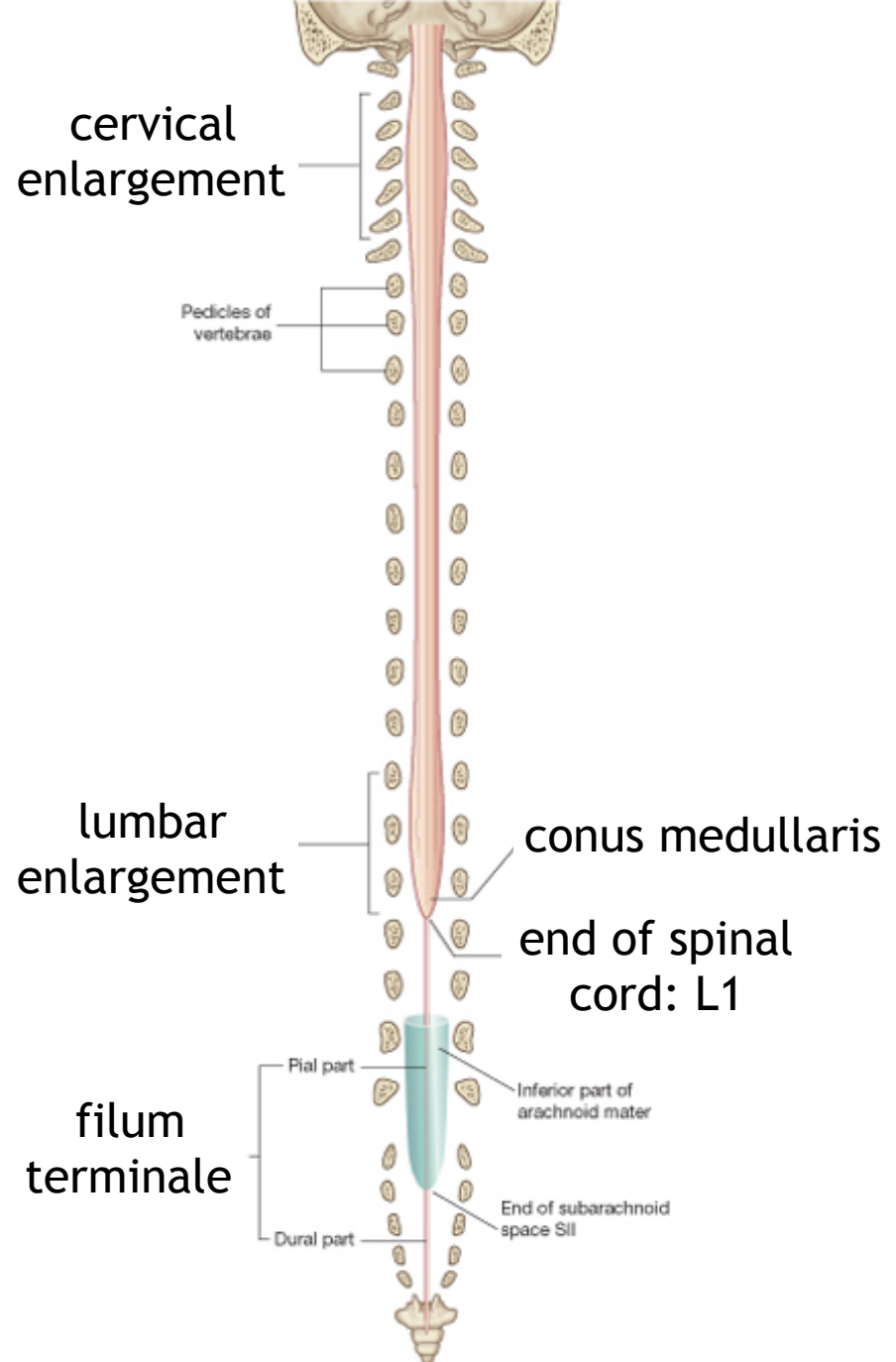


Spinal cord

Sándor Katz M.D., Ph.D.

Spinal cord - gross anatomy (overview)



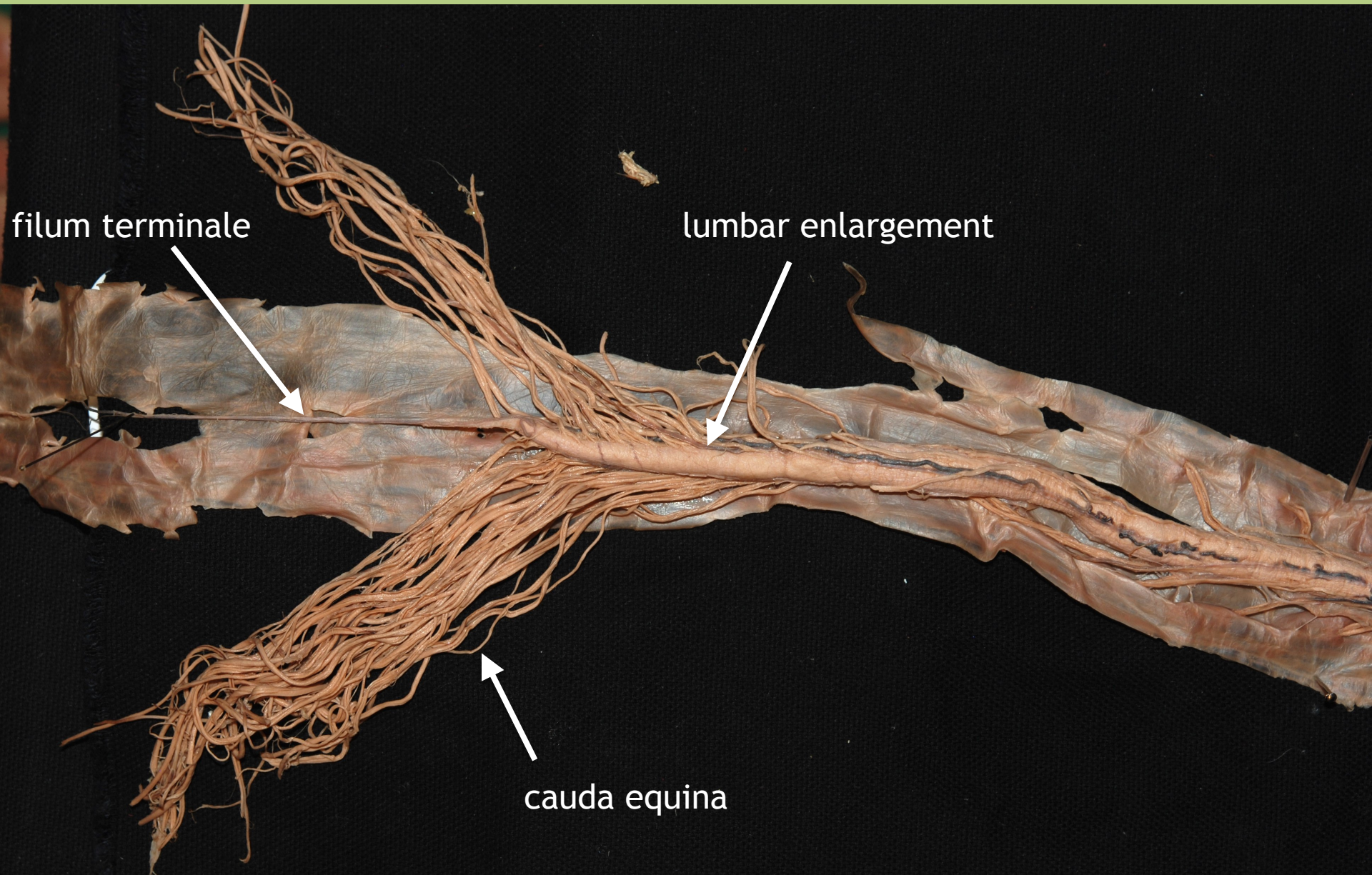
Drake: Gray's Anatomy for Students, 2nd Edition.

