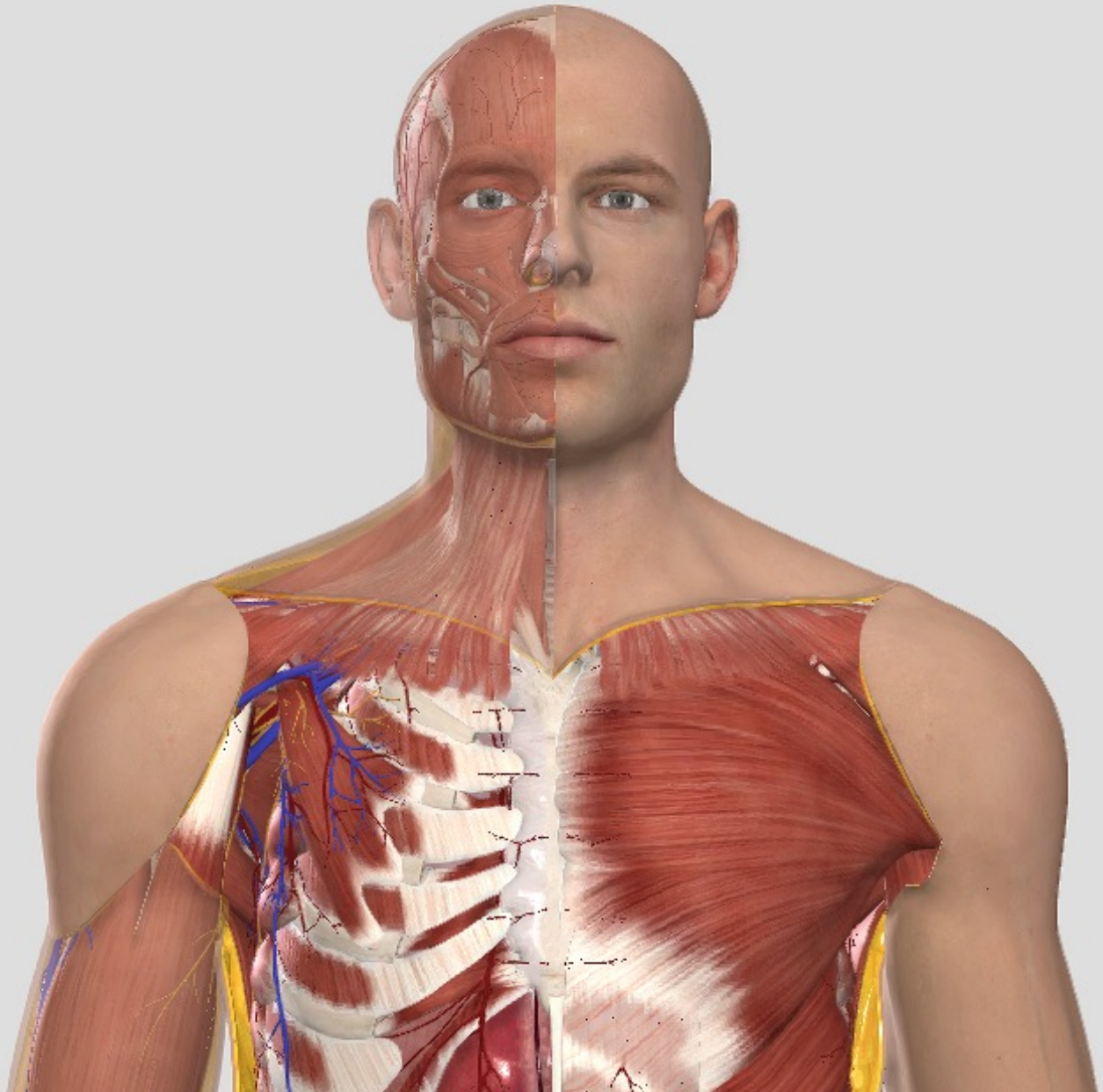
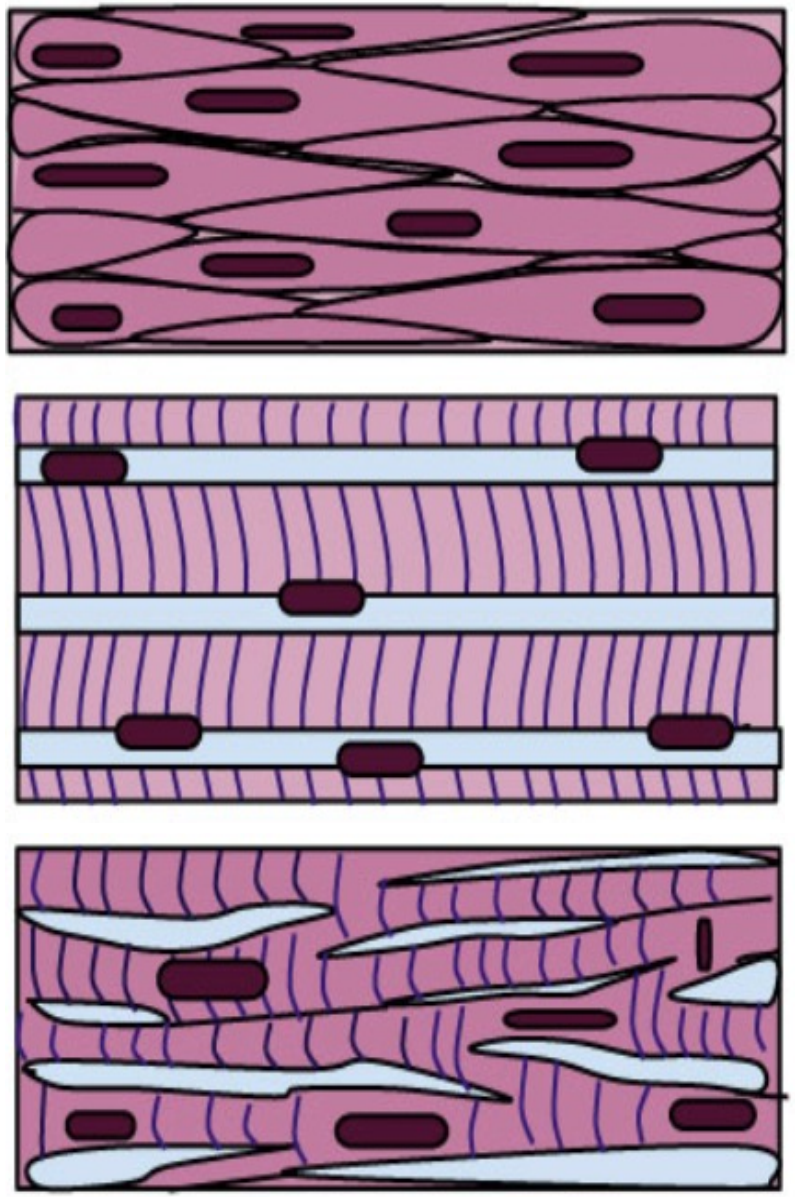
General anatomy 3



Muscles

- **Smooth muscles – single cells**
  - Sarcolemma
  - Sarcoplasma - myofibrils
  - Nucleus
  - Autonomous inervation – *sympathetic, parasympathetic*
  - Slow contraction, but long-lasting
- **Stripped muscles - syncytium**
  - Sarcoplasma
  - Myofibrils – isotropic/anisotropic stripes
  - Cerebrospinal inervation
  - Fast contraction, but fast tired
- **Myocardial muscle**
  - striped
  - intercalar discs – intercellular borderline
  - bridges
  - Autonomous continuous work, autonom. inervation



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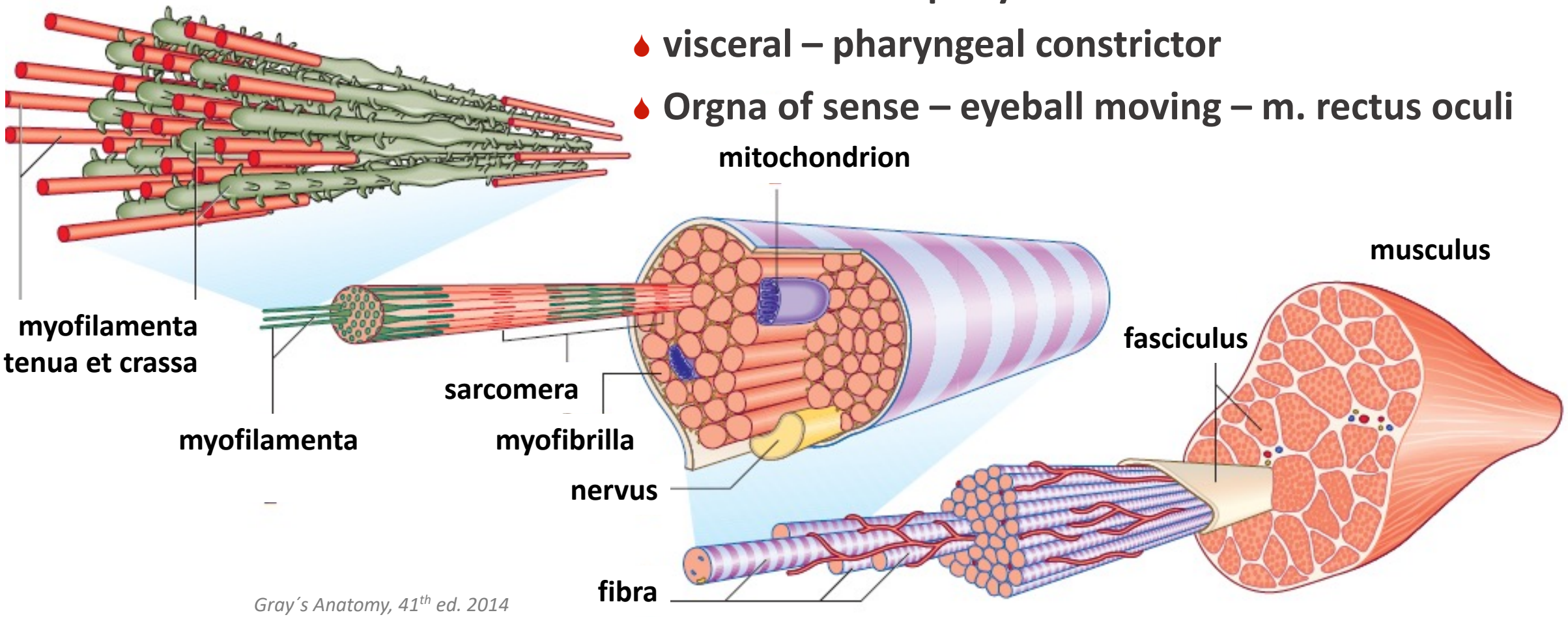
Stripped muscles

- skeletal –biceps brachii muscle
- skin - mimic – platysma
- visceral – pharyngeal constrictor
- Orgna of sense – eyeball moving – m. rectus oculi



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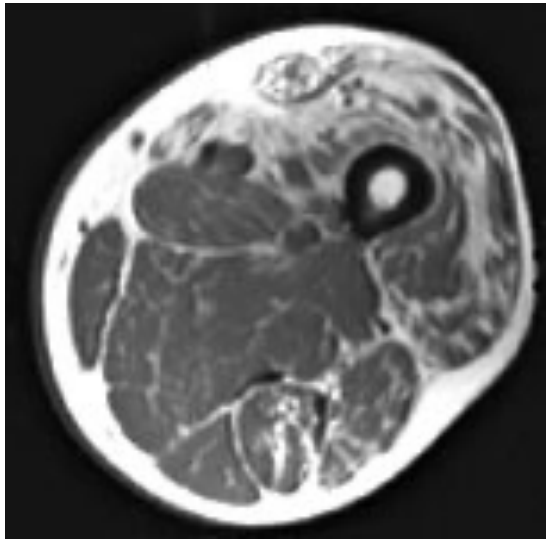
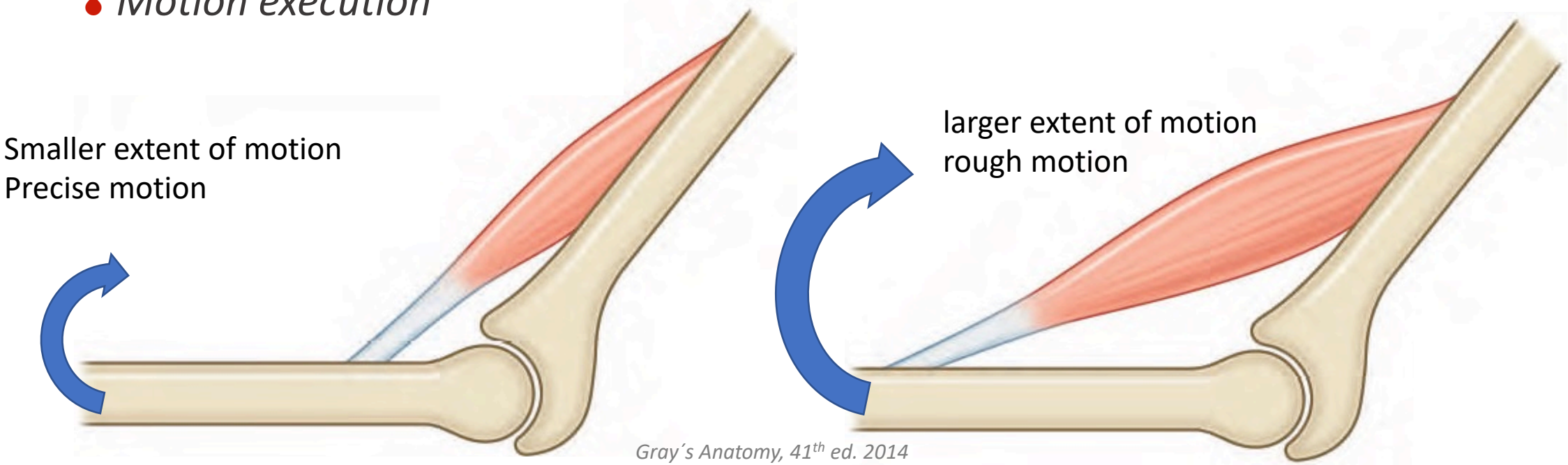
Function of muscles

- **Static muscles**
  - *Position holding*
  - *Postural muscles*
  - *Increased fibrous content*
  - *More myoglobine – more red*
- **Dynamic muscles**
  - *Motion execution*



- **hypertrophy**
  - *trained*
- **atrophy**
  - *Decreased activity*



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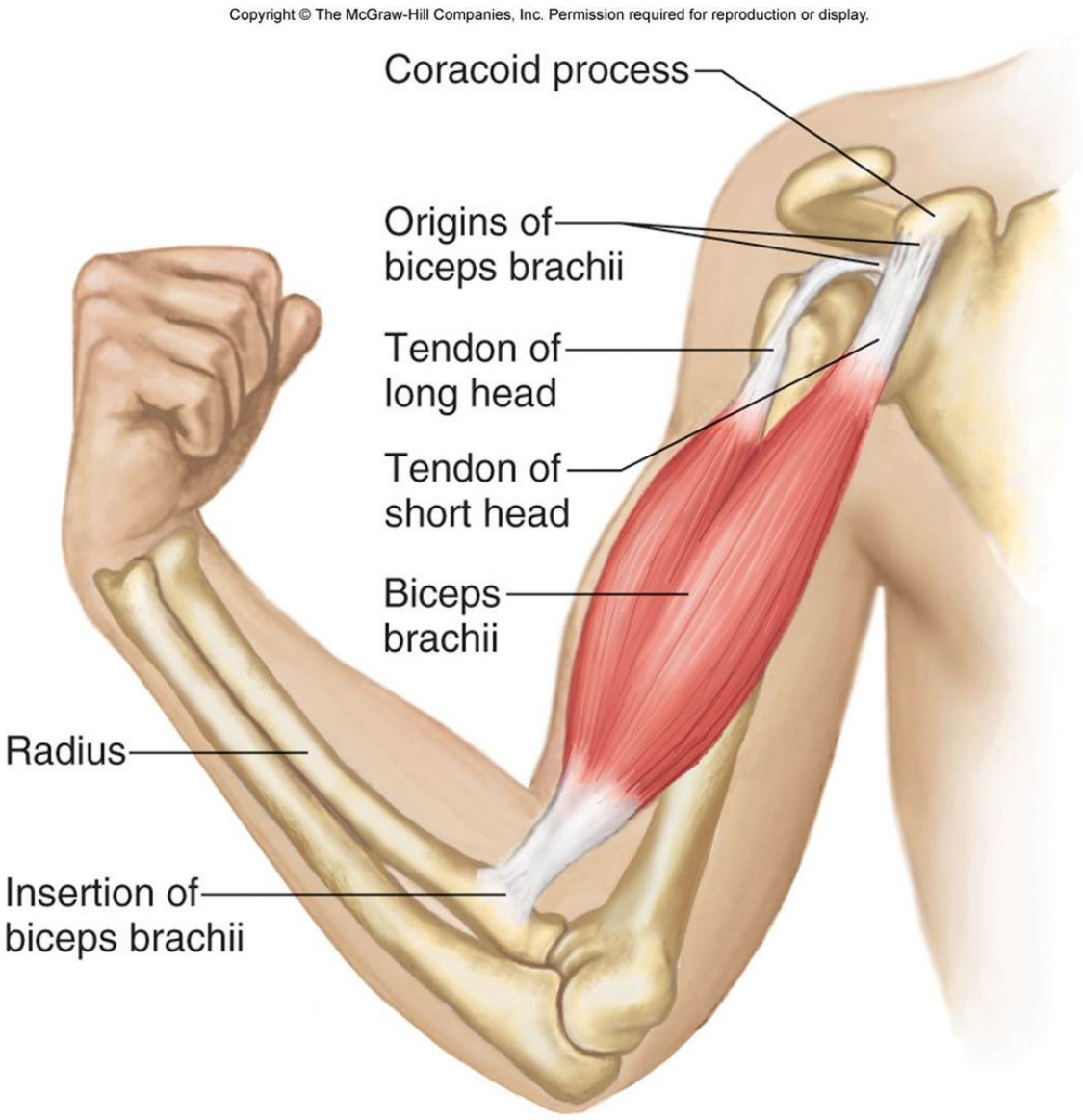
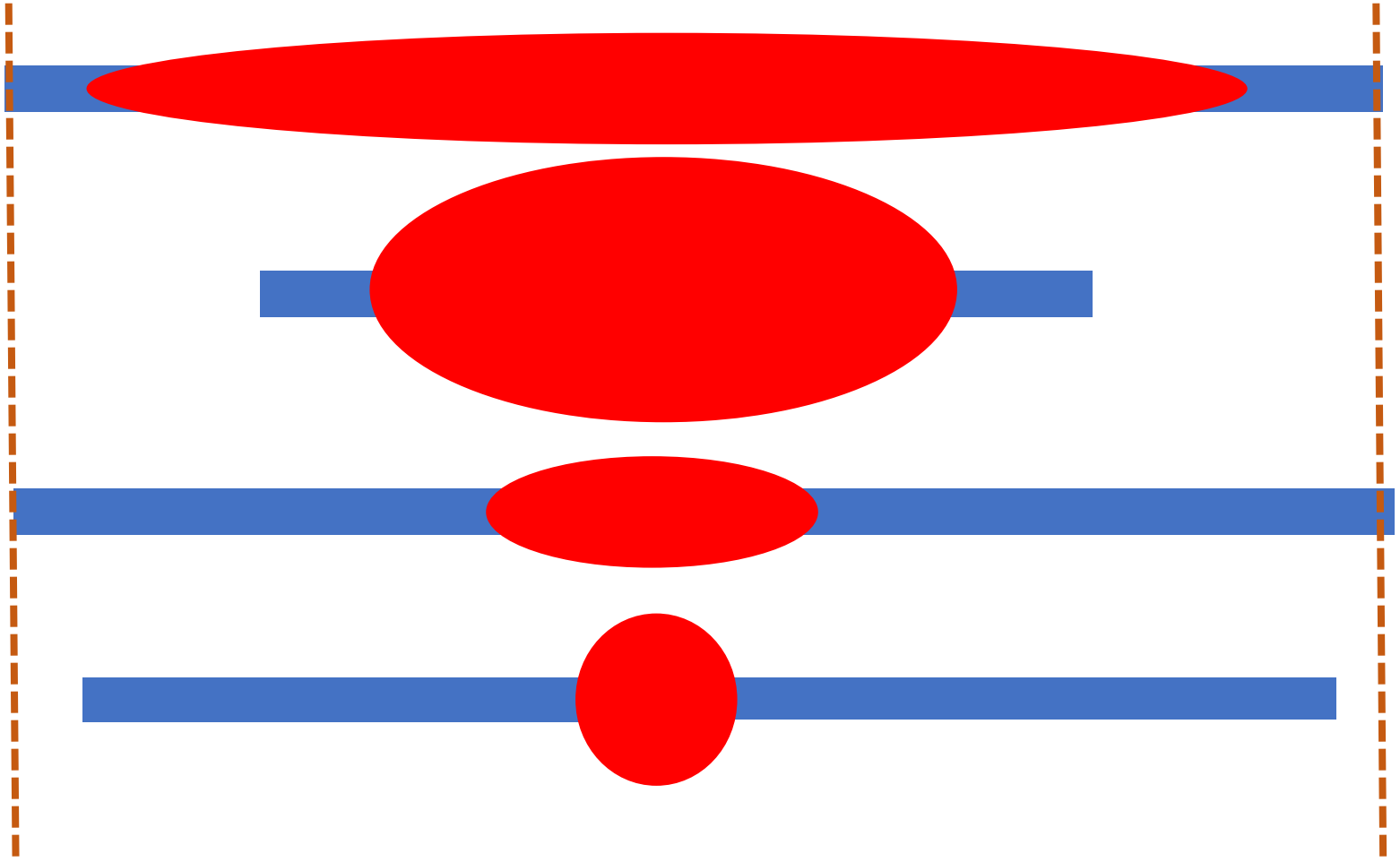
The origin and the insertion

