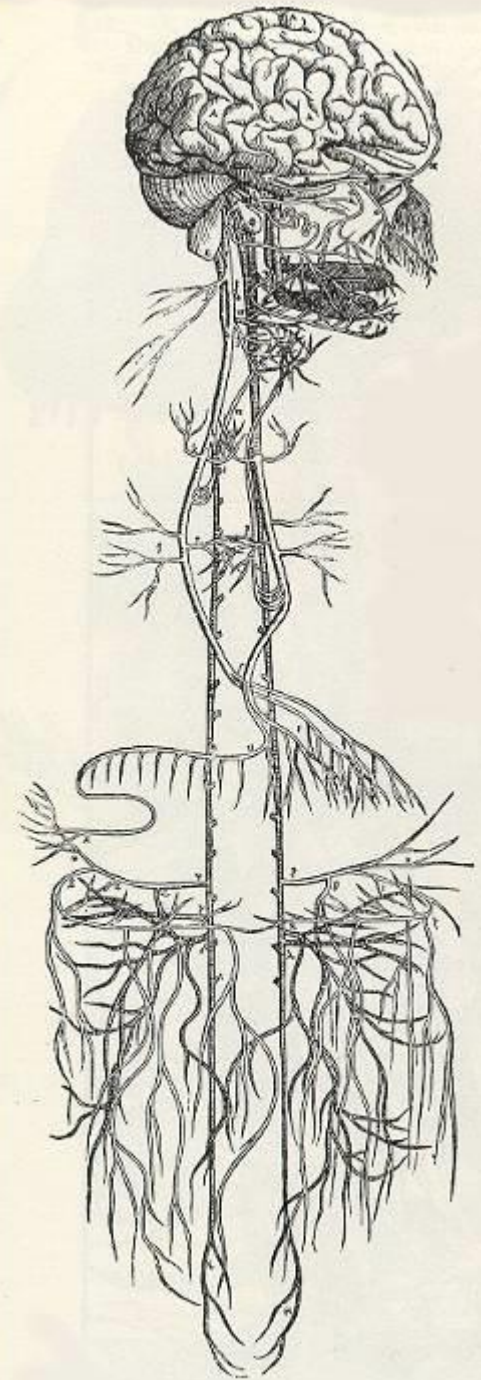


***Systema
nervosum
periphericum***

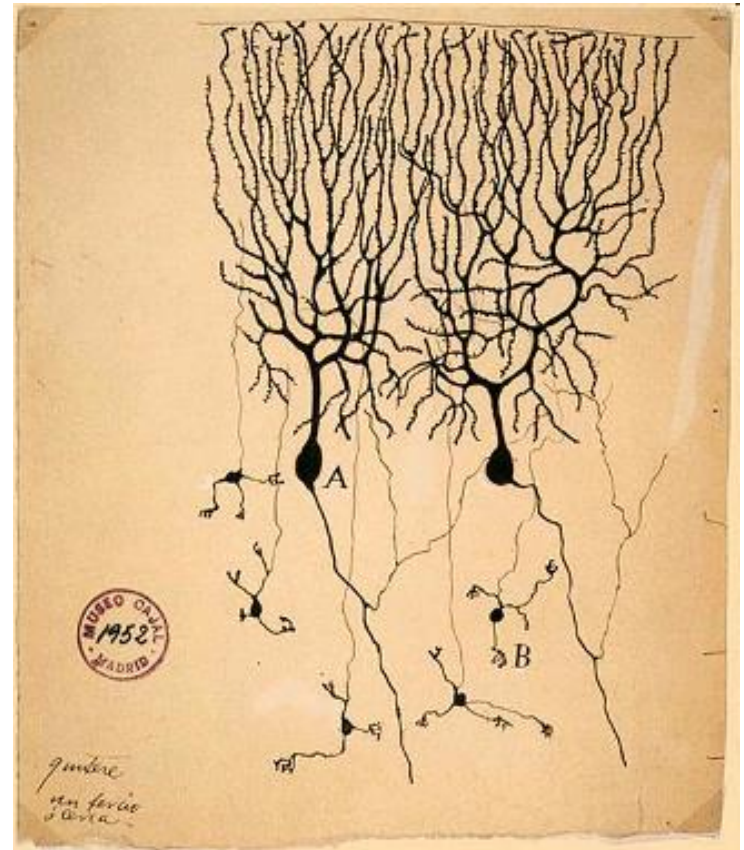
**Peripheral
nervous system**

David Kachlík



Terminology

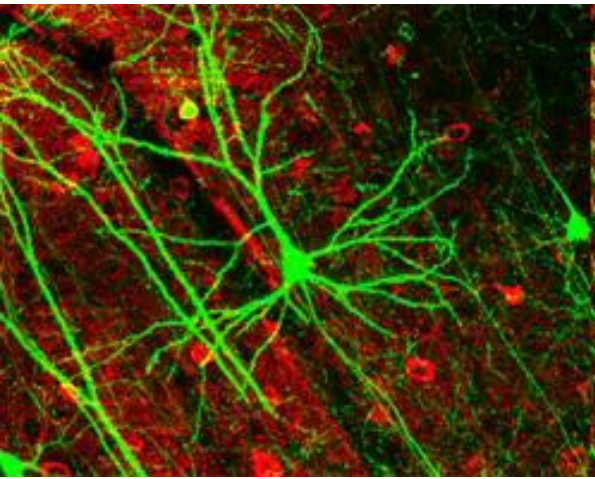
- neuron
 - perikaryon / soma (nerve cell body)
 - axon
 - dendritum (dendrite)
- neuroglia
- neurofibra (nerve fiber)
- nervus (nerve)
- nucleus
- ganglion



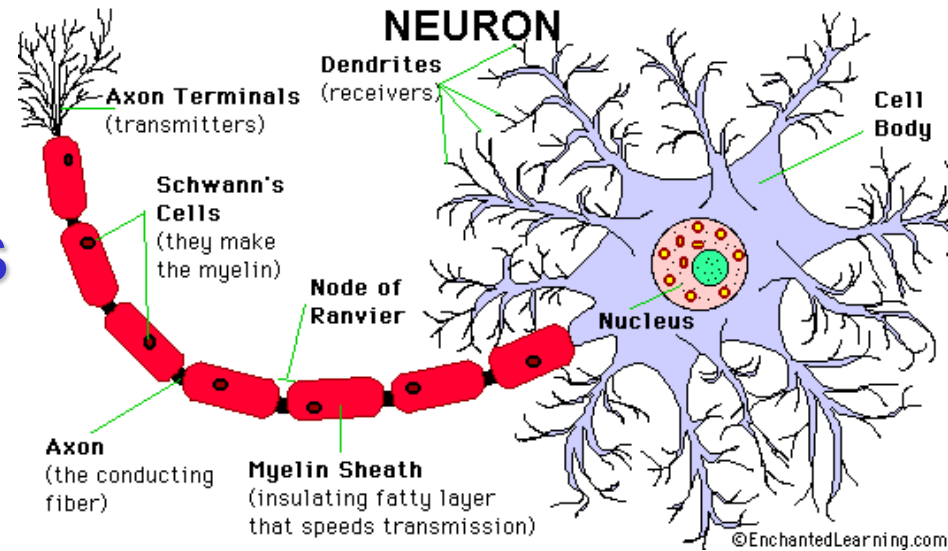
Drawing of Purkyně cells (A) and granule cells (B) from pigeon cerebellum by Santiago Ramón y Cajal (1899)

Cell types in CNS

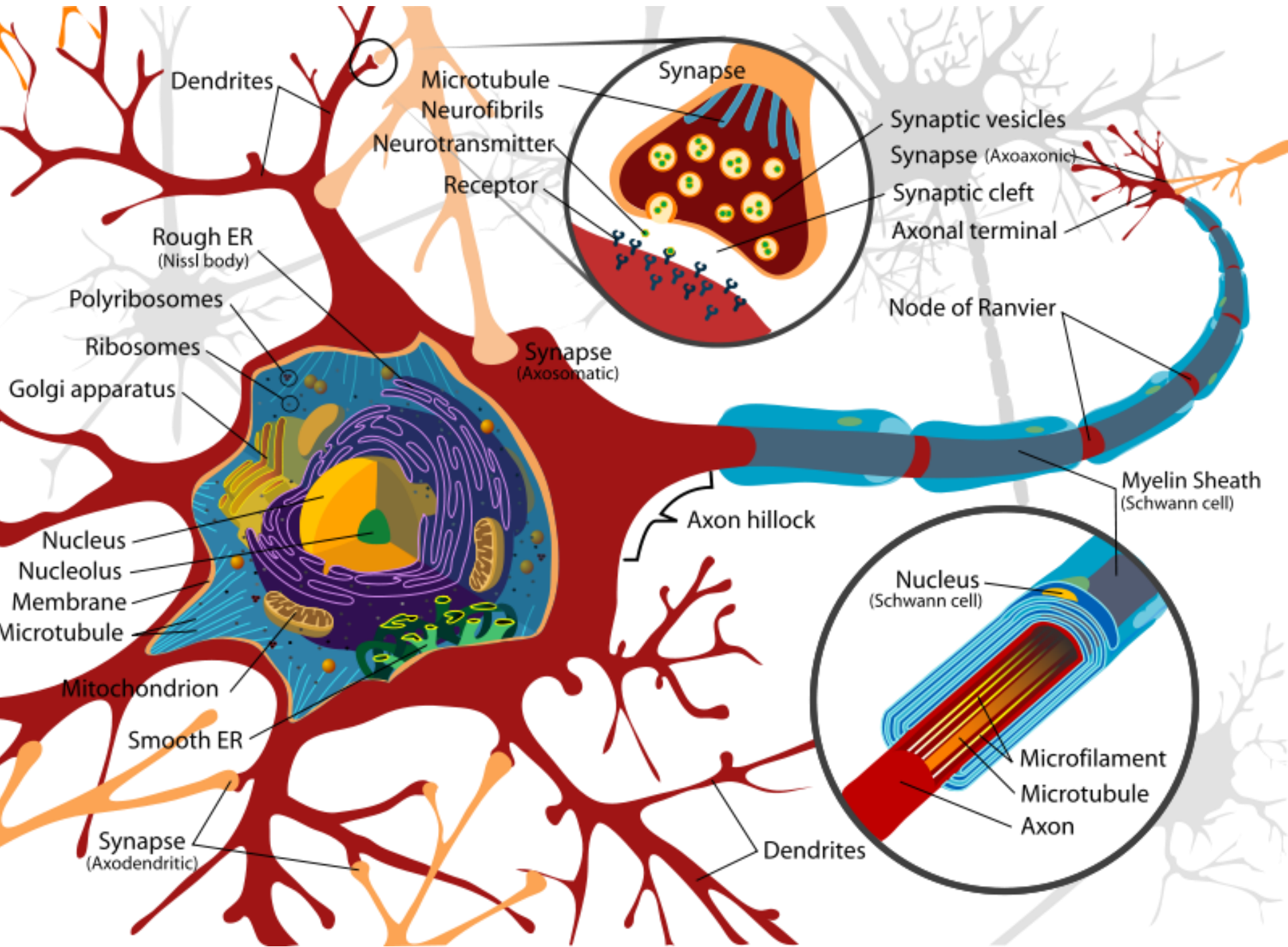
- neurons
 - multipolar, bipolar, pseudounipolar, unipolar
- neuroglia
 - astrocytes
 - oligodendrocytes
 - microglia
 - ependymal cells
 - proper ependymal cells, tanycytes



Neurons

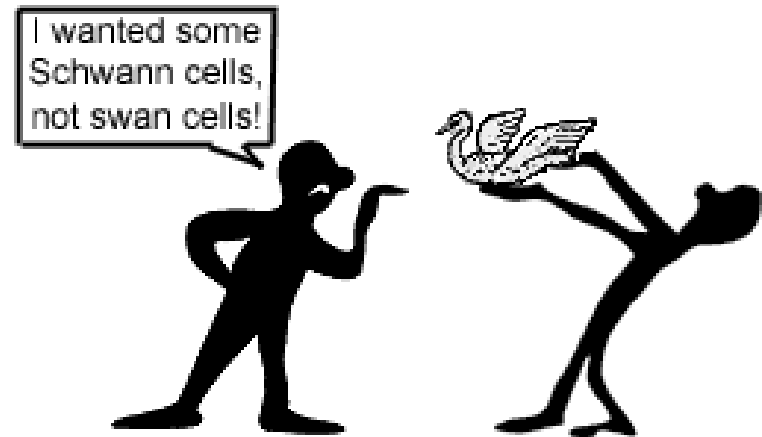


- basic unit of nervous tissue
- receive, process and transmit signals
- size: from 5 μm (granular cells of cerebellum) to 150 μm (Purkinje cells of cerebellum)
- some can multiply even after birth
- synapsis interconnects neurons



Neuroglia

- CNS:
 - oligodendroglia
 - astrocytes
 - microglia
 - ependymal cells
- PNS
 - satellite cells
 - Schwann cells

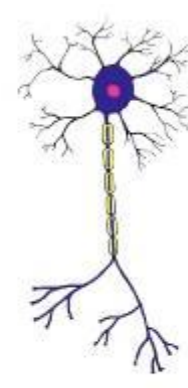


Neuron types according to shape

- multipolar
 - more than 2 processes (axon + dendrites)
 - majority of neurons
- bipolar
 - two processes only (axon + dendrite)
 - retina, ganglia n. VIII, olfactory mucosa
- pseudounipolar
 - one process bifurcated into peripheral and central processes (shape „T“)
 - somatosensory and viscerosensory ganglia
- unipolar
 - only one process
 - rods and cones in retina



PSEUDOUNIPOLÁRNÍ

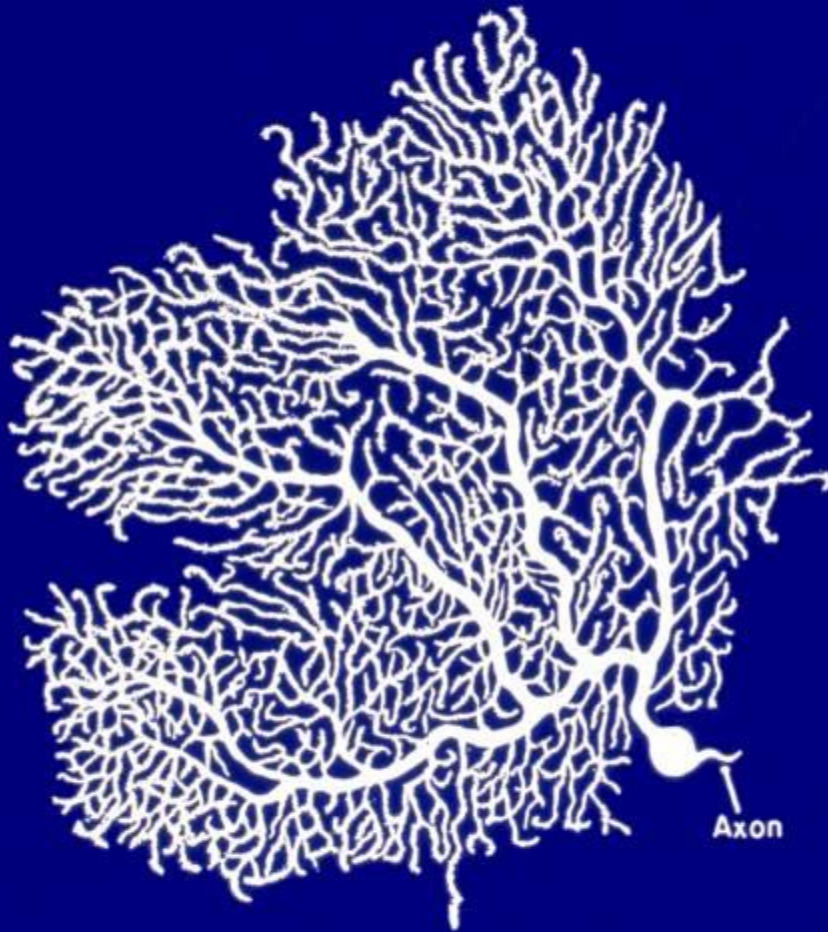


MULTIPOLÁRNÍ

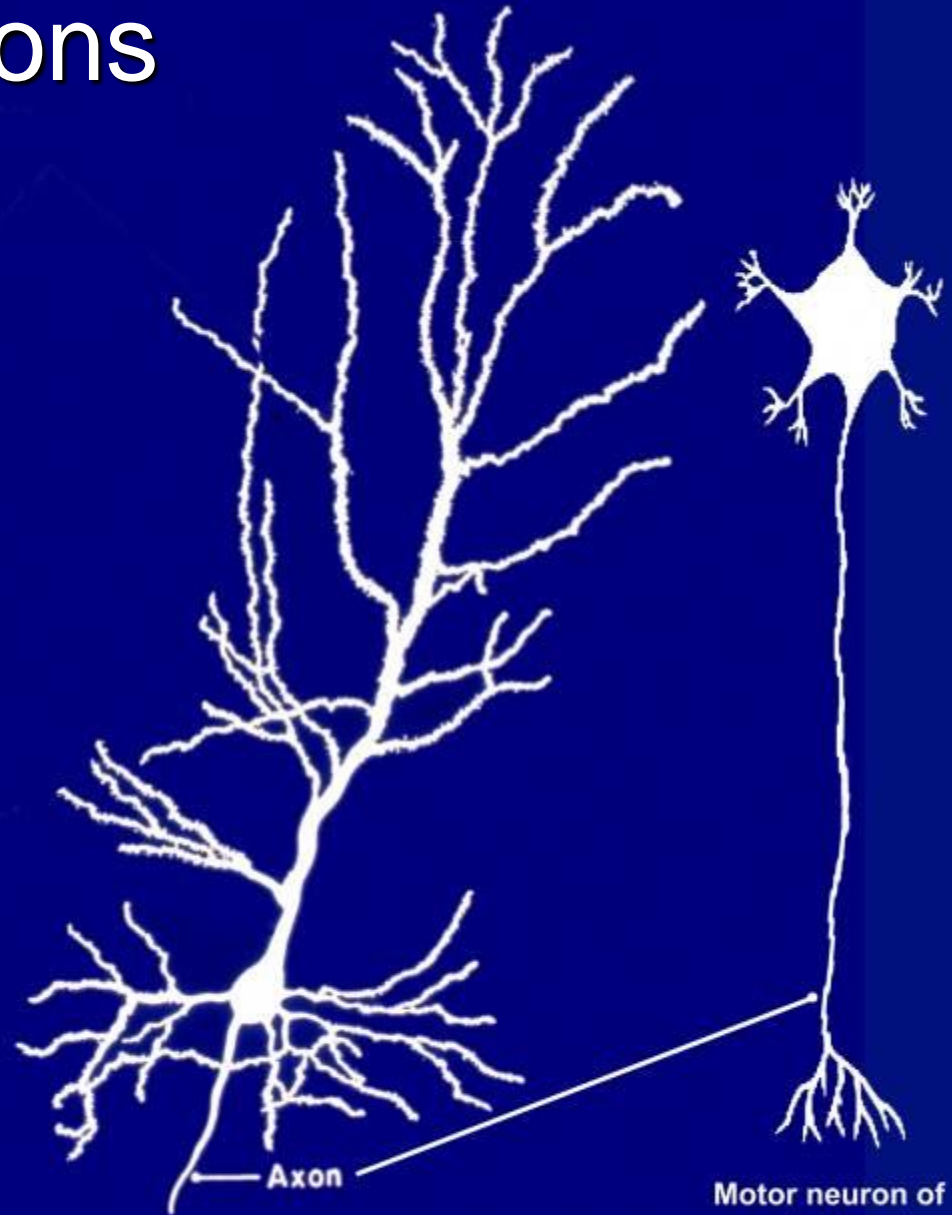


BIPOLÁRNÍ

Shapes of neurons



Purkinje cell of cerebellar cortex



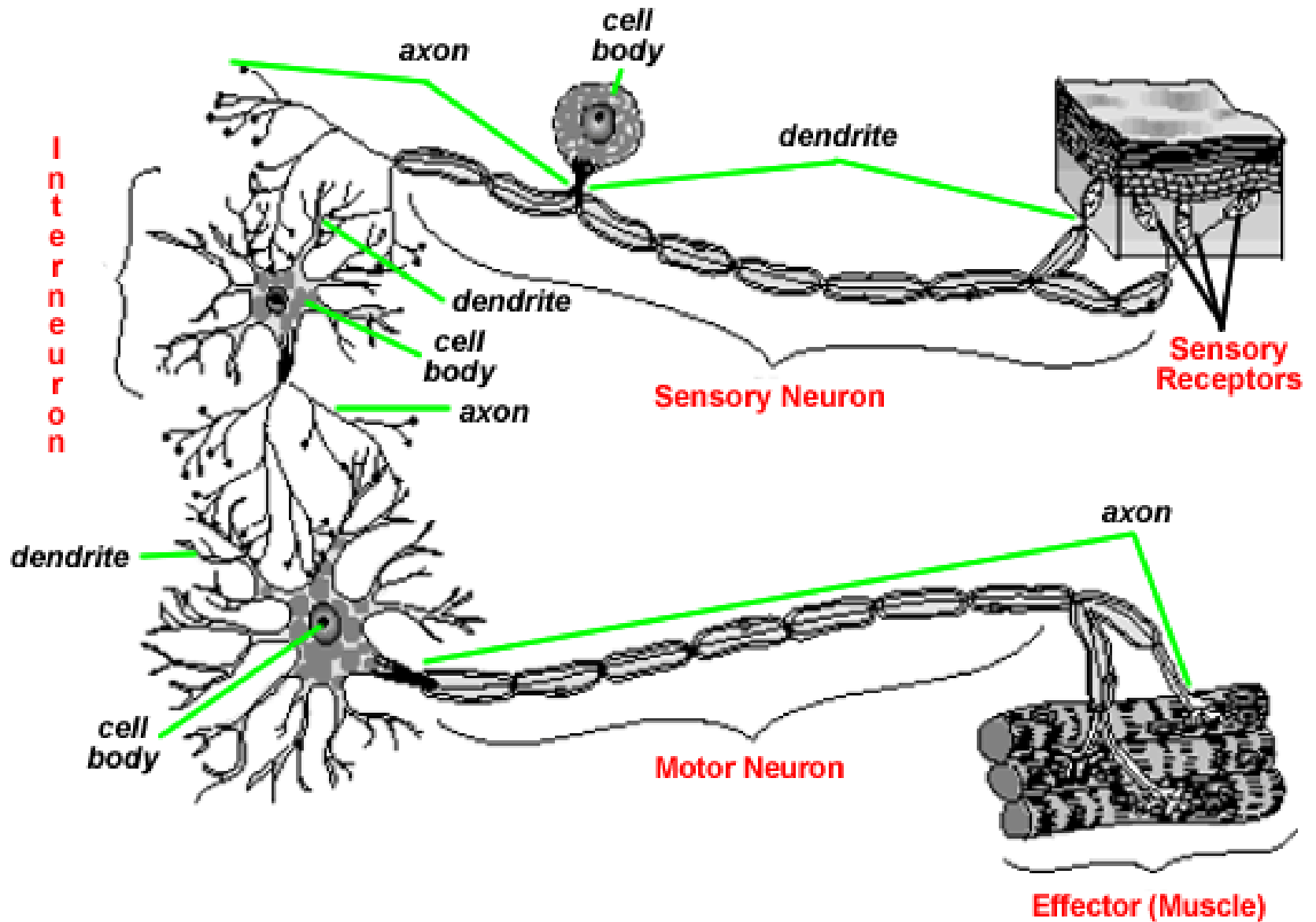
Pyramidal cell of cerebral cortex

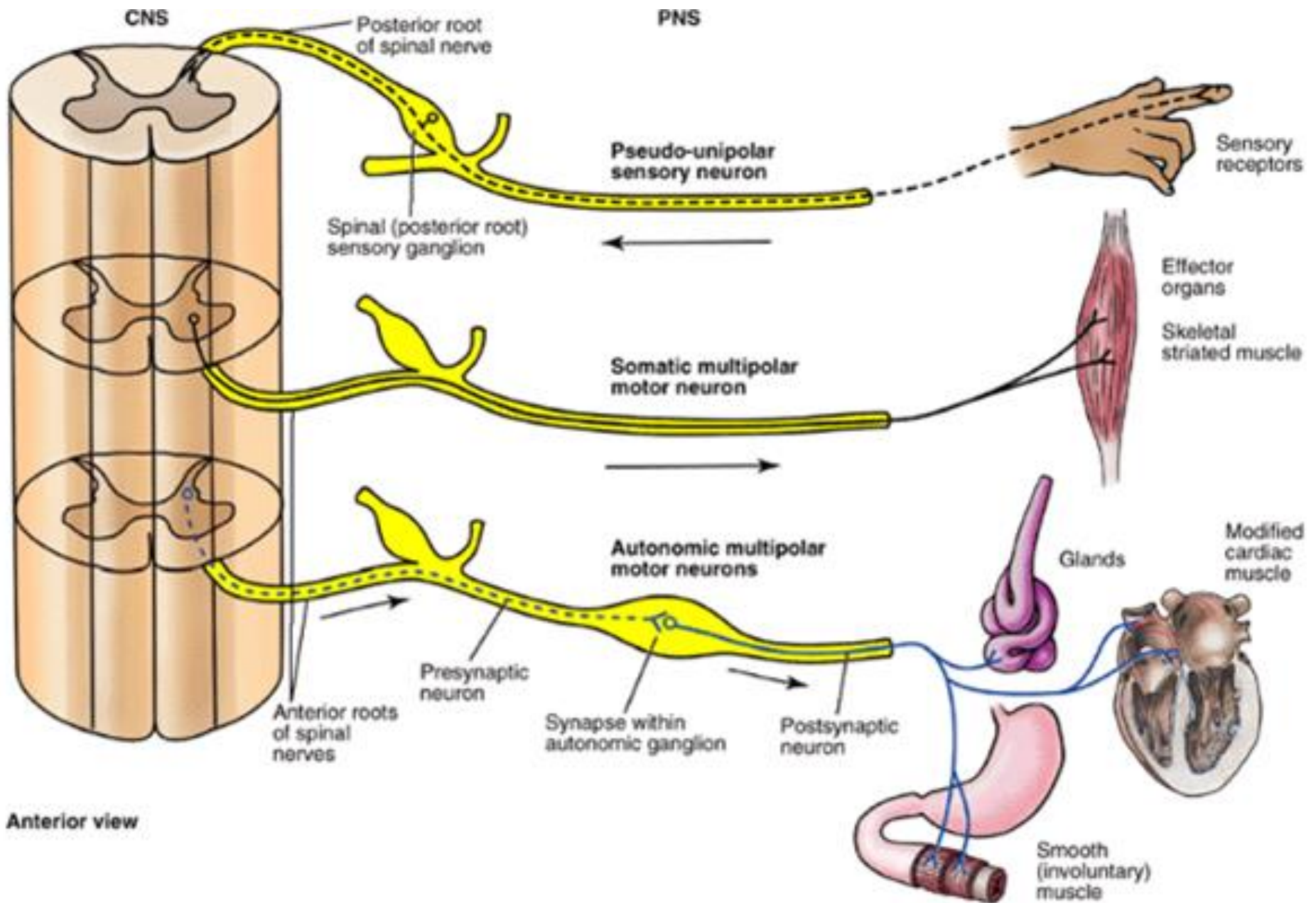
Motor neuron of spinal cord

Neuron types according to function

- motor neuron / motoneurons (efferent, centrifugal)
 - axons from CNS to periphery (effector organ)
 - somatomotor to skeletal muscles
 - visceromotor to smooth and cardiac muscles and glands
- sensory neurons (afferent, centripetal)
 - axons from periphery to CNS
 - receive information receptors
 - skin (somatosensory) = exteroception
 - organs (viscerosensory) = interoception
 - muscles, tendons, joint capsule = proprioception
 - eye, ear, tongue, nose = special sensory
- interneurons
 - complex interconnections between motor and sensory neurons

