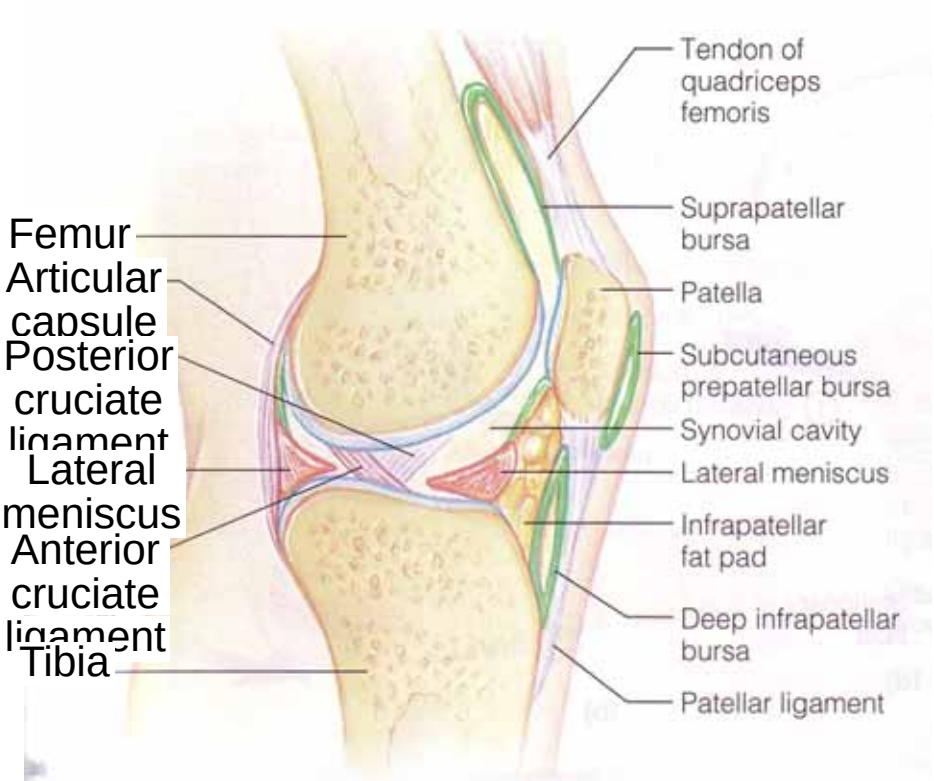
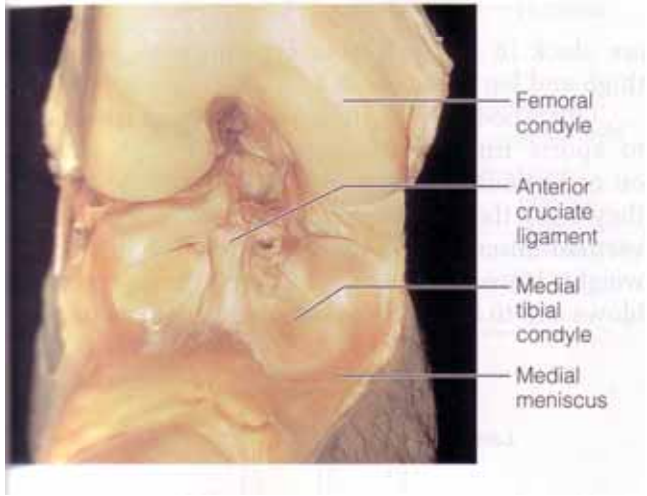
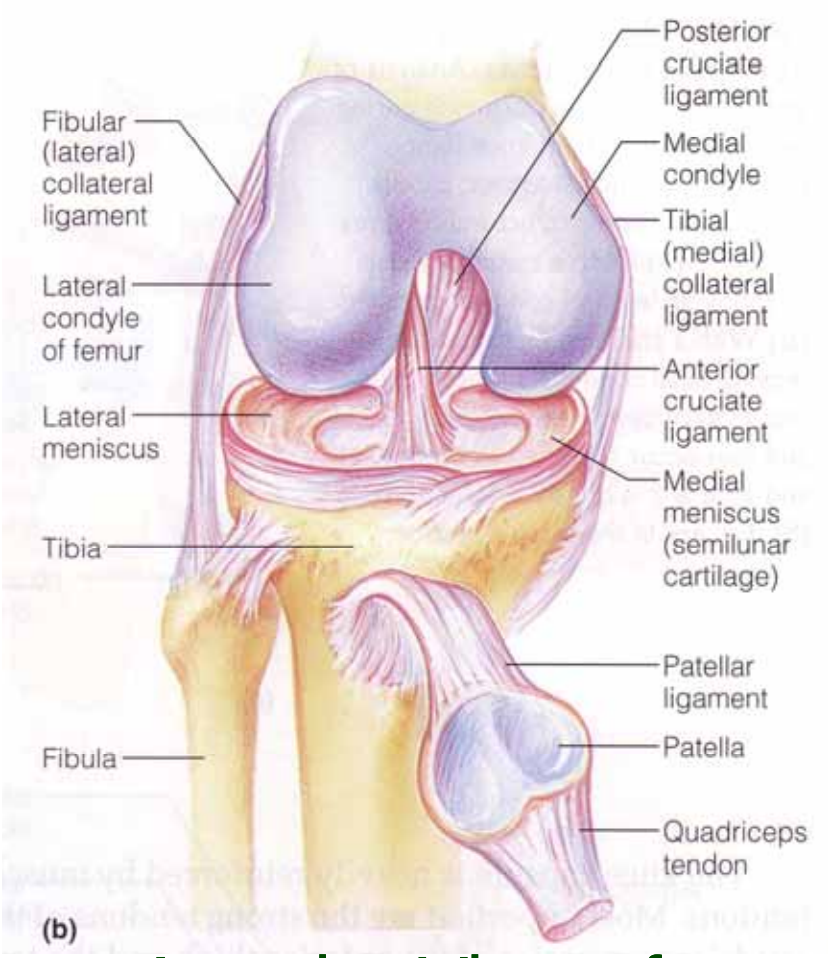
Section 29: Knee Biomechanics Structure and Function







