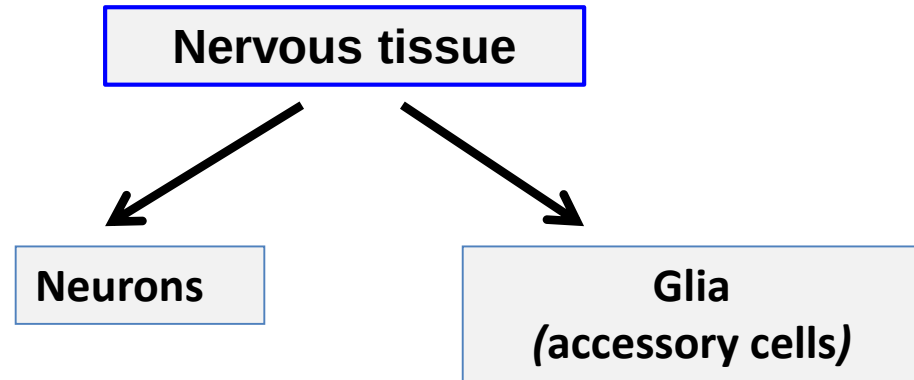
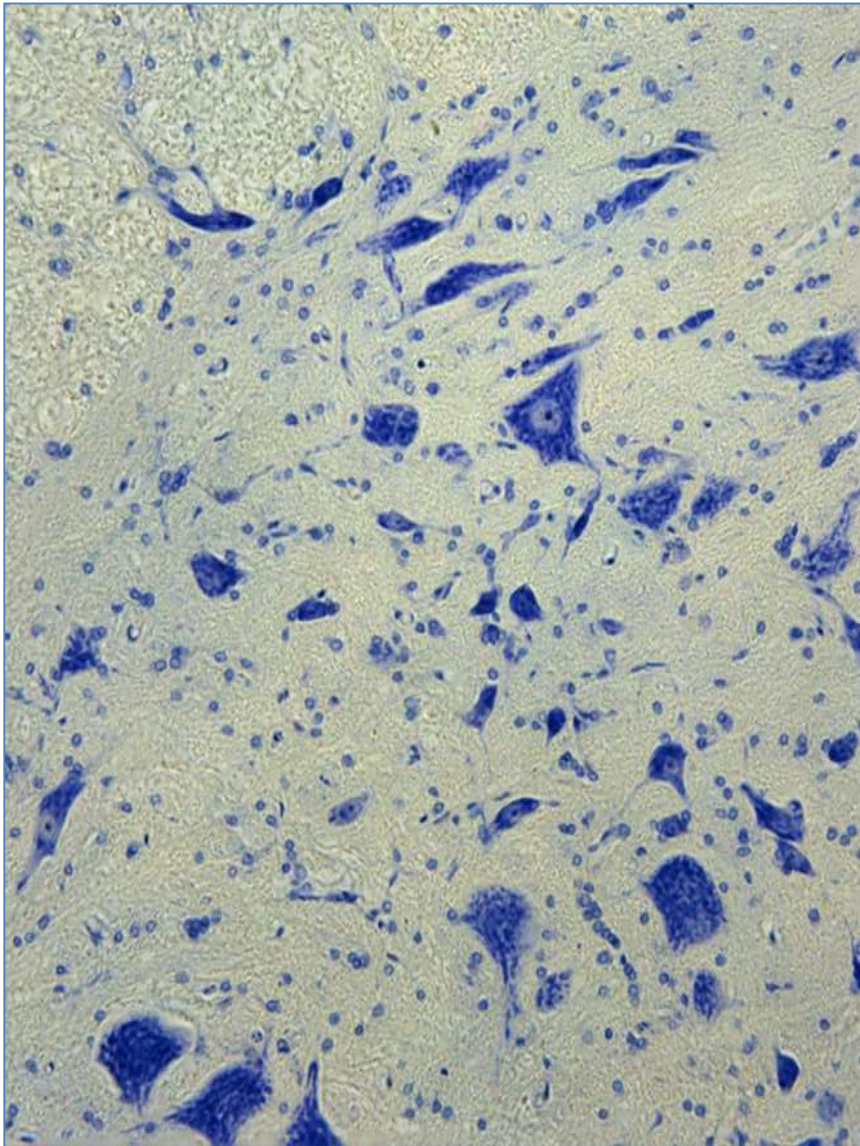


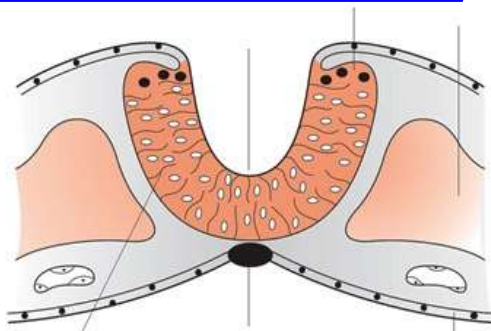
NERVOUS TISSUE

*Department of Histology, Embryology, and Cytology
of the General Medicine Faculty, RNMR*

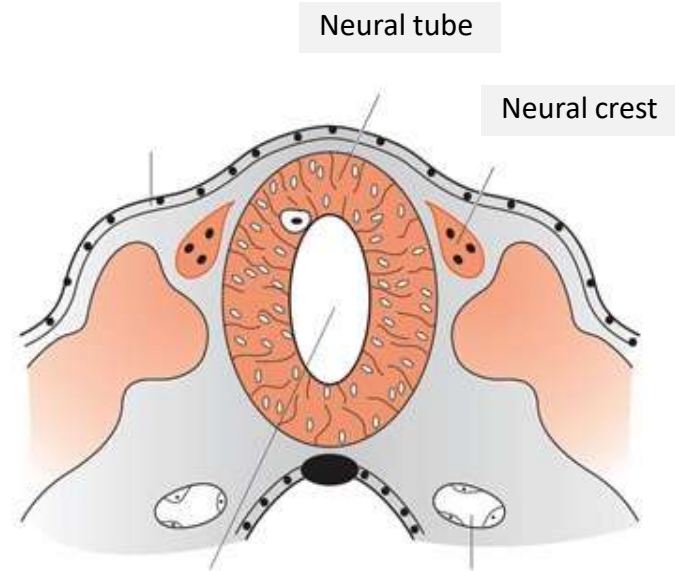


NEURONS – static cell population
GLIA – stable cell population

HISTOGENESIS OF NERVE TISSUE



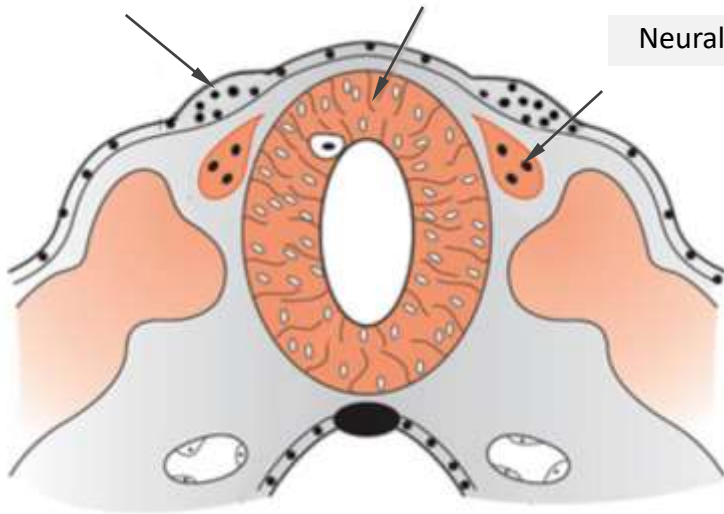
18 day – neural plate
20 day – neural groove
21 day – beginning of neural tube formation



neuroectodermal
placodes

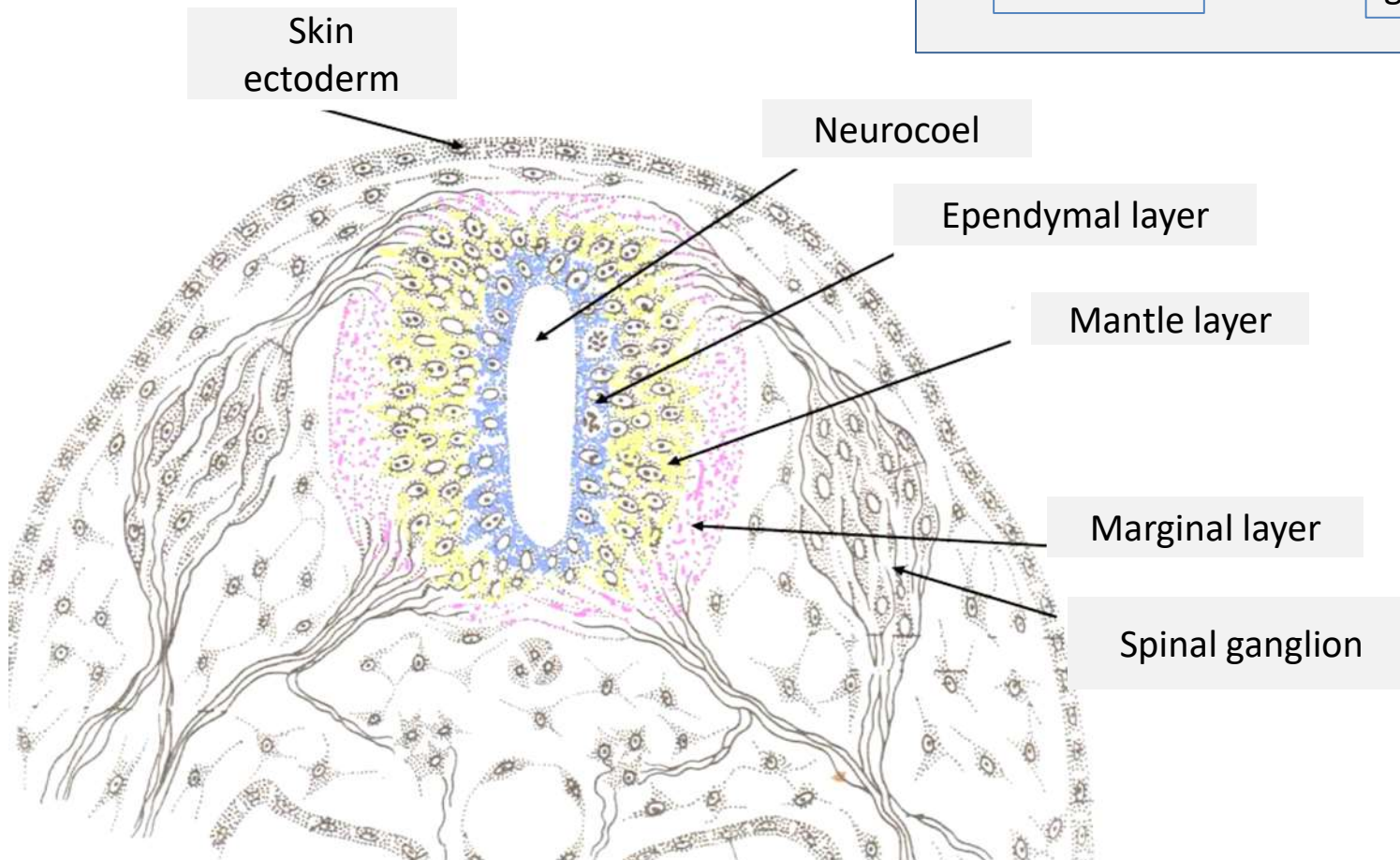
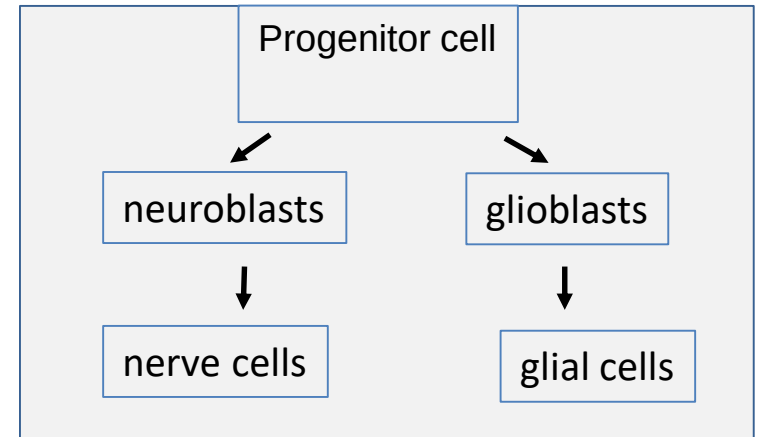
Neural tube

Neural crest



- ✓ From **neural tube** – neurons and glia of CNS
- ✓ From **neural crest** – neurons and glia of PNS (autonomic and sensory ganglia), sensory cells, pia mater and arachnoid mater of brain)
- ✓ From **ectodermal placodes** – ganglia of cranial nerves III, VII, IX, X

HISTOGENESIS OF NERVE TISSUE



DEVELOPMENT OF NERVOUS TISSUE

LAYERS OF THE NEURAL TUBE

CELLULAR MECHANISMS

EPENDYMAL LAYER

PROLIFERATION

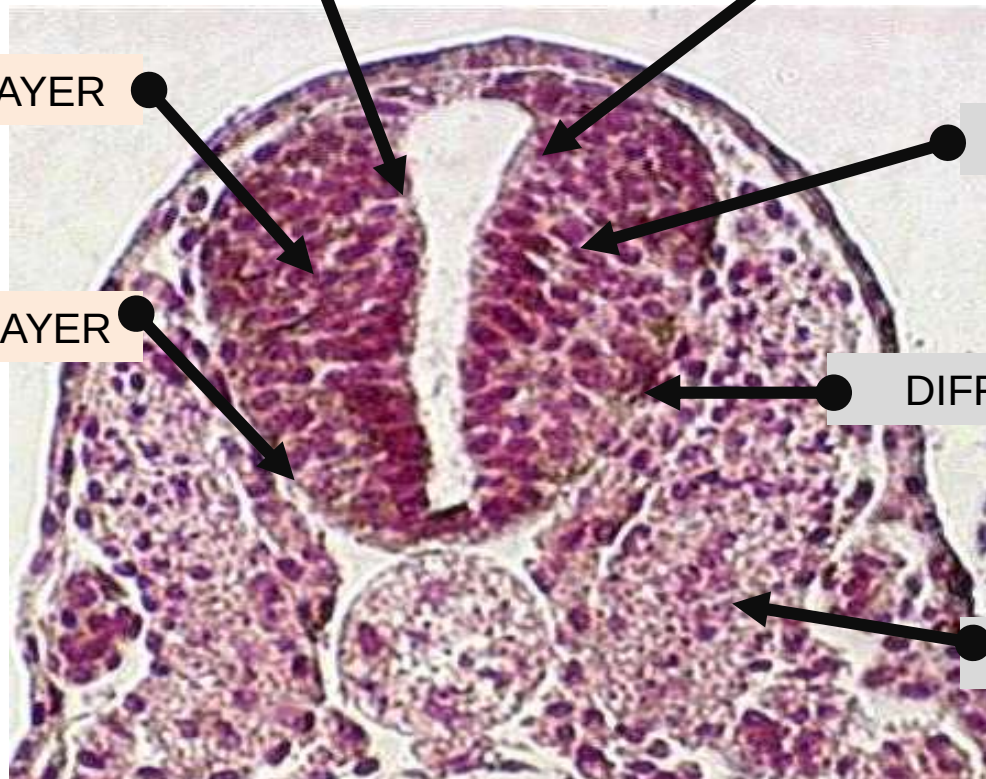
MANTLE LAYER

MIGRATION

MARGINAL LAYER

DIFFERENTIATION

APOPTOSIS



TYPES OF NEURONS

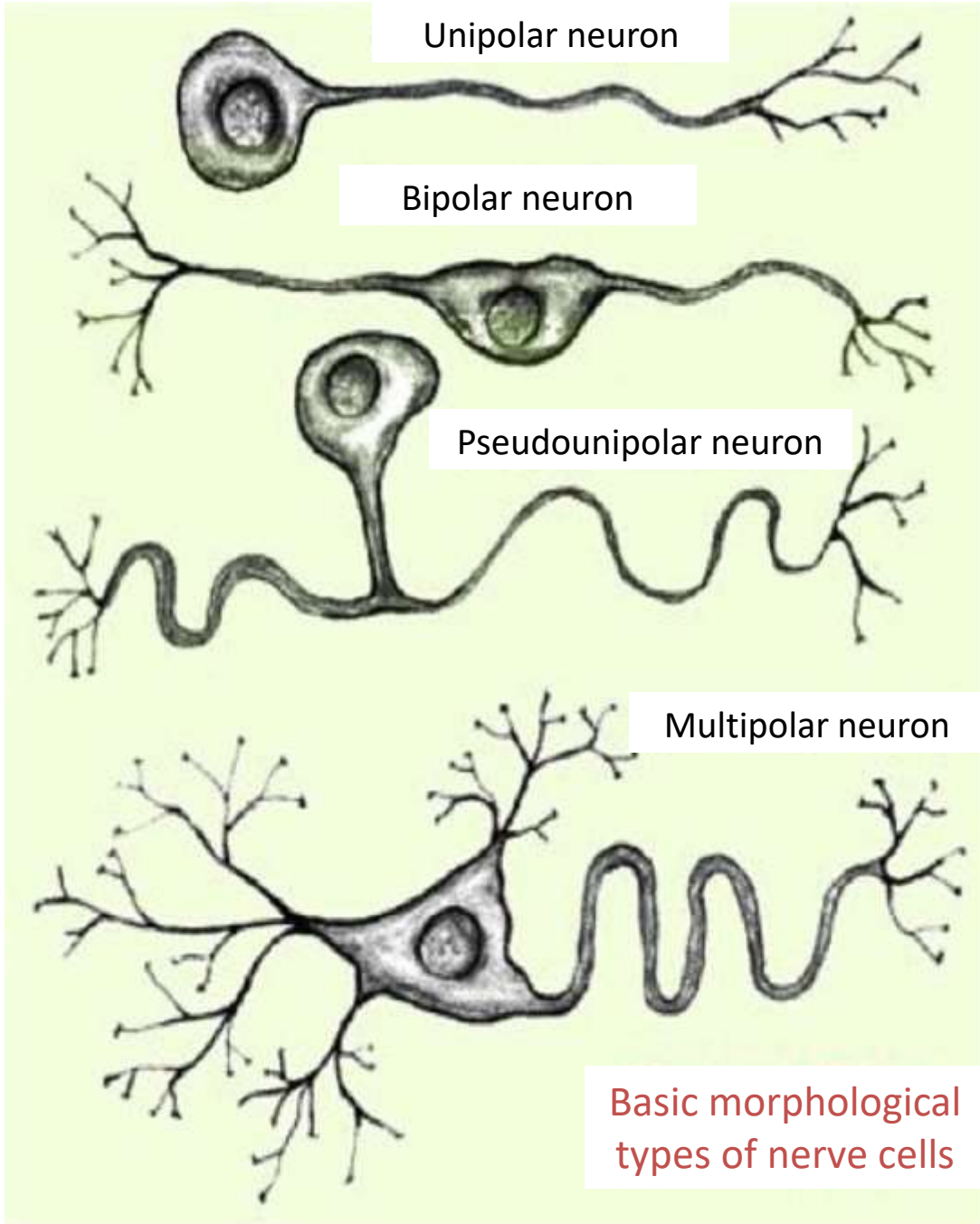
Unipolar neuron

Bipolar neuron

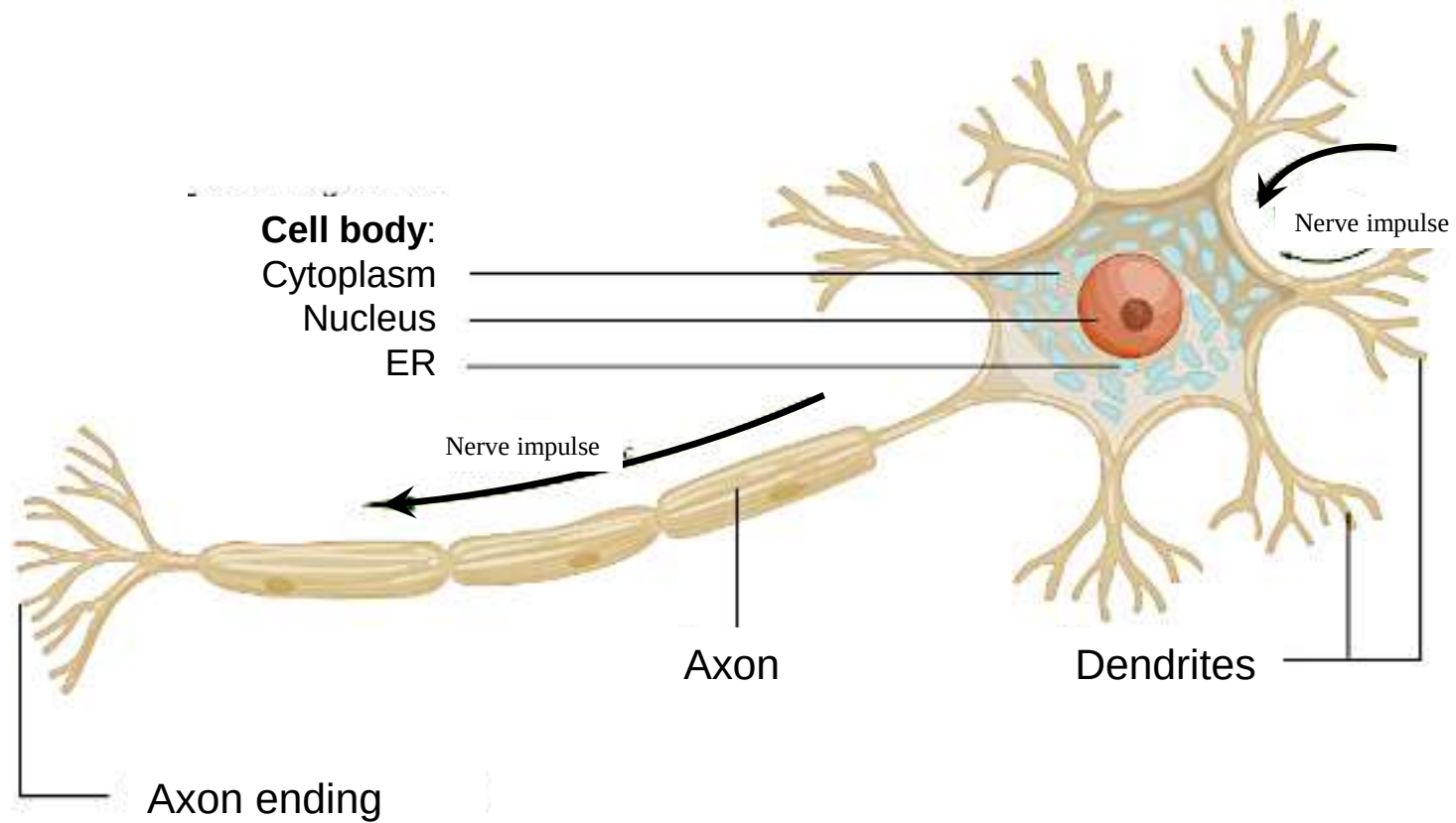
Pseudounipolar neuron

Multipolar neuron

Basic morphological
types of nerve cells

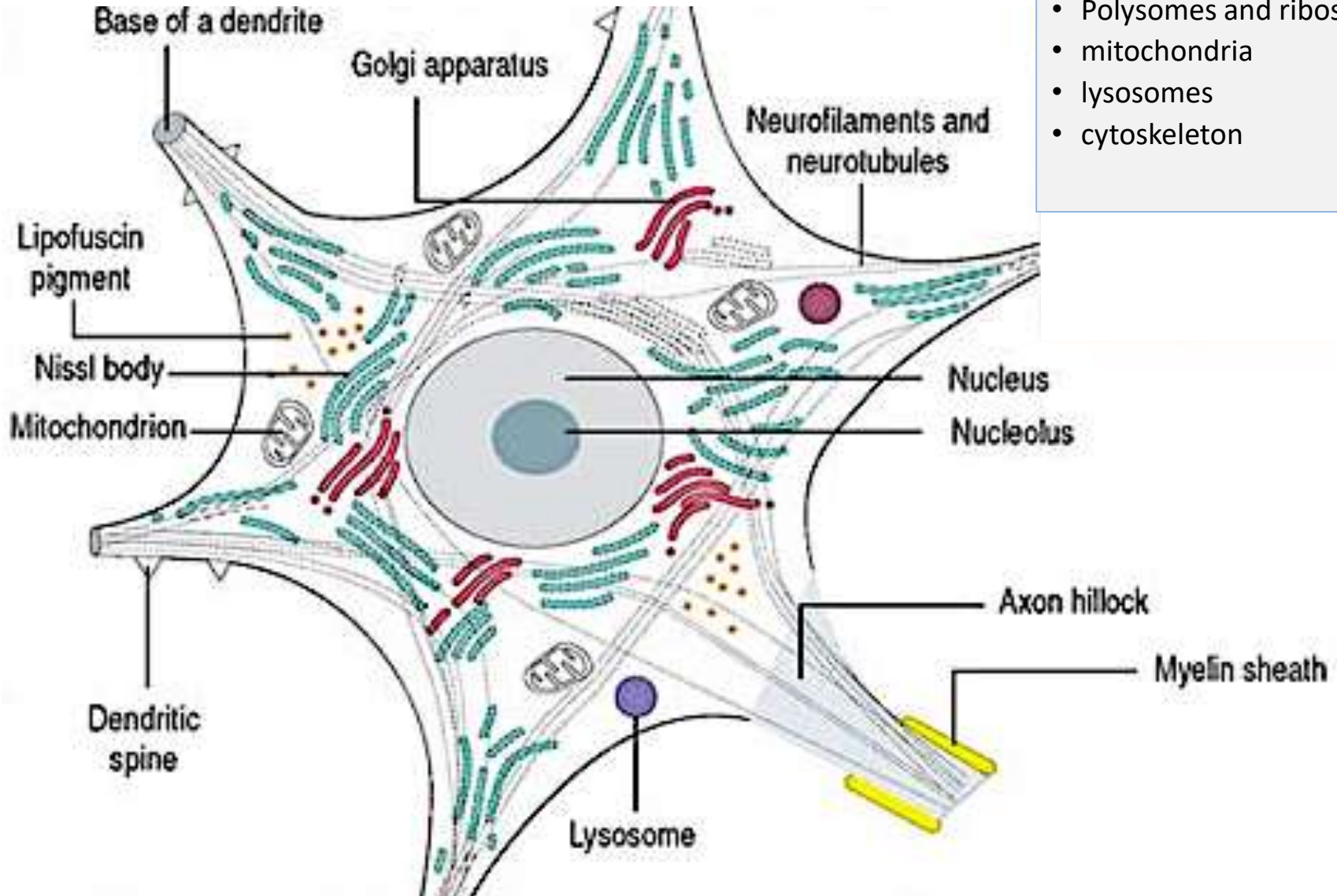


NEURON STRUCTURE



Neurons – static cell population

NEURON STRUCTURE

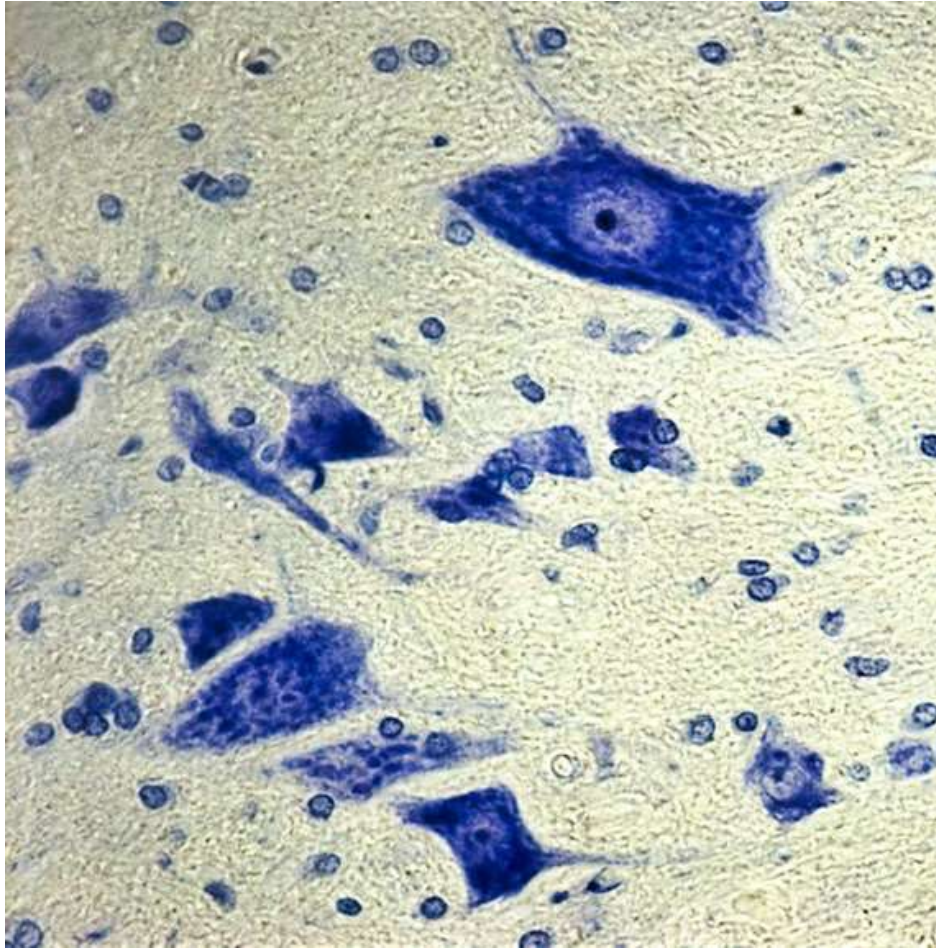


Cell body:

- Nucleus
- Golgi apparatus
- Granular ER
- Polysomes and ribosomes
- mitochondria
- lysosomes
- cytoskeleton

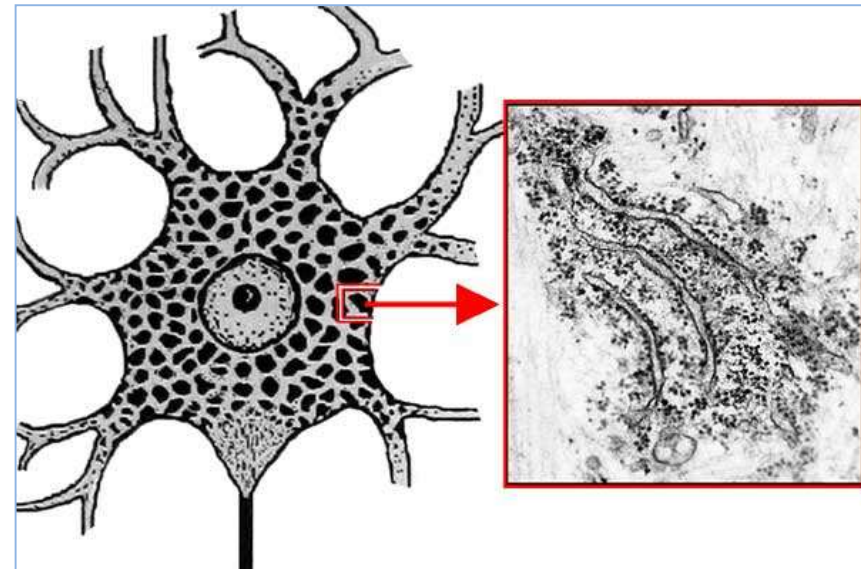
NEURON STRUCTURE

Nissl stain



Nissl bodies -

complex of well developed granular endoplasmic reticulum, polyribosomes and free ribosomes



Synapse

Glia

Nissl body

Golgi apparatus

Synapse

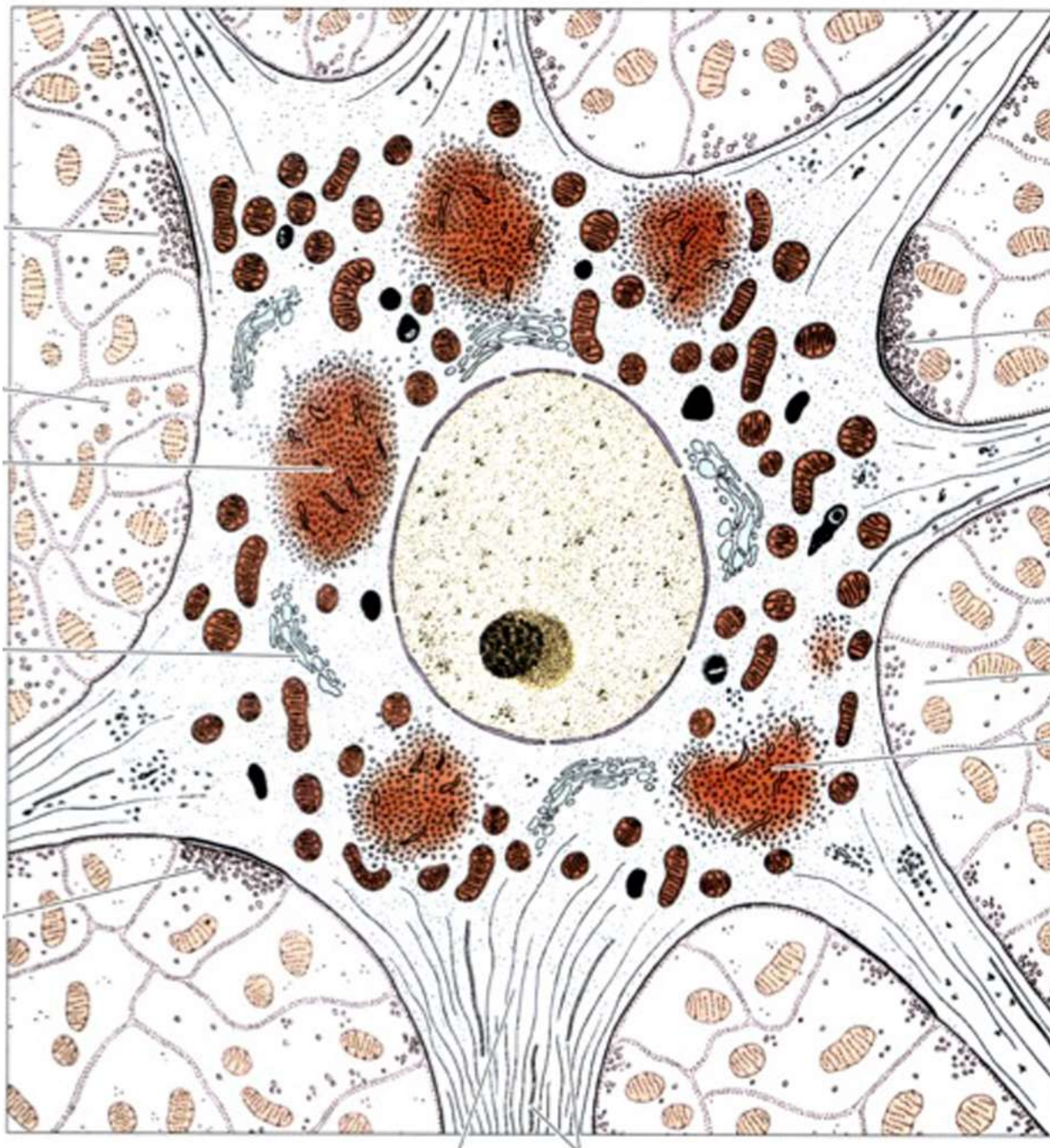
Synapse

Glia

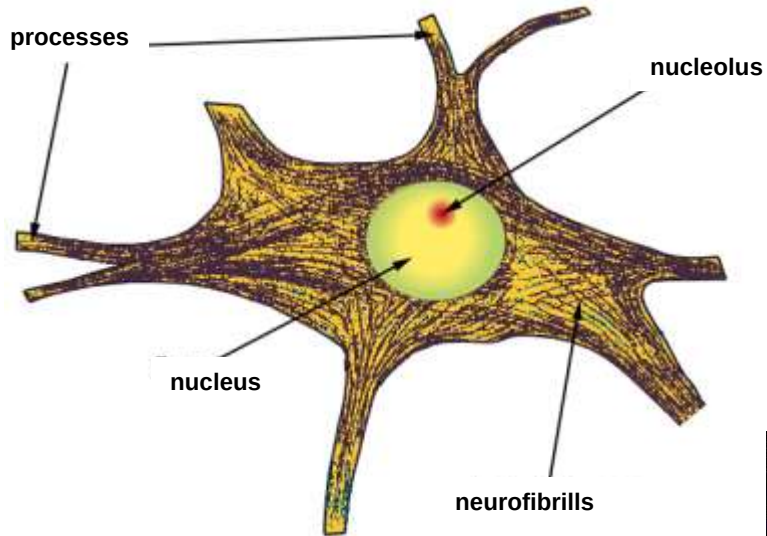
Nissl body

Axon hillock

Microtubules



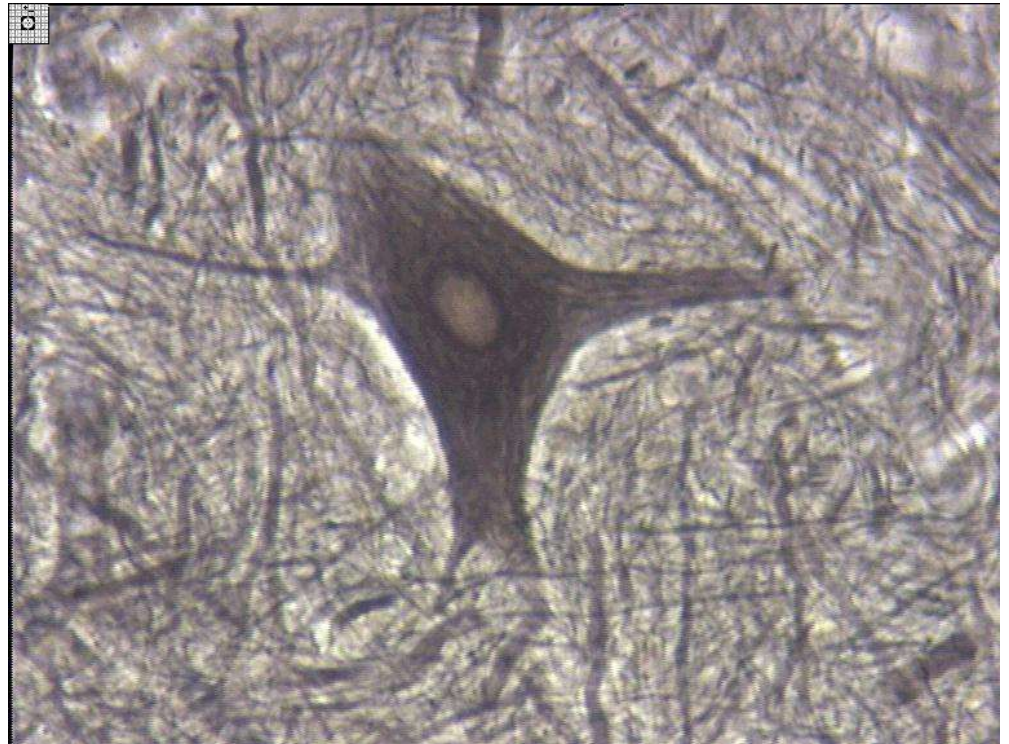
SILVER STAIN



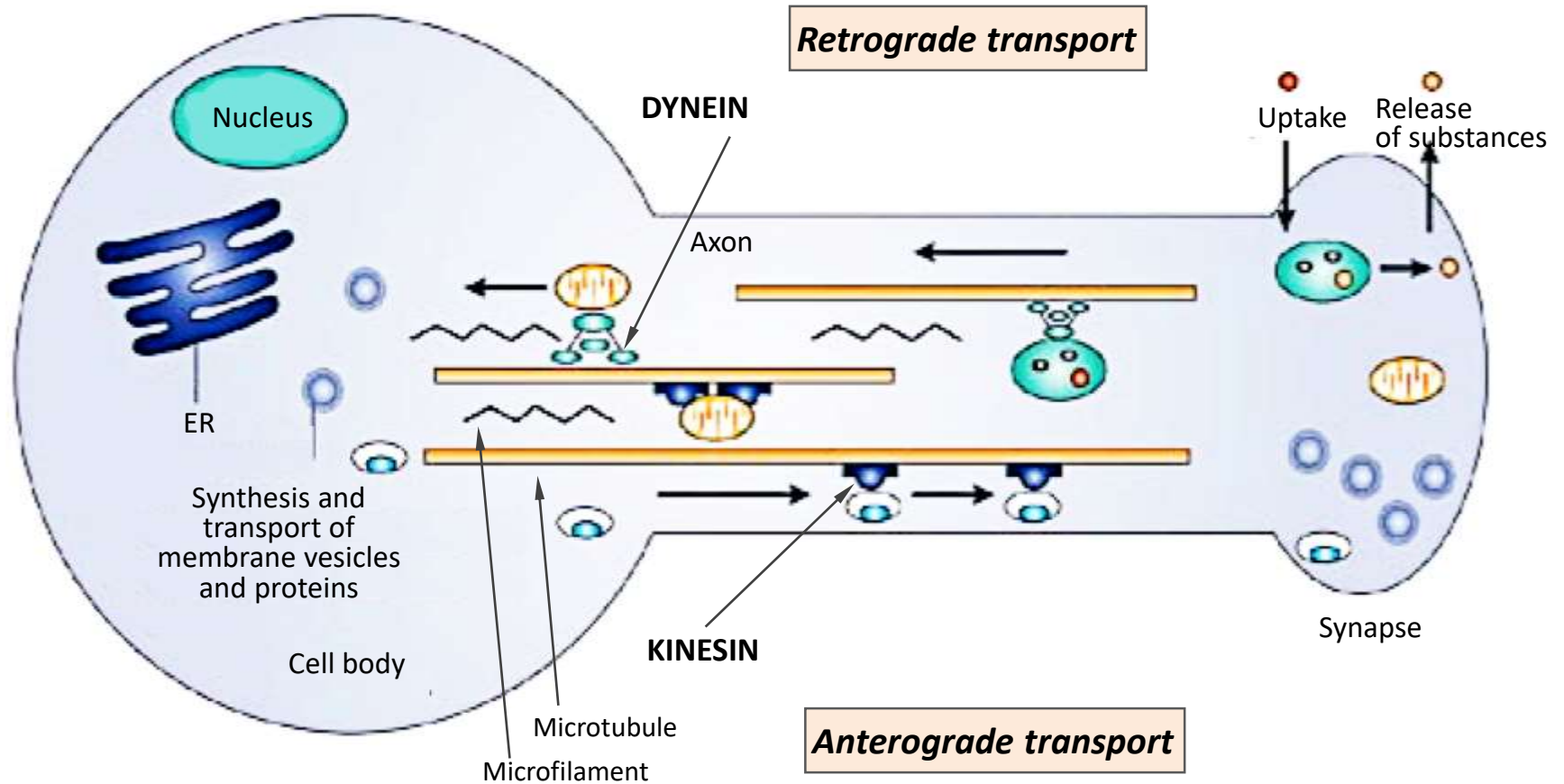
NEURON STRUCTURE

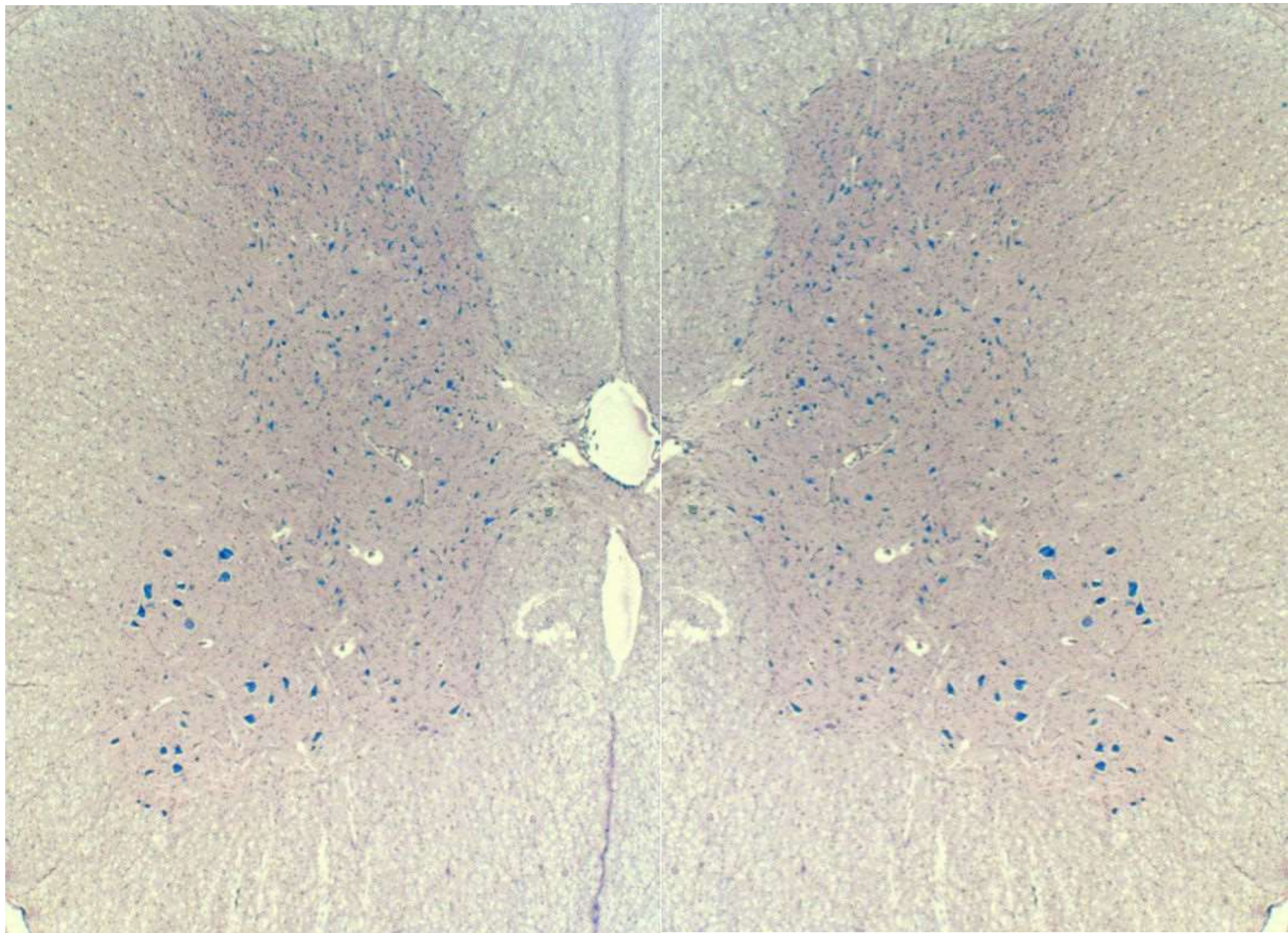
CYTOSKELETON of NEURON

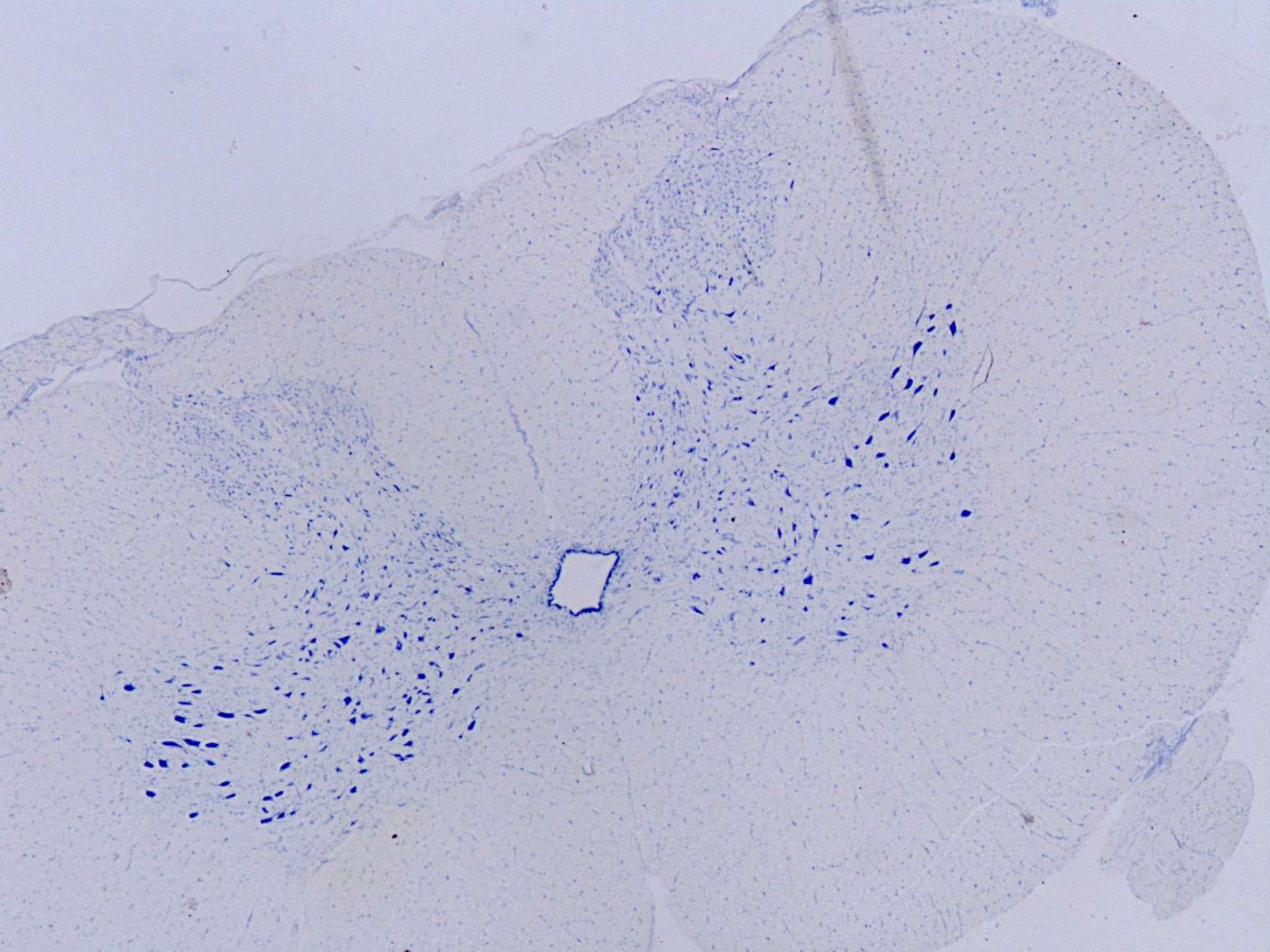
- ✓ Neurotubules + neurofilaments =
= neurofibrills
- ✓ Microfilaments

