The Knee

Tibio-Femoral
Osteology

- 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

- Tibial nerve (branch of L4 to S3)
- Common fibular nerve (L4 to S2)
Support

- 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

- 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

- Intercondylar region
- Attachment of posterior cruciate ligament
- Posterior attachment of medial meniscus
- Posterior attachment of lateral meniscus
- Area of articulation with medial meniscus
- Area of articulation with lateral meniscus
- Tubercles of intercondylar eminence
- Attachment of anterior cruciate ligament
- Anterior attachment of lateral meniscus
- Roughened and perforated area
- Anterior attachment of medial meniscus
- Tuberosity
In high 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 semimenbranosis sends fibers to the posterior edge of medial meniscus
- The popliteus muscle sends fibers to the lateral meniscus
- The **meniscofemoral** ligament extends from the lateral meniscus (post) to the inside of the medial condyle near the PCL
- The **coronary ligaments** – AKA **meniscotibial**
Menisci
Menisci

A  Posterior cruciate ligament

Infrapatellar fold

Alar fold

Qua femori

Infrapatellar fat

Synovial membrane

Popliteus tendon

Patellar tendon

P

Subpopliteal recess

Tibia

Lateral meniscus

Deep infr

Fibula
Coronary Ligaments
Menisci

Knee - Cruciate and Collateral Ligaments
Right Knee in Extension
Menisci

Knee
Posterl View

- Adductor magnus tendon
- Medial head of gastrocnemius muscle and bursa beneath it
- Tibial collateral ligament
- Semimembranosus tendon
- Bursa under tendon (broken line)
- Oblique popliteal ligament (tendinous expansion of semimembranosus muscle)
- Femur
- Attachment of joint capsule
- Plantaris muscle
- Lateral head of gastrocnemius muscle and bursa beneath it
- Fibular collateral ligament and bursa beneath it
- Arcuate popliteal ligament (edge of capsule that arches over popliteus muscle)
- Ectes femoris tendon and bursa deep to it
- Head of fibula
- Popliteus muscle
- Posterior ligament of head of fibula
- Attachment of joint capsule
Joint Capsule

- 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

- Adductor magnus tendon
- Medial head of gastrocnemius muscle and bursa beneath it
- Tibial collateral ligament
- Semimembranosus tendon
- Bursa under tendon (broken line)
- Oblique popliteal ligament (tendinous expansion of semimembranosus muscle)
- Femur
- Attachment of joint capsule
- Plantaris muscle
- Lateral head of gastrocnemius muscle and bursa beneath it
- Fibular collateral ligament and bursa beneath it
- Arquate popliteal ligament (edge of capsule that arches over popliteus muscle)
- Biceps femoris tendon and bursa deep to it
- Head of fibula
- Popliteus muscle
- Posterior ligament of head of fibula
- Attachment of joint capsule
Collaterals

- Fibular collateral ligament
- Proximal tibiofibular joint
- Anterior ligament of joint
- Interosseous membrane
Collaterals
Capsule

- 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

- Adductor magnus tendon
- Medial head of gastrocnemius muscle and bursa beneath it
- Tibial collateral ligament
- Semimembranosus tendon
- Bursa under tendon (broken line)
- Oblique popliteal ligament (tendinous expansion of semimembranosus muscle)
- Femur
- Attachment of joint capsule
- Plantaris muscle
- Lateral head of gastrocnemius muscle and bursa beneath it
- Fibular collateral ligament and bursa beneath it
- Arcuate popliteal ligament (edge of capsule that arches over popliteus muscle)
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- Head of fibula
- Popliteus muscle
- Posterior ligament of head of fibula
- Interosseous membrane
- Attachment of joint capsule
Little Guys
Capsule

- 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

- Intercondylar region
- Patella
  - Surface for articulation with patella
- Posterior cruciate ligament
- Meniscus
  - Flat surfaces for articulation with tibia in extension
- Anterior cruciate ligament
  - Round surfaces for articulation with tibia in flexion
Cruciates

- Infrapatellar fat
- Transverse ligament
- Patellar tendon
- Joint capsule
- Popliteus tendon
- Lateral meniscus
- Medial meniscus
Cruciates

