

The Nervous System & Nervous tissue

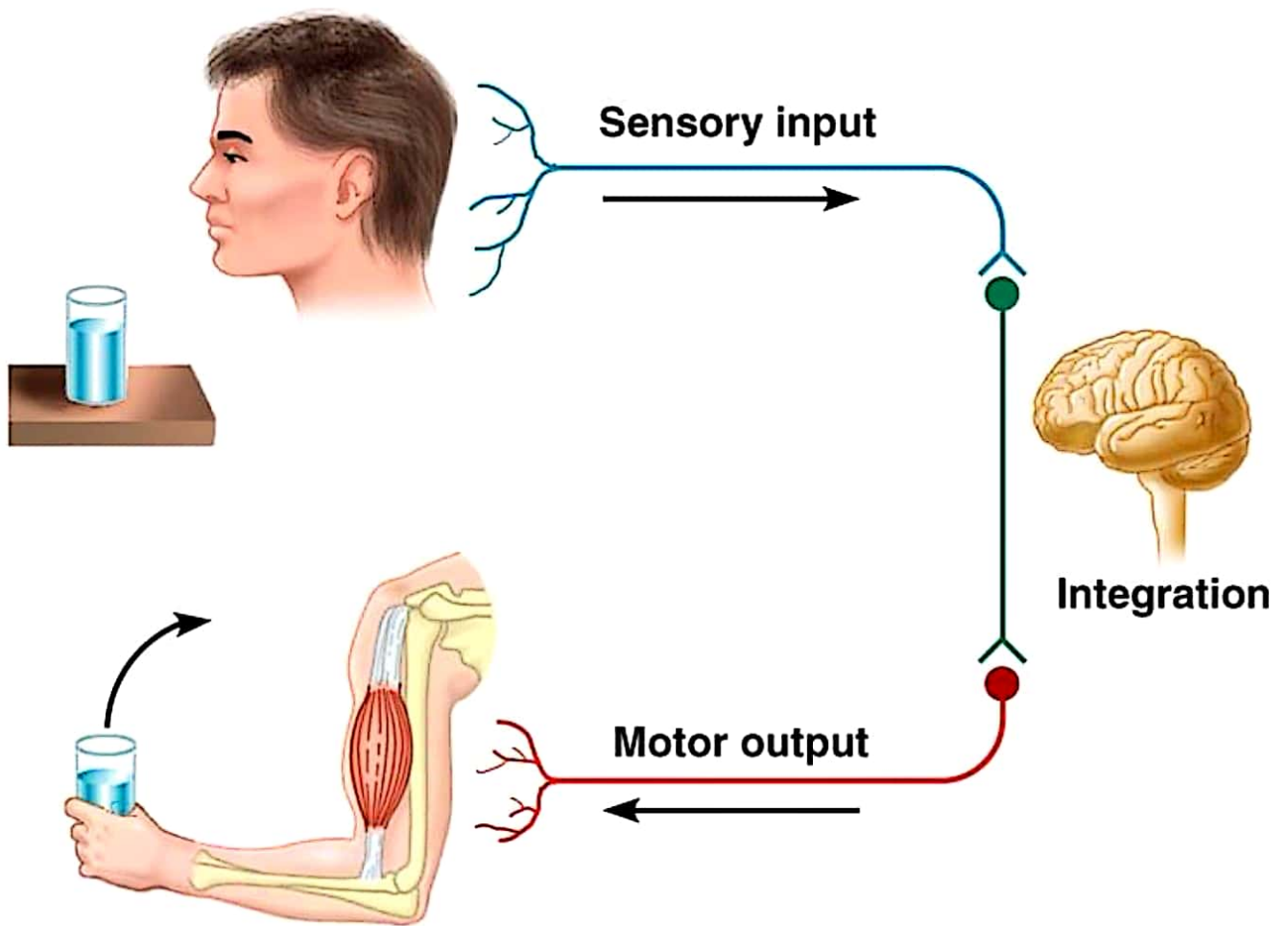
Functions of the Nervous System

1. Nervous system and endocrine system are the chief control centers in maintaining body homeostasis.
2. Nervous system uses electrical signals (**nerve impulses**) which produce immediate (but short-lived) responses; endocrine system uses chemical signals (**hormones**) that produce slower (but long lasting) responses.
3. Nervous system has 3 major functions:

Sensory input – sensory or afferent neurons detect internal or external changes (stimuli) and send the message to the brain or spinal cord.

Integration – interneurons in the brain or spinal cord process and interpret the message from the sensory neurons, and relay the message back to body parts.