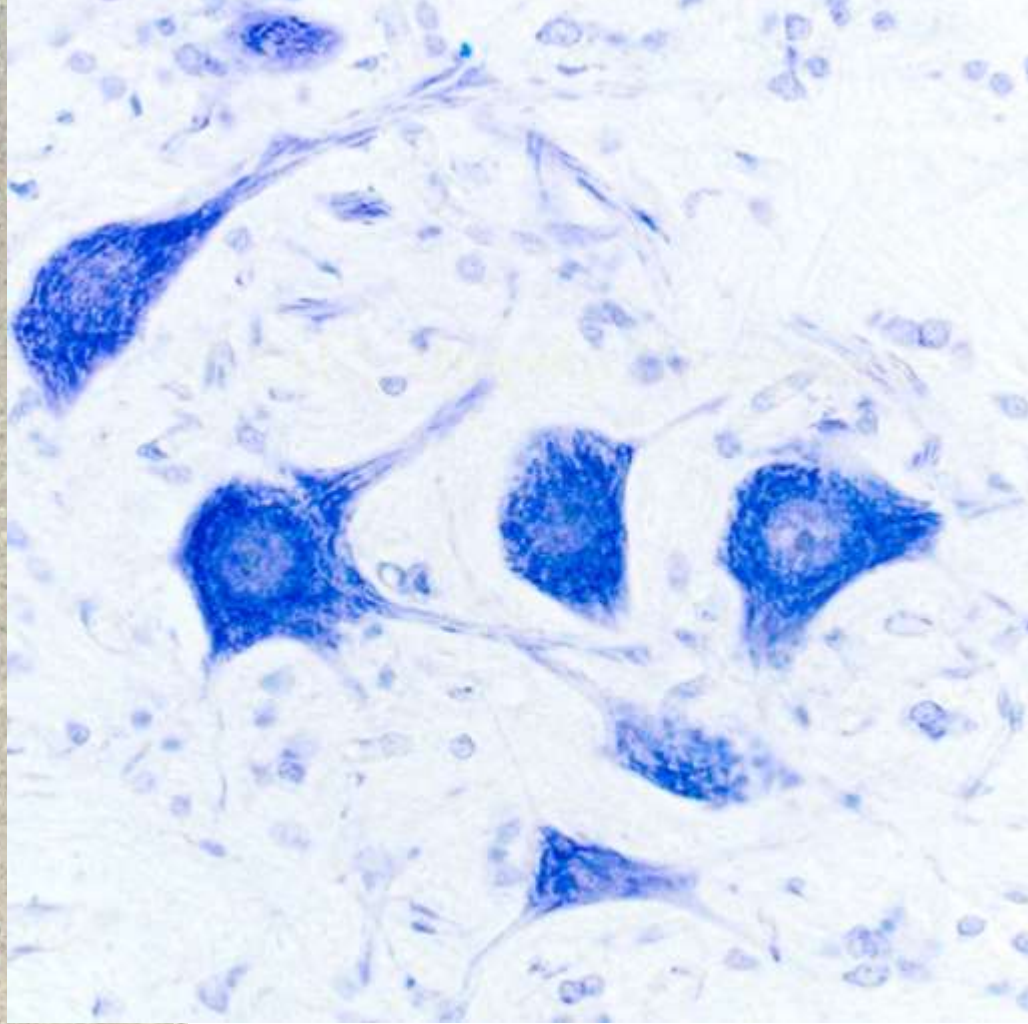
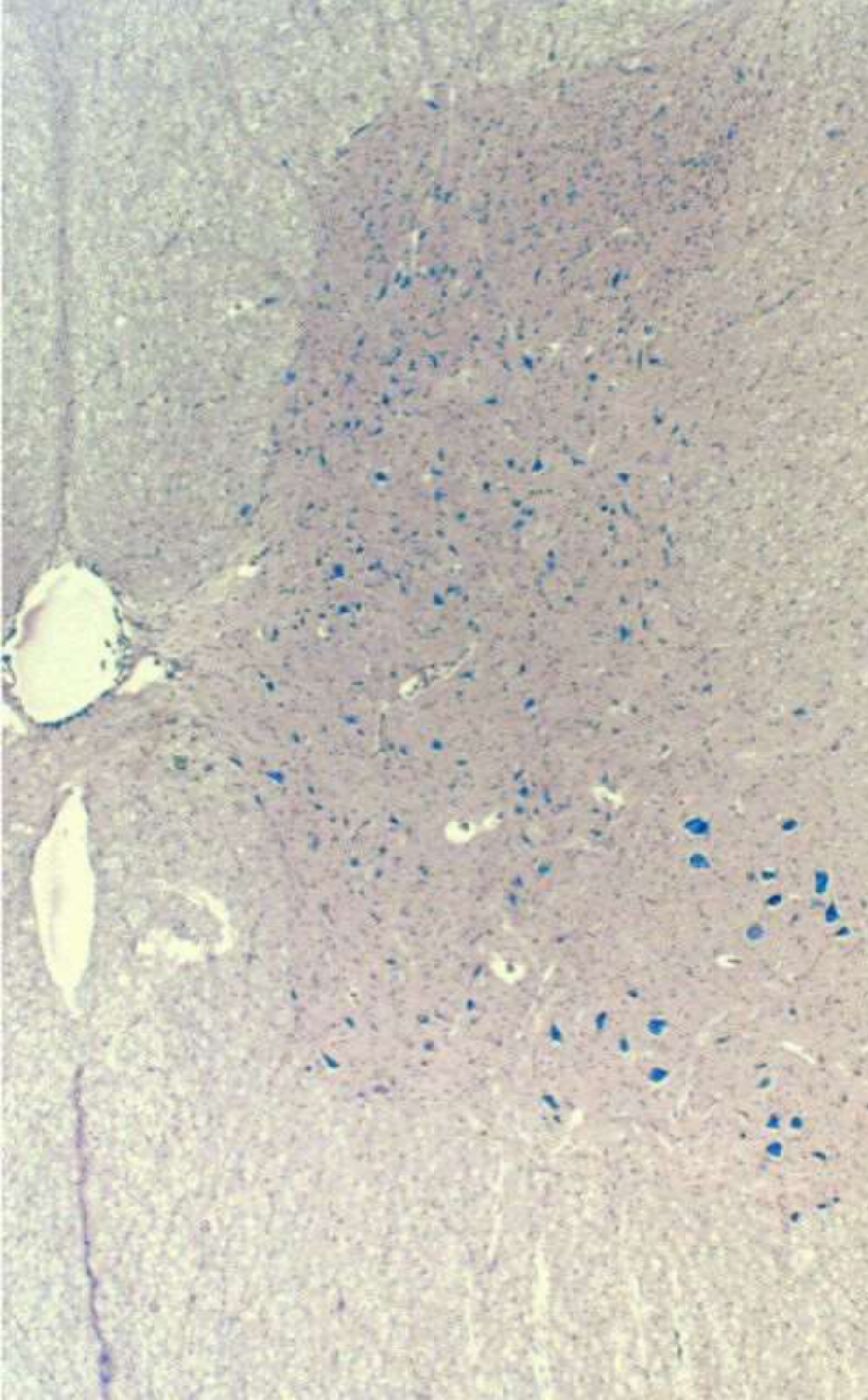


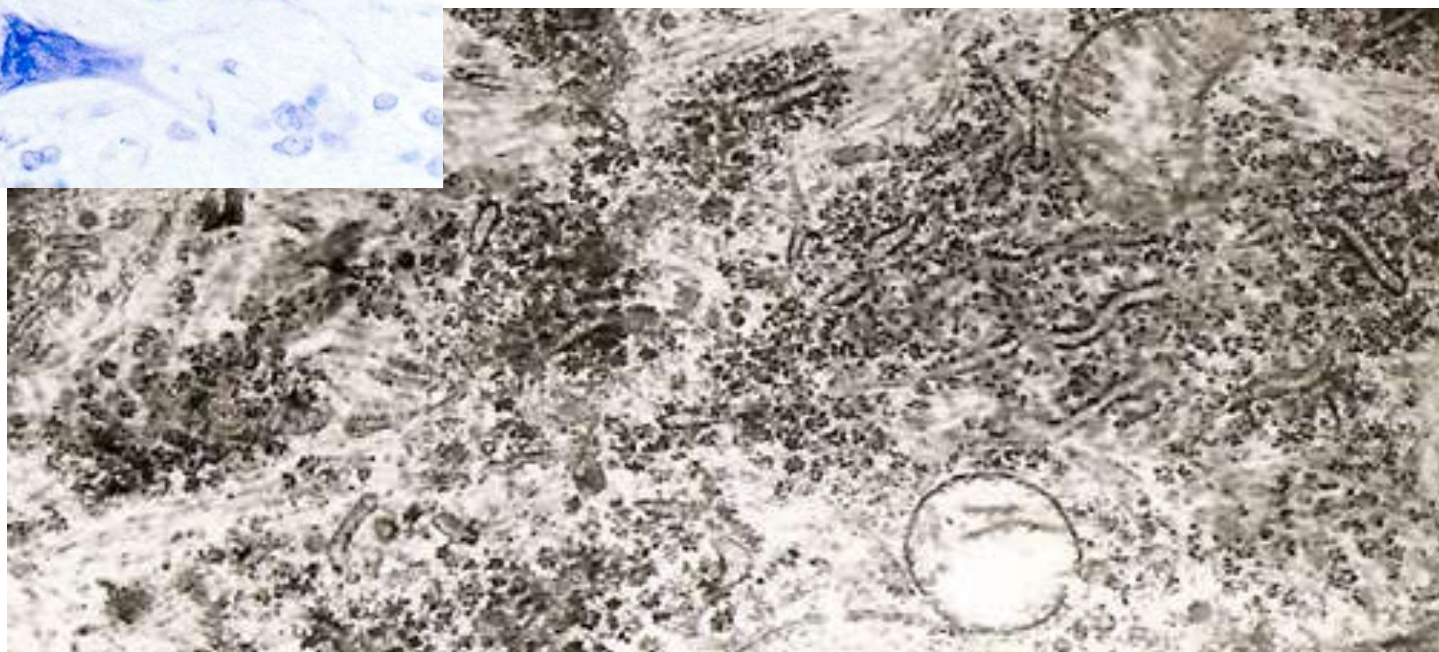
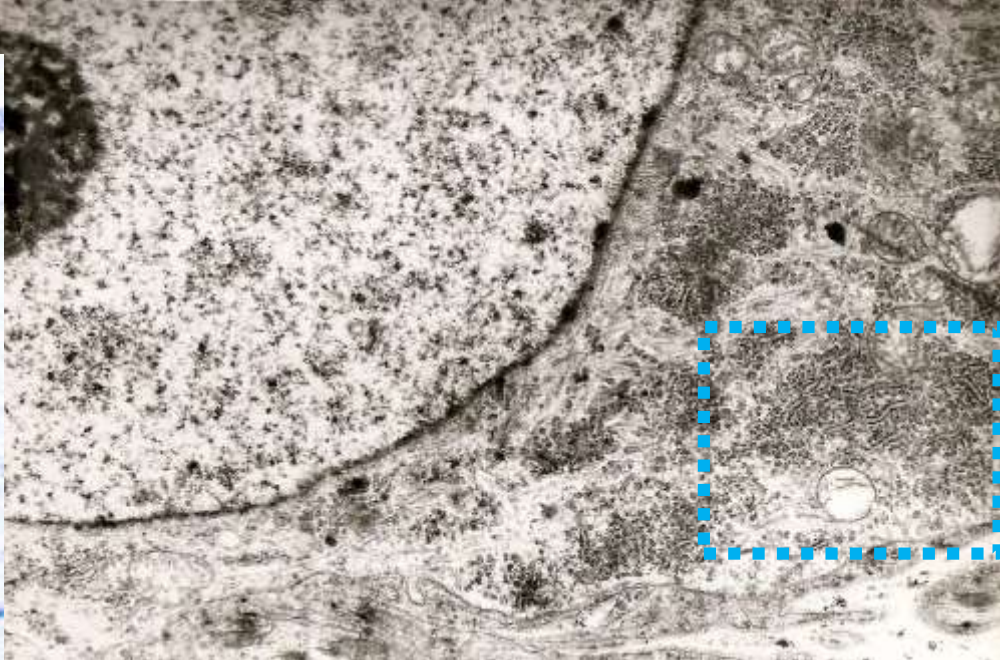
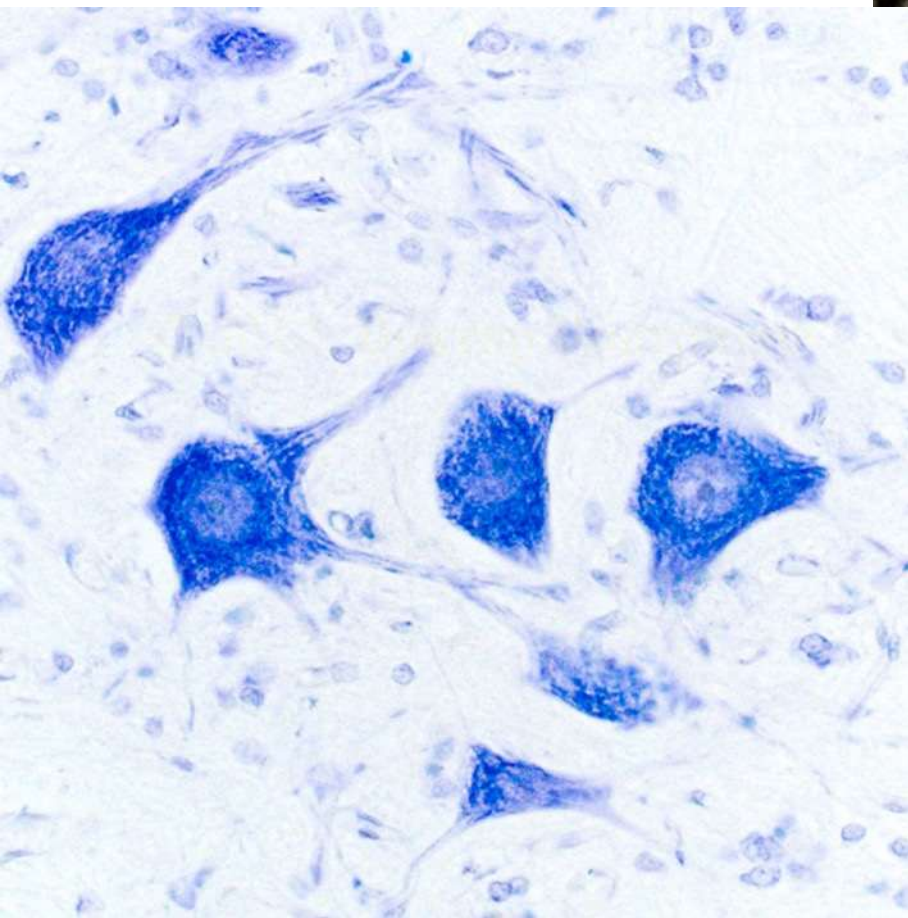
AXONAL TRANSPORT SYSTEM





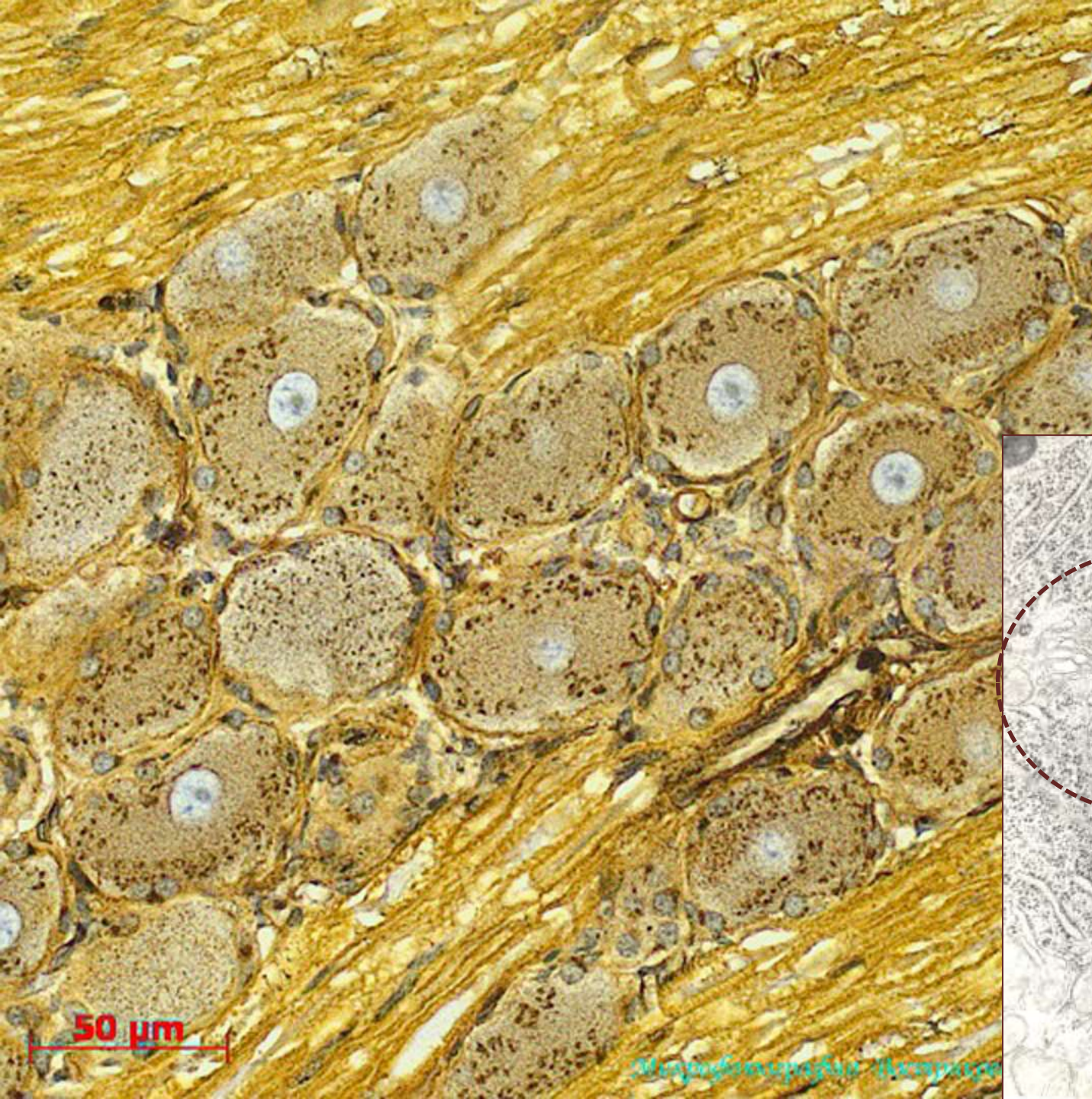






Franz Nissl (1860-1919) was a German psychiatrist, medical researcher, and also a noted neuropathologist, remembered for his method of nerve fiber staining and also for the discovery of chromophilic substance in pericarion and dendrites (Nissl bodies). The main achievement of F.Nissl as a scientist was his interpretation of mental and nervous diseases by relating them to observable changes in glial cells, blood elements, blood vessels, and the brain tissue. He was a close collaborator of Alois Alzheimer whom he met in Frankfurt. During World War I Nissl was charged with administering a large military hospital. He died in Munich from kidney disease.





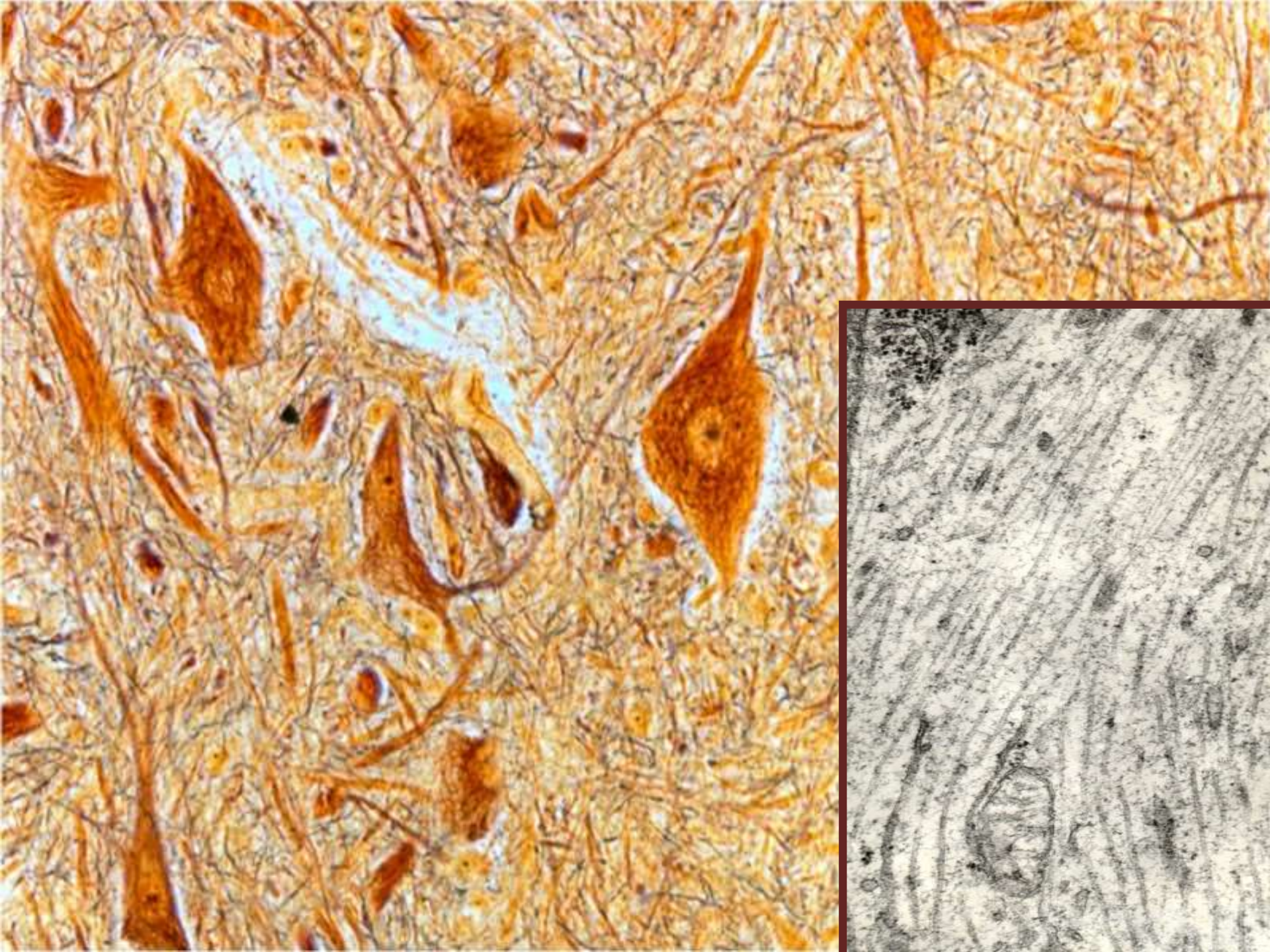
Μεγιστοποίηση: 1000x

Camillo Golgi (1843-1926) was an Italian physician and medical researcher who won the Nobel Prize in Physiology or Medicine 1906. He was awarded jointly with Santiago Ramón y Cajal *"in recognition of their work about the structure of the nervous system"*. Cell types and structures described by Camillo Golgi include the Golgi apparatus, the proprioceptive sensory receptor organ that senses changes in muscle tension (the Golgi tendon organ), and the Golgi neurons of the cerebellum. He is also famous for his modification of silver staining technique, which enabled scientists to view entire neurons for the first time and forever changed the way people discussed the development and composition of the brain cells.

