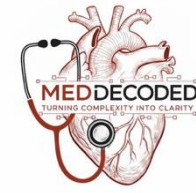


بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ



HISTOLOGY

Final | Lecture 8

وَلَقَدْ خَلَقْنَا الْإِنْسَانَ وَنَعَلَهُمَّا تَوْسُوسُ بِهِ نَفْسُهُ وَنَحْنُ أَقْرَبُ إِلَيْهِ مِنْ حَبْلِ الْوَرِيدِ

Nervous Tissue Lab

Written by : Dareen Alhababseh
Hala Marei
Lamar Khorma

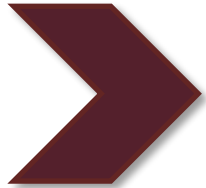


Reviewed by : Reem Aldahamsheh
Amal Al-khatib

Color coding used in the modified:



Black: the original slides



Maroon: the doctor's explanation/words



Gray: additional information and explanation



Red: important information

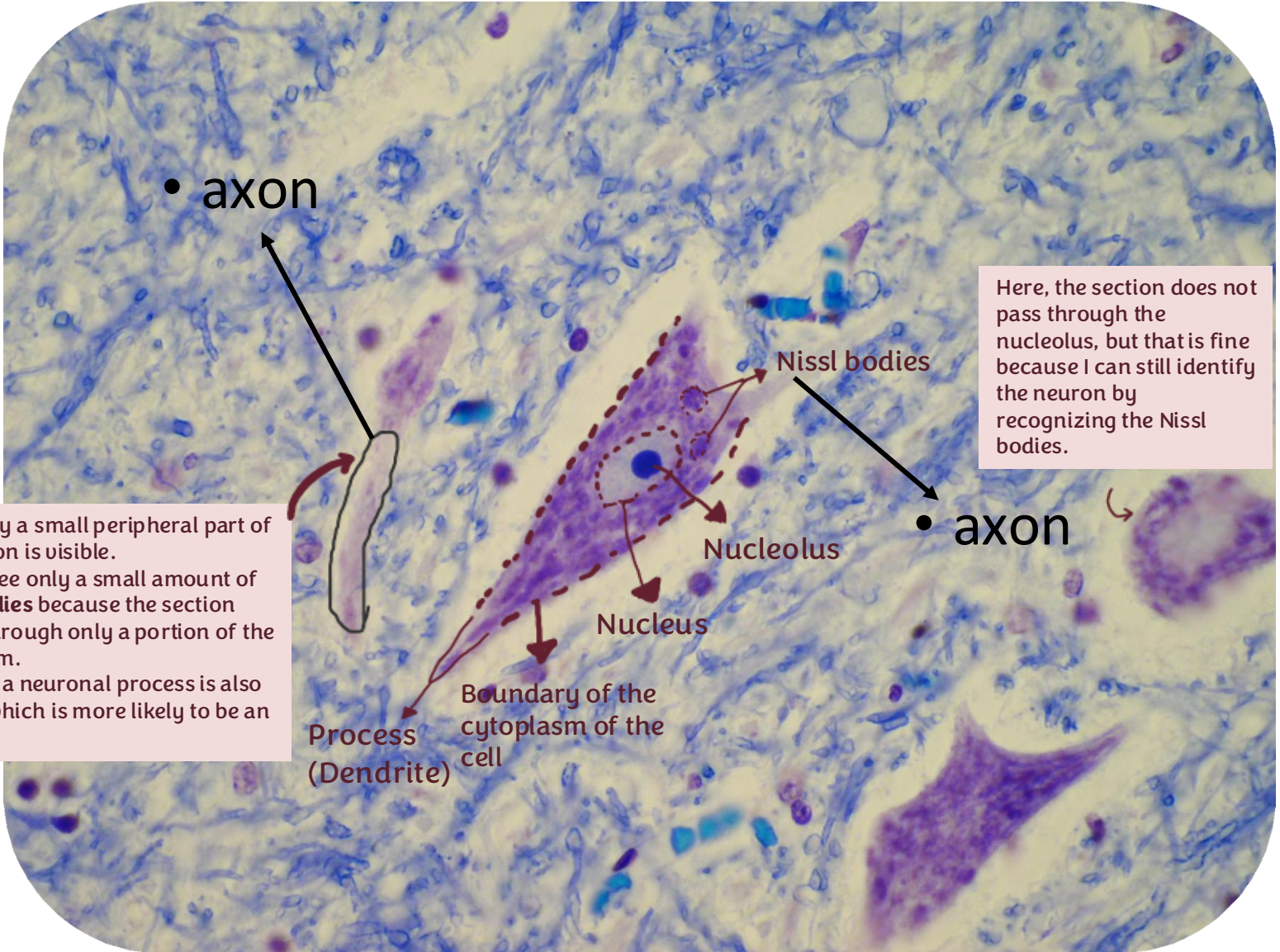
Nervous tissue

In this section:
we can identify 4 neurons.

In a histological slide, the **axon** is characterized by a completely clear cytoplasm, whereas **dendrites** contain dark-staining **Nissl bodies** similar to those found in the main cell body.

neuron: soma (Nissl bodies) nucleus, nucleolus

Nissl bodies look like clumps.



Here, only a small peripheral part of the neuron is visible. We can see only a small amount of **Nissl bodies** because the section passes through only a portion of the cytoplasm. A part of a neuronal process is also visible, which is more likely to be an axon.

Here, the section does not pass through the nucleolus, but that is fine because I can still identify the neuron by recognizing the Nissl bodies.

Here, we are looking at a histological section from the central nervous system (CNS). This tissue contains two main types of cells: Neurons and neuroglia (glial cells).

- How do we identify neuroglia?

Neuroglial cells are usually identified mainly by their nuclei.

- How do we identify neurons?

Neurons are usually the largest cells seen in nervous tissue sections, it may look like an eye looking at you.

If the section passes through the nucleus, neurons are very easy to identify, If the nucleus is not visible (because the section did not pass through it), another clue is the cell body (by identifying Nissl bodies). A large cell body with visible processes is most likely a neuron.

Here, we can see several neuronal processes arising from the cell body.

When you see more than two processes, the neuron is classified as a multipolar neuron. Multipolar neurons are the most common type of neurons and usually function as motor neurons and interneurons.

This applies to most neurons found in the central nervous system (CNS).

When a neuron has an irregular shape, this usually indicates the presence of multiple processes, suggesting a multipolar neuron.

In contrast, unipolar neurons have only one process, so the cell body tends to remain more rounded. Bipolar neurons have two processes, and their cell body is also usually rounded in shape.

Therefore, it is easy to recognize a multipolar neuron from other types.



In the CNS, we have four types of neuroglia:

***Astrocytes**

Help in maintaining the BBB (blood-brain barrier).

***Oligodendrocytes**

Form **myelin** in the CNS , in the PNS, **Schwann cells** form myelin.

Difference between oligodendrocytes and Schwann cells:

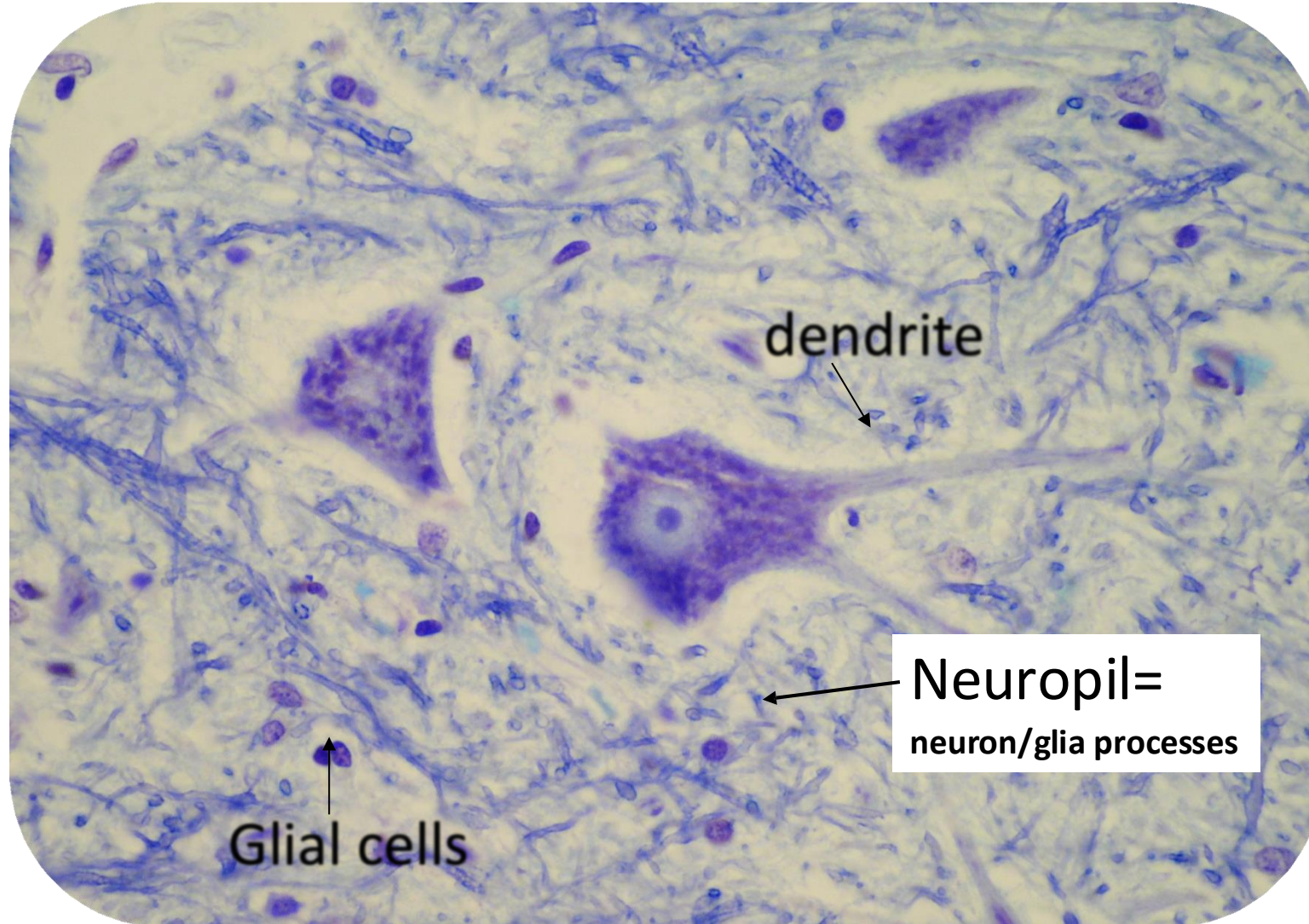
- One **Schwann cell** forms myelin around **one axon segment**.
- One **oligodendrocyte** can form myelin around **multiple segments**. It can send multiple processes to different segments and even to different axons in different neurons.

***Microglia:** Their origin is from **monocytes**.

They are the only neuroglial cells that differ from the others in origin.

***Ependymal cells:** Found in the **ventricles** and the **central canal** of the spinal cord. They assist in the circulation of **CSF** (It doesn't produce the CSF), the choroid plexus produces the cerebrospinal fluid.

multipolar neuron (toluidine blue stain)

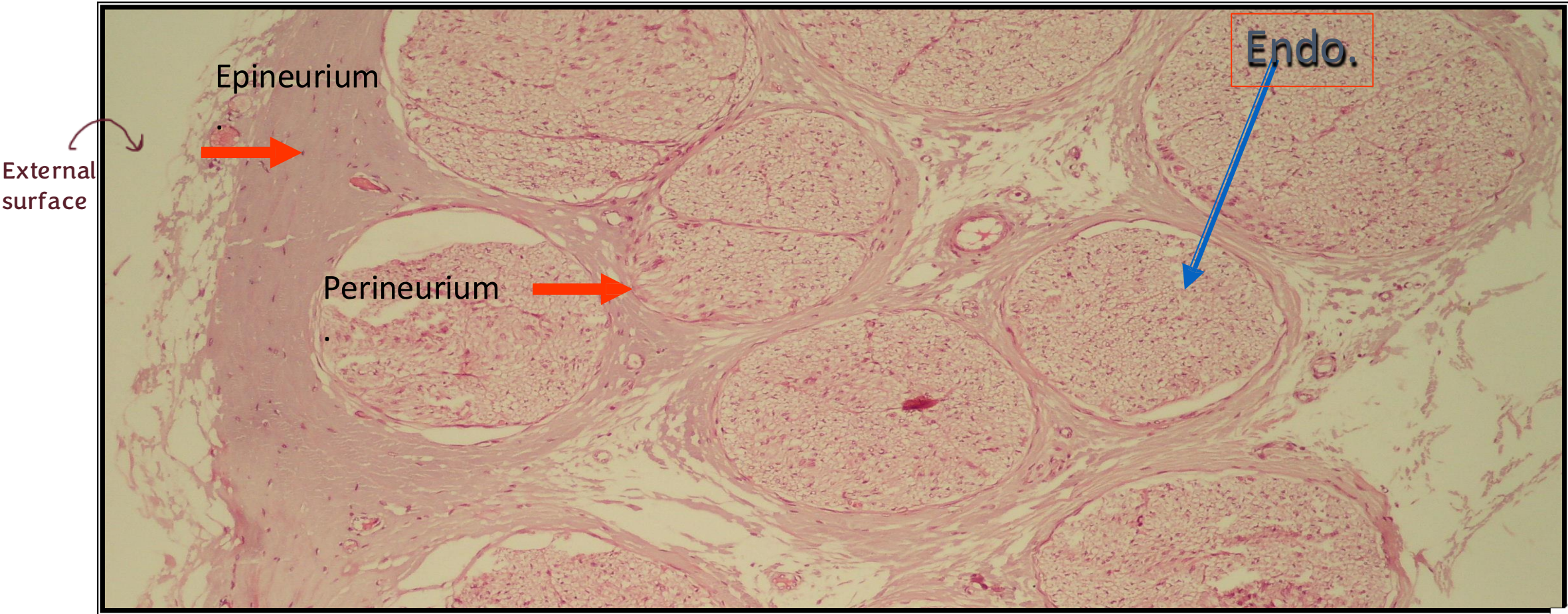


Here, we have three neurons, and the remaining cells are neuroglia. The fiber-like structures seen here may give the impression of connective tissue, but this is not connective tissue. These fibers represent the processes of glial cells and the processes (mainly dendrites) of neurons. This network of neuronal and glial processes is called the neuropil.



