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## *The Knee*

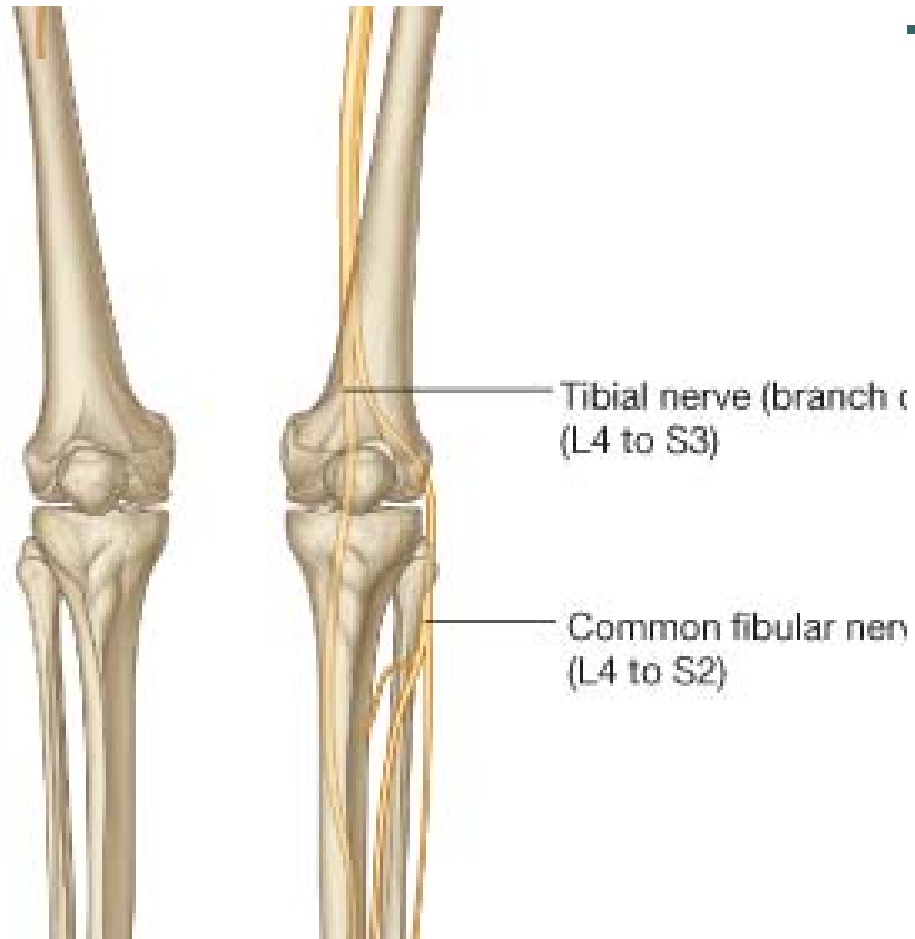
Tibio-Femoral

# Osteology

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- Distal Femur with Proximal Tibia
- Largest Joint Cavity in the Body
- A modified hinge joint with significant passive rotation
- Technically, one degree of freedom (Flexion/Extension) but passive rotary component is essential
- Unites the two longest levers in the body

# Tibio-Femoral



## Support

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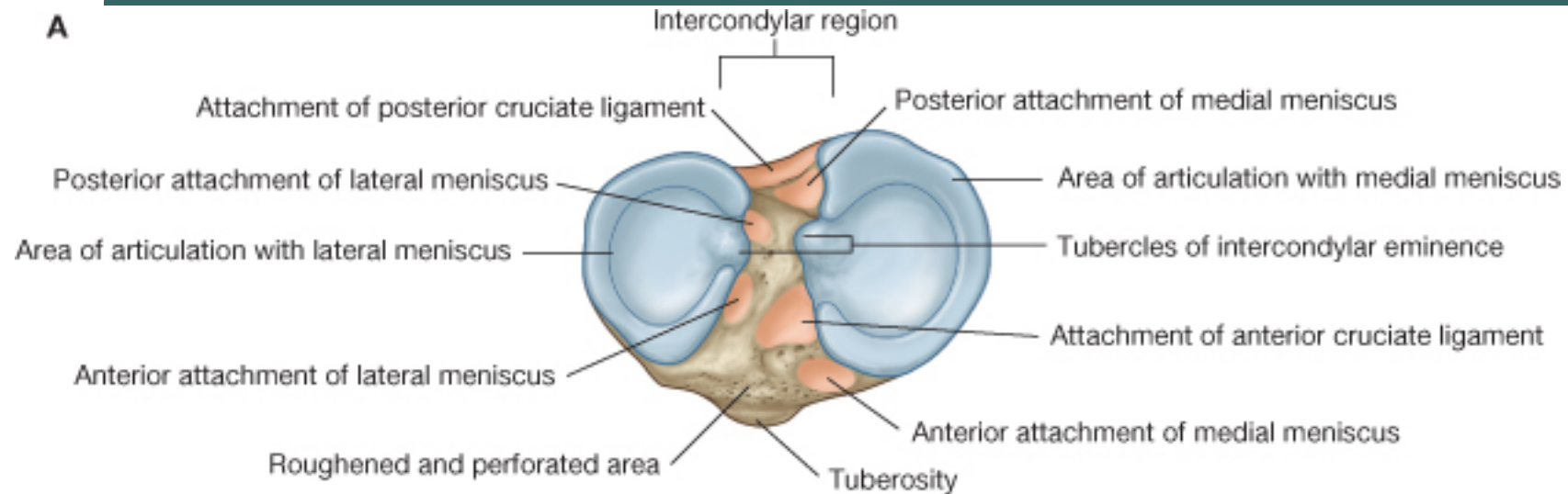
- Knee supports the weight of the body and transmits forces from the ground
- Functional stability of the joint is derived from the passive restraint of the ligaments, the active support of muscles, the joint geometry, and the compressive forces pushing the bones together

# Menisci

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- The surface of the tibia is covered by fibrocartilaginous menisci - They:
  - Enhance the joint stability by deepening the contact surface
  - They help with shock absorption by transmitting  $\frac{1}{2}$  of weight bearing load in full extension and some in flexion as well
  - They protect the articular cartilage
  - They transmit the load across the surface of the joint, thus reducing the load per unit area on the tibio-femoral contact sites. The contact area in the joint is reduced 50% when the menisci are absent

# Menisci



# Menisci

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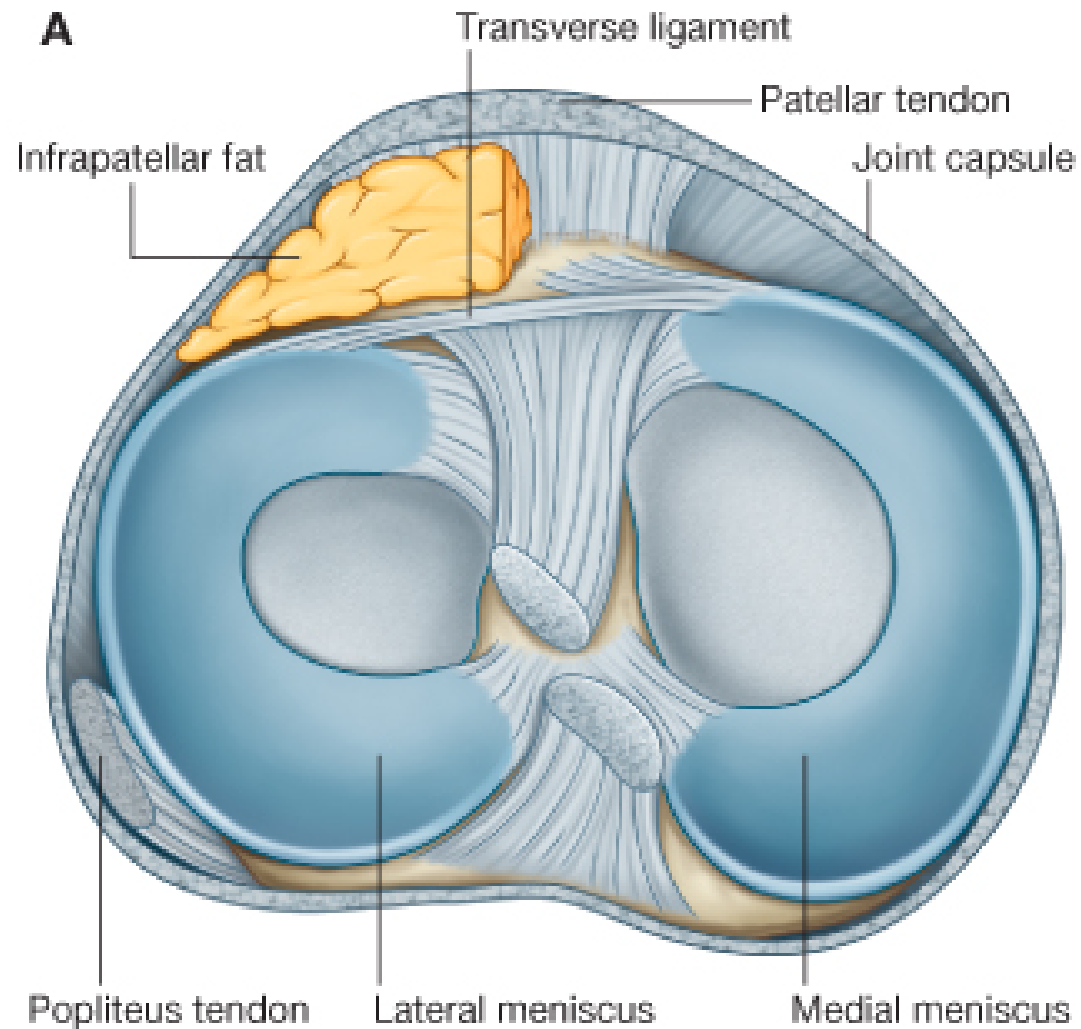
- In hi load situations, 70% of the load is absorbed by the menisci, especially the lateral meniscus
- The menisci assist in lubrication of the joint by acting as a space filling mechanism, more fluid is dispersed to the surface of tibia and femur
- 20% increase in friction following meniscal removal
- Medial Meniscus – larger, reflects the shape of medial tibial condyle A + P horns – attached to medial collateral ligament and basically immobile
- Lateral Meniscus – smaller, tighter, almost a complete circle A+ P horns – NOT attached to lateral collateral ligament

# Menisci

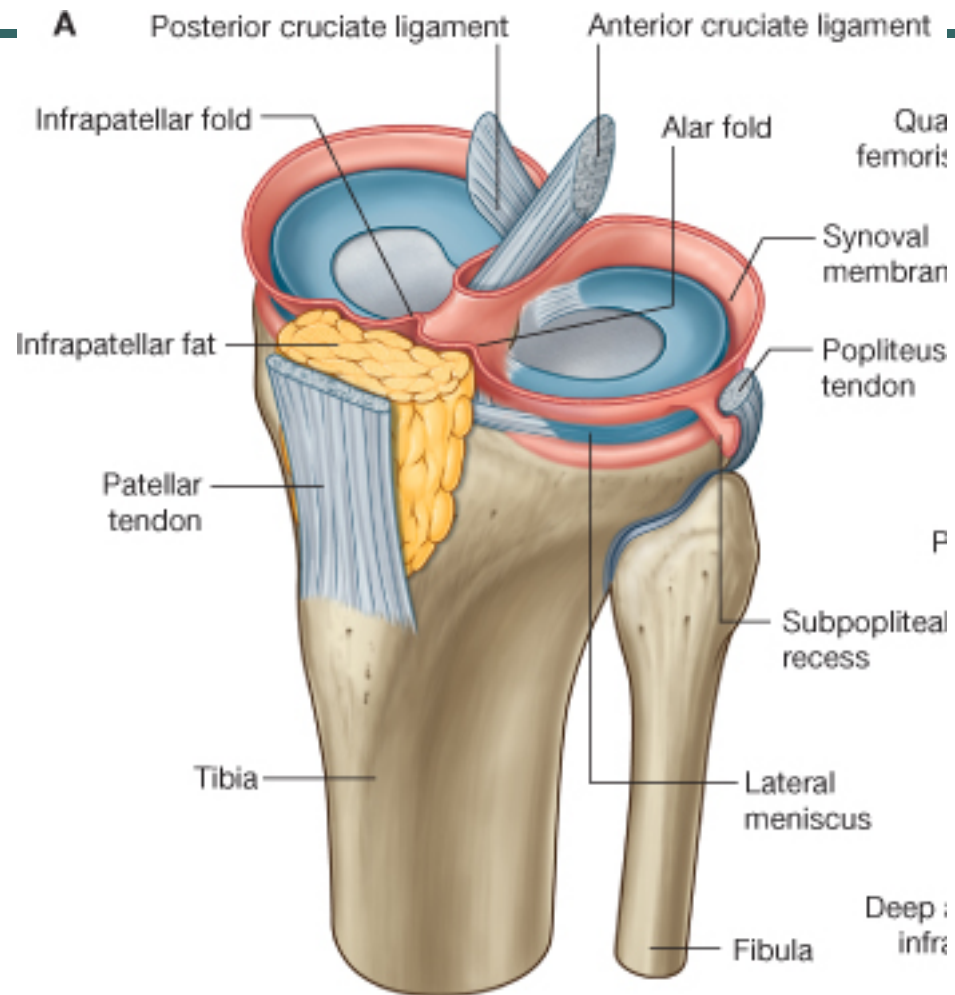
- Attached via:
  - **Transverse ligament** anteriorly
  - Fibrous bands connecting the anterior horns of both menisci to the medial and lateral retinaculum sometimes called the **meniscopatellar** fibers or ligaments
  - The medial collateral ligament attaches to the medial meniscus
  - The tendon of semimembranosis sends fibers to the posterior edge of medial meniscus
  - The popliteus muscle sends fibers to the lateral meniscus
  - The **meniscomfemoral** ligament extends from the lateral meniscus (post) to the inside of the medial condyle near the PCL
  - The **coronary** ligaments – AKA **meniscotibial**

