

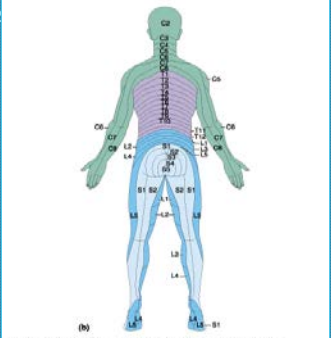
# UPPER LIMBS

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- Somatic outgrowth :
    - Bones (with bone, cartilage, marrow, VAN, etc.)
    - Joints
    - Muscle
    - Nerves
    - Vascular supply
  - No viscera--all innervation is somatic (motor or sensory) from ventral ramus of spinal nerve (except autonomic to blood vessels)
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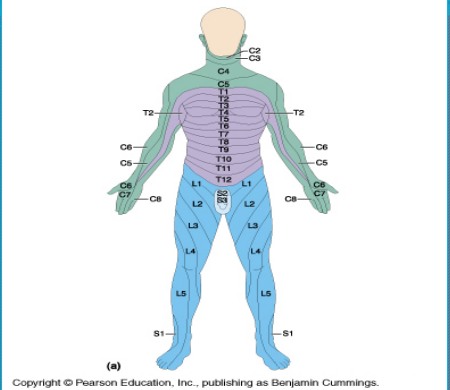
### Sensory from limb (dermatomes/sensory skin segment)

- Dermatomes extend over limbs
- Twisted orientation reflects twisting of limb during development
- Named nerves generally innervate skin over muscles that they innervate



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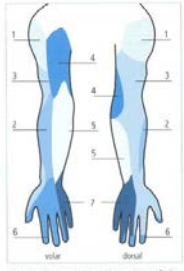
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### Sensory territory of nerves



1 Axillary nerve  
2 Musculocutaneous nerve  
3 Radial nerve  
4 Medial cutaneous nerve of the arm  
5 Medial cutaneous nerve of the forearm  
6 Median nerve  
7 Ulnar nerve


Fig. 2: Sensory supply areas of the brachial plexus

Brachial plexus serves to re-direct spinal routes into named nerves covering certain territory

Cutaneous branches of medial cord/ulnar nerve

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### Upper Limb Skeleton



- Scapula
- Humerus
- Radius, ulna
- Carpals--proximal, distal
- Digits
  - Metacarpals
  - Phalanges

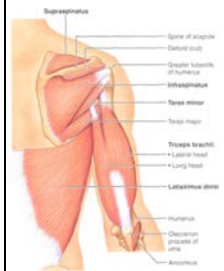
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### Joints

JOINT	BETWEEN	MOVEMENT
Shoulder		
Elbow		
Radio Ulnar		
Wrist		
Metacorpo-phalyngeal		
Inter-phalyngeal		

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### Muscles of Scapula



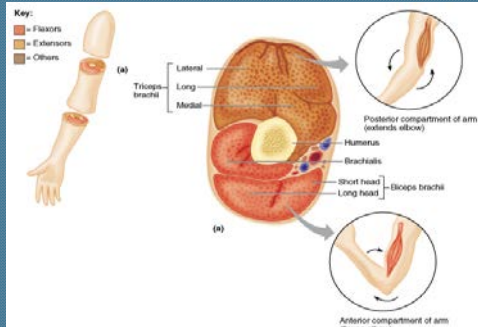
- If INSERTION on scapula = Move scapula
  - Rhomboids
  - Trapezius
  - Pectoralis Minor
  - Serratus Ventralis
  - Levator Scapulae
- If ORIGIN on scapula = Move Arm
  - Subscapularis
  - Supraspinatus
  - Infraspinatus
  - Teres Minor
  - Teres Major
  - Latissimus Dorsi
  - Coracobrachialis

Rotator Cuff

Use location of Insertion to determine exact movement!!!