- **Origo - caput - origin**
- **Punctum fixum**
  - *More cranial or proximal*
  - *Non-moving point during contraction*
- **Venter - belly**
- **Insertio – cauda - insertion**
- **Punctum mobile**
  - *Caudal or more distal*
  - *More-moving point during contraction*

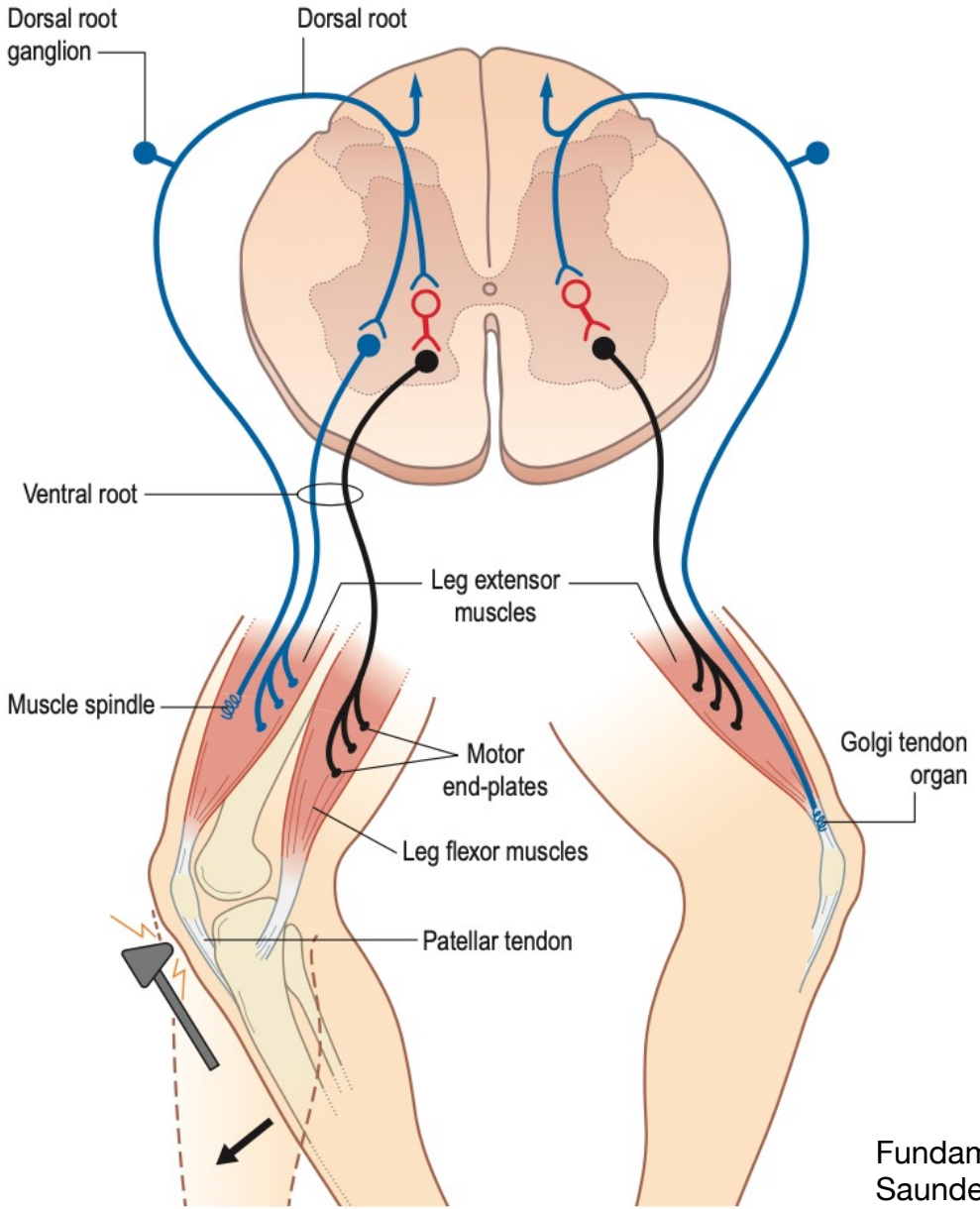


Weber –Fick law

- Shortening of the muscle is ½ of the belly length at the maximum
- The shortening is defined by the portion of tendon



Function of the nervous system

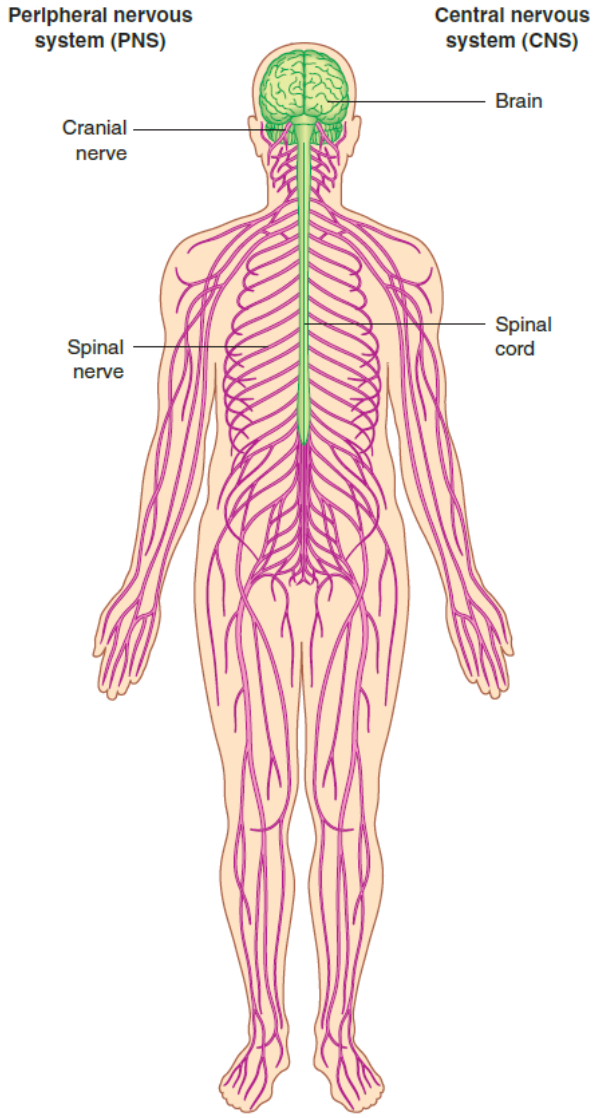


- **neurons**
- ***Information encoding***
  - ***Specialized endins***
  - ***Creation of the information quantum***
  - ***Translation into electrical signal***
- ***Information conduction***
  - ***propagation***
  - ***Fast electrical signal conduction***
  - ***Action potential***
- ***Information transmission***
  - ***Other neurons***
  - ***Muscular cells***
  - ***Glandullar cels***
  - ***With the help of synapsis and neurotransmitter***

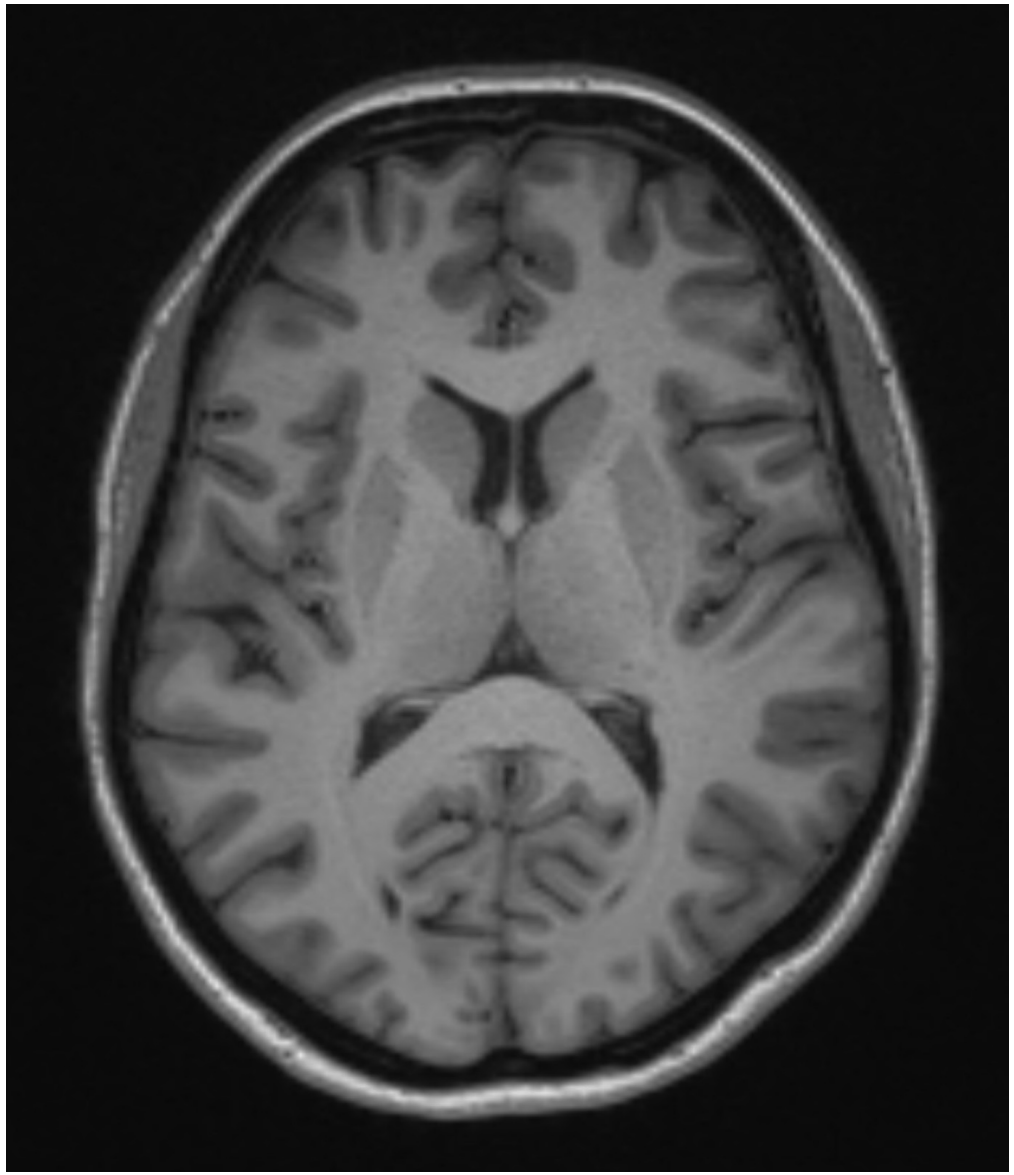
Fundamental Neuroscience for Basic and Clinical Applications, 4th Edition, 2013, Saunders, Elsevier.

Nervous system as a unit

- **Central nervous system (CNS)**
- Cerebrum
- Medulla spinalis
- Nervus opticus
- Retina
- **Peripheral nervous system (PNS)**
- Nervi craniales
- Nervi spinales
- Peripheral autonomous system (ANS)
  - Sympaticus
  - Parasympaticus
- ***Neteral nervous system (ENS)***
- Special senses
- *Taste, olfaction, vision, hearing, ballance*



Cetral nervous system



- **Grey matter – substantia grisea**
  - Somata (bodies) of the neurons
  - Nuclei
  - Grouping of the grey matter (basal ganglia)
  - Cortex
- *Neuropil – the largest volume of the nervous system*
  - Un-myelinizated axons, dendrites, synapses, glial processes
- **White matter – substantia alba**
  - Axons
  - Bundes of fibers
  - Tend to be organized in tracts
  - Zone where the tracts are organized – white matter
  - Telencefalon
  - Cerebellum
  - Medulla spinalis

nervi craniales – cranial nerves – hlavové nervy

0. nervus terminalis – terminal nerve – koncový nerv

I. nervus olfactorius – olfactory nerve – čichový nerv

II. nervus opticus – optic nerve – zrakový nerv

III. nervus oculomotorius – oculomotor nerve – okohybný nerv

IV. nervus trochlearis – trochlear nerve – kladkový nerv

V. nervus trigeminus – trigeminal nerve – trojklanný nerv

VI. nervus abducens – abducent nerve – odtahovací nerv

VII. nervus facialis – facial nerve – lícní nerv

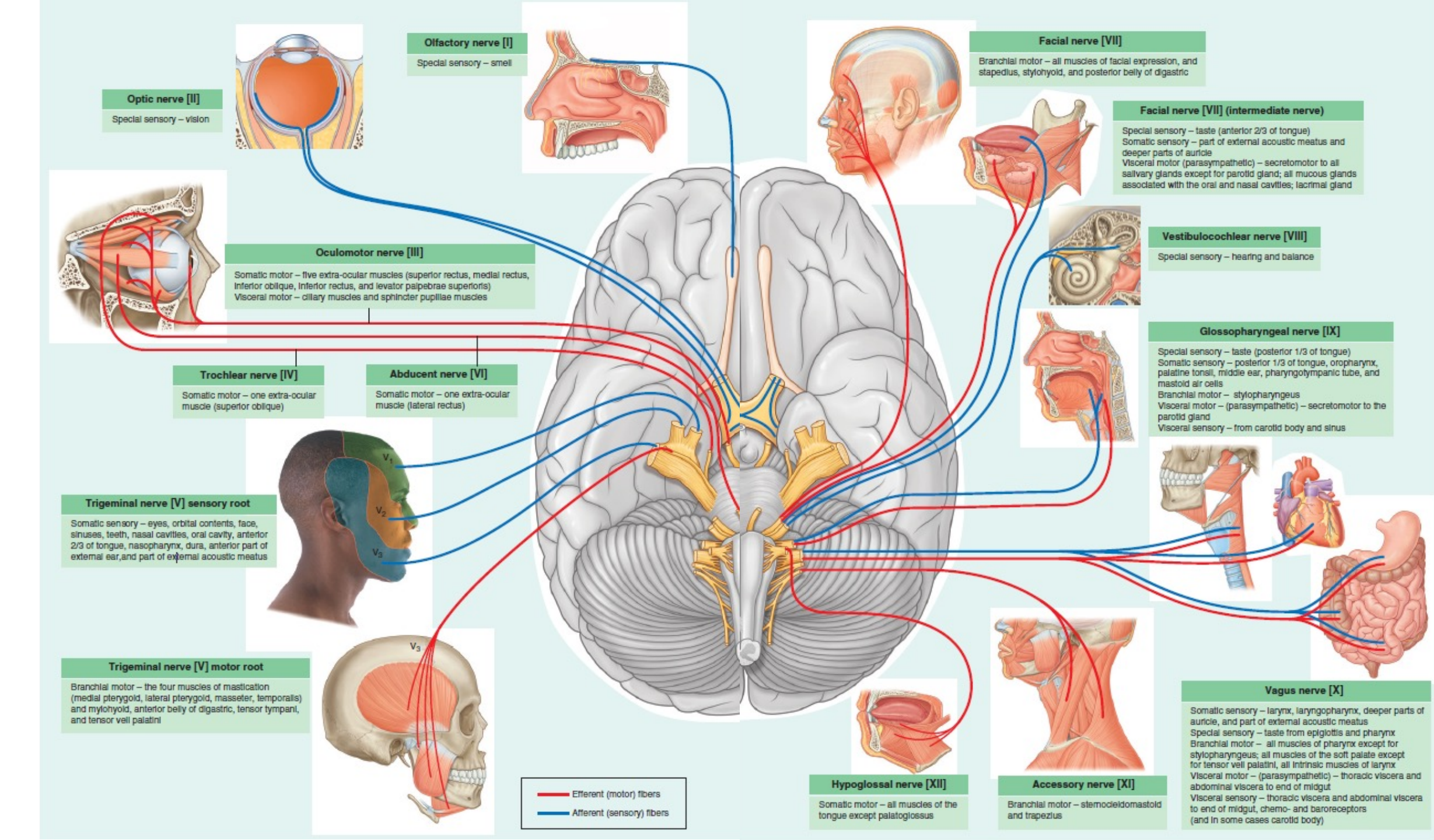
VIII. nervus vestibulocochlearis – vestibulocochlear nerve – rovnovážný a sluchový nerv

IX. nervus glosshopharyngeus – glossopharyngeal nerve – jazykohltanový nerv

X. nervus vagus – vagal nerve – bloudivý nerv

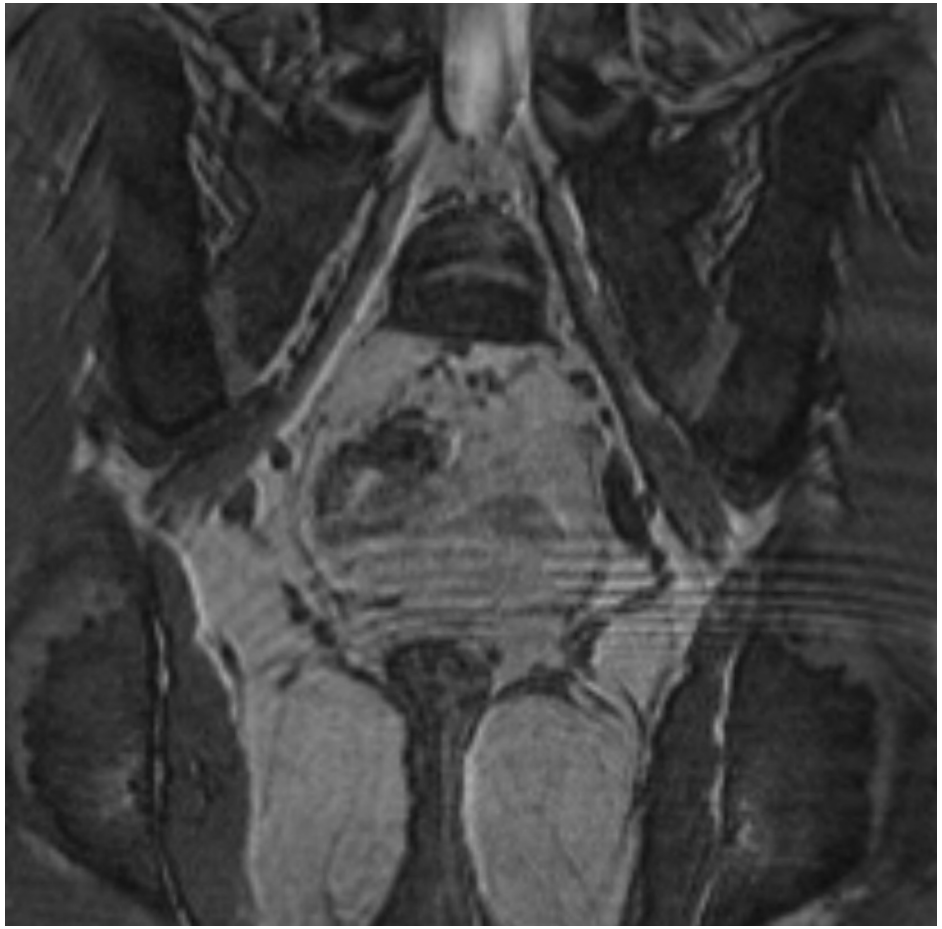
XI. nervus accesorius – accesory nerve – přídatný nerv

