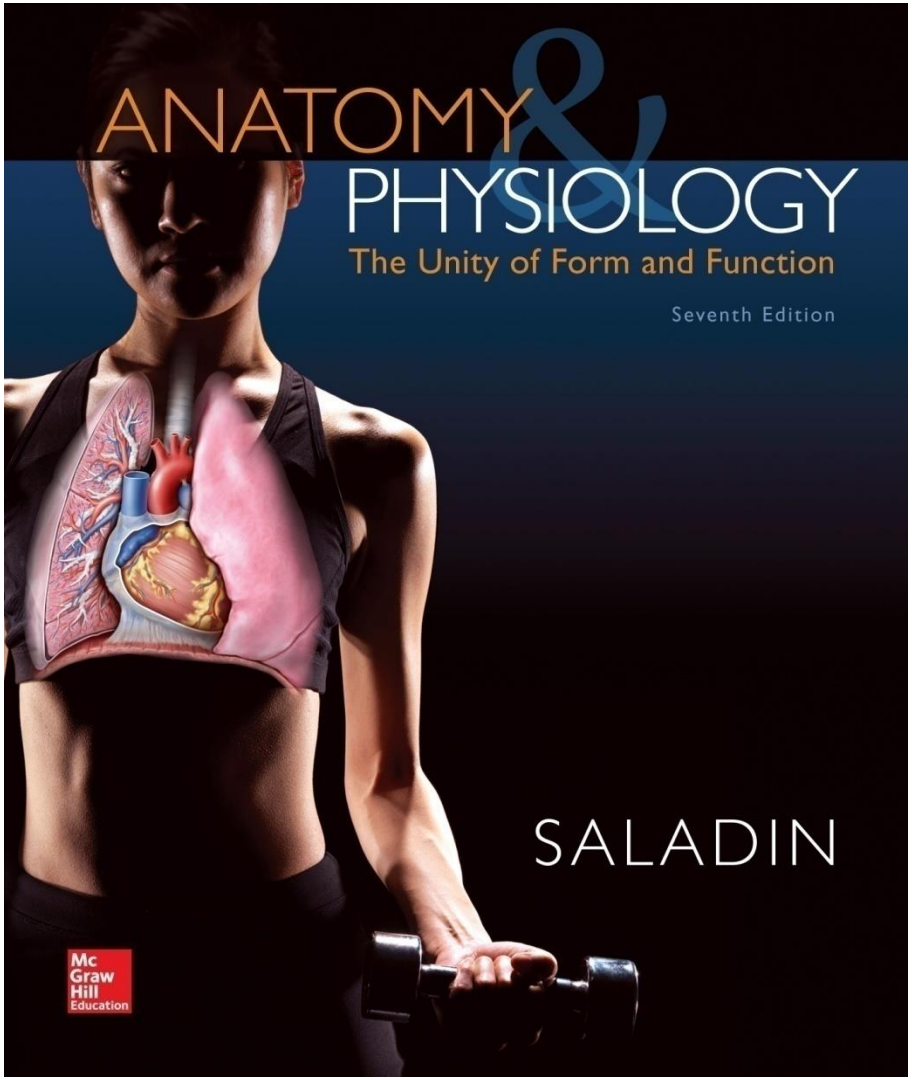
Chapter 9
Lecture Outline

See separate PowerPoint slides for all figures and tables pre-inserted into PowerPoint without notes.



Introduction

- **Joints link the bones of the skeletal system, permit effective movement, and protect the softer organs**

- **Joint anatomy and movements will provide a foundation for the study of muscle actions**

Joints and Their Classification

- **Expected Learning Outcomes**
  - Explain what joints are, how they are named, and what functions they serve.
  - Name and describe the four major classes of joints.
  - Describe the three types of fibrous joints and give an example of each.
  - Distinguish between the three types of sutures.
  - Describe the two types of cartilaginous joints and give an example of each.
  - Name some joints that become synostoses as they age.

Joints and Their Classification

- **Joint (articulation)**—any point where two bones meet, whether or not the bones are movable at that interface

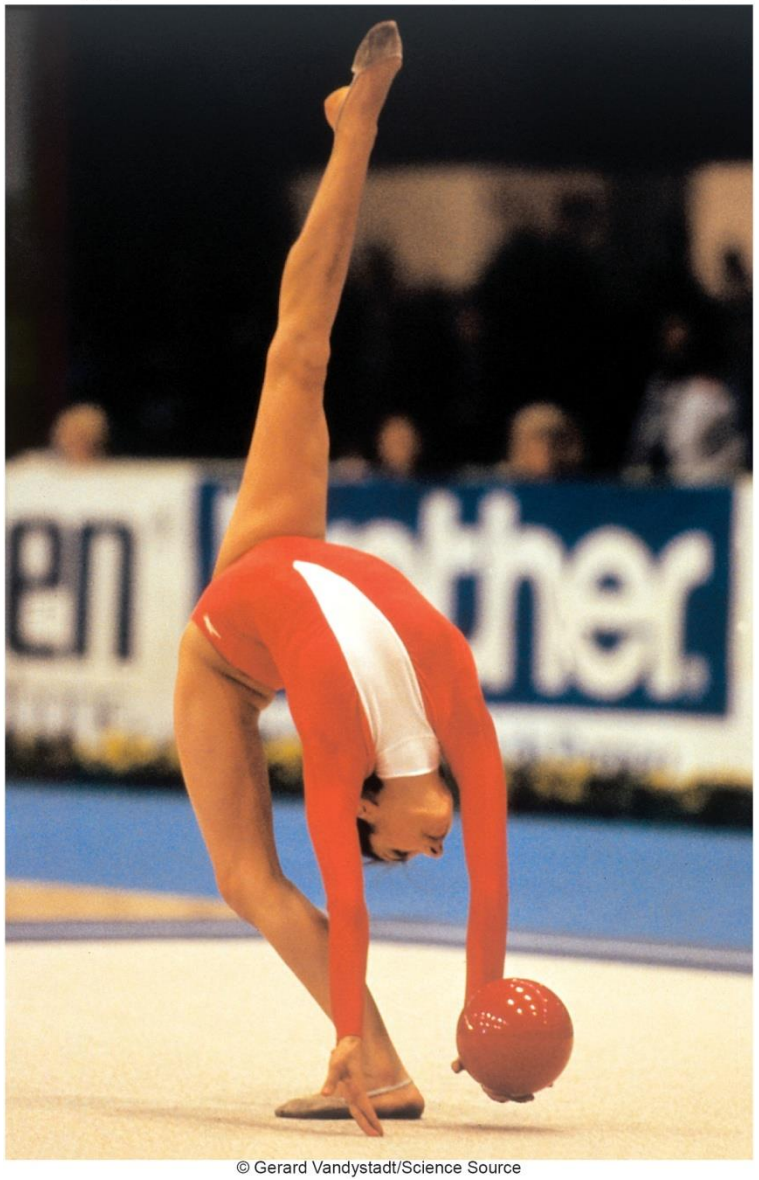


Figure 9.1

Joints and Their Classification

- **Arthrology**—science of joint structure, function, and dysfunction

- **Kinesiology**—the study of musculoskeletal movement
  - A branch of **biomechanics,** which deals with a broad variety of movements and mechanical processes

Joints and Their Classification

- **Joint name**—typically derived from the names of the bones involved (example: radioulnar joint)
- **Joints classified** according to the manner in which the bones are bound to each other
- **Four major** joint categories
  - **Bony joints**
  - **Fibrous joints**
  - **Cartilaginous joints**
  - **Synovial joints**

Bony Joints

- **Bony joint,** or **synostosis—**an immobile joint formed when the gap between two bones ossifies, and the bones become, in effect, a single bone
  - Examples:
    - Left and right mandibular bones in infants
    - Cranial sutures in elderly
    - Attachment of first rib and sternum with old age
- **Can occur in either fibrous or cartilaginous joint**

Fibrous Joints

- **Fibrous joint, synarthrosis, or synarthrodial joint**—adjacent bones are bound by collagen fibers that emerge from one bone and penetrate into the other

- **Three kinds of fibrous joints**
  - **Sutures**
  - **Gomphoses**
  - **Syndesmoses**

Sutures

- **Sutures**—immobile or slightly mobile fibrous joints in which short collagen fibers bind the bones of the skull to each other
- **Sutures can be classified as:**
  - **Serrate:** interlocking wavy lines
    - Coronal, sagittal, and lambdoid sutures
  - **Lap (squamous):** overlapping beveled edges
    - Temporal and parietal bones
  - **Plane (butt):** straight, non-overlapping edges
    - Palatine processes of the maxillae

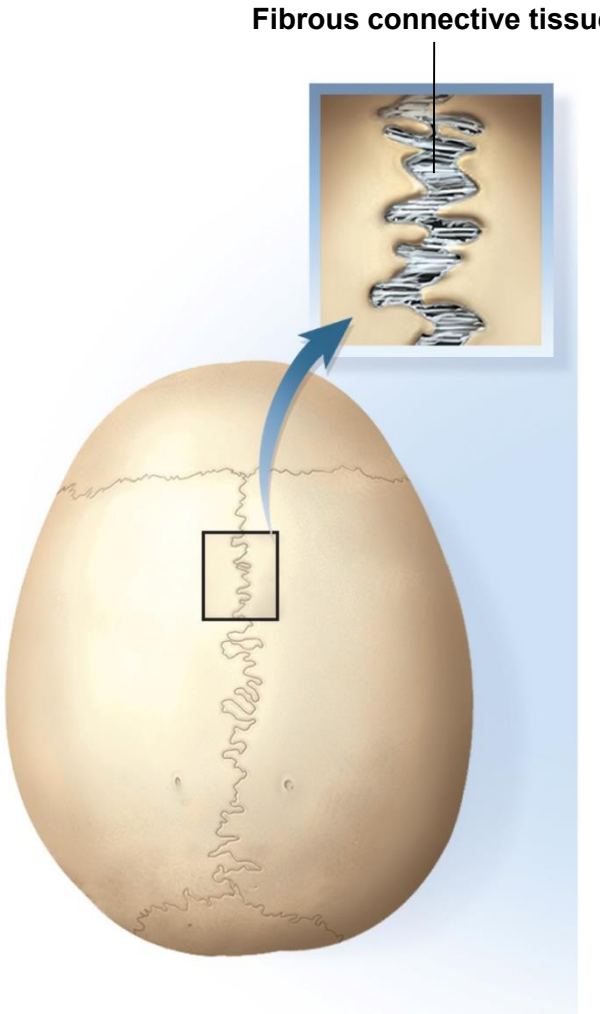


Figure 9.2a

Sutures

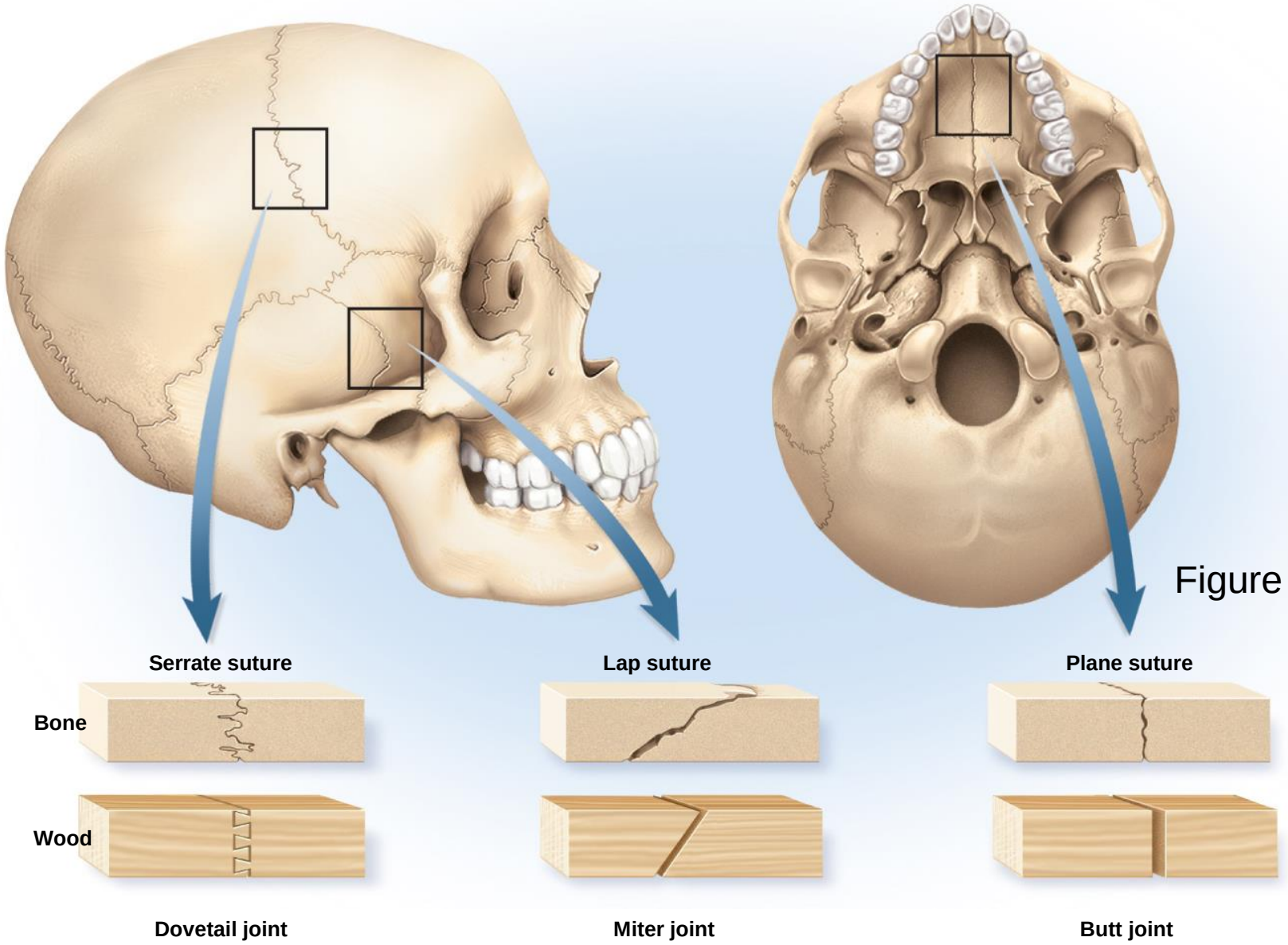
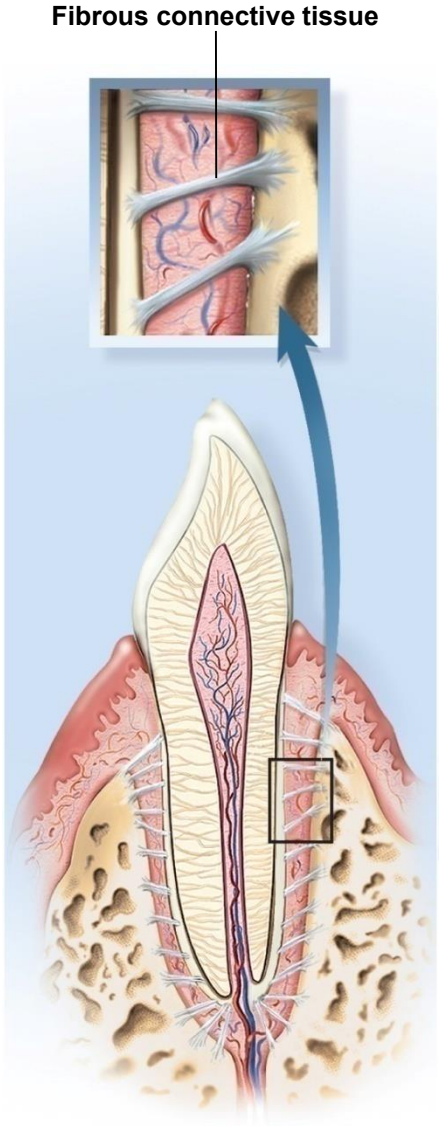


Figure 9.3

Gomphoses

- **Gomphosis (fibrous joint)**—attachment of a tooth to its socket
- Held in place by fibrous **periodontal ligament**
  - Collagen fibers attach tooth to jawbone
  - Allows the tooth to move a little under the stress of chewing



(b) Gomphosis

Figure 9.2b

Syndesmoses

- **Syndesmosis**—a fibrous joint at which two bones are bound by long collagen fibers
- Example of a very mobile syndesmosis: **interosseus membrane** joining radius to ulna allowing supination and pronation
- **Example of a less mobile syndesmosis: joint between tibia to fibula**

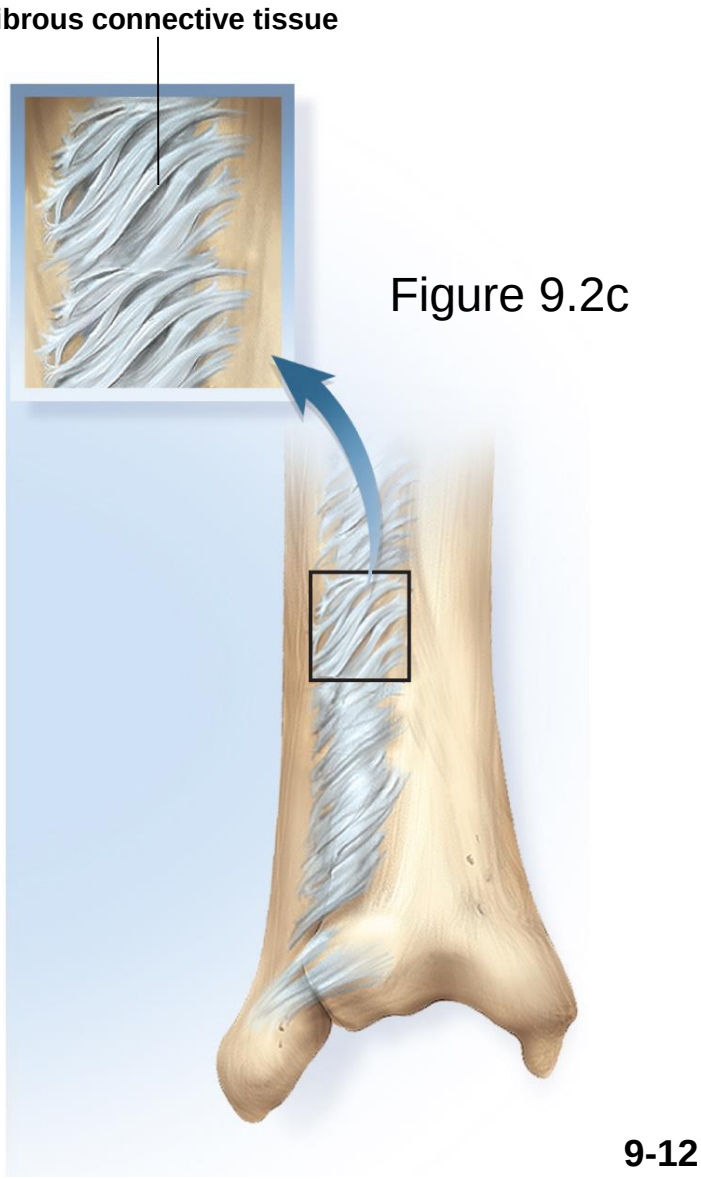


Figure 9.2c

(c) Syndesmosis

Cartilaginous Joints

- **Cartilaginous joint, amphiarthrosis,** or **amphiarthrodial joint**—two bones are linked by cartilage
- **Two types** of cartilaginous joints
  - **Synchondroses**
  - **Symphyses**

Synchondroses

- **Synchrondrosis**—bones joined by **hyaline cartilage**
  - Temporary joints in the epiphyseal plates in children
    - Bind epiphysis to diaphysis
  - First rib attachment to sternum
    - Other costal cartilages joined to sternum by synovial joints