Knee
Right Knee Slightly in Flexion [Joint Opened]
Cruciates

- Intercondylar fossa
- Posterior cruciate ligament
- Anterior cruciate ligament
- Posterior displacement of tibia on fixed femur restricted by posterior cruciate ligament
- Anterior displacement of tibia on fixed femur restricted by anterior
Capsule

- 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

- Sartorius muscle
- Gracilis muscle
- Semitendinosus muscle
- Semimembranosus muscle
- Vastus medialis muscle
- Quadriceps femoris tendon
- Parallel fibers of tibial collateral ligament
- Patella
- Medial patellar retinaculum
- Joint capsule
- Patellar ligament
- Tuberosity of tibia
- Soleus muscle
- Gastrocnemius muscle
- Adductor magnus tendon
- Adductor tubercle (on medial epicondyle of femur)
- Bursa under semimembranosus muscle
- Oblique fibers of tibial collateral ligament
- Anserine bursa under pes anserinus
- Semitendinosus tendon (part of pes anserinus)
- Gracilis tendon (part of pes anserinus)
- Sartorius tendons (part of pes anserinus)

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Unholy Triad

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

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

- **Lateral**
  - Lateral Retinaculum
  - IT Band
  - Biceps Attachment
  - Popliteus MM
  - LCL
  - Lateral capsular ligaments – meniscofemoral, meniscotibial
  - Arcuate ligament
  - ACL

- Arcuate Lig., Post. Lateral Capsule, LCL – Called **Arcuate Complex**
Patello-Femoral Joint

- 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

- Intercondylar region
- Patella
- Surface for articulation with patella
- Posterior cruciate ligament
- Meniscus
- Flat surfaces for articulation with tibia in extension
- Round surfaces for articulation with tibia in flexion
- Anterior cruciate ligament
Patella

- 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

A

B

C

Lateral

Medial

Quadriceps tendon

Patellar tendon

Lateral

Lateral

Patella

Distal end of femur

Medial
Patella

- 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]

- Femur
- Suprapatellar synovial bursa
- Articularis genus muscle
- Lateral condyle (of femur)
- Synovial membrane (cut edge)
- Cruciate ligaments (covered by synovial membrane)
- Medial condyle (of femur)
- Origin of popliteus tendon (covered by synovial membrane)
- Subpopliteal recess
- Lateral meniscus
- Infrapatellar synovial fold
- Medial meniscus
- Alar folds
- Fibular collateral ligament
- Head of fibula
- Patella (articular surface)
- Infrapatellar fat pads (under synovial membrane)
- Suprapatellar synovial bursa (roof reflected)
- Vastus lateralis muscle (reflected)
- Vastus medialis muscle (reflected)
Patella

Knee in Extension
Anterior View

- Vastus intermedius muscle
- Vastus lateralis muscle
- Iliotibial tract
- Lateral patellar retinaculum
- Lateral condyle (of femur)
- Fibular collateral ligament and bursa
- Biceps femoris tendon and bursa
- Broken line indicates bursa under iliotibial tract
- Common fibular (peroneal) nerve
- Head of fibula
- Insertion of iliotibial tract to Gerdy's tubercle and oblique line of tibia
- Fibularis (peroneus) longus muscle
- Extensor digitorum longus muscle
- Tibialis anterior muscle
- Medial patellar retinaculum
- Semitendinosus tendon (part of pes anserinus)
- Gracilis tendon (part of pes anserinus)
- Sartorius tendon (part of pes anserinus)
- Anserine bursa
- Medial condyle (of tibia)
- Patellar ligament
- Gastrocnemius muscle
- Tuberosity of tibia

Right Knee
Patella

Knee
Lateral View

- Biceps femoris muscle (long head)
- Biceps femoris muscle (short head)
- Fibular collateral ligament and bursa under it
- Plantaris muscle
- Biceps femoris tendon and bursa deep to it
- Common fibular (peroneal) nerve
- Head of fibula
- Gastrocnemius muscle
- Iliotibial tract
- Vastus lateralis muscle
- Quadriceps femoris tendon
- Lateral patellar retinaculum
- Patellar ligament
- Bursa under iliotibial tract
- Patella
- Joint capsule
- Tuberosity of tibia
Patella

