

## PowerPoint Handout: Lab 8, Axilla and Brachial Plexus

Slide Title	Slide Number
Axilla: Introduction	<a href="#">Slide 2</a>
Axilla: Contents	<a href="#">Slide 3</a>
Axillary Artery: Review	<a href="#">Slide 4</a>
Axillary Vein	<a href="#">Slide 5</a>
Axillary Lymph Nodes	<a href="#">Slide 6</a>
Upper Limb Lymph Drainage	<a href="#">Slide 7</a>
Brachial Plexus: Introduction	<a href="#">Slide 8</a>
Brachial Plexus: Upper Trunk Injury	<a href="#">Slide 9</a>
Brachial Plexus: Lower Trunk Injury	<a href="#">Slide 10</a>
Supraclavicular Branches: Dorsal Scapular, Long Thoracic, Suprascapular, and Subclavian Nerves	<a href="#">Slide 11</a>
Scapular Winging	<a href="#">Slide 12</a>
Infraclavicular Branches Upper Subscapular, Lower Subscapular, & Thoracodorsal Nerves	<a href="#">Slide 13</a>

Slide Title	Slide Number
Infraclavicular Branches: Medial & Lateral Pectoral & Subclavian Nerve	<a href="#">Slide 14</a>
Infraclavicular Branches: Medial Cutaneous Nerves of Arm and Forearm	<a href="#">Slide 15</a>
Terminal Branches: Musculocutaneous Nerve	<a href="#">Slide 16</a>
Terminal Branches: Median Nerve	<a href="#">Slide 17</a>
Terminal Branches: Ulnar Nerve	<a href="#">Slide 18</a>
Terminal Branches: Axillary Nerve	<a href="#">Slide 19</a>
Surgical Neck Fracture of Humerus	<a href="#">Slide 20</a>
Terminal Branches: Radial Nerve	<a href="#">Slide 21</a>

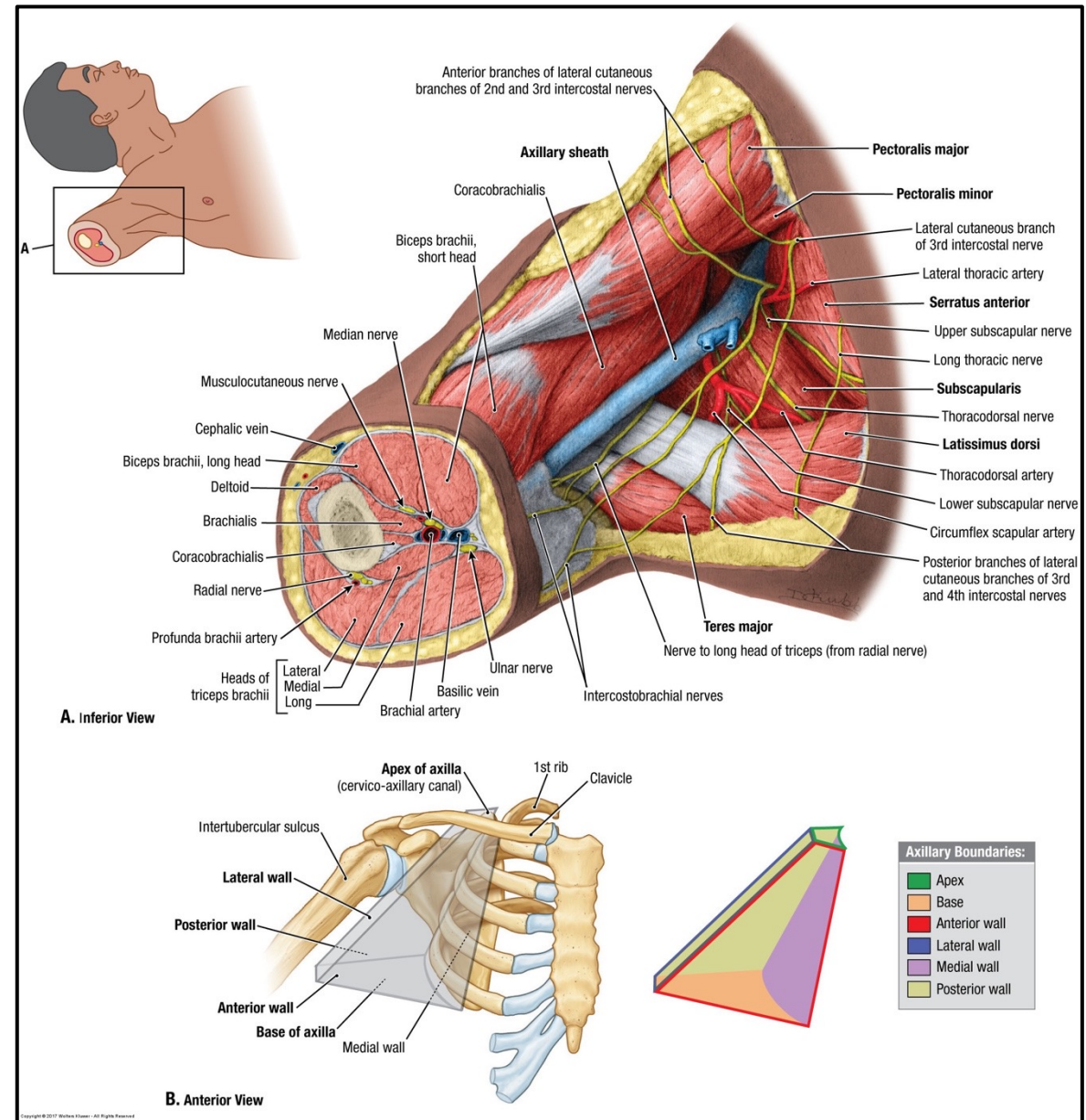
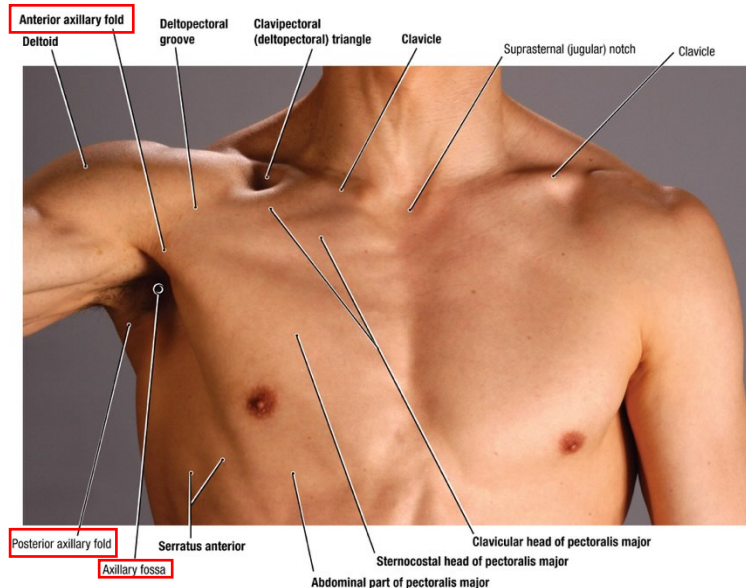
# Axilla: Introduction

The **axilla** is a pyramidal space located between the proximal arm and the lateral thoracic wall. The walls of the axilla are listed below.

- Anterior wall: pectoralis major, pectoralis minor, and subclavius muscle
- Posterior wall: latissimus dorsi, teres major, and subscapularis muscles
- Medial wall: serratus anterior
- Lateral wall: intertubercular groove on humerus
- Apex (passageway between the neck and axilla): lateral border 1<sup>st</sup> rib, superior border scapula, posterior border clavicle

Axillary folds are visible surface features that demarcate the inferior parts of both the anterior and posterior axillary boundaries..

- The **posterior axillary fold** is formed by the latissimus dorsi winding around the lateral border of the *teres major* muscle. Latissimus dorsi forms much of the muscle mass underlying the posterior axillary fold extending obliquely upward from the trunk to the arm.
- The **anterior axillary fold** is formed by the inferior border of the pectoralis major muscle.

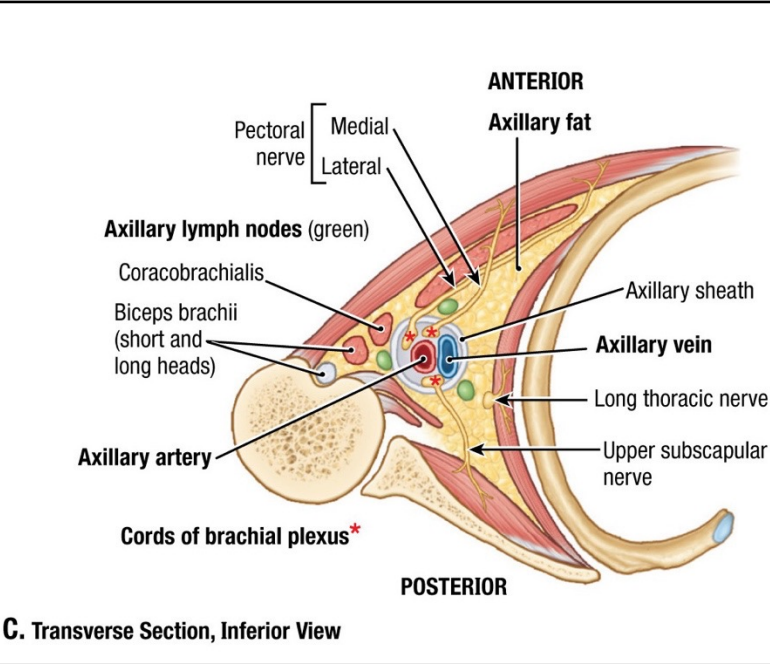
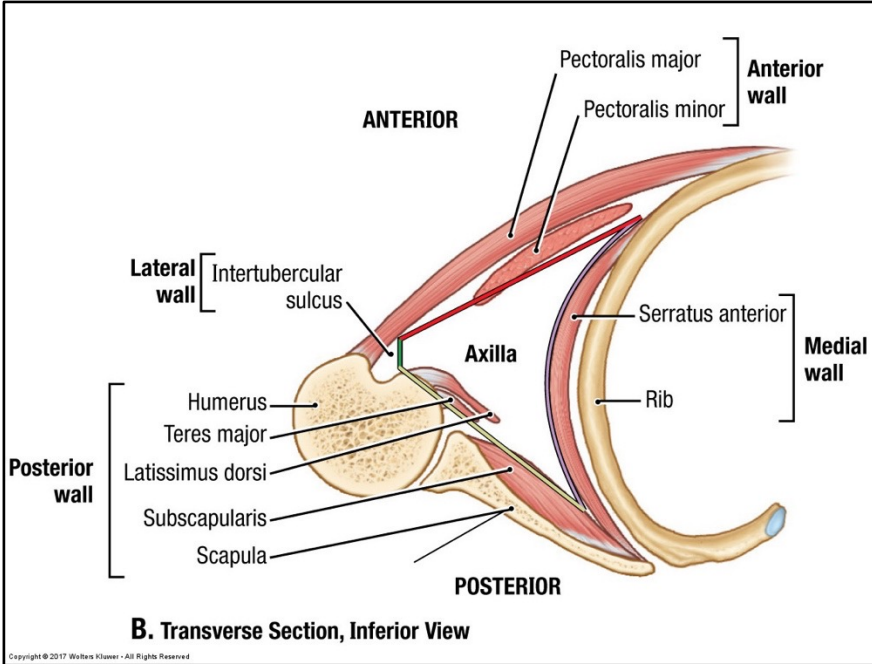
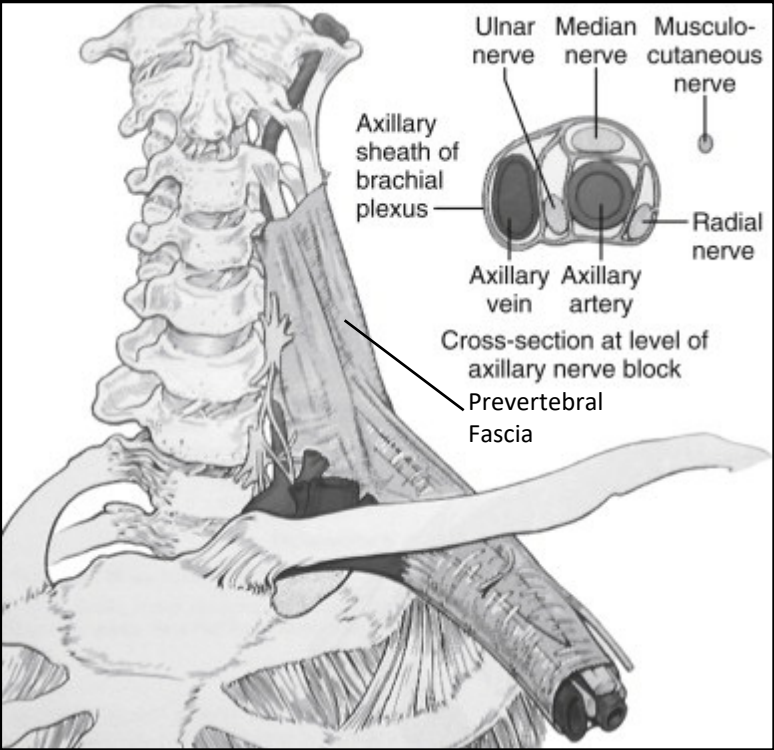


# Axilla: Contents

The following structures are located within the axilla

- **Axillary artery**
- **Axillary vein**
- **Brachial Plexus cords and branches**
- **Lymphatic vessels and axillary lymph nodes**
- Axillary fat

The prevertebral fascia that surrounds muscles associated with the vertebral column continues as the axillary sheath where the subclavian artery passes through the interscalene triangle. The first part of the subclavian artery/axillary artery, axillary vein, and the brachial plexus, are all enclosed by the axillary sheath.

