Chapter 8
Joints of the Skeletal System

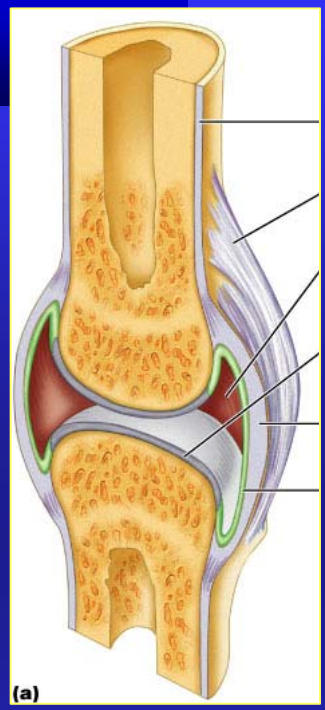
- Articulations
- Junctions between bones
- Bind parts of skeletal system together
- Make bone growth possible
- Permit parts of the skeleton to change shape during childbirth
- Enable body to move in response to skeletal muscle contraction

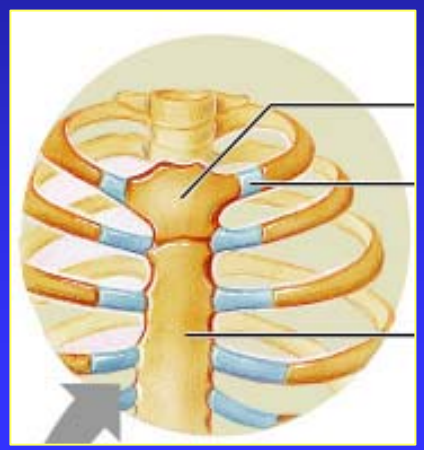
Joints = Articulations

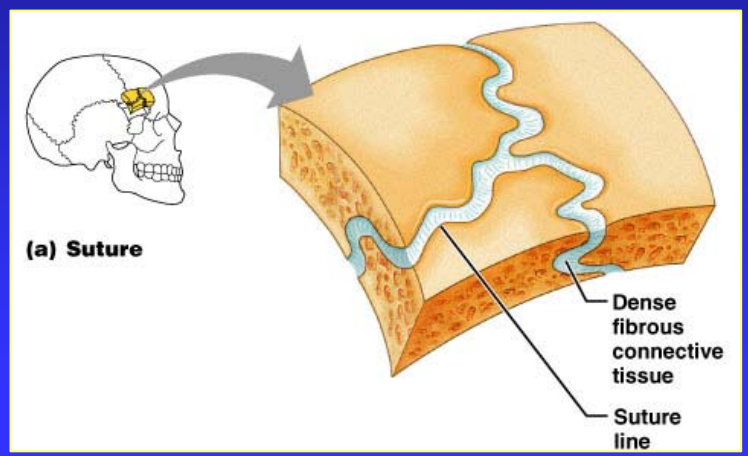
Articulation – site where two or more bones meet

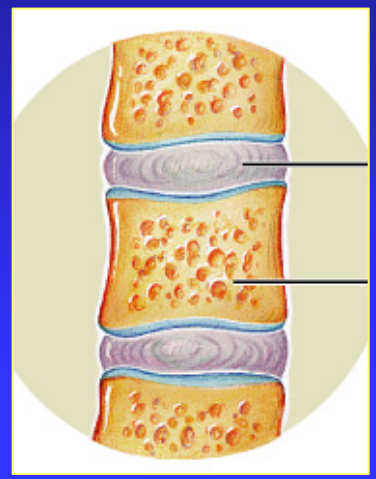
Two Fundamental Functions of Joints:

- Allow the skeleton to have mobility
- Hold the skeleton together









Joints – Structural and Functional Classes

Three Structural Classifications:

- Fibrous – suture, syndesomosis, gomphosis
- Cartilaginous – synchondrosis, symphysis
- Synovial

Three Functional Classifications

- Synarthrosis – immovable
- Amphiarthrosis – slightly movable
- Diarthrosis – freely movable

Classification of Joints

- **Fibrous Joints**
  - dense connective tissues connect bones
  - between bones in close contact
- **Cartilaginous Joints**
  - hyaline cartilage or fibrocartilage connect bones
- **Synovial Joints**
  - most complex
  - allow free movement

- **synarthrotic**
  - immovable
- **amphiarthrotic**
  - slightly movable
- **diarthrotic**
  - freely movable

TABLE 8.1 Types of Joints

Type of Joint	Description	Possible Movements	Example
Fibrous	Articulating bones fastened together by thin layer of dense connective tissue containing many collagenous fibers		
1. *Syndesmosis* (amphiarthrotic)	Bones bound by interosseous ligament	Joint flexible and may be twisted	Tibiofibular articulation
2. *Suture* (synarthrotic)	Flat bones united by sutural ligament	None	Parietal bones articulate at sagittal suture of skull
3. *Gomphosis* (synarthrotic)	Cone-shaped process fastened in bony socket by periodontal ligament	None	Root of tooth united with mandible
Cartilaginous	Articulating bones connected by hyaline cartilage or fibrocartilage		
1. *Synchondrosis* (synarthrotic)	Bones united by bands of hyaline cartilage	Movement occurs during growth process until ossification occurs	Joint between epiphysis and diaphysis of a long bone
2. *Symphysis* (amphiarthrotic)	Articular surfaces separated by thin layers of hyaline cartilage attached to band of fibrocartilage	Limited movement, as when back is bent or twisted	Joints between bodies of vertebrae
Synovial (diarthrotic)	Articulating bones surrounded by a joint capsule of ligaments and synovial membranes; ends of articulating bones covered by hyaline cartilage and separated by synovial fluid		
1. *Ball-and-socket*	Ball-shaped head of one bone articulates with cup-shaped socket of another	Movements in all planes; rotation	Shoulder, hip
2. *Condyloid*	Oval-shaped condyle of one bone articulates with elliptical cavity of another	Variety of movements in different planes, but no rotation	Joints between metacarpals and phalanges
3. *Gliding*	Articulating surfaces are nearly flat or slightly curved	Sliding or twisting	Joints between various bones of wrist and ankle
4. *Hinge*	Convex surface of one bone articulates with concave surface of another	Flexion and extension	Elbow and joints of phalanges
5. *Pivot*	Cylindrical surface of one bone articulates with ring of bone and fibrous tissue	Rotation	Joint between proximal ends of radius and ulna
6. *Saddle*	Articulating surfaces have both concave and convex regions; surface of one bone fits the complementary surface of another	Variety of movements, mainly in two planes	Joint between carpal and metacarpal of thumb

TABLE 8.2 Joints of the Body

Joint	Location	Type of Joint	Type of Movement
Skull	Cranial and facial bones	Suture, fibrous	Immovable, synarthrotic
Temporomandibular	Temporal bone, mandible	Modified hinge, synovial	Elevation, depression, protraction, retraction, diarthrotic
Atlanto-occipital	Atlas, occipital bone	Condyloid, synovial	Flexion, extension, diarthrotic
Atlantoaxial	Atlas, axis	Pivot, synovial	Rotation
Intervertebral	Between vertebral bodies	Symphysis, cartilaginous	Slight movement, amphiarthrotic
Intervertebral	Between articular processes	Gliding, synovial	Flexion, extension, slight rotation, diarthrotic
Sacroiliac	Sacrum and hipbone	Gliding, synovial	Little to no movement, diarthrotic
Vertebrocostal	Vertebrae and ribs	Gliding, synovial	Slight movement during breathing, diarthrotic
Sternoclavicular	Sternum and clavicle	Gliding, synovial	Slight movement when shrugging shoulders, diarthrotic
Sternocostal	Sternum and rib 1	Synchondrosis, cartilaginous	Immovable, synarthrotic
Sternocostal	Sternum and ribs 2–7	Gliding, synovial	Slight movement during breathing, diarthrotic
Acromioclavicular	Scapula and clavicle	Gliding, synovial	Protraction, retraction, elevation, depression, diarthrotic
Shoulder (glenohumeral)	Humerus and scapula	Ball-and-socket, synovial	Flexion, extension, adduction, abduction, rotation, circumduction, diarthrotic
Elbow	Humerus and ulna	Hinge, synovial	Flexion, extension, diarthrotic
Proximal radioulnar	Radius and ulna	Pivot, synovial	Rotation, diarthrotic
Distal radioulnar	Radius and ulna	Syndesmosis, fibrous	Slight movement, amphiarthrotic
Wrist (radiocarpal)	Radius and carpals	Condyloid, synovial	Flexion, extension, adduction, abduction, circumduction, diarthrotic

TABLE 8.2 Joints of the Body *(continued)*

Joint	Location	Type of Joint	Type of Movement
Intercarpal	Adjacent carpals	Gliding, synovial	Slight movement, diarthrotic
Carpometacarpal	Carpal and metacarpal 1	Saddle, synovial	Flexion, extension, adduction, abduction, diarthrotic
Carpometacarpal	Carpals and metacarpals 2–5	Condyloid, synovial	Flexion, extension, adduction, abduction, diarthrotic
Metacarpophalangeal	Metacarpal and proximal phalanx	Condyloid, synovial	Flexion, extension, adduction, abduction, diarthrotic
Interphalangeal	Adjacent phalanges	Hinge, synovial	Flexion, extension, diarthrotic
Symphysis pubis	Pubic bones	Symphysis, cartilaginous	Slight movement, amphiarthrotic
Hip	Hipbone and femur	Ball-and-socket, synovial	Flexion, extension, adduction, abduction, rotation, circumduction, diarthrotic
Knee (tibiofemoral)	Femur and tibia	Modified hinge, synovial	Flexion, extension, slight rotation when flexed, diarthrotic
Knee (femoropatellar)	Femur and patella	Gliding, synovial	Slight movement, diarthrotic
Proximal tibiofibular	Tibia and fibula	Gliding, synovial	Slight movement, diarthrotic
Distal tibiofibular	Tibia and fibula	Syndesmosis, fibrous	Slight movement, amphiarthrotic
Ankle (talocrural)	Talus, tibia, and fibula	Hinge, synovial	Dorsiflexion, plantar flexion, slight circumduction, diarthrotic
Intertarsal	Adjacent tarsals	Gliding, synovial	Inversion, eversion, diarthrotic
Tarsometatarsal	Tarsals and metatarsals	Gliding, synovial	Slight movement, diarthrotic
Metatarsophalangeal	Metatarsal and proximal phalanx	Condyloid, synovial	Flexion, extension, adduction, abduction, diarthrotic

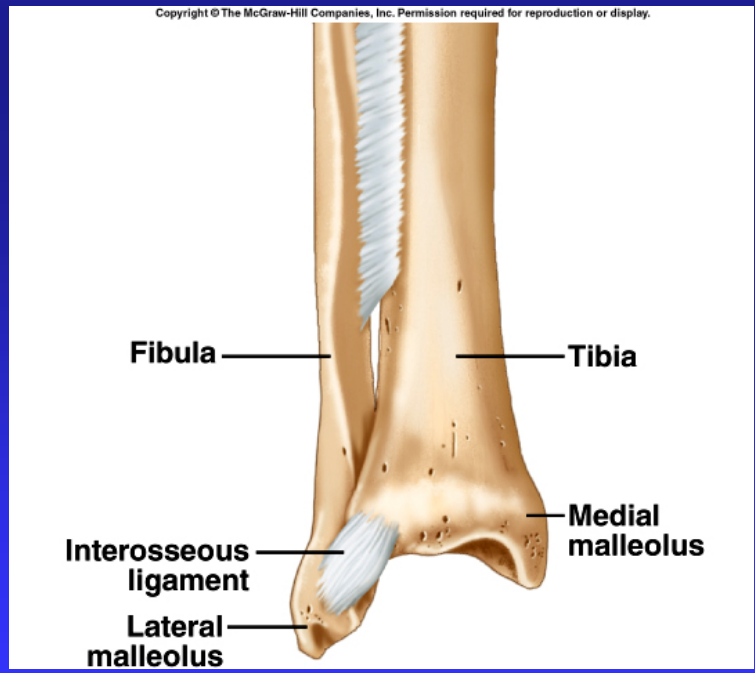
Fibrous Joints

3 Types

- Syndesmosis
- Suture
- Gomphosis

Syndesmosis

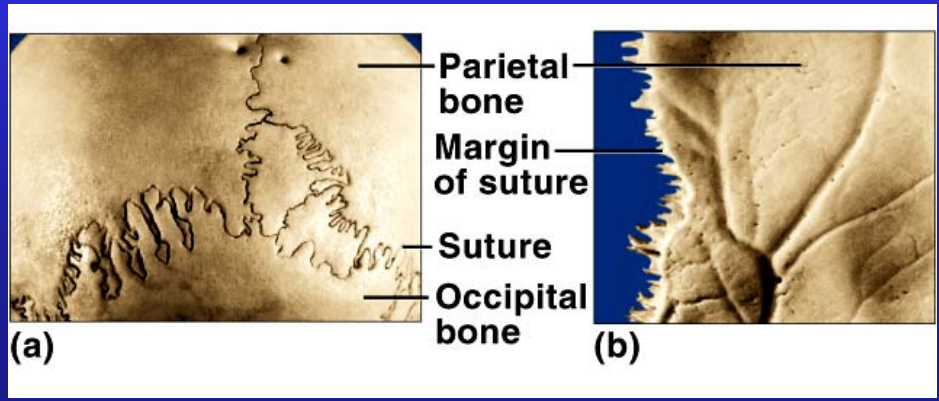
- long fibers connect bones
- amphiarthrotic
- distal ends of tibia and fibula



