



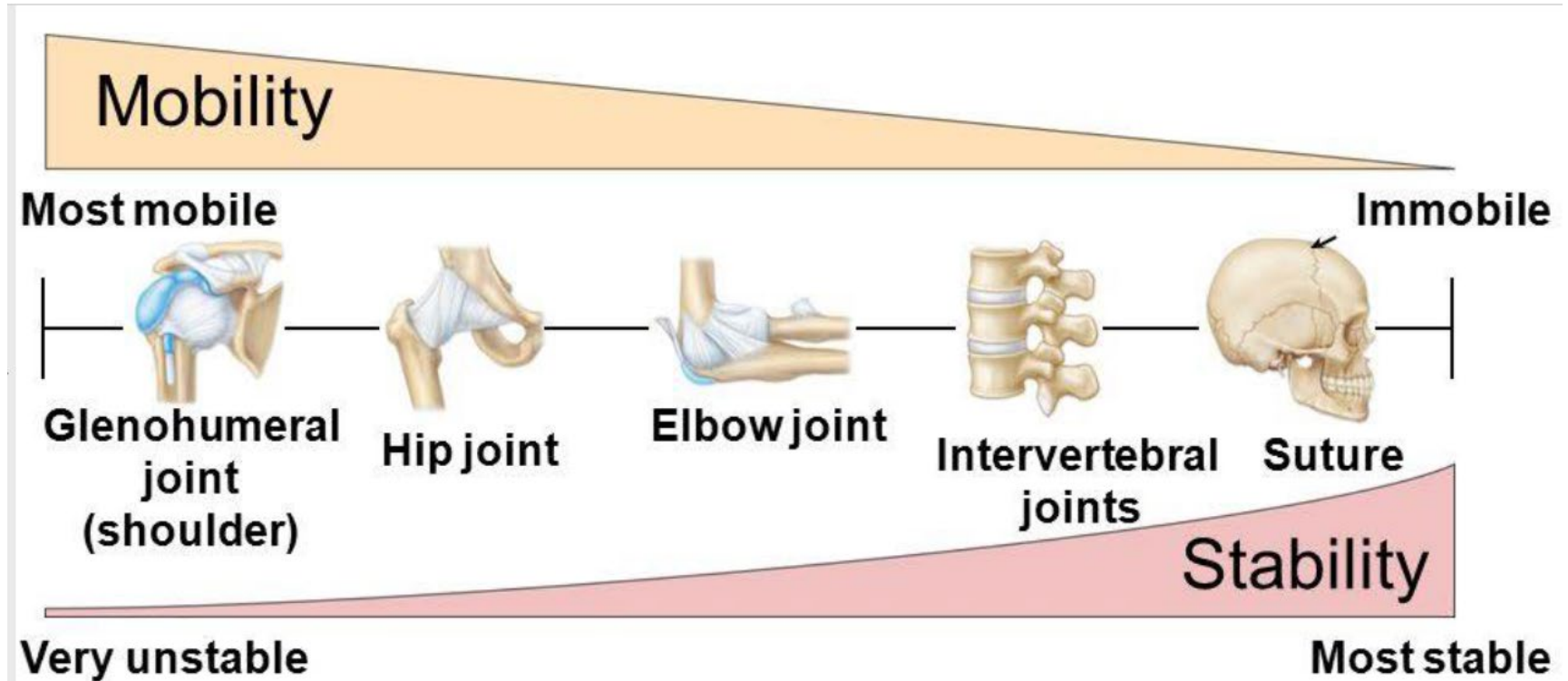
# Mechanics of Human Movement

Material and Mechanics in Medicine HS 2019

Jack Kendall

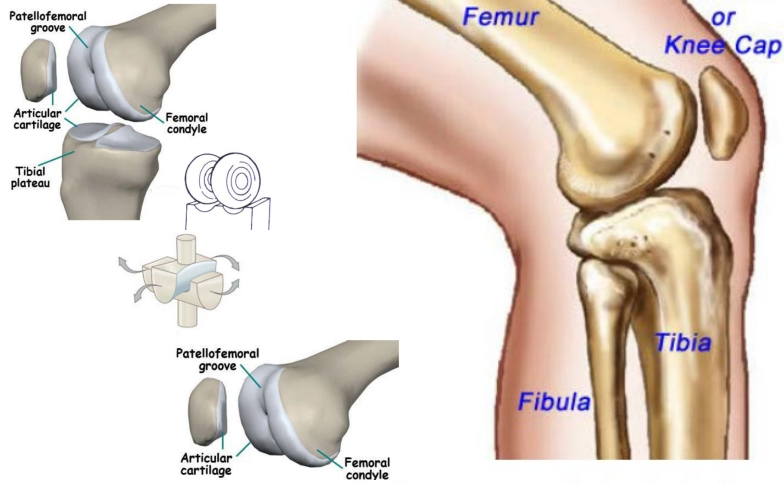
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# Joints Tradeoff



