

Introduction to the Upper Limb



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Overview

- Shoulder
- Arm
- Forearm
- Hand

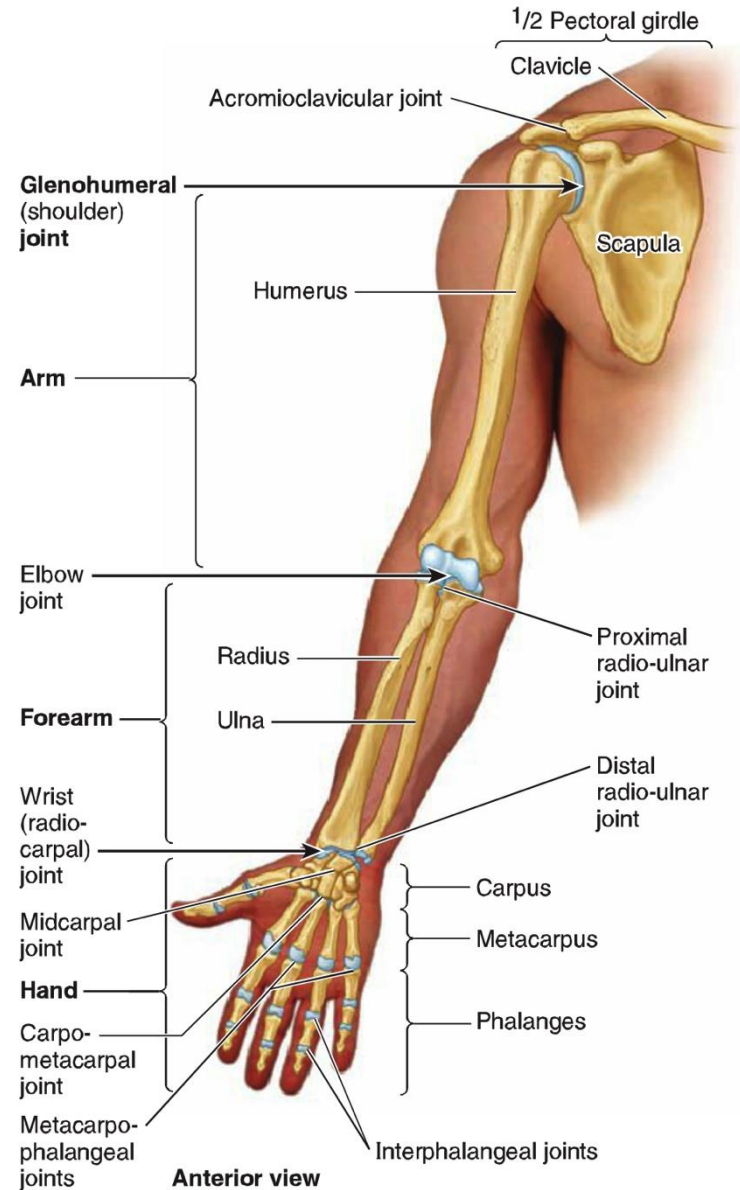
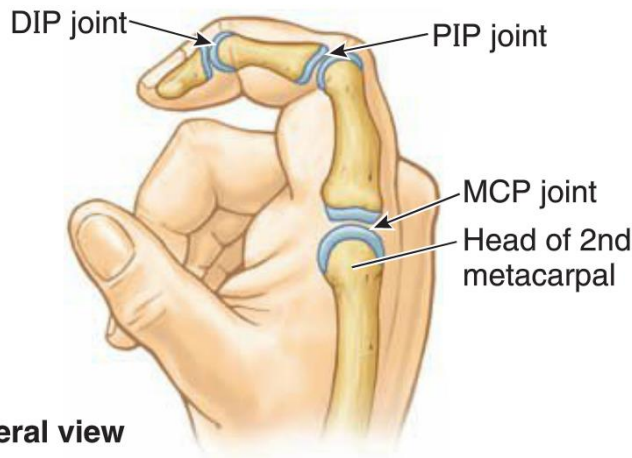


FIGURE 6.1. Segments and bones of upper limb. The upper limb is divided into four main segments: shoulder, arm, forearm, and hand.

Overview

- Bones
- Joints

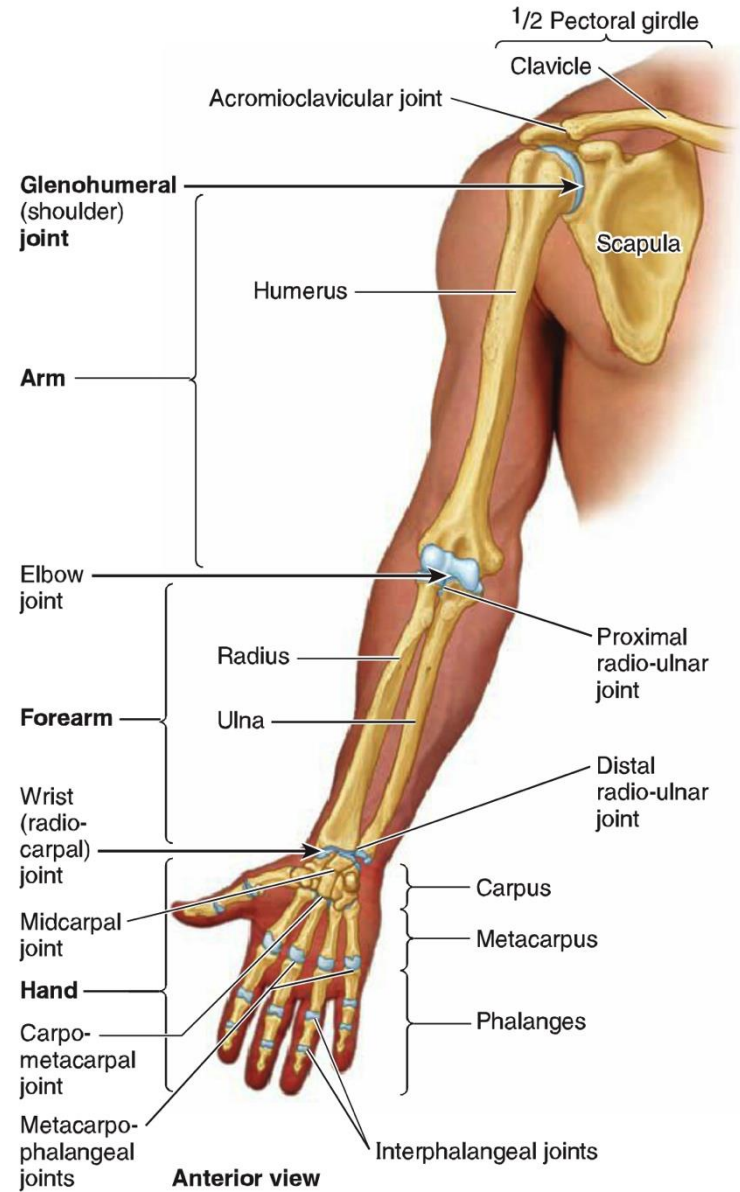
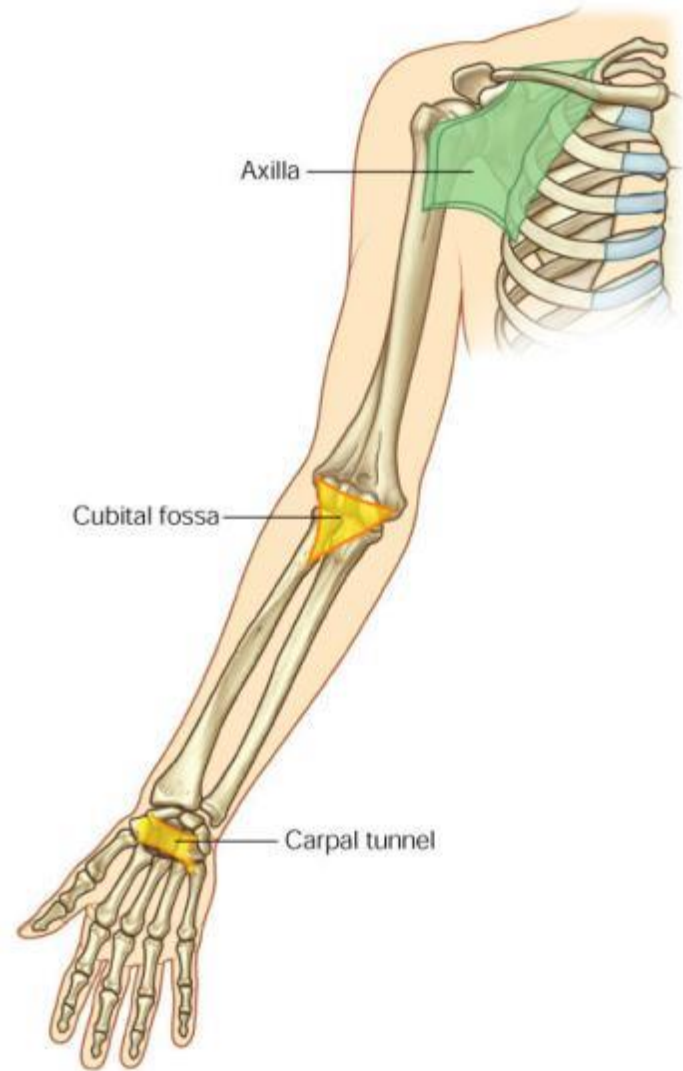


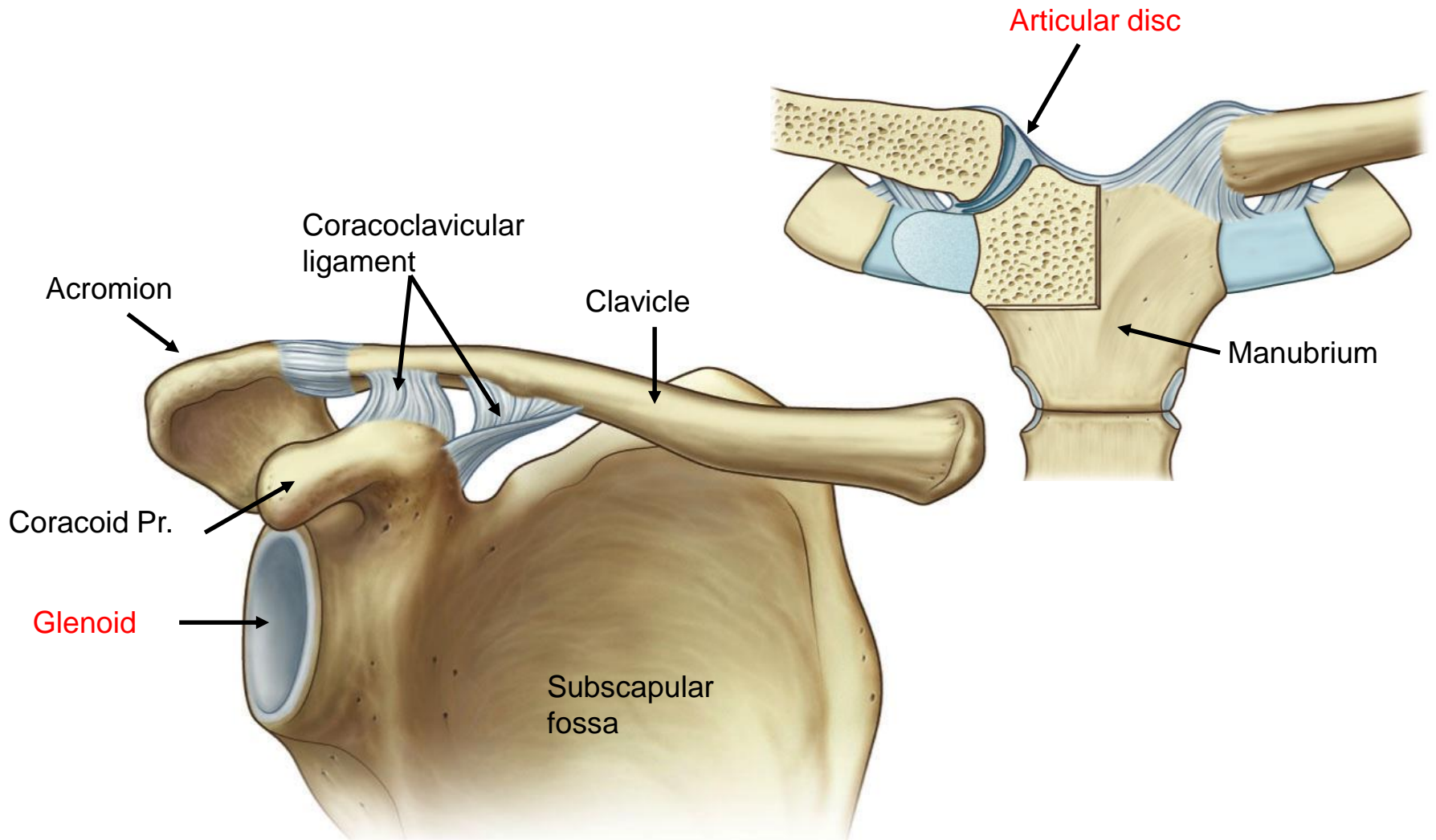
FIGURE 6.1. Segments and bones of upper limb. The upper limb is divided into four main segments: shoulder, arm, forearm, and hand.

Overview

- Bones
- Joints
- Areas of transition



Clavicle



Upper limb movements

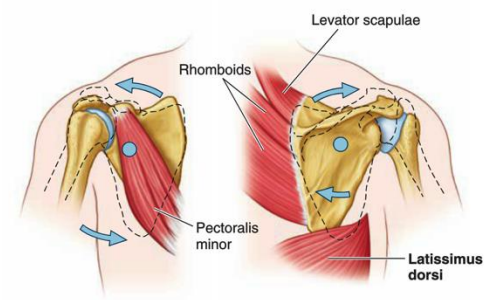
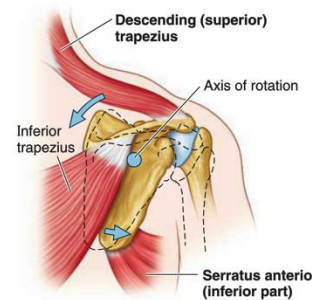
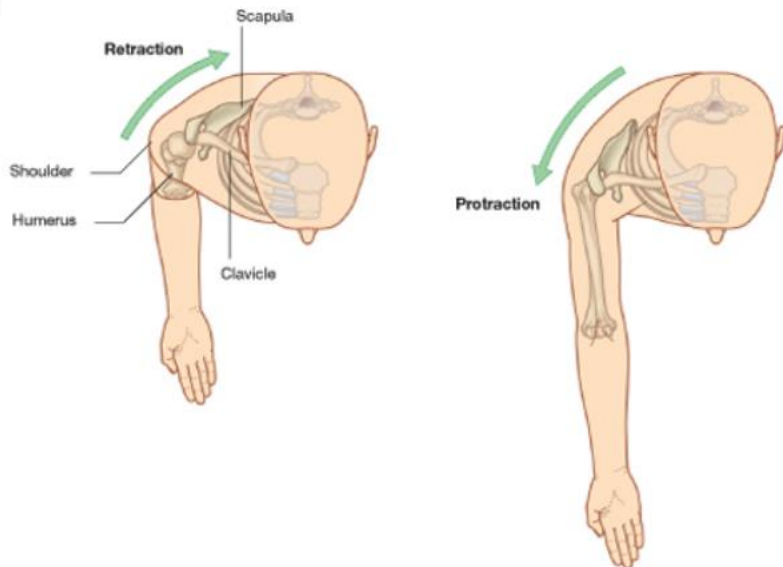
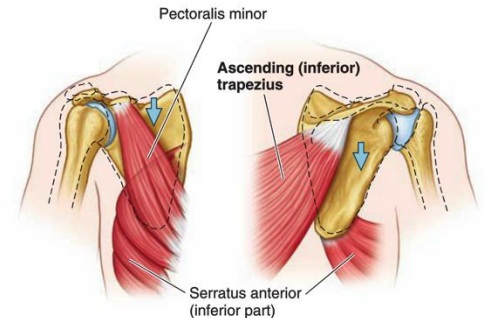
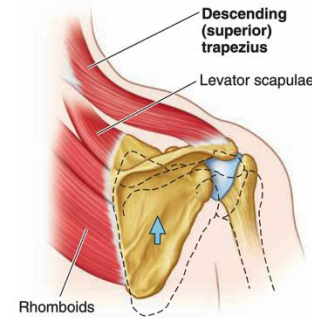
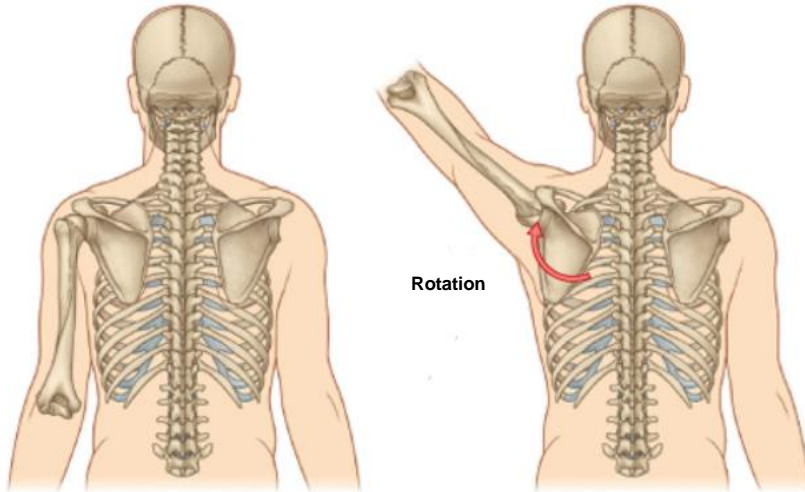
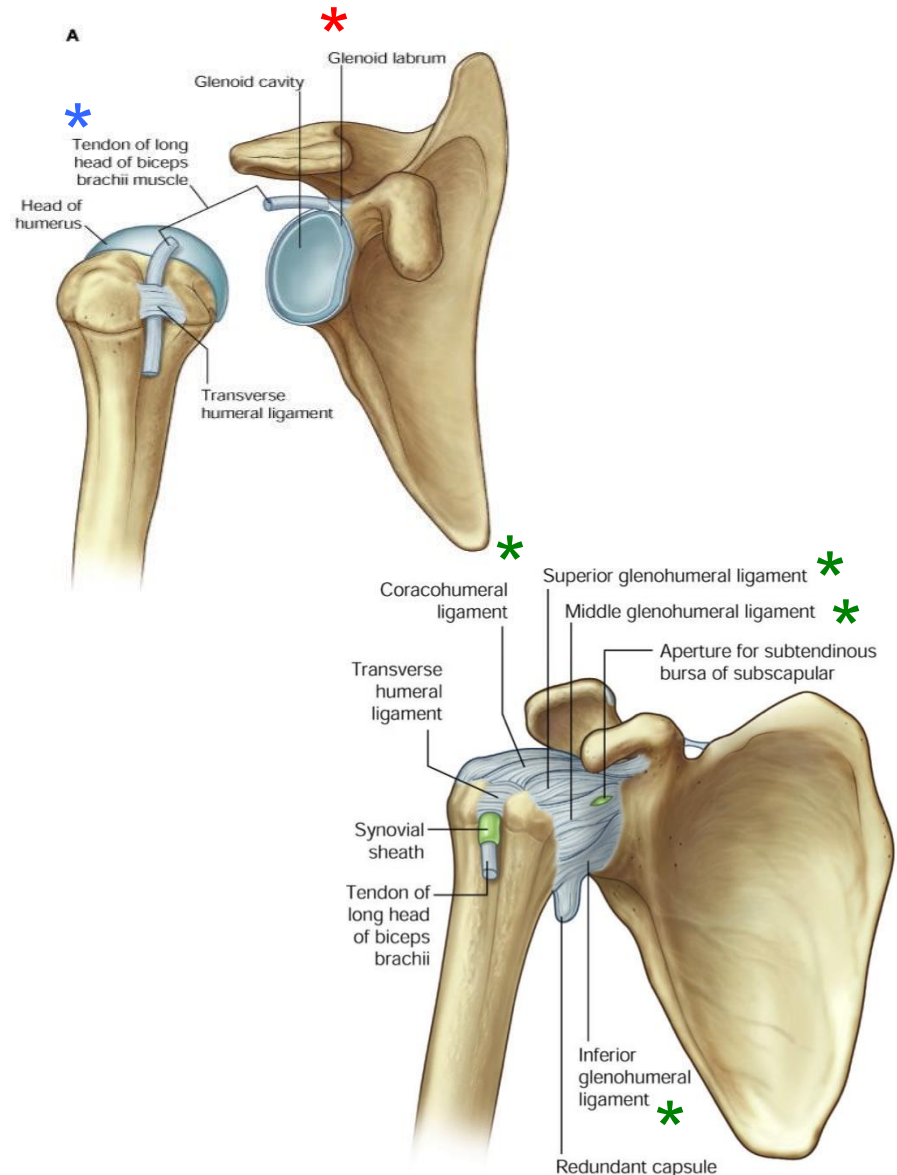


FIGURE 6.53. Scapular movements. Scapula moves on the thoracic wall at the conceptual "scapulohoracic joint." Dotted lines, the starting position of each movement.

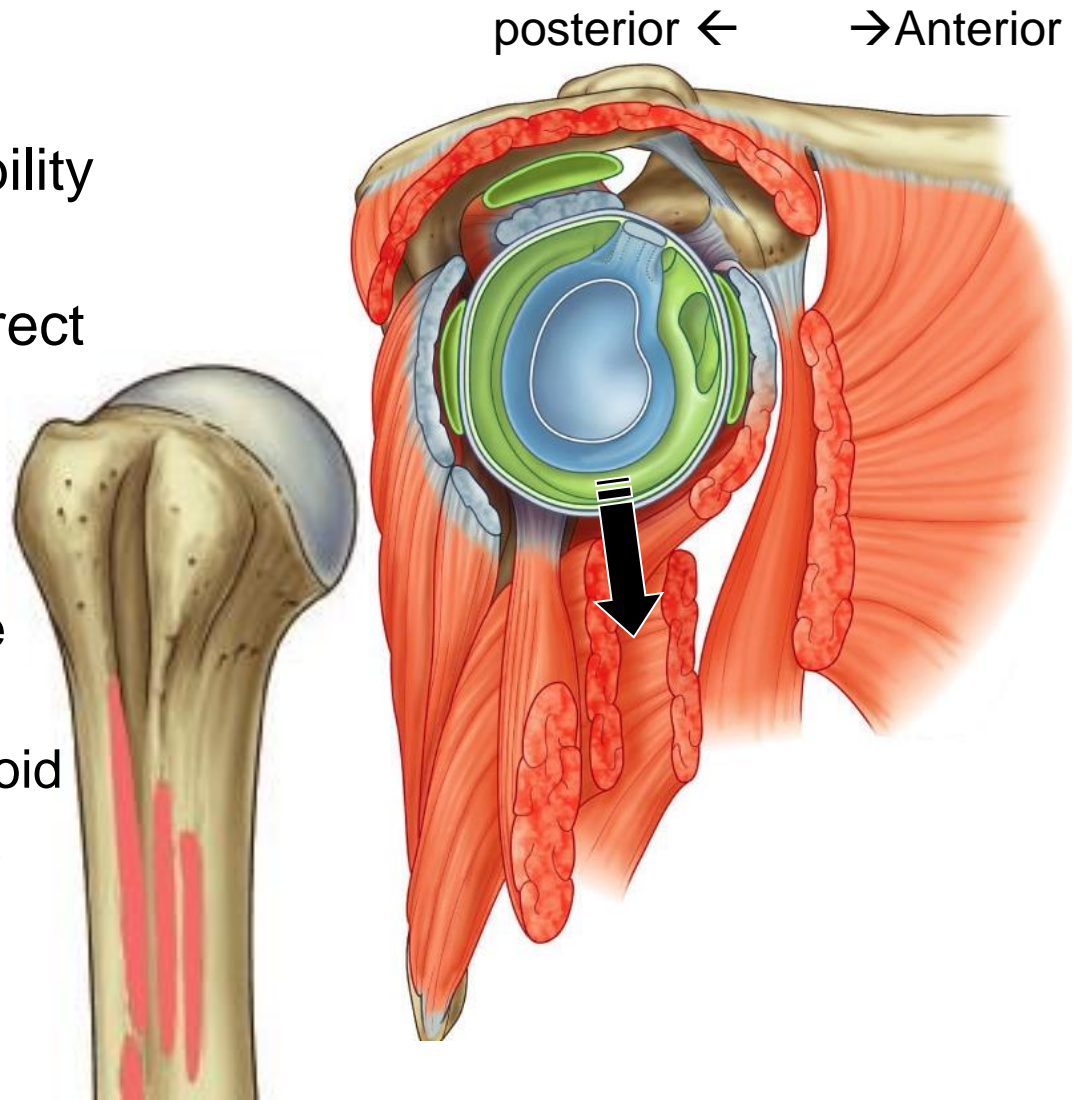
Glenohumeral Joint

- Broad movement
- Reduced skeletal stability
- Enhanced muscular, ligamentous, and indirect skeletal stability
 - Biceps tendon *
 - Glenoid labrum *
 - Fibrous joint capsule *
 - Acromion and coracoid



