Part I-Knee

Bones

Femur

The femur (Os femoris), the bone of the thigh, is the longest bone in the body. Its upper (proximal) end comprises a head, neck, greater trochanter and lesser trochanter. The head of the femur is hemi-spheroidal in shape, and has a smooth articular surface for articulation with the acetabulum of the hip bone. The medial aspect of the femoral head has a pit termed the fovea. Attached to the fovea is the ligament of the head of femur. Passing infero-laterally and somewhat backwards from the head of femur to join the shaft, is the neck of femur. Thus the femoral neck is anteverted in relation to the femoral shaft apart from subtending an angle with the shaft in the coronal plane. The surface of the femoral neck is characterized by many small vascular foramina, and by the presence of many grooves and ridges.

Below the neck, and continuous with it, is the femoral shaft.

The junction between the neck and shaft of femur displays on the anterior aspect an oblique and somewhat rough ridge termed the intertrochanteric line, while the posterior aspect of the junction between the neck and shaft of femur is marked by a prominent and smooth elevation called the intertrochanteric crest.

The front and sides of the femoral shaft are smooth. The femoral shaft shows a gentle anterior convexity. The posterior surface of the middle third of the length of the femoral shaft is characterized by the presence of a rough vertical ridge termed the lineae asperae. Superiorly the lineae asperae appears to split into two ridges. The lateral ridge, rough and prominent, is termed the gluteal crest and receives the insertion of part of the gluteus maximus muscle. The medial
ridge which is less prominent is called the spiral line.

Inferiorly too, the linea aspera appears to split into two ridges; the medial ridge is the medial supracondylar line and the lateral ridge, the lateral supracondylar line.

The aponeuroses of several muscles gain a linear attachment to the linea aspera. From lateral to medial these are vastus lateralis, biceps femoris (short head), adductor magnus, adductor brevis, adductor longus and vastus medialis.

The lower end of the femur comprises two prominences, the lateral and medial femoral condyles. The femoral condyles are continuous superiorly with the femoral shaft. Each condyle is curved from front to back, and may be described as being cam-shaped.

Anteriorly the two femoral condyles are confluent. Posteriorly, and to an extent inferiorly, they are separated from each other by a deep notch termed the intercondylar fossa (or intercondylar notch). The anterior, inferior and posterior aspects of each condyle are smooth and represent the articular surface. In life, this area is covered by articular hyaline cartilage. Viewed end-on, the articular surface on the distal (condylar) end of the femur is in the shape of a broad, inverted letter U. The articular surfaces of the medial and lateral femoral condyles engage, respectively, the meniscus-bearing medial and lateral articular facets on the tibial plateau.

The lateral surface of the lateral condyle and the medial surface of the medial condyle are non-articular, and both surfaces are readily palpable. The epiphyseal line at the lower end of femur is above the level of the femoral condyles.

**Tibia**

The tibia is the larger and the medial of the two bones of the leg. It consists of two expanded extremities joined by a shaft. The proximal (upper) end is the larger of the two extremities. The upper surface of the proximal end of the tibia is termed the tibial plateau.

The anterior aspect of the upper end of the tibia, a short distance below the level of the plateau, is characterized by the presence of an irregular prominence, the tibial tuberosity. The upper half of the tibial tuberosity is smooth and is the site of attachment of the patellar ligament (patellar tendon, ligamentum patellae). The lower half of the tibial tuberosity is rough and is overlain by the subcutaneous (superficial) infrapatellar bursa.

The shaft of the tibia is approximately triangular in cross section, and may be described as possessing three borders - anterior, lateral and medial. The anterior border of the tibial shaft is colloquially referred to as the shin, and is readily palpable along its entire length. The lateral border of the tibial shaft gives attachment to the medial edge of the interosseous membrane and is therefore also referred to as the interosseous border. These three borders serve to demarcate the following three surfaces on the tibial shaft:

i) The medial surface (between the anterior and medial borders)

ii) The posterior surface (between the medial and interosseous borders)

iii) The lateral surface (between the anterior and interosseous borders)

The medial surface of the tibial shaft is almost entirely subcutaneous. The upper part of this surface receives the attachment of the pes anserinus (the partially conjoined tendons of insertion of sartorius, gracilis and semitendinosus). The upper part of the medial surface of the tibial shaft also receives the attachment of the lower end of the tibial collateral ligament, postero-inferior to the insertion of the pes anserinus.
The lateral surface of the tibial shaft forms part of the floor of the anterior (extensor) compartment of the leg. The upper two-thirds of the lateral surface of the tibia gives attachment to tibialis anterior.

The posterior surface of the tibial shaft displays, in its upper part, an oblique ridge which runs infero-medially from just below the lateral tibial condyle to the medial border of the tibial shaft. This ridge is called the soleal line and gives attachment to part of the long linear attachment of the soleus muscle.

The triangular area on the posterior surface of the tibial shaft proximal to the soleal line gives attachment to the popliteus muscle. Below the soleal line, the posterior surface of the tibia displays a vertical ridge which fades out distally. Tibialis posterior takes origin from the area lateral to the vertical ridge while flexor digitorum longus takes origin from the area medial to the ridge. The junction between the proximal three-fourths and distal fourth of the tibial shaft is the narrowest and weakest part of the tibial shaft. It is significant that beyond this junction, the tibial shaft has no muscular attachments on any of its surfaces. Consequently the periosteum of the distal tibia is less vascularized than in the proximal part of the bone. This has unfavorable implications for healing of fractures in this region. The medial aspect of the lower end of the tibia shows a prominent and thick process which projects distally. This is called the medial malleolus.

The upper end of the tibia is transversely expanded and is much wider than the lower end of the bone. It is composed of two prominences, the lateral and medial tibial condyles which are confluent. The upper surface of the tibia is termed the tibial plateau and displays two smooth, gently concave articular areas, the medial and lateral articular facets, which surmount the corresponding tibial condyles. In life these articular facets are covered by articular hyaline cartilage.

Patella
The patella, the largest sesamoid bone in the body, is embedded in the tendon of quadriceps femoris, and is located anterior to the tibio-femoral articulation. Its outline is somewhat in the shape of an inverted triangle with the apex of the bone directed inferiorly. Thus it possesses a base, lateral and medial borders and an apex. The base is a relatively expansive surface and receives the lower end of the quadriceps tendon.

The patella is part of the knee joint extensor mechanism.

The patella has an anterior surface which is gently convex forwards. It often shows a number of small perforations, (for nutrient vessels), and a few ridges, but is otherwise featureless.

