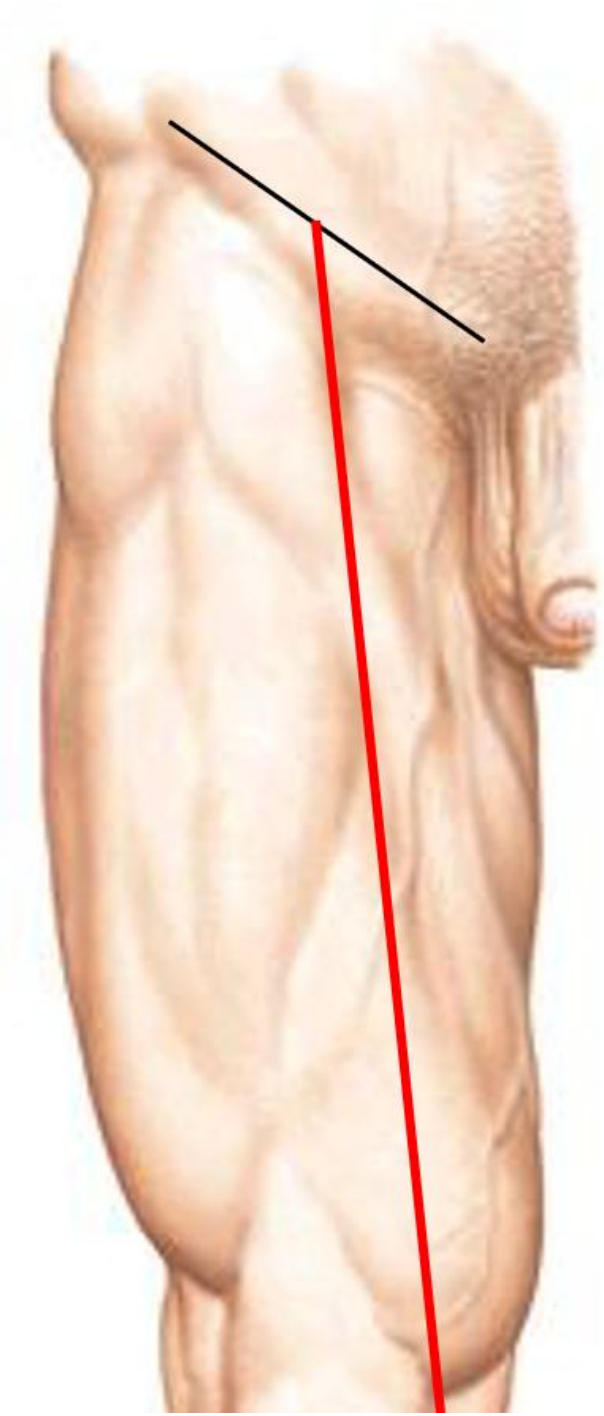
(B) Posterior view

Arteries of anterior and medial thigh



Femoral Artery: projection line (Ken's line, line of Ken)

