AL MUSTAQBAL UNIVERSITY

College of Medicine / First Year

ANATOMY

(L6) Nerves of Upper Limbs

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NERVES

Most of the nerves that supply the upper limb are derived from anterior (ventral) primary rami of spinal nerves. Most of the spinal nerve derivatives are branches of the brachial plexus.

Spinal Accessory Nerve (Cranial Nerve XI)

The spinal accessory nerve is the only cranial nerve that supplies the upper limb. It runs downward in the posterior triangle of the neck on the levator scapulae muscle and is accompanied by branches from the anterior rami of the third and fourth cervical nerves. The accessory nerve runs along the deep aspect of the belly of the trapezius muscle at the junction of its middle and lower thirds.The accessory nerve provides motor fibers to the trapezius, whereas the cervical nerves supply sensory innervation.

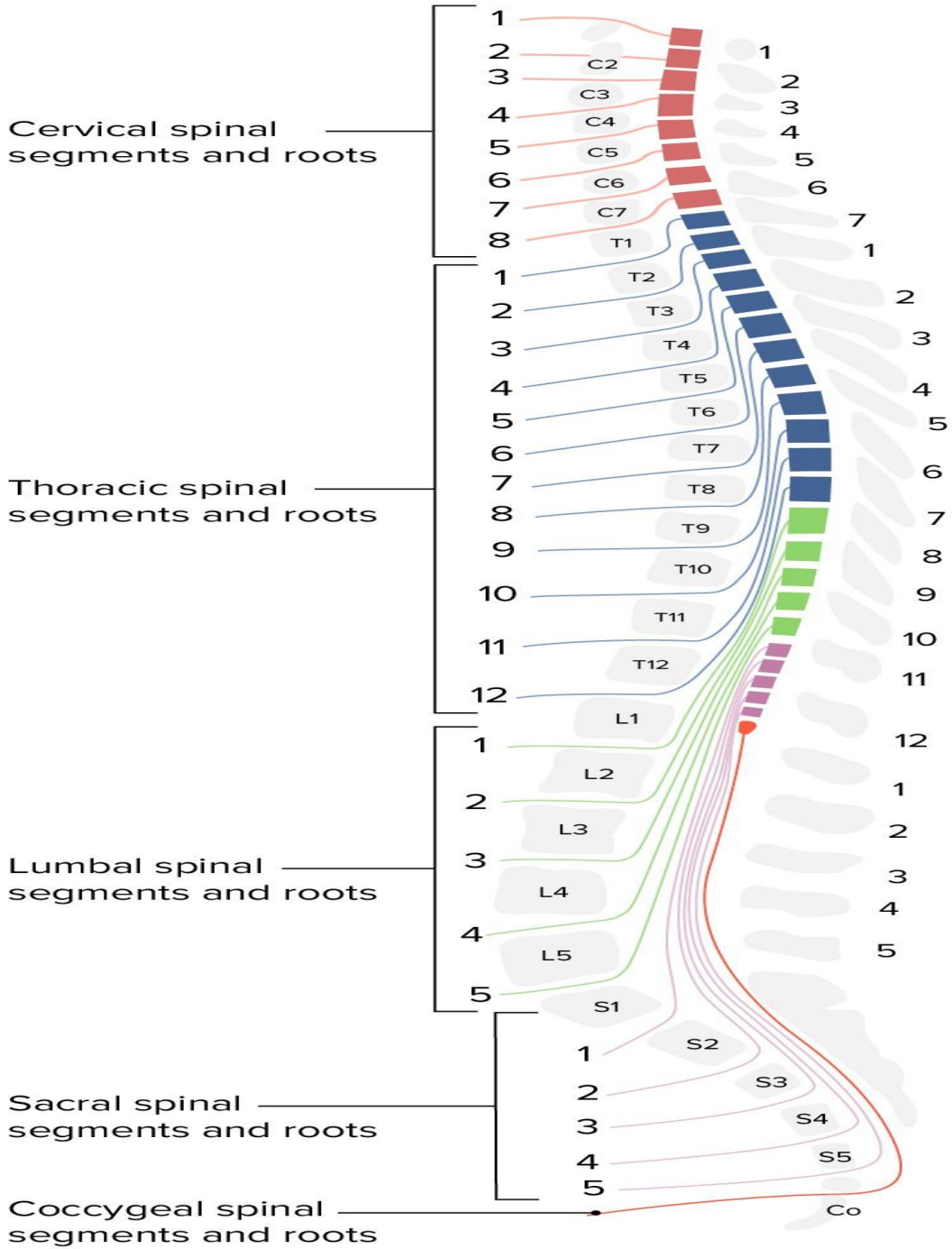
Accessory Nerve Injury

The accessory nerve can be injured as the result of penetrating wounds to the neck (e.g., stab wounds).

Brachial Plexus

The nerves entering the upper limb provide the following important functions: sensory innervation to the skin and deep structures, such as the joints; motor innervation to the muscles; influence over the diameters of the blood vessels by the sympathetic vasomotor nerves; and sympathetic secretomotor supply to the sweat glands.

The anterior (ventral) rami of the fifth through eighth cervical and the first thoracic spinal nerves (C5 to T1) intermingle with one another in the posterior triangle of the neck and form a complex nerve network termed the brachial plexus. Individual nerves branch off the brachial plexus and distribute through the upper limb. Thus, nerve fibers that originate in single segments of the spinal cord contribute to the composition of multiple individual nerves. Therefore, each nerve that branches off the brachial plexus carries fibers from multiple segments of the spinal cord.


Cervical spinal segments and roots
Thoracic spinal segments and roots
Lumbal spinal segments and roots
Sacral spinal segments and roots
Coccygeal spinal segments and roots
C2
C3
C4
C5
C6
C7
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
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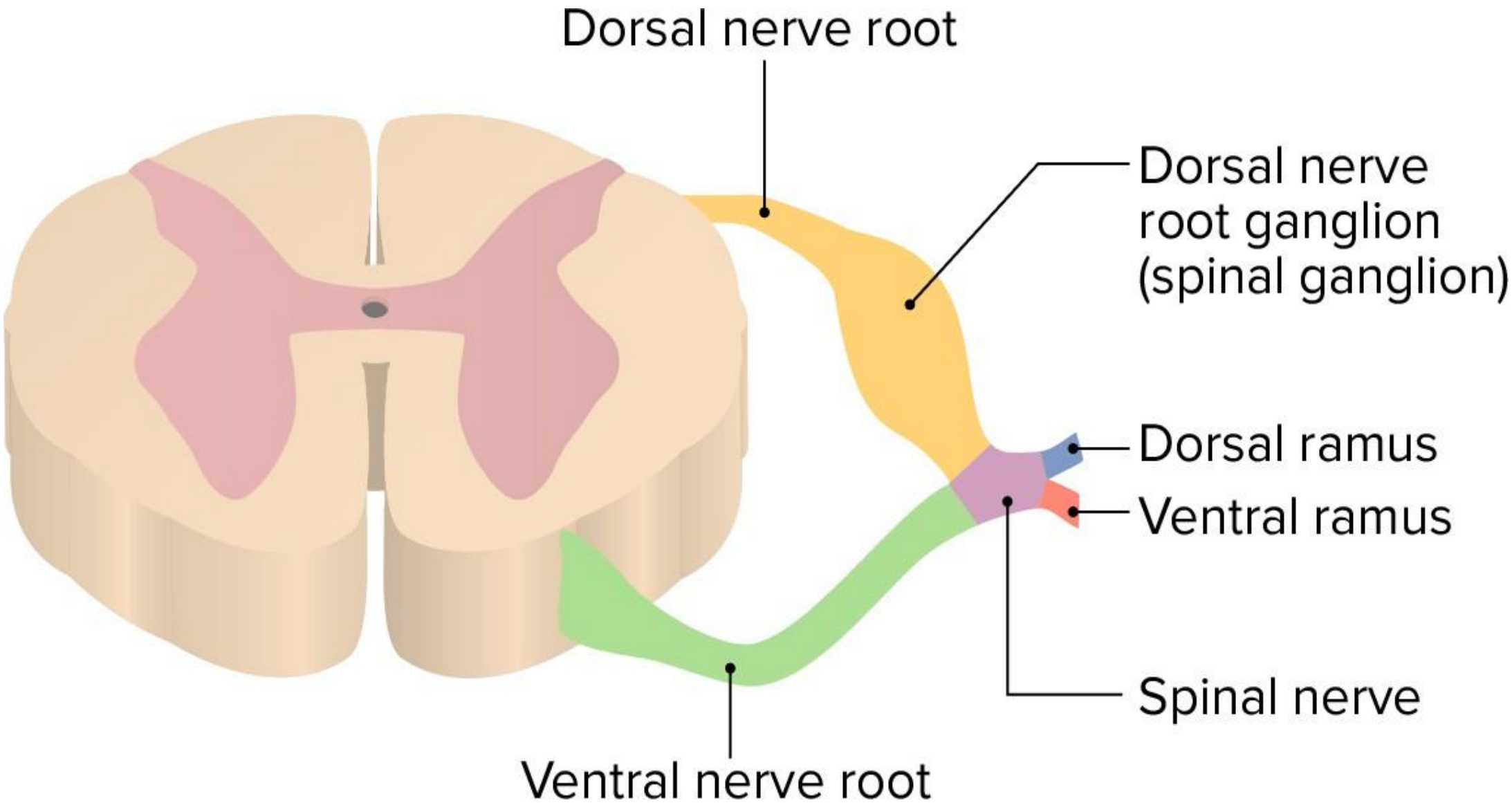
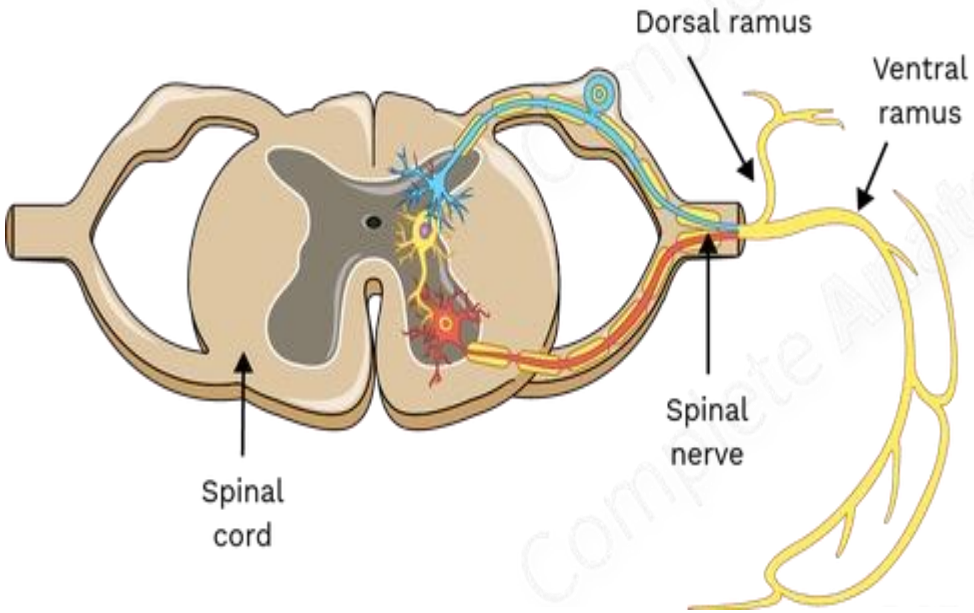
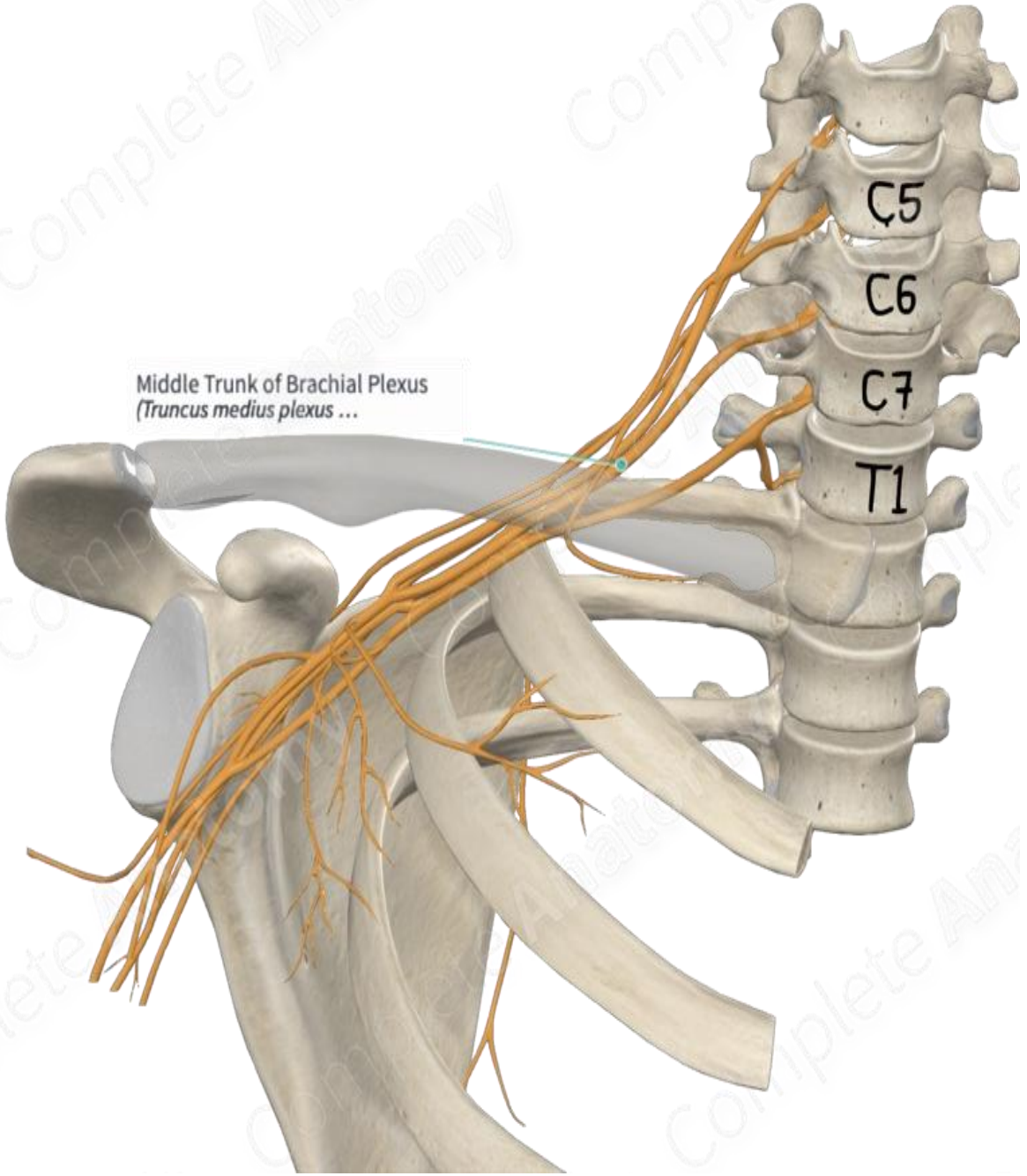
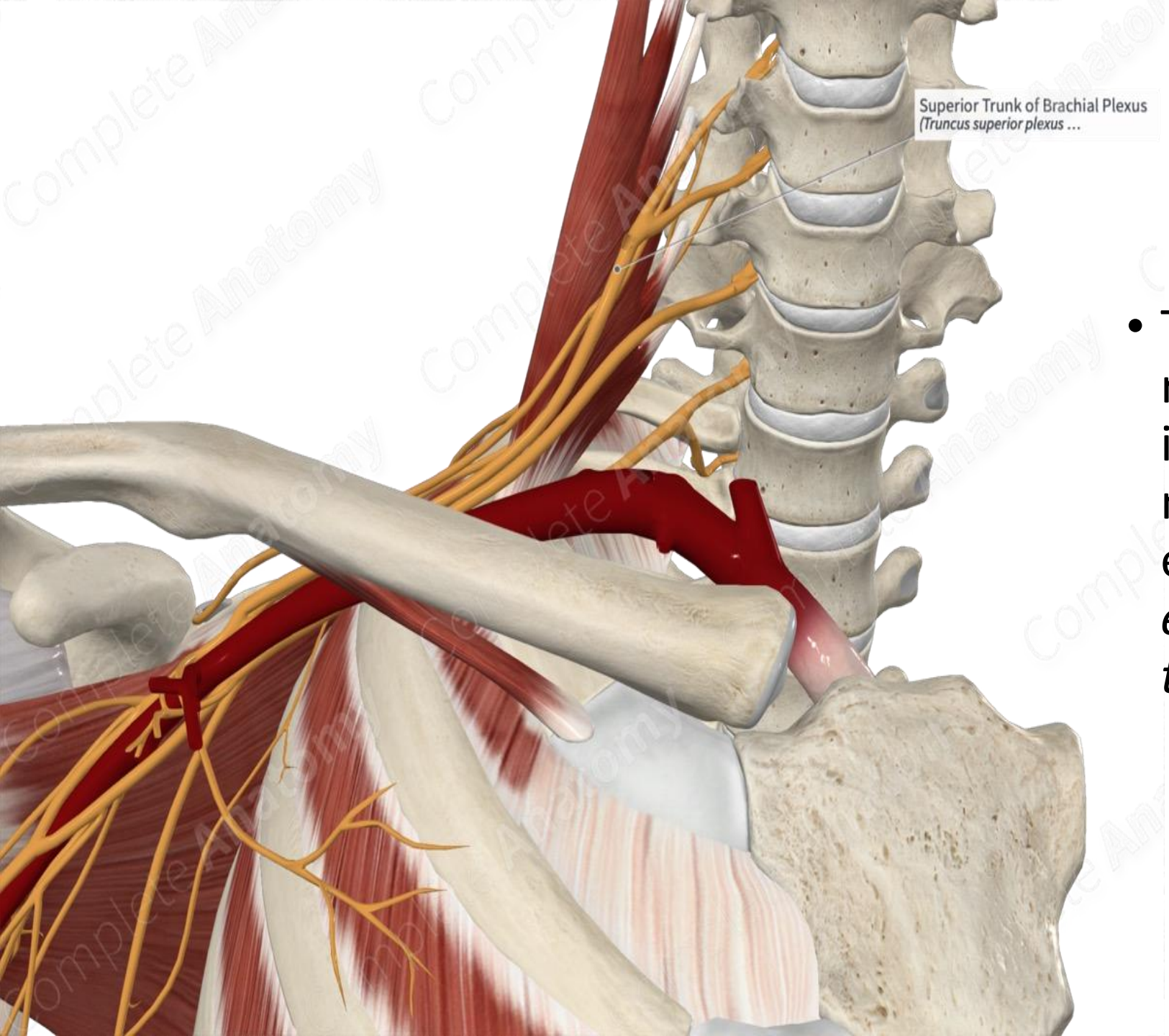