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### POSTERIOR AND ANTERIOR COMPARTMENTS

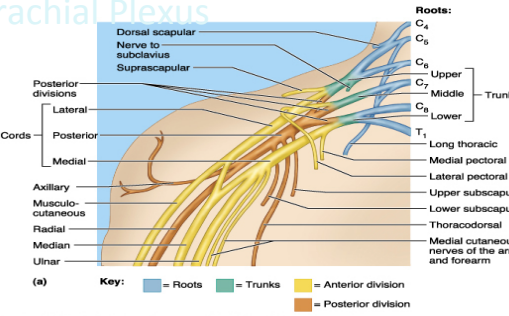


**Key:**  
■ Flexors  
■ Extensors  
■ Others

Posterior compartment of arm (extends elbow)  
 Anterior compartment of arm (flexes elbow)

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### Brachial Plexus



**Roots:**  
 C<sub>4</sub>  
 C<sub>5</sub>  
 C<sub>6</sub>  
 C<sub>7</sub>  
 C<sub>8</sub>  
 T<sub>1</sub>

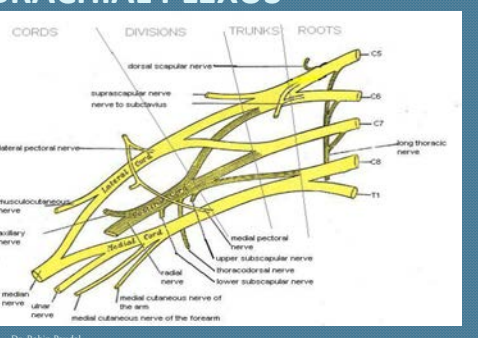
Trunks:  
 Upper  
 Middle  
 Lower

Cords:  
 Lateral  
 Posterior  
 Medial

Key:  
■ = Roots  
■ = Trunks  
■ = Anterior division  
■ = Posterior division

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### BRACHIAL PLEXUS



**CORDS:** Lateral, Posterior, Medial

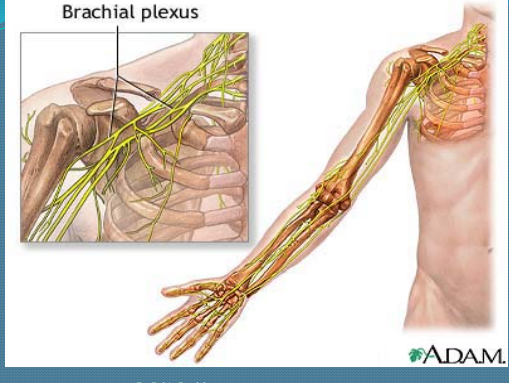
**DIVISIONS:** Anterior, Posterior

**TRUNKS:** Upper, Middle, Lower

**ROOTS:** C<sub>5</sub>, C<sub>6</sub>, C<sub>7</sub>, C<sub>8</sub>, T<sub>1</sub>

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### Brachial plexus

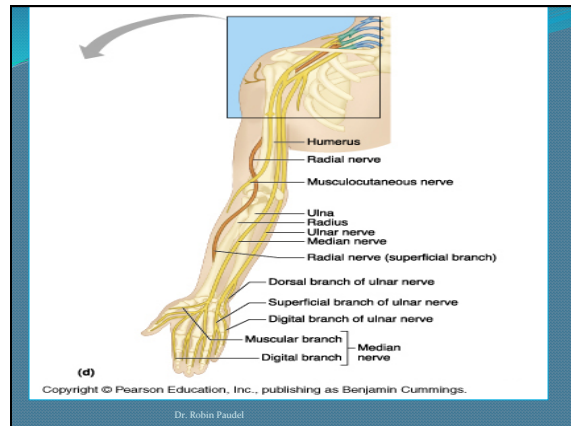


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## Lesions of the Brachial Plexus

- Upper trunk (C5,C6)
  - Erb's paralysis affects axillary, suprascapular, and musculocutaneous nerves.
  - Loss of intrinsic muscles of the shoulder. Loss of muscles of the anterior arm. Arm is medially rotated and adducted. The forearm is extended and pronated. Sign is "waiter's tip"
- Lower trunk (C8,T1)
  - Thoracic outlet syndrome. Loss of all the muscles of the forearm and hand. Sign is combination of "claw hand" and "ape hand"
  - May include a Horner syndrome.

