

Anatomy of the knee joint

Introduction

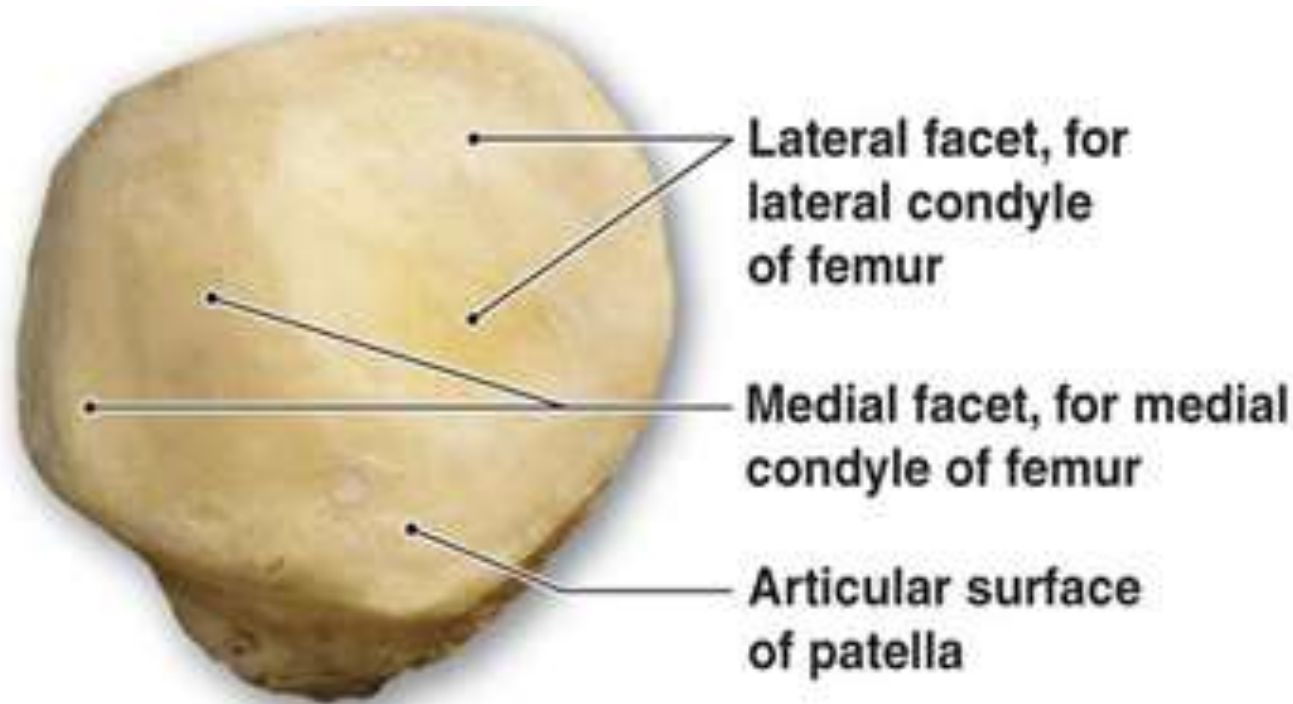
- The knee joint is the largest and most complicated joint in the body
- It is a modified hinge variety of synovial joint (because it allows some rotatory movements beside flexion and extension)

- It consists of 3 joints
 1. Medial condylar joint - between the medial condyle of the femur & medial condyle of tibia
 2. Lateral condylar joint – between the lateral condyle of tibia & lateral condyle of femur
 3. Patellofemoral joint – between the patella & patellar surface of the femur (called trochlea)

Patellofemoral joint

- The patellofemoral joint is composed of the suprapatellar pouch, the patella bone, trochlea, the medial and lateral femoral condyles, and the medial and lateral patellofemoral ligaments

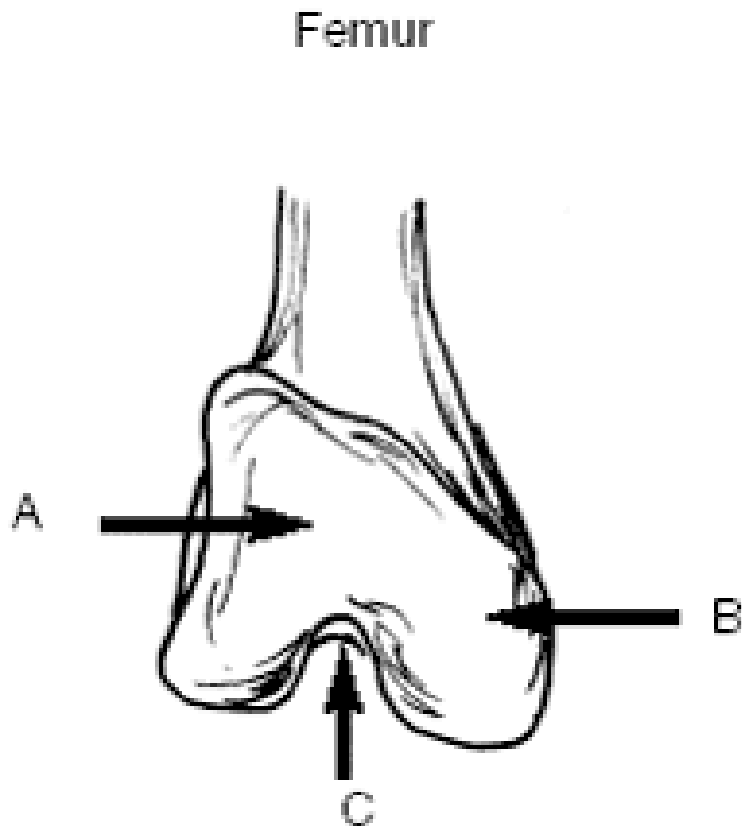
- The patella is one of the sesamoid bones of the body. It has a medial and a lateral facet that articulate with its respective condyles.
- Centrally, there is an apex of the bone that sits in the trochlea



- In extension, the distal portion of lateral articular patella facet articulate with the lateral femoral condyle, but medial patellar facet barely articulates with the medial femoral condyle until complete flexion is approached
- The medial and lateral patellofemoral ligaments are thickenings of the medial and lateral retinaculum respectively. They originate centrally on the patella and insert onto the medial and lateral epicondyles of the femur

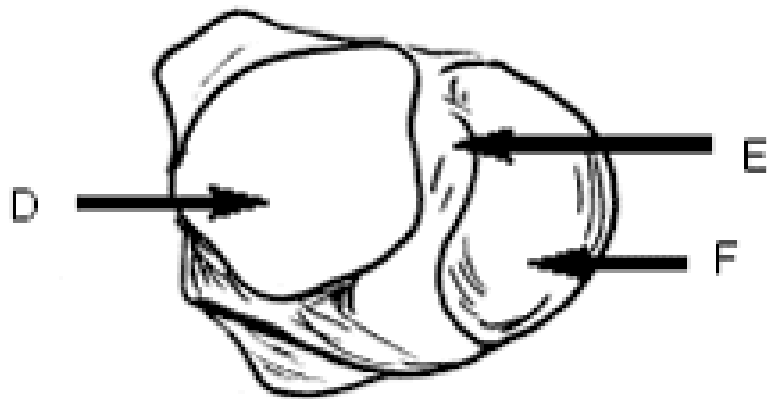
TIBIOFEMORAL JOINT

FEMORAL CONDYLES



- A – Lateral Condyle
 - Smaller radius of curvature
 - Smaller in all dimensions
 - Extends more anteriorly
- B – Medial Condyle
 - Larger radius of curvature
 - Extends more distally
- C – Intercondylar notch

TIBIAL PLATEAU



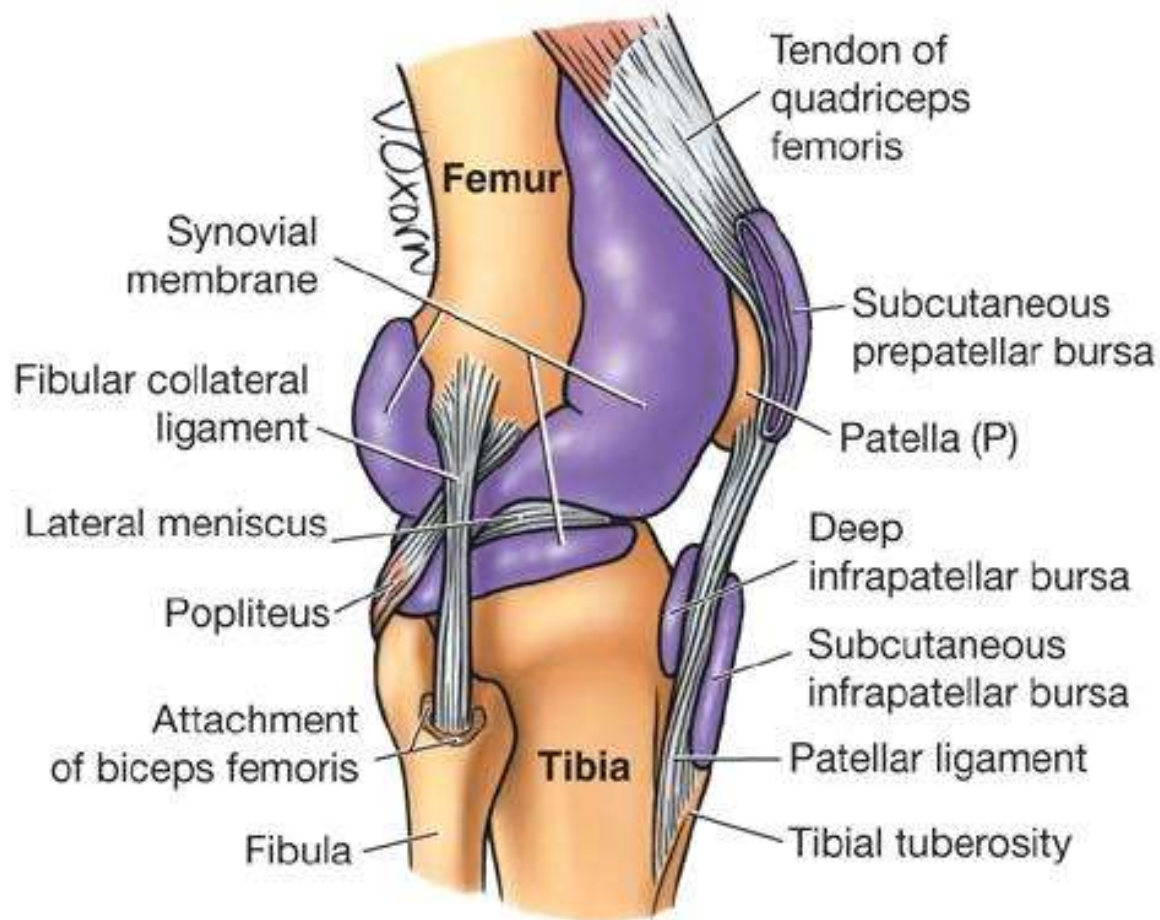
Tibia

- D – Medial Plateau
 - Greater surface area
 - Concave
 - Circular shape
- E – Intercondylar Eminence
- F – Lateral Plateau
 - Smaller surface area
 - Convex
 - Oval shape

