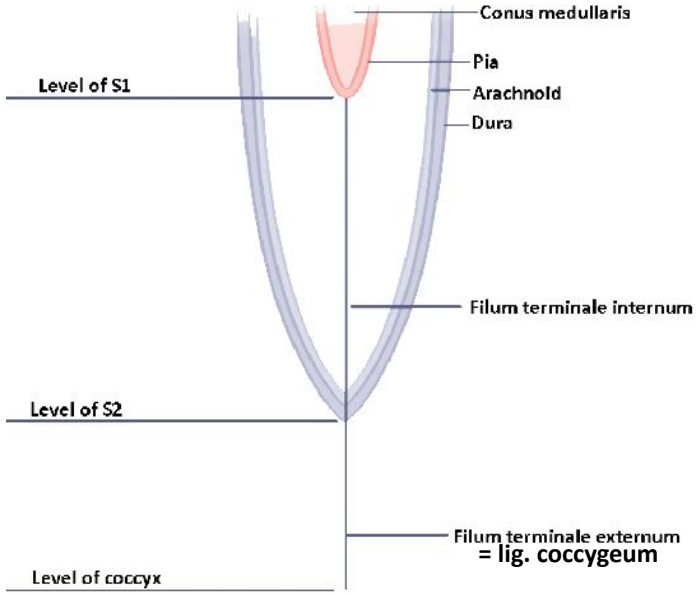
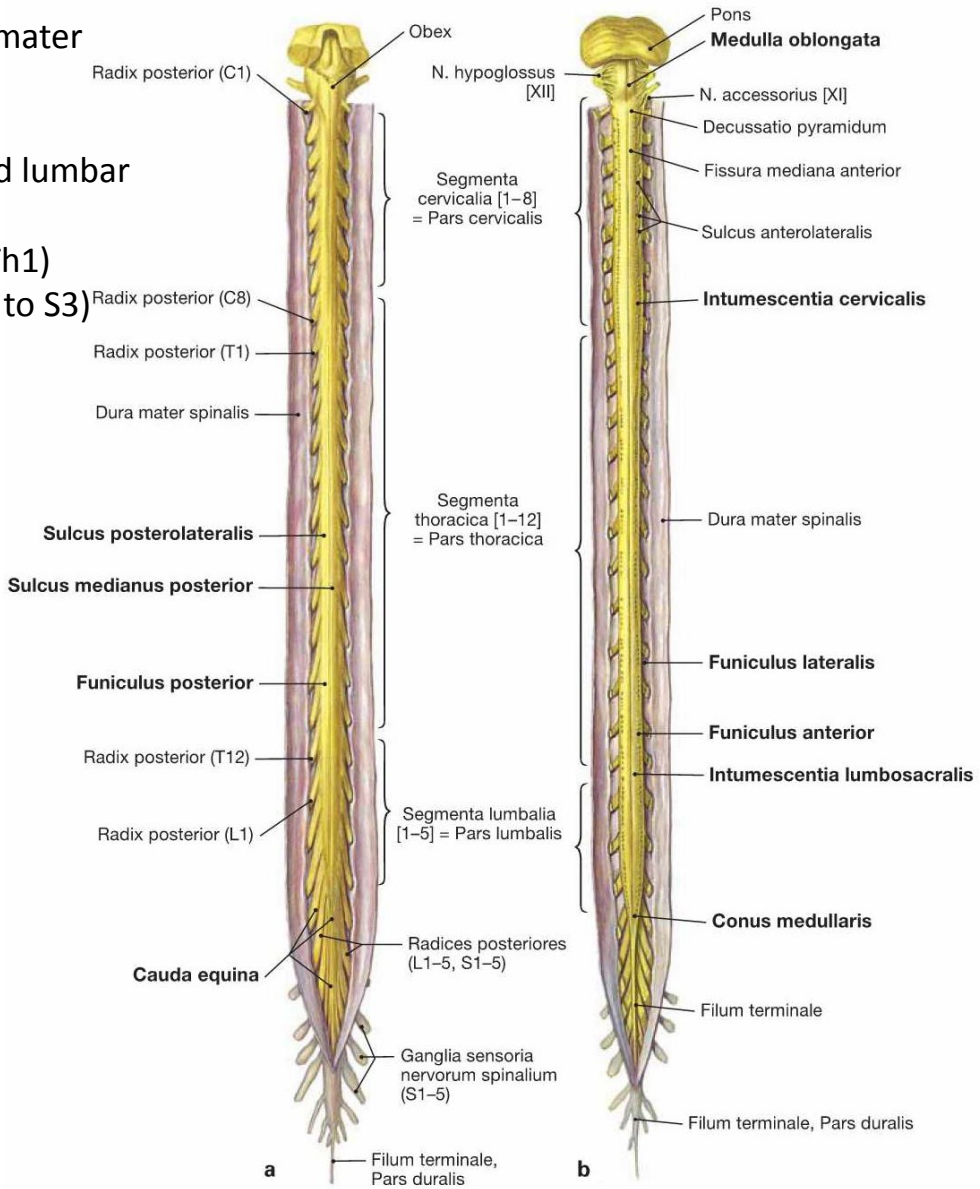
MEDULLA SPINALIS

- a cord of nerve tissue located in the spinal canal and surrounded by spinal meninges
  - begins below the foramen magnum with the exit of the first cervical spinal nerve
  - ends as the conus medullaris (♂ L1/L2, ♀ L2)
  - the filum terminale continues from it (neuroglia + pia mater spinalis; fuses with the periosteum of S2)
  - approx. 44 cm long
  - intumescentia cervicalis et lumbosacralis – cervical and lumbar enlargements (motor nerves of limb muscles)
  - intumescentia cervicalis – C3 to Th2 (segments C3 to Th1)
  - intumescentia lumbosacralis – Th9 to L1 (segments L1 to S3)
  - cauda equina – root fibers L1 to Co
- spinal meninges
  - pia mater spinalis
  - arachnoidea mater spinalis
  - dura mater

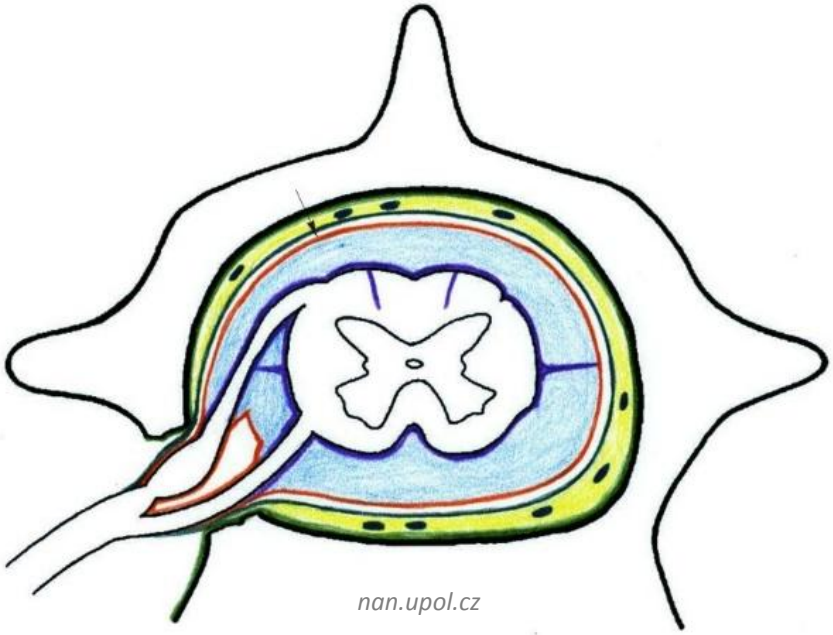
Paulsen et Waschke 2011
Sobotta Atlas of Anatomy





SPINAL MENINGES

- pia mater spinalis
  - on the surface of the spinal cord, penetrates into all folds and grooves
  - lig. denticulatum – approx. 21 slips of a continuous fibrous strip of pia mater towards the dura mater, where it attaches through the arachnoid
- cavitas subarachnoidea
  - cerebrospinal fluid
- arachnoidea spinalis
- dura mater spinalis
  - saccus durae matris spinalis (from foramen magnum to S2, then filum terminale externum to the coccyx), into the foramina intervertebralia
- spatium epidurale
  - fatty tissue and vascular plexuses
- endorhachis – periosteum



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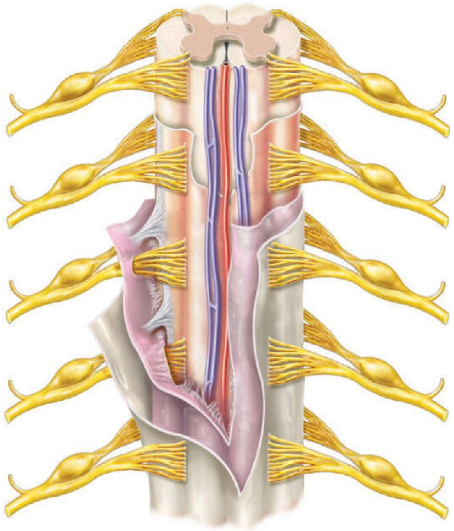
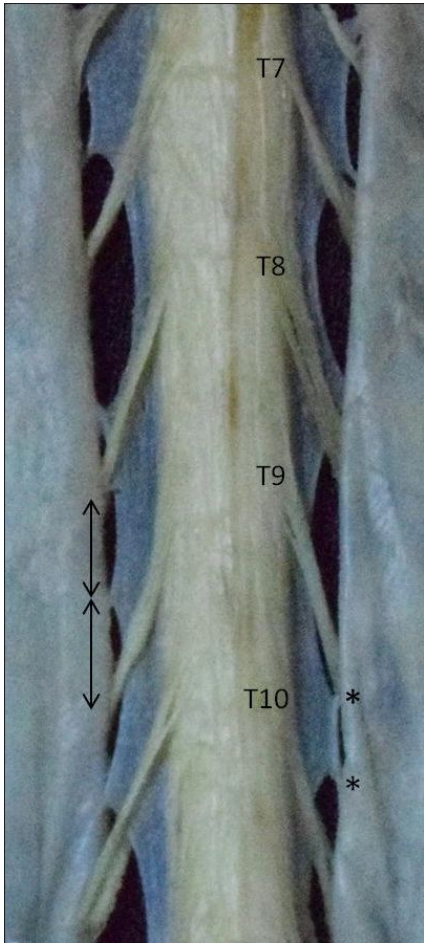
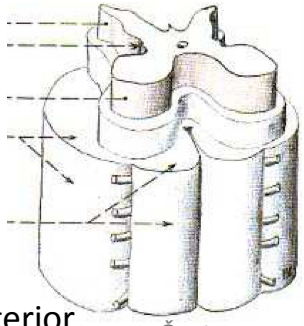


Tortora et Nielsen 2017
Principles of human anatomy

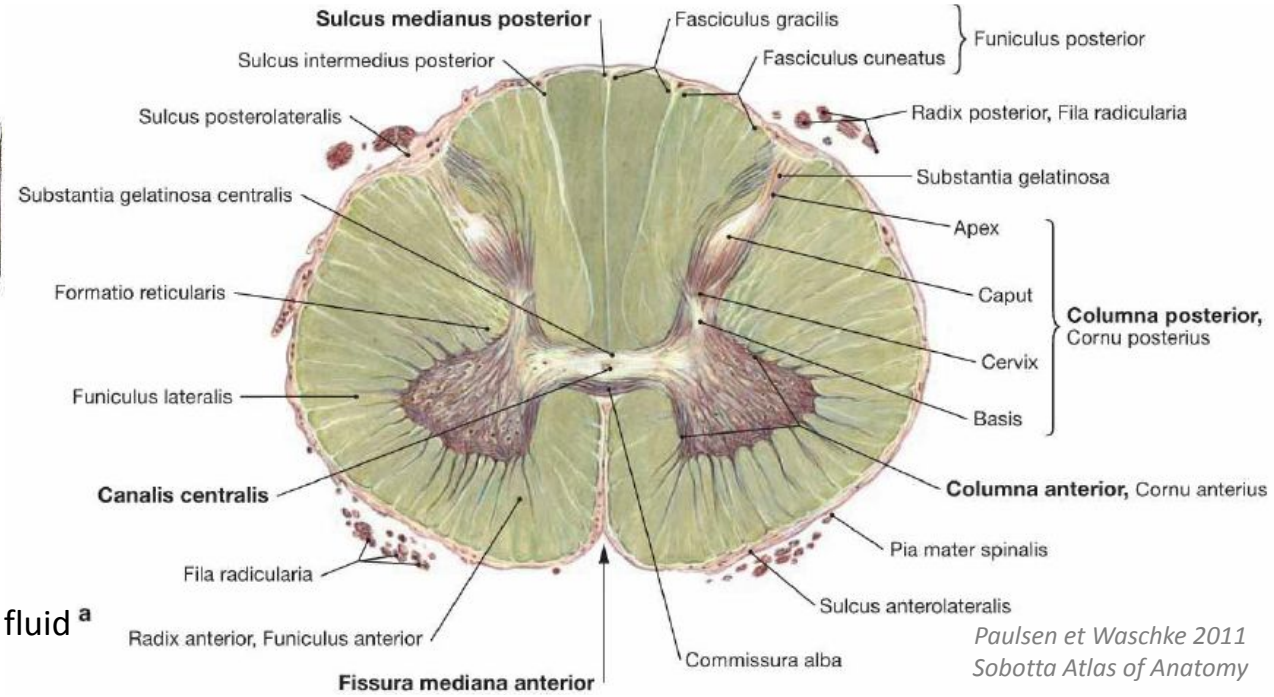
Elvan et al. 2020 The anatomical features of denticulate ligament in human fetuses



EXTERNAL DESCRIPTION OF THE SPINAL CORD



Čihák 2003
Anatomie 3



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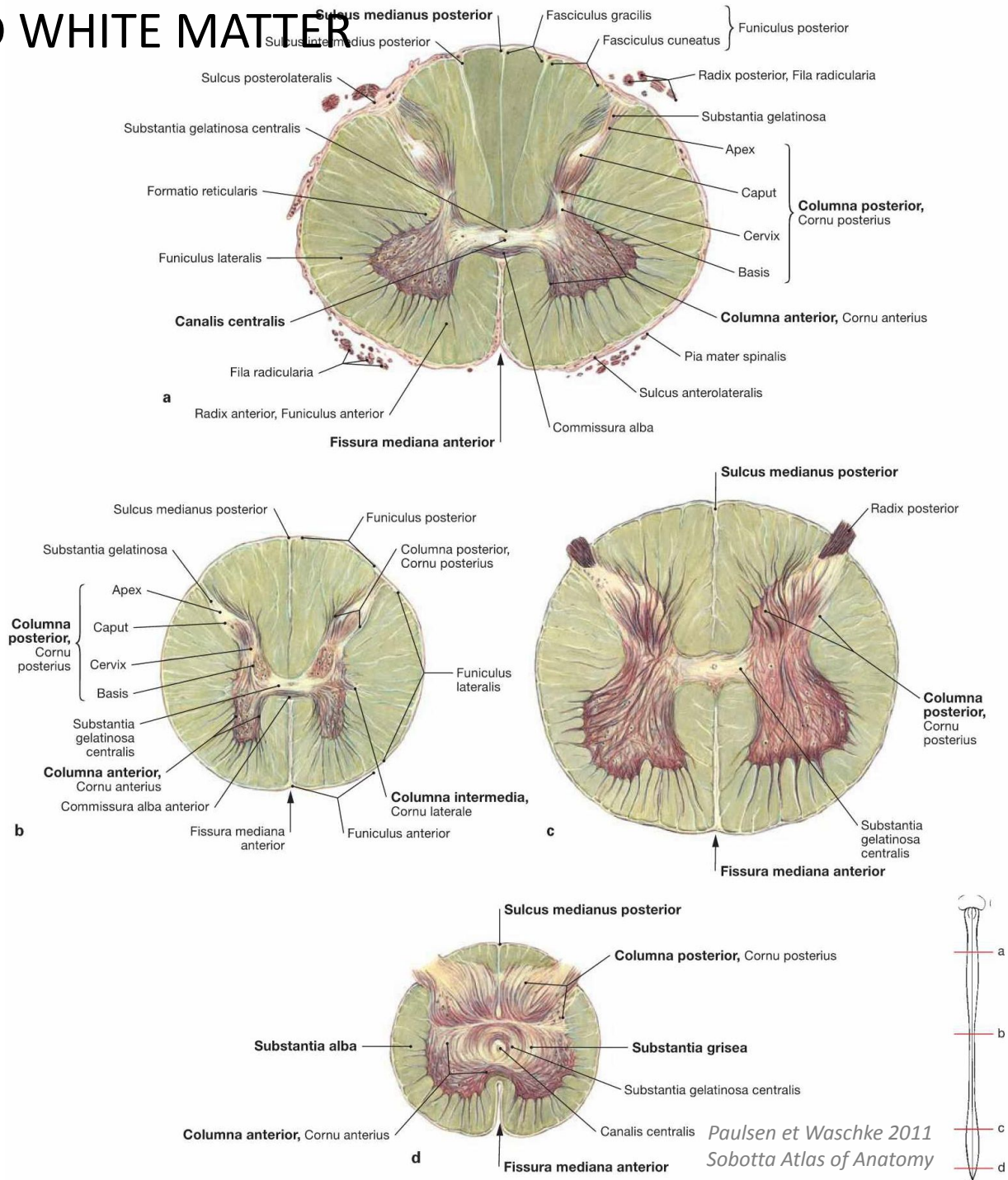
- fissura
  - mediana anterior
- sulcus
  - medianus posterior
  - anterolateralis
  - posterolateralis
- substantia grisea
  - canalis centralis with cerebrospinal fluid [a]
  - cornua (2D) = columnae (3D)
  - columnae posteriores – sensory cells, their axons to the CNS/to cells of the columnae anteriores
  - columnae anteriores – motor cells, axons through the anterior spinal roots to the muscles
  - columnae laterales – visible in the thoracic and lumbar spinal cord (Th1 to L2)
  - formatio reticularis medullae spinalis – in the cervical spinal cord, white matter penetrates the columnae laterales, giving it a reticular appearance
- substantia alba
  - funiculi medullae spinalis
  - funiculus posterior – fasciculus gracilis (Golli) et cuneatus (Burdachi), mainly ascending pathways
  - funiculus lateralis – both ascending and descending pathways
  - funiculus anterior – both ascending and descending pathways
  - fasciculi proprii (posteriores, laterales, anteriores) – propriospinal pathways (spinospinal)

VARIABILITY OF GRAY AND WHITE MATTER



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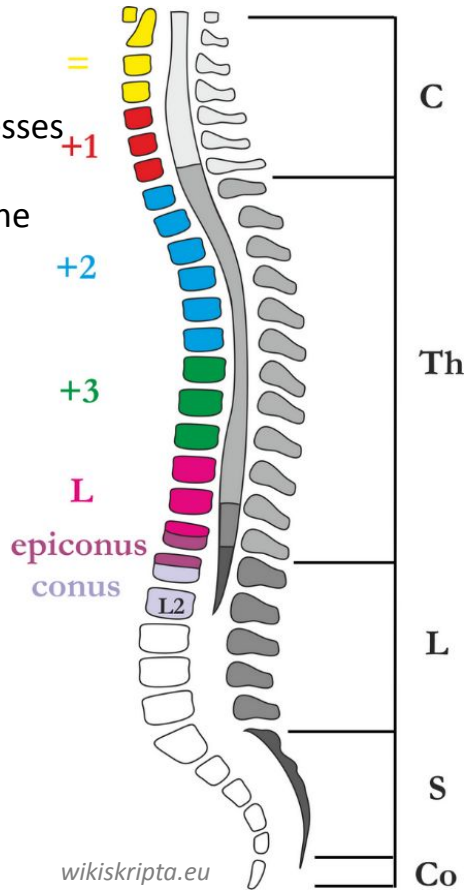
SPINAL SEGMENT

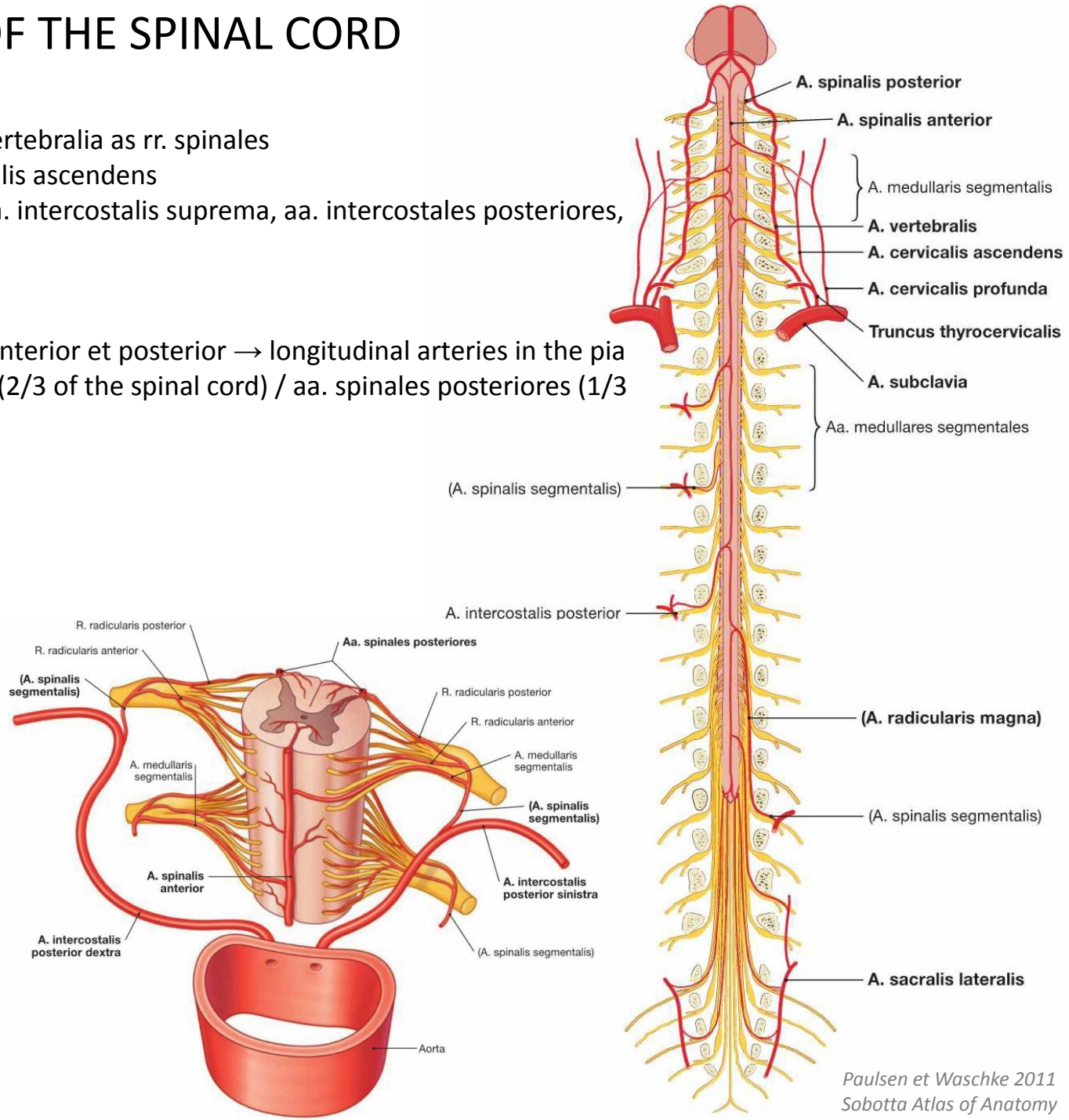
- section of the spinal cord from which root fibers are collected into one pair of spinal nerves
- exits through one pair of foramina intervertebralia
- 31 pairs (8+12+5+5+1)
- eighth cervical spinal nerve below C7, then always below the same numbered vertebra
- L5 and coccygeal segments (1–3) – through the hiatus sacralis
- cauda equina (below L1 to L2)
- Chipault's Rule
  - in an adult, determines the position of spinal segments according to the spinous processes of the vertebrae
  - spinal segments are shifted relative to the corresponding vertebra – faster growth of the spinal cord relative to the spine

Trny	segmenty
C horní	stejné
C dolní	+1
Th horní	+2
Th dolní	+3
Th 10–12	L_1–L_4
Přechod Th_{12}–L_1	epiconus (L_5–S_2)
L_1–L_2	conus (S_3–Co)



VASCULAR SUPPLY OF THE SPINAL CORD

- arteries
  - through the foramina intervertebralia as rr. spinales
  - from a. vertebralis, a. cervicalis ascendens
  - from a. cervicalis profunda, a. intercostalis suprema, aa. intercostales posteriores, a. subcostalis
  - from aa. lumbales
  - from aa. sacrales laterales
  - rr. spinales ⟶ a. radicularis anterior et posterior ⟶ longitudinal arteries in the pia mater ⟶ a. spinalis anterior (2/3 of the spinal cord) / aa. spinales posteriores (1/3 of the spinal cord)



