Clinical anatomy of the knee joint

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The learner should be able to:

1. Describe the anatomy of the knee joint: location, type, articulating bones, synovial membrane, fibrous capsule, ligaments, movements of the knee joint, *NAVaL* of knee joint.
2. To summarise the muscles responsible for these movements, their innervation and main attachments.
3. To identify the factors responsible for maintaining the stability of the knee joint.
4. To describe the locking mechanism that occurs in full extension.
5. To explain the anatomical basis of tests that assess the integrity of the cruciate ligaments.
6. Use anatomical knowledge learnt to solve relevant biomedical and clinical problems

Location and surface anatomy

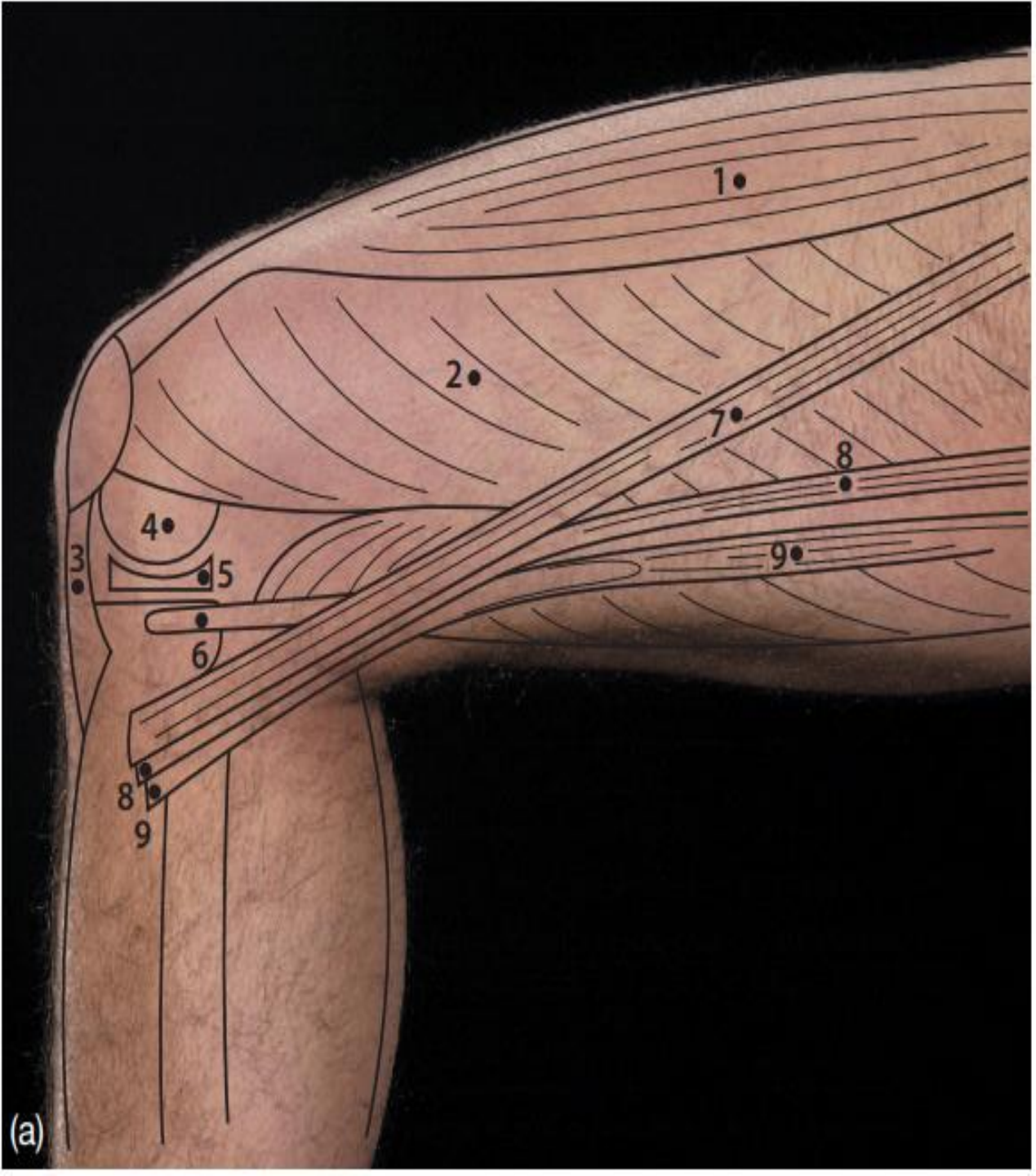
Also known as the Genu

The largest and most complicated joint in the body.

Consists of:

1. Lateral and medial condylar joints between the medial and lateral condyles of the femur and the corresponding condyles of the tibia, and
2. An intermediate gliding joint, between the patella and the patellar surface of the femur.

The fibula is not directly involved in the joint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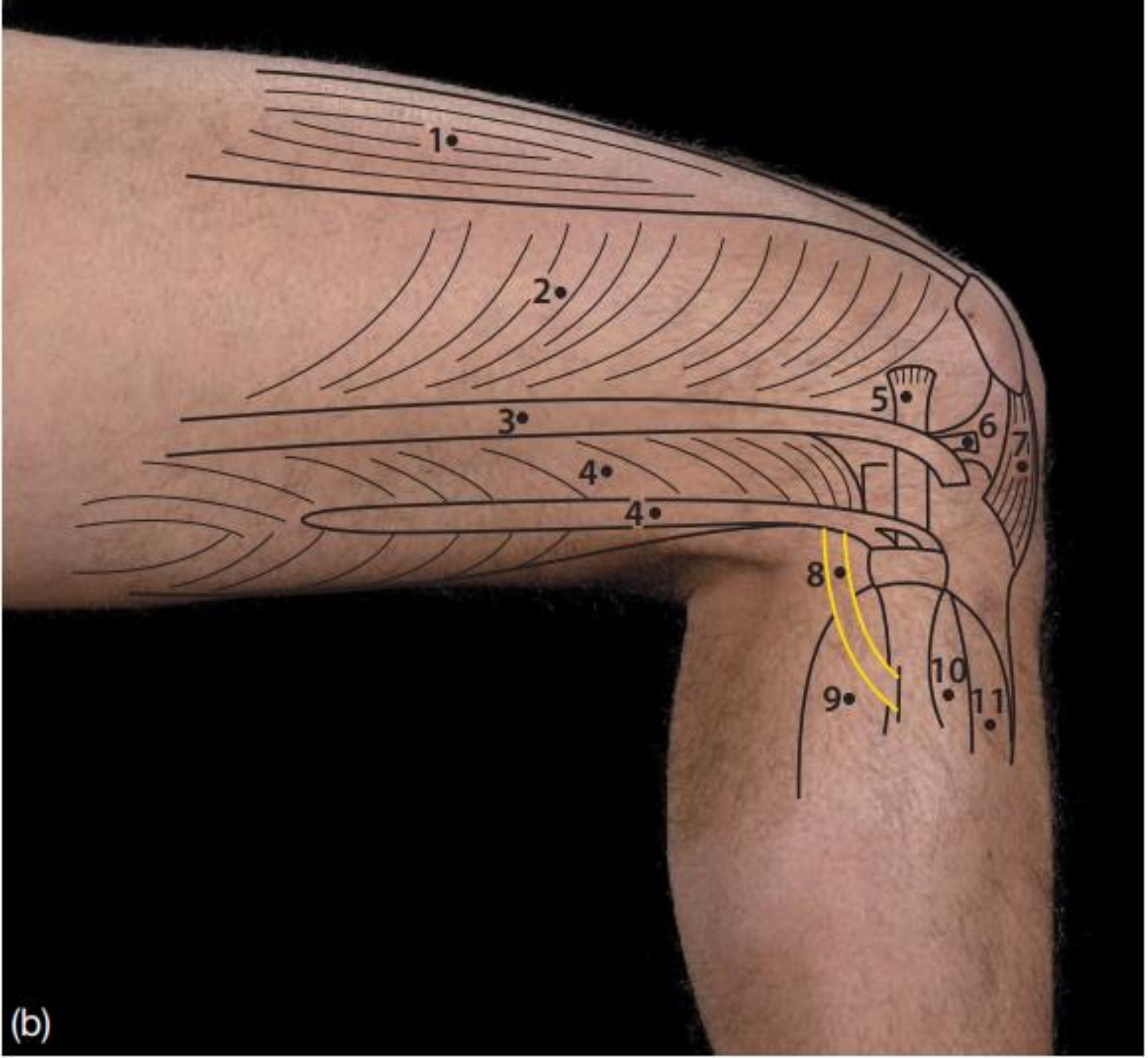
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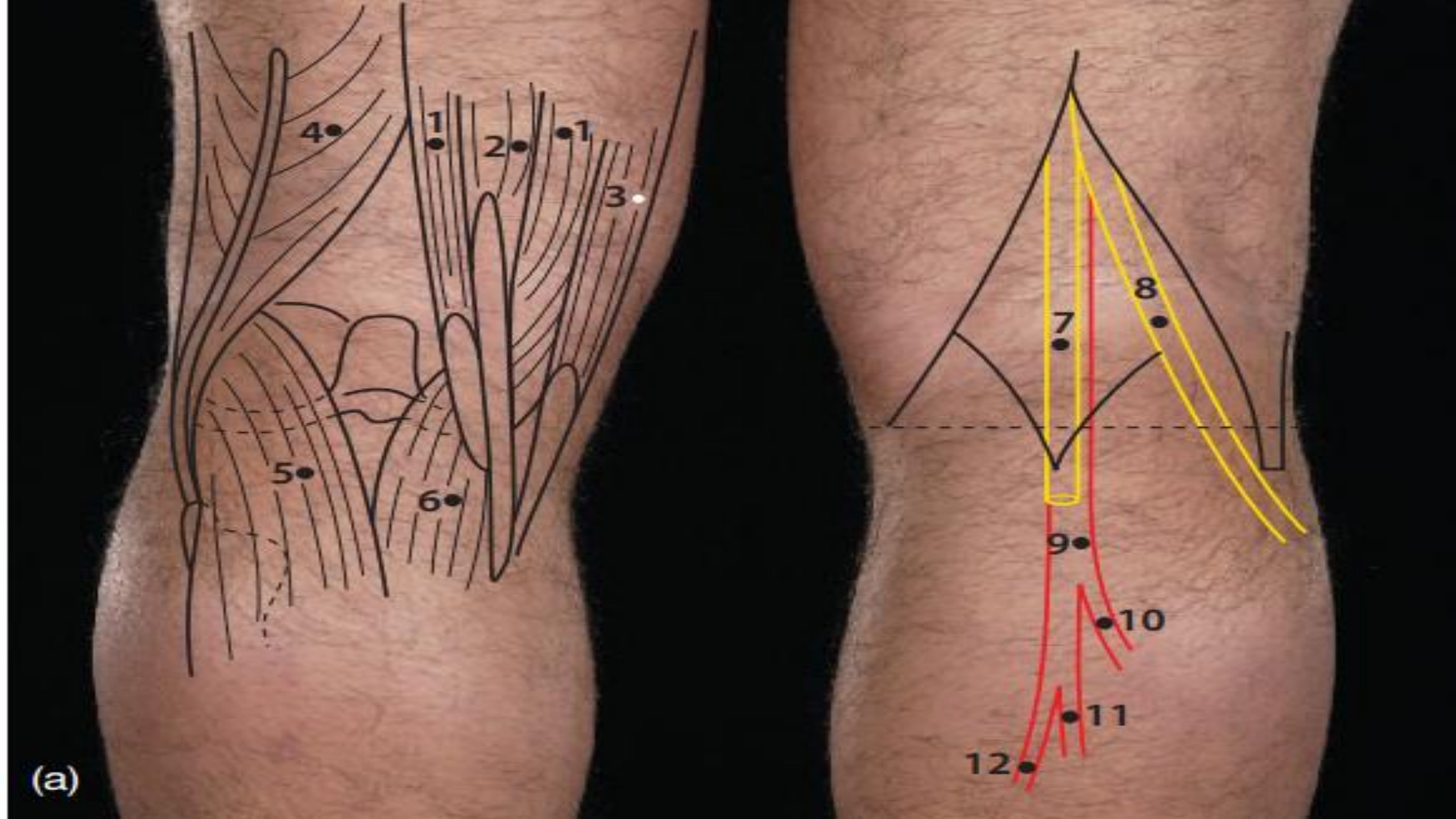
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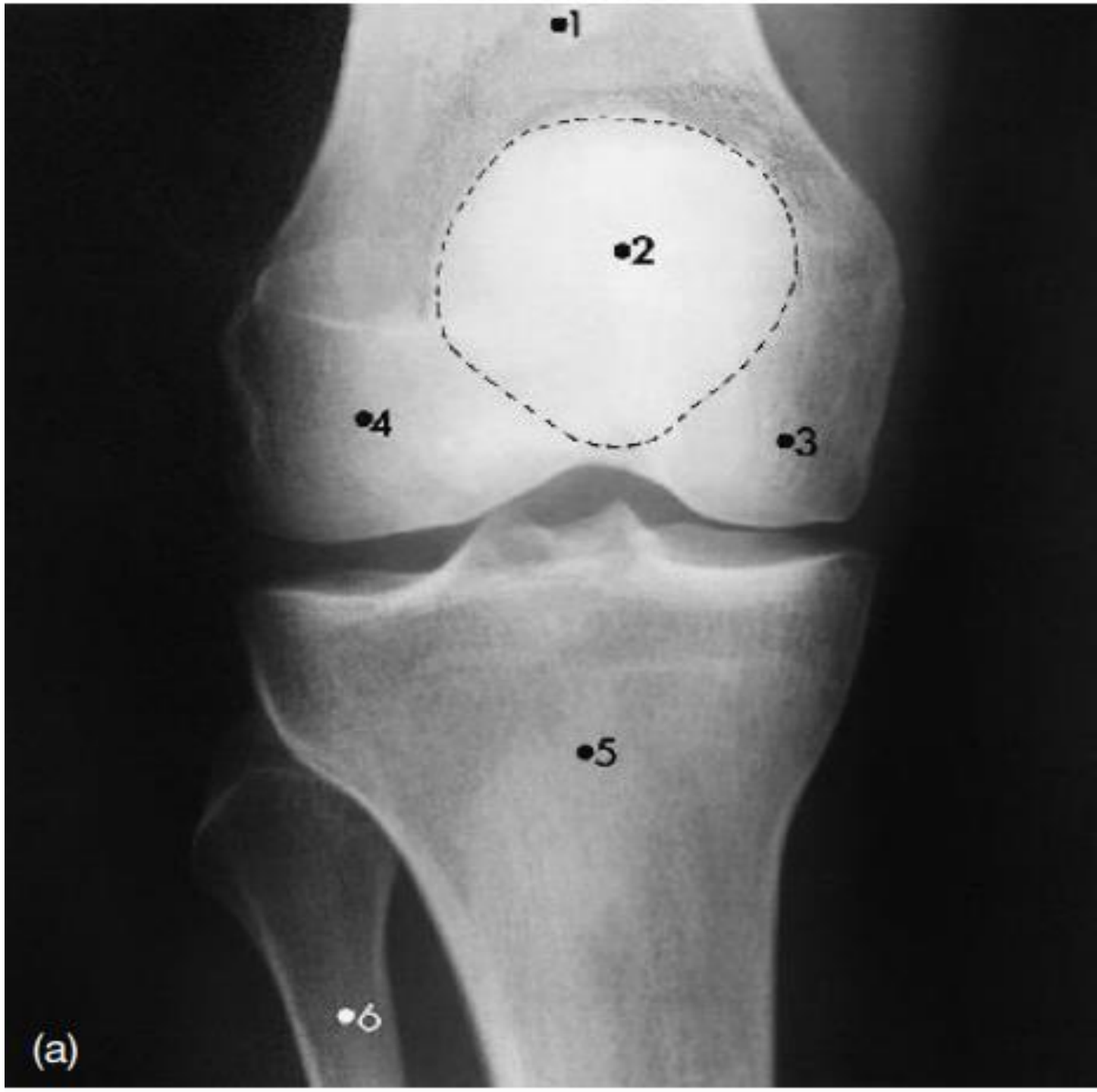
(a)

Articulations

1. The rounded condyles of the femur
2. The condyles of the tibia and their cartilaginous menisci.
   Two sets clinically known as the medial and the lateral **tibial plateaus**
3. Patellar surface of the femur
4. The femoral surface of the patella

All three sets of articular surfaces are covered by hyaline cartilage



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Type of joint

Femoro-tibial joint

Complex, multiaxial, modified hinge synovial joint

Femoro-patellar joint

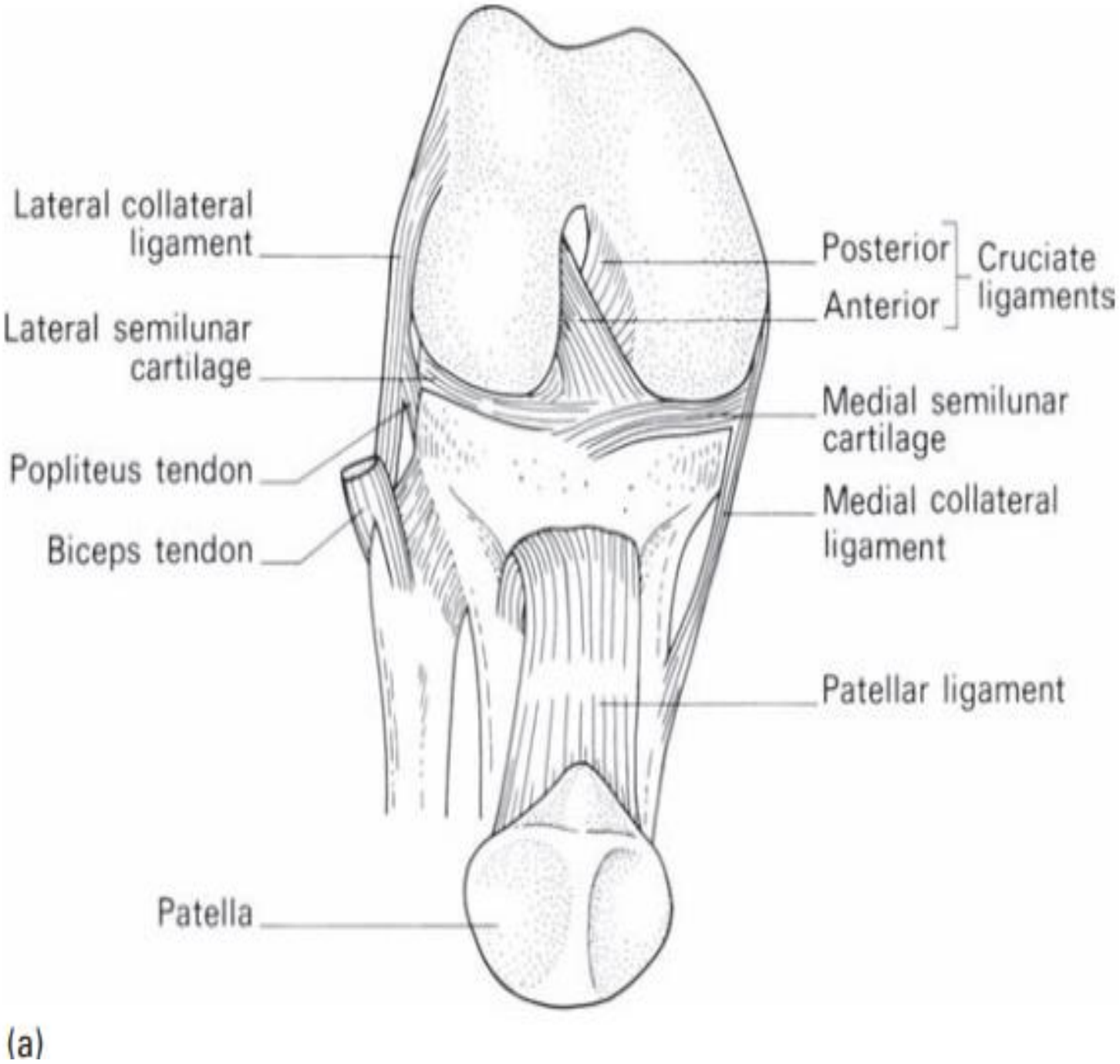
Saddle (sellar) synovial

Altogether a compound joint

Complex: presence of the intra-articular discs (menisci)

Multiaxial: sagittal plane angulation, rotatory and translational movements.

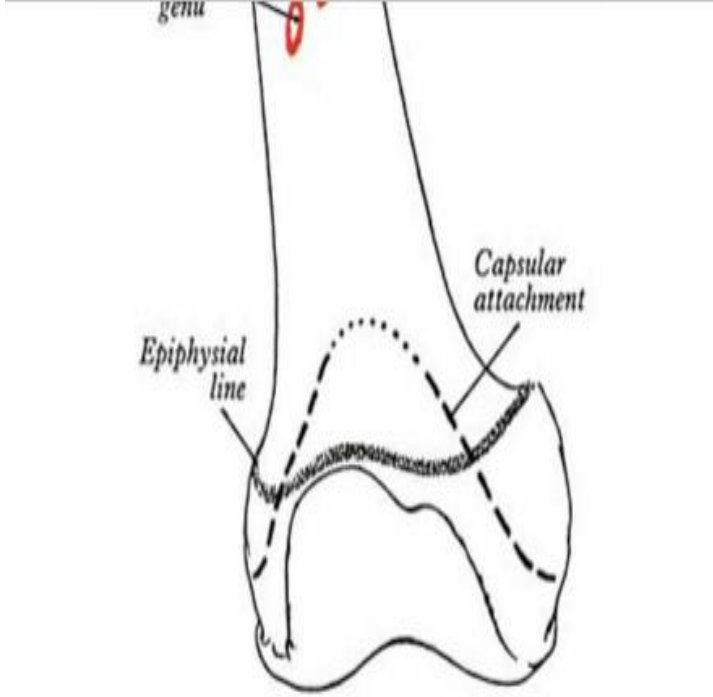
Modified hinge: disc to motivate congruence and allowing some rotatory movements.

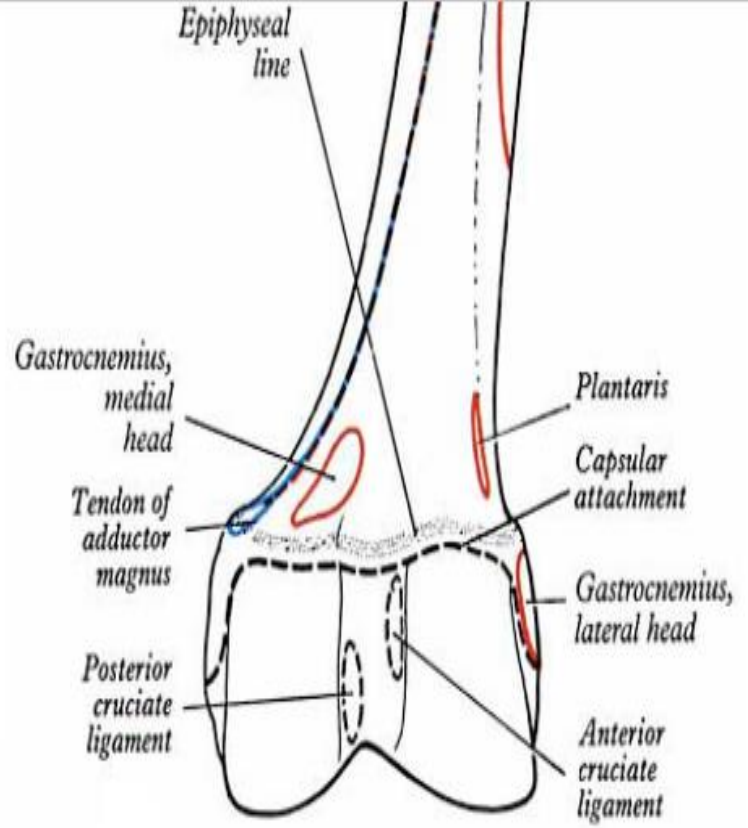


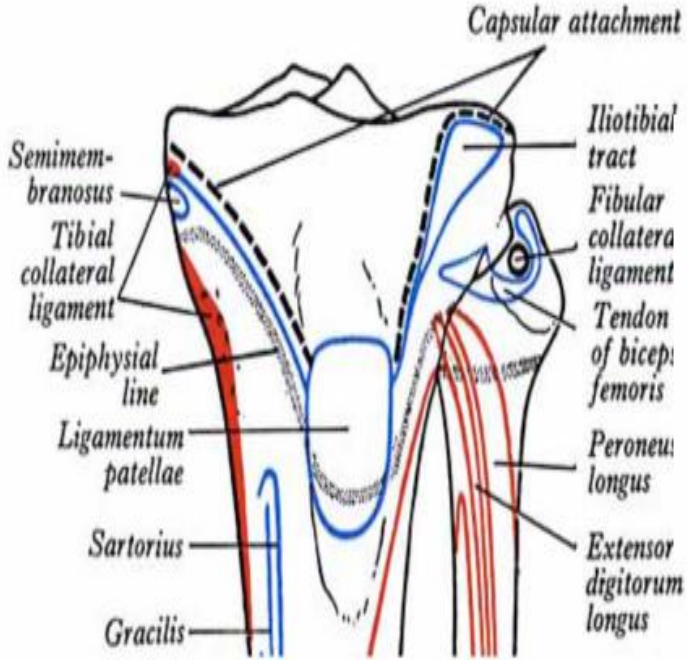
Fibrous capsule

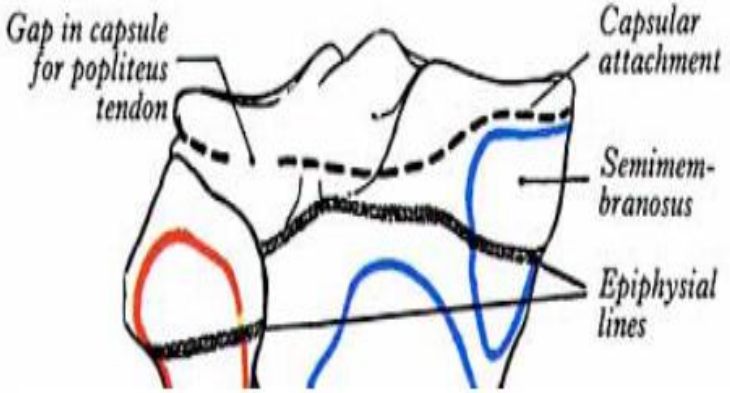
Attached to the margins of the articular surfaces

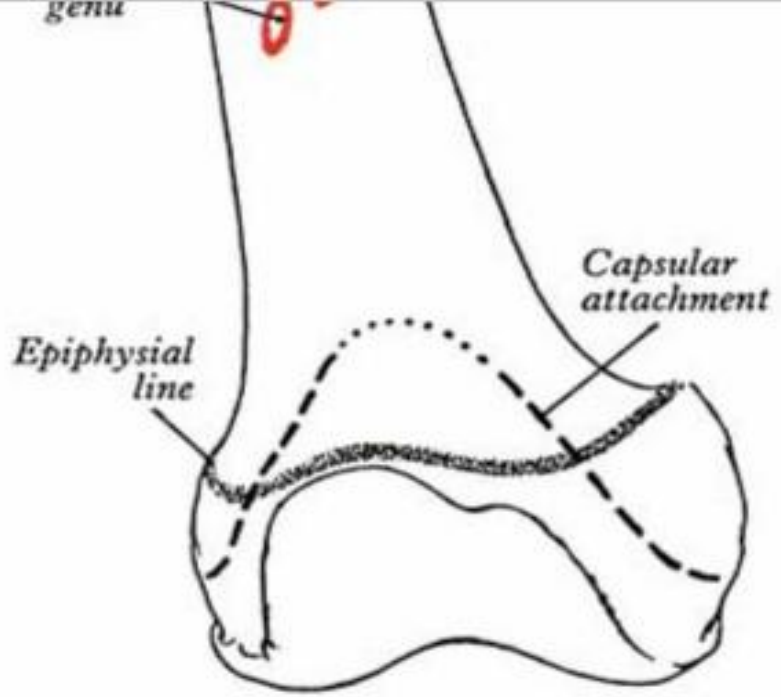
Surrounds the sides and posterior aspect of the joint.