Motor output – motor or efferent neurons receive the message from interneuron and produce a response at the effector organ (a muscle or a gland).



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Nerve tissue

1. Nerve tissue is composed of 2 main types of cells:

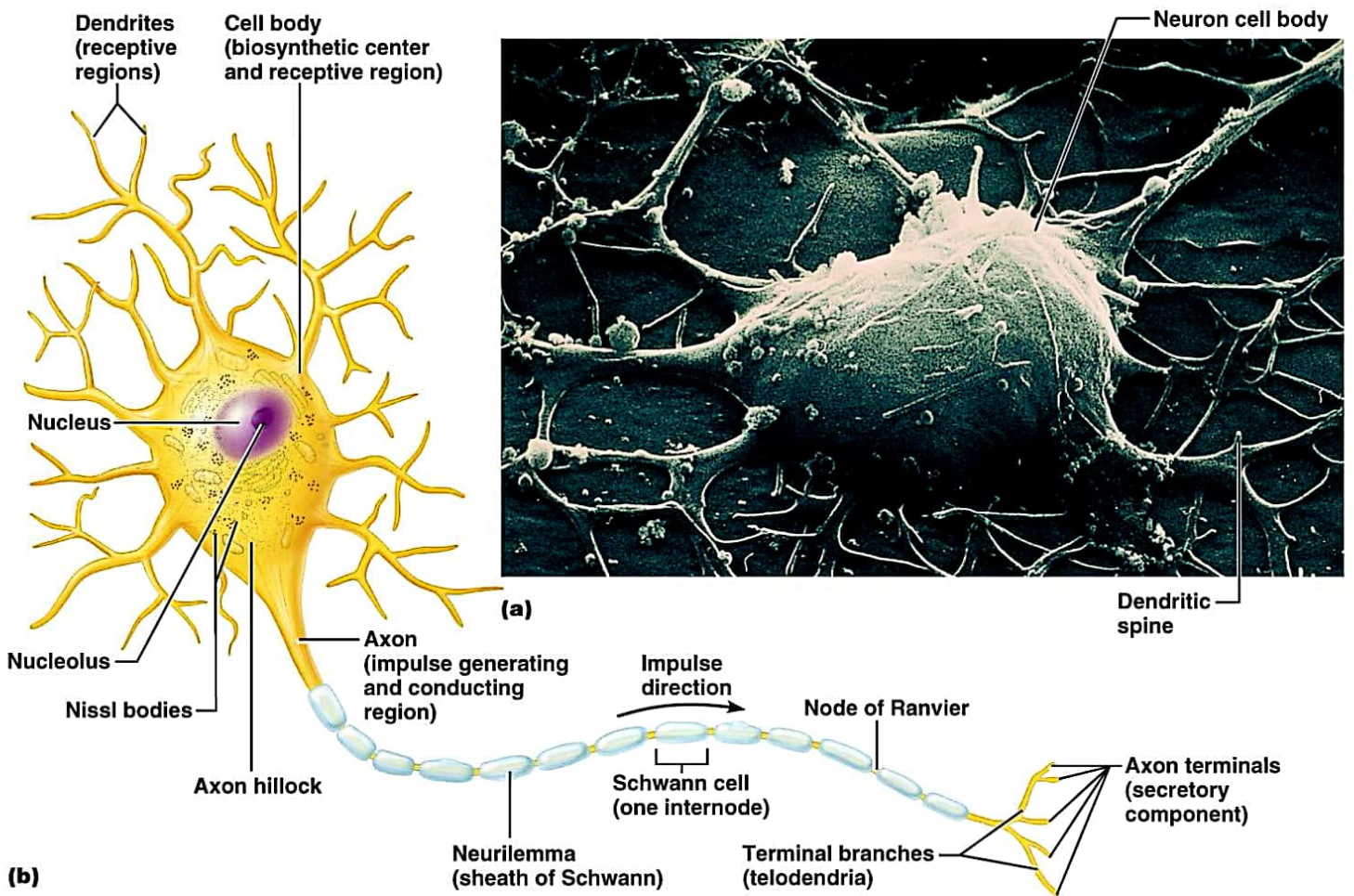
Neurons- nerve cells that are specialized to detect and react to stimuli, by generating and conducting nerve impulses.

Neuroglial cells- accessory cells for filling spaces and supporting neurons.