Dorsal nerve root
Dorsal nerve root ganglion (spinal ganglion)
Dorsal ramus
Ventral ramus
Spinal nerve
Ventral nerve root

Definition of Brachial Plexus

- The brachial plexus (plexus brachialis) is a somatic nerve plexus formed by intercommunications among the ventral rami (roots) of the lower 4 cervical nerves (C5-C8) and the first thoracic nerve (T1).

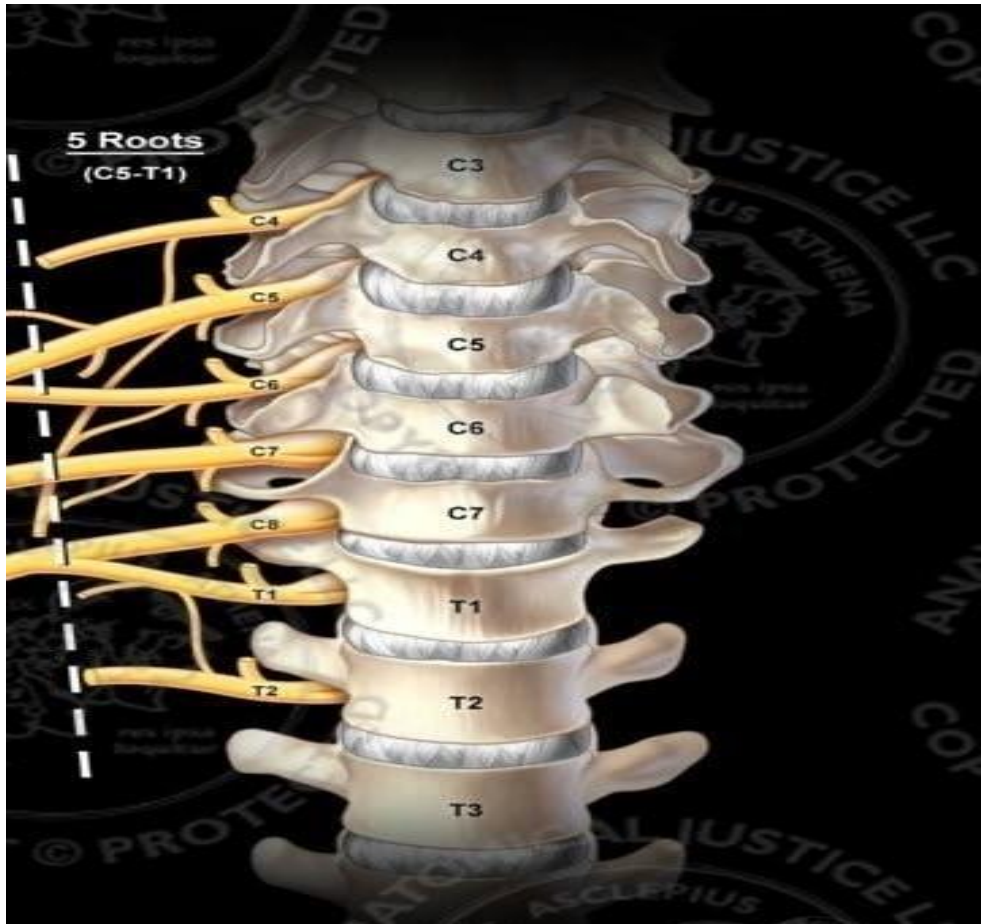






- The brachial plexus, is responsible for the motor innervation of all of the muscles of the upper extremity, with the *exception of the trapezius*

The brachial plexus is divided schematically into subparts termed **roots, trunks, divisions, cords**, and (terminal) **branches**. A traditional way to help remember these parts is to recall that "Robert (roots) Taylor (trunks) drinks (divisions) cold (cords) beer (branches)." **The roots** are the anterior rami of spinal nerves C5 to T1. The roots of **C5 and 6** unite to form the **upper trunk**, the root of **C7** continues as the **middle trunk**, and the roots of **C8 and T1** unite to form the **lower trunk**. Each trunk then divides into **anterior and posterior divisions**. The anterior divisions of the **upper and middle trunks** unite to form the **lateral cord**, the anterior division of **the lower trunk** continues as the **medial cord**, and the **posterior divisions** of all three trunks join to form the **posterior cord.**



Roots

The 'roots' refer the anterior rami of the **spinal nerves** that comprise the brachial plexus. These are the anterior rami of spinal nerves C5, C6, C7, C8, and T1.

At each vertebral level, paired spinal nerves arise. They leave the spinal cord via the **intervertebral foramina** of the vertebral column.

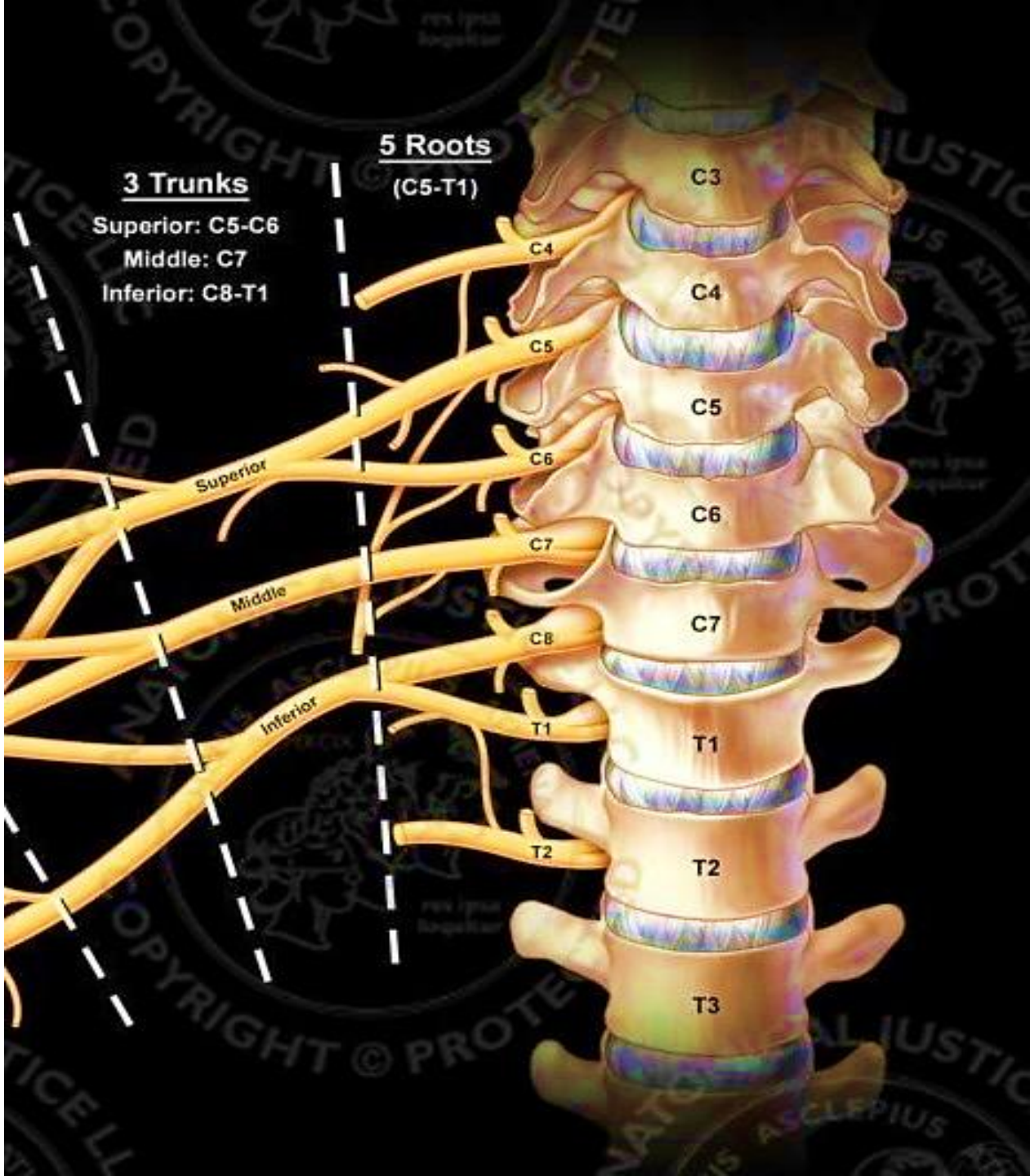
Each spinal nerve then divides into an anterior and a posterior ramus. The roots of the brachial plexus are formed by the **anterior rami** of spinal nerves C5-T1 (the posterior divisions innervate the skin and musculature of the intrinsic back muscles).