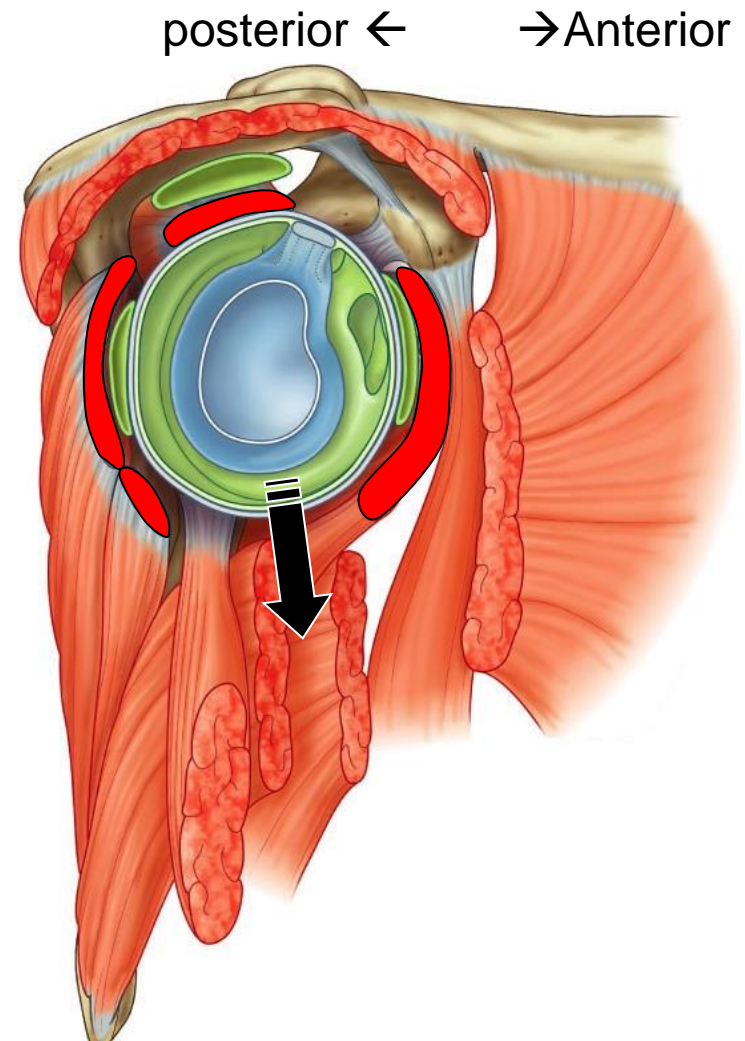
Glenohumeral Joint

- Broad movement
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 - Biceps tendon
 - Glenoid labrum
 - Fibrous joint capsule membrane
 - Acromion and coracoid
 - **Rotator cuff muscles**



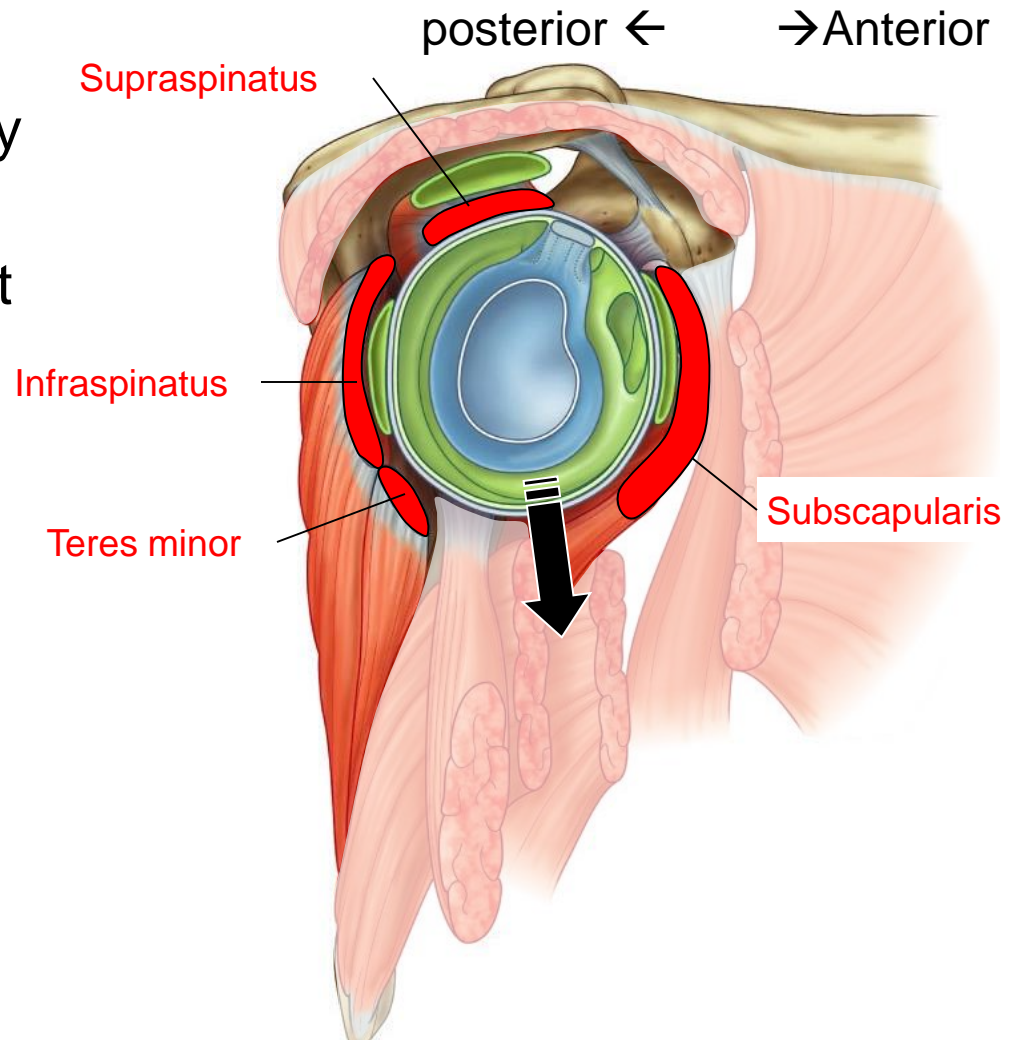
Glenohumeral Joint

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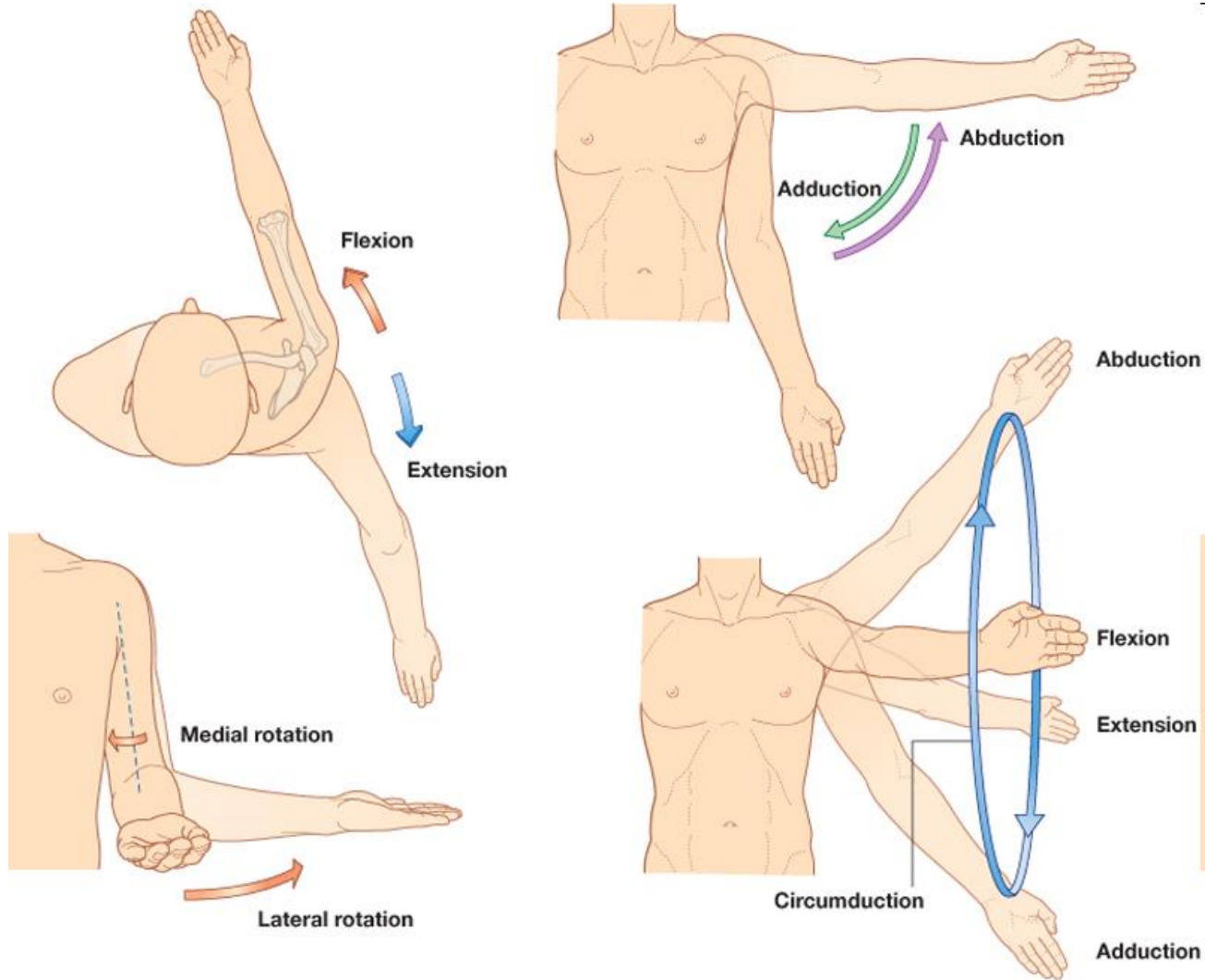


Glenohumeral joint

- Broad movement
- Reduced skeletal stability
- Enhanced muscular, ligamentous, and indirect skeletal stability
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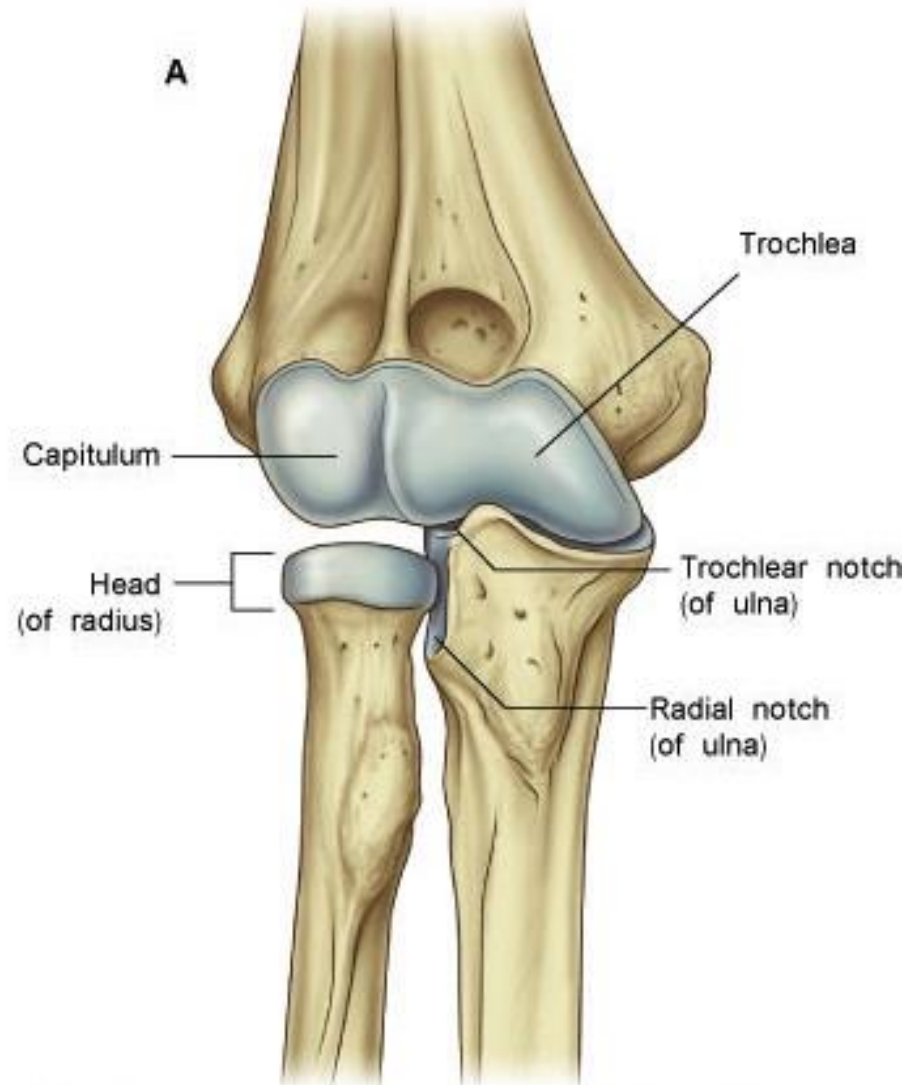