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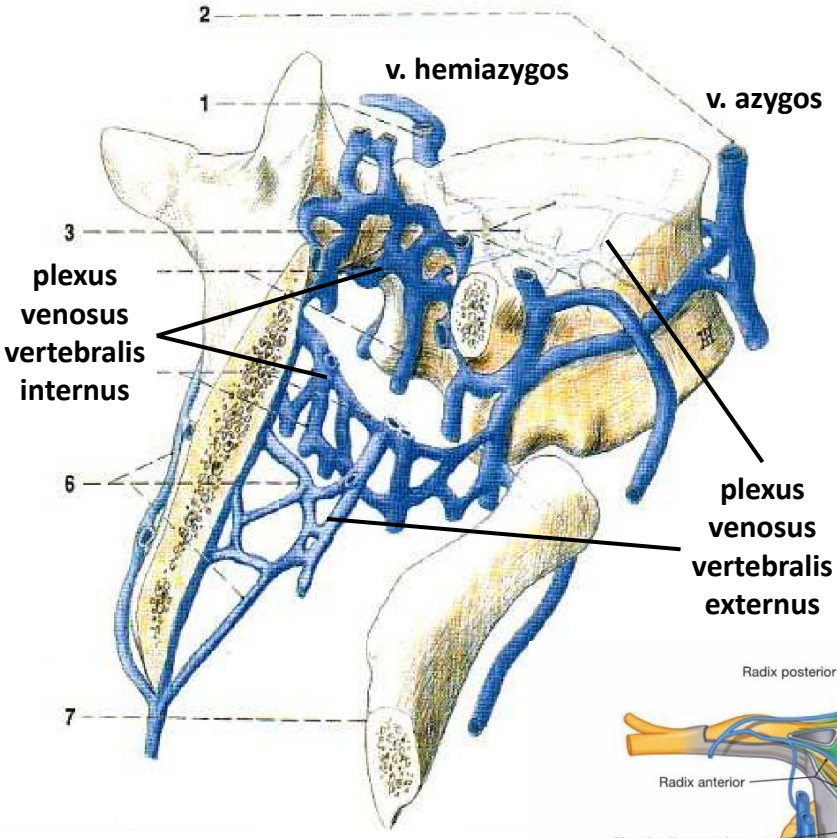
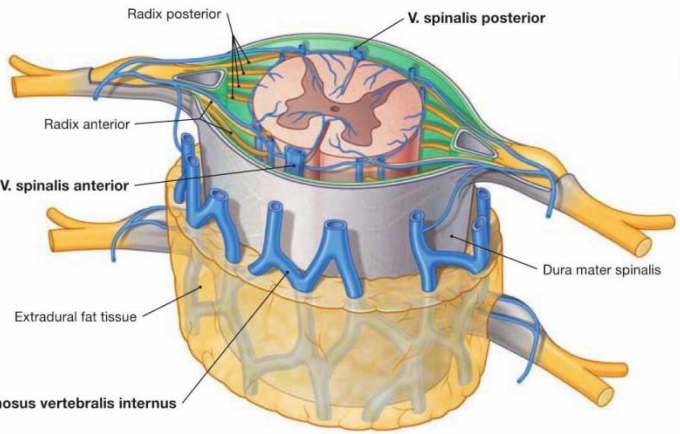
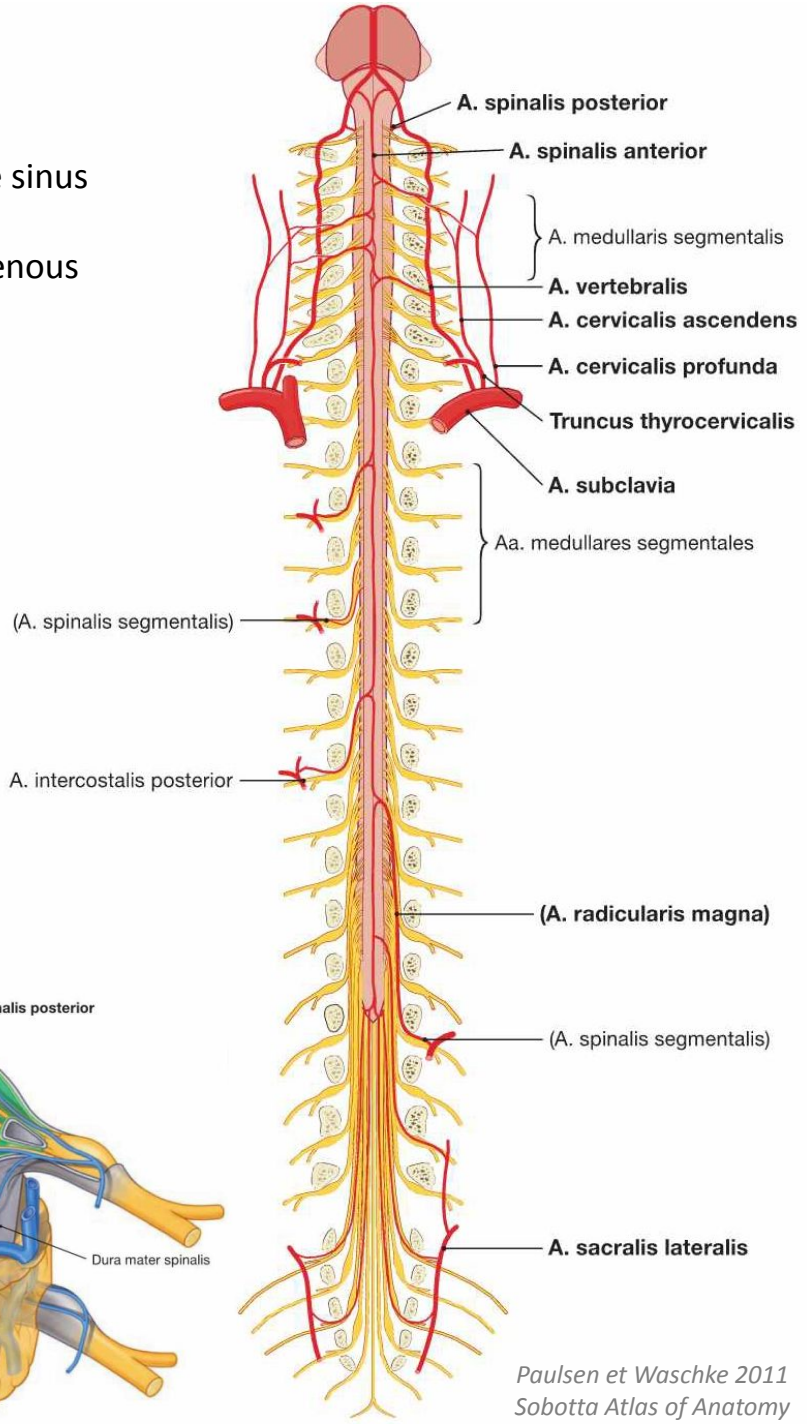
VASCULAR SUPPLY OF THE SPINAL CORD

- veins
  - from cranial sections into the veins of the cerebellum and into the sinus durae matris
  - from lower sections into the internal and then into the external venous plexuses and further into the venous analogs of the arteries







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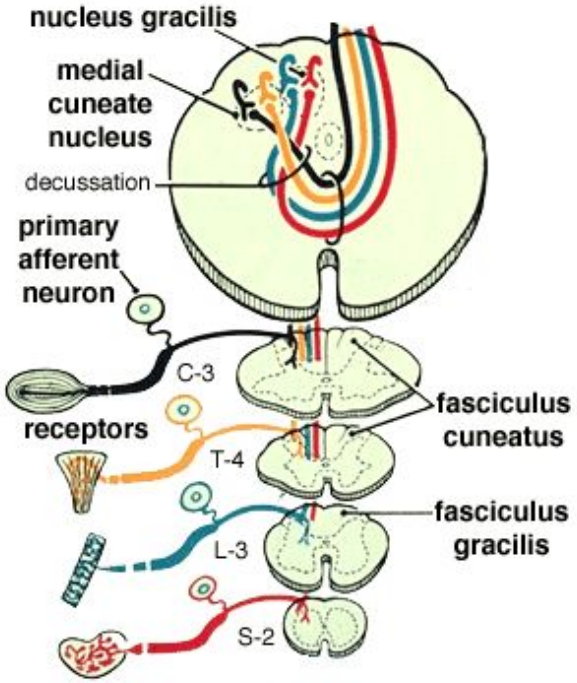
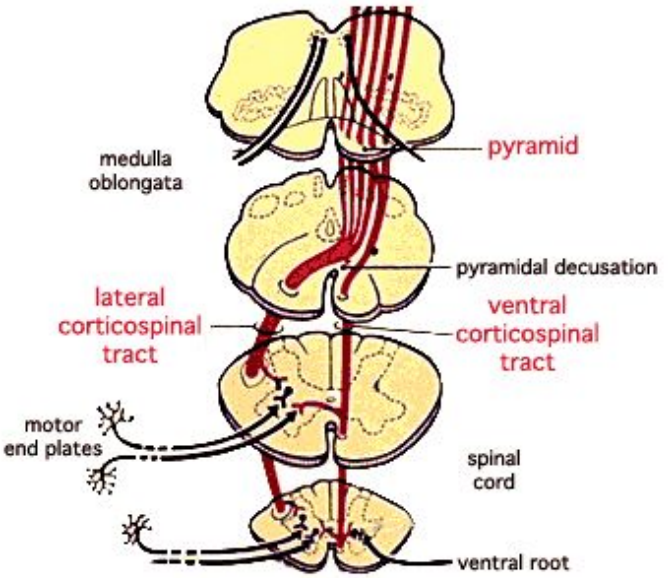
SPINAL WHITE AND GRAY MATTER

- substantia grisea
  - macroscopic areas of the dorsal spinal cord where numerous neuron perikarya are close to each other with neuroglia between them
  - neuropil – terminal sections of axons, dendrites with spines, synapses, processes of neuroglia cells, capillaries
- substantia alba
  - macroscopic areas with a quantity of myelinated axons
  - tractus nervosus / fasciculus / fibrae – macroscopically visible strip or bundle of common axon path
  - afferent / efferent pathway – relative term to the CNS
  - ascending = sensory pathways – bring information to "higher" centers (topographically and functionally)
  - descending = motor pathways – lead "instructions" from "higher" centers to the spinal cord and from there through peripheral nerves to the executive organs



Ascending Pathway



Descending Pathway

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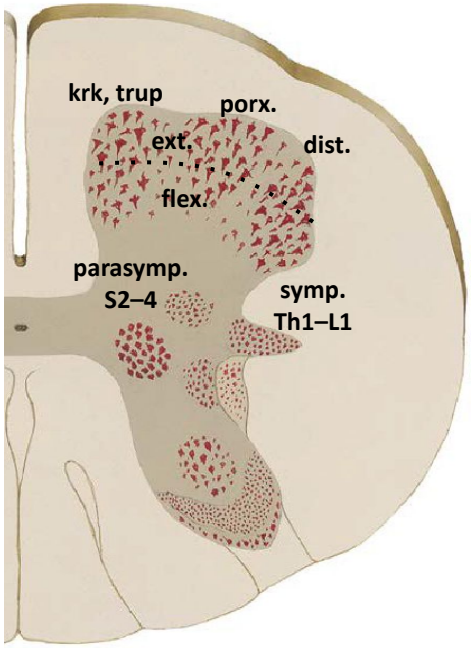
SPINAL GRAY MATTER

columnae anteriores

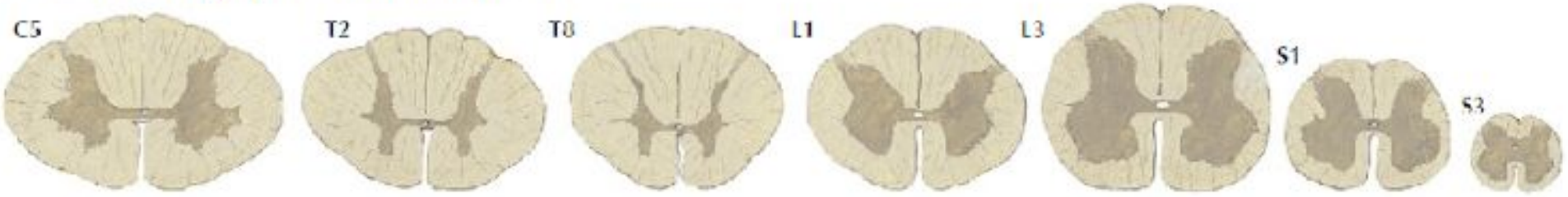
- alpha motoneurons
  - axons through the anterior spinal roots to the spinal nerves
  - most in the intumescences
  - five nuclei (according to muscle groups)
  - nc. anteromedialis, centralis, anterolateralis, posteromedialis et posterolateralis
  - nc. nervi accessorii (C1–5)
- gamma motoneurons
  - lie between alpha motoneurons
  - intrafusal fibers of muscle spindles

columnae laterales

- visceral motoneurons
  - impulses for the function of smooth muscle and glands
  - nc. intermediolateralis (C7–L2, sympathetic; S2–S4, sacral parasympathetic)
- nucleus intermediomedialis
  - eceive sensory stimuli from interoreceptors of internal organs via axons of spinal ganglia cells
  - transfer these impulses to visceral motoneurons in nc. intermediolateralis



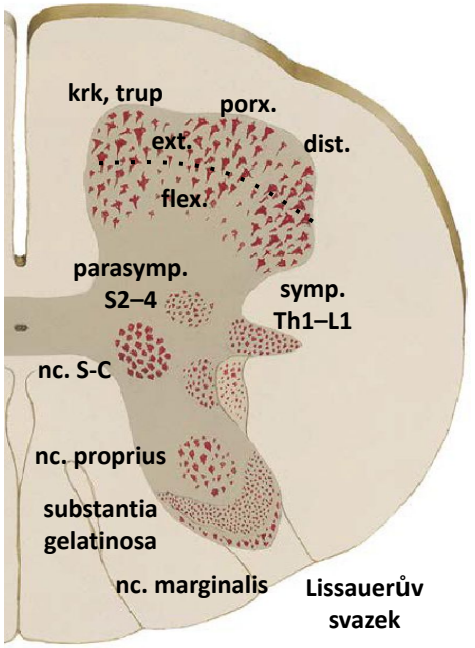
Felten et al. 2022 Netter's atlas of neuroscience



SPINAL GRAY MATTER

columnae posteriores

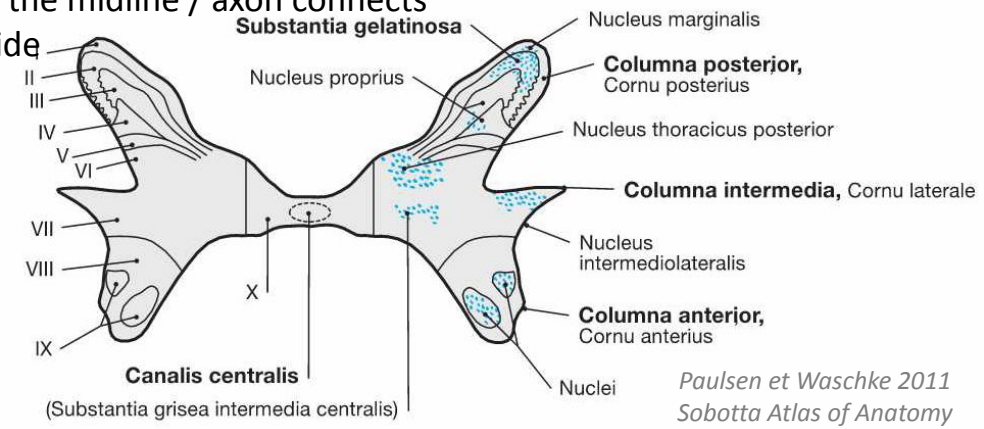
- nc. marginalis (apicalis)
  - propriospinal pathways
  - ascending (up to the brainstem or diencephalon) and descending pathways
- nc. proprius
  - tractus spinotectalis, spinoreticularis et spinothalamicus
  - ascending axons, immediately cross and ascend mainly in the lateral cords (also in the anterior)
  - mediate sensations of heat, cold, and pain, partly tactile skin sensitivity
- nc. thoracicus (Stilling-Clarke)
  - proprioception from the lower limbs
  - axons, crossed and uncrossed, lead information to the cerebellar cortex; C8–L3



Felten et al. 2022 Netter's atlas of neuroscience

interneurons

- in all sections of the spinal cord
- they pass received stimuli to other neurons
- more often shorter axons
- over longer distances axons in fasciculi proprii (around the entire circumference of the gray matter)
- commissural / association interneurons – axon crosses the midline / axon connects similar structures upward or downward on the same side
- also in other sections of the spinal gray matter



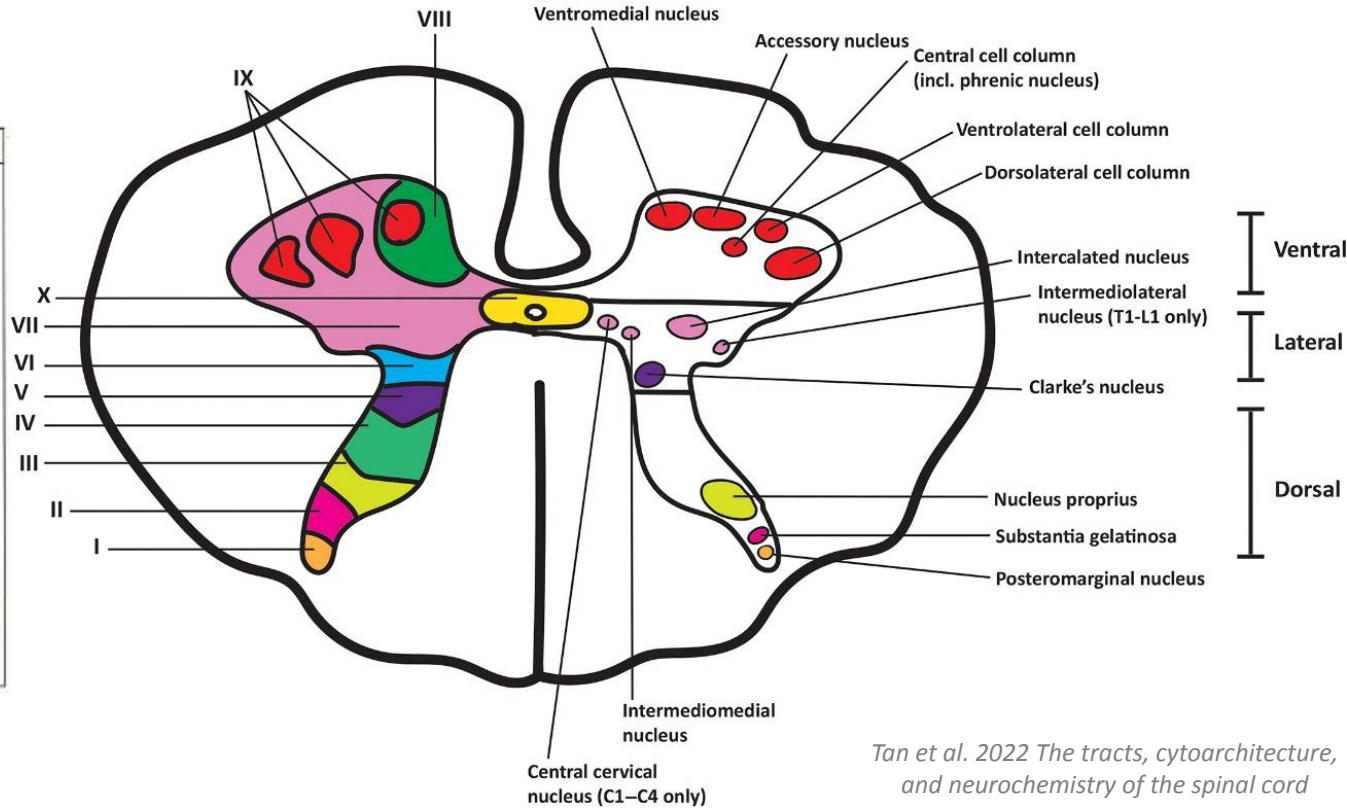
Paulsen et Waschke 2011 Sobotta Atlas of Anatomy

SPINAL GRAY MATTER

- Older classification
  - sets of nuclei
- Newer classification
  - Rexed lamellae (1952) – according to cell density and size
  - posterior horns – lamina I–VI; reception, modulation and transfer of somatosensory signals to higher levels
  - lateral horns, zona intermedia – lamina VII
  - anterior horns – lamina VIII and IX; somatomotor
  - canalis centralis – lamina X
- Latest
  - functional classification, e.g., posterior horn 15 areas *(Häring et al. 2018 Neuronal atlas of the dorsal horn [...])*

Rexedova zóna	oblast jader šedé hmoty
I.	nucleus apicalis
II. a III.	substantia gelatinosa
IV. a V.	nucleus proprius columnae posterioris
VI.	nucleus thoracicus (Stilling-Clarke)
VII.	interneurony mezi předním a zadním rohem
VIII.	mediální jádra motoneuronů (nucl. posteromedialis a nucl. anteromedialis)
IX.	laterální jádra motoneuronů (nucl. centralis, nucl. anterolateralis a nucl. posterolateralis)
X.	substantia grisea intermedia

Čihák 2003 Anatomie 3



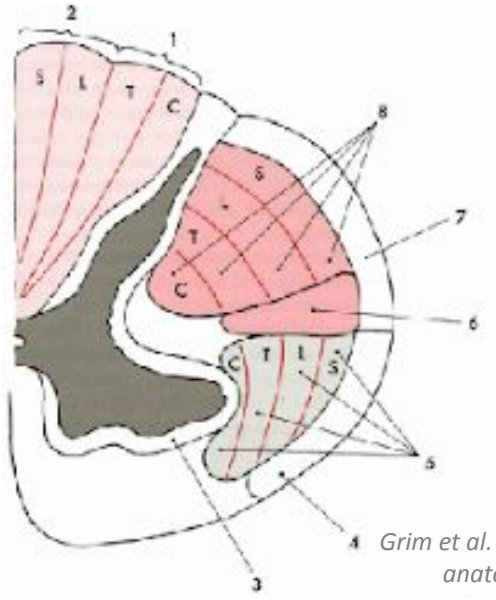
Tan et al. 2022 The tracts, cytoarchitecture, and neurochemistry of the spinal cord

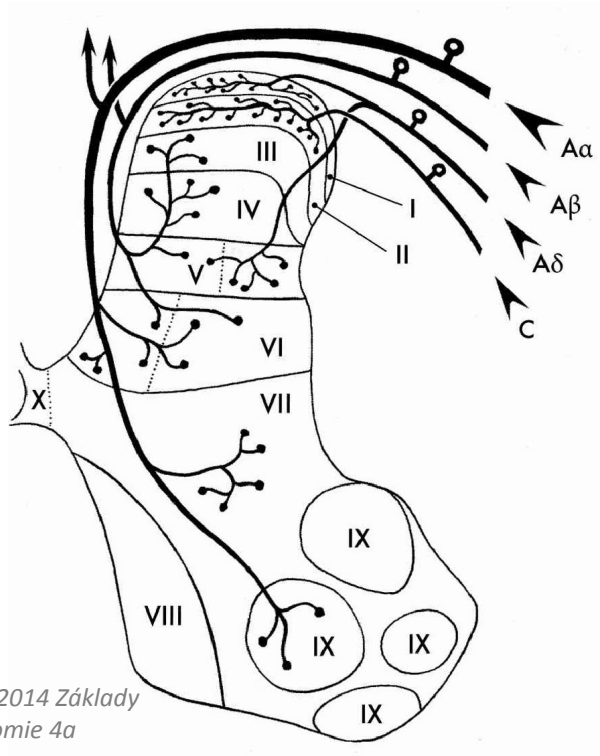
SPINAL WHITE MATTER

- consists mainly of myelinated axons of ascending and descending pathways
- small part of unmyelinated fibers, neuroglia cells, vessels, spinal roots between the gray matter and the surface of the spinal cord

posterior columns

- posterior roots of spinal nerves = axons of pseudounipolar cells of spinal ganglia
  - a number of fibers after entering the white matter send out a) ascending and descending collaterals, b) one collateral to motor cells of anterior spinal roots and a second collateral to higher centers
  - part of the fibers into the gray matter and there on the cells of the posterior columns
  - part of the fibers (from the lower half of the body – medially; from the upper half – laterally) to the nuclei of the posterior columns (nc. gracilis et cuneatus) in the medulla oblongata – **spinobulbar tract**
- dorsal column medial lemniscus pathway
  - proprioception from joints and tendons (partly also from muscles)
  - somatotopic arrangement (Kahler's rule)
  - 1st neuron of the pathway – ganglion spinale → tr. spinobulbaris
  - followed by 2nd tractus bulbothalamicus
  - followed by 3rd tractus thalamocorticalis





Grim et al. 2014 Základy anatomie 4a

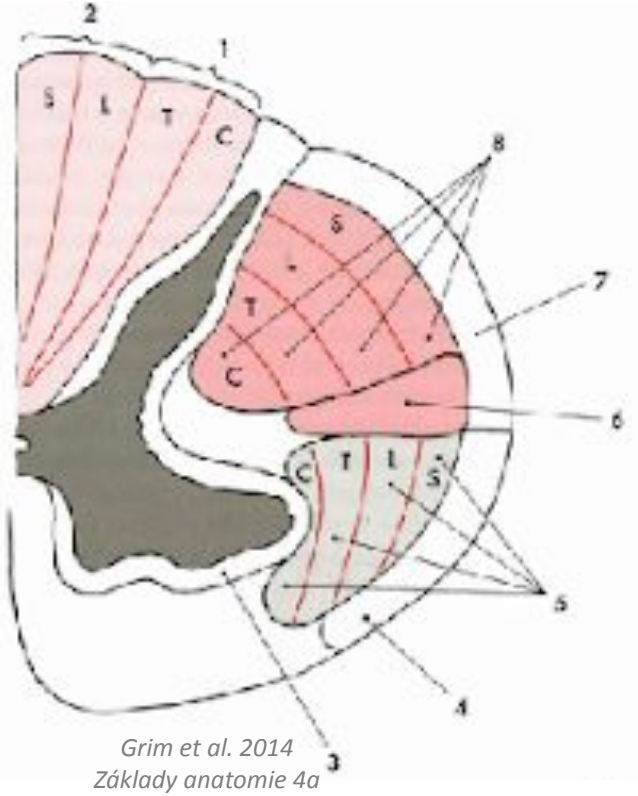
SPINAL WHITE MATTER

lateral funiculus

- completely separated from the posterior columns by the spinal gray matter, not truly separated from the anterior – exits of the anterior spinal roots
  - near the surface, ascending pathways for the cerebellum (tr. spinocerebellaris ant. et post.)
  - inside at the back are descending pathways to motoneurons (directly or via interneurons) – voluntary motility (tr. corticospinalis lateralis); unconscious reflex control of flexor and extensor tension (tr. rubrospinalis)
  - inside at the front, ascending pathways (anterolateral system) – cold, heat, pain (small part of touch) and descending pathway (tr. vestibulospinalis lat.) – coordination of head and body orientation in space

anterior funiculus

- tracks distributed across two zones—in the lateral portion of the anterior funiculus and along the anterior median fissure
  - lateral part – maintaining an upright posture against gravity, touch
  - medial part – head and neck movements in relation to visual input and coordination of head and neck movements with eye movements depending on the vestibular apparatus (fasciculus longitudinalis medialis), voluntary movement (anterior corticospinal tract)



