The 7th lecture

In

Anatomy and Physiology

For
the

1st Class

By
Dr. Ala'a Hassan Mirza

Nervous System (part I)

The Nerve Tissue and the Nervous System

The Tissues of the Body

There are 4 types of tissues which make up the body organs:

1. **Epithelial tissue**: is made of different cell types organized into a sheet with one or more layers which resting on basement membrane.

2. **Connective tissue**: is the most abundant body tissue it consists of cells and matrix of ground substance and fiber.

3. **Muscular tissue** consists of three types (skeletal muscle, cardiac muscle, and smooth muscle).

4. **Nervous tissue**.

Nervous tissue

- Human nervous system is the most complex system in the human body it consists of:

    1. **Nerve cells (neurons)**
    2. **Glial cells**
    3. **Nerve fibers**

- Nerve tissue is distributed throughout the body as an integrated communications network.

Nerve cells (neurons)

- More than 100 million of neurons form a network for communication.
- Each neuron has an average at least a thousand interconnections with other neurons, forming a very complex system for communication.
- Neurons are *responsible for* ***reception, transmission****, and* ***processing*** *of stimuli.*

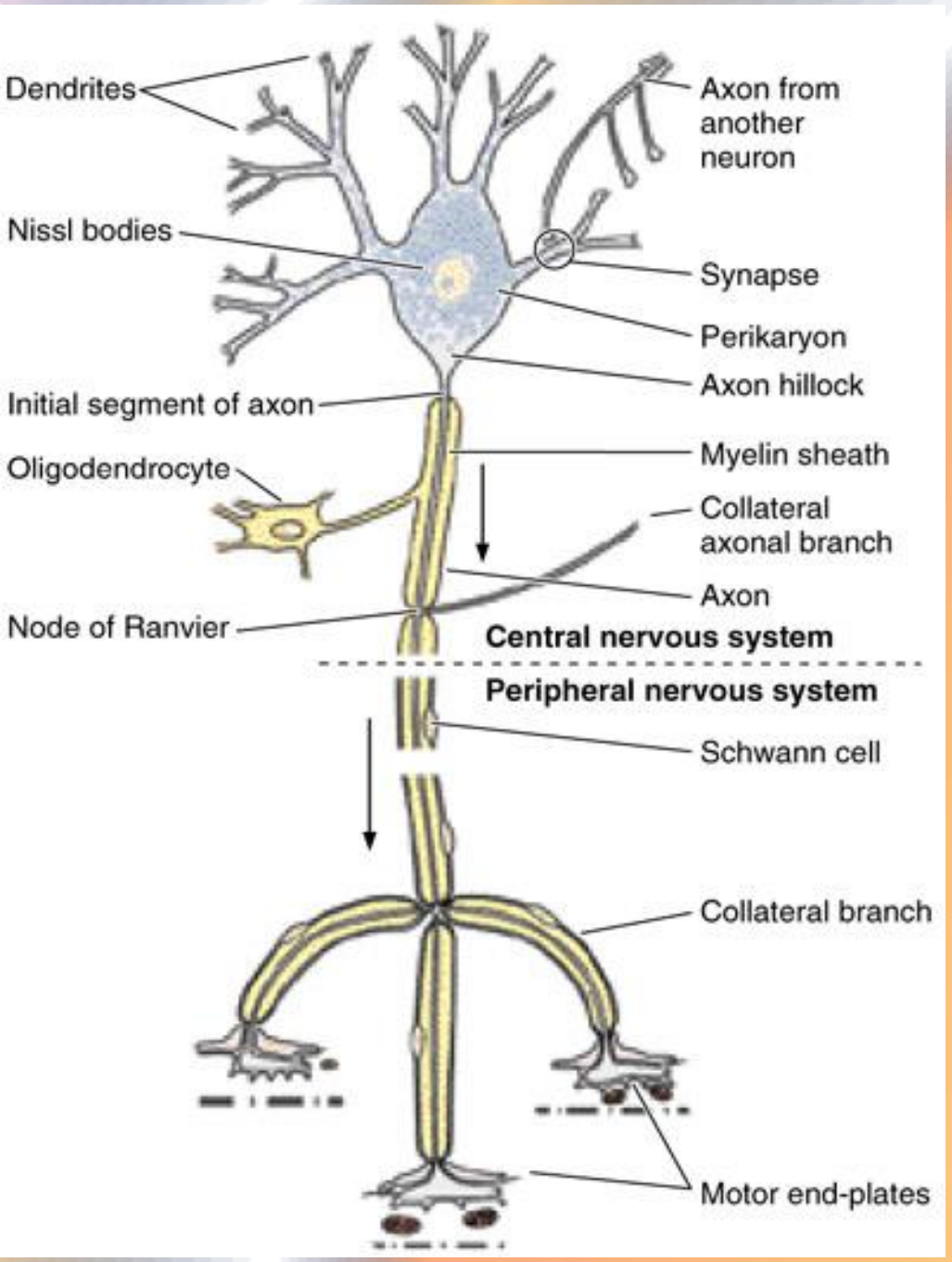
- ***Neurons are sensitive to stimuli convert stimuli into nerve impulse and conduct nerve impulses.***

- Most neurons consist of 3 parts:

1). Cell body has ability to generate impulse.

