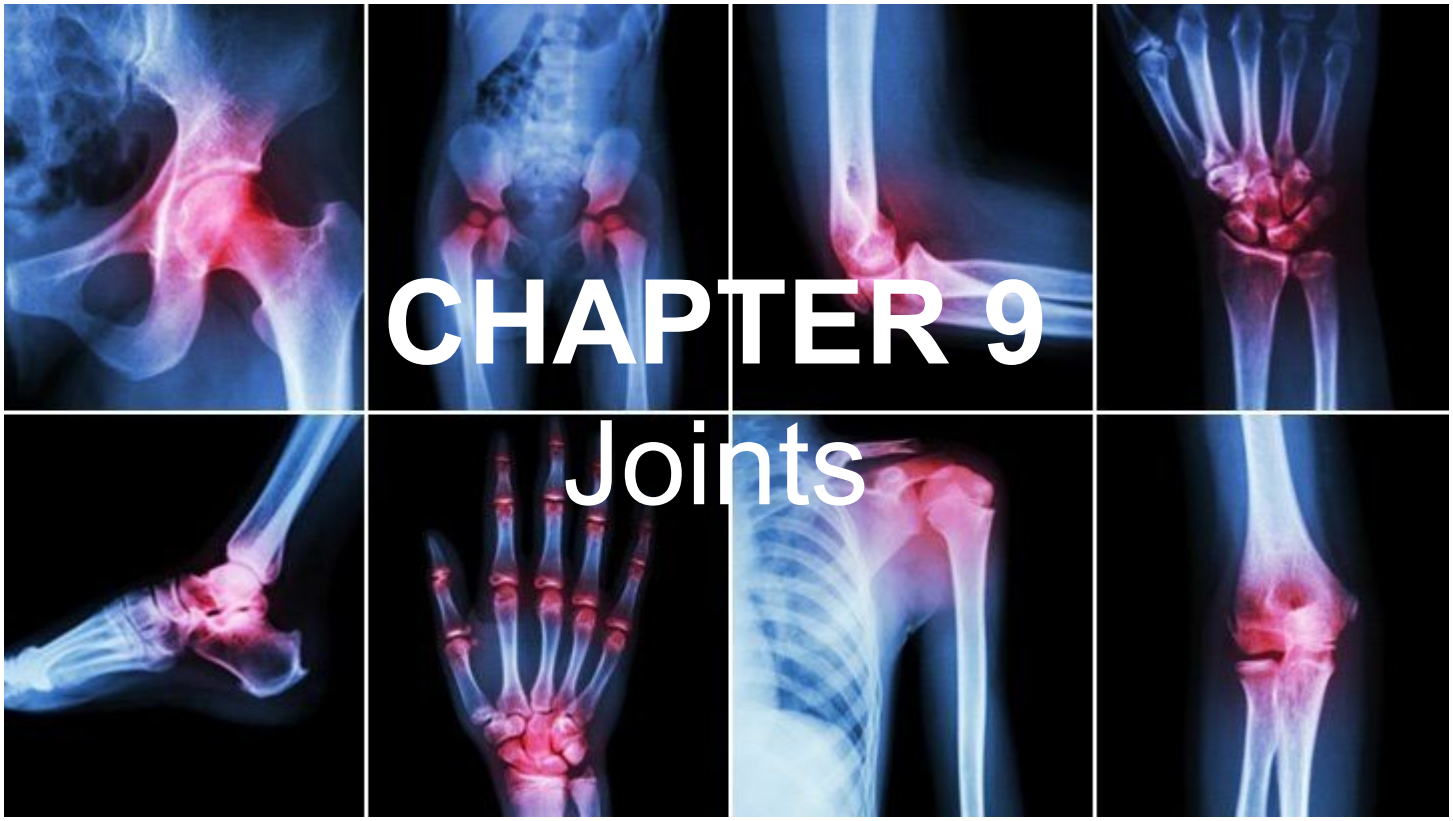

CHAPTER 9

Joints

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What Is a Joint?

- **Joint:** also called an articulation or arthrosis is a point of contact between two bones, between bone and cartilage, or between bone and teeth.
- **Articulation**
- **Arthrosis**
- *Arthrology*: The scientific study of joints
- *Kinesiology:* The study of motion of the human body

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Joint Classifications: General Points

- Classification schemes used today are based upon the structure of the joint.
- The structure of a joint includes the connecting tissues between the neighboring bones.
- Bones actually do not contact one another directly. Some other connective tissue is always present between the surfaces of the bones that contact one another to make up joints such as your knees, ankles, wrists, and elbows.

- *WE CAN* classify joints based on structure or on function BUT *present-day classification and the current anatomical nomenclature are based on the logic of* ***joint structure***.

- **IT IS IMPORTANT** to learn the **location of each bone** (and its surface features) **relative to the location of other bones** (and their surface features) in order to understand the **3-D relationship** between bones.

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Joints

Anatomy Overview

- Joints

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Functional Joint Classifications:

- **Synarthrosis:** An immovable joint.
- **Amphiarthrosis:** A slightly movable joint.
- **Diarthrosis:** A freely movable joint; these come in a variety of shapes and permit several different types of movements.

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Structural Joint Classifications:

- 2 basic ways bones connect with one another to form joints.
- 1) Bones are either held together by solid masses of connective tissue
- **fibrous joints** have connective tissue masses of dense irregular connective tissue
- **cartilaginous joints** use some type of cartilage as the connecting tissue between the bones.
- 2) Bones are connected by a connective tissue capsule that surrounds a lubricated cavity.
- **synovial joints** are divided into various types based on the structure of the joint surfaces, but all share the common design of a joint capsule surrounding a lubricated synovial cavity

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Ligaments (*ligare* = to bind)

- dense irregular or dense regular connective tissue structures that bind one bone to another bone
- come in a variety of forms and are integral parts of joints
  - **intrinsic binding structures** within the joint itself (eg. sutural ligaments of the skull, periodontal ligaments of the teeth)
  - **extrinsic supporting bands** that stabilize joints while limiting their range of motion (eg. anterior cruciate ligament of the knee)

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Fibrous Joints

- Examples include
  - **Sutures:** are immovable junctions between two bones, such as those of the skull.
  - **Syndesmosis:** is a slightly movable fibrous joint in which bones such as the tibia and fibula are joined together by connective tissue. An example is the distal tibiofibular joint. Injuries to the ankle syndesmosis are commonly known as a "high ankle sprain
  - is a thick dense fibrous sheet of connective tissue that spans the space between two bones forming a type of syndesmosis joint. Interosseous membranes in the human body: Interosseous membrane of forearm

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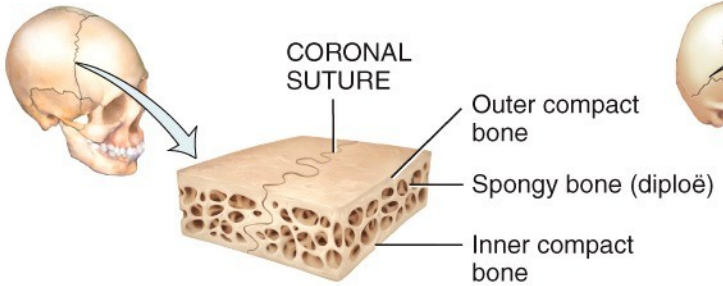
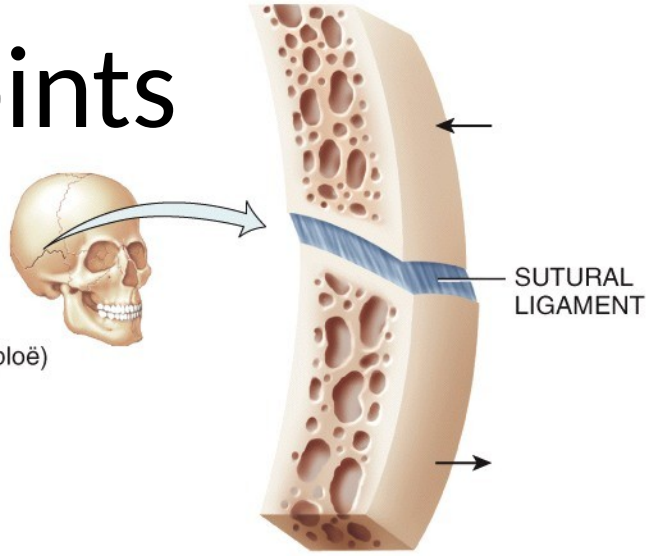
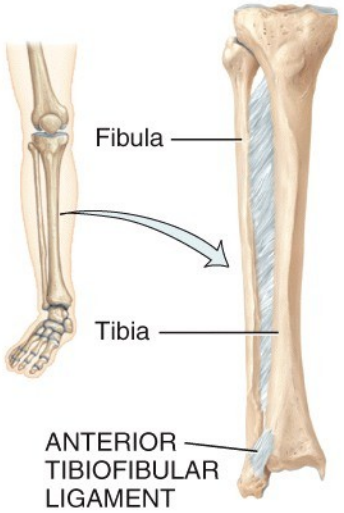
Fibrous Joints



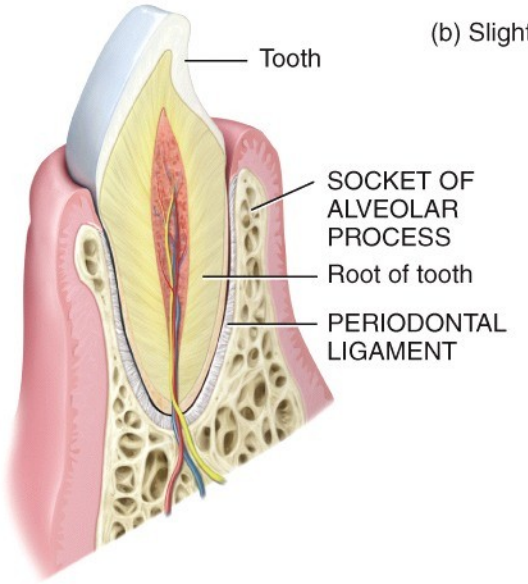
(a) Suture between skull bones



(b) Slight movement at suture

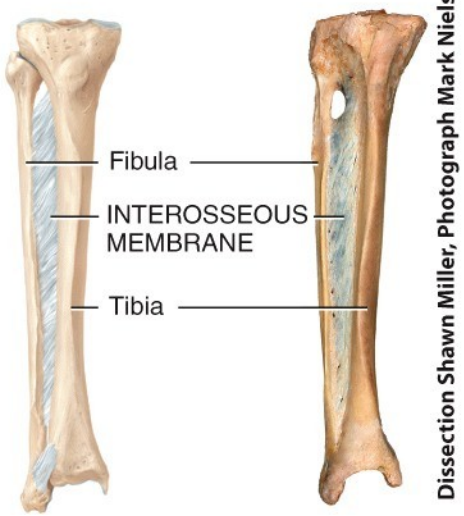


Syndesmosis between tibia and fibula at distal tibiofibular joint



Syndesmosis (gomphosis) between tooth and socket of alveolar process

(c) Syndesmosis



Dissection Shawn Miller, Photograph Mark Nielsen

(d) Interosseous membrane between diaphyses of tibia and fibula

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Cartilaginous Joints

- **Synchondrosis:** an almost immovable joint between bones bound by a layer of cartilage, as in the vertebrae.
- **Symphysis:** a place where two bones are closely joined, either forming an immovable joint (as between the pubic bones in the center of the pelvis) or completely fused (as at the midline of the lower jaw)

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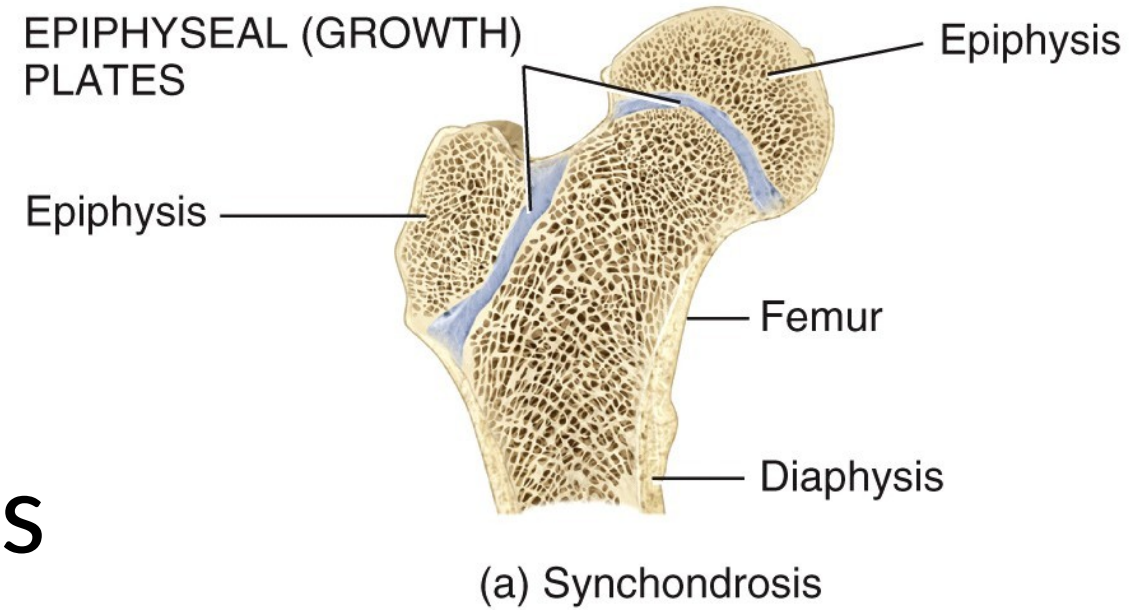
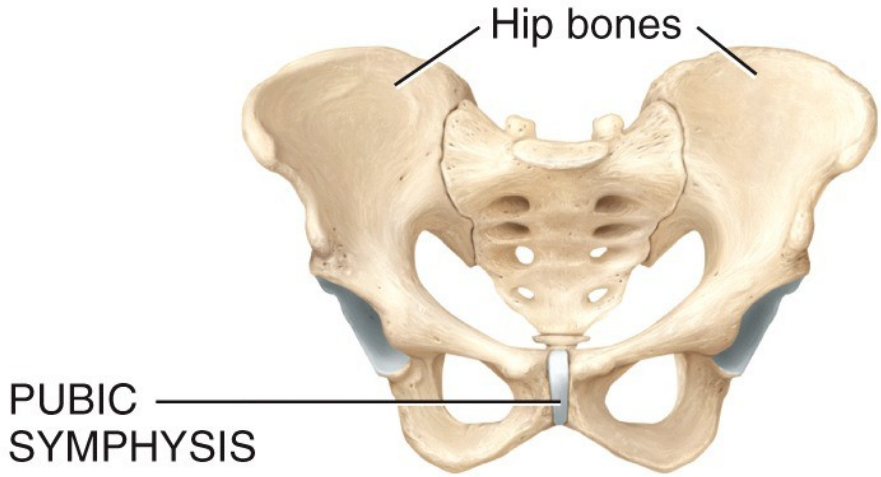
Cartilaginous Joints



(a) Synchondrosis



(b) Symphysis

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Synovial Joints

- **Articular capsule:** a joint capsule or articular capsule is an envelope surrounding a synovial joint. Each joint capsule has two parts: an outer fibrous layer or membrane, and an inner synovial layer or membrane
- **Fibrous membrane:** A membrane composed entirely of fibrous connective tissue. Examples include the fasciae, aponeuroses, perichondrium, periosteum, dura mater, and the capsules of some organs.
- **Synovial membrane:** is a specialized connective tissue that lines the inner surface of capsules of synovial joints and tendon sheath
- **Articular fat pads:** adipose tissue pads that protect the articular cartilage, as seen in the infrapatellar fat pad in the knee
- **Synovial fluid:** is a viscous fluid found in the cavities of synovial joints. With its egg white–like consistency, the principal role of synovial fluid is to reduce friction between the articular cartilage of synovial joints during movement

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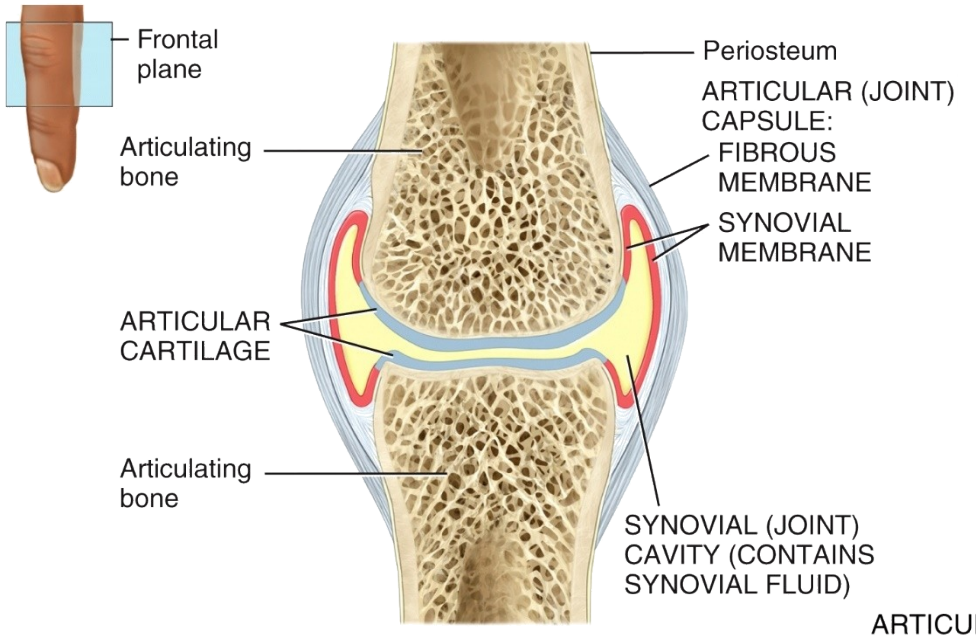
Structure of a Typical Synovial Joint



(a) Frontal section

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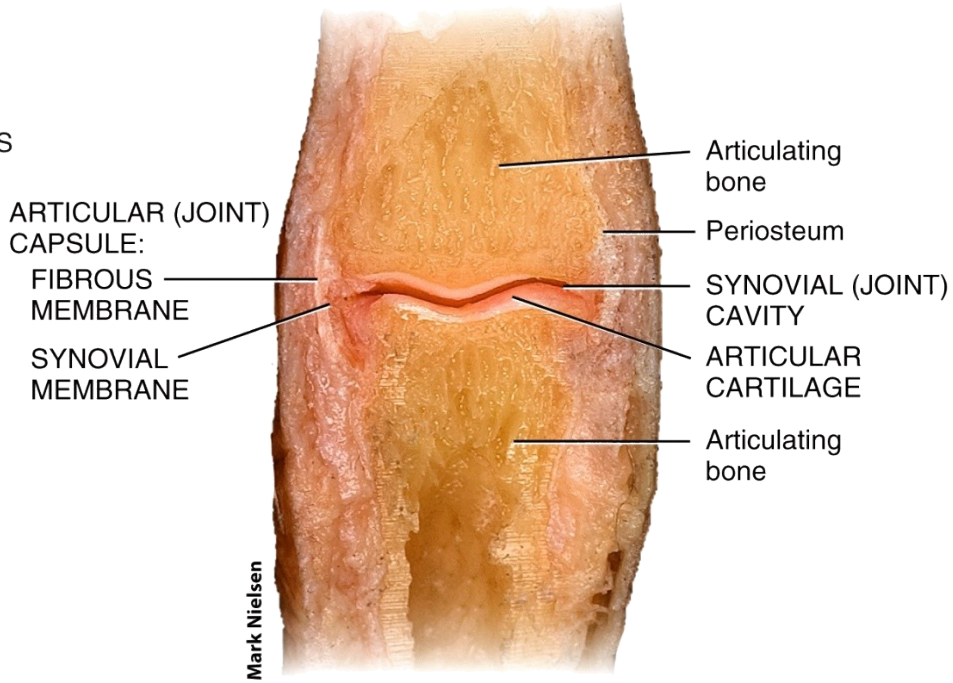

(b) Frontal section

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Clinical Connection - Sprains

- Ligaments are *noncontractile tissues* (cannot contract or shorten)
- resist stretching and are typically damaged when forces are exerted that exceed their strength may also damage surrounding blood vessels, muscles, tendons, or nerves
- severe sprains
- caused by forcible wrenching or twisting of a joint that stretches the connective tissue but does not dislocate the bones.
- Severe sprains may be so painful that the joint cannot be moved. There is considerable swelling, which results from hemorrhage of ruptured blood vessels.
- The ankle is the joint most often sprained; the numerous small joints between the vertebrae of the lower back are also the sites of frequent strains.