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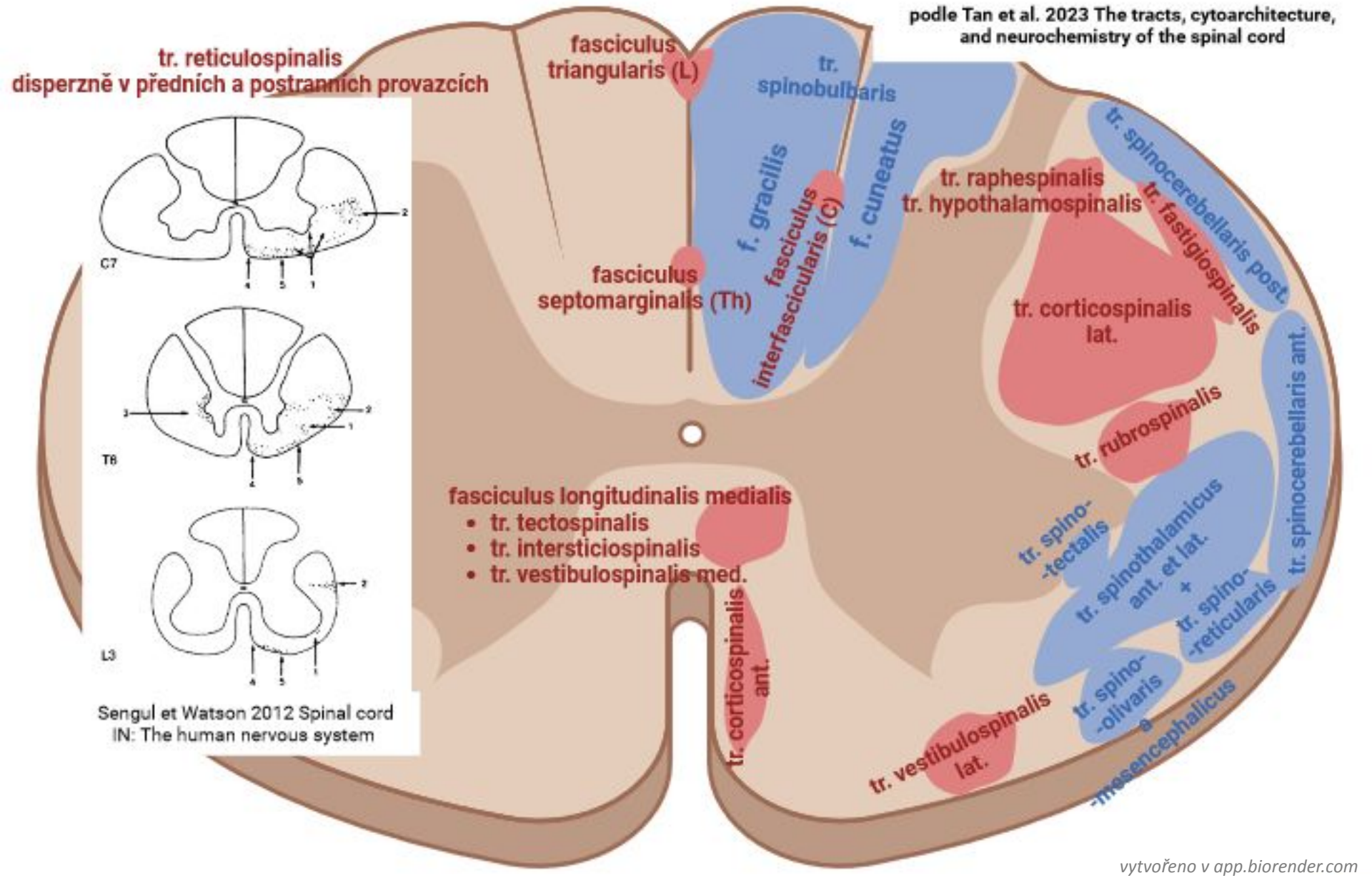
Základy anatomie 4a

SPINAL WHITE MATTER – TRACTS



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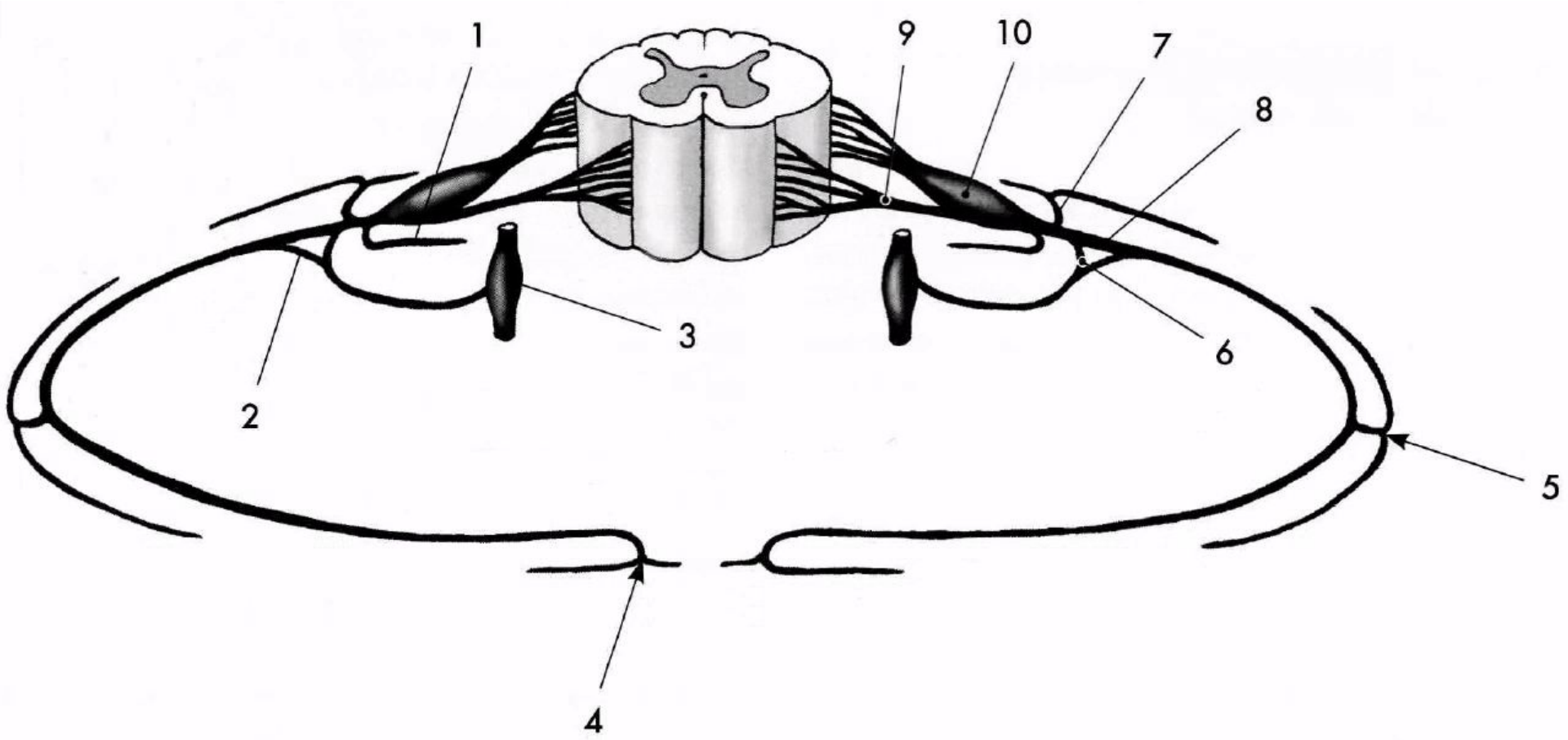
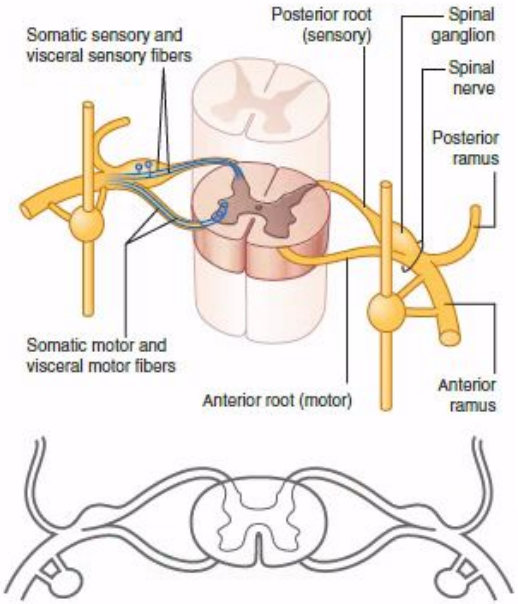
SPINAL NERVE BAUPLAN



Obr. 11.5. Větvení míšního nervu (schematicky). 1 – ramus meningeus, 2 – ramus communicans griseus, 3 – ganglion trunci sympatici, 4 – ramus cutaneus anterior, 5 – ramus cutaneus lateralis, 6 – ramus communicans albus, 7 – ramus dorsalis, 8 – ramus ventralis, 9 – radix ventralis, 10 – radix dorsalis a ganglion spinale

SPINAL NERVE BAUPLAN



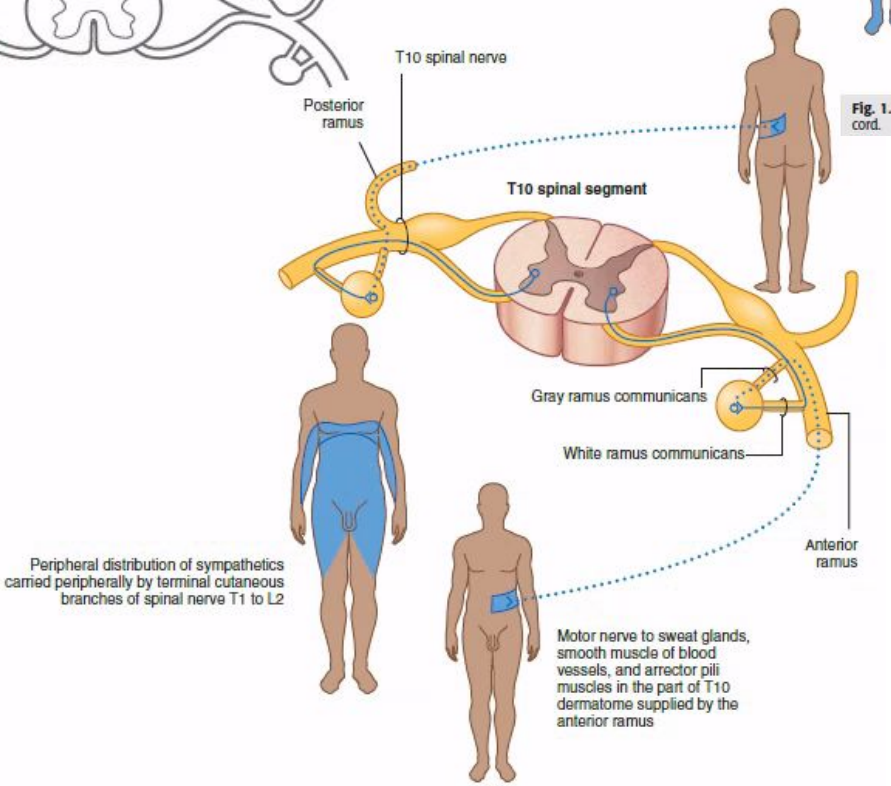


Fig. 1.43 Course of sympathetic fibers that travel to the periphery in the same spinal nerves in which they travel out of the spinal cord.

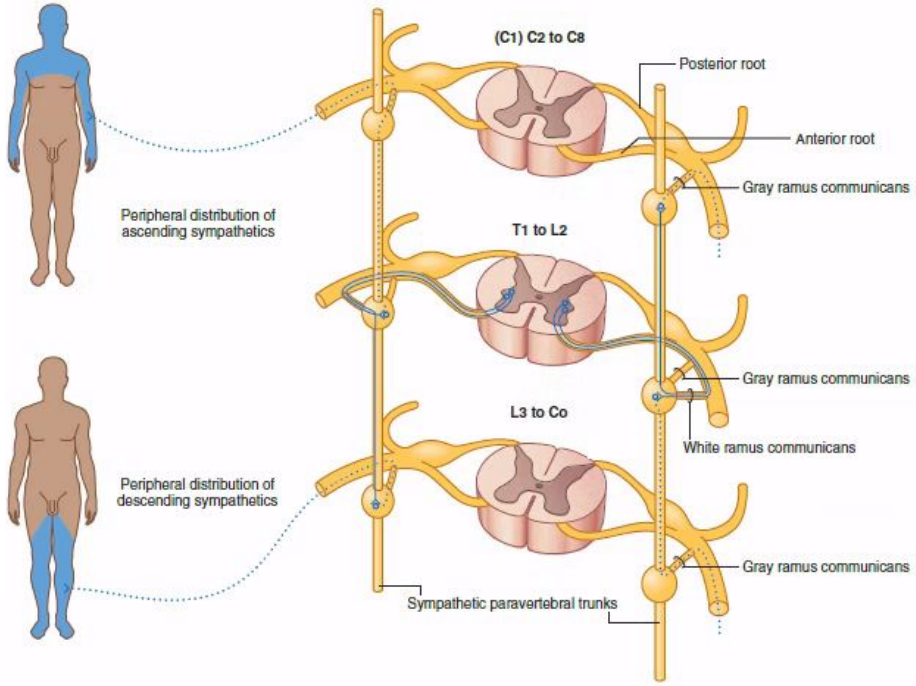
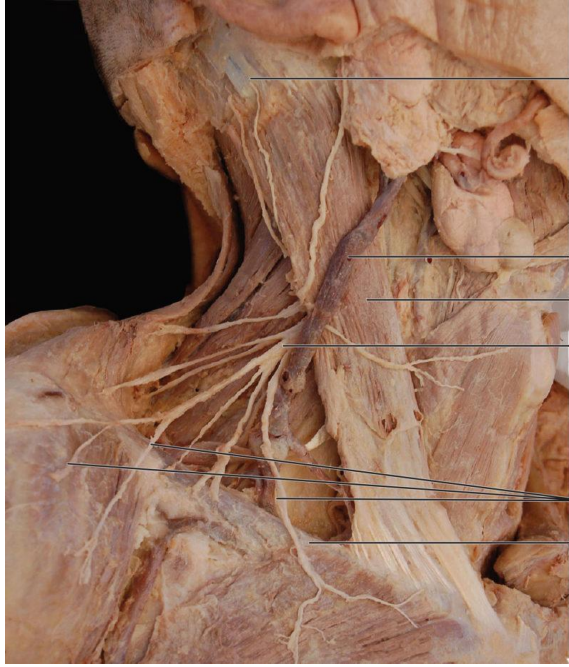


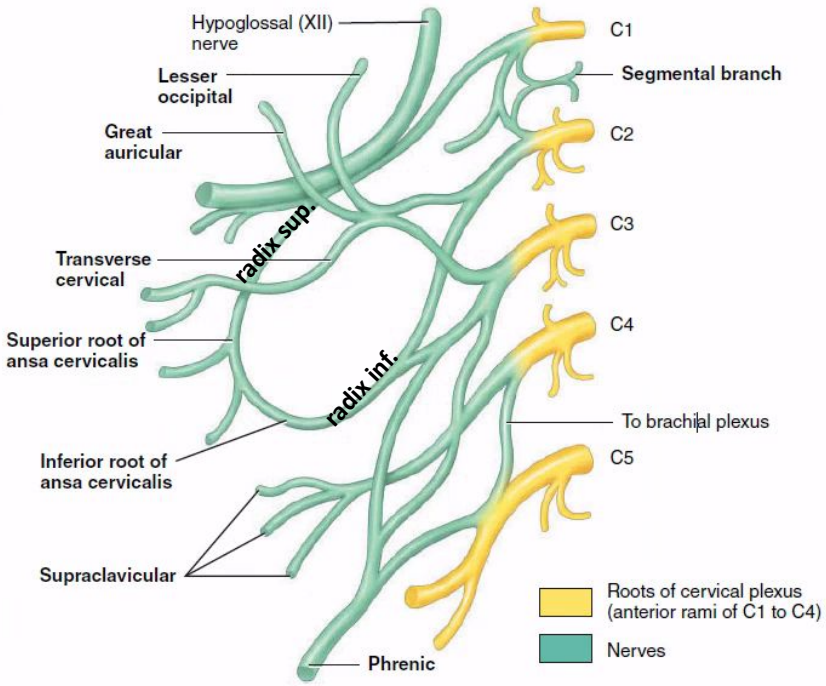
Fig. 1.44 Course of sympathetic nerves that travel to the periphery in spinal nerves that are not the ones through which they left the spinal cord.

PLEXUS CERVICALIS

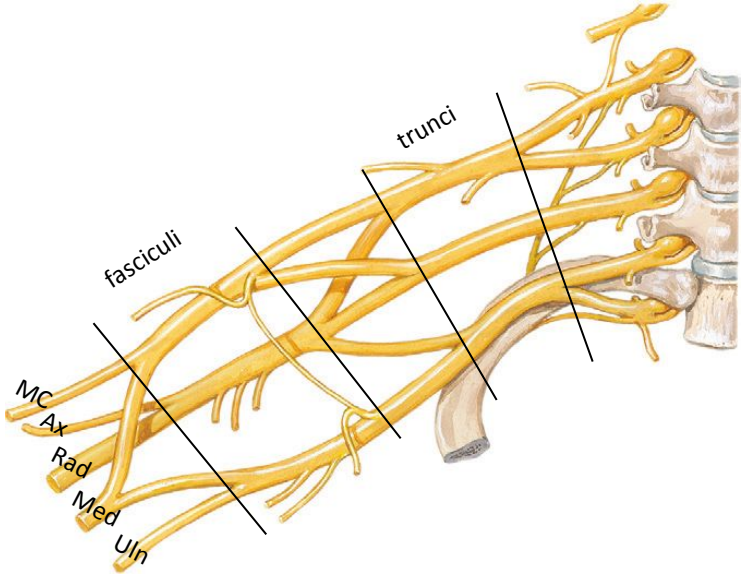
- ventral branches of C1–C4, beneath the sternocleidomastoid, to the middle scalene muscle and the levator scapulae
- nerves connected by arcuate anastomoses: ansa cervicalis superficialis et profunda
- both sensory (punctum nervosum) and motor nerves emerge
- sensory
  - n. occipitalis minor (C2–C3)
  - n. auricularis magnus (C2–C3)
  - n. transversus colli (C3) – with r. colli n. facialis ansa cervicalis spf.
  - nn. supraclaviculares (C3–C4)
- motor
  - rr. musculares (C1–C4) – m. rectus capitis lateralis et anterior, m. longus capitis, m. longus colli



- nerve phrenicus (C3–C5)
  - runs down along the anterior scalene muscle between the subclavian artery and vein into the mediastinum and in front of the pulmonary hilum
  - motor innervation – diaphragm
  - sensory innervation: phrenicoabdominal branches – peritoneum to the gallbladder (inclusive) and to the pancreas



NERVES OF THE UPPER LIMB

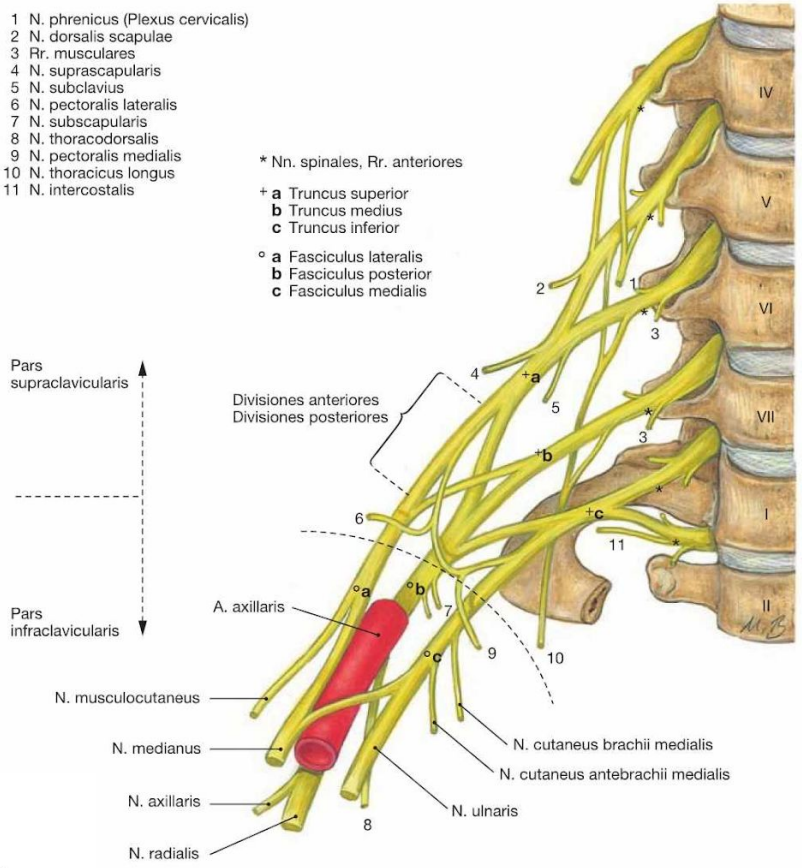


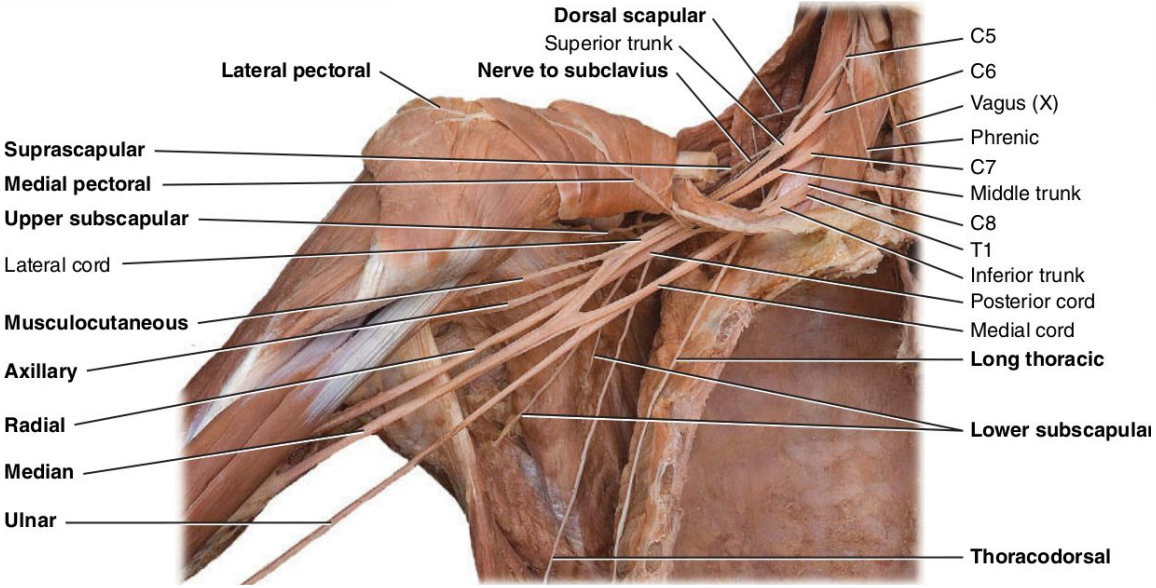
1 N. phrenicus (Plexus cervicalis)
2 N. dorsalis scapulae
3 Rr. musculares
4 N. suprascapularis
5 N. subclavius
6 N. pectoralis lateralis
7 N. subscapularis
8 N. thoracodorsalis
9 N. pectoralis medialis
10 N. thoracicus longus
11 N. intercostalis

* Nn. spinales, Rr. anteriores

+ **a** Truncus superior
b Truncus medius
c Truncus inferior

° **a** Fasciculus lateralis
b Fasciculus posterior
c Fasciculus medialis

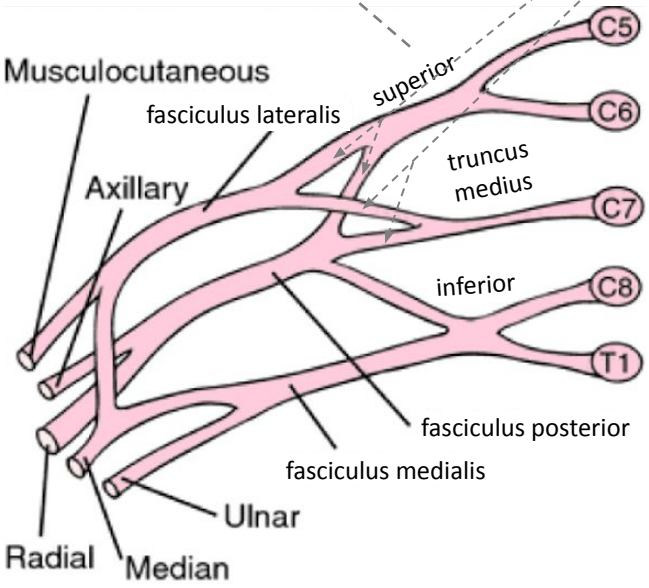


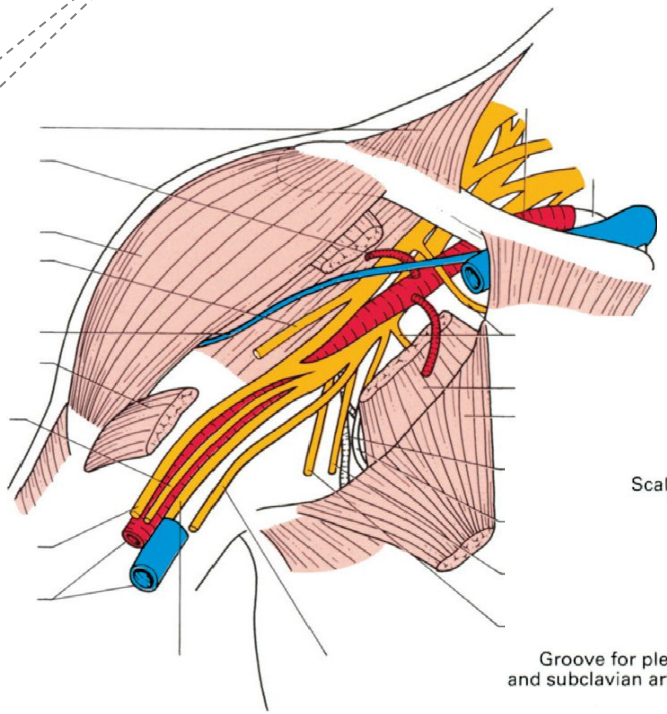


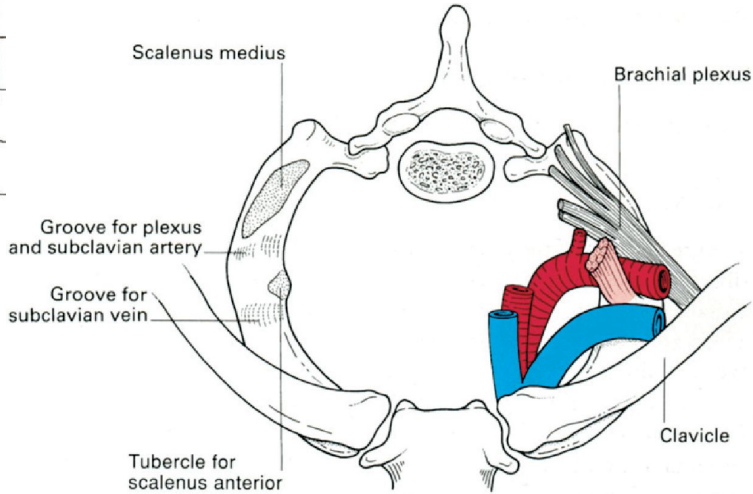
MOTOR INNERVATION OF THE UPPER LIMB MUSCLES

- brachial plexus (C5–Th1)
  - from the cervical spine to the axilla
  - the clavicle divides it into the supraclavicular and infraclavicular parts

