

THE KNEE JOINT

Type and articulation

The knee is the largest joint in the body. It is a modified, complex synovial **hinge** joint formed by the articulation between the tibial and femoral condyles on one hand (hinge tibiofemoral joint) and the femoral condyles with the posterior surface of the patella on the other hand (saddle patellofemoral joint). Functionally, it moves as a hinge joint.

The knee is relatively unstable. The stability is maintained by 2 main factors;

- The presence of a large bulk of supporting muscles and strong ligaments.

- The presence of the menisci which increase the congruence of the articular surfaces.

The fibrous capsule and ligaments

The fibrous capsule

□ The **fibrous capsule** is broad and thin posteriorly where it is strengthened by the oblique popliteal and arcuate popliteal ligaments. The posterior fibers of the capsule pass obliquely downwards and medially parallel to popliteus muscle; from the articular margins of the femoral condyles and intercondylar line to the articular margins of the tibia. Laterally, the attachment is proximal to the lateral femoral condyle so that the origin of popliteus lies within the joint capsule cavity. The capsule is short and thick on the sides where it is strengthened by the medial and lateral collateral ligaments. Anteriorly, the capsule is deficient. As it passes anteriorly, it blends with the patellar retinacula gaining attachment to the sides of the patella and spreading upwards to the sides of the quadriceps tendon and downwards to the sides of the ligamentum patellae and the tibial tuberosity. The deep surface of the capsule attaches weakly to the rims of the menisci as the **coronary ligament** and helps attaching them to the tibial plateau.

□ The fibrous capsule of the knee has three thickenings;

□ The **oblique popliteal ligament** is an expansion of the semimembranosus tendon passing upwards and laterally to be attached to the intercondylar fossa and the posterior surface of the lateral femoral condyle.

□ The **arcuate popliteal ligament** is a Y-shaped thickening on the posterior surface of the capsule with its stem attached to the fibular head, its lower limb attached to the posterior edge of the tibial intercondylar area and its upper limb attached to the posterior surface of the lateral femoral condyle. A thin fibrous band extends from the fabella in the lateral head of gastrocnemius muscle to the head of the fibula forming the weak **fabellofibular ligament**.

□ A **medial capsular thickening** is firmly attached to the medial meniscus and represents the **deep part of the medial collateral ligament**.

□ The knee capsule also has three perforations;

□ A posterolateral perforation is posterior to the lateral femoral condyle for the emergence of popliteus muscle.

□ A posteromedial perforation for extension of the synovial membrane into the bursa of the medial head of gastrocnemius and semimembranosus.

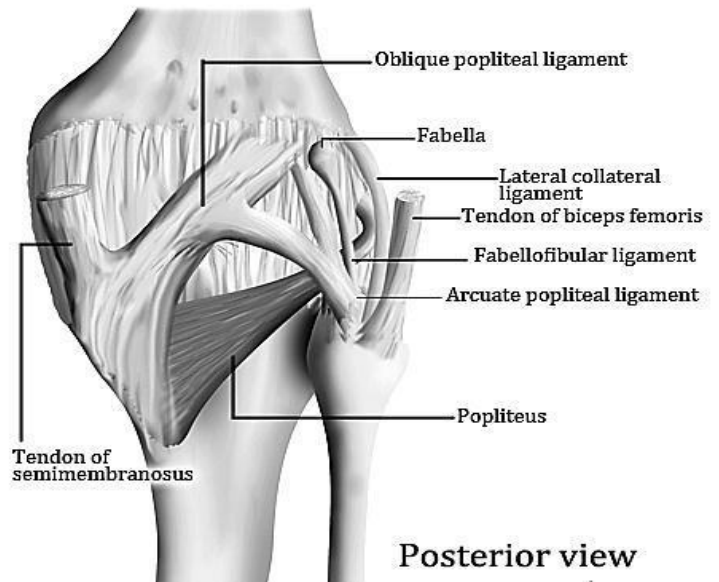
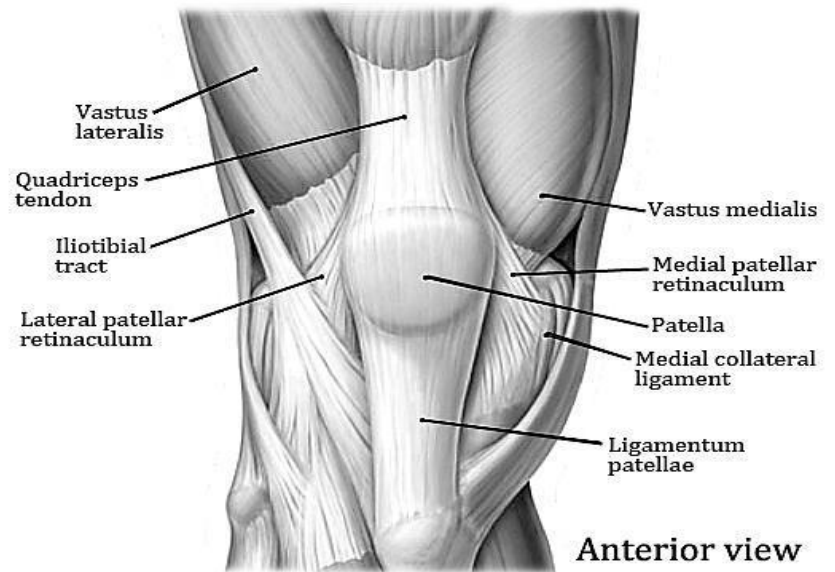
□ An anterosuperior perforation for the extension of the synovial membrane into the suprapatellar bursa.

