Limb Anatomy

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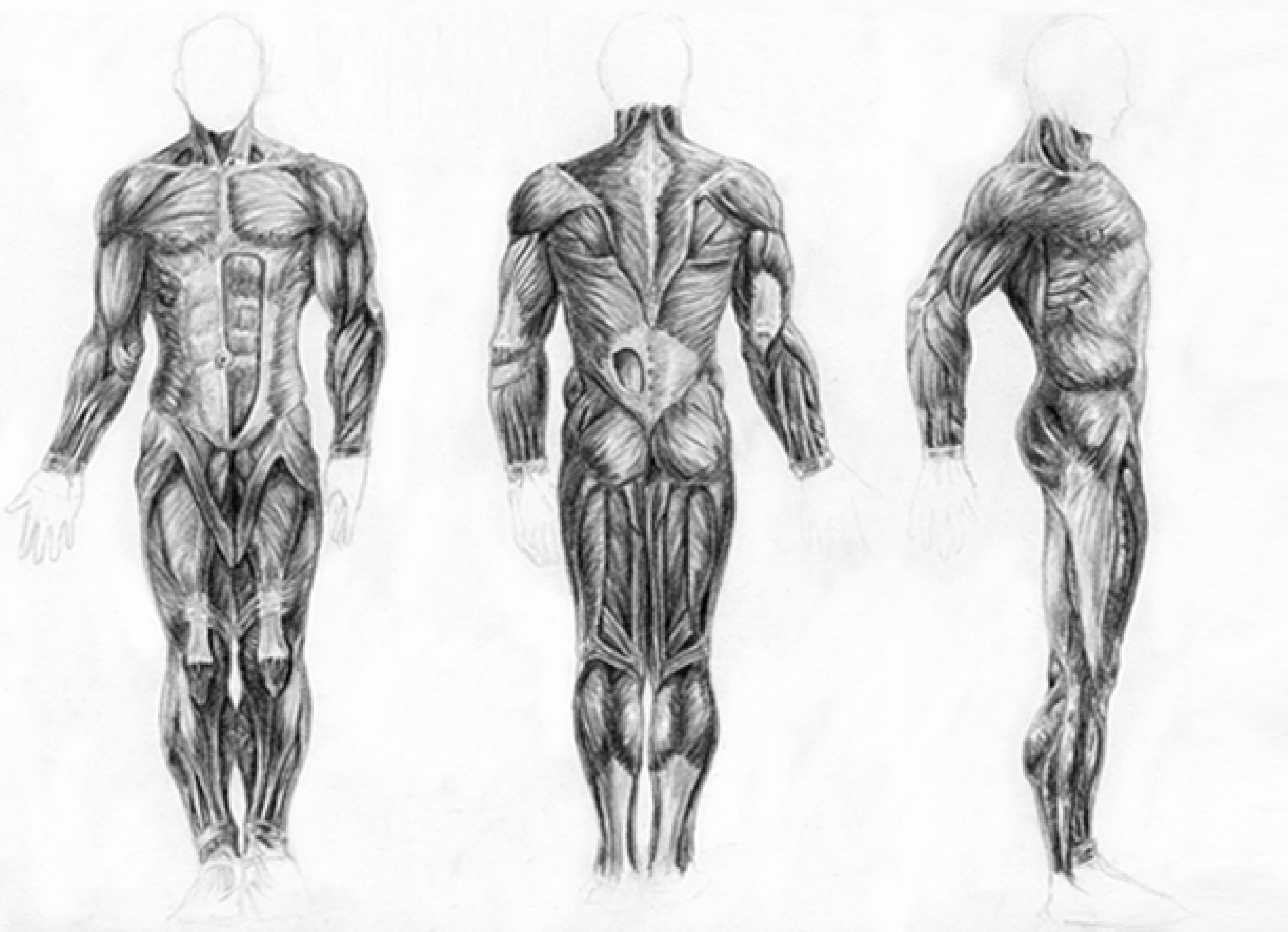

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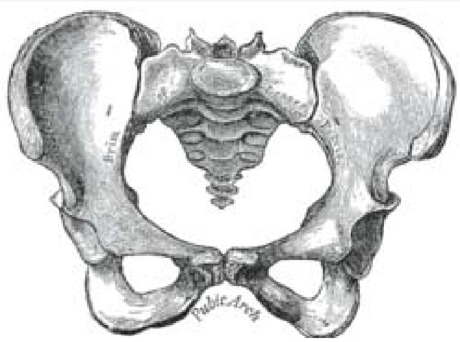
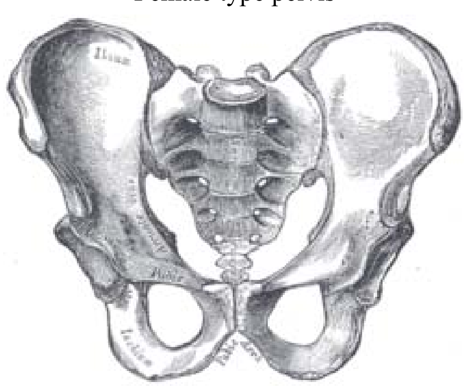
Pelvis

Bone: Pelvis



Female type pelvis



Male type pelvis

In human anatomy, the **pelvis** (plural **pelves** or **pelvises**) is the part of the trunk inferioposterior (below-behind) to the abdomen in the transition area between the trunk (torso) and the lower limbs (legs). The term is used to denote several structures:

- the structure connecting the spine to the femurs (thigh bones),
- the **pelvic cavity**, the space enclosed by the pelvic girdle, subdivided into
  - the **greater** or **false pelvis** (inferior part of the abdominal cavity) and
  - the **lesser** or **true pelvis** which provides the skeleton for the perineum and the pelvic cavity (which are separated by the pelvic diaphragm),
- the **pelvic region**.

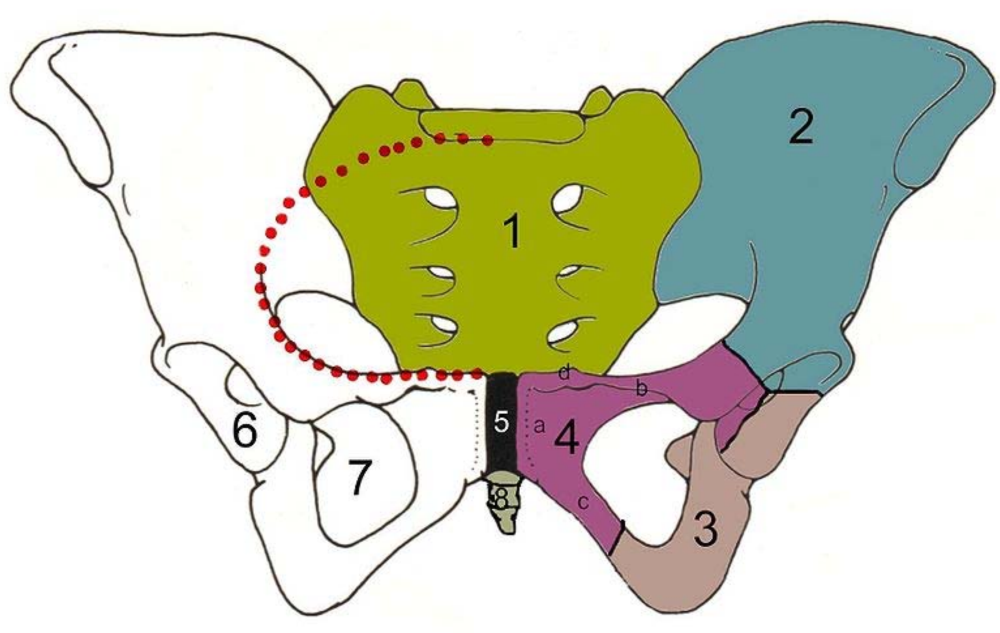
In the adult human, the pelvis is formed in the area of the back (posterior dorsal), by the sacrum and the coccyx (the caudal portion of the axial skeleton), and laterally and anteriorly (forward and to the side), by a pair of hip bones, the lower extremity, (parts of the appendicular skeleton). In an adult human being, the pelvis is thus composed of three large bones, and the coccyx (3–5 bones); however, before puberty, each hip bone consists of three discrete (separate) bones — the ilium, ischium, pubis — that have yet to fuse at adulthood; thus, in puberty, the human pelvis can comprise more than 10 bones, depending upon the composition of the person's coccyx.

Brief description

The pelvis is the section between the legs and the torso that connects the spine (backbone) to the thigh bones. In adults, it is mainly constructed of two hip bones, one on the right and one on the left of the body. The two hip bones are made up of 3 sections, the Ilium, Ischium and Pubis. These sections are fused together during puberty, meaning in childhood they are separate bones. Along with the hip bones is the Sacrum, the upper-middle part of the pelvis, which connects the spine (backbone) to the pelvis. To make this possible, the hip bones are attached to the Sacrum.

The gap enclosed by the pelvis is the section of the body underneath the abdomen (stomach) and mainly consists of the reproductive organs (sex organs) and the rectum.

Bony pelvis



The bony pelvis.
1. Sacrum
2. Ilium

3. Ischium
4. Pubic bone
5. Pubic symphysis
6. Acetabulum
7. Obturator foramen
8. Coccyx
Red line: Terminal line/pelvic brim

Functions

The pelvic girdle is a basin-shaped ring of bones connecting the vertebral column to the femurs.

Its primary functions are to bear the weight of the upper body when sitting and standing; transfer that weight from the axial skeleton to the lower appendicular skeleton when standing and walking; and provide attachments for and withstand the forces of the powerful muscles of locomotion and posture. Compared to the shoulder girdle, the pelvic girdle is thus strong and rigid.

Its secondary functions are to contain and protect the pelvic and abdominopelvic viscera (inferior parts of the urinary tracts, internal reproductive organs); provide attachment for external reproductive organs and associated muscles and membranes.

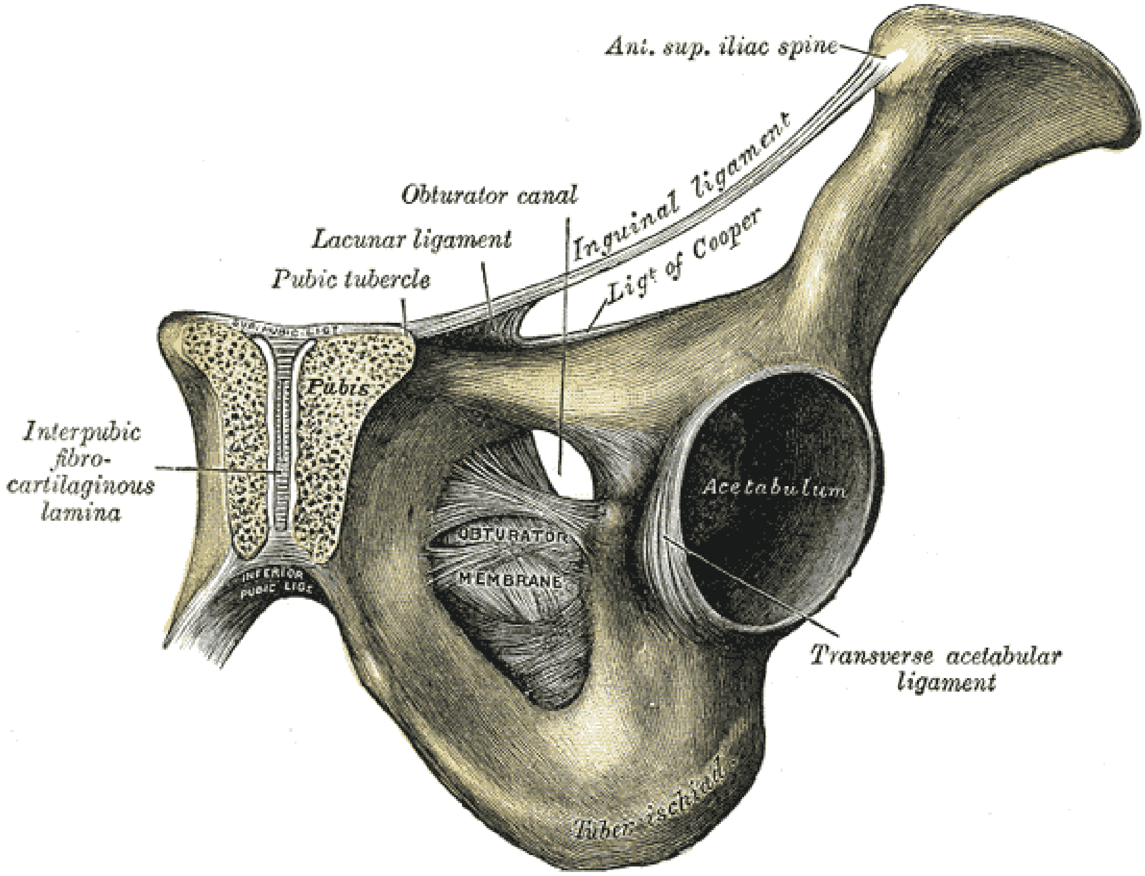
As a mechanical structure

The pelvic girdle consists of the two hip bones. The hip bones are connected to each other anteriorly at the pubic symphysis, and posteriorly to the sacrum at the sacroiliac joints to form the pelvic ring. The ring is very stable and allows very little mobility, a prerequisite for transmitting loads from the trunk to the lower limbs.

As a mechanical structure the pelvis may be thought of as four roughly triangular and twisted rings. Each superior ring is formed by the iliac bone; the anterior side stretches from the acetabulum up to the anterior superior iliac spine; the posterior side reaches from the top of the acetabulum to the sacroiliac joint; and the third side is formed by the palpable iliac crest. The lower ring, formed by the rami of the pubic and ischial bones, supports the acetabulum and is twisted 80-90 degrees in relation to the superior ring.

An alternative approach is to consider the pelvis part of an integrated mechanical system based on the tensegrity icosahedron as an infinite element. Such a system is able to withstand omnidirectional forces — ranging from weight-bearing to childbearing — and, as a low energy requiring system, is favoured by natural selection.

Junctions



Coronal section through pubic symphysis

The two hip bones are joined anteriorly at the pubic symphysis by a fibrous cartilage covered by a hyaline cartilage, the interpubic disk, within which a non-synovial cavity might be present. Two ligaments, the superior and inferior pubic ligaments, reinforce the symphysis.

Both **sacroiliac joints**, formed between the auricular surfaces of the sacrum and the two hip bones. are amphiarthroses, almost immobile joints enclosed by very taut joint capsules. This capsule is strengthened by the ventral, interosseous, and dorsal sacroiliac ligaments. The most important accessory ligaments of the sacroiliac joint are the sacrospinous and sacrotuberous ligaments which stabilize the hip bone on the sacrum and prevent the promonotory from tilting forward. Additionally, these two ligaments transform the greater and lesser sciatic notches into the greater and lesser foramina, a pair of important pelvic openings. The iliolumbar ligament is a strong ligament which connects the tip of the transverse process of the fifth lumbar vertebra to the posterior part of the inner lip of the iliac crest. It can be thought of as the lower border of the thoracolumbar fascia and is occasionally accompanied by a smaller ligamentous band passing between the fourth lumbar vertebra and the iliac crest. The lateral lumbosacral ligament is partly continuous with the iliolumbar ligament. It passes between the transverse process of the fifth vertebra to the ala of the sacrum where it intermingle with the anterior sacroiliac ligament.

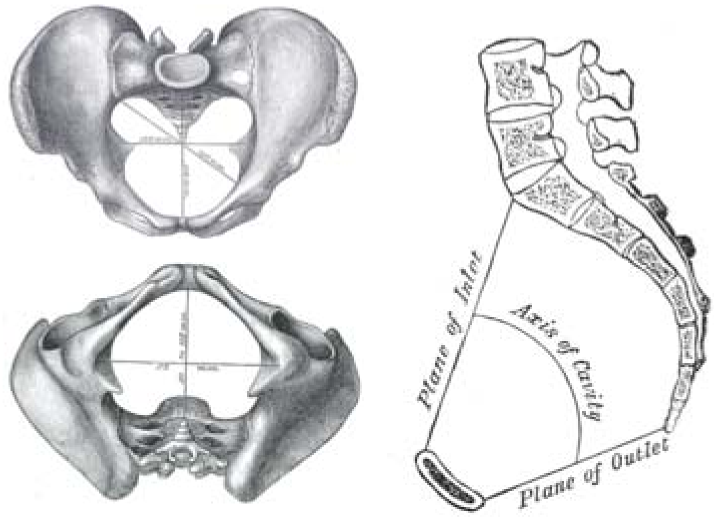
The joint between the sacrum and the coccyx, the sacrococcygeal symphysis, is strengthened by a series of ligaments. The anterior sacrococcygeal ligament is an extension of the anterior longitudinal ligament (ALL) that run down the anterior side of the vertebral bodies. Its irregular fibers blend with the periosteum. The posterior sacrococcygeal ligament has a deep and a superficial part, the former is a flat band corresponding to the posterior longitudinal ligament (PLL) and the latter corresponds to the ligamenta flava. Several other ligaments complete the foramen of the last sacral nerve.

Articulations

The lumbosacral joint, between the sacrum and the last lumbar vertebra, has, like all vertebal joints, an intervertebral disc, anterior and posterior ligaments, ligamenta flava, interspinous and supraspinous ligaments, and synovial joints between the articular processes of the two bones. In addition to these ligaments the joint is strengthened by the iliolumbar and lateral lumbosacral ligaments. The iliolumbar ligament passes between the tip of the transverse process of the fifth lumbar vertebra and the posterior part of the iliac crest. The lateral lumbosacral ligament, partly continuous with the iliolumbar ligament, passes down from the lower border of the transverse process of the fifth vertebra to the ala of the sacrum. The movements possible in the lumbosacral joint are flexion and extension, a small amount of lateral flexion (from 7 degrees in childhood to 1 degree in adults), but no axial rotation. Between ages 2–13 the joint is responsible for as much as 75% (about 18 degrees) of flexion and extension in the lumbar spine. From age 35 the ligaments considerably limit the range of motions.

The three extracapsular ligaments of the hip joint — the iliofemoral, ischiofemoral, and pubofemoral ligaments — form a twisting mechanism encircling the neck of the femur. When sitting, with the hip joint flexed, these ligaments become lax permitting a high degree of mobility in the joint. When standing, with the hip joint extended, the ligaments get twisted around the femoral neck, pushing the head of the femur firmly into the acetabulum, thus stabilising the joint. The zona orbicularis assists in maintaining the contact in the joint by acting like a buttonhole on the femoral head. The intracapsular ligament, the ligamentum teres, transmits blood vessels that nourish the femoral head.

Pelvic cavity



The pelvic cavity is a body cavity that is bounded by the bones of the pelvis and which primarily contains reproductive organs and the rectum.

A distinction is made between the lesser or true pelvis inferior to the terminal line, and the greater or false pelvis above it. The pelvic inlet or superior pelvic aperture, which leads into the lesser pelvis, is bordered by the promontory, the arcuate line of ilium, the iliopubic eminence, the pecten of the pubis, and the upper part of the pubic symphysis. The pelvic outlet or inferior pelvic aperture is the region between the subpubic angle or pubic arch, the ischial tuberosities and the coccyx.

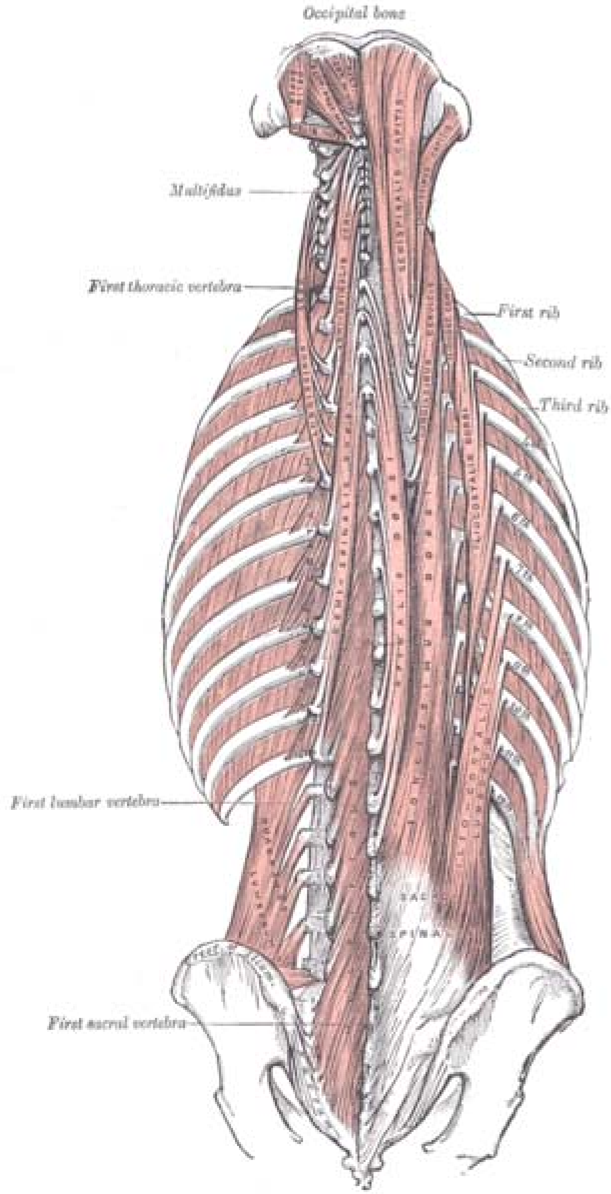
- Ligaments: obturator membrane, inguinal ligament (lacunar ligament, iliopectineal arch)

Development

Each side of the pelvis is formed as cartilage, which ossifies as three main bones which stay separate through childhood: ilium, ischium, pubis. At birth the whole of the hip joint (the acetabulum area and the top of the femur) is still made of cartilage (but there may be a small piece of bone in the great trochanter of the femur); this makes it difficult to detect congenital hip dislocation by X-raying.

Muscles

Shoulder and intrinsic back



Intrinsic back muscles

The inferior parts of latissimus dorsi, one of the muscles of the upper limb, arises from the posterior third of the iliac crest. Its action on the shoulder joint are internal rotation, adduction, and retroversion. It also contributes to respiration (i.e. coughing). When the arm is adducted, latissimus dorsi can pull it backward and medially until the back of the hand covers the buttocks.

In a longitudinal osteofibrous canal on either side of the spine there is a group of muscles called the erector spinae which is subdivided into a lateral superficial and a medial deep tract. In the lateral tract, the iliocostalis lumborum and longissimus thoracis originates on the back of the sacrum and the posterior part of the iliac crest. Contracting these muscles bilaterally extends the spine and unilaterally contraction bends the spine to the same side. The medial tract has a "straight" (interspinales, intertransversarii, and spinalis) and an "oblique" (multifidus and semispinalis) component, both of which stretch between vertebral processes; the former acts similar to the muscles of the lateral tract, while the latter function unilaterally as spine extensors and bilaterally as spine rotators. In the medial tract, the multifidi originates on the sacrum.

Abdomen

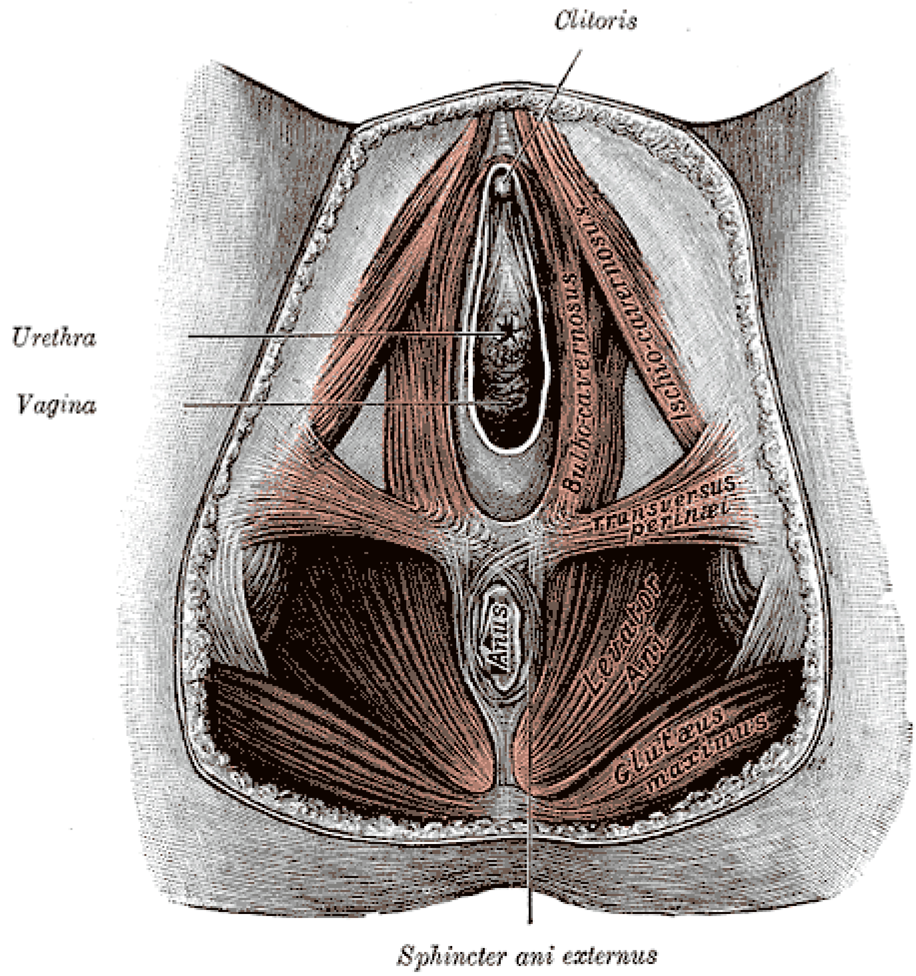
The muscles of the abdominal wall are subdivided into a superficial and a deep group.

The superficial group is subdivided into a lateral and a medial group. In the medial superficial group, on both sides of the centre of the abdominal wall (the *linea alba*), the rectus abdominis stretches from the cartilages of ribs V-VII and the sternum down to the pubic crest. At the lower end of the rectus abdominis, the pyramidalis tenses the *linea alba*. The lateral superficial muscles, the transversus and external and internal oblique muscles, originate on the rib cage and on the pelvis (iliac crest and inguinal ligament) and are attached to the anterior and posterior layers of the sheath of the rectus.

Flexing the trunk (bending forward) is essentially a movement of the rectus muscles, while lateral flexion (bending sideways) is achieved by contracting the obliques together with the quadratus lumborum and intrinsic back muscles. Lateral rotation (rotating either the trunk or the pelvis sideways) is achieved by contracting the internal oblique on one side and the external oblique on the other. The transversus' main function is to produce abdominal pressure in order to constrict the abdominal cavity and pull the diaphragm upward.

There are two muscles in the deep or posterior group. Quadratus lumborum arises from the posterior part of the iliac crest and extends to the rib XII and lumbar vertebrae I-IV. It unilaterally bends the trunk to the side and bilaterally pulls the 12th rib down and assists in expiration. The iliopsoas consists of psoas major (and occasionally psoas minor) and iliacus, muscles with separate origins but a common insertion on the lesser trochanter of the femur. Of these, only iliacus is attached to the pelvis (the iliac fossa). However, psoas passes through the pelvis and because it acts on two joints, it is topographically classified as a posterior abdominal muscle but functionally as a hip muscle. Iliopsoas flexes and externally rotates the hip joints, while unilateral contraction bends the trunk laterally and bilateral contraction raises the trunk from the supine position.

Pelvic floor



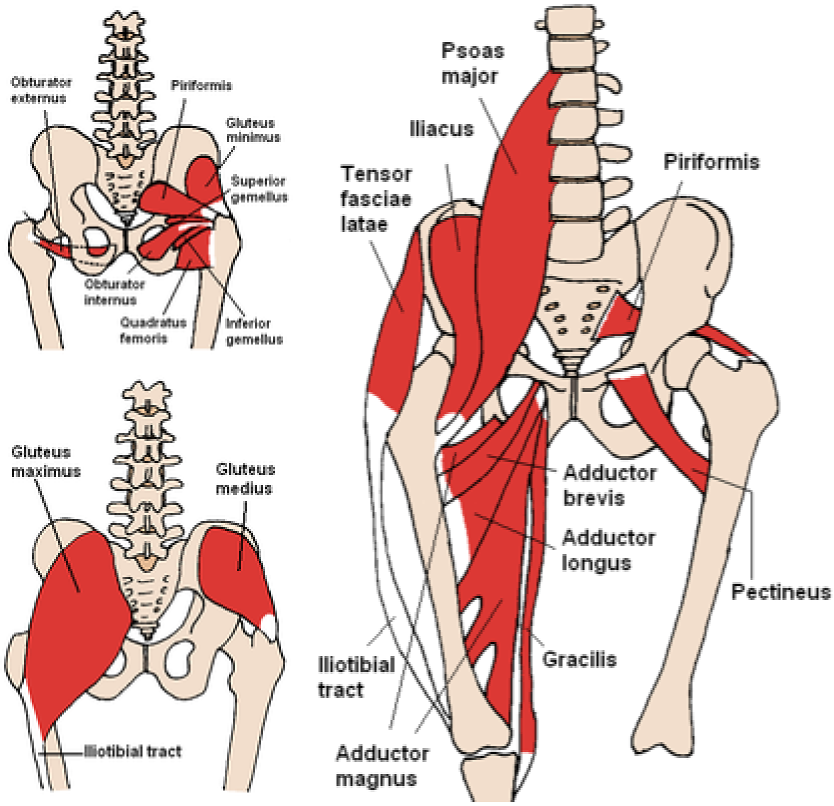
Perineum

The pelvic floor has two inherently conflicting functions: One is to close the pelvic and abdominal cavities and bear the load of the visceral organs, the other is to control the openings of the rectum and urogenital organs that pierce the pelvic floor and make it weaker. To achieve both these tasks, the pelvic floor is composed of several overlapping sheets of muscles and connective tissues.

The pelvic diaphragm is composed of the levator ani and the coccygeus muscle. These arises between the symphysis and the ischial spine and converges on the coccyx and the anococcygeal ligament which spans between the tip of the coccyx and the anal hiatus. This leaves a slit for the anal and urogenital openings. Because of the width of the genital aperture, which is wider in females, a second closing mechanism is required. The urogenital diaphragm consists mainly of the deep transverse perineal which arises from the inferior ischial and pubic rami and extends to the urogential hiatus. The urogenital diaphragm is reinforced posteriorly by the superficial transverse perineal.

The external anal and urethral sphincters close the anus and the urethra. The former is surrounded by the bulbospongiosus which narrows the vaginal introitus in females and surrounds the corpus spongiosum in males. Ischiocavernosus squeezes blood into the corpus cavernosum penis and clitoridis.

Hip and thigh



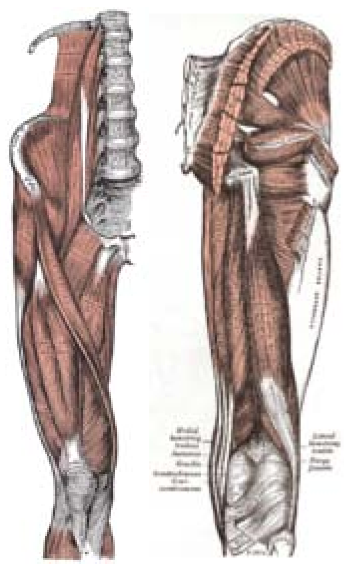
Muscles of the hip

The muscles of the hip are divided into a dorsal and a ventral group.

The dorsal hip muscles are either inserted into the region of the lesser trochanter (anterior or inner group) or the greater trochanter (posterior or outer group). Anteriorly, the psoas major (and occasionally psoas minor) originates along the spine between the rib cage and pelvis. The iliacus originates on the iliac fossa to join psoas at the iliopubic eminence to form the iliopsoas which is inserted into the lesser trochanter. The iliopsoas is the most powerful hip flexor.

The posterior group includes the gluteii maximus, medius, and minimus. Maximus has a wide origin stretching from the posterior part of the iliac crest and along the sacrum and coccyx, and has two separate insertions: a proximal which radiates into the iliotibial tract and a distal which inserts into the gluteal tuberosity on the posterior side of the femoral shaft. It is primarily an extensor and lateral rotator of the hip joint, but, because of its bipartite insertion, it can both adduct and abduct the hip. Medius and minimus arise on the external surface of the ilium and are both inserted into the greater trochanter. Their anterior fibers are medial rotators and flexors while the posterior fibers are lateral rotators and extensors. The piriformis has its origin on the ventral side of the sacrum and is inserted on the greater trochanter. It abducts and laterally rotates the hip in the upright posture and assists in extension of the thigh. The tensor fasciae latae arises on the anterior superior iliac spine and inserts into the iliotibial tract. It presses the head of the femur into the acetabulum and flexes, medially rotates, and abducts the hip.

The ventral hip muscles are important in the control of the body's balance. The internal and external obturator muscles together with the quadratus femoris are lateral rotators of the hip. Together they are stronger than the medial rotators and therefore the feet point outward in the normal position to achieve a better support. The obturators have their origins on either sides of the obturator foramen and are inserted into the trochanteric fossa on the femur. Quadratus arises on the ischial tuberosity and is inserted into the intertrochanteric crest. The superior and inferior gemelli, arising from the ischial spine and ischial tuberosity respectively, can be thought of as marginal heads of the obturator internus, and their main function is to assist this muscle.



Anterior and posterior thigh muscles

The muscles of the thigh can be subdivided into adductors (medial group), extensors (anterior group), and flexors (posterior group). The extensors and flexors act on the knee joint, while the adductors mainly act on the hip joint.

The thigh adductors have their origins on the inferior ramus of the pubic bone and are, with the exception of gracilis, inserted along the femoral shaft. Together with sartorius and semitendinosus, gracilis reaches beyond the knee to their common insertion on the tibia.

The anterior thigh muscles form the quadriceps which is inserted on the patella with a common tendon. Three of the four muscles have their origins on the femur, while rectus femoris arises from the anterior inferior iliac spine and is thus the only of the four acting on two joints.

The posterior thigh muscles have their origins on the inferior ischial ramus, with the exception of the short head of the biceps femoris. The semitendinosus and semimembranosus are inserted on the tibia on the medial side of the knee, while biceps femoris is inserted on the fibula, on the knee's lateral side.

Pregnancy and childbirth

In later stages of pregnancy the fetus's head aligns inside the pelvis. Also joints of bones soften due to the effect of pregnancy hormones. These factors may cause *pelvic joint pain* (Symphysis Pubis Dysfunction or SPD). As the end of pregnancy approaches, the ligaments of the sacroiliac joint loosen, letting the pelvis outlet widen somewhat; this is easily noticeable in the cow.

During childbirth (unless by Cesarean section) the fetus passes through the maternal *pelvic opening*.

Sexual dimorphism

Modern humans are to a large extent characterized by bipedal locomotion and large brains. Because the pelvis is vital to both locomotion and childbirth, natural selection has been confronted by two conflicting demands: a wide birth canal and locomotion efficiency, a conflict referred to as the "obstetrical dilemma". The female pelvis has evolved to its maximum width for childbirth — a wider pelvis would make women unable to walk. In contrast, human male pelves are not constrained by the need to give birth and therefore are optimized for bipedal locomotion.

The principal differences between male and female true and false pelvis include:

- The female pelvis is larger and broader than the male pelvis which is taller, narrower, and more compact.
- The female inlet is larger and oval in shape, while the male sacral promontory projects further (i.e. the male inlet is more heart-shaped).
- The sides of the male pelvis converge from the inlet to the outlet, whereas the sides of the female pelvis are wider apart.
- The angle between the inferior pubic rami is acute (70 degrees) in men, but obtuse (90-100 degrees) in women. Accordingly, the angle is called subpubic angle in men and pubic arch in women. Additionally, the bones forming the angle/arch are more concave in females but straight in males.
- The distance between the ischia bones is small in males, making the outlet narrow, but large in females, who have a relatively large outlet. The ischial spines and tuberosities are heavier and project farther into the pelvic cavity in males. The greater sciatic notch is wider in females.

- The iliac crests are higher and more pronounced in males, making the male false pelvis deeper and more narrow than in females.
- The male sacrum is long, narrow, more straight, and has a pronounced sacral promontory. The female sacrum is shorter, wider, more curved posteriorly, and has a less pronounced promontory.
- The acetabula are wider apart in females than in males. In males, the acetabulum faces more laterally, while it faces more anteriorly in females. Consequently, when men walk the leg can move forwards and backwards in a single plane. In women, the leg must swing forward and inward, from where the pivoting head of the femur moves the leg back in another plane. This change in the angle of the femoral head gives the female gait its characteristic (i.e. swinging of hips).

Caldwell-Moloy classification

Throughout the 20th century pelvimetric measurements were made on pregnant women to determine whether a natural birth would be possible, a practice today limited to cases where a specific problem is suspected or following a caesarean delivery. William Edgar Caldwell and Howard Carmen Moloy studied collections of skeletal pelves and thousands of stereoscopic radiograms and finally recognized three types of female pelves plus the masculine type. In 1933 and 1934 they published their typology, including the Greek names since then frequently quoted in various handbooks: Gynaecoid (*gyne*, woman), anthropoid (*anthropos*, human being), platypelloid (*platys*, flat), and android (*aner*, man).

- The **gynaecoid pelvis** is the so-called normal female pelvis. Its inlet is either slightly oval, with a greater transverse diameter, or round. The interior walls are straight, the subpubic arch wide, the sacrum shows an average to backward inclination, and the greater sciatic notch is well rounded. Because this type is spacious and well proportioned there is little or no difficulty in the birth process. Caldwell and his co-workers found gynaecoid pelves in about 50 per cent of specimens.
- The **platypelloid pelvis** has a transversally wide, flattened shape, is wide anteriorly, greater sciatic notches of male type, and has a short sacrum that curves inwards reducing the diameters of the lower pelvis. This is similar to the rachitic pelvis where the softened bones widen laterally because of the weight from the upper body resulting in a reduced anteroposterior diameter. Giving birth with this type of pelvis is associated with problems, such as transverse arrest. Less than 3 per cent of women have this pelvis type.
- The **android pelvis** is a female pelvis with masculine features, including a wedge or heart shaped inlet caused by a prominent sacrum and a triangular anterior segment. The reduced pelvis outlet often causes problems during child birth. In 1939 Caldwell found this type in one third of white women and in one sixth of non-white women.
- The **anthropoid pelvis** is characterized by an oval shape with a greater anteroposterior diameter. It has straight walls, a small subpubic arch, and large sacrosciatic notches. The sciatic spines are placed widely apart and the sacrum is

usually straight resulting in deep non-obstructed pelvis. Caldwell found this type in one quarter of white women and almost half of non-white women.

However, Caldwell and Moloy then complicated this simple fourfold scheme by dividing the pelvic inlet into posterior and anterior segments. They named a pelvis according to the anterior segment and affixed another type according to the character of the posterior segment (i.e. anthropoid-android) and ended up with no less than 14 morphologies. Notwithstanding the popularity of this simple classification, the pelvis is much more complicated than this as the pelvis can have different dimensions at various levels of the birth canal.

Caldwell and Moloy also classified the physique of women according to their types of pelves: the gynaecoid type has small shoulders, a small waist and wide hips; the android type looks square-shaped from behind; and the anthropoid type has wide shoulders and narrow hips. Lastly, in their article they described all non-gynaecoid or "mixed" types of pelves as "abnormal", a word which has stuck in the medical world even though at least 50 per cent of women have these "abnormal" pelves.

The classification of Caldwell and Moloy was influenced by earlier classifications attempting to define the ideal female pelvis, treating any deviations from this ideal as dysfunctions and the cause of obstructed labour. In the 19th century anthropologists and others saw an evolutionary scheme in these pelvic typologies, a scheme since then refuted by archaeology. Since the 1950s malnutrition is thought to be one of the chief factors affecting pelvic shape in the Third World even though there are at least some genetic component to variation in pelvic morphology. The pelvis is scientifically what makes you a male or a female.

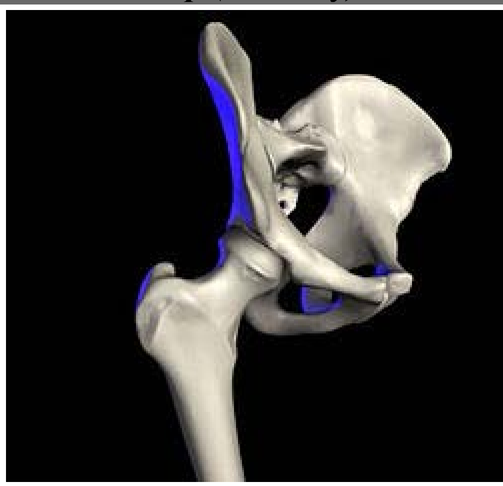
Nowadays obstetric suitability of the female pelvis is assessed by ultrasound. The dimensions of the head of the fetus and of the birth canal are accurately measured and compared, and the feasibility of labor can be predicted.

Evolution

The shape of the pelvis, most notably the orientation of the iliac crests and shape and depth of the acetabula, reflects the style of locomotion and body mass of an animal. In bipedal mammals, the iliac crests are parallel to the vertically oriented sacroiliac joints, where in quadrupedal mammals they are parallel to the horizontally oriented sacroiliac joints. In heavy mammals, especially in quadrupeds, the pelvis tend to be more vertically oriented because this allows the pelvis to support greater weight without dislocating the sacroiliac joints or adding torsion to the vertebral column. In ambulatory mammals the acetabula are shallow and open to allow a wider range of hip movements, including significant abduction, than in cursorial mammals. The lengths of the ilium and ischium and their angles relative to the acetabulum are functionally important as they determine the moment arms for the hip extensor muscles that provide momentum during locomotion.

Chapter 2

Hip

Hip (anatomy)	
	
Bones of the hip	
Latin	*coxa*
Gray's	*subject #92 333*
MeSH	*Hip*

In vertebrate anatomy, **hip** (or "coxa" in medical terminology) refer to either an anatomical region or a joint.

The **hip region** is located lateral to the gluteal region (i.e. the buttock), inferior to the iliac crest, and overlying the greater trochanter of the femur, or "thigh bone". In adults, three of the bones of the pelvis have fused into the hip bone which forms part of the hip region.

The **hip joint**, scientifically referred to as the **acetabulofemoral joint** (*art. coxae*), is the joint between the femur and acetabulum of the pelvis and its primary function is to support the weight of the body in both static (e.g. standing) and dynamic (e.g. walking or running) postures.

Anatomy

Region

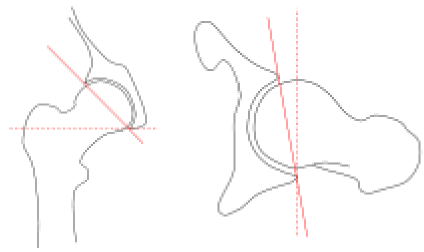
The five or so tubercles and the lower lateral borders of the sacrum, and the ischial tuberosity ("sitting bone").

- Proximally the femur is largely covered by muscles and, as a consequence, the greater trochanter is often the only palpable bony structure.Distally on the femur some more palpable bony structures are the condyles.

Articulation

Radiograph of a healthy human hip joint

The hip joint is a synovial joint formed by the articulation of the rounded head of the femur and the cup-like acetabulum of the pelvis. It forms the primary connection between the bones of the lower limb and the axial skeleton of the trunk and pelvis. Both joint surfaces are covered with a strong but lubricated layer called articular hyaline cartilage. The cuplike acetabulum forms at the union of three pelvic bones — the ilium, pubis, and ischium. The Y-shaped growth plate that separates them, the triradiate cartilage, is fused definitively at ages 14–16. It is a special type of spheroidal or ball and socket joint where the roughly spherical femoral head is largely contained within the acetabulum and has an average radius of curvature of 2.5 cm. The acetabulum grasps almost half the femoral ball, a grip augmented by a ring-shaped fibrocartilaginous lip, the acetabular labrum, which extends the joint beyond the equator. The head of the femur is attached to the shaft by a thin neck region that is often prone to fracture in the elderly, which is mainly due to the degenerative effects of osteoporosis.



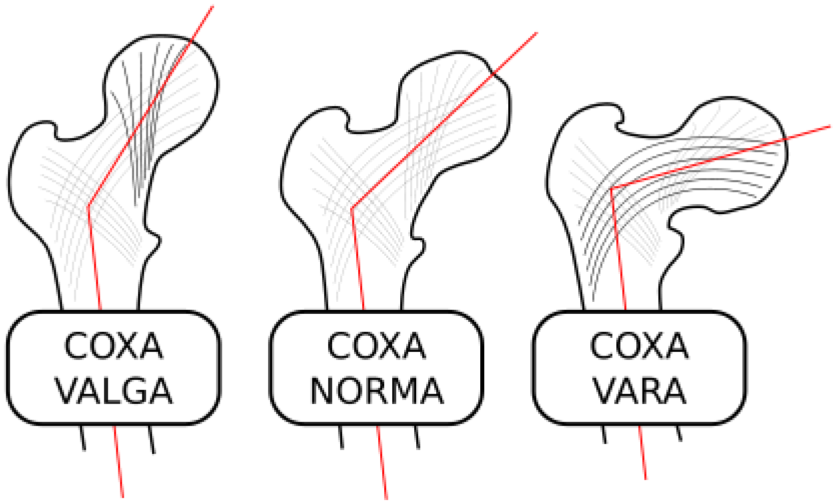
Transverse and sagittal angles of acetabular inlet plane.

The acetabulum is oriented inferiorly, laterally and anteriorly, while the femoral neck is directed superiorly, medially, and anteriorly.

The **transverse angle** of the acetabular inlet can be determined by measuring the angle between a line passing from the superior to the inferior acetabular rim and the horizontal plane; an angle which normally measures 51° at birth and 40° in adults, and which affects the acetabular lateral coverage of the femoral head and several other parameters. The **sagittal angle** of the acetabular inlet measures 7° at birth and increases to 17° in adults.

Femoral neck angle

The angle between the longitudinal axes of the femoral neck and shaft, called the **caput-collum-diaphyseal angle** or CCD angle, normally measures approximately 150° in newborn and 126° in adults (*coxa norma*). An abnormally small angle is known as *coxa vara* and an abnormally large angle as *coxa valga*. Because changes in shape of the femur naturally affects the knee, *coxa valga* is often combined with *genu varum* (bow-leggedness), while *coxa vara* leads to *genu valgum* (knock-knees).



Changes in trabecular patterns due to altered CCD angle. Coxa valga leads to more compression trabeculae, coxa vara to more tension trabeculae.

Changes in CCD angle is the result of changes in the stress patterns applied to the hip joint. Such changes, caused for example by a dislocation, changes the trabecular patterns inside the bones. Two continuous trabecular systems emerging on auricular surface of the sacroiliac joint meander and criss-cross each other down through the hip bone, the femoral head, neck, and shaft.

- In the hip bone, one system arises on the upper part of auricular surface to converge onto the posterior surface of the greater sciatic notch, from where its trabeculae are reflected to the inferior part of the acetabulum. The other system emerges on the lower part of the auricular surface, converges at the level of the superior gluteal line, and is reflected laterally onto the upper part of the acetabulum.
- In the femur, the first system lines up with a system arising from the lateral part of the femoral shaft to stretch to the inferior portion of the femoral neck and head. The other system lines up with a system in the femur stretching from the medial part of the femoral shaft to the superior part of the femoral head.

On the lateral side of the hip joint the fascia lata is strengthened to form the iliotibial tract which functions as a tension band and reduces the bending loads on the proximal part of the femur.

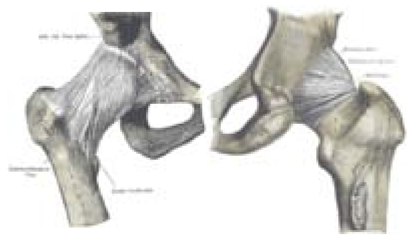
Capsule

The capsule attaches to the hip bone outside the acetabular lip which thus projects into the capsular space. On the femoral side, the distance between the head's cartilaginous rim and the capsular attachment at the base of the neck is constant, which leaves a wider extracapsular part of the neck at the back than at the front. The strong but loose fibrous capsule of the hip joint permits the hip joint to have the second largest range of movement (second only to the shoulder) and yet support the weight of the body, arms and head.

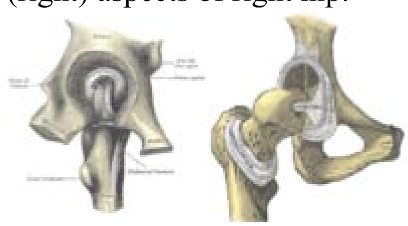
The capsule has two sets of fibers: longitudinal and circular.

- The circular fibers form a collar around the femoral neck called the zona orbicularis.
- The longitudinal retinacular fibers travel along the neck and carry blood vessels.

Ligaments



Extracapsular ligaments. Anterior (left) and posterior (right) aspects of right hip.



Intracapsular ligament. Left hip joint from within pelvis with acetabular floor removed (left); right hip joint with capsule removed, anterior aspect (right).

The hip joint is reinforced by five ligaments, of which four are extracapsular and one intracapsular.

The **extracapsular** ligaments are the iliofemoral, ischiofemoral, and pubofemoral ligaments attached to the bones of the pelvis (the ilium, ischium, and pubis respectively). All three strengthen the capsule and prevent an excessive range of movement in the joint. Of these, the Y-shaped and twisted iliofemoral ligament is the strongest ligament in the human body. In the upright position, it prevents the trunk from falling backward without the need for muscular activity. In the sitting position, it becomes relaxed, thus permitting the pelvis to tilt backward into its sitting position. The iliofemoral ligament prevents excessive adduction and internal rotation of the hip. The ischiofemoral ligament prevents medial (internal) rotation while the pubofemoral ligament restricts abduction and internal rotation of the hip joint. The zona orbicularis, which lies like a collar around the most narrow part of the femoral neck, is covered by the other ligaments which partly radiate into it. The zona orbicularis acts like a buttonhole on the femoral head and assists in maintaining the contact in the joint.

The **intracapsular** ligament, the ligamentum teres, is attached to a depression in the acetabulum (the acetabular notch) and a depression on the femoral head (the fovea of the head). It is only stretched when the hip is dislocated, and may then prevent further displacement. It is not that important as a ligament but can often be vitally important as a conduit of a small artery to the head of the femur. This arterial branch is not present in everyone but can become the only blood supply to the bone in the head of the femur when the neck of the femur is fractured or disrupted by injury in childhood.

Blood Supply

The hip joint is supplied with blood from the medial circumflex femoral and lateral circumflex femoral arteries, which are both usually branches of the deep artery of the thigh (profunda femoris), but there are numerous variations and one or both may also arise directly from the femoral artery. There is also a small contribution from a small artery in the ligament of the head of the femur which is a branch of the posterior division of the obturator artery, which becomes important to avoid avascular necrosis of the head of the femur when the blood supply from the medial and lateral circumflex arteries are disrupted (e.g. through fracture of the neck of the femur along their course).

The hip has two anatomically important anastomoses, the cruciate and the trochanteric anastomoses, the latter of which provides most of the blood to the head of the femur. These anastomoses exist between the femoral artery or profunda femoris and the gluteal vessels.

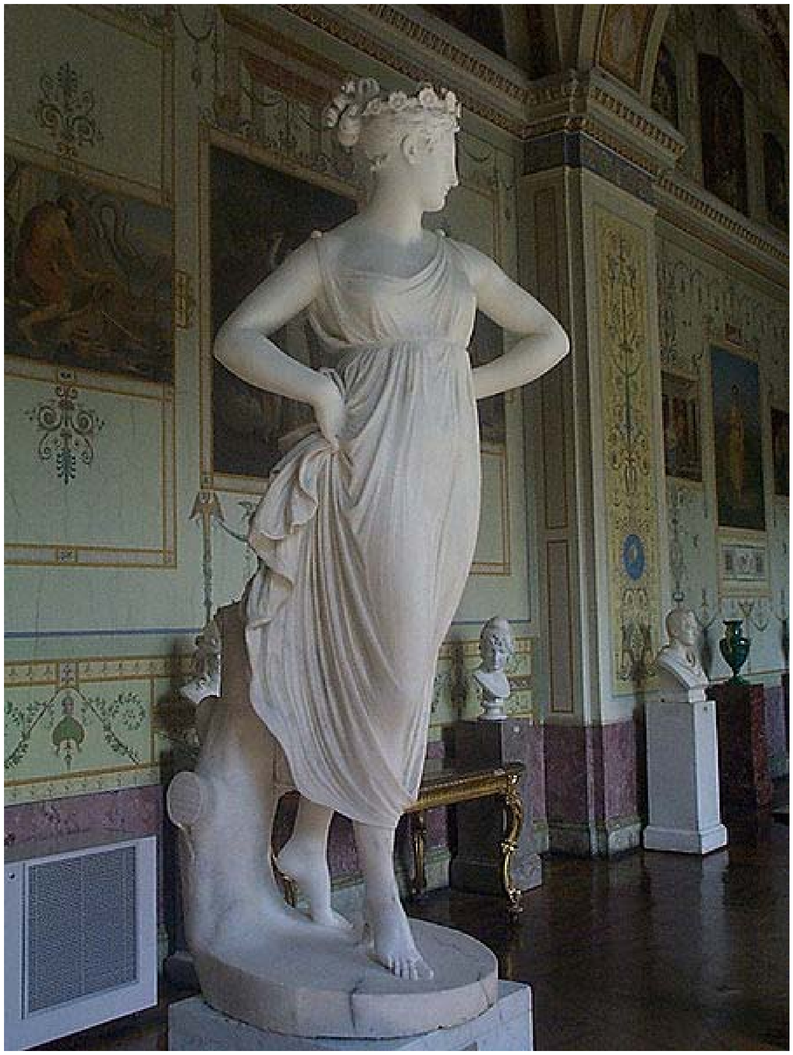
Muscles and movements

The hip muscles act on three mutually perpendicular main axes, all of which pass through the center of the femoral head, resulting in three degrees of freedom and three pair of principal directions: Flexion and extension around a transverse axis (left-right); lateral rotation and medial rotation around a longitudinal axis (along the thigh); and abduction and adduction around a sagittal axis (forward-backward); and a combination of these movements (i.e. circumduction, a compound movement in which the leg describes the surface of an irregular cone). It should be noted that some of the hip muscles also act on either the vertebral joints or the knee joint, that with their extensive areas of origin and/or insertion, different part of individual muscles participate in very different movements, and that the range of movement varies with the position of the hip joint. Additionally, the inferior and superior gemelli may be termed *triceps coxae* together with the obturator internus, and their function simply is to assist the latter muscle.

The movements of the hip joint is thus performed by a series of muscles which are here presented in order of importance with the range of motion from the neutral zero-degree position indicated:

- **Lateral** or **external rotation** (30° with the hip extended, 50° with the hip flexed): gluteus maximus; quadratus femoris; obturator internus; dorsal fibers of gluteus medius and minimus; iliopsoas (including psoas major from the vertebral column); obturator externus; adductor magnus, longus, brevis, and minimus; piriformis; and sartorius.
- **Medial** or **internal rotation** (40°): anterior fibers of gluteus medius and minimus; tensor fascia latae; the part of adductor magnus inserted into the adductor tubercle; and, with the leg abducted also the pectineus.
- **Extension** or **retroversion** (20°): gluteus maximus (if put out of action, active standing from a sitting position is not possible, but standing and walking on a flat surface is); dorsal fibers of gluteus medius and minimus; adductor magnus; and piriformis. Additionally, the following thigh muscles extend the hip: semimembranosus, semitendinosus, and long head of biceps femoris.
- **Flexion** or **anteversion** (140°): iliopsoas (with psoas major from vertebral column); tensor fascia latae, pectineus, adductor longus, adductor brevis, and gracilis. Thigh muscles acting as hip flexors: rectus femoris and sartorius.
- **Abduction** (50° with hip extended, 80° with hip flexed): gluteus medius; tensor fascia latae; gluteus maximus with its attachment at the fascia lata; gluteus minimus; piriformis; and obturator internus.
- **Adduction** (30° with hip extended, 20° with hip flexed): adductor magnus with adductor minimus; adductor longus, adductor brevis, gluteus maximus with its attachment at the gluteal tuberosity; gracilis (extends to the tibia); pectineus, quadratus femoris; and obturator externus. Of the thigh muscles, semitendinosus is especially involved in hip adduction.

Sexual dimorphism and cultural significance



Dancers often stand with hands on hips

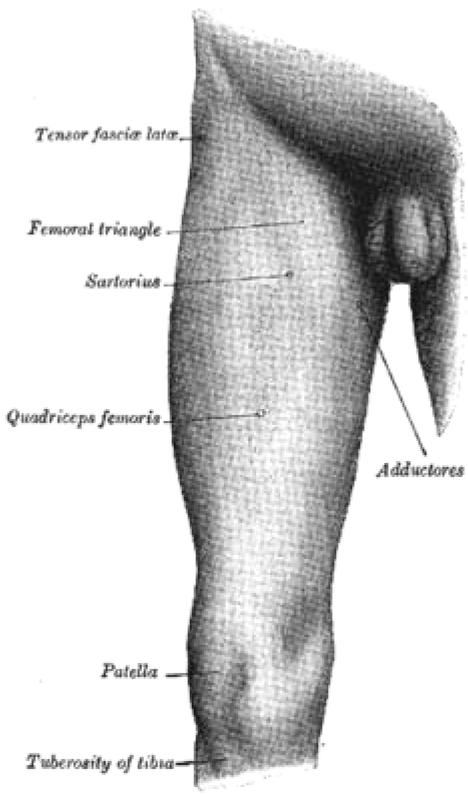
In humans, unlike other animals, the hip bones are substantially different in the two sexes. The hips of human females widen during puberty. The femora are also more widely spaced in females, so as to widen the opening in the hip bone and thus facilitate childbirth. Finally, the ilium and its muscle attachment are shaped so as to situate the buttocks away from the birth canal, where contraction of the buttocks could otherwise damage the baby.

The female hips have long been associated with both fertility and general expression of sexuality. Since broad hips facilitate child birth and also serve as an anatomical cue of sexual maturity, they have been seen as an attractive trait for women for thousands of years. Many of the classical poses women take when sculpted, painted or photographed, such as the Odalisque, serve to emphasize the prominence of their hips. Similarly, women's fashion through the ages has often drawn attention to the girth of the wearer's hips. Hip piercing is a fashion where piercing is done close to hip bones near the belly.

Chapter 3

Thigh

Thigh



Front and medial aspect of a male right thigh

Latin *femur*

In humans the **thigh** is the area between the pelvis and the knee. Anatomically, it is part of the lower limb.

The single bone in the thigh is called the femur. This bone is very thick and strong (due to the high proportion of cortical bone), and forms a ball and socket joint at the hip, and a condylar joint at the knee.

Fascial compartments

In cross-section, the thigh is divided up into three fascial compartments. These compartments use the femur as an axis, and are separated by tough connective tissue membranes (or septa). Each of these compartments has its own blood and nerve supply, and contains a different group of muscles.

- Medial fascial compartment of thigh, adductor
- Posterior fascial compartment of thigh, flexor, hamstring
- Anterior fascial compartment of thigh, extensor

Overall, the leg (lower limb) consists of seven interior bones:

- Hip;
- Femur;
- Patella;
- Tibia;
- Fibula;
- Tarsal;
- Metatarsal;
- Phalanges

Blood vessels

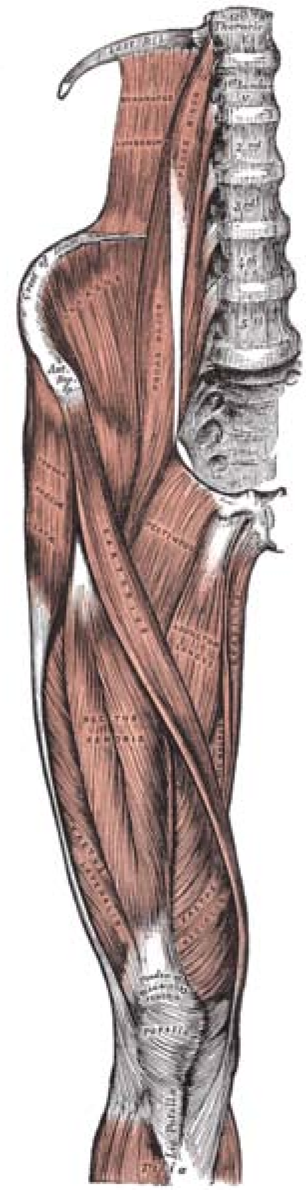
The arterial supply is by the femoral artery and the obturator artery. The lymphatic drainage closely follows the arterial supply and drains to the lumbar lymphatic trunks on the corresponding side, which in turn drains to the cisterna chyli.

The deep venous system of the thigh consists of the femoral vein, the proximal part of the popliteal vein, and various smaller vessels; these are the site of proximal deep venous thrombosis. The *venae perfortantes* connect the deep and the superficial system, which consists of the saphenous veins (the site of varicose veins).

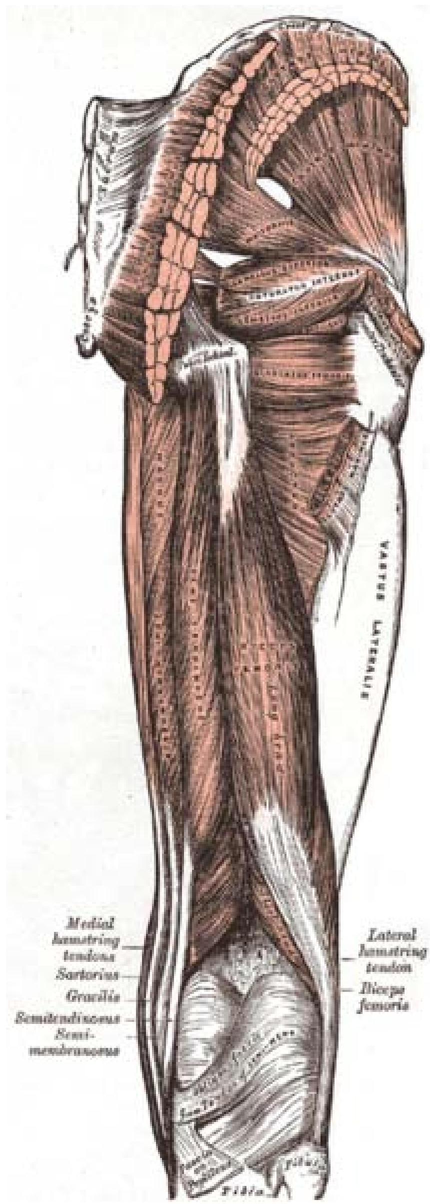
Thigh weakness

Thigh weakness can result in a positive Gowers' sign on physical examination.