The 3 main types of Neurons

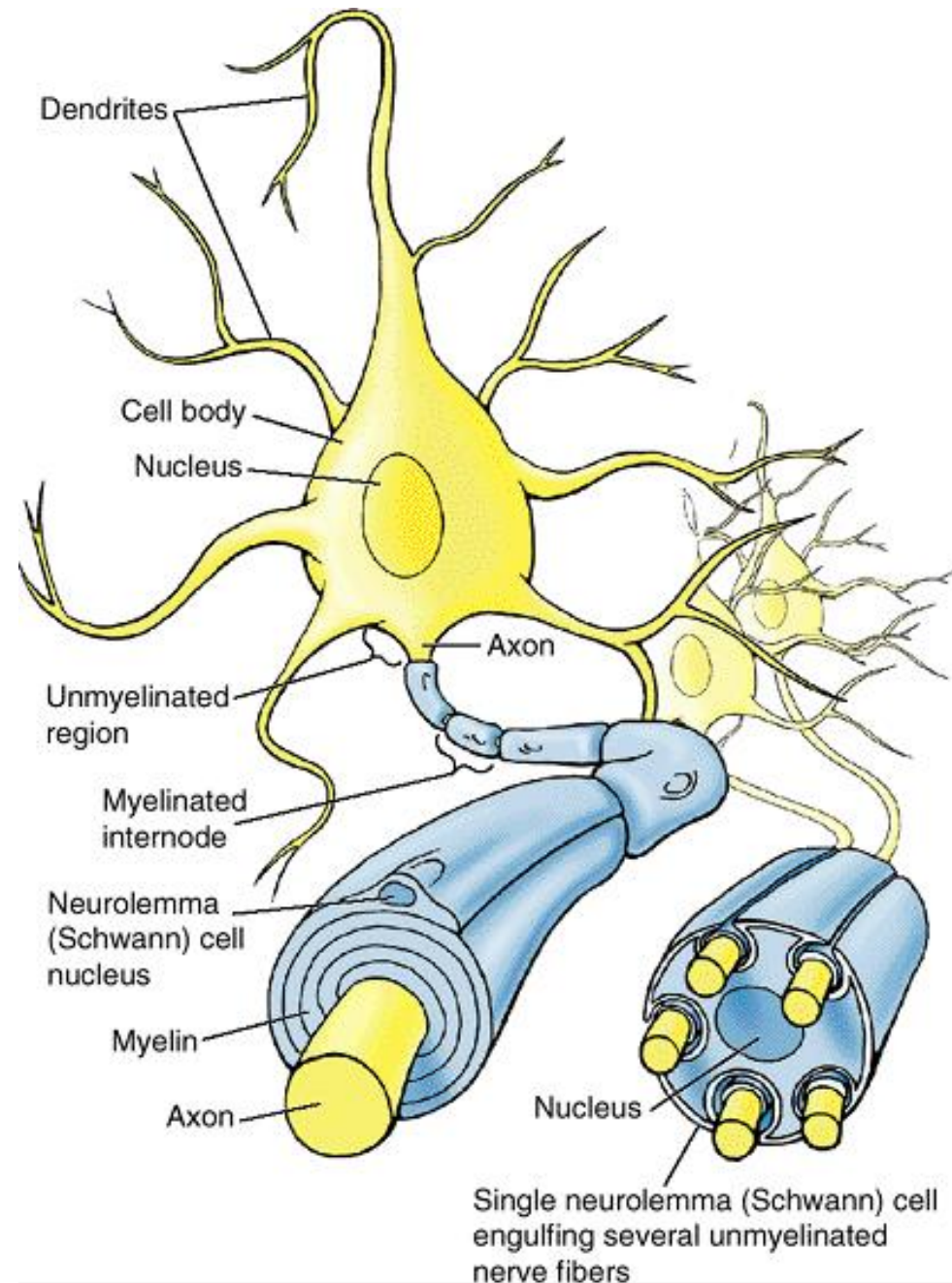


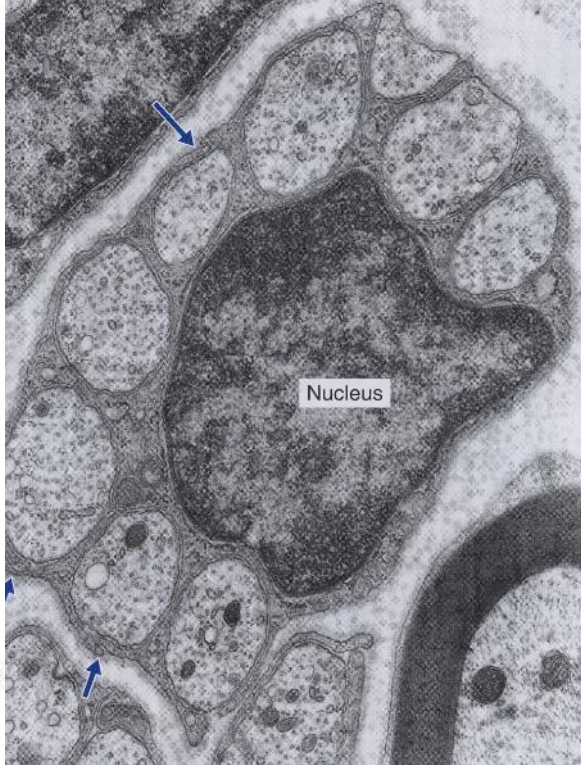


Neurofibra

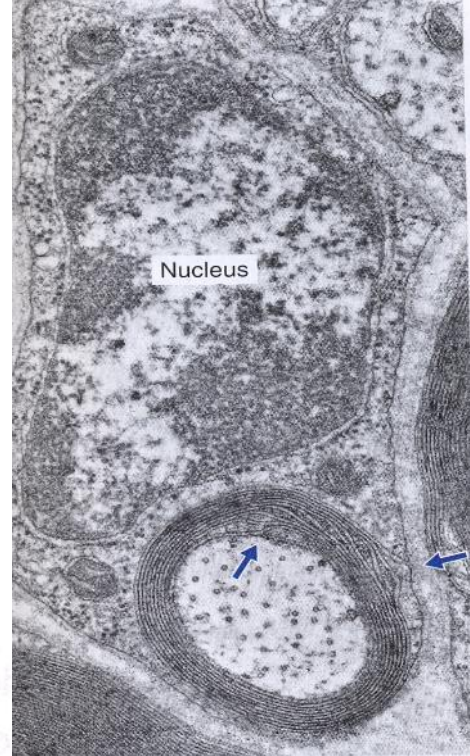
Nerve fibre

- axon
- neurolemma
- gray x white
- myelin sheath (*stratum myelini*)
- Ranvier's nodes (*nodi interruptionis myelini*; myelin sheath gaps)
- oligodendrocytes
- schwannocytes



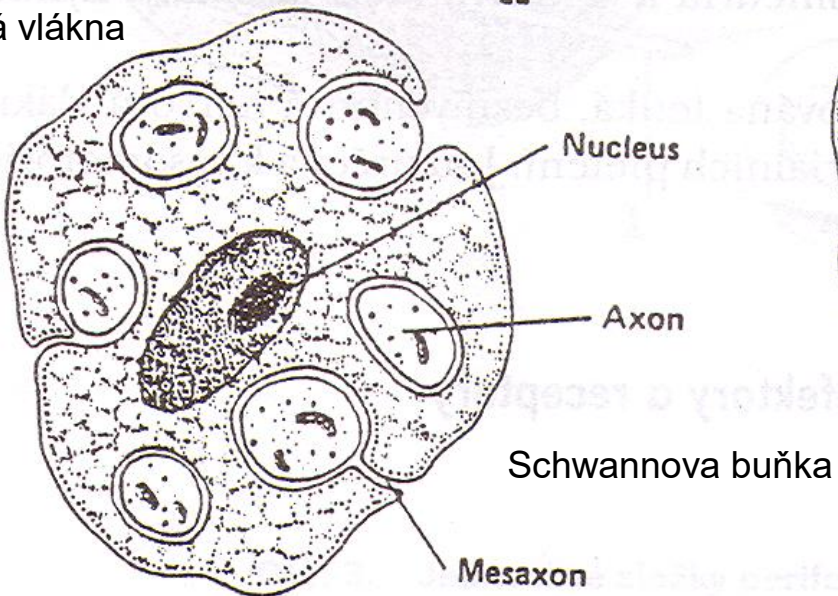


A

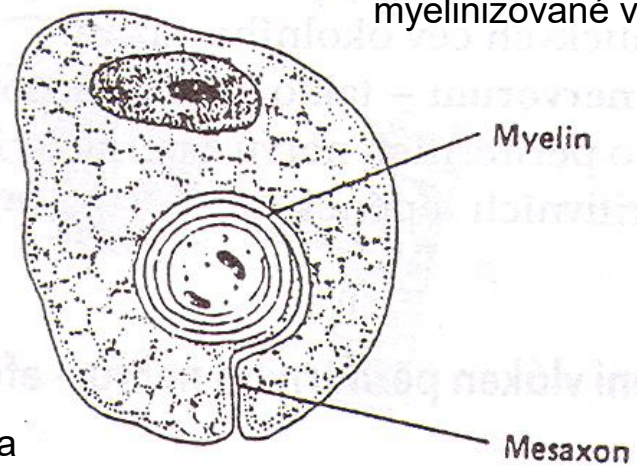


B

nemyelinizovaná vlákna

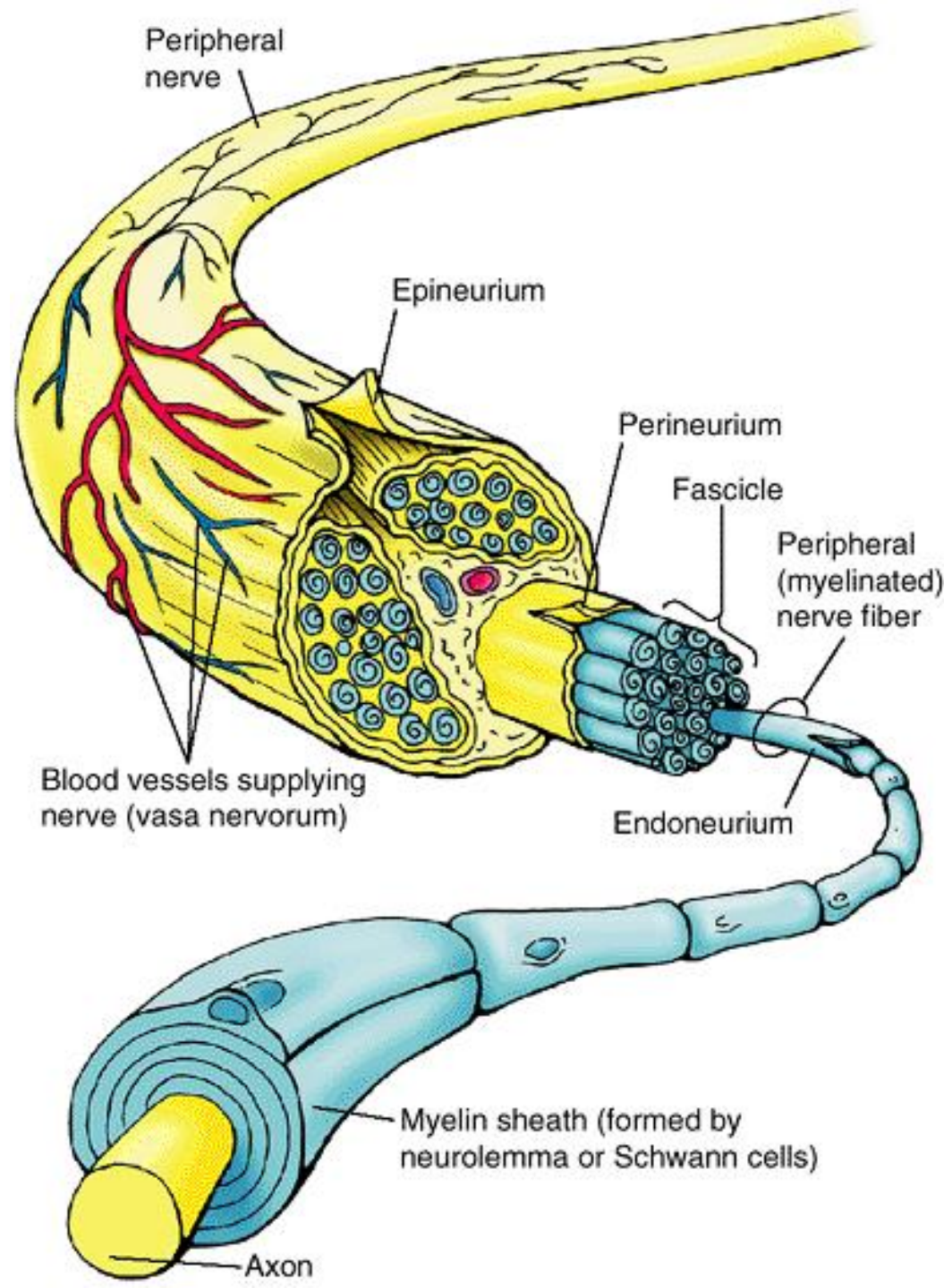


myelinizované vlákno



Nervi Nerves

- composed of nerve fibers
- covered with connective tissue
 - endoneurium
 - perineurium
 - epineurium
- vasa nervorum



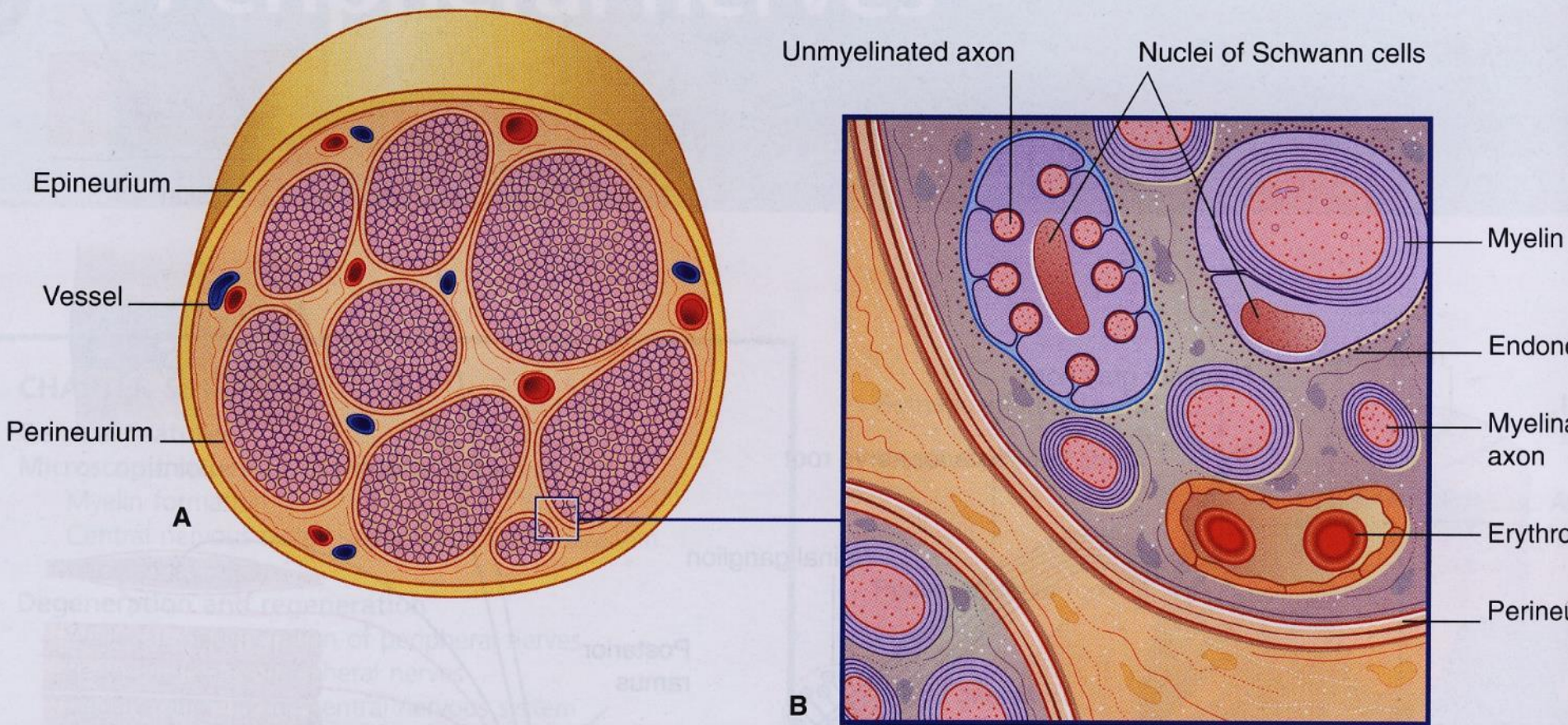
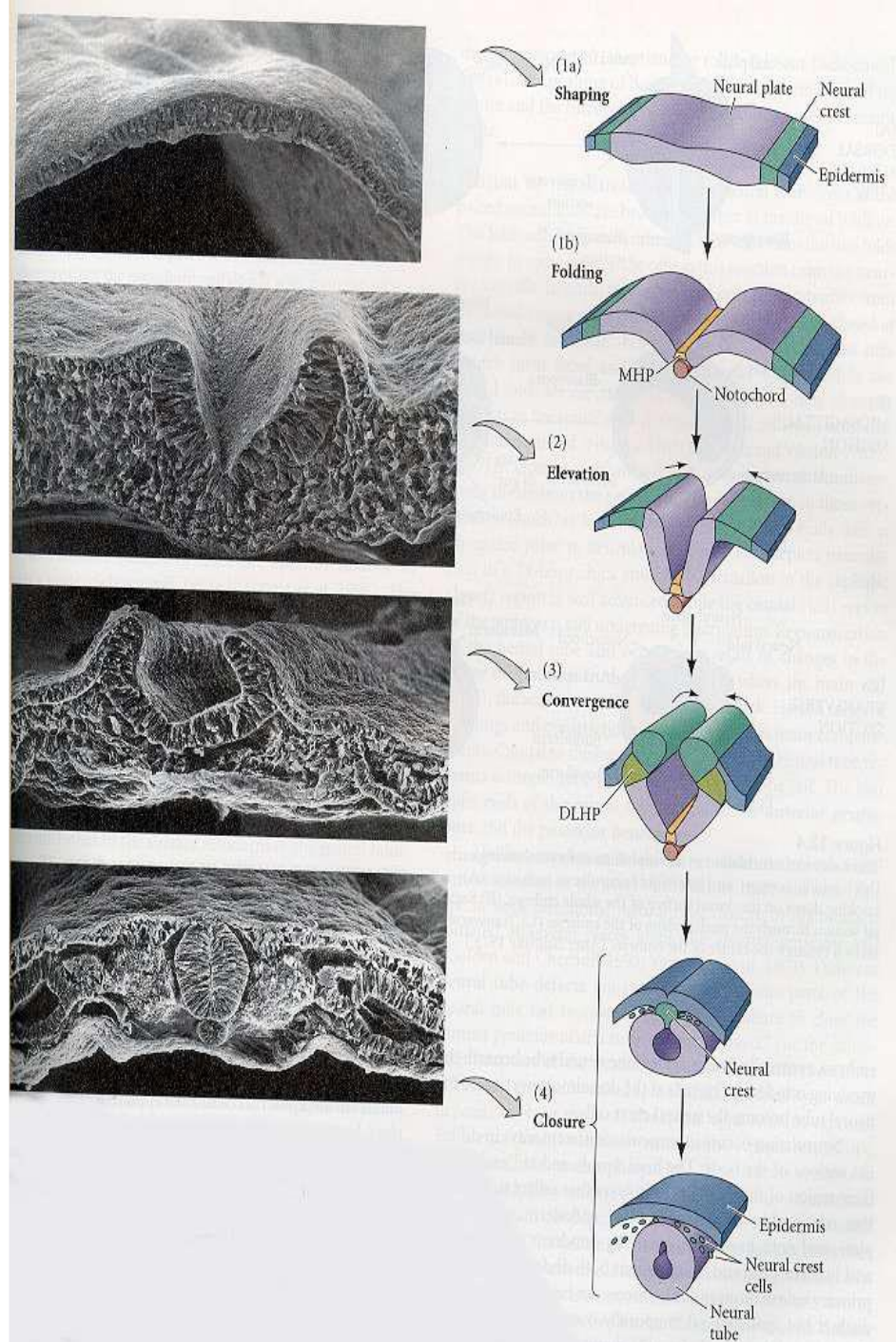


Figure 9.3 Transverse section of a nerve trunk. **(A)** Light microscopy. **(B)** Electron microscopy.

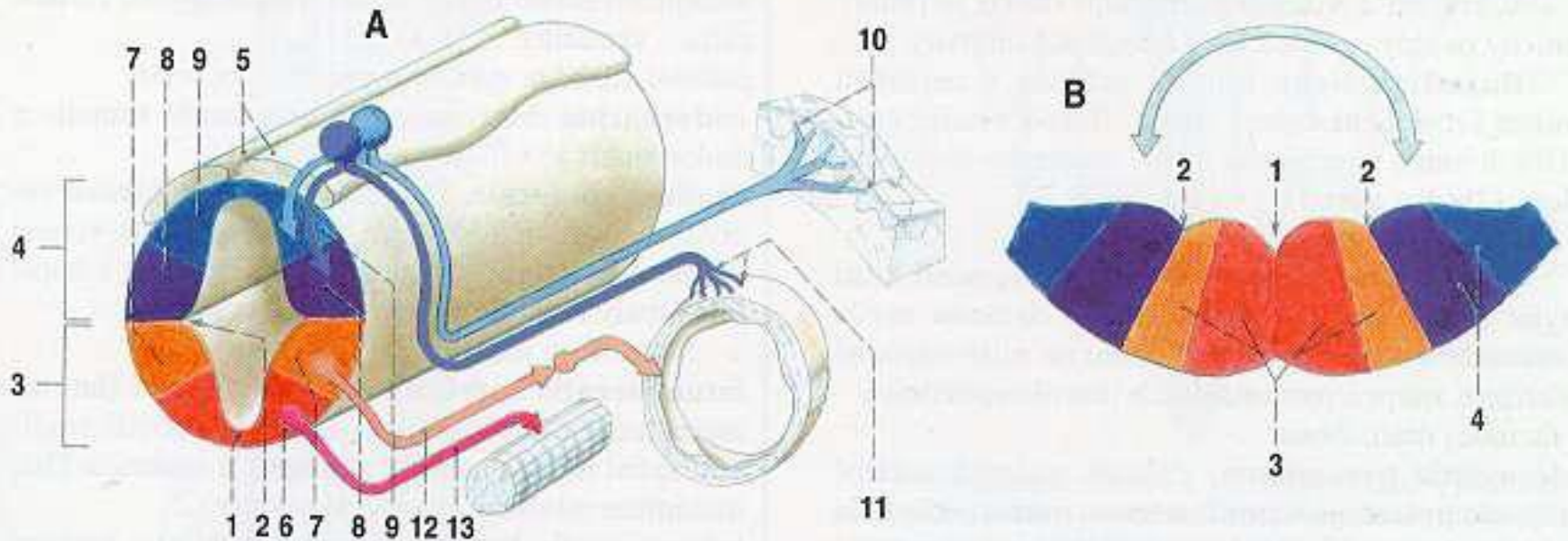
Development

- neural plate
- neural groove
- neural tube
- neural crest



- alar plate
- *sulcus limitans*
- basal plate

- somatosensory
- viscerosensory
- *sulcus limitans*
- visceromotor
- somatomotor



Peripheral nerves can carry 5 kinds of functionally different fibers

- **somatomotor** – to skeletal musculature of trunk and limbs
- **somatosensory** – from skin and musculature of trunk and limbs (touch, pain, proprioception)
- **visceromotor** – to cardiac and smooth musculature of viscera, blood vessels and glands
- **viscerosensory** – from viscera, vessels and heart
- **special sensory** – from special sensory organs (vision, hearing, balance, taste, smell)

The proportion of different fibers vary greatly in particular nerves.

Afferent fibers

- begins at receptors in periphery
 - exteroceptors (somatosensory, special sensory)
 - interoceptors (viscerosensory)
 - proprioceptors
- always synapsed in spinal / cranial ganglia
- enter the posterior spinal horn / brainstem
- ascending tracts in CNS (to cortex, cerebellum, RF)

Efferent fibers

- begin at anterior spinal horns
- **somatomotor** (conscious / voluntary movements)
 - motor unit
 - to extrafusal (alpha) and intrafusal fibers (gamma)
 - no ganglia, directly to neuromuscular plate
- **visceromotor** (unconscious / involuntary movements)
 - follow cranial nerves (III, VII, IX, X)
 - leave nervus spinalis as ramus communicans albus („preganglionic“)
 - synapsed in autonomic ganglion to „postganglionic“ and diverge
 - as ramus communicans griseus to spinal nerve and further to periphery
 - via branches of truncus sympathicus

Nuclei and ganglia

= collection of neuron cell bodies

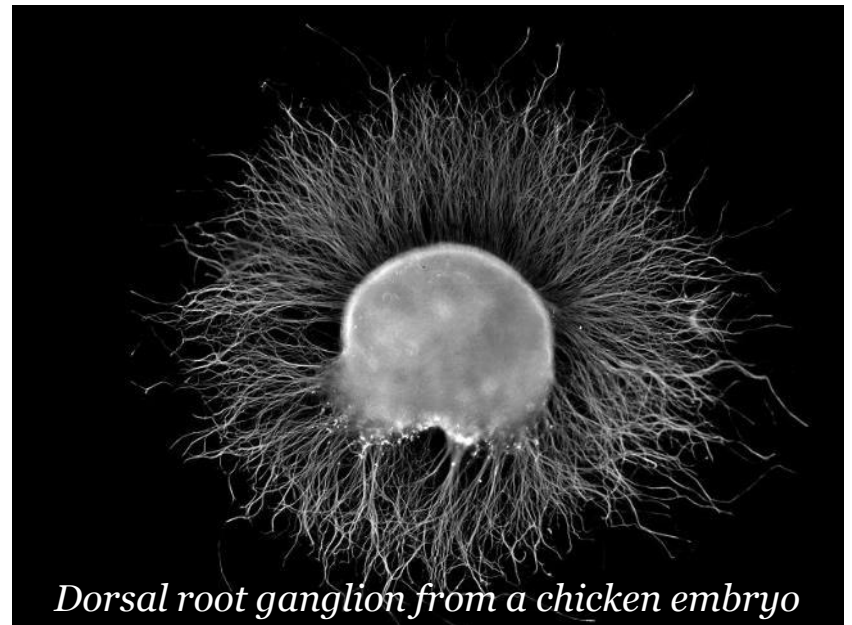
- ganglion

- outside CNS

- nerves of all modalities except somatomotor

- nucleus

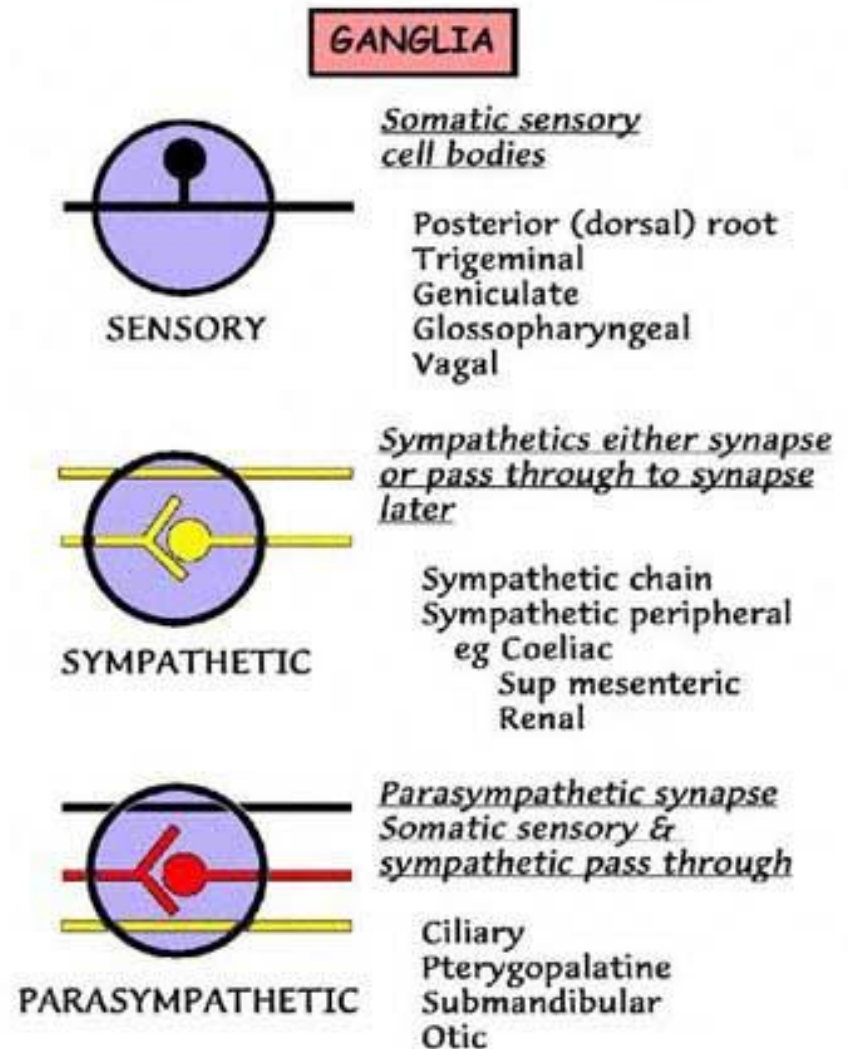
- within CNS



Dorsal root ganglion from a chicken embryo

Ganglia

- sensory
 - somatosensory
+ viscerosensory
 - special sensory
- autonomic (*obsolete term „vegetative“*)
 - sympathetic
 - parasympathetic



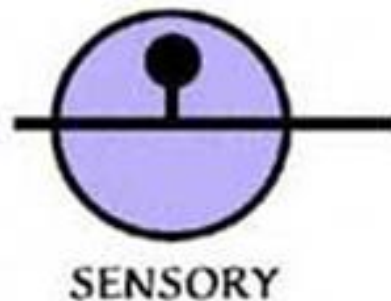
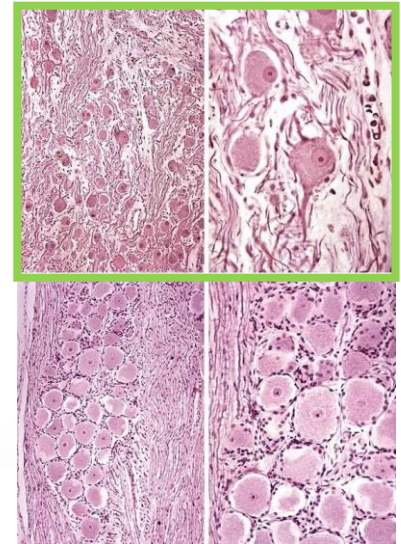
Each nerve has a cell body. For the sensory system this cell body is in the dorsal root ganglion or the equivalent for the sensory cranial nerves. There are no synapses in such ganglia.