The extracapsular ligaments

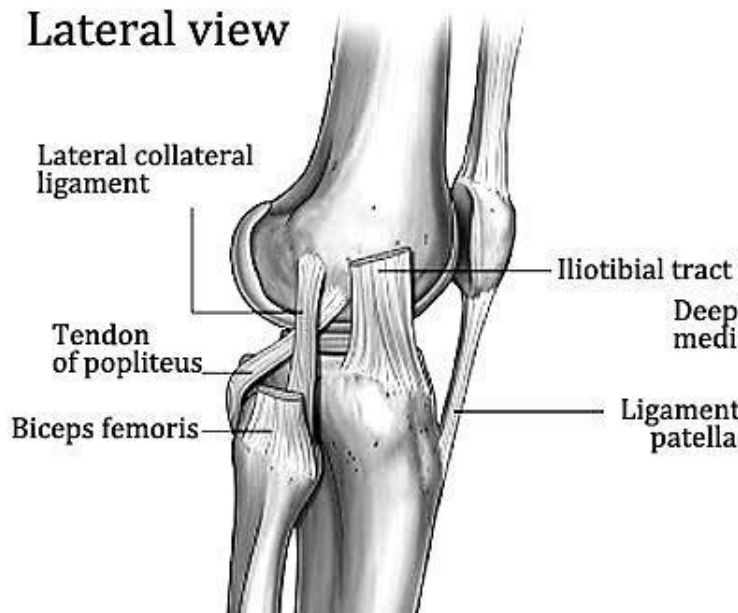
The extracapsular ligaments of the knee joint are derived from the fibrous capsule of the joint or from fascial expansions of the surrounding muscles. They include;

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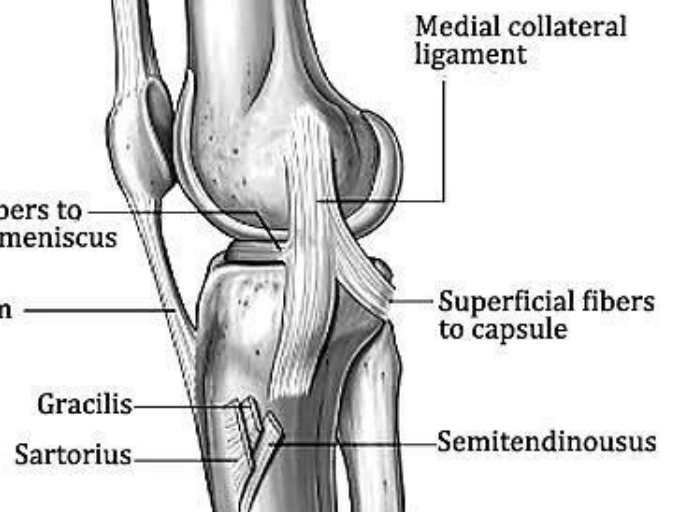
□ The **ligamentum patellae** is the continuation of the quadriceps femoris tendon passing from the front and the lower margins of the patella to the tibial tuberosity. It is separated from the knee joint by the infrapatellar pad of fat, from the upper part of the tibial tuberosity by the deep infrapatellar bursa and from the overlying skin by the superficial infrapatellar bursa. The iliotibial tract also spreads into a sheet of fibers that attach to the medial patellar



Lateral view



Medial view



retinaculum.