# Menisci

**A**

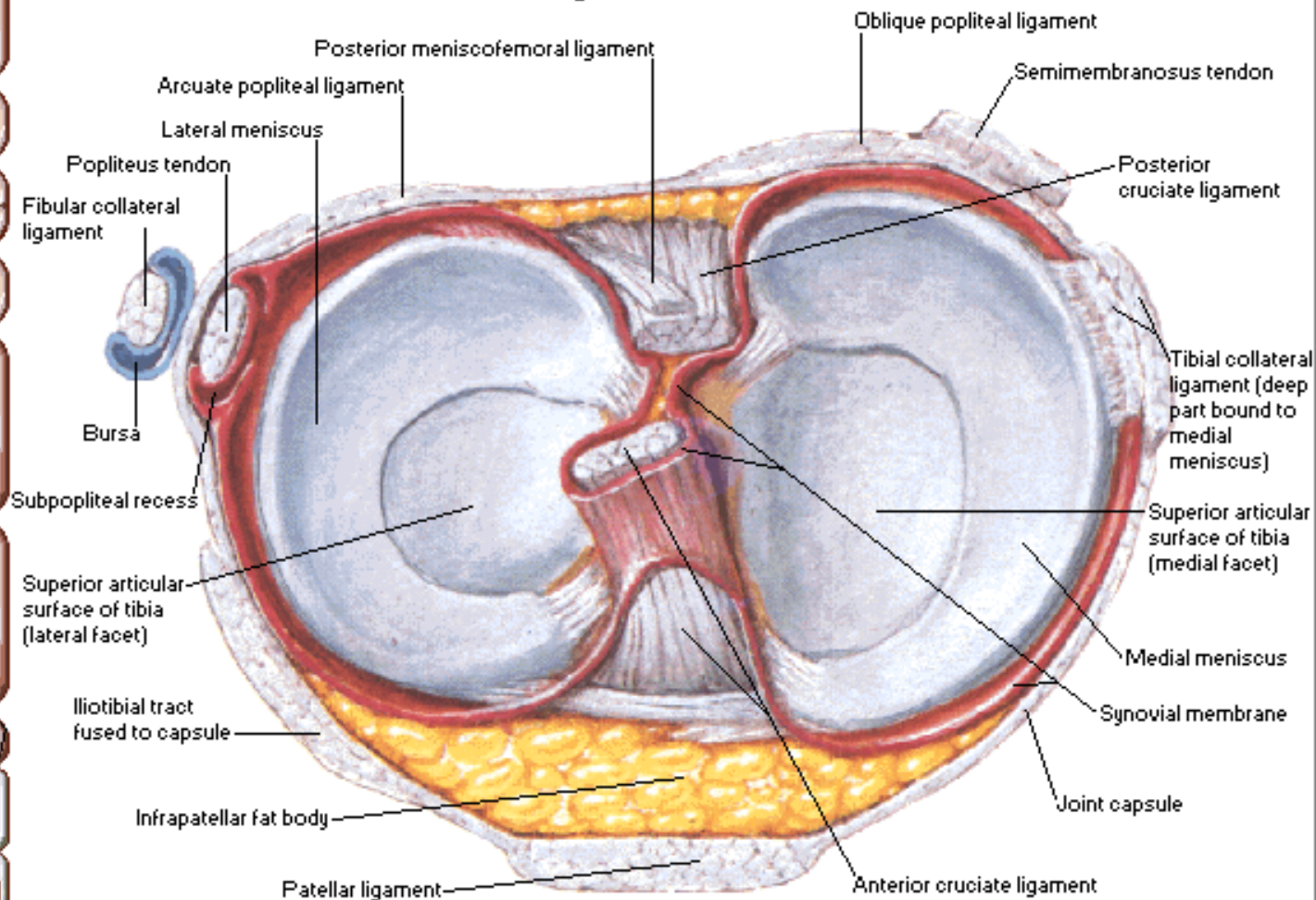


# Menisci



# Meniscal Attachments

## Knee - Interior Superior View



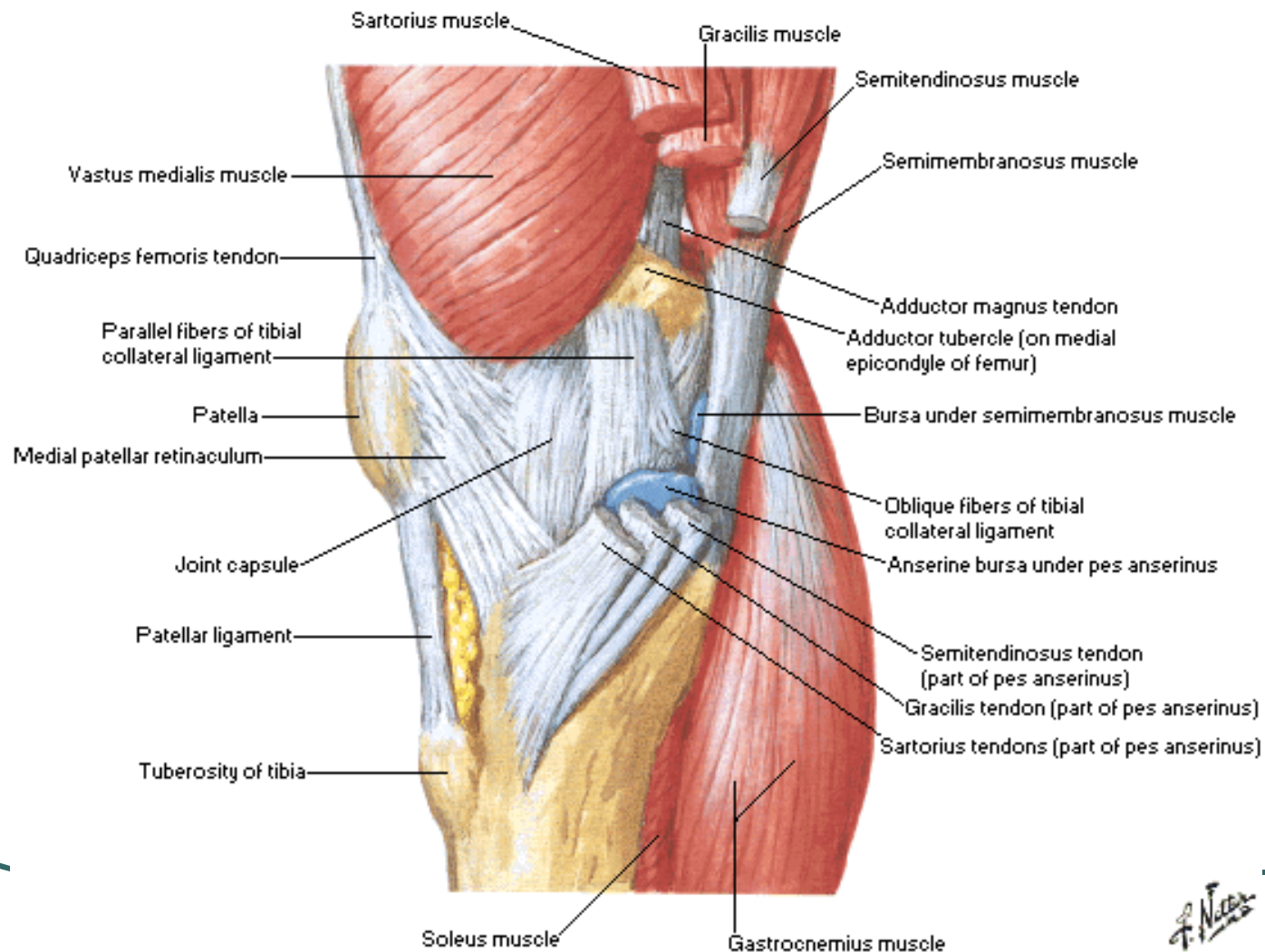
# Coronary Ligaments

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# Patellomeniscal Ligament

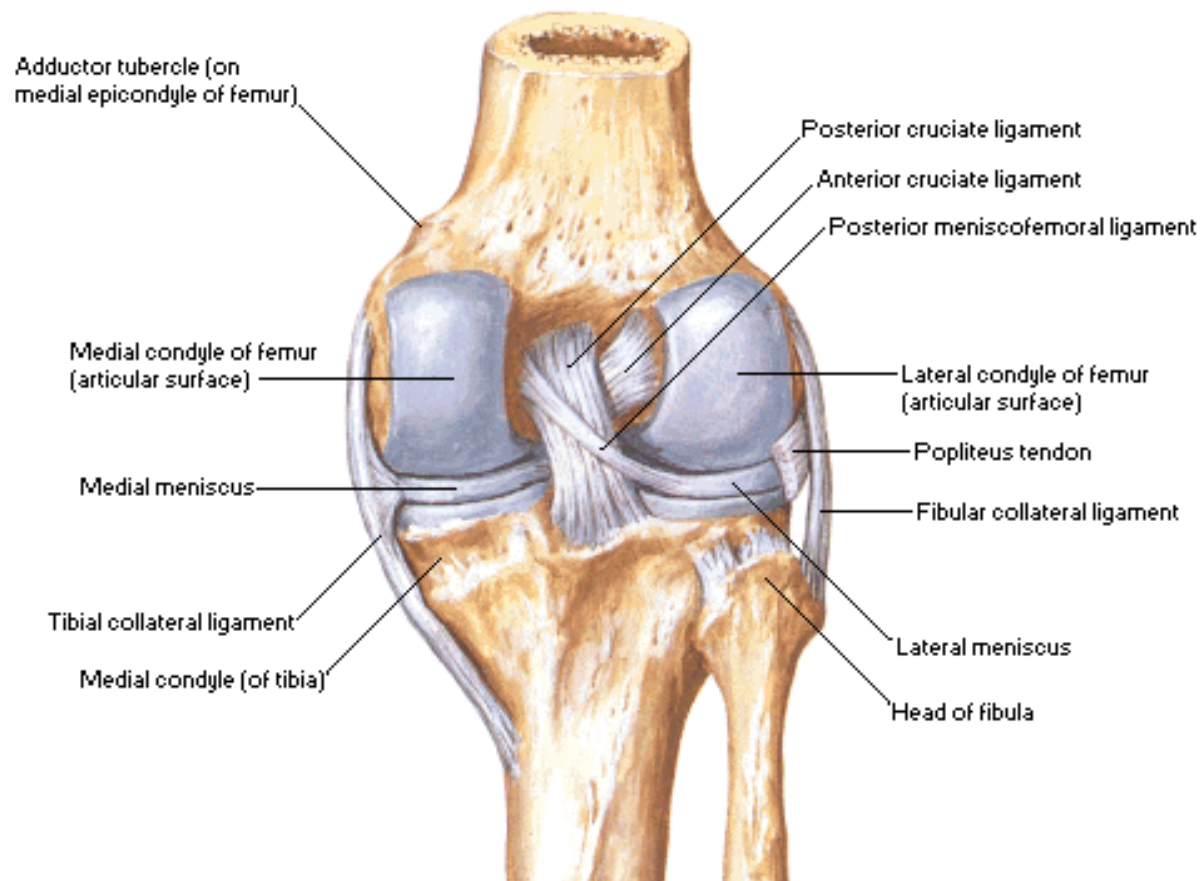
## Knee Medial View



# Menisci

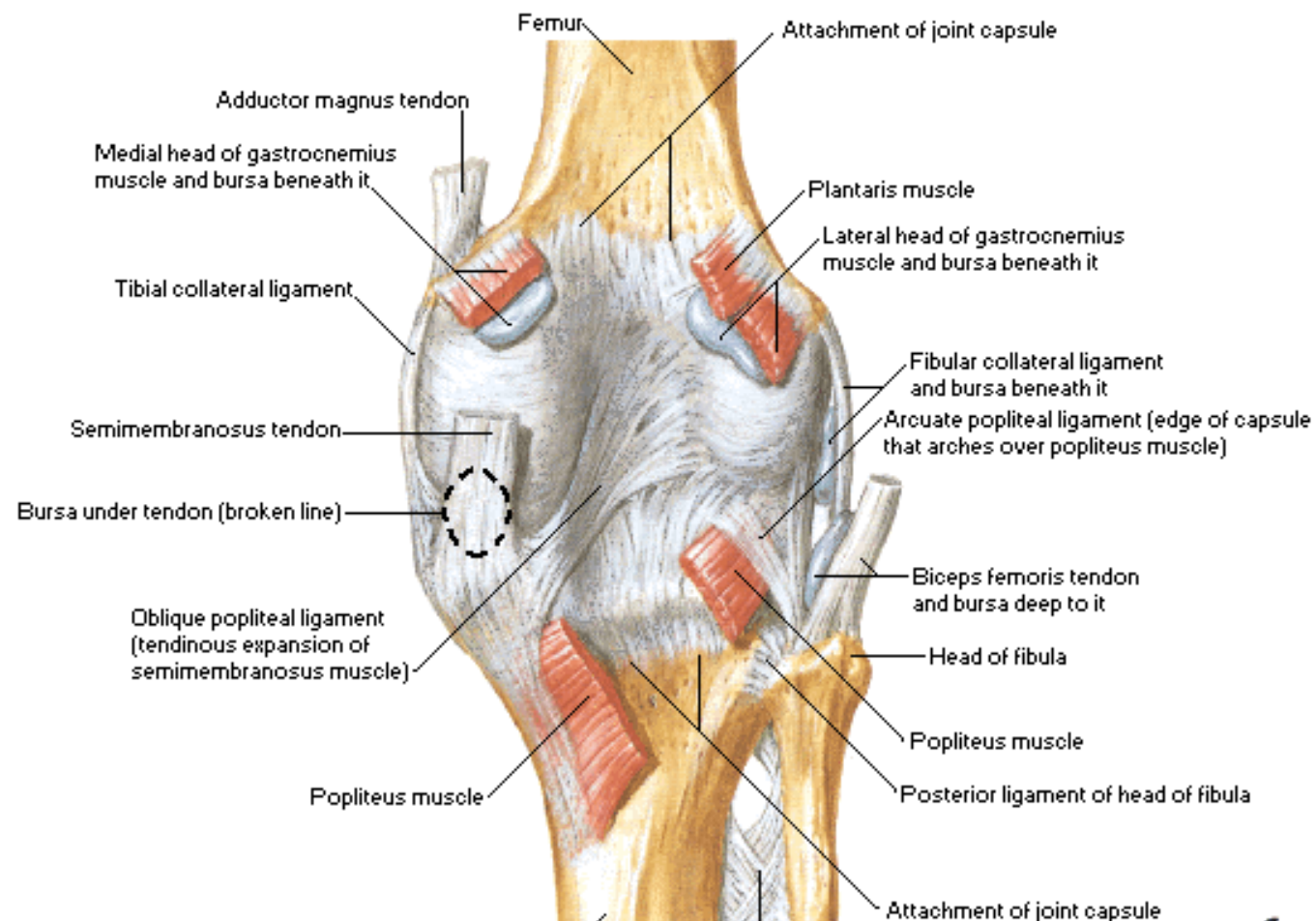
## Knee - Cruciate and Collateral Ligaments