The posterior surface of the patella carries a large, smooth, undulant and quadrangular articular area. This facet occupies the upper four-fifths or so of the posterior surface of the patella, and is covered by a continuous plate of articular hyaline cartilage. A vertical ridge on this articular surface divides the area into lateral and medial facets, the lateral facet usually being larger and significantly more concave. These two facets of the patellar articular surface are apposed to the corresponding femoral condyles, while the vertical ridge separating them faces the groove on the anterior aspect of the lower end of femur between the two femoral condyles.

The medial patellar articular facet is further subdivided into two narrow vertical regions by means of a faint ridge, the medial of the two regions coming into contact with the medial femoral condyle in extreme flexion of the knee.
Attached to the apex of the patella and the adjoining part of the posterior patellar surface is the patellar ligament, the inferior continuation of the quadriceps tendon. Attached to the medial and lateral borders of the patella are, respectively, the medial and lateral patellar retinacula. Superficial to these retinacula, the medial and lateral patellar borders receive the attachments of the lowest fibers of vastus medialis and vastus lateralis respectively.

**Muscles-Anterior**

![Muscle Diagram]

**Vastus medialis** has a continuous linear attachment, proximally, to the spiral line on the posteromedial aspect of the upper part of the femoral shaft, the medial lip of the linea aspera, the medial supracondylar line and the tendon of adductor magnus. From this attachment the muscle fibers run antero-inferiorly, covering but not attaching to the medial aspect of the femoral shaft.

Distally, the muscle fibers become continuous with an aponeurosis which joins the quadriceps tendon. A part of the vastus medialis aponeurosis is inserted directly into the medial edge of the patella. This is an important factor in maintaining patellar stability. A further expansion from the vastus medialis aponeurosis blends with the medial part of the capsule of the knee joint before attaching to the medial aspect of the medial tibial condyle.

Vastus medialis is innervated by a branch from the posterior division of the femoral nerve.

**Vastus lateralis** has a continuous linear attachment on the femur along the upper half of the intertrochanteric line, the anterior and inferior borders of the greater trochanter, the lateral lip of the glutaeal tuberosity and the upper half of the lateral lip of the linea aspera. Additionally, vastus lateralis arises, in part, from the lateral intermuscular septum. Distally, the flattened tendon of vastus lateralis joins the quadriceps femoris tendon. A part of the tendon of vastus lateralis inserts directly into the upper and lateral borders of the patella. An expansion from the vastus lateralis tendon blends with the lateral aspect of the capsule of the knee joint and the iliotibial tract, before attaching to the lateral tibial condyle.
It is innervated by a branch from the posterior division of the femoral nerve.

**Vastus intermedius** arises from the anterior and lateral surfaces of the proximal two-thirds of the femoral shaft. Distally, the muscle becomes an aponeurosis which in turn continues into the quadriceps femoris tendon.

It is innervated by a branch from the posterior division of the femoral nerve.

**Rectus femoris** has two 'heads' of origin, both of which arise from the hip bone. The straight head (straight tendon) arises from the anterior inferior iliac spine; the reflected head (reflected tendon) arises from a groove on the upper surface of the acetabulum and from the fibrous capsule of the hip joint. The two tendons of origin give rise to muscle fibers which fuse to form a spindle-shaped muscle.

Distally, a thick tendon develops from the muscle and joins the quadriceps femoris tendon, through which it attaches to the upper border of the patella.

Usually, each head of rectus femoris is innervated by a separate branch from the posterior division of the femoral nerve.

The four muscles listed above constitute the **Quadriceps Muscles**, and supply the leg with the power to extend the knee.

**Muscles-Posterior**

**Biceps femoris** is a muscle of the posterior (hamstring) compartment of the thigh, and lies in the posterolateral part of the thigh.

Biceps femoris arises proximally by two 'heads' - termed the long head and short head. The long head of biceps femoris arises in common with the tendon of origin of semitendinosus from the superomedial part of the ischial tuberosity. The short head has a continuous origin from the
lateral lip of the linea aspera on the posterior surface of the femoral shaft, the upper half of the lateral supracondylar line and from the lateral intermuscular septum.

Distally, the two muscular heads fuse and give rise to a tendon which inserts principally onto the lateral surface of the fibular head. Extensions from the tendon gain attachment to the lower end of the iliotibial tract and to the lateral tibial condyle.

The two heads of biceps femoris are innervated separately by the sciatic nerve; the long head of biceps femoris by the tibial component and the short head by the common peroneal component.

In common with the other hamstring muscles, the action of biceps femoris is to flex the knee joint and to assist in extending the hip joint.

**Semitendinosus** arises from the supero-medial part of the ischial tuberosity of the hip bone in common with the tendon of origin of the long head of biceps femoris. From this origin, the semitendinosus muscle runs obliquely, infero-medially behind semimembranosus. Approximately halfway down the thigh, the semitendinosus muscle gives rise to a strong, rounded tendon.

In the lower part of the thigh, semitendinosus and semimembranosus together form the upper medial boundary of the popliteal fossa.

Distally, semitendinosus is attached to the upper part of the medial surface of the tibial shaft postero-inferior to the insertion of gracilis.

Semitendinosus is innervated by the sciatic nerve (tibial component).

Being a hamstring muscle, its action is to assist in flexion of the knee and extension of the hip joint.

Semitendinosus is innervated by the sciatic nerve (tibial component).

**Semimembranosus** is a muscle of the posterior (hamstring) compartment of the thigh, and occupies the posteromedial part of the thigh. Proximally, semimembranosus arises from the superolateral aspect of the ischial tuberosity by a long and flattened tendon. Distally, semimembranosus is attached principally to the posterior surface of the medial tibial condyle. From this insertion several expansions from the tendon pass in different directions.

Thus one expansion (oblique popliteal ligament) runs supero-laterally behind the knee joint reinforcing the joint capsule. Another prominent expansion passes downwards and laterally to cover the popliteus muscle. This is called popliteus fascia. A further expansion runs anteromedially along the medial aspect of the knee joint and partially blends with the capsule of the knee joint.

Lying superficial to semimembranosus is semitendinosus.

Semimembranosus is innervated by the sciatic nerve (tibial, component).

In common with the other hamstring muscles, the action of semimembranosus is to flex the knee joint and to assist in extending the hip joint.