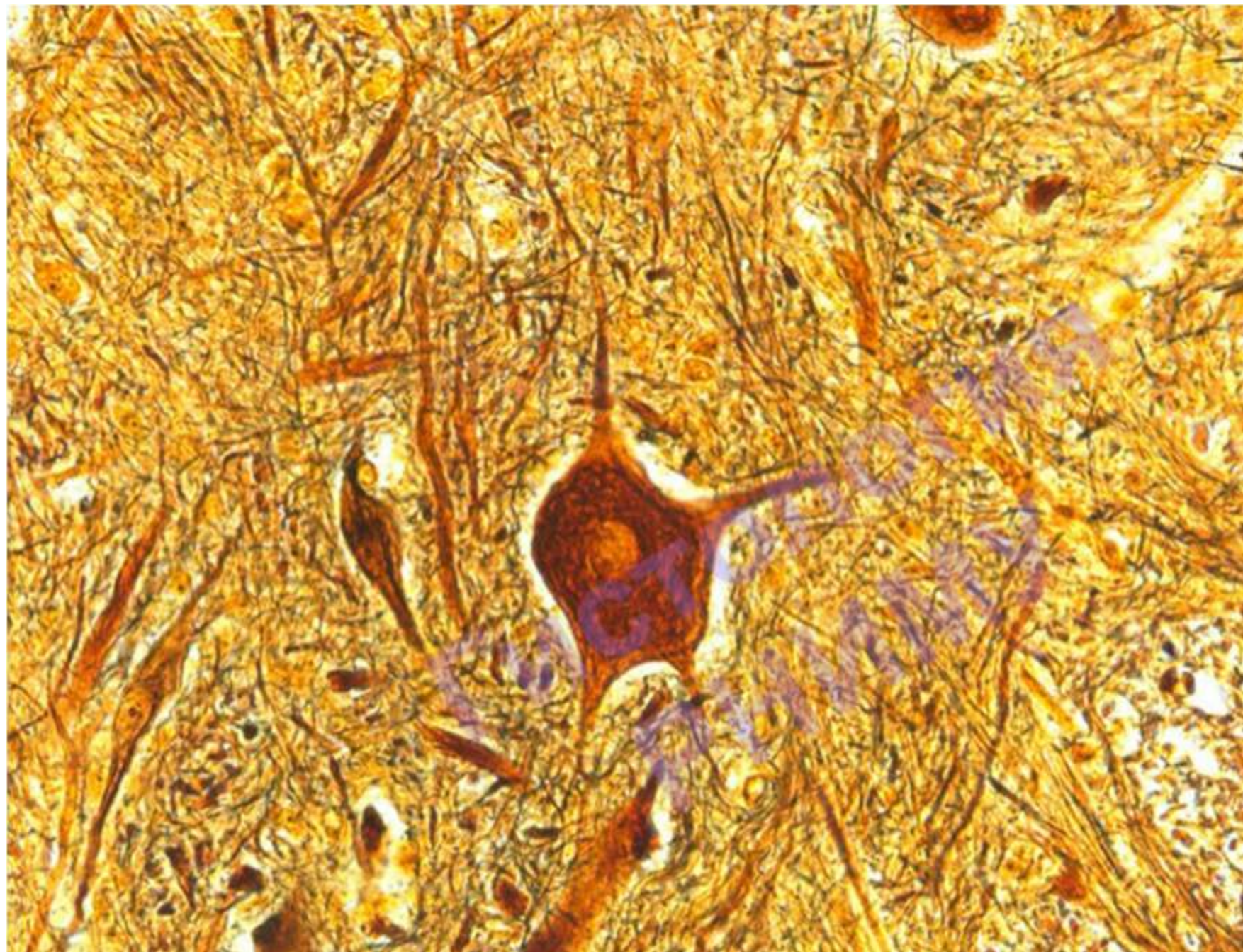












NERVE TISSUE

GLIAL CELLS TYPES

Neurons

Glia

(accessory cells)

CNS

PNS

MICROGLIA

MACROGLIA

SCHWANN CELLS
(neurolemmocytes)

MANTLE
GLIOCYTES

GLIAL
MACROPHAGES

ASTROCYTES

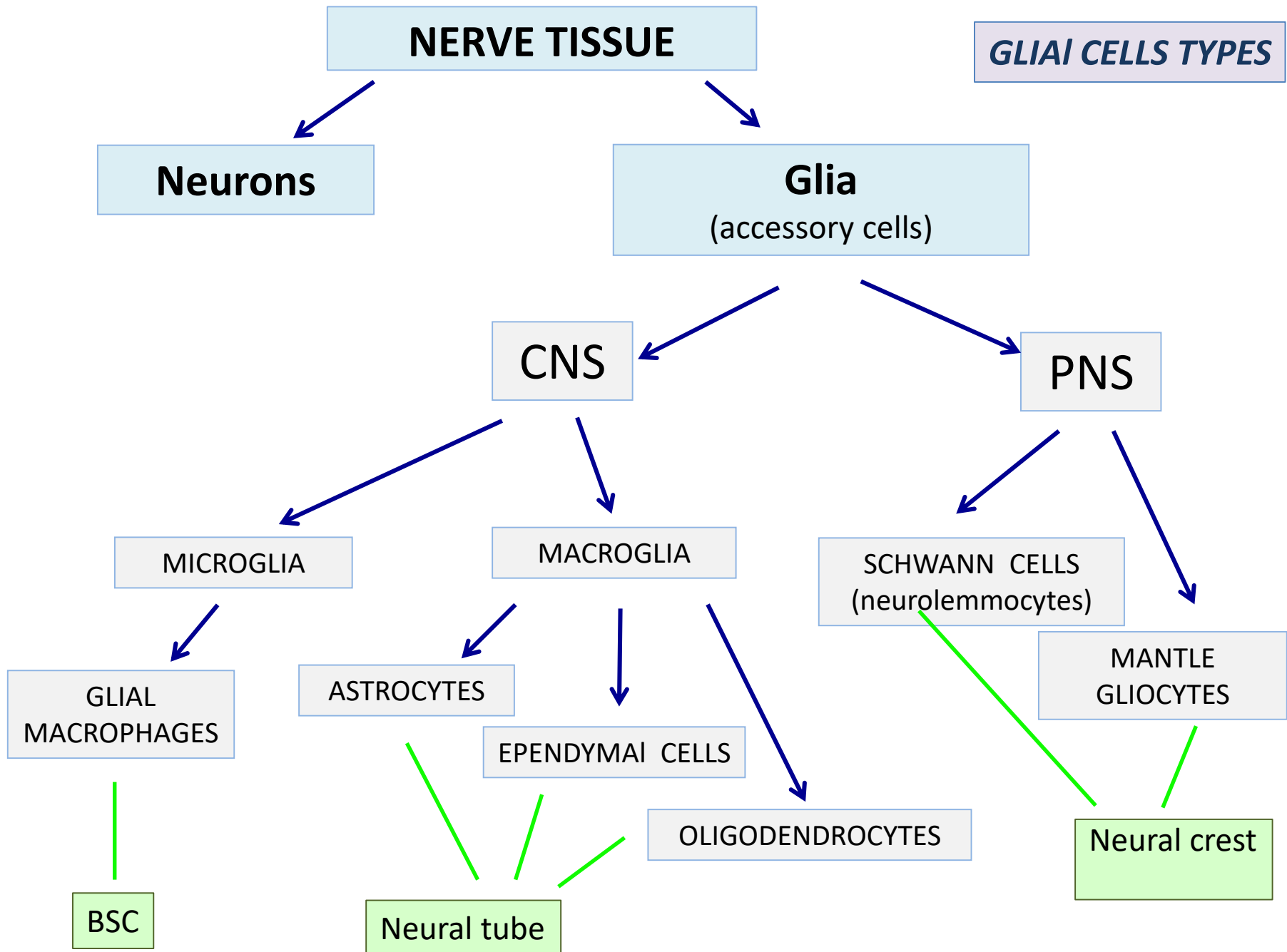
EPENDYMAI CELLS

OLIGODENDROCYTES

Neural crest

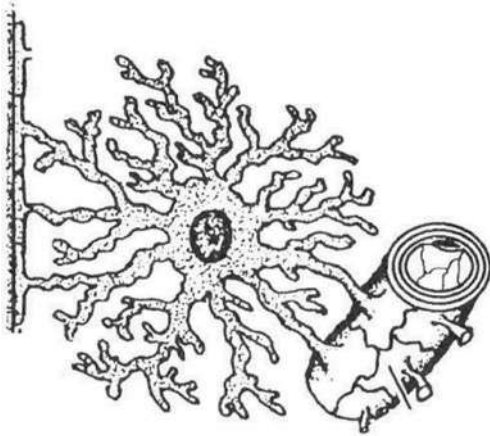
BSC

Neural tube

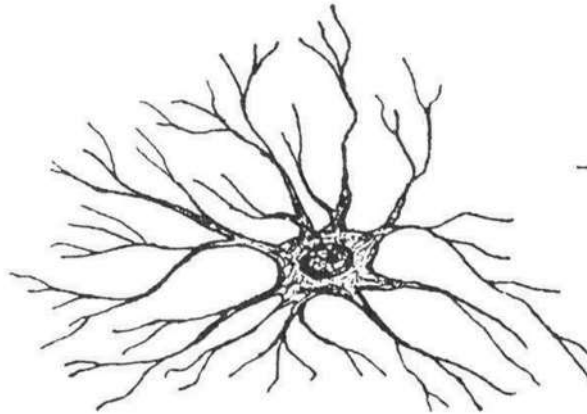


GLIAL CELLS TYPES

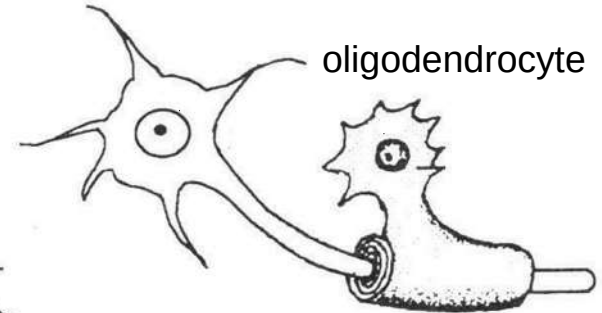
Protoplasmic astrocyte



Fibrous astrocyte



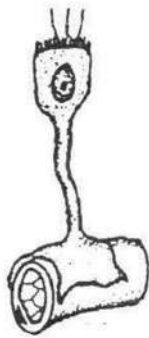
Neuron of CNS



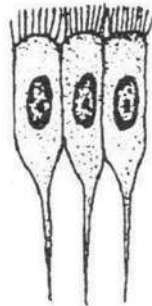
oligodendrocyte



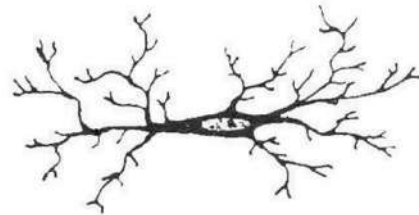
Choroid plexus



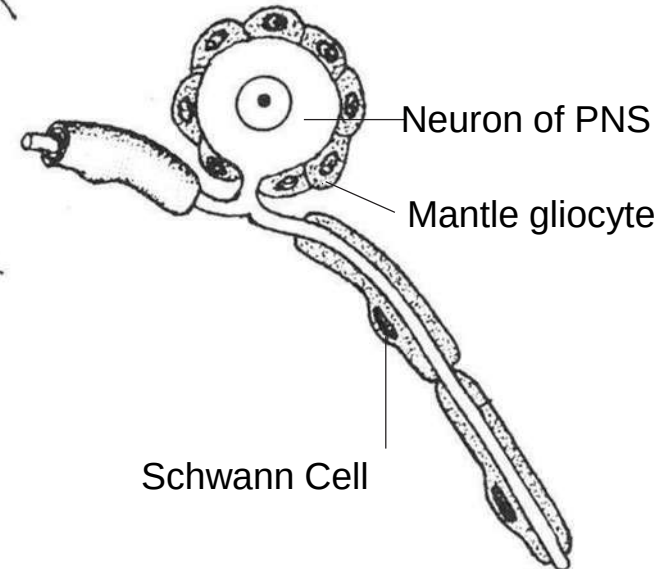
Tanycyte



Ependymal cells



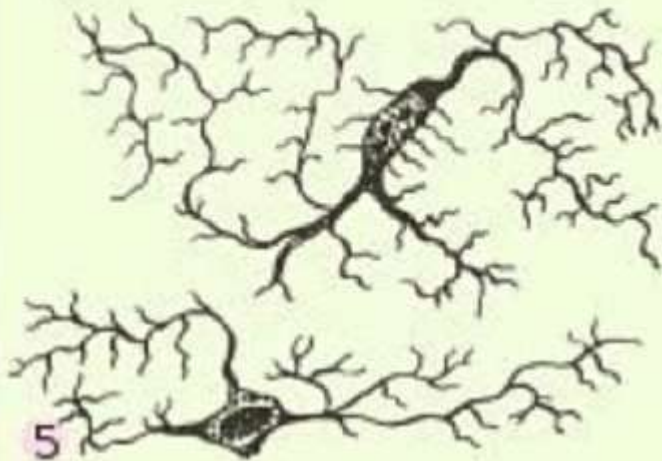
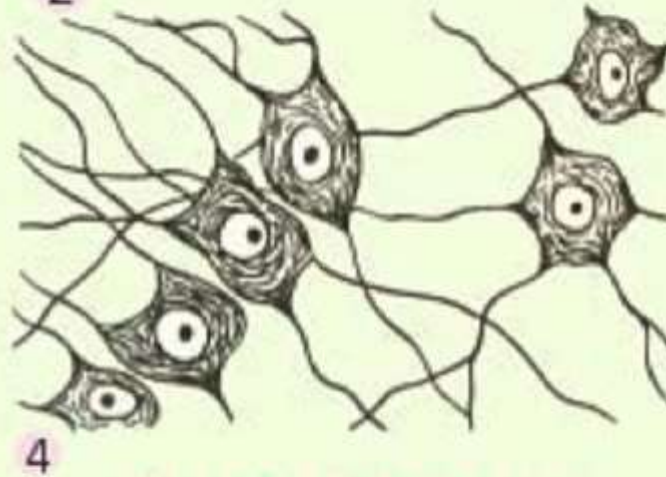
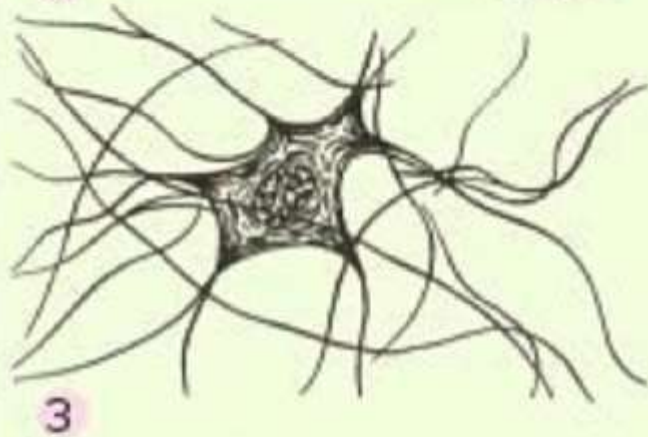
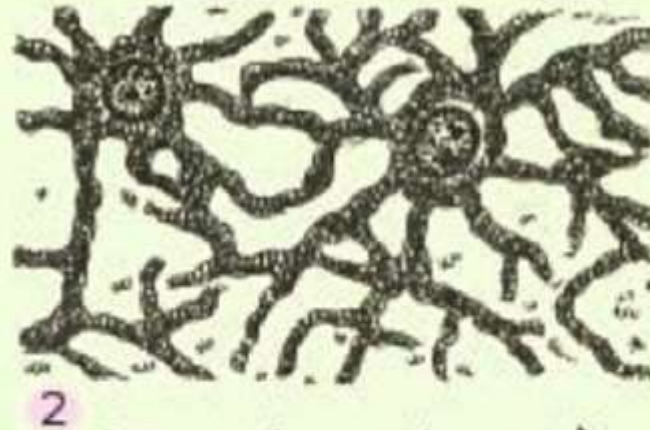
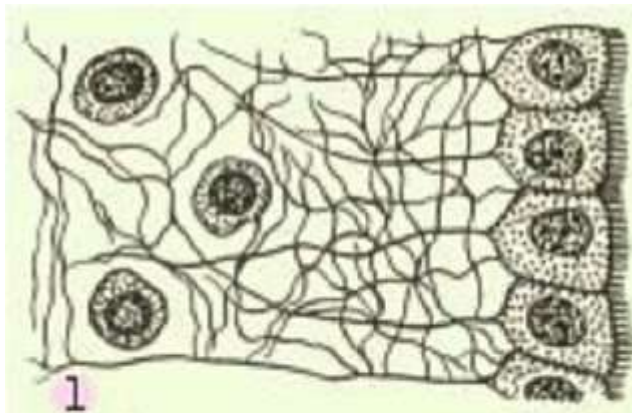
Microglial cell



Neuron of PNS

Mantle gliocyte

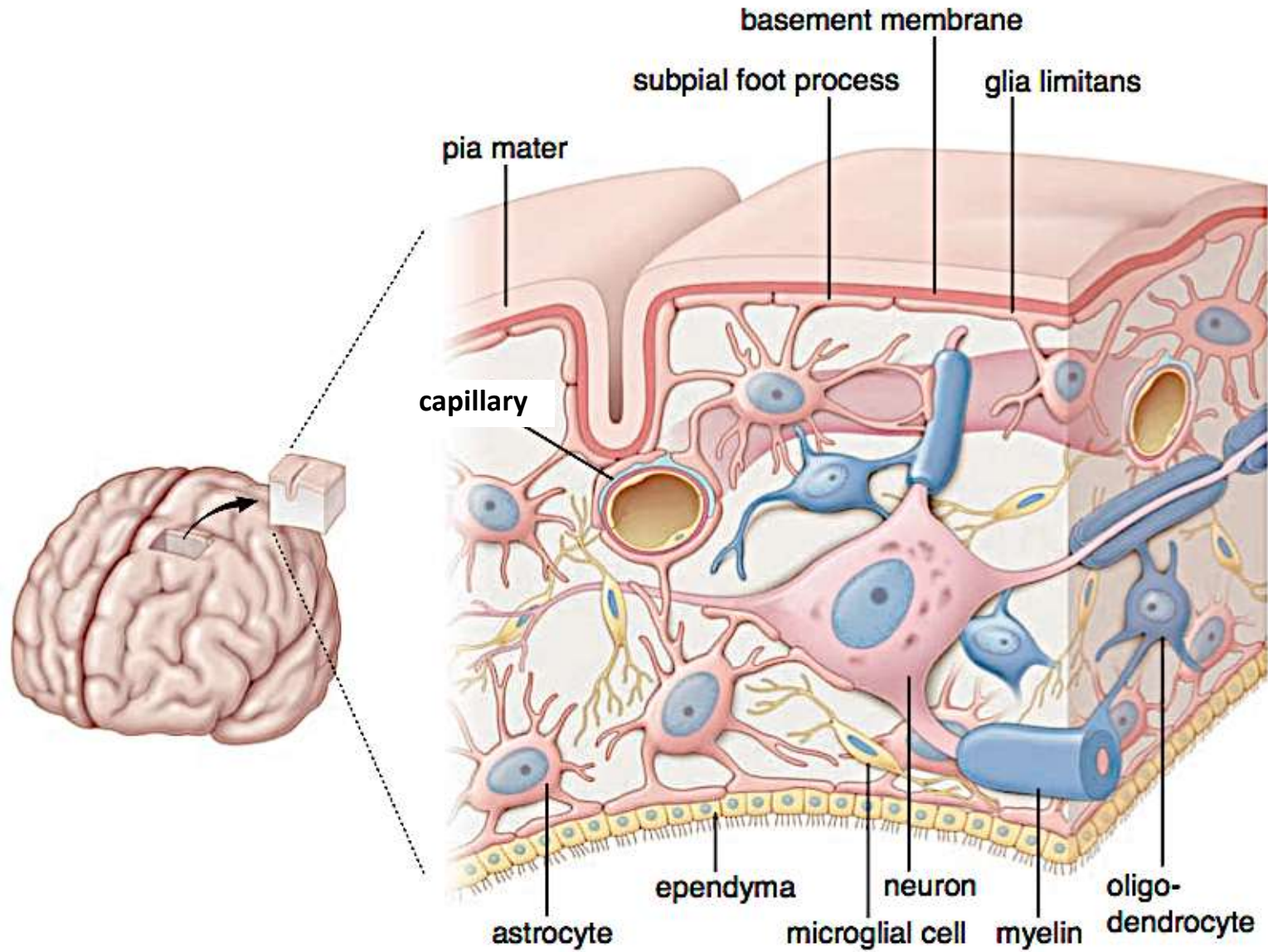
Schwann Cell

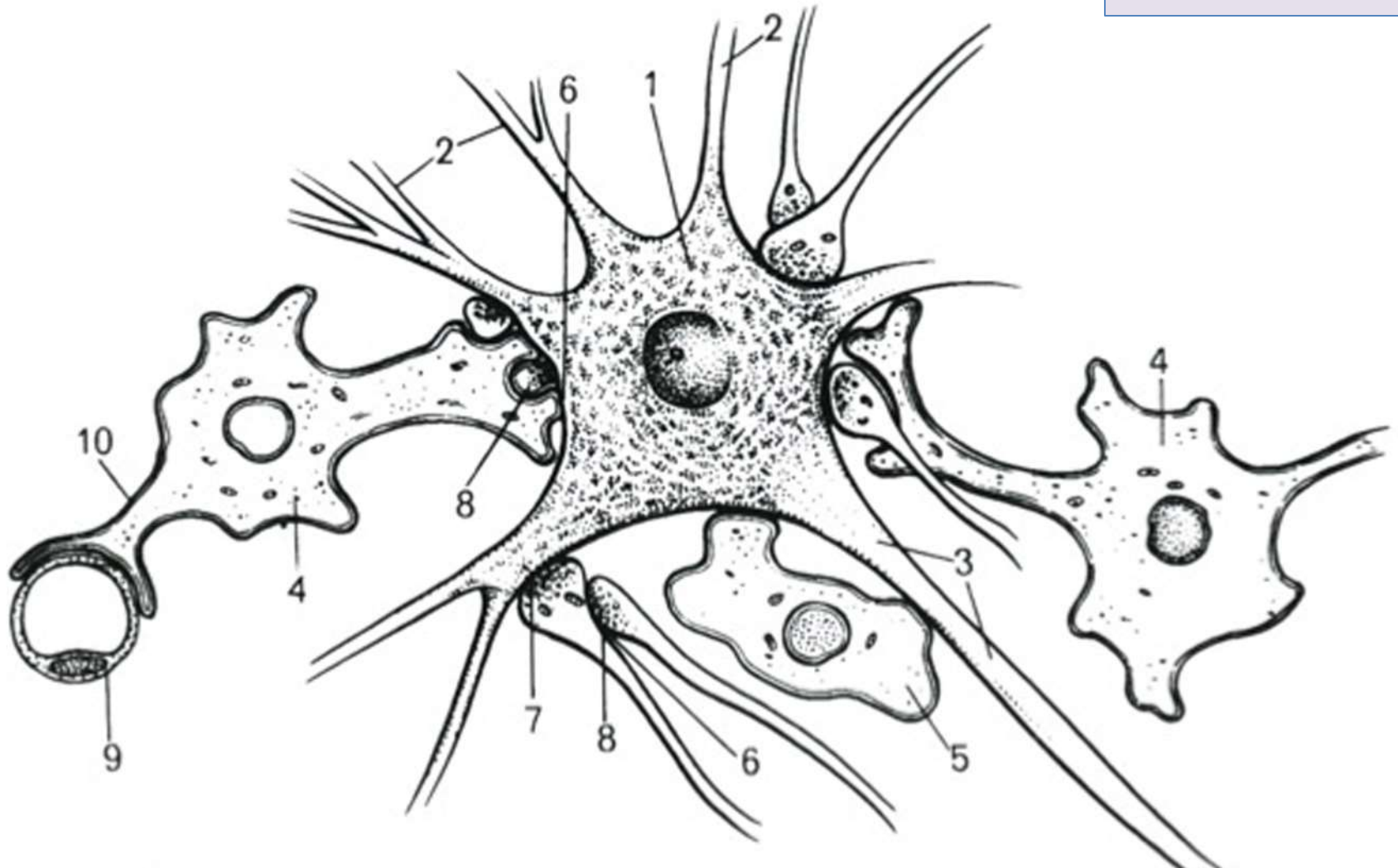


Glial cell morphology

- 1- ependymal cells;
- 2- protoplasmic astrocytes;
- 3- fibrous astrocytes;
- 4- oligodendrocytes; 5-microglia

NERVE TISSUE CELLS



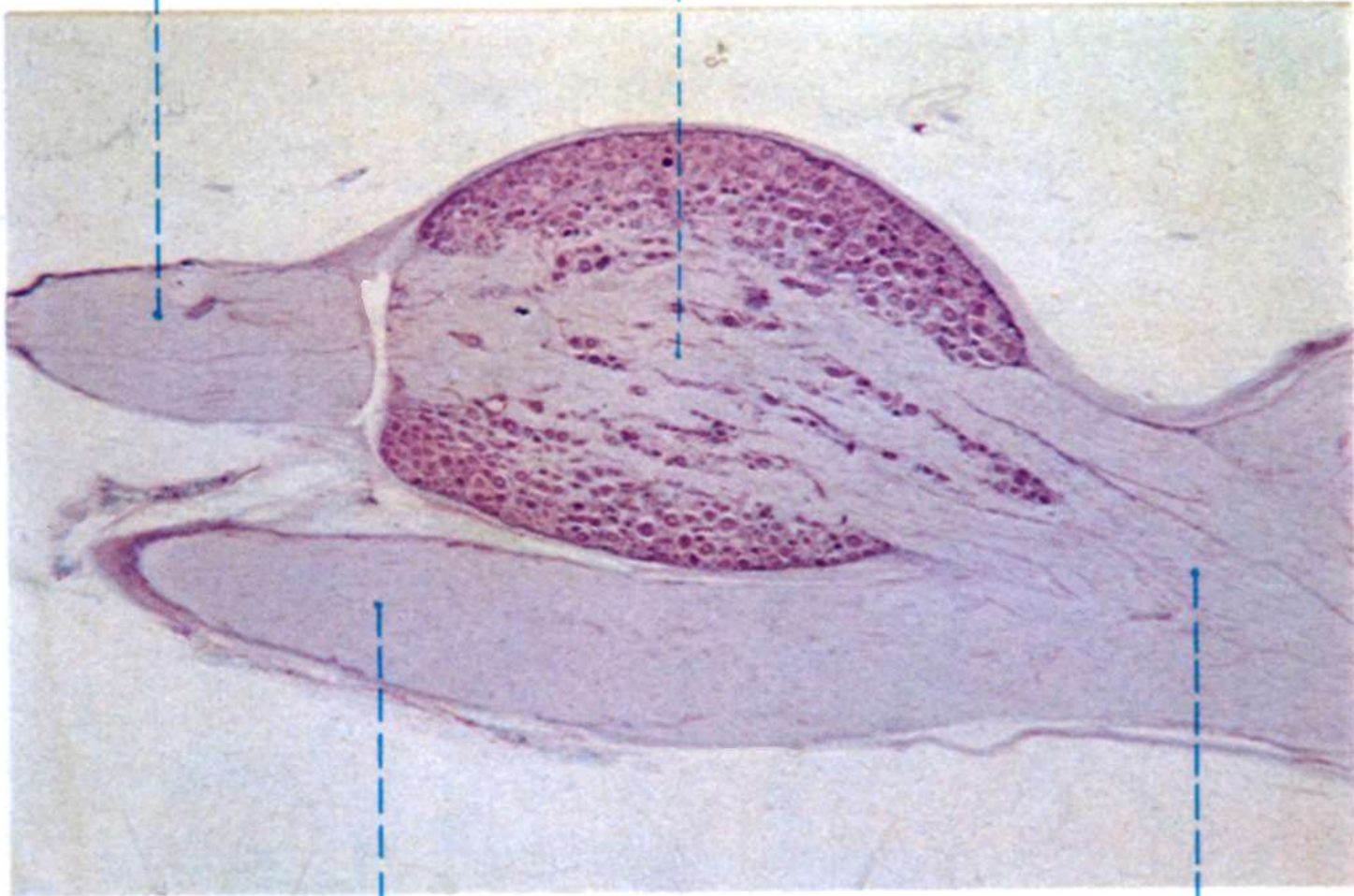


Relationships between neurons, astroglia, oligodendroglia and nerve terminals within the CNS

1- neuron body; 2- dendrites; 3- axon; 4- astrocytes; 5- oligodendrocyte; 6- axoaxonal synapse;
7- axodendritic synapse; 8- axosomatic synapse; 9- capillary; 10- perivascular foot process of an astrocyte