Here we have the external surface. Moving inward, we first see the outermost layer, the epineurium is a layer of connective tissue. We usually cover exposed structures either with epithelium or connective tissue, depending on the organ. However, nerves cannot be covered by epithelium because they need a stronger protective layer. Therefore, they are protected by **dense irregular** connective tissue. We already saw this concept in other structures: In bone: the periosteum (dense irregular connective tissue), in cartilage: the perichondrium, which follows the same idea. So, the same protective principle applies here: the nerve is well protected by dense irregular connective tissue.

The eosinophilia mainly comes from collagen fibers.
The nuclei seen here belong to fibrocytes (fibroblasts).



H&E- Fascicles of nerve fibers



The previous picture is a section of a nerve.

Nerves contain many axons, and these axons are already covered by a layer of myelin.

On top of that, there are additional **connective tissue** coverings that wrap the nerve in layers.

We have three levels of wrapping:

- Endoneurium (small layer):

 - Wraps around each single axon individually.

- Perineurium (intermediate layer):

 - Wraps around a bundle of axons (fascicle).

- Epineurium (large layer):

 - Wraps the entire nerve.

Small → around single axon (endo)

Medium → around fascicles (peri)

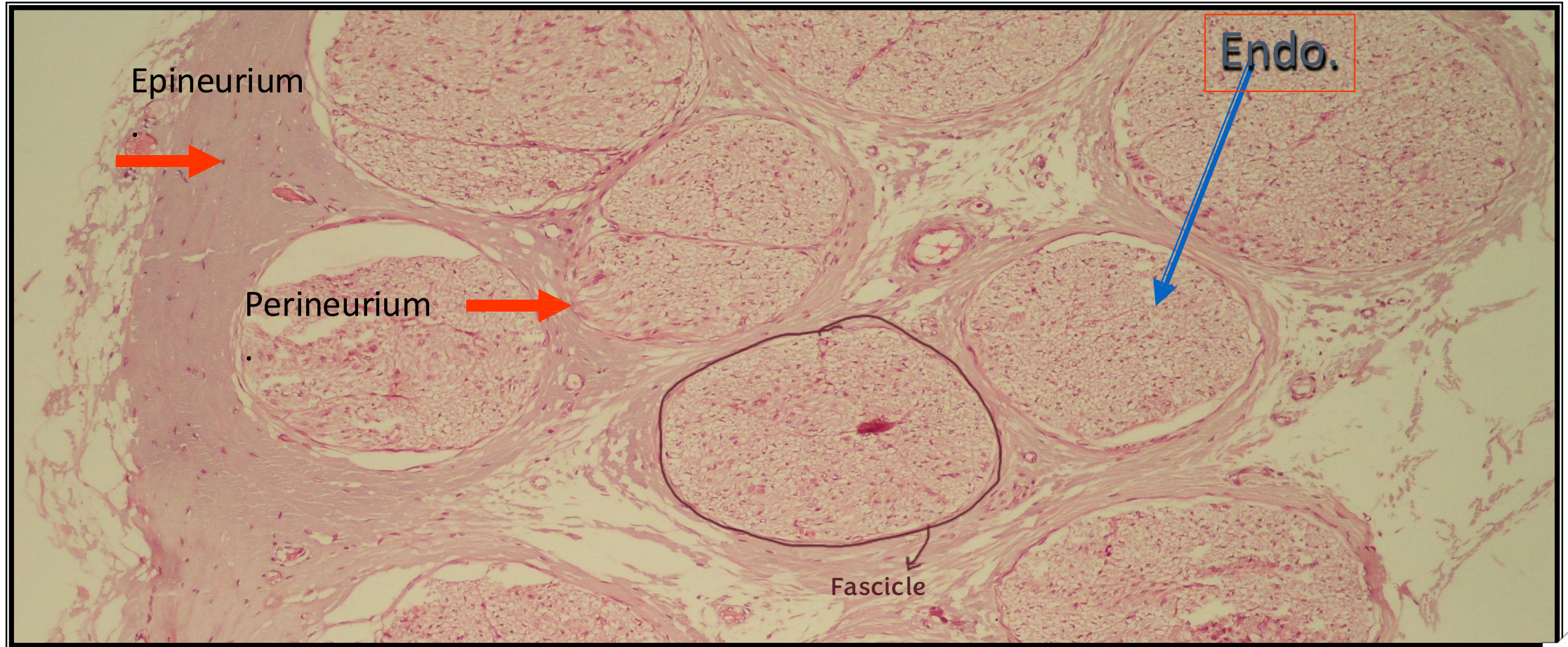
Large → around whole nerve (epi)

This layered organization is similar to what we see in muscles.

Here, if we use a lower magnification, we can see the entire nerve surrounded as a whole. In this section, we are only seeing part of it. We can observe that the **epineurium** extends and continues around structures. It covers the outer surface and extends between the fascicles. So, when it extends, it goes in between and around the fascicles to provide support.

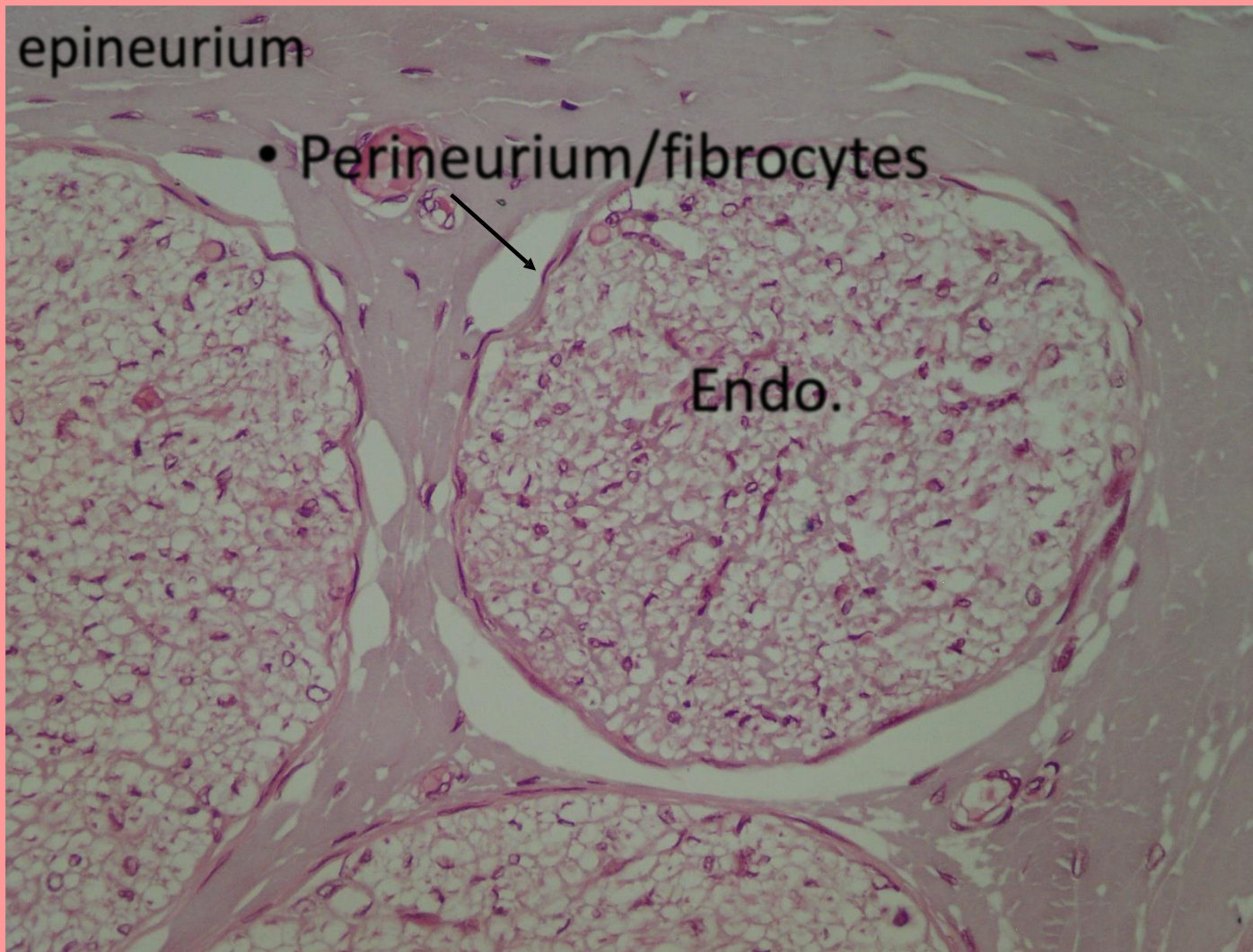
Around the fascicles, we see darker areas with nuclei, this is the **perineurium**. The perineurium is composed of multiple layers of **fibroblasts** surrounding each fascicle, it forms a **blood nerve barrier** around the fascicles and helps protect the axons inside.

The perineurium (together with the epineurium) continues between structures to further strengthen and support the organization of different fascicles.



H&E- Fascicles of nerve fibers





Here, we can identify the **epineurium**, **perineurium**, and **endoneurium**. The **endoneurium** is composed of delicate **reticular fibers**. Although there are special stains used to visualize it more clearly, it can still be recognized at this magnification.

Inside the fascicles, I can identify structures composed mainly of **axons** and their covering. Since this is a nerve in the **PNS**, this covering is formed by **Schwann cells**.

The nuclei seen within the fascicles mainly belong to **Schwann cells**. However, not all nuclei belong to Schwann cells, because blood vessels are also present in the section, so some nuclei belong to **endothelial cells**.

Here we have spaces in the fascicle because of the myelin. The Schwann cells bind to the surface of the axon and revolve around it (with its all cytoplasm and the double-layered membrane). The more wrapping, the heavier the myelination will be.

The myelin which is a double layer of membrane is actually a lipid; so during processing it dissolves, so we have spaces left by the myelin produced by Schwann cells.