XII. nervus hypoglossus – hypoglossal nerve – podjazykový nerv


Optic nerve [II]
Special sensory – vision
Olfactory nerve [I]
Special sensory – smell
Facial nerve [VII]
Branchial motor – all muscles of facial expression, and stapedius, stylohyoid, and posterior belly of digastric
Facial nerve [VII] (intermediate nerve)
Special sensory – taste (anterior 2/3 of tongue)
Somatic sensory – part of external acoustic meatus and deeper parts of auricle
Visceral motor (parasympathetic) – secretomotor to all salivary glands except for parotid gland; all mucous glands associated with the oral and nasal cavities; lacrimal gland
Vestibulocochlear nerve [VIII]
Special sensory – hearing and balance
Oculomotor nerve [III]
Somatic motor – five extra-ocular muscles (superior rectus, medial rectus, inferior oblique, inferior rectus, and levator palpebrae superioris)
Visceral motor – ciliary muscles and sphincter pupillae muscles
Trochlear nerve [IV]
Somatic motor – one extra-ocular muscle (superior oblique)
Abducent nerve [VI]
Somatic motor – one extra-ocular muscle (lateral rectus)
Glossopharyngeal nerve [IX]
Special sensory – taste (posterior 1/3 of tongue)
Somatic sensory – posterior 1/3 of tongue, oropharynx, palatine tonsil, middle ear, pharyngotympanic tube, and mastoid air cells
Branchial motor – stylopharyngeus
Visceral motor – (parasympathetic) – secretomotor to the parotid gland
Visceral sensory – from carotid body and sinus
Trigeminal nerve [V] sensory root
Somatic sensory – eyes, orbital contents, face, sinuses, teeth, nasal cavities, oral cavity, anterior 2/3 of tongue, nasopharynx, dura, anterior part of external ear,and part of external acoustic meatus
V1
V2
V3
Trigeminal nerve [V] motor root
Branchial motor – the four muscles of mastication (medial pterygoid, lateral pterygoid, masseter, temporalis) and mylohyoid, anterior belly of digastric, tensor tympani, and tensor veli palatini
V3
Hypoglossal nerve [XII]
Somatic motor – all muscles of the tongue except palatoglossus
Accessory nerve [XI]
Branchial motor – sternocleidomastoid and trapezius
Vagus nerve [X]
Somatic sensory – larynx, laryngopharynx, deeper parts of auricle, and part of external acoustic meatus
Special sensory – taste from epiglottis and pharynx
Branchial motor – all muscles of pharynx except for stylopharyngeus; all muscles of the soft palate except for tensor veli palatini, all intrinsic muscles of larynx
Visceral motor – (parasympathetic) – thoracic viscera and abdominal viscera to end of midgut
Visceral sensory – thoracic viscera and abdominal viscera to end of midgut, chemo- and baroreceptors
(and in some cases carotid body)
Efferent (motor) fibers
Afferent (sensory) fibers

Peripheral nervous system

- Efferent axones (fibres) of motor neurons
  - Motor neurones localized in CNS
- Somata and processes of sensitive (senzoric) neurons
  - Bodies withou synapses localized in spinal ganglia of dorsal roots
  - Afferent processes of the sensitive neurons
- Ganglial neurons of hte autonomous system
- Peripheral fibres of the autonomous neurones
  - Bodies localized in CNS



Microstructure

- More cellular populations
- Neurons
- Non-neuronal cells – neuroglia, glial cells
  - *Cells are not able to generate electrical potential*
  - *Information conducton, facilitation or fixation through calcium signalling*
  - *Interaction neuron-glia*
- *Ratio between populations*
  - *Glial cells: neurons*
  - *Eighties 17:1*
  - *Current hyposthesis 1:1*
- *Secretoric part of the neurvous system – choroidal plexus*
  - *Roof of the neural tube, where are not created neurons*
- *Hematoencephalic barrier (blood-brain barrier – BBB)*
  - *Regulatio of ht emolecular exchanges between vascular systém and neurons*
  - *Interaction between microcirculation – glia - neurons*

Neuron

- **Neurons**
- ***Grouped in clusters***
- ***Nuclei, columnes, strata (CNS)***
- ***Ganglia (PNS)***
- ***Dispersed (ENS)***

- *Variability in size and shape*
- **Extreme ratio between surface and volume**
  - *Multiple processes*
  - *Classification according to the size, shape and localization*
- **Dendrites - multiple afferent processes**
- **Body (soma)**
- **Axon – unique efferent process**
  - **Axonal hillock**

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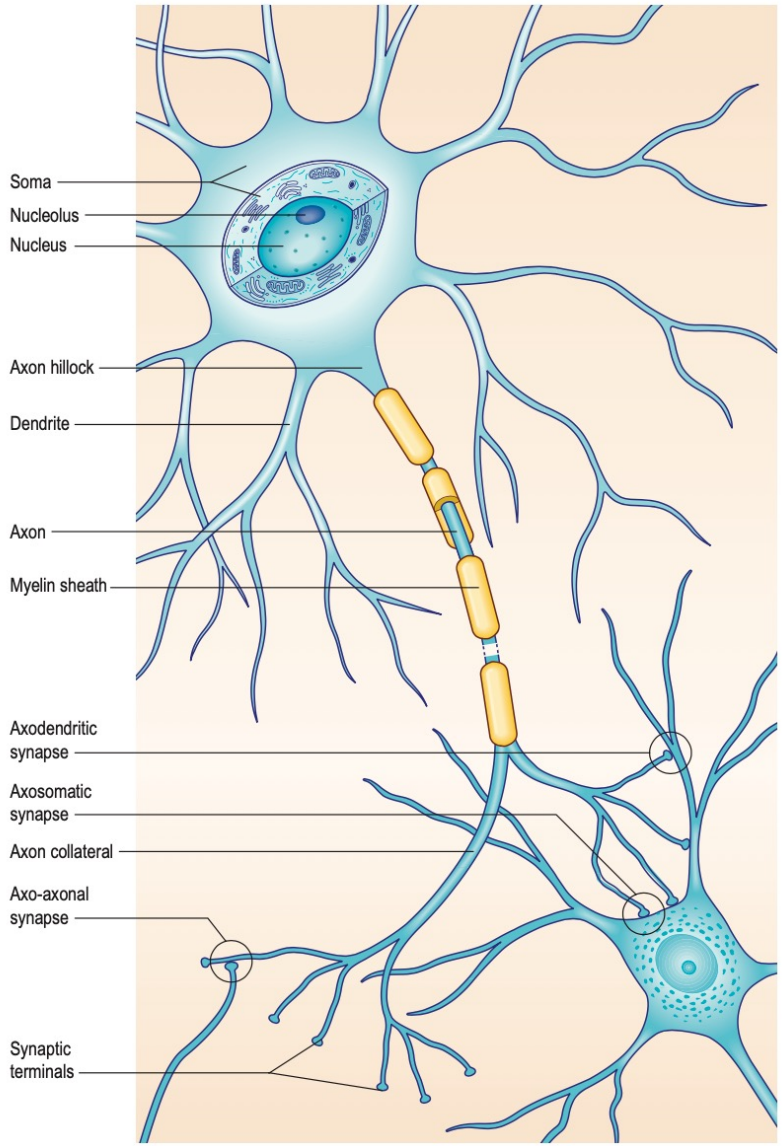

Soma

- **Size - 5 – 100 micrometers**
- ***Un-myelinized***
- ***Axosomatic synapses***
- ***Inhibitoric***
- ***Excitatoric***
- ***Dendrosomatic contacts***
- ***Somatosomatic contacts***
- ***connections***
- ***With (pedal) processes of astrocytes***
- ***With satellite processes of the oligodendrocytes***

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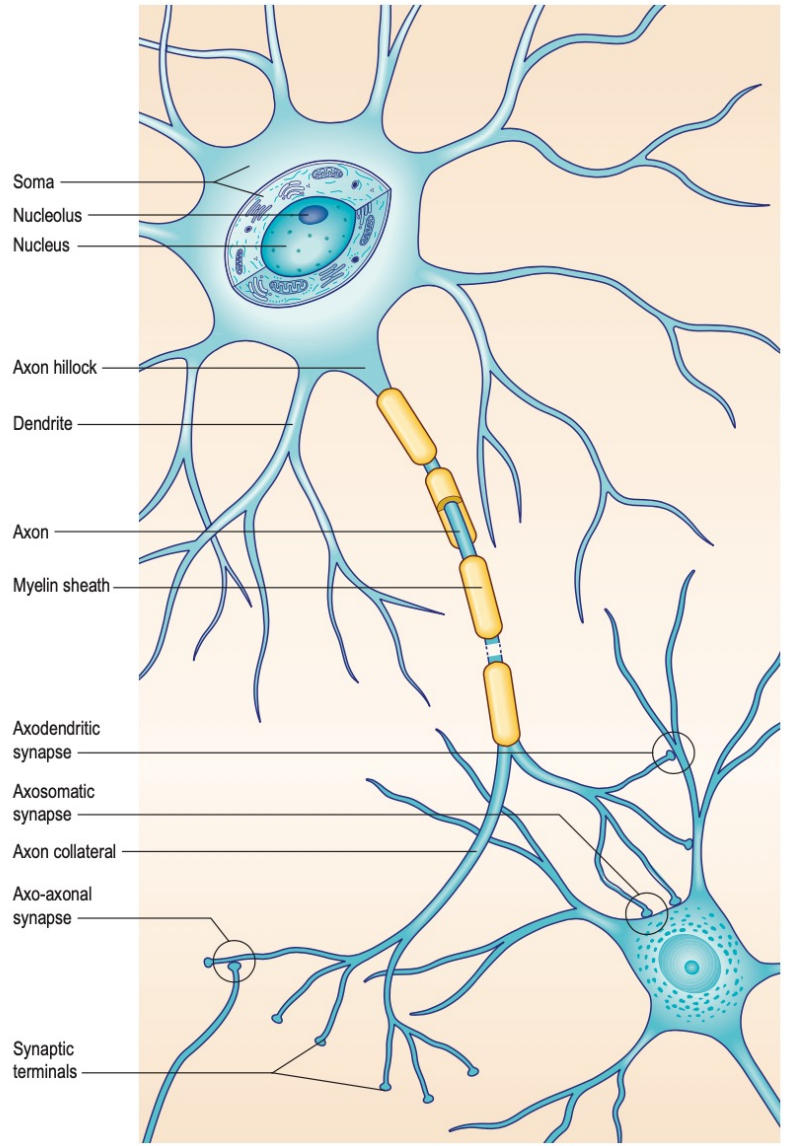

Dendrites

- **Dendrites**
  - ***short***
  - ***Abundant of branches***
  - ***Modulation of the postsynaptic signal***
  - ***Chemically directed channels***
- ***Signal registration***
  - ***Excitative and inhibitoric axodendritic contacts***
  - ***Dendrodendritic contacts***
  - ***Dendrosomatic contacts***
- ***Trophic functions***

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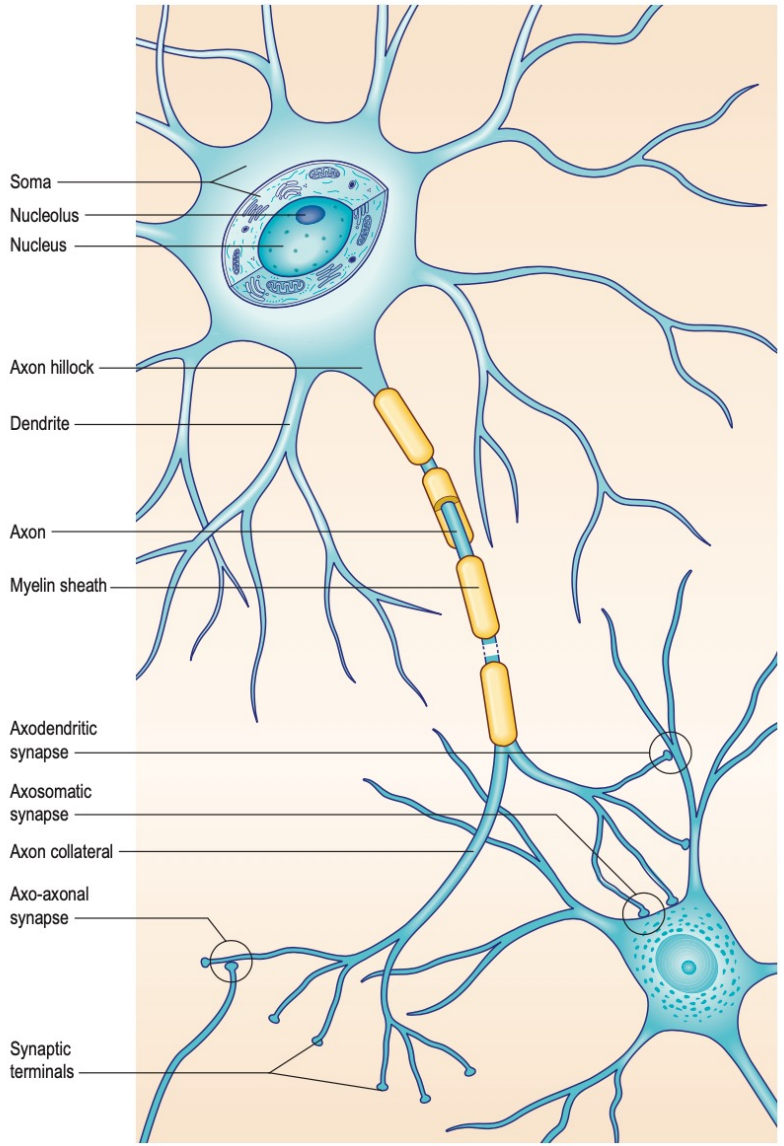

Neurit

- **Neurit – *efferent procesus – to next neuron or effector***
  - *Nemyelinizated versus myelinizated (axon)*
  - *Voltage-directed channels*
  - *Axoplasmatic flow – transportation*
- ***Axonal hillock***
  - *The site of the electric action potential origin*
  - *Site of the inhibitory axon-axonal connections*
- ***Myelinized section***
  - *Oligodendroglia (CNS)*
  - *Schwann´s cells (PNS)*
- ***nodes of Ranvier***
  - *PNS – basement membrane*
  - *CNS – astrocytary processes*
  - *The highest concetration of natrium channels*
  - *Potassium channels – paranodal axolemma*
- ***Pre-synaptic boutton***
  - *Un-myelinizated ending*

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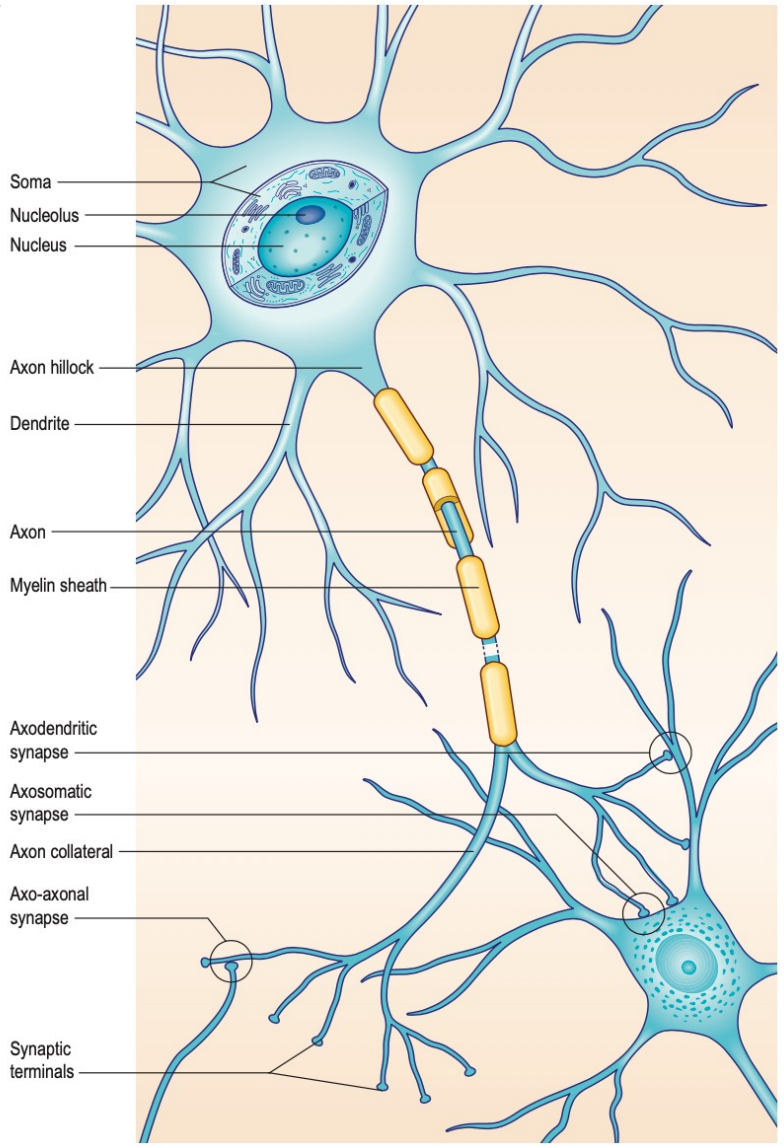

Axoplasmatic flow

- **Cirkulation of cytoplasm and neuronals organels**
- **Prograde – soma – axonal ending**
- **Retrograde – axonal ending - soma**
- ***Slow flow***
  - ***Proteins of cytoskeleton***
  - ***Proteins unbound to membranes***
  - ***0,1 – 3 mm /d***
- ***Fast flow***
  - ***Material bound to vesicles, mitochondria***
  - ***200 mm/d - retrograde***
  - ***Neuroinfection viruses - herpes zooster, rabies, polio***
  - ***40 mm/d – prograde***
  - ***Synaptic vesicules with neurotransmitters***

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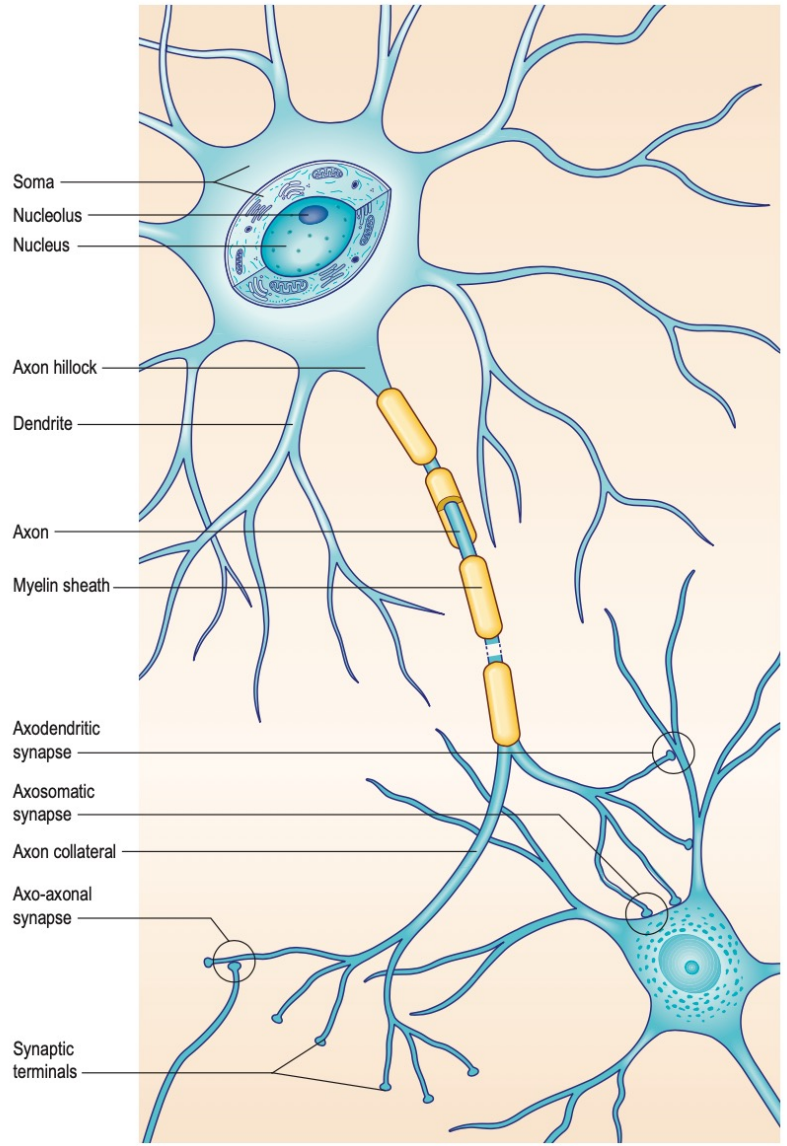
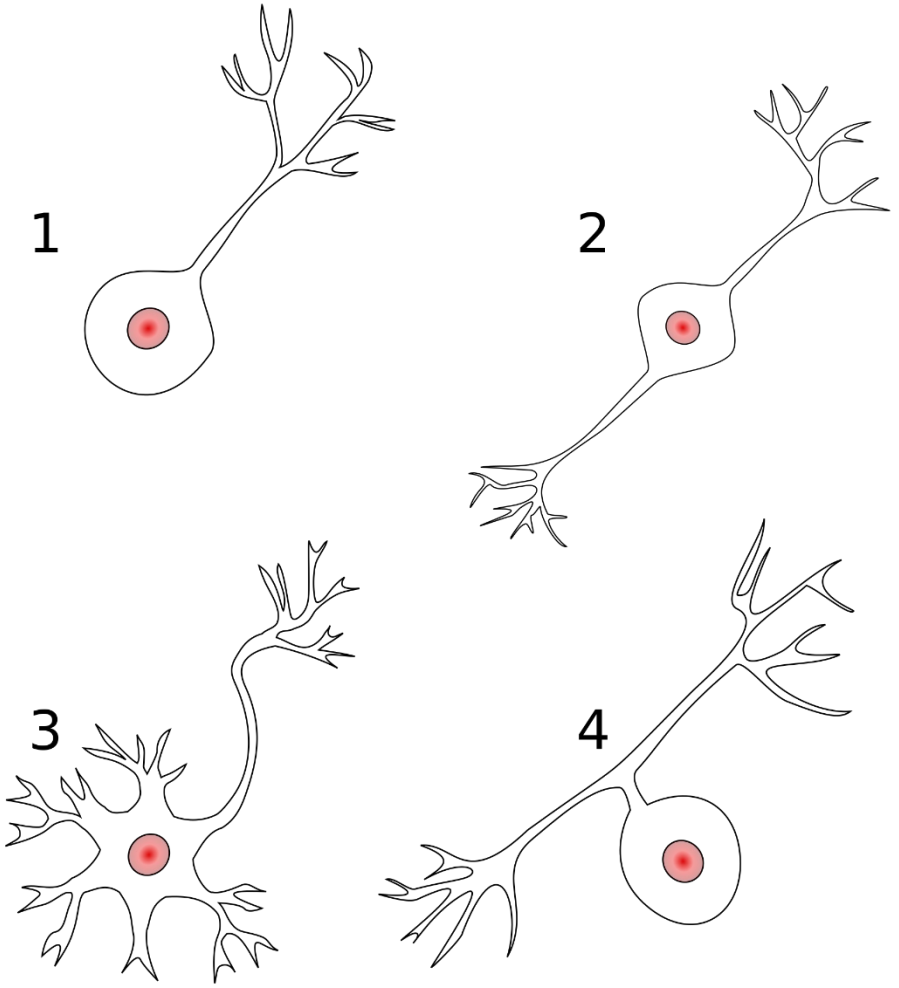