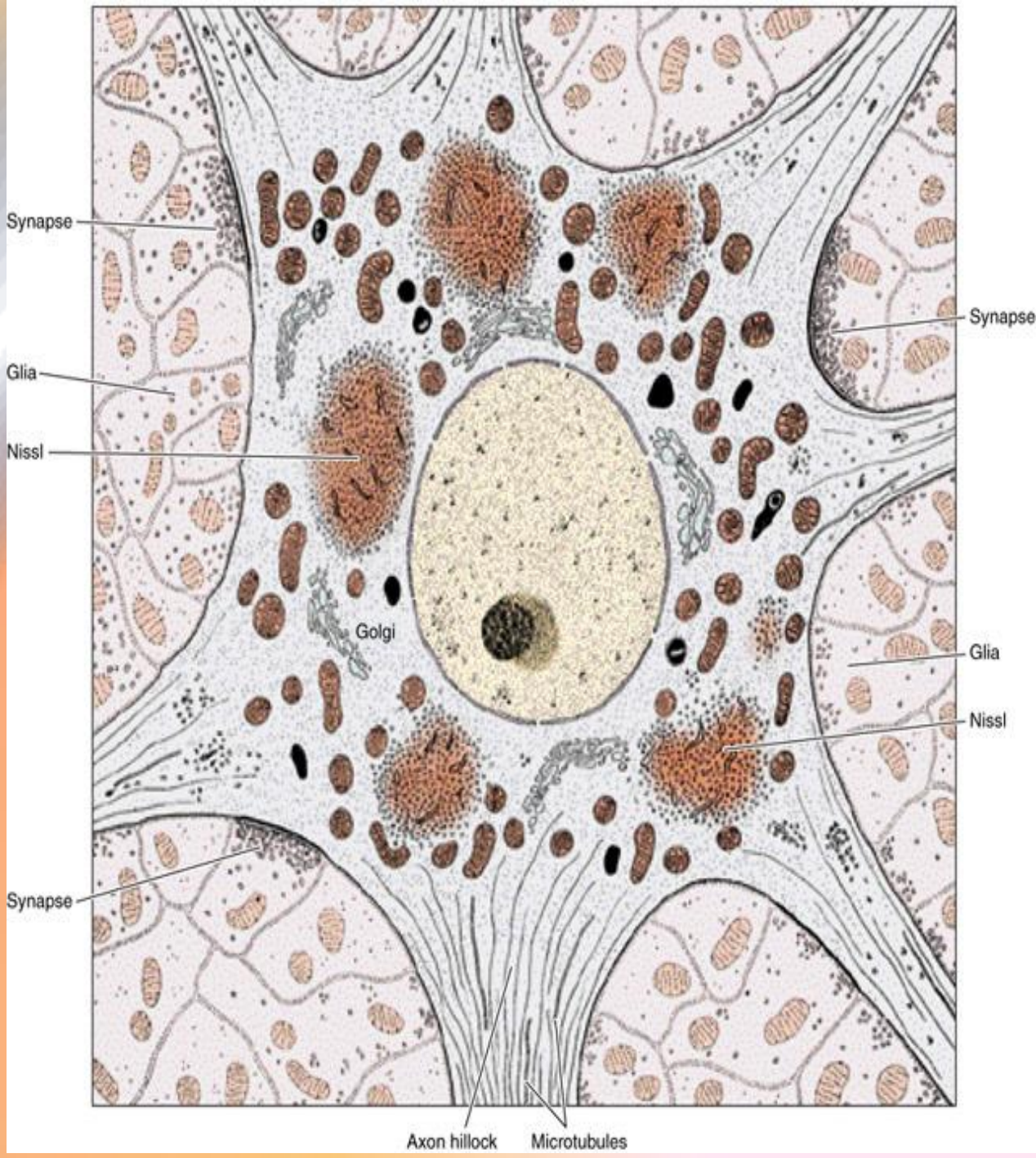
2). Dendrites which are multiple elongated cytoplasmic processes have ability to receive stimuli from the environment and transport them to the neuron body.

3). Axon which is a single process has ability to transport the nerve impulses to other cells.



Motor neuron. The myelin sheath is produced by oligodendrocytes in the central nervous system and by Schwann cells in the peripheral nervous system. The neuronal cell body has an unusually large, euchromatic nucleus with a well-developed nucleolus. The perikaryon contains Nissl bodies, which are also found in large dendrites. An axon from another neuron is shown at upper right. It has 3 end bulbs, one of which forms a synapse with the neuron. Note also the 3 motor end-plates, which transmit the nerve impulse to striated skeletal muscle fibers. Arrows show the direction of the nerve impulse.

. Ultrastructure of a neuron. The neuronal surface is completely covered either by synaptic endings of other neurons or by processes of glial cells. At synapses, the neuronal membrane is thicker and is called the postsynaptic membrane. The neuronal process devoid of ribosomes (lower part of figure) is the axon hillock. The other processes of this cell are dendrites.



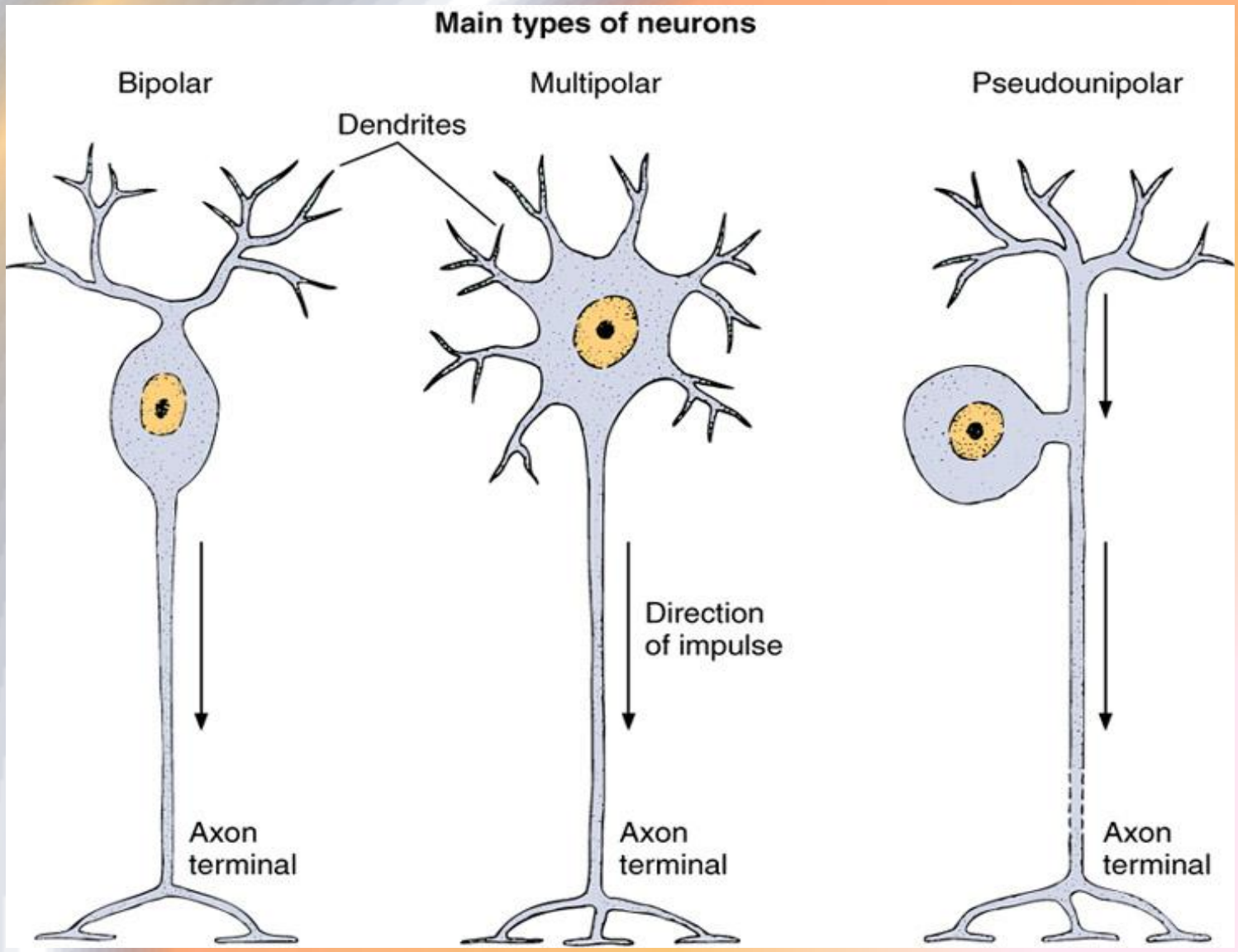
The main character features of the nerve cells