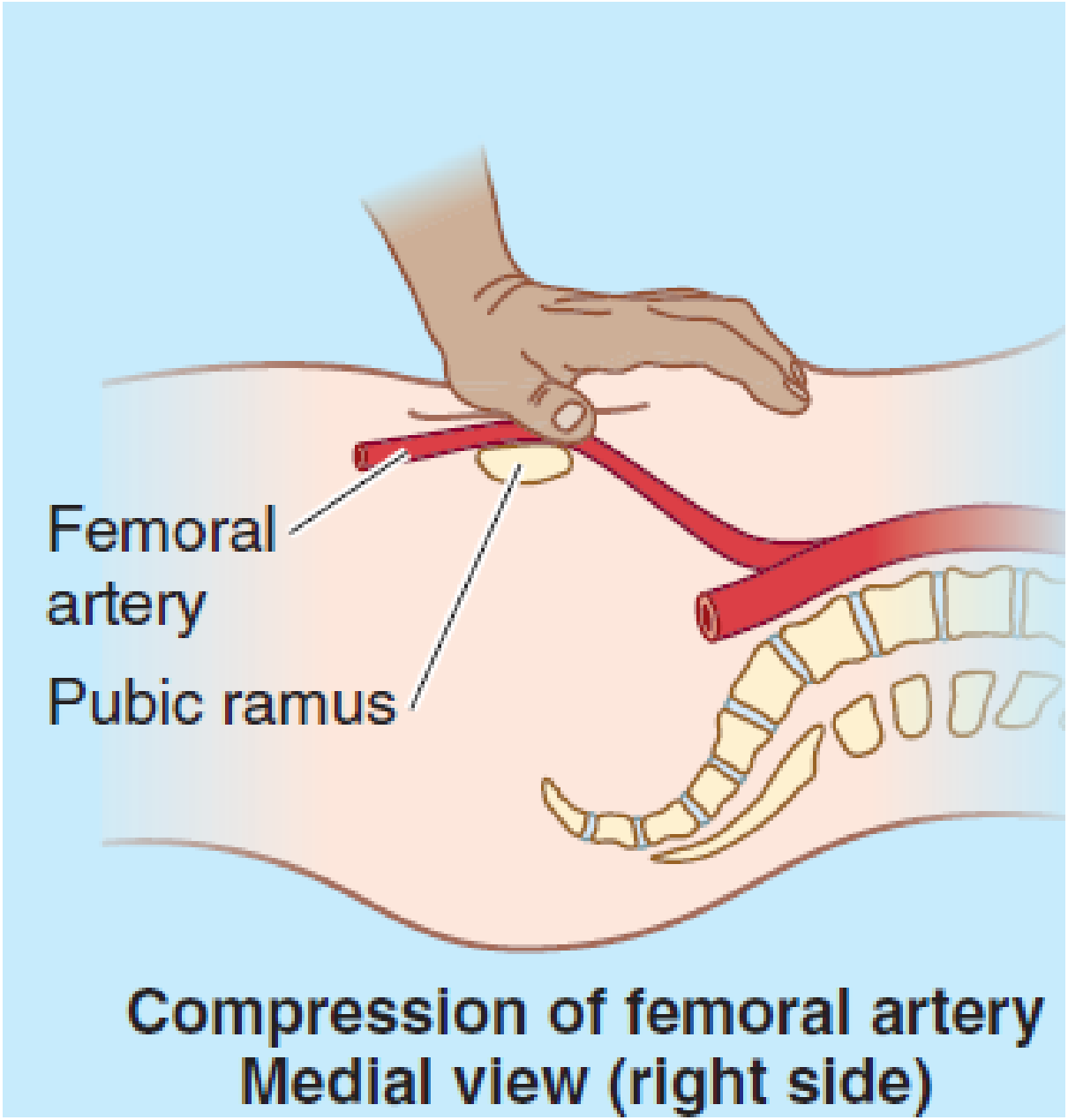




Femoral artery

The pulse of the femoral artery is usually palpable just inferior to the midpoint of the inguinal ligament. Normally, the pulse is strong; however, if the common or external iliac arteries are partially occluded, the pulse may be diminished.

The femoral artery may be manually compressed at the midpoint of the inguinal ligament to control arterial bleeding after lower limb trauma