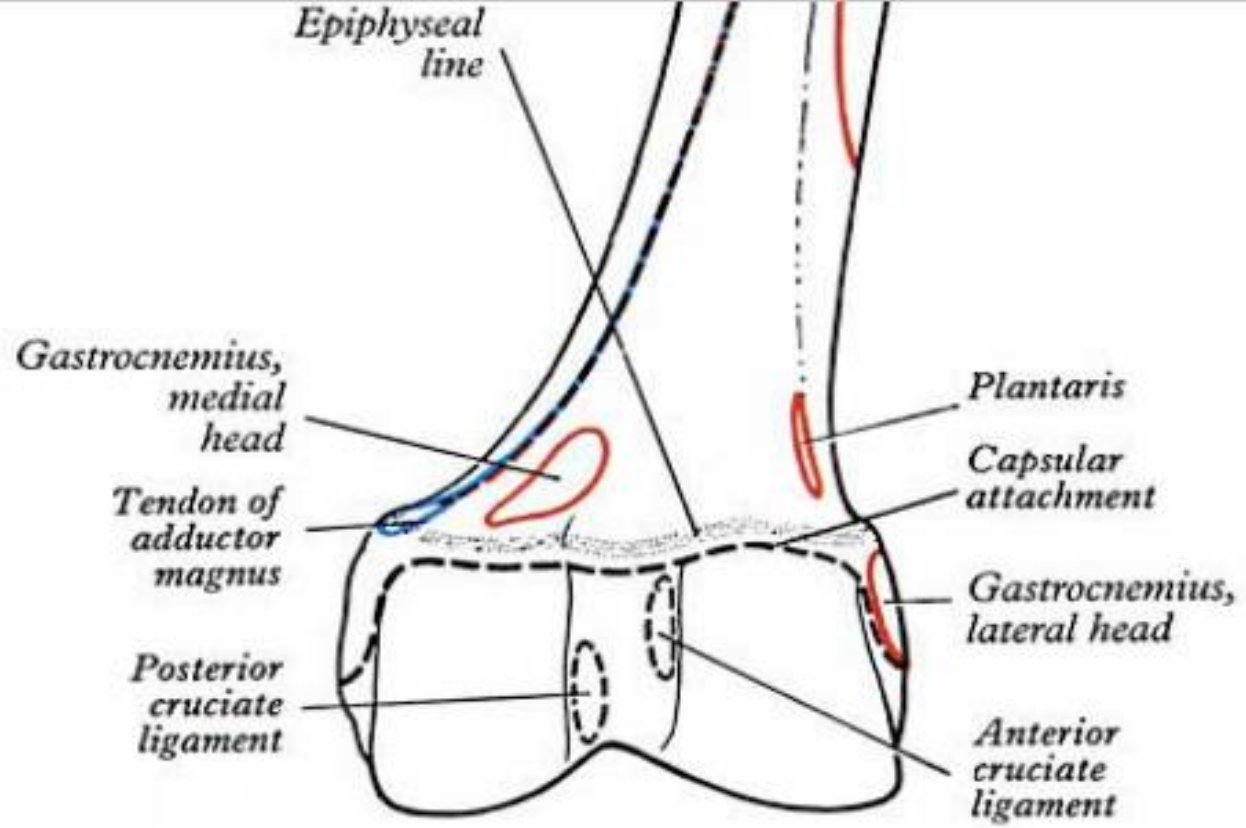


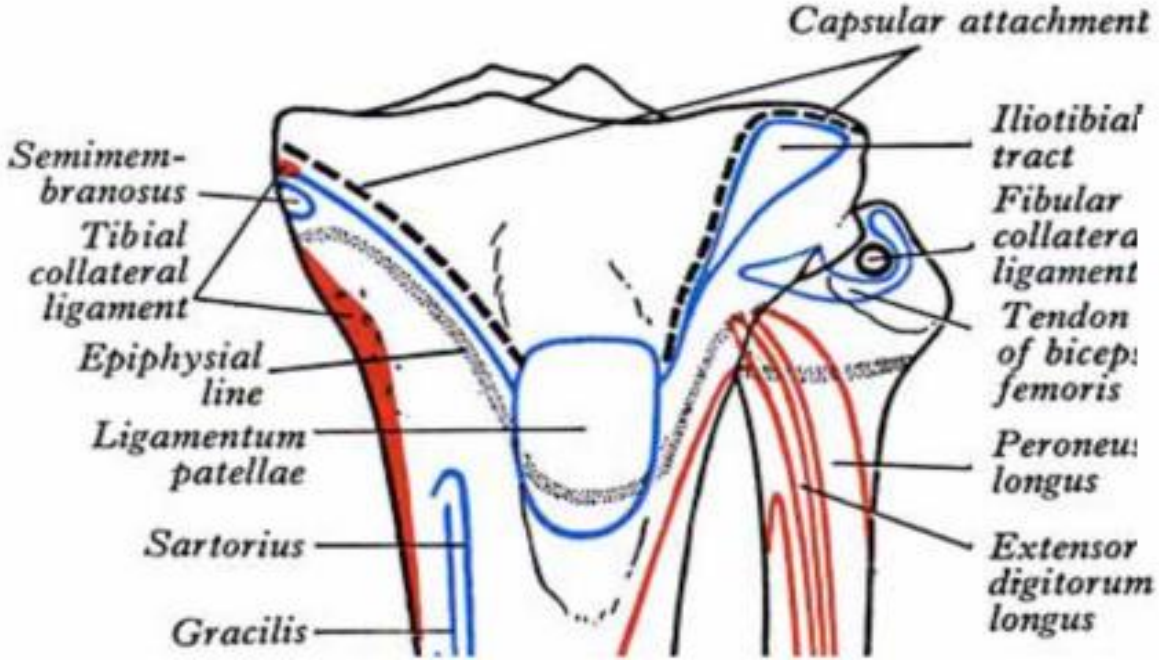







Capsular attachment
Epiphysial line


Epiphyseal line
Gastrocnemius, medial head
Tendon of adductor magnus
Posterior cruciate ligament
Plantaris
Capsular attachment
Gastrocnemius, lateral head
Anterior cruciate ligament


Capsular attachment
Semimembranosus
Tibial collateral ligament
Epiphysial line
Ligamentum patellae
Sartorius
Gracilis
Iliotibial tract
Fibular collateral ligament
Tendon of biceps femoris
Peroneus longus
Extensor digitorum longus

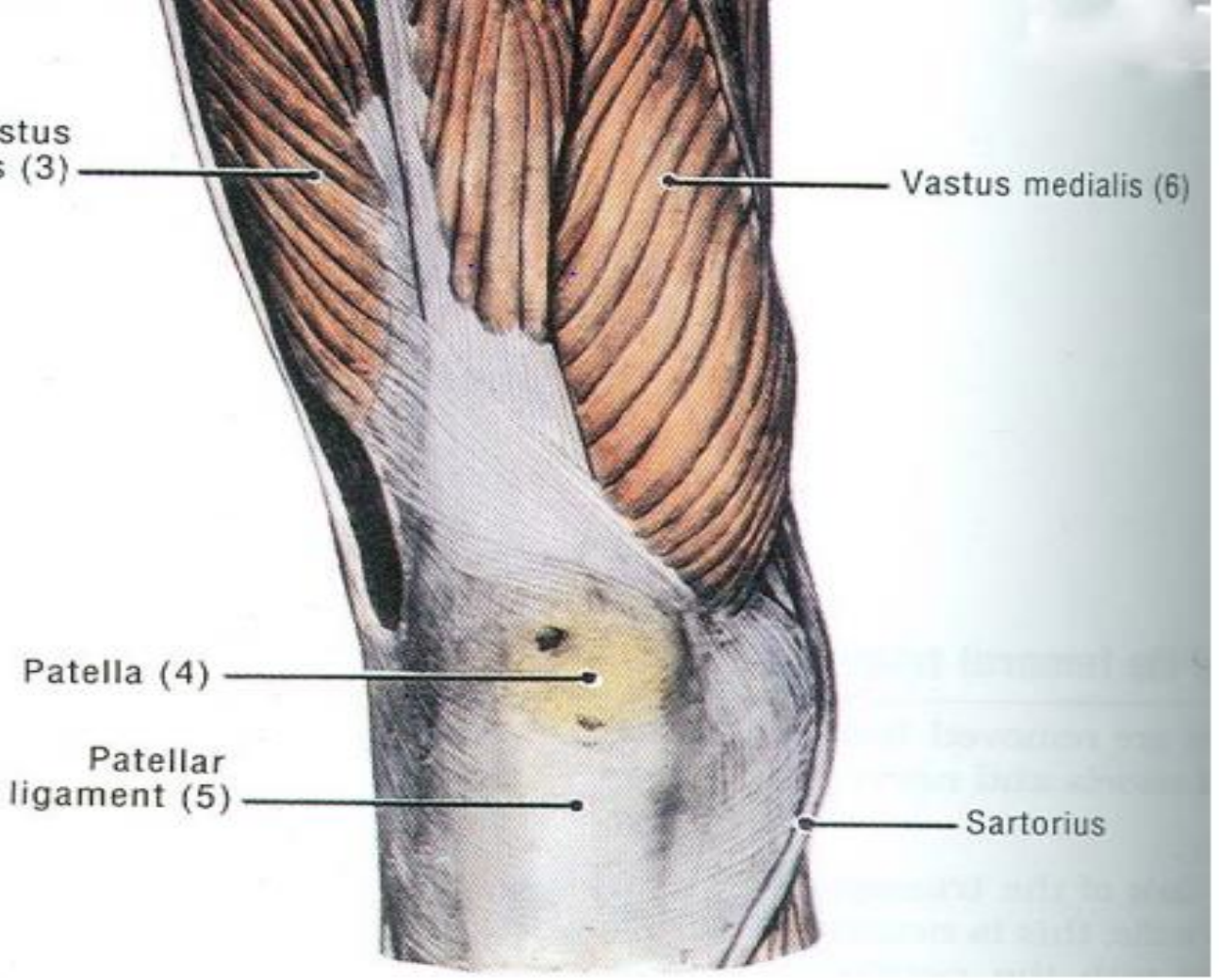

Gap in capsule for popliteus tendon
Capsular attachment
Semimembranosus
Epiphysial lines

Fibrous capsule

Reinforcements

1. Expansions from the tendons of vasti on either side of the patella (parapatellar retinaculum)

2. Expansion of the semimembranous muscle called the oblique popliteal ligament



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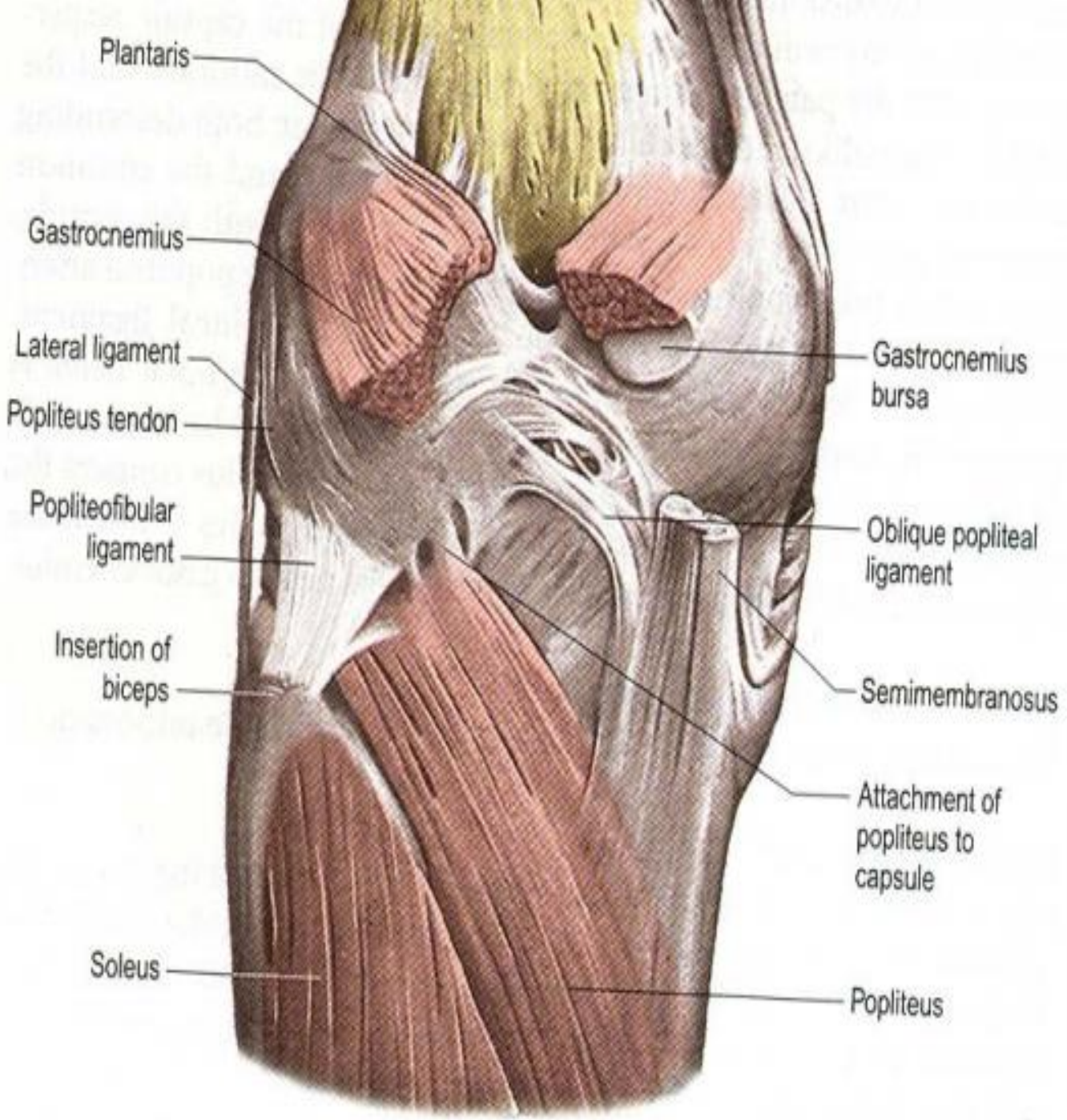
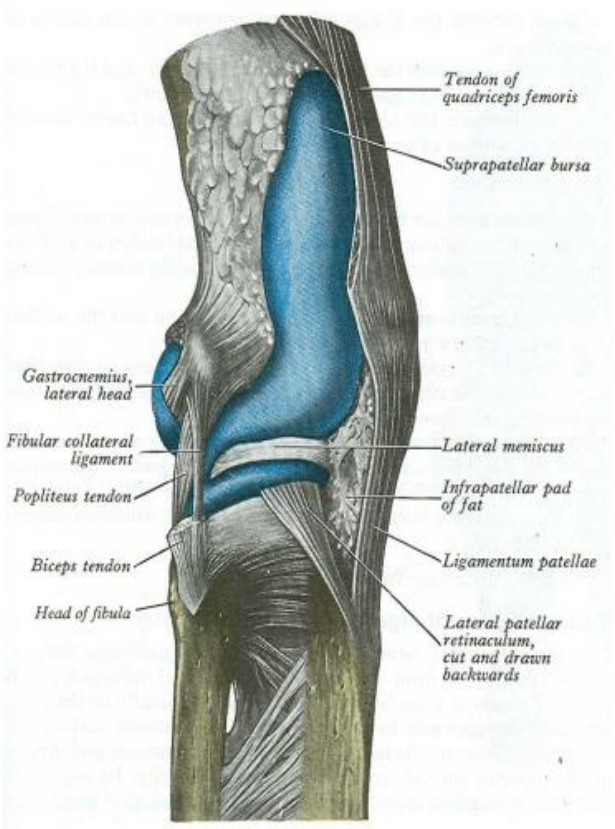
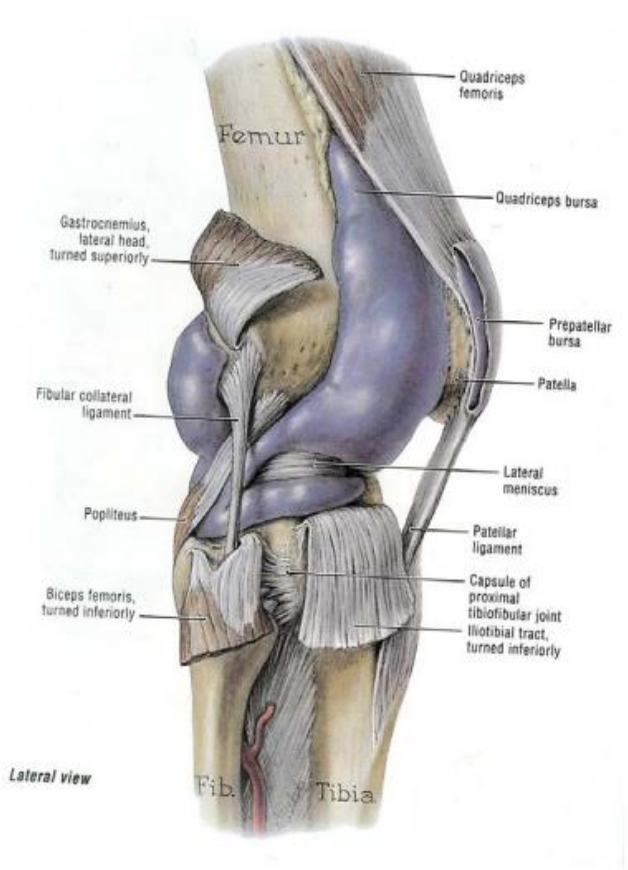


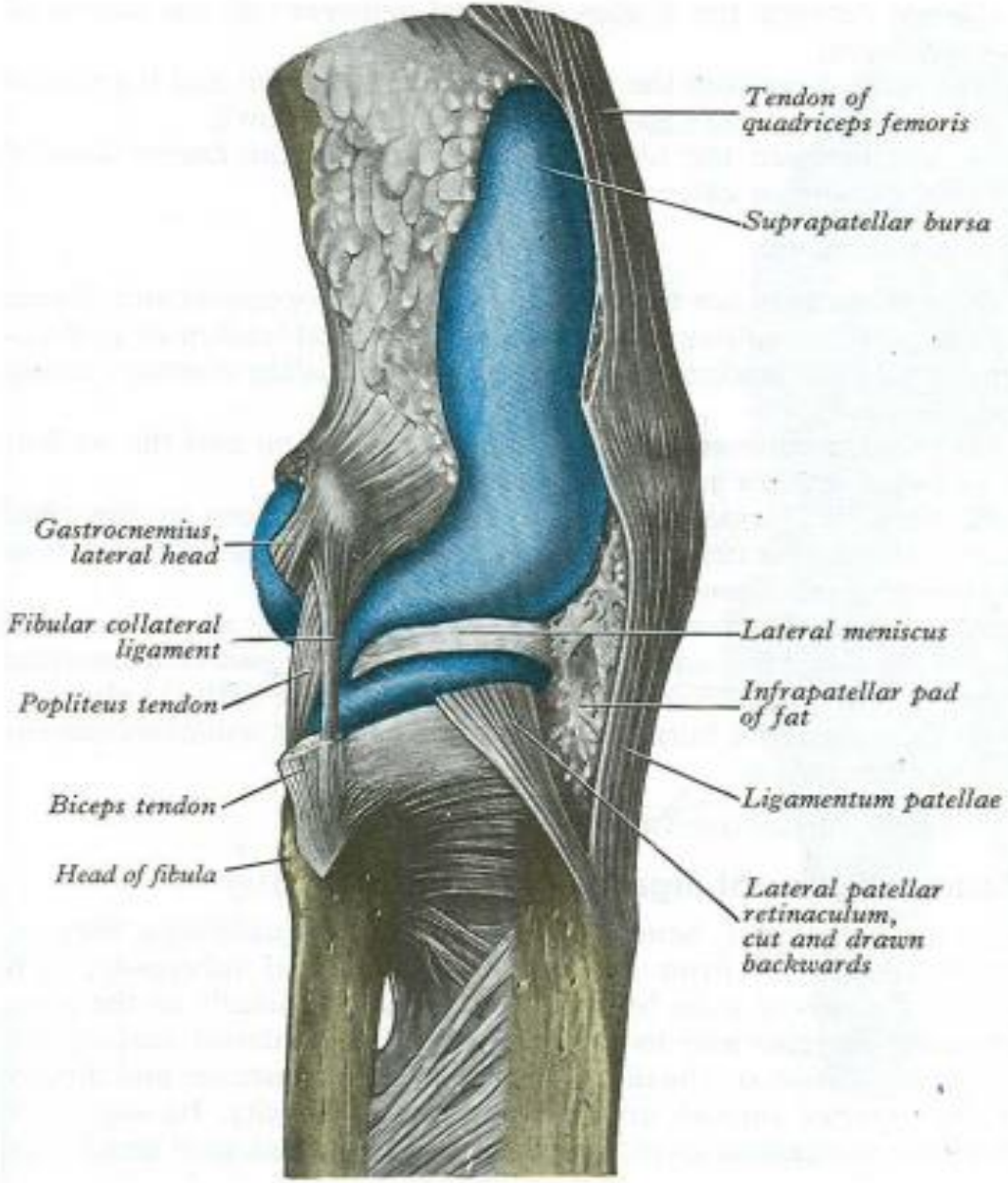
Fibrous capsule

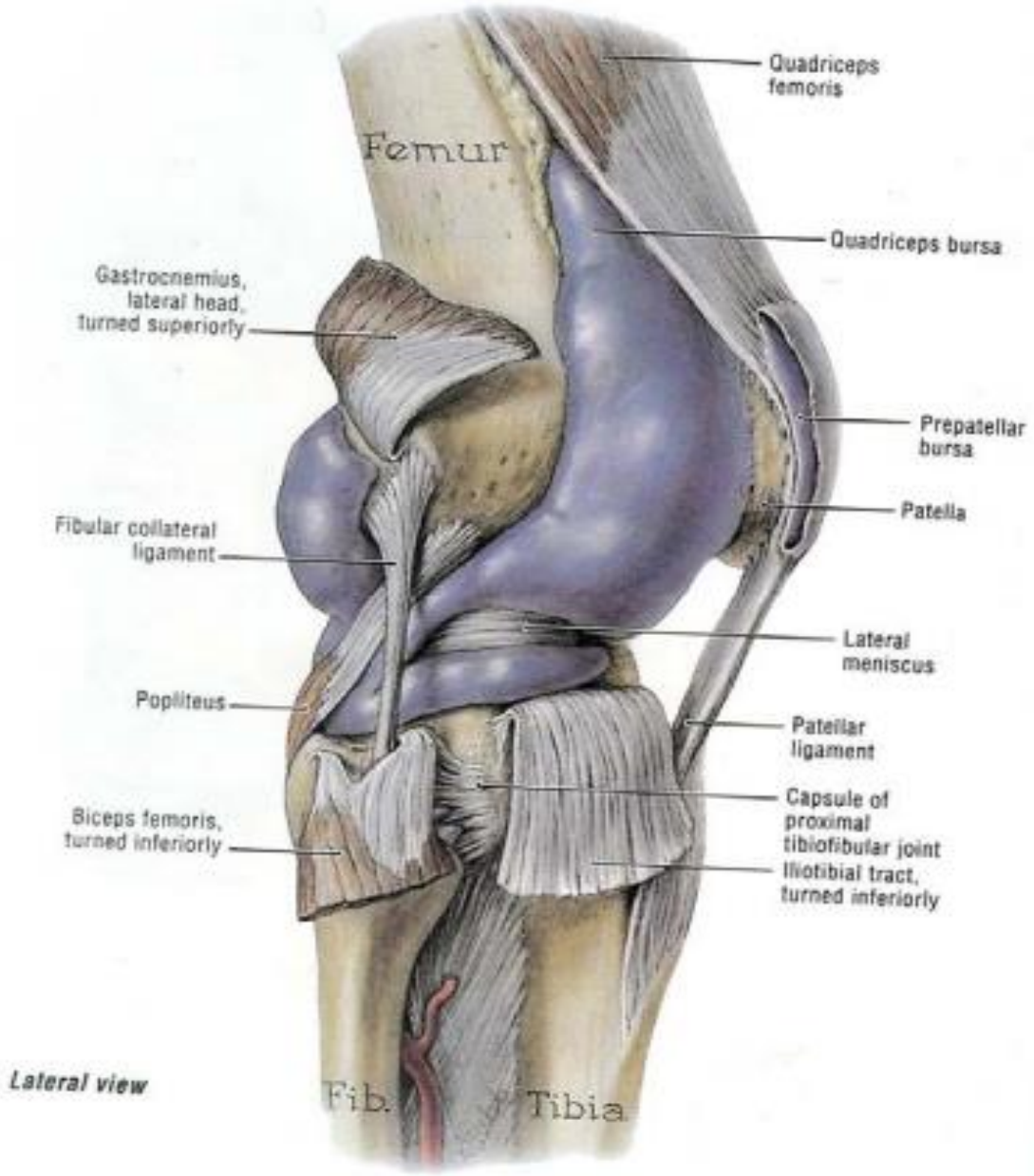
Defects/openings

1. In the front for synovial out-pocketing called suprapatellar bursa
2. Behind the lateral tibial condyle permits for popliteal tendon









