The Upper Limb: Osteology

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Introduction

- The **bones of the upper limb** can be divided into four main groups:
    i. the shoulder girdle
    ii. arm
    iii. forearm and
    iv. hand
- In contrast to the lower limb (which is involved in weight-bearing and locomotion), the main role of the upper limb is to control the position of the hand in space – enabling manipulation of objects in the environment.

Bones of the Upper Limb

32 bones in all

Shoulder Girdle -

- Clavicle (Collar Bone)
- Scapula (Shoulder Blade)

Arm

- Humerus

Forearm

- Radius (Lateral bone of forearm)
- Ulna (Medial bone of forearm)

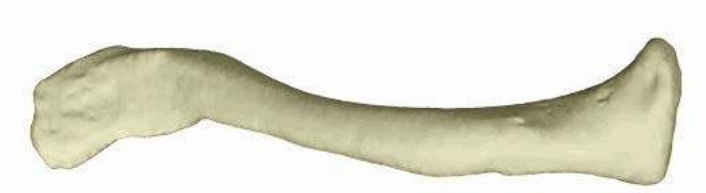
Hand

- Carpal Bones (8)
- Metacarpals (5)
- Phalanges (14)

BONES OF THE SHOULDER GIRDLE

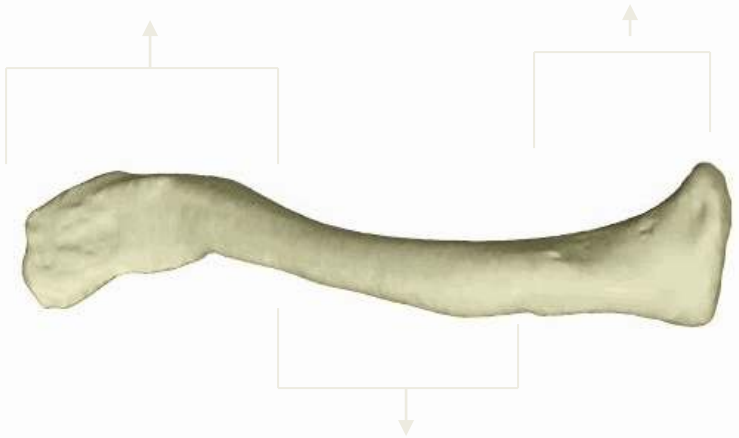
CLAVICLE

- Longest *horizontal* bone in the body.
- Anterior to the root of neck.
- “S” shaped bone
- subcutaneous throughout its length.
- 1st bone to ossify (5-6th week of fetal life)



- FUNCTIONS :-
- Attaches the upper limb to the trunk as part of the shoulder girdle
- Transmit weight of upper limb to the trunk
- Protects the underline neurovascular structures

CLAVICLE



- **PARTS :-**

1. SHAFT

a) Lateral 1/3 (Flattened)

b) Medial 2/3 (cylindrical shape)

2. ACROMIAL END

Flattened with small oval facet

Articulates with acromion process of scapula (Acromioclavicular joint)

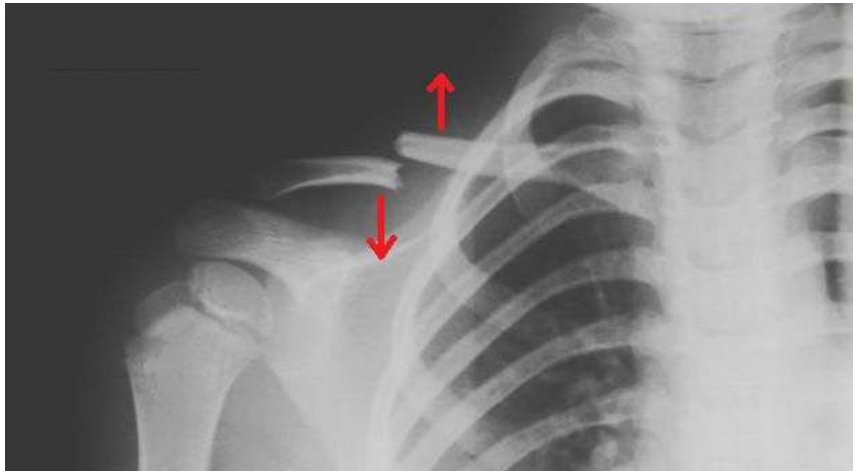
3. STERNAL END

Quadrangular and expanded, upper part rough

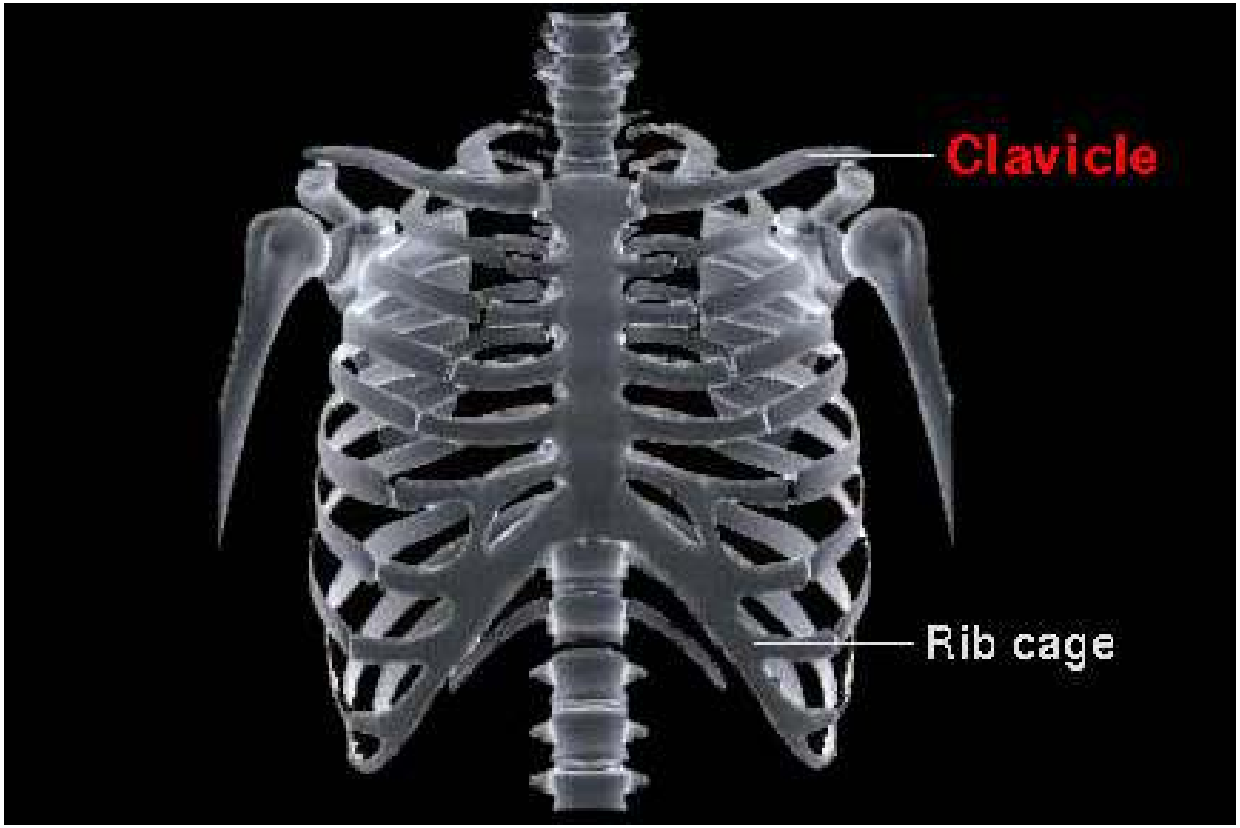
Articulates with manubrium sterni (Sternoclavicular joint)

Clavicle: Clinical Relevance

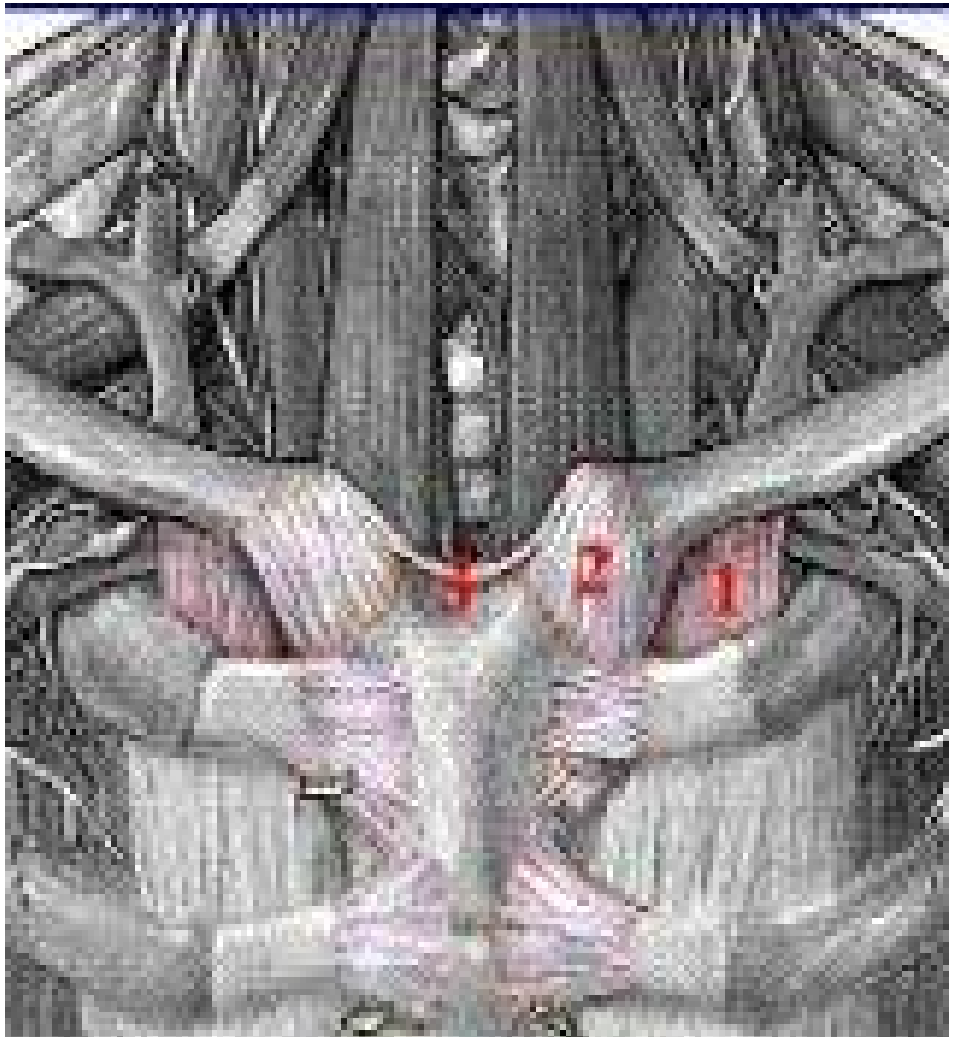
- Fractures are the most common clinical presentation of the clavicle
- This is because:
  - The clavicle acts to **transmit forces** from the upper limb to the axial skeleton.
  - It is relatively small size
- 15% of fractures occur in the lateral third
- 80% occur in the middle third
- 5% occur in the medial third.



Clavicle

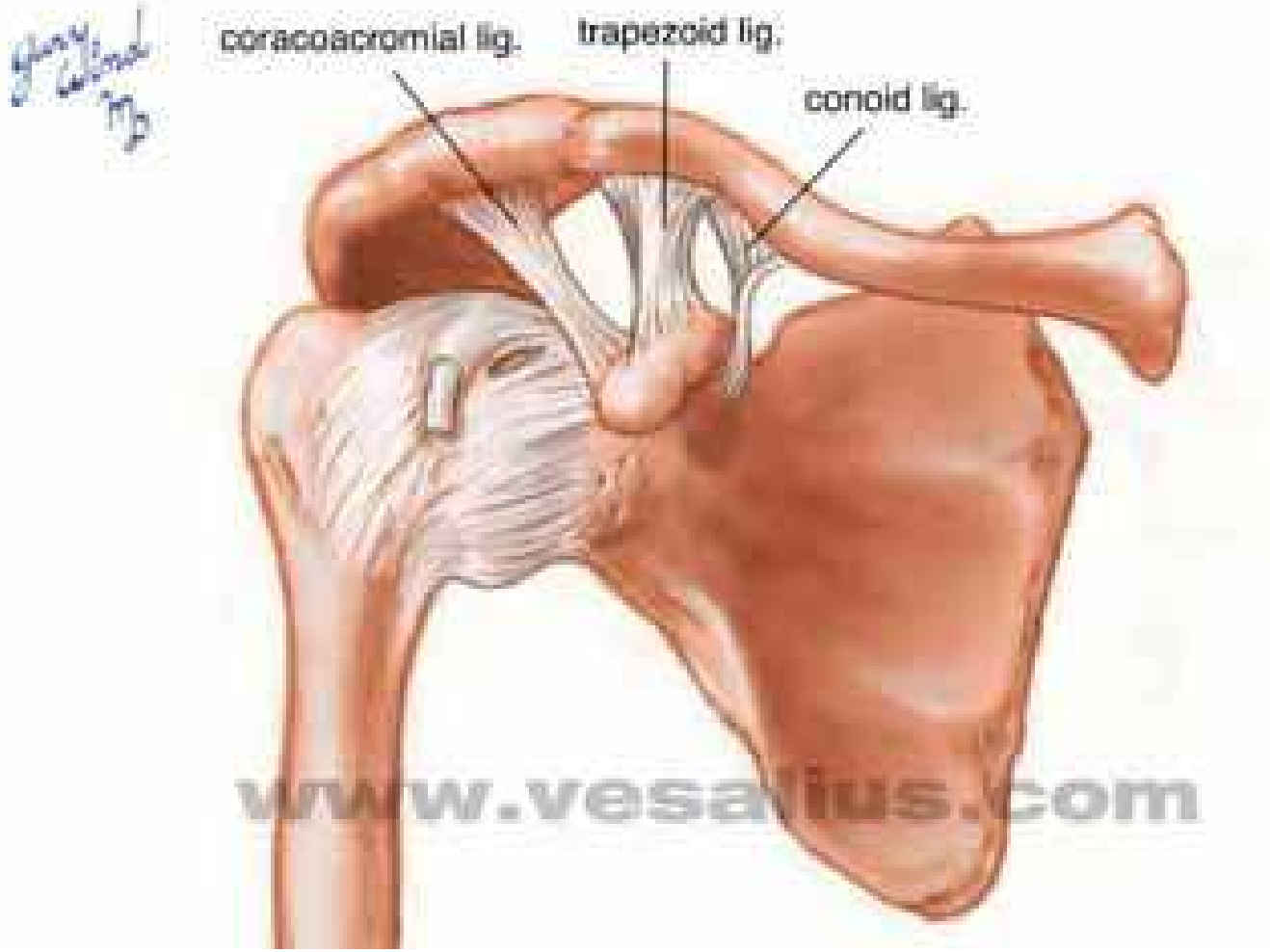


Sternoclavicular Joint (SC)



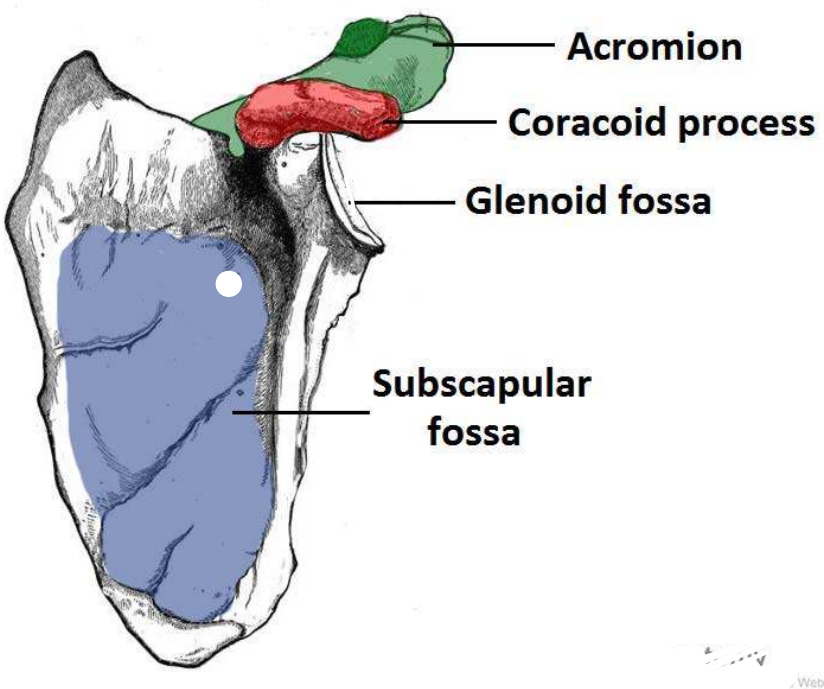
1= Costoclavicular ligament
2= Anterior sternoclavicular ligament
3= Interclavicular ligament

Acromioclavicular Joint (AC)