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filum terminale

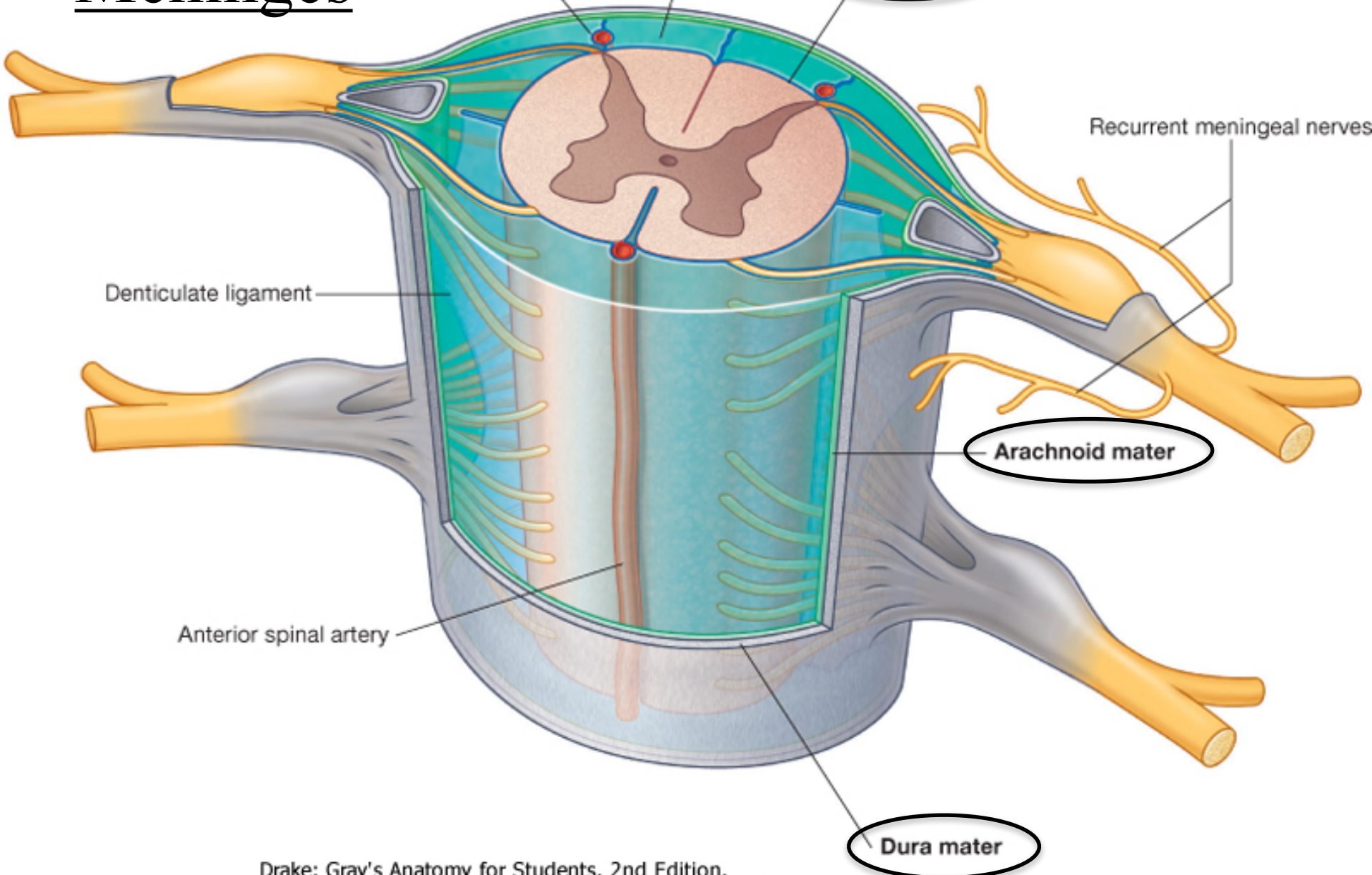
lumbar enlargement

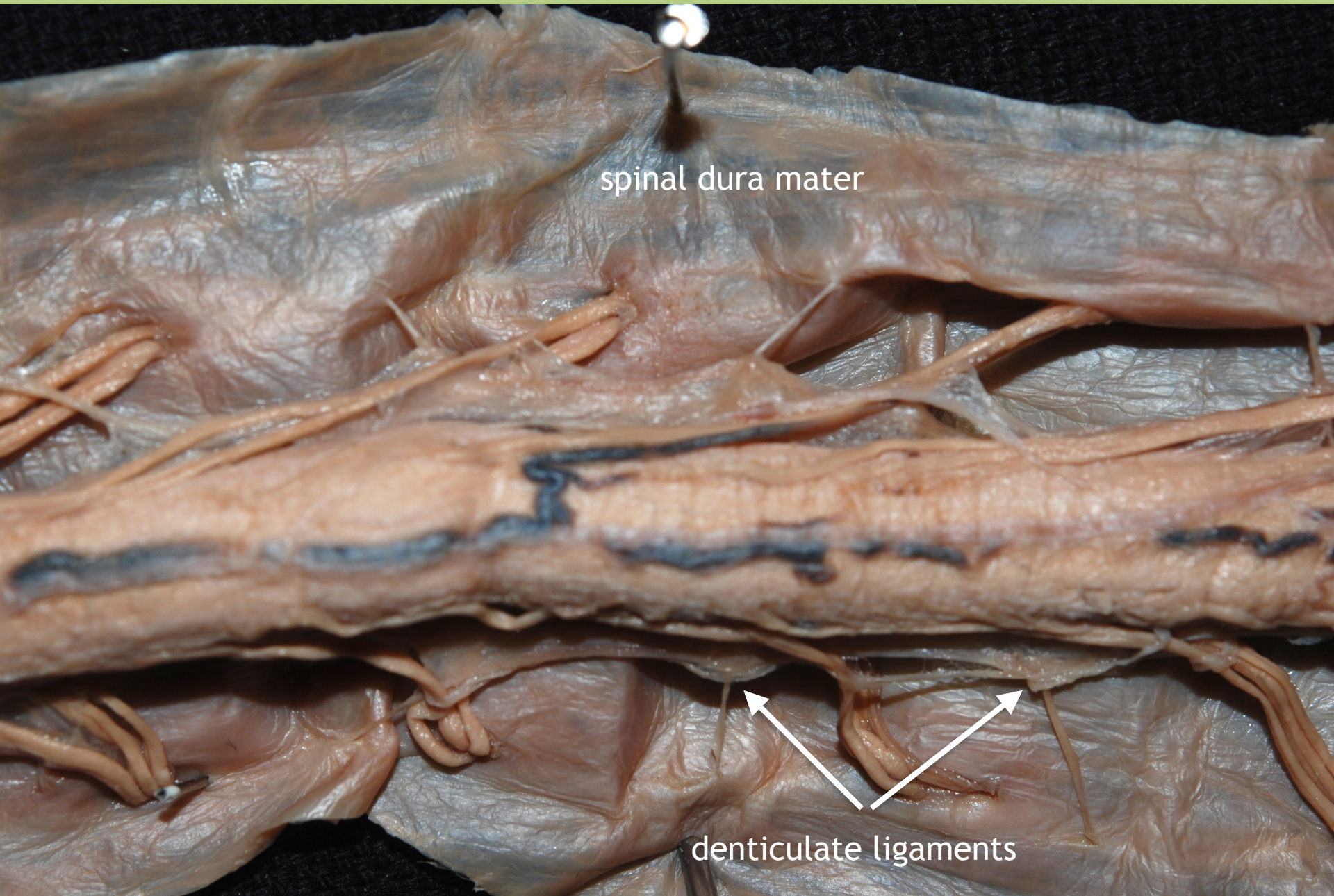
cauda equina



Subarachnoid space: filled by cerebrospinal fluid

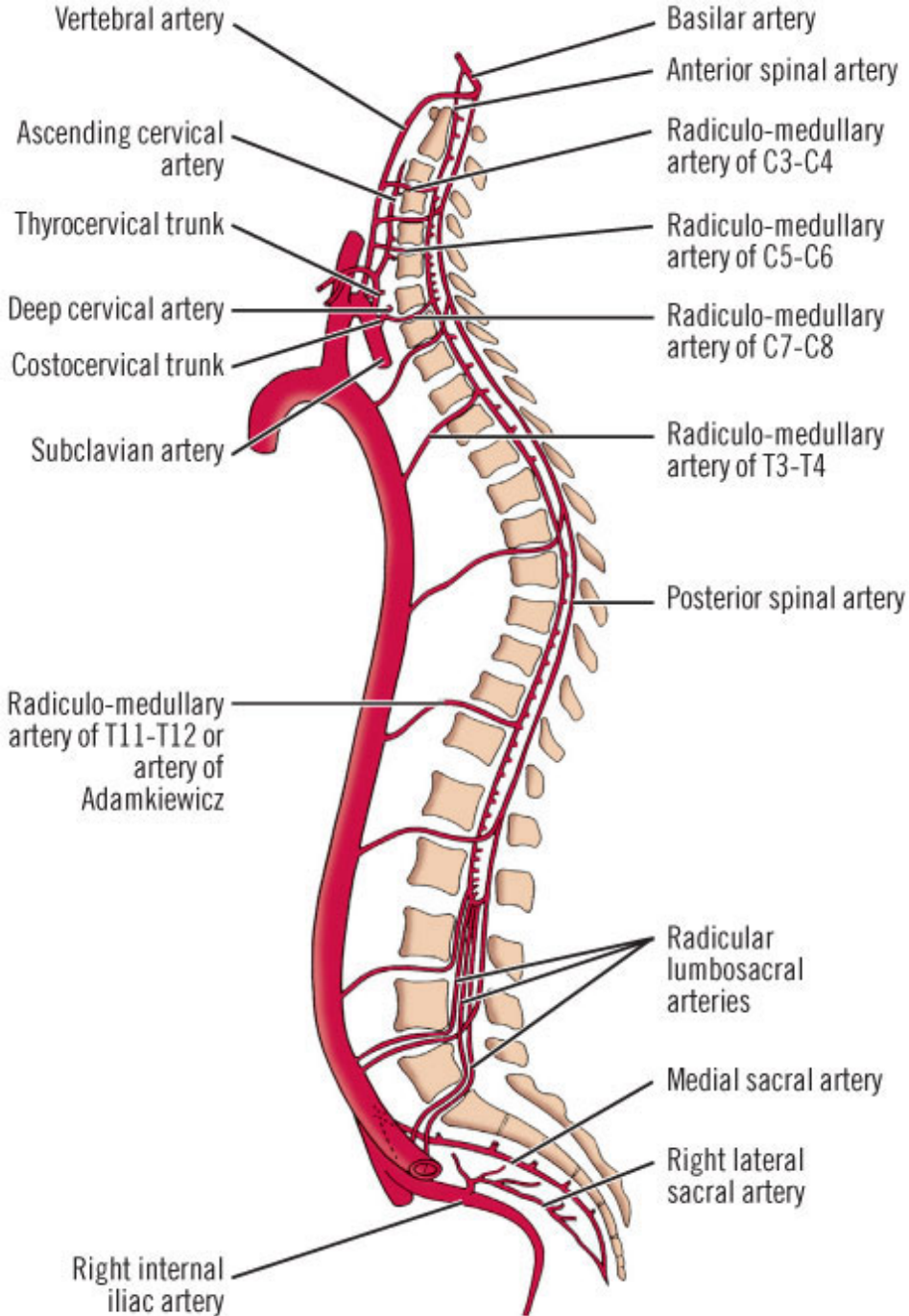
Meninges





spinal dura mater

denticulate ligaments



Blood supply of the spinal cord

- **ant. spinal artery** (*from vertebral artery*)
- **post. spinal arteries** (*from vertebral artery*)

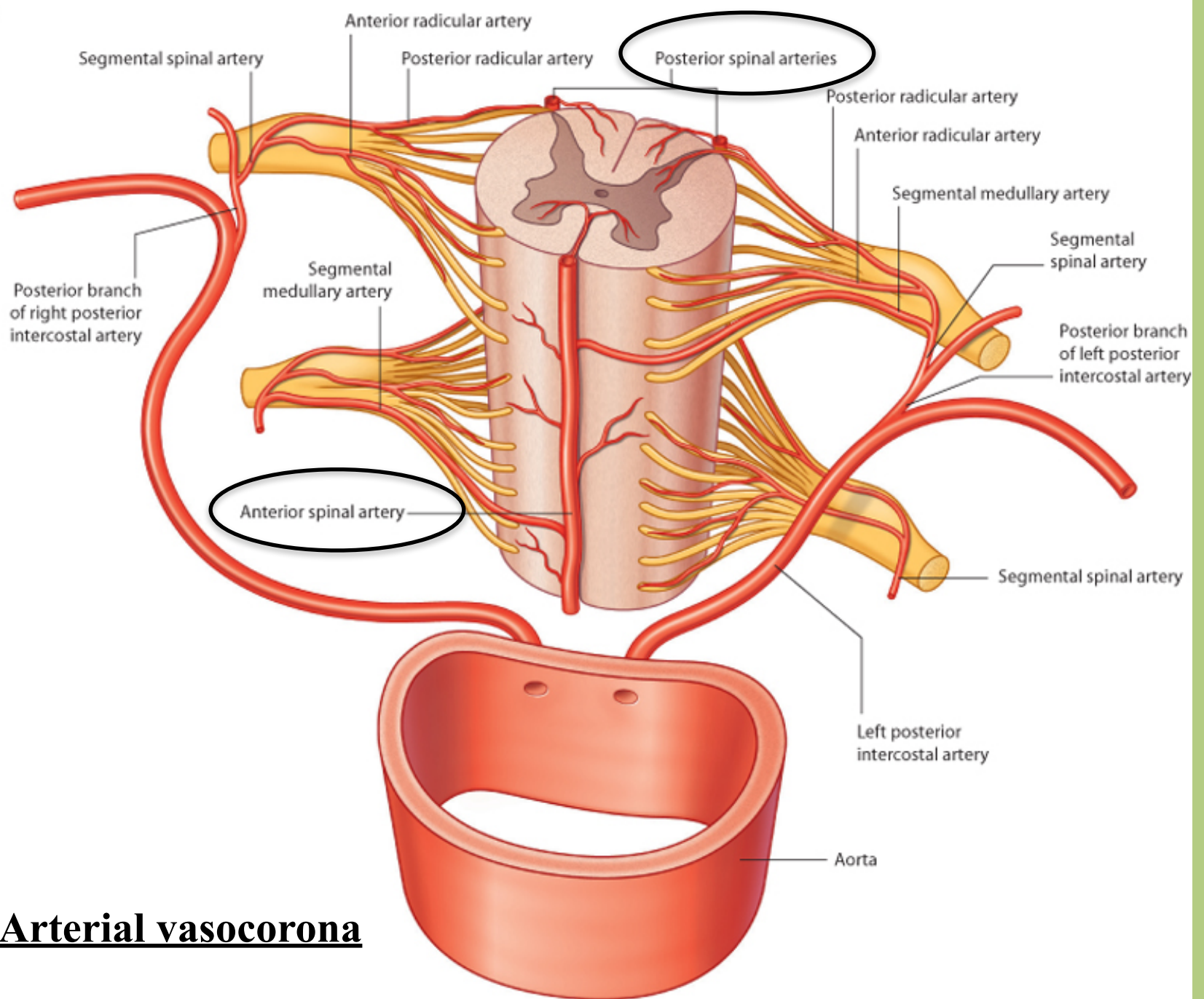
segmental arteries supply the longitudinal branches:

- vertebral artery
- ascending cervical artery
- deep cervical artery
- posterior intercostal arteries
- first pair of lumbar arteries

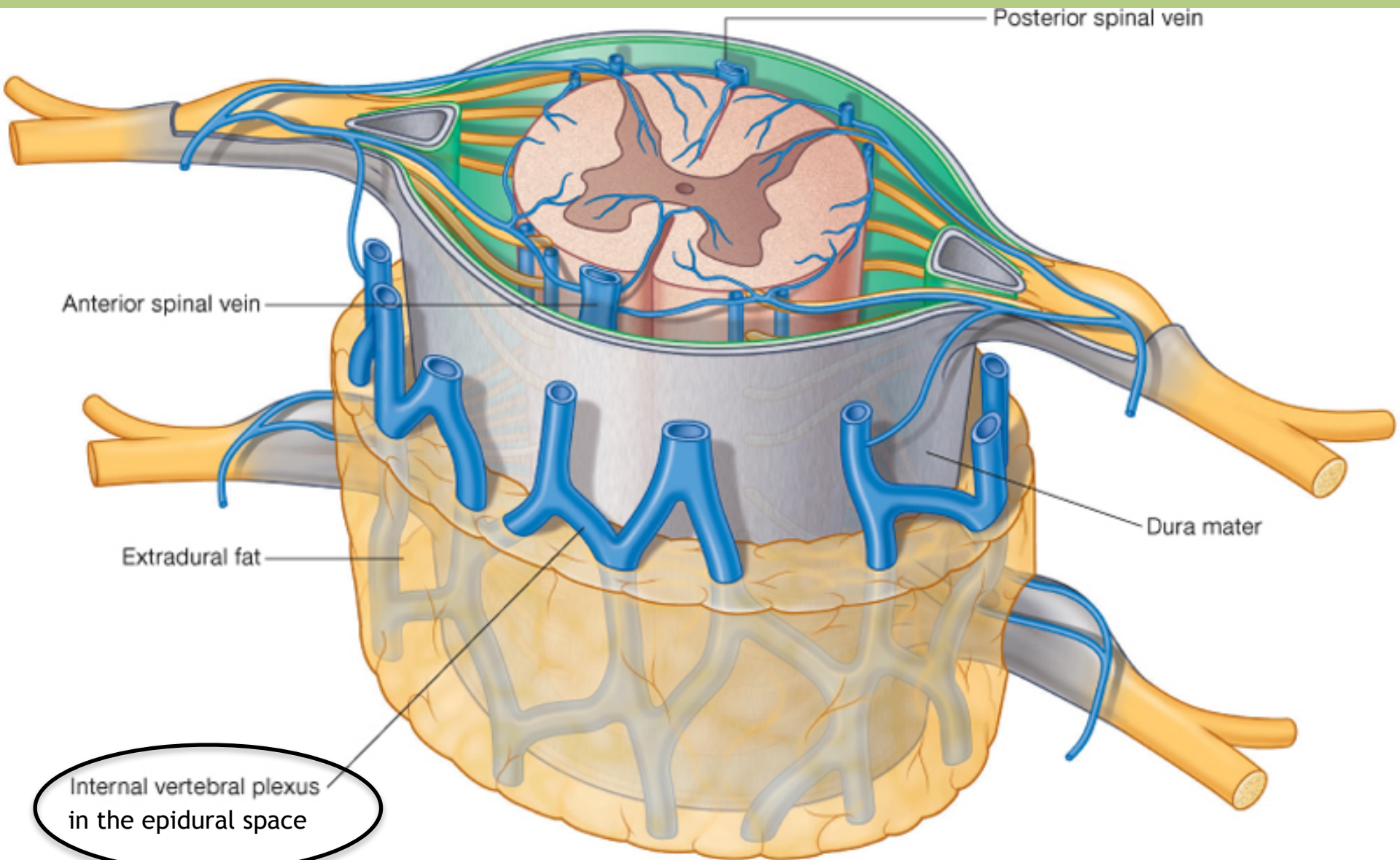
Artery of Adamkiewicz:

a prominent anterior thoracolumbal segmental artery

B



Arterial vasocorona



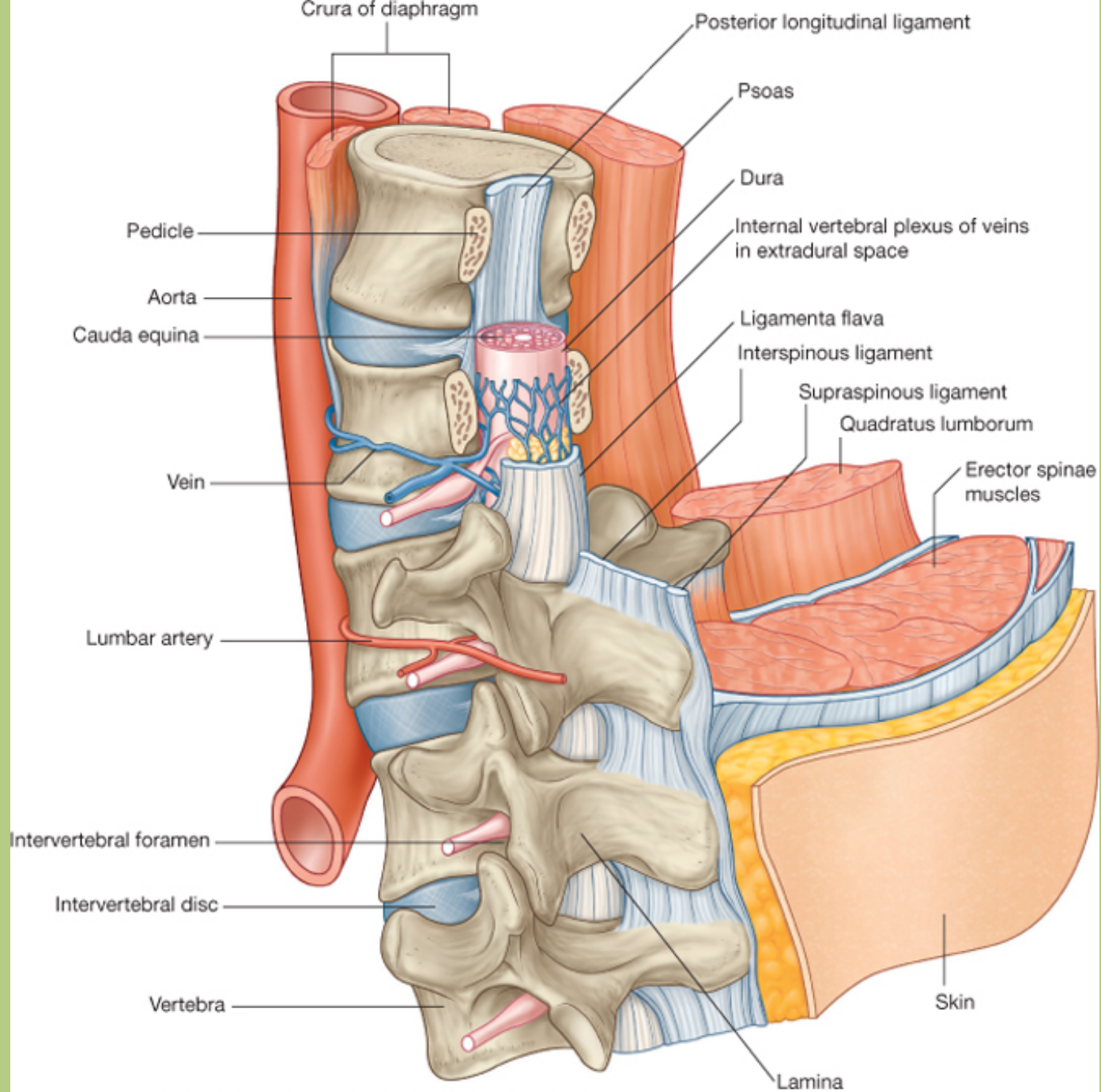
Posterior spinal vein

Anterior spinal vein

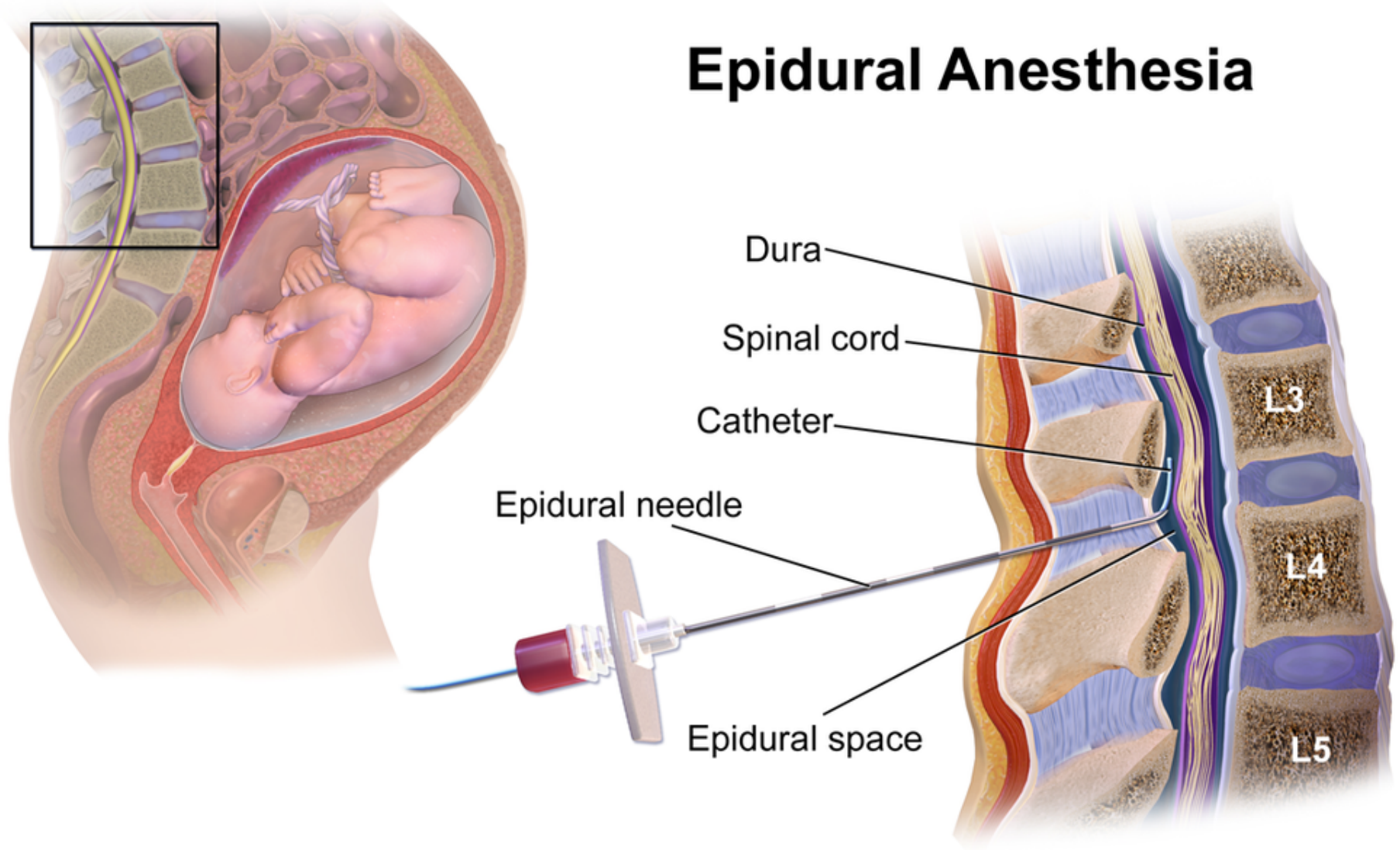
Extradural fat

Dura mater

Internal vertebral plexus
in the epidural space

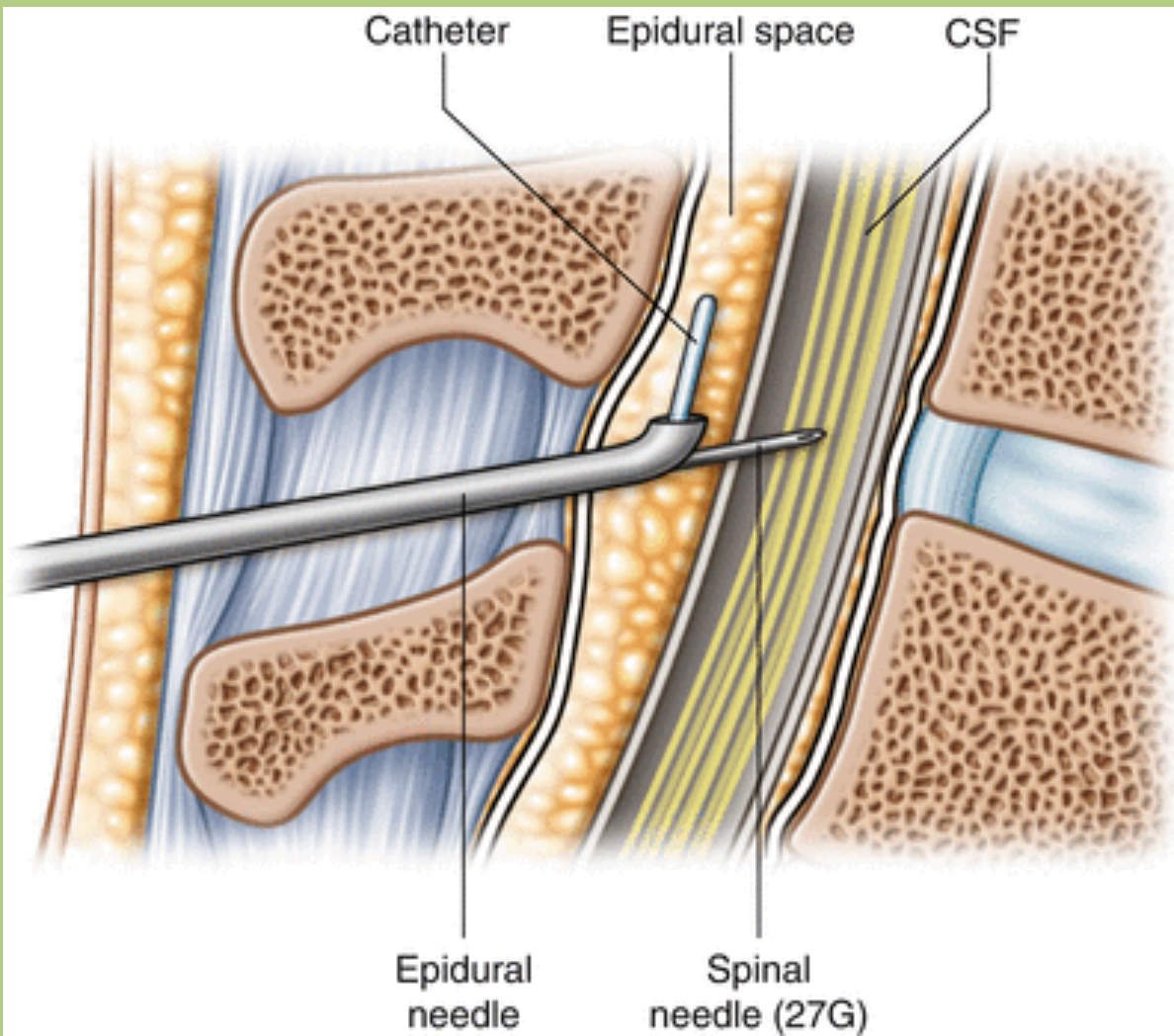


Epidural Anesthesia



The epidural route is used to administer local anaesthetic agents, analgesics or other medicines such as glucocorticoids.

Epidural anaesthesia vs. spinal anaesthesia



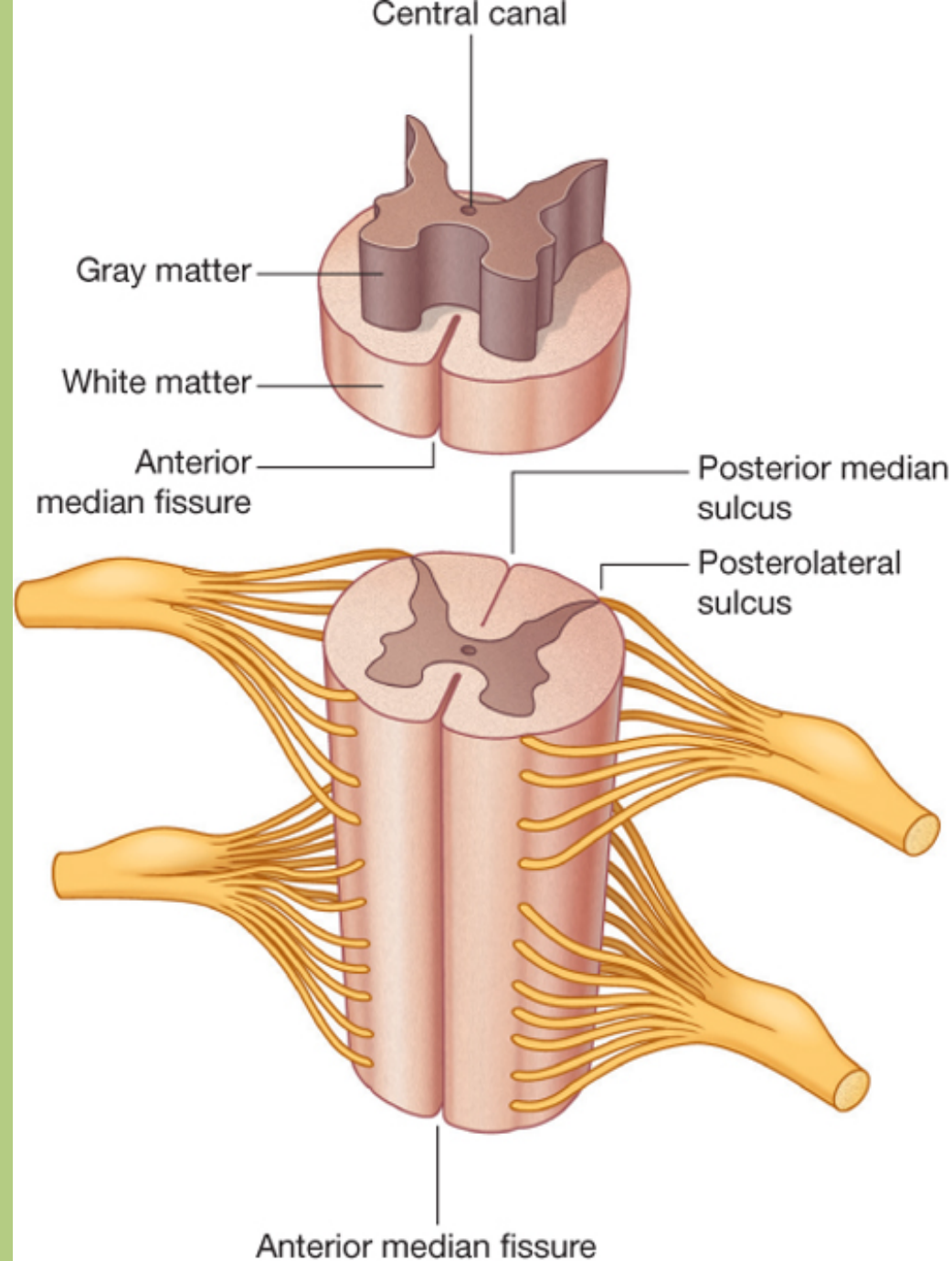
Spinal anaesthesia

Can be used as an alternative to general anaesthesia commonly in surgeries involving the lower limbs and surgeries below the umbilicus.

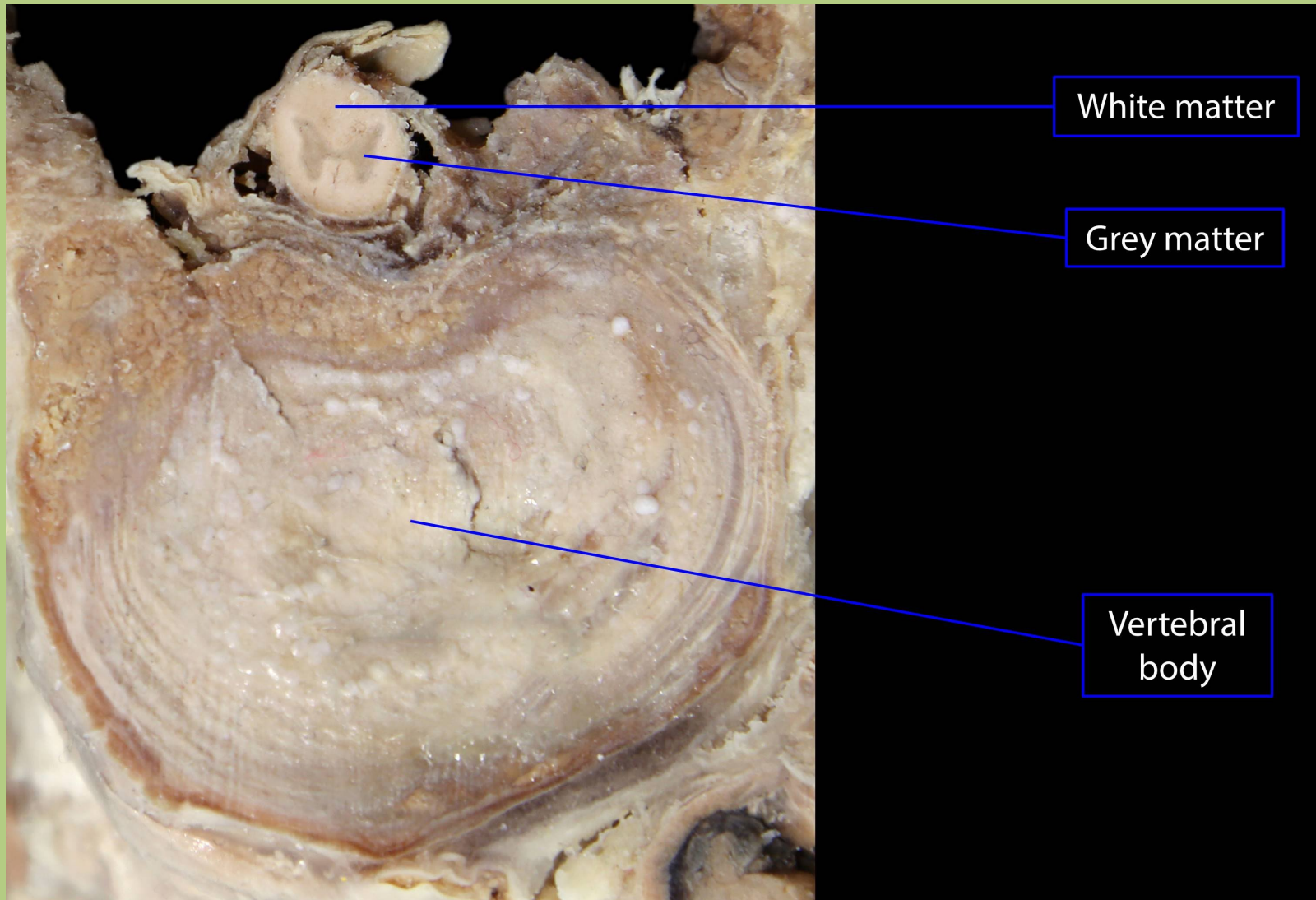
Lumbar puncture

Removing a sample of cerebrospinal fluid.