Lateral view

Ligaments

Dense regular fibrous tissue

Attach adjacent bones across the joint

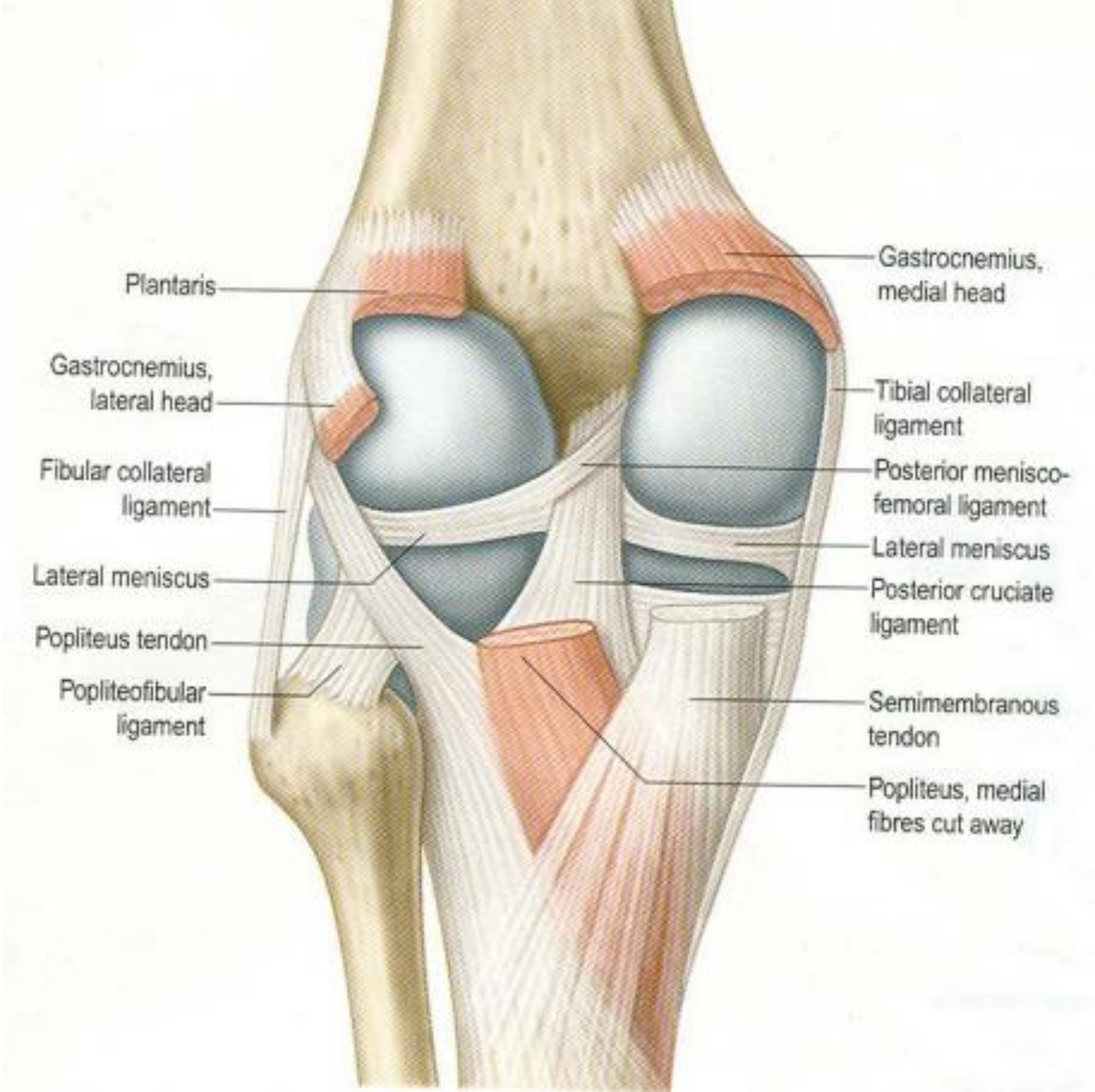
Check/modulate movements of the joints

Strengthen the joint capsule further

Two main types are recognized, viz:

1. Intracapsular

2. Extracapsular



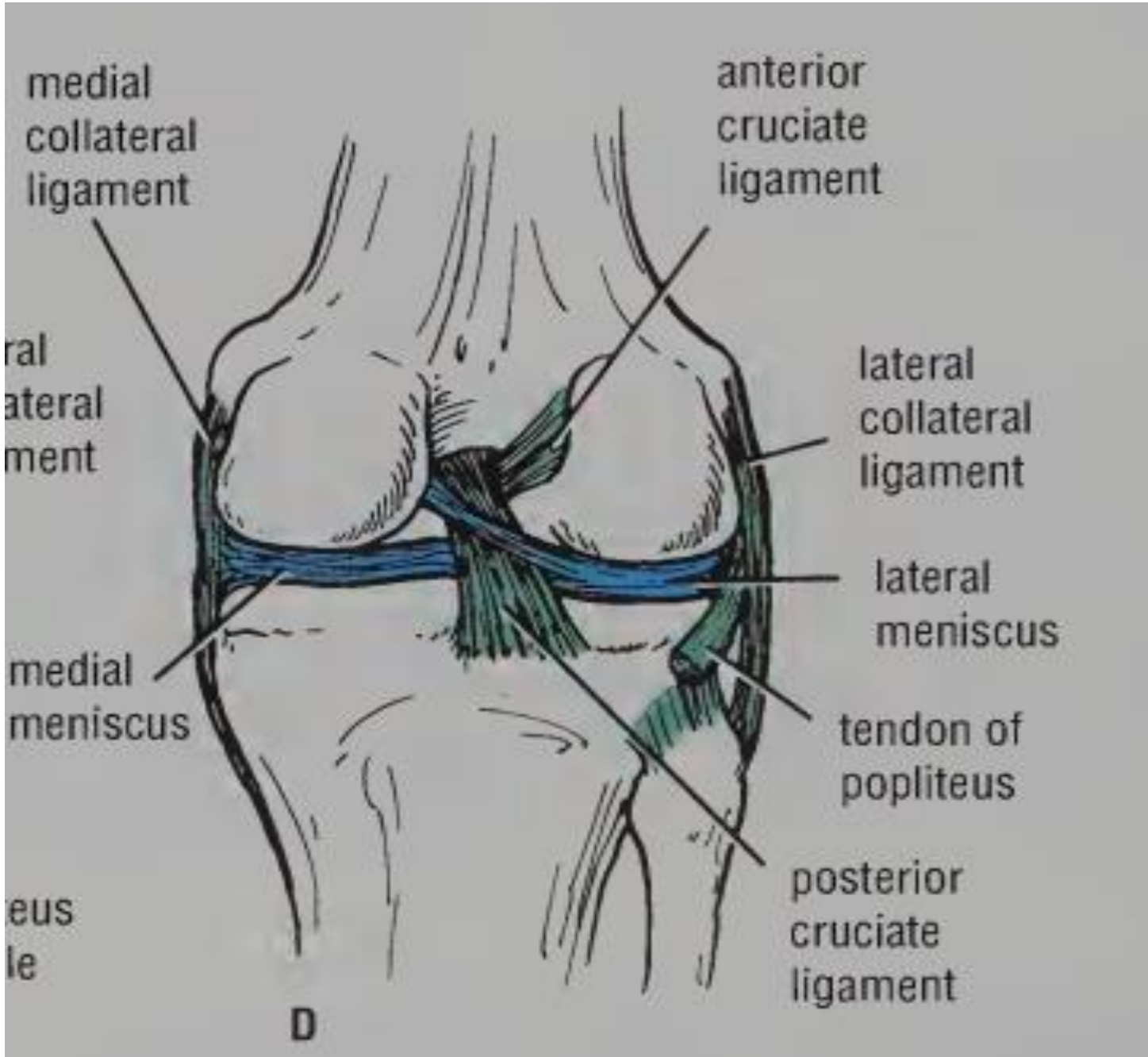
Extracapsular ligaments

1. **Lateral collateral ligament**: cordlike and attached to lateral condyle of the femur and the head of the fibula

2. **Medial collateral ligament** is a flat band and attached to the medial condyle of the femur and to the medial surface of the tibia.

3. ***Ligamentum patellae***: from lower border of the patella and below to tibial tuberosity

4.***The oblique popliteal ligament*** *(vide supra)*



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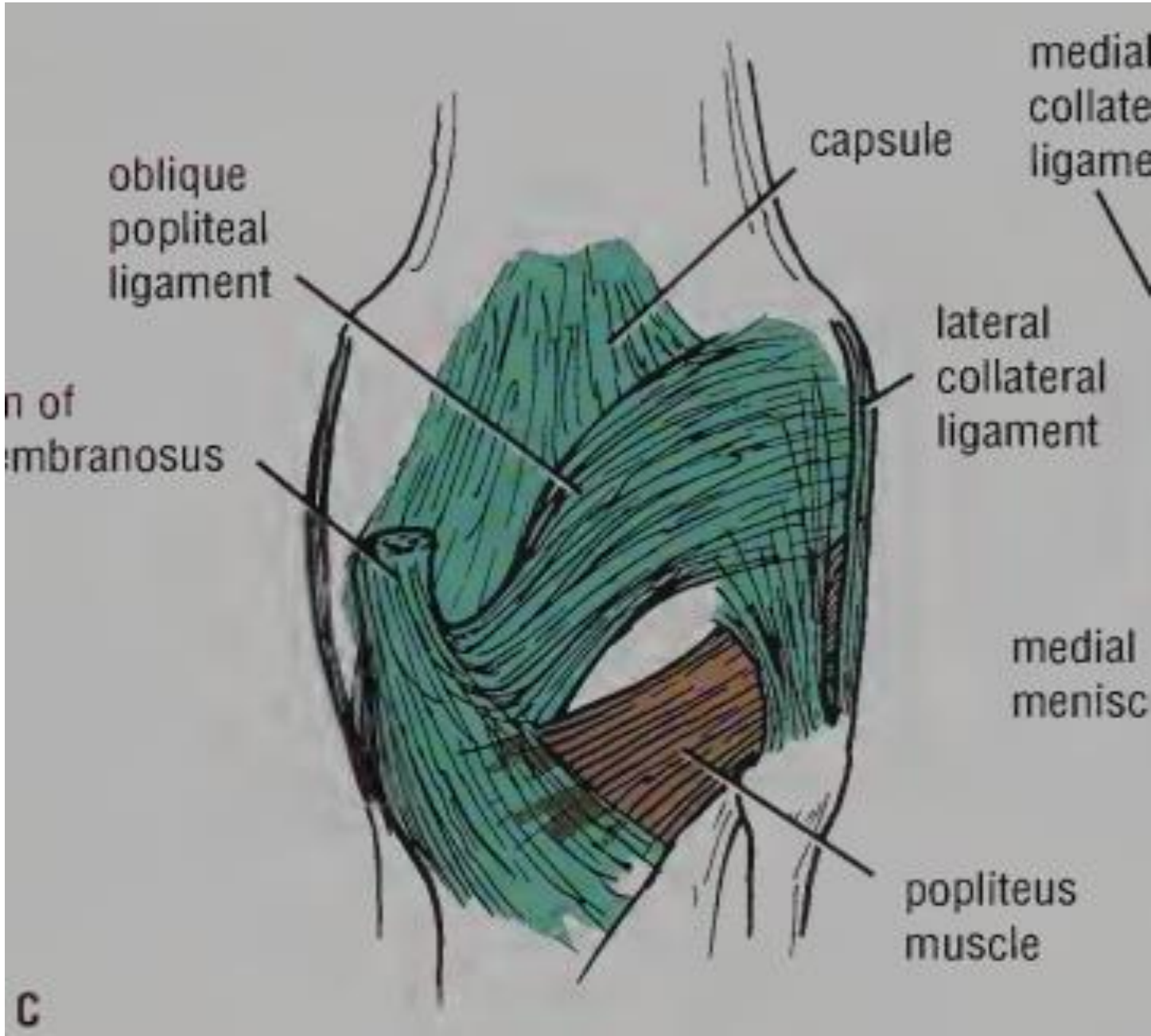
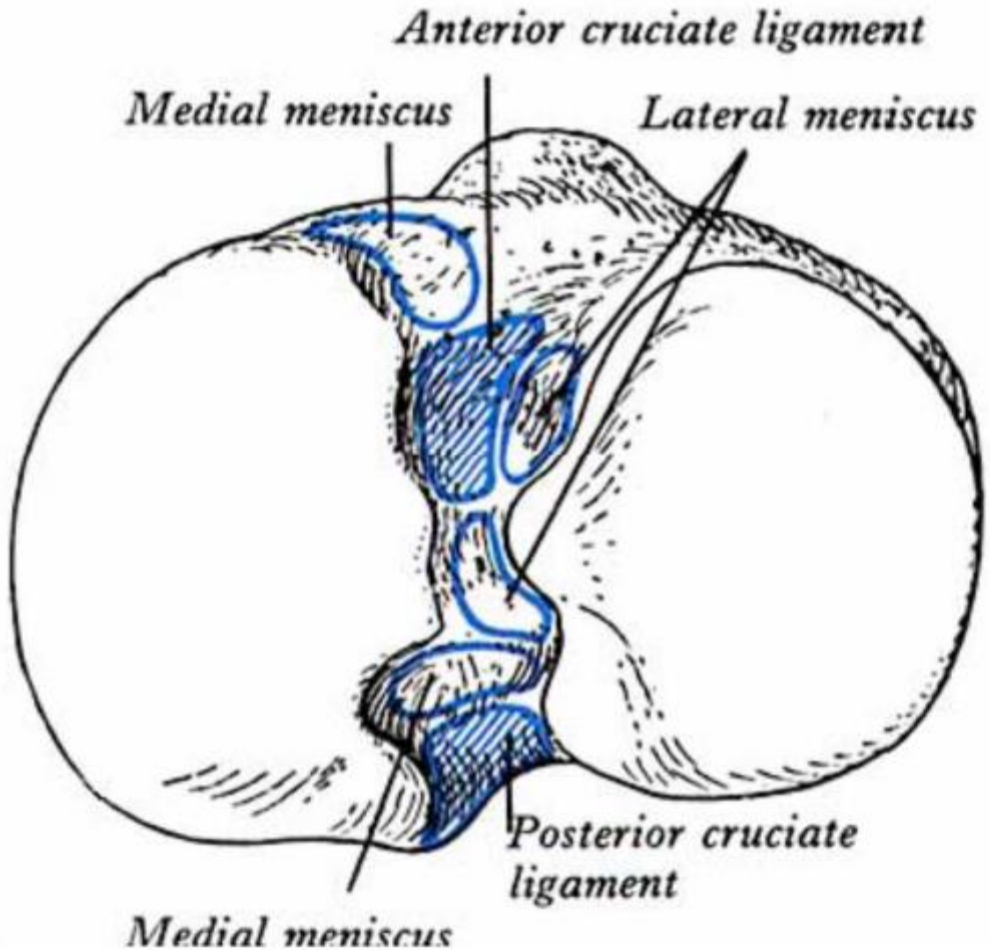



Anterior cruciate ligament
Medial meniscus
Lateral meniscus
Posterior cruciate ligament
Medial meniscus

Intracapsular ligaments

Cruciate ligaments

two and strong cross each other within the joint

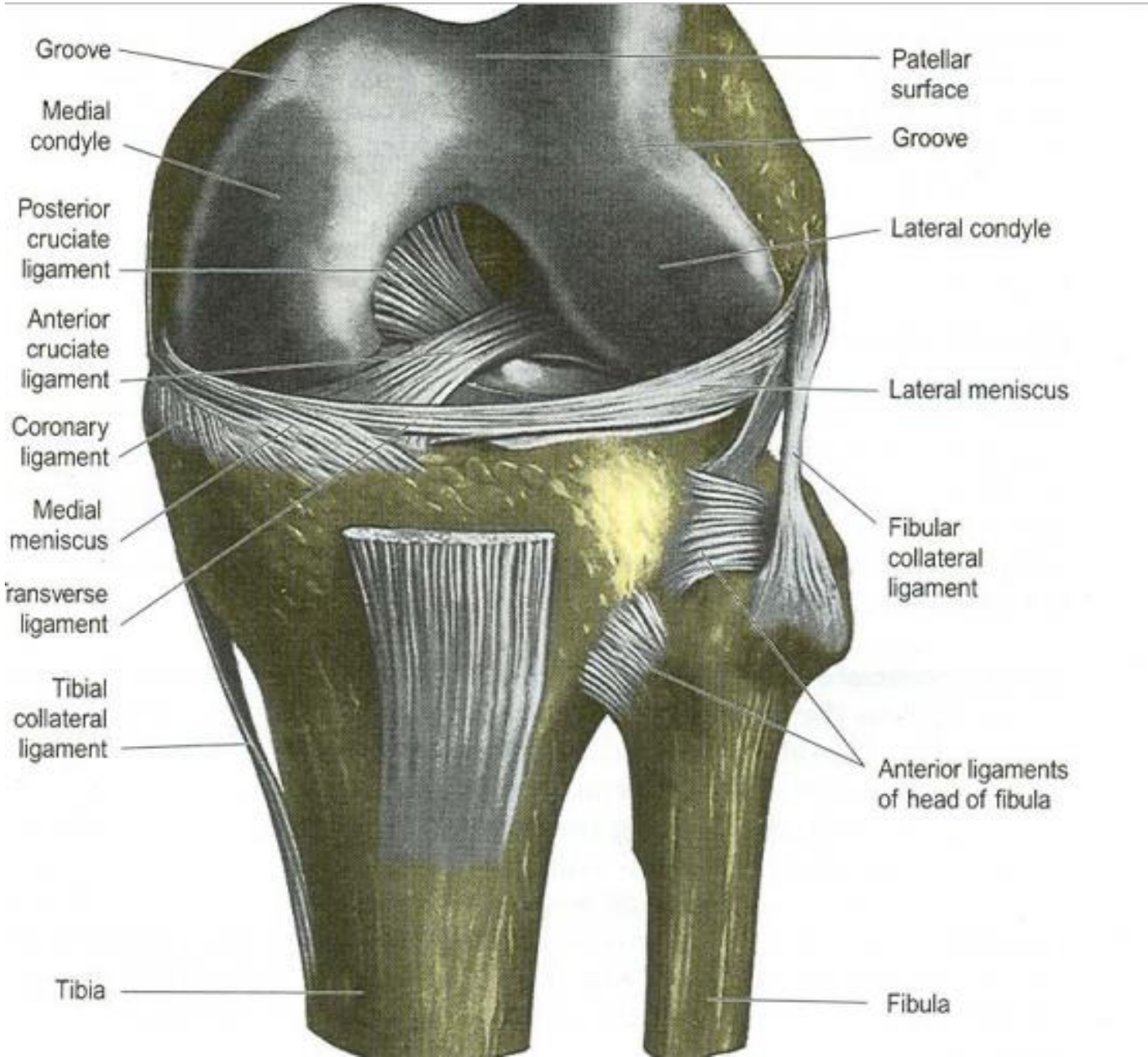
They are the main bond between the femur and the tibia throughout the joint's range of movement.

Anterior Cruciate Ligament :

1. **APEx** orientation
2. Prevents posterior displacement of the femur on the tibia.

Posterior Cruciate Ligament :

1. **PAIn** orientation
2. Prevents anterior displacement of the femur on the tibia.



(a) Anterior cruciate ligament – resists forward movement of tibia on femur

(b) Posterior cruciate ligament – resists backward movement of tibia on femur

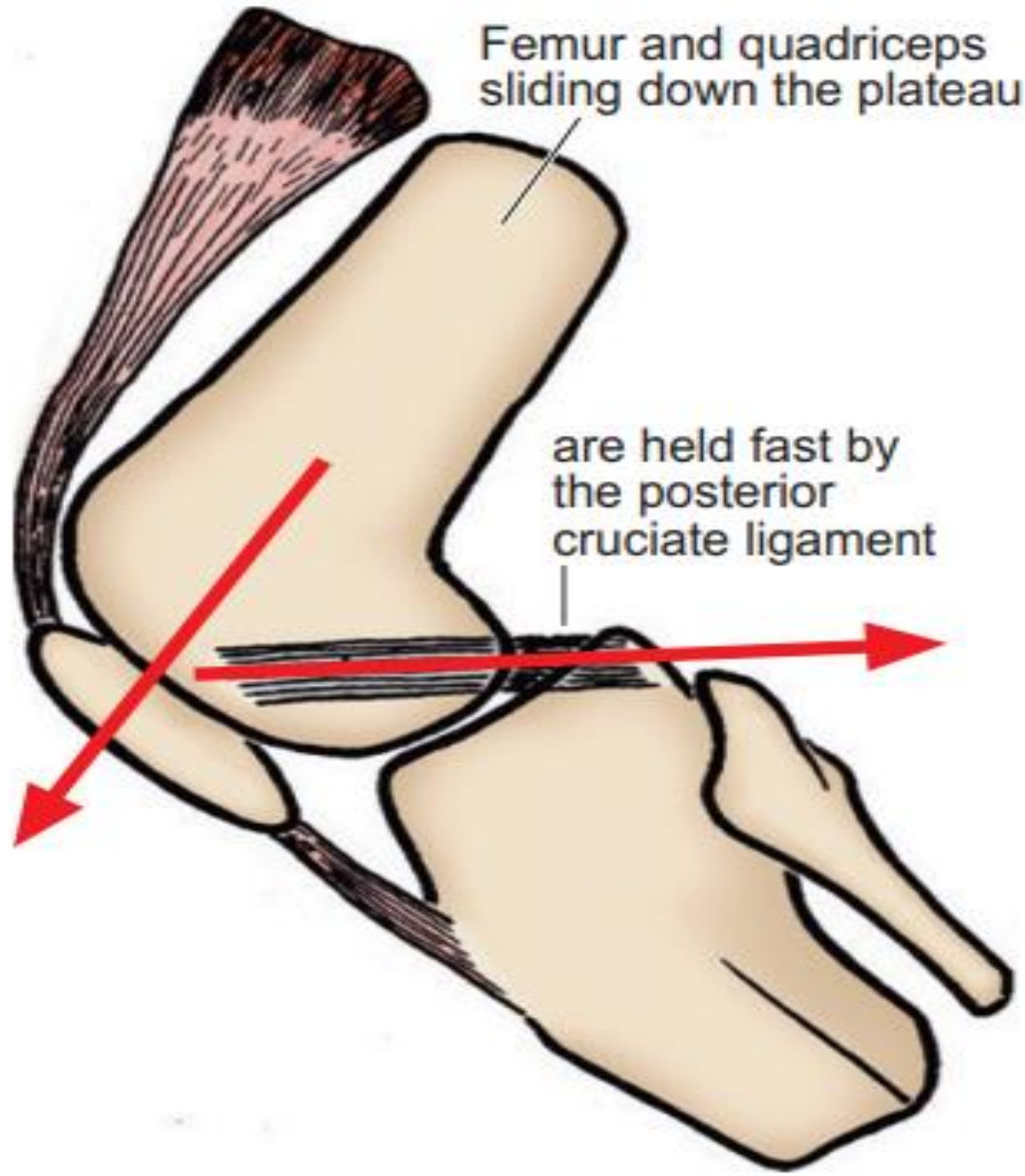


Figure 3.29 Weight-bearing on the flexed knee. This is the position of the upper knee during progression downhill. The body weight is suspended on the posterior cruciate ligament.