Fibrous Joints

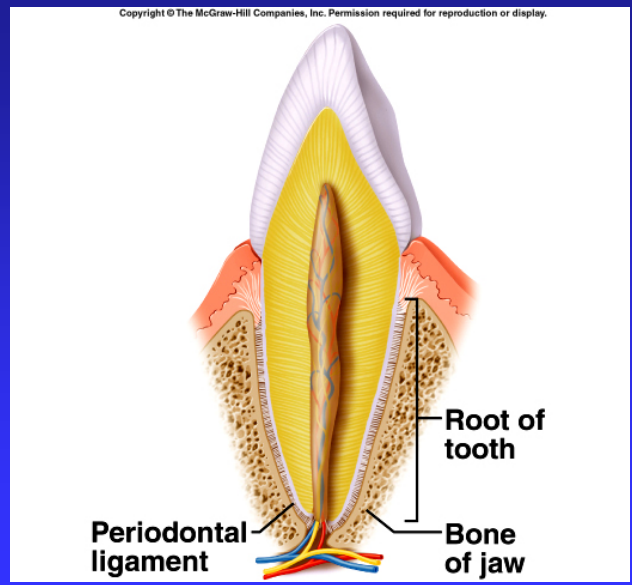
Suture

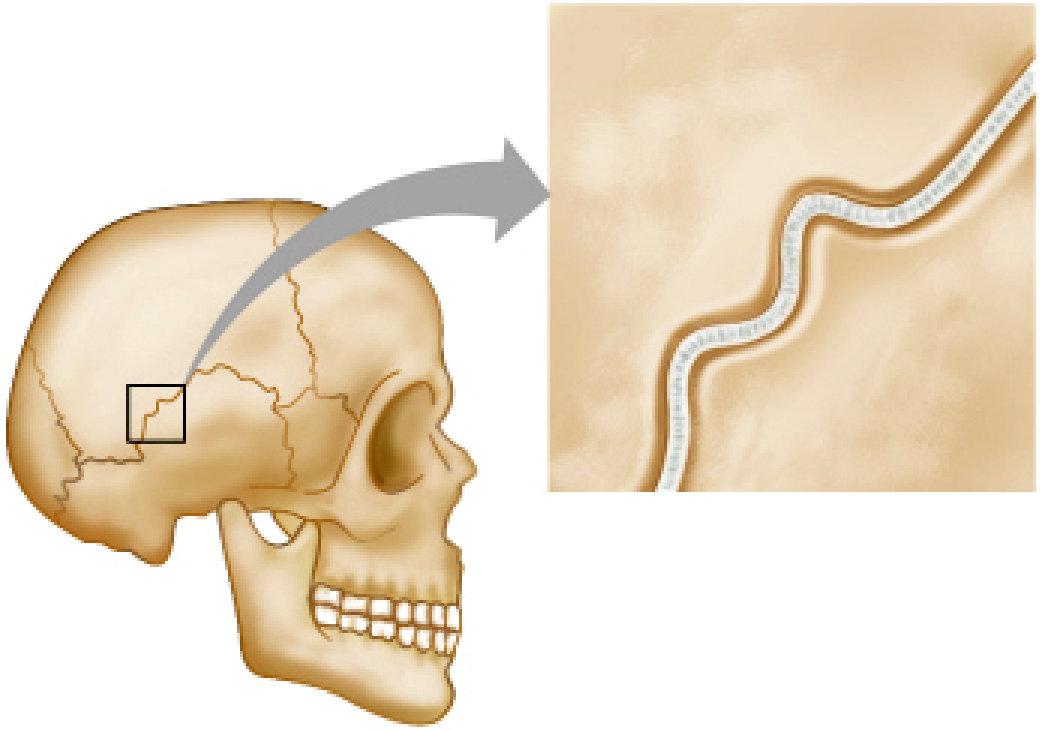
- between flat bones
- synarthrotic
- thin layer of connective tissue connects bones



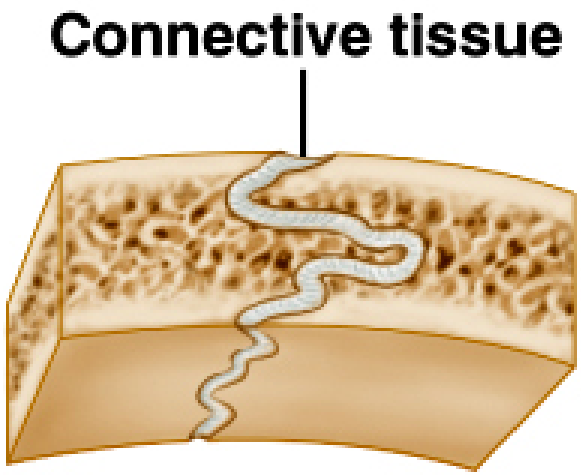
Gomphosis

- cone-shaped bony process in a socket
- tooth in jawbone
- synarthrotic





(a)

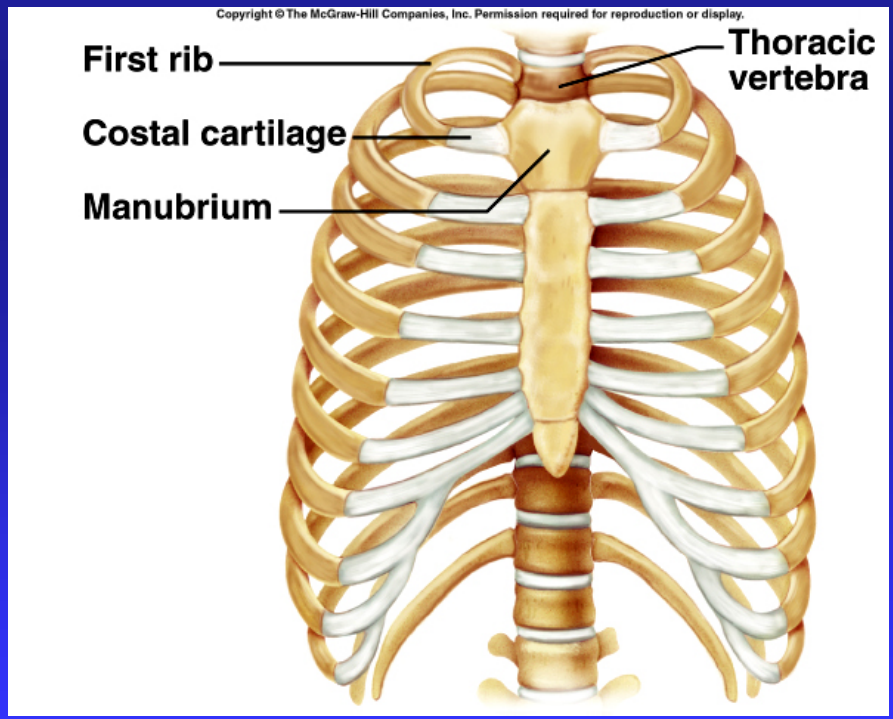


(b)

Cartilaginous Joints

2 Types
- Synchondrosis
- Symphysis

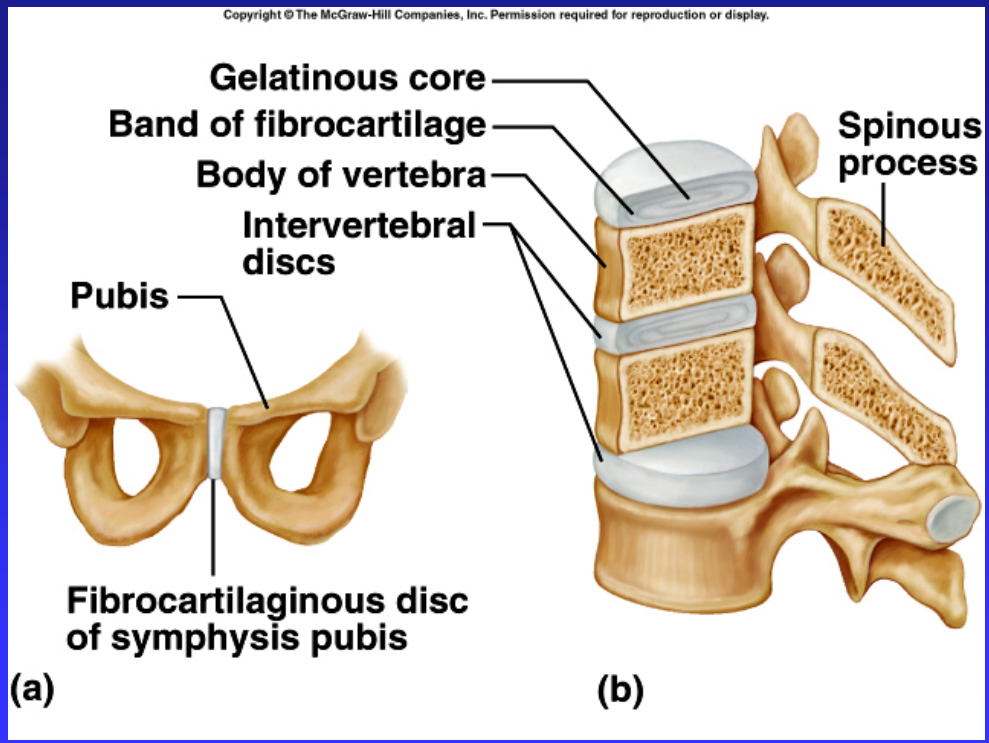
Synchondrosis
- bands of hyaline cartilage unite bones
- epiphyseal plate (temporary)
- between manubrium and first rib
- synarthrotic



Cartilaginous Joints

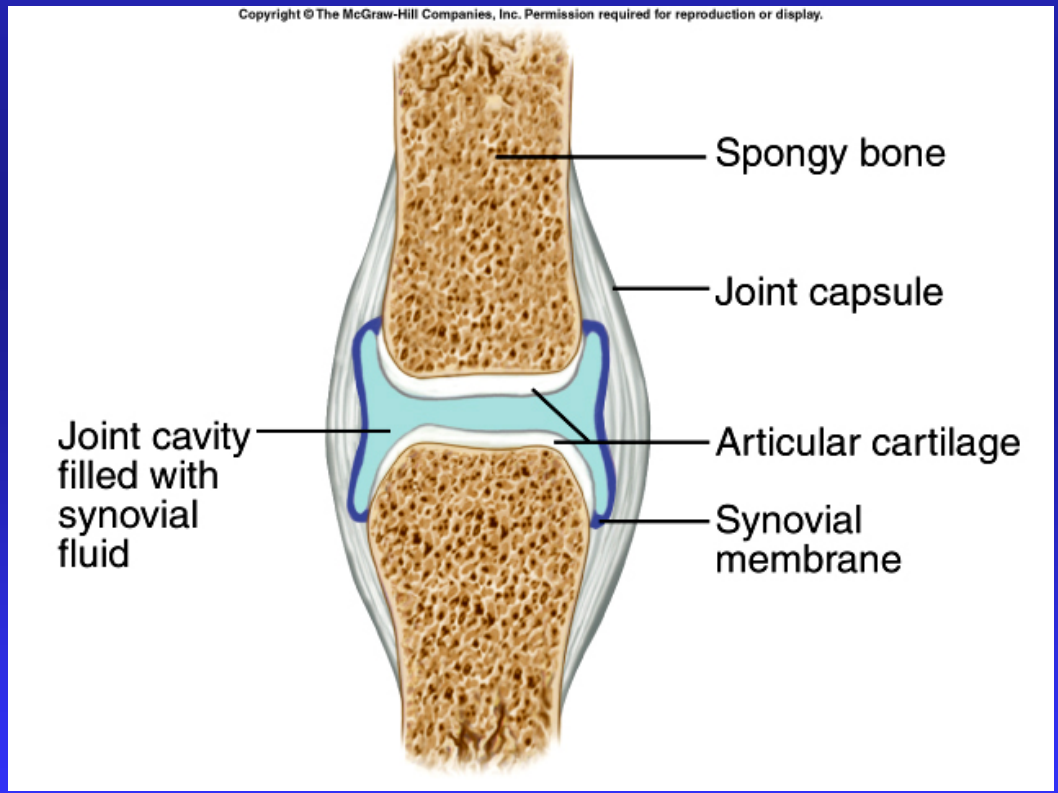
Symphysis

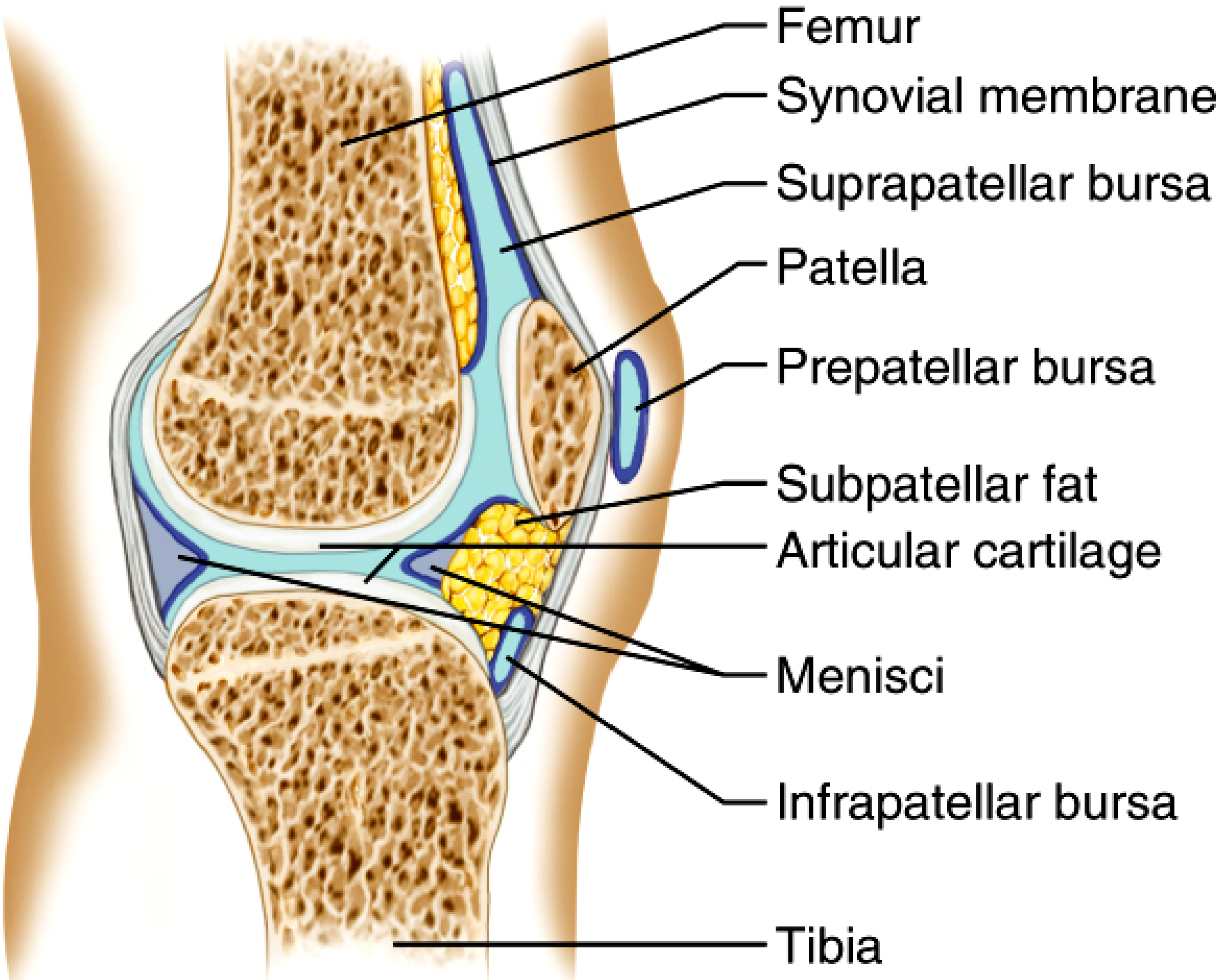
- pad of fibrocartilage between bones
- pubis symphysis
- joint between bodies of vertebrae
- amphiarthrotic