□ The **medial and lateral patellar retinacula** represent an expansion of fibers of quadriceps femoris passing backwards to the collateral ligaments of the knee and downwards to the tibial plateaus.

□ The **lateral (fibular) collateral ligament** is cord-like and passes from the lateral femoral condyle to the head of the fibula piercing the tendon of biceps femoris. It is separated from the lateral meniscus by the popliteus tendon and a bursa intervening in between.

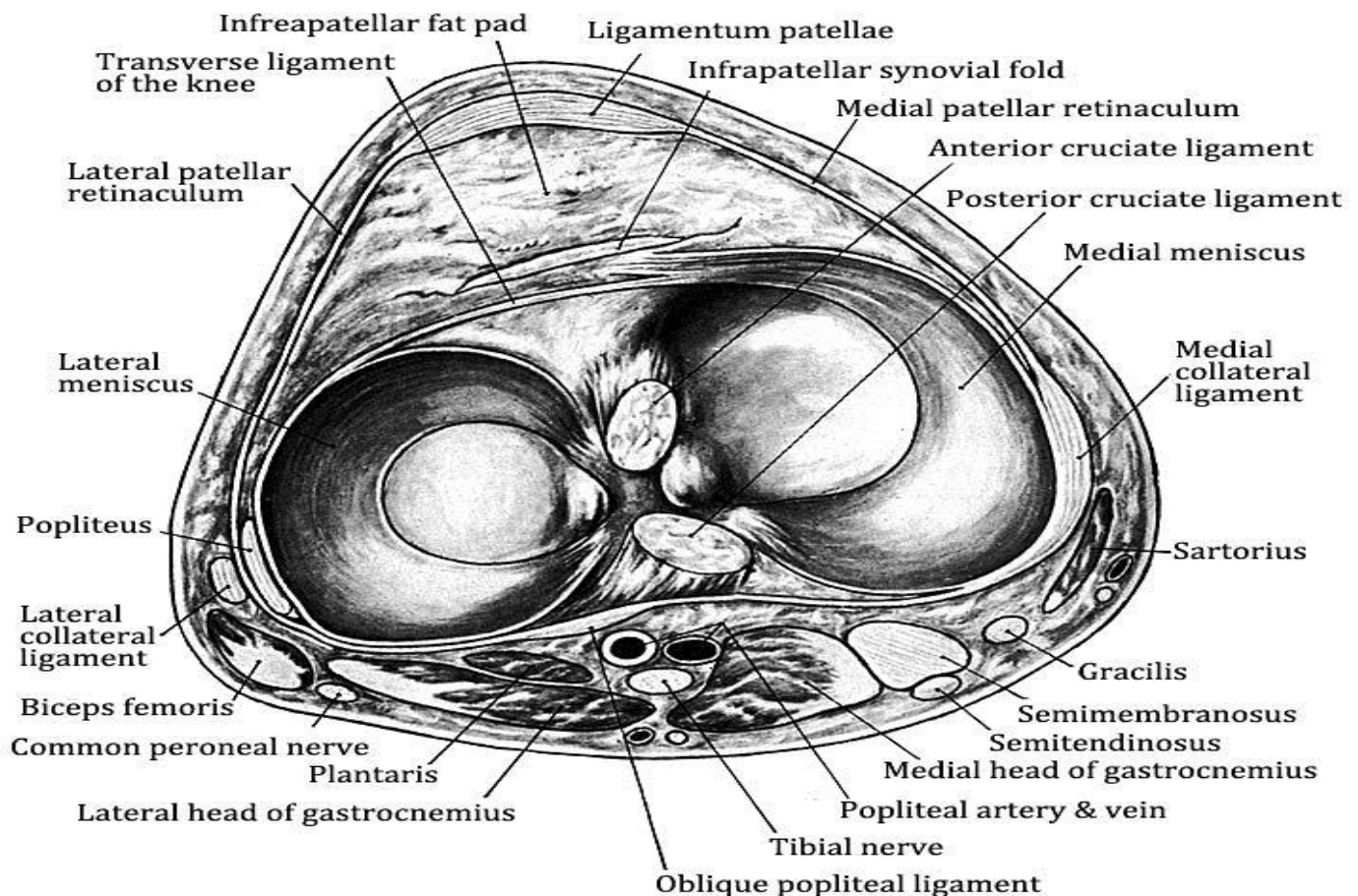
The **medial (tibial) collateral ligament** is a broad band passing from the medial femoral condyle to the upper part of the medial surface of the shaft of the tibia deep to the tendons of the pes anserinus muscles. Its deep fibers are firmly attached to the medial meniscus.