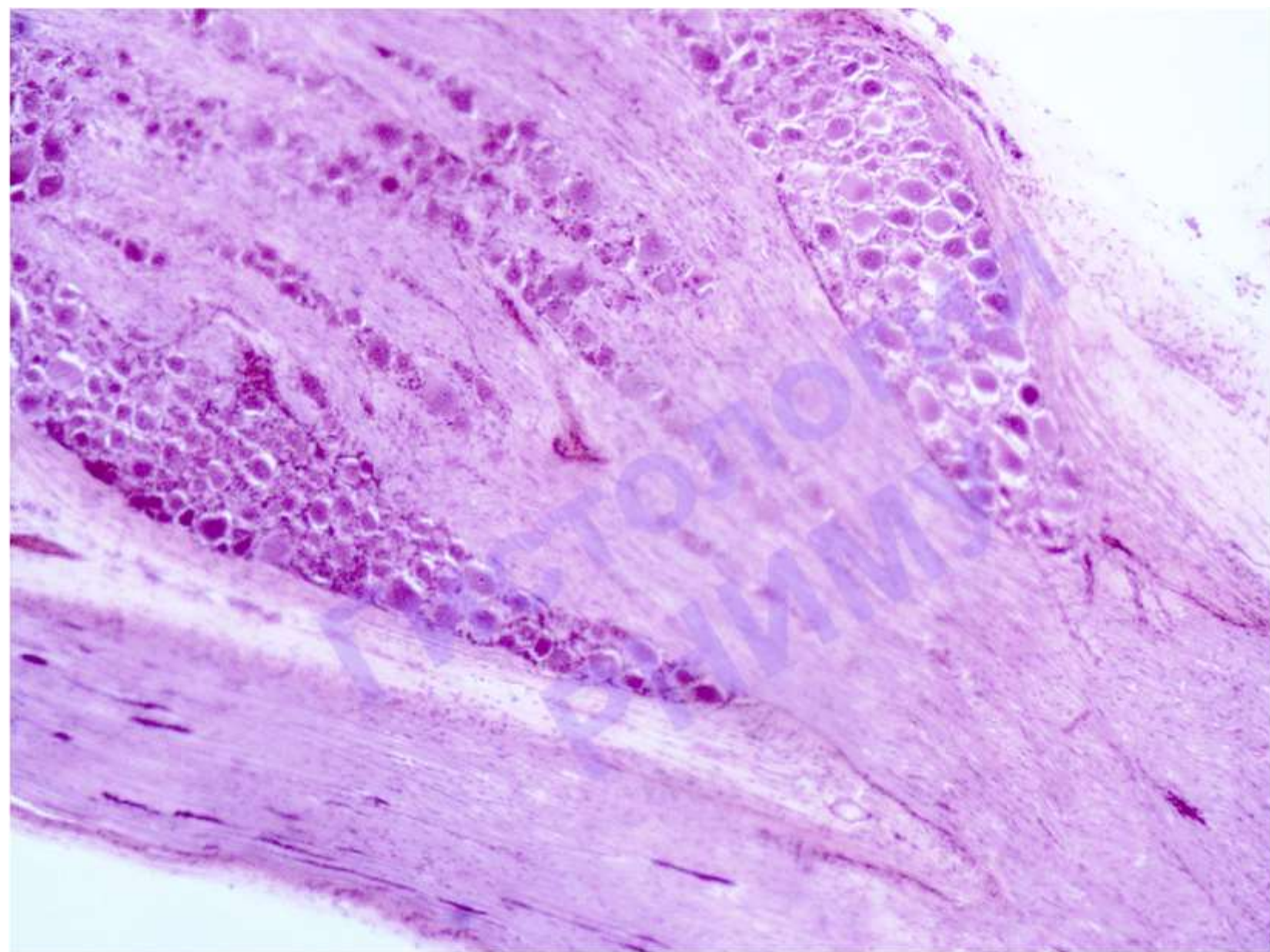
Dorsal root

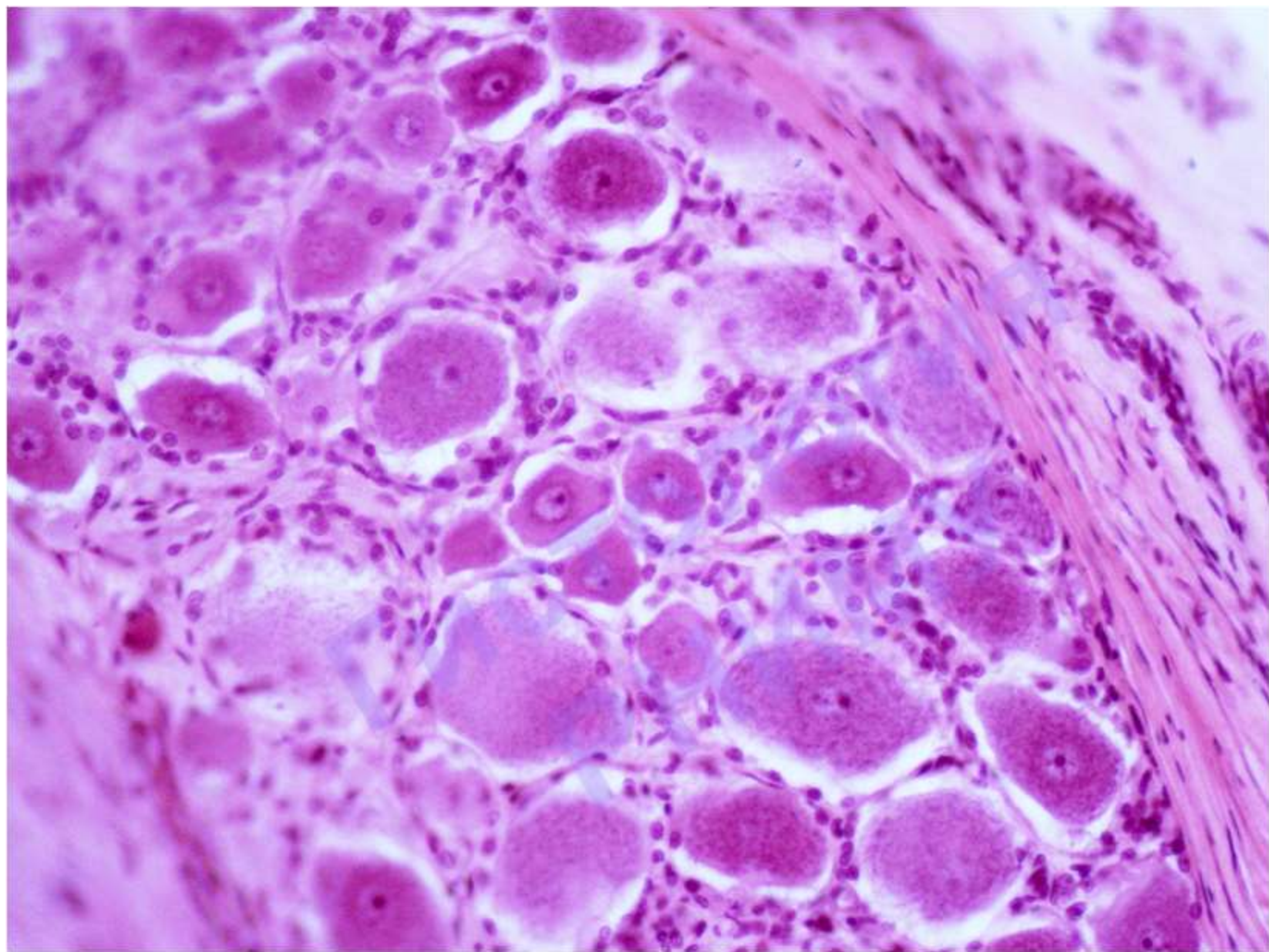
*Dorsal root ganglion
(=spinal ganglion)*

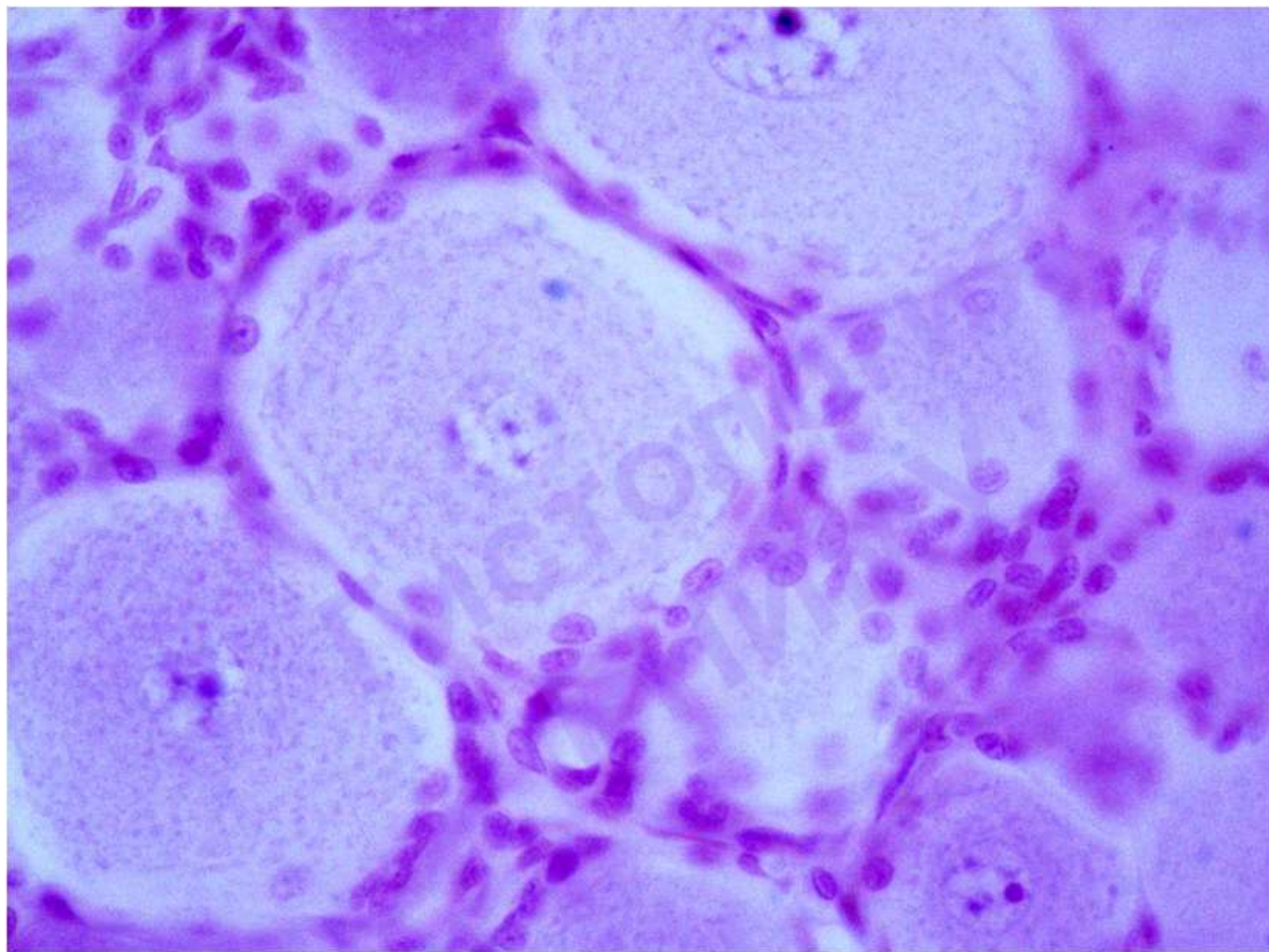


Ventral root

Spinal nerve





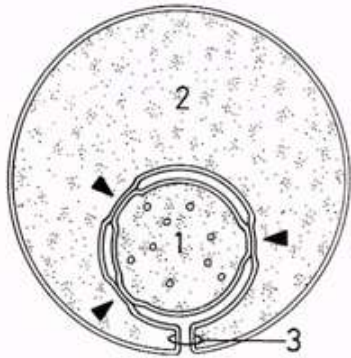


NERVE FIBERS

NERVE FIBERS – nerve cell processes (axon and dendrites),
surrounding glial sheath (glial cells)

UNMYELINATED

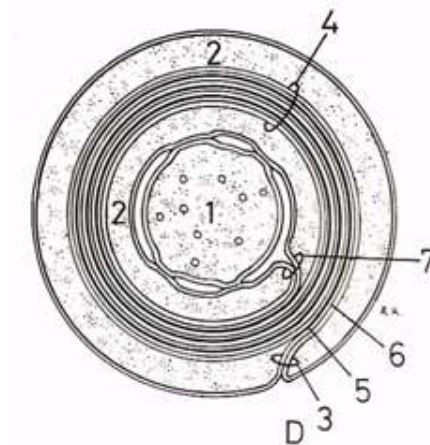
- ✓ Postganglionic nerve fibers of autonomic NS



Unmyelinated fibers
 $D \ll 1 \mu\text{m}$
speed < 2 m/sec

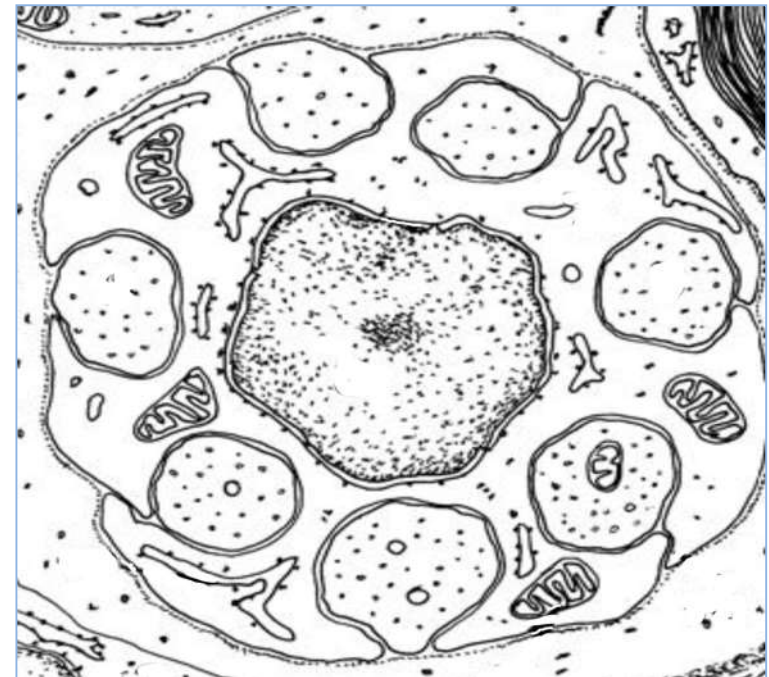
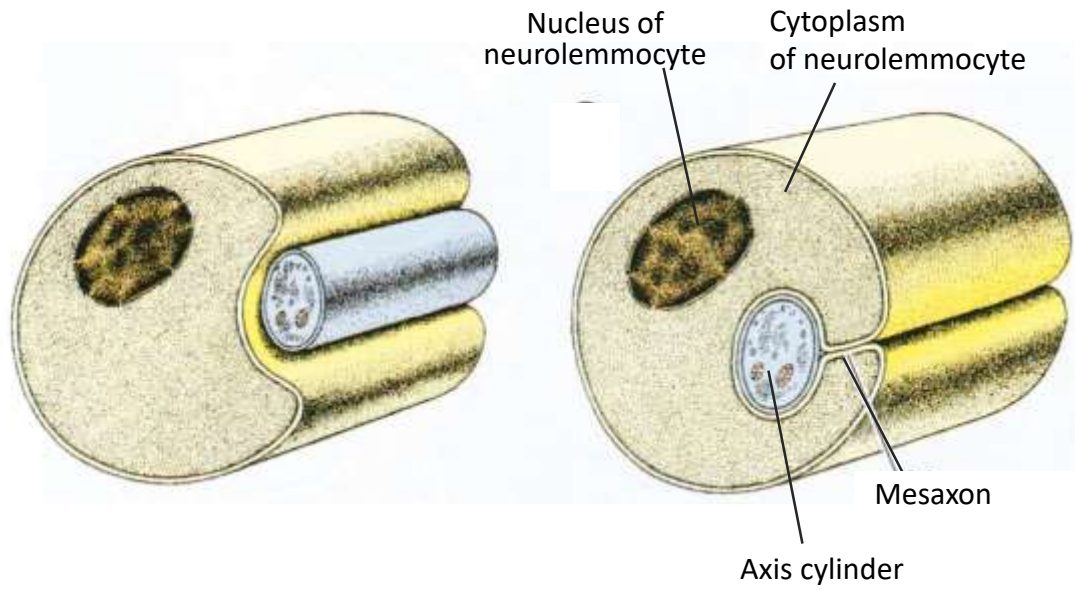
MYELINATED

- ✓ CNS and PNS
- ✓ Somatic PNS
- ✓ Preganglionic nerve fibers of autonomic NS



Myelinated fibers
 $D = 3-20 \mu\text{m}$
speed - 120 m/sec

UNMYELINATED NERVE FIBER



Sequential stages of nerve fiber myelination

A- cross sections of sequential stages of nerve fiber myelination

B- three-dimensional image of the myelinated nerve fiber

1- formation of **mesaxon** – duplication of plasma membranes of a **neurolemmocyte (Schwann cell)**, which then wraps around an **axis cylinder**

2- axis cylinder

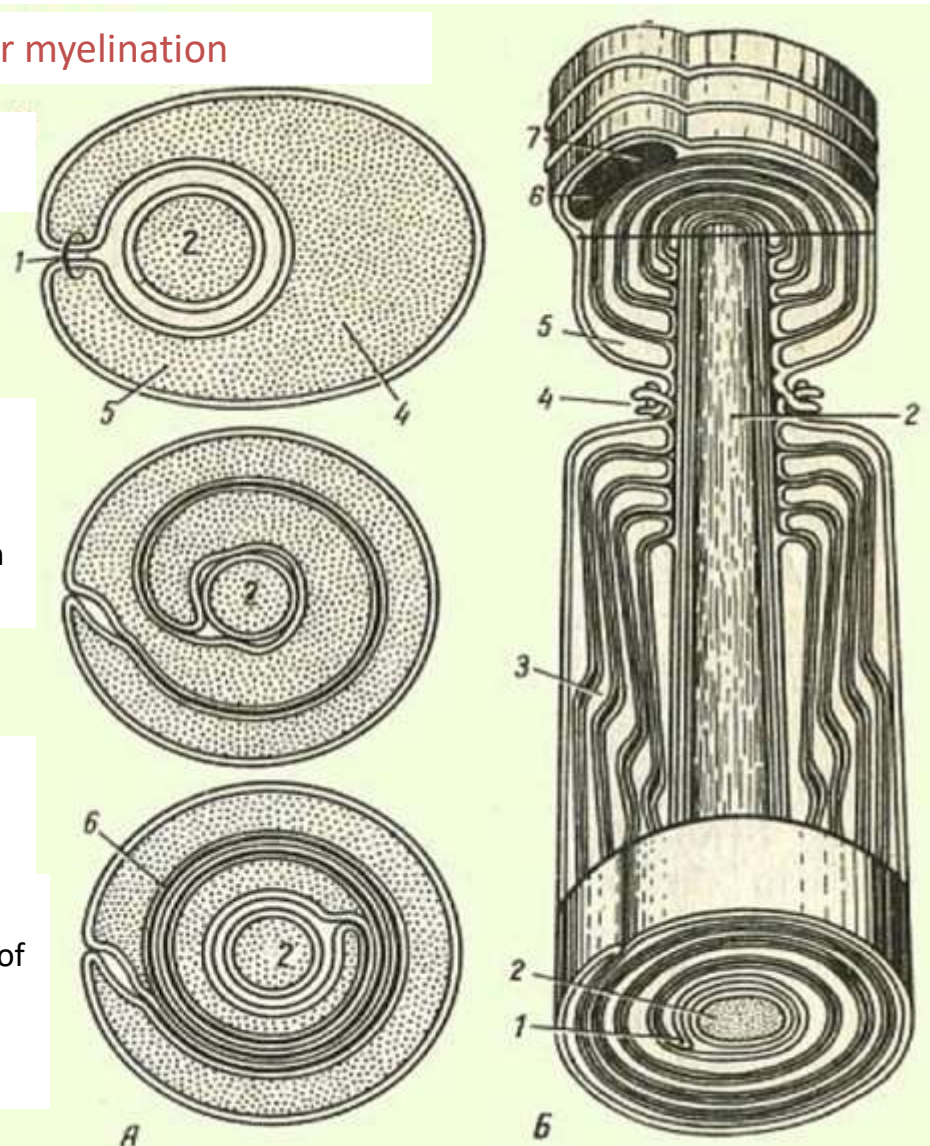
3- Schmidt-Lanterman cleft

4- finger-like junctions of adjacent neurolemmocytes at the node of Ranvier

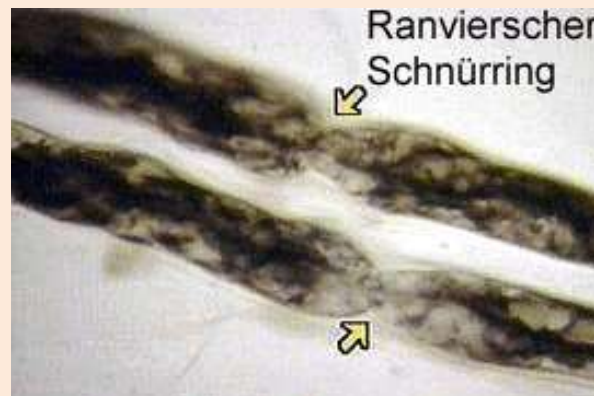
5- cytoplasm of neurolemmocyte

6- myelin sheath formed as a result of spiral movement of the mesaxon around the axis cylinder

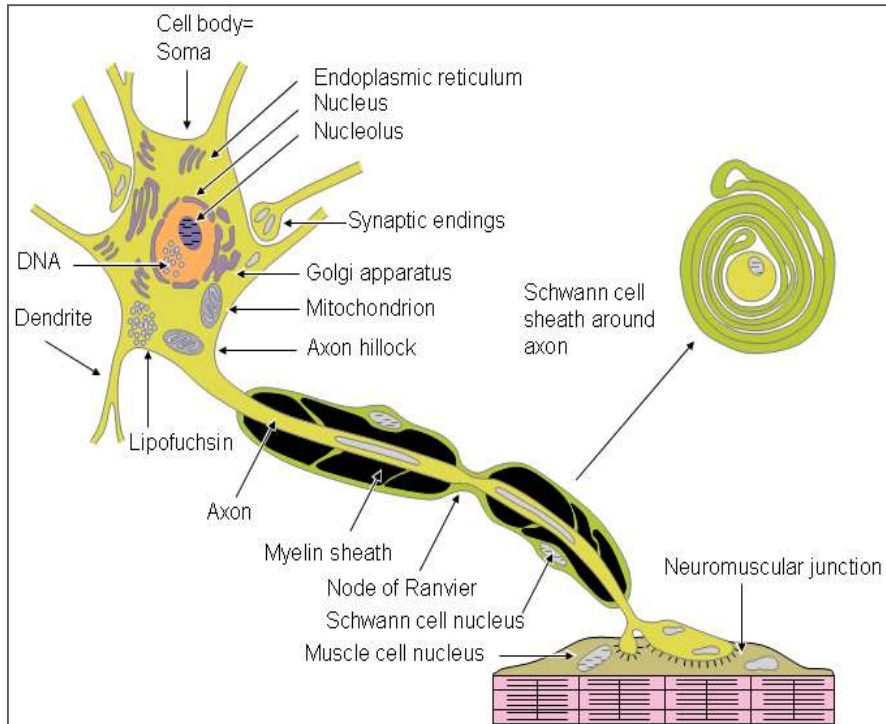
7- nucleus of neurolemmocyte



Louis-Antoine Ranvier (1835-1922) was the most prominent French histologist of the late 19th century. Ranvier was born in Lyon and studied medicine there. In 1867, he entered the Collège de France and in 1875 was appointed to its chair of general anatomy. In 1878, Ranvier discovered the nodes - regularly spaced discontinuities of the myelin sheath, occurring at varying intervals along the length of a nerve fiber, called “nodes of Ranvier” ever since. Other anatomical structures bearing his name are the Merkel-Ranvier cells, melanocyte-like cells in the basal layer of the epidermis that contain catecholamine granules, and also Ranvier’s tactile disks, a special type of sensory nerve endings.