Synovial Joints

- diarthrotic
- joint cavity
- synovial fluid
- joint capsule
- synovial membrane
- bursae





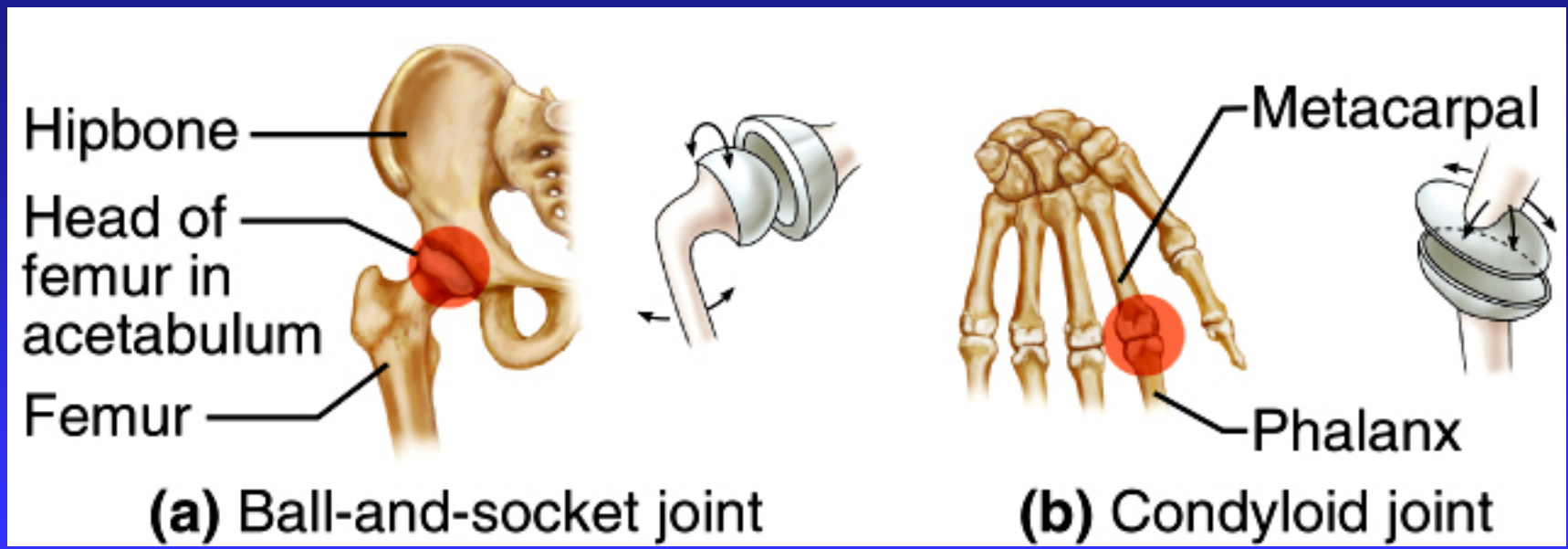
Types of Synovial Joints

Ball-and-Socket Joint

- **hip**
- **shoulder**

Condyloid Joint

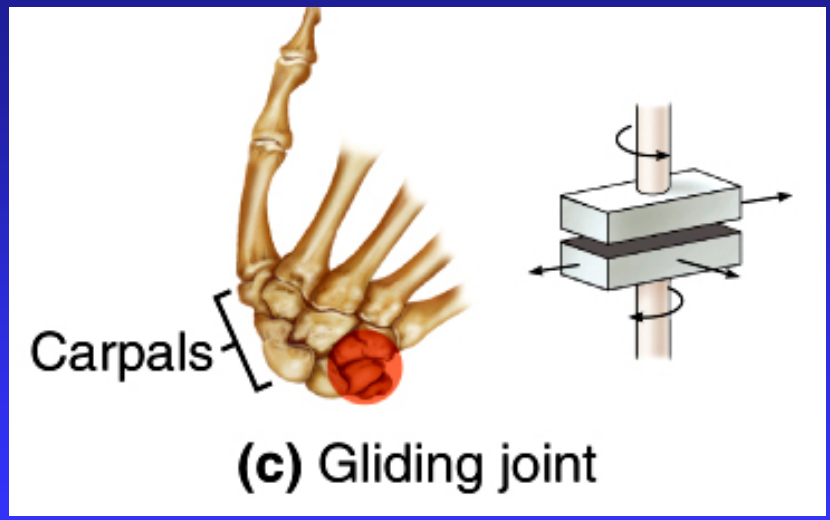
- **between metacarpals and phalanges**



Types of Synovial Joints

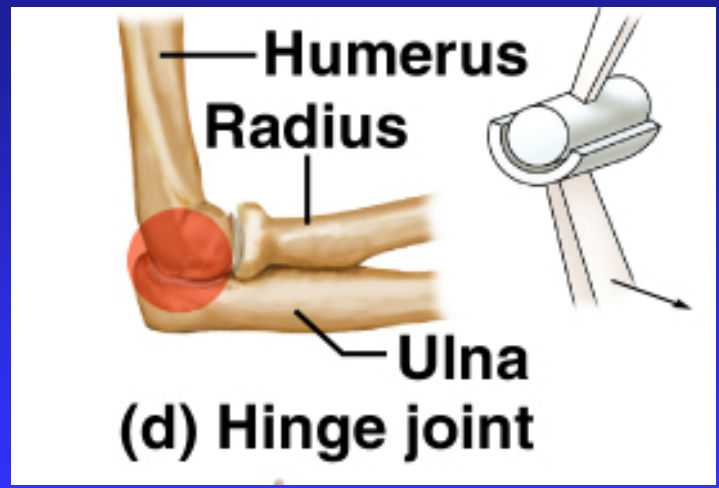
Gliding Joint

- between carpals
- between tarsals



Hinge Joint

- elbow
- between phalanges



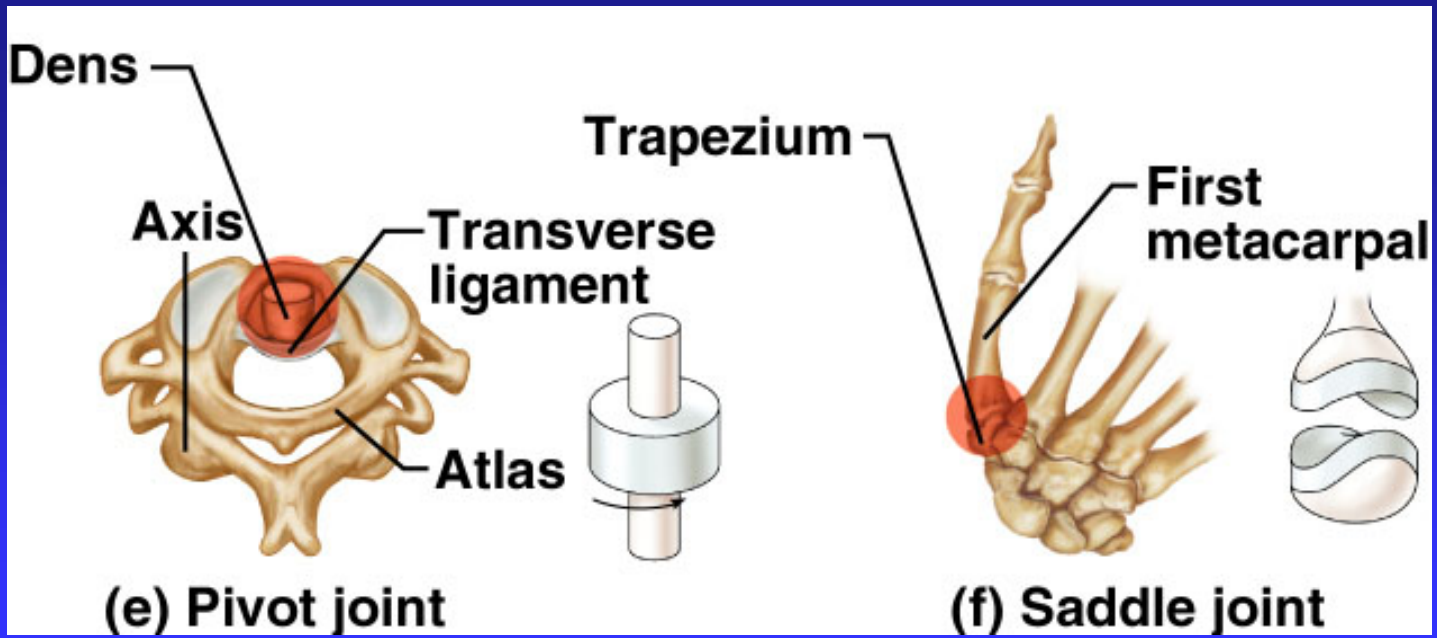
Types of Synovial Joints

Pivot Joint

- between proximal ends of radius and ulna

Saddle Joint

- between carpal and metacarpal of thumb



Angular Movement – Change of Angle Between Bones

Flexion — bending movement that decreases the angle of the joint

Extension — reverse of flexion; joint angle increases

Dorsiflexion and Plantar flexion — up and down movement of the foot

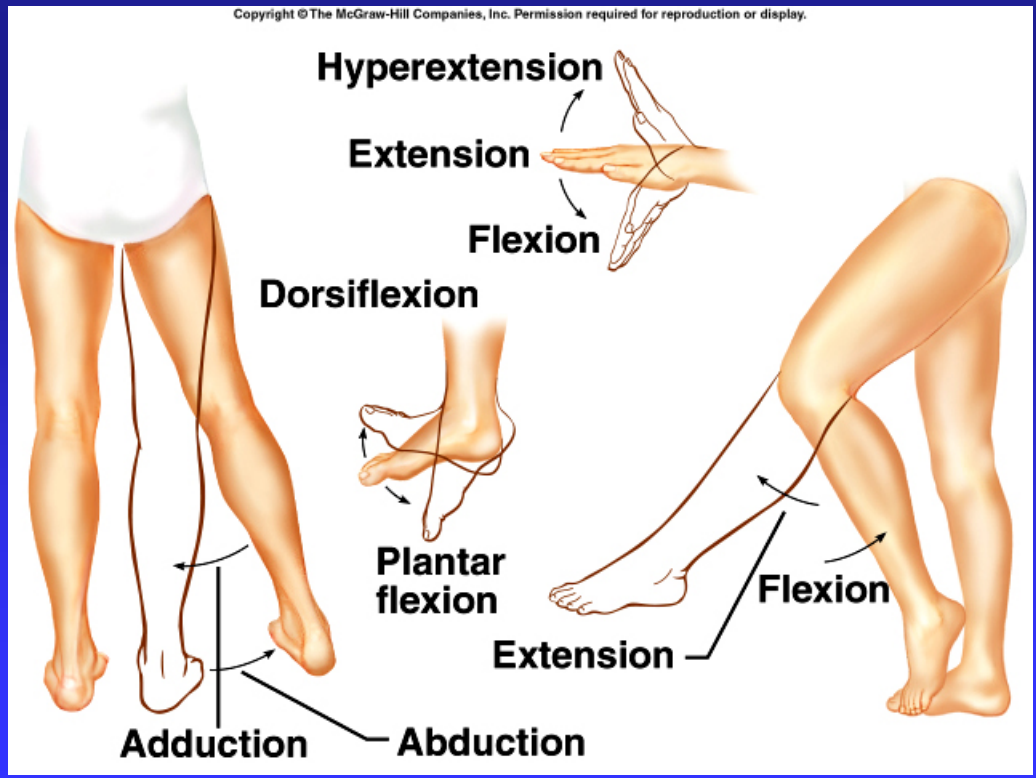
Abduction — movement of a limb away from the midline or median plane

Adduction — movement of a limb toward the midline or median plane

Circumduction — movement of a limb describing a cone in space

Types of Joint Movements

- abduction/adduction
- dorsiflexion/plantarflexion
- flexion/extension/hyperextension