□ The **oblique popliteal ligament**.

□ The **arcuate popliteal ligament**.

The intracapsular ligaments

The anterior and posterior cruciate ligaments lie within the cavity of the knee joint capsule but outside the synovial membrane cavity. Each ligament is named according to its tibial area of attachment; anterior or posterior. Each ligament limits the tibia from moving in the direction consistent with its name



□ The **anterior cruciate ligament** passes from the anterior intercondylar area of the tibia upwards, backwards and laterally to attach to the posteromedial surface of the lateral femoral condyle. It prevents forward gliding of the tibia on the femur i.e. prevents backward movement of the femur on the tibia.

□ The **posterior cruciate ligament** is stronger, shorter and less oblique than the anterior one. It passes from the posterior intercondylar area of the tibia upwards, forwards and medially to be attached to the anterolateral surface of the medial femoral condyle. It prevents backward gliding of the tibia on the femur i.e. prevents forward movement of the femur on the tibia. Fibers from the lateral meniscus pass in front and behind the posterior cruciate ligament to the medial femoral condyle as the **anterior and posterior meniscofemoral ligaments**.

The menisci (semilunar cartilages)

The menisci are two C-shaped avascular fibrocartilaginous cushions that deepen the articular surface of the tibial plateaus and act as shock absorbers.

Each meniscus is attached by its **elevated thick periphery** to the margins of the tibial condyle via fibers that blend with the fibrous capsule as the **coronary ligaments**. The **inner margins** of the menisci are **thin and concave**. Each meniscus attaches to the anterior and posterior parts of the intercondylar area by its anterior and posterior **horns**. Some fibers of the anterior horns of both menisci are joined together forming the **transverse ligament of the knee**.

□ The **lateral meniscus** is smaller, more deeply concave, more circular (4/5 of a circle) and has a more regular breadth than the medial meniscus. Its horns are more closely attached to each other.

□ The **medial meniscus** is larger, less concave, more oval anteroposteriorly and less regular in breadth than the lateral meniscus. Its horns are more widely separated in their attachments.

Because of its shape and because the medial femoral condyle is larger than the lateral one, the medial meniscus is 20 times more liable to be irreversibly damaged than the lateral meniscus. This type of injury occurs when the femur is rotated on the tibia in the weight-bearing, partially flexed knee resulting in crushing of the meniscus under the weight of the femoral condyles and irreparable tears. The injury is irreparable because the menisci are avascular.

The synovial membrane and related bursae

□ The synovial cavity of the knee may be divided into four continuous parts; **two tibiofemoral cavities** between the tibial and femoral condyles which are separated from each other posteriorly by a synovial membrane septum but communicate with each other and with the third cavity; the **infrapatellar cavity**; anteriorly. The infrapatellar cavity continues upwards with the fourth cavity; the **suprapatellar cavity** represented by the suprapatellar bursa.

□ The septum that separates the 2 tibiofemoral cavities posteriorly consists of the synovial membrane that covers the upper surface and the sides of the cruciate ligaments which appear as if they herniated into the

joint cavity from behind. This septum isolates the cruciate ligaments from the synovial fluid. The septum extends anteriorly and reflects on the infrapatellar pad of fat as the **infrapatellar fold**.

□ The synovial membrane has three extensions through perforations in the fibrous capsule;
 □ The **suprapatellar bursa** extends 3 fingerbreadths proximal to the patella deep to the quadriceps femoris tendon. It becomes elevated during knee extension by the articularis genu fibers of vastus intermedius.

□ The **popliteus bursa** lies between popliteus and the lateral femoral condyle and sometimes extends between popliteus and the lateral collateral ligament.