Right Knee in Extension



# Menisci

## Knee Posterior View



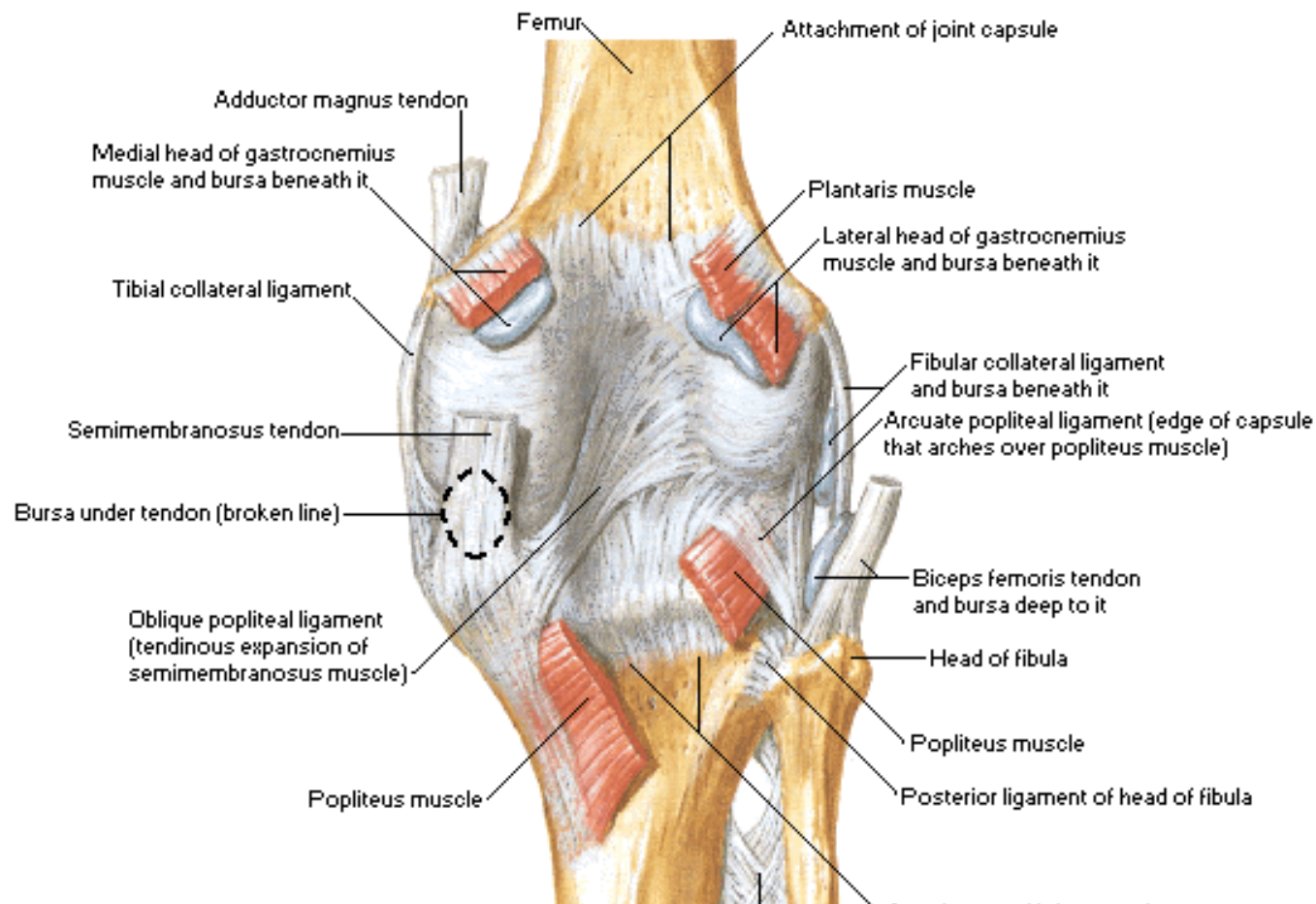
# Joint Capsule

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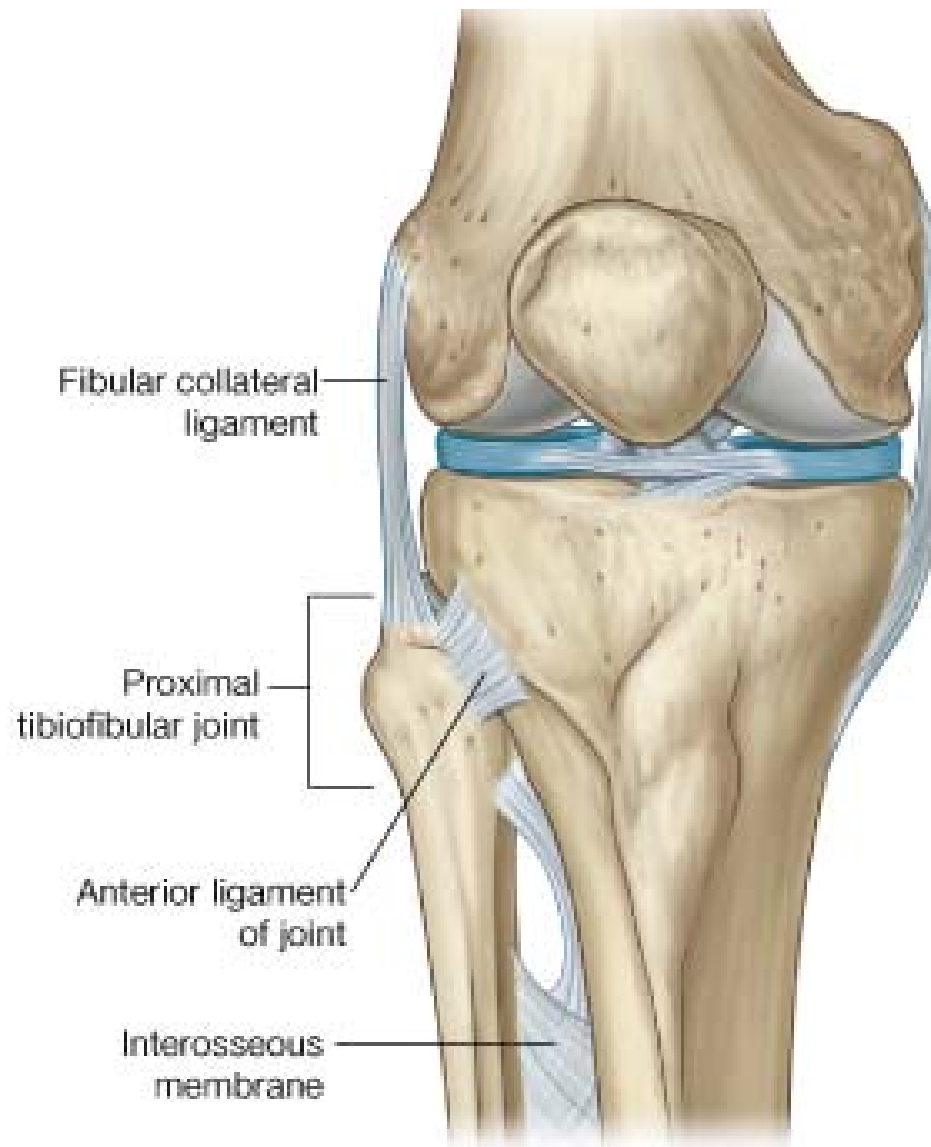
- Largest in body
- Surrounds entire joint, except anteriorly
- Originally (in utero) is three capsule that merge into one
- MCL – flat band, attached above medial condyle of the femur and below to the medial surface of the shaft of the tibia – resists lateral displacement
- LCL – cordlike, attached above the lateral condyle of femur and below the head of the fibula – resists medial displacement

# Capsule

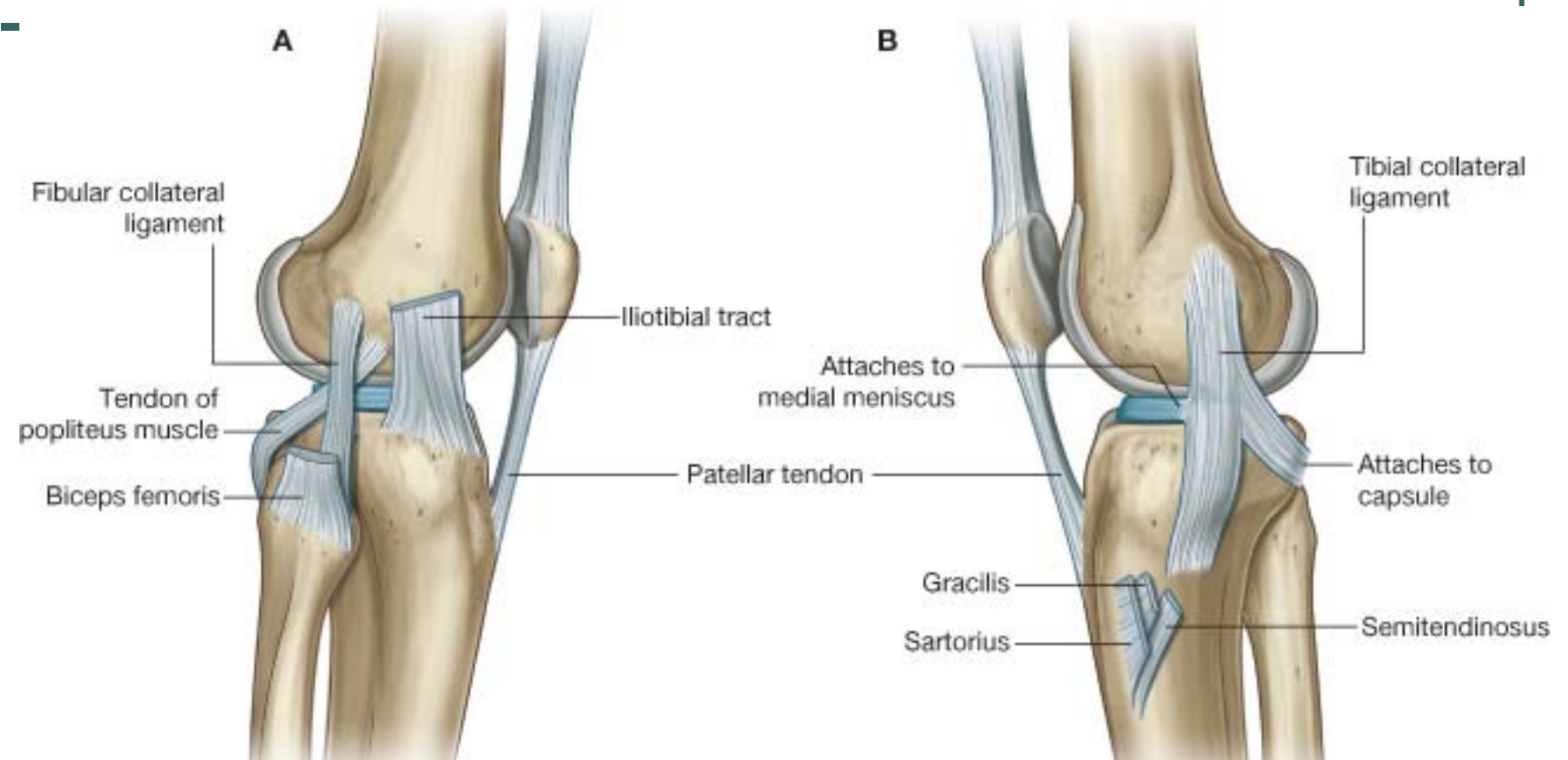
## Knee Posterior View



# Collaterals



# Collaterals

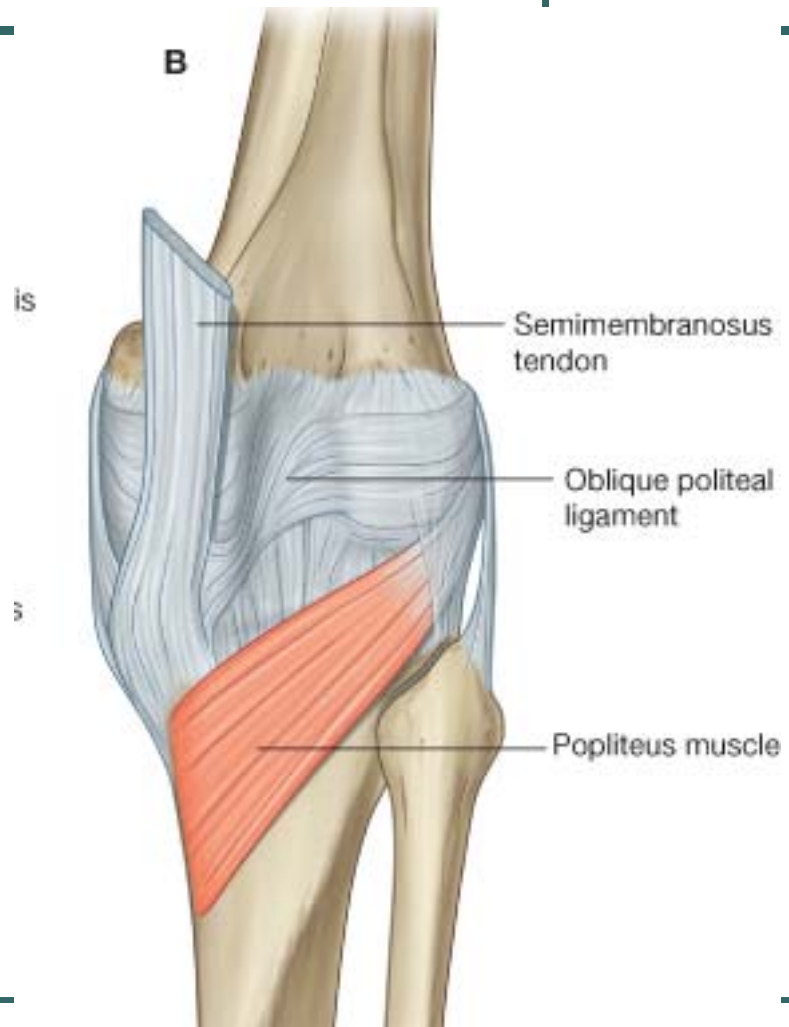


## Capsule

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- Oblique Popliteal – derived from semimembranosus on posterior aspect of the capsule, runs from that tendon to medial aspect of the lateral femoral condyle (posteriorly)
- Arcuate popliteal from head of fibula, runs over the popliteus muscle to attach into posterior joint capsule

