LEARNING OUTCOMES

As a result of the lesson you will be able to:

- identify the major anatomical features of the jaw, shoulder joints
- explain how mechanical advantage relates to the power and speed of the jaw, shoulder joints movement;
- discuss the factors that determine the jaw, shoulder joint range of motion
- describe the primary axes of rotation that a bone can have and relate this to a joint’s degrees of freedom

Mechanical Advantage

- advantage conferred by a lever can be of two kinds:
  - to exert more force against a resisting object than the force applied to the lever
    - human moving a heavy object with help of crowbar
  - to move 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

Range of Motion

- range of motion (ROM) –the degrees through which a joint can move
  - an aspect of joint performance
  - physical assessment of a patient's joint flexibility

- range of motion 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

Axes of Rotation

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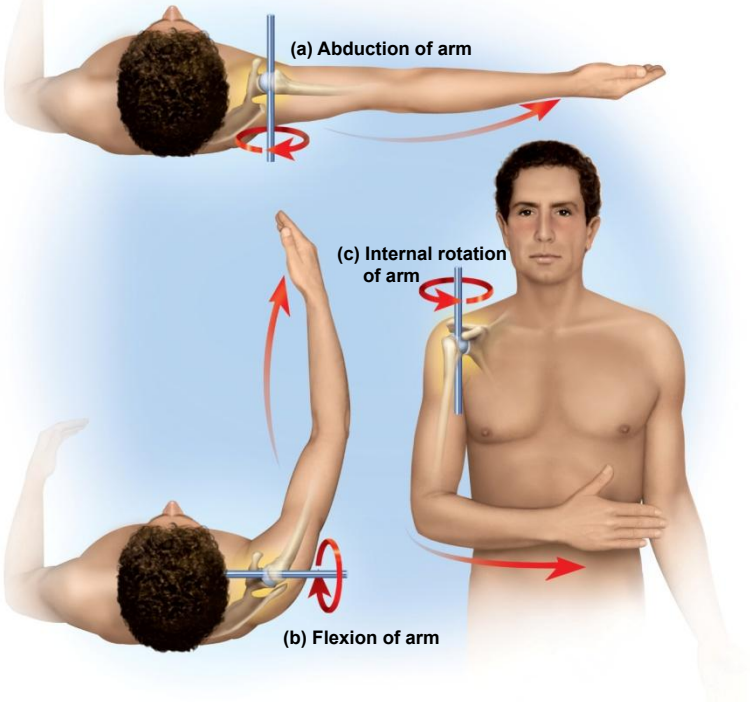

- a moving bone has a relatively stationary **axis of rotation** that passes through the bone in a direction perpendicular to the plane of movement
- multiaxial joint - shoulder joint has three degrees of freedom or axes of rotation
- other joints – **monoaxial** or **biaxial**

Classes of Synovial Joints

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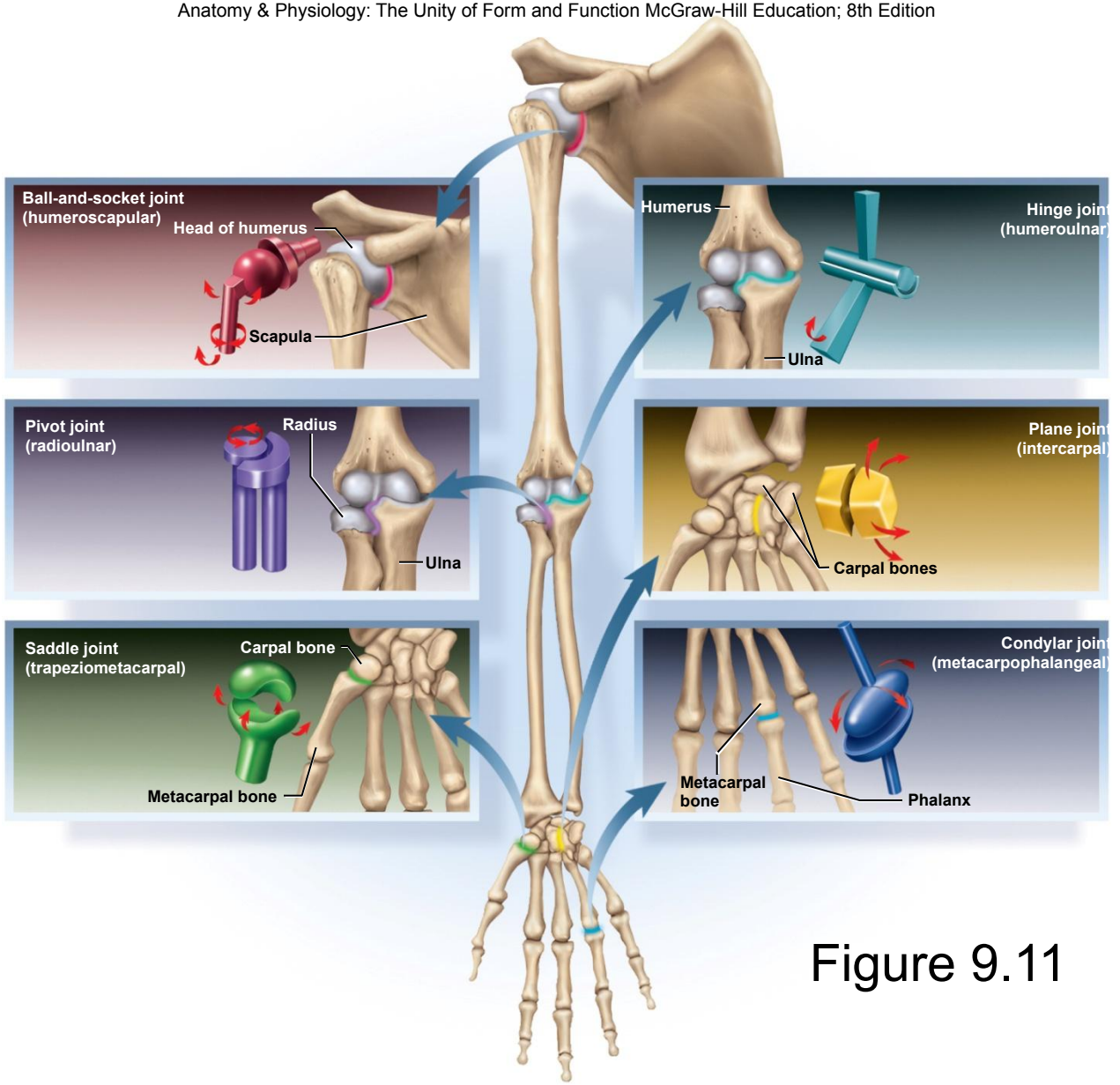

Figure 9.11

Movement of Synovial Joints

- vocabulary of movements of synovial joints used in kinesiology, physical therapy, and other medical fields
  - many 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 movement are described as deviating from the zero position or returning to it

Flexion, Extension and Hyperextension

- flexion – movement that decreases the a joint angle
  - common in **hinge joints**
- extension – movement that straightens a joint and generally returns a body part to the zero position
- hyperextension – further extension of a joint beyond the zero position
  - flexion and extension occur at nearly all diarthroses, hyperextension is limited to a few

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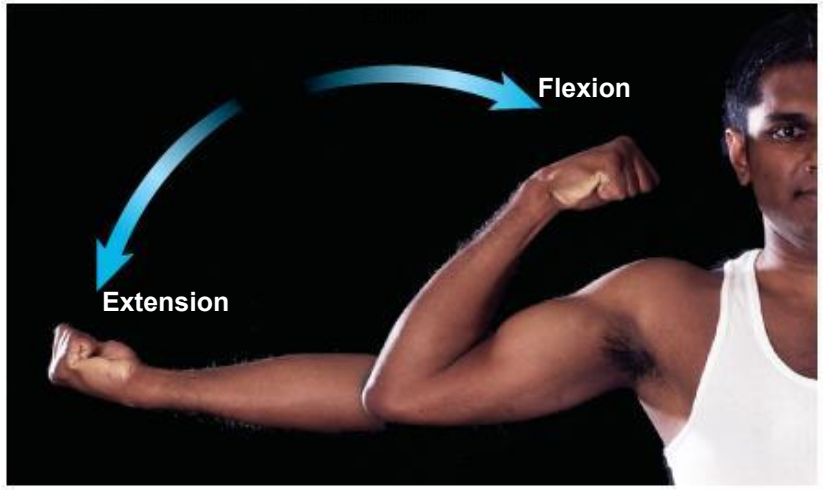
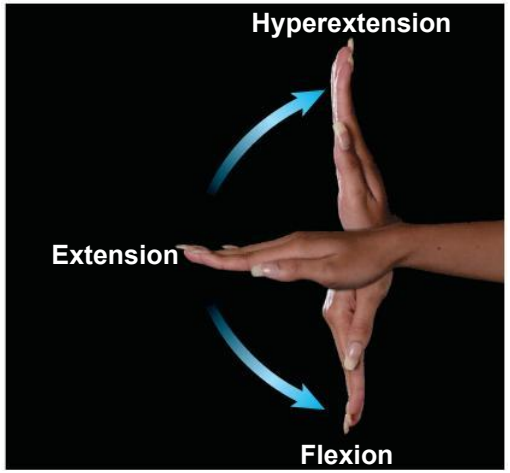


(a)

Figure 9.12a



(b)

Figure 9.12b

Flexion, Extension and Hyperextension

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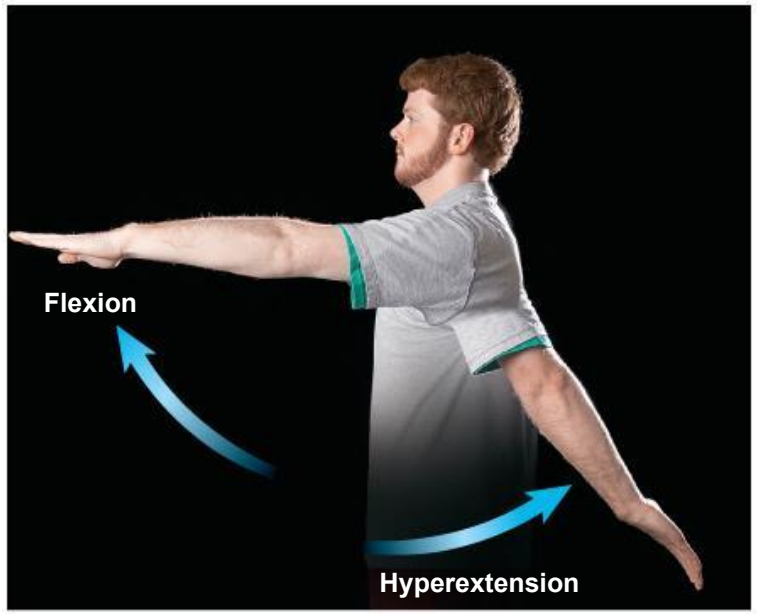

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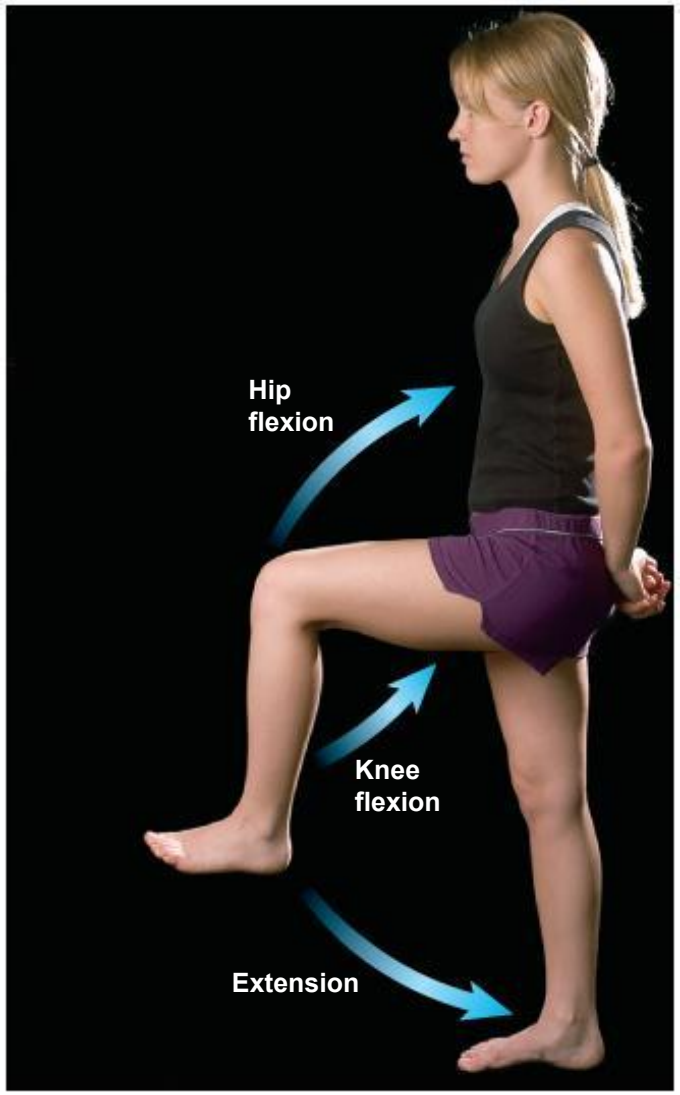

(d)

Abduction and Adduction

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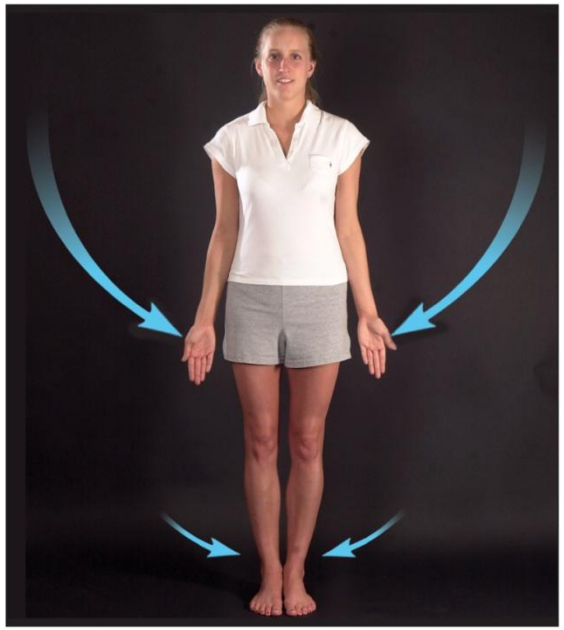
(a) Abduction



(b) Adduction

- 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

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(a) Elevation **(b) Depression**

Figure 9.14a,b

- elevation - a movement that raises a body part vertically in the frontal plane

- depression – 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

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(a) Protraction

(b) Retraction

Figure 9.15a,b

Circumduction

Choose any example of circumduction and explain why this motion is actually a sequence of flexion, abduction, extension, and adduction.

- circumduction - one end of an appendage remains stationary while the other end makes a circular motion
- sequence of flexion, abduction, extension and adduction movements
  - baseball player winding up for a pitch

At the shoulder joint, flexion raises the upper limb anteriorly, abduction directs it laterally, extension moves it posteriorly, and adduction brings it back to the zero position; the combined effect of all these movements is circumduction.