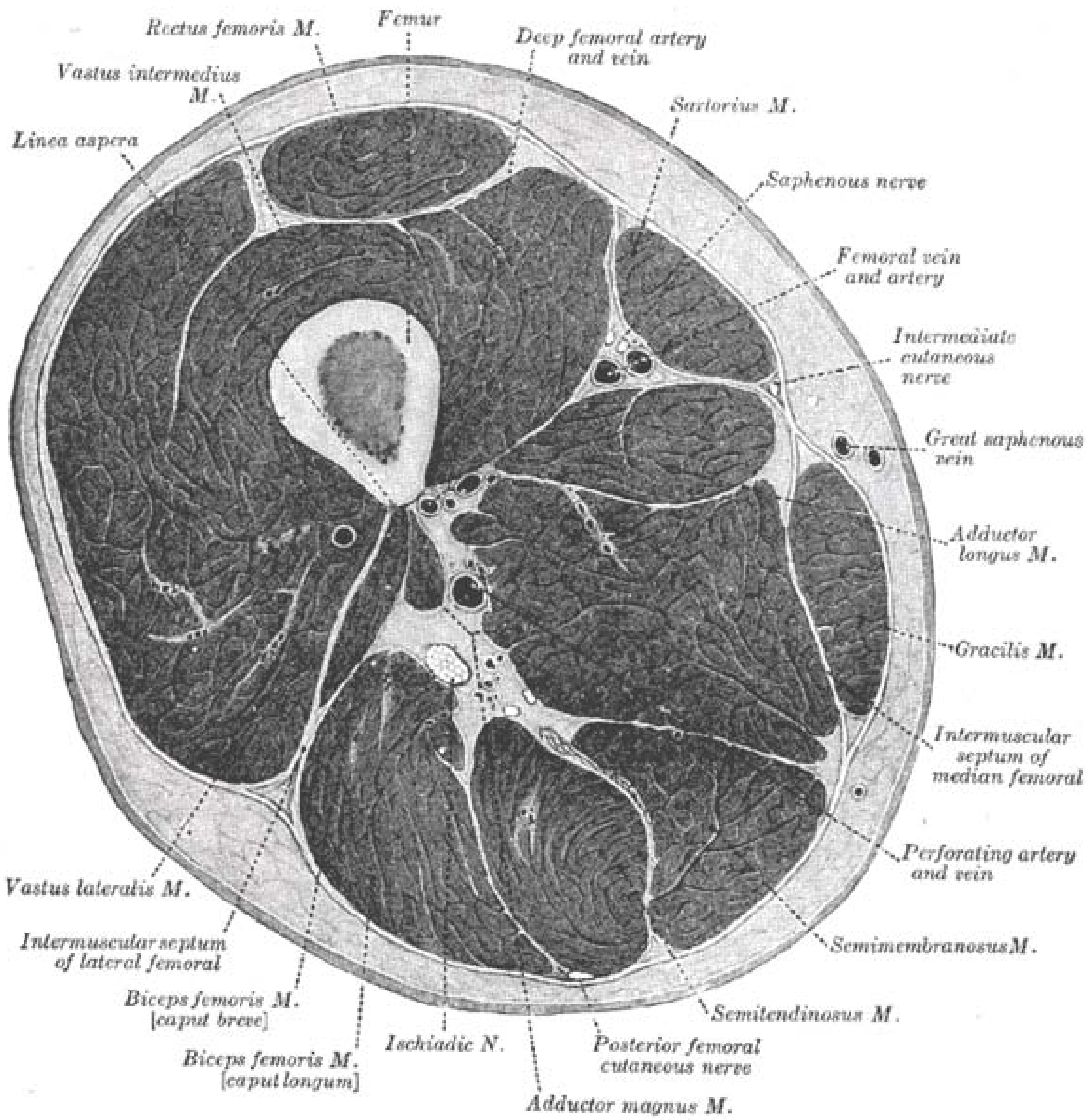
Muscles and Fascia of the Thigh



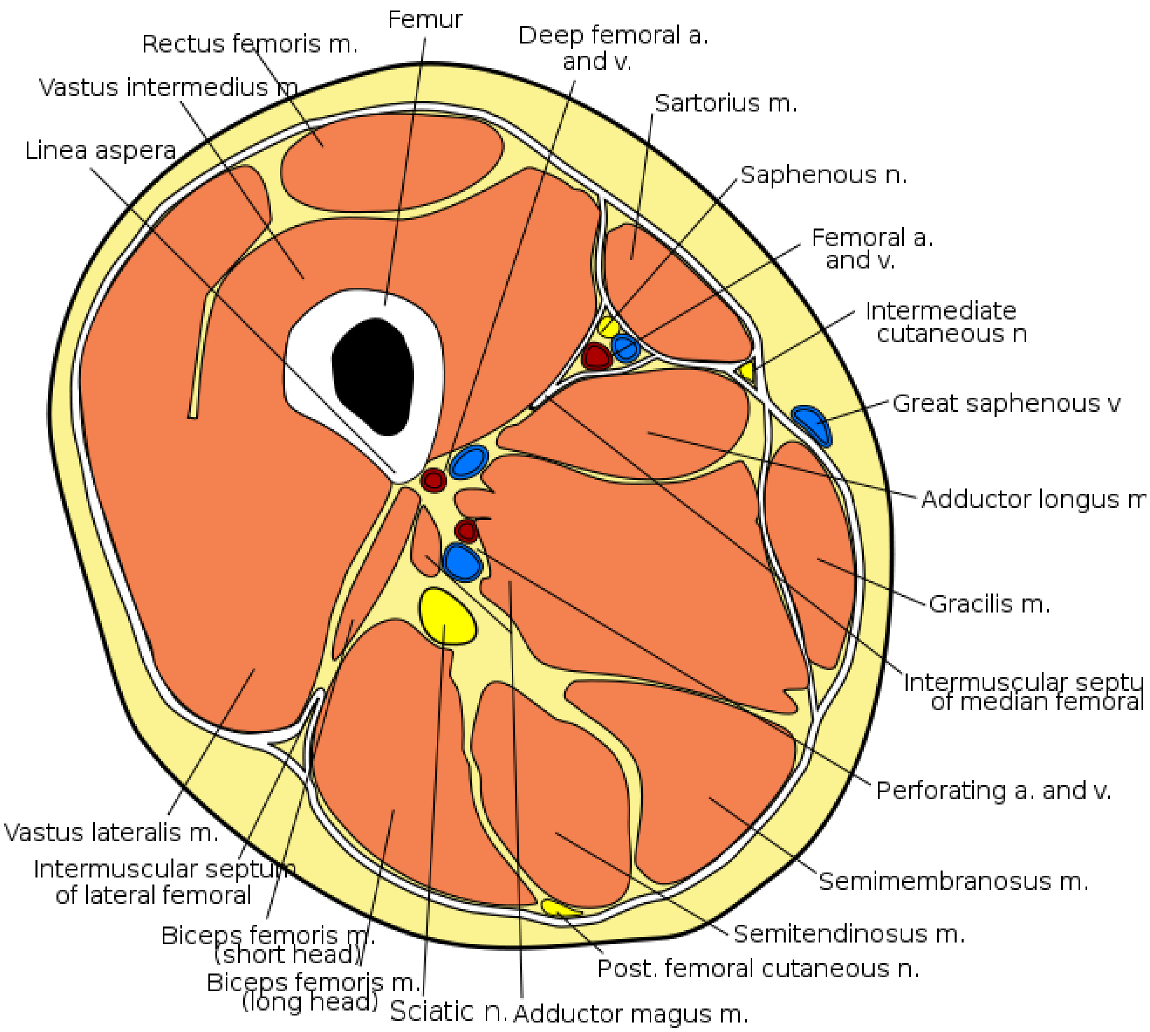
Front of thigh muscles from Gray's Anatomy of the human body



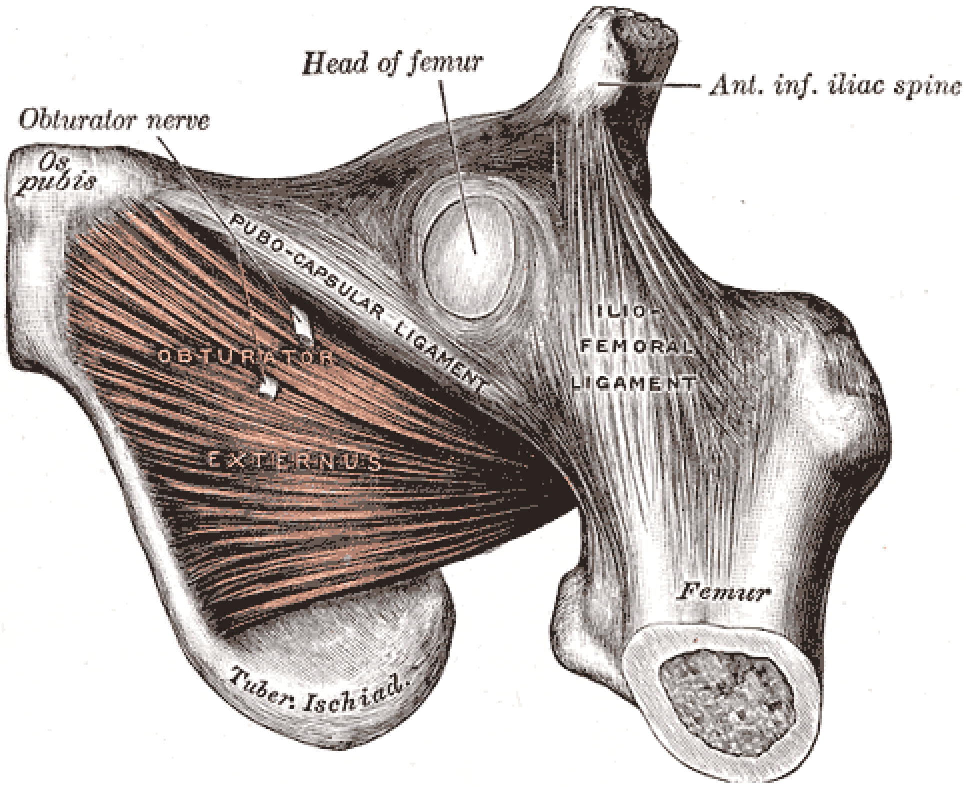
Back thigh muscles of the gluteal and posterior femoral regions from Gray's Anatomy of the human body



Cross-section through the middle of the thigh



Cross-section through the middle of the thigh

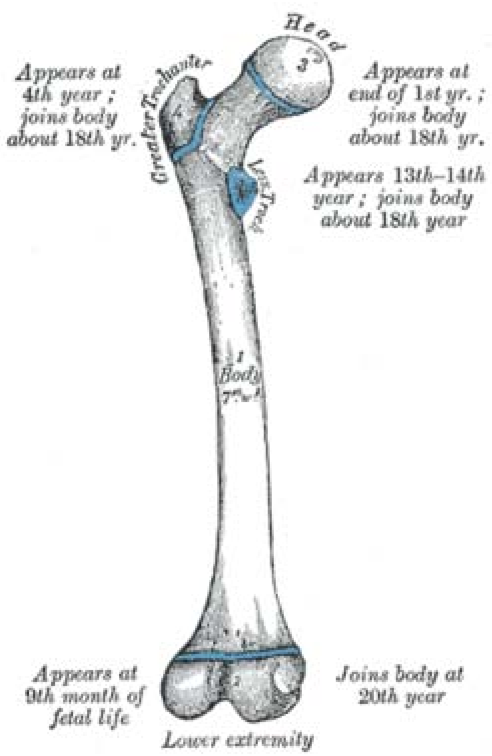


The Obturator externus

Chapter 4

Femur

Bone: Femur



Anterior view of the femur

Latin	*os femoris*
Gray's	*subject #59 242*
Origins	Gastrocnemius , Vastus lateralis, Vastus medialis, Vastus intermedius
Insertions	tensor fasciae latae, gluteus medius, gluteus minimus, Gluteus maximus, Iliopsoas
Articulations	**hip:** acetabulum of pelvis superiorly **knee:** with the tibia and patella

	inferiorly
MeSH	*Femur*

The **femur**, or **thigh bone**, is the most proximal (closest to the body) bone of the leg in vertebrates capable of walking or jumping, such as most land mammals, birds, many reptiles such as lizards, and amphibians such as frogs. In vertebrates with four legs such as dogs and horses, the femur is found only in the rear legs.

Human anatomy

In human anatomy, the femur is the longest and largest bone. The average adult male femur is 48 centimeters (18.9 in) in length and 2.84 cm (1.12in) in diameter at the midshaft, and can support up to 30 times the weight of an adult. It forms part of the hip joint (at the acetabulum) and part of the knee joint, which it is located above. There are four eminences, or protuberances, in the human femur: the head, the greater trochanter, the lesser trochanter, and the lower extremity. They appear at various times from just before birth to about age 14. Initially, they are joined to the main body of the femur with cartilage, which gradually becomes ossified until the protuberances become an integral part of the femur bone, usually in early adulthood.

The shaft of femur is cylindrical with a rough line on its posterior surface (linea aspera).

The intercondylar fossa is present between the condyles at the distal end of the femur. In addition to the intercondylar eminence on the tibial plateau, there is both an anterior and posterior intercondylar fossa (area), the sites of anterior cruciate and posterior cruciate ligament attachment, respectively.

Variation

In primitive tetrapods, the main points of muscle attachment along the femur are the **internal trochanter** and **fourth trochanter**, and a ridge along the ventral surface of the femoral shaft referred to as the **adductor crest**. The neck of the femur is generally minimal or absent in the most primitive forms, reflecting a simple attachment to the acetabulum. The greater trochanter was present in the extinct archosaurs, as well as in modern birds and mammals, being associated with the loss of the primitive sprawling gait. The lesser trochanter is a unique development of mammals, which lack both the internal and fourth trochanters. The adductor crest is often also absent in mammals, or reduced to a series of creases along the surface of the bone.

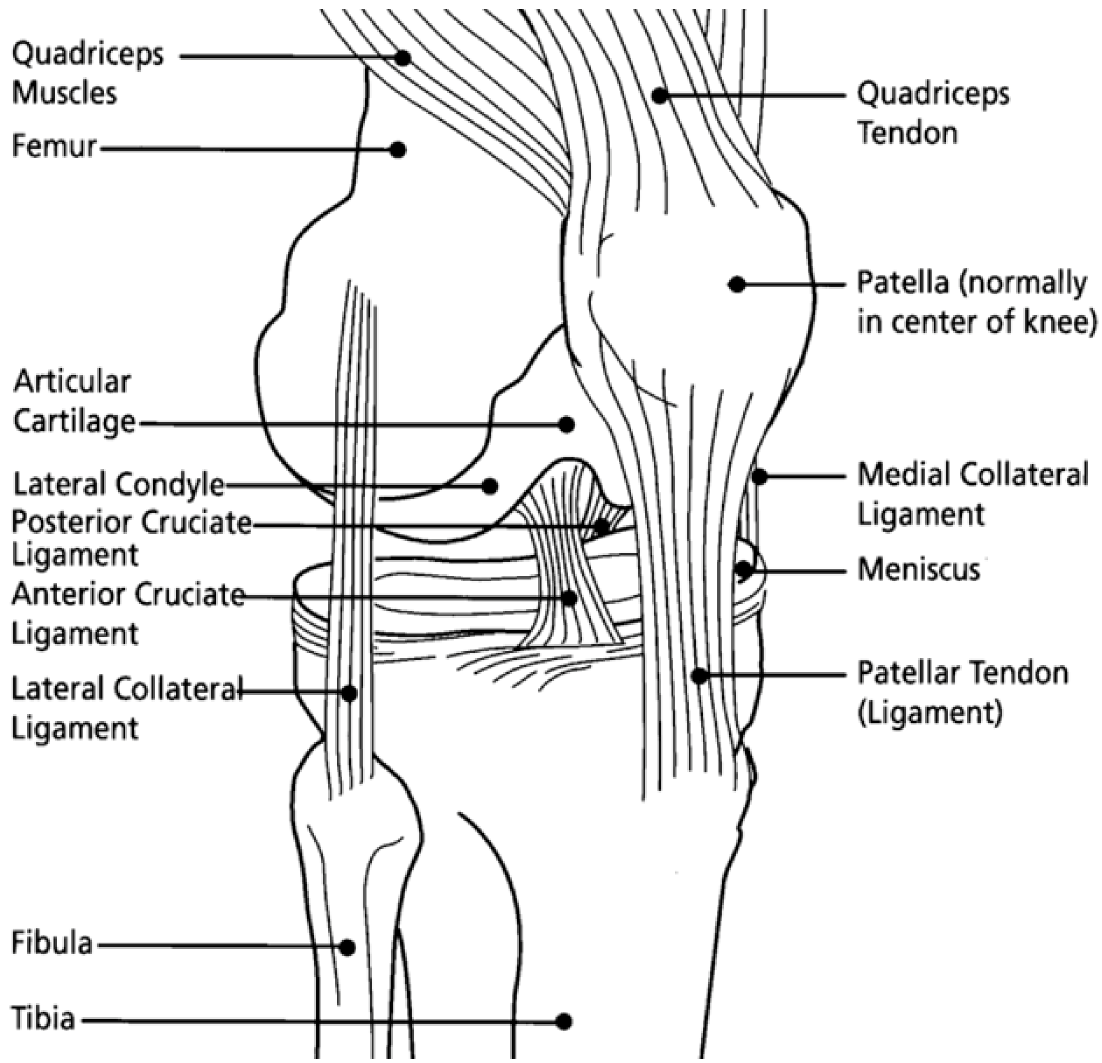
Some species of whales, snakes, and other non-walking vertebrates have vestigial femurs. One of the earliest known vertebrates to have a femur is the *Eusthenopteron*, a prehistoric lobe-finned fish from the Late Devonian period. In invertebrates, the name *femur tite* is also given to the most proximal full-length jointed segment of the legs of some arthropods such as spiders.

Fractures

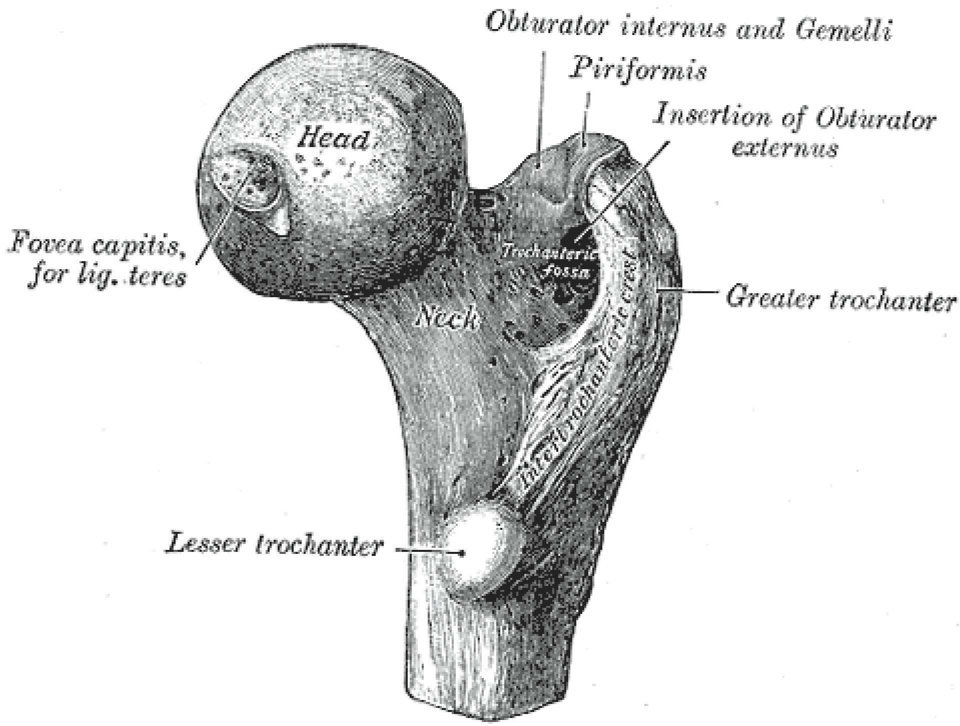
A femoral fracture that involves the femoral head, femoral neck or the shaft of the femur immediately below the lesser trochanter may be classified as a hip fracture, especially when associated with osteoporosis.

Etymology

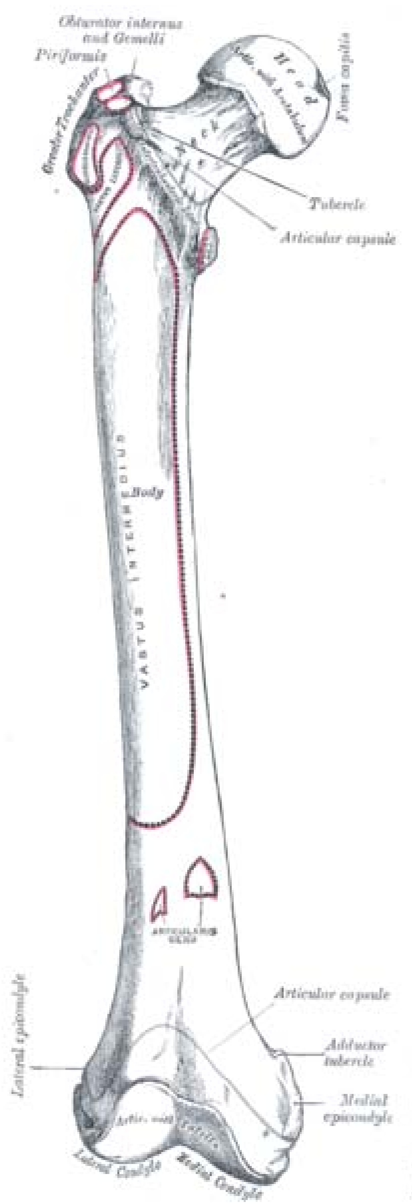
In medical Latin its genitive is always *femoris*, but in classical Latin its genitive is often *feminis*, and should not be confused with case forms of *femina*, which means "woman".



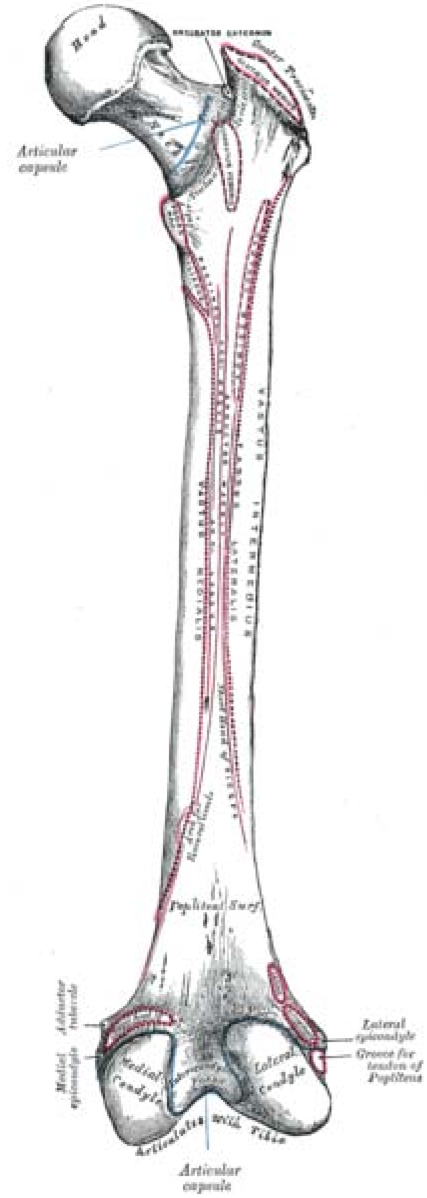
Knee diagram



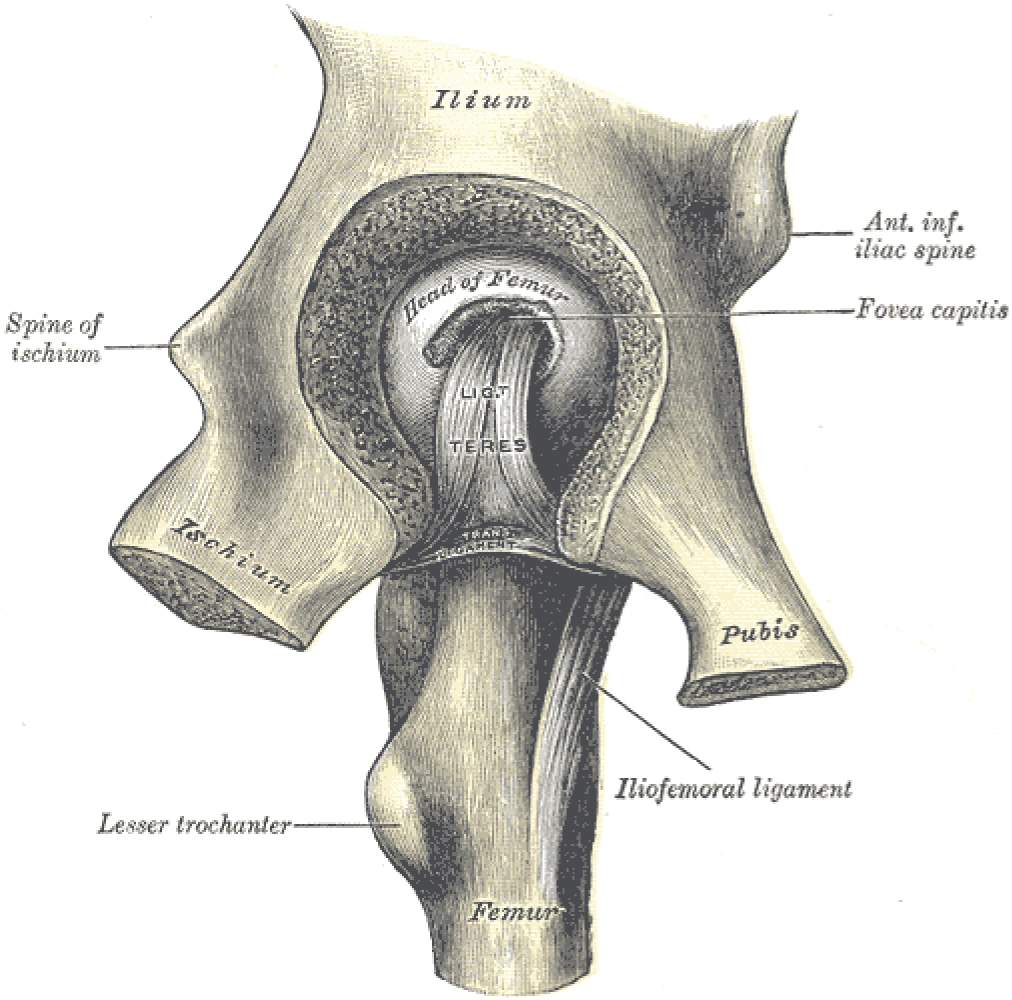
Upper extremity of right femur viewed from behind and above



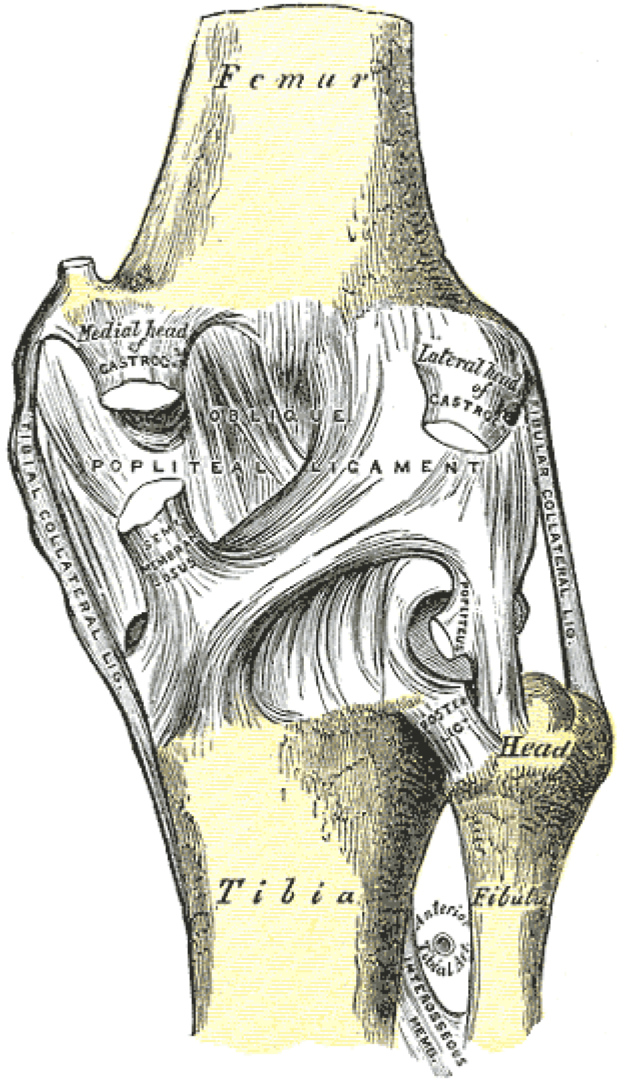
Right femur. Anterior surface



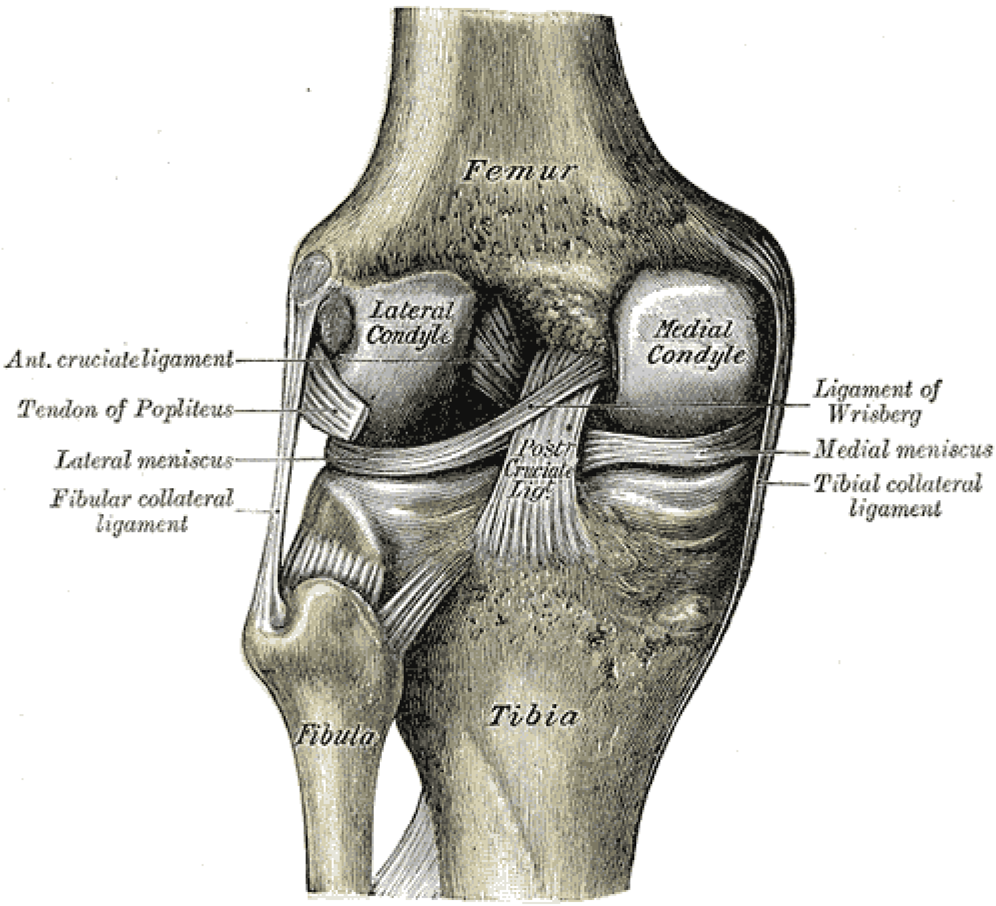
Right femur. Posterior surface.



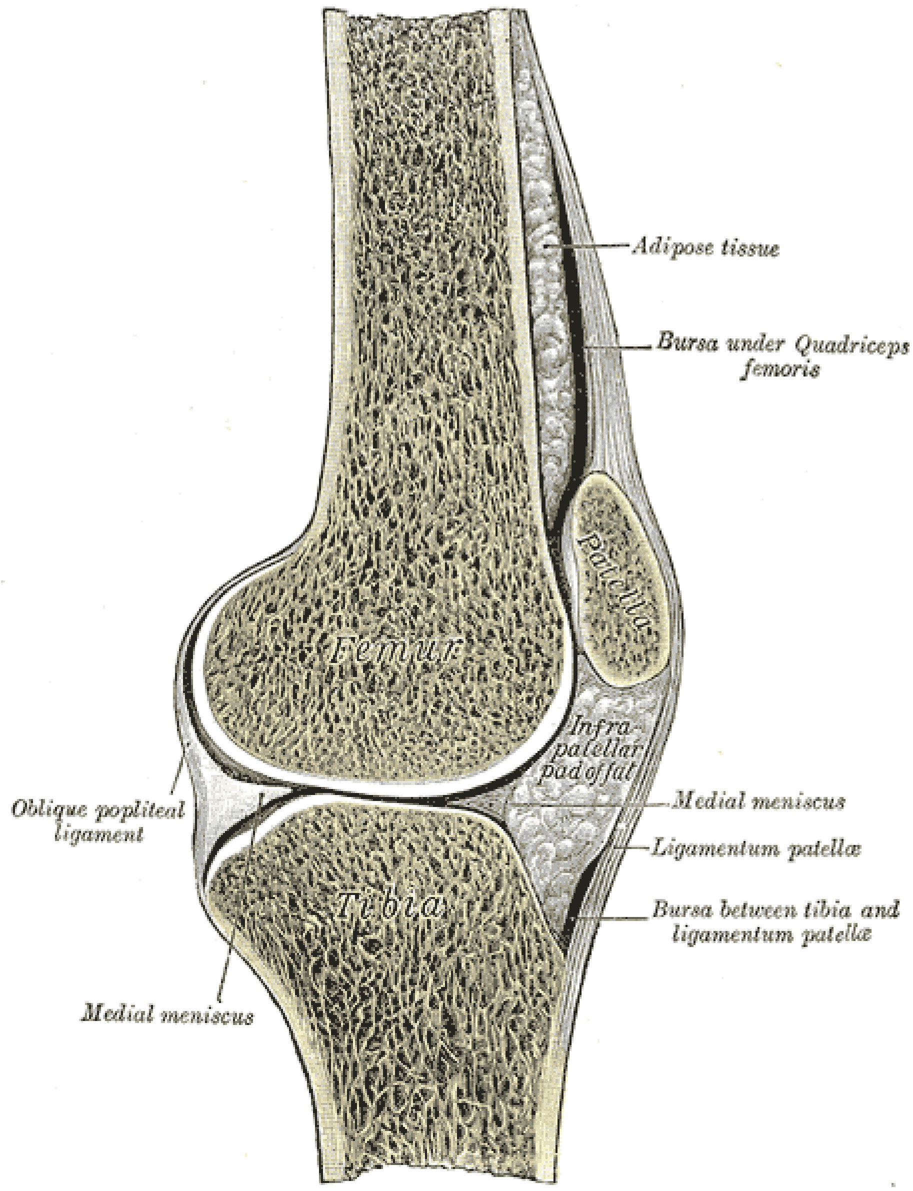
Left hip-joint, opened by removing the floor of the acetabulum from within the pelvis



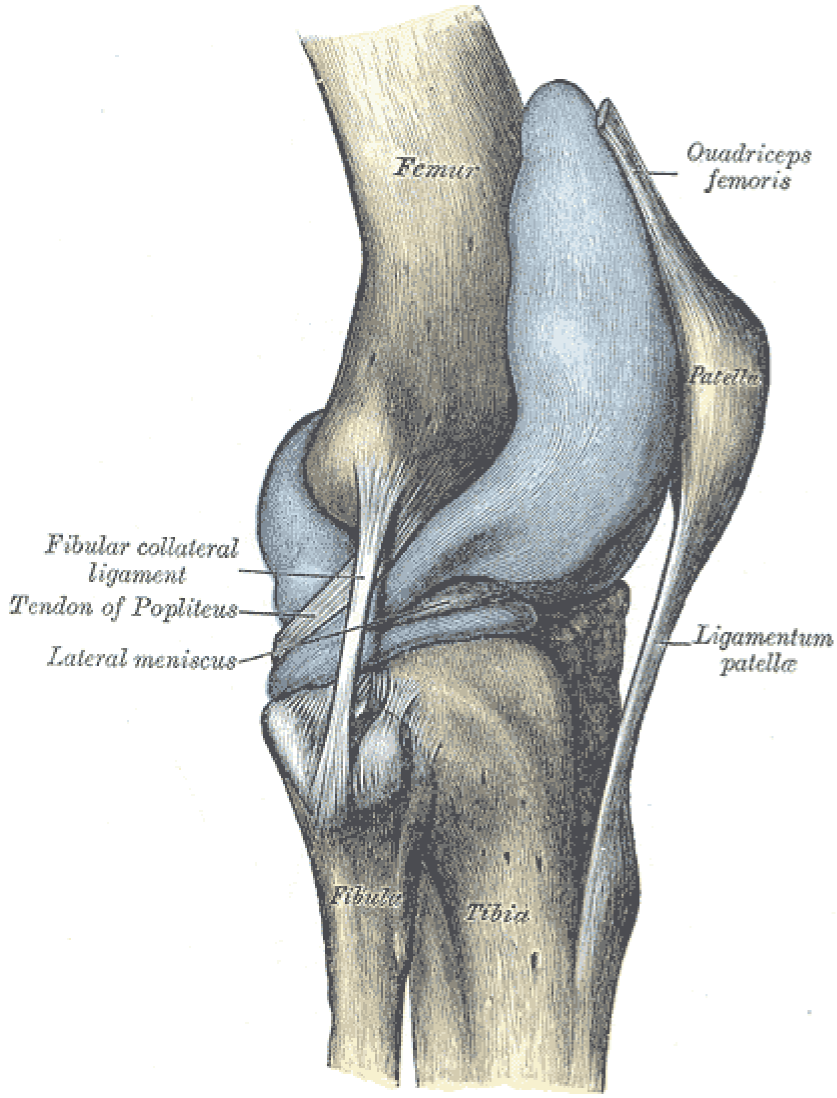
Right knee-joint. Posterior view.



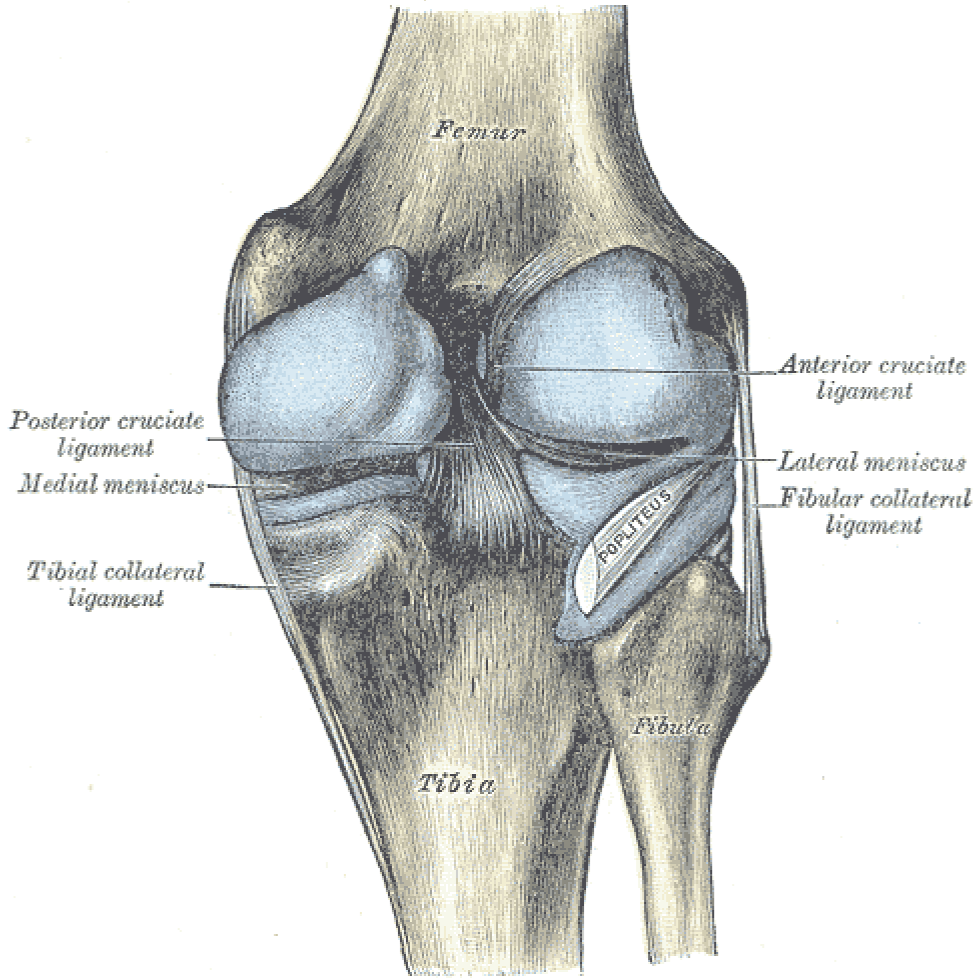
Left knee-joint from behind, showing interior ligaments



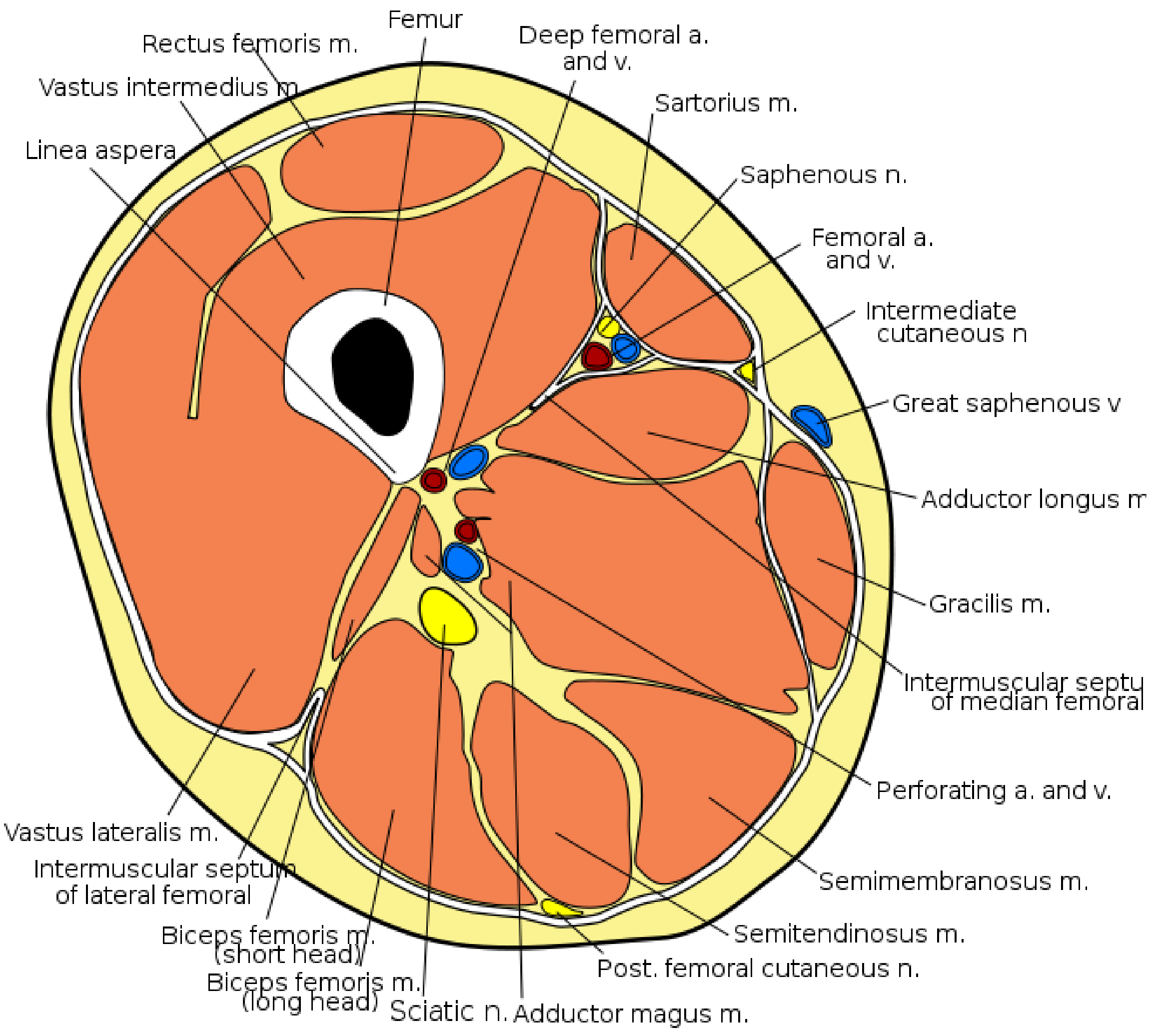
Sagittal section of right knee-joint



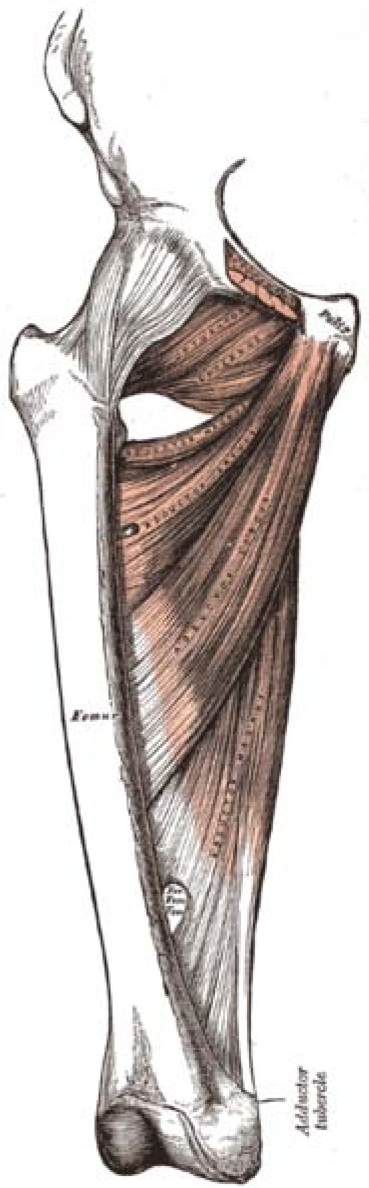
Capsule of right knee-joint (distended). Lateral aspect.



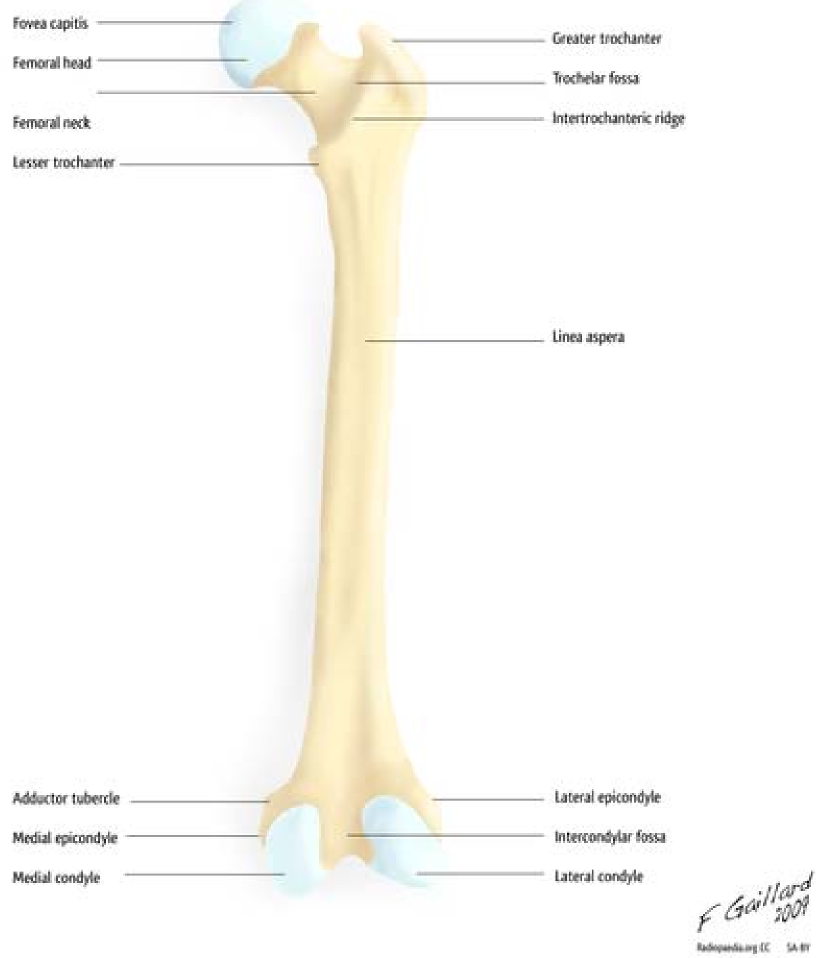
Capsule of right knee-joint (distended). Posterior aspect.



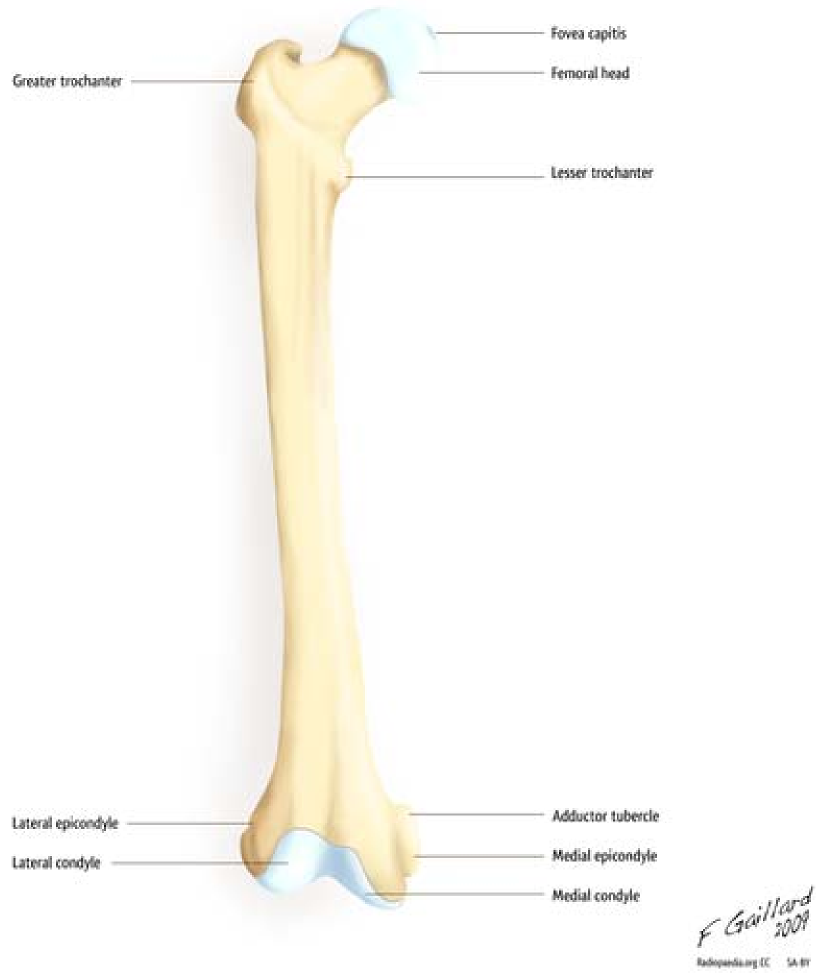
Cross-section through the middle of the thigh



Deep muscles of the medial femoral region



Posterior view



Anterior view

Chapter 5

Foot

Foot	
	
Latin	*pes*
Artery	dorsalis pedis, medial plantar, lateral plantar
Nerve	medial plantar, lateral plantar, deep fibular, superficial fibular
MeSH	*Foot*
Dorlands/Elsevier	*Foot*

The **foot** is an anatomical structure found in many vertebrates. It is the terminal portion of a limb which bears weight and allows locomotion. In many animals with feet, the foot is a separate organ at the terminal part of the leg made up of one or more segments or bones, generally including claws or nails.

Human foot

Anatomy

The human foot and ankle is a strong and complex mechanical structure containing more than 26 bones, 33 joints (20 of which are actively articulated), and more than a hundred muscles, tendons, and ligaments.

An anthropometric study of 1197 North American adult Caucasian males (mean age 35.5 years) found that a man's foot length was 26.3 cm with a standard deviation of 1.2 cm.

The foot can be subdivided into the hindfoot, the midfoot, and the forefoot:

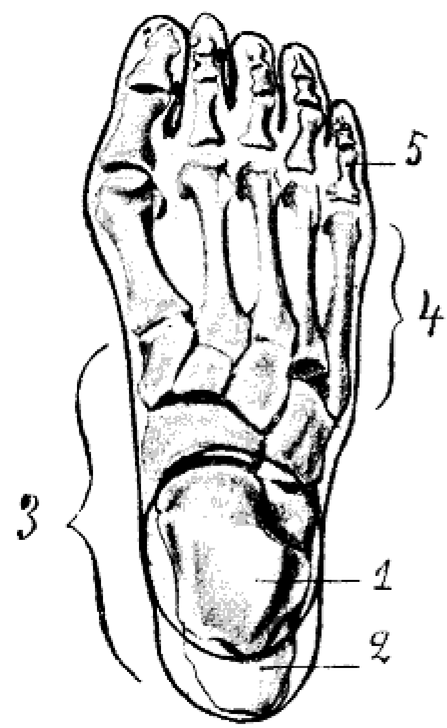
The **hindfoot** is composed of the talus or ankle bone and the calcaneus or heel bone. The two long bones of the lower leg, the tibia and fibula, are connected to the top of the talus to form the ankle. Connected to the talus at the subtalar joint, the calcaneus, the largest bone of the foot, is cushioned inferiorly by a layer of fat.

The five irregular bones of the **midfoot**, the cuboid, navicular, and three cuneiform bones, form the arches of the foot which serves as a shock absorber. The midfoot is connected to the hind- and fore-foot by muscles and the plantar fascia.

The **forefoot** is composed of five toes and the corresponding five proximal long bones forming the metatarsus. Similar to the fingers of the hand, the bones of the toes are called phalanges and the big toe has two phalanges while the other four toes have three phalanges. The joints between the phalanges are called interphalangeal and those between the metatarsus and phalanges are called metatarsophalangeal (MTP).

The **instep** is the arched part of the top of the foot between the toes and the ankle.

Skeleton



A human foot; label three is the instep

- tibia, fibula
- tarsus: talus, calcaneus, cuneiformes, cuboid, and navicular
- metatarsus: first, second, third, fourth, and fifth metatarsal bone
- phalanges

There can be many sesamoid bones near the metatarsophalangeal joints, although they are only regularly present in the distal portion of the first metatarsal bone.

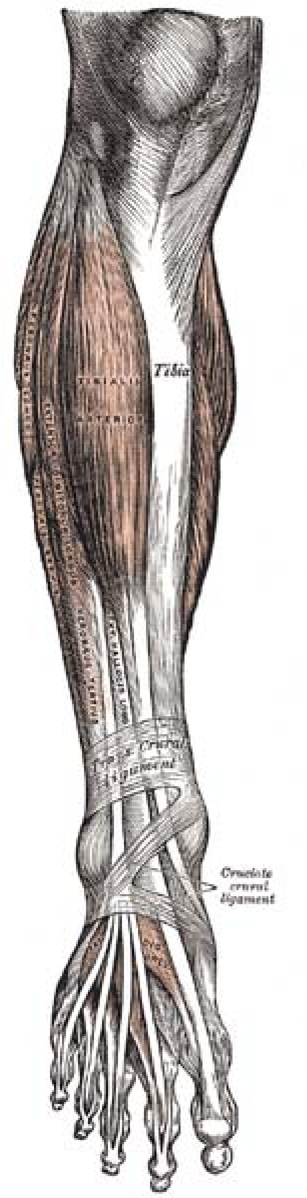
Arches

The human foot has two longitudinal arches and a transverse arch maintained by the interlocking shapes of the foot bones, strong ligaments, and pulling muscles during activity. The slight mobility of these arches when weight is applied to and removed from the foot makes walking and running more economical in terms of energy. As can be examined in a footprint, the medial longitudinal arch curves above the ground. This arch stretches from the heel bone over the "keystone" ankle bone to the three medial metatarsals. In contrast, the lateral longitudinal arch is very low. With the cuboid serving as its keystone, it redistributes part of the weight to the calcaneus and the distal end of the fifth metatarsal. The two longitudinal arches serve as pillars for the transverse arch which run obliquely across the tarsometatarsal joints. Excessive strain on the tendons and ligaments of the feet can result in fallen arches or flat feet.

Muscles

The muscles acting on the foot can be classified into extrinsic muscles, those originating on the anterior or posterior aspect of the lower leg, and intrinsic muscles, originating on the dorsal or plantar aspects of the foot.

Extrinsic



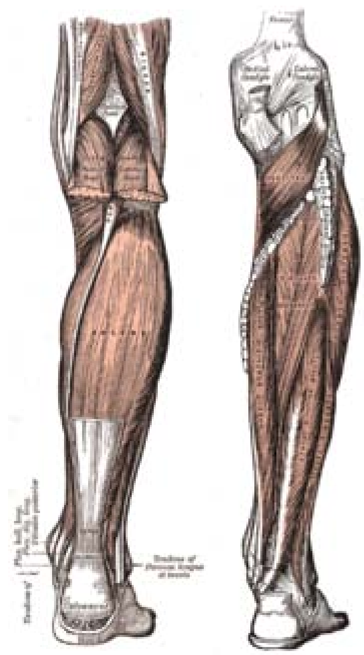
Anterior leg muscles

All muscles originating on the lower leg except the popliteus muscle are attached to the bones of the foot. The tibia and fibula and the interosseous membrane separate these muscles into anterior and posterior groups, in their turn subdivided into subgroups and layers.

Anterior group

Extensor group: tibialis anterior originates on the proximal half of the tibia and the interosseous membrane and is inserted near the tarsometatarsal joint of the first digit. In the non-weight-bearing leg tibialis anterior flexes the foot dorsally and lift its medial edge (supination). In the weight-bearing leg it brings the leg towards the back of the foot, like in rapid walking. Extensor digitorum longus arises on the lateral tibial condyle and along the fibula to be inserted on the second to fifth digits and proximally on the fifth metatarsal. The extensor digitorum longus acts similar to the tibialis anterior except that it also dorsiflexes the digits. Extensor hallucis longus originates medially on the fibula and is inserted on the first digit. As the name implies it dorsiflexes the big toe and also acts on the ankle in the unstressed leg. In the weight-bearing leg it acts similar to the tibialis anterior.

Peroneal group: peroneus longus arises on the proximal aspect of the fibula and peroneus brevis below it on the same bone. Together, their tendons pass behind the lateral malleolus. Distally, peroneus longus crosses the plantar side of the foot to reach its insertion on the first tarsometatarsal joint, while peroneus brevis reaches the proximal part of the fifth metatarsal. These two muscles are the strongest pronators and aid in plantar flexion. Longus also acts like a bowstring that braces the transverse arch of the foot.



Deep and superficial layers
of posterior leg muscles

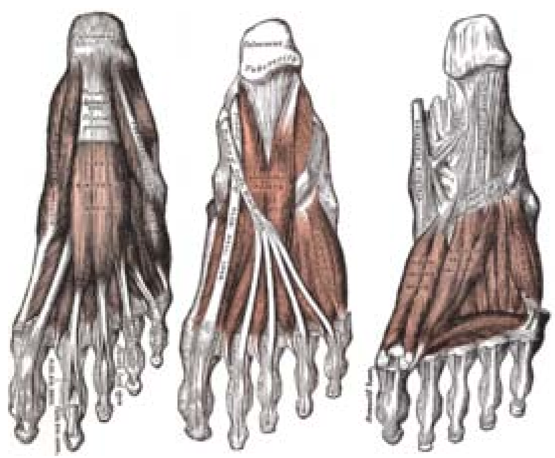
Posterior group

The **superficial layer** of posterior leg muscles is formed by the triceps surae and the plantaris. The triceps surae consists of the soleus and the two heads of the gastrocnemius. The heads of gastrocnemius arise on the femur, proximal to the condyles, and soleus arises on the proximal dorsal parts of the tibia and fibula. The tendons of these muscles merge to be inserted onto the calcaneus as the Achilles tendon. Plantaris originates on the femur proximal to the lateral head of the gastrocnemius and its long tendon is embedded medially into the Achilles tendon. The triceps surae is the primary plantar flexor and its strength becomes most obvious during ballet dancing. It is fully activated only with the knee extended because the gastrocnemius is shortened during knee flexion. During walking it not only lifts the heel, but also flexes the knee, assisted by the plantaris.

In the **deep layer** of posterior muscles tibialis posterior arises proximally on the back of the interosseous membrane and adjoining bones and divides into two parts in the sole of the foot to attach to the tarsus. In the non-weight-bearing leg, it produces plantar flexion and supination, and, in the weight-bearing leg, it proximates the heel to the calf. flexor hallucis longus arises on the back of the fibula (i.e. on the lateral side), and its relatively thick muscle belly extends distally down to the flexor retinaculum where it passes over to the medial side to stretch across the sole to the distal phalanx of the first digit. The popliteus is also part of this group, but, with its oblique course across the back of the knee, does not act on the foot.

Intrinsic

On the **back** (top) **of the foot**, the tendons of extensor digitorum brevis and extensor hallucis brevis lie deep to the system of long extrinsic extensor tendons. They both arise on the calcaneus and extend into the dorsal aponeurosis of digits one to four, just beyond the penultimate joints. They act to dorsiflex the digits.



Plantar aspects of foot, varying depths
(superficial to deep)

Similar to the intrinsic muscles of the hand, there are three groups of muscles in the **sole of foot**, those of the first and last digits, and a central group:

Muscles of the big toe: abductor hallucis stretches medially along the border of the sole, from the calcaneus to the first digit. Below its tendon, the tendons of the long flexors pass through the tarsal canal. It is an abductor and a weak flexor, and also helps maintain the arch of the foot. flexor hallucis brevis arises on the medial cuneiform bone and related ligaments and tendons. An important plantar flexor, it is crucial for ballet dancing. Both these muscles are inserted with two heads proximally and distally to the first metatarsophalangeal joint. Adductor hallucis is part of this group, though it originally formed a separate system. It has two heads, the oblique head originating obliquely across the central part of the midfoot, and the transverse head originating near the metatarsophalangeal joints of digits five to three. Both heads are inserted into the lateral sesamoid bone of the first digit. Adductor hallucis acts as a tensor of the plantar arches and also adducts the big toe and then might plantar flex the proximal phalanx.

Muscles of the little toe: Stretching laterally from the calcaneus to the proximal phalanx of the fifth digit, abductor digiti minimi form the lateral margin of the foot and is the largest of the muscles of the fifth digit. Arising from the base of the fifth metatarsal, flexor digiti minimi is inserted together with abductor on the first phalanx. Often absent, opponens digiti minimi originates near the cuboid bone and is inserted on the fifth metatarsal bone. These three muscles act to support the arch of the foot and to plantar flex the fifth digit.

Central muscles of foot

Central muscle group: The four lumbricales arise on the medial side of the tendons of flexor digitorum longus and are inserted on the medial margins of the proximal phalanges. Quadratus plantae originates with two slips from the lateral and medial margins of the calcaneus and inserts into the lateral margin of the flexor digitorum tendon. It is also known as flexor accessorius. Flexor digitorum brevis arise inferiorly on the calcaneus and its three tendons are inserted into the middle phalanges of digits two to four (sometimes also the fifth digit). These tendons divide before their insertions and the tendons of flexor digitorum longus pass through these divisions. Flexor digitorum brevis flexes the middle phalanges. It is occasionally absent. Between the toes, the dorsal and plantar interossei stretch from the metatarsals to the proximal phalanges of digits two to five. The plantar interossei adducts and the dorsal interossei abducts these digits and are also plantar flexors at the metatarsophalangeal joints.

Medical aspects

Due to their position and function, feet are exposed to a variety of potential infections and injuries, including athlete's foot, bunions, ingrown toenails, Morton's neuroma, plantar fasciitis, plantar warts and stress fractures. In addition, there are several genetic disorders that can affect the shape and function of the feet, including a club foot or flat feet.

This leaves humans more vulnerable to medical problems that are caused by poor leg and foot alignments. Also, the wearing of shoes, sneakers and boots can impede proper alignment and movement within the ankle and foot. For example, high heels are known to throw off the natural weight balance (this can also affect the lower back). For the sake of posture, flat soles and heels are advised.

A doctor who specializes in the treatment of the feet practices podiatry and is called a podiatrist. A pedorthist specializes in the use and modification of footwear to treat problems related to the lower limbs.

Fractures of the foot include:

- Lisfranc fracture - in which one or all of the metatarsals are displaced from the tarsus
- Jones fracture - a fracture of the fifth metatarsal
- March fracture - a fracture of the distal third of one of the metatarsals occurring because of recurrent stress
- Calcaneal fracture

Foot sweat is the major cause of foot odor. Sweat itself is odorless, but it creates a beneficial environment for certain bacteria to grow and produce bad-smelling substances.

Evolutionary variations

A paw is the soft foot of a mammal, generally a quadruped, that has claws or nails. A hard foot is called a hoof.

Depending on style of locomotion, animals can be classified as plantigrade (sole walking), digitigrade (toe walking), or unguligrade (nail walking).

The metatarsals are the bones that make up the main part of the foot in humans, and part of the leg in large animals or paw in smaller animals. The number of metatarsals are directly related to the mode of locomotion — five digits being the most primitive setup, with many larger animals having their digits reduced to two (elk, cow, sheep) or one (horse). The metatarsal bones of feet and paws are tightly grouped compared to, most notably, the human hand where the thumb metacarpal diverges from the rest of the metacarpus.

Chapter 6

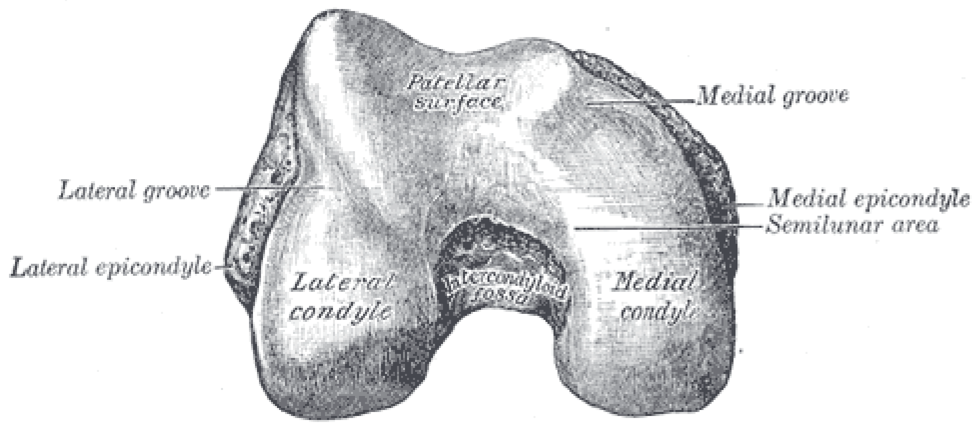
Knee

Knee joints	
	
Right knee	
Latin	*articulatio genus*
Gray's	*subject #93 339*
Nerve	femoral, obturator, sciatic
MeSH	*Knee*
Dorlands/Elsevier	*Knee*

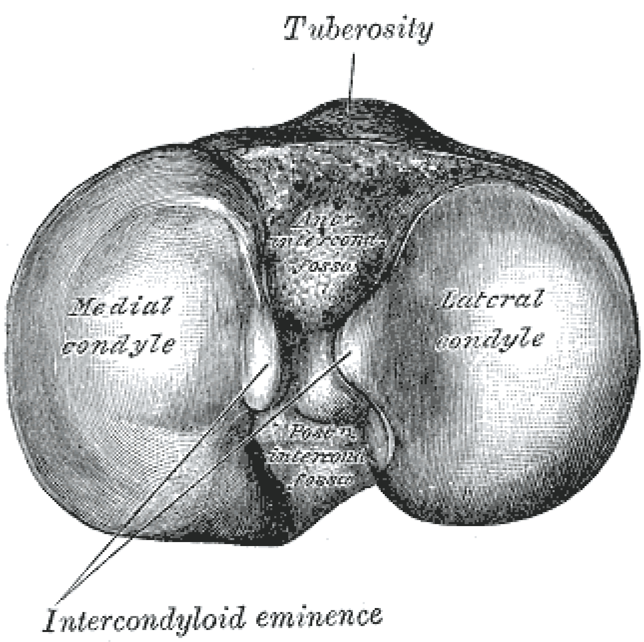
The **knee** joint joins the thigh with the leg and consists of two articulations: one between the femur and tibia, and one between the femur and patella. It is the largest joint in the human body and is very complicated. The knee is a mobile trocho-ginglymus (i.e. a pivotal hinge joint), which permits flexion and extension as well as a slight medial and lateral rotation. Since in humans the knee supports nearly the whole weight of the body, it is the joint most vulnerable to both acute injury and the development of osteoarthritis.

It is often grouped into **tibiofemoral** and patellofemoral components. (The fibular collateral ligament is often considered with tibiofemoral components.)

Human anatomy



Articular surfaces of femur



Articular surfaces of tibia

The knee is a complex, compound, condyloid variety of a synovial joint. It actually comprises three functional compartments: the femoropatellar articulation consists of the patella, or "kneecap", and the patellar groove on the front of the femur through which it slides; and the medial and lateral femorotibial articulations linking the femur, or thigh bone, with the tibia, the main bone of the lower leg. The joint is bathed in synovial fluid which is contained inside the synovial membrane called the joint capsule.

Upon birth, a baby will not have a conventional knee cap, but a growth formed of cartilage. In human females this turns to a normal bone knee cap by the age of 3, in males the age of 5.

Articular bodies

The articular bodies of the femur are its lateral and medial condyles. These diverge slightly distally and posteriorly, with the lateral condyle being wider in front than at the back while the medial condyle is of more constant width. The radius of the condyles' curvature in the sagittal plane becomes smaller toward the back. This diminishing radius produces a series of involute midpoints (i.e. located on a spiral). The resulting series of transverse axes permit the sliding and rolling motion in the flexing knee while ensuring the collateral ligaments are sufficiently lax to permit the rotation associated with the curvature of the medial condyle about a vertical axis.

The pair of tibial condyles are separated by the intercondylar eminence composed of a lateral and a medial tubercle.

The patella is inserted into the thin anterior wall of the joint capsule. On its posterior surface is a lateral and a medial articular surface, both of which communicate with the patellar surface which unites the two femoral condyles on the anterior side of the bone's distal end. A common disease found in the knee is "Tartas".

Articular capsule

Lateral and posterior aspects
of right knee

The articular capsule has a synovial and a fibrous membrane separated by fatty deposits. Anteriorly, the synovial membrane is attached on the margin of the cartilage both on the femur and the tibia, but on the femur, the suprapatellar bursa or recess extends the joint space proximally. The suprapatellar bursa is prevented from being pinched during extension by the articularis genu muscle. Behind, the synovial membrane is attached to the margins of the two femoral condyles which produces two extensions similar to the anterior recess. Between these two extensions, the synovial membrane passes in front of the two cruciate ligaments at the center of the joint, thus forming a pocket direct inward.

Bursae

Numerous bursae surround the knee joint. The largest communicative bursa is the suprapatellar bursa described above. Four considerably smaller bursae are located on the back of the knee. Two non-communicative bursae are located in front of the patella and below the patellar tendon, and others are sometimes present.