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Clinical Connection – Grading Sprains

Ligament injuries are graded on a scale from I - III.

Grade I sprains: a stretch without a tear – 20% tear of the ligament's collagen fibers

Grade II sprains: 20-75% tear of the ligament

Grade III sprains: >75% tear of ligament

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Clinical Connection – PRICE

- **P**rotection means protecting the injury from further damage
- **R**est the injured area to avoid further damage to the tissues.
- **I**ce the injured area as soon as possible: Applying ice slows blood flow to the area, reduces swelling, and relieves pain. Ice works effectively, when applied for 20 minutes, off for 40 minutes, back on for 20 minutes, and so on
- **C**ompression by wrap or bandage helps to reduce swelling.
- **E**levation of the injured area above the level of the heart, when possible, will reduce potential swelling.

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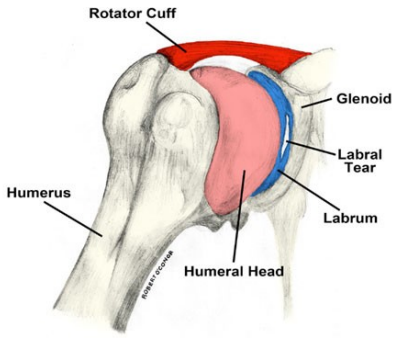
Accessory Ligaments, Articular Discs, and Labra

- Extracapsular and intracapsular ligaments
- Menisci: a thin fibrous cartilage between the surfaces of some joints, e.g. the knee
- Labrum: is the cup-shaped rim of cartilage that lines and reinforces the ball and socket joint of the shoulder, which is comprised of the glenoid - the shallow shoulder socket - and the head, or ball, of the upper arm bone known as the humerus



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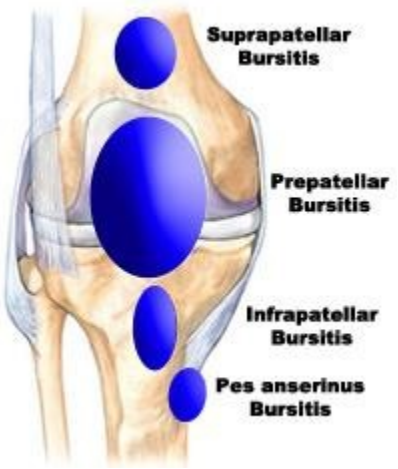
Accessory Ligaments, Articular Discs, and Labra

- **Bursa:** is a small fluid-filled sac lined by synovial membrane with an inner capillary layer of viscous synovial fluid (similar in consistency to that of a raw egg white). It provides a cushion between bones and tendons and/or muscles around a joint



- **Tendon sheaths:** is a layer of synovial membrane around a tendon. It permits the tendon to stretch and not adhere to the surrounding fascia. It has two layers: synovial sheath. fibrous tendon sheath.

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Clinical Connection

- **Bursitis:** is a painful condition that affects the small, fluid-filled sacs — called bursae— that cushion the bones, tendons and muscles near your joints. Bursitis occurs when bursae become inflamed. The most common locations for bursitis are in the shoulder, elbow and hip.

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Types of Movements at Synovial Joints

- Gliding
- Angular
- Flexion and extension
- Lateral flexion
- Hyperextension
- Abduction and adduction
- Circumduction
- Rotation

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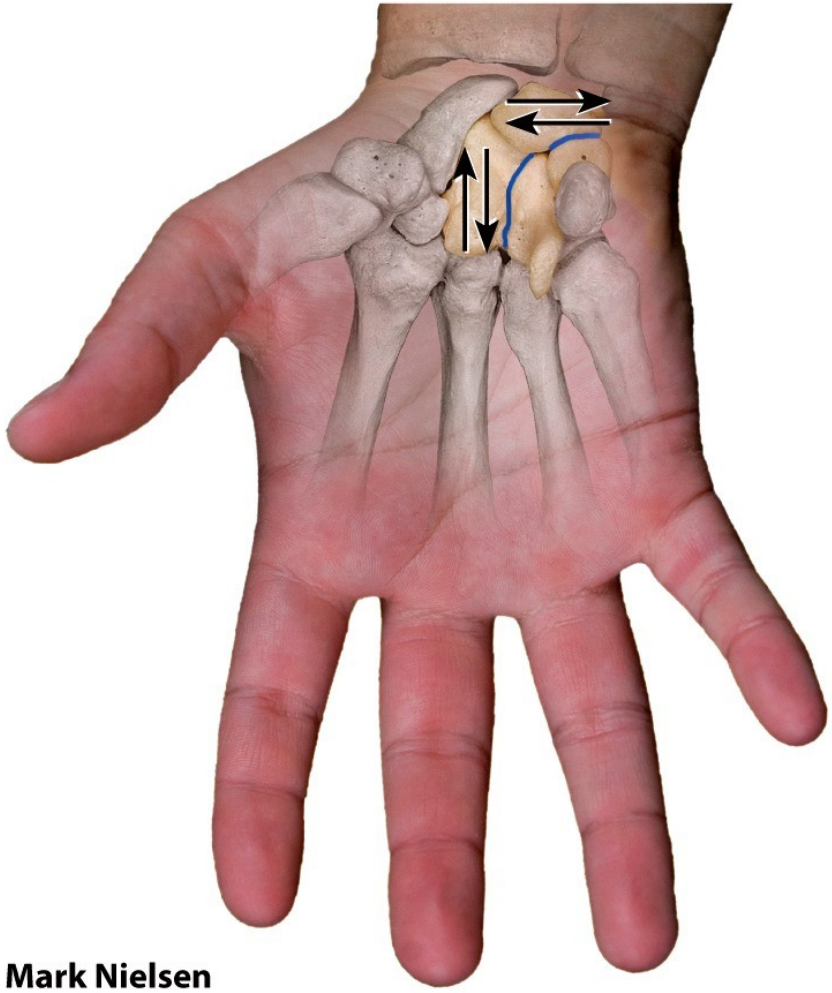
Gliding Movements at Synovial Joints



Gliding between carpals (arrows)

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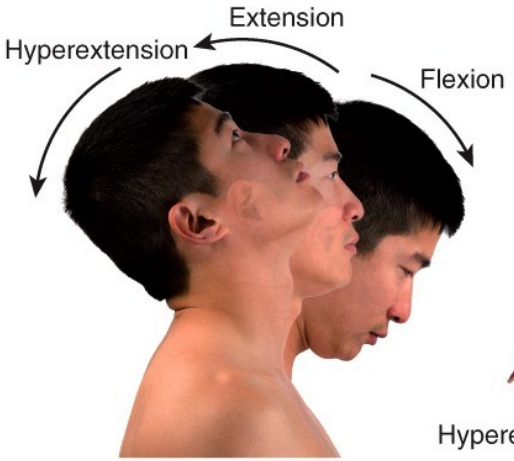
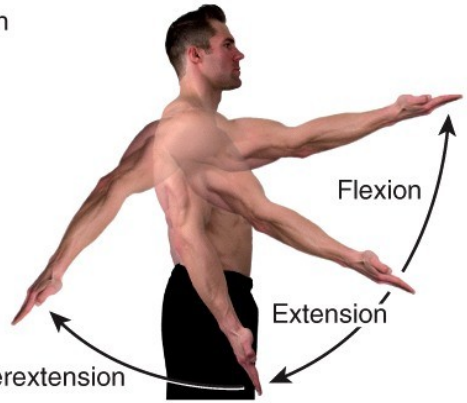
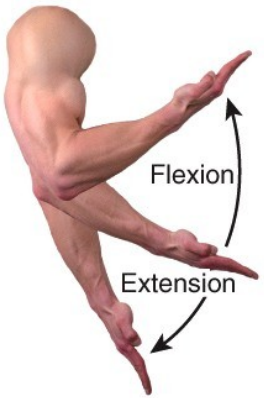
Angular Movements at Synovial Joints



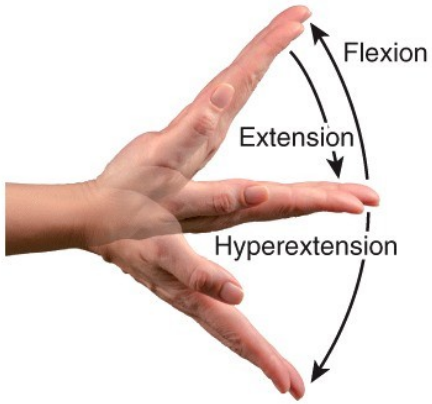
(a) Atlanto-occipital and cervical intervertebral joints



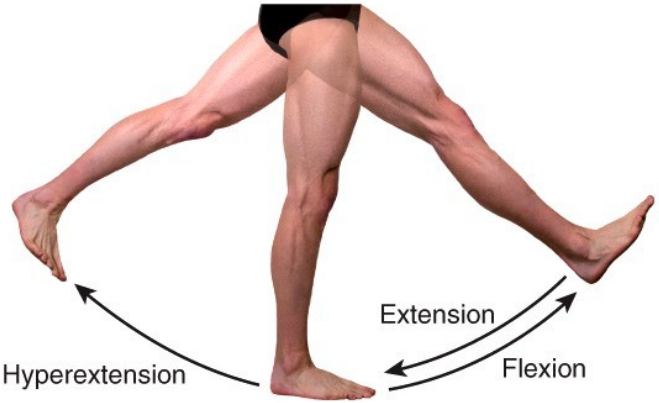
(b) Shoulder joint



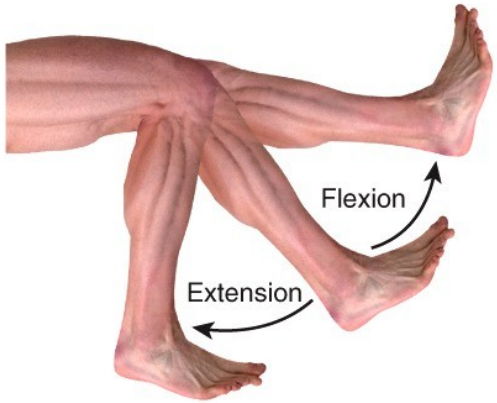
(c) Elbow joint



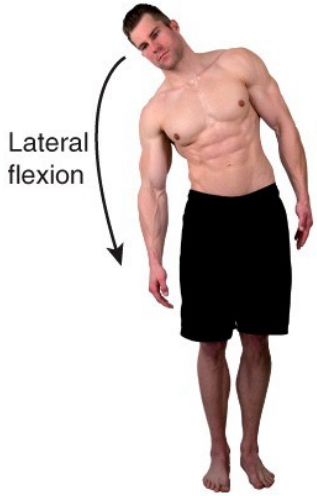
(d) Wrist joint



(e) Hip joint



(f) Knee joint



(g) Intervertebral joints

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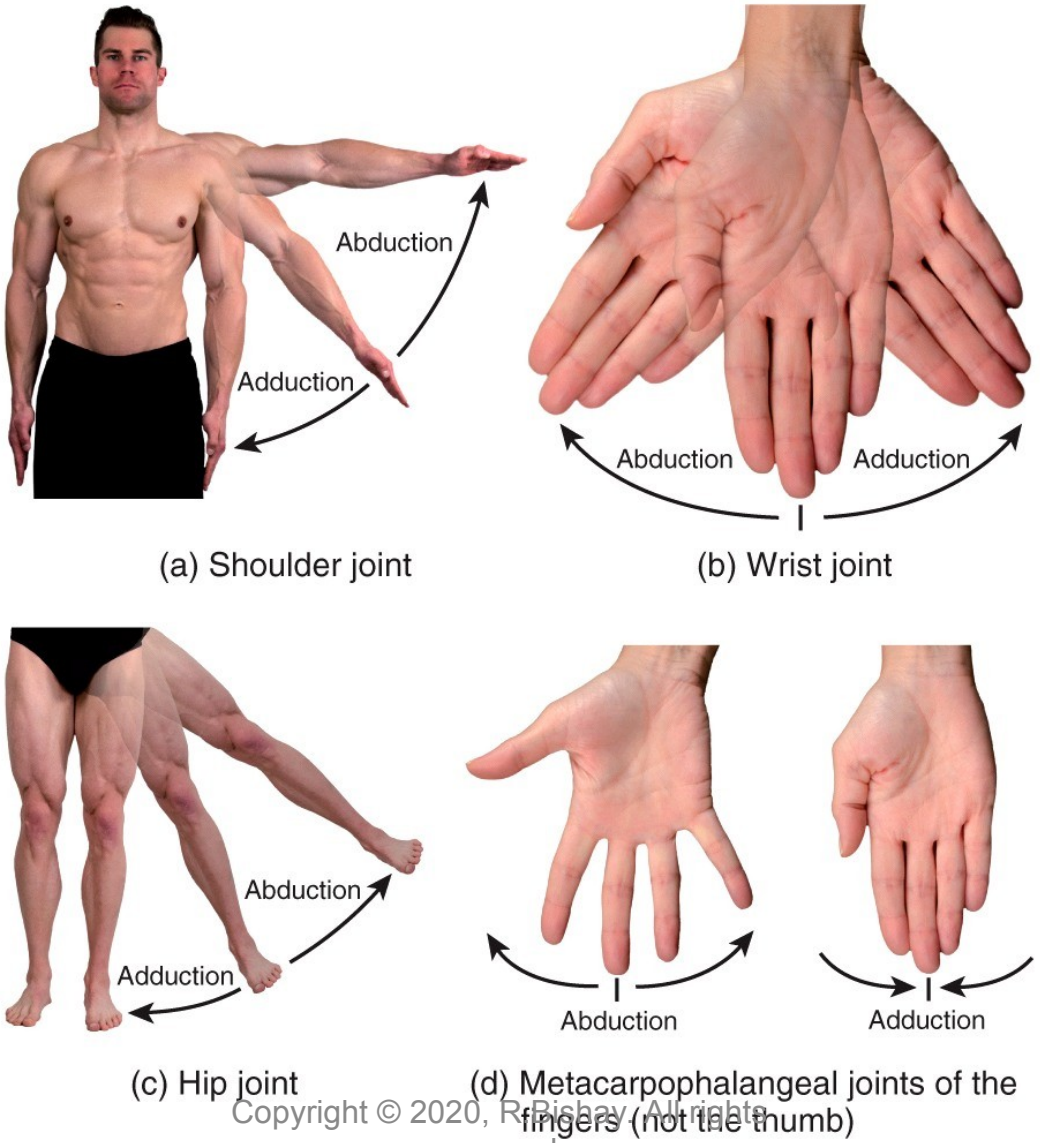
Angular Movements at Synovial Joints



(a) Shoulder joint

(b) Wrist joint

(c) Hip joint

(d) Metacarpophalangeal joints of the fingers (not the thumb)

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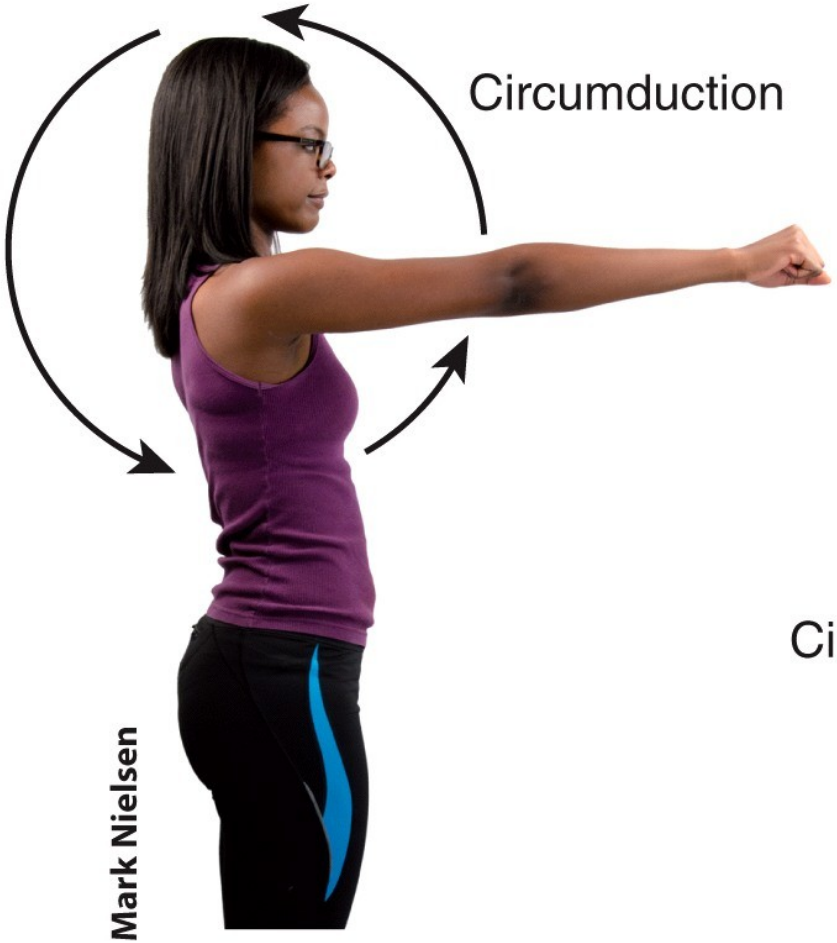
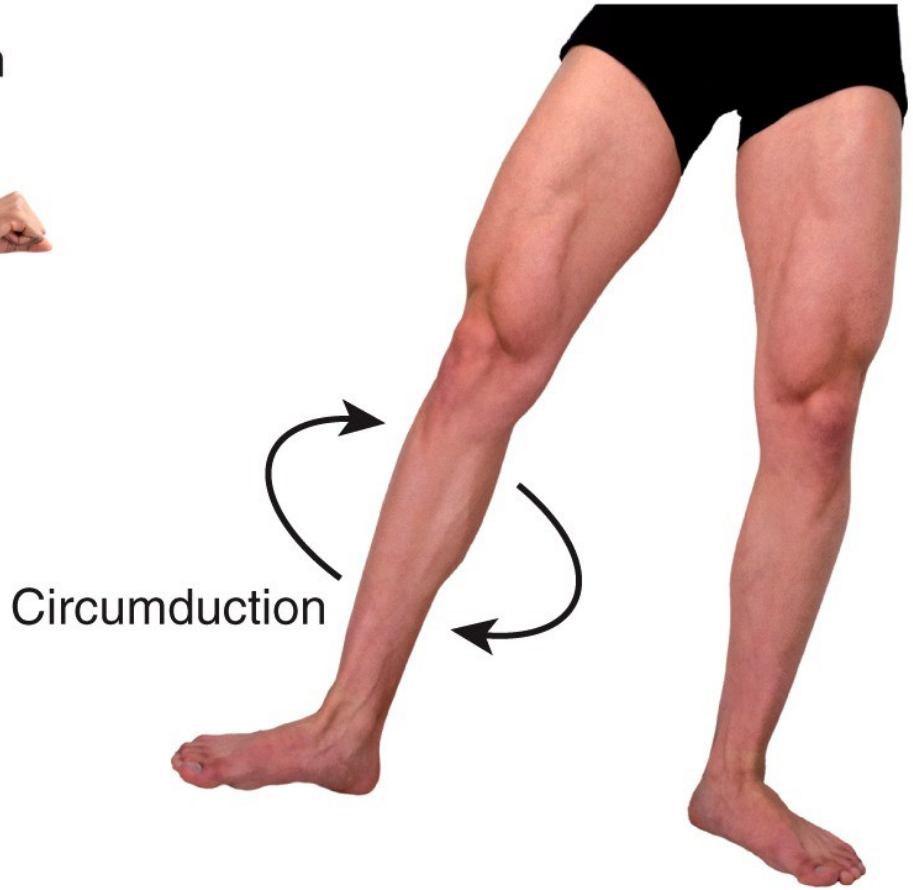
Angular Movements at Synovial Joints