The arts of neurones

- **Morfologic**
- *Unipolar (1)*
- *Bipolar (2)*
- *multipolar (3)*
- *Pseudounipolární (4)*
  - *Sensitive neurones of spinal ganglia*

- **Acording to the lenght of axon**
  - *With the long neurite*
  - *With the short neurite*
- **According to the function**
  - *Projectory – connecting the distant parts of NS*
  - *Interneurons - local connections of next parts of NS*



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Neuron

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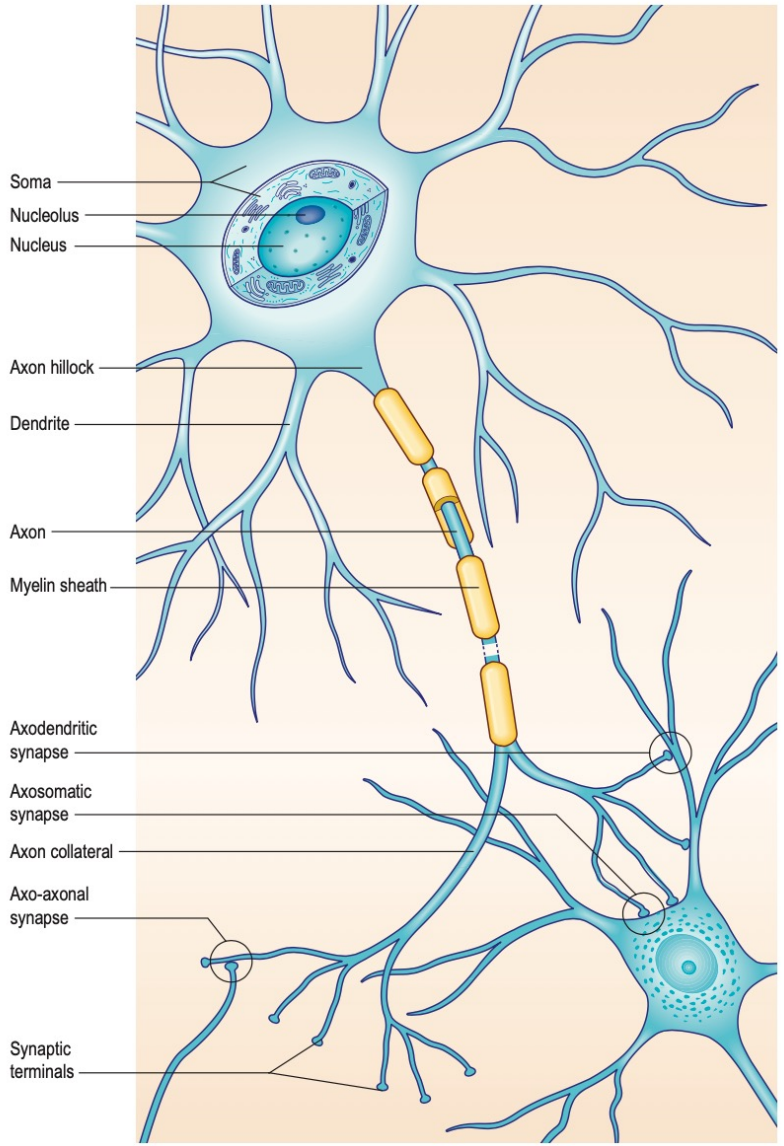

synapsis

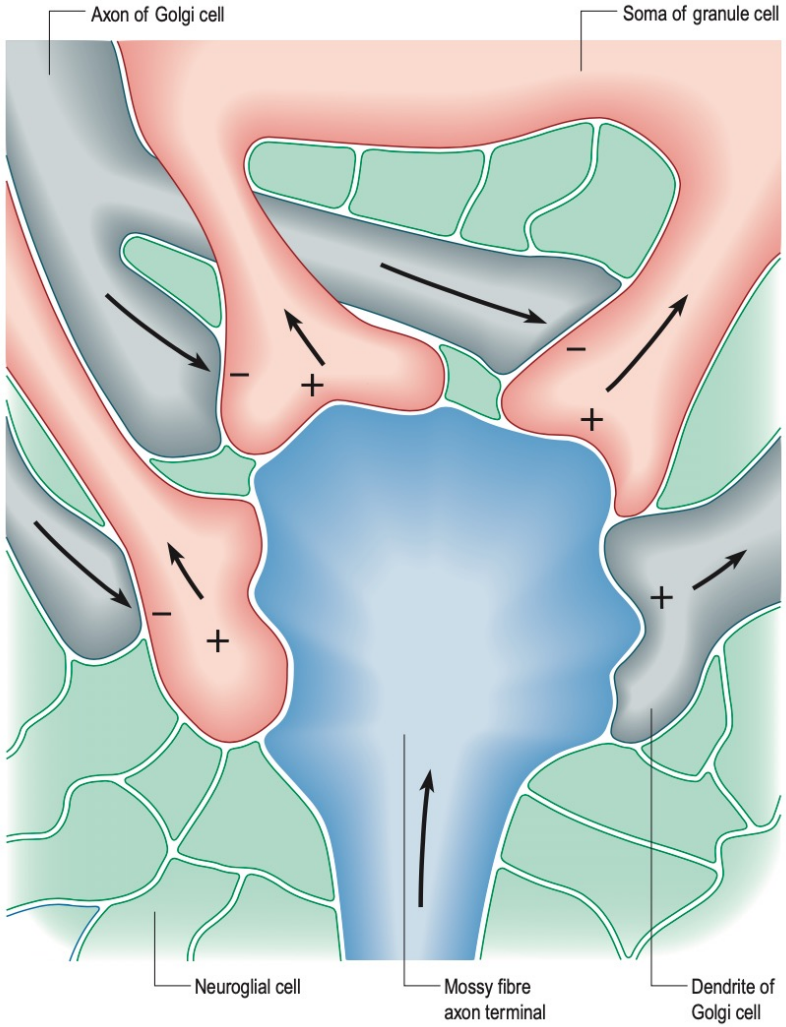

Fig. 3.7 The arrangement of a complex synaptic unit. A cerebellar synaptic glomerulus with excitatory ('+') and inhibitory ('–') synapses grouped around a central axonal bouton. The directions of transmission are shown by the arrows.

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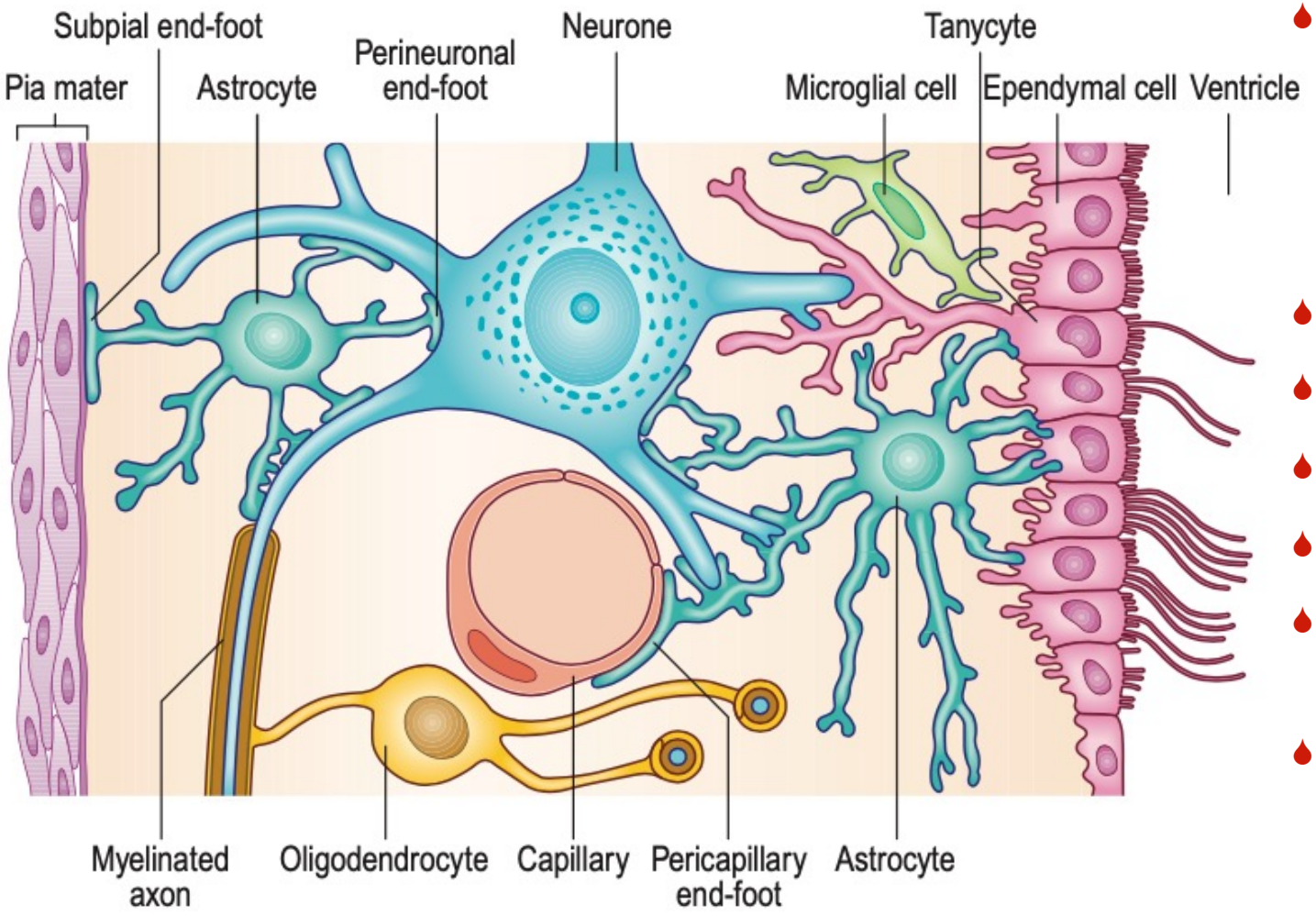
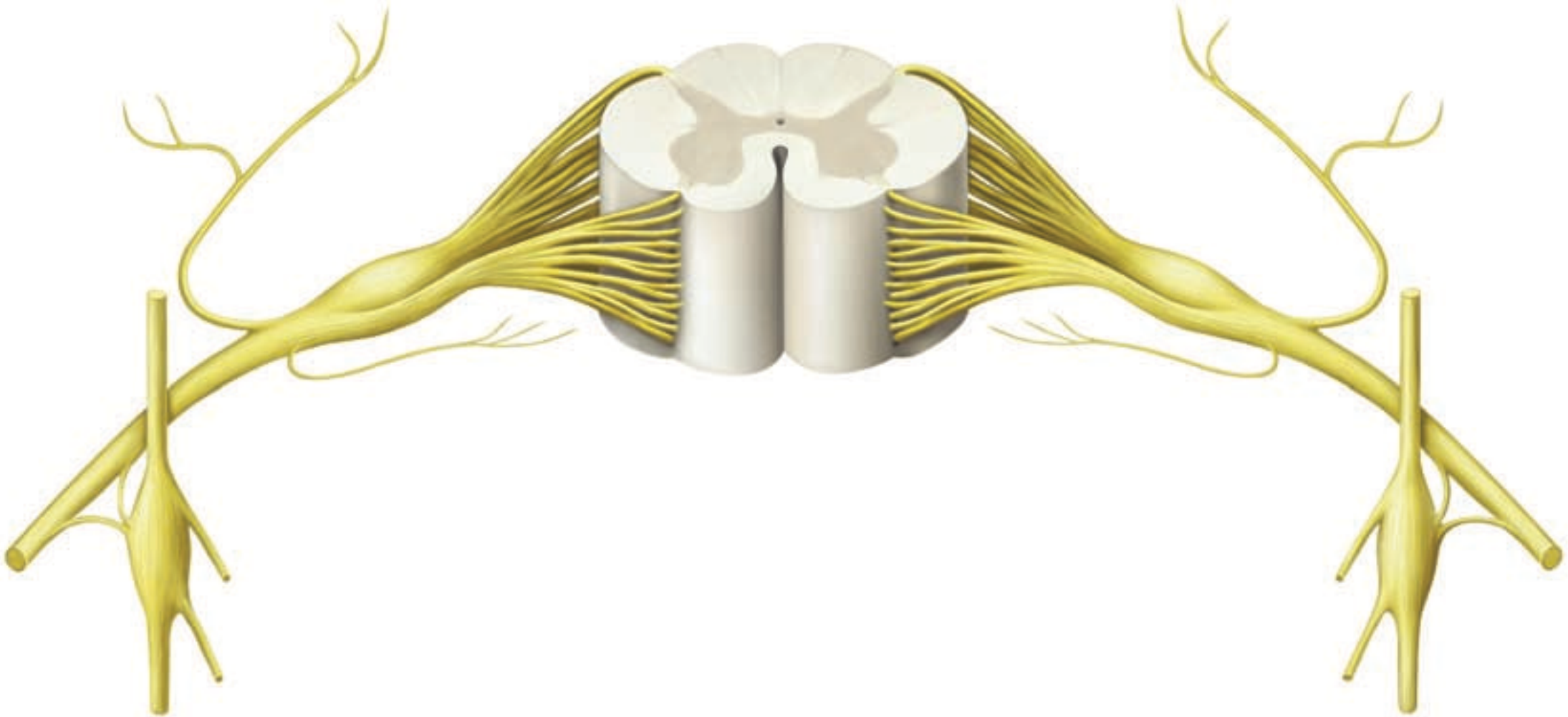
- **Organization of the ending**
- **single direction transmission**
  - ***Chemicla transmission***
    - ***Neurotransmitter***
  - ***Presynaptic thickenning***
  - ***Synaptic cleft***
  - ***Postsynaptic thickening***
- ***Site of synapse***
  - ***Dendritic spne***
  - ***Flat part of dendrite***
  - ***Soma***
  - ***Axon***
- ***The synaptic organization*** ***(CNS a autonomic ganglia, thalamus)***
  - ***Axo-axonal***
  - ***Axo-somatic***
  - ***Dendro-axonal***
  - ***Dendro-dendritic***
  - ***Somato-dendritic***
  - ***Somato-somatic***

Glia

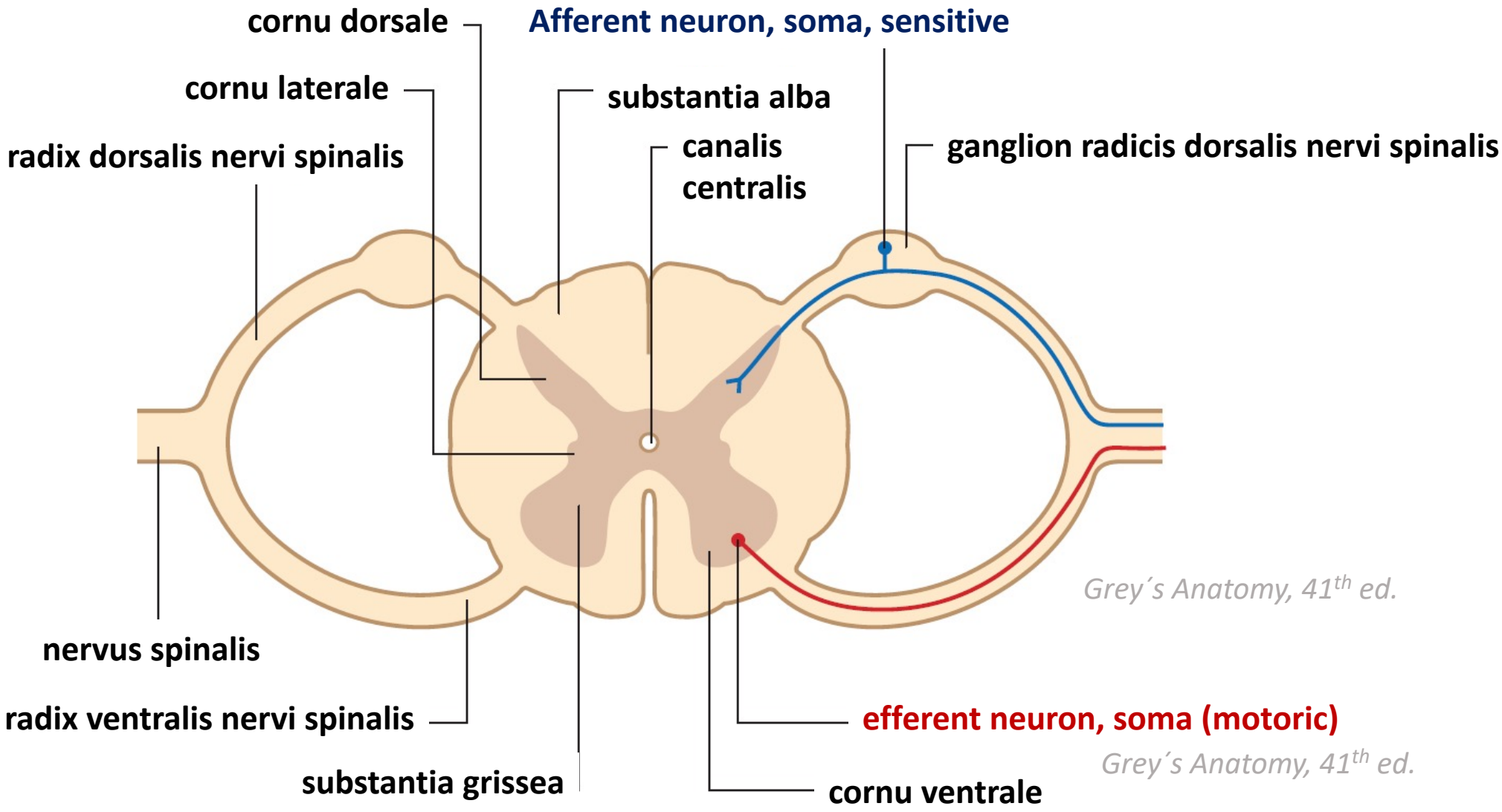


- **Astrocytes**
  - Syncytium in gray matter
  - Iont-exchanges
  - glucose transportation and exchange
  - Glucose flow maintenance
- **Modulation of ht eactivity – neuropil**
- **Neurovascular coupling**
- **Specialized (neurohypohysis)**
- ***Glia limitans***
- ***Oligodendrocytes***
  - ***Creation of the myelin sheath***
- ***Mikroglia***
  - ***Endogenous immune brain systém***
  - ***Origin in mesnechymal original monocytes***
- ***Ependyma***