In the sympathetic ganglia there are two alternatives. For those nerves that synapse there are cell bodies belonging to the post-ganglionic fibres. Others pass through without synapsing (gut & adrenal).

In the parasympathetic ganglia in the head and neck there is always a synapse with a post-ganglionic cell body.

Somatosensory ganglion

- **ggl. spinalia** – at radix posterior n. spinalis
- **ggl. of cranial nerves** – V, VII, IX, X
- contain **pseudounipolar neurons** („T-cells“)
- afferent
- neuromediator is glutamate (GLT)
- fibers do **not** synapse here !

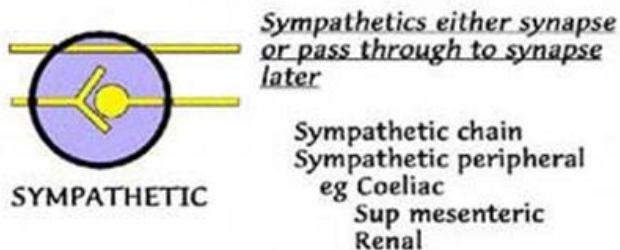
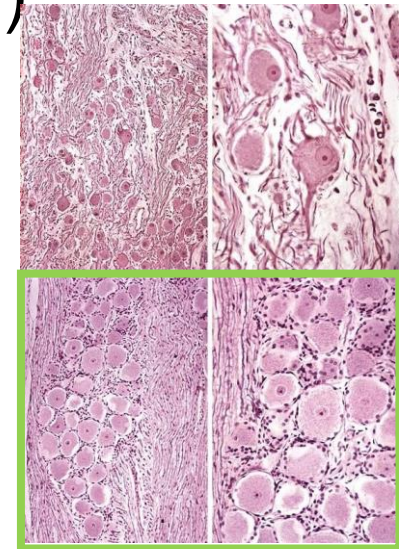


*Somatic sensory
cell bodies*

Posterior (dorsal) root
Trigeminal
Geniculate
Glossopharyngeal
Vagal

Autonomic ganglion

- **sympathetic** – paravertebral and prevertebral
- **parasympathetic** – cranial (ggl. ciliare, pterygoplatinum, submandibulare, oticum) and organ (within wall of internal organs = intramural)
- contain multipolar neurons
- efferent
- neuromediator is acetylcholine (Ach) in P_{Sy} and noradrenaline (Nor) in S_y
- fibers usually do synapse here !

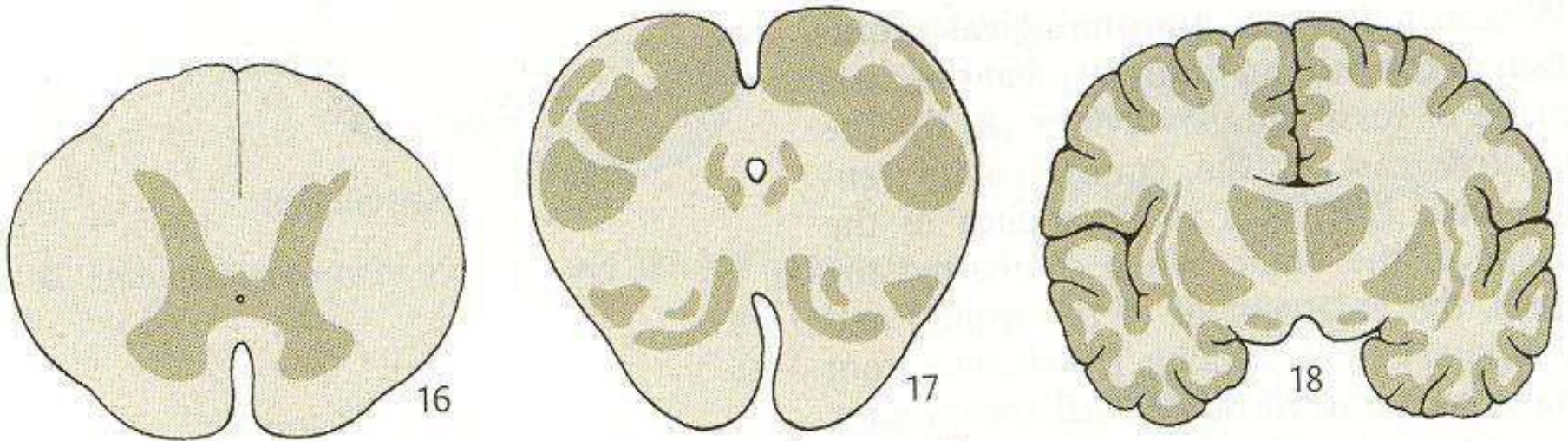


Special sensory ganglion

ganglia n. VIII

- ggl. cochleare
- ggl. vestibulare
- functionally correspond to sensory ganglion
- afferent
- contain **bipolar neurons**
- fibers do always synapse here

- **substantia grisea (gray matter)**
 - contains neurons (perikarya and dendrites)
- **substantia alba (white matter)**
 - bundles of nerve fibers (axons and central processes of pseudounipolar neurons) passing to or from nuclear region,
 - form tract or fasciculus

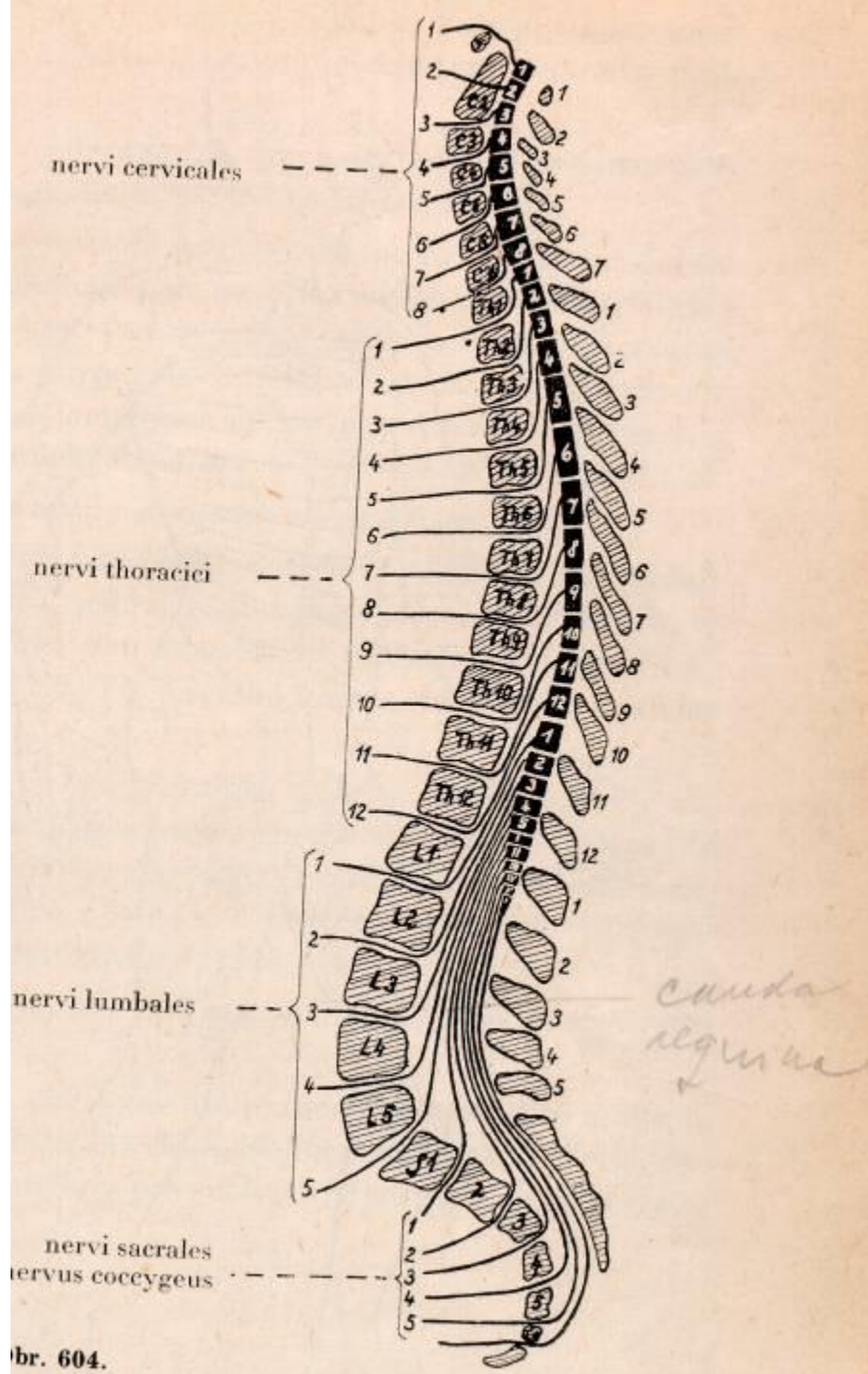
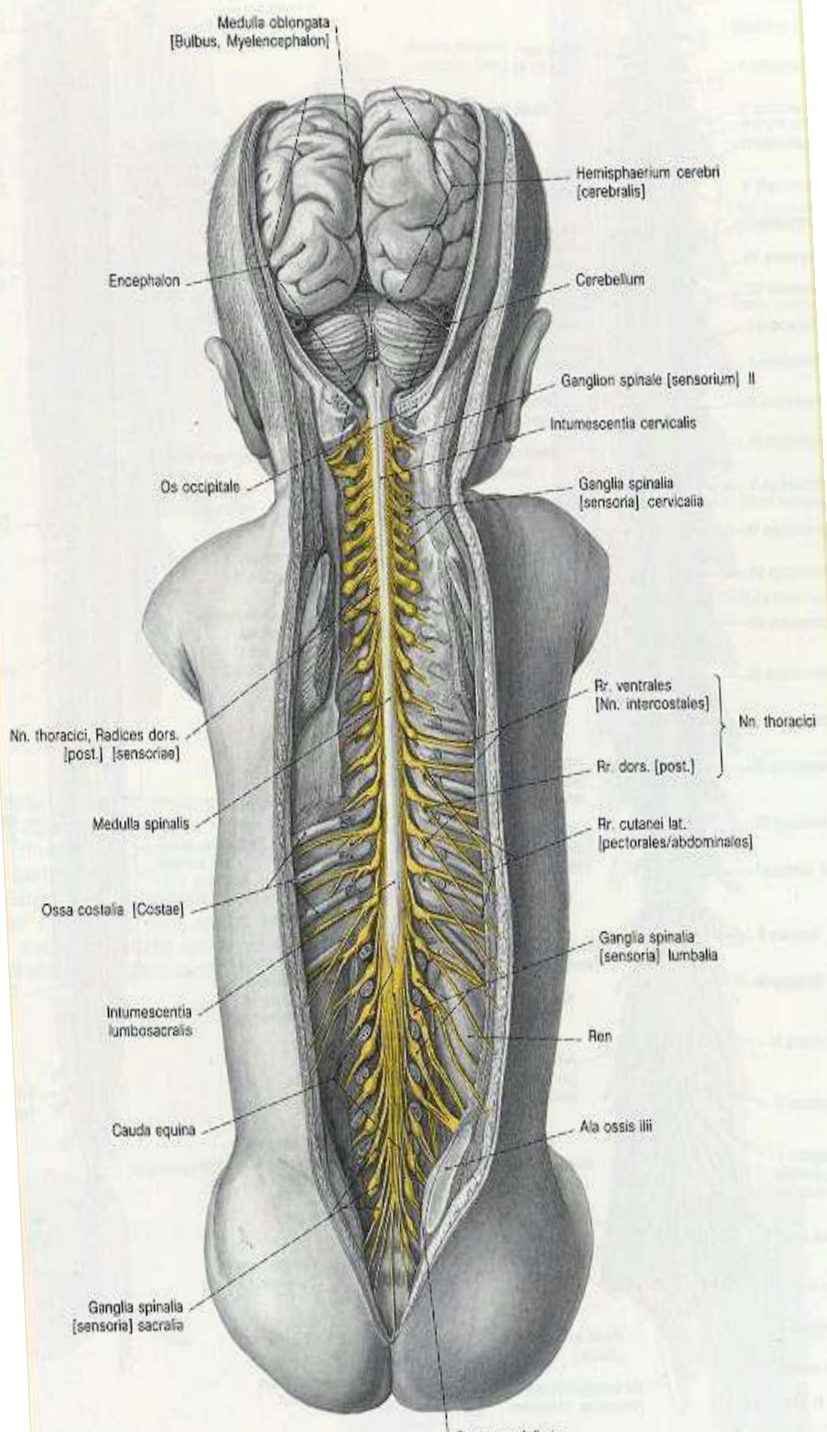


B Distribution of white and gray matter

Basic neuroanatomy - Parts of nervous system

Systema nervosum periphericum (peripheral nervous system)

- nervi spinales (spinal nerve)
- nervi craniales (cranial nerves)
- systema autonomicum (autonomic nerves)
 - obsolete term „vegetative system“
 - pars sympathica (sympathetic)
 - pars parasympathica (parasympathetic)
 - pars enterica (enteric nervous system)



br. 604.

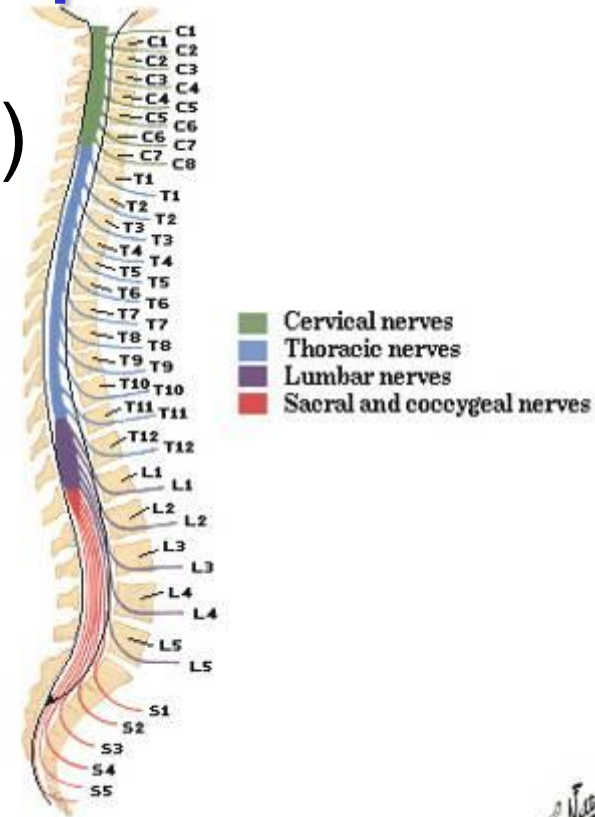
Nervi spinales – 31 pairs

mixed nerves (different modalities)

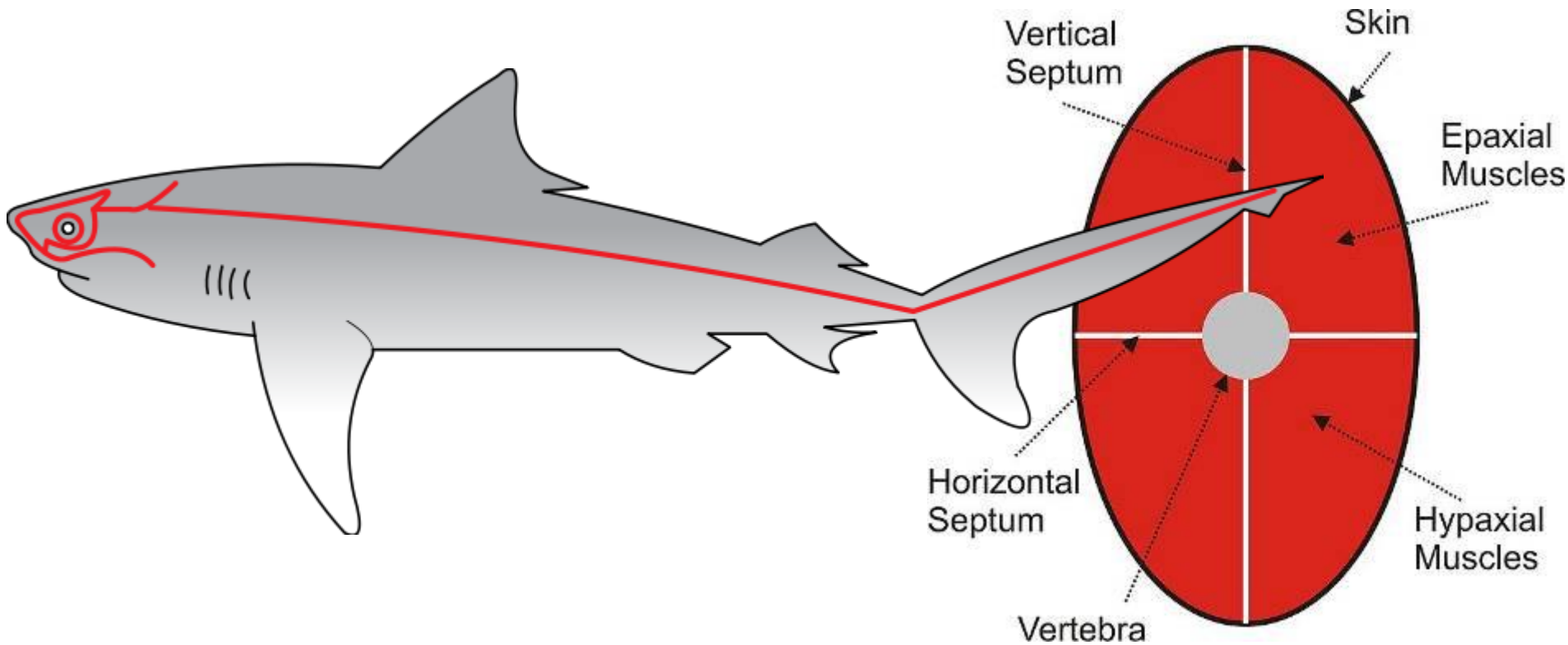
- nervi cervicales – 8 pairs
- nervi thoracici – 12 pairs
- nervi lumbales – 5 pairs
- nervi sacrales – 5 pairs
- nervus coccygeus – 1 pair

exit via foramen intervertebrale

- S1-S4 already as r. ant+post. via foramina sacralia ant.+post.
- S5 + Co via hiatus sacralis

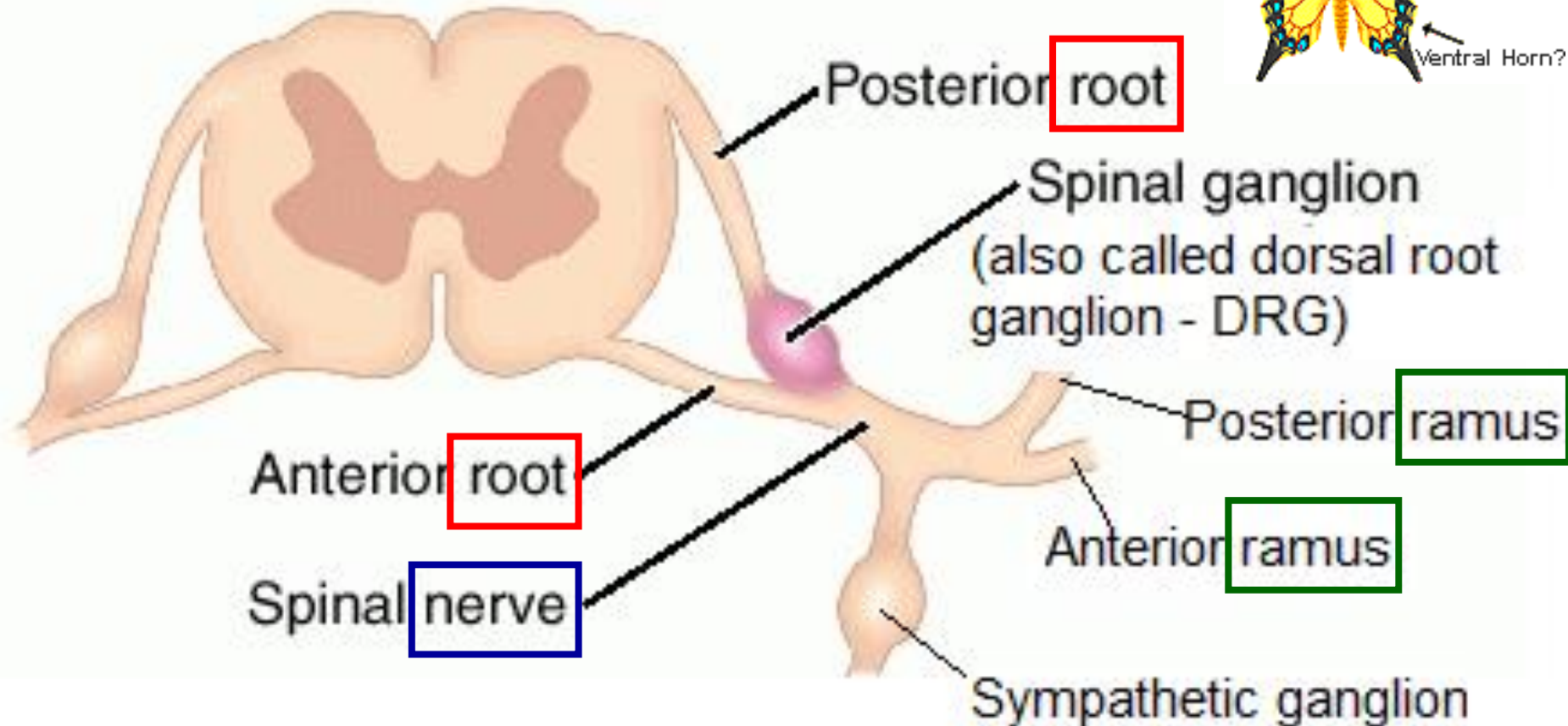


Epaxial and hypaxial muscles



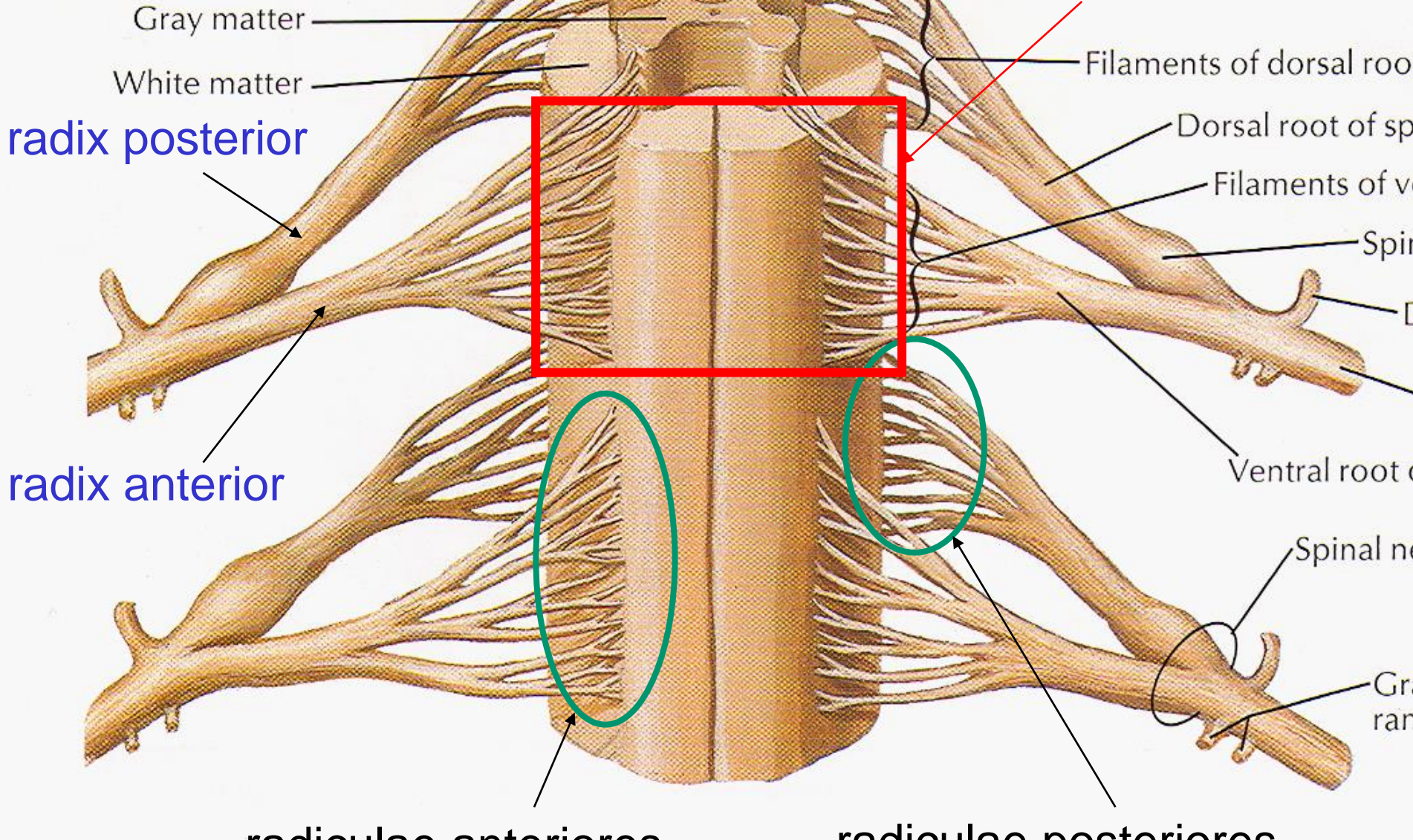
Macroscopy of spinal nerve branching

radices → nervus → rami



Radices nervi spinalis Roots of spinal nerves

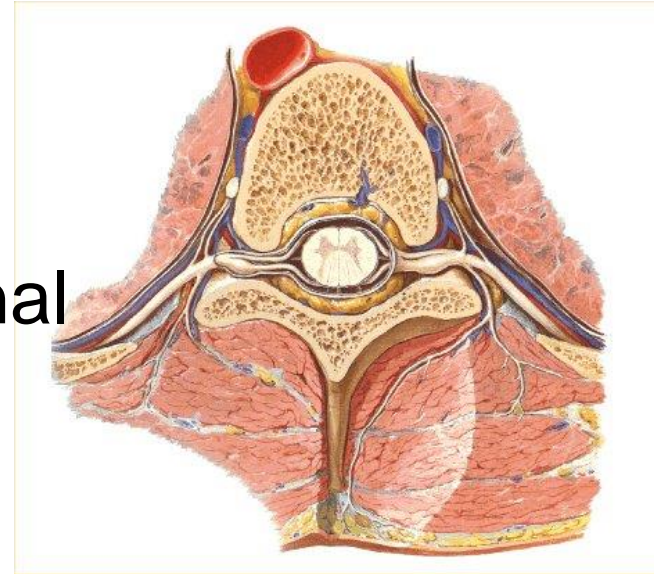
Membranes removed: anterior view
(greatly magnified)