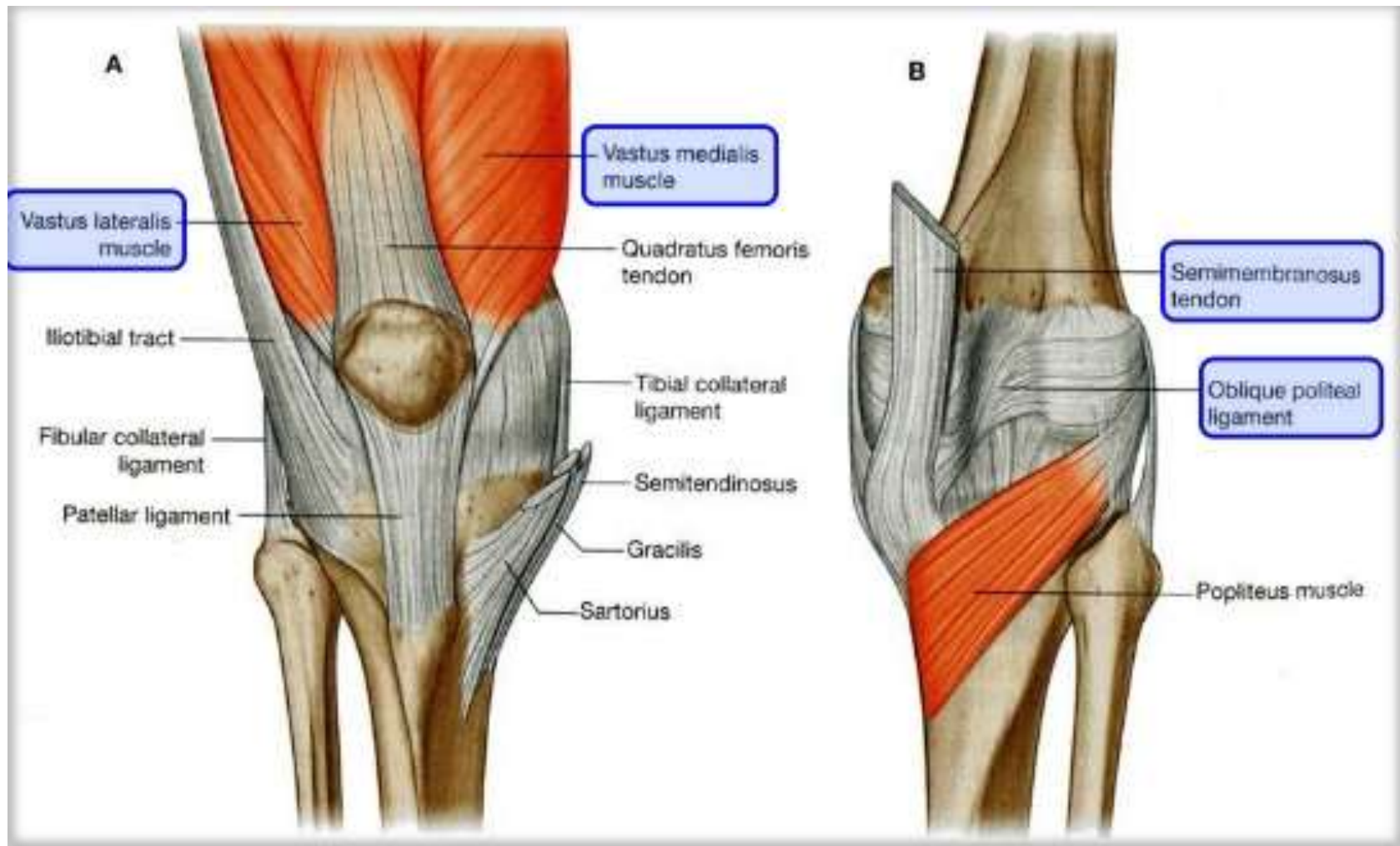
Capsule

- Attached to the margins of articular surfaces & surrounds the sides and posterior aspect of the knee joint
- On the front of the joint the capsule is absent, permitting the synovial membrane to pouch upward beneath the quadriceps tendon forming the suprapatellar bursa
- On each side of the patella the capsule is strengthened by expansions from the tendons of vastus lateralis & medialis

- Behind the joint, the capsule is strengthened by an expansion of semimembranosus muscle called the oblique popliteal ligament
- An opening in the capsule behind the lateral tibial condyle permits the tendon of the popliteus to emerge



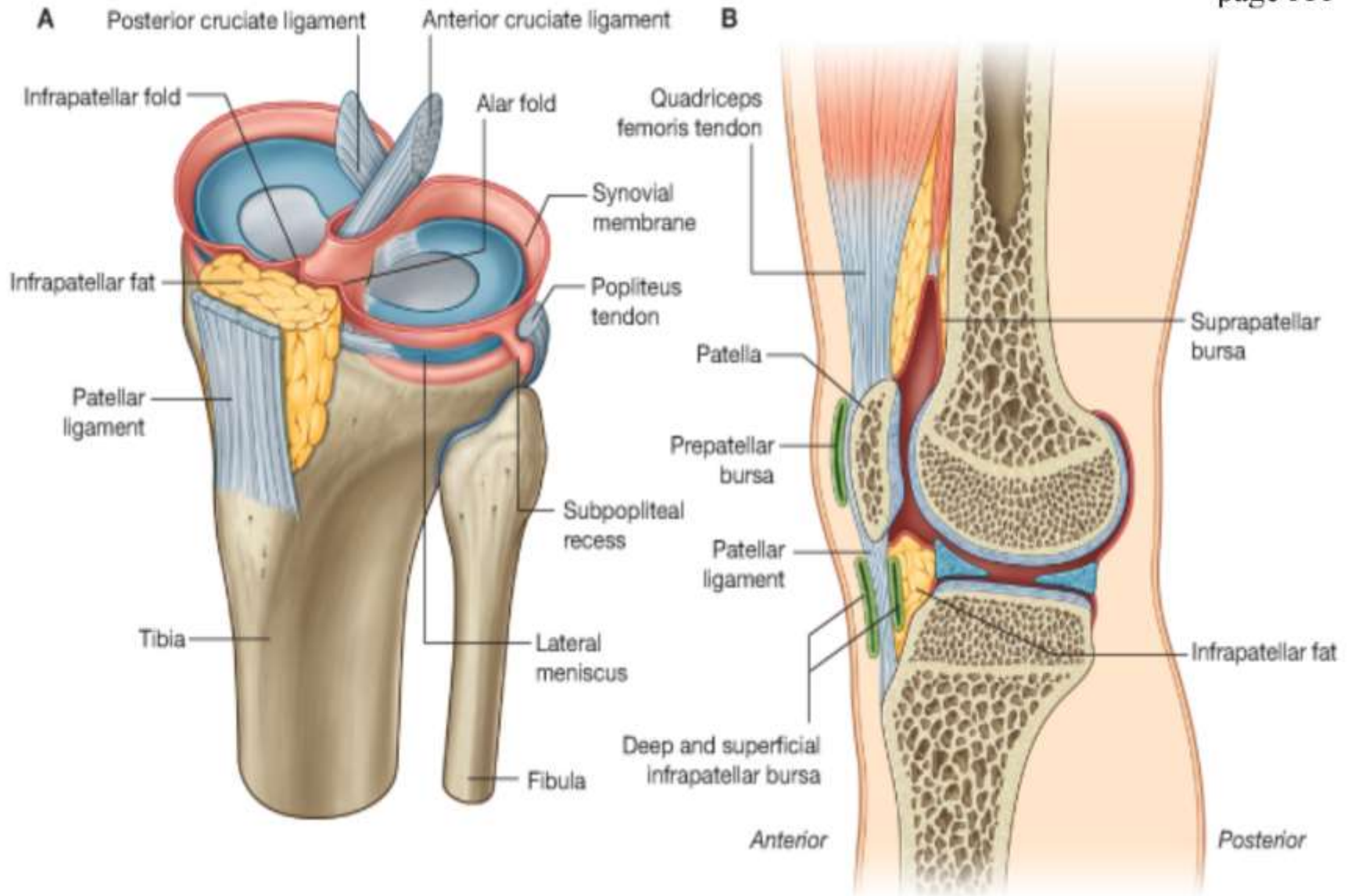
A Lateral view



Synovial membrane

- The synovial membrane of the knee joint attaches to the margins of the articular surfaces and to the superior and inferior outer margins of the menisci.
- It lines the joint capsule except posteriorly where cruciate ligaments found.
- In front, it is absent from patella
-

- The two cruciate ligaments, which attach in the intercondylar region of the tibia below and the intercondylar fossa of the femur above are outside the articular cavity, but enclosed within the fibrous membrane of the knee joint.
- Posteriorly, the synovial membrane reflects off the fibrous membrane of the joint capsule on either side of the posterior cruciate ligament and loops forward around both ligaments thereby excluding them from the articular cavity

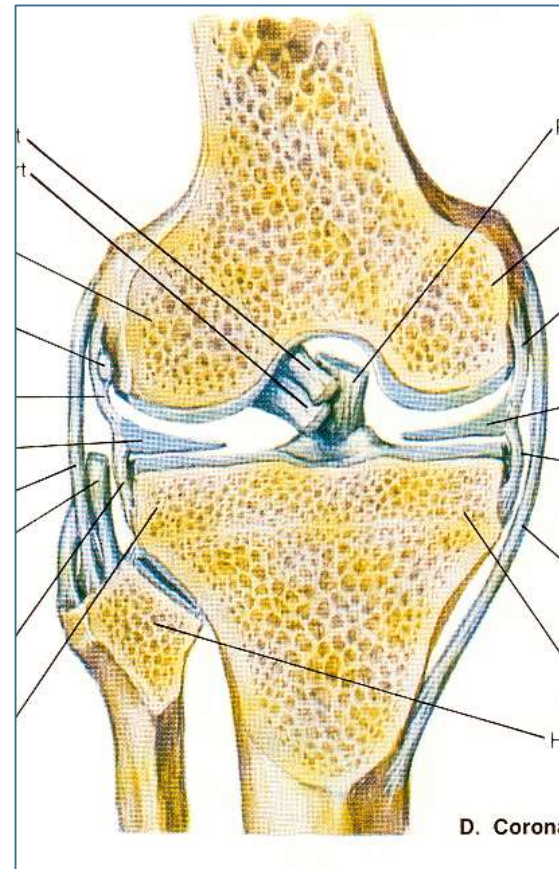


LIGAMENTS

- CORONARY LIGAMENT.
- LIGAMENTUM PATELLAE.
- ANTERIOR CRUCIATE LIGAMENT.
- POSTERIOR CRUCIATE LIGAMENT.
- TIBIAL/MEDIAL COLLATERAL LIGAMENT.
- FIBULAR/LATERAL COLLATERAL LIGAMENT.
- OBLIQUE POPLITEAL LIGAMENT.
- ARCUATE POPLITEAL LIGAMENT.
- MEDIAL MENISCUS.
- LATERAL MENISCUS.
- TRANSVERSE LIGAMENT.