(a) Shoulder joint



(b) Hip joint

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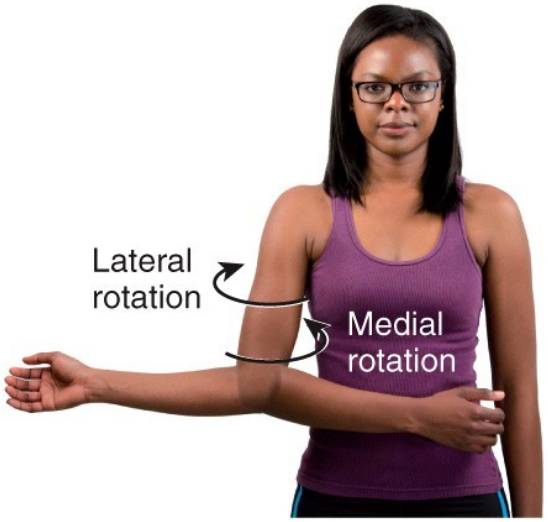
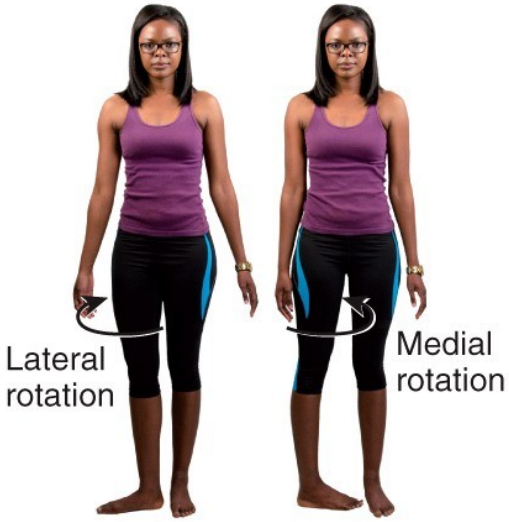
Rotation at Synovial Joints

(a) Atlanto-axial joints



(b) Shoulder joint



(c) Hip joint

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Special Movements at Synovial Joints

- Elevation and depression
- Protraction and retraction
- Inversion and eversion
- Dorsiflexion and plantar flexion
- Supination and pronation
- Opposition

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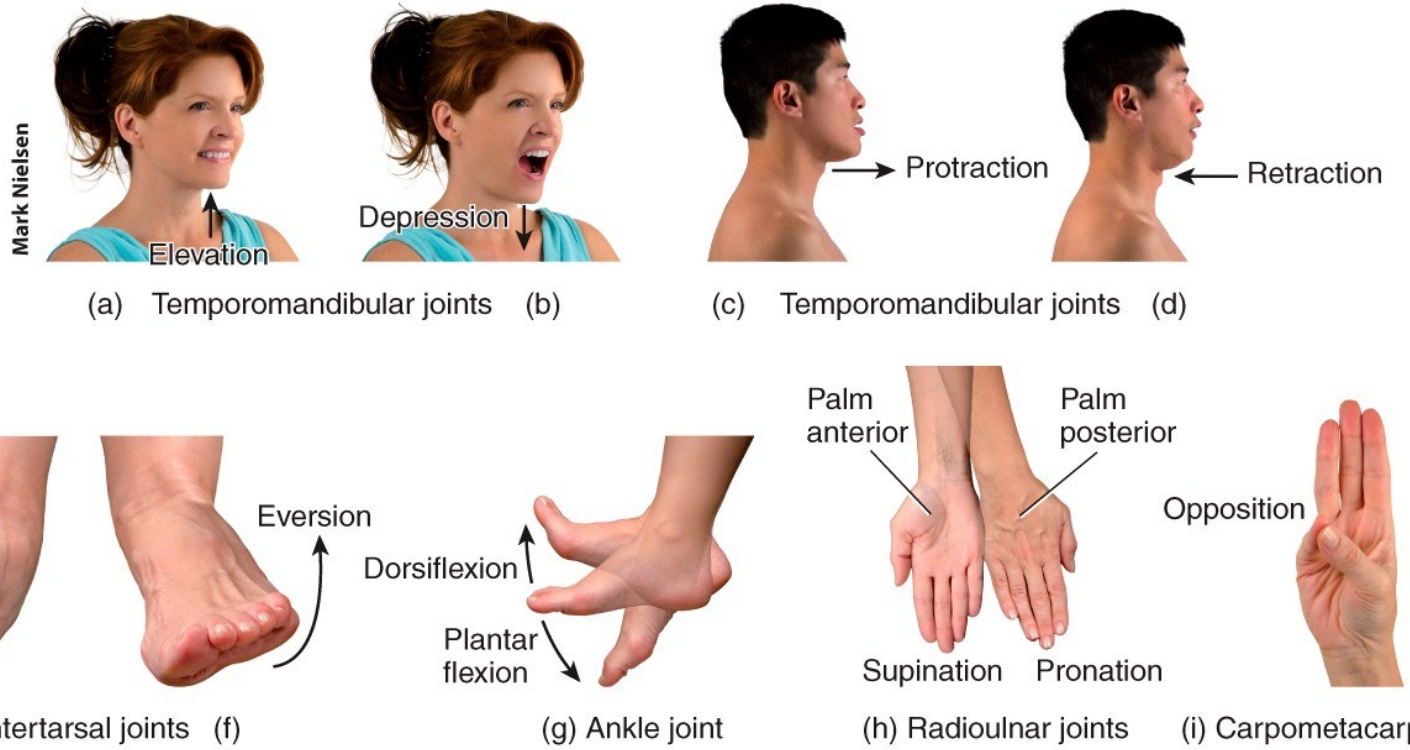
Special Movements at Synovial Joints



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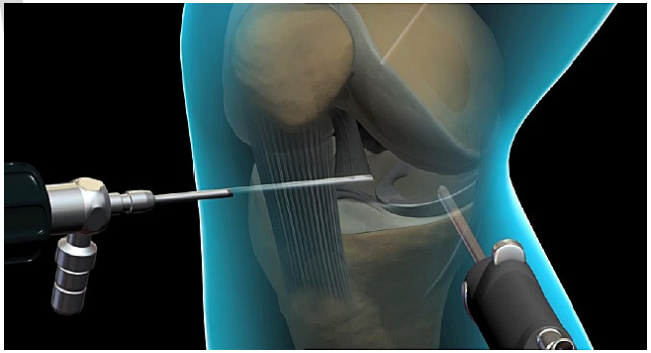
Clinical Connection

- **Torn cartilage :** is a white, gristle-like material covering the ends. Torn cartilage can cause you may long-term issues if not properly treated when the injury occurs. Cartilage can tear in almost any joint of the body. Cartilage tears are the most common cause of leg pain in active people
- **Arthroscopy:** is a procedure for diagnosing and treating joint problems. A surgeon inserts a narrow tube attached to a fiber-optic video camera through a small incision — about the size of a buttonhole. The view inside your joint is transmitted to a high-definition video monitor



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Types of Synovial Joints

- The shapes of the articulating surfaces vary.
- Variation in shape governs the range and type of movements possible.
  - Plane joints
  - Hinge joints
  - Pivot joints
  - Condyloid joints
  - Saddle joints
  - Ball and socket joints

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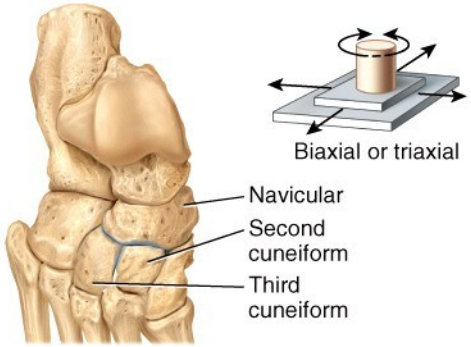
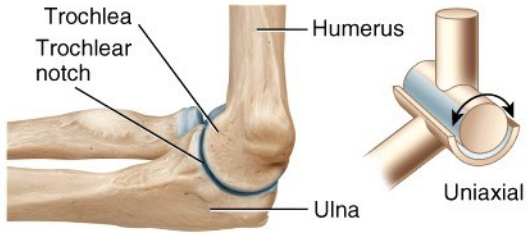
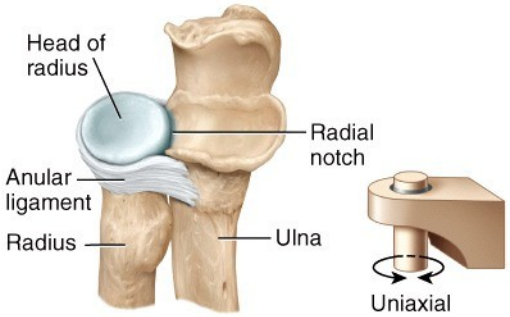
Types of Synovial Joints



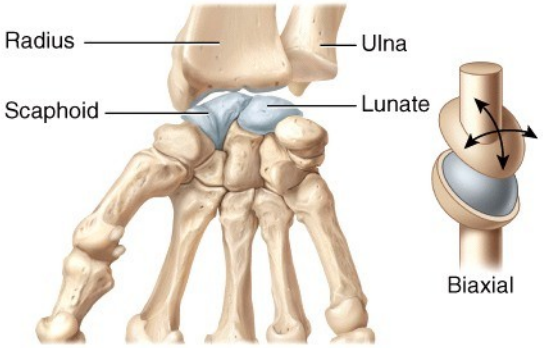
(a) Plane joint between navicular and second and third cuneiforms of tarsus in foot



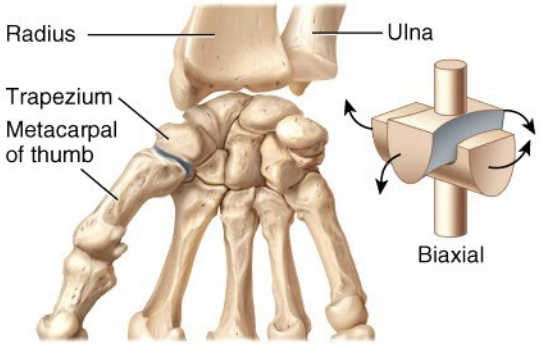
(b) Hinge joint between trochlea of humerus and trochlear notch of ulna at the elbow



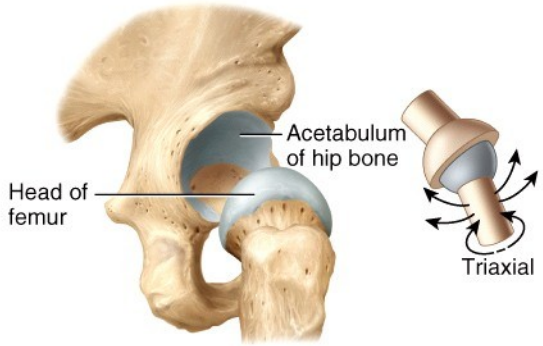
(c) Pivot joint between head of radius and radial notch of ulna



(d) Condyloid joint between radius and scaphoid and lunate bones of carpus (wrist)



(e) Saddle joint between trapezium of carpus (wrist) and metacarpal of thumb



(f) Ball-and-socket joint between head of femur and acetabulum of hip bone

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Factors Affecting Contact and Range of Motion at Synovial Joints

- Structure of the articulating surfaces
- Strength and tension of joint ligaments
- Arrangement and tension of muscles
- Contact of soft parts
- Hormones
- Disuse

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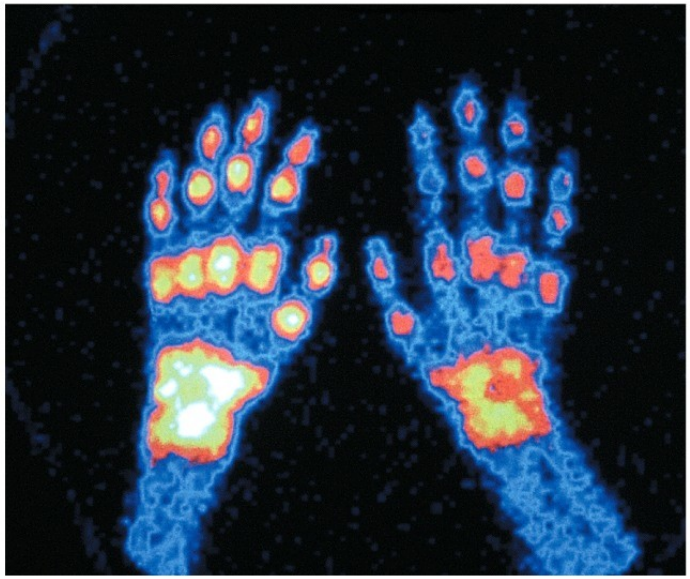
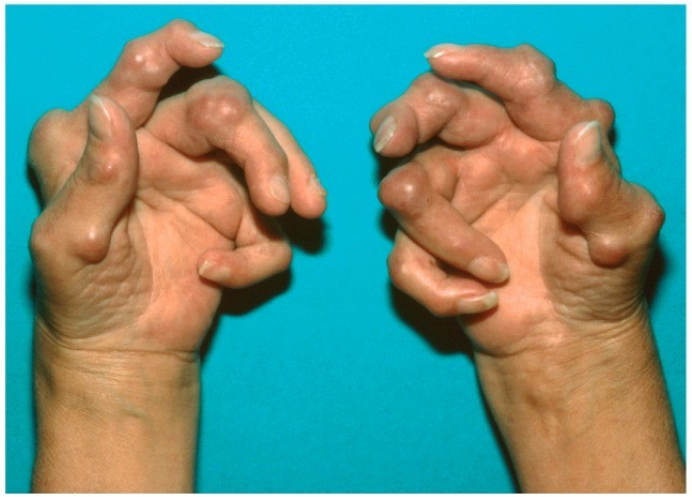
Clinical Connection

- Rheumatism
- Osteoarthristis (OA)
- Rheumatoid arthritis (RA)
- Gout



CNRI/Photo Researchers, Inc.

(A) Gamma ray photograph of swollen joints (bright spots) due to RA



Bart's Medical Library/Phototake

(B) Photograph of an individual with severe RA

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Selected Joints of the Body

- Temporomandibular joint (TMJ)
- Shoulder joint
- Elbow joint
- Hip joint
- Knee joint
- Ankle joint

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Temporomandibular Joint (TMJ)

- This is the only free moveable joint of the exterior of the skull.
- **Anatomical components**
- **Movements:** a combined hinge and plane joint
- only freely movable joint between skull bones (with the exception of the ear ossicles); all other skull joints are sutures and are immovable to slightly movable.
- only the mandible moves
  - Depression (jaw opening) and elevation (jaw closing), which occur in the inferior compartment
  - Protraction, retraction, lateral displacement, and slight rotation, which occur in the superior compartment

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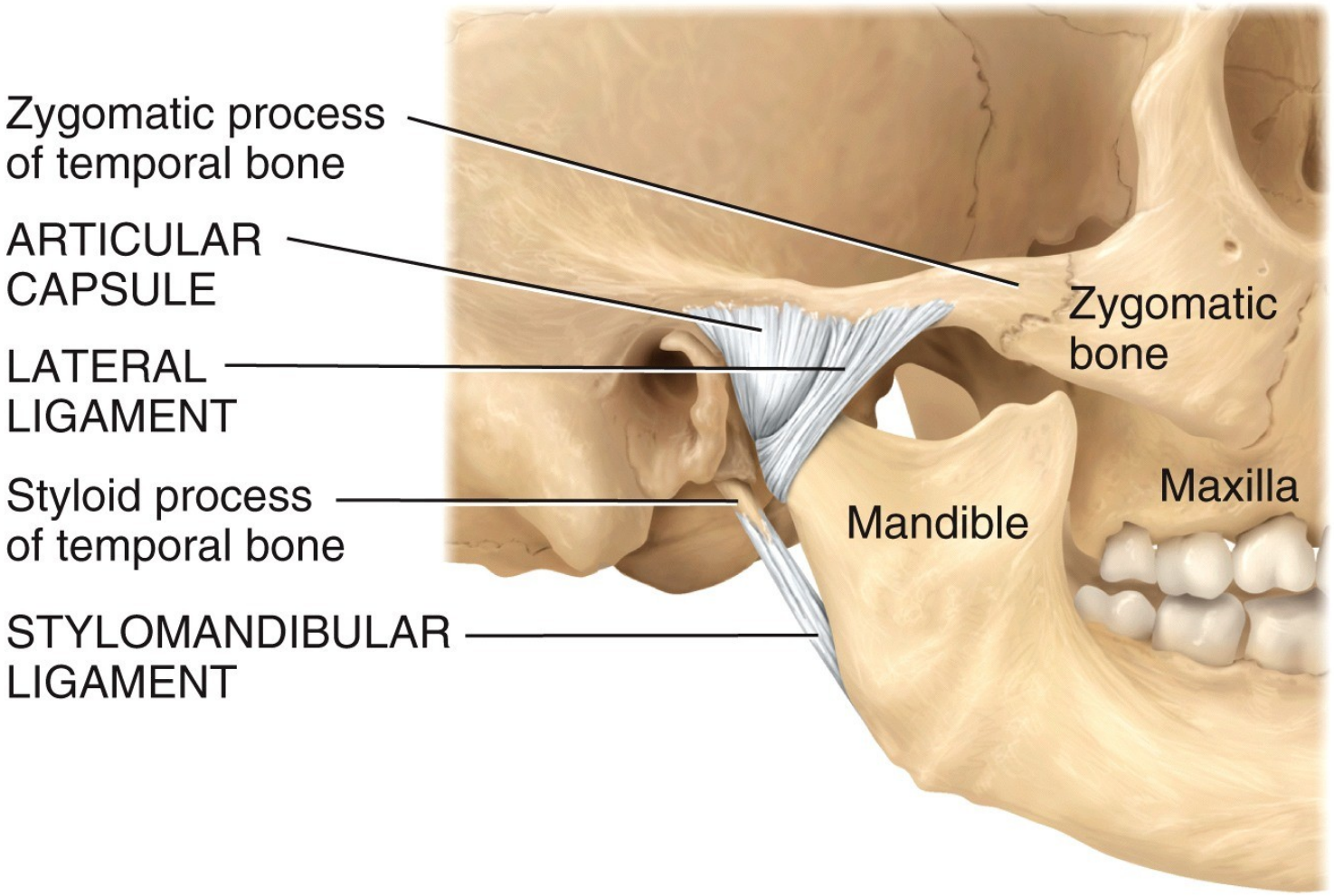
Right Tempromandibular Joint



(a) Right lateral view

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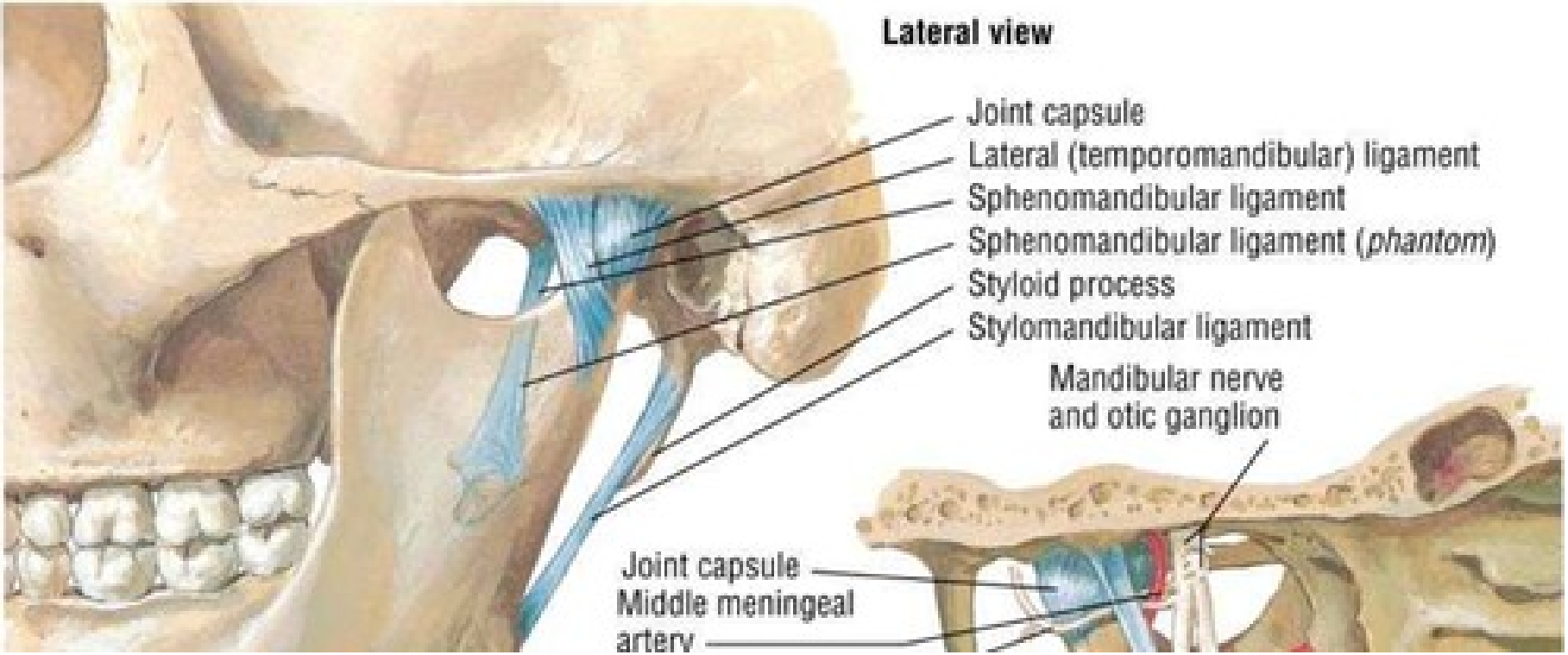
Ligamentous support of TMJ



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Ligamentous support of TMJ

TMJ is formed by the **condylar process of the mandible** and the **mandibular fossa and articular tubercle of the temporal bone**.