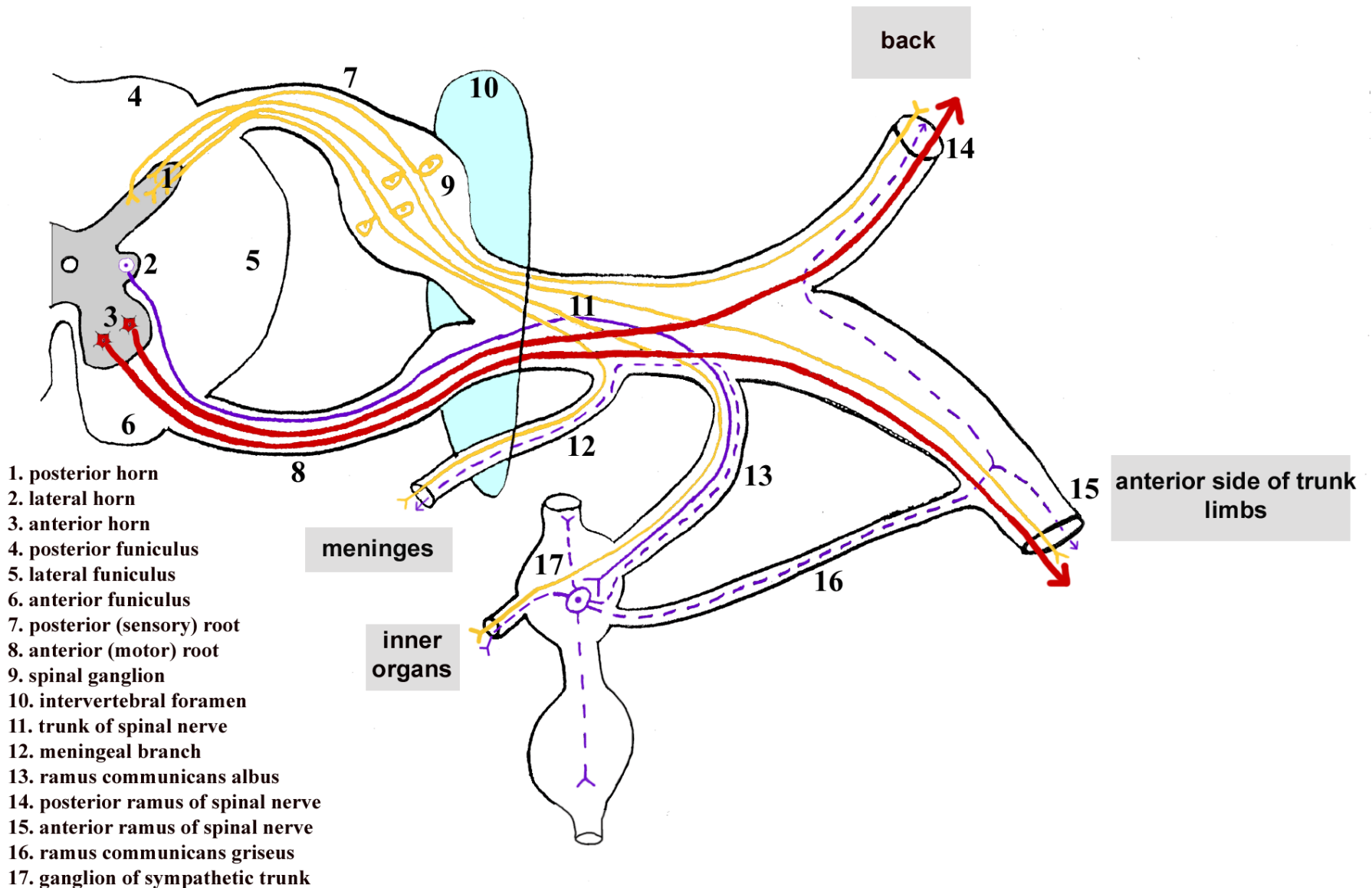
Rami nervi spinalis

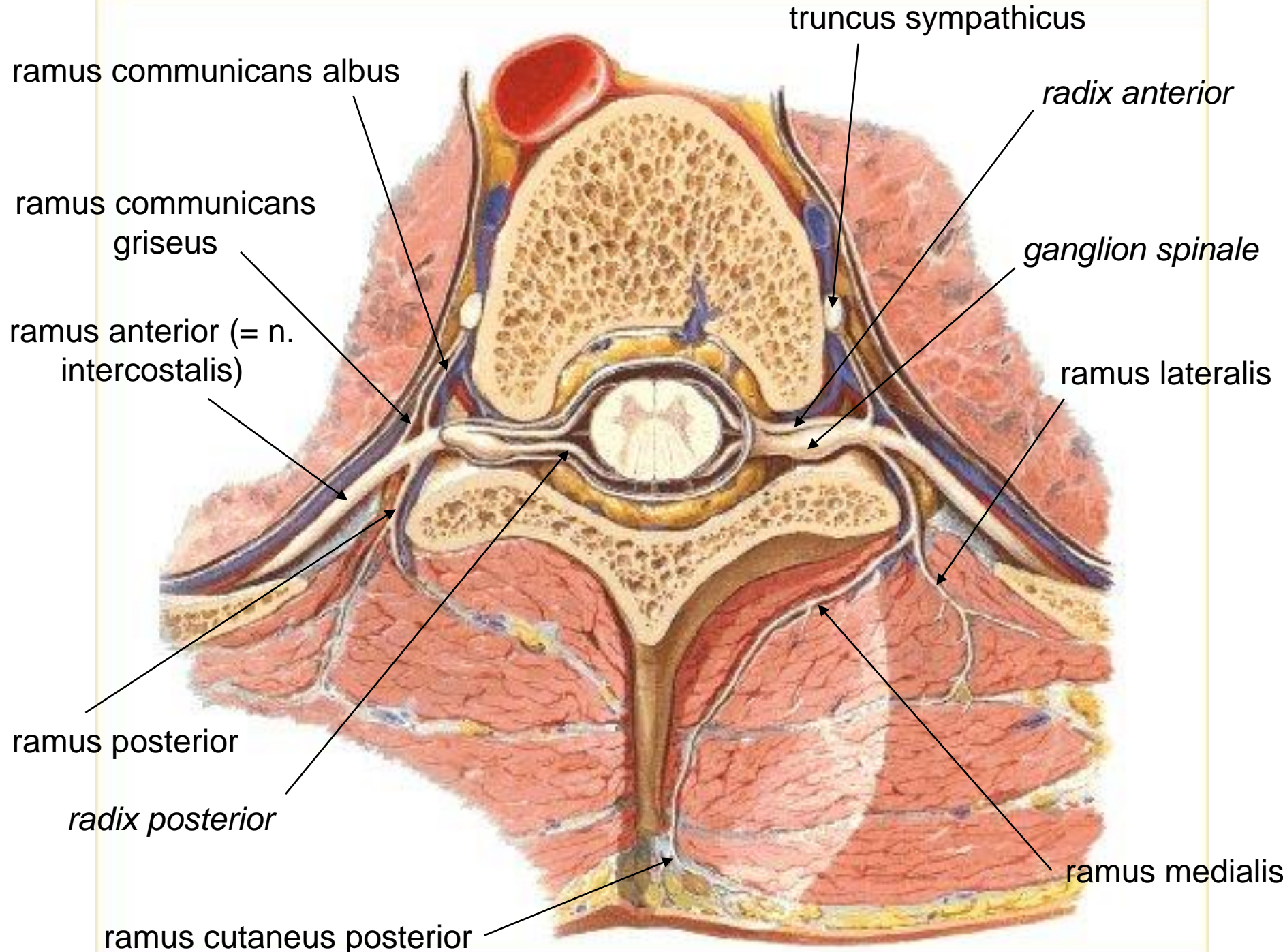
Branches of spinal nerve

- **r. anterior** → *forms plexuses* → *hypaxial muscles*
- **r. posterior** → *epaxial muscles*
- **r. meningeus**
 - recurrent branch to vertebral canal
 - sensory and visceromotor fibers
- **r. communicans albus**
 - preganglionic fibers to truncus sympathicus and its ganglia (C8-L3)
- **r. communicans griseus**
 - postganglionic fibers from ganglion trunci sympathici back to n. spinalis



SCHEME OF SPINAL NERVE BRANCHING

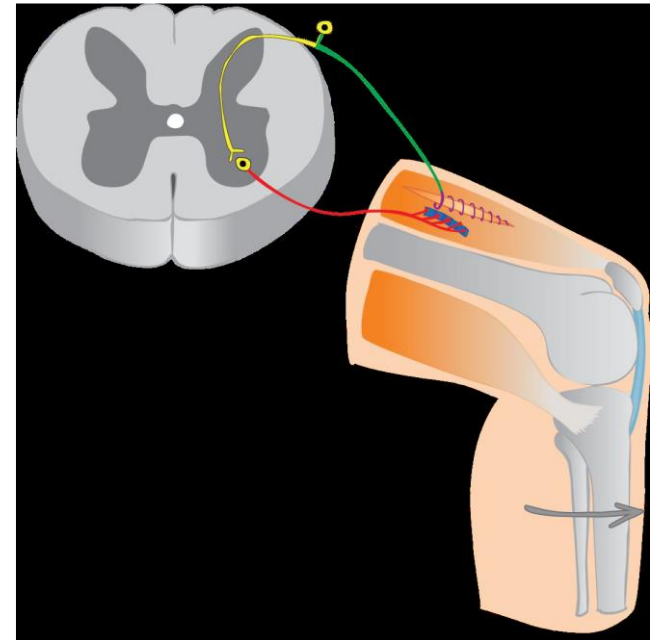




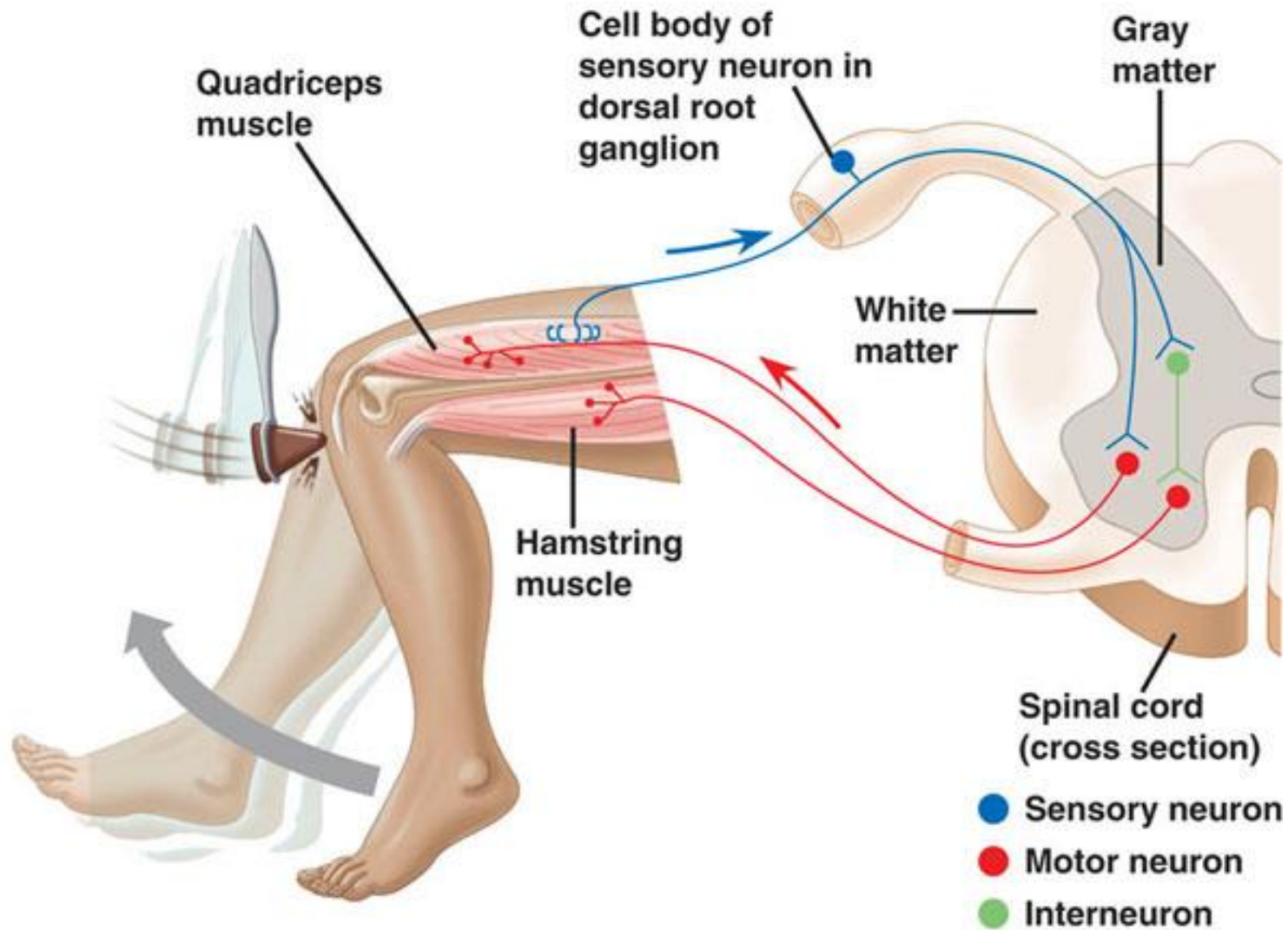
Proprioceptive monosynaptic reflex arc

– jerk reflex

1. somatic **receptor** – muscle spindle (intrafusal muscle fibers)
2. **afferent limb** – peripheral + central process of pseudounipolar neuron
3. integrating center in CNS (synapse)
 - 3.1 somat**ensory** – pseudounipolar neuron
 - 3.2 somat**omotor** – alfa-motoneuron
4. **efferent limb** – axon of alfa-motoneuron
5. **effector** – contraction of striated muscle (agonist)

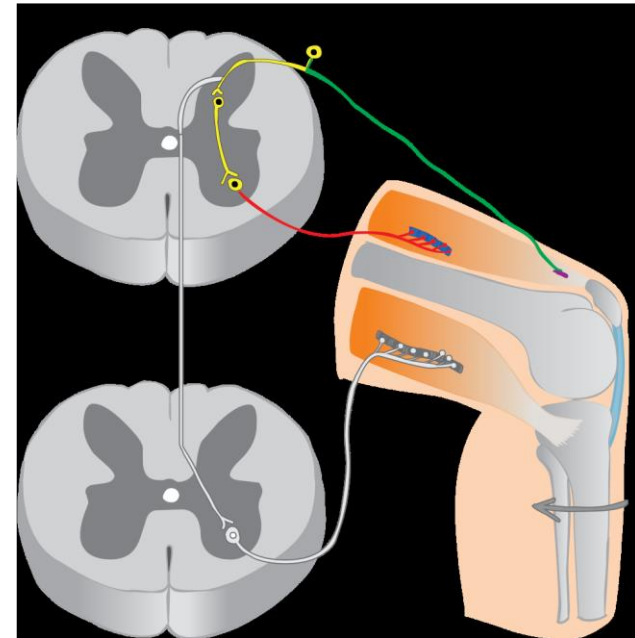


Monosynaptic reflex



Polysynaptic monosegmental spinal reflex arc

1. **receptor** – Golgi tendon organ of striated muscle
2. **afferent limb** – peripheral + central process of pseudounipolar neuron
3. **integrating center** in CNS (synapse)
 - more than 2 neurons
 - 3.1 **somatosensory** – pseudounipolar neuron
 - 3.2 **interneuron**
 - 3.3 **somatomotor** – alfa-motoneuron
4. **efferent limb** – axon of alfa-motoneuron
5. **effector** – relaxation of the stimulated muscle (agonist), dominance of antagonist



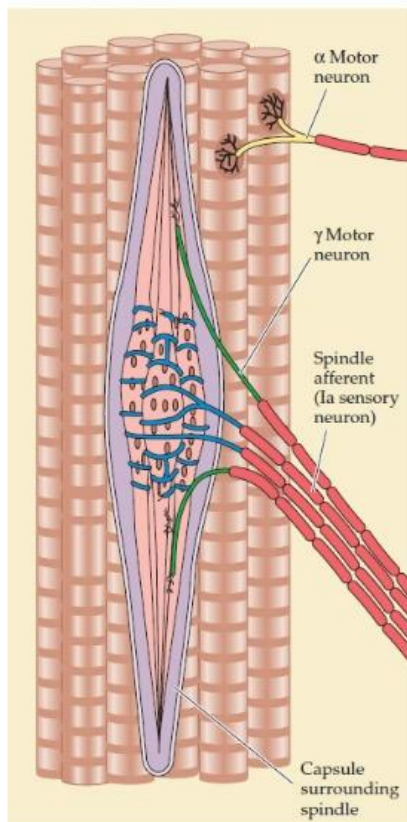
Maintaining of muscle spindle

Muscle spindle responds to muscle stretching → increased activity of α -motoneurons for the same muscle

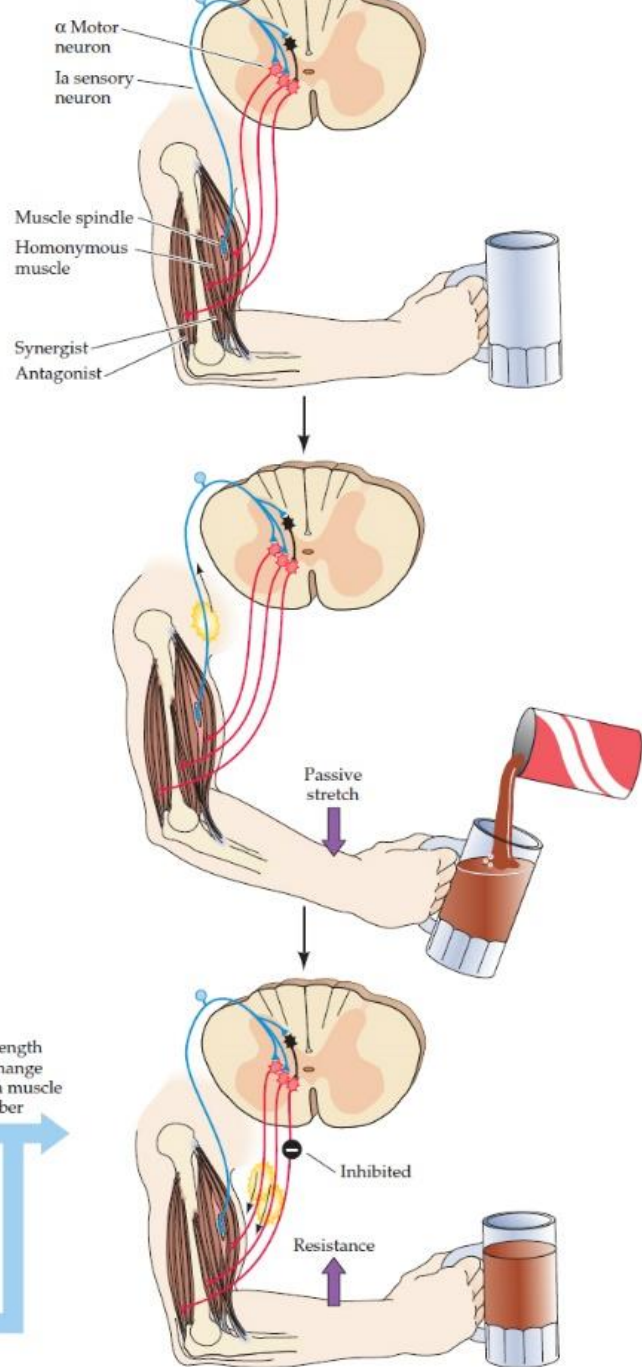
+ simultaneous excitation of synergist motoneurons
+ simultaneous inhibition of antagonist motoneurons

The reflex acts as a feedback and regulates the length of the muscle

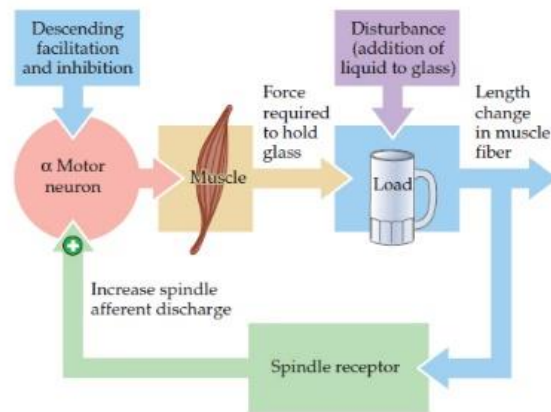
(A) Muscle spindle



(B)



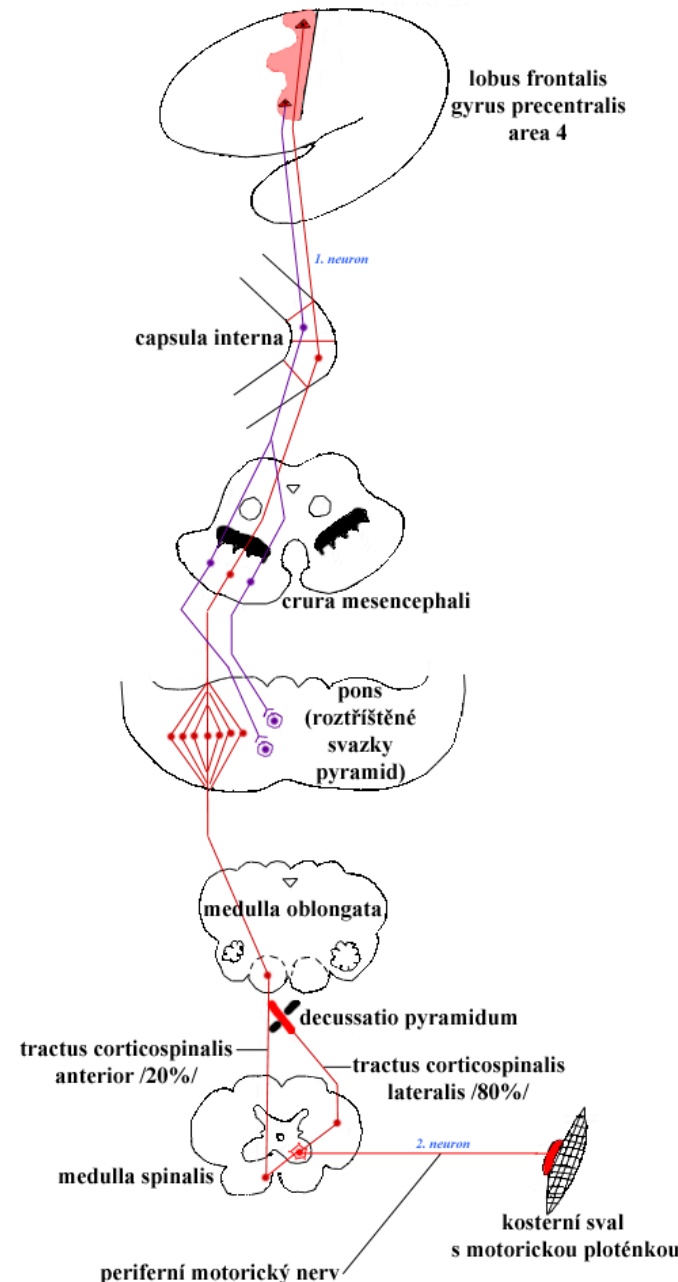
(C)



Tractus pyramidalis

- 2-neuron tract
- cortex → muscle
- 1st-order-neuron (upper motoneuron) = pyramidal cell of cerebral cortex
- 2nd-order-neuron (lower motoneuron) = alpha-motoneuron of anterior spinal horn
- decussated at level of C1
- lesion: *central contralateral palsy*

TRACTUS PYRAMIDALIS
- **fibrae corticospinales (zkřížená dráha)**
- **fibrae corticonucleares**
(nezkřížená dráha s výjimkou n. IV a části n. III)



Peripheral (= flaccid) paralysis/palsy

- lesion of peripheral = 2nd = motoneuron of anterior spinal horn (perikaryon within spinal cord or axon within nerve)
- **reduced muscle tone (= hypotonia)**
- **lesion of voluntary motorics (= paresis) –**
checked by muscle test 0-5
- **reduced or absent tendon reflexes (= hypo-, areflexia)**
- absent pathological pyramidal irritation reflexes
- prominent muscle hypotrophy
- reduced or absent exteroceptive (= skin) reflexes
- typical lesions of sensitivity (according to dermatomes)

Central (= spastic) paralysis/palsy

- lesion of central = 1st = cortical motoneuron (axon travels within tractus pyramidalis)
- **elevated muscle tone (= spasticity)**
- **lesion of voluntary motorics (= paresis)** – *checked by muscle test 0-5*
- **elevated tendon reflexes (= hyperreflexia)**
 - lowered threshold of sensitivity, elevated intensity of muscle response, extended reflectory zone
- pathological pyramidal irritation reflexes (e.g. Babinski)
- discrete muscle hypotrophy
- reduced or absent exteroceptive (= skin) reflexes
- spinal shock (3 days up to several weeks)
 - pseudoflaccid palsy during this period

plegia/paralysis = complete palsy (*muscle test* = 0)

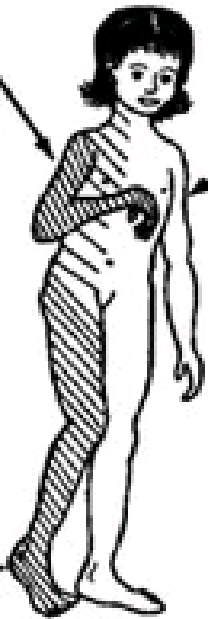
paresis = incomplete/partial palsy

Central (= spastic) paralysis/palsy

**ARM AND LEG
ON ONE SIDE
(HEMIPLEGIC)**

arm bent;
hand
spastic
or floppy,
often of
little use

She walks
on tiptoe
or outside
of foot on
affected
side.



this side
completely
or almost
normal

**BOTH LEGS ONLY
(PARAPLEGIC)
or with slight
involvement elsewhere
(DIPLEGIC)**

upper body
usually
normal or
with very
minor signs

Child may
develop
contractures
of ankles
and feet.