- Most nerve cells have a large nucleus with a prominent nucleolus.
- The cytoplasm of the nerve cell shows the presence of a granular material that stains intensely with basic dyes; this material is the **Nissl substances (Nissl body).**
- **Neurofibrils** also found abundantly in the *neuron body and its processes*.
- ***Neurofibrils represent microfilamints and microtubulaes.***
- ***Axon hillock*** is a part of neuron body, free of Nissl body in which the axon originated from it.
- The portion of the axon between the axon hillock and the point at which myelination begins is called the **initial segment.**
- Some axons are surrounded by a myelin sheath. Axon having a myelin sheath are called **myelinated axons**.
- There are some axons that are devoid of myelin sheath. These are **unmyelinated axons**.
- Axons constitute what are commonly called **nerve fibers.**

Types of neurons according to the shape and size of their processes

- **Multipolar neurons** have more than 2 cell processes (one process being the axon and the others dendrites.
- **Bipolar neurons** have one dendrites and one axon.
- **Psuedounipolar neurons** have a single process that is close to the cell body and divides into two branches.

. Simplified view of the 3 main types of neurons, according to their morphologic characteristics.



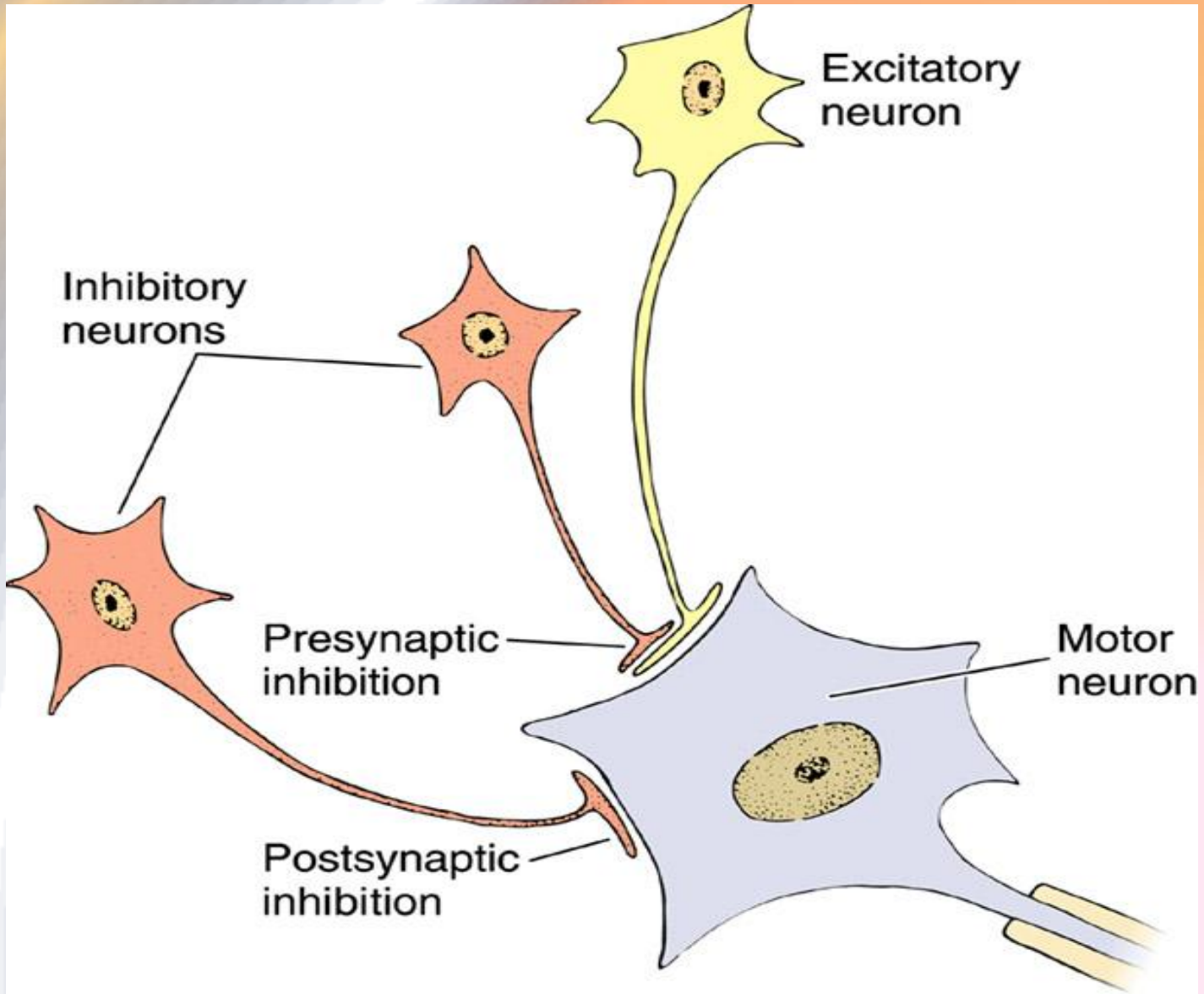
Types of neurons according to the their functions

- **Motor (efferent) neurons** control effector organs such as muscle fibers and exocrine and endocrine glands.

- **Sensory (afferent) neurons** are involved in the reception of sensory stimuli from the environment and from within the body.

- **Interneurons** establish relationships among other neurons forming complex functional networks.