2. Microscopic anatomy of neurons

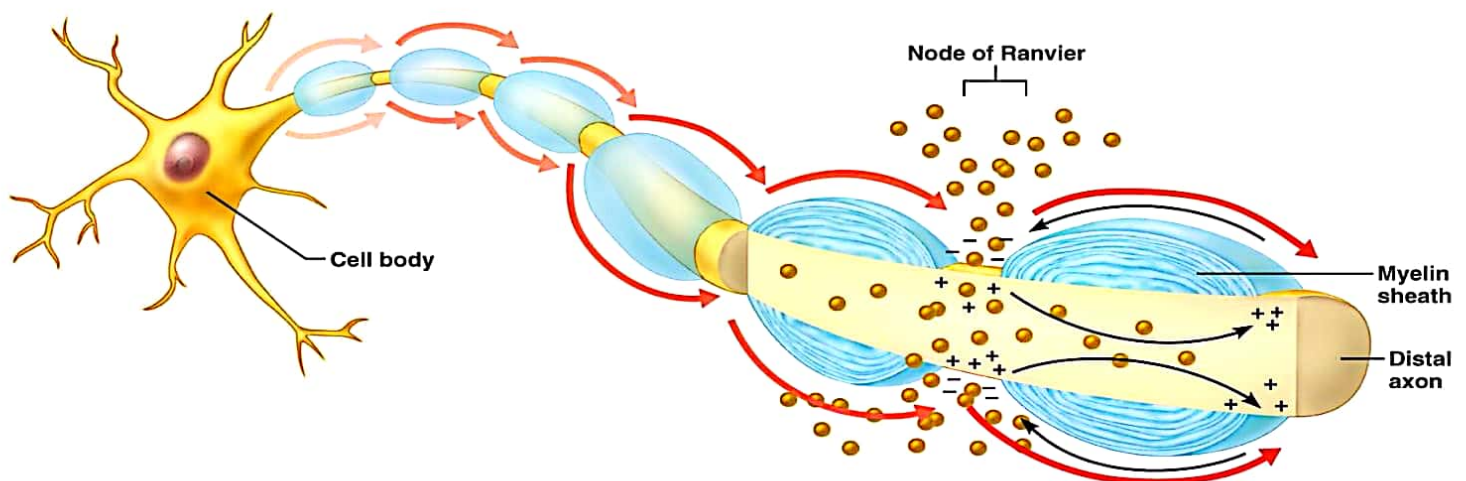
All neurons have a cell body called **soma** which contains a nucleus, organelles, and a modified endoplasmic reticulum called **Nissl body**.

Although there is **DNA** in the neuron, somehow DNA replication and mitosis do not occur, resulting in the neurons lack of ability to reproduce or regenerate.



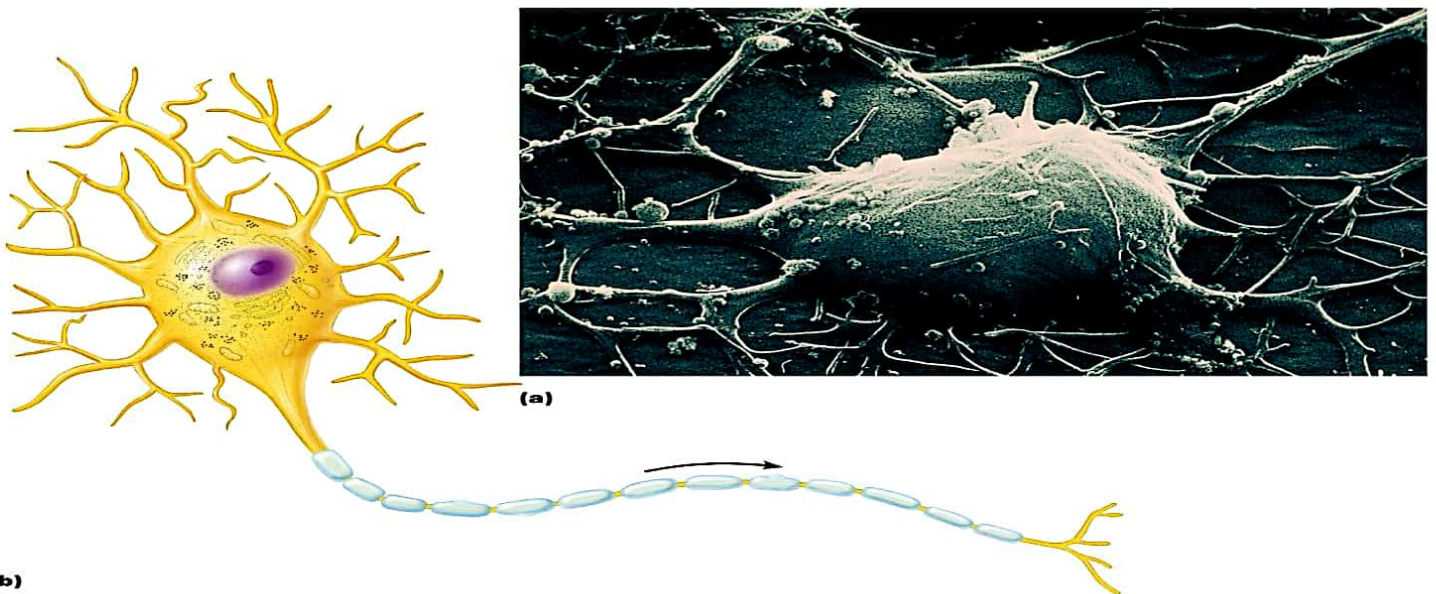
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- Extensions of the soma form nerve such as **dendrites** which conduct nerve impulses toward the soma, and **axon** which conducts nerve impulses away from the soma (to another neuron, or to an effect or organ).
- The number of dendrites ranges from 1 (in unipolar and bipolar neurons) to thousands (in multipolar neurons).
- All neurons only contain 1 axon.
- Longer axons are enclosed by a lipoprotein substance called **myelin sheath** produced by type of neuralgia cell celled **schwann cells**.