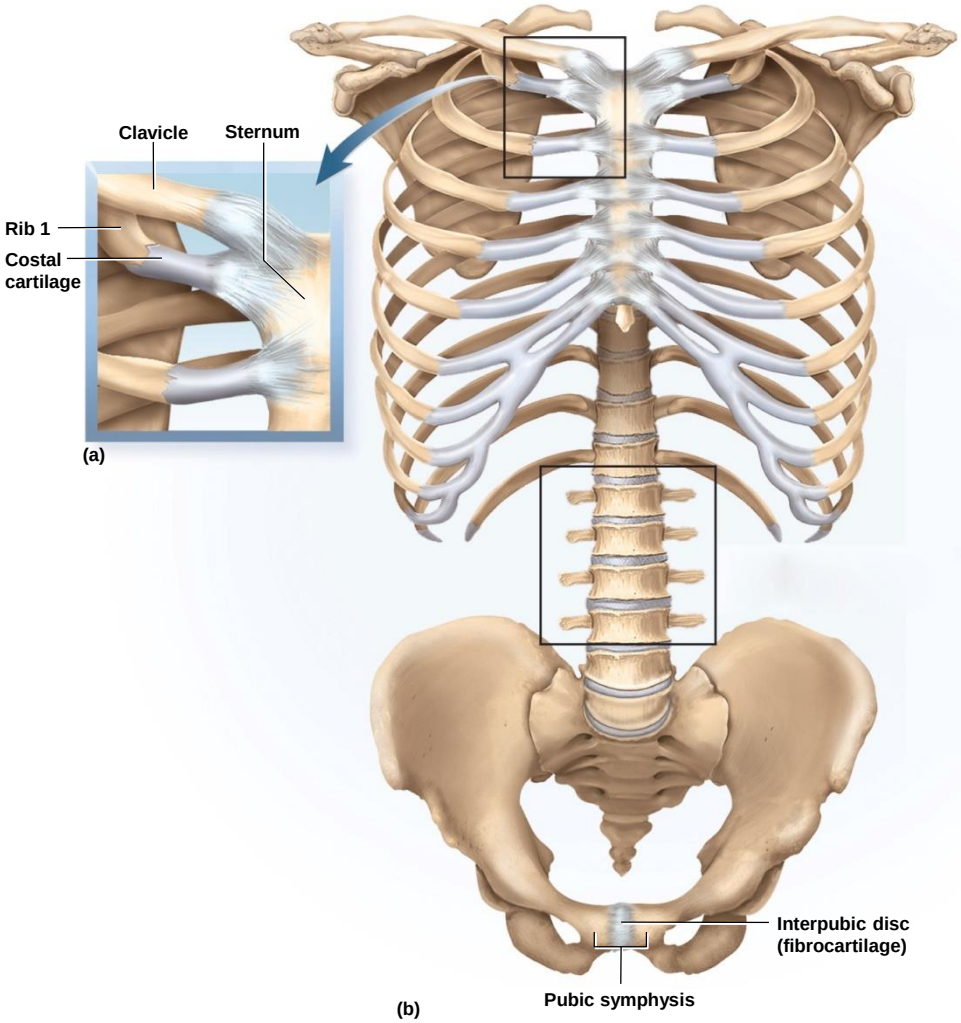


Figure 9.4a,b

Symphyses

- **Symphysis**—two bones joined by **fibrocartilage**
  - **Pubic symphysis** joins right and left pubic bones with **interpubic disc**
  - **Bodies of vertebrae** joined by **intervertebral discs**
    - Only slight movements between adjacent vertebrae
    - Collective effect of all 23 discs gives spine considerable flexibility

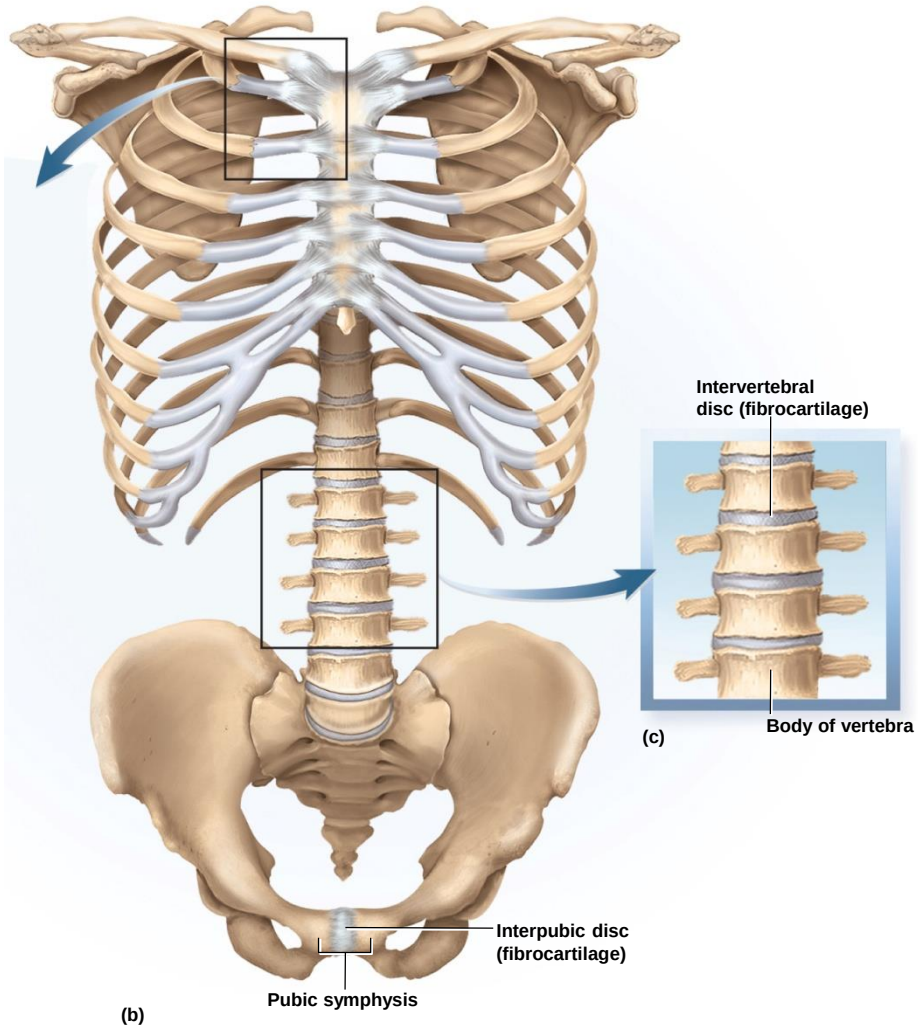


Figure 9.4b,c

Synovial Joints

- **Expected Learning Outcomes**
  - Identify the anatomical components of a typical synovial joint.
  - Classify any given joint action as a first-, second-, or third-class lever.
  - Explain how mechanical advantage relates to the power and speed of joint movement.
  - Discuss the factors that determine a joint's range of motion.

Synovial Joints

(Continued)

- Describe the primary axes of rotation that a bone can have and relate this to a joint's degrees of freedom.
- Name and describe six classes of synovial joints.
- Use the correct standard terminology for various joint movements.

Synovial Joints

- **Synovial joint, diarthrosis,** or **diarthrodial joint**—joint in which two bones are separated by a **joint cavity**
- **Most familiar type of joint**
- **Most are freely mobile**
- **Most structurally complex type of joint**

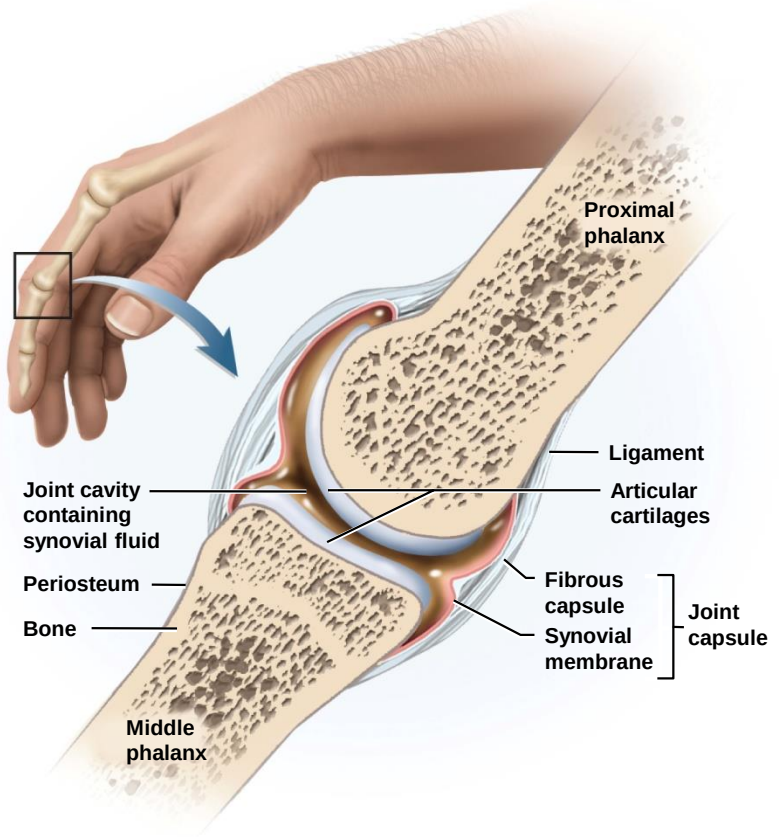


Figure 9.5

Synovial Joints

- **Most likely to develop painful dysfunction**
- **Most important joints for physical and occupational therapists, athletic coaches, nurses, and fitness trainers**
- **Their mobility makes them important to quality of life**

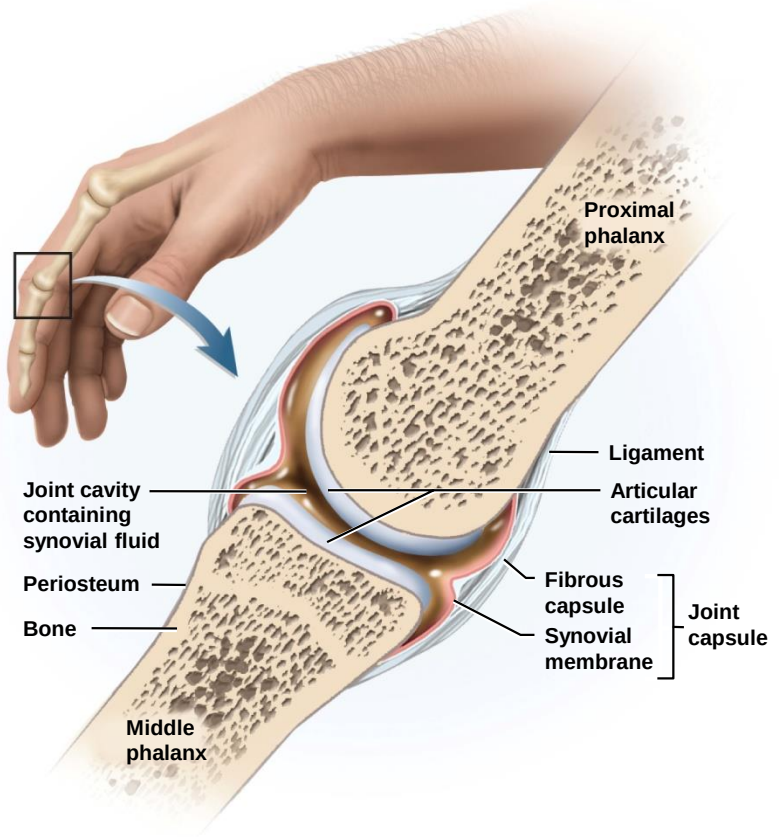


Figure 9.5

General Anatomy of Synovial Joints

- **Articular cartilage—**layer of hyaline cartilage that covers the facing surfaces of two bones
  - Usually 2 or 3 mm thick
- **Joint (articular) cavity—**separates articular surfaces
- **Synovial fluid—**slippery lubricant in joint cavity
  - Rich in albumin and hyaluronic acid
  - Gives it a viscous, slippery texture like raw egg whites
  - Nourishes articular cartilage and removes waste
  - Makes movement of synovial joints almost friction free

General Anatomy of Synovial Joints

- **Joint (articular) capsule—**connective tissue that encloses the cavity and retains the fluid
  - **Outer fibrous capsule:** continuous with periosteum of adjoining bones
  - **Inner, cellular, synovial membrane:** composed mainly of **fibroblast-like cells** that secrete synovial fluid and **macrophages** that remove debris from the joint cavity

General Anatomy of Synovial Joints

- In a few synovial joints, **fibrocartilage** grows inward from the joint capsule
  - **Articular disc** forms a pad between articulating bones that crosses the entire joint capsule
    - Example found in temporomandibular joint
  - **Meniscus:** moon-shaped cartilage in knee; in each knee, menisci extend inward from the left and right
    - These cartilages absorb shock and pressure
    - Guide bones across each other and improve their fit together
    - Stabilize the joints, reducing the chance of dislocation

General Anatomy of Synovial Joints

- **Accessory structures**
  - **Tendon:** strip of collagenous tissue attaching muscle to bone
  - **Ligament:** strip of collagenous tissue attaching one bone to another
  - **Bursa:** fibrous sac filled with synovial fluid, located between muscles, where tendons pass over bone, or between bone and skin
    - Cushions muscles, helps tendons slide more easily over joints, modifies direction of tendon pull
  - **Tendon sheath:** elongated cylindrical bursa wrapped around a tendon
    - In hand and foot

General Anatomy of Synovial Joints

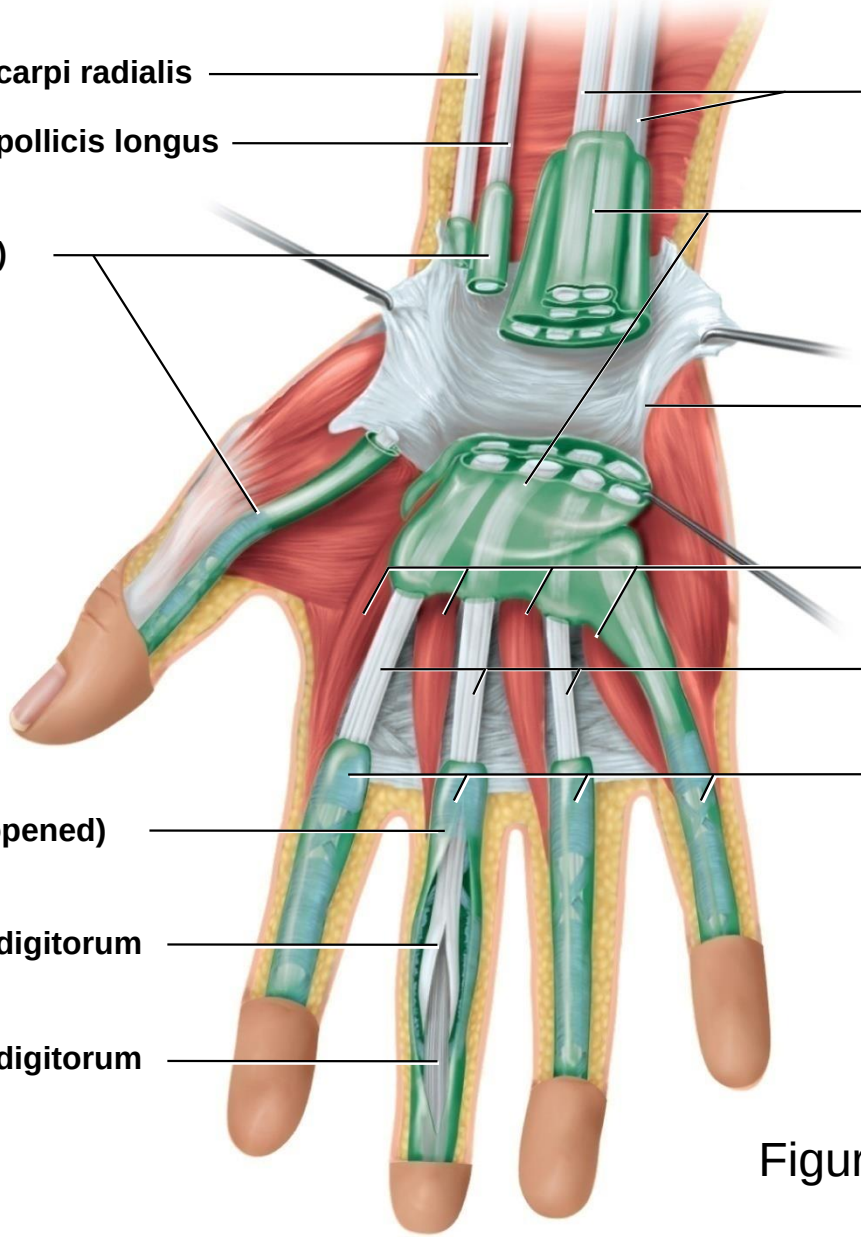


Figure 9.6

Exercise and Articular Cartilage

- **Exercise** warms synovial fluid
  - Becomes less viscous, more easily absorbed by cartilage
- **Cartilage then swells and provides a more effective cushion**
  - Warm-up period before vigorous exercise helps protect cartilage from undue wear and tear
- **Repetitive compression of nonvascular cartilage during exercise squeezes fluid and metabolic waste out of the cartilage**
- **When weight removed, cartilage absorbs synovial fluid like a sponge taking in oxygen and nutrients to the chondrocytes**
- **Without exercise, cartilage deteriorates more rapidly from inadequate nutrition and waste removal**

Joints and Lever Systems

- **Long bones** act as **levers** to enhance the speed or power of limb movements
- **Lever**—any elongated, rigid object that rotates around a fixed point called a **fulcrum**
- Rotation occurs when an **effort** applied overcomes **resistance (load)** at some other point
  - **Resistance arm** and **effort arm** are described relative to fulcrum

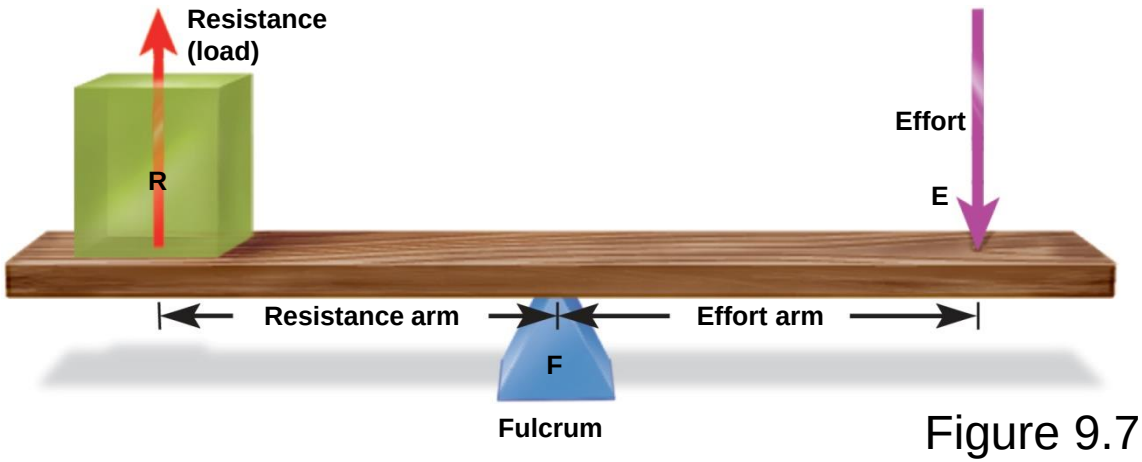


Figure 9.7

Mechanical Advantage

- Two kinds of **advantage** conferred by a lever
  - Exerting more force against a resisting object than the force applied to the lever
    - Moving a heavy object with help of crowbar
  - Moving the resisting object farther or faster than the effort arm is moved
    - Movement of rowing a boat
  - A single lever cannot confer both advantages
    - As one increases, the other decreases
- **Mechanical advantage (MA)** of a lever—the ratio of its output force to its input force
- **MA** is calculated from length of effort arm divided by length of resistance arm

Mechanical Advantage

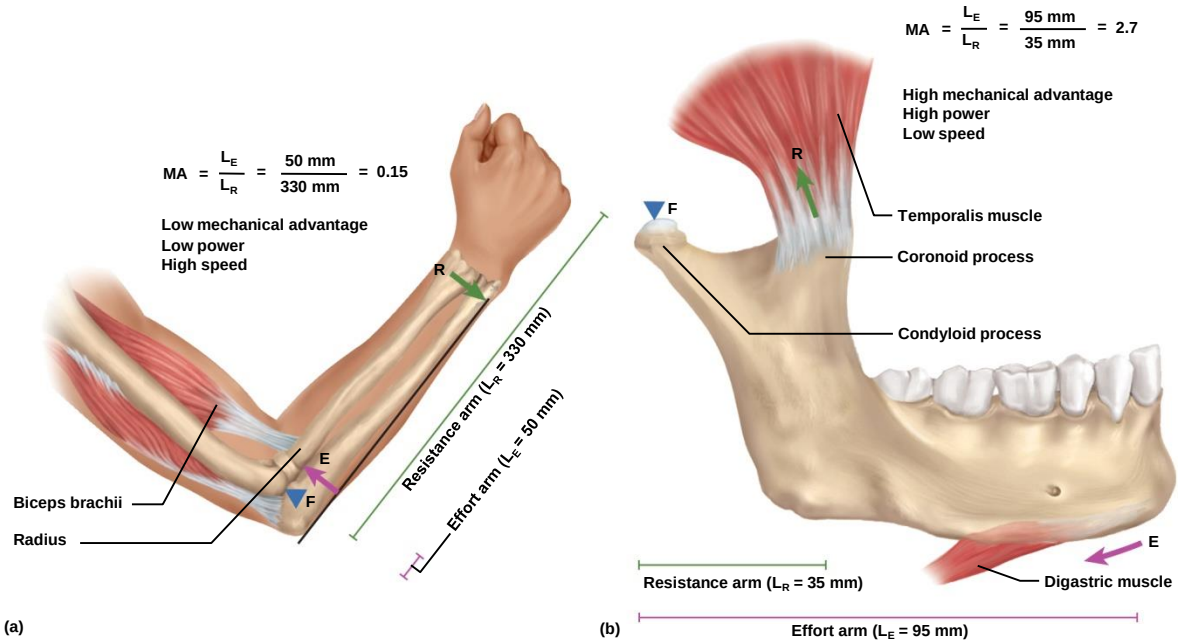
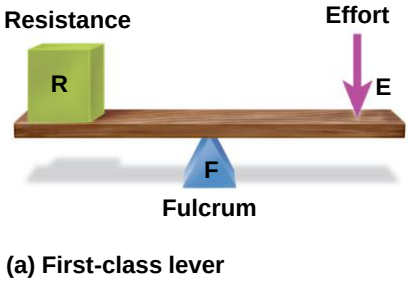