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### ANTERIOR MUSCLES

- M-C
  - Biceps
  - brachialis
- Median
  - Forearm flexors
  - Thumb intrinsics
- Ulnar
  - Flexor carpi ulnaris
  - Hand intrinsics

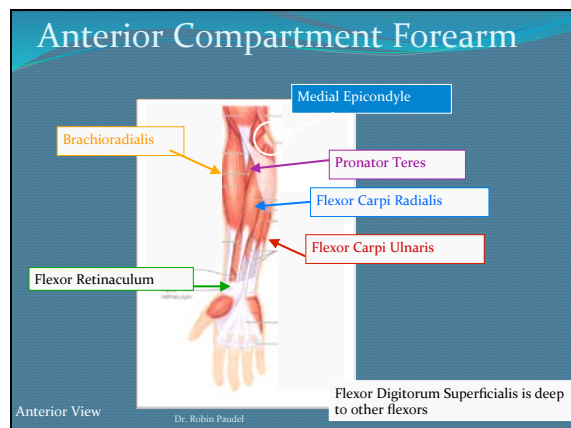
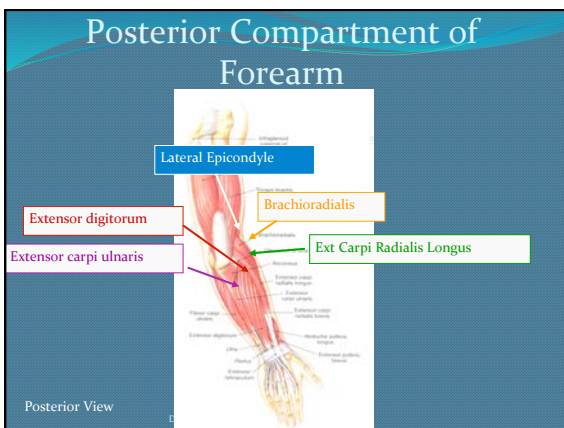
### POSTERIOR MUSCLES

- Muscles (radial nerve)
  - Triceps
  - Anconeus
  - Brachioradialis
  - Carpal, digit extensors

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### Muscles and nerves by compartment

	ANTERIOR	POSTERIOR
NERVES	M-C, ulnar, median	Radial
MOVEMENT	Flexion	Extension
MUSCLES	Biceps, flexors	Triceps, extensors
TWIST	Flexors from medial epicondyle	Extensors from lateral epicondyle



## Routes of nerves

- M-C: between biceps brachii and brachialis
- Median: medial/posterior to biceps, branches into forearm flexors at elbow then to hand through carpal tunnel
- Ulnar: medial in arm, posterior to medial epicondyle of humerus (funny bone) down medial forearm medial to carpal tunnel into palm
- Radial: deep posterior arm around lateral epicondyle of humerus to forearm (deep and superficial branches)

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Where's the Radial Nerve?