**Bursa between semimembranosus and medial head of gastrocnemius**

A bursa is usually present between the distal part of semimembranosus and the underlying medial head of gastrocnemius. The bursa may at times become enlarged with distended fluid. This swelling is termed Baker's cyst (described by Morrant Baker in the 19th century as a cystic
mass in the popliteal fossae of children).

Clinical notes

Adults sometimes present with knee swellings resembling an enlarged semimembranosus bursa. Such a lesion is usually a mass of synovium or a knee joint synovial pouch which swells in the popliteal fossa due to an associated knee effusion, synovitis or other pathology affecting the joint as a whole. This posterior synovial pouch may become so large as to interfere with venous return from the leg. The posterior synovial cyst may also burst and leak synovial fluid into the popliteal fossa and into the calf musculature, producing a synovial pseudocyst. The associated pain and swelling may falsely suggest an acute deep vein thrombosis, with consequent unnecessary and inappropriate hospitalization and anti-coagulation of patients.

Nerves

The common peroneal nerve is the smaller and the lateral of the two terminal branches of the sciatic nerve. It carries fibers derived from spinal cord segments L4, L5, S1 and S2. From its origin in the upper part of the popliteal fossa it descends infero-laterally just medial to the tendon of biceps femoris. It runs superficial to plantaris, lateral head of gastrocnemius and the posterolateral part of the capsule of the knee joint before reaching the posterior aspect of the fibular head.

It then winds around the lateral aspect of the fibular neck to enter the substance of peroneus longus muscle, where it may be palpated against the underlying bone.

Here the common peroneal nerve divides into its two terminal branches:

i) The superficial peroneal nerve

ii) The deep peroneal nerve
In and about the knee region, the common peroneal nerve gives the following branches before dividing into its terminal branches:

i) The peroneal communicating nerve which pierces the deep fascia and joins the sural nerve in the subcutaneous fat distal to the level of the muscular bellies of gastrocnemius

ii) Articular branches: lateral superior genicular nerve, lateral inferior genicular nerve and recurrent genicular nerve. The lateral superior and inferior genicular nerves accompany the corresponding arteries. The recurrent genicular nerve is an articular branch which arises within the peroneus longus muscle. It then runs superiorly through the upper fibers of tibialis anterior muscle and supplies the superior tibiofibular joint and knee joint.

iii) The lateral cutaneous nerve of calf which arises within the popliteal fossa, pierces the fascial roof of the popliteal fossa and supplies the skin over the upper part of the anterolateral aspect of the leg.

The tibial nerve, arises in the popliteal fossa as the larger and more medial of the two terminal branches of the sciatic nerve and carries fibers derived from the spinal cord segments L4, L5, S1, S2 and S3. It descends vertically within the popliteal fossa, leaving the fossa distally by running deep to the arch of the soleus muscle. The nerve then lies in the flexor (posterior) compartment of the leg, before dividing into the medial and lateral plantar nerves for sensory and motor distribution to the foot.

The tibial nerve is relatively superficial within the proximal part of the popliteal fossa. In the distal part of the popliteal fossa however, the tibial nerve lies in the depths of the interval between the two heads of the gastrocnemius muscle.

Within the popliteal fossa the tibial nerve gives the following branches:

i) muscular branches to gastrocnemius (both heads), plantaris, soleus and popliteus,

ii) articular branches: medial superior genicular nerve, medial inferior genicular nerve and middle genicular nerve to the knee joint. These genicular nerves accompany the corresponding arteries on their way to the interior of the knee joint,

iii) the sural nerve, a cutaneous nerve.

Distal to the popliteal fossa, the tibial nerve is distributed to the muscles of the flexor (posterior) compartment of the leg, before it divides into the medial and lateral plantar nerves.
Arterial Structures

**The Popliteal artery** is the direct continuation of the femoral artery at the level of the adductor hiatus. The popliteal artery runs down the popliteal fossa in a medial to lateral obliquity, in a plane anterior to the popliteal vein at all times. The central segment of the popliteal artery is immediately behind the knee joint capsule and its associated oblique popliteal ligament. In the distal part of the popliteal fossa, level with the distal border of popliteus muscle, the popliteal artery terminates by dividing into the anterior and posterior tibial arteries.

The popliteal artery gives the following branches:

i) the genicular arteries, namely: medial superior genicular artery, lateral superior genicular artery, medial inferior genicular artery, lateral inferior genicular artery, and middle genicular artery,

ii) muscular branches for supply to the hamstring muscles,

iii) cutaneous branches, and

iv) sural arteries

and two terminal branches:

i) the anterior tibial artery, and

ii) the posterior tibial artery.
The genicular anastomosis (anastomosis around the knee joint) is a rich and intricate interconnection of several arteries in the vicinity of the knee joint. This arterial anastomosis supplies the distal femur, proximal tibia, patella, joint capsule, synovium and superficial tissues. Vascular injection techniques have demonstrated that the anastomosis is composed of two interconnected arterial networks: a superficial network located in the superficial tissues, and a deep network situated adjacent to the bone and fibrous capsule of the knee joint.

The arteries which make up the genicular anastomosis are:

i) the medial and lateral superior genicular arteries,

ii) the medial and lateral inferior genicular arteries,

iii) the descending genicular artery and its branch the saphenous artery,

iv) the anterior and posterior tibial recurrent arteries,

the circumflex fibular artery and the descending branch of the lateral circumflex femoral artery.
Part II-Hip

Bones

The hip bone is formed from the fused ilium, ischium, and pubis (slide 1, slide 2). The ilium is a broad fan-shaped bone, joined to the other two at the acetabulum. The long axis of the sinuous iliac crest is almost at 90 degrees to the axis through the ischium and pubis. The Ischium and pubis are fused with each other and with the ilium at the acetabulum. They are also joined to each other by the ischiopubic ramus. The acetabulum is a deep cup-shaped fossa in the lateral aspect of the hip bone, which articulates with the head of the femur.

The ilium forms about two-fifths of the acetabulum and is expanded superiorly to form the slightly sinuous fan-shaped ala. The ala has gluteal and pelvic surfaces separated by the iliac crest superiorly and by anterior and posterior borders. Its gluteal surface gives attachment to muscles of the lower limb. The medial surface has a posterior sacropelvic component and an anteriorly situated iliac fossa.

The ischium forms the posterior inferior part of the hip bone. The body of the ischium forms two-fifths of the acetabulum. It is expanded inferiorly to form the ischial tuberosity. Its posterior border bears a conical ischial spine, which separates the greater and lesser sciatic notches. The ischial ramus passes forwards from the ischial tuberosity to join the inferior pubic ramus, forming the inferior boundary of the obturator foramen.