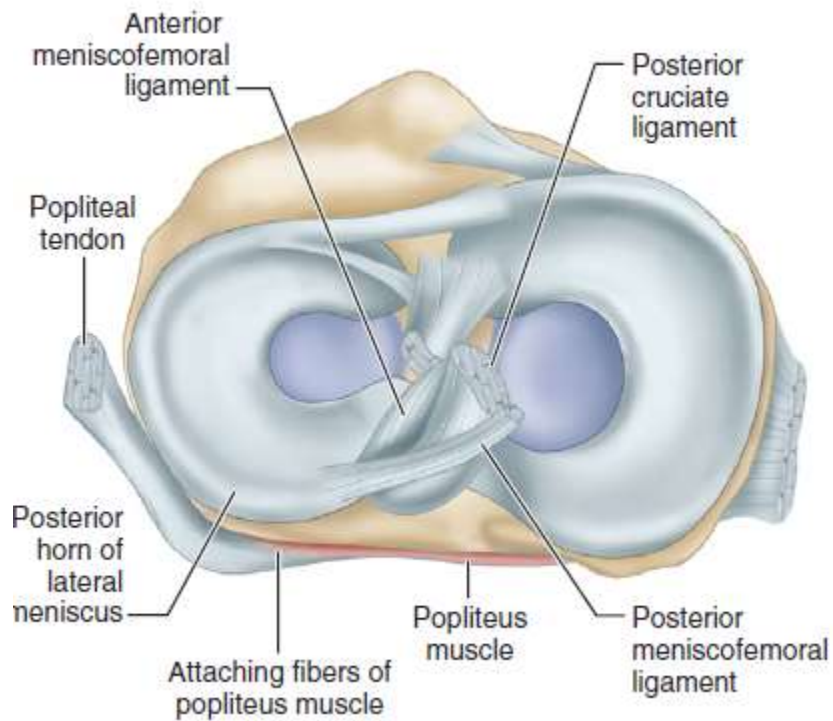
CORONARY LIGAMENT

- Fibrous Capsule is attached to periphery of Menisci.
- Connects the periphery of the menisci to the tibia
- They are the portion of the capsule that is stressed in rotary movements of the knee



CRUCIATE LIGAMENTS

- VERY THICK, STRONG FIBROUS BANDS
- DIRECT BONDS OF UNION BETWEEN FEMUR & TIBIA
- REPRESENT COLLATERAL LIGAMENTS OF ORIGINAL FEMORO TIBIAL JOINTS
- MAINTAIN ANTERO-POSTERIOR STABILITY
- NAMED ACCORDING TO ATTACHMENT ON TIBIA
- SUPPLIED BY VESSELS AND NERVES WHICH PIERCE OBLIQUE POPLITEAL LIGAMENT



ANTERIOR CRUCIATE LIGAMENT

- the **anterior cruciate ligament** attaches to a facet on the anterior part of the intercondylar area of the tibia and ascends posteriorly to attach to a facet at the back of the lateral wall of the intercondylar fossa of the femur;
- The anterior cruciate ligament crosses lateral to the posterior cruciate ligament as they pass through the intercondylar region.
- The anterior cruciate ligament prevents anterior displacement of the tibia relative to the femur
- it is taut during knee extension

POSTERIOR CRUCIATE LIGAMENT

- the **posterior cruciate ligament** attaches to the posterior aspect of the intercondylar area of the tibia and ascends anteriorly to attach to the medial wall of the intercondylar fossa of the femur.
- posterior cruciate ligament restricts posterior displacement
- it tauts during knee flexion

MEDIAL COLLATERAL LIGAMENT (MCL) OR TIBIAL COLLATERAL LIGAMENT



- Is attached superiorly to the medial epicondyle of the femur just below adductor tubercle.
- Inferiorly it divides into superficial and deep
- Superficial part attached to the upper third of the tibia, as far down as the tibial tuberosity
- The deep portion, which is short, fuses with the capsule and with the medial meniscus
- A bursa usually separates the two parts
- MCL, tightens in extension
- A valgus stress will put a strain on the ligament

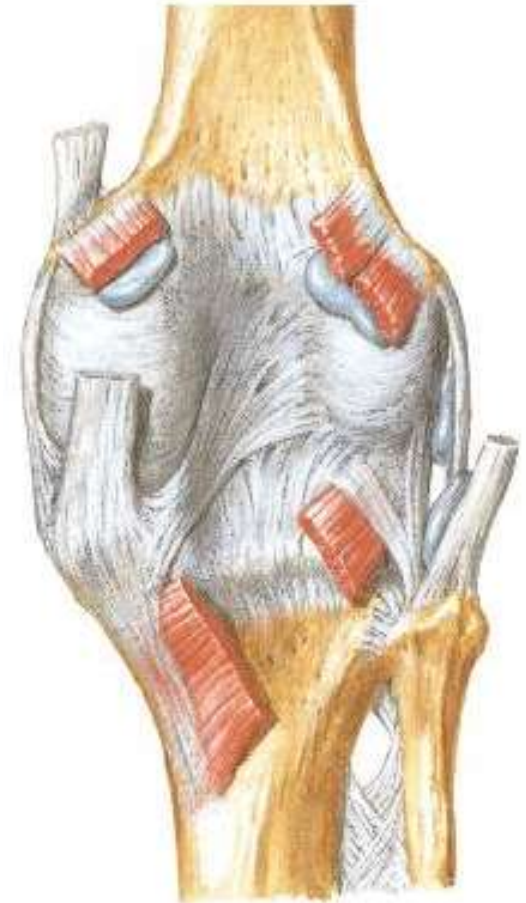


LATERAL/FIBULAR COLLATERAL LIGAMENT (LCL)

MOB TCD



- Superiorly attached to lateral condyle of femur just above popliteal groove.
- Inferiorly embraced with tendon of biceps femoris and attached to head of fibula in front of its apex.
- Separated from lateral meniscus by popliteal tendon and fibrous capsule
- Inferolateral genicular vessels and nerve separate it from capsule
- **Tightest in extension, 0-30 degrees**
- **Becomes looser in flexion >30 degrees**
- **Primary restraint to varus**
- **Secondary restraint to ER and posterior translation**





Oblique Popliteal Ligament

- It is an expansion from the semimembranosus tendon close to its insertion to the tibia
- Oblique popliteal ligament passes upwards and laterally
- Fuses with the Fabella if present
- Lends with posterior surface of Capsule above lateral femoral condyle
- Pierced by middle genicular vessels and nerve
- Branch from the posterior division of the obturator nerve, pierces the ligament, supplies cruciates and articular twig to knee (referred pain from pelvic peritoneum to knee)
- Popliteal artery lies on it
- Strengthens the posterior portion of the capsule and prevents extreme lateral rotation





Fabella

- Fabella lies at point on the poster lateral side of knee
- Where multidirectional collagenous tensile stress meet
- 8% - 10% osseous
- 90% - 92% cartilagenous

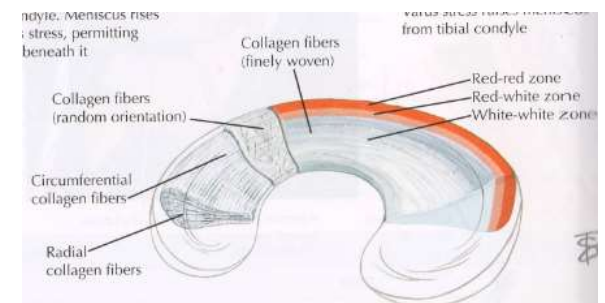
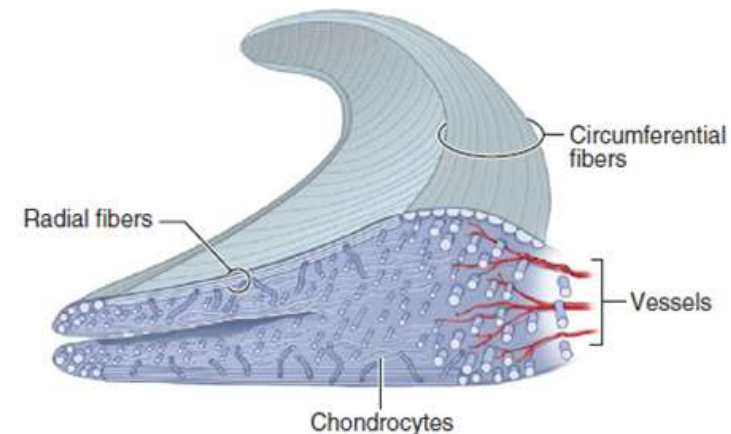
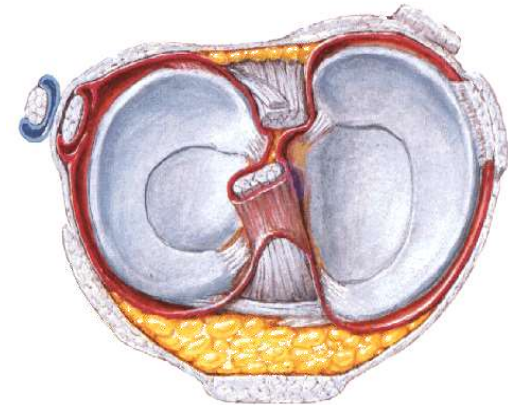
Fabbricani & Oransky, 1992



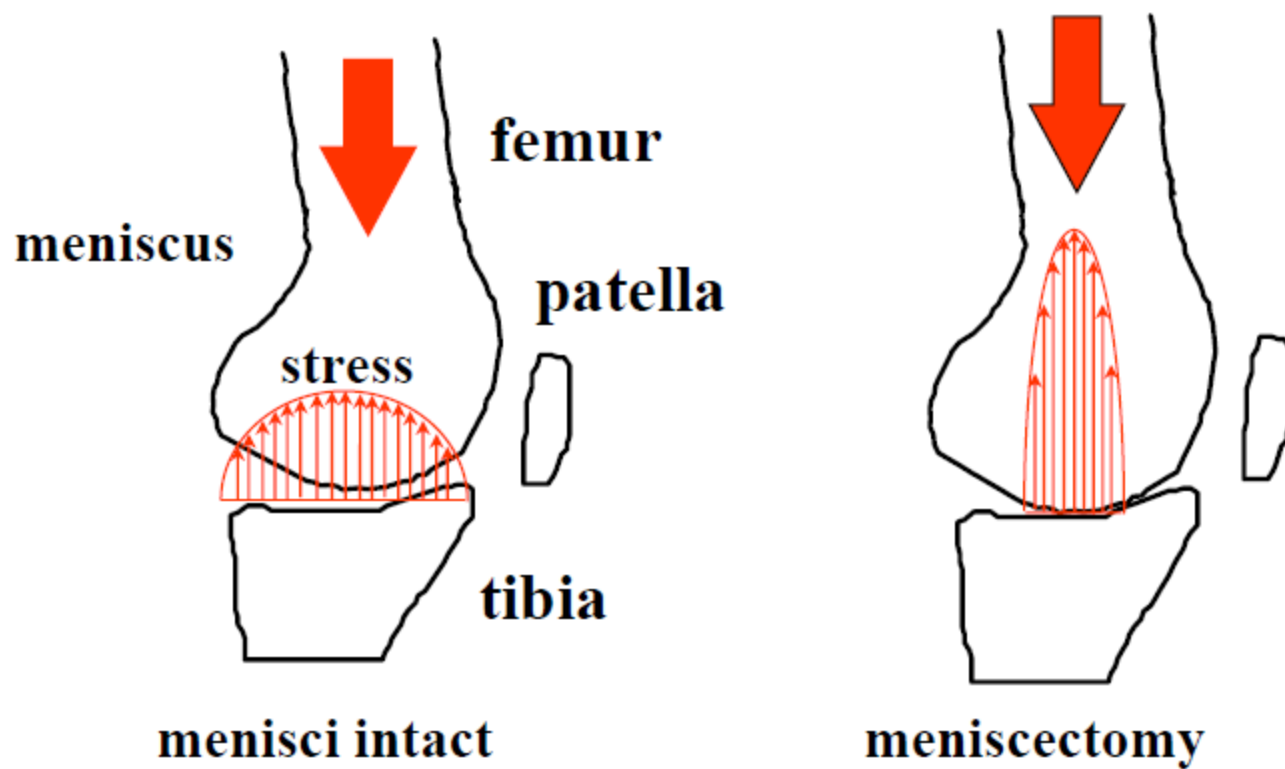


MENISCI

- Menisci are fibro cartilagenous.
- Crescent shaped attached ends to tibia. Deepen the articular surface of tibia.
- Wedge shaped on cross section
- Outer border thick, convex, fixed and vascular
- Inner border thin, concave, free, avascular and nourished by synovial fluid
- They are intracapsular and intra synovial