## Axilla = Armpit

- Region between arm and chest
- Boundaries
  - Ventral - pectoral muscles
  - Dorsal = latissimus dorsi, teres major subscapularis
  - Medial = serratus ventralis
  - Lateral = bicipital groove of humerus
- Contents
  - Axillary lymph nodes, Axillary vessels
  - Brachial Plexus

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## Surface Anatomy of Upper Limb

- Biceps + Triceps brachii
- Olecranon Process
- Medial Epicondyle
- Cubital Fossa
  - Anterior surface elbow
  - Contents
    - Median Cubital Vein
    - Brachial Artery
    - Median Nerve
  - Boundaries
    - Medial= Pronator teres
    - Lateral= Brachioradialis
    - Superior= Line between epicondyles

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## Surface Anatomy of Upper Limb

- Carpal Tunnel
  - Carpals concave anteriorly
  - Carpal ligament covers it
  - Contains: long tendons, Median nerve
  - Inflammation of tendons = compression of Median nerve
- Anatomical Snuffbox
  - Lateral = E. pollicis brevis
  - Medial = E. pollicis longus
  - Floor = scaphoid, styloid of radius
  - Contains Radial Artery (pulse)

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Suggestion: a muscle table organized by

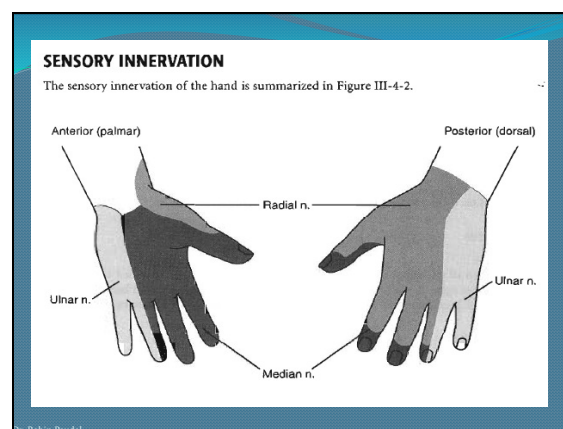
- Joint crossed?
- Nerve innervating?
- Action?
- Compartments?
- All of the above?

MUSCLE	ACTION	ORIGIN	INSERTION	INNERVATION (cord to nerve)
Biceps	Flex, sup.	Humerus, glenoid	Radial tuberosity	Medial cord- M-C.

**Table III-4-1. The Motor Innervation by the Five Terminal Nerves**

Terminal Nerve	Muscles Innervated
Musculocutaneous nerve	All the muscles of the anterior compartment of the arm
Median nerve	All the muscles of the anterior compartment of the forearm except 1 [1/2] muscles (flexor carpi ulnaris and the ulnar [1/2] of the flexor digitorum profundus)  The 3 thenar compartment muscles and the 1st and 2nd lumbricals
Ulnar nerve	The 1 [1/2] muscles of the forearm not innervated by the median nerve  All the muscles of the hand except those innervated by the median nerve
Axillary nerve	Deltoid and teres minor
Radial nerve	The posterior muscles of the arm and forearm

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In addition to the five terminal nerves, there are several collateral nerves that arise from the brachial plexus proximal to the terminal nerves (i.e., from the rami, trunks, or cords). These nerves innervate proximal limb muscles (shoulder girdle muscles).

Collateral Nerve	Muscles or Skin Innervated
Dorsal scapular nerve	Rhomboids
Long thoracic nerve	Serratus anterior
Suprascapular nerve	Supraspinatus and infraspinatus
Lateral pectoral nerve	Pectoralis major
Medial pectoral nerve	Pectoralis major and minor
Upper subscapular nerve	Subscapularis
Middle subscapular (thoracodorsal) nerve	Latissimus dorsi
Lower subscapular nerve	Subscapularis and teres major
Medial brachial cutaneous nerve	Skin of medial arm
Medial antebrachial cutaneous nerve	Skin of medial forearm

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## Nerve Injuries

### Radial nerve

**At the Axilla**  
Loss of extensors at the elbow, wrist, and digits;  
Weakened extension at the shoulder;  
Weakened supination.  
Sensory loss on posterior arm, forearm, and hand.  
Sign is "wrist drop."  
Shoulder dislocation may injure the radial nerve.  
Also, pressure on the floor of axilla may injure nerve (Saturday night palsy).