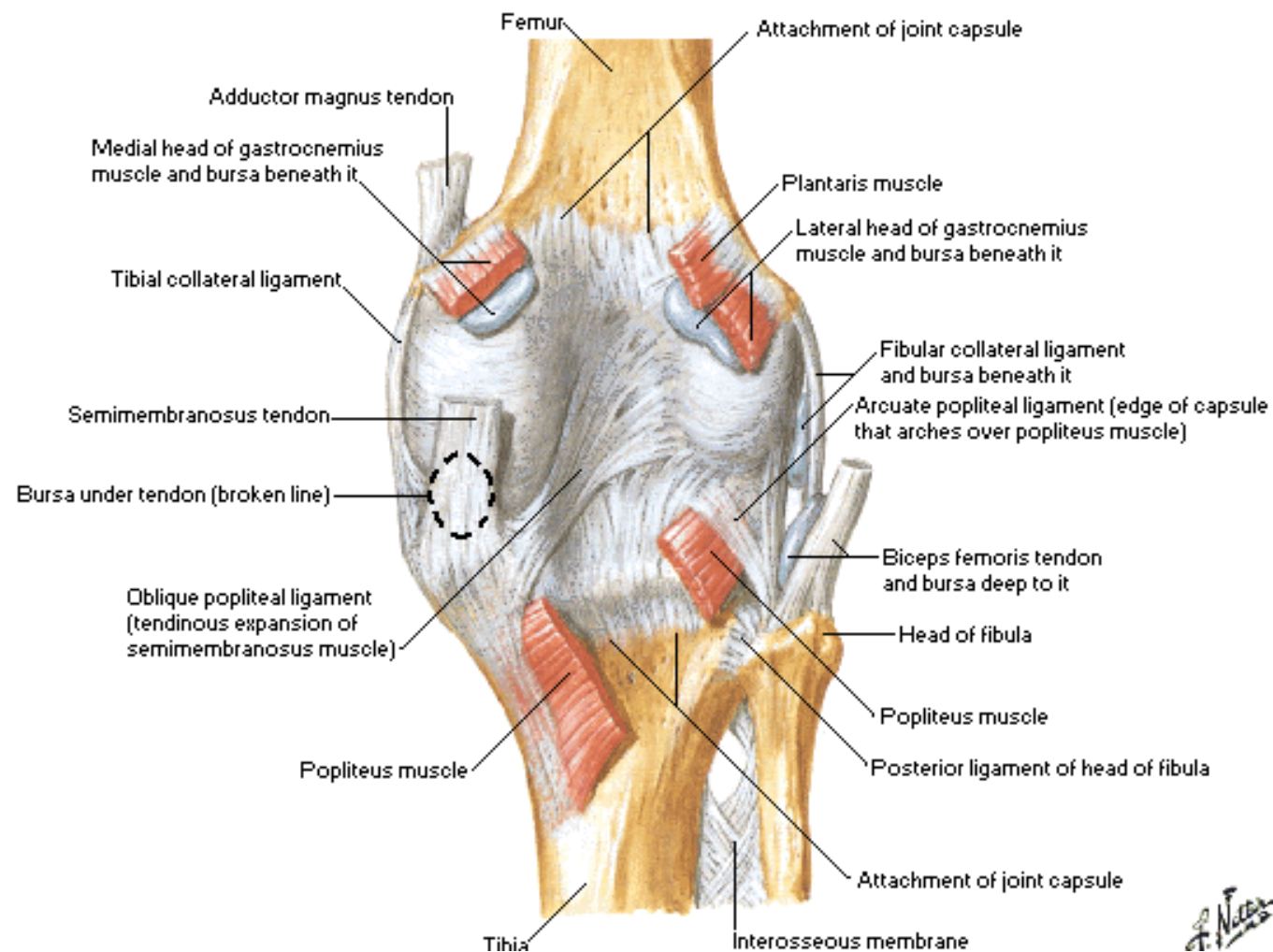
# Posterior Capsule



# Posterior Capsule

## Knee

### Posterior View



*A. Netter*

# Little Guys

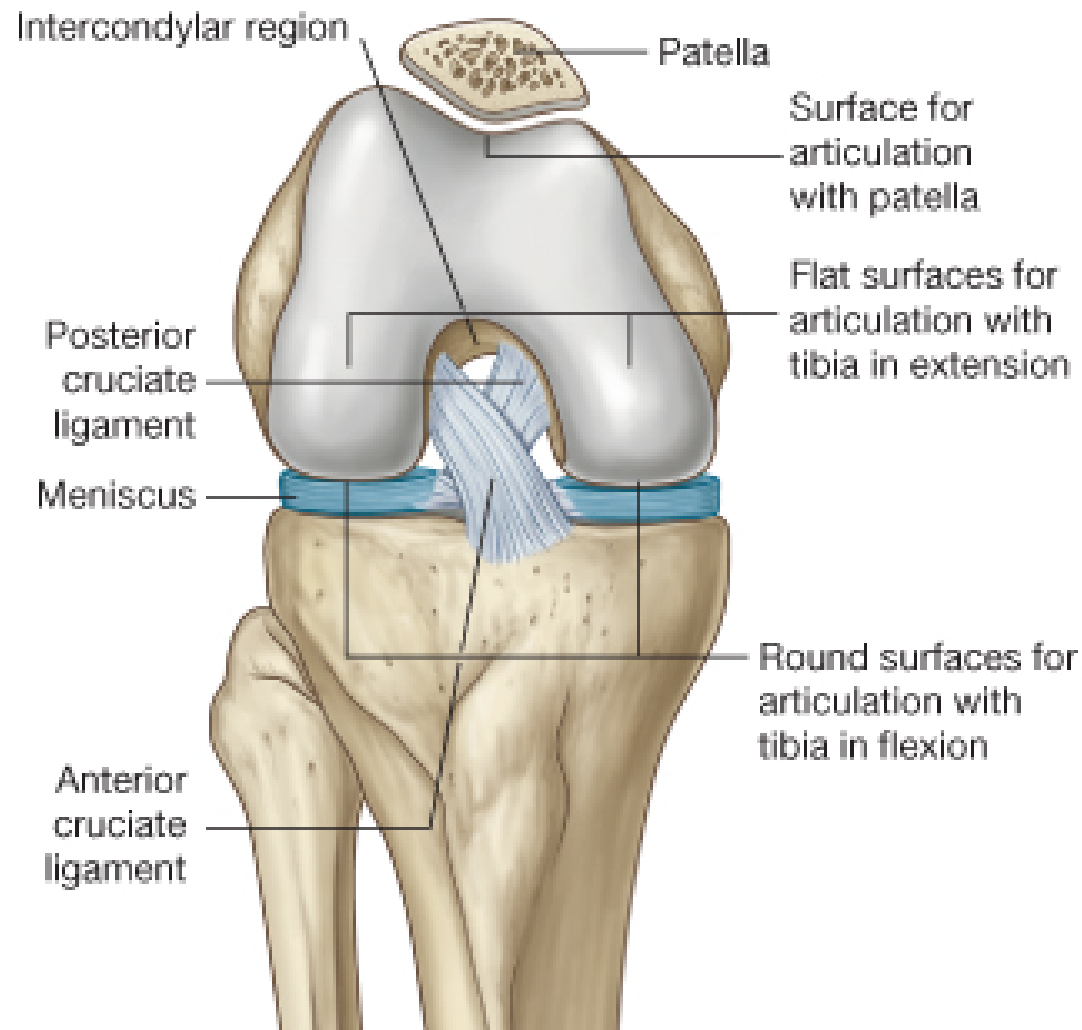


# Capsule

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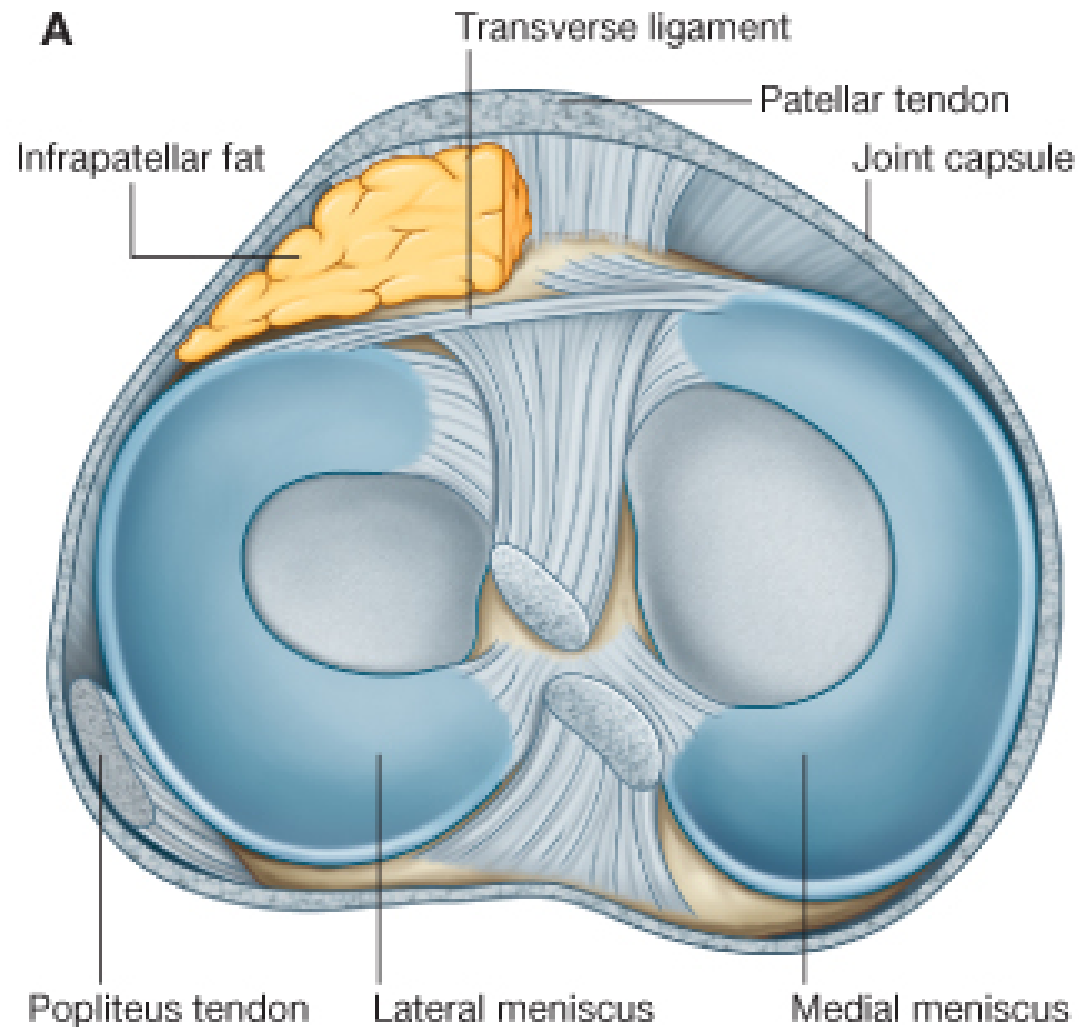
- Cruciates – called intrinsic- note synovium
- ACL – attached to the anteriorly intercondylar area of the tibia and passes upward, backward, and laterally to be attached to the posterior part of medial surface of the lateral femoral condyle.
- ACL fibers run in three directions – anteromedial, intermediate and posterolateral directions
- NWB this ligament prevents anterior displacement of tibia on femur