Upper limb movements



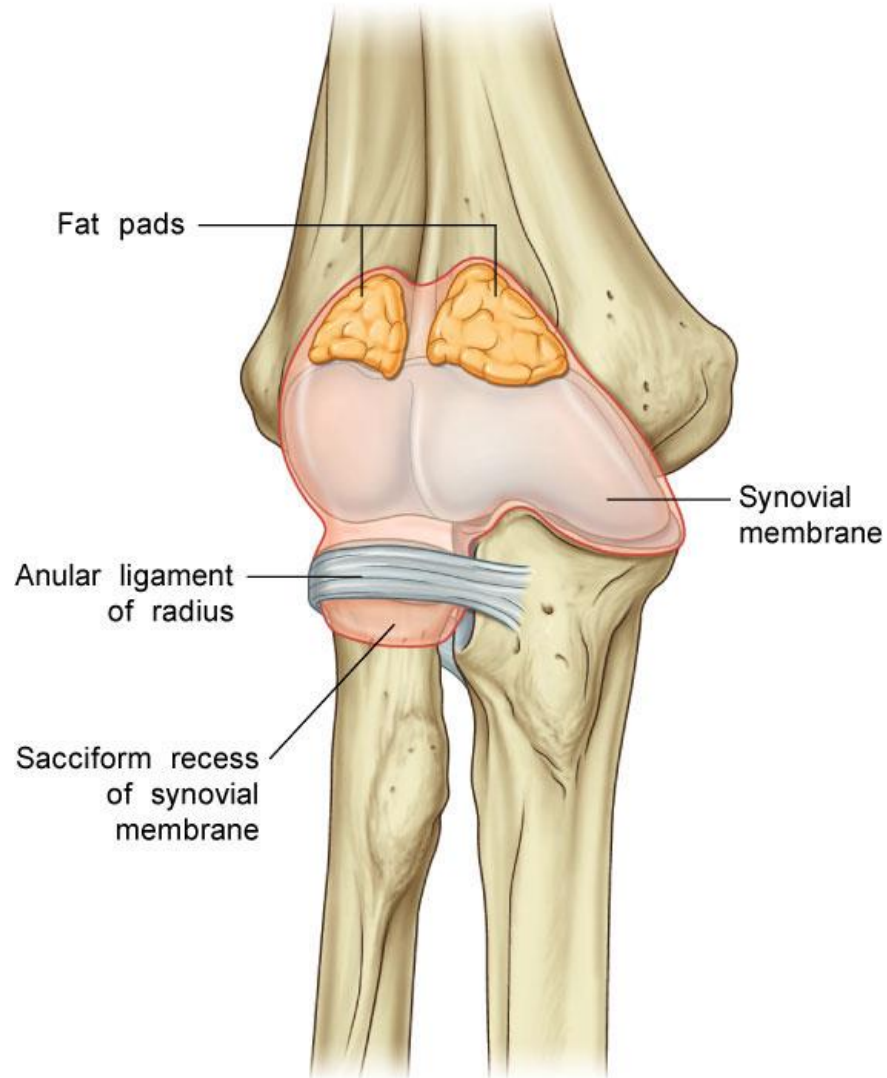
Elbow Joint

Anterior View



Elbow Joint

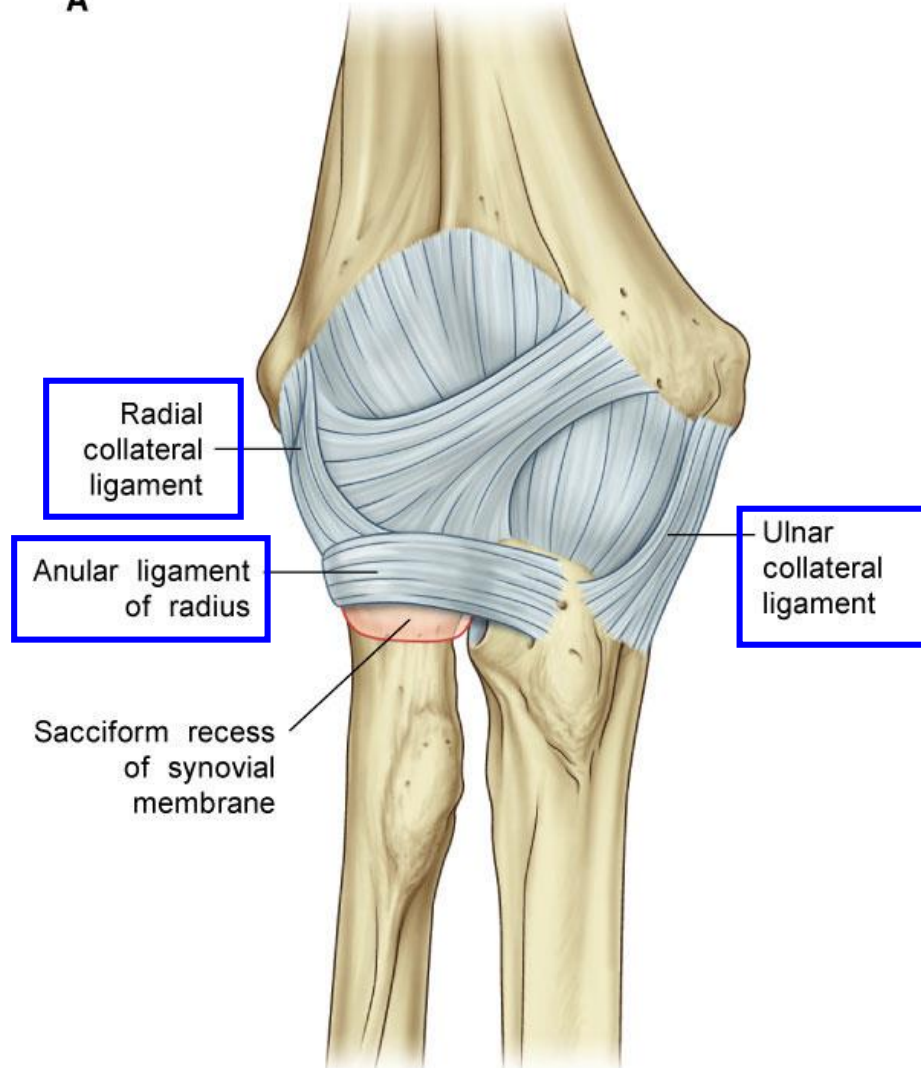
Anterior View



Elbow Joint

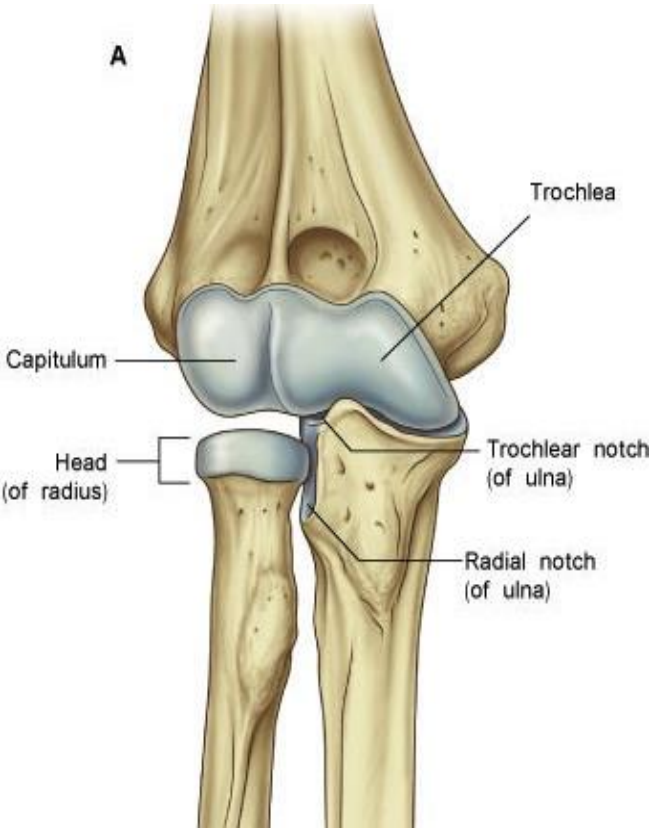
Anterior View

A

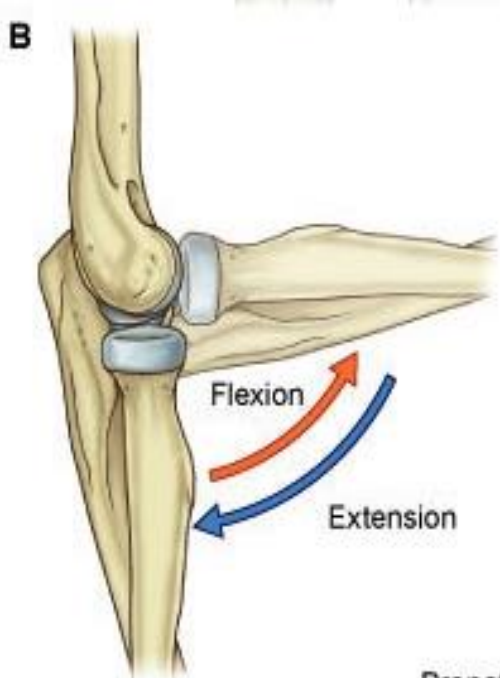


Elbow Joint

Anterior



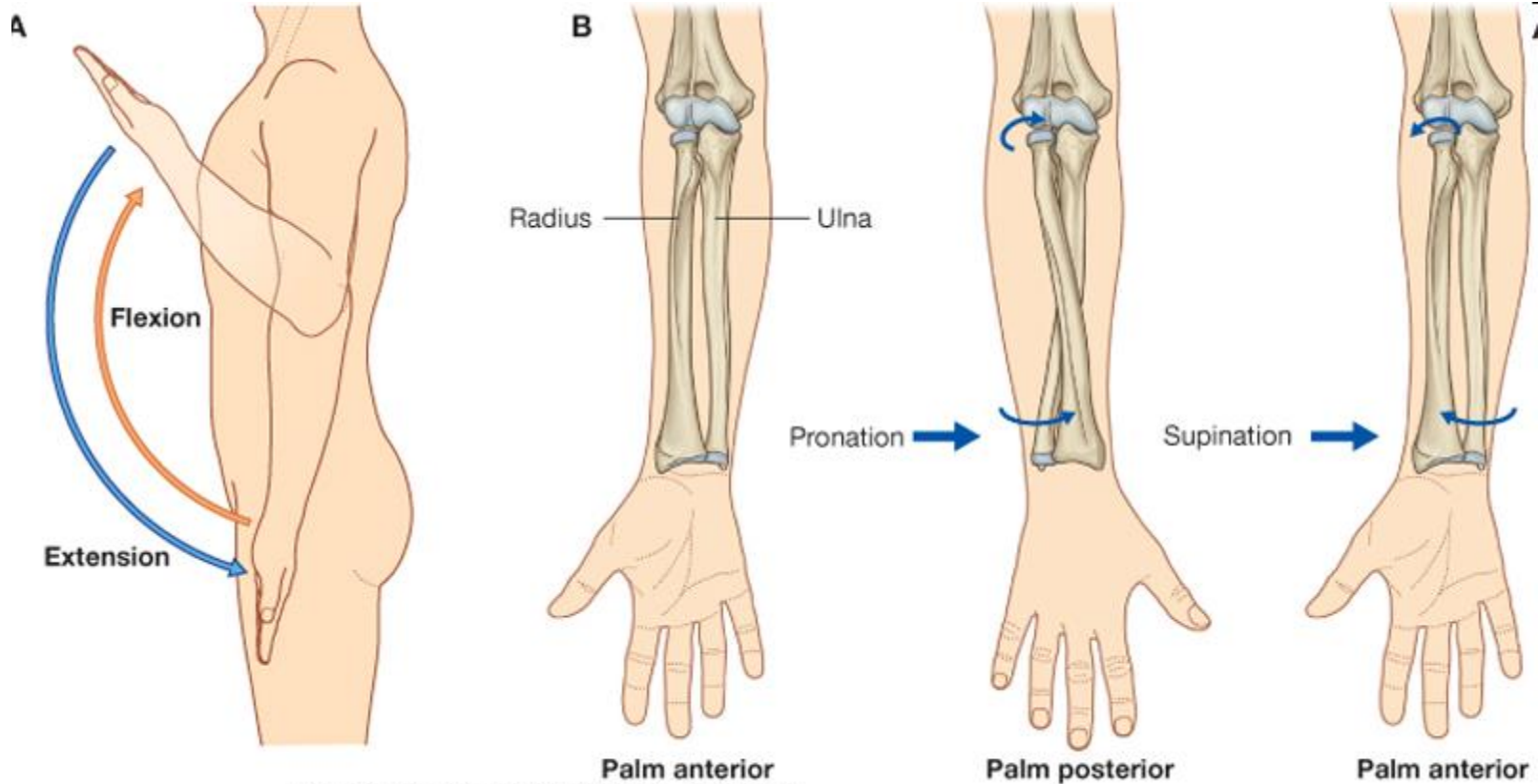
Lateral



Anterior



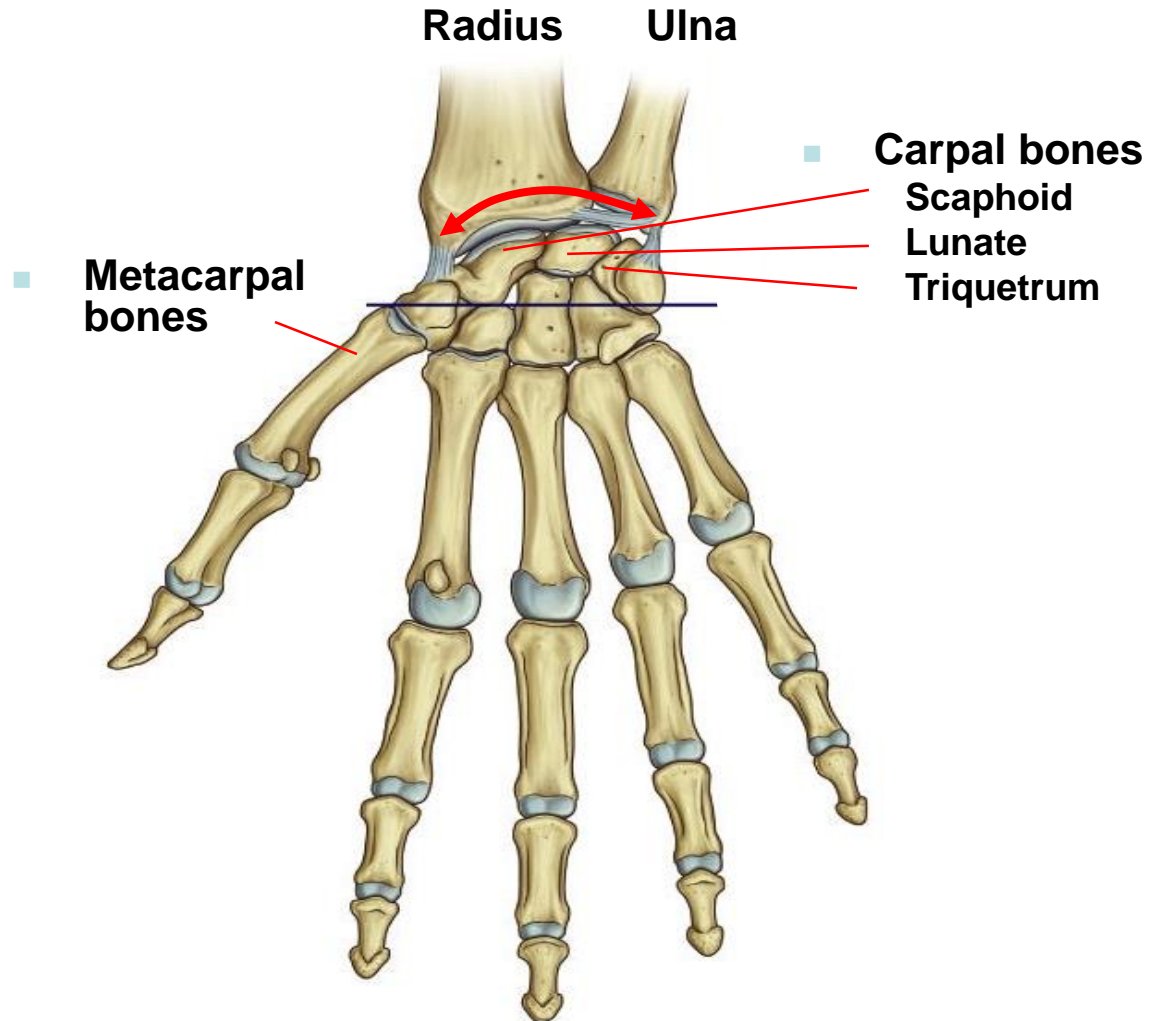
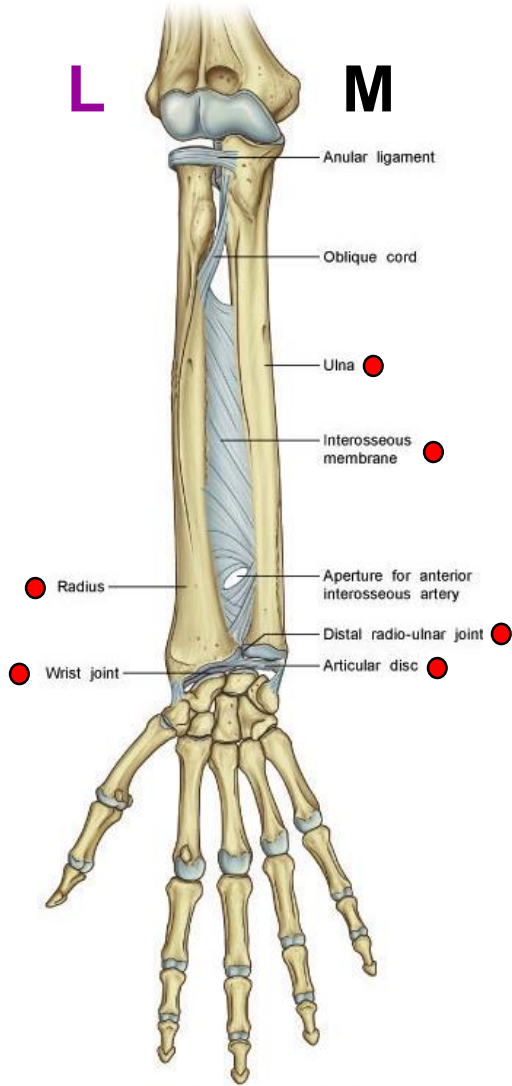
Upper limb movements



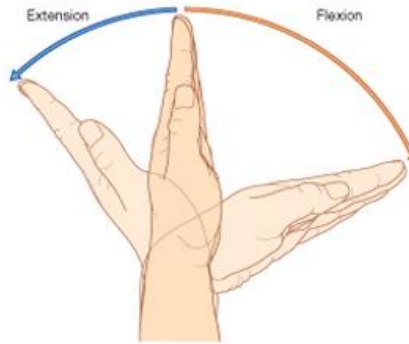
Drake: Gray's Anatomy for Students, 2nd Edition.

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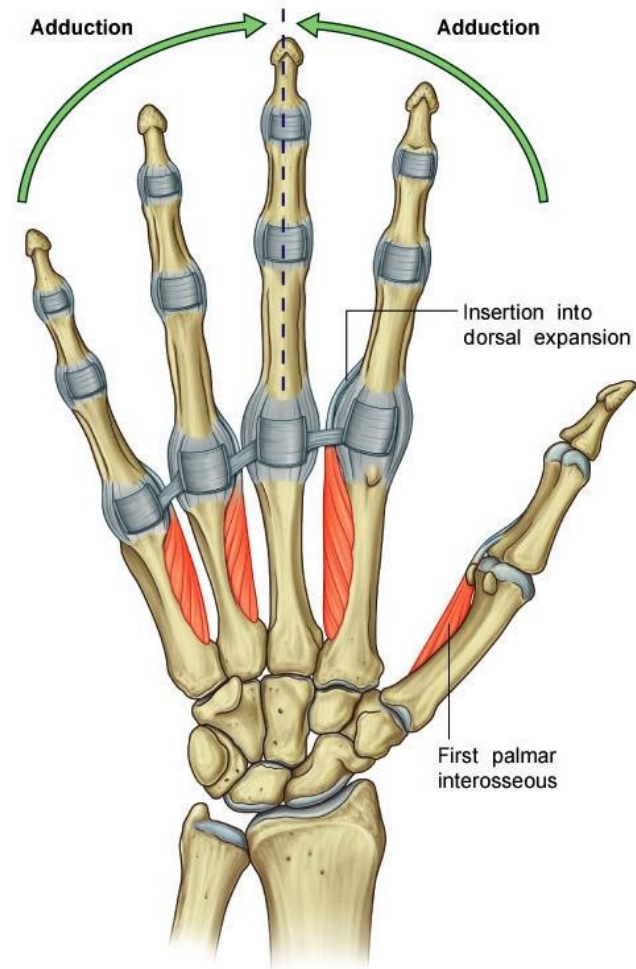
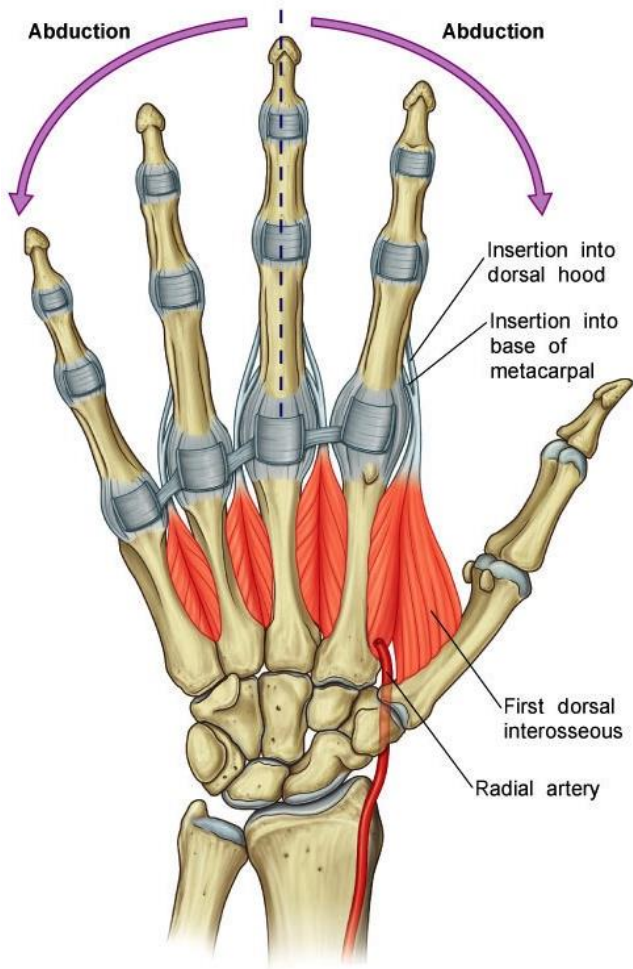
Wrist



Upper limb movements

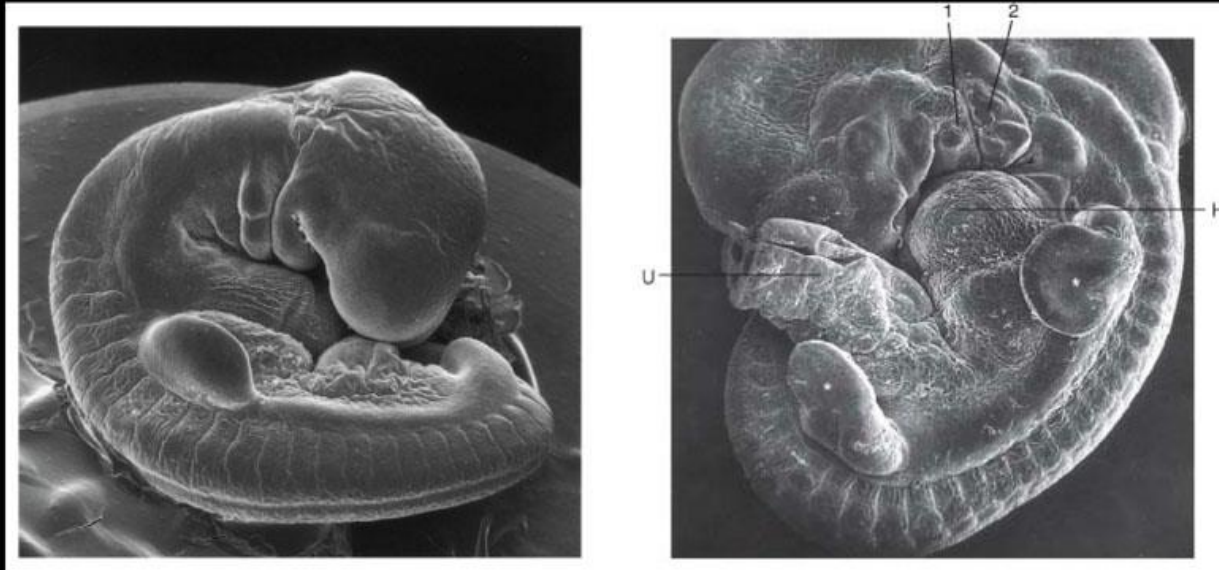


Upper limb movements



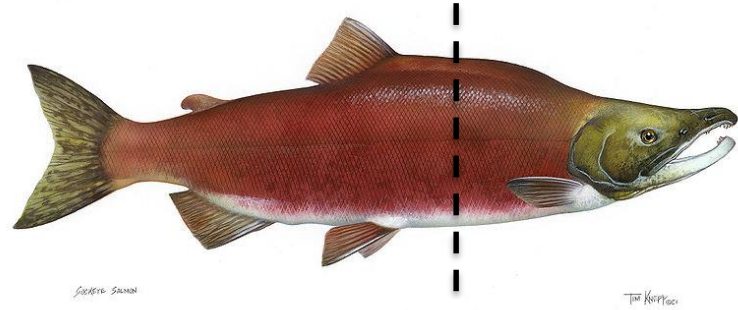
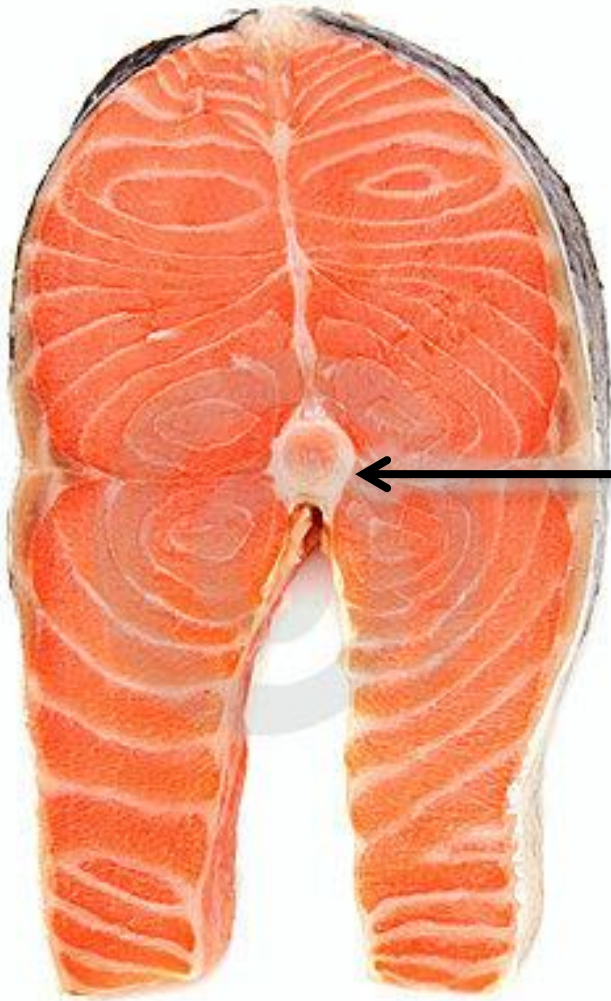
Innervation of the Upper Limb

4- and 5- week human embryos



- Limbs develop on the ventral (anterior) side of an embryo

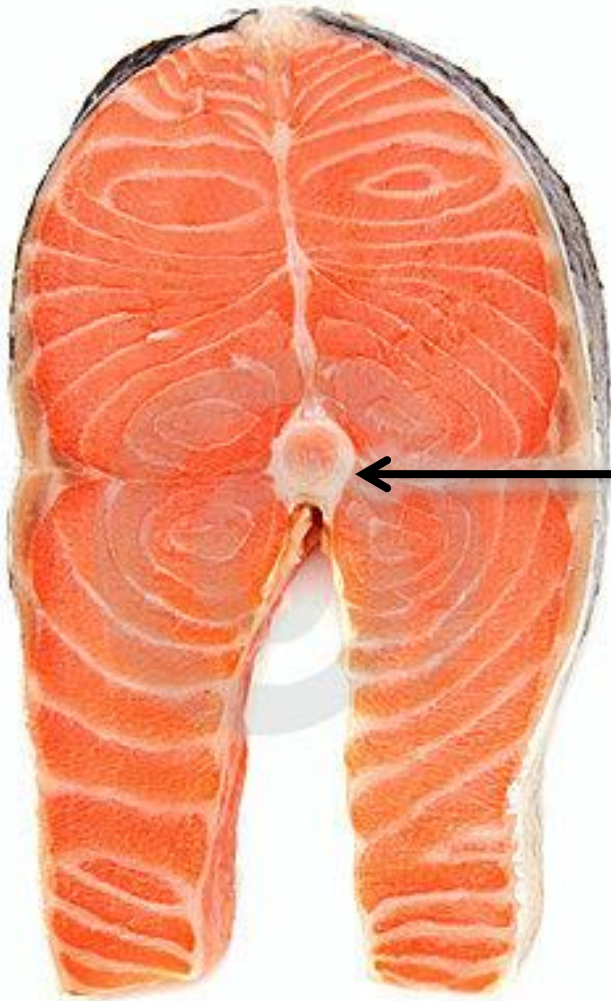
Epaxial vs. Hypaxial



Vertebral Column = Body **Axis**

dreamstime.com
Insert guts here

Epaxial vs. Hypaxial

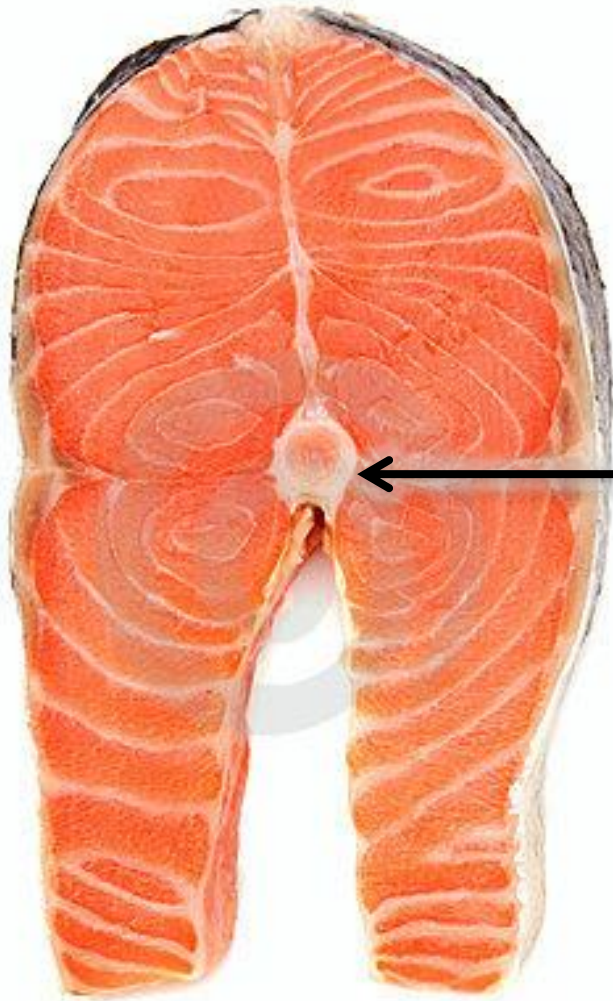


Epi = above or over

← Vertebral column = body **axis**

Hypo = below or under

Epaxial vs. Hypaxial

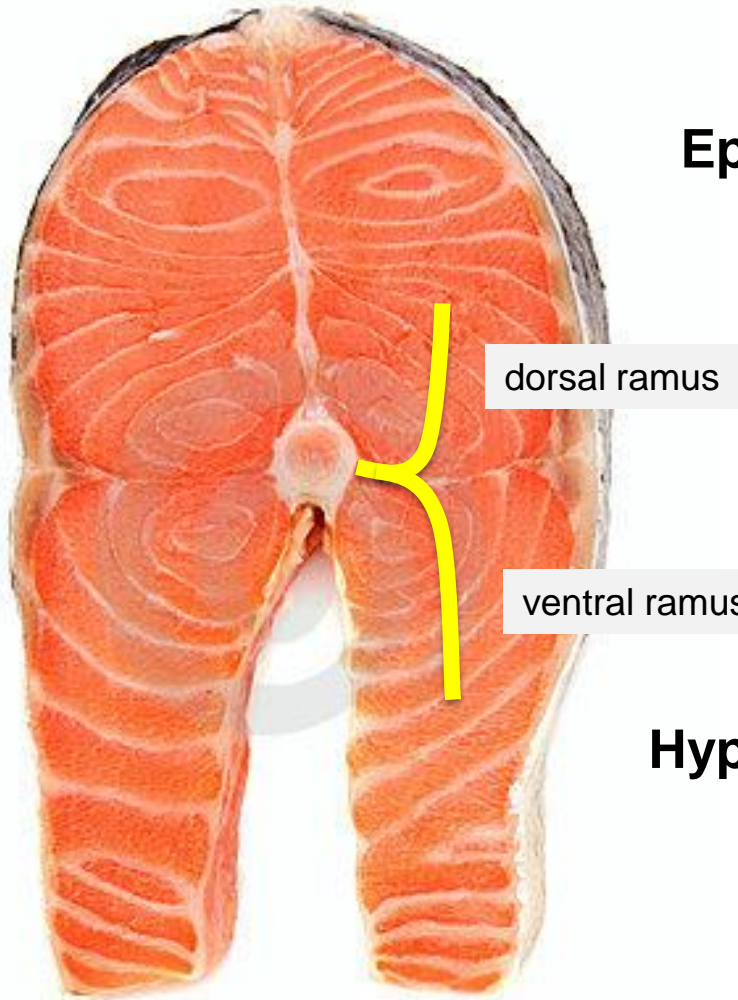


Epaxial = muscle above the axis

← Vertebral column = body **axis**

Hypaxial = muscle below the axis

Epaxial vs. Hypaxial



Epaxial muscles

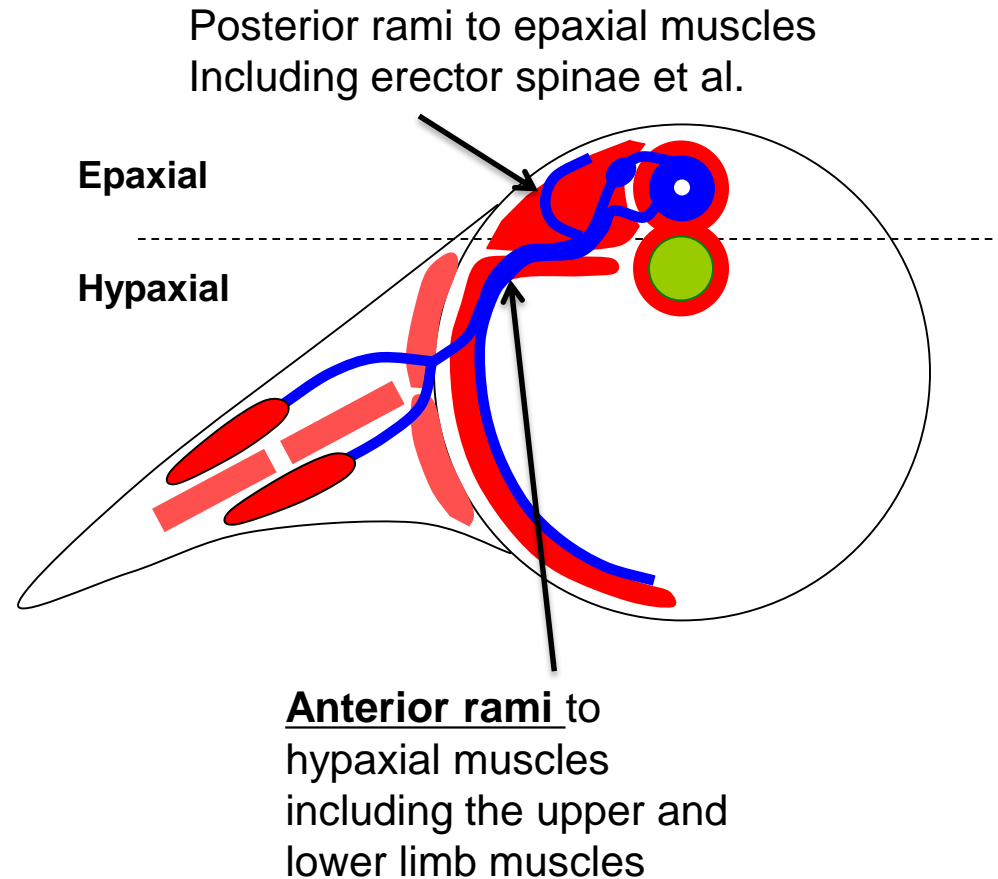
- innervated by dorsal (posterior) rami of spinal nerves

Hypaxial muscles

- innervated by ventral (anterior) rami of spinal nerves

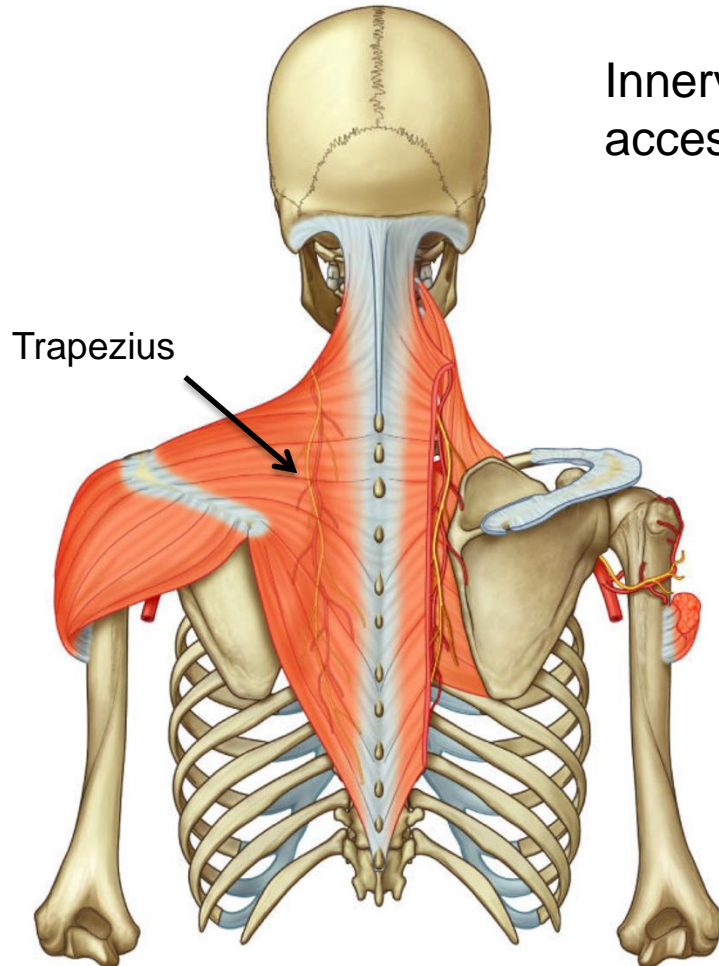
Limbs Develop on the Hypaxial = Ventral = Anterior Side of the Trunk

- Most of the muscles that attach to the girdle and limb are **hypaxial muscles**
- Thus, they are innervated by branches of **anterior rami** of spinal nerves
- Exceptions are the trapezius and SCM that are not hypaxial muscles and are innervated by cranial nerve XI



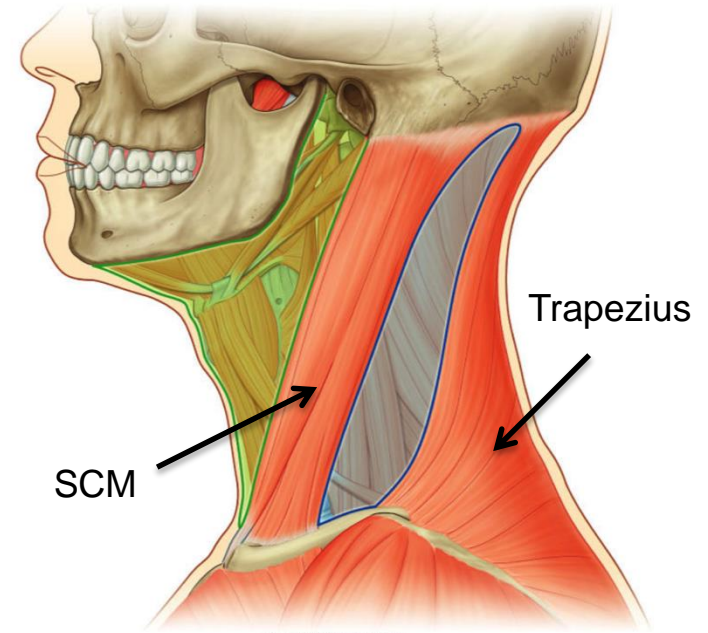
Trapezius and Sternocleidomastoid

Only muscles acting directly on the upper limb that are not innervated by branches of anterior primary rami of spinal nn.