1. Articular disc (meniscus). Fibrocartilage disc that separates the synovial cavity into superior and inferior compartments, each with a synovial membrane.

2. Articular capsule. Thin, fairly loose envelope around the circumference of the joint.

3. Lateral ligament. Two short bands on the lateral surface of the articular capsule that extend inferiorly and posteriorly from the inferior border and tubercle of the zygomatic process of the temporal bone to the lateral and posterior aspect of the neck of the mandible. The lateral ligament is covered by the parotid gland and helps strengthen the joint laterally and prevent displacement of the mandible.

4. Sphenomandibular ligament Thin band that extends inferiorly and anteriorly from the spine of the sphenoid bone to the ramus of the mandible (Figure 9.11b). It does not contribute significantly to the strength of the joint.

5. Stylomandibular ligament Thickened band that extends from the styloid process of the temporal bone to the inferior and posterior border of the ramus of the mandible. This ligament separates the parotid gland from the submandibular gland and limits movement of the mandible at the TMJ.

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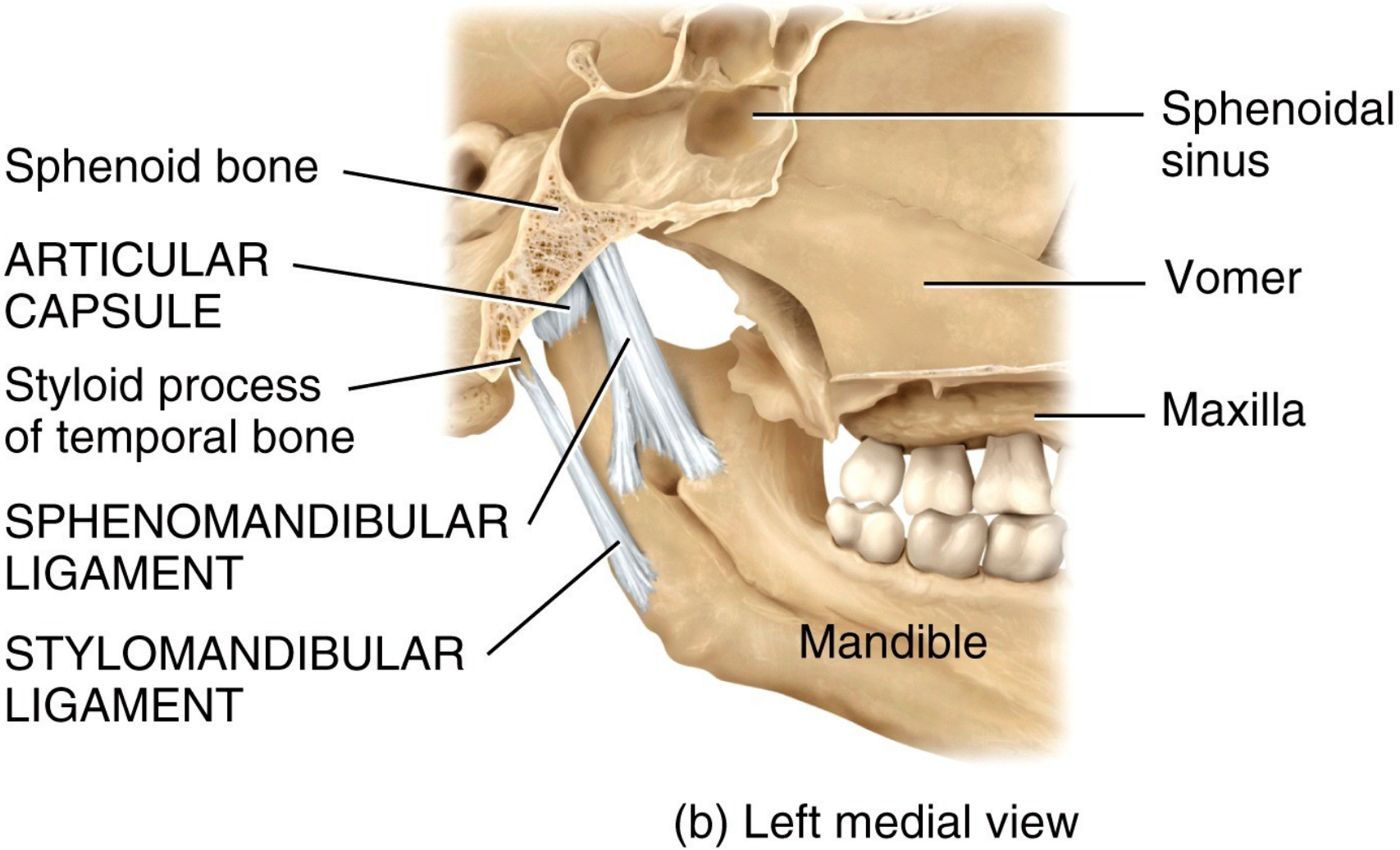
Right Tempromandibular Joint



(b) Left medial view

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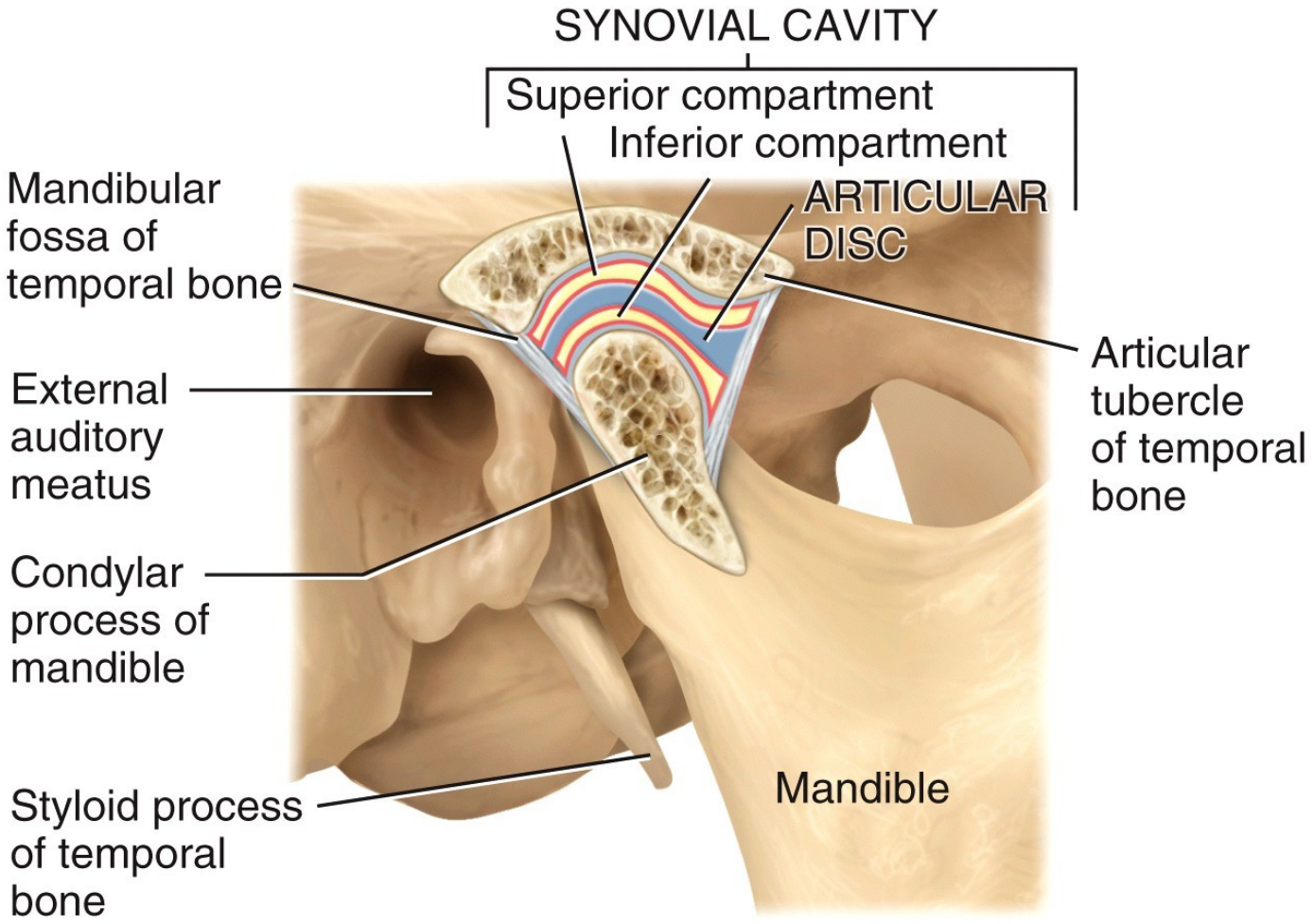
Right Tempromandibular Joint



(c) Sagittal section viewed from right

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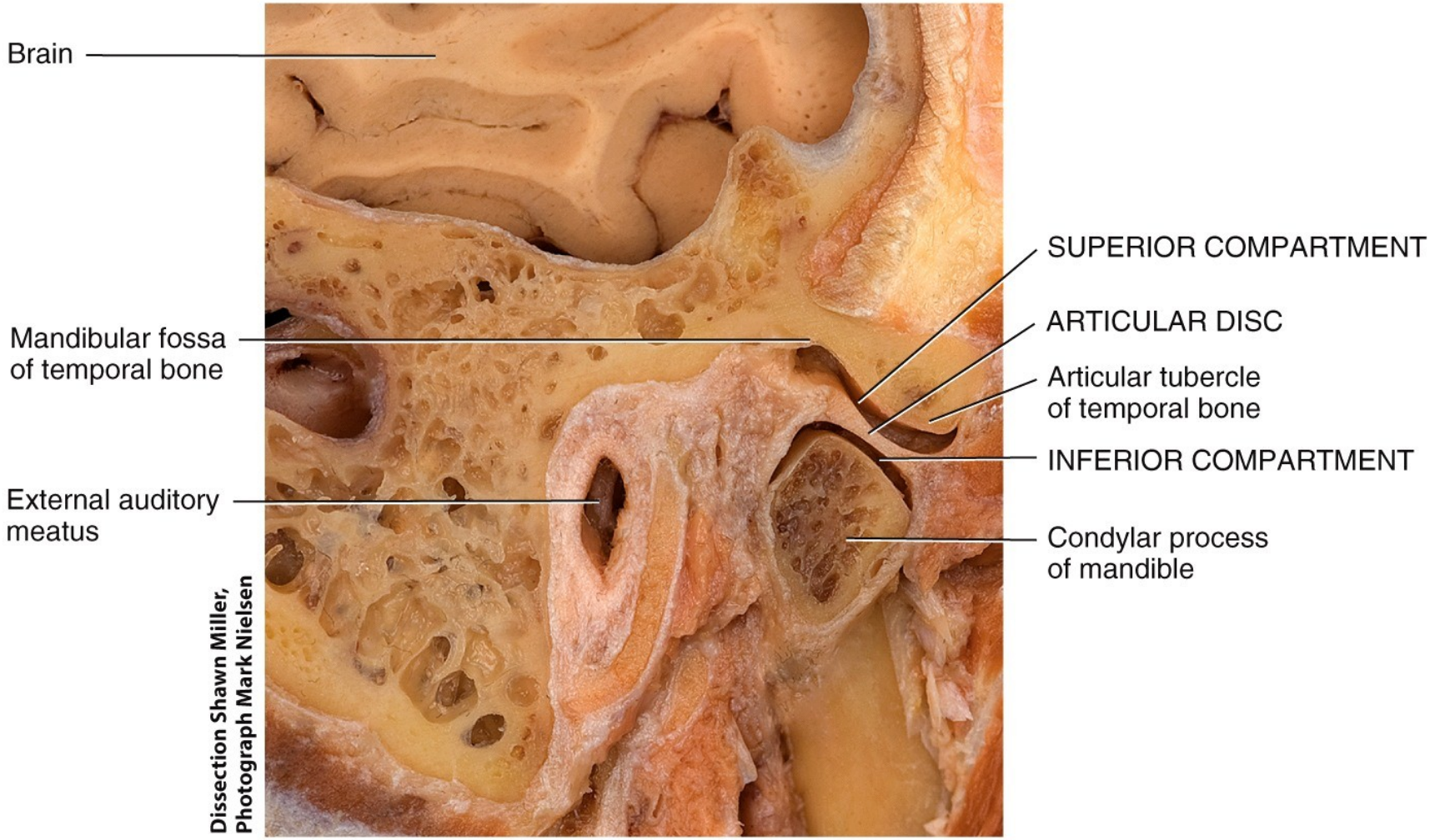
Right Tempromandibular Joint



(d) Sagittal section

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Shoulder Joint:
A Ball and Socket Joint

The shoulder joint is formed from the head of the humerus and the glenoid cavity of the scapula.

- Anatomical components
- Movements

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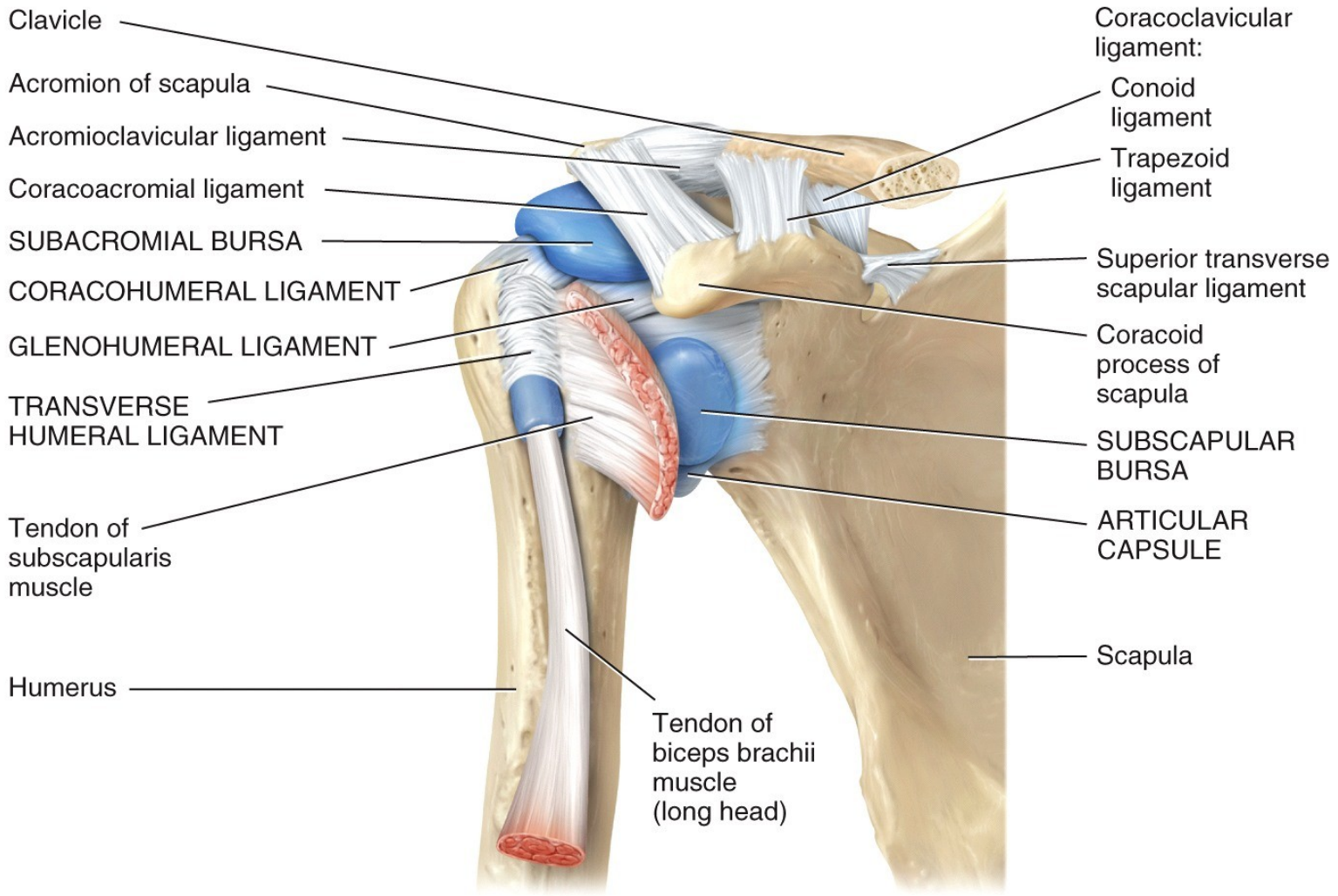
Right Shoulder Joint