# Cruciates



# Cruciates

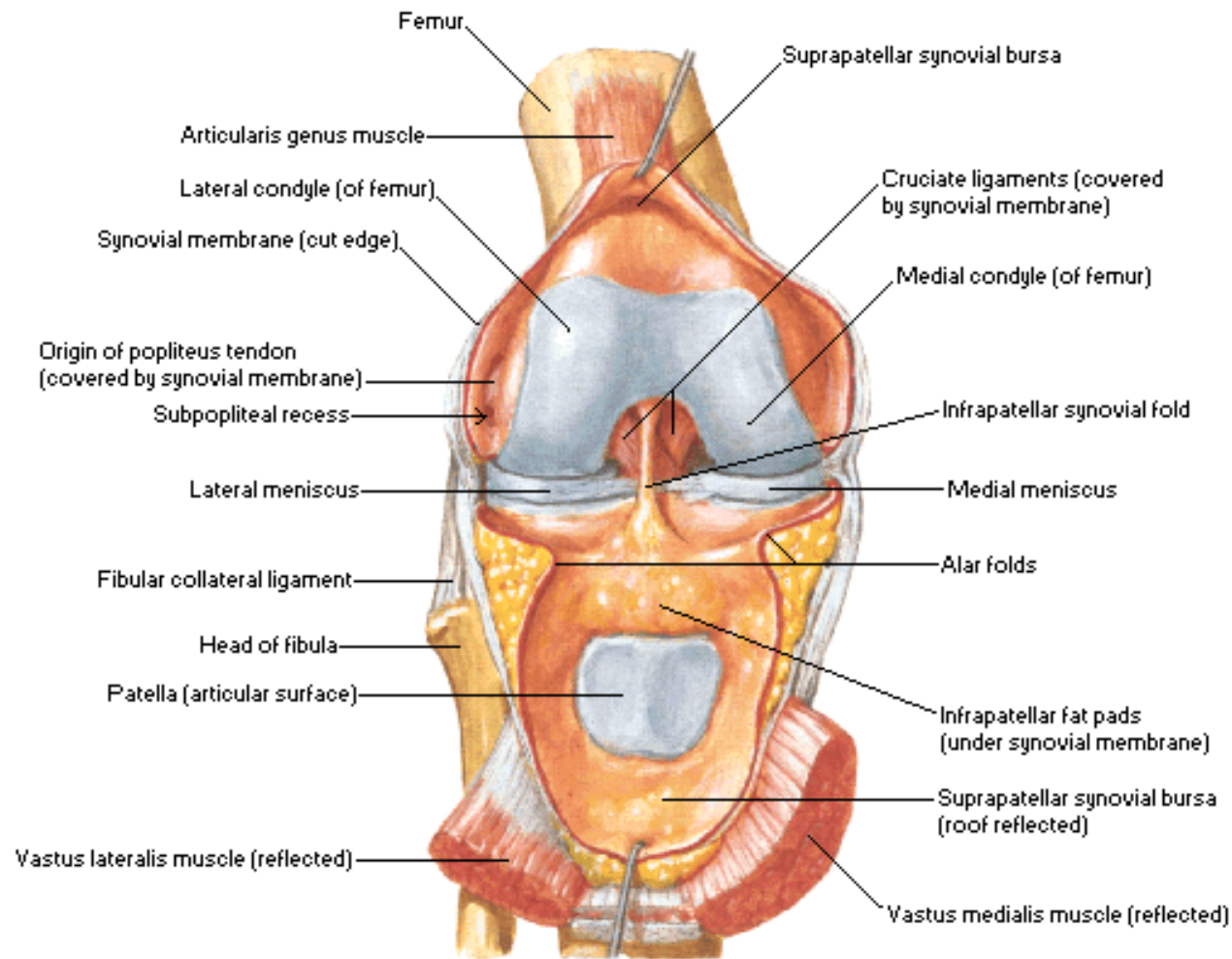
**A**



# Cruciates

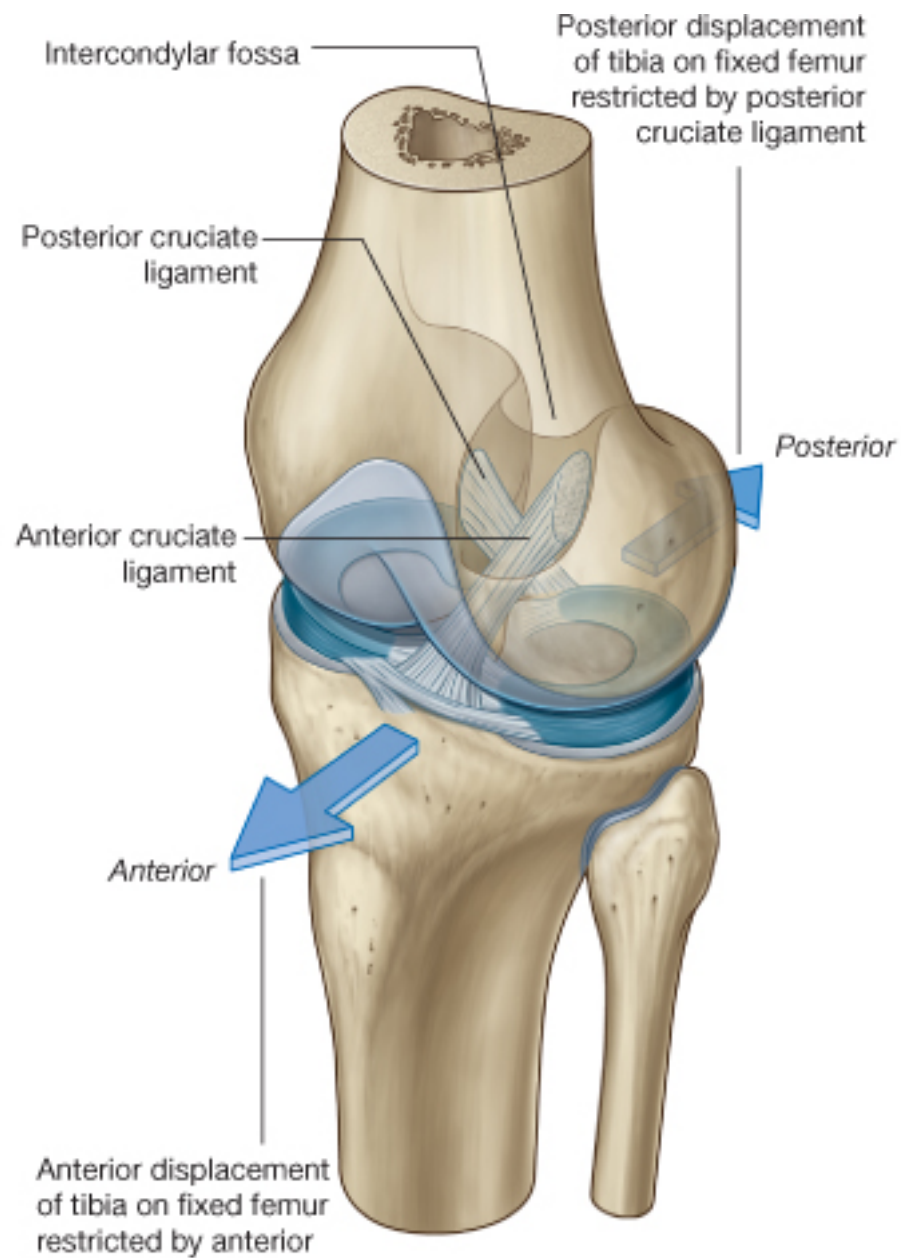
## Knee

### Right Knee Slightly in Flexion [Joint Opened]



Anterior View

# Cruciates



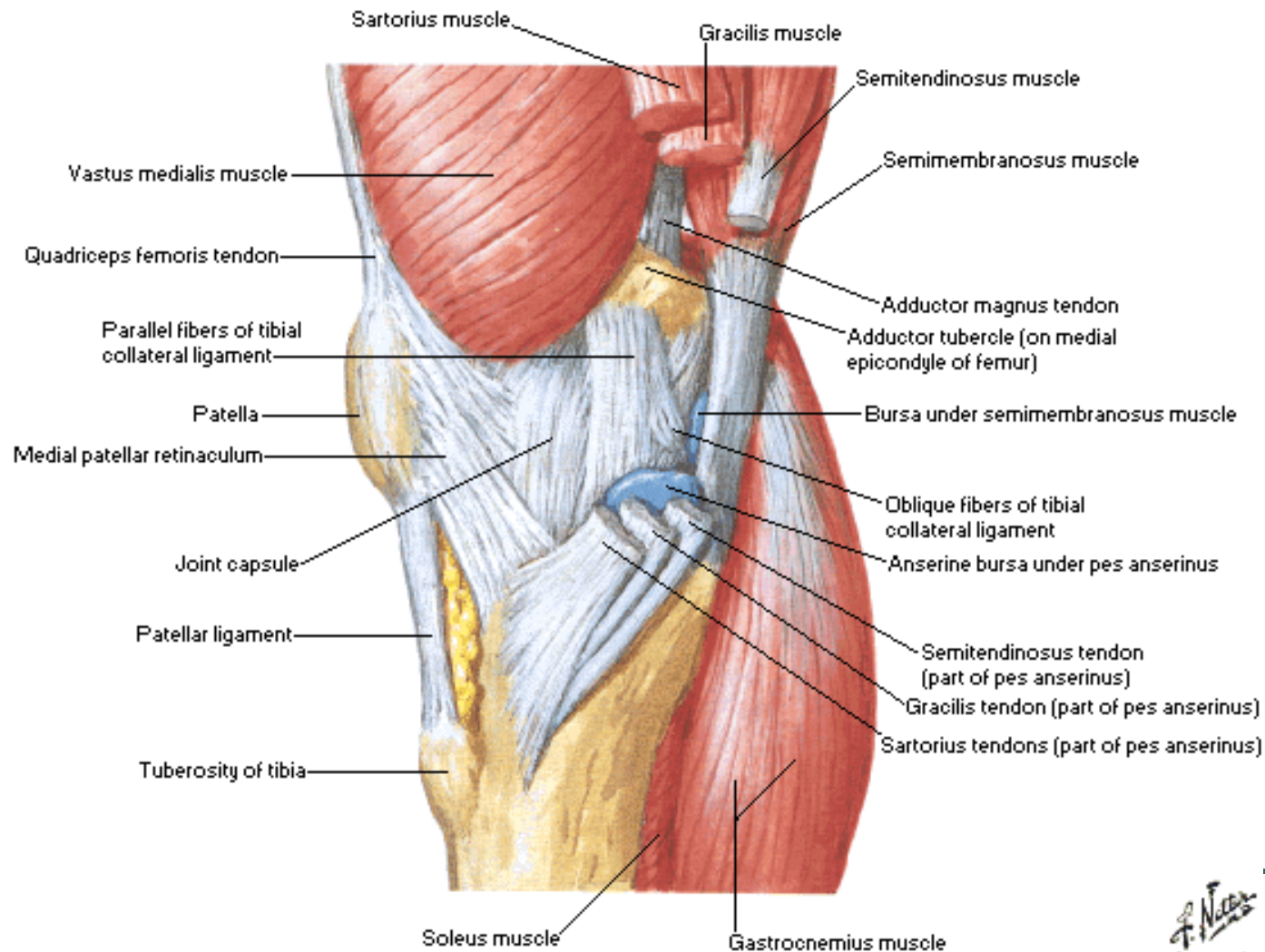
# Capsule

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- PCL – attached to the posterior intercondylar area of the tibia and passes upward, forward, and medially to be attached to the anterior part of the lateral surface of the medial femoral condyle.
- PCL fibers run in two directions, anteromedial and posterolateral directions
- NWB prevents posterior displacement of tibia on femur
- In closed chain, the role of cruciates changes

# Pes Anserine

## Knee Medial View



## Unholy Triad

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- ACL, MCL, Medial Meniscus
- Mechanism of injury generally involves all three at same time

# Compartments of the Knee

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- Medial

- Medial retinaculum
- Pes anserine
- Adductor Magnus
- Semimembranosus
- Capsular ligaments – meniscomfemoral, meniscotibial, post. Oblique
- MCL
- PCL

# Compartments

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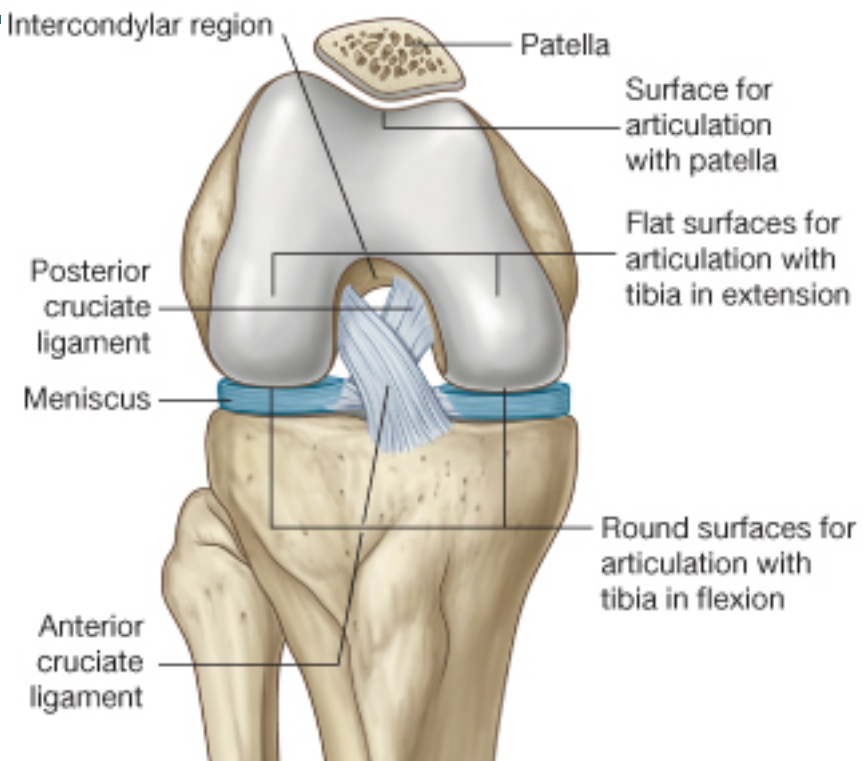
- Lateral
  - Lateral Retinaculum
  - IT Band
  - Biceps Attachment
  - Popliteus MM
  - LCL
  - Lateral capsular ligaments – meniscomfemoral, meniscotibial
  - Arcuate ligament
  - ACL
- Arcuate Lig., Post. Lateral Capsule, LCL –  
Called **Arcuate Complex**

# Patello-Femoral Joint

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- Patella with ant. and distal femur (so-called trochlear groove)
- Patella is a sesamoid bone imbedded in the quadriceps mechanism (tendon attachment continuing on to patellar ligament to tibial tuberosity)
- Purposes
  - Increase the leverage or torque of quads by increasing distance from the axis of motion
  - Provide bony protection to distal joint surface of femoral condyles when knee is flexed
  - Prevent damaging compression forces on the quadriceps tendon with resisted knee flexion such as squats

# Patello-Femoral Joint

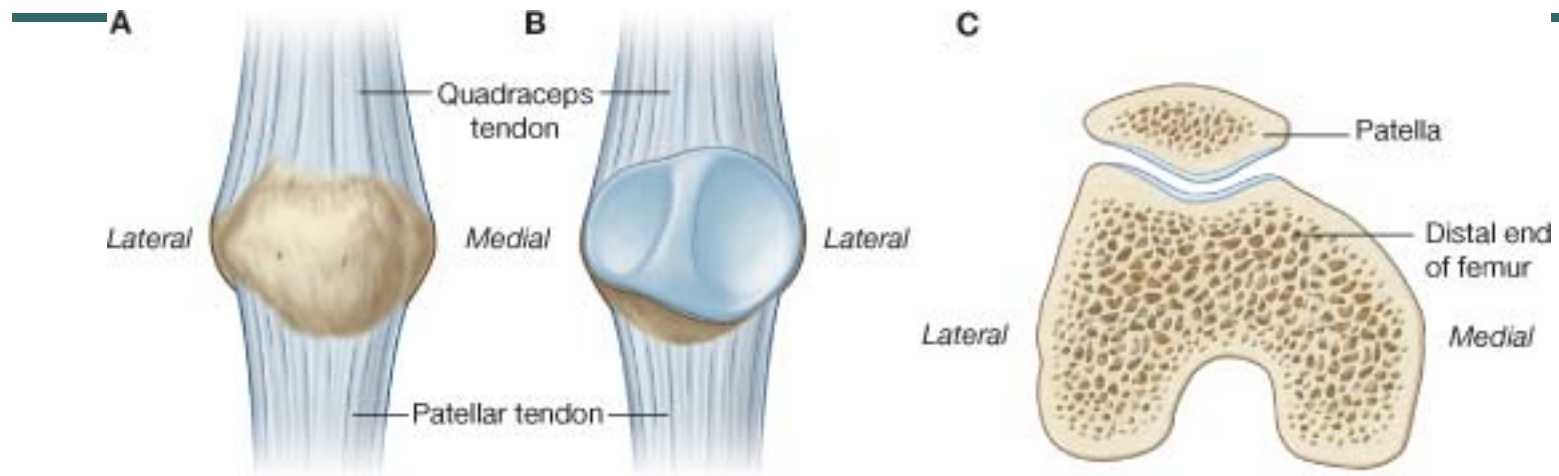


# Patella

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- Posterior surface covered with articular cartilage – Thickest articular cartilage in body
- Facets – Medial side had medial facet and the odd facet
- Lateral side has lateral facet
- Separated by vertical ridge
- Can divide med. and lat. facets to superior and inferior
- Proximal part called the base, distal part the pole or apex