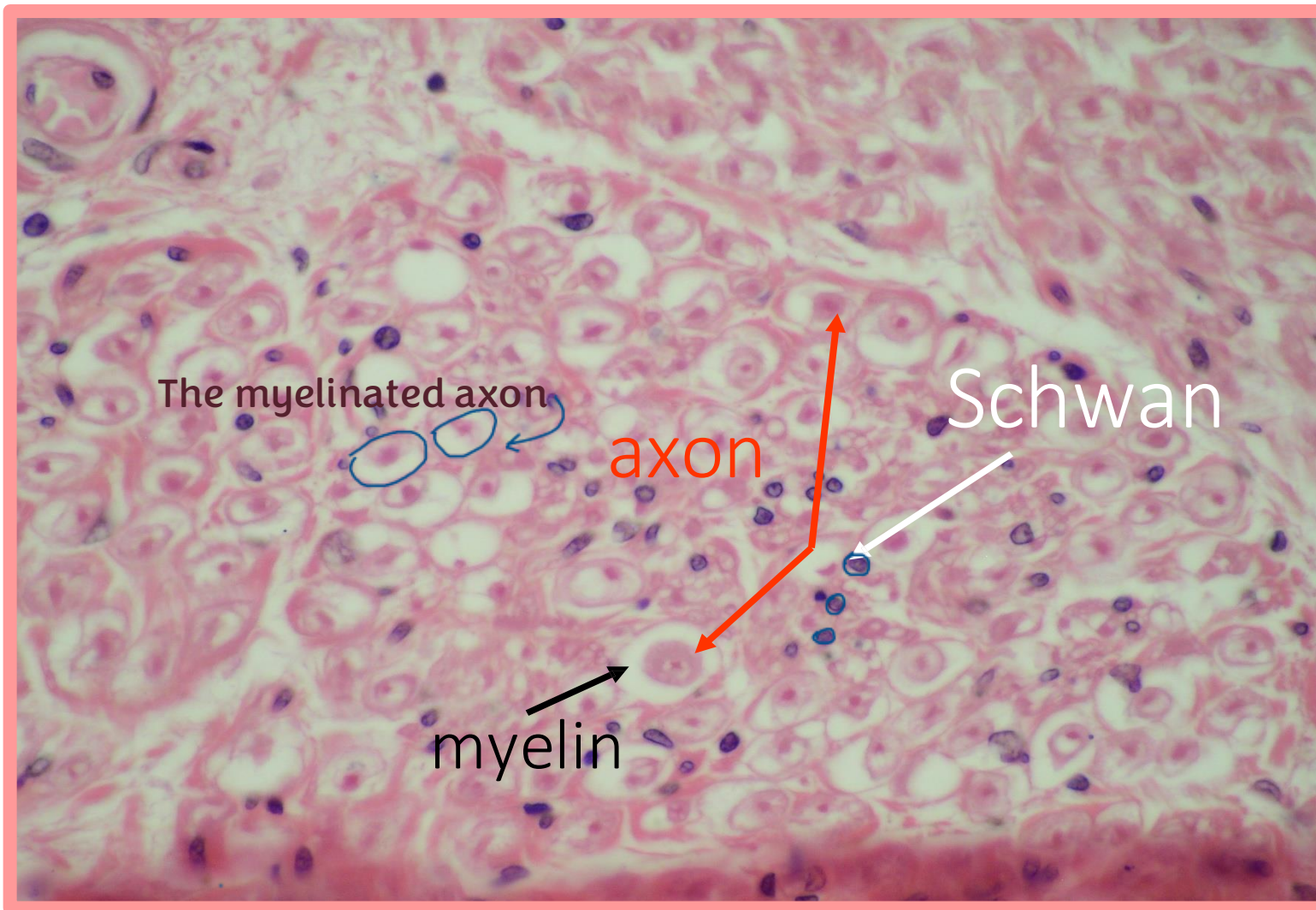
A group of unmyelinated axons are simply tucked into a single Schwann cell without a thick spiral wrap, which results in a much slower conductance of nerve impulses compared to myelinated fibers (no jumping).



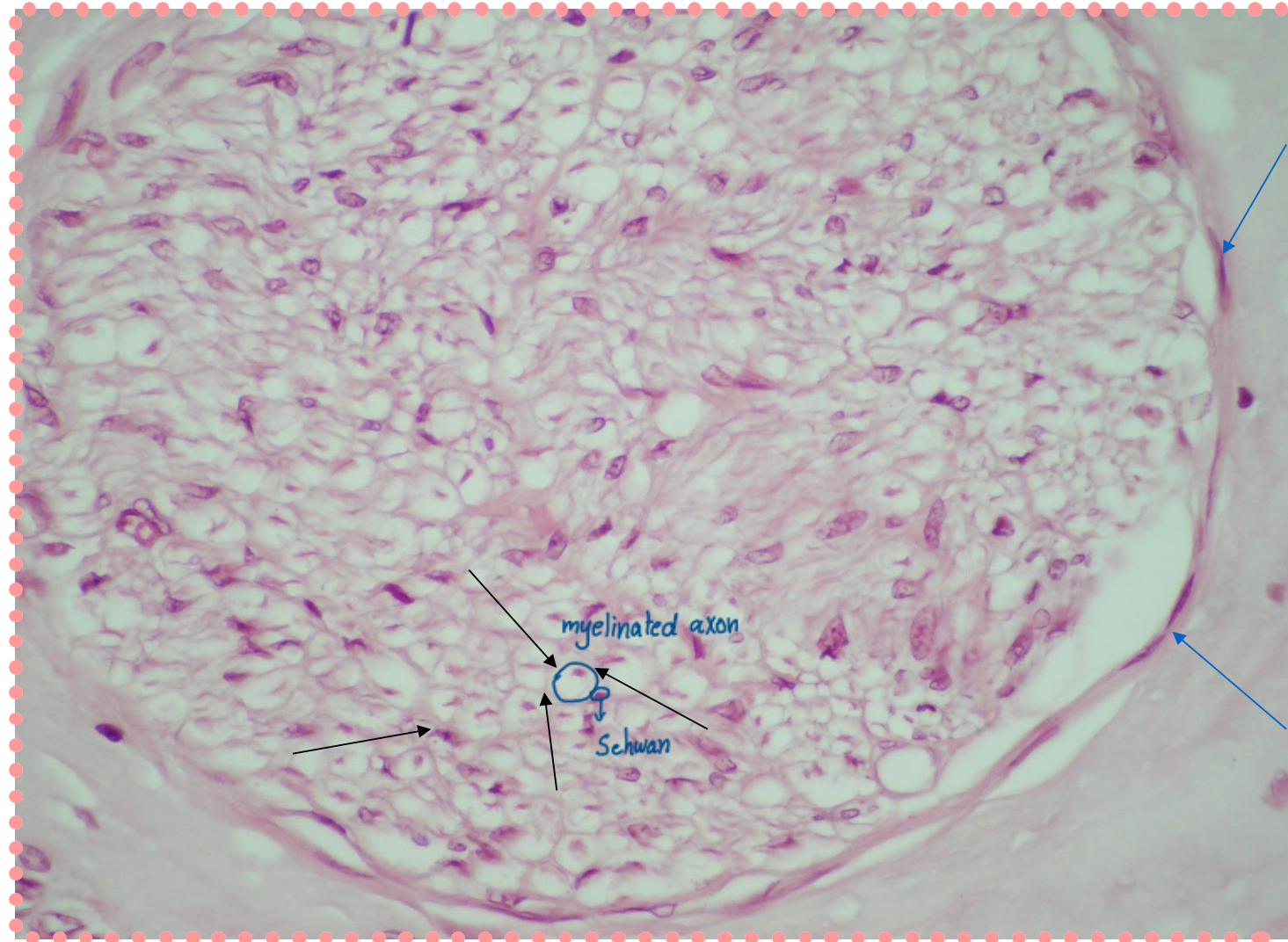
Most of the nuclei belong to Schwann cells.

The area of eosinophilia is what is left from the axon which is not empty it actually contain organelles, microtubules and filaments.

We can see the endoneurium here just right outside the axon.

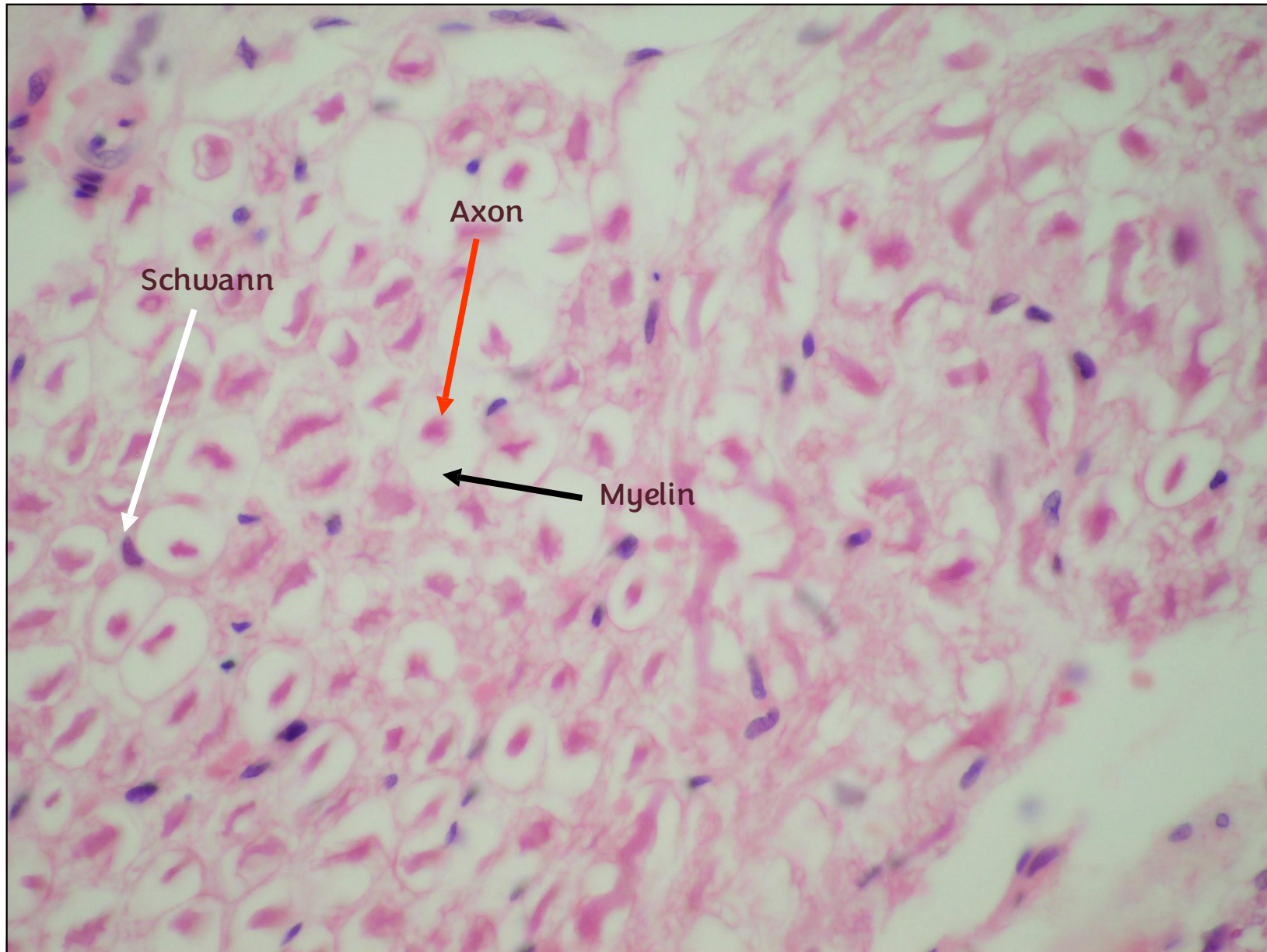


All of the nuclei are
for Schwann cells
unless we're sure
it's endothelial cell
for a blood vessel.



Perineurium(Fibroblasts)





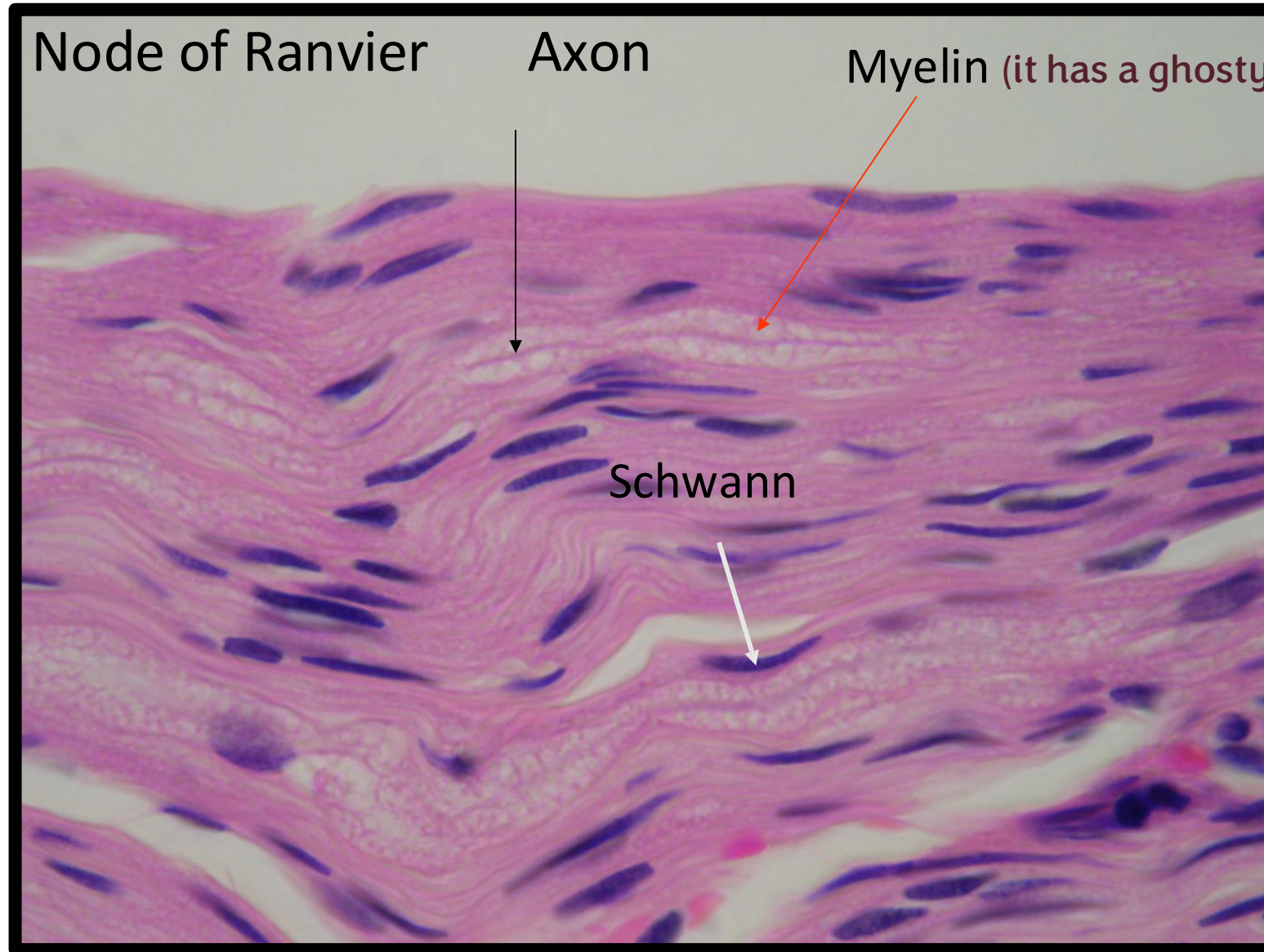
L.S. in nerve fibers

The difference here is the sectioning, all pervious sections were cross sections, but this one is longitudinal.