1. the ventral branches of the spinal nerves C5 through Th1 merge into 3 primary bundles (trunks)
2. the trunks pass through the scalene fissure together with the subclavian artery and beneath the clavicle (the trunks run above the artery, in the subclavian artery sulcus on the 1st rib)
3. each trunk divides into anterior and posterior branches, which then merge to form secondary bundles (fasciculi)







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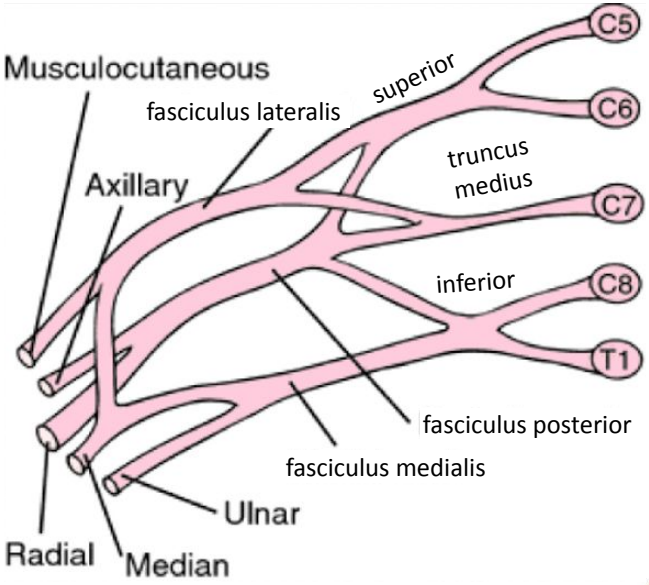
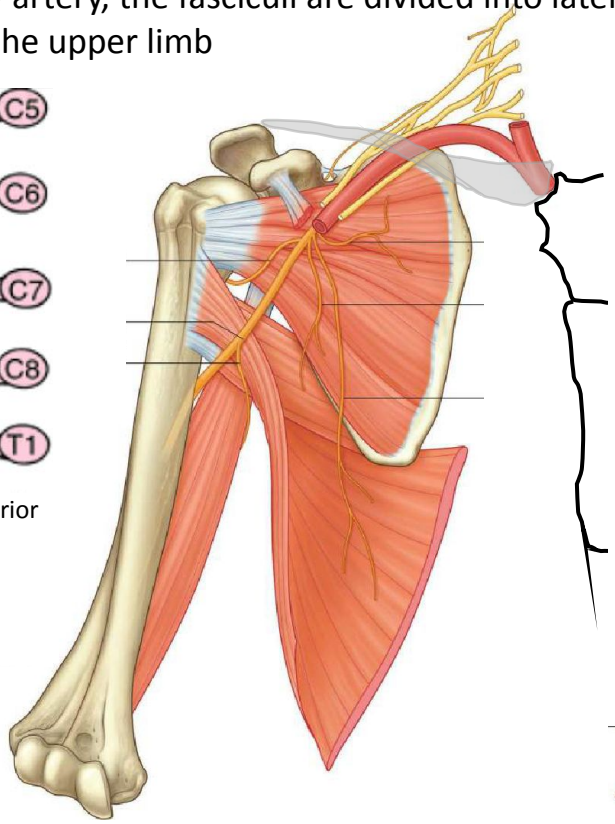
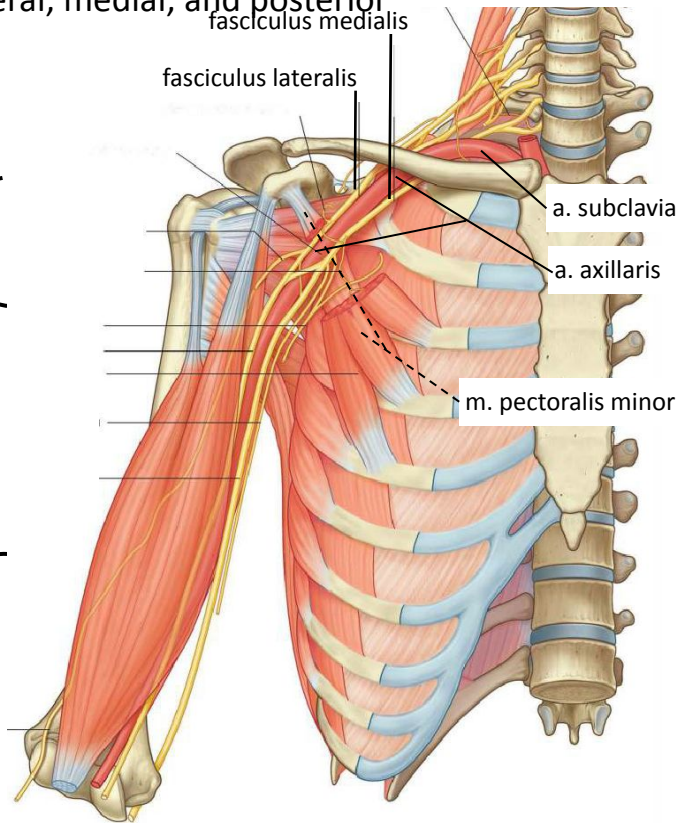
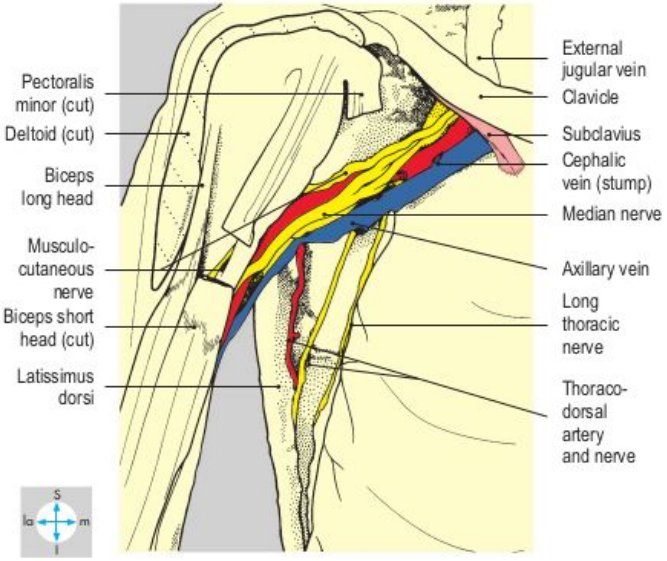
3. each trunk divides into anterior and posterior branches, which then merge to form secondary bundles (fasciculi)
4. the subclavian artery is renamed the axillary artery lateral to the first rib
5. the fasciculi lie beneath the pectoralis minor muscle and surround the axillary artery—based on their position relative to the axillary artery, the fasciculi are divided into lateral, medial, and posterior
6. the fasciculi supply nerves to the upper limb








Pectoralis minor (cut)
Deltoid (cut)
Biceps long head
Musculo-cutaneous nerve
Biceps short head (cut)
Latissimus dorsi
External jugular vein
Clavicle
Subclavius
Cephalic vein (stump)
Median nerve
Axillary vein
Long thoracic nerve
Thoraco-dorsal artery and nerve
S
la
m
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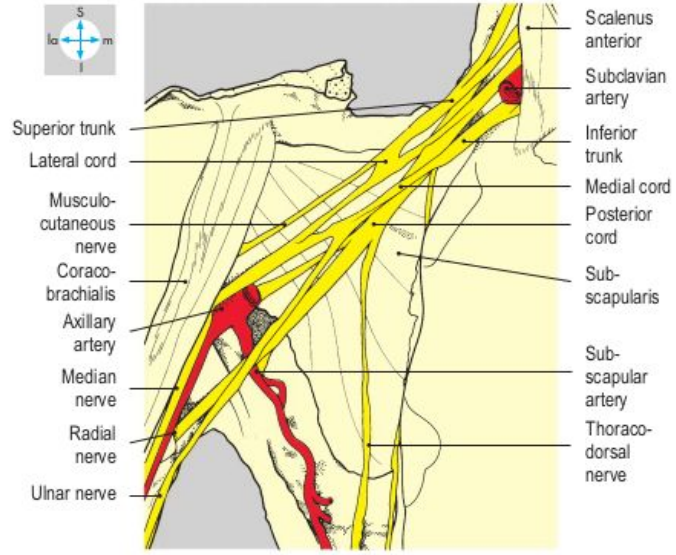
S
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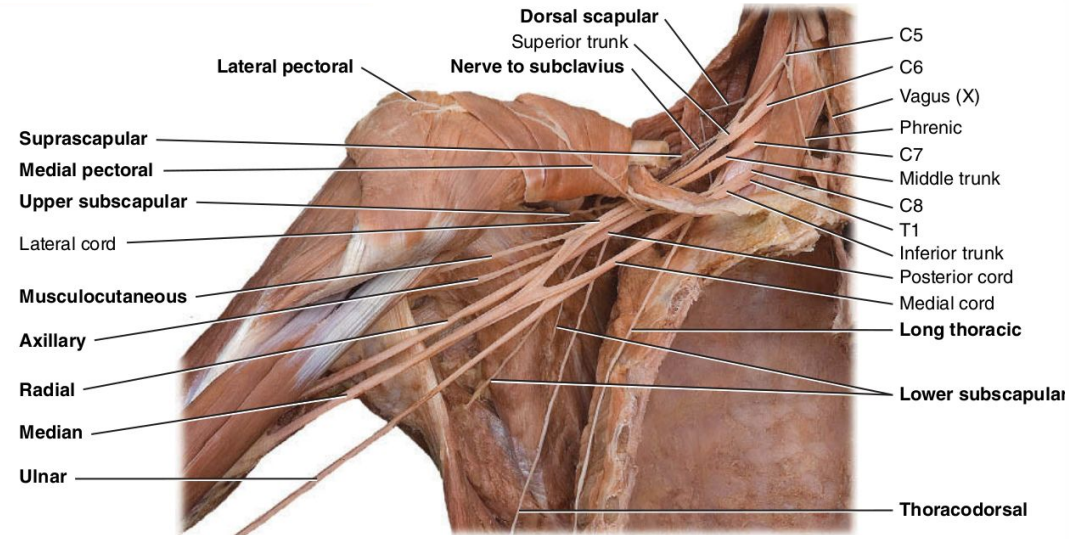
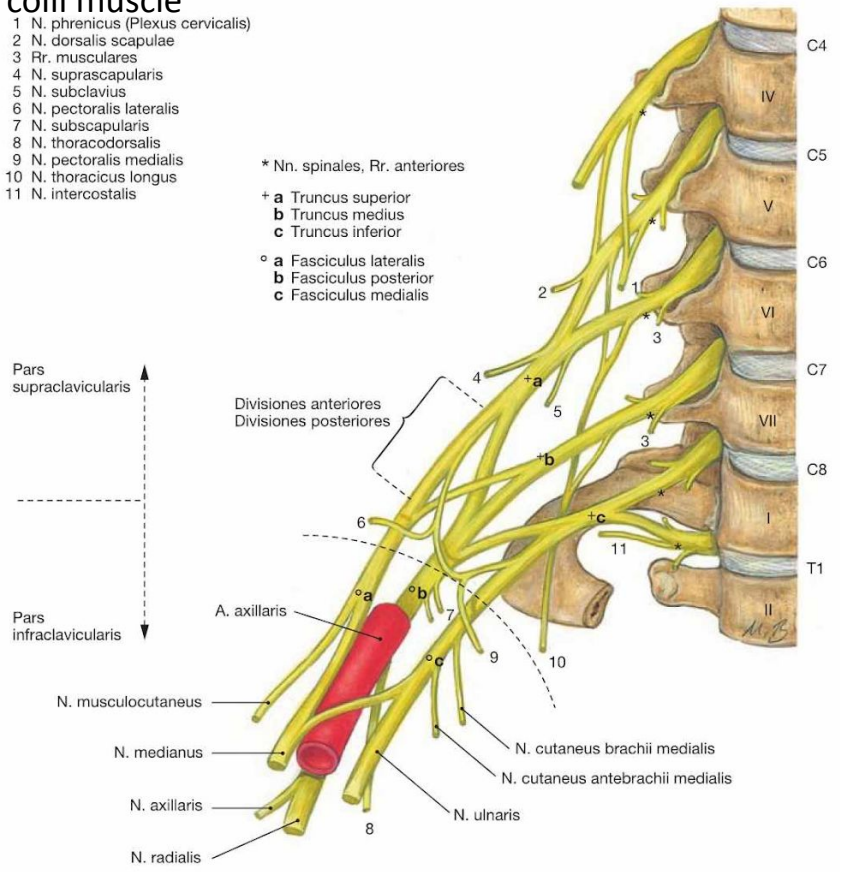
Superior trunk
Lateral cord
Musculo-cutaneous nerve
Coraco-brachialis
Axillary artery
Median nerve
Radial nerve
Ulnar nerve
Scalenus anterior
Subclavian artery
Inferior trunk
Medial cord
Posterior cord
Sub-scapularis
Sub-scapular artery
Thoraco-dorsal nerve


Deltoid muscle
Lateral pectoral nerve
Lateral cord
Musculocutaneous nerve
Superior subscapular nerve
Posterior cord
Axillary nerve
Inferior subscapular nerve
Radial nerve
Median nerve
Ulnar nerve
Medial cutaneous nerve of forearm
Thoracodorsal artery
Latissimus dorsi muscle
Serratus anterior muscle
External oblique muscle
Levator scapulae muscle
Roots of brachial plexus (C5, C6)
Suprascapular nerve
Subclavian nerve
Roots of brachial plexus (C7 to T1)
Trunks of brachial plexus
Medial cord
Medial pectoral nerve
Subscapularis muscle
Thoracodorsal nerve
Long thoracic nerve
Pectoralis major muscle (cut)

NERVES OF THE UPPER LIMB

- the following nerves emerge from the supraclavicular division of the brachial plexus:
  - dorsal nerve of the scapula – passing over the middle and posterior scalene muscles and over the levator scapulae muscle to the medial border of the scapula
  - long thoracic nerve – running along the mid-axillary line over the serratus anterior muscle
  - subclavian nerve – a thin nerve, beneath the clavicle
  - the suprascapular nerve – along the omohyoid muscle to the scapular notch
  - the medial and lateral pectoral nerves – between the pectoral muscles
  - the subscapular nerve – several small branches
  - the thoracodorsal nerve – along the inner surface of the latissimus dorsi muscle
  - the muscular branches – to the scalene muscles and the longus colli muscle

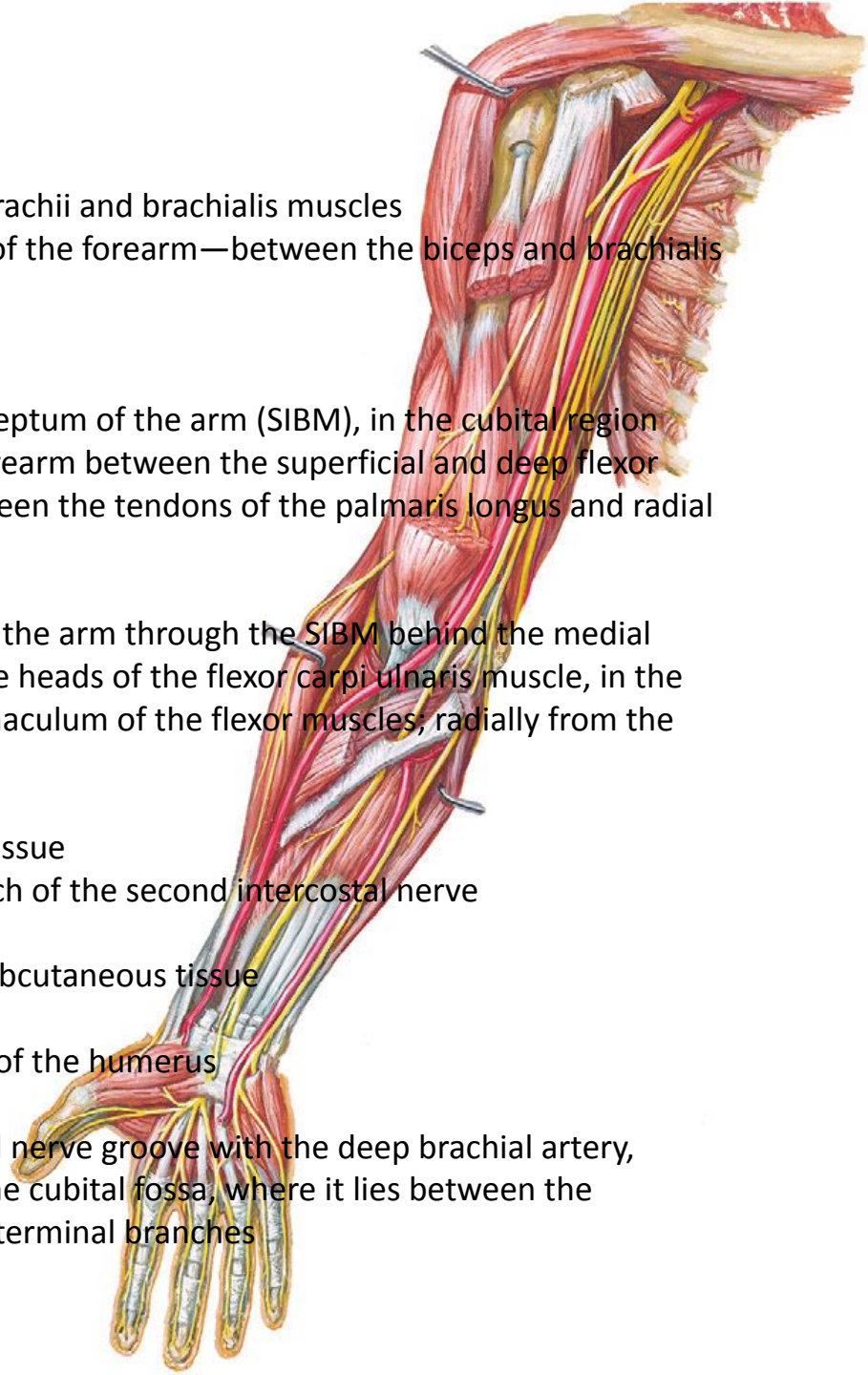




NERVES OF THE UPPER LIMB

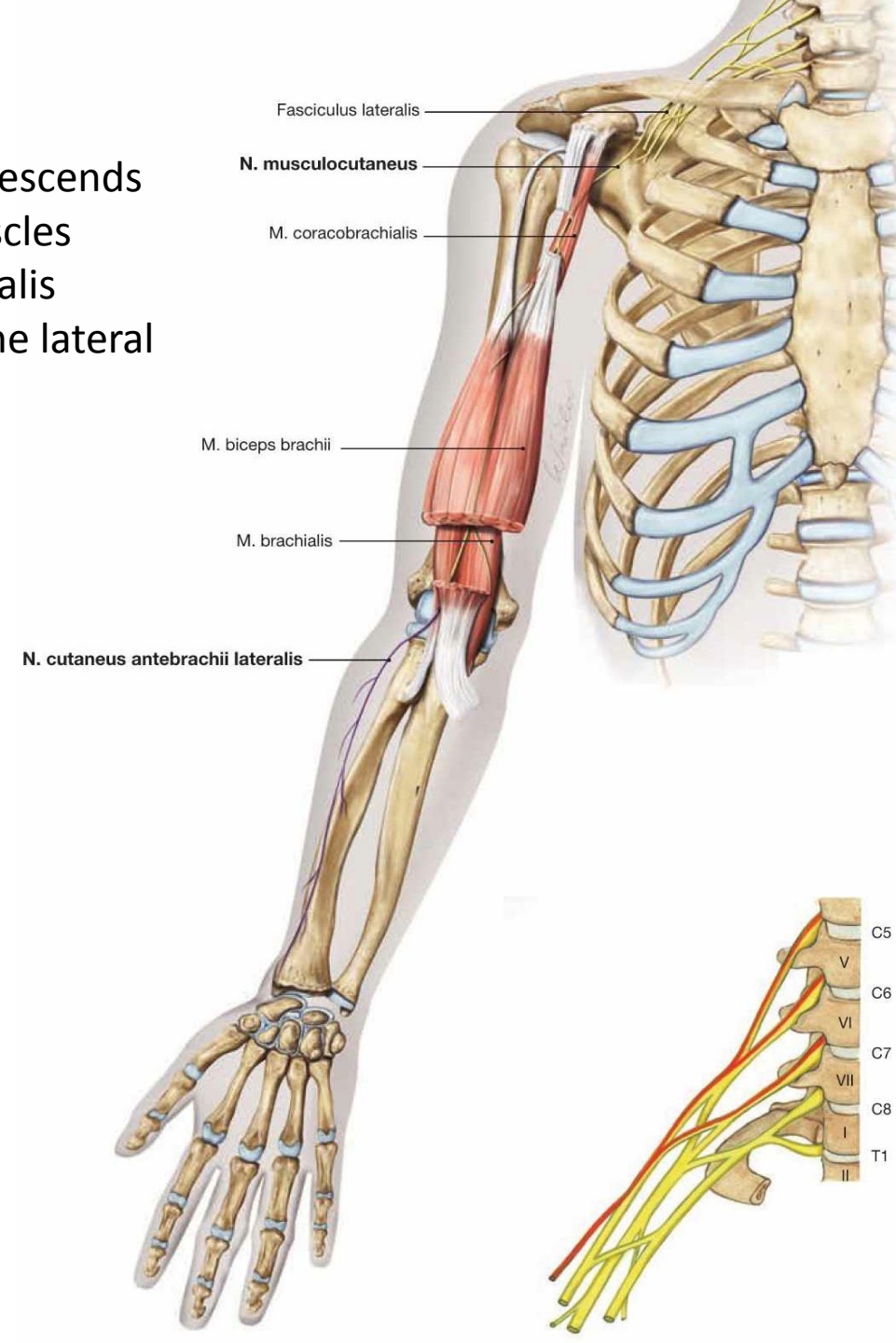
from the infraclavicular branch of the brachial plexus

- musculocutaneous nerve
  - through the coracobrachialis muscle, between the biceps brachii and brachialis muscles
  - in the forearm, it continues as the lateral cutaneous nerve of the forearm—between the biceps and brachialis muscles, pierces the fascia, and joins the cephalic vein
- median nerve
  - formed by the union of the medial and lateral roots
  - along the brachial artery before the medial intermuscular septum of the arm (SIBM), in the cubital region between the heads of the pronator teres muscle, on the forearm between the superficial and deep flexor digitorum muscles, and in the distal third superficially between the tendons of the palmaris longus and radial flexor carpi muscles, into the carpal tunnel
- ulnar nerve
  - with the median nerve and brachial artery, in the middle of the arm through the SIBM behind the medial epicondyle of the humerus, in the cubital fossa between the heads of the flexor carpi ulnaris muscle, in the forearm with the ulnar artery, into the palm above the retinaculum of the flexor muscles; radially from the pisiform bone, it divides into two terminal branches
- medial cutaneous nerve of the arm
  - through the axillary/brachial fascia into the subcutaneous tissue
  - intercostobrachial nerve – connection with the lateral branch of the second intercostal nerve
- medial cutaneous nerve of the forearm
  - with the brachial vein, through the basilic hiatus into the subcutaneous tissue
- axillary nerve
  - into the humerotricipital foramen behind the surgical neck of the humerus
- radial nerve
  - behind the axillary artery and brachial artery, into the radial nerve groove with the deep brachial artery, through the lateral intermuscular septum of the arm into the cubital fossa, where it lies between the brachioradialis and brachialis muscles and divides into two terminal branches



N. MUSCULOCUTANEUS

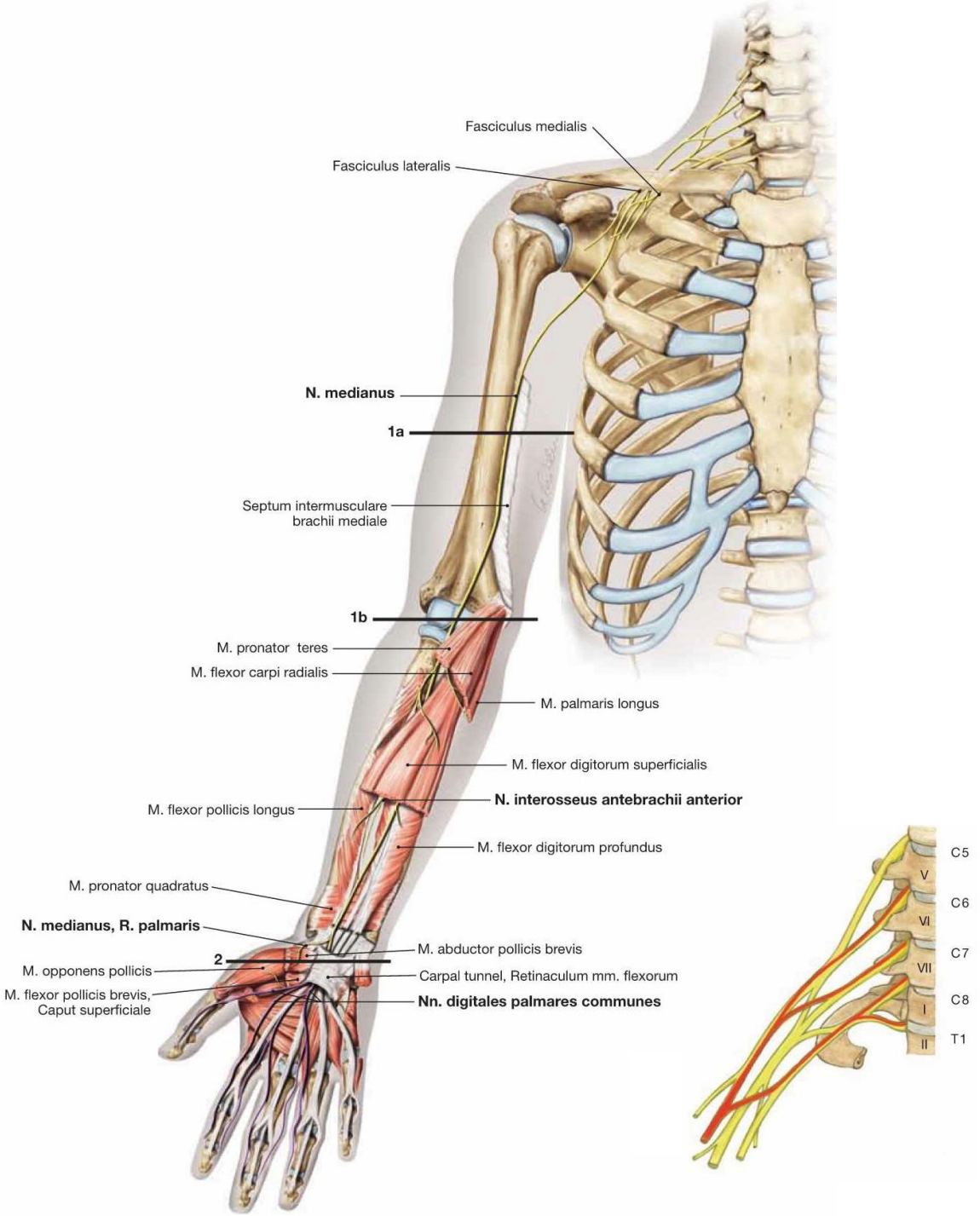
- C5–C7; from the lateral fascicle
- passes through the coracobrachialis muscle, descends between the biceps brachii and brachialis muscles
- motor: biceps brachii, coracobrachialis, brachialis
- after the muscular branches, it continues as the lateral cutaneous nerve of the forearm
- sensory: skin of the lateral half of the forearm