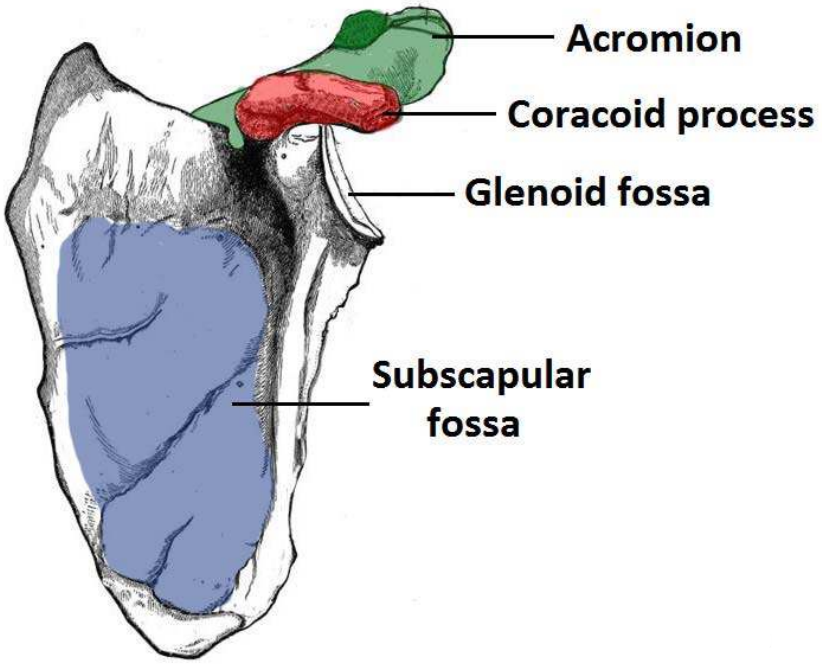


Scapula

- Also known as the shoulder blade.
- It articulates with:
  I. the humerus at the **glenohumeral** joint
  II. the clavicle at the **acromioclavicular** joint.
- In doing so, the scapula connects the upper limb to the trunk
- It serves as a site for attachment for seventeen muscles



SCAPULA



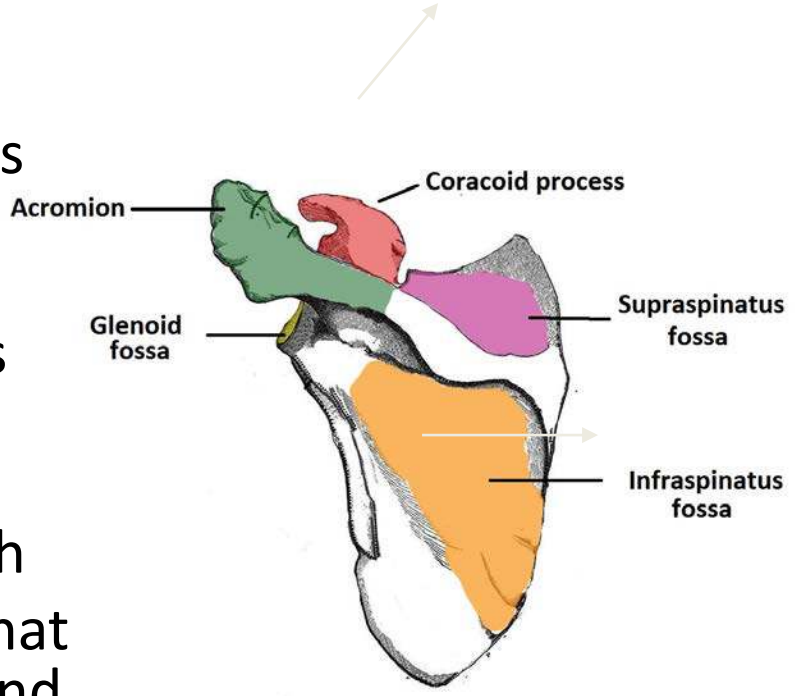
Surfaces : Three surfaces

1. COSTAL SURFACE:

- Costal because it faces the ribs
- Faces forward and medially
- Largely made of a concave and hollow part
- This concave and hollow part is called the **subscapular fossa**
- The subscapularis (rotator cuff muscle) originates from this fossa.
- **Coracoid process:**
  - originates from the superolateral surface of the costal scapula
  - Hook-like projection, which lies just underneath the clavicle.
  - The pectoralis minor attaches here
  - The coracobrachialis and biceps brachii (short head) muscles originates here

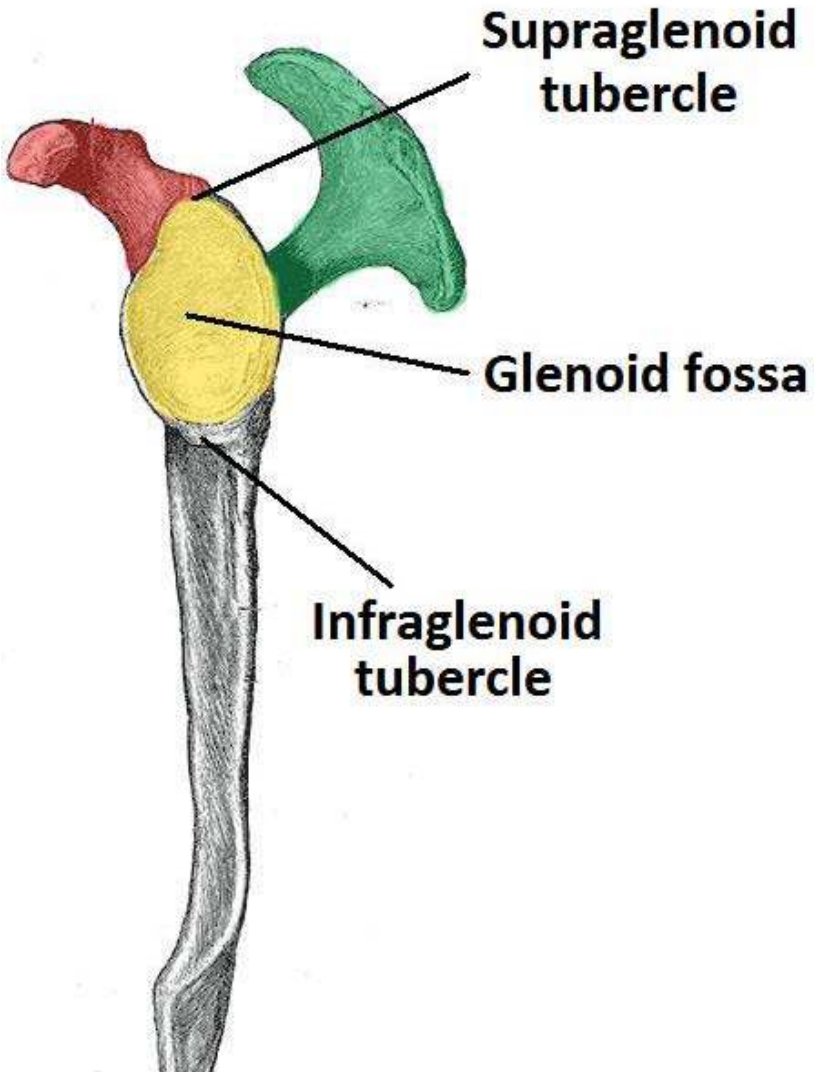
SCAPULA: Dorsal Surface

- It is divided in to 2 halves by the **spine** of scapula.
- Upper small part is called the **supraspinous** fossa. The supraspinous muscle originates here
- Lower large part is called the **infraspinous** fossa. The infraspinatus muscle originates from this area
- Both fossae communicate with each other through the **spinoglenoid** notch
- **Acromion** – projection of the spine that arches over the glenohumeral joint and articulates with the clavicle at the acromioclavicular joint



Scapula: Lateral Surface

- Faces the humerus.
- Site of the glenohumeral joint
- **Glenoid fossa** – a shallow cavity, located superiorly on the lateral border.
  - It articulates with the head of the humerus to form the glenohumeral (shoulder) joint.
- **Supraglenoid tubercle** – a roughening immediately superior to the glenoid fossa.
  - The place of attachment of the long head of the biceps brachii.
- **Infraglenoid tubercle** – a roughening immediately inferior to the glenoid fossa.
  - The place of attachment of the long head of the triceps brachii.



SCAPULA: BORDERS

BORDERS : Three borders

1. LATERAL BORDER :

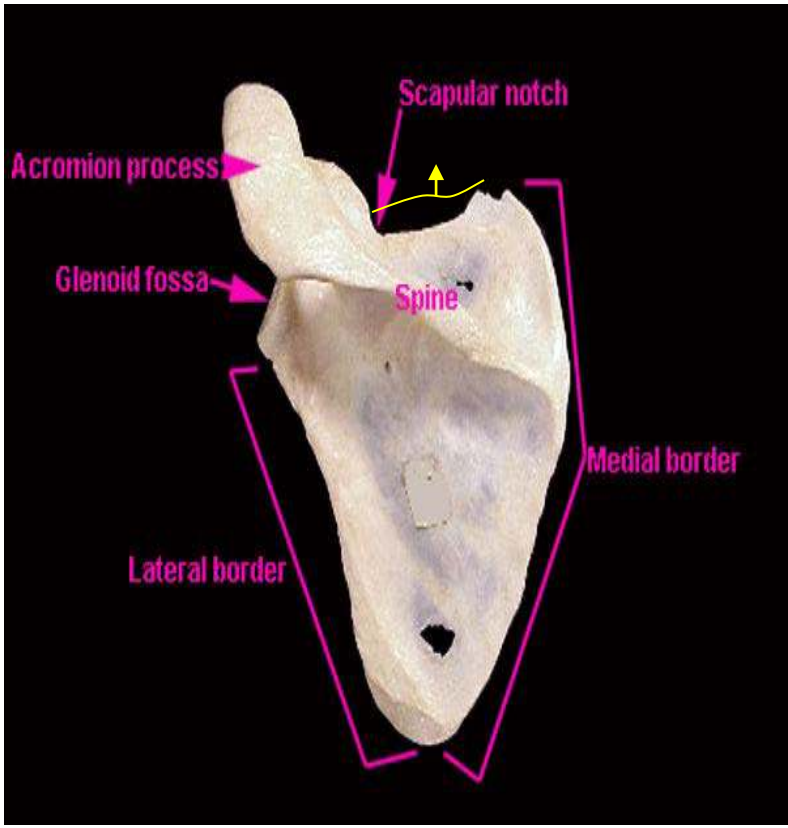
- Thickest border
- Extends from glenoid cavity to inf. angle

2. MEDIAL BORDER :

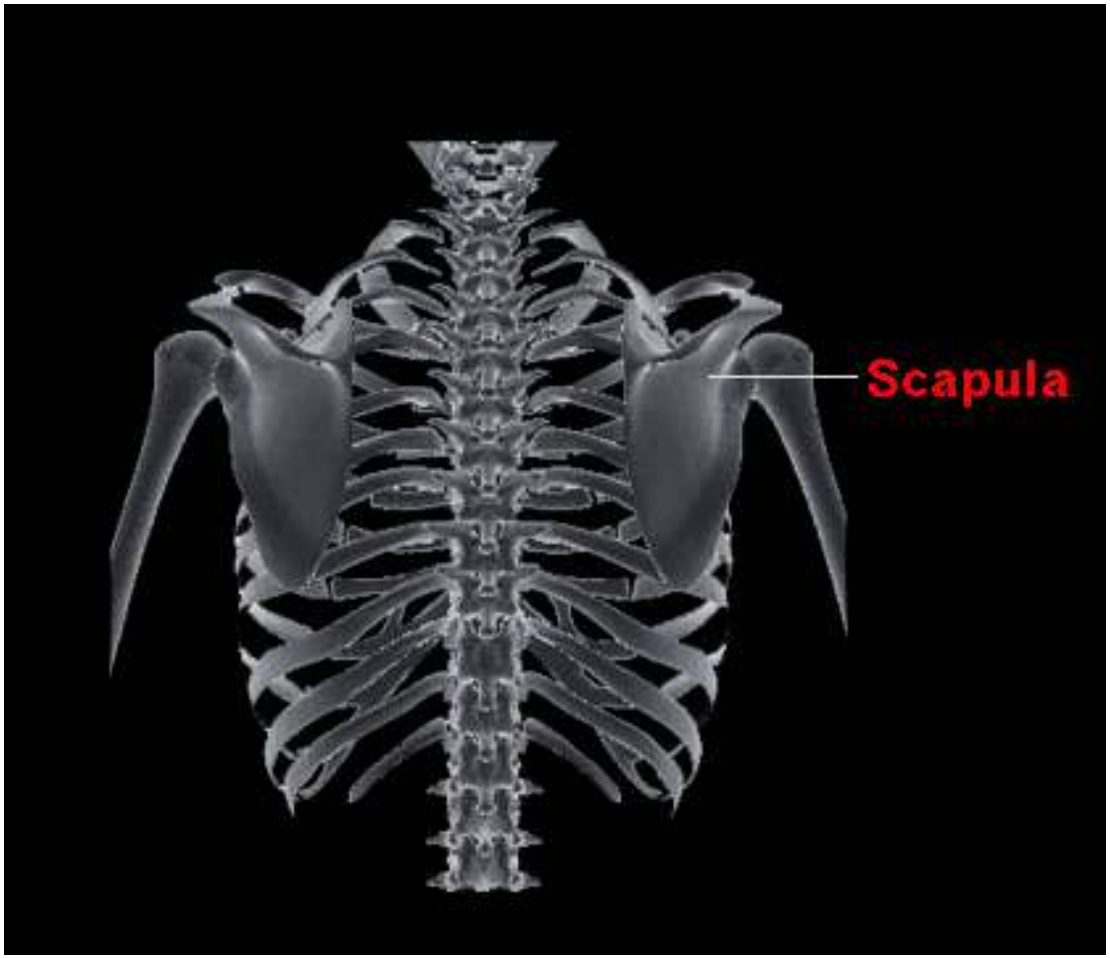
- Longest border
- Extends from superior angle to inferior angle.

3. UPPER BORDER :

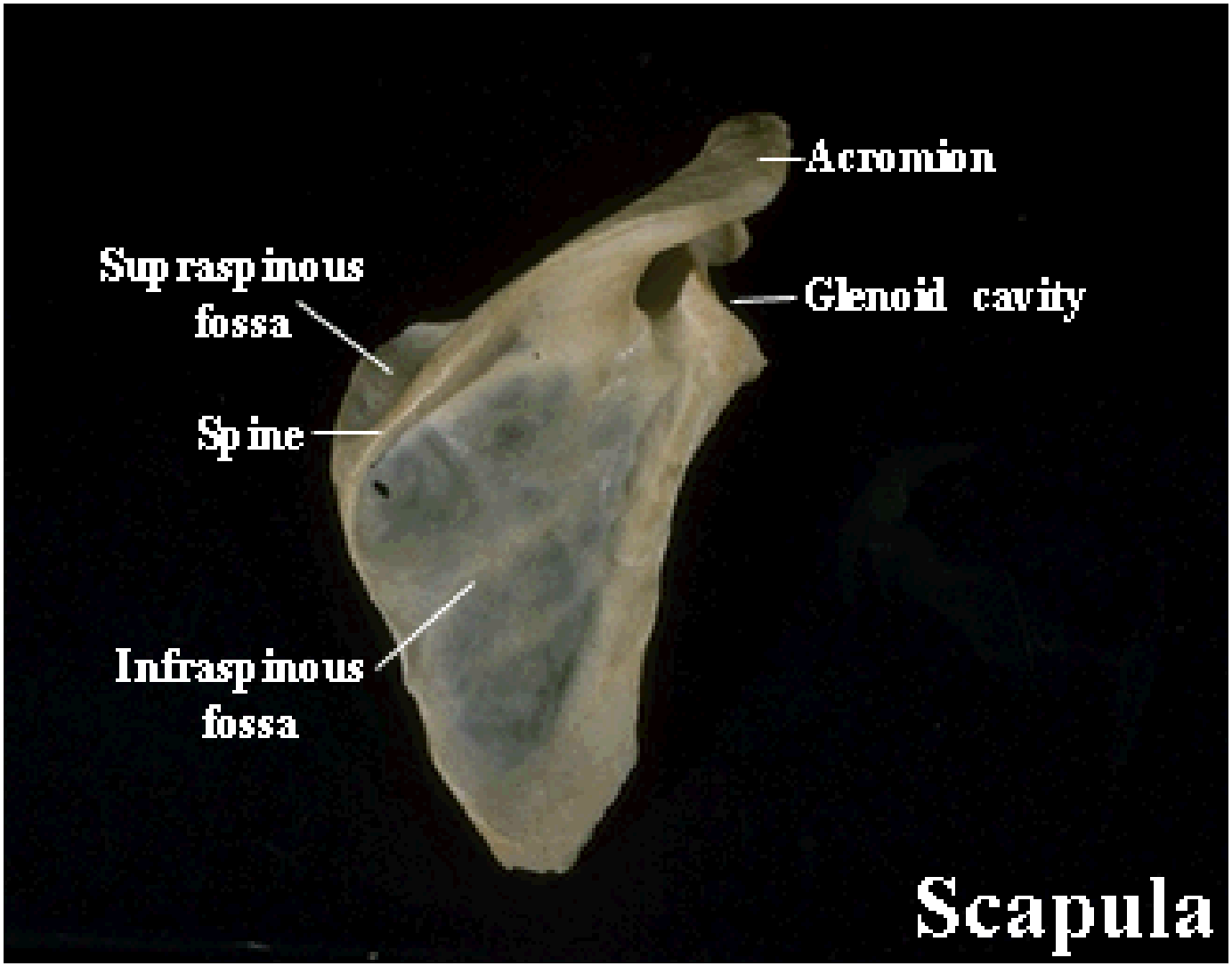
- Thinnest & shortest border
- Extends from superior angle to supra scapular notch.