**BOTH ARMS AND
BOTH LEGS
(QUADRIPLEGIC)**

When he walks, his
arms, head, and
even his mouth may
twist strangely.

Children with all
4 limbs affected
often have such
severe brain damage
that they never
are able to walk.

The knees press
together.

legs and feet
turned inward



Central (= spastic) paralysis/palsy

Identifying gait abnormalities

SPASTIC GAIT



SCISSORS GAIT



PROPULSIVE GAIT



STEPPAGE GAIT



WADDLING GAIT



Mixed paralysis/palsy

- in ALS (= amyotrophic lateral sclerosis)
- concurrent lesion of anterior spinal horns and pyramidal tract
- 2-3 year survival
- *Stephen W. Hawking (1942-2018) – ill from 1963*



Axon regeneration

- PNS
cca 2 mm/day
- CNS
no
regeneration

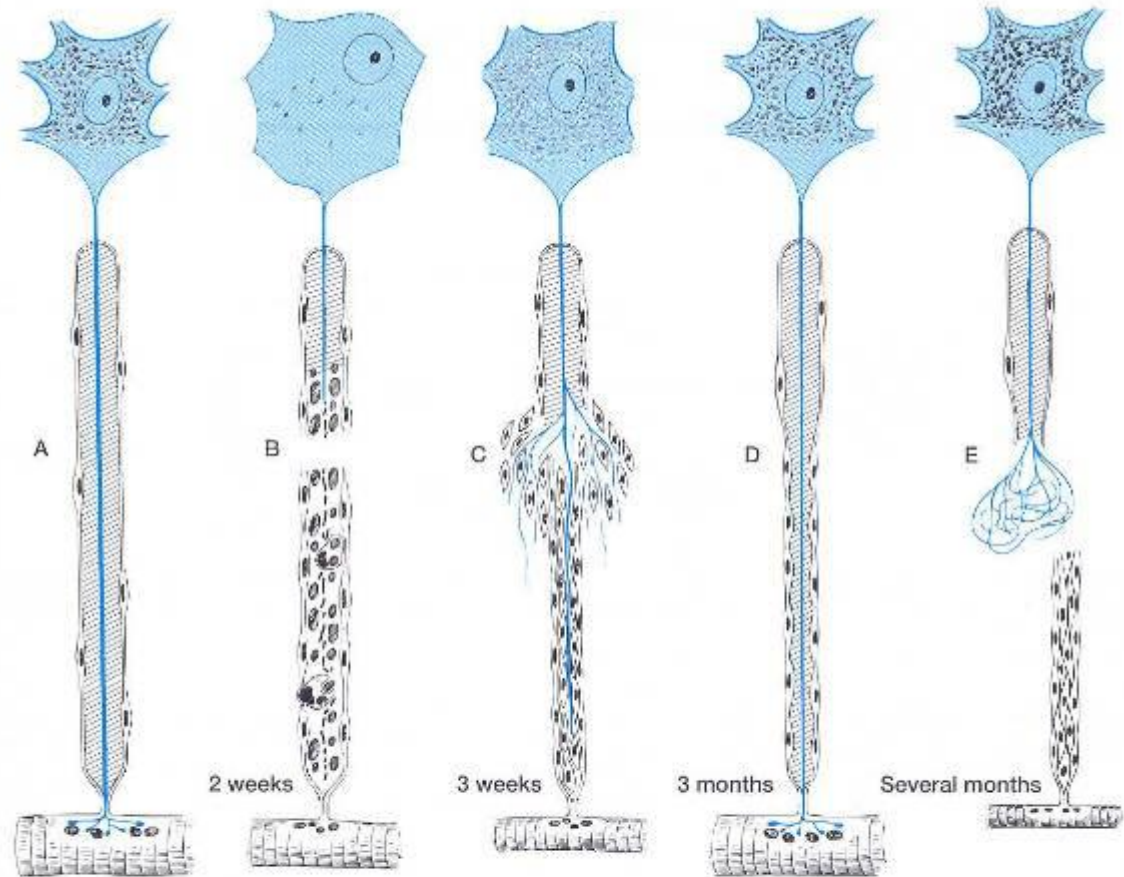


Figure 22-8. Main changes that take place in an injured nerve fiber. **A:** Normal nerve fiber, with its perikaryon and the effector cell (striated skeletal muscle). Notice the position of the neuron nucleus and the amount and distribution of Nissl bodies. **B:** When the fiber is injured, the neuronal nucleus moves to the cell periphery, and Nissl bodies become greatly reduced in number (chromatolysis), and the nerve fiber distal to the injury degenerates along with its myelin sheath. Debris is phagocytized by macrophages. **C:** The muscle fiber shows pronounced disuse atrophy. Schwann cells proliferate, forming a compact cord that is penetrated by the growing axon. The axon grows at a rate of 0.5-3 mm/d. **D:** In this example, the nerve fiber regeneration was successful, and the muscle fiber was also regenerated after receiving nerve stimuli. **E:** When the axon does not penetrate the cord of Schwann cells, its growth is not organized and successful regeneration does not occur. (Redrawn and reproduced, with permission, from Willis RA, Willis AT: *The Principles of Pathology and Bacteriology*, 3rd ed. Butterworth, 1972.)

Difference between rami anteriores et posteriores nervorum spinalium

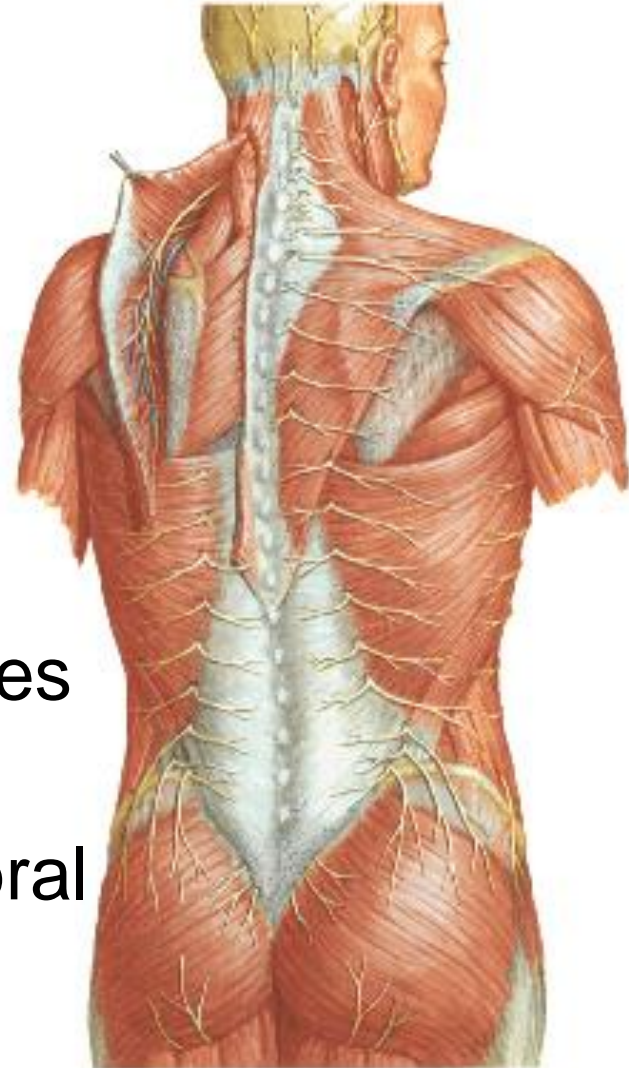
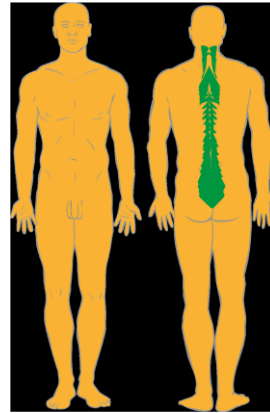
Rami posteriores	Rami anteriores
no plexuses	form major somatic plexuses
both sensory and motor fibers	both sensory and motor fibers
sensory: skin medially close to vertebral column	sensory: skin on rest of body
motor: epaxial muscles	motor: hypaxial muscles

Rami posteriores nervorum spinalium

= posterior branches

(obsolete term „dorsal branches“)

- segmental arrangement
- do not form plexuses
- mixed nerves
- **motor**: deep back (epaxial) muscles
 - r. medialis + lateralis
- **sensory**: skin medial along vertebral column
 - r. medialis → r. cutaneus posterior



Individual nerves from rami posteriores nervorum spinalium in the neck

■ motor

■ sensory

C1 = **n. suboccipitalis**

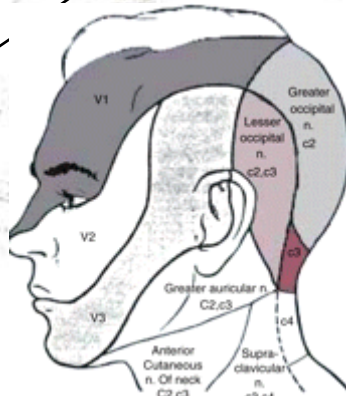
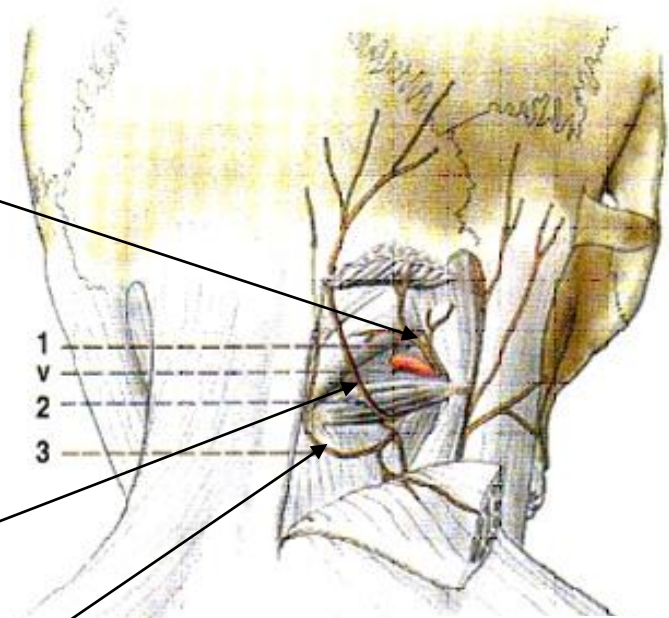
- pure somatomotor
- trigonum suboccipitale
- *m. rectus capitis post. major et minor*
- *m. obliquus capitis sup. et inf.*

sensory component of C2

= **n. occipitalis major**

sensory component of C3

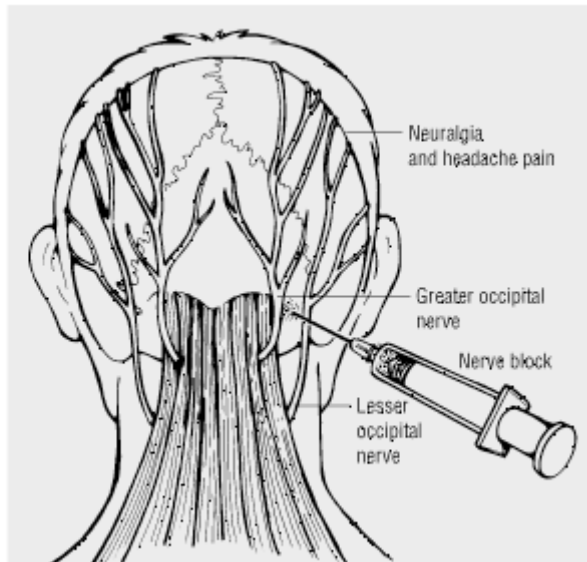
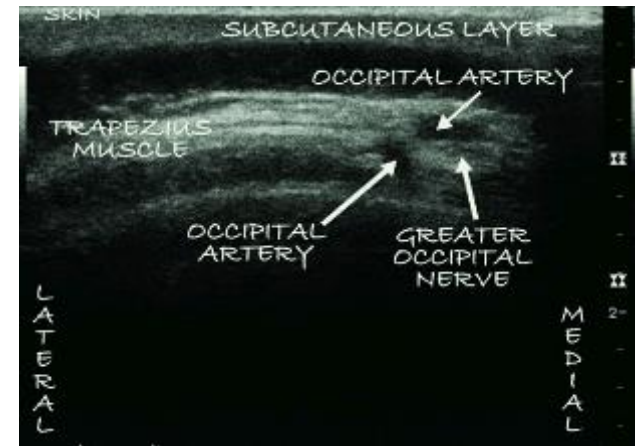
= **n. occipitalis tertius**



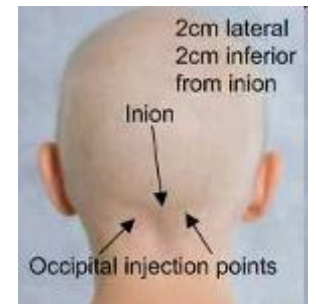
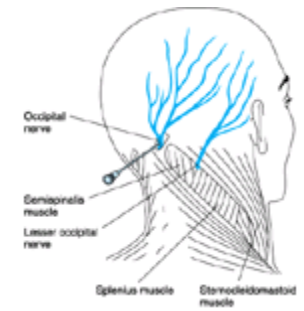
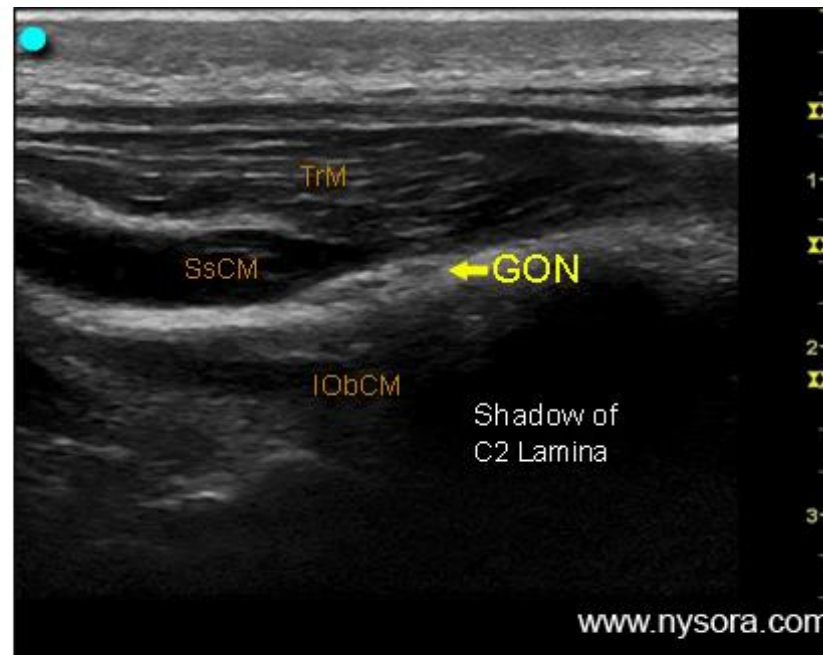
Occipital neuralgia

= Arnold's syndrome

- lesion of n. occipitalis major or minor

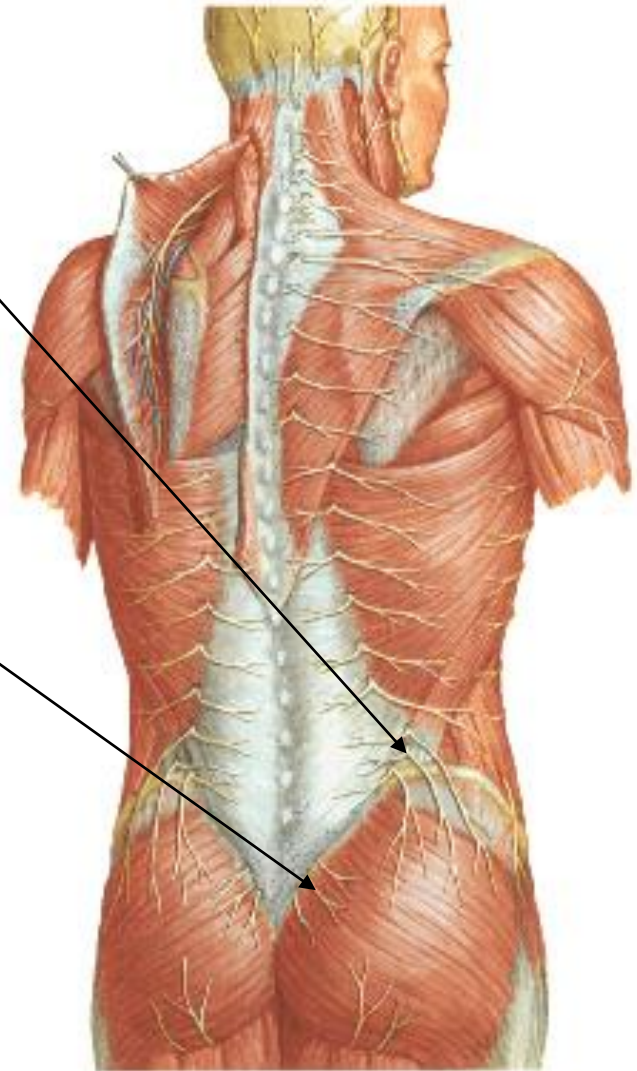


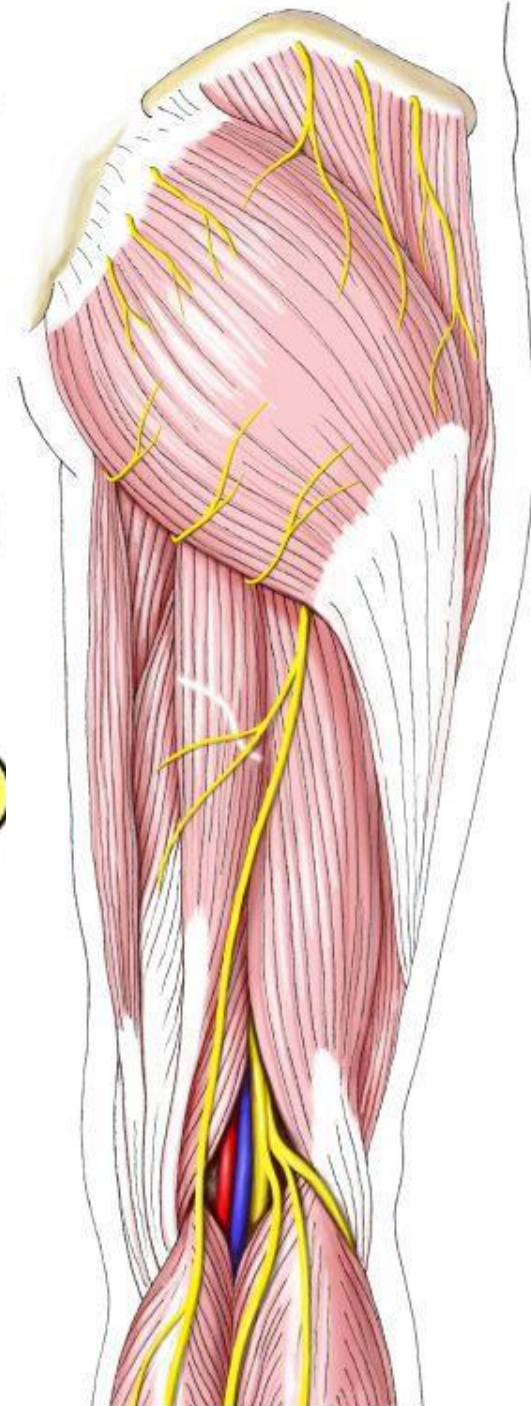
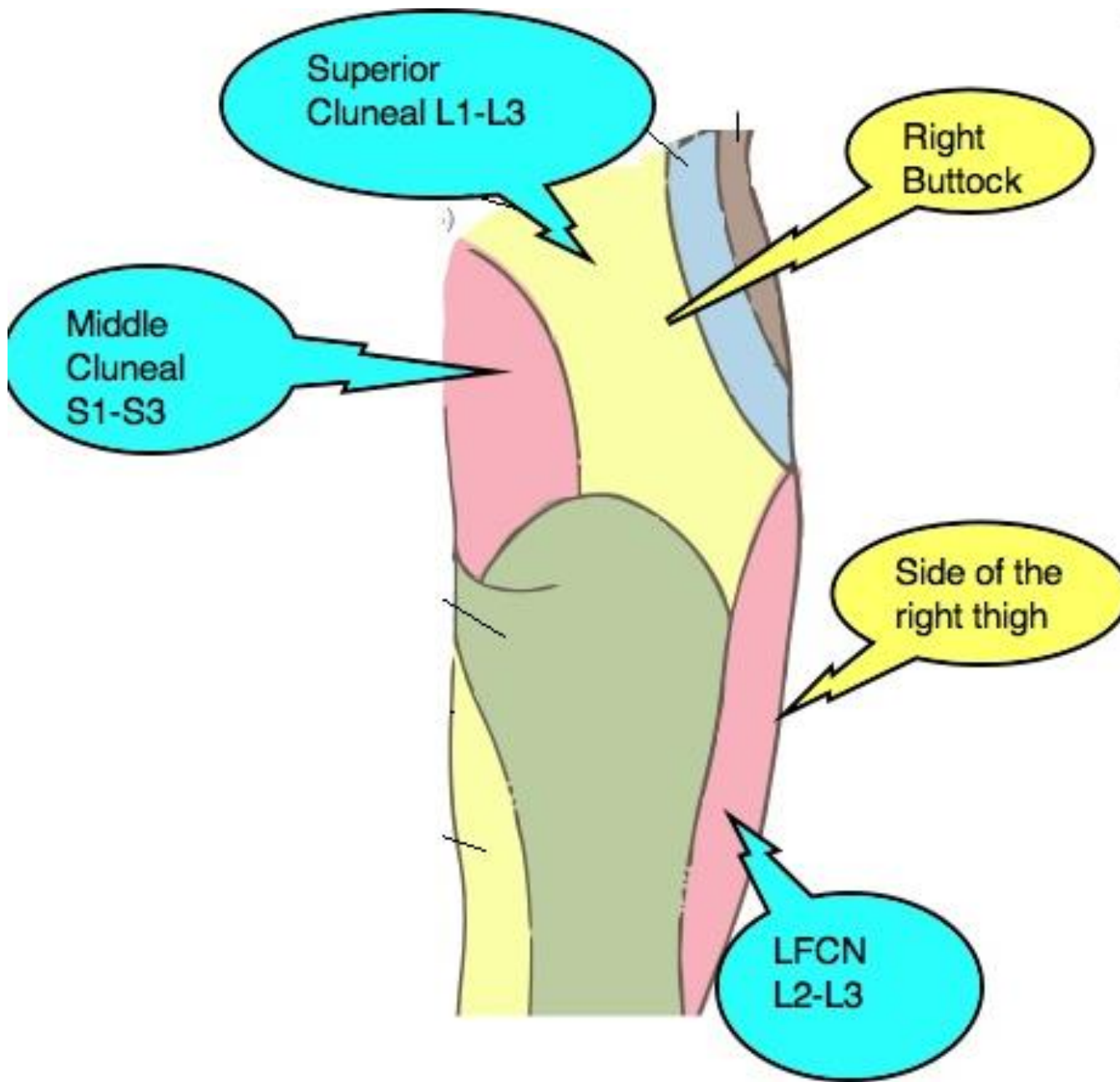
Lateral - Cephalad



Individual nerves from rami posteriores nervorum spinalium in the trunk

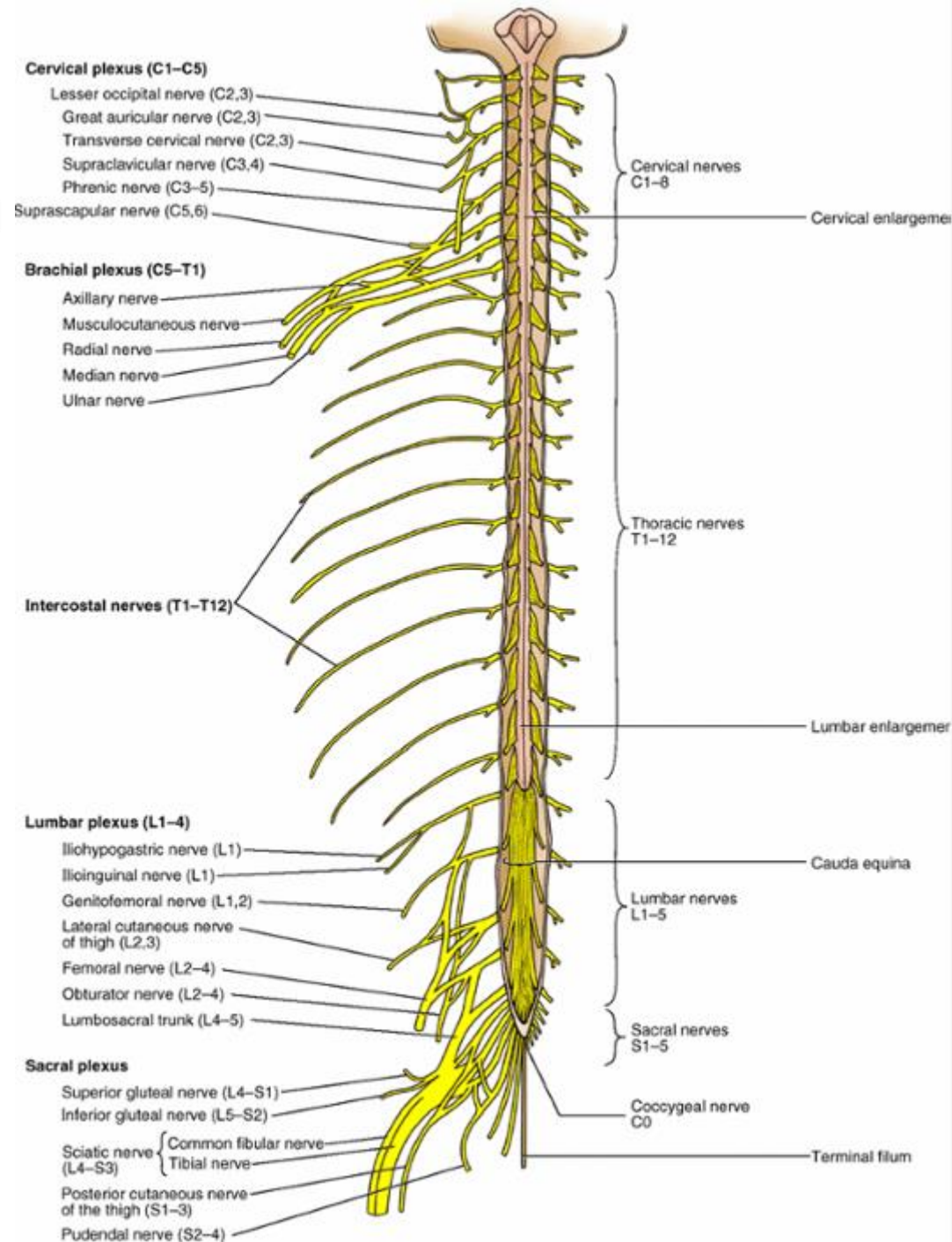
- sensory component of L1–L3
= **nervi clunium superiores**
→ upper part of gluteal region
- sensory component of S1–S3
= **nervi clunium medii**
→ sacral region and medial part of gluteal region