The eosinophilia is way more intense than before.

The spaces are way more than the streaks.

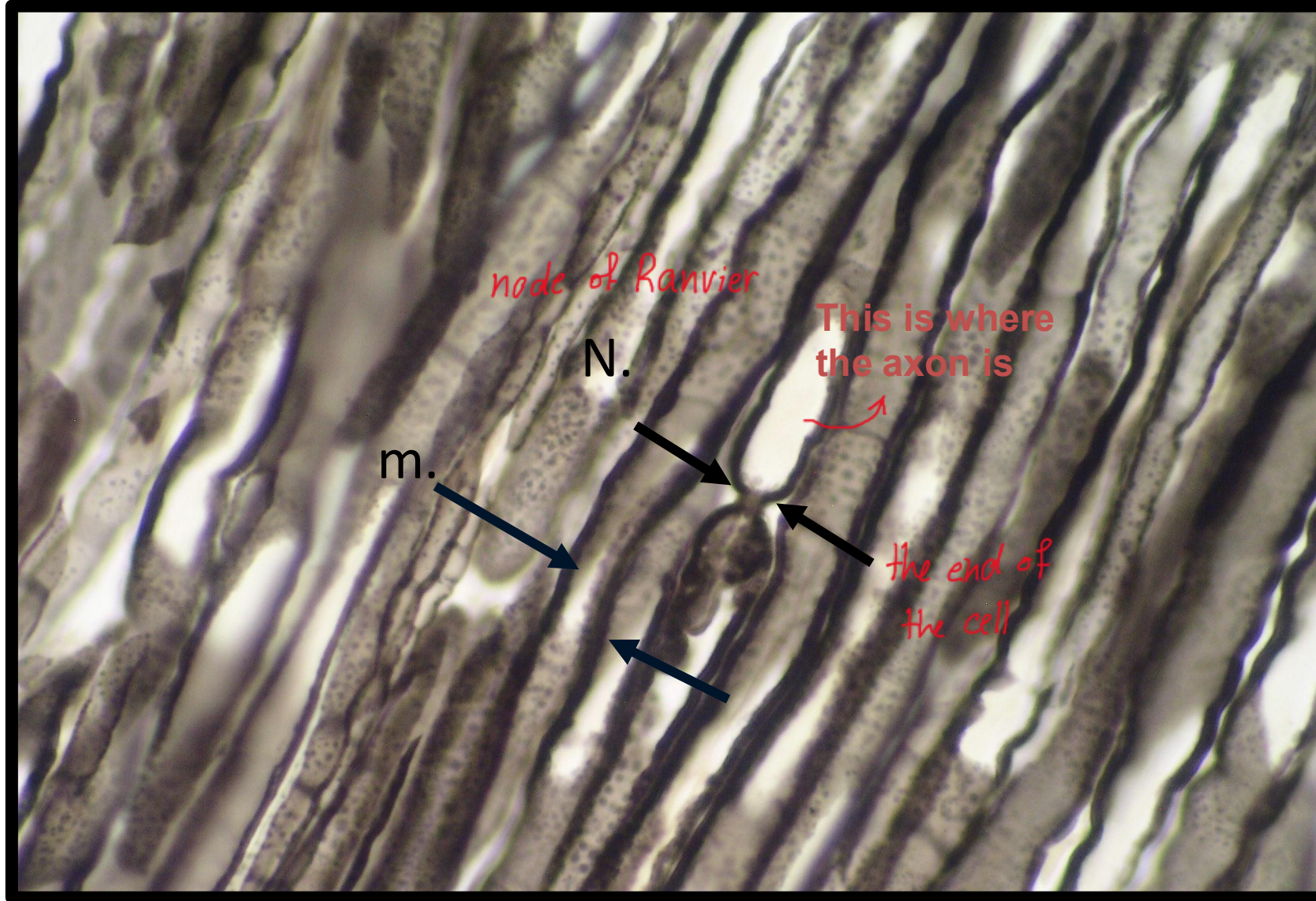
If the cross section passes through the white empty bubble, it will look like an empty space, but if it passes through the streaks, it will give a hazy pinkish look.



In a longitudinal section, the myelin sheath is not entirely white because the spaces are not completely empty; they contain protein remnants of the Schwann cell membrane that appear as pink streaks, representing the structural network left behind after the lipids have dissolved.



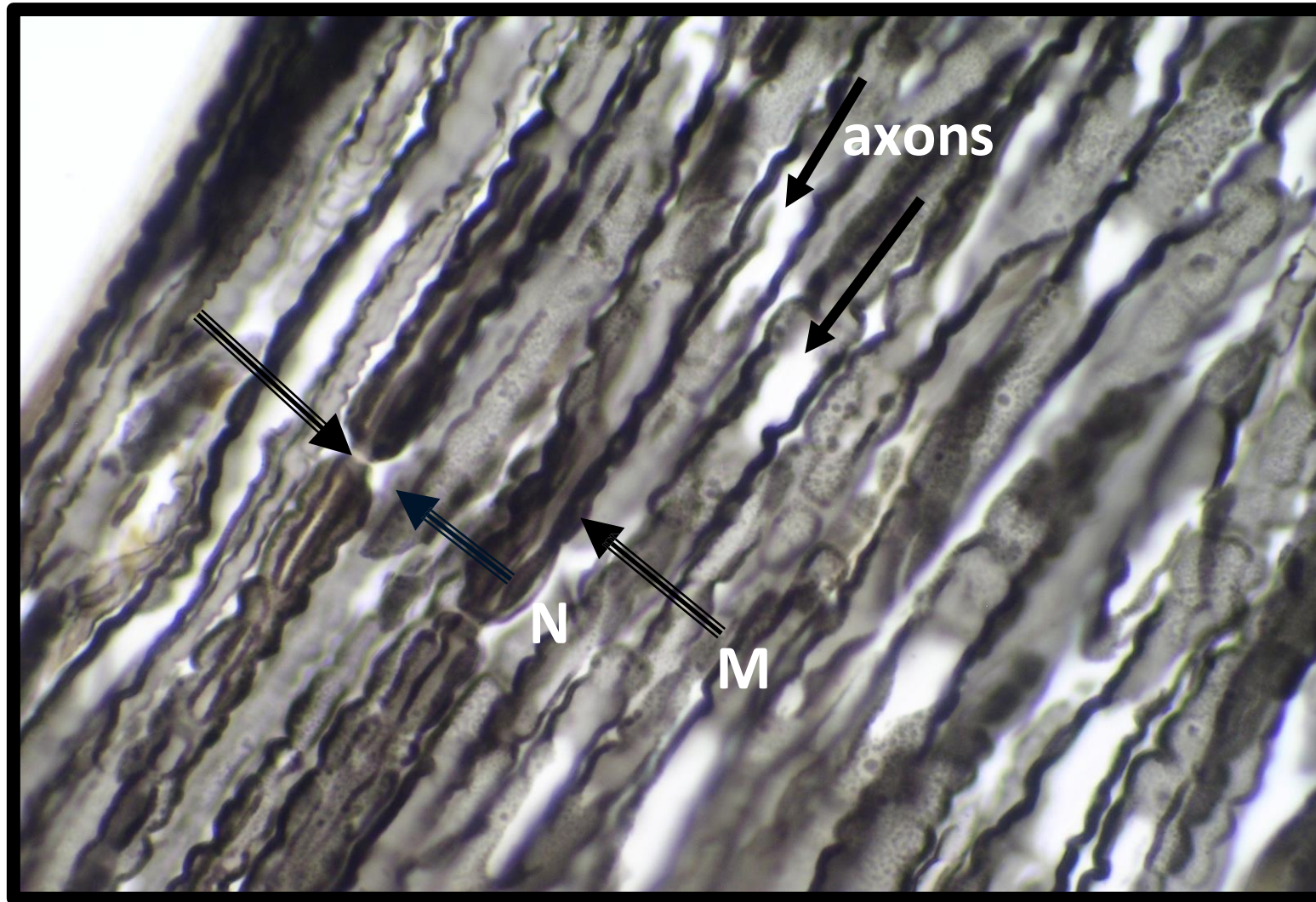
L.S. in nerve fibers (osmium tetroxide) myelin- Node of Ranvier



This is a special type of staining that deposits in the myelin and when looking in the picture, we can see the thickness of the myelin. The gray, white or black areas are a result of the sectioning.