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 inwards
- lateral (external) rotation turns the bone outwards

(a) Medial (internal) rotation

(b) Lateral (external) rotation

Supination and Pronation

- primarily forearm movements

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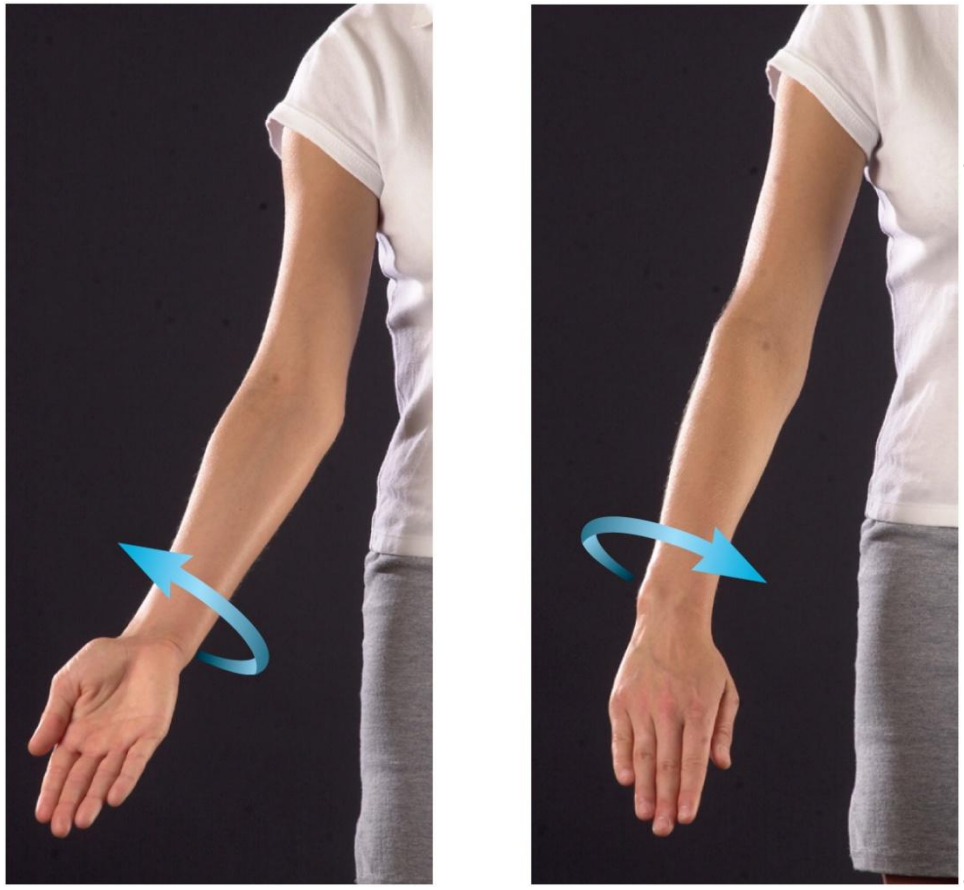

(a) Supination **(b) Pronation**

Figure 9.18a,b

- supination – forearm movement that turns the palm to face anteriorly or upward
  - forearm supinated in anatomical position
  - radius is parallel to the ulna
- pronation – forearm movement that turns the palm to face posteriorly or

Movements of Head and Trunk

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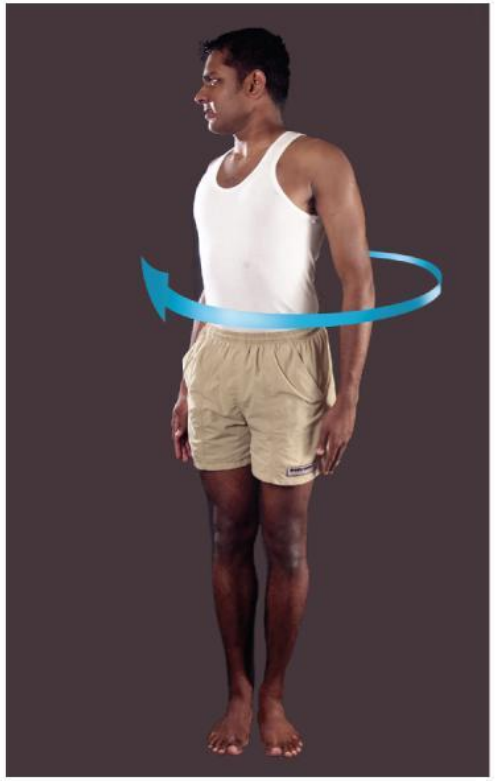
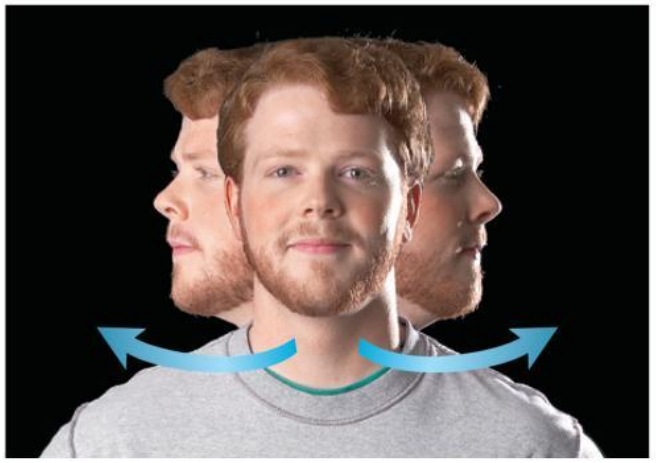
(a) Flexion **(b) Hyperextension** **(c) Lateral flexion**

Figure 9.19a,b,c

flexion, hyperextension, and lateral flexion of vertebral column

Rotation of Trunk and Head





right and left rotation of trunk

right and left rotation of head

In rotation of the head , what bone spins on its axis?

Special Movements of Mandible

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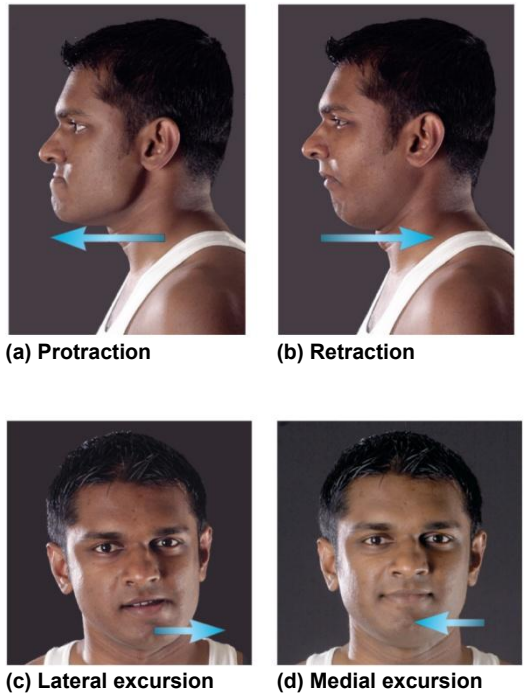

- lateral excursion – right or left movement from the zero position
- medial excursion - movement back to the median, zero position
  - side-to-side grinding during chewing
- protraction – retraction elevation - depression

Special Movement of Hand and Digits

- ulnar flexion – tilts the hand toward the little finger
- radial flexion – tilts the hand toward the thumb
- flexion of fingers – curling them
- extension of fingers – straightening them
- abduction of the fingers – spread them apart
- adduction of the fingers – bring them together again
- flexion of thumb – tip of thumb directed toward palm
- extension of thumb – straightening the thumb
- radial abduction – move thumb away from index finger 90°
- palmar abduction – moves thumb away from hand and points it anteriorly
- adduction of thumb – moves it to the zero position
- opposition – move the thumb to touch the tips of any of the fingers
- reposition – return the thumb to the zero position

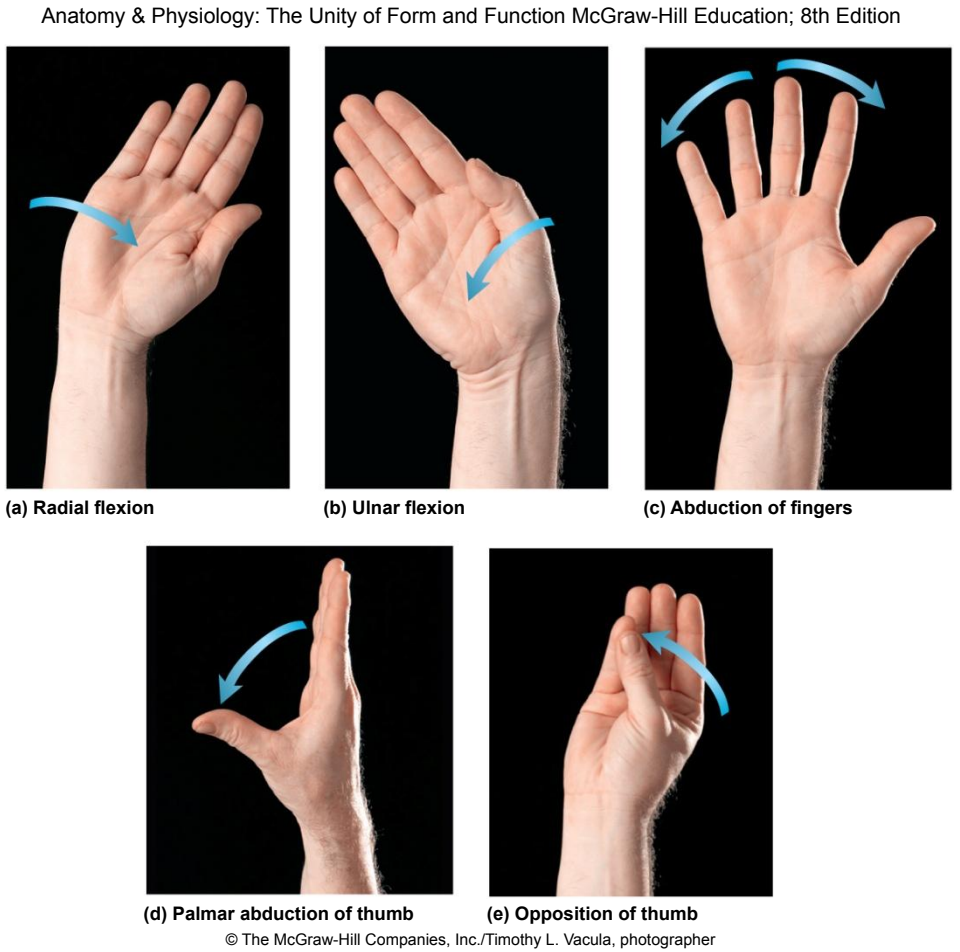

Figure 9.21

Special Movements of the Foot

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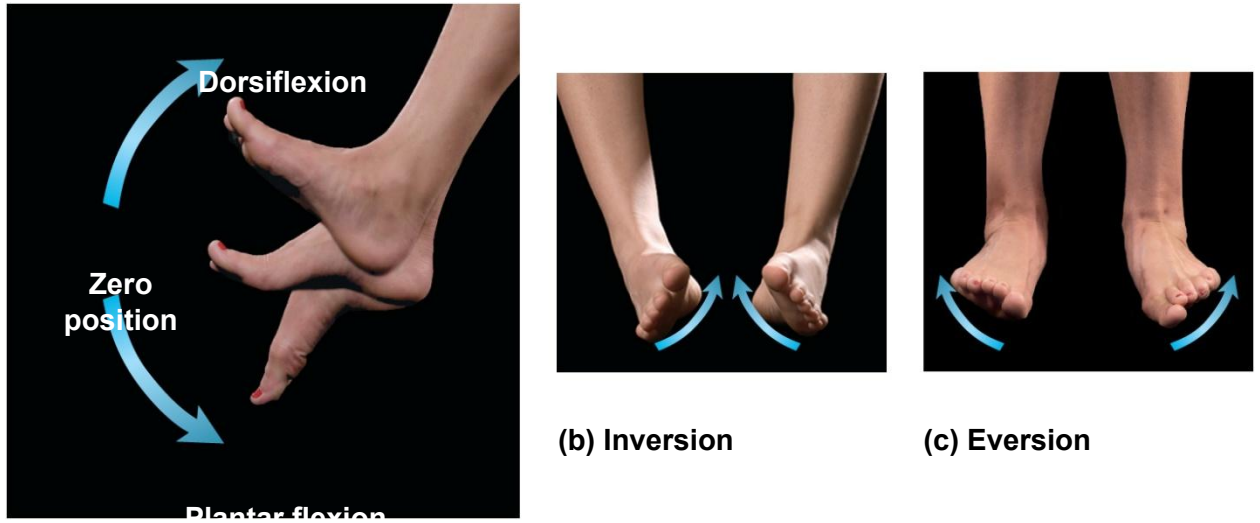


Figure 9.22

- dorsiflexion – elevation of the toes as you do while swinging the foot forward to take a step (heel strike)
- plantar flexion - extension of the foot so that the toes point downward as in standing on tiptoe (toe-off)
- inversion - a movement in which the soles are turned medially
- eversion - a movement in which the soles are turned laterally
- supination of foot – complex combination of plantar flexion, inversion, and adduction
- pronation of foot – complex combination of dorsiflexion, eversion, and abduction

Discuss the joints involved and movements required for you to cross your arms together in front of your chest.

Cartilaginous Joint - Symphysis

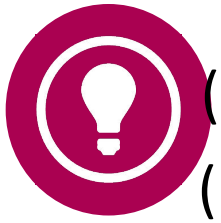
Discuss the joints involved and movements required for you to cross your arms together in front of your chest.

To cross your arms, you need to use both your shoulder and elbow joints. At the shoulder, the arm would need to flex and medially rotate. At the elbow, the forearm would need to be flexed.

Cartilaginous Joint - Symphysis

In order of occurrence, list the joint actions (flexion, pronation, etc.) and the joints where they would occur as you (a) sit down at a table, (b) reach out and pick up an apple, (c) take a bite, and (d) chew it. Assume that you start in anatomical position.

Cartilaginous Joint - Symphysis



(a) Flexion of the hip, knee, and elbow as you sit;

(b) pronation of the forearm, extension of the elbow, and flexion of the shoulder as you reach for the apple;

(c) depression and protraction followed by elevation of the mandible as you take a bite;

(d) retraction of the mandible and cyclic elevation, depression, and lateral and medial excursion as you chew it.

Temporomandibular Joint

- Temporomandibular (jaw) joint (TMJ) – articulation of the condyle of the mandible with the mandibular fossa of the temporal bone

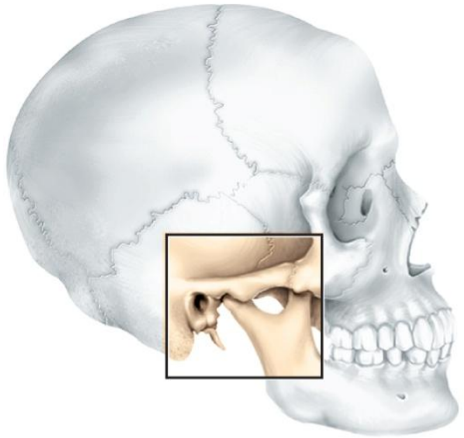
  - combines elements of condylar, hinge, and plane joints

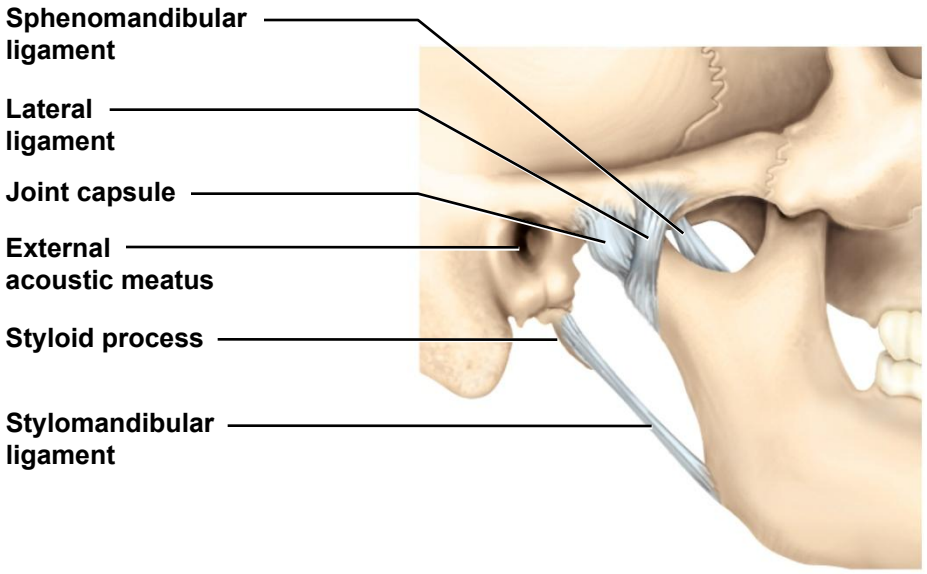
  - synovial cavity of the TMJ is divided into **superior and inferior chambers** by an **articular disc**

  - two ligaments support joint
    - lateral ligament – prevents posterior displacement of mandible
    - sphenomandibular ligament – on the medial side

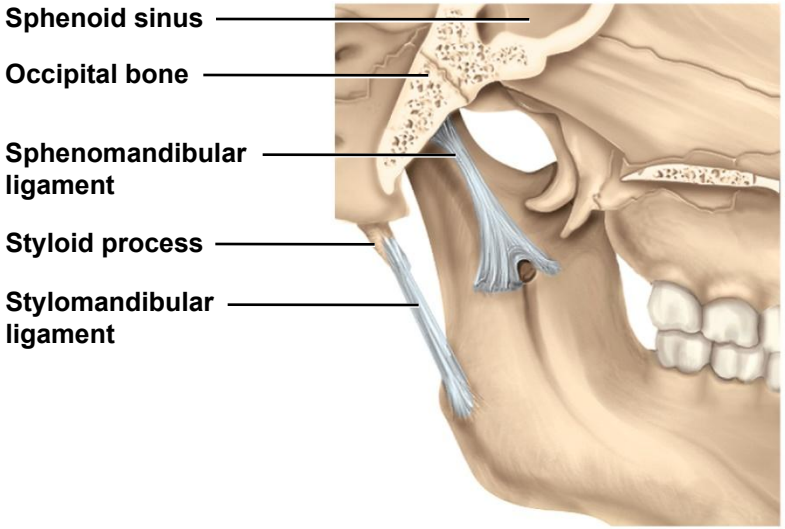
  - deep yawn or strenuous depression can **dislocate the TMJ**
    - condyles pop out of fossa and slip forward
    - relocated by pressing down on molar teeth while pushing the jaw backward