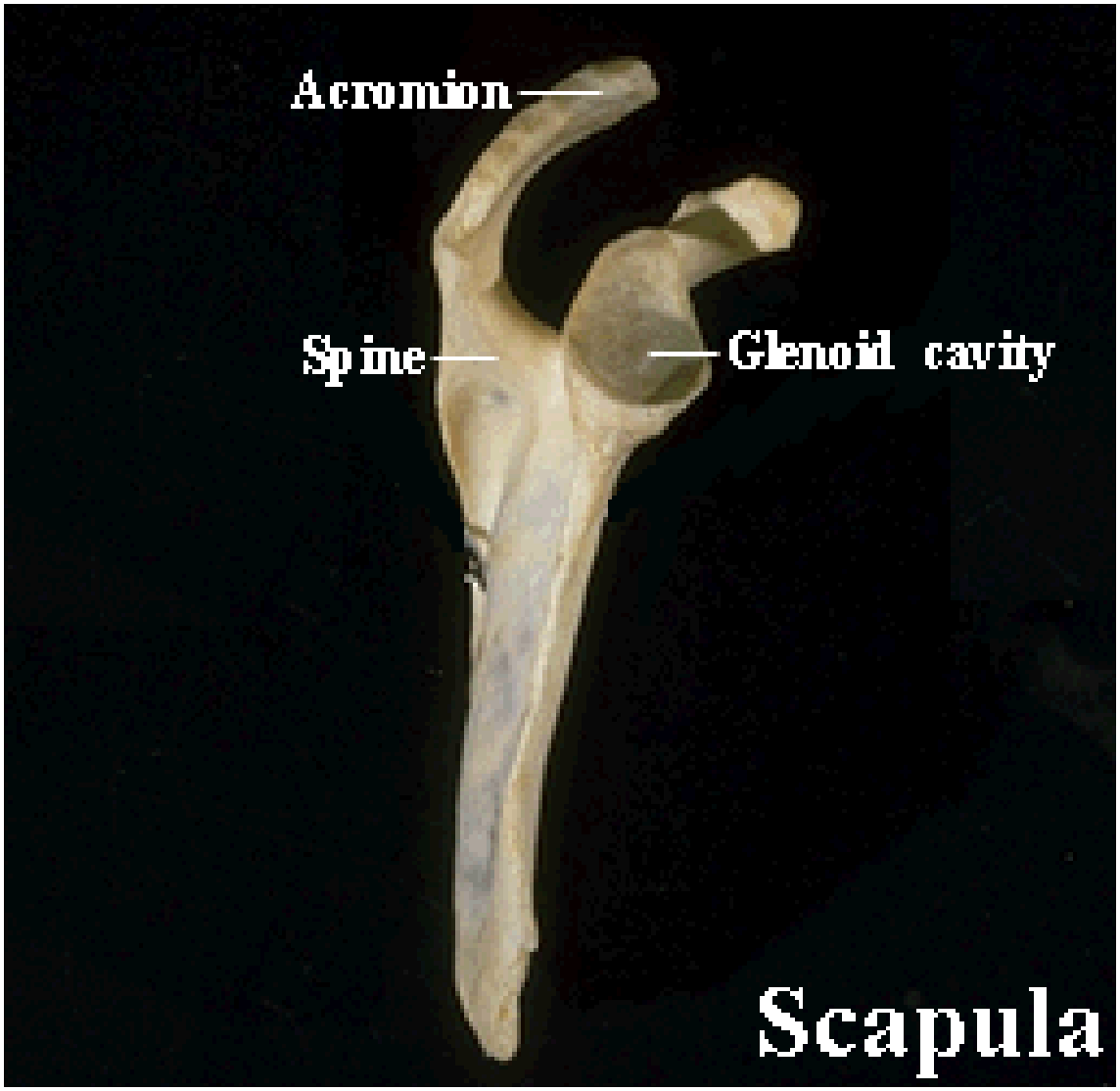
Scapula



Scapula


Acromion
Supraspinous fossa
Glenoid cavity
Spine
Infraspinous fossa
Scapula

Scapula



Scapula: Clinical Relevance

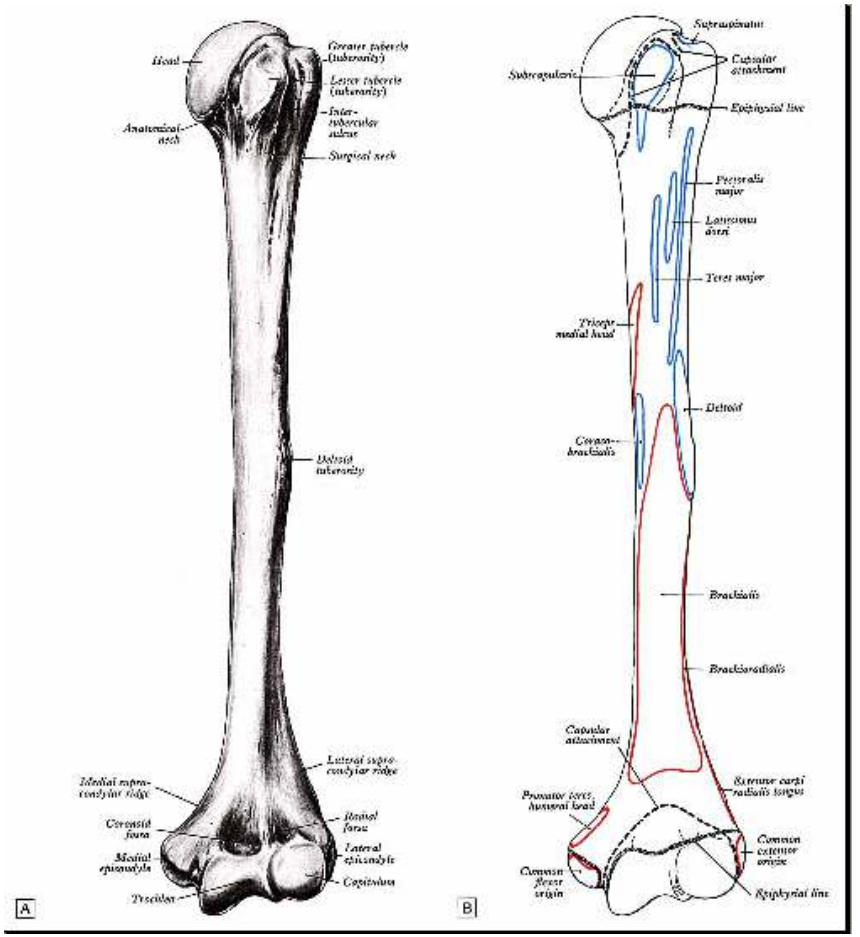
- Fractures
  - Relatively uncommon
  - Indication of severe chest trauma.
- Winged Scapula:
  - Due to injury to long thoracic nerve which innervates the serratus anterior muscle
  - Causes the scapula to protrude out of the back when pushing with the arm.

HUMERUS

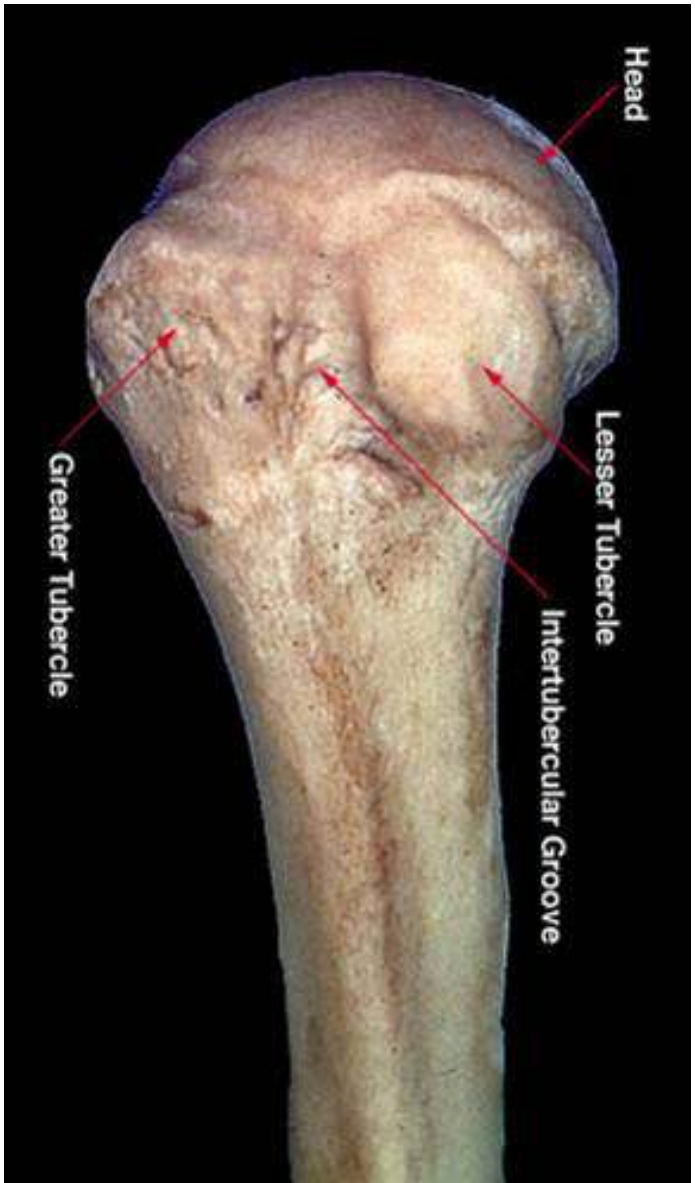
- Longest and strongest bone of upper limb

PARTS :

1. Proximal end
2. Shaft
3. Distal end



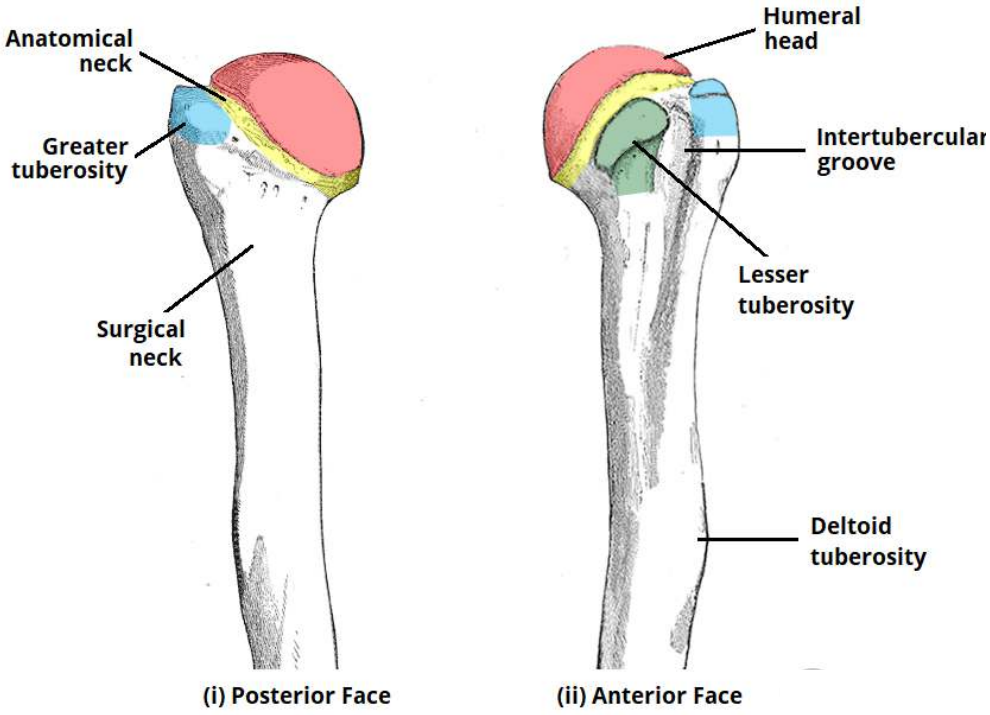
HUMERUS: Proximal End



- **Head**: Fits into the glenoid cavity of the scapula. Faces medially, upwards and backwards
- **Neck**
  - Anatomical neck: Separates the head from the tuberosities
  - Surgical neck: Most prone to fractures, hence the name
- **Greater tuberosity**: Most lateral part of the proximal end. serves as an attachment site for three of the rotator cuff muscles – **supraspinatus**, **infraspinatus** and **teres minor**
- **Lesser tuberosity:** Provides attachment for the subscapularis
- **intertubercular (Bicipital) groove(Sulcus): The** tendon of the long head of the biceps brachii emerges from the shoulder joint and runs through this groove

HUMERUS: Proximal End

- The edges of the intertubercular sulcus are known as lips.
- **Pectoralis major** attaches to lateral lip
- **Teres major** to medial lip
- **Latissimus dorsi** in between them
- (mnemonic = *“a lady between two majors”)*



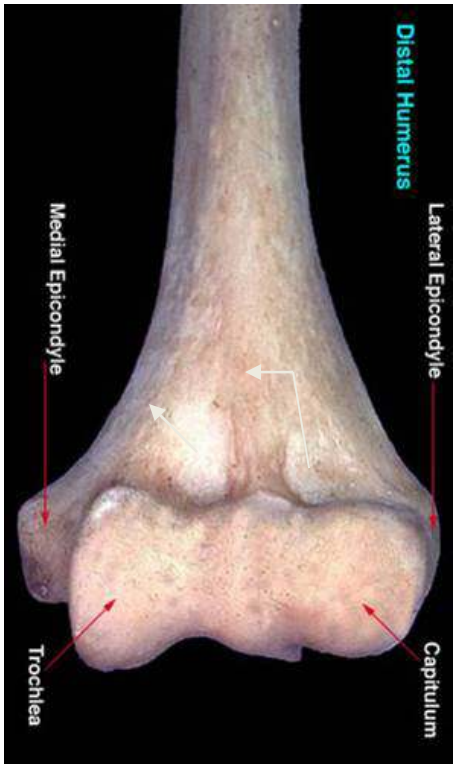
Humerus: Shaft

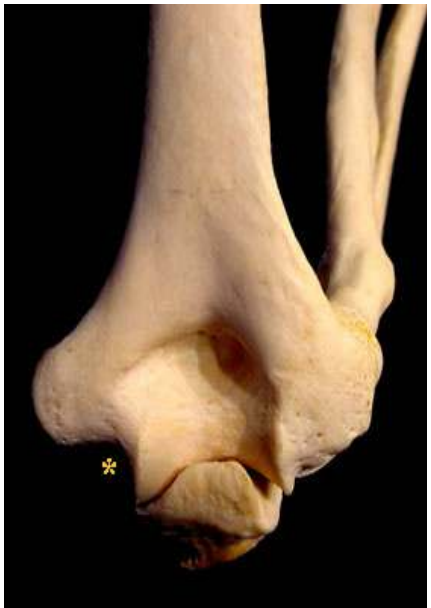
- **Deltoid tuberosity:** On the lateral side of the humeral shaft, roughed for the attachment of the deltoid muscle
- **Radial (or spiral) groove** is a shallow depression that runs diagonally down the posterior surface of the humerus, parallel to the deltoid tuberosity. The radial nerve and profunda brachii artery lie in this groove.
- The following muscles attach to the humerus along its shaft:
  - Anteriorly – **coracobrachialis, deltoid, brachialis, brachioradialis**.
  - Posteriorly **– medial and lateral heads of the triceps** (the spiral groove lies between their origins).