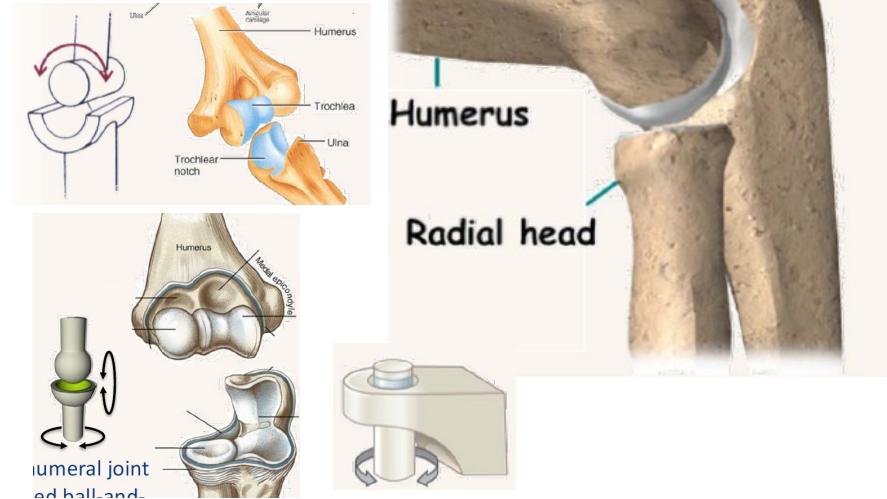
# Anatomy

## Knee



- Fibula is not part of the joint
- Tibiofemoral joint: Condylloid hinge joint
- Patellafemoral joint: Saddle joint

## Elbow



- Radius is part of the joint
- Ulnohumeral joint: Typical hinge joint
- Radiohumeral joint: limited ball-and-socket joint
- Radioulnar joint: pivot joint

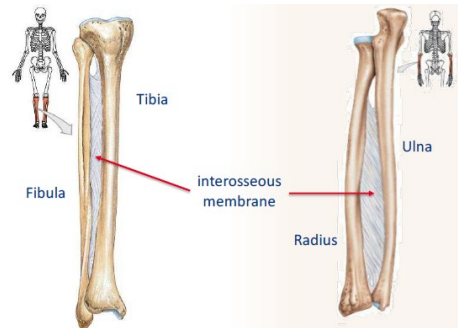
# Anatomy

## Knee

- Extension dominant
- Lever arm achieved with patella

### *Interosseous Membrane:*

- Stability
- Transmits forces
- 100% transmitted tibia → femur



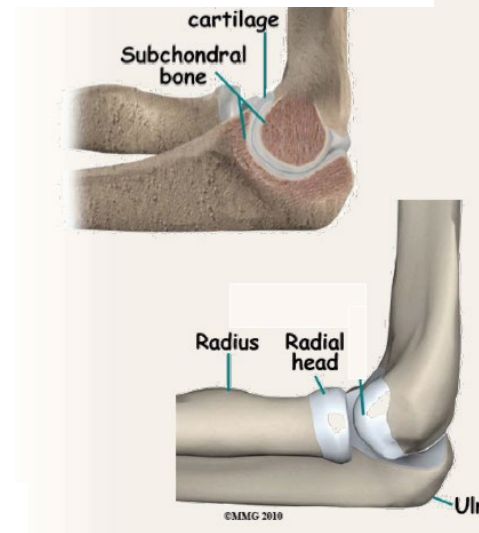
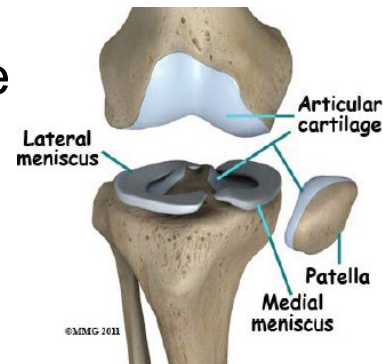
## Elbow

- Flexion dominant
- Lever arm with biceps-radius attachment

- 57% radius vs 43% humerus
- Separates tissues during twisting

# Cartilage and Meniscus

- Osteoarthritis
  - Women are more susceptible
  - Risk factors:
    - Overuse
    - Skeletal deformations
    - Joint laxity



## Meniscus

- 60-70%
- Type I 75% dw
- 1.5% dw
- 'Fibrochondrocytes'

## Composition

- Water
- Collagen
- Proteoglycans
- Cells

## Cartilage

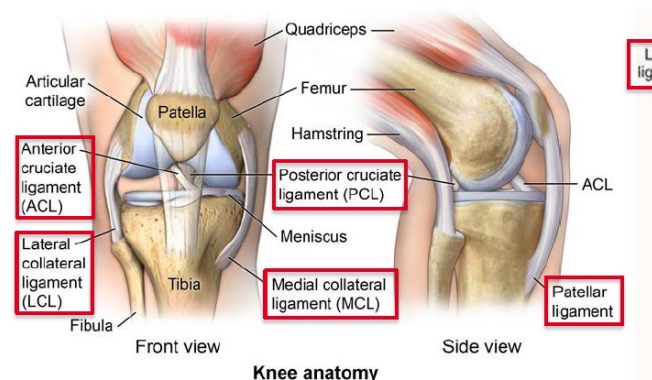
- 65-85%
- Type II 60% dw
- 12.5% dw
- Chondrocytes