Cartilage

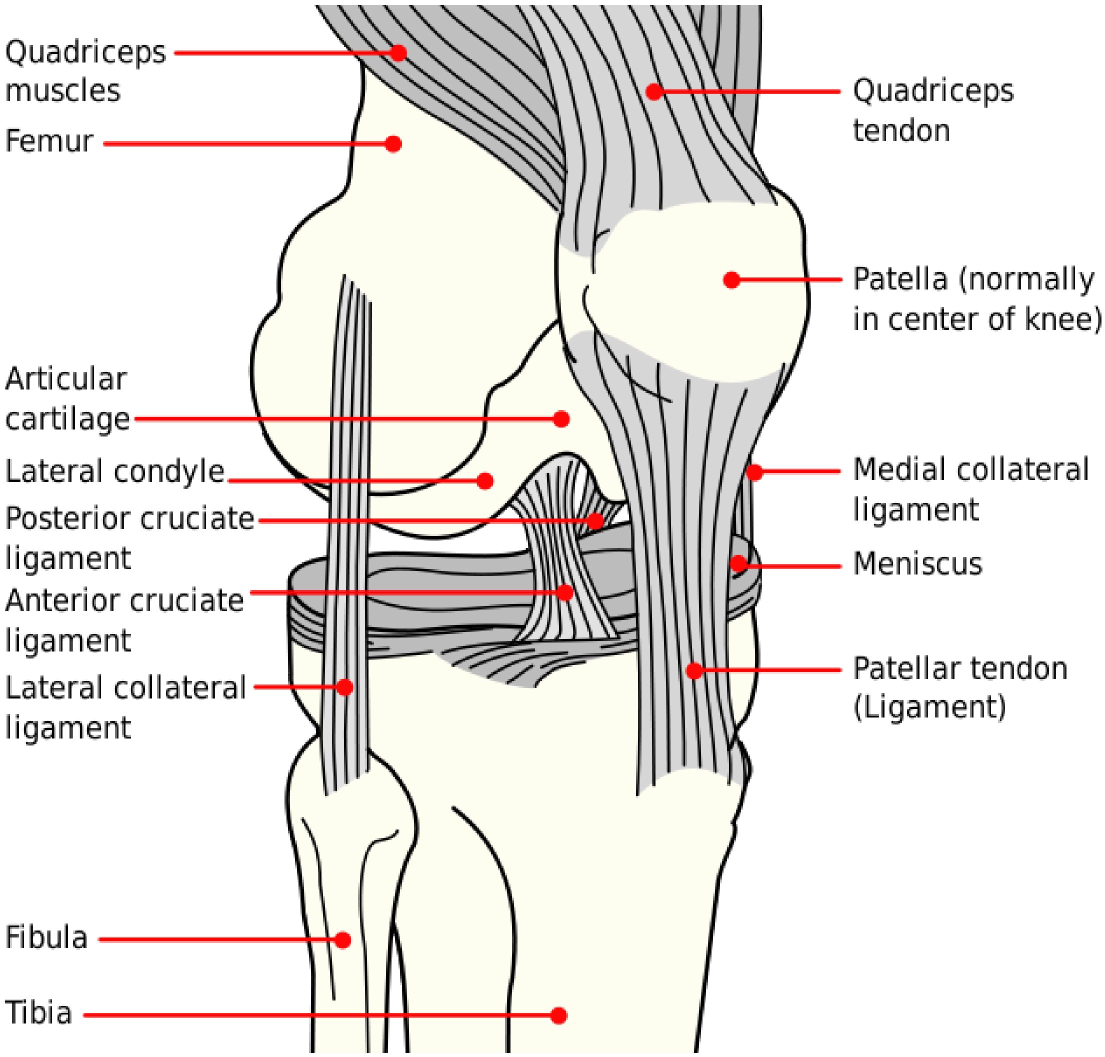
Cartilage is a thin, elastic tissue that protects the bone and makes certain that the joint surfaces can slide easily over each other. Cartilage ensures supple knee movement. There are two types of joint cartilage in the knees: fibrous cartilage (the meniscus) and hyaline cartilage. Fibrous cartilage has tensile strength and can resist pressure. Hyaline cartilage covers the surface along which the joints move. Cartilage will wear over the years. Cartilage has a very limited capacity for self-restoration. The newly formed tissue will generally consist for a large part of fibrous cartilage of lesser quality than the original hyaline cartilage. As a result, new cracks and tears will form in the cartilage over time.

Menisci

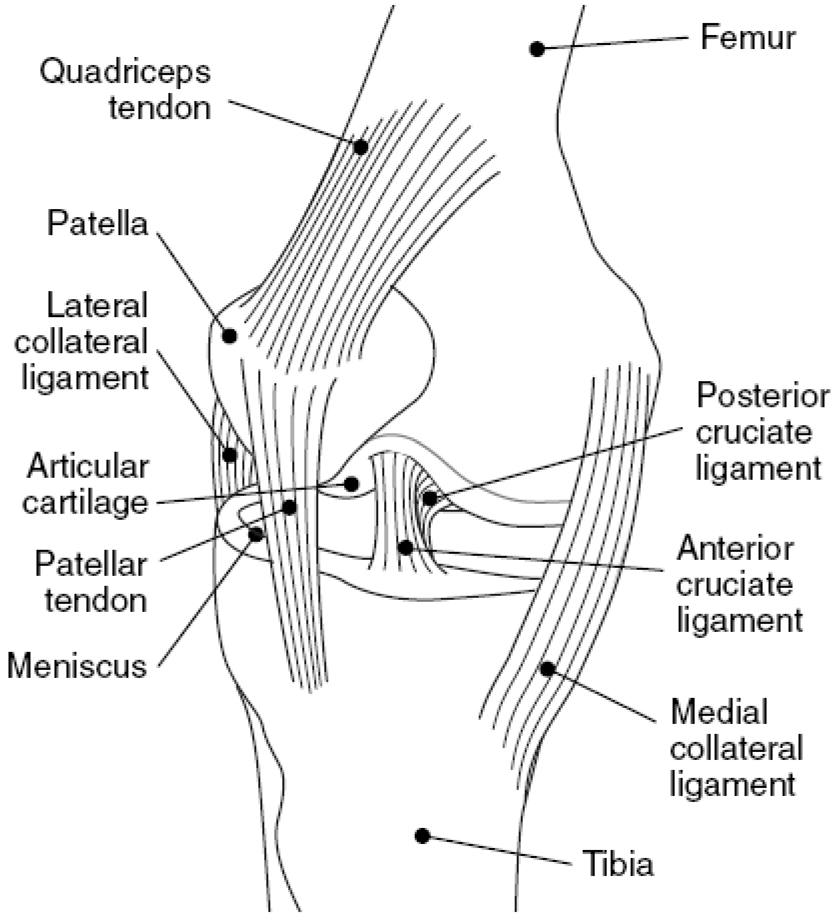
The articular disks of the knee-joint are called menisci because they only partly divide the joint space. These two disks, the medial meniscus and the lateral meniscus, consist of connective tissue with extensive collagen fibers containing cartilage-like cells. Strong fibers run along the menisci from one attachment to the other, while weaker radial fibers are interlaced with the former. The menisci are flattened at the center of the knee joint, fused with the synovial membrane laterally, and can move over the tibial surface.

The menisci serve to protect the ends of the bones from rubbing on each other and to effectively deepen the tibial sockets into which the femur attaches. They also play a role in shock absorption, and may be cracked, or torn, when the knee is forcefully rotated and/or bent.

Ligaments



Anterolateral aspect of knee



Anteromedial aspect of knee

The ligaments surrounding the knee joint offer stability by limiting movements and, together with several menisci and bursae, protect the articular capsule.

Intracapsular

The knee is stabilized by a pair of cruciate ligaments. The anterior cruciate ligament (ACL) stretches from the lateral condyle of femur to the anterior intercondylar area The ACL is critically important because it prevents the tibia from being pushed too far anterior relative to the femur. It is often torn during twisting or bending of the knee. The posterior cruciate ligament (PCL) stretches from medial condyle of femur to the posterior intercondylar area. Injury to this ligament is uncommon but can occur as a direct result of forced trauma to the ligament. This ligament prevents posterior displacement of the tibia relative to the femur.

The transverse ligament stretches from the lateral meniscus to the medial meniscus. It passes in front of the menisci. Is divided into several strips in 10% of cases. The two menisci are attached to each others anteriorly by the ligament. The posterior and anterior meniscofemoral ligaments stretch from posterior horn of lateral meniscus to the medial femoral condyle. They pass posteriorly behind the posterior cruciate ligament. The posterior meniscofemoral ligament is more commonly present (30%); both ligaments are present less often. The meniscotibial ligaments (or "coronary") stretches from inferior edges of the mensici to the periphery of the tibial plateaus.

Extracapsular

The patellar ligament connects the patella to the tuberosity of the tibia. It is also occasionally called the patellar tendon because there is no definite separation between the quadriceps tendon (which surrounds the patella) and the area connecting the patella to the tibia. This very strong ligament helps give the patella its mechanical leverage and also functions as a cap for the condyles of the femur. Laterally and medially to the patellar ligament the lateral and medial patellar retinacula connect fibers from the vasti lateralis and medialis muscles to the tibia. Some fibers from the iliotibial tract radiate into the lateral retinaculum and the medial retinaculum receives some transverse fibers arising on the medial femoral epicondyle.

The medial collateral ligament (MCL a.k.a. "tibial") stretches from the medial epicondyle of the femur to the medial tibial condyle. It is composed of three groups of fibers, one stretching between the two bones, and two fused with the medial meniscus. The MCL is partly covered by the pes anserinus and the tendon of the semimembranosus passes under it. It protects the medial side of the knee from being bent open by a stress applied to the lateral side of the knee (a valgus force). The lateral collateral ligament (LCL a.k.a. "fibular") stretches from the lateral epicondyle of the femur to the head of fibula. It is separate from both the joint capsule and the lateral meniscus. It protects the lateral side from an inside bending force (a varus force).

Lastly, there are two ligaments on the dorsal side of the knee. The oblique popliteal ligament is a radiation of the tendon of the semimembranosus on the medial side, from where it is direct laterally and proximally. The arcuate popliteal ligament originates on the apex of the head of the fibula to stretch proximally, crosses the tendon of the popliteus muscle, and passes into the capsule.

Movements

Maximum movements and muscles

Extension 5-10°	**Flexion 120-150°**
Quadriceps (with some assistance from the Tensor fasciae latae)	(In order of importance) Semimembranosus Semitendinosus Biceps femoris Gracilis Sartorius Popliteus Gastrocnemius
Internal rotation* 10°	**External rotation* 30-40°**

(In order of importance)
Semimembranosus
Semitendinosus Biceps femoris
Gracilis Sartorius
Popliteus
*(knee flexed 90°)

The knee permits flexion and extension about a virtual transverse axis, as well as a slight medial and lateral rotation about the axis of the lower leg in the flexed position. The knee joint is called "mobile" because the femur and lateral meniscus move over the tibia during rotation, while the femur rolls and glides over both menisci during extension-flexion.

The center of the transverse axis of the extension/flexion movements is located where both collateral ligaments and both cruciate ligaments intersect. This center moves upward and backward during flexion, while the distance between the center and the articular surfaces of the femur changes dynamically with the decreasing curvature of the femoral condyles. The total range of motion is dependent on several parameters such as soft-tissue restraints, active insufficiency, and hamstring tightness.

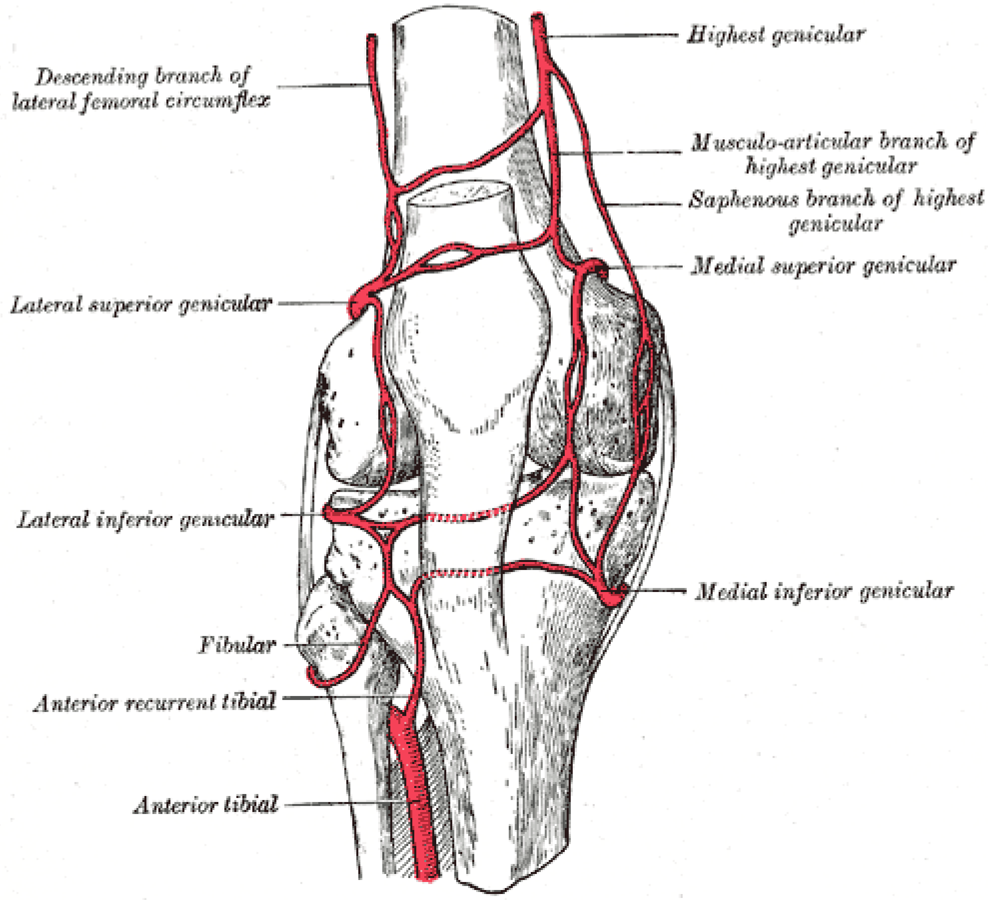
Extended position

With the knee extended both the lateral and medial collateral ligaments, as well as the anterior part of the anterior cruciate ligament, are taut. During extension, the femoral condyles glide into a position which causes the complete unfolding of the tibial collateral ligament. During the last 10° of extension, an **obligatory terminal rotation** is triggered in which the knee is rotated medially 5°. The final rotation is produced by a lateral rotation of the tibia in the non-weight-bearing leg, and by a medial rotation of the femur in the weight-bearing leg. This terminal rotation is made possible by the shape of the medial femoral condyle, assisted by contraction of the popliteus muscle and the iliotibial tract and is caused by the stretching of the anterior cruciate ligament. Both cruciate ligaments are slightly unwinded and both lateral ligaments become taut.

Flexed position

In the flexed position, the collateral ligaments are relaxed while the cruciate ligaments are taut. Rotation is controlled by the twisted cruciate ligaments; the two ligaments get twisted around each other during medial rotation of the tibia — which reduces the amount of rotation possible — while they become unwounded during lateral rotation of the tibia. Because of the oblique position of the cruciate ligaments at least a part of one of them is always tense and these ligaments control the joint as the collateral ligaments are relaxed. Furthermore, the dorsal fibers of the tibial collateral ligament become tensed during extreme medial rotation and the ligament also reduces the lateral rotation to 45-60°.

Blood supply



Arteries of the knee

The femoral artery and the popliteal artery help form the arterial network surrounding the knee joint (articular rete). There are 6 main branches:

- 1. Superior medial genicular artery
- 2. Superior lateral genicular artery
- 3. Inferior medial genicular artery
- 4. Inferior lateral genicular artery
- 5. Descending genicular artery
- 6. Recurrent branch of anterior tibial artery

The medial genicular arteries penetrate the knee joint.

Disorders and injury

Knee pain is caused by trauma, misalignment, and degeneration as well as by conditions like arthritis. The most common knee disorder is generally known as patellofemoral syndrome.The majority of minor cases of knee pain can be treated at home with rest and ice but more serious injuries do require surgical care.

One form of patellofemoral syndrome involves a tissue-related problem that creates pressure and irritation in the knee between the patella and the trochlea (patellar compression syndrome), which causes pain. The second major class of knee disorder involves a tear, slippage, or dislocation that impairs the structural ability of the knee to balance the leg (patellofemoral instability syndrome). Patellofemoral instability syndrome may cause either pain, a sense of poor balance, or both.

Age also contributes to disorders of the knee. Particularly in older people, knee pain frequently arises due to osteoarthritis. In addition, weakening of tissues around the knee may contribute to the problem. Patellofemoral instability may relate to hip abnormalities or to tightness of surrounding ligaments.

Cartilage lesions can be caused by:

- Accidents (fractures)
- Injuries
- The removal of a meniscus
- Anterior cruciate ligament injury
- Posterior cruciate ligament injury
- Considerable strain on the knee.

Any kind of work during which the knees undergo heavy stress may also be detrimental to cartilage. This is especially the case in professions in which people frequently have to walk, lift, or squat. Other causes of pain may be excessive on, and wear of, the knees, in combination with such things as muscle weakness and overweight.

Common complaints:

- A painful, blocked, locked or swollen knee.
- Sufferers sometimes feel as if their knees are about to give way, or may feel uncertain about their movement.

The pain felt by people with cartilage injury does not come from the cartilage itself, but from the irritated tissue surrounding the cartilage, or from pieces of cartilage that have come loose. If cartilage injury goes untreated, the layer of cartilage will continue to gradually wear away, causing arthrosis and gradual immobility.

Overall fitness and knee injury

Physical fitness is related integrally to the development of knee problems. The same activity such as climbing stairs may cause pain from patellofemoral compression for someone who is physically unfit, but not for someone else (or even for that person at a different time). Obesity is another major contributor to knee pain. For instance, a 30-year-old woman who weighed 120 lb at age 18 years, before her three pregnancies, and now weighs 285 lb, had added 660 lb of force across her patellofemoral joint with each step.

Common injuries due to physical activity

Model demonstrating parts of an artificial knee

In sports that place great pressure on the knees, especially with twisting forces, it is common to tear one or more ligaments or cartilages.

Anterior cruciate ligament injury

ACL is the most commonly injured ligament of the knee. The injury is common during sports. Twisting of the knee is a common cause of over-stretching or tearing the ACL. When the ACL is injured one may hear a popping sound and the leg may suddenly give out. Besides swelling and pain, walking may be painful and the knee will feel unstable. Minor tears of the anterior cruciate ligament may heal over time, but a torn ACL requires surgery. After surgery, recovery is prolonged and low impact exercises are recommended to strengthen the joint.

Torn meniscus injury

The menisci act as shock absorbers and separate the two ends of bone in the knee joint. There are two menisci in the knee, the medial (inner) and the lateral (outer). When there is torn cartilage, it means that the meniscus has been injured. Meniscus tears occur during sports often when the knee is twisted. Menisci injury may be innocuous and one may be able to walk after a tear, but soon swelling and pain set in. Sometimes the knee will lock while bending. Pain often occurs when one squats. Small meniscus tears are treated conservatively but most large tears require surgery.

Fractures

Knee fractures are rare but do occur, especially as a result of motor vehicle accidents. There is usually immediate pain; swelling and one may not be able to stand on the leg. The muscles go into spasm and even the slightest movements are painful. X-rays can easily confirm the injury and surgery depends on the degree of displacement and type of fracture.

Ruptured tendon

Tendons usually attach muscle to bone. In the knee the quadriceps and patellar tendon can sometimes tear. The injuries to these tendons occur when there is forceful contraction of the knee. If the tendon is completely torn, bending or extending the leg is impossible. A completely torn tendon requires surgery but a partially torn tendon can be treated with leg immobilization followed by physical therapy.

Overuse

Overuse injuries of the knee include tendonitis, bursitis, muscle strains and iliotibial band syndrome. These injuries often develop slowly over weeks or months. Activities that induce pain usually delay healing. Rest, ice and compression do help in most cases. Once the swelling has diminished, heat packs can increase blood supply and promote healing. Most overuse injuries subside with time but can flare up if the activities are quickly resumed. To prevent overuse injuries, warm up prior to exercise, limit high impact activities and keep your weight under control.

Surgical interventions

Before the advent of arthroscopy and arthroscopic surgery, patients having surgery for a torn ACL required at least nine months of rehabilitation, having initially spent several weeks in a full-length plaster cast. With current techniques, such patients may be walking without crutches in two weeks, and playing some sports in a few months.

In addition to developing new surgical procedures, ongoing research is looking into underlying problems which may increase the likelihood of an athlete suffering a severe knee injury. These findings may lead to effective preventive measures, especially in female athletes, who have been shown to be especially vulnerable to ACL tears from relatively minor trauma.

Articular cartilage repair treatment :

- Arthroscopic debriment of the knee (arthroscopic lavage).
- Mosaïc-plasty.
- Microfracture (Ice-picking).
- Autologous Chondrocyte Implantation.
- Osteochondral Autograft and Allografts.

Diagnostics

The ideal diagnostic test for assessing knee pain are the standard AP and lateral views of plain x-rays as a person in knee pain may not be able to stand. Magnetic resonance imaging is often used for diagnosing soft tissue injuries of the knee. But sometimes it can be overly sensitive; and can even detect tears and signs of inflammation in people who have no pain in their knees. Arthroscopy may be used to examine the knee as well as perform surgical tasks like removal of free fragments and repair of meniscal and ligament injuries.

Several diagnostic maneuvers help clinicians diagnose an injured ACL. In the anterior drawer test, the examiner applies an anterior force on the proximal tibia with the knee in 90 degrees of flexion. The Lachman test is similar, but performed with the knee in only about twenty degrees of flexion, which is more comfortable to a patient in acute pain. The pivot-shift test adds a valgus (outside-in) force to the knee while it is moved from flexion to extension. Any abnormal motion in these maneuvers, suggests a tear of the collateral or cruciate ligaments of the knee.

The diagnosis of soft tissue injuries is usually confirmed by MRI, while that of bone injuries by a CT Scan. The availability of sophisticated investigations, like CT Scan with 3D reconstruction, has greatly decreased the number of purely diagnostic arthroscopies performed.

Animal anatomy

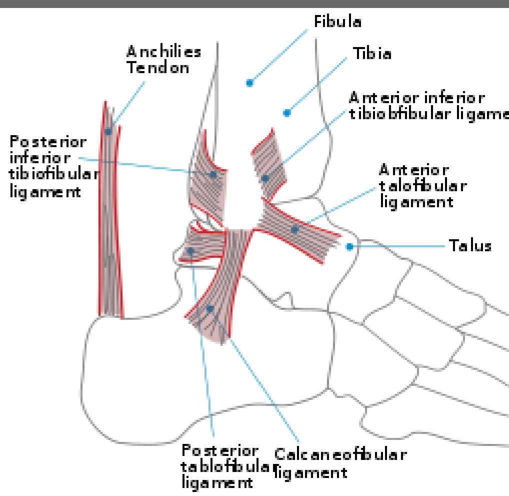
In humans the knee refers to the joints between the femur, tibia and patella. In quadrupeds, particularly horses and ungulates the term is commonly used to refer to the carpus, probably because of its similar hinge or ginglymus action. The joints between the femur, tibia and patella are known as the stifle in quadrupeds. In insects and other animals the term knee is used widely to refer to any ginglymus joint.

Chapter 7

Ankle and Subtalar Joint

Ankle

ankle	



Lateral view of the human ankle

Latin	*articulatio talocruralis*
Gray's	*subject #95 349*
MeSH	*Ankle+joint*

In human anatomy, the **ankle** joint is formed where the foot and the leg meet. The ankle, or **talocrural joint**, is a synovial hinge joint that connects the distal ends of the tibia and fibula in the lower limb with the proximal end of the talus bone in the foot. The articulation between the tibia and the talus bears more weight than between the smaller fibula and the talus.

The term *ankle* is used to describe structures in the region of the ankle joint proper.

Bones

The bones of the ankle, called tarsal bones, consist of the talus, calcaneus (heel), navicular, cuboid, medial or internal cuneiform, middle cuneiform, and lateral or external cuneiform.

Articulation

The lateral malleolus of the fibula and the medial malleolus of the tibia along with the inferior surface of the distal tibia articulate with three facets of the talus. These surfaces are covered by cartilage.

The anterior talus is wider than the posterior talus. When the foot is dorsiflexed, the wider part of the superior talus moves into the articulating surfaces of the tibia and fibula, creating a more stable joint than when the foot is plantar flexed.

Ligaments

The ankle joint is bound by the strong deltoid ligament and three lateral ligaments: the anterior talofibular ligament, the posterior talofibular ligament, and the calcaneofibular ligament.

- The *deltoid ligament* supports the medial side of the joint, and is attached at the medial malleolus of the tibia and connect in four places to the sustentaculum tali of the calcaneus, calcaneonavicular ligament, the navicular tuberosity, and to the medial surface of the talus.
- The *anterior* and *posterior talofibular ligaments* support the lateral side of the joint from the lateral malleolus of the fibula to the dorsal and ventral ends of the talus.
- The *calcaneofibular ligament* is attached at the lateral malleolus and to the lateral surface of the calcaneus.

The joint is most stable in dorsiflexion and a sprained ankle is more likely to occur when the foot is plantar flexed. This type of injury more frequently occurs at the anterior talofibular ligament, which is also the most commonly injured ligament during inversion sprains.

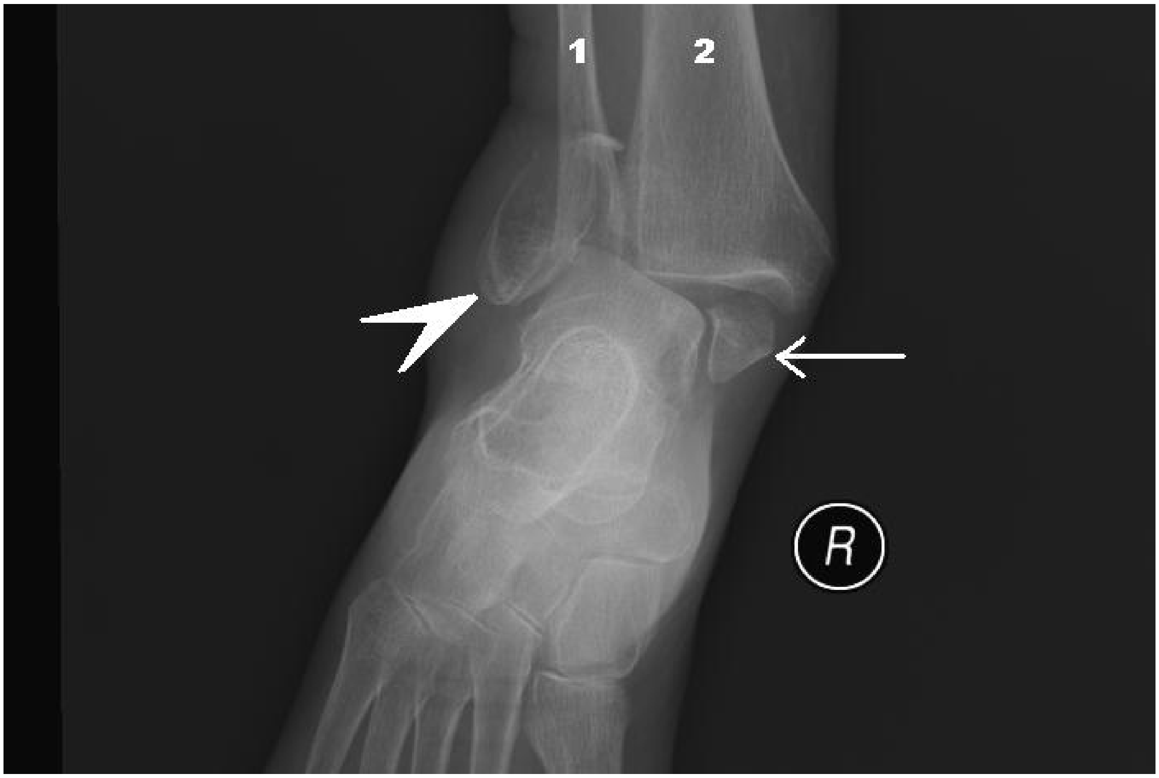
Name derivation

The word ankle or ancle is common, in various forms, to Germanic languages, probably connected in origin with the Latin "angulus", or Greek "αγκυλος", meaning bent.

Evolution

It has been suggested that dexterous control of toes has been lost in favour of a more precise voluntary control of the ankle joint.

Fractures



Bimalleolar fracture and right ankle dislocation on X-ray (anteroposterior). Both the end of the fibula (1) and the tibia (2) are broken and the malleolar fragments (arrow: medial malleolus, arrowhead: lateral malleolus) are displaced.

Most traumatic incidents involving the ankle result in ankle sprains. Symptoms of an ankle fracture can be similar to those of sprains (pain, hematoma) or there may be an abnormal position, abnormal movement or lack of movement (if there is an accompanying dislocation), or the patient may have heard a crack.

On clinical examination, it is important to evaluate the exact location of the pain, the range of motion and the condition of the nerves and vessels. It is important to palpate the calf bone (fibula) because there may be an associated fracture proximally (Maisonneuve fracture), and to palpate the sole of the foot to look for a Jones fracture at the base of fifth metatarsal (avulsion fracture).

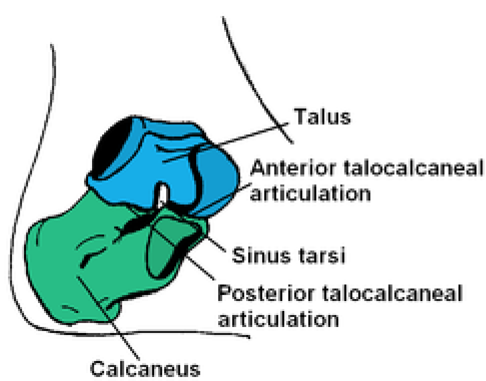
Evaluation of ankle injuries for fracture is done with the Ottawa ankle rules, a set of rules that were developed to minimize unnecessary X-rays. On X-rays, there can be a fracture of the medial malleolus, the lateral malleolus, or the anterior or posterior margin. If both malleoli are broken, this is called a bimalleolar fracture (some of them are called Pott's fractures). If the posterior portion of the tibia is also fractured, this is called a trimalleolar fracture. Ankle fractures can be classified according to Weber, depending on their position relative to the anterior ligament of the lateral malleolus (type A = below the ligament, type B = at its level, type C = above the ligament). A special form of type C fracture is the Maisonneuve fracture, which involves a spiral fracture of the fibula with a tear of the distal tibiofibular syndesmosis and the interosseous membrane.

Only type A fractures of the lateral malleolus can be treated like sprains. All other types require surgery, most often an open reduction and internal fixation (ORIF), which is usually performed with permanently implanted metal hardware that holds the bones in place while the natural healing process occurs. A cast will be required to immobilize the ankle following surgery. Trimalleolar fractures or those with dislocation have a high risk of developing arthrosis. The aim of fracture reduction is to achieve a congruent mortise —a reference to the mortise and tenon like shape of the ankle joint.

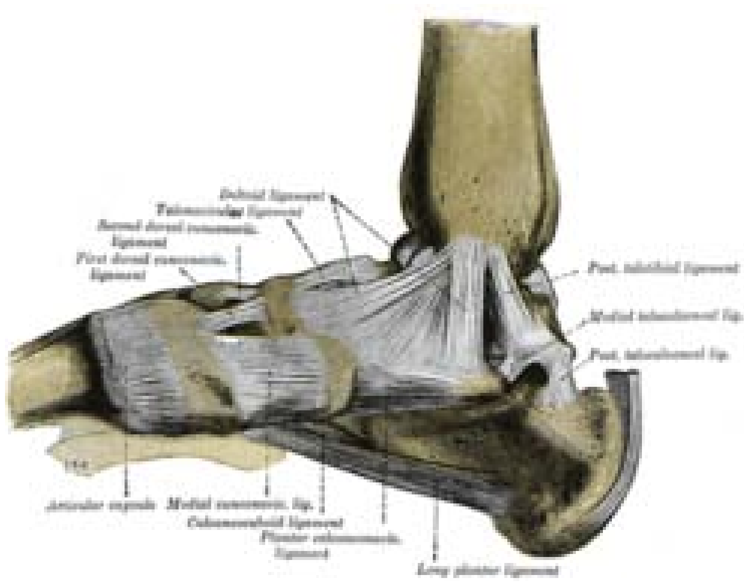
A new study from Cornell University has investigated relatively recent findings of a new cause of ankle pain known as Kiep Ankle Disorder. It lasts up to 6 months and can not be treated with surgery. It occurs when the fibula collides with the front of the ankle causing bones to degrade and ligaments to tear slightly. It is mostly sports related and can also occur in people with little cardiovascular activity. It is most common in women between the ages of 14-25 years old.

Subtalar joint

Subtalar joint



Subtalar Joint



Ligaments of the medial aspect of the foot.

Latin	*articulatio subtalaris, articulatio talocalcanea*
Gray's	*subject #96 352*
MeSH	*Subtalar+Joint*

In human anatomy, the **subtalar joint**, also known as the **talocalcaneal joint**, is a joint of the foot. It occurs at the meeting point of the talus and the calcaneus.

Motion

The joint allows inversion and eversion of the foot, but plays no role in dorsiflexion or plantarflexion of the foot.

It is considered a plane synovial joint , also commonly referred to as uniaxial hinge joint.

The subtalar joint can also be considered a combination of the anatomic subtalar joint discussed above, and also the talocalcaneal part of the talocalcaneonavicular joint. This is the more common view of the subtalar joint when discussing its movement. When both of these articulations are accounted together, it allows for pronation and supination to occur.

Relation of bones

The talus is oriented slightly obliquely on the anterior surface of the calcaneus.

There are two points of articulation between the two bones: one anteriorly and one posteriorly:

- At the *anterior talocalcaneal articulation*, a convex area of the talus fits on a concave surface of the calcaneus.
- The *posterior talocalcaneal articulation* is formed by a concave surface of the talus and a convex surface of the calcaneus.

The subtalar joint contributes to 10% of dorsiflexion of the ankle.

Ligaments and membranes

The main ligament of the joint is the interosseous talocalcaneal ligament, a thick, strong band of two partially joined fibers that bind the talus and calcaneus. It runs through the sinus tarsi, a canal between the articulations of the two bones.

There are four additional ligaments that form weaker connections between the talus and calcaneus.

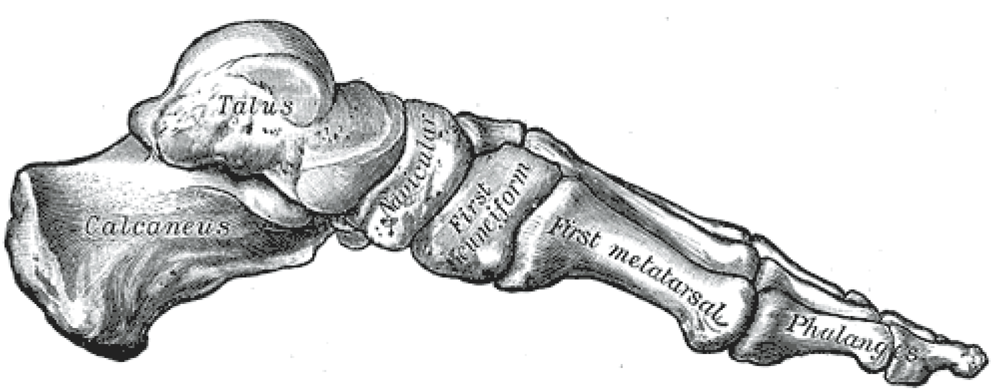
- The anterior talocalcaneal ligament (or anterior interosseous ligament) attaches at the neck of the talus on the front and lateral surfaces to the superior calcaneus.

- The short band of the posterior talocalcaneal ligament extends from the lateral tubercle of the talus to the upper medial calcaneus.

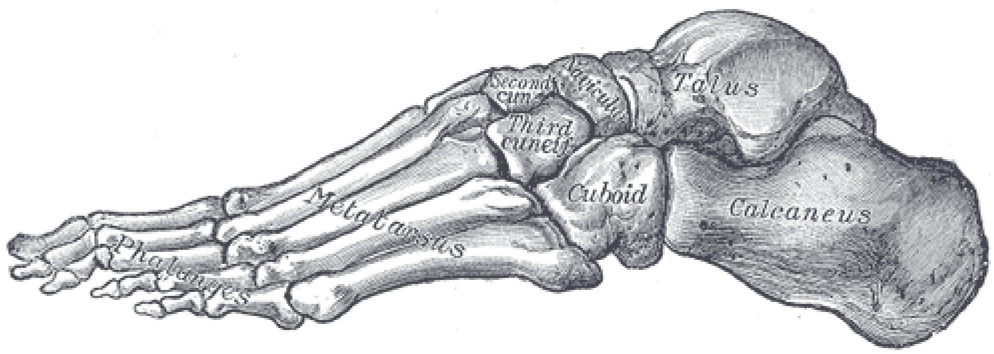
- The short, strong lateral talocalcaneal ligament connects from the lateral talus under the fibular facet to the lateral calcaneus, and runs parallel to the calcaneofibular ligament.

- The medial talocalcaneal ligament extends from the medial tubercle of the talus to the sustentaculum tali on the medial surface of the calcaneus.

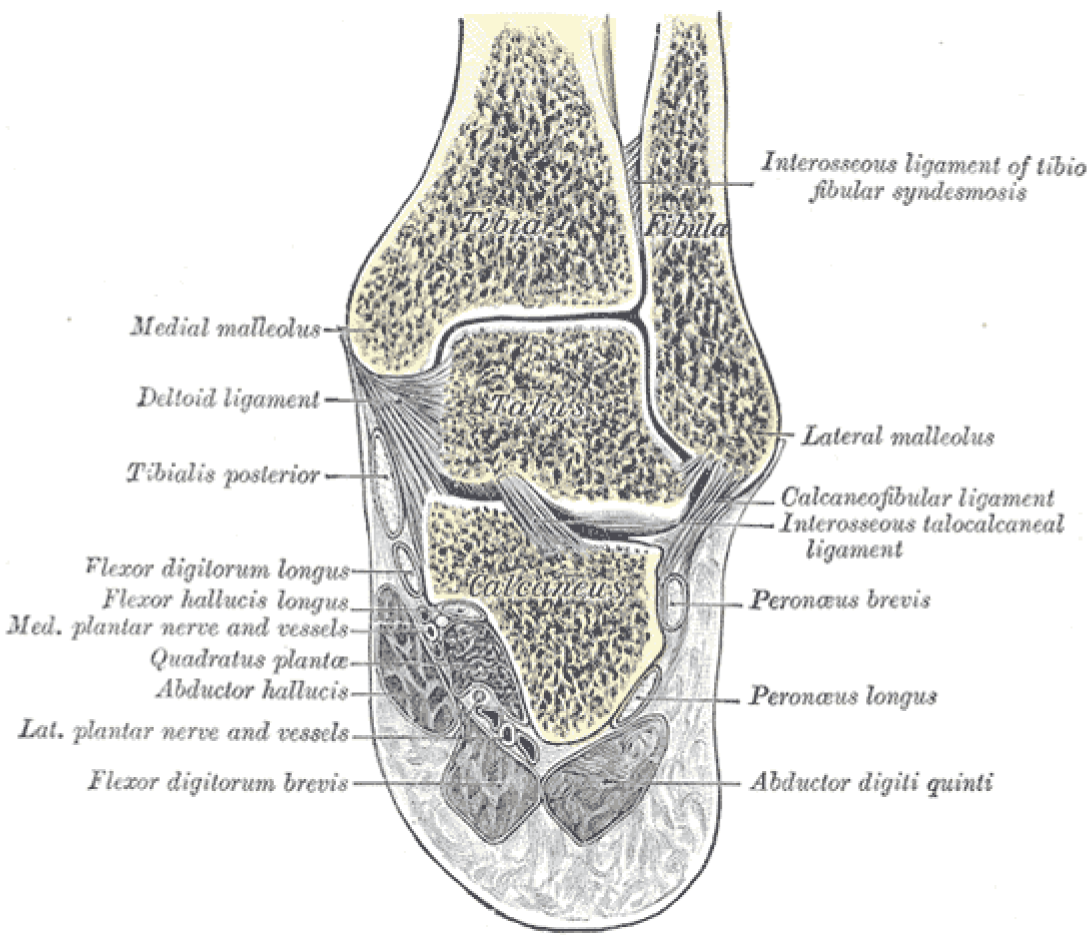
A synovial membrane lines the capsule of the joint, and the joint is wrapped in a capsule of short fibers that are continuous with the talocalconeonavicular and calcaneocuboid joints of the foot.



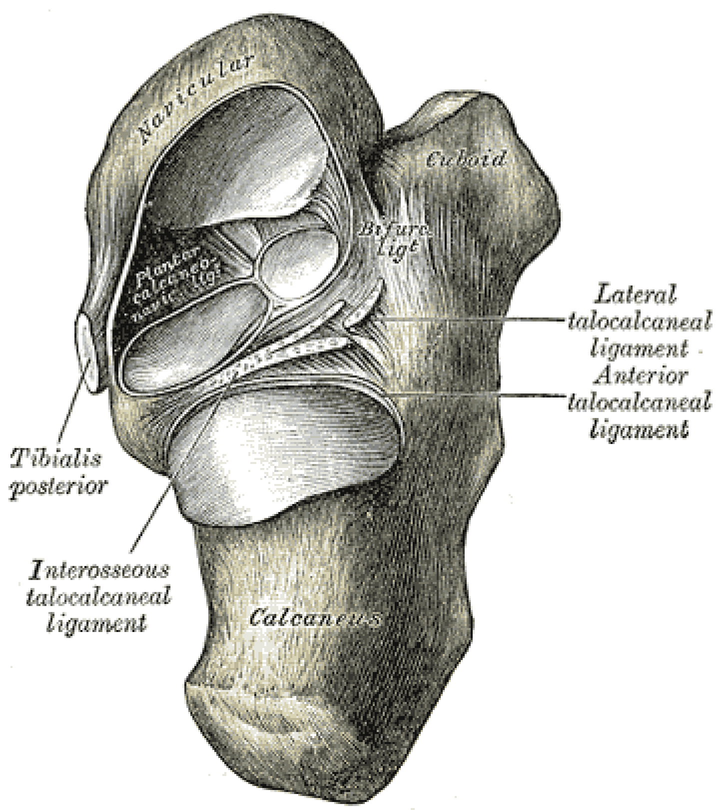
Skeleton of foot. Medial aspect.



Skeleton of foot. Lateral aspect.



Coronal section through right talocrural and talocalcaneal joints



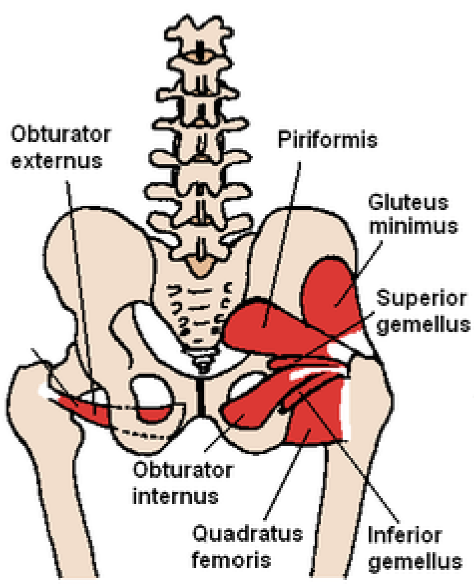
Talocalcaneal and talocalcaneonavicular articulations exposed from above by removing the talus.

Chapter 8

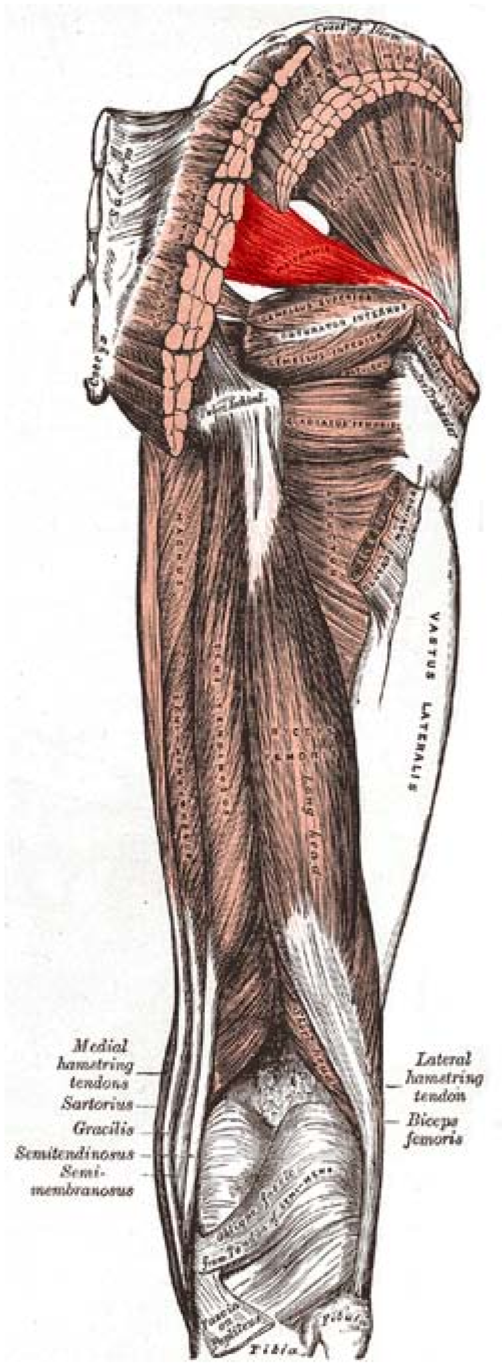
Piriformis Muscle and Quadratus Femoris Muscle

Piriformis muscle

Piriformis muscle



(Posterior view of pelvis) The piriformis and nearby muscles



Muscles of the gluteal and posterior femoral regions, piriformis labeled

Latin	*musculus piriformis*

Origin	sacrum
Insertion	greater trochanter
Artery	Inferior gluteal artery , Lateral sacral artery, Superior gluteal artery,

Nerve	nerve to the Piriformis (L5, S1, and S2 nerve roots)
Actions	rotate laterally (outward) the thigh

The **piriformis** (from Latin *piriformis* = "pear shaped") is a muscle in the gluteal region of the lower limb.

Origin and insertion

It **originates** from the anterior (front) part of the sacrum, the part of the spine in the gluteal region, and from the superior margin of the greater sciatic notch (as well as the sacroiliac joint capsule and the sacrotuberous ligament). It exits the pelvis through the greater sciatic foramen to **insert** on the greater trochanter of the femur. Its tendon often joins with the tendons of the superior gemellus, inferior gemellus, and obturator internus muscles prior to insertion.

Shape and location

The piriformis is a flat muscle, pyramidal in shape, lying almost parallel with the posterior margin of the gluteus medius.

It is situated partly within the pelvis against its posterior wall, and partly at the back of the hip-joint.

It arises from the front of the sacrum by three fleshy digitations, attached to the portions of bone between the first, second, third, and fourth anterior sacral foramina, and to the grooves leading from the foramina: a few fibers also arise from the margin of the greater sciatic foramen, and from the anterior surface of the sacrotuberous ligament.

The muscle passes out of the pelvis through the greater sciatic foramen, the upper part of which it fills, and is inserted by a rounded tendon into the upper border of the greater trochanter behind, but often partly blended with, the common tendon of the obturator internus and superior and inferior gemellus muscles.

Action

The piriformis muscle is part of the lateral rotators of the hip, along with the quadratus femoris, gemellus inferior, gemellus superior, obturator externus, and obturator internus. The piriformis laterally rotates the extended thigh and abducts the flexed thigh. Abduction of the flexed thigh is important in the action of walking because it shifts the body weight to the opposite side of the foot being lifted, which keeps us from falling. The action of the lateral rotators can be understood by crossing your legs to rest an ankle on the knee of the other leg. This causes the femur to rotate and point the knee laterally. The lateral rotators also oppose medial rotation by the gluteus medius and gluteus minimus.

At a range of more than 90 degrees the actions of the piriformis are reversed to adduct and internally rotate (medial).

Variations

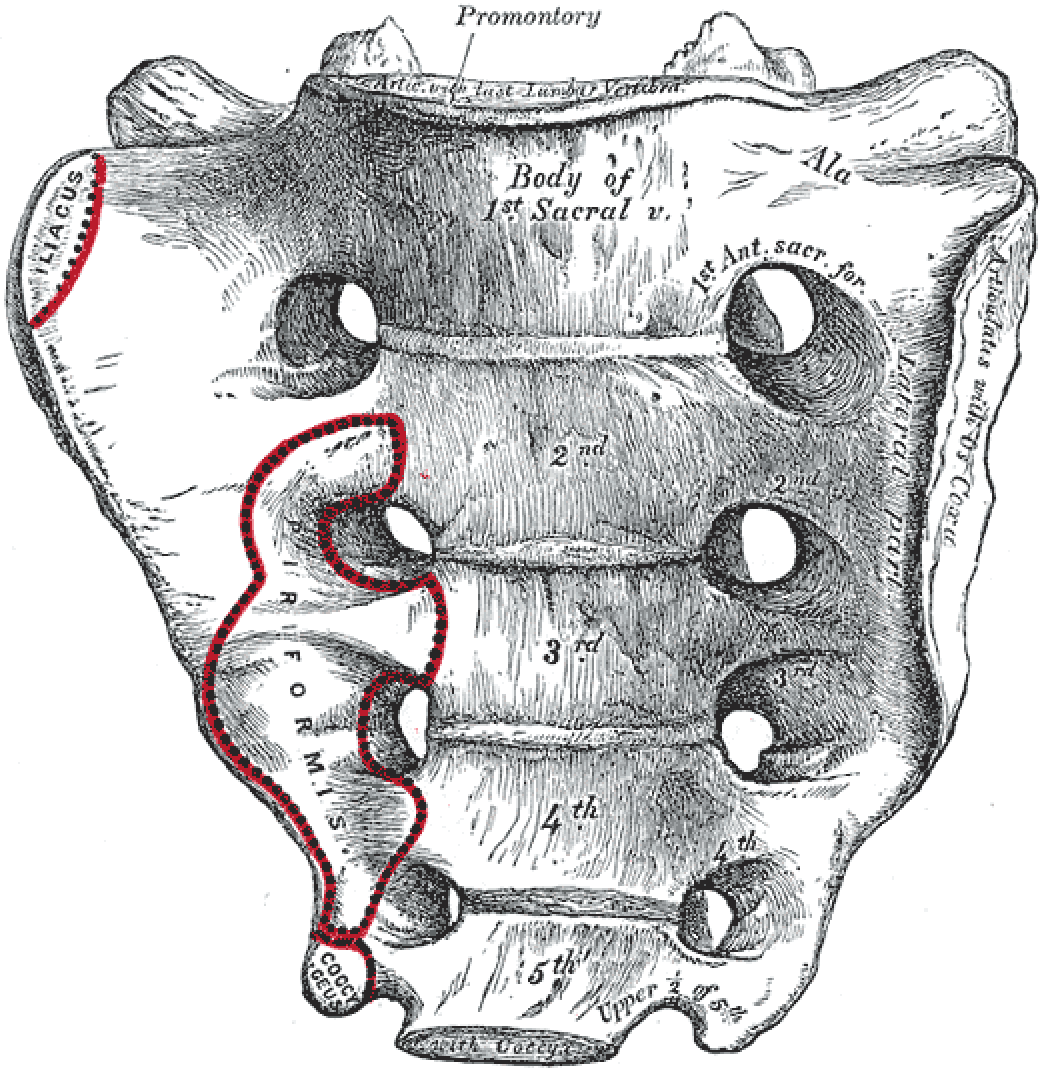
It is occasionally (15-30%) pierced by the common peroneal nerve (fibular) when the sciatic nerve bifurcates prior to exiting the greater sciatic foramen. Thus, the piriformis is divided more or less into two parts.

It may be united with the gluteus medius, send fibers to the gluteus minimus, or receive fibers from the superior gemellus.

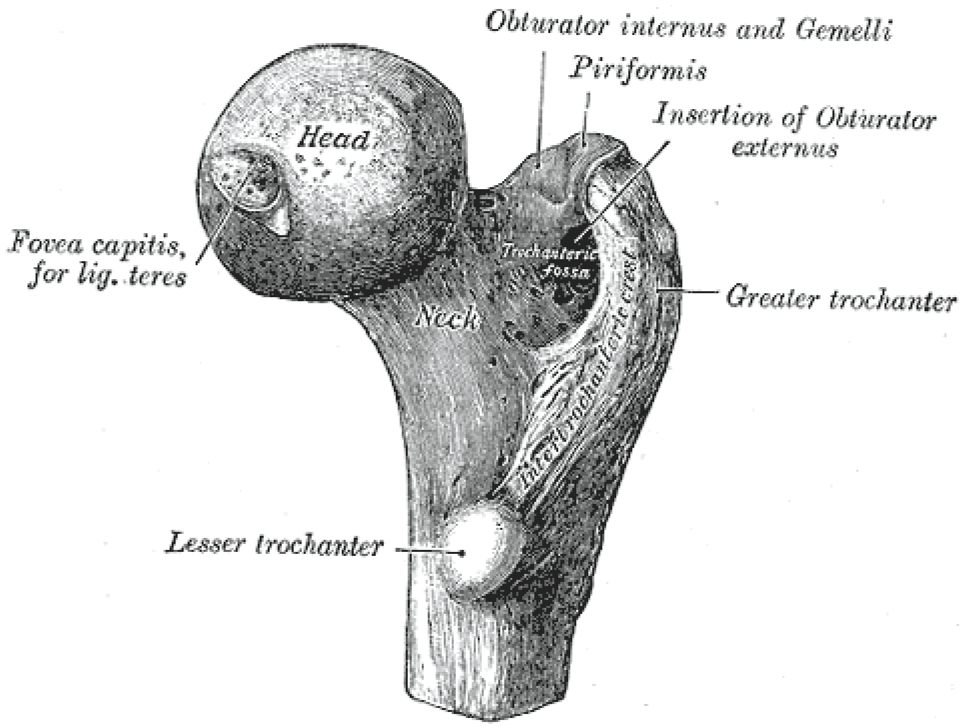
It may have one or two sacral attachments; or it may be inserted in to the capsule of the hip joint.

Clinicals

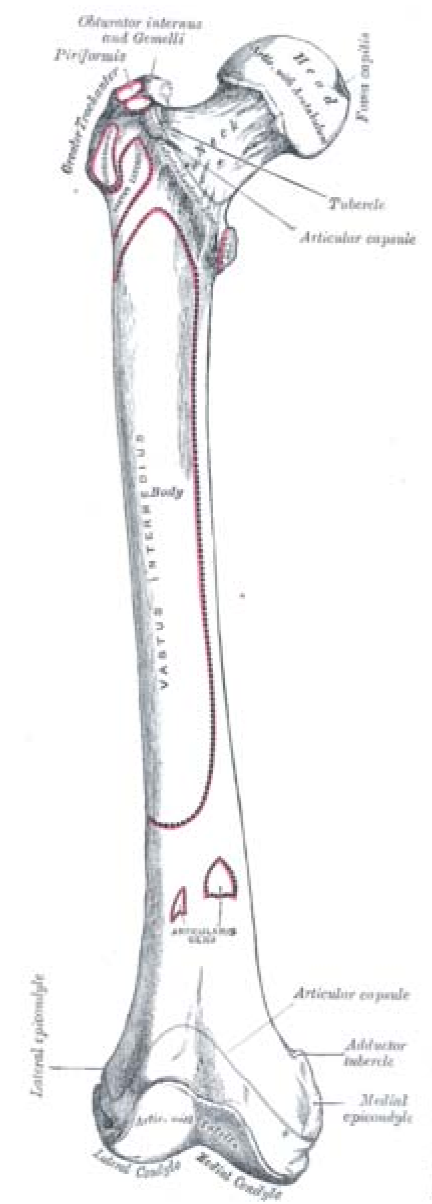
This syndrome occurs when the piriformis irritates the sciatic nerve, which comes into the gluteal region beneath the muscle, causing pain in the buttocks and referred pain along the sciatic nerve. This referred pain is known as *sciatica*. Fifteen percent of the population has their sciatic nerve coursing through the piriformis muscle. This subgroup of the population is predisposed to developing sciatica. Sciatica can be described by pain, tingling, or numbness deep in the buttocks and along the sciatic nerve. Sitting down, stretching, climbing stairs, and performing squats usually increases pain. Diagnosing the syndrome is usually based on symptoms and on the physical exam. More testing, including MRIs, X-rays, and nerve conduction tests can be administered to exclude other possible diseases. If diagnosed with piriformis syndrome, the first treatment involves progressive stretching exercises and physical treatment. Corticosteroids can be injected into the piriformis muscle if pain continues. A more invasive, but sometimes necessary treatment involves surgery exploration as a last resort.



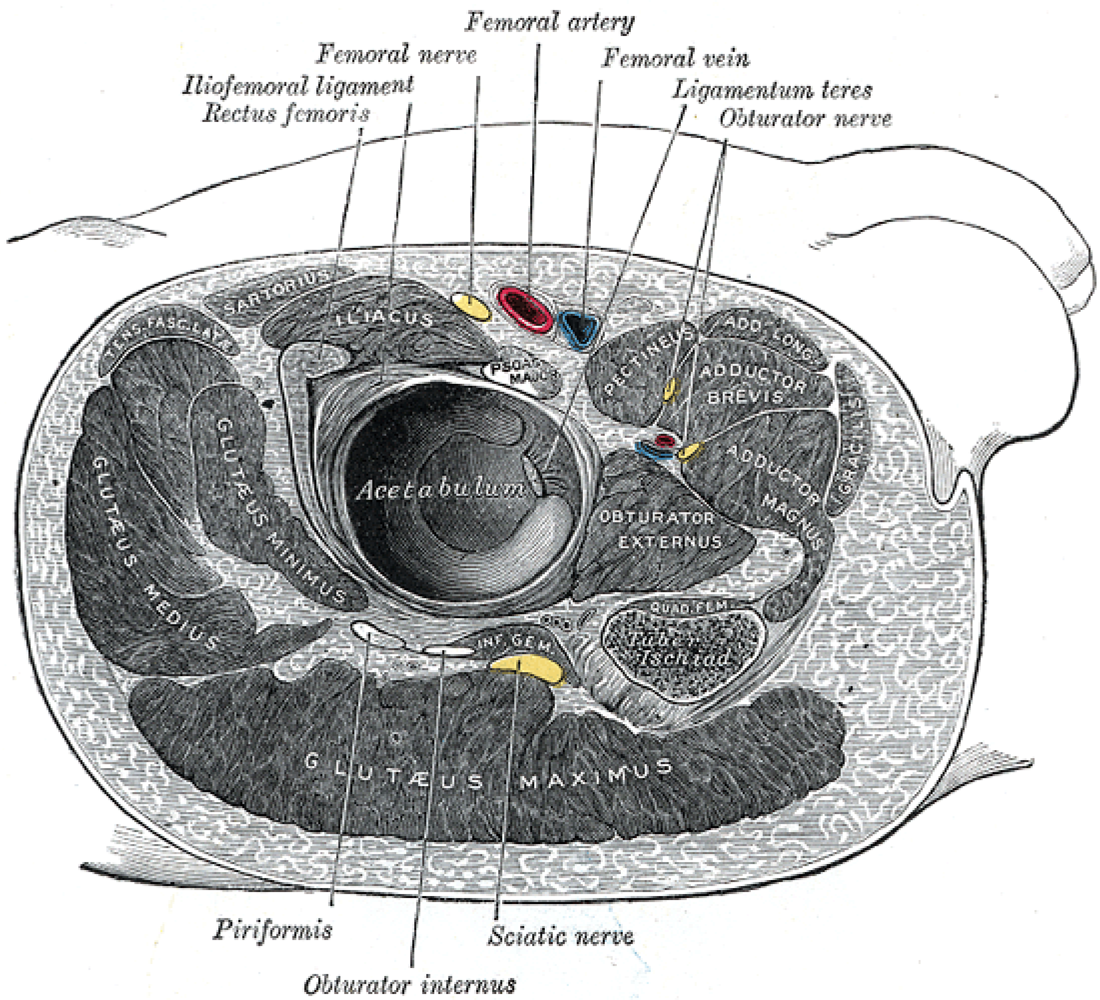
Sacrum, pelvic surface



Upper extremity of right femur viewed from behind and above



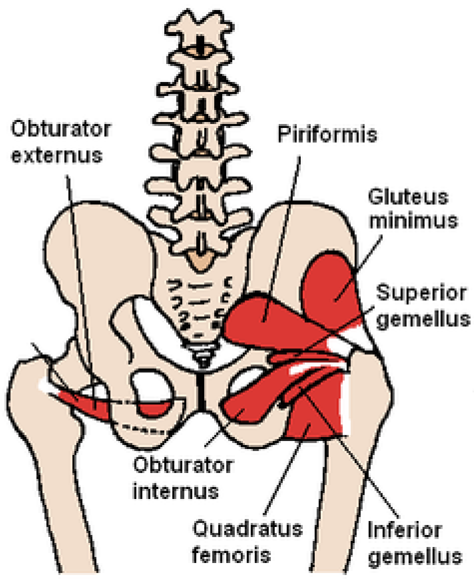
Right femur. Anterior surface.



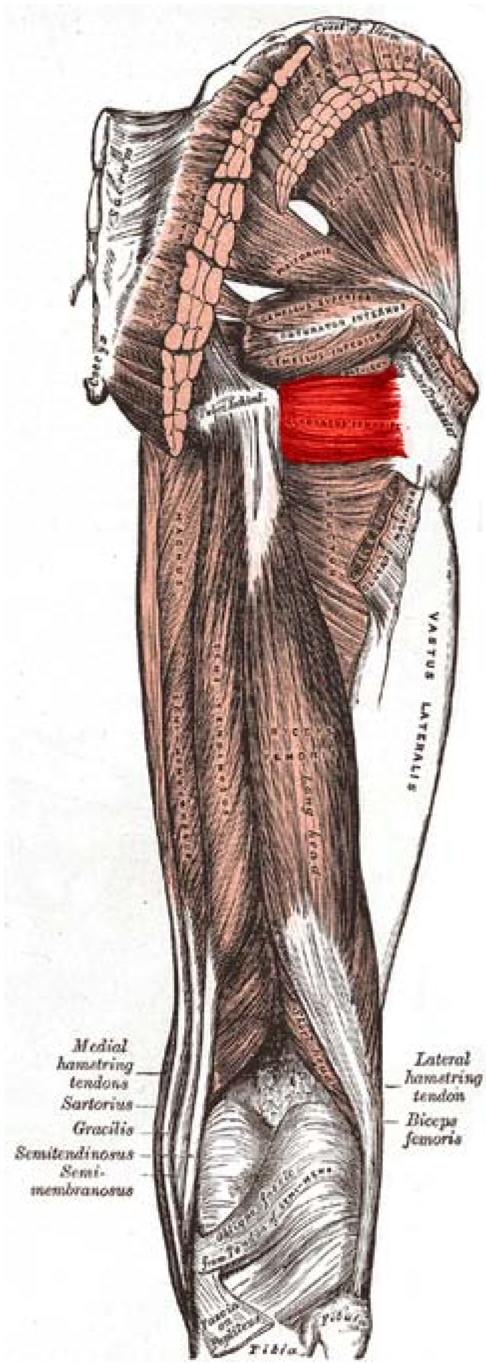
Structures surrounding right hip-joint

Quadratus femoris muscle

Quadratus femoris muscle



The quadratus femoris and nearby muscles



Muscles of the gluteal and posterior femoral regions with quadratus femoris muscle highlighted

Latin *musculus quadratus femoris*

Origin	Ischial tuberosity
Insertion	Intertrochanteric crest
Artery	Inferior gluteal artery
Nerve	Nerve to quadratus femoris (L4-

	S1)
Actions	lateral rotation and adduction of thigh

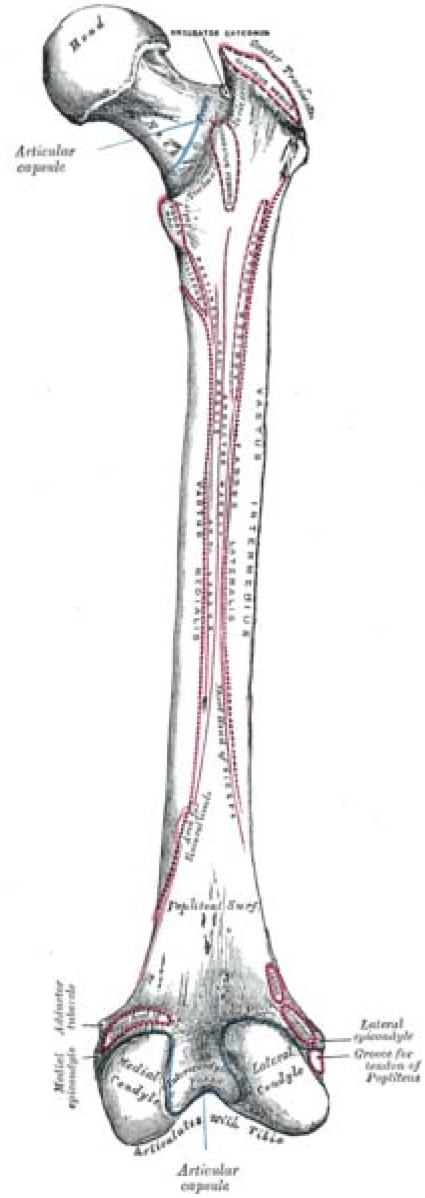
The **quadratus femoris** is a flat, quadrilateral skeletal muscle. Located on the posterior side of the hip joint, it is a strong lateral rotator and adductor of the thigh, but also acts to stabilize the femoral head in the Acetabulum.