Rotation

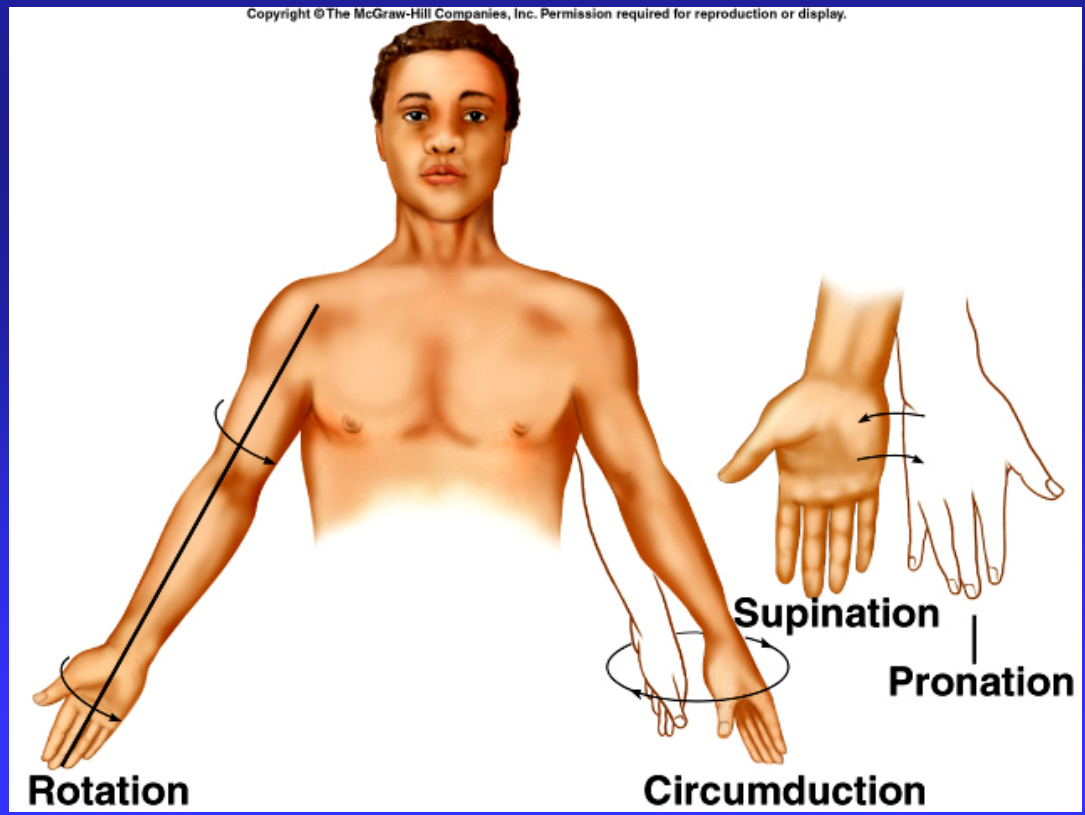
The turning of a bone around its own long axis

Examples:

- Between first two vertebrae
- Hip and shoulder joints

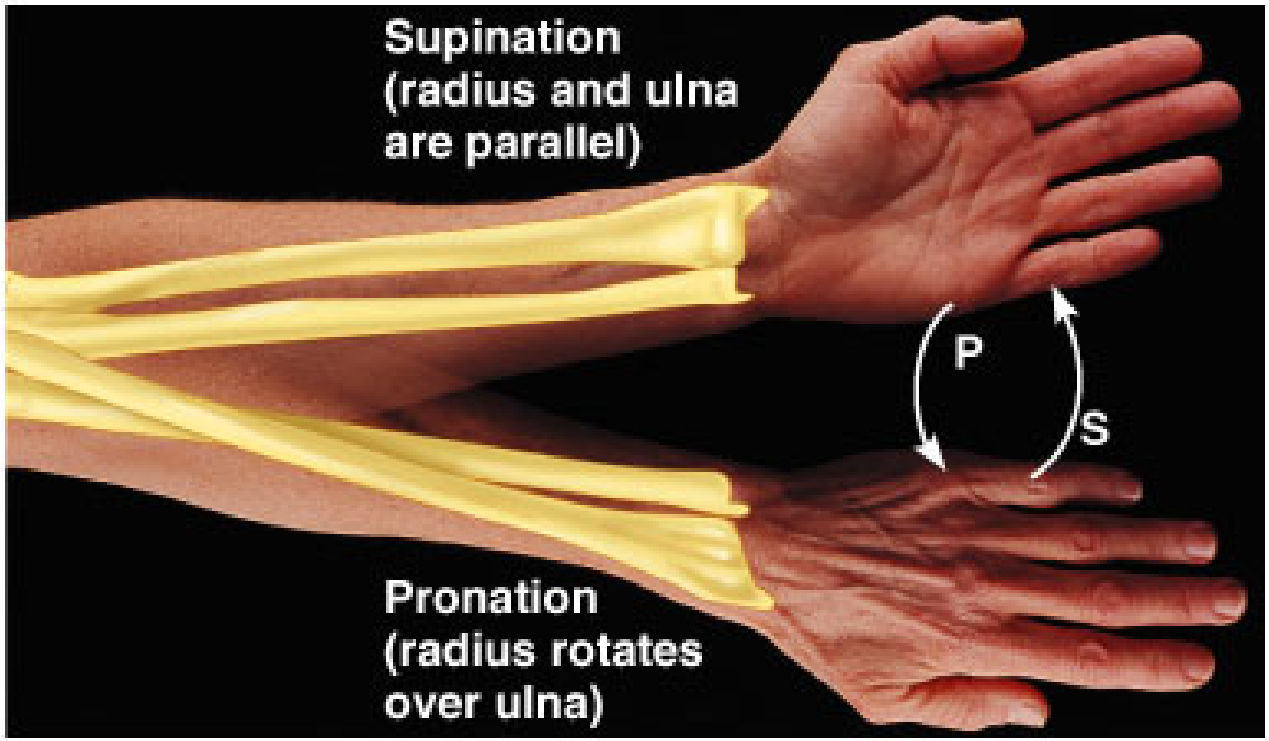
Types of Joint Movements

- rotation/circumduction
- supination/pronation



Special Movements

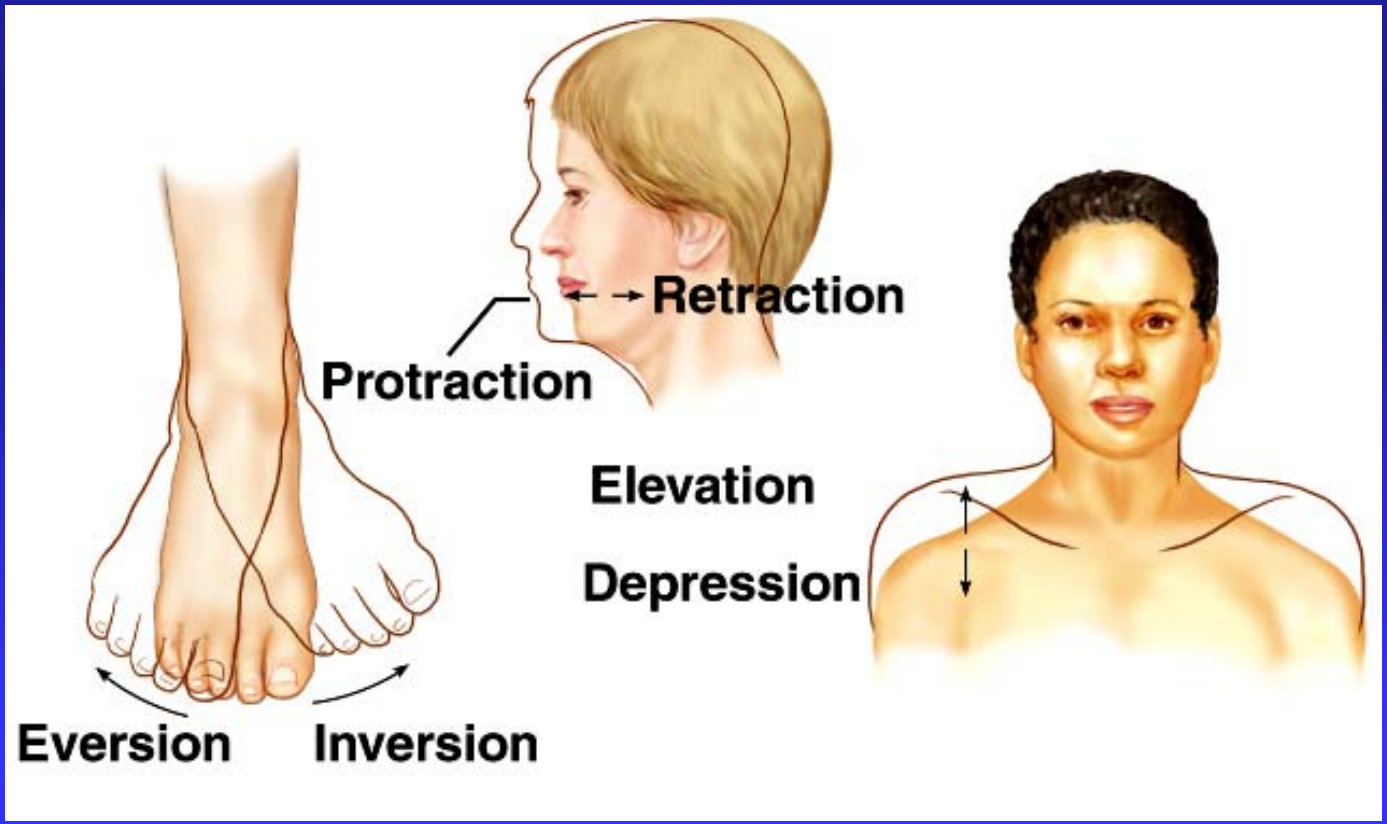
Supination and Pronation – refer to movements of radius around the ulna (also applied to foot movements)



(a) Supination (S) and pronation (P)

Types of Joint Movements

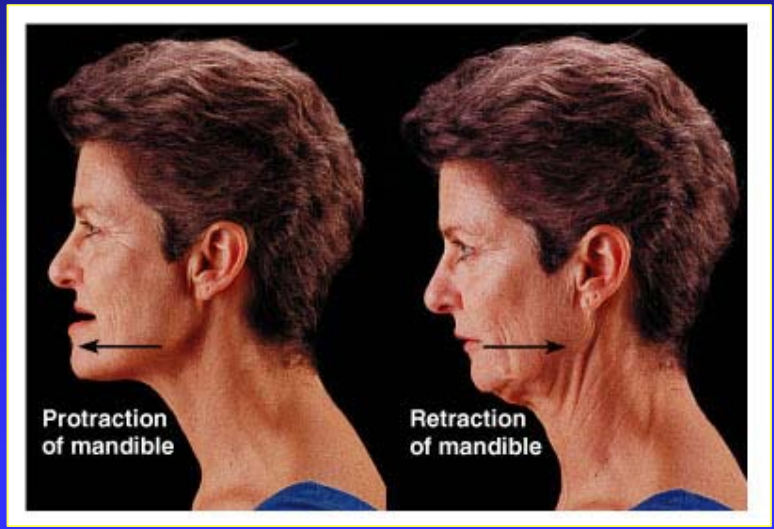
- eversion/inversion
- protraction/retraction
- elevation/depression