Menisci & Stress Distribution

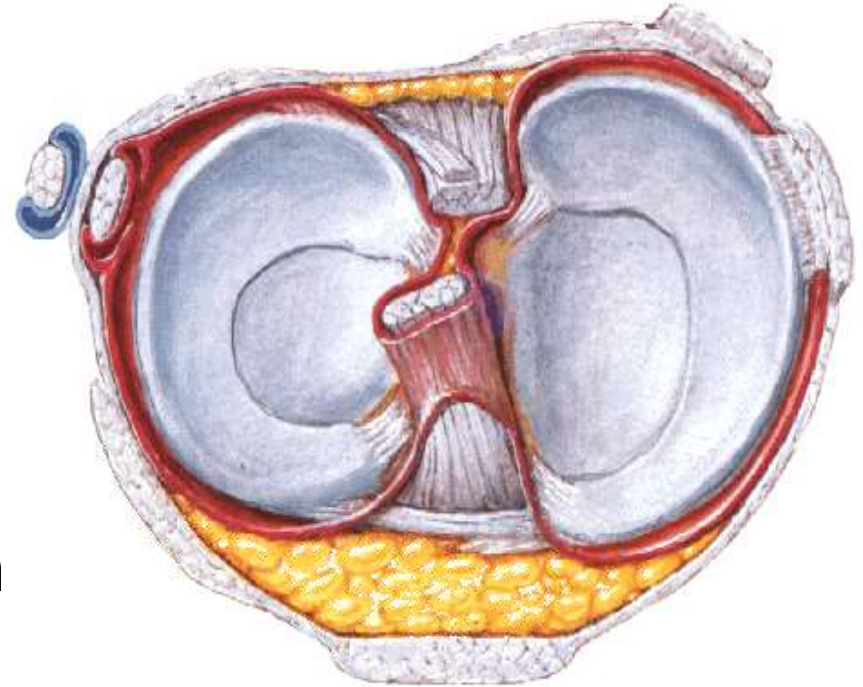


- The major orientation of collagen fibers in the meniscus is circumferential; radial fibers and perforating fibers also are present.
- The circumferential tension in the menisci counteracts this outward or radial force.
- These hoop forces are transmitted to the tibia through the strong anterior and posterior attachments of the menisci.
- Hoop tension is lost when a single radial cut or tear extends to the capsular margin; in terms of load bearing, a single radial cut through the meniscus may be equivalent to meniscectomy.



Anatomy of menisci

- IT HAS TWO ENDS, TWO BORDERS AND TWO SURFACES
- Flexion and extension takes place at the upper surface of the menisci
- Rotation occurs between the lower surface of the menisci and the tibia



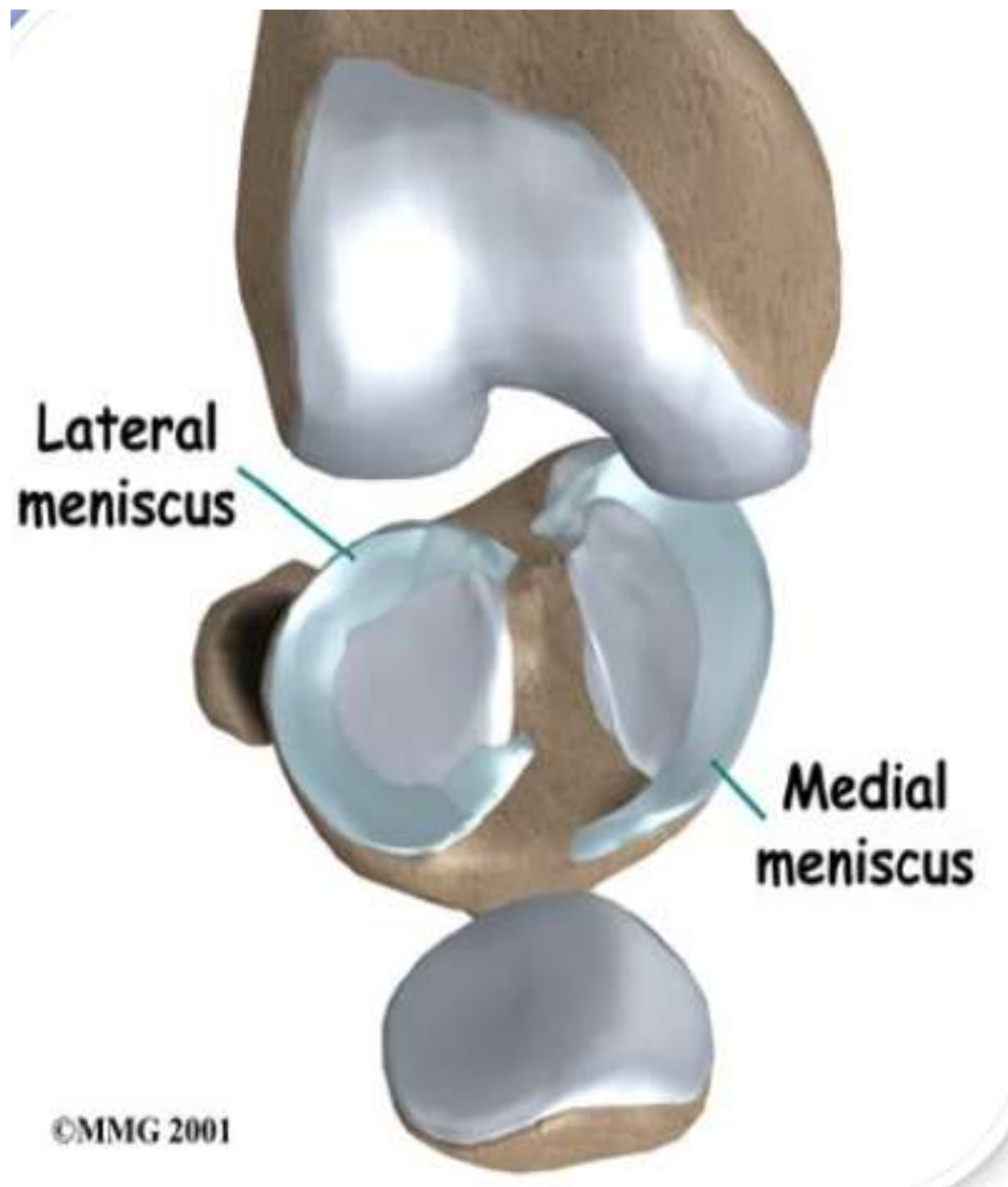
anterior

MEDIAL MENISCUS

- IT IS RELATIVELY IMMOBILE.
- IT IS C-SHAPED/SEMICIRCULAR FIBROCARILAGENOUS DISC.
- PERIPHERAL MARGIN ADHERENT TO TIBIAL COLLATERAL LIGAMENT.
- MORE LIABLE TO INJURY.

LATERAL MENISCUS

- IT IS MORE ROUND/CIRCULAR IN SHAPE.
- THE POSTERIOR END OF THE MENISCUS IS ATTACHED TO FEMUR THROUGH 2 MENISCOFEMORAL LIGAMENTS.
- THE TENDON OF POPLITEUS AND FIBROUS CAPSULE SEPARATE IT FROM LCL.
- MOBILITY OF POSTERIOR END IS CONTROLLED BY POPLITEUS AND 2 MENISCOFEMORAL LIGAMENTS.



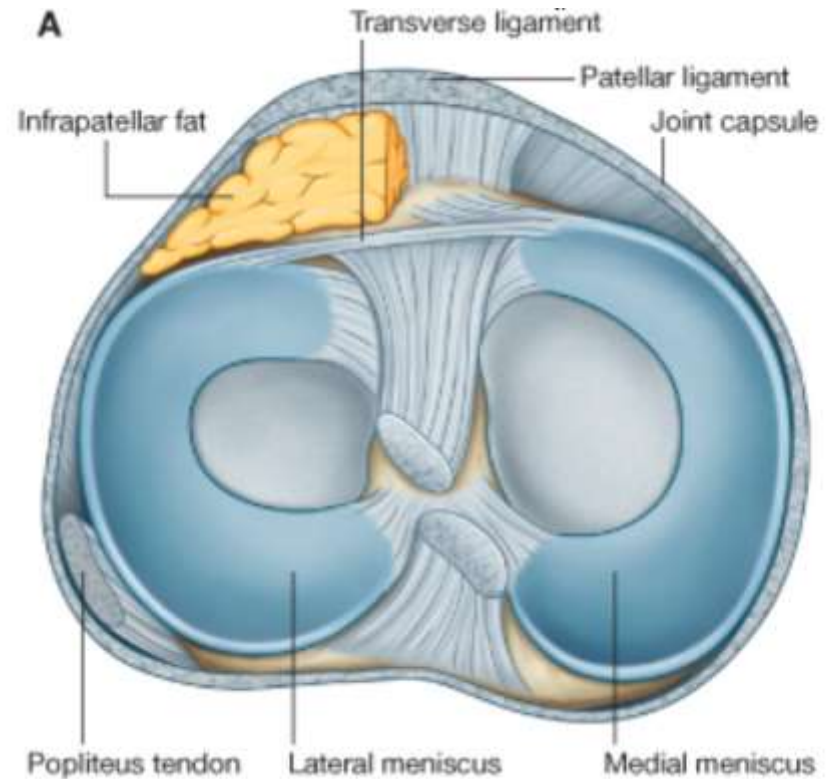
FUNCTION OF MENISCI



- Shock absorption
- Redistributes forces
- Spread synovial fluid
- Minimal effect on stability
- On rotation menisci move with femur
- Lateral moves 20 - 24 mm
- Medial less mobile 10 -15 mm
- Lateral meniscus bears more load

TRANSVERSE LIGAMENT

- IT CONNECTS THE ANTERIOR ENDS OF MEDIAL AND LATERAL MENISCI.