Temporomandibular Joint

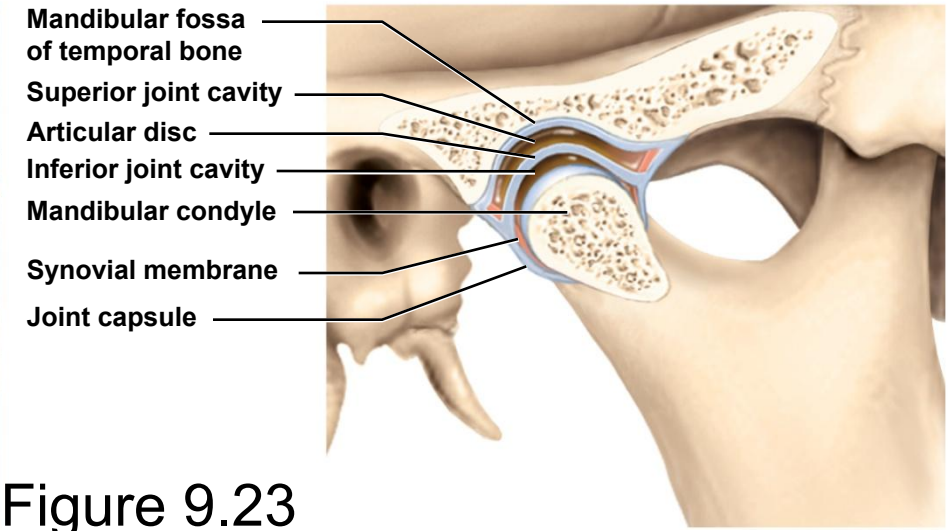




(a) Lateral view



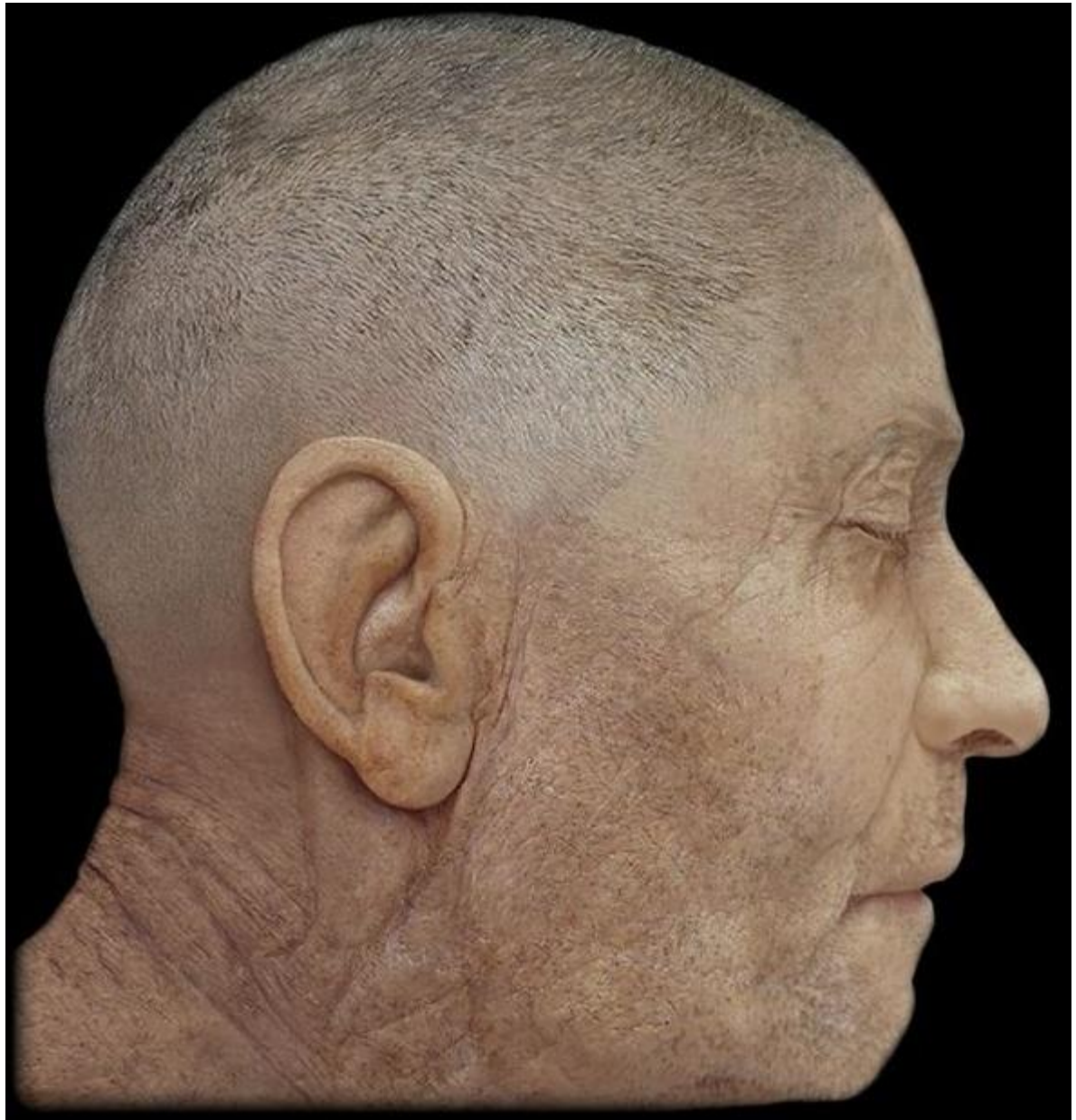
(b) Medial view



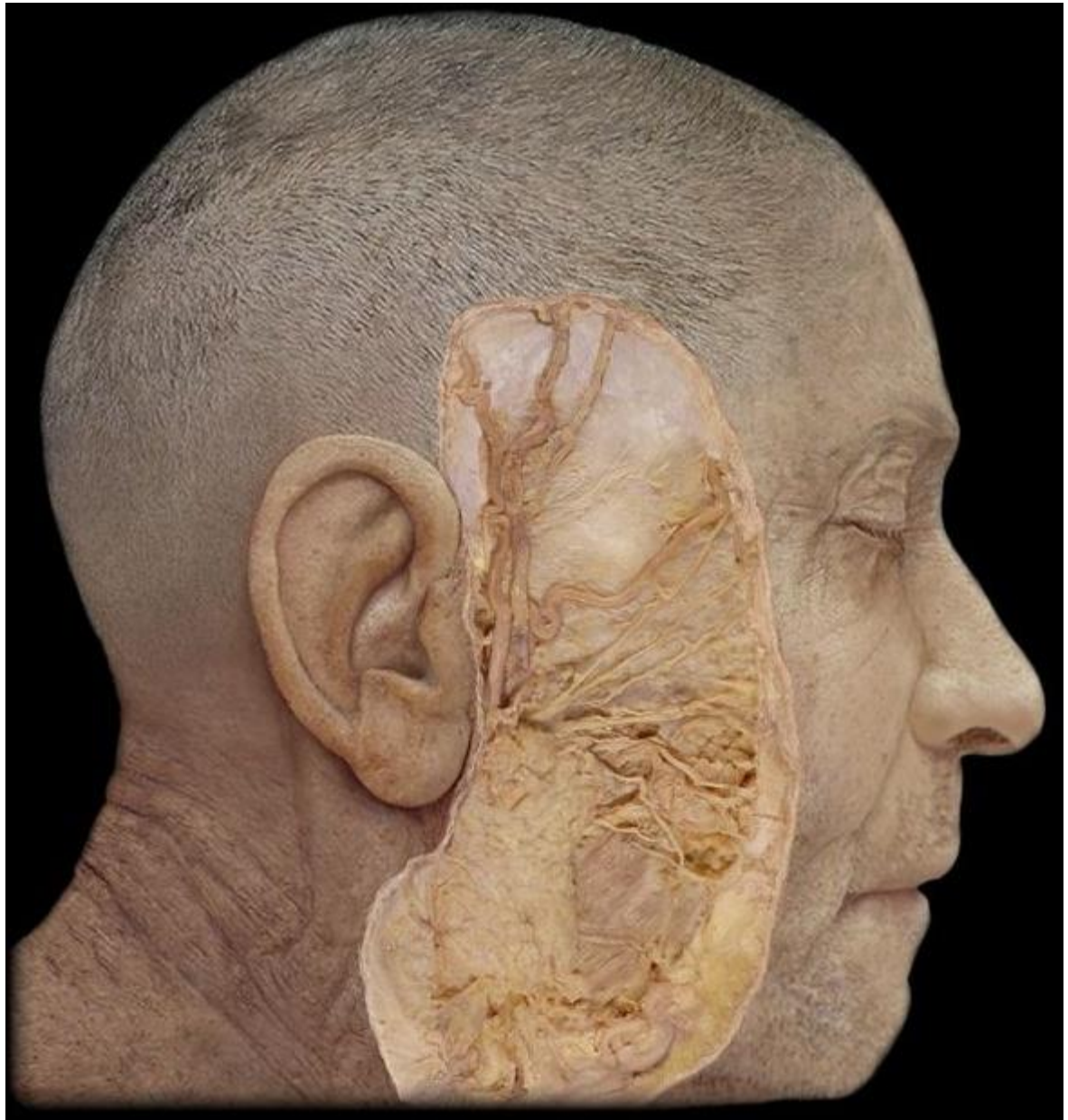
(c) Sagittal section

Figure 9.23

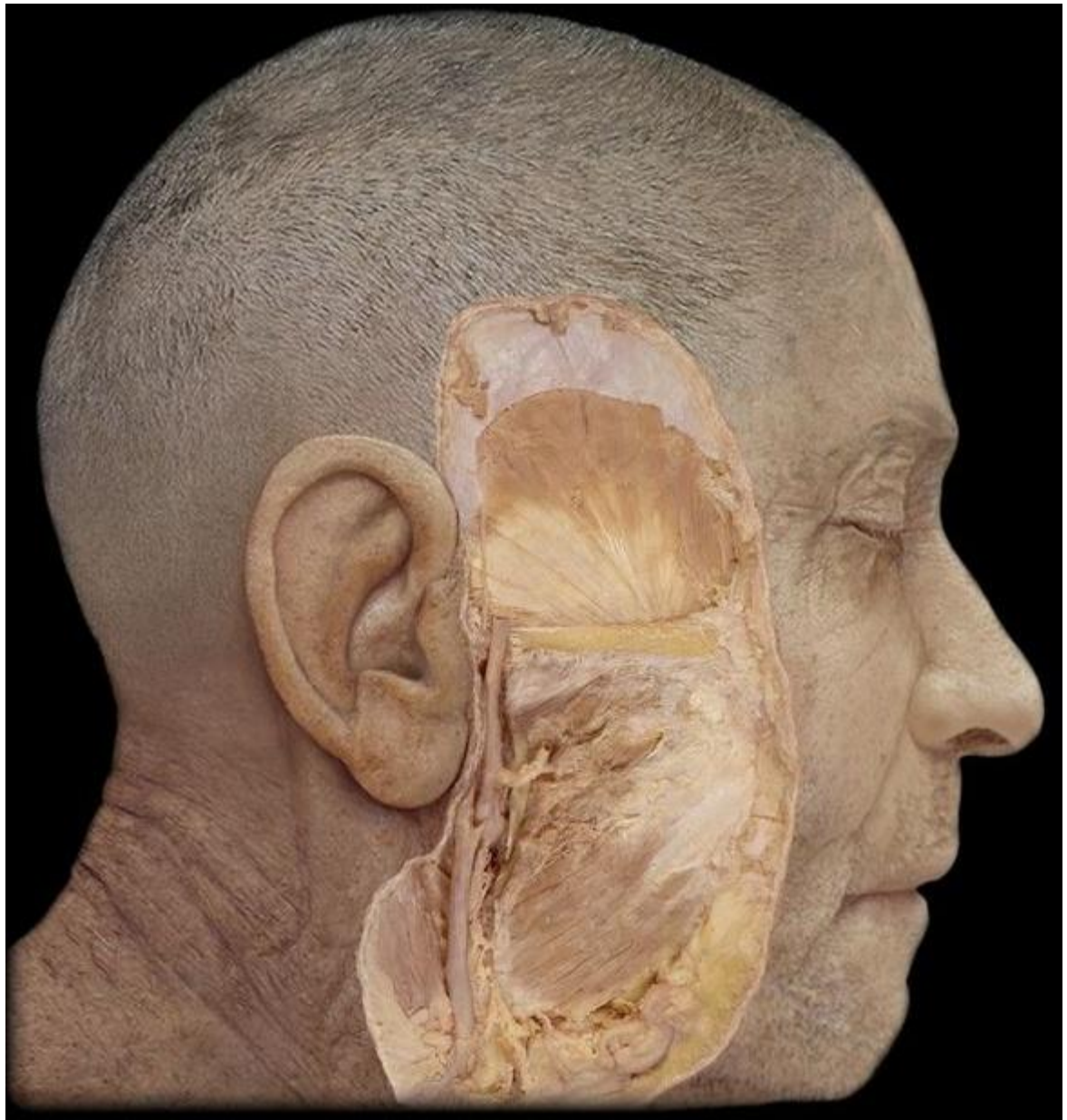
Temporomandibular Joint (TMJ)



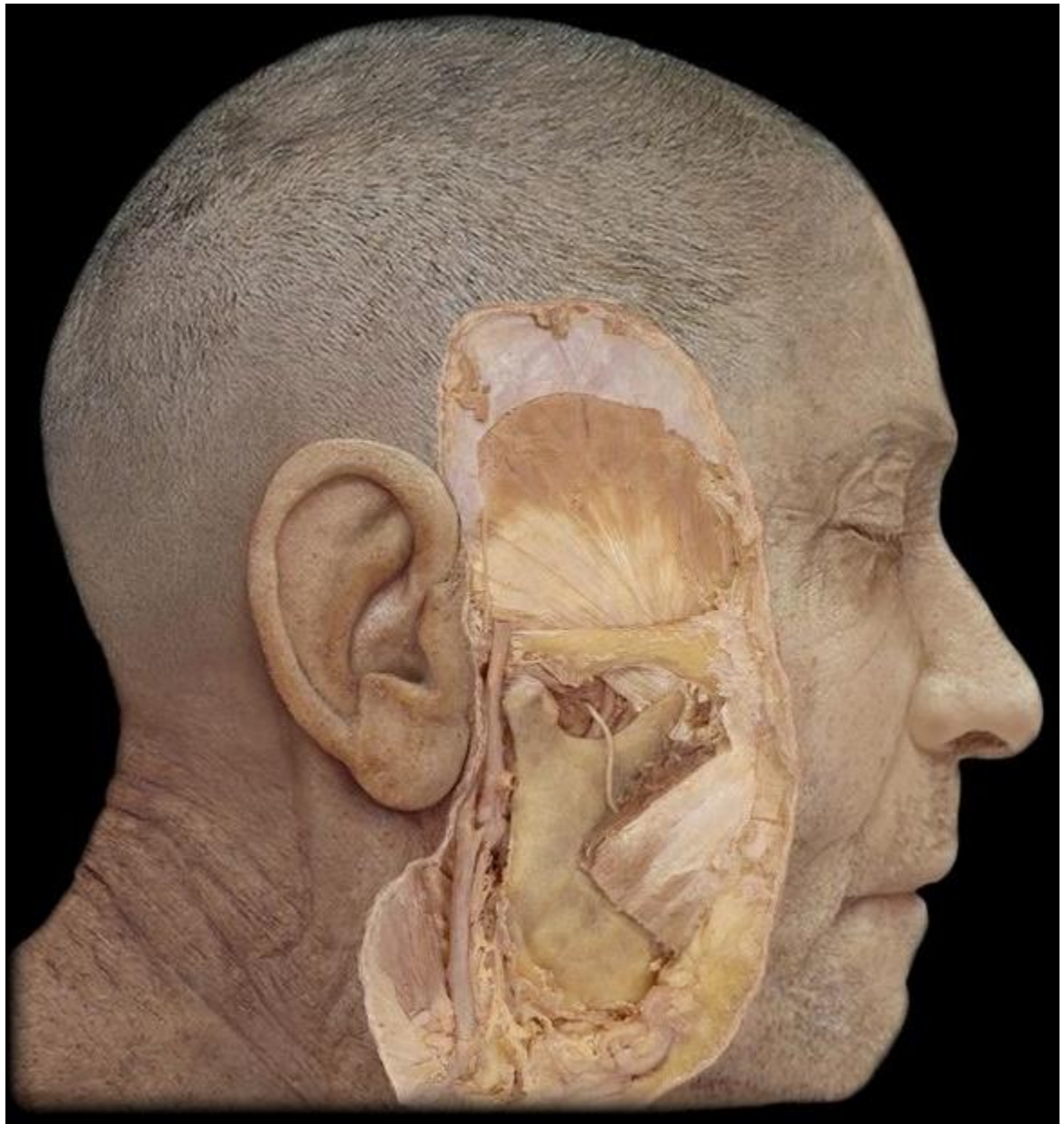
Temporomandibular Joint (TMJ)