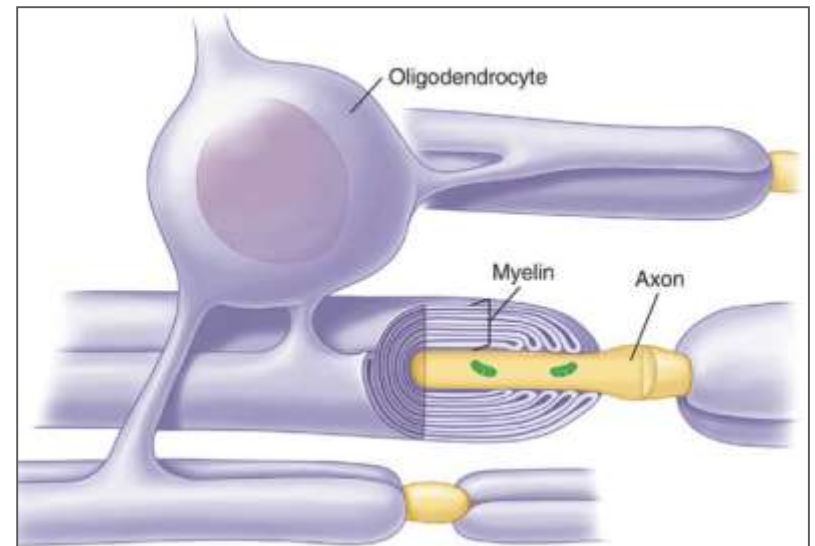


PNS

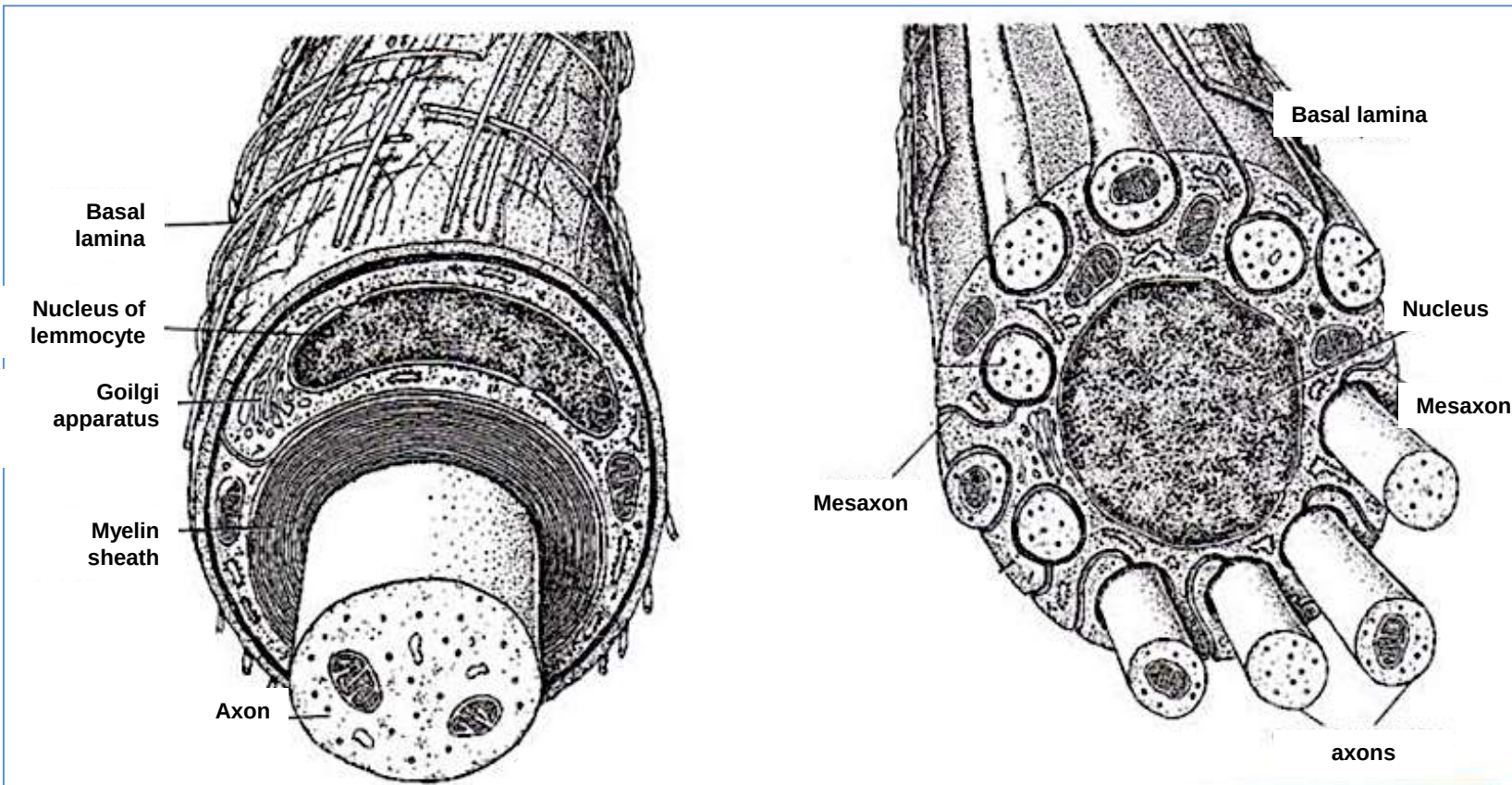
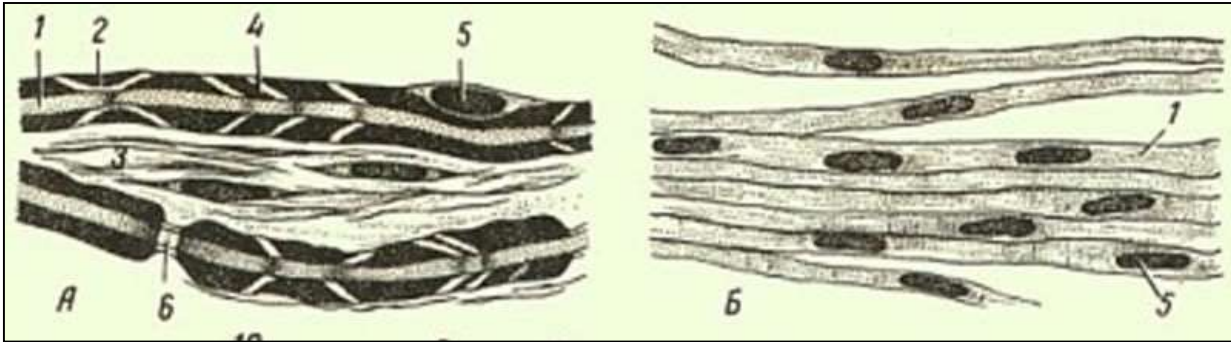