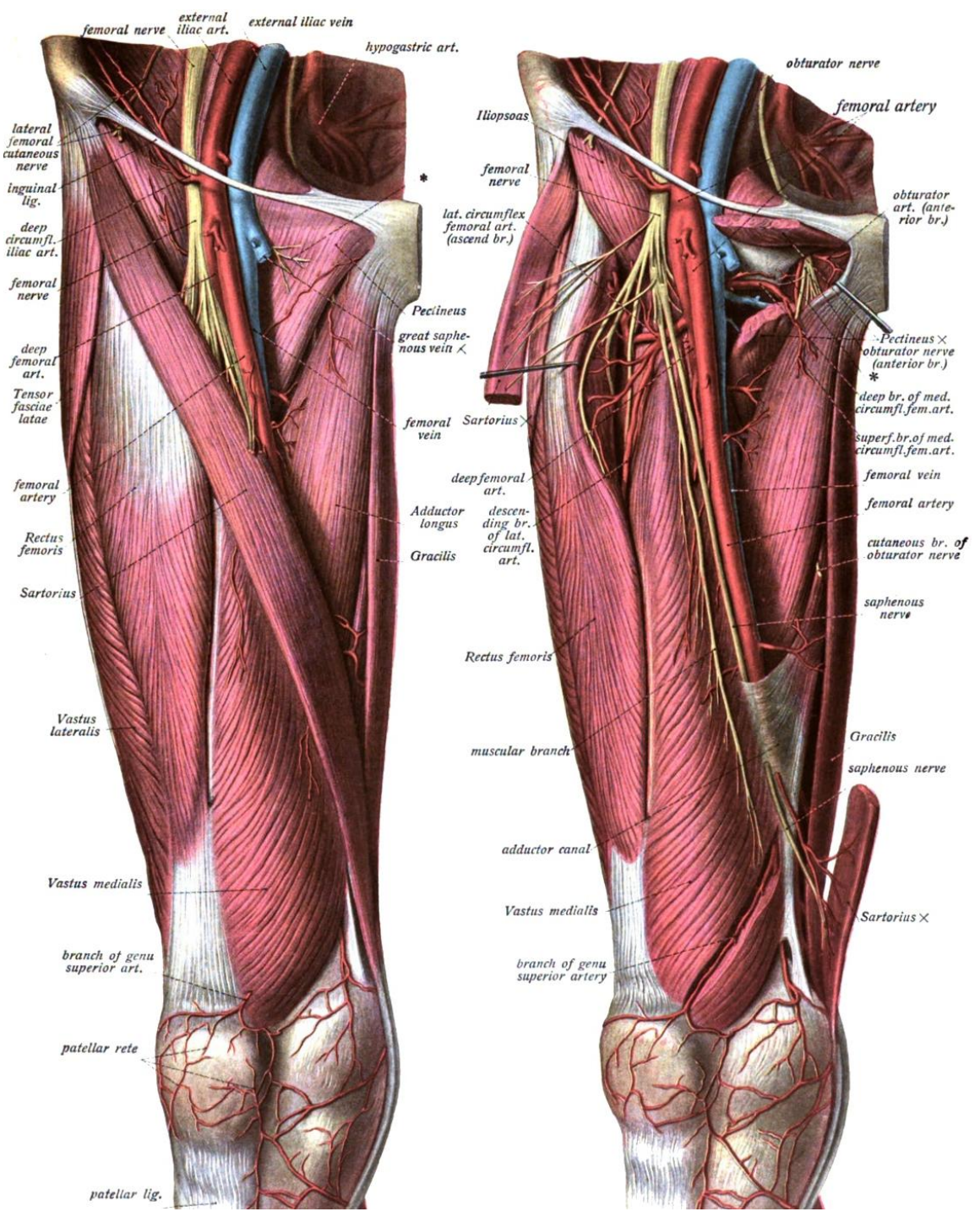


The adductor canal

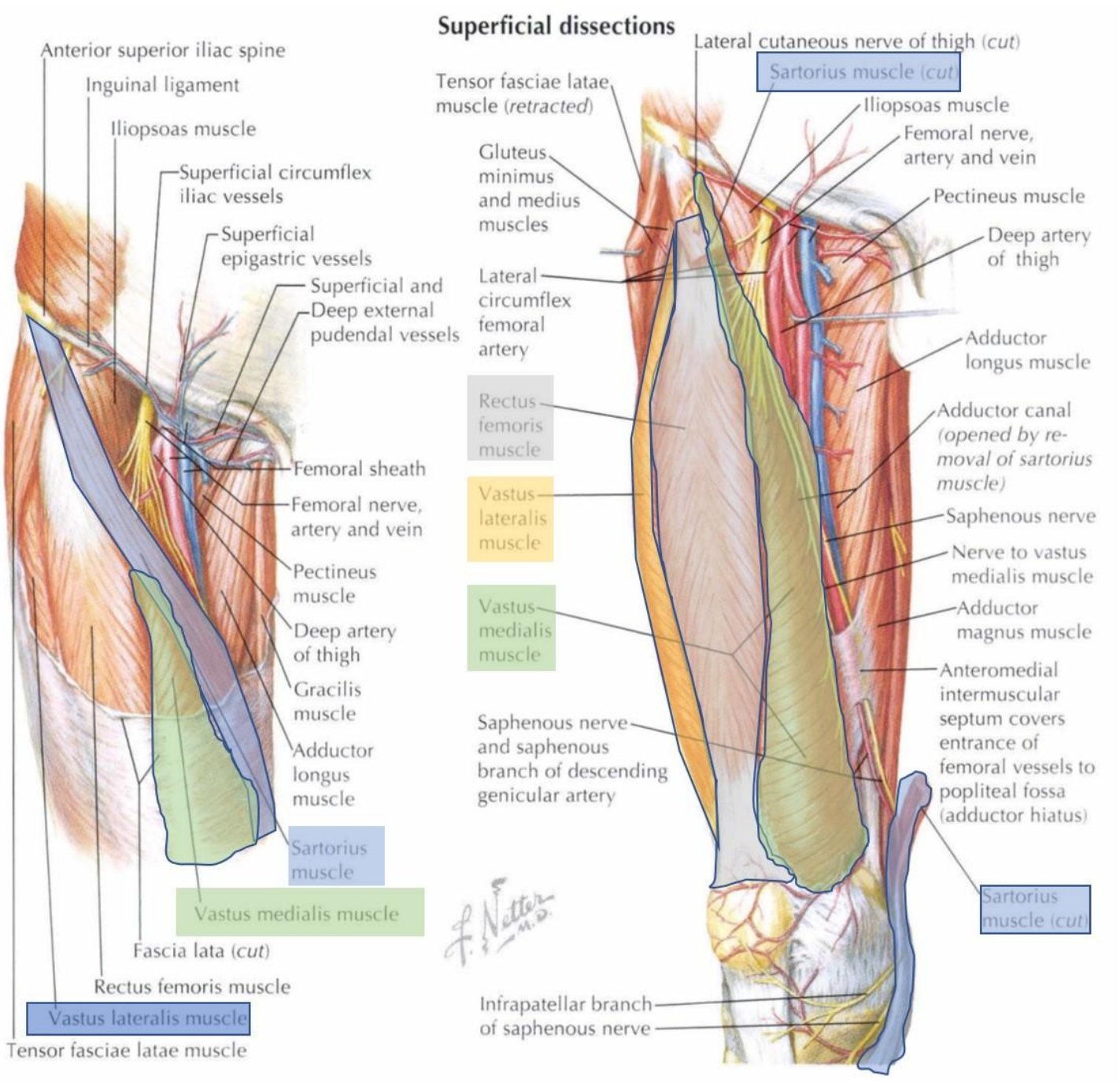
The femoral artery and vein bisect by the femoral triangle and pass to and from the adductor canal at the apex of the triangle. The adductor canal (subsartorial canal, Hunter canal) extends from the apex of the femoral triangle, where the sartorius crosses over the adductor longus, to the adductor hiatus in the tendon of adductor magnus. It provides an intermuscular passage for the femoral artery and vein, the saphenous nerve, and the nerve to vastus medialis, delivering the femoral vessels to the popliteal fossa where they become popliteal vessels.