Temporomandibular Joint (TMJ)

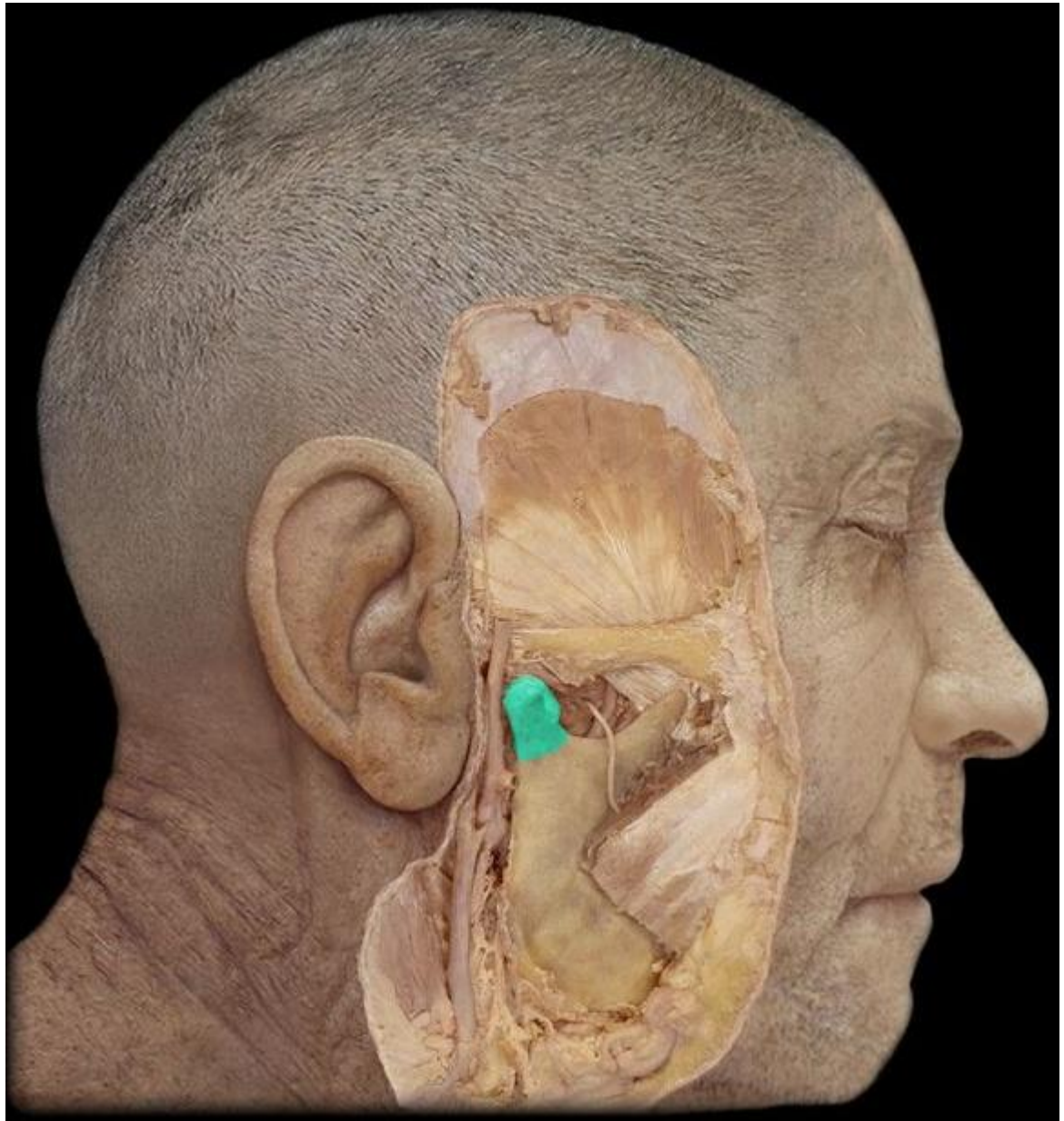


Temporomandibular Joint (TMJ)



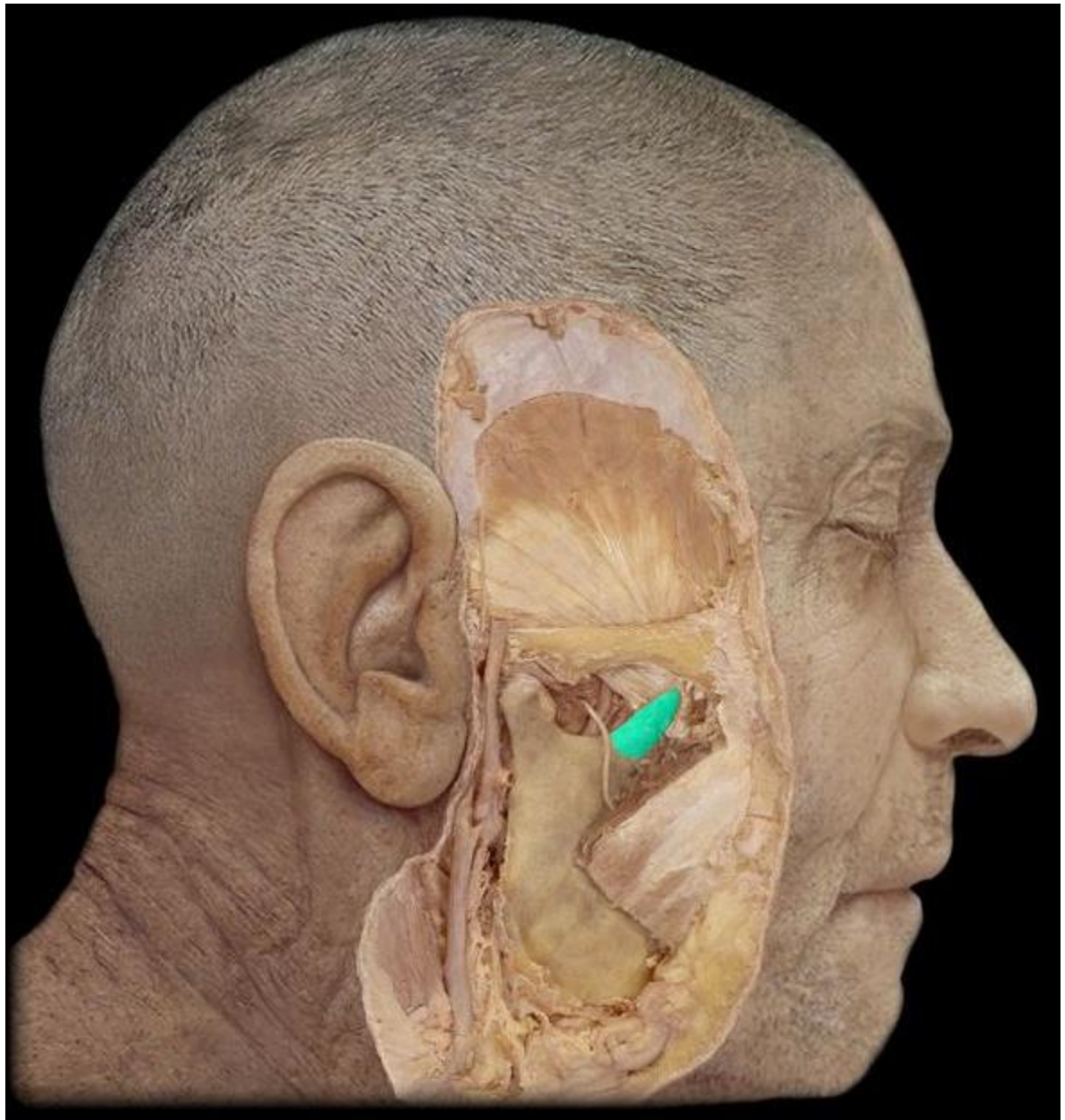
Temporomandibular Joint (TMJ)

Condylar Process of Mandible



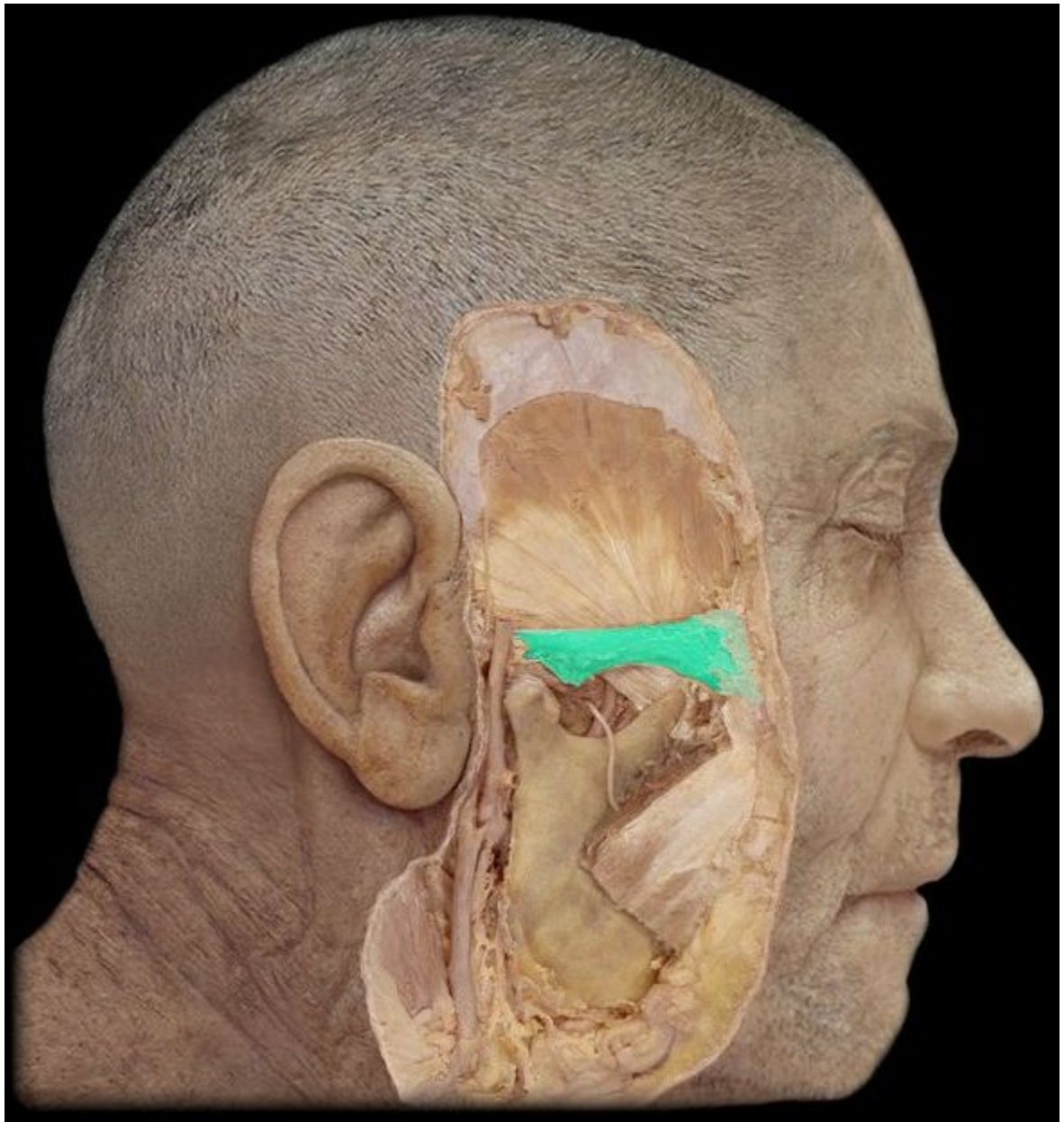
Temporomandibular Joint (TMJ)

Coronoid Process of Mandible



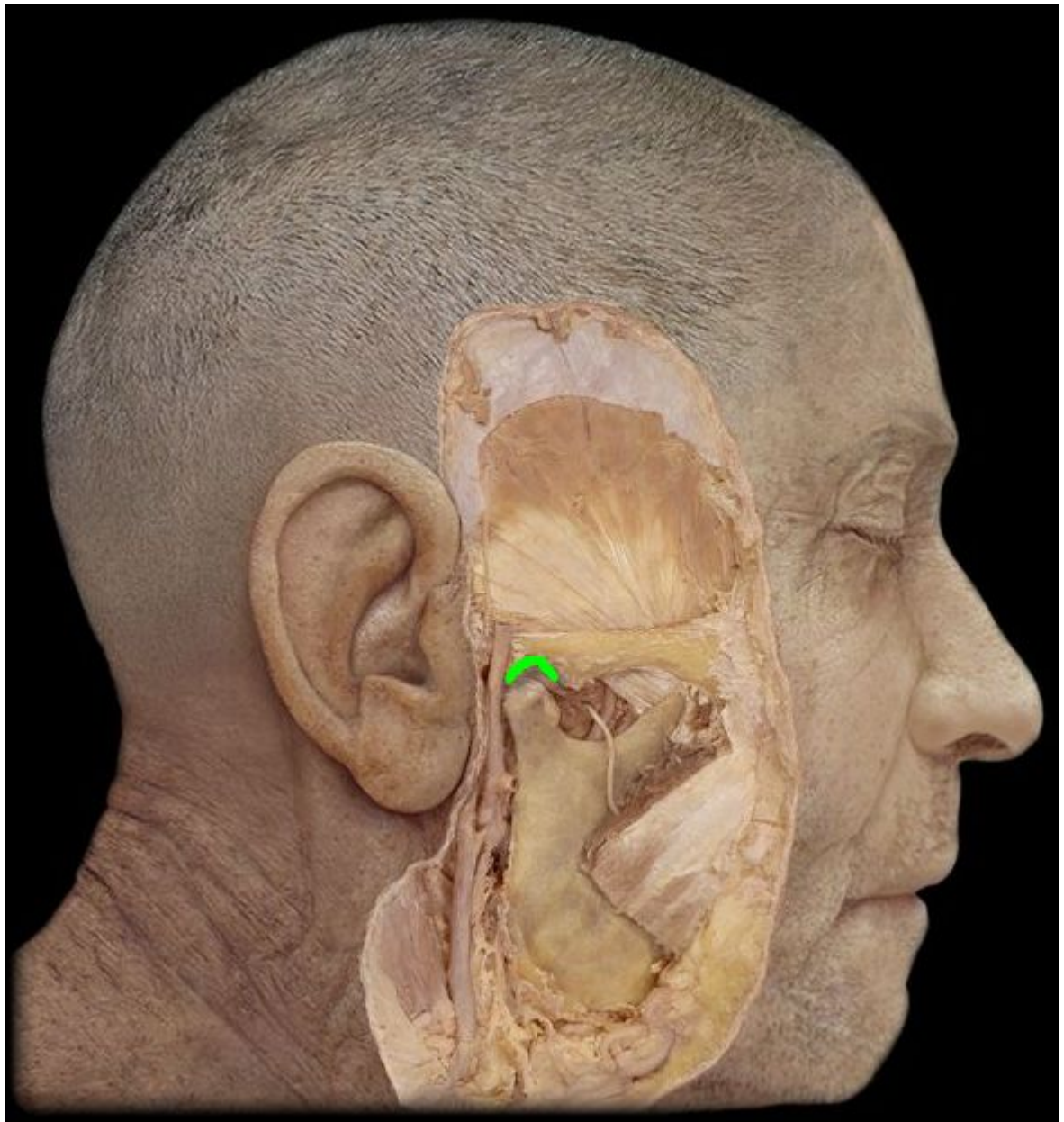
Temporomandibular Joint (TMJ)