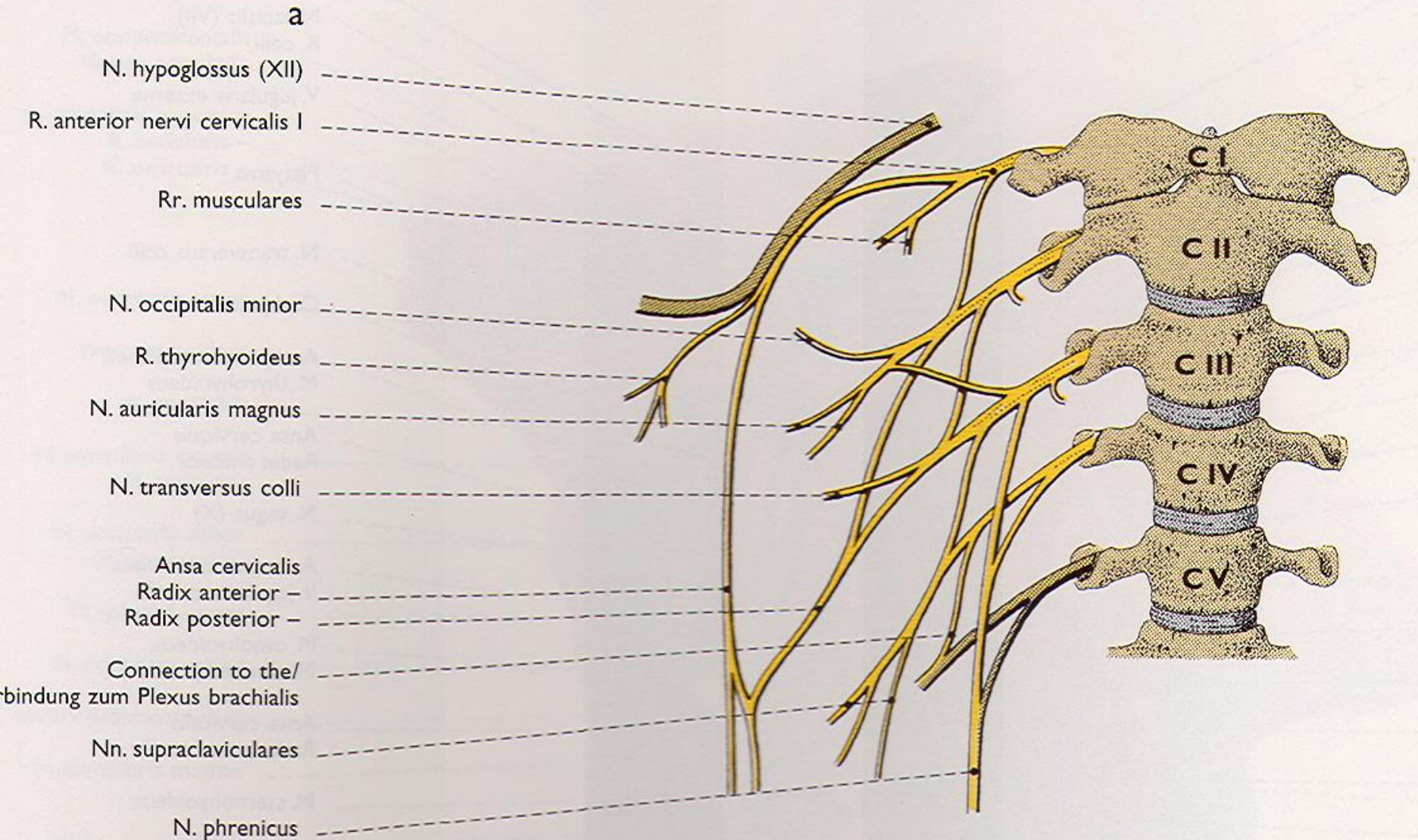


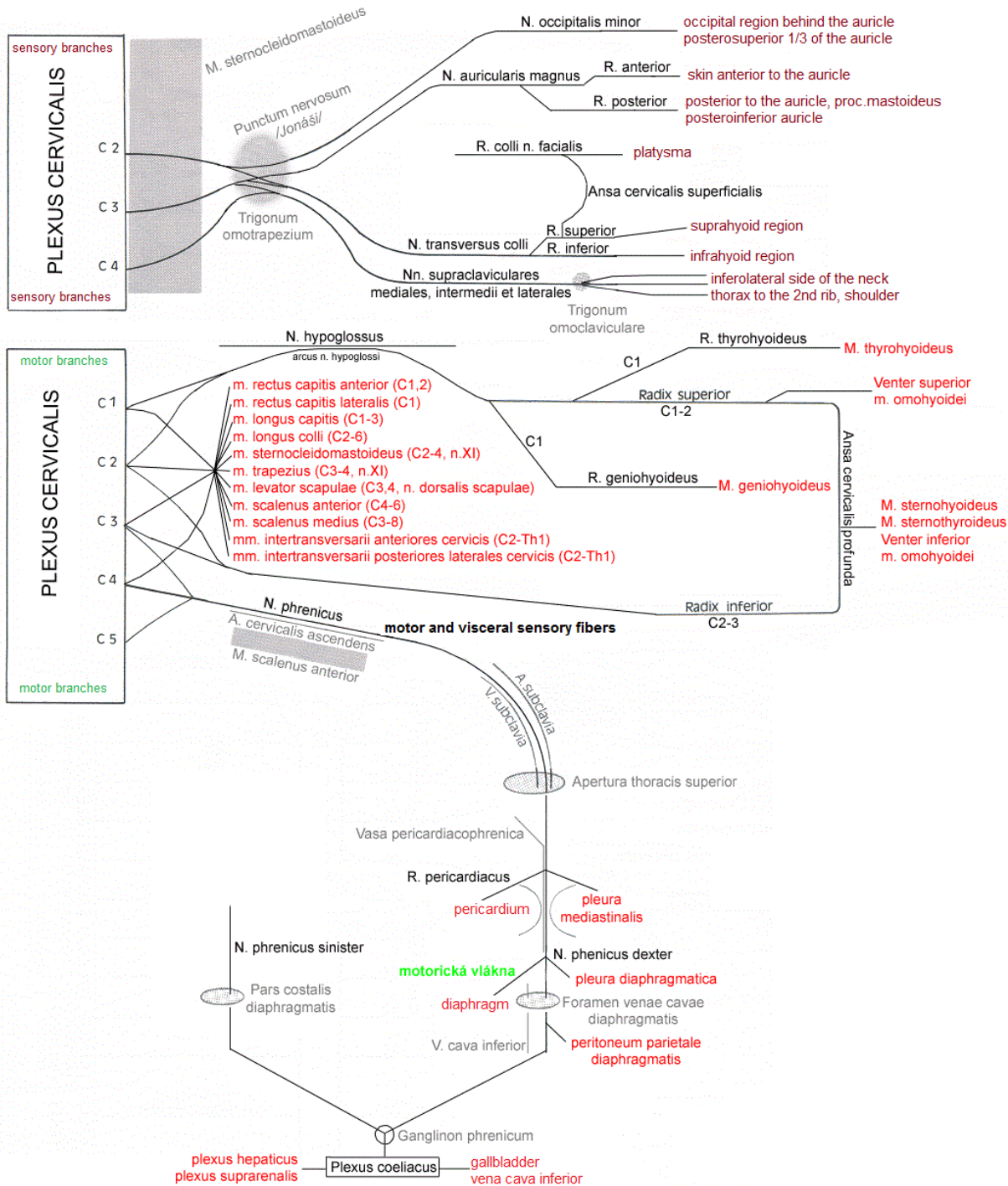
Rami anteriores nervorum spinalium

- plexus cervicalis (C1-4)
- plexus brachialis (C4-T1)
- nn. intercostales (T1-T12)
- plexus lumbalis (T12-L4)
- plexus sacralis (L4-S4)
- plexus coccygeus (S5-Co)



Plexus cervicalis (C1–C4)

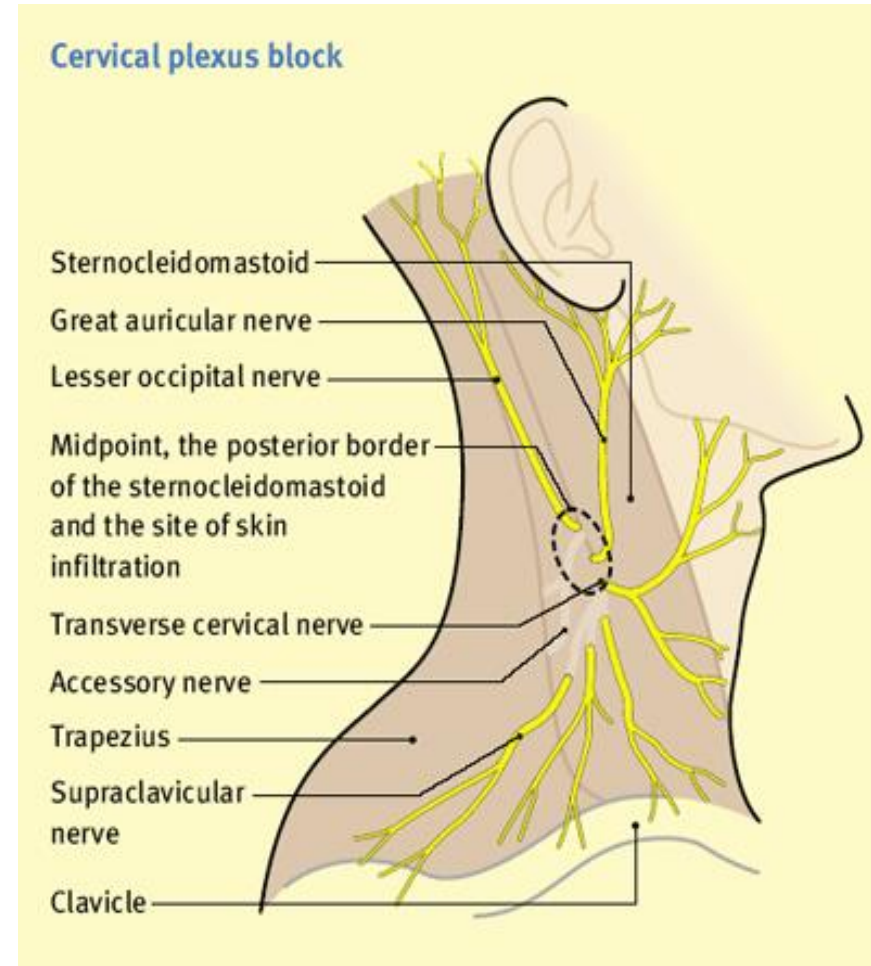




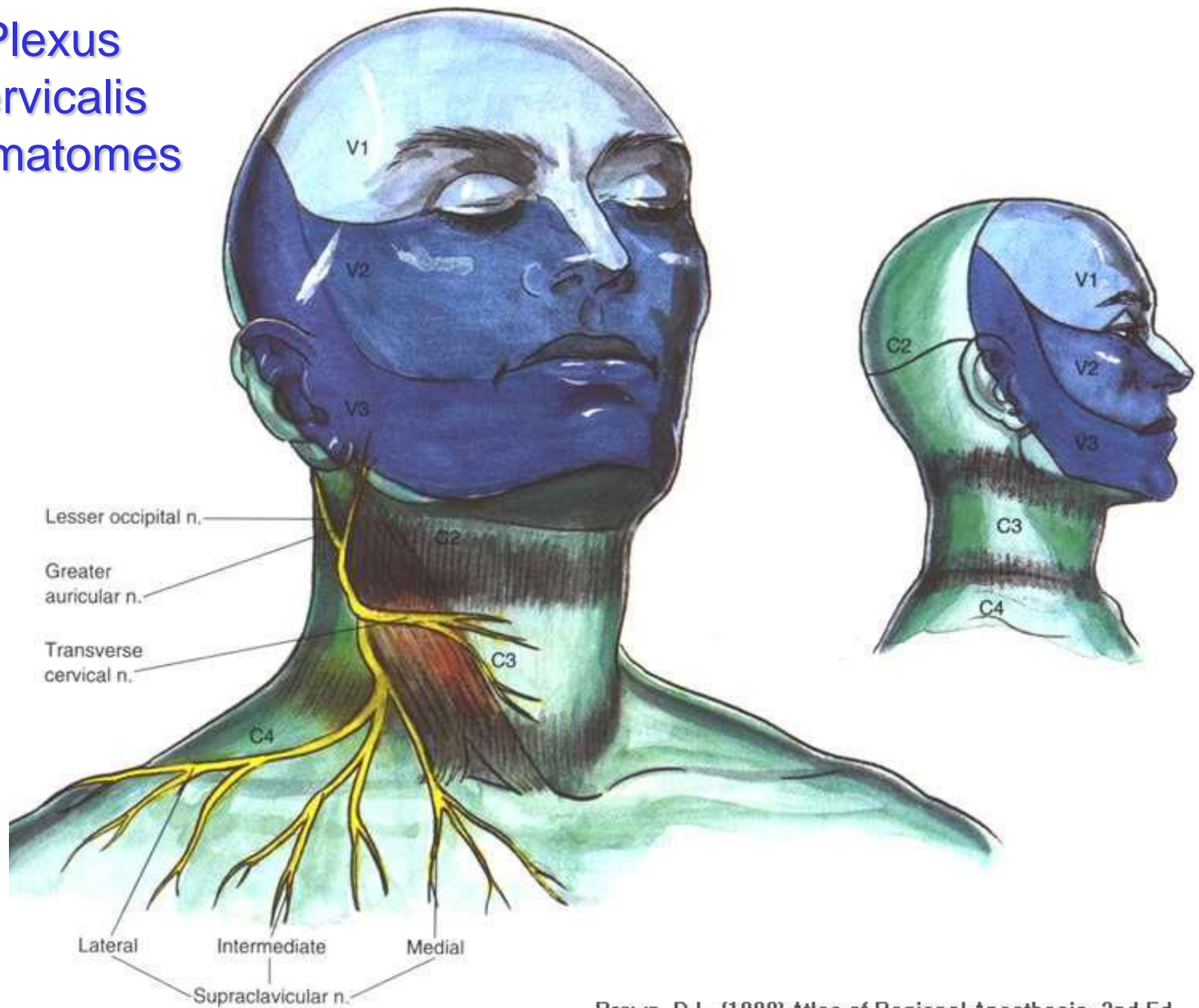
Plexus cervicalis (C1–C4)

sensory branches

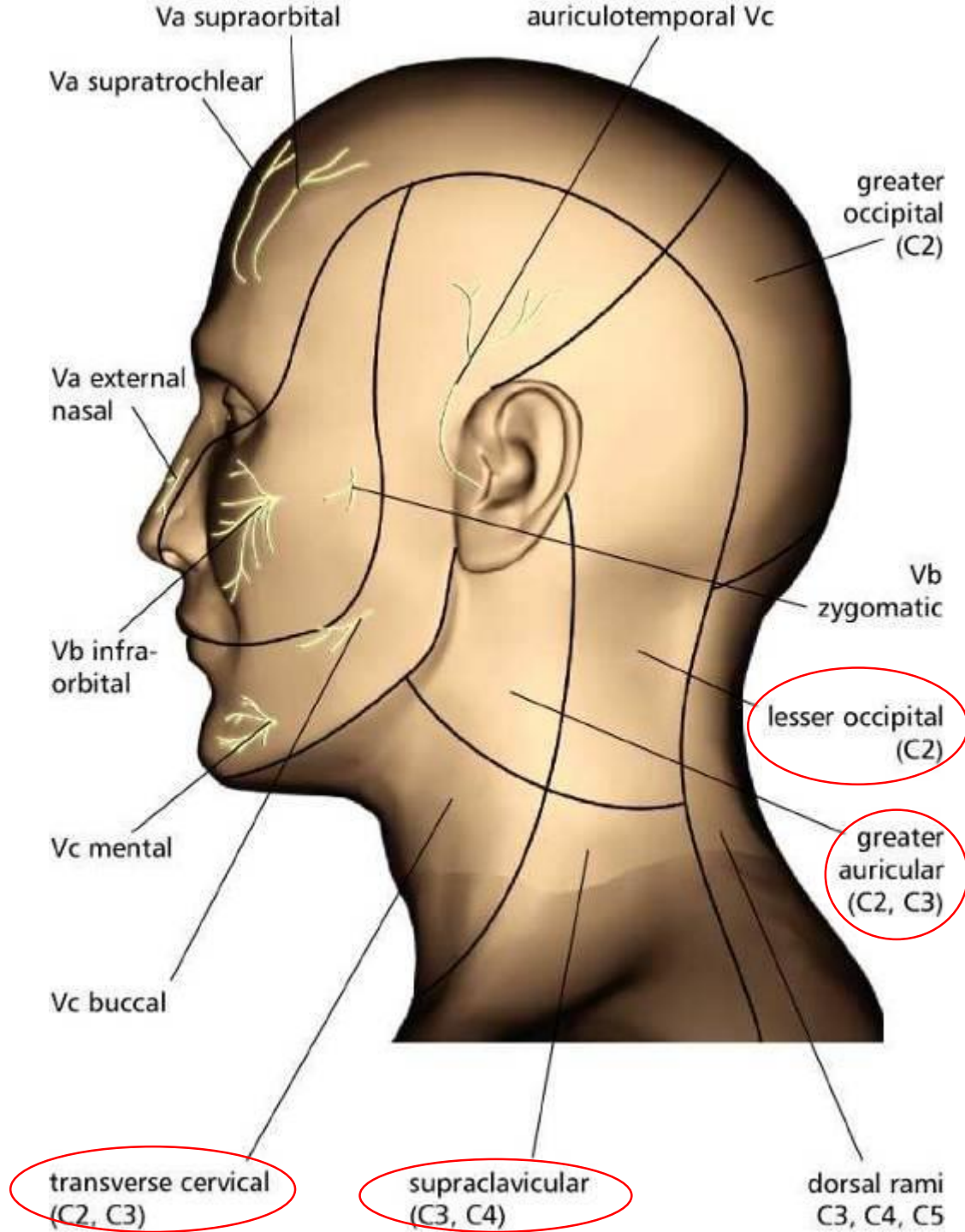
- punctum nervosum *Jonáši*
- n. occipitalis minor
- n. auricularis magnus
 - r. anterior + posterior
- n. transversus colli
 - r. superior
 - ansa cervicalis superficialis → connection to r. colli n.VII
 - r. inferior
- nn. supraclaviculares
 - mediales, intermedii, laterales



Plexus cervicalis dermatomes

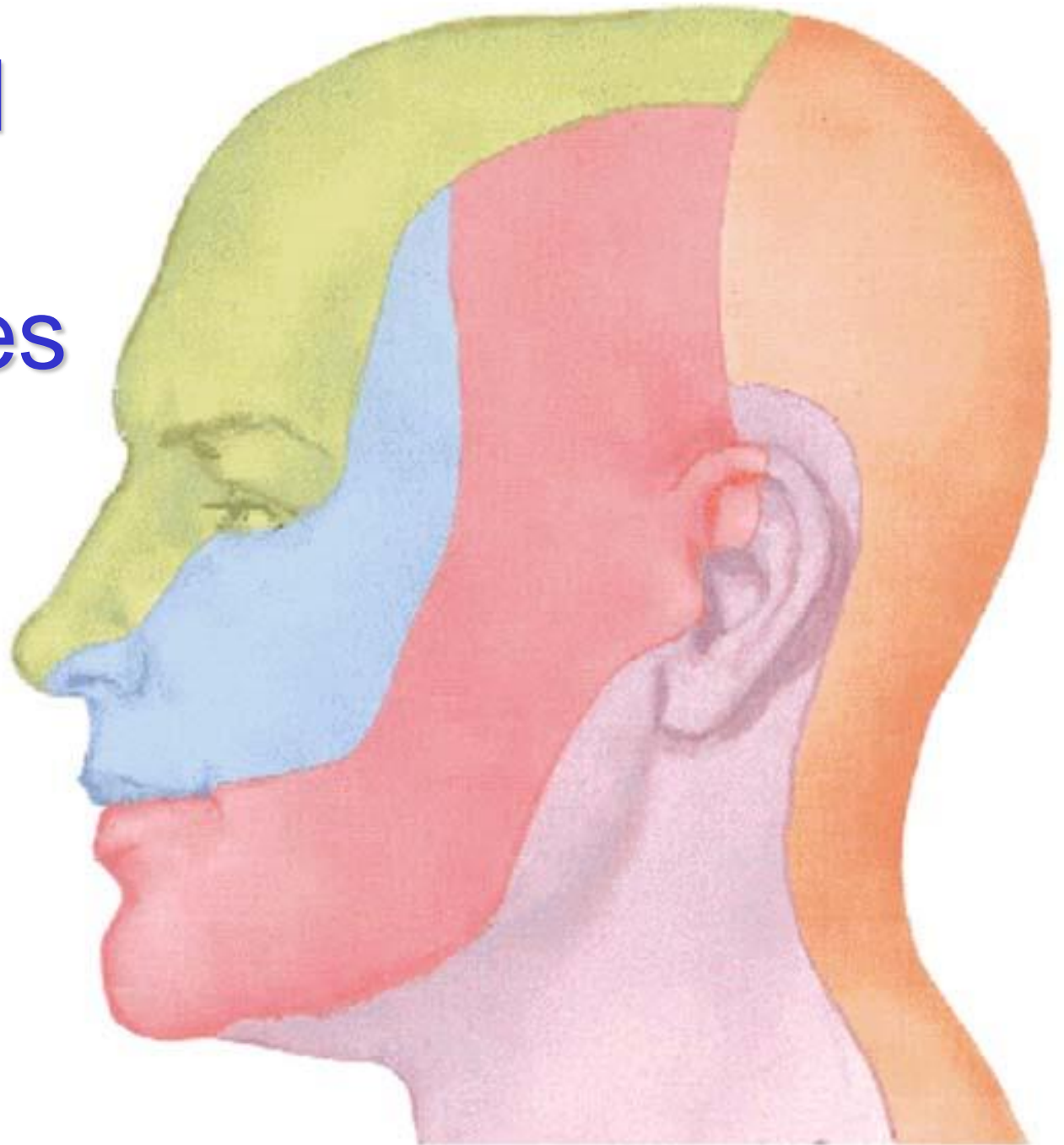


Plexus cervicalis areae nervinae

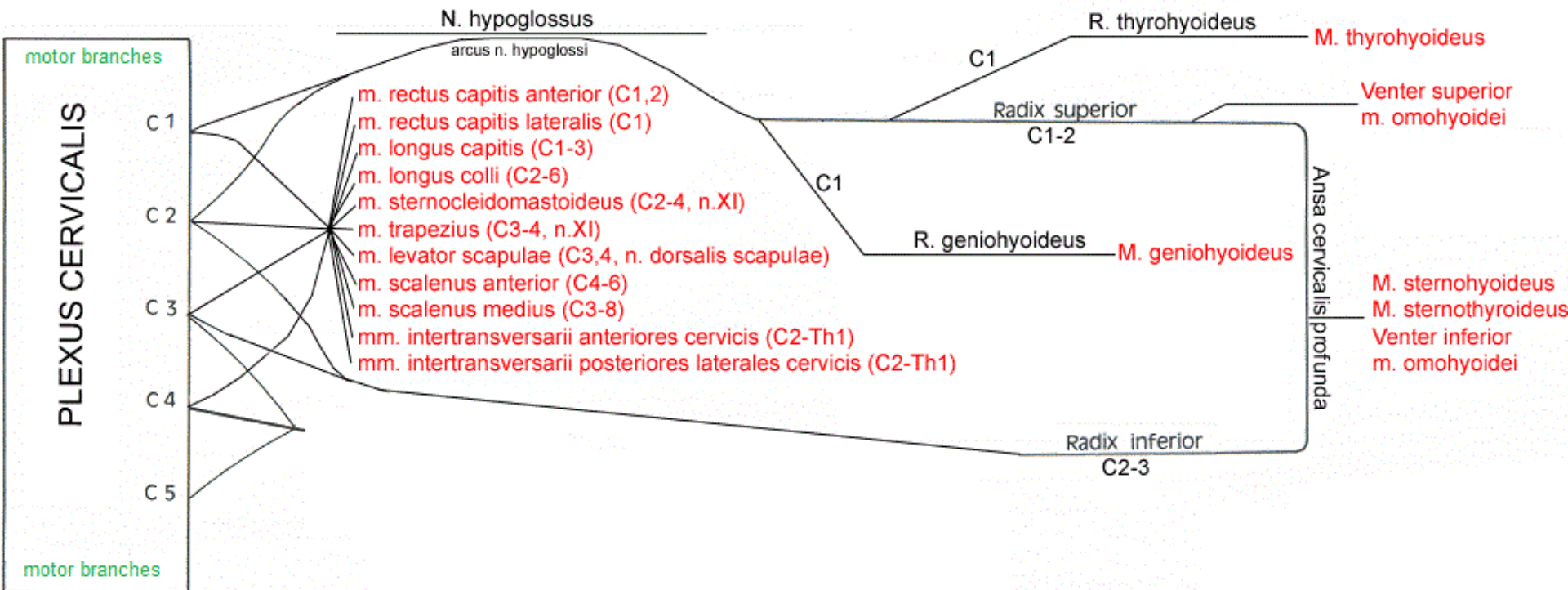


Head and neck dermatomes

- V1
- V2
- V3
- C2
- C3



Plexus cervicalis motor branches



Plexus cervicalis

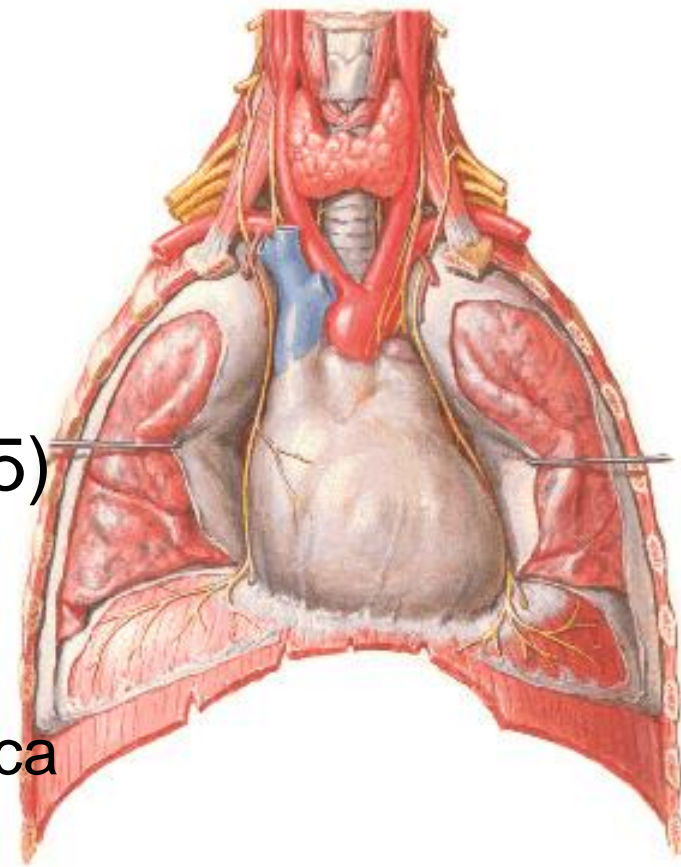
muscles and their motor branches

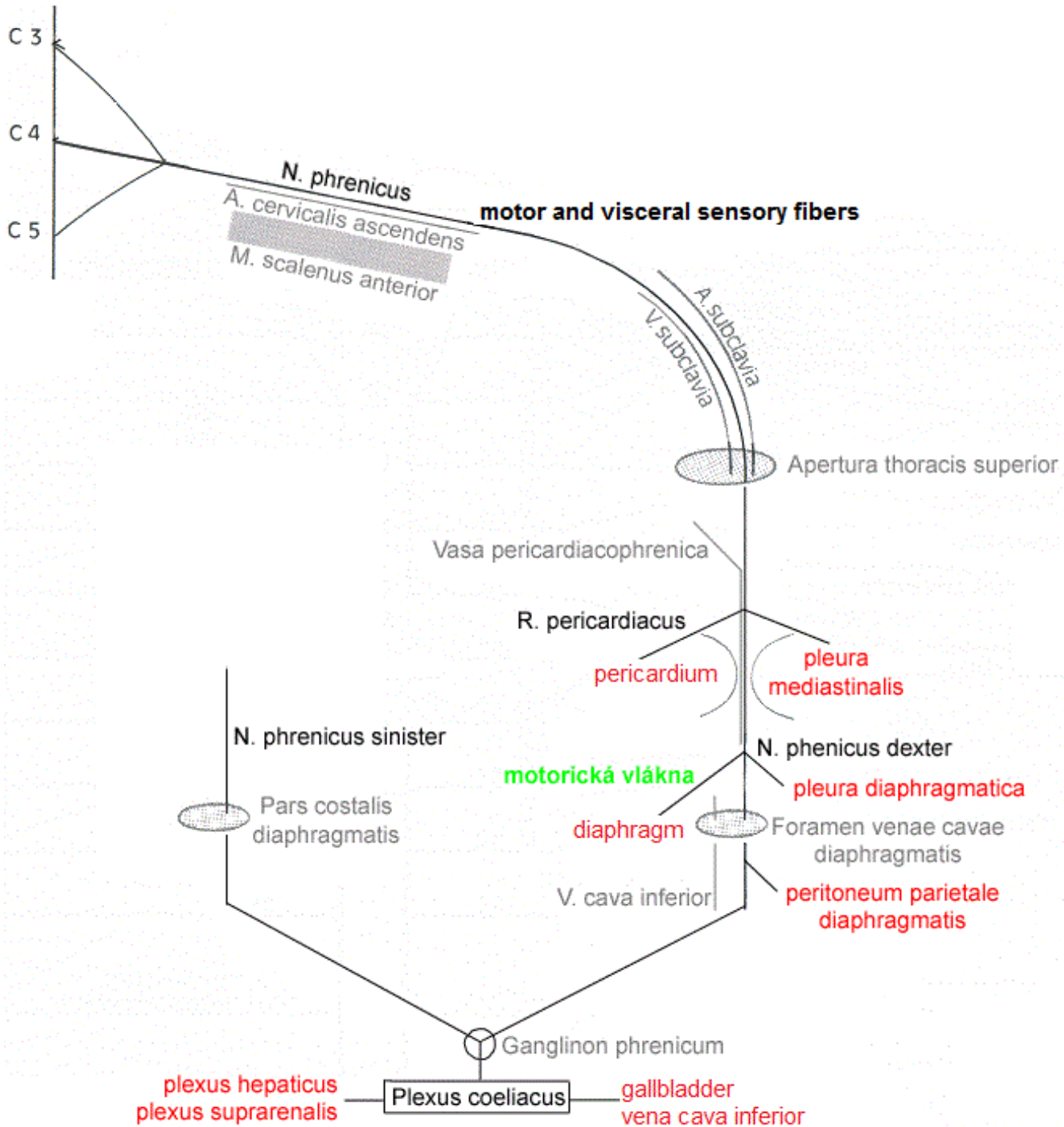
Muscle	Plexus cervicalis	Plexus brachialis
m. scalenus ant.+ med.	C3-4	C5-8
m. sternothyroideus, m. sternohyoideus, m. omohyoideus	ansa cervicalis profunda (C1-3)	-
m. thyrohyoideus + m. geniohyoideus	C1	-
m. rectus capitis ant. + lat.	C1	-
m. longus capitis	C1-3	-
m. longus capitis	C3-4	C5-6
m. sternocleidomastoideus + m. trapezius	C2-4 = ansa Maubraci	-
m. levator scapulae	C3-4	C5 = n. dorsalis scapulae
diaphragma	C3-5 = n. phrenicus	C5