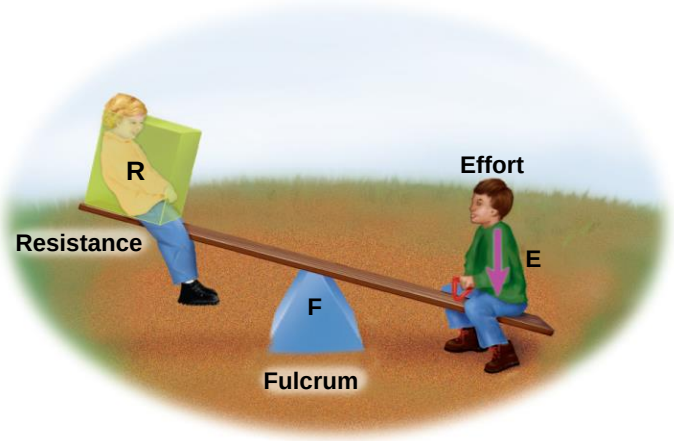
Figure 9.8

- **MA > 1.0:** lever produces more force, but less speed and distance, than force exerted on it
- **MA < 1.0:** lever produces more speed or distance, but less force, than input
- **Contraction of biceps brachii muscle puts more power into lever than we get out of it, but hand moves faster and farther than spot of biceps attachment (MA < 1.0)**

Types of Levers



(a) First-class lever



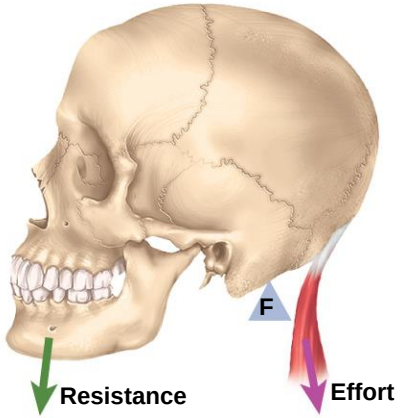
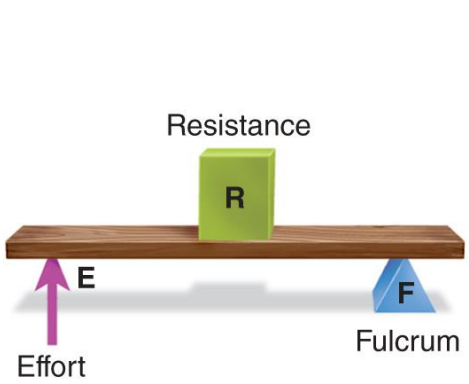
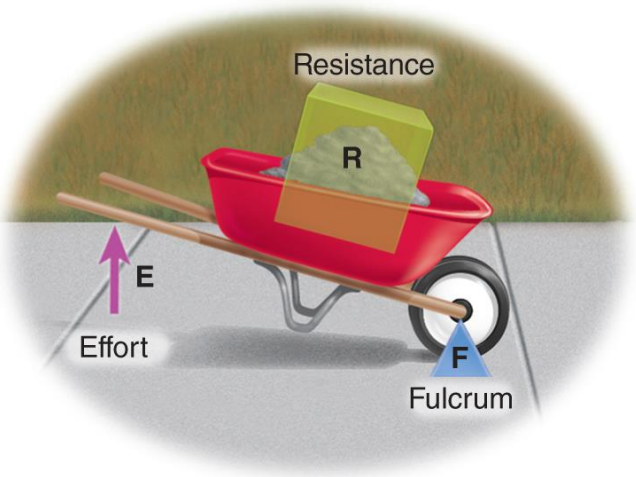


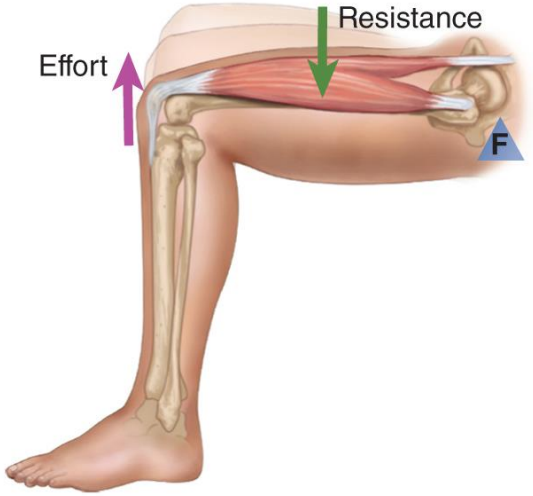
Figure 9.9a

- **First-class lever**
  - Has fulcrum in the middle between effort and resistance (EFR)
  - Atlanto–occipital joint lies between the muscles on the back of the neck (applying effort) and the weight of the face (resistance)
  - Loss of muscle tone occurs when you nod off in class

Types of Levers





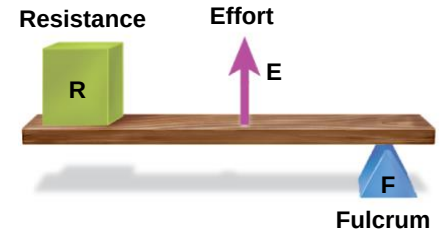


(b) Second-class lever

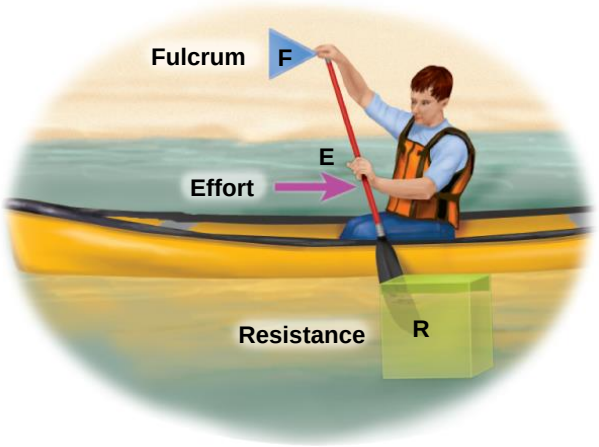
Figure 9.9b

- **Second-class lever**
  - Resistance between fulcrum and effort (FRE)
  - Example: when bouncing a baby on your knee, hip is fulcrum, baby's weight is resistance, and effort is applied at the tibia

Types of Levers



(c) Third-class lever



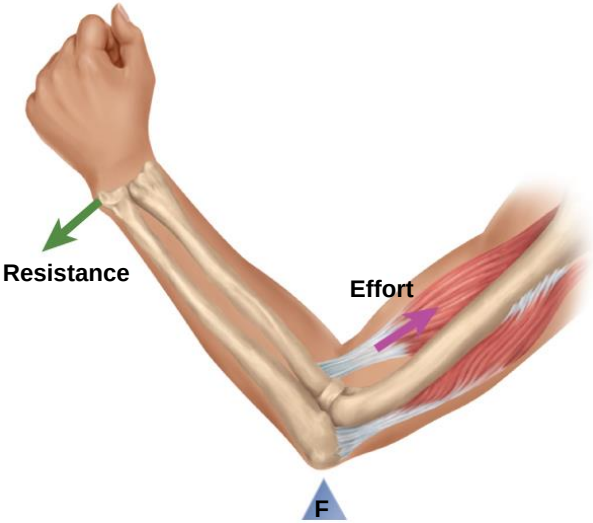


Figure 9.9c

- **Third-class lever**
  - Effort between the resistance and the fulcrum (REF)
  - Most joints of the body
  - The effort of a biceps curl is applied to the forearm between the elbow joint (fulcrum) and the weight in the hand (resistance)

Range of Motion

- **Range of motion (ROM)**—the degrees through which a joint can move
  - Aspect of joint performance
  - Physical assessment of a patient's joint flexibility
- **ROM determined by:**
  - **Structure of the articular surfaces**
    - Elbow—olecranon of ulna fits into olecranon fossa of humerus
  - **Strength and tautness of ligaments and joint capsules**
    - Stretching of ligaments increases range of motion
    - Double-jointed people have long or slack ligaments
  - **Action of the muscles and tendons**
    - Nervous system monitors joint position and muscle tone
    - **Muscle tone**—state of tension maintained in resting muscles

Axes of Rotation

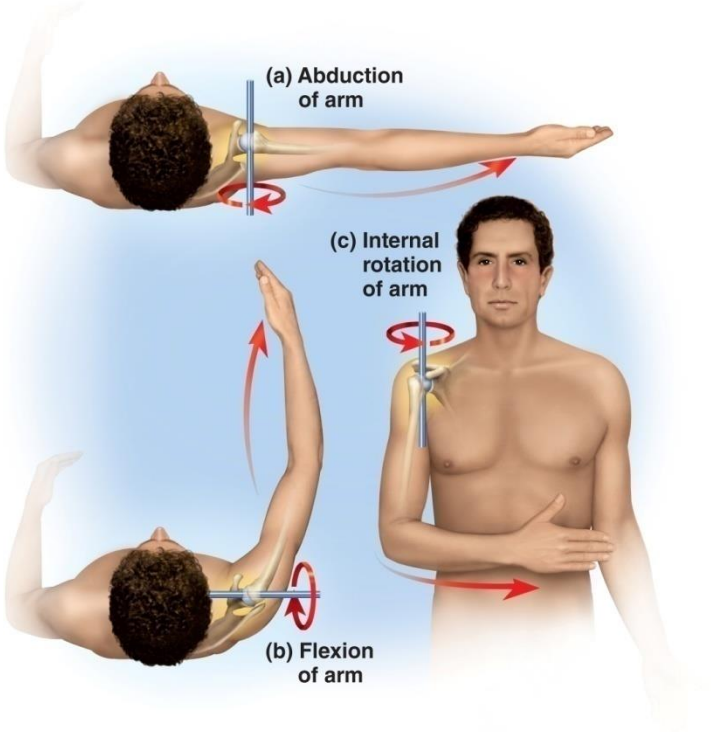


Figure 9.10

- **A moving bone has a relatively stationary axis of rotation that passes through the bone in a direction perpendicular to the plane of movement**
- **Multiaxial joint—**shoulder joint has three degrees of freedom or axes of rotation
- Other joints are **monoaxial** or **biaxial**

Classes of Synovial Joints

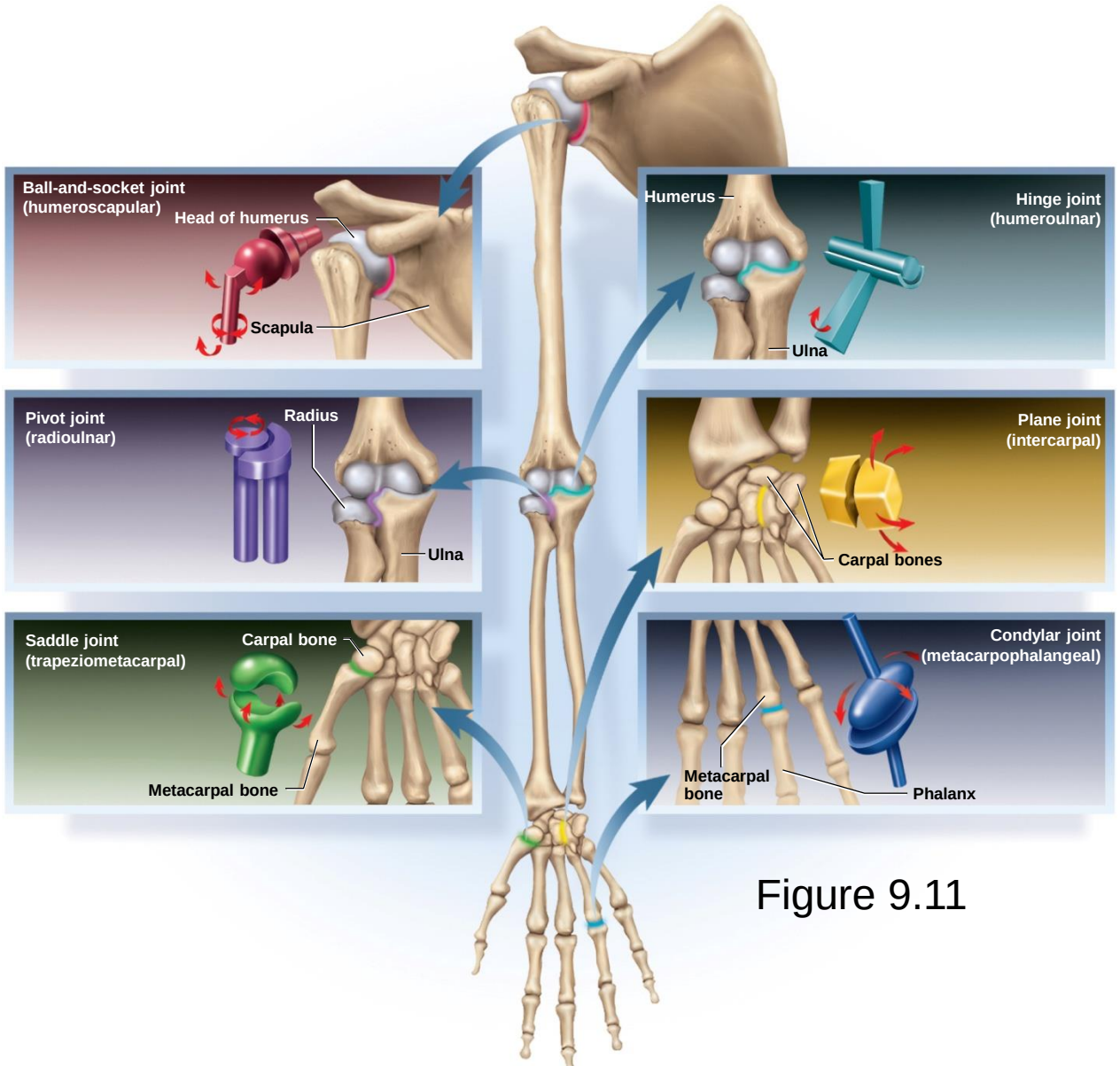


Figure 9.11

Classes of Synovial Joints

- **Six** classes of synovial joints: ball-and-socket, condylar, saddle, plane, hinge, pivot
- **Ball-and-socket joints**
  - Smooth, hemispherical head fits within cup-like socket
  - Only **multiaxial** joints in body
  - Examples: shoulder, hip
- **Condylar (ellipsoid) joints**
  - Oval convex surface of one bone fits into a complementary-shaped depression on the other
  - **Biaxial** joints—movement in two planes
  - Examples: radiocarpal joint, metacarpophalangeal joints

Classes of Synovial Joints

- **Saddle joints**
  - Both bones have an articular surface that is shaped like a saddle, one concave, the other convex
  - **Biaxial** joints
  - Examples: trapeziometacarpal (opposable thumb), sternoclavicular joint
- **Plane (gliding) joints**
  - Flat articular surfaces, bones slide over each other
  - Usually **biaxial** joints
  - Examples: between carpal bones of wrist; between tarsal bones of ankle; also between articular processes of vertebrae

Classes of Synovial Joints

- **Hinge joints**
  - One bone with convex surface fits into a concave depression of another bone
  - **Monoaxial** joints—move freely in one plane
  - Examples: elbow, knee, joints within fingers, toes
- **Pivot joints**
  - A bone spins on its longitudinal axis
  - **Monoaxial** joints
  - Examples: atlantoaxial joint (C1 and C2), radioulnar joint at the elbow

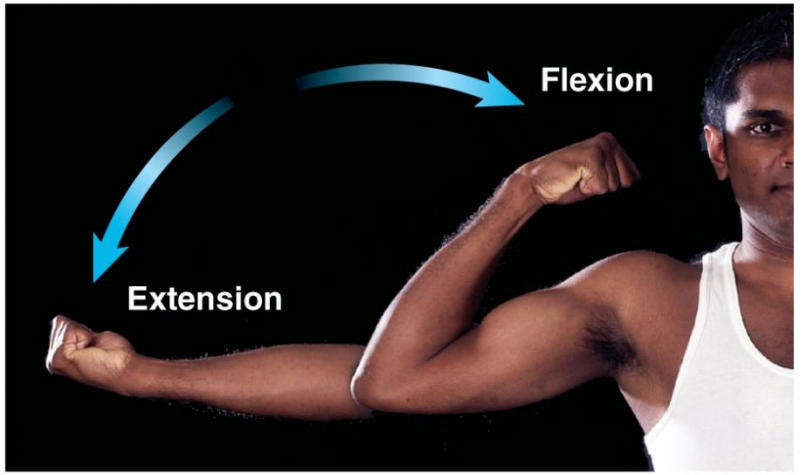
Movement of Synovial Joints

- There is a **vocabulary** for joint movements used in many medical and scientific fields
  - Many terms presented in pairs with opposite or contrasting meanings
  - Need to understand anatomical planes and directional terms

- **Zero position**—the position of a joint when a person is in the standard anatomical position
  - Joint movements described as deviating from the zero position or returning to it

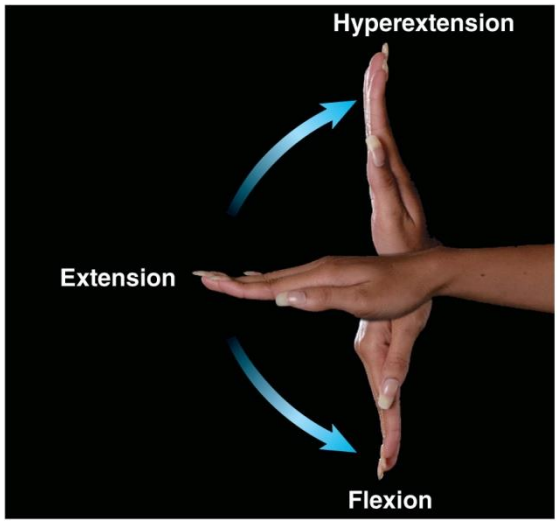
Flexion and Extension

- **Flexion**—movement that decreases joint angle
  - Common in hinge joints
- **Extension**—movement that straightens a joint and returns a body part to the zero position
- **Hyperextension**—extension of a joint beyond the zero position
  - Flexion and extension occur at nearly all diarthroses, hyperextension is limited to a few



(a)

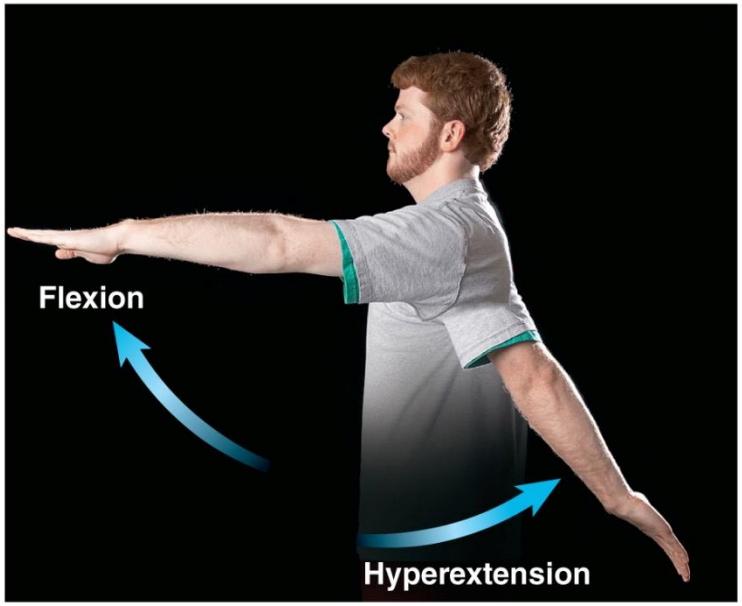
Figure 9.12a



(b)

Figure 9.12b

Flexion and Extension



(c)