Zygomatic Arch of Temporal Bone



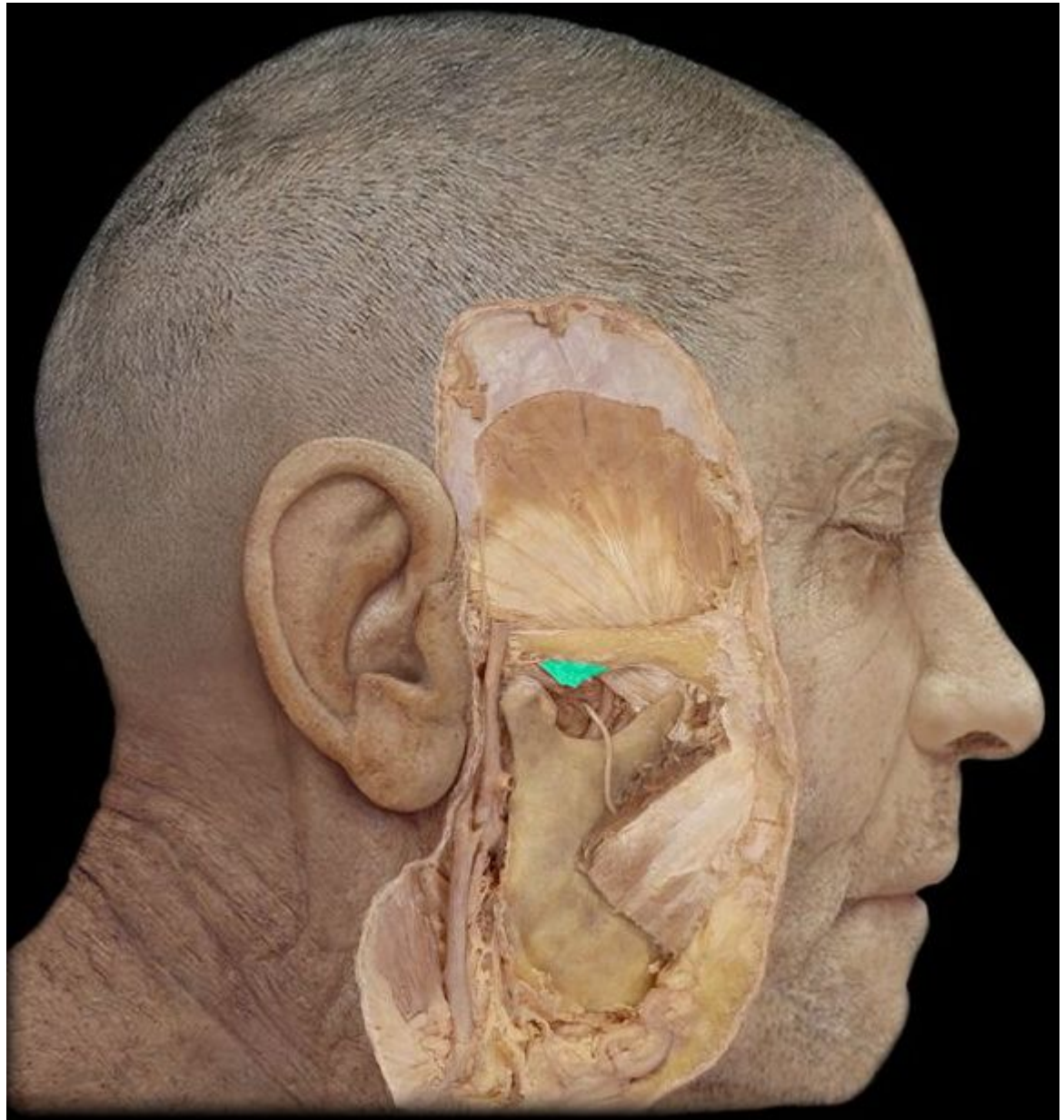
Temporomandibular Joint (TMJ)

Mandibular Fossa of Temporal Bone



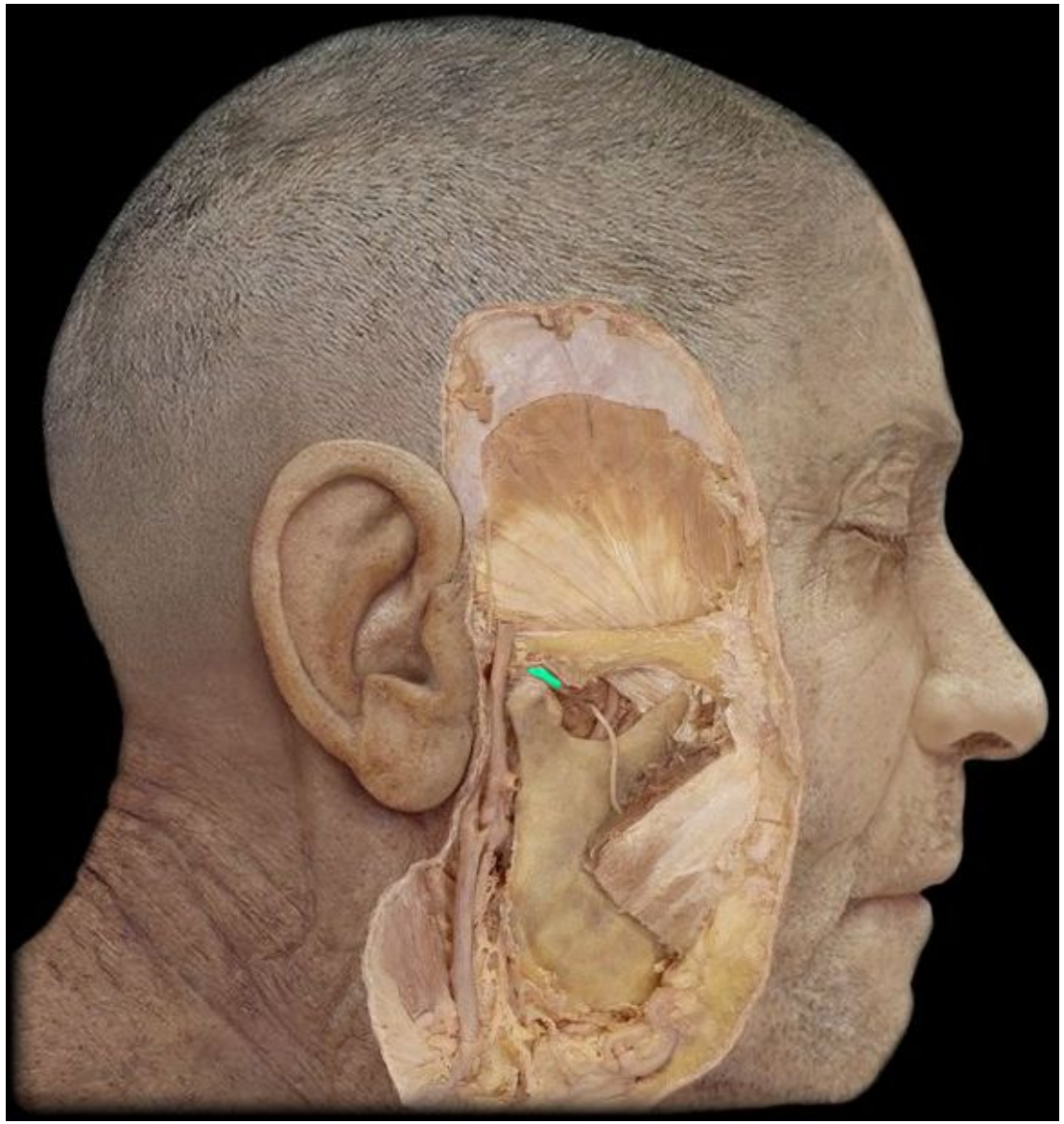
Temporomandibular Joint (TMJ)

Articular Tubercle of Temporomandibular Joint



Temporomandibular Joint (TMJ)

Articular Disc of Temporomandibular Joint



Temporomandibular Joint (TMJ)

Temporomandibular Joint (TMJ)

Opening of the mouth requires the combination of two motions at the temporomandibular joint, an anterior gliding motion of the articular disc and mandible and the downward hinging of the mandible. What is the initial movement of the mandible during opening and how much mouth opening does this produce?

The first motion is rotation (hinging) of the mandible, but this only produces about 20 mm (0.78 in) of mouth opening.

DEEPER INSIGHT 9.1
CLINICAL APPLICATION

TMJ Syndrome

Temporomandibular joint (TMJ) syndrome affects as many as 75 million Americans. It can cause moderate intermittent facial pain, clicking sounds in the jaw, limitation of jaw movement, and in some people, more serious symptoms—severe headaches, vertigo (dizziness), tinnitus (ringing in the ears), and pain radiating from the jaw down the neck, shoulders, and back. It seems to be caused by a combination of psychological tension and malocclusion (misalignment of the teeth). Treatment may involve psychological management, physical therapy, analgesic and anti-inflammatory drugs, and sometimes corrective dental appliances to align the teeth properly.

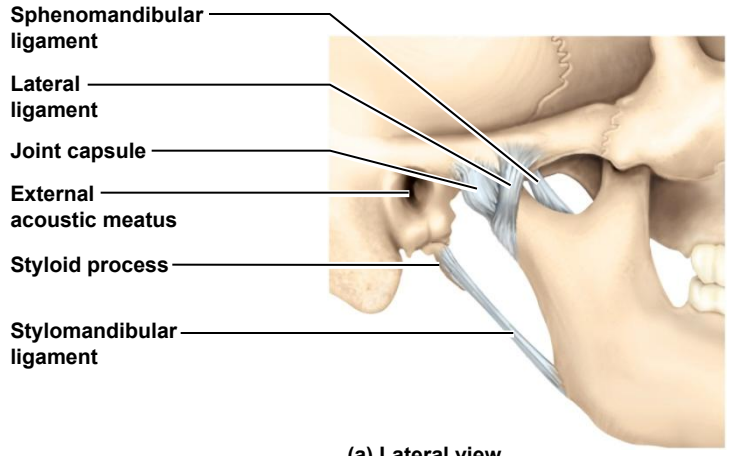
TMJ Syndrome

- temporomandibular joint (TMJ) syndrome
  - may affect as many as 75 million Americans

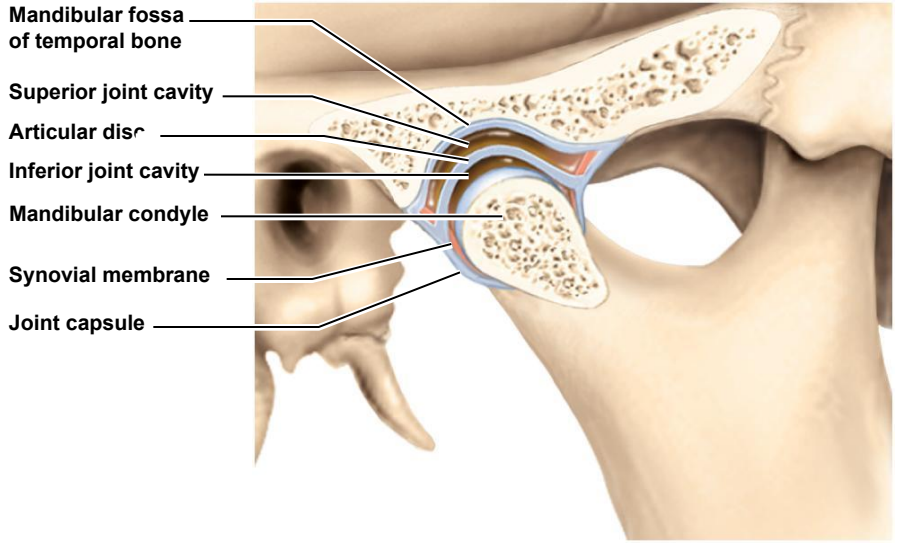
- signs and symptoms
  - can cause moderate intermittent facial pain
  - clicking sounds in the jaw
  - limitation of jaw movement
  - often severe headaches, vertigo (dizziness), tinnitus (ringing in the ears)
  - pain radiating from jaw down the neck, shoulders, and back

- 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



(a) Lateral view



(c) Sagittal section

Figure 9.23 a,c

Cartilaginous Joint - Symphysis

What movements are available at the shoulder joint ?What is the shape of the glenoid labrum in cross section, and what is the importance of this shape?

Cartilaginous Joint - Symphysis

The shoulder joint is a ball-and-socket joint that allows for flexion-extension, abduction-adduction, medial rotation, lateral rotation, and circumduction of the humerus.

The glenoid labrum is wedge-shaped in cross-section. This is important because it creates an elevated rim around the glenoid cavity, which creates a deeper socket for the head of the humerus to fit into.

The Shoulder Joint

- glenohumeral (humeroscapular) joint – the hemispherical head of the humerus articulates with the glenoid cavity of the scapula
  - the most freely movable joint in the body
  - shallow glenoid cavity and loose shoulder joint capsule sacrifice joint stability for freedom of movement
  - glenoid labrum – fibrocartilage ring that deepens glenoid cavity

- shoulder supported by **biceps brachii** tendon anteriorly and also the **rotator cuff** tendons
  - tendons fuse to joint capsule and strengthens it
  - supraspinatus, infraspinatus, teres minor and subscapularis