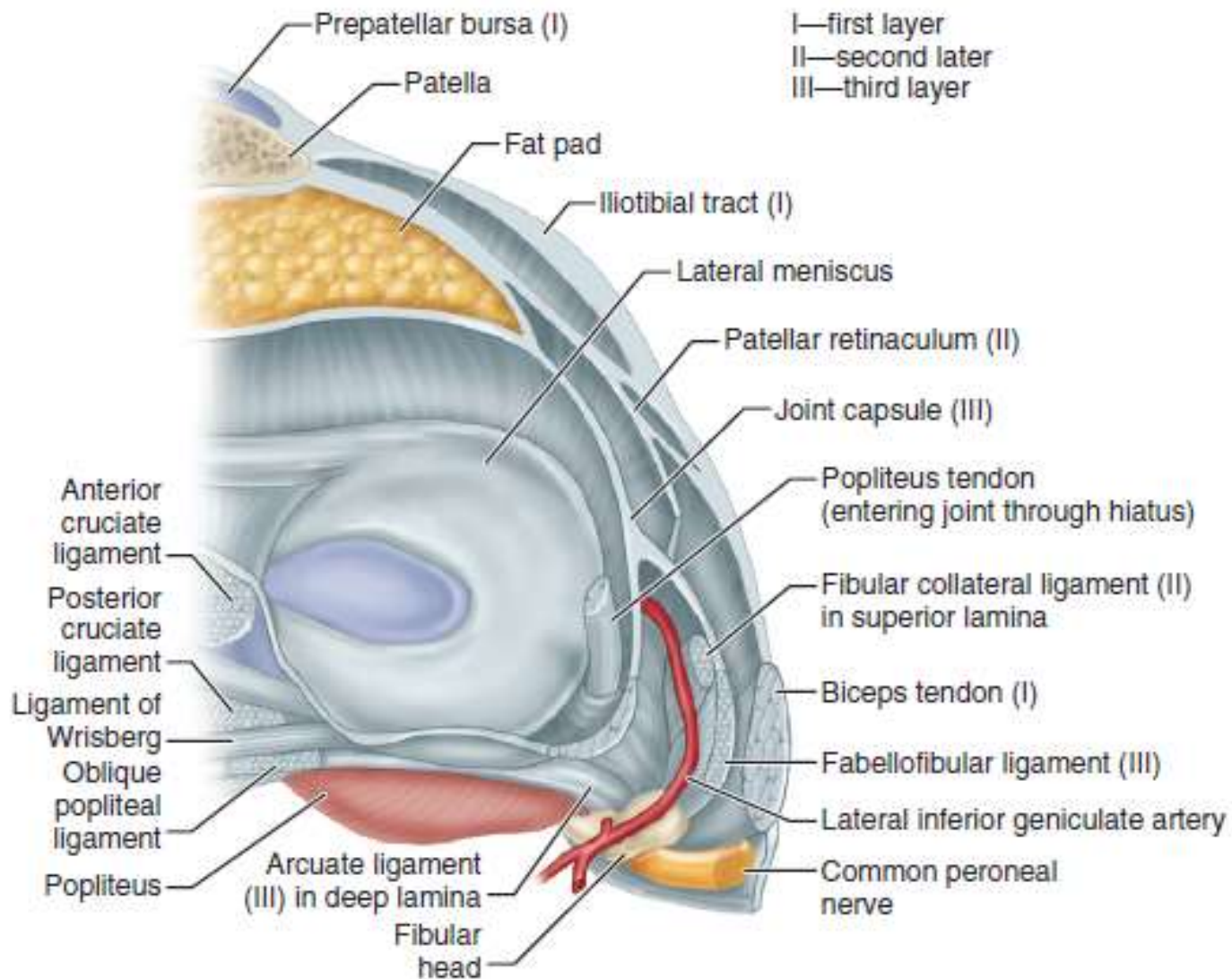




MENISCOFEMORAL LIGAMENTS

- The ANTERIOR MENISCOFEMORAL LIGAMENTS (Humphrey) is attached to lateral aspect of the medial femoral condyle in front of the PCL
- The POSTERIOR MENISCOFEMORAL LIGAMENTS (Wrisberg) is attached posterior to the PCL







SHORT LATERAL LIGAMENT

- Extends from Lateral epicondyle of femur to Medial border of the Apex of Fibula
- It is a cord-like thickening of capsule deep to LCL.
- Deep in interval between iliotibial band and biceps femoris
- Surrounded by biceps femoris

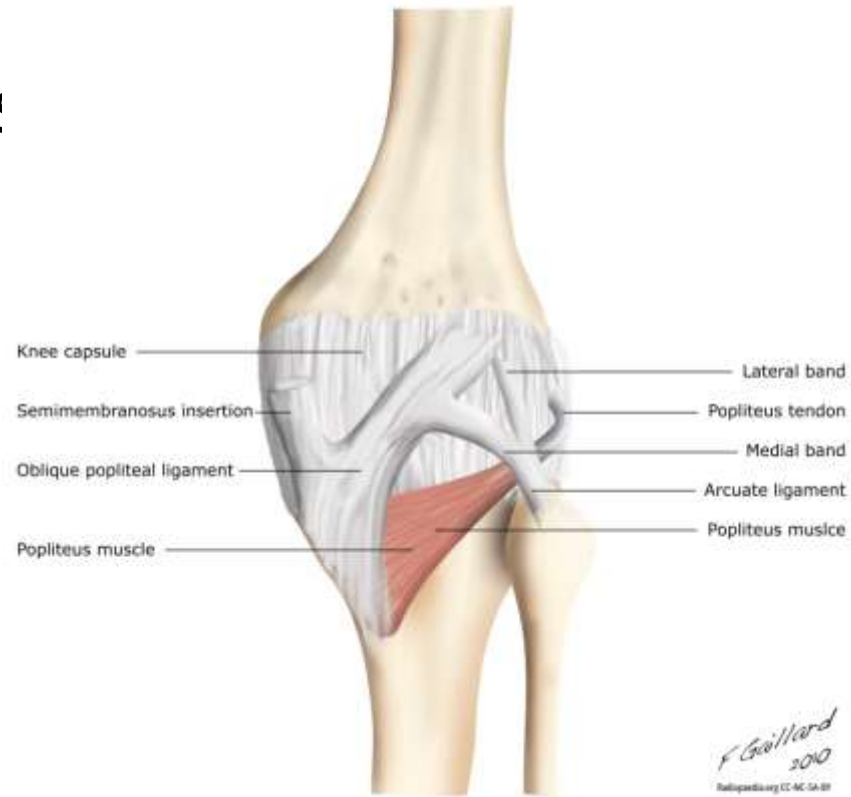
ARCUATE LIGAMENT



- Its posterior expansion of the Short Lateral Ligament
- It extends backwards from head of the Fibula, arches over the popliteal tendon and is attaches to posterior border of the intercondylar area of the tibia

ARCUATE LIGAMENT

- Fibers oriented in various directions
- Y-shaped configuration over popliteus
- Medial limb terminates into oblique popliteal ligament
- Lateral limb invariable present, and is less distinct



Bursae related to knee joint

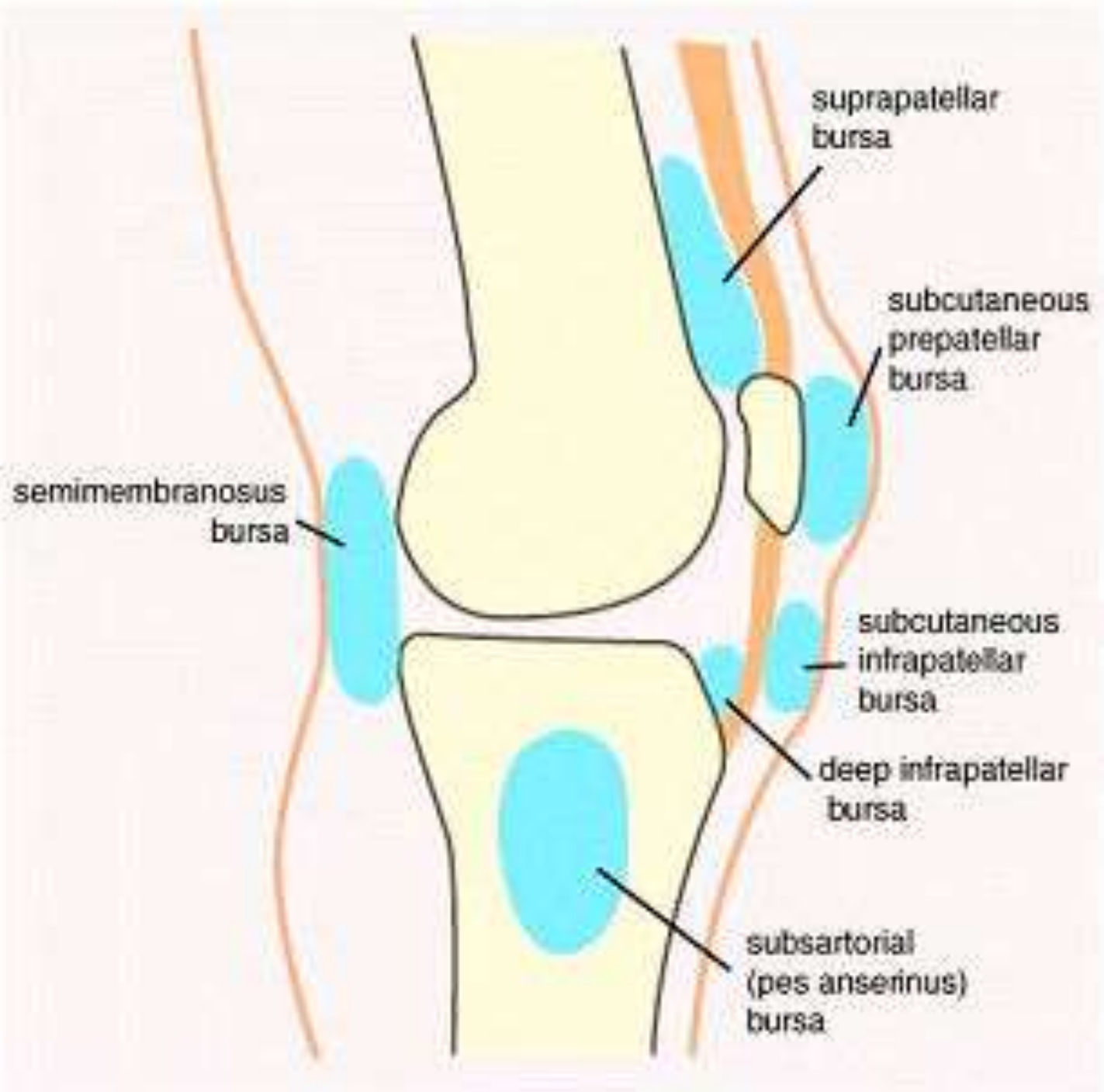
- Ten bursae are related to the knee joint
- 4 anterior, 6 posterior

Anterior bursae

- Suprapatellar bursa
- Prepatellar bursa
- Superficial infrapatellar bursa
- Deep infrapatellar bursa

Posterior bursae

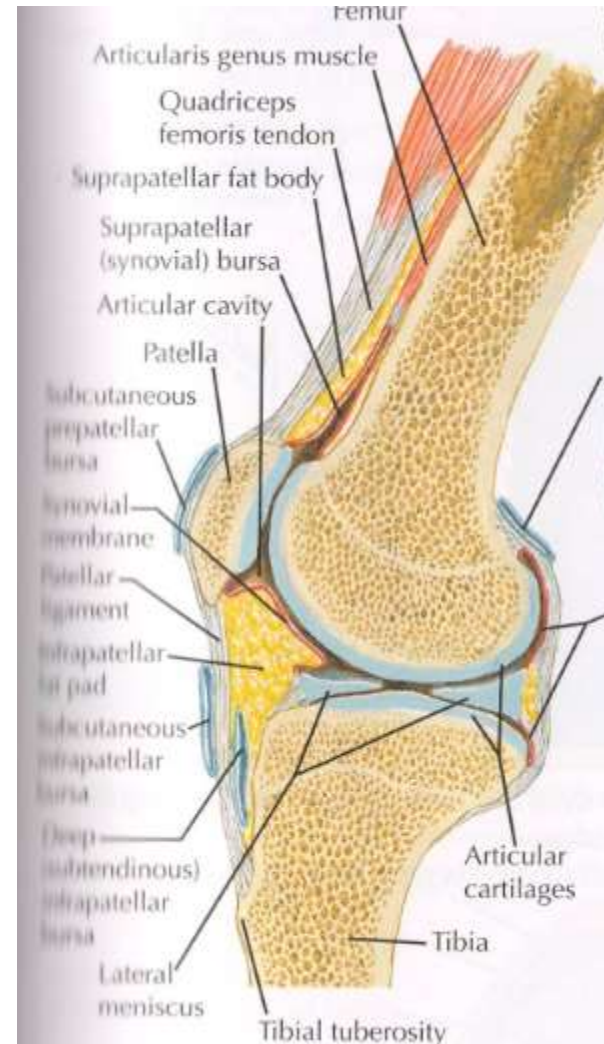
- Popliteal bursa
- Semimembranous bursa
- Tendon of insertion of biceps femoris
- Anserine bursa
- Beneath the origin of lateral head of gastrocnemius muscle
- Beneath the origin of medial head of gastrocnemius muscle