Spinal cord, roots, spinal nerve, branches



Spinal cord, roots, spinal nerve, branches



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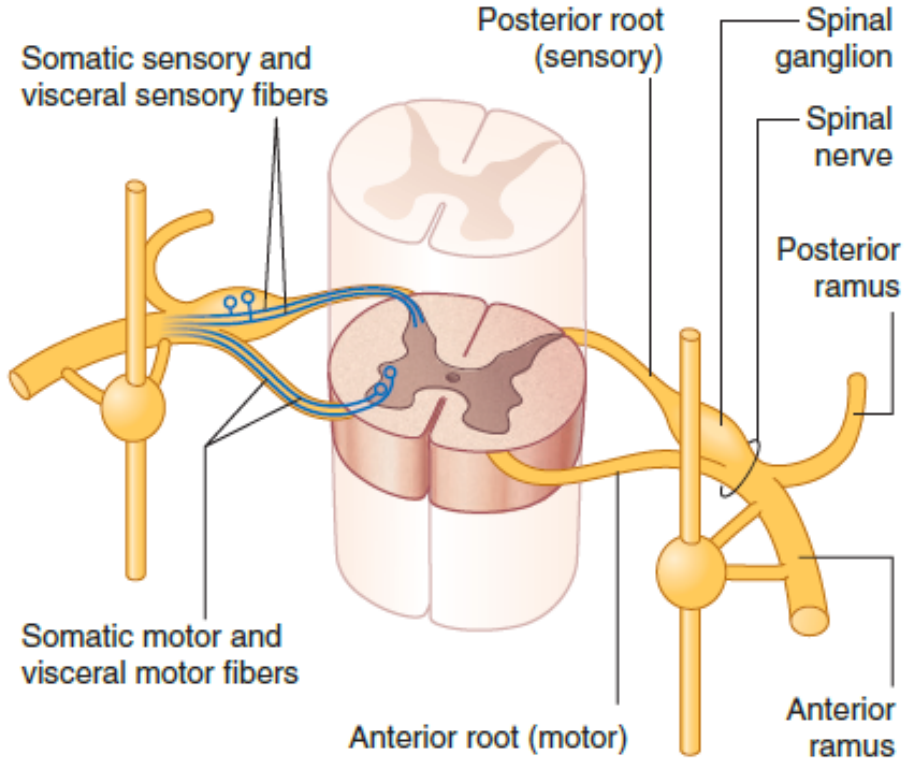
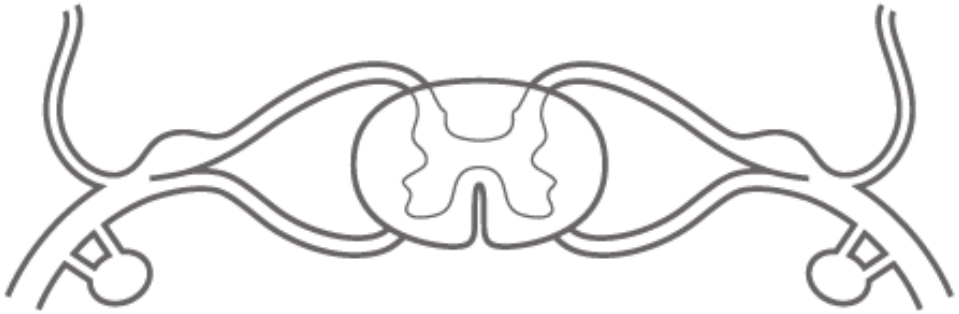
Radices, nervi spinales, rami

- Anterior roots– radices ventrales
  - Somatomotor and visceromotor
- Posterior roots – radices dorsales
  - Sensoric – ganglion spinale

- Nervi spinales – spinal nerves
- Junction of posterior and anterior roots
  - One segment of spinal cord – one spinal nerve
- foramen intervertebrale
  - Four branches - rami





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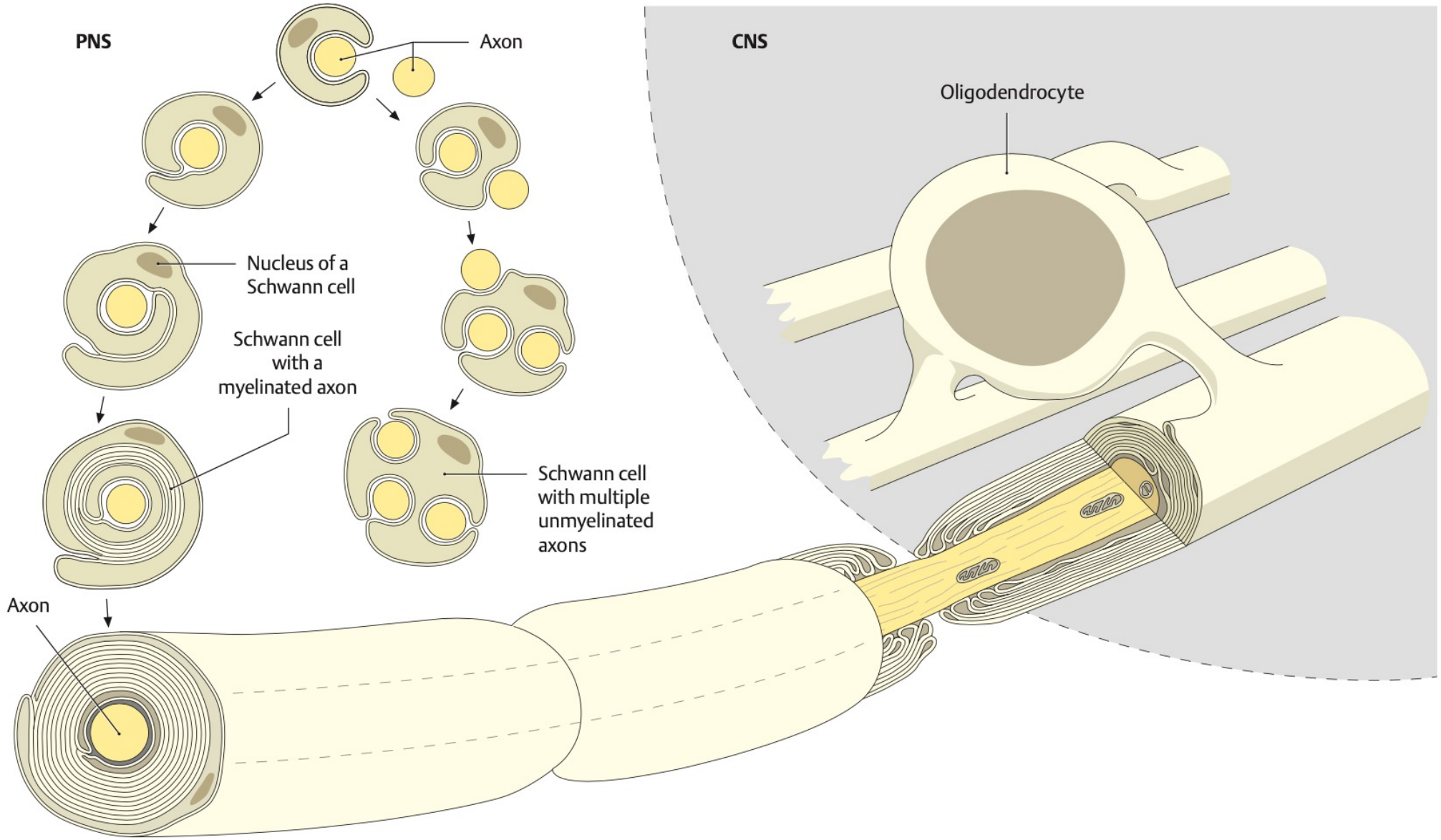
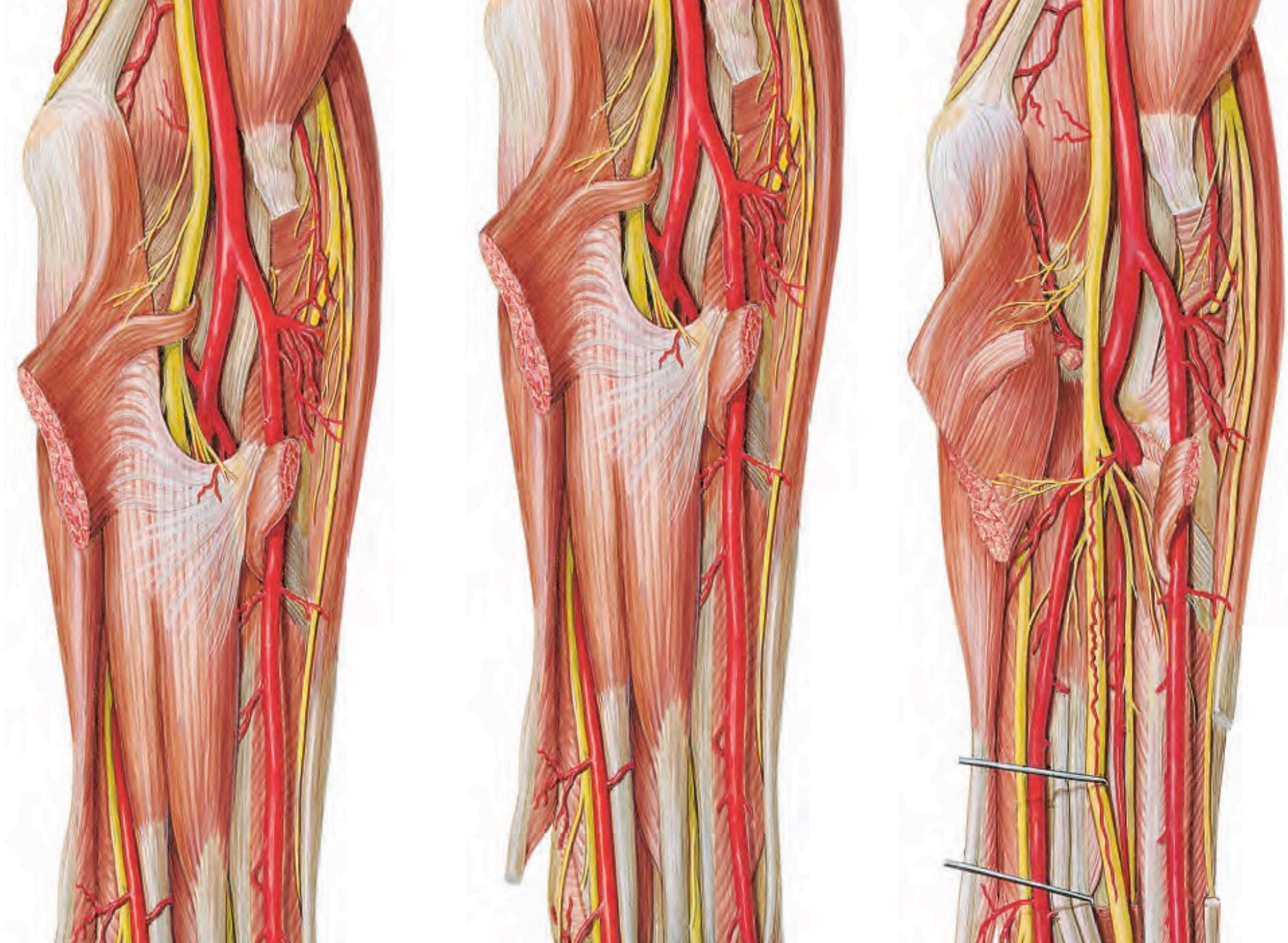
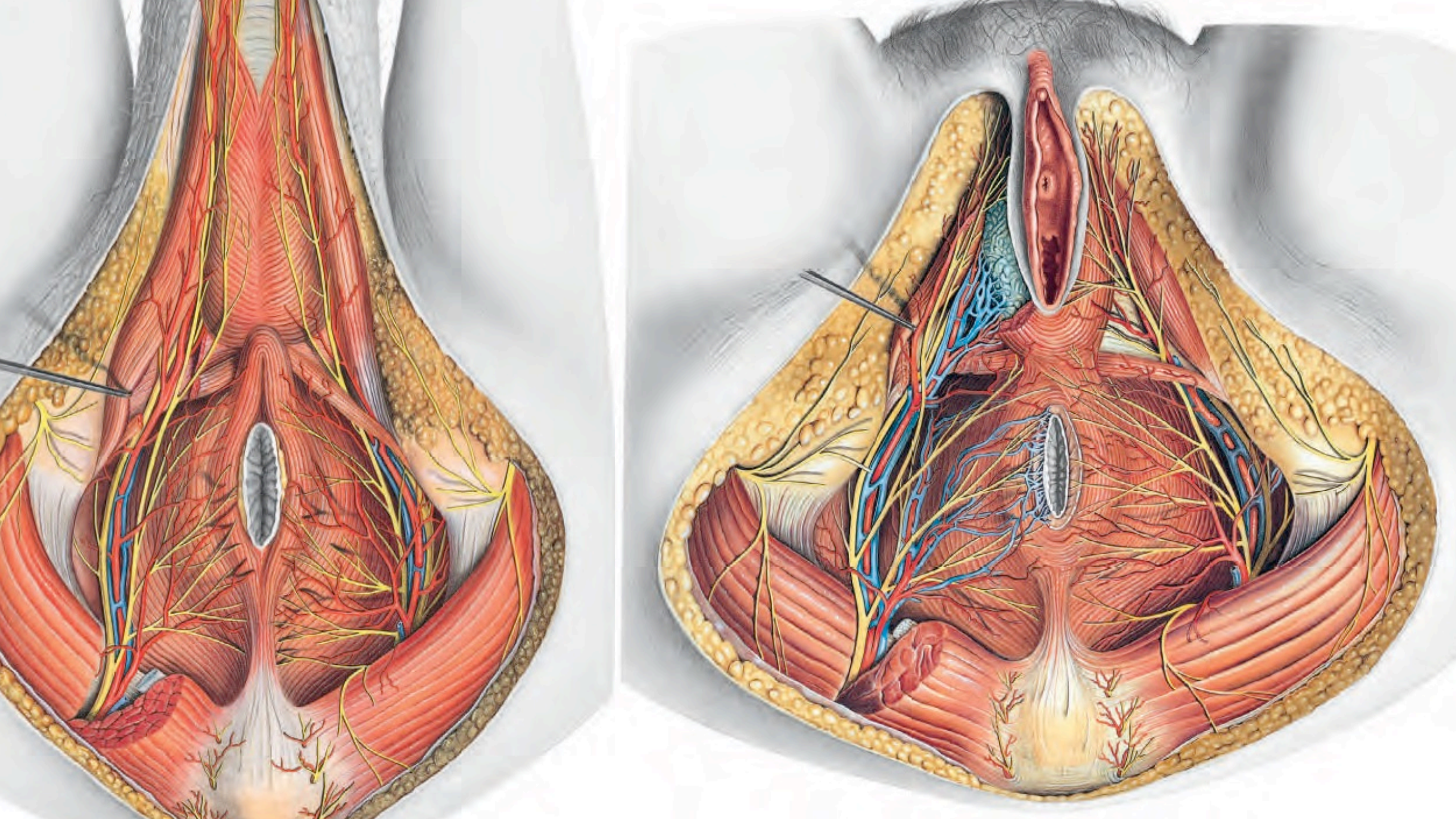
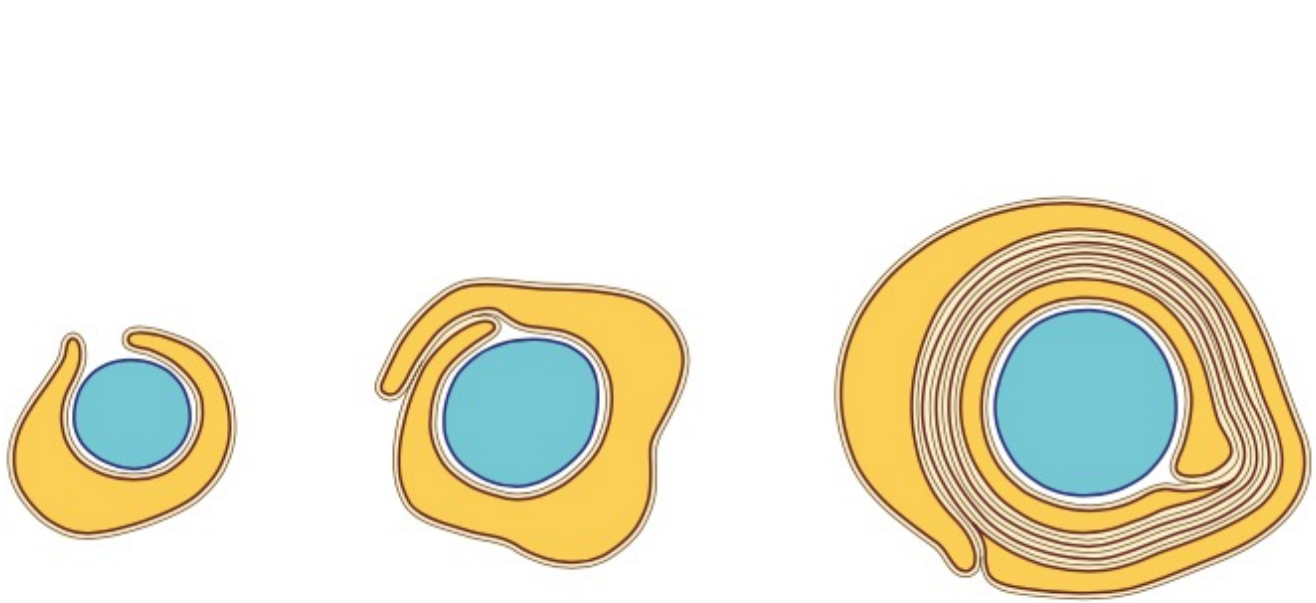
Central and peripheral nervous system - myelinization