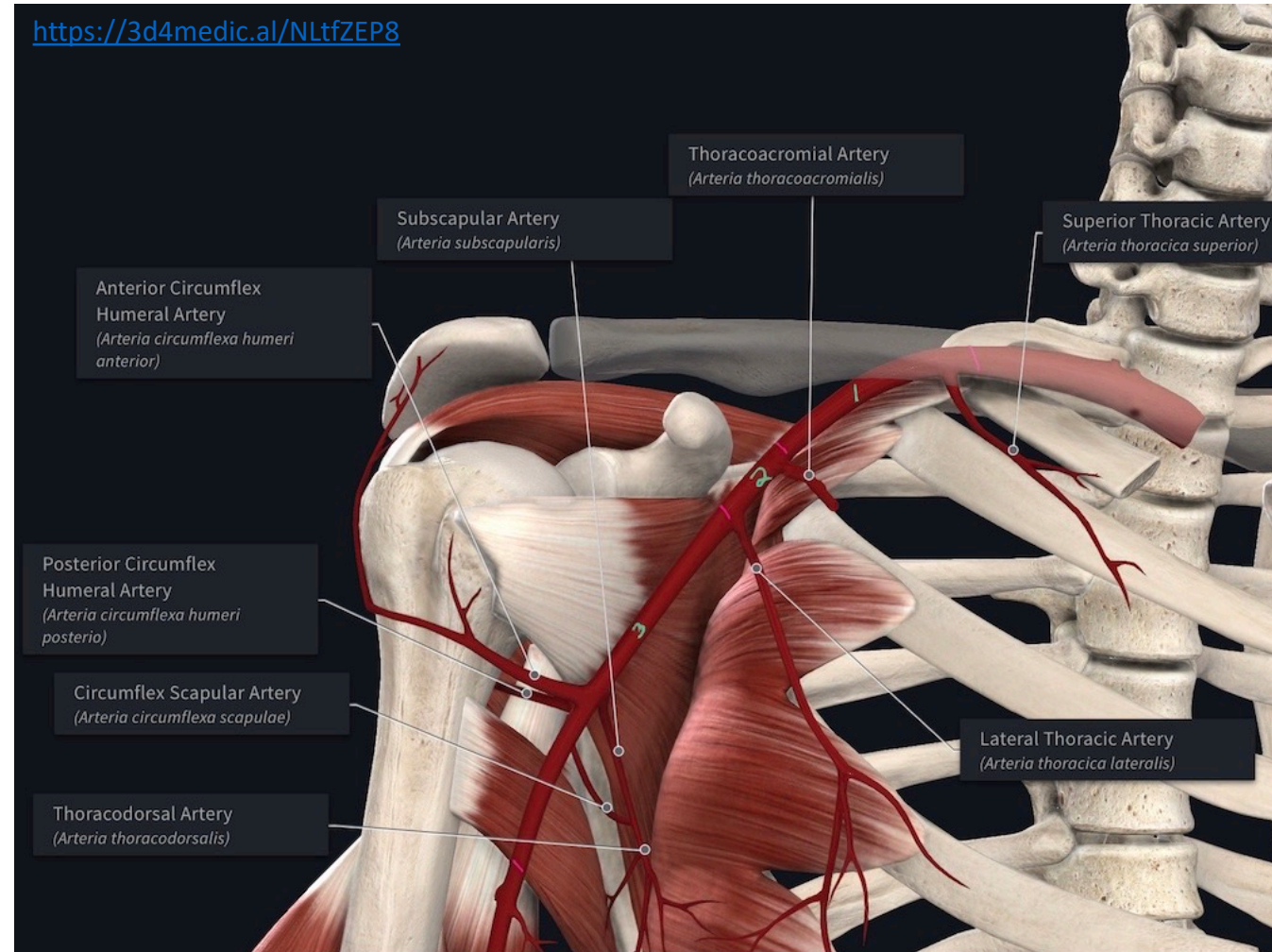




# Axillary Artery: Review

The **axillary artery** is a continuation of the **subclavian artery** at the lateral edge of the first rib. Its distal boundary is at the inferior border of the teres major muscle where it becomes the brachial artery. It is divided into three parts, with the pectoralis minor muscle defining the separation between the 3 parts. All of the branches are listed below, but each of these branches will be explored in detail when we continue our anatomical study further into the axilla.

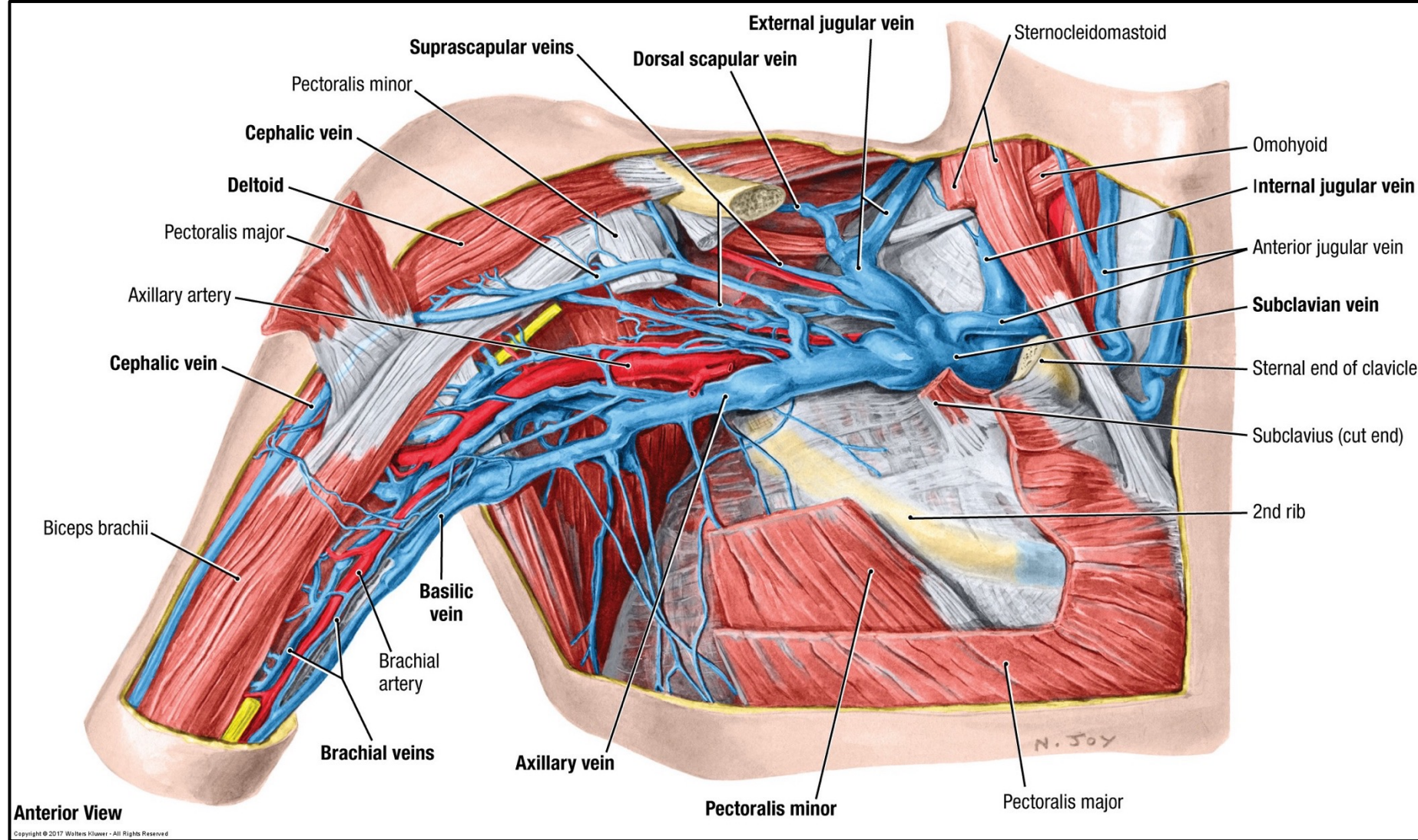
1. First part is proximal to the pectoralis minor and distal to the lateral edge of the first rib. The first part gives off 1 branch.
  - **Superior thoracic artery** (courses to anterior thoracic wall)
2. Second part is posterior to the pectoralis minor muscle and gives off 2 branches.
  - The **thoracoacromial artery** forms four named branches that ultimately supply to the pectoralis major and minor muscles, the anterior part of the deltoid muscle, and skin overlying the clavipectoral fascia.
  - The **lateral thoracic artery** supplies the serratus anterior muscle and the breast. It is accompanied by the long thoracic nerve.
3. Third Part is between the pectoralis minor muscle and the lateral border of the teres major muscle and gives off 3 branches.
  - The **subscapular artery** courses along the anterior aspect of the subscapularis muscle and forms two branches.
    - The **thoracodorsal artery** courses with the thoracodorsal nerve to supply the latissimus dorsi muscle.
    - The **circumflex scapular artery** passes through the triangular space to form collateral circulation with the suprascapular and dorsal scapular arteries.
  - The **posterior humeral circumflex** artery passes through the quadrangular space with the axillary nerve to course posteriorly around the surgical neck of the humerus.
  - The **anterior humeral circumflex artery**: Courses anterior around the surgical neck of the humerus to anastomose with the posterior circumflex artery.





# Axillary Vein

- The axillary vein is formed by the union of the brachial veins (venae comitantes) and the basilic vein at the inferior border of teres major.
- The vein has 3 parts that correspond to the 3 parts of the axillary artery.



Anterior View

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## Axillary Lymph Nodes

The axilla contains about 20-30 lymph nodes that can anatomically be divided into five “groups”. Their separation into individual groups is somewhat artificial, but it facilitates the understanding of regional lymphatic drainage and helps to clarify the location of the nodes. It should be understood, however, that the axillary nodes are subject to great variations in location, size, and number. In addition, the listed groups have a rich system of anastomoses.

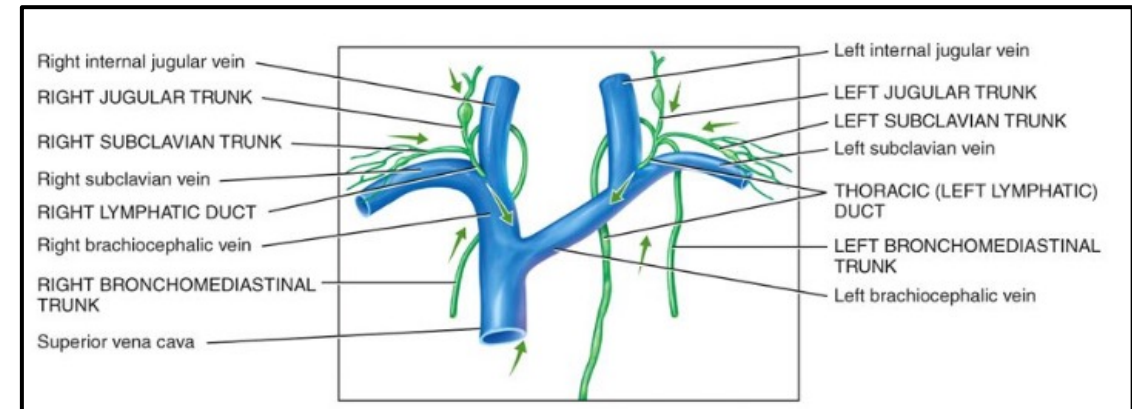
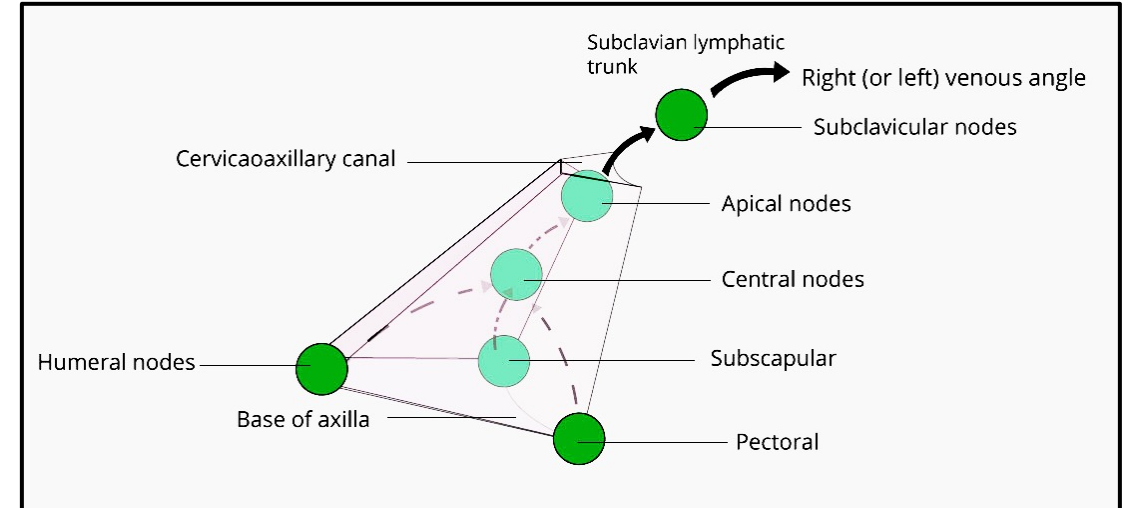
- **Pectoral (anterior):** located along the lower border of pectoralis minor;
- **Subscapular (posterior):** located on the anterior surface of the subscapularis muscle, on the posterior wall of the axilla;
- **Humeral (lateral):** located along the medial side of the axillary vein;
- **Central:** large and fairly numerous nodes in the fat of the axilla; central nodes receive lymph from the preceding three outlying groups;
- **Apical:** located at the apex of the axilla; apical nodes receive lymph from all other axillary groups

Three streams of lymph drain into the axillary nodes from the following regions.