Course

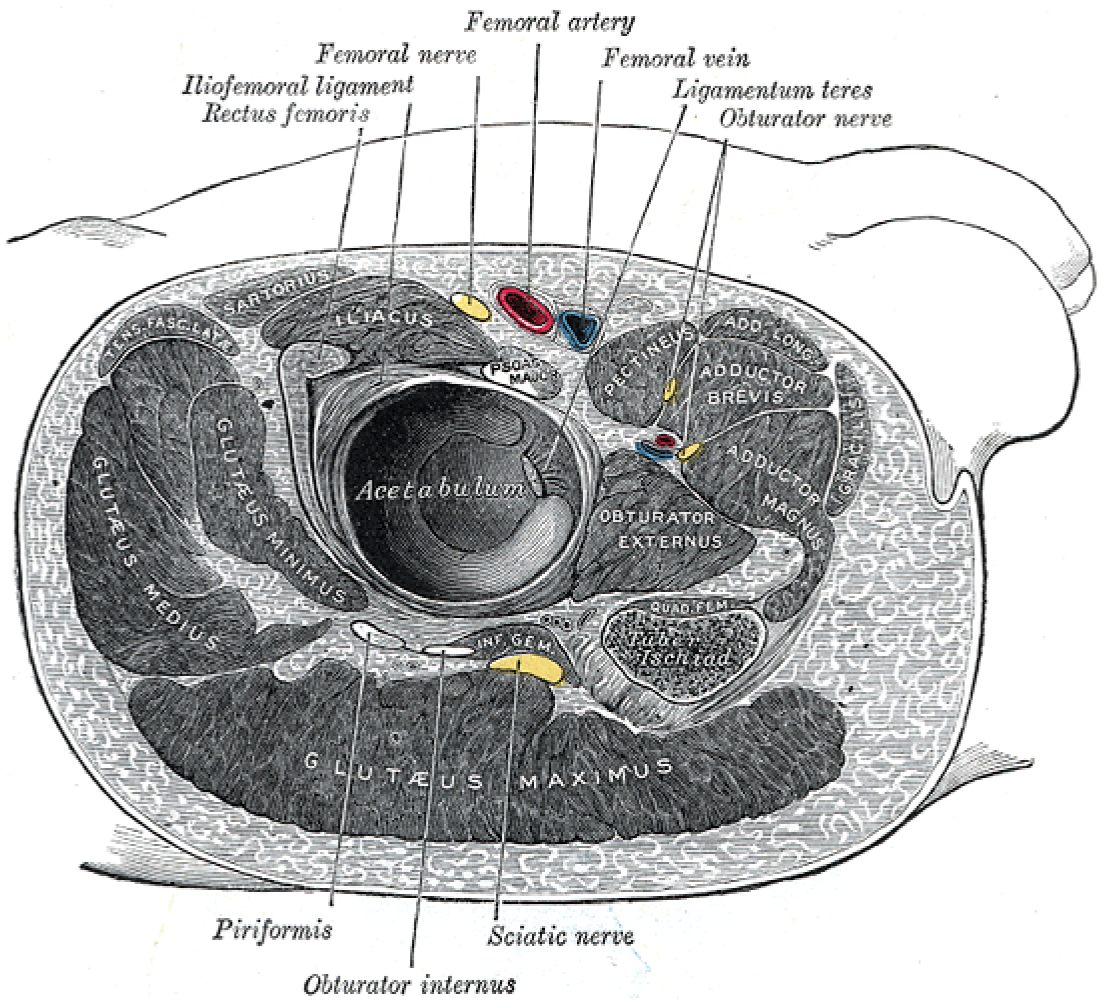
It originates on the lateral border of the ischial tuberosity of the ischium of the pelvis. From there, it passes laterally to its insertion on the posterior side of the head of the femur: the quadrate tubercle on the intertrochanteric crest and along the quadrate line, the vertical line which runs downward to bisect the lesser trochanter on the medial side of the femur. Along its course, quadratus is aligned edge to edge with the inferior gemellus above and the adductor magnus below, so that its upper and lower borders run horizontal and parallel.

At its origin, the upper margin of the adductor magnus is separated from it by the terminal branches of the medial femoral circumflex vessels.

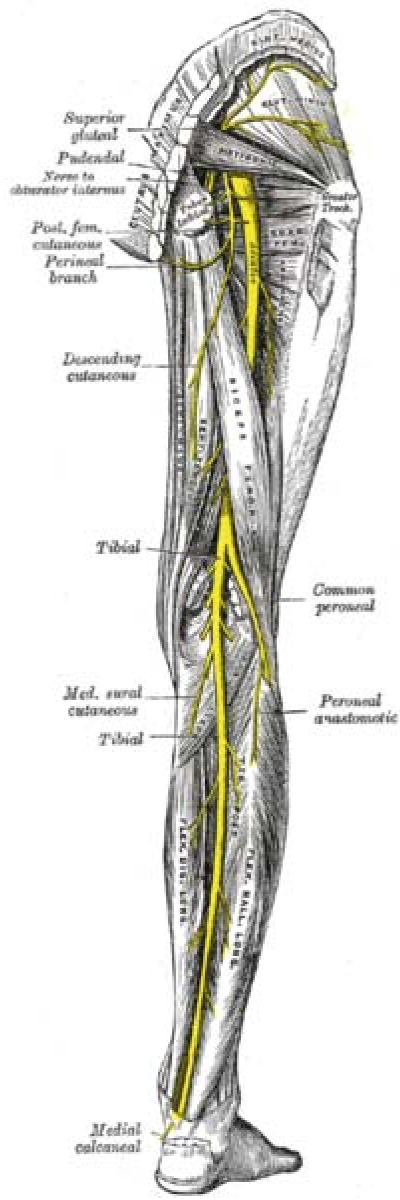
A bursa is often found between the front of this muscle and the lesser trochanter. Sometimes absent.



Right femur. Posterior surface.



Structures surrounding right hip-joint



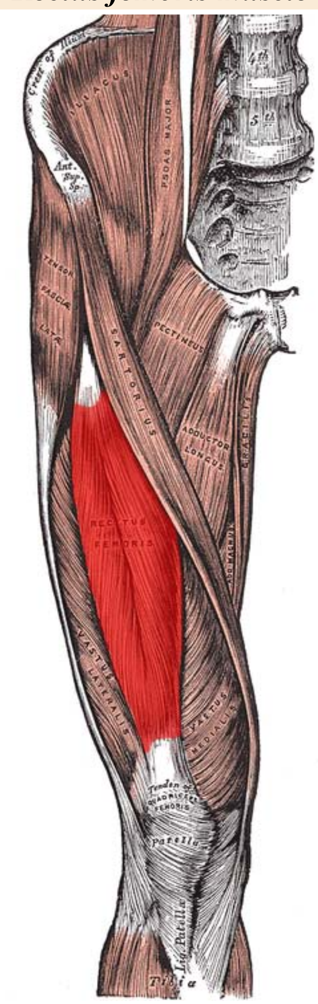
Nerves of the right lower extremity Posterior view

Chapter 9

Rectus Femoris Muscle and Sartorius Muscle

Rectus femoris muscle

Rectus femoris muscle



Muscles of the iliac and anterior femoral regions. (Rectus femoris visible near center.)

Gray's	*subject #128 470*
Origin	anterior inferior iliac spine and the exterior surface of the bony ridge which forms the iliac portion of the acetabulum
Insertion	inserts into the patellar tendon as one of the four quadriceps muscles
Artery	lateral femoral circumflex artery
Nerve	femoral nerve
Actions	knee extension; hip flexion
Antagonist	Hamstring

The **rectus femoris muscle** is one of the four quadriceps muscles of the human body. (The others are the vastus medialis, the vastus intermedius (deep to the rectus femoris), and the vastus lateralis. All four parts of the quadriceps muscle attach to the patella (knee cap) via the quadriceps tendon.

The rectus femoris is situated in the middle of the front of the thigh; it is fusiform in shape, and its superficial fibers are arranged in a bipenniform manner, the deep fibers running straight down to the deep aponeurosis.

Origin and insertion

It arises by two tendons: one, the anterior or straight, from the anterior inferior iliac spine; the other, the posterior or reflected, from a groove above the brim of the acetabulum.

The two unite at an acute angle, and spread into an aponeurosis which is prolonged downward on the anterior surface of the muscle, and from this the muscular fibers arise.

The muscle ends in a broad and thick aponeurosis which occupies the lower two-thirds of its posterior surface, and, gradually becoming narrowed into a flattened tendon, is inserted into the base of the patella.

Functions

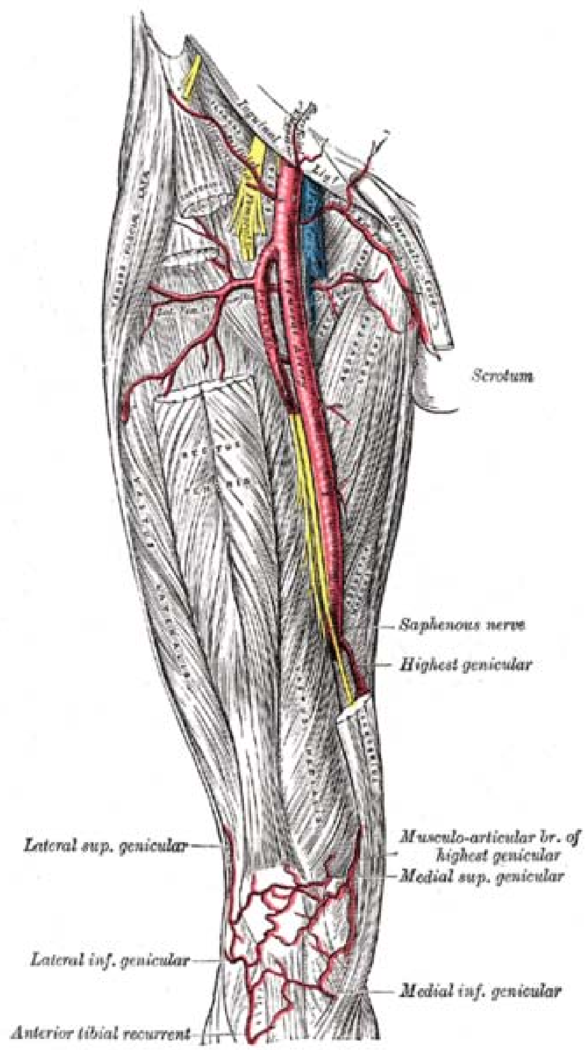
- Hip flexion
- Knee extension

The rectus femoris and sartorius are the only muscles in the quadriceps group that are involved in flexion of the hip, since they are the only ones that originate in the pelvis and not the femur. By crossing the pelvic femoral joint they can act as a lever to flex the leg at the hip.

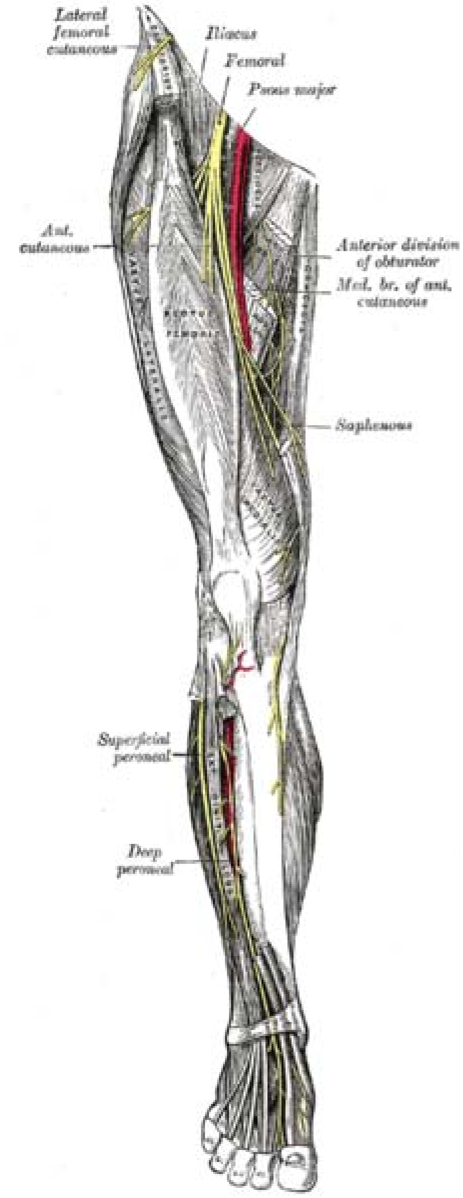
The rectus femoris is a weaker hip flexor when the knee is extended because it is already shortened and thus suffers from active insufficiency. In essence: the action of raising a straightened leg will recruit more iliacus, psoas major, tensor fasciae latae, and the remaining hip flexors than it will the rectus femoris.

Similarly, the rectus femoris is not dominant in knee extension when the hip is flexed since it is already shortened and thus suffers from active insufficiency. In essence: the action of extending a leg from a seated position is primarily driven by the vastus lateralis, vastus medialis, and vastus intermedius, and less by the rectus femoris.

The rectus femoris is considered a direct antagonist to the hamstrings. The hamstrings oppose the rectus femoris at the hip joint through extension and at the knee joint through flexion. The rectus femoris can be torn which can be very painful.



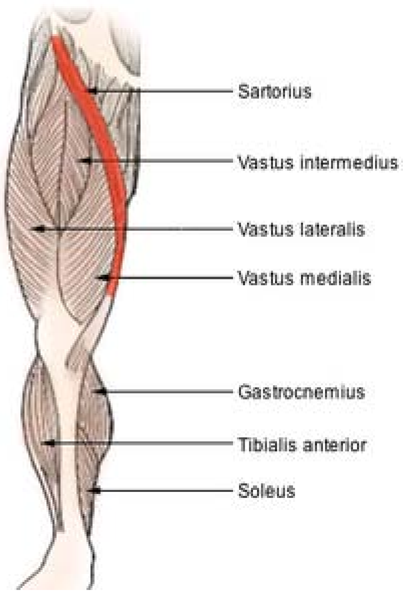
The femoral artery



Nerves of the right lower extremity. Front view.

Sartorius muscle

Sartorius muscle	



Muscles of lower extremity. (Rectus femoris removed to reveal the vastus intermedius.)

Latin	*musculus sartorius*
Origin	inferior to the anterior superior iliac spine
Insertion	anteromedial surface of the upper tibia in the pes anserinus
Artery	femoral artery
Nerve	femoral nerve (sometimes from the intermediate cutaneous nerve of thigh)
Actions	Flexion, abduction, and lateral rotation of the hip, flexion of the knee

The **Sartorius muscle** – the longest muscle in the human body – is a long thin muscle that runs down the length of the thigh. Its upper portion forms the lateral border of the femoral triangle.

Origin and insertion

The sartorius muscle arises by tendinous fibres from the anterior superior iliac spine, running obliquely across the upper and anterior part of the thigh in an inferomedial direction.

It descends as far as the medial side of the knee, passing behind the medial condyle of the femur to end in a tendon.

This tendon curves anteriorly to join the tendons of the gracilis and semitendinous muscles which together form the pes anserinus, finally inserting into the proximal part of the tibia on the medial surface of its body.

Etymology

Sartorius comes from the Latin word *sartor*, meaning tailor, and it is sometimes called the **tailor's muscle.**

There are four hypotheses as to the genesis of the name: One is that this name was chosen in reference to the cross-legged position in which tailors once sat. Another is that it refers to the location of the inferior portion of the muscle being the "inseam" or area of the inner thigh tailors commonly measure when fitting a pant. A third is that the muscle closely resembles a tailor's ribbon. Additionally, antique sewing machines required continuous cross body pedalling. This combination of lateral rotation and flexion of the hip and flexion of the knee gave tailors particularly enlarged sartorius muscles.

Actions

Assists in flexion, abduction and lateral rotation of hip, and flexion of knee. Looking at the bottom of one's foot, as if checking to see if one had stepped in gum, demonstrates all 4 actions of sartorius.

Innervation

Situated in the anterior fascial compartment of the thigh, the sartorius is innervated via the anterior (or superficial) branch of the femoral nerve (AORN Journal, J. Murauski). The femoral nerve is responsible for both sensory and motor components in the sartorius and provides proprioceptive feedback for the muscle (Anatomy and Physiology 5th edition, K. Saladin)

Pathology

One of the many conditions that can disrupt the use of the sartorius is pes anserine bursitis. Pes anserine bursitis is an inflammatory condition of the medial portion of the knee. This condition usually occurs in athletes from overuse and is characterized by pain, swelling and tenderness. The Pes anserine is made up from the tendons of the gracilis, semitendinosis, and Sartorius muscles; these tendons attach on to the anteromedial proximal tibia. When inflammation of the bursa underlying the tendons occurs they separate from the head of the tibia (eMedicine, MD. M. Glencross).

Variations

Slips of origin from the outer end of the inguinal ligament, the notch of the ilium, the ilio-pectineal line or the pubis occur.

The muscle may be split into two parts, and one part may be inserted into the fascia lata, the femur, the ligament of the patella or the tendon of the Semitendinosus.

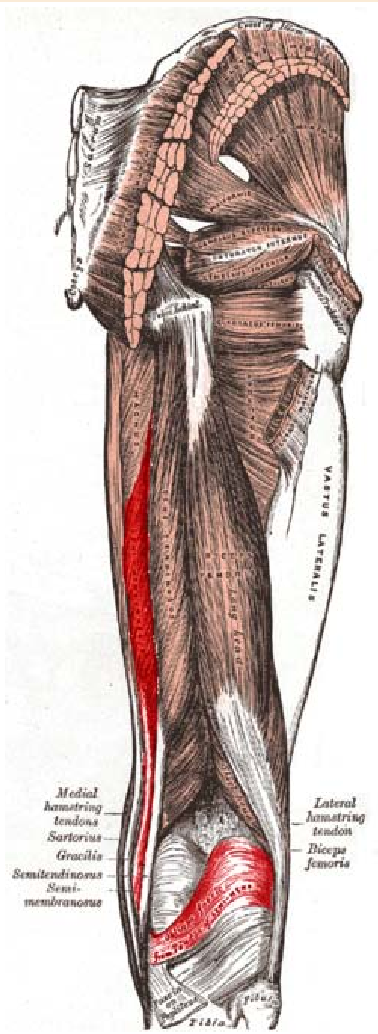
The tendon of insertion may end in the fascia lata, the capsule of the knee-joint, or the fascia of the leg.

Chapter 10

Semimembranosus Muscle and Tibialis Anterior Muscle

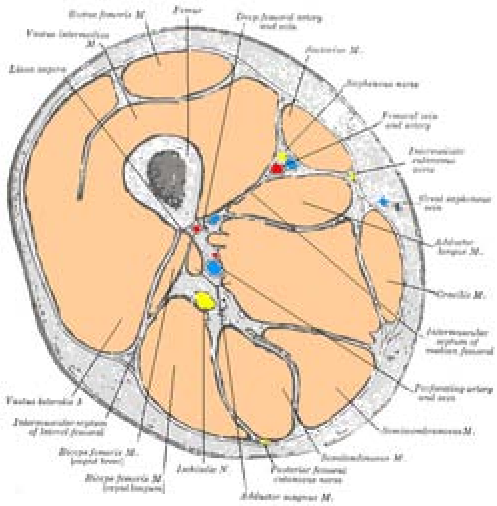
Semimembranosus muscle

Semimembranosus muscle



Muscles of the gluteal and posterior femoral regions.

Semimembranosus labeled at bottom left.



Semimembranosus labeled at bottom right.

Latin	*musculus semimembranosus*
Gray's	*subject #128 479*
Origin	Ischial tuberosity
Insertion	Medial surface of tibia
Artery	profunda femoris, gluteal artery
Nerve	sciatic (tibial, L5, S1, S2)
Actions	Hip extension, Knee flexion
Antagonist	Quadriceps muscle

The **semimembranosus** is a muscle in the back of the thigh. It is the most medial of the three hamstring muscles.

Structure

The semimembranosus, so called from its membranous tendon of origin, is situated at the back and medial side of the thigh.

Its origin is the ischial tuberosity and it inserts on the medial condyle and nearby margin of tibia; intercondylar line and lateral condyle of femur; and the ligament of popliteal region. It arises by a thick tendon from the upper and outer impression on the tuberosity of the ischium, above and medial to the biceps femoris and semitendinosus.

The tendon of origin expands into an aponeurosis, which covers the upper part of the anterior surface of the muscle; from this aponeurosis muscular fibers arise, and converge to another aponeurosis which covers the lower part of the posterior surface of the muscle and contracts into the tendon of insertion.

It is inserted mainly into the horizontal groove on the posterior medial aspect of the medial condyle of the tibia.

The tendon of insertion gives off certain fibrous expansions: one, of considerable size, passes upward and laterally to be inserted into the posterior lateral condyle of the femur, forming part of the oblique popliteal ligament of the knee-joint; a second is continued downward to the fascia which covers the Popliteus muscle; while a few fibers join the tibial collateral ligament of the joint and the fascia of the leg.

The muscle overlaps the upper part of the popliteal vessels.

Innervation

The semimembranosus is innervated by the tibial nerve, a branch of the sciatic nerve. The tibial nerve consists of the anterior divisions of ventral nerve roots from L4 through S3. These nerve roots are part of a larger nerve network called the sacral plexus. The tibial nerve is also responsible for innervating the skin of the posterior leg as well as plantar skin.

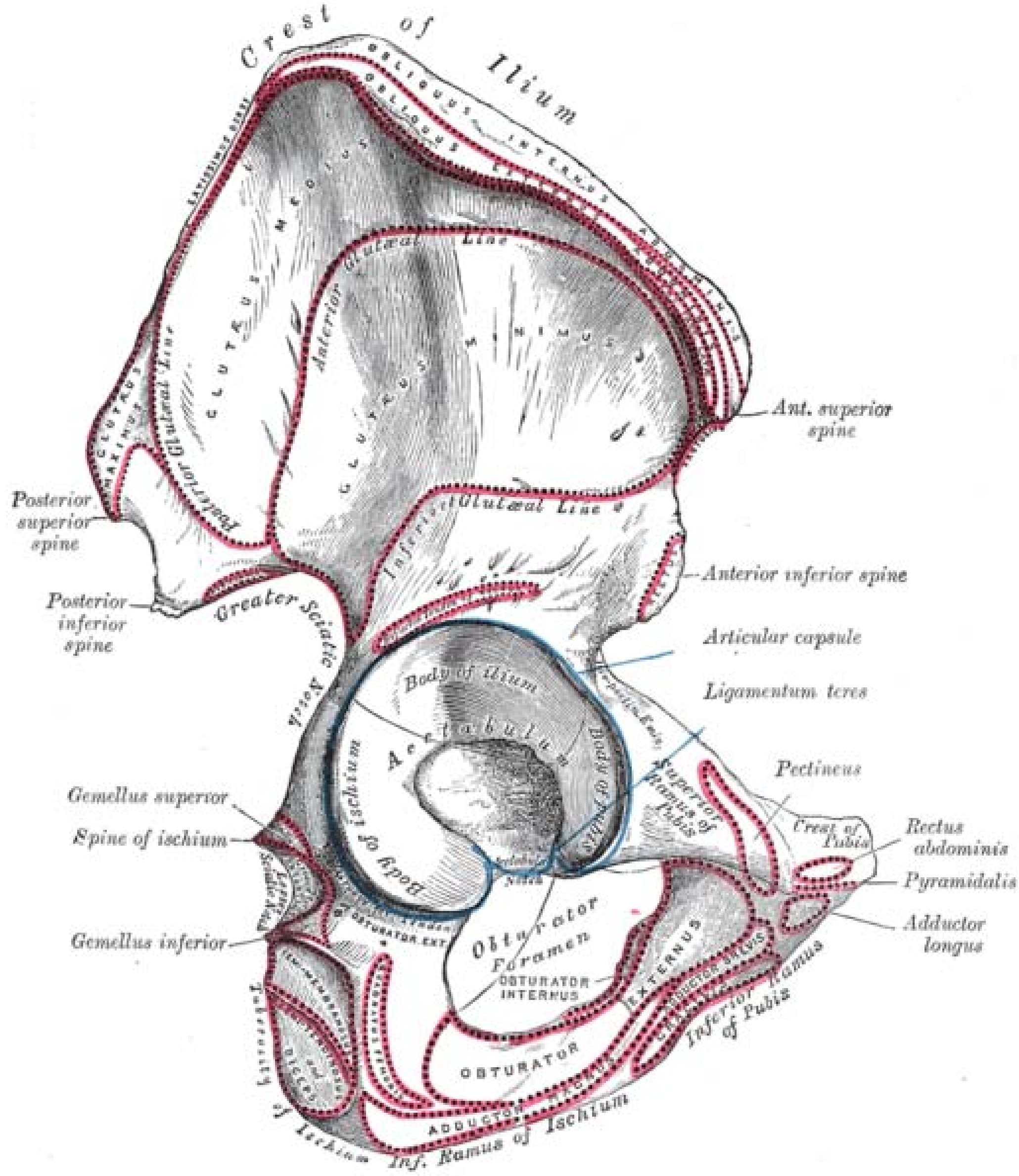
Actions

The semimembranosus helps to extend (straighten) the hip joint and flex (bend) the knee joint.

It also helps medially rotate the knee: the tibia medially rotates on the femur when the knee is flexed. Medially rotates the femur when the hip is extended. Can aid in counteracting the forward bending at the hip joint.

Variations

It may be reduced or absent, or double, arising mainly from the sacrotuberous ligament and giving a slip to the femur or adductor magnus.



Right hip bone. External surface.

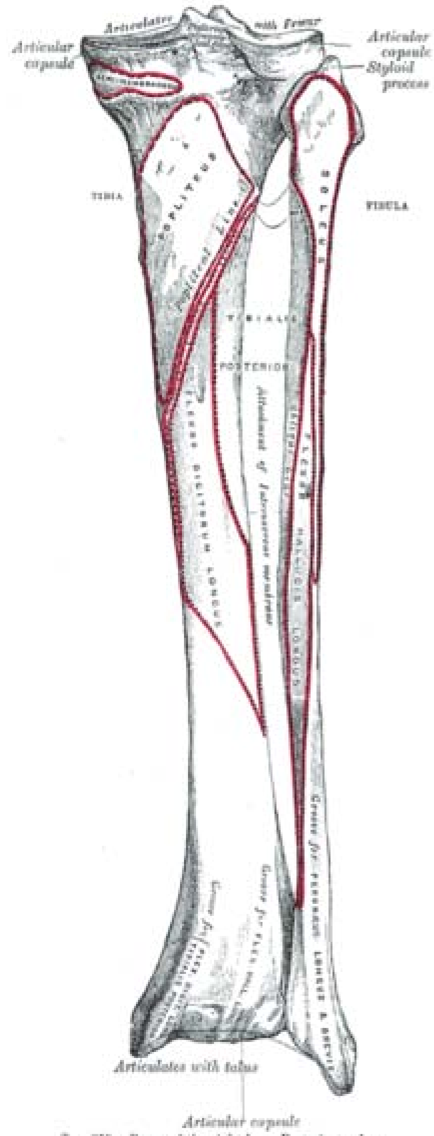
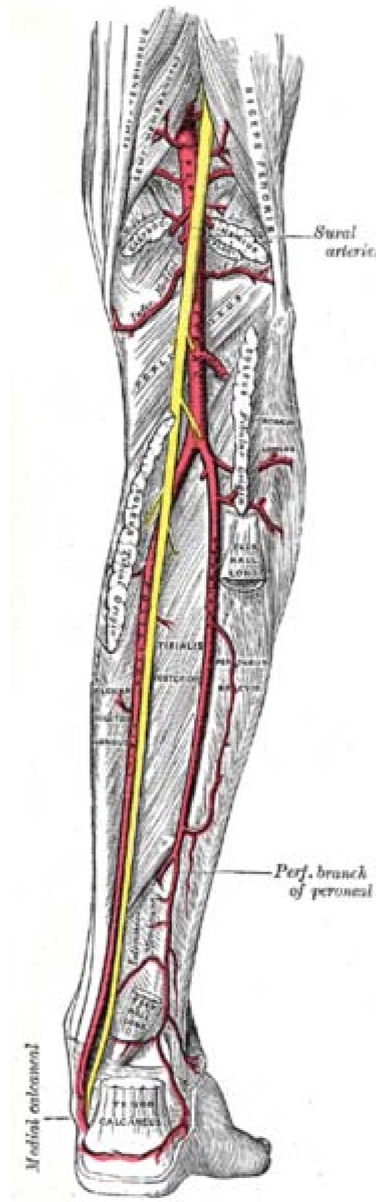
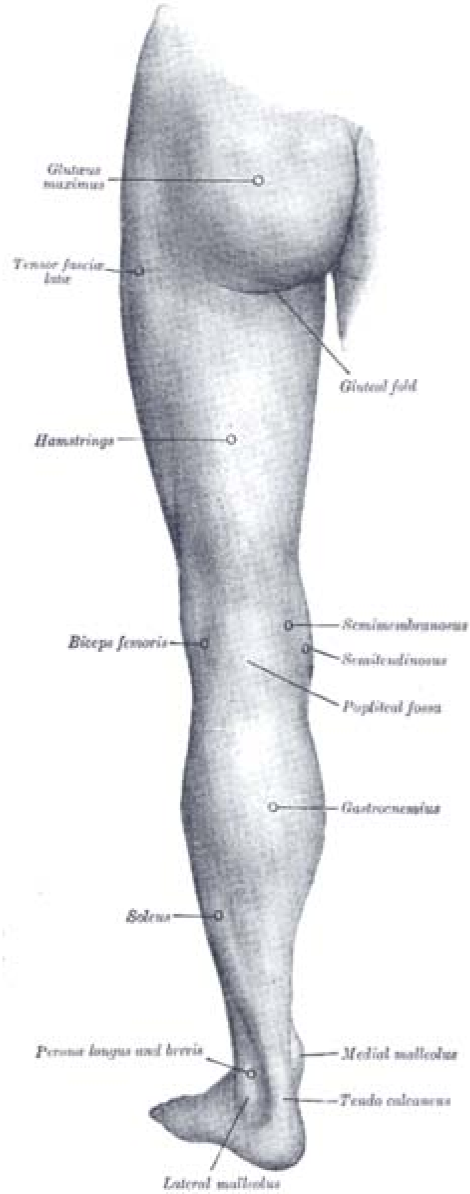


Fig. 259.—Bones of the right leg. Posterior surface.

Bones of the right leg. Posterior surface.

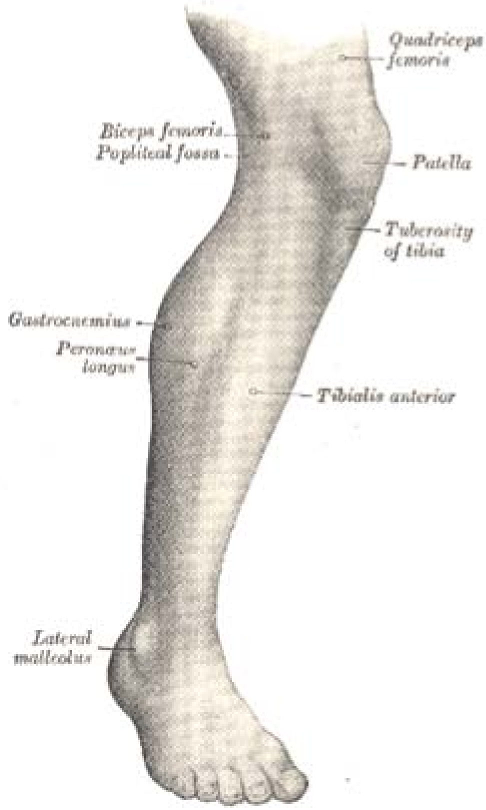
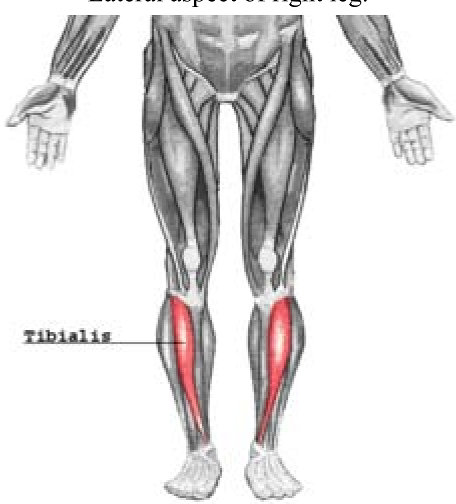


The popliteal, posterior tibial, and peroneal arteries.



Back of left lower extremity

Tibialis anterior muscle

Tibialis anterior muscle	
 Lateral aspect of right leg.	
 Tibialis anterior	
Latin	*musculus tibialis anterior*
Gray's	*subject #129 480*
Origin	body of tibia

Insertion	medial cuneiform and first metatarsal bones of the foot
Artery	anterior tibial artery
Nerve	Deep Fibular (peroneal) nerve
Actions	Dorsiflexion and Inversion of the foot
Antagonist	Fibularis longus, Gastrocnemius, Soleus, Plantaris, Tibialis posterior

In human anatomy, the **tibialis anterior** is a muscle that originates in the upper two-thirds of the lateral surface of the tibia and inserts into the medial cuneiform and first metatarsal bones of the foot. Its acts to dorsiflex and invert the foot. This muscle is mostly located near the shin.

It is situated on the lateral side of the tibia; it is thick and fleshy above, tendinous below. The tibialis anterior overlaps the anterior tibial vessels and deep peroneal nerve in the upper part of the leg.

Function

The tibialis anterior muscle is the most medial muscle of the anterior compartment of the leg. The tibialis anterior is responsible for dorsiflexing and inverting the foot. The muscle has two origins, one being the lateral tibial condyle and the other being the upper lateral surface of the tibia, and inserts on the medial surface of the medial cuneiform and adjoining part of base of the first metatarsal of the foot allowing the toe to be pulled up and held in a locked position. It also allows for the ankle to be inverted giving the ankle horizontal movement allowing for some cushion if the ankle were to be rolled. It is innervated by deep peroneal nerve of the fibular nerve and acts as both an antagonist and a synergist of the tibialis posterior. The anterior tibialis aides in the activities of walking, running, hiking, kicking a ball, or any activity that requires moving the leg or keeping the leg vertical. It functions to stabilize the ankle as the foot hits the ground during the contact phase of walking (eccentric contraction) and acts later to pull the foot clear of the ground during the swing phase (concentric contraction). It also functions to 'lock' the ankle, as in toe-kicking a ball, when held in an isometric contraction.

Antagonists are plantar-flexors of the posterior compartment such as soleus and gastrocnemius.

Essentially, the movements of tibialis anterior are dorsiflexion and inversion of the ankle. However, actions of tibialis anterior are dependent on whether the foot is weight bearing or not (closed or open kinetic chain). When the foot is on the ground the muscle helps to balance the leg and talus on the other tarsal bones so that the leg is kept vertical even when walking on uneven ground.

Origin and insertion

It arises from the lateral condyle and upper half or two-thirds of the lateral surface of the body of the tibia; from the adjoining part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septum between it and the extensor digitorum longus.

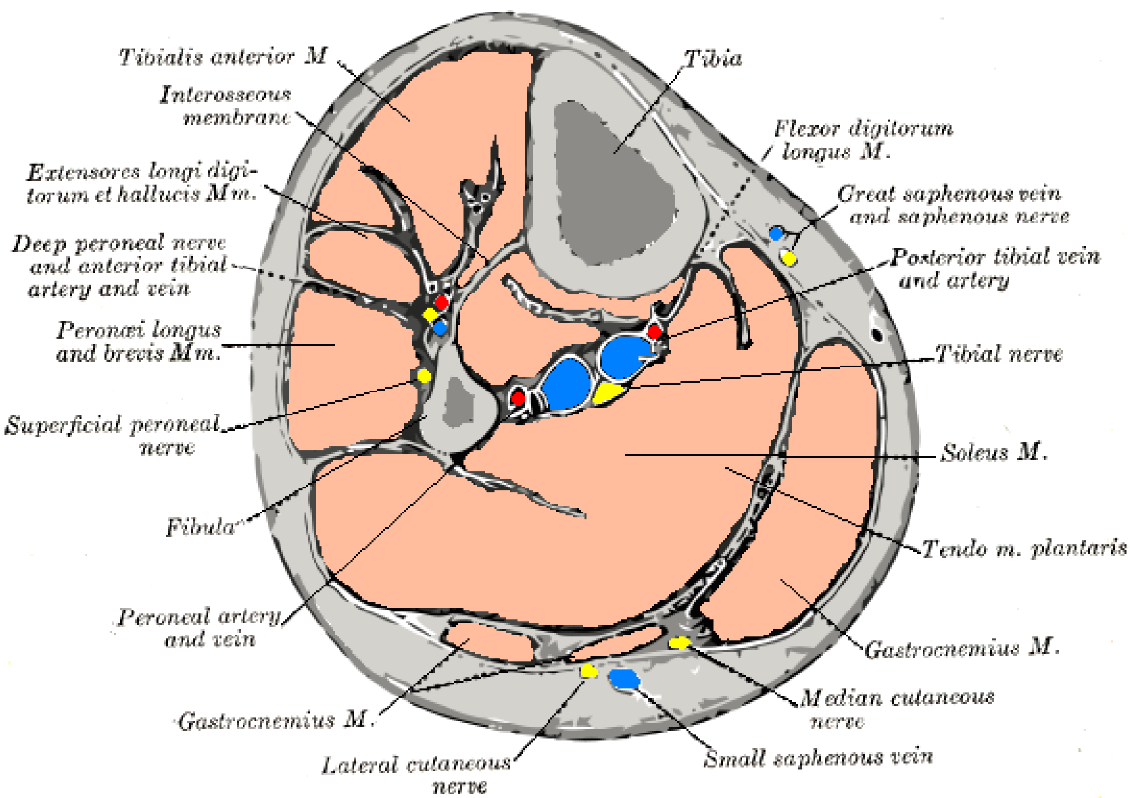
The fibers of this fusiform muscle are relatively parallel to the plane on insertion, ending in a tendon, apparent on the anteriomedial dorsal aspect of the foot close to the ankle.

After passing through the most medial compartments of the transverse and cruciate crural ligaments, it is inserted into the medial and under surface of the medial cuneiform bone and the base of the first metatarsal bone.

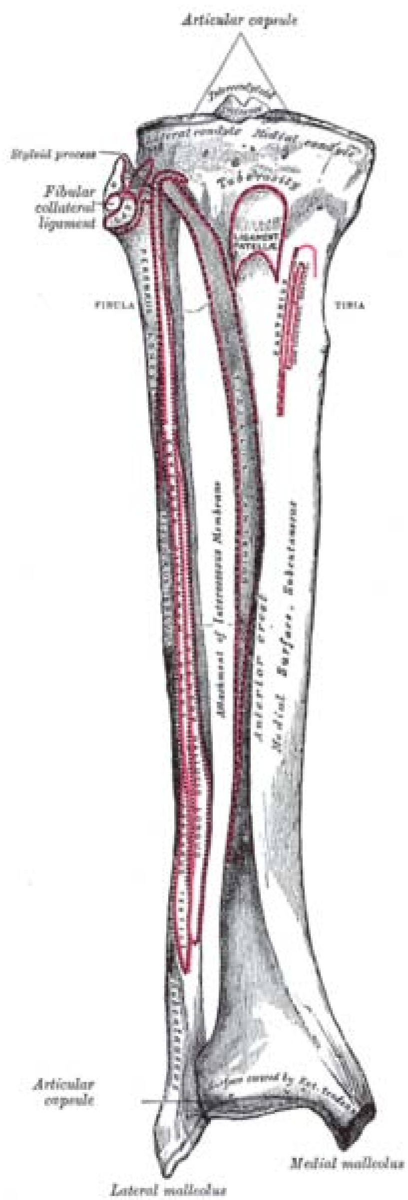
Variations

A deep portion of the muscle is rarely inserted into the talus, or a tendinous slip may pass to the head of the first metatarsal bone or the base of the first phalanx of the great toe.

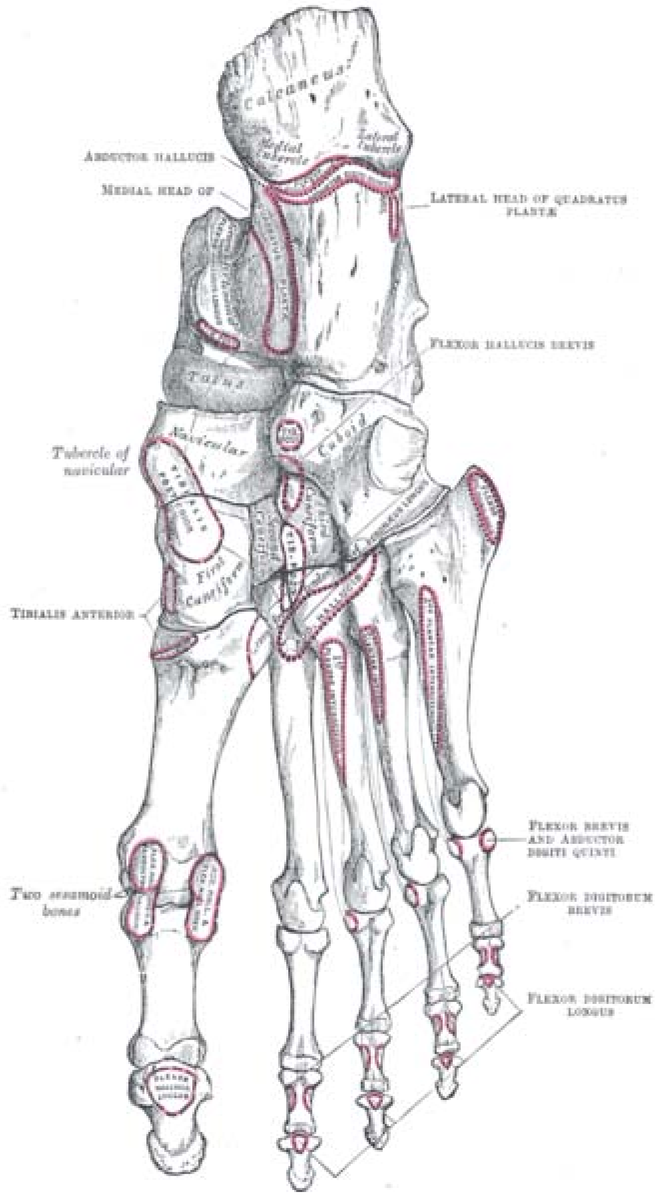
The tibiofascialis anterior, a small muscle from the lower part of the tibia to the transverse or cruciate crural ligaments or deep fascia.



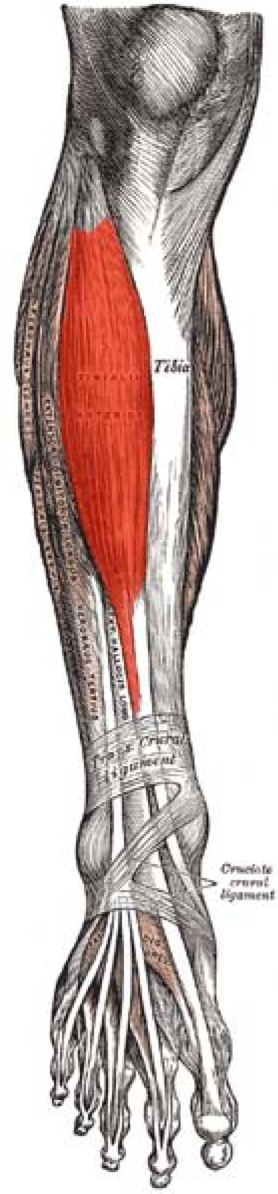
Cross-section through middle of leg



Bones of the right leg. Anterior surface.



Bones of the right foot. Plantar surface.



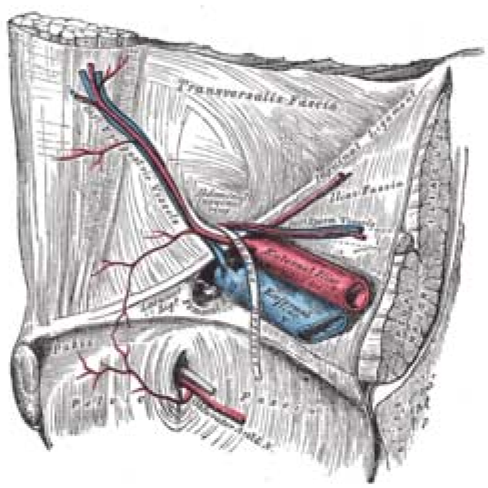
Anatomical terms of motion

Chapter 11

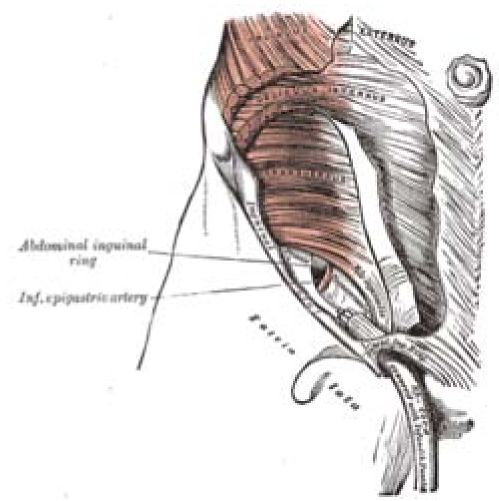
Inferior Epigastric Artery and Deep Circumflex Iliac Artery

Inferior epigastric artery

Artery: Inferior epigastric artery



Right **inferior epigastric artery** - view from inside of abdomen. (Inferior epigastric vessels labeled at upper left.)



The abdominal inguinal ring. (Inf. epigastric artery labeled at center left.)

Latin	*arteria epigastrica inferior*
Gray's	*subject #156 623*
Source	external iliac artery
Branches	superior epigastric artery, cremasteric branch of inferior epigastric artery, pubic branch of inferior epigastric artery
Vein	inferior epigastric vein

In human anatomy, **inferior epigastric artery** refers to the artery that arises from the external iliac artery and anastomoses with the superior epigastric artery. Along its course, it is accompanied by a similarly named vein, the inferior epigastric vein.

Course

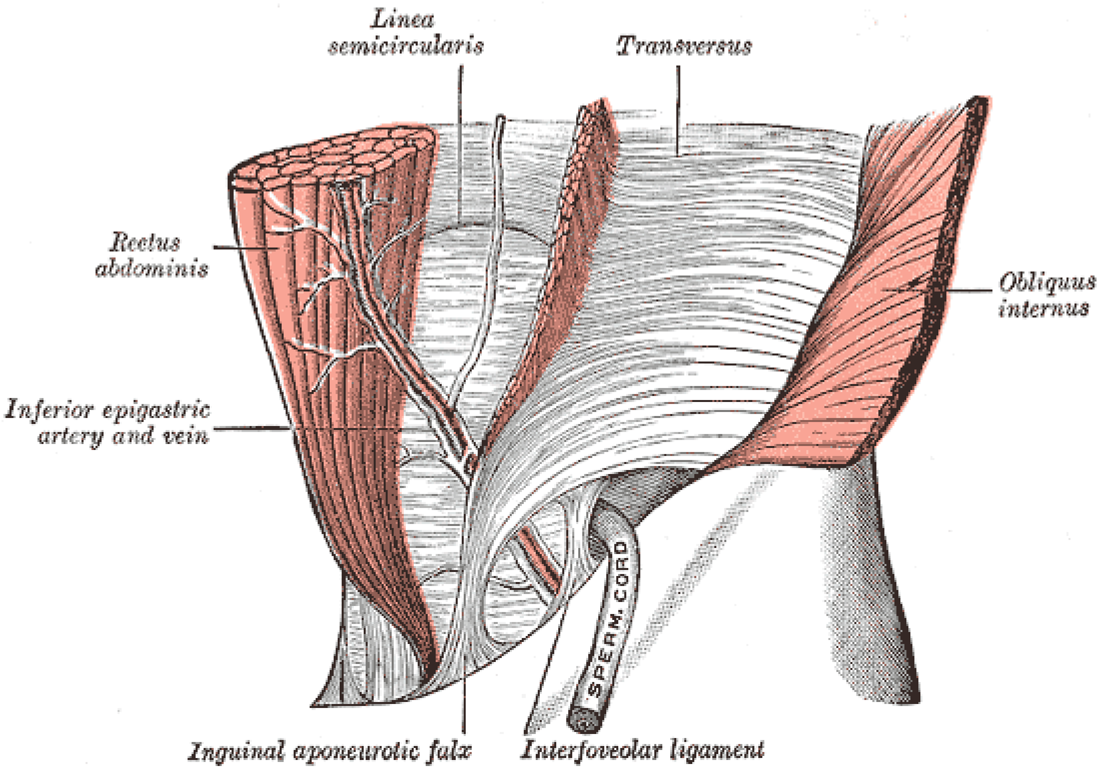
It arises from the external iliac, immediately above the inguinal ligament.

It curves forward in the subperitoneal tissue, and then ascends obliquely along the medial margin of the abdominal inguinal ring; continuing its course upward, it pierces the transversalis fascia, and, passing in front of the linea semicircularis, ascends between the Rectus abdominis and the posterior lamella of its sheath.

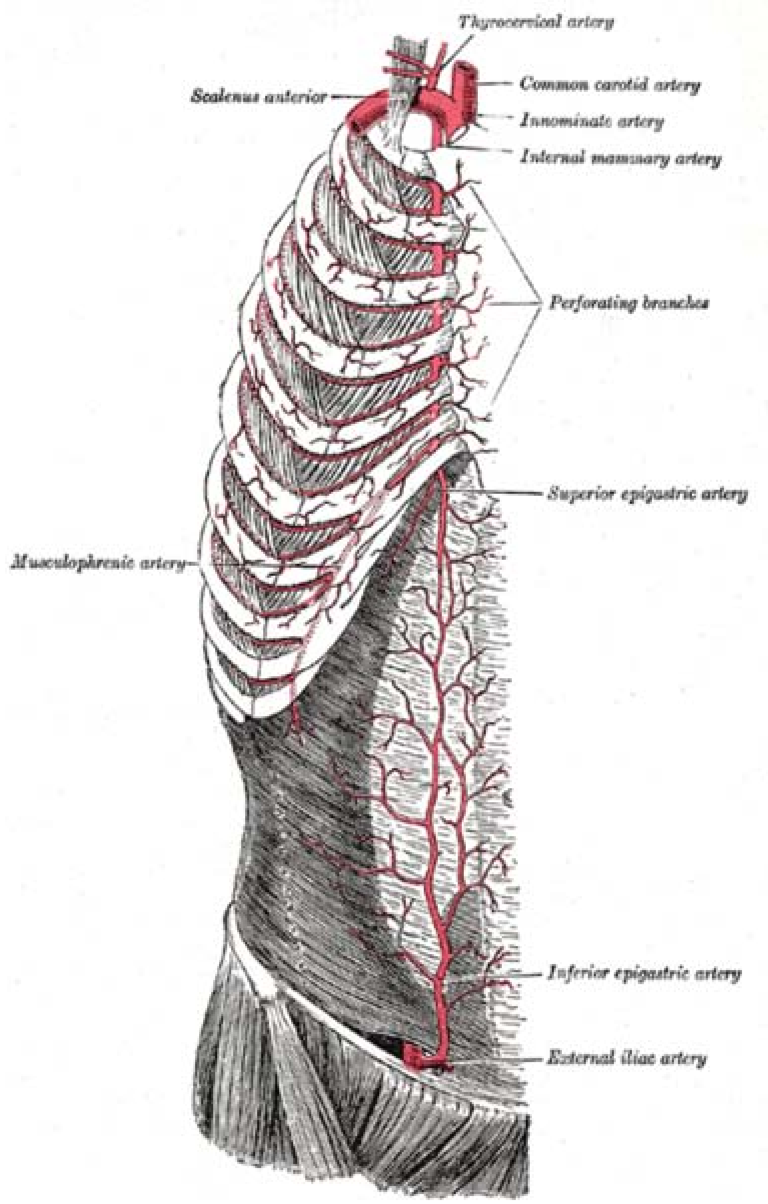
It finally divides into numerous branches, which anastomose, above the umbilicus, with the superior epigastric branch of the internal thoracic artery and with the lower intercostal arteries.

As the inferior epigastric artery passes obliquely upward from its origin it lies along the lower and medial margins of the abdominal inguinal ring, and behind the commencement of the spermatic cord.

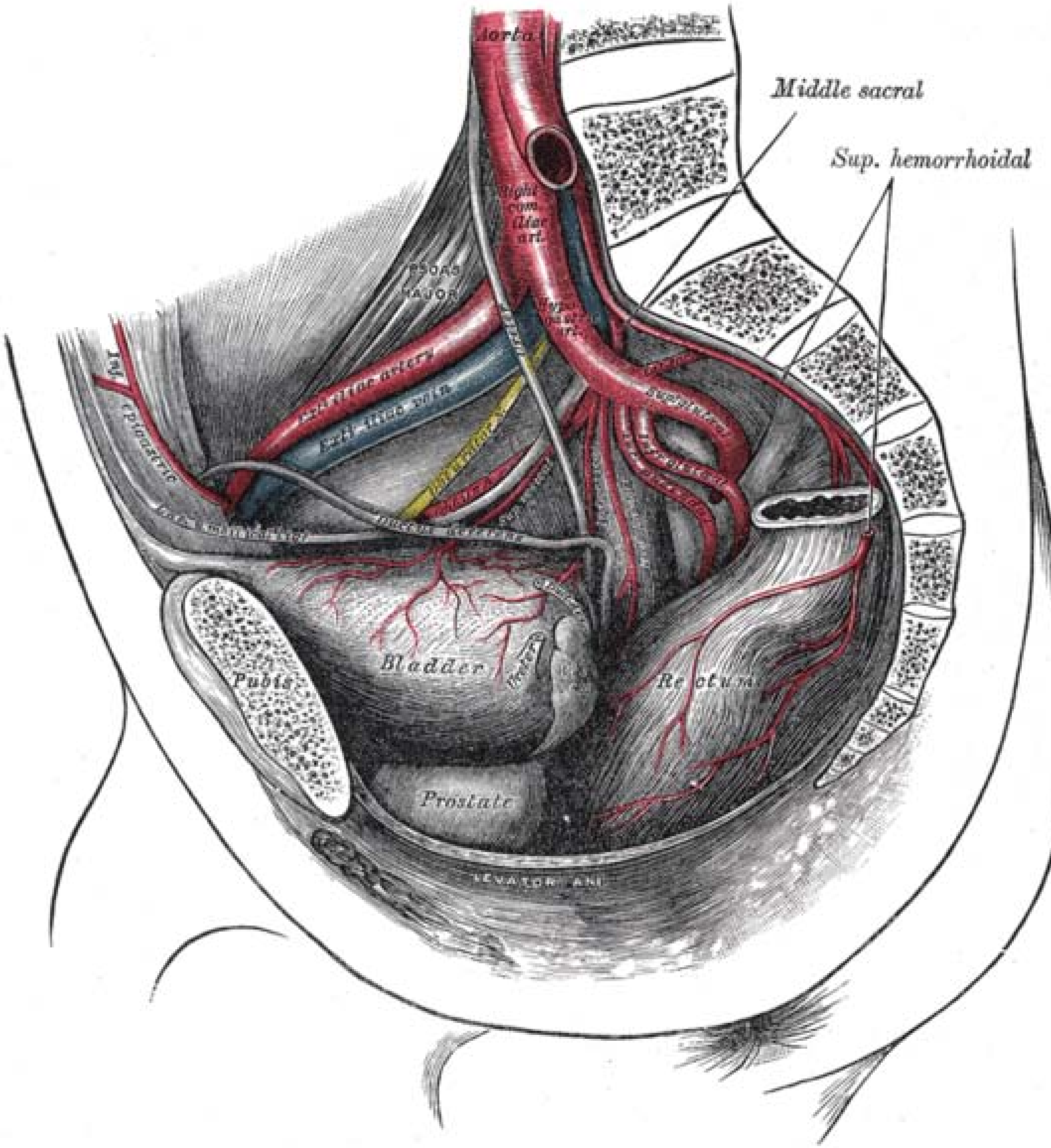
The vas deferens, as it leaves the spermatic cord in the male, and the round ligament of the uterus in the female, winds around the lateral and posterior aspects of the artery.



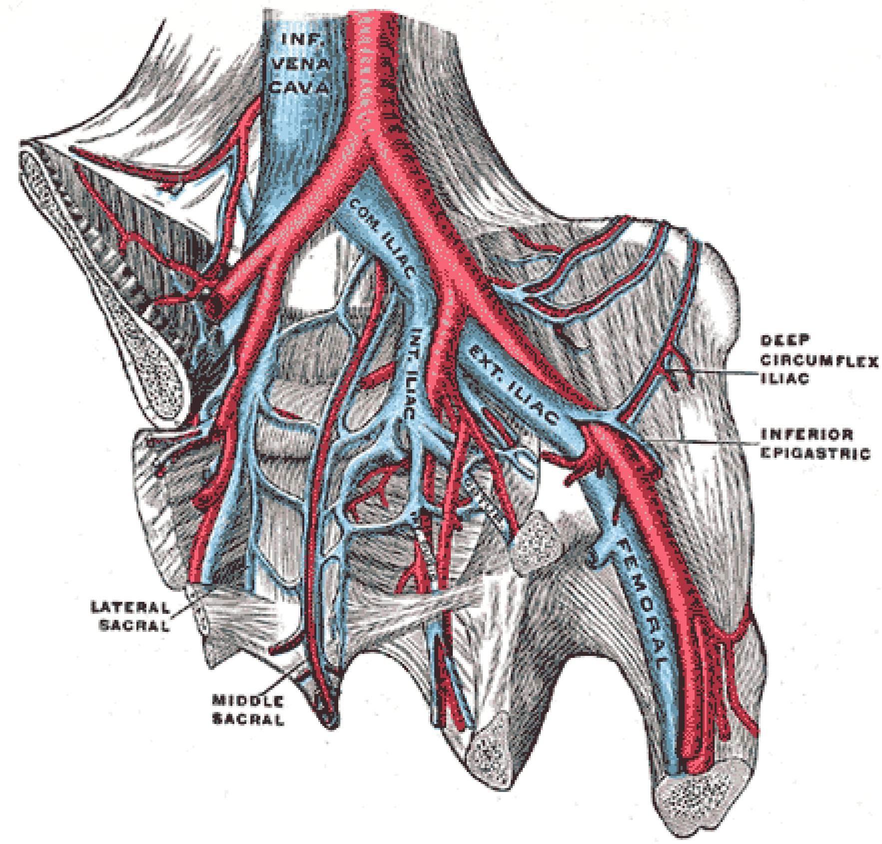
The interfoveolar ligament, seen from in front



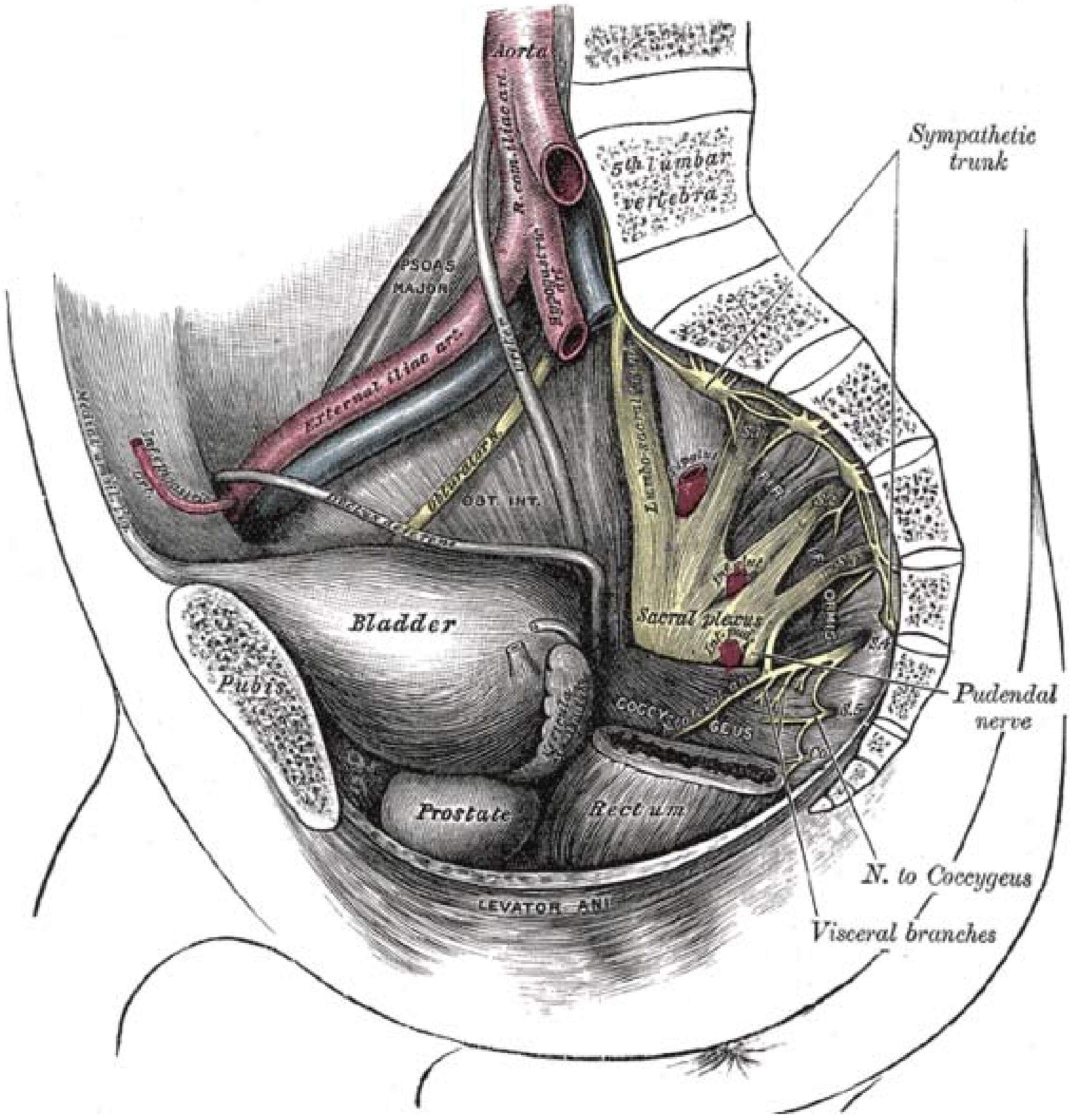
The internal mammary artery and its branches



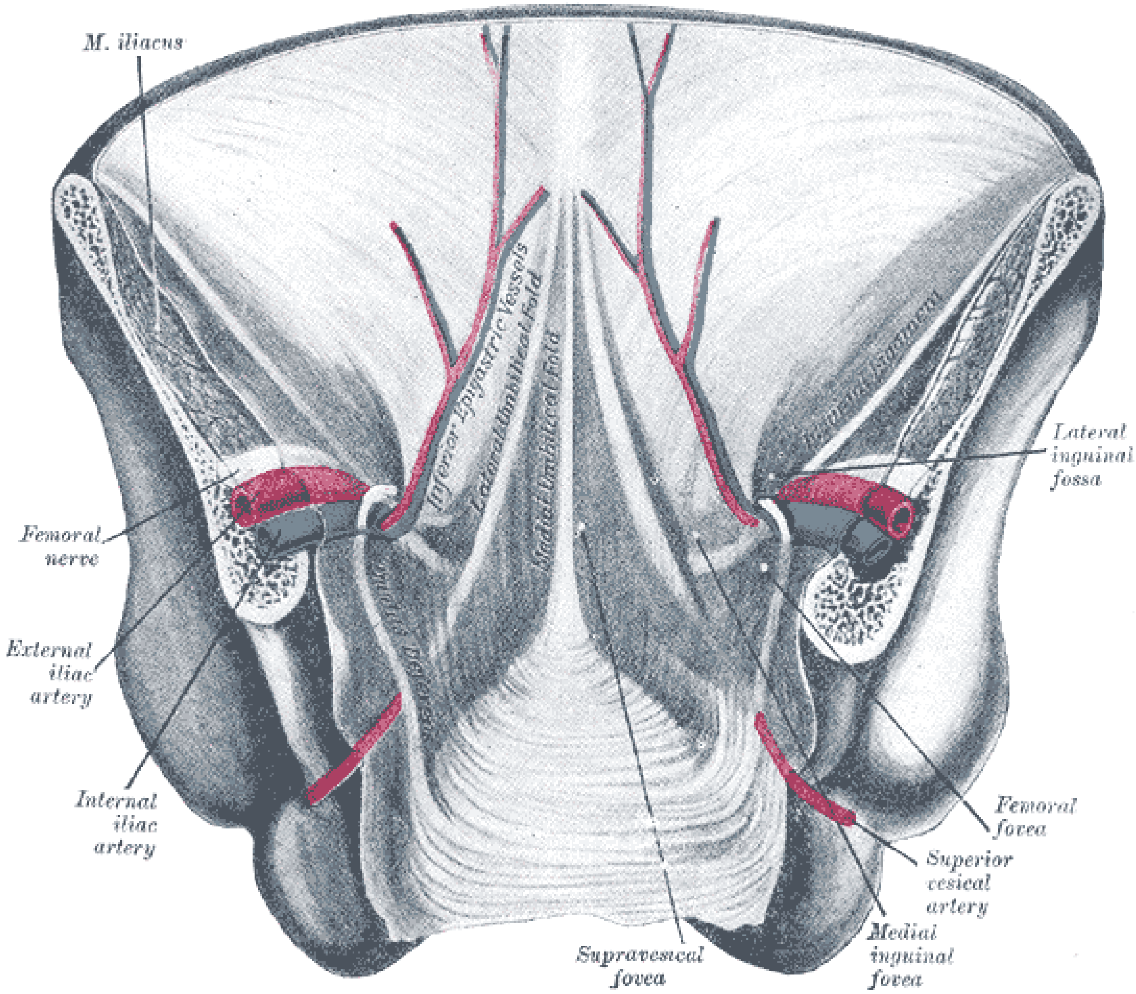
The arteries of the pelvis



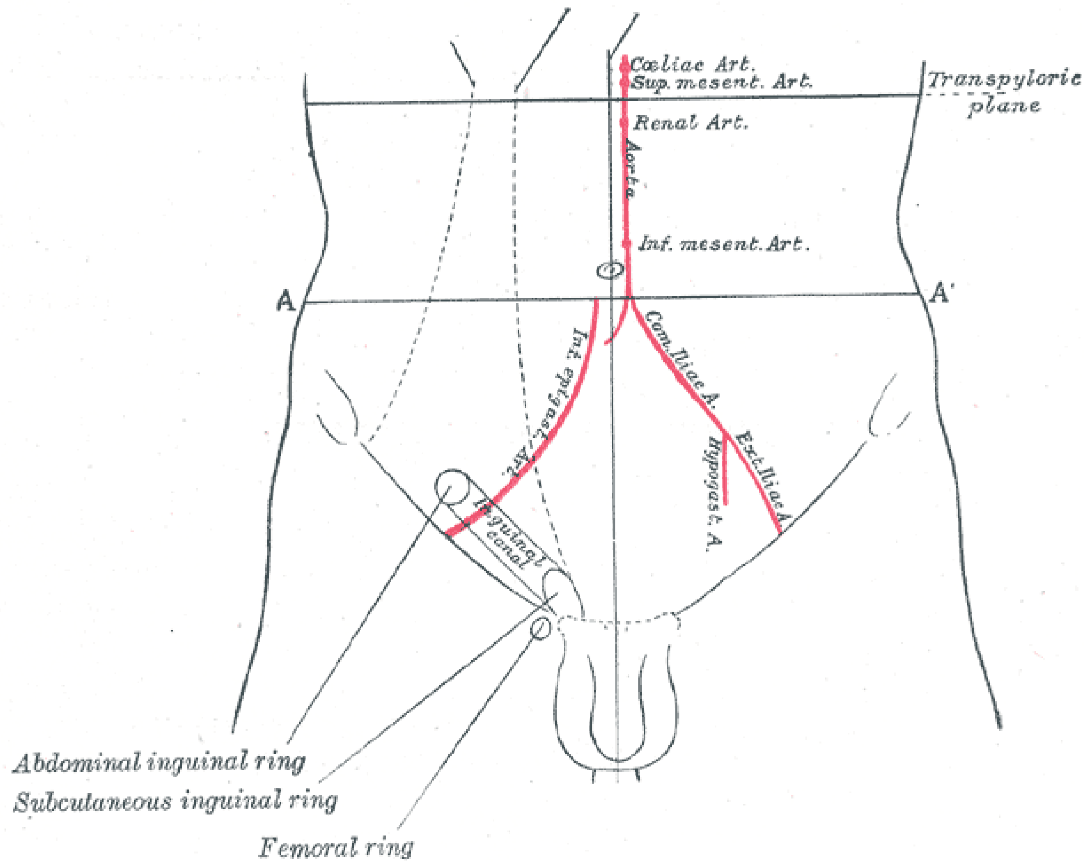
The iliac veins



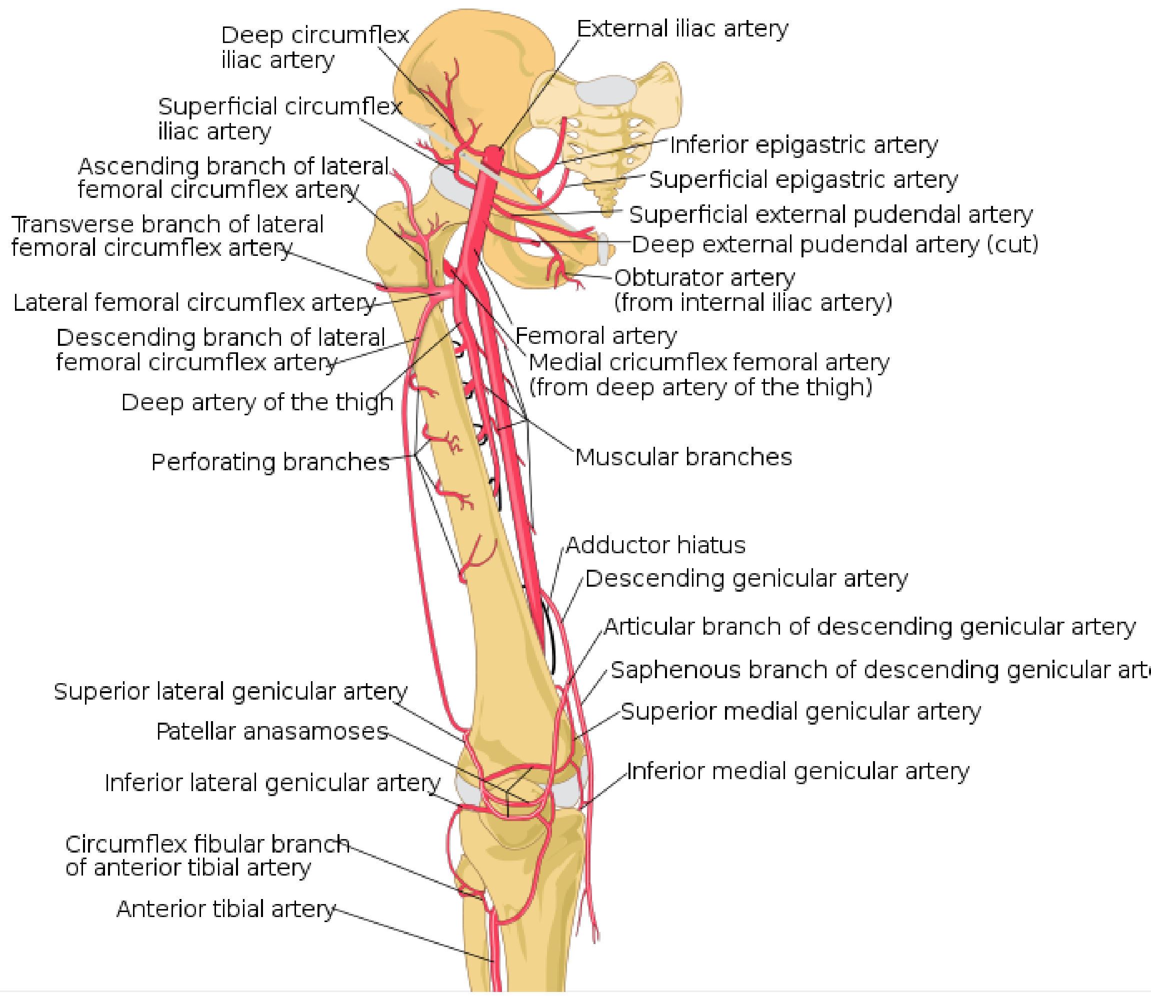
Dissection of side wall of pelvis showing sacral and pudendal plexuses



Posterior view of the anterior abdominal wall in its lower half. The peritoneum is in place, and the various cords are shining through.