Examples of excitatory and inhibitory synapses in a motor neuron



Glial Cells (neuroglia)

- These cells have supporting and protective functions in the nervous tissue.
- The neuroglia includes:

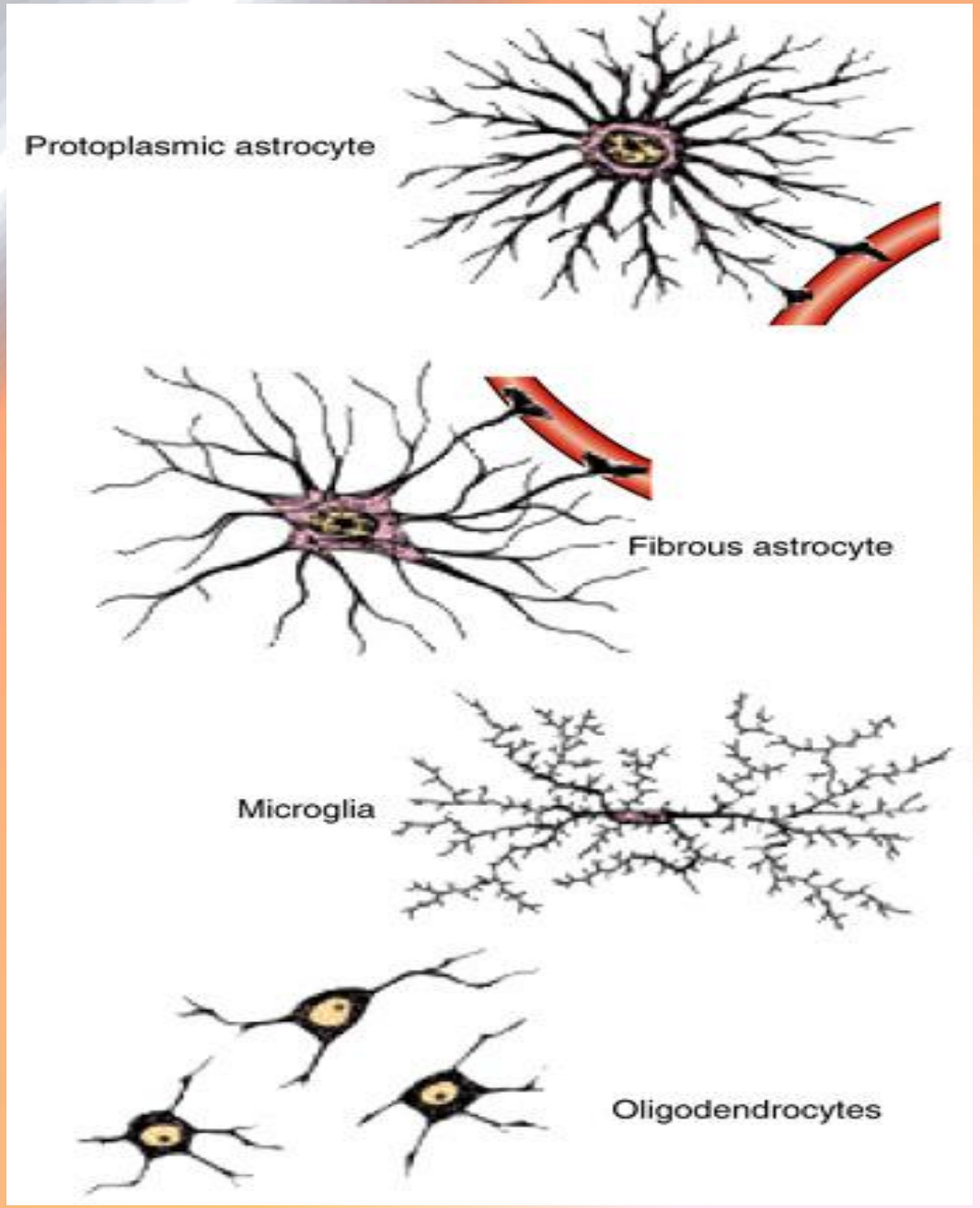
1. **Astrocytes** (the most abundant type of glial cells) have supporting function and controlling ionic and chemical environment of neurons.

2. **Oligodendrocytes** produce the myelin sheath for axon in the central nervous system.

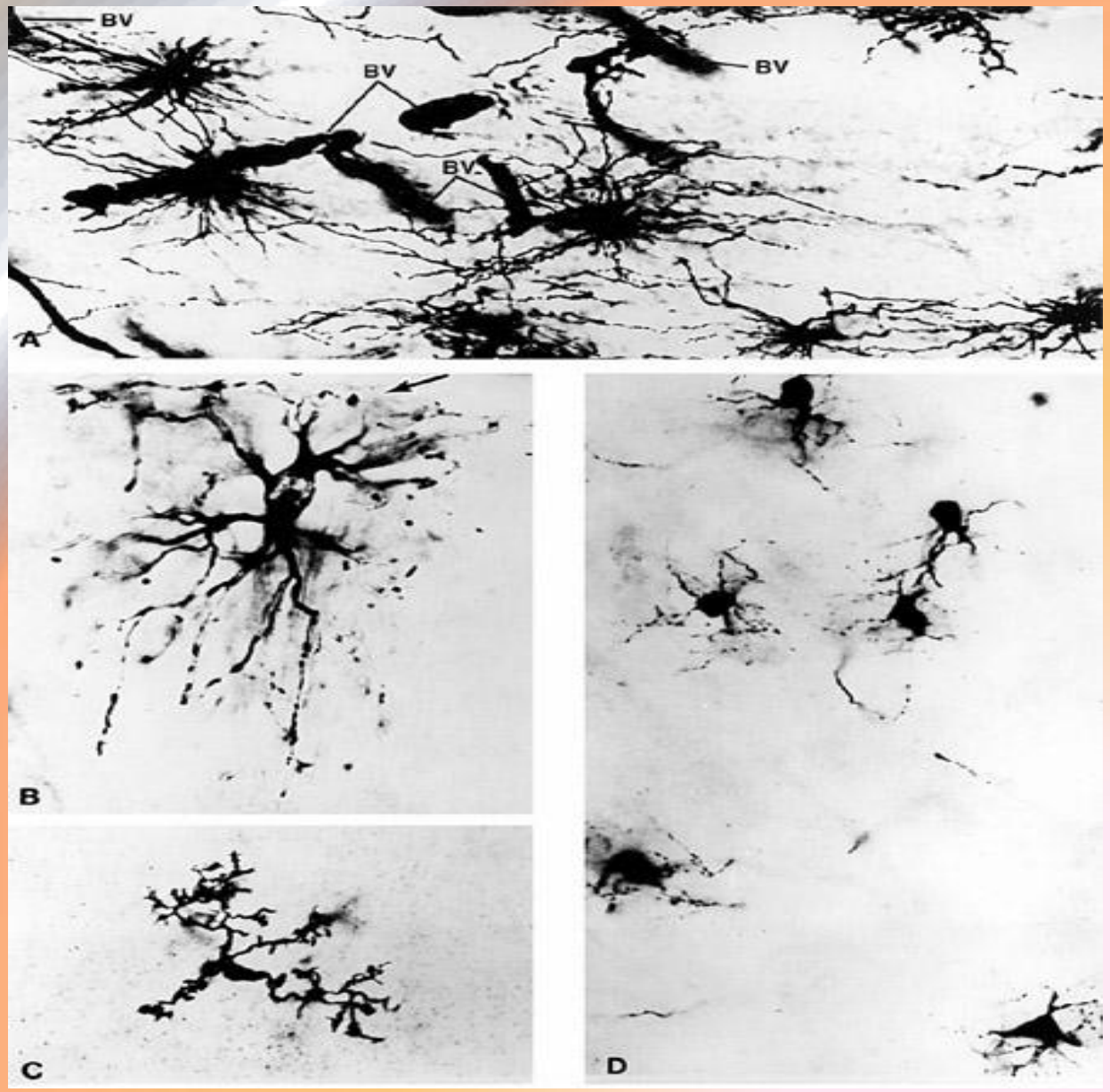
3. **Schwann cells** produce myelin sheath in the peripheral nervous system.