(a) Anterior view

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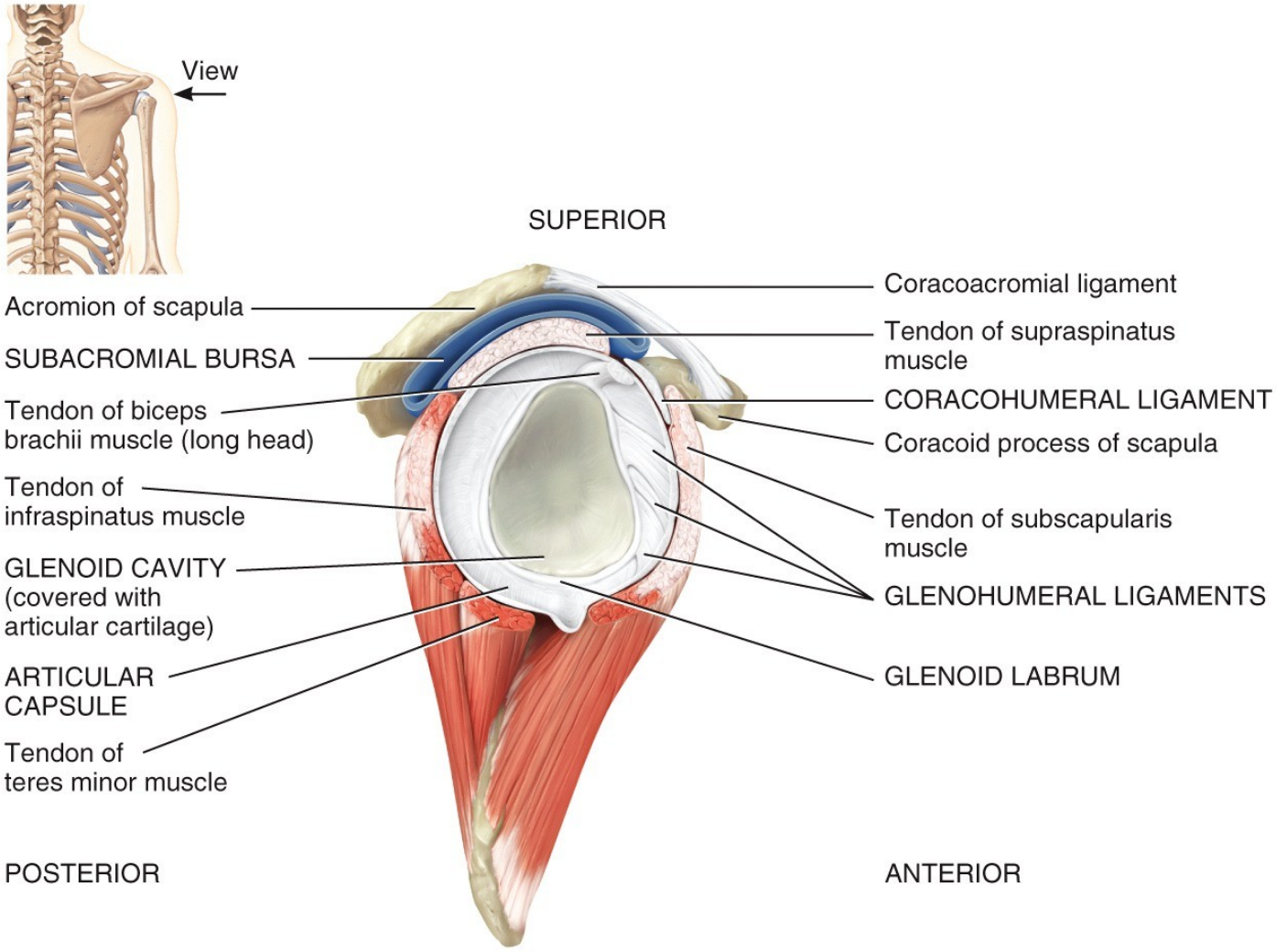
Right Shoulder Joint



(b) Lateral view (opened)

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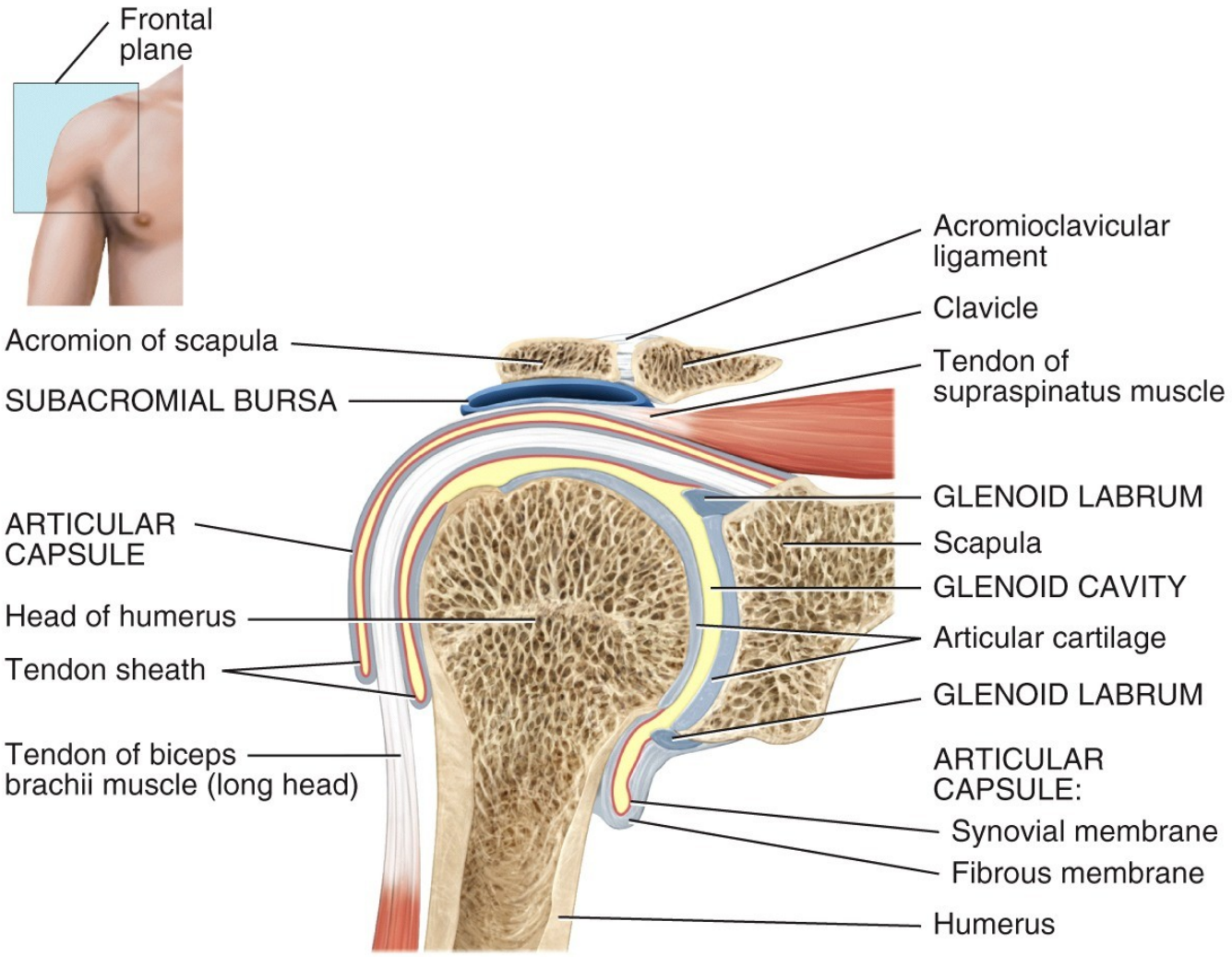
Right Shoulder Joint



(c) Frontal section

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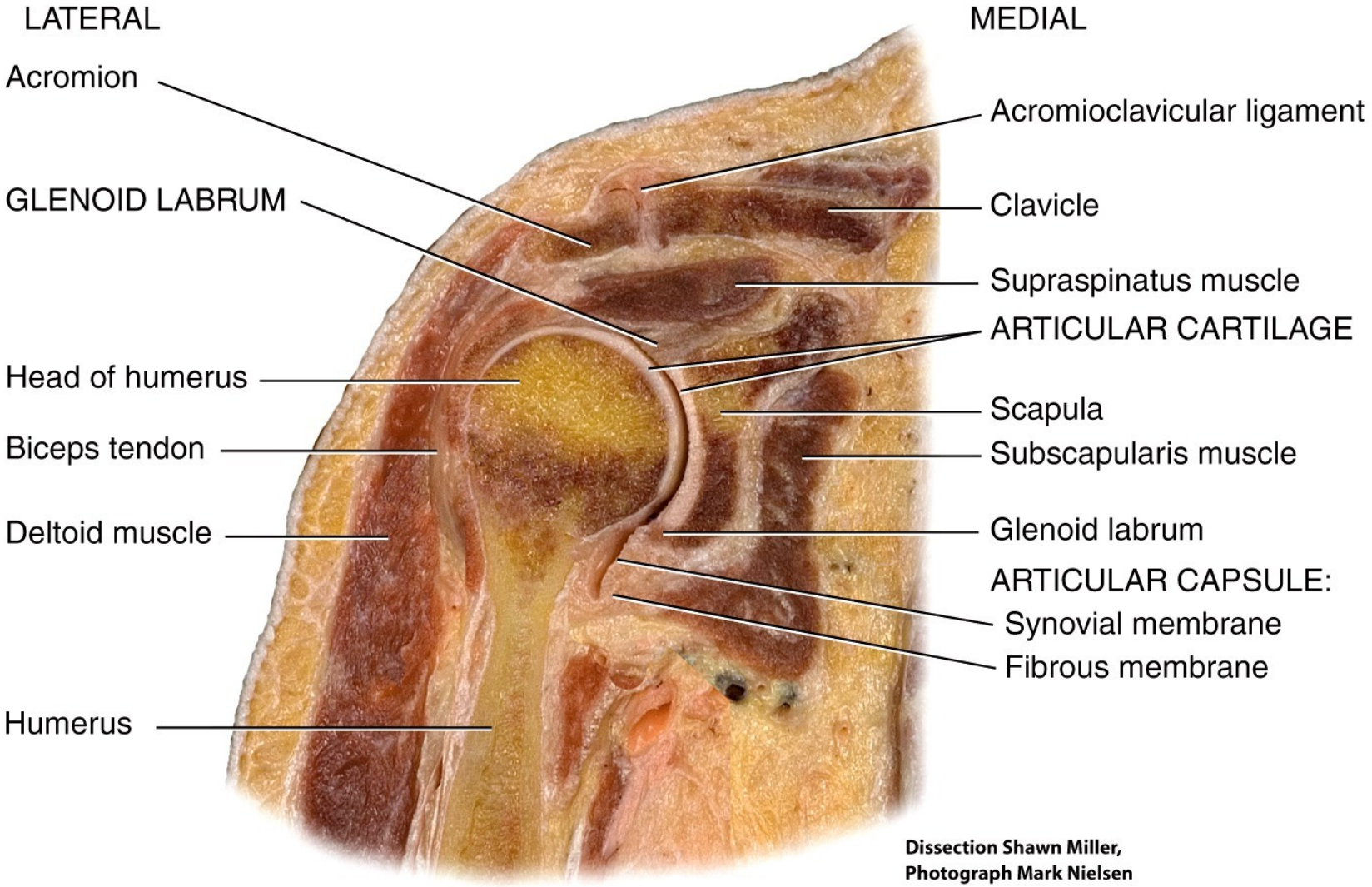
Right Shoulder Joint



(d) Frontal section

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Elbow Joint

The elbow joint is formed from the humeral trochlea and capitulum, the trochlear notch of the ulna, and the head of the radius.

- Anatomical components
- Movements

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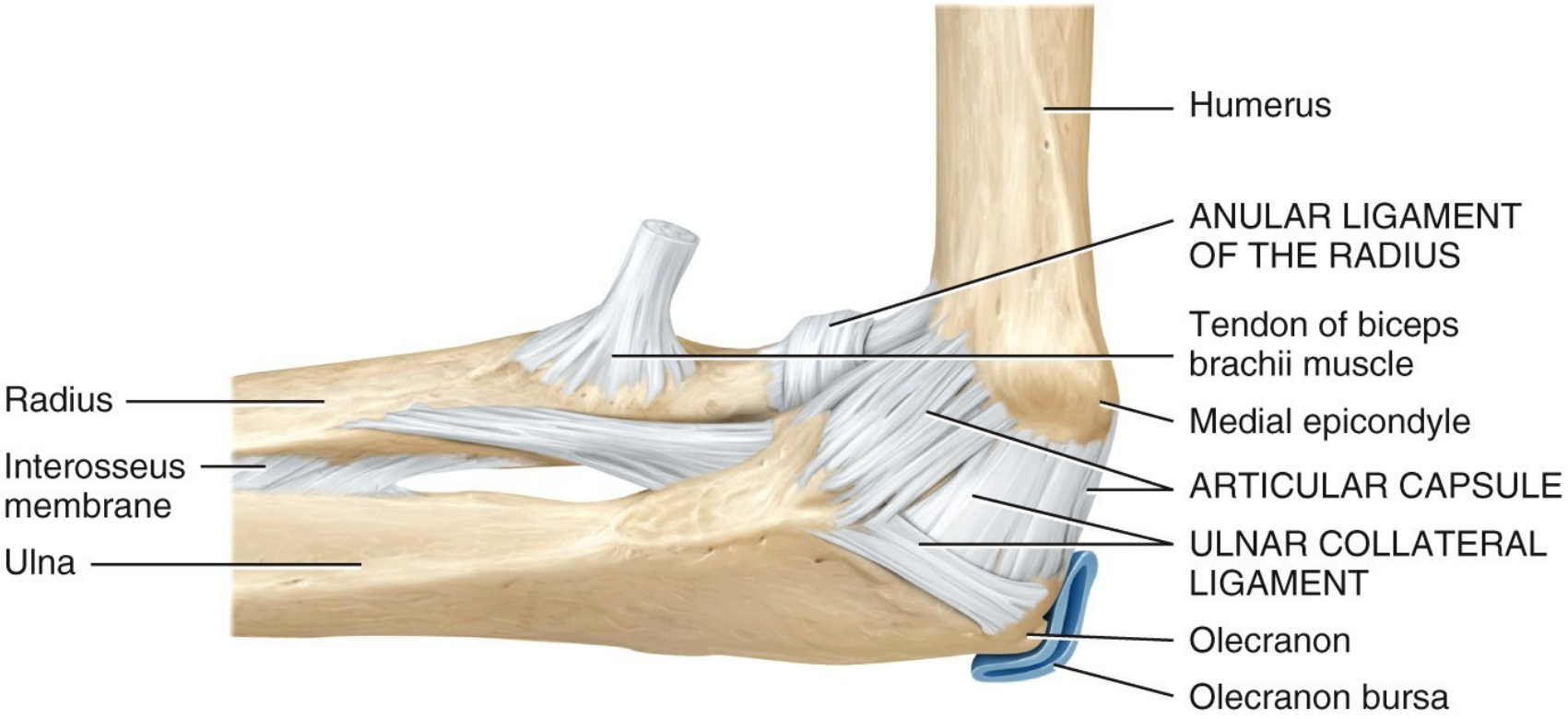
Right Elbow Joint



(a) Medial aspect

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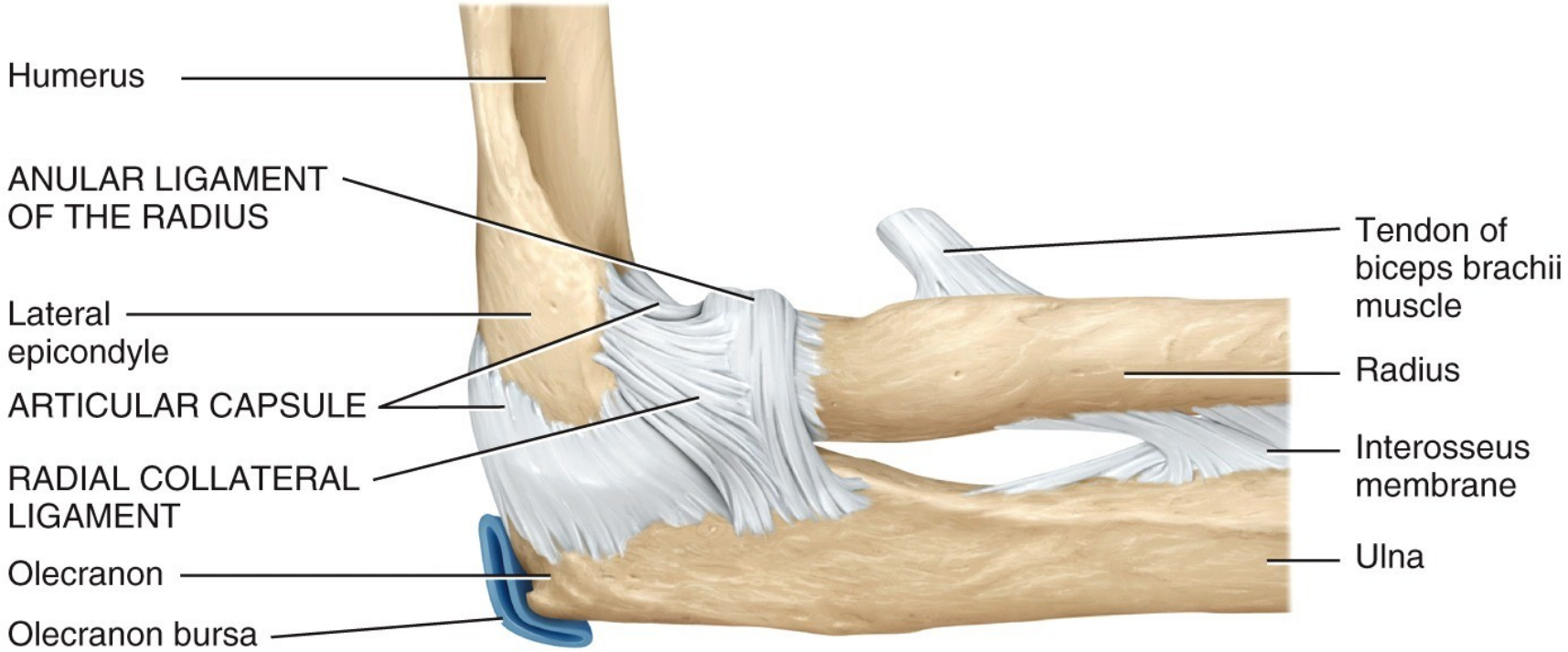
Right Elbow Joint



(b) Lateral aspect

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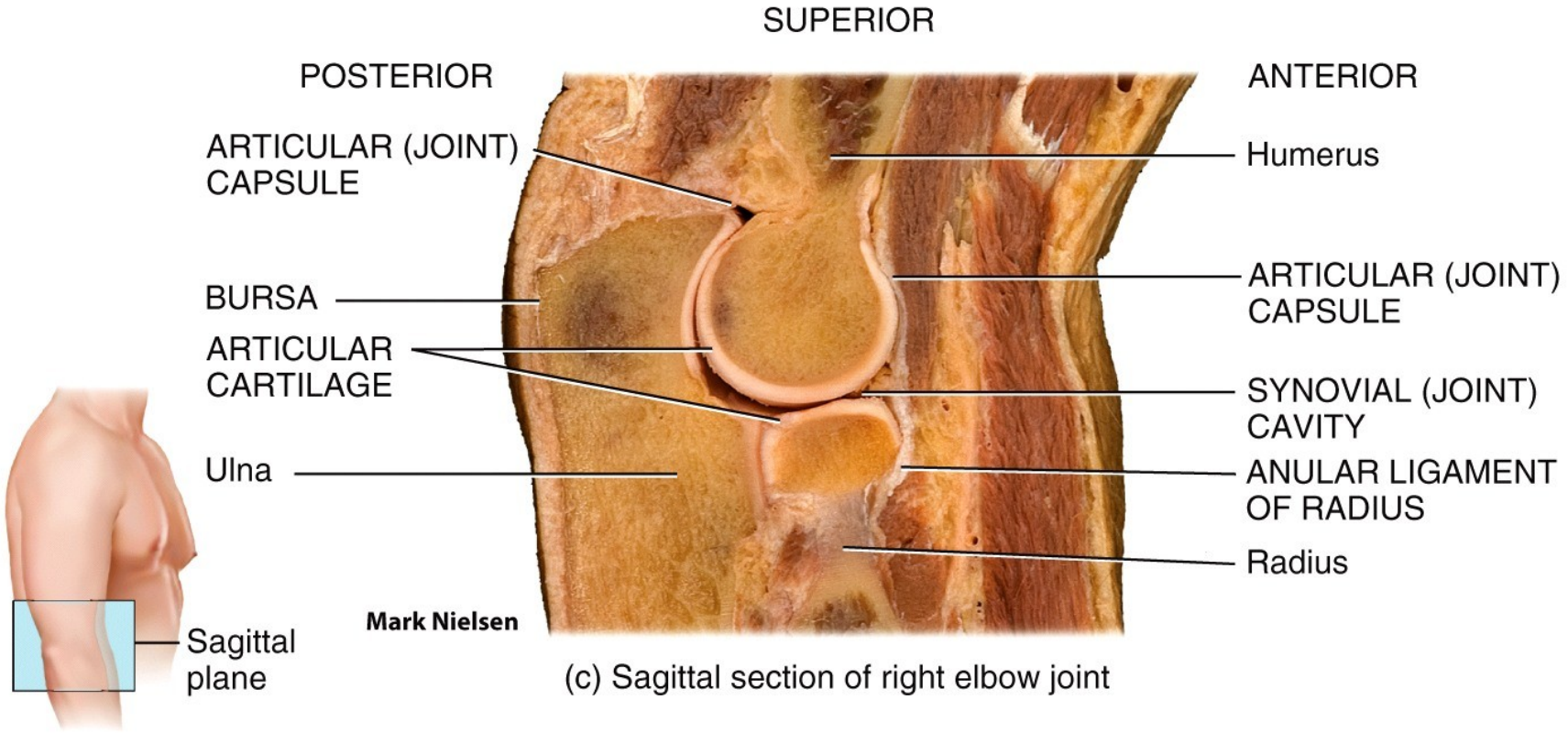
Right Elbow Joint



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Hip Joint: A Ball and Socket Joint

The hip joint is formed by the head of the femur and the acetabulum of the hip.