Spinal cord - histology



Spinal cord - gross anatomy



Transverse section of vertebral column, superior

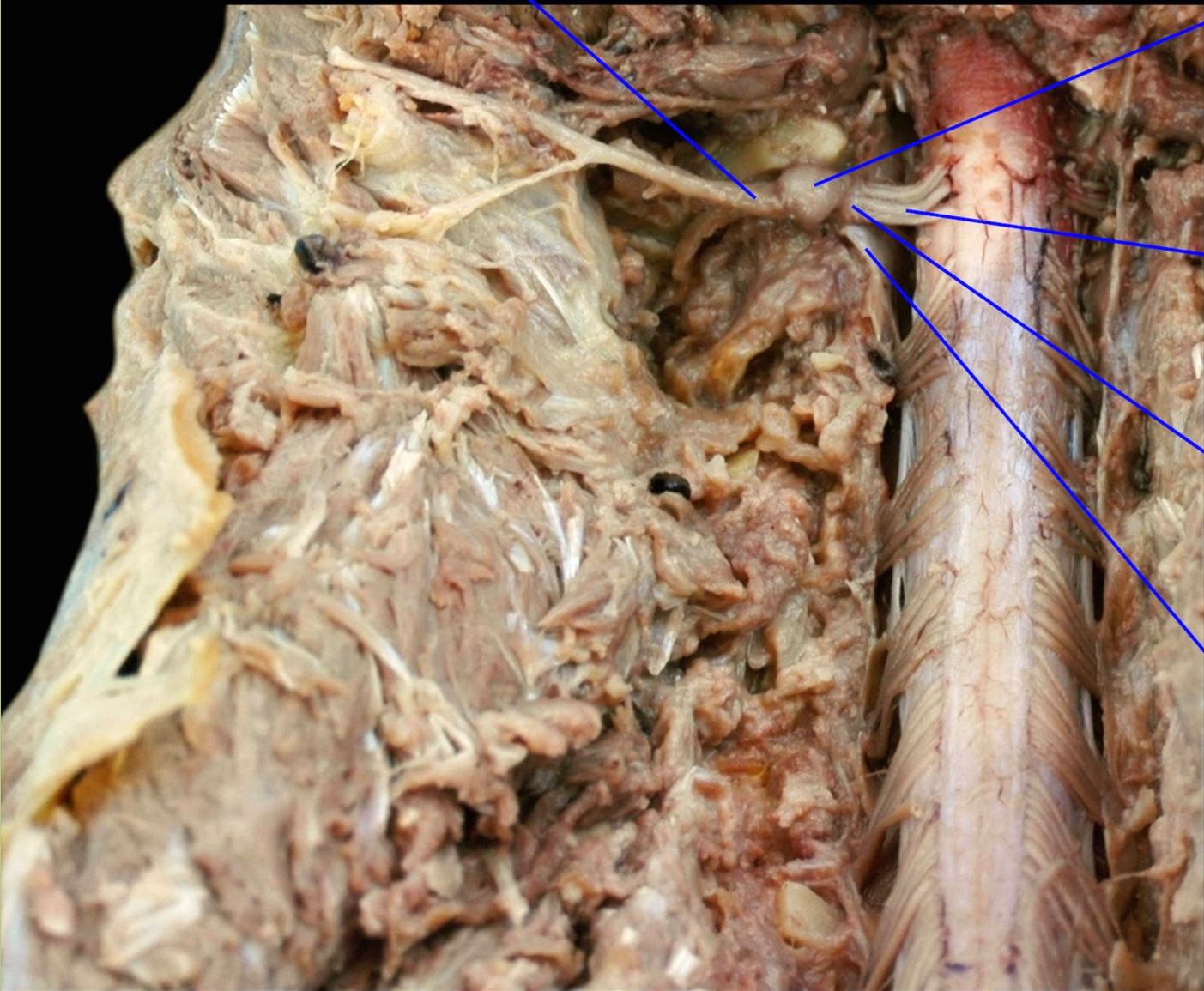
Trunk of spinal nerve

Dorsal root ganglion

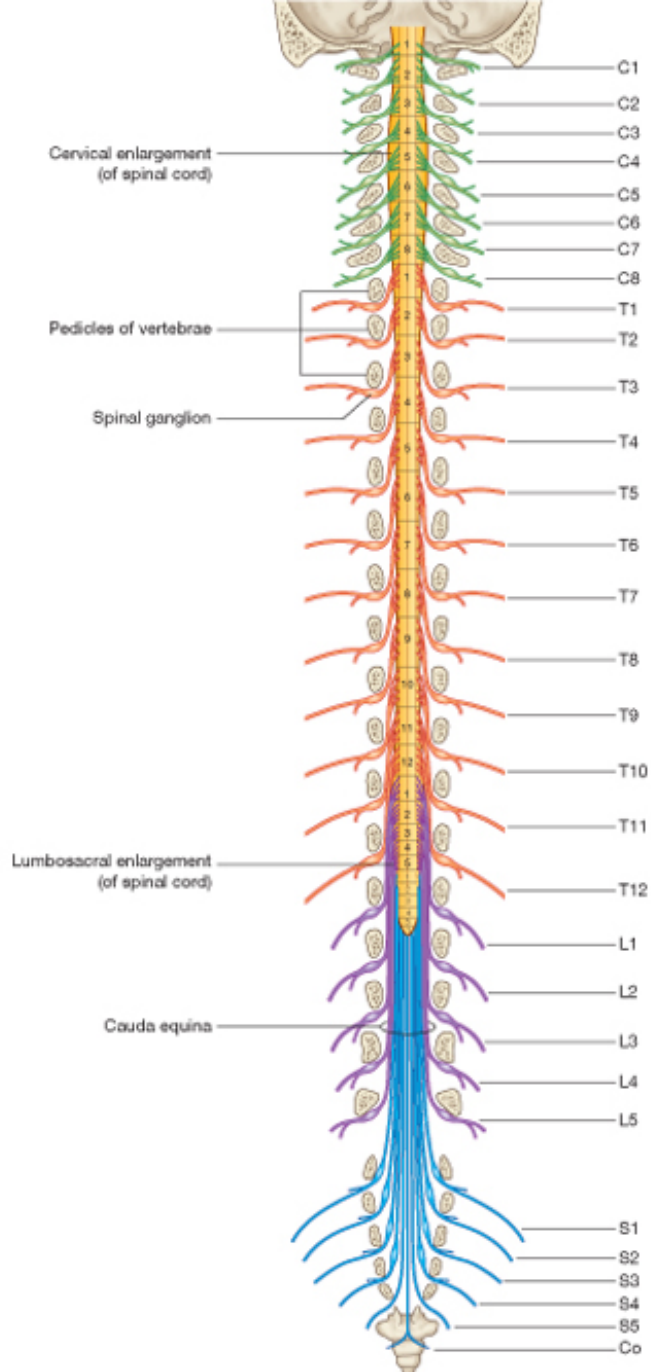
Dorsal rootlets

Dorsal root

Ventral root

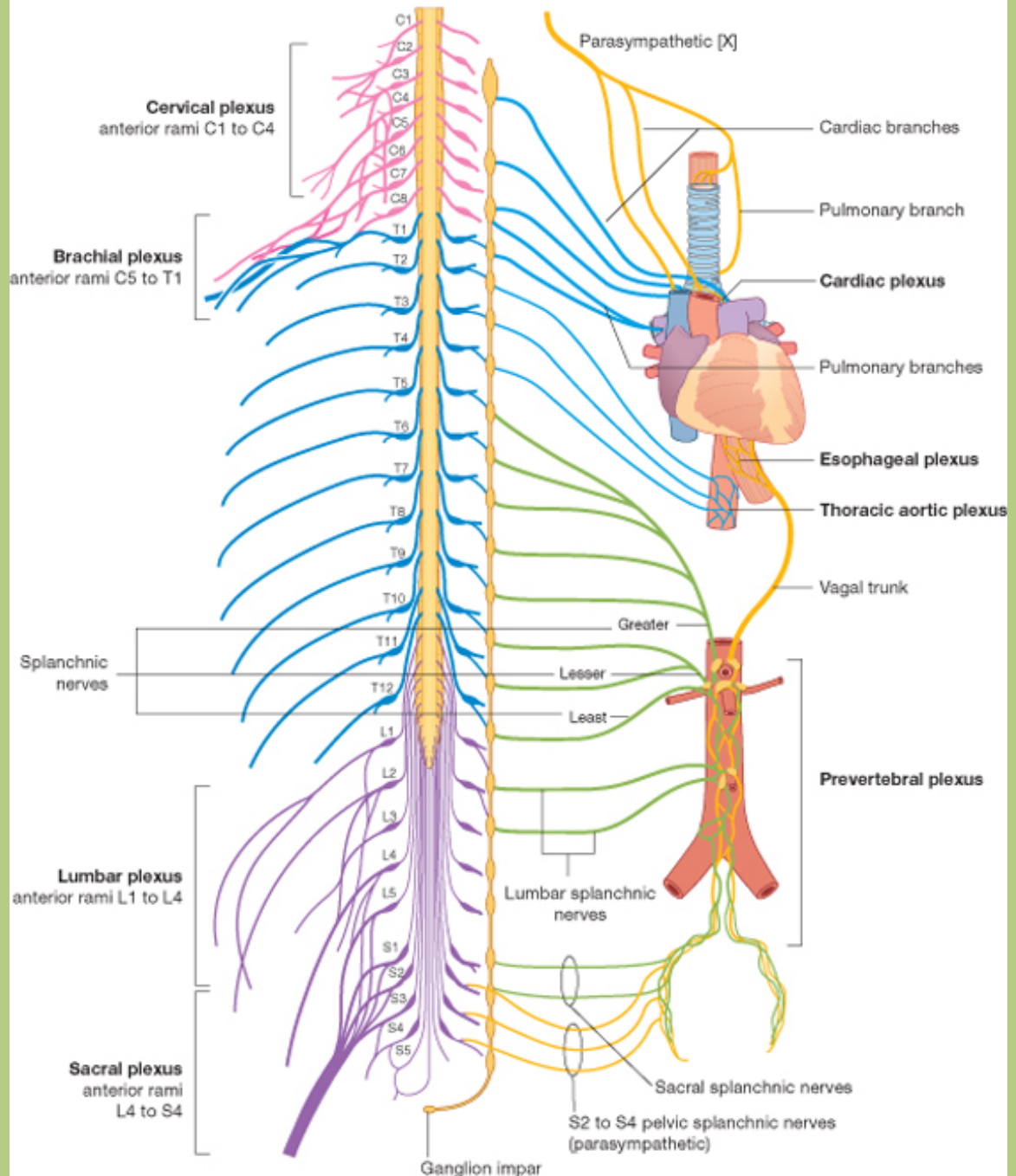


Spinal nerve, posteroinferior

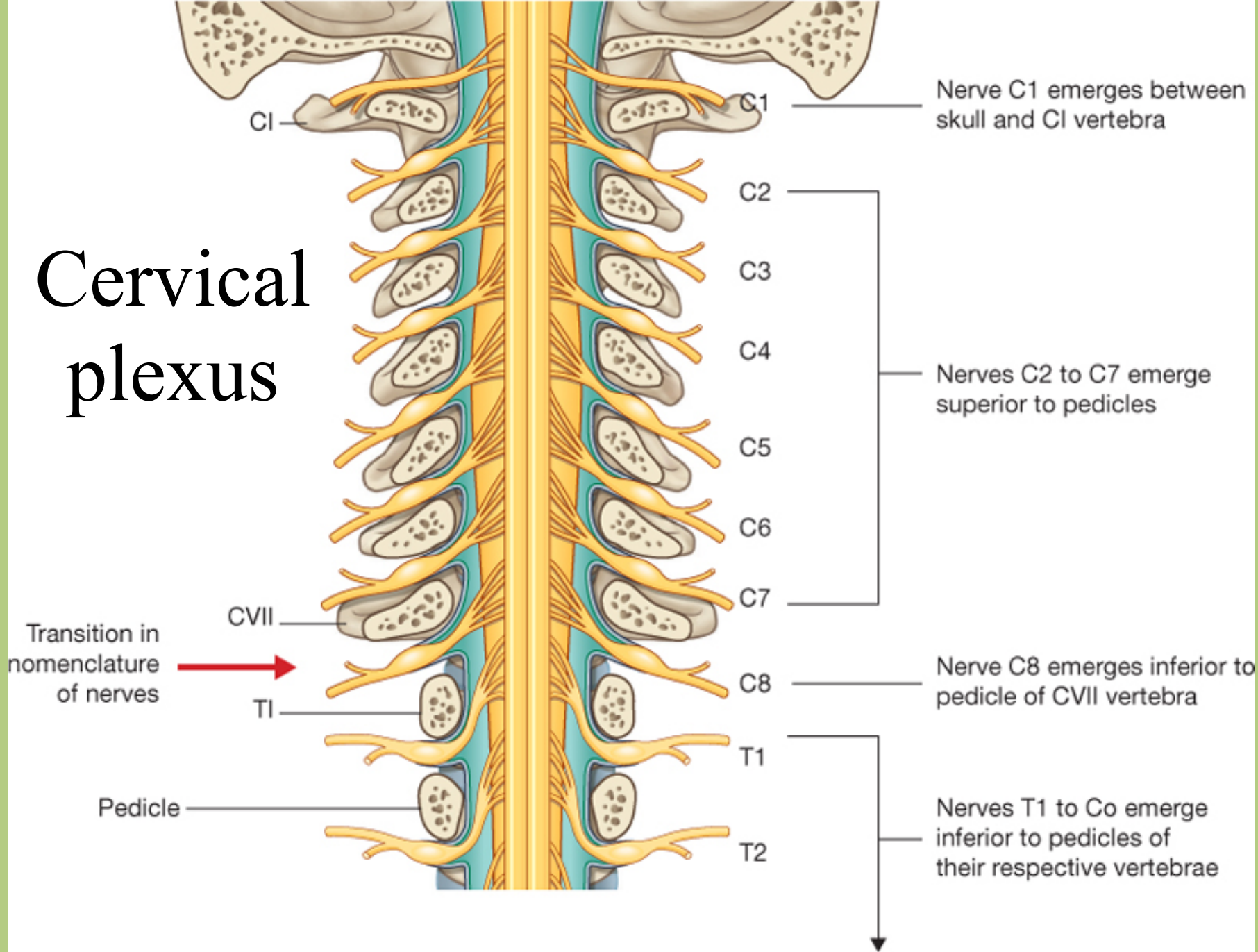


SOMATIC PLEXUSES

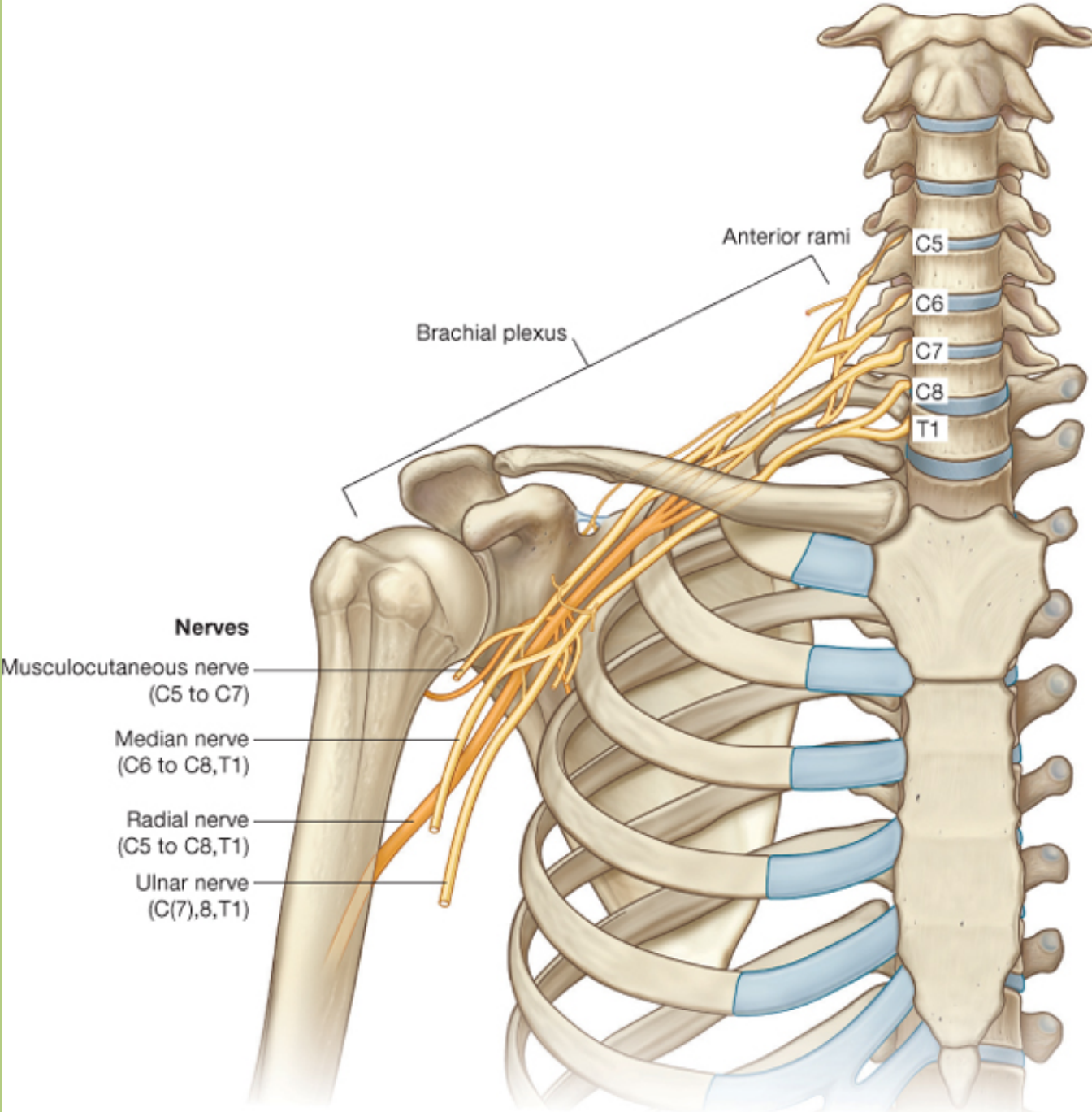
VISCERAL PLEXUSES



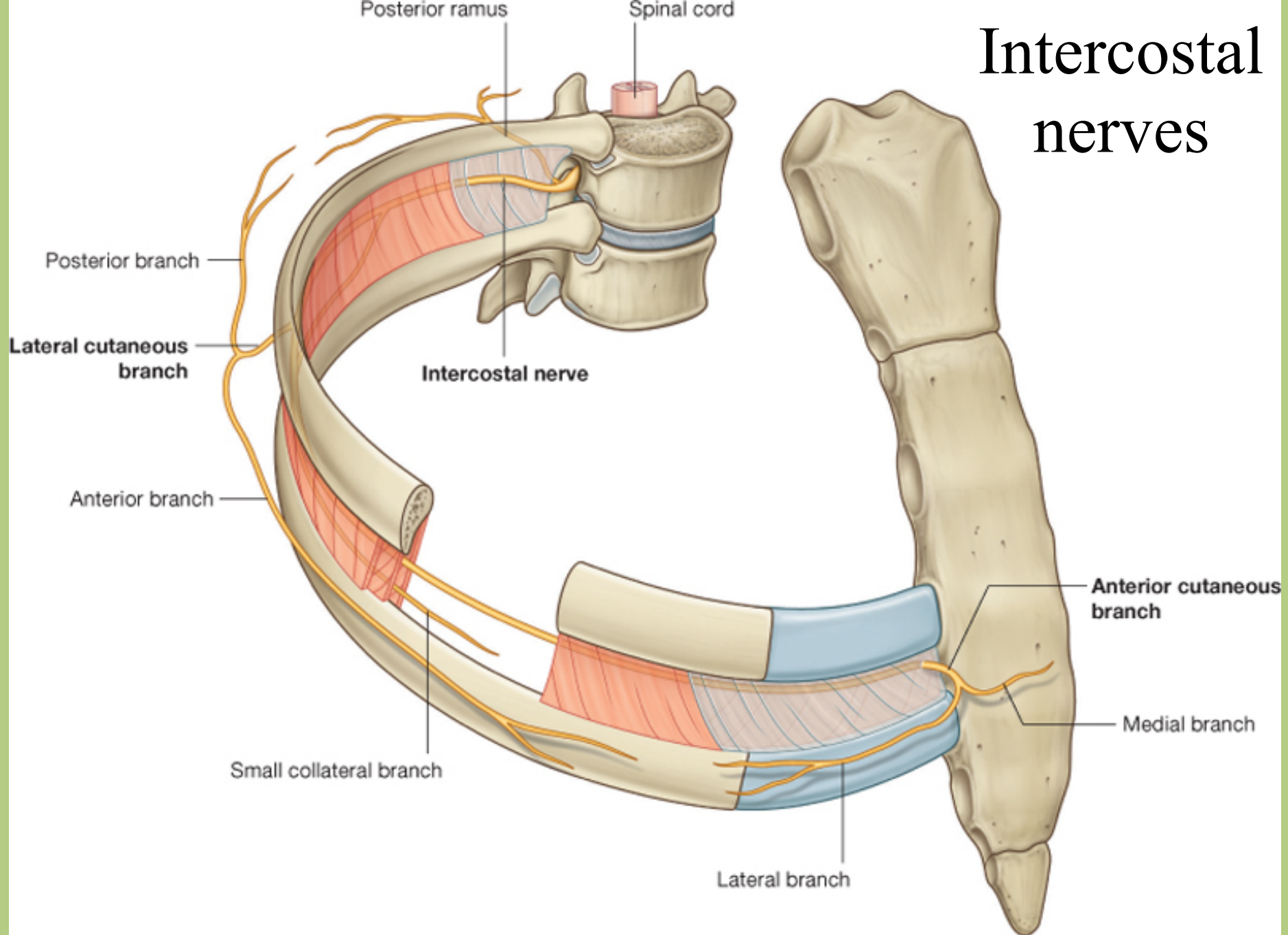
Cervical plexus



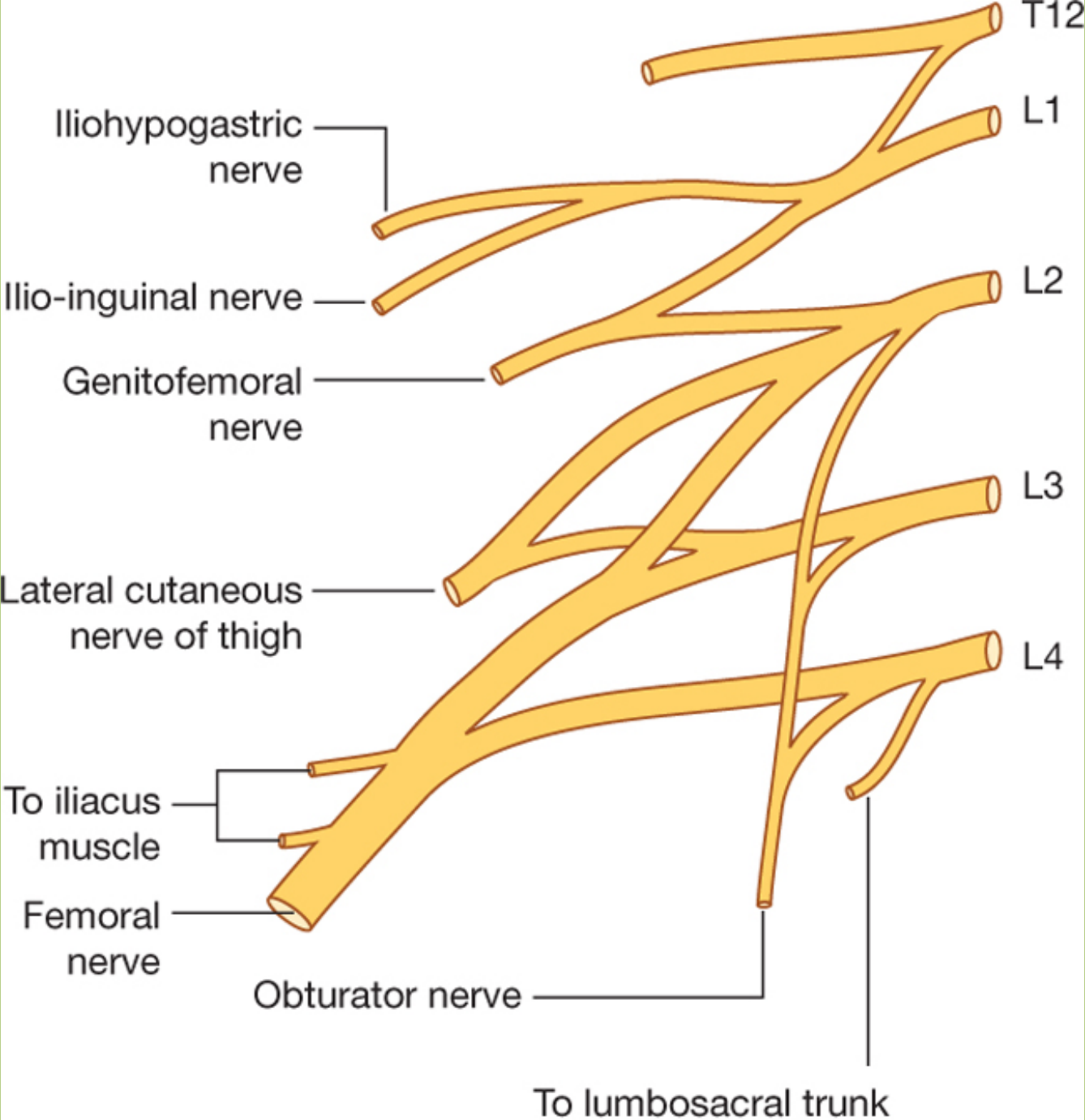
Brachial plexus



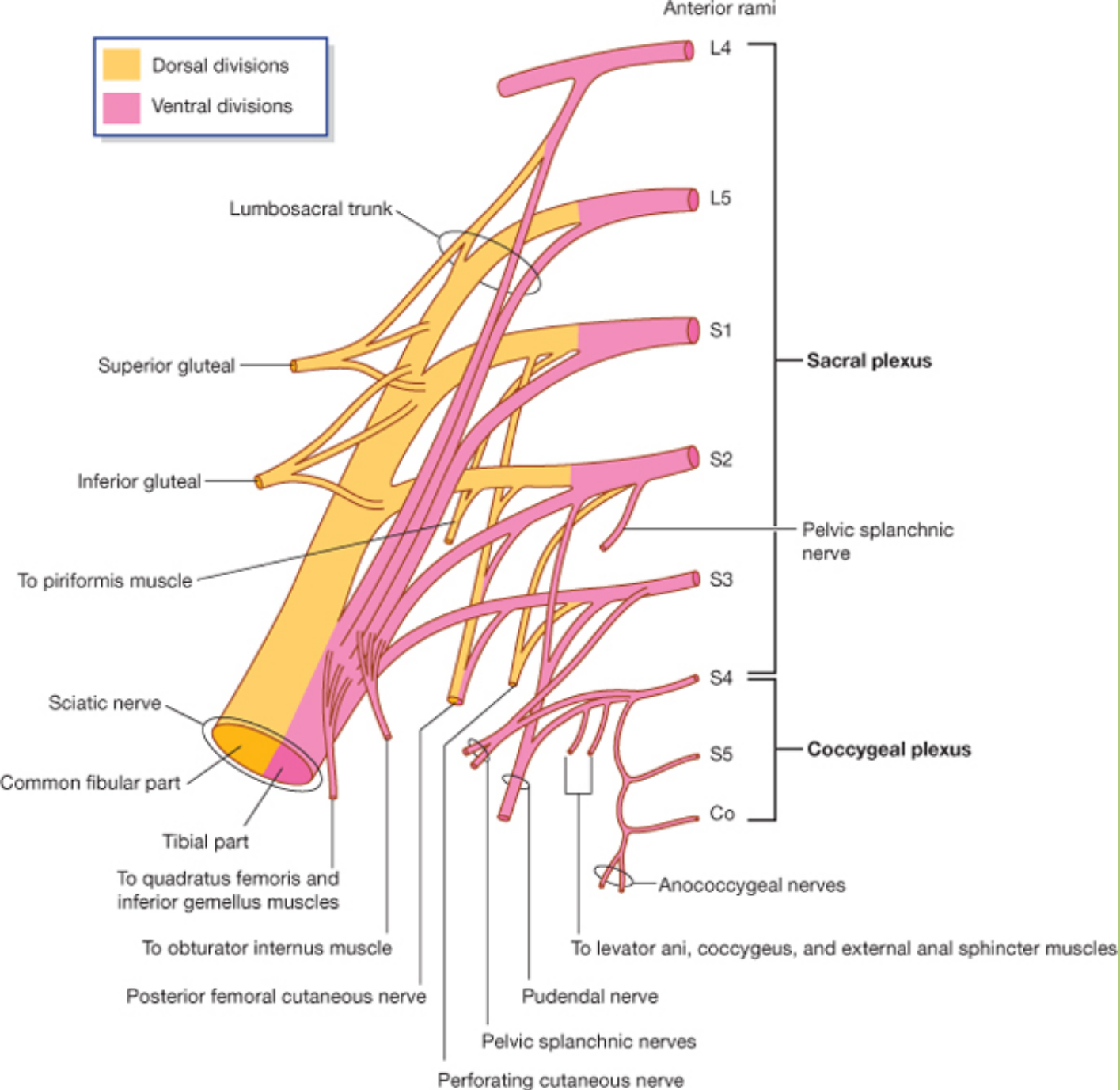