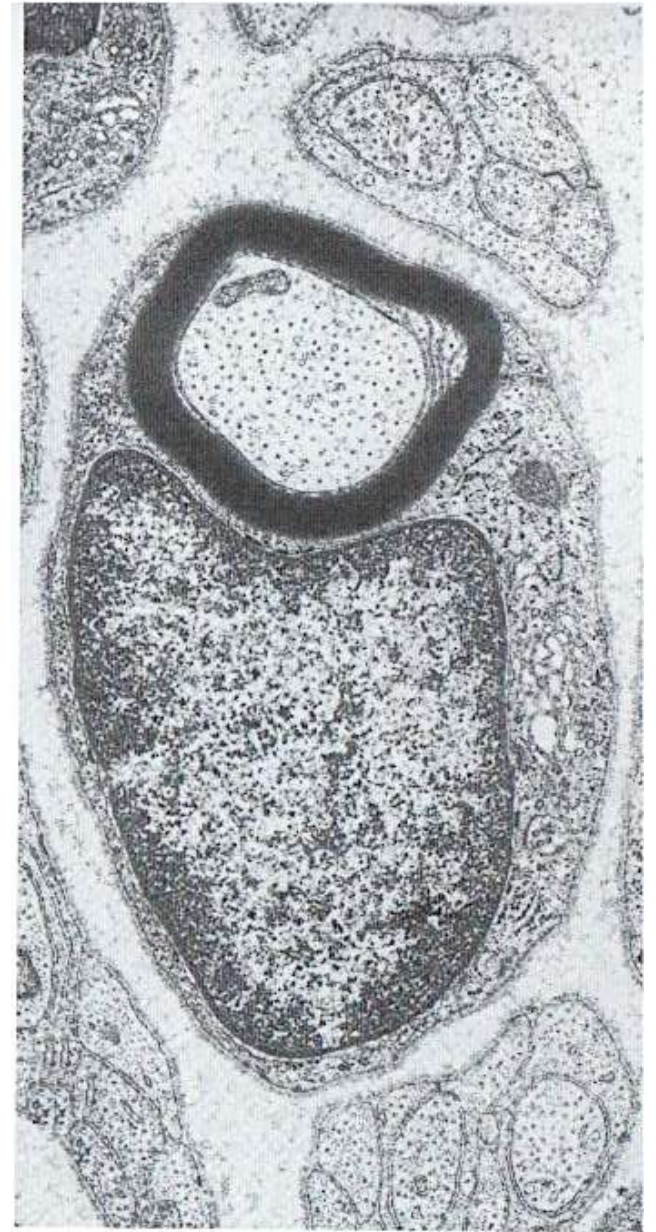
MYELINATED NERVE FIBERS

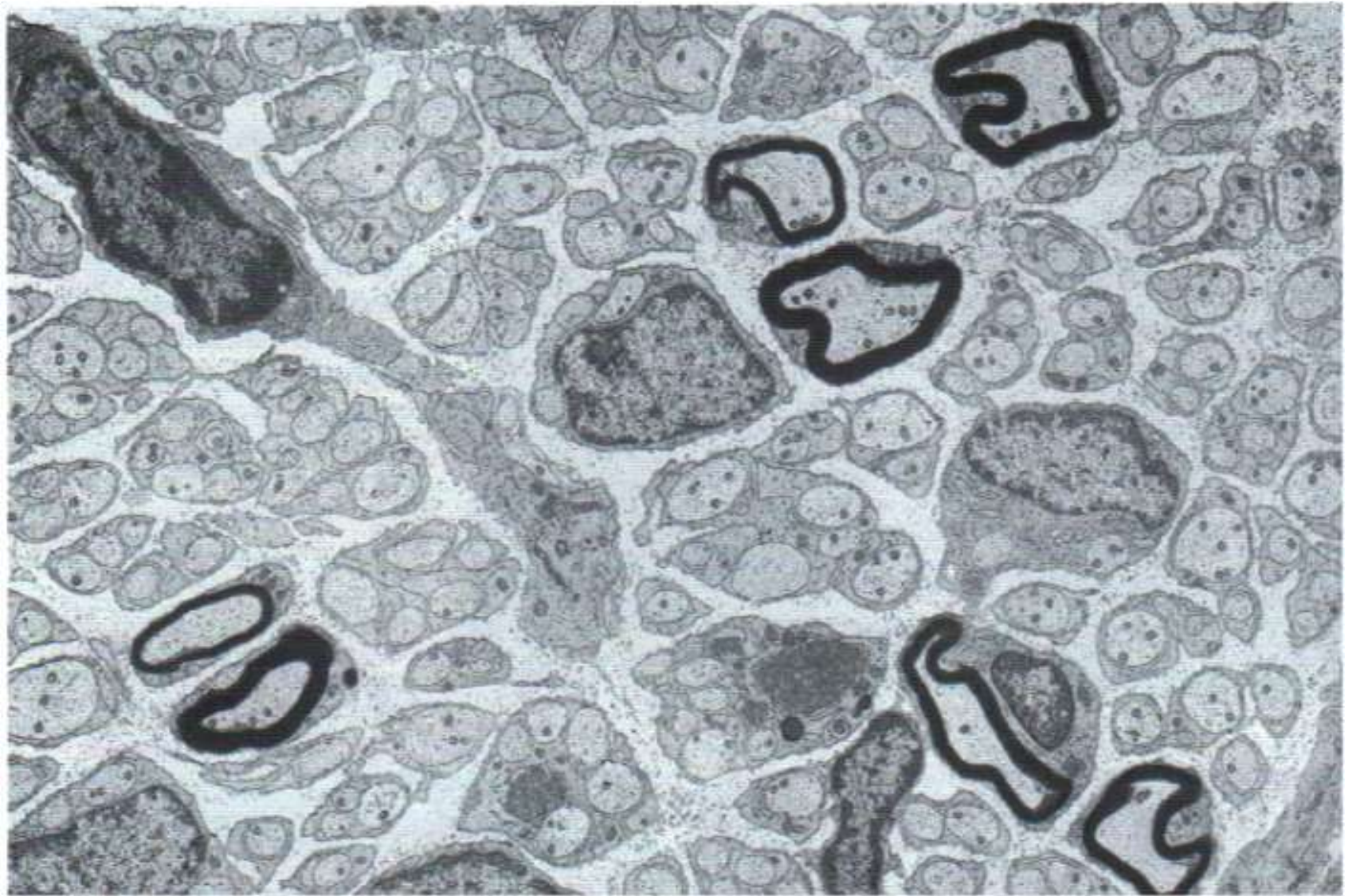
CNS

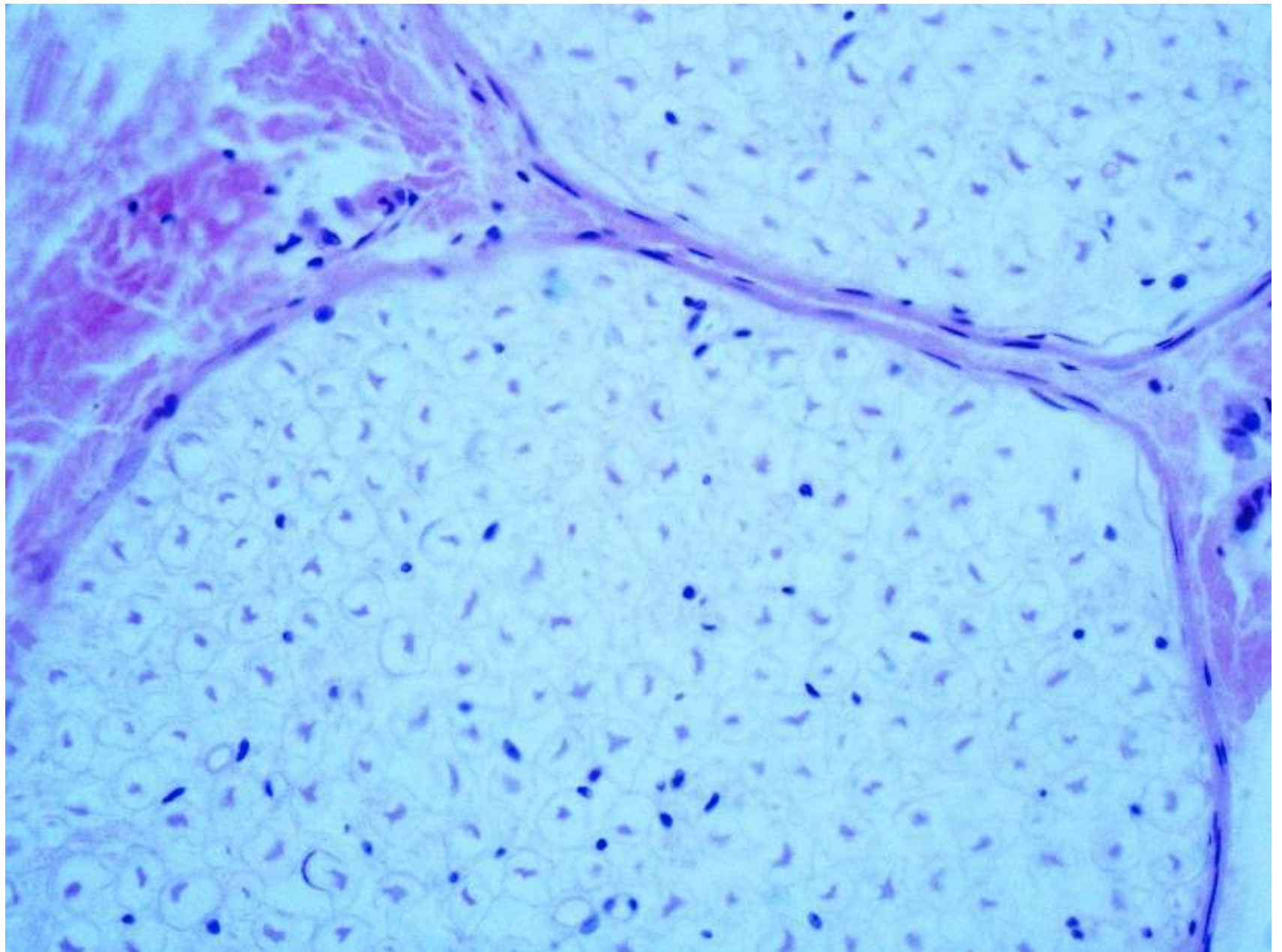


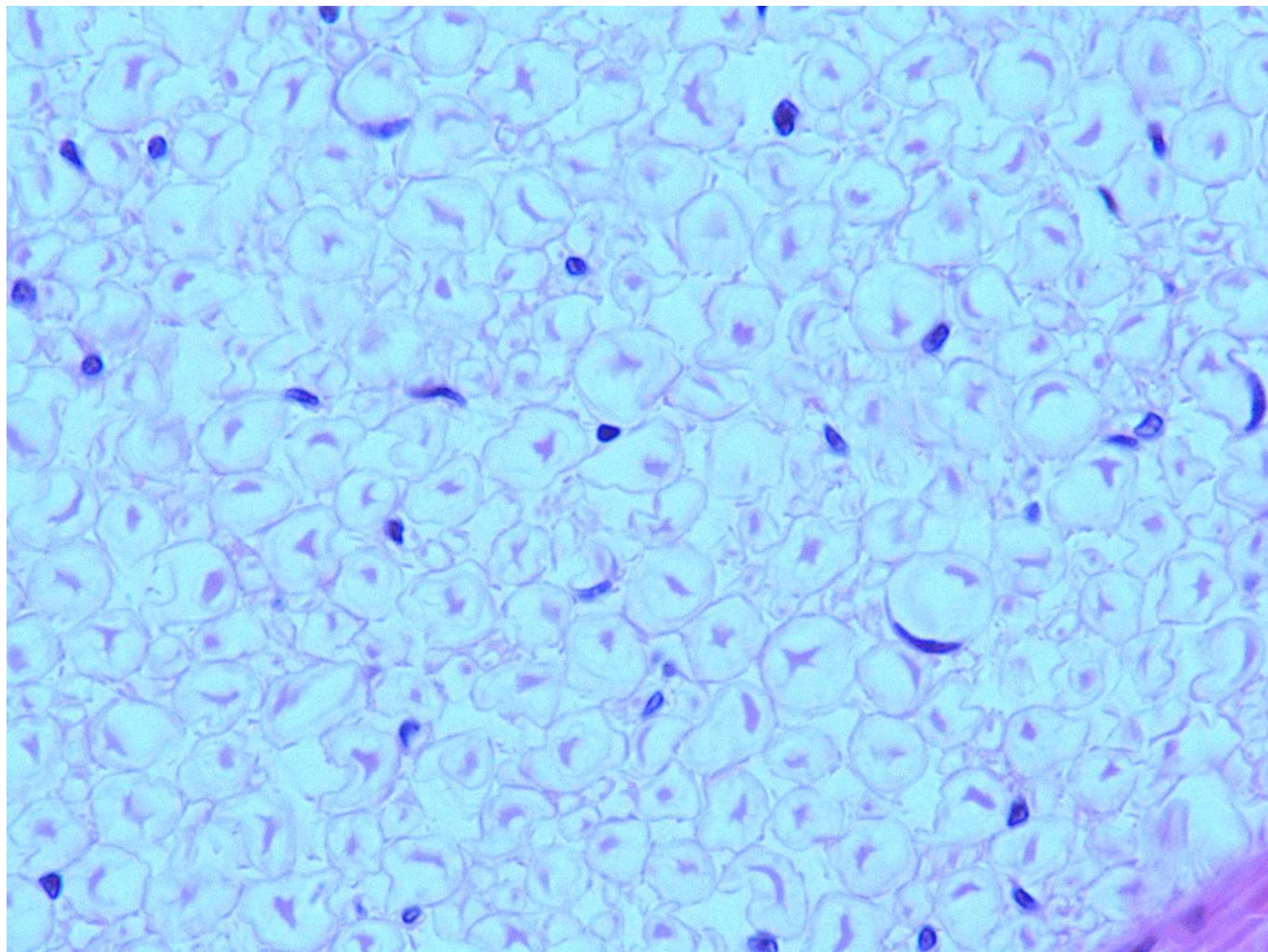
NERVE FIBERS









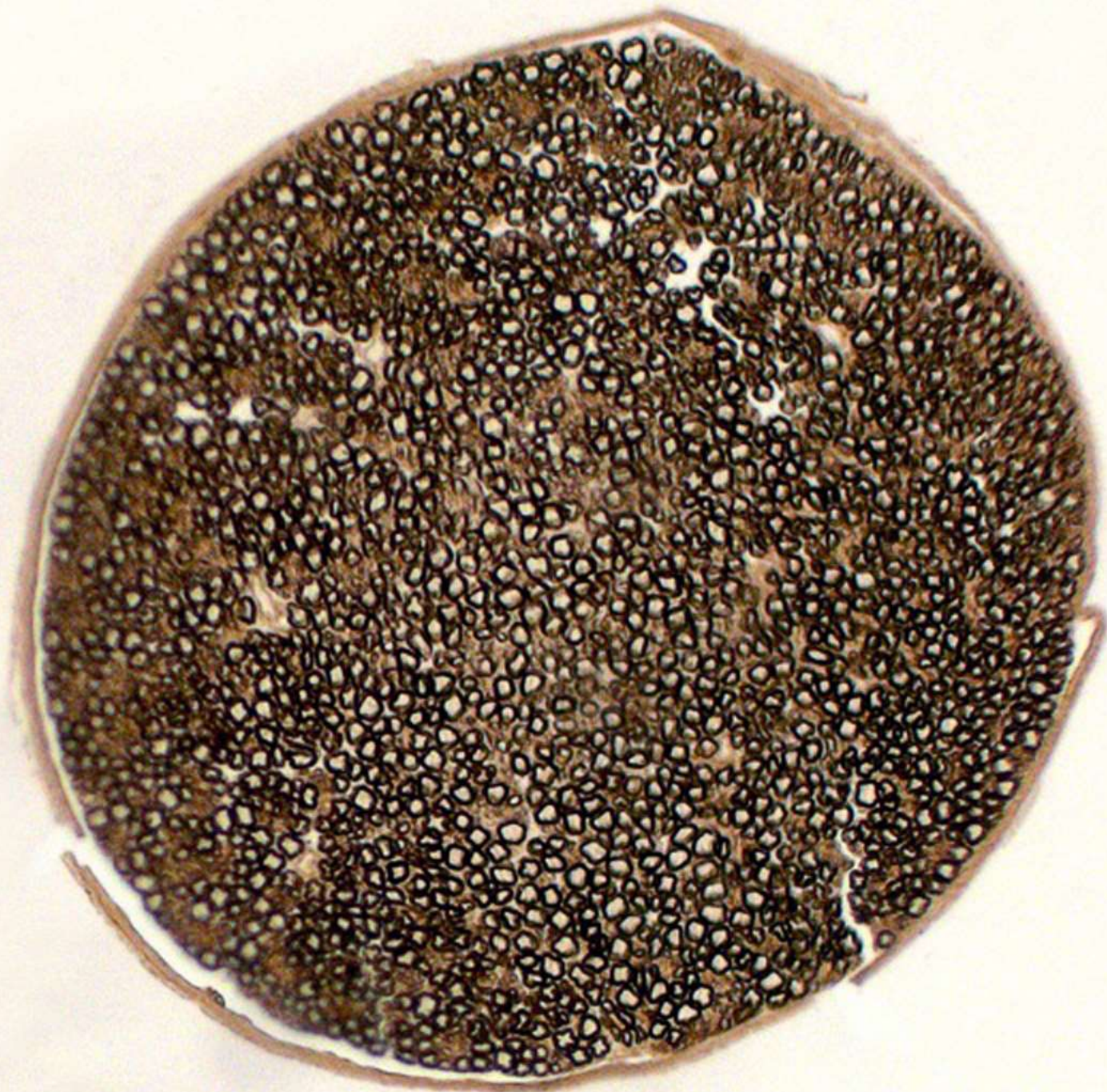


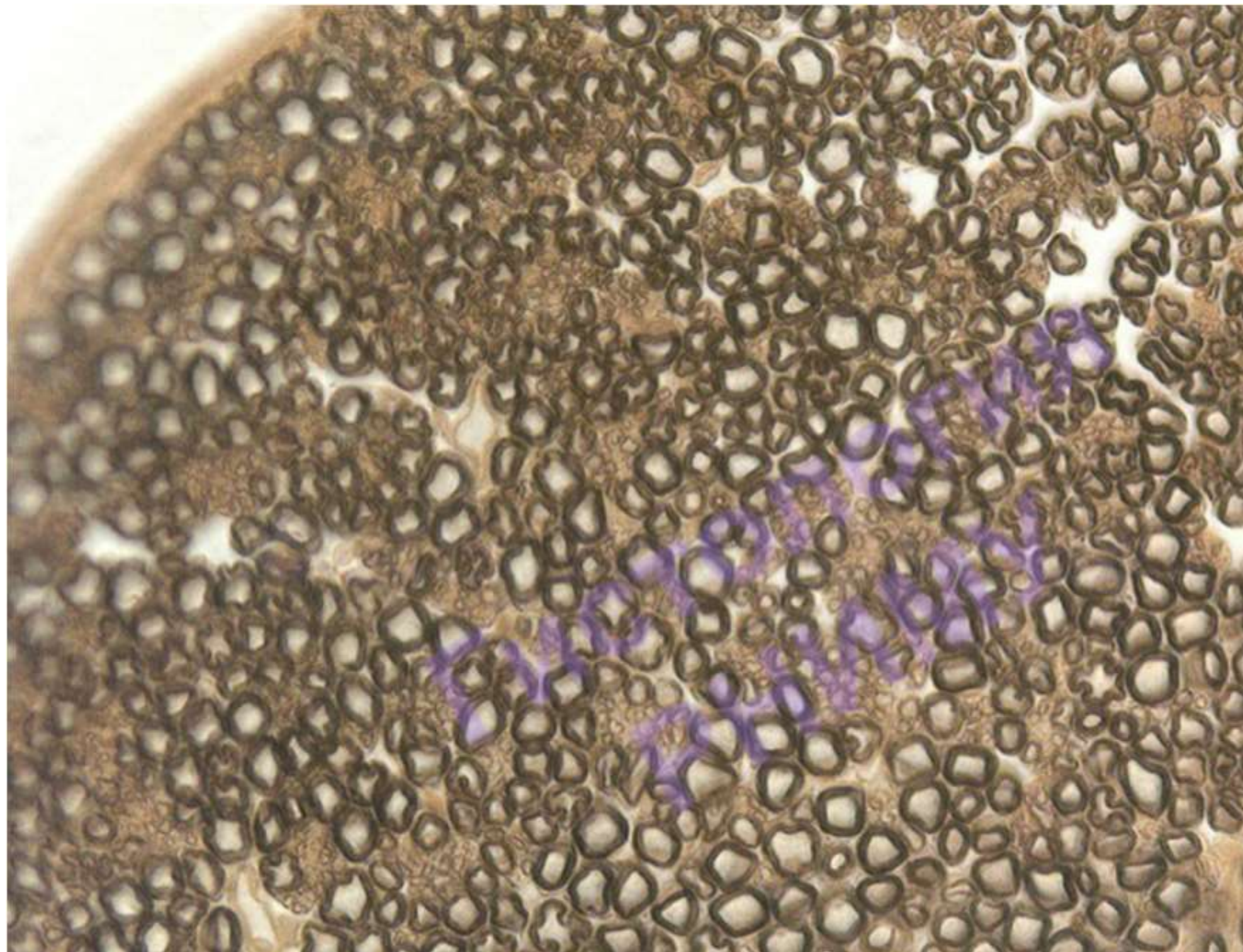




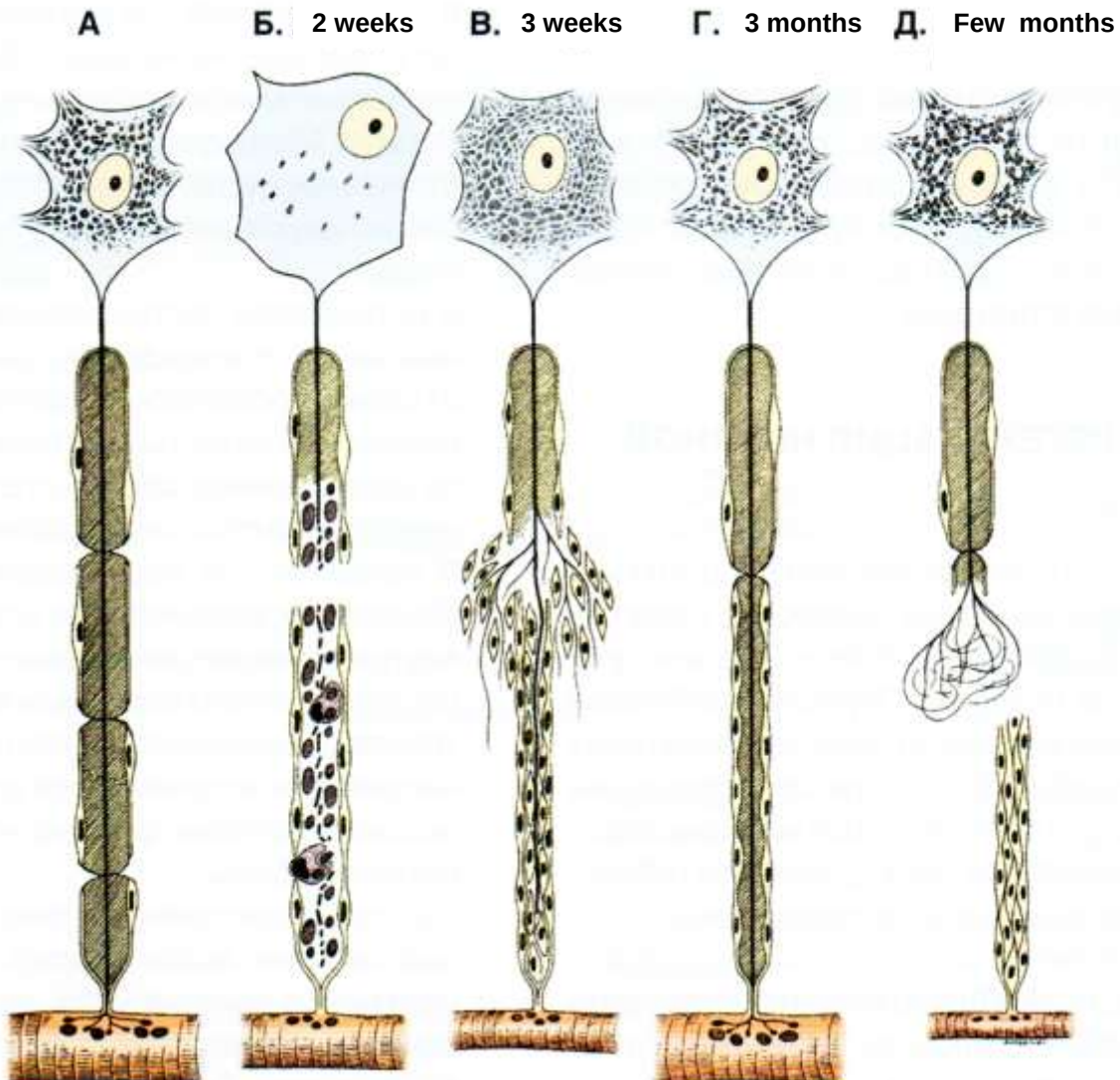






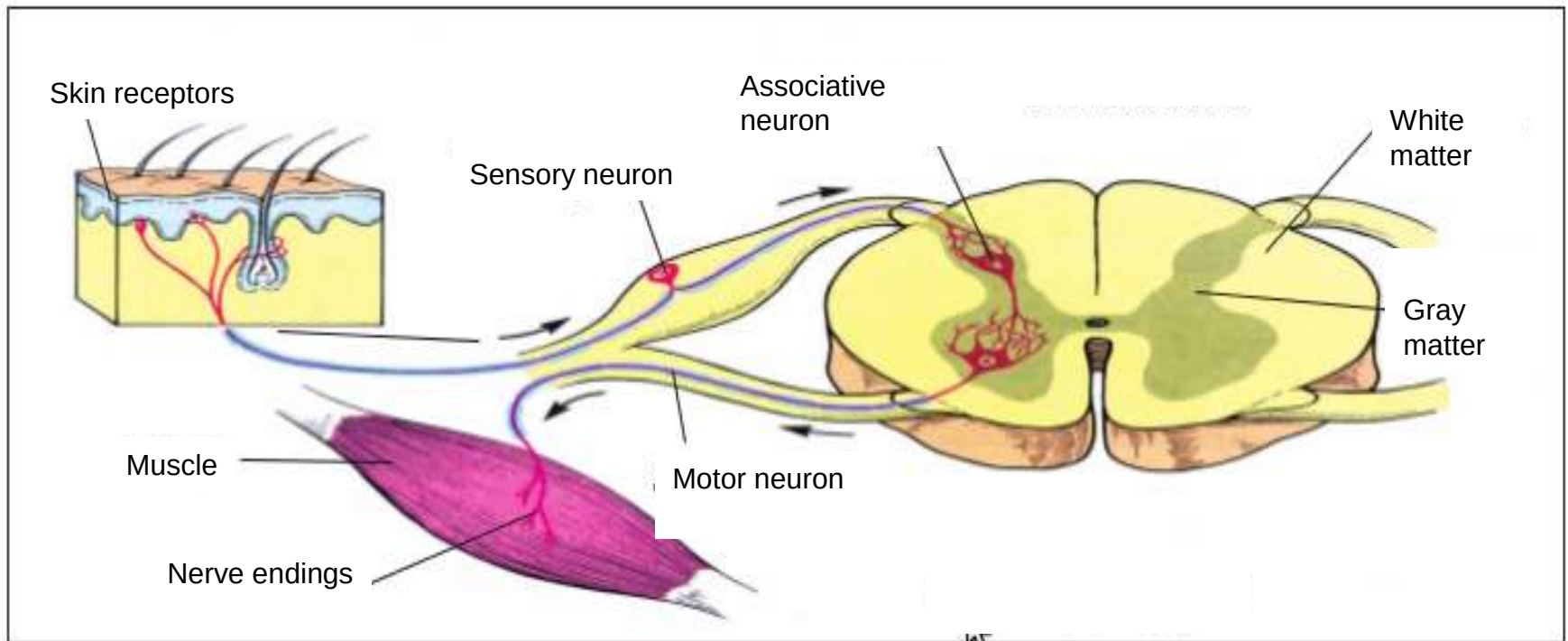


AXON REGENERATION

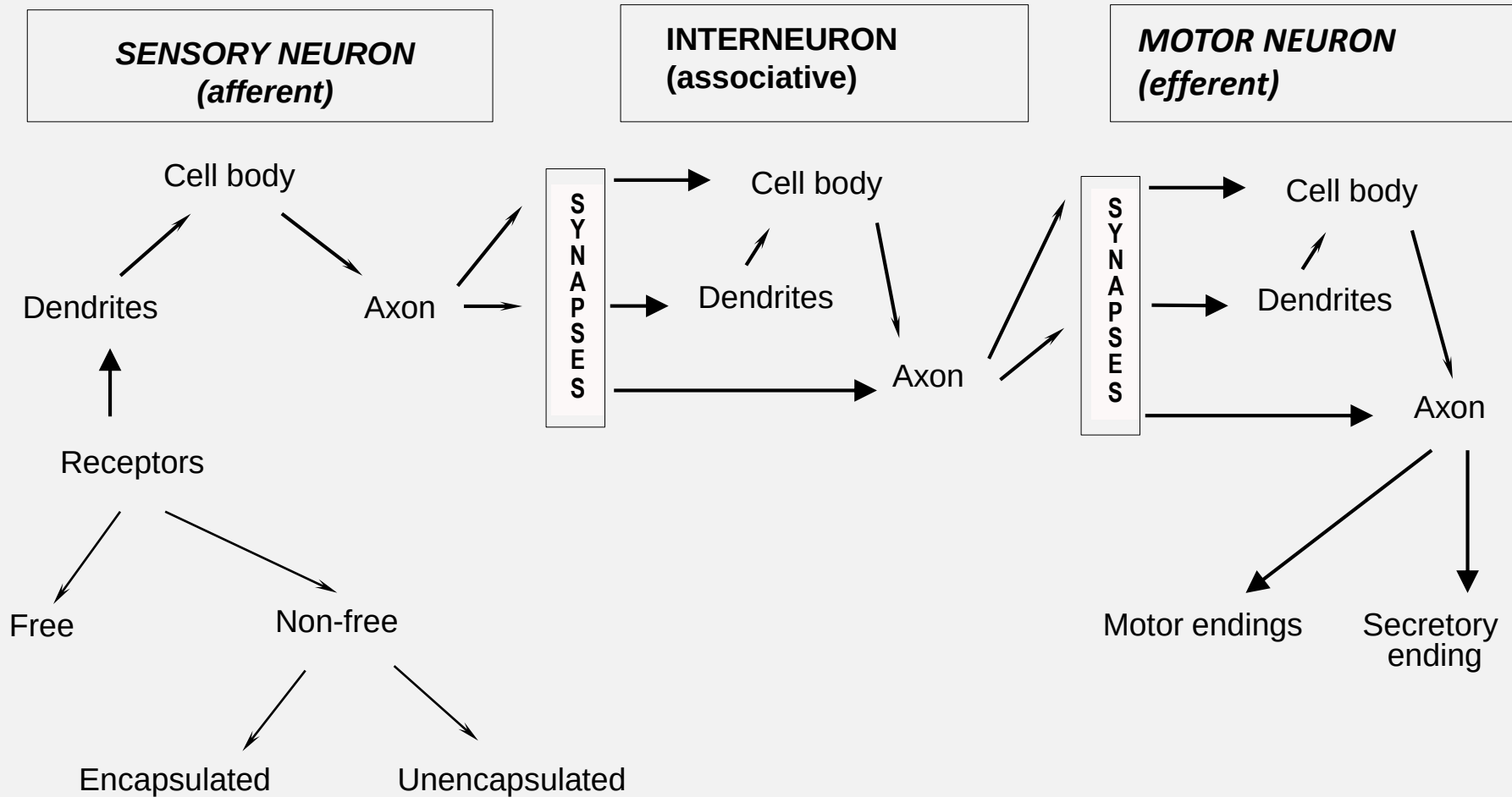


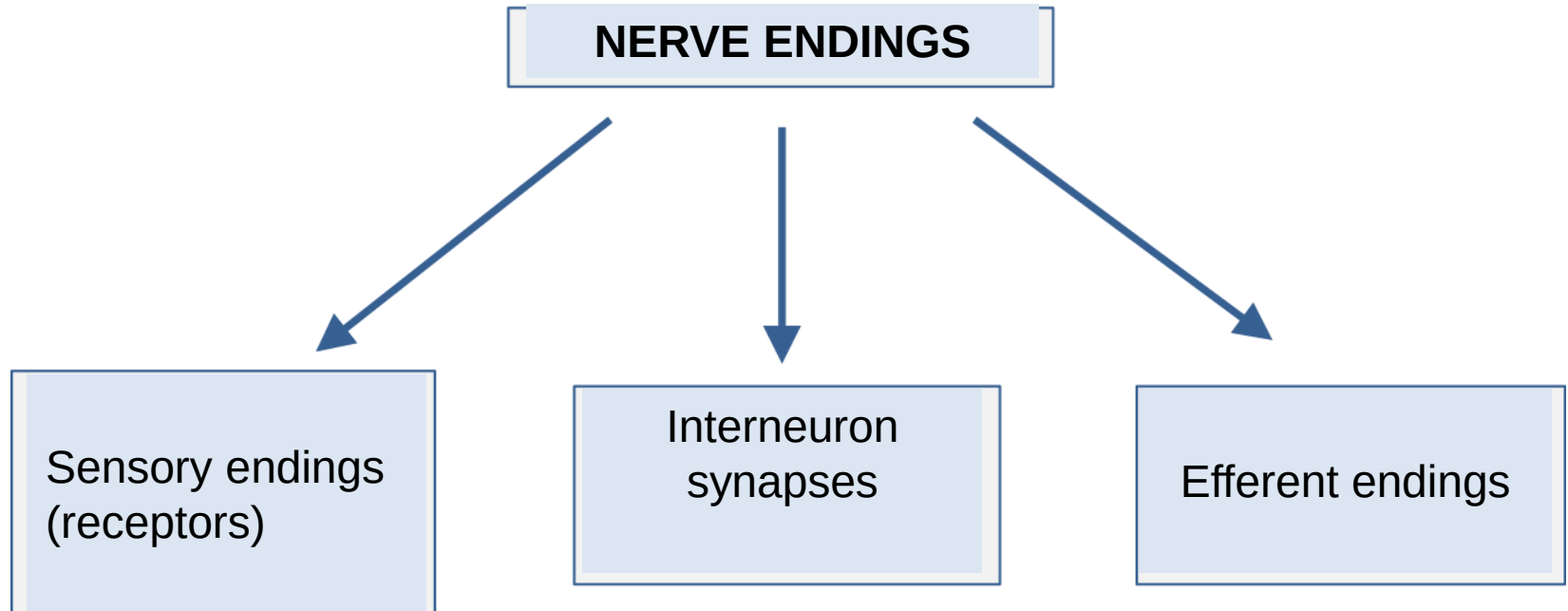
REFLEX ARCH

– a chain of neurons connected by synapses and providing a nerve impulse conduction from the receptor of a sensory neuron to the effector ending of motor neuron, that innervates target organ



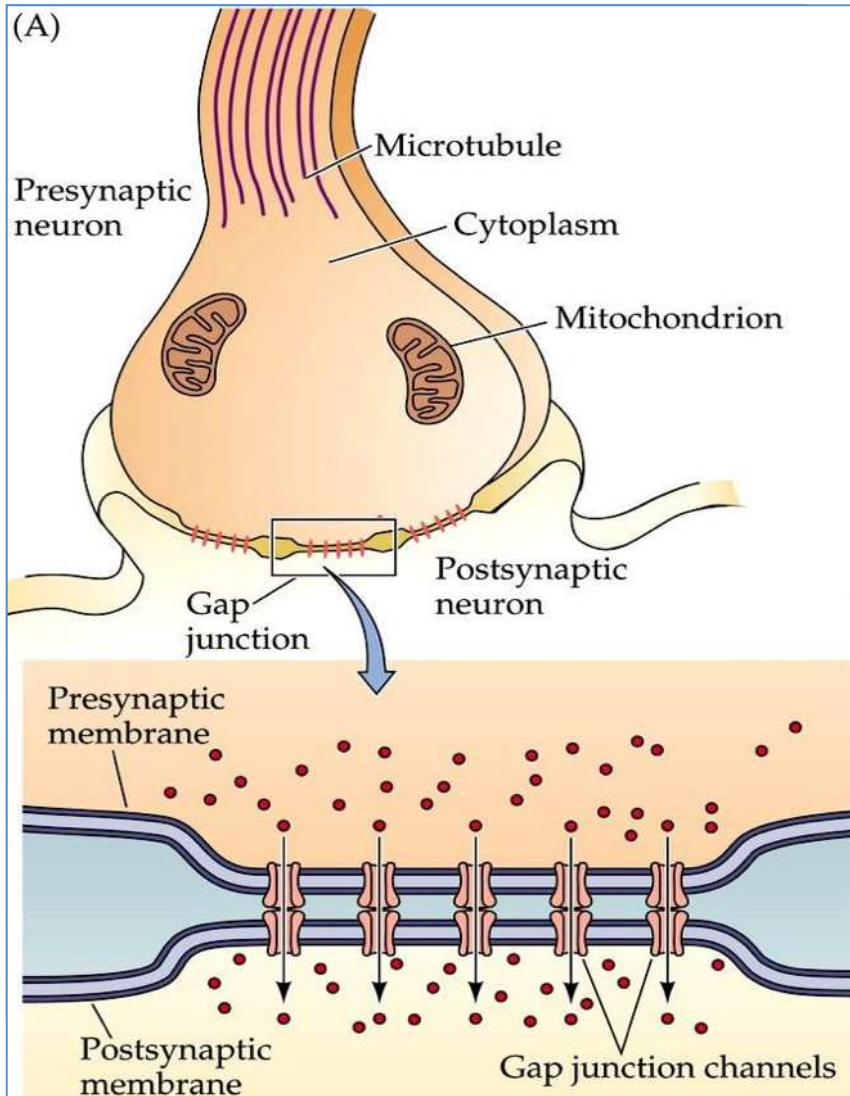
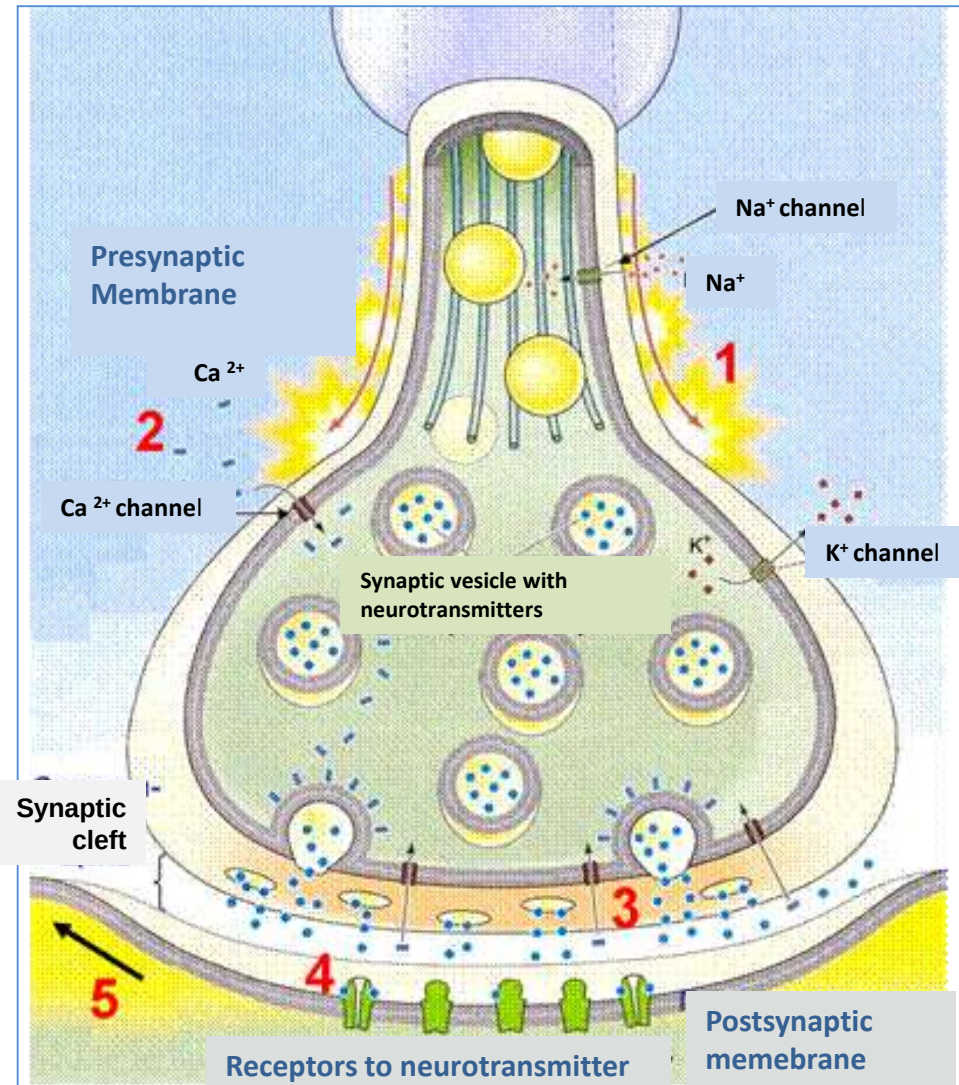
REFLEX ARCH