Knee
Medial View

- Sartorius muscle
- Gracilis muscle
- Semitendinosus muscle
- Semimembranosus muscle
- Vastus medialis muscle
- Quadriceps femoris tendon
- Parallel fibers of tibial collateral ligament
- Patella
- Medial patellar retinaculum
- Joint capsule
- Patellar ligament
- Tuberosity of tibia
- Soleus muscle
- Gastrocnemius muscle
- Adductor magnus tendon
- Adductor tubercle (on medial epicondyle of femur)
- Bursa under semimembranosus muscle
- Oblique fibers of tibial collateral ligament
- Anserine bursa under pes anserinus
- Semitendinosus tendon (part of pes anserinus)
- Gracilis tendon (part of pes anserinus)
- Sartorius tendons (part of pes anserinus)
Patella

- 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

- The odd facet is frequently the 1st part of patella to be affected in premature degeneration of articular cartilage.
- The load on the patella differs according to activity.
  - In walking = 1/3 body weight
  - Climbing stairs = 3 to 4 X body weight
  - Squatting without weight = 7 to 8 X body weight
Q Angle

- 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

- Line from ASIS to midpoint of the patella
- Line from Tibial tubercle to midpoint of the patella
“Q” Angle

- Normal
  - about 15°

- Males vs. Females
  - wider pelvis
Girls Play Too
Knee Motion

- The long articulating surface of the femoral condyles is about twice the length of the tibial condyles.
- Therefore the activity of flexion and extension cannot 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

- 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

- 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

- Vastus intermedius muscle
- Vastus lateralis muscle
- Articularis genus muscle
- Femur
- Vastus medialis muscle
- Iliotibial tract
- Lateral patellar retinaculum
- Lateral condyle (of femur)
- Tibial collateral ligament
- Patella
- Medial condyle (of femur)
- Fibular collateral ligament and bursa
- Sartorius tendon (part of pes anserinus)
- Semitendinosus tendon (part of pes anserinus)
- Gracilis tendon (part of pes anserinus)
- Anserine bursa
- Medial condyle (of tibia)
- Patellar ligament
- Gastrocnemius muscle
- Tuberosity of tibia

Right Knee
Bursa

Knee
Parasagittal Section - Lateral to Midline of Knee

Articularis genus muscle
Quadiceps femoris tendon
Suprapatellar fat body
Suprapatellar synovial bursa
Subcutaneous prepatellar bursa
Patella
Articular cavity
Infrapatellar fat body
Patellar ligament
Synovial membrane
Subcutaneous infrapatellar bursa
Deep (subtendinous) infrapatellar bursa
Articular cartilages
Lateral meniscus
Tuberosity of tibia
Bursa under lateral head of gastrocnemius muscle
Synovial membrane
Popliteal Fossa

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

Semimembranosus muscle
Adductor magnus muscle
Linea aspera
Adductor hiatus
Semitendinosus muscle
Medial head of gastrocnemius muscle
Popliteal muscle
Plantaris muscle
Lateral head of gastrocnemius muscle
Popliteal fossa

Biceps femoris muscle (short head)
Femoral vein
Biceps femoris muscle (long head)
Femoral artery
Sciatic nerve
Tibial nerve
Popliteal vein
Popliteal artery
Common peroneal nerve
Small saphenous vein
Posterior cutaneous
Blood Supply to Knee

- 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
Innervation

- 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

- Lateral cutaneous nerve of thigh
- Anterior cutaneous branches of femoral nerve
- Infrapatellar branch of saphenous nerve
- Medial crural cutaneous branches of saphenous nerve
Cutaneous

Obturator Nerve
Cutaneous Innervation
Cutaneous

Sciatic and Posterior Femoral Cutaneous Nerves

Cutaneous Innervation

- Posterior cutaneous nerve of thigh
- Medial sural cutaneous nerve (from sciatic nerve)
- Sural nerve (from sciatic nerve)
- Common fibular (peroneal) nerve via lateral sural cutaneous nerve (from sciatic nerve)
- Superficial fibular (peroneal) nerve (from sciatic nerve)
- Tibial nerve via medial calcaneal branches (from sciatic nerve)
Cutaneous

Common Fibular [Peroneal] Nerve
Cutaneous Innervation

- Lateral sural cutaneous nerve
- Superficial fibular (peroneal) nerve
- Sural nerve via lateral dorsal cutaneous branch
- Deep fibular (peroneal) nerve
Dermatomes

Dermatomes of Lower Limb
Anterior and Posterior Views