# Patella



# Patella

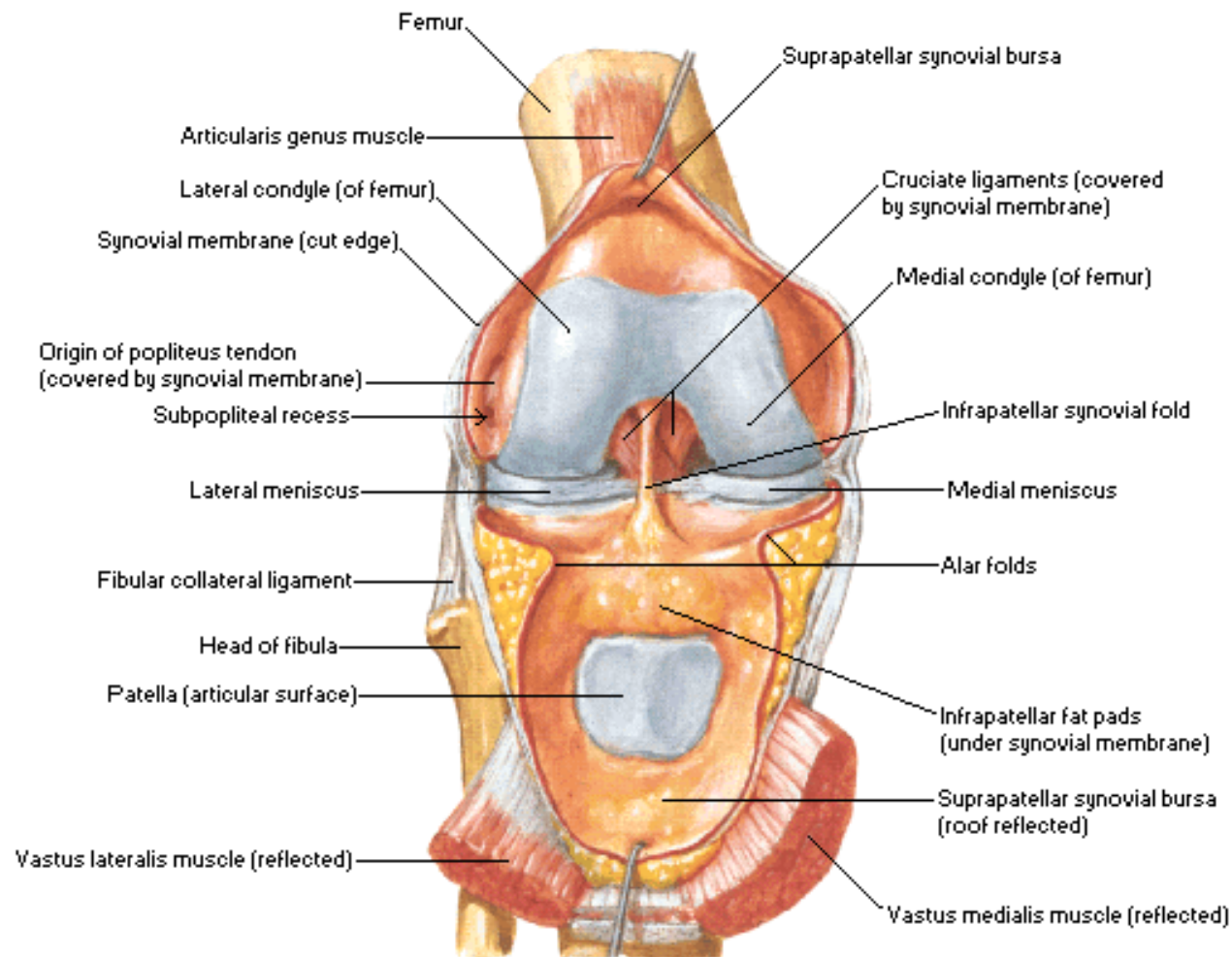
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- Quads stabilize patella on all sides and guide motion between patella and femur
- Distally, the patella is anchored by the patellar ligament
- Retinaculum anchor patella on each side
- VMO contributes on medial side
- IT band and VL assist laterally

# Patella

## Knee

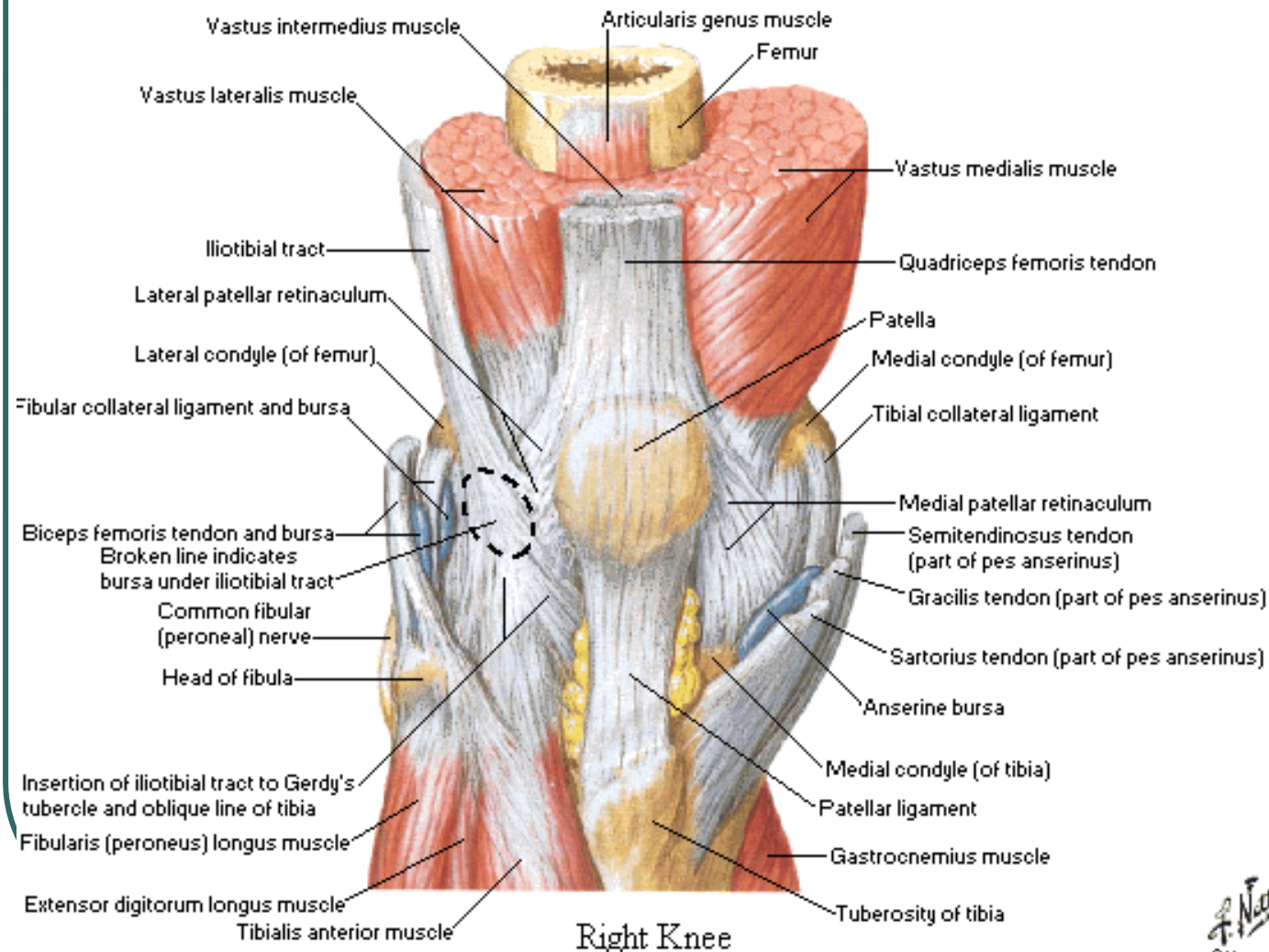
### Right Knee Slightly in Flexion [Joint Opened]



# Patella

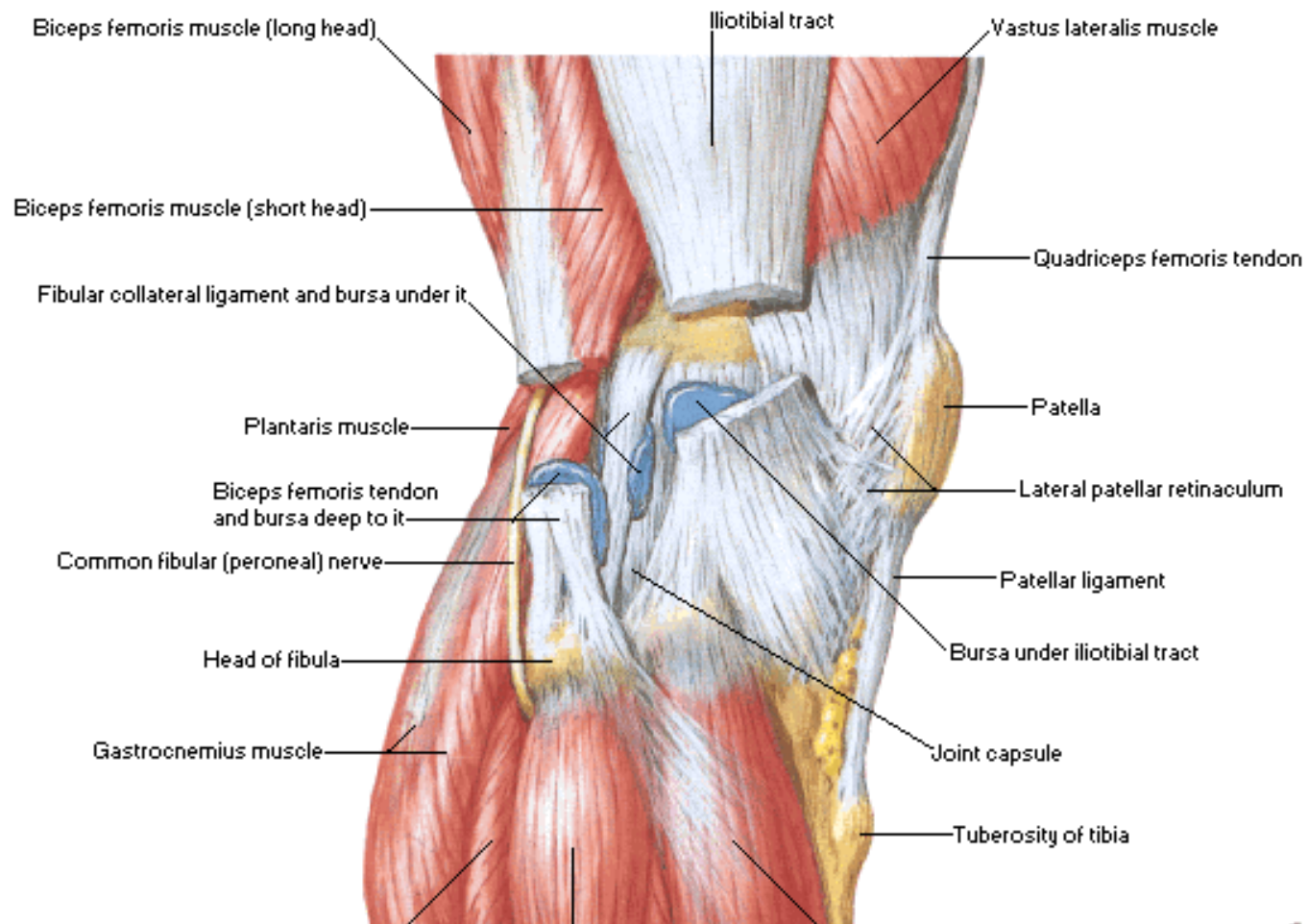
## Knee in Extension

### Anterior View



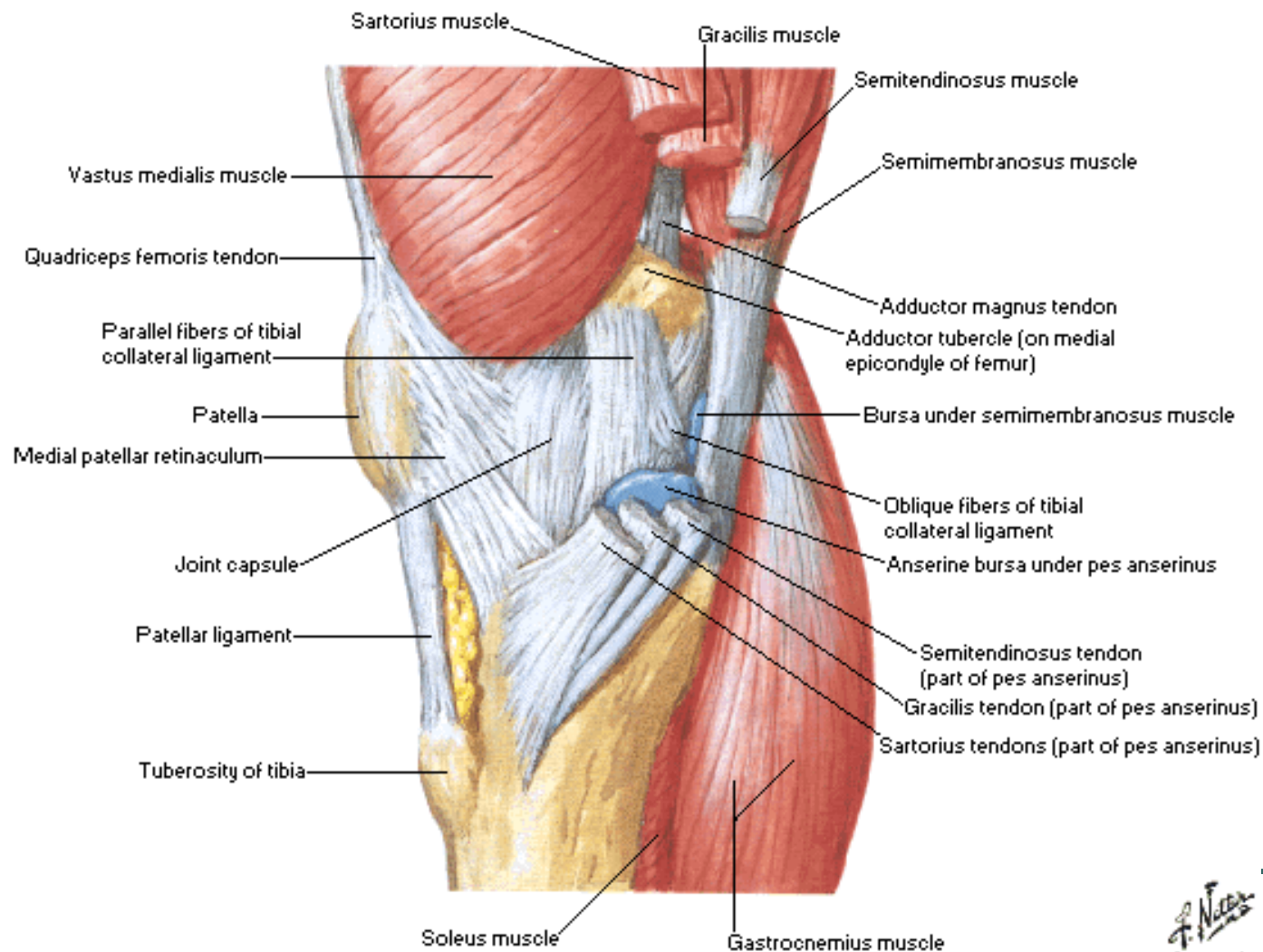
# Patella

## Knee Lateral View



# Patella

## Knee Medial View



# Patella

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- From full flexion to extension, the patella slides 7 to 8 cm
- During the beginning of flexion, the contact is on the distal patella
- As flexion approaches 90 degrees, the articulating surface moves towards the base to cover the proximal one half of the patella
- At 135 degrees of flexion, the odd facet comes into contact

# Patella

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- The odd facet is frequently the 1<sup>st</sup> part of patella to be affected in premature degeneration of articular cartilage
- The load on the patella differs according to activity
- In walking =  $\frac{1}{3}$  body weight
- Climbing stairs = 3 to 4 X body weight
- Squatting without weight = 7 to 8 X body weight