N. MEDIANUS

- C5–Th1; from the lateral and medial fascicles, formed by the union of the lateral and medial roots,
- it descends anterior to the medial intermuscular septum along the lateral aspect of the brachial artery, then crosses medially; in the elbow region, it passes deep between the pronator teres and flexor digitorum superficialis muscles, between the palmaris longus and flexor carpi radialis muscles, runs under the retinaculum flexorum, and divides into sensory branches to the fingers
- it does not send branches to the arm
- forearm
  - muscular branches
  - palmar branch of the median nerve – skin of the radial half of the carpus
- palm
  - communicating branch with the ulnar nerve
- muscular branches
  - palmar digital nerves
- motor
  - pronator teres, palmaris longus, flexor carpi radialis, flexor digitorum superficialis, flexor digitorum profundus – 2nd and 3rd fingers, m. flexor pollicis longus, m. pronator quadratus, thenar muscles (excluding the caput profundum of m. flexoris pollicis brevis and m. adductor pollicis), mm. lumbricales I and II
- sensory
  - the skin of the radial half of the palmar surface of the wrist, on the radial side of the palm, on the palmar side of the radial three and a half fingers, and on the dorsal side of the nail phalanges of those same fingers

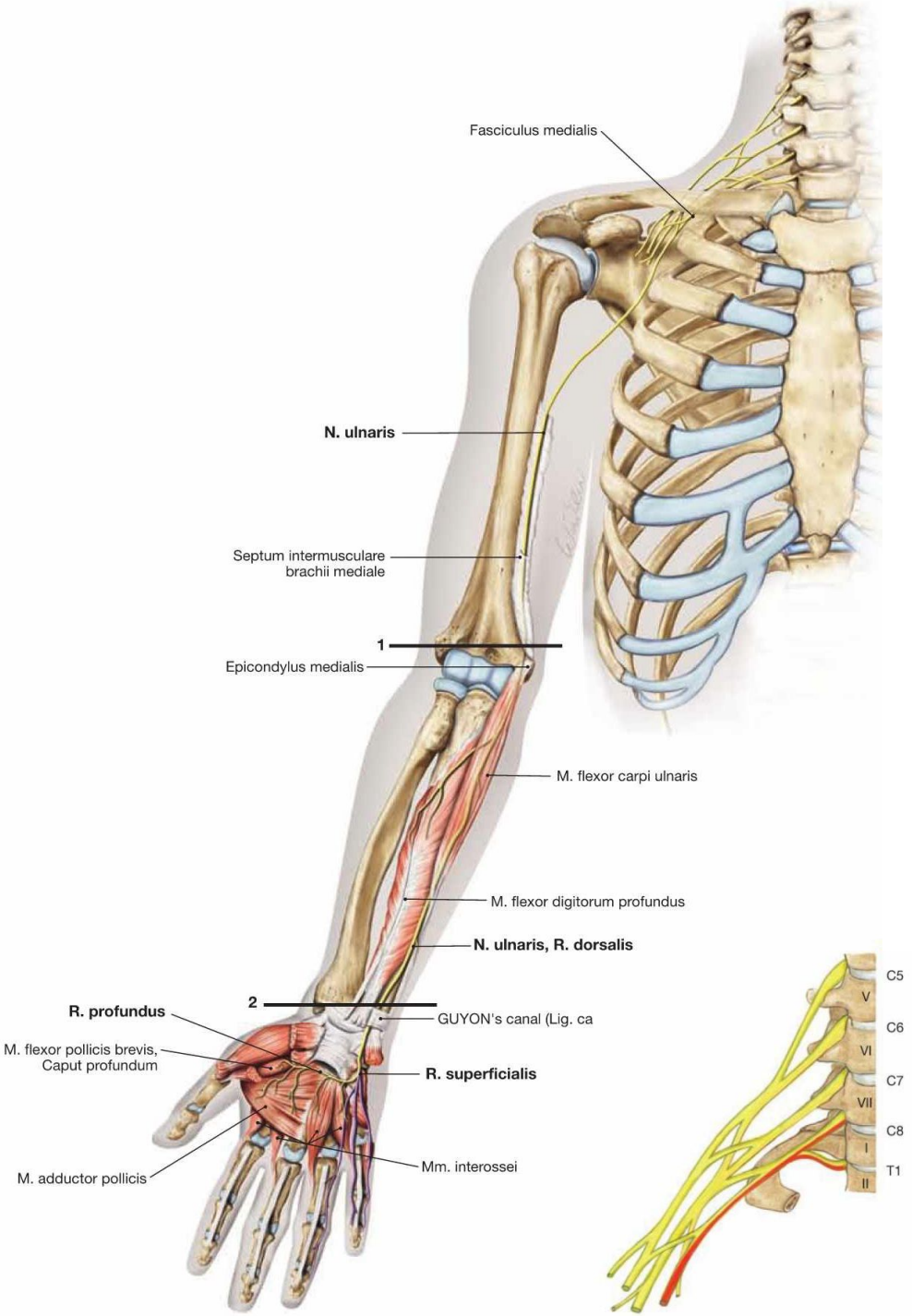
N. MEDIANUS


Fasciculus medialis
Fasciculus lateralis
N. medianus
1a
Septum intermusculare brachii mediale
1b
M. pronator teres
M. flexor carpi radialis
M. palmaris longus
M. flexor digitorum superficialis
M. flexor pollicis longus
N. interosseus antebrachii anterior
M. flexor digitorum profundus
M. pronator quadratus
N. medianus, R. palmaris
M. abductor pollicis brevis
2
M. opponens pollicis
Carpal tunnel, Retinaculum mm. flexorum
M. flexor pollicis brevis, Caput superficiale
Nn. digitales palmares communes
C5
V
C6
VI
C7
VII
C8
I
T1
II

N. ULNARIS

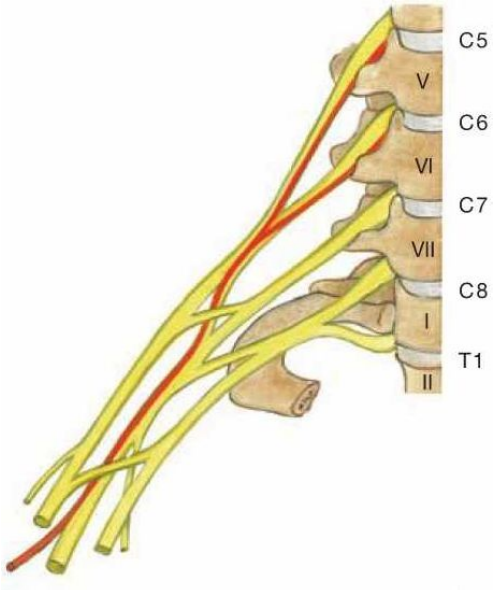
- C8 and Th1; from the medial fascicle
- it descends medially from the median nerve, passes through the medial intermuscular septum to the posterior aspect of the medial epicondyle of the humerus (sulcus, groove), between the heads of the flexor carpi ulnaris muscle; halfway along the forearm, together with the ulnar artery (in the fascial septum between the second and third layers of muscles), it passes through the flexor retinaculum along the pisiform bone, dividing into the superficial and deep branches
- it does not send branches to the upper arm
- forearm
  - muscular branches
  - dorsal branch of the ulnar nerve – sensory, palmar digital nerves
  - palmar cutaneous branch – sensory
- palm
  - superficial branch – along the hypothenar muscles, passes beneath the palmaris brevis muscle (innervates)
  - r. profundus – penetrates the origins of the hypothenar muscles; in the palm, it runs alongside the arcus palmaris profundus
- motor
  - m. flexor carpi ulnaris, m. flexor digitorum profundus (4th and 5th fingers), hypothenar muscles, mm. interossei, m. lumbricalis III et IV, caput profundum musculi flexoris pollicis brevis, m. adductor pollicis
- sensory
  - skin of the ulnar aspect of the carpal region on both the palmar and dorsal sides, ulnar aspect of the palm, skin of the back of the hand, skin of 1½ fingers on the palmar side and 2½ fingers on the dorsal side

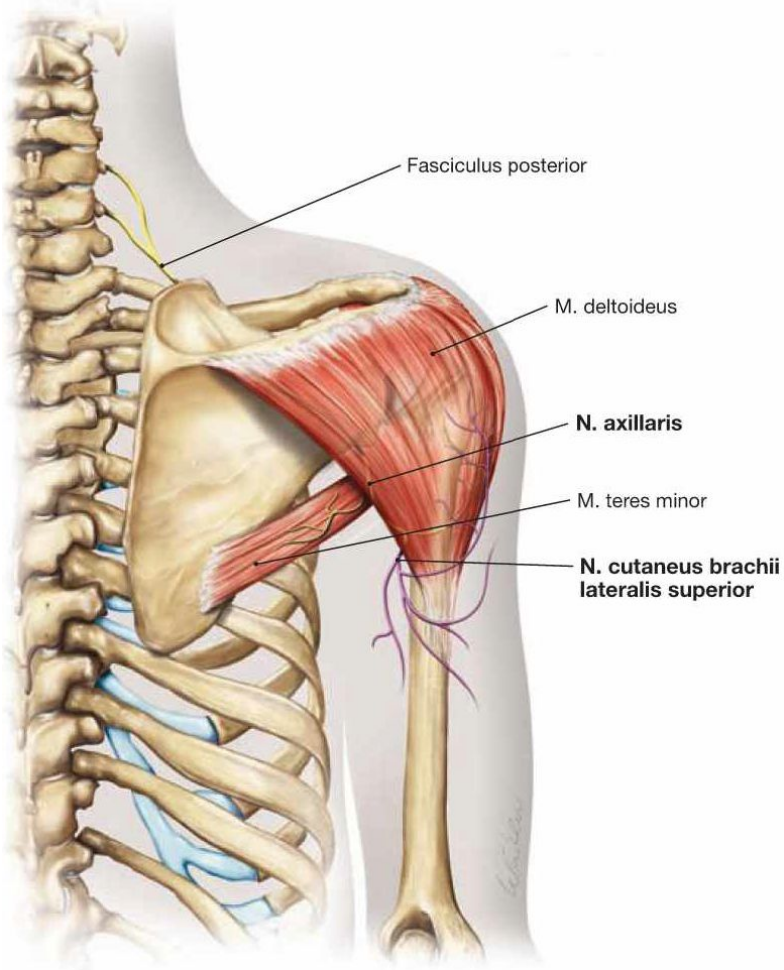
N. ULNARIS


Fasciculus medialis
N. ulnaris
Septum intermusculare brachii mediale
1
Epicondylus medialis
M. flexor carpi ulnaris
M. flexor digitorum profundus
N. ulnaris, R. dorsalis
2
R. profundus
GUYON's canal (Lig. ca
M. flexor pollicis brevis, Caput profundum
R. superficialis
Mm. interossei
M. adductor pollicis
C5
V
C6
VI
C7
VII
C8
I
T1
II

N. AXILLARIS

- C5 and C6; from the posterior fascicle
- with the posterior circumflex humeral artery to the humerotriceps foramen, encircling the surgical neck of the humerus from behind, beneath the deltoid muscle
  - muscular branches
  - articular branches
  - superior lateral cutaneous nerve of the arm – sensory
- motor
  - deltoid muscle, teres minor muscle
- sensory
  - skin over the deltoid muscle on the lateral side of the arm

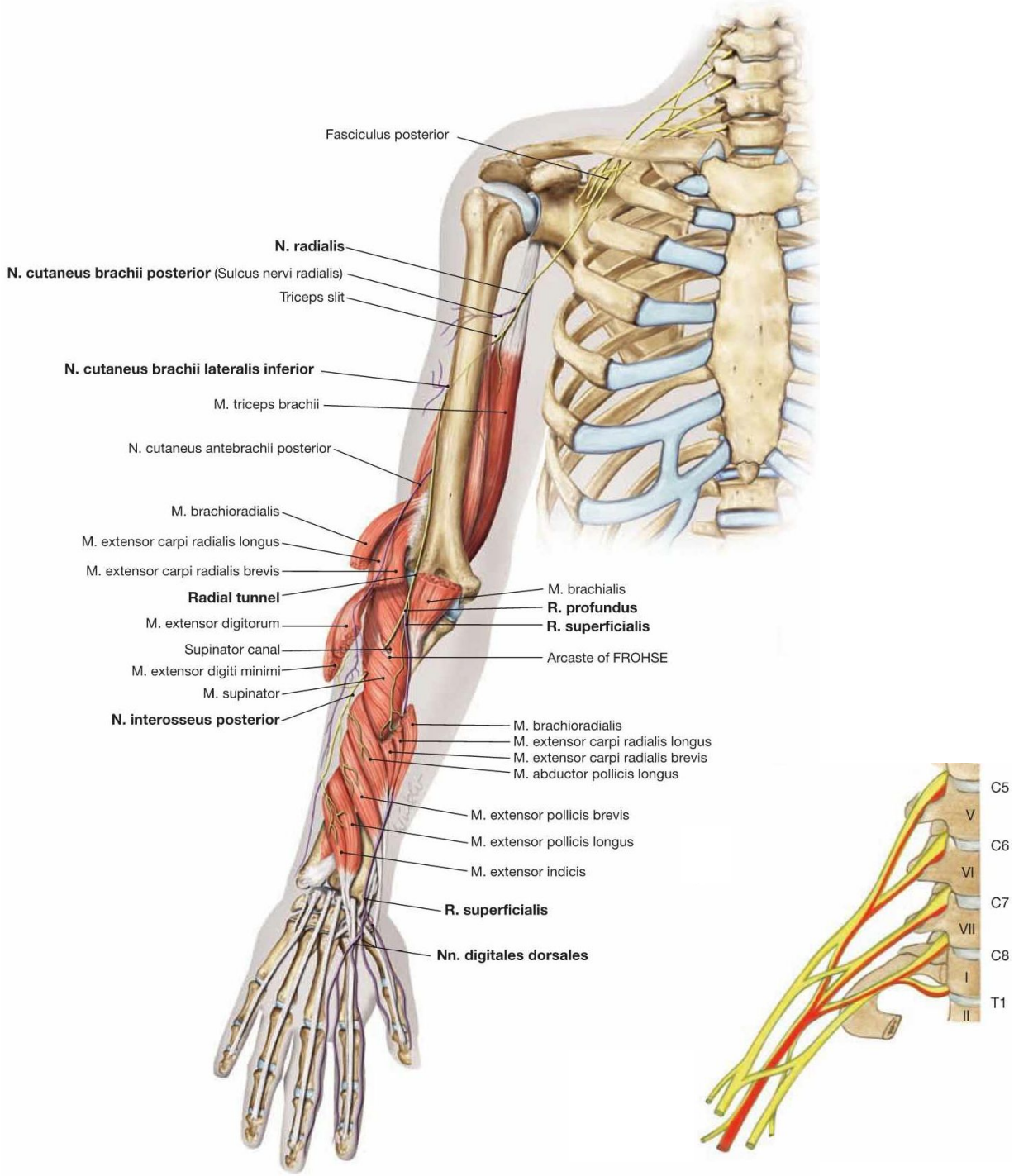


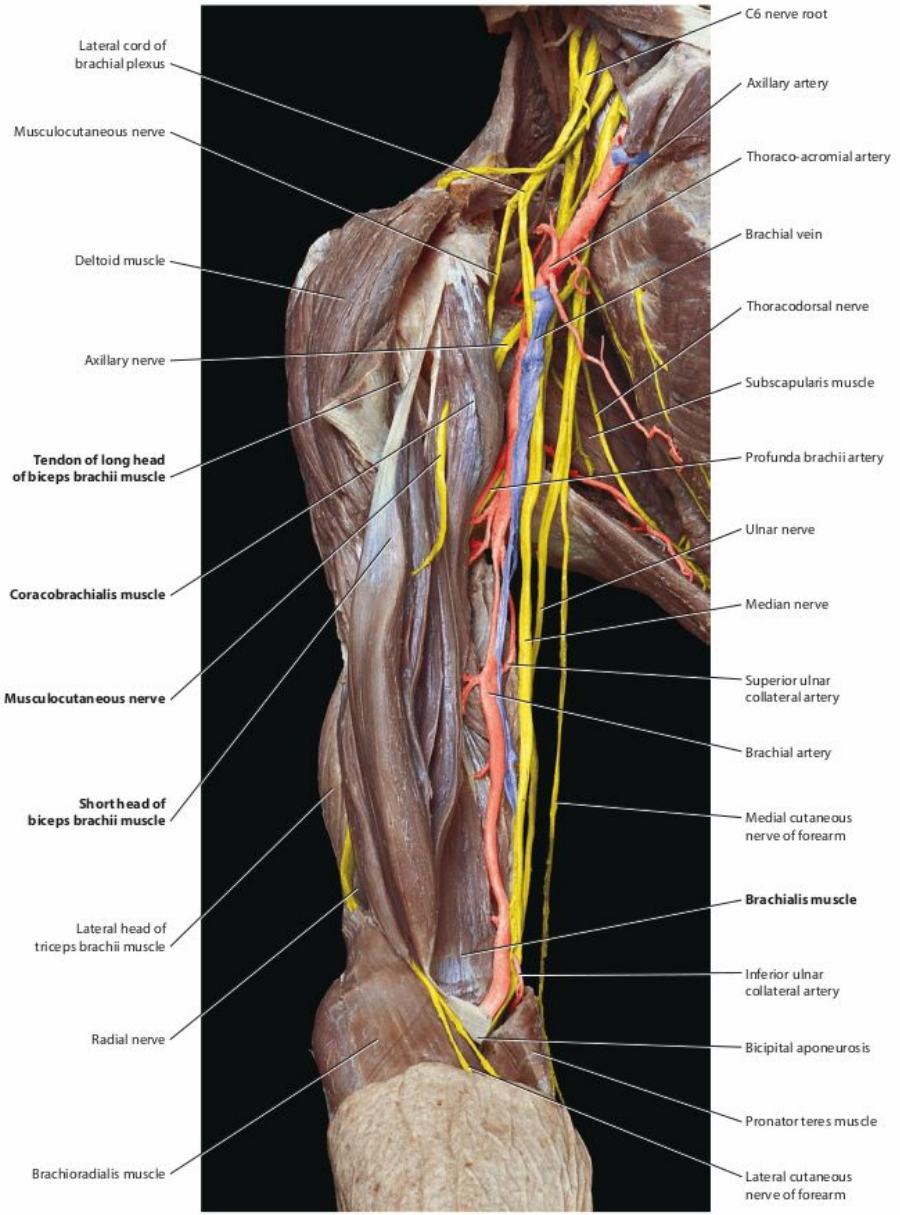


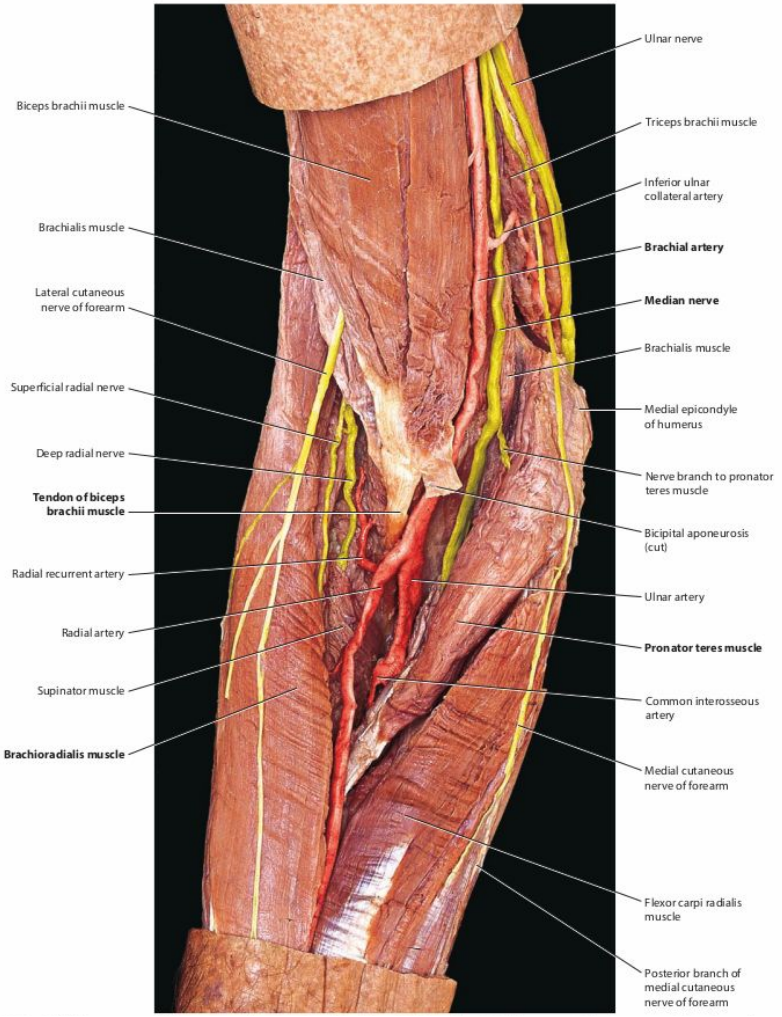
N. RADIALIS

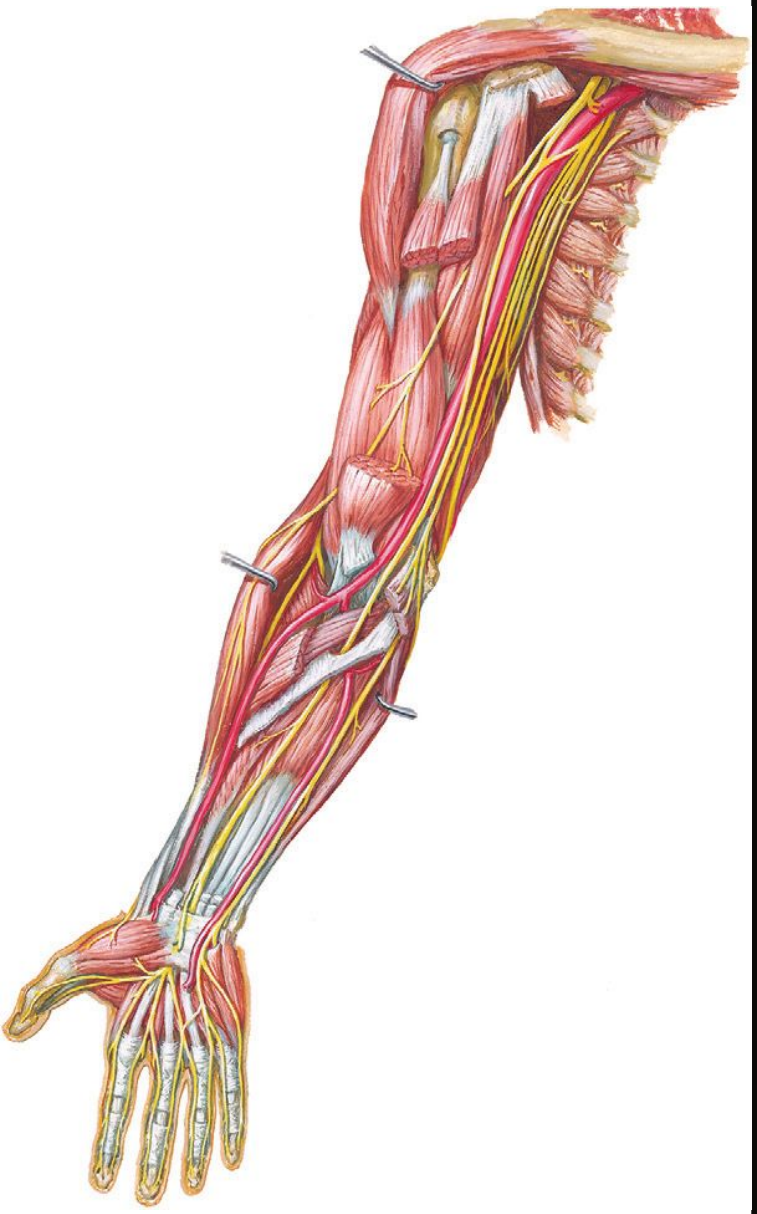
- C5–C8, var. Th1; continuation of the posterior fascicle
- behind the axillary artery, together with the deep brachial artery, into the radial nerve groove on the radial side of the humerus; it pierces the radial intermuscular septum of the brachium; above the elbow, in the septum between the brachialis and brachioradialis muscles, it divides into the superficial and deep branches
  - posterior cutaneous nerve of the arm (skin of the posterior aspect of the arm)
  - inferior lateral cutaneous nerve of the arm (skin of the lateral aspect of the arm)
  - posterior cutaneous nerve of the forearm (skin of the posterior forearm)
  - muscular branches
  - deep branch – through the supinator muscle, mixed nerve
  - superficial branch – together with the radial artery along the brachioradialis muscle, sensory nerve
- motor
  - triceps brachii muscle, anconeus muscle, muscles of the radial and dorsal groups of the forearm
- sensory
  - skin of the posterior and lateral aspects of the arm, posterior aspect of the forearm, elbow joint capsule, skin of the posterior aspect of the forearm, radial half of the carpal region, half of the dorsal aspect of the hand, and dorsal aspect of the radial two and a half fingers

