Nerve tissue

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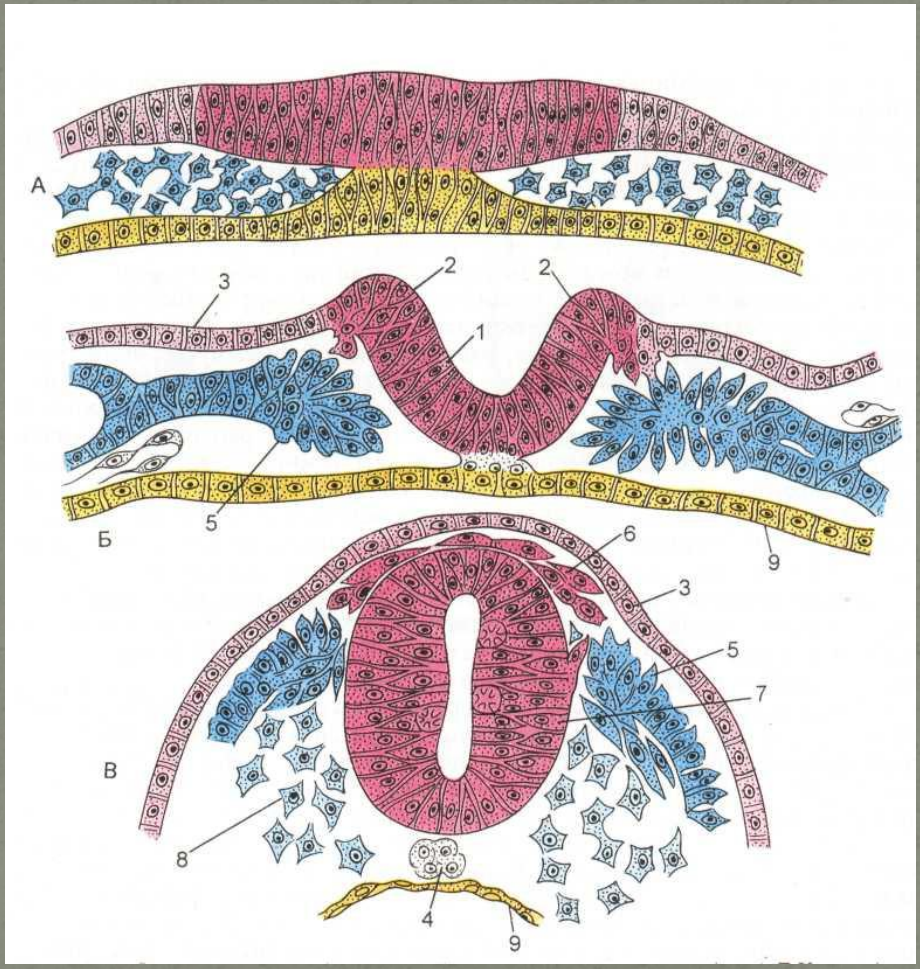
Nerve tissue is a system of nerve cells and neuroglia that provide specific functions of perception of stimulation, excitation, generation of an impulse and its transmission. It provides the regulation of all tissues and organs, their integration in the body and communication with the environment.

Structural components of nerve tissue

- **Nerve cells - neurons -** the main component of nerve tissue.
- **Neuroglia -** provides the existence and functioning of nerve cells, implements supporting, trophic, barier, secretory and protective function.

Histogenesis of nerve tissue

- NT develops from ectoderm
- For 18 day the neural plate (thickening of the dorsal ectoderm) is differentiated, then the nerve folds (the thickened edges of the neural plate, which rise and close) form the neural tube
- Part of the cells of the N. plate forms the N. crest (ganglionic plate).
- CNS neurons and macroglia of the central nervous system are formed from the N. tube
- From the neural crest neurons of sensitive and autonomic ganglia, brain membrane cells, neurolemmocytes, ganglia satellite, medulla of adrenal medulla, melanocytes of the skin are formed.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In the cranial part of the embryo, thickening of the ectoderm is formed - placodes from which the ganglia of V, VII, IX, X pairs of cranial nerves are formed.

In the neural tube 3 concentric zones are formed:

- ventricular (ependymal)
- intermediate - (mantle)
- marginal veil (marginal).

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- The ventricular zone consists of ependymocyte progenitor cells

- The intermediate zone consists of neuroblasts and glioblasts. Neuroblasts differentiate into neurons, glioblasts → into astrocytes and oligodendrocytes. From the cells of this zone, gray matter s / m and part of the gray matter g / m are formed.

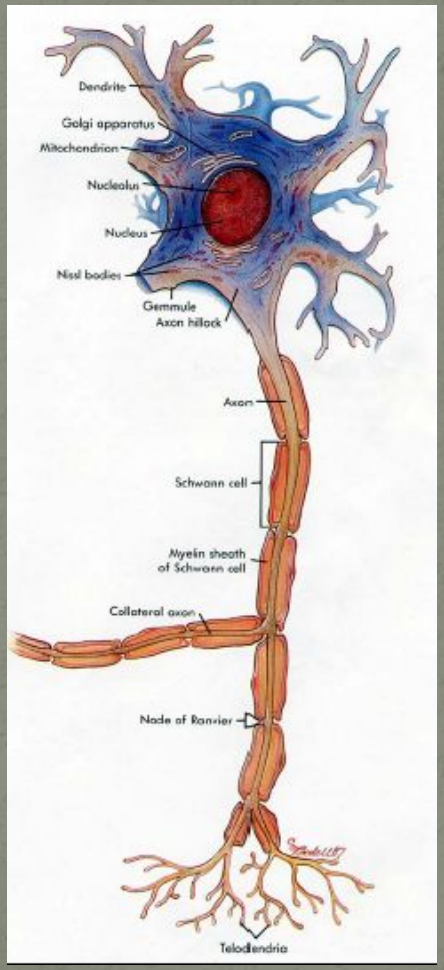
- The marginal zone is formed from the axons of neuroblasts and macroglia and gives rise to white matter.
- Neuroblasts differentiate into mature cells - neurons (about 1 trillion total)
- Neurons die by apoptosis, about 10 million nerve cells are destroyed annually.

Characteristic of neurons

- These are specialized cells,
- responsible for the reception, conduction, processing of the impulse and its transmission to other neurons, muscle or secretory cells.
- With the help of their processes, neurons form contacts with other neurons (reflex arcs).

Structure of neuron

- Neurons are composed of the body (pericarion) and processes (1 axon and dendrites)
- Axon (neuritis) is the central process along which the impulse is transmitted from the body of the neuron.
- Dendrites - transmit nerve impulses to the body of a neuron
- The sizes of neurons range from 4-6 microns (certebellar cortex-granuk cells) to 130-150 microns (Betz pyramidal cells