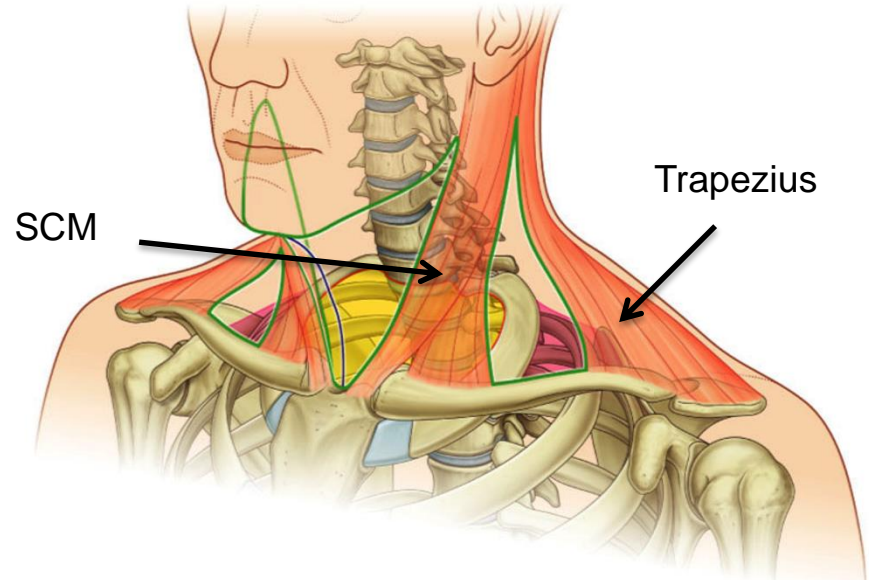


Innervated by spinal accessory n. (CN XI)

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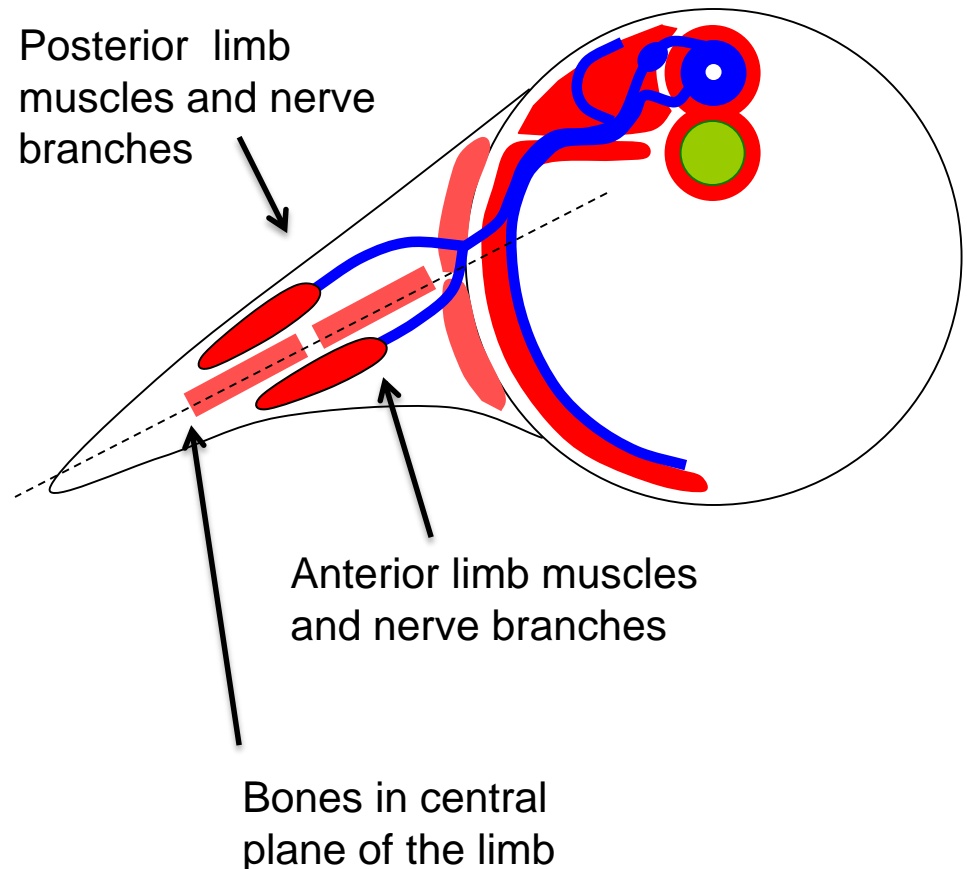


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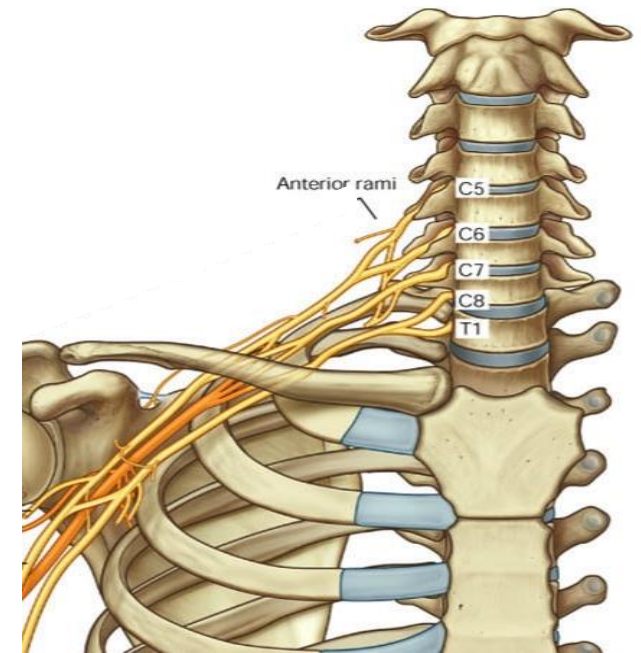
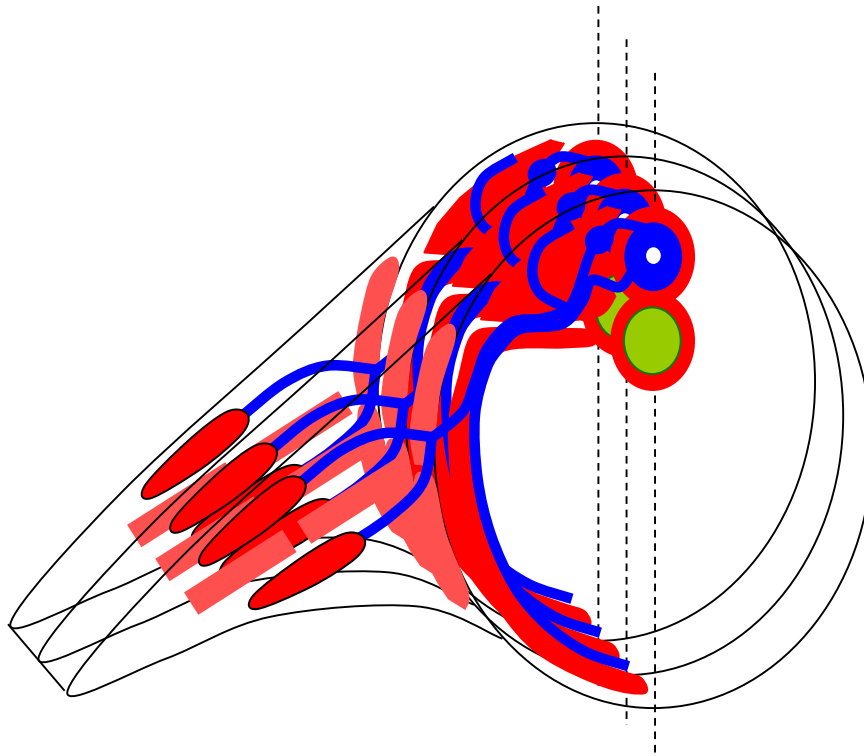
Limbs have posterior and anterior “halves” relative to their internal axis

- Limb girdle with posterior and anterior elements
- Limb skeleton in plane of separation
- Nerves with dorsal and ventral divisions
- Muscles in posterior (extensor) and anterior (flexor) groups

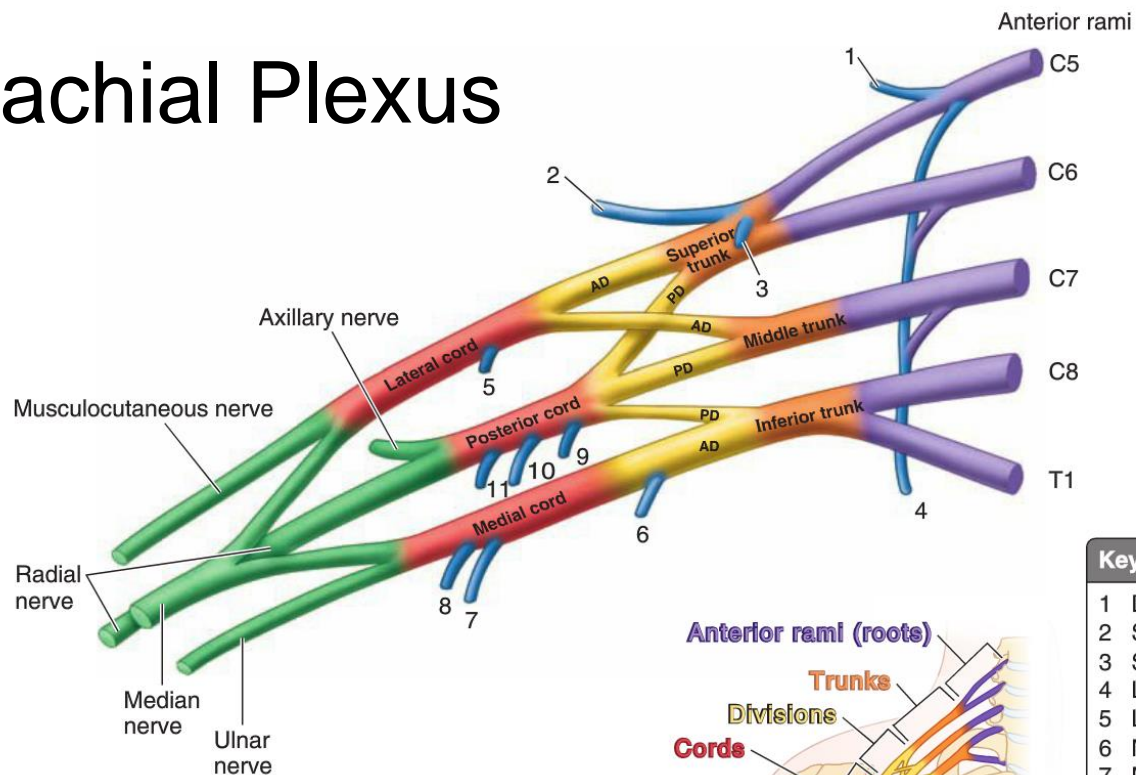


Limb innervation

- Limbs are multi-segmental
- They are supplied by multiple nerve segments



The Brachial Plexus



Key	
1	Dorsal scapular nerve
2	Suprascapular nerve
3	Subclavian nerve
4	Long thoracic nerve
5	Lateral pectoral nerve
6	Medial pectoral nerve
7	Medial cutaneous nerve of arm
8	Medial cutaneous nerve of forearm
9	Upper subscapular nerve
10	Thoracodorsal nerve
11	Lower subscapular nerve
AD:	Anterior division
PD:	Posterior division
1-4:	Supraclavicular branches
5-11:	Infraclavicular branches

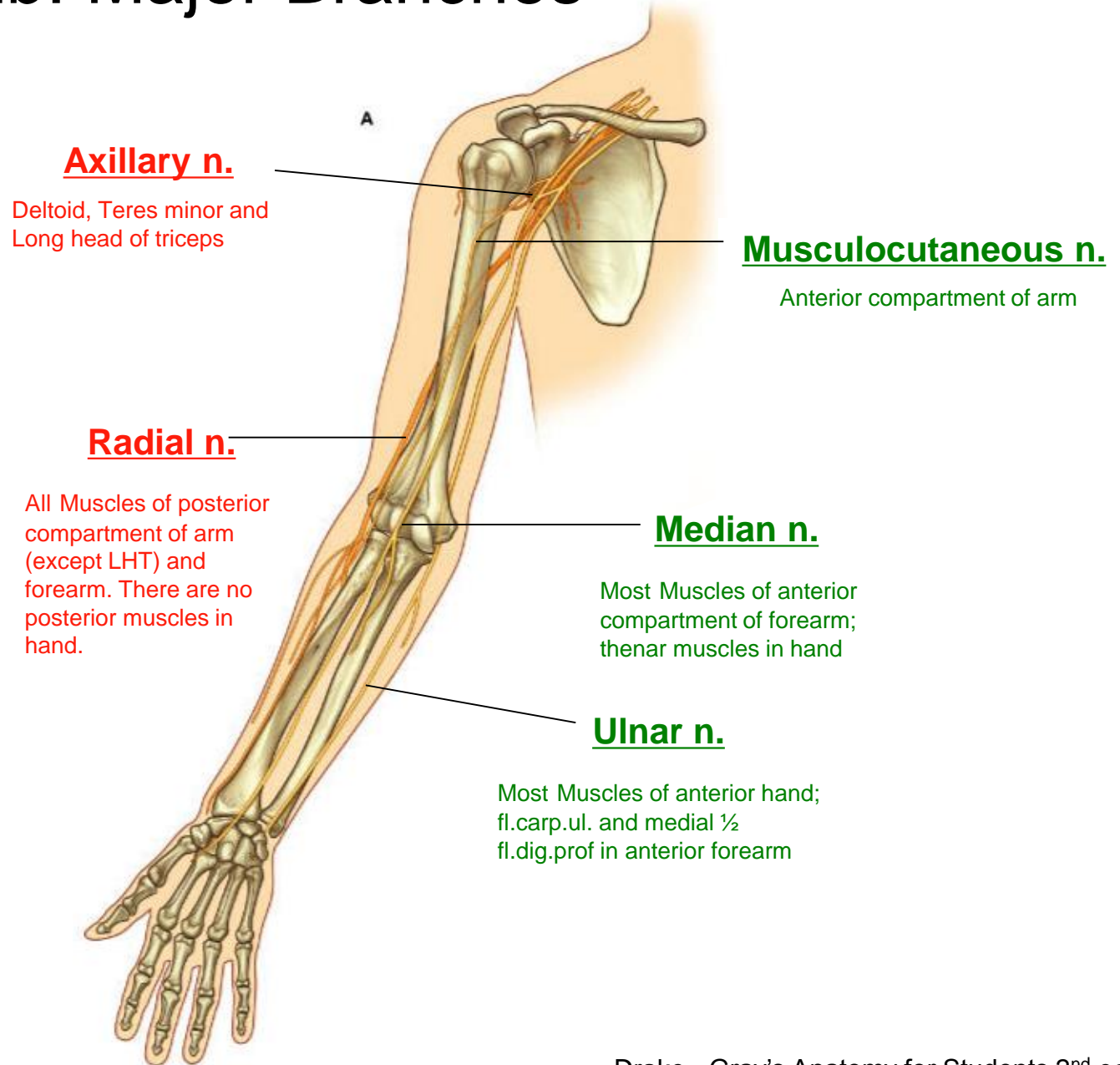
FIGURE 6.23. Schematic illustrations of brachial plexus.



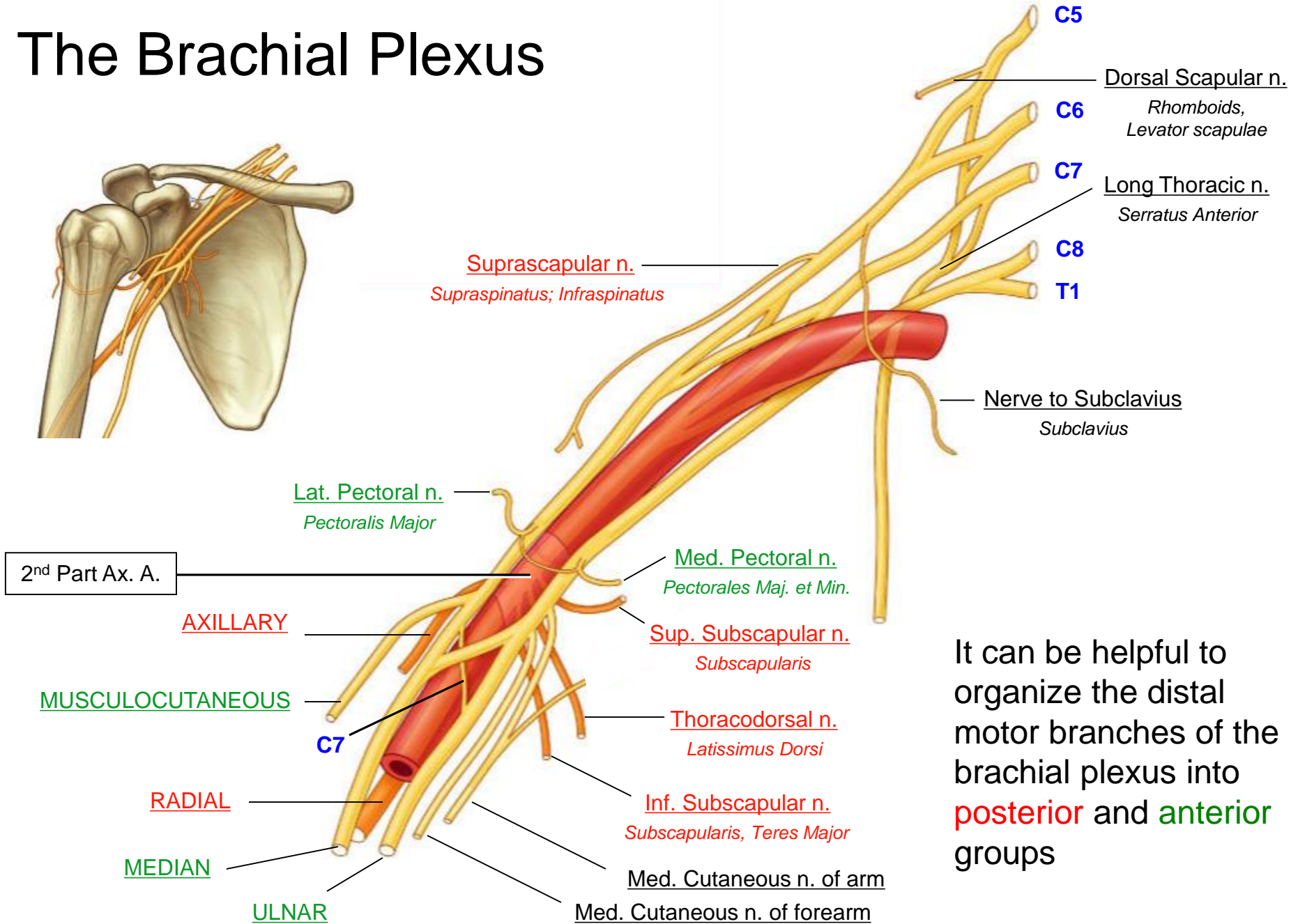
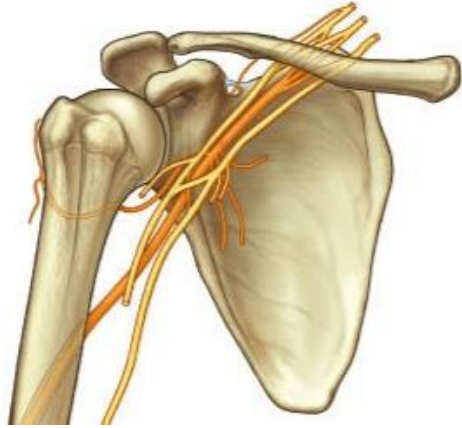
Randy Travis

Randy Travis Drinks Cold (Root) Beer

Upper Limb: Major Branches



The Brachial Plexus



It can be helpful to organize the distal motor branches of the brachial plexus into **posterior** and **anterior** groups

Muscles of the Shoulder

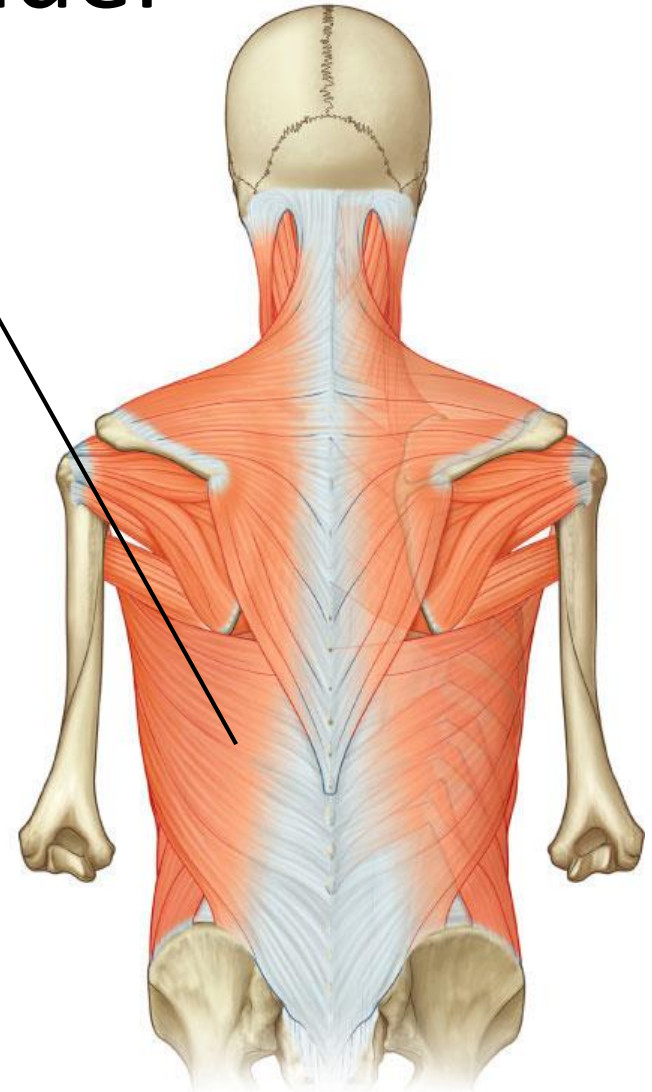
Latissimus dorsi

Origin: spinous processes of T6-L5 and sacrum, iliac crest, & ribs 10 to 12

Insertion: intertubercular sulcus of humerus

Innervation: Thoracodorsal nerve (C6-C8)

Action: Extends, adducts and medially rotates the humerus.