- Anatomical components
- Movements

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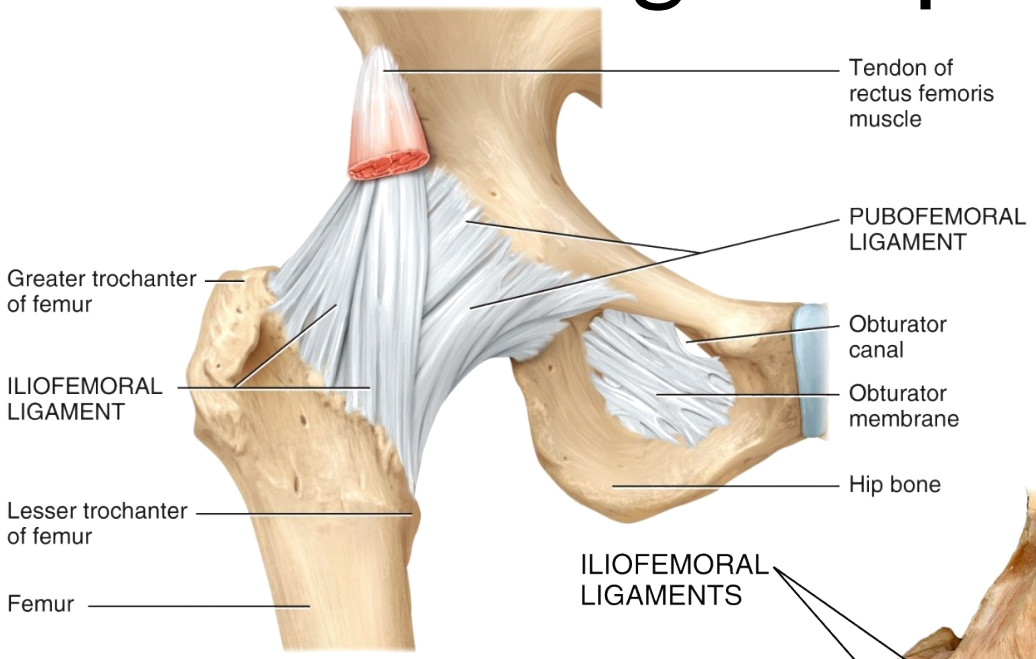
Right Hip Joint



(a) Anterior view

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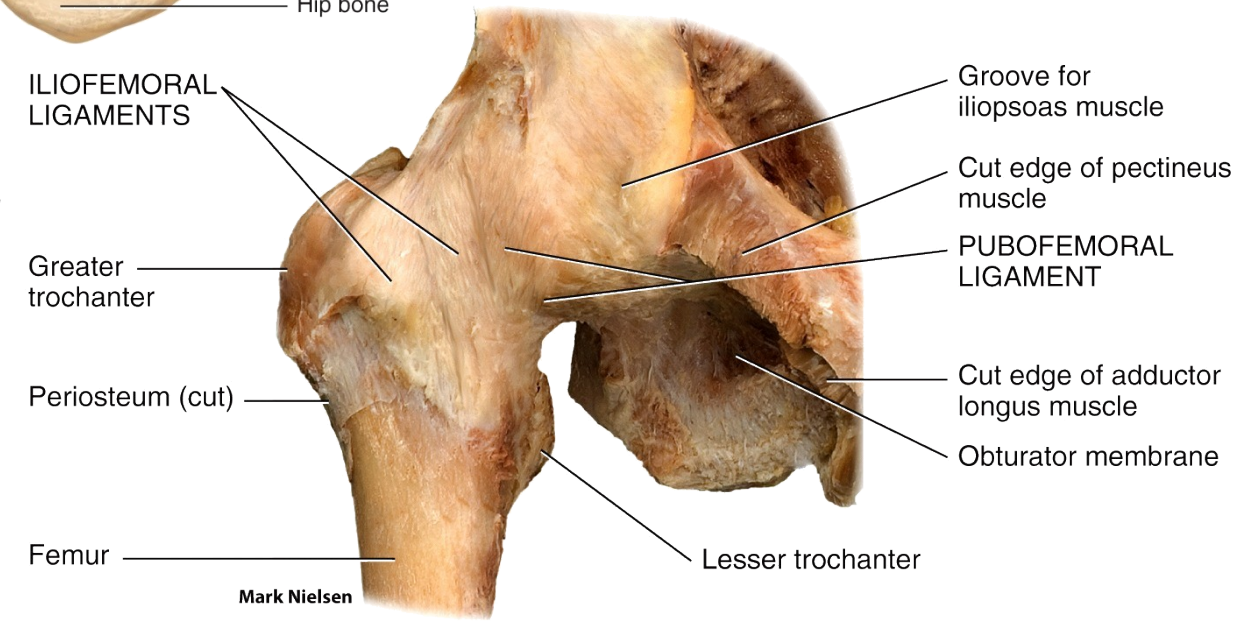

(b) Anterior view

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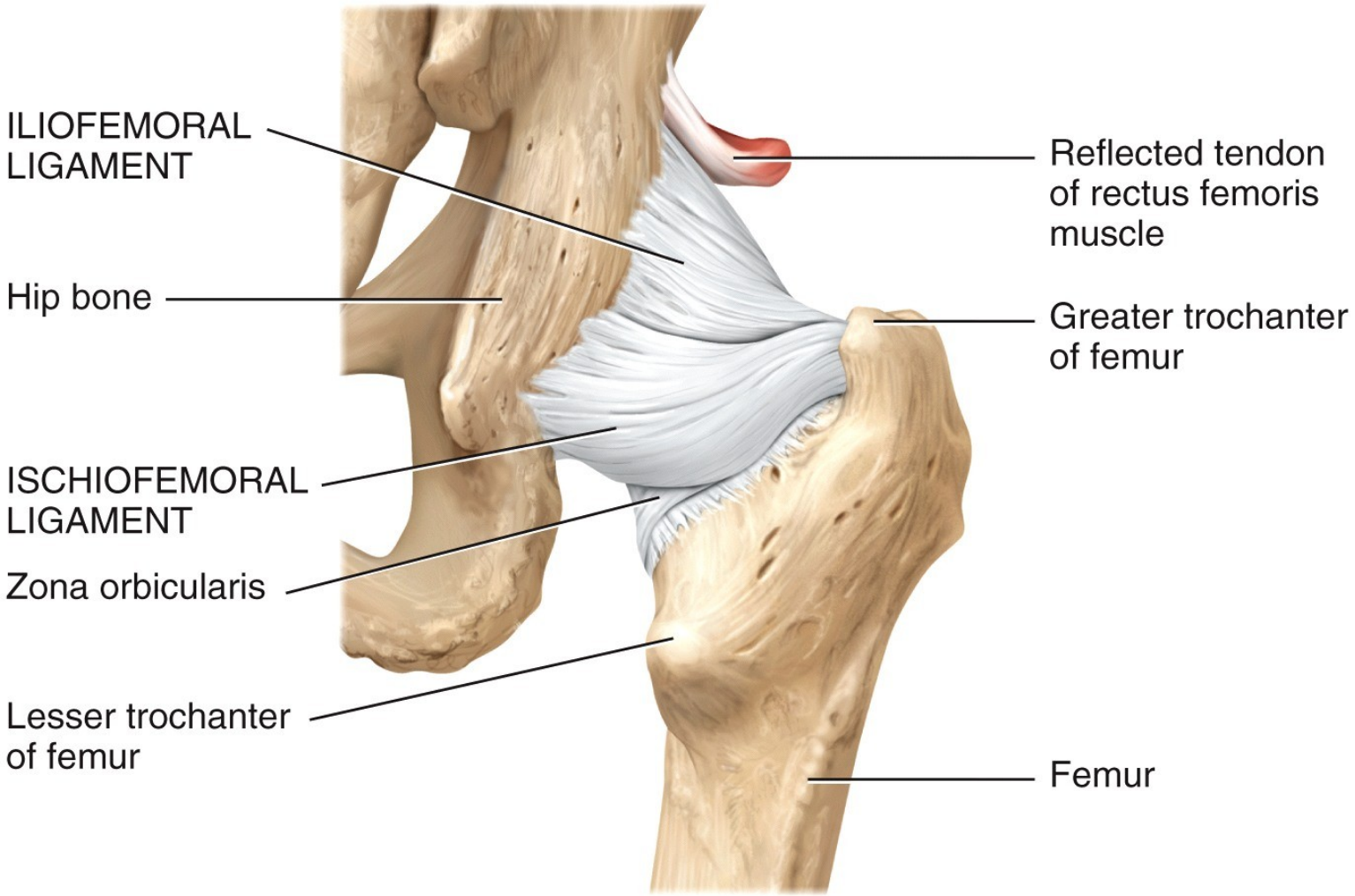
Right Hip Joint



(c) Posterior view

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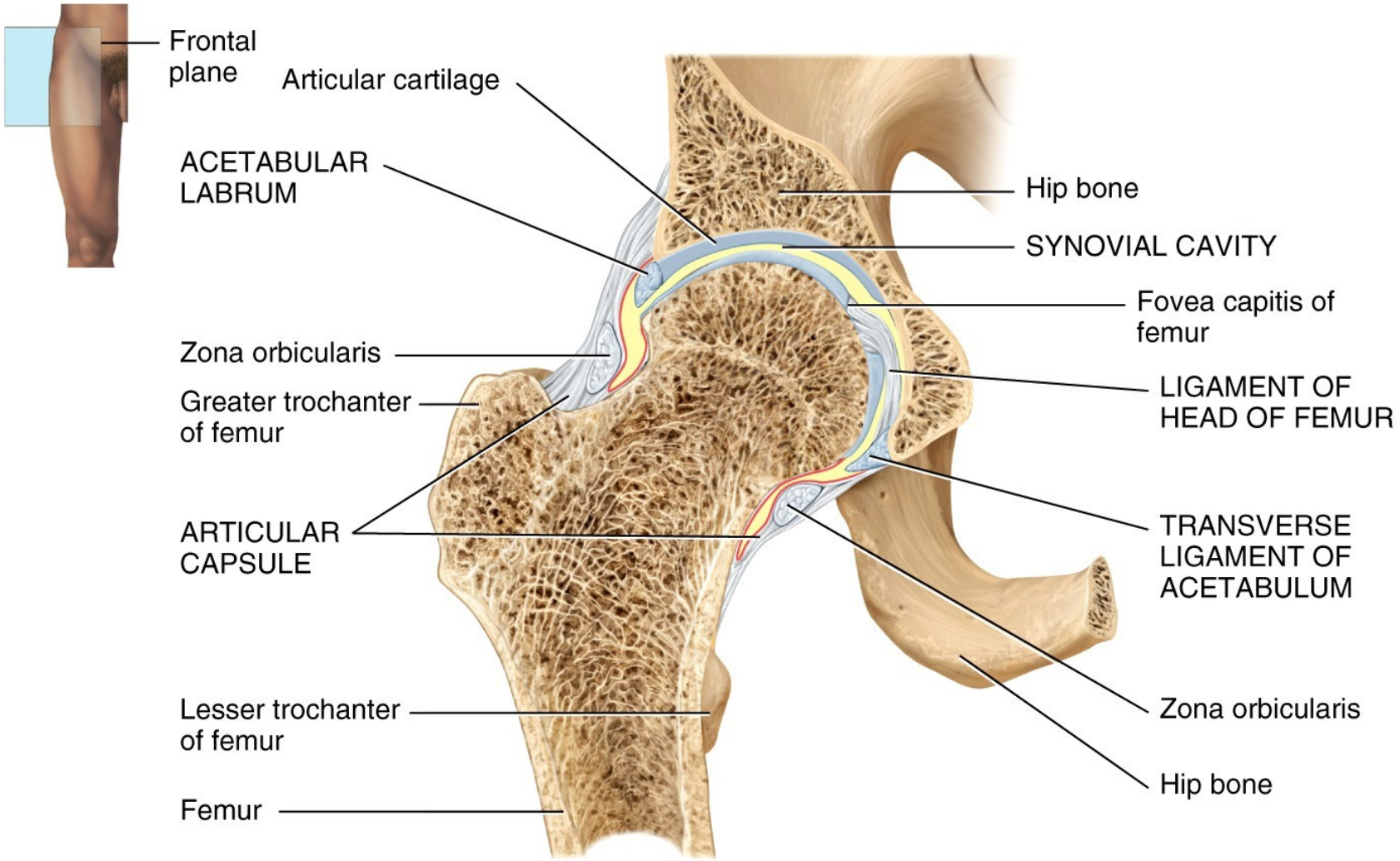
Right Hip Joint



(d) Frontal section

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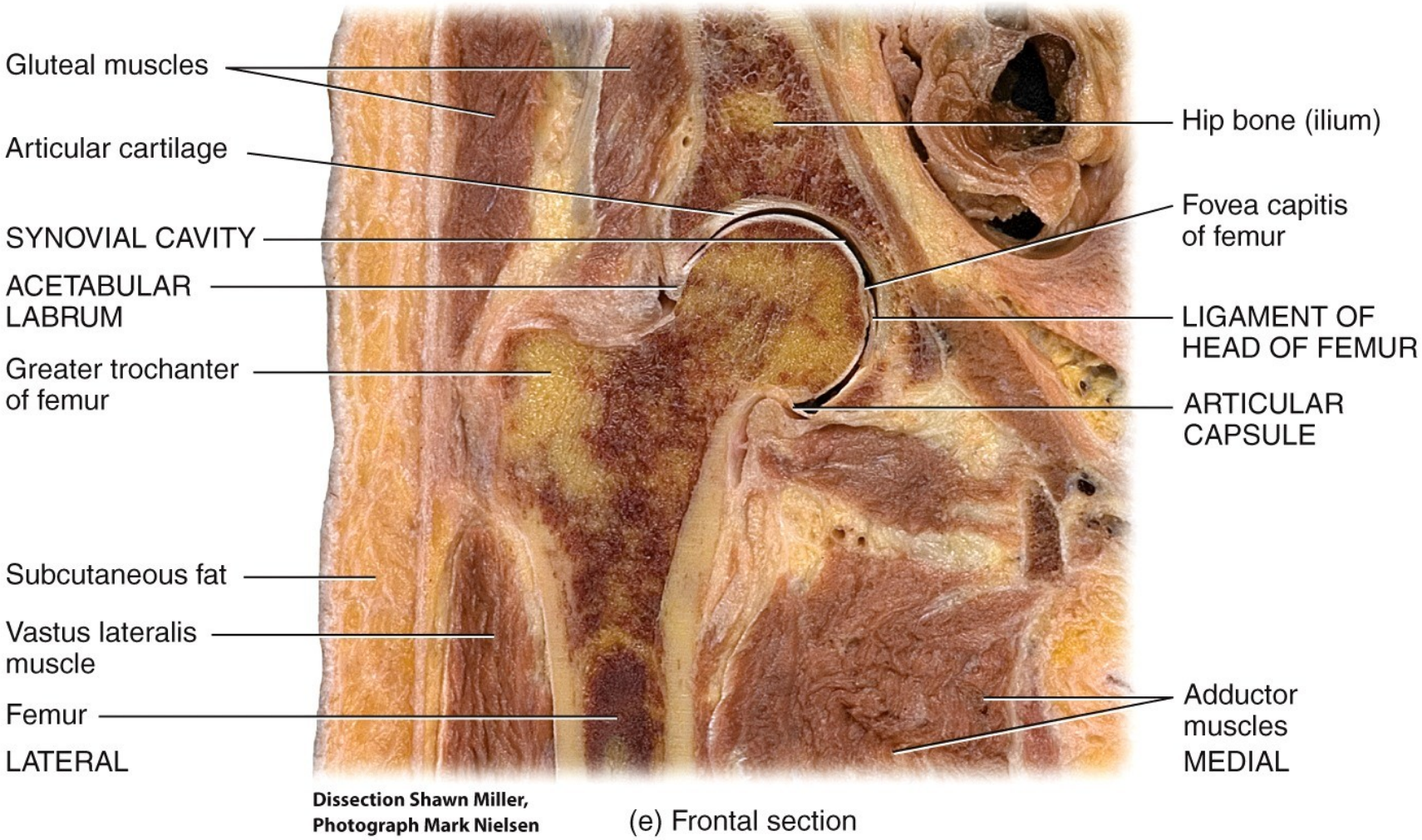
Right Hip Joint



Dissection Shawn Miller, Photograph Mark Nielsen

(e) Frontal section

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Knee Joint

The knee joint is formed by the femoral and tibial condyles and the patella.