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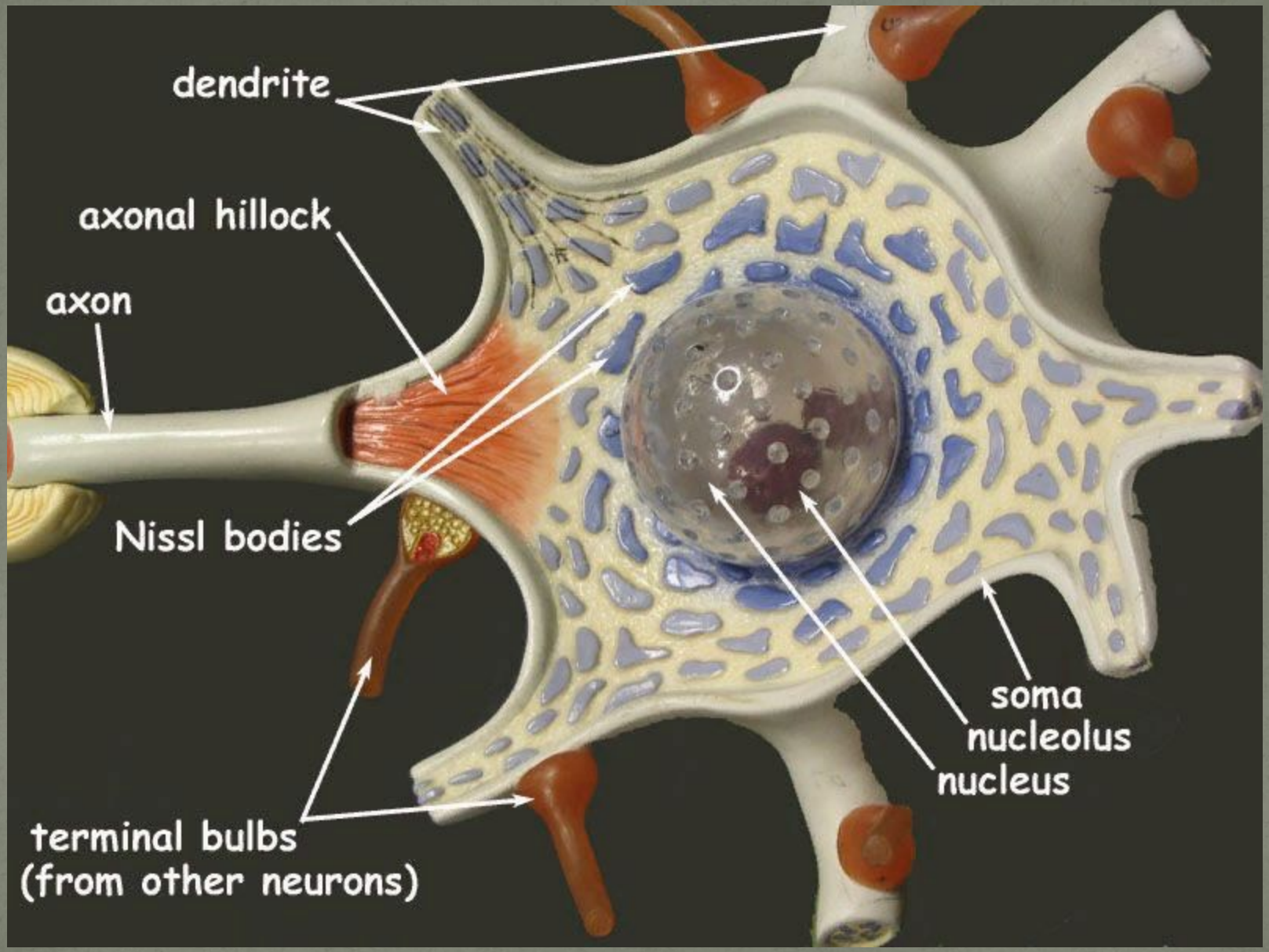
dendrite
axonal hillock
axon
Nissl bodies
terminal bulbs
(from other neurons)
soma
nucleolus
nucleus

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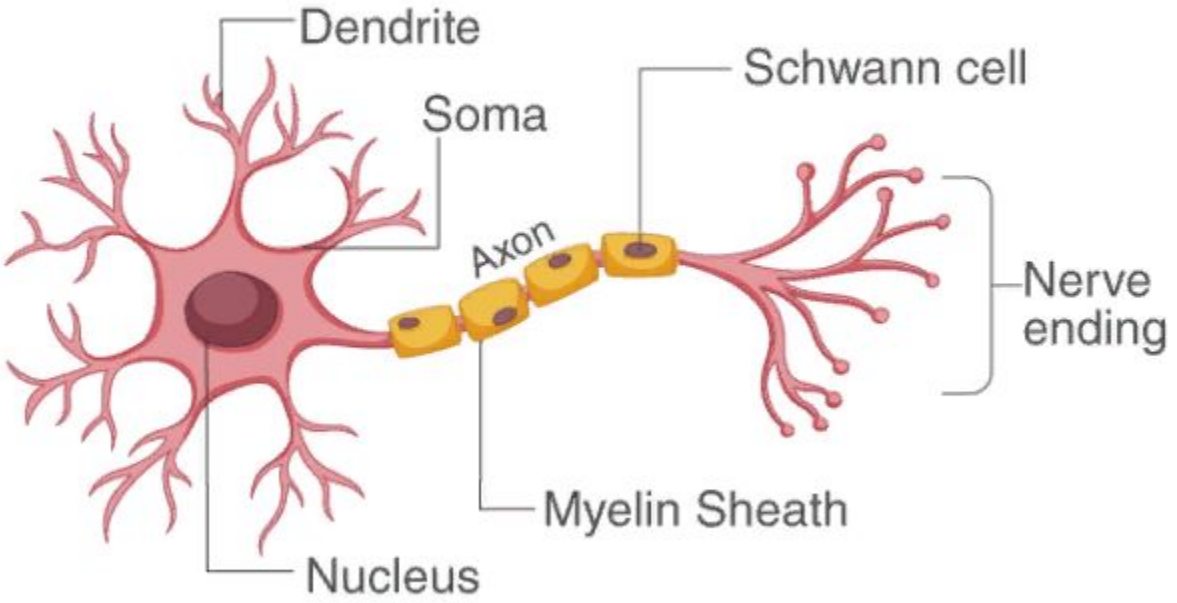
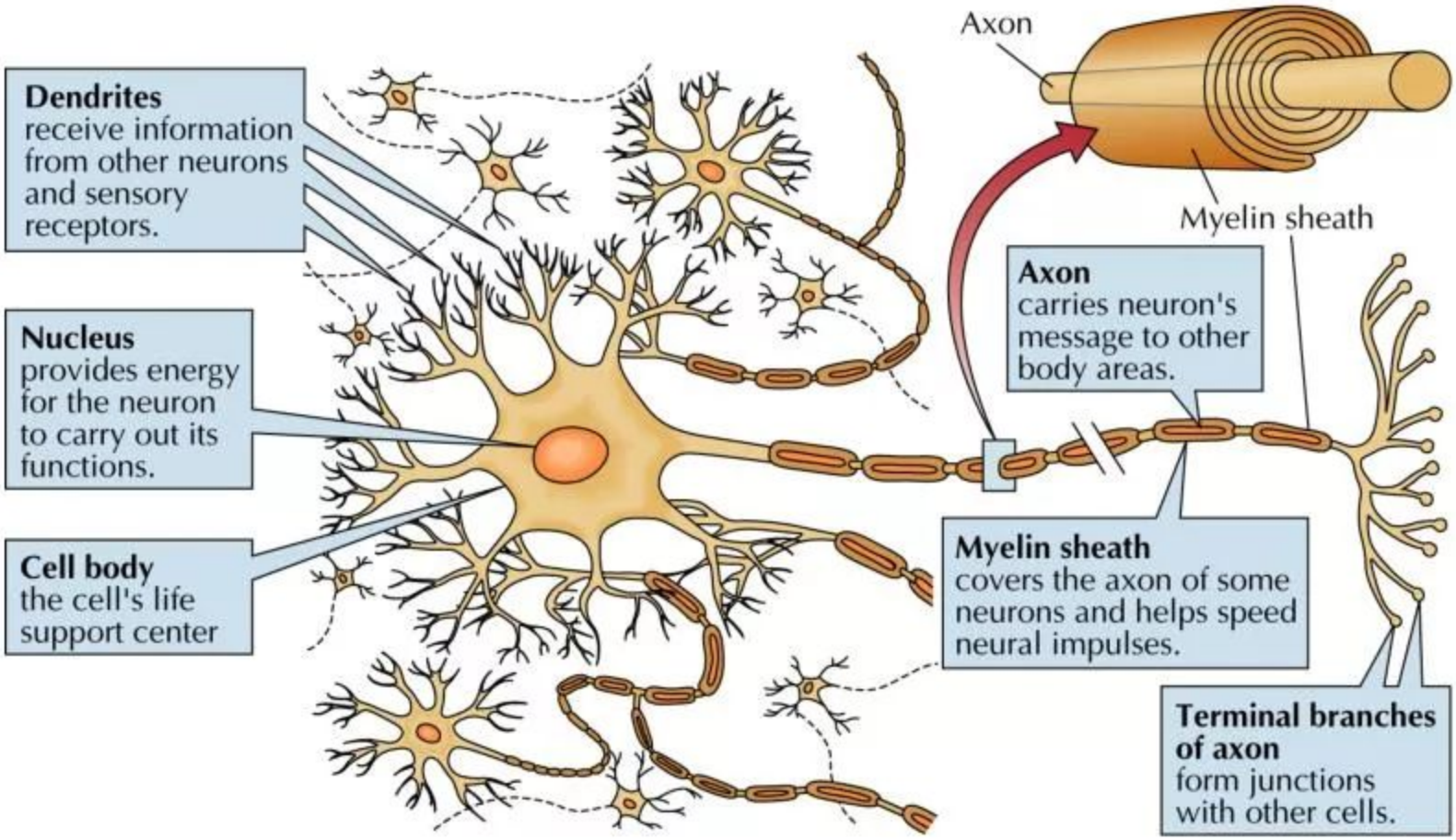
STRUCTURE OF NEURON