Figure 9.12c

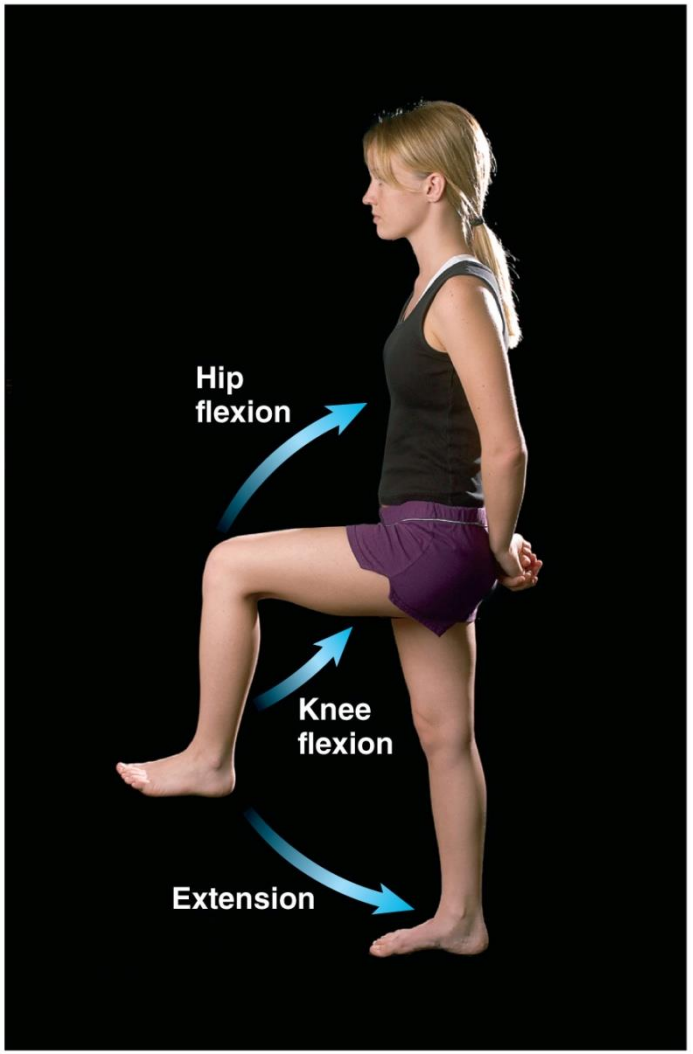
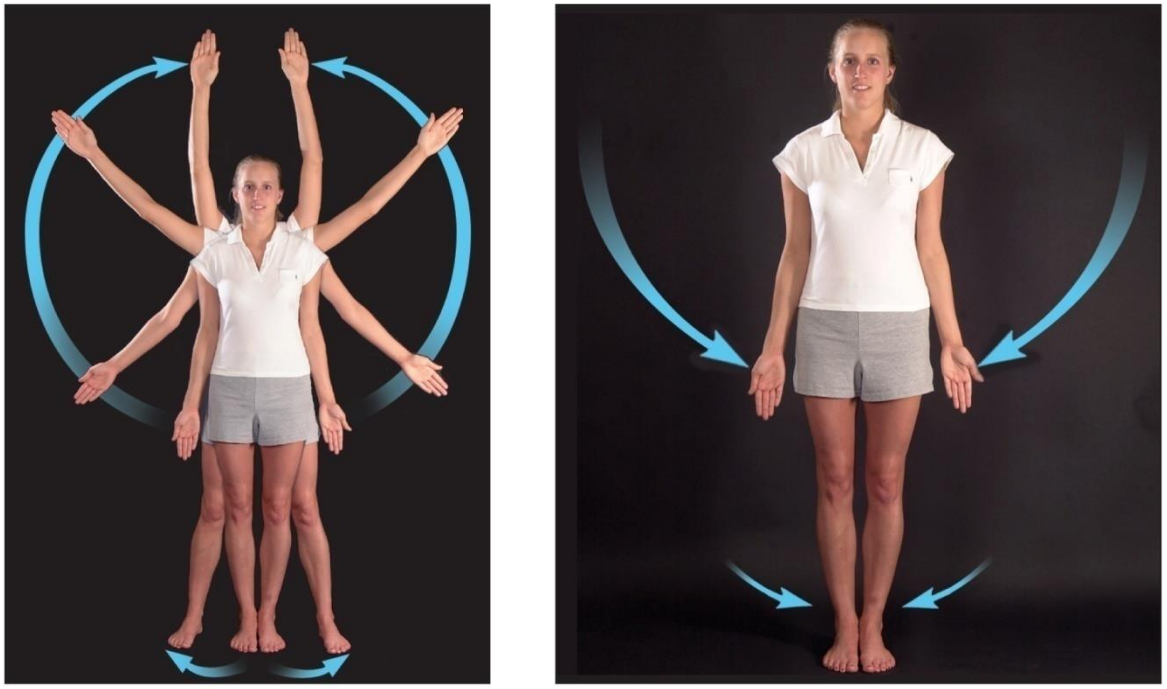


Figure 9.12d (d)

Abduction and Adduction



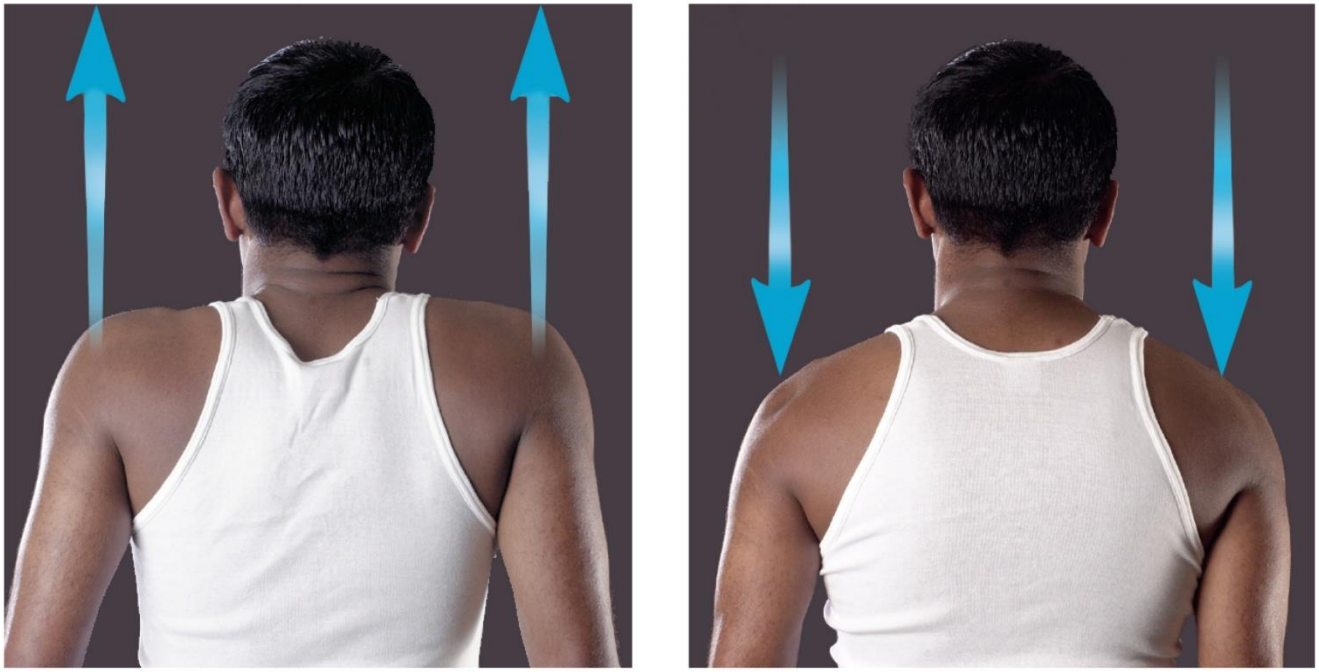
(a) Abduction (b) Adduction

a-b: ©McGraw-Hill Education/Timothy L. Vacula

Figure 9.13a,b

- **Abduction**—movement of a body part in the frontal plane away from the midline of the body
  - **Hyperabduction:** raise arm over back or front of head
- **Adduction**—movement in the frontal plane back toward the midline
  - **Hyperadduction:** crossing fingers, crossing ankles

Elevation and Depression



(a) Elevation (b) Depression

a-b: ©McGraw-Hill Education/Timothy L. Vacula

Figure 9.14a,b

- **Elevation**—movement that raises a body part vertically in the frontal plane
- **Depression**—movement that lowers a body part in the same plane

Protraction and Retraction

- **Protraction**—the anterior movement of a body part in the transverse (horizontal) plane
- **Retraction**—posterior movement

(a) Protraction

(b) Retraction

Figure 9.15a,b

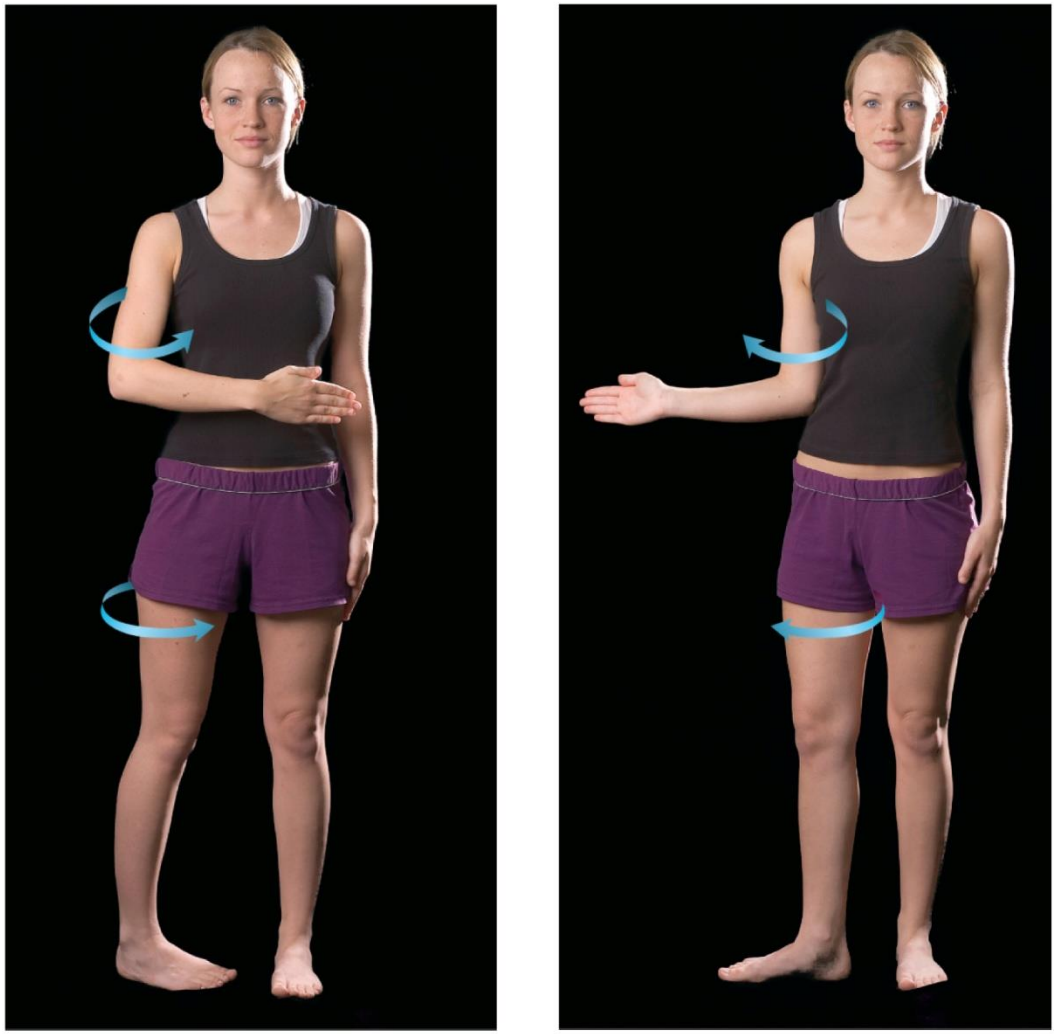
Circumduction

- **Circumduction**—one end of an appendage remains stationary while other end makes a circular motion
  - Example: an artist circumducts upper limb when painting a circle on a canvas

Figure 9.16

Rotation

- **Rotation**—movement in which a bone spins on its longitudinal axis
  - Rotation of trunk, thigh, head, or arm
- **Medial (internal) rotation** turns the bone inward
- **Lateral (external) rotation** turns the bone outward



(a) Medial (internal) rotation (b) Lateral (external) rotation

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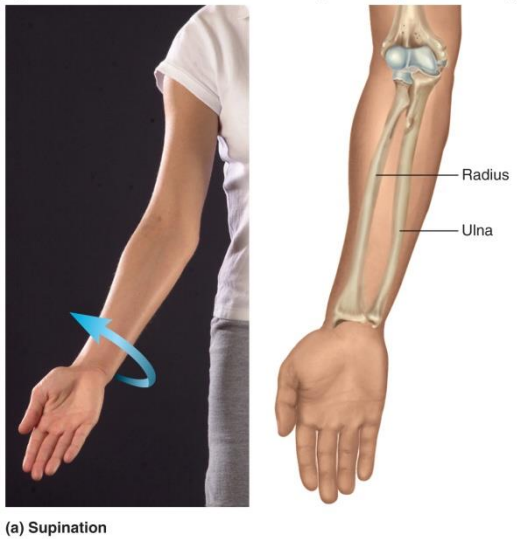
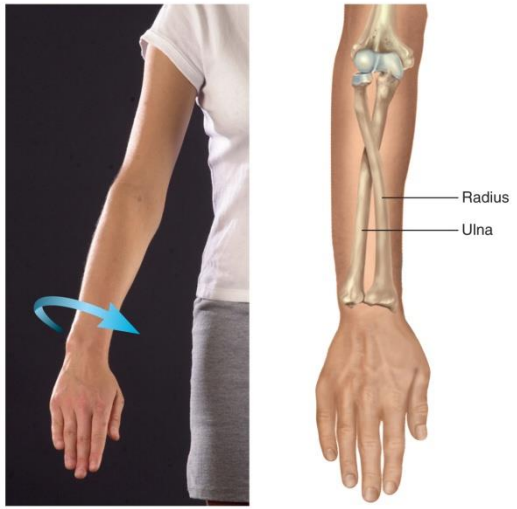
Figure 9.17a,b

Supination and Pronation



(a) Supination

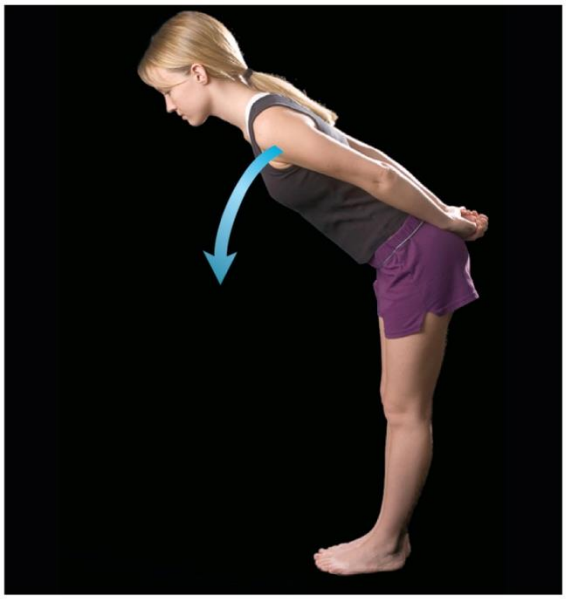


(b) Pronation

Figure 9.18a,b

- **Primarily forearm movements**
- **Supination**—forearm movement that turns palm to face anteriorly or upward
  - Forearm supinated in anatomical position
  - Radius is parallel to the ulna
- **Pronation**—forearm movement that turns palm to face either posteriorly or downward
  - Head of radius spins
  - Radius crosses stationary ulna like an X

Special Movements of Head and Trunk



(a) Flexion

(b) Hyperextension

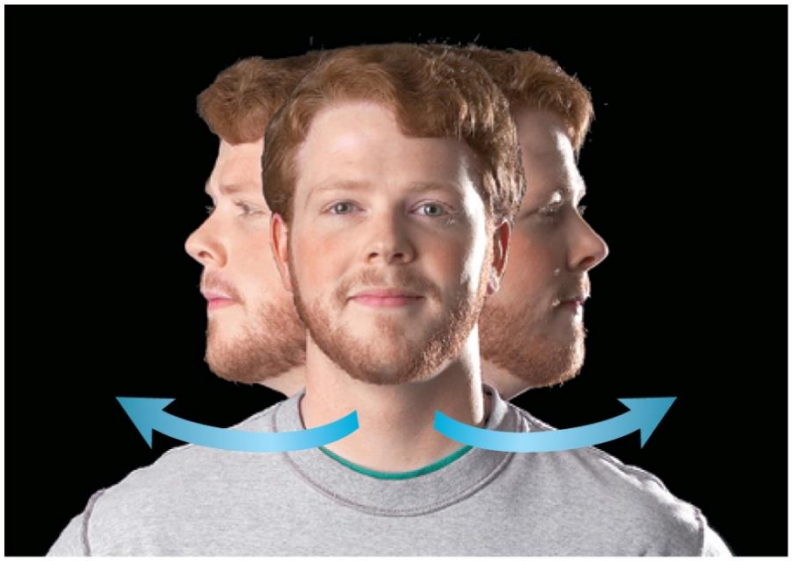
(c) Lateral flexion

Figure 9.19a,b,c

- **Flexion**—forward-bending movements at the waist or neck
- **Extension**—straightens trunk or neck
- **Hyperextension**—bending over backward
- **Lateral flexion**—tilting the head or trunk to the right or left at the midline

Special Movements of Head and Trunk

(d) Right rotation



(e) Rotation

Figure 9.19d,e

- **Right and left rotation of trunk and head**

Special Movements of the Mandible

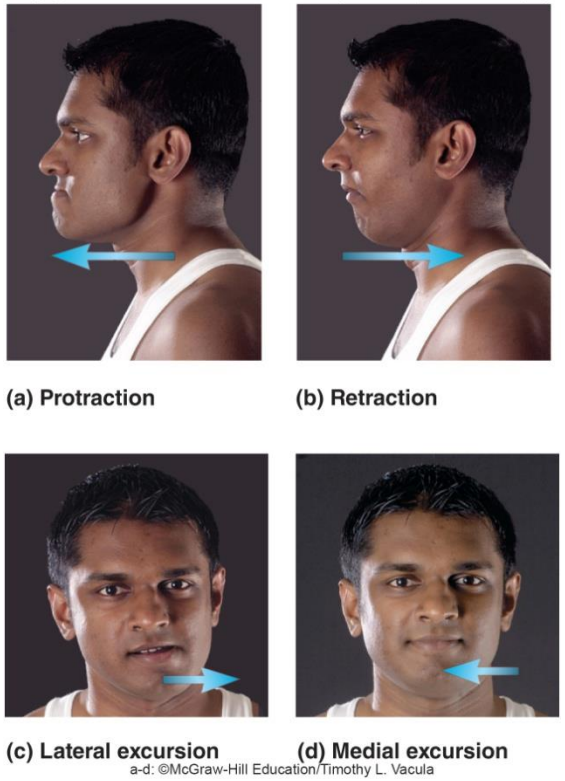


Figure 9.20

- **Lateral excursion—**right or left movement from the zero position
- **Medial excursion—**movement back to the median, zero position
  - Side-to-side grinding during chewing
- **Protraction–retraction**
- **Elevation–depression**

Special Movements of Hand and Digits

- **Radial flexion—**tilting hand toward thumb
- **Ulnar flexion—**tilting hand toward little finger
- **Abduction vs. adduction of the fingers—**spreading them apart vs. bringing them together
- **Flexion vs. extension of fingers—**curling vs. straightening them

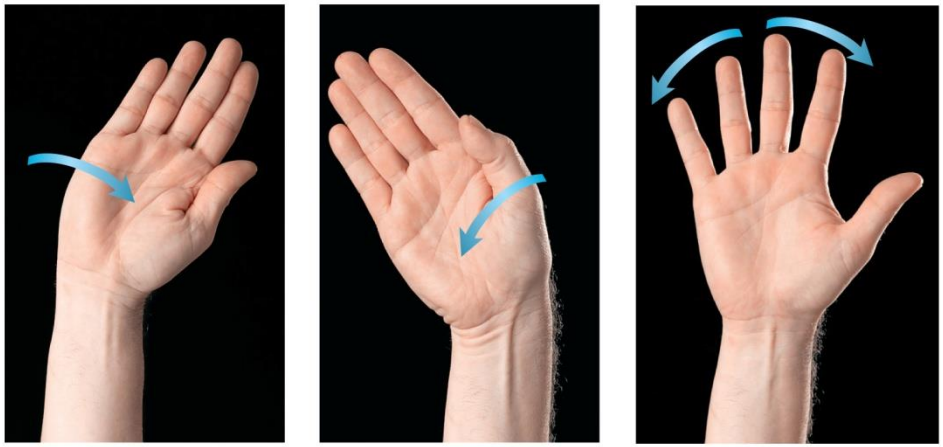
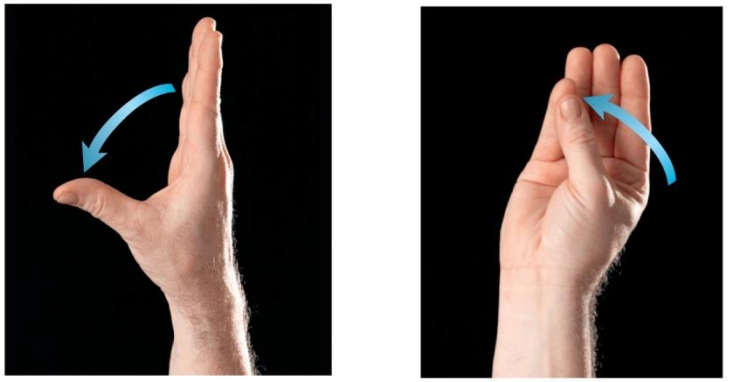


Figure 9.21a,b,c

Special Movements of Hand and Digits

- **Palmar abduction**—moving thumb away from hand and pointing it anteriorly
- **Radial abduction**—moving thumb away from index finger (90°)
- **Flexion of thumb**—tip of thumb directed toward palm
- **Extension of thumb**—straightening the thumb
- **Opposition**—moving thumb to touch tip of a finger
- **Reposition**—returning thumb to the zero position