Intracapsular ligaments

The menisci

Fibrocartilaginous C-shaped sheets

Peripheral border is thick and attached to the capsule

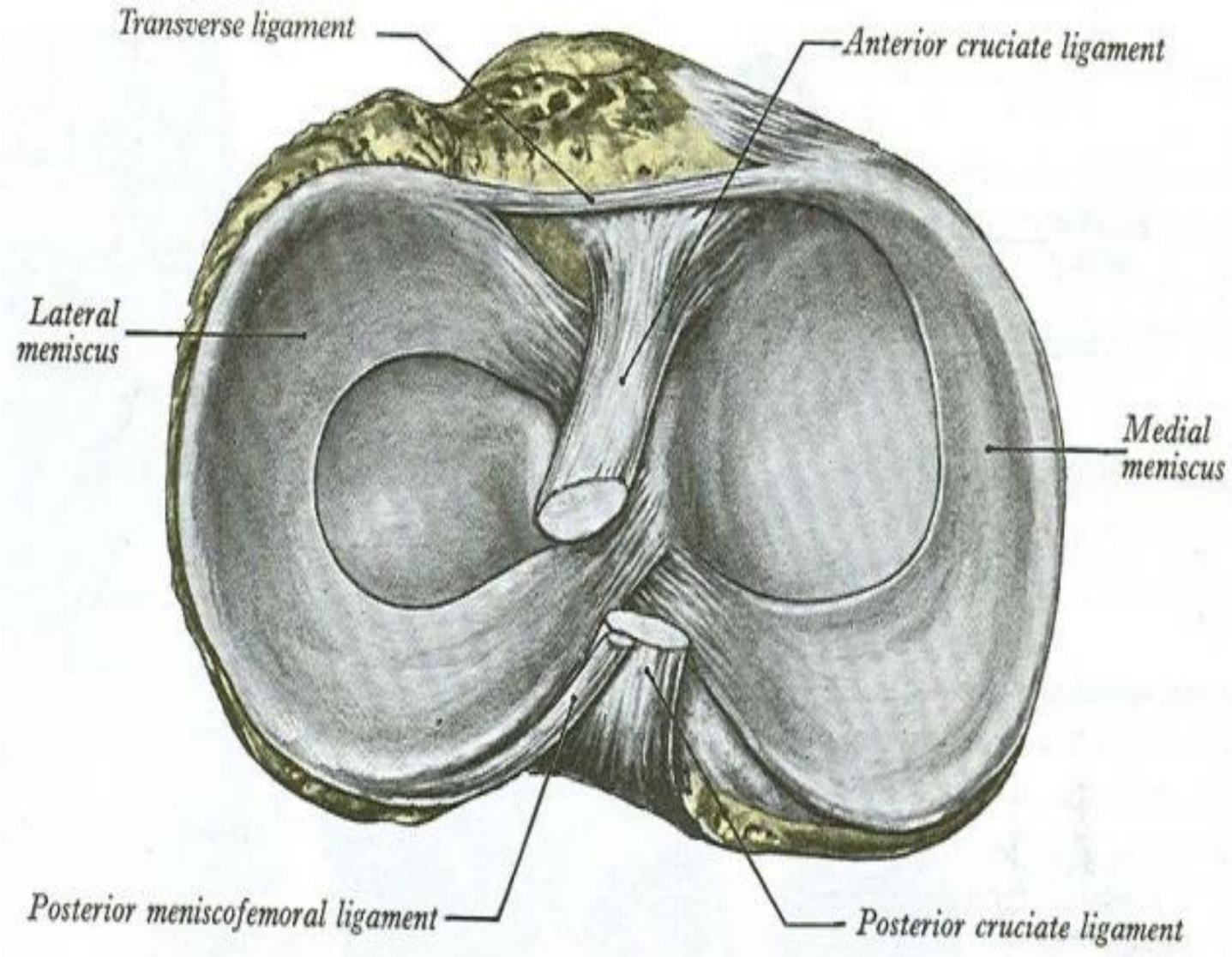
Inner border is thin and concave and forms a free edge

Upper surfaces contact femoral condyles.

Lower surfaces contact tibial condyles.

Each meniscus is attached to the upper surface of the tibia by anterior and posterior horns

Medial meniscus is relatively immobile. Why?



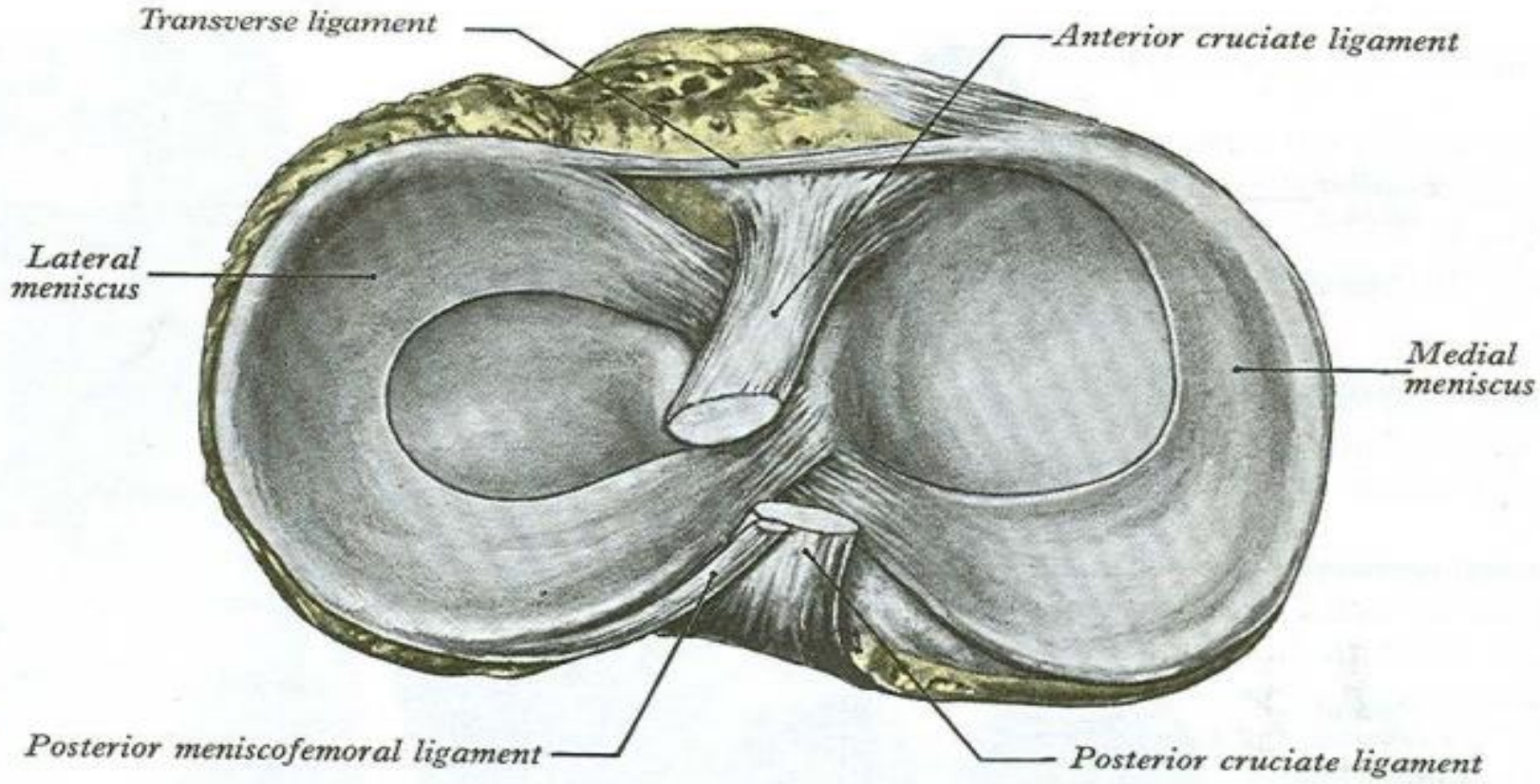
What is the function(s) of the menisci?

lateral

Is nearly circular

Is separated from fibular collateral ligament by the tendon of popliteus muscle.

Transverse ligament : binds the anterior horns of the lateral & medial menisci



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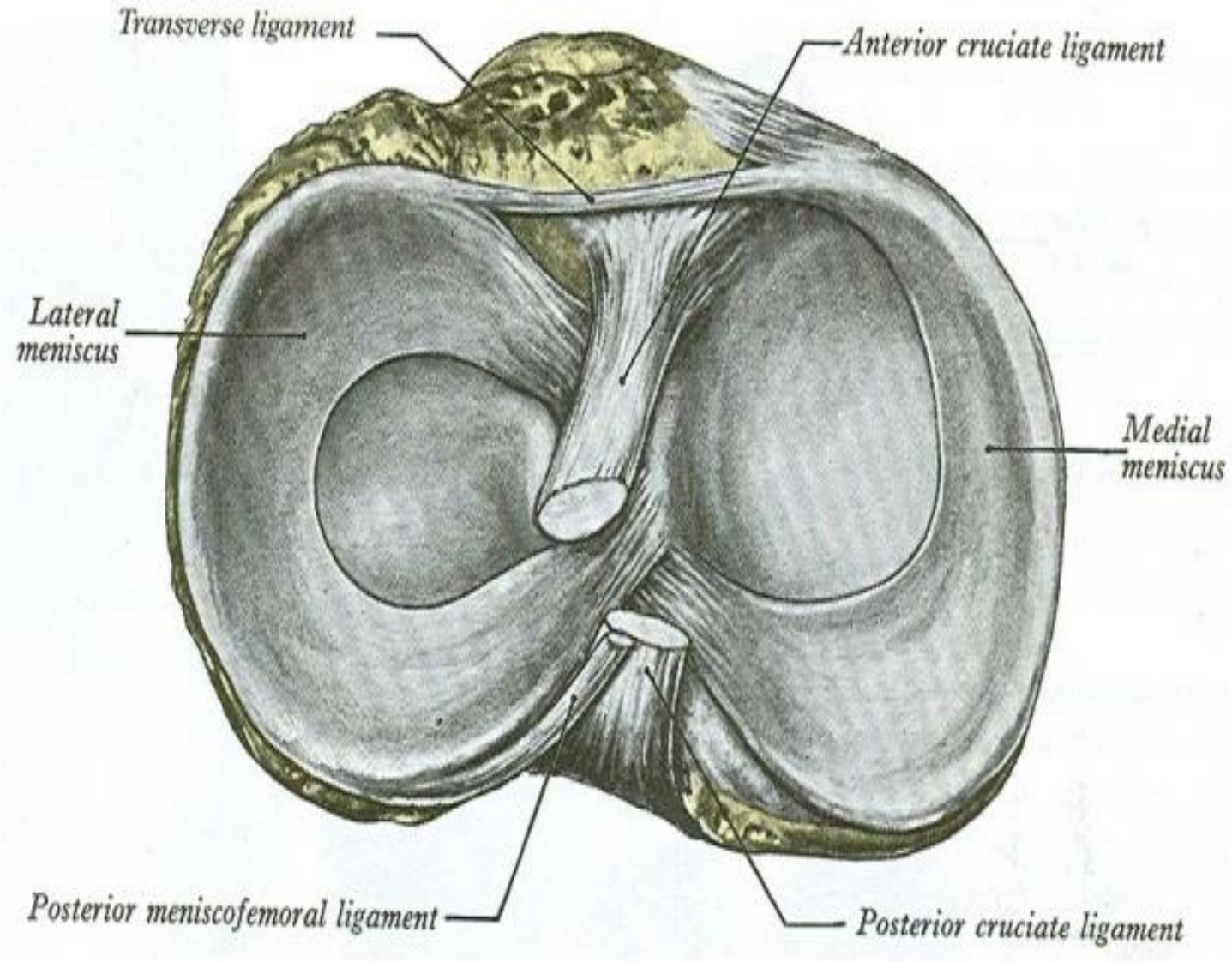
Three Cs

Soft tissue injuries of the knee?

1. Collateral ligaments— varus and valgus stress tests
2. Cruciates—Anterior and posterior drawers tests
3. Cartilages—Thessaly and McMurry tests

Watch expert videos on the above tests. Then…

Write NOT exceeding one page of anatomical considerations of such tests.



Synovial membrane

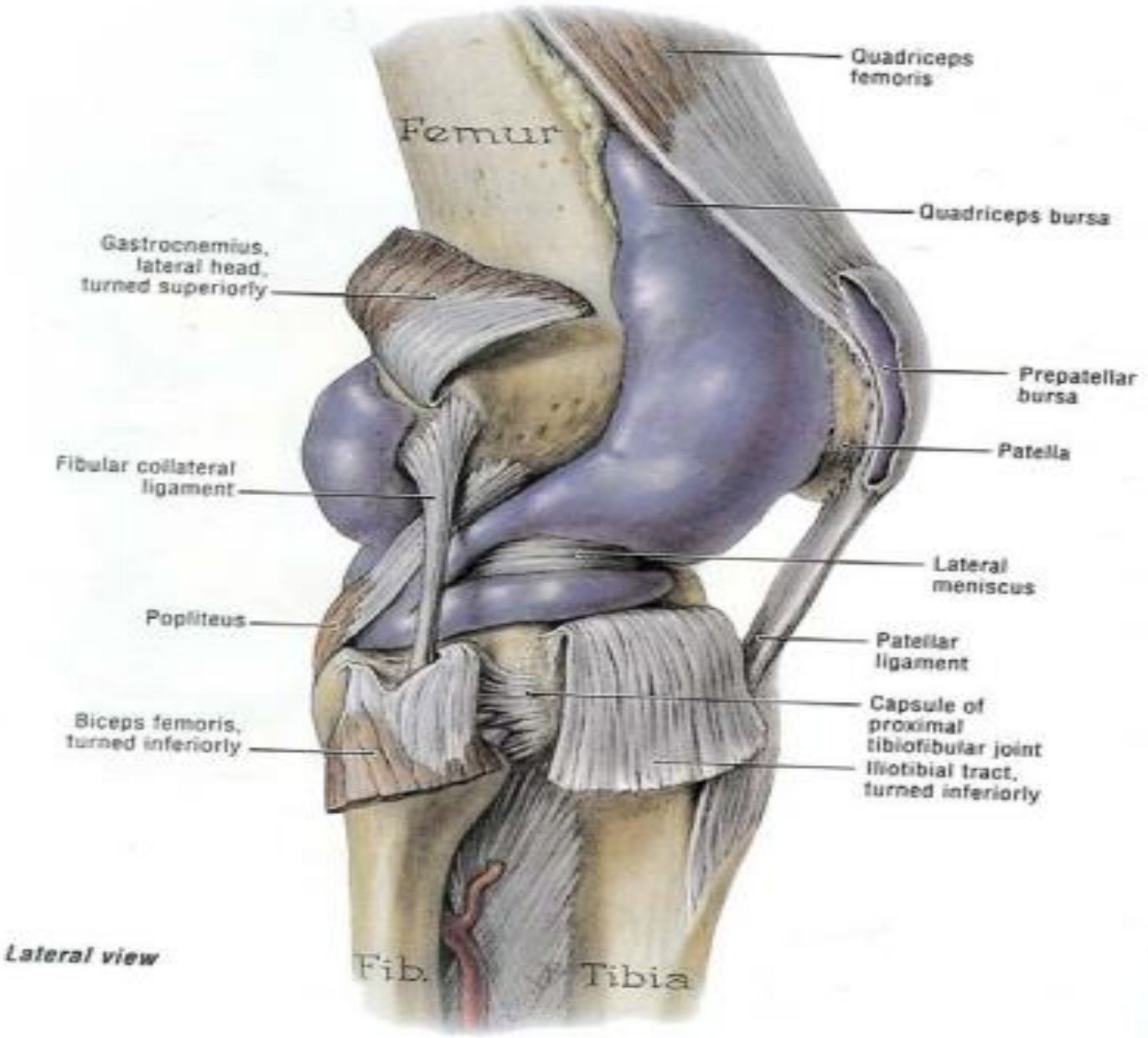
Internal lining of the fibrous capsule

Attached to the margins of the articular surfaces

On the front and above the joint it forms a synovial pouch

The pouch extends up beneath the quadriceps femoris muscle for 3 fingers breadths above the patella, forming the **suprapatellar bursa (SupB)**

The SupB is held in position by the **articuluralis genus**



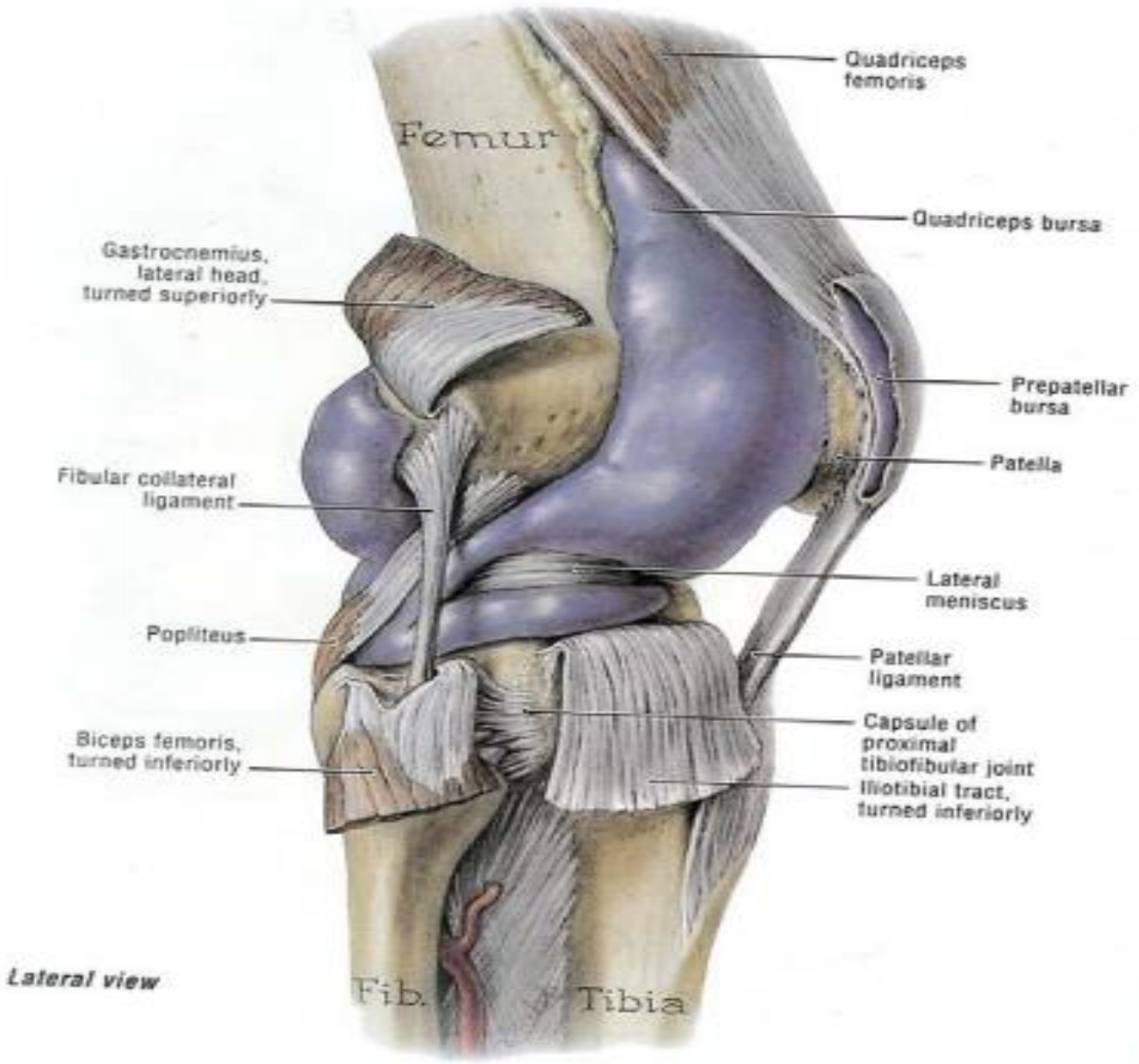
Synovial membrane

At the back of the joint the is a downward prolongation.

It is named **semimembranosus bursa** (SemB)

SemB is interposed between the medial head of the gastrocnemius and the medial femoral condyle and the semimembranosus tendon

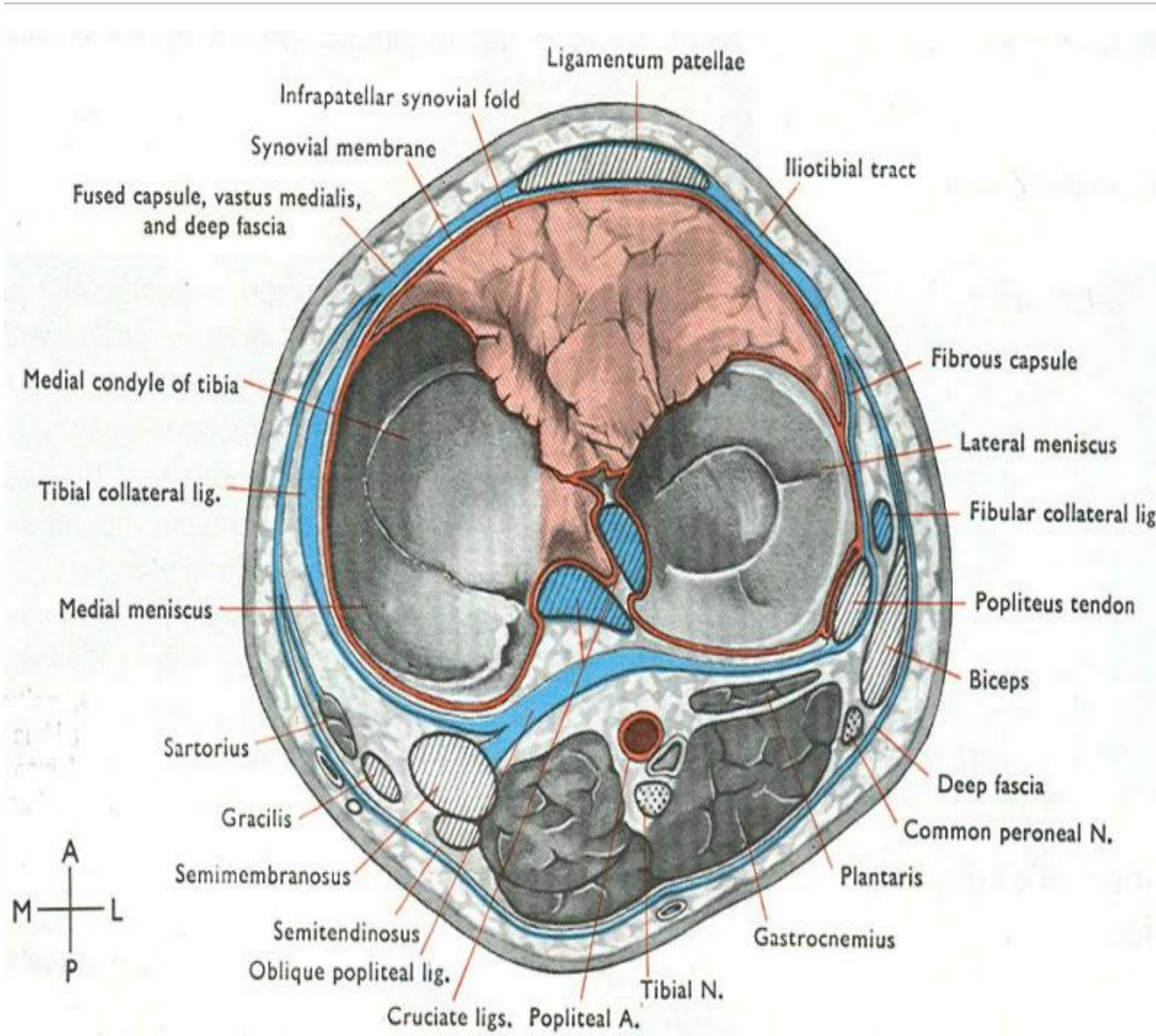
SemB frequently communicates with the synovial cavity of the joint.



