The Knee
The Knee

- Two Joints:
  - Tibiofemoral
  - Patellofemoral
Normal alignment due to difference between femoral condyles

The medial condyle extends further distally

Oatis, 2004
Osteochondral Defects

- Fractures of articular cartilage and underlying bone
- Shear and compressive forces
TibioFemoral Alignment

What are the consequences of faulty alignment?
Triplanar Knee Motion

• A simple hinge joint would simply flex and extend

• This is not a simple hinge joint!!
Tibia on a fixed Femur

• FLEXION
  – Backward Rolling
  – Internal Rotation
  – Varus
  – Posterior Translation

• EXTENSION
  – Forward Rolling
  – External Rotation
  – Valgus
  – Anterior Translation
Femur on a fixed Tibia

• FLEXION
  – Backward Rolling
  – External Rotation
  – Varus
  – Anterior Translation

• EXTENSION
  – Forward Rolling
  – Internal Rotation
  – Valgus
  – Posterior Translation
Knee Motion

• Bony Geometry

• Soft Tissue Constraints

• Muscle Forces
Bony Factors

• Different size of the medial and lateral femoral condyles

• Different size of the articular surfaces of the femoral condyles and the tibial condyles

• Variation in curvature from anterior to posterior
Medial Condyle is larger than the Lateral Condyle
Larger Femoral Condyles

What’s the consequence of larger femoral condyles?
Motion of the femoral condyles during flexion

Motion of the femoral condyles during extension
Convex-Concave Rule

Diagram:

a. Convex-Concave Rule

b. Fixed bony lever
The Menisci
The Menisci

- Tibiofemoral load transmission
- Shock absorption
- Lubrication
- Prevent synovial impingement
- Distribute synovial fluid
- Contribute to joint stability
- Assist in gliding motion
My Third Law

Levangie and Norkin, 2001
Movements of menisci

- during flexion - move posteriorly
- during extension - ... menisci move posteriorly unequally

... the menisci follow, or stay with the, femoral condyles
Movements of menisci

• during lateral rotation of the tibia
  – the menisci follow the femoral condyles, e.g. they remain with the femoral condyles while the tibia rotates

• during medial rotation (compare to lateral rotation)

... the menisci follow, or stay with the, femoral condyles
The menisci attach to the tibia, but move with the femur.

What are the consequences?
Let’s Review…

• Different sizes of femoral condyles means triplanar motion.

• Different sizes of the femoral and tibial condyles means that gliding must accompany rolling.

• The meniscal reaction force is partially responsible for this gliding.
Anterior Cruciate Ligament

- Prevents anterior translation of the tibia with respect to the femur
- Or…
- Stabilize in other directions as well
Posterior Cruciate Ligament

- Prevents posterior translation of the tibia with respect to the femur
- Or…
- Provides stability in other directions as well
The Cruciates & Knee Motion

ACL assists in anterior glide during flexion

PCL assists in posterior glide during extension
Tibial:

• Anterior Translation
• Internal Rotation
• Valgus or Varus
PCL injuries...direct impact
Let’s Review…

• Larger medial condyle produces triplanar motion

• Larger femoral condyles require a combination of rolling and gliding

• The menisci and cruciates are largely responsible for these gliding motions
Medial Collateral Ligament

- Restrains valgus loading
- Checks lateral tibial rotation
- Back-up anterior displacement
Lateral Collateral Ligament

- Resists varus stress
- Also limits lateral rotation
Why do we have a patella?
Patellar Motions
The Effect of the Quads on the Patella

Frontal view

Lateral view
Patellofemoral Pain

\[ \text{Stress} = \frac{\text{Force}}{\text{Area}} \]
Trochlear Depth – 60° Flexion
Trochlear Depth – Full Extension
The knee is part of a kinetic chain.

*Don’t look at it in isolation!*
It's not my fault!!

Heh! Heh!

Heh! Heh!

It's not my fault!!