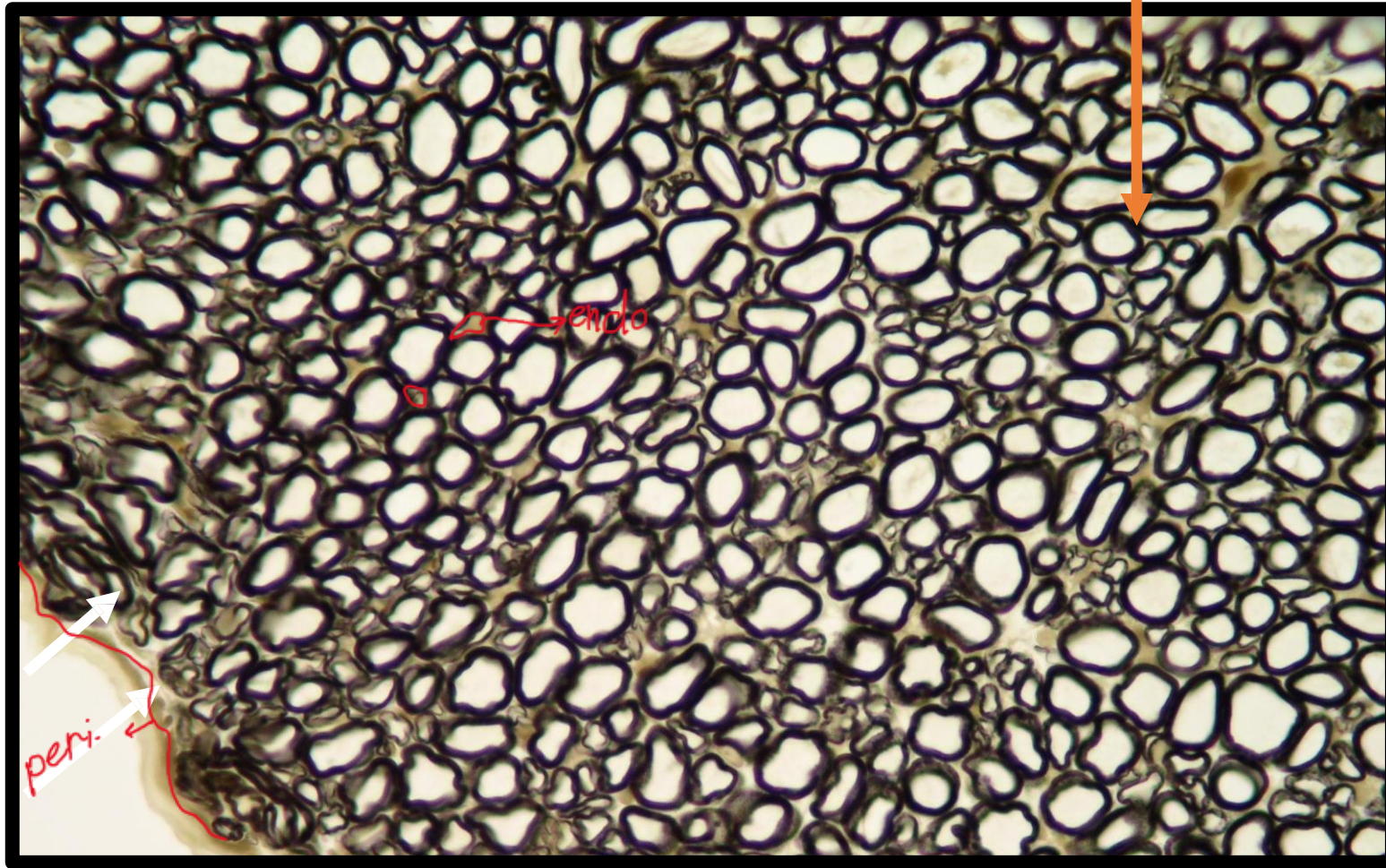


Axon cylinder



T.s.in nerve fibers

endoneurium perineurium



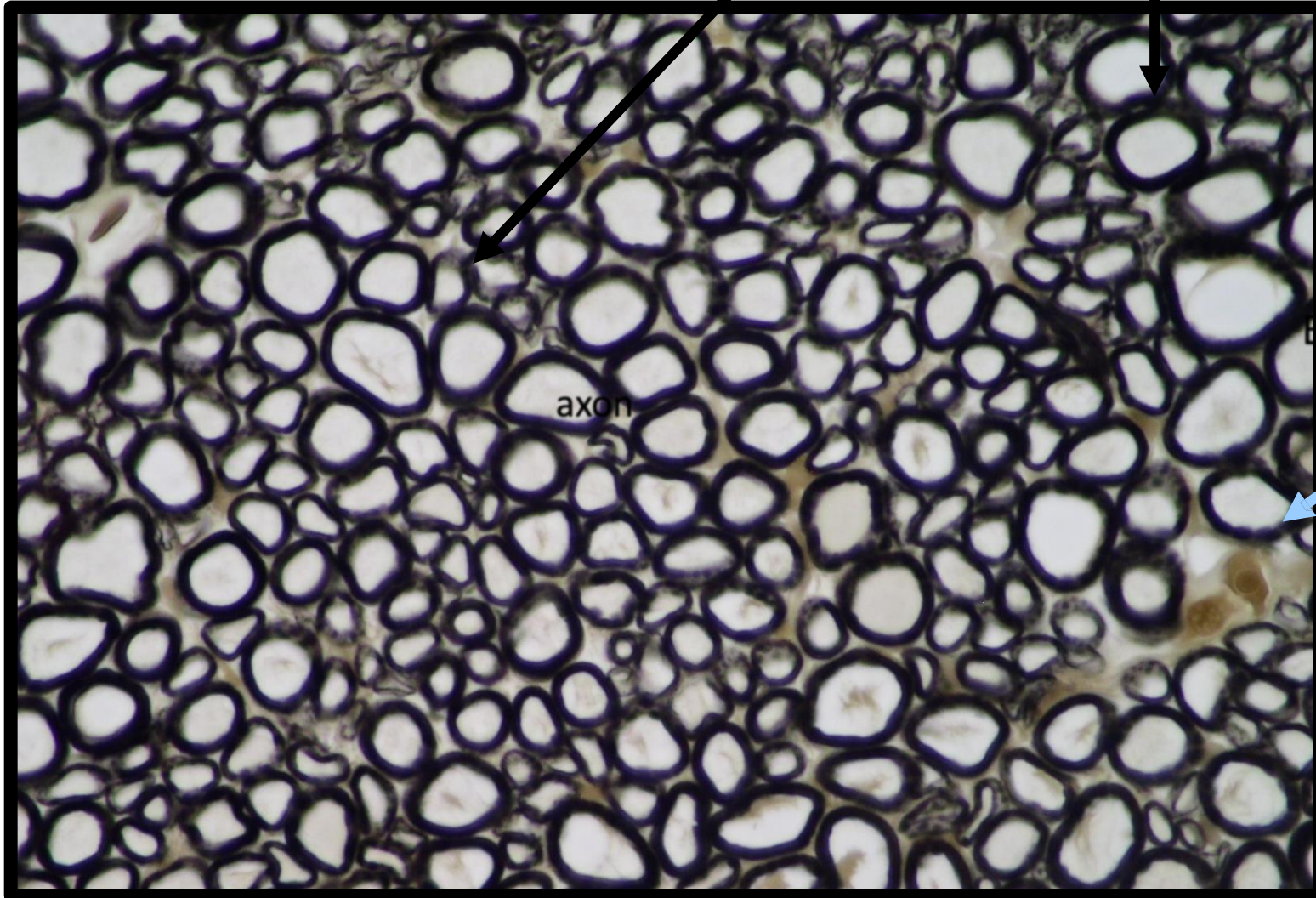
This is actually a cross-section so we can easily determine the level of myelination and the size of axon. We can see variation and lumen size because of the axon, and variation in the thickness of the black ribbon because of the variation of the level of my myelination (this is actually determined by the type of fiber)

Larger ones and usually heavily myelinated



myelin

axon

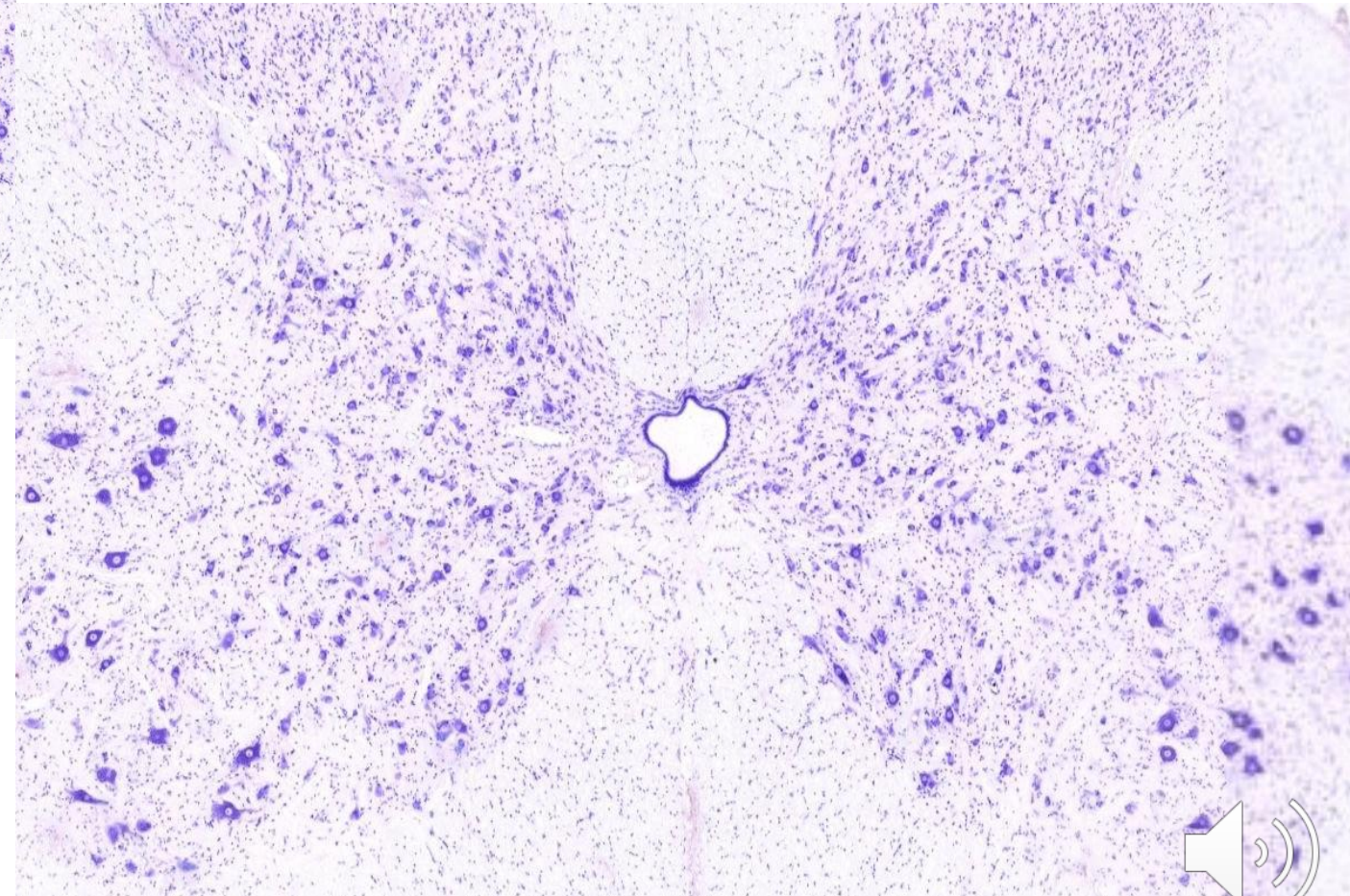
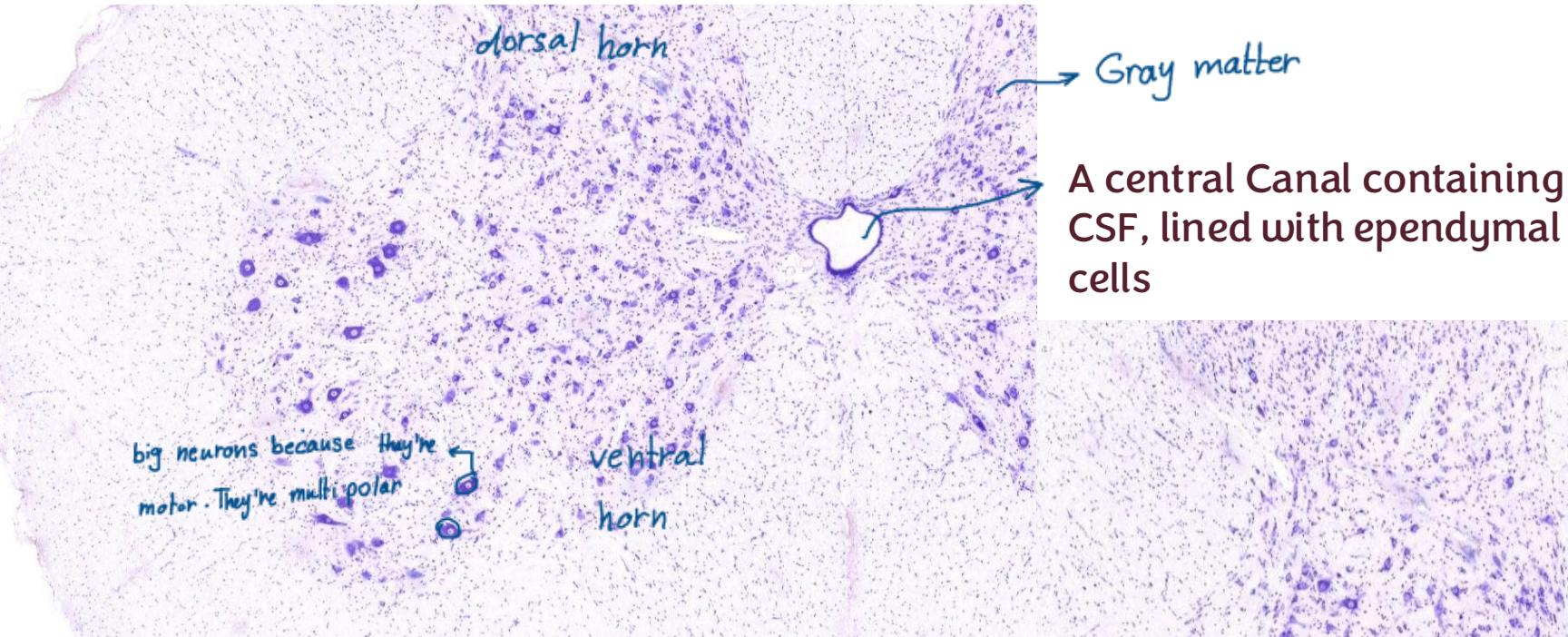