- Anatomical components
- Movements

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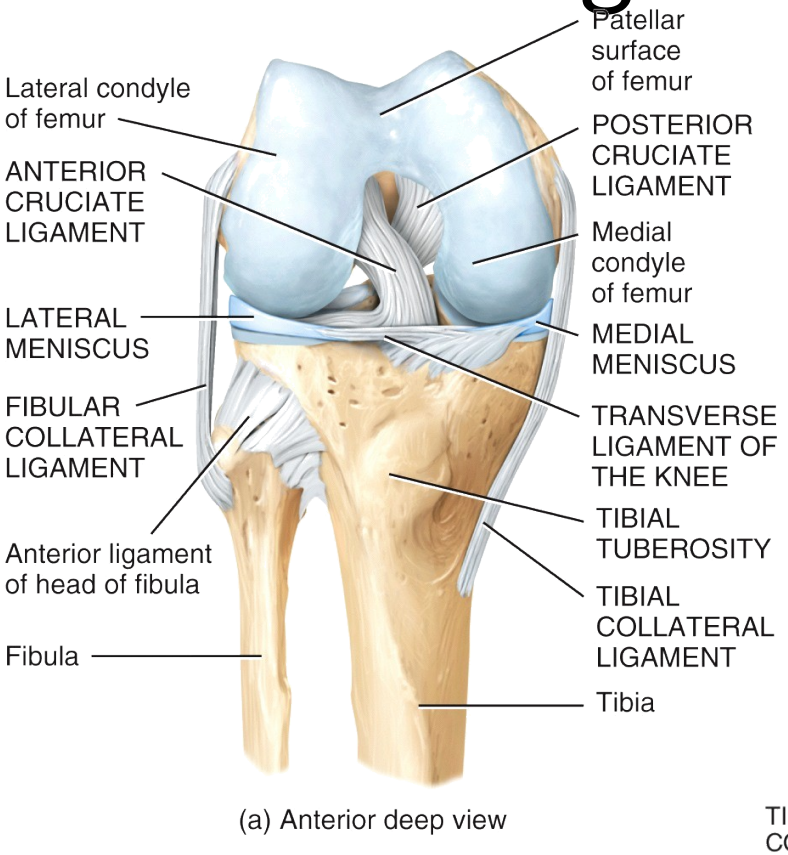
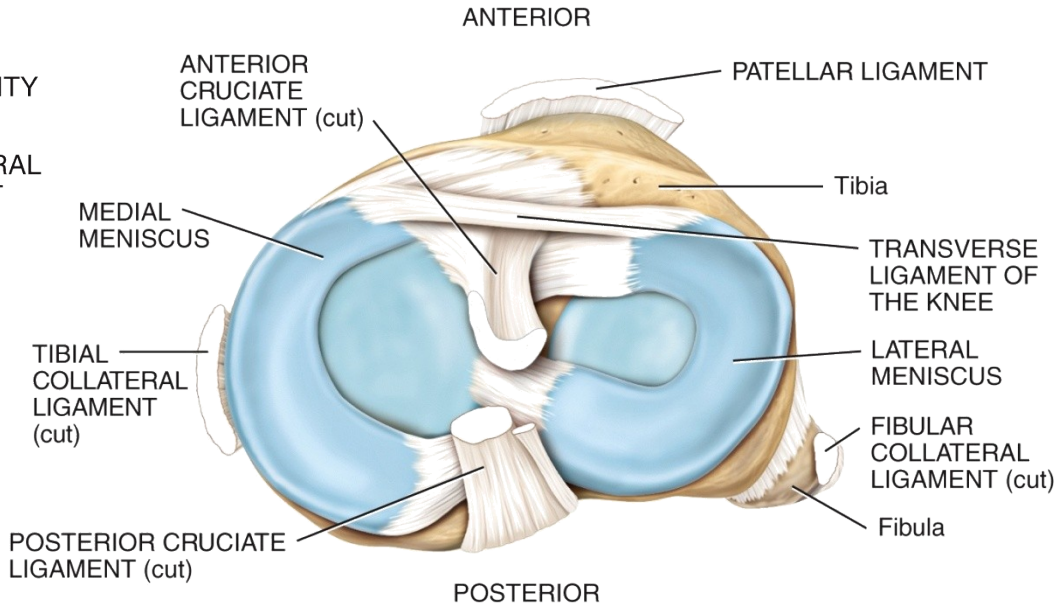
Right Knee Joint



(a) Anterior deep view



(b) Superior view of menisci

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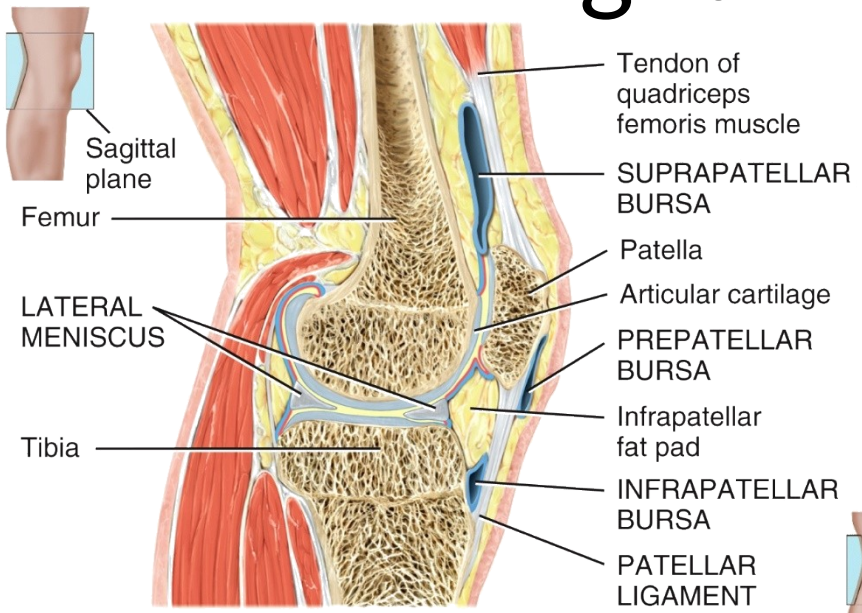
Right Knee Joint



(c) Sagittal section

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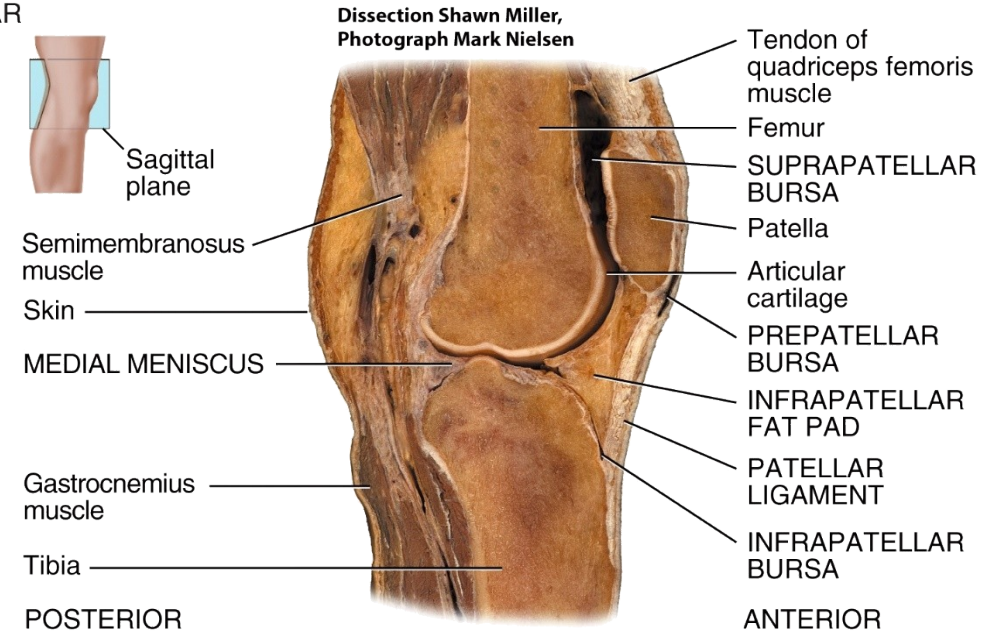

(d) Sagittal section

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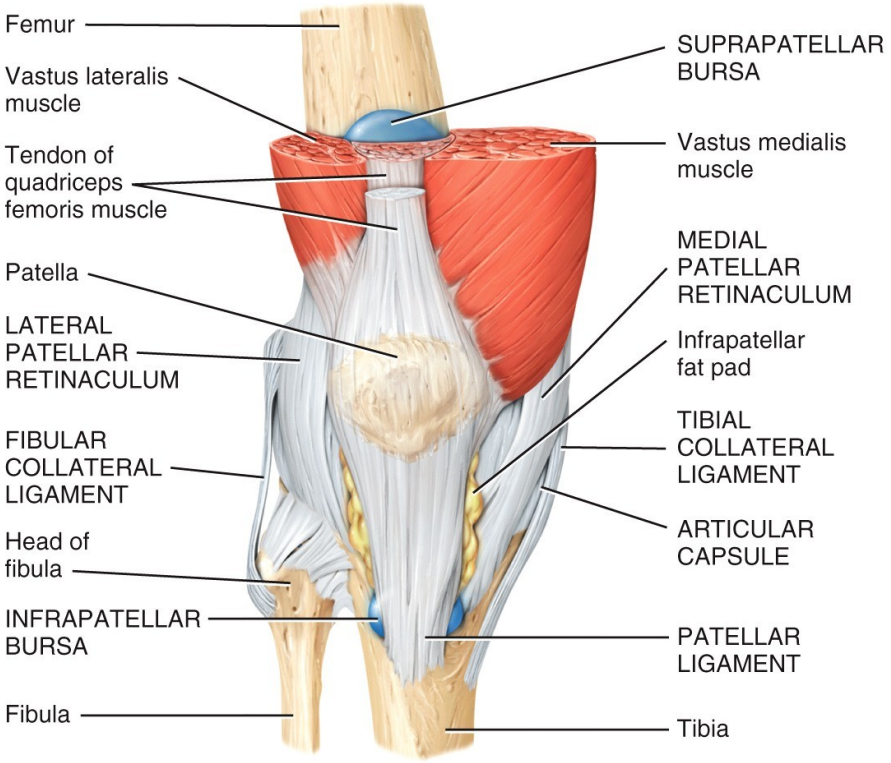
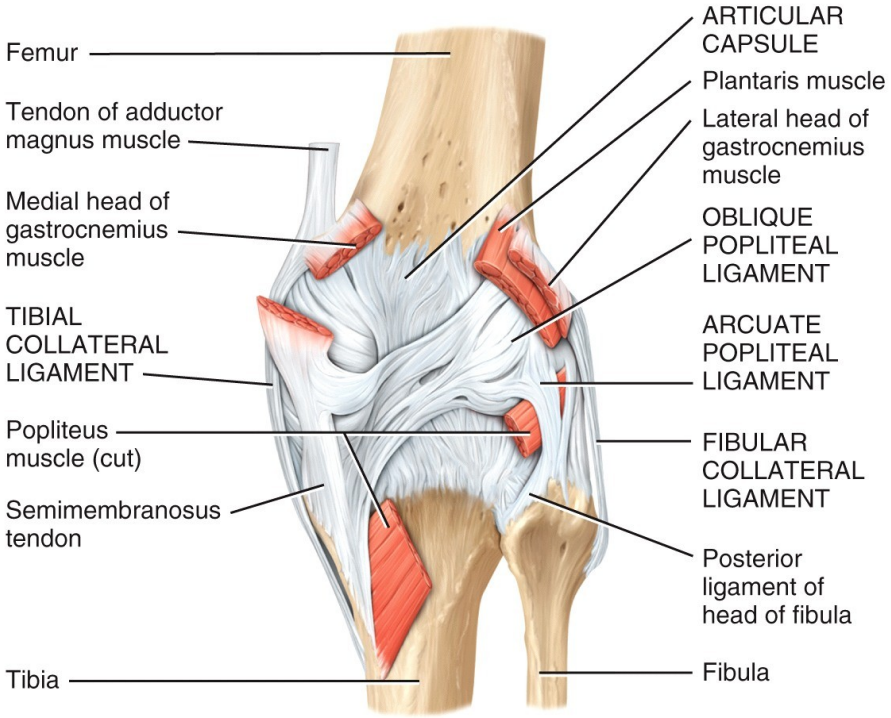
Right Knee Joint



(e) Anterior superficial view



(f) Posterior deep view

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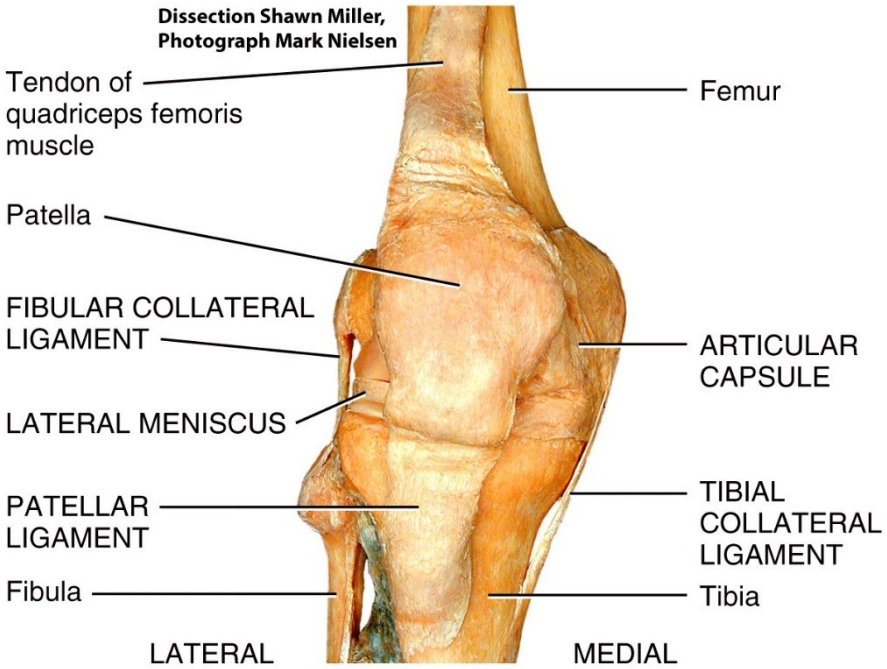
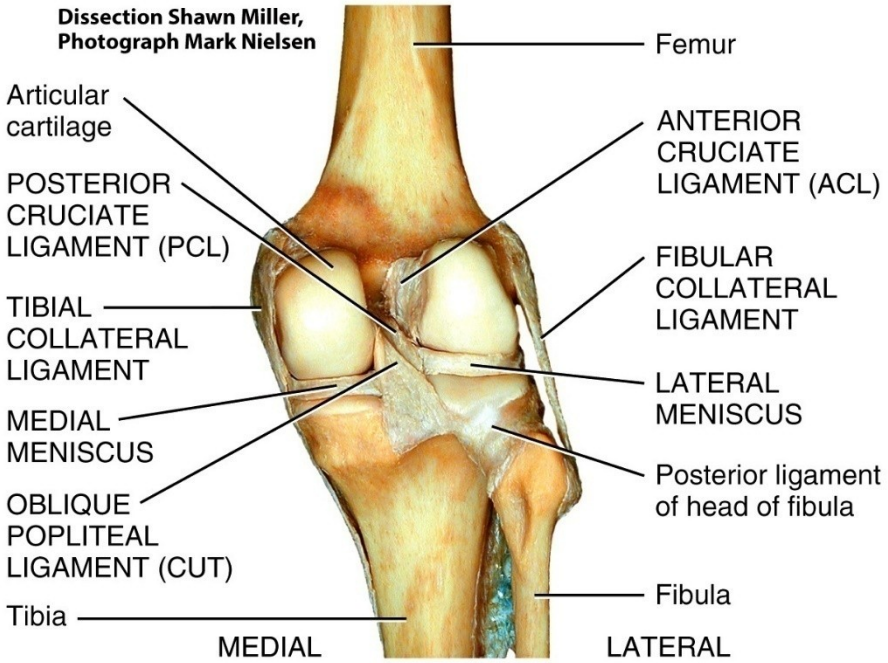
Right Knee Joint



(g) Anterior view



(h) Posterior view

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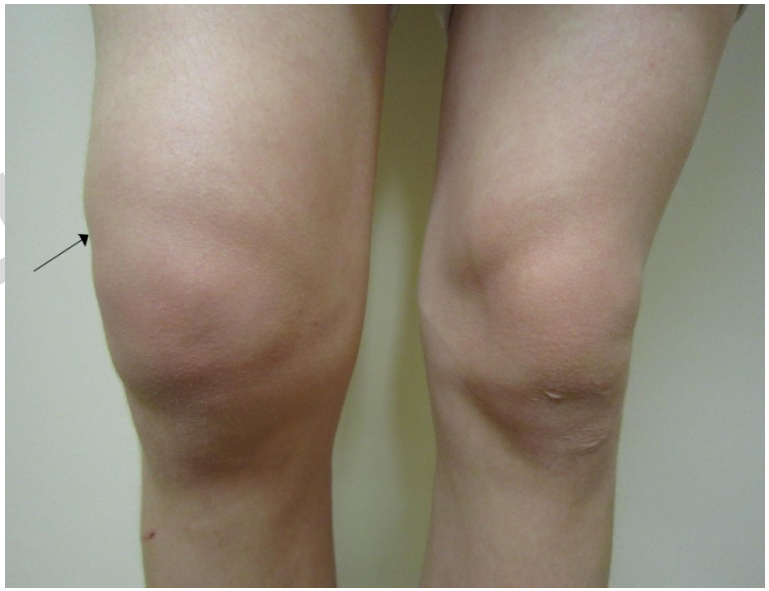
Clinical Connection

- **Swollen knee:** occurs when excess fluid accumulates in or around your knee joint. … A swollen knee may be the result of trauma, overuse injuries, or an underlying disease or condition. To determine the cause of the swelling, your doctor might need to obtain a sample of the fluid to test for infection, disease or injury



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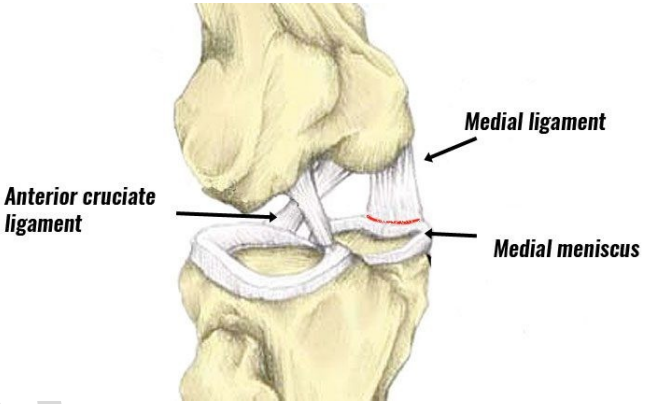
Clinical Connection

- **Unhappy triad:** occurs due to a lateral blow to the knee causing a rupture in the anterior cruciate ligament, medial collateral ligament, and meniscus. Injury is most often sustained when a lateral (from the outside) force impacts the knee while the foot is fixed on the ground



- **Dislocated knee:**occurs when the position of the thighbone relative to the shinbone becomes disrupted at the knee joint. It can happen through trauma to your leg, like from falls, sports injuries, and car accidents. A dislocated knee is different than a dislocated kneecap

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Ankle Joint

The ankle joint is formed from the articulations among the lateral and medial malleoli and the talus.