- 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

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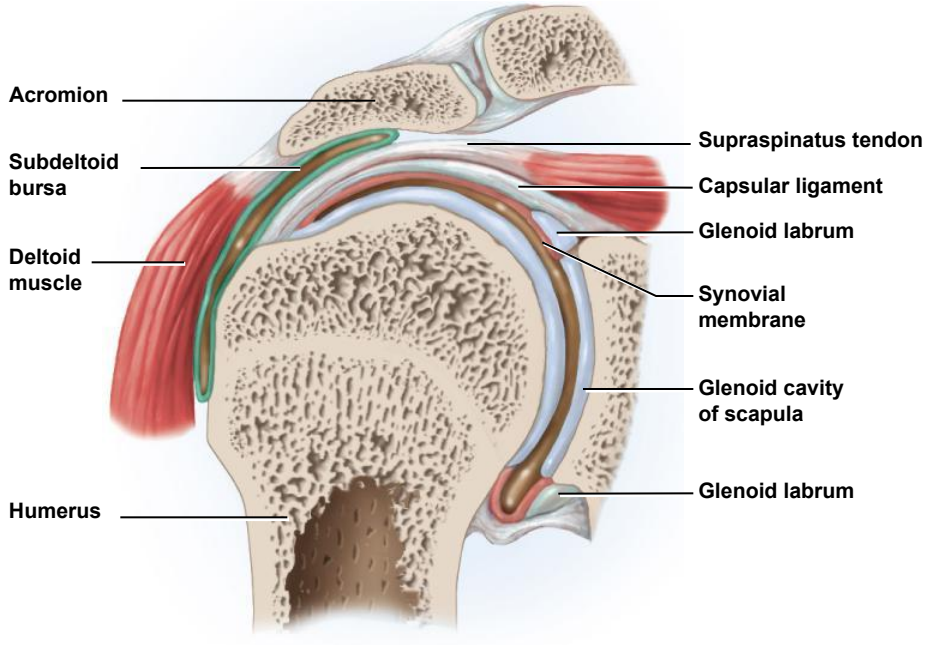
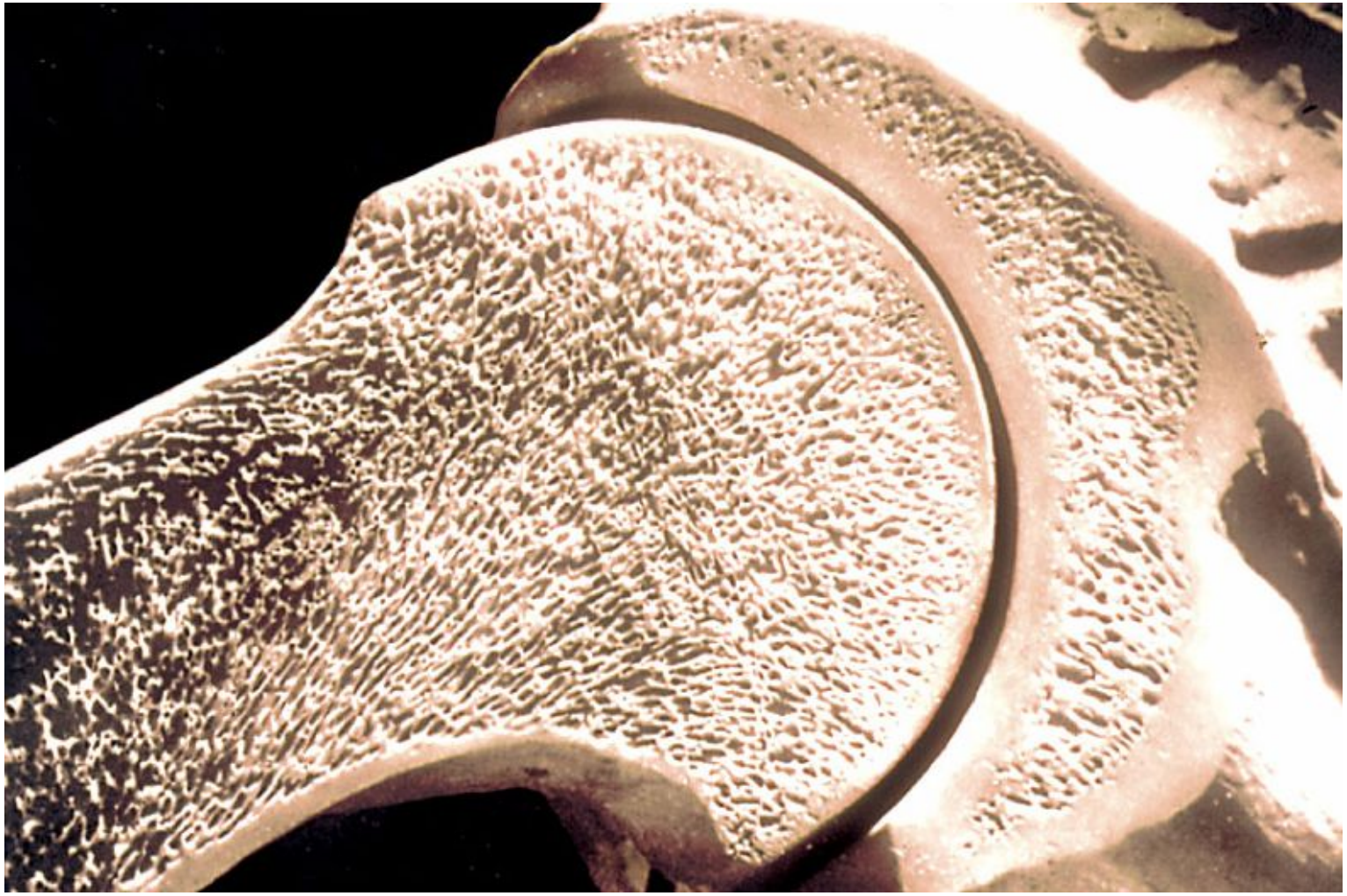
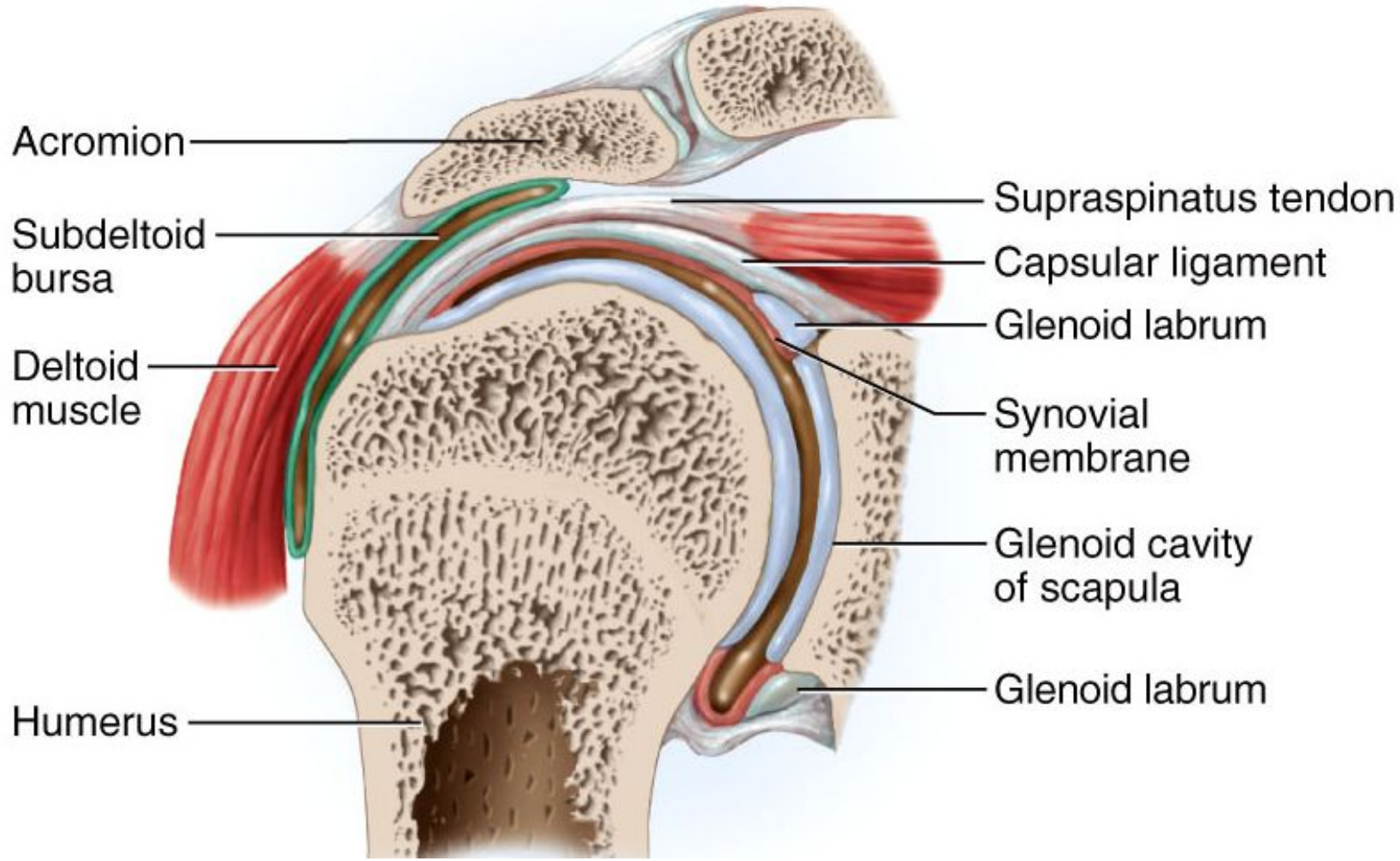