Synovial membrane

The synovial membrane is reflected forward from the posterior part of the capsule around the front of the cruciate ligaments

As a result the cruciate ligaments are ‘retrosynovial’

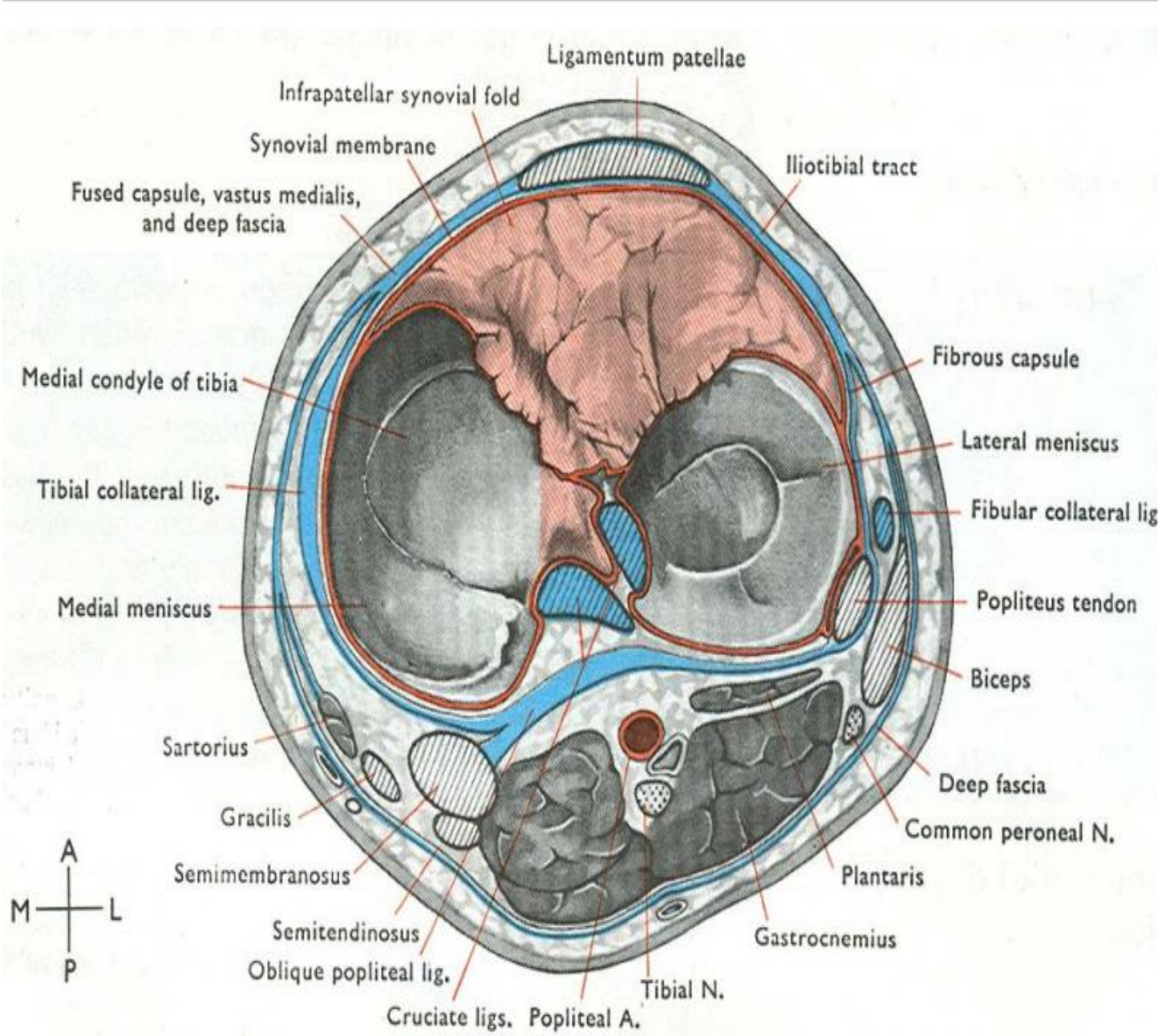


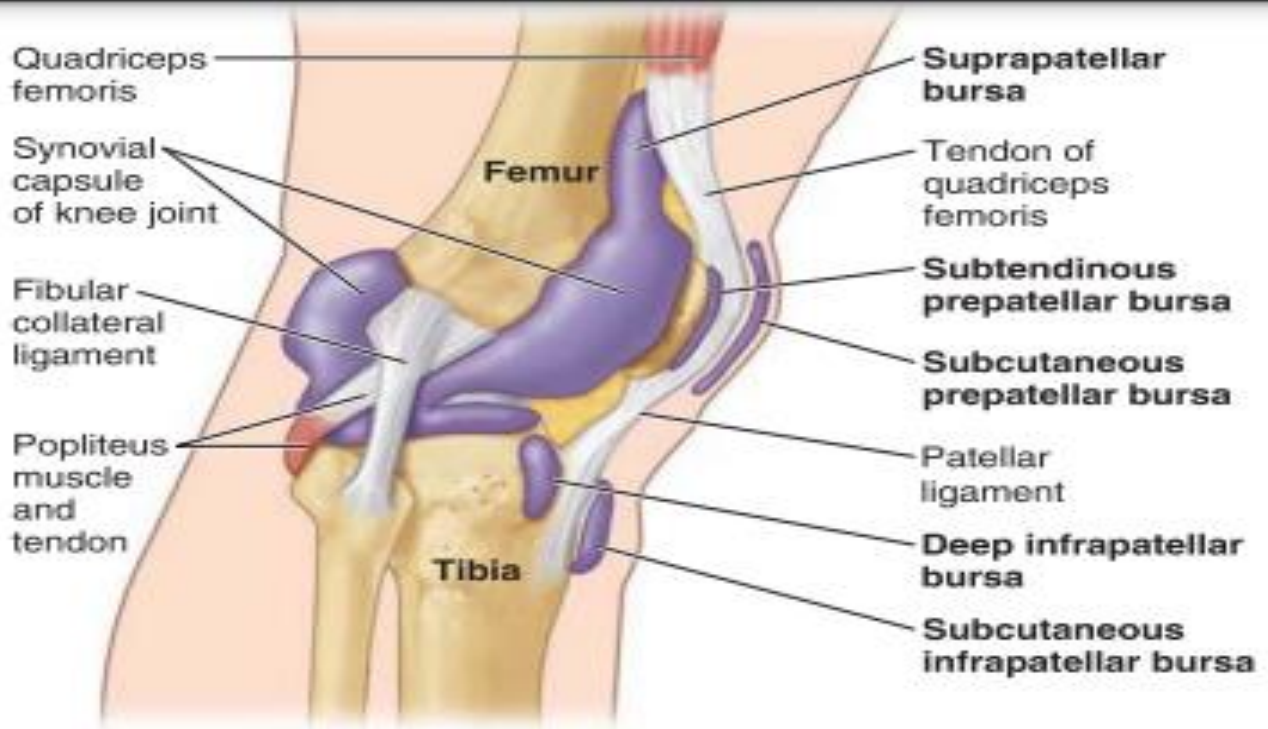
Synovial membrane

In the anterior part of the joint the synovial membrane is

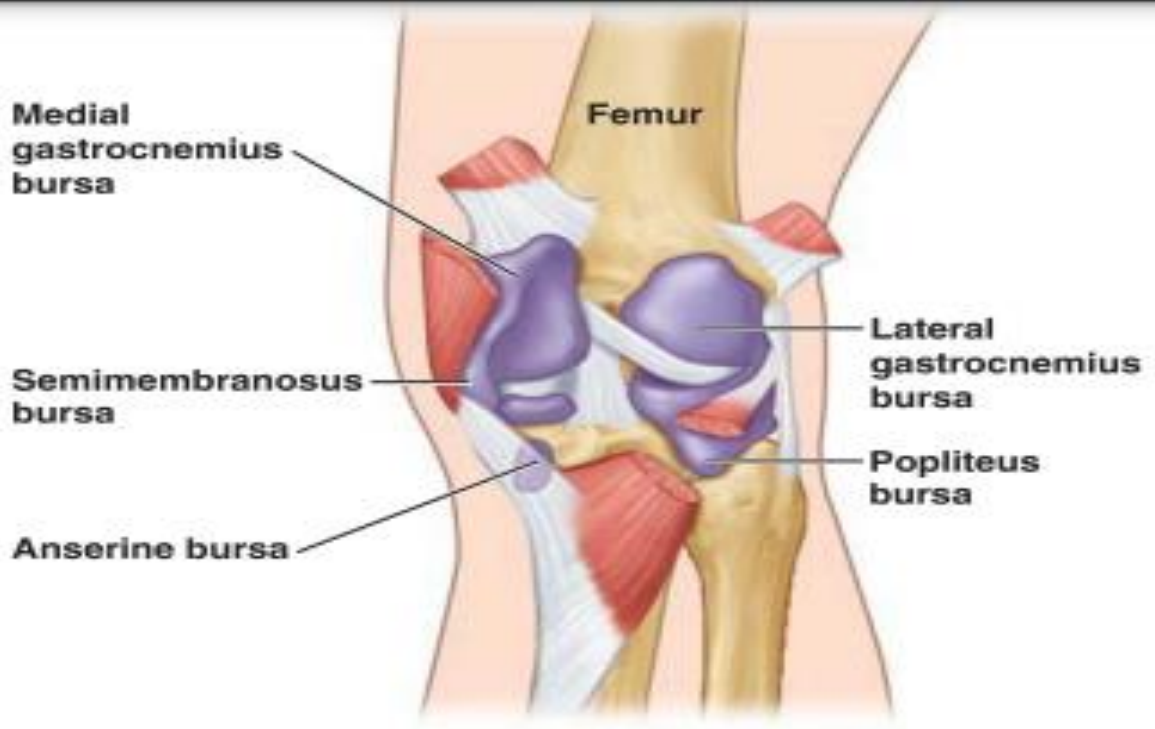
reflected backward from the posterior surface of the ligamentum patellae to form the **infrapatellar fold**

The free borders of the fold are termed the **alar folds**

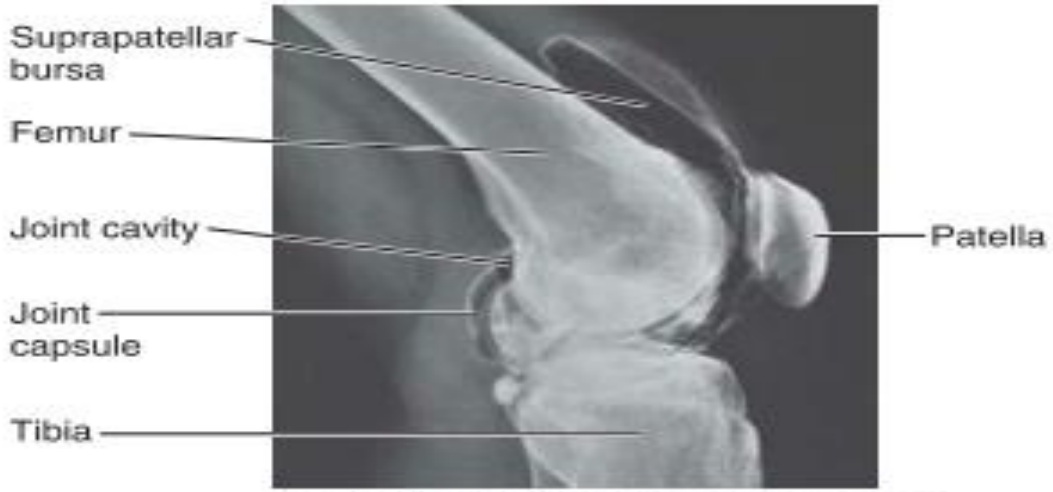




(A) Lateral view



(B) Posterior view



(C) Lateral radiograph. Suprapatellar bursitis (excess fluid in supra-patellar bursa and synovial cavity of knee joint)

(D) Medial view

Synovial bursae

They are found wherever skin, muscle, or tendon rubs against bone.

There are two classifications, viz;

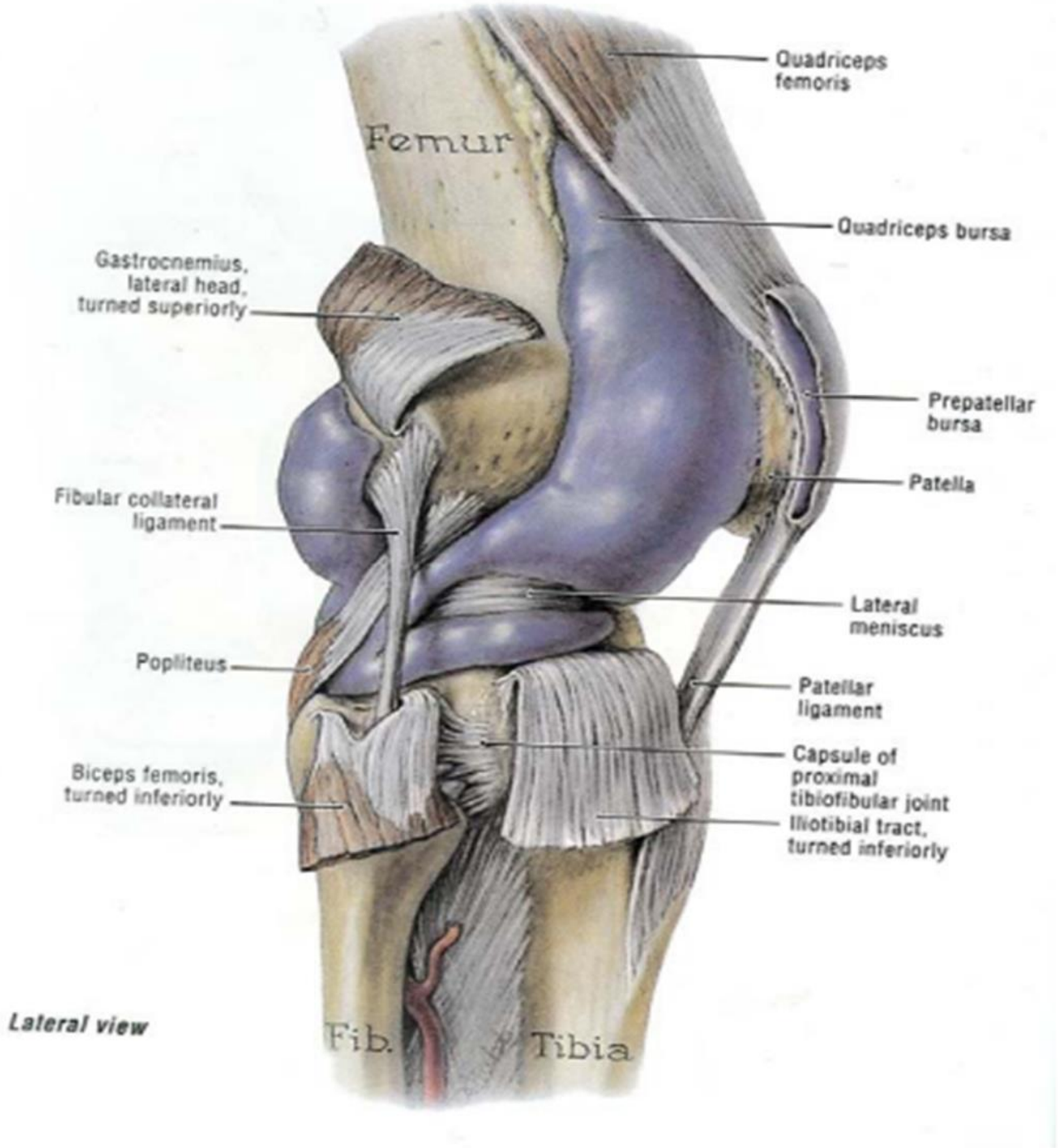
1. By position
2. By communication with the synovial cavity

<u>By position</u>

1. Anterior bursae
2. Posterior bursae

<u>By communication</u>

1. Communicating busae
2. Non-communicating bursae



Synovial bursae

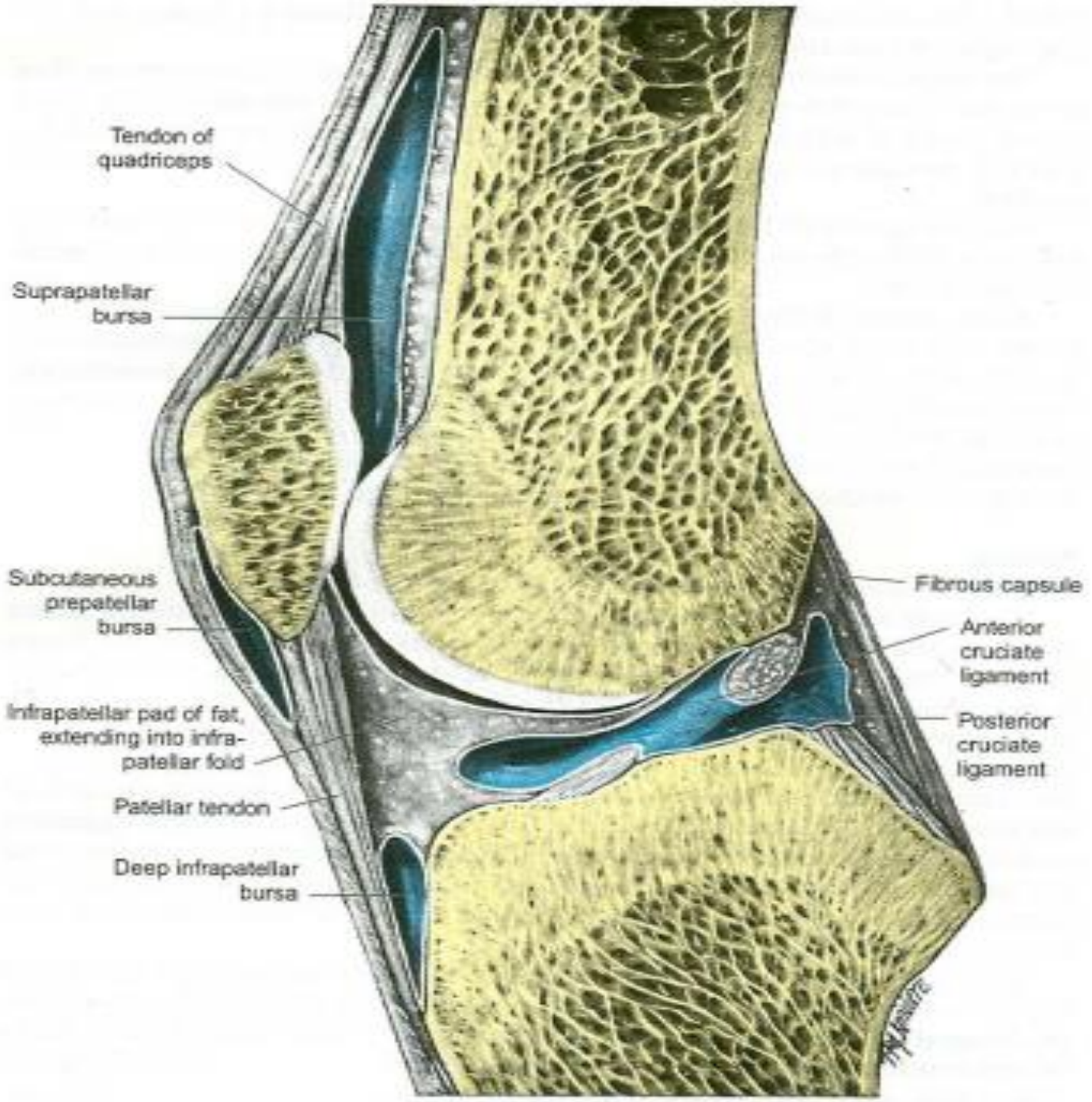
Anterior bursae

1.Suprapatellar bursa: communicating. Vide supra.

2. The **prepatellar bursa** lies in the subcutaneous tissue between the skin and the front of the lower half of the patella and the upper part of the ligamentum patellae

3. The **superficial infrapatellar bursa** lies in the subcutaneous tissue between the skin and the front of the lower part of the ligamentum patellae

4. **The deep infrapatellar bursa** lies between the ligamentum patellae and the tibia.

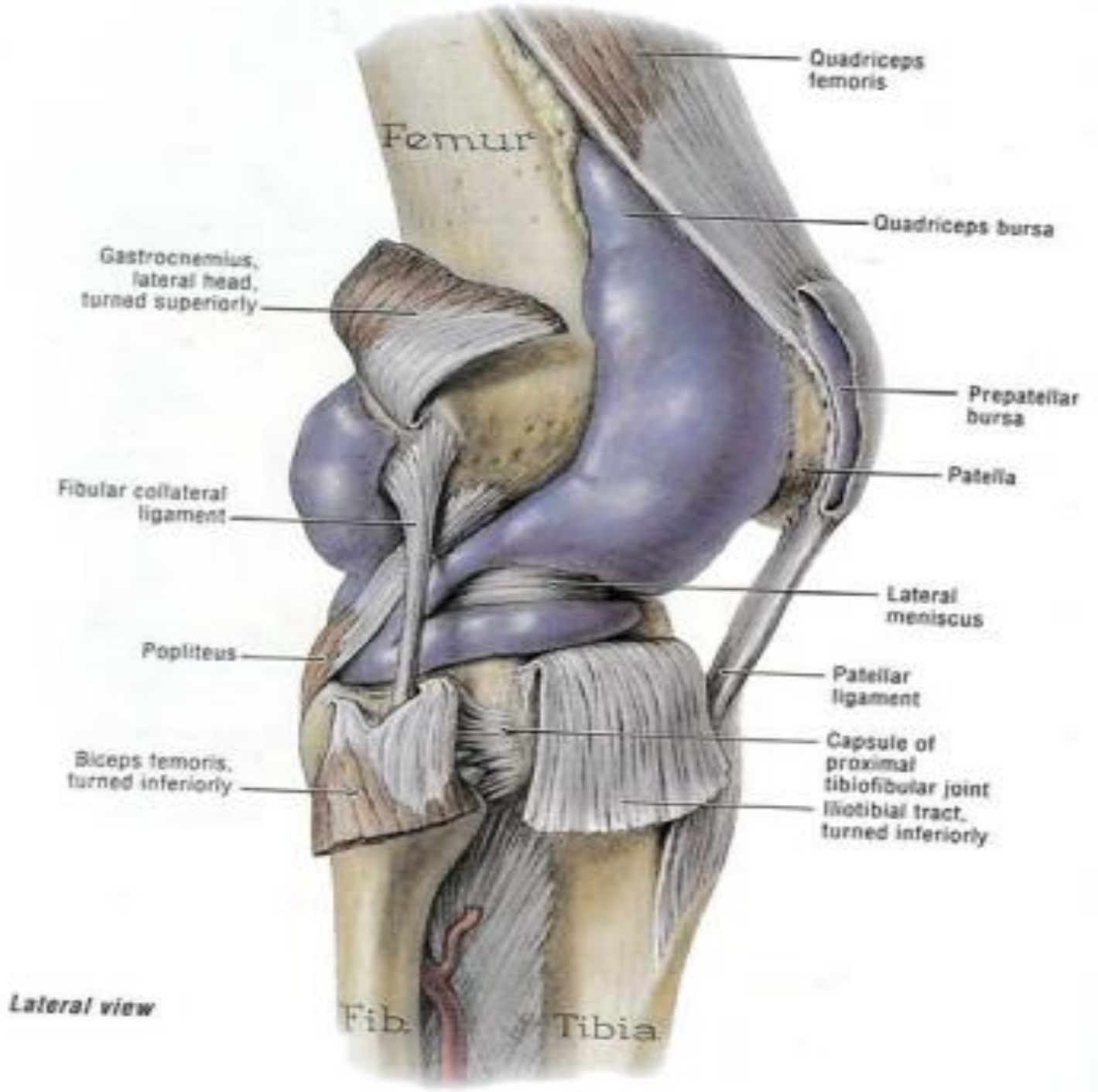


Synovial bursae

Posterior bursae

1. **Popliteal bursa** is found in association with the tendon of the popliteus and communicates with the joint cavity. It was described previously.

2. **Semimembranosus bursa** is found related to the insertion of the semimembranosus muscle and may communicate with the joint cavity. Vide supra



Synovial bursae

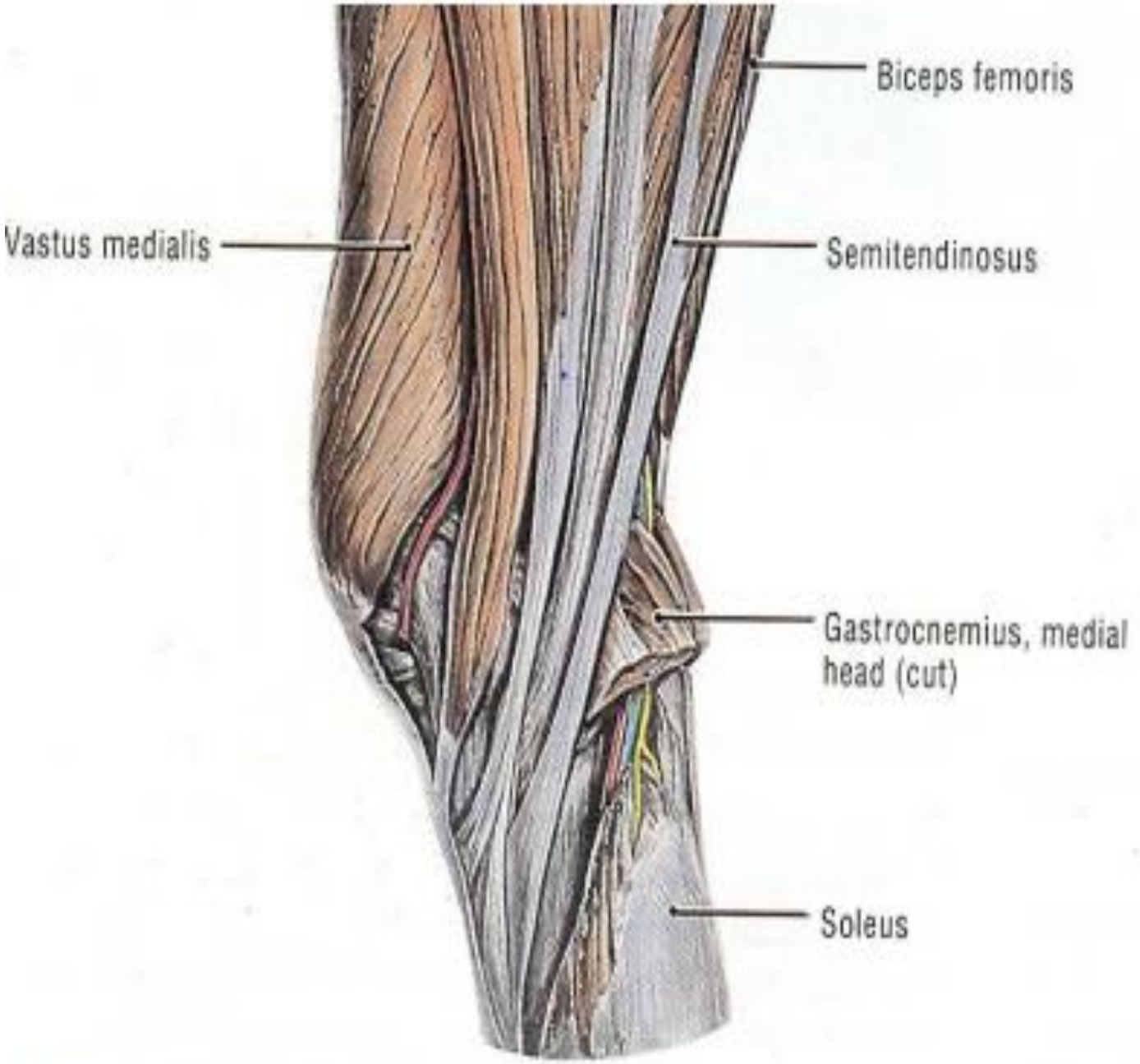
The remaining four bursae are found related to:

(1) the tendon of insertion of the biceps femoris;

(2) the tendons of the sartorius, gracilis, and semitendinosus muscles as they pass to their insertion on the tibia;

(3) beneath the lateral head of origin of the gastrocnemius muscle; and

(4) beneath the medial head of origin of the gastrocnemius muscle.