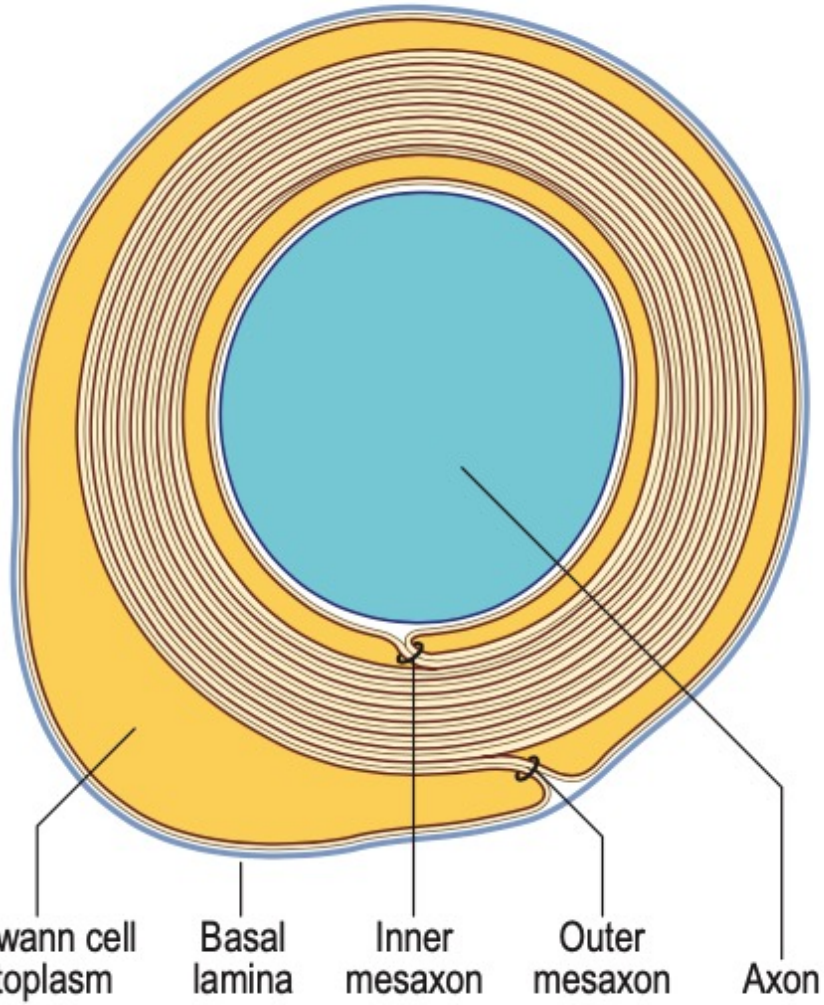




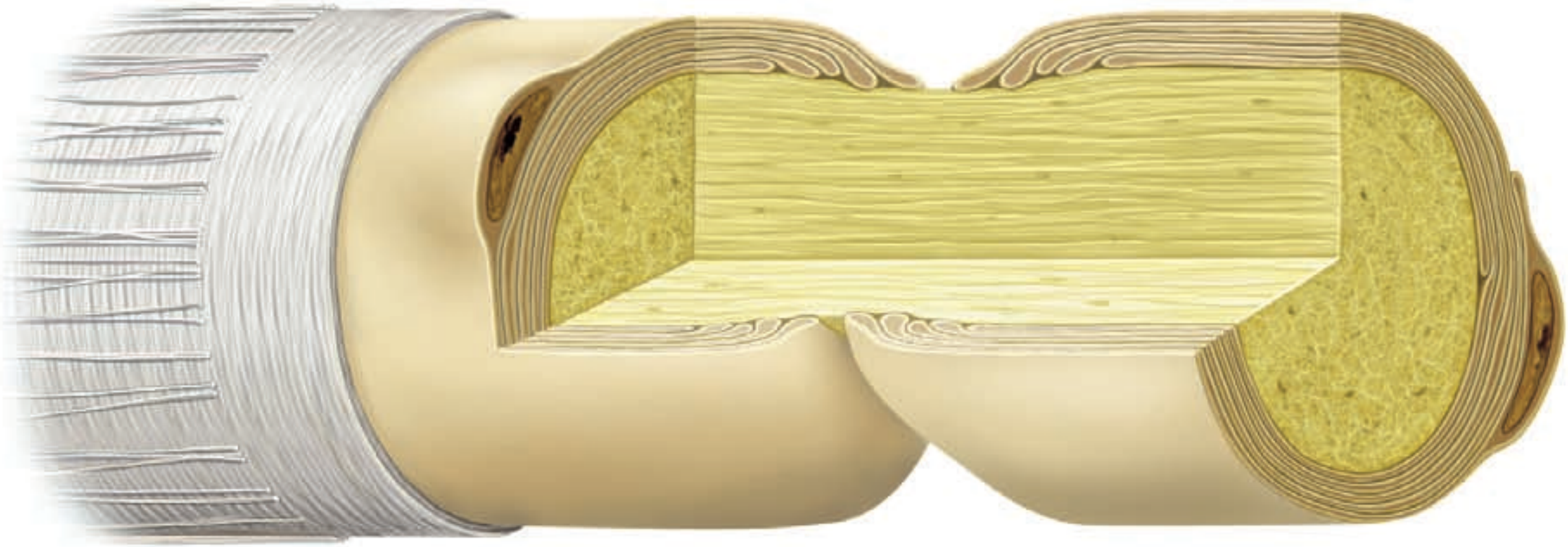


Schwann cell



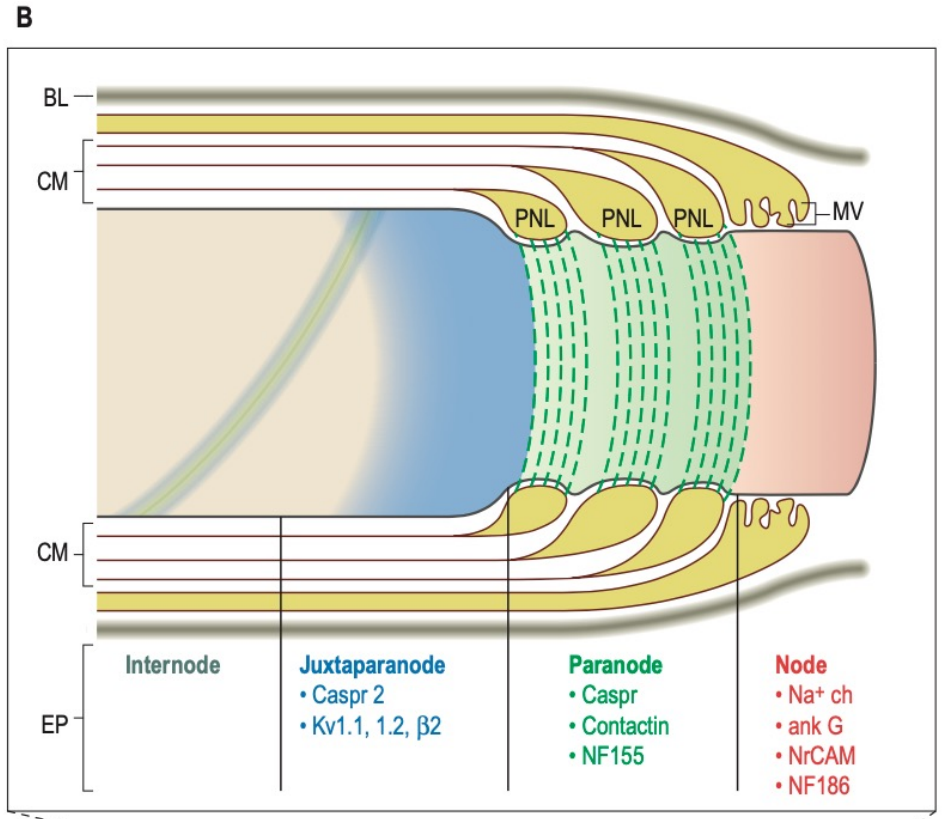


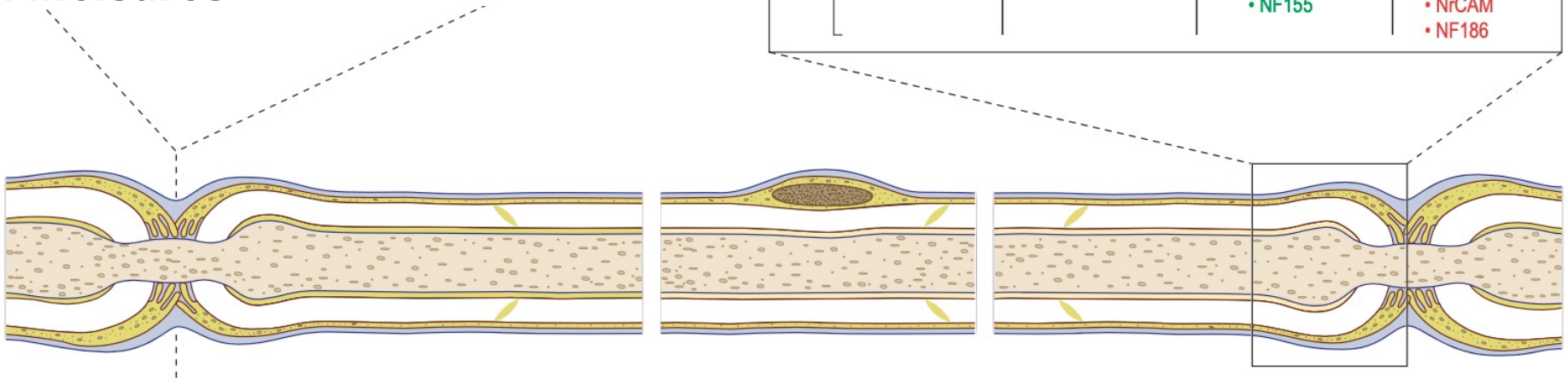
Myelin sheath



Schwann cells and myelinization

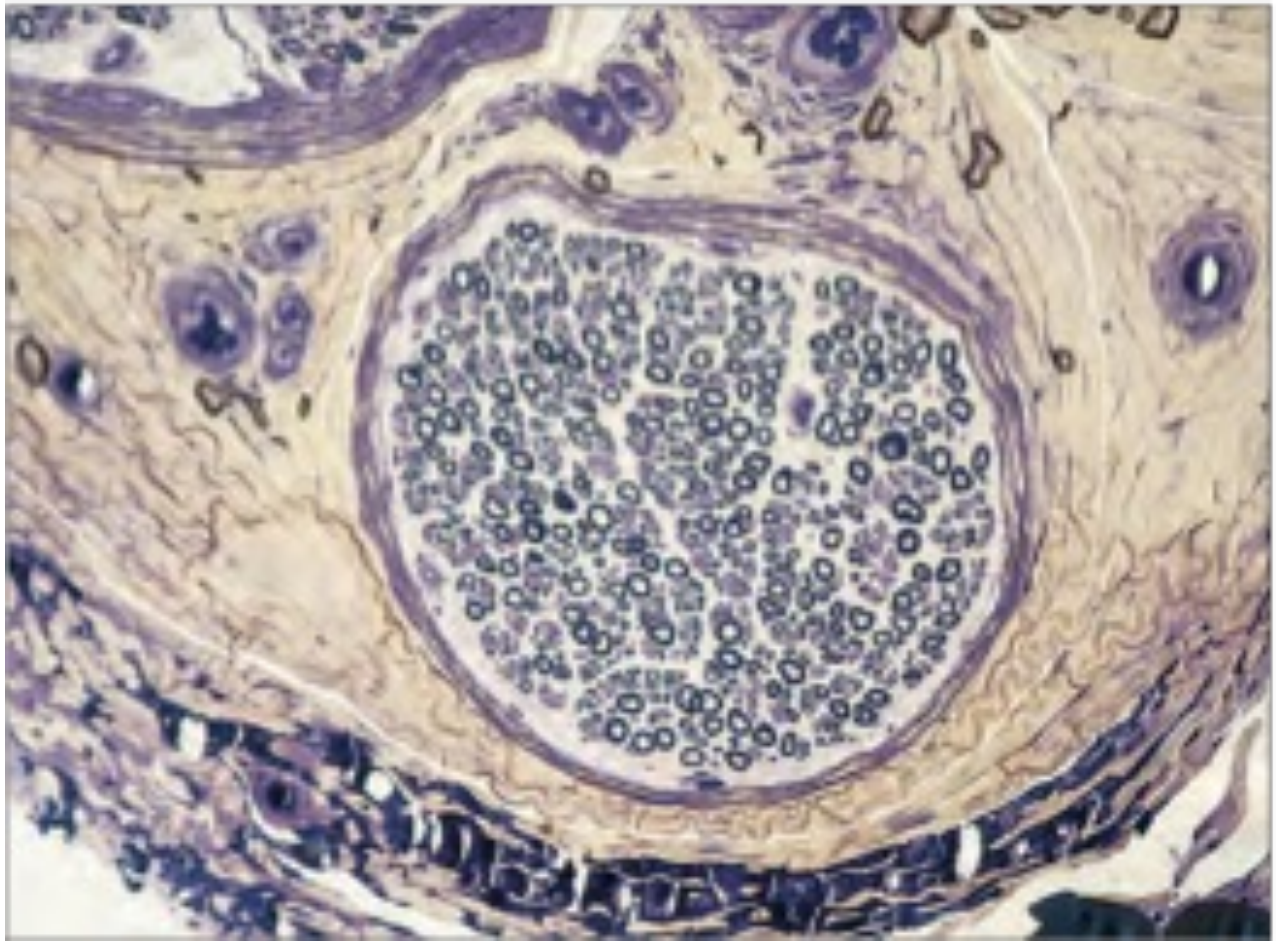
- **Schvann cell**
  - **Spirally around the axon, creating the myelin sheath**
- **Nodi**
  - **nodes of Ranvier**
- ***Paranode***
  - ***margins***
  - ***Deffence from the potassium channels migration to node***
  - ***Paranodal cytoplasmatic loops***
- ***Juxtaparanodes***
  - ***Potassium channels***
- ***Schmidt-Lantermann incisures***





Peripheral nerves

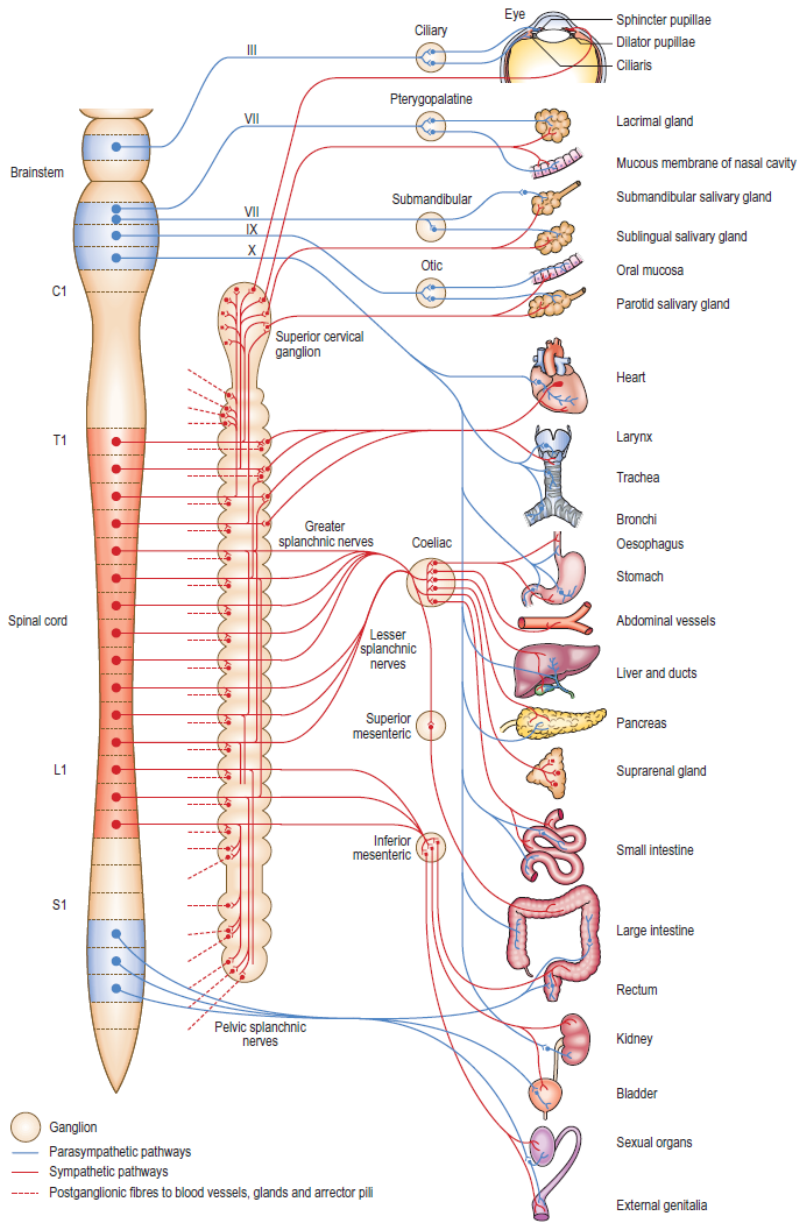
- **Sheath made by connective tissue**
- ***Epineurium***
  - *Condensation of loose connective tissue*
  - *Fibroblasts, kollagene type I and III*
  - *Lymfatics, vasa nervorum, nervi nervorum*
  - *Vasa nervorum equipped by perivascular plexus*
  - *Similarly pennetrates to perineuria*
- ***Perineurium***
  - *15 - 20 cellular layers*
  - *Metabolically active diffusible membrane*
  - *blood-nerve barrier*
  - *Maitanance of osmotic pressure*
  - *No lymphatic vessels*
- ***Endoneurium***
  - *Intrafascicular connective tissue*
  - *Endoneurial arterioles*
  - *Schvann cells*
  - *Endothelium of endoneurial vessels - bad autoregulation*



Autonomous nerves

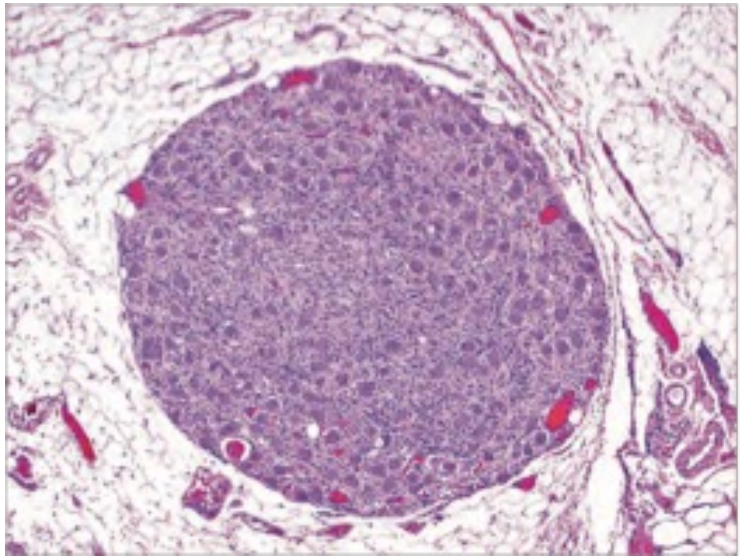
- *Maintenance of viscera*
- *Visceromotor*
- **Parasympattheticus – cranila nad sacral**
- **N. III, N. VI, N. VII, N.IX, N.X**
- **Sympattheticus - TH1 - L3**
  - **Nervus splanchnicus maior**
  - **Nervus splanchnicus minor**
  - **Nervus splanchnicus minimus**
  - **Nervi cardiaci**

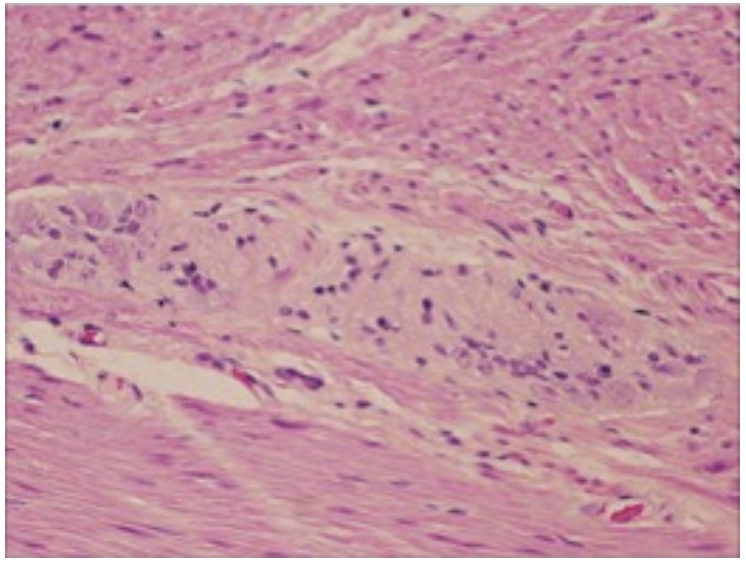
  - **Ganglion cervicalis superius, medium, stellatum**
  - **Ganglia trunci sympatici**
  - **Ganglion coeliacum**
  - **Ganglion mesentericum superius**
  - **Ganglion mesentricum inferius**



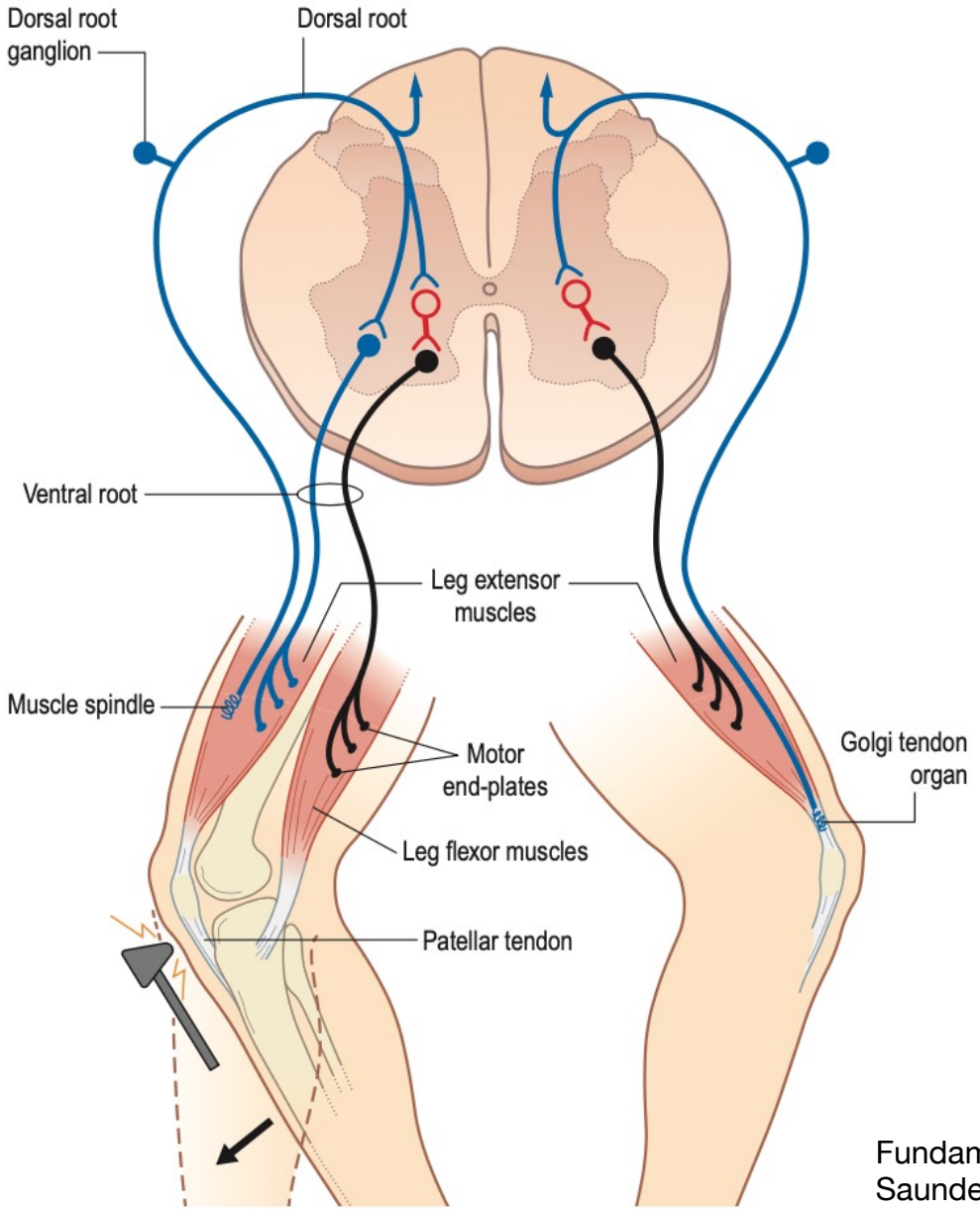
Ganglia

- **Gouping of neruons outsideCNS**
  - *(cave: basal ganglia – central grey matter)*
- ***Ganglia of spinal nerves spinal nerves***
  - ***Dorsal roots of spinal nerves, pseudounipolar cells***
  - ***Ganglial cells completelly surrounded by satellite glial cells – SGCs***
  - ***No synapses, chemical communication inter-neuronal and with glia***
  - ***HERPES ZOOSTER***
- ***Ganglia autonomic***
  - ***Autonomous ganglal neurons***
  - ***small intensely fluorescent (SIF) a SGCs***
- *Ganglia parasympathetic*
  - ***Cranial nerves, pelvis – less dendrites – less cooperatin neurons***
- *Ganglia sypathetic*
  - ***Multipolar cells, multiple branching of dendrites, interneurons***
- *Ganglia enteric*
  - ***Plexus submucosus etc.***





Function of the nervous system



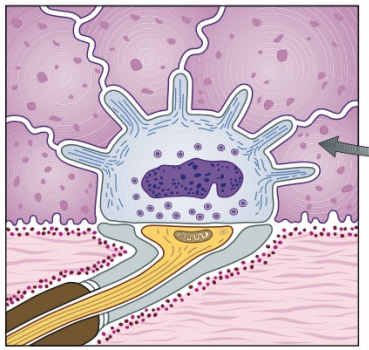
- **neurons**
- ***Information encoding***
  - ***Specialized endins***
  - ***Creation of the information quantum***
  - ***Translation into electrical signal***
- ***Information conduction***
  - ***propagation***
  - ***Fast electrical signal conduction***
  - ***Action potential***
- ***Information transmission***
  - ***Other neurons***
  - ***Muscular cells***
  - ***Glandullar cels***
  - ***With the help of synapsis and neurotransmitter***

Fundamental Neuroscience for Basic and Clinical Applications, 4th Edition, 2013, Saunders, Elsevier.