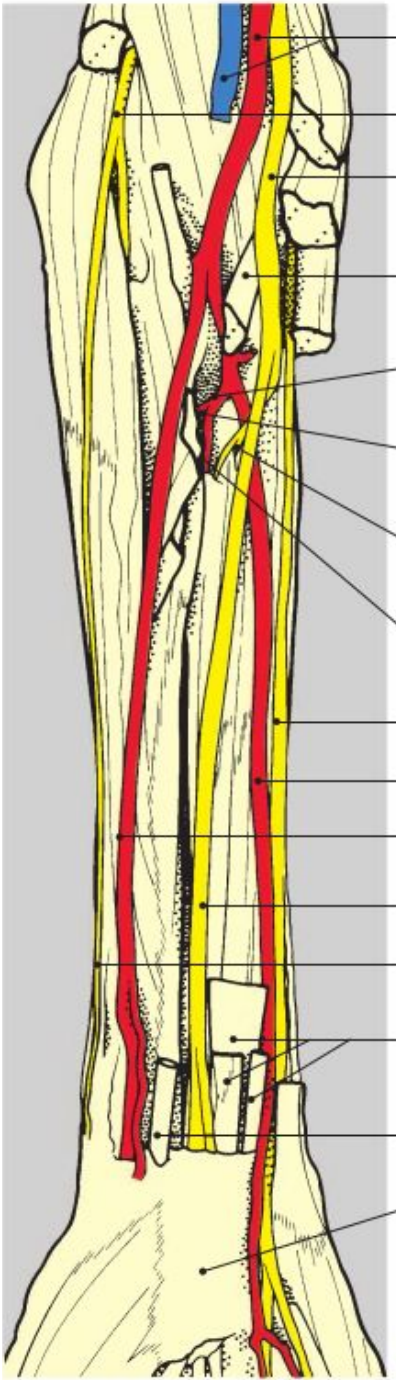
N. RADIALIS


Fasciculus posterior
N. radialis
N. cutaneus brachii posterior (Sulcus nervi radialis)
Triceps slit
N. cutaneus brachii lateralis inferior
M. triceps brachii
N. cutaneus antebrachii posterior
M. brachioradialis
M. extensor carpi radialis longus
M. extensor carpi radialis brevis
Radial tunnel
M. extensor digitorum
Supinator canal
M. extensor digiti minimi
M. supinator
N. interosseus posterior
M. brachialis
R. profundus
R. superficialis
Arcaste of FROHSE
M. brachioradialis
M. extensor carpi radialis longus
M. extensor carpi radialis brevis
M. abductor pollicis longus
M. extensor pollicis brevis
M. extensor pollicis longus
M. extensor indicis
R. superficialis
Nn. digitales dorsales
C5
V
C6
VI
C7
VII
C8
I
T1
II


Lateral cord of brachial plexus
Musculocutaneous nerve
Deltoid muscle
Axillary nerve
Tendon of long head of biceps brachii muscle
Coracobrachialis muscle
Musculocutaneous nerve
Short head of biceps brachii muscle
Lateral head of triceps brachii muscle
Radial nerve
Brachioradialis muscle
C6 nerve root
Axillary artery
Thoraco-acromial artery
Brachial vein
Thoracodorsal nerve
Subscapularis muscle
Profunda brachii artery
Ulnar nerve
Median nerve
Superior ulnar collateral artery
Brachial artery
Medial cutaneous nerve of forearm
Brachialis muscle
Inferior ulnar collateral artery
Bicipital aponeurosis
Pronator teres muscle
Lateral cutaneous nerve of forearm

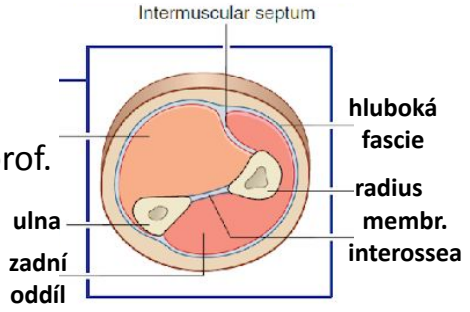

Biceps brachii muscle
Brachialis muscle
Lateral cutaneous nerve of forearm
Superficial radial nerve
Deep radial nerve
Tendon of biceps brachii muscle
Radial recurrent artery
Radial artery
Supinator muscle
Brachioradialis muscle
Ulnar nerve
Triceps brachii muscle
Inferior ulnar collateral artery
Brachial artery
Median nerve
Brachialis muscle
Medial epicondyle of humerus
Nerve branch to pronator teres muscle
Bicipital aponeurosis (cut)
Ulnar artery
Pronator teres muscle
Common interosseous artery
Medial cutaneous nerve of forearm
Flexor carpi radialis muscle
Posterior branch of medial cutaneous nerve of forearm

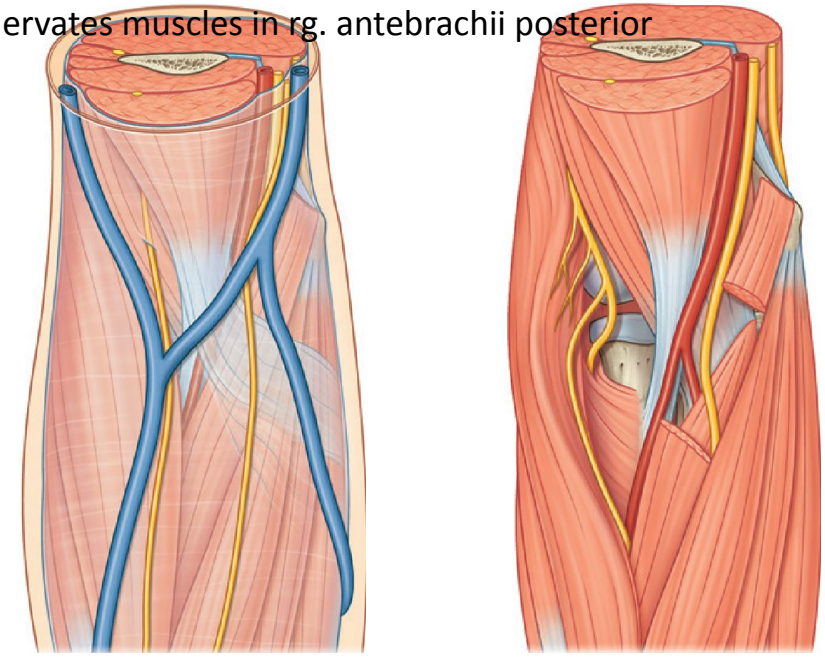


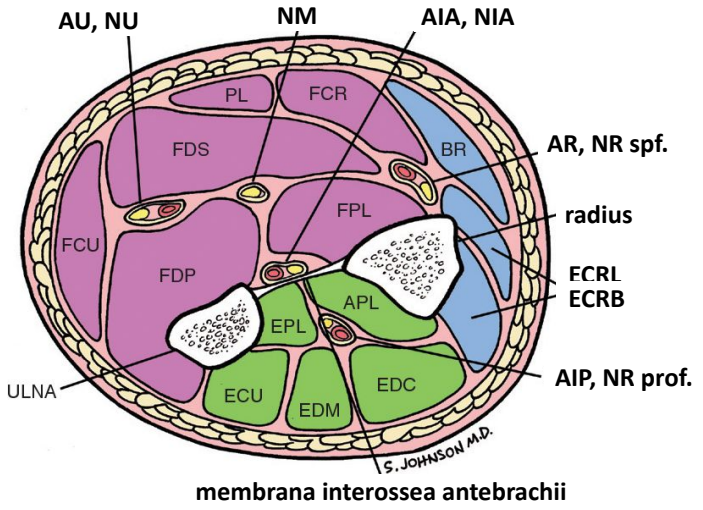

Brachial artery and vena comitans
Radial nerve
Median nerve
Deep head of pronator teres
Common interosseous artery
Posterior interosseous artery
Anterior interosseous nerve
Anterior interosseous artery
Ulnar nerve
Ulnar artery
Radial artery
Median nerve
Superficial radial nerve
Flexor digitorum superficialis tendons (cut)
Flexor carpi radialis tendon (cut)
Flexor retinaculum
S
la
m
I

FORELIMB TOPOGRAPHY

- vasa radialia and r. spf. nervi radialis
  - between m. pronator teres and m. brachioradialis, then between m. brachioradialis and m. flexor carpi radialis
  - vasa in the distal third to the superficial fascia between the tendons B and FCR
  - nerve under tendon B and on the back of the hand
- n. medianus
  - between the heads of PT, then under the beginning of FDspf. and between FDspf. and FDprof.
  - in the distal part to the superficial fascia between FCR and PL
- vasa ulnaria
  - runs mediodistally
  - under n. medianus, then between FDspf. and FDprof., then between FDspf. and FCU
- n. ulnaris
  - between the heads of FCU, distally under FCU and joins vasa ulnaria from the medial side
- r. prof. nervi radialis
  - through S (canalis supinatorius), then branches into rr. musculares, the deepest branch is n. interosseus posterior
  - innervates muscles in rg. antebrachii posterior

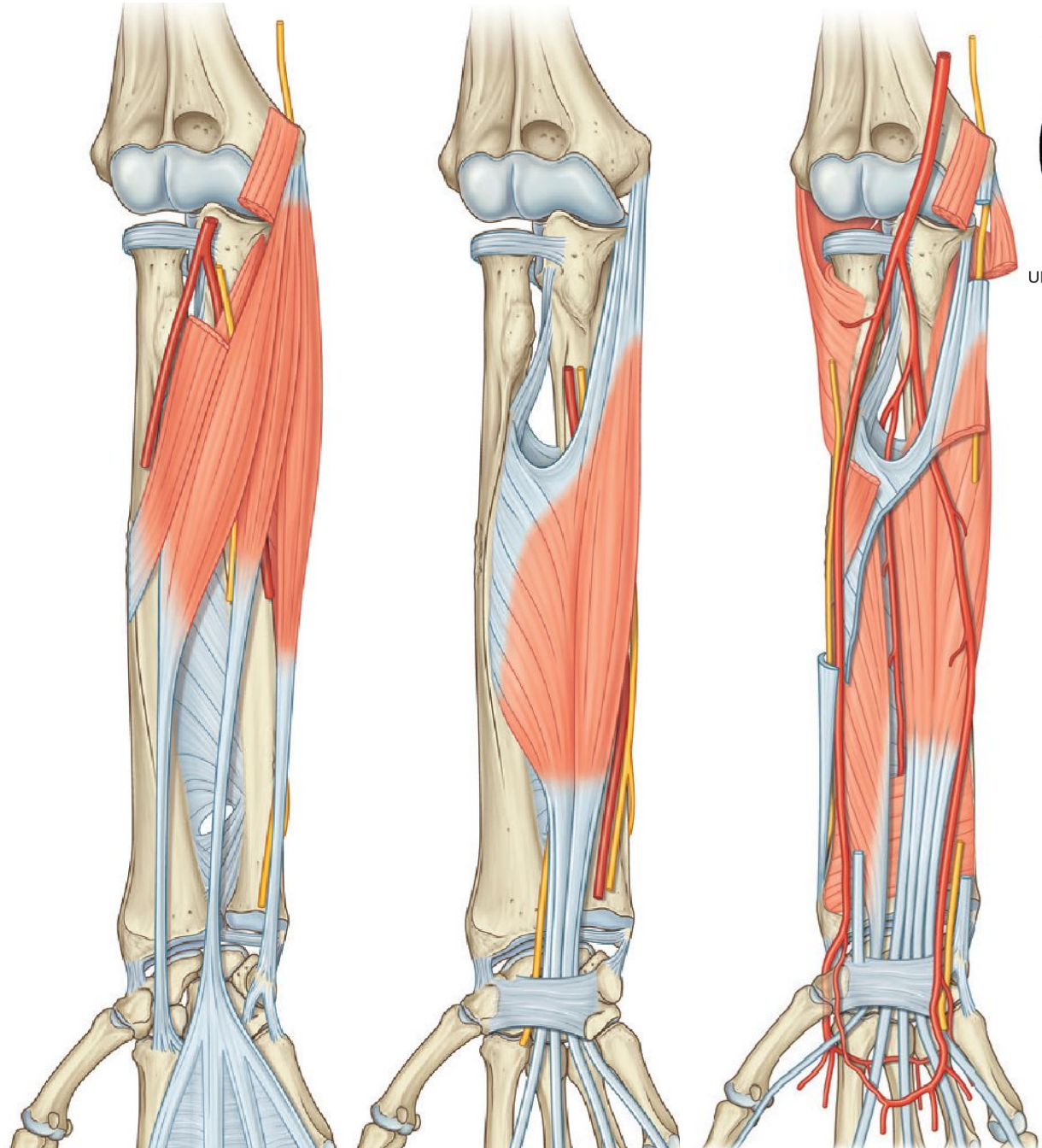


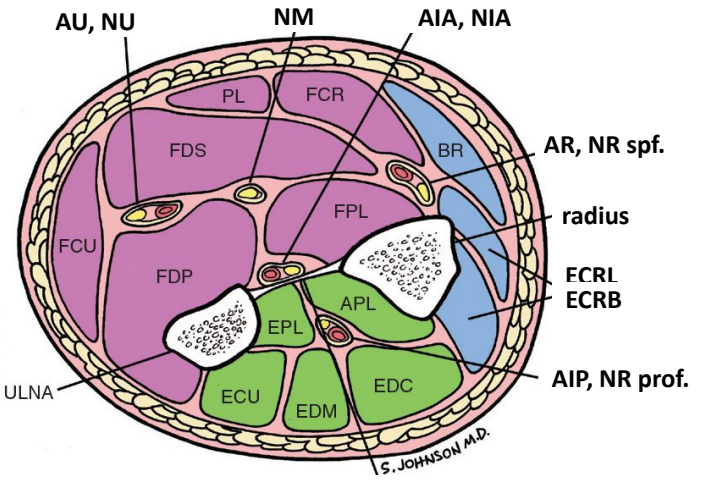




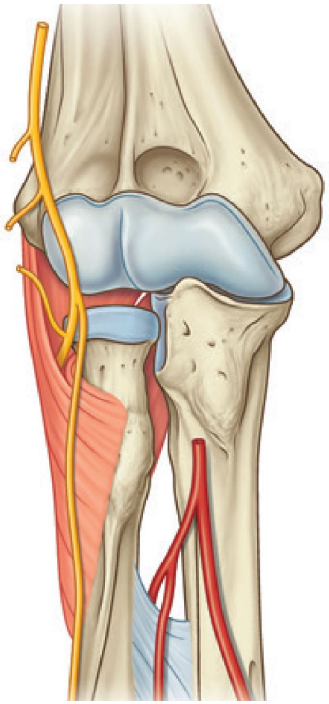
membrana interossea antebrachii

FORELIMB TOPOGRAPHY

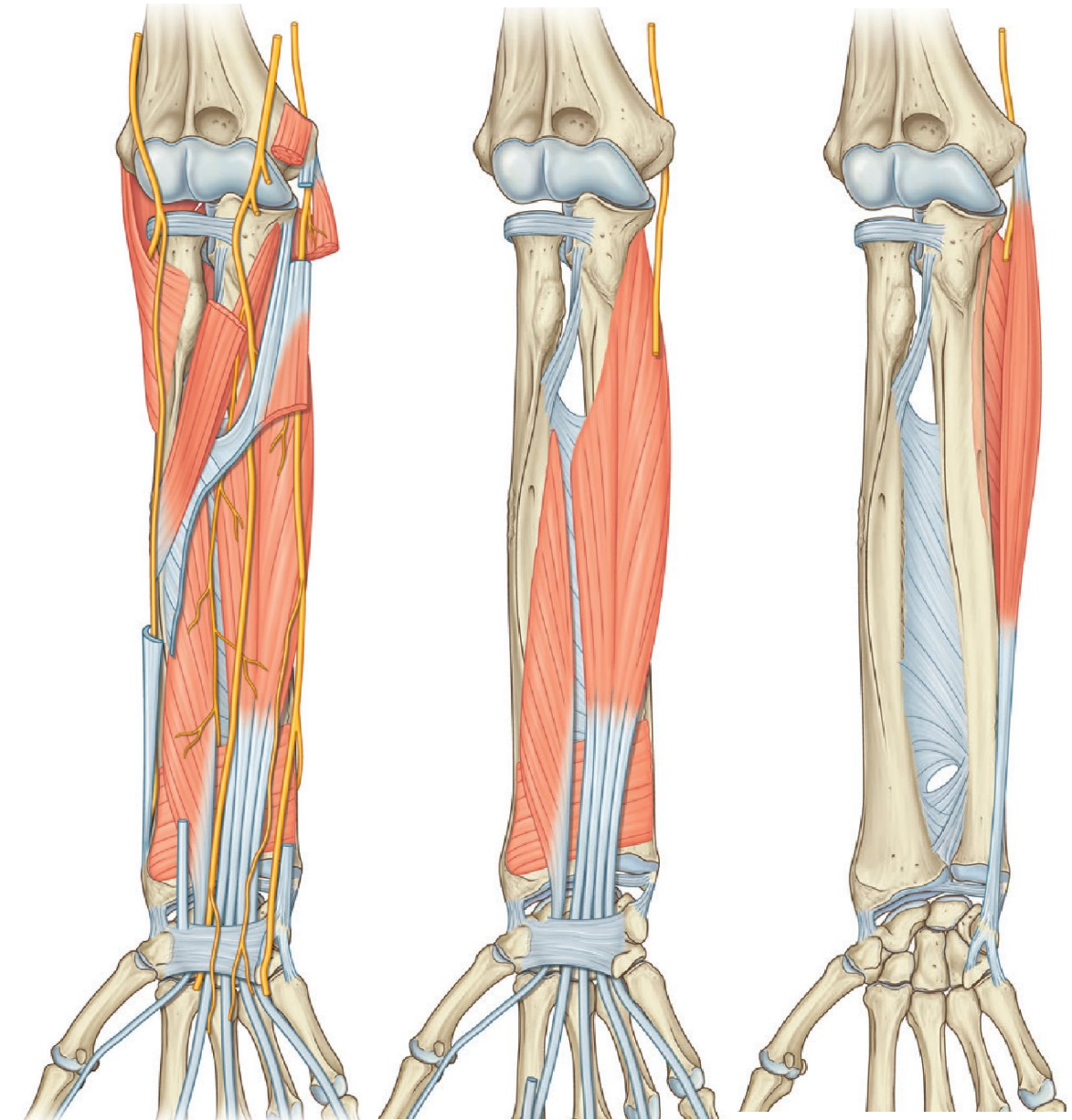


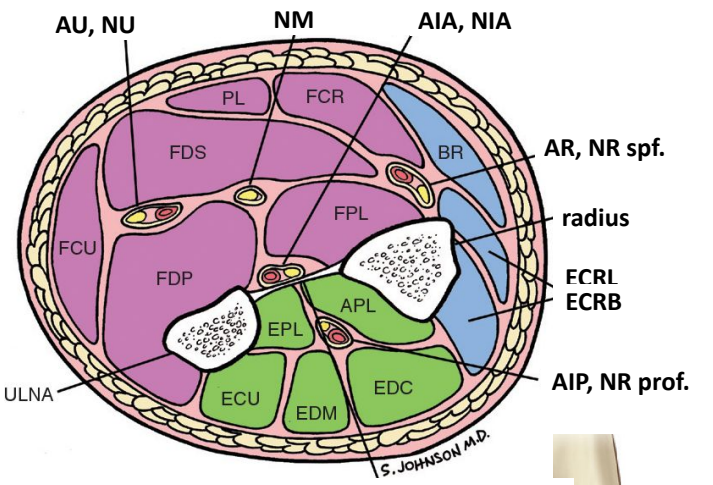


membrana interossea antebrachii



FORELIMB TOPOGRAPHY





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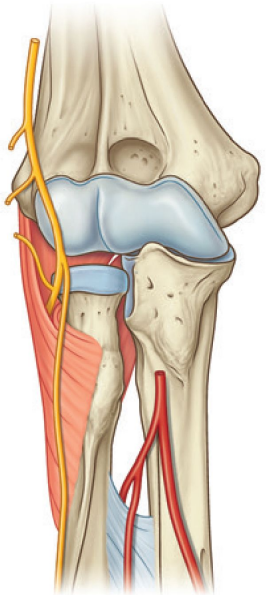
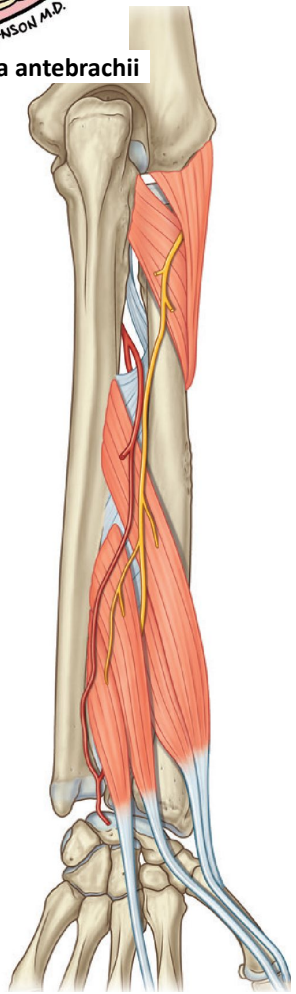
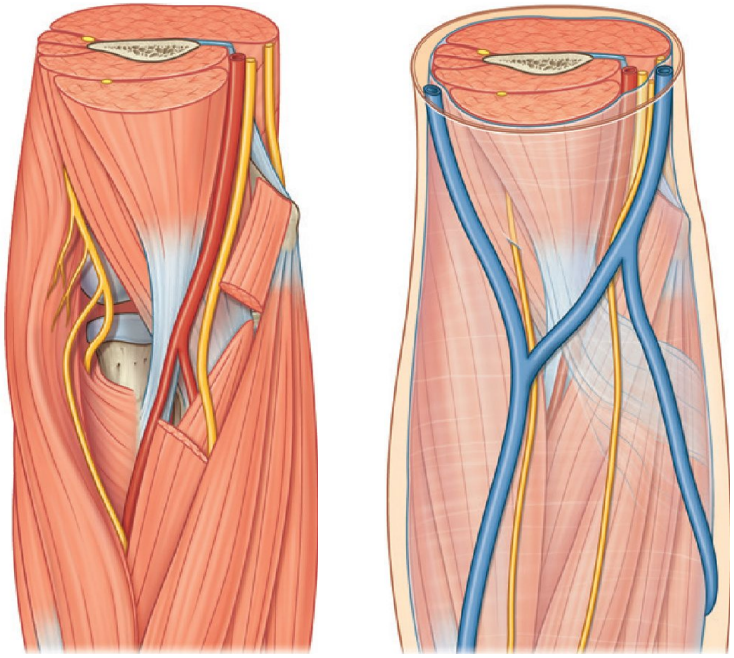


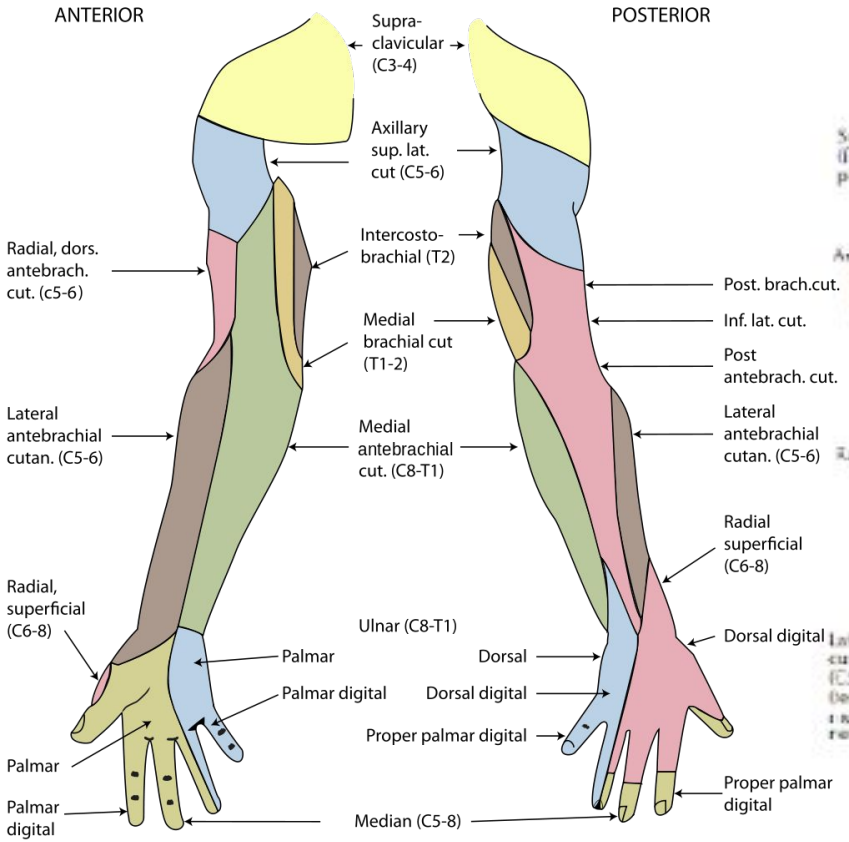


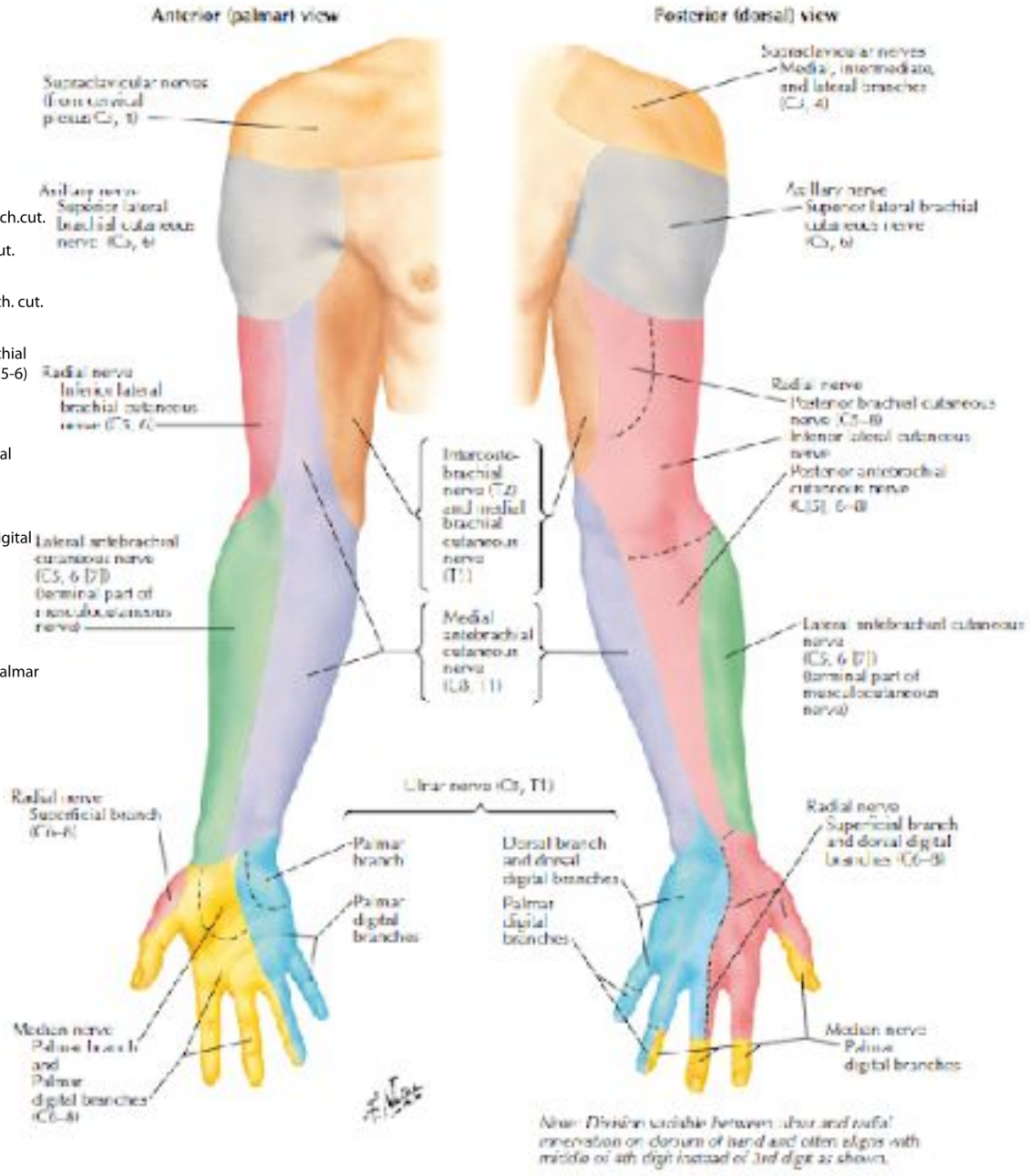
FOSSA CUBITALIS

- boundaries
  - brachioradialis muscle, pronator teres muscle; inferior border: brachialis muscle
- contents
  - tendon of the biceps brachii muscle, brachial artery, median nerve
  - the radial nerve divides into two branches: the superficial branch beneath the brachioradialis muscle, and the deep branch between the heads of the supinator muscle