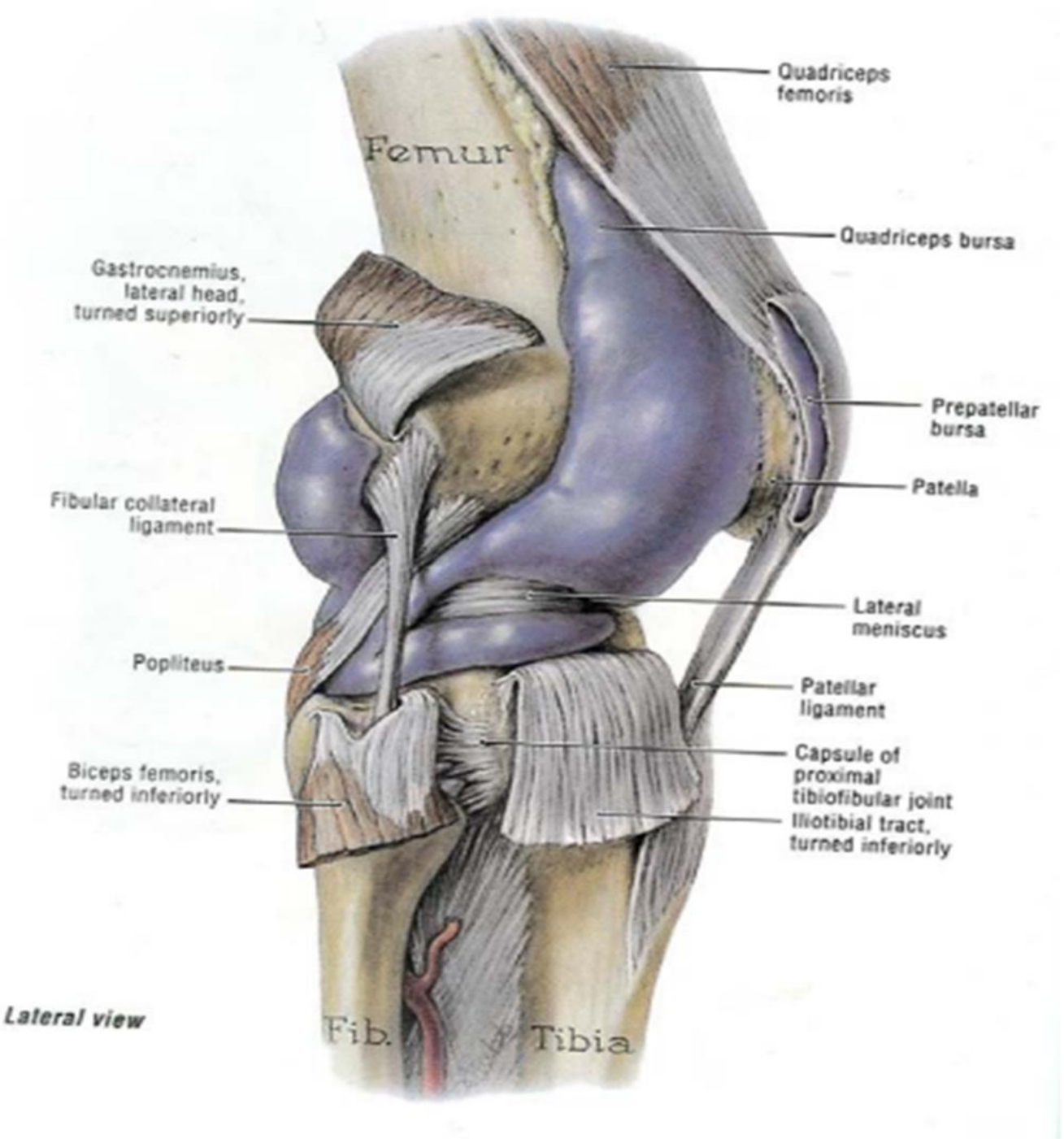


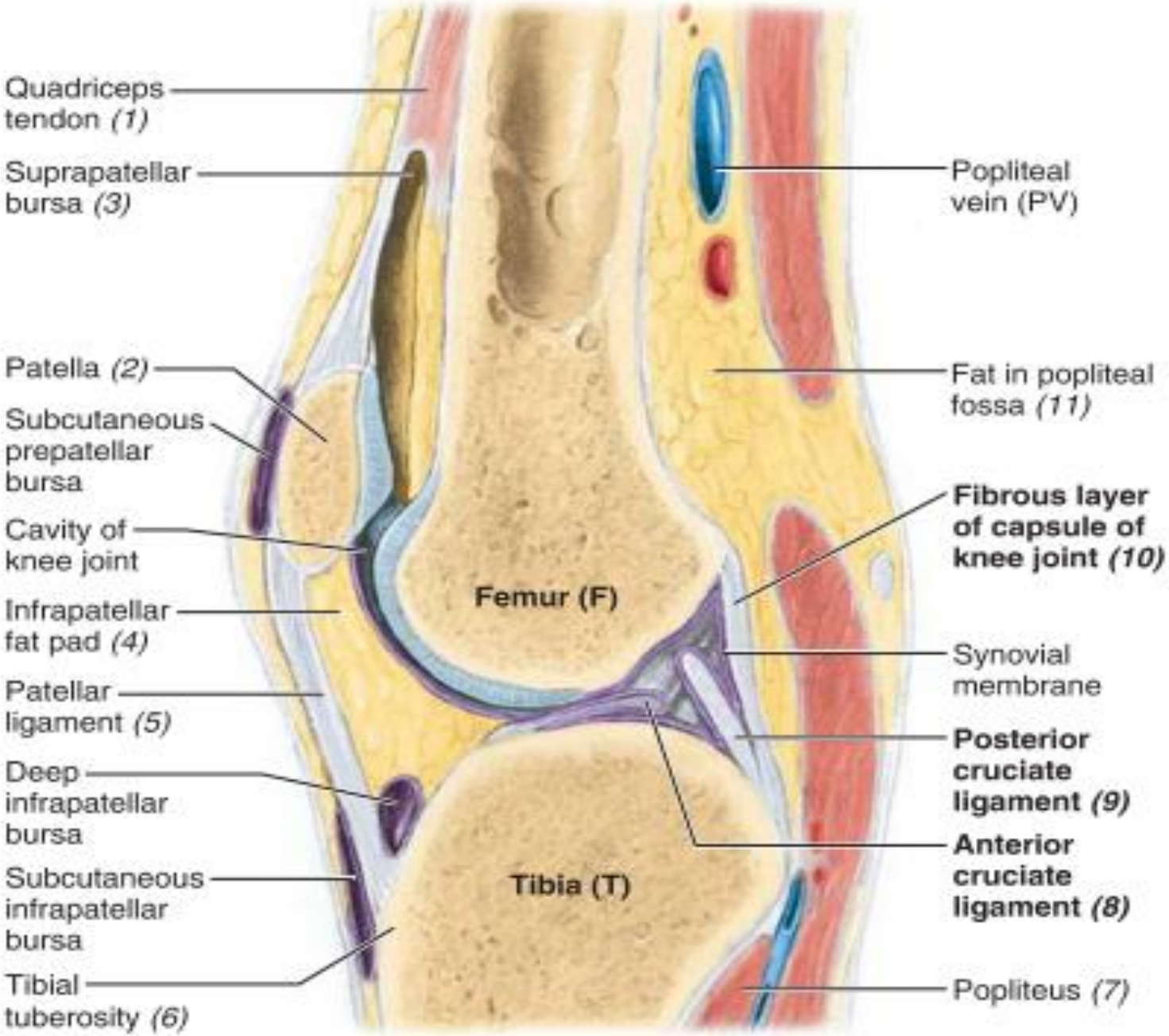
Bursae	Locations	Comments
Suprapatellar	Between femur and tendon of quadriceps femoris	Held in position by articularis genu muscle; communicates freely with synovial cavity of knee joint
Popliteus	Between tendon of popliteus and lateral condyle of tibia	Opens into synovial cavity of knee joint inferior to lateral meniscus
Anserine	Separates tendons of sartorius, gracilis, and semitendinosus from tibia and tibial collateral ligament	Area where tendons of these muscles attach to tibia; resembles a goose's foot (L. *pes*, foot; L. *anserinus*, goose)
Gastrocnemius	Lie deep to proximal attachment of tendon of medial and lateral heads of gastrocnemius	Extensions of synovial cavity of knee joint
Semimembranosus	Between medial head of gastrocnemius and semimembranosus tendon	Related to distal attachment of semimembranosus
Subcutaneous prepatellar	Between skin and anterior surface of patella	Allows free movement of skin over patella during movements of leg
Subcutaneous infrapatellar	Between skin and tibial tuberosity	Helps knee withstand pressure when kneeling
Deep infrapatellar	Between patellar ligament and anterior surface of tibia	Separated from knee joint by infrapatellar fat pad

Synovial bursae

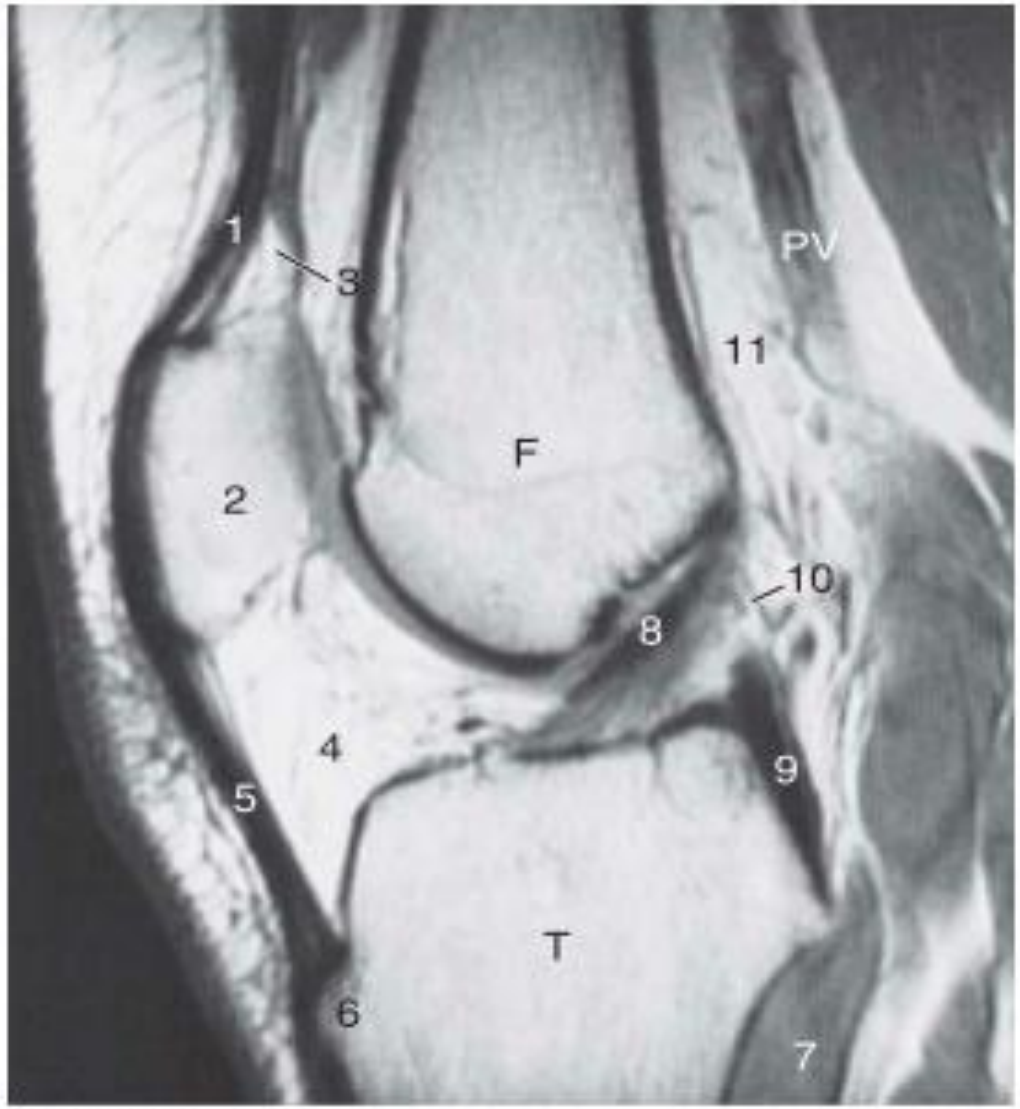
The suprapatellar bursa and the popliteal bursa always communicate with the joint,

Semimembranosus bursa may communicate with the joint





(A) Sagittal section



(B) Sagittal MRI

Movements

The knee joint allows angulational and rotatory movements, viz:

1.Flex

2.Extend

3.Rotate

Surface anatomy exercise!

Demonstrate this on yourself or on your colleague.

Palpate and outline major muscle groups or muscles that contract during the exercise.

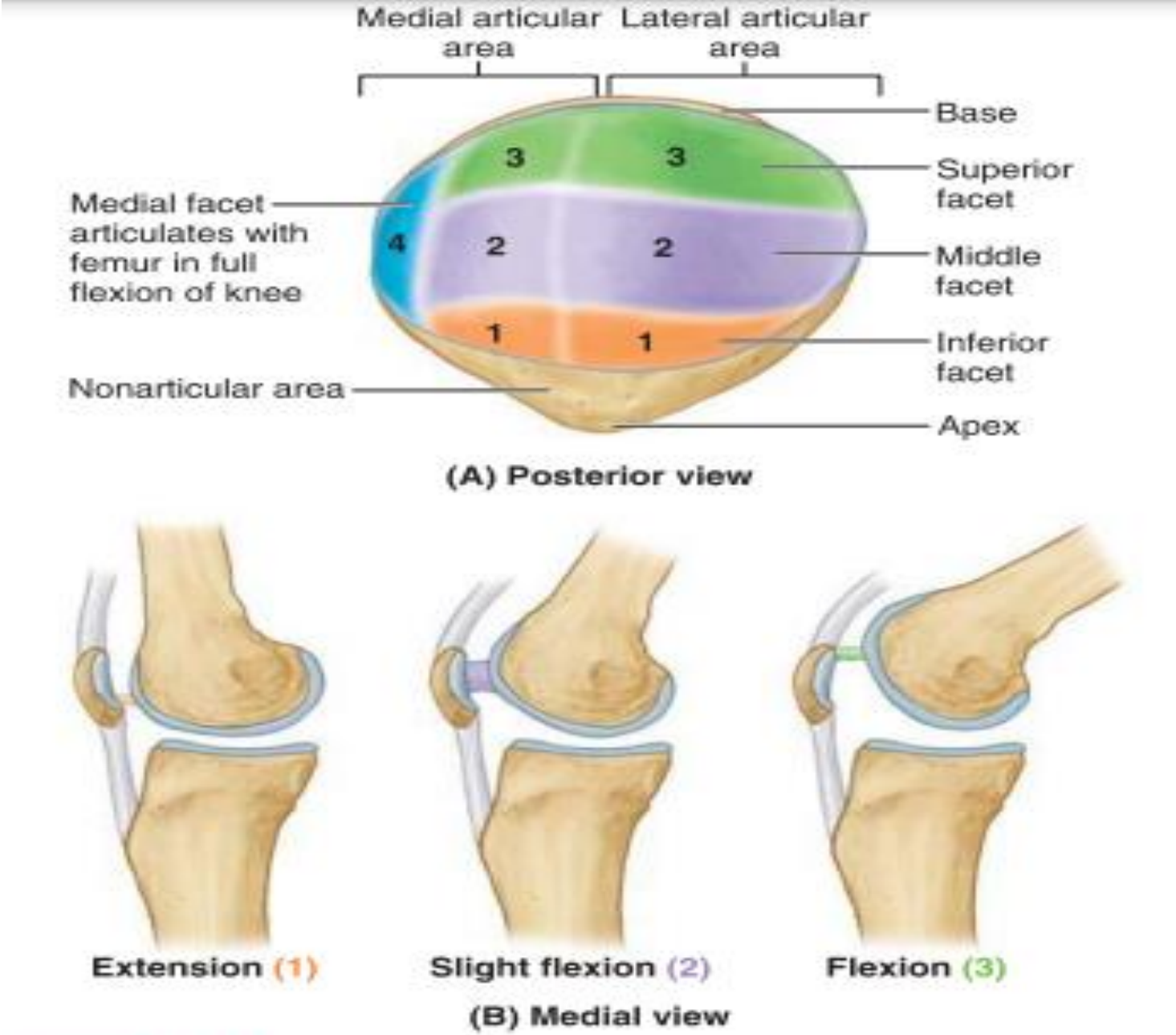


FIGURE 7.54. **Femoropatellar articulation. A.** Articular surfaces of patella. **B.** Articulation of patella with femur during flexion and extension of knee.

Movements and prime movers

Flexion

Biceps femoris, semitendinosus, and semimembranosus assisted by the gracilis, sartorius, and popliteus.

Limited by the contact of the back of the leg with the thigh.

Extension

Quadriceps femoris.

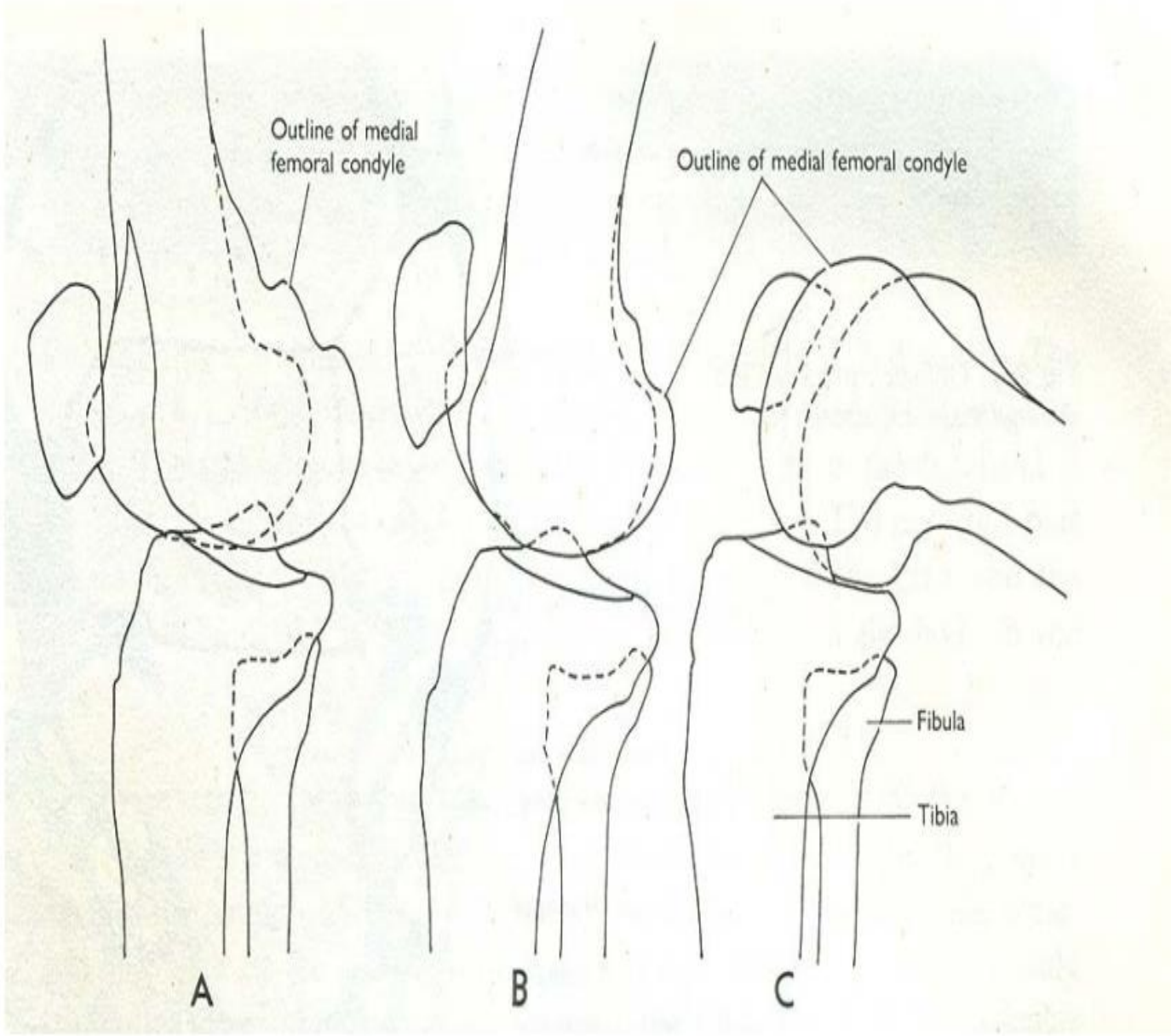
Limited by the tension of major ligaments

Medial Rotation

Sartorius, gracilis, and semitendinosus.

Lateral Rotation

Biceps femoris



‘Locking’ of the knee

Towards full extension, medial rotation of the femur→ in a twisting and tightening of all the major ligaments of the joint→ the knee becomes a mechanically rigid structure and the cartilaginous menisci are compressed like rubber cushions between the femoral and tibial condyles→The extended knee is said to be in the **locked position.**

This is achieved by the action of the **iliotibiotract**

‘Locking’ of the knee

So what?

‘Unlocking’ of the knee

To flex from full extension→

major ligaments must be untwisted and slackened to permit movements between the joint surfaces.

This unlocking or untwisting process is accomplished by the **popliteus muscle**, which laterally rotates the femur on the tibia.

‘Unlocking’ of the knee (cont’d)

Once again the menisci have to adapt their shape to the changing contour of the femoral condyles.

The attachment of the popliteus to the lateral meniscus results in that structure being pulled backward also

Demonstrate this on yourself/colleague--1

When the foot is firmly planted on the ground when a person is standing, the femur is medially rotated on the tibia to lock and stabilize the knee joint.

However, if the foot is raised off the ground, the tibia may be laterally rotated on the femur to lock the knee joint.

Confirm!

Demonstrate this on yourself/colleague---2

When the knee joint is flexed to a right angle, a considerable range of rotation is possible.

In the flexed position, the

tibia can also be moved passively forward and backward on the femur.

This is possible because the major ligaments, especially the cruciate ligaments, are slack in this position. **Confirm!**

Relations

1.**Anteriorly**: The prepatellar bursa

2. **Posteriorly**: The popliteal fossa. *Name boundary(es) and content(s).*

3.**Medially**: Sartorius, gracilis, and semitendinosus muscles

- **Laterally**: Biceps femoris and common peroneal nerve

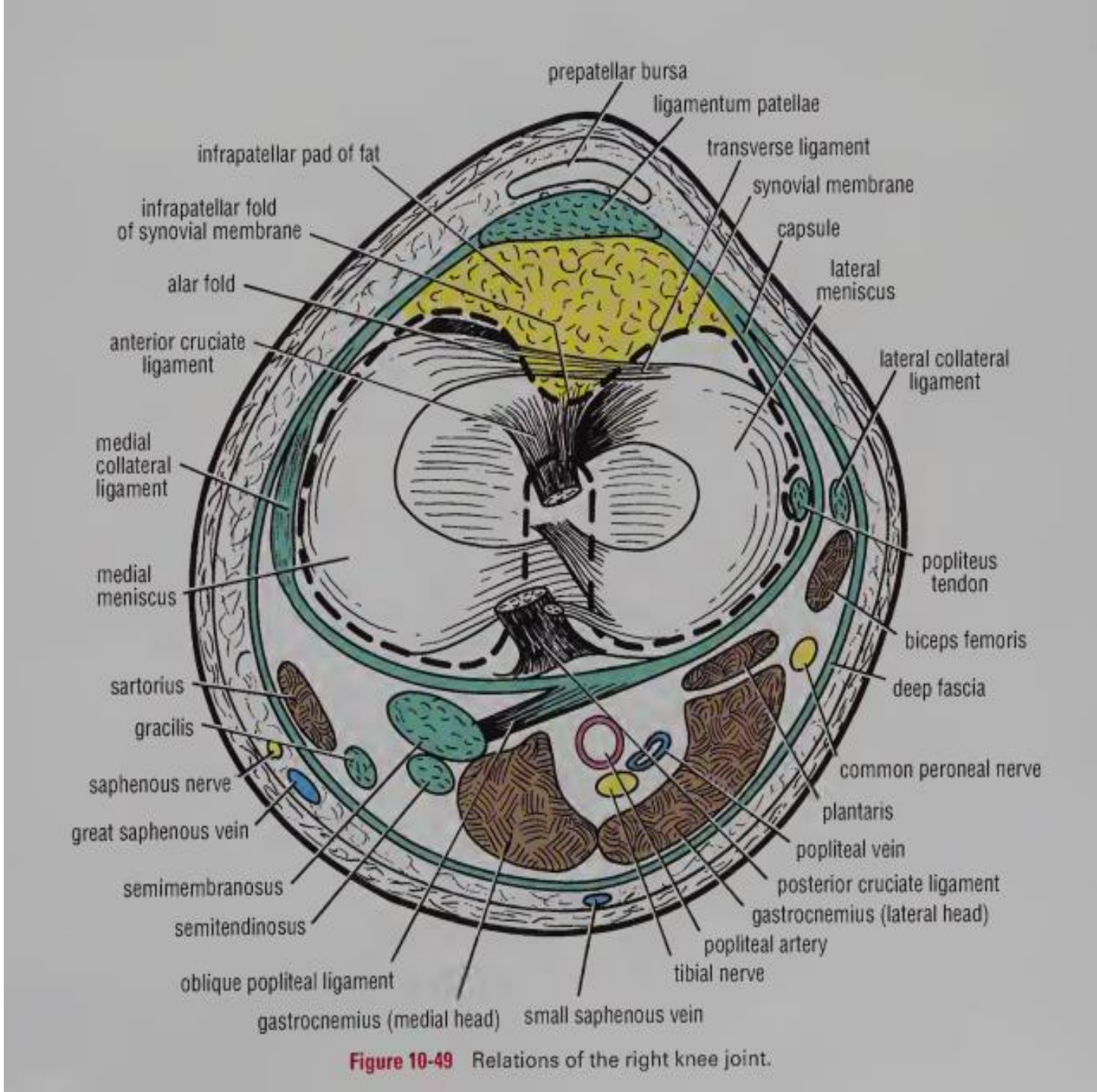


Figure 10-49 Relations of the right knee joint.