HUMERUS: DISTAL END

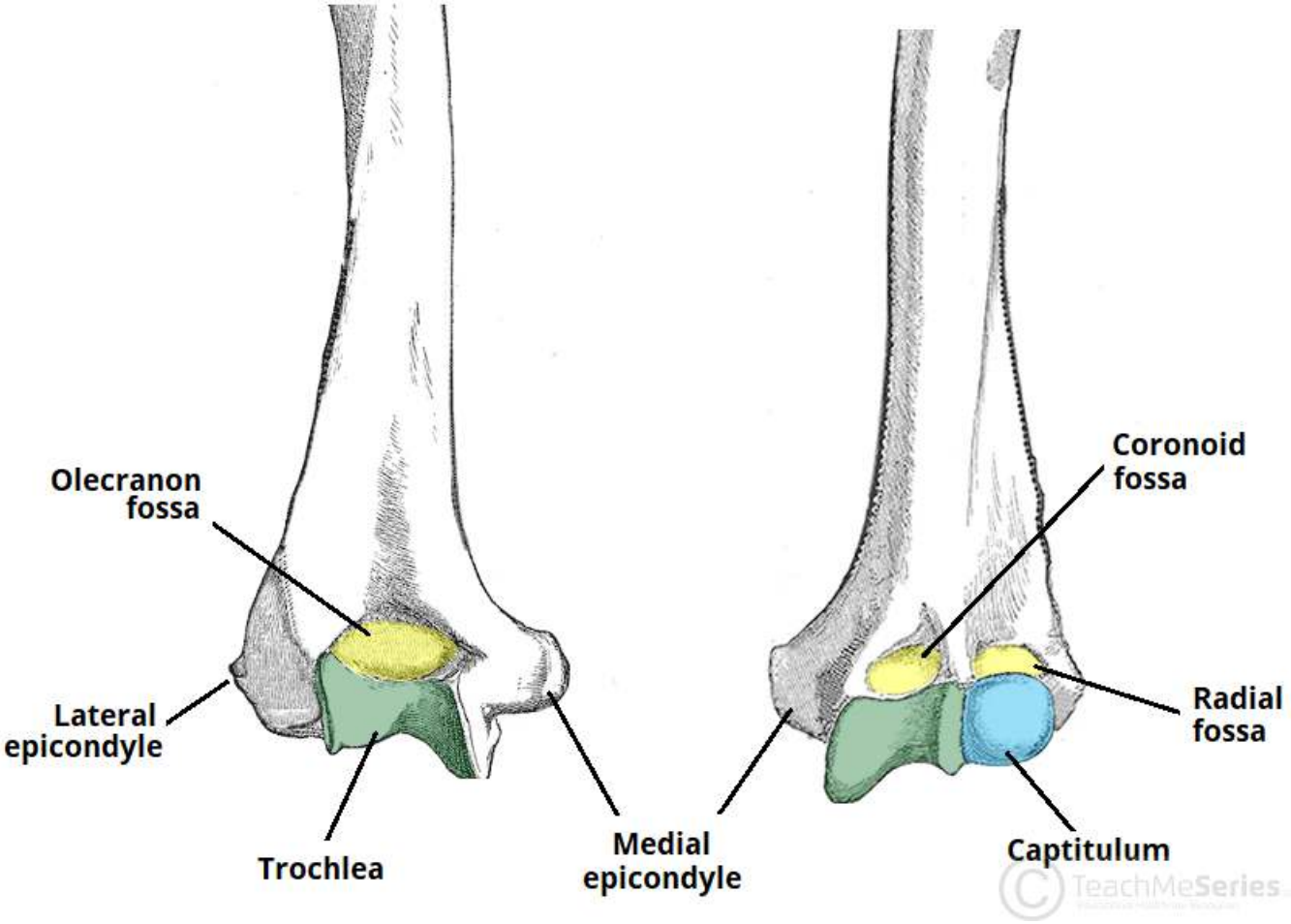
A) Articular part
- Capitulum: for the radius
- Trochlea; for the ulna

B) Non-articular Part
- Medial Epicondylar Ridge
- Lateral epicondylar ridge: rougher, serves as attachment for the **forearm extensors**
- Lateral Epicondyle
- Medial Epicondyle: larger of the two and extends more distally. The **ulnar nerve** passes in a groove on the posterior aspect of the medial epicondyle where it is palpable
- Olecranon Fossa: posterior, accommodates olecranon at full extension
- Coronoid Fossa: Anterior: accommodates the coronoid process of the ulna at full flexion
- Radial Fossa: Anterior





Humerus: Distal end



Humerus: Clinical Relevance

- **Mid-shaft fracture** of the humerus can injure the radial nerve and profunda brachii artery (both in the radial groove).
- Symptoms of radial nerve damage
- The nerve innervates the extensors of the wrist. When the nerve is damaged, either direct or as a consequence of swelling, the extensors will be paralysed. This results in unopposed flexion of the wrist, causing a ‘wrist drop’.
- There can also be some sensory loss over the dorsal surface of the hand, and the proximal ends of the lateral three and a half fingers dorsally.

Humerus: Clinical Relevance

- The fracture is typically transverse or oblique, and the most common mechanism of injury is falling on an outstretched hand. It is more common in children than adults
- Following structures can be damaged:
- **Brachial artery** can be damaged directly or via swelling following the trauma. The resulting ischaemia can cause **Volkmann's ischaemic contracture** – uncontrolled flexion of the hand – as flexor muscles become fibrotic and short.
- **Nerves:**
  i. **Anterior interosseous nerve** (branch of the median nerve),
  ii. **Ulnar nerve** or
  iii. **Radial nerve**

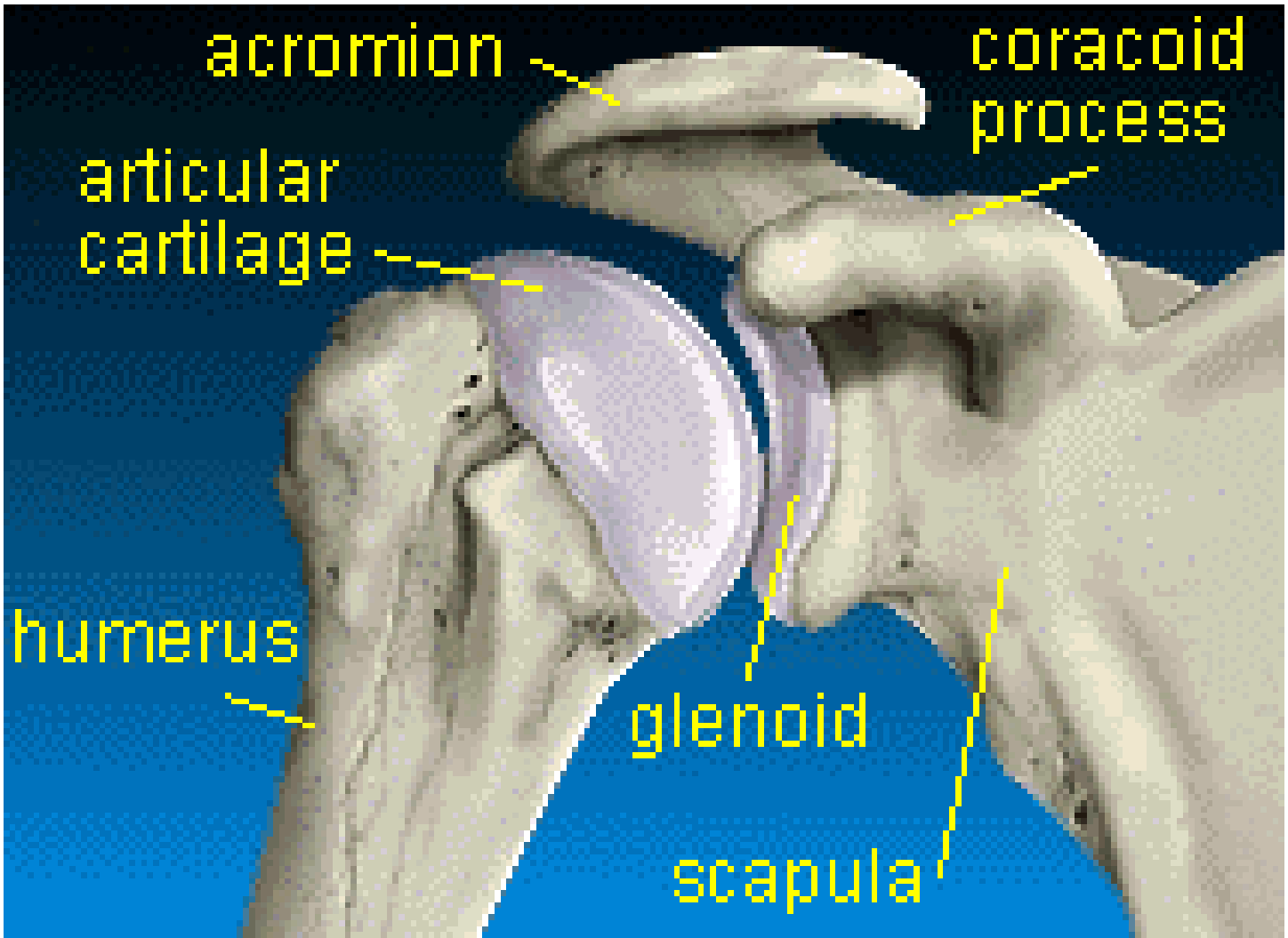
Supracondylar fracture: fracture of the distal humerus just above the elbow joint.

Humerus: Articulations

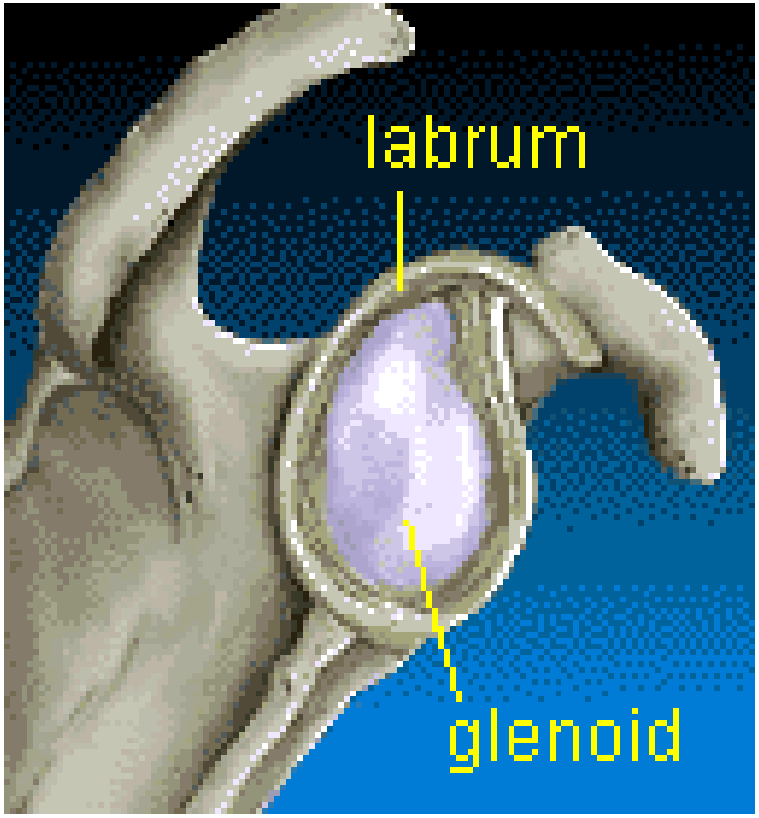
- The proximal region of the humerus articulates with the glenoid fossa of the scapula to form the **glenohumeral joint** (shoulder joint).

- Distally, at the **elbow joint**, the capitulum of the humerus articulates with the head of the radius and the trochlea of the humerus articulates with the trochlear notch of the ulna

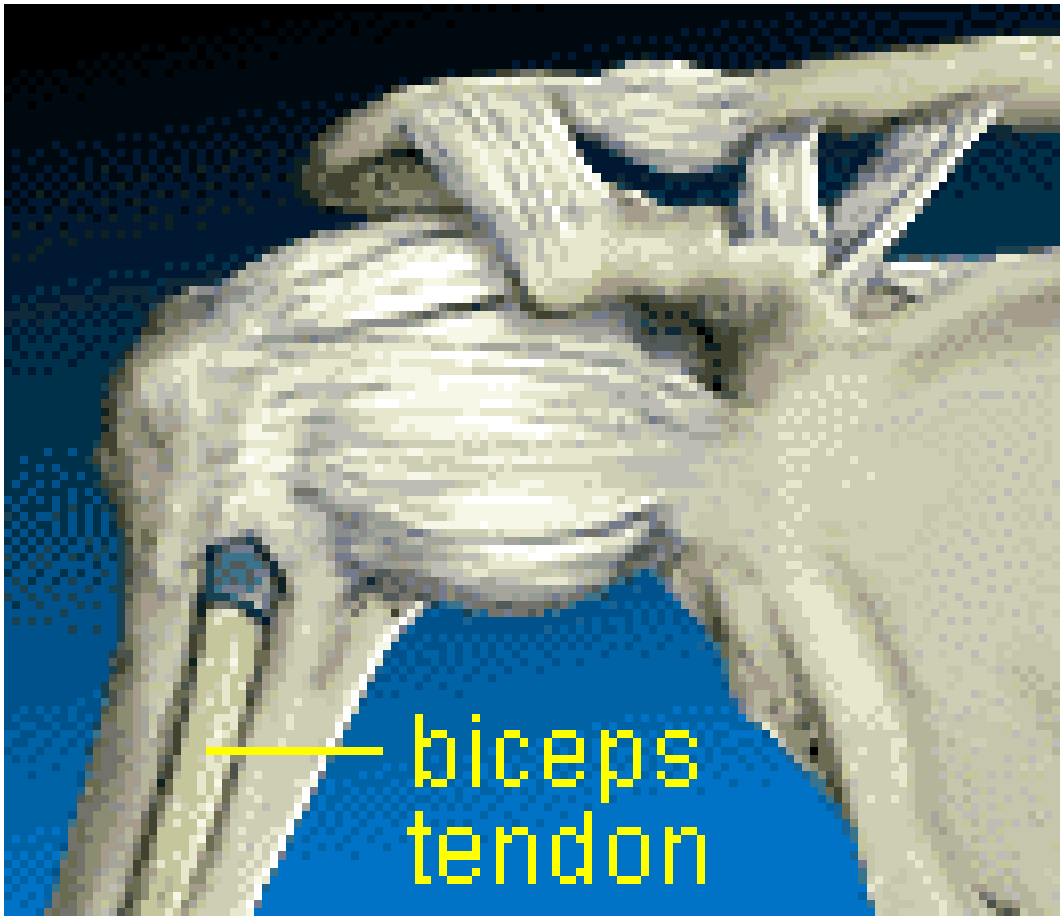
Glenohumeral Joint (Shoulder)