Special Movements

Inversion and Eversion

Protraction and Retraction



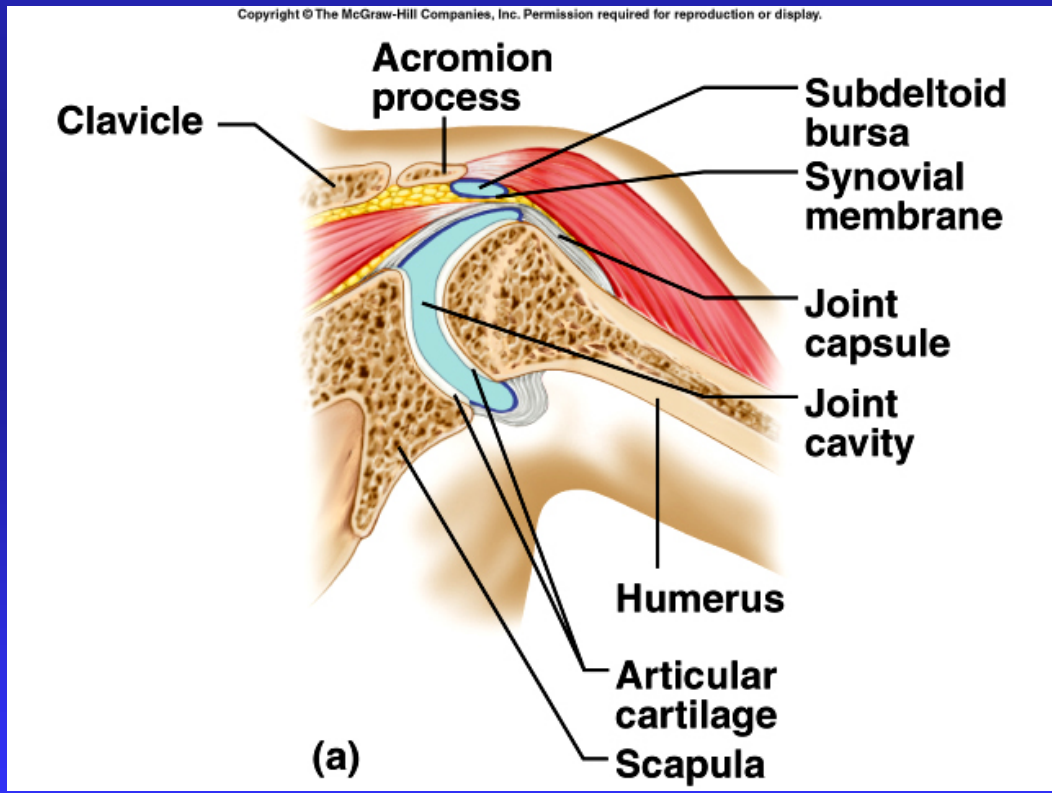
Special Movements

Elevation and Depression

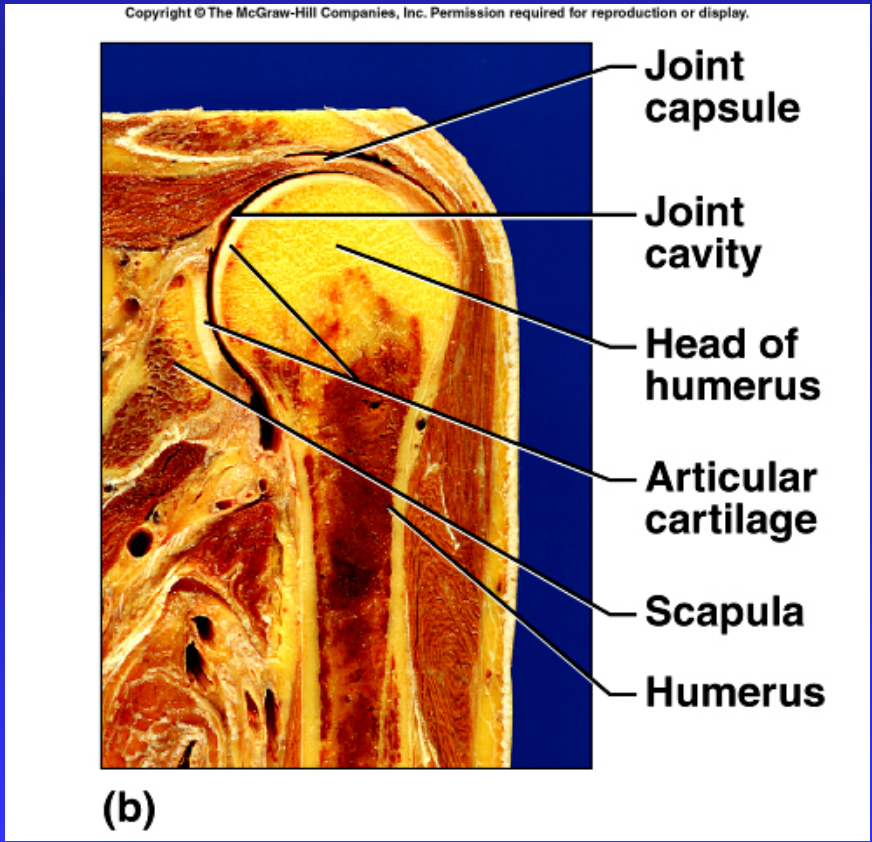
Opposition

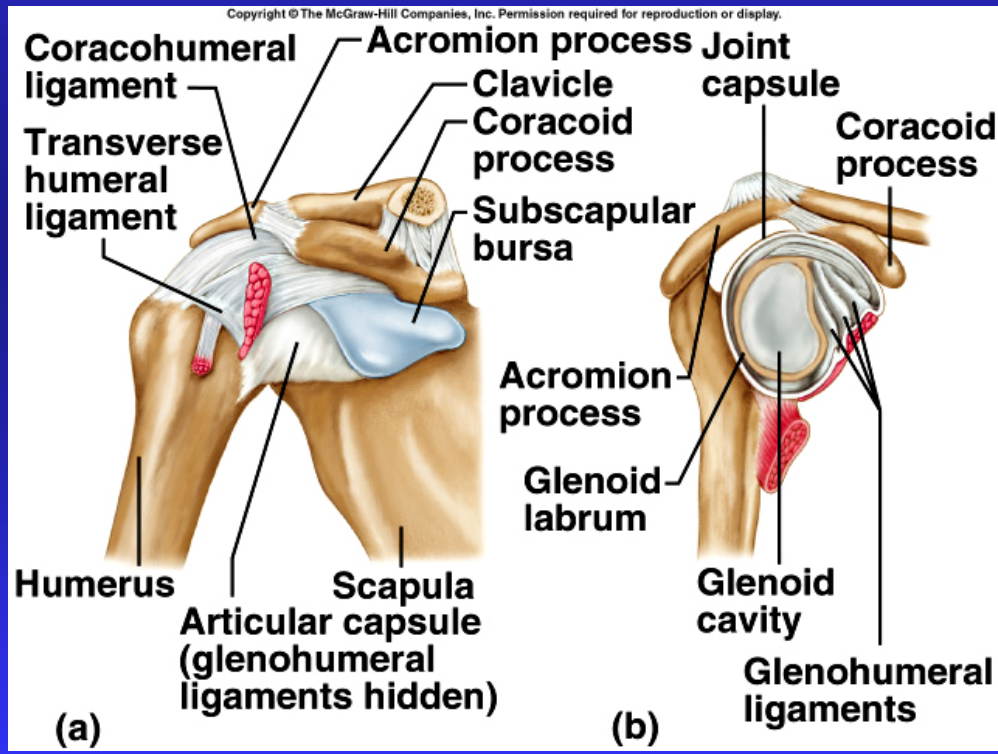
Shoulder Joint

- ball-and-socket
- head of humerus
- glenoid cavity of scapula
- loose joint capsule
- bursae
- ligaments prevent displacement
- very wide range of movement



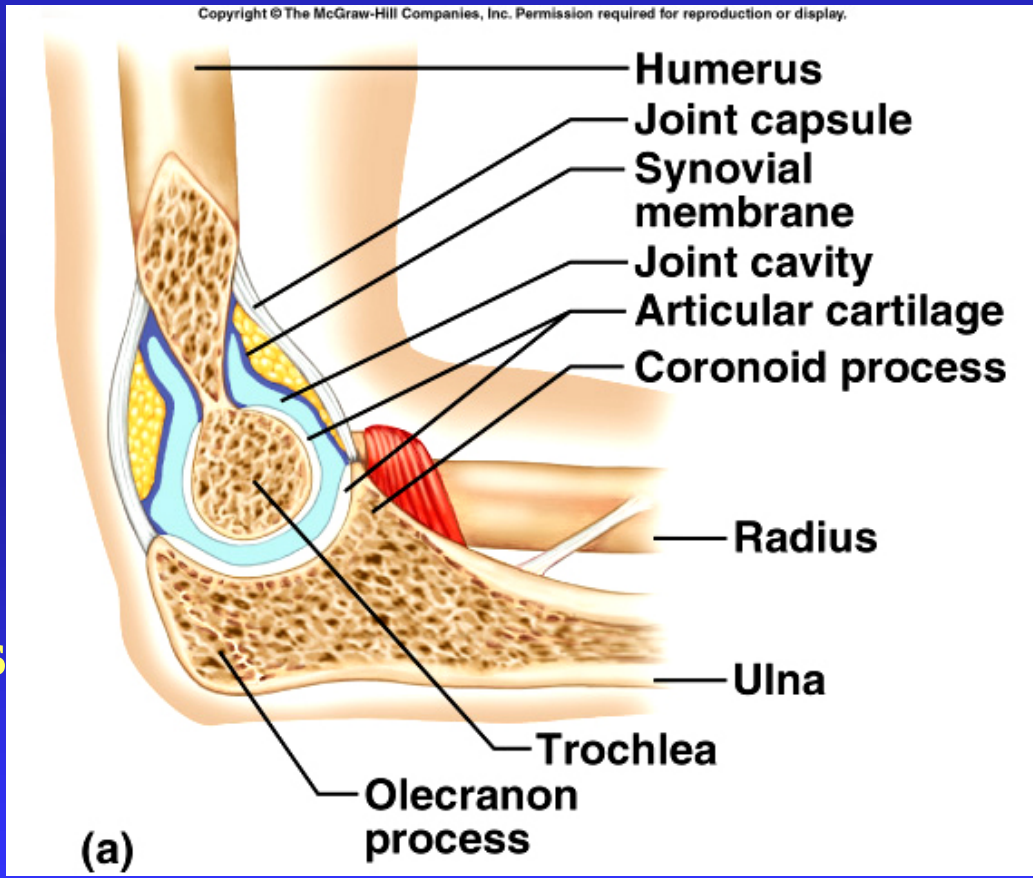
Shoulder Joint

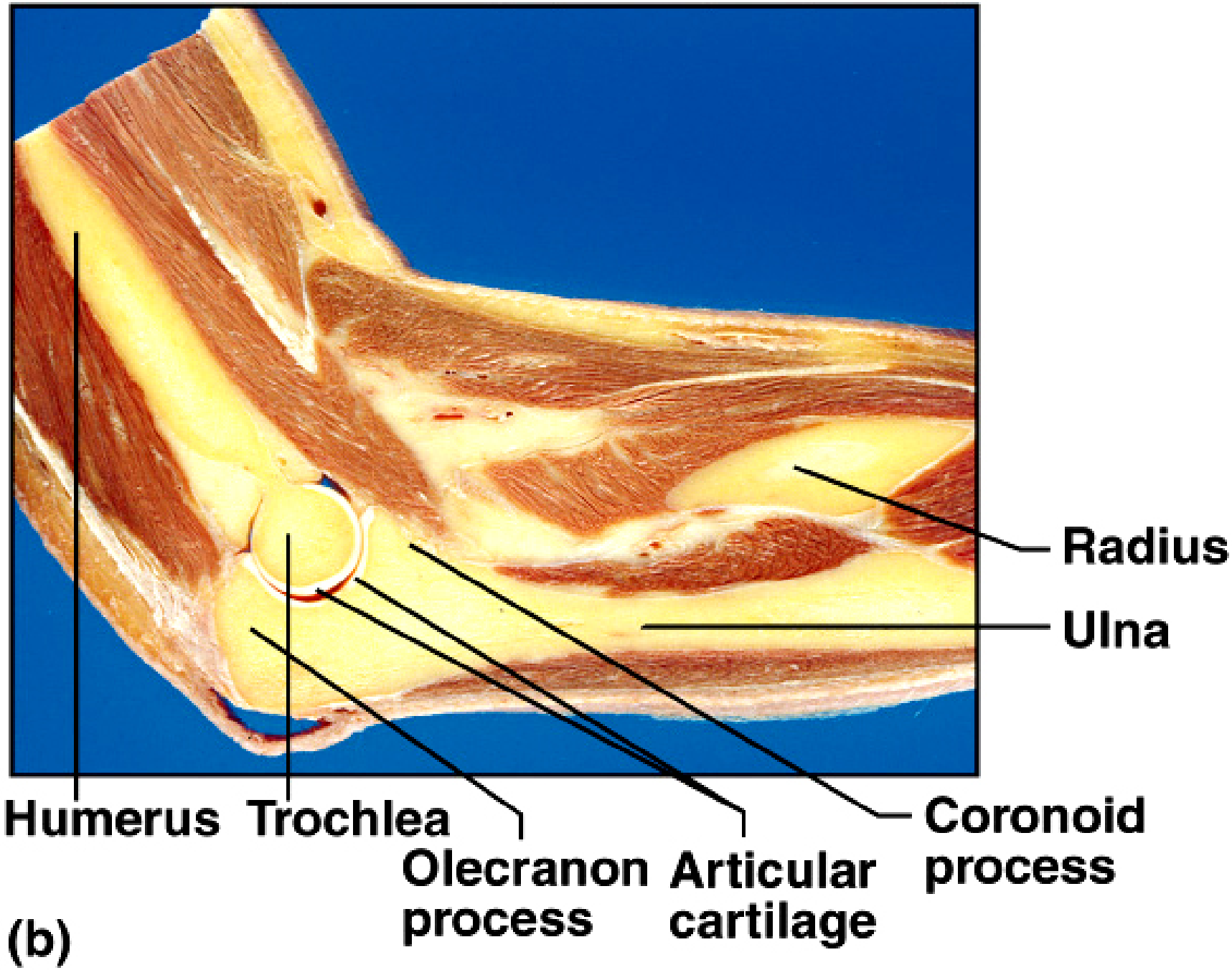




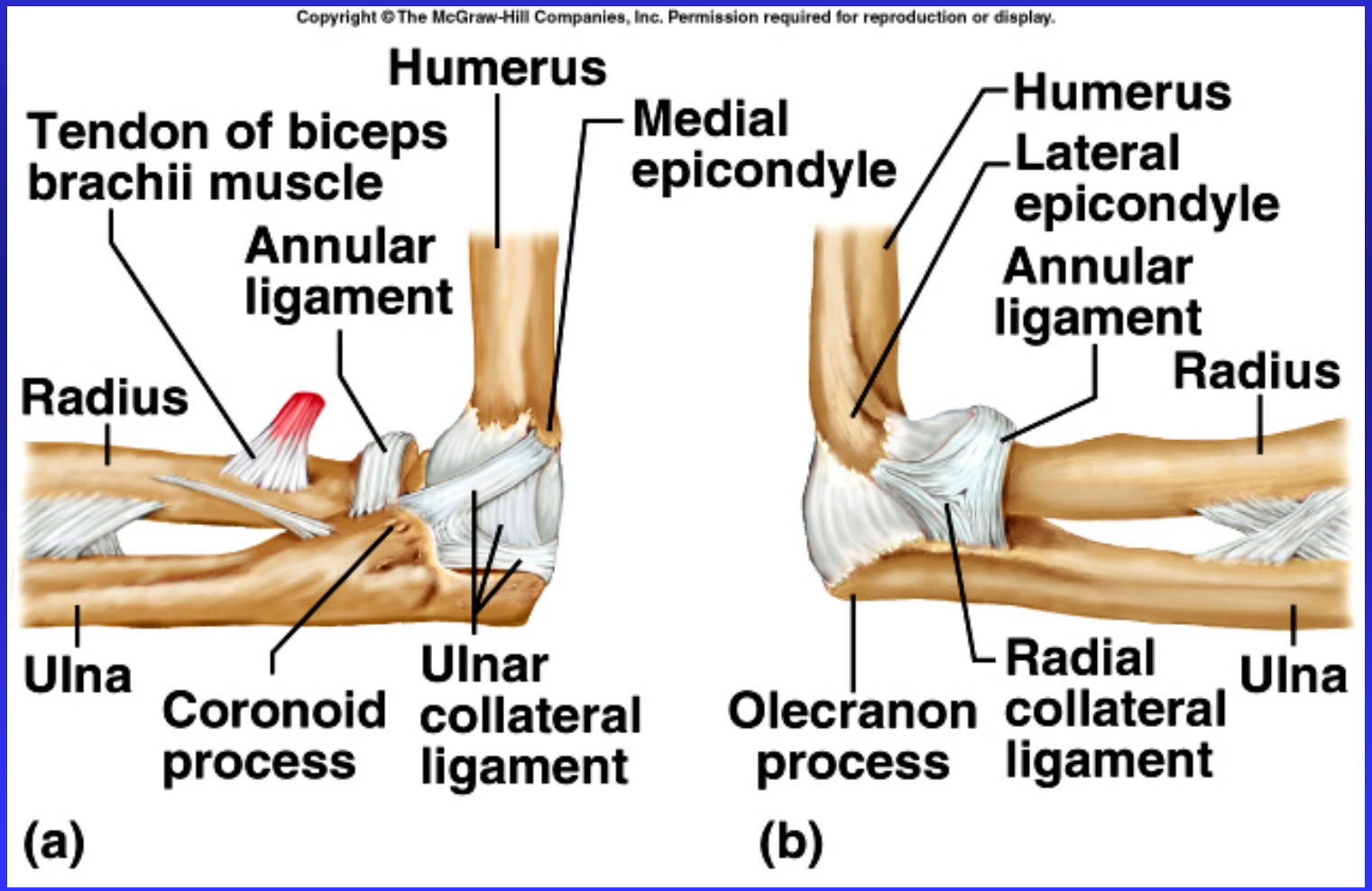
Elbow Joint

- hinge joint
  - trochlea of humerus
  - trochlear notch of ulna
- gliding joint
  - capitulum of humerus
  - head of radius
- flexion and extension
- many reinforcing ligaments
- stable joint