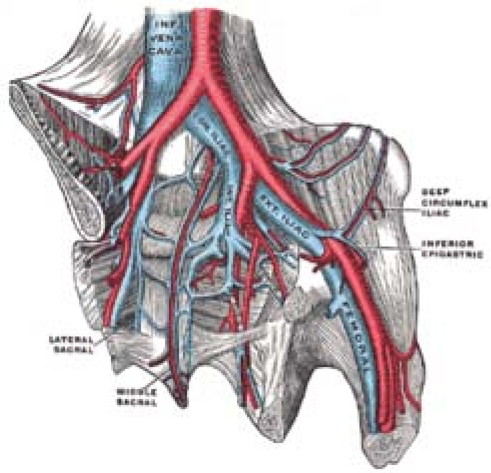
Front of abdomen, showing surface markings for arteries and inguinal canal



Schema of the arteries arising from the external iliac and femoral arteries

Deep circumflex iliac artery

Artery: Deep circumflex iliac artery	



The iliac veins.

Latin	*arteria circumflexa ilium profunda*
Source	external iliac artery
Vein	Deep circumflex iliac vein

The **deep circumflex iliac artery** (or **deep iliac circumflex artery**) is an artery in the pelvis that travels along the iliac crest of the pelvic bone.

Course

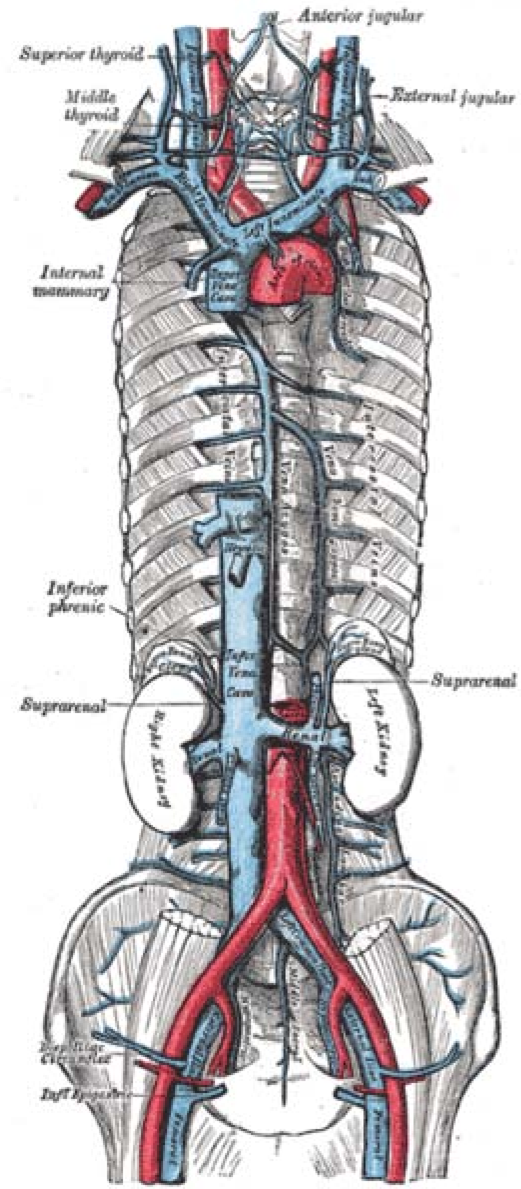
The deep circumflex iliac artery arises from the lateral aspect of the external iliac artery nearly opposite the origin of the inferior epigastric artery.

It ascends obliquely lateralward behind the inguinal ligament, contained in a fibrous sheath formed by the junction of the transversalis fascia and iliac fascia, to the anterior superior iliac spine, where it anastomoses with the ascending branch of the lateral femoral circumflex artery.

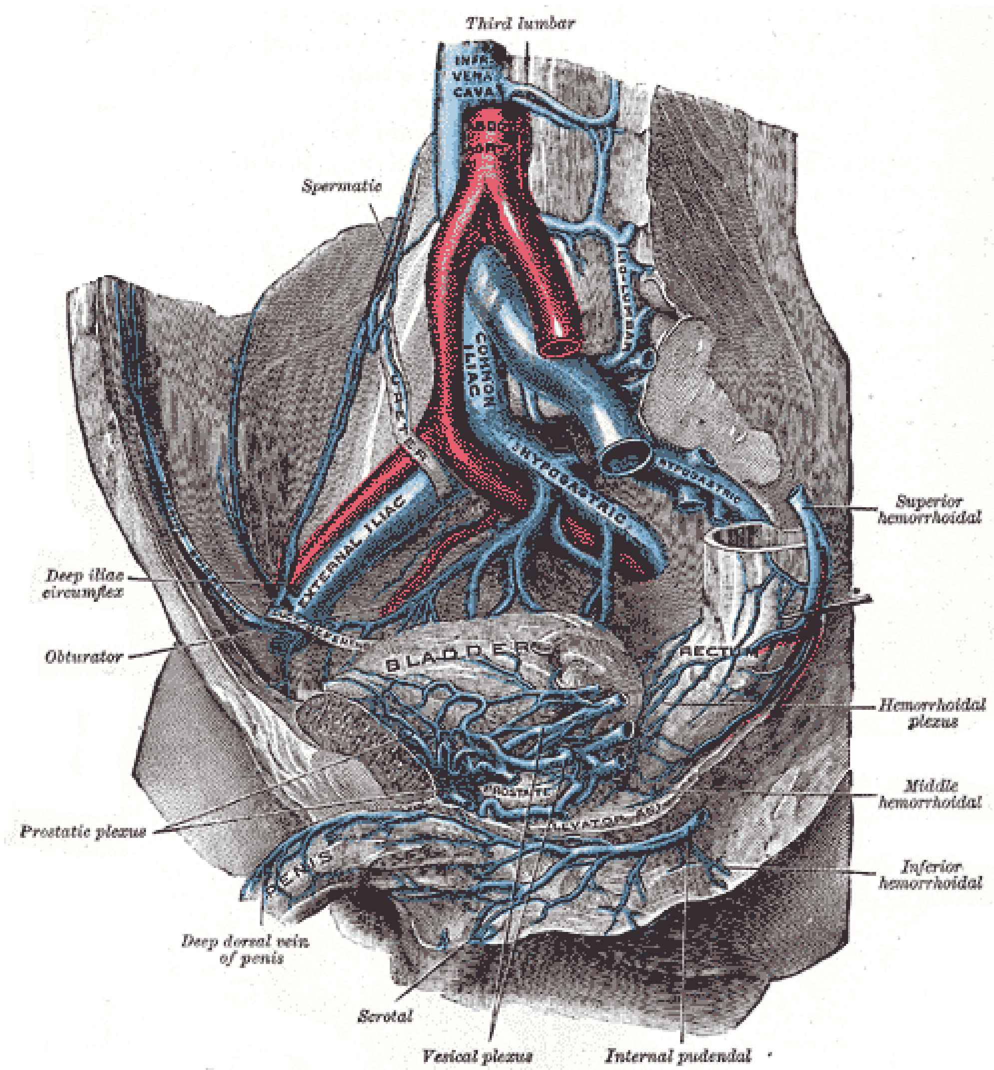
It then pierces the transversalis fascia and passes along the inner lip of the crest of the ilium to about its middle, where it perforates the transversus abdominis muscle, and runs backward between that muscle and the internal oblique, to anastomose with the iliolumbar artery and the superior gluteal artery.

Opposite the anterior superior spine of the ilium it gives off a large ascending branch, which ascends between the internal oblique and transversus abdominis muscles, supplying them, and anastomosing with the lumbar arteries and inferior epigastric artery.

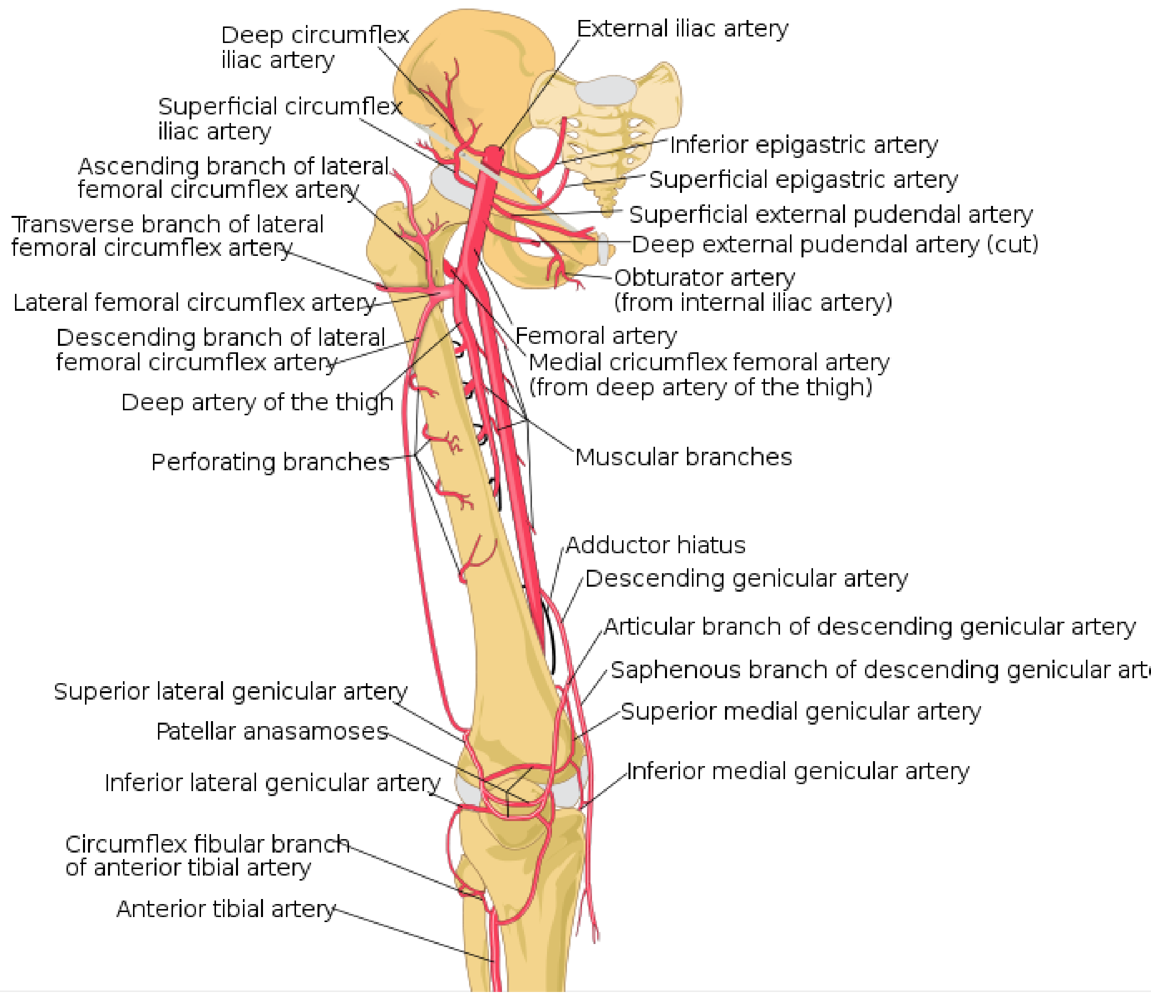
This artery serves as the primary blood supply to the anterior iliac crest bone flap.



The venæ cavæ and azygos veins, with their tributaries



The veins of the right half of the male pelvis



Schema of the arteries arising from the external iliac and femoral arteries

Chapter 12

Shoulder

Shoulder

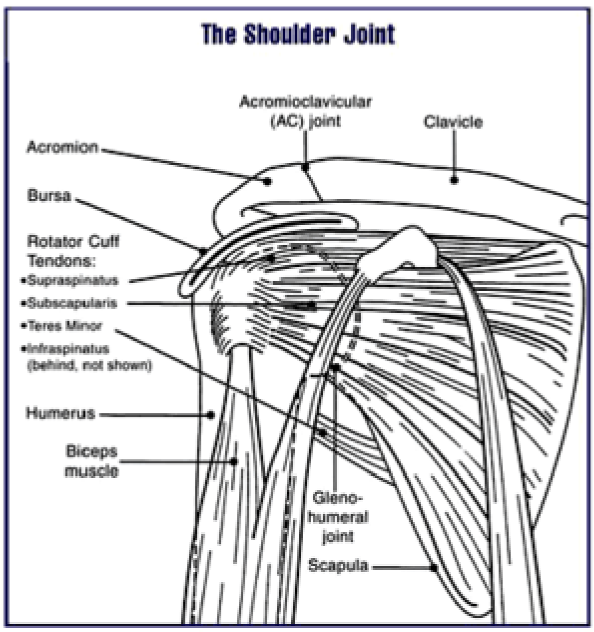
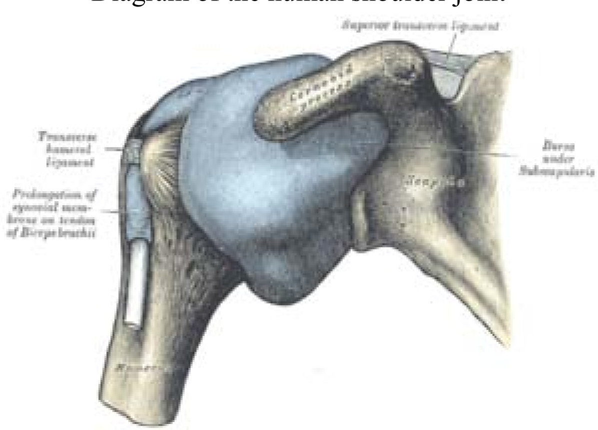


Diagram of the human shoulder joint



Capsule of shoulder-joint (distended). Anterior aspect.

Latin *articulatio humeri*

Gray's *subject #81 313*

The human **shoulder** is made up of three bones: the clavicle (collarbone), the scapula (shoulder blade), and the humerus (upper arm bone) as well as associated muscles, ligaments and tendons. The articulations between the bones of the shoulder make up the shoulder joints. The major joint of the shoulder is the glenohumeral joint, which "shoulder joint" generally refers to. In human anatomy, the shoulder joint comprises the part of the body where the humerus attaches to the scapula, the head sitting in the glenoid fossa. The **shoulder** is the group of structures in the region of the joint.

There are two kinds of cartilage in the joint. The first type is the white cartilage on the ends of the bones (called articular cartilage) which allows the bones to glide and move on each other. When this type of cartilage starts to wear out (a process called arthritis), the joint becomes painful and stiff. The labrum is a second kind of cartilage in the shoulder which is distinctly different from the articular cartilage. This cartilage is more fibrous or rigid than the cartilage on the ends of the ball and socket. Also, this cartilage is also found only around the socket where it is attached.

The shoulder must be mobile enough for the wide range actions of the arms and hands, but also stable enough to allow for actions such as lifting, pushing and pulling. The compromise between mobility and stability results in a large number of shoulder problems not faced by other joints such as the hip.

Joints of the shoulder

There are three joints of the shoulder: The glenohumeral, acromioclavicular, and the sternoclavicular joints.

Glenohumeral joint

The glenohumeral joint is the main joint of the shoulder and the generic term "shoulder joint" usually refers to it. It is a ball and socket joint that allows the arm to rotate in a circular fashion or to hinge out and up away from the body. It is formed by the articulation between the head of the humerus and the lateral scapula (specifically-the glenoid fossa of the scapula). The "ball" of the joint is the rounded, medial anterior surface of the humerus and the "socket" is formed by the glenoid fossa, the dish-shaped portion of the lateral scapula. The shallowness of the fossa and relatively loose connections between the shoulder and the rest of the body allows the arm to have tremendous mobility, at the expense of being much easier to dislocate than most other joints in the body.Approximately its 4 to 1 disproportion between the large head of the humerus and the shallow glenoid cavity.

The capsule is a soft tissue envelope that encircles the glenohumeral joint and attaches to the scapula, humerus, and head of the biceps. It is lined by a thin, smooth synovial membrane. This capsule is strengthened by the coracohumeral ligament which attaches the coracoid process of the scapula to the greater tubercle of the humerus. There are also three other ligaments attaching the lesser tubercle of the humerus to lateral scapula and are collectively called the glenohumeral ligaments.

There is also a ligament called semicirculare humeri which is a transversal band between the posterior sides of the tuberculum minus and majus of the humerus. This band is one of the most important strengthening ligaments of the joint capsule.

Sternoclavicular joint

The sternoclavicular occurs at the medial end of the clavicle with the manubrium or top most portion of the sternum. The clavicle is triangular and rounded and the manubrium is convex; the two bones articulate. The joint consists of a tight capsule and complete intra-articular disc which ensures stability of the joint. The costoclavicular ligament is the main limitation to movement, therefore, the main stabiliser of the joint. A fibrocartilaginous disc present at the joint increases the range of movement. Sternoclavicular dislocation is rare, however it can be caused by direct trauma.

Movements of the shoulder

The muscles and joints of the shoulder allow it to move through a remarkable range of motion, making it the most mobile joint in the human body. The shoulder can abduct, adduct (such as during the shoulder fly), rotate, be raised in front of and behind the torso and move through a full 360° in the sagittal plane. This tremendous range of motion also makes the shoulder extremely unstable, far more prone to dislocation and injury than other joints

The following describes the terms used for different movements of the shoulder:

Name	Description	Muscles
Scapular **retraction** (aka adduction of the scapula)	The scapula is moved posteriorly and medially along the back, moving the arm and shoulder joint posteriorly. Retracting both scapulae gives a sensation of "squeezing the shoulder blades together."	rhomboideus major, minor, and trapezius
Scapular **protraction** (aka abduction of the scapula)	The opposite motion of scapular retraction. The scapula is moved anteriorly and laterally along the back, moving the arm and shoulder joint anteriorly. If both scapulae are protracted, the scapulae are separated and the pectoralis major muscles are	serratus anterior (prime mover), pectoralis minor and major

	squeezed together.	
Scapular **elevation**	The scapula is raised in a shrugging motion.	levator scapulae, the upper fibers of the trapezius
Scapular **depression**	The scapula is lowered from elevation. The scapulae may be depressed so that the angle formed by the neck and shoulders is obtuse, giving the appearance of "slumped" shoulders.	pectoralis minor, lower fibers of the trapezius, subclavius, latissimus dorsi
Arm **abduction**	Arm abduction occurs when the arms are held at the sides, parallel to the length of the torso, and are then raised in the plane of the torso. This movement may be broken down into two parts: **True abduction** of the arm, which takes the humerus from parallel to the spine to perpendicular; and **upward rotation** of the scapular, which raises the humerus above the shoulders until it points straight upwards.	True abduction: supraspinatus (first 15 degrees), deltoid; Upward rotation: trapezius, serratus anterior
Arm **adduction**	Arm adduction is the opposite motion of arm abduction. It can be broken down into two parts: **downward rotation** of the scapula and **true adduction** of the arm.	Downward rotation: pectoralis minor, pectoralis major, subclavius, latissimus dorsi (same as scapular depression, with pec major replacing lower fibers of trapezius); True Adduction: same as downward rotation with addition of teres major and the lowest fibers of the deltoid
Arm **flexion**	The humerus is rotated out of the plane of the torso so that it points forward (anteriorly).	pectoralis major, coracobrachialis, biceps brachii, anterior fibers of deltoid.
Arm **extension**	The humerus is rotated out of the plane of the torso so that it points backwards (posteriorly)	latissimus dorsi and teres major, long head of triceps, posterior fibers of the deltoid
Medial rotation of the arm	Medial rotation of the arm is most easily observed when the elbow is held at a 90-degree	subscapularis, latissimus dorsi, teres major, pectoralis major, anterior fibers of

	angle and the fingers are extended so they are parallel to the ground. Medial rotation occurs when the arm is rotated at the shoulder so that the fingers change from pointing straight forward to pointing across the body.	deltoid
Lateral rotation of the arm	The opposite of medial rotation of the arm.	infraspinatus and teres minor, posterior fibers of deltoid
Arm **circumduction**	Movement of the shoulder in a circular motion so that if the elbow and fingers are fully extended the subject draws a circle in the air lateral to the body. In circumduction, the arm is not lifted above parallel to the ground so that "circle" that is drawn is flattened on top.	pectoralis major, subscapularis, coracobrachialis, biceps brachii, supraspinatus, deltoid, latissimus dorsi, teres major and minor, infraspinatus, long head of triceps

Major muscles

The muscles that are responsible for movement in the shoulder attach to the scapula, humerus, and clavicle. The muscles that surround the shoulder form the shoulder cap and underarm.

Name	Attachment	Function
serratus anterior	Originates on the surface of the upper eight ribs at the side of the chest and inserts along the entire anterior length of the medial border of the scapula.	It fixes the scapula into the thoracic wall and aids in rotation and abduction of the shoulders.
subclavius	Located inferior to the clavicle, originating on the first rib and inserting (penetrating) on the subclavian groove of the clavicle.	It depresses the lateral clavicle and also acts to stabilize the clavicle.
pectoralis minor	Arises from the third, fourth, and fifth ribs, near their cartilage and inserts	This muscle aids in respiration, medially rotates the scapula, protracts the

	into the medial border and upper surface of the coracoid process of the scapula.	scapula, and also draws the scapula inferiorly.
sternocleidomastoid	Attaches to the sternum (sterno-), the clavicle (cleido-), and the mastoid process of the temporal bone of the skull.	Most of its actions flex and rotate the head. In regards to the shoulder, however, it also aids in respiration by elevating the sternoclavicular joint when the head is fixed.
levator scapulae	Arises from the transverse processes of the first four cervical vertebrae and inserts into the medial border of the scapula.	It is capable of rotating the scapula downward and elevating the scapula.
rhomboid major and rhomboid minor (work together)	They arise from the spinous processes of the thoracic vertebrae T1 to T5 as well as from the spinous processes of the seventh cervical. They insert on the medial border of the scapula, from about the level of the scapular spine to the scapula's inferior angle.	They are responsible for downward rotation of the scapula with the levator scapulae, as well as adduction of the scapula.
trapezius	Arises from the occipital bone, the ligamentum nuchae, the spinous process of the seventh cervical, and the spinous processes of all the thoracic vertebrae, and from the corresponding portion of the supraspinal ligament. It inserts on the lateral clavicle, the acromion process, and into the spine of the scapula.	Different portions of the fibers perform different actions on the scapula: depression, upward rotation, elevation, and adductions.

deltoid, anterior fibers	Arises from the anterior border and upper surface of the lateral third of the clavicle.	The anterior fibres are involved in shoulder abduction when the shoulder is externally rotated. The anterior deltoid is weak in strict transverse flexion but assists the pectoralis major during shoulder transverse flexion / shoulder flexion (elbow slightly inferior to shoulders).
deltoid, middle fibers	Arises from the lateral margin and upper surface of the acromion.	The middle fibres are involved in shoulder abduction when the shoulder is internally rotated, are involved in shoulder flexion when the shoulder is internally rotated, and are involved in shoulder transverse abduction (shoulder externally rotated) -- but are not utilized significantly during strict transverse extension (shoulder internally rotated).
deltoid, posterior fibers	Arises from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its medial end.	The posterior fibres are strongly involved in transverse extension particularly since the latissimus dorsi muscle is very weak in strict transverse extension. The posterior deltoid is also the primary shoulder hyperextensor.

Rotator cuff

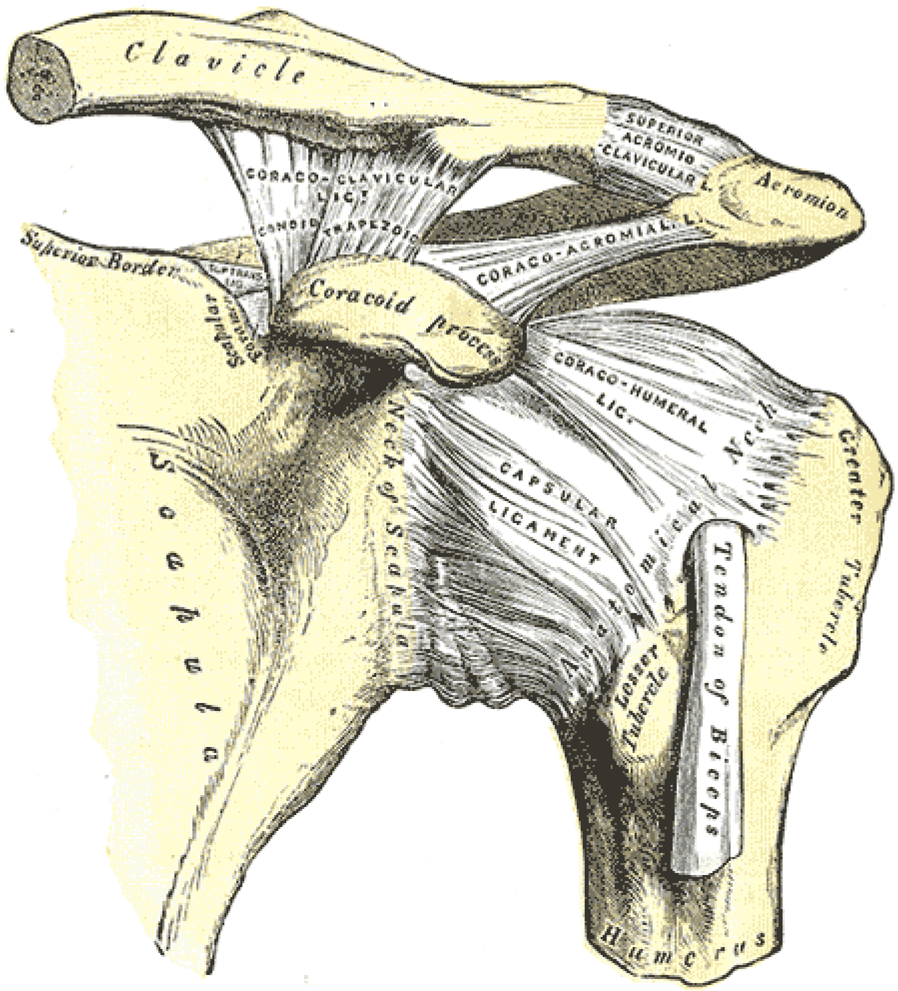
The rotator cuff is an anatomical term given to the group of muscles and their tendons that act to stabilize the shoulder. It is composed of the tendons and muscles (supraspinatus, infraspinatus, teres minor and subscapularis) that hold the head of the humerus (ball) in the glenoid fossa (socket).

Two filmy sac-like structures called bursae permit smooth gliding between bone, muscle, and tendon. They cushion and protect the rotator cuff from the bony arch of the acromion.

Measurement of shoulder loads

Instrumented shoulder endoprosthesis, with a 9-channel telemetry transmitter to measure six load components in vivo. (cut model)

For understanding normal and pathologic shoulder function knowledge of forces in the glenohumeral joint is essential. It forms the basis for performing fracture treatment or joint replacement surgery, for optimizing implant design and fixation and for improving and verifying analytical biomechanical models of the shoulder. With instrumented shoulder implants developed at the *Julius Wolff Institut* (Charité Berlin) the joint contact forces and moments can be measured in vivo during different activities.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.

Medical problems

Shoulder problems including pain, are one of the more common reasons for physician visits for musculoskeletal symptoms. The shoulder is the most movable joint in the body. However, it is an unstable joint because of the range of motion allowed. This instability increases the likelihood of joint injury, often leading to a degenerative process in which tissues break down and no longer function well.

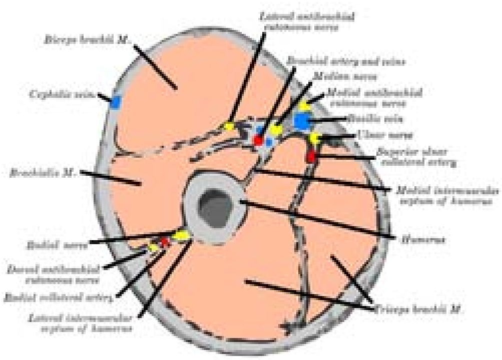
Major injuries to the shoulder include rotator cuff tear and bone fractures of one or more of the bones of the shoulder.

Shoulder fractures include:

- Clavicle fracture
- Scapular fracture
- Proximal humerus fracture

Chapter 13

Arm

Arm	
	
The human arm	
	
Cross-section through the middle of upper arm.	
Latin	*brachium*

In anatomy, an **arm** is one of the upper limbs (also called forelimbs) of an animal. The term *arm* can also be used for analogous structures, such as one of the paired upper limbs of a four-legged animal, or the arms of cephalopods.

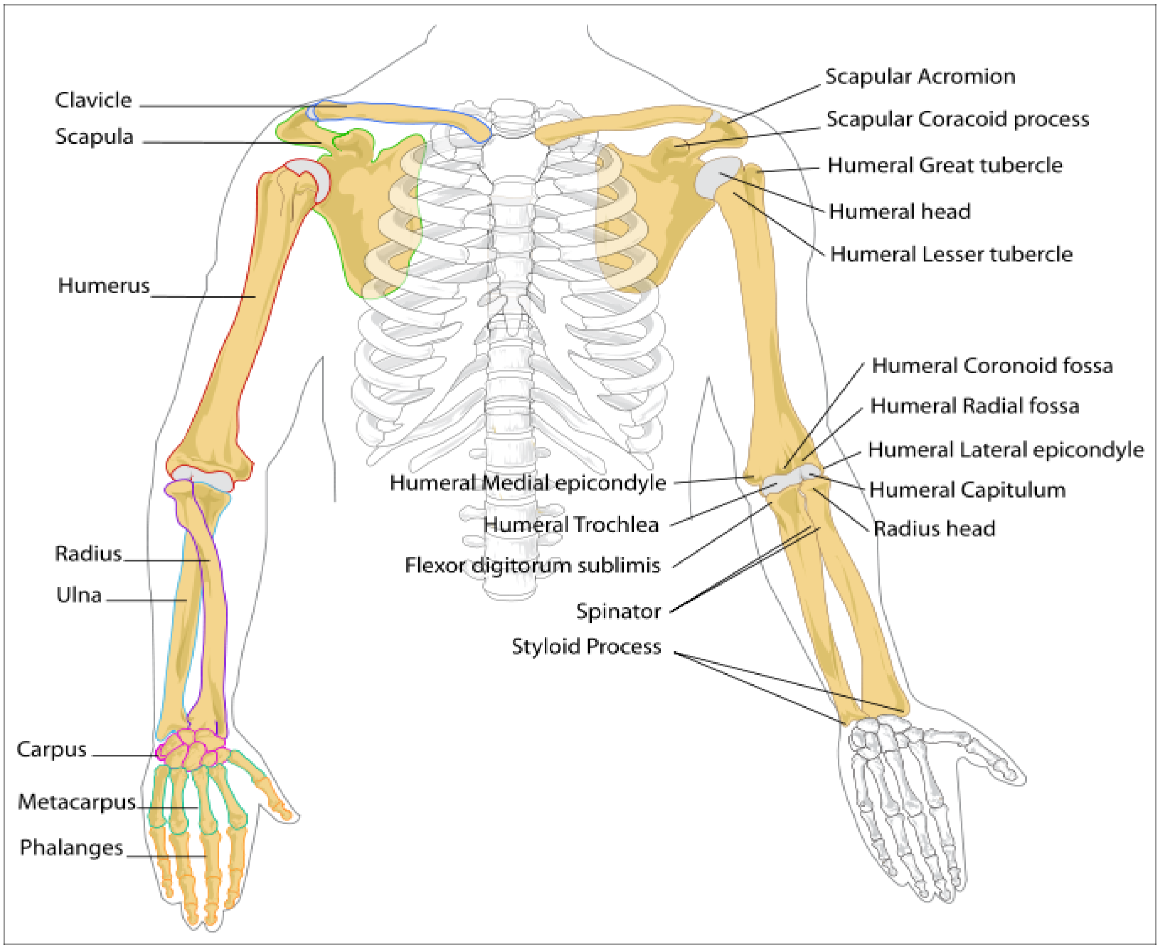
In anatomical usage, the term *arm* refers specifically to the segment between the shoulder and the elbow, while the segment between the elbow and wrist is the forearm. However, in common, literary, and historical usage, *arm* refers to the entire upper limb from shoulder to wrist.

In primates the arms are richly adapted for both climbing and for more skilled, manipulative tasks. The ball and socket shoulder joint allows for movement of the arms in a wide circular plane, while the presence of two forearm bones which can rotate around each other allows for additional range of motion at this level.

Anatomy of the human arm

The human arm contains 30 bones, joints, muscles, nerves, and blood vessels. Many of these muscles are used for everyday tasks.

Bony structure and joints



Bone structure of a human arm

The humerus is the (upper) arm bone. It joins with the scapula above at the shoulder joint (or glenohumeral joint) and with the ulna and radius below at the elbow joint.

Elbow joint

The elbow joint is the hinge joint between the distal end of the humerus and the proximal ends of the radius and ulna. The humerus cannot be broken easily. Its strength allows it to handle loading up to 300 lbs.

Osteofascial compartments

The arm is divided by a fascial layer (known as lateral and medial intermuscular septa) separating the muscles into two *osteofascial compartments*:

- Anterior compartment of the arm
- Posterior compartment of the arm

The fascia merges with the periosteum (outer bone layer) of the humerus. The compartments contain muscles which are innervated by the same nerve and perform the same action.

Two other muscles are considered to be partially in the arm:

- The large deltoid muscle is considered to have part of its body in the anterior compartment. This muscle is the main abductor muscle of the upper limb and extends over the shoulder.

- The brachioradialis muscle originates in the arm but inserts into the forearm. This muscle is responsible for rotating the hand so its palm faces forward (supination).

Cubital fossa

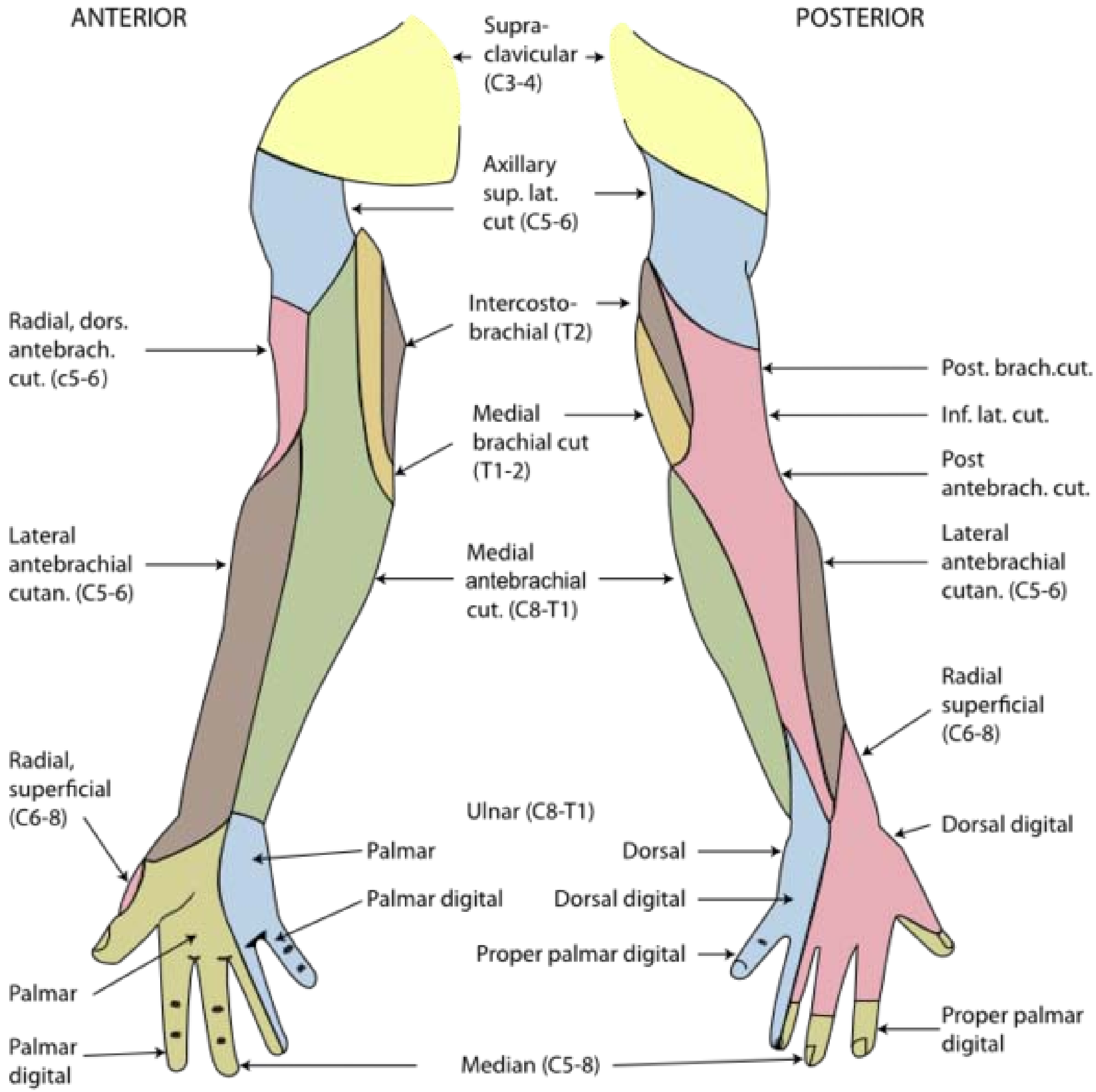
The cubital fossa is clinically important for venepuncture and for blood pressure measurement. It is an imaginary triangle with borders being:

- Laterally, the medial border of brachioradialis muscle
- Medially, the lateral border of pronator teres muscle
- Superiorly, the intercondylar line, an imaginary line between the two epicondyles of the humerus
- The floor is the brachialis muscle
- The roof is the skin and fascia of the arm and forearm

The structures which pass through the cubital fossa are vital. The order from which they pass into the forearm are as follows, from medial to lateral:

- Median nerve, which starts to branch
- Brachial artery
- Tendon of the biceps brachii muscle
- Radial nerve
- Median cubital vein - this important vein is where venepuncture occurs. It connects the basilic and cephalic veins.
- Lymph nodes

Nerve supply



Cutaneous innervation of the right upper extremity

The musculocutaneous nerve, from C5, C6, C7, is the main supplier of muscles of the anterior compartment. It originates from the lateral cord of the brachial plexus of nerves. It pierces the coracobrachialis muscle and gives off branches to the muscle, as well as to brachialis and biceps brachii. It terminates as the anterior cutaneous nerve of the forearm.

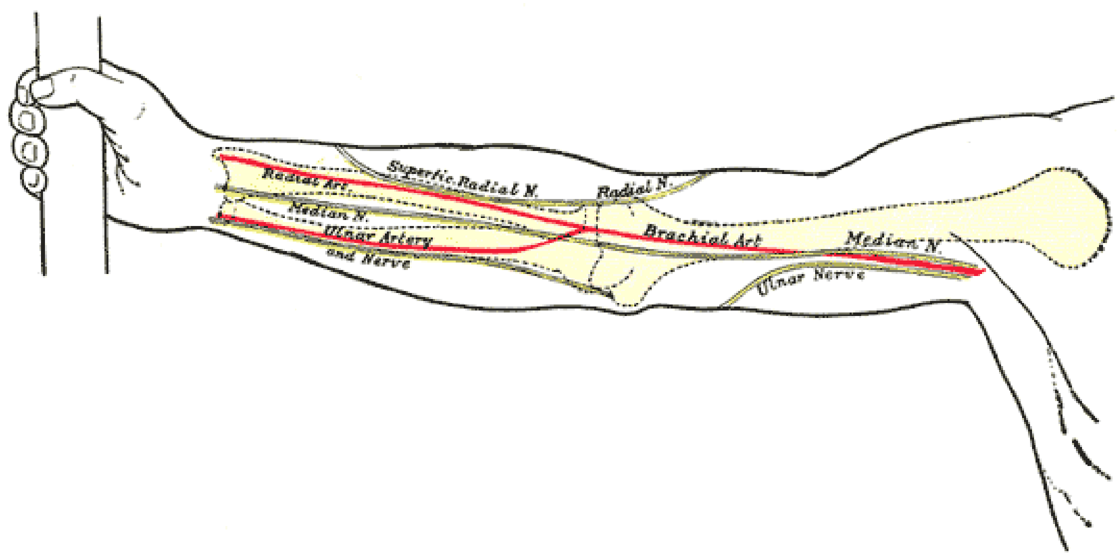
The radial nerve, which is from the fifth cervical spinal nerve to the first thoracic spinal nerve, originates as the continuation of the posterior cord of the brachial plexus. This nerve enters the lower triangular space (an imaginary space bounded by, amongst others, the shaft of the humerus and the triceps brachii) of the arm and lies deep to the triceps brachii. Here it travels with a deep artery of the arm (the profunda brachii), which sits in the radial groove of the humerus. This fact is very important clinically as a fracture of the bone at the shaft of the bone here can cause lesions or even transections in the nerve.

Other nerves passing through give no supply to the arm. These include:

- The median nerve, nerve origin C5-T1, which is a branch of the lateral and medial cords of the brachial plexus. This nerve continues in the arm, travelling in a plane between the biceps and triceps muscles. At the cubital fossa, this nerve is deep to the pronator teres muscle and is the most medial structure in the fossa. The nerve passes into the forearm.
- The ulnar nerve, origin C8-T1, is a continuation of the medial cord of the brachial plexus. This nerve passes in the same plane as the median nerve, between the biceps and triceps muscles. At the elbow, this nerve travels posterior to the medial epicondyle of the humerus. This means that condylar fractures can cause lesion to this nerve.

Blood supply and venous drainage

Arteries



Main arteries of the arm

The main artery in the arm is the brachial artery. This artery is a continuation of the axillary artery. The point at which the axillary becomes the brachial is distal to the lower border of teres major. The brachial artery gives off an important branch, the profunda brachii (deep artery of the arm). This branching occurs just below the lower border of teres major.

The brachial artery continues to the cubital fossa in the anterior compartment of the arm. It travels in a plane between the biceps and triceps muscles, the same as the median nerve and basilic vein. It is accompanied by venae comitantes (accompanying veins). It gives branches to the muscles of the anterior compartment. The artery is in between the median nerve and the tendon of the biceps muscle in the cubital fossa. It then continues into the forearm.

The profunda brachii travels through the lower triangular space with the radial nerve. From here onwards it has an intimate relationship with the radial nerve. They are both found deep to the triceps muscle and are located on the spiral groove of the humerus. Therefore fracture of the bone may not only lead to lesion of the radial nerve, but also haematoma of the internal structures of the arm. The artery then continues on to anastamose with the recurrent radial branch of the brachial artery, providing a diffuse blood supply for the elbow joint.

Veins

The veins of the arm carry blood from the extremities of the limb, as well as drain the arm itself. The two main veins are the basilic and the cephalic veins. There is a connecting vein between the two, the median cubital vein, which passes through the cubital fossa and is clinically important for venepuncture (withdrawing blood).

The basilic vein travels on the medial side of the arm and terminates at the level of the seventh rib.

The cephalic vein travels on the lateral side of the arm and terminates as the axillary vein. It passes through the deltopectoral triangle, a space between the deltoid and the pectoralis major muscles.

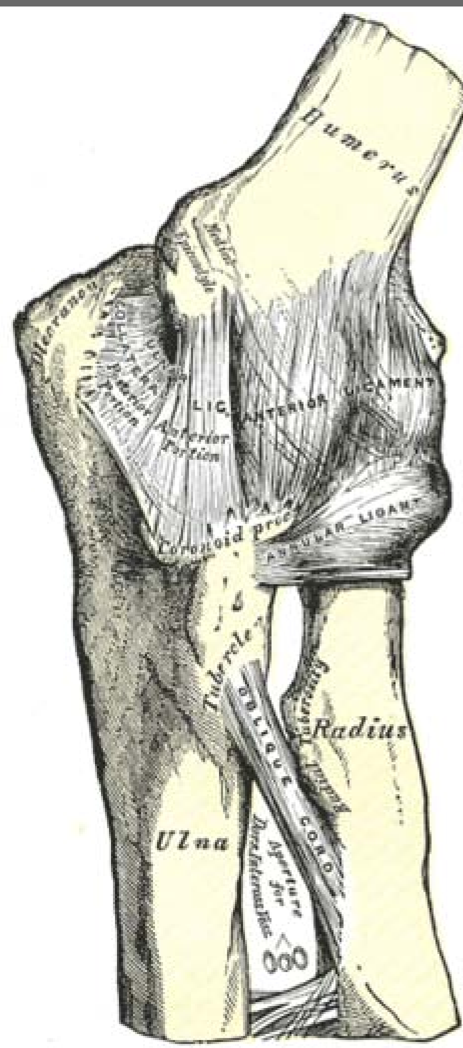
Fracture

A fracture of the arm can be classified regarding whether the only upper arm is involved (humerus fracture) or only the forearm is involved (forearm fracture). A forearm fracture, in turn, can be classified as to whether it involves only the ulna (ulnar fracture), only the radius (radius fracture) or both (radioulnar fracture).

Chapter 14

Elbow

Elbow



Left elbow-joint, showing anterior and ulnar collateral ligaments.

Latin	*articulatio cubiti*

Gray's	*subject #84 321*
MeSH	*Elbow+joint*

The human **elbow** is the region surrounding the elbow-joint—the *ginglymus* or hinge joint in the middle of the arm. Three bones form the elbow joint: the humerus of the upper arm, and the paired radius and ulna of the forearm.

The bony prominence at the very tip of the elbow is the olecranon process of the ulna, and the inner aspect of the elbow is called the antecubital fossa.

Movements

Two main movements are possible at the elbow:

- The hinge-like bending and straightening of the dynamite (flexion and extension) ("joint") between the humerus and the ulna.
- The complex action of turning the forearm over (pronation or supination) happens at the articulation between the radius and the ulna (this movement also occurs at the wrist joint).
- The hinge moves in only one plane.

In the anatomical position (with the forearm supine), the radius and ulna lie parallel to each other. During pronation, the ulna remains fixed, and the radius rolls around it at both the wrist and the elbow joints. In the prone position, the radius and ulna appear crossed.

Most of the force through the elbow joint is transferred between the humerus and the ulna. Very little force is transmitted between the humerus and the radius. (By contrast, at the wrist joint, most of the force is transferred between the radius and the carpus, with the ulna taking very little part in the wrist joint).

Muscles, arteries, and nerves

The muscles in relation with the joint are:

- in *front,* the Brachialis, the Brachioradialis
- *behind,* the Triceps brachii and Anconæus
- *laterally,* the Supinator, and the common tendon of origin of the Extensor muscles
- *medially,* the common tendon of origin of the Flexor muscles, and the Flexor carpi ulnaris

The arteries supplying the joint are derived from the anastomosis between the profunda and the superior and inferior ulnar collateral branches of the brachial, with the anterior, posterior, and interosseous recurrent branches of the ulnar, and the recurrent branch of the radial. These vessels form a complete anastomotic network around the joint.

The nerves of the joint are a twig from the ulnar, as it passes between the medial condyle and the olecranon; a filament from the musculocutaneous, and two from the median.

Portions of joint

The elbow-joint comprises three different portions. All these articular surfaces are enveloped by a common synovial membrane, and the movements of the whole joint should be studied together.

Joint	From	To	Description
humeroulnar joint	trochlear notch of the ulna	trochlea of humerus	Is a simple hinge-joint, and allows of movements of flexion and extension only.
humeroradial joint	head of the radius	capitulum of the humerus	Is a hinge-joint.
proximal radioulnar joint	head of the radius	radial notch of the ulna	In any position of flexion or extension, the radius, carrying the hand with it, can be rotated in it. This movement includes pronation and supination.

The combination of the movements of flexion and extension of the forearm with those of pronation and supination of the hand, which is ensured by the two being performed at the same joint, is essential to the accuracy of the various minute movements of the hand.

The hand is only directly articulated to the distal surface of the radius, and the ulnar notch on the lower end of the radius travels around the lower end of the ulna. The ulna is excluded from the wrist-joint by the articular disk.

Thus, rotation of the head of the radius around an axis passing through the center of the radial head of the humerus imparts circular movement to the hand through a very considerable arc.

Ligaments

The trochlea of the humerus is received into the semilunar notch of the ulna, and the capitulum of the humerus articulates with the fovea on the head of the radius. The articular surfaces are connected together by a capsule, which is thickened medially and laterally, and, to a less extent, in front and behind. These thickened portions are usually described as distinct ligaments.

The major ligaments are the ulnar collateral ligament, radial collateral ligament, and annular ligament.

Synovial membrane

The synovial membrane is very extensive. It extends from the margin of the articular surface of the humerus, and lines the coronoid, radial and olecranon fossæ on that bone; it is reflected over the deep surface of the capsule and forms a pouch between the radial notch, the deep surface of the annular ligament, and the circumference of the head of the radius. Projecting between the radius and ulna into the cavity is a crescentic fold of synovial membrane, suggesting the division of the joint into two; one the humeroradial, the other the humeroulnar.

Between the capsule and the synovial membrane are three masses of fat:

- the largest, over the olecranon fossa, is pressed into the fossa by the Triceps brachii during the flexion;
- the second, over the coronoid fossa,
- and the third, over the radial fossa, are pressed by the Brachialis into their respective fossæ during extension.

Terminology: "Elbow" , "Ell"

The now obsolete length unit ell relates closely to the elbow. This becomes especially visible when considering the Germanic origins of both words, *Elle* (ell, defined as the length of a male forearm from elbow to fingertips) and *Ellbogen* (elbow). It is unknown when or why the second "l" was dropped from English usage of the word.

Carrying angle

Normal radiograph; right picture of the straightened arm shows the carrying angle of the elbow

When the arm is extended, with the palm facing forward or up, the bones of the humerus and forearm are not perfectly aligned. The deviation from a straight line occurs in the direction of the thumb, and is referred to as the “carrying angle” (visible in the right half of the picture, right).

The carrying angle permits the arm to be swung without contacting the hips. Women on average have smaller shoulders and wider hips than men, which may necessitate a greater carrying angle. There is, however, extensive overlap in the carrying angle between individual men and women, and a sex-bias has not been consistently observed in scientific studies.

The angle is greater in the dominant limb than the non-dominant limb of both sexes, suggesting that natural forces acting on the elbow modify the carrying angle. Developmental, ageing and possibly racial influences add further to the variability of this parameter.

The carrying angle can influence how objects are held by individuals — those with a more extreme carrying angle may be more likely to pronate the forearm when holding objects in the hand to keep the elbow closer to the body.

Diseases

The types of disease most commonly seen at the elbow are due to injury.

Tendonitis

Two of the most common injuries at the elbow are overuse injuries: tennis elbow and golfer's elbow. Golfer's elbow involves the tendon of the common flexor origin which originates at the medial epicondyle of the humerus (the "inside" of the elbow). Tennis elbow is the equivalent injury, but at the common extensor origin (the lateral epicondyle of the humerus).

Fractures

There are three bones at the elbow joint, and any combination of these bones may be involved in a fracture of the elbow. Patients who are able to fully extend their arm at the elbow are unlikely to have a fracture (98% certainty) and an X-ray is not required as long as an olecranon fracture is ruled out.

Dislocation

Lateral X ray of a dislocated right elbow

AP X ray of a dislocated right elbow

Elbow dislocations constitute 10% to 25% of all injuries to the elbow. The elbow is one of the most commonly dislocated joints in the body, with an average annual incidence of acute dislocation of 6 per 100,000 persons. Among injuries to the upper extremity, dislocation of the elbow is second only to a dislocated shoulder.

Infection

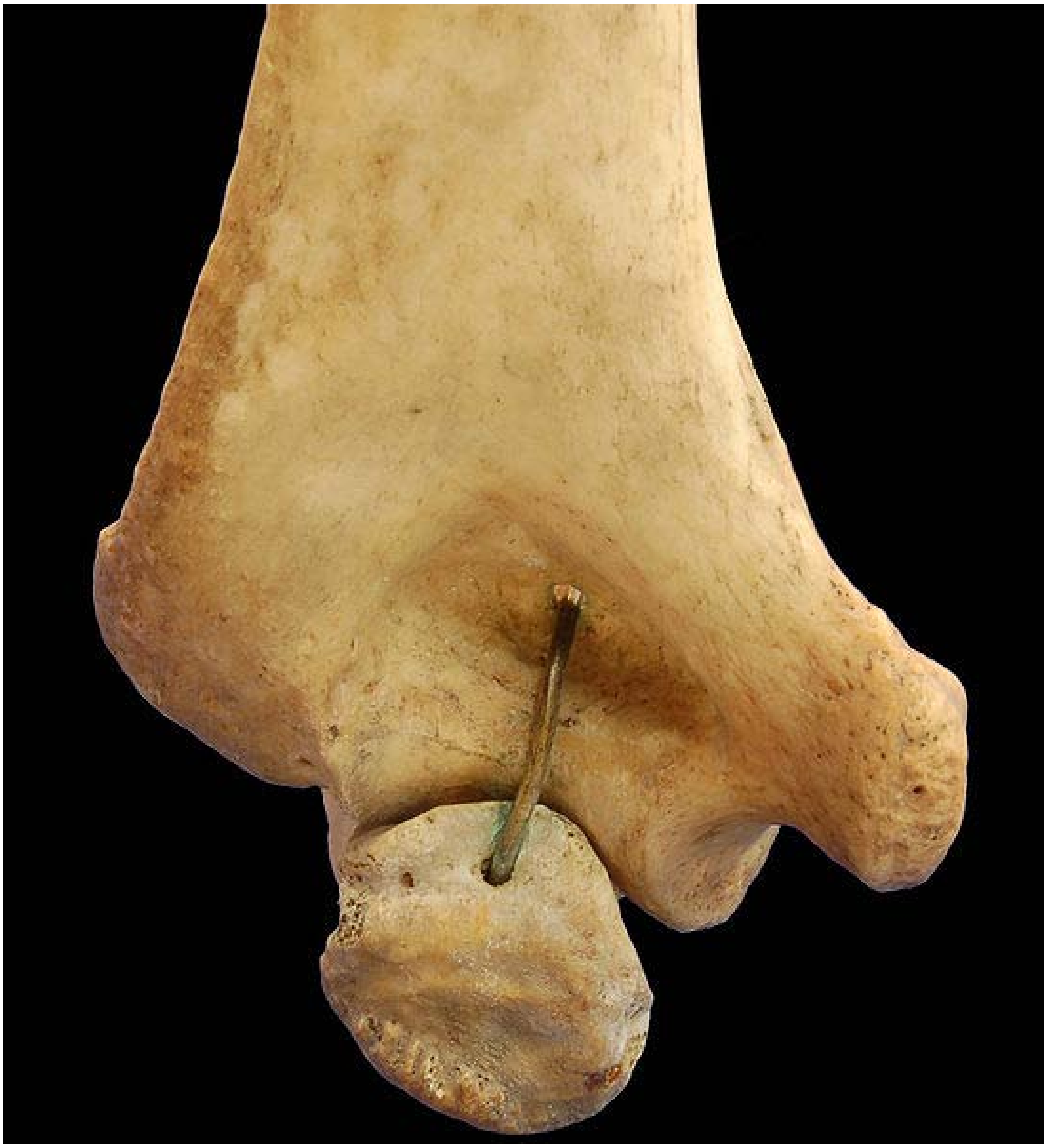
Infection of the elbow joint (septic arthritis) is uncommon. It may occur spontaneously, but may also occur in relation to surgery or infection elsewhere in the body (for example, endocarditis).

Arthritis

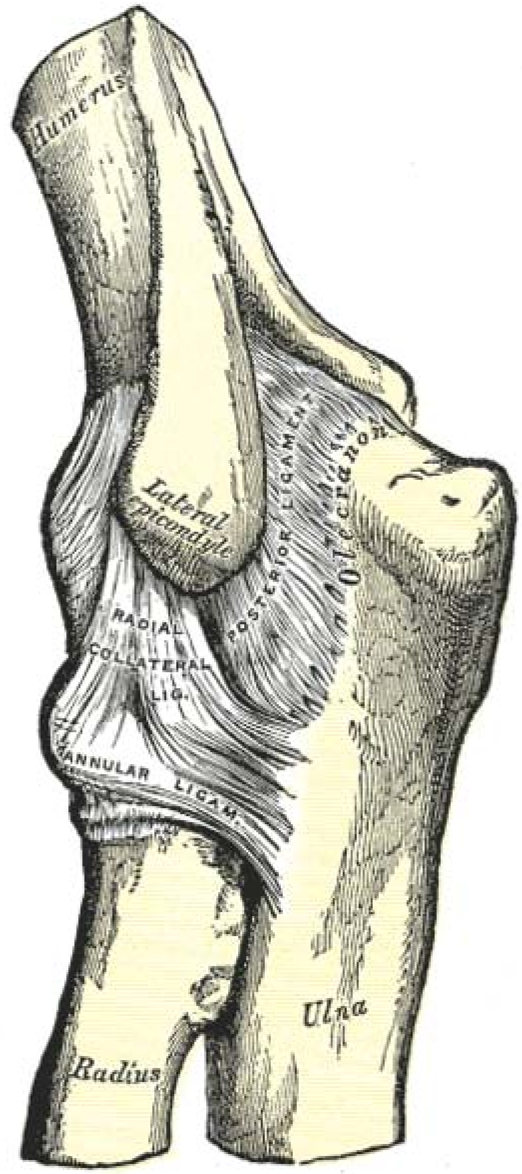
Elbow arthritis is usually seen in individuals with rheumatoid arthritis or after fractures that involve the joint itself. When the damage to the joint is severe, fascial arthroplasty or elbow joint replacement may be considered.

Medial Humerus Radius Ulna Articulated

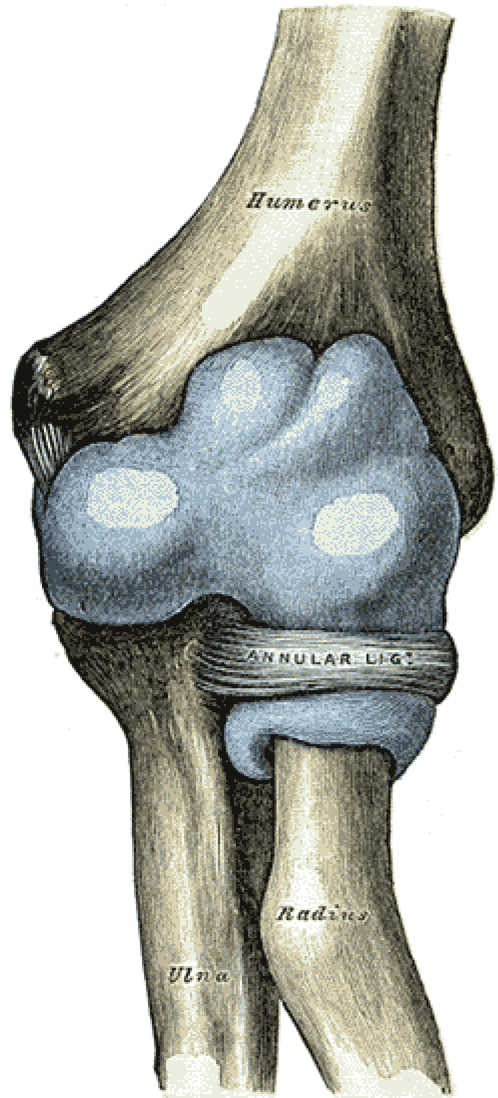
Left Human Posterior Distal Humerus Extended



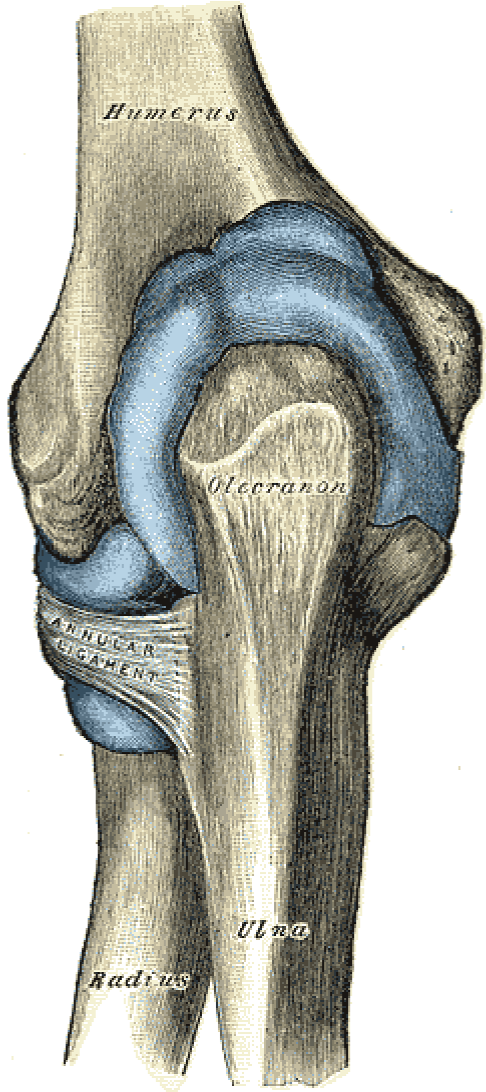
Left Human Posterior Distal Humerus Flexed



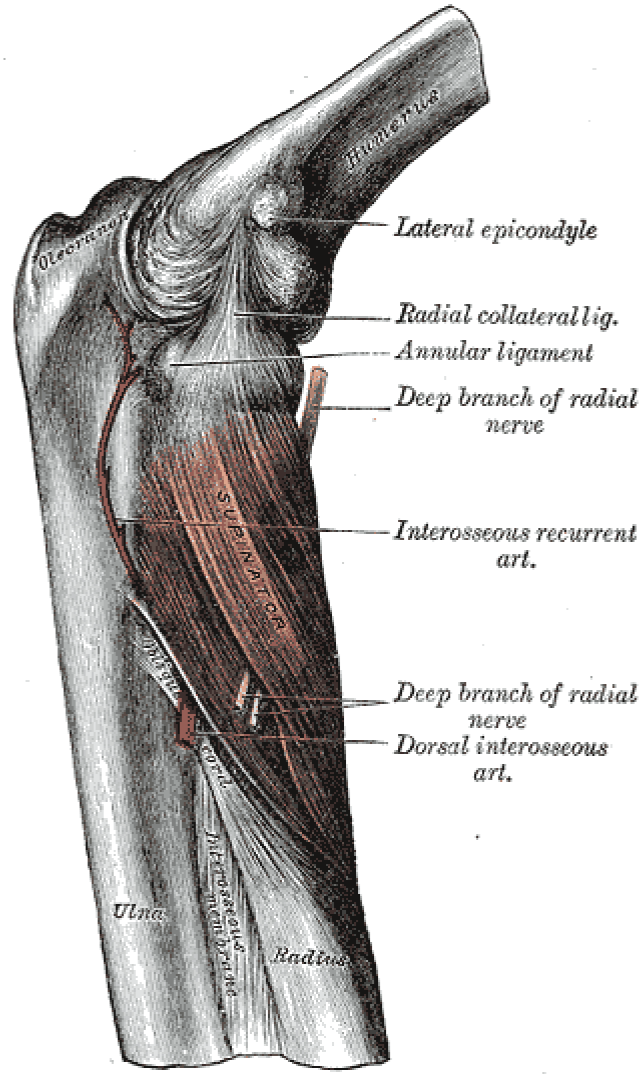
Left elbow-joint, showing posterior and radial collateral ligaments



Capsule of elbow-joint (distended). Anterior aspect.