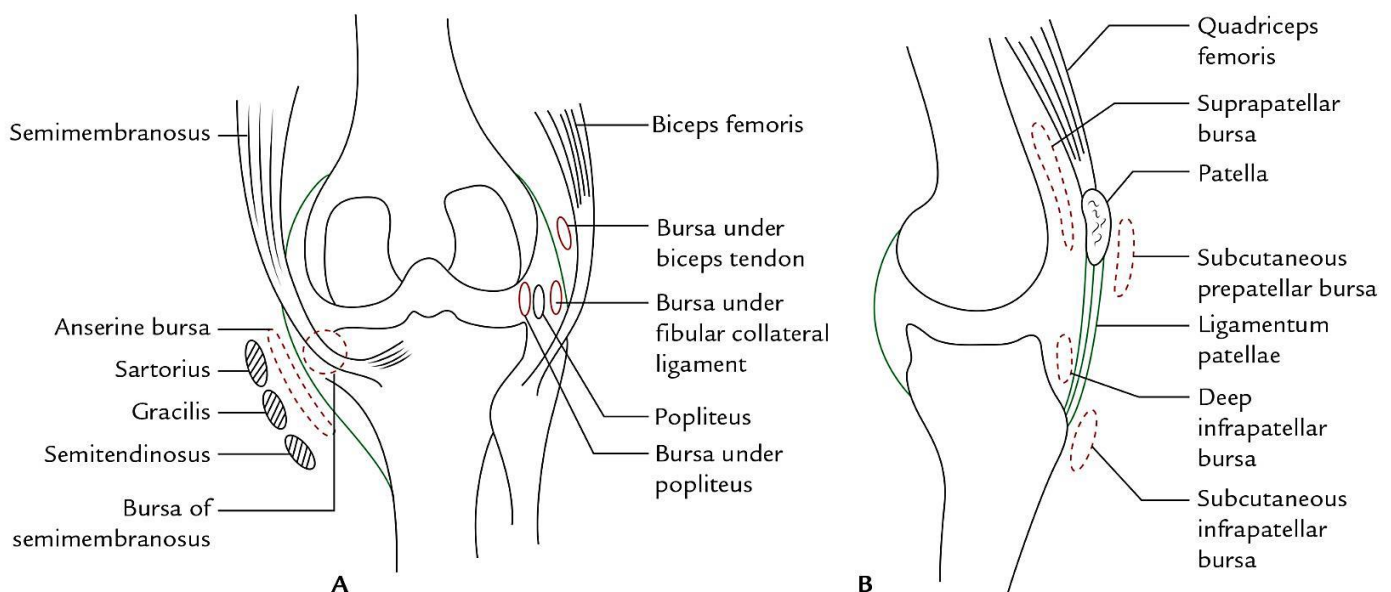
□ The **bursa of the medial head of gastrocnemius** that lies between the medial femoral condyle and the medial head of gastrocnemius. It usually communicates with the semimembranosus bursa (deep to semimembranosus).

Bursae related to the knee joint

Anteriorly

- The suprapatellar bursa; posterior to quadriceps femoris tendon and anterior to the femur.
- The prepatellar bursa; between the patella and the overlying skin.
- The superficial infrapatellar bursa; between the ligamentum patellae/tibial tuberosity and the overlying skin.
- The deep infrapatellar bursa; between the ligamentum patellae and the upper part of the tibial tuberosity.

Laterally



- A bursa between the lateral collateral ligament and the fibrous capsule

□ A bursa between the lateral collateral ligament and the tendon of biceps femoris.

Medially

□ A bursa between the medial collateral ligament, the tibia and fibrous capsule.

□ A bursa between the medial collateral ligament and the pes anserinus muscles.

Posteriorly

□ A bursa between the fibrous capsule and the medial head of gastrocnemius.

□ A bursa between the fibrous capsule and the lateral head of gastrocnemius.

□ The semimembranosus bursa; between semimembranosus tendon and the medial head of gastrocnemius.

□ A bursa between popliteus and the upper parts of the back of the tibia and fibula.

Blood supply

Arterial supply of the knee is provided by the genicular anastomosis formed by the following arteries;

□ Descending arteries from the thigh

□ Descending genicular branch of the femoral artery medially.

□ Descending genicular branch of the lateral circumflex femoral artery laterally.

□ Ascending arteries from the leg

□ Anterior and posterior recurrent genicular branches of the anterior tibial artery.

□ Ascending genicular branch of the circumflex fibular branch of the posterior tibial artery.