Endo-neurium

axon



Spinal cord



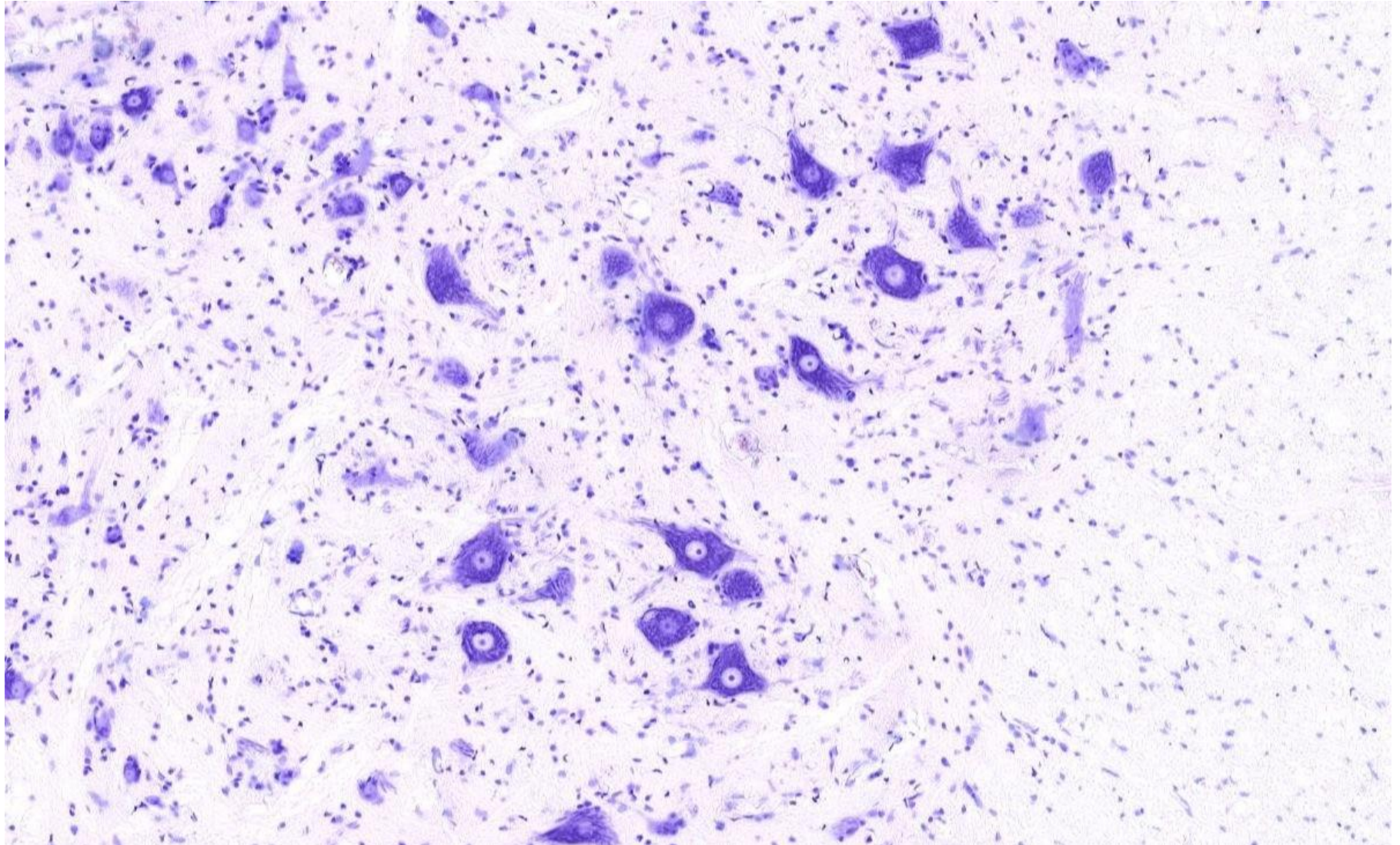
We can see darker and lighter areas, and this is due to the presence of neurons. We can recognize the nuclei, which is the light areas in the center of highly basophilic area even in this low magnified image.

The horns are more way complicated and they are divided into Laminae based on their function.

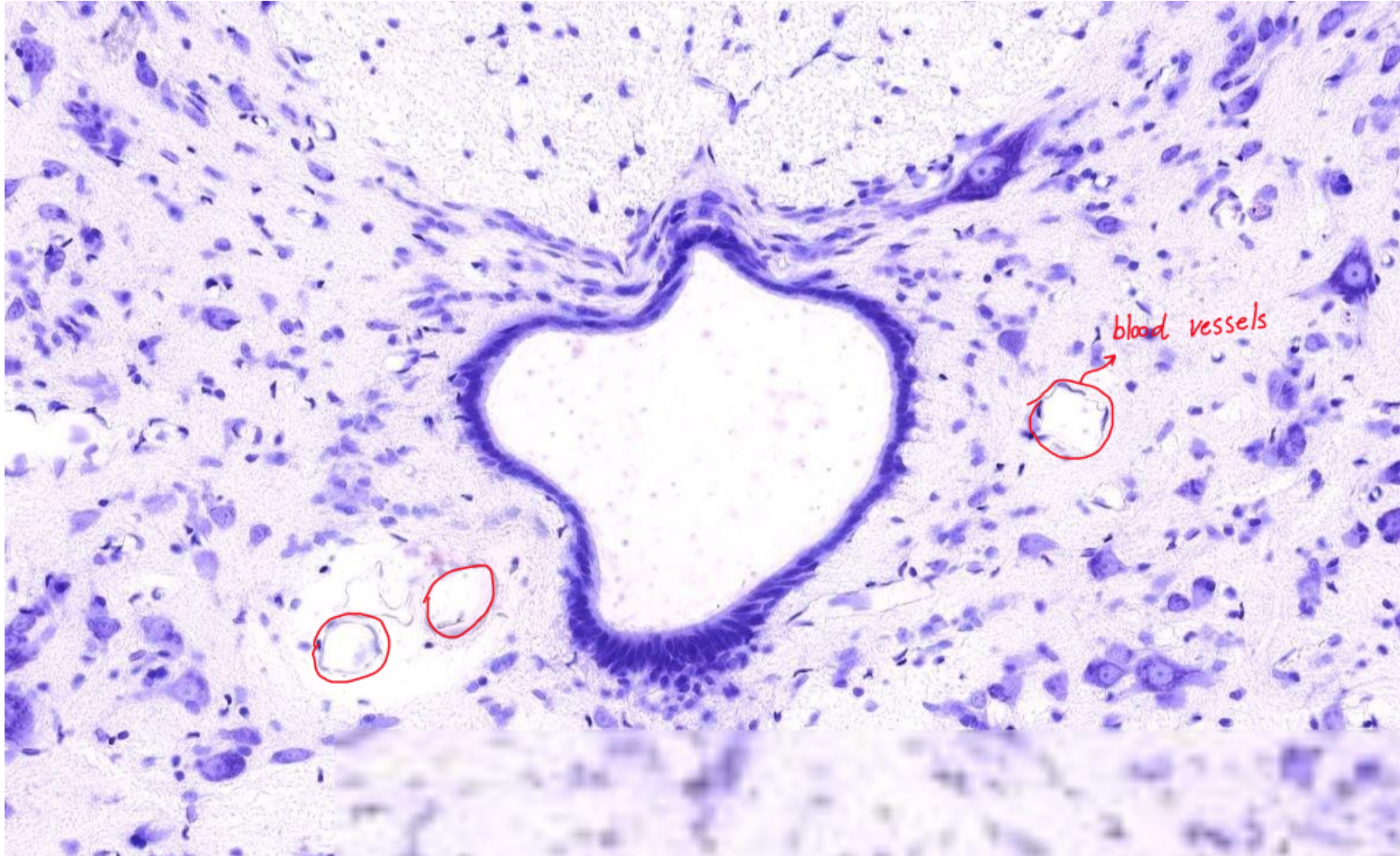


Anterior horns-spinal cord

I can find the
stem cells here
as well as
progenitor cells



Central canal-spinal cord



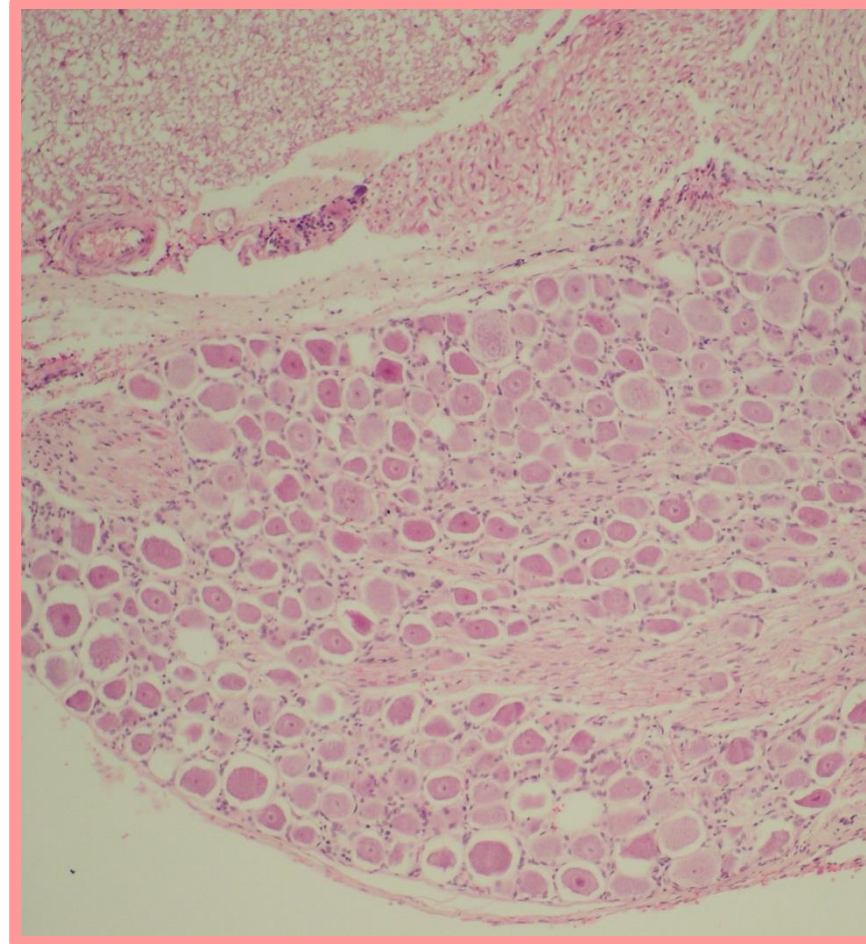
Spinal (dorsal) root ganglia

Spinal nerves are mixed (motor and sensory) so before the spinal nerve enters the spinal cord , motor and sensory will be separated .



spinal cord

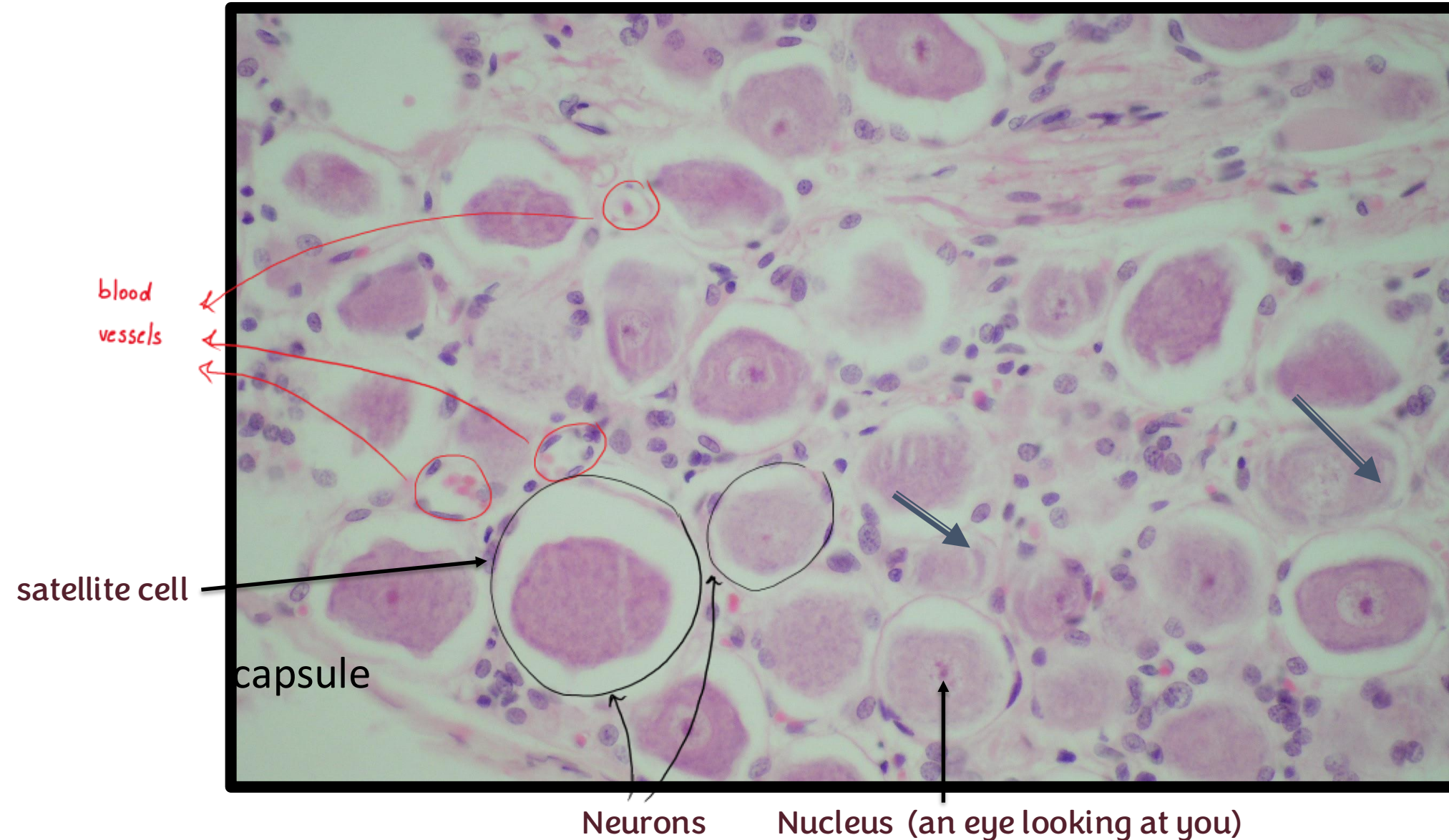
Neurons



The image on the right is high magnification, and the image on the left is dorsal root ganglion (contains body of sensory neurons). In sensation, I don't have just one neuron that works, in the ganglion this is the one that , peripherally we have we have sensory receptors that be excited (action potential). Sensory : toward the CNS , Motor : away from the CNS