4. **Ependymal cells** found in the central nervous system which facilitate the movement of cerebral spinal fluids.
5. **Microglia** have phagocytic function.

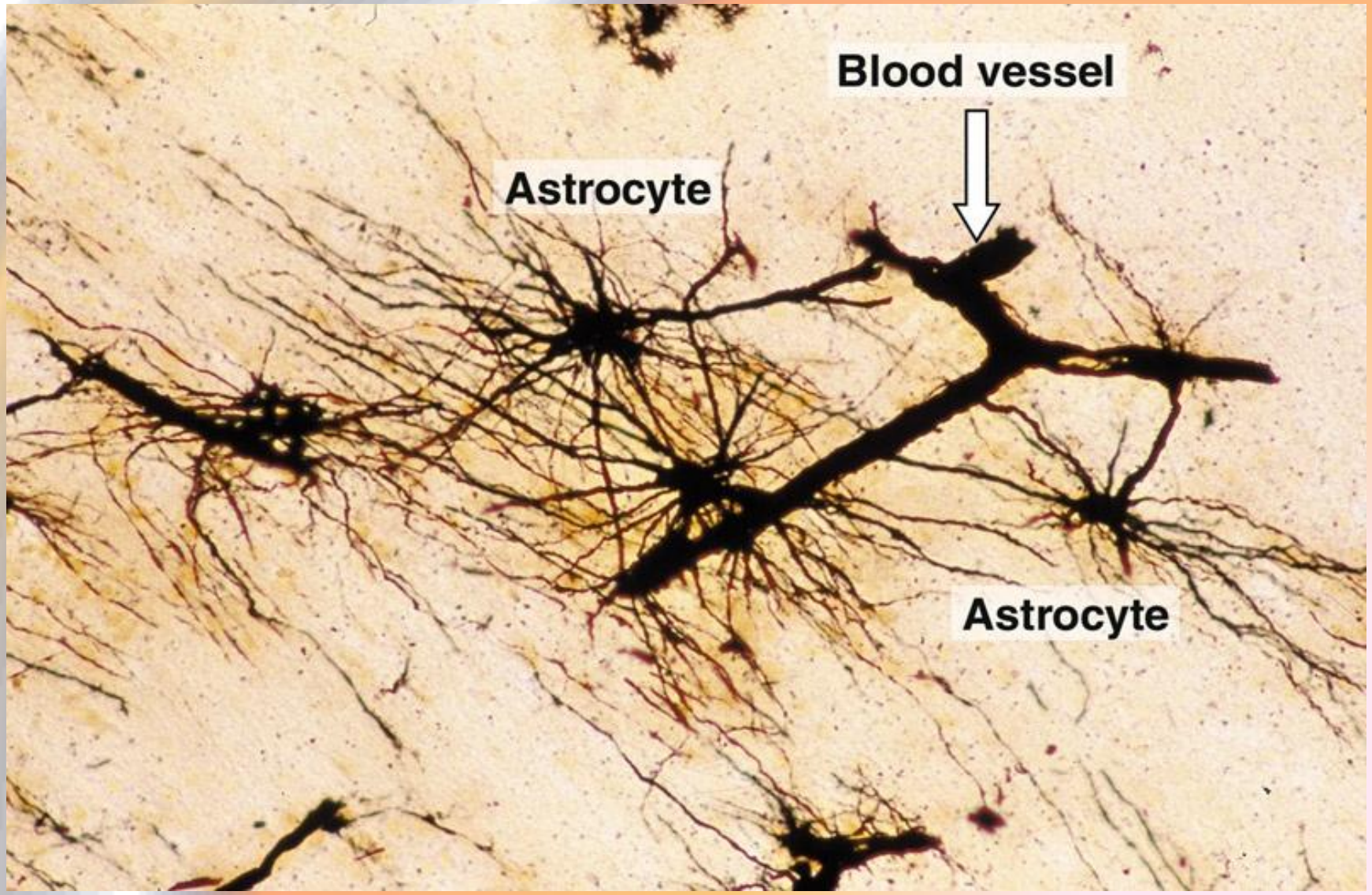
Drawings of neuroglial cells as seen in slides stained by metallic impregnation. Note that only astrocytes exhibit vascular end-feet, which cover the walls of blood capillaries.