The adductor canal

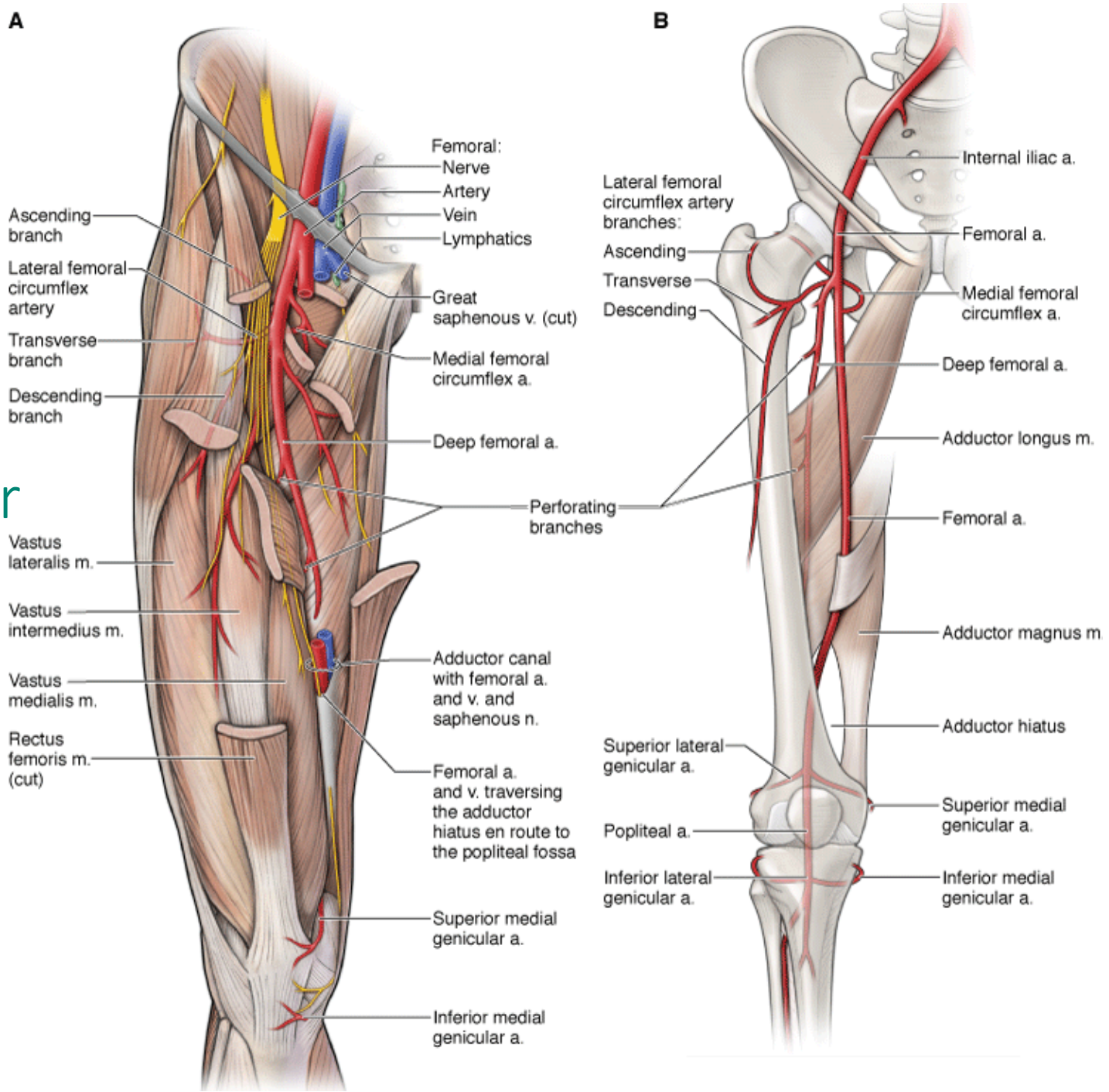
The adductor canal is bounded anteriorly and laterally by the vastus medialis; posteriorly by the adductor longus and adductor magnus; and medially by the sartorius, which overlies the groove between the above muscles, forming the roof of the canal.