(c) Frontal section

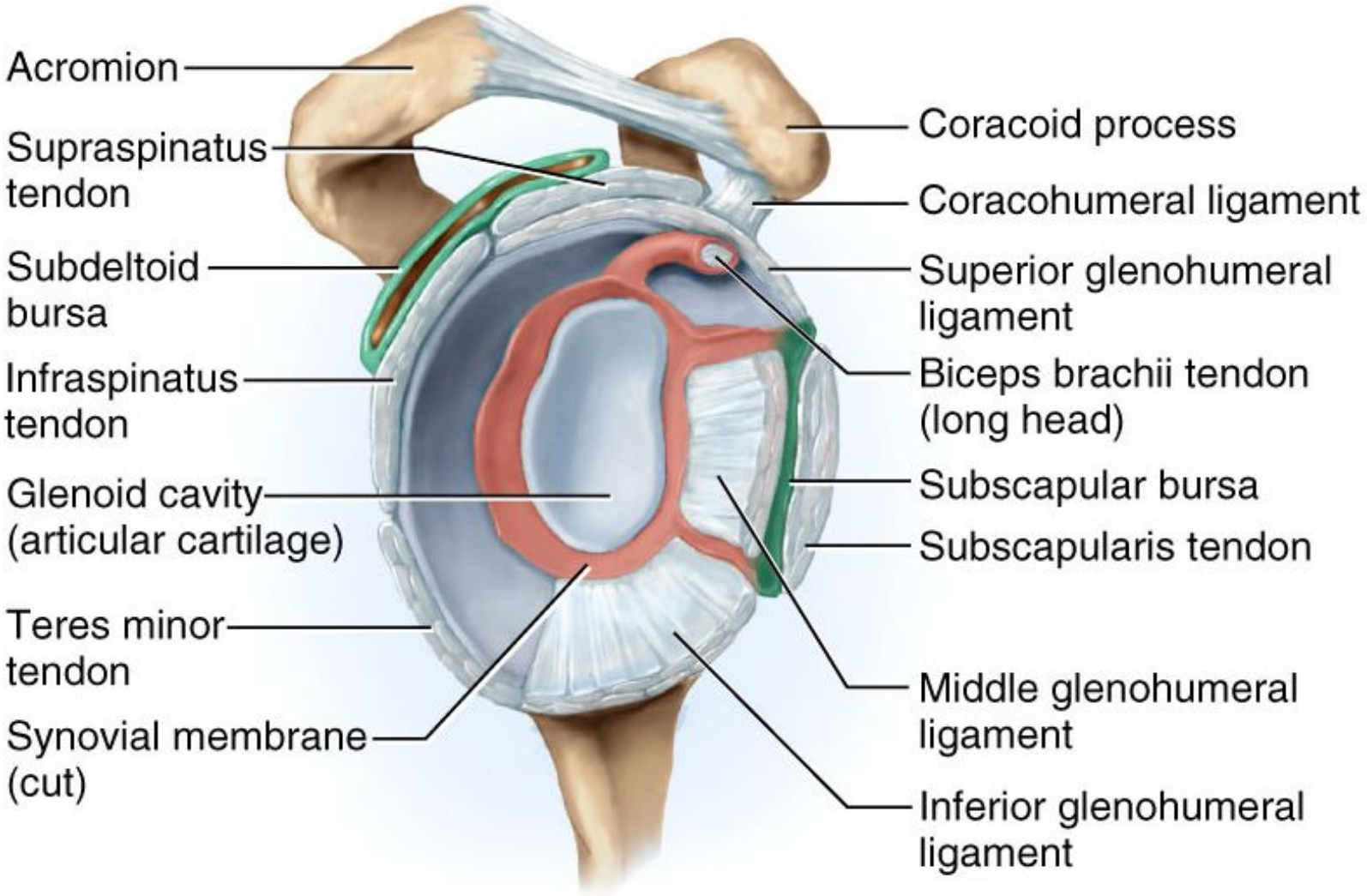
Humeroscapular (shoulder) Joint

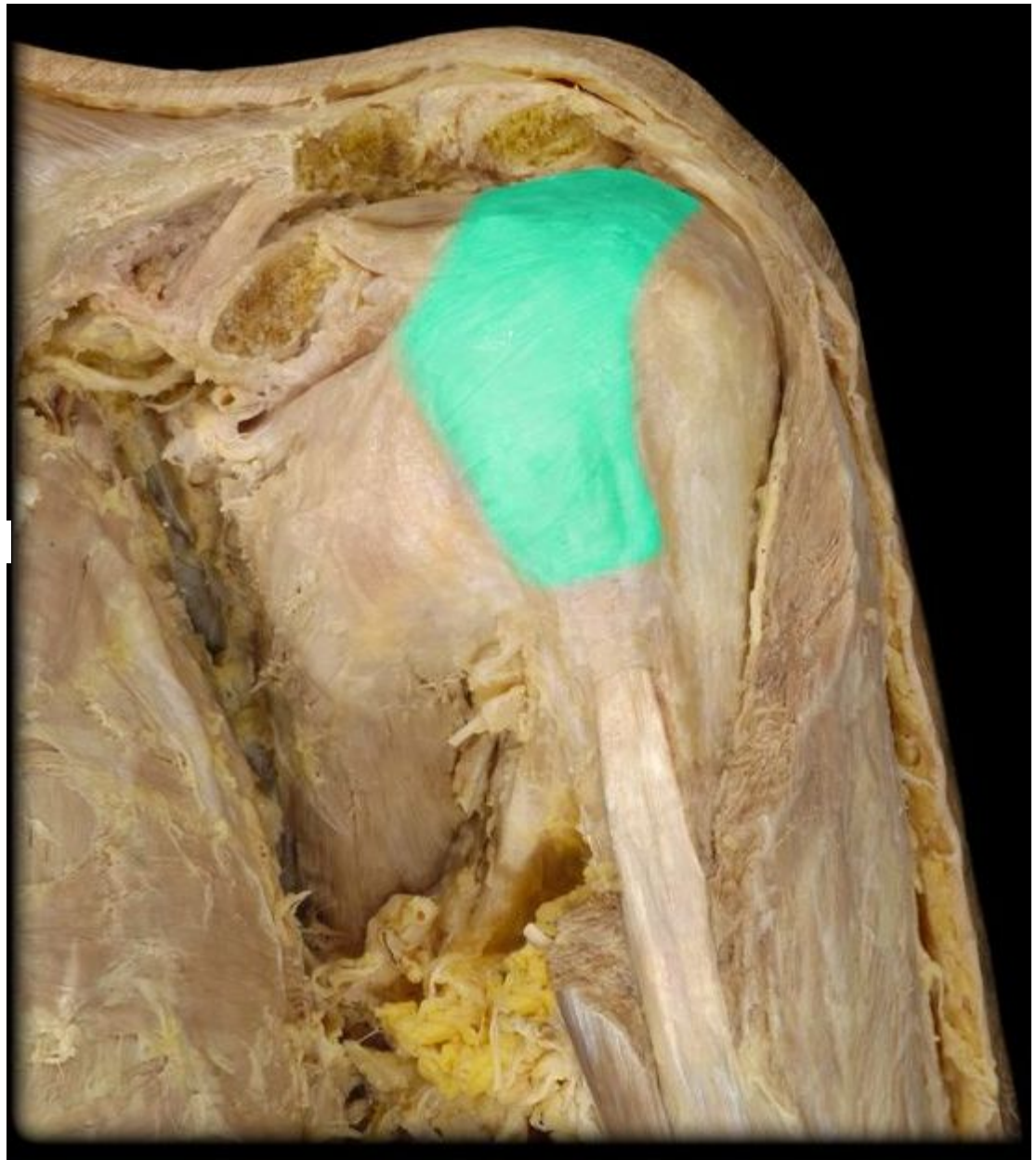


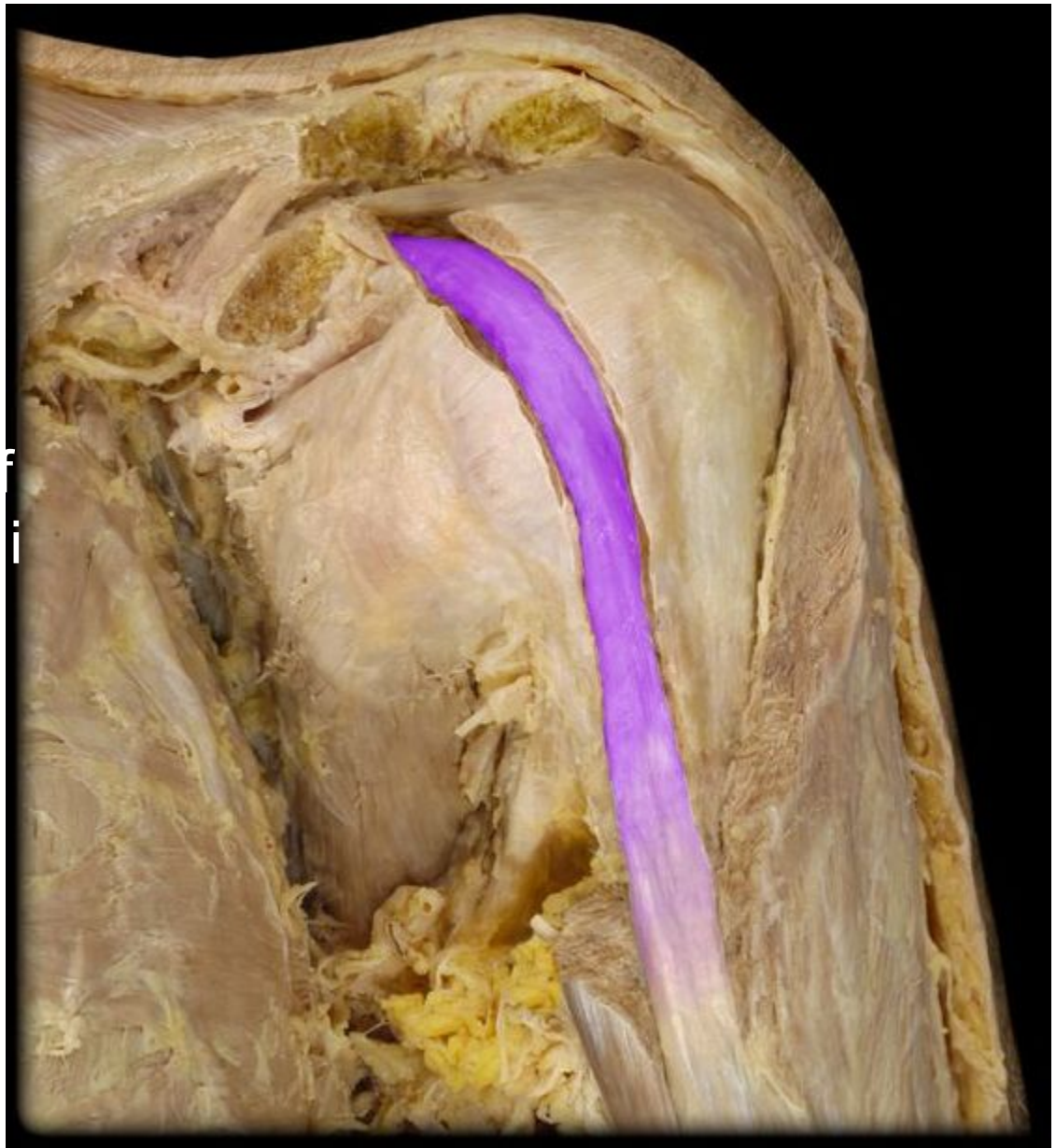
Humeroscapular (shoulder) Joint

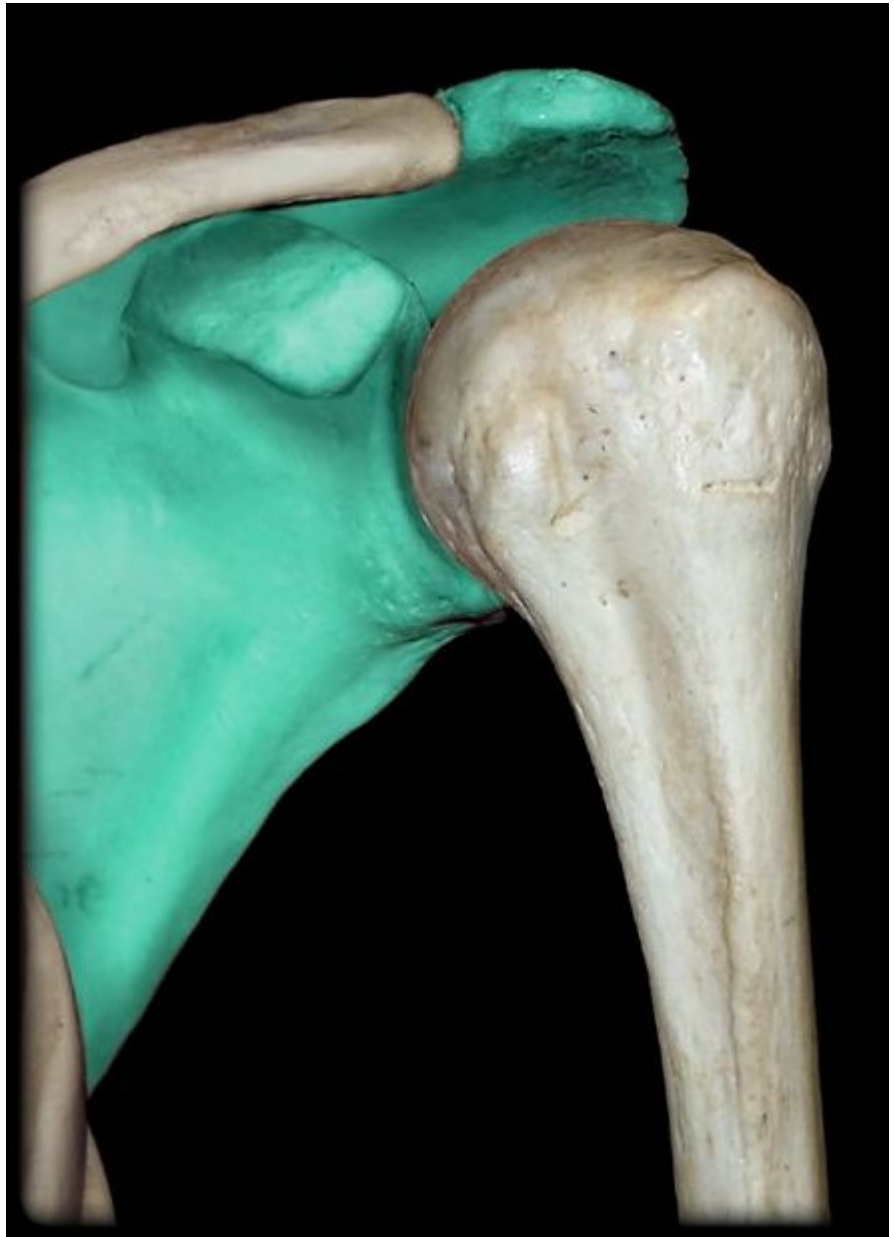


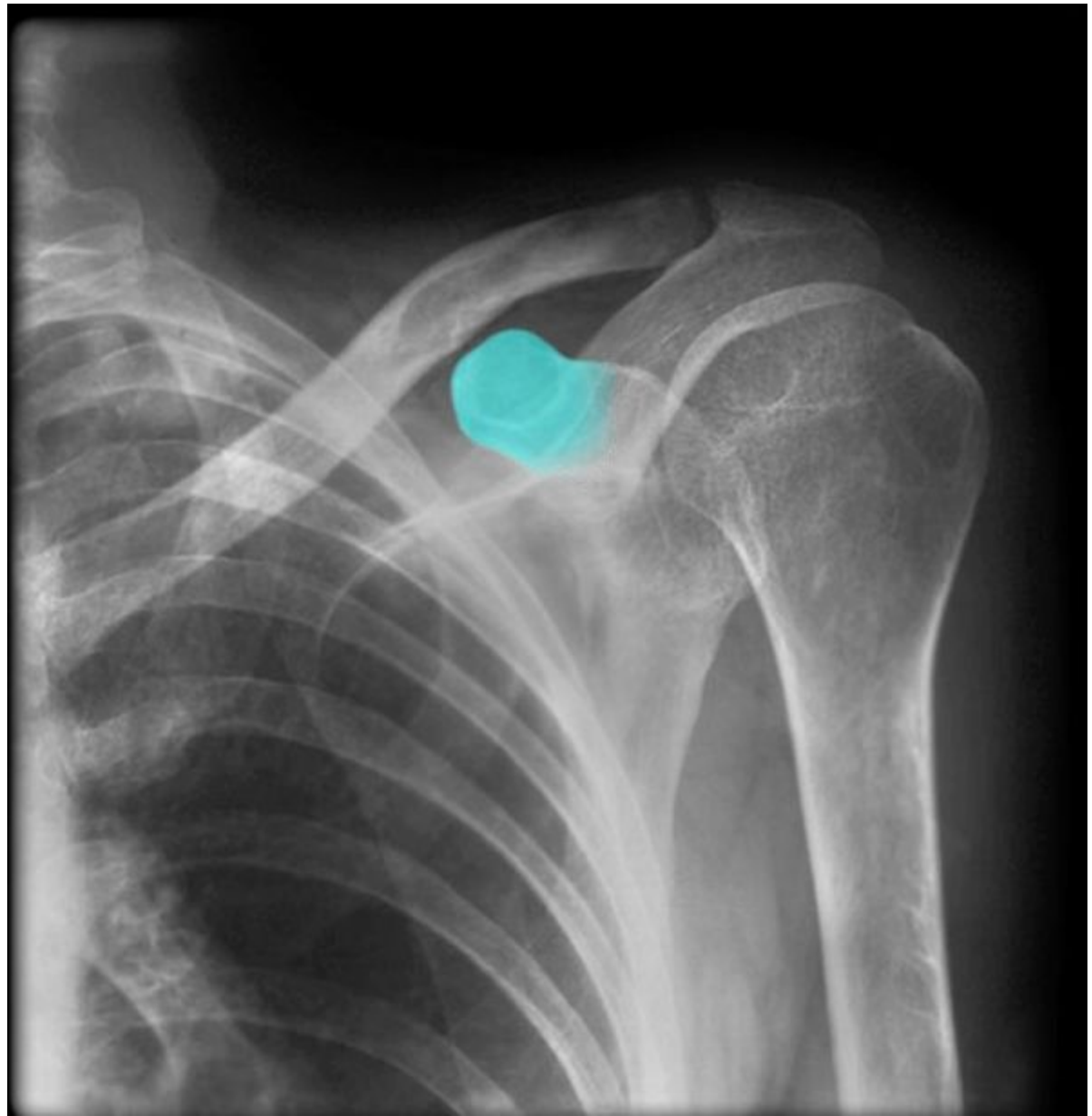
Humeroscapular (shoulder) Joint
Glenoid Labrum