RELATIONS OF KNEE

ANTERIORLY:-

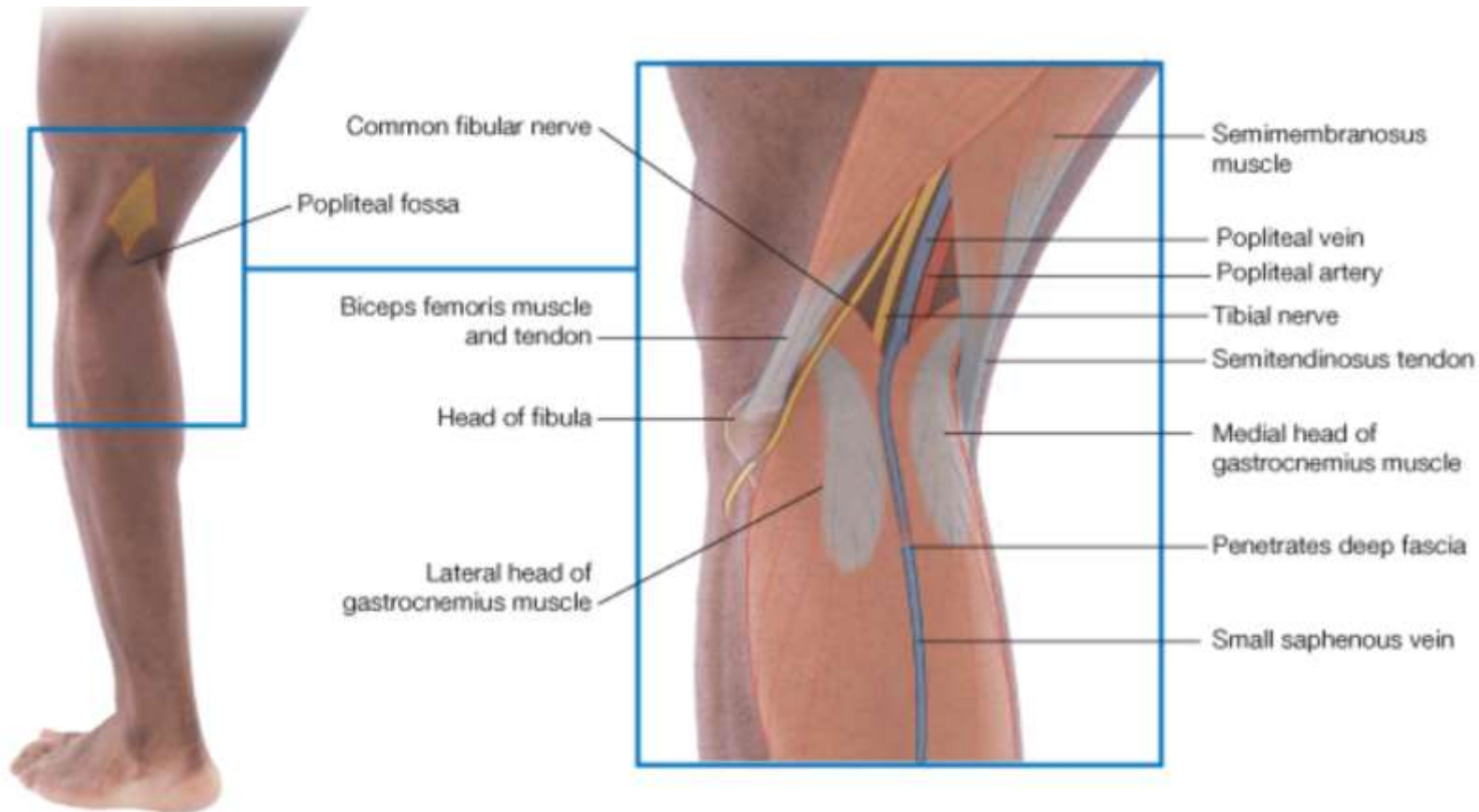
- ANTERIOR BURSA,
LIGAMENTUM
PATELLAE, PATELLAR
PLEXUS



RELATIONS OF KNEE

POSTERIORLY:-

- POPLITEAL VESSEL, TIBIAL NERVE, PERONEAL NERVE, GASTROCNEMIUS, PLANTARIS, SEMITENDINOSUS, SEMIMEMBRANOSUS, GRACILIS, POPLITEUS



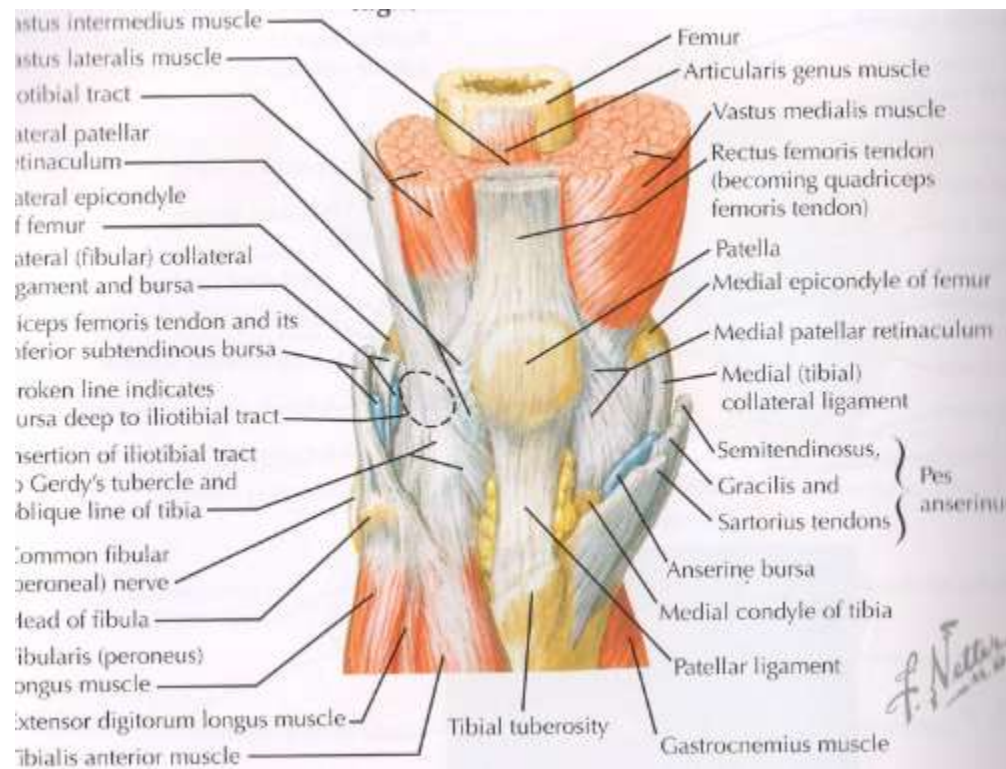
RELATIONS OF KNEE

MEDIAALLY:-

- SARTORIUS, GRACILIS, SEMITENDINOSUS, SAPHENOUS VEIN, SAPHENOUS NERVE, SEMIMEMBRANOSUS

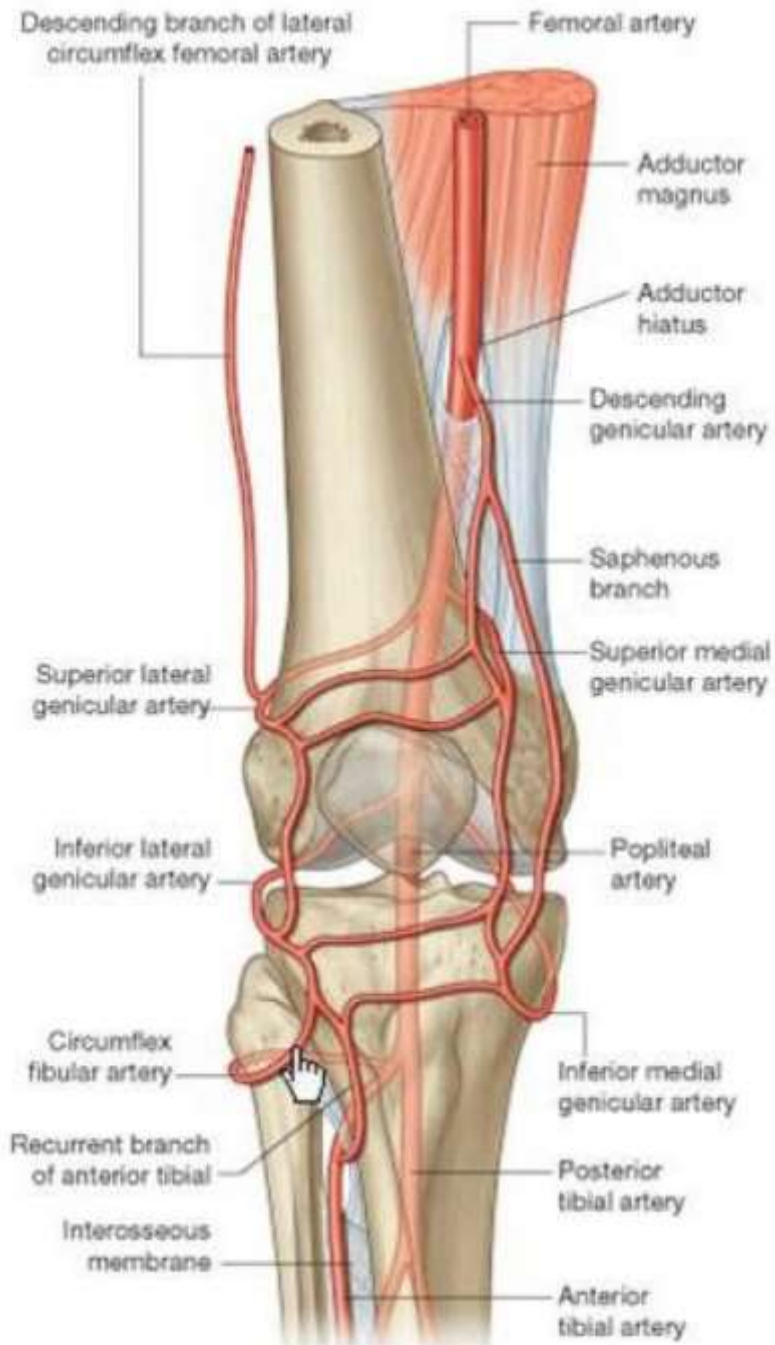
LATERALLY:-

- BICEPS FEMORIS, TENDON OF POPLITEUS



Arterial supply

- Femoral artery – descending genicular
descending branch of the
lateral circumflex femoral
- Popliteal artery – sup & inf. medial genicular
middle genicular
sup & inf. Lateral genicular
- Anterior tibial artery – ant & post tibial recurrent
- Posterior tibial artery- circumflex fibular



Nerve supply

- Femoral nerve – gives twigs from the nerves to the three vasti
- Tibial nerve - sup & inf. Medial genicular N.
middle genicular N.
- Common peroneal N. - sup & inf lateral genicular N.
recurrent genicular N.
- Obturator nerve – genicular branch from its posterior division

Kinematics

- Inherently unstable joint. Bony morphology adds little stability. Stability primarily provided by surrounding static and dynamic stabilizers. (Dynamic stabilizers may compensate when static stabilizers are injured [e.g., complete or partial ACL rupture].)

Medial:

- Static—superficial and deep medial collateral ligaments (MCL), posterior oblique ligament (POL).
Dynamic—semimembranosus, vastus medialis, medial gastrocnemius, PES tendons

Lateral:

- Static—lateral collateral ligament (LCL), iliotibial band (ITB), arcuate ligament.
- Dynamic—popliteus, biceps femoris, lateral gastrocnemius

MEDIAL AND POSTEROMEDIAL CORNER OF THE KNEE

STABILISER

STATIC

- JOINT CAPSULE
- SUPERFICIAL MCL
- DEEP MCL
- POSTERIOR OBLIQUE LIG.