Stability of the joint

1. Tone of the strong muscles acting on the joint
2. The strength of the ligaments.

Of these factors, the tone of the muscles is the most important, and it is the job of the physiotherapist to build up the strength of these muscles, especially the quadriceps femoris, after injury to the knee joint.

Stability of the joint

Providing quadriceps femoris is powerfully developed,

the knee will function satisfactorily even in the face of considerable ligamentous damage.

Conversely, the most skilful surgical repair of torn ligaments is doomed to failure unless the muscles are functioning strongly;

without their support, reconstructed ligaments will merely stretch once more.

TABLE 7.15. STRUCTURES LIMITING MOVEMENTS OF KNEE JOINT

Movement	Limiting Structures
Flexion (femoropatellar and femorotibial)	Soft tissue apposition posteriorly Tension of vastus lateralis, medialis, and intermedius Tension of rectus femoris (especially with hip joint extended)
Extension (femoropatellar and femorotibial)	*Ligaments*: anterior cruciate and posterior cruciate, fibular and tibial collateral, posterior joint capsule, and oblique popliteal ligament
Internal rotation (femorotibial with knee flexed)	*Ligaments*: anterior cruciate and posterior cruciate
External rotation (femorotibial with knee flexed)	*Ligaments*: fibular and tibial collateral

NAVaL: Nerves

Articular branches of:

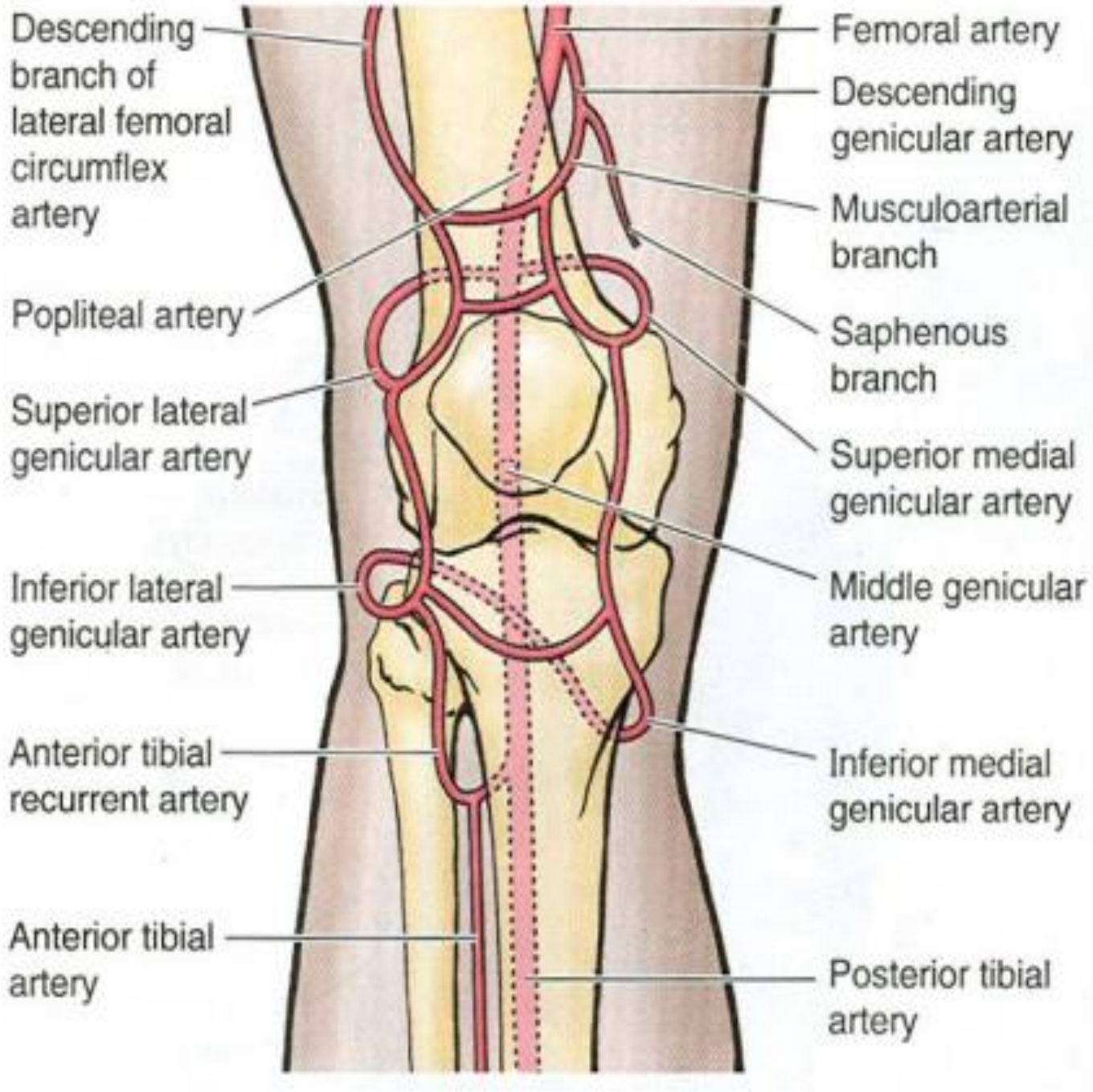
1. Femoral
2. Obturator,
3. Common peroneal
4. Tibial nerves.

At what level do articular branches of each detach?

NAVaL: Arteries

Articular branches from the **genicular anastomosis**. *Outline the anastomosis highlighting its roots and branches and distribution*

The **middle genicular artery** penetrates the oblique popliteal ligament and supplies the cruciate ligaments, synovial membranes of the menisci. *What would follow its rupture?*



NAVaL: Veins

Trace the reverse of arteries.

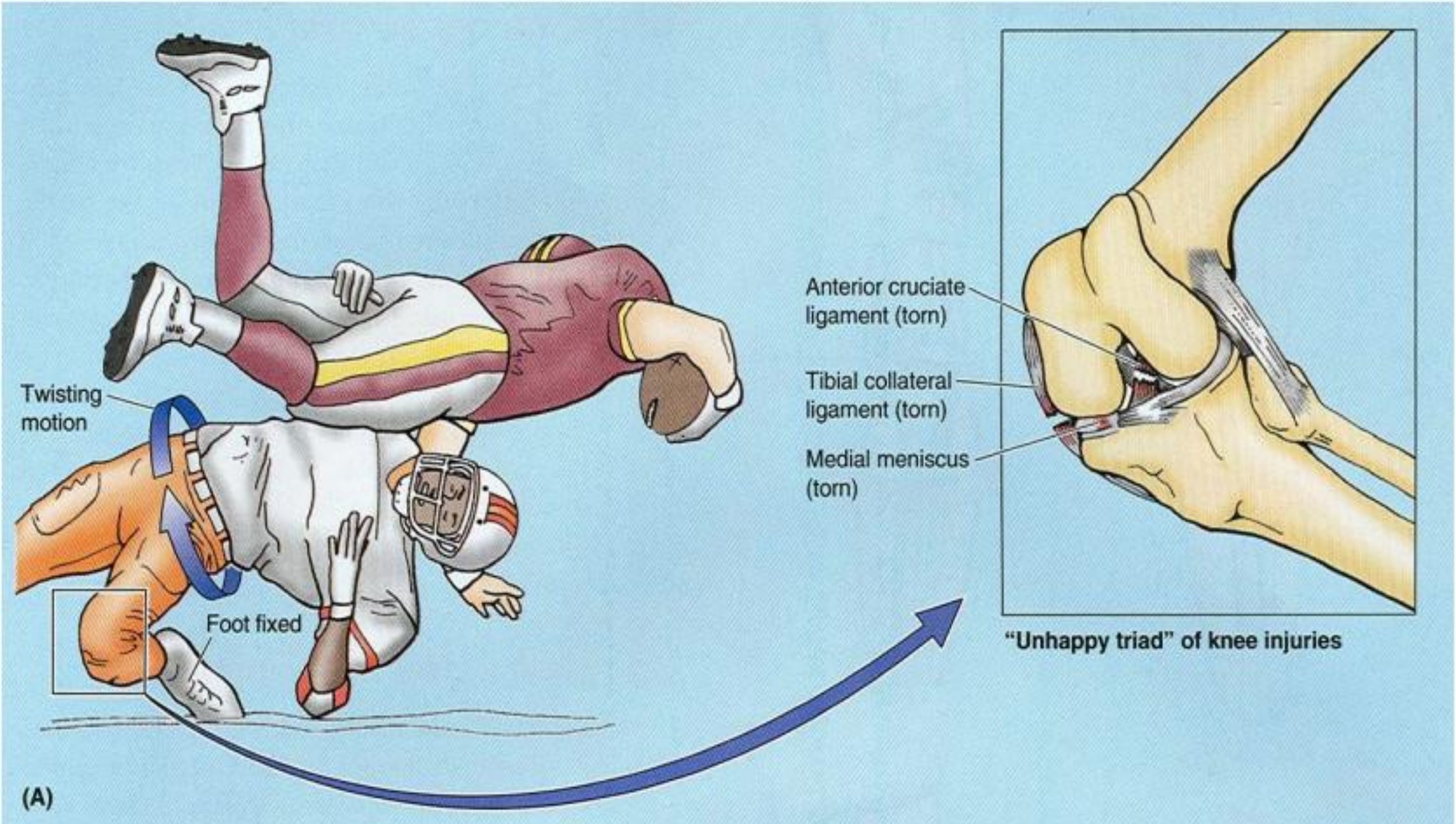
List small named genicular veins that drain into:

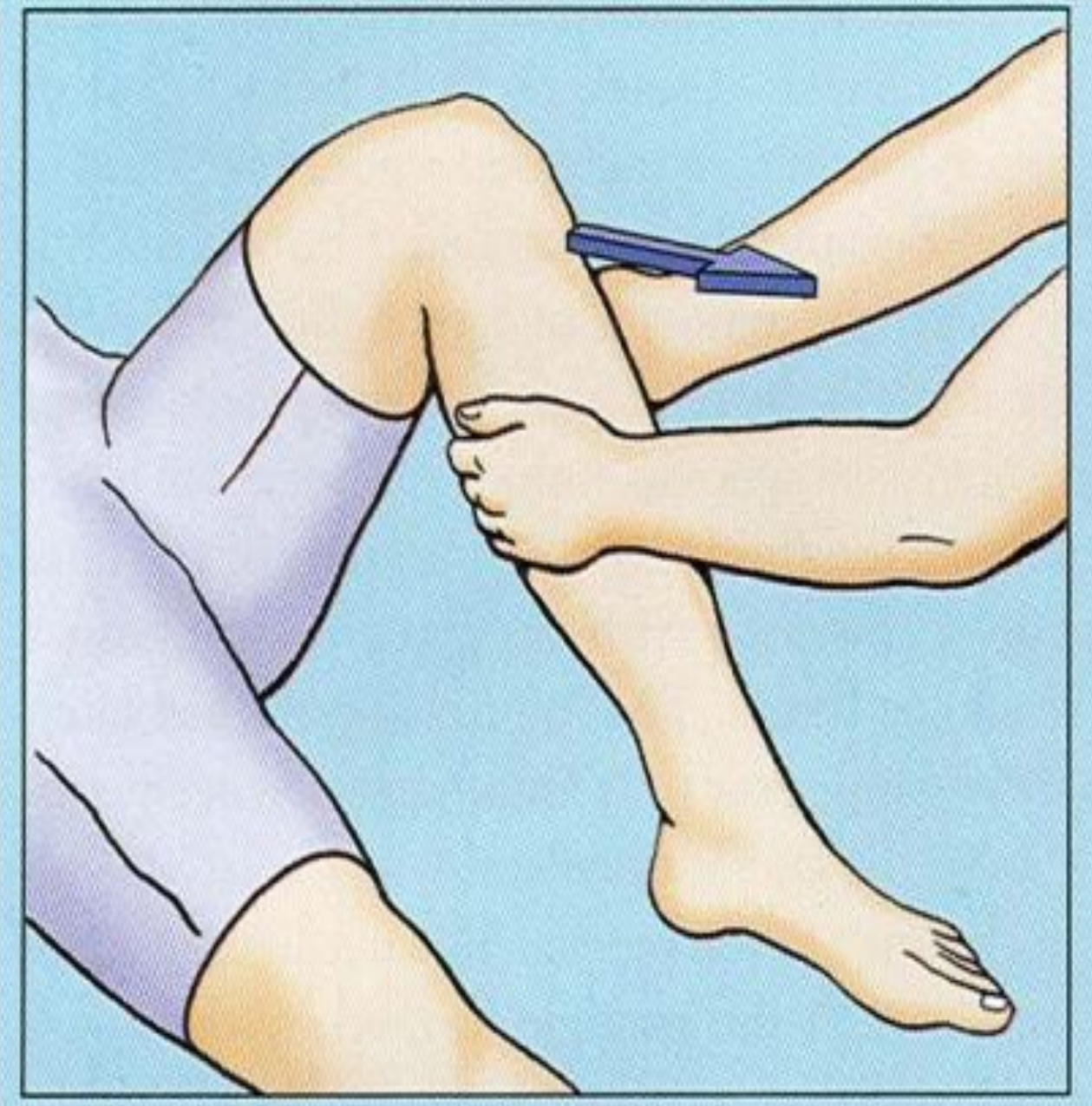
1. Femoral vein
2. Popliteal vein

NAVaL: Lymphatics

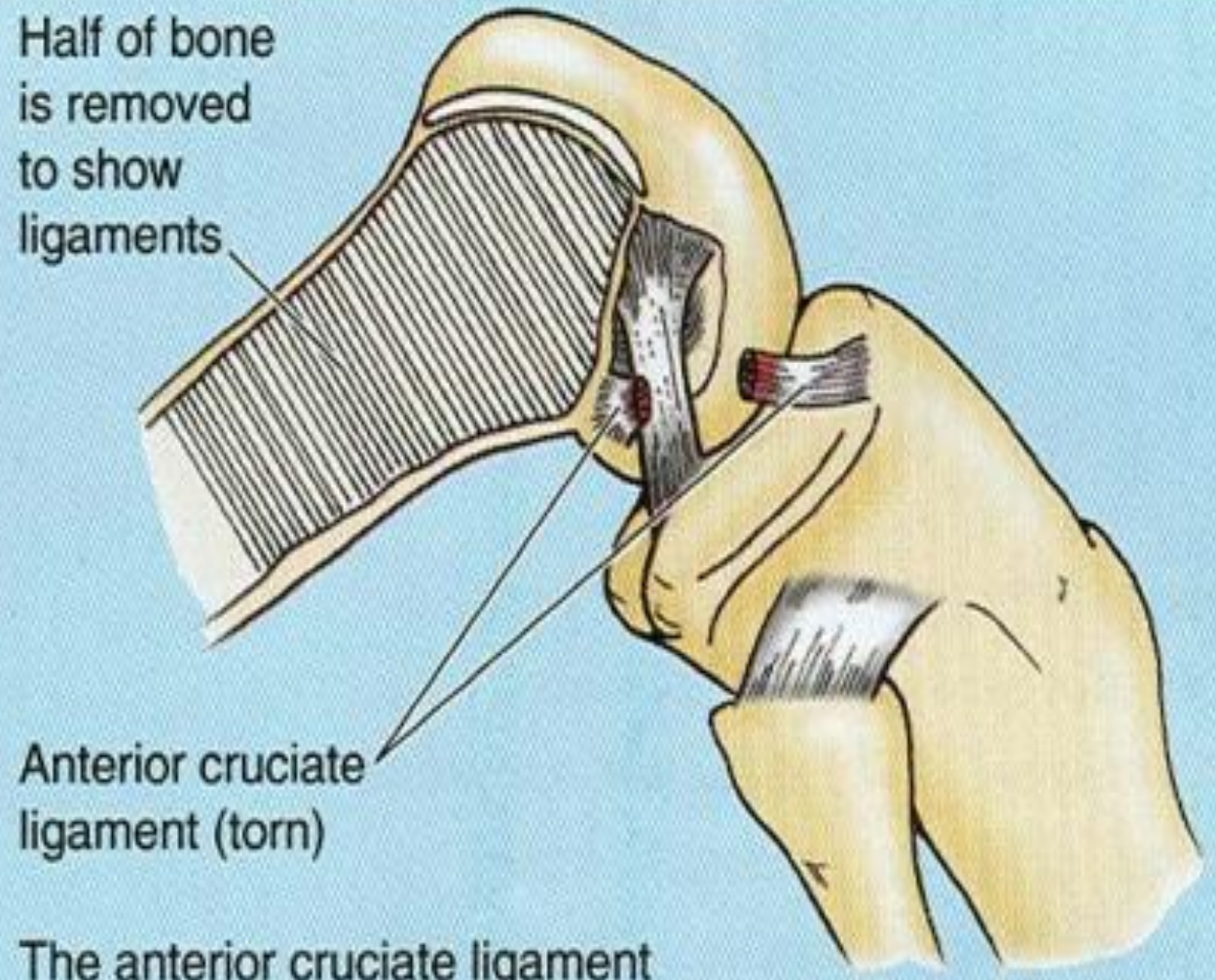
Accompany arteries.

Predominantly accompany popliteal artery to **popliteal lymph nodes.**

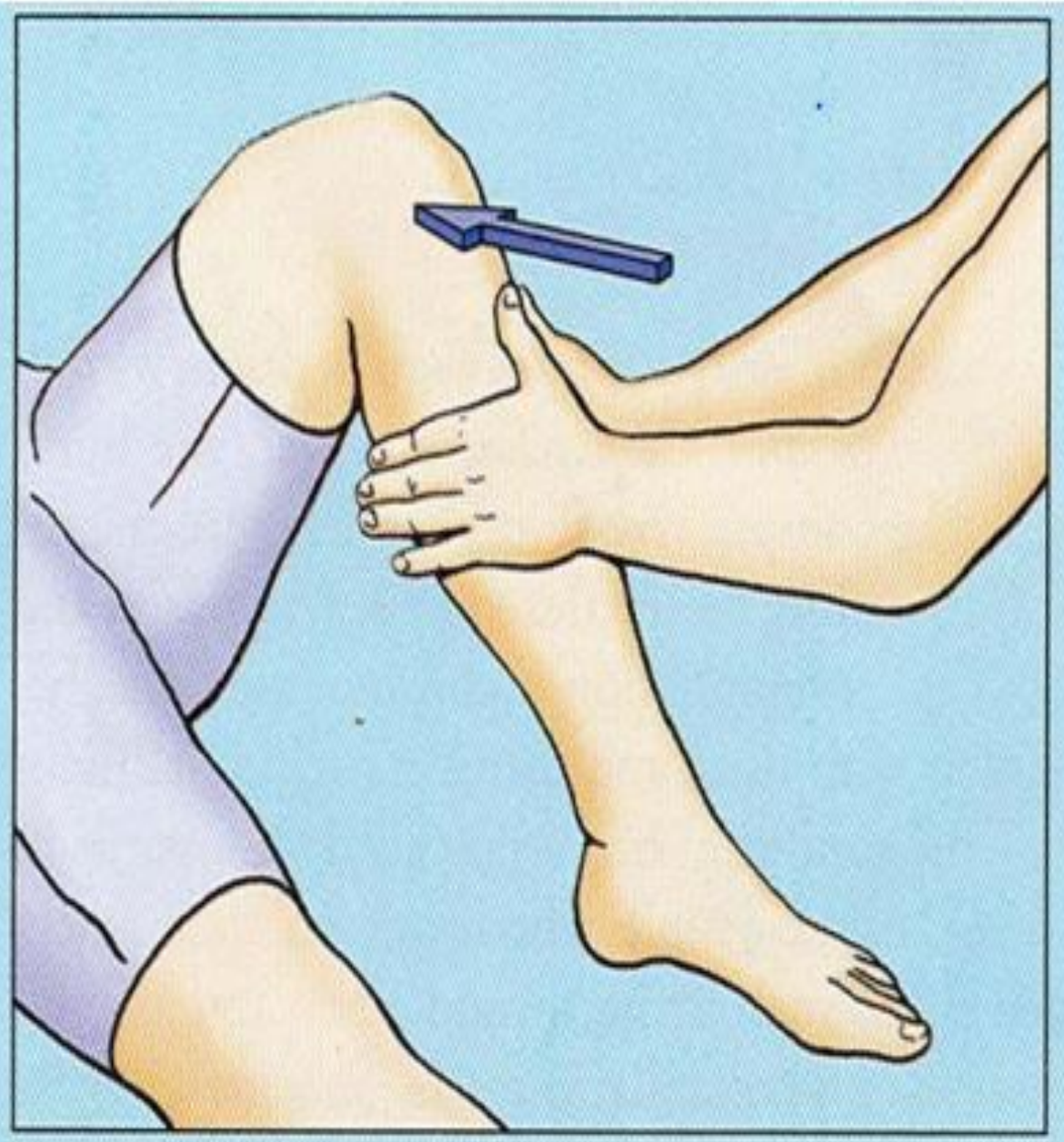

Twisting motion
Foot fixed
(A)
Anterior cruciate ligament (torn)
Tibial collateral ligament (torn)
Medial meniscus (torn)
"Unhappy triad" of knee injuries



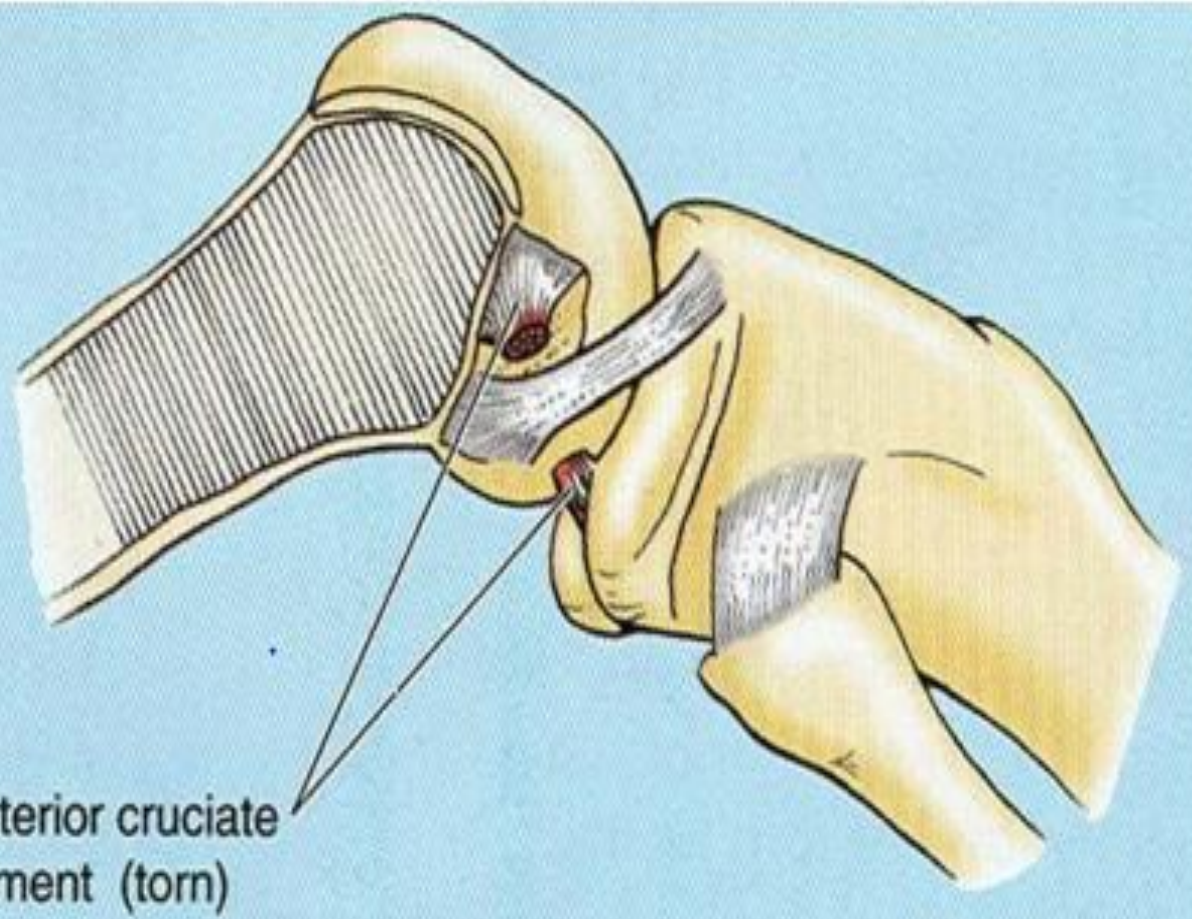
(B) Anterior drawer sign (ACL)



The anterior cruciate ligament prevents the femur from sliding posteriorly on the tibia and hyperextension of the knee and limits medial rotation of the femur when the foot is on the ground, and the leg is flexed.