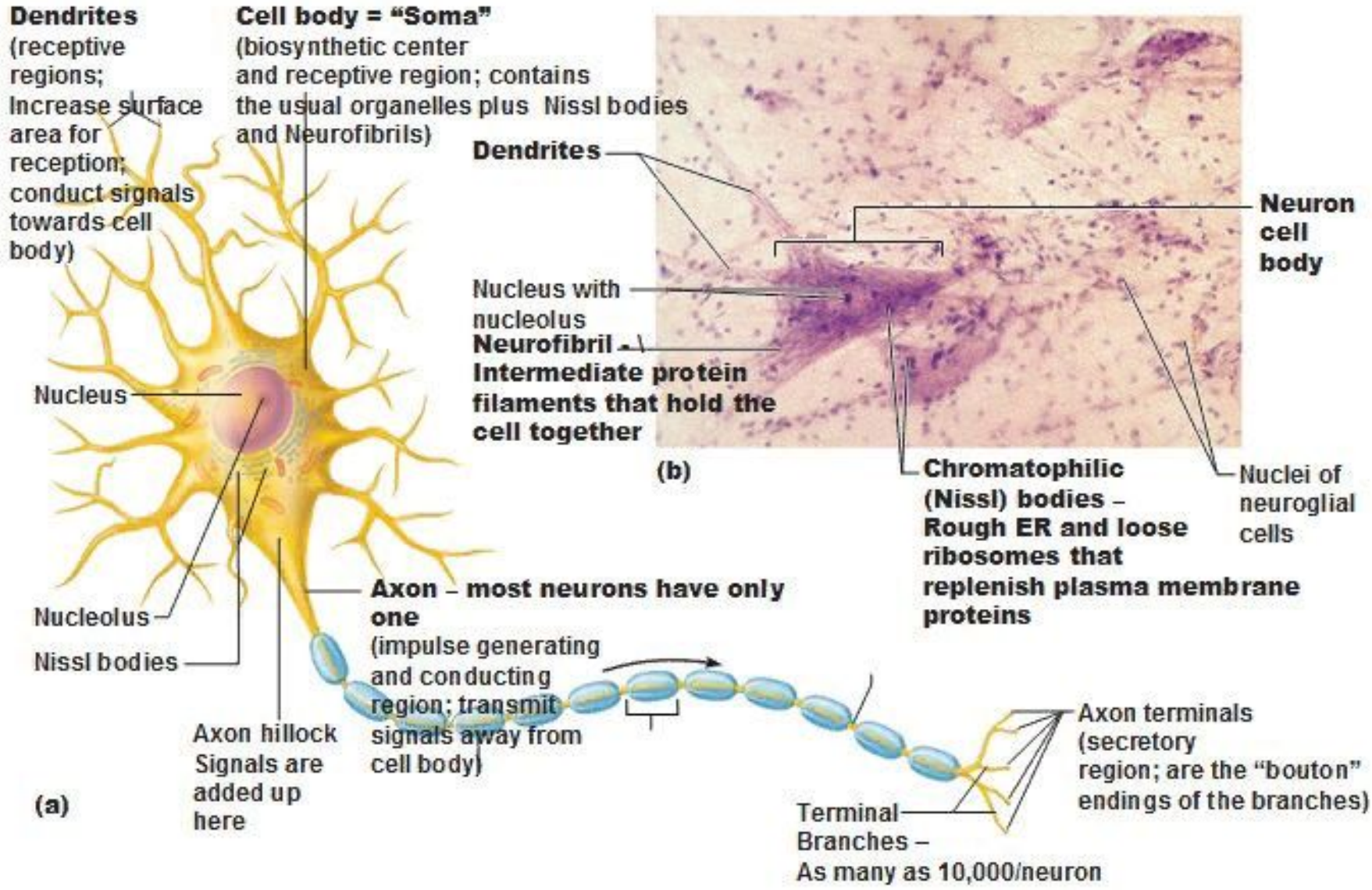
nucleus

myelin

Neuron Structure



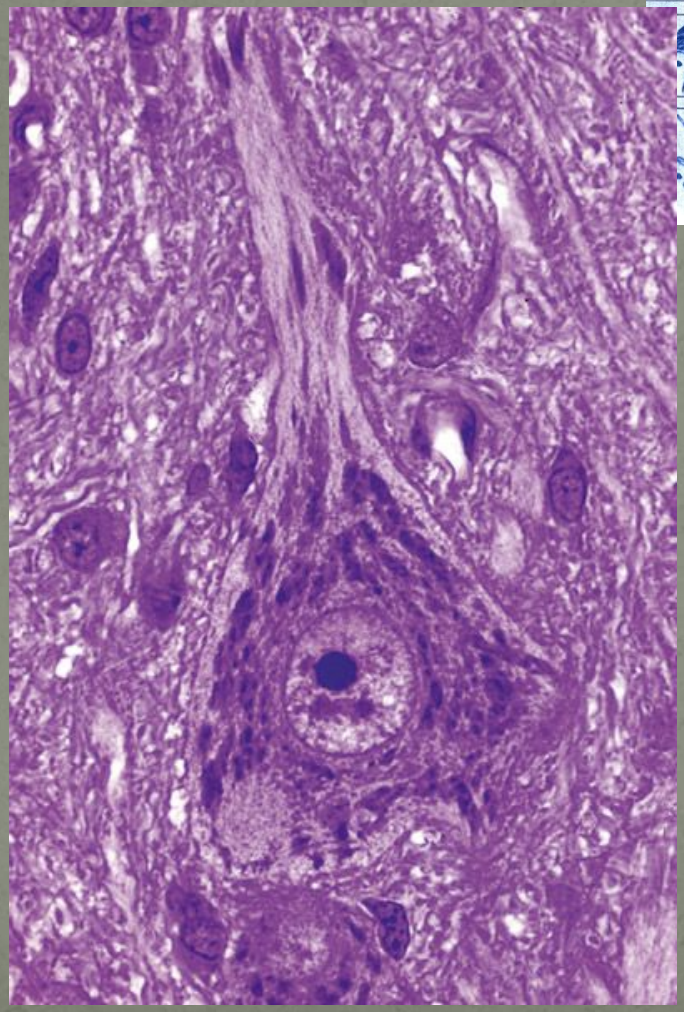
Structure of a Typical Motor Neuron

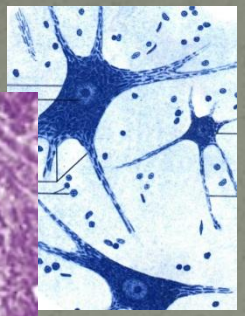


- Plasmolemma has the ability to generate and conduct impulse
- The nucleus is usually one
- Among other organelles are well developed: CG, mitochondria, lysosomes.
- With age lipofuscin - an aging pigment accumulates in neurons. These are residual bodies.