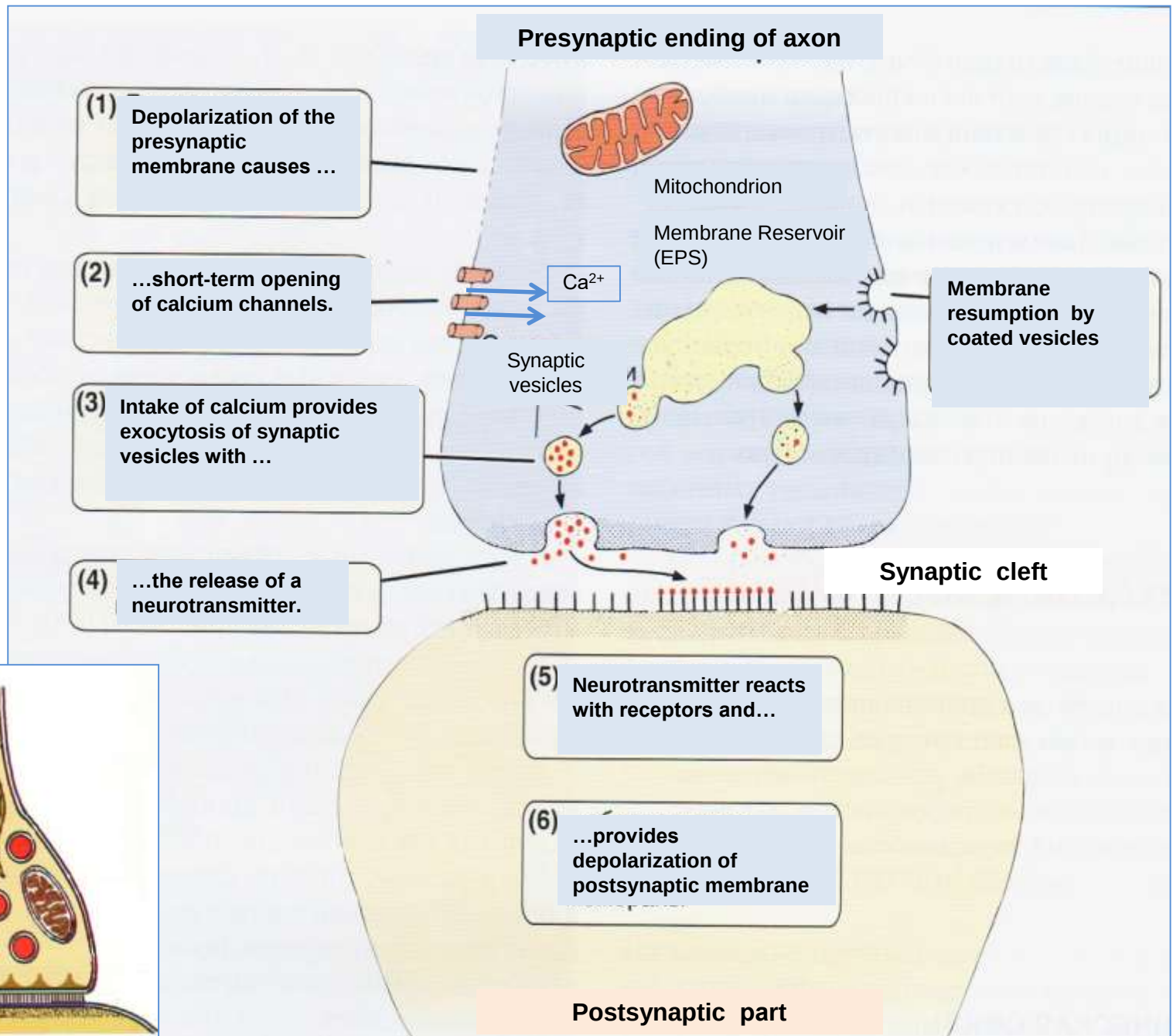
TYPES of SYNAPSES

Chemical

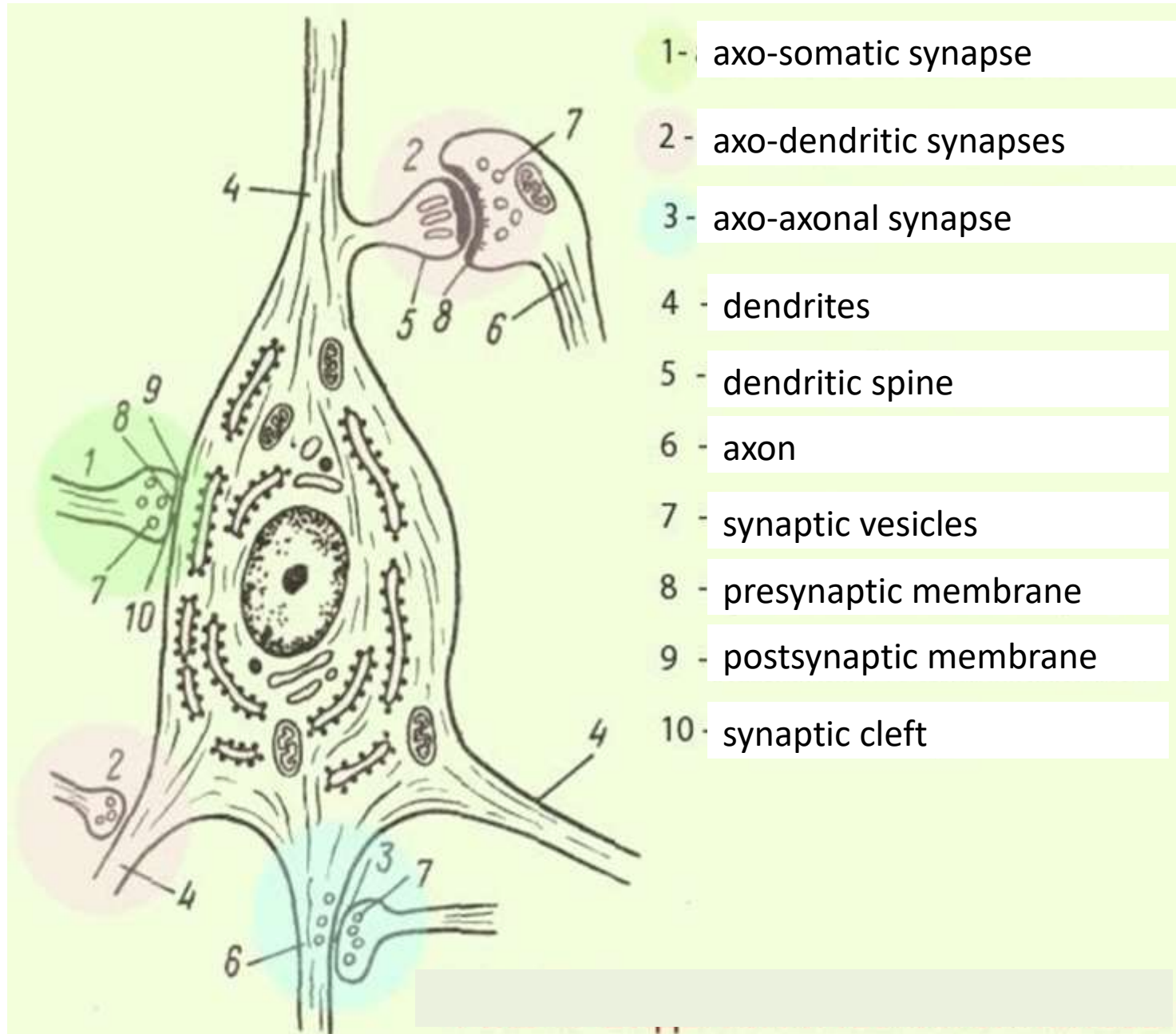


Electrical

SYNAPSE



CLASSIFICATION OF SYNAPSES according to *THEIR LOCATION*

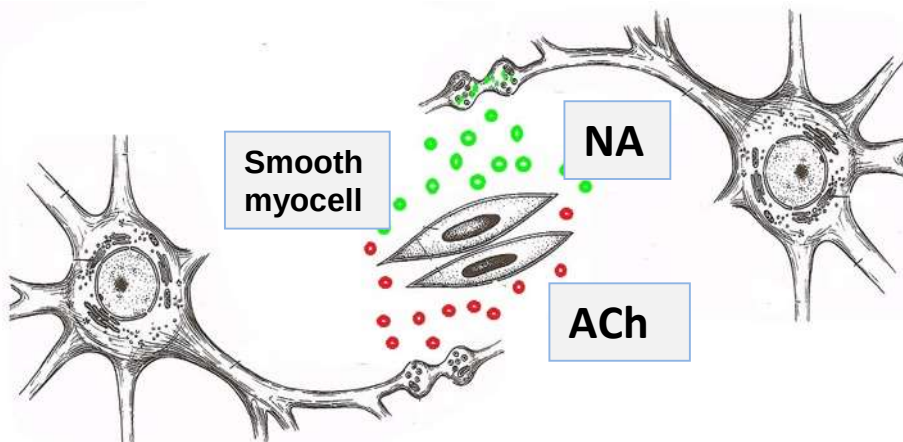
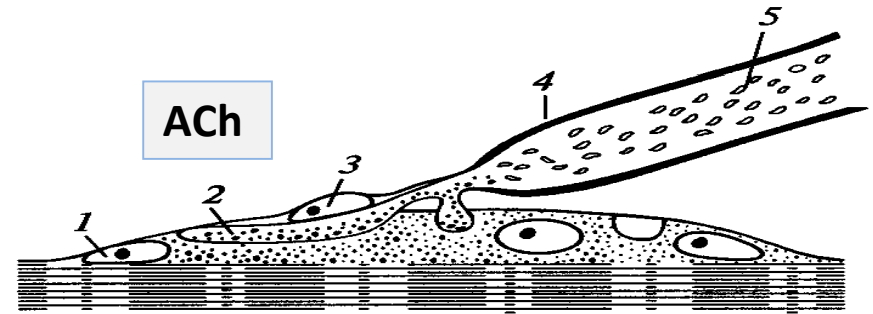


EFFERENT ENDINGS

SOMATIC NS

triggers skeletal muscle contraction

Neuro-muscle synapse
Motor end plate

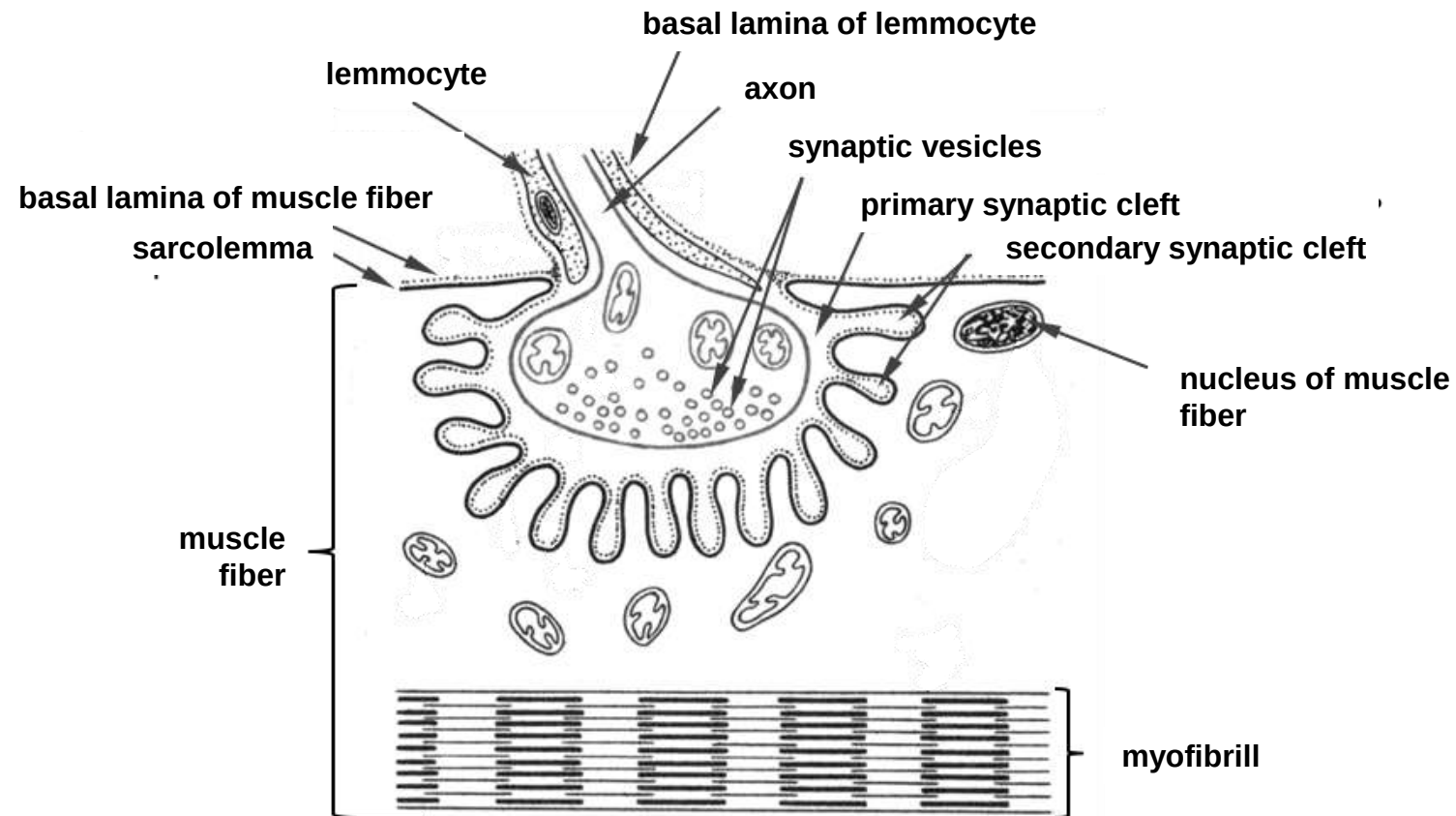


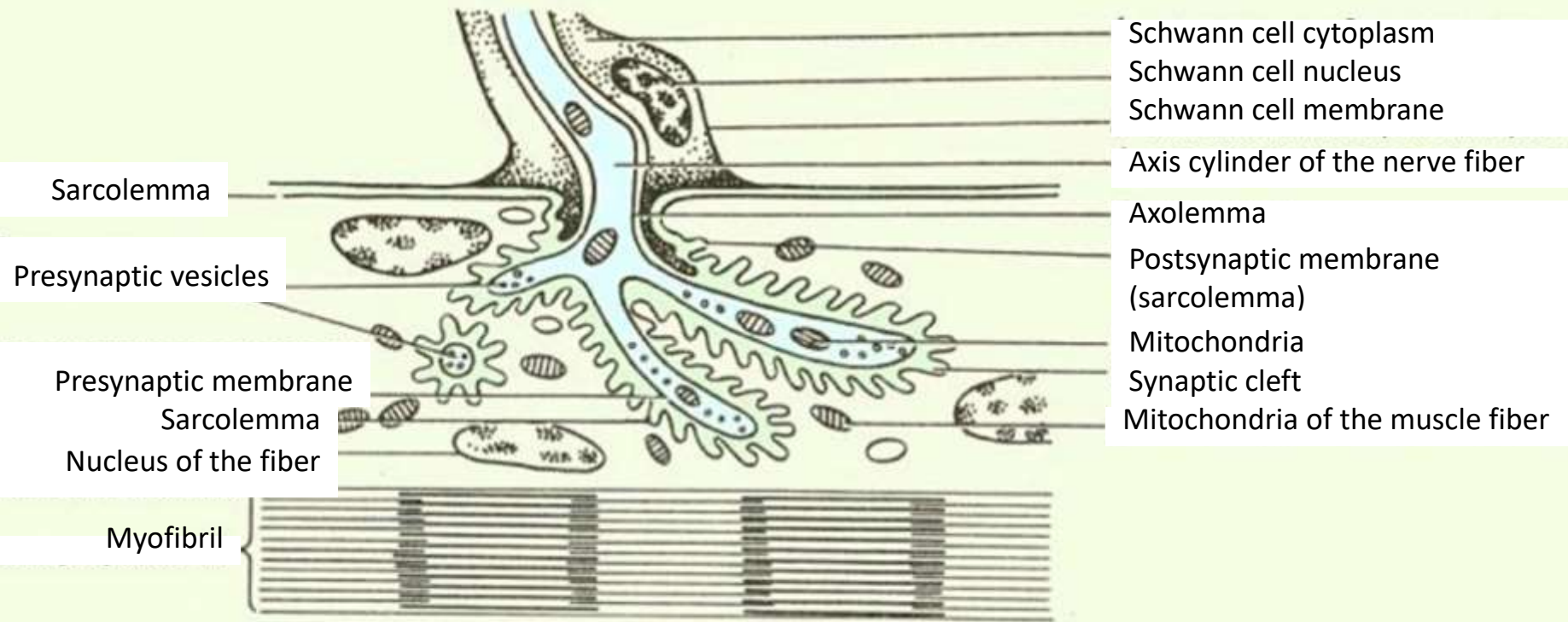
Secretory ending

AUTONOMIC NS

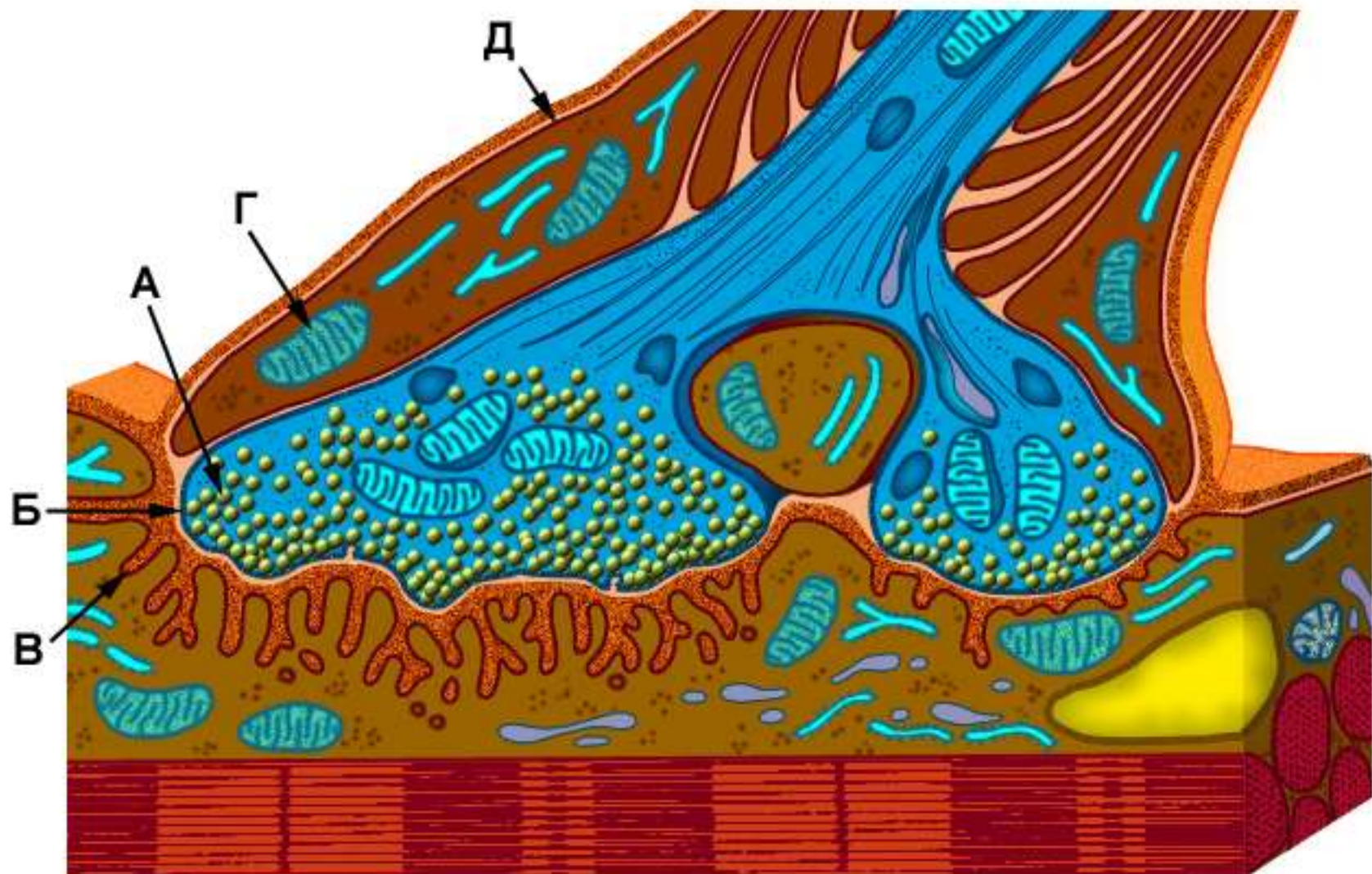
Does not have a triggering function.
Regulates the activity of cardiac muscle tissue ,
smooth muscles and secretory cells.

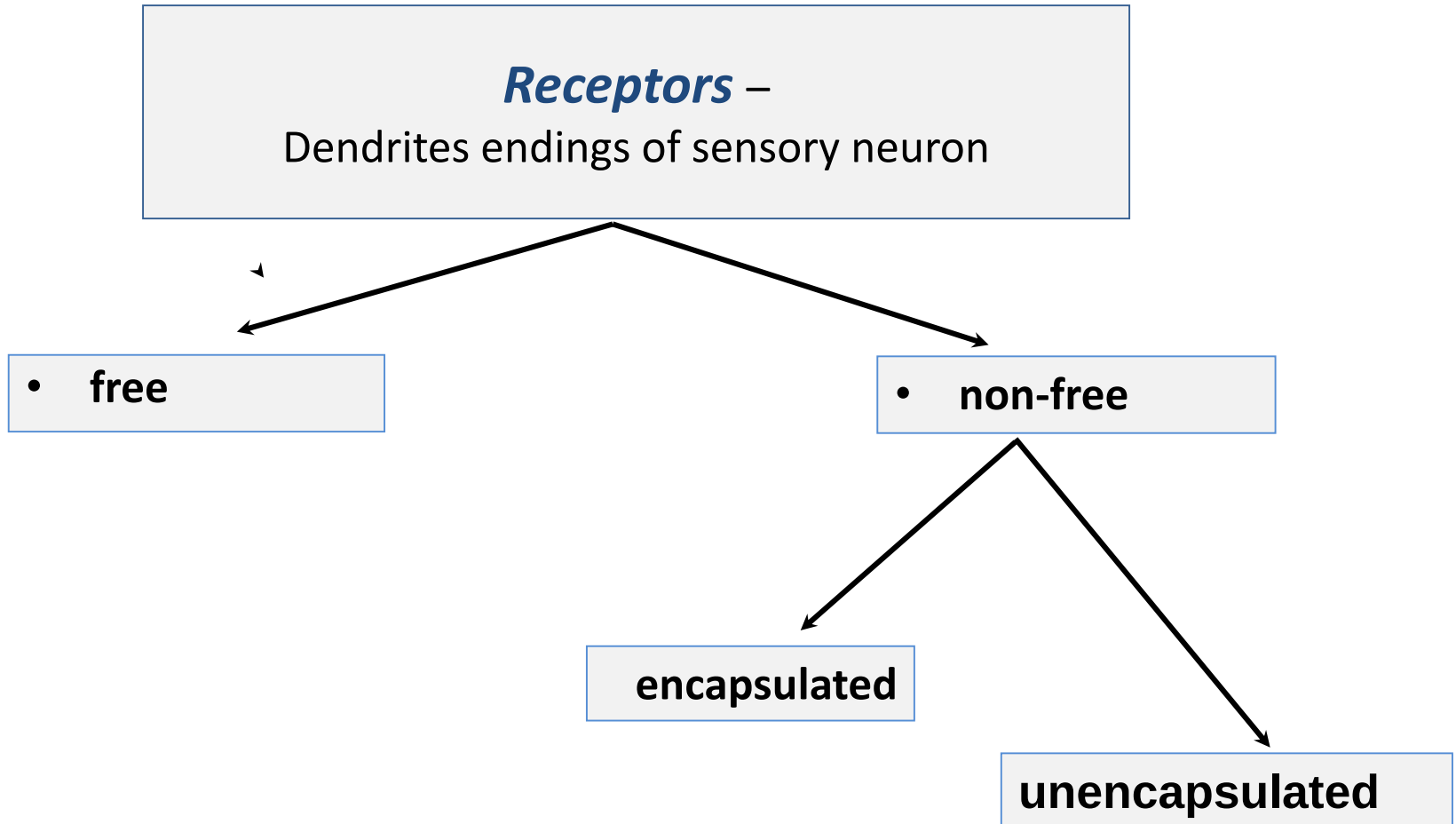
Motor end plate





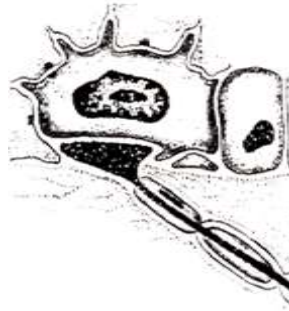
Ultramicroscopic structure of the neuromuscular junction







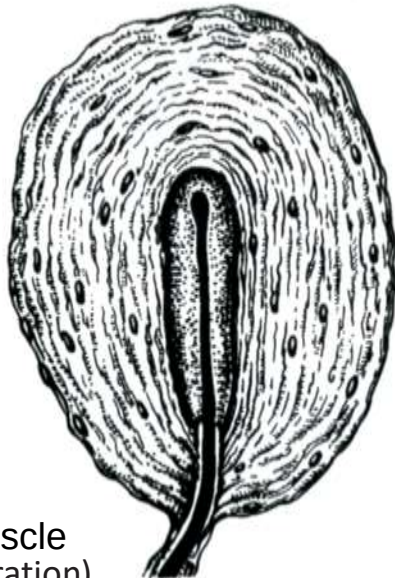
Free nerve ending
(pain, temperature)



Merkel's discs
(touch receptor)



Meissner's corpuscle
(touch receptor)



Pacinian corpuscle
(pressure and vibration)



Krause's bulb
(cold)



Ruffini's corpuscle
(stretch, heat)

Thick skin

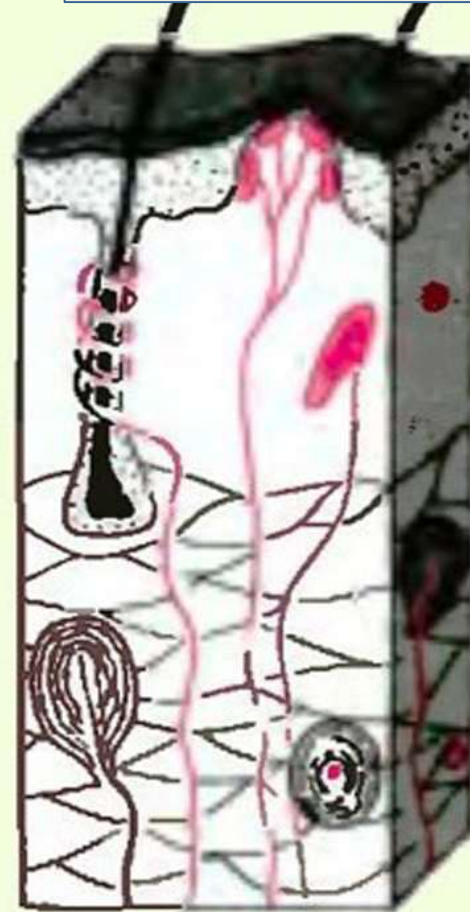
Thin skin

Stratum
corneum

Epidermis

Dermis

Hypodermis



Meissner's
corpuscle



Merkel's
discs



Pacinian
corpuscle



Hair follicle
receptor

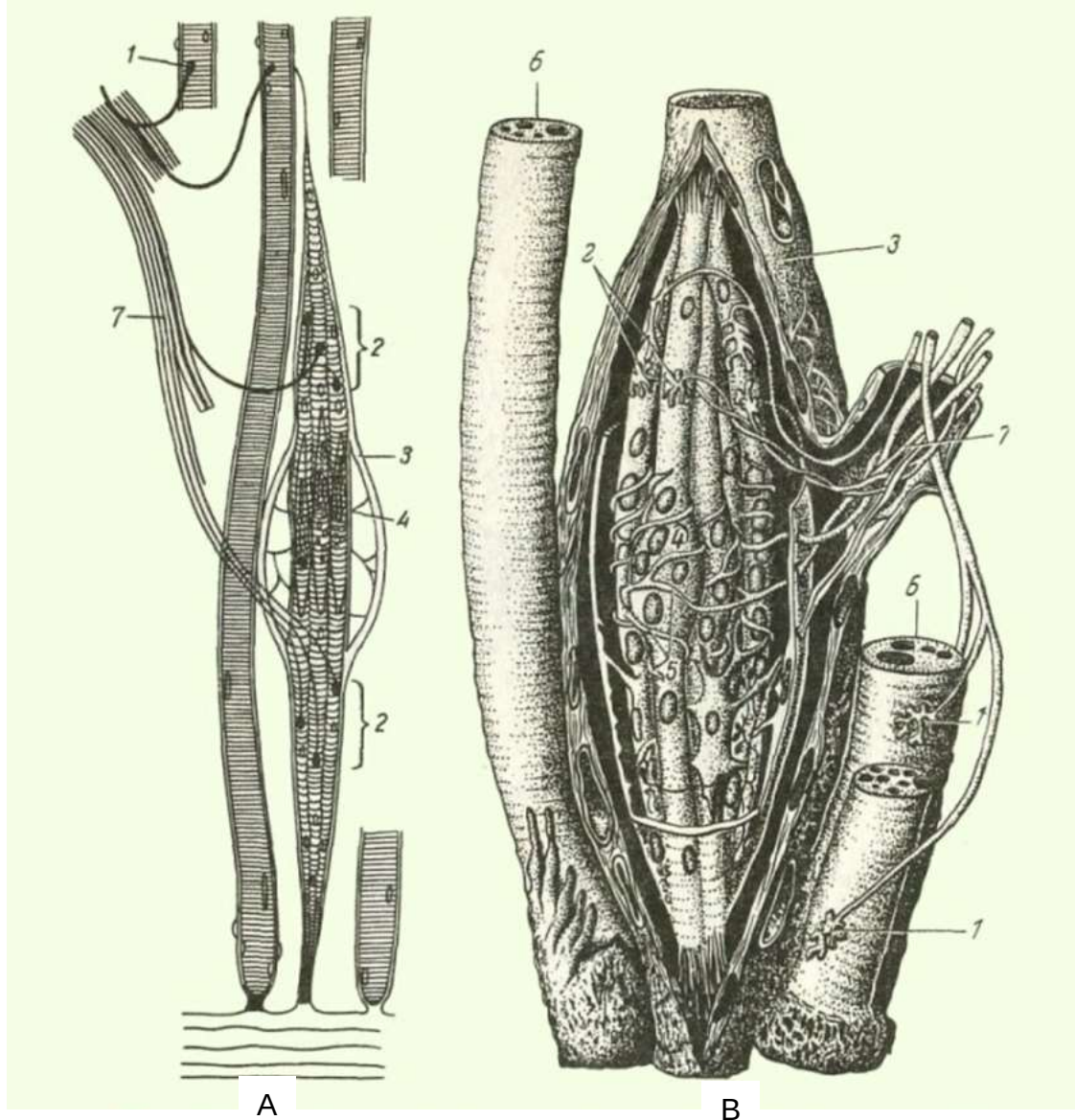


Tactile corpuscle
of Iggo



Ruffini's
corpuscle

Histology of the skin mechanoreceptors



Anatomy of muscle spindles

A- motor innervation of intrafusal and extrafusal muscle fibers;
 B- spiral afferent nerve endings around the perinuclear portions of the intrafusal muscle fibers