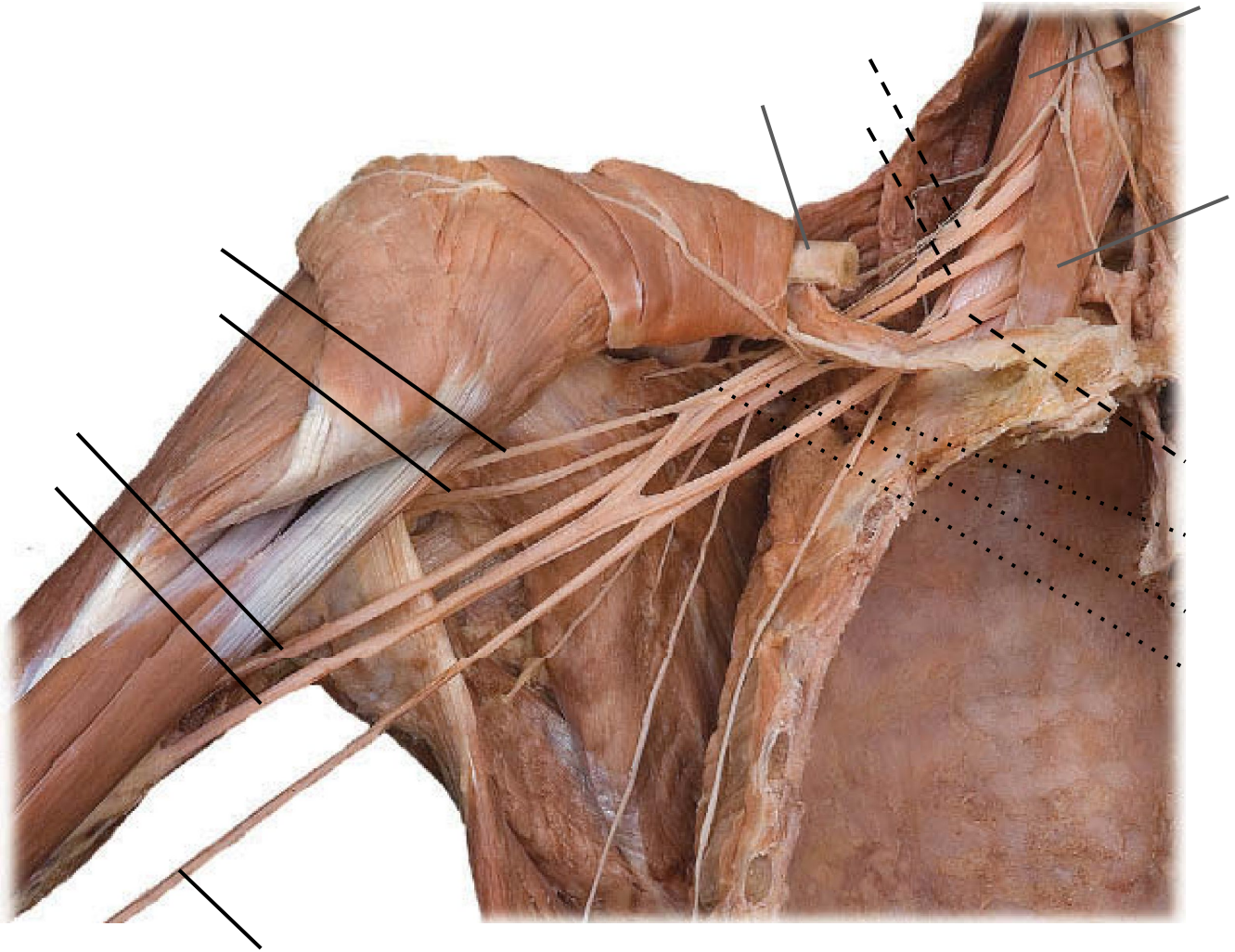


SENSORY INNERVATION OF THE UPPER LIMB

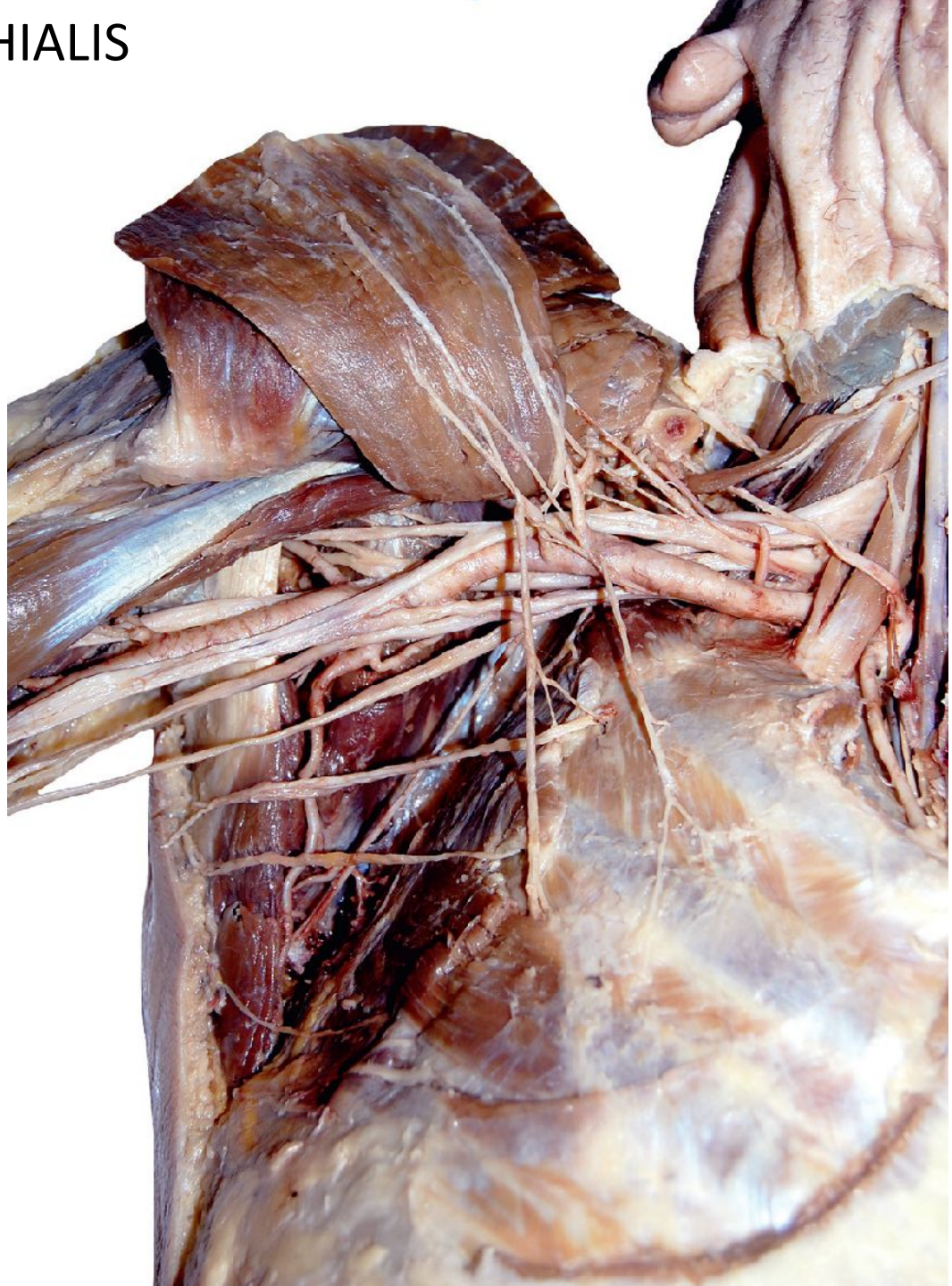




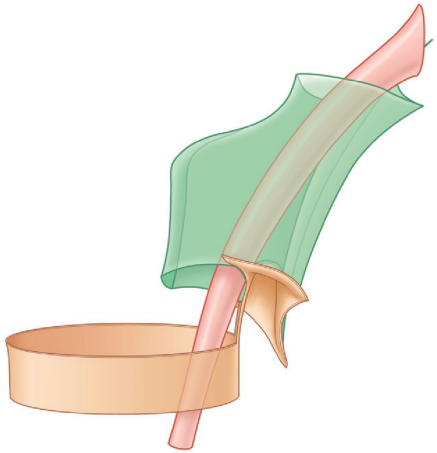
PLEXUS BRACHIALIS

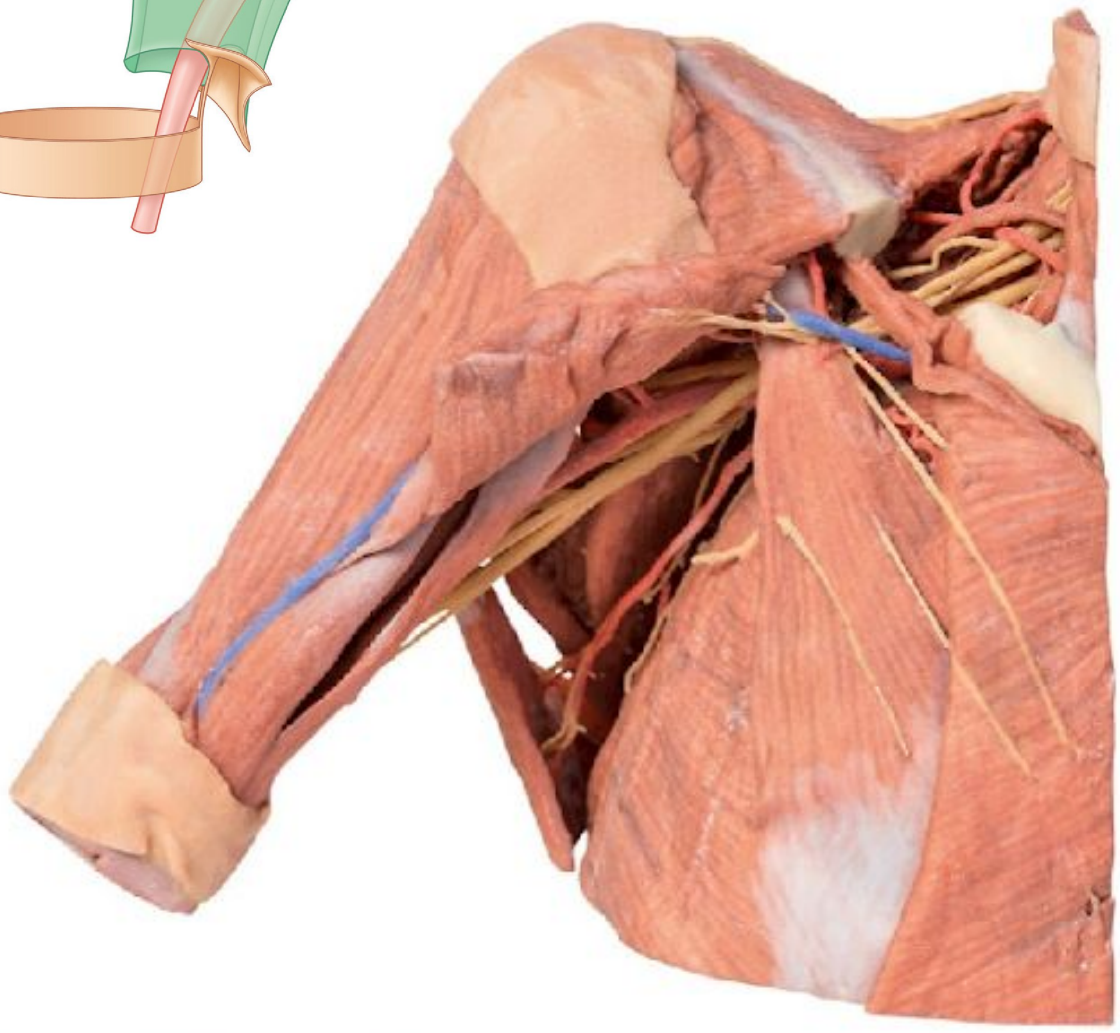


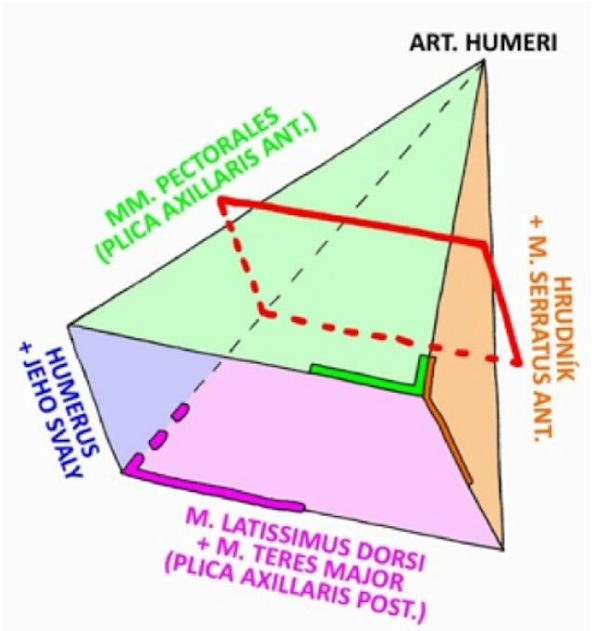
PLEXUS BRACHIALIS

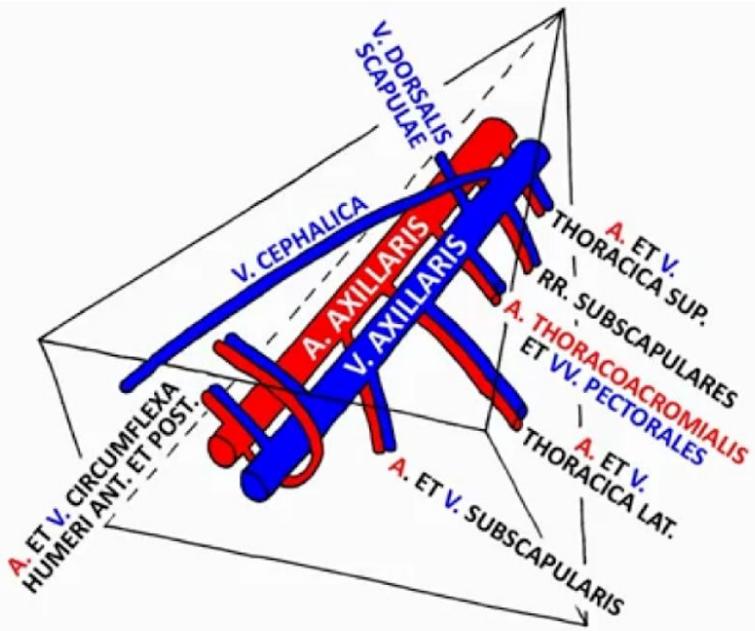


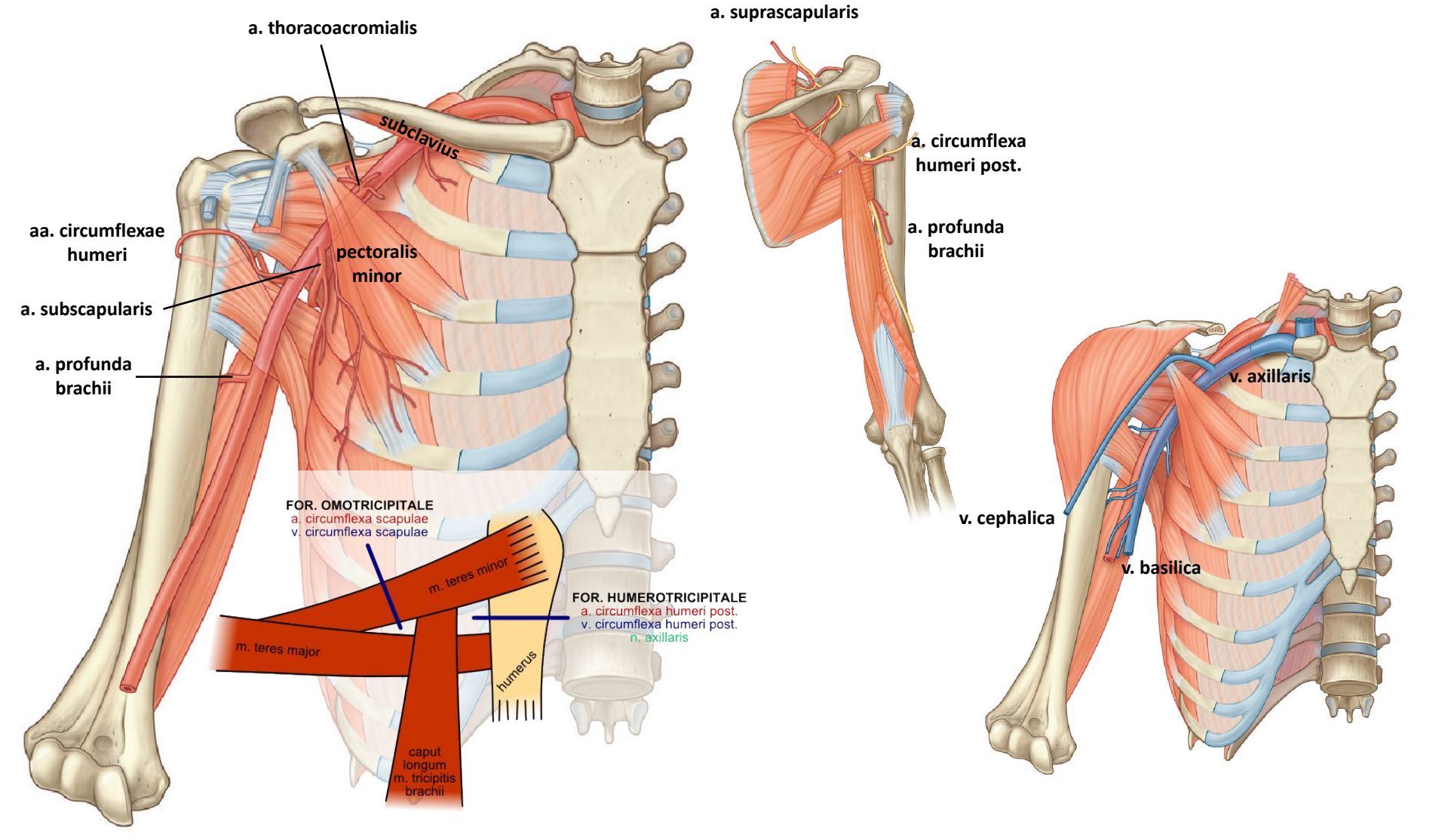
FOSSA AXILLARIS





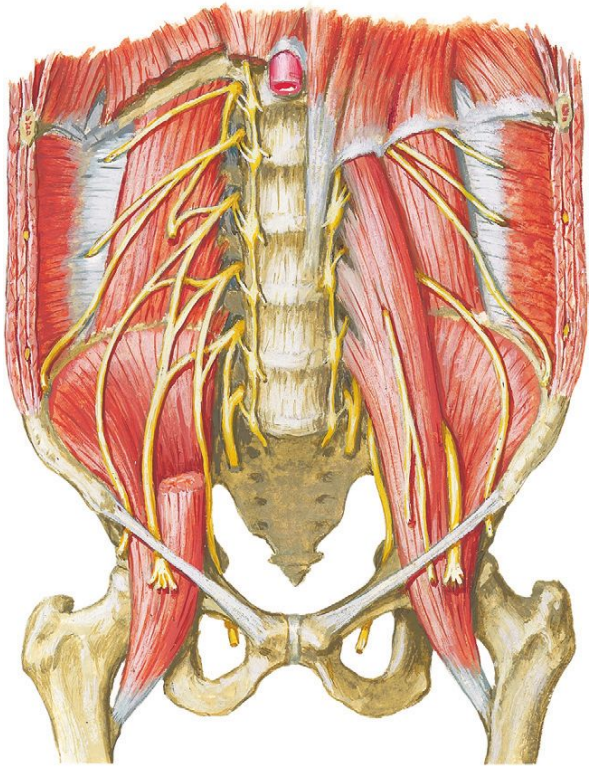


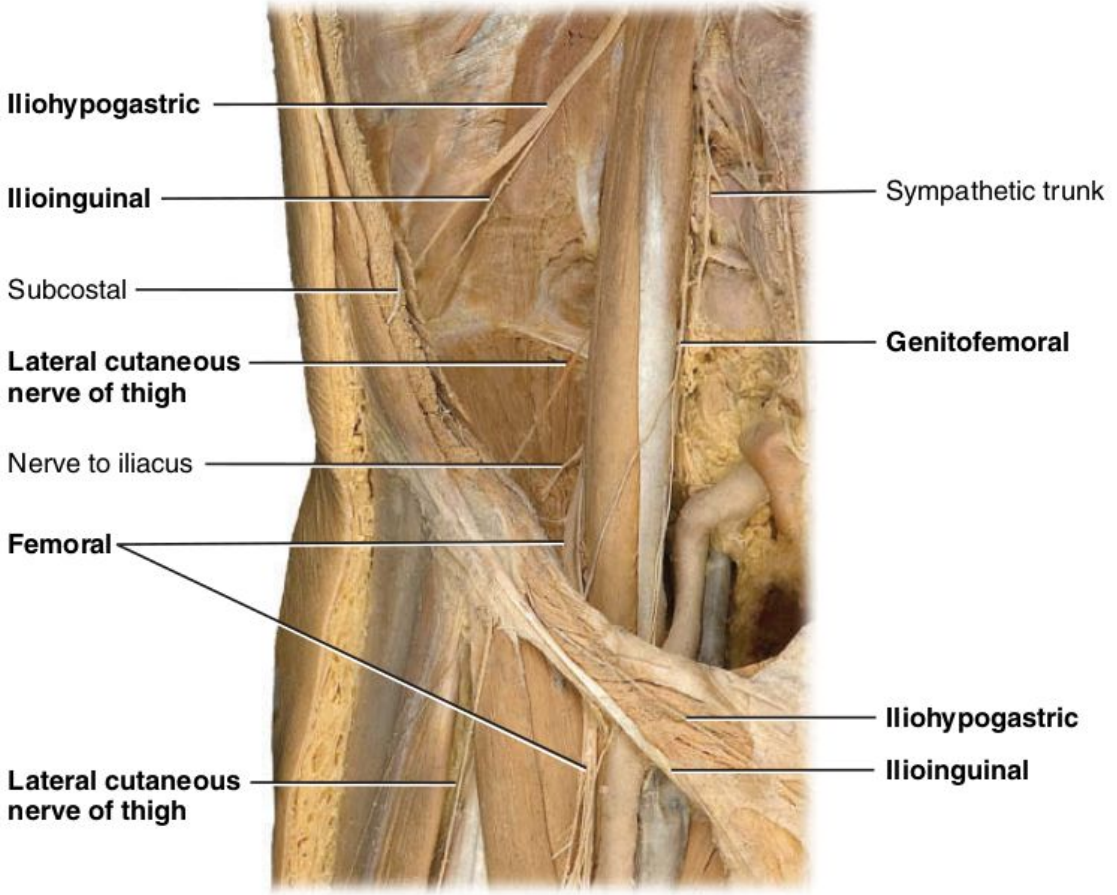



a. thoracoacromialis
subclavius
aa. circumflexae humeri
pectoralis minor
a. subscapularis
a. profunda brachii
FOR. OMOTRICIPITALE
a. circumflexa scapulae
v. circumflexa scapulae
m. teres minor
m. teres major
humerus
caput longum m. tricipitis brachii
FOR. HUMEROTRICIPITALE
a. circumflexa humeri post.
v. circumflexa humeri post.
n. axillaris
a. suprascapularis
a. circumflexa humeri post.
a. profunda brachii
v. axillaris
v. cephalica
v. basilica

PLEXUS LUMBALIS (PLEXUS LUMBOSACRALIS)