(d) Palmar abduction of thumb (e) Opposition of thumb

Figure 9.21d, e

Special Movements of the Foot

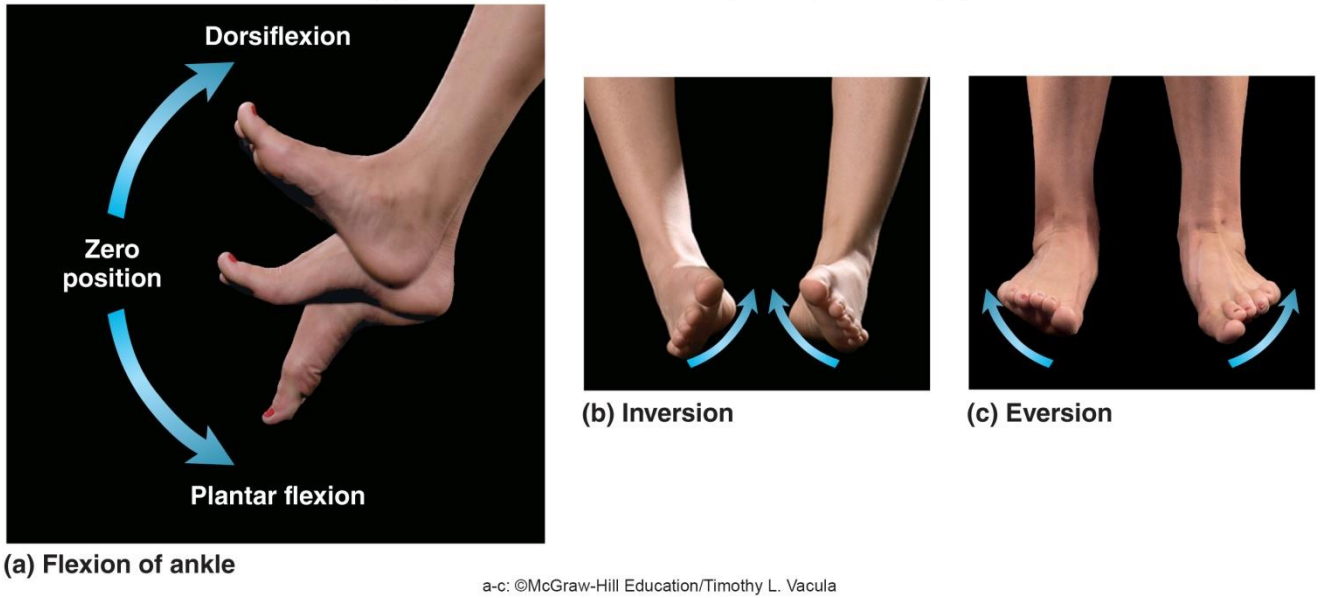


Figure 9.22

- **Dorsiflexion**—elevating toes as you do while swinging foot forward to take a step (heel strike)
- **Plantar flexion**—extending foot so that toes point downward as in standing on tiptoe (toe-off)
- **Inversion**—movement in which the soles are turned medially
- **Eversion**—movement in which the soles are turned laterally

Special Movements of the Foot

- **Supination of foot**—complex combination of plantar flexion, inversion, and adduction
- **Pronation of foot**—complex combination of dorsiflexion, eversion, and abduction

Anatomy of Selected Diarthroses

- **Expected Learning Outcomes**
  - Identify the major anatomical features of the jaw, shoulder, elbow, hip, knee, and ankle joints.
  - Explain how the anatomical differences between these joints are related to differences in function.

The Jaw Joint

- **Temporomandibular** (jaw) **joint (TMJ)**—articulation of the condyle of the mandible with the mandibular fossa of the temporal bone
  - Combines elements of condylar, hinge, and plane joints
  - Synovial cavity of the TMJ is divided into **superior and inferior chambers** by an **articular disc**

The Jaw Joint

- **Two ligaments** support joint
  - **Lateral ligament—**prevents posterior displacement of mandible
  - **Sphenomandibular ligament—**on the medial side

- Deep yawn or strenuous depression can **dislocate the TMJ**
  - Condyles pop out of fossa and slip forward
  - **Relocated** by pressing down on molar teeth while pushing the jaw backward

The Jaw Joint

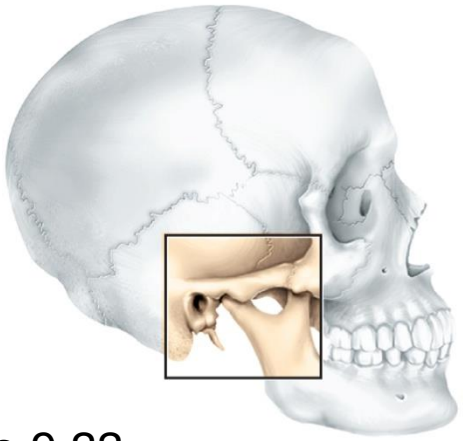
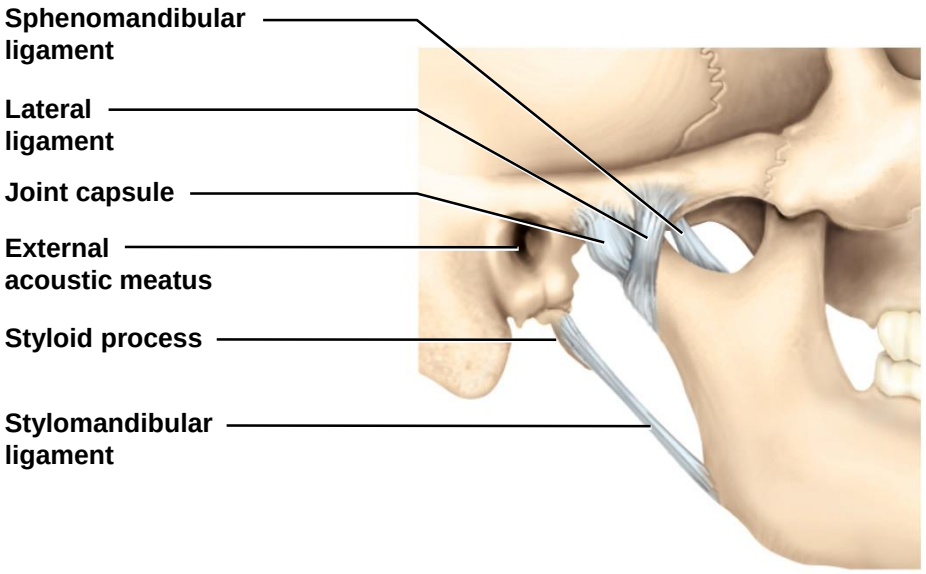
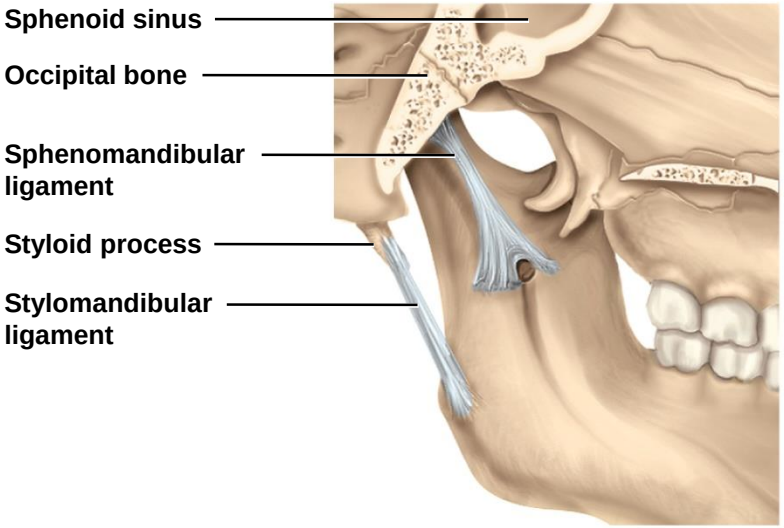


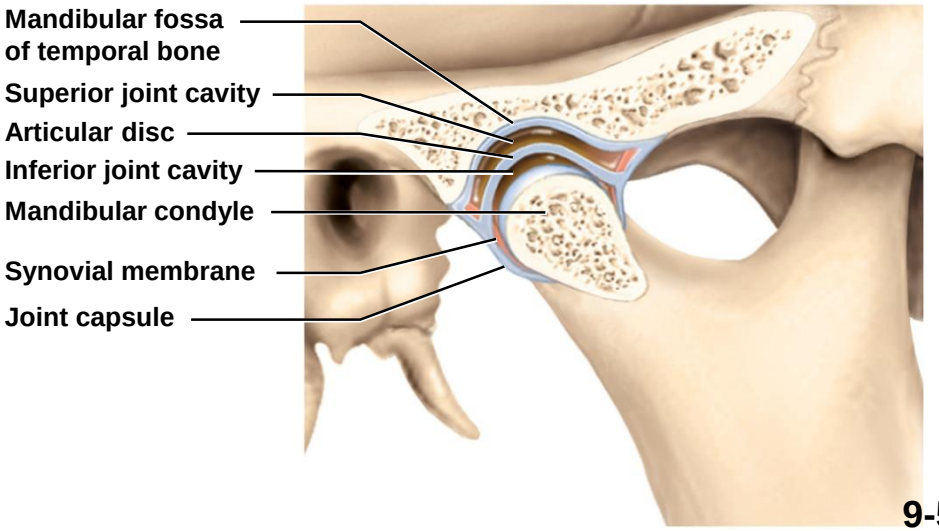
Figure 9.23



(a) Lateral view



(b) Medial view



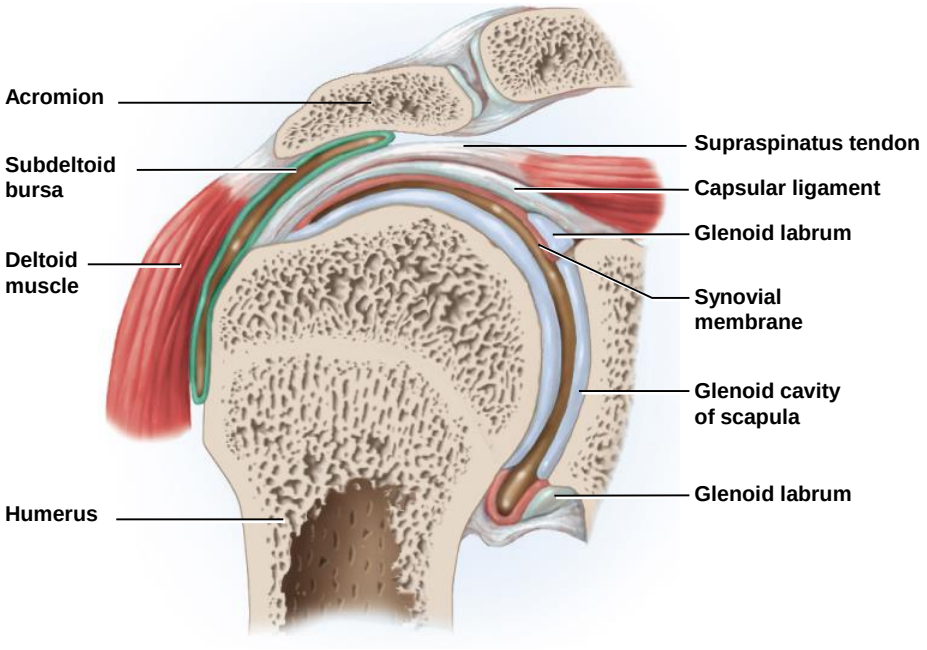
(c) Sagittal section

TMJ Syndrome

- **Temporomandibular joint (TMJ) syndrome**
  - May affect as many as 75 million Americans
- **Signs and symptoms**
  - Clicking sounds in the jaw, imitation of jaw movement
  - Pain radiating from jaw down the neck, shoulders, and back
  - Can cause moderate intermittent facial pain, or severe headaches, vertigo (dizziness), tinnitus (ringing in the ears)
- **Cause of syndrome**
  - Caused by combination of psychological tension and malocclusion (misalignment of teeth)
- **Treatment**
  - Psychological management, physical therapy, analgesic and anti-inflammatory drugs, corrective dental appliances to align teeth properly

The Shoulder Joint

- **Glenohumeral (humeroscapular) joint—** hemispherical head of humerus articulates with glenoid cavity of scapula
  - Most freely mobile joint in body
  - Shallow glenoid cavity and loose shoulder joint capsule sacrifice stability for freedom of movement
  - **Glenoid labrum:** fibrocartilage ring that deepens glenoid cavity

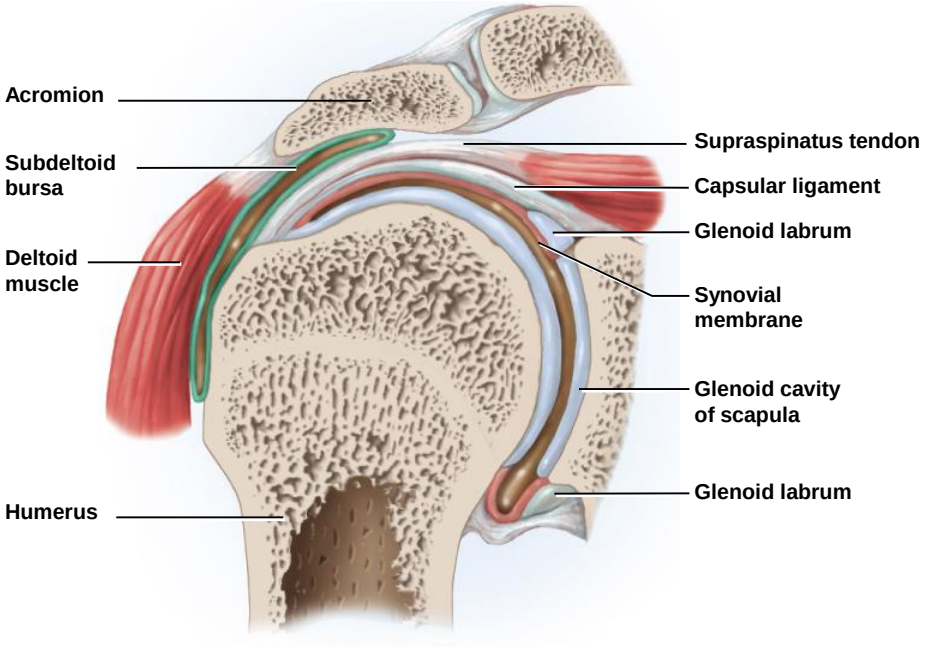


(c) Frontal section

Figure 9.24c

The Shoulder Joint

- Shoulder supported by **biceps brachii** tendon anteriorly and also **rotator cuff** tendons
  - Tendons fuse to joint capsule and strengthen it
  - **Supraspinatus**, **infraspinatus**, **teres minor,** and **subscapularis**

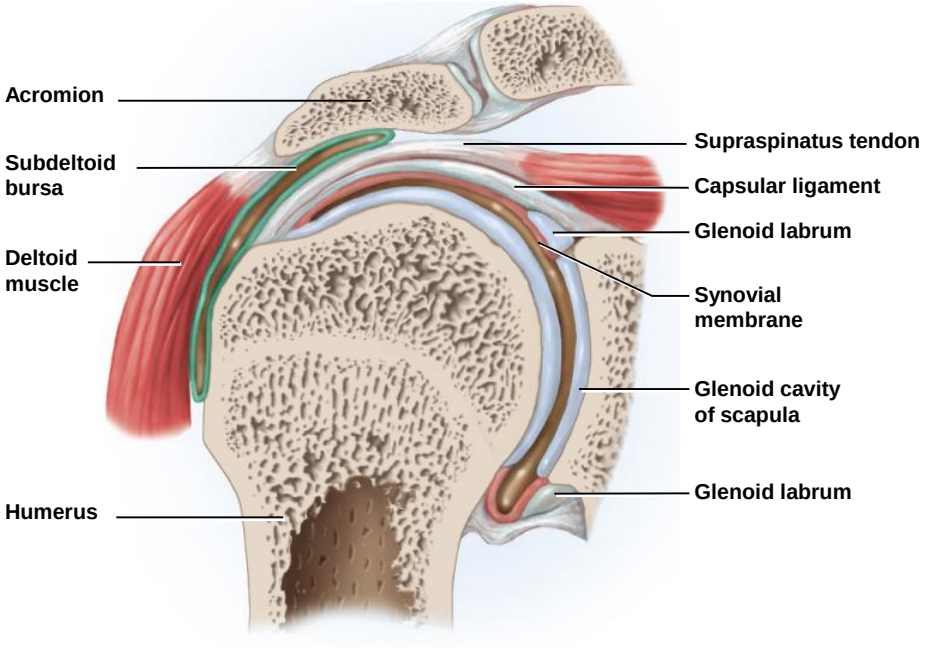


(c) Frontal section

Figure 9.24c

The Shoulder Joint

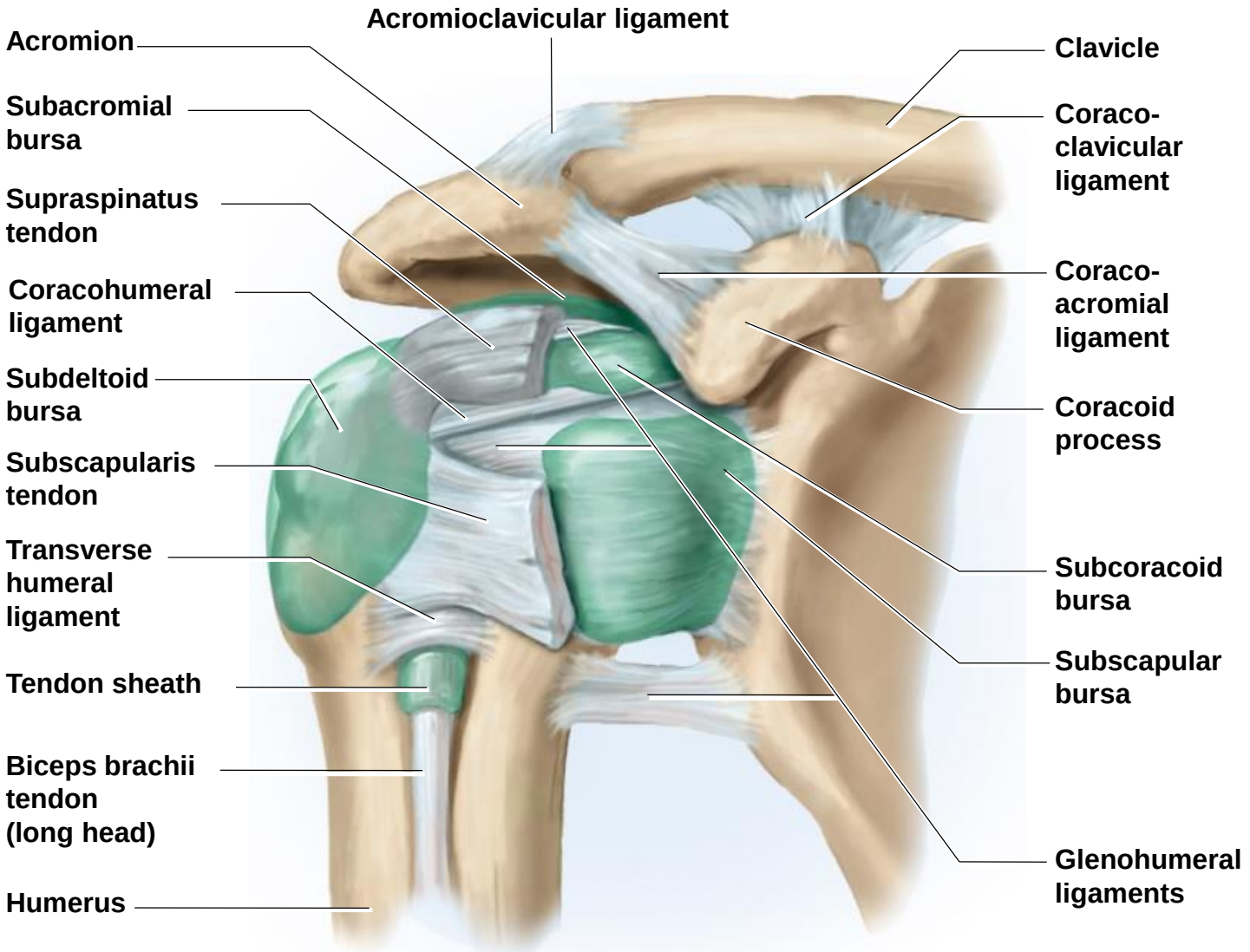
- **Five principal ligaments support shoulder**
  - Three are called the **glenohumeral ligaments**
  - **Coracohumeral ligament**
  - **Transverse humeral ligament**
- **Four bursa occur at the shoulder**
  - **Subdeltoid, subacromial, subcoracoid,** and **subscapular bursae**