Trunks

At the base of the neck, the roots of the brachial plexus converge to form three **trunks**. These structures are named by their relative anatomical location:

- **Superior trunk** – a combination of C5 and C6 roots.
- **Middle trunk** – continuation of C7.
- **Inferior trunk** – combination of C8 and T1 roots.

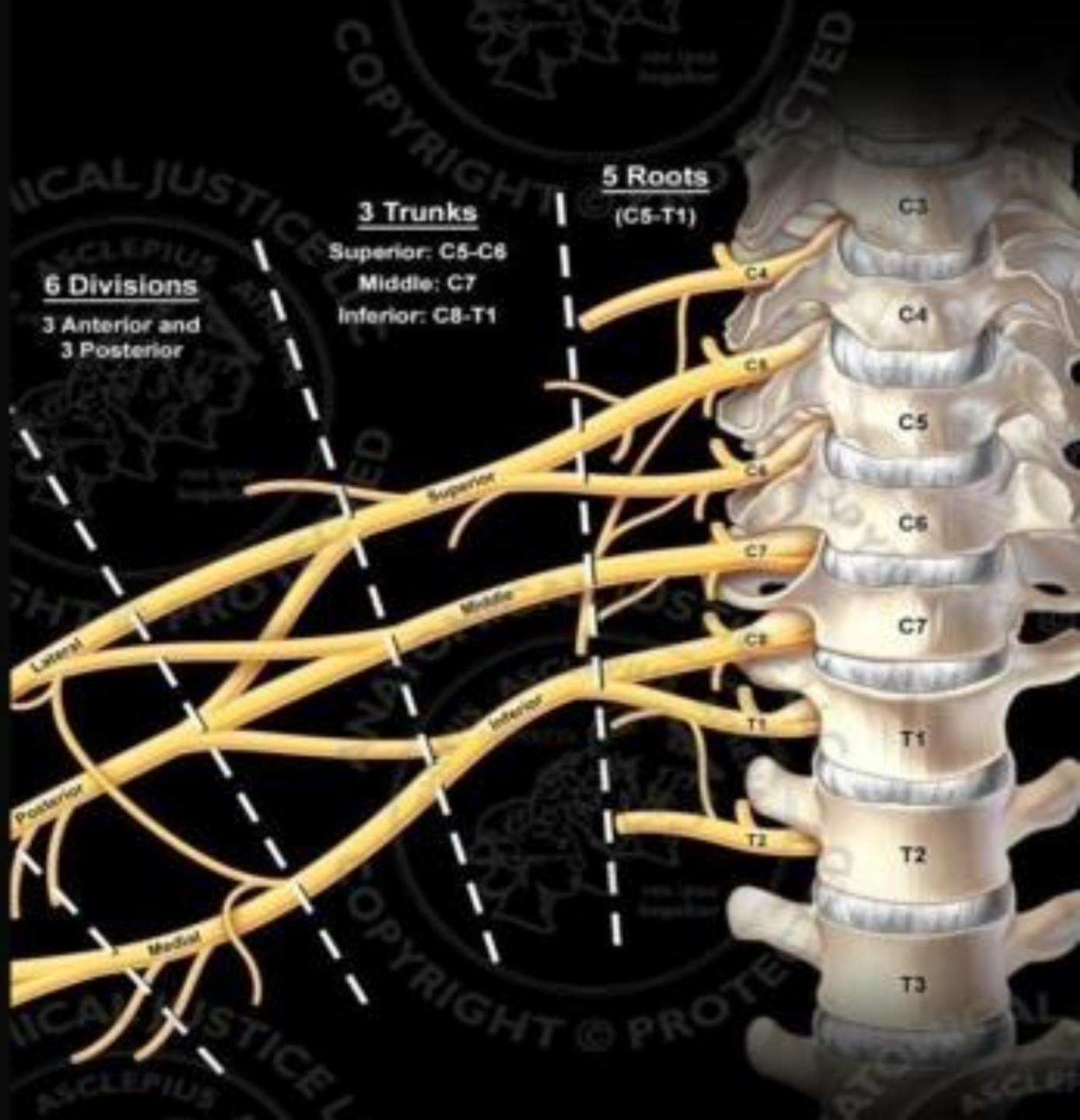
The trunks traverse laterally, crossing the posterior triangle of the neck



Divisions

Each trunk divides into two branches within the posterior triangle of the neck. One division moves **anteriorly** (toward the front of the body) and the other **posteriorly** (towards the back of the body). Thus, they are known as the anterior and posterior divisions.

We now have three anterior and three posterior nerve fibres. These divisions leave the posterior triangle and pass into the axila. They **recombine** into the cords of the brachial plexus

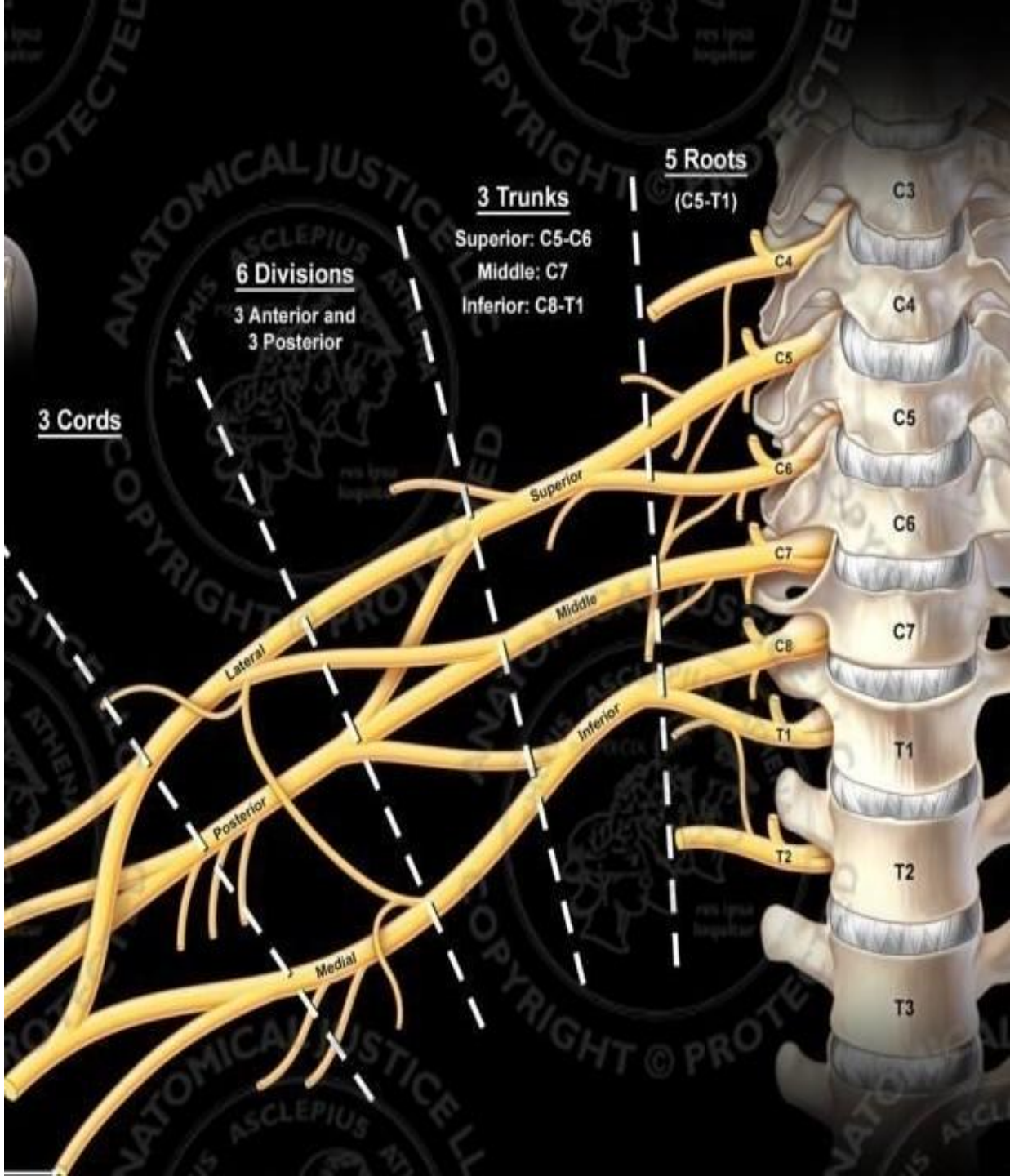


Cords Once the anterior and posterior divisions have entered the axilla, they combine together to form three cords, named by their position relative to the **axillary artery.** Here, the brachial plexus and the axillary artery and vein are enclosed together in a connective tissue wrapping termed the **axillary sheath.**

The **lateral cord** is formed by:
•The anterior division of the superior trunk
•The anterior division of the middle trunk

The **posterior cord** is formed by:
•The posterior division of the superior trunk
•The posterior division of the middle trunk
•The posterior division of the inferior trunk

The **medial cord** is formed by**:**
•The anterior division of the inferior trunk.
The cords give rise to the major branches of the brachial plexus.



5 Roots
(C5-T1)

3 Trunks
Superior: C5-C6
Middle: C7
Inferior: C8-T1

6 Divisions
3 Anterior and
3 Posterior

3 Cords

Terminal Branches

Musculocutaneous nerve

Axillary nerve

Radial nerve

Median nerve

Ulnar nerve

Lateral

Posterior

Medial

Superior

Middle

Inferior

C3

C4

C4

C5

C5

C6

C6

C7

C7

C8

T1

T1

T2

T2

T3

Major Branches

In the axilla and the proximal aspect of the upper limb, the three cords give rise **to five major branches**. These nerves continue into the upper limb to provide innervation to the muscles and skin present.

Musculocutaneous Nerve

- **Roots**: C5, C6, C7.
- **Motor Functions**: Innervates the brachialis, biceps brachii and coracobrachialis muscles.
- **Sensory Functions**: Gives off the lateral cutaneous branch of the forearm, which innervates the lateral half of the anterior forearm, and a small lateral portion of the posterior forearm.

Axillary Nerve

- **Roots**: C5 and C6.
- **Motor Functions**: Innervates the teres minor and deltoid muscles.
- **Sensory Functions**: Gives off the superior lateral cutaneous nerve of arm, which innervates the inferior region of the deltoid (“regimental badge area”).

Median Nerve

- **Roots**: C6 – T1. (Also contains fibres from C5 in some individuals).
- **Motor Functions**: Innervates most of the flexor muscles in the forearm, the thenar muscles, and the two lateral lumbricals associated with the index and middle fingers.
- **Sensory Functions**: Gives off the palmar cutaneous branch, which innervates the lateral part of the palm, and the digital cutaneous branch, which innervates the lateral three and a half fingers on the anterior (palmar) surface of the hand.

Radial Nerve

•**Roots**: C5 – T1.

•**Motor Functions**: Innervates the triceps brachii, and the muscles in the posterior compartment of the forearm (which are primarily, but not exclusively, extensors of the wrist and fingers).