Sensory ganglion. : neuronal cell bodies



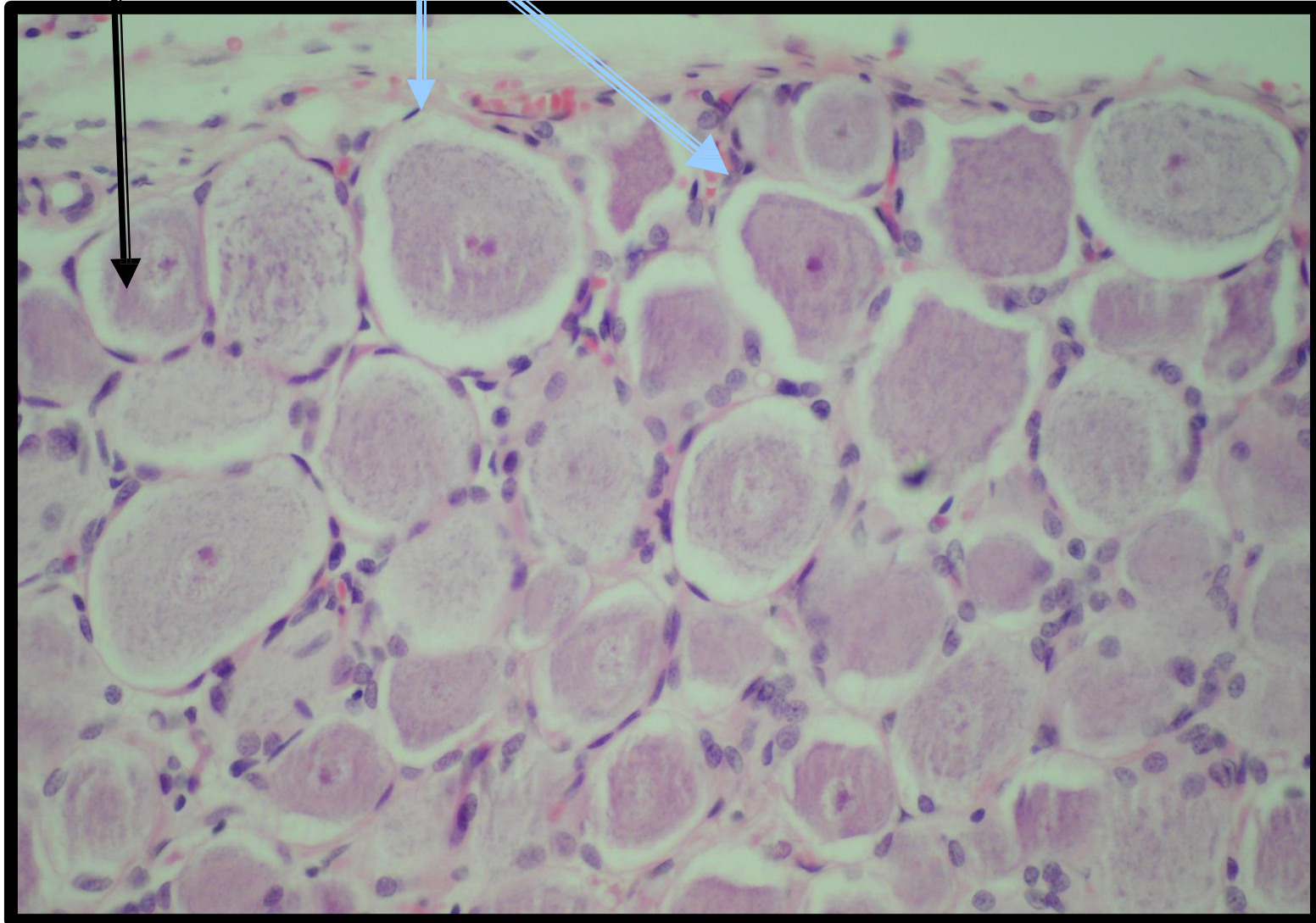
Rough and rounded : neurons with nucleus and a satellite surrounded and protected them (satellite cells of ganglia , the second member of the PNS)



cell bodies

satellite cells

Same as before

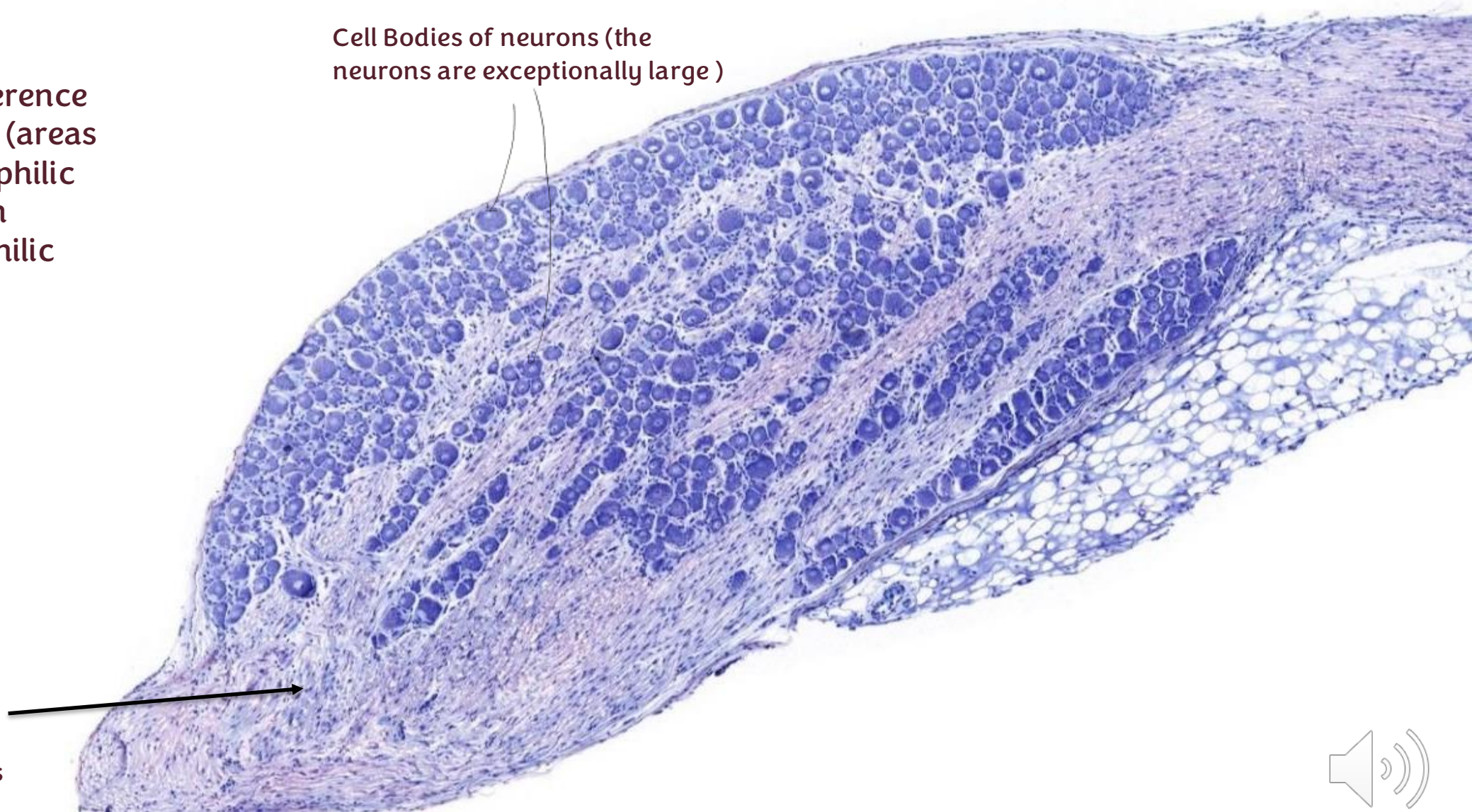


Dorsal root ganglia

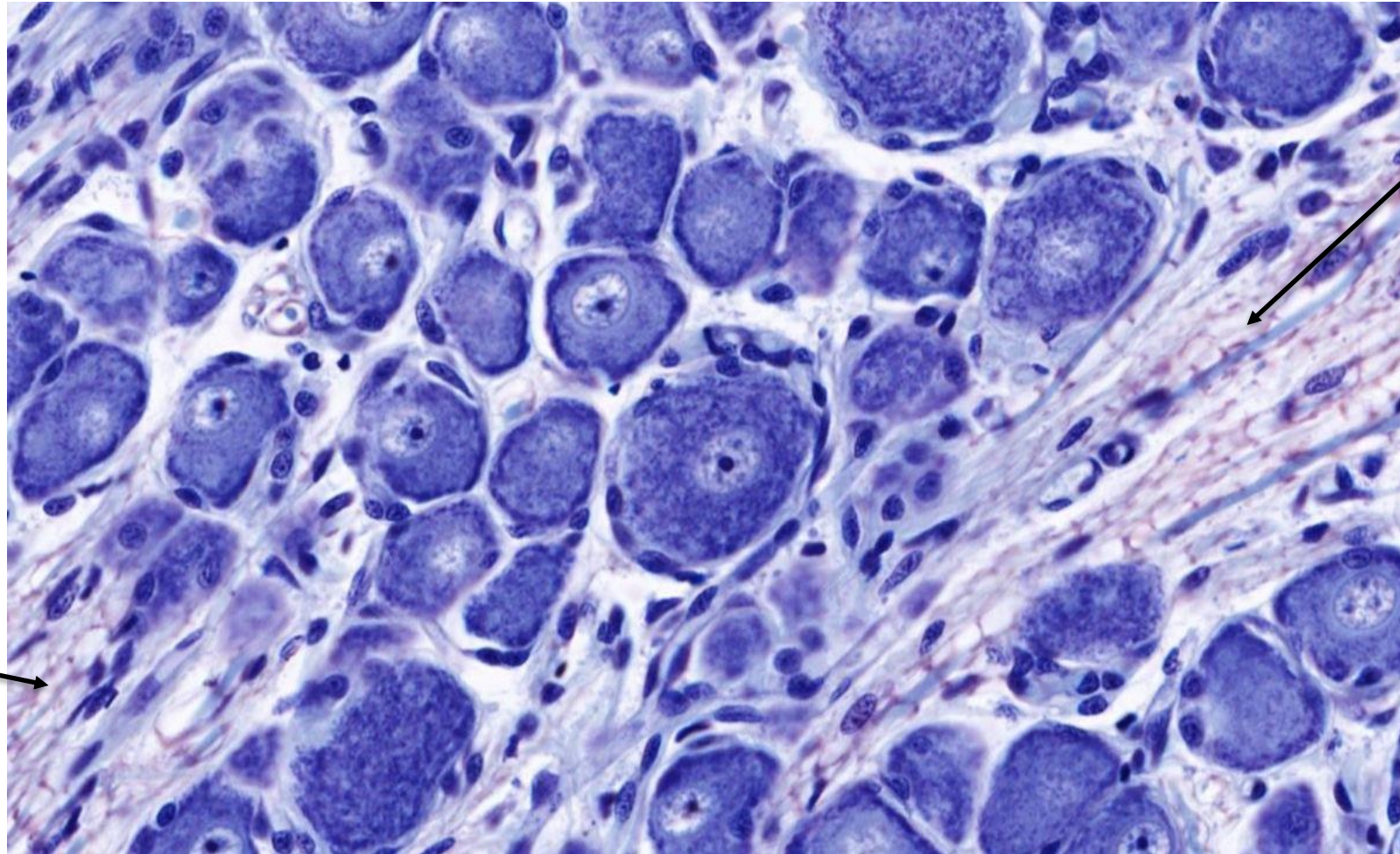
There is a difference in the staining (areas with less basophilic and areas with intense basophilic)