## Q Angle

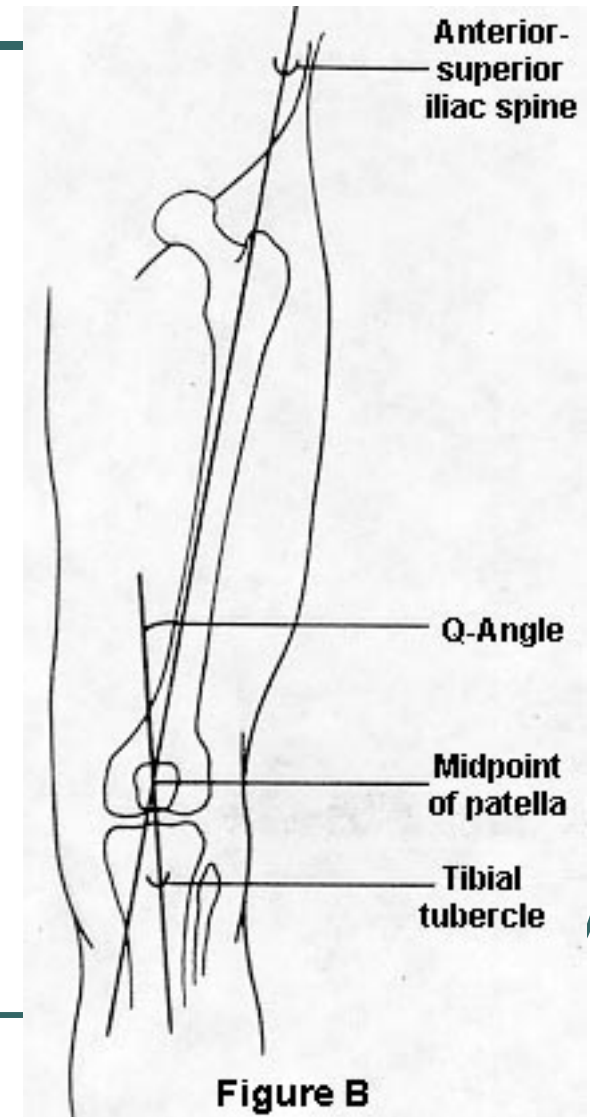
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- An angle found by drawing a line from ASIS to middle of patella and a second line from mid patella to tibial tuberosity
  - Represents efficiency of Quads
  - Most efficient = 10 degrees
  - Males range from 10-14
  - Females from 15-17
  - Represents the valgus stress acting on knee and, if excessive, can cause patello femoral problems
- Great than 17 degrees considered excessive, called Genu Valgum or knock knees
- Very small angle causes genu varum

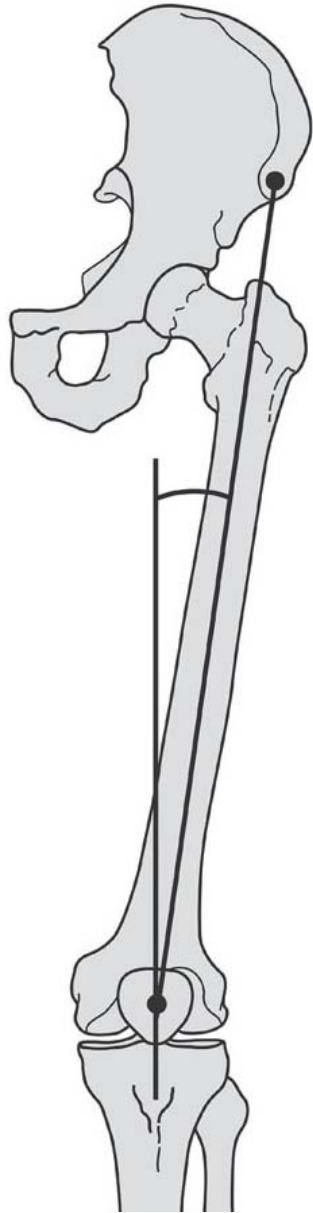
## "Q" Angle

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- Line from ASIS to midpoint of the patella
- Line from Tibial tubercle to midpoint of the patella



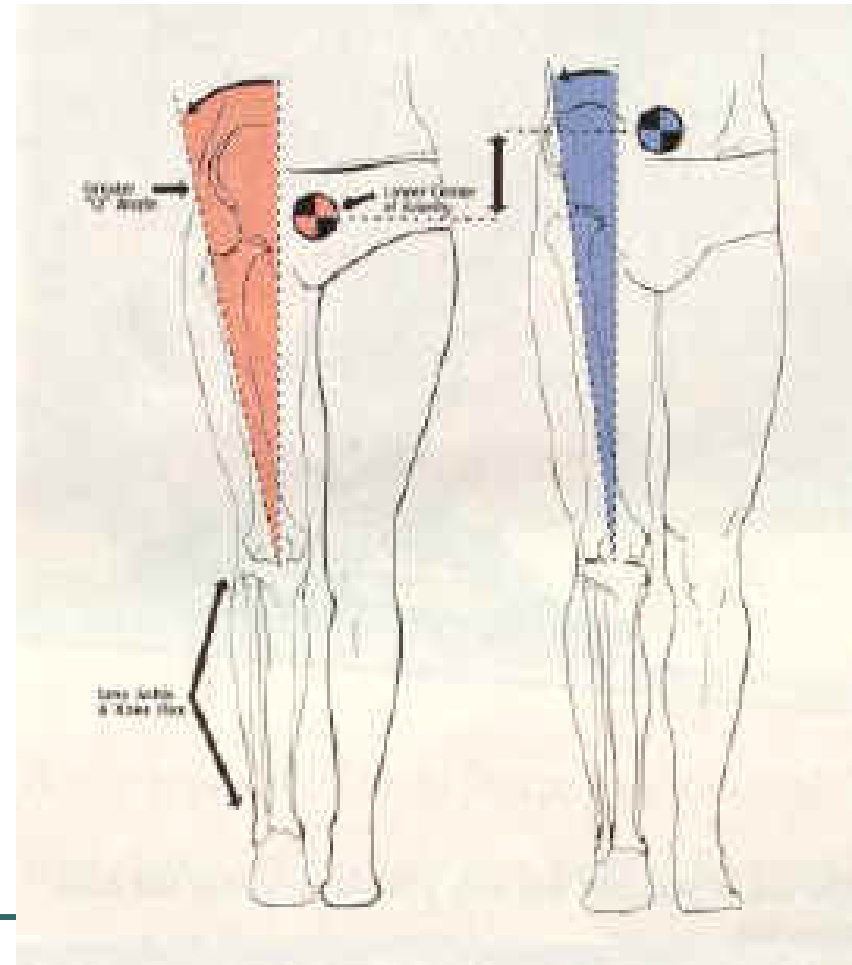
## Q Angle



# "Q" Angle

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- Normal
  - about 15°
- Males vs. Females
  - wider pelvis



# Girls Play Too



# Knee Motion

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- The long articulating surface of the femoral condyles is about twice the length of the tibial condyles
- Therefore the activity of flexion and extension can not be a pure hinge motion or simple rolling of one bone over the other
- Instead the condyles execute both rolling and sliding motions
- Rolling is predominant at the initiation of flexion and sliding occurs more at the end of flexion

# Terminal Rotation AKA Locking Home

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- When the knee moves towards full extension, the tibia external rotates about 20 degrees on the fixed femur – Explain relationship of condyles
- Purely mechanical event, occurs with passive or active knee extension and can not be produced voluntarily
- In closed chain motion, such as rising from sitting, terminal rotation is seen as internal rotation of the femur on fixed tibia

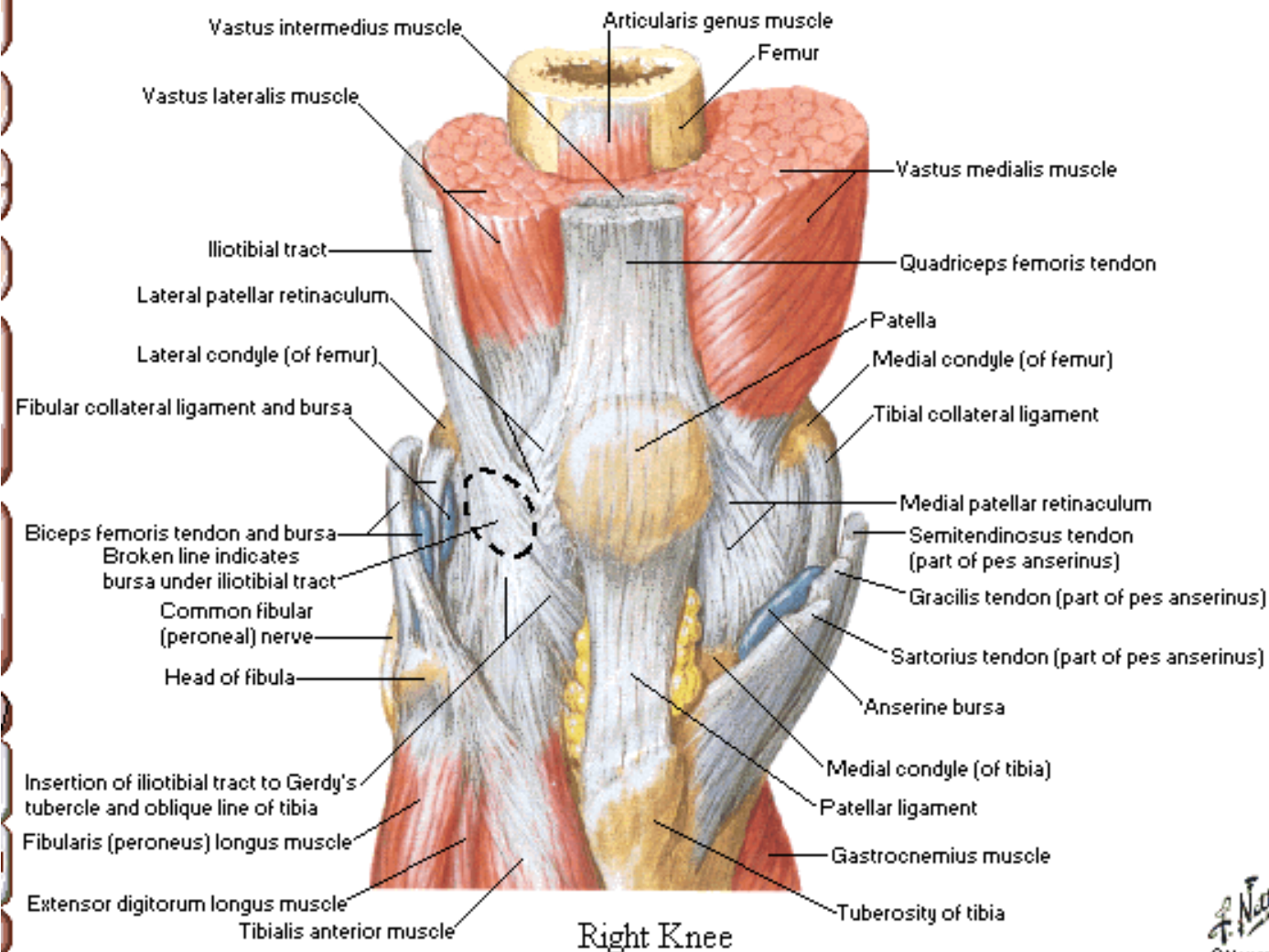
## Bursa

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- 20 + associated with the knee
- Most important
- Subcutaneous prepatellar
- Subcutaneous infrapatellar
- Deep infrapatellar
- Anserine bursa
- Bursa deep to iliotibial band
- Inferior subtendinous bursa of biceps