Plexus cervicalis

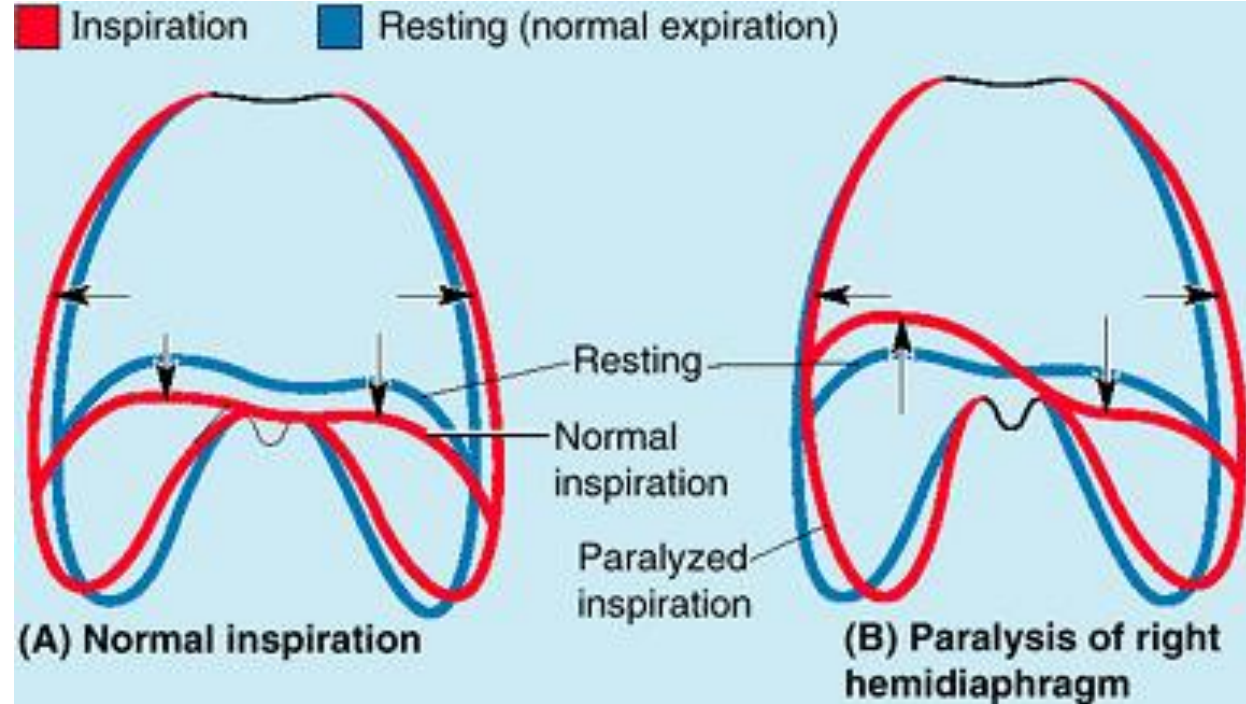
N. phrenicus (C3-C5)

- mixed nerve
- major root C4 (minor roots C3+C5)
- motor: **diaphragm**
- sensory:
 - pleura mediastinalis + diaphragmatica
 - pericardium parietale
 - peritoneum parietale (diaphragm + liver + gallbladder)
 - (capsula thymi = Cruchet' s nerve)
- n. phrenicus accessorius
 - branch from C5 via n. subclavius, running laterally
 - joins n. phrenicus at level of 1st rib





Diaphragm paralysis *palsy of nervus phrenicus*



palsy:

- unilateral → dyspnoe
- bilateral → no breathing

irritation:

jerks, hick-up (= singultus)

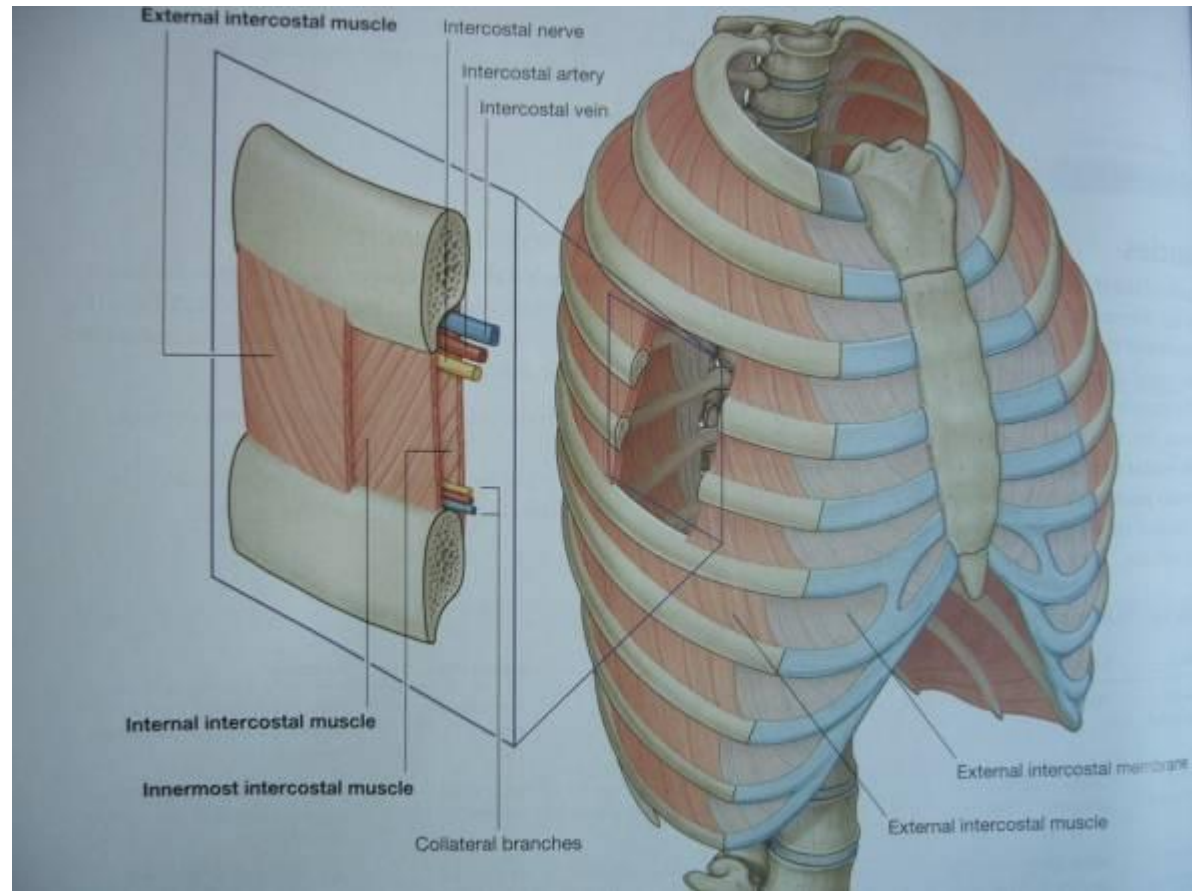
e.g. peritonitis, cerebral damage

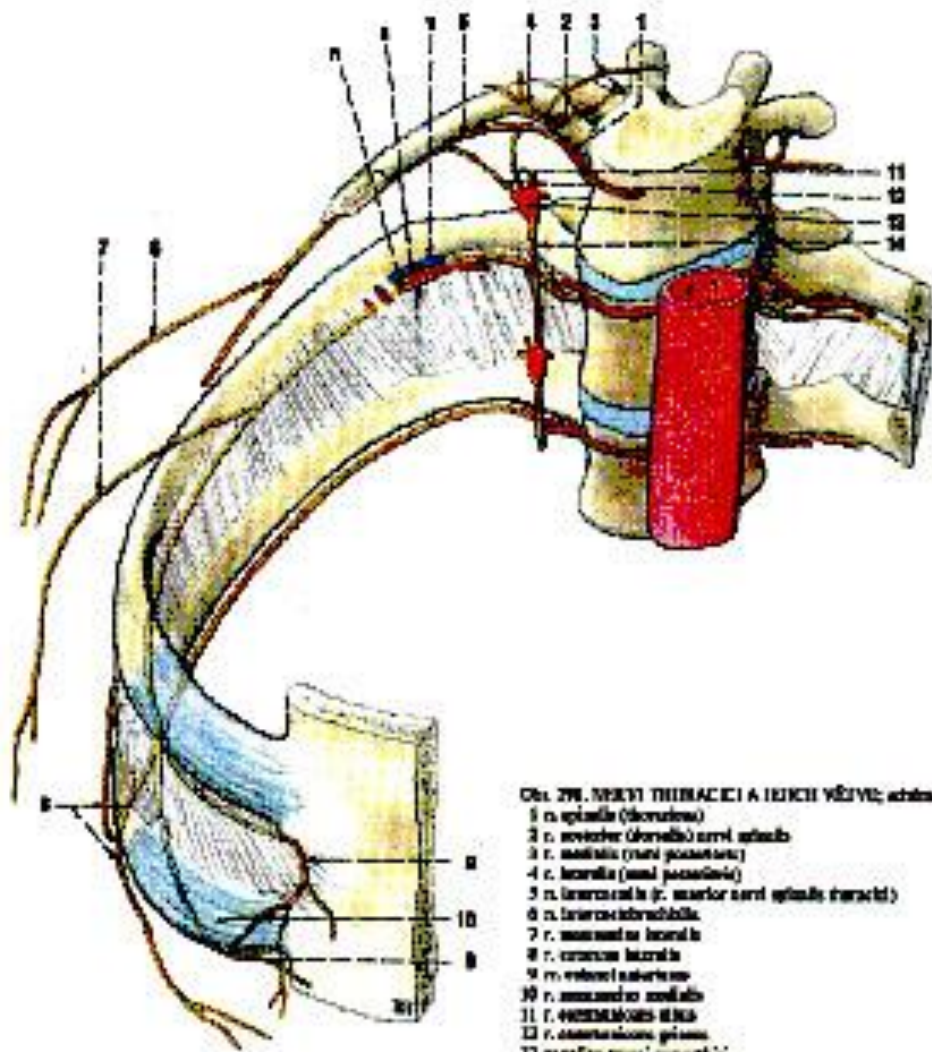
Rami anteriores nervorum thoracicorum T1-12

- **nn. intercostales + n. subcostalis**
- segmental arrangement
- do not form plexuses
- mixed nerves
- spatium intercostale and below 12th rib
- motor: mm. intercostales, anterior and lateral abdominal muscles
- sensory: skin on anterior and lateral aspect of thorax and abdomen, pleura parietalis, peritoneum parietale

Spatium intercostale

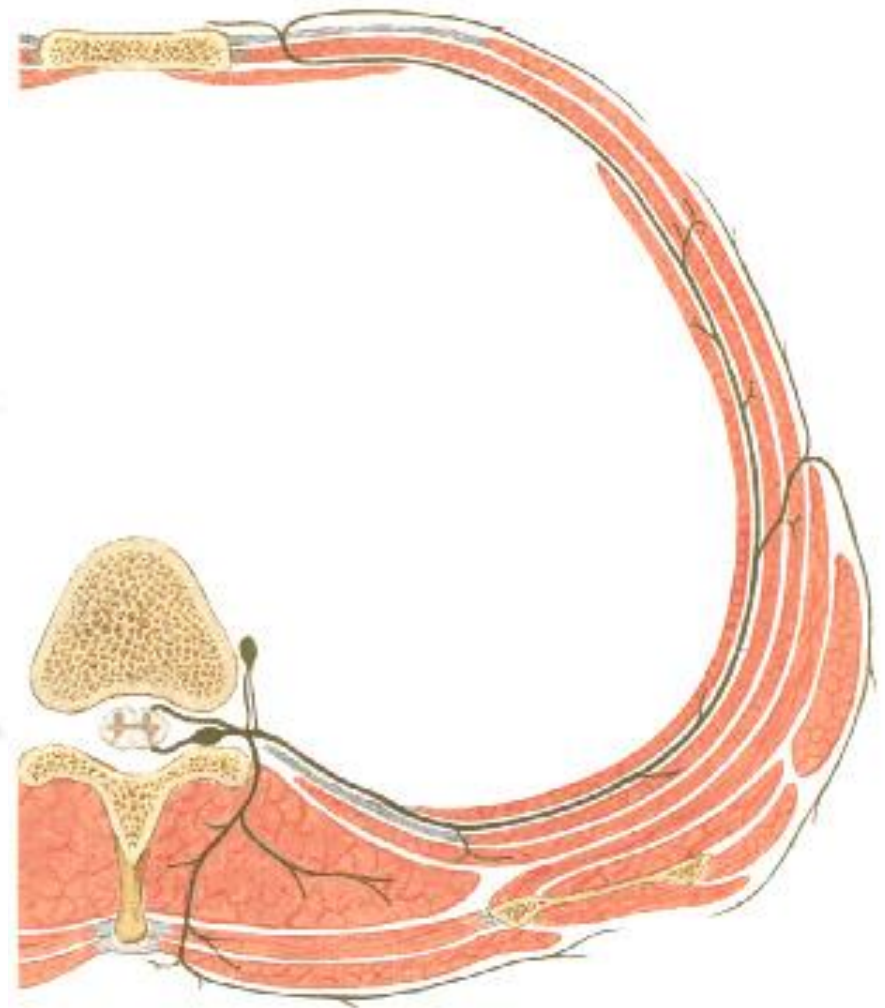
V
A
N



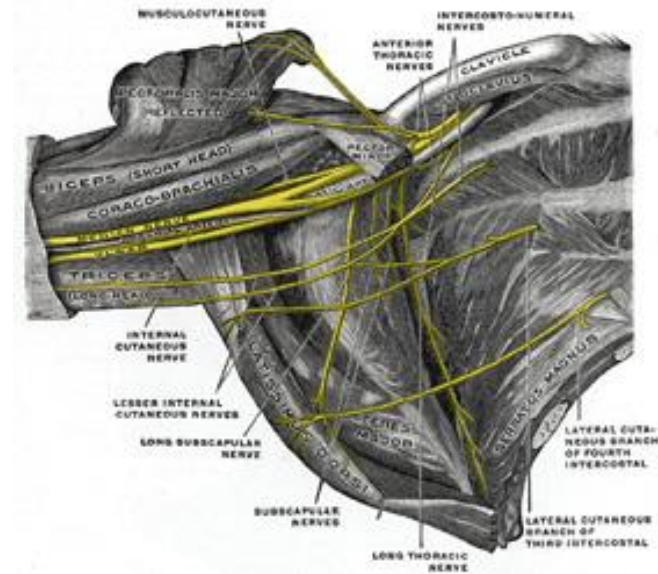


Obz. 298. NERVY THORACICI A KRNKI VĚZVY; ačrtno

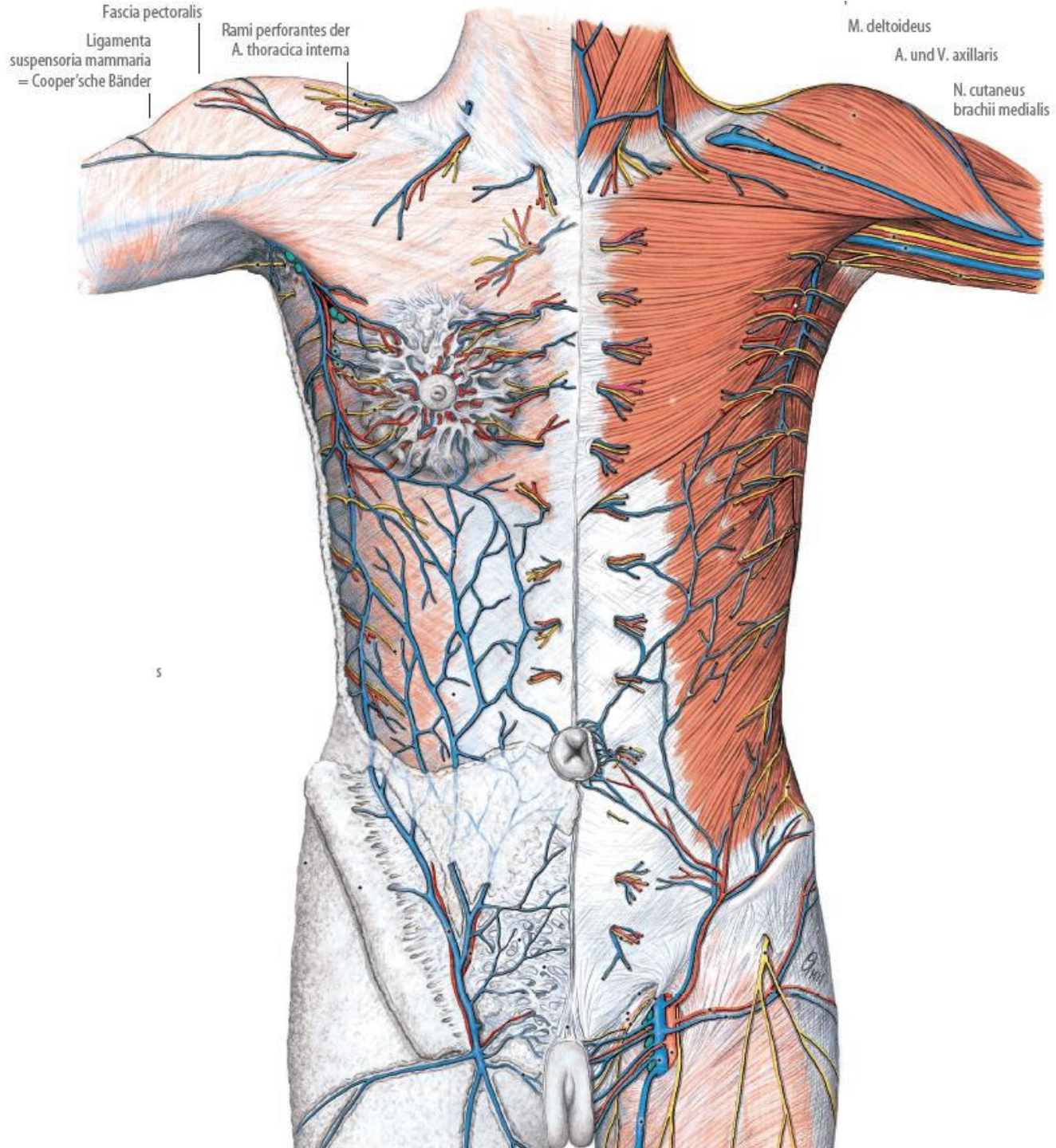
- 1 r. epistula (obscurosa)
- 2 r. nervus (obscurosa) nervi subclavi
- 3 r. medianus (nervus pectoralis)
- 4 r. lateralis (nervus pectoralis)
- 5 r. lateralis (nervus pectoralis)
- 6 r. lateralis (nervus pectoralis)
- 7 r. nervus lateralis
- 8 r. nervus lateralis
- 9 r. nervus lateralis
- 10 r. nervus lateralis
- 11 r. nervus lateralis
- 12 r. nervus lateralis
- 13 ganglion nervi sympathici
- 14 nervus sympathicus
- v - nervus lateralis
- z - nervus lateralis
- x - nervus lateralis



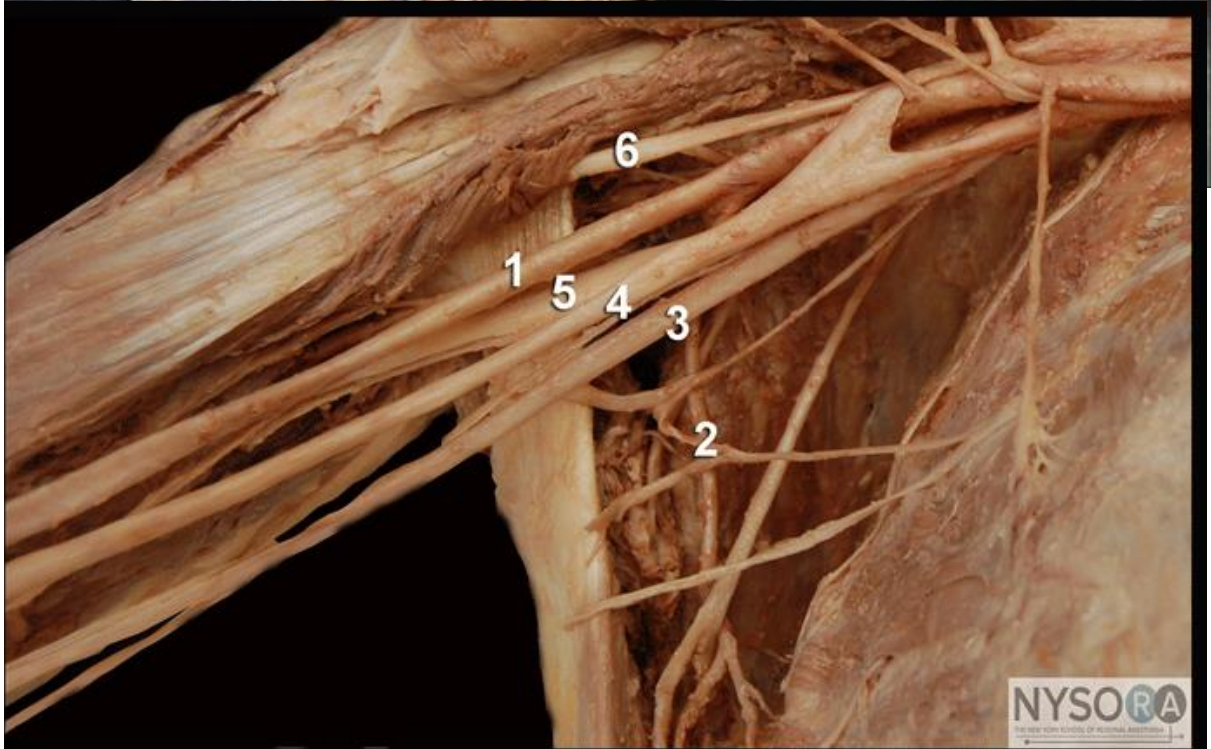
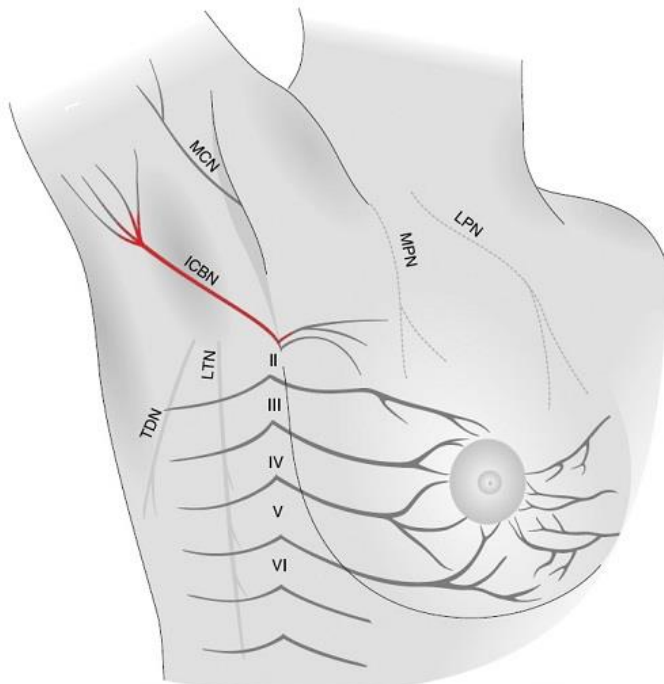
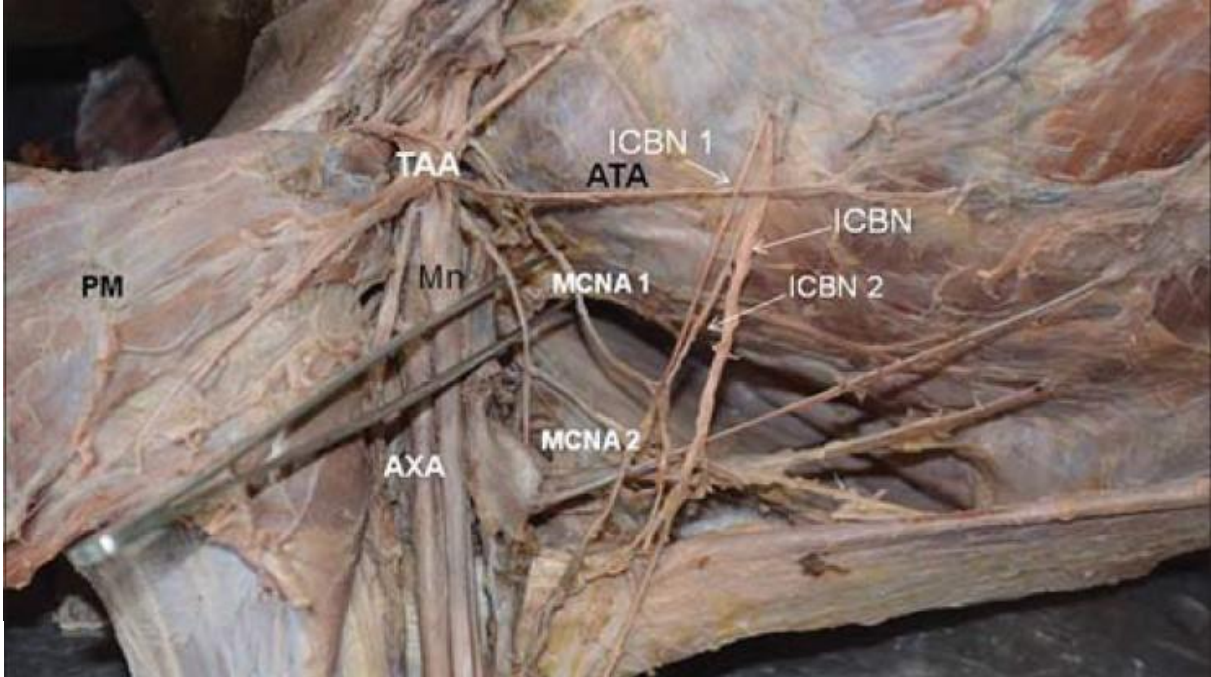
Nervus intercostalis *somatosensory branches*