- Anatomical components
- Movements

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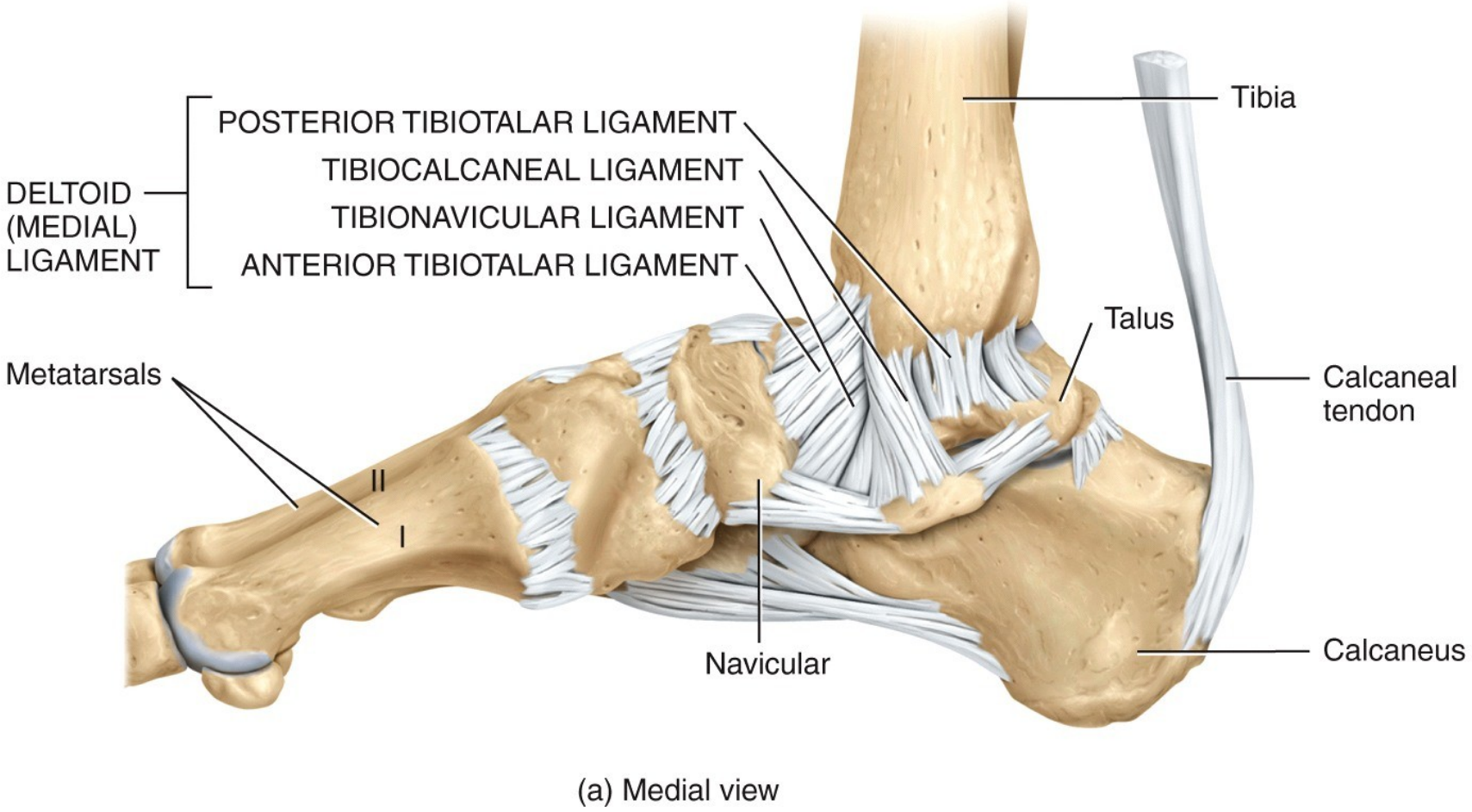
Right Ankle Joint



(a) Medial view

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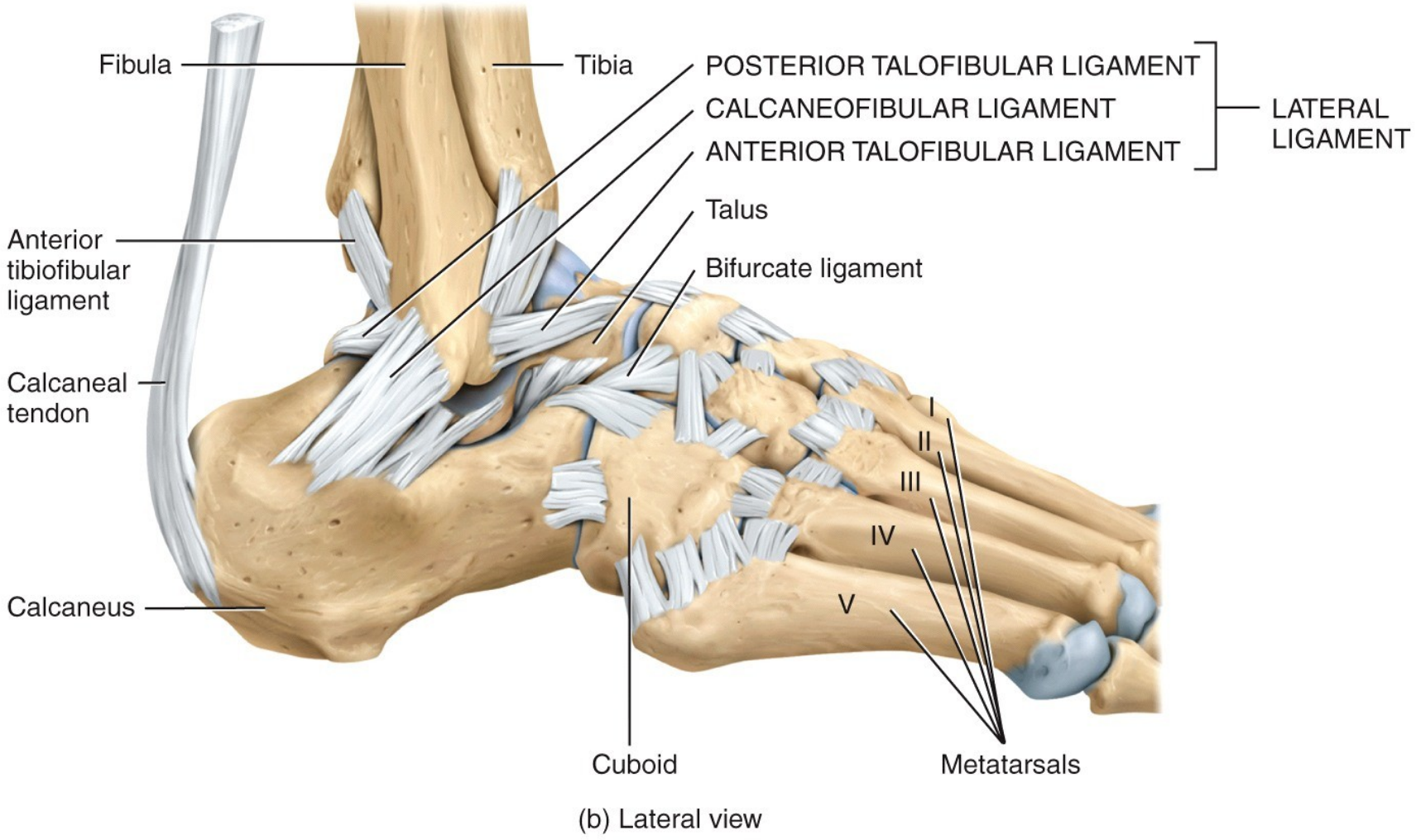
Right Ankle Joint



(b) Lateral view

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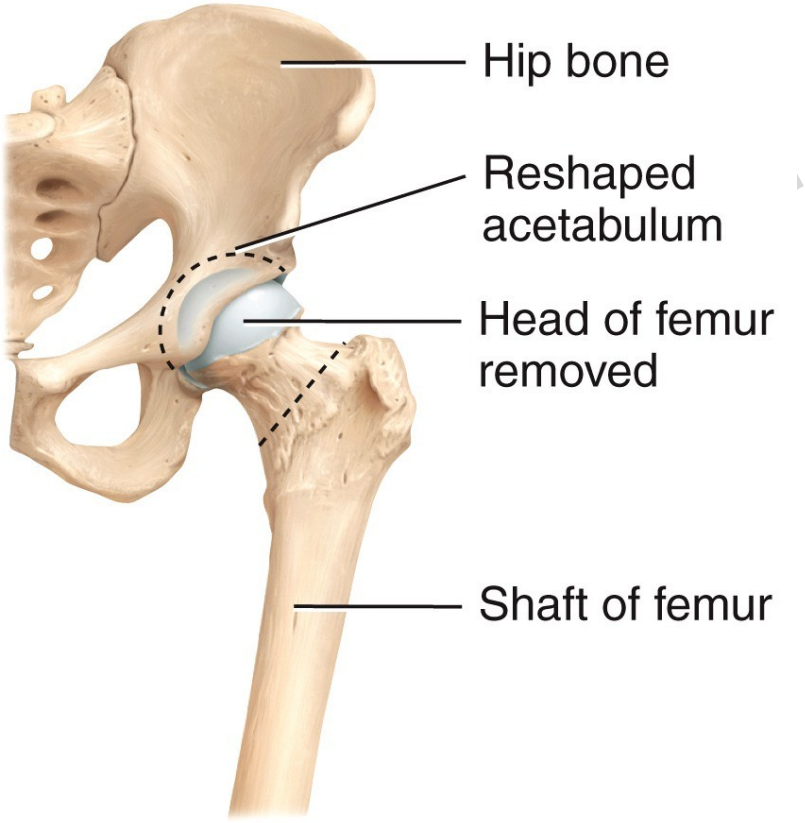
Clinical Connection

- Arthroplasty



(A) Preparation for total hip replacement

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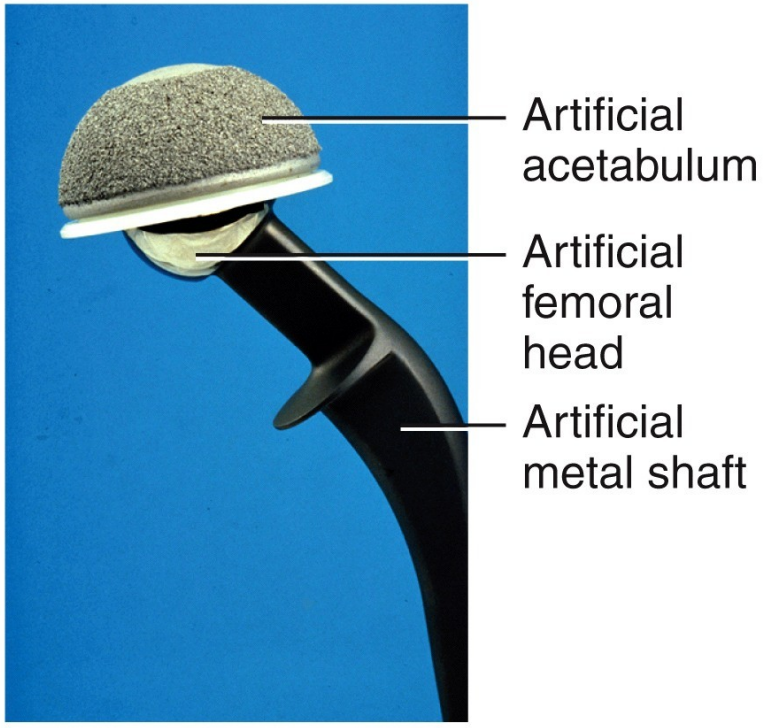
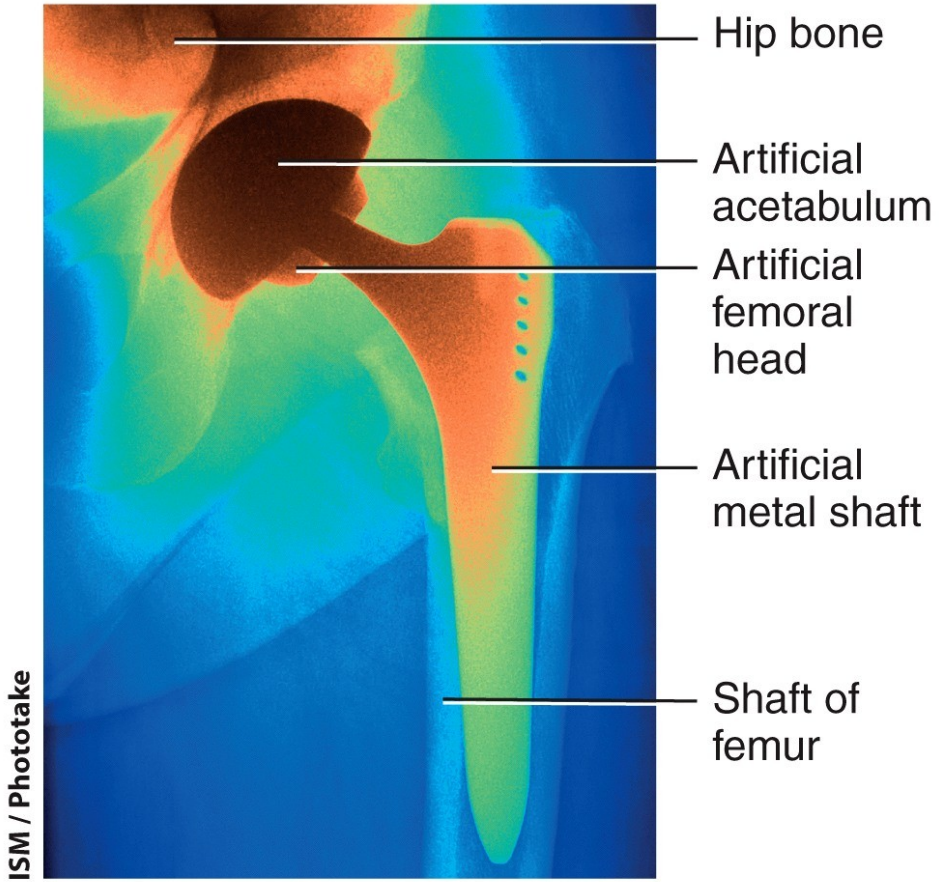
Clinical Connection

- Arthroplasty



(B) Components of an artificial hip joint prior to implantation



(C) Radiograph of an artificial hip joint

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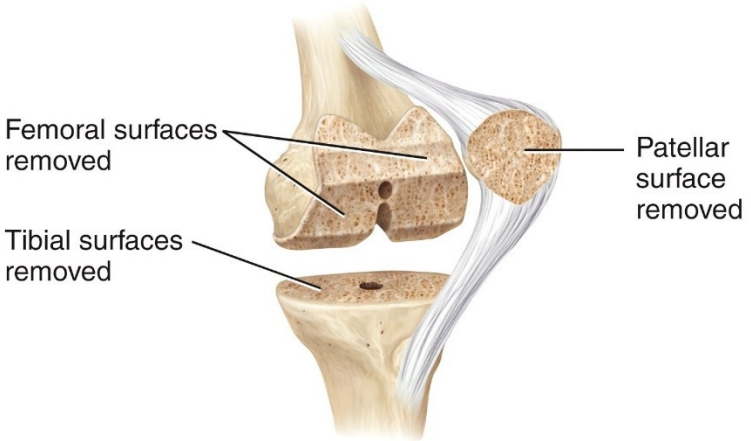
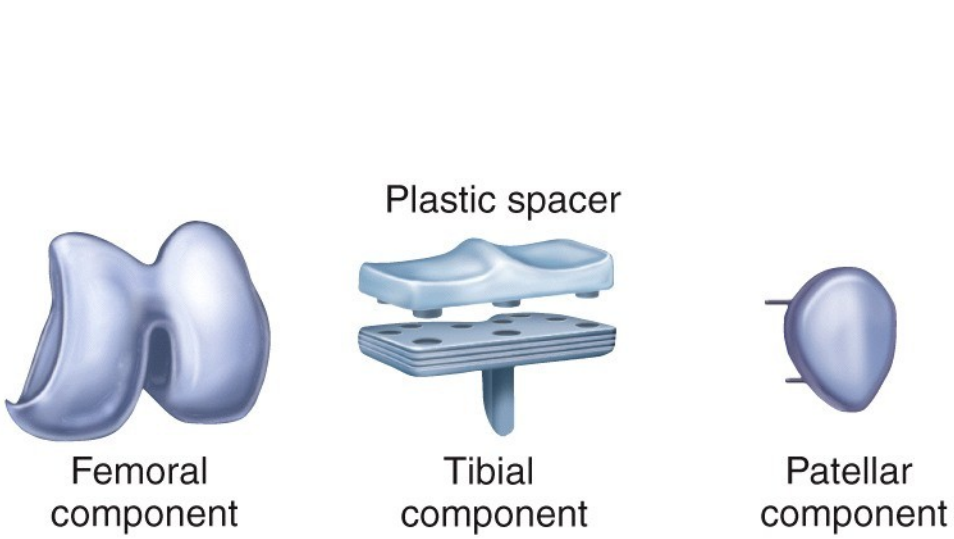
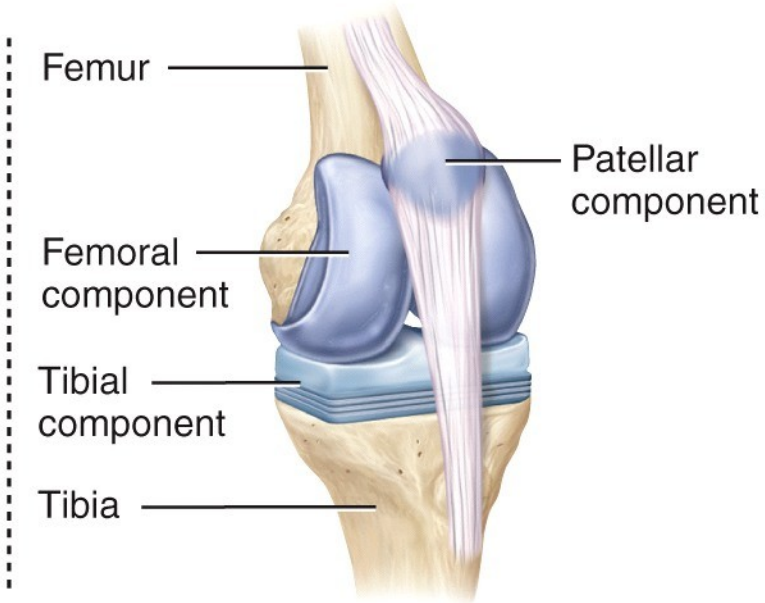
Clinical Connection

- Arthroplasty



(D) Preparation for total knee replacement





(E) Components of artificial knee joint prior to implantation (left) and implanted (right)

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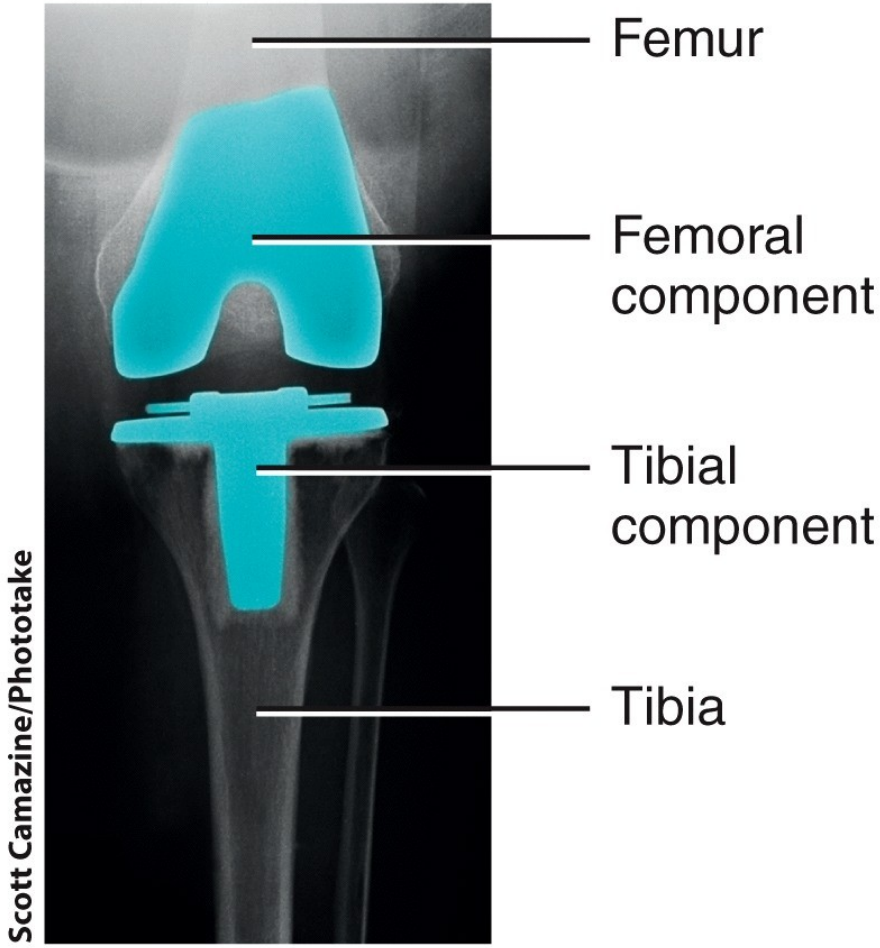
Clinical Connection

- Arthroplasty



(F) Radiograph of total knee replacement

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