1. The upper extremity (humeral)
2. The adjacent thoracic and upper abdominal wall and breast (pectoral)
3. The back (subscapular region).

These three lymph currents meet and fuse within the central and apical chains. Efferent vessels from the most apical group converge to form the subclavian trunk, which ultimately joins the venous circulation.

- On the right side, the subclavian lymphatic trunk joins the venous circulation at the junction between the right subclavian vein and the right internal jugular vein (venous angle).
- On the left side, the subclavian trunk usually joins the thoracic duct in the base of the neck. The thoracic duct then joins the venous circulation at the junction between the left subclavian vein and the left internal jugular vein (venous angle),



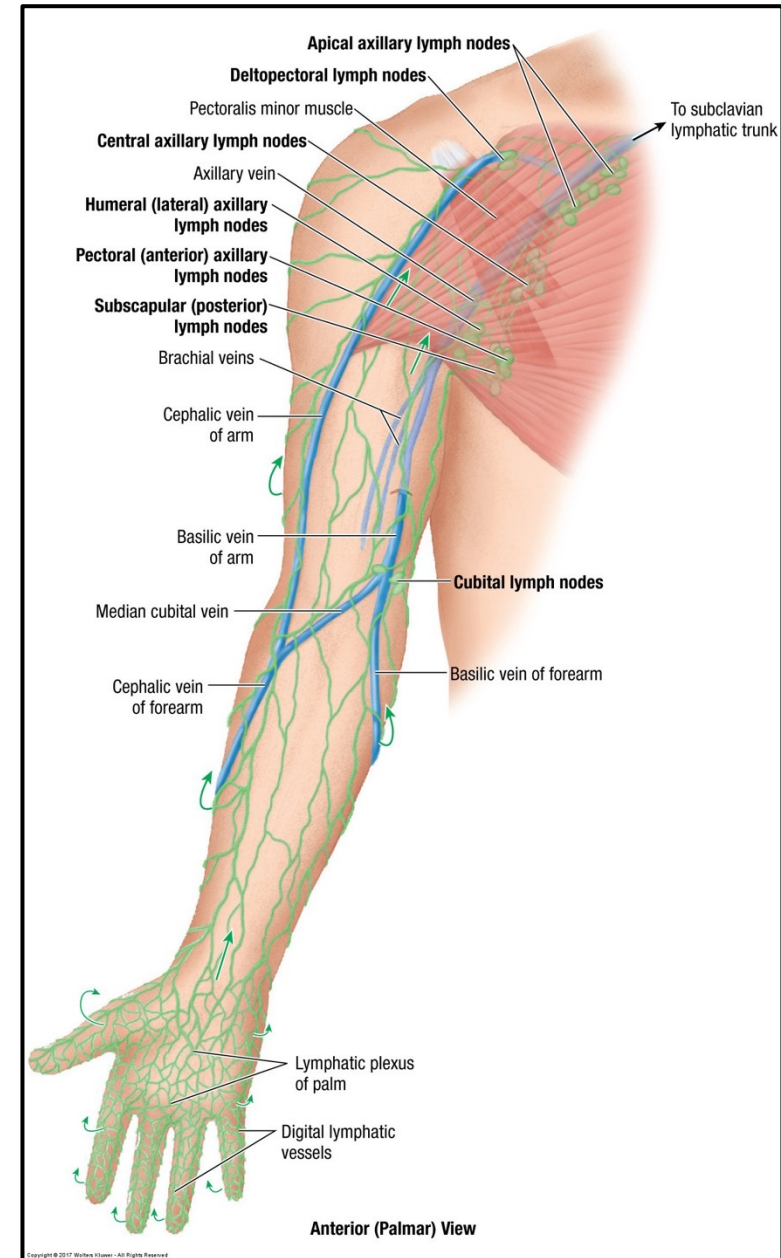


# Upper Limb Lymph Drainage

Superficial lymphatic vessels of the upper extremity arise from lymphatic plexuses in the skin of the fingers, palm, and the dorsum of the hand and ascend primarily with the superficial veins.

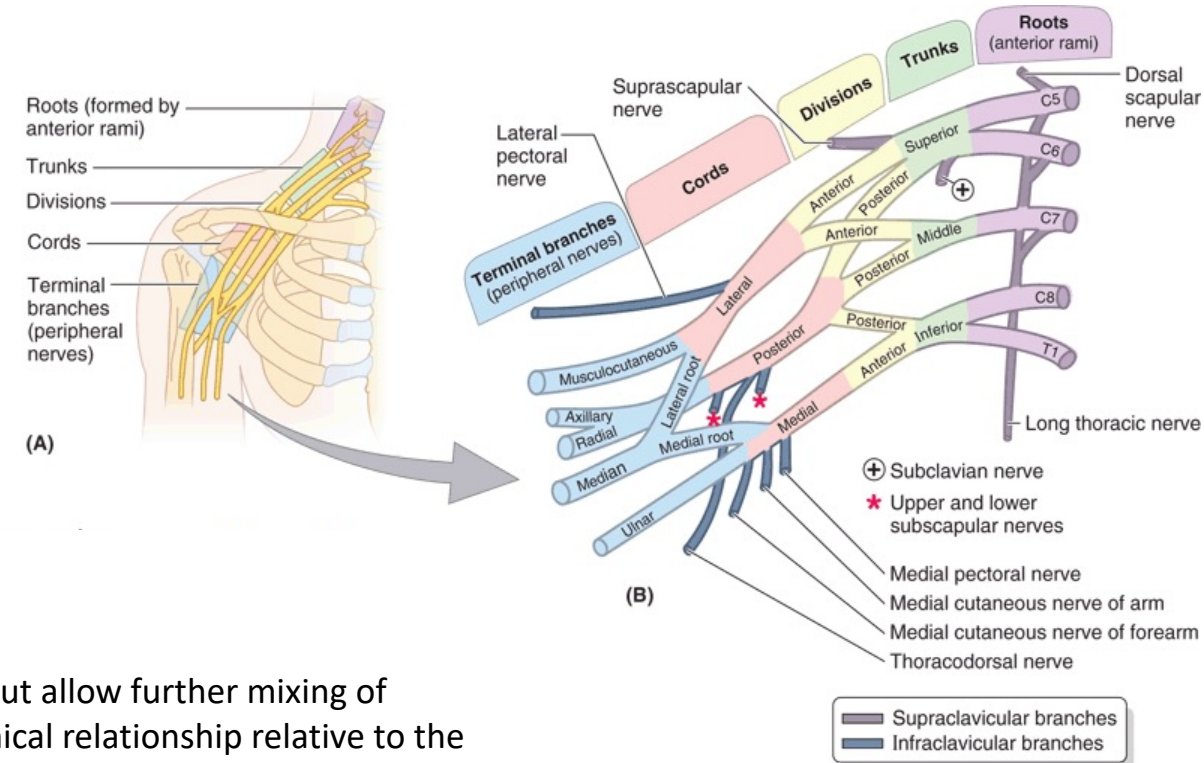
- Lymph vessels traveling with the cephalic vein originate from capillaries in the superficial fascia and skin of the lateral aspects of the hand, forearm and arm. These vessels drain to the deltopectoral (infraclavicular) nodes, which drain directly to the apical nodes.
- Lymph vessels traveling with the basilic vein originate from capillaries in the superficial fascia and skin of the medial three digits, the medial part of the hand and the medial side of the forearm. These vessels drain first to the **supratrochlear (cubital) nodes** which lie in the superficial fascia anterior to the trochlea of the humerus. These nodes drain to the **humeral (lateral) group** of axillary lymph nodes.

Deep lymphatic vessels are less numerous than superficial vessels; they accompany the major deep veins of the upper extremity and terminate in the **humeral (lateral) group** of axillary lymph nodes.



## Brachial Plexus: Introduction

- The brachial plexus is created by the joining, separating, and regrouping of the ventral rami of the spinal nerves.
- The brachial plexus is composed of rami, trunks, divisions, cords, and branches.
  - The **ventral primary rami** of C5 - T1 join into three **trunks**. Within the **trunks**, the sensory and motor components of the rami mix together.
    - Superior Trunk** is formed by the union of C5 and C6 ventral rami
    - Middle Trunk** is formed by the ventral ramus of C7
    - Inferior Trunk** is formed by the joining of C8 and T1 ventral rami
  - The trunks divide into **divisions**, which separate the axons destined for anterior structures from those destined for posterior structures.
    - The anterior divisions contain neurons destined for flexor muscles.
    - The posterior divisions contain neurons destined for extensor muscles.



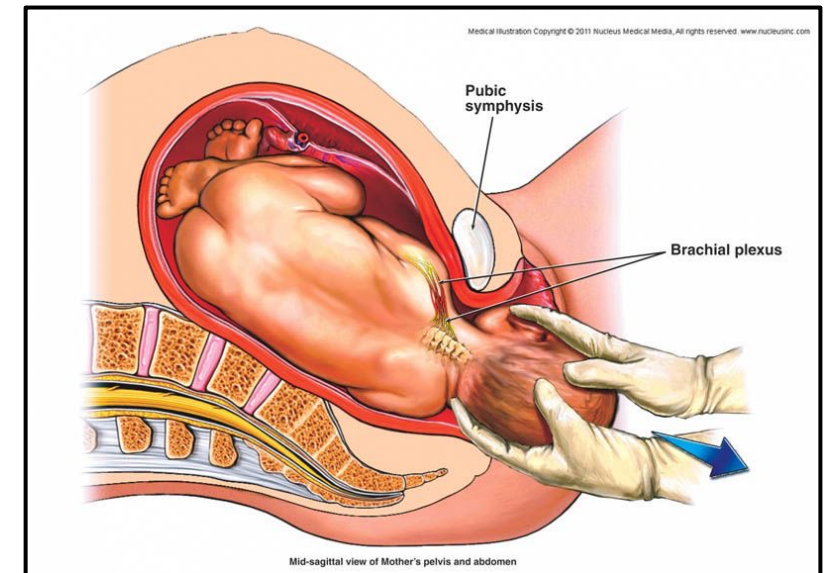
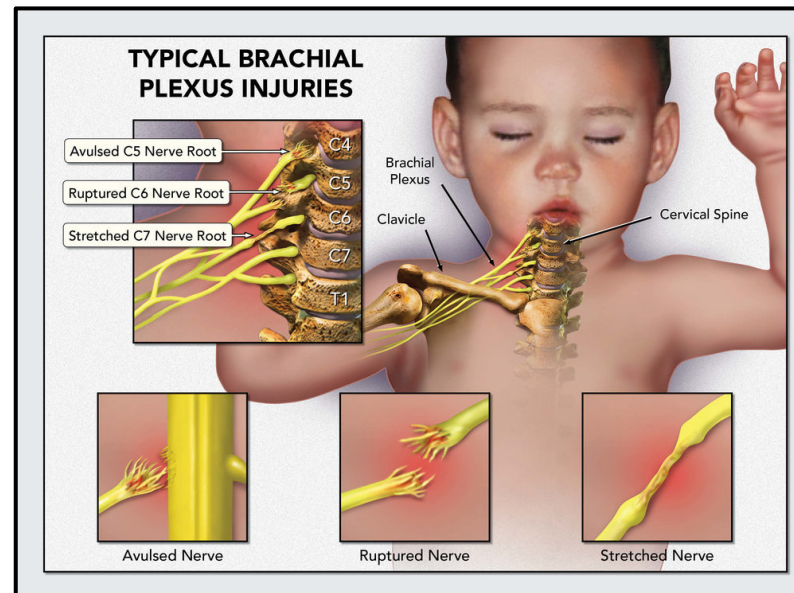
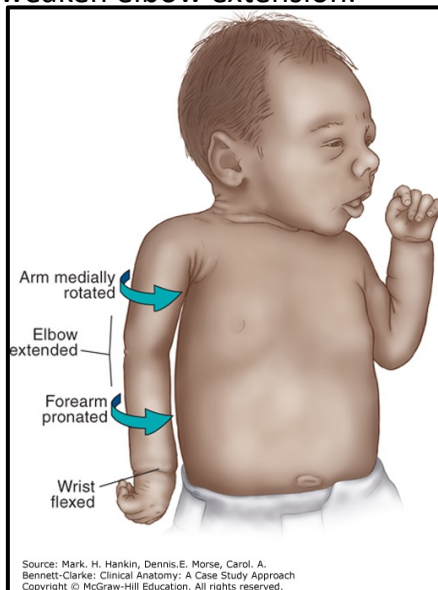
- The divisions fuse into **cords** that retain the anterior-posterior segregation but allow further mixing of axons from different spinal segments. The cords are named for their anatomical relationship relative to the second part of the axillary artery.
- Branches** are the named nerves that branch from the brachial plexus. The branches can be described as organized into different groups.
  - Terminal branches are the nerves formed from the distal terminations of the medial, lateral, and posterior cords (light blue branches on picture).
  - Infraclavicular branches are named nerves that branch from the medial, lateral, and posterior cord (dark blue branches on picture).
  - Supraclavicular branches are branches of the rami or trunks (dark purple branches on picture).