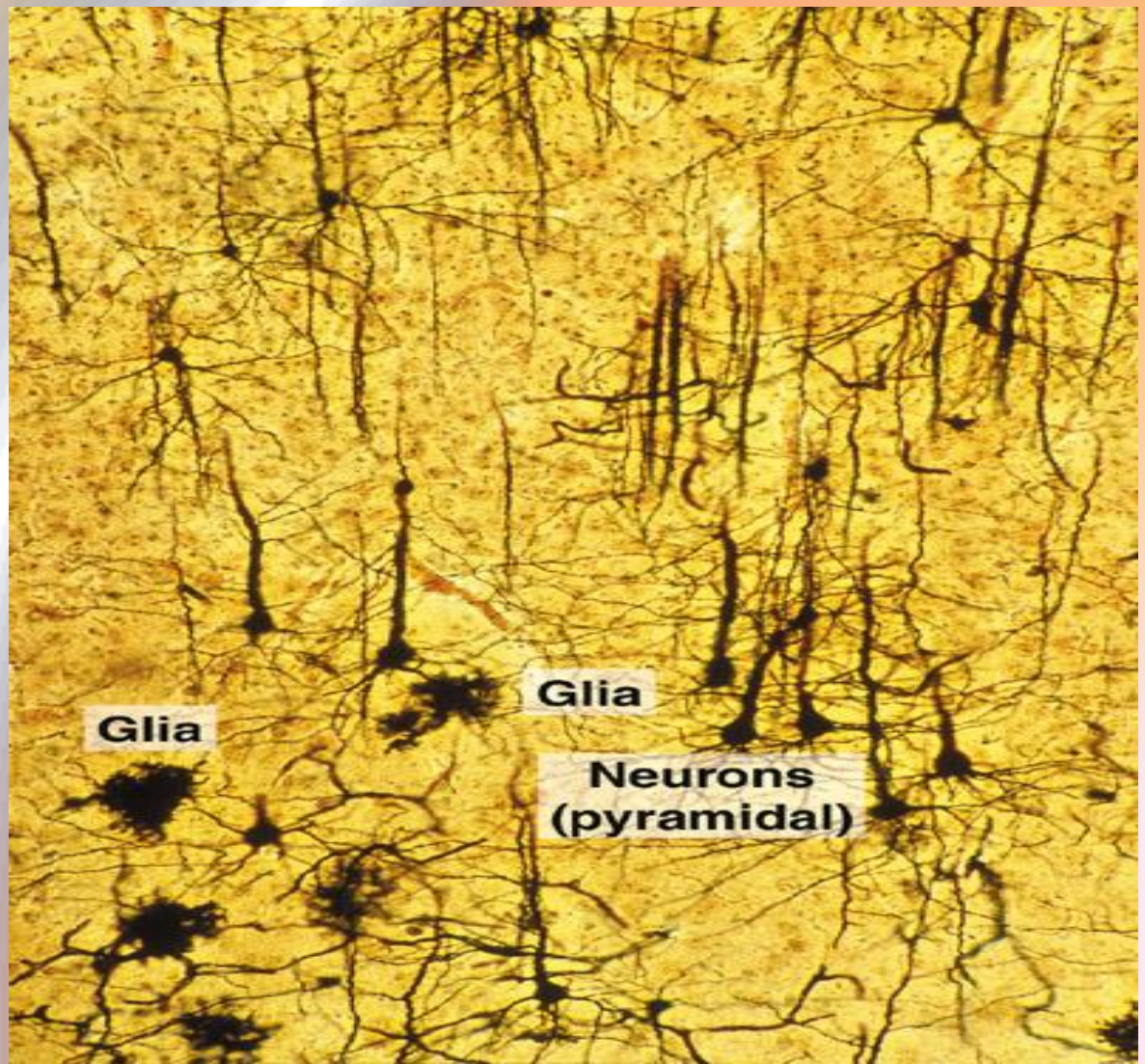
Photomicrographs (prepared with Golgi stain) of glial cells from the cerebral cortex. A: Fibrous astrocytes, showing blood vessels (BV). x1000. B: Protoplasmic astrocyte showing brain surface (arrow). x1900. C: Microglial cell. x1700. D: Oligodendrocytes. x1900. (Reproduced, with permission, from Jones E, Cowan WM: The nervous tissue.



Brain section prepared with Rio Hortega silver stain showing fibrous astrocytes with their processes ending on the external surface of blood vessels. Medium magnification.



Silver-stained section of cerebral cortex showing many pyramid-shaped neurons with their processes and a few glial cells. Medium magnification.



Membrane potentials

- Plasma membrane of the axon (axolemma) pumps **Na^+** out of the axoplasma, maintaining the concentration of **Na^+** that only a tenth of that in the excetracellular fluid.
- In contrast the concentration of K^+ is maintained at a level many times greater than that prevailing in the excetracellular environment.
- Therefore there is a potential difference across the axolemma of -65mV with the inside negative to the outside. This is the **resting membrane potential**.

- When a neuron is stimulated the excetracellular **Na^+** suddenly influx that changes the resting potential from -65 mV to the +30 mV. The cell interior becomes positive in relation to the cellular environment that determines the beginning of the **action potential** or **nerve impulse.**

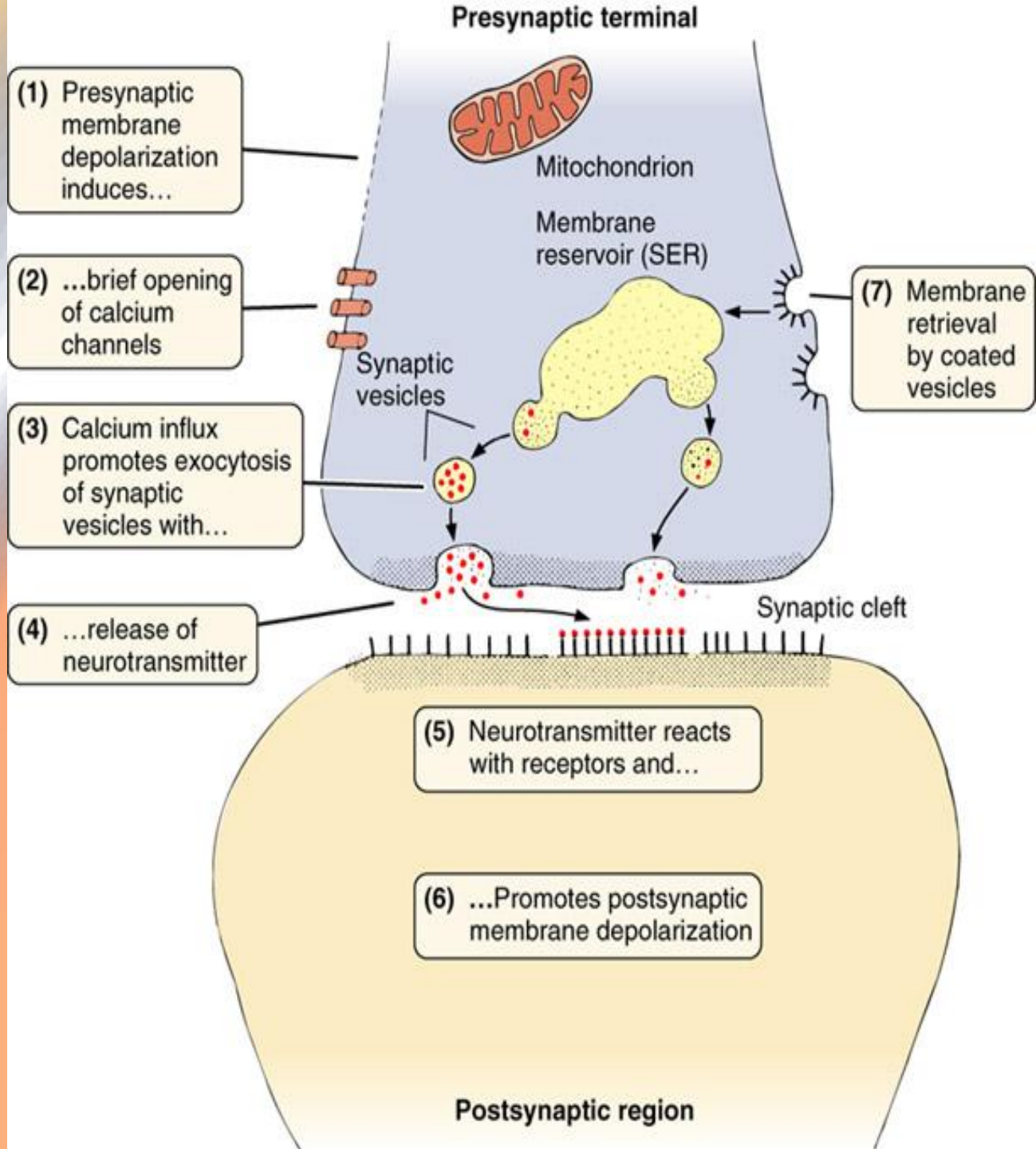
Synaptic communication

- Synapses are sites of functional contact between neurons or neurons and other effector cells (e.g. muscle cells).