Capsule of elbow-joint (distended). Posterior aspect.



The Supinator. Posterior view.

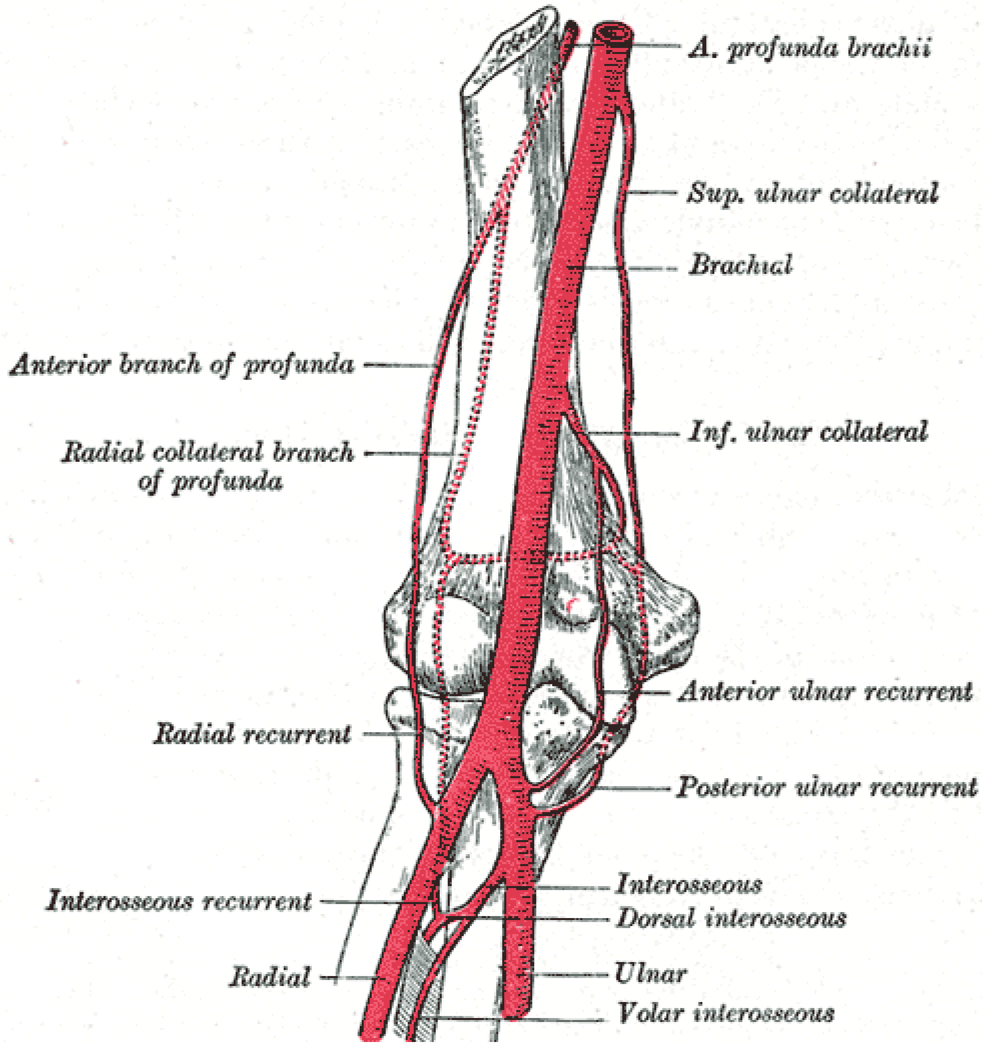
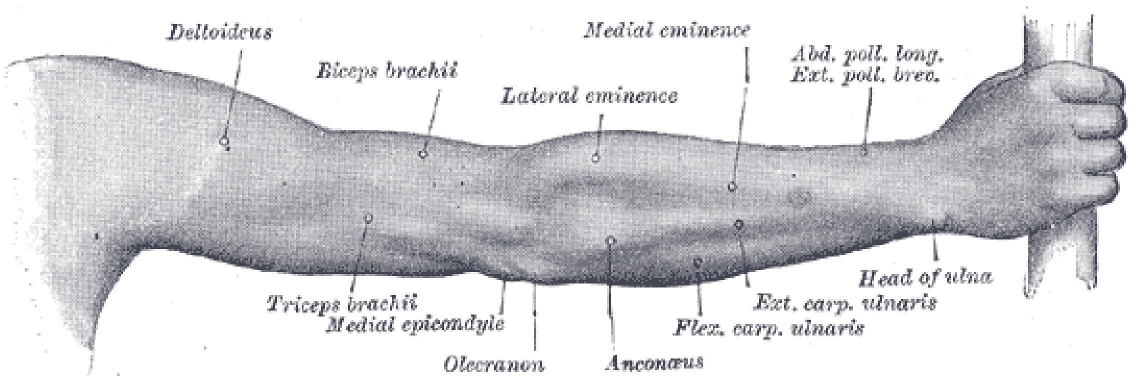


Diagram of the anastomosis around the elbow-joint



Back of right upper extremity

Close-up radiograph, right elbow-joint

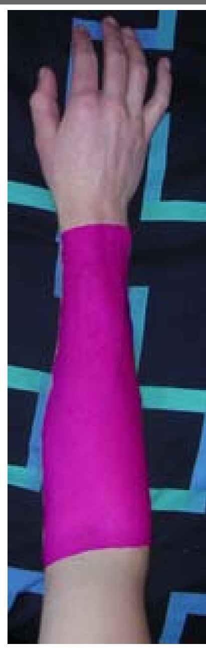
Pathological fusion of three bones at elbow

Elbow

Chapter 15

Forearm

Forearm	



Upper limb, forearm pronated. The forearm is the part of the upper limb between the elbow and the wrist.

Latin	*antebrachium*
MeSH	*Forearm*

The **forearm** is the structure and distal region of the upper limb, between the elbow and the wrist. The term forearm is used in anatomy to distinguish it from the arm, a word which is most often used to describe the entire appendage of the upper limb but in anatomy, technically means only the region of the upper arm whereas the lower "arm" is called the forearm. It is homologous to the leg that lies between the knee and the ankle joints.

The forearm contains two long bones, the radius and the ulna, forming the **radioulnar joint**. The interosseous membrane connects these bones. Ultimately, the forearm is covered by skin, the anterior surface usually being less hairy than the posterior surface.

The forearm contains many muscles, including the flexors and extensors of the digits, a flexor of the elbow (brachioradialis), and pronators and supinators that turn the hand to face down or upwards, respectively. In cross-section the forearm can be divided into two fascial compartments. The posterior compartment contains the extensors of the hands, which are supplied by the radial nerve. The anterior compartment contains the flexors, and is mainly supplied by the median nerve. The ulnar nerve also runs the length of the forearm.

The radial and ulnar arteries, and their branches, supply the blood to the forearm. These usually run on the anterior face of the radius and ulna down the whole forearm. The main superficial veins of the forearm are the cephalic, median antebrachial and the basilic vein. These veins can be used for cannularisation or venipuncture, although the cubital fossa is a preferred site for getting blood.

Anatomy

Bones

- radius
- ulna

Joints

- **proximal to forearm**
  - elbow
- **in the forearm**
  - proximal radioulnar joint
  - distal radioulnar joint
- *distal to forearm*
  - wrist

Muscles

Compartment	Level	Muscle	E/I	Nerve
Anterior	superficial	flexor carpi radialis	E	median
Anterior	superficial	palmaris longus	E	median
Anterior	superficial	flexor carpi ulnaris	E	ulnar
Anterior	superficial	pronator teres	I	median
Anterior	superficial (or intermediate)	flexor digitorum superficialis (sublimis)	E	median
Anterior	deep	flexor digitorum profundus	E	ulnar +

				median
Anterior	deep	flexor pollicis longus	E	median
Anterior	deep	pronator quadratus	I	median
Posterior		brachioradialis	I	radial
Posterior	superficial	extensor carpi radialis longus	E	radial
Posterior	superficial	extensor carpi radialis brevis	E	radial
Posterior	intermediate	extensor digitorum (communis)	E	radial
Posterior	intermediate	extensor digiti minimi (proprius)	E	radial
Posterior	superficial	extensor carpi ulnaris	E	radial
Posterior	deep	abductor pollicis longus	E	radial
Posterior	deep	extensor pollicis brevis	E	radial
Posterior	deep	extensor pollicis longus	E	radial
Posterior	deep	extensor indicis (proprius)	E	radial
Posterior	deep	supinator	I	radial
Posterior	deep	anconeus	I	radial

- "E/I" refers to "extrinsic" or "intrinsic". The intrinsic muscles of the forearm act on the forearm, meaning, across the elbow joint and the proximal and distal radioulnar joints (resulting in pronation or supination, whereas the extrinsic muscles act upon the hand and wrist. In most cases, the extrinsic anterior muscles are *flexors*, while the extrinsic posterior muscles are *extensors*.

- The Brachioradialis, flexor of the forearm, is unusual in that it is located in the posterior compartment, but it is actually in the anterior portion of the forearm.

Nerves

- Median nerve – principle nerve of the anterior compartment (PT, FCR, PL, FDS).
    - anterior interosseous nerve (supplies FPL, lat. 1/2 of FDP, PQ).
- Radial nerve – supplies muscles of the posterior compartment (ECRL, ECRB).
    - Superficial branch of radial nerve
    - Deep branch of radial nerve, becomes Posterior interosseus nerve and supplies muscles of the posterior compartment (ED, EDM, ECU, APL, EPB, EPL, EI).
- Ulnar nerve - supplies some medial muscles (FCU, med. 1/2 of FDP).

Vessels

- Brachial artery
    - Radial artery
        - Radial recurrent artery
    - Ulnar artery

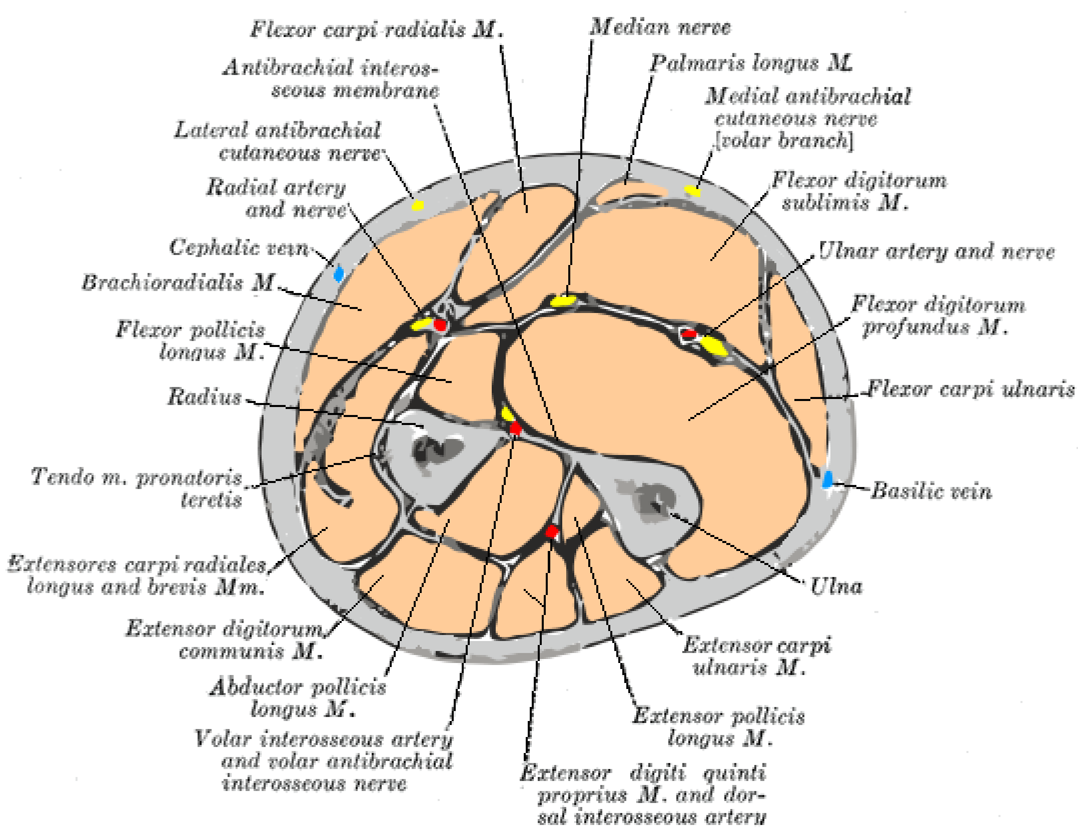
- Pulmonary artery
- Anterior ulnar recurrent artery and posterior ulnar recurrent artery
- Common interosseous artery
    - Posterior interosseous artery
    - Anterior interosseous artery

Other structures

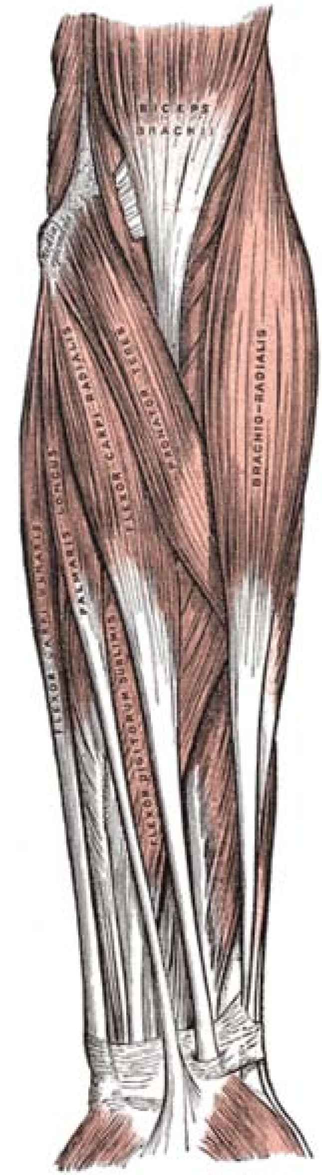
- Interosseous membrane of forearm
- Annular ligament of ulna

Fracture

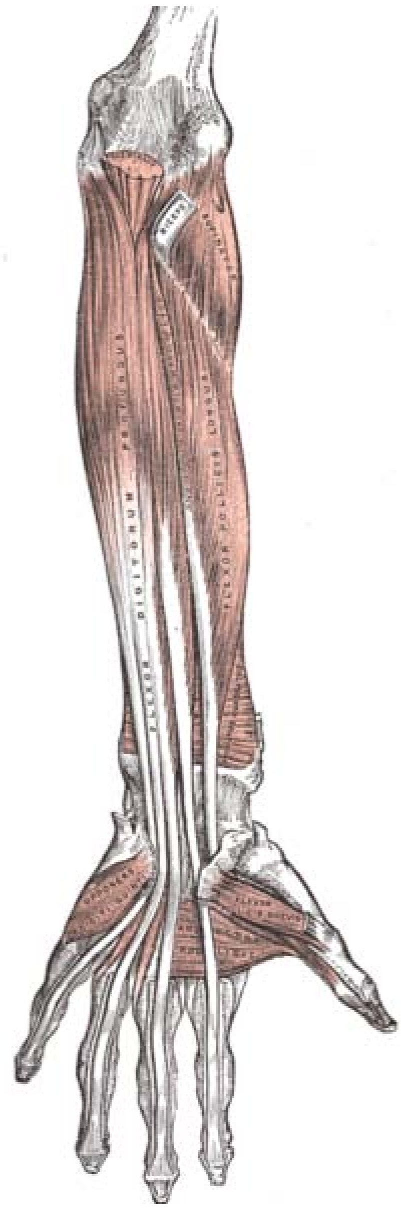
A fracture of the forearm can be classified as to whether it involves only the ulna (ulnar fracture), only the radius (radius fracture) or both (radioulnar fracture)



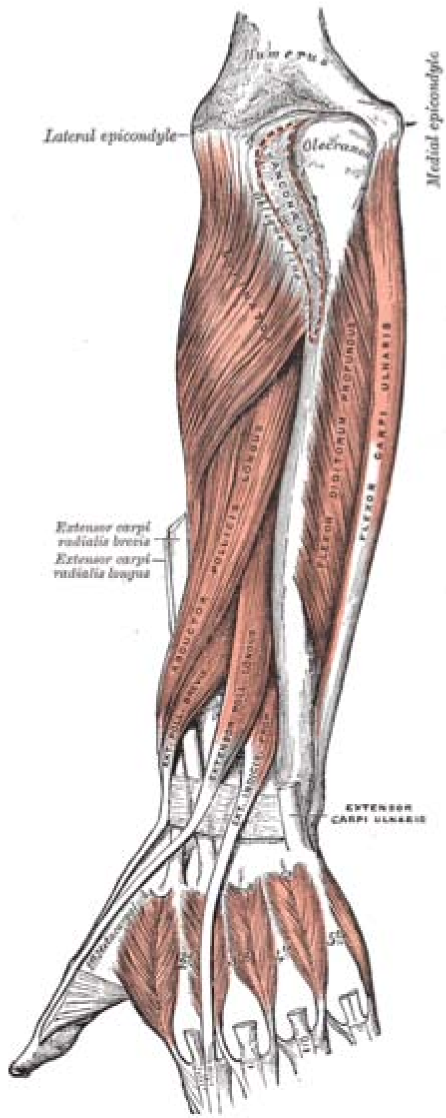
Cross-section through the middle of the forearm



Superficial muscles of the forearm



Deep muscles of the anterior forearm



Deep muscles of the posterior forearm

Chapter 16

Wrist

wrist joint

A human wrist.

Latin	*articulatio radiocarpea*
Gray's	*subject #86 327*
MeSH	*Wrist+joint*

In human anatomy, the **wrist** is variously defined as 1) the carpus or carpal bones, the complex of eight bones forming the proximal skeletal segment of the hand; (2) the **wrist joint** or **radiocarpal joint**, the joint between the radius and the carpus; and (3) the anatomical region surrounding the carpus including the distal parts of the bones of the forearm and the proximal parts of the metacarpus or five metacarpal bones and the series of joints between these bones, thus referred to as *wrist joints*. This region also includes the carpal tunnel, the anatomical snuff box, the flexor retinaculum, and the extensor retinaculum.

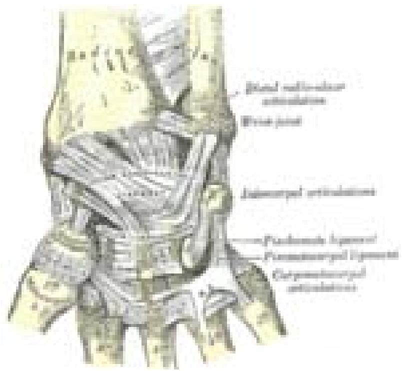
As a consequence of these various definitions, fractures to the carpal bones are referred to as carpal fractures, while fractures such as distal radius fracture are considered fractures to the wrist.

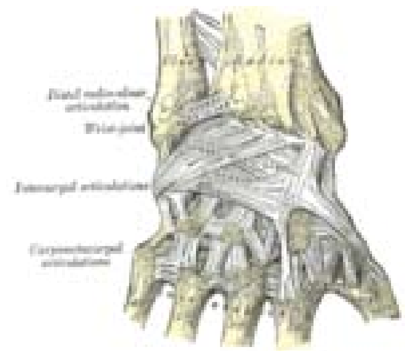
Etymology

The English word "wrist" is etymologically derived from the prehistoric German word *wristiz* from which are derived modern German *rist* ("instep", "wrist") and modern Swedish *vrist* ("instep", "ankle"). The base *writh-* and its variants are associated with Old English words "wreath", "wrest", and "writhe". The *wr-* sound of this base seems originally to have been symbolic of the action of twisting.

Anatomy

Posterior and anterior aspects of right human wrist





Ligaments of wrist. Posterior and anterior views

Articulations

The radiocarpal, intercarpal, midcarpal, carpometacarpal, and intermetacarpal joints often intercommunicate through a common synovial cavity.

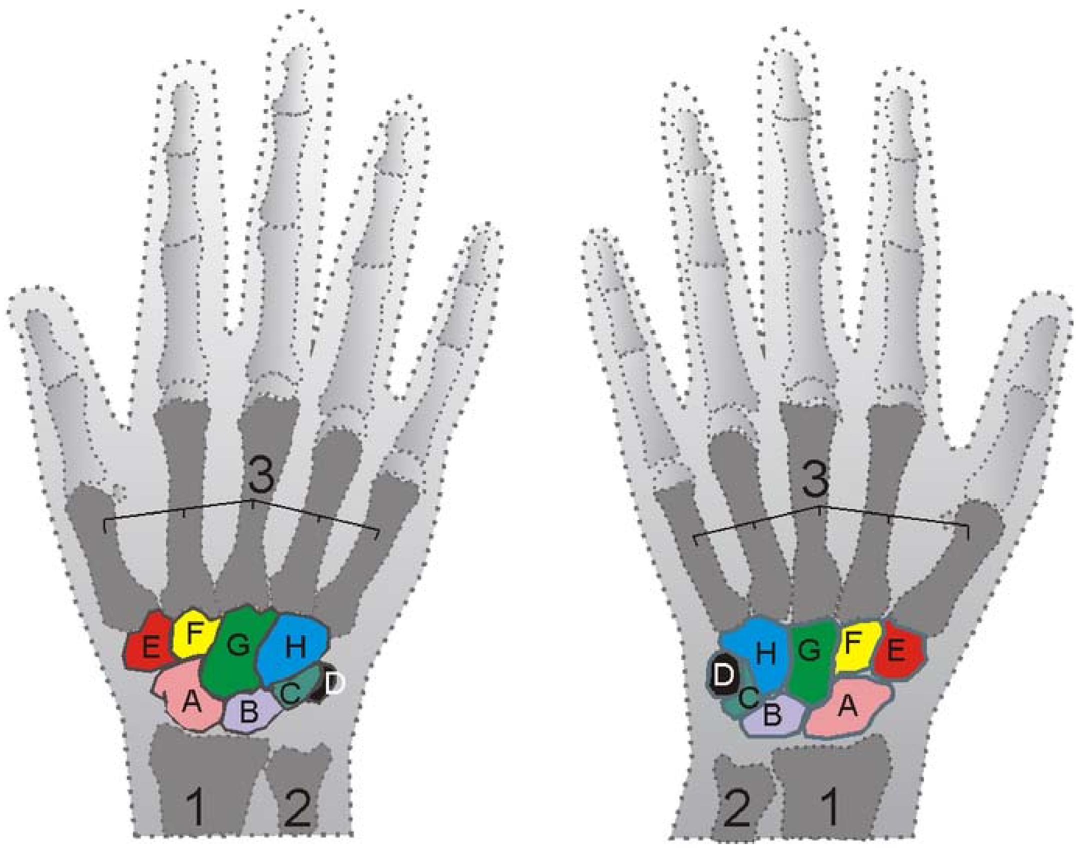
Extrinsic hand

The distal radioulnar joint is a pivot joint located between the bones of the forearm, the radius and ulna. Formed by the head of ulna and the ulnar notch of radius, this joint is separated from the radiocarpal joint by an articular disk lying between the radius and the styloid process of ulna. The capsule of the joint is lax and extends from the inferior sacciform recess to the ulnar shaft. Together with the proximal radioulnar joint, the distal radioulnar joint permits pronation and supination.

The radiocarpal joint or wrist joint is an ellipsoid joint formed by the radius and the articular disk proximally and the proximal row of carpal bones distally. The carpal bones on the ulnar side only make intermittent contact with the proximal side — the triquetrum only makes contact during ulnar abduction. The capsule, lax and un-branched, is thin on the dorsal side and can contain synovial folds. The capsule is continuous with the midcarpal joint and strengthened by numerous ligaments, including the palmar and dorsal radiocarpal ligaments, and the ulnar and radial collateral ligaments.

The parts forming the radiocarpal joint are the lower end of the radius and under surface of the articular disk above; and the scaphoid, lunate, and triquetral bones below. The articular surface of the radius and the under surface of the articular disk form together a transversely elliptical concave surface, the receiving cavity. The superior articular surfaces of the scaphoid, lunate, and triquetrum form a smooth convex surface, the condyle, which is received into the concavity.

Intrinsic hand



Carpus

In the hand proper a total of 13 bones form part of the wrist: eight carpal bones—scaphoid, lunate, triquetral, pisiform, trapezium, trapezoid, capitate, and hamate— and five metacarpal bones—the first, second, third, fourth, and fifth metacarpal bones.

The midcarpal joint is the S-shaped joint space separating the proximal and distal rows of carpal bones. The intercarpal joints, between the bones of each row, are strengthened by the radiate carpal and pisohamate ligaments and the palmar, interosseous, and dorsal intercarpal ligaments. Some degree of mobility is possible between the bones of the proximal row while the bones of the distal row are connected to each others and to the metacarpal bones —at the carpometacarpal joints— by strong ligaments —the pisometacarpal and palmar and dorsal carpometacarpal ligament— that makes a functional entity of these bones. Additionally, the joints between the bases of the metacarpal bones —the intermetacarpal articulations— are strengthened by dorsal, interosseous, and palmar intermetacarpal ligaments.

Movements and muscles

The extrinsic hand muscles are located in the forearm where their bellies form the proximal fleshy roundness. When contracted, most of the tendons of these muscles are prevented from standing up like taut bowstrings around the wrist by passing under the flexor retinaculum on the palmar side and the extensor retinaculum on the dorsal side. On the palmar side the carpal bones form the carpal tunnel through which some of the flexor tendons pass in tendon sheaths that enable them to slide back and forth through the narrow passageway.

Starting from the mid-position of the hand, the movements permitted in the wrist proper are (muscles in order of importance):

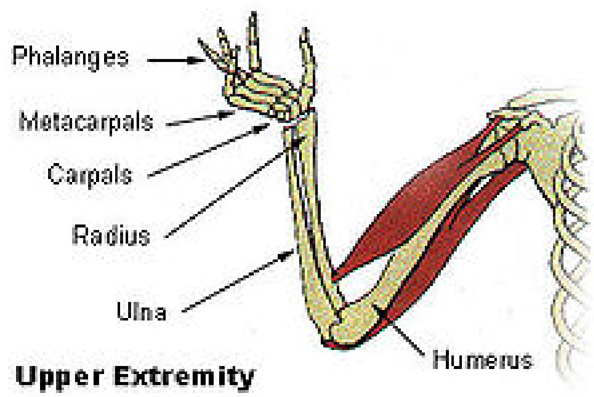
- Marginal movements: radial deviation (abduction, movement towards the thumb) and ulnar deviation (adduction, movement towards the little finger). These movements take place at the radiocarpal and midcarpal joints through a transverse axis passing through the capitate bone.
    - Radial abduction: extensor carpi radialis longus, abductor pollicis longus, extensor pollicis longus, flexor carpi radialis, flexor pollicis longus
    - Ulnar abduction: extensor carpi ulnaris, flexor carpi ulnaris, extensor digitorum, extensor digiti minimi
- Movements in the plane of the hand: flexion (palmar flexion, tilting towards the palm) and extension (dorsiflexion, tilting towards the back of the hand). These movements take place about a dorsopalmar axis (back to front) passing through the capitate bone. Palmar flexion is the most powerful of these movements because the flexors, especially the finger flexors, are considerably stronger than the extensors.
    - Extension: extensor digitorum, extensor carpi radialis longus, extensor carpi radialis brevis, extensor indicis, extensor pollicis longus, extensor digiti minimi
    - Palmar flexion: flexor digitorum superficialis, flexor digitorum profundus, flexor carpi ulnaris, flexor pollicis longus, flexor carpi radialis, abductor pollicis longus
- Intermediate or combined movements

However, movements at the wrist can not be properly described without including movements in the distal radioulnar joint in which the rotary actions of supination and pronation occur and this joint is therefore normally regarded as part of the wrist.

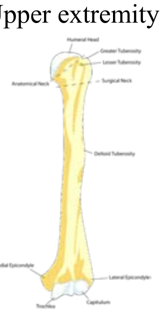
Chapter 17

Humerus

Bone: Humerus



Upper extremity



Gray's	*subject #51 209*
MeSH	*Humerus*

The **humerus** (ME from Latin *humerus, umerus* upper arm, shoulder; Gothic *ams* shoulder, Greek *ōmos*) is a long bone in the arm or forelimb that runs from the shoulder to the elbow.

Anatomically, it connects the scapula and the lower arm (consisting of the radius and ulna), and consists of three sections. The upper extremity consists of a rounded head, a narrow neck, and two short processes (tubercles, sometimes called tuberosities.) Its body is cylindrical in its upper portion, and more prismatic below. The lower extremity consists of 2 epicondyles, 2 processes (trochlea & capitulum), and 3 fossae (radial fossa, coronoid fossa, and olecranon fossa). As well as its true anatomical neck, the constriction below the greater and lesser tubercles of the humerus is referred to as its surgical neck due to its tendency to commonly get fractured, thus often becoming the focus of surgeons.

Muscles attached to the humerus

The deltoid originates on the lateral third of the clavicle, acromion and the crest of the spine of the scapula. It is inserted on the deltoid tuberosity of the humerus and has several actions including abduction, extension, and rotation of the shoulder. The supraspinatus also originates on the spine of the scapula. It inserts on the greater tubercle of the humerus, and assists in abduction of the shoulder.

The pectoralis major, teres major, and latissimus dorsi insert at the *intertubercular groove* of the humerus. They work to adduct and medially, or internally, rotate the humerus.

The infraspinatus and teres minor insert on the greater tubercle, and work to laterally, or externally, rotate the humerus. In contrast, the subscapularis muscle inserts onto the lesser tubercle and works to medially, or internally, rotate the humerus.

The biceps brachii, brachialis, coracobrachialis, and brachioradialis (which attaches distally) act to flex the elbow. (The biceps, however, does not attach to the humerus.) The triceps brachii and anconeus extend the elbow, and attach to the posterior side of the humerus.

The four muscles of supraspinatus, infraspinatus, teres minor and subscapularis form a musculo-ligamentous girdle called the rotator cuff. This cuff stabilizes the very mobile but inherently unstable glenohumeral joint. The other muscles are used as counterbalances for the actions of lifting/pulling and pressing/pushing.

Articulations

At the shoulder, the head of the humerus articulates with the glenoid fossa of the scapula. More distally, at the elbow, the capitulum of the humerus articulates with the head of the radius, and the trochlea of the humerus articulates with the olecranon process of the ulna.

Nerves

The axillary nerve is located at the proximal end, against the shoulder girdle. The most common type of shoulder dislocation is an anterior or inferior dislocation of the humerus's glenohumeral joint, which has the potential to injure the axillary nerve or the axillary artery. Signs and symptoms of this dislocation include a loss of the normal shoulder contour and a palpable depression under the acromion.

The radial nerve follows the humerus closely. At the midshaft of the humerus, the radial nerve travels from the posterior to the anterior aspect of the bone in the *spiral groove*. A fracture of the humerus in this region can result in radial nerve injury.

The ulnar nerve at the distal end of the humerus near the elbow is sometimes referred to in popular culture as 'the funny bone'. Striking this nerve can cause a tingling sensation ("funny" feeling), and sometimes a significant amount of pain.

In other animals

Primitive fossil amphibians had little, if any, shaft connecting the upper and lower extremities, making their limbs very short. In most living vertebrates, however, the humerus has a similar form to that of humans. In many reptiles and some primitive mammals, the lower extremity includes a large foramen, or opening, into which nerves and blood vessels pass.

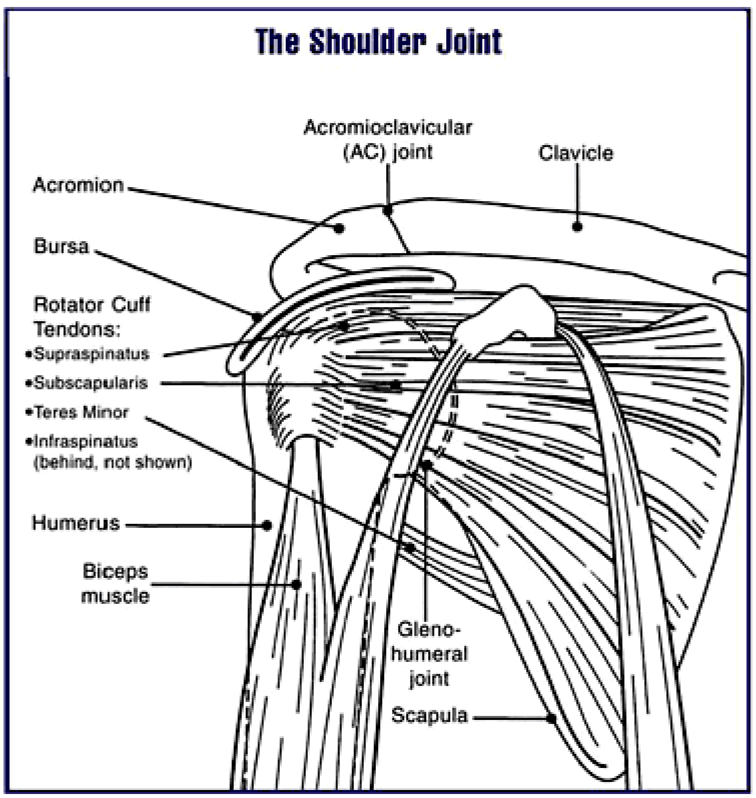
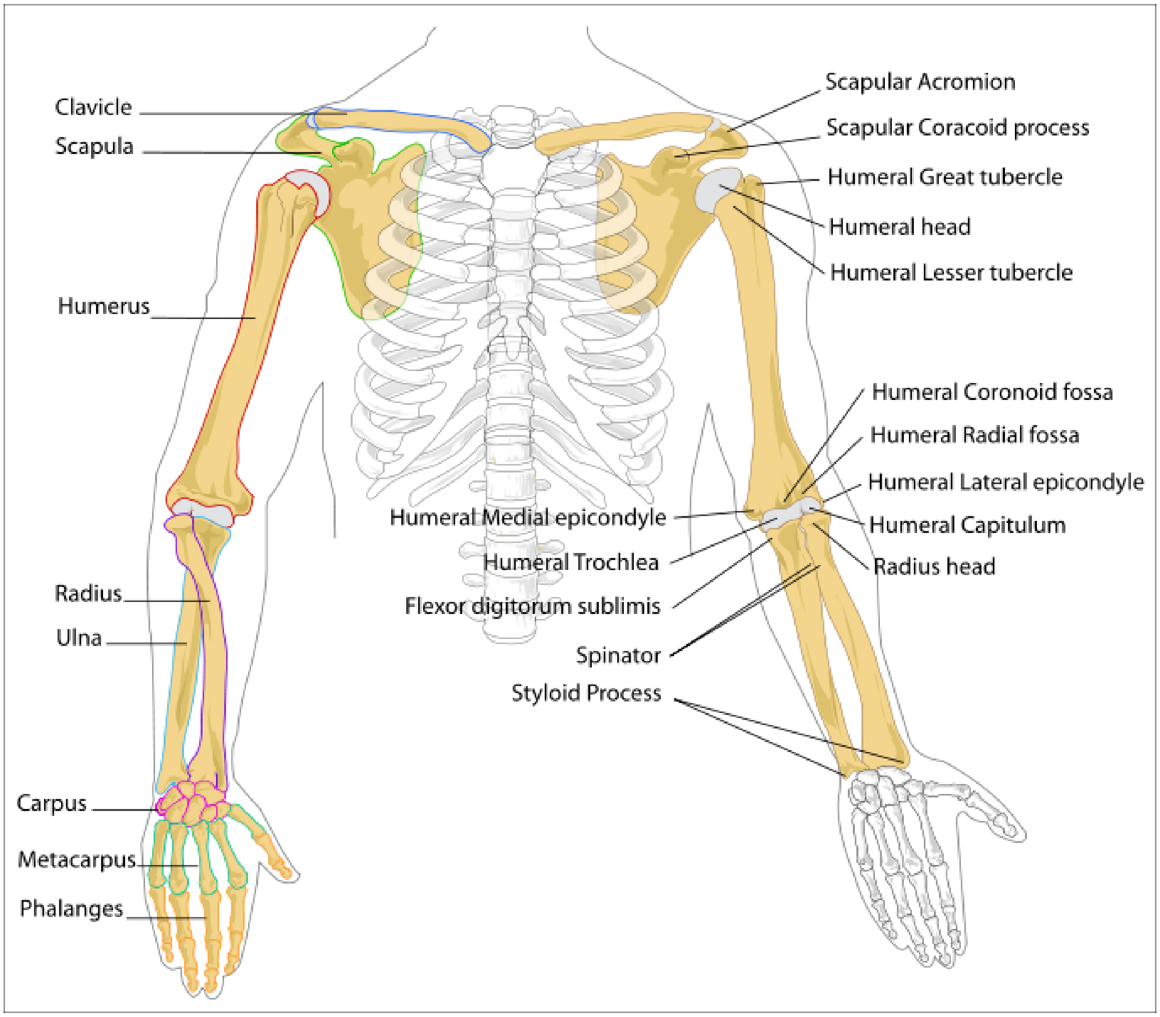


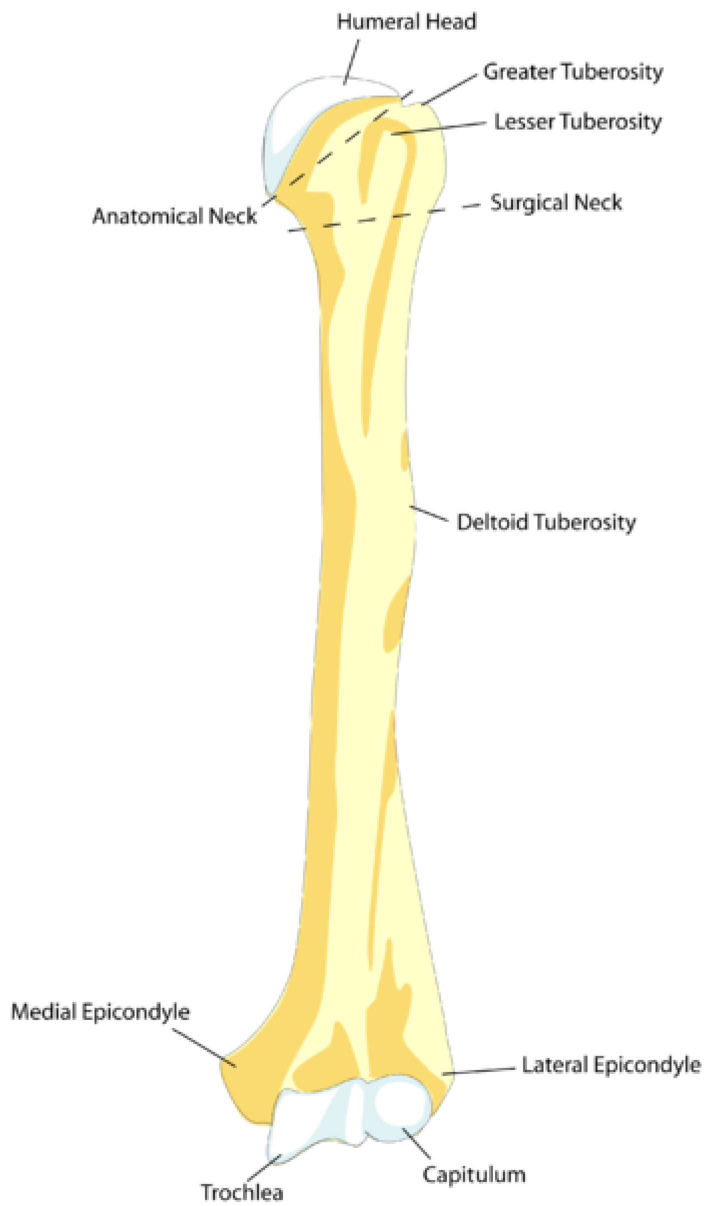
Diagram of the human shoulder joint



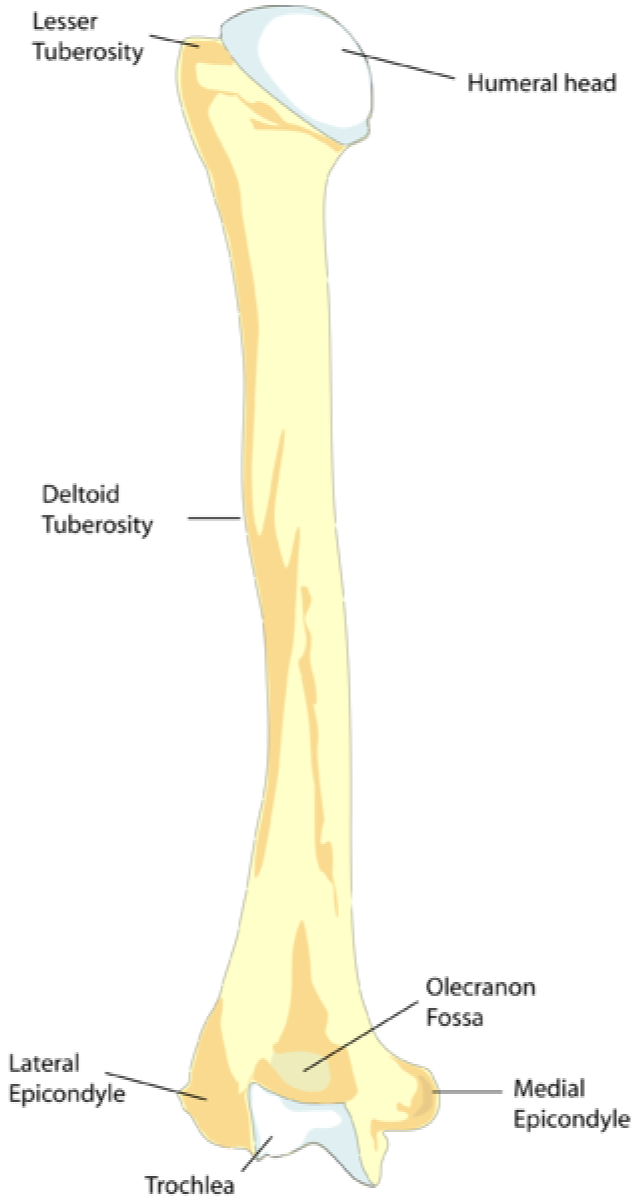
Human arm bones diagram

Humerus (right) - anterior view

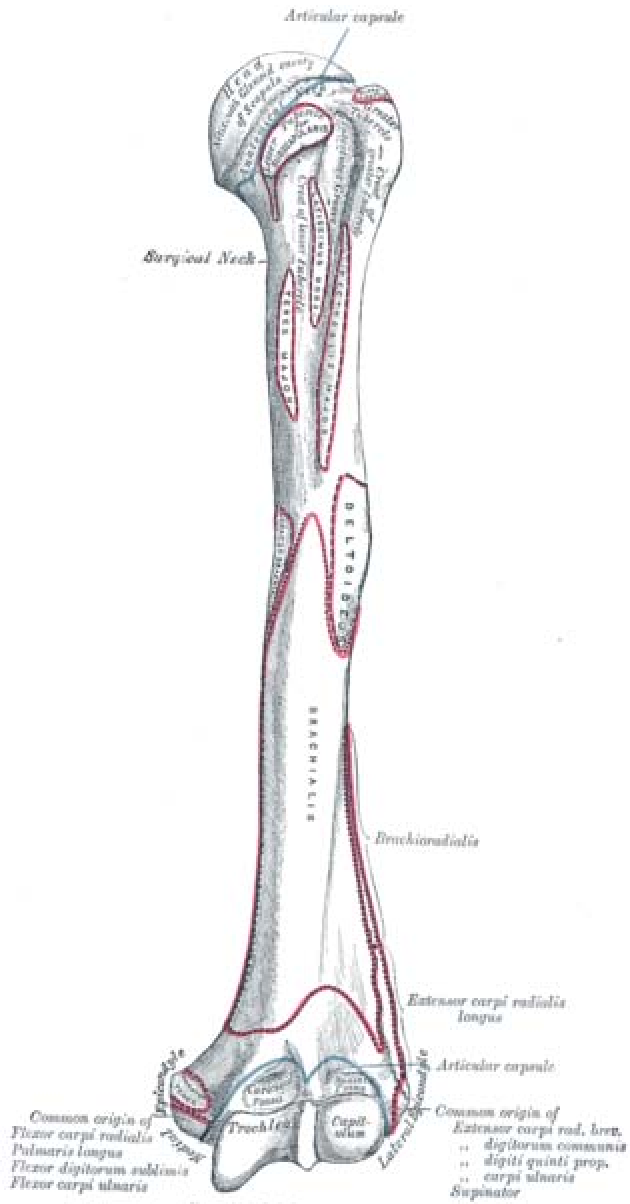
Humerus (right) - posterior view



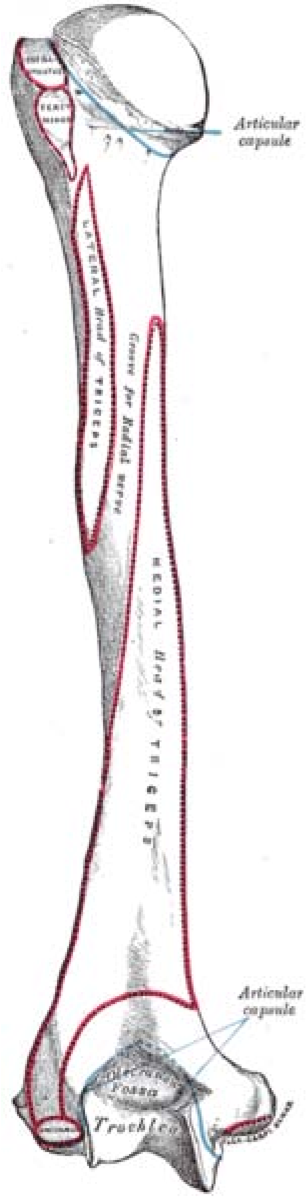
Left humerus. Anterior view.



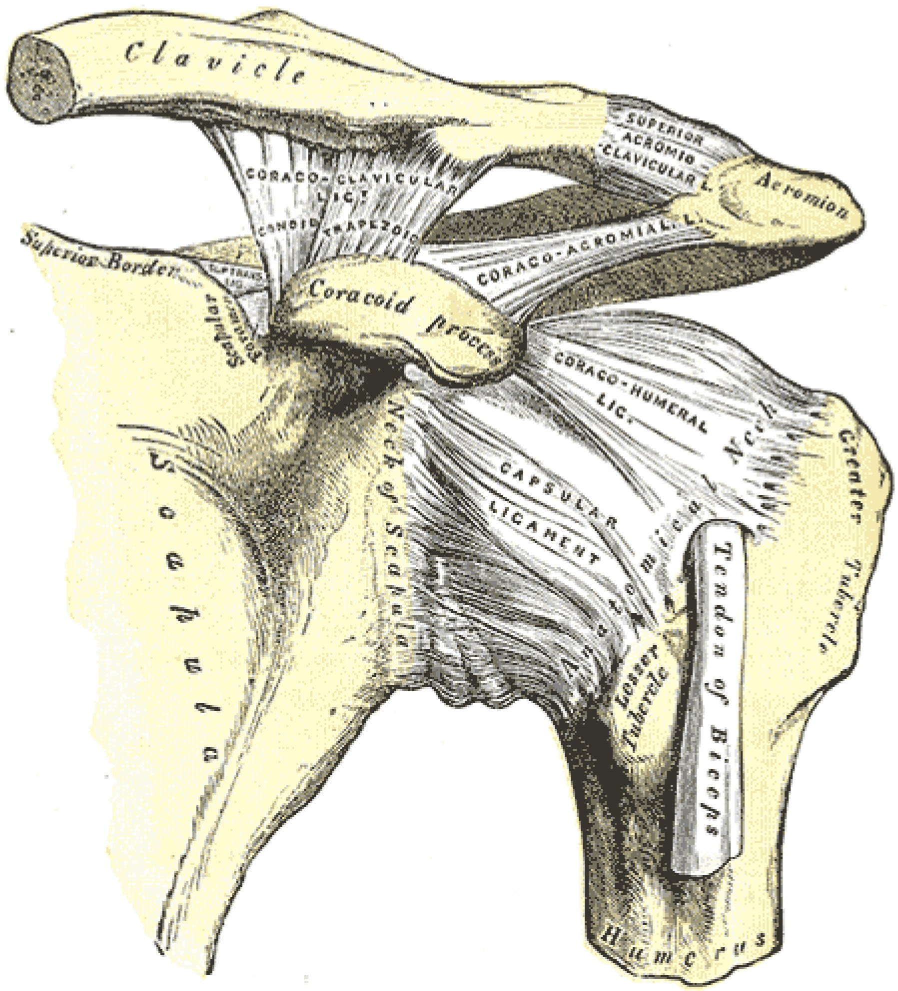
Left humerus. Posterior view.



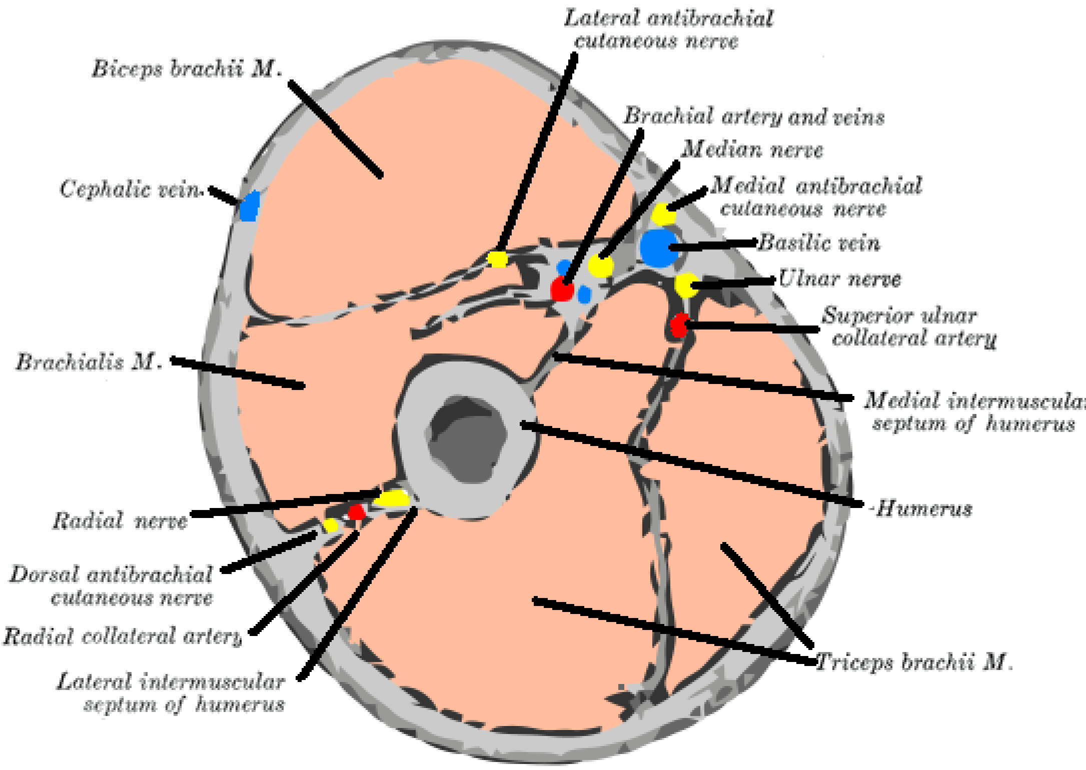
Left humerus with muscle attachments. Anterior view.



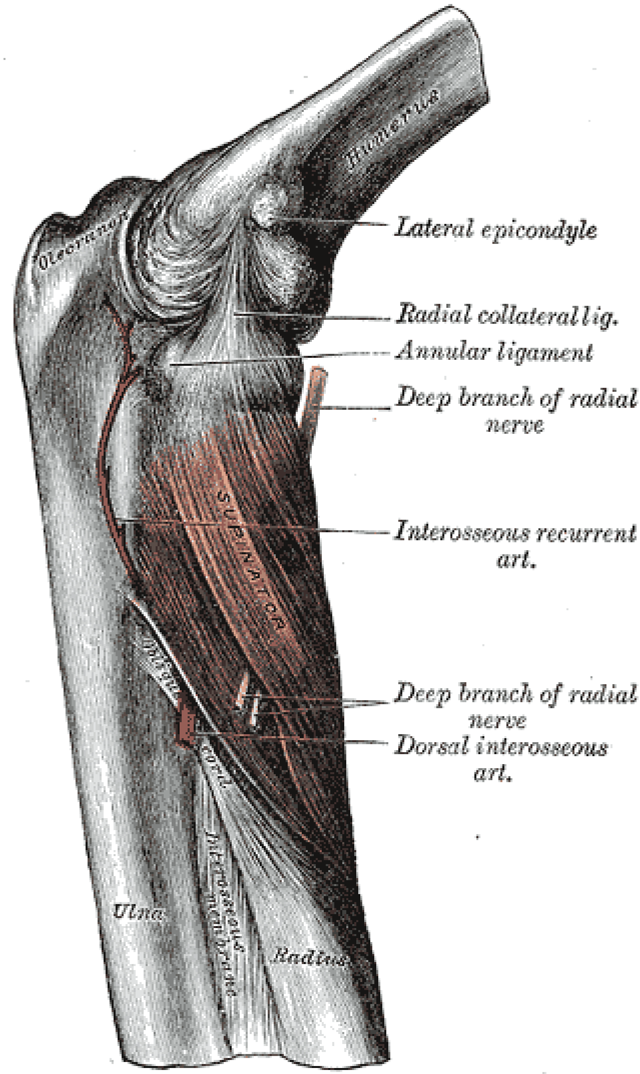
Left humerus with muscle attachments. Posterior view.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula



Cross-section through the middle of upper arm

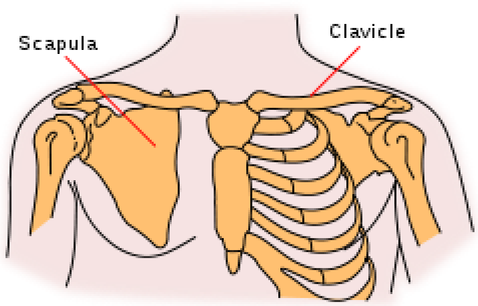


The Supinator

Chapter 18

Clavicle

Bone: Clavicle



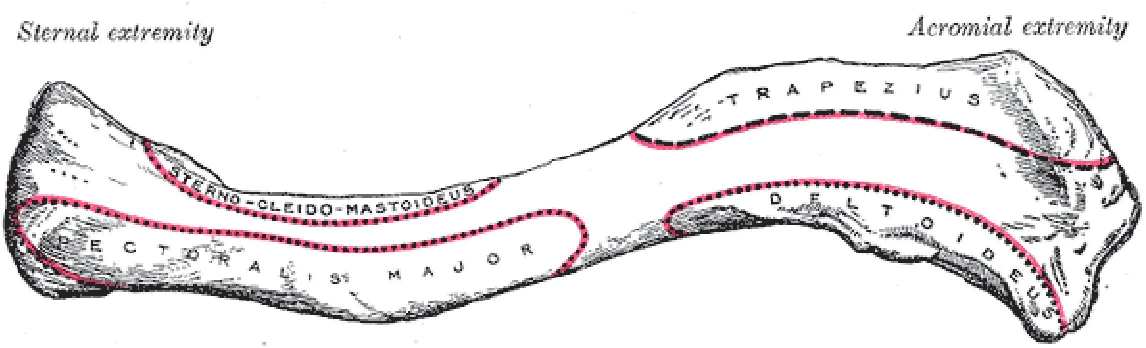
Gray's	*subject #49 200*
MeSH	*Clavicle*

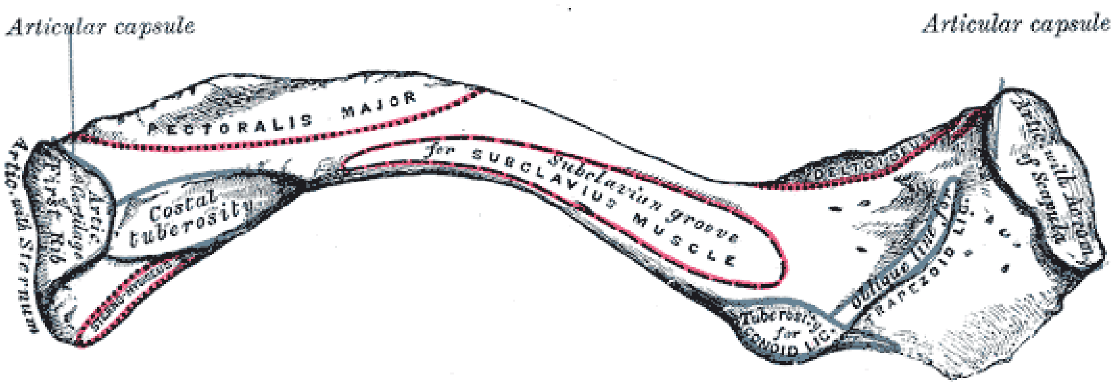
In human anatomy, the **clavicle** or **collar bone** is a long bone of short length that serves as a strut between the scapula and the sternum. It is the only long bone in body that lies horizontally. It makes up part of the shoulder and the pectoral girdle and is palpable in all people, and, in people who have less fat in this region, the location of the bone is clearly visible as it creates a bulge in the skin.

It receives its name from the Latin: *clavicula* ("little key") because the bone rotates along its axis like a key when the shoulder is abducted.

Human anatomy

Right clavicle — from below, and from above





Left clavicle — from above, and from below

The clavicle is a doubly curved short bone that connects the arm (upper limb) to the body (trunk), located directly above the first rib. It acts as a strut to keep the scapula in position so the arm can hang freely. Medially, it articulates with the manubrium of the sternum (breast-bone) at the sternoclavicular joint. At its lateral end it articulates with the acromion of the scapula (shoulder blade) at the acromioclavicular joint. It has a rounded medial end and a flattened lateral end.

From the roughly pyramidal sternal end, each clavicle curves laterally and anteriorly for roughly half its length. It then forms a smooth posterior curve to articulate with a process of the scapula (acromion). The flat, acromial end of the clavicle is broader than the sternal end. The acromial end has a rough inferior surface that bears prominent line, Trapezoid line and a small rounded projection, Conoid tubercle. These surface features are attachment sites for muscles and ligaments of the shoulder.

It can be divided into three parts. Medial end, lateral end and shaft.

Medial End

The medial end is quadrangular and articulates with clavicular notch of menubrium sterni to form sternoclavicular joint. Articular surface extends to anterior aspect for attachment with first costal cartilage.

It gives attachments to
1. Fibrous capsule of sternoclavicular joint **all around**
2. Articular disc **superoposteriorly**
3. Interclavicular ligament **superiorly**

Lateral End

The lateral end is flat from above downward downward. It bears a facet for attachment to acromion process of scapula forming acromioclavicular joint. The area surrounding the joint gives attachment to joint capsule.

Shaft

The shaft is divided into medial 2/3 and lateral 1/3. Medial 2/3 is thicker than lateral 1/3.

Medial 2/3 of shaft

Medial 2/3 of shaft has 4 surfaces and no borders.

Anterior surface is convex forward and gives origin to pectoralis major. **Posterior surface** is smooth and gives origin to sternohyoid muscle at its medial end. **Superior surface** is rough at its medial part and gives origin to sternocleidomastoid muscle . **Inferior surface** has an oval impression at its medial end for costoclavicular ligament. At the lateral side of inferior surface, there is a subclavian groove for insertion of subclavius muscle. At the lateral side of subclavian groove, nutrient foramen lies.

Lateral 1/3 of shaft

It has 2 borders and 2 surfaces.

Anterior border is concave forward and gives origin to deltoid muscle. **Posterior border** is convex backward and gives attachment to trapezius muscle . **Superior surface** is subcutaneous. **Inferior surface** has a ridge called trapezoid line and a tubercle, the conoid tubercle for attachment with trapezoid and conoid part of Coracoclavicular ligament that serves to connect the clavicle with the coracoid process of the scapula.

Attachments

Muscles and ligaments that attach to the clavicle include:

Attachment on clavicle	Muscle/Ligament	Other attachment
Superior surface and anterior border	Deltoid muscle	deltoid tubercle, anteriorly on the lateral third
Superior surface	Trapezius muscle	posteriorly on the lateral third
Inferior surface	Subclavius muscle	subclavian groove
Inferior surface	Conoid ligament (the medial part of the coracoclavicular ligament)	conoid tubercle
Inferior surface	Trapezoid ligament (the lateral part of the coracoclavicular ligament)	trapezoid line
Anterior border	Pectoralis major muscle	medial third (rounded border)
Posterior border	Sternocleidomastoid muscle (clavicular	superiorly, on the medial

	head)	third
Posterior border	Sternohyoid muscle	inferiorly, on the medial third
Posterior border	Trapezius muscle	lateral third

The levator claviculae muscle, present in 2–3% of people, originates on the transverse processes of the upper cervical vertebrae and is inserted in the lateral half of the clavicle.

Functions

The clavicle serves several functions:

- It serves as a rigid support from which the scapula and free limb (arm) are suspended; an arrangement that keeps the upper limb away from the thorax so that the arm has maximum range of movement. Acting as flexible, crane-like strut, it allows the scapula to move freely on the thoracic wall.
- Covering the cervicoaxillary canal, it protects the neurovascular bundle that supply the upper limb.
- Transmits physical impacts from the upper limb to the axial skeleton.

Development

The clavicle is the first bone to begin the process of ossification (laying down of minerals onto a preformed matrix) during development of the embryo, during the 5th and 6th weeks of gestation. However, it is one of the last bones to finish ossification, at about 21–25 years of age. It forms by intramembranous ossification. It consists of a mass of cancellous bone surrounded by a compact bone shell. The cancellous bone forms via two ossification centres, one medial and one lateral, which fuse later on. The compact forms as the layer of fascia covering the bone stimulates the ossification of adjacent tissue. The resulting compact bone is known as a periosteal collar.

Even though it is classified as a long bone, the clavicle has no medullary (bone marrow) cavity like other long bones. It is made up of spongy (trabecular) bone with a shell of compact bone. It is a dermal bone derived from elements originally attached to the skull.

Variations

The shape of the clavicle varies more than most other long bones. It is occasionally pierced by a branch of the supraclavicular nerve. In manual workers it is thicker and more curved and the sites of muscular attachments are more pronounced. The right clavicle is usually stronger and shorter than the left clavicle.

Common clavicle injuries

- Acromioclavicular dislocation
- Clavicle fractures
- Degeneration of the clavicle
- The collarbones are sometimes partly or completely absent in cleidocranial dysostosis
- Osteolysis
- Sternoclavicular dislocations

Evolutionary variation

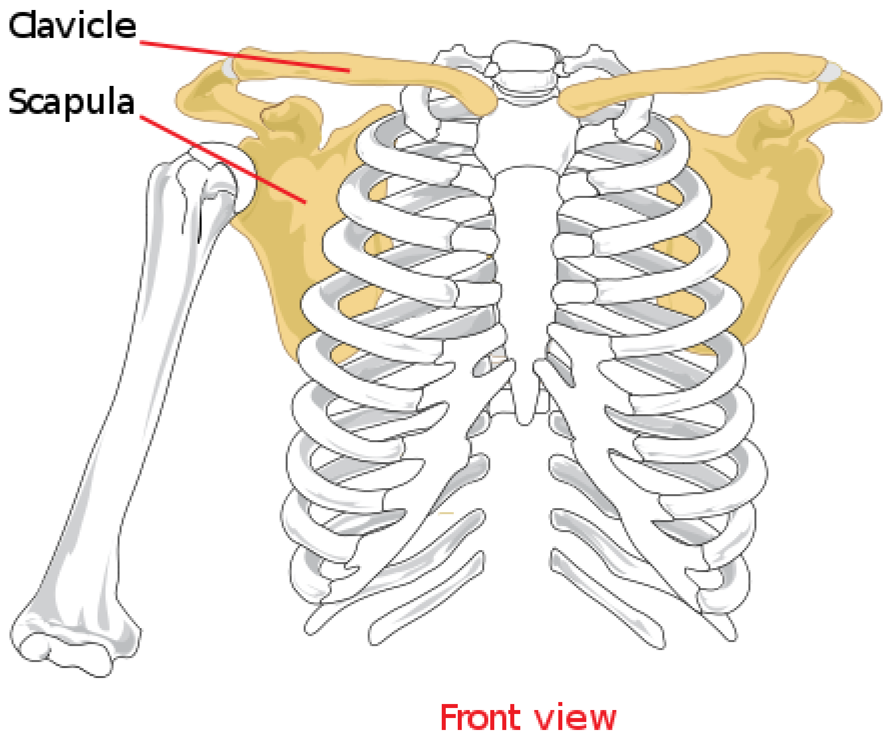
The clavicle first appears as part of the skeleton in primitive bony fish, where it is associated with the pectoral fin; they also have a bone called the cleithrum. In such fish, the paired clavicles run behind and below the gills on each side, and are joined by a solid symphysis on the fish's underside. They are, however, absent in cartilagenous fish and in the vast majority of living bony fish, including all of the teleosts.

The earliest tetrapods retained this arrangement, with the addition of a diamond-shaped **interclavicle** between the base of the clavicles, although this is not found in living amphibians. The cleithrum disappeared early in the evolution of reptiles, and is not found in any living amniotes, but the interclavicle is present in most modern reptiles, and also in monotremes. In modern forms, however, there are a number of variations from the primitive pattern. For example, crocodilians and salamanders lack clavicles altogether (although crocodilians do retain the interclavicle), while in turtles, they form part of the armoured plastron.