# Brachial Plexus: Upper Trunk Injury

**Injury to the upper trunk** (formed by C5-C6) of the brachial plexus can be called Erb-Duchenne paralysis (palsy). It is caused by a violent distraction (lateral bending) of the head away from the shoulder. This can occur in trauma, such as results from a fall from a motorcycle or horse. In addition, it can occur from traction placed on the brachial plexus during a difficult birth (Figure bottom right). The resulting presentation of the upper extremity is described as a **“waiter’s tip hand,”** in which the arm rests in medial rotation, the forearm is pronated, and the wrist is flexed (figure bottom left).

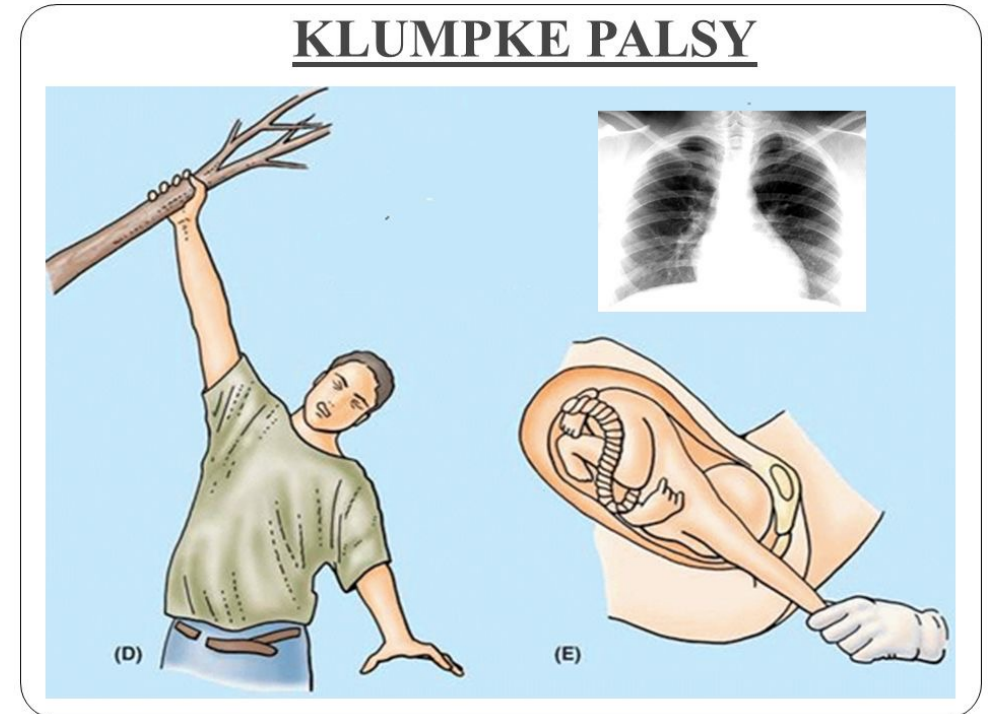
- The following nerves are involved in an injury to the upper trunk.
  - Axillary nerve
    - Deltoid paralysis results in an inability to laterally rotate and abduct arm. When at rest, deltoid paralysis results in the arm by the side and medially rotated. (medial rotators are still active)
    - loss of skin sensation from lateral aspect of arm
  - Suprascapular nerve:
    - Suprascapular and infraspinatus paralysis results in an inability to laterally rotate and abduct. When at rest, suprascapular and infraspinatus paralysis results in the arm in medial rotation. (medial rotators are still active)
  - Musculocutaneous nerve:
    - Biceps brachii, brachialis, and coracobrachialis paralysis results in an inability to flex the elbow and weakened supination of the forearm. When at rest, paralysis of these muscles results in a pronated forearm with the elbow extended. (pronators are still active)
    - loss of skin sensation from lateral aspect forearm
  - Radial nerve (C5-T1): Due to C5 and C6 contributing to the radial nerve, and being the primary innervation of extensor carpi radialis longus, weakened extension at the wrist also occurs, which causes the resting position of the wrist to be flexed. In some situations, C7 can also be involved, which will further weaken wrist extension and weaken elbow extension.



## Brachial Plexus: Lower Trunk Injury

**Injury to nerve roots C8 and T1**, or where they combine to form the lower trunk, is called Klumpke's paralysis. Injury to only the inferior trunk of the brachial plexus is rare. Klumpke's paralysis can be caused by violent hyperabduction of the arm, as when a person is grasping an object to prevent a fall. It can also be caused by a difficult breech delivery, or by pressure on the lower trunk by a cervical rib.

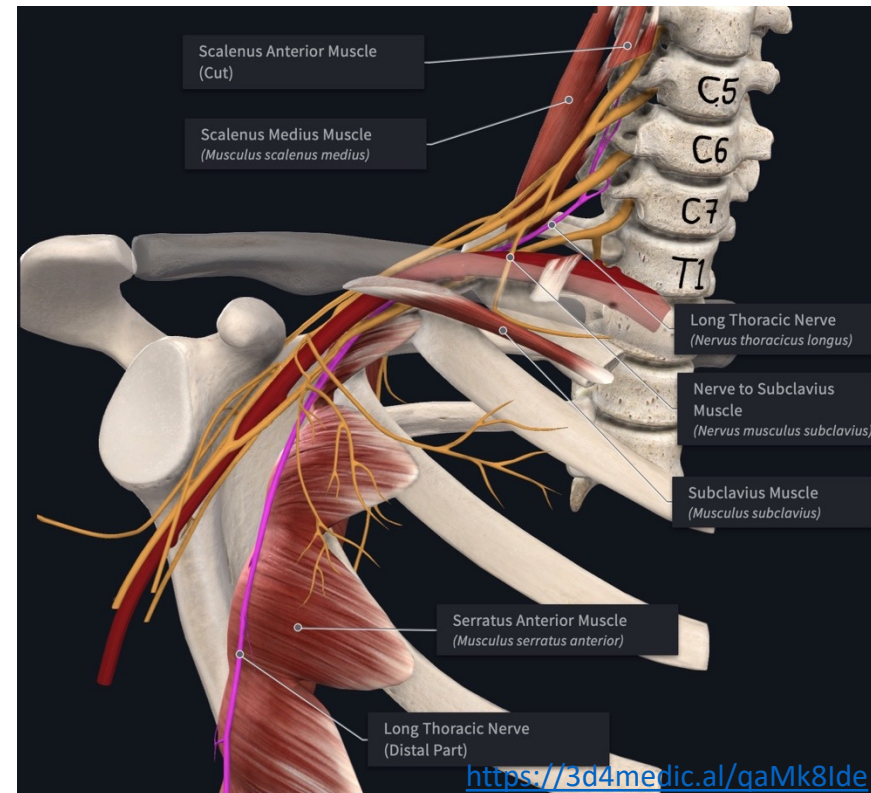
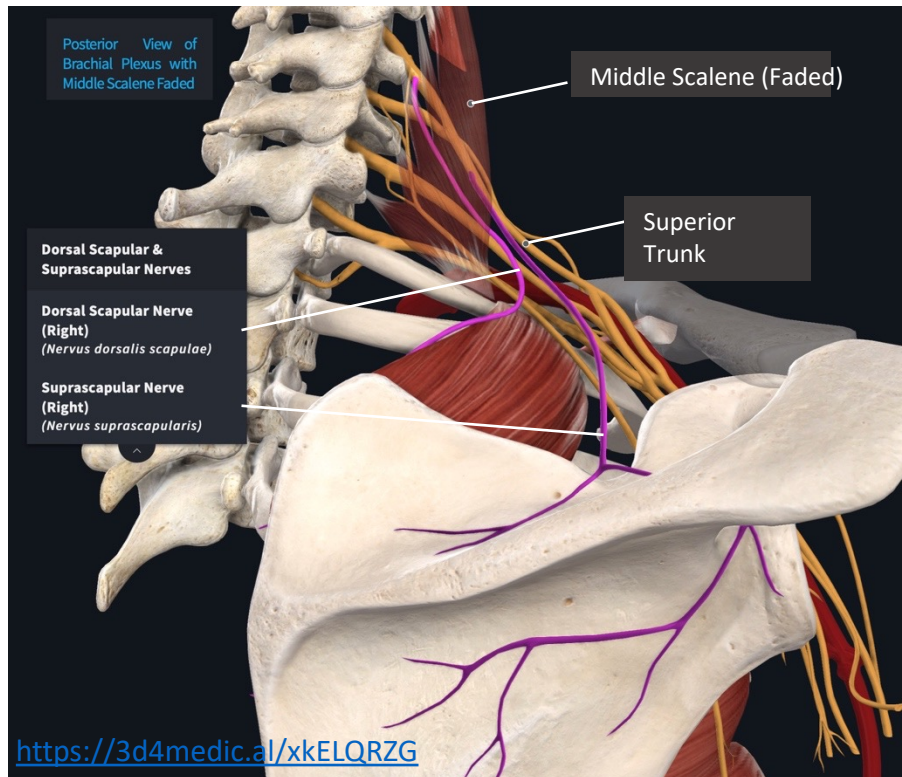
- The ulnar nerve and median nerves are the primary nerves involved in an injury to the lower trunk of the brachial plexus.
- Most importantly, **all the intrinsic hand muscles** are affected in Klumpke's paralysis.
- The hand is held in a position known as "total" claw hand, which is when ALL of the fingers are in flexion when the hand is at rest. Don't confuse "total" claw hand" with "ulnar nerve" claw hand in which only digits 4 and 5 are in a flexed position at rest.
- Total claw hand results from the following situation.
  - Wrist is slightly extended: This is due to a loss of some opposition of wrist flexors (total loss of flexor carpi ulnaris and flexor digitorum profundus, so active flexion of the wrist will be weak)
  - MP joints extended: loss of opposed flexion from lumbricals and interossei.
  - Flexion of IP joints: loss of opposed extension from lumbricals and interossei (flexion of IP joints results from flexor digitorum superficialis still being active due to receiving innervation from C7)
  - At rest, the thumb will retreat posteriorly into the same plane as the fingers. This is due to the loss of innervation to the thenar muscles. This position is described as "ape hand."
- In addition to claw hand, the following signs will be present.
  - The forearm is supinated due to paralysis of pronator quadratus
  - Loss of skin sensation from the medial aspect of the arm, forearm and ulnar sensory domain of the hand.





# Supraclavicular Branches: Dorsal Scapular, Long Thoracic, Suprascapular, and Subclavian Nerves

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Dorsal scapular</b>	Posterior aspect of anterior ramus of <b>C5</b> with a frequent contribution from C4	Pierces middle scalene; descends deep to levator scapulae and rhomboids	<b>Motor:</b> Rhomboids; occasionally supplies levator scapulae
<b>Long thoracic</b>	Posterior aspect of anterior rami of <b>C5, C6, C7</b>	Passes through cervico-axillary canal (Fig. 6.14), descending posterior to C8 and T1 roots of plexus (anterior rami); runs inferiorly on superficial surface of serratus anterior	<b>Motor:</b> Serratus anterior
<b>Suprascapular</b>	Superior trunk, receiving fibers from <b>C5, C6</b> and often C4	Passes laterally across lateral cervical region (posterior triangle of neck), superior to brachial plexus; then through scapular notch inferior to superior transverse scapular ligament	<b>Motor:</b> Supraspinatus and infraspinatus muscles <b>Sensory:</b> glenohumeral (shoulder) joint
<b>Subclavian nerve</b> (nerve to subclavius)	Superior trunk, receiving fibers from C5, <b>C6</b> and often C4	Descends posterior to clavicle and anterior to brachial plexus and subclavian artery (Fig. 6.29); often giving an <i>accessory root to phrenic nerve</i>	<b>Motor:</b> Subclavius and sternoclavicular joint (accessory phrenic root innervates diaphragm)





## Scapular Winging

**CLINICAL ANATOMY:** Medial winging of the scapula is the result of **serratus anterior** paralysis from injury to the **long thoracic nerve**. The most common etiology is neuropraxia after blunt trauma or a stretch injury. In addition, surgical procedures in the thoracic region such as radical mastectomy, resection of the first rib, and transthoracic sympathectomy can expose the long thoracic nerve and make it susceptible to damage.

To test for medial scapular winging, ask patient to push against a wall and observe the inferior angle of scapula. If nerve is damaged, the inferior angle and medial border will project from the posterior thoracic wall (medial scapular “winging”). In addition, a person with long thoracic nerve injury will have difficulty abducting the arm past a horizontal position (90 degrees) due to an inability to upwardly rotate the scapula.