(c) Frontal section

Figure 9.24c

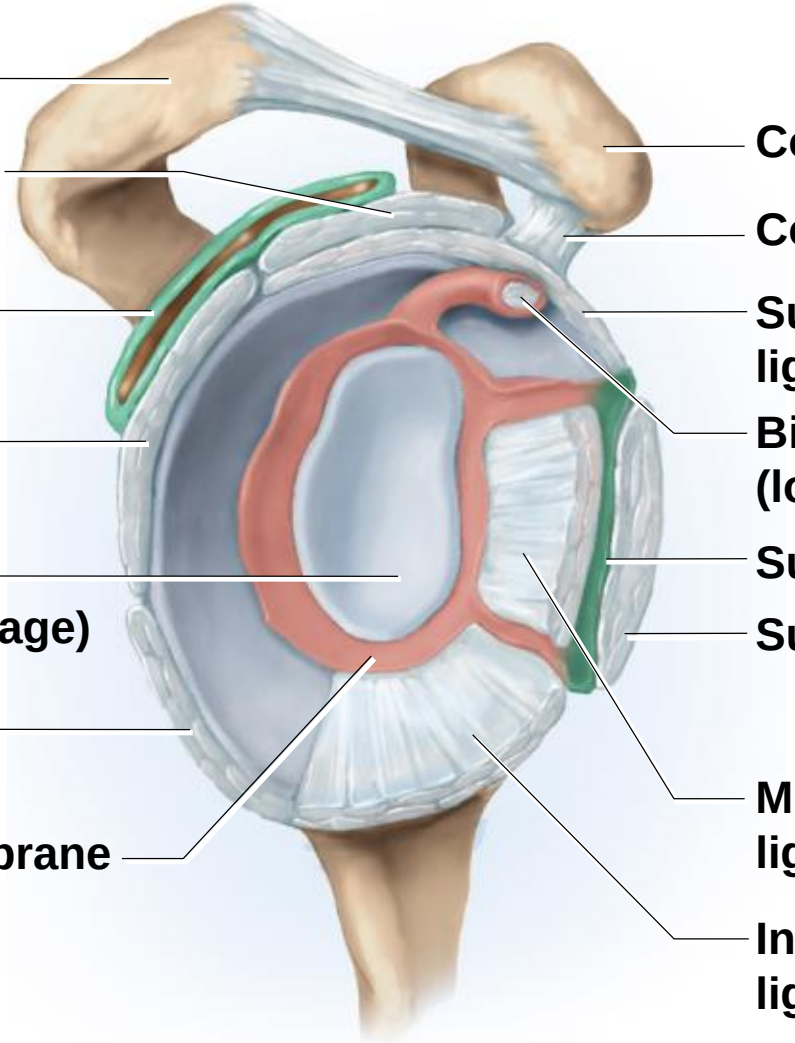
The Shoulder Joint



(b) Anterior view

Figure 9.24b

The Shoulder Joint

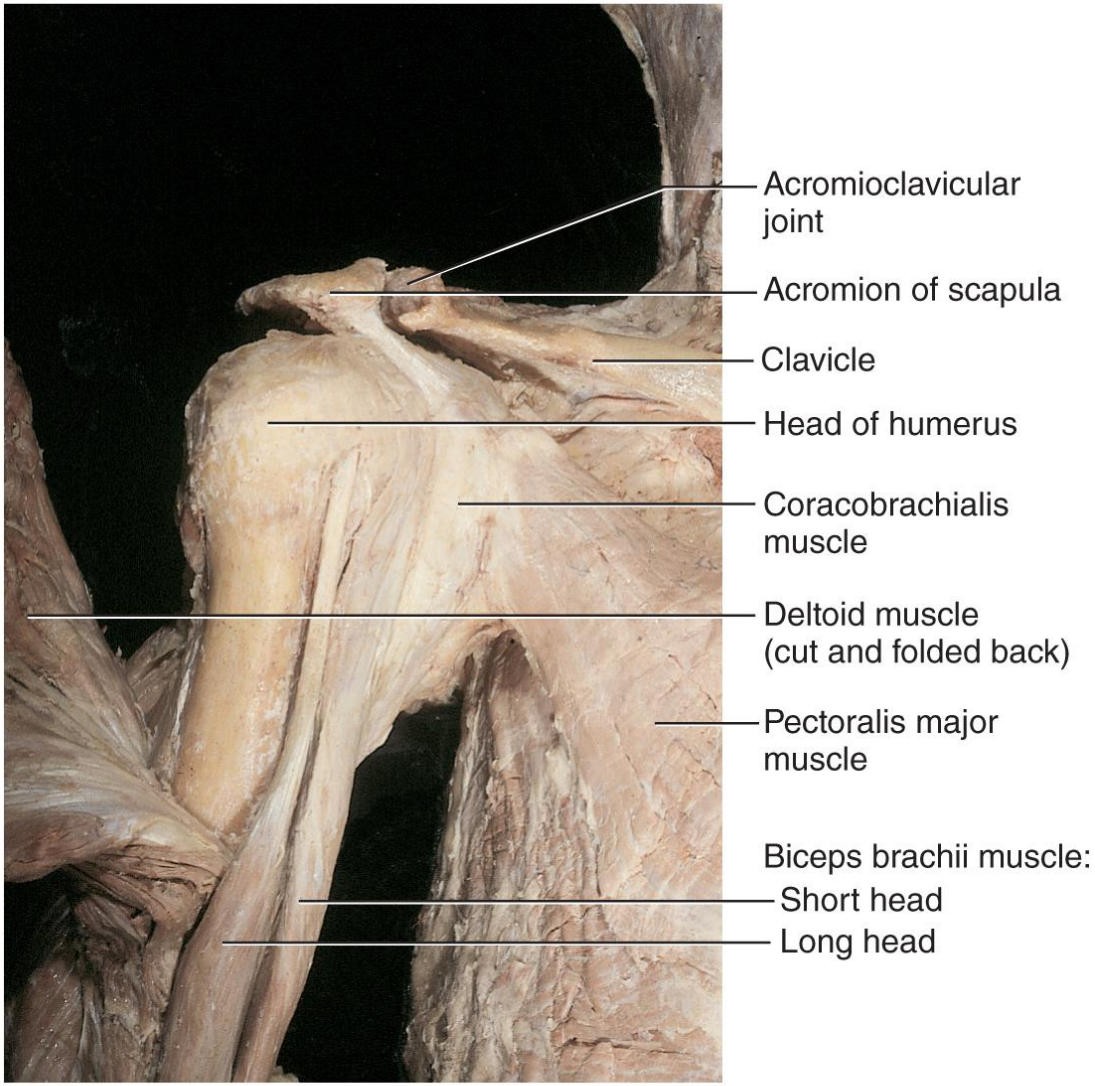


Acromion
Supraspinatus tendon
Subdeltoid bursa
Infraspinatus tendon
Glenoid cavity (articular cartilage)
Teres minor tendon
Synovial membrane (cut)
Coracoid process
Coracohumeral ligament
Superior glenohumeral ligament
Biceps brachii tendon (long head)
Subscapular bursa
Subscapularis tendon
Middle glenohumeral ligament
Inferior glenohumeral ligament

(d) Lateral view, humerus removed

Figure 9.24d

The Shoulder Joint

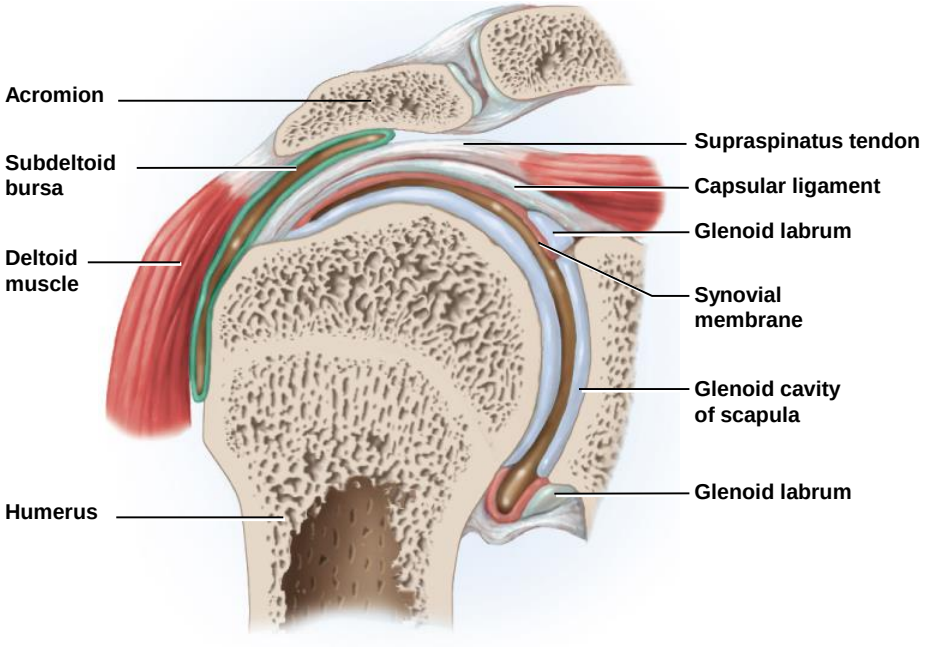


(a) Anterior dissection

Figure 9.24a

Shoulder Dislocation

- **Very painful and sometimes causes permanent damage**
- **Downward displacement of the humerus is the most common shoulder dislocation**
  - Rotator cuff protects the joint in all directions but inferiorly
  - Joint protected from above by coracoid process, acromion, and clavicle
  - Dislocations most often occur when the arm is abducted and then receives a blow from above
- **Children especially prone to dislocation**

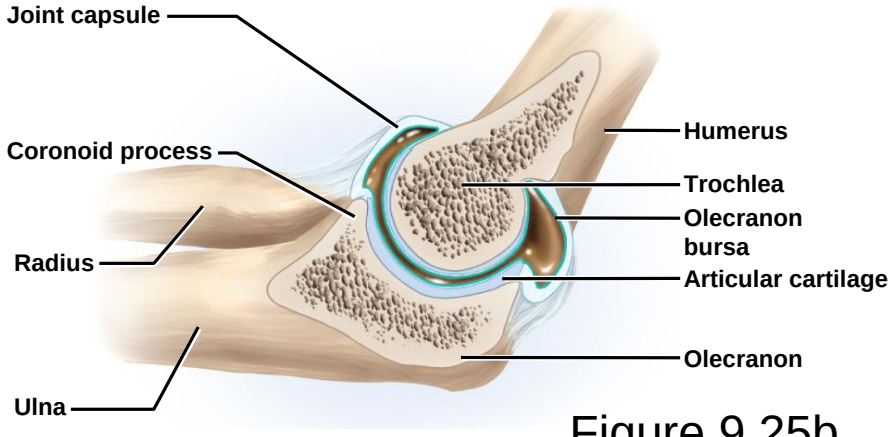


(c) Frontal section

Figure 9.24c

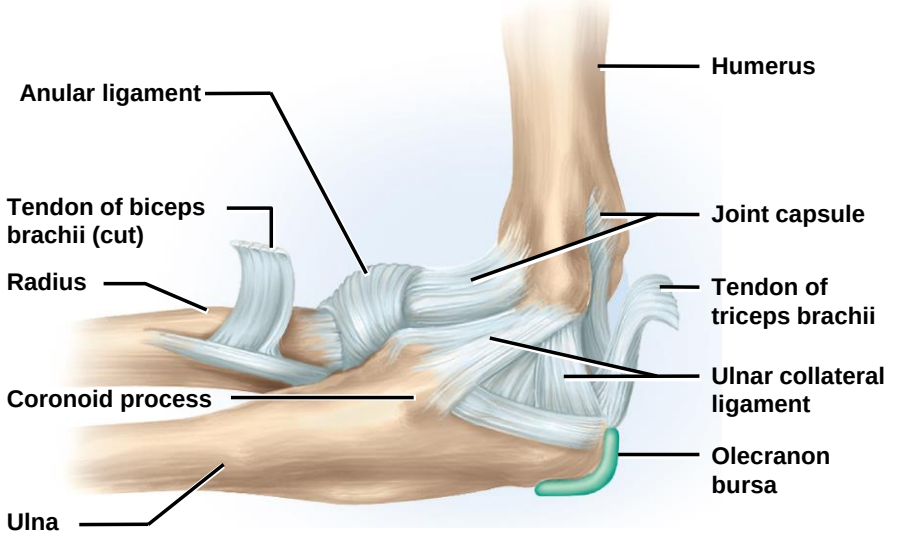
The Elbow Joint

- **Elbow**—a hinge that includes two articulations:
  - **Humeroulnar joint:** trochlea of the humerus joins trochlear notch of the ulna
  - **Humeroradial joint**: capitulum of humerus meets head of radius
  - Both articulations enclosed in one joint capsule
  - **Olecranon bursa** on posterior side of elbow eases movements of tendons
  - **Radial (lateral) collateral ligament and ulnar (medial) collateral ligaments** restrict side-to-side motions



(b) Sagittal section

Figure 9.25b



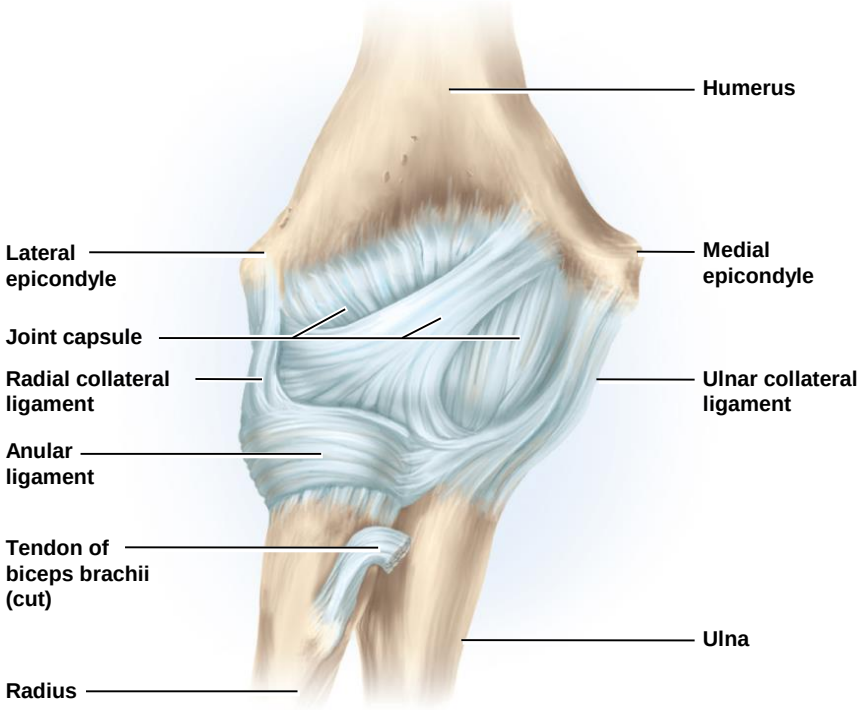
(c) Medial view

Figure 9.25c

The Elbow Joint

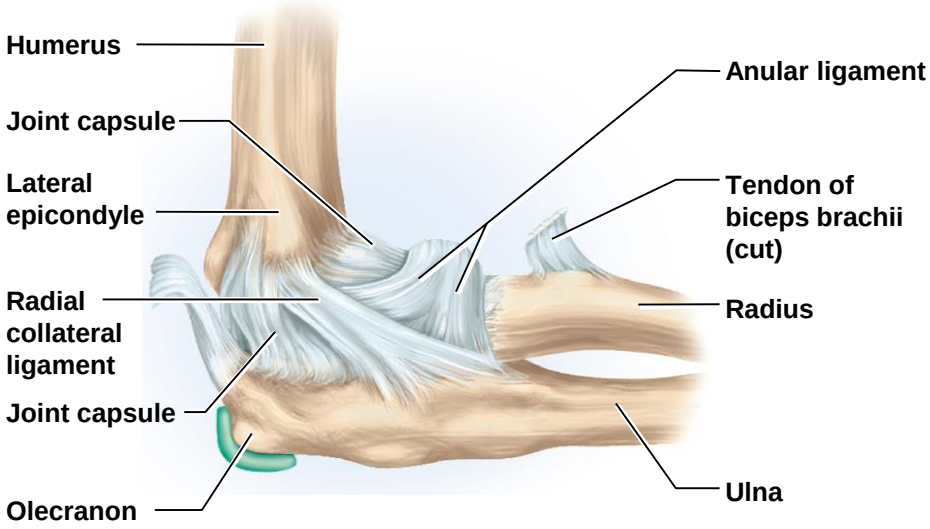
- **Elbow region also contains proximal radioulnar joint**
  - Functions as a pivot, not a hinge
  - Head of radius fits into radial notch of ulna
  - Held in place by **anular ligament** encircling radial head
  - Allows for pronation and supination

The Elbow Joint



(a) Anterior view

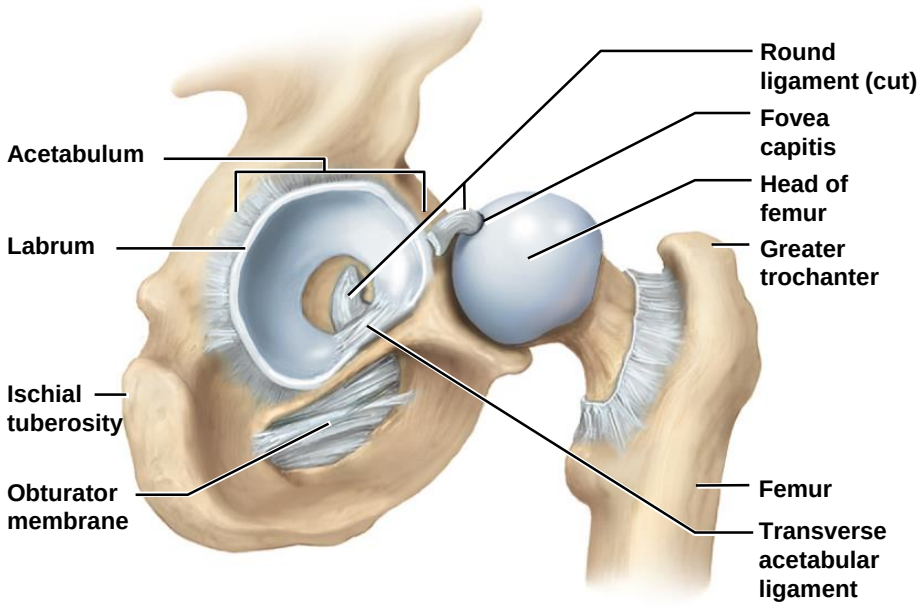
Figure 9.25a



(d) Lateral view

Figure 9.25d

The Hip Joint



(b) Lateral view, femur retracted

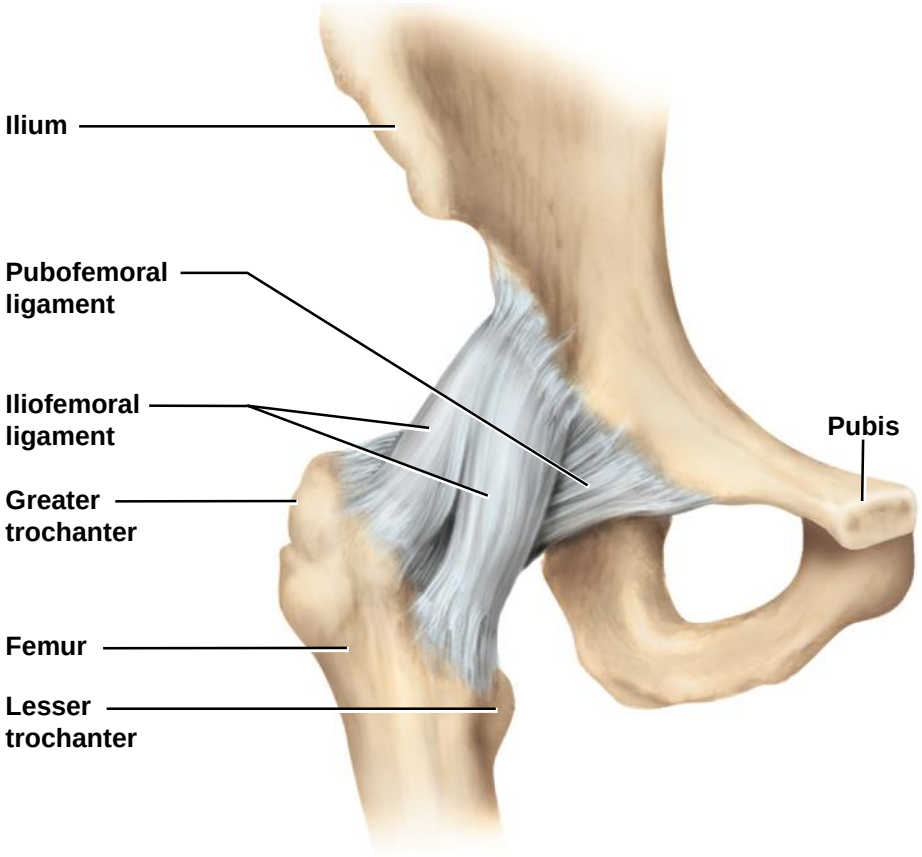
Figure 9.26b

- **Coxal (hip) joint**—head of femur inserts into acetabulum of hip bone
- **Bears weight, has deeper sockets, more stable than shoulder**