Anterior View of Right Knee

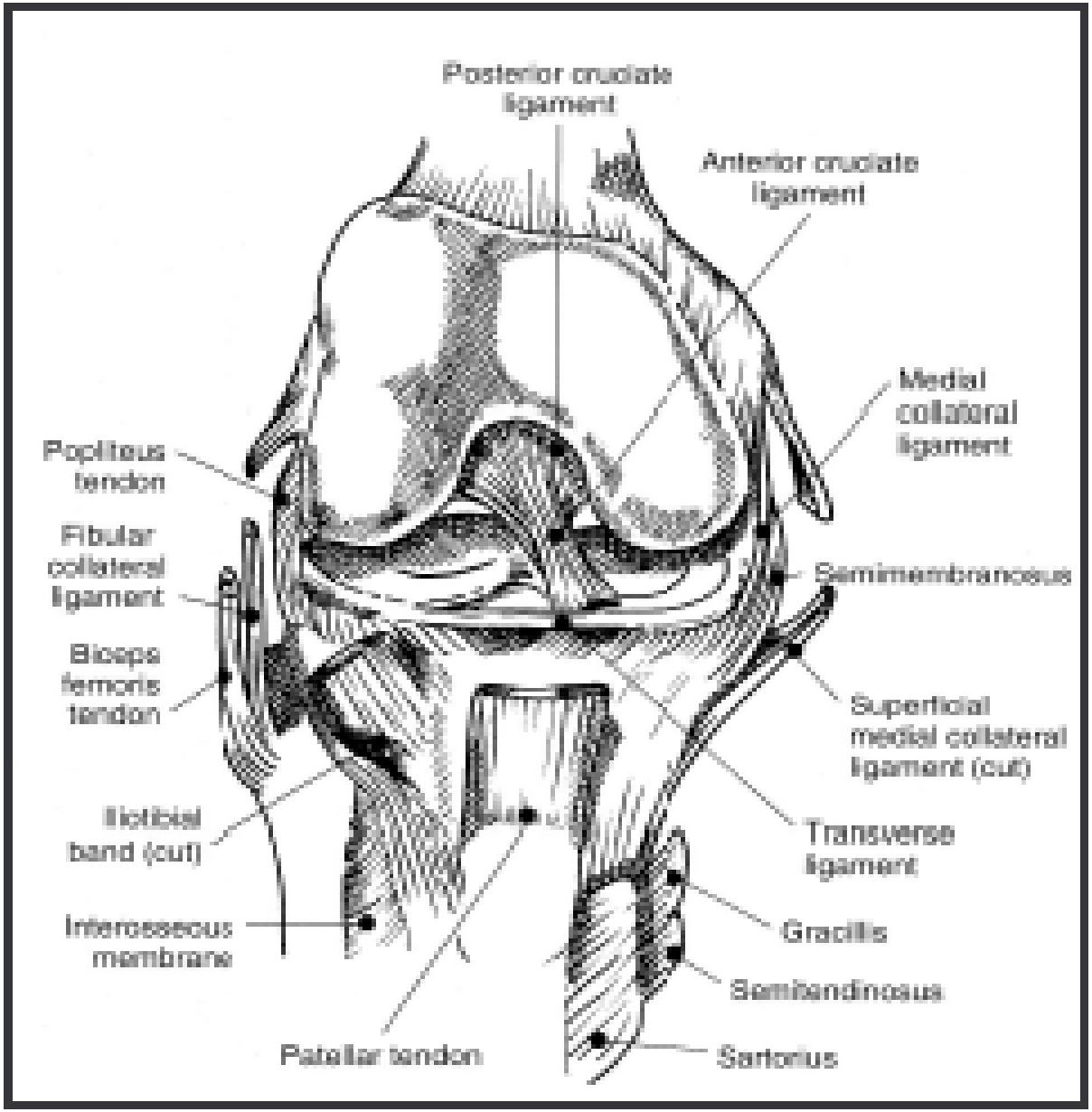
From: Garner

Introduction

- Knee is a 2-joint structure
  - Tibiofemoral joint
  - Patellofemoral joint
- Sustains high forces and moments
- Situated between the body's 2 longest lever arms

From: Iatridis

- Bones
- Ligaments
- Capsule
- Menisci
- Muscles
- Tendons
- Bursa



From: Peeler

Quick Facts

- Patellofemoral Joint (PFJ)
- Variations in PFJ loading during OKC (open kinetic chain) and CKC (closed kinetic chain) activities
- PFJ loading increases:
  - with increased flexion in CKC
  - with increased extension in OKC
- PFJ Loading
- Walking
  - 0.3 x body weight
- Ascending Stairs
  - 2.5 x body weight
- Descending Stairs
  - 3.5 x body weight
- Squatting
  - 7 x body weight