Two mnemonics that might help remember medial scapular winging:

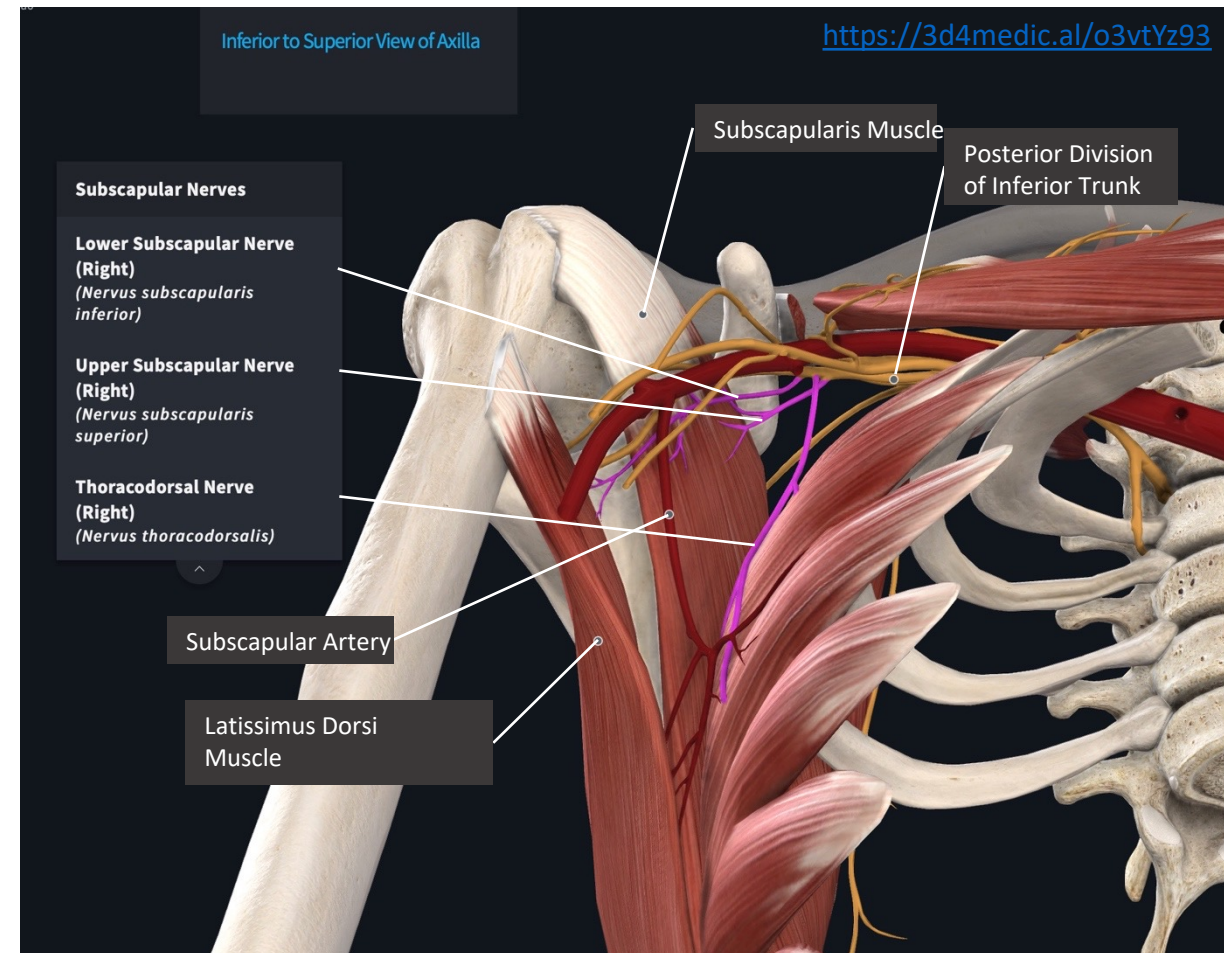
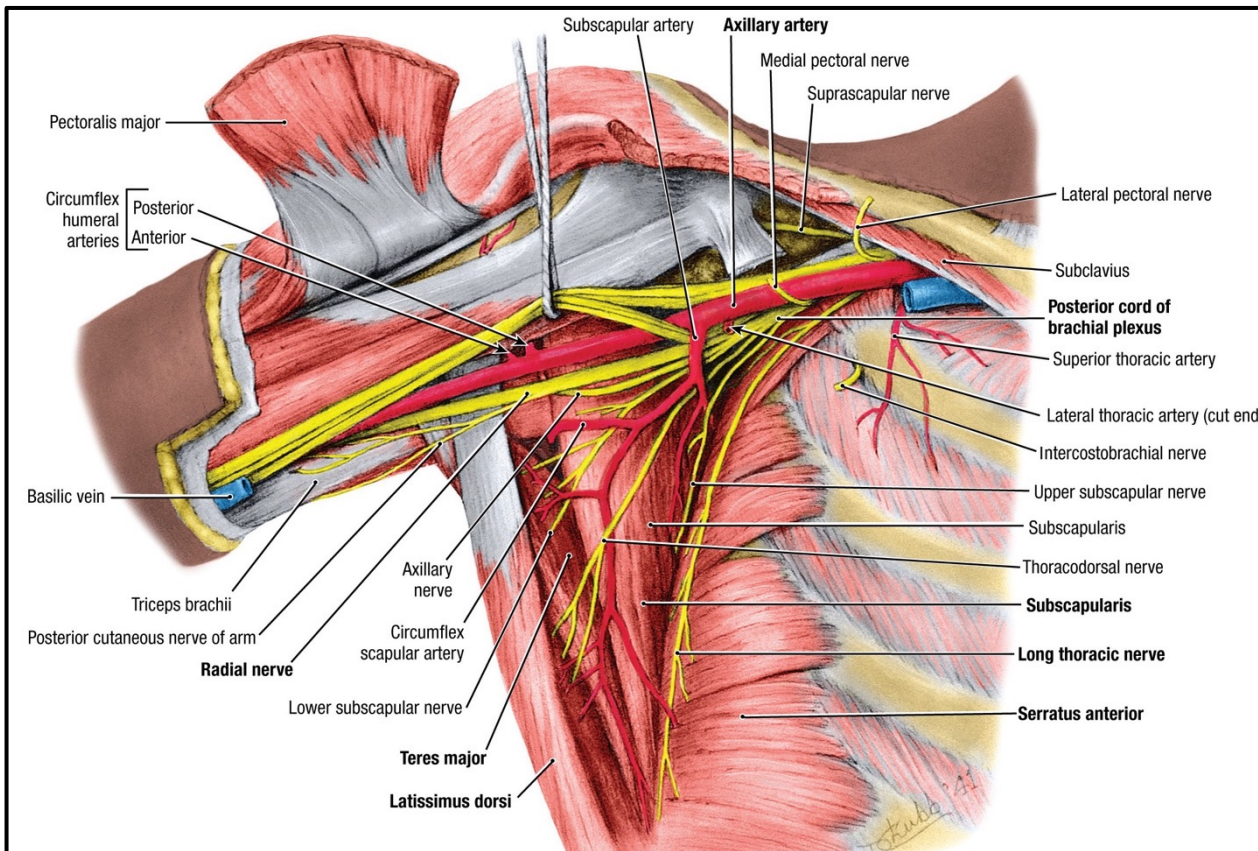
1. C5,6,7 wings to heaven: The serratus anterior is innervated by the long thoracic nerve (C5-C), so damage to the nerve results in (medial) winging of the scapula.
2. SALT on the birds wings: SA=serratus anterior, LT=long thoracic nerve. Damage to the long thoracic nerve results in (medial) winging of the scapula.

**CLINICAL ANATOMY:** Lateral Winging of the scapula results from a dysfunction in the trapezius (spinal accessory nerve: CN XI) and/or rhomboid muscles (dorsal scapular nerve). In lateral winging, the scapula is excessively protracted (abducted) on the thoracic wall.



# Infraclavicular Branches: Upper Subscapular, Lower Subscapular, & Thoracodorsal Nerves

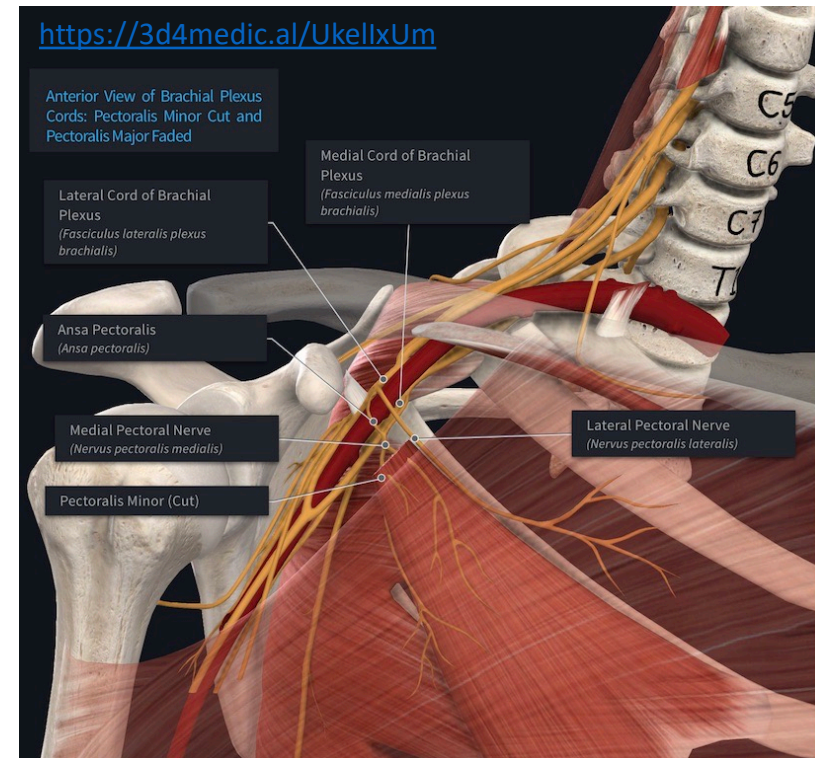
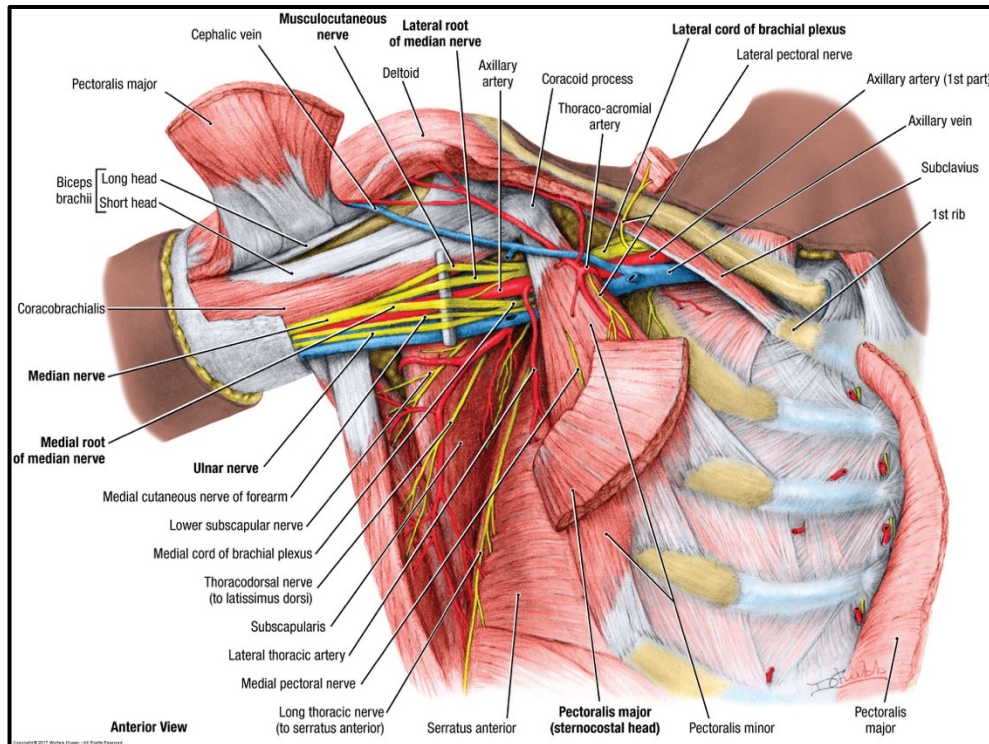
NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Upper subscapular</b>	Side branch of posterior cord, receiving fibers from <b>C5</b>	Courses posteriorly to enter subscapularis	<b>Motor:</b> Superior portion of subscapularis muscle
<b>Lower subscapular</b>	Side branch of posterior cord, receiving fibers from <b>C6</b>	Courses inferolaterally (deep to subscapular artery and vein) to enter subscapularis and teres major muscles	<b>Motor:</b> Inferior portion of subscapularis and teres major muscles
<b>Thoracodorsal</b>	Side branch of posterior cord, receiving fibers from C6, <b>C7</b> , C8	<ul style="list-style-type: none"> <li>Arises between upper and lower subscapular nerves (aka: middle scapular nerve)</li> <li>Courses inferolaterally along the posterior axillary wall to enter latissimus dorsi</li> </ul>	<b>Motor:</b> Latissimus dorsi muscle