□ Arteries from the popliteal fossa

□ The superior, middle and inferior medial and lateral genicular branches of the popliteal

Nerve supply

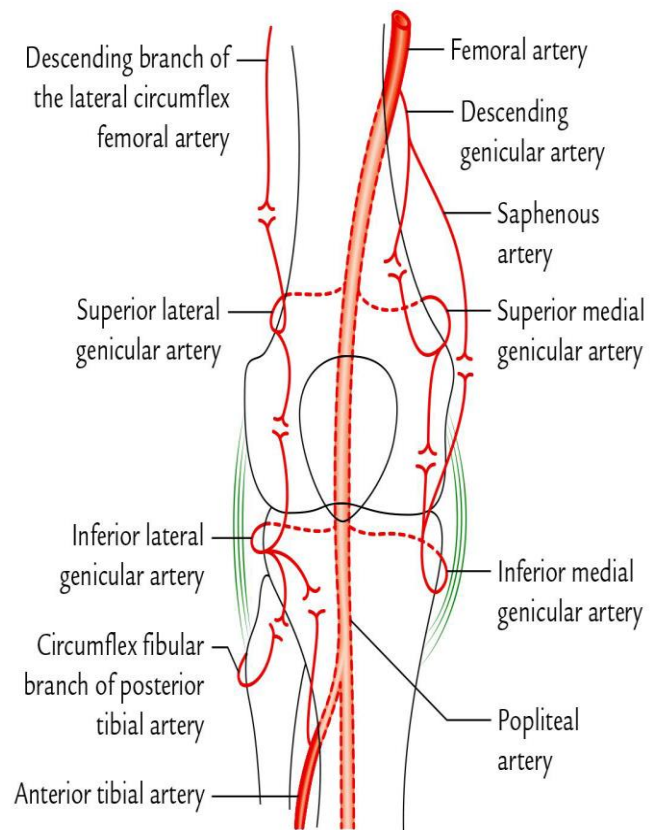
□ Articular branches to the knee are derived from;

□ Genicular branch of the posterior division of the obturator nerve.

□ Articular branches of the femoral nerve via its branches to the vasti.

□ Superior, middle and inferior medial genicular branches of the tibial nerve.

□ Superior and inferior lateral genicular and recurrent genicular branches of the common peroneal nerve.



Movements

The knee is a functionally hinge joint allowing flexion and extension. However, there is some degree of rotation of the tibia on the femur in flexion because of the unequal sizes of the medial and lateral femoral condyles and the menisci.

When the knee is fully extended with the foot on the ground, the knee passively “locks” because of medial rotation of the femoral condyles on the tibial plateau. Full fitness is achieved in both tibiofemoral surfaces, the cruciate and collateral ligaments and the iliotibial tract and skin and fascia all become taut and the knee is said to be “locked” in extension i.e. the femur cannot be rotated on the tibia. Moreover, the body's center of gravity is positioned along a vertical line that passes anterior to the knee joint so a fully extended knee is actually 5°-10° hyperextended. This position makes the lower limb a solid column and more adapted for weight-bearing. When the knee is “locked,” the thigh and leg muscles can relax briefly without making the knee joint too unstable.

To unlock the knee, the popliteus contracts, rotating the femur laterally about 5° on the tibial plateau so that flexion of the knee can occur. This will allow the flexors to continue knee flexion.

Movement	Muscles
Flexion	Popliteus (unlocking) Biceps femoris Semitendinosus Semimembranosus Adductor magnus (hamstring part) Sartorius Gracilis Gastrocnemius Plantaris
Extension	Quadriceps femoris Tensor fascia latae & gluteus maximus (keep the iliotibial tract taut)
Medial rotation (in flexion)	Semitendinosus Semimembranosus Sartorius Gracilis
Lateral rotation (in flexion)	Biceps femoris

Relations

- **Anteriorly**; quadriceps femoris tendon, ligamentum patellae and related bursae.
- **Laterally**; biceps femoris, common peroneal nerve and lateral head of gastrocnemius.
- **Posteriorly**; popliteus, popliteal vessels, tibial and common peroneal nerves, popliteal lymph nodes, skin and fascia.
- **Medially**; the pes anserinus muscles, semimembranosus and medial head of gastrocnemius.

THE TIBIOFIBULAR JOINTS

- The small **proximal tibiofibular joint** is **synovial pivot joint** and allows very little rotation of the leg when the knee joint is flexed. It is formed by the articulation of the flat undersurface of the lateral condyle of the tibia and the circular superomedial surface of the head of the fibula. The joint capsule is reinforced by anterior and posterior ligaments.
- The **distal tibiofibular joint** is a **compound fibrous joint**. It is the fibrous union of the tibia and fibula by means of the interosseous membrane (uniting the shafts) and the anterior, interosseous, and posterior tibiofibular ligaments. The posterior tibiofibular ligament unites the distal ends of the tibia and fibula. The integrity of the inferior tibiofibular joint is essential for the stability of the ankle joint because it keeps the lateral malleolus firmly against the lateral surface of the talus.