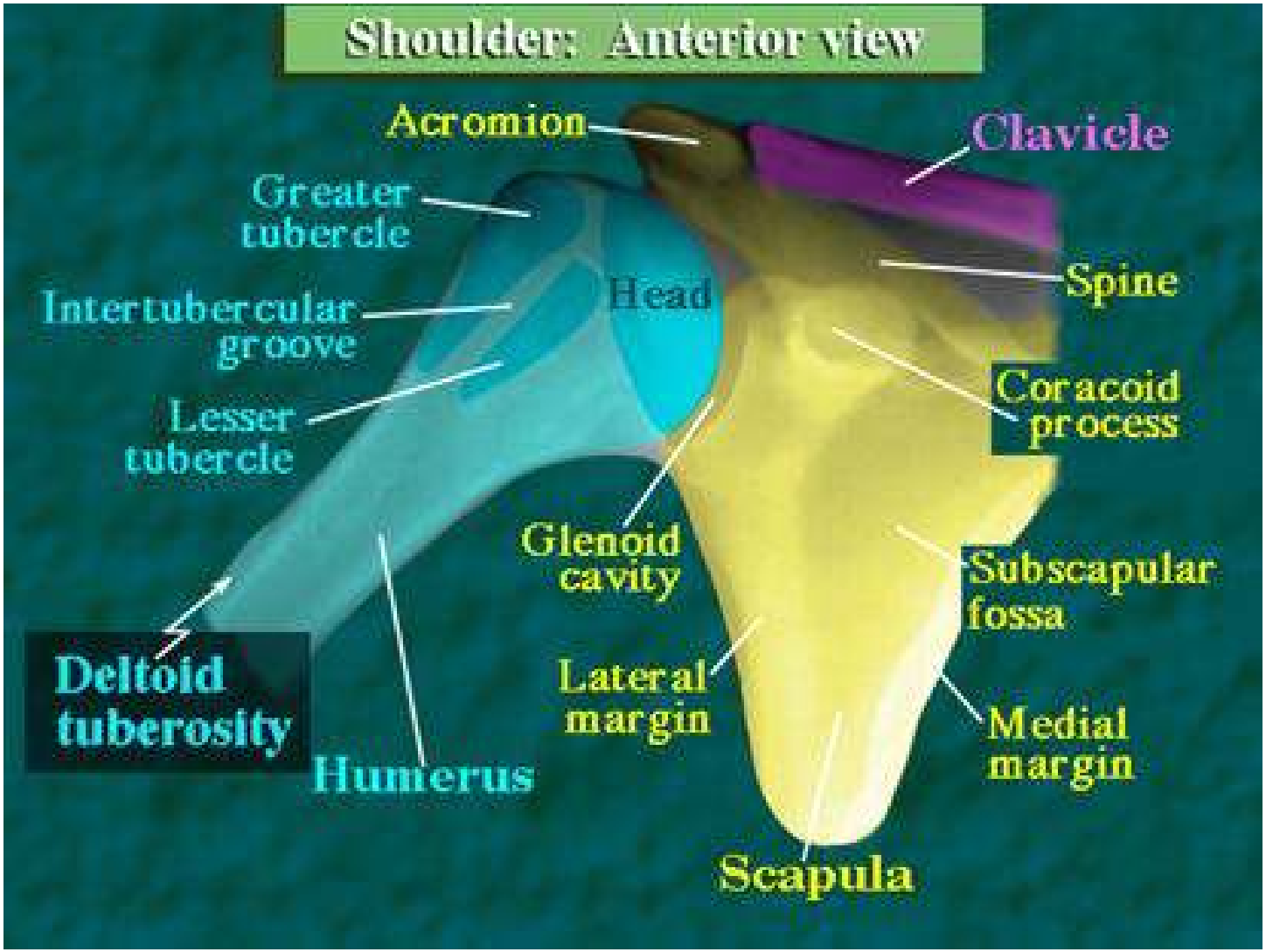
Labrum



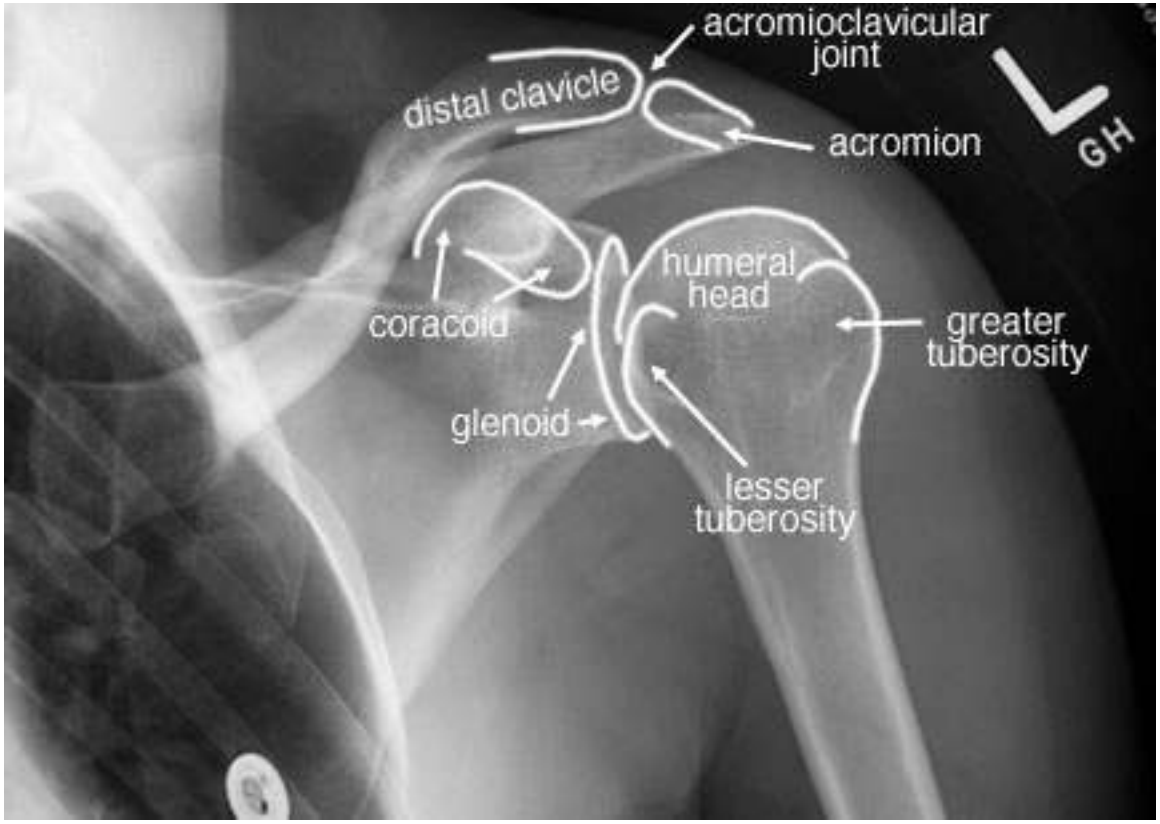
Shoulder (anterior)



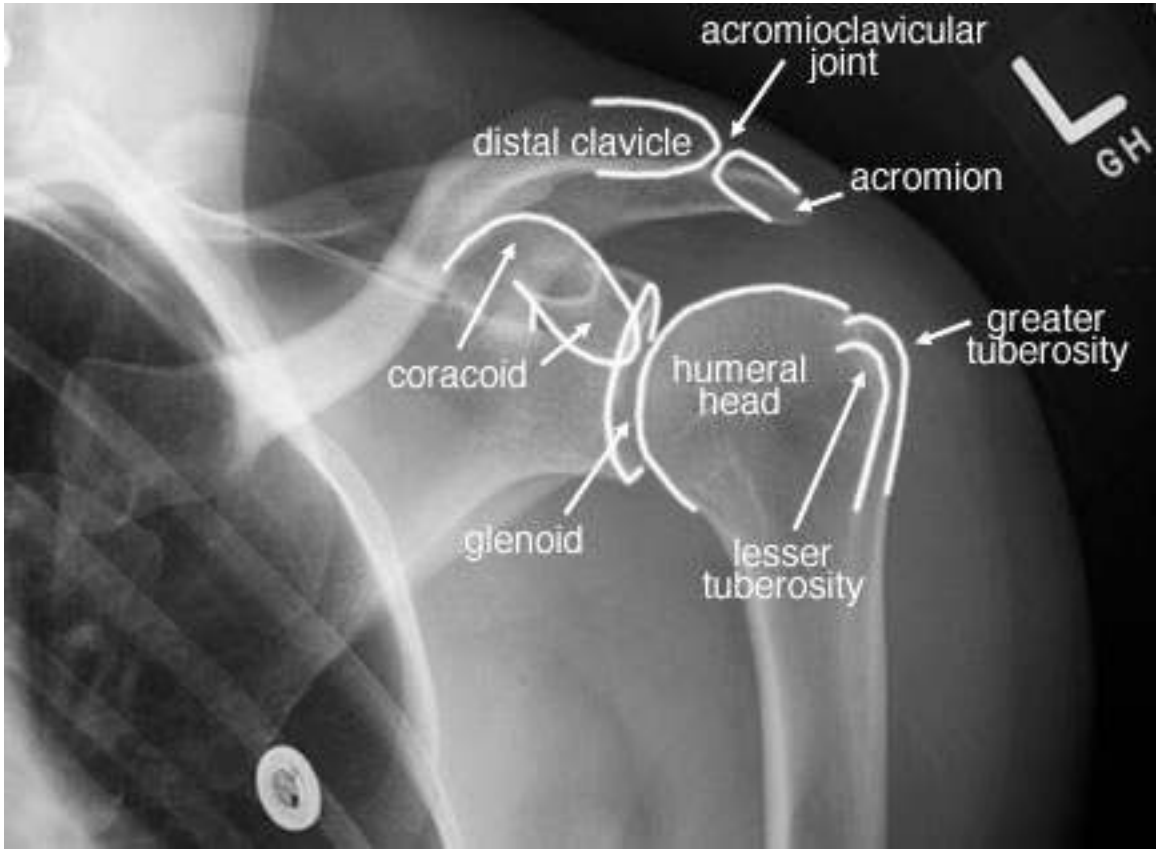
Shoulder (anterior)



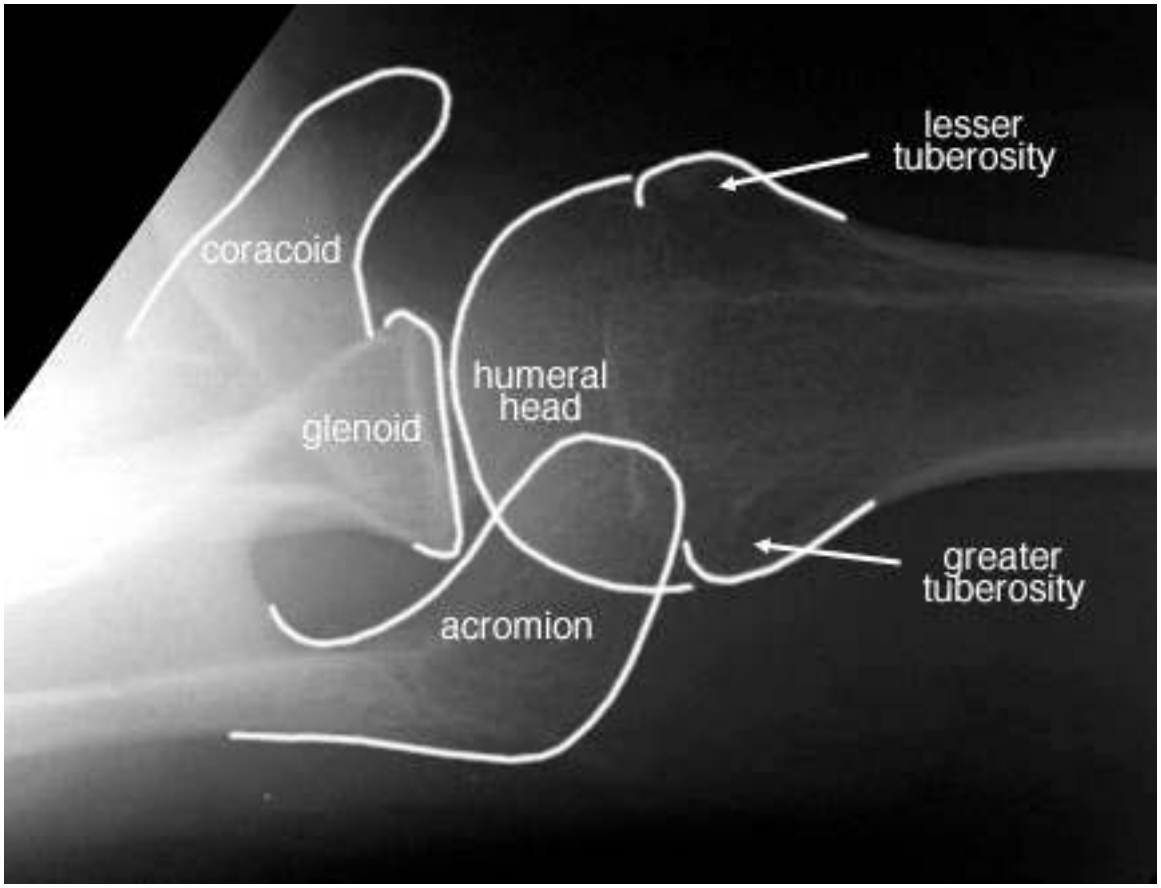
Shoulder Girdle (Internal Rotation)



Shoulder Girdle (External Rotation)



Shoulder Girdle (Axillary)



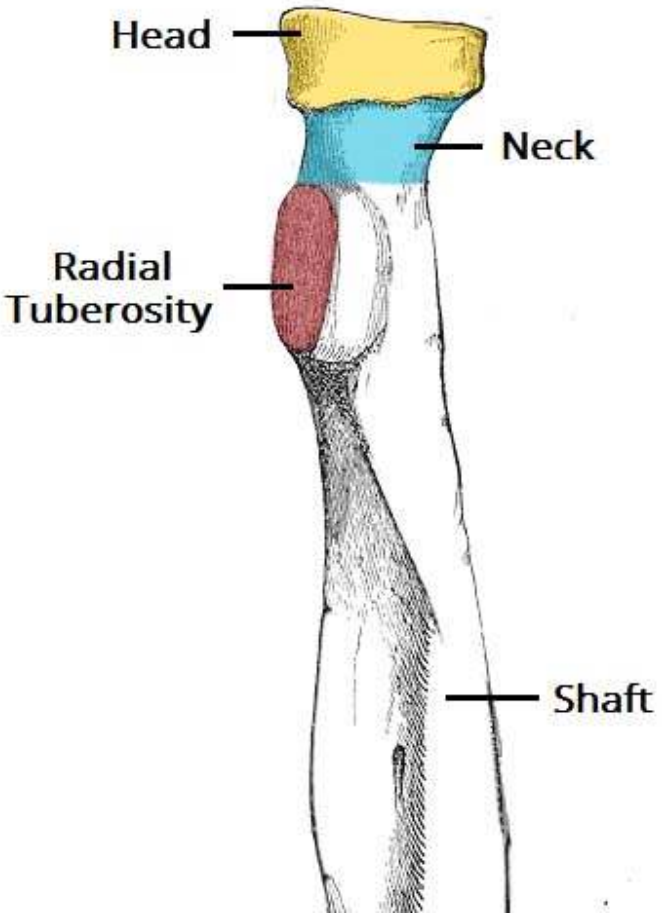
THE FOREARM BONES

RADIUS

- It lies laterally and parallel to ulna
- The second of the forearm bones. The radius pivots around the ulna to produce **movement** at the proximal and distal radio-ulnar joints.

Proximal Region of the Radius

- The proximal end of the radius articulates in both the elbow and proximal radioulnar joints.
- Important bony landmarks include:
- **Head of radius** – A disk shaped structure, with a concave articulating surface. It is thicker medially, where it takes part in the proximal radioulnar joint.
- **Neck** – A narrow area of bone, which lies between the radial head and radial tuberosity.
- **Radial tuberosity** – A bony projection, which serves as the place of attachment of the biceps brachii muscle.

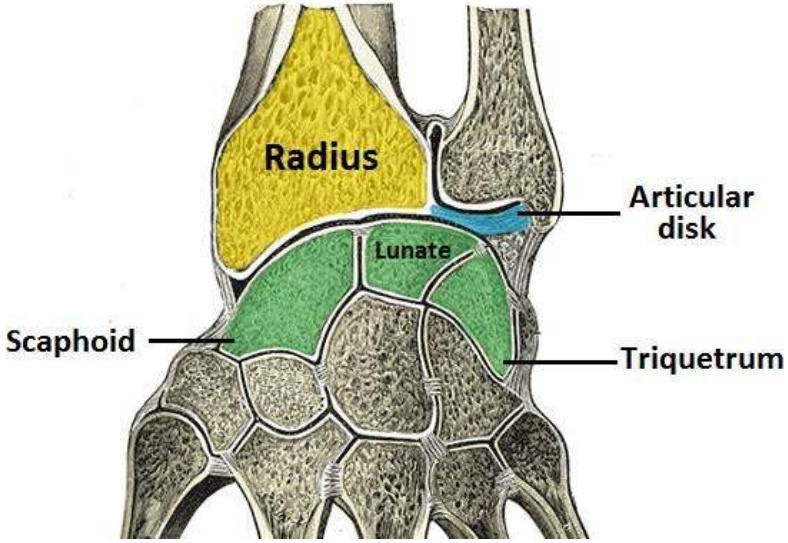


Shaft of the Radius

- The radial shaft expands in diameter as it moves distally.
- Like the ulna, it is **triangular** in shape, with three borders and three surfaces.
- In the middle of the lateral surface, there is a small roughening for the attachment of the **pronator teres** muscle.

Distal End of the Radius

- In the distal region, the radial shaft expands to form a rectangular end.
- The lateral side projects distally as the **styloid process**.
- **Ulnar notch:** concavity in the medial surface, articulates with the head of ulna to form the distal **radioulnar joint**.
- **Wrist joint:** The distal surface of the radius has two facets, for articulation with the **scaphoid** and **lunate** carpal bones. This makes up the

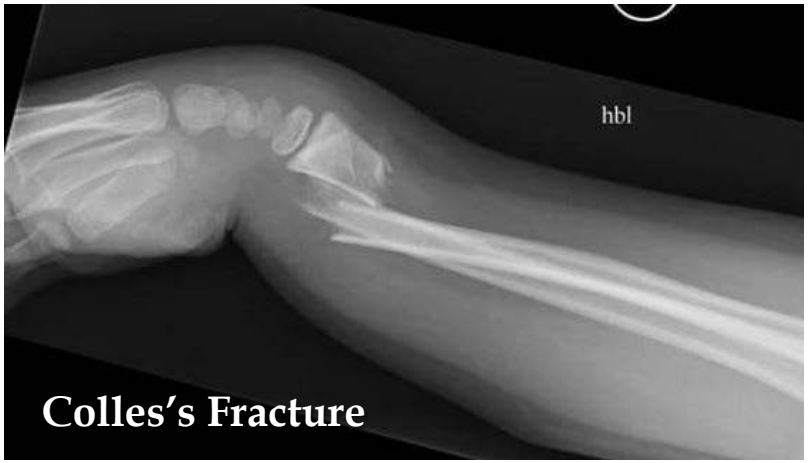


Articulations of the Radius

- The radius articulates in four places:
  i. **Elbow joint** – Partly formed by an articulation between the head of the radius, and the capitulum of the humerus.
  ii. **Proximal radioulnar joint** – An articulation between the radial head, and the radial notch of the ulna.
  iii. **Wrist joint** – An articulation between the distal end of the radius and the carpal bones.
  iv. **Distal radioulnar joint** – An articulation between the ulnar notch and the head of the ulna.

RADIUS: Clinical Relevance

- **Colles' Fracture** – The most common type of radial fracture. A fall onto an outstretched hand causing a fracture of the distal radius. The structures distal to the fracture (wrist and hand) are displaced posteriorly. It produces what is known as the 'dinner fork deformity'.
- **Fractures of the radial head** – This is characteristically due to falling on an outstretched hand. The radial head is forced into the capitulum of humerus, causing it to fracture.
- **Smith's Fracture** – A fracture caused by falling onto the back of the hand. It is the opposite of a Colles' fracture, as the distal fragment is now placed anteriorly.