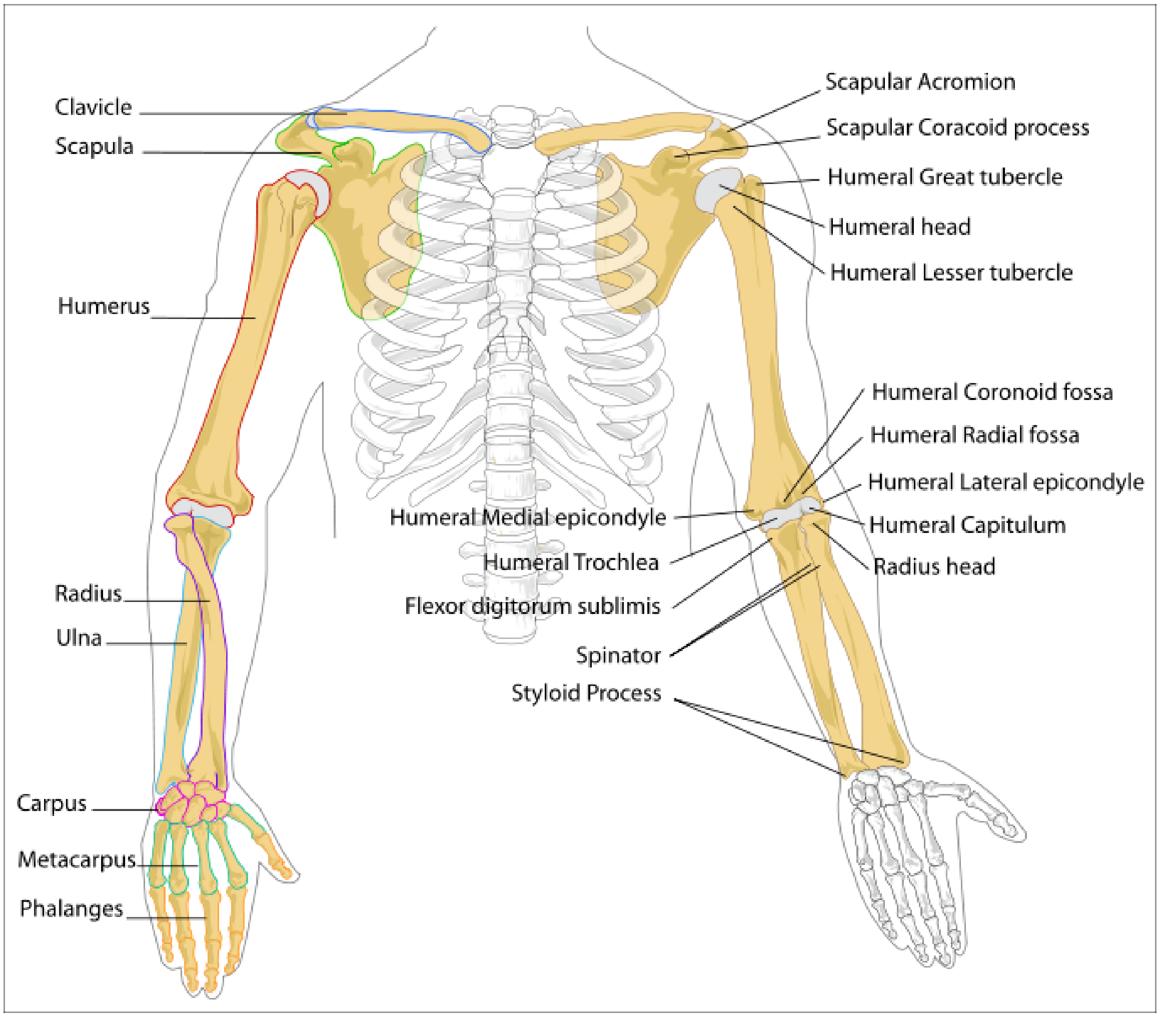
In birds, the clavicles and interclavicle have fused to form a single Y-shaped bone, the furcula or "wishbone".

The interclavicle is absent in marsupials and placental mammals. In many mammals, the clavicles are also reduced, or even absent, to allow the scapula greater freedom of motion, which may be useful in fast-running animals.

Though a number of fossil hominin (humans and chimpanzees) clavicles have been found, most of these are mere segments offering limited information on the form and function of the pectoral girdle. One exception is the clavice of AL 333x6/9 attributed to *Australopithecus afarensis* which has a well-preserved sternal end. One interpretation of this specimen, based on the orientation of its lateral end and the position of the deltoid attachment area, suggests that this clavicle is distinct from those found in extant apes (including humans), and thus that the shape of the human shoulder dates back to less than 3 to 4 million years ago. However, analyses of the clavicle in extant primates suggest that the low position of the scapula in humans is reflected mostly in the curvature of the medial portion of the clavicle rather than the lateral portion. This part of the bone is similar in *A. afarensis* and it is thus possible that this species had a high shoulder position similar to that in modern humans.



Pectoral girdle — front



Human arm bones diagram

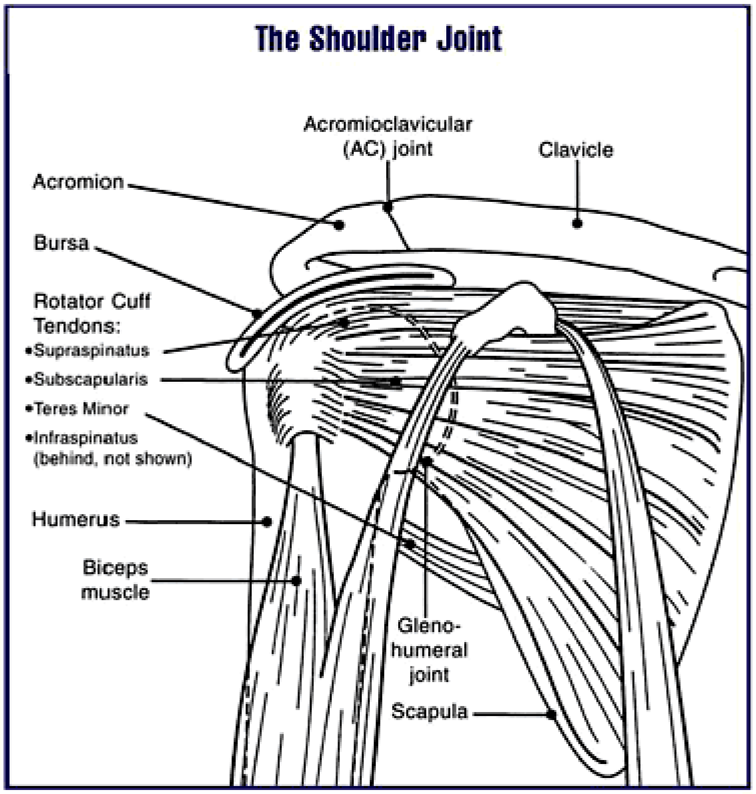
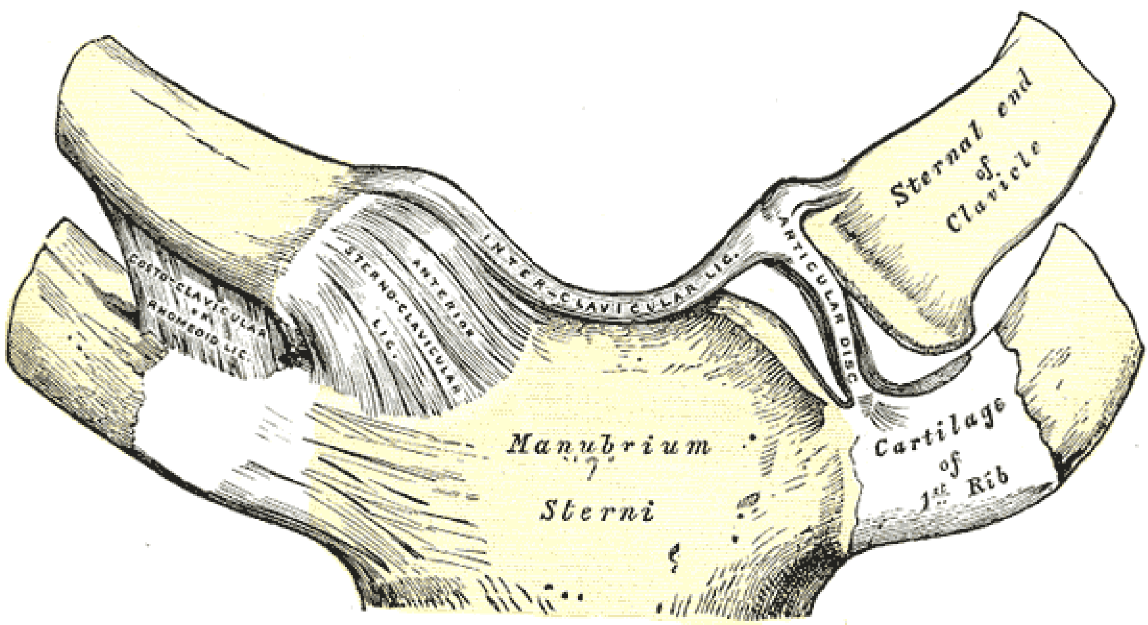
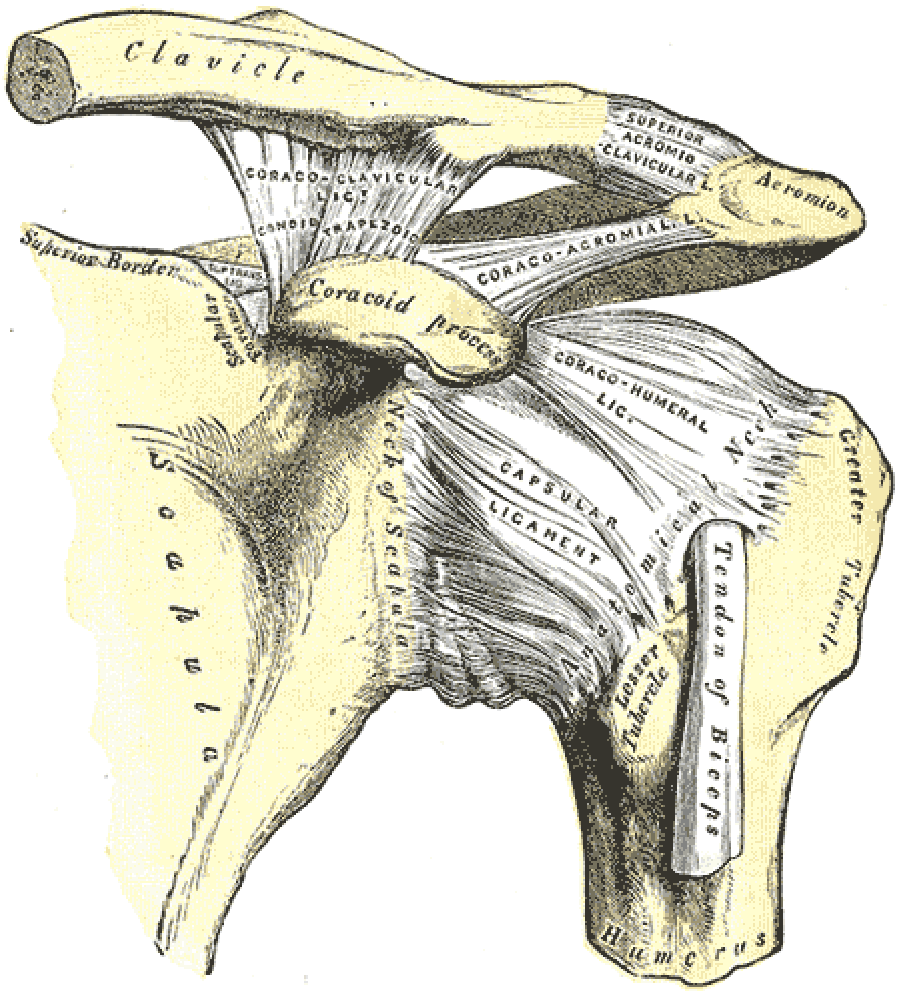


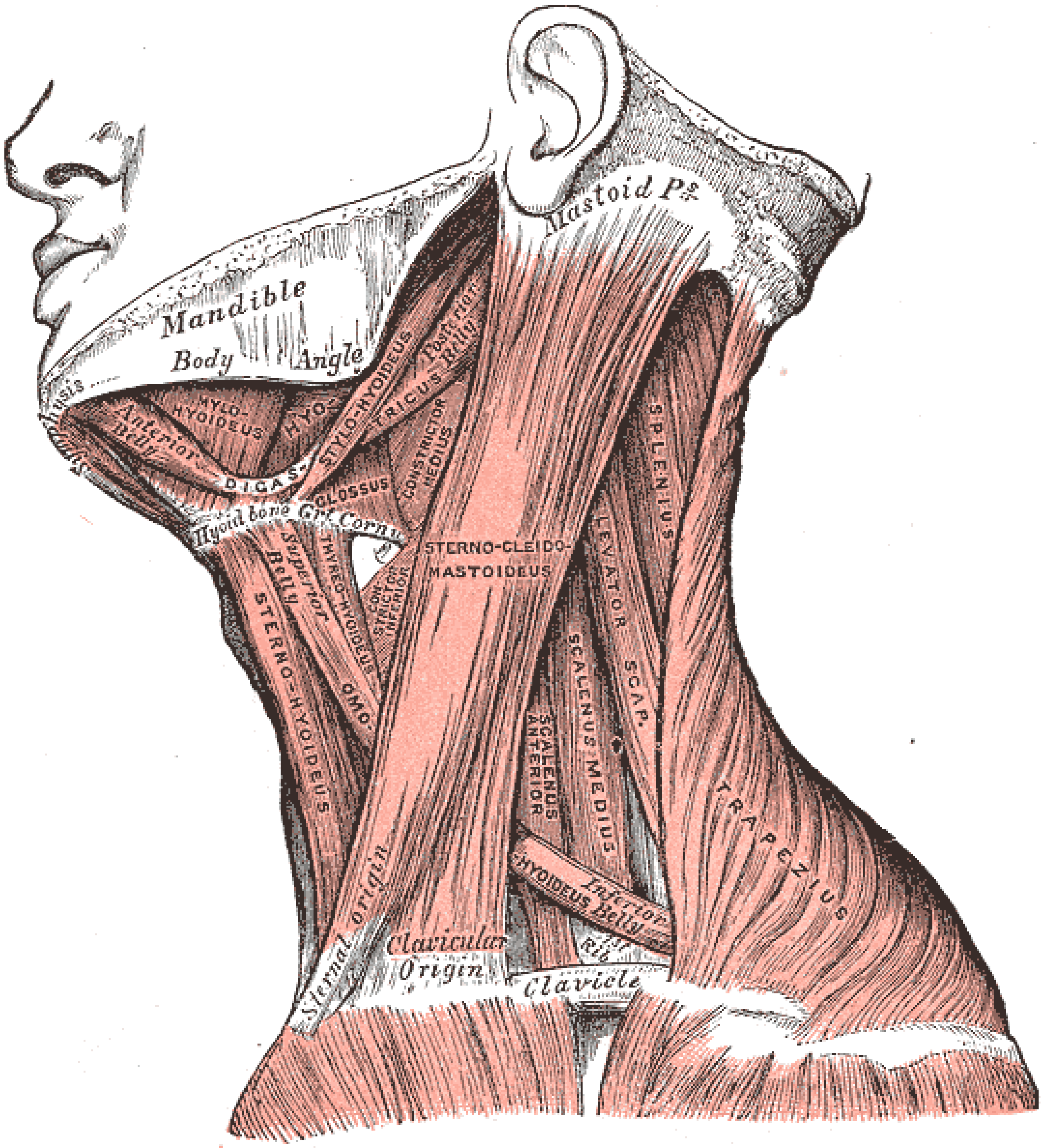
Diagram of the human shoulder joint



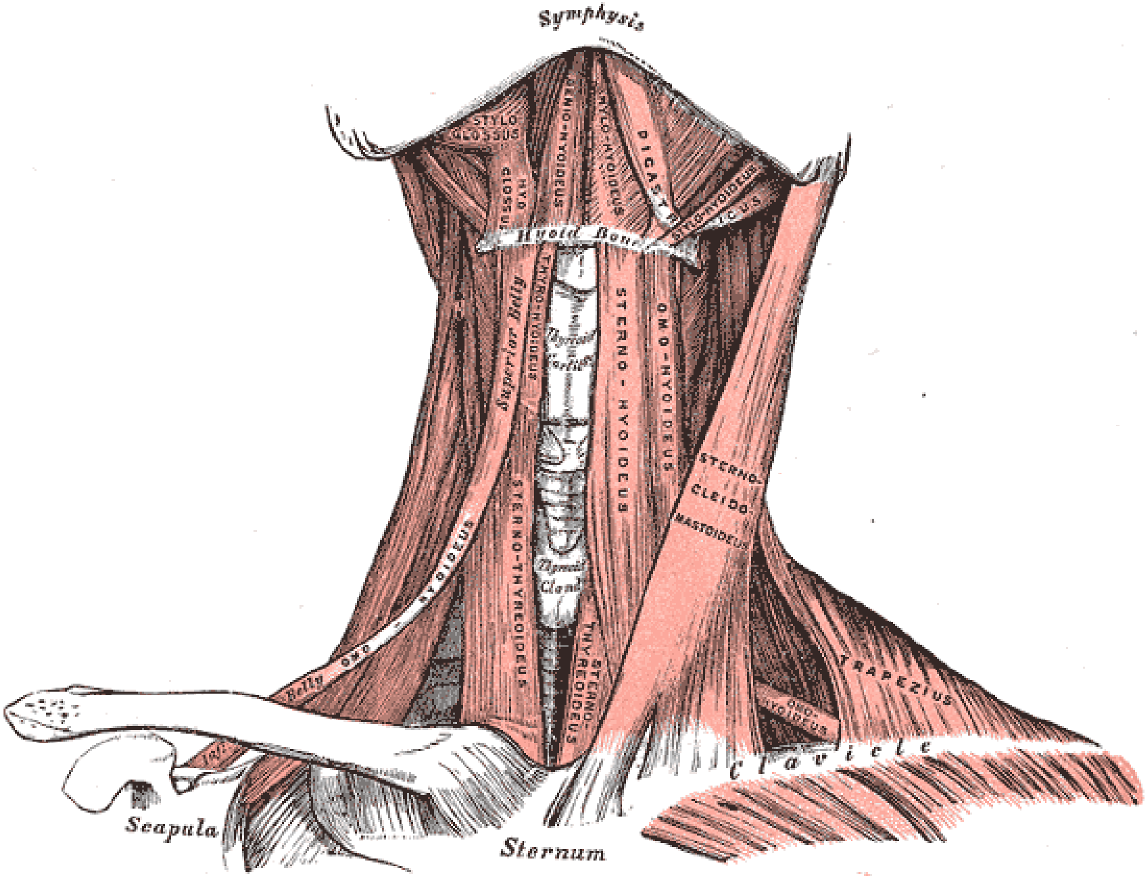
Sternoclavicular articulation. Anterior view.



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula



Muscles of the neck. Lateral view.

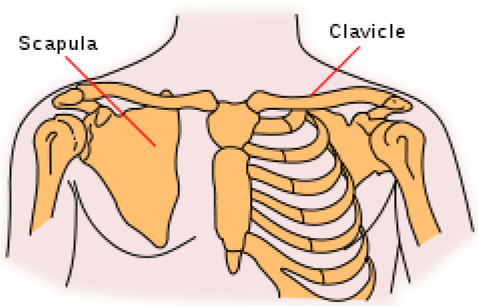


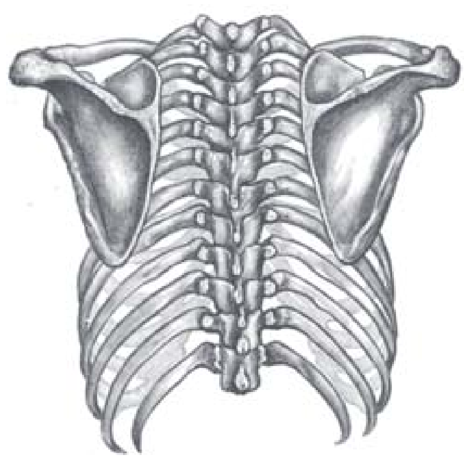
Muscles of the neck. Anterior view.

Chapter 19

Scapula

Bone: shoulder blade





Posterior view of the thorax and shoulder girdle. (Scapula visible at either side.)

Gray's	*subject #50 202*
MeSH	*Scapula*

In anatomy, the **scapula**, **omo** (Medical Latin), or **shoulder blade**, is the bone that connects the humerus (upper arm bone) with the clavicle (collar bone).

The scapula forms the posterior (back) located part of the shoulder girdle. In humans, it is a flat bone, roughly triangular in shape, placed on a posterolateral aspect of the thoracic cage.

Structure

Surfaces

Costal (Front, Ventral, Anterior)

The **costal or ventral surface** [Fig. 1] presents a broad concavity, the *subscapular fossa*.

The medial two-thirds of this fossa are marked by several oblique ridges, which run lateralward and upward. The ridges give attachment to the tendinous insertions, and the surfaces between them to the shelby, of the Subscapularis. The lateral third of the fossa is smooth and covered by the fibers of this muscle.

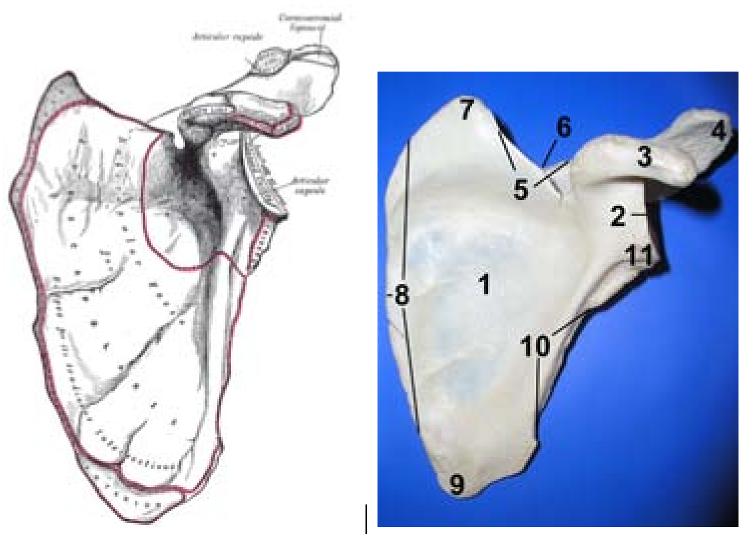


Figure 1 : Left scapula. Costal surface.

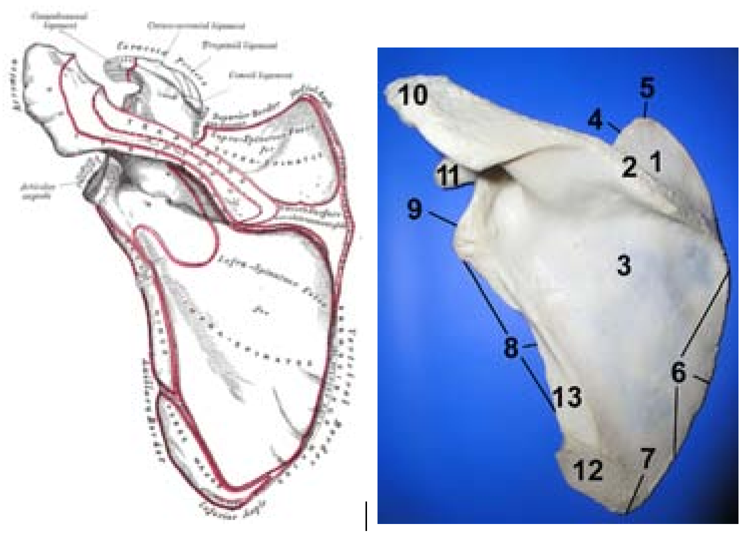


Figure 2 : Left scapula. Dorsal surface.

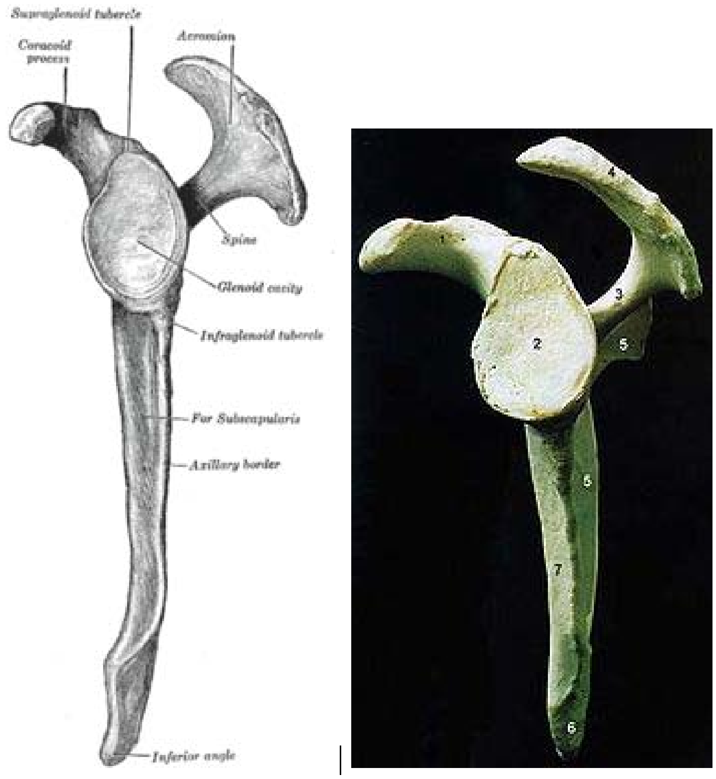


Figure 3 : Left scapula. Lateral surface.

At the upper part of the fossa is a transverse depression, where the bone appears to be bent on itself along a line at right angles to and passing through the center of the glenoid cavity, forming a considerable angle, called the subscapular angle; this gives greater strength to the body of the bone by its arched form, while the summit of the arch serves to support the spine and acromion.

Dorsal (Back, Posterior)

The **dorsal surface** [Fig. 2] is arched from above downward, and is subdivided into two unequal parts by the spine; the portion above the spine is called the supraspinous fossa, and that below it the infraspinous fossa.

- The *supraspinous fossa*, the smaller of the two, is concave, smooth, and broader at its vertebral than at its humeral end; its medial two-thirds give origin to the Supraspinatus.

- The *infraspinous fossa* is much larger than the preceding; toward its vertebral margin a shallow concavity is seen at its upper part; its center presents a prominent convexity, while near the axillary border is a deep groove which runs from the upper toward the lower part. The medial two-thirds of the fossa give origin to the Infraspinatus; the lateral third is covered by this muscle.

The dorsal surface is marked near the axillary border by an elevated ridge, which runs from the lower part of the glenoid cavity, downward and backward to the vertebral border, about 2.5 cm above the inferior angle.

The ridge serves for the attachment of a fibrous septum, which separates the Infraspinatus from the Teres major and Teres minor.

The surface between the ridge and the axillary border is narrow in the upper two-thirds of its extent, and is crossed near its center by a groove for the passage of the scapular circumflex vessels; it affords attachment to the Teres minor.

Its lower third presents a broader, somewhat triangular surface, which gives origin to the Teres major, and over which the Latissimus dorsi glides; frequently the latter muscle takes origin by a few fibers from this part.

The broad and narrow portions above alluded to are separated by an oblique line, which runs from the axillary border, downward and backward, to meet the elevated ridge: to it is attached a fibrous septum which separates the Teres muscles from each other.

Borders

There are three borders of the scapula:

- The superior border is the shortest and thinnest; it is concave, and extends from the medial angle to the base of the coracoid process. It is referred to as the cranial border in animals.

- The axillary border (or "lateral border") is the thickest of the three. It begins above at the lower margin of the glenoid cavity, and inclines obliquely downward and backward to the inferior angle. It is referred to as the caudal border in animals.

- The vertebral border (or "medial border") is the longest of the three, and extends from the medial to the inferior angle. It is referred to as the dorsal border in animals.

The acromion

The acromion forms the summit of the shoulder, and is a large, somewhat triangular or oblong process, flattened from behind forward, projecting at first lateralward, and then curving forward and upward, so as to overhang the glenoid cavity.

Development

The larger part of the scapula undergoes membranous ossification.. Some of the outer parts of the scapula are cartilaginous at birth, and would therefore undergo endochondral ossification.

The head, processes, and the thickened parts of the bone, contain cancellous tissue; the rest consists of a thin layer of compact tissue.

The central part of the supraspinatus fossa and the upper part of the infraspinatous fossa, but especially the former, are usually so thin in humans as to be semitransparent; occasionally the bone is found wanting in this situation, and the adjacent muscles are separated only by fibrous tissue.

Muscular attachments

The following muscles attach to the scapula:

Muscle	Direction	Region
Pectoralis Minor	insertion	coracoid process
Coracobrachialis	origin	coracoid process
Serratus Anterior	insertion	medial border
Triceps Brachii (long head)	origin	infraglenoid tubercle
Biceps Brachii (short head)	origin	coracoid process
Biceps Brachii (long head)	origin	supraglenoid tubercle
Subscapularis	origin	subscapular fossa
Rhomboid Major	insertion	medial border
Rhomboid Minor	insertion	medial border
Levator Scapulae	insertion	medial border
Trapezius	insertion	spine of scapula
Deltoid	origin	spine of scapula
Supraspinatus	origin	supraspinous fossa
Infraspinatus	origin	infraspinous fossa
Teres Minor	origin	lateral border
Teres Major	origin	lateral border
Latissimus Dorsi (a few fibers)	origin	inferior angle
Omohyoid	origin	superior border

Movements

Movements of the scapula are brought about by scapular muscles:

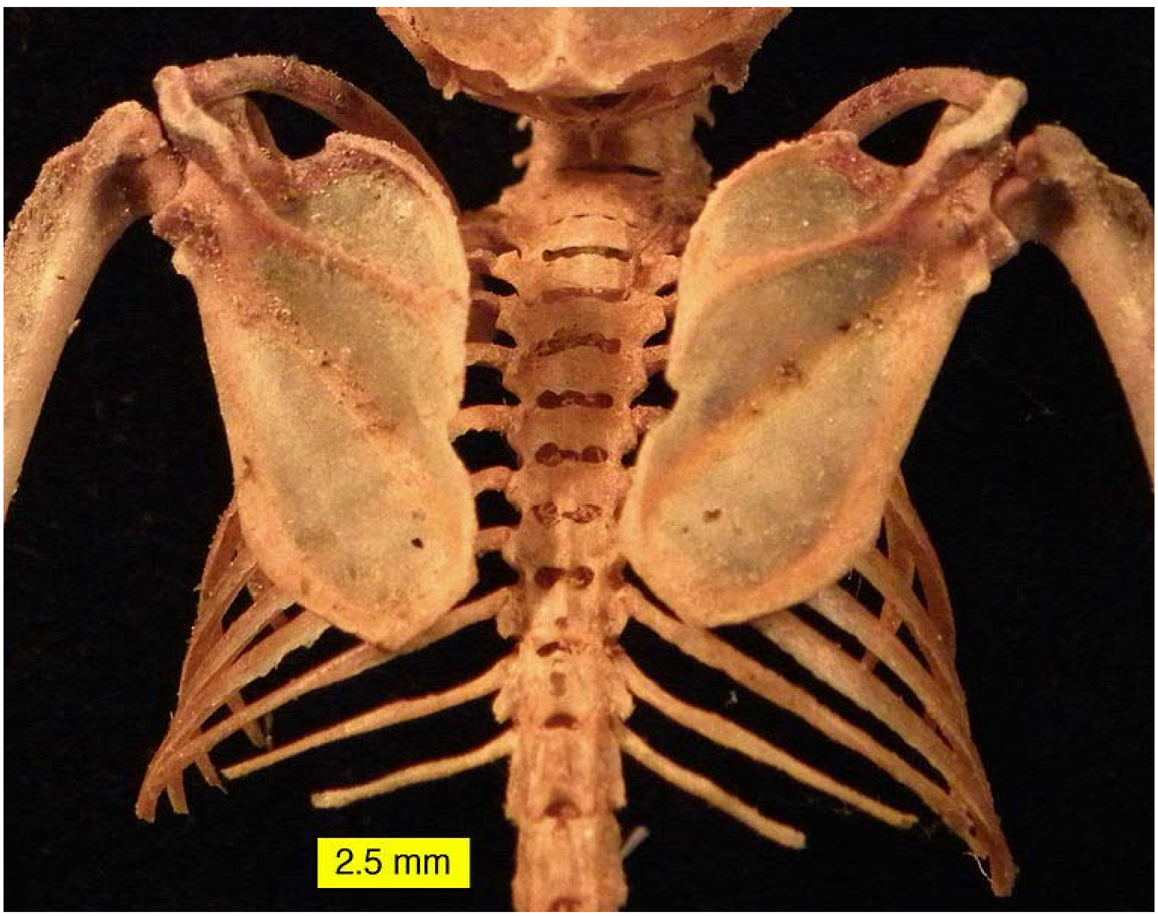
Elevation, Depression, Protraction, Retraction, Lateral rotation, Medial rotation, Upward Rotation, Downward Rotation, Anterior Tipping, and Posterior Tipping

Injury

Because of its sturdy structure and protected location, scapular fractures are uncommon; when they do occur, they are an indication that severe chest trauma has occurred.

A winged scapula is a condition in which the medial border (the side nearest the spine) of a person's scapula is abnormally positioned outward and backward. The resulting appearance of the upper back is said to be wing-like because the inferior angle of the shoulder blade protrudes backward rather than lying mostly flat like in people without the condition.

In other animals



Scapulae, spine and ribs of *Myotis lucifugus* (Little Brown Bat)

In fish, the **scapular blade** is a structure attached to the upper surface of the articulation of the pectoral fin, and is accompanied by a similar **coracoid plate** on the lower surface.

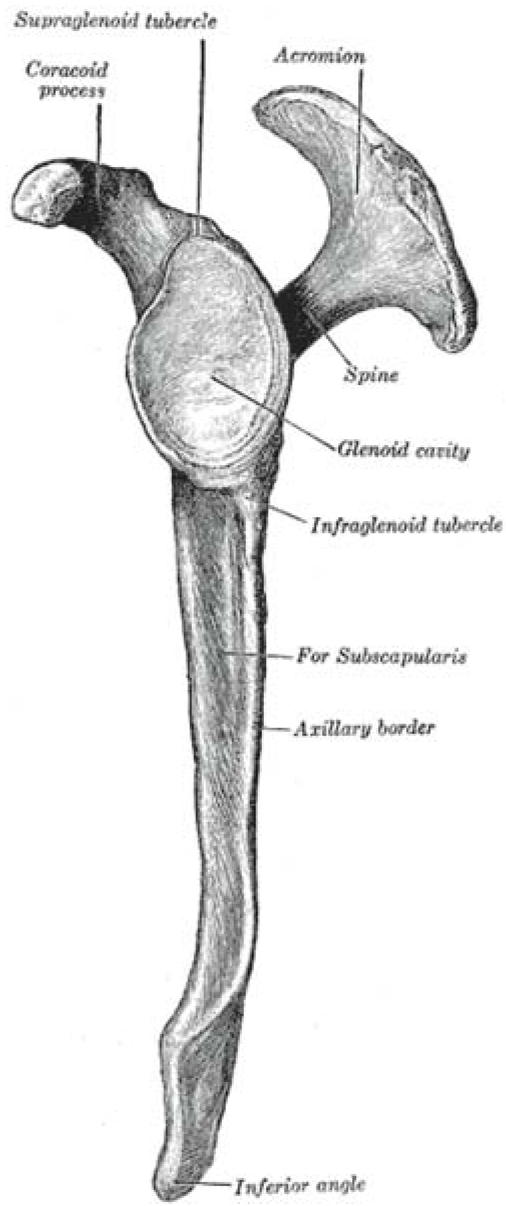
Although sturdy in cartilagenous fish, both plates are generally small in most other fish, and may be partially cartilagenous, or consist of multiple bony elements.

In the early tetrapods, these two structures respectively became the scapula and a bone referred to as the **procoracoid** (commonly called simply the "coracoid", but not homologous with the mammalian structure of that name). In amphibians, birds, and reptiles, these two bones are distinct, but together form a single structure bearing many of the muscle attachments for the forelimb. In such animals, the scapula is usually a relatively simple plate, lacking the projections and spine that it possesses in mammals. However, the detailed structure of these bones varies considerably in living groups. For example, in frogs, the procoracoid bones may be braced together at the animal's underside to absorb the shock of landing, while in turtles, the combined structure forms a Y-shape in order to allow the scapula to retain a connection to the clavicle (which is part of the shell). In birds, the procoracoids help to brace the wing against the top of the sternum.

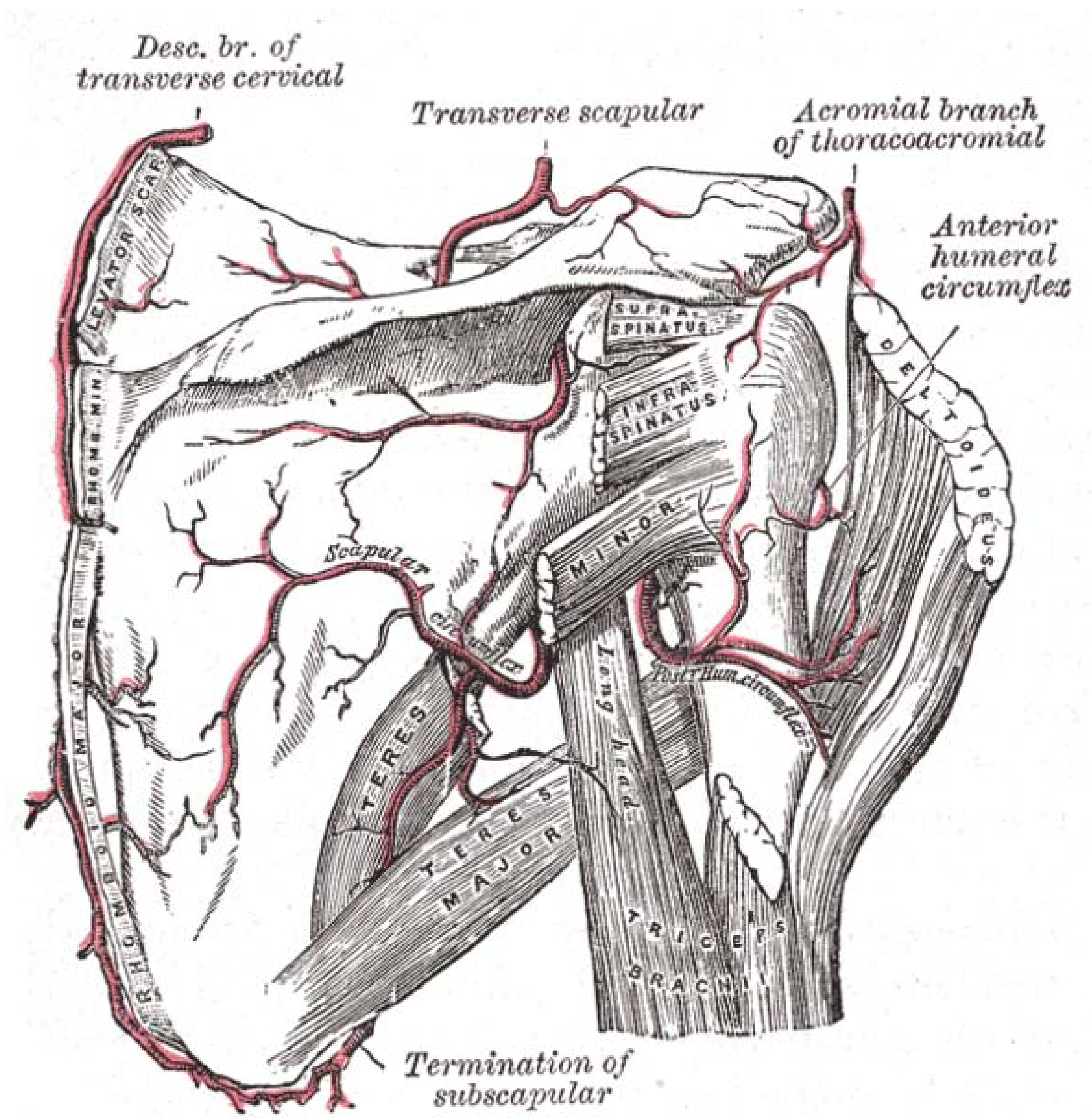
In the fossil therapsids, a third bone, the true **coracoid**, formed just behind the procoracoid. The resulting three-boned structure is still seen in modern monotremes, but in all other living mammals, the procoracoid has disappeared, and the coracoid bone has fused with the scapula, to become the coracoid process. These changes are associated with the upright gait of mammals, compared with the more sprawling limb arrangement of reptiles and amphibians; the muscles formerly attached to the procoracoid are no longer required. The altered musculature is also responsible for the alteration in the shape of the rest of the scapula; the forward margin of the original bone became the spine and acromion, from which the main shelf of the shoulder blade arises as a new structure.

As a shovel

In neolithic times and earlier a large animal's scapula was often used as a crude shovel.



Left scapula. Lateral view.

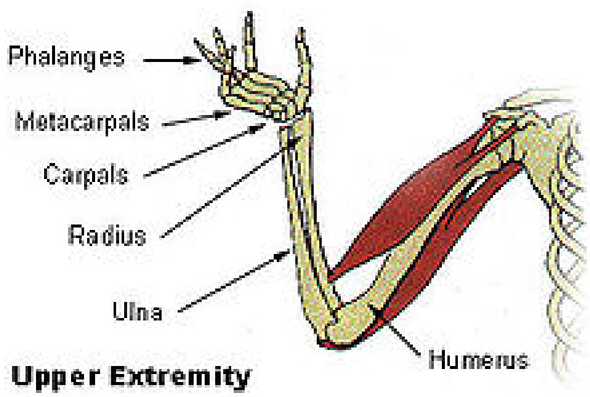


The scapular and circumflex arteries

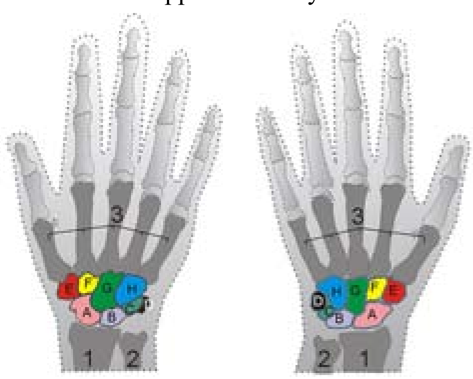
Chapter 20

Ulna

Bone: Ulna



Upper extremity



Ulna is #2

Gray's	*subject #52 214*
MeSH	*Ulna*

The **ulna** is one of the two long bones in the forearm, the other being the radius. It is prismatic in form and runs parallel to the radius, which is shorter and smaller. In anatomical position (i.e. when the palms of the hands face forward) the ulna is located at the side of the forearm closest to the body (the medial side), the side of the little finger. The corresponding bone in the leg is the fibula.

Articulations

The ulna articulates with:

- trochlea of the humerus, at the right side elbow as a hinge joint with semilunar trochlear notch of the ulna.
- the radius, near the elbow as a pivot joint, this allows the radius to cross over the ulna in pronation.
- the distal radius, where it fits into the ulna notch.
- the radius along its length via the interosseous membrane that forms a syndesmoses joint

Proximal and distal aspects

The ulna is broader *proximally*, and narrower *distally*.

Proximally, the ulna has a bony process, the olecranon process, a hook-like structure that fits into the olecranon fossa of the **humerus**. This prevents hyperextension and forms a hinge joint with the trochlea of the humerus. There is also a radial notch for the head of the radius, and the ulnar tuberosity to which muscles can attach.

At the distal end of the ulna is a styloid process.

Structure

The long, narrow medullary cavity is enclosed in a strong wall of compact tissue which is thickest along the interosseous border and dorsal surface. At the extremities the compact layer thins. The compact layer is continued onto the back of the olecranon as a plate of close spongy bone with lamellæ parallel. From the inner surface of this plate and the compact layer below it trabeculæ arch forward toward the olecranon and coronoid and cross other trabeculæ, passing backward over the medullary cavity from the upper part of the shaft below the coronoid. Below the coronoid process there is a small area of compact bone from which trabeculæ curve upward to end obliquely to the surface of the semilunar notch which is coated with a thin layer of compact bone. The trabeculæ at the lower end have a more longitudinal direction.

Muscle attachments

Muscle	Direction	Attachment
Triceps brachii muscle	Insertion	posterior part of superior surface of Olecranon process (via common tendon)
Anconeus muscle	Insertion	Olecranon process (lateral aspect)
Brachialis muscle	Insertion	anterior surface of Coronoid process of the ulna
Pronator teres muscle	Origin	medial surface on middle portion of Coronoid process (also shares origin with medial epicondyle of the

		humerus)
Flexor carpi ulnaris muscle	Origin	Olecranon process and posterior surface of ulna (also shares origin with medial epicondyle of the humerus)
Flexor digitorum superficialis muscle	Origin	Coronoid process (also shares origin with medial epicondyle of the humerus and shaft of the radius)
Flexor digitorum profundus muscle	Origin	Coronoid process, anteromedial surface of ulna (also shares origin with the interosseous membrane)
Pronator quadratus muscle	Origin	Distal portion of anterior ulnar shaft
Extensor carpi ulnaris muscle	Origin	Posterior border of ulna (also shares origin with lateral epicondyle of the humerus)
Supinator muscle	Origin	Proximal ulna (also shares origin with lateral epicondyle of the humerus)
Abductor pollicis longus muscle	Origin	Posterior surface of ulna (also shares origin with the posterior surface of the radius bone)
Extensor pollicis longus muscle	Origin	dorsal shaft of ulna (also shares origin with the dorsal shaft of the radius and the interosseous membrane)
Extensor pollicis brevis muscle	Origin	Dorsal shaft of ulna (also shares origin with the dorsal shaft of the radius and the interosseous membrane)
Extensor indicis muscle	Origin	Posterior surface of distal ulna (also shares origin with the interosseous membrane)

Fracture

Specific fracture types of the ulna include:

- Monteggia fracture - a fracture of the proximal third of the ulna with the dislocation of the head of the radius
- Hume fracture - a fracture of the olecranon with an associated anterior dislocation of the radial head

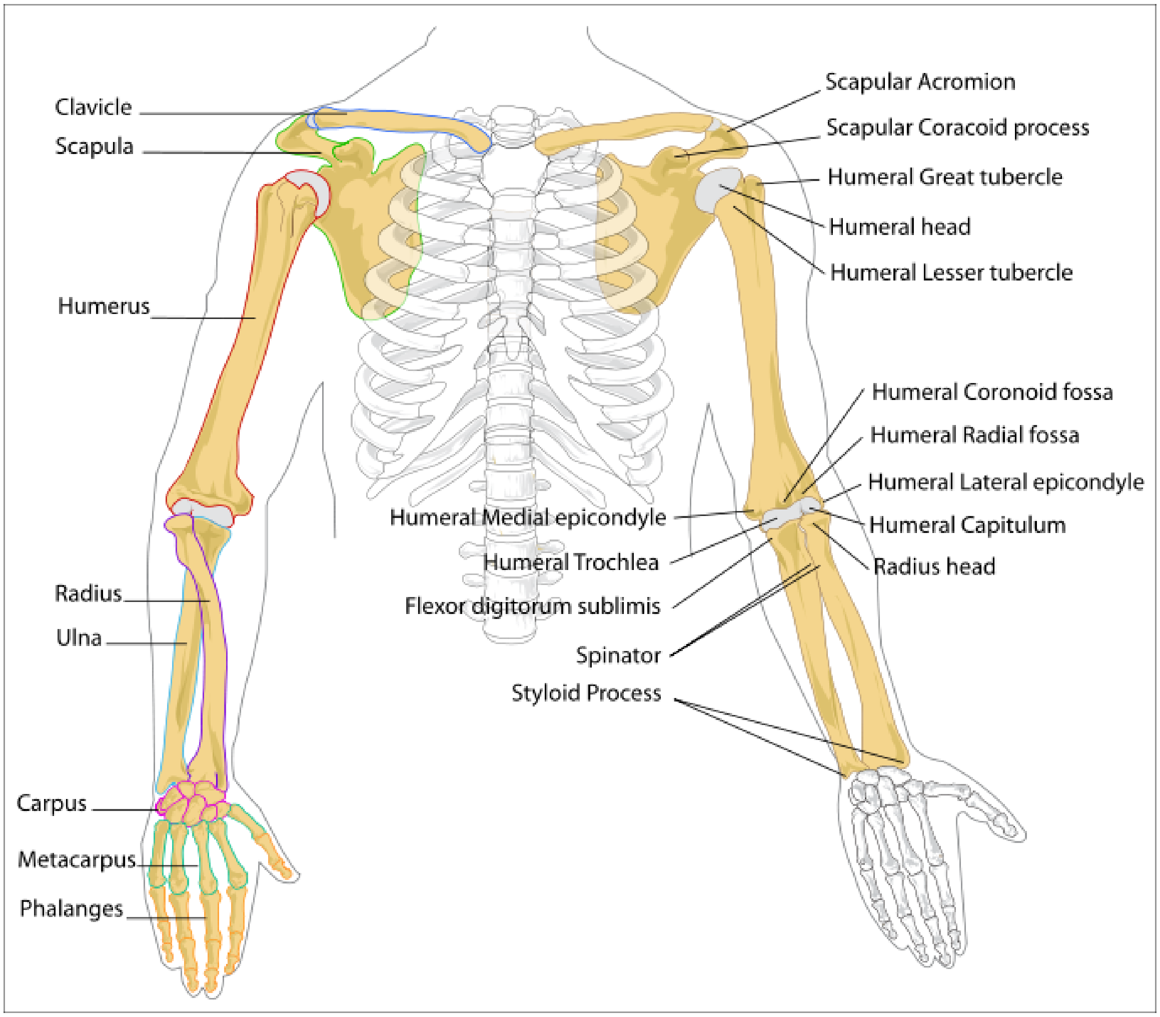
In other animals

In four-legged animals, the radius is the main load-bearing bone of the lower forelimb, and the ulna is important primarily for muscular attachment. In many mammals, the ulna is partially or wholly fused with the radius, and may therefore not exist as a separate bone. However, even in extreme cases of fusion, such as in horses, the olecranon process is still present, albeit as a projection from the upper radius.

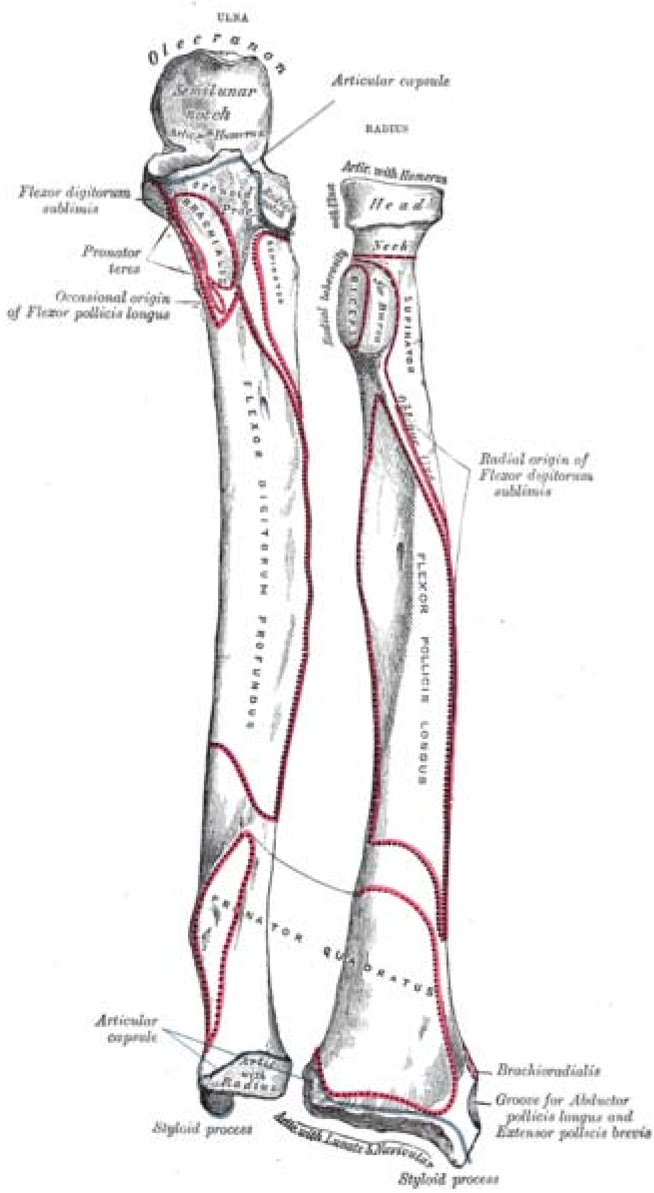
Ulna l. dx. - ant. View

Ulna l. dx. - lat. view

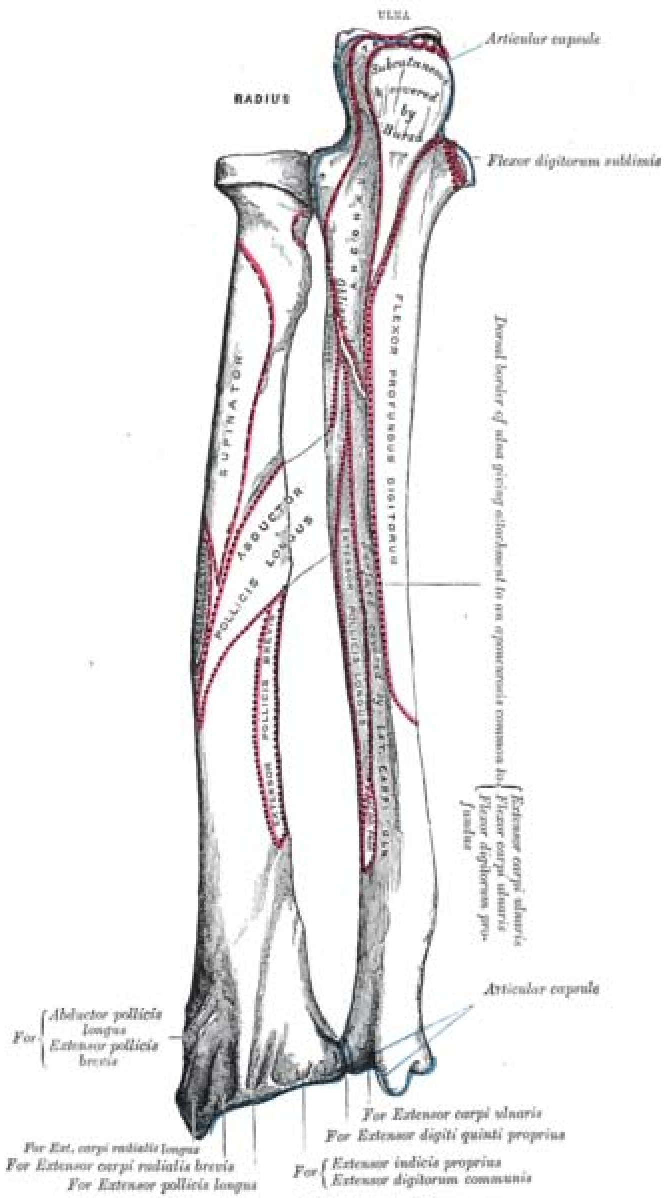
Right posterior human radius and ulna



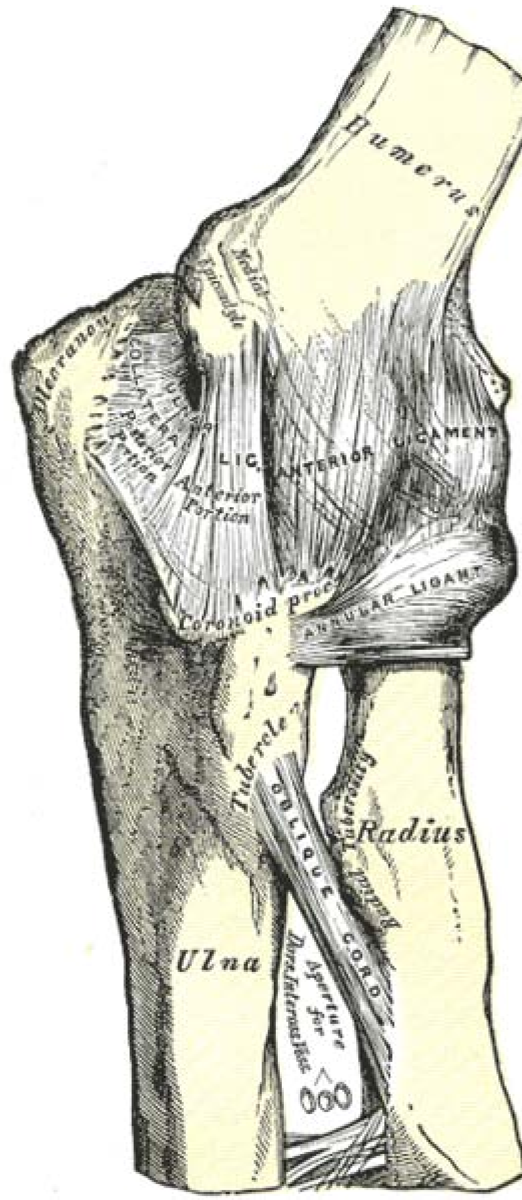
Human arm bones diagram



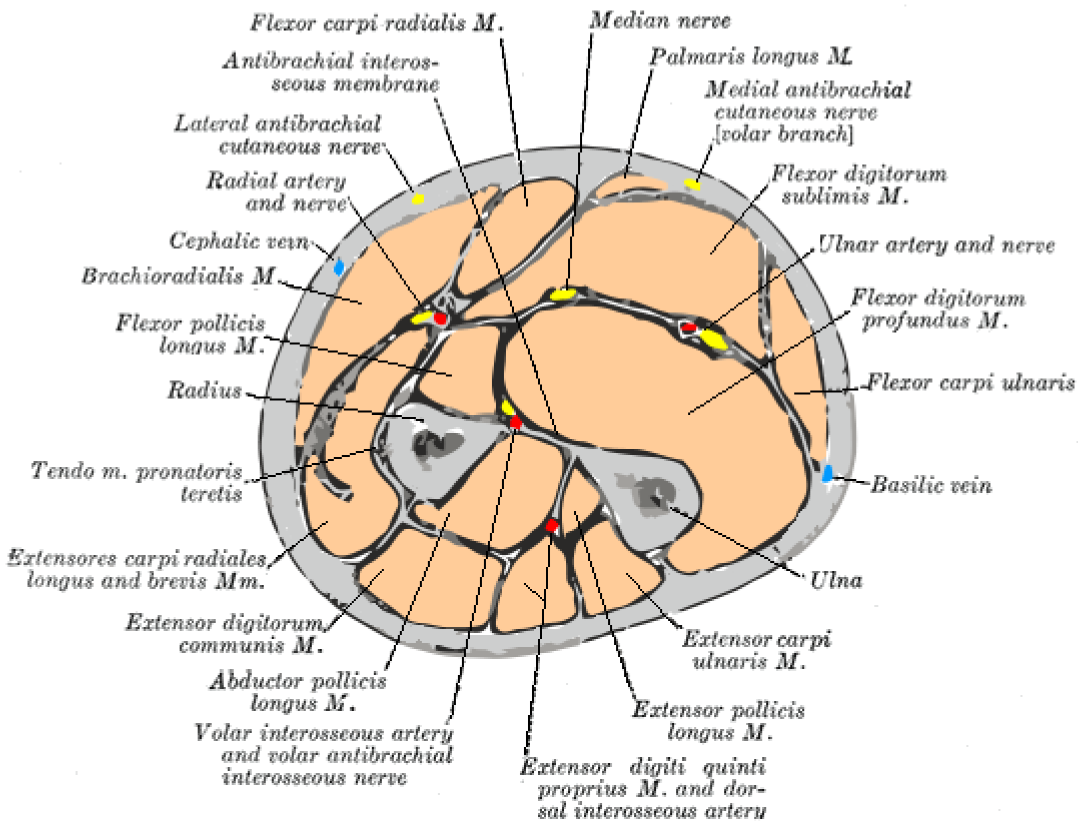
Bones of left forearm. Anterior aspect.



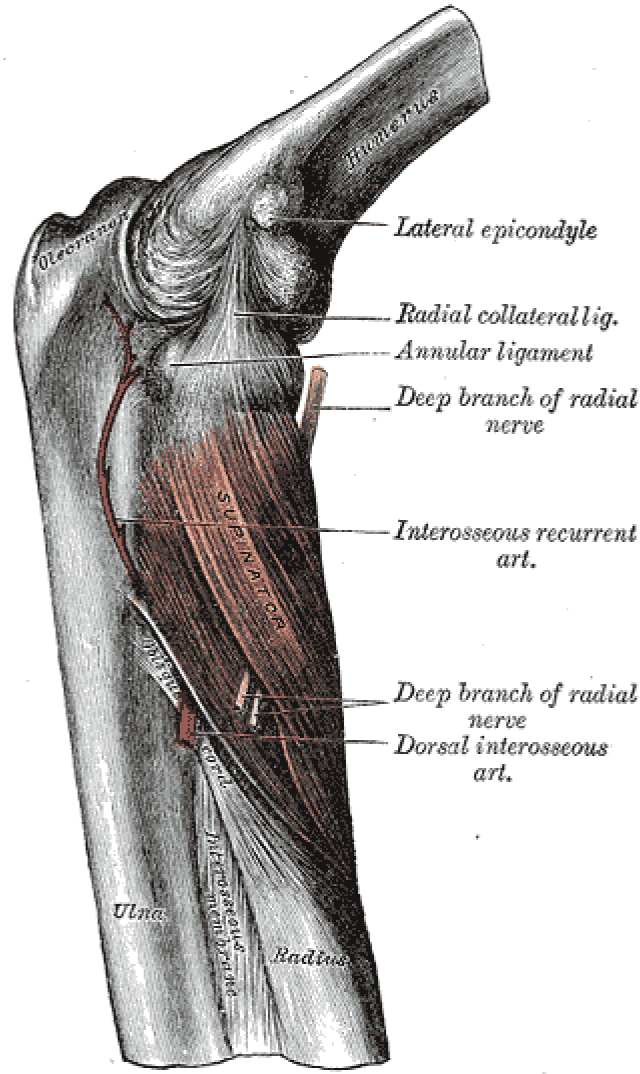
The radius and ulna of the left forearm, posterior surface.



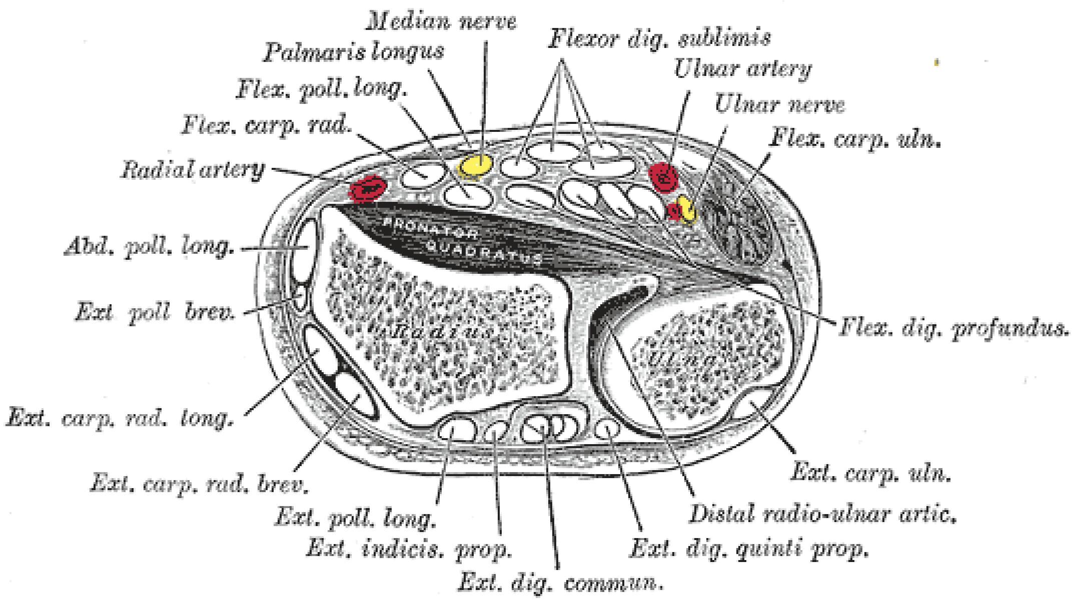
Left elbow-joint, showing anterior and ulnar collateral ligaments.



Cross-section through the middle of the forearm



The Supinator

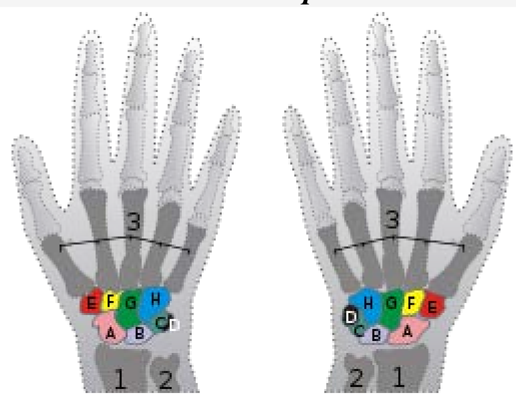


Transverse section across distal ends of radius and ulna

Chapter 21

Carpus

Bone: Carpals



BONES OF HAND
Proximal: A=Scaphoid, B=Lunate, C=Triquetrum, D=Pisiform
Distal: E=Trapezium, F=Trapezoid, G=Capitate, H=Hamate

Latin	*ossa carpi*
Gray's	*subject #54 221*
MeSH	*Carpal+Bones*
Dorlands / Elsevier	*Carpus*

In tetrapods, the **carpus** is the sole cluster of bones in the wrist between the radius and ulna and the metacarpus. The bones of the carpus do not belong to individual fingers (or toes in quadrupeds), whereas those of the metacarpus do. The corresponding part of the foot is the tarsus. The carpal bones allow the wrist to move and rotate vertically.

In human anatomy, the main role of the carpus is to facilitate effective positioning of the hand and powerful use of the extensors and flexors of the forearm, but the mobility of individual carpal bones increase the freedom of movements at the wrist.

Etymology

The Latin word "carpus" is derived from Greek καρπός meaning "wrist". The root "carp-" translates to "pluck", an action performed by the wrist.

As a whole

In human anatomy, the carpal bones can be classified as belonging to two transverse rows or three longitudinal columns.

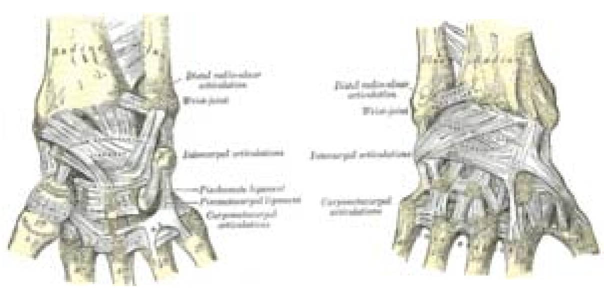
The pair of rows together form an arch which is convex proximally and concave distally. On the palmar side, the carpus is concave, forming the carpal tunnel which is covered by the flexor retinaculum. Because the proximal row is simultaneously related to the articular surfaces of the radius and the distal row, it adapts constantly to these mobile surfaces. The bones of this row - scaphoid, lunate, and triquetrum - have their individual movements. The scaphoid contributes to the stability of the midcarpus as it articulates distally with the trapezium and the trapezoid. The distal row is more rigid as its transverse arch moves with the metacarpals.

Biomechanically and clinically, the carpal bones are better understood as arranged in three longitudinal columns:

1. A radial scaphoid column consisting of the scaphoideum, trapezium, and trapezoideum
2. A lunate column consisting of the lunate and capitate
3. A ulnar triquetral column consisting of the triquetrum and hamatum.

In this context the pisiform is regarded as a sesamoid bone embedded in the tendon of the flexor carpi ulnaris. The ulnar column leaves a gap between the ulna and the triquetrum, and therefore, only the radial or scaphoid and central or capitate columns articulate with the radius. The wrist is more stable in flexion than in extension more because of the strength of various capsules and ligaments than the interlocking parts of the skeleton.