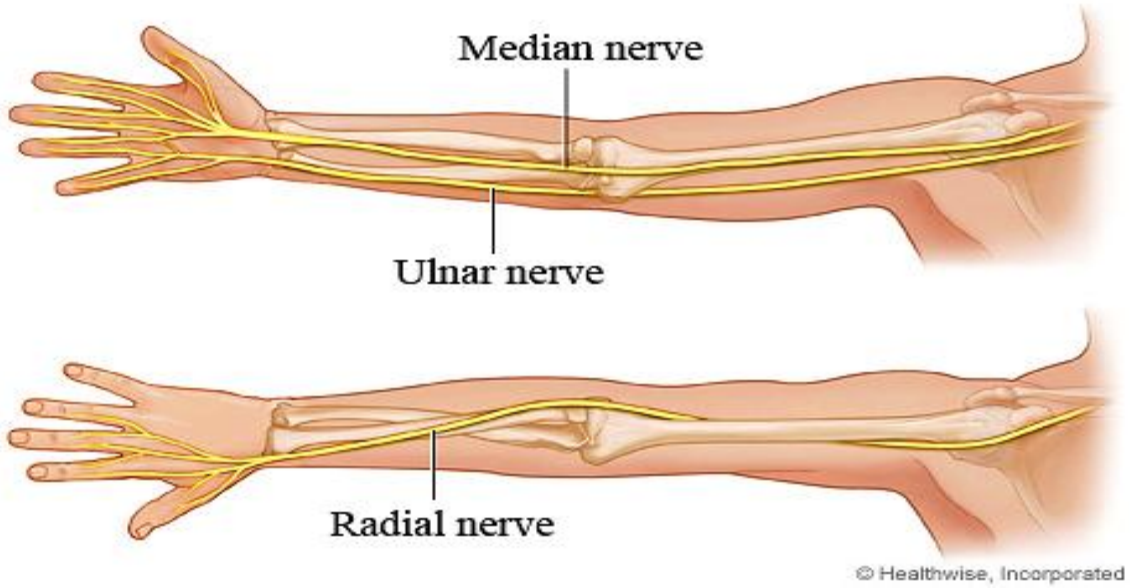
•**Sensory Functions**: Innervates the posterior aspect of the arm and forearm, and the posterolateral aspect of the hand.

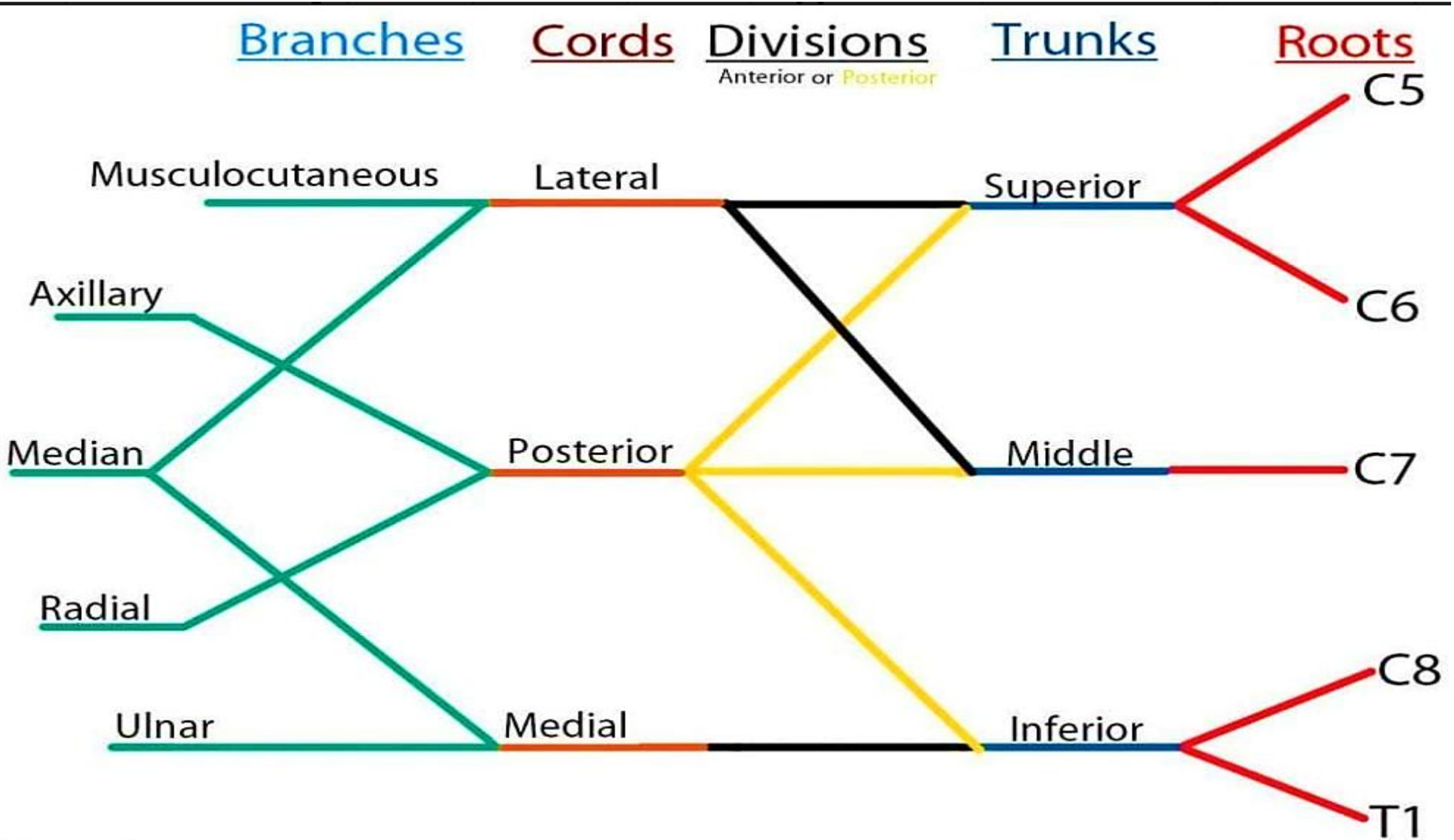
Ulnar Nerve

•**Roots**: C8 and T1.

•**Motor Functions**: Innervates the muscles of the hand (apart from the thenar muscles and two lateral lumbricals), flexor carpi ulnaris and medial half of flexor digitorum profundus.

•**Sensory Functions**: Innervates the anterior and posterior surfaces of the medial one and half fingers, and associated palm area

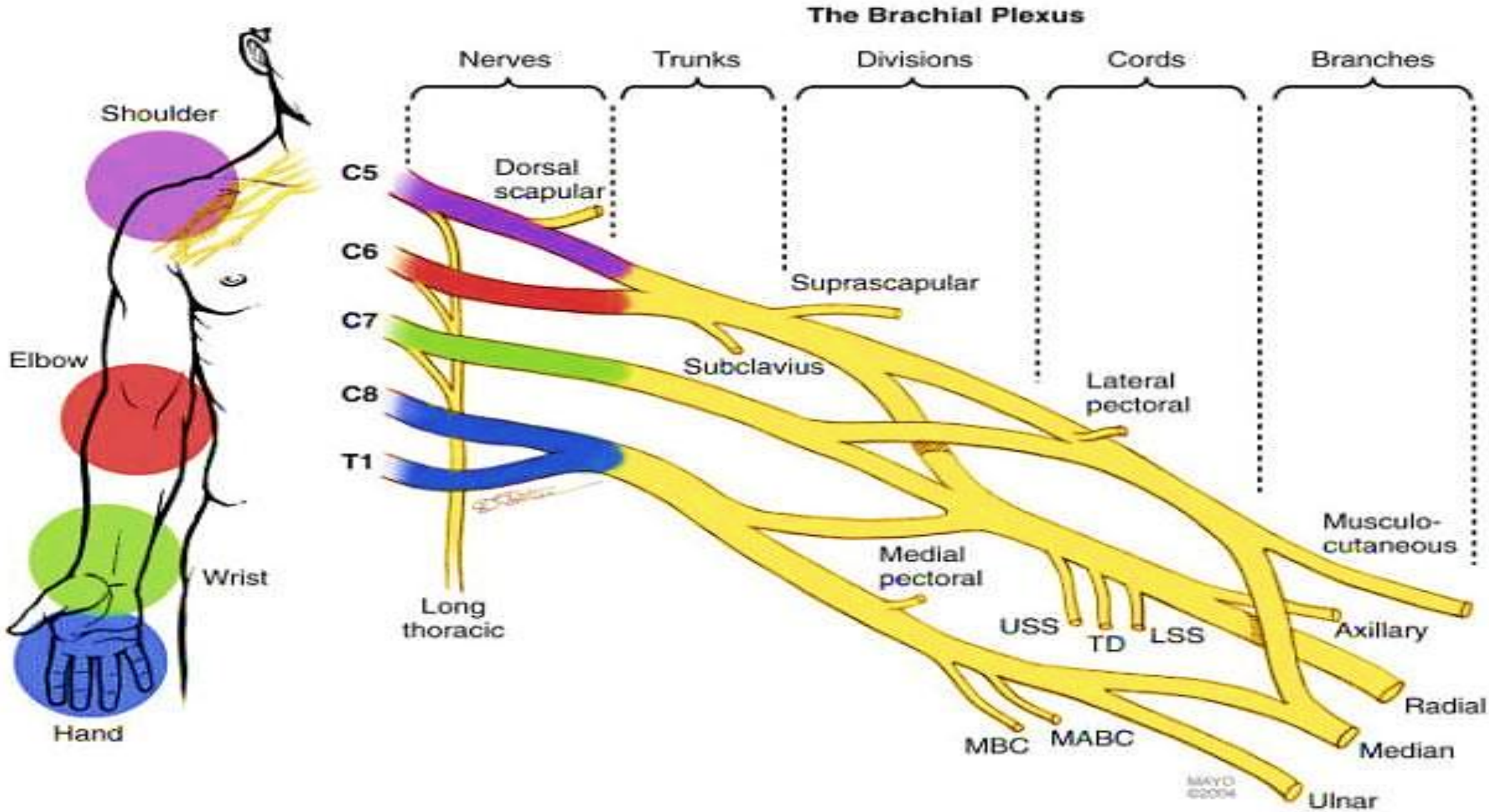



Branches
Cords
Divisions
Anterior or Posterior
Trunks
Roots
Musculocutaneous
Axillary
Median
Radial
Ulnar
Lateral
Posterior
Medial
Superior
Middle
Inferior
C5
C6
C7
C8
T1

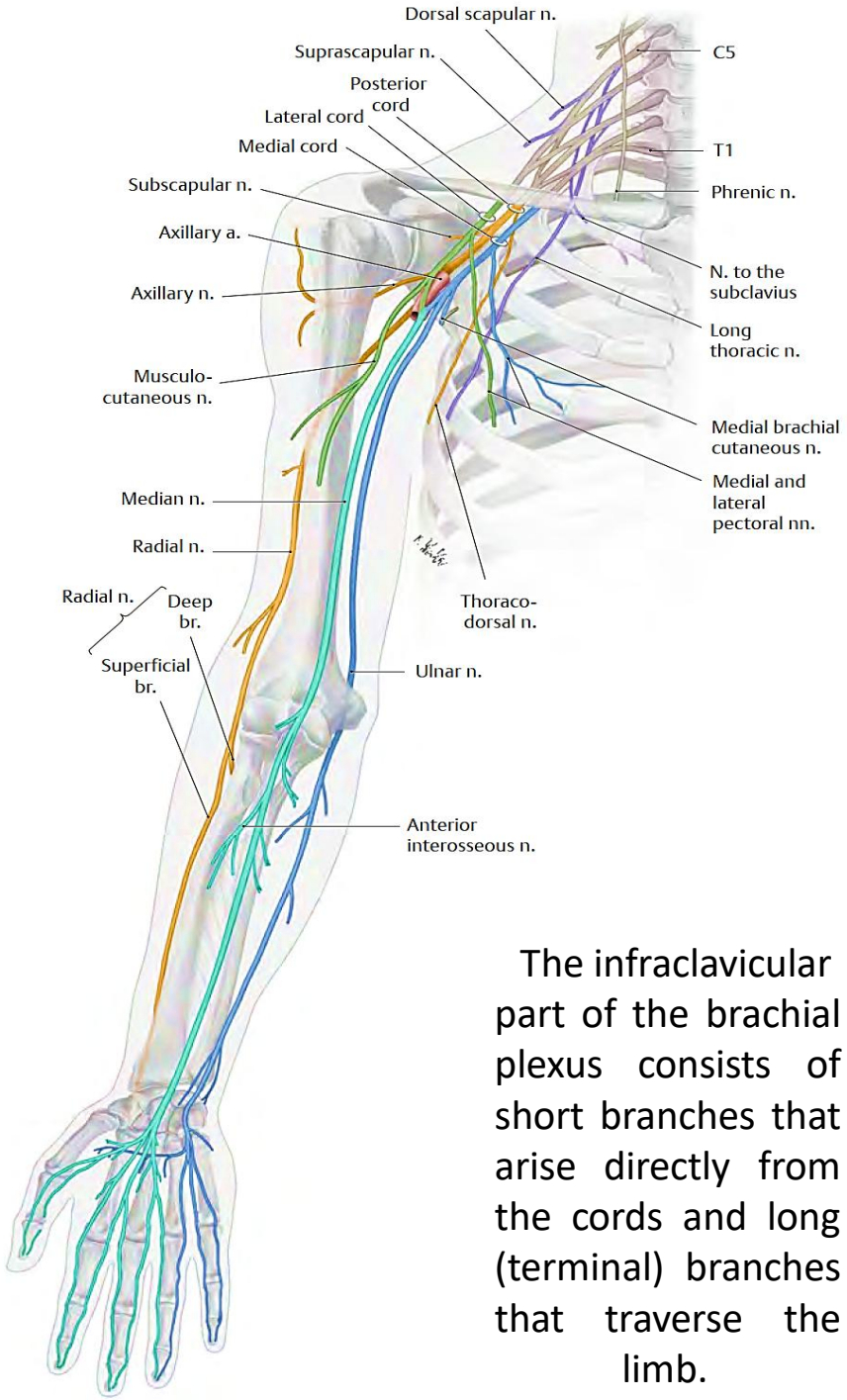
Minor Branches

In addition to the five major branches of the brachial plexus, there are a number of smaller nerves that arise. They do so from all five parts of the brachial plexus, and are listed below