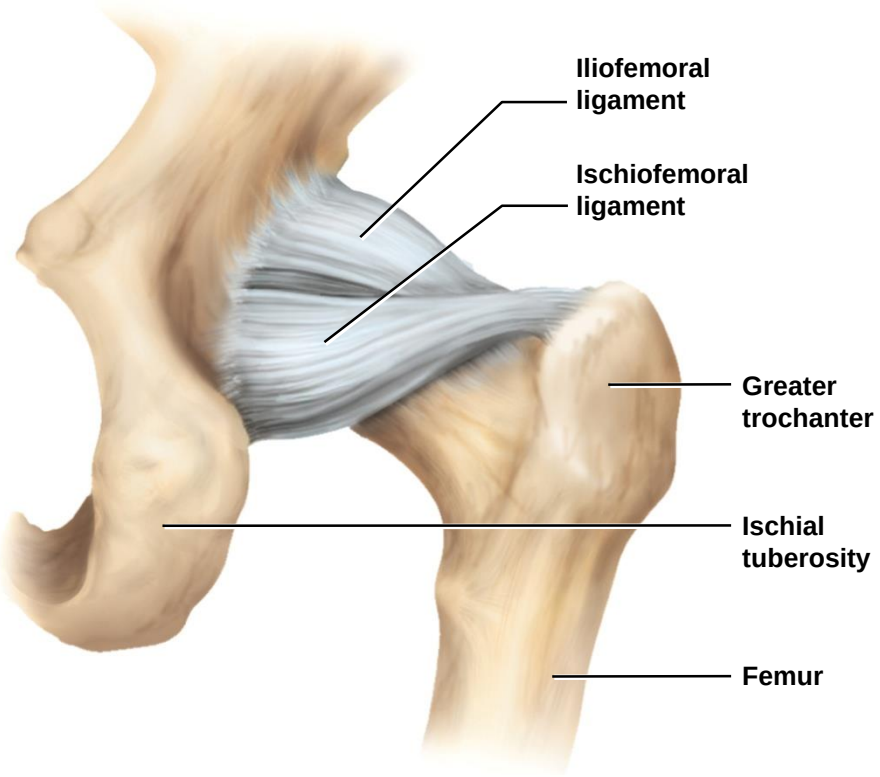
The Hip Joint

- **Acetabular labrum**—horseshoe-shaped ring of fibrocartilage that deepens socket
  - Dislocations are rare
- **Ligaments** supporting hip joint
  - **Iliofemoral** and **pubofemoral**— anterior
  - **Ischiofemoral** ligament—posterior
  - When standing, ligaments become twisted and pull head of femur tightly into acetabulum
  - **Transverse acetabular ligament** bridges gap on inferior margin of acetabular labrum
- **Round ligament** (**ligamentum teres)**—arises from **fovea capitis** and attaches to lower margin of acetabulum
  - Contains artery that supplies blood to head of femur

The Hip Joint



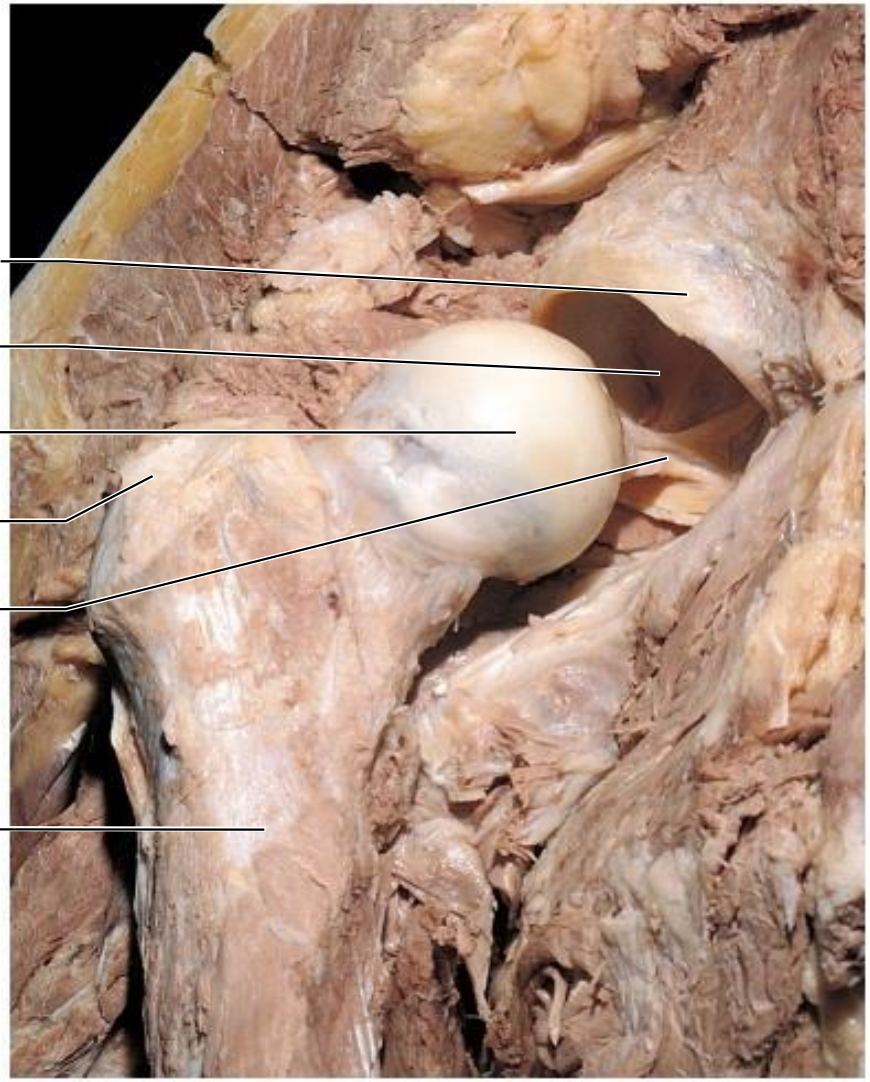
(c) Anterior view



(d) Posterior view

Figure 9.26c,d

The Hip Joint



(a) Anterior dissection

Figure 9.26a

The Hip Joint

- **Dislocation of hip is rare**
- **Some infants suffer congenital dislocation**
  - Acetabulum is not deep enough to hold head of femur in place
- **Harness, worn for 2 to 4 months can assist with proper positioning**

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Figure 9.27

The Knee Joint

- **Tibiofemoral (knee) joint**—largest and most complex diarthrosis of the body

- Primarily a **hinge joint**
  - Capable of slight rotation and lateral gliding when knee is flexed
  - **Patellofemoral joint**—gliding joint

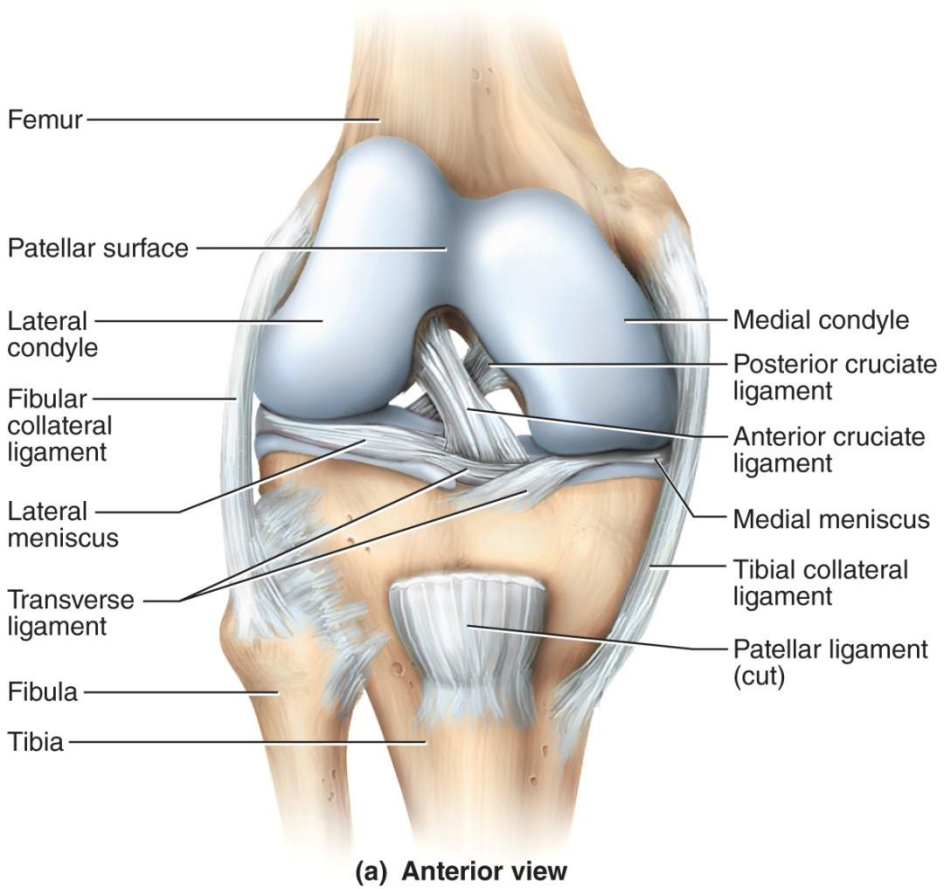


Figure 9.29a

The Knee Joint

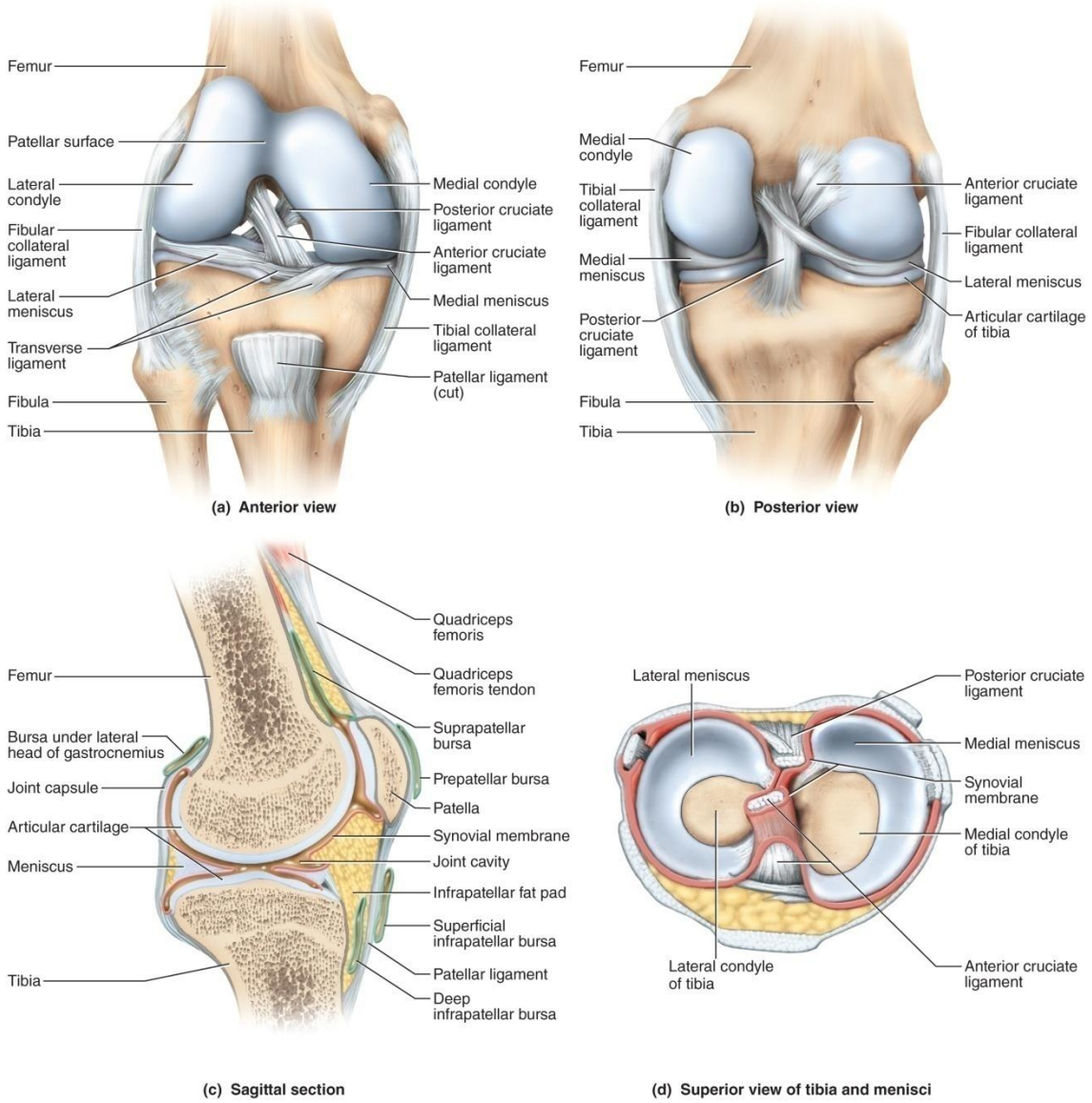
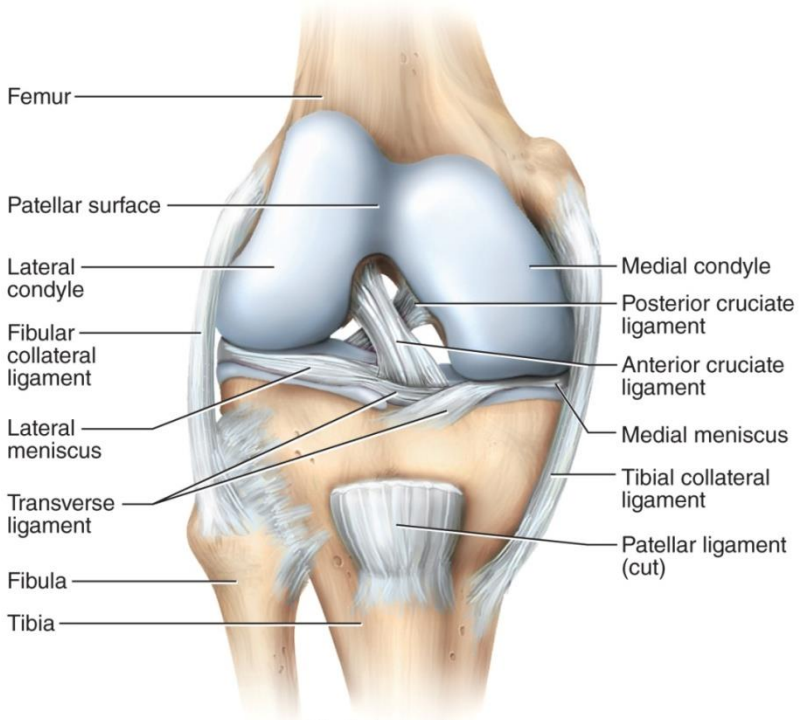


Figure 9.29

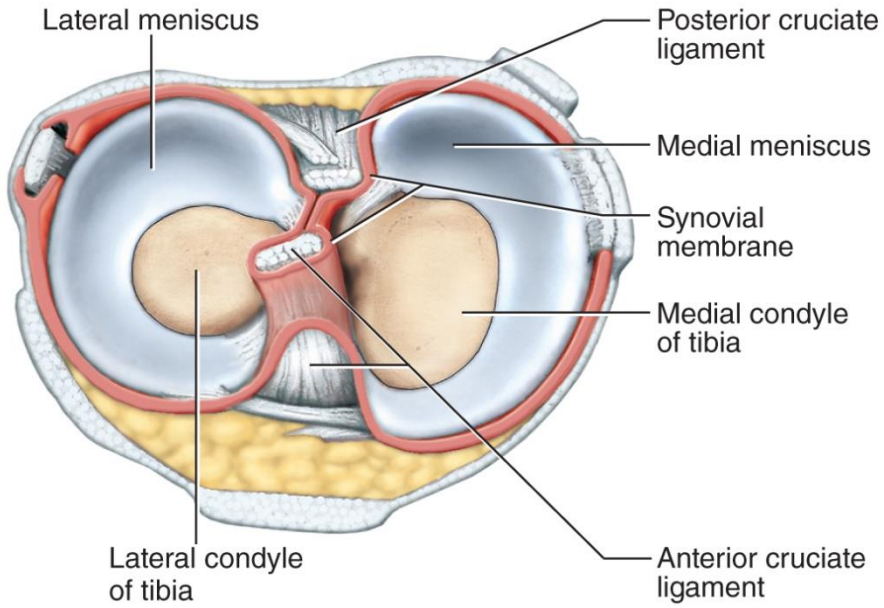
The Knee Joint

- **Joint capsule** encloses only the lateral and posterior aspects of the knee
  - Anterior aspect covered by **patellar ligament** and **lateral** and **medial retinacula**
    - All are extensions of **the tendon of quadriceps femoris** muscle
- **Knee stabilized by:**
  - **Quadriceps tendon** in front
  - **Tendon of semimembranosus muscle** on rear of thigh

The Knee Joint



(a) Anterior view



(d) Superior view of tibia and menisci

Figure 9.29a, 9.29d

- **Lateral meniscus** and **medial meniscus—**C-shaped cartilages within joint capsule
  - Absorb shock and prevent side-to-side rocking
  - Joined by transverse ligament

The Knee Joint

- **Popliteal (posterior) region**
  - Extracapsular ligaments
    - **Fibular (lateral) collateral ligament**
    - **Tibial (medial) collateral ligament**
  - Intracapsular ligaments cross each other to form X
    - **Anterior cruciate ligament (ACL)**
      - Prevents hyperextension of knee when ACL is pulled tight
      - Common site of knee injury
    - **Posterior cruciate ligament (PCL)**
      - Prevents femur from sliding off tibia

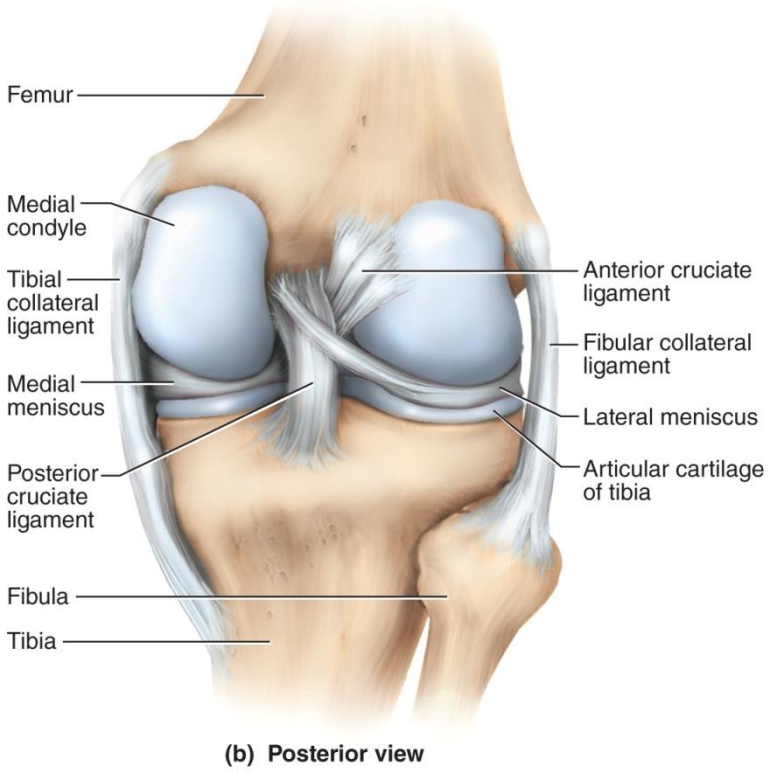
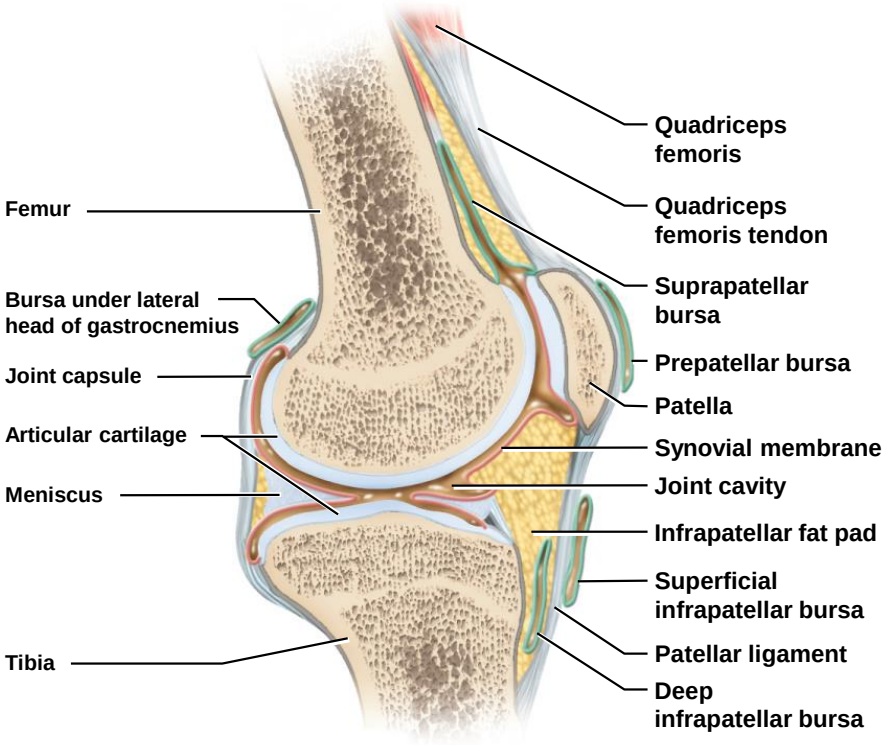