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Muscles of the Shoulder

Levator scapulae

Origin: Transverse process of C1 to C4

Insertion: Upper medial border of scapula

Innervation: C3, C4 & Dorsal scapular nerve (C4,C5)

Action: Elevates scapula

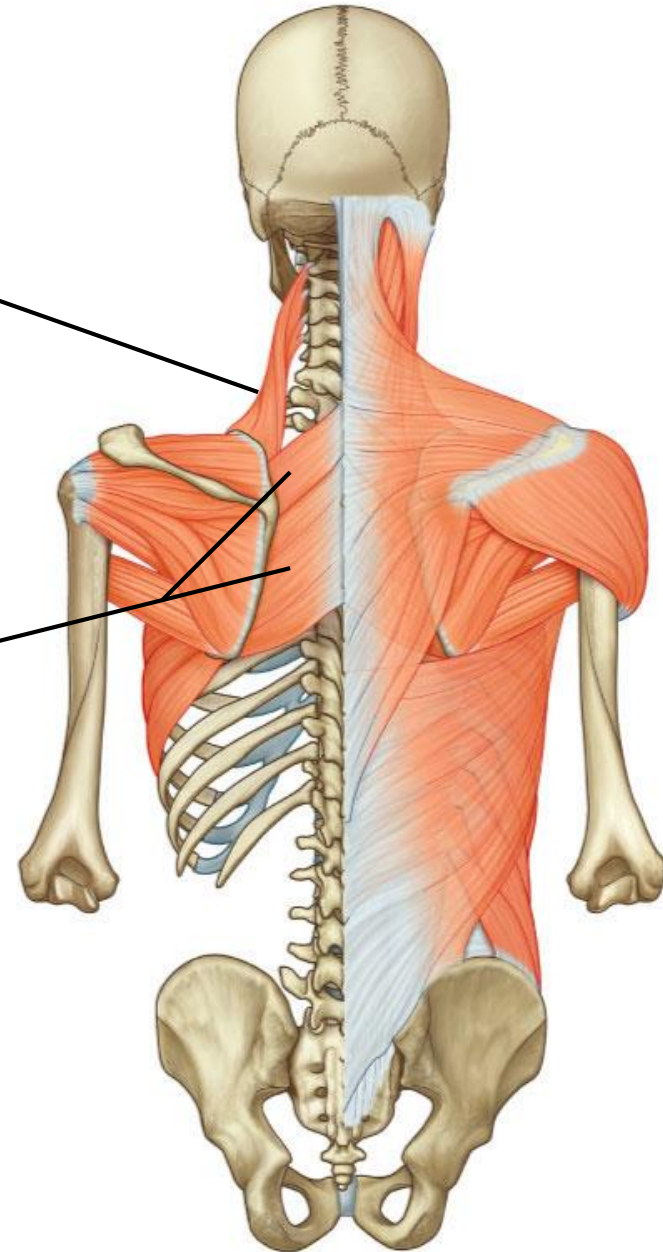
Rhomboid minor and major

Origin: Ligmentum nuchae and spinous processes of C7 to T5

Insertion: medial border of scapula

Innervation: Dorsal scapular nerve (C4,C5)

Action: Adducts, elevates and rotates scapula



Muscles of the Shoulder

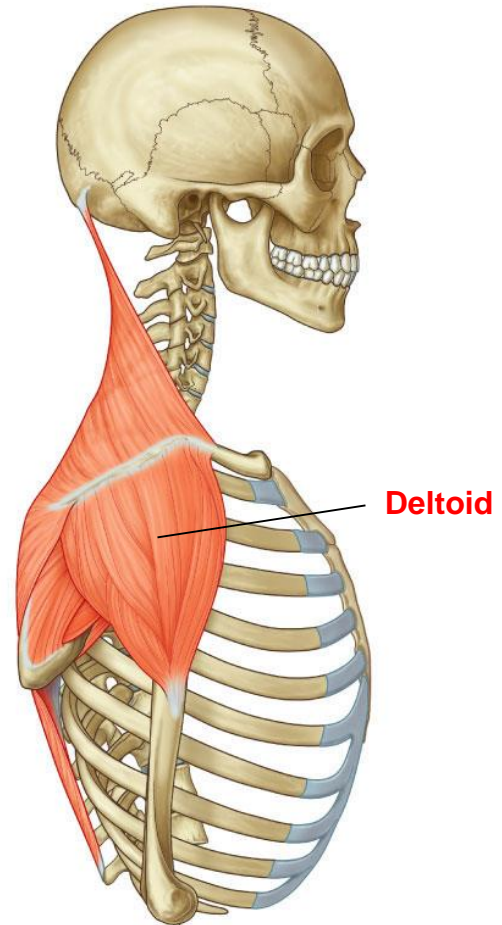
Deltoid

Origin: spine of scapula, acromion and lateral third of the clavicle

Insertion: Deltoid tuberosity of the humerus

Innervation: Axillary nerve (C5, C6)

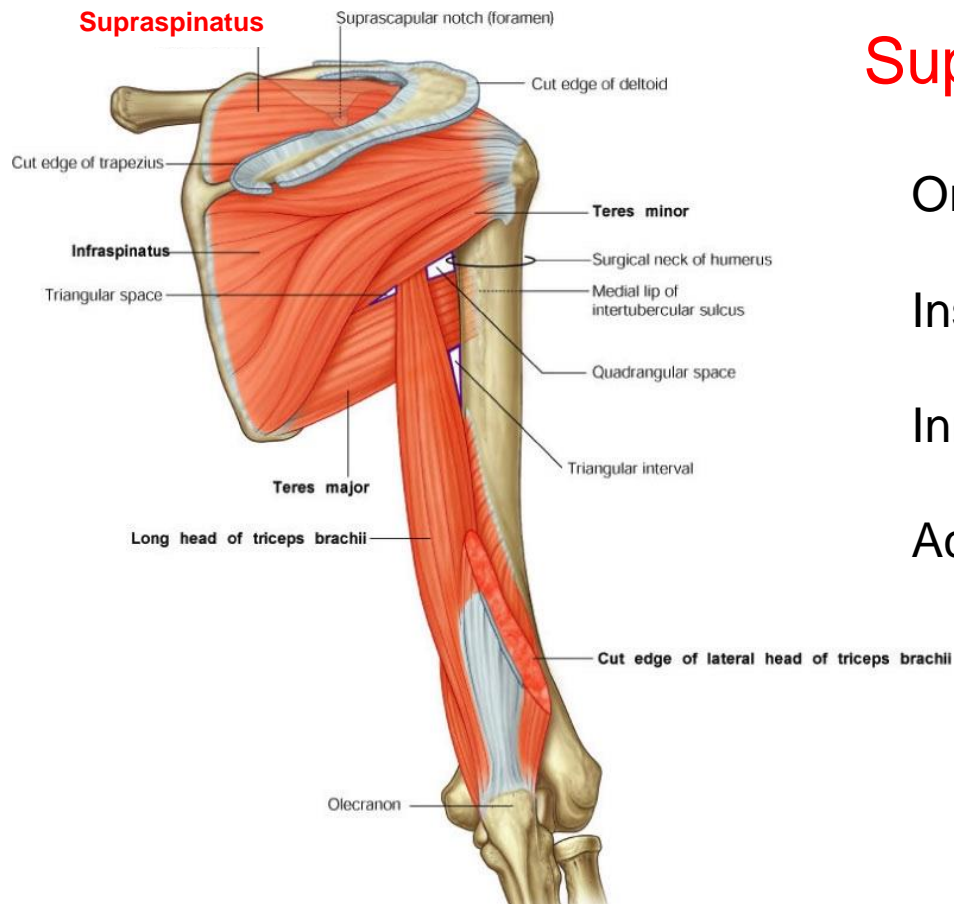
Action: Abducts humerus (15-90° abduction of arm)



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Muscles of the Shoulder

Rotator Cuff Muscles



Supraspinatus

Origin: Supraspinous fossa

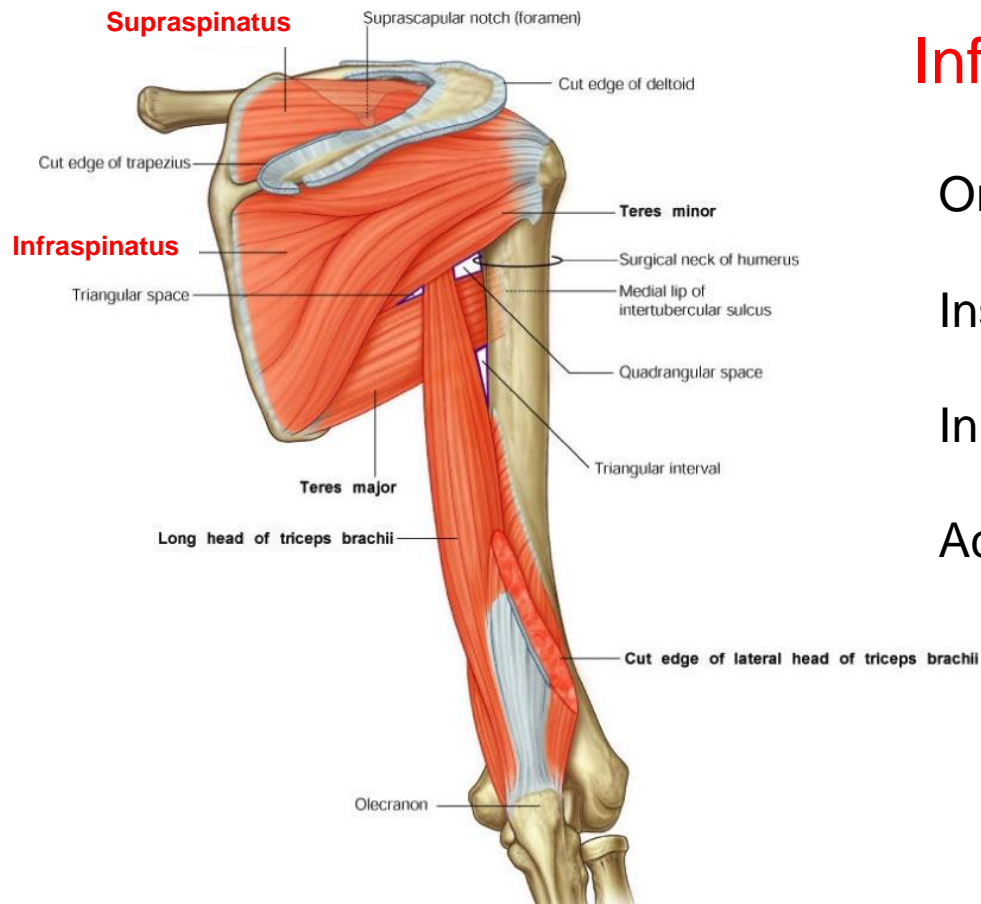
Insertion: Greater tubercle of humerus

Innervation: Suprascapular n. (C5, C6)

Action: abducts arm (below 15°)

Muscles of the Shoulder

Rotator Cuff Muscles



Infraspinatus

Origin: Infraspinous fossa

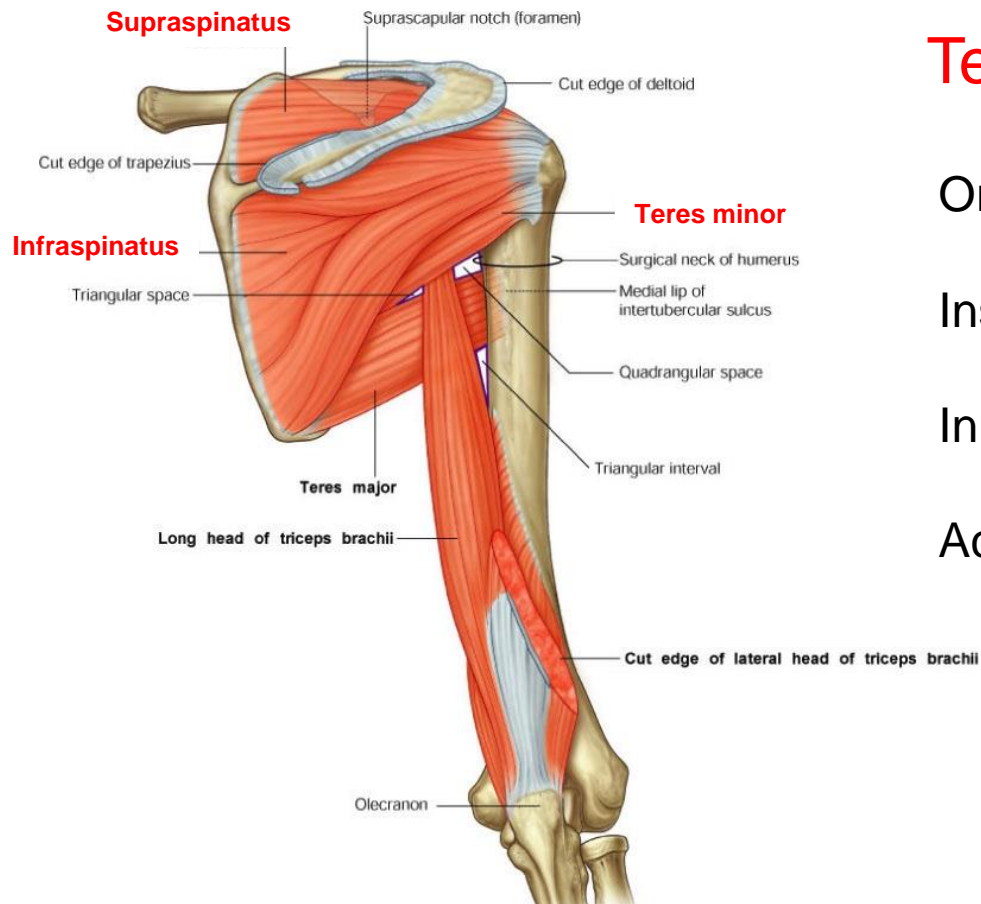
Insertion: Greater tubercle of humerus

Innervation: Suprascapular n. (C5, C6)

Action: Lateral rotation of humerus

Muscles of the Shoulder

Rotator Cuff Muscles



Teres Minor

Origin: lateral part of Infraspinous fossa

Insertion: Greater tubercle of humerus

Innervation: Axillary n. (C5, C6)

Action: Lateral rotation of humerus

Muscles of the Shoulder

Rotator Cuff Muscles

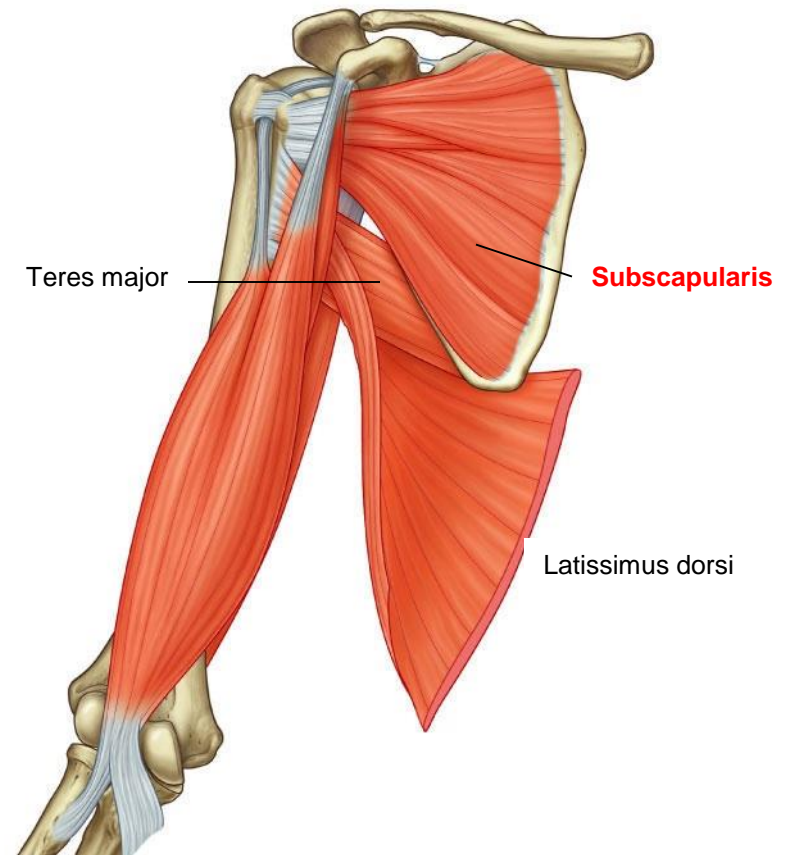
Subscapularis

Origin: subscapular fossa of the scapula

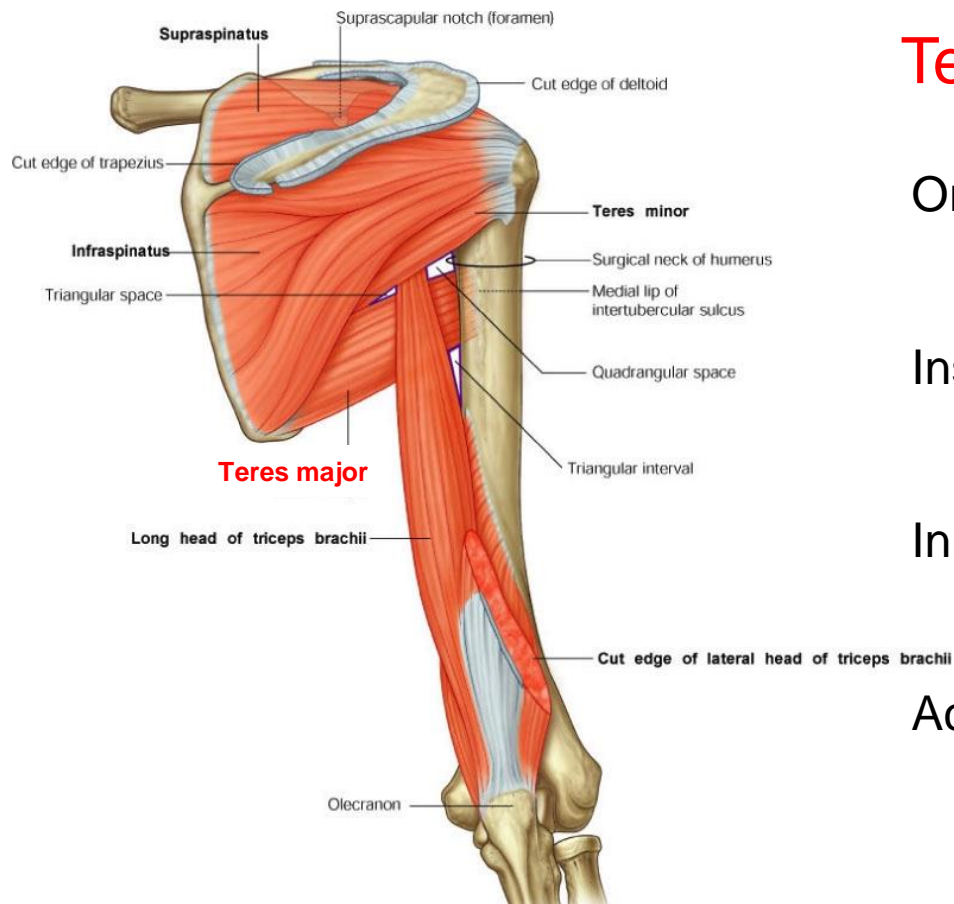
Insertion: Lesser tubercle of humerus

Innervation: Upper and lower subscapular nn. (C5 - C7)

Action: Medial rotation of arm



Muscles of the Shoulder



Teres major

Origin: posterior surface of inferior triangle of the scapula

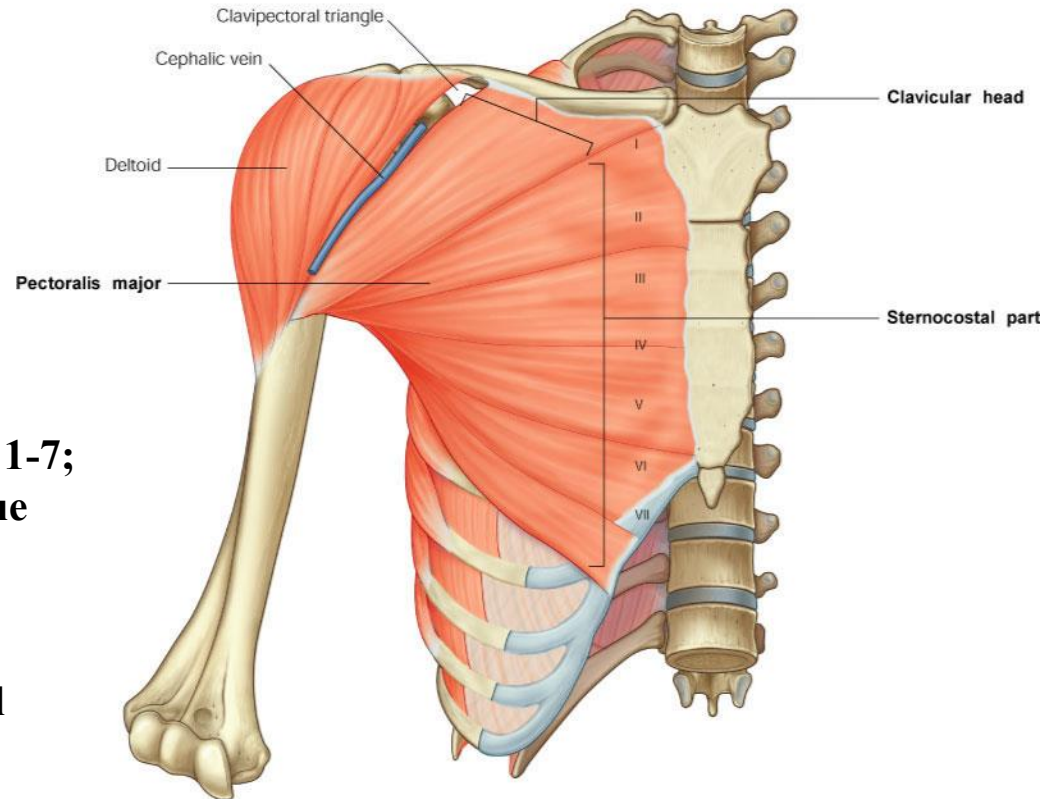
Insertion: Medial side of lesser tubercle on anterior side of humerus

Innervation: Inferior subscapular n.
(C5 - C7)

Action: Medial rotation and extension of humerus

Muscles of the Shoulder

Pectoralis Major



Origin: anterior, medial half of clavicle; anterior surface of sternum; costal cart. 1-7; rib 6; and aponeurosis of external oblique

Insertion: intertubercular sulcus of humerus (lateral lip)

Innervation: Medial and lateral pectoral nerves (C5-T1)

Action: Flexion, adduction and medial rotation of humerus. Extension of flexed arm (sternocostal part only)

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Muscles of the Shoulder

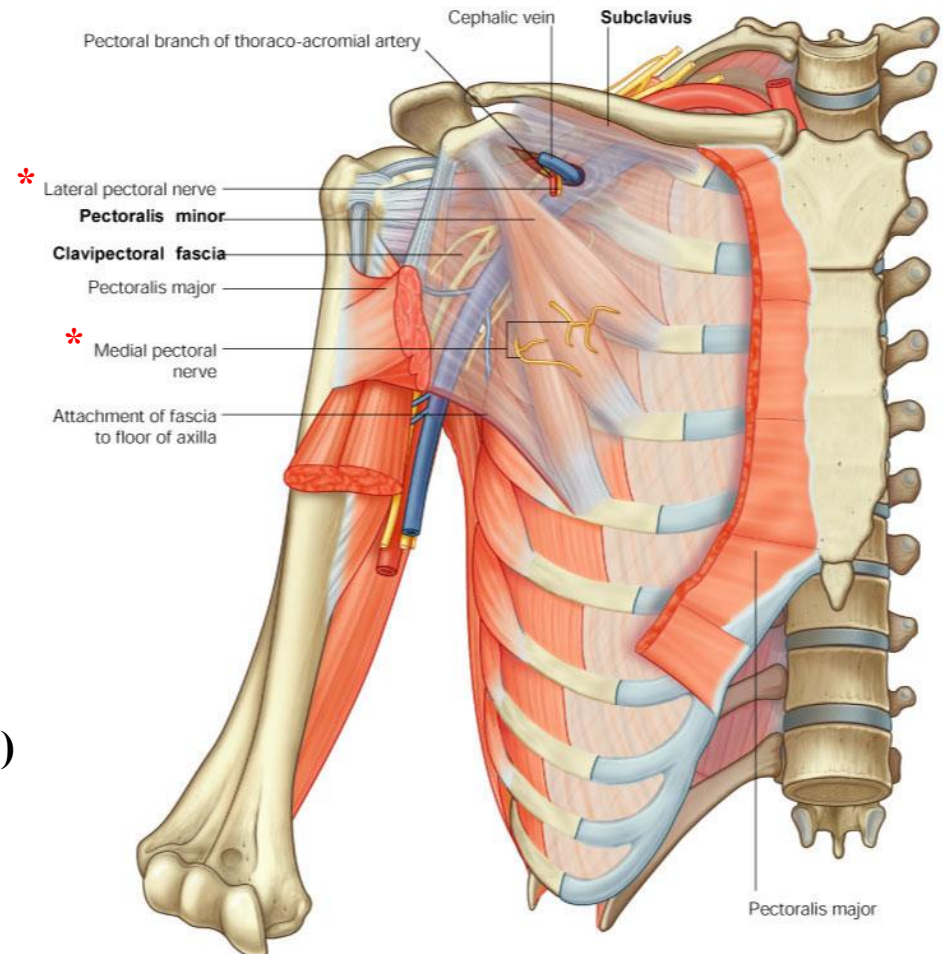
Pectoralis Minor

Origin: anterior surfaces and superior borders of ribs 3 to 5

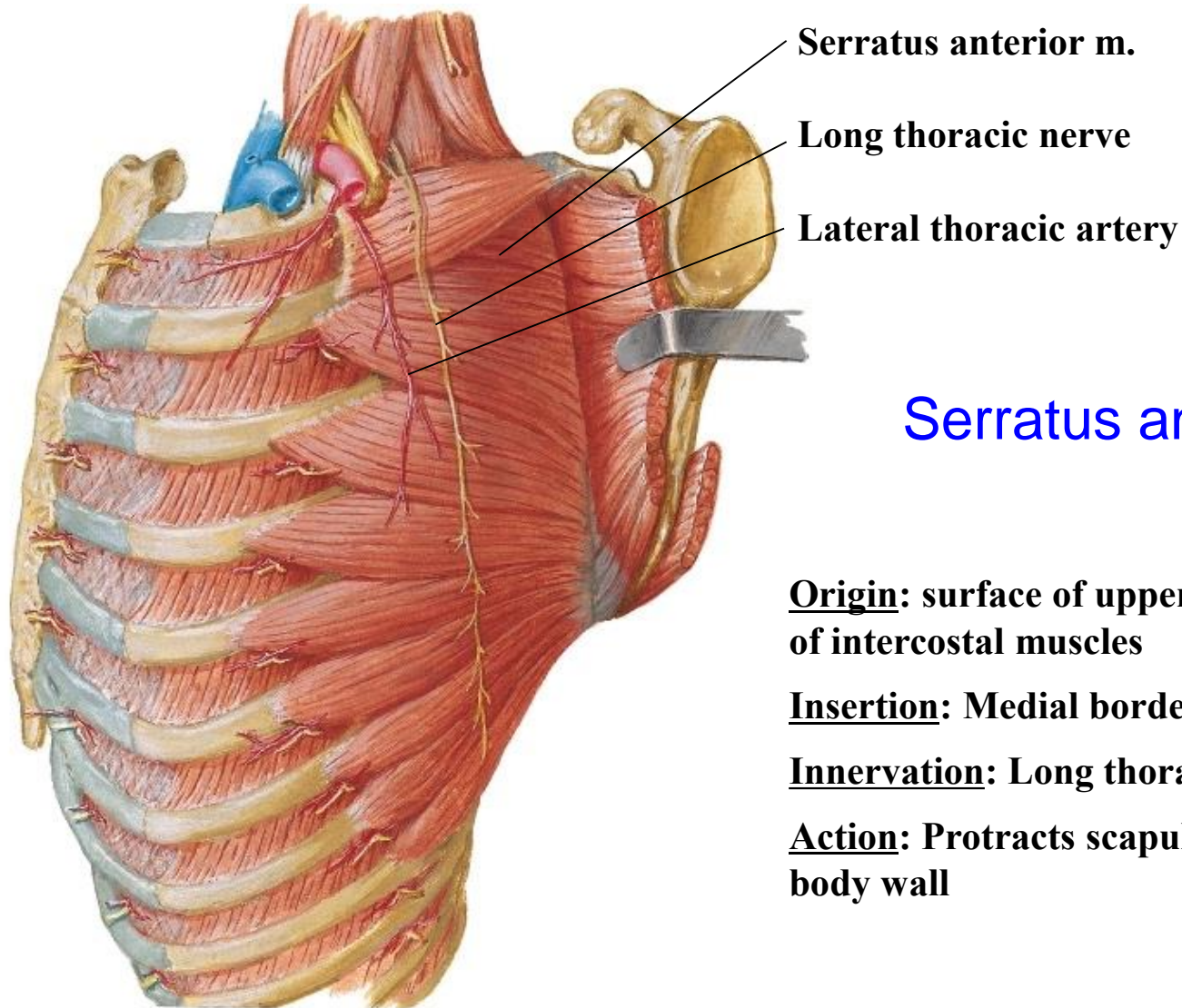
Insertion: Corocoid process of scapula

Innervation: Medial pectoral nerve (C6-C8)