Roots	Trunks	Lateral cord	Medial cord	Posterior cord
Dorsal scapular nerve Long thoracic nerve	Suprascapular nerve Nerve to subclavius	Lateral pectoral nerve	Medial pectoral nerve Medial cutaneous nerve of arm Medial cutaneous nerve of forearm	Superior subscapular nerve Thoracodorsal nerve Inferior subscapular nerve


The Brachial Plexus
Nerves
Trunks
Divisions
Cords
Branches
Shoulder
Elbow
Wrist
Hand
C5
C6
C7
C8
T1
Dorsal scapular
Long thoracic
Suprascapular
Subclavius
Lateral pectoral
Medial pectoral
Musculo-cutaneous
USS
TD
LSS
Axillary
Radial
Median
Ulnar
MBC
MABC
MAYO ©2004

Branches of Brachial Plexus

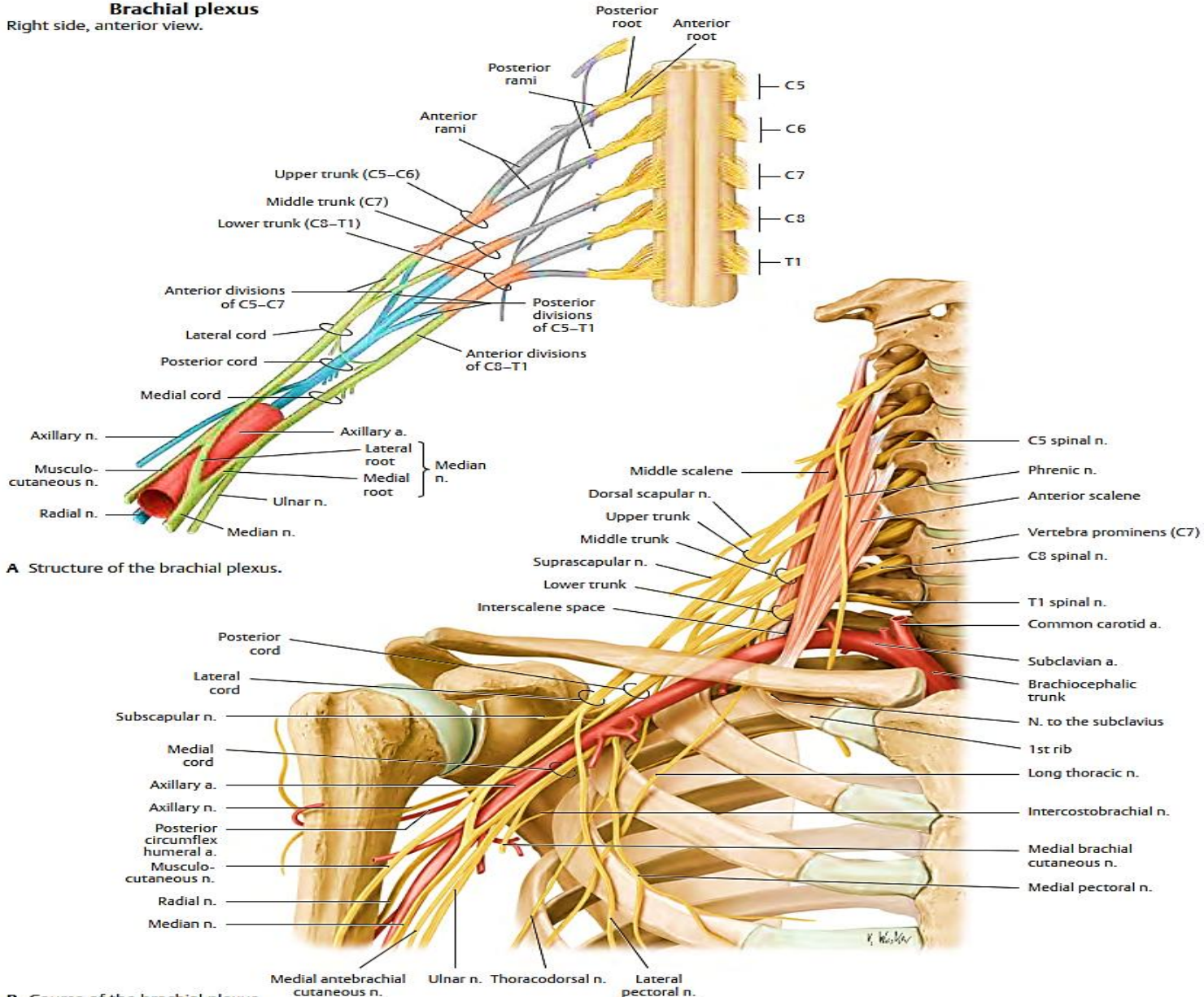


The infraclavicular part of the brachial plexus consists of short branches that arise directly from the cords and long (terminal) branches that traverse the limb.

Supraclavicular part				
Direct branches from the anterior rami or plexus trunks				
●		Dorsal scapular n.		C4–C5
		Suprascapular n.		C5, C6
		N. to the subclavius		C5–C6
		Long thoracic n.		C5–C7
Infraclavicular part				
Short and long branches from the plexus cords				
●	**Lateral cord**	Lateral pectoral n.		C5–C7
		Musculocutaneous n.		
●		Median n.	Lateral root	C6–C7
			Medial root	C8–T1
●	**Medial cord**	Medial pectoral n.		
		Medial antebrachial cutaneous n.		
		Medial brachial cutaneous n.		T1
		Ulnar n.		C7–T1
●	**Posterior cord**	Upper subscapular n.		C5–C6
		Thoracodorsal n.		C6–C8
		Lower subscapular n.		C5–C6
		Axillary n.		
		Radial n.		C5–T1

Brachial plexus

Right side, anterior view.



A Structure of the brachial plexus.

B Course of the brachial plexus, stretched for clarity.

The supraclavicular branches of the brachial plexus arise directly from the plexus roots (anterior rami of the spinal nerves) or from the plexus trunks in the lateral cervical triangle.

Supraclavicular branches

Nerve	Level	Innervated muscle
Dorsal scapular n.	C4–C5	Levator scapulae Rhomboids major and minor
Suprascapular n.	C5, C6	Supraspinatus Infraspinatus
N. to the subclavius	C5–C6	Subclavius
Long thoracic n.	C5–C7	Serratus anterior

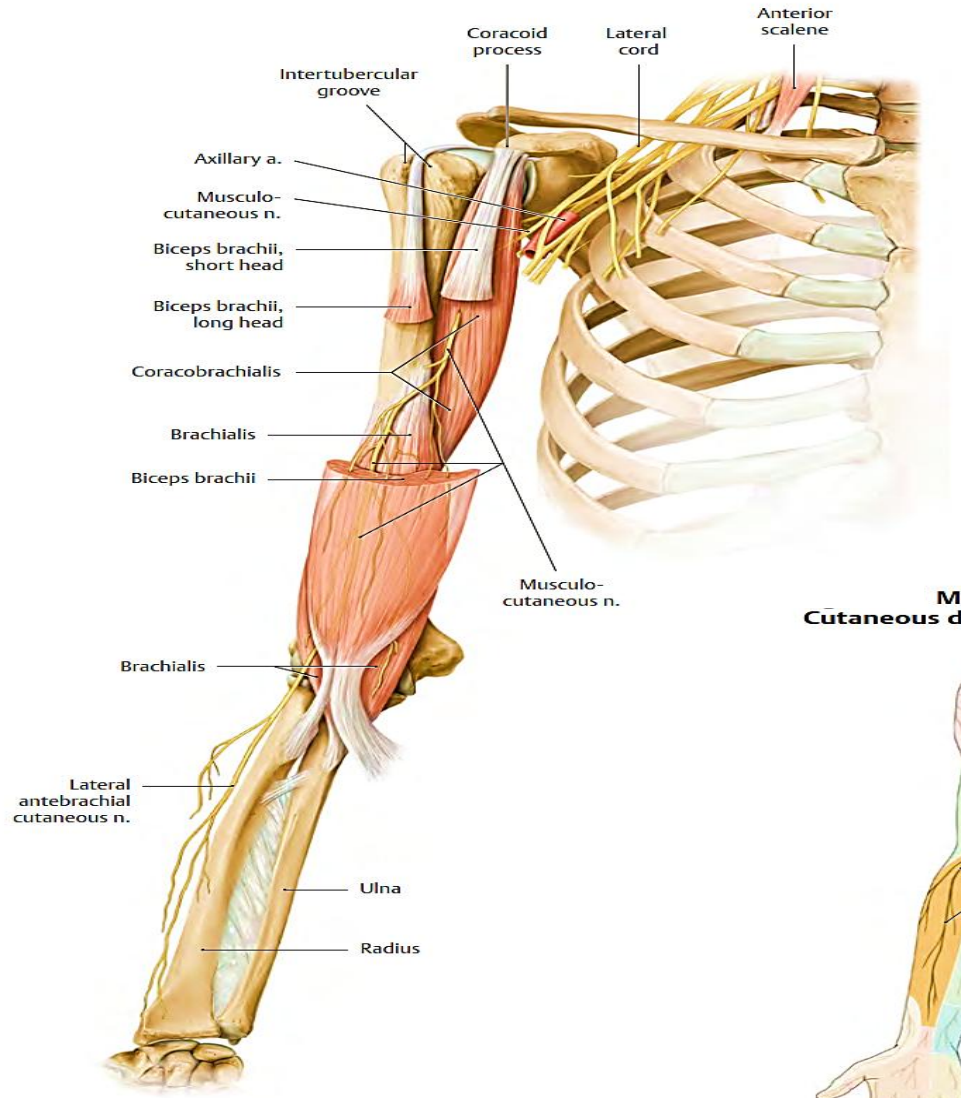
Branches of the medial and lateral cords

Nerve	Level	Cord	Innervated muscle
Short branches			
Lateral pectoral n.	C5–C7	Lateral cord	Pectoralis major
Medial pectoral n.	C8–T1	Medial cord	Pectoralis major and minor
Medial brachial cutaneous n.	T1		— (sensory brs., do not innervate any muscles)
Medial antebrachial cutaneous n.	C8–T1		
Intercostobrachial nn.	T2–T3		
Long (terminal) branches			
Musculocutaneous n.	C5–C7	Lateral cord	Coracobrachialis Biceps brachii Brachialis
Median n.	C6–T1	Lateral and medial cord	
Ulnar n.	C7–T1	Medial cord	

Branches of the posterior cord

Nerve	Level	Innervated muscle
Short branches		
Upper subscapular n.	C5–C6	Subscapularis
Lower subscapular n.		Subscapularis Teres major
Thoracodorsal n.	C6–C8	Latissimus dorsi
Long (terminal) branches		
Axillary n.	C5–C6	
Radial n.	C5–T1	

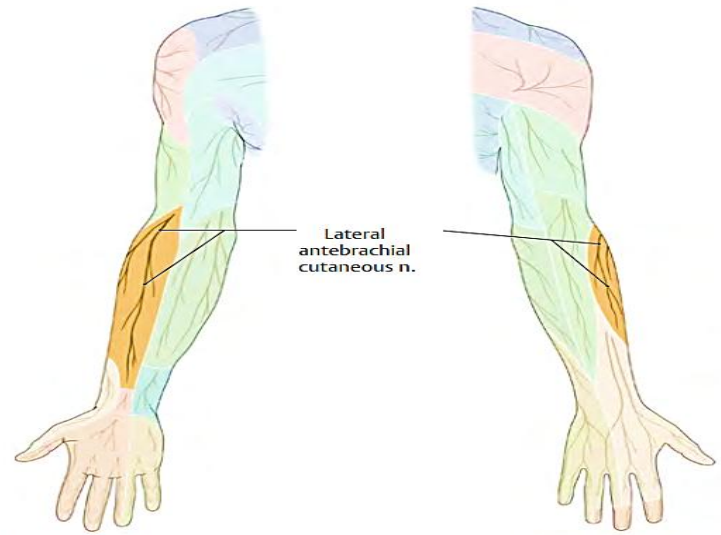
Musculocutaneous nerve
Right limb, anterior view.