From: Scifers

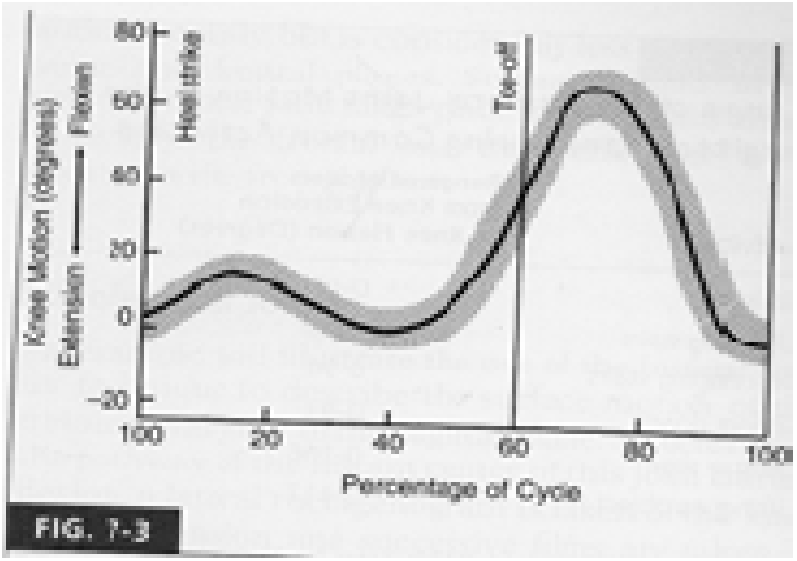
Movements at Joint
3 planes of motion

- Sagittal plane (flex – ext)
  - 0° to 140° of flexion
  - Largest range
  - Most important to movement
- Transverse plane (int – ext rotation)
  - ROM influenced by position of the joint in the sagittal plane
  - Ext. – almost no ROM
  - Max at 90° of knee flexion (45° of ext / 30° of into rotation)
  - Beyond 90° of knee flexion rotation decreases because of soft tissue approximation
- Frontal plane (abd – adduction)
  - None with knee in full ext.
  - Increases as knee moves to 30° of flexion

From: Peeler

Range of motion

- Tibiofemoral joint
  - Motion in all 3 planes
  - Range of motion is largest in sagittal plane
    - 0 to ~140 degrees
  - Knee flexion greatest after toe-off in gait cycle



Range of motion in sagittal plane during gait cycle

Range of Tibiofemoral Joint Motion in the Sagittal Plane During Common Activities

Activity	Range of Motion from Knee Extension to Knee Flexion (Degrees)
Walking	0–67[a]
Climbing stairs	0–83[b]
Descending stairs	0–90
Sitting down	0–93