- connections between L1–L3, branches from Th1 and L4
- the ventral branches of the lumbar nerves enter the psoas major muscle and form a plexus
  - short branches of the muscular nerves arise from the plexus
  - long branches emerge at the lateral border of the psoas major muscle (iliohypogastric nerve, ilioinguinal nerve, femoral nerve, lateral cutaneous nerve of the thigh)
  - emerges at the medial border (obturator nerve)
  - pierces through and descends along the anterior surface of the psoas major muscle (genitofemoral nerve)





Dissection Shawn Miller, Photograph Mark Nielsen

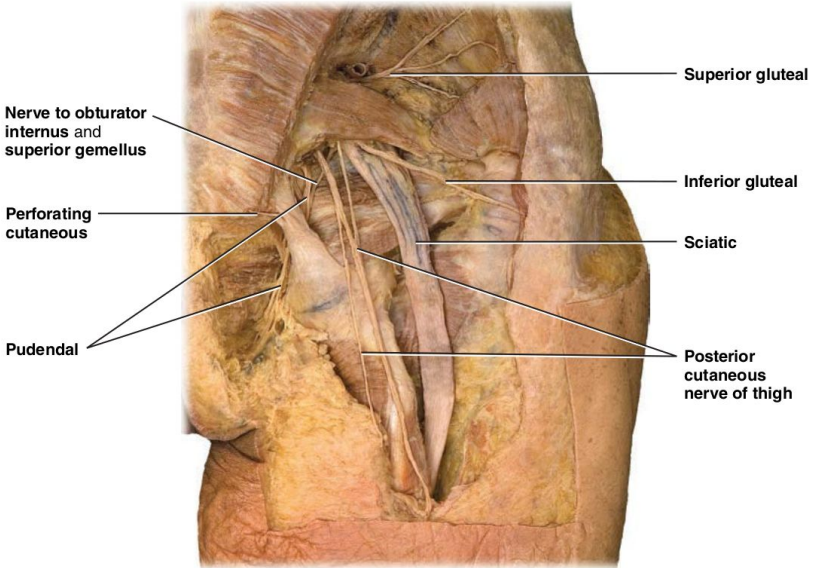
(c) Anterior view of lumbar plexus in right pelvic region

PLEXUS SACRALIS (PLEXUS LUMBOSACRALIS)

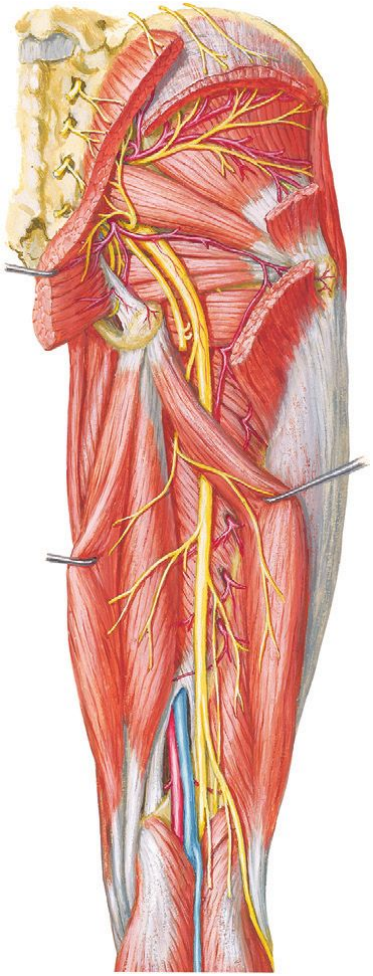
- L4–Co; formed by the union of the ventral branches of S1–S5 from the sacral foramina of the pelvis, to which are added the lumbosacral trunk (L4 and L5) and the coccygeal nerve from the sacral hiatus
- on the sides of the sacrum to the piriformis muscle
- motor and sensory innervation of the entire lower limb, including the gluteal region

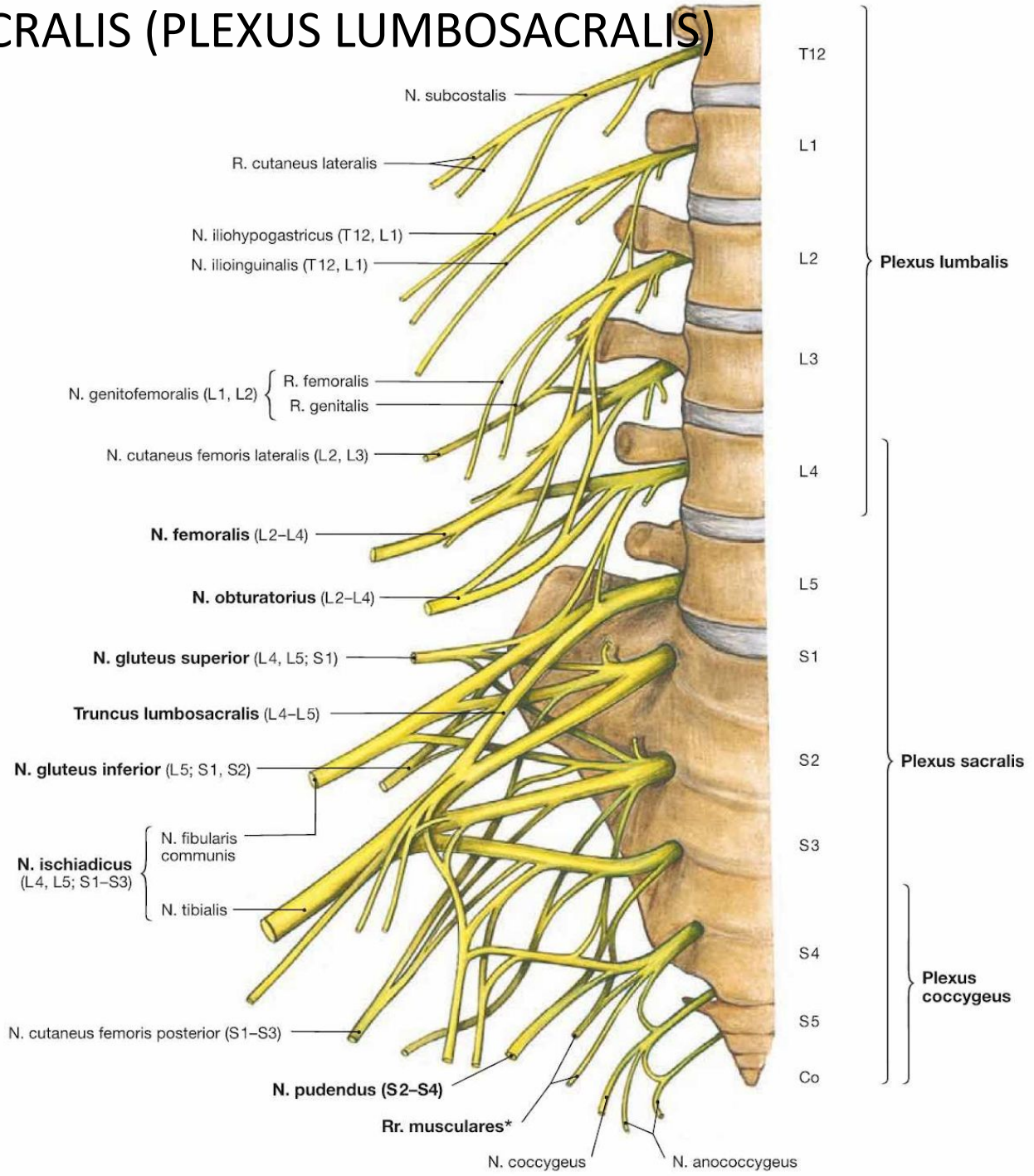
1 External oblique
2 External oblique aponeurosis
3 Femoral nerve
4 Genitofemoral nerve
5 Iliacus
6 Iliohypogastric nerve
7 Ilio-inguinal nerve
8 Iliolumbar ligament
9 Internal oblique
10 Lateral femoral cutaneous nerve
11 Lumbosacral trunk
12 Obturator nerve
13 Quadratus lumborum
14 Rami communicantes
15 Superficial inguinal ring
16 Sympathetic trunk and ganglia
17 Third lumbar vertebra and anterior longitudinal ligament
18 Transversus abdominis
19 Upper surface of inguinal ligament
20 Ventral ramus of fifth lumbar nerve
21 Ventral ramus of first sacral nerve
22 Ventral ramus of fourth lumbar nerve

- anterior thigh muscles (femoral nerve, part of the pectineus muscle)
- adductors (obturator nerve, part of the pectineus muscle and the adductor magnus muscle)
- muscular branches – short branches supplying muscles in the vicinity of the sacral plexus (piriformis muscle, internal obturator muscle, superior and inferior gemellus muscles, quadratus femoris muscle)



PLEXUS LUMBALIS ET SACRALIS (PLEXUS LUMBOSACRALIS)





N. ILIOHYPOGASTRICUS

- Th12 and L1
- laterocaudally behind the kidney along the quadratus lumborum muscle, entering between the transversus abdominis and internal oblique muscles
    - muscular branches
    - lateral cutaneous branch
    - anterior cutaneous branch
- motor
    - internal oblique muscle and transverse abdominal muscle
- sensory
    - skin in the hip joint region, skin in the pubic region, skin in the caudal portion of the abdominal wall

N. ILIOINGUINALIS

- L1
- laterocaudally behind the kidney, through the quadratus lumborum and iliacus muscles, between the muscles of the abdominal wall, into the inguinal canal; it emerges through the superficial inguinal ring and travels toward the external genitalia
    - muscular branches
    - cutaneous branches (scrotal branches/anterior labial branches)
- motor
    - internal oblique muscle, transverse abdominis muscle, cremaster muscle
- sensory
    - skin in the inguinal canal region, skin of the anterior surface of the scrotum and the root of the penis/skin of the mons pubis and the anterior portions of the labia majora

N. GENITOFEMORALIS

- L1 and L2
- penetrate the psoas major muscle, run down the anterior surface, and divide into two branches
    - genital branch – into the inguinal canal behind the spermatic cord/round ligament of the uterus
    - femoral branch – through the lacuna vasorum or musculorum, penetrates the fascia lata or through the saphenous hiatus into the subcutaneous tissue
- motor
    - m. cremaster
- sensory
    - skin of the scrotum/skin of the labia majora, area of skin below the inguinal ligament

N. CUTANEUS FEMORIS LATERALIS

- L2 and L3
- at the lateral border of the psoas major muscle, then laterally toward the anterior superior iliac spine, passing beneath the inguinal ligament and descending caudally beneath the fascia lata, which it then pierces (5–6 cm below the spine)
- sensory
    - skin of the anterolateral aspect of the thigh

N. FEMORALIS

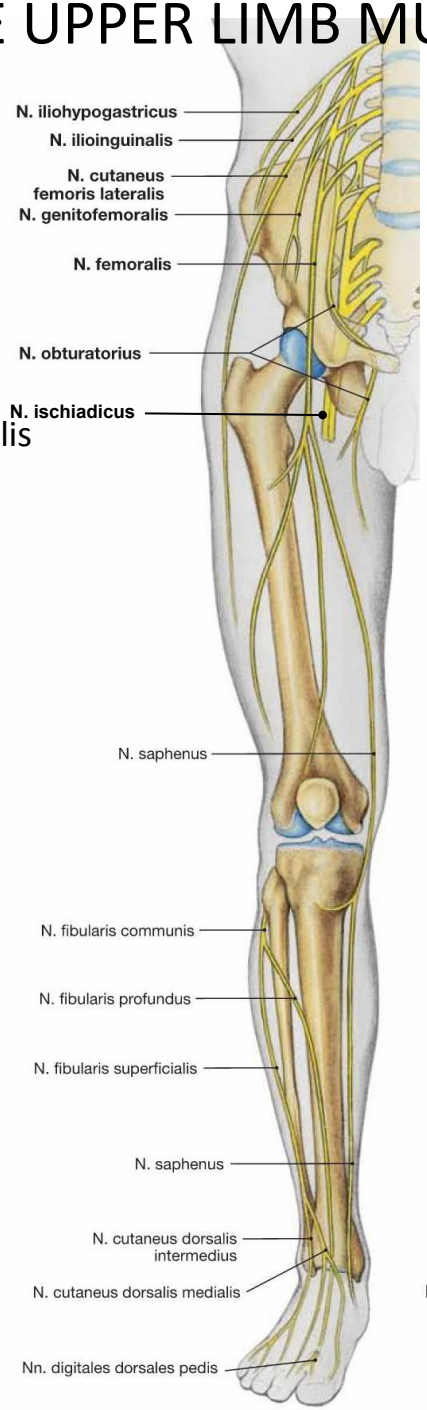
- var. L1, L2–L4
- at the lateral border of the psoas major muscle, descends in the groove between the psoas and iliacus muscles, through the lacuna musculorum into the iliopectineal fossa, where it divides into branches
    - muscular branches
    - anterior cutaneous branches – anterior aspect of the thigh to the patella
    - saphenous nerve – sensory, descends with the femoral artery into the adductor canal, then to the anterior medial aspect of the lower leg along the great saphenous vein, across the medial malleolus to the navicular bone
- motor
    - m. iliopsoas, all muscles of the anterior thigh group, part of m. pectineus
- sensory
    - part of the hip joint, part of the knee joint, skin of the anterior thigh, skin of the anterior and medial aspects of the knee and lower leg, and parts of the dorsum of the foot

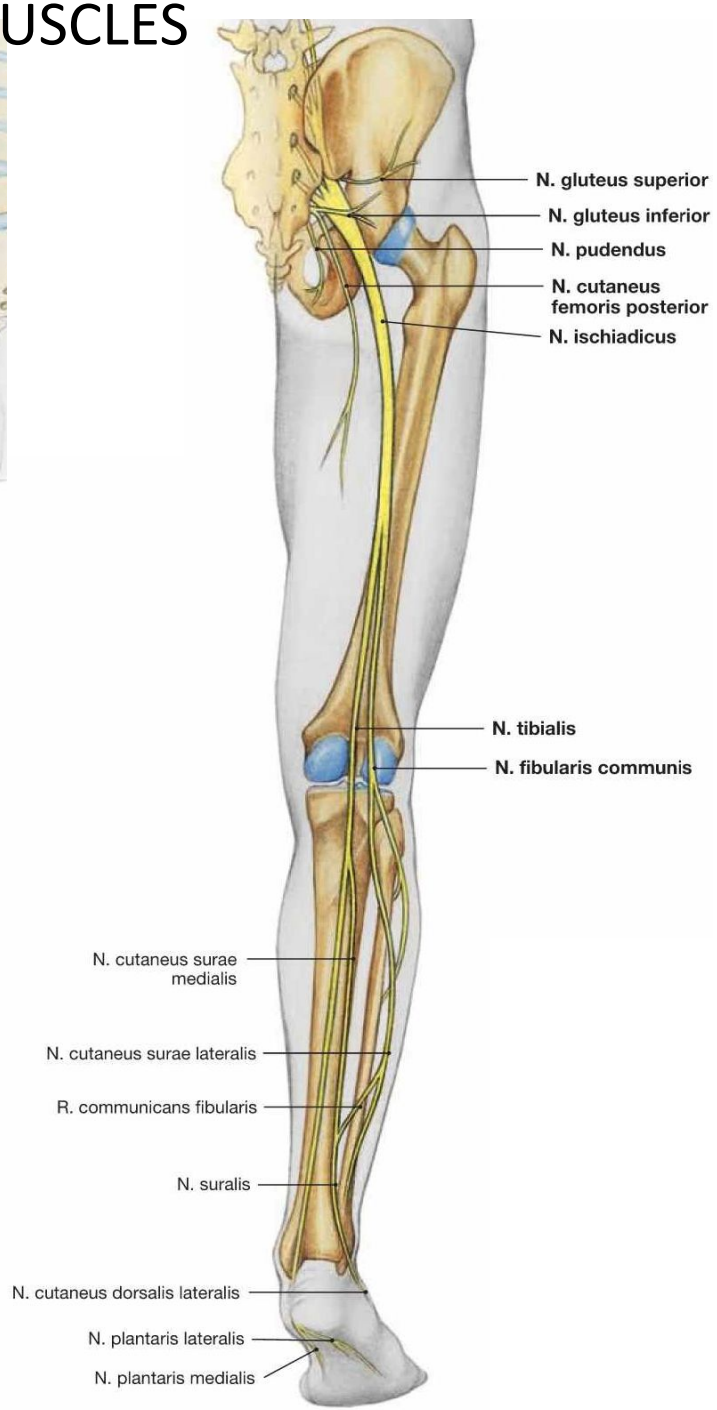
N. OBTURATORIUS

- L2–L4
- The only nerve of the plexus that emerges on the medial side of the iliopsoas muscle; it passes beneath the superior ramus of the pubic bone into the obturator canal, branching immediately after entering
    - anterior branch – cutaneous branch (lower two-thirds of the medial thigh)
    - posterior branch – muscular branches, sensory branch to medial knee joint
- motor
    - all thigh adductors
    - diploneural muscles – pectineus muscle (femoral nerve), adductor magnus muscle (sciatic nerve)
- sensory
    - skin on the inner side of the thigh, parts of the hip and knee joint capsules

MOTOR INNERVATION OF THE UPPER LIMB MUSCLES

- n. femoralis
- n. obturatorius
- n. gluteus superior
- n. gluteus inferior
- n. ischiadicus
  - n. tibialis a n. fibularis communis
  - n. tibialis → n. plantaris medialis et lateralis
  - n. peroneus communis → n. fibularis superficialis et profundus





MOTOR INNERVATION OF THE UPPER LIMB MUSCLES

- n. femoralis
  - at the lateral edge of m. psoas major, descends in the groove between m. psoas and m. iliacus, through lacuna musculorum into fossa iliopectinea, where it divides into branches
- n. obturatorius
  - the only nerve of the plexus that emerges on the medial side of the m. iliopsoas, passes under the ramus superior ossis pubis into the canalis obturatorius, branches immediately after passing through
- n. gluteus superior
  - through the foramen suprapiriforme (with vasa glutea superior)
- n. gluteus inferior
  - through the foramen infrapiriforme (with vasa glutea inferior)
- n. ischiadicus
  - through the foramen infrapiriforme, descends under the m. gluteus maximus along the pelvitrochanteric muscles, then along the posterior surface of the m. adductor magnus under the flexors of the thigh, above the entrance to the fossa poplitea it divides into n. tibialis and n. peroneus (fibularis) communis
  - **n. tibialis** – through the center of the popliteal fossa, between the heads of the m. gastrocnemius (dorsally from the m. popliteus), passes under the arcus tendineus m. solei, descends with the vasa tibialia and the medial malleolus, passes under the retinaculum flexorum in the canalis malleolaris (anterior-posterior order of structures: m. tibialis posterior, m. flexor digitorum longus, v. et a. tibialis posteior, n. tibialis, m. flexor hallucis longus) and divides into two branches: n. plantaris medialis et lateralis
  - **n. fibularis communis** – after separating from n. ischiadicus, it descends along the medial edge of m. biceps femoris to the muscle attachment on caput fibulae, wraps around the neck of fibula from the outside and enters the beginning of m. fibularis longus, where it divides into final branches: n. fibularis superficialis (to the dorsum pedis) et profundus (anterior group of the lower leg)

n. saphenus
- sensory
- along the thigh together with the femoral artery into the adductor canal, leaving the artery at the level of the tibial tuberosity and piercing the vastoadductor lamina into the subcutaneous tissue, continuing along the anterior medial side of the lower leg, along the great saphenous vein in front of the medial ankle and onto the tarsus up to the navicular bone
- branches: infrapatellar branch, medial cutaneous branches of the leg

n. suralis
- sensory, formed by the union of
  - the fibularis communicans nerve (from the lateral cutaneous nerve of the calf or the common fibular nerve)
  - the medial cutaneous nerve of the calf (from the tibial nerve in the popliteal fossa in the middle of the calf)
- behind the outer ankle to the lateral edge of the foot as the lateral dorsal cutaneous nerve

N. GLUTEUS SUPERIOR

- L4–S1
- through the suprapiriform foramen (with the superior gluteal vessels)
- gluteus medius muscle, gluteus minimus muscle, tensor fasciae latae muscle

N. GLUTEUS INFERIOR

- L5–S2
- through the infrapiriform foramen
- motor
    - gluteus maximus muscle
- sensory
    - posterior aspect of the hip joint capsule

N. CUTANUES FEMORIS POSTERIOR

- S1–S3
- through the infrapiriform foramen between the semitendinosus and biceps femoris muscles into the popliteal fossa
- sensory
    - skin of the lower gluteal region, skin of the posterior femoral region, skin of the perineum, and the posterior and lateral parts of the scrotum/labia majora

N. ISCHIADICUS

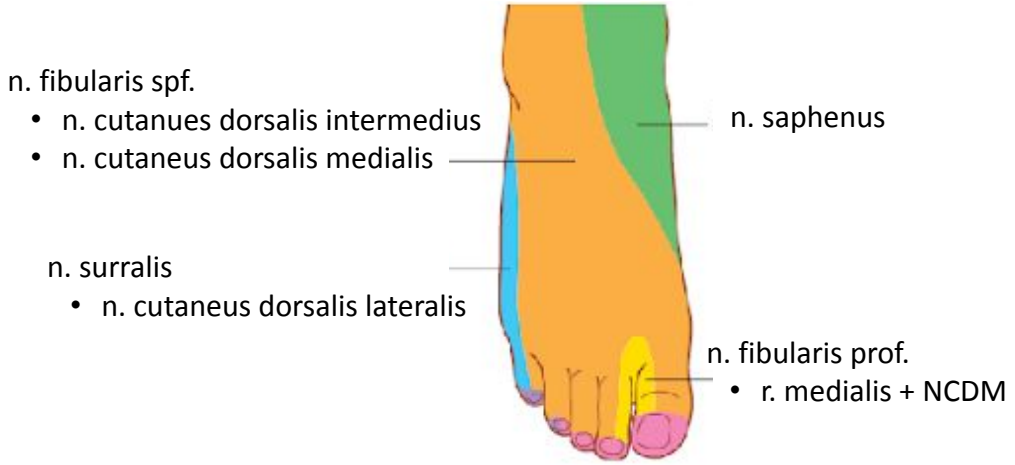
- L4–S3; the longest and strongest nerve in the human body
- passes through the infrapiriform foramen, descends beneath the gluteus maximus muscle along the pelvitrochanteric muscles, then along the posterior surface of the adductor magnus muscle beneath the thigh flexors; above the entrance to the popliteal fossa, it divides into the tibial nerve and the common peroneal (fibular) nerve
    - muscular branches (semitendinosus muscle, semimembranosus muscle, biceps femoris muscle, part of the adductor magnus muscle)
    - articular branches – the capsules of the hip and knee joints
- in the trunk
    - motor – biceps femoris, semitendinosus, semimembranosus, part of the adductor magnus
    - sensory – part of the hip and knee joints
- via the tibial nerve
    - motor – gastrocnemius muscle, soleus muscle, plantaris muscle, popliteus muscle, flexor digitorum longus muscle, posterior tibial muscle, flexor hallucis longus muscle, all muscles of the sole
    - sensory – most of the posterior surface of the lower leg, the sole of the foot, and the plantar surface of the toes
- via the common fibular nerve
    - sensory – part of the knee joint, tibiofibular joint
- via the superficial fibular nerve
    - motor – fibularis longus and brevis muscles
    - sensory – skin of the dorsum of the foot and toes
- via the deep fibular nerve
    - motor – tibialis anterior muscle, extensor digitorum longus muscle, extensor hallucis longus muscle, extensor digitorum brevis muscle, extensor hallucis brevis muscle
    - sensory – skin on the dorsal side of the adjacent sides of the 1st and 2nd toes

N. TIBIALIS

- L4–S3
- in the center of the popliteal fossa, between the heads of the gastrocnemius muscle (dorsal to the popliteus muscle), passes beneath the tendinous arch of the soleus muscle, descends with the tibial vessels and the medial malleolus, and passes beneath the flexor retinaculum in the malleolar canal (anterior-posterior order of structures: posterior tibial muscle, long flexor of the toes muscle, posterior tibial vein and artery, tibial nerve, long flexor of the big toe muscle) and divides into two branches (medial and lateral plantar nerves)
  - muscular branches
  - interosseous nerve of the lower leg
  - medial cutaneous nerve of the calf
  - sural nerve – medial cutaneous nerve of the calf with fibular communicating branch
  - medial calcaneal branches
  - medial plantar nerve – flexor digitorum brevis muscle, abductor hallucis muscle, flexor hallucis brevis muscle, lumbrical muscles I and II; plantar skin of the toes
  - lateral plantar nerve – quadratus plantae muscle; superficial branch (abductor digiti minimi muscle, plantar skin of the toes), deep branch (flexor digiti minimi brevis muscle, opponens digiti minimi muscle, lumbrical muscles III and IV, interossei muscles, adductor hallucis muscle) – analogous to the median and ulnar nerves

N. FIBULARIS (PERONEUS) COMMUNIS

- L4–S2
- after branching off from the sciatic nerve, it descends along the medial border of the biceps femoris muscle to the muscle's insertion on the head of the fibula, wraps around the neck of the fibula from the lateral side, and enters the origin of the fibularis longus muscle, where it divides into its terminal branches (superficial and deep fibular nerves)
- articular branches
- lateral cutaneous nerve of the calf
- fibular communicating branch
- deep fibular nerve
  - through the fibularis longus muscle into the septum between the anterior and lateral groups of calf muscles (anterior intermuscular septum of the leg)
  - deep in the lower leg, together with the vasa tibialis ant., at the membrana interossea cruris
  - at the skeleton, it runs along the dorsum of the foot and emerges above the fascia proximal to the first interdigital space
- n. fibularis spf.
  - between the fibula and the fibularis longus muscle
  - descends the lower leg between the fibularis longus and extensor digitorum longus muscles
  - in the lower third of the lower leg, it passes through the fascia and superficially over the retinacula musculorum extensorum, descending to the dorsum of the foot, where it divides (dorsal cutaneous nerves)



N. PUDENDUS

- S2–S4
- passes through the infrapiriform foramen, behind the ischial spine (with the internal pudendal vessels), and returns to the pelvis through the lesser ischial foramen; enters the ischioanal fossa, travels with the vessels into the pudendal canal, and terminates as the dorsal nerve of the penis/dorsal nerve of the clitoris
    - inferior rectal nerves; motor – external anal sphincter muscle; sensory – skin around the anal opening
    - perineal nerves; motor – perineal muscles; sensory – scrotum/labia majora
    - dorsal nerve of the penis/clitoris; somatomotor, somatosensory, visceromotor, and viscerosensory (sympathetic and parasympathetic) fibers; somatomotor – muscles of the perineum and external anal sphincter; visceromotor – blood vessels in the corpus cavernosum and spongiosum, in the bulbus vestibuli; sensory – skin of the penis/clitoris, mucosa of the urethra