Action: Inferior rotation of scapula
(= Rotates glenoid fossa inferiorly),
protracts scapula



Muscles: Trunk to Girdle



Serratus anterior

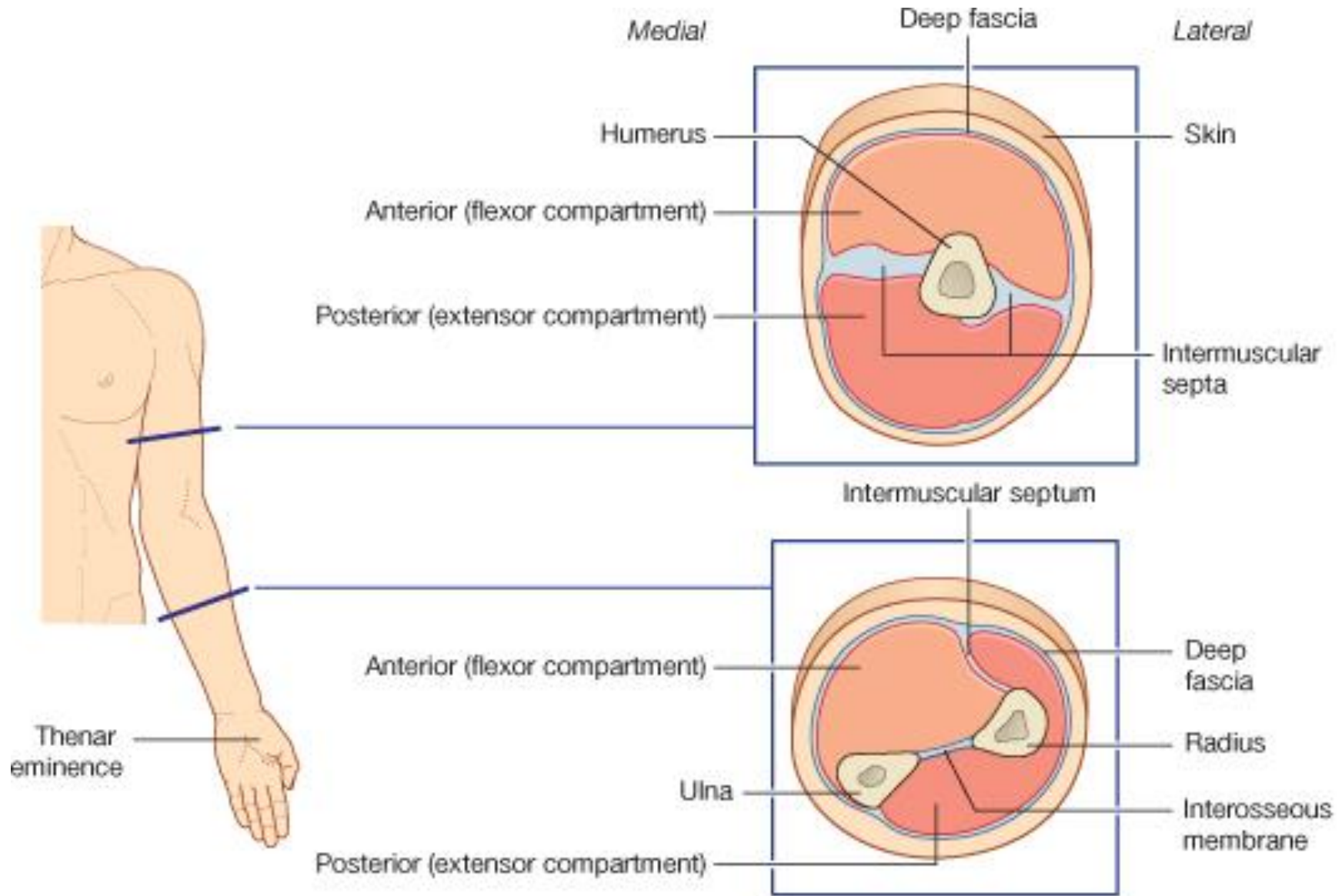
Origin: surface of upper 8 or 9 ribs and fascia of intercostal muscles

Insertion: Medial border of scapula

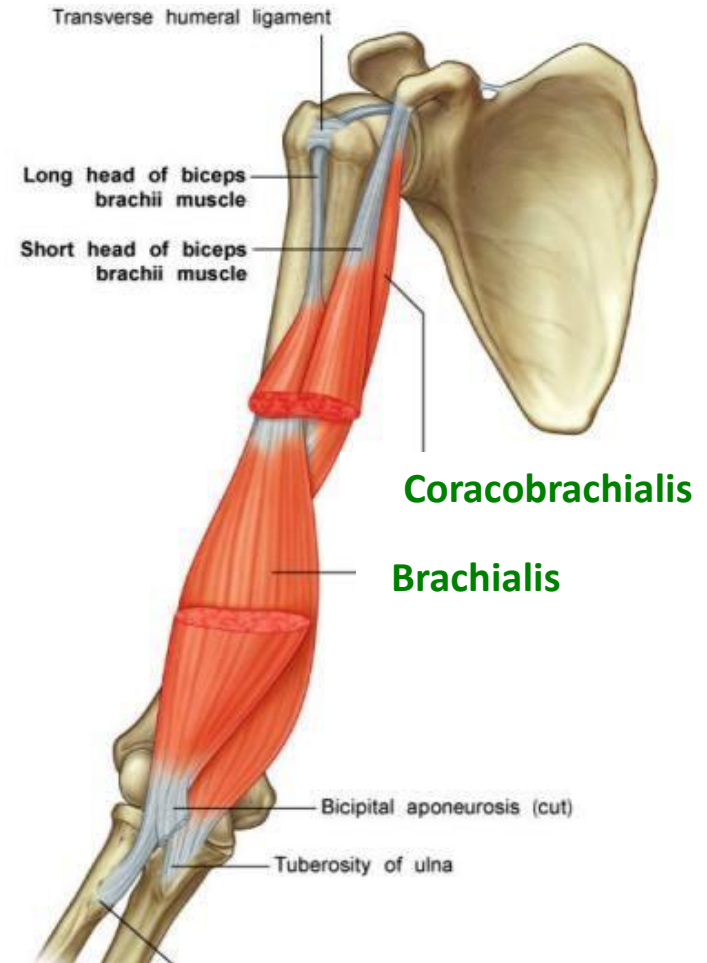
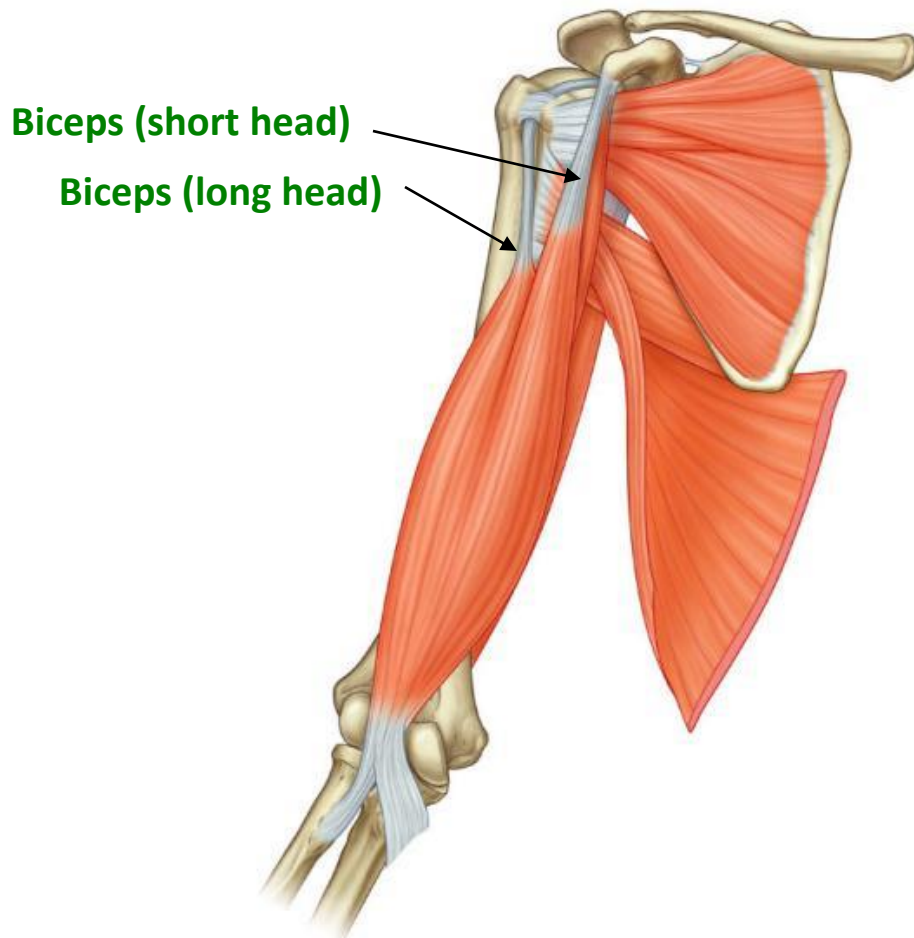
Innervation: Long thoracic nerve (C5-C7)

Action: Protracts scapula, holds scapula to body wall

Compartments of Upper Limb



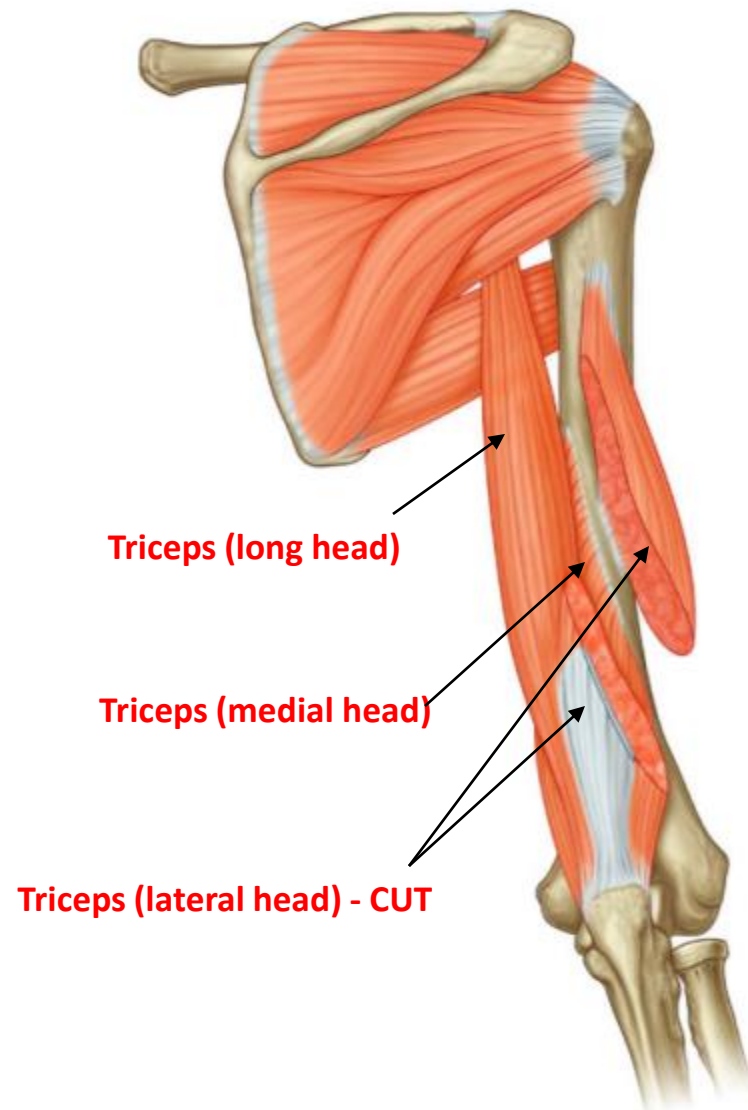
Anterior Compartment of Arm



Muscles of the anterior compartment of the arm are mostly innervated by the **musculocutaneous n.**

Posterior Compartment of Arm

Muscles in the *posterior* compartments of arm AND forearm are innervated by **radial n.**

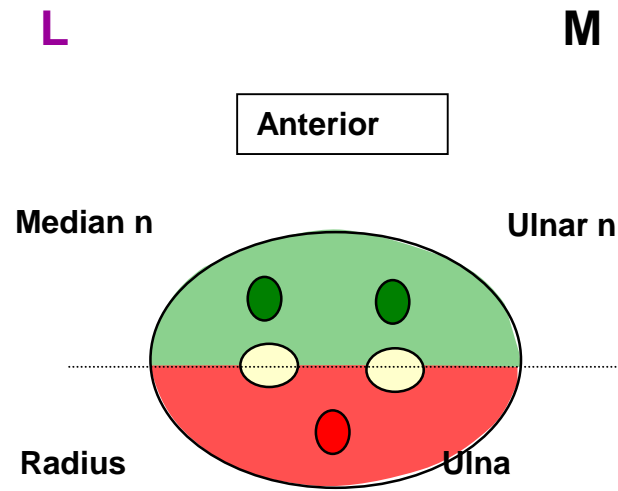


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Compartments of the forelimb

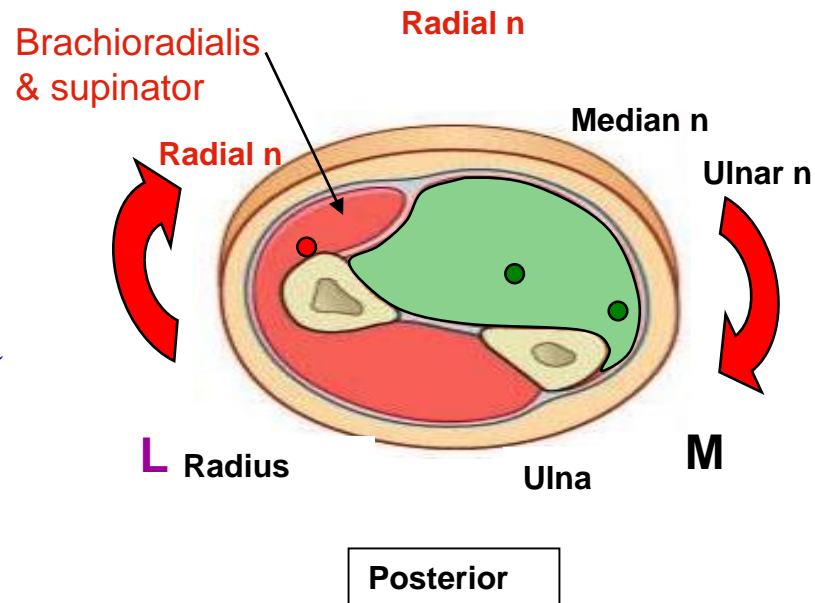
Idealized Left Arm

As you look down at your left elbow in anatomical position



Actual Left Arm

As you look down at your left elbow in anatomical position: a clockwise rotation

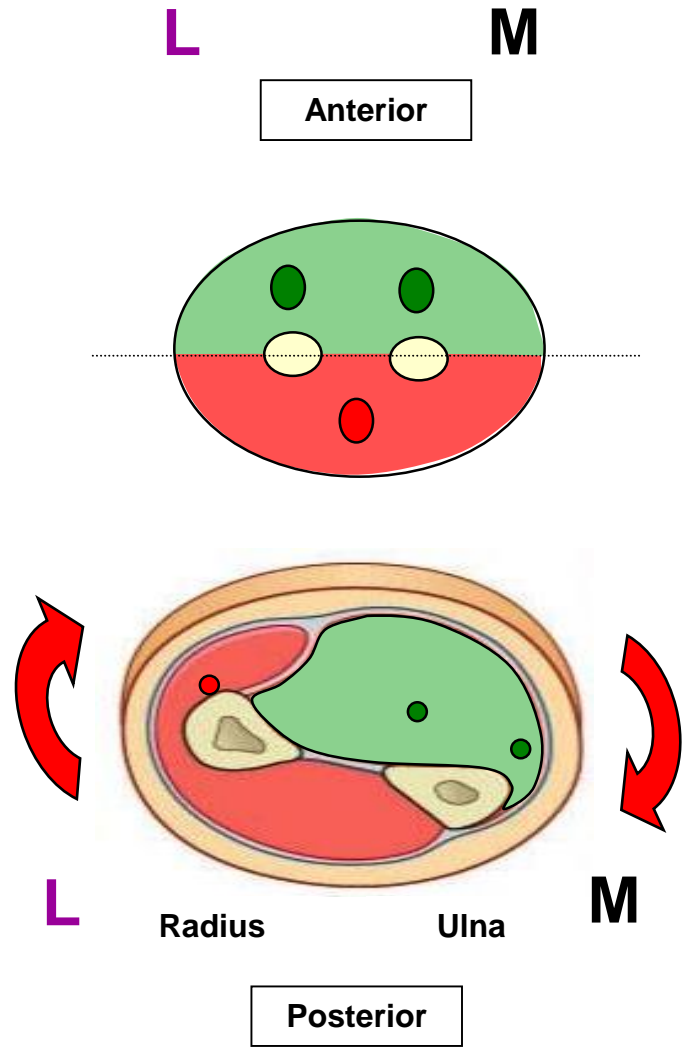


Compartments of the forelimb

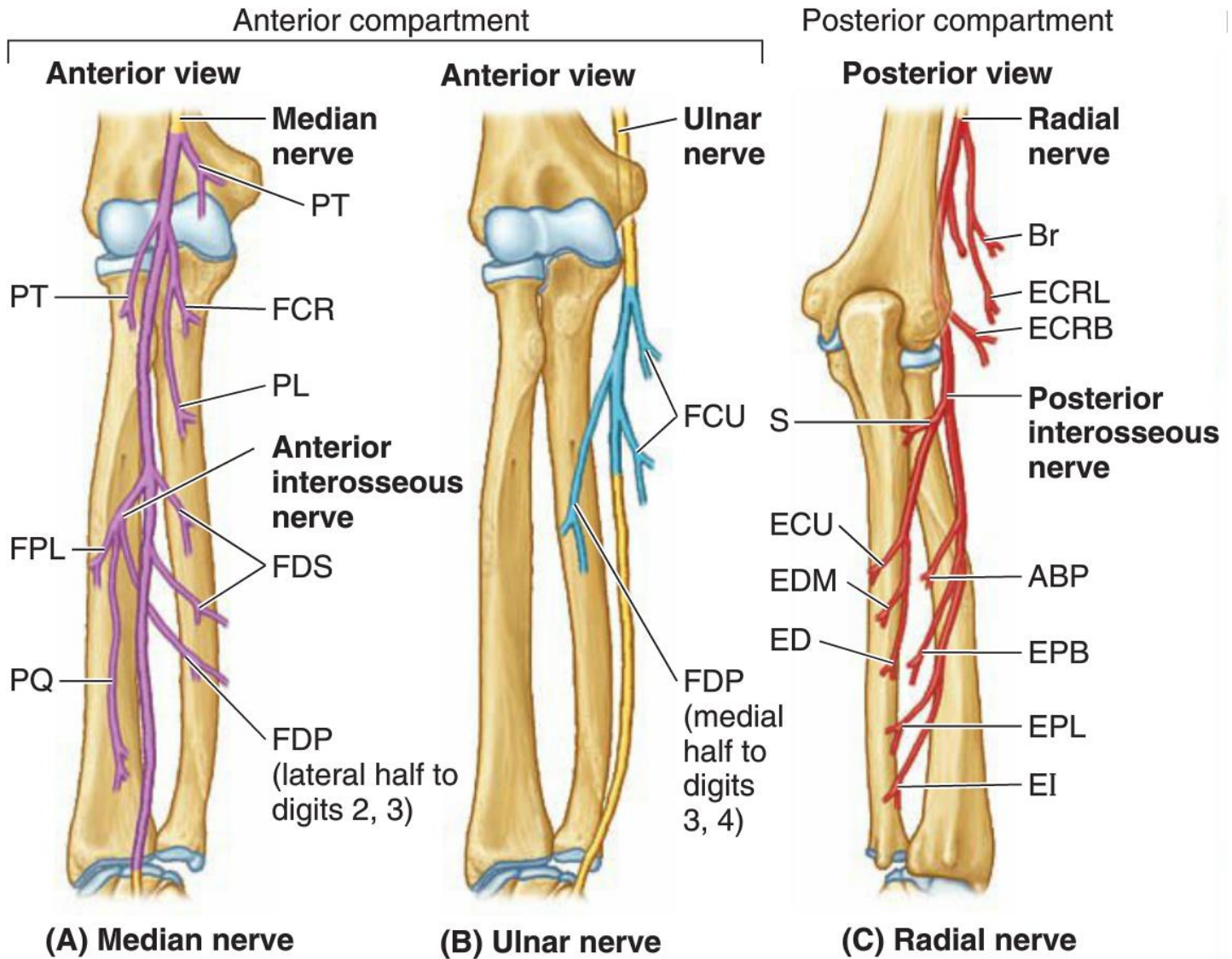
Anterior right limb



Posterior left limb



Innervation of the Forearm



Anterior Compartment of the Arm – Mostly Median n.

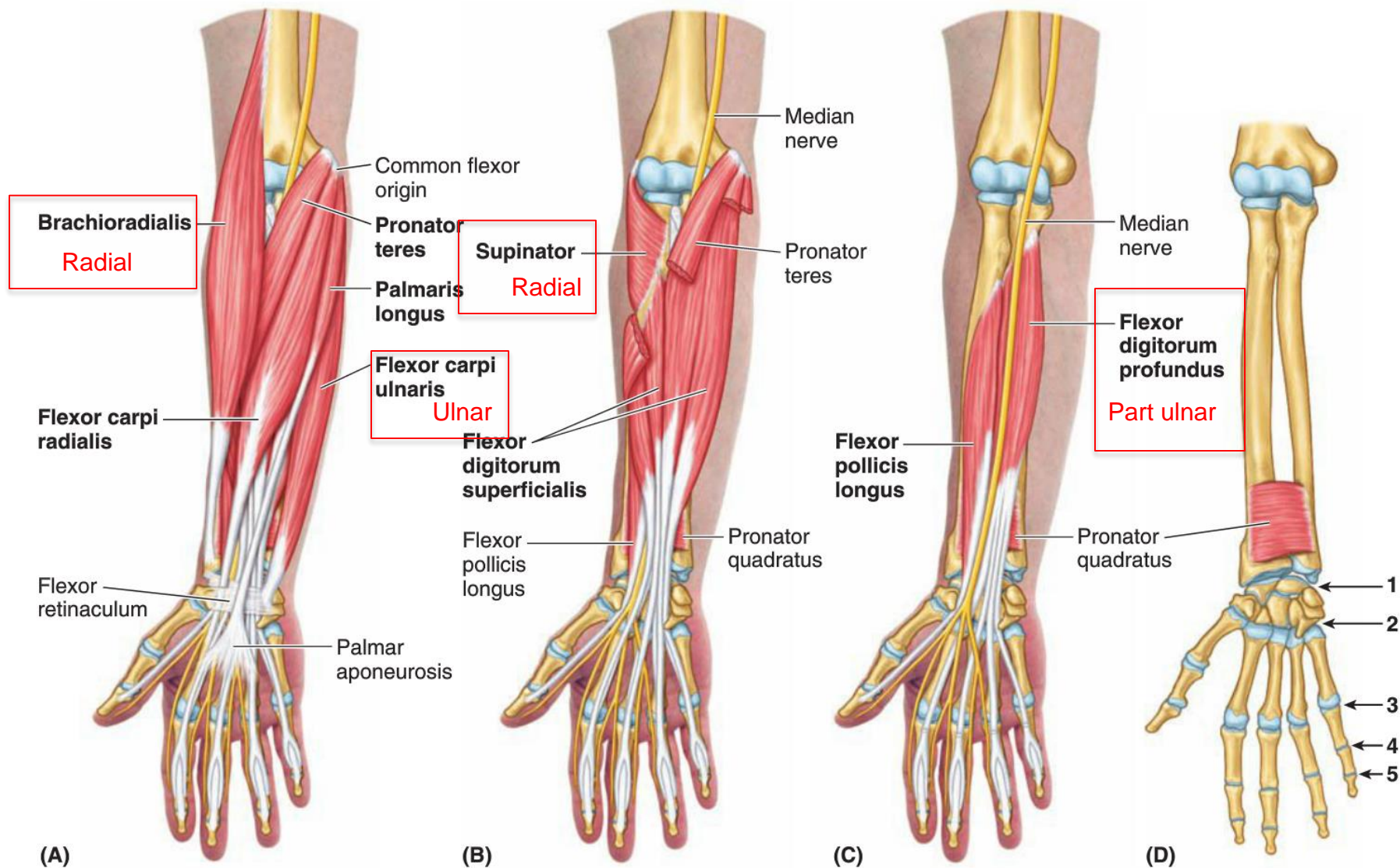


FIGURE 6.31. Muscles of anterior compartment of forearm. A. First layer. B. Second layer. C. Third layer. D. Fourth layer.

Intrinsic Muscles of Hand – Mostly Ulnar n.