The pubis has a flattened body and superior and inferior pubic rami. The body has pelvic and outer surfaces. The superior border bears the pubic tubercle laterally. Its oval symphyseal surface is covered with hyaline cartilage.
The articulated pelvis

In the erect posture, the pelvis lies obliquely so that the anterior superior iliac spine and the top of the pubic symphysis lie in the same vertical plane. The pelvis is divided into greater and lesser parts by a plane through the pelvic brim. The pelvic brim is bounded by the arcuate lines anteriorly and laterally and by the sacral promontory posteriorly. The greater, or false, pelvis is above the pelvic brim and forms the lower part of the abdominal cavity. The lesser, or true, pelvis is below the pelvic brim.

In the female, the lesser pelvis forms the birth canal; and is described in terms of its inlet, cavity and outlet. The pelvic brim forms the inlet. The cavity is a short curved canal, its posterior wall about three times longer than its anterior wall. Its walls are formed by the pelvic surfaces of the hip bones and sacrum, by the sacrospinous and the sacrotuberous ligaments and by the muscles lining the lesser pelvis. The outlet is diamond-shaped with the coccyx posteriorly, the pubic symphysis anteriorly, the ischiopubic rami anterolaterally and sacrotuberous ligaments posterolaterally. The largest diameter of the inlet is in the transverse plane, and the largest diameter of the outlet in the sagittal plane.

In the male, the pelvic inlet tends to be heart-shaped, whilst in the female it is oval or rounded.

In the male, the pelvis tends to be heavier, with more prominent muscle and ligament attachments. The brim is heart-shaped, the cavity longer and narrower. The ischiopubic rami are everted. The subpubic angle is less than 90 degrees. The auricular surface of the sacrum extends over three vertebrae. The greater sciatic notch forms a more acute angle than in the female. The female pelvis is lighter, thinner and less roughened by its muscle and ligamentous attachments. The brim tends to be rounded or oval, with a shorter and wider pelvic cavity. The subpubic angle is greater than 90 degrees. The auricular surface of the sacrum extends over two vertebrae.

The hip joint

The hip joint is a synovial ball and socket joint between the acetabulum of the hip bone and the head of the femur. The articular surface of the femoral head forms two-thirds of a spheroid and is covered in hyaline articular cartilage. The cartilage is interrupted at the pit on the head of the femur, and extends to the junction of the head and the neck.

The acetabulum

The acetabulum has a broad horseshoe-shaped lunate articular surface, the open end is found inferiorly. The cartilage encloses the depressed non-articular part of the acetabulum, the acetabular fossa. The acetabular fossa lodges a fat pad covered in synovial membrane.

The joint is enclosed in a fibrous capsule. This is very strong, and tense in full extension. The capsule surrounds the acetabulum and is attached above and behind directly to the hip bone just wide of the labrum. Below and in front it is attached to the bone and outer surface of labrum and to the transverse ligament of the acetabulum. Distally, the capsule is attached to the intertrochanteric line, to the femoral neck close to its junction with the trochanters, and posteriorly to the posterior aspect of the femoral neck itself. The lateral third of the femoral neck is extra-capsular. The growth plate of the femoral head is intra-capsular. Three thickened bands, the iliofemoral, pubofemoral and ischiofemoral ligaments, reinforce the capsule.

Within the hip joint is the ligament of the head of the femur, a flattened band of connective tissue surrounded by synovial membrane. It is attached to the margins of the acetabular fossa and the transverse ligament of the acetabulum. This tip is attached to the pit on the head of the femur. A small artery accompanies the ligament.
The joint is lined by synovial membrane, which covers the capsule and the labrum. At the acetabular notch it is attached to the medial margin of the transverse ligament and covers the fibrofatty pad in the acetabular fossa. It forms a sleeve around the ligament of the head of the femur. At the femoral attachment of the joint capsule, the membrane is reflected upwards onto the neck of the femur as far as the edge of the articular cartilage.

**Muscles**

**Sartorius** is the longest muscle in the body. The upper third of the muscle forms the lateral boundary of the femoral triangle, while the lower two-thirds of the muscle lies superficial to the fibrous roof of the adductor canal.

**Proximal Attachment**

It arises from the anterior superior iliac spine of the hip bone and from the notch immediately below.

**Distal Attachment**

From this origin it runs infero-medially and attaches by an aponeurosis to the upper part of the medial surface of the tibial shaft in front of the tendons of gracilis and semitendinosus.

**Pes anserinus** is a commonly used expression (though not one that is officially recognized in anatomical nomenclature) for the partly joined flattened tendons of the insertion of sartorius, gracilis and semitendinosus. These tendons are inserted onto the medial surface of the upper part of the tibia. The fancied resemblance of this arrangement to a goose's foot is the reason for the name! Within this arrangement, the tendons of gracilis and semitendinosus are relatively thick, strong and cord-like, whereas the sartorius tendon is almost fascial in its appearance.

**Nerve Supply**

The anterior division of the femoral nerve, derived from L2 and 3, innervates sartorius.

**Action**

**Sartorius** is a weak flexor, lateral rotator and assists in abduction of the hip joint. It also flexes the knee and medially rotates the leg when the knee is flexed.

**Tensor fasciae latae** arises from the anterior part of the outer lip of the iliac crest, the lateral aspect of the anterior superior iliac spine and the upper part of the anterior border of the iliac wing.

**Distal Attachment**

It descends between, and is attached to the two layers of the iliotibial tract, generally ending around mid-thigh.

**Nerve Supply**

By a branch from the superior gluteal nerve (L4, 5).

**Action**

**Tensor fasciae latae** acts through the iliotibial tract by pulling it superiorly and anteriorly. It assists in the flexion, abduction and medial rotation of the hip joint and extension of the knee joint.
Through these actions, tensor fasciae latae aids in the stabilization of the pelvis on the head of the femur and of the condyles of the femur on the tibial condyles.

**Gluteus medius** lies between gluteus maximus posteriorly and tensor fasciae latae anteriorly. Much of the muscle is covered by gluteus maximus.

**Proximal Attachment**

This fan-shaped muscle arises from the outer surface of ilium between the posterior and anterior gluteal lines.

**Distal Attachment**

The muscle converges to form a tendon, which is attached to the oblique ridge sloping downwards and forwards on the lateral surface of the greater trochanter. There is a bursa between the tendon and the upper lateral surface of the trochanter. The posterior border of gluteus medius may blend with piriformis.