- **Chromatophilic substance (tigroid or Nissl's body) - detected in the cytoplasm in the form of basophilic clumps or grains of various sizes. Formed by rEPR cisternas.**
- **Basophilia of Nissle body is associated with a high content of RNA.**
- **THIS IS THE MOST IMPORTANT NEURON STRUCTURE!**

NISSLE BODIES





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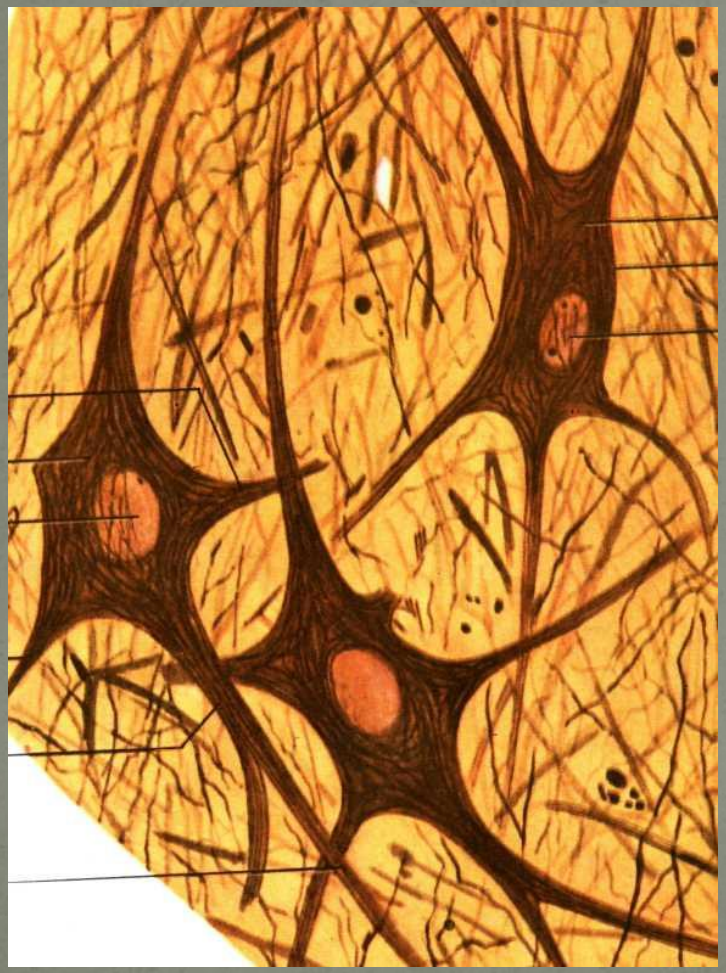
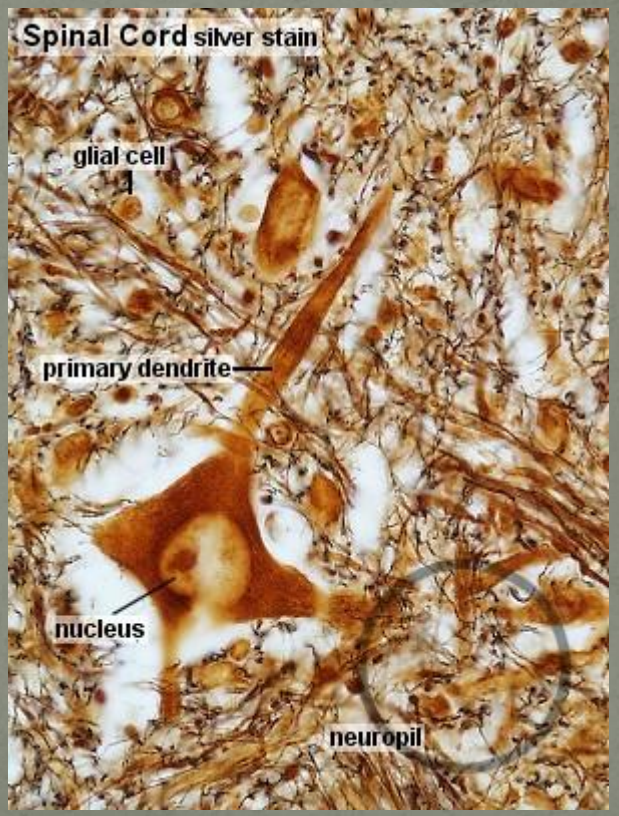
- The cytoskeleton is represented by **neurofibrils** (12 nm) and neurotubules (24-27 nm). In the body of the neuron they are located in the form of a network, and in the processes - in parallel.
  - THIS IS THE SECOND IMPORTANT NEURON STRUCTURE
- Neurotubules are involved in maintaining cell shape and axonal transport.
- Axonal transport - the movement of substances from the body to the processes - and vice versa (retrograde - to the body of a neuron, anterograde - from the body of a neuron - to the processes;
- fast - 400-2000 mm per day, slow -1-2 mm per day).

CYTOSKELETON





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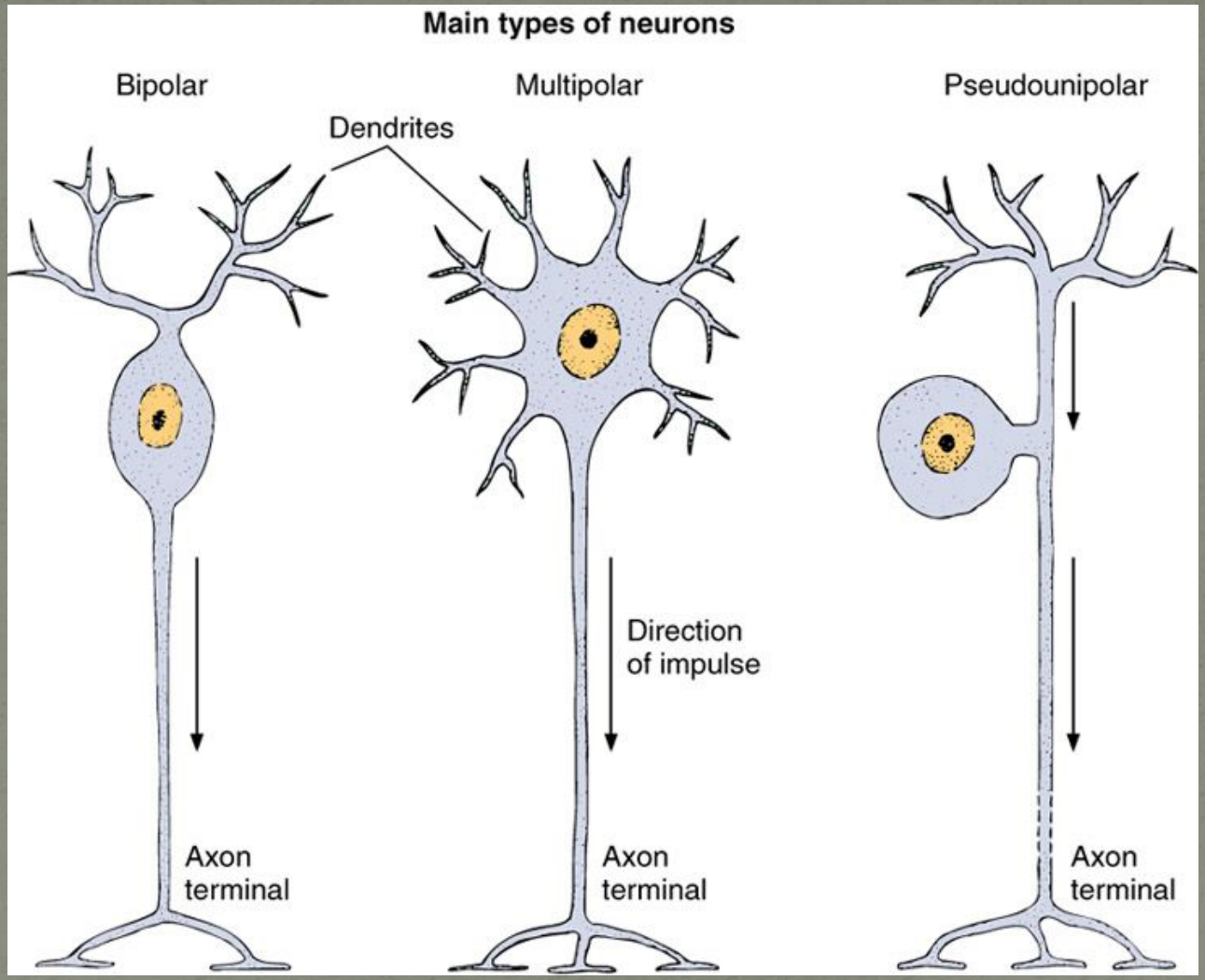
Morphological classification of neurons

- **Unipolar** (with one process - axon) - a person has only embryogenesis
- **Bipolar** (with two processes - one axon and one dendrite) – it is retinal photoreceptors
- **Multipolar** (with many processes)
- **Pseudo-unipolar** (the common process departs from the body of such neurons, then subdivided into axon and dendrite) –present in the dorsal root ganglion


Main types of neurons
Bipolar
Multipolar
Pseudounipolar
Dendrites
Direction of impulse
Axon terminal
Axon terminal
Axon terminal

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Functional classification of neurons

- **Sensitive** (afferent, receptor) - located in the spinal node. They generate n. impulse and spend it in the dorsal horn of the spinal cord).
- **Motor** (motor, efferent) -they carry out n. impulse from the ventral horns of the spinal cord to the working organ.
- **Interneurons** (associative) - located in the horn horns. Spend n impulse inside spinal cord.