Figure 9.29b

The Knee Joint

- Knee joint has at least **13 bursae**
- **Four anterior: superficial infrapatellar, suprapatellar, prepatellar, and deep infrapatellar**
- **Popliteal region: popliteal bursa and semimembranosus bursa**
- **Seven more bursae on lateral and medial sides of knee joint**



(c) Sagittal section

Figure 9.29c

The Knee Joint

- Ability to **lock** and **unlock** knees
  - Important aspect of **human bipedalism**
  - When knee fully extended, ACL allows locking
    - Femur rotates medially on the tibia, major knee ligaments taut
  - To unlock knee, popliteus contracts and rotates femur laterally
    - Lateral rotation of femur untwists ligaments

The Knee Joint

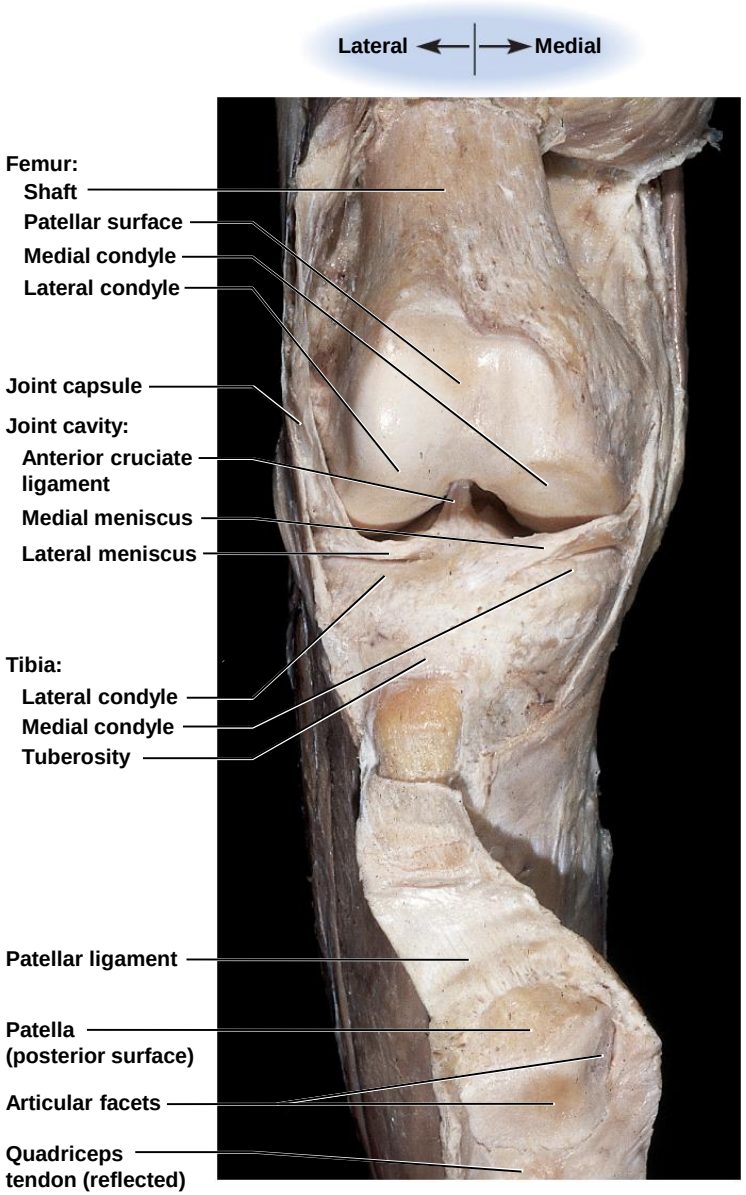


Figure 9.28

Knee Injuries and Arthroscopic Surgery

- **Highly vulnerable to rotational and horizontal stress**
- Most common injuries are to the **menisci** and **anterior cruciate ligament (ACL)**
- **Heal slowly due to scanty blood flow**

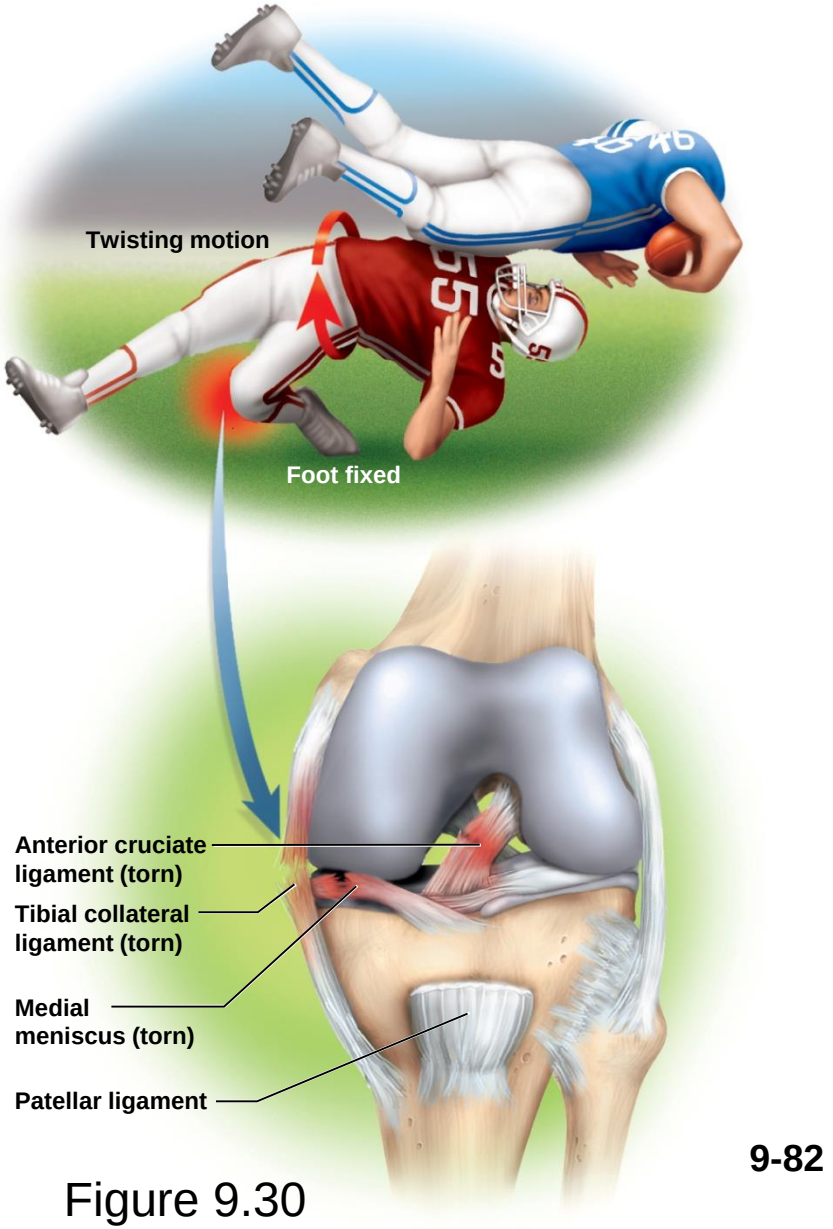


Figure 9.30

Knee Injuries and Arthroscopic Surgery

- **Arthroscopy**—procedure in which interior of joint is viewed with a pencil-thin **arthroscope** inserted through a small incision
  - Less tissue damage than conventional surgery
  - Recover more quickly
  - Arthroscopic **ACL repair:** about 9 months for healing to be complete

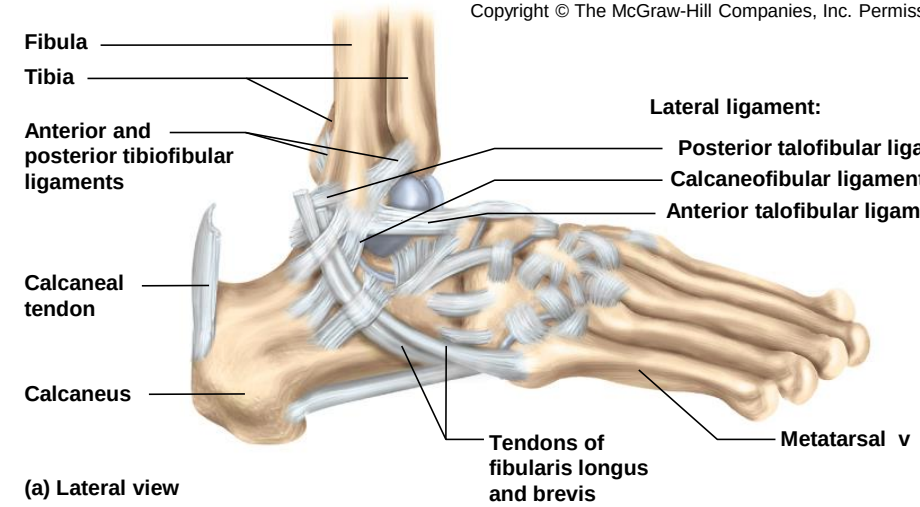
The Ankle Joint

- **Talocrural (ankle) joint**—includes two articulations:
  - **Medial joint:** between tibia and talus
  - **Lateral joint:** between fibula and talus
- **Both articulations enclosed by one joint capsule**
- **Malleoli** of tibia and fibula overhang the talus on either side and prevent side-to-side motion
- **More restricted range of motion than the wrist**

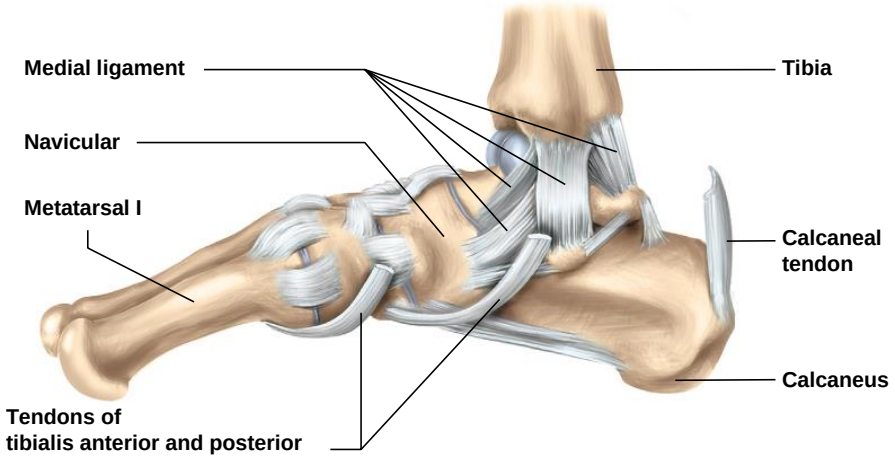
The Ankle Joint

- **Ankle ligaments**
  - **Anterior** and **posterior tibiofibular ligaments:** bind tibia to fibula
  - **Multipart medial (deltoid) ligament:** binds tibia to the foot on the medial side
  - **Multipart lateral (collateral) ligament:** binds fibula to the foot on the lateral side
  - **Calcaneal (Achilles) tendon:** extends from the calf muscles to the calcaneus
    - Plantarflexes the foot and limits dorsiflexion
  - **Sprains (torn ligaments and tendons)** are common at the ankle
    - Pain and immediate swelling

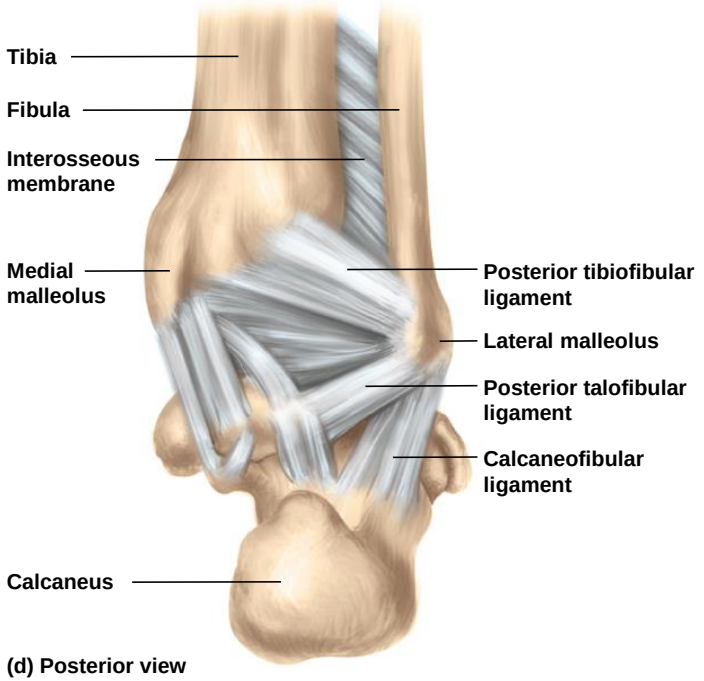
The Ankle Joint



(a) Lateral view



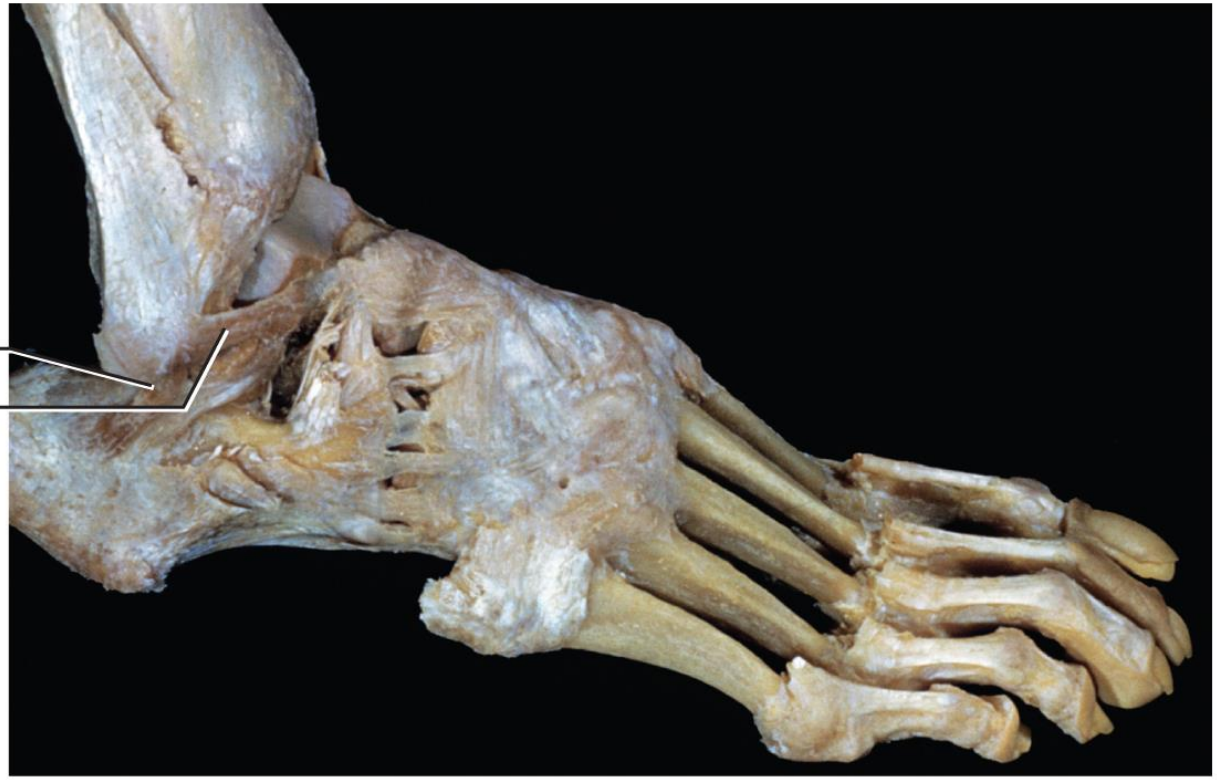
(c) Medial view



(d) Posterior view

Figure 9.31a,c,d

The Ankle Joint



(b) Lateral dissection

Figure 9.31b

Arthritis and Artificial Joints

- **Arthritis—**a broad term for pain and inflammation of joints
- **Most common crippling disease in the United States**
- **Rheumatologists—**physicians who treat arthritis and other joint disorders
- **Osteoarthritis (OA)—**most common form of arthritis
  - "Wear-and-tear arthritis"
  - Results from years of joint wear
  - Articular cartilage softens and degenerates
  - Accompanied by crackling sounds called **crepitus**
  - Bone spurs develop on exposed bone tissue causing pain

Arthritis and Artificial Joints

- **Rheumatoid arthritis (RA)**—autoimmune attack against the joint tissues
  - Misguided antibodies (**rheumatoid factor**) attack synovial membrane, enzymes in synovial fluid degrade the articular cartilage, joint begins to ossify
  - **Ankylosis:** solidly fused, immobilized joint
  - Remissions occur, steroids and aspirin control inflammation

- **Arthroplasty**—replacement of diseased joint with artificial device called **prosthesis**

Rheumatoid Arthritis

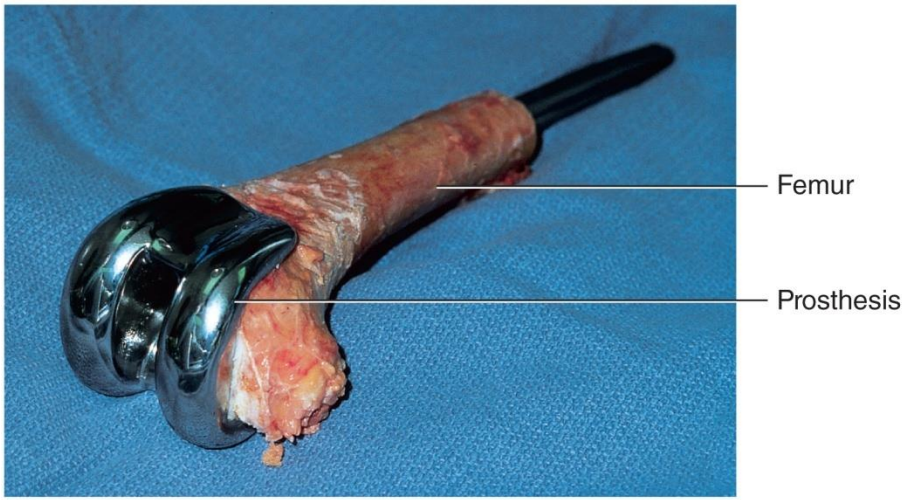
(a)

(b)

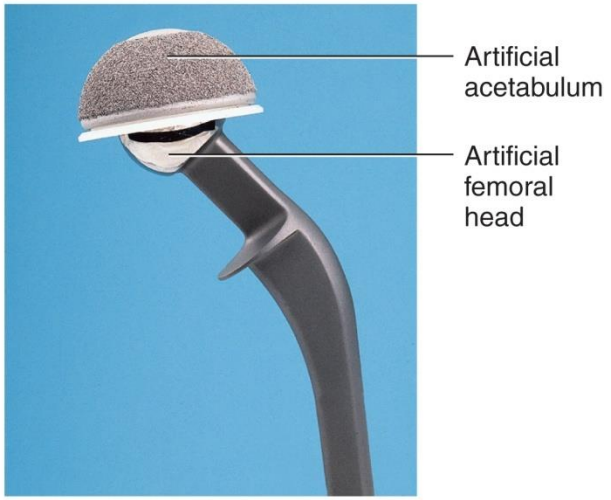
a: ©Dr. Ken Greer/Visuals Unlimited; b: ©CNRI/Science Photo Library/Science Source

Figure 9.32a,b

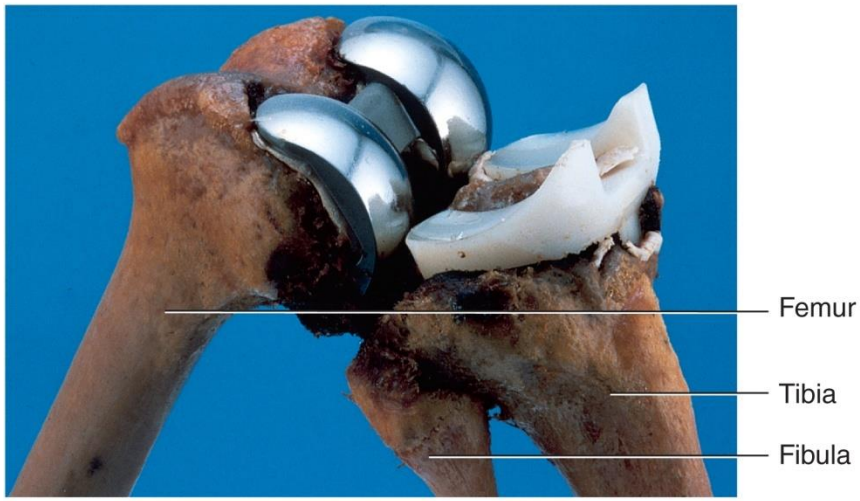
Joint Prostheses



(a)



(c)



(b)

(d)

Figure 9.33a,b

Figure 9.33c,d