Musculocutaneous nerve (C5–C7)

Motor branches	Innervated muscles
Muscular brs.	Coracobrachialis
	Biceps brachii
	Brachialis
Sensory branches	
Lateral antebrachial cutaneous n.	
Articular brs.: Joint capsule of the elbow (anterior part)	
Note: Musculocutaneous n. innervation of the arm is purely motor; innervation of the forearm is purely sensory.	

Musculocutaneous nerve: Cutaneous distribution

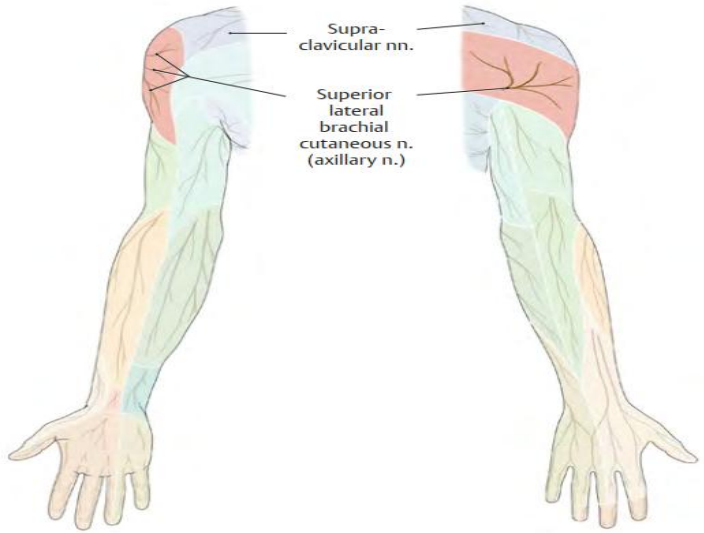


A Anterior view. **B** Posterior view.

Posterior Cord: Axillary & Radial Nerves

Axillary nerve: Cutaneous distribution

Right limb.



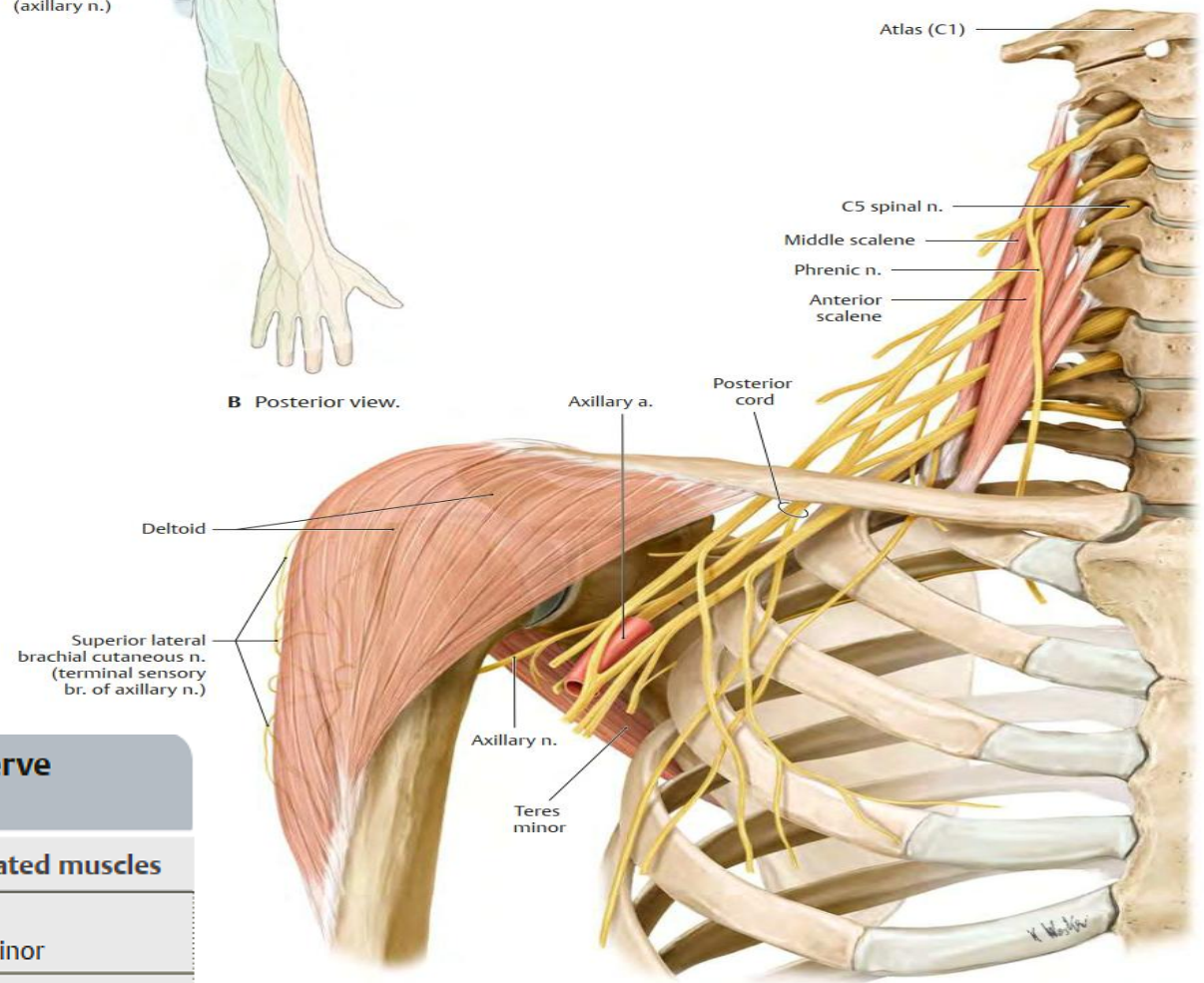
A Anterior view. **B** Posterior view.

Clinical box 28.3

The axillary nerve may be damaged in a fracture of the surgical neck of the humerus. This results in limited ability to abduct the arm and may cause a loss of profile of the shoulder.

Axillary nerve

Right side, anterior view, stretched for clarity.



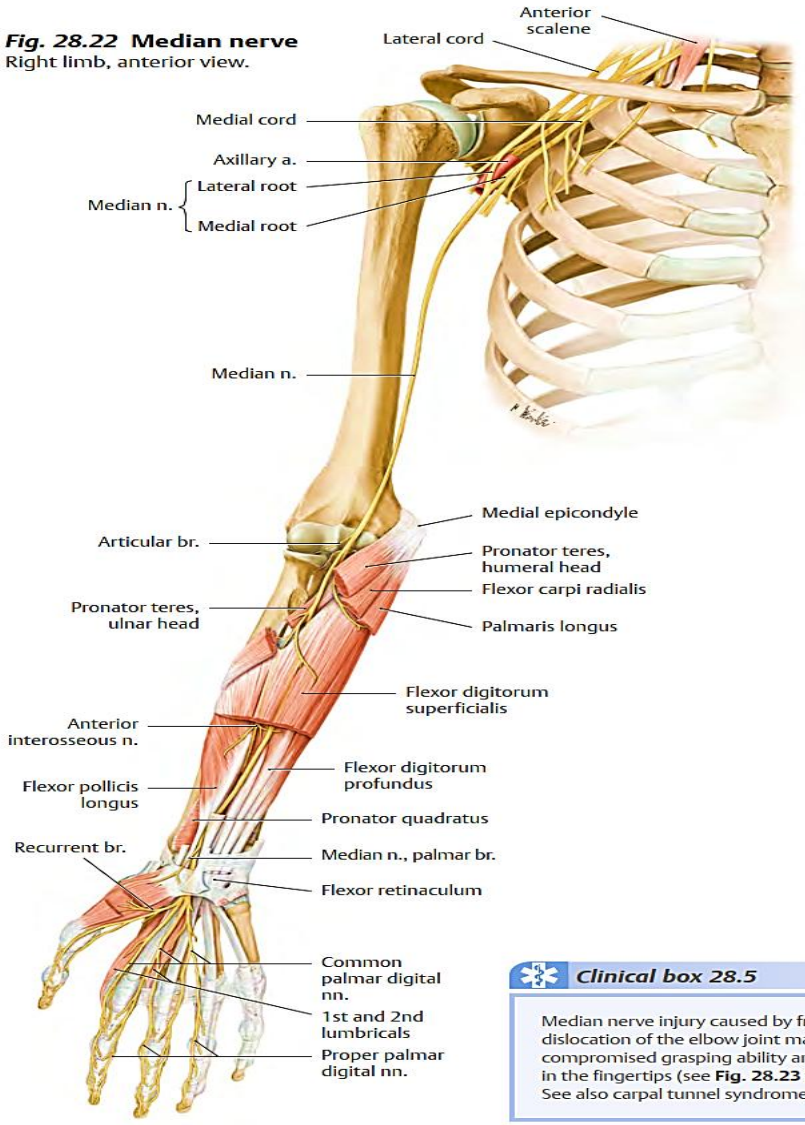
Axillary nerve (C5–C6)

Motor branches	Innervated muscles
Muscular brs.	Deltoid Teres minor
Sensory branch	
Superior lateral brachial cutaneous n.	

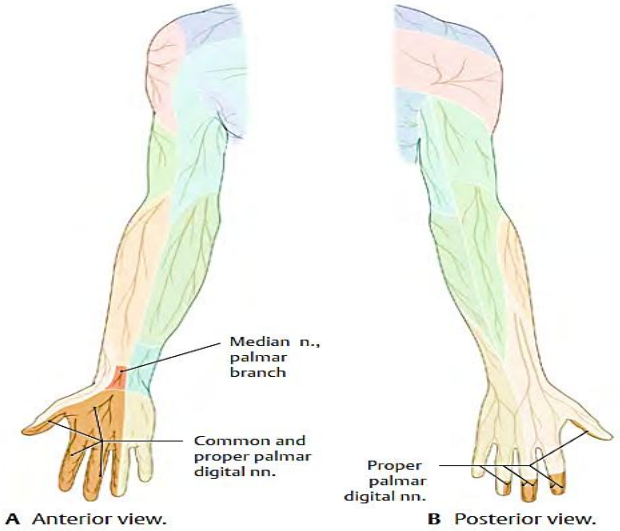
Median & Ulnar Nerves

The median nerve is a terminal branch arising from both the medial and the lateral cords. The ulnar nerve arises exclusively from the medial cord.

Fig. 28.22 **Median nerve**
Right limb, anterior view.



Median nerve: Cutaneous distribution



A Anterior view. **B** Posterior view.

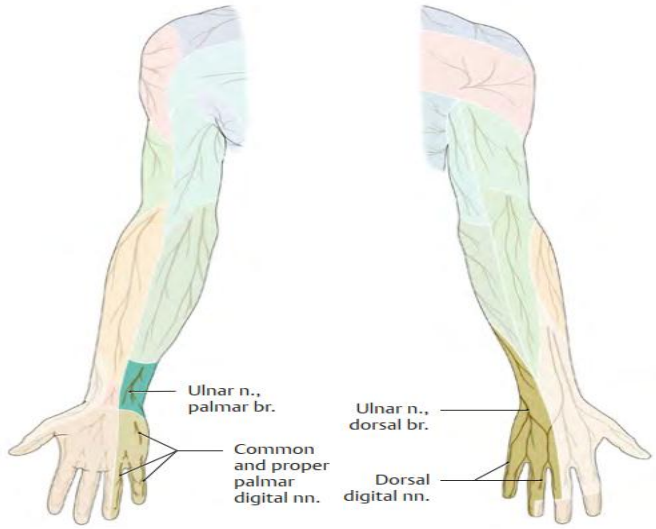
Median nerve (C6–T1)

Motor branches	Innervated muscles
Direct muscular brs.	Pronator teres
	Flexor carpi radialis
	Palmaris longus
	Flexor digitorum superficialis
Muscular brs. from anterior interosseous n.	Pronator quadratus
	Flexor pollicis longus
	Flexor digitorum profundus (radial half)
Recurrent br.	Abductor pollicis brevis
	Flexor pollicis brevis (superficial head)
	Opponens pollicis
Muscular brs. from common palmar digital nn.	1st and 2nd lumbricals
Sensory branches	
Articular brs.: Capsules of the elbow and wrist joints	
Palmar br. of median n. (thenar eminence)	
Communicating br. to ulnar n.	
Common palmar digital nn.	
Proper palmar digital nn.	