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SECRETORY NEURONS

- In the cytoplasm and axons are large granules of neurosecrete, which are excreted into the blood or cerebrospinal fluid.
- Similar neurons are localized in the neurosecretory nuclei of the hypothalamic region.

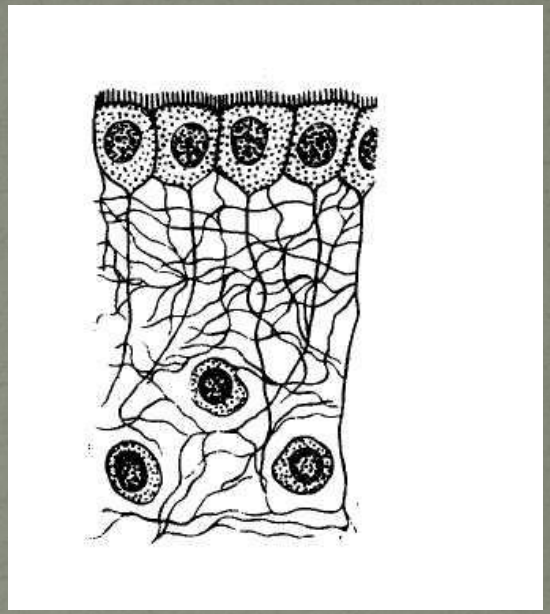
GLIAL CELLS

- CNS
- PNS

NEUROGLIA

- CNS glial cells are divided into:
- 1) **macroglia** (originates from the glioblast of the neural tube)
- ependymocytes,
- astrocytes
- (fibrous and protoplasmic)
- oligodendrocytes
- 2) **microglia** (from PHSC-monocytes of blood)

- Ependymocytes
- - form lining of the ventricles of the brain and central canal of spinal cord
- They have a columnar shape
- - on the apical surface there are movable cilia
- - a long process leaves the basal part
- - Participate in the secretion of cerebrospinal fluid and its circulation



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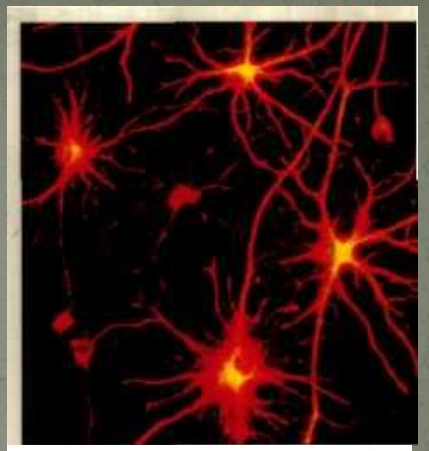
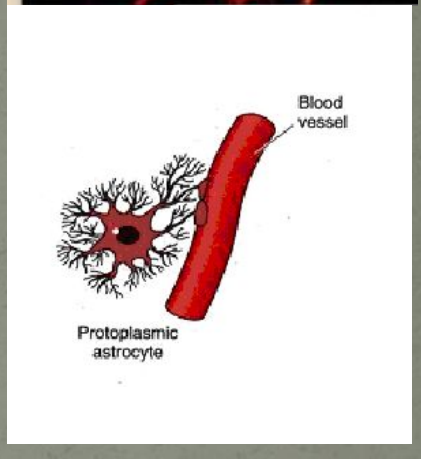
❖Astrocytes:

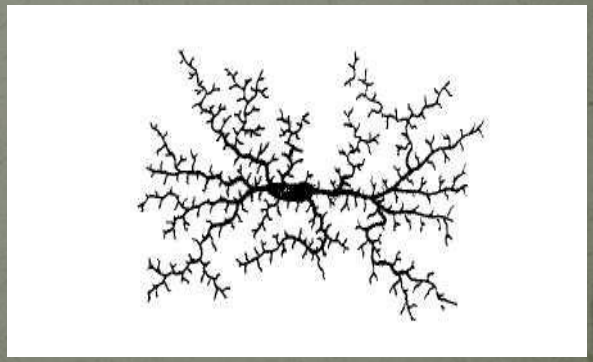
- **protoplasmic** (present in the gray central nervous system, have short branching processes) - -

-**fibrous** (present in the white matter of central nervous system, have up to 40 long non-branching processes)

Perform a supporting and distinguishing function, participate in trophic neurons, form a blood-brain barrier







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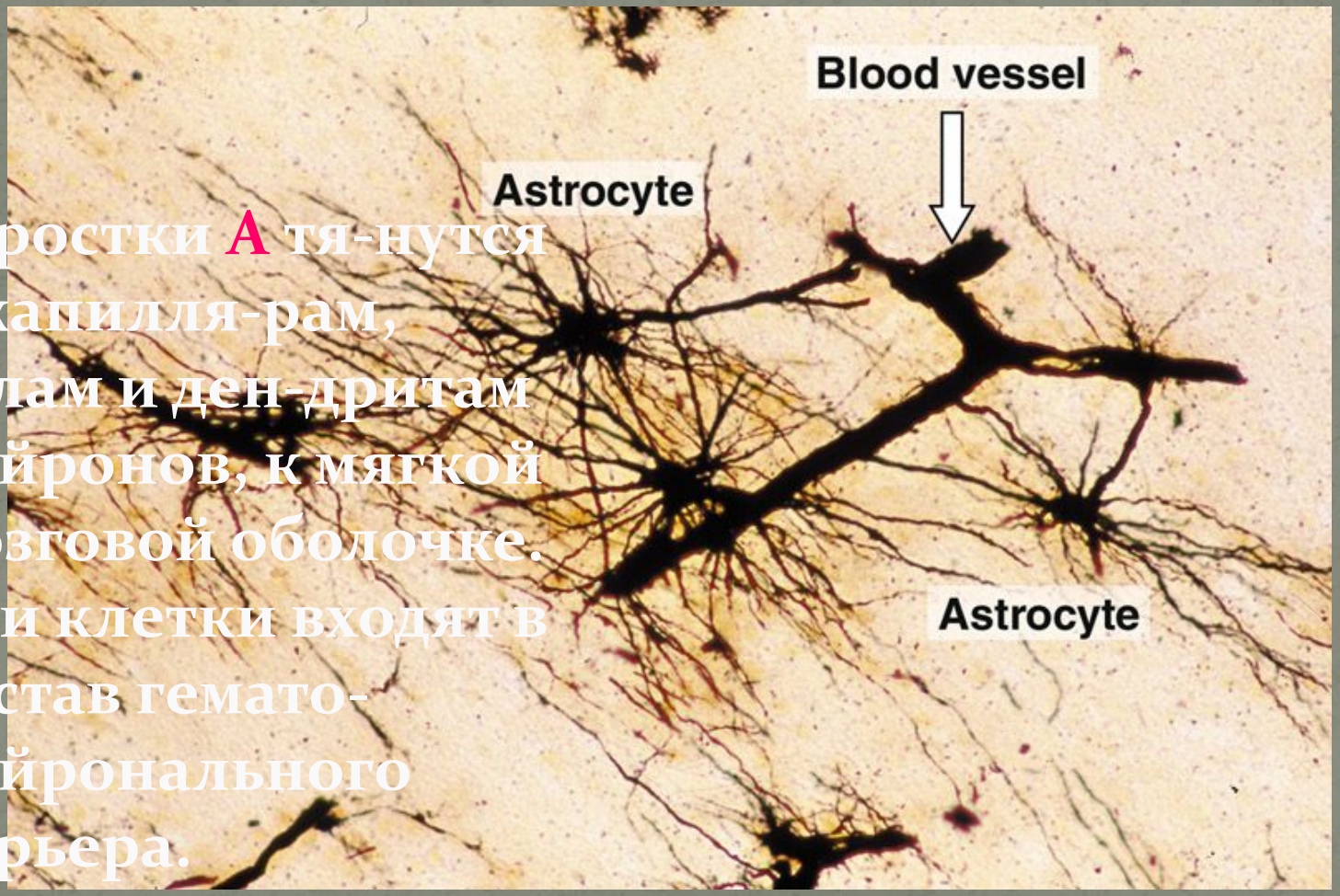
-отростки А тя-нутся к капилля-рам, телам и ден-дритам нейронов, к мягкой мозговой оболочке. Эти клетки входят в состав гемато-нейронального барьера.