Colles's Fracture

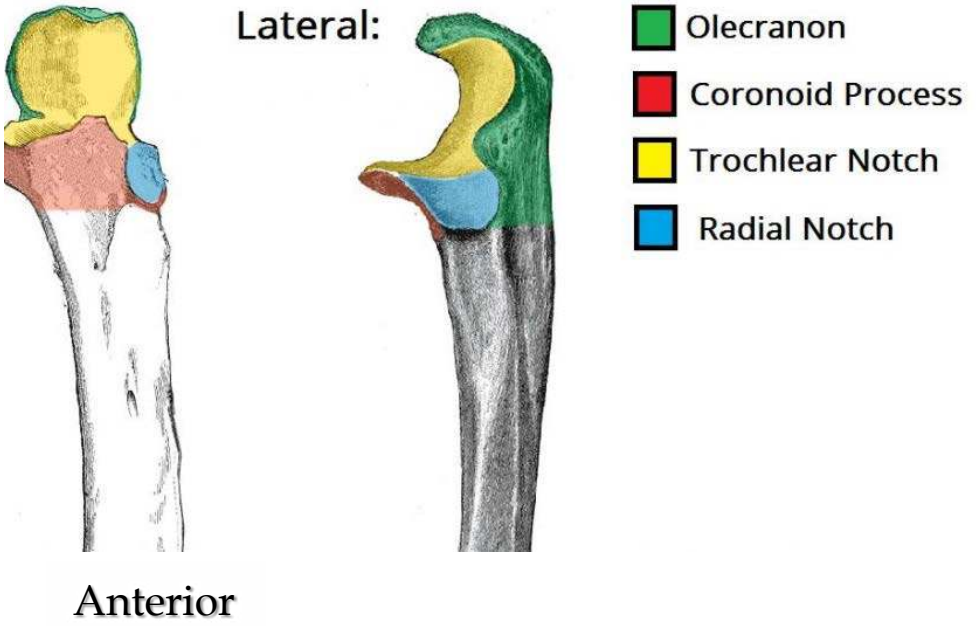

Smith's Fracture

Ulna

- The medial of the forearm bones
- Acts as the **stabilising** bone, with the radius pivoting to produce forearm movement.

Ulna: Proximal End

- **Olecranon** – a large projection of bone that extends proximally, forming part of trochlear notch. It can be palpated as the 'tip' of the elbow. The triceps brachii muscle attaches to its superior surface.
- **Coronoid process** – this ridge of bone projects outwards anteriorly, forming part of the trochlear notch.
- **Trochlear notch** – formed by the olecranon and coronoid process. It articulates with the trochlea of the humerus.
- **Radial notch** – located on the lateral surface of the trochlear notch, this area articulates with the head of the radius.
- **Tuberosity of ulna** – a roughening immediately distal to the coronoid process. It is where the brachialis muscle attaches.



Ulna: Shaft

- Triangular in shape
- As it moves distally, it decreases in width.
- **Three surfaces:**
  i. **Anterior** – site of attachment for the **pronator quadratus muscle** distally.
  ii. **Posterior** – site of attachment for many muscles.
  iii. **Medial** – unremarkable.
- **Three borders**:
  i. **Posterior** – palpable along the entire length of the forearm posteriorly
  ii. **Interosseous** – site of attachment for the interosseous membrane, which spans the distance between the two forearm bones. It is the sharpest border, and most lateral
  iii. **Anterior –** unremarkable.

Ulna: Proximal End and Articulations

- The proximal end of the ulna articulates with the **trochlea** of the humerus.
- It also articulates with the head of the radius to form the superior radio-ulna joint

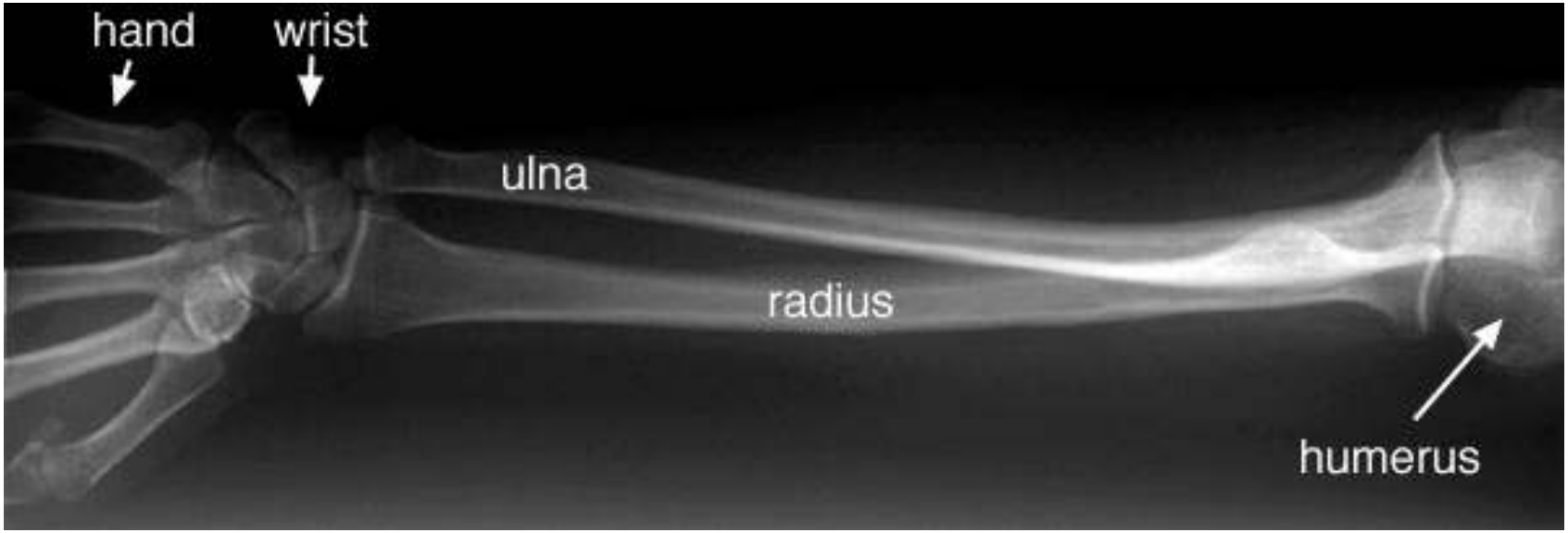
Ulna: Distal End and Articulations

- The distal end of the ulna is much smaller in diameter than the proximal end. It terminates in a rounded head, with distal projection – the ulnar **styloid process**.
- The head articulates with the **ulnar notch** of the radius to form the distal radio-ulna joint.

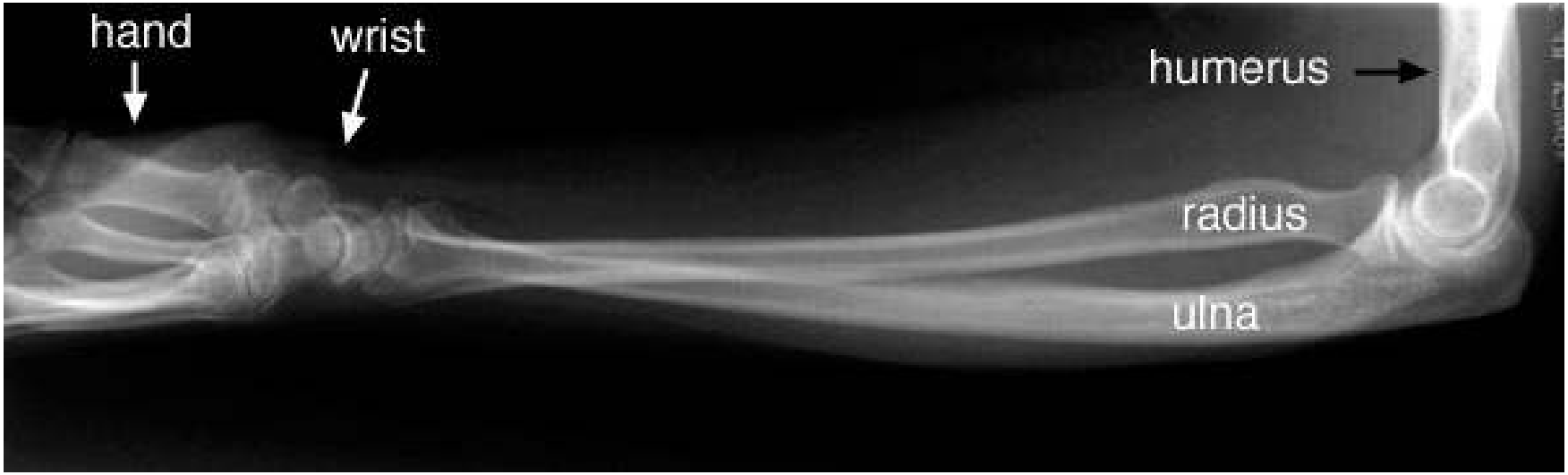
Ulna: Clinical Relevance

- **Lone Ulna Fracture**
  - A fracture of the ulna alone (not involving the radius) usually occurs as a result of the ulna being hit by an object. The **shaft** is the most likely site of fracture. Commonly called nightstick fracture
  - Less commonly, the **olecranon process** can be fractured. This is caused by the patient falling on a flexed elbow. The triceps brachii can displace part of the fragments proximally.
- **Both Bones.**
- Fractures of both bones
- Fracture of one bone with dislocation of any of the radio-ulna joints
- There are two classical fractures:
  - **Monteggia's Fracture** – Usually caused by a force from behind the ulna. The proximal shaft of ulna is fractured, and the head of the radius dislocates anteriorly at the elbow.
  - **Galeazzi's Fracture** – A fracture to the distal radius, with the ulna head dislocating at the distal radio-ulnar joint.

X-ray of the Forearm (AnterioPosterior) view



X-ray of the Forearm (lateral) View



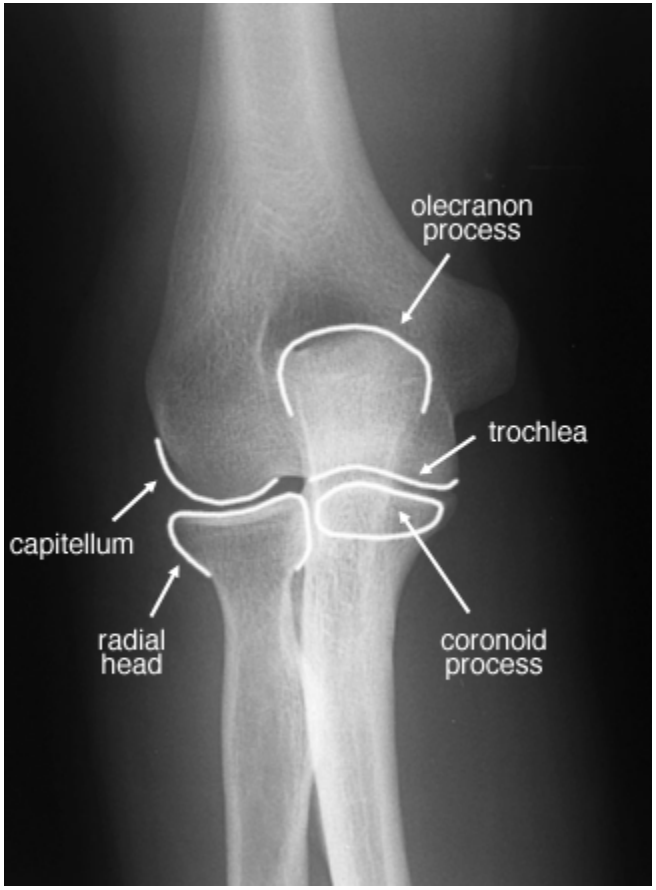
Radius and Ulna Fracture

Radius and Ulna Fractures

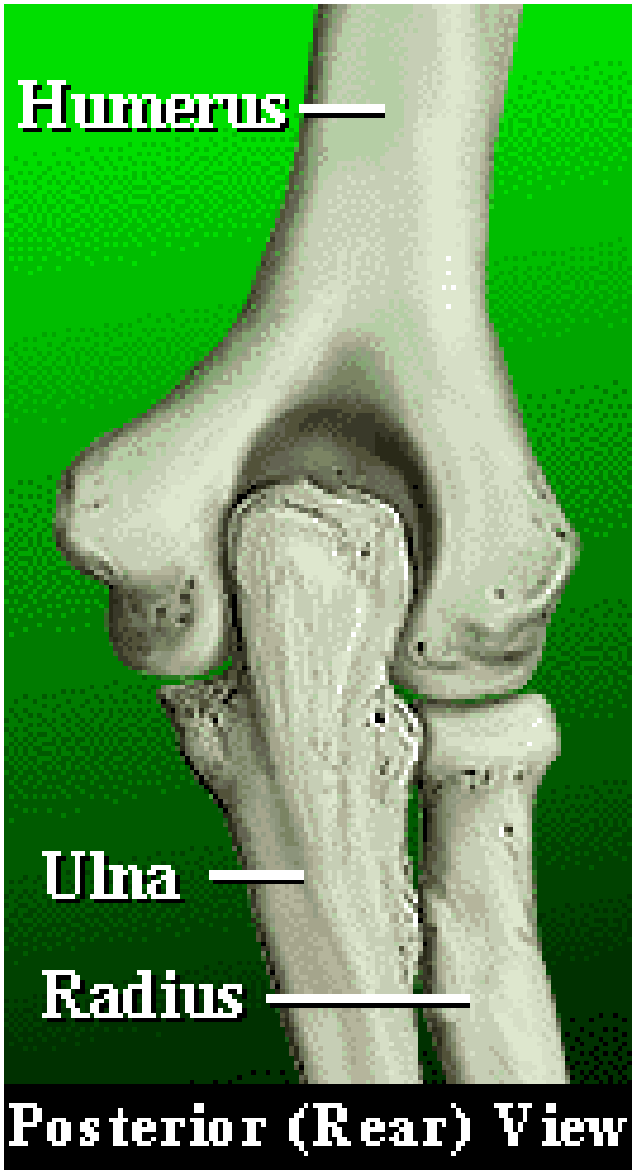
Galleazzi's Fracture

Monteggia's Fracture

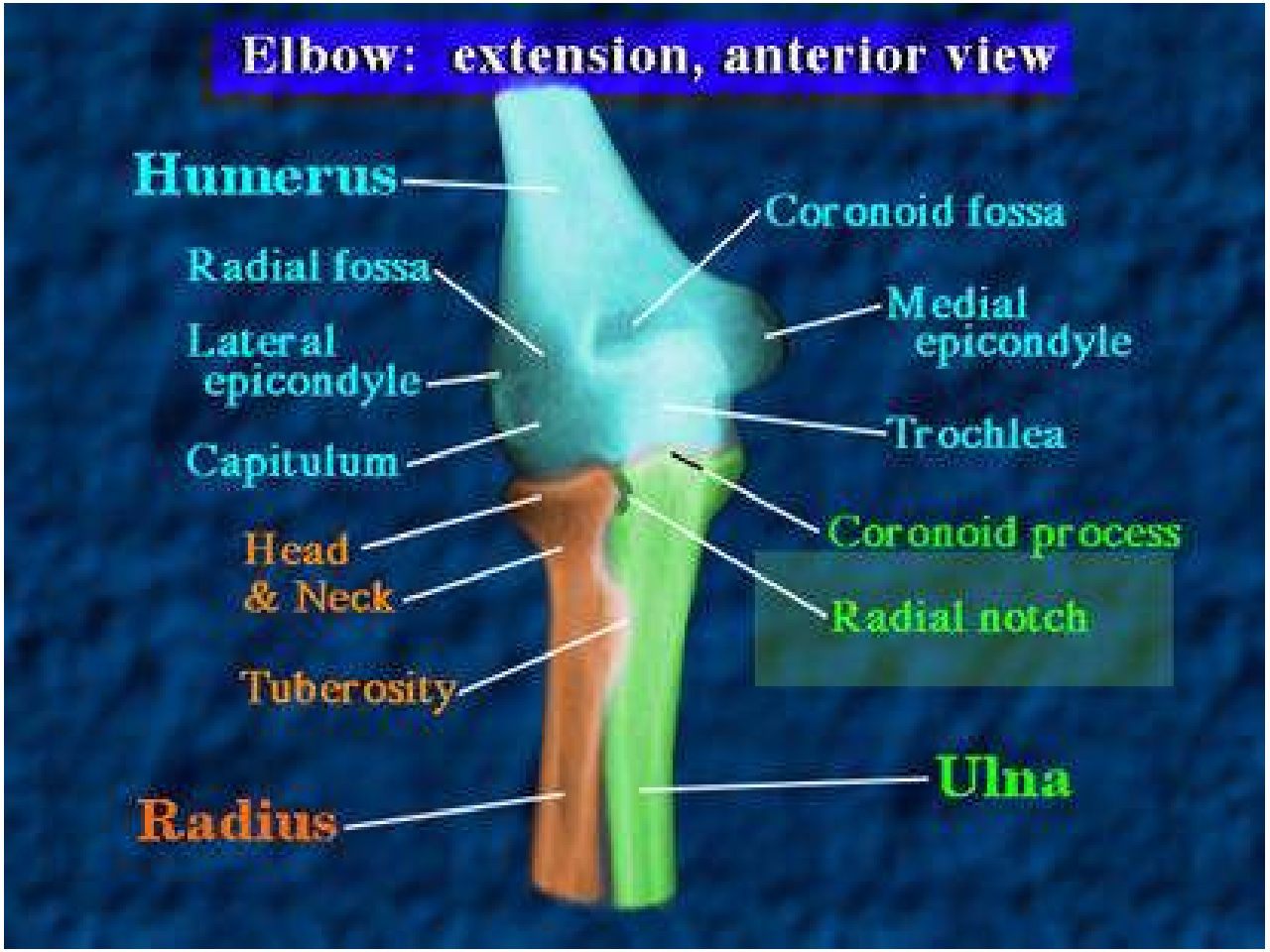
Elbow (Anterio-Posterior)