# Infraclavicular Branches: Medial & Lateral Pectoral & Subclavian Nerve

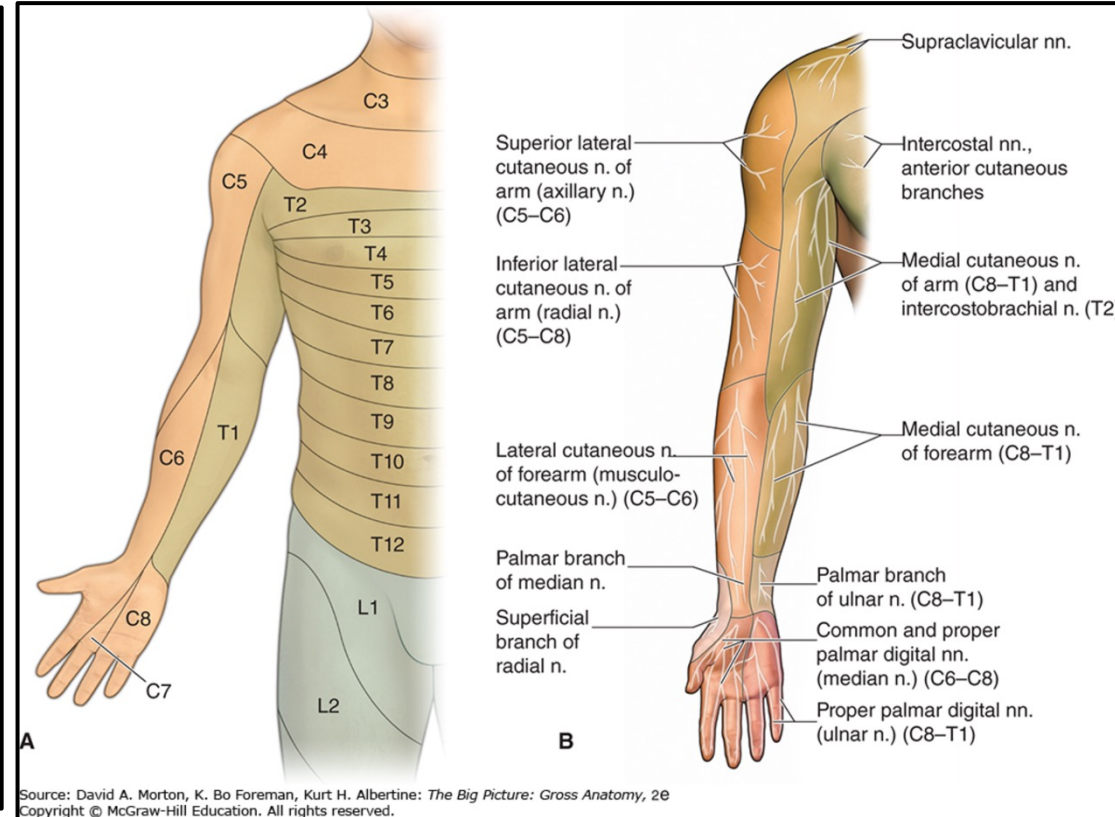
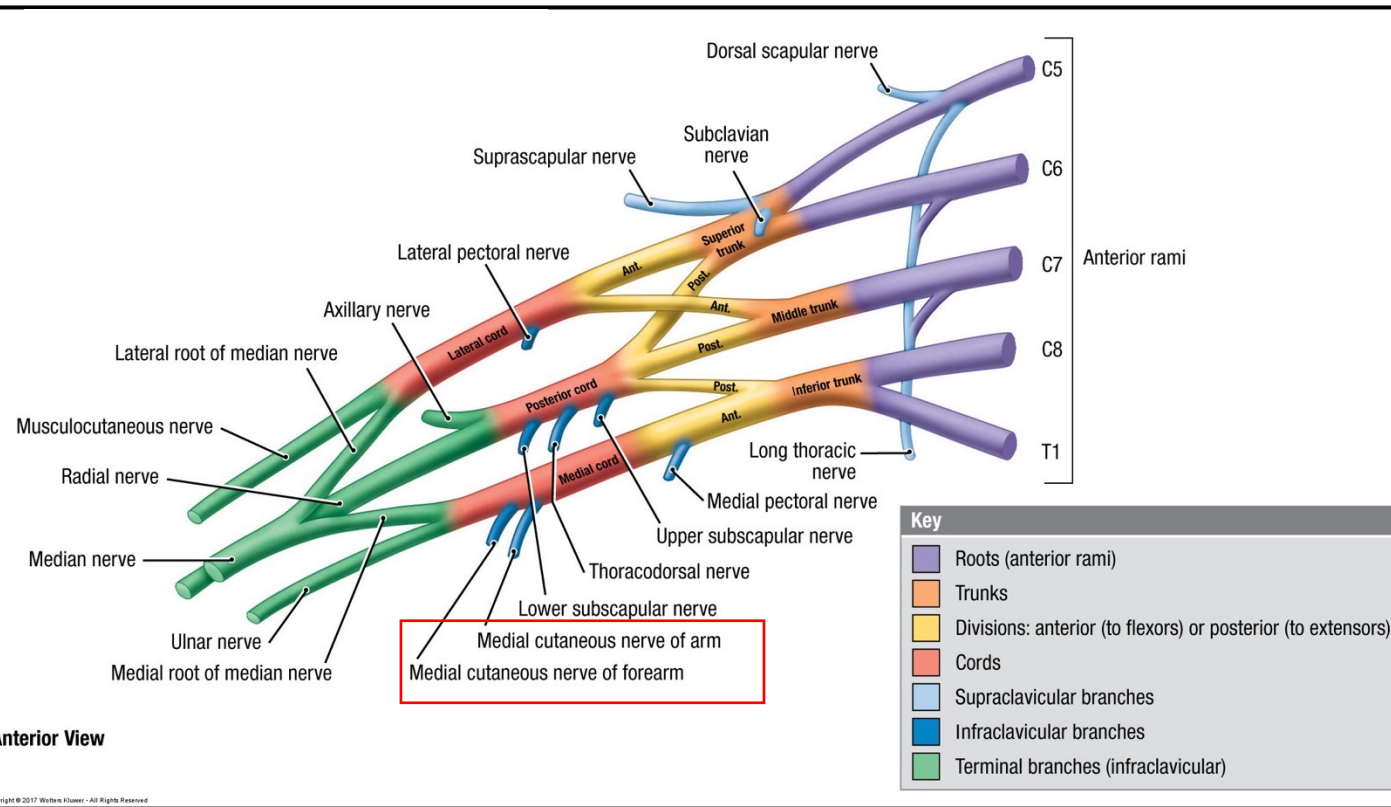
NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Lateral pectoral</b>	Side branch of lateral cord, receiving fibers from C5, <b>C6</b> , C7	<ul style="list-style-type: none"> <li>Pierces costocoracoid membrane to reach deep surface of pectoral muscles</li> <li>Forms a communicating branch to the medial pectoral nerve</li> <li>Passes anterior to axillary artery and vein</li> </ul>	<b>Motor:</b> Primarily pectoralis major; but some lateral pectoral nerve fibers pass to pectoralis minor via branch to medial pectoral nerve
<b>Medial pectoral</b>	Side branches of medial cord, receiving fibers from C8, T1	<ul style="list-style-type: none"> <li>Passes between axillary artery and vein</li> <li>Pierces pectoralis minor and enters deep surface of pectoralis major</li> <li>Although it is called <i>medial</i> for its origin from medial cord, its anatomical position is lateral to lateral pectoral nerve</li> </ul>	<b>Motor:</b> Pectoralis minor and sternocostal part of pectoralis major
<b>Subclavian nerve</b> (nerve to subclavius)	Superior trunk, receiving fibers from C5, <b>C6</b> and often C4	<ul style="list-style-type: none"> <li>Descends posterior to clavicle and anterior to brachial plexus and subclavian artery</li> <li>Often contributes to <i>accessory root to phrenic nerve</i></li> </ul>	<b>Motor:</b> Subclavius and sternoclavicular joint (accessory phrenic root innervates diaphragm)





# Infraclavicular Branches: Medial Cutaneous Nerves of Arm and Forearm

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Medial cutaneous nerve of arm</b>	Side branches of medial cord, receiving fibers from C8, T1	<ul style="list-style-type: none"> <li>Smallest nerve of plexus</li> <li>Courses along medial side of axillary and brachial veins and communicates with <i>intercostobrachial nerve</i></li> </ul>	<b>Sensory:</b> Skin of medial side of arm, as far distal as medial epicondyle of humerus and olecranon of ulna
<b>Medial cutaneous nerve of forearm</b>		<ul style="list-style-type: none"> <li>Initially runs with ulnar nerve</li> <li>Then pierces deep fascia with basilic vein and enters subcutaneous tissue, dividing into anterior and posterior branches</li> <li>Often confused with ulnar nerve</li> </ul>	<b>Sensory:</b> Skin of medial side of forearm, as far distal as wrist



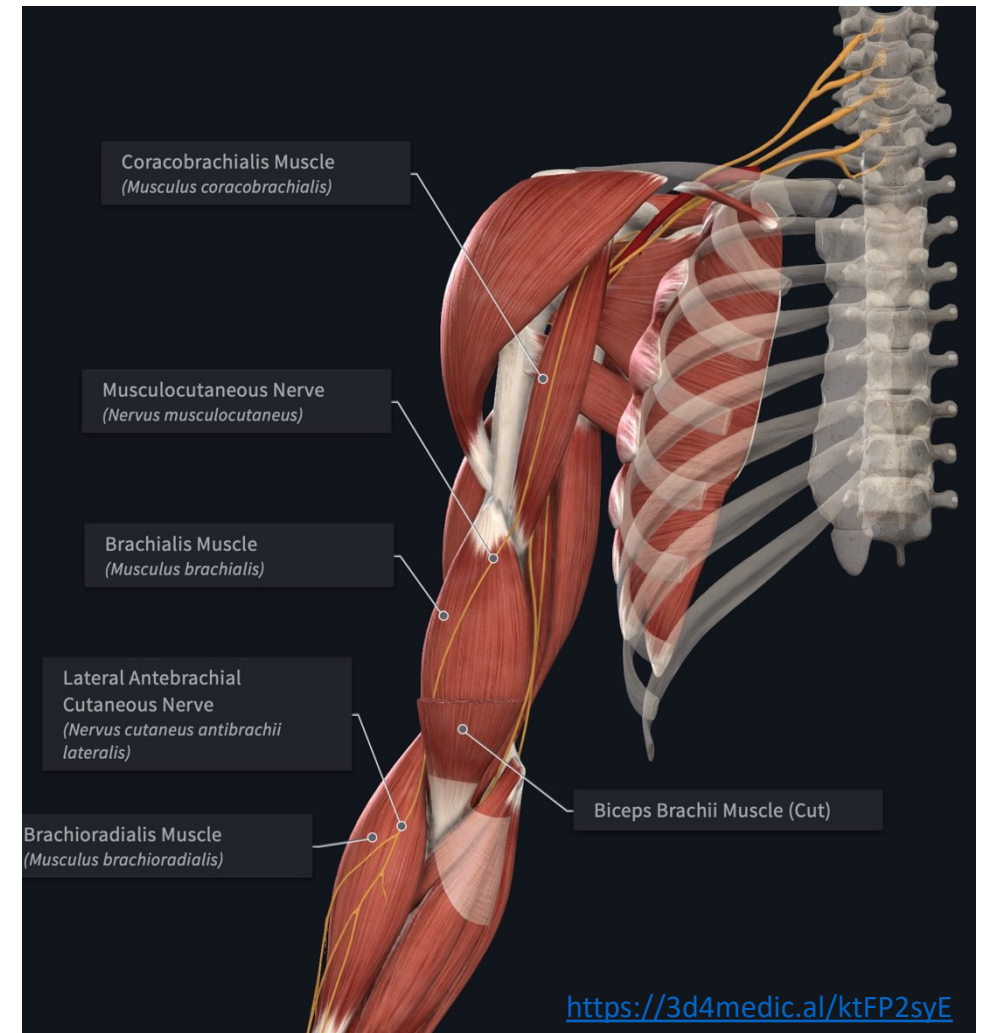
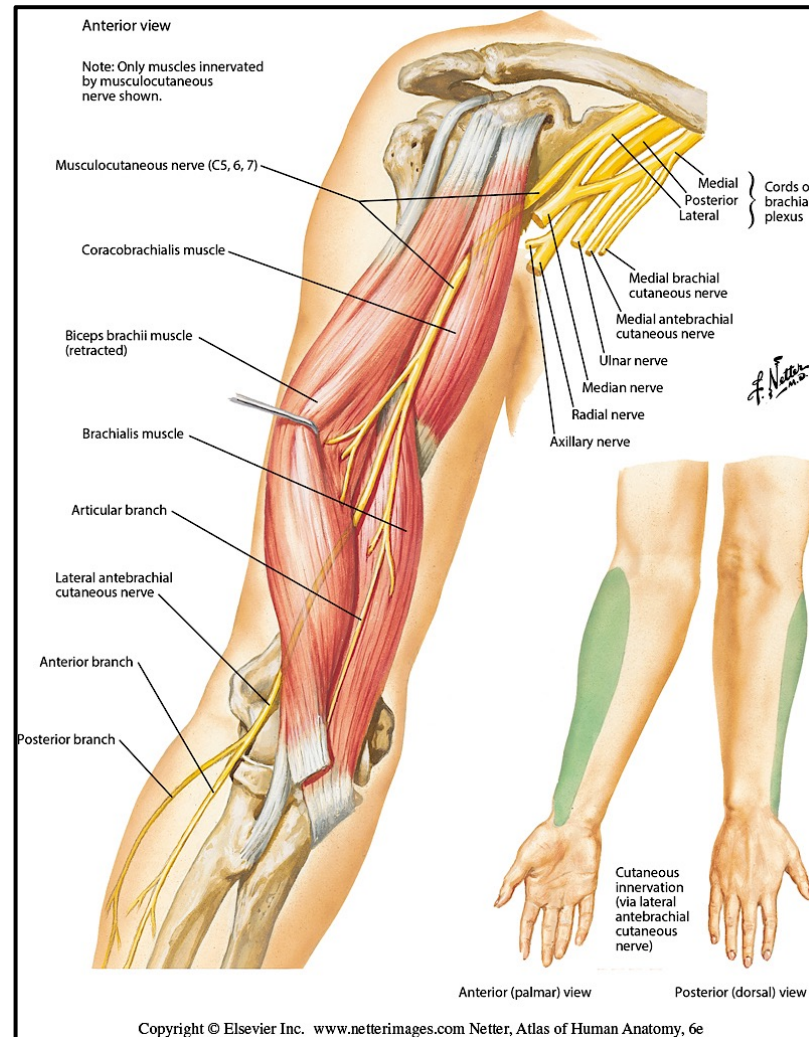
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## Terminal Branches: Musculocutaneous Nerve

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Musculocutaneous</b>	Terminal branch of lateral cord, receiving fibers from C5–C7	<ul style="list-style-type: none"> <li>Exits axilla by piercing coracobrachialis</li> <li>Descends through the arm between biceps brachii and brachialis</li> <li>Continues into forearm as <b>lateral cutaneous nerve of forearm</b></li> </ul>	<ul style="list-style-type: none"> <li><b>Motor:</b> Muscles of anterior compartment of the arm (coracobrachialis, biceps brachii and brachialis)</li> <li><b>Sensory:</b> Skin of lateral aspect of forearm</li> </ul>

**CLINICAL ANATOMY:** Lesions of the musculocutaneous nerve can result in both muscle weakness and loss/reduction of sensation.