Intercostal nerves



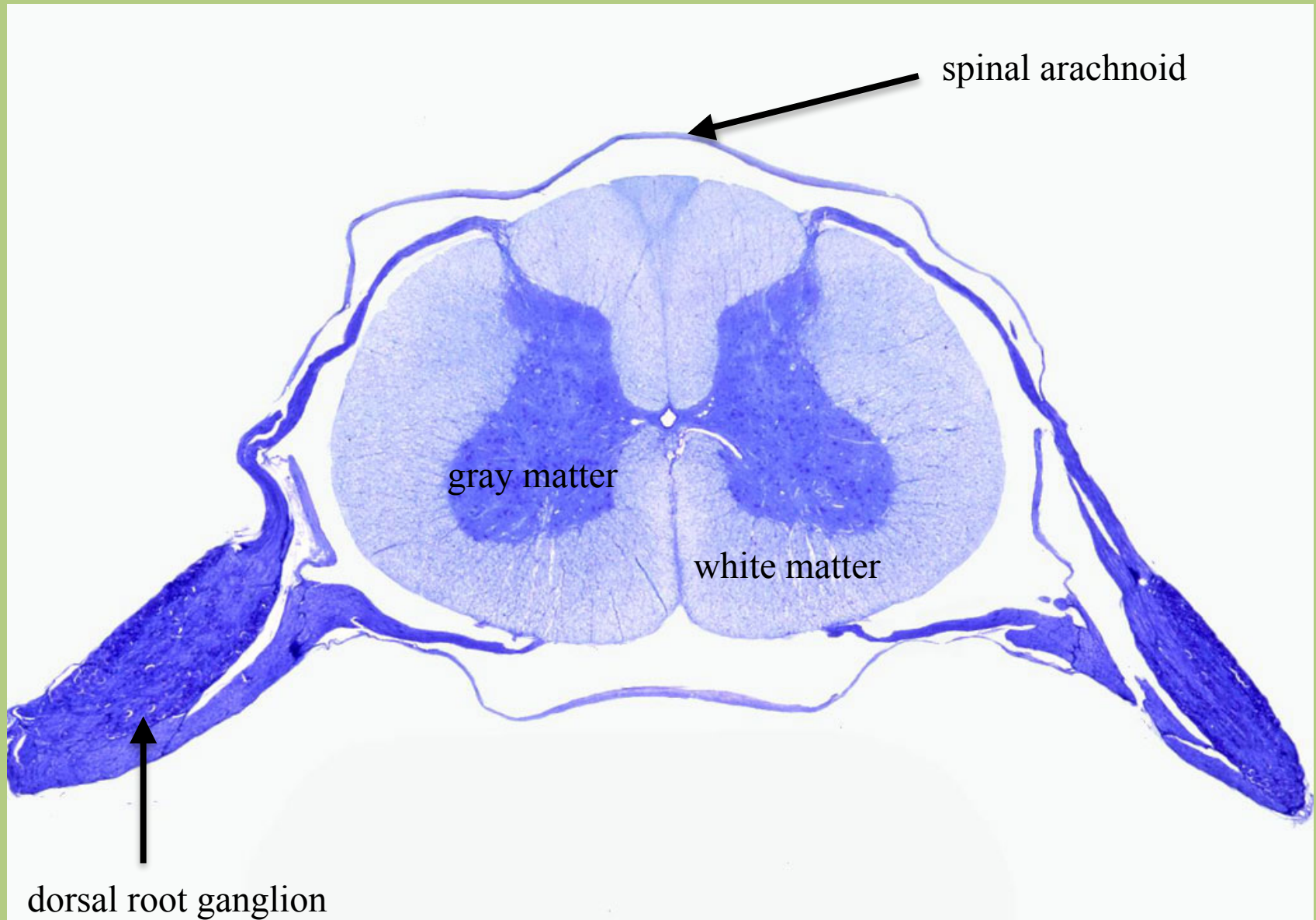
Lumbar plexus



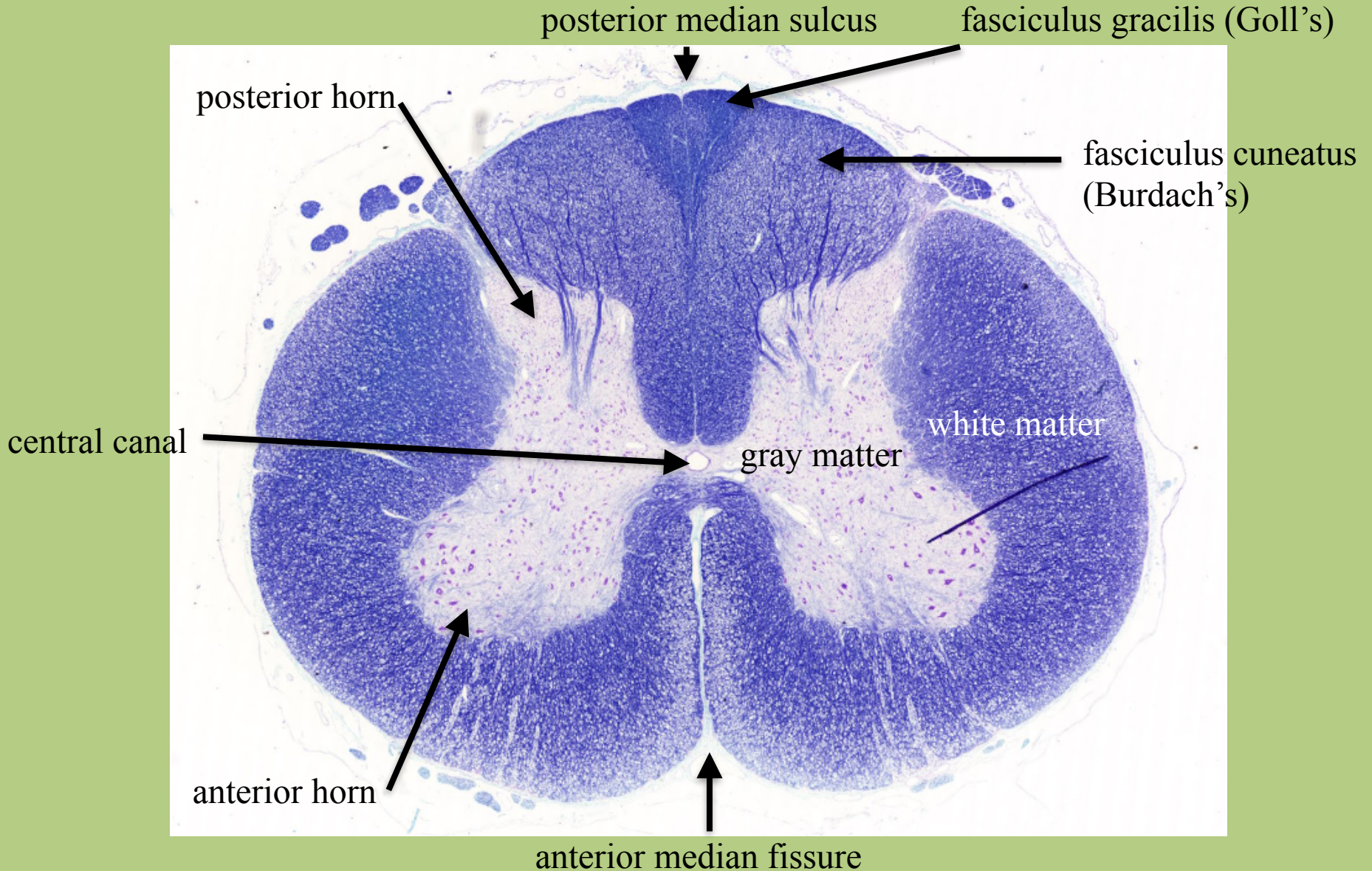
Sacral and coccygeal plexuses



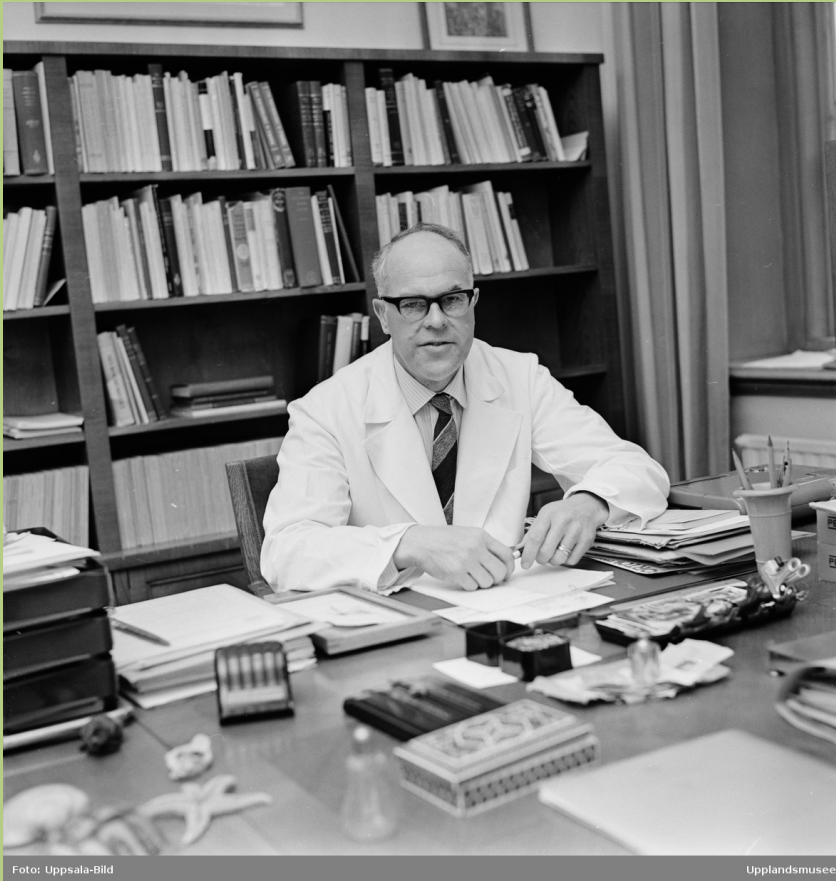
Spinal cord - histology



Spinal cord - histology

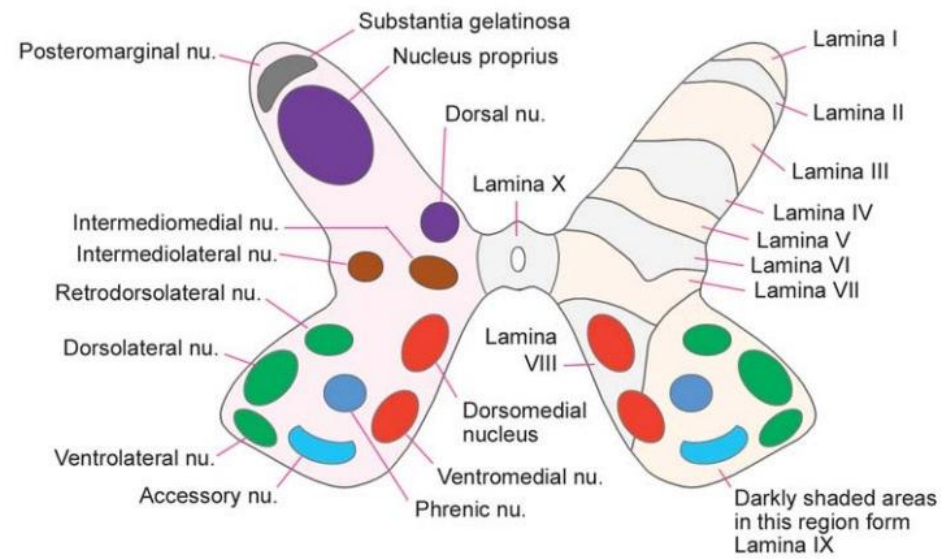


Subdivisions of the gray matter



Bror Rexed: Swedish neuroscientist who described the gray matter of the spinal cord in 10 layers (*Rexed laminae*) in the early 1950s.

Lamina II. - Substantia gelatinosa (Rolando's substance)

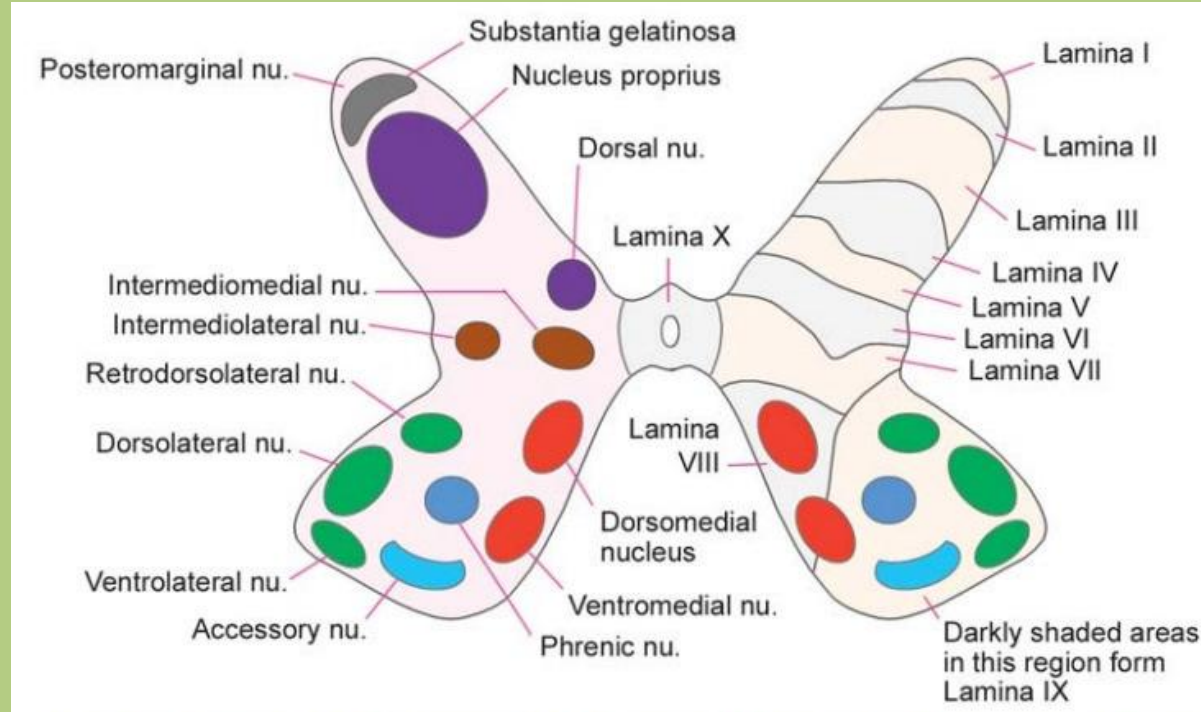


It extends the *entire length of the spinal cord* and into the medulla oblongata where it *becomes the spinal nucleus of trigeminal nerve*.

It receives direct input from the dorsal (sensory) nerve roots, especially fibers *from pain and thermoreceptors*. Composed of fine *networks of interneurons*, it contains high levels of substance P as well a *large number of opiate type receptors*, both of which are involved in the perception of pain.

Thus, the substantia gelatinosa is believed to *play an important role in the modulation of and/or mediation of pain perception* at the spinal level.

Lamina IX.



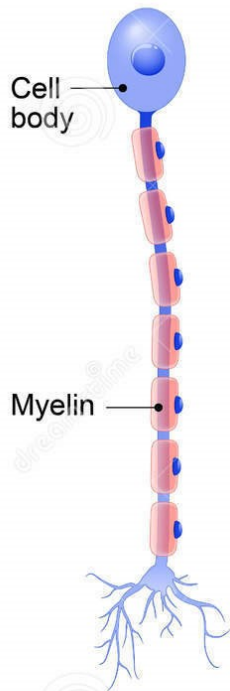
Lamina IX.:

Motor neurons (alpha and gamma)