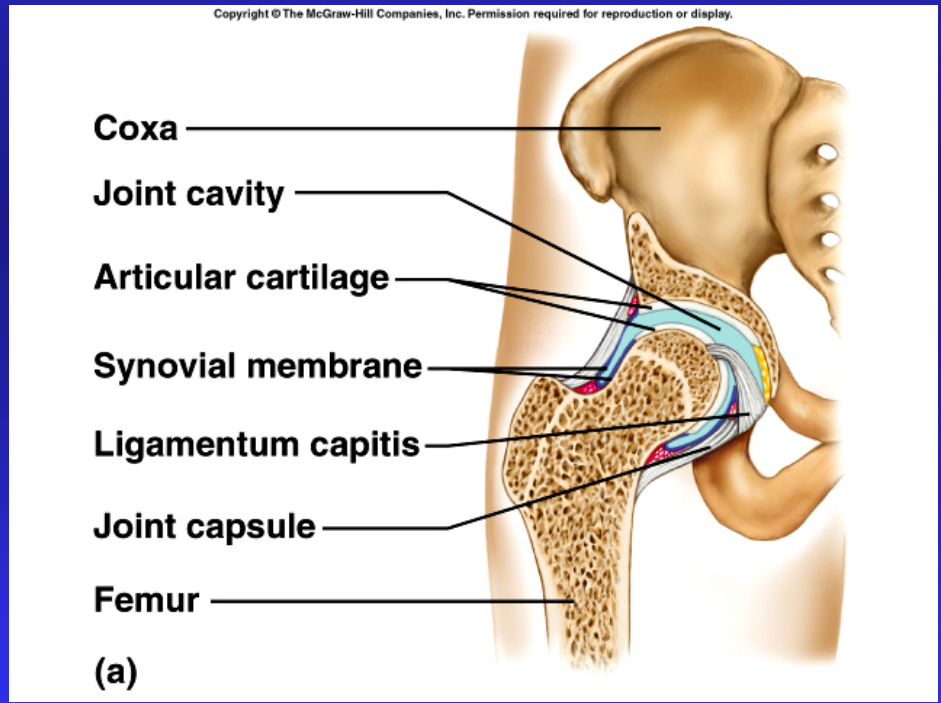


Elbow Joint

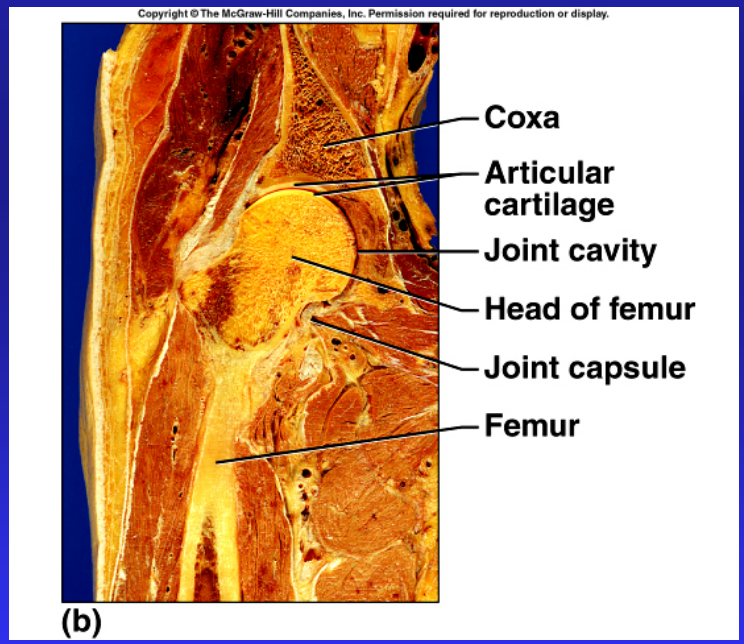

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Humerus
Tendon of biceps brachii muscle
Medial epicondyle
Annular ligament
Radius
Ulna
Coronoid process
Ulnar collateral ligament
(a)
Humerus
Lateral epicondyle
Annular ligament
Radius
Olecranon process
Radial collateral ligament
Ulna
(b)

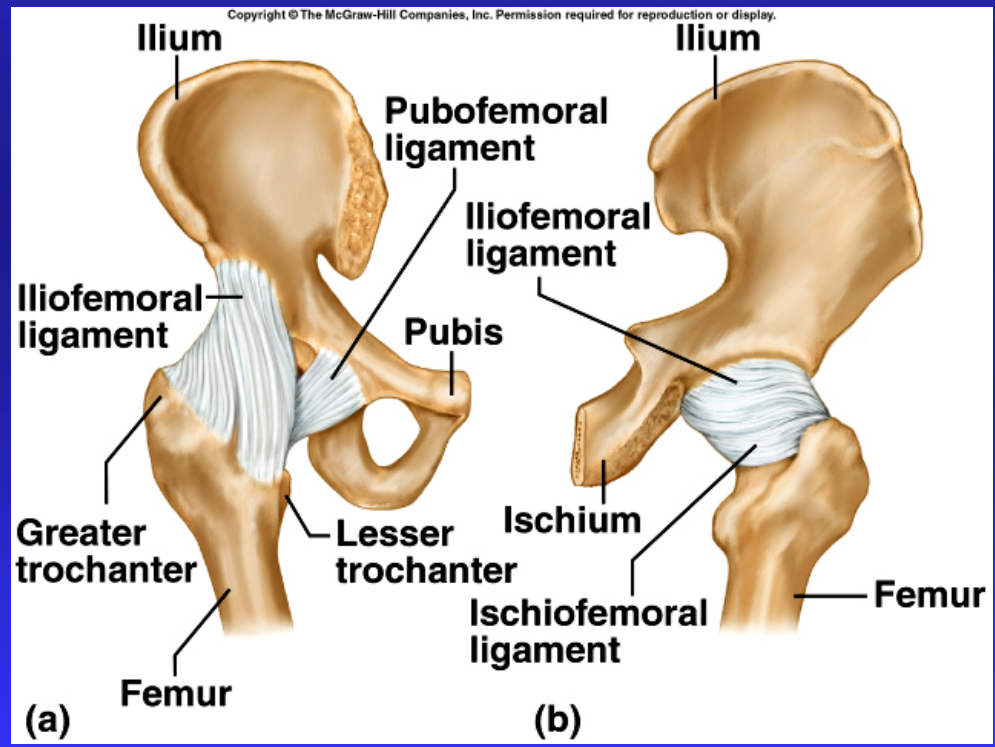
Hip Joint

- ball-and-socket joint
- head of femur
- acetabulum
- heavy joint capsule
- many reinforcing ligaments
- less freedom of movement than shoulder joint



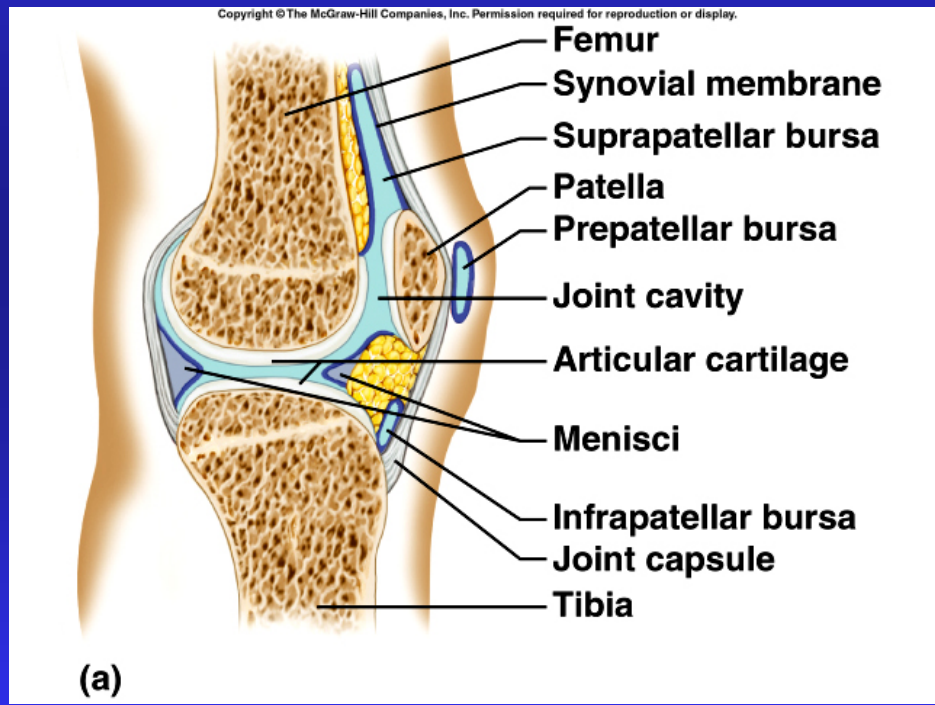
Hip Joint


Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Coxa
Articular cartilage
Joint cavity
Head of femur
Joint capsule
Femur
(b)

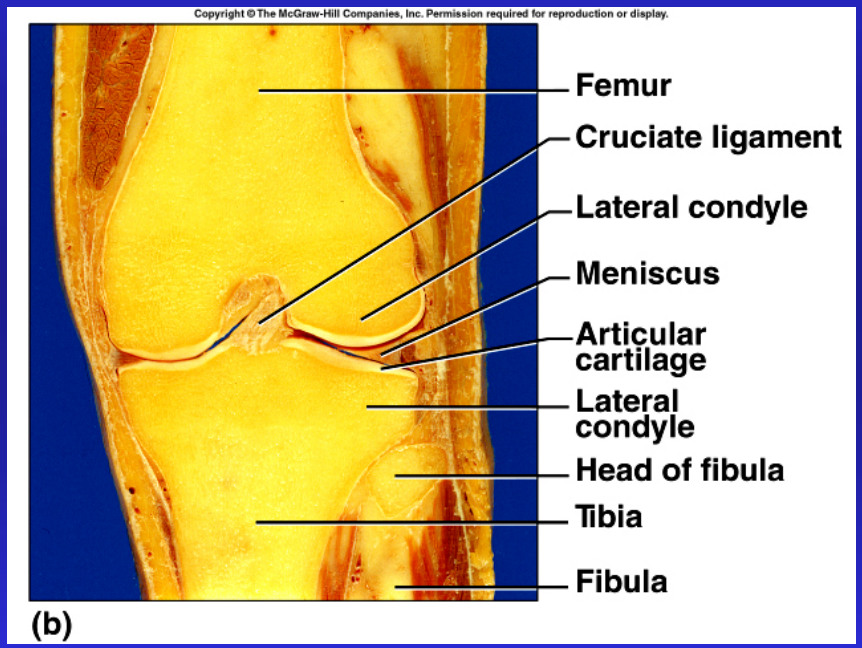

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Ilium
Pubofemoral ligament
Iliofemoral ligament
Pubis
Greater trochanter
Lesser trochanter
Femur
(a)
Ilium
Iliofemoral ligament
Ischium
Femur
Ischiofemoral ligament
(b)

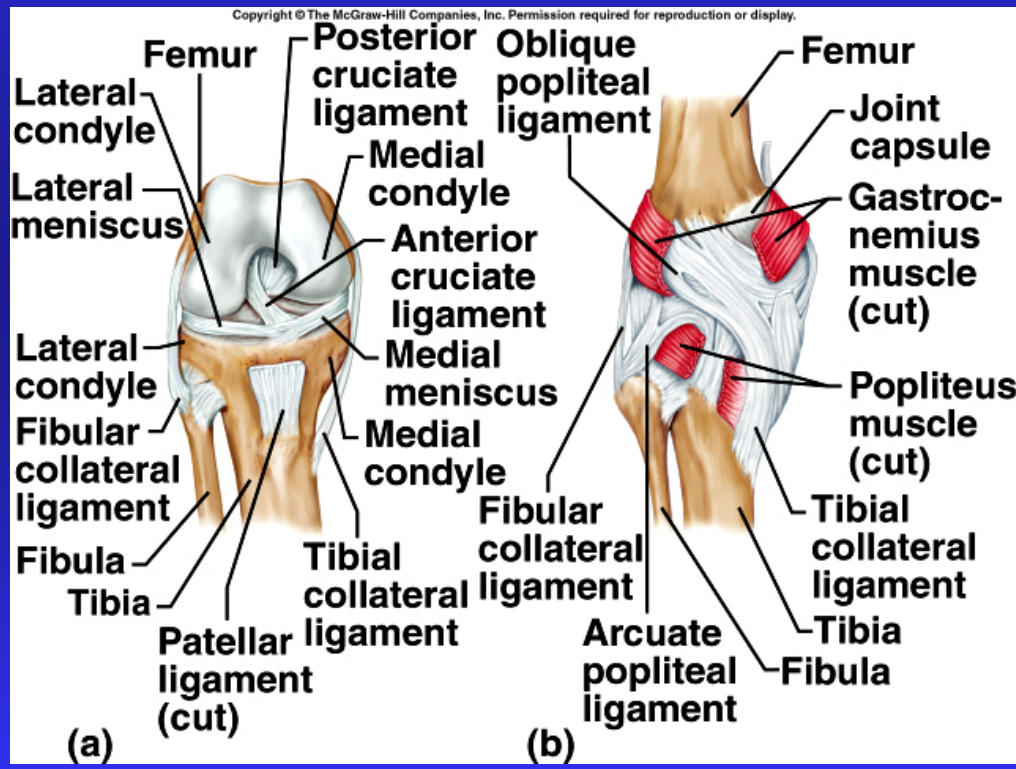
Knee Joint

- largest joint
- most complex
- medial and lateral condyles of distal end of femur
- medial and lateral condyles of proximal end of tibia
- femur articulates anteriorly with patella
- modified hinge joint
- flexion/extension/little rotation
- strengthened by many ligaments and tendons
- menisci separate femur and tibia
- bursae