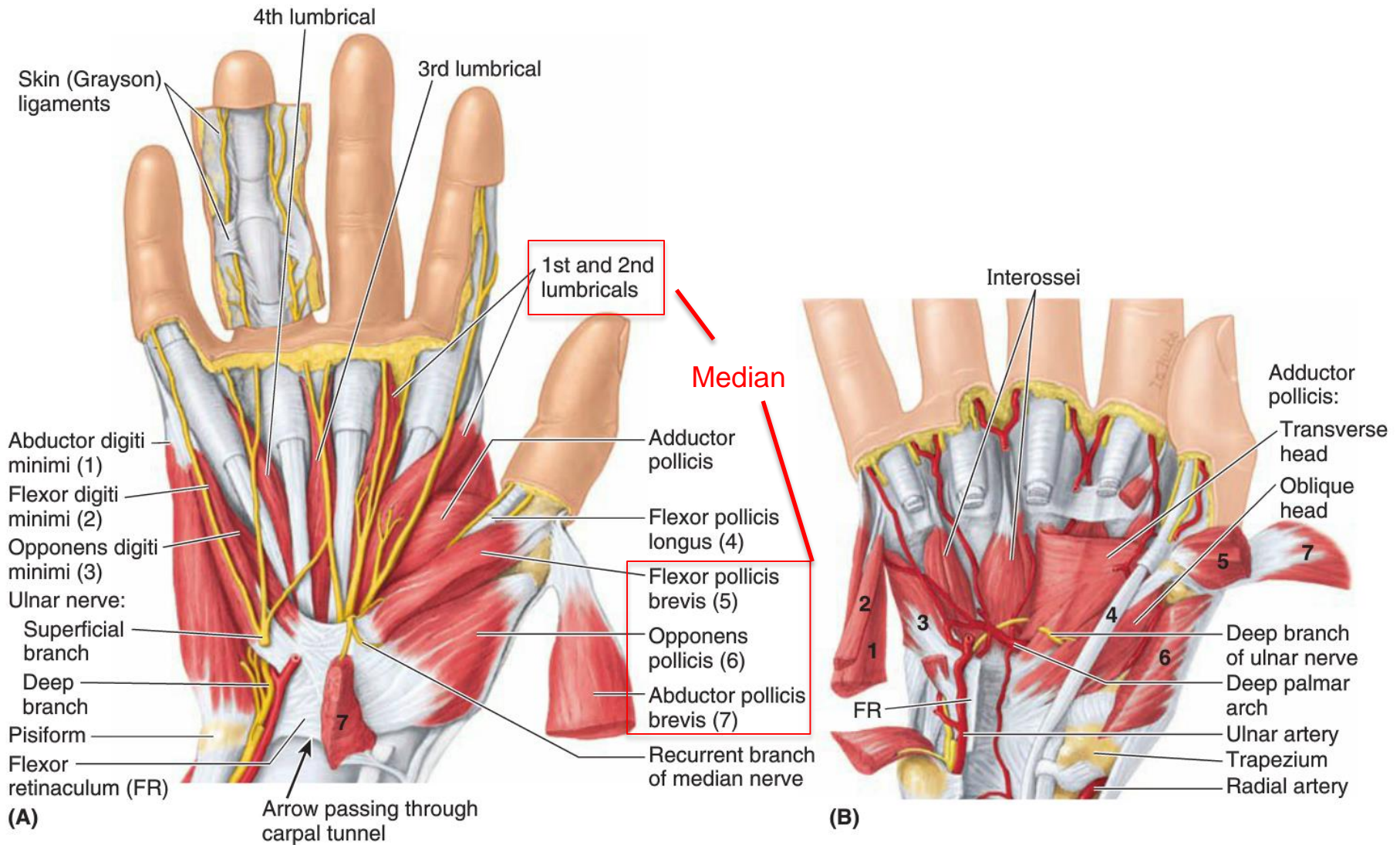
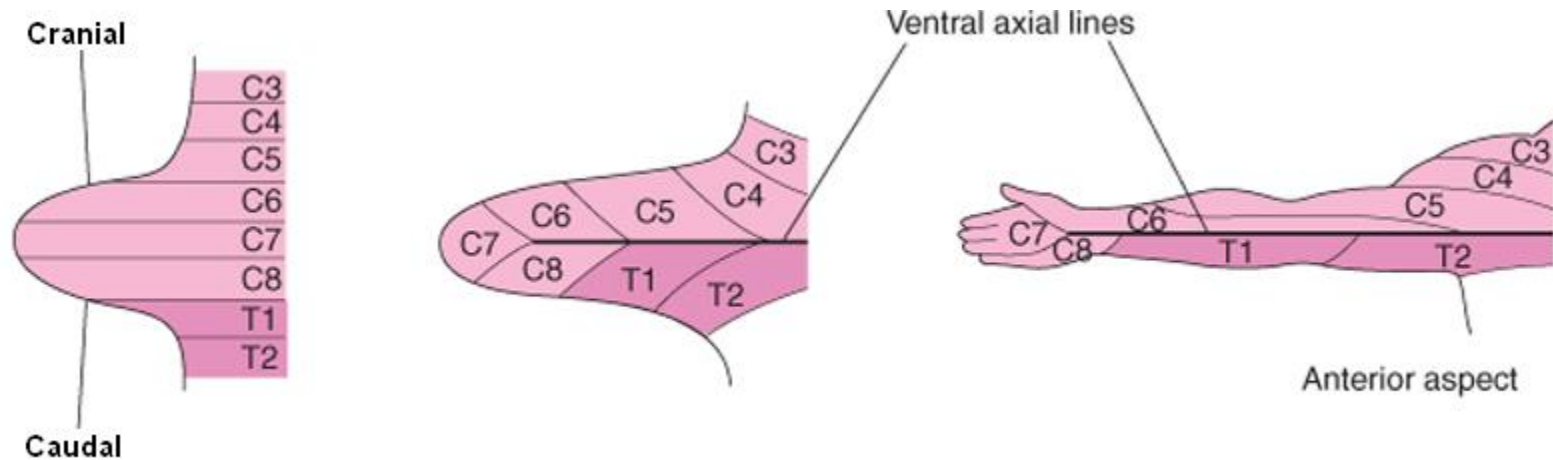


FIGURE 6.49. Muscles and nerves of hand and deep palmar arch. A. Distribution of median and ulnar nerves. **B.** Deep dissection showing muscles, nerves, and deep palmar arch.

Sensory Innervation

- Dermatomes make sense from a developmental perspective
- Arranged superior to inferior in sequence in an arc following the central axis of the limb



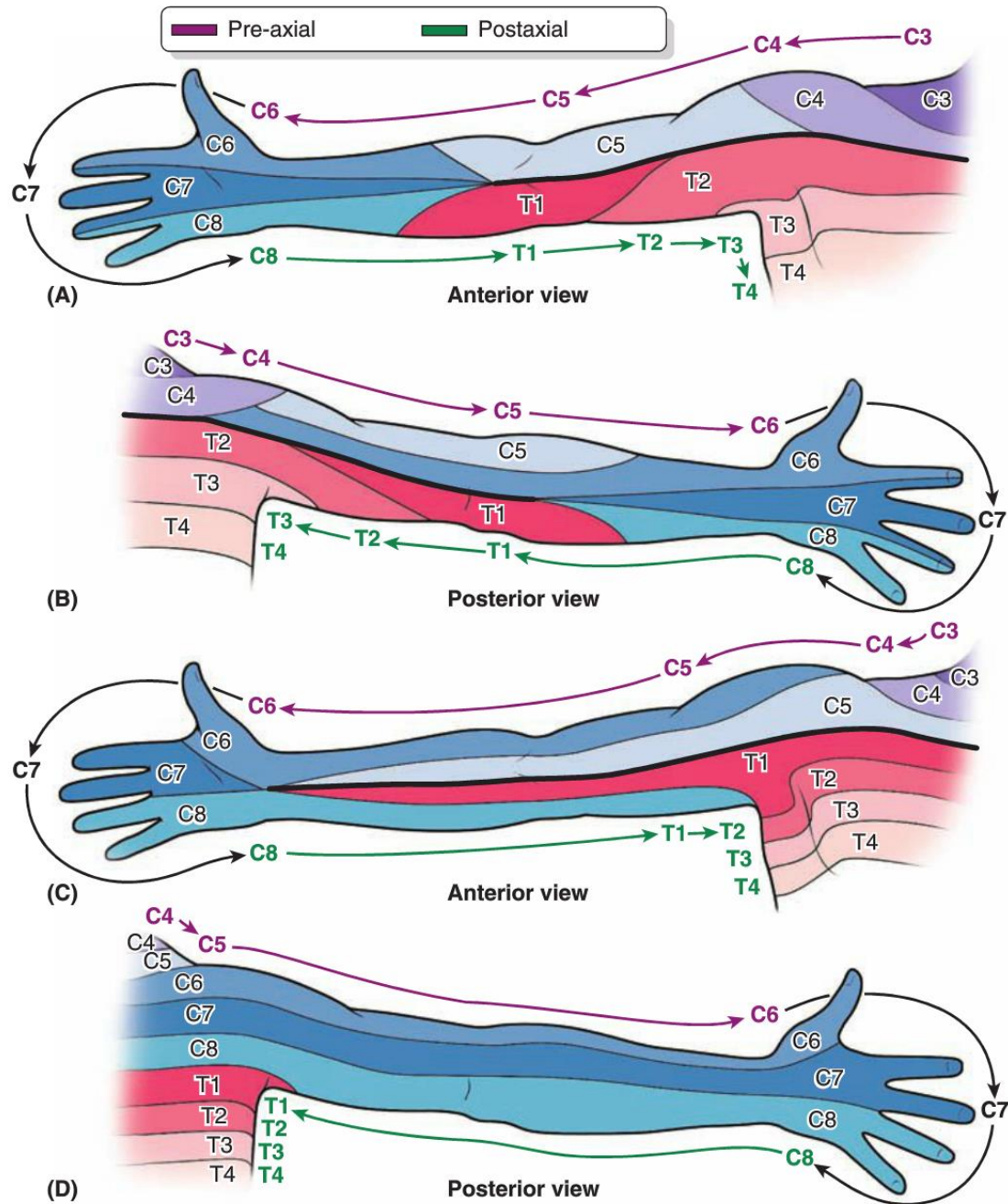


FIGURE 6.11. Segmental (dermatomal) innervation. A and B. The pattern of segmental innervation proposed by Foerster (1933). C and D. The pattern of segmental innervation proposed by Keegan and Garrett (1948).
 Moore – Clinically Oriented Anatomy

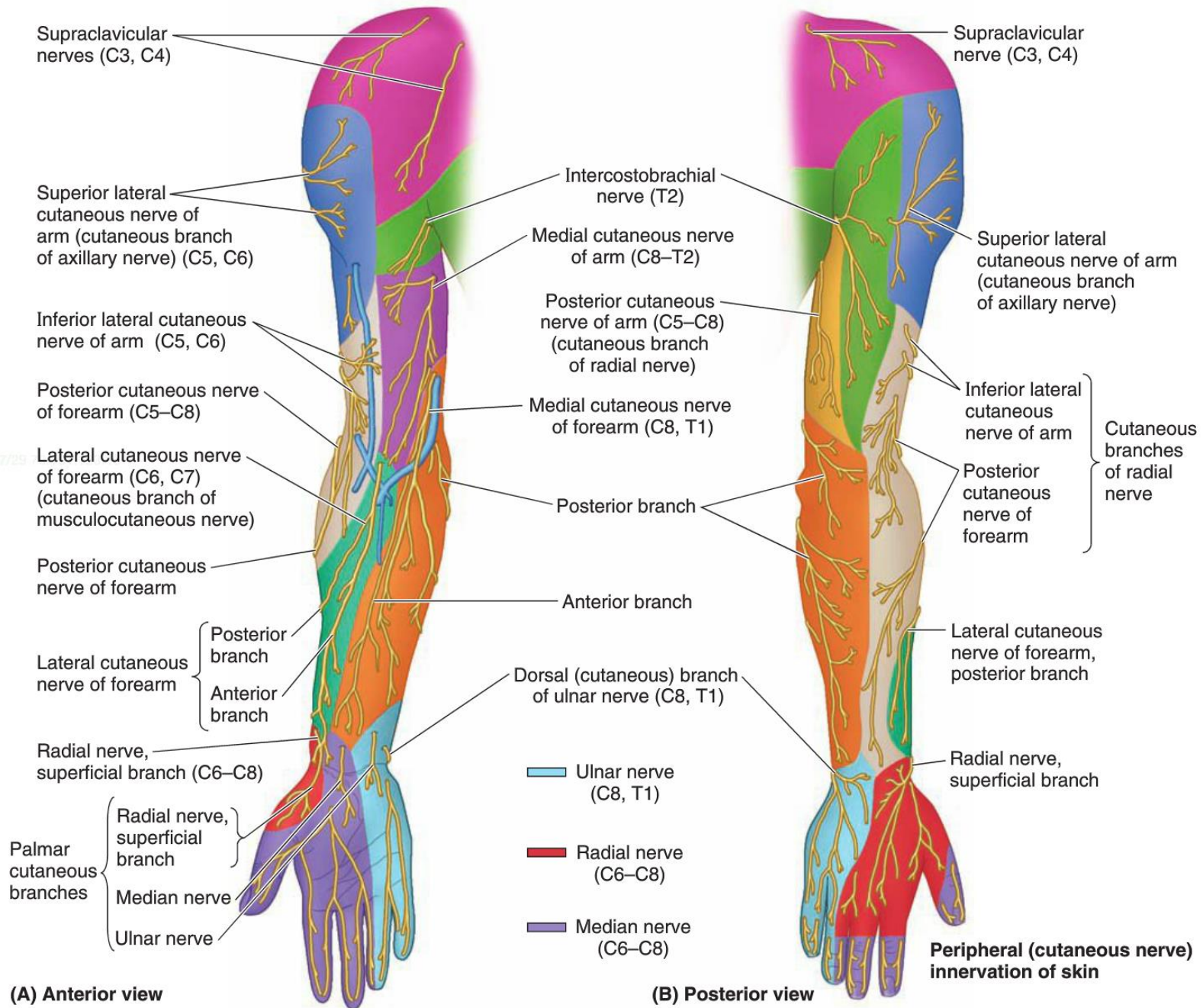


FIGURE 6.12. Peripheral (cutaneous) innervation of upper limb.

Dermatome Maps vs Peripheral Nerve Maps

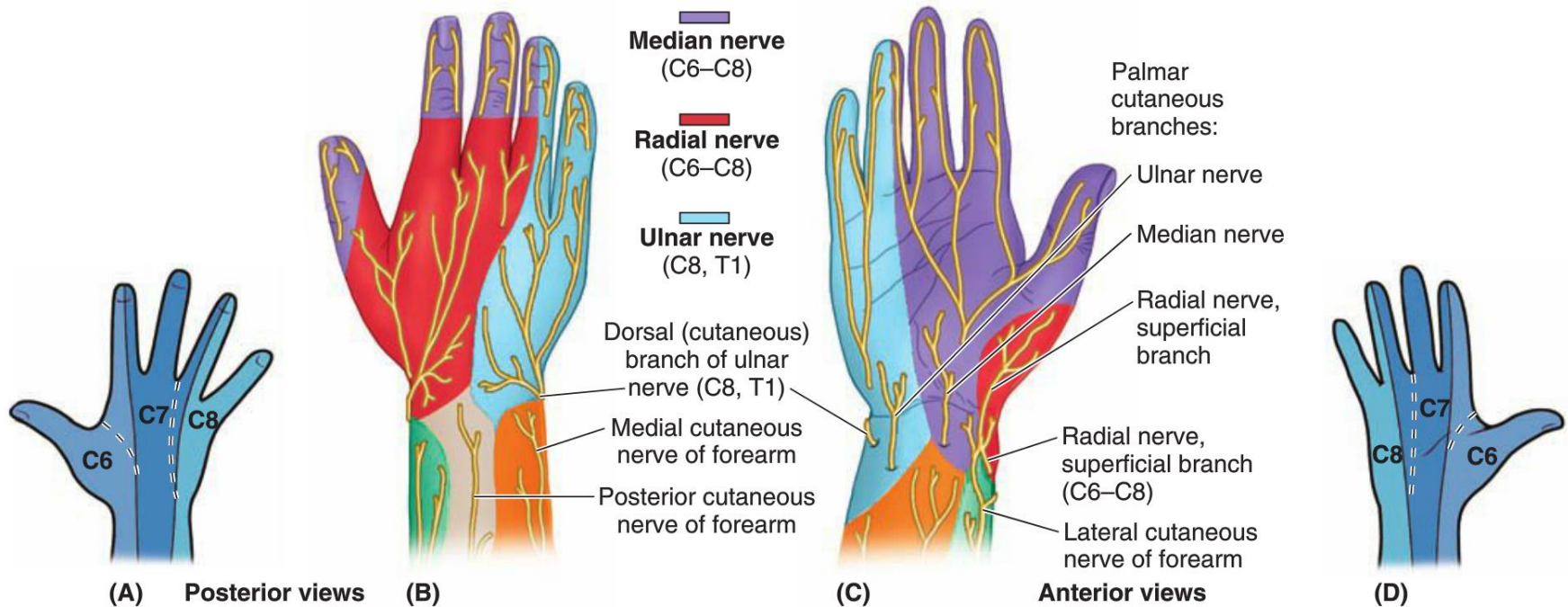


FIGURE 6.50. Cutaneous innervation of hand. **A and D.** Segmental (dermatomal) innervation. **B and C.** Distribution of peripheral cutaneous nerves.

It is important to understand that peripheral nerves contain fibers from multiple spinal cord levels and nerve maps are not the same as dermatomes

Testing Nerves of the Upper Limb

Avulsion - spinal nerve torn from spinal cord

Rupture - spinal nerve torn beyond CNS

Neuroma - spinal nerve torn and partially healed

Neuropraxia - spinal nerve stretched and damaged
(most common)

Testing Nerve Function

Symptoms

Anesthesia - Loss of Sensation

Paresthesia – Abnormal sensations e.g., “Pins and Needles”

Paralysis - Loss of Motor Control & Abnormal Limb Postures

If damage is at level of spinal nerve

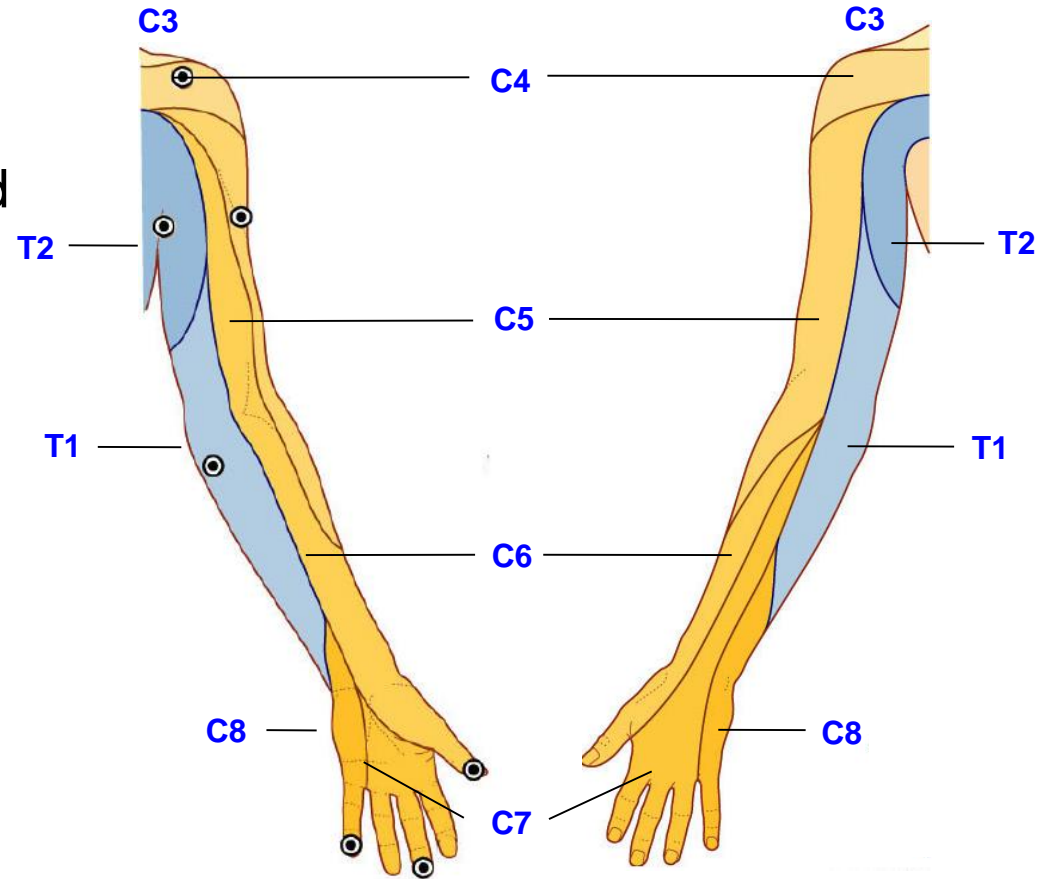
- both anesthesia and paralysis
- effects entire dermatome and myotome

If damage is more peripheral

- effects more localized region
- may only include anesthesia or paralysis
- can include parts of dermatomes and myotomes of multiple spinal nerves

Dermatomes – Spinal nerves

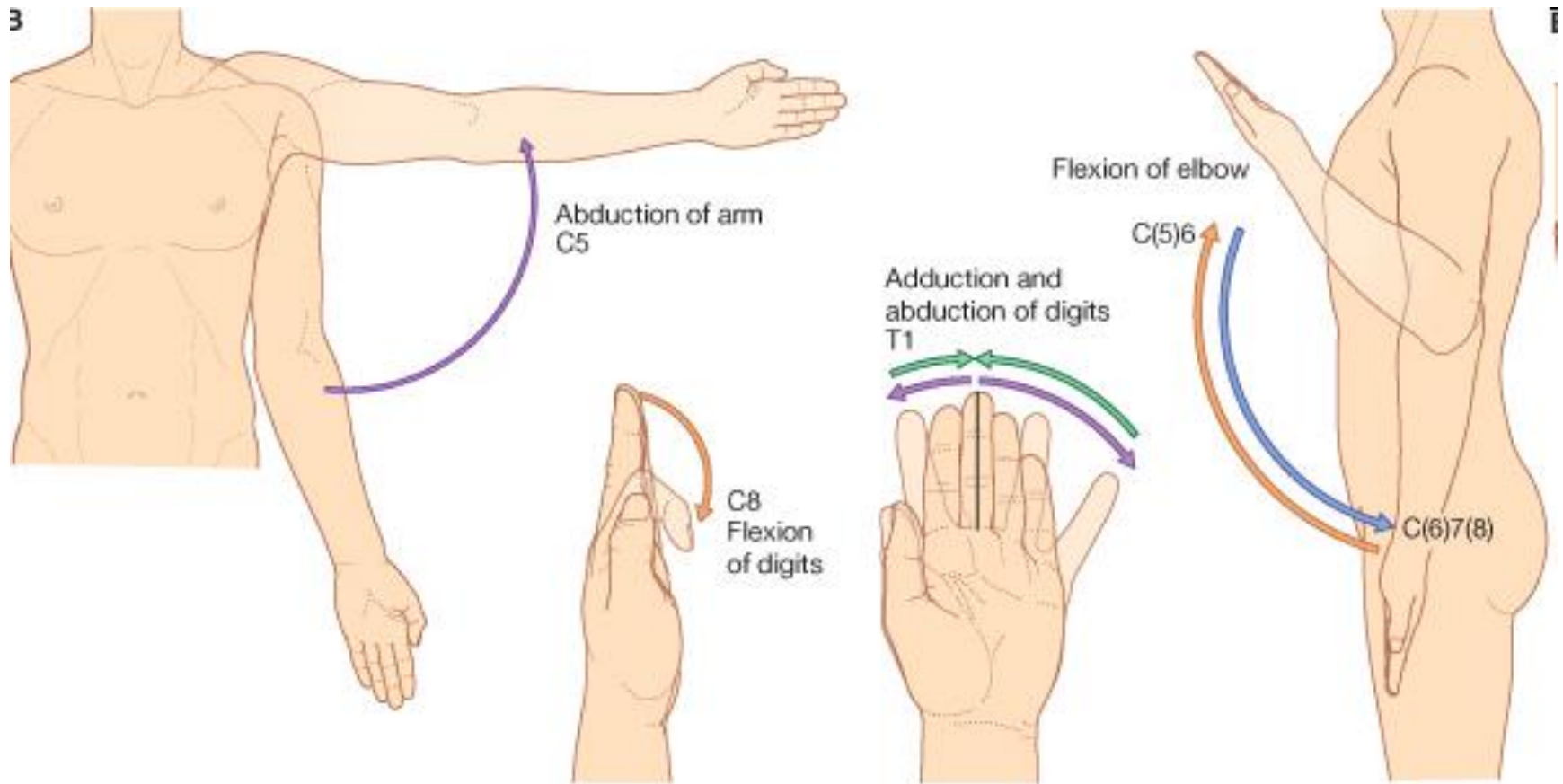
- Dermatomes overlap
- Minimal areas of overlap (used for testing):
 - C5 – upper lateral arm
 - C6 – Pad of thumb (I)
 - C7 – Pad of middle finger (III)
 - C8 – Pad of little finger (V)
 - T1 – Medial elbow



Evaluation of derma- and myotomes may provide important information about potential breathing problems that may develop (C3-5 is phrenic nerve!)