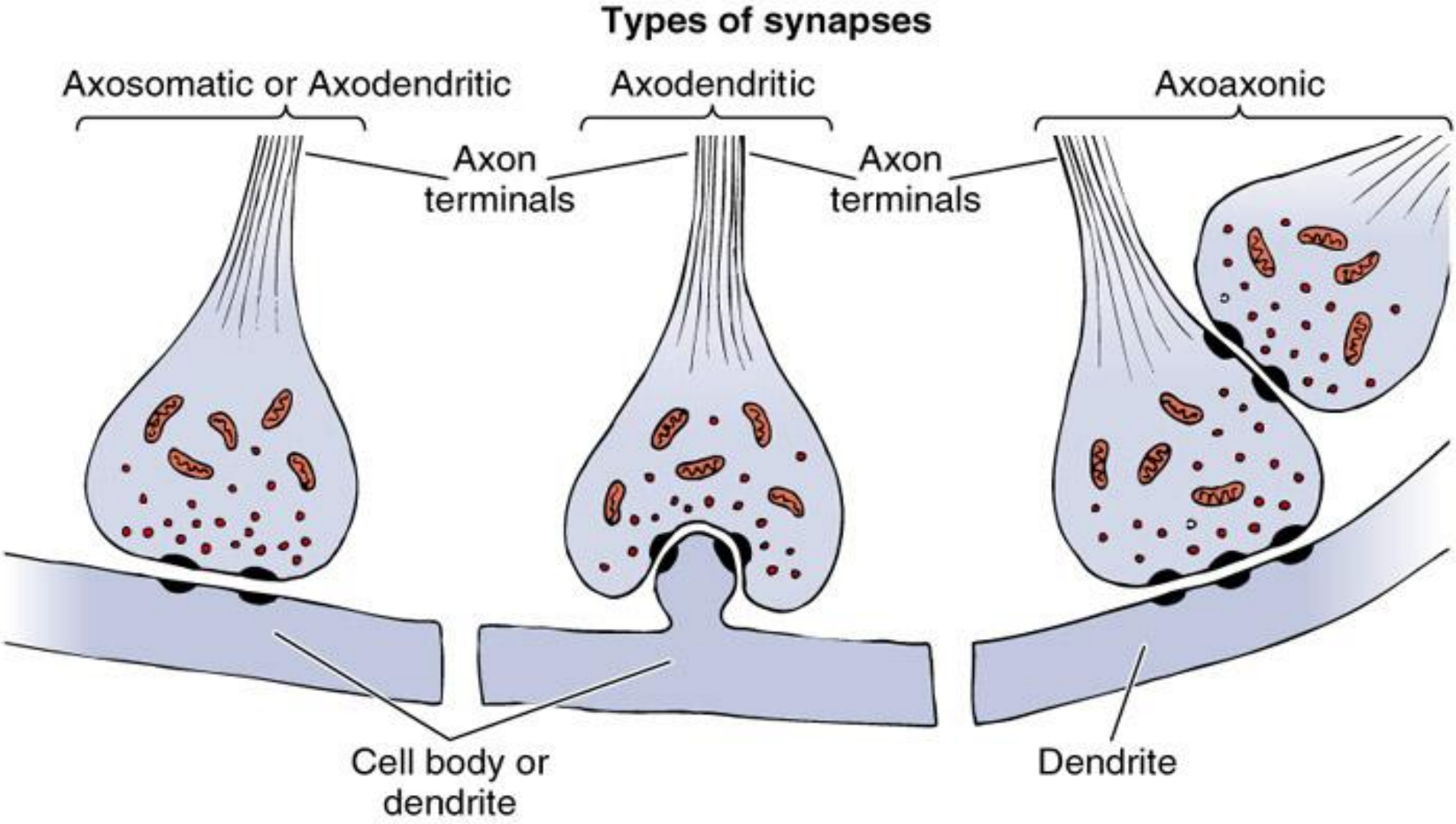
- The synapse itself is formed by: **1. presynaptic terminal** an axon terminal that deliver the signal; **2. postsynaptic terminal** a region on the surface of another cell where a new signal is generated and **3. synaptic cleft** a thin intercellular space.

- the function of the synapse is to convert an electrical signal (impulse) from the **presynaptic cell** into a chemical signal that act on the **postsynaptic cell**.
- Most synapses transmit information by releasing **neurotransmitters** during the signaling process.
- Neurotransmitters are chemical substances present in the vesicles of presynaptic button.
- When a nerve impulse reaches a button of presynaptic terminal

THE MAIN FUNCTIONAL ASPECTS OF THE TWO PARTS OF THE SYNAPSE: THE PRESYNAPTIC AXON TERMINAL AND THE POSTSYNAPTIC REGION OF THE NEXT NEURON IN THE CIRCUIT. NUMBERS INDICATE THE SEQUENCE OF EVENTS DURING ITS ACTIVITY. SER, SMOOTH ENDOPLASMIC RETICULUMA.



Types of synapses. The axon terminals usually transmit the nerve impulse to a dendrite or to a nerve cell body; less frequently, they make a synapse with another axon.