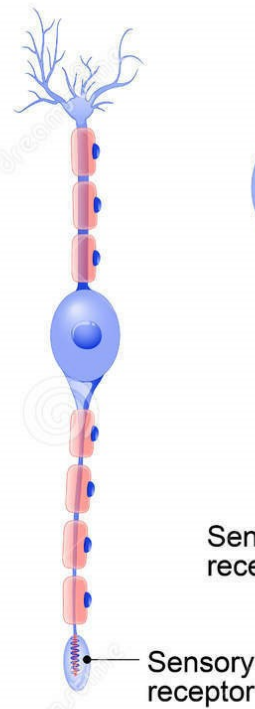
Composition of nerve tissue - neurons

DIFFERENT KINDS OF NEURONS

Unipolar



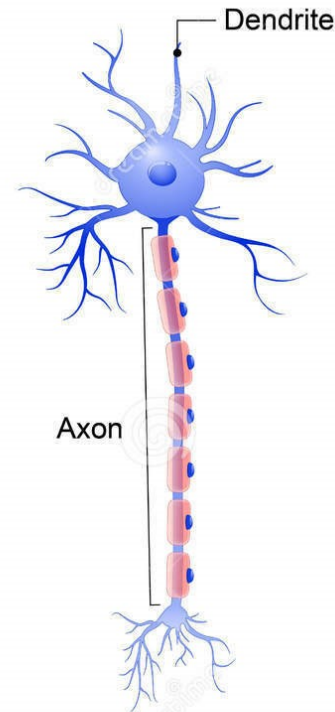
Bipolar



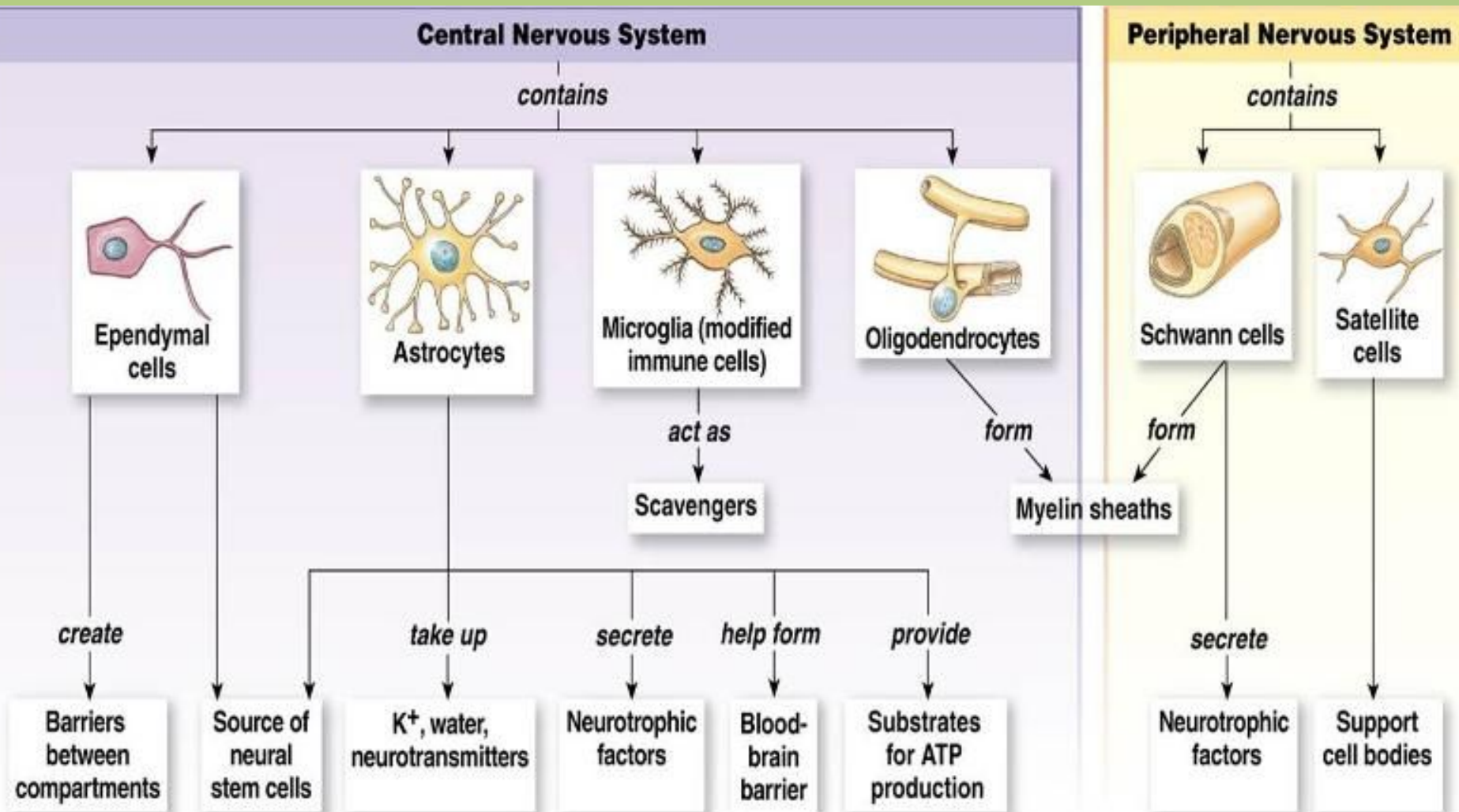
Pseudounipolar



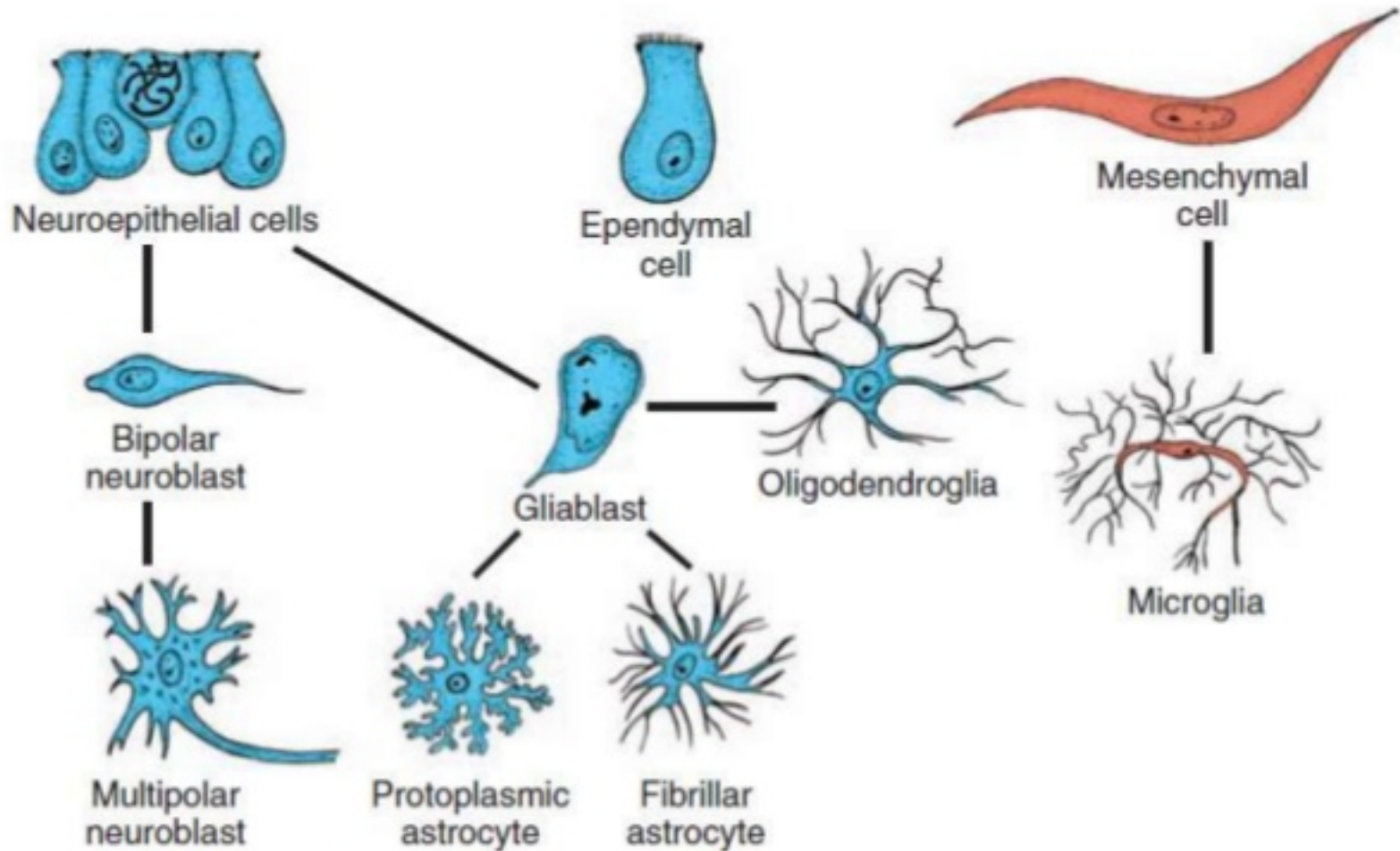
Multipolar



Composition of nerve tissue - neuroglial cells



Origin of the nerve cell and glial cells



Motor neurons - their axons form the ventral root

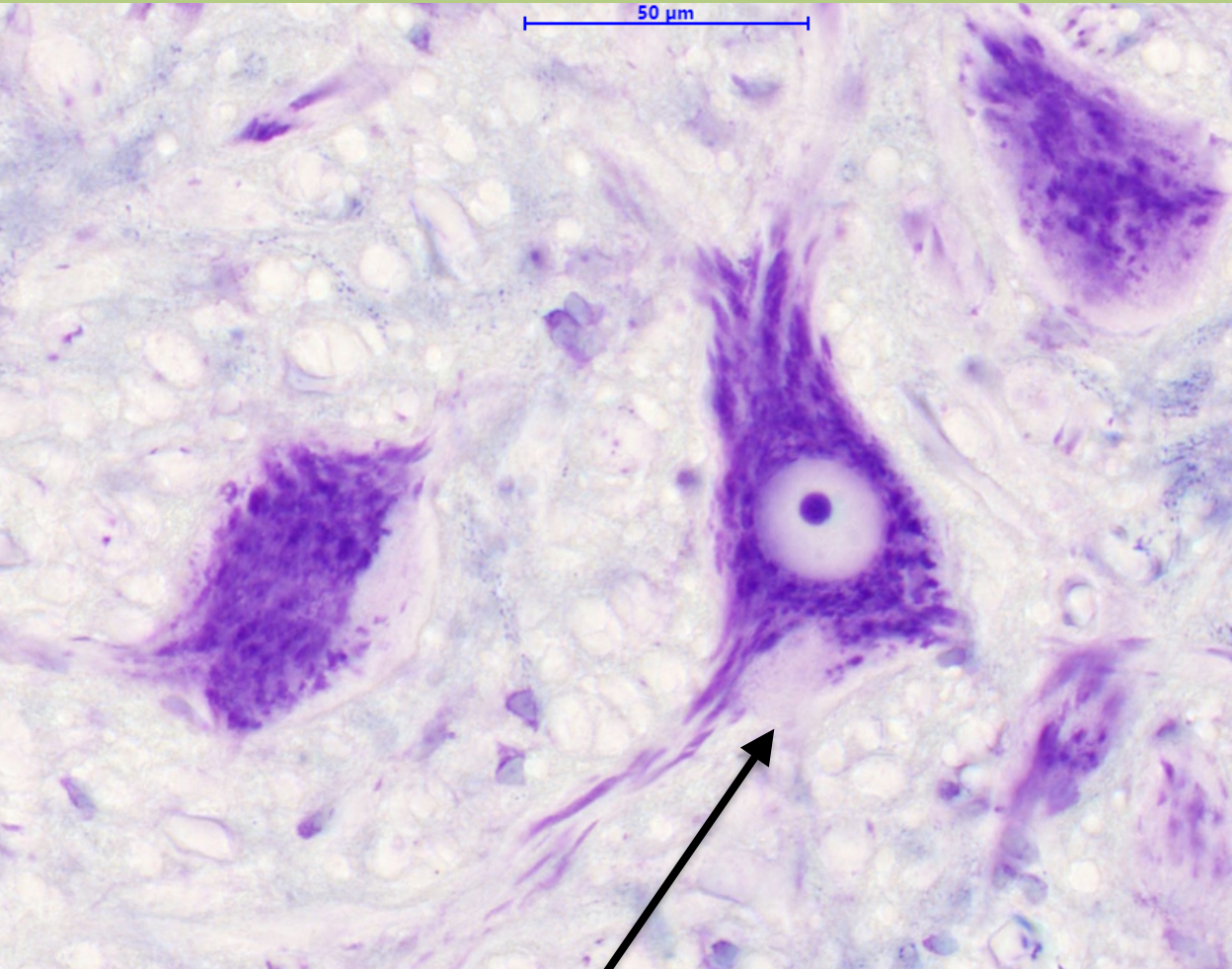
Somatic motor neurons:

Alpha and gamma motor neurons

Visceral motor neurons:

Preganglionic neurons innervating ganglion cells. At the thoracolumbar region they are sympathetic neurons, at the mid-sacral level they are parasympathetic neurons.

Alpha motor neurons



axon hillock (free of Nissl bodies)



Fig. 16. On the Starnberg lake, from left to right:
Alzheimer, Kraepelin, Gaupp, Nissl (about 1908)

Nissl bodies:

In the cytoplasm *well-developed rough endoplasmic reticulum* is presented (intensely stained small bodies), indicating intense protein synthetic activity.

Intrinsic neurons -

their axons go to other CNS locations

Secondary sensory neurons:

They receive synapses from 1st order neurons whose cell bodies are in the dorsal root ganglia and send their axons in ascending tracts.

Interneurons:

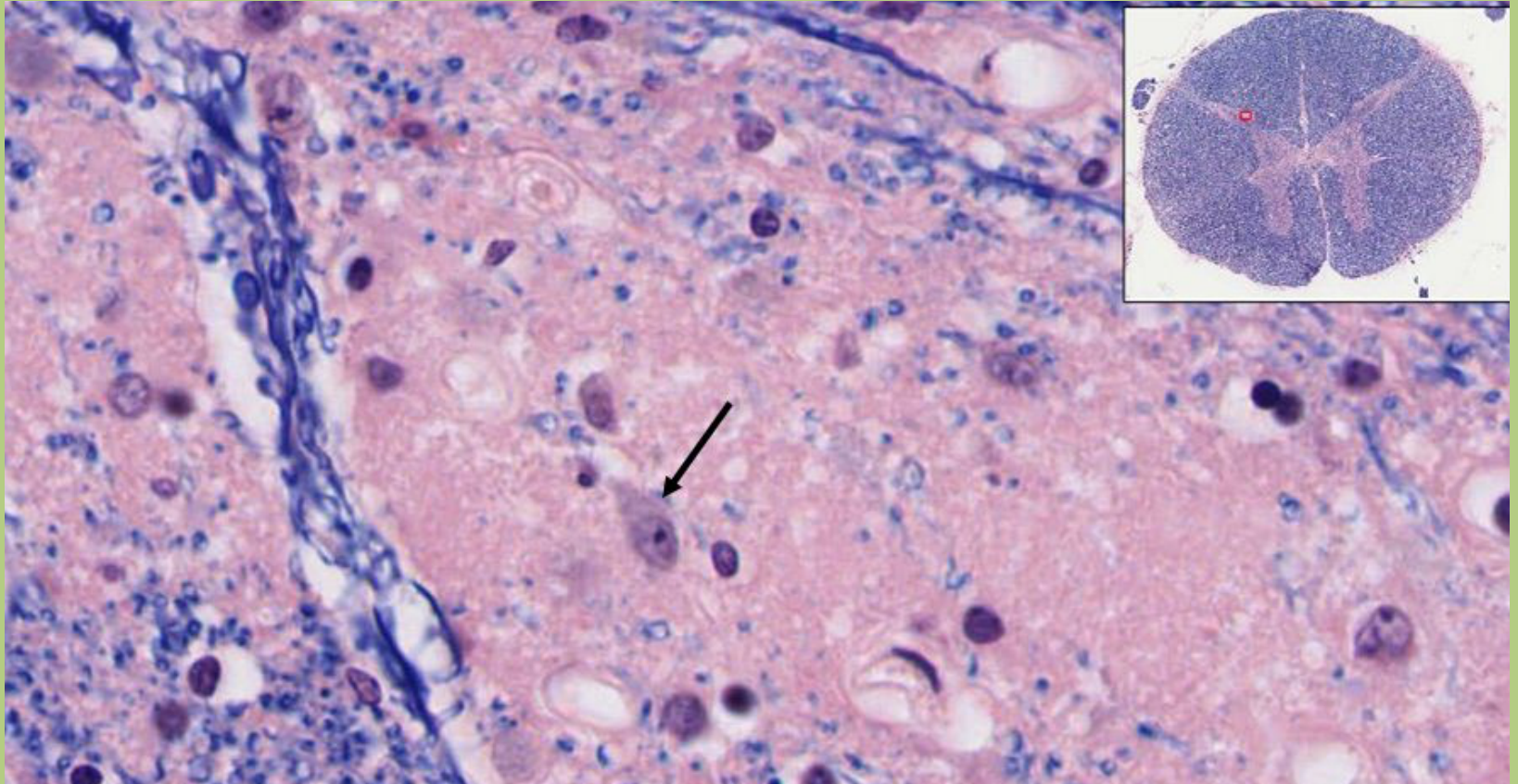
Intercalated cells: their axons remain at the same segmental level.

Commissural cells: their axons cross in the anterior commissure to the contralateral side.

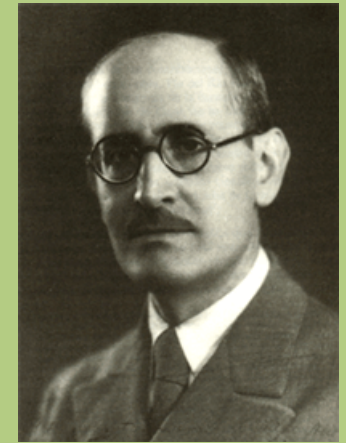
Association cells: their axons interconnect different spinal segments.

Renshaw cells: inhibitory neurons, excited by axon collaterals of alpha motor neurons. They inhibit their activator alpha motor neurons and the neighboring motor neurons, modulating the firing rate of neurons.

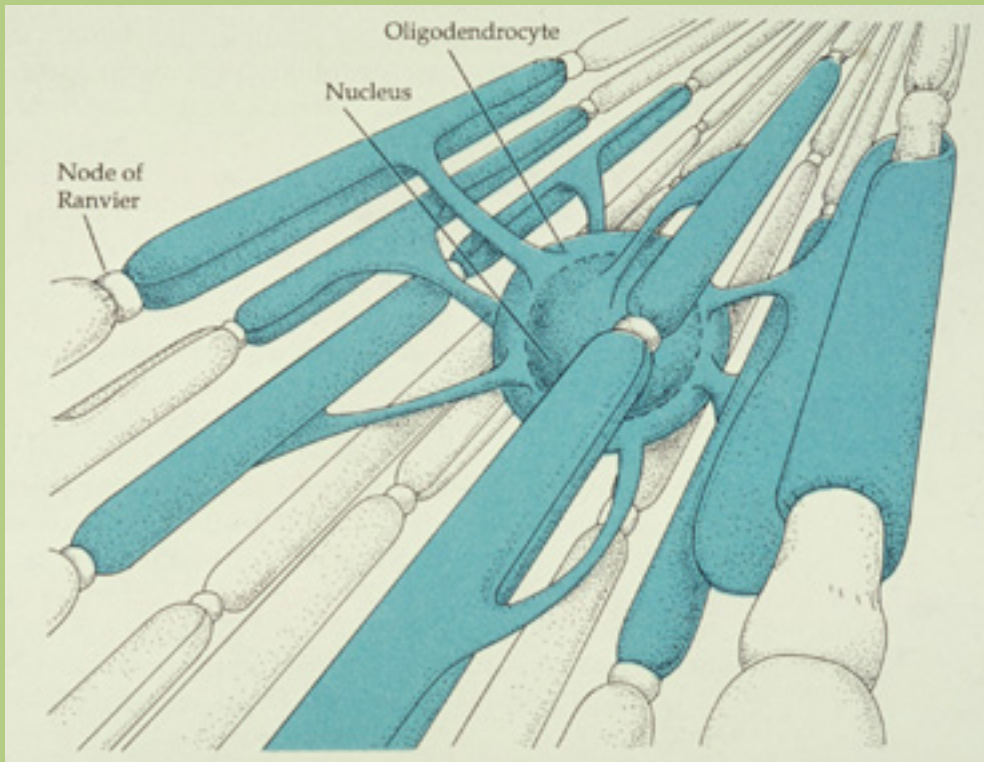
Interneurons



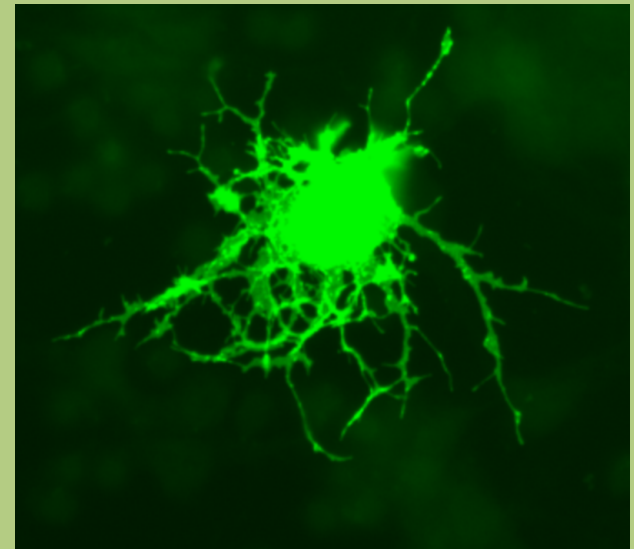
Oligodendrocytes



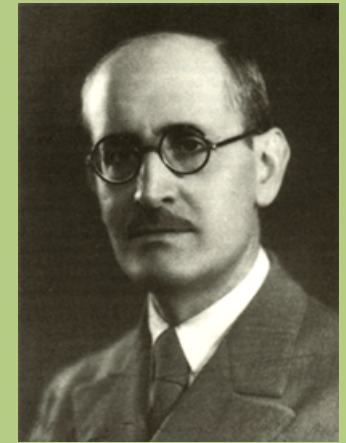
Discovered by
Pío del Río
Hortega at
1921