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Oligodendrocytes

- Have few processus
- Present in gray matter near perikarions of neurons
- In white, they are part of the myelin and non-myelin nerve fibers.

Microglia (glial macrophages)

- Come from blood monocyte!
- Function - protecting brain tissue from infection
- Microglia cells are motile, capable of phagocytosis.
- Types:
- Resting - in adults, low activity
- Amoeboid - in newborns with high phagocytic activity
- Reactive - after damage

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Glia of the peripheral nervous system (originates from the neural crest)

- **Neurolemmocytes** (Schwann cells) form the sheaths of the processes of nerve cells in the nerve fibers of the peripheral nervous system
- **Ganglial glyocytes** (surround the bodies of neurons in the nerve nodes)

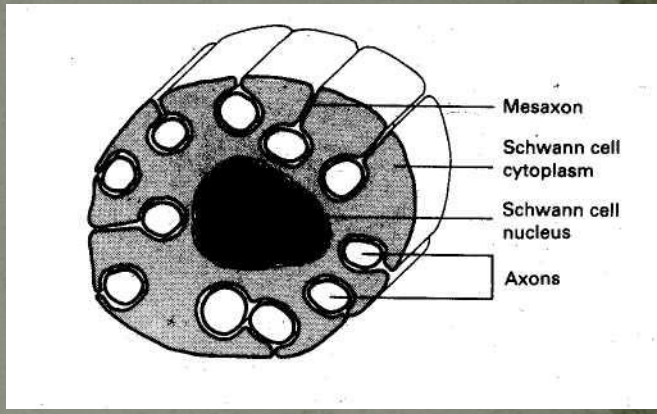
NERVE FIBERS

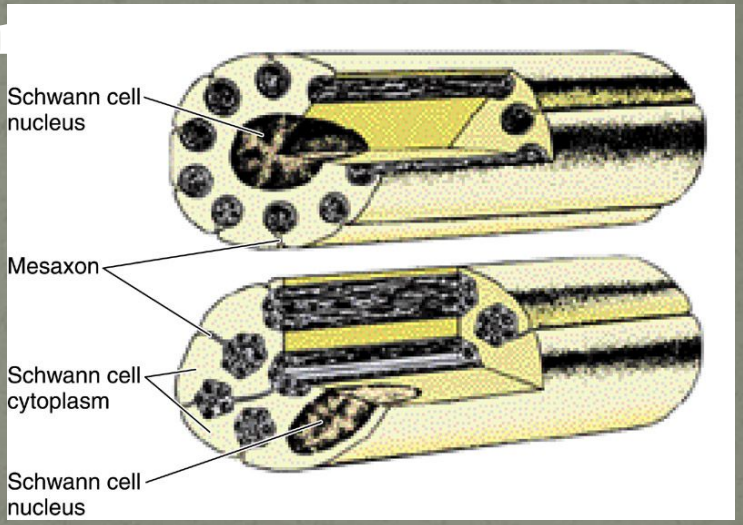
- are processes of nerve cells which are covered with sheath.
- Process is almost always AXON (axial cylinder)
- In the central nervous system fiber sheaths are formed using oligodendrocytes,
- In the peripheral - with the help of neurolemmocytes.

- Distinguish:
- myelinated nerve fibers
- unmyelinated nerve fibers
- ----------*

Non-myelinated nerve fibers

- Are part of vegetative NS.
- The axial cylinders of several neurons take part in the structure of the fiber. They are located on the periphery of the fiber. Mesaxones are short. There are r gaps between adjacent neurolemmocytes.
- The resulting fibers are called cable-type fibers.





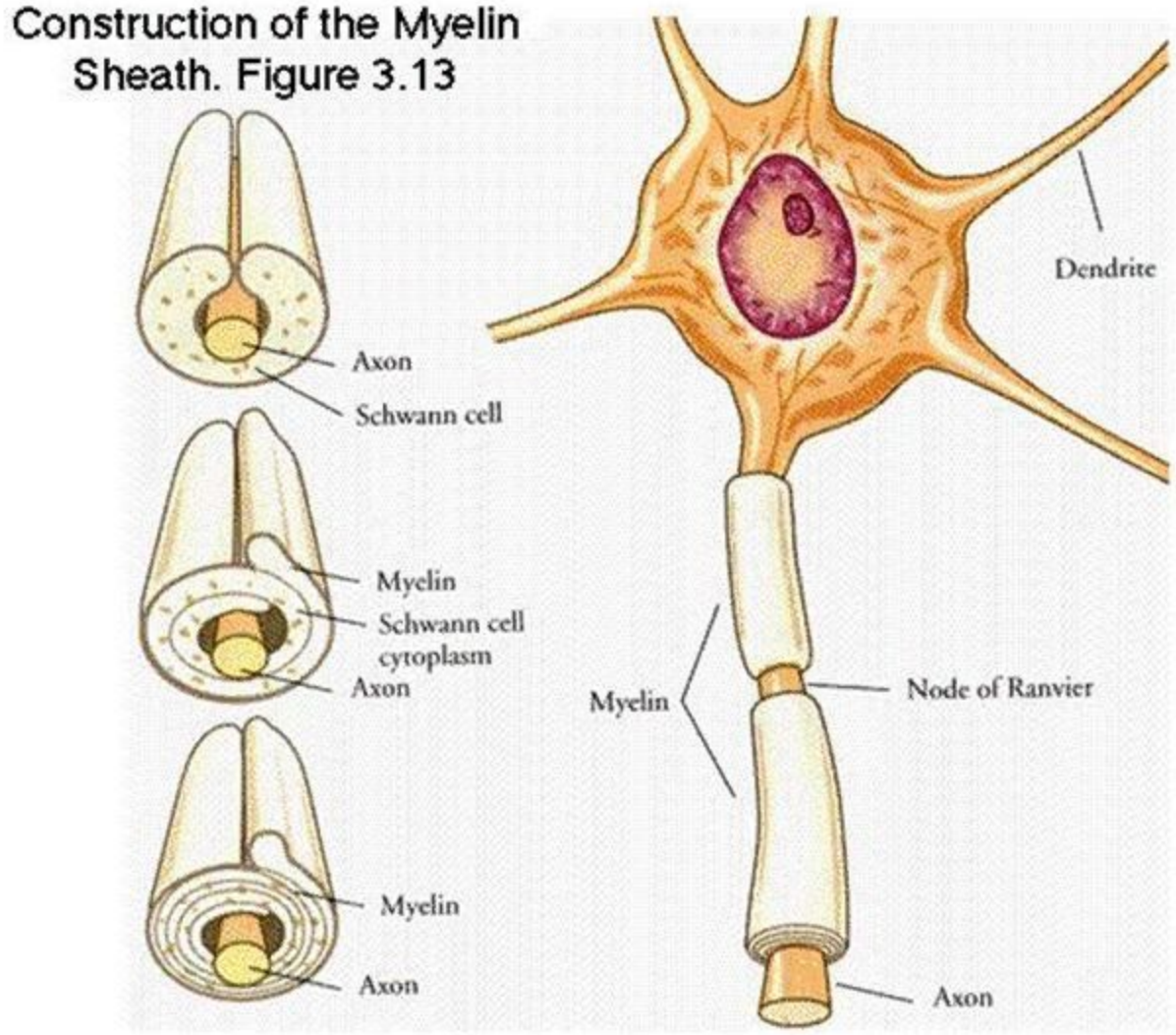
MYELINATED NERVE FIBER

- They are found both in the central nervous system and in peripheral NS.
- They consist of one axial cylinder located in the center of the fiber.
- Covered with a complex membrane consisting of Schwann cells.
- Two layers are distinguished in the shell:
- - internal - myelin
- - external - consists of the cytoplasm and the nucleus of a neurolemmocyte.