Tying a shoe	0–106
Lifting an object	0–117

From: Peeler

Range of motion during common activities

- Range of motion of at least 117 deg of flexion is required to carry out the activities of daily living
- Restriction of knee motion can be compensated for by increasing motion in other joints

TABLE 7-1

Range of Tibiofemoral Joint Motion in the Sagittal Plane During Common Activities

Activity	Range of Motion from Knee Extension to Knee Flexion (Degrees)
Walking	0–67[a]
Climbing stairs	0–83[a]
Descending stairs	0–90
Sitting down	0–93
Tying a shoe	0–106
Lifting an object	0–117

[a]Data from Kettelkamp et al. (1970). Mean for 22 subjects. A slight difference was found between right and left knees (mean for right knee 68.1°, mean for left knee 66.7°).

[b]These and subsequent data from Laubenthal et al. (1972). Mean for 30 subjects.

From: Iatridis

Range of motion during ADL's (2)

- As speed of motion increases, so does the range of motion in knee joint

TABLE 7-2

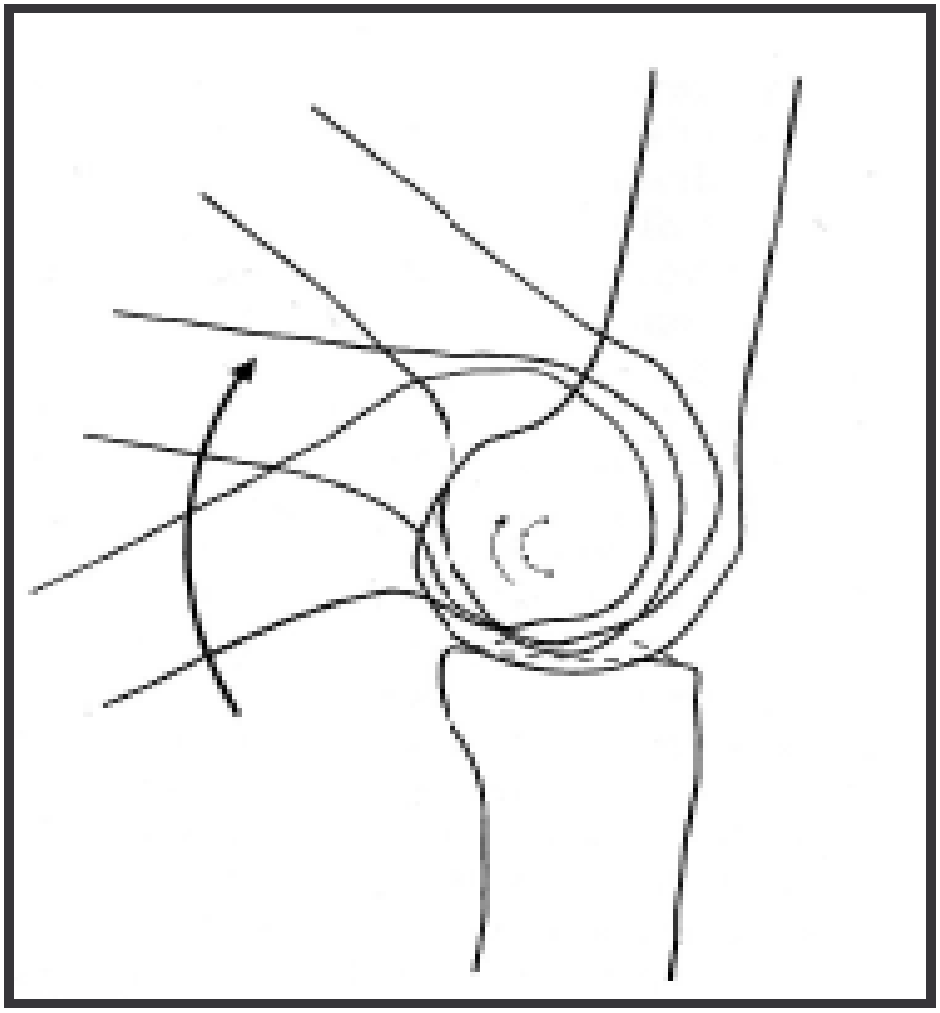
Amount of Knee Flexion During Stance Phase of Walking and Running