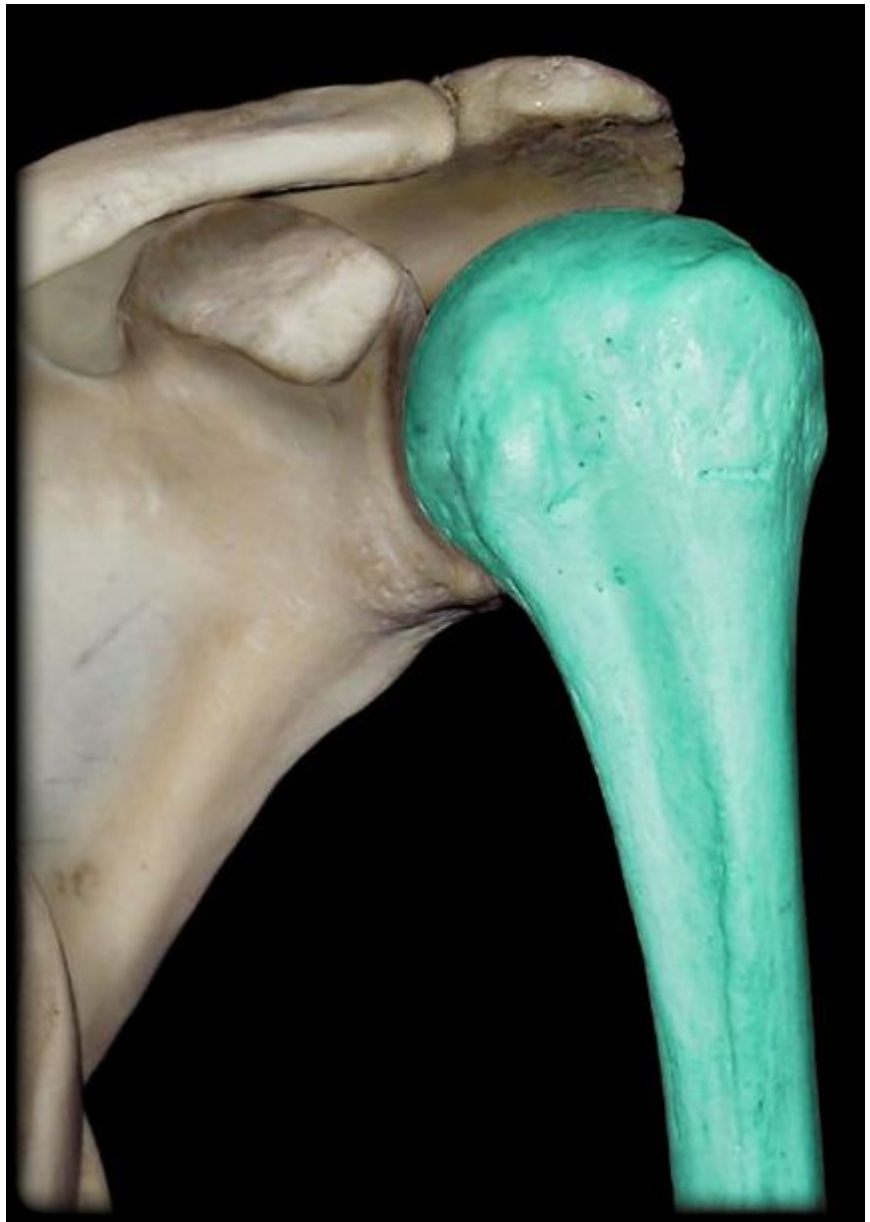


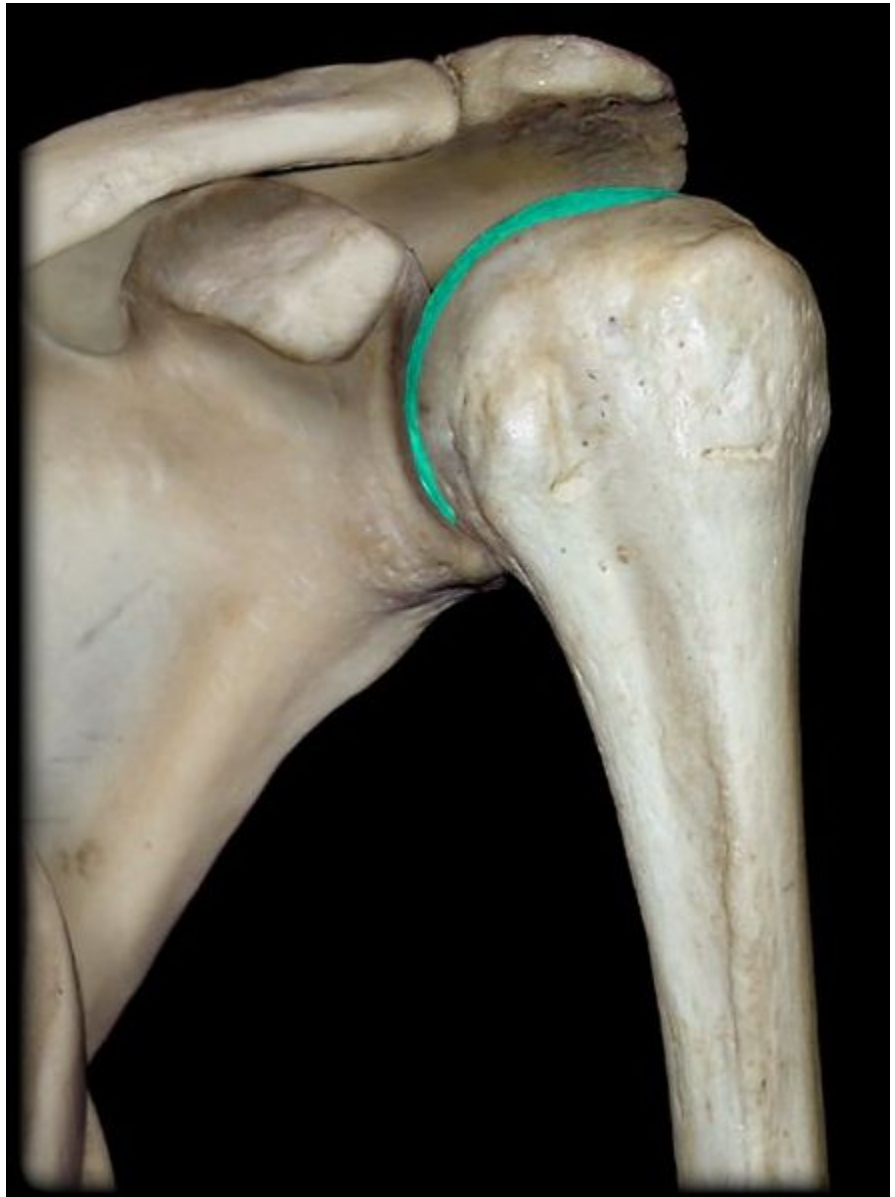






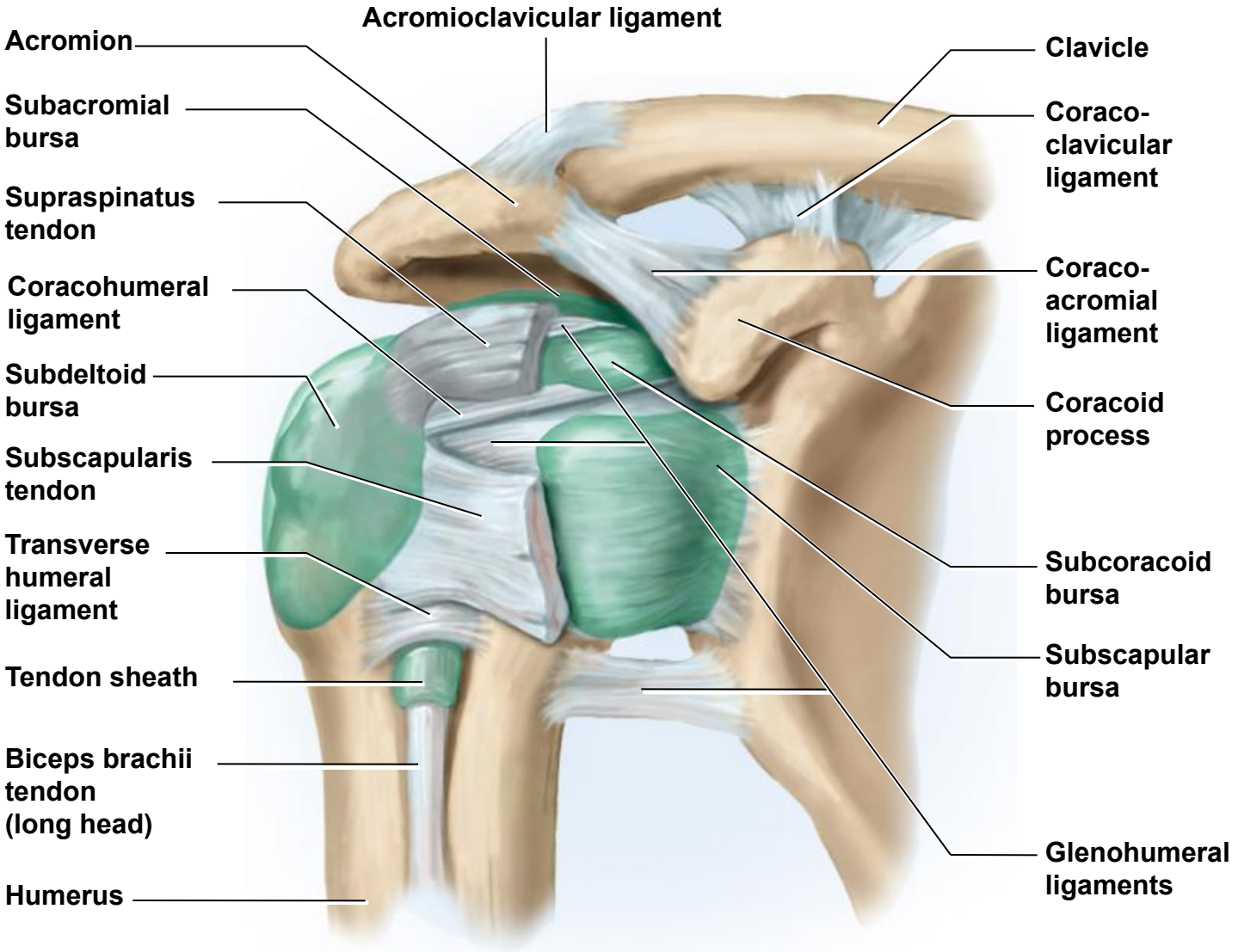







Glen

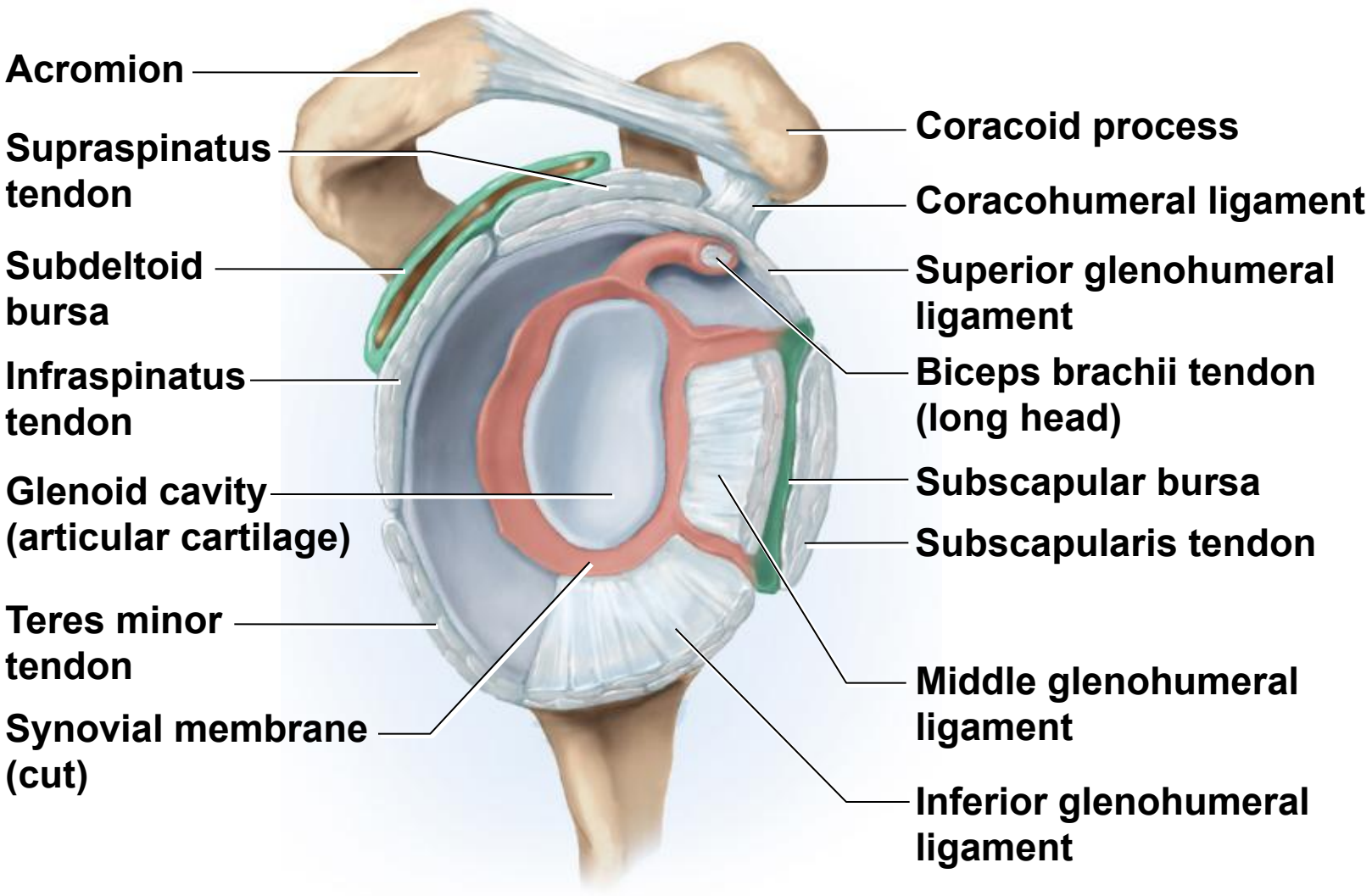
Stabilizers of the Shoulder Joint



(b) Anterior view

Figure 9.24b

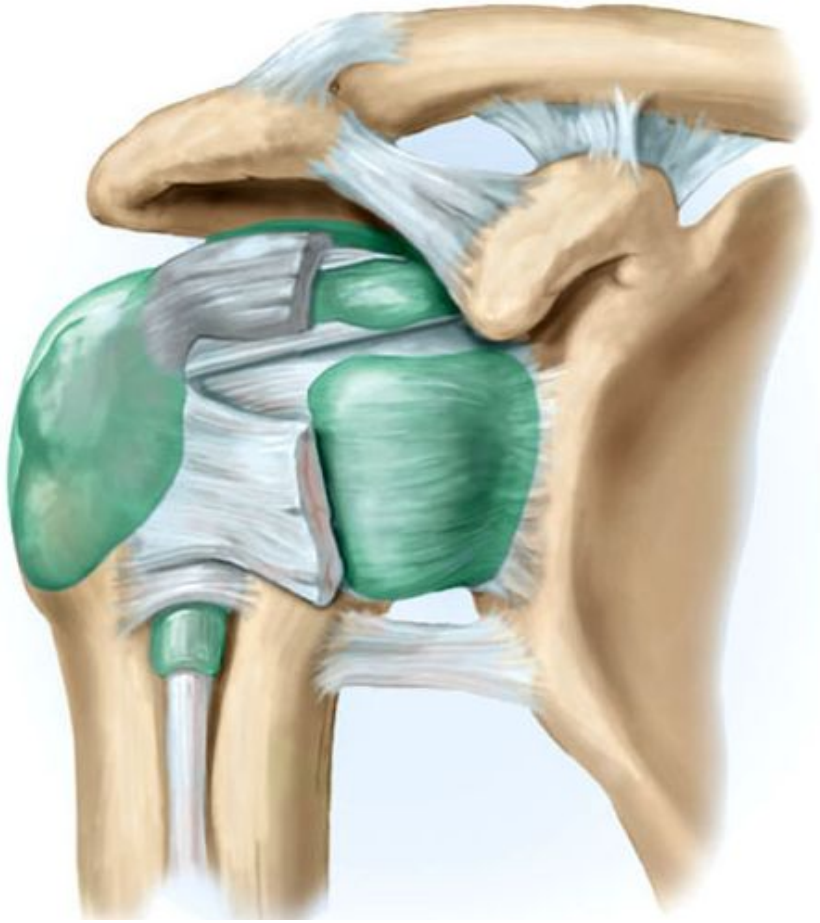
Tendons of Rotator Cuff Muscles



(d) Lateral view , humerus removed

Figure 9.24d

Humeroscapular (shoulder) Joint



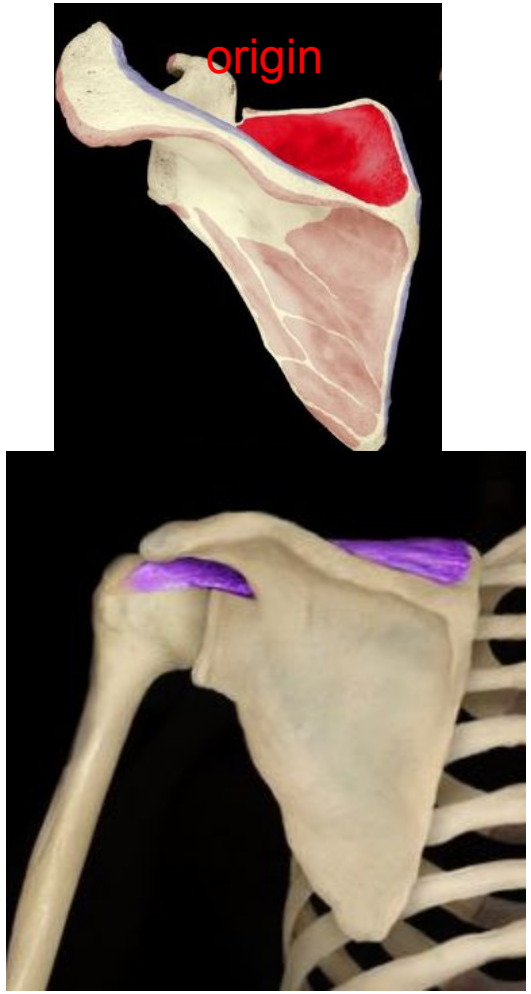
Rotator Cuff

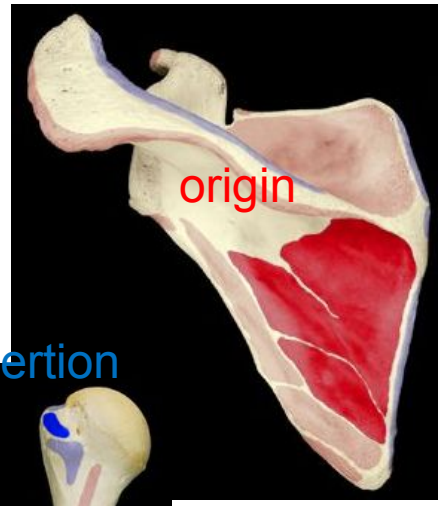
"SITS' muscles

- supraspinatus
- infraspinatus
- teres minor
- subscapularis

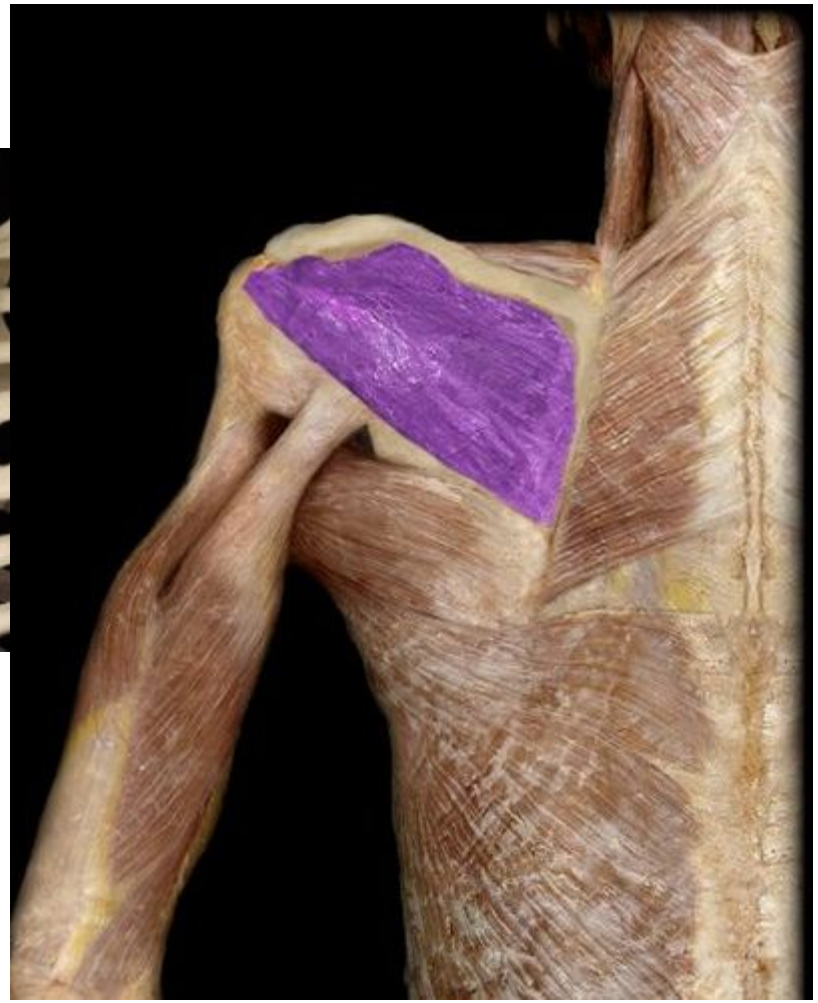
insertion

origin





insertion



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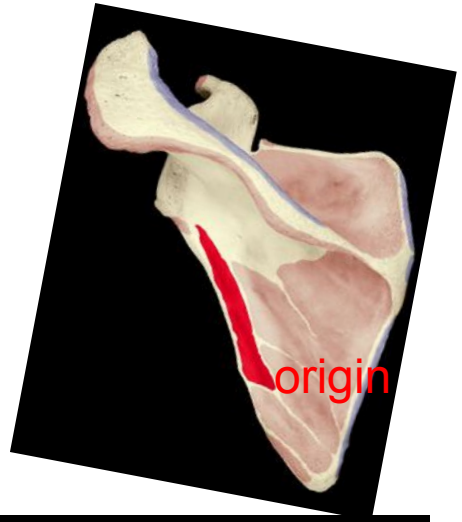


origin


origin


insertion

Shoulder

DEEPER INSIGHT 9.1

CLINICAL APPLICATION

Shoulder Dislocation

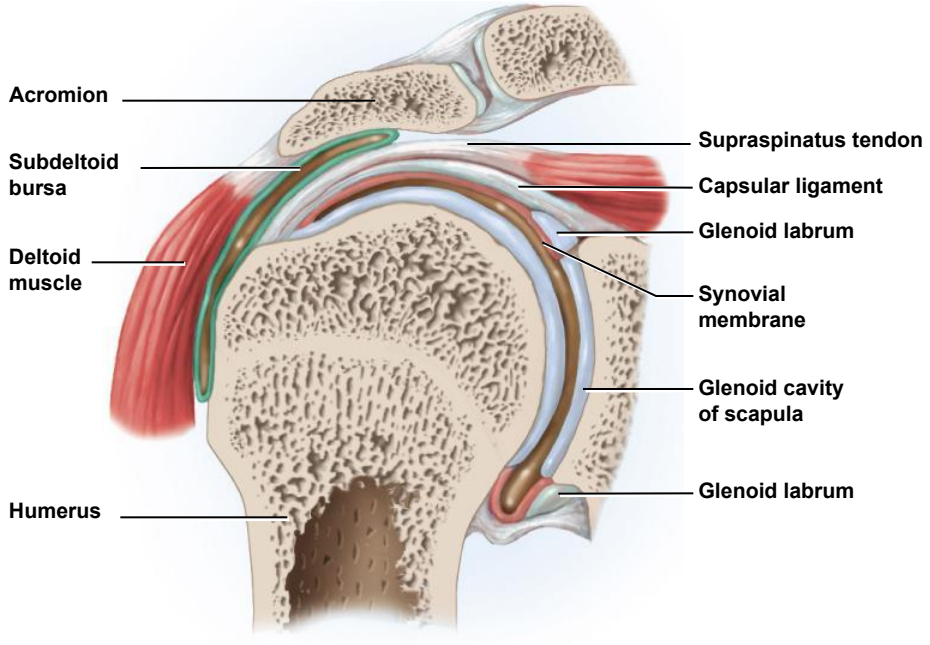
The anatomy and mobility of the shoulder joint make it especially susceptible to dislocation. Over 95% of cases are classified as *anterior dislocation* (displacement of the humeral head in the anterior direction). Such dislocations are usually caused when the arm is abducted and receives a blow from above—for example, by heavy objects falling from a shelf. A complex of nerves and blood vessels traverses the axillary region, and shoulder dislocation can easily damage the axillary nerve or artery (see figs. 13.16 and 20.35). Left untreated, this can lead to muscle atrophy, weakness, or paralysis. Greek physician Hippocrates taught students to treat shoulder dislocation by placing a heel in the patient's axilla and pulling on the arm, but this can cause even worse nerve damage and is never done anymore by professionals. Because the shoulder is so easily dislocated, one also should never attempt to move an unconscious or immobilized person by pulling on his or her arm.

Shoulder Dislocation

- very painful and sometimes cause 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



(c) Frontal section

Figure 9.24c

Dissection of Shoulder Joint

Anatomy & Physiology: The Unity of Form and Function McGraw-Hill Education; 8th Edition

Figure 9.24a

(a) Anterior dissection