**Nerve Supply**

By a branch from superior gluteal nerve (L4, 5, S1).

**Action**

Together with gluteus minimus it abducts and medially rotates the hip joint. Gluteus medius and minimus are fundamental in keeping the trunk in an upright position when the contra-lateral foot is raised during walking.

**Clinical Pathology Text**

**Trendelenburg Test**

The 'Trendelenburg test' is conducted with the opposite non-weight bearing hip in extension. This allows the pelvis to be carefully tilted for assessment from the front. Flexion of the opposite hip tends to cause a forced negative result owing to action of the psoas muscle. Both an immediate and a delayed, after 20 to 30 second, Trendelenburg test are checked and correlated with gait and the ability to hop. In a negative test, the hemi-pelvis on the weight bearing side stays low but if the test is positive the muscle forces cannot keep that side of the pelvis down, and it rises. This is due to a number of causes including weakness of the hip abductors (gluteus medius and minimus), short femoral neck and coxa vara.

**Gluteus maximus** is a large, coarsely fibered, quadrilateral mass of muscle, which forms the prominence of the buttock and covers the ischial tuberosity.

**Proximal Attachment**

It arises from the iliac wing behind the posterior gluteal line, including the iliac crest, from the posterior layer of thoracolumbar fascia, the posterior surfaces of the sacrum, coccyx, and sacrotuberous ligament and from the fascia covering gluteus medius (the gluteal aponeurosis).

**Distal Attachment**

The fibers descend downwards and laterally. The deeper fibers of the lower part of the muscle are inserted into the gluteal tuberosity. The superficial fibers and the upper deep part of the muscle end in a tendinous sheet, which passes lateral to the greater trochanter and is attached to
the iliotibial tract of the fascia lata.

The iliotibial tract runs down the anterior lateral side of the thigh. It blends with the capsule of the knee joint to attach to Gerdy's tubercle, the lateral condyle of the tibia and the head of the fibula.

Nerve Supply

The inferior gluteal nerve derived from the ventral rami of L5, S1 and S2, supplies the gluteus maximus muscle.

Action

Gluteus maximus extends (movie 1, movie 2), laterally rotates and assists in abduction of the hip joint. Through its attachment to the iliotibial tract it stabilizes the knee joint when the extensors are relaxed.

Piriformis arises from the anterior aspect of the second to the fourth segments of the sacrum, between and lateral to the sacral foramina. As the muscle leaves the pelvis, some slips arise from the margin of the greater sciatic notch as well as from the pelvic surface of sacrotuberous ligament.

Distal Attachment

The muscle passes out of the pelvis through the greater sciatic foramen. Its rounded tendon is attached to the upper border and medial aspect of the greater trochanter, close to the insertion of the obturator internus and the gemelli, with which it may be partially merged. It may also merge with the gluteus medius.

Nerve Supply

It is supplied by the nerve to piriformis derived from the ventral rami of L5, S1 and S2. If the common peroneal nerve leaves the pelvis separately, it may pierce the piriformis muscle, whose anterior surface is intimately related to the sacral plexus.

The anterior surface of the piriformis is related to the rectum, the sacral plexus and branches of the internal iliac vessels. Outside the pelvis, the anterior surface is in contact with the posterior surface of the ischium and the capsular hip joint. Sciatic, posterior femoral cutaneous and pudendal nerves, inferior gluteal and internal pudendal vessels and muscular branches from the sacral plexus, lie in the interval between piriformis and the superior gemellus/obturator internus.

Action

Piriformis laterally rotates the extended hip joint and abducts the flexed hip joint.

Clinical Pathology Text

Sciatic Nerve

A great deal of variability exists in relationship of the sciatic nerve to the piriformis muscle and short external rotators. In approximately 85% of cases the sciatic nerve exits the pelvis deep to the muscle belly of the piriformis. It is usually superficial (posterior to the other external rotators). In 11% of individuals a portion of the piriformis muscle splits the common peroneal nerve and tibial nerve. These anatomic variations are important in the interpretation of intra-operative findings.
Piriformis Syndrome

Youngman described ‘Piriformis Syndrome’ in 1928 as an evolving compression of the sciatic nerve by the piriformis muscle. This is associated with acute trauma to the buttock and occurs when the sciatic nerve exits posterior to the piriformis. The patient finds sitting difficult and participation in activities where hip flexion or internal rotation is required, almost impossible. The pain is in the sciatic nerve distribution.

Physical examination reveals tenderness directly over the piriformis tendinous or in the gluteal area, and the pain can be listed by forced internal rotation of the extended thigh – this is sometimes called ‘Pace’s sign’. There is sometimes weak abduction against resistance or external rotation against resistance, and the pain may also be reproduced by rectal or vaginal examination.

Treatment involves rest and oral anti-inflammatory drugs. The diagnosis can also be confirmed by the injection of local anesthetic under fluoroscopy into the area of injury. Steroid injection may occasionally be necessary. In refractory cases, surgical exploration of the piriformis and/or division of the piriformis muscle and/or mobilization of the sciatic nerve may be necessary.

The piriformis syndrome is thought to be due to irritation of the sciatic nerve as it passes over the piriformis tendon. This causes buttock pain and sciatica. The pain can be reproduced by applying pressure to the piriformis fossa on the posterior aspect of the greater trochanter and by stressing the piriformis muscle. Injections can once again be diagnostic and therapeutic. Some authors have reported good results by sectioning the piriformis to relieve the pain.

The superior and inferior gemelli arise from the superior and inferior margins of the lesser sciatic notch on either side of the obturator internus tendon with which they blend. The superior gemellus muscle is sometimes absent and is the smaller of the two gemelli.

Proximal Attachment

It arises from the gluteal surface of the ischial spine.

Distal Attachment

It blends with the upper part of the tendon of obturator internus, and is attached to the medial surface of the greater trochanter.

Nerve Supply

The nerve to obturator internus, derived from the ventral rami of L5 and S1, supplies the superior gemellus.

Action

The gemelli together with the tendon of obturator internus laterally rotates the extended hip joint and abducts the flexed hip joint.