Activity	Range in Amount of Knee Flexion During Stance Phase (Degrees)
Walking	
Slow	0–6
Free	6–12
Fast	12–18
Running	18–30

Data from Perry et al. (1977). Range for seven subjects

Normal Joint Motion

- Semicircular instant centre pathway
- Smooth and consistent motion between articular surfaces of a joint
- During knee flexion the femur slides & rolls (or glides) on the tibial condyles causing the instant centre of the joint to move slightly backwards.
- Provides max. joint contact at all times.
- Cruciate ligaments restrict the amount of backwards movement.



From: Peeler

Consequence of abnormal motion

- If joint surfaces do not glide tangentially throughout range of motion
  - Stretching of ligaments (lower angles of flexion)
  - Excessive compression on cartilage (higher angles of flexion)

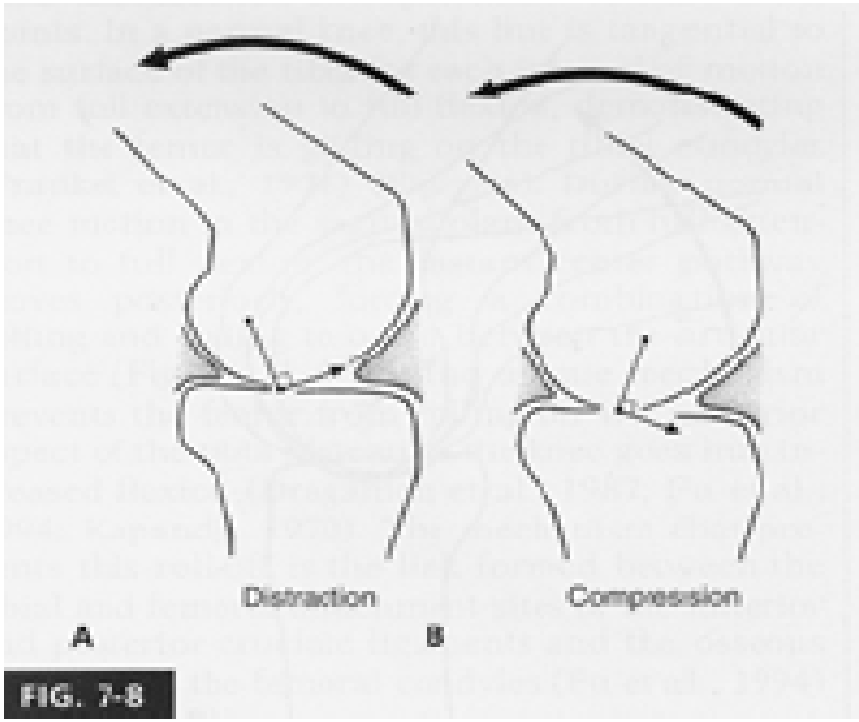


FIG. 7-8

From: Iatridis