Cell Bodies of neurons (the neurons are exceptionally large)

This area has axons and nuclei of the schwann cells



Dorsal root ganglia



Axon with
nucleus of
schwann cell
(foamy
appearance)

Axon with
nucleus of
schwann cell
(foamy
appearance)

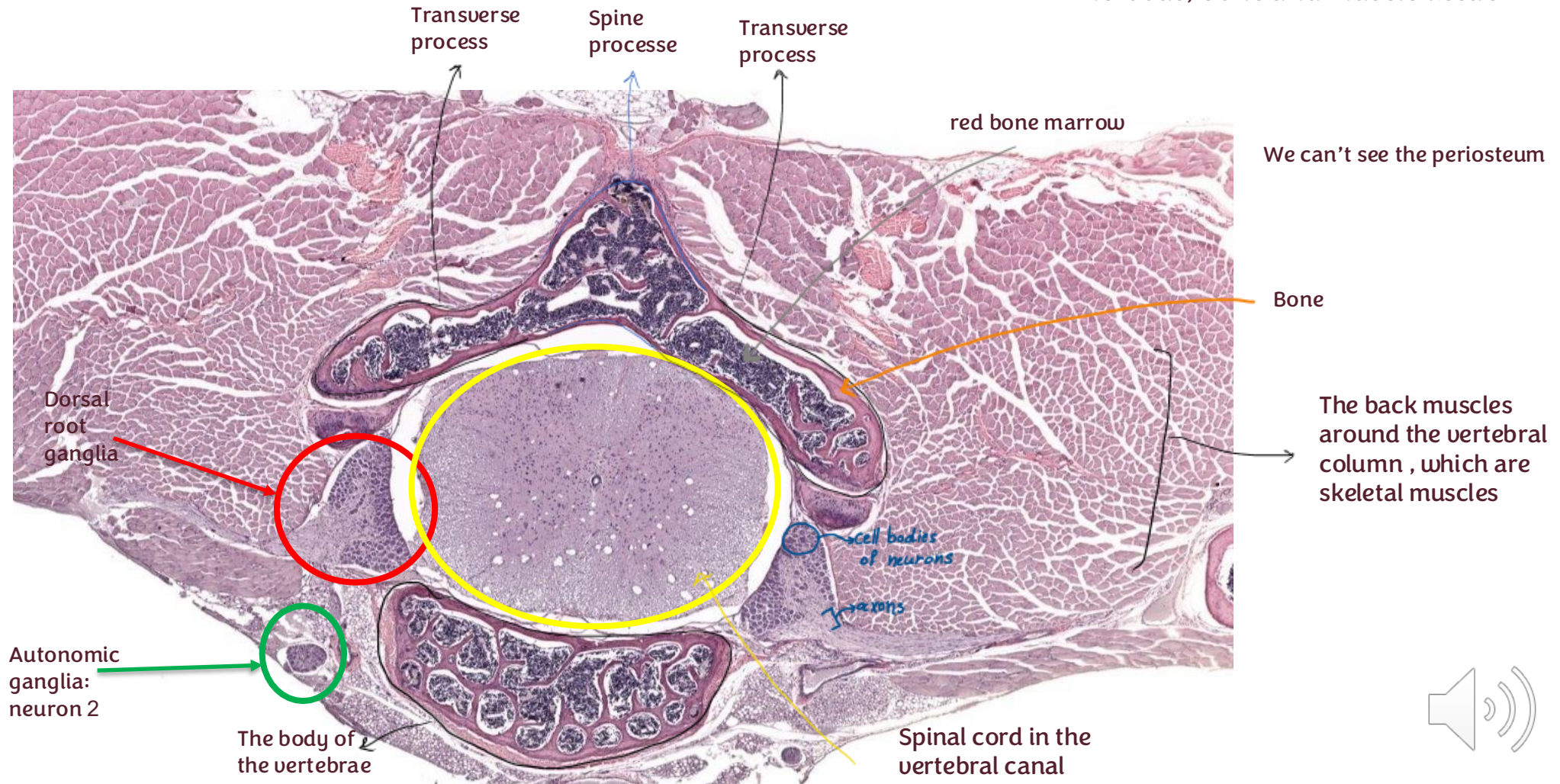


Spinal cord

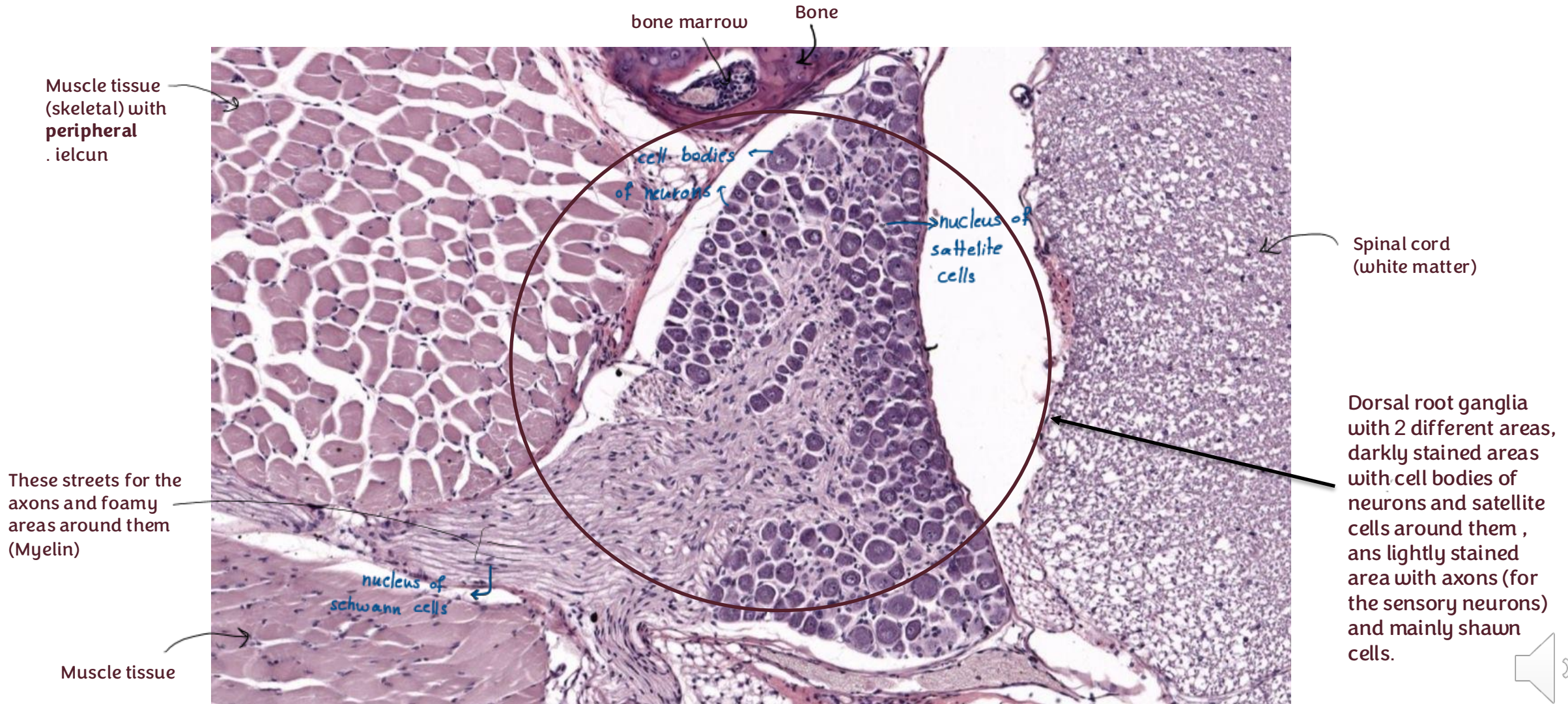
Transverse section with low magnification of spinal cord and part of vertebrae around it

There are 3 tissues in this images :
nervous, bone and muscle tissue

Autonomic system works in the background, the output not controlled consciously and divided into sympathetic and parasympathetic. This system works by 2 set of neurons or 2 order neurons, neuron 1 (preganglionic) the CNS (brain and spinal cord) and neuron 2 (postganglionic) is outside the CNS which means ganglia. Preganglionic doesn't work by itself so it need an order from a higher center to turn on then send a neuronal impulse to the postganglionic which the one will synapse with the organs and deliver the neuronal impulse system.

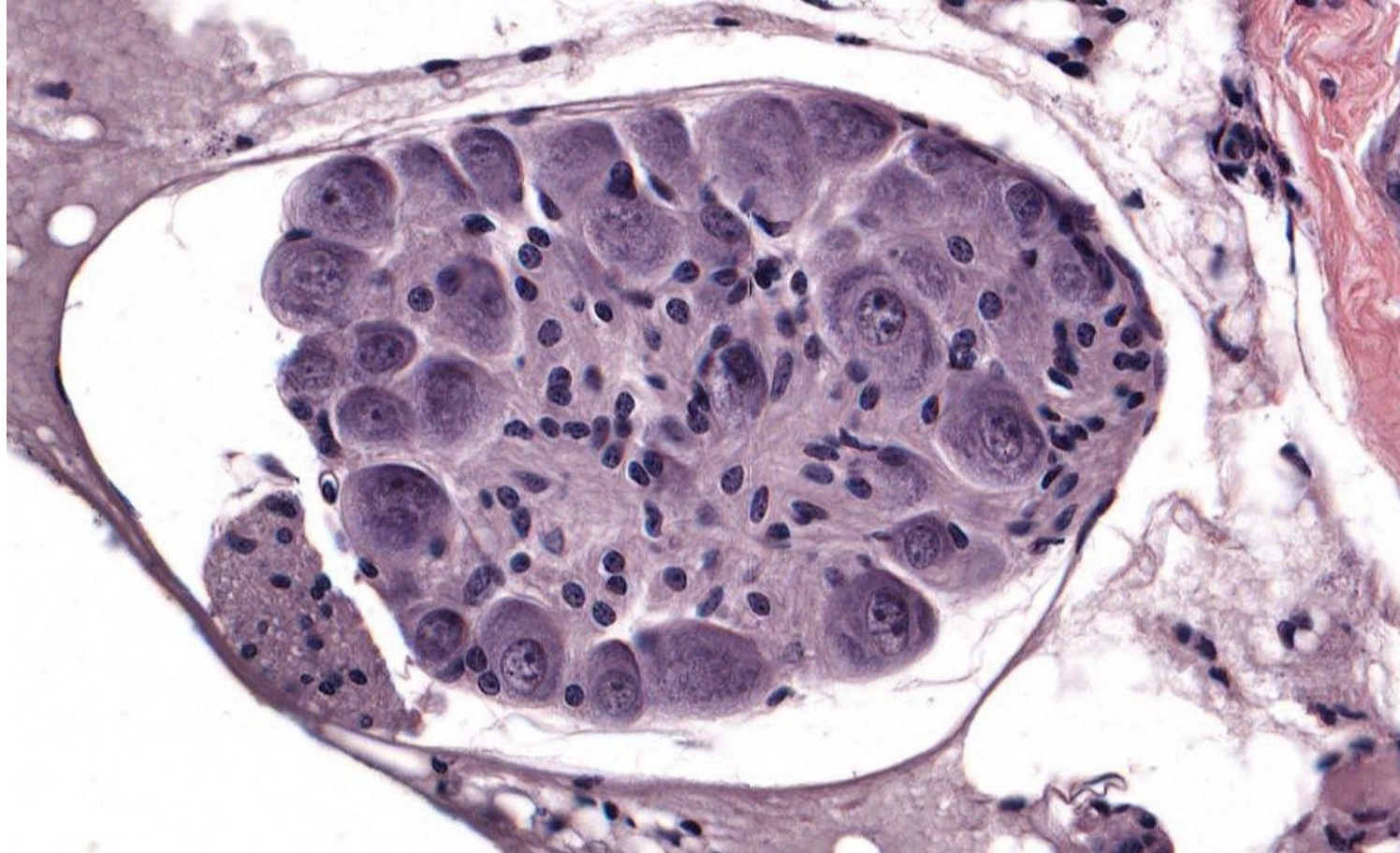


Dorsal root ganglia



Autonomic ganglia

All of them are neuron 2 (postganglionic) , located parallel to the spinal cord and usually for the sympathetic



Test your study.... GOOD LUCK

<https://gemini.google.com/share/ff4a5c4eb1a1>

For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide 6 (the location of axon)	The location of the axon was incorrect	Deleted
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

Reference Used:
(numbered in order as cited in the text)

1. Dr.Ghada's slides
2. Dr.Ghada's recorded lectures

"يَرْفَعُ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ
وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ"
[المجادلة: 11]

ولقد يَنَالُكَ فِي الطَّرِيقِ مَشَقَّةٌ ... لَكِنَّ أَسْقَامَ الْجَهَالَةِ
أَوْجَعُ

Study well for finals :-)