Clinical box 28.5

Median nerve injury caused by fractu
dislocation of the elbow joint may re
compromised grasping ability and se
in the fingertips (see **Fig. 28.23** for t
See also carpal tunnel syndrome (**p.**

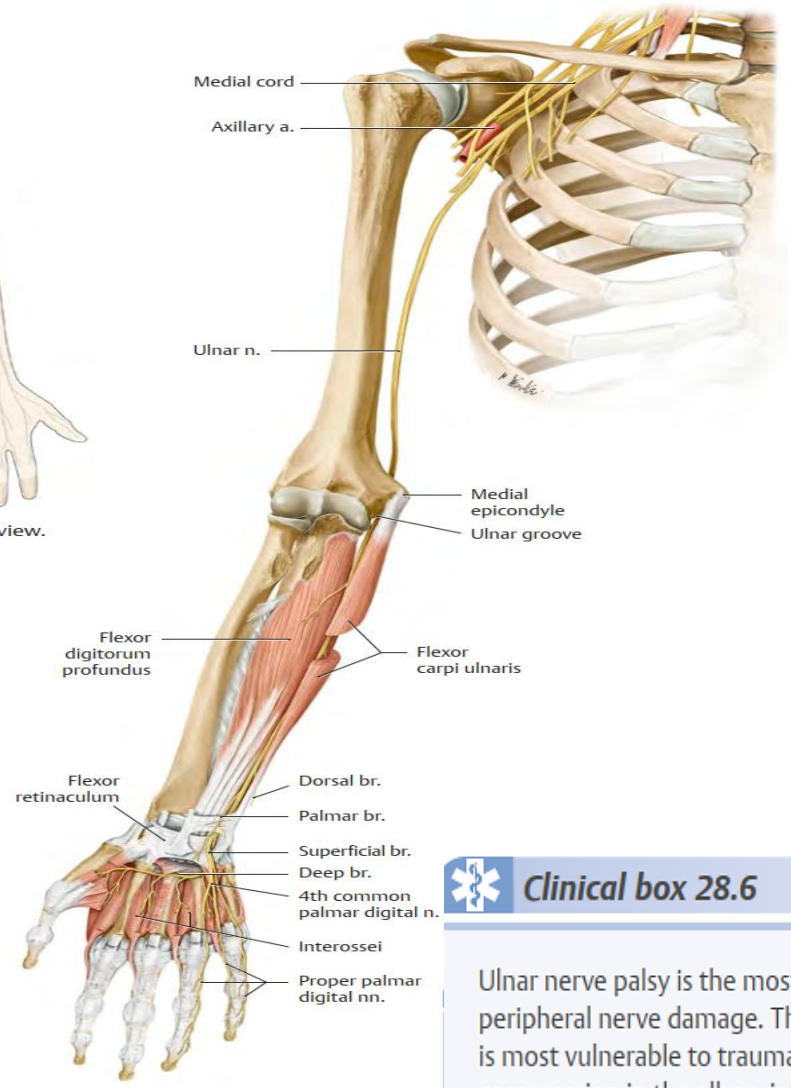
Ulnar nerve: Cutaneous distribution



A Anterior view. **B** Posterior view.

Ulnar nerve

Right limb, anterior view.



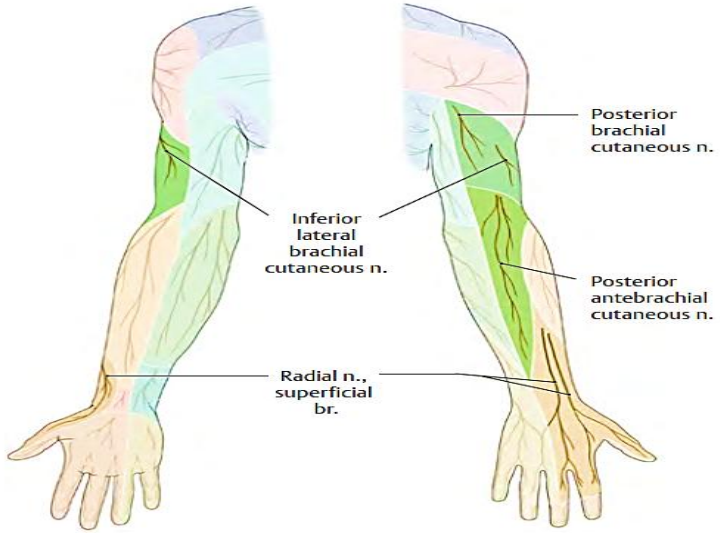
Ulnar nerve (C7–T1)

Motor branches	Innervated muscles
Direct muscular brs.	Flexor carpi ulnaris
	Flexor digitorum profundus (ulnar half)
Muscular br. from superior ulnar n.	Palmaris brevis
Muscular brs. from deep ulnar n.	Abductor digiti minimi
	Flexor digiti minimi brevis
	Opponens digiti minimi
	3rd and 4th lumbricals
	Palmar and dorsal interosseous muscles
	Adductor pollicis
	Flexor pollicis brevis (deep head)
Sensory branches	
Articular brs.: Capsules of the elbow, carpal, and metacarpophalangeal joints	
Dorsal br. (terminal brs.: dorsal digital nn.)	
Palmar br.	
Proper palmar digital n. (from superficial br.)	
Common palmar digital n. (from superficial br.; terminal brs.: proper palmar digital nn.)	

Clinical box 28.6

Ulnar nerve palsy is the most common peripheral nerve damage. The ulnar nerve is most vulnerable to trauma or chronic compression in the elbow joint and ulnar tunnel ( ). Nerve damage causes "clawing" of the hand and atrophy of the interossei. Sensory losses are often limited to the 5th digit.

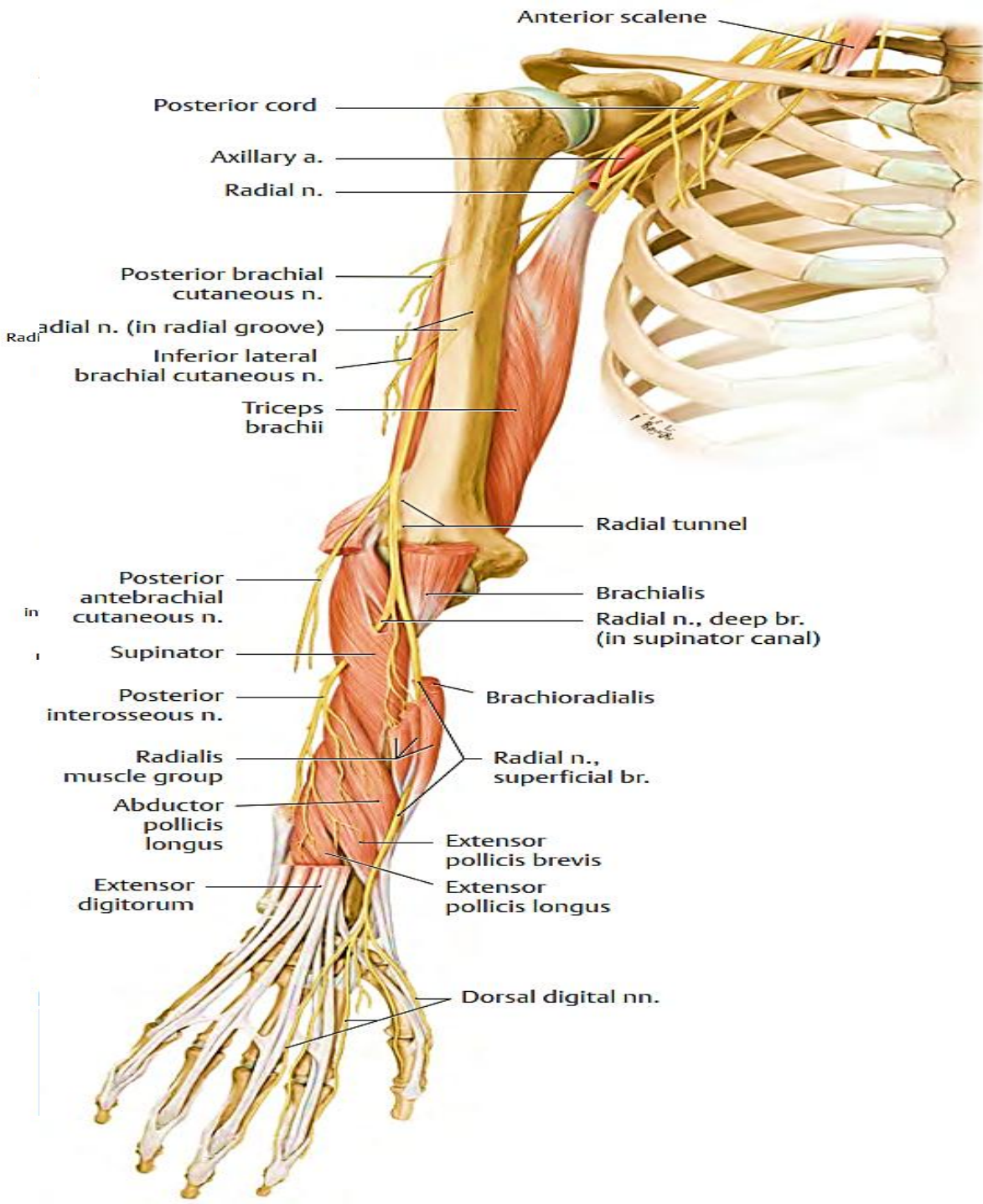
Radial nerve: Cutaneous distribution



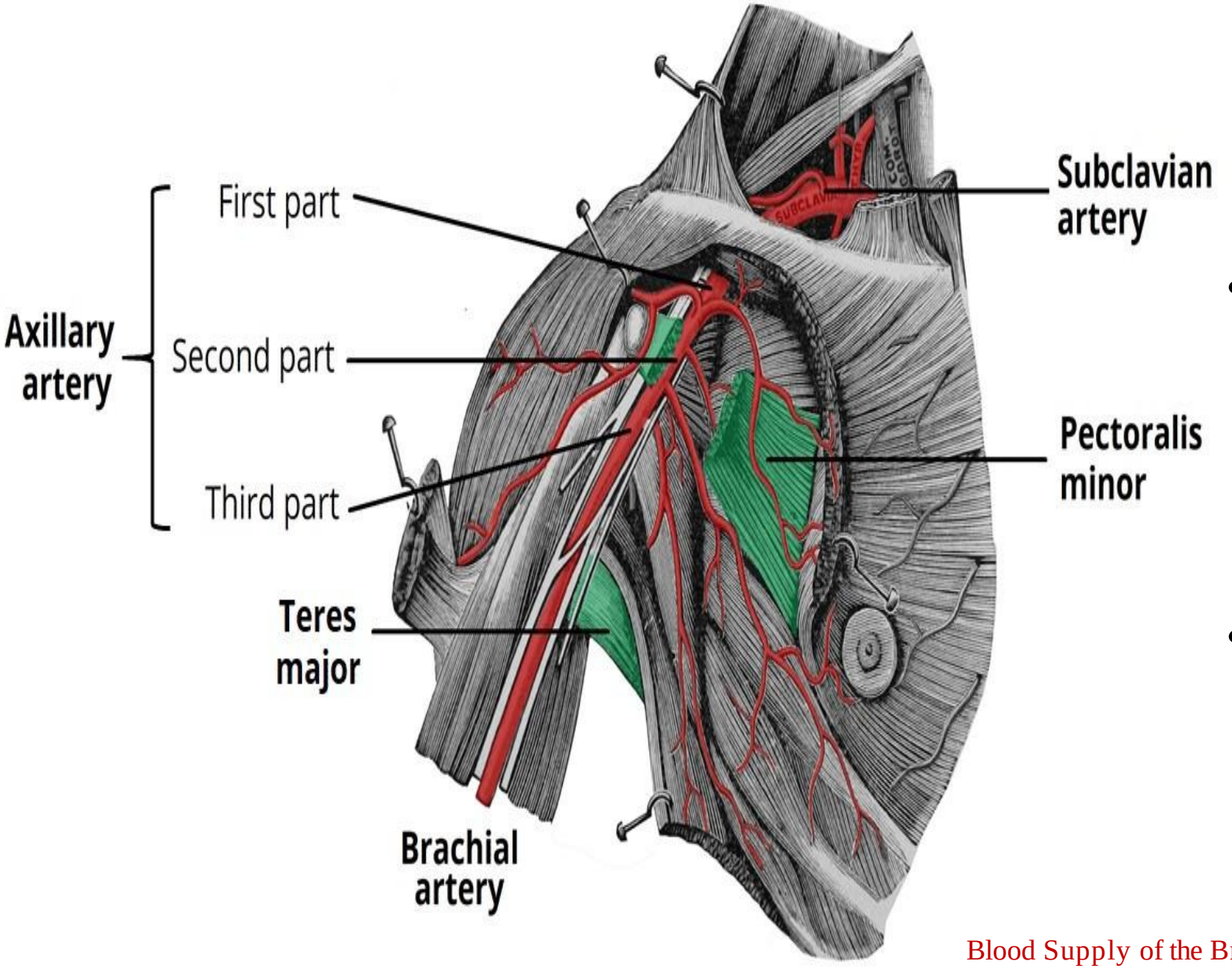
A Anterior view. **B** Posterior view.