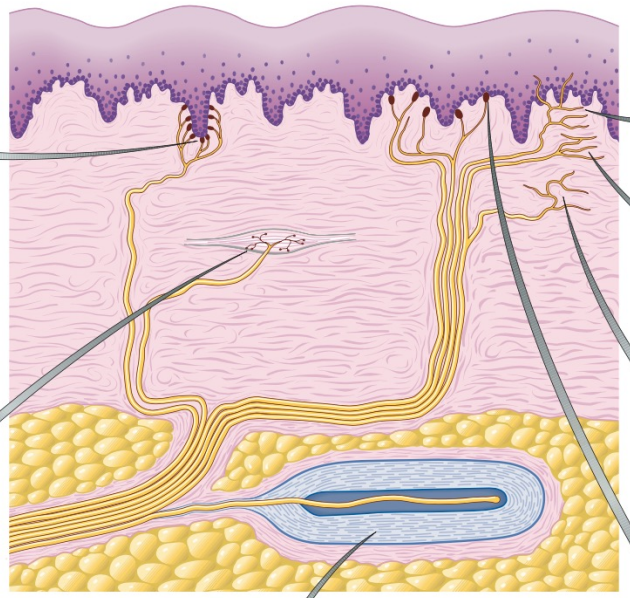
Receptors

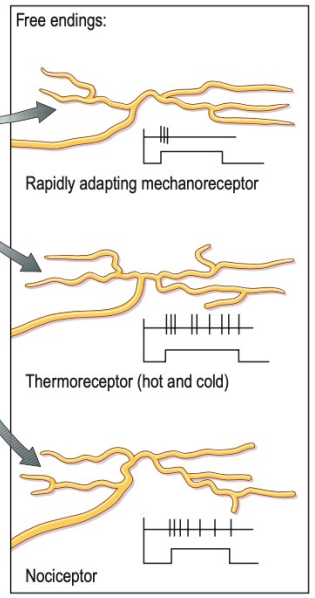
- **Free nervous ending – un-myelinized neural ending**
  - Dermis, fascies, peritoneum, vessels, meninges, perimyosium, perichondrium, periost
  - Thermoreceptors, unimodal and multimodal nociceptors – pain detection – iritation and/or cell destruction
  - fine mechanoreceptors - Merkel tactile endings slowly addapting
- ***Meissner body***
  - *Papillary parts of the hand and foor, forearm, eyelids*
  - *Fingers pads 24/cm2*
  - *Senzitive to shape and texture*
- ***Paccini body***
  - *Palma and planta, genitalia, neck, nipples, mesentery*
  - *Fast addaptation, sensitive to oscilations and vibrations un-myelinuzed with lamellar structure*
- ***Ruffini ending***
  - *Slow addaptation, tension in dermis, fibrocelular sheath – derrivate of perineurium*
  - *Simmilar to Golgiho organe – ending is branching between collagene fibers fascicles*
- ***Golgi tendinous organ***
  - *Proprioception - ending is branching between tendinous fascicles, in musculotendinoius junction*
  - *Excitation by the passive or active tension during motion*

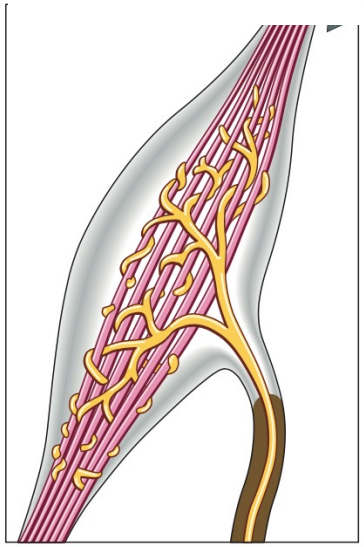
Receptors



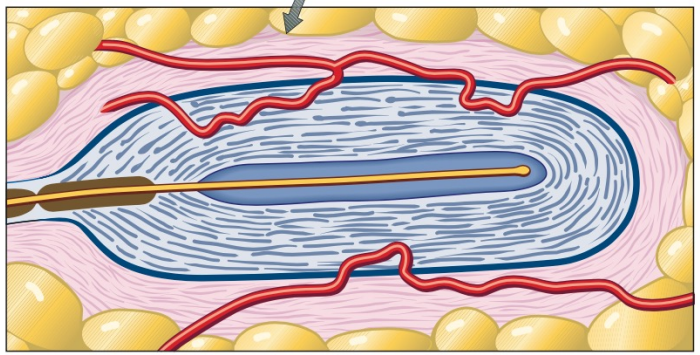
Fine mechanorecepttion



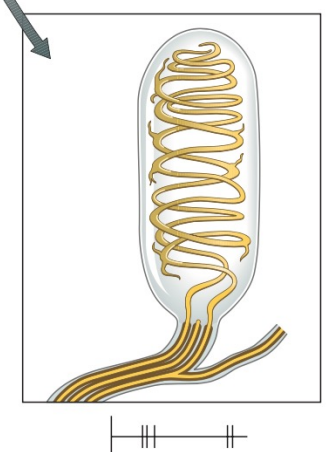




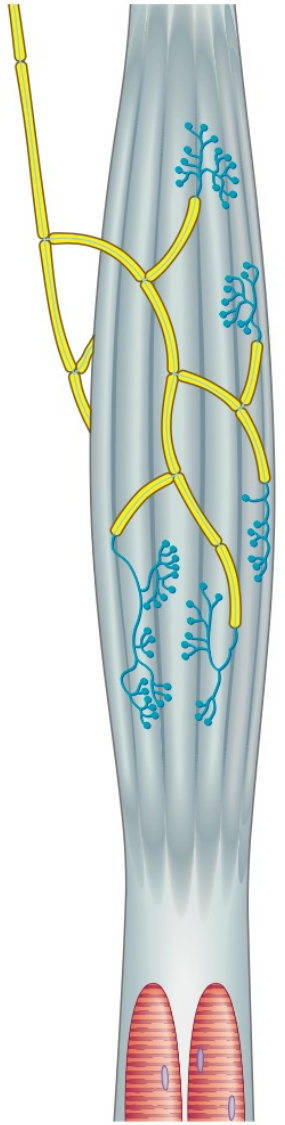
Ruffini



Paccini



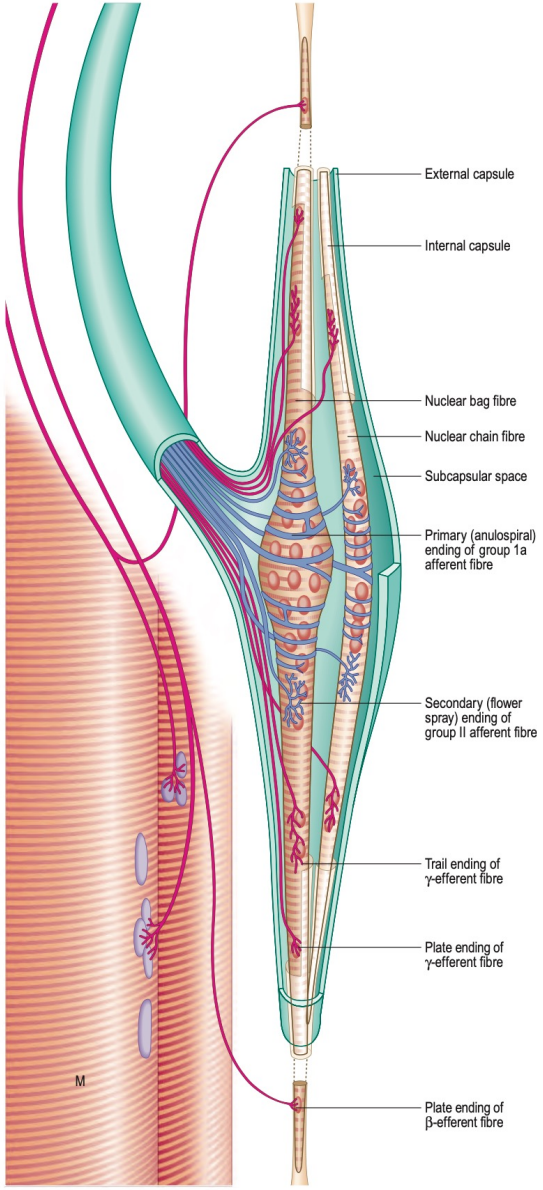
Meissner

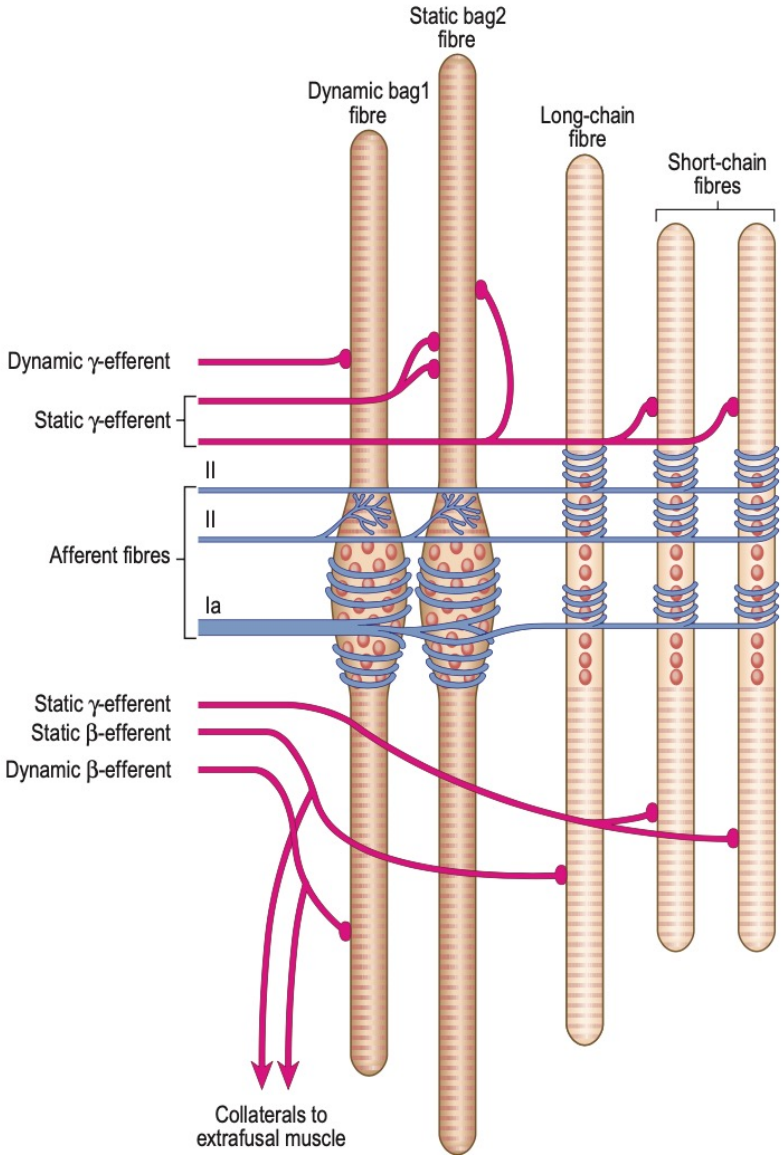


Golgi

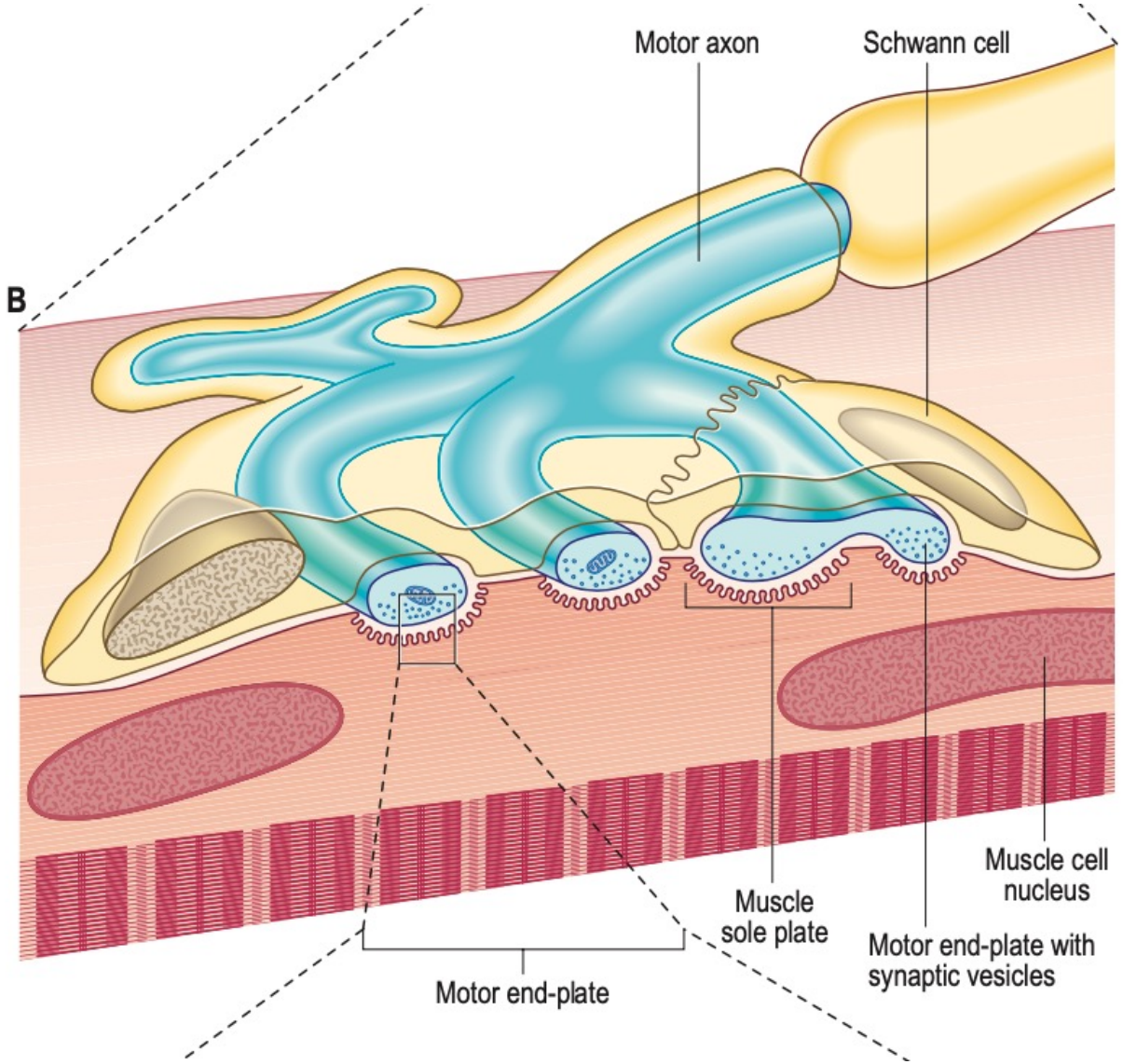
Neuromuscular spindle

- Motor and sensitive endings
- Modified muscullar stripped cells
- Information about velocity and power of contraction