Myelinated nerve fiber structure

Nodes of Ranvier – spaces between 2 Schwann cells – free from myelin

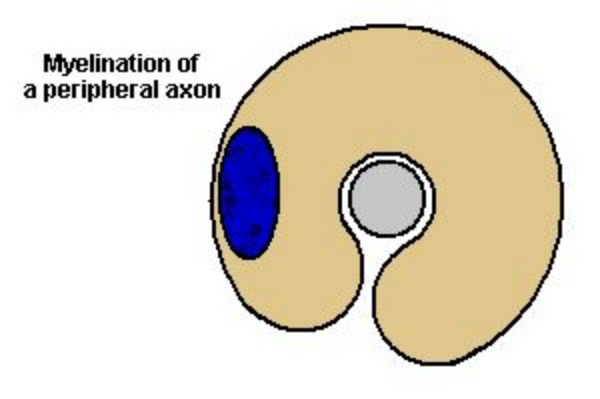
- Nodes of Ranvier provide saltatory conduction of nerve impulse



In myelin fiber of nodesRanvier (after 1-2 mm) and myelin incisions are distinguished

- during myelinisation the axon is immersed in to the cytoplasm of the neurolemmocyte.
- In this case, mesaxone is formed (duplication of the Schwann cell cytolemma).
- Mesaxon is layered on the

MYELINISATION



- The speed of impulse transmission along myelin fibers (5-120 m / s), along bezmyelinovyh - (1-2 m / s).

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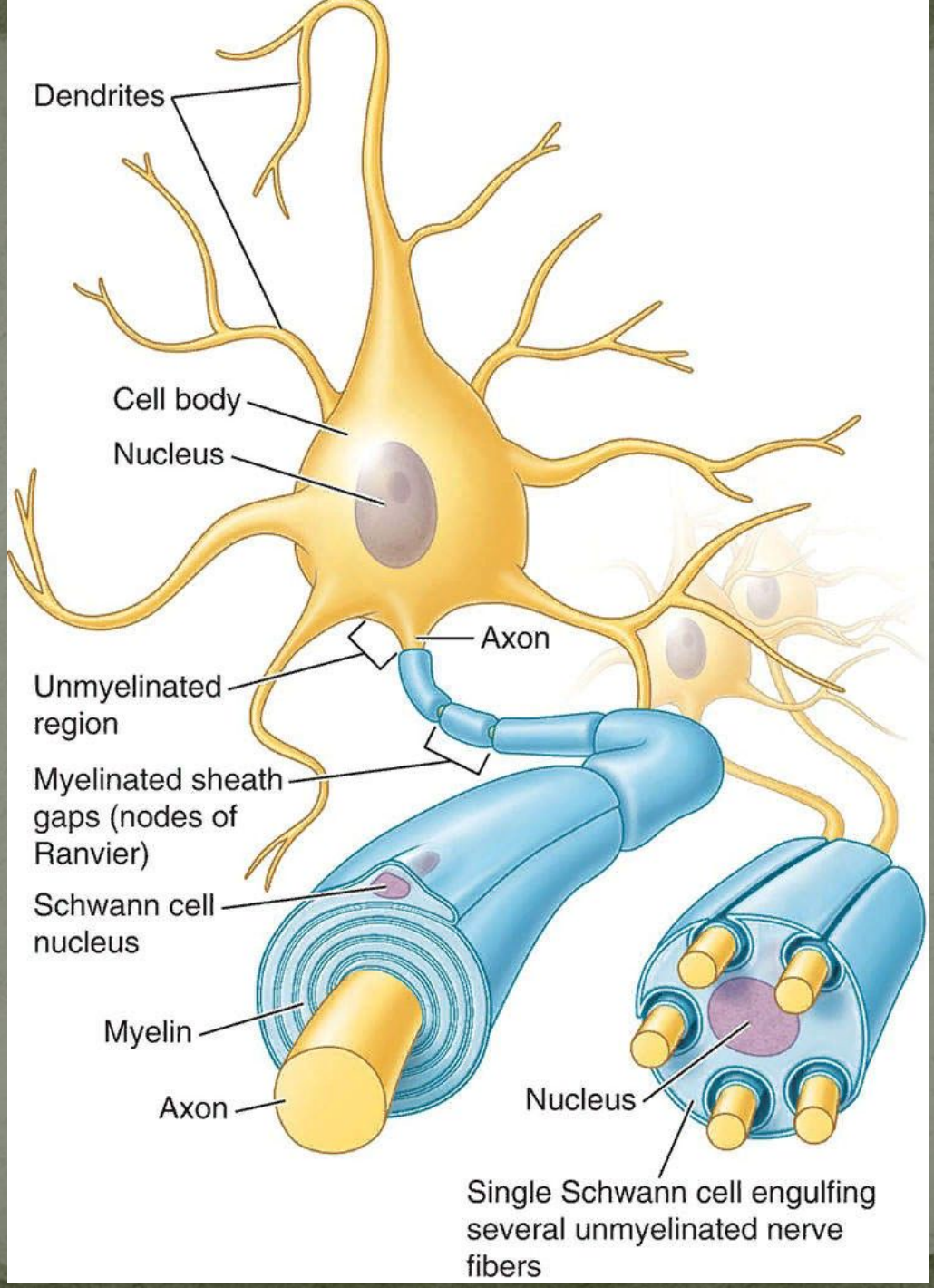
Dendrites
Cell body
Nucleus
Axon
Unmyelinated region
Myelinated sheath gaps (nodes of Ranvier)
Schwann cell nucleus
Myelin
Axon
Nucleus
Single Schwann cell engulfing several unmyelinated nerve fibers

NERVE ENDINGD
are terminal parts of nerve fibers

- They are divided into 3 groups according to functions:
- - motor (effector)
- - sensitive (receptor)
- - synapses

SYNAPSE

- Structurally:
- - axodendritic
- - axosomatic
- - axoaxial
- muscle or motor plaques
- By transmission method:
- - chemical (due to mediators or neurotransmiters)
- - electrical (contribute to the synchronization of activity).

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Chemical

- Transmit impulse using mediators
- The axon terminal is the presynaptic part . It contains synaptic vesicles, mitochondria, neurofilaments, calcium ions.
- The postsynaptic part is represented by the membrane of the second neuron with which it is in contact. Contains receptors, a recognizable mediator.
- Synaptic cleft = 20-30 nm