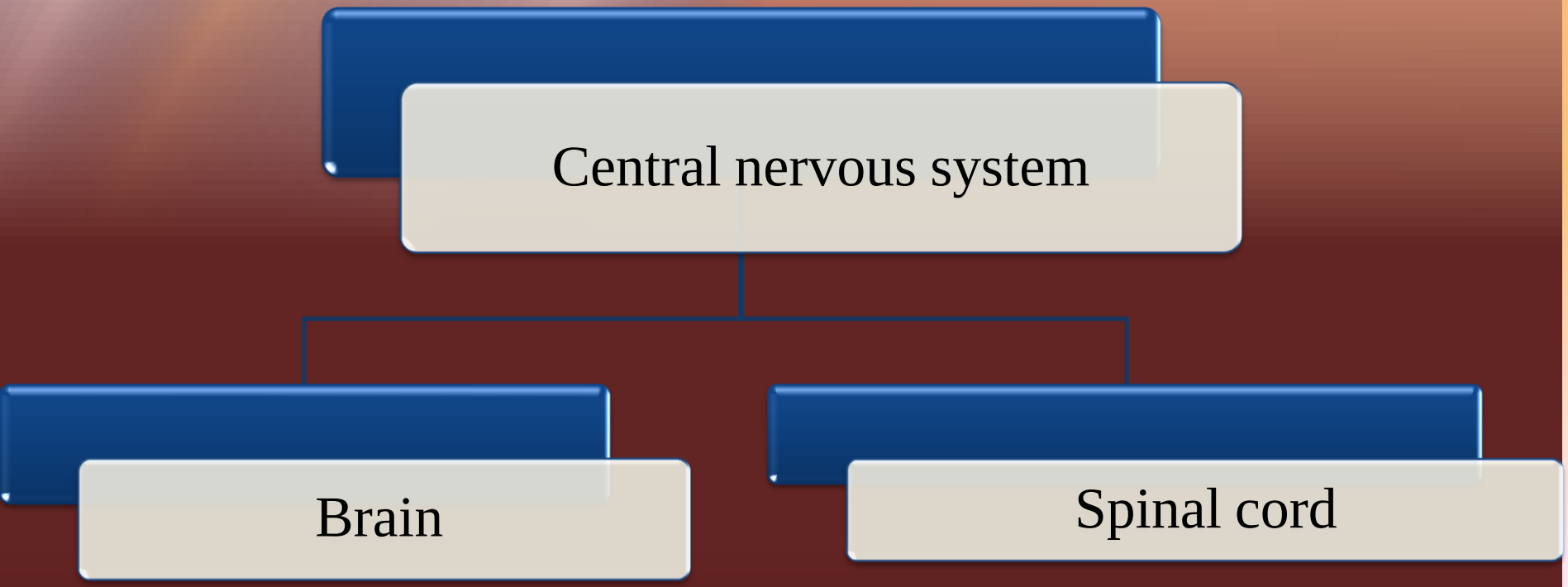
Nervous System

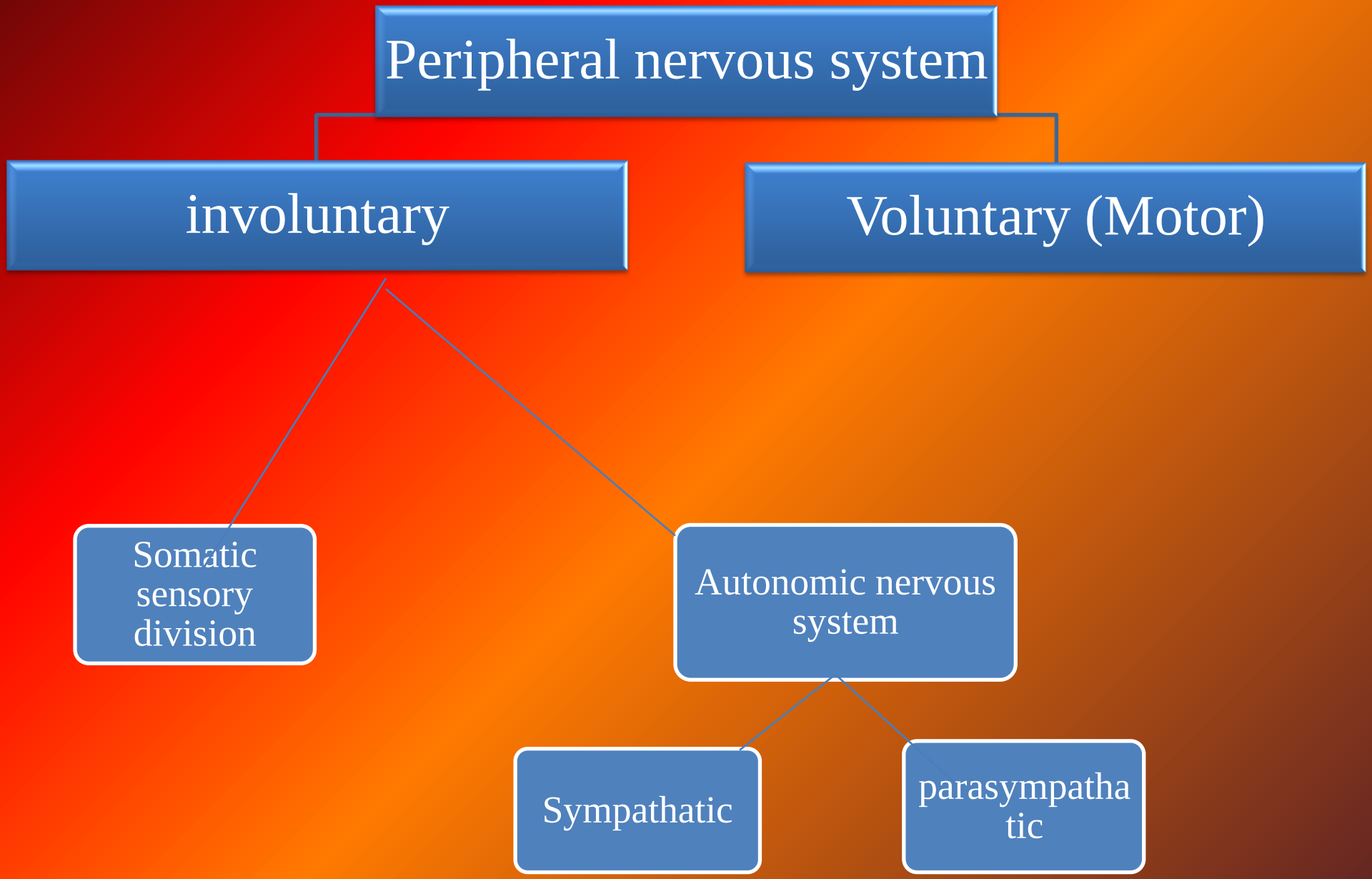
- The nervous system basically is the control center of the body.

- the nervous system is divided into two main parts:

1. Central nervous system (CNS). It is the control center of the body.

2. Peripheral nervous system (PNS). It communicate the body with CNS.


Central nervous system
Brain
Spinal cord


Peripheral nervous system
involuntary
Voluntary (Motor)
Somatic sensory division
Autonomic nervous system
Sympathatic
parasympathatic