Obturator internus arises as a large fan-shaped muscle from the; pelvic margins of the obturator foramen, from the medial two-thirds of the obturator membrane that fills it and from the anterolateral pelvic surface of the hip bone. The muscle fibers converge, passing backwards, towards a groove on the lesser sciatic foramen. Here its fibers make a right-angled turn, inferior to the ischial spine, to leave the pelvis. The groove is covered by hyaline cartilage, which is separated from the tendon of obturator internus by a bursa termed the ‘sciatic bursa of obturator internus’.
Distal Attachment

The tendon of obturator internus then passes horizontally across the posterior aspect of the hip joint capsule to insert, with the gemelli, into an impression on the medial surface of the greater trochanter. Usually a long thin bursa separates the tendon from the hip joint capsule often communicating with the sciatic bursa of obturator internus.

Nerve Supply

Obturator internus is supplied by the nerve to obturator internus, which is derived from the ventral rami of L5, S1 and S2.

Action

Due to the inaccessibility of obturator externus in humans, no direct studies have been carried out on its actions. However, its attachment points suggest that it laterally rotates the extended hip joint and abducts the flexed hip joint.

Anatomy Text

The superior and inferior gemelli arise from the superior and inferior margins of the lesser sciatic notch on either side of the obturator internus tendon. The inferior gemellus muscle is the larger of the two gemelli.

Proximal Attachment

It arises from the upper part of the ischial tuberosity, immediately below the groove for obturator internus tendon.

Distal Attachment

It blends with the lower part of the tendon of obturator internus, and is attached to the medial surface of the greater trochanter.

Nerve Supply

The nerve to quadratus femoris, derived from the ventral rami of L5 and S1, supplies the inferior gemellus.

Action

The gemelli together with the tendon of obturator internus laterally rotates the extended hip joint and abducts the flexed hip joint.

Anatomy Text

Proximal Attachment

This flat triangular muscle arises from the outer margins of the obturator foramen and from the medial two-thirds of the obturator membrane that fills it. The obturator vessels lie between the muscle and the obturator membrane. The anterior branch of obturator nerve enters the thigh by passing in front of the muscle, with the posterior branch piercing it.
Distal Attachment

The muscle fibers converge, passing backwards, laterally and upwards on the undersurface of the femoral neck and hip joint capsule, to insert into the trochanteric fossa at the medial aspect of the greater trochanter. There may be a bursa lying between the hip joint capsule, femoral neck and the obturator externus tendon. It may communicate with the hip joint.

Nerve Supply

The posterior branch of the obturator nerve, derived from L3 and 4, supplies obturator externus.

Action

Due to the inaccessibility of obturator externus in humans, no direct studies have been carried out on its actions. However, its attachment points suggest that it laterally rotates the extended hip joint and abducts the flexed hip joint.

Quadratus femoris lies posterior to the hip joint and femoral neck, separated from them by the tendon of obturator externus and the transverse branch of the medial circumflex femoral artery. There is often a bursa between the anterior aspect of the muscle and the lesser trochanter.

Proximal Attachment

Quadratus femoris is a flat quadrilateral muscle, which arises from the superior lateral margin of the ischial tuberosity.

Distal Attachment

It inserts into the quadrate tubercle situated at the mid-point of the intertrochanteric crest of the femur and to the bone immediately below it.

Nerve Supply

The nerve to quadratus femoris, which is derived from L5 and S1, supplies the quadratus femoris muscle.

Action

Quadratus femoris laterally rotates and adducts the hip joint.
Nerves

The femoral nerve is a branch of the lumbosacral plexus. It arises from the posterior divisions of the ventral rami of the second, third and fourth lumbar nerves. It passes infero-laterally through the substance of psoas major, behind the obturator nerve, gaining the groove between the psoas major and iliacus muscles, just below the iliac crest. It descends in the groove behind the iliac fascia. Within the abdomen, it gives off branches to iliacus, pectineus and the femoral artery. The nerve (or nerves) to pectineus arises close to the inguinal ligament, passing behind the femoral vessels to the lateral border of the muscle.

The nerve enters the thigh posterior to the inguinal ligament and lateral to the femoral artery and femoral sheath. It divides into anterior and posterior divisions. It supplies all the muscles in the anterior compartment of the thigh. It also gives articular branches to the hip and knee joints. A branch to the hip joint arises from the nerve to rectus femoris and branches to the knee joint arise from each of the nerves supplying the vastus muscles with a fourth branch possibly arising from the saphenous nerve.
The sciatic nerve is the largest nerve in the body, and consists of the medially placed tibial nerve and the laterally placed common peroneal nerve. It is formed from the ventral rami of the fourth lumbar to third sacral spinal nerves and is a continuation of the upper band of the sacral plexus.

It leaves the pelvis through the greater sciatic foramen, below the piriformis muscle, and descends between the greater trochanter of the femur and the ischial tuberosity. Initially deep to piriformis, it runs inferiorly and laterally posterior to the ischium, crossing over the nerve to quadratus femoris. Inferior to piriformis; it lies deep to gluteus maximus. It passes inferiorly crossing obturator internus, the gemelli and quadratus femoris. The posterior cutaneous nerve of thigh and the inferior gluteal artery lie on its medial side. Descending vertically, it enters the thigh at the lower border of gluteus maximus, where it lies on the posterior surface of adductor magnus. It gives off nerves to the hamstring muscles. The nerve is crossed obliquely on its superficial aspect by the long head of biceps femoris. The nerve ends at the upper aspect of the popliteal fossa by dividing into the tibial and common perineal nerves.

The nerve can be represented on the back of the thigh by a line drawn from just medial to the midpoint of the line from the ischial tuberosity to the apex of greater trochanter down to the apex of popliteal fossa.

It supplies articular branches to the hip joint, with muscular branches to biceps femoris, semitendinosus and semimembranosus and the ischial head of adductor magnus. The nerve to the short head of biceps is from the common peroneal division, with the other muscular branches emerging from the tibial division.
Arterial Supply

The inferior gluteal artery is a branch of the anterior trunk of the internal iliac artery. It supplies the buttock and the back of the thigh. The artery runs backwards and laterally between the first and second, or second and third, ventral sacral nerves. It traverses the greater sciatic foramen below the piriformis and enters the gluteal region. It descends at the postero-medial aspect of the sciatic nerve to reach the proximal thigh.

Within the pelvis; the inferior gluteal artery gives branches to the piriformis, coccygeus and levator ani muscles, perirectal fat, the fundus of the bladder, the seminal vesicles and the prostate. Outside the pelvis; it supplies gluteus maximus, obturator internus, the gemelli, quadratus femoris and the upper hamstrings. The artery to the sciatic nerve penetrates and runs along the surface of the nerve, accompanying it as far as the lower thigh.

The inferior gluteal and internal pudendal arteries may arise as a common stem from the internal iliac artery.