The adductor canal



The adductor canal



Adductor canal

DIMENSION

It extends from the apex of the femoral triangle to adductor hiatus

BOUNDARIES

Anterioromedial:

Sartorius fascia

Posterior:

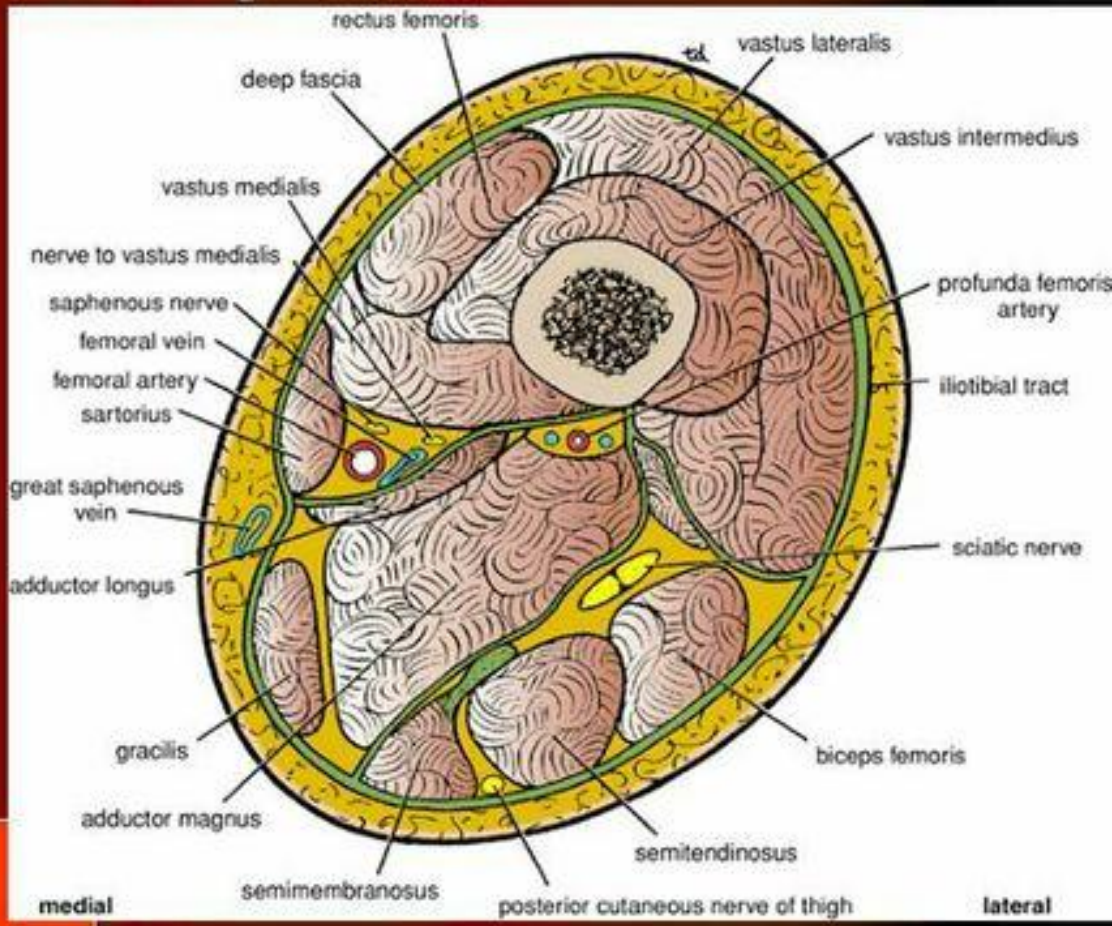
Adductor longus magnus

Lateral:

Vastus medialis

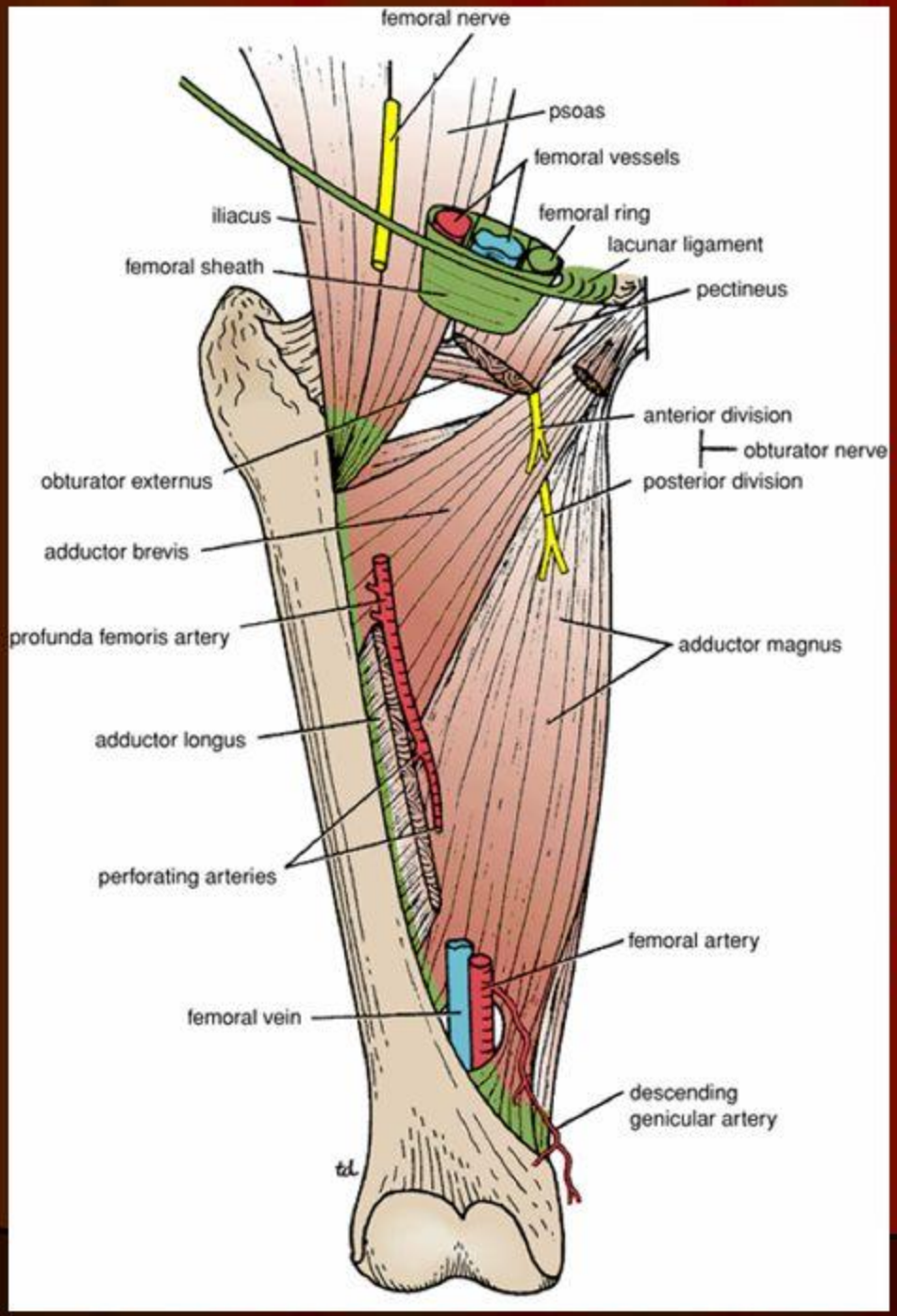
CONTENTS:

a. Femoral artery
b. Femoral vein
c. Deep lymph vessels
d. Saphenous nerve
e. Nerve to vastus medialis
f. Anterior division of obturator nerve



Subsartorial plexuses

Dr. Vohra



The adductor hiatus is a gap in the distal attachment of adductor magnus to the femur, which permits the femoral vessels to pass from the adductor canal downward into the popliteal space.

The adductor canal: nerves and vessels