DYNAMIC

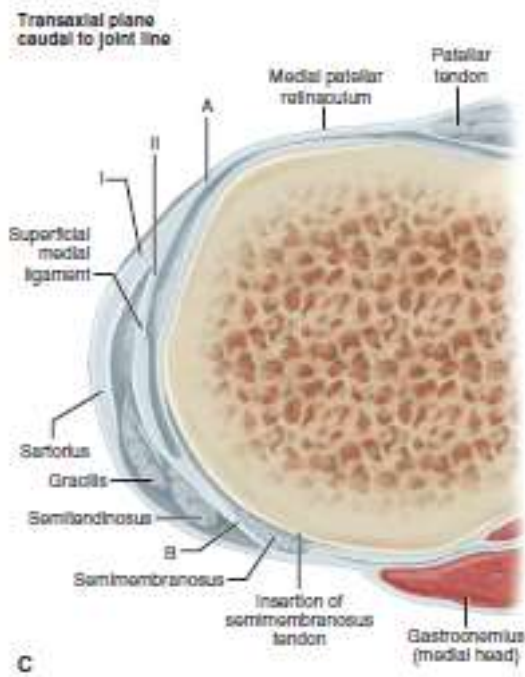
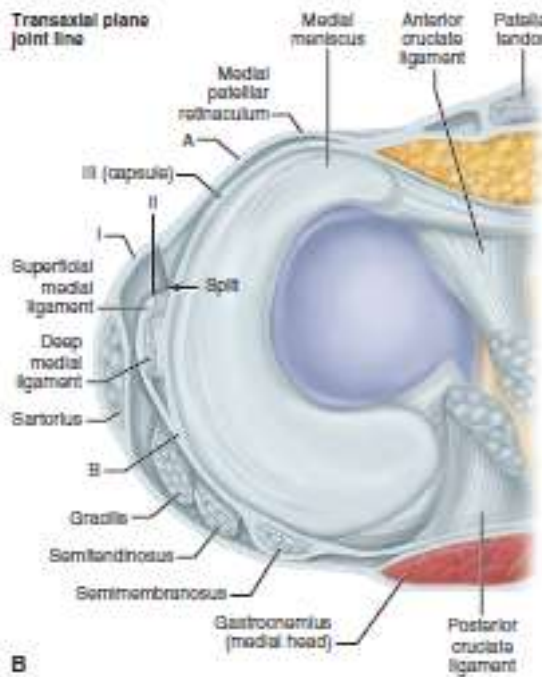
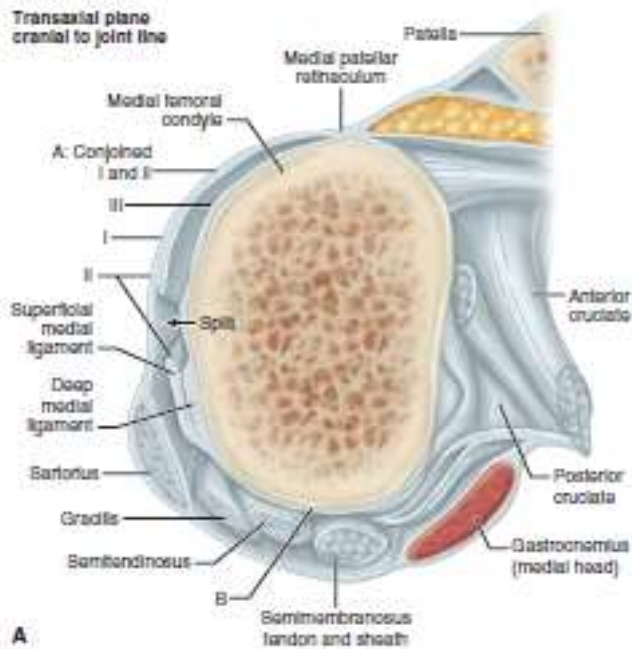
- PES ANSERINUS
- SEMI MEMBRANOSUS
- MEDIAL HEAD OF GASTROCNEMIUS
- VASTUS MEDIALIS

MARSHALL AND WARREN - THREE LAYERS OF MEDIALCAPSULER LIGA.STRUCTURE

LAYER-1: SUPERFICIAL FACIA THAT INVESTS SARTORIUS & QUADR. PROXIMALLY WITH PES ANSERINUS & PERIOSTEUM PROXIMALLY.

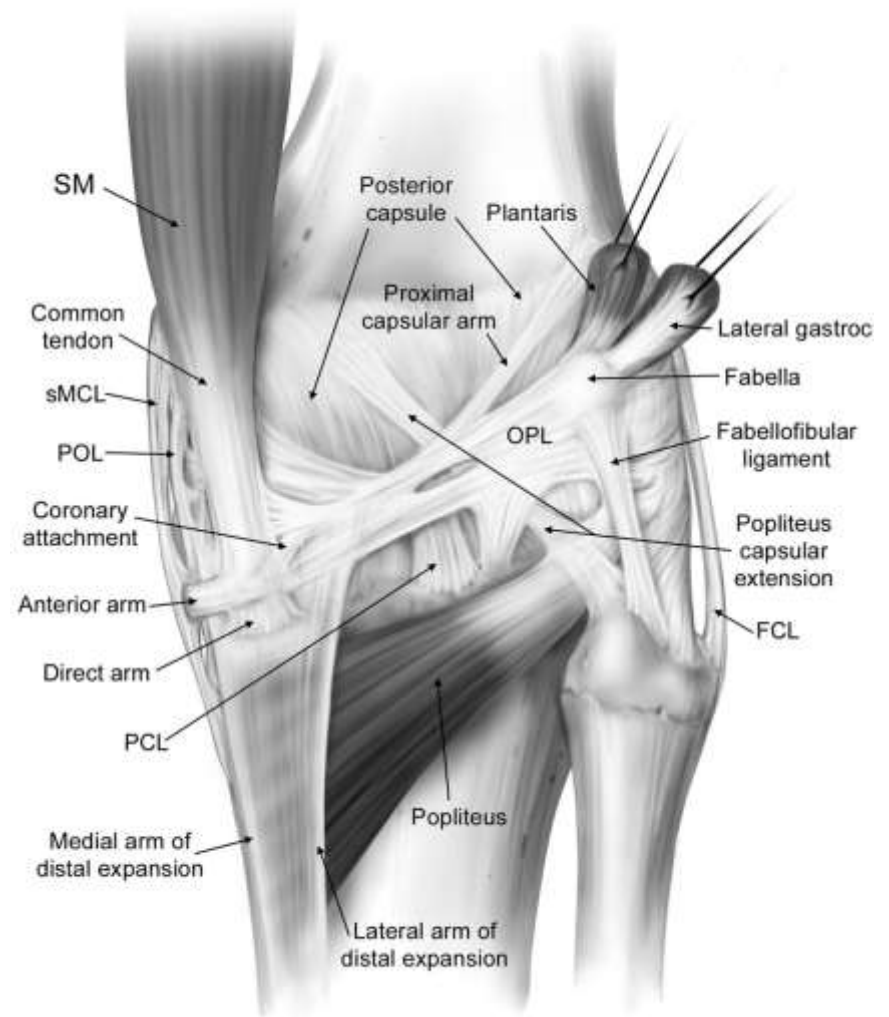
LAYER-2: SUPERFICIAL MCL PARALLEL FIBERS AND OBLIQUE FIBERS.

LAYER-3 DEEP MCL - MENISCO FEMORAL & MENIS-COTIBIAL PART.

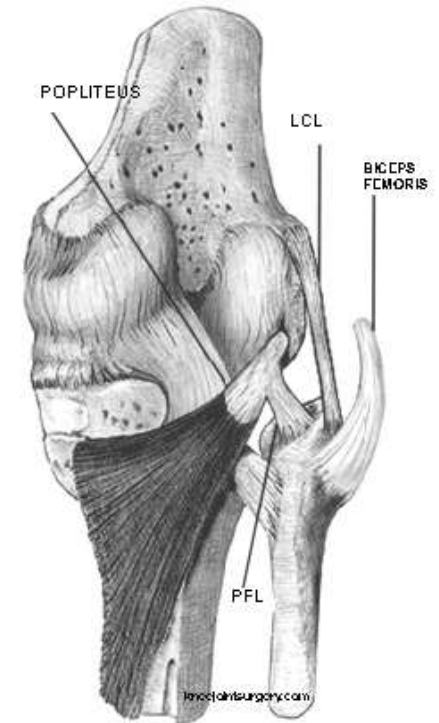
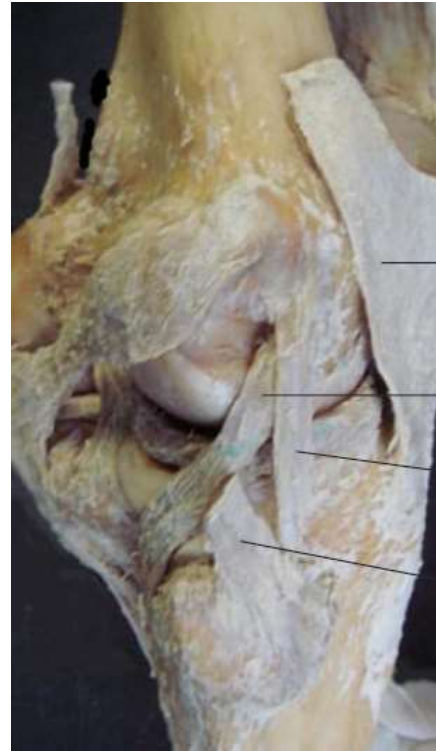


Posterolateral Corner

- Static Stabilizers (highly variable)
 - LCL
 - Fabellofibular ligament
 - Short lateral ligament
 - Popliteofibular ligament
 - Arcuate ligament
 - Posterolateral capsule
 - Posterior horn lateral meniscus
 - Lateral coronary ligament



- Dynamic Stabilizers
 - IT band
 - Lateral gastrocnemius
 - Biceps femoris
 - Popliteus