The superficial branch of the superior gluteal artery enters the deep surface of gluteus maximus with its corresponding nerve. Here is gives off several branches, which supply the muscle and anastomose with the inferior gluteal artery and the posterior branches of the lateral sacral artery.
The femoral artery is the direct continuation of the external iliac artery at the point where the latter crosses deep to the inguinal ligament; the vessel passes behind the ligament halfway along a line between the anterior superior iliac spine and the pubic symphysis. It passes vertically down the anterior medial aspect of the thigh, to end at the adductor hiatus, where it becomes the popliteal artery.

The femoral artery enters the femoral triangle where, for the first few centimeters of its course, it is enclosed in the femoral sheath (a funnel-shaped sleeve of fascia). It lies superficial as it crosses the femoral triangle where it is covered only by skin and fascia. Behind, from above downwards, are the tendon of psoas major and the pectineus, adductor longus and adductor magnus muscles. The femoral vein and profunda vessels lie between the artery and pectineus, with the femoral vein lying between the artery and adductor longus. The femoral vein lies medial to the artery in the upper part of the femoral triangle and posterior to it in the lower part.

The profunda femoris (deep femoral) artery is the largest and most important of the many branches of the femoral artery and is given off in the femoral triangle. It arises from the lateral aspect of femoral artery about 3.5cm below the inguinal ligament and is initially lateral to and then posterior to the femoral artery. Vascular surgeons and radiologists usually refer to that part of the femoral artery proximal to the origin of the profunda femoris artery as the ‘common femoral artery’, and the distal segment of the femoral artery as the ‘superficial femoral artery’.

Proximal to the origin of the profunda femoris artery, the femoral artery gives a variable number of relatively small, superficial branches. It gives rise to the superficial epigastric and superficial external iliac arteries just below the inguinal ligament, with the superficial external pudendal artery arising from the medial aspect of the femoral artery close by. The deep external pudendal artery also arises medially at a slightly lower level. The medial circumflex femoral artery usually arises from the arteria profunda femoris, but may arise from the femoral artery.
The femoral artery runs infero-medially, leaving the femoral triangle at its apex to enter the adductor canal in the medial part of the middle of the thigh. It is covered by muscle in the adductor (subsartorial) canal, with vastus medialis antero-laterally and sartorius antero-medially. In the distal part of the adductor canal the femoral artery gives off a branch called the ‘descending genicular artery’, which contributes to the anastomosis around the knee joint. The femoral artery then leaves the adductor canal through the adductor hiatus (a gap in the tendon of adductor magnus) to enter the popliteal fossa as the popliteal artery.

**Part III-Shoulder**

**Bones**

Humerus

Anatomy Text

Proximal End (Head)

The head forms one third of a sphere and faces posteromedially to articulate with the glenoid fossa of the scapula. Distal to the head are the greater and lesser tuberosities which merge distally into a rounded shaft.

The intertubercular or bicipital groove is located between the greater and lesser tuberosities along the anterior surface of the humerus.
Distal End

Distally the humerus articulates with the radius at the capitulum and ulna at the trochlea. The capitulum is a smaller section of a smaller sphere and faces ventrally. The trochlea is grooved, bears a large medial and smaller lateral ridge and runs onto the posterior aspect of the humerus to the olecranon fossa.

The anterior aspect of the distal end possesses coronoid and radial fossae and the posterior aspect a large olecranon fossa. Prominent medial and lateral epicondyles are readily palpable.

Glenohumeral Joint

This is a synovial ball and socket joint between the shallow glenoid cavity of the scapula and the hemispherical head of the humerus. The glenoid cavity is deepened by the glenoid labrum, a ring of fibrocartilage attached to the boundaries of glenoid fossa. The articular area of glenoid and labrum is less than a third of the area of humeral head.

Articular surfaces are lined by hyaline cartilage. Over the humeral head this is thicker in the middle and thinner towards the periphery. In the glenoid fossa, cartilage is thinner in the middle and thicker towards the rim.

The non articular surfaces of the joint are lined by synovial membrane, which communicates with the subscapular bursa. The tendon of long head of biceps enters the joint space through the bicipital groove and lies in a tubular synovial sheath as it passes posteriorly and medially across the superior aspect of humeral head.

The joint is supplied by the circumflex humeral and supra scapular arteries and axillary and supra scapular nerves.
Muscles

Rotator cuff

The rotator cuff consists of the tendinous insertions of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles. These tendons form a hood, that surrounds the head of the humerus anteriorly, superiorly and posteriorly. Co-contraction of these muscles stabilizes the glenohumeral joint during normal activities. In particular, abduction in the plane of the scapula will be accomplished principally by action of the deltoid muscle, but this acts nearly vertically when the humerus is still close to the side of the body, and so tends to sublux the head of the humerus superiorly. The rotator cuff muscles act more horizontally, and their tensions combine with that of the deltoid to direct the resultant joint force vector into the superior concavity of the glenoid, which is normally a stable state. Conversely, rotator cuff deficiency leads to superior subluxation of the head of the humerus, leading to impingement against the coracoacromial ligament, accompanied by abduction weakness and loss of motion.

The complex anatomical structure of the rotator cuff means that the reasons for the frequency of cuff degeneration, which is most often in the supraspinatus tendon, are not fully understood. It is known, for example, that there are distinct layers with different histological and mechanical properties, so this can lead to shearing between the layers, and this also applies to the zone of overlap of the supraspinatus and infraspinatus tendons. The tendons are also subjected to compression forces onto their surfaces, either due to the wrapping around the glenoid and head of the humerus, or from superior impingement beneath the acromion. Finally, humeral rotation will tense and slacken the edges of the supraspinatus tendon.

Supraspinatus

This muscle and tendon unit is important in maintaining stability of the glenohumeral joint, as the dominant part of the rotator cuff. It is affected frequently by degenerative changes near the tendinous insertion into the head of the humerus with advancing age, and so forms a disproportionate part of clinical practice. The supraspinatus acts to elevate, or abduct, the
humerus. There are various hypotheses regarding the causes of the degenerative changes. As well as transmitting tensile loads from the muscle fibers to the greater tuberosity on the head of the humerus, the supraspinatus tendon is subjected to compressive loads on the inferior aspect, as it wraps around the head of the humerus. Similarly, it may be subjected to impingement of the superior aspect against the underside of the coracoacromial ligament and adjacent bone. It is likely that shoulder elevation with different positions of rotation of the humerus will cause the supraspinatus and other elements of the rotator cuff to become skewed, resulting in stress concentrations at one or other of the edges of the attachments.