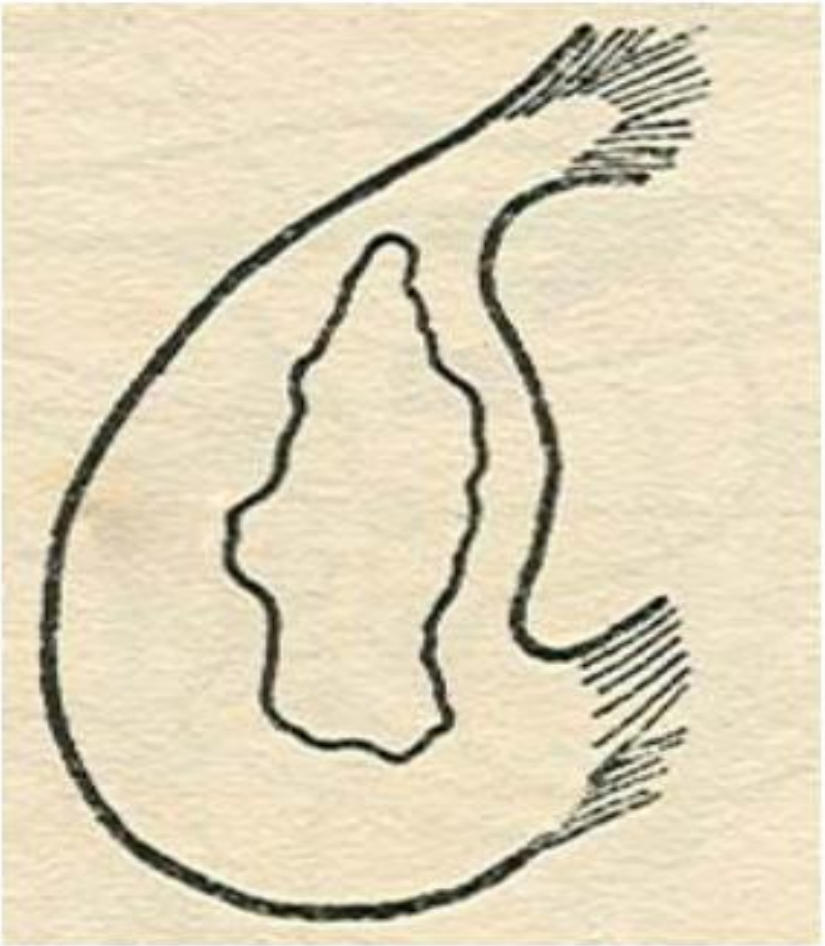
(C) Posterior drawer sign (PCL)

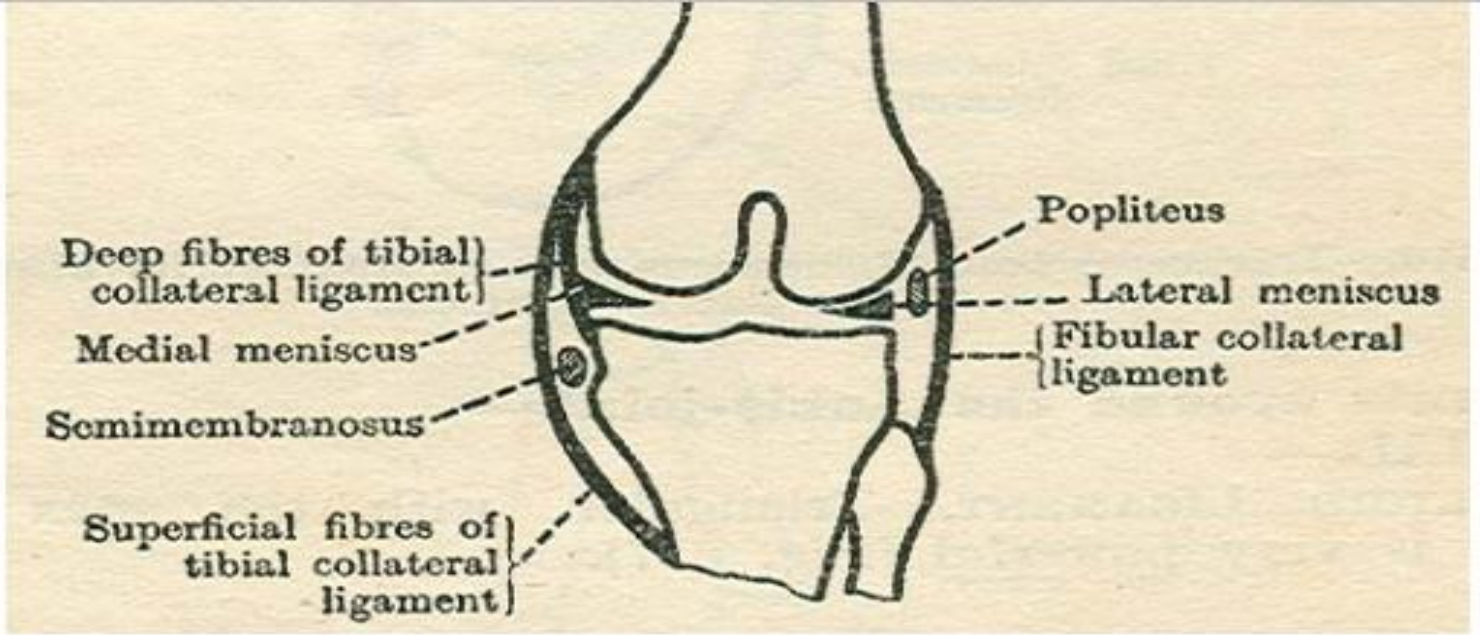


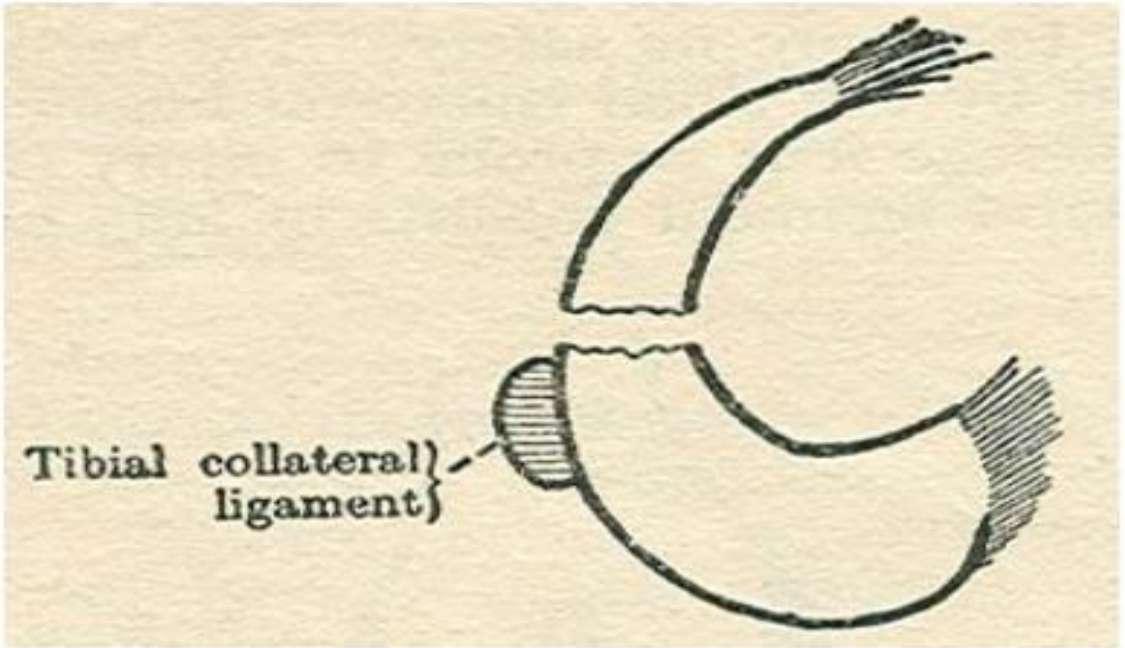
Posterior cruciate ligament (torn)

The posterior cruciate ligament prevents the femur from sliding anteriorly on the tibia, particularly when the knee is flexed.

- Meniscal tears:







- Bursitis

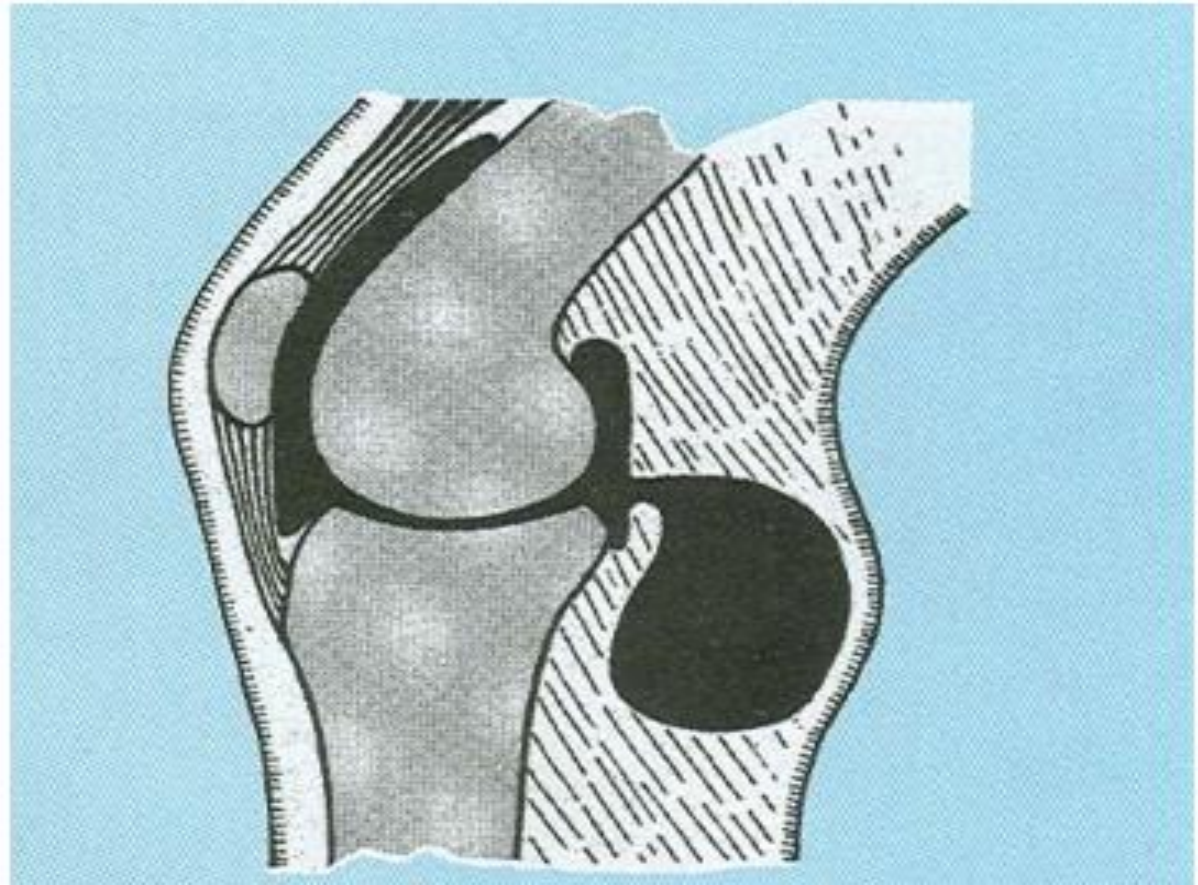
  Housemaid's knee (prepatellar)

  Clergyman's knee (subcutaneous infrapatellar)

  Deep infrapatellar

  Suprapatellar

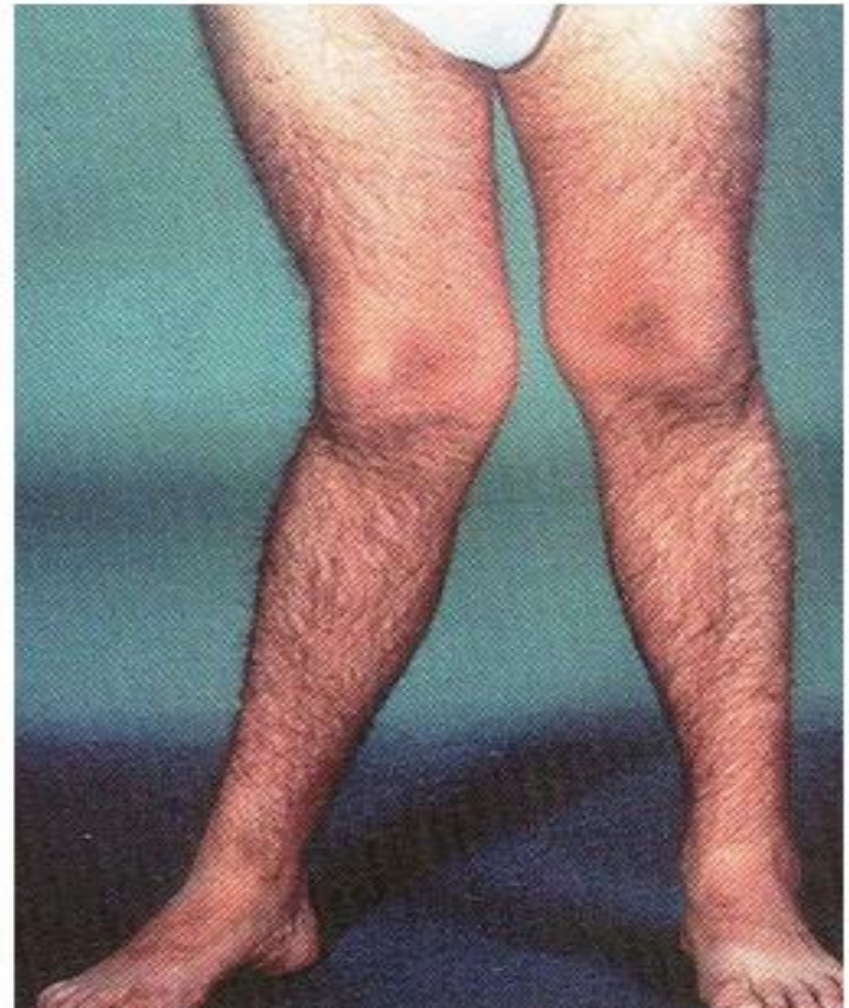
  Popliteal cysts

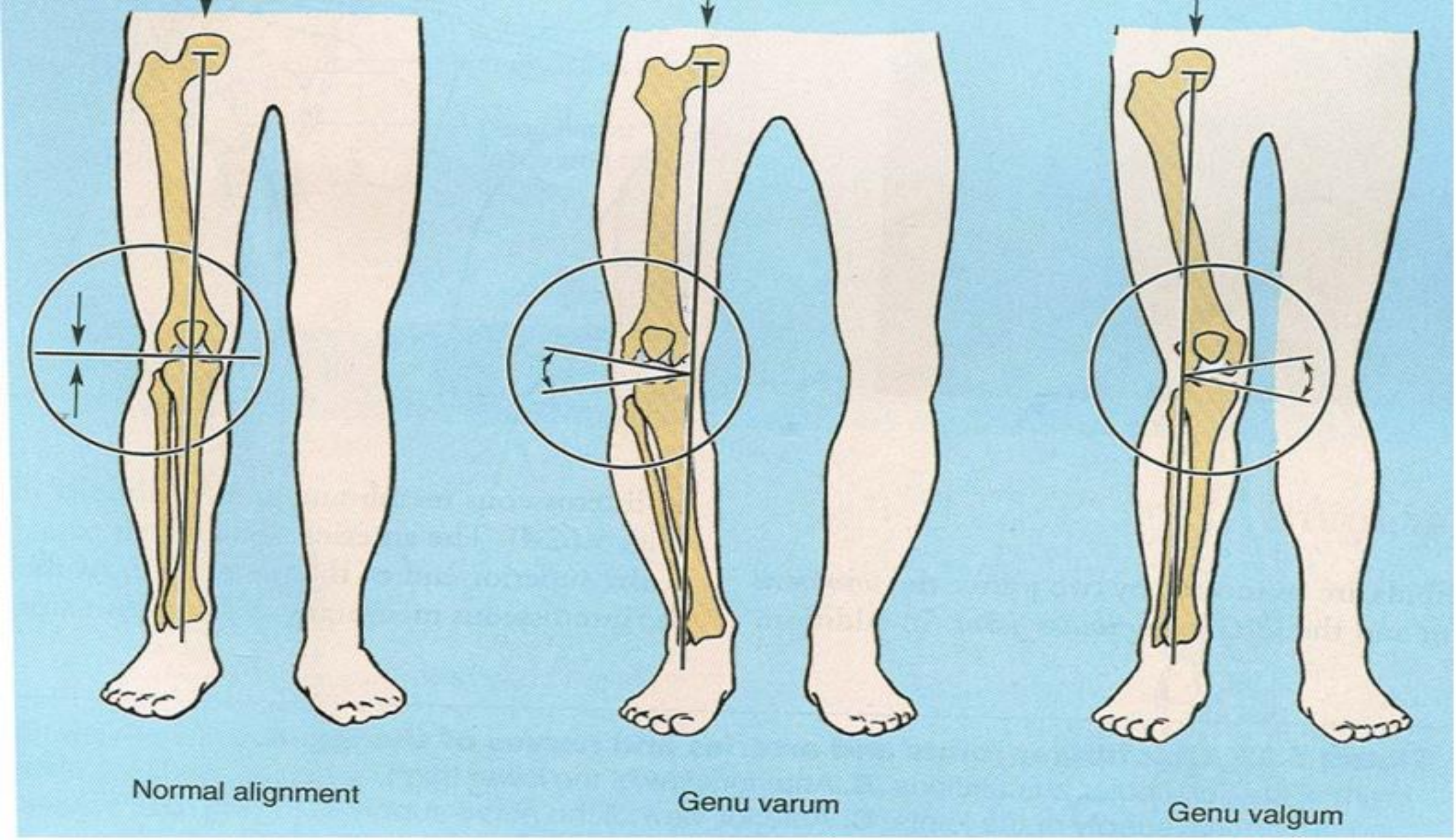


- Deformities

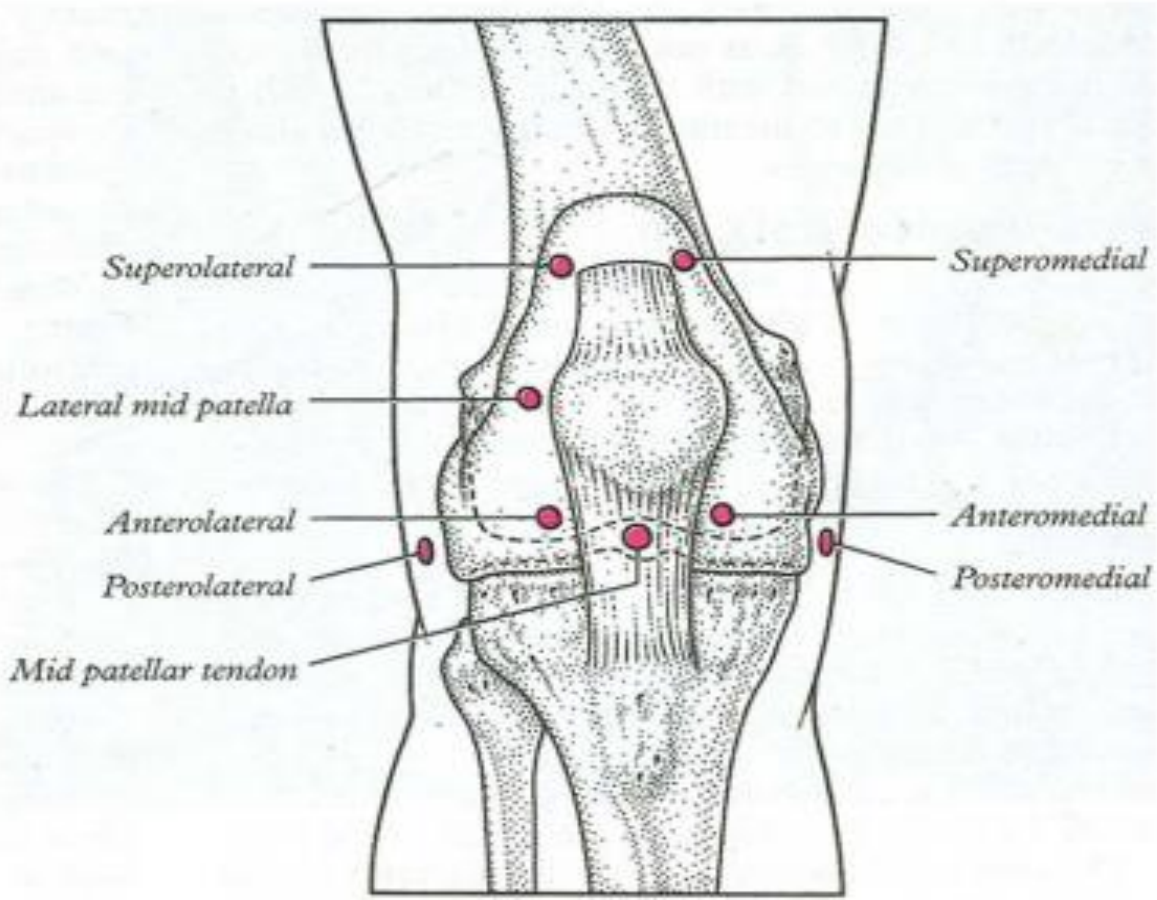
  Genu varum (adduction deformity)

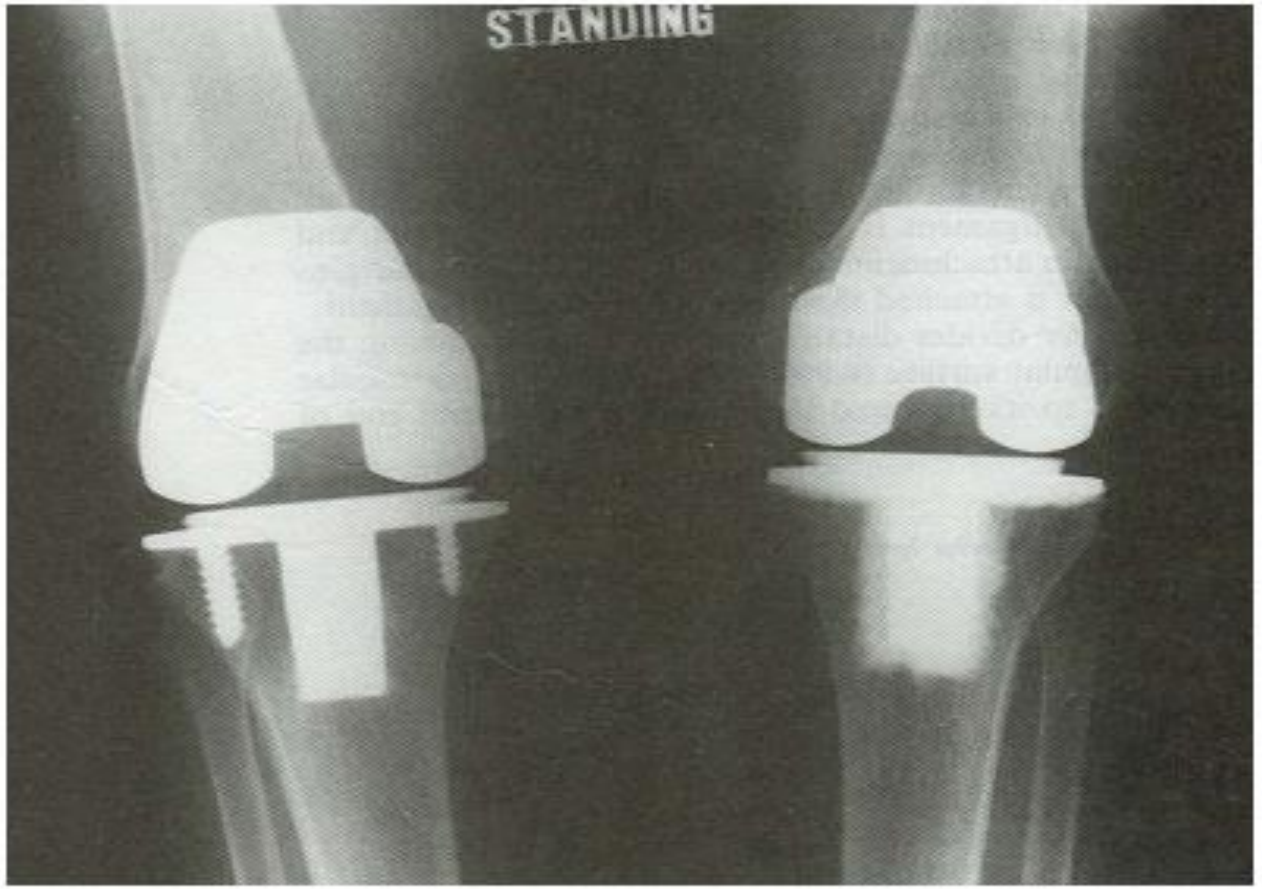
  Genu valgum (abduction deformity)




Normal alignment
Genu varum
Genu valgum

- Aspiration
- Arthroscopy
- Replacements





The learner should also read:

BD Chauarasia’s Human Anatomy

Thank you for your attention