Radial nerve (C5–T1)

Motor branches	Innervated muscles
Muscular brs.	Brachialis (partial)
	Triceps brachii
	Anconeus
	Brachioradialis
	Extensors carpi radialis longus and brevis
Deep br. (terminal br.: posterior interosseous n.)	Supinator
	Extensor digitorum
	Extensor digiti minimi
	Extensor carpi ulnaris
	Extensors pollicis brevis and longus
	Extensor indicis
	Abductor pollicis longus
Sensory branches	
Articular brs. from radial n.: Capsule of the shoulder joint	
Articular brs. from posterior interosseous n.: Joint capsule of the wrist and four radial metacarpophalangeal joints	
Posterior brachial cutaneous n.	
Inferior lateral brachial cutaneous n.	
Posterior antebrachial cutaneous n.	
Superficial brs.	Dorsal digital nn.
	Ulnar communicating br.



Blood Supply of the Brachial Plexus



- The blood supply of the brachial plexus is based largely on the subclavian (which becomes the axillary) artery and its branches, and variations exist.

- Generally, the vessels involved are the vertebral, the ascending and deep cervical, and the superior intercostal arteries.

Upper Brachial Plexus Injury (Erb's Palsy)

Erb's palsy refers to an injury to the upper roots of the brachial plexus (typically C5-6). It most commonly occurs as a result of a stretching injury during a difficult vaginal delivery. While common in newborns from difficult births, adults can sustain similar injuries.

•**Nerves affected** – the peripheral nerves derived from C5-6 roots are most affected. This includes the musculocutaneous, axillary, suprascapular, and nerve to subclavius.

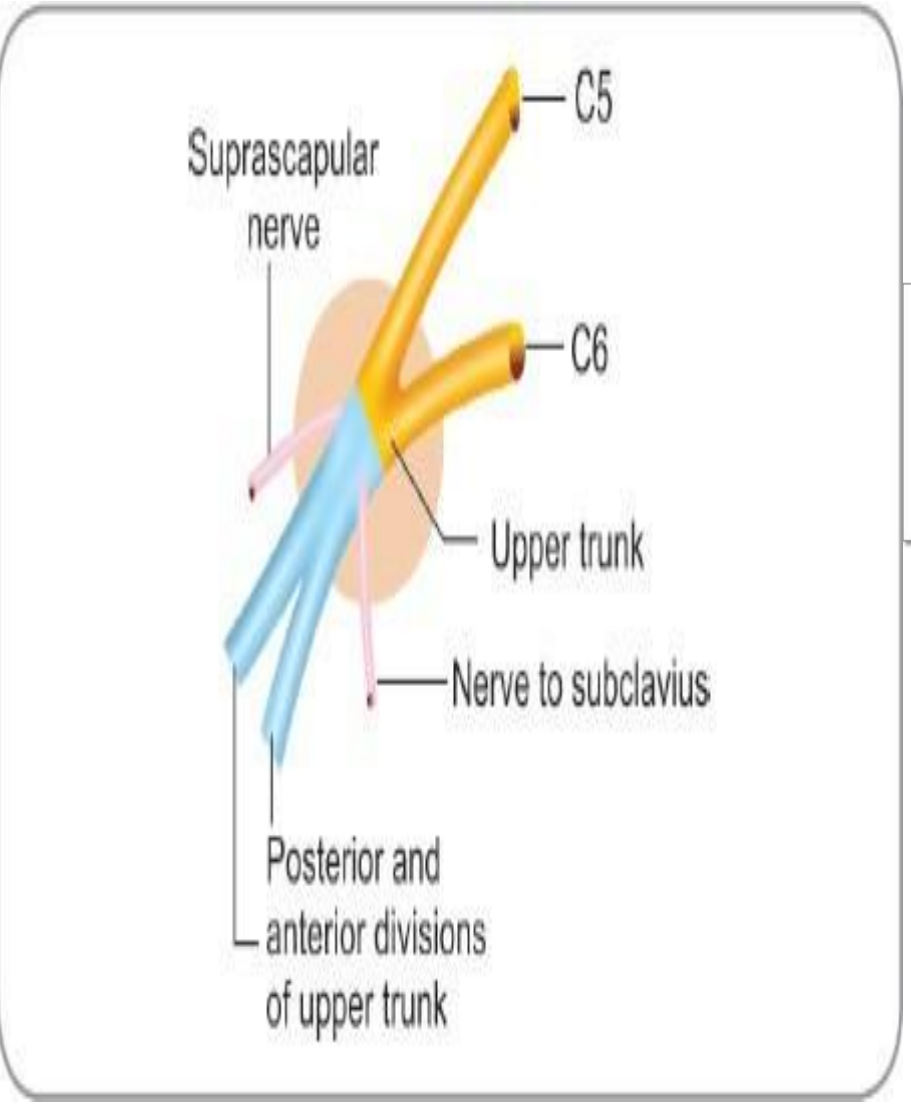
•**Muscles affected** – supraspinatus, infraspinatus, subclavius, biceps brachii, brachialis, coracobrachialis, deltoid and teres minor.

•**Motor functions affected** – abduction at shoulder, lateral rotation of arm, supination of forearm, and flexion at shoulder.

•**Sensory functions affected** – sensation over the lateral aspect of upper limb (C5-6 dermatomes).

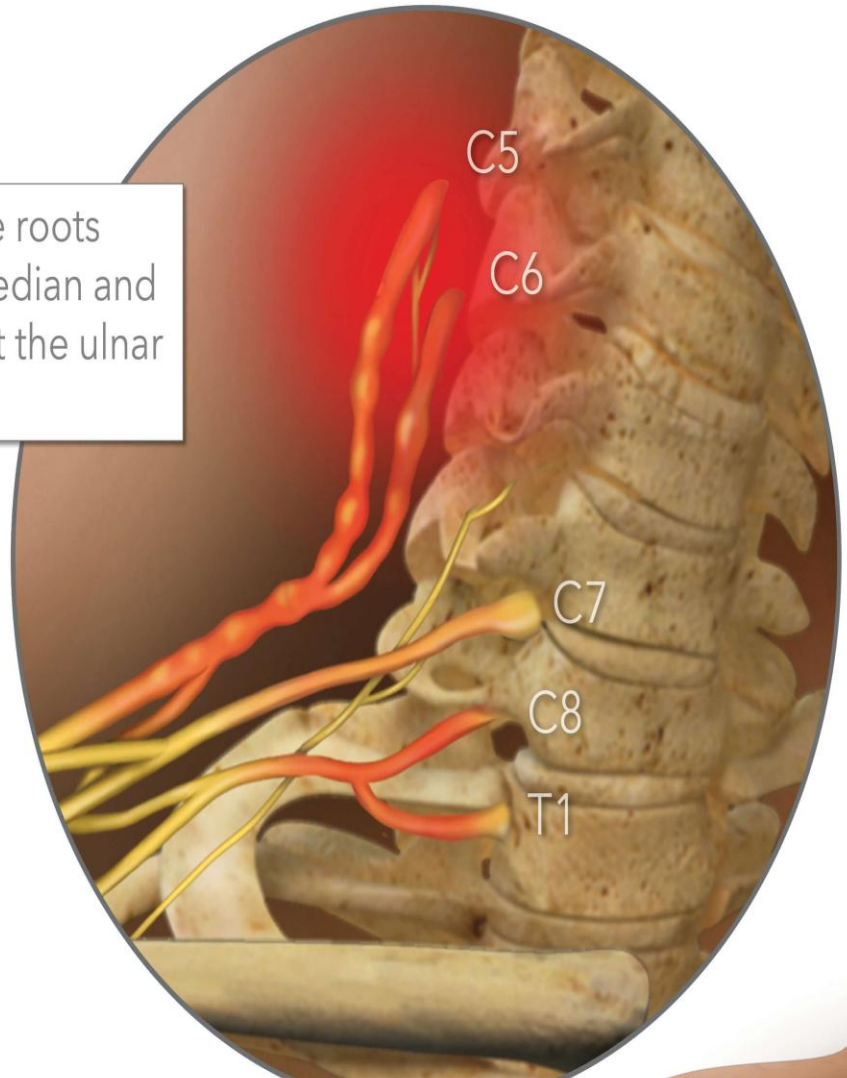
The affected limb hangs limply, medially rotated by the unopposed action of pectoralis major. The forearm is pronated due to the loss of biceps brachii. The wrist is weakly flexed due to the normal tone of the wrist flexors relative to the weakened wrist extensors. This is position is known as '**waiter's tip**' and is characteristic of Erb's palsy.

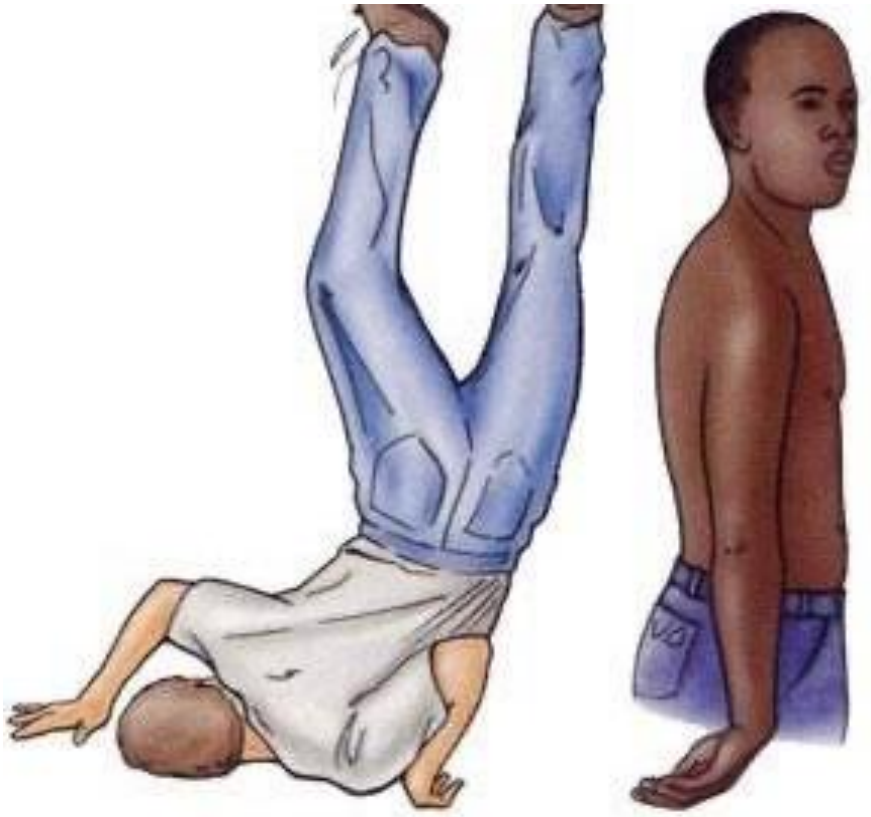
Erb's point



Nerve roots involved

C5 and C6 nerve roots contribute to the median and radial nerves but not the ulnar nerve





Causes

- Muscles Paralyzed
- Deformity
- Disability

Lower Brachial Plexus Injury (Klumpke's Palsy)

Klumpke's palsy is an injury of the lower roots of the brachial plexus (C8-T1). It is also most commonly associated with a difficult vaginal delivery but has a much lower incidence than Erb's palsy.

•**Nerves affected** – the peripheral nerves derived from T1 root are most affected; the ulnar and median nerves

•**Muscles affected** – the intrinsic hand muscles

•**Sensory functions affected** – sensation along medial side of upper limb (C8-T1 dermatomes).

The primary feature of Klumpke's palsy is a **clawed hand**.

This occurs due to paralysis of the lumbrical muscles, which normally act to flex the metacarpophalangeal joints (MCPJs) and extend the interphalangeal joints (IPJs). When paralysed, the fingers subsequently become extended at the MCPJs and flexed at the IPJs, producing a clawed appearance.

THANK YOU!