Testing Nerves of the Upper Limb

Myotomes



Testing spinal level deficits

Arm movement	Muscle	Root	Nerve
Shoulder abduction	Deltoid	C5	Axillary
Elbow flexion	Biceps	C5/6	Musculocutaneous
	Brachioradialis	C6	Radial
Elbow extension	Triceps	C7	Radial
Radial wrist extensor	Extensor carpi radialis longus	C6	Radial
Finger extensors	Extensor digitorum	C7	Posterior interosseous
Finger flexors	Flexor pollicis longus & flexor digitorum profundus	C8	Anterior interosseous
	Index		
	Flexor digitorum profundus		Ulnar
	Ring & little		
Finger abduction	First dorsal interosseous	T1	Ulnar
	Abductor pollicis brevis	T1	Median

Testing Nerves of the Upper Limb

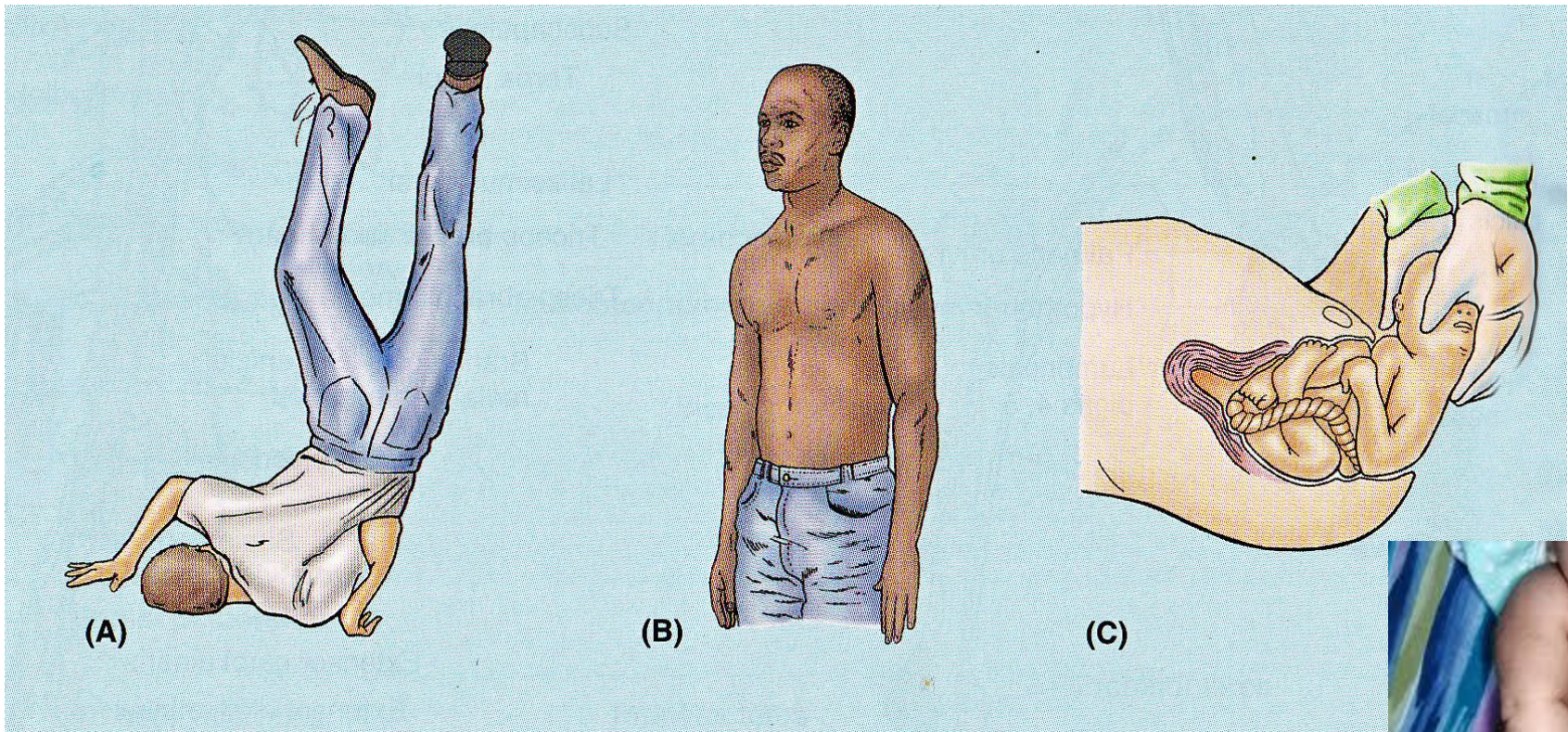
Brachial plexus injuries

- Upper brachial plexus injuries (Erb-Duchenne palsy)
 - Damage to root of C5 and C6
 - Traumatic lateral neck bending
 - during childbirth
 - from fall on shoulder
 - Paralysis or weakness of shoulder and arm
 - Deltoid, biceps, brachialis and brachioradialis
 - “Waiter’s tip” position
 - adducted and medially rotated arm
 - extended elbow

Testing Nerves of the Upper Limb

Brachial plexus injuries

Upper brachial plexus injuries (Erb-Duchenne palsy)



Waiter's Tip Position

Testing Nerves of the Upper Limb

Brachial plexus injuries

- Lower brachial plexus injuries (Klumpke Palsy)
 - Damage to roots of C8 and T1
 - From traumatic hyper-abduction of arm
 - childbirth
 - Spiderman (?)
 - Paralysis or weakness of most intrinsic muscles of hand
 - results in “Claw hand”

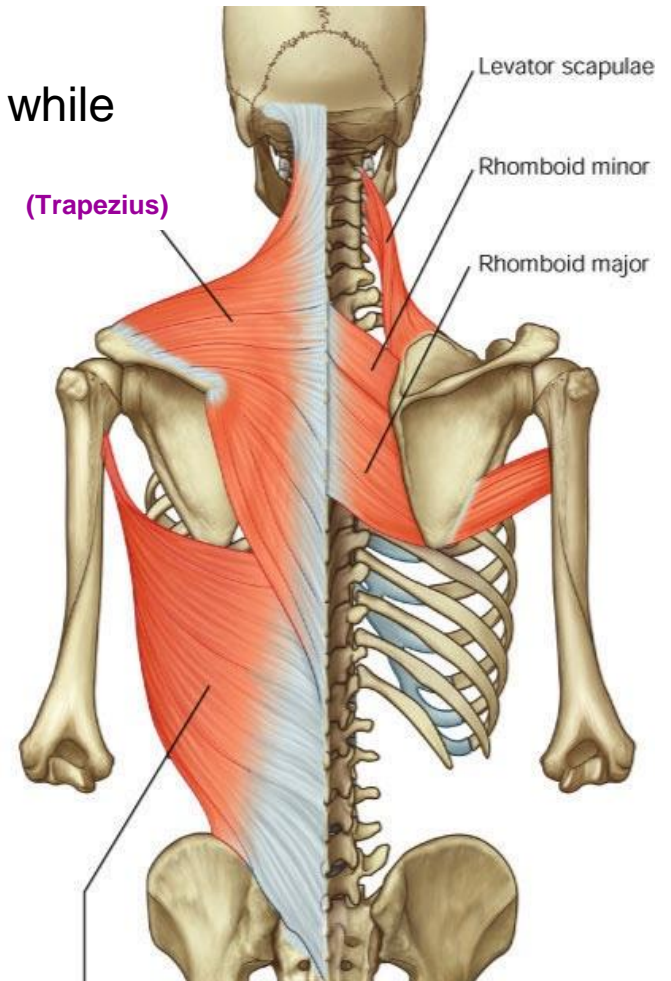
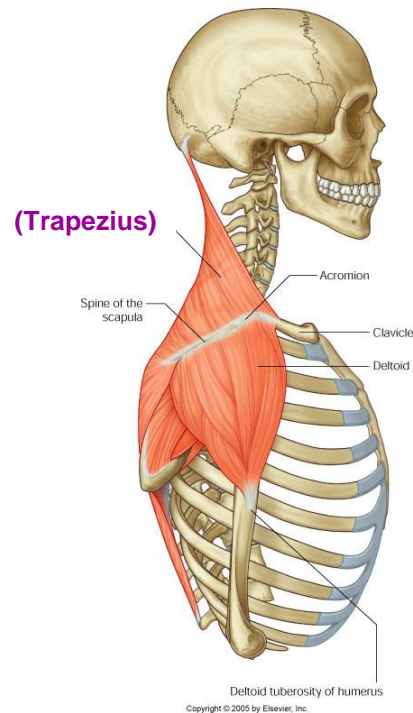
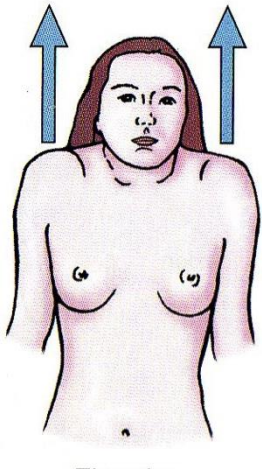


Testing Nerves of the Upper Limb

Accessory n.

Test trapezius function

- elevate scapula (shrug) against resistance while palpating superior border of muscle



Testing Nerves of the Upper Limb

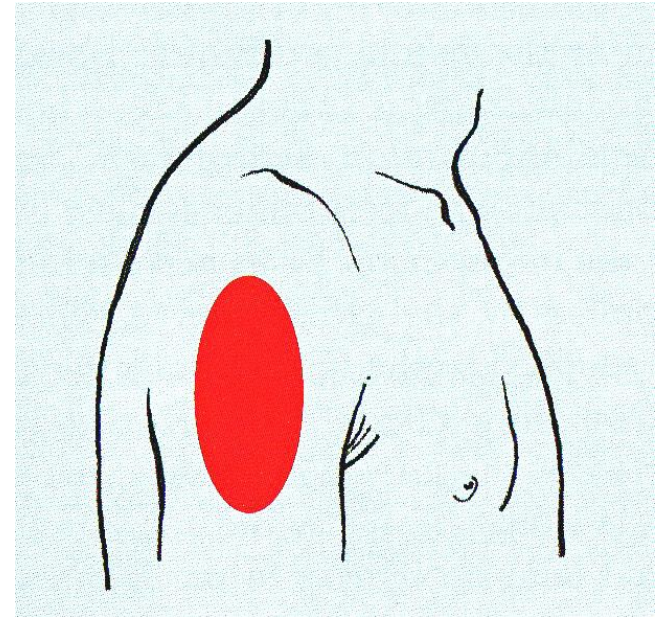
Axillary Nerve

Common Causes

- Fracture of surgical neck of humerus
- Dislocation of glenohumeral joint
- Improper use of crutches
- Intramuscular injections

Sensory

- loss of sensation on lateral shoulder
- superior lateral cutaneous n. of arm



Testing Nerves of the Upper Limb

Axillary Nerve

Motor

- paralysis of deltoid
- atrophy of deltoid

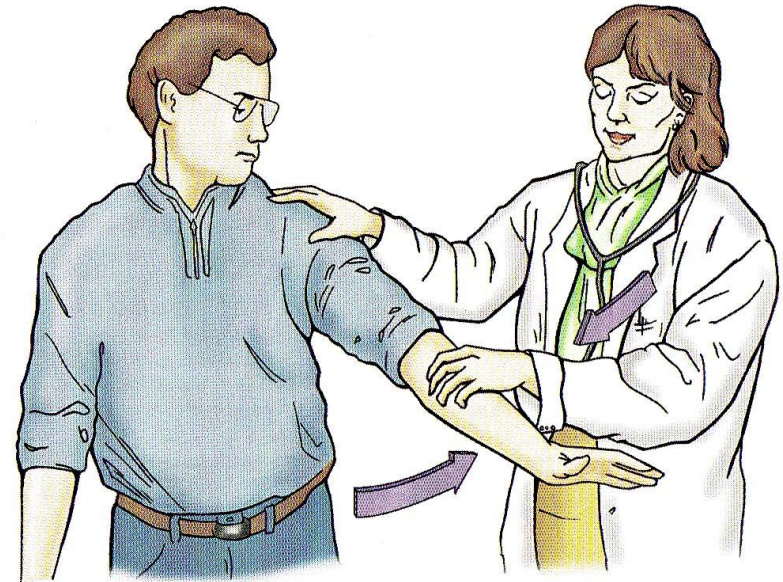
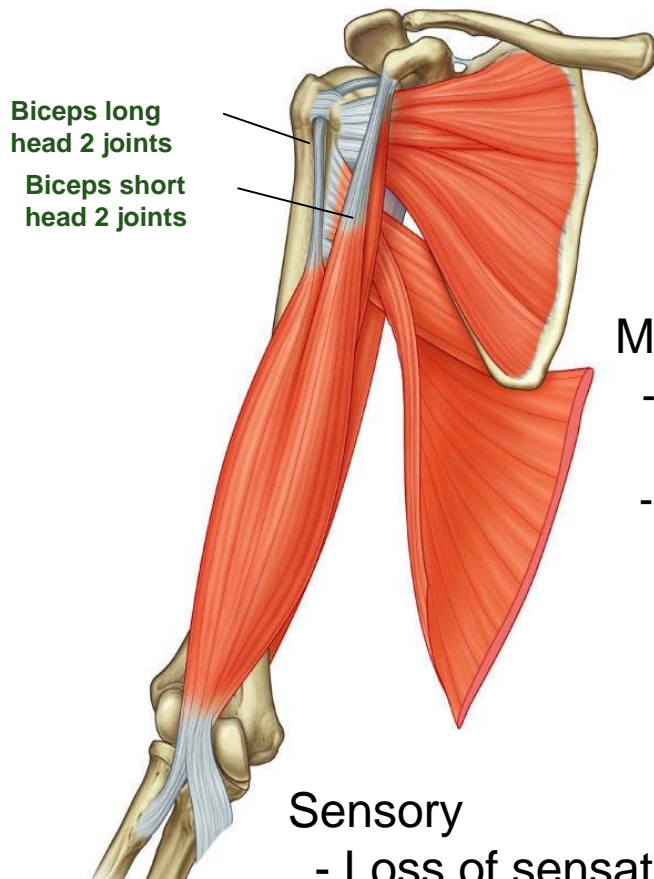


Figure 6.20. Testing deltoid muscle. The examiner resists the patient's abduction of the limb by the deltoid. If the deltoid is acting normally, contraction of the middle part of the muscle can be palpated.

Testing Nerves of the Upper Limb

Musculocutaneous nerve

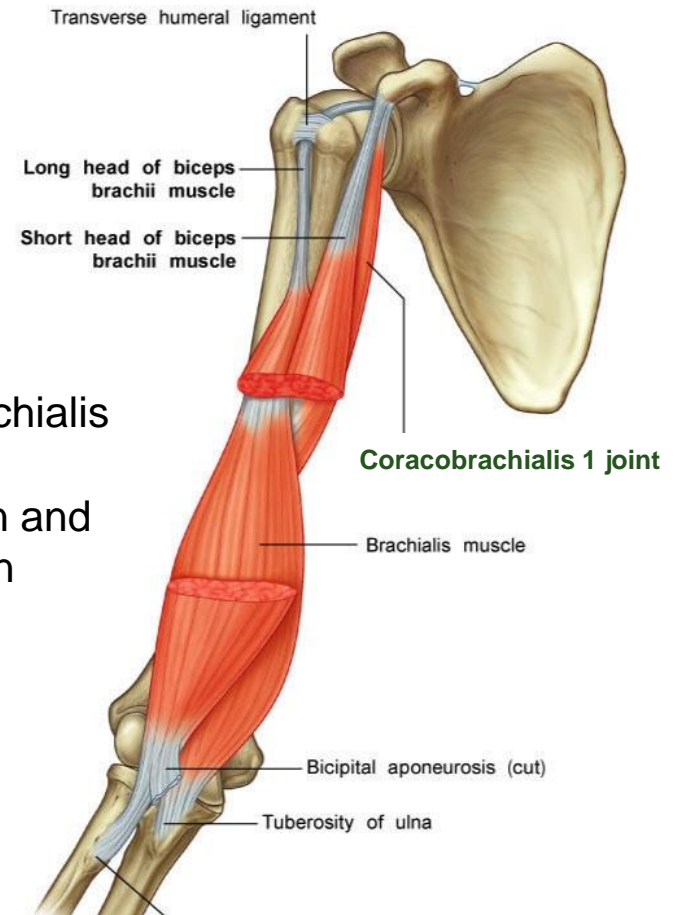


Motor

- biceps, coracobrachialis and brachialis
- weak elbow flexion and forearm supination

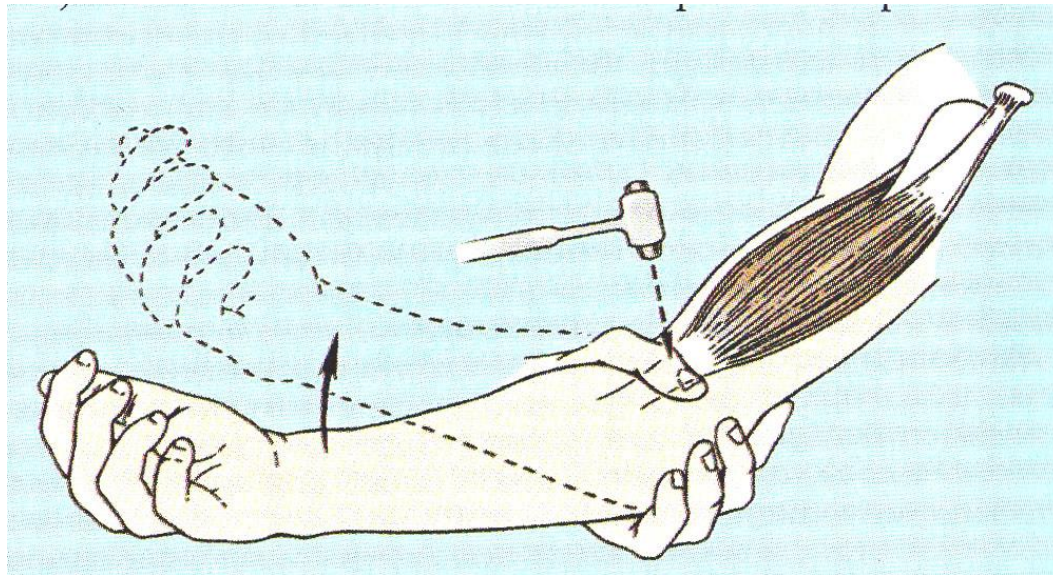
Sensory

- Loss of sensation on lateral surface of forearm
- Lateral cutaneous n. of forearm



Testing Nerves of the Upper Limb

Bicipital Reflex



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Tests musculocutaneous n. and C5,C6 spinal nerves

Testing Nerves of the Upper Limb

Radial nerve

Motor

- Triceps, brachioradialis, supinator and extensors of wrist and fingers
- “Wrist drop” - patient unable to extend wrist
- if lesion is beyond humerus, triceps not effected

Sensory

- Loss of sensation on lateral elbow, posterior forearm and dorsum of hand
- Inferior lateral cut. n. of arm, post. cut. n. of forearm, and superficial branch of radial nerve

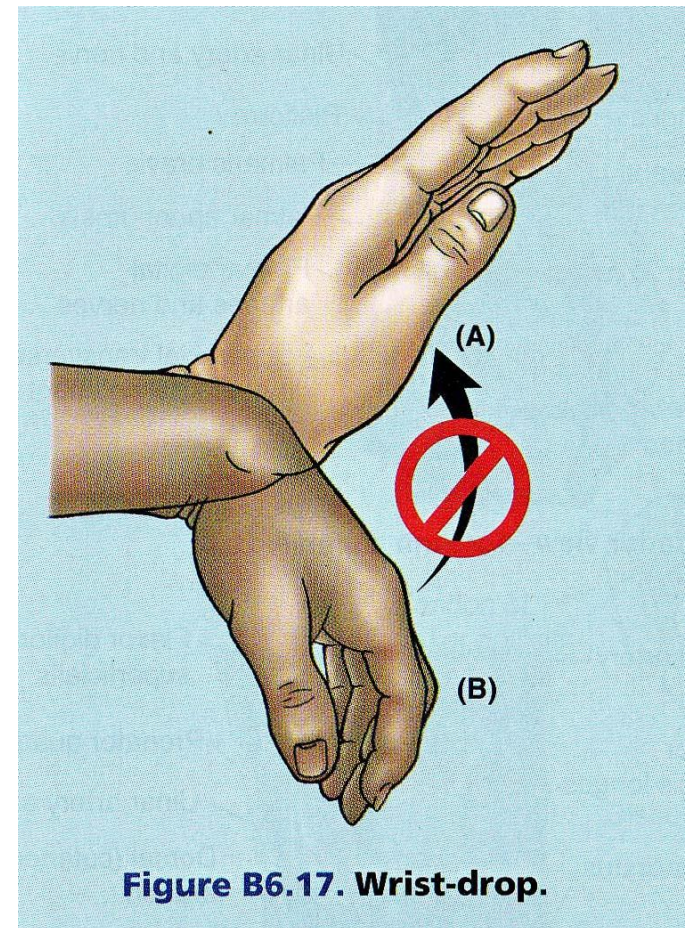


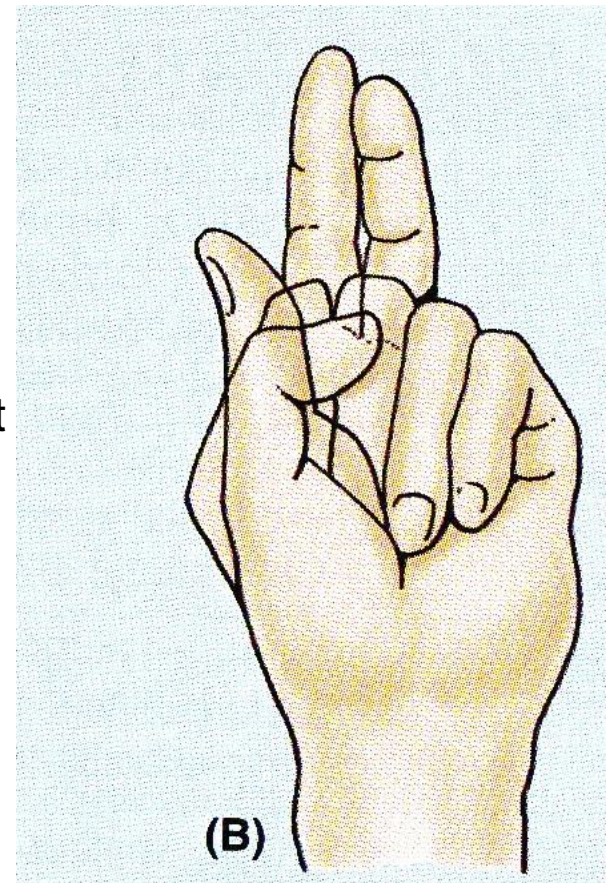
Figure B6.17. Wrist-drop.

Testing Nerves of the Upper Limb

Median nerve

Motor

- Finger and wrist flexors (most), thenar muscles and 1st and 2nd lumbricals
- Can't flex proximal IP joints of digits 1-3
- Can't flex distal IP joints on digits 2 and 3
- "Benediction hand" when attempting to make fist

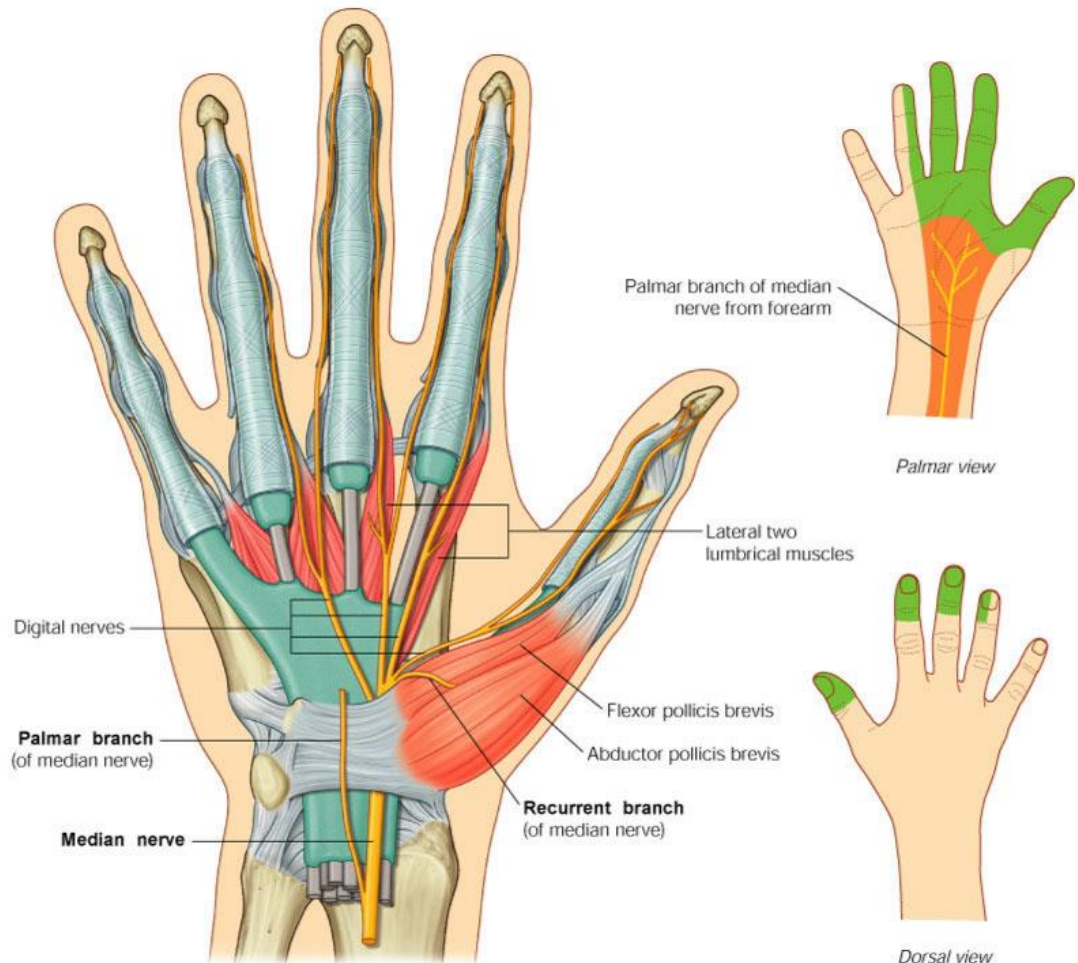


Testing Nerves of the Upper Limb

Median nerve

Sensory

- loss of sensation in lateral palm and tips of digits 1-3



Testing Nerves of the Upper Limb

Ulnar nerve

Motor

- Flexor carpi ulnaris, medial part of FDP, most intrinsic hand muscles
- Wrist adduction impaired
- Lateral deviation of wrist flexion
- MP joints become hyperextended
- Cannot flex digits 4 and 5 when making a fist

Sensory

- loss of sensation in medial palm and tip of digit 5