- Weakness of elbow flexion and supination result. Supination weakness occurs because the biceps brachii is major contributor to supination of the forearm.
- Sensory loss occurs on the lateral side of the forearm in the domain of the **lateral cutaneous nerve of the forearm**.

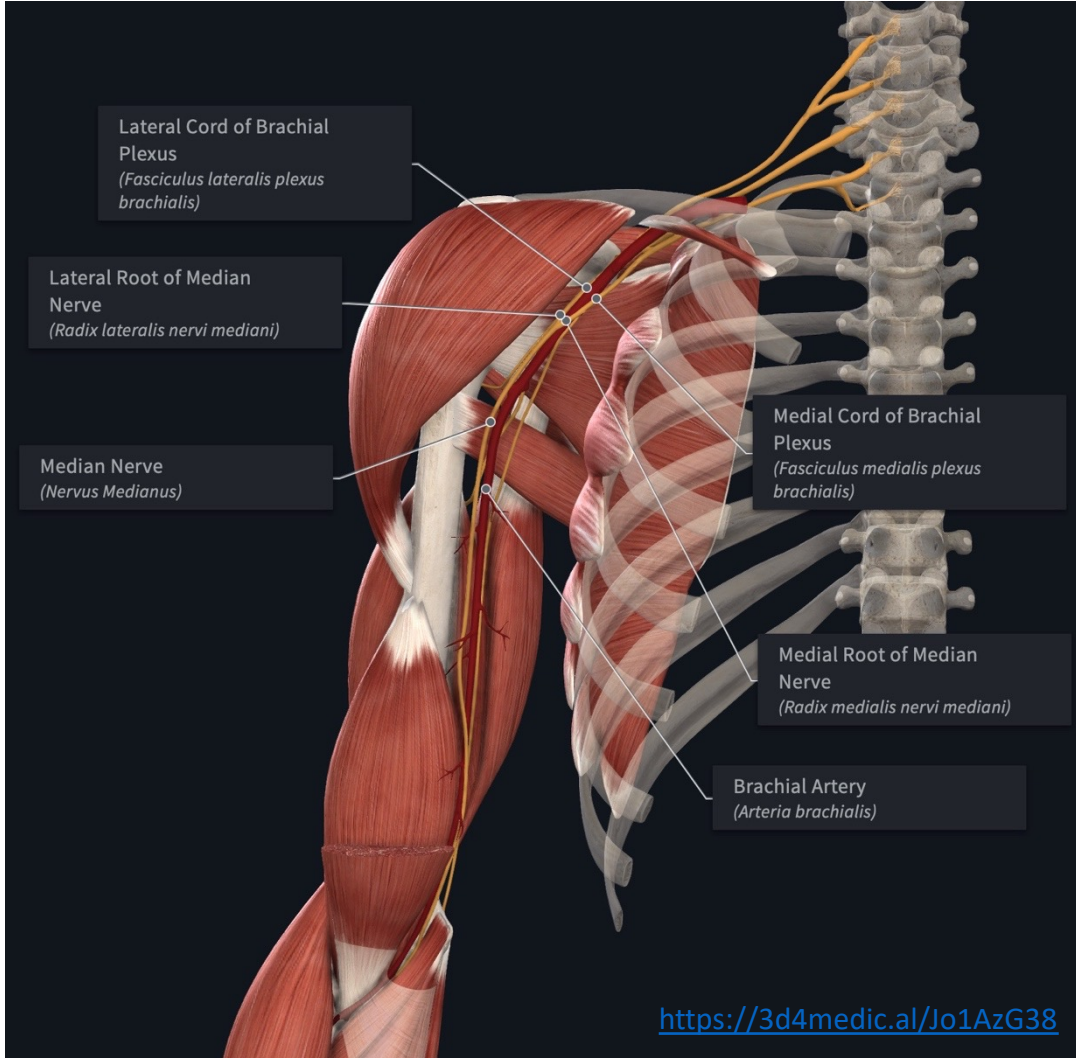
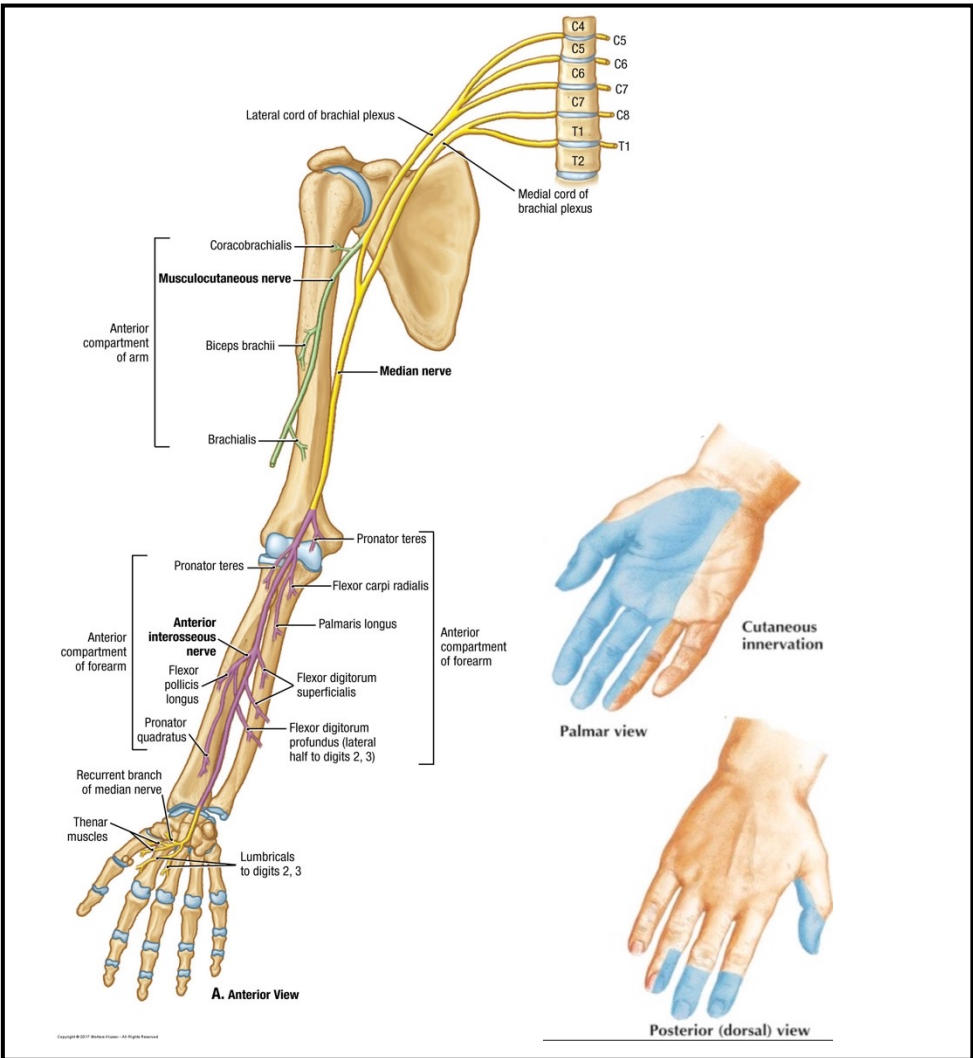




# Terminal Branches: Median Nerve

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Median</b>	<p>Lateral root of median nerve is a terminal branch of lateral cord (C6, C7)</p> <p>Medial root of median nerve is a terminal branch of medial cord (C8, T1)</p>	<ul style="list-style-type: none"> <li>Lateral and medial roots merge to form median nerve (lateral position relative to the axillary artery)</li> <li>Descends through arm adjacent to brachial artery, with nerve gradually crossing anterior to artery to lie medial to artery in cubital fossa</li> </ul>	<ul style="list-style-type: none"> <li><b>Motor:</b> Muscles of anterior forearm compartment (except flexor carpi ulnaris and ulnar half of flexor digitorum profundus), lumbricals of digits 2 and 3, and thenar muscles (abductor pollicis brevis, opponens pollicis, flexor pollicis brevis)</li> <li><b>Sensory:</b> Skin of palm, palmar side of digits 1-3, lateral palmar side of digit 4, and the distal half on the dorsal surface of digits 1-4.</li> </ul>

**CLINICAL ANATOMY:** Lesions of the median nerve (and its branches) will be explored in upcoming units when we study the anatomical area in which a lesion typically occurs.



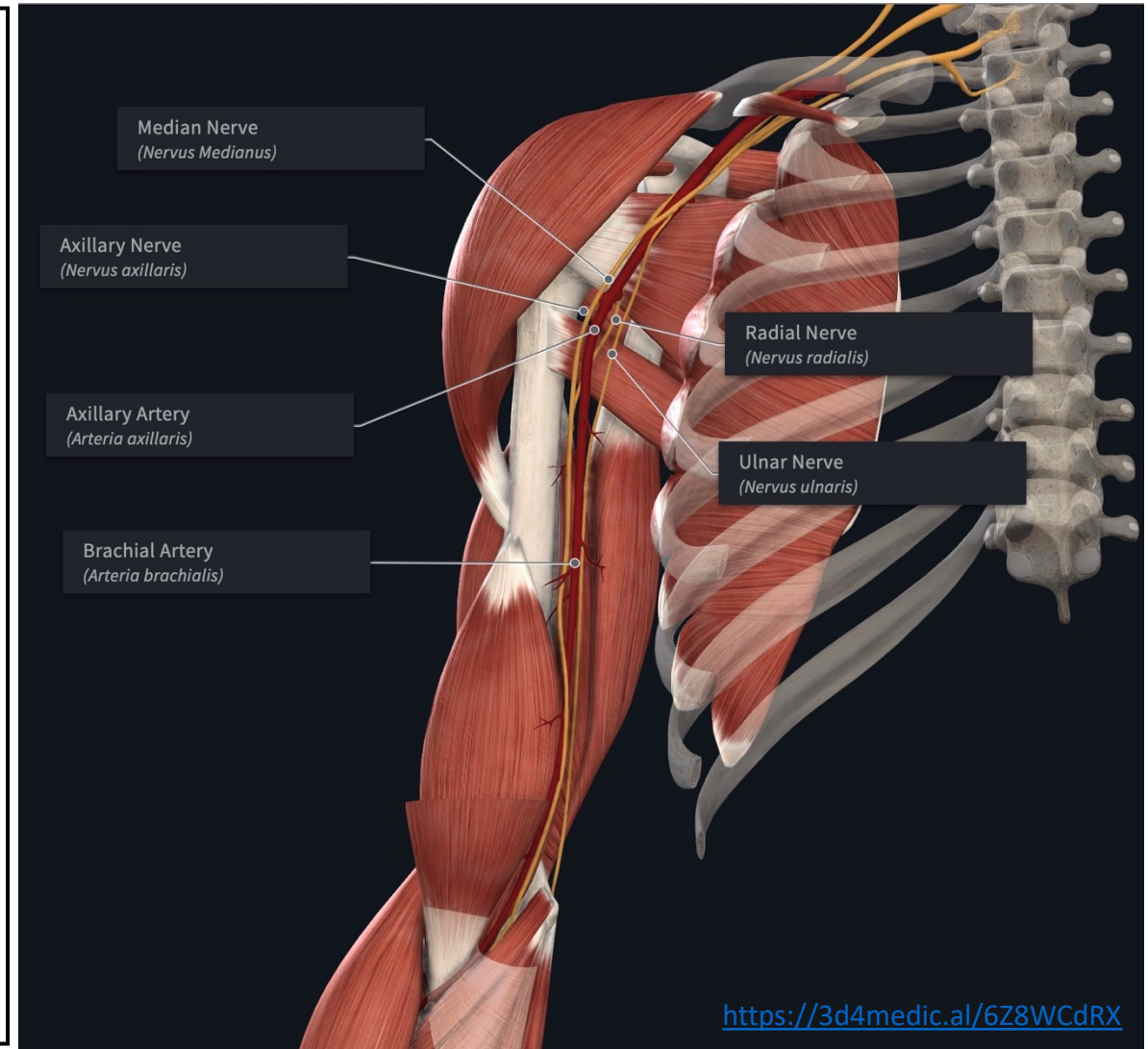
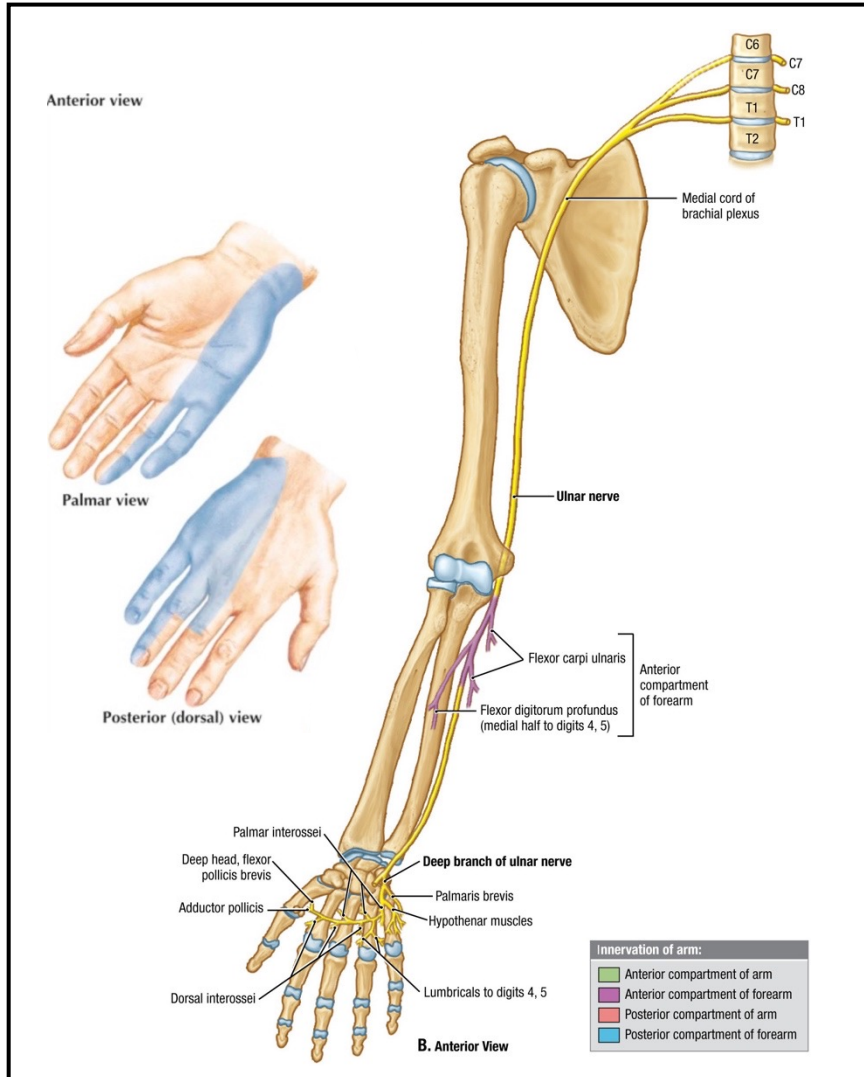