- nn. cutanei laterales
 - rr. mammarii laterales (T4-6)
 - nn. intercostobrachiales (T2-3)
 - n. intercostobrachialis (T2) joins n. cutaneus brachii med.
 - n. intercostobrachialis accessorius (T3)
 - across axilla – *danger of lesion in axillary lymphadenectomy*
- nn. cutanei anteriores
 - rr. mammarii mediales (T4-6)
- rr. pleurales (T1-12) et peritoneales (T7-12)
 - „défense musculaire“



- n. intercostobrachialis (T2)
- n. intercostobrachialis accessorius (T3)



Innervation of the breast and location of the nerves at risk during breast cancer surgery. ICBN indicates intercostobrachial nerve (sensory only); II-VI, intercostal nerves 2 to 6, lateral cutaneous branches (sensory only); LPN, lateral pectoral nerve (mixed sensory and motor); LTN, long thoracic nerve (motor only); MCN, medial cutaneous nerve of the arm (sensory only); MPN, medial pectoral nerve (mixed sensory and motor); TDN, thoracodorsal nerve (motor only).
 Reg Anesth Pain Med. 2014 Jun in press. Neural Blockade for Persistent Pain After Breast Cancer Surgery. Wijayasinghe N et al

Nervus intercostalis

somatomotor branches

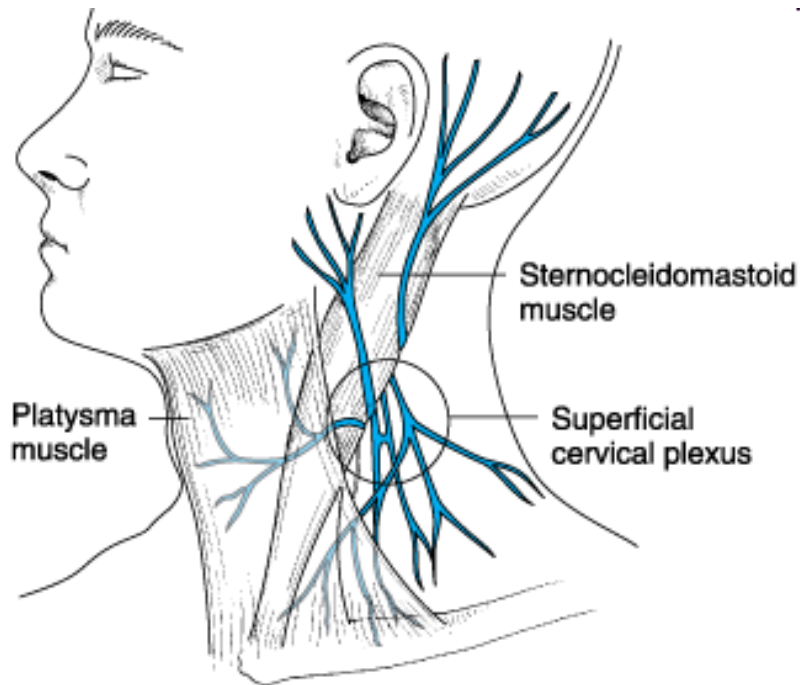
- rr. musculares:
 - mm. intercostales externi, interni, intimi (mm. subcostales)
 - m. transversus thoracis (T1-6)
 - m. serratus post. sup. (T1-4) et inf. (T9-12)
 - m. rectus abdominis (T7-12)
 - m. obliquus abdominis ext. (T5-12)
 - m. obliquus abdominis int. (T8-12)
 - m. transversus abdominis (T7-12)
 - m. pyramidalis (T12)
 - m. quadratus lumborum (T12)

Regional anesthesia

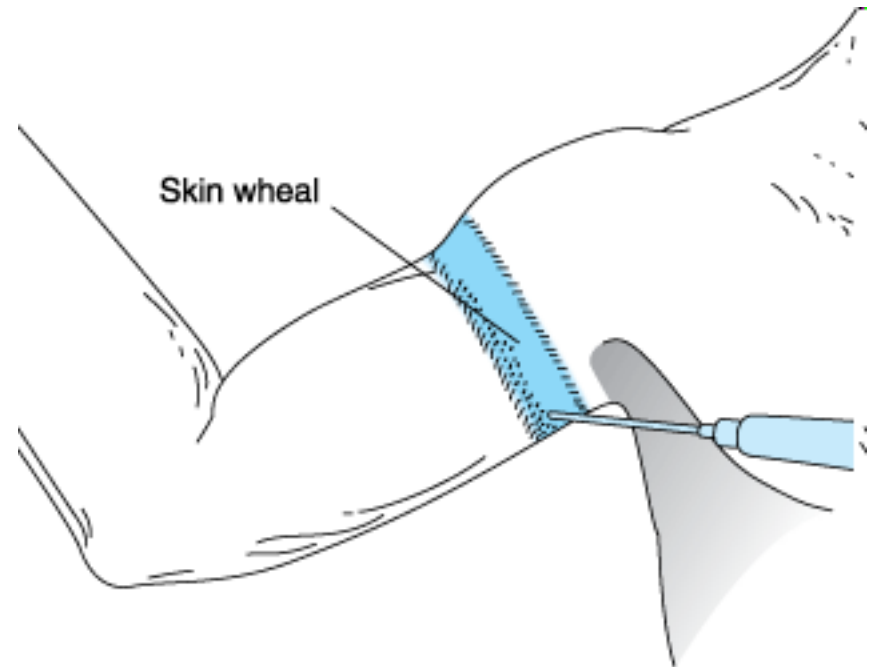
Superficial block of plexus cervicalis (1)

Block of nn. intercostobrachiales (2)

(2) in application of air tourniquet for upper limb



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Palsy of intercostal nerves

- irritation → pain in the intercostal spaces (e.g. *herpes zoster* surviving in ganglion spinale)
- peritoneal irritation – reflective contraction of abdominal muscle wall = *défense musculaire* (e.g. *peritonitis*)

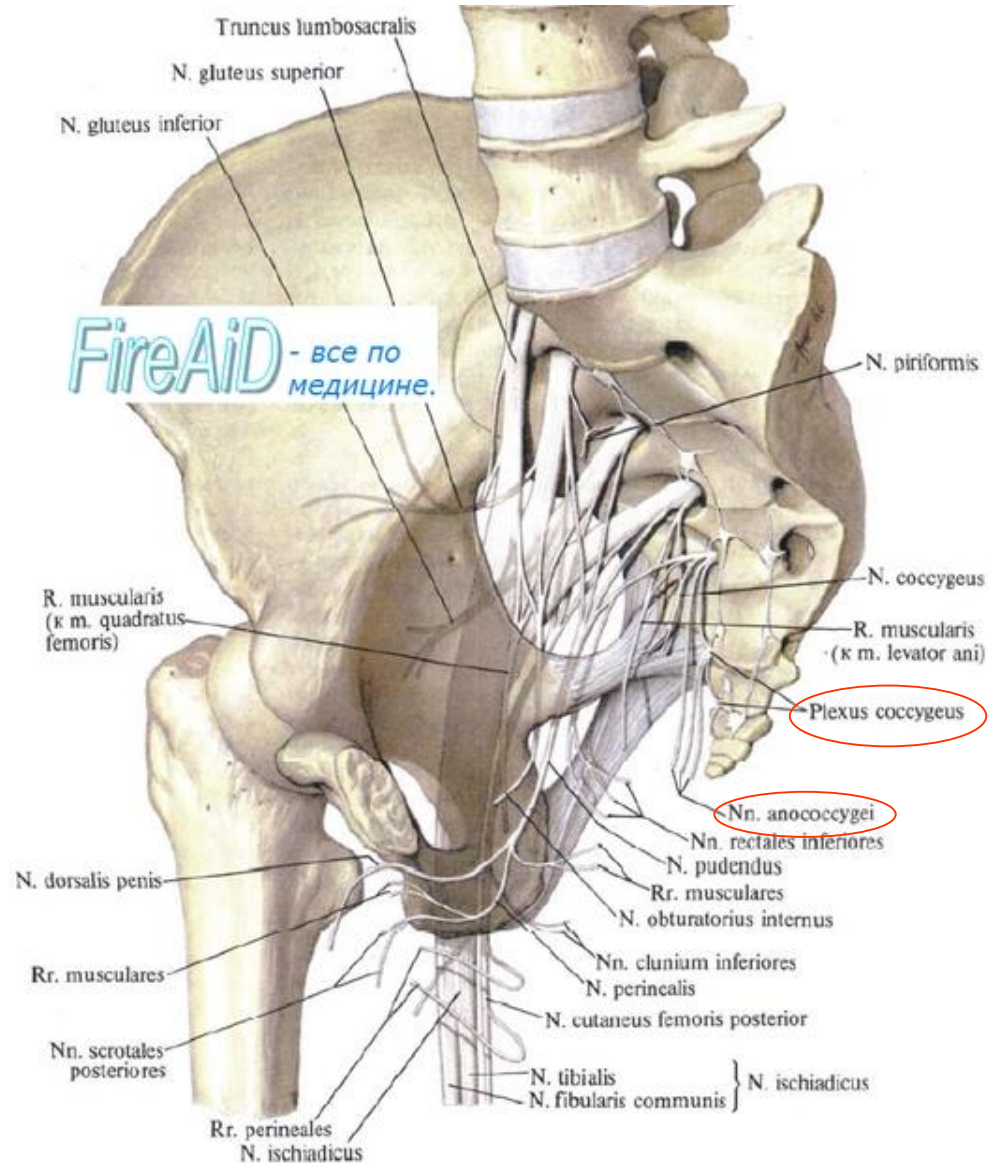


Reflexes of abdomen


Epigastric	T7-8
Mesogastric	T9-10
Hypogastric	T11-12

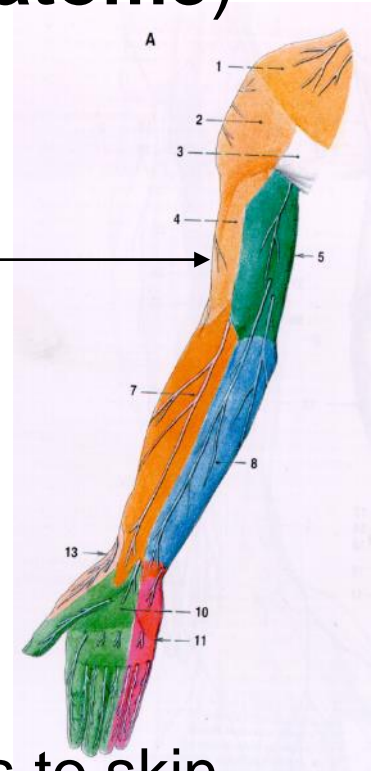
Plexus coccygeus S5–Co

- small plexus
- on m. ischiococcygeus
- motor:
 - m. levator ani
 - m. ischiococcygeus
- sensory:
 - nn. anococcygei
 - skin between tip of cocyx and anus
- *pain in coccygeal fractures*



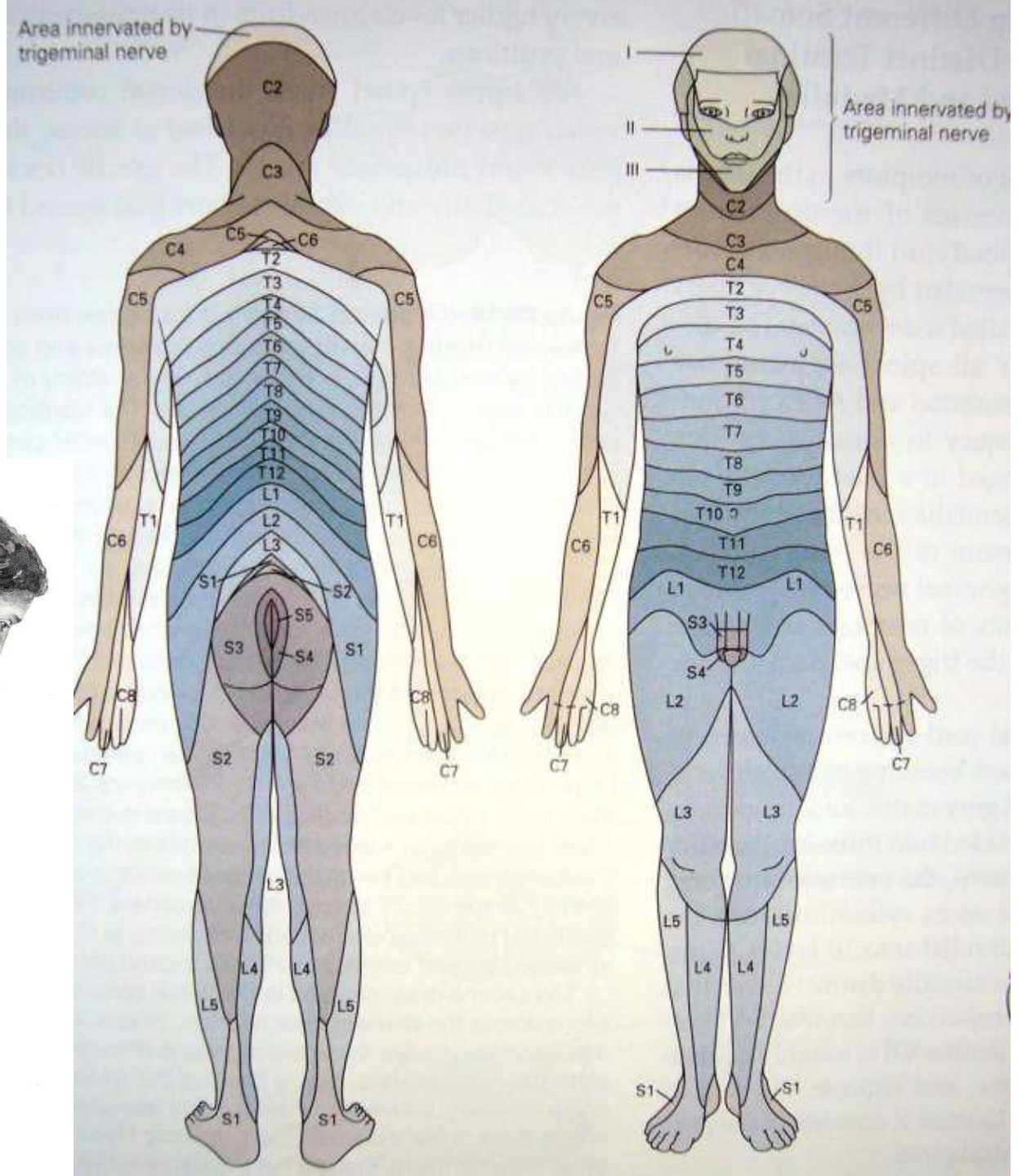
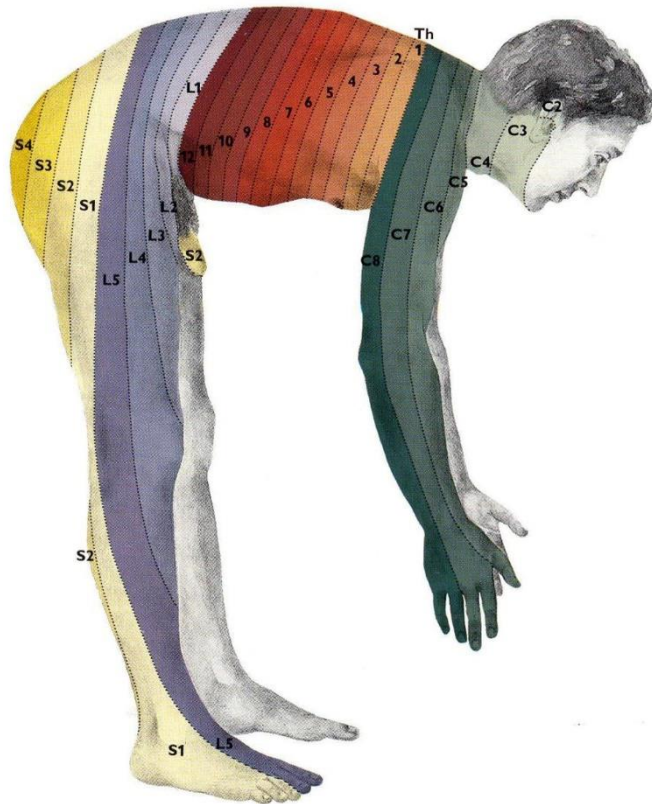
Somatosensory skin innervation

- **area radicularis somatosensoria (dermatome)**
 - area of skin supplied by one **spinal** nerve (= by one **spinal segment**)
- **area nervina** 
 - area of skin supplied by **one specific nerve**
- **area radicularis visceralis**
 - area of internal organ supplied by viscerosensory nerves of one spinal segment
- ***Head's (reflex) zone***
 - segmental projection of sensitivity from organs to skin
- **area radicularis sensoria** = skin + organs + meninges supplied by one **spinal** nerve (= by one **spinal segment**)
- **area radicularis motoria** = muscles or their parts supplied by one **spinal** nerve (= by one **spinal segment**)



Dermatomes

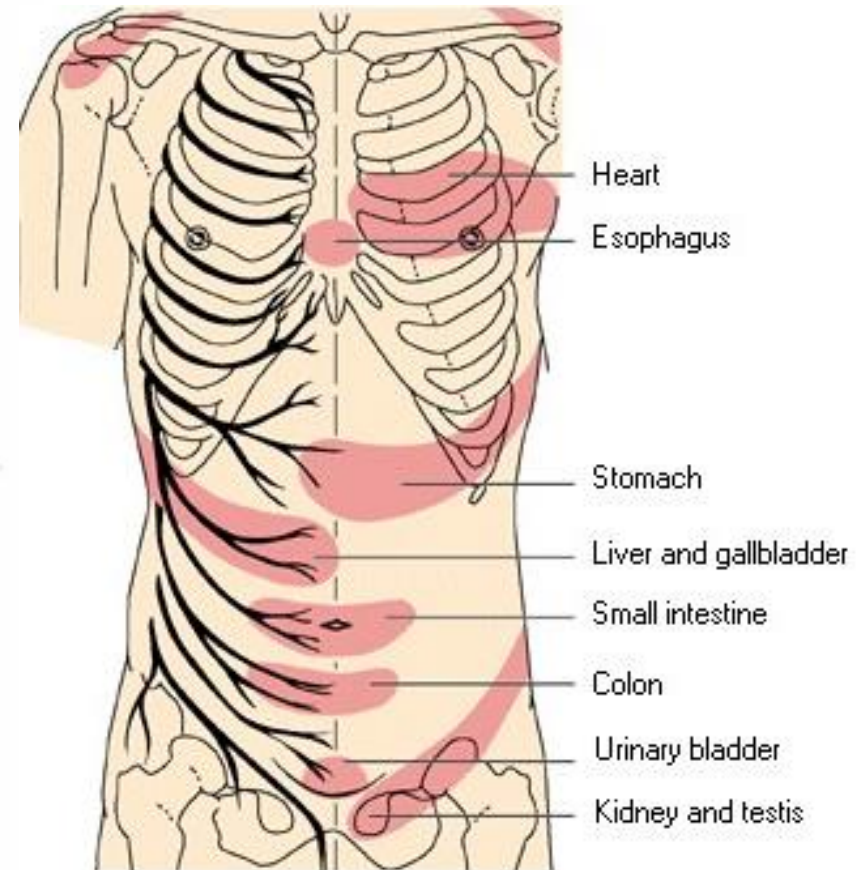
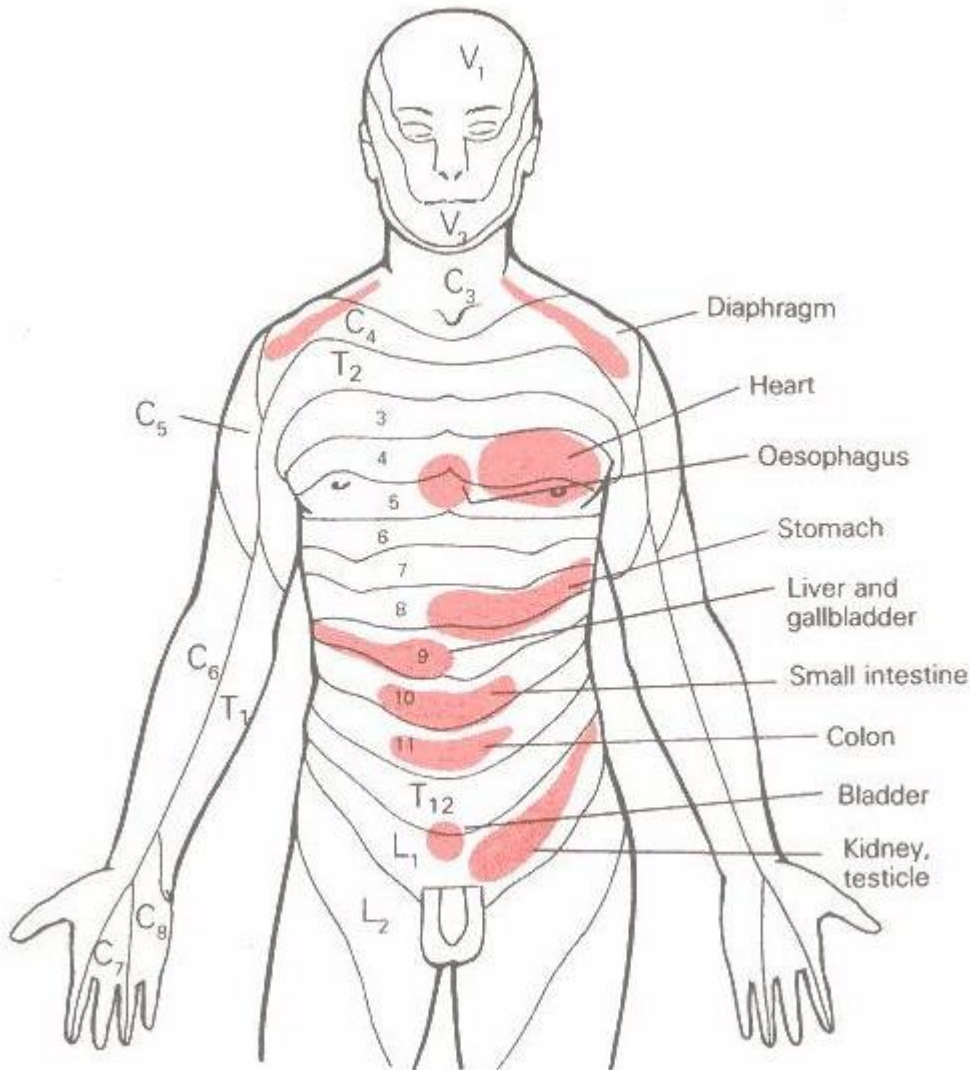
skin area supplied by **one spinal nerve** (= by one spinal segment)



Head's zones



Sir Henry Head (1861-1940)



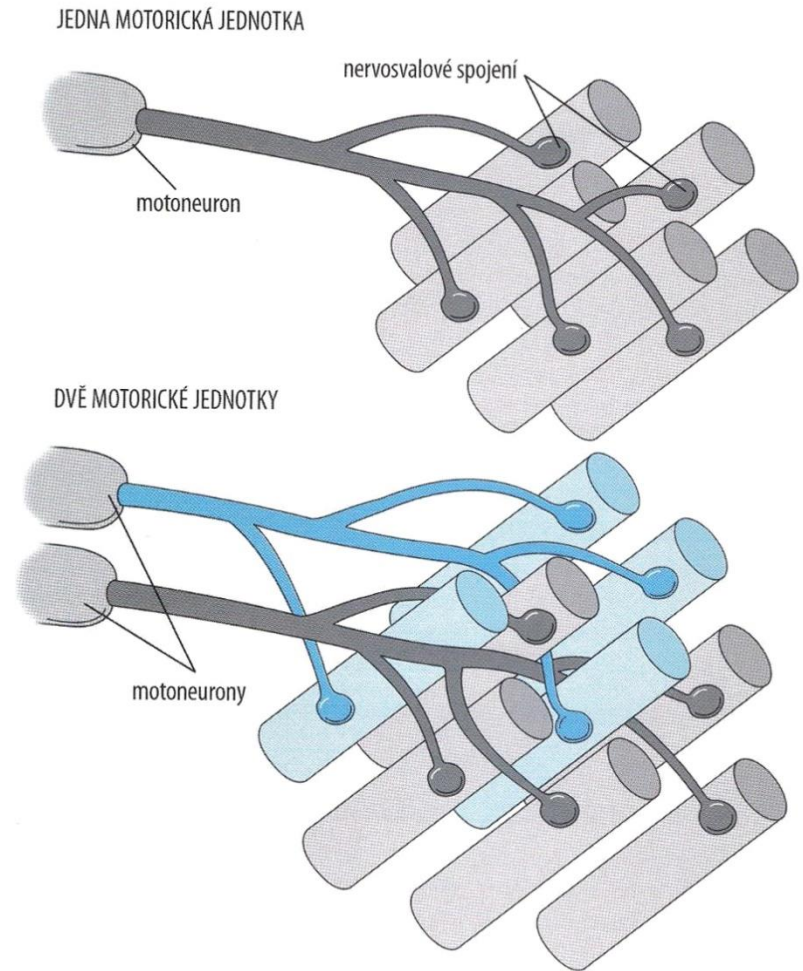
Head's zone

- diaphragm (C3–C5)
- lungs (T2–T5)
- heart (C8–T4)
- oesophagus (T4–T8)
- gonads (T10–T11)
- stomach (T6–T9)
- liver + gallbladder (T7–T9)
- intestine (T8–L2)
- appendix (T11–T12)
- pancreas (T7–T9)
- kidneys (T10–L1)

Motor unit

= group of muscle fibers supply by one motoneuron

- the more muscle fibers in the motor unit → the more precise the movement



Can we see that trick again please?