# Bursa

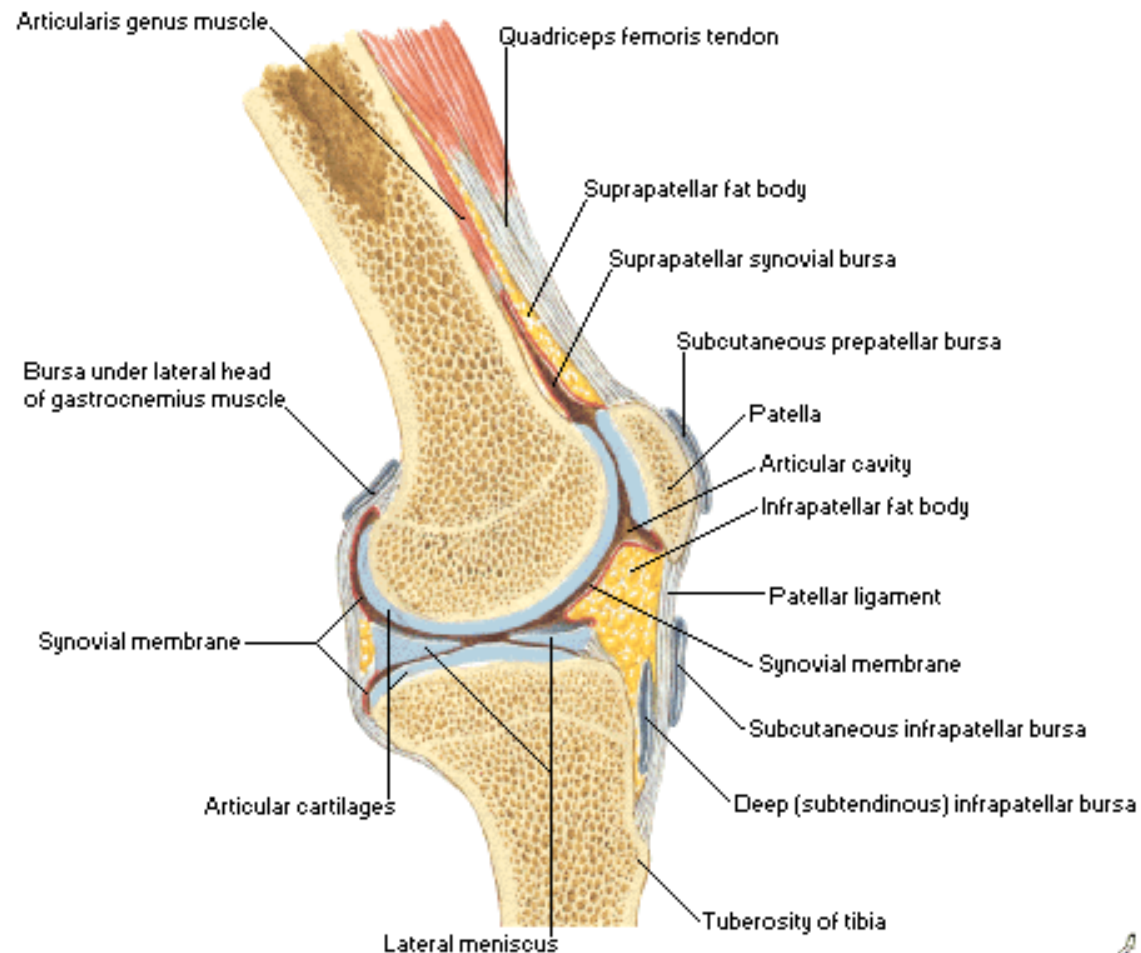
## Knee in Extension Anterior View



# Bursa

## Knee

### Parasagittal Section - Lateral to Midline of Knee

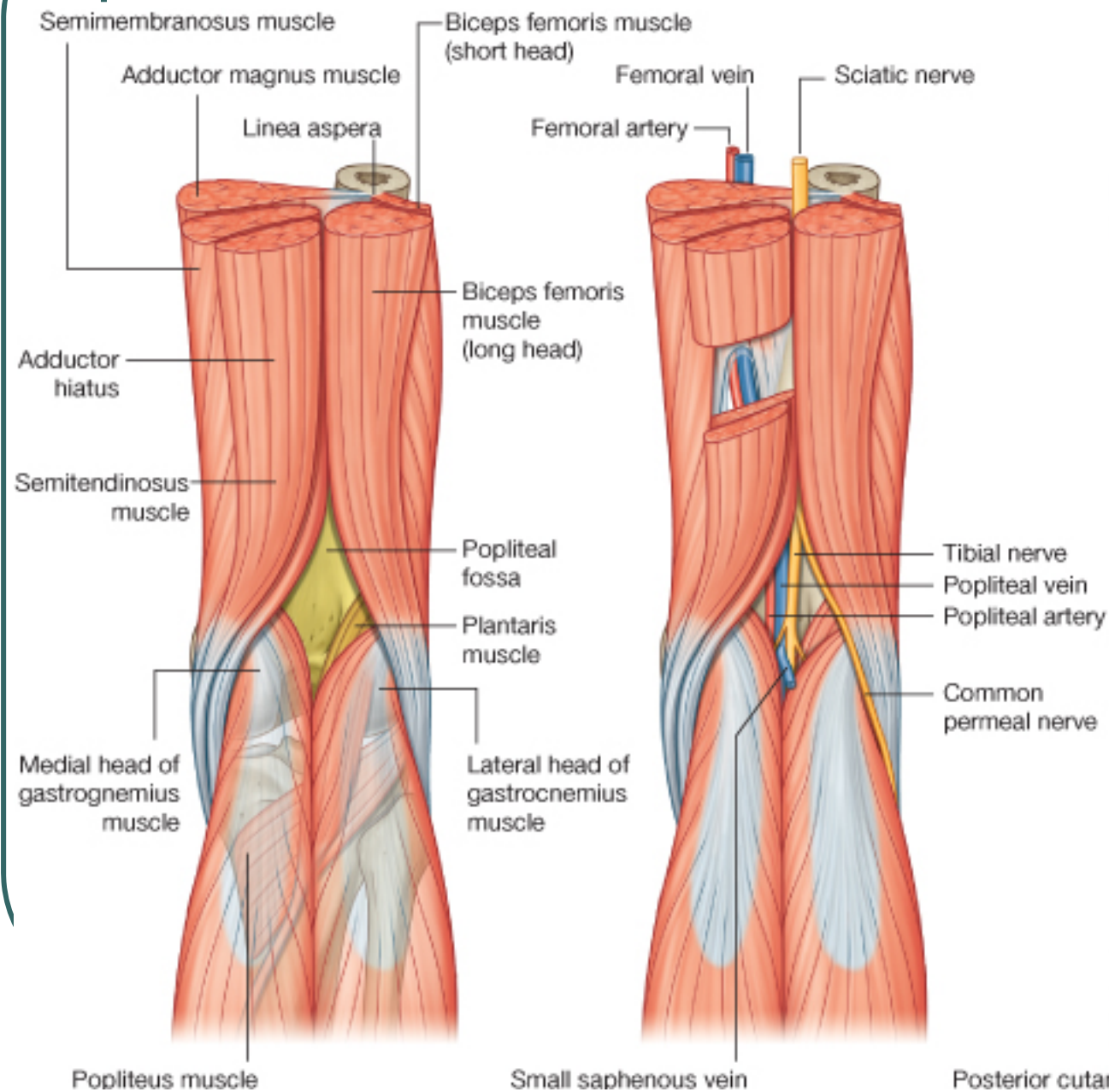


## Popliteal Fossa

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- The diamond shaped region posterior to knee joint
- Transition between thigh and leg
- Boundaries = sup. – biceps laterally, semitendinosus medially; inf. Medial and lateral gastrocnemius
- Contents = popliteal artery and branches, popliteal vein, tibial nerve

# Popliteal Fossa

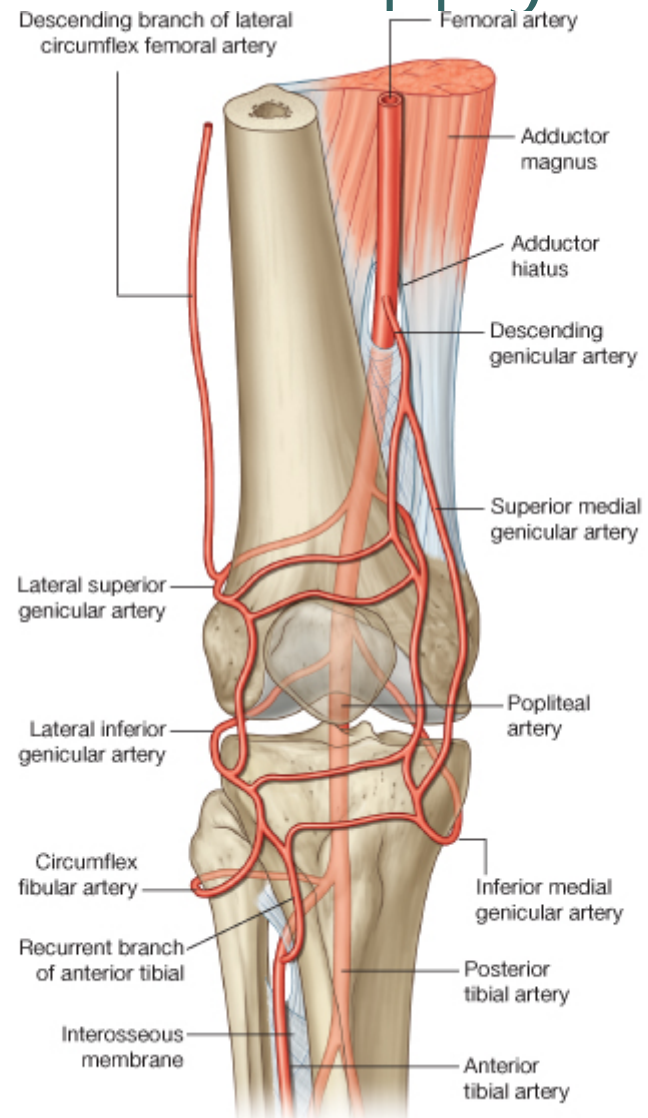


# Blood Supply to Knee

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- From femoral aa
  - Descending genicular – articular and saphenous
- From popliteal
  - Superior medial genicular, middle genicular, inferior middle genicular, superior lateral and inferior lateral genicular
- From tibial
  - Anterior and posterior tibial recurrents
- Also, anastamosis from descending branch of lateral circumflex femoral aa

# Blood Supply



## Innervation

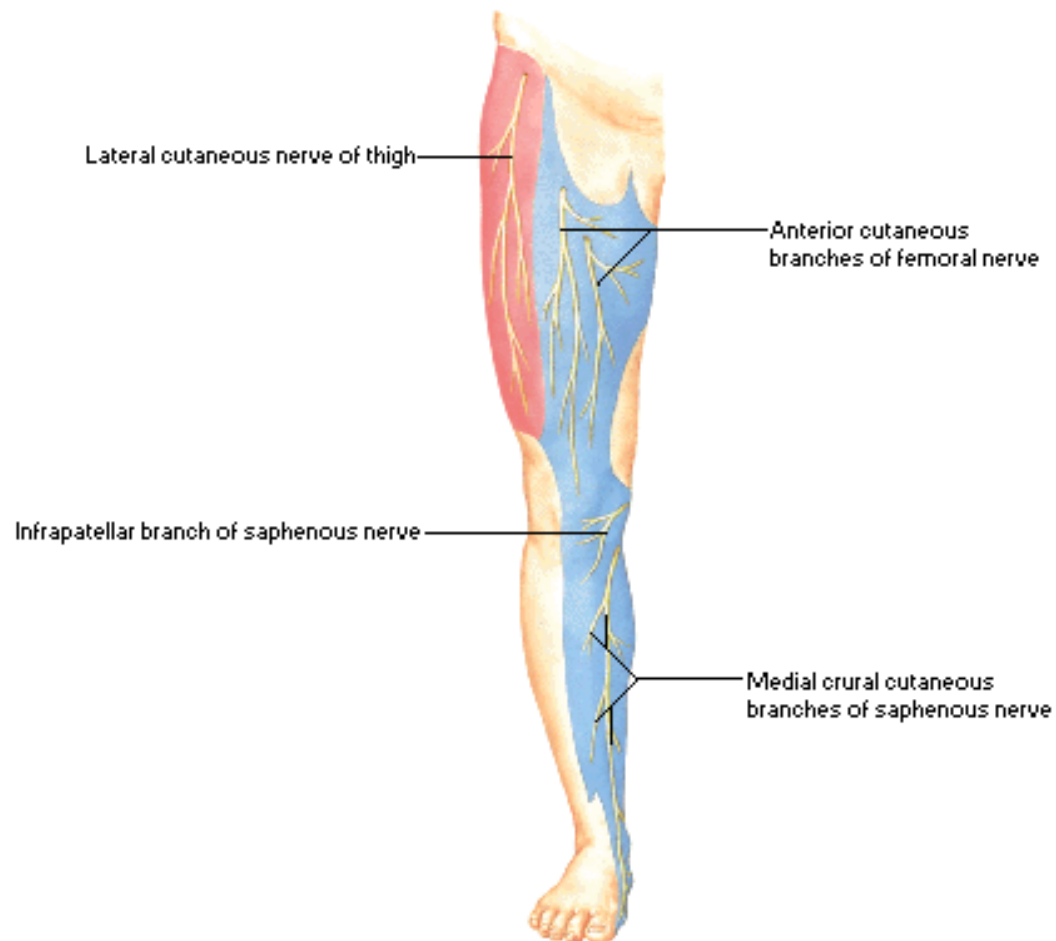
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- Branches from saphenous, obturator (a stretch), tibial and common peroneal
- Note the cutaneous coverage about the knee region

# Cutaneous

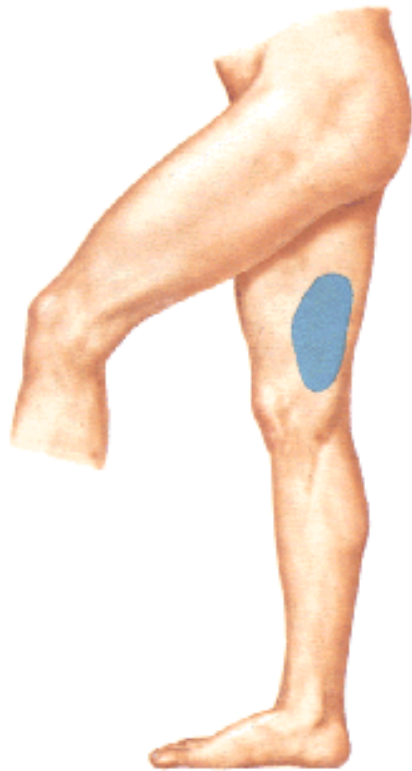
## Femoral and Lateral Femoral Cutaneous Nerves

### Cutaneous Innervation



# Cutaneous

**Obturator Nerve**  
Cutaneous Innervation



# Cutaneous

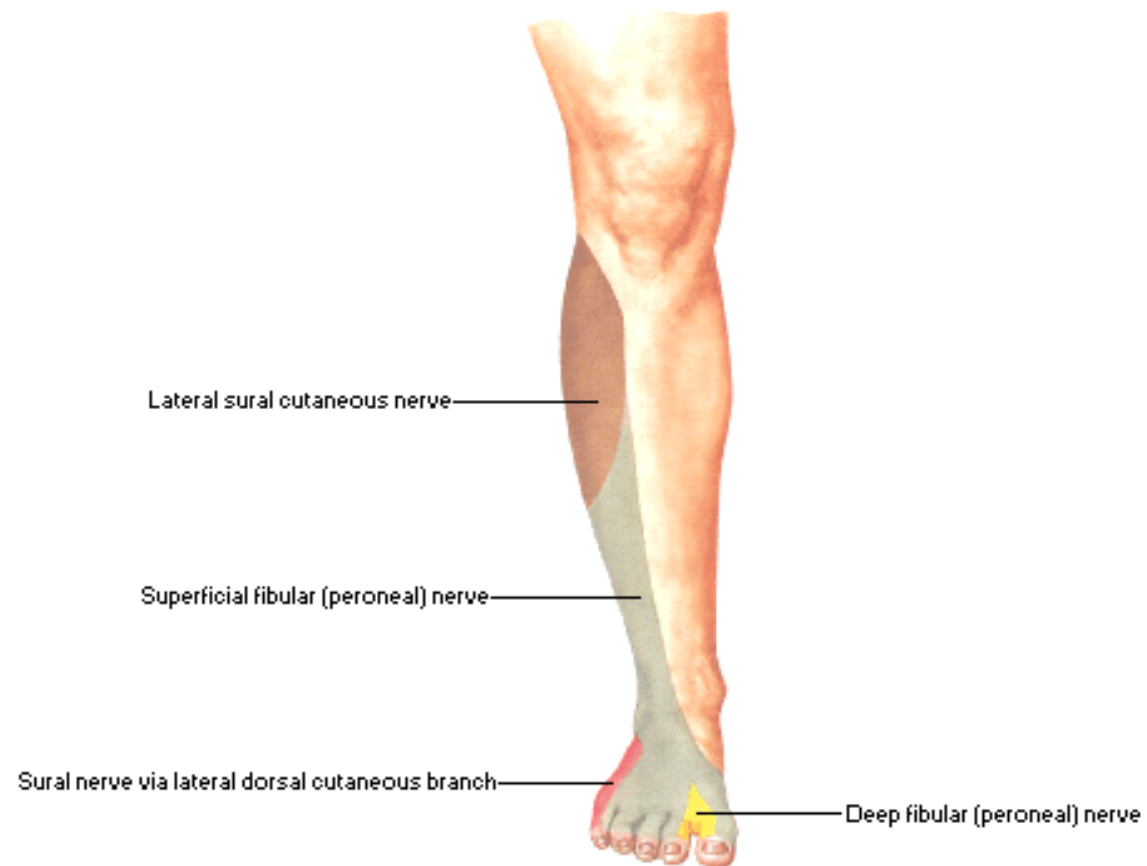
## Sciatic and Posterior Femoral Cutaneous Nerves

### Cutaneous Innervation



# Cutaneous

## **Common Fibular [Peroneal] Nerve** Cutaneous Innervation



# Dermatomes

## Dermatomes of Lower Limb

Anterior and Posterior Views