# Terminal Branches: Ulnar Nerve

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Ulnar</b>	Larger terminal branch of medial cord, receiving fibers from C8, T1 and often C7	<ul style="list-style-type: none"> <li>• Descends medial arm</li> <li>• Courses posterior to medial epicondyle of humerus</li> <li>• Descends ulnar aspect of forearm to hand</li> </ul>	<p><b>Motor:</b> Flexor carpi ulnaris and ulnar half of flexor digitorum profundus (forearm); most intrinsic muscles of the hand</p> <p><b>Sensory:</b> Skin of hand medial to midline of digit 4, medial half of digit 4, all of digit 5</p>

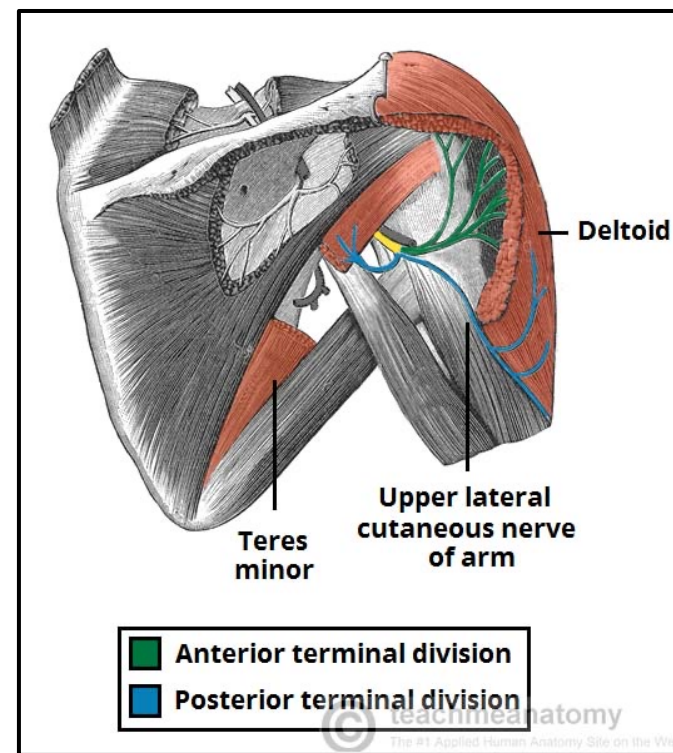
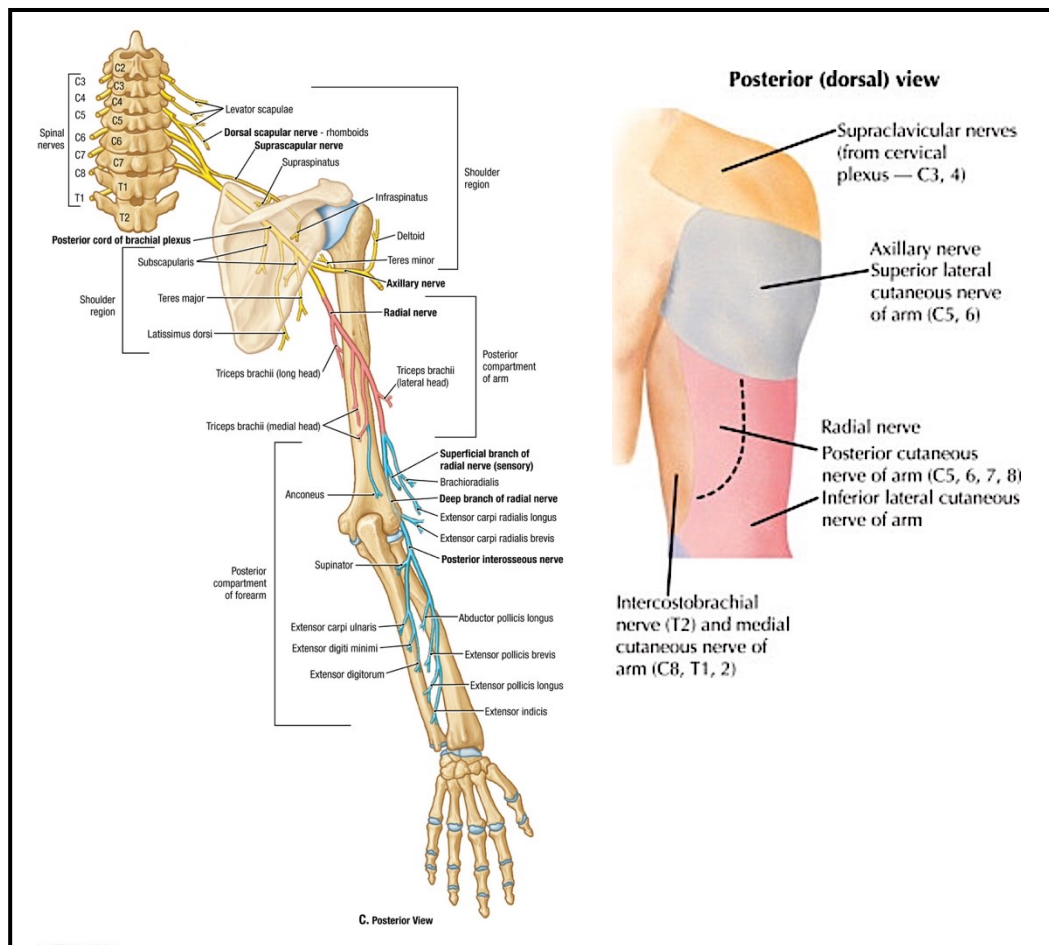
## Clinical Anatomy:

Lesions of the ulnar nerve (and its branches) will be explored in upcoming units when we study the anatomical area in which a lesion typically occurs.



# Terminal Branches: Axillary Nerve

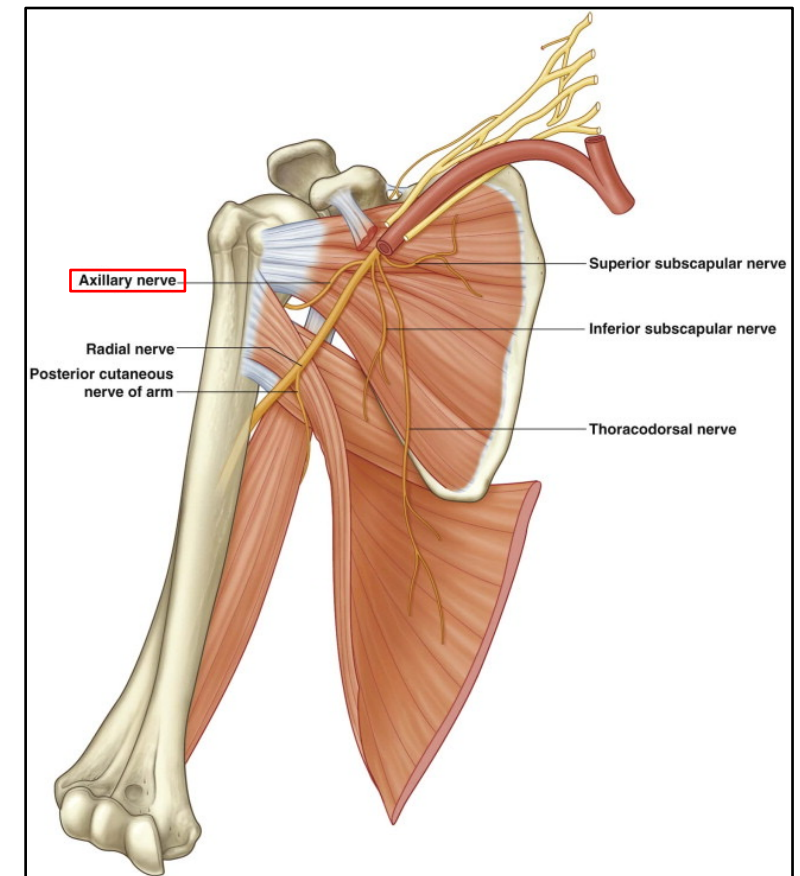
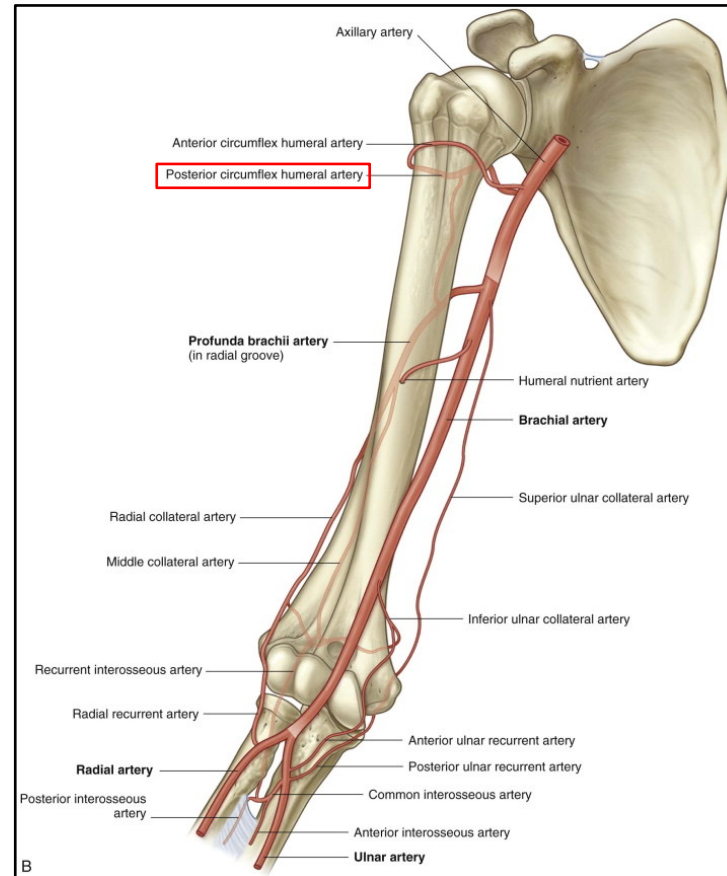
NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Axillary</b>	Terminal branch of posterior cord, receiving fibers from <b>C5, C6</b>	<ul style="list-style-type: none"> <li>Exits axilla posteriorly by passing through the quadrangular space with posterior circumflex humeral artery,</li> <li>Gives rise to superior lateral brachial cutaneous nerve</li> <li>Winds around surgical neck of humerus deep to deltoid</li> </ul>	<p><b>Motor:</b> Teres minor and deltoid muscles</p> <p><b>Sensory:</b> Superolateral arm (skin over inferior part of deltoid muscle), Glenohumeral (shoulder) joint</p>





# Surgical Neck Fracture of Humerus

**CLINICAL ANATOMY:** Because of their anatomical relationship to the proximal humerus and glenohumeral joint, the **axillary nerve and posterior circumflex humeral vessels** are at risk of injury in shoulder dislocations and when the **surgical neck of the humerus** is fractured.



# Terminal Branches: Radial Nerve

NERVE	ORIGIN	COURSE	STRUCTURES INNERVATED
<b>Radial</b>	Larger terminal branch of posterior cord (largest branch of plexus), receiving fibers from C5–T1	<ul style="list-style-type: none"> <li>Exits axilla posterior to axillary artery and passes posterior to humerus in radial groove with deep brachial artery, between lateral and medial heads of triceps</li> <li>Perforates lateral intermuscular septum</li> <li>Enters cubital fossa, dividing into <i>superficial</i>(cutaneous) and <i>deep</i> (motor) <i>radial nerves</i> (Fig. 6.46D)</li> </ul>	<p><b>Motor:</b> All muscles of posterior compartments of arm and forearm</p> <p><b>Sensory:</b> skin of posterior and inferolateral arm, posterior forearm, and dorsum of hand lateral to axial line of digit 4</p>

## Clinical Anatomy:

Lesions of the radial nerve (and its branches) will be explored in upcoming units when we study the anatomical area in which a lesion typically occurs.