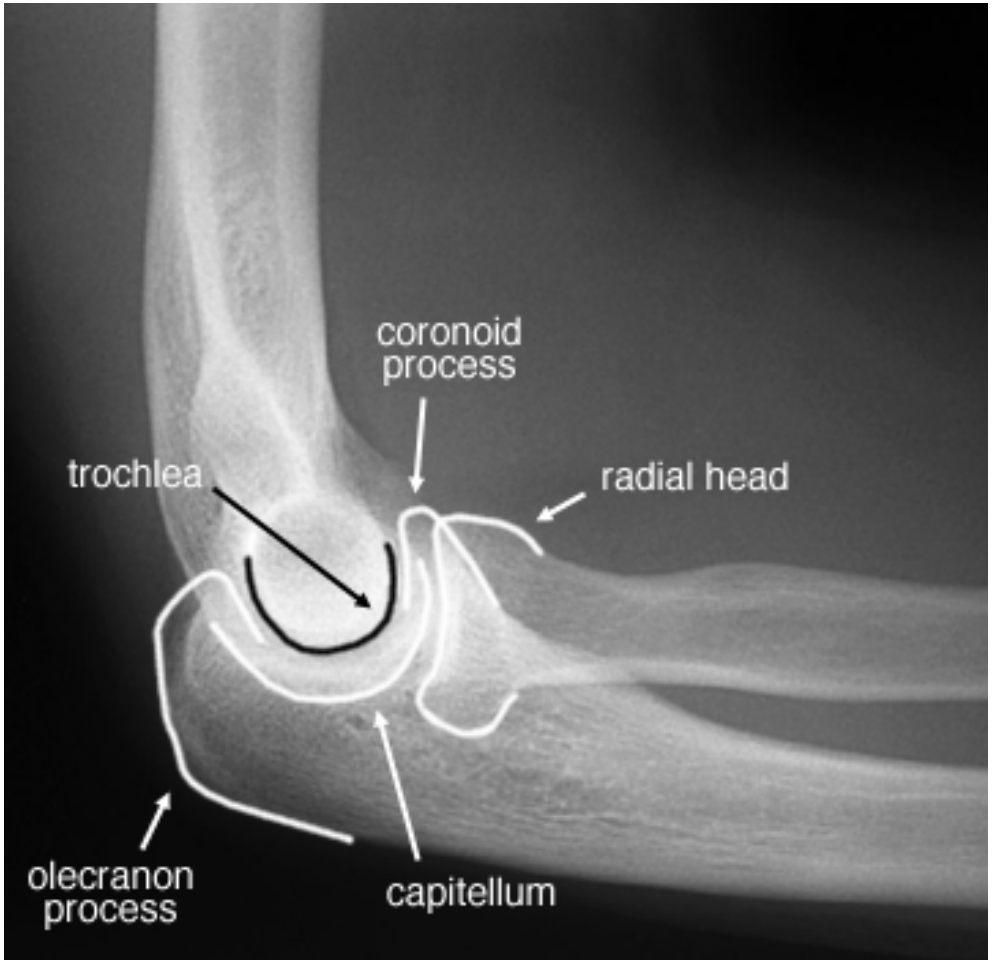
Elbow (post)



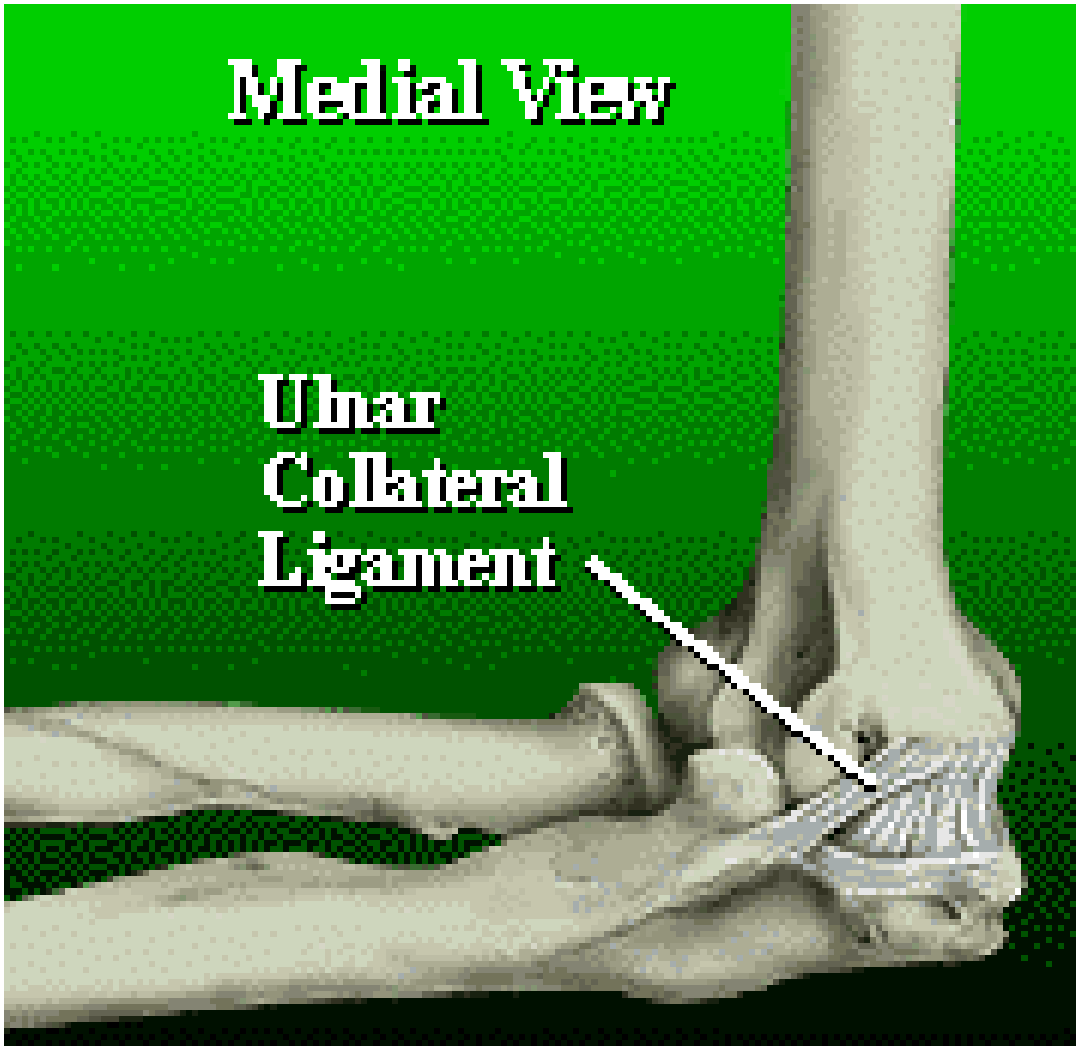
Elbow (ant)


Elbow: extension, anterior view
Humerus
Radial fossa
Lateral epicondyle
Capitulum
Head & Neck
Tuberosity
Radius
Coronoid fossa
Medial epicondyle
Trochlea
Coronoid process
Radial notch
Ulna

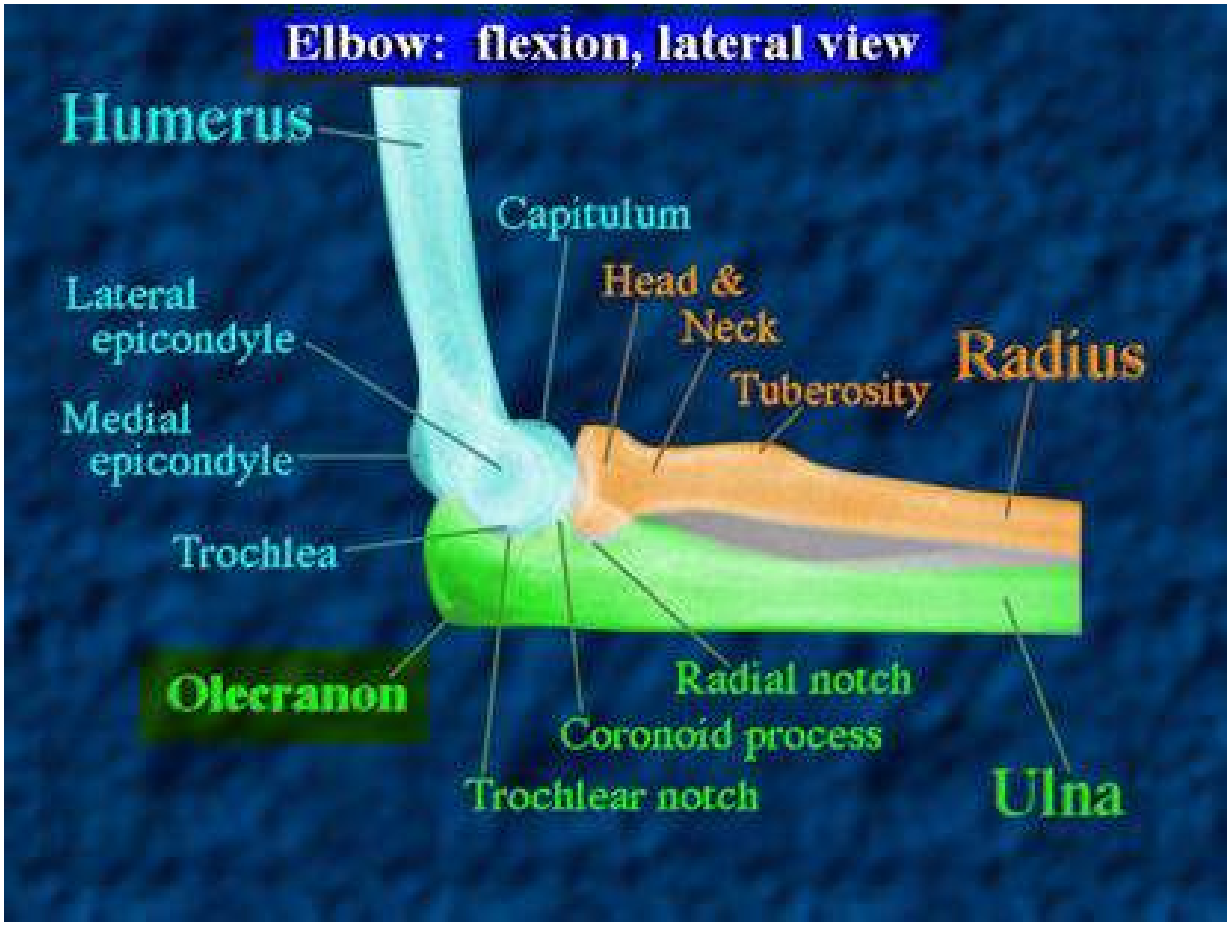
Elbow (lateral)



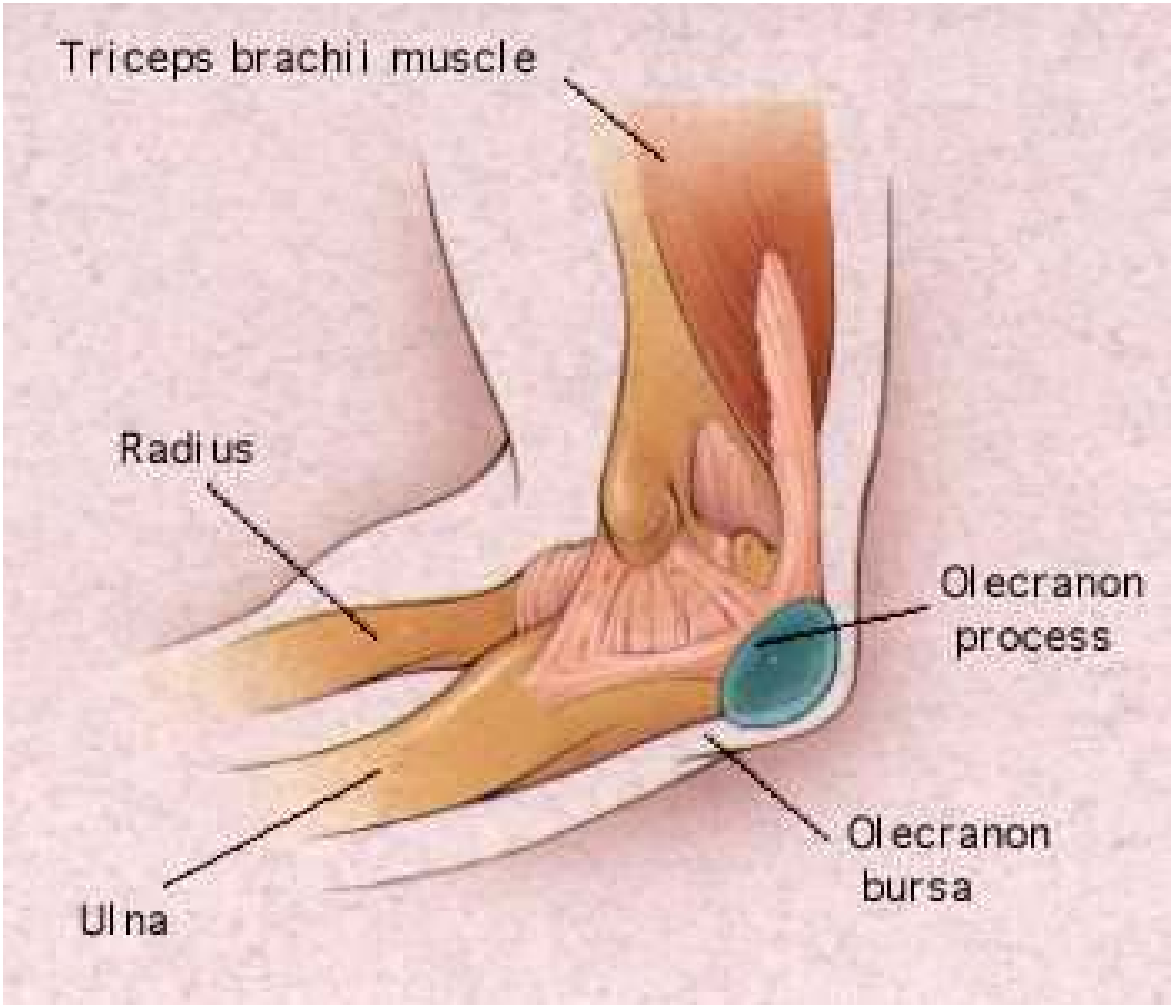
Elbow (medial)



Elbow (lateral)



Olecranon Bursa

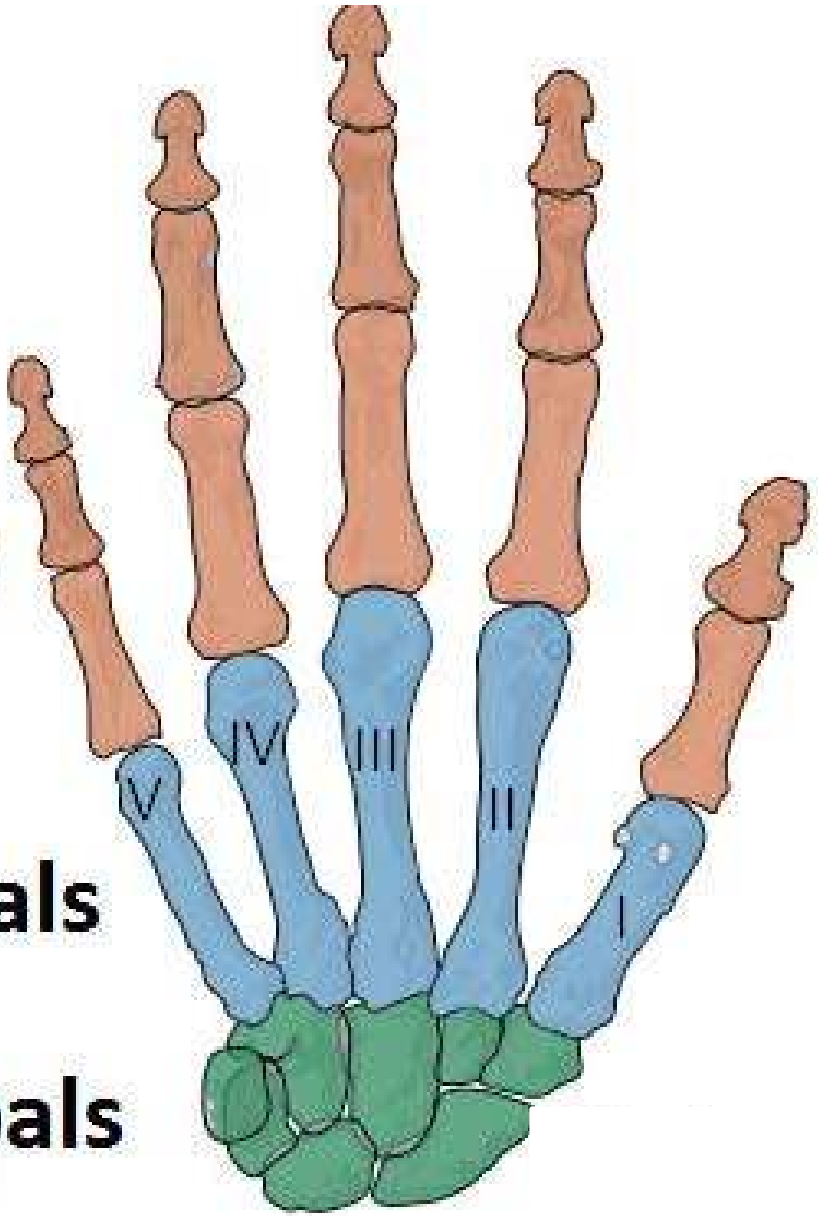


BONES OF THE HAND

Phalanges

Metacarpals

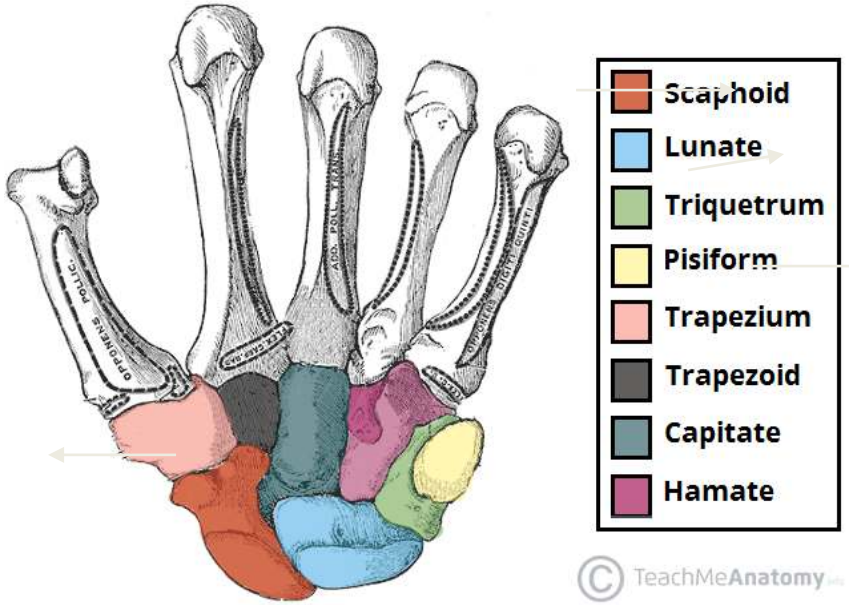
Carpals



CARPAL BONES

- **8 IN 2 ROWS**
- **PROXIMAL ROW – 4**
    1. **SCAPHOID –** Boat Shaped
    2. **LUNATE** - Semilunar
    3. **TRIQUETRAL -** Pyramidal
    4. **PISIFORM** - Sesamoid bone Pea Shaped