- Stability due to wedge effect
- Optimized load distribution (shock absorption)

# Ligaments and Tendons

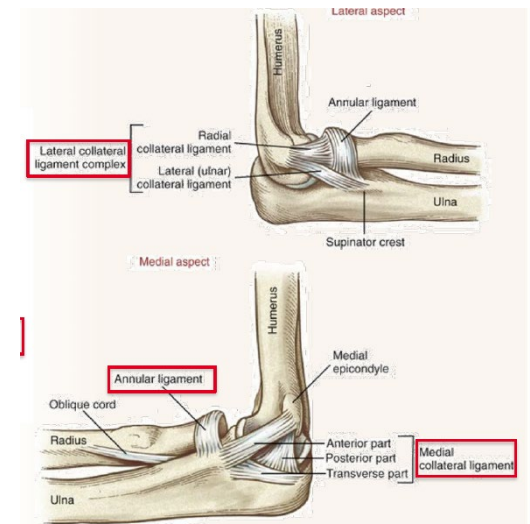
## Knee

- LCL: restrain to varus stress
- MCL: restrain to valgus stress
- ACL:
  - anterior displacement of tibia
  - Internal knee rotation
  - Hyperextension
- PCL:
  - Posterior displacement of tibia
  - External knee rotation



## Elbow

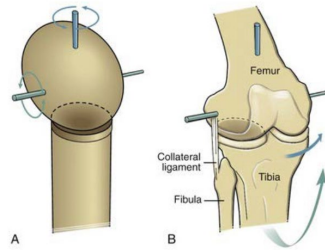
- LCL: restrain to varus stress
- MCL: restrain to valgus stress
- Quadrate ligament: prevents hyper-supination



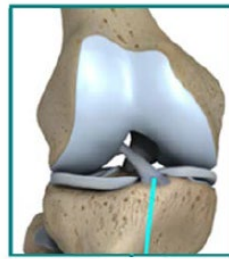
# Kinematics

## Knee

- Rotation
  - Condylod hinge joint: 2 axes
  - Frontal plane rotation blocked by MCL and LCL



- Flexion:
  - Tissue contact

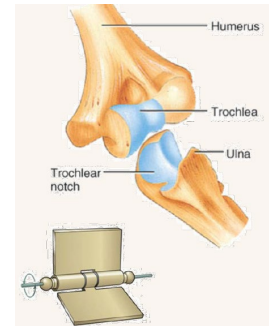


Anterior cruciate ligament

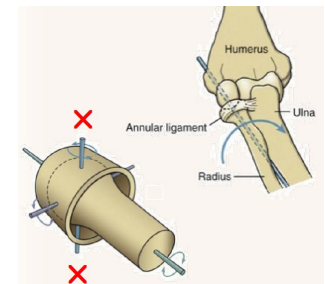
- Extension:
  - ACL
- Centre of rotation not fixed

## Elbow

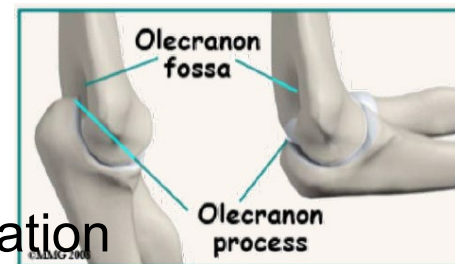
- Rotation
  - Hinge joint: 1 axis,
  - Pivot/Hinge joint: 2 axes
  - others axes blocked by joint shape and collateral ligaments



- Flexion:
  - Tissue Contact



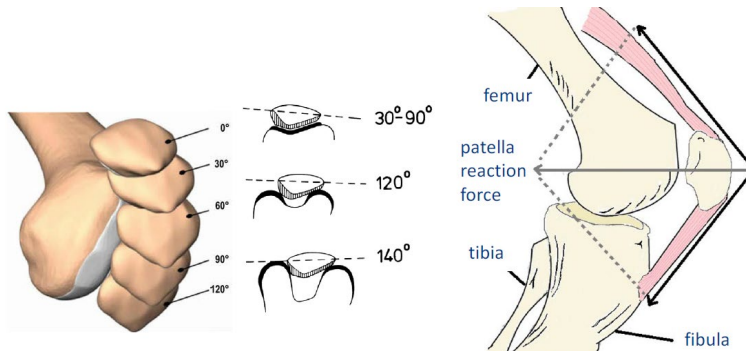
- Extension:
  - Olecranon
- Fix centre of rotation



# Kinetics

## Patella

- Patellar force:
  - Low in extension
  - Very high in flexion
- Force reducing mechanisms
  - Meniscus and femur slide posterior
  - Patella sinks into patella groove (provides also joint stability)



## Meniscus

- Shock-absorption
- Increase congruency & area of contact
- Deepens articulation
- Wedge shape:
  - Increased area of contact
  - Less contact between opposing cartilages in flexion
  - Load transmission:
    - 50% in extension
    - 85% in flexion



**Thank you!**