**At the Elbow**  
Loss of extensors at the wrist and digits.  
Sensory loss on the posterior forearm and hand.  
Sign is "wrist drop."  
Fracture of the shaft of the humerus could lacerate the radial nerve, and the deficits would be the same as if the nerve were damaged at the level of the elbow.

**At the Wrist**  
Sensory loss on the posterior hand (first dorsal web space).

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## Median nerve

**At the Elbow**  
Loss of flexion of the digits, thenar muscles, and lumbricals 1 and 2; weakened wrist flexion;  
Ulnar deviation upon flexion of the wrist; **loss of pronation**.  
Sensory loss on lateral palm and digits 1, 2 and 3, and one half of 4.  
Sign is "ape or simian hand" and "flattening of the thenar eminence."

**At the Wrist**  
Loss of function of the thenar muscles and lumbricals 1 and 2; "clawing" of digits 2 and 3.  
Sensory loss on palmar surface of digits 1, 2, and 3, and one-half of 4.  
Sign is "ape or simian hand" and "flattening of thenar eminence."  
Carpal tunnel compression or wrist laceration can lead to damage to the median nerve at the wrist

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## Ulnar nerve

**At the Elbow (medial epicondyle)**  
Weakened wrist flexion  
Radial deviation upon flexion of the wrist  
Loss of abduction and adduction of the digits  
Loss of hypothenar muscles and lumbricals 3 and 4.  
Weakened flexion of digits 4 and 5.  
Sensory loss on digits 5 and one half of 4.  
Sign is "claw hand."

**At the Wrist**  
Loss of abduction and adduction of the digits; loss of the hypothenar muscles and lumbricals 3 and 4.  
Sensory loss on digits 5 and one half of 4.  
Sign is "claw hand."

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## Axillary nerve

Loss of abduction of the arm to the horizontal plane.  
The axillary nerve could be damaged with a fracture of the surgical neck of the humerus or dislocation of the shoulder.

## ARTERIAL SUPPLY AND MAJOR ANASTOMOSES

**Subclavian artery**  
Branch of brachiocephalic trunk on the right and aortic arch on the left

**Axillary artery**  
From the first rib to the posterior edge of the teres major muscle.

- Superior thoracic artery
- Thoracoacromial artery
- Lateral thoracic artery-supplies mammary gland
- Subscapular artery-collateral to shoulder
- Posterior humeral circumflex artery-at surgical neck with axillary nerve
- Anterior humeral circumflex artery

**Brachial artery**  
Profunda brachii artery with radial nerve.

**Radial artery**  
Deep palmar arch.

**Ulnar artery**  
Common interosseous artery.  
Superficial palmar arch.

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## Vascular supply

- Subclavian → axillary → radial
- Collateral circulation
  - Posterior/anterior circumflex humeral
  - Deep brachial a.
- Radial a. (with median n.) → deep palmar arch
- Ulnar a. (with ulnar n.) → superficial palmar arch

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## LUMBRICALS

- Nerve supply:**
  - 1st & 2nd lumbricals: **median: C7 > C6**;
  - 3rd & 4th lumbricals: **ulnar: L5**;
- Action:**
  - when the lumbrical muscle contracts, it draws the lateral band proximally and pulls the FDP distally (relaxing the tendon);
  - extends IP joints:**
    - principal extensors of the interphalangeal joints (work horse);
    - extends the IP joint, irrespective of MCP joint position;
    - facilitates IP extension by pulling profundus distally (unique ability to relax its on antagonist)
  - flexes MCP joint;
    - mainly in mechanical way by being pulled by the profundus;
    - Lumbricals** are prime flexors of MP joints;
    - when MP joints are stabilized, lumbricals bend fingers toward thumb (index finger abduction, middle finger radial flexion, ring and little finger adduction);
    - when fingers are flexed, lumbricals are pulled into carpal canal & recede proximally to the distal end of radius;

## Radiology

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