Knee Joint


Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Femur
Cruciate ligament
Lateral condyle
Meniscus
Articular cartilage
Lateral condyle
Head of fibula
Tibia
Fibula
(b)


Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Femur
Posterior cruciate ligament
Lateral condyle
Lateral meniscus
Medial condyle
Anterior cruciate ligament
Lateral condyle
Medial meniscus
Fibular collateral ligament
Medial condyle
Fibula
Tibia
Tibial collateral ligament
Patellar ligament (cut)
(a)
Oblique popliteal ligament
Femur
Joint capsule
Gastroc-nemius muscle (cut)
Popliteus muscle (cut)
Fibular collateral ligament
Tibial collateral ligament
Tibia
Arcuate popliteal ligament
Fibula
(b)

Life-Span Changes

- Joint stiffness is an early sign of aging
- Regular exercise can prevent stiffness
- Fibrous joints first to strengthen over a lifetime
- Changes in symphysis joints of vertebral column diminish flexibility and decrease height
- Synovial joints lose elasticity

Clinical Application

Joint Disorders

Sprains

- damage to cartilage, ligaments, or tendons associated with joints
- forceful twisting of joint

Bursitis

- inflammation of a bursa
- overuse of a joint

Arthritis

- inflamed, swollen, painful joints
  - Rheumatoid Arthritis
  - Osteoarthritis
  - Gout

Joint Injuries – Sprains & Cartilage Injury

Sprain - the ligaments in a joint are stretched or torn. Partially torn ligaments may repair themselves, but healing is slow due to lack of vascularization. Completely torn ligaments require surgical repair.

Cartilage is mostly avascular and largely unable to repair itself when torn. Most cartilage injuries involve tearing of the menisci.

Dislocations - Luxation

Occur when bones are forced out of alignment

Usually accompanied by sprains, inflammation, and joint immobilization

Subluxation – partial dislocation of a joint

Inflammatory Conditions

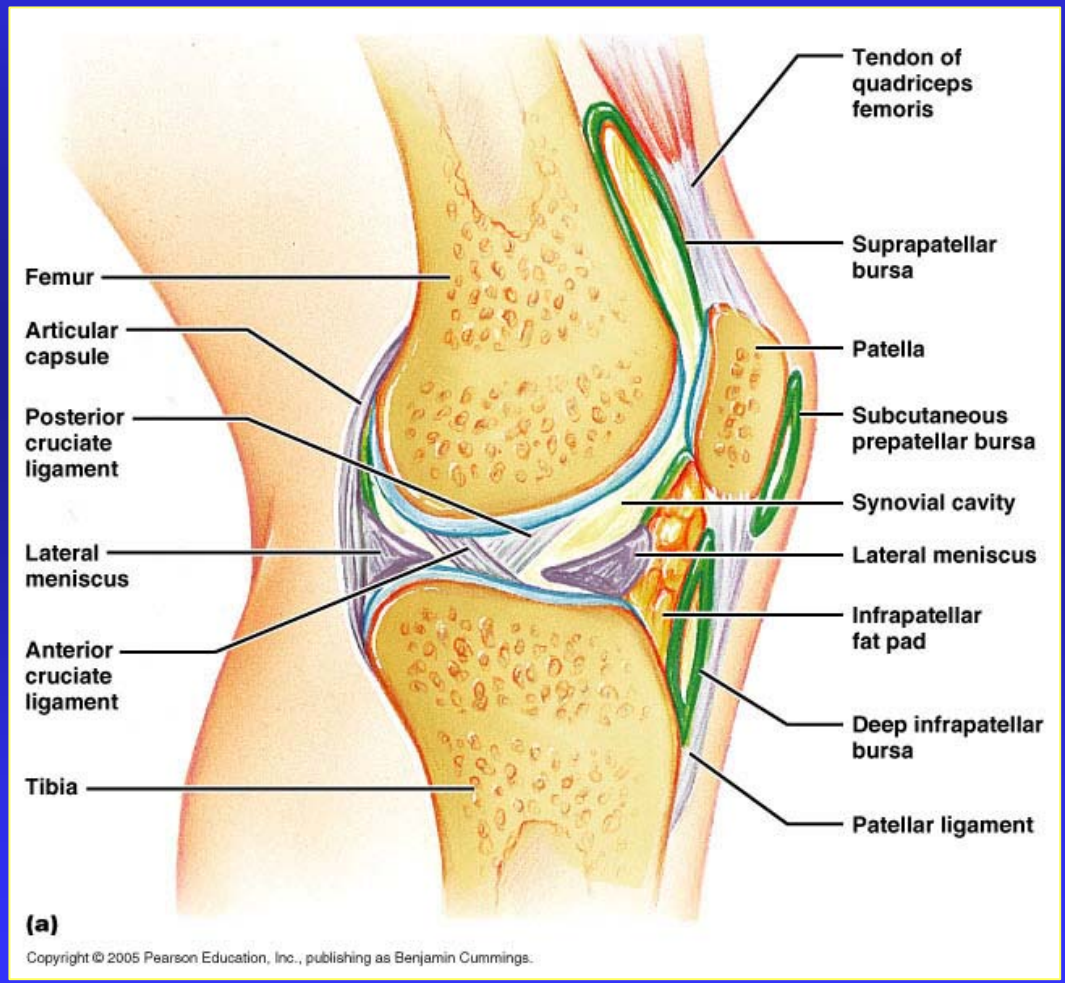
Bursitis

Inflammation of a bursa, usually caused by a blow or friction. Symptoms are pain and swelling. Treated with anti-inflammatory drugs; excessive fluid may be aspirated.

Tendonitis

Inflammation of tendon sheaths.
Symptoms and treatment are similar to bursitis.

Ligament and Cartilage Tears: Example of the Knee Joint



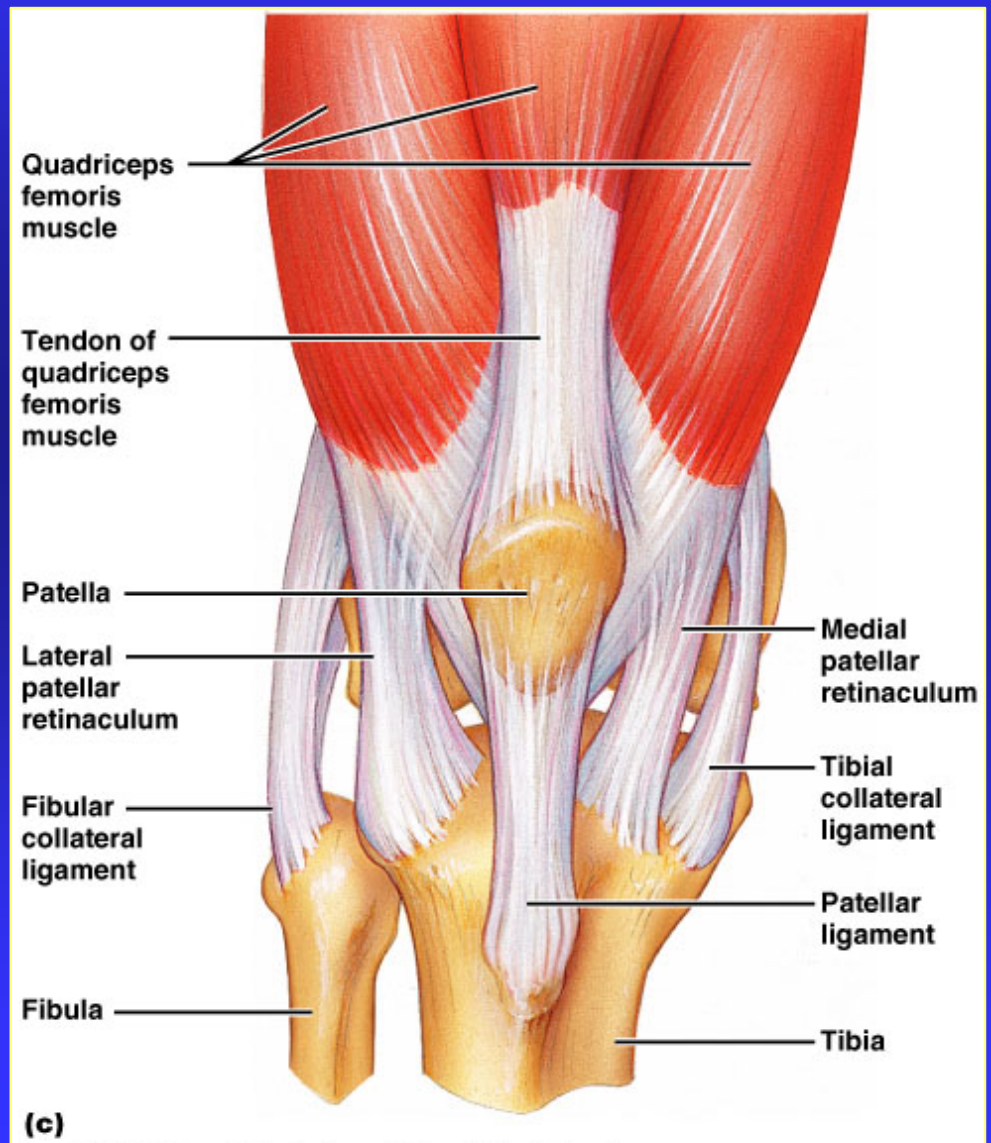
Knee Ligaments and Tendons – Anterior View

Tendon of the Quadriceps Femoris

Lateral and Medial Patellar Retinacula

Fibular and Tibial Collateral Ligaments

Patellar Ligament



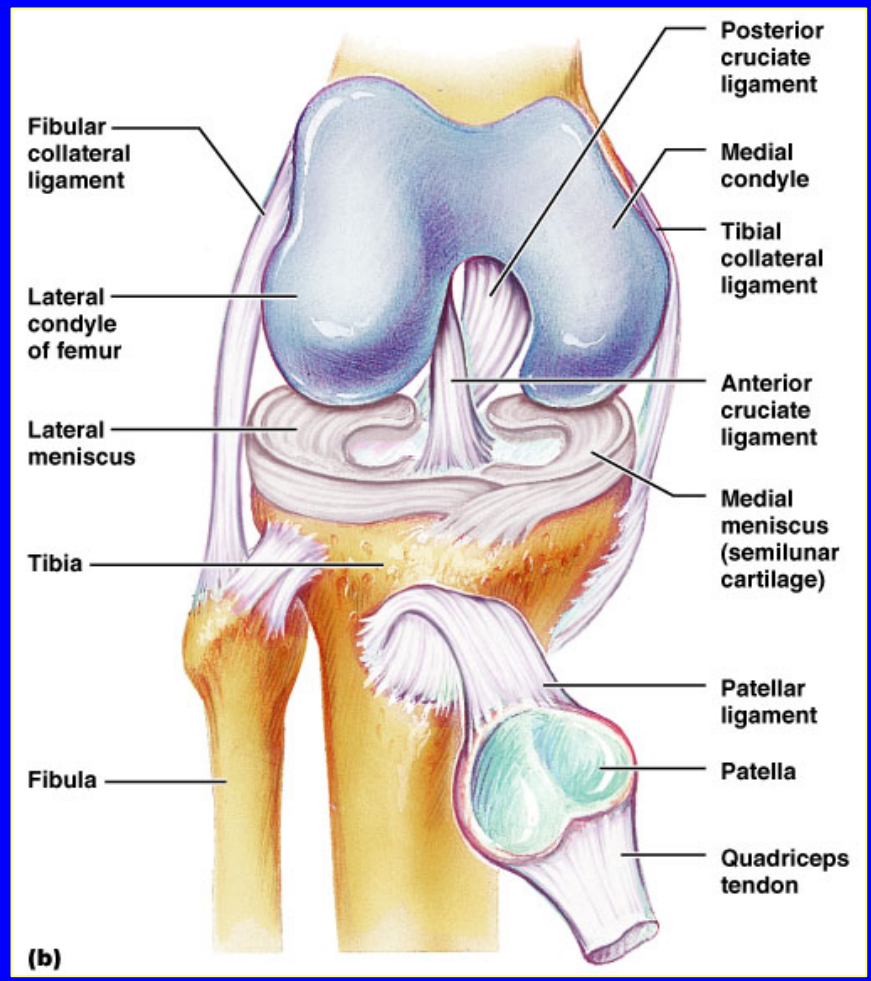
Knee Ligaments and other Supporting Structures

Intracapsular Ligaments (but outside of synovial cavity)