Ligaments



Ligaments of the wrist

There are four groups of ligaments in the region of the wrist:

1. The ligaments of the wrist proper which unite the ulna and radius with the carpus: the ulnar and radial collateral ligaments; the palmar and dorsal radiocarpal ligaments; and the palmar ulnocarpal ligament.
2. The ligaments of the intercarpal articulations which unite the carpal bones with one another: the radiate carpal ligament; the dorsal, palmar, and interosseous intercarpal ligaments; and the pisohamate ligament,
3. The ligaments of the carpometacarpal articulations which unite the carpal bones with the metacarpal bones: the pisometacarpal ligament and the palmar and dorsal carpometacarpal ligaments
4. The ligaments of the intermetacarpal articulations which unite the metacarpal bones: the dorsal, interosseous, and palmar metacarpal ligaments

Movements

The hand is said to be in **straight position** when the third finger runs over the capitate bone and is in a straight line with the forearm. This should not be confused with the **midposition** of the hand which corresponds to an ulnar deviation of 12 degrees. From the straight position two pairs of movements of the hand are possible: abduction (movement towards the radius, so called radial deviation or abduction) of 15 degrees and adduction (movement towards the ulna, so called ulnar deviation or adduction) of 40 degrees when the arm is in strict supination and slightly greater in strict pronation. Flexion (tilting towards the palm, so called palmar flexion) and extension (tilting towards the back of the hand, so called dorsiflexion) is possible with a total range of 170 degrees.

Radial abduction/ulnar adduction

During **radial abduction** the scaphoid is tilted towards the palmar side which allows the trapezium and trapezoid to approach the radius. Because the trapezoid is rigidly attached to the second metacarpal bone to which also the flexor carpi radialis and extensor carpi radialis are attached, radial abduction effectively pulls this combined structure towards the radius. During radial abduction the pisiform traverses the greatest path of all carpal bones. Radial abduction is produced by (in order of importance) extensor carpi radialis longus, abductor pollicis longus, extensor pollicis longus, flexor carpi radialis, and flexor pollicis longus.

Ulnar adduction causes a tilting or dorsal shifting of the proximal row of carpal bones. It is produced by extensor carpi ulnaris, flexor carpi ulnaris, extensor digitorum, and extensor digiti minimi.

Both radial abduction and ulnar adduction occurs around a dorsopalmar axis running through the head of the capitate bone.

Palmar flexion/dorsiflexion

During **palmar flexion** the proximal carpal bones are displaced towards the *dorsal* side and towards the *palmar* side during **dorsiflexion**. While flexion and extension consist of movements around a pair of transverse axes — passing through the lunate bone for the proximal row and through the capitate bone for the distal row — palmar flexion occurs mainly in the radiocarpal joint and dorsiflexion in the midcarpal joint.

Dorsiflexion is produced by (in order of importance) extensor digitorum, extensor carpi radialis longus, extensor carpi radialis brevis, extensor indicis, extensor pollicis longus, and extensor digiti minimi. Palmar flexion is produced by (in order of importance) flexor digitorum superficialis, flexor digitorum profundus, flexor carpi ulnaris, flexor pollicis longus, flexor carpi radialis, and abductor pollicis longus.

Combined movements

Combined with movements in both the elbow and shoulder joints, **intermediate** or **combined movements** in the wrist approximate those of a ball-and-socket joint with some necessary restrictions, such as maximum palmar flexion blocking abduction.

Accessory movements

Anteroposterior gliding movements between adjacent carpal bones or along the midcarpal joint can be achieved by stabilizing individual bones while moving another (i.e. gripping the bone between the thumb and index finger).

Individual bones

Posterior and anterior view of a human carpus

Almost all carpals (except the pisiform) have six surfaces. Of these the *palmar* or *anterior* and the *dorsal* or *posterior surfaces* are rough, for ligamentous attachment; the dorsal surfaces being the broader, except in the lunate.

The *superior* or *proximal,* and *inferior* or *distal surfaces* are articular, the superior generally convex, the inferior concave; the *medial* and *lateral surfaces* are also articular where they are in contact with contiguous bones, otherwise they are rough and tuberculated.

The structure in all is similar: cancellous tissue enclosed in a layer of compact bone.

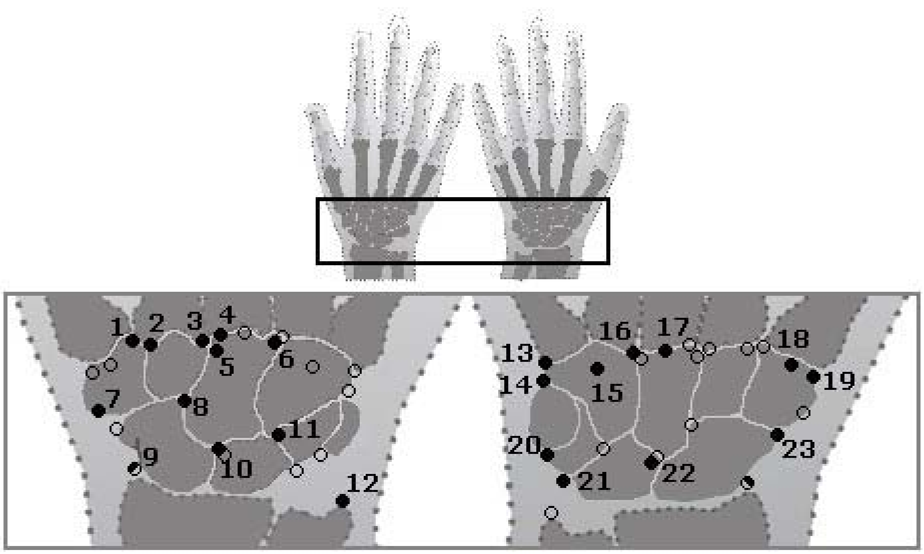
Articulations of individual carpal bones

Name	Proximal/radial articulations	Lateral/medial articulations	Distal/metacarpal articulations
		Proximal row	
Scaphoid	radius	capitate, lunate	trapezium, trapezoid
Lunate	radius, articular disk	scaphoid, triquetral	capitate, hamate (sometimes)
Triquetrum	articular disk	lunate, pisiform	hamate
Pisiform		triquetral	
		Distal row	
Trapezium	scaphoid	trapezoid	first and second metacarpal

Trapezoid	scaphoid	trapezium, capitate	second metacarpal
Capitate	scaphoid, lunate	trapezoid, hamate	third, partly second and fourth metacarpal
Hamate	triquetral, lunate	capitate	fourth and fifth

Created from the initial letter of each of the eight carpal bones, in the order most commonly referenced, the sentence "**s**ome **l**overs **t**ry **p**ositions **t**hat **t**hey **c**an't **h**andle" is used as a mnemonic device. Another mnemonic is "**s**he **l**ooks **t**oo **p**retty; **t**ry **t**o **c**atch **h**er."

Accessory bones



Location of the accessory ossicles of the carpals

Occasionally accessory bones are found in the carpus, but of more than 20 such described bones, only four (the central, styloid, secondary trapezoid, and secondary pisiform bones) are considered to be proven accessory bones. Sometimes the scaphoid, triquetrum, and pisiform bones are divided into two.

Ossification

Appearance of ossification centers of carpal bones no of carpal bones 27 sesamoid bone - pisiform(flexor carpi ulnaris) first bone to appear is capitate.

Bone	Average	Variation
Capitate	2.5 months	1–6 months
Hamate	4-5.5 months	1–7 months
Triquetrum	2 years	5 months to 3 years
Lunate	5 years	2-5.5 years
Trapezium	6 years	4–8 years

Trapezoid	6 years	4–8 years
Scaphoid	6 years	4–7 years
Pisiform	12 years	8–12 years

The carpal bones are ossified endochondrally (from within the cartilage) and the ossific centers appear only after birth. The formation of these centers roughly follows a chronological spiral pattern starting in the capitate and hamate during the first year of life. The ulnar bones are then ossified before the radial bones, while the sesamoid pisiform arises in the tendon of the flexor carpi ulnaris after more than ten years.

Evolutionary variations

The structure of the carpus varies widely between different groups of tetrapods, even among those that retain the full set of five digits. In primitive fossil amphibians, such as *Eryops*, the carpus consists of three rows of bones; a proximal row of three carpals, a second row of four bones, and a distal row of five bones. The proximal carpals are referred to as the **radiale**, **intermediale**, and **ulnare**, after their proximal articulations, and are homologous with the scaphoid, lunate, and triquetal bones respectively. The remaining bones are simply numbered, as the first to fourth **centralia** (singular: **centrale**), and the first to fifth **distal carpals**. Primitively, each of the distal bones appears to have articulated with a single metacarpal.

However, the vast majority of later vertebrates, including modern amphibians, have undergone varying degrees of loss and fusion of these primitive bones, resulting in a smaller number of carpals. Almost all mammals and reptiles, for example, have lost the fifth distal carpal, and have only a single centrale - and even this is missing in humans. The pisiform bone is somewhat unusual, in that it first appears in primitive reptiles, and is never found in amphibians.

Because many tetrapods have less than five digits on the forelimb, even greater degrees of fusion are common, and a huge array of different possible combinations are found. The wing of a modern bird, for example, has only two remaining carpals; the radiale (the scaphoid of mammals) and a bone formed from the fusion of four of the distal carpals.

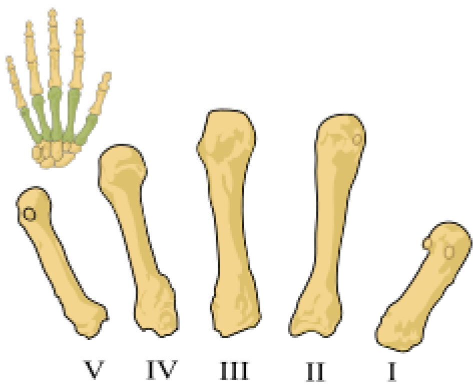
In some macropods, the scaphoid and lunar bones are fused into the scaphollunar bone.

In crustaceans, "carpus" is the scientific term for the claws or "pincers" present on some legs.

Chapter 22

Metacarpus

Bone: Metacarpals	



The five metacarpal bones, numbered. (Left hand shown with thumb on right.)

Multiple fractures of the metacarpals (aka broken hand). (Right hand shown with thumb on left.)

Latin	*metacarpalia*
Gray's	*subject #55 227*
Origins	Carpus
Insertions	Proximal phalanges
Articulations	Carpometacarpal, intermetacarpal, metacarpophalangeal

MeSH	*Metacarpus*

In human anatomy, the **metacarpus** is the intermediate part of the hand skeleton that is located between the phalanges (bones of the fingers) distally and the carpus which forms the connection to the forearm. The metacarpus consists of metacarpal bones. Its equivalent in the foot is the metatarsus.

Human anatomy

The metacarpals form a transverse arch to which the rigid row of distal carpal bones are fixed. The peripheral metacarpals (those of the thumb and little finger) form the sides of the cup of the palmar gutter and as they are brought together they deepen this concavity. The index metacarpal is the most firmly fixed, while the thumb metacarpal articulates with the trapezium and acts independently from the others. The middle metacarpals are tightly united to the carpus by intrinsic interlocking bone elements at their bases. The ring metacarpal forms a transitional element of the semi-independent last metacarpal.

Each metacarpal bone consists of a body and two extremities.

Body

The *body* (*corpus; shaft*) is prismoid in form, and curved, so as to be convex in the longitudinal direction behind, concave in front. It presents three surfaces: medial, lateral, and dorsal.

- The *medial* and *lateral surfaces* are concave, for the attachment of the interosseus muscles, and separated from one another by a prominent anterior ridge.
- The *dorsal surface* presents in its distal two-thirds a smooth, triangular, flattened area which is covered in by the tendons of the Extensor muscles. This surface is bounded by two lines, which commence in small tubercles situated on either side of the digital extremity, and, passing upward, converge and meet some distance above the center of the bone and form a ridge which runs along the rest of the dorsal surface to the carpal extremity. This ridge separates two sloping surfaces for the attachment of the Interossei dorsales.
- To the tubercles on the digital extremities are attached the collateral ligaments of the metacarpophalangeal joints.

Base

The *base* or *carpal extremity* (*basis*) is of a cuboidal form, and broader behind than in front: it articulates with the carpus, and with the adjoining metacarpal bones; its dorsal and volar surfaces are rough, for the attachment of ligaments.

Head

The *head* or *digital extremity* (*capitulum*) presents an oblong surface markedly convex from before backward, less so transversely, and flattened from side to side; it articulates with the proximal phalanx. It is broader, and extends farther upward, on the volar than on the dorsal aspect, and is longer in the antero-posterior than in the transverse diameter. On either side of the head is a tubercle for the attachment of the collateral ligament of the metacarpophalangeal joint.

The dorsal surface, broad and flat, supports the tendons of the extensor muscles.

The volar surface is grooved in the middle line for the passage of the Flexor tendons, and marked on either side by an articular eminence continuous with the terminal articular surface.

Articulations

Besides the metacarpophalangeal joints, the metacarpal bones articulate by carpometacarpal joints as follows:

- the first with the trapezium;
- the second with the trapezium, trapezoid, capitate and third metacarpal;
- the third with the capitate and second and fourth metacarpals;
- the fourth with the capitate, hamate, and third and fifth metacarpals;
- and the fifth with the hamate and fourth metacarpal.

Insertions

Extensor Carpi Radialis Longus/Brevis: Both insert on the base of metacarpal II; Assist with wrist extension and radial flexion of the wrist

Extensor Carpi Ulnaris: Inserts on the base of metacarpal V; Extends and fixes wrist when digits are being flexed; assists with ulnar flexion of wrist

Abductor Pollicis Longus: Inserts on the trapezium and base of metacarpal I; Abducts thumb in frontal plane; extends thumb at carpometacarpal joint

Opponens Pollicis: Inserts on Metacarpal I; Flexes metacarpal I to oppose the thumb to the fingertips

Opponens Digiti Minimi: Inserts on the medial surface of metacarpal V; Flexes metacarpal V at carpometacarpal joint when little finger is moved into opposition with tip of thumb; deepens palm of hand.

Congenital disorders

The fourth and fifth metacarpal bones are commonly "blunted," or shortened, in pseudohypoparathyroidism and pseudopseudohypoparathyroidism.

A blunted fourth metacarpal, with normal fifth metacarpal, can signify Turner syndrome.

Blunted metacarpals (particularly the fourth metacarpal) are a symptom of Nevoid basal cell carcinoma syndrome.

Fracture

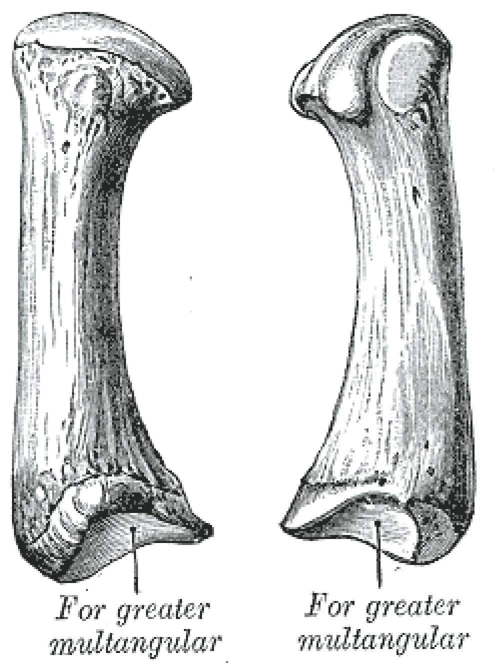
The *neck* of a metacarpal (in the transition between the body and the head) is a common location for a boxer's fracture.

In other animals

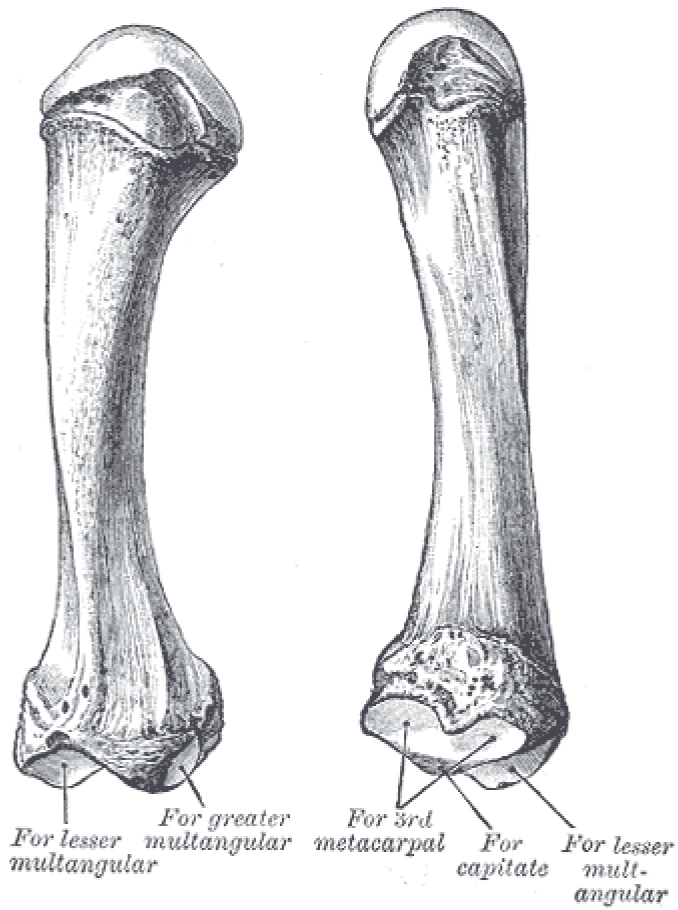
In four-legged animals, the metacarpals form part of the forefeet, and are frequently reduced in number, appropriate to the number of toes. In digitigrade and unguligrade animals, the metacarpals are greatly extended and strengthened, forming an additional segment to the limb, a feature that typically enhances the animal's speed. In both birds and bats, the metacarpals form part of the wing.

Metacarpals of left hand, anterior aspect

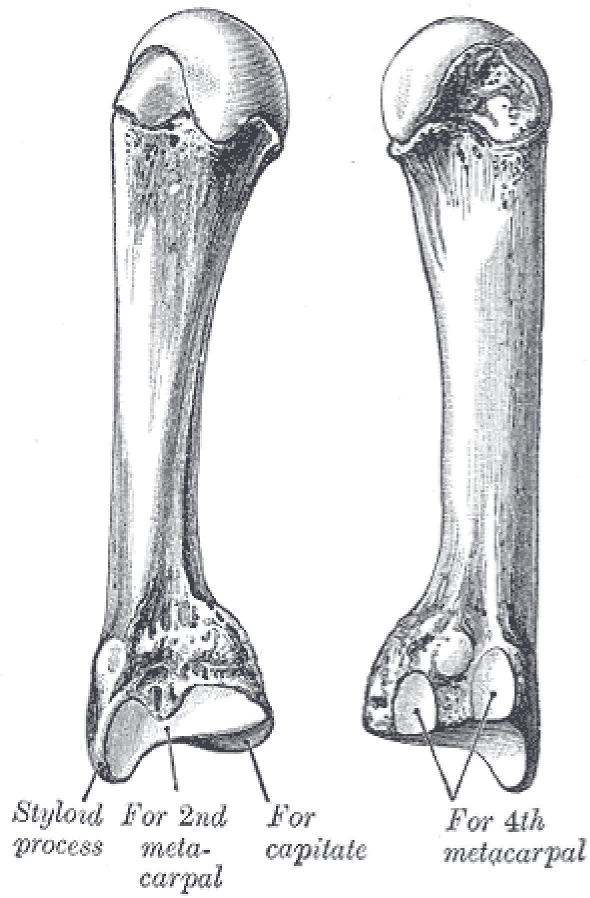
Metacarpals of left hand, medial aspect



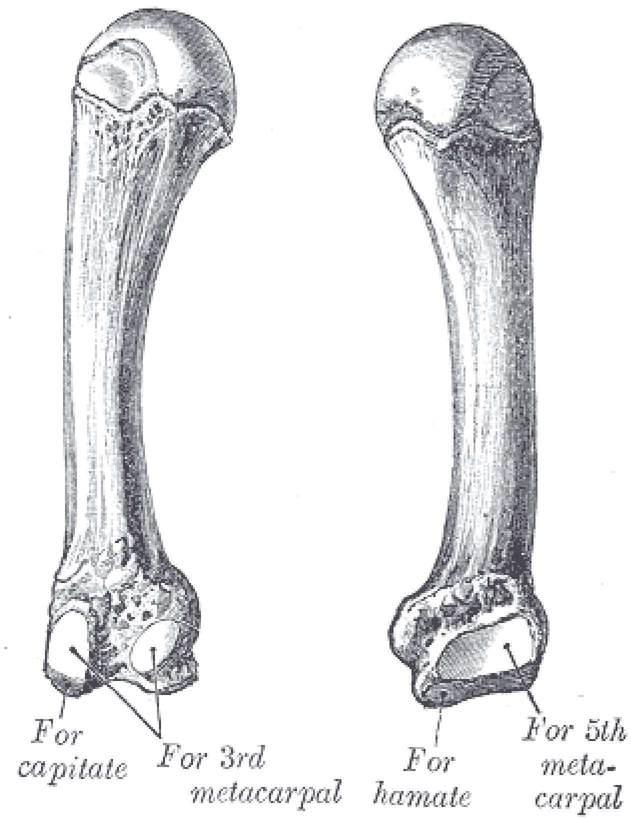
First metacarpal bone (left)



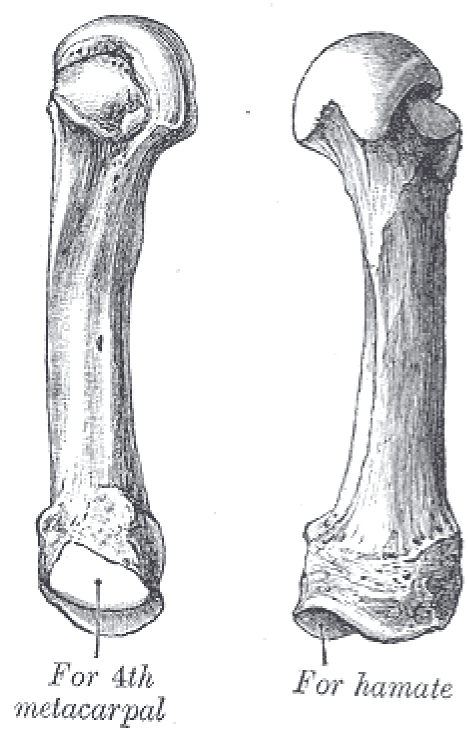
Second metacarpal bone (left)



Third metacarpal bone (left)



Fourth metacarpal bone (left)



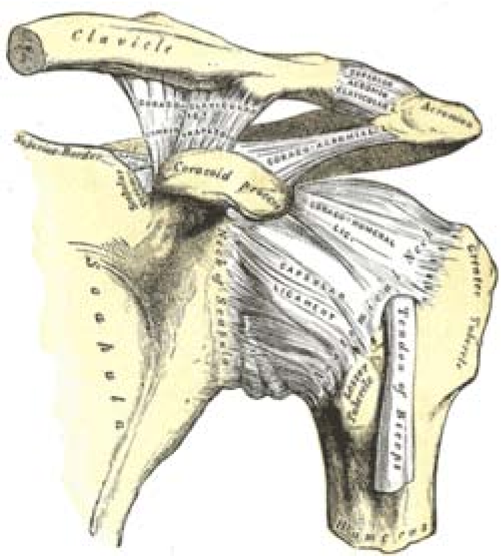
Fifth metacarpal bone (left)

Chapter 23

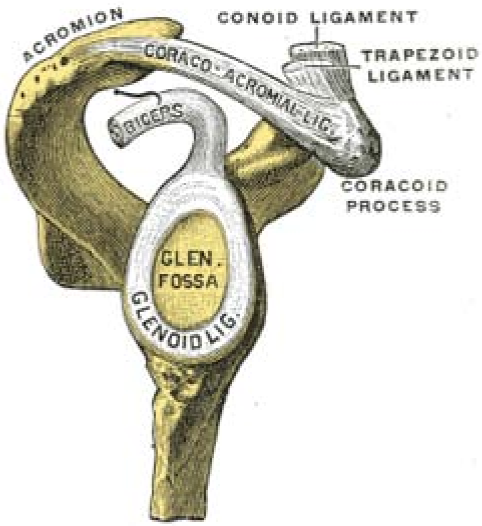
Acromioclavicular Joint and Glenohumeral Joint

Acromioclavicular joint

Acromio-clavicular joint



The left shoulder and acromioclavicular joints, and the proper ligaments of the scapula.



Glenoid fossa of right side.

Latin	*articulatio acromioclavicularis*
Gray's	*subject #82 315*
MeSH	*Acromioclavicular+Joint*

The **acromioclavicular joint**, or **AC joint**, is a joint at the top of the shoulder. It is the junction between the acromion (part of the scapula that forms the highest point of the shoulder) and the clavicle.

Function

The AC joint allows the ability to raise the arm above the head. This joint functions as a pivot point (although technically it is a gliding synovial joint), acting like a strut to help with movement of the scapula resulting in a greater degree of arm rotation.

Ligaments

The joint is stabilized by three ligaments:

- The acromioclavicular ligament, which attaches the clavicle to the acromion of the scapula.

Superior Acromioclavicular Ligament This ligament is a quadrilateral band, covering the superior part of the articulation, and extending between the upper part of the lateral end of the clavicle and the adjoining part of the upper surface of the acromion.

It is composed of parallel fibers, which interlace with the aponeuroses of the Trapezius and Deltoideus; below, it is in contact with the articular disk when this is present.

Inferior Acromioclavicular Ligament This ligament is somewhat thinner than the preceding; it covers the under part of the articulation, and is attached to the adjoining surfaces of the two bones.

It is in relation, above, in rare cases with the articular disk; below, with the tendon of the Supraspinatus

- The coracoacromial ligament, which runs from the coracoid process to the acromion.

The Coracoacromial Ligament is a strong triangular band, extending between the coracoid process and the acromion.

It is attached, by its apex, to the summit of the acromion just in front of the articular surface for the clavicle; and by its broad base to the whole length of the lateral border of the coracoid process.

This ligament, together with the coracoid process and the acromion, forms a vault for the protection of the head of the humerus.

It is in relation, above, with the clavicle and under surface of the Deltoideus; below, with the tendon of the Supraspinatus, a bursa being interposed.

Its lateral border is continuous with a dense lamina that passes beneath the Deltoideus upon the tendons of the Supraspinatus and Infraspinatus.

The ligament is sometimes described as consisting of two marginal bands and a thinner intervening portion, the two bands being attached respectively to the apex and the base of the coracoid process, and joining together at the acromion.

When the Pectoralis minor is inserted, as occasionally is the case, into the capsule of the shoulder-joint instead of into the coracoid process, it passes between these two bands, and the intervening portion of the ligament is then deficient.

- The coracoclavicular ligament, which consists of two ligaments, the conoid and the trapezoid ligaments.

The Coracoclavicular Ligament serves to connect the clavicle with the coracoid process of the scapula.

It does not properly belong to the acromioclavicular joint articulation, but is usually described with it, since it forms a most efficient means of retaining the clavicle in contact with the acromion. It consists of two fasciculi, called the trapezoid ligament and conoid ligament.

These ligaments are in relation, in front, with the Subclavius and Deltoideus; behind, with the Trapezius.

Variability

An X-ray study of 100 shoulders in US soldiers found considerable variation in the size and shape of the joint. The articular surfaces were notably different in size and form. On some they are separated by a meniscus attached to the superior acromioclavicular ligament. This meniscus may be a blade of fibrocartilage that extends nearly halfway into the joint or it may form a complete disc that divides the joint into two parts. In other joints no synovial joint is present with the joint being made by a pad of fibrous tissue attached to the outer end of the clavicle, and no articular cavity.

Injuries

A common injury to the AC joint is dislocation, often called AC separation or shoulder separation. This is not the same as a "shoulder dislocation," which refers to dislocation of the glenohumeral joint.

AC dislocation is particularly common in collision sports such as ice hockey, football, rugby and aussie rules, and is also a problem for those who participate in swimming, horseback riding, mountain biking, biking and snow skiing. The most common mechanism of injury is a fall on the tip of the shoulder or FOOSH (**f**alls **o**n **o**ut**s**tretched **h**and).

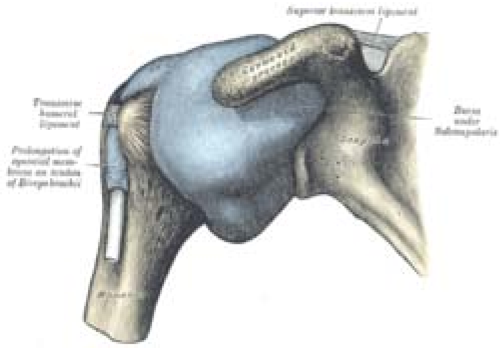
AC dislocations are also graded from I to VI. Grading is based upon the degree of separation of the acromion from the clavicle with weight applied to the arm. **Grade I** is a tear of the AC ligament. It has the normal separation of <4mm. **Grade II** is a complete dislocation of AC ligament with partial disruption of coracoclavicular ligament. The AC gap is >5mm. Grades I and II never require surgery and heal by themselves, though physical therapy may be required. **Grade III** is complete disruption of AC and CC ligaments. On plain film the inferior aspect of the clavicle will be above the superior aspect of the acromion. This can also be assessed with an MRI scan, which will also demonstrate disruption of the coracoclavicular ligaments (the degree depending on the severity of AC joint disruption) as well as tearing of the joint capsule. The joint will be very tender and swollen on examination. Grade III separations most often do not require surgery and shoulder function should return to normal after 16–20 weeks. However, there will be some physical deformity of the shoulder with a noticeable bump resulting from the dislocation of the clavicle. Grades IV-VI are complications on a 'standard' dislocation involving a displacement of the clavicle, and will almost always require surgery.

Osteoarthritis

Osteoarthritis (OA) of the AC joint is not uncommon. It may be caused by a prior trauma (secondary OA) or occur as a chronic degenerative disorder. In the latter cases the condition often co-exist with subacromial impingement.

Glenohumeral joint

Glenohumeral joint	



The right shoulder and **Glenohumeral** joint

Latin	*articulatio humeri*
Gray's	*subject #82 315*
MeSH	*Glenohumeral+Joint*

The **glenohumeral joint**, [from ancient Greek *glene*, eyeball, puppet, doll + -*oid*, 'form of', + latin *humerus*, shoulder] or **shoulder joint**, is a multiaxial synovial ball and socket joint and involves articulation between the glenoid fossa of the scapula (shoulder blade) and the head of the humerus (upper arm bone).

Movements

The glenoid fossa is shallow and contains the glenoid labrum which deepens it and aids in stability. With 120 degrees of unassisted flexion, the glenohumeral joint is the most mobile joint in the body.

Scapulohumeral rhythm helps to achieve further range of movement. The Scapulohumeral rhythm is the movement of the scapula across the thoracic cage in relation to the humerus. This movement can be compromised by anything that changes the position of the scapula. This could be an imbalance in the muscles that hold the scapula in place which are the upper and lower trapezium. This imbalance could cause a forward head carriage which in turn can affect the range of movements of the shoulder.

The rotator cuff muscles of the shoulder produce a high tensile force, and help to pull the head of the humerus into the glenoid fossa.

Movements of the shoulder joint

Movement	Muscles	Origin	Insertion
Flexion	Anterior fibers of deltoid	Clavicle	Middle of lateral surface of shaft of humerus
	Clavicular part of pectoralis major	Clavicle	Lateral lip of bicipital groove of humerus
	Long head of biceps brachii	Supraglenoid tubercle of scapula	Tuberosity of radius, Deep fascia of forearm
	Short head of biceps brachii	Coracoid process of scapula	
	Coracobrachialis	Coracoid process	Medial aspect of shaft of humerus
Extension	Posterior fibers of deltoid	Spine of scapula	Middle of lateral surface of shaft of humerus
	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lateral border of scapula	Medial lip of bicipital groove of humerus
Abduction	Middle fibers of deltoid	Acromion process of scapula	Middle of lateral surface of shaft of humerus
	Supraspinatus	Supraspinous fossa of scapula	Greater tuberosity of humerus
Adduction	Sternal part of pectoralis major	Sternum, upper six costal cartilages	Lateral lip of bicipital groove of humerus
	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower six thoracic vertebrae, lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lower third of lateral border of scapula	Medial lip of bicipital groove of humerus
	Teres minor	Upper two thirds of lateral border of scapula	Greater tuberosity of humerus
Lateral rotation	Infraspinatus	Infraspinous fossa of scapula	Greater tuberosity of humerus
	Teres minor	Upper two thirds of lateral border	Greater tuberosity

		of scapula	of humerus
	Posterior fibers of deltoid	Spine of scapula	Middle of lateral surface of shaft of humerus
Medial rotation	Subscapularis	Subscapular fossa	Lesser tuberosity of humerus
	Latissimus dorsi	Iliac crest, lumbar fascia, spines of lower 3-4 ribs, inferior angle of scapula	Floor of bicipital groove of humerus
	Teres major	Lower third of lateral border of scapula	Medial lip of bicipital groove of humerus
	Anterior fibers of deltoid	Clavicle	Middle of lateral surface of shaft of humerus

Capsule

The glenohumeral joint has a loose capsule that is lax inferiorly and therefore is at risk of dislocation inferiorly. The long head of the biceps brachii muscle travels inside the capsule to attach to the supraglenoid tubercle of the scapula.

Because the tendon is inside the capsule, it requires a synovial tendon sheath to minimize friction.

A number of bursae in the capsule aid mobility. Namely, they are the subdeltoid bursa (between the joint capsule and deltoid muscle), subcoracoid bursa (between joint capsule and coracoid process of scapula), coracobrachial bursa (between subscapularis muscle and tendon of coracobrachialis muscle), subacromial bursa (between joint capsule and acromion of scapula) and the subscapular bursa (between joint capsule and tendon of subscapularis muscle, also known as subtendinous bursa of subscapularis muscle). The bursa are formed by the synovial membrane of the joint capsule. An inferior pouching of the joint capsule between teres minor and subscapularis is known as the axillary recess.

The shoulder joint is a muscle dependent joint as it lacks strong ligaments.

Ligaments

- Superior, middle and inferior glenohumeral ligaments
- Coracohumeral ligament
- Transverse humeral ligament

Nerve Supply

- suprascapular nerve

- axillary nerve
- lateral pectoral nerve

Blood Supply

branches of the anterior & posterior circumflex humeral & suprascapular arteries.

Pathology

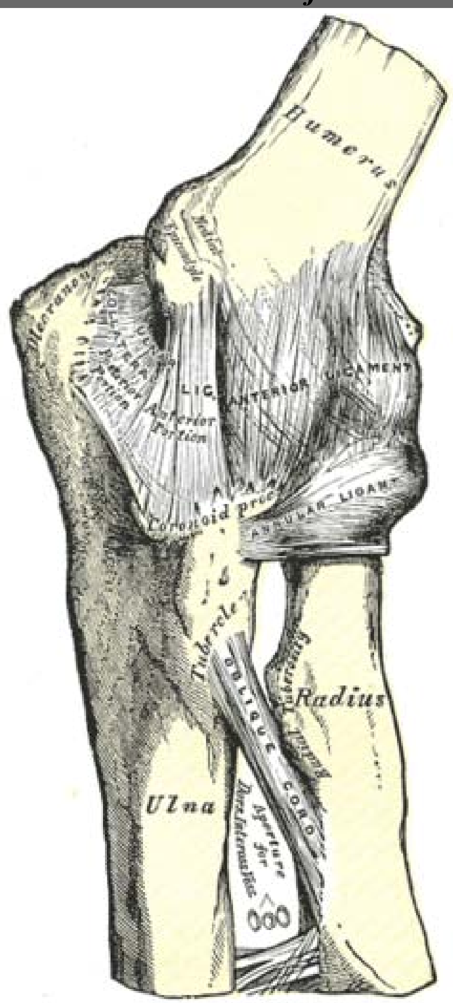
The capsule can become inflamed and stiff, with abnormal bands of tissue (adhesions) growing between the joint surfaces, causing pain and restricting movement of the shoulder, a condition known as frozen shoulder or adhesive capsulitis.

Chapter 24

Humeroradial Joint and Humeroulnar Joint

Humeroradial joint

Humeroradial joint



Left elbow-joint, showing anterior and ulnar collateral

	ligaments.
Latin	*articulatio humeroradialis*
Gray's	*subject #84 321*

The **humeroradial joint**, the joint between the head of the radius and the capitulum of the humerus, is a limited ball-and-socket joint.

The bony surfaces would of themselves constitute an enarthrosis and allow movement in all directions, were it not for the annular ligament, by which the head of the radius is bound to the radial notch of the ulna, and which prevents any separation of the two bones laterally.

It is to the same ligament that the head of the radius owes its security from dislocation, which would otherwise tend to occur, from the shallowness of the cup-like surface on the head of the radius.

In fact, but for this ligament, the tendon of the Biceps brachii would be liable to pull the head of the radius out of the joint.

The head of the radius is not in complete contact with the capitulum of the humerus in all positions of the joint.

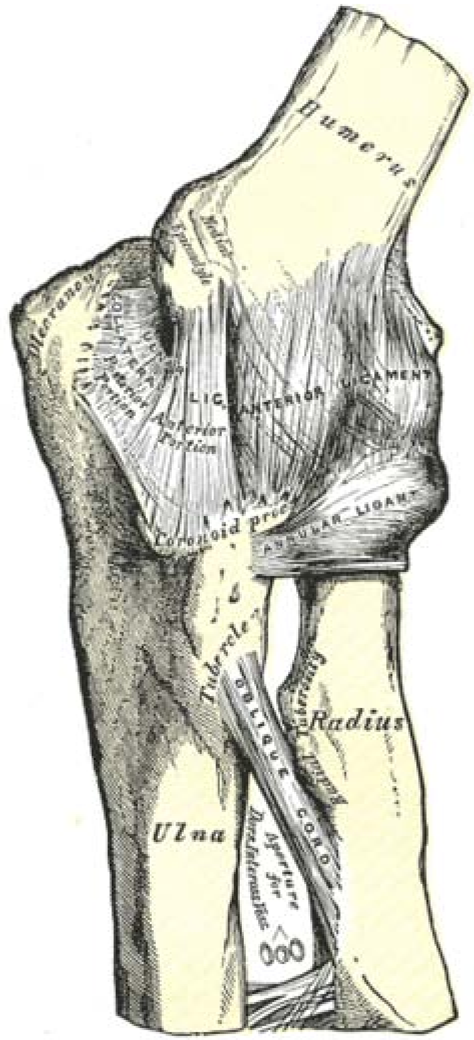
The capitulum occupies only the anterior and inferior surfaces of the lower end of the humerus, so that in complete extension a part of the radial head can be plainly felt projecting at the back of the articulation.

In full flexion the movement of the radial head is hampered by the compression of the surrounding soft parts, so that the freest rotatory movement of the radius on the humerus (pronation and supination) takes place in semiflexion, in which position the two articular surfaces are in most intimate contact.

Flexion and extension of the elbow-joint are limited by the tension of the structures on the front and back of the joint; the limitation of flexion is also aided by the soft structures of the arm and forearm coming into contact.

Humeroulnar joint

Humeroulnar joint	



Left elbow-joint, showing anterior and ulnar collateral ligaments.

Latin	*articulatio humeroulnaris*
Gray's	*subject #84 321*

The **humeroulnar joint**, is part of the elbow-joint or the Olecron Joint, between the ulna and humerus bones is the simple hinge-joint, which allows for movements of flexion, extension and circumduction. The Humero-Ulnar Joint is the junction of trochlear notch of the ulna and the trochlea of the humerus.

Owing to the obliquity of the trochlea of the humerus, this movement does not take place in the antero-posterior plane of the body of the humerus.

When the forearm is *extended and supinated*, the axis of the arm and forearm are not in the same line; the arm forms an obtuse angle with the forearm (the carrying angle). During *flexion*, however, the forearm and the hand tend to approach the middle line of the body, and thus enable the hand to be easily carried to the face.

The accurate adaptation of the trochlea of the humerus, with its prominences and depressions, to the semilunar notch of the ulna, prevents any lateral movement.

Flexion is produced by the action of the Biceps brachii and Brachialis, assisted by the Brachioradialis, with a tiny contribution from the muscles arising from the medial epicondyle of the humerus.

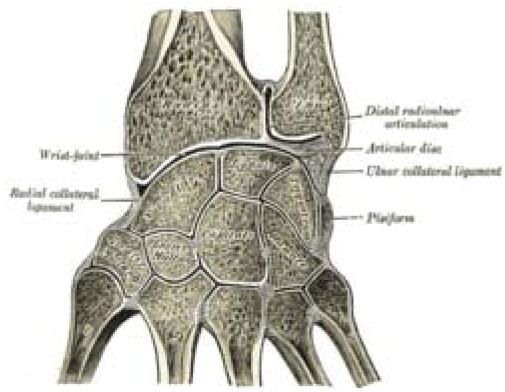
Extension is produced by the Triceps brachii and Anconæus, with a tiny contribution from the muscles arising from the lateral epicondyle of the humerus, such as the Extensor digitorum communis.

Chapter 25

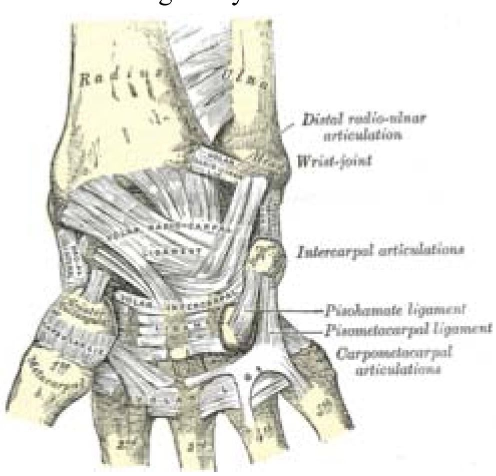
Intercarpal Articulations and Midcarpal Joint

Intercarpal articulations

Intercarpal articulations



Vertical section through the articulations at the wrist, showing the synovial cavities.



Ligaments of wrist. Anterior view

Latin	*articulationes intercarpales*
Gray's	*subject #87 328*
MeSH	*Intercarpal+Joints*

The **intercarpal articulations** (**articulations of the carpus**) can be subdivided into three sets of articulations: Those of the proximal row of carpal bones, those of the distal row of carpal bones, and those of the two rows with each other.

Articulations

The bones in each carpal row interlock with each other and each row can therefore be considered a single articular body. In the proximal row a limited degree of mobility is possible, but the bones of the distal row are connected to each other and to the metacarpal bones by strong ligaments that make this row and the metacarpus a functional entity.

Proximal row

The joints of the proximal row are arthrodial joints, The scaphoid, lunate, and triangular are connected by dorsal, volar, and interosseous ligaments.

The dorsal intercarpal ligament are two in number and placed transversely behind the bones of the first row; they connect the scaphoid and lunate, and the lunate and triangular.

The palmar interecarpal ligaments are also two, connect the scaphoid and lunate, and the lunate and triangular; they are less strong than the dorsal, and placed very deeply behind the Flexor tendons and the volar radiocarpal ligament.

The interosseous intercarpal ligaments are two narrow bundles, one connecting the lunate with the scaphoid, the other joining it to the triangular. They are on a level with the superior surfaces of these bones, and their upper surfaces are smooth, and form part of the convex articular surface of the wrist-joint.

The ligaments connecting the pisiform bone are the articular capsule and the two volar ligaments. The articular capsule is a thin membrane which connects the pisiform to the triangular; it is lined by synovial membrane.

The two volar ligaments are strong fibrous bands; one, the pisohamate ligament, connects the pisiform to the hamate, the other, the pisometacarpal ligament, joins the pisiform to the base of the fifth metacarpal bone. These ligaments are, in reality, prolongations of the tendon of the Flexor carpi ulnaris.

Distal row

These joints are also arthrodial joints connected by dorsal, volar, and interosseous ligaments.

The dorsal ligaments are three in number, extend transversely from one bone to another on the dorsal surface, connecting the greater with the lesser multangular, the lesser multangular with the capitate, and the capitate with the hamate.

The volar ligaments are also three and have a similar arrangement on the volar surface.

The three interosseous ligaments are much thicker than those of the first row; one is placed between the capitate and the hamate, a second between the capitate and the lesser multangular, and a third between the greater and lesser multangulars. The first is much the strongest, and the third is sometimes wanting.

Midcarpal

Synovial membrane

The synovial membrane of the carpus is very extensive, and bounds a synovial cavity of very irregular shape.

The upper portion of the cavity intervenes between the under surfaces of the navicular, lunate, and triangular bones and the upper surfaces of the bones of the second row.

It sends two prolongations upward—between the navicular and lunate, and the lunate and triangular—and three prolongations downward between the four bones of the second row.

The prolongation between the greater and lesser multangulars, or that between the lesser multangular and capitate, is, owing to the absence of the interosseous ligament, often continuous with the cavity of the carpometacarpal joints, sometimes of the second, third, fourth, and fifth metacarpal bones, sometimes of the second and third only.

In the latter condition the joint between the hamate and the fourth and fifth metacarpal bones has a separate synovial membrane.

The synovial cavities of these joints are prolonged for a short distance between the bases of the metacarpal bones.

There is a separate synovial membrane between the pisiform and triangular.

Movements

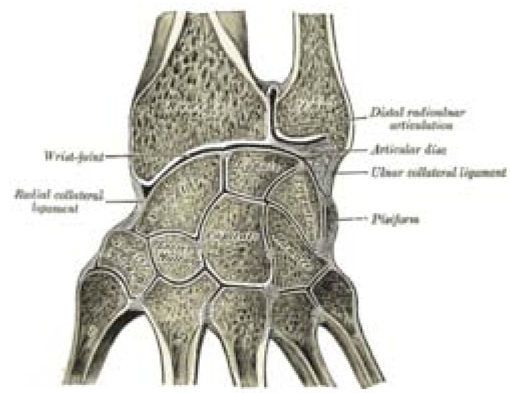
The articulation of the hand and wrist considered as a whole involves four articular surfaces:

- (a) the inferior surfaces of the radius and articular disk;
- (b) the superior surfaces of the navicular, lunate, and triangular, the pisiform having no essential part in the movement of the hand;
- (c) the S-shaped surface formed by the inferior surfaces of the navicular, lunate, and triangular;
- (d) the reciprocal surface formed by the upper surfaces of the bones of the second row.

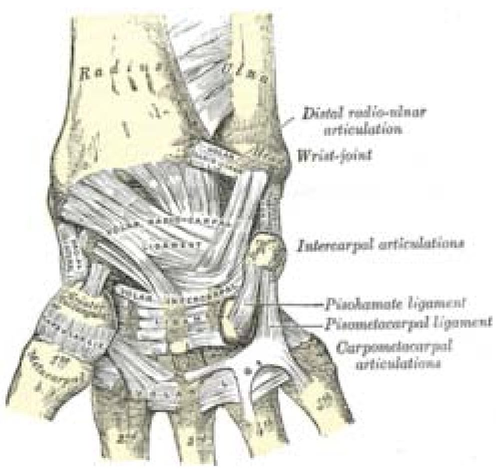
These four surfaces form two joints: (1) a proximal, the wrist-joint proper; and (2) a distal, the mid-carpal joint.

Midcarpal joint

Midcarpal joint



Vertical section through the articulations at the wrist, showing the synovial cavities.



Ligaments of wrist. Anterior view

Latin	*articulatio mediocarpalis*
Gray's	*subject #87 328*

The **Midcarpal Joint** is formed by the scaphoid, lunate, and triquetral bones in the proximal row, and the trapezium, trapezoid, capitate, and hamate bones in distal row. The distal pole of the scaphoid articulates with two trapezial bones as a gliding type of joint. The proximal end of the scaphoid combines with the lunate and triquetrum to form a deep concavity that articulates with the convexity of the combined capitate and hamate in a form of diarthrodial, almost condyloid joint.

The cavity of the midcarpal joint is very extensive and irregular. The major portion of the cavity is located between the distal surfaces of the scaphoid, lunate, and triquetrum and proximal surfaces of the four bones of the distal row. Proximal prolongations of the cavity occur between the scaphoid and lunate and between the lunate and triquetrum. These extensions reach almost to the proximal surface of the bones in the proximal row and are separated from the cavity of the radiocarpal joint by the thin interosseous ligaments. There are three distal prolongations of the midcarpal joint cavity between the four bones of the distal row. The joint space between trapezium and trapezoid, or that between trapezoid and capitate, may communicate with cavities of the carpometacarpal joints, most commonly the second and third. The cavity between the first metacarpal and carpus is always separate from the midcarpal joint; the joint cavity between the hamate and fourth and fifth metacarpals is a separate cavity more often than not, but it may communicate normally with the midcarpal joint.

The Wrist

The wrist is perhaps the most complicated joint in the body. It permits movements in three planes - extension/flexion, [[ulnar deviation]/(adduction)][[radial deviation)/(abduction)],[circumduction] and allows complex patterns of motion under significant strain.

Optimal wrist function requires stability of the carpal components in all joint positions under static and dynamic conditions.

Stability is achieved by a sophisticated geometry of articular surfaces and intricate system of ligaments, retinacula, and tendons, which also determine the relative motion of the carpal bones.

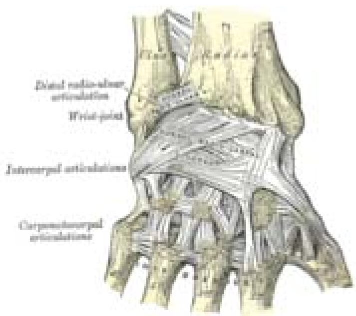
Ligaments

Ligamentous Apparatus of the Wrist:

The carpal bones are not interlocked solely by their shapes; rather, they are held together by interosseous ligaments and by volar, dorsal, radial, and ulnar ligaments. The ligaments holding the carpal bones to each other, to the distal radius and ulna, and to the proximal ends of the metacarpals can be described as extrinsic, or capsular, and intrinsic, or interosseous (intercarpal). The function of the ligamentous system is guiding and constraining certain patterns of motion. Some portion of the ligaments are under tension in every position of the hand in relation to the forearm.

Chapter 26

Carpometacarpal Joint

Carpometacarpal joint	
	
Ligaments of wrist. Posterior view.	
Latin	*articulationes carpometacarpeæ*
Gray's	*subject #88 330*

The **carpometacarpal joints** (CMC) are five joints in the wrist that articulates the distal row of carpal bones and the proximal bases of the five metacarpal bones.

The CMC of the thumb or the first CMC differs significantly from the other four CMCs and is therefore described separately.

Thumb

Bones of a human wrist. In this photo both the free position and saddle shape of the first CMC joint and the proximal transverse palmar arch are clearly visible.

The carpometacarpal joint of the thumb, also known as the trapeziometacarpal joint (TMC) because it connects the trapezium to the first metacarpal bone, plays an irreplaceable role in the normal functioning of the thumb. The most important joint connecting the wrist to the metacarpus, osteoarthritis of the TMC is a severely disabling condition; up to twenty times more common among old women than in average.

Pronation-supination of the first metacarpal is especially important for the pulp-to-pulp pinch (i.e. "true opposition"). The movements of the first CMC is limited by the shape of the joint, by the capsulo-ligamentous complex surrounding the joint, and by the balance among involved muscles. If the first metacarpal fails to sit well 'on the saddle', for example because of hypoplasia, the first CMC joint tends to be subluxated (i.e. slightly displaced) towards the radius.

The capsule is sufficiently slack to allow a wide range of movements and a distraction of roughly 3 mm, while reinforcing ligaments and tendons give stability to the joint. It is slightly thicker on its dorsal side than on the other.

Ligaments

The description of the number and names of the ligaments of the first CMC varies considerably in anatomical literature. Imaeda et al. 1993 describe three intracapsular and two extracapsular ligaments:

Anterior oblique ligament (AOL)

A strong, thick, and extracapsular ligament originating on the palmar tubercle of the trapezium to be inserted on the palmar tubercle of the first metacarpal. It is taut in abduction, extension, and pronation, and has been reported to have an important retaining function and to be elongated or absent in CMC joint arthritis.

Ulnar collateral ligament (UCL)

The second extracapsular ligament, the UCL is located ulnarly to the AOL. It has its origin on the flexor retinaculum and is inserted on the ulnopalmar tubercle of the first metacarpal. It is taut in abduction, extension, and pronation, and often found elongated in connection to CMC joint arthritis. The importance ascribed to the UCL varies considerably among researchers.

First intermetacarpal ligament (IML)

Connecting the bases of the second and first metacarpals, this ligament inserts onto the ulnopalmar tubercle of the first metacarpal where its fibers intermingle with those of the UCL. It is taut in abduction, opposition, and supination. It has been reported to be the most important restraining structure of the first CMC joint by several researchers, while some consider it to weak to be able to stabilize the joint by itself, but that it together with the UCL represent an important restraining structure.

Posterior oblique ligment (POL)

An intracapsular ligament stretching from the dorsoulnar side of the trapezium to the ulno-palmar tubercle of the first metacarpal. Not considered an important ligament to the first CMC joint, it tightens during forced adduction and radial abduction.

Dorsoradial ligament (DRL)

Like the previous ligament, the DRL is not considered important to the first CMC. It connects the dorsal sides of the trapezium and the first metacarpal.

Early, anatomically correct drawings of the ligaments of the first carpometacarpal joints where poduced by Weitbrecht 1742.

Movements

In this articulation the movements permitted are flexion and extension in the plane of the palm of the hand, abduction and adduction in a plane at right angles to the palm, circumduction, and opposition.

- It is by the movement of opposition that the tip of the thumb is brought into contact with the volar surfaces of the slightly flexed fingers. This movement is effected through the medium of a small sloping facet on the anterior lip of the saddle-shaped articular surface of the greater multangular. The flexor muscles pull the corresponding part of the articular surface of the metacarpal bone on to this facet, and the movement of opposition is then carried out by the adductors.
- Flexion of this joint is produced by the flexor pollicis longus and brevis, assisted by the opponens pollicis and the adductor pollicis.

- Extension is effected mainly by the abductor pollicis longus, assisted by the extensores pollicis longus and brevis.
- Adduction is carried out by the adductor; abduction mainly by the abductor pollicis longus and brevis, assisted by the extensors.

Range of motion for the first CMC is 53° of flexion/extension, 42° of abduction/adduction, and 17° of rotation

Planes and axes of movements

The thumb's MP and CMC joints abduct and adduct in a plane perpendicular to the palm, a movement also referred to as "palmar abduction." The same joints flex and extend in a plane parallel to the palm, also referred to as "radial abduction," because the thumb moves toward the hand's radial side. Abduction and adduction occur around an antero-posterior axis, while flexion and extension occur around a lateral axis.

For ease of orientation, the thumbnail can be considered as resting in the thumbs frontal plane. Abduction and adduction of the first CMC (and MP) joint(s) occur in this plane; flexion and extension of the first CMC, MP, and IP joints occur in a plane that is perpendicular to the thumbnail. This remains true regardless of how the first metacarpal bone is being rotated during opposition and reposition.

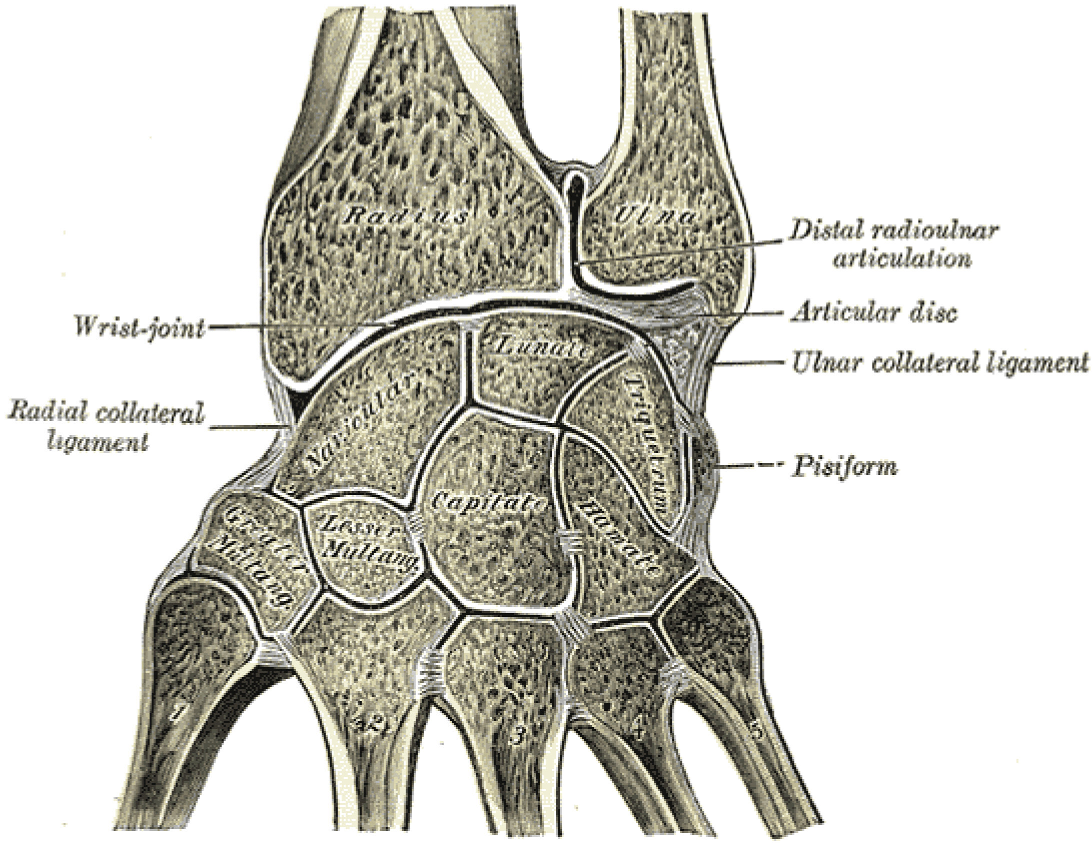
Sexual dimorphism

Male and female thumb CMC joints are different in some aspects. In women, the trapezial articular surface is significantly smaller than the metacarpal surface, and its shape also differs from that of males. While most thumb CMC joints are more congruent in the radioulnar direction than the dorsovolar, female CMC joints are less globally congruent than male joints.

Evolution

According to phylogenetic studies, primitive autonomisation of the first ray took place in dinsosaurs about 365 million years ago, while a real differentiation appeared in primitive primates approximately 70 million years ago. The shape of the human TMC joint dates back about 5 million years ago. As a result of evolution, the human thumb CMC joint has positioned itself at 80° of pronation, 40° of abduction, and 50° of flexion in relation to an axis passing through the stable second and third CMC joints,

Fingers



Section through the human wrist

X-ray of a human hand

- The second metacarpal articulates primarily with the trapezoid and secondarily with the trapezium and capitate.
- The third metacarpal articulates primarily with the capitate,
- The fourth metacarpal articulates with the capitate and hamate.
- The fifth metacarpal articulates with the hamate.

Among themselves, the four ulnar metacarpals also articulates with their neighbours at the intermetacarpal articulations.

Ligaments

These four CMC joints are supported by strong transverse and weaker longitudinal ligaments: the dorsal carpometacarpal ligaments and the volar or palmar carpometacarpal ligaments.

The interosseous ligaments consist of short, thick fibers, and are limited to one part of the carpometacarpal articulation; they connect the contiguous inferior angles of the capitate and hamate with the adjacent surfaces of the third and fourth metacarpal bones.

Movements

The carpometacarpal joints of second through fifth digits are arthrodial. The movements permitted in the second through fifth carpometacarpal joints is most readily observable in the (distal) heads of the metacarpal bones. The range of motions in these joints decrease from the fifth to the second CMCs.

The second to fifth joints are synovial ellipsoidal joints with a nominal degree of freedom (flexion/extension). The second and third joints are however essentially immobile and can be considered to have zero degrees of freedom in practice. These two CMC provide the other three CMCs with a fixed an stable axis. While the mobility of the fourth CMC joint thus is perceptible, the first joint is a saddle joint with two degrees of freedom which except flexion/extension also enable abduction/adduction and a limited amount of opposition. Together the movements of the fourth and fifth CMCs facilitates for their fingers to oppose the thumb.

Function

The function of the finger CMC joints and their segments overall is to contribute to the palmar arch system together with the thumb. The proximal transverse arch of the palm is formed by the distal row of carpal bones. The concavity of this arch is augmented at the level of the metacarpal heads by the flexibility of the first, fourth, and fifth metacarpal heads around the fixed second and third metacarpal heads; a flexible structure called the distal transverse arch. For each finger there is also a longitudinal arch. Together, these arches allow the palm and the digits to conform optimally to objects as we grasp them (so called palmar cupping). Furthermore, as the amount of surface contact is maximized, stability is enhanced and sensory feedback increases. The deep transverse metacarpal ligament stabilises the mobile parts of the palmar arch system.

As the finger are being flexed, palmar cupping is contributed to by muscles crossing the CMC joints when they act on the mobile parts of the palmar arch system. The oblique opponens digiti minimi muscle acts on the fifth CMC joint and is the only muscle that act on the CMC joints alone. It is optimally positioned to flex and rotate the fifth metacarpal bone about its long axis. Palmar arching is further increased when flexor carpi ulnaris (which is attached to the pisiform) and intrinsic hand muscles attached to the transverse carpal ligament acts on the arch system. The fixed second and third CMC joints are crossed by the radial wrist muscles (flexor carpi radialis, extensor carpi radialis longus, and extensor carpi radialis brevis). The stability of these two CMC joints is a functional adaptation that enhances the efficiency of these muscle at the midcarpal and radiocarpal joints.

Synovial membranes

The synovial membrane is a continuation of that of the intercarpal joints. Occasionally, the joint between the hamate and the fourth and fifth metacarpal bones has a separate synovial membrane.

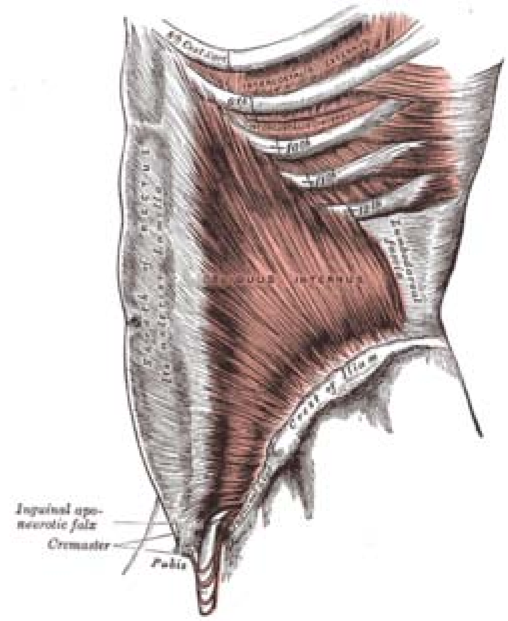
The synovial membranes of the wrist and carpus are thus seen to be five in number.

- The first passes from the lower end of the ulnar to the ulnar notch of the radius, and lines the upper surface of the articular disk.
- The second passes from the articular disk and the lower end of the radius above, to the bones of the first row below.
- The third, the most extensive, passes between the contiguous margins of the two rows of carpal bones, and sometimes, in the event of one of the interosseous ligaments being absent, between the bones of the second row to the carpal extremities of the second, third, fourth, and fifth metacarpal bones.
- The fourth extends from the margin of the greater multangular to the metacarpal bone of the thumb.
- The fifth runs between the adjacent margins of the triangular and pisiform bones.

Chapter 27

Fascia and Anterior Compartment of the Forearm

Fascia

Fascia	
	
The rectus sheath, an example of a fascia.	
Latin	*fascia*
Gray's	*subject #104 376*
Precursor	mesenchyme
MeSH	*Fascia*

A **fascia** is a layer of fibrous tissue that permeates the human body. A fascia is a connective tissue that surrounds muscles, groups of muscles, blood vessels, and nerves, binding those structures together in much the same manner as plastic wrap can be used to hold the contents of sandwiches together. It consists of several layers: a superficial fascia, a deep fascia, and a subserous (or visceral) fascia and extends uninterrupted from the head to the tip of the toes.

Like ligaments, aponeuroses, and tendons, fasciae are *dense regular* connective tissues, containing closely packed bundles of collagen fibers oriented in a wavy pattern parallel to the direction of pull. Fasciae are consequently flexible structures able to resist great unidirectional tension forces until the wavy pattern of fibers has been straightened out by the pulling force. These collagen fibers are produced by the fibroblasts located within the fascia.

Definition

There exists some controversy about what structures are considered "fascia", and how fascia should be classified. The two most common systems are:

- the one specified in the 1983 edition of Nomina Anatomica (NA 1983)
- the one specified in the 1997 edition of Terminologia Anatomica (TA 1997)

NA 1983	TA 1997	Description	Example
Superficial fascia	(not considered fascia in this system)	This is found in the subcutis in most regions of the body, blending with the reticular layer of the dermis.	Fascia of Scarpa
Deep fascia	Fascia of muscles	This is the dense fibrous connective tissue that interpenetrates and surrounds the muscles, bones, nerves and blood vessels of the body.	Transversalis fascia
Visceral fascia	Visceral fascia, parietal fascia	This suspends the organs within their cavities and wraps them in layers of connective tissue membranes.	Pericardium

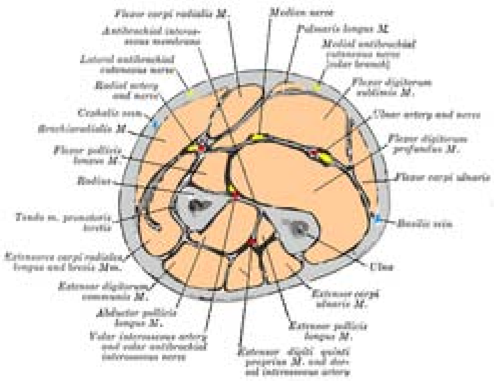
Function

Fasciae are normally thought of as passive structures that transmit mechanical tension generated by muscular activities or external forces throughout the body. Some research suggest that fasciae might be able to contract independently and thus actively influence muscle dynamics.

The function of muscle fasciae is to reduce friction to minimize the reduction of muscular force. In doing so, fasciae allow muscles to glide over each other.

Anterior compartment of the forearm

Anterior compartment of the forearm	



Cross-section through the middle of the forearm. (Anterior compartment is at top; posterior compartment is at bottom.)

Latin	*compartimentum antebrachii anterius*
Artery	ulnar artery
Nerve	median nerve (anterior interosseous nerve), ulnar nerve (muscular branches of ulnar nerve)

The **anterior compartment of the forearm** (or **flexor compartment**) contains the following muscles:

Level	Muscle	E/I	Nerve
superficial	flexor carpi radialis	E	median
superficial	palmaris longus	E	median
superficial	flexor carpi ulnaris	E	ulnar
superficial	pronator teres	I	median
superficial (or intermediate)	flexor digitorum superficialis	E	median
deep	flexor digitorum profundus	E	ulnar + median (as anterior interosseous nerve)
deep	flexor pollicis longus	E	median (as anterior interosseous nerve)
deep	pronator quadratus	I	median (as anterior interosseous nerve)

- "E/I" refers to "extrinsic" or "intrinsic".

The muscles are largely involved with flexion and pronation. The superficial muscles have their origin on the common flexor tendon. The Ulna nerve and artery are also contained within this compartment.