Neuromuscular transmission

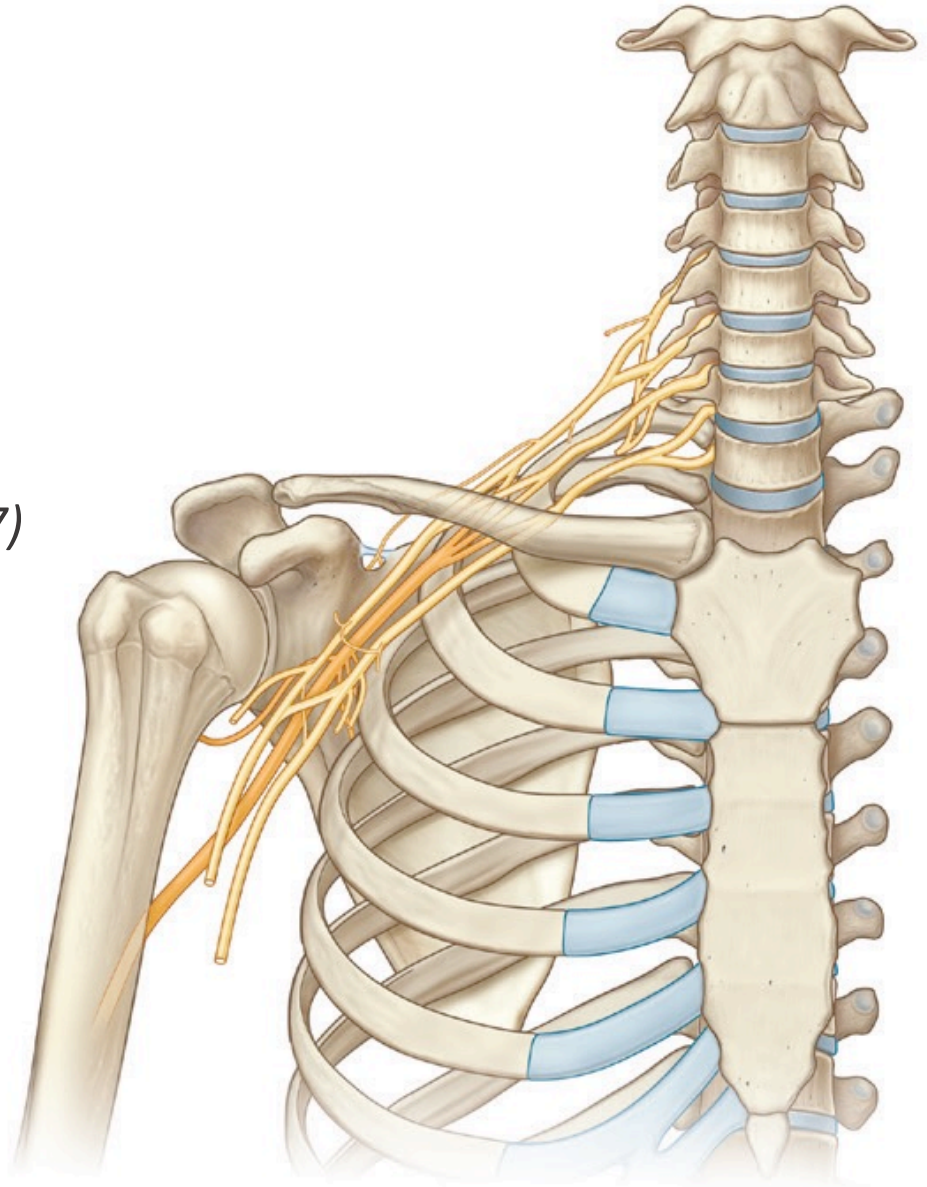


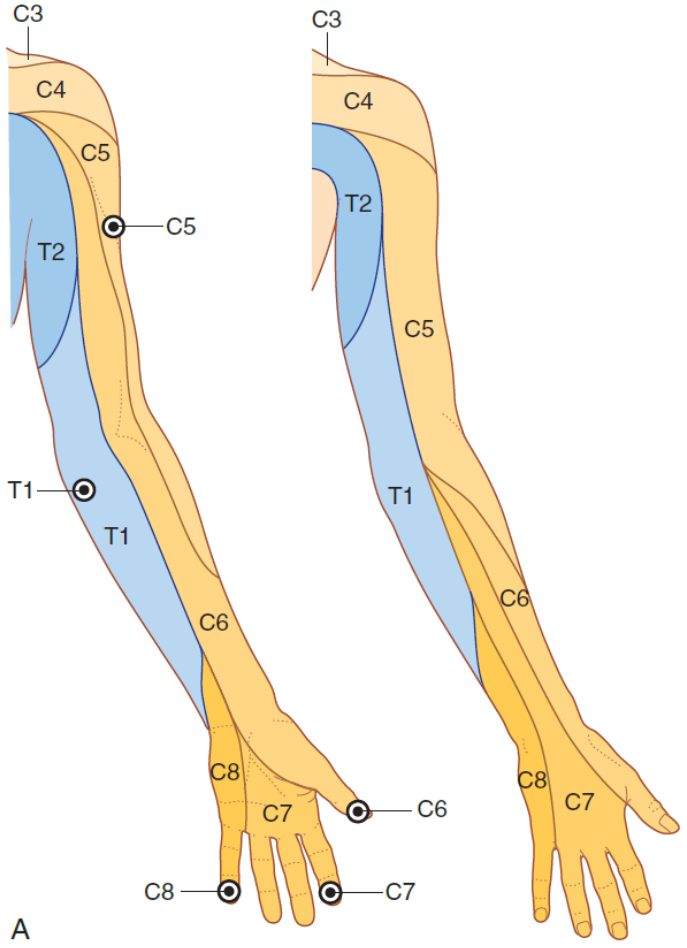
- **Trasmission to stripped muscle**
- Myelinizated axon
- Cholinergic (ACh)
- Multiple folding of sarcolemma

- **Autonomic motor transmission**
- Non-myelinzated axon
- Varicose ending
- Adrenergic
  - Almost all sympathetic endings
- Cholinergic
  - parasympathetic
  - (less frequent sympathetic type of transmission)

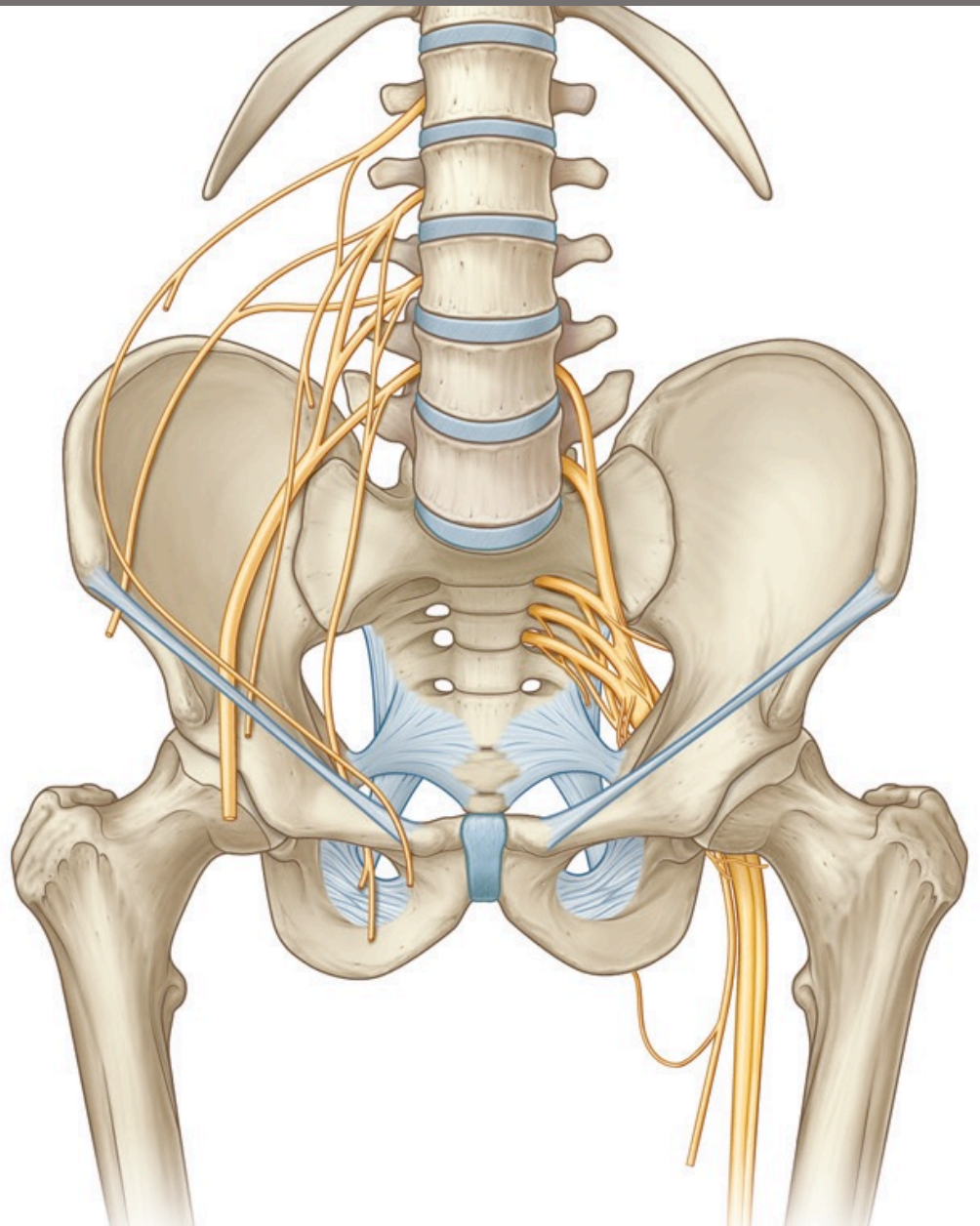
extremities

- **Cervical plexus**
- **Brachial plexus**
  - ***Upper free limb***
  - *N. axillaris*
  - *N. musculocutaneus (C5-7)*
  - *N. radialis (C5 - 8, Th1)*
  - *N. medianus (C6 - 8, Th1)*
  - *N. ulnaris (C7, C8, TH1)*
- *Lumbal plexus*
- *Sacral plexus*





extremities

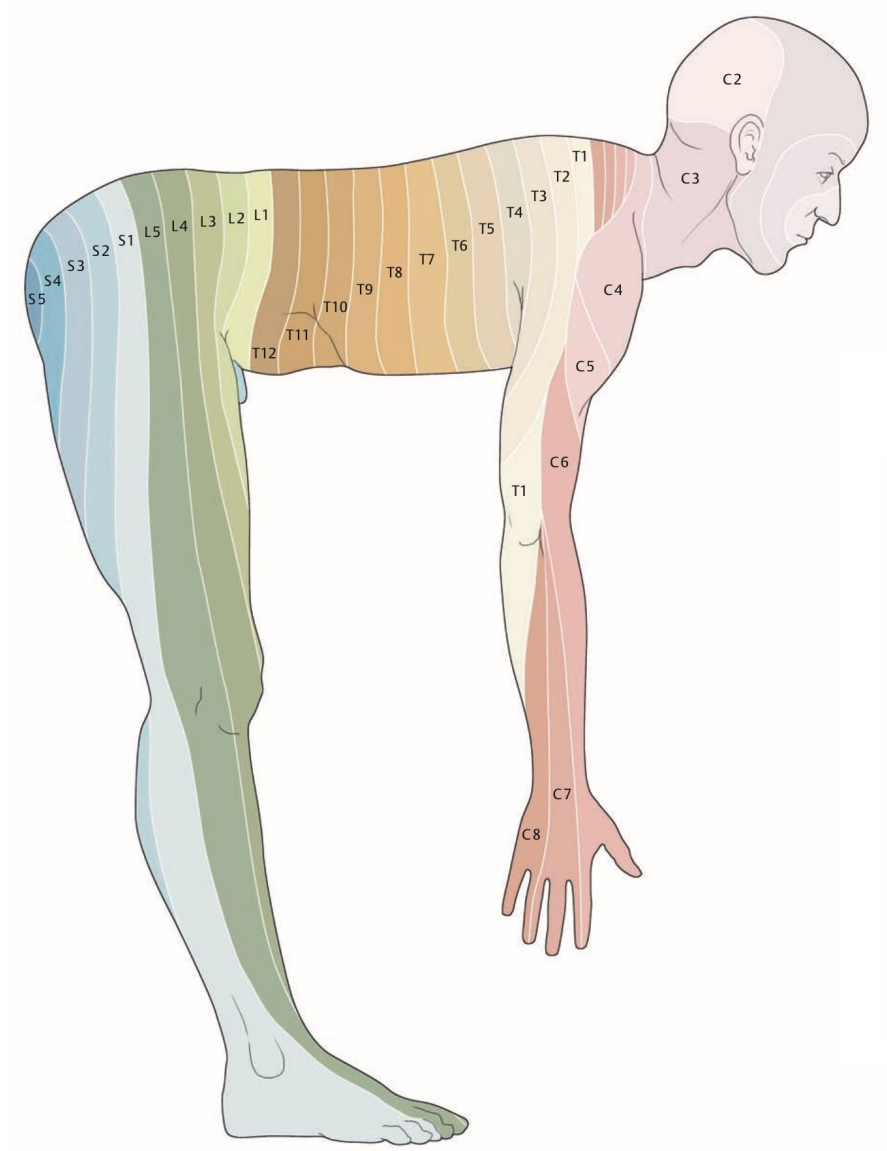


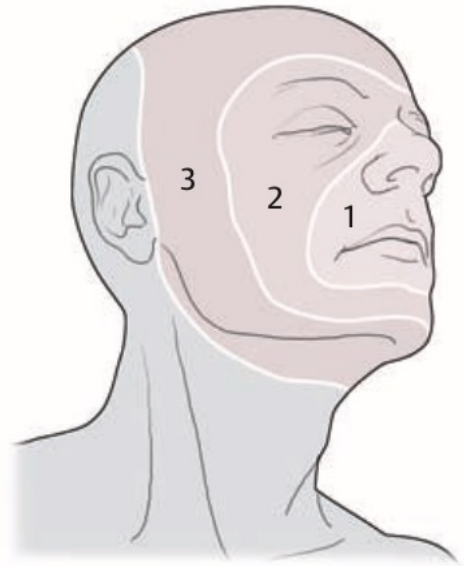
- **Plexus sacralis**
  - Plexus ischiadicus
  - Plexus pudens
  - Plexus coccygeus
- **N. glutaeus sup. L4-S1 - foramen suprapiriforme**
- **N. glutaeus inferior L5-S2 - for. infrapiriforme**
- **N. ischiadicus L4-S3 - for. infrapiriforme**
  - Fossa poplitea
  - N. peroneus communis (superifcialis et profundus)
  - N. tibialis
- **N. cutaneus femoris post. S1-3 - for. infrapiriforme**
- **N. pudendus S4-5**
- **N. cocygeus S4-Co**

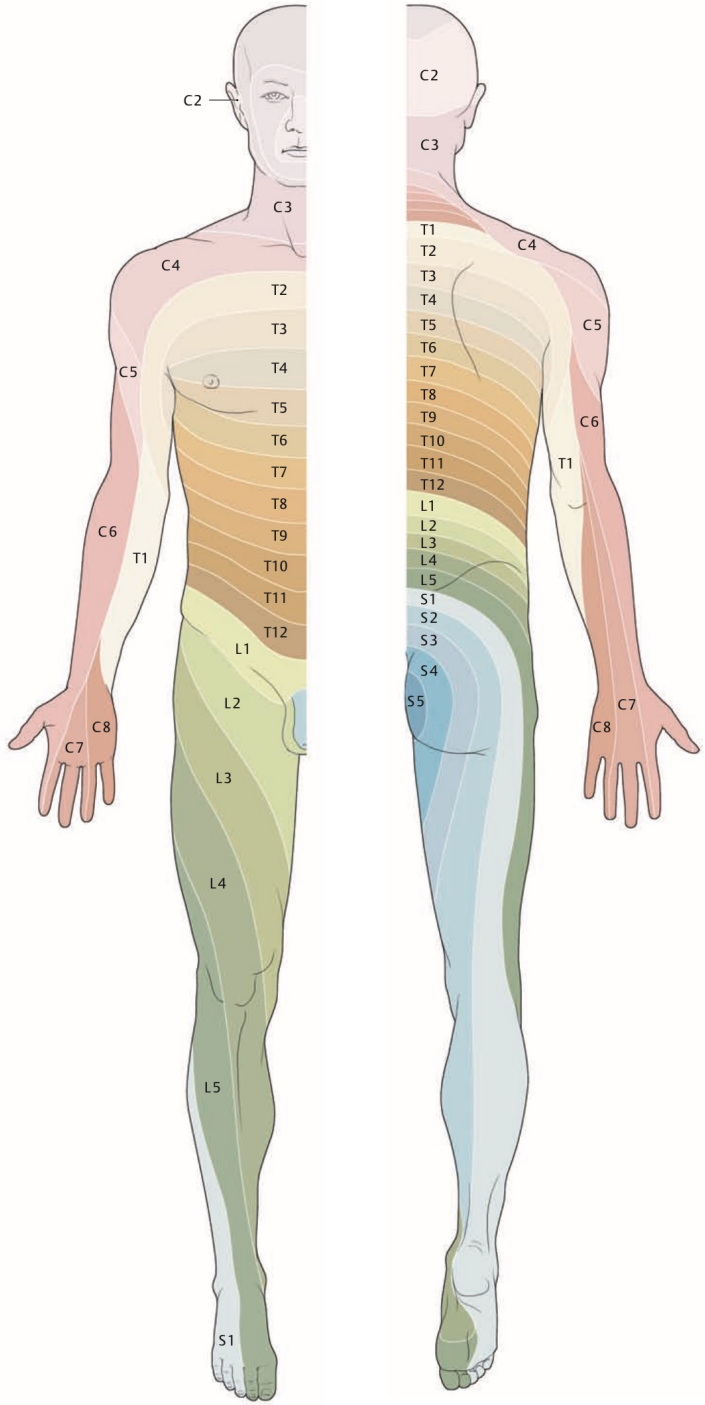
Areae nervinae

dermatomes

- Antero-posterior
- Area radicularis
- Area nervina






C2
C3
C4
T2
T3
T4
C5
T5
T6
T7
T8
T9
C6
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T12
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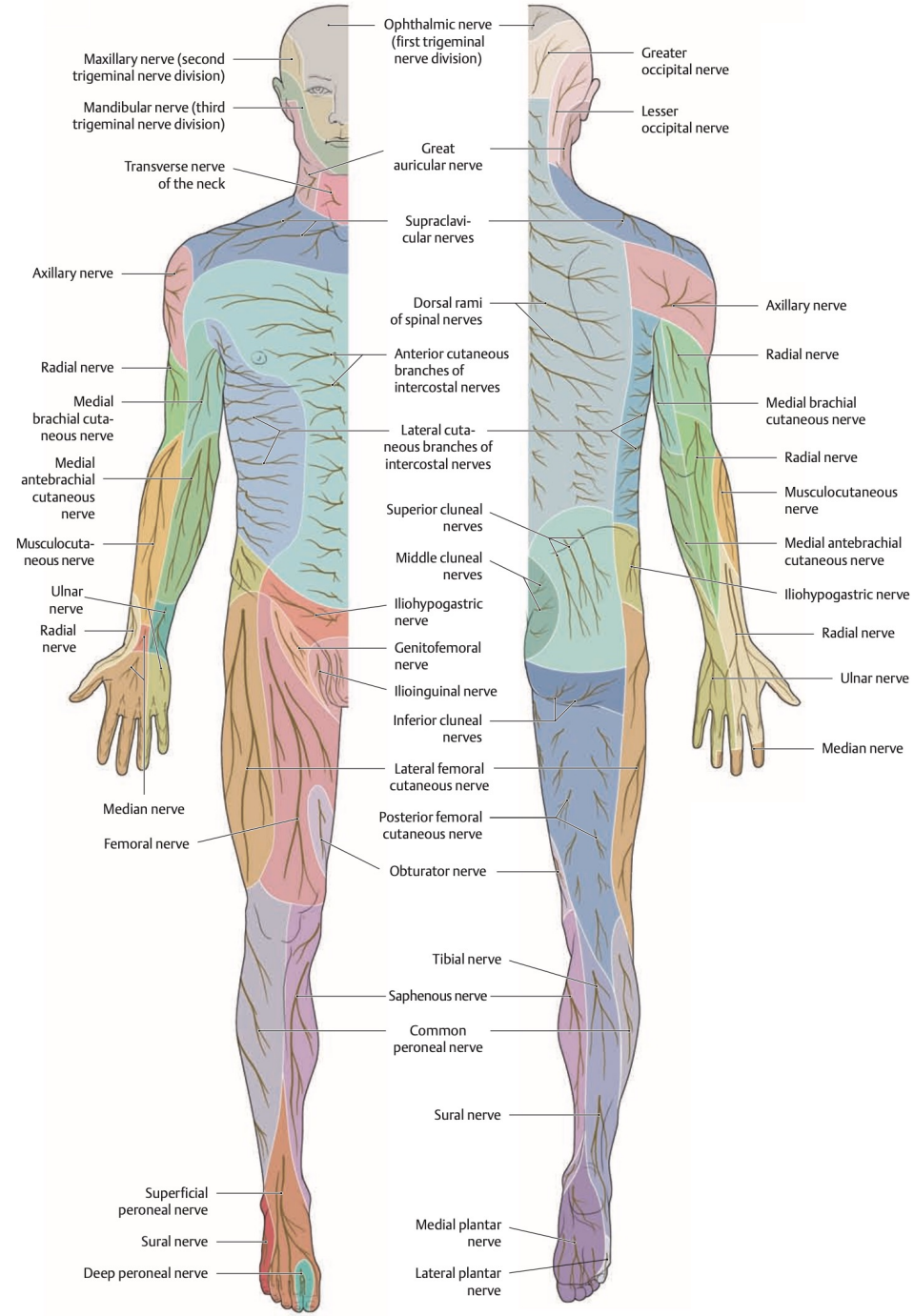
Ophthalmic nerve (first trigeminal nerve division)
Maxillary nerve (second trigeminal nerve division)
Mandibular nerve (third trigeminal nerve division)
Transverse nerve of the neck
Great auricular nerve
Supraclavicular nerves
Axillary nerve
Dorsal rami of spinal nerves
Anterior cutaneous branches of intercostal nerves
Radial nerve
Medial brachial cutaneous nerve
Lateral cutaneous branches of intercostal nerves
Medial antebrachial cutaneous nerve
Superior cluneal nerves
Musculocutaneous nerve
Middle cluneal nerves
Ulnar nerve
Iliohypogastric nerve
Radial nerve
Genitofemoral nerve
Ilioinguinal nerve
Inferior cluneal nerves
Lateral femoral cutaneous nerve
Median nerve
Posterior femoral cutaneous nerve
Femoral nerve
Obturator nerve
Tibial nerve
Saphenous nerve
Common peroneal nerve
Sural nerve
Superficial peroneal nerve
Sural nerve
Deep peroneal nerve
Medial plantar nerve
Lateral plantar nerve
Greater occipital nerve
Lesser occipital nerve
Axillary nerve
Radial nerve
Medial brachial cutaneous nerve
Radial nerve
Musculocutaneous nerve
Medial antebrachial cutaneous nerve
Iliohypogastric nerve
Radial nerve
Ulnar nerve
Median nerve

Obecná anatomie 1