Layer 1

IT band

biceps tendon

Layer 2

Lateral retinaculum

patellofemoral ligaments

Layer 3

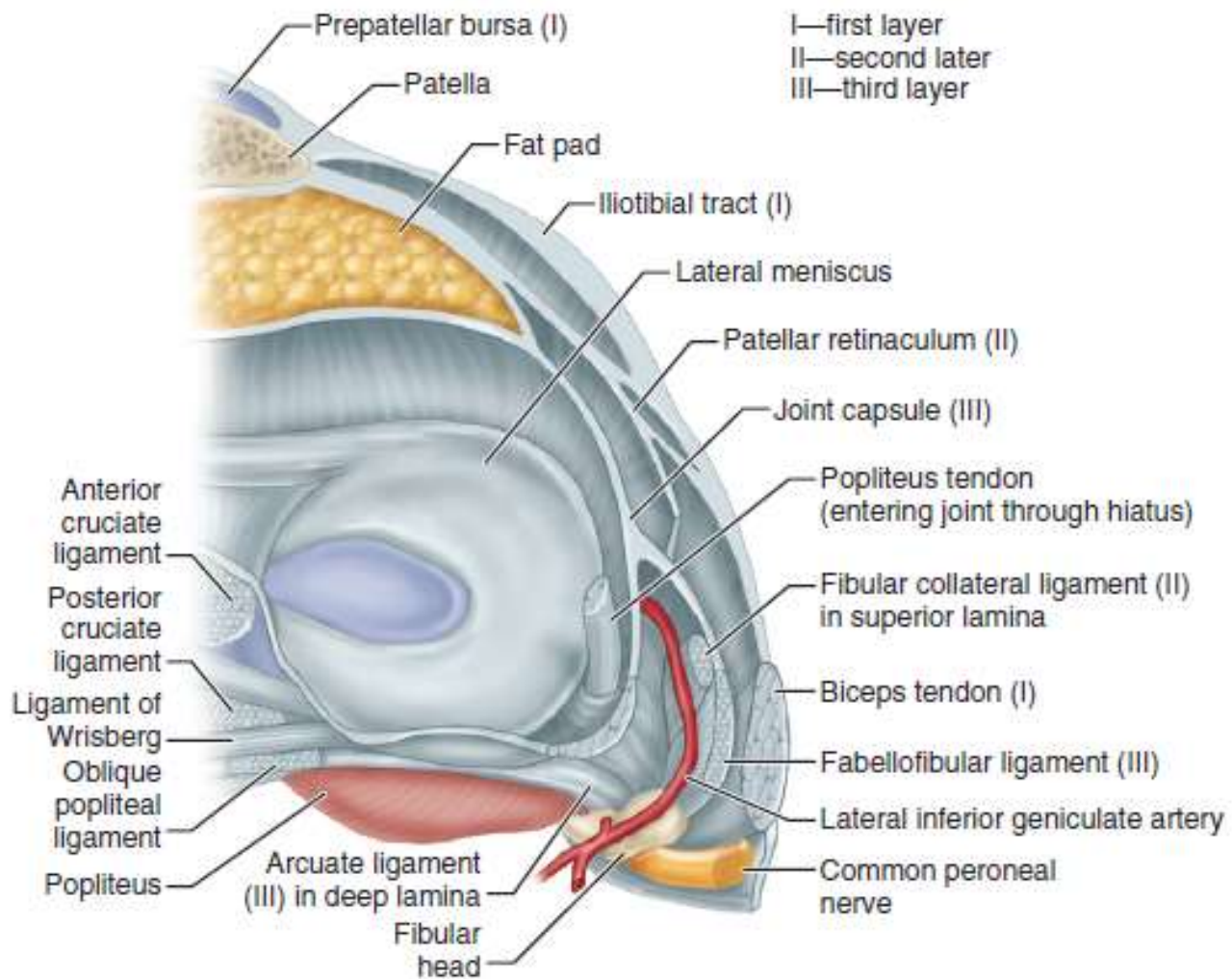
Joint capsule

LCL

arcuate ligament

fabellofibular ligament

popliteofibular ligament



Not a simple hinge joint. The knee has 6 degrees of motion:

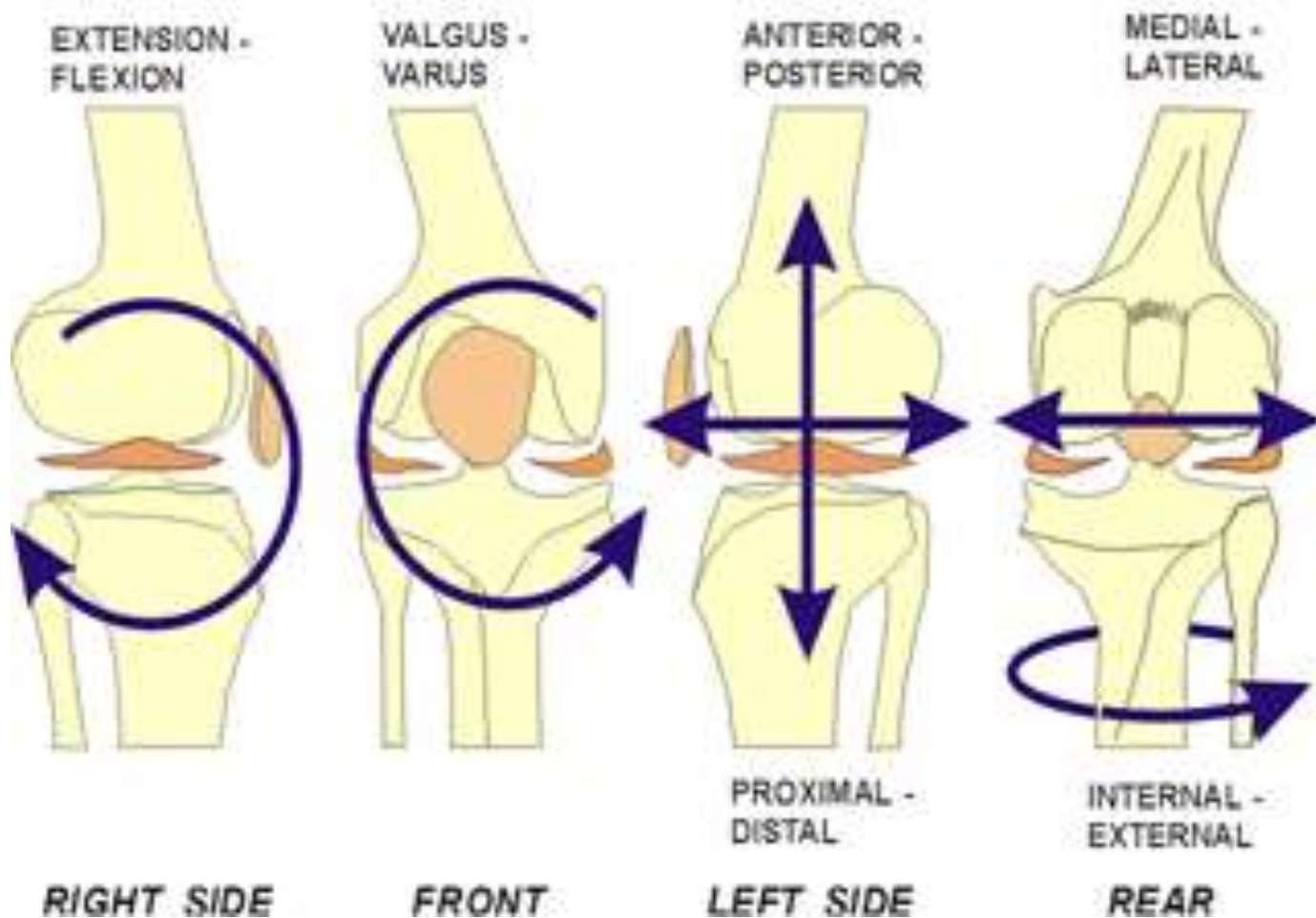
- Extension/flexion
- IR/ER
- varus/valgus
- anterior/posterior translation
- medial/lateral translation
- compression/distraction

- Flexion & extension are the primary motions in the knee.
- Flexion is a combination of both “rolling” and “sliding” of the femur on the tibia in varying ratios depending on the degree of flexion.
- Rolling: equal translation of tibiofemoral contact point & joint axis. Rolling predominates in early flexion.
- Gliding: translation of tibiofemoral contact point without moving the joint axis. Increased gliding is needed for deep flexion.
- The cruciate ligaments control the roll/glide function. The PCL alone can maintain this function (e.g., PCL retaining TKA).
- Normal motion: Extension/flexion: 5 to 140°. 115° needed to get out of a chair; 130° needed for fast running.

- IR/ER: about 10° total through arc of motion. Tibia IRs in swing, and ERs in stance via “screw home mechanism.”
- Screw home mechanism: biceps femoris ERs tibia in full extension, tightening cruciates and stabilizing the knee in stance.
- Popliteus IRs the tibia to “unlock” the knee, loosen the cruciates, which allows the knee to initiate flexion

- Other motions: Medial/lateral translation: minimal in normal knees
- Anterior/posterior translation: dependent on tissue laxity, usually within 2mm of contralateral side in normal knees
- Varus/valgus: approximately 5mm of gapping laterally or medially when stressed in normal knees

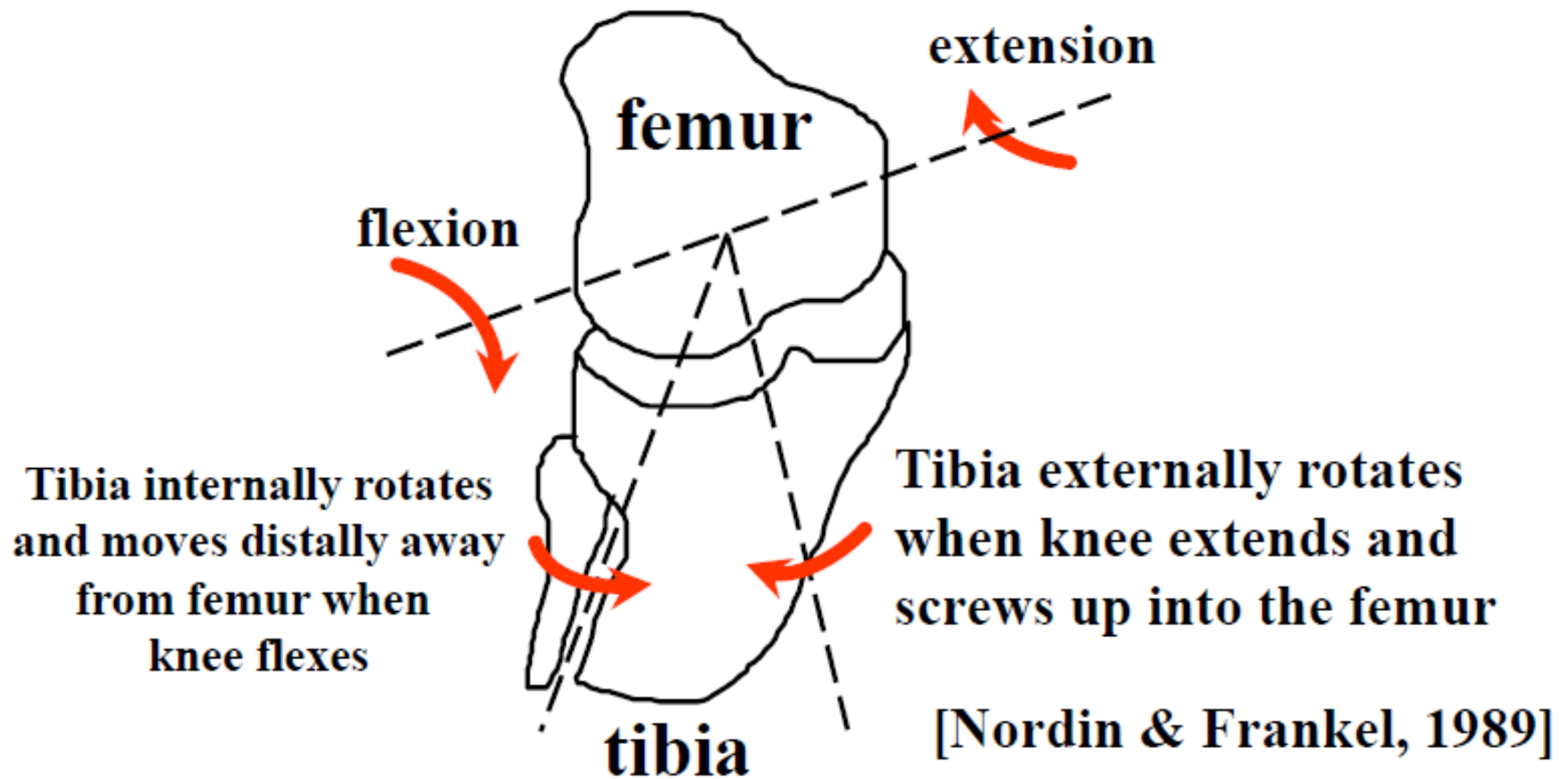
6 Degrees of Motion Present in the Human Knee



Locking of knee

- Is the terminal stage of full extension of knee joint
- The tibia is laterally rotated & femur is medially rotated
- This rotatory movement locks the joint (which means that the joint cannot be flexed unless It is unlocked by reverse rotation)
- In full extension with the locked knee, all the ligaments are stretched and the joint is stable
- Produced by biceps femoris muscle (the only lateral rotator)

Screw-Home Mechanism



Unlocking of knee

- "Unlocking" of the knee. During knee flexion, it is first necessary to "untwist" and reduce tension within the major ligaments of the knee, in order to prevent their repeated excessive stretching.
- Contraction of the popliteus muscle, laterally rotates the femur on the tibia, and pulls the lateral meniscus posteriorly, out of the way of the rotating lateral femoral condyle. Once the femur has laterally rotated, the knee is said to be "unlocked" and flexion can proceed.