Ant.Cruciate Ligament
Post. Cruciate Ligament

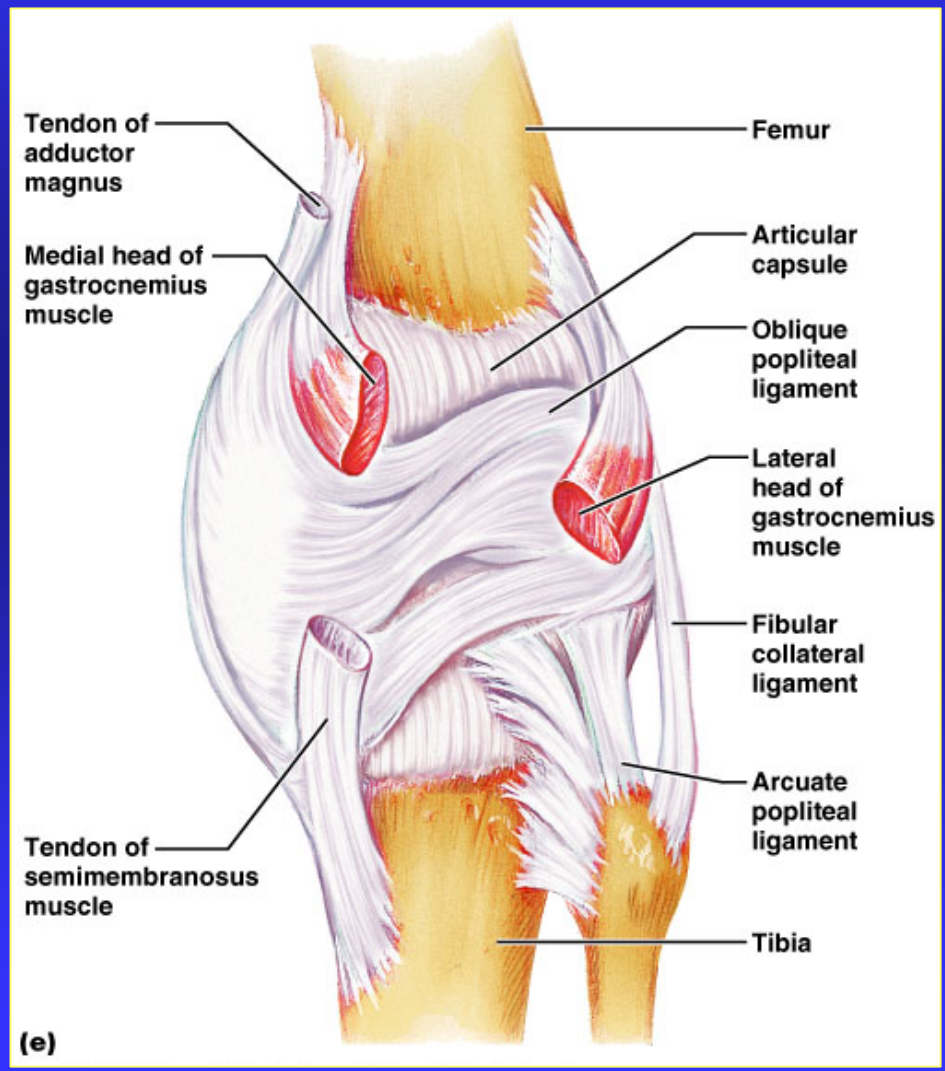
Semilunar Cartilages

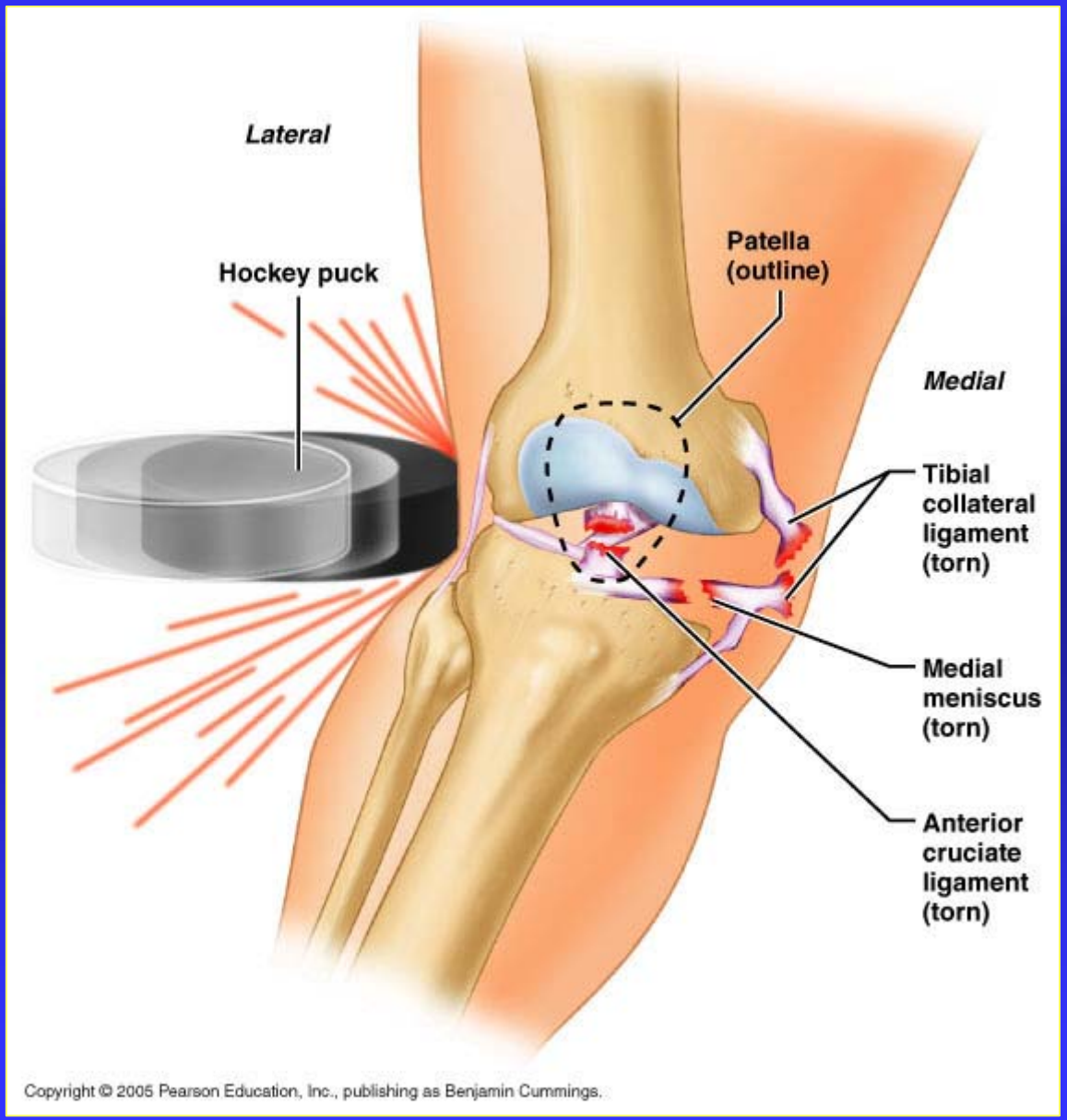
Medial Meniscus
Lateral meniscus



Knee Ligaments and other Supporting Structures

- Adductor Magnus Tendon
- Articular Capsule
- Oblique Popliteal Ligament
- Arcuate Popliteal Ligament
- Semimembranosus Tendon





Arthritis

- More than 100 different types of inflammatory or degenerative diseases that damage the joints
- Most widespread crippling disease in the U.S. (1 out of every 7 people)
- Symptoms – pain, stiffness, and swelling of a joint
- Acute forms are caused by bacteria and are treated with antibiotics
- Chronic forms include osteoarthritis, rheumatoid arthritis, and gouty arthritis

Arthritis: Causes and Symptoms

TABLE 8A Different Types of Arthritis

Some More-Common Forms of Arthritis

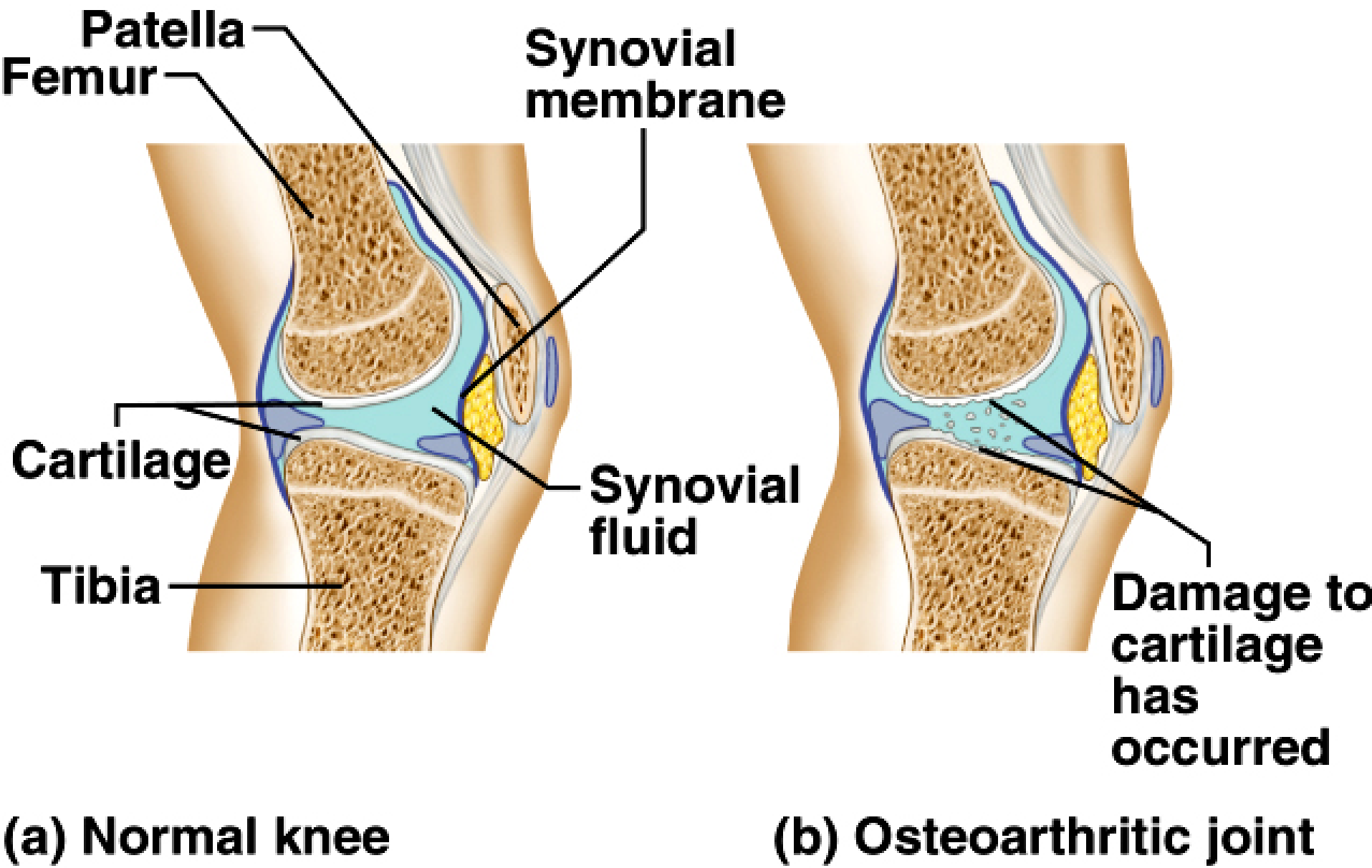
Type	Incidence in the United States
Osteoarthritis	20.7 million
Rheumatoid arthritis	2.1 million
Spondyloarthropathies	2.5 million

Some Less-Common Forms of Arthritis

Type	Incidence in the United States	Age of Onset	Symptoms
Gout	1.6 million (85% male)	>40	Sudden onset of extreme pain and swelling of a large joint
Juvenile rheumatoid arthritis	100,000	<18	Joint stiffness, often in knee
Scleroderma	300,000	30–50	Skin hardens and thickens
Systemic lupus erythematosus	500,000 (>90% female)	teens–50s	Fever, weakness, upper body rash, joint pain
Kawasaki disease	Hundreds of cases in local outbreaks	6 months–11 years	Fever, joint pain, red rash on palms and soles, heart complications
Strep A infection	100,000	any age	Confusion, body aches, shock, low blood pressure, dizziness, arthritis, pneumonia
Lyme disease	15,000	any age	Arthritis, malaise, neurologic and cardiac manifestations

Osteoarthritis (OA)

- Most common chronic arthritis; often called “wear-and-tear” arthritis
- Affects women more than men
- 85% of all Americans develop OA
- More prevalent in the aged, and is probably related to the normal aging process



Osteoarthritis: Course

- OA reflects the years of abrasion and compression causing increased production of metalloproteinase enzymes that break down cartilage
- As one ages, cartilage is destroyed more quickly than it is replaced
- The exposed bone ends thicken, enlarge, form bone spurs, and restrict movement
- Crepitus – crunching noise as roughened articular surfaces rub together
- Joints most affected are the cervical and lumbar spine, fingers, knuckles, knees, and hips

Osteoarthritis: Treatments

- OA is usually slow and irreversible
- Treatments include:
  - Mild pain relievers, along with moderate activity
  - Magnetic therapy?
  - Glucosamine sulfate? said to decrease pain and inflammation

Rheumatoid Arthritis (RA)

- Chronic, inflammatory, autoimmune disease of unknown cause, with an insidious onset
- Usually arises between the ages of 40 to 50, but may occur at any age
- Signs and symptoms include joint tenderness, anemia, osteoporosis, muscle atrophy, and cardiovascular problems
  - The course of RA is marked with exacerbations and remissions

Rheumatoid Arthritis: Course

- RA begins with synovitis of the affected joint
- Inflammatory chemicals are inappropriately released
- Inflammatory blood cells migrate to the joint, causing swelling
- Inflamed synovial membrane thickens into a pannus
- Pannus erodes cartilage, scar tissue forms, articulating bone ends fuse
- The end result, ankylosis, produces bent, deformed fingers

Rheumatoid Arthritis: Treatment

- Conservative therapy – aspirin, long-term use of antibiotics, and physical therapy
- Progressive treatment – anti-inflammatory drugs or immunosuppressants
- The drug Enbrel, a biological response modifier, neutralizes the harmful properties of inflammatory chemicals

Gouty Arthritis

- Deposition of uric acid crystals in joints and soft tissues, followed by an inflammatory response
- Typically, gouty arthritis affects the joint at the base of the great toe
- In untreated gouty arthritis, the bone ends fuse and immobilize the joint
- Treatment – colchicine, nonsteroidal anti-inflammatory drugs, and glucocorticoids