Although the supraspinatus acts to abduct the humerus, it is only a secondary muscle when compared to the deltoid, since the deltoid has a much greater lever arm. The supraspinatus action, however, is essential for normal glenohumeral joint stability. The supraspinatus has been estimated to exert a force of 200 N during abduction of the unloaded arm to 30 degrees, and up to 700 N during abduction with a weight supported in the hand. Since the muscle-tendon unit is an elastic structure, passive tension rises as it is stretched by adduction of the humerus, and so the arm may be supported in an elevated position after supraspinatus repair to release this tension.

Deltoid Muscle

The deltoid is a thick, powerful muscle which covers the shoulder joint and upper humerus (Slide 1, Slide 2). It arises from the anterior border of lateral third of clavicle, the lateral border of acromion and the lower lip of scapular spine, as well as from the fascia over infraspinatus muscle.
**Distal Attachments**

It inserts on the V shaped deltoid tuberosity half way down the lateral aspect of the shaft of humerus.

**Nerve Supply**

Deltoid is innervated by the axillary nerve (C5,6).

**Actions**

It is a powerful abductor of the humerus. Abduction is, however, initiated by supraspinatus. The anterior portion of deltoid contributes to flexion of the humerus (Movie 1, Movie 2), with the posterior portion to extension (Movie 1, Movie 2). When supraspinatus is torn, the upward pull of deltoid results in superior subluxation of the humeral head.

The acromial part of the deltoid is multipennate. Tendinous septa arising from the acromion and the deltoid tuberosity interdigitate, with short muscle fibers extending between the septa. This gives the muscle a short but powerful pull.

**Nerves**

![Interactive Shoulder © 2000 Primal Pictures Ltd.](image)

The Brachial Plexus
Subclavian artery

The right subclavian artery arises from the brachiocephalic artery behind the sternoclavicular joint, passing laterally, arching over the apical pleura and behind scalenus anterior, crossing the first rib, at the outer border of which it becomes axillary artery.

The left subclavian artery arises from the arch of the aorta, ascends through the mediastinum and arches over the apical pleura, passing laterally behind scalenus anterior to enter the arm.

The artery is conventionally divided into three parts. The first part is between the origin and the medial border of scalenus anterior, the second part behind the muscle, and the third part from the lateral border of the muscle to the outer border of first rib.

Relations-right

Medial to scalenus anterior, the artery lies behind the right common carotid, vagus nerve, and internal jugular vein, in front of the supra pleural membrane, pleura and lung. The right recurrent laryngeal nerve and the ansa subclavia wind round it. Behind scalenus anterior, which separates it from the phrenic nerve, the artery lies on cervical pleura. Lateral to the muscle, the artery lies on the first rib with the vein and the clavicle in front, the lower trunk of brachial plexus and scalenus medius behind.

Relations-left

In the chest, the artery lies behind the left common carotid, the left vagus, and left phrenic nerves. The trachea, recurrent laryngeal nerve, esophagus, trachea, and left recurrent laryngeal nerve lie medial to it. The left pleura and lung lie lateral to it. In the root of the neck its relations differ from
those on the right in that the thoracic duct and the phrenic nerve cross anterior to it and the left recurrent laryngeal nerve does not wind around it.

Branches

The vertebral, internal thoracic and thyrocervical arteries arise in the root of the neck medial to scalenus anterior. On the right the costocervical trunk is formed behind the muscle and on the left it usually arises medial to the muscle.

**Axillary artery**

The axillary artery is the continuation of the subclavian artery beyond the outer border of the first rib. It curves through the axilla, continuing as the brachial artery at the lower border of teres major. It is conventionally divided into three parts, the first part medial to pectoralis minor, the second part behind the muscle and the third part distal to it. As it curves through the axilla, it is surrounded by the cords and branches of the brachial plexus, with the axillary vein at its medial aspect. The vessels and nerves are surrounded by a sheath of connective tissue, the axillary sheath, a prolongation of the pre vertebral fascia. The axillary artery continues as the brachial artery distal to the lower border of the teres major.

**First part of Axillary Artery**

From the lateral border of first rib to the medial border of pectoralis minor. It give off one branch, the superior thoracic artery.

Pectoralis muscle, fascia and skin lie in front. The artery is separated from cephalic vein by clavipectoral fascia. The long thoracic nerve and the medial cord of the brachial plexus lie behind. The lateral and posterior cords of the brachial plexus lie laterally, with the axillary vein medially.

**Second part of Axillary Artery**

From medial to lateral border of pectoralis minor. It gives off two branches, acromiothoracic and lateral thoracic arteries.

The posterior cord of brachial plexus and subscapularis muscle lie behind the artery, with pectoralis major and minor muscles in front. The lateral and medial cord of the brachial plexus are at lateral and medial aspect. The medial cord lies between the artery and axillary vein.

**Third part of Axillary Artery**

From the lateral border of pectoralis minor to the lower border of teres major. It gives off three branches, subscapular, anterior circumflex and posterior circumflex humeral arteries.

Subscapularis, latissimus dorsi and teres major muscles lie behind, with axillary and radial nerves running between artery and muscle. Anteriorly, the upper part is covered by pectoralis major, with the lower part by fascia and skin. Coracobrachialis muscle, median, and musculocutaneous nerve lie laterally, with axillary vein medially.
Special Clinical Anatomy Situations

Dorsalis Pedis and Posterior Tibial Arteries-Foot

Figure 12-56. The anatomy of the superficial structures of the anterior portion of the ankle and the dorsum of the foot. At the level of the ankle joint, the neurovascular bundle lies immediately lateral to the extensor hallucis longus tendon.

Figure 12-57. The extensor retinaculum and part of the flexor retinaculum have been removed to reveal the deeper tendons and the neurovascular bundle. The abductor hallucis has been detached from its origin to reveal the base of the first metatarsal and lateral plantar arteries and nerves.
Pulses in the Upper Arm - Radial and Ulnar Artery

Figure 4-14. The middle layer of the forearm, with the superficial branch of the radial nerve. In the proximal part of the wound, the median nerve enters the undersurface of the superficialis.
Peroneal Nerve at Head of Fibula

Figure 11-17. Make a long linear incision just posterior to the fibula.

Figure 11-11. The internervous plane lies between the gastrocnemius, soleus, and flexor hallucis longus muscles (which are supplied by the tibial nerve) and the peroneal muscles (which are supplied by the superficial peroneal nerve).