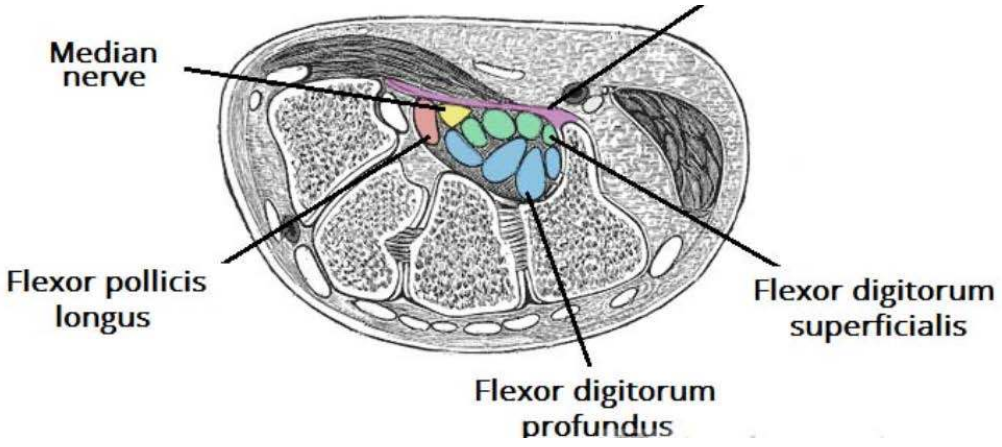
- **DISTAL ROW – 4**
    1. **TRAPEZIUM -**
    2. **TRAPEZOID -**
    3. **CAPITATE -**
    4. **HAMATE** - Has a hook



Mnemonic: She Likes To Play, Try To Catch Her

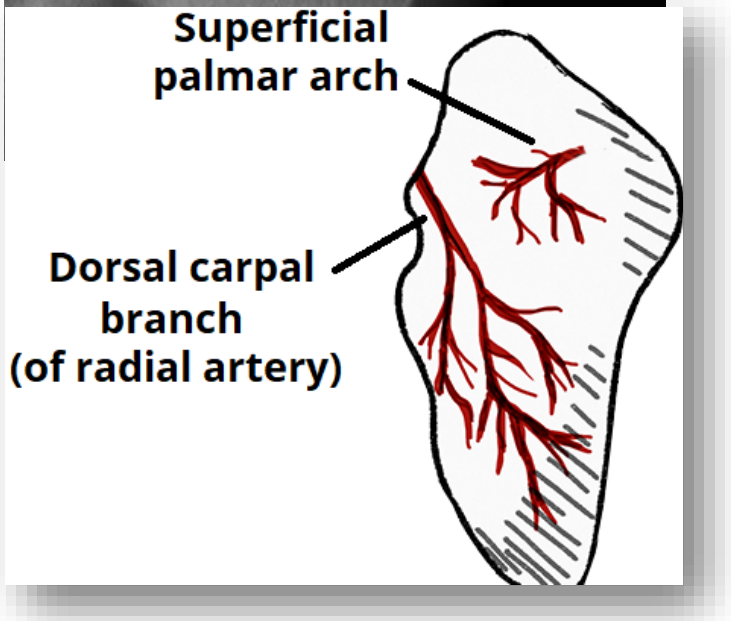
Carpal Bones

- Collectively, the carpal bones form an **arch** in the coronal plane.
- A membranous band, the flexor retinaculum, spans between the medial and lateral edges of the arch, forming the **carpal tunnel**.
- Proximally, the scaphoid and lunate articulate with the radius to form the **wrist joint** (also known as the 'radio-carpal joint').
- In the distal row, all of the carpal bones articulate with the metacarpals. To form the Carpometacarpal joints

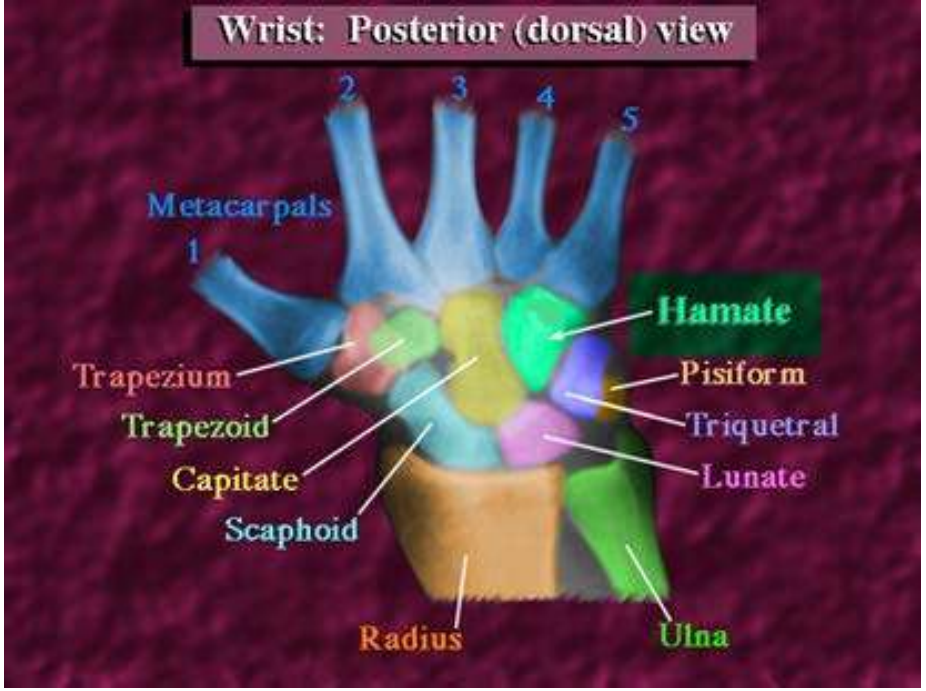


Carpal Bones: Clinical Relevance

- The **scaphoid bone** of the hand is the most commonly fractured carpal bone
- In a fracture of the scaphoid, the characteristic clinical feature is pain and tenderness in the **anatomical snuff box**
- The scaphoid is at particular risk of avascular necrosis after fracture because of its 'retrograde blood supply' which enters at its distal end.
- This means that a fracture to the middle (or 'waist') of the scaphoid may interrupt the blood supply to the proximal part of the scaphoid bone rendering it avascular.
- Patients with a missed scaphoid fracture are likely to develop **osteoarthritis** of the wrist in later life.



METACARPALS



- Short long bones – 5
- PARTS :
  1. HEAD – lies distally
  2. BASE – lies proximally
  3. SHAFT – lies in the middle

ARTICULATIONS :

1st – Trapezium

2nd – Trapezium + Trapezoid + Capitate+ 3rd Metacarpal

3rd – Capitate + 2nd Metacarpal + 4th Metacarpal

4th – Hamate + 3rd Metacarpal + 4th Metacarpal

5th – Hamate + 4th Metacarpal

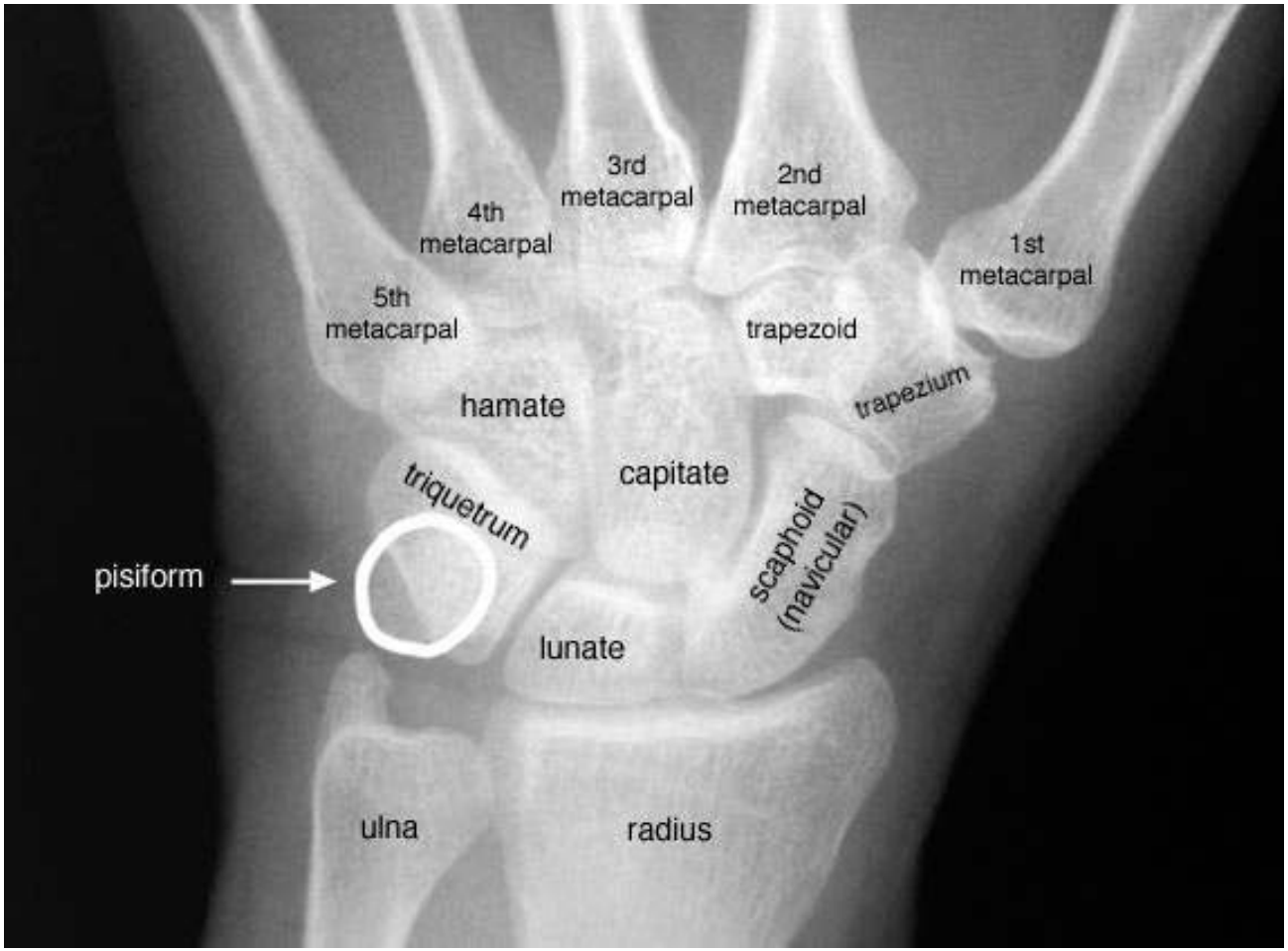
Metacarpals: Clinical Relevance

- **Boxer's fracture** – A fracture of the 5th metacarpal neck. It is usually caused by a clenched fist striking a hard object. The distal part of the fracture is displaced anteriorly, producing shortening of the affected finger.
- **Bennett's fracture** – A fracture of the 1st metacarpal base, caused by axial loading on a partially flexed metacarpal. This fracture extends into the first carpometacarpal joint leading to instability and subluxation of the joint. As a result, it often needs surgical repair.

Boxer's Fracture

Bennet's Fracture

Bones of the Wrist

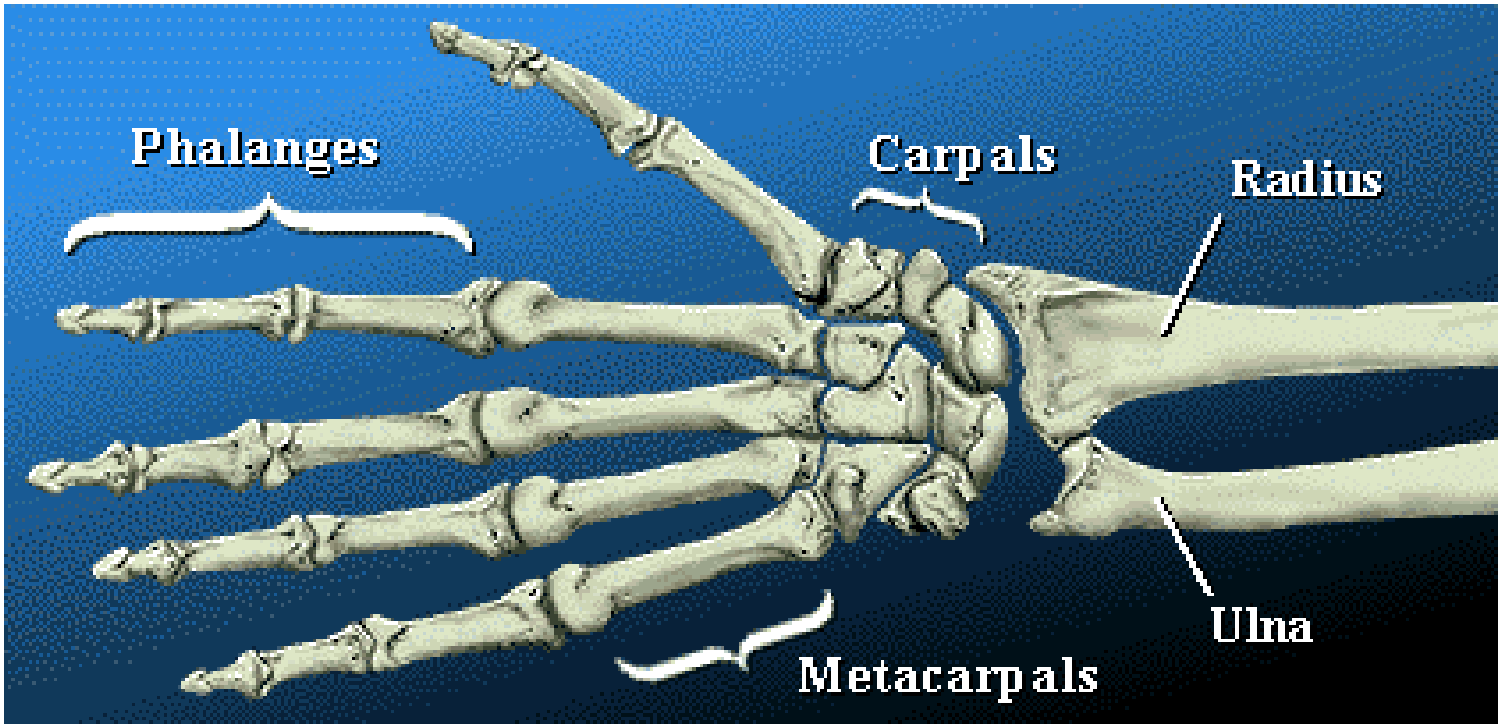


Plain X-ray: Lateral View

PHALANGES OF THE HAND

- 14: 2+3+3+3+3
- PARTS :
    1. BASE – lies proximally
    2. SHAFT – lies in the middle
    3. HEAD – lies distally

Bones of the Hand



THANK YOU

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