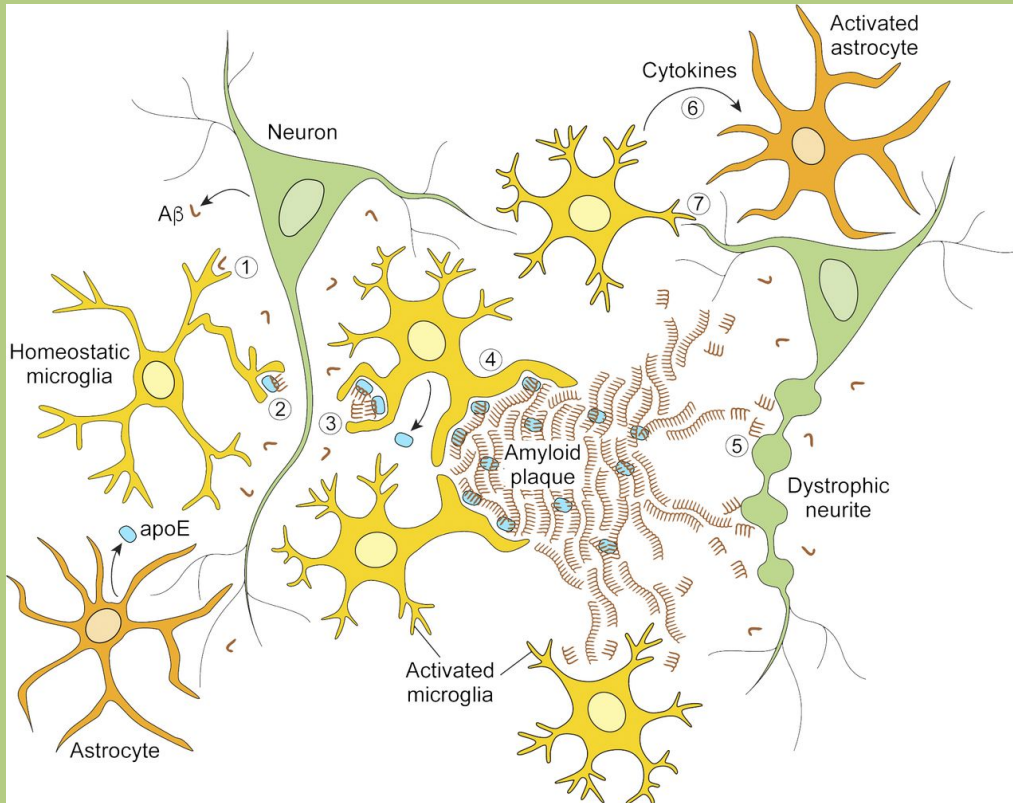
Support and insulation of axons in the CNS. A single oligodendrocyte can extend its processes to 50 axons, wrapping approximately $1\ \mu\text{m}$ of ***myelin sheath*** around each axon.



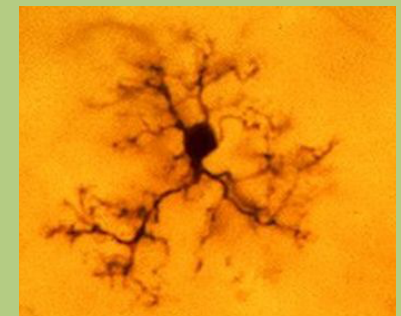
Microglia



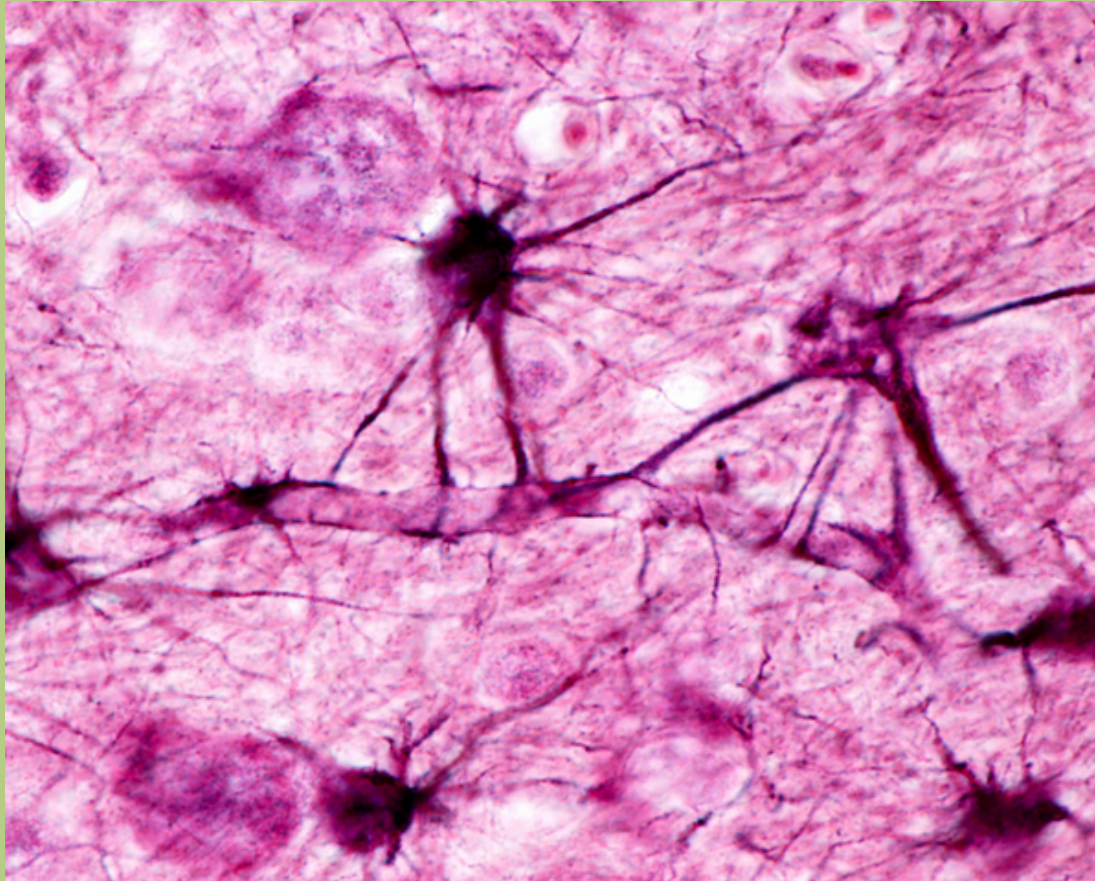
Pío del Río
Hortega -
'Father of
Microglia'



They *originate from erythromyeloid progenitor cells*. Microglial function is normally *protective in the brain, with microglia acting as housekeeping phagocytes to maintain tissue homeostasis and keep the extracellular space clean of amyloid bodies*, thereby preventing Alzheimer's disease (AD). *Sometimes*, because of aging or genetic susceptibility, microglial function becomes inadequate: *they eat synapses, secrete neurotoxic cytokines that injure neurons*, becoming harmful in AD.

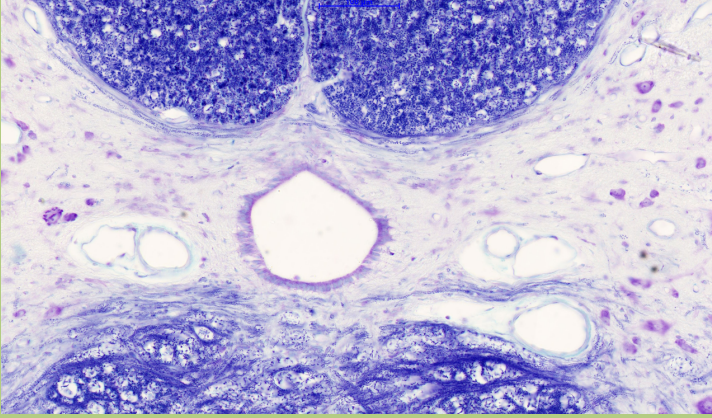


Astrocytes

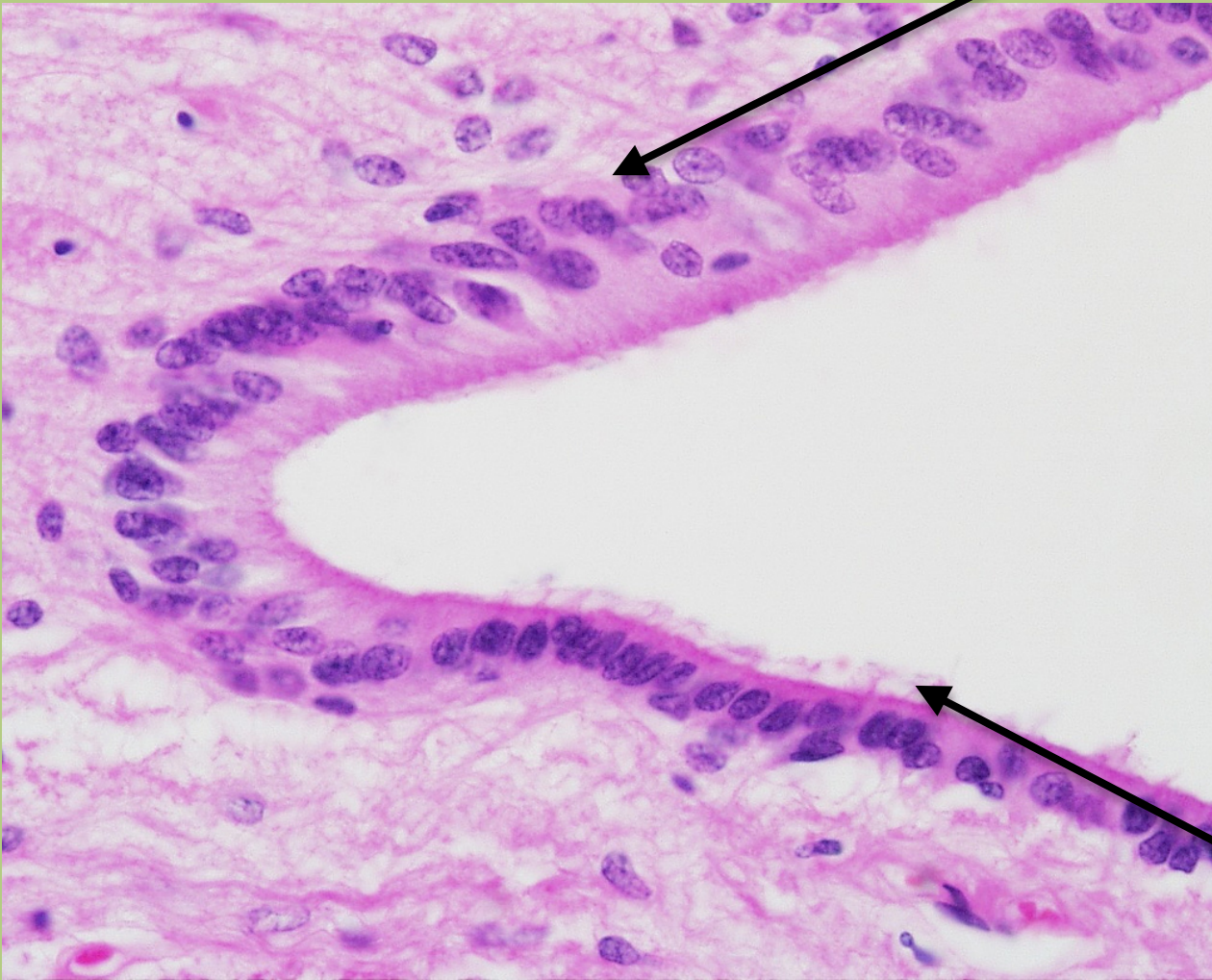


They perform many functions, including *biochemical support of endothelial cells that form the blood–brain barrier, provision of nutrients to the nervous tissue, maintenance of extracellular ion balance, and a role in the repair and scarring process* of the brain and spinal cord following traumatic injuries. Astrocytes also *signal to neurons* through Ca^{2+} -dependent release of glutamate.

Ependymal cells



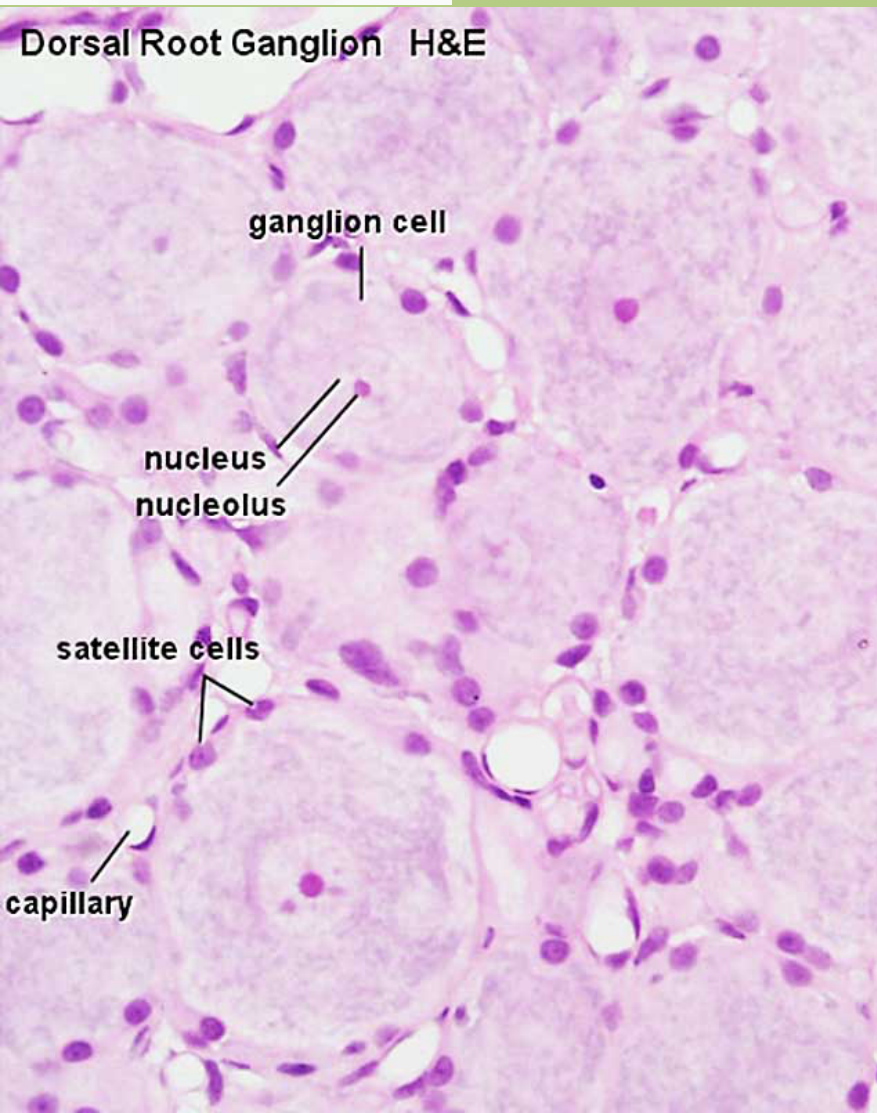
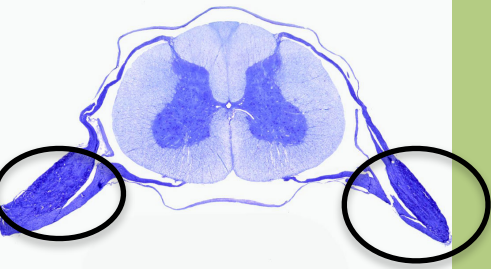
No real basement membrane just tentacle-like extensions of astrocytes are presented.



Neuroepithelial *lining of ventricular system and central canal*. They play an important role in the *production and regulation of CSF* and act as *reservoir cells* in the forebrain, which can be activated after stroke.

Microvilli

Dorsal root (spinal) ganglion



Ganglionic cells:

- pseudounipolar neurons
- 1st order neurons in many ascending sensory tracts

Satellite cells:

- glial cells
- derived from the neural crest
- they keep up special micro environment

Thank you for your
attention.



“Oops! Sorry about that spontaneous
reflex action, doctor!”

References:

McGraw-Hill Company's pictures

Nature Reviews

Pearson Education

Thieme: Atlas of Anatomy, Head, Neck, and Neuroanatomy