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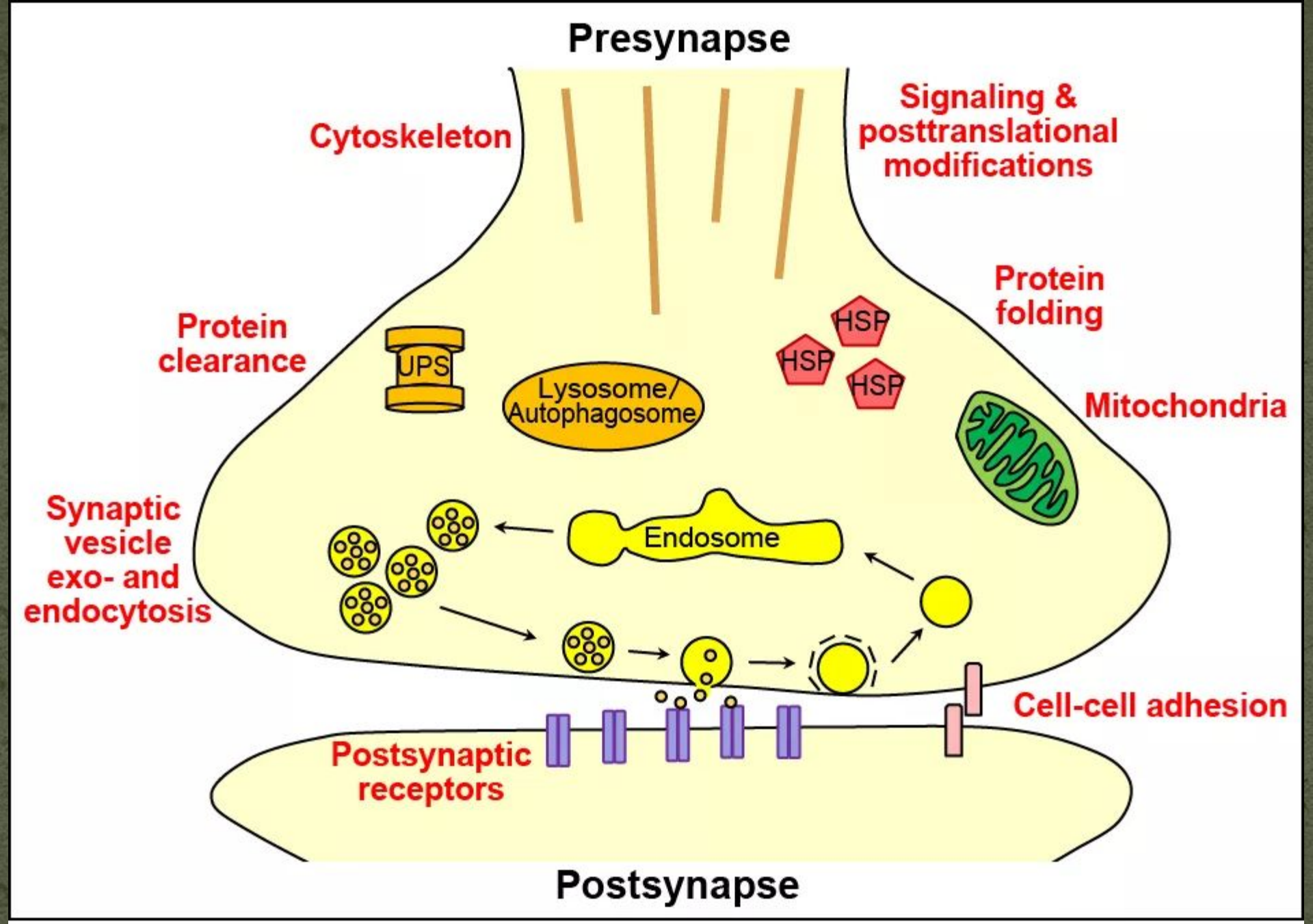

Synaptic terminals as initiation sites for neurodegeneration

- Low molecular weight mediators:
- - Acetylcholin, norepinephrine, serotonin, histamine, glutamate, glycine, GABA, dopamine,
- Neuropeptides:
- - endorphins, enkephalins, dinorins, substance R.

- Brain synapse mediators:
- dopamine, glycine, GABA

- **The processes in the synapse are developed as follows:**
- **Depolarization wave reaches presynaptic membrane**
- **Ca channels open**
- **Ca causes neurotransmitter exocytosis**
- **Diffusion of the neurotransmitter through the synaptic cleft**
- **Ion channels open in the postsynaptic membrane**
- **The postsynaptic potential is created..**

Effector nerve endings

- They are terminal apparatuses of axons of motor cells of somatic or vegetative
- With their participation the impulse is transmitted to the tissues of the working organs.
- The neuromuscular ending consists of the terminal branching of the axial cylinder of the nerve fiber and the muscle fiber site.

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Neuromuscular nerve ending

- Myelin ed nerve fiber loses the myelin layer and is submerged in muscle fiber.
- Plasmolemma and sarcolema are separated by a synaptic cleft of about 50 nm.
- In the postsynaptic part folds are formed
- Skeletal fiber loses striation in the contact area

In the smooth muscle tissue nerve endings are clearly distinct thickenings occurring among smooth myocytes.

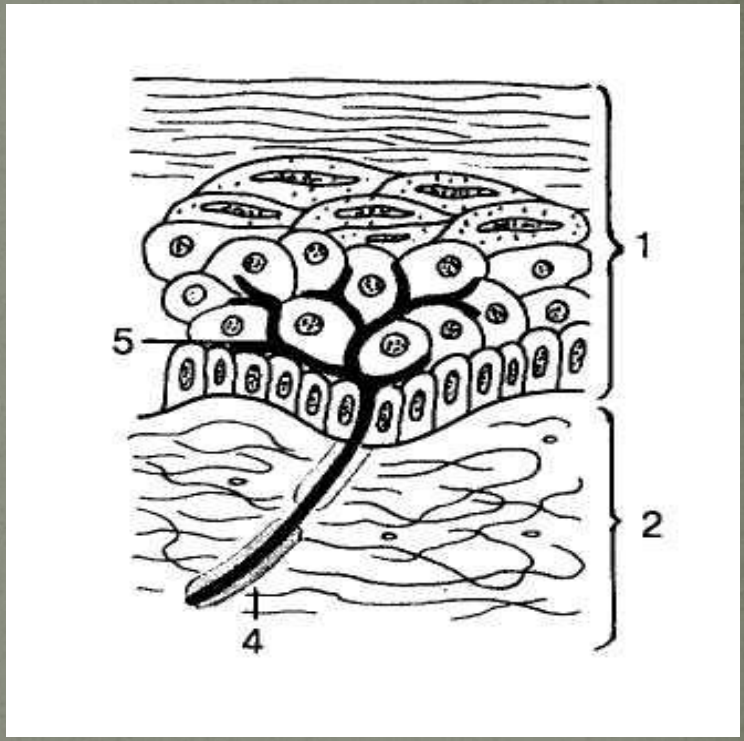
- Secretory nerve endings are thickening of the terminals along the nerve fiber.

RECEPTORS

- 1) By localization:
- extero- and interoreceptors
- 2) By the specificity of perception: chemoreceptors, mechanoreceptors, baroreceptors, thermoreceptors, etc.
- 3) According to the features of the structure:
- a) - free nerve endings (consist of branching of the axial cylinder)
- b) - non-free nerve endings (conteins axon and sheath)
- - encapsulated (covered with a capsule)
- - unencapsulated (not having capsules).

FREE N.E.

- PRESENT in the epithelium
- Myelin fibers approach the epithelial layer, lose myelin, axial cylinders enter the epithelium and break up between cells into terminal branches.



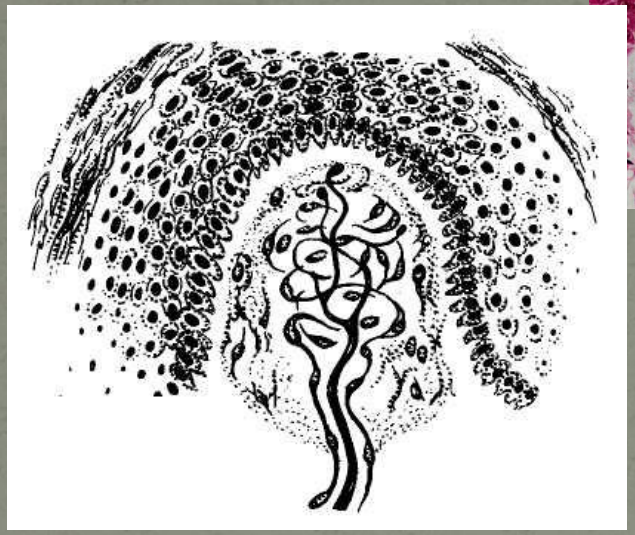
A variety of receptors is found in connective tissue.

- Lamellar bodies of Fater-Pacini (0.5-2 mm) are found in the skin and int. organs.
- In the center is ext. bulbs
- The myelin fiber loses myelin, penetrates the bulb and branches.
- Outside, the body is surrounded by a layered capsule consisting of fibroblasts and spiral fibers.
- Taurus FP perceives pressure and vibration.

Meissner's tactile bodies

- They are located at the apex of the connective tissue papillae of the skin.
- They consist of modified neurolemocytes - tactile cells.
- Outside surrounded by a thin capsule
- The myelin fiber enters from below loses the myelin layer and branches. Any displacement of the epidermis is transmitted to the tactile body.

Meissner's tactile bodies



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