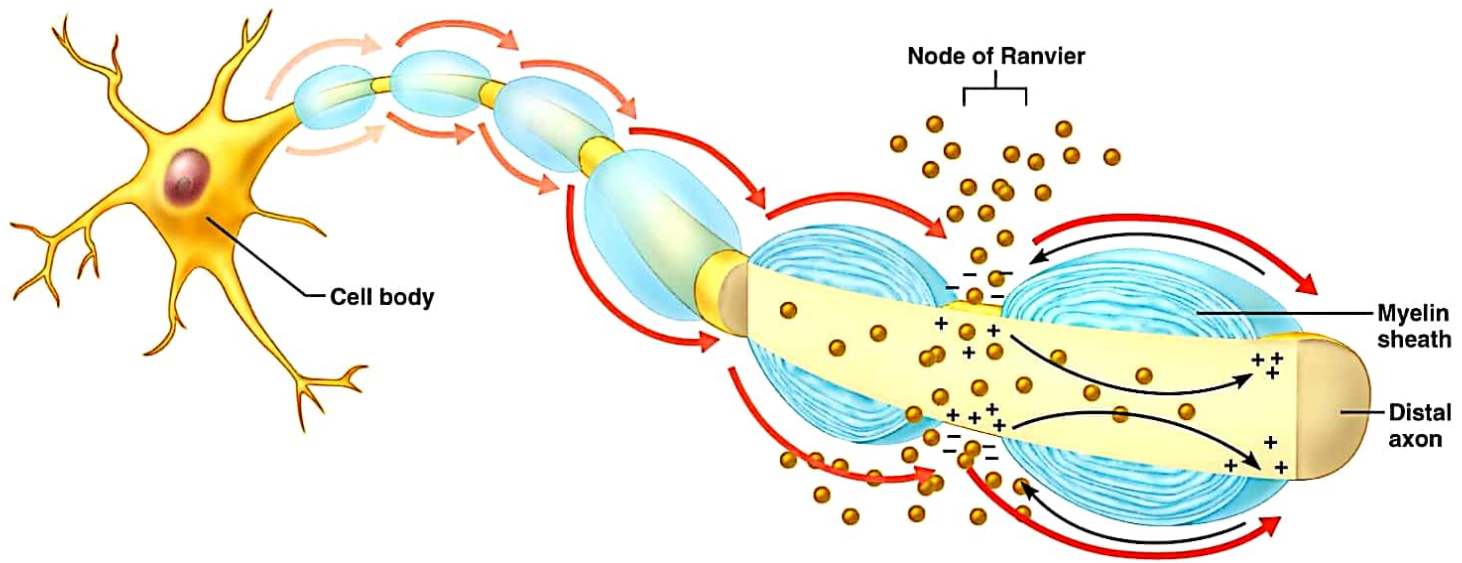
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- This myelin sheath insulates the axon against depolarization, and forces action potential to occur in the gaps (**node of Ranvier**) in between the myelin sheath.
- g) axons enclosed by myelin sheath are called myelinated axons which make up the **white matter** in the nervous system; while axons that have no myelin sheath are called unmyelinated axons which make up the **gray matter** in the nervous system.



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- The myelin sheath insulates the axon leaving only narrow gaps called **nodes of Ranvier** to allow action potential to occur. This type of nerve impulse propagation where action potential jumps from one gap to the next is referred to as "**saltatory conduction**" (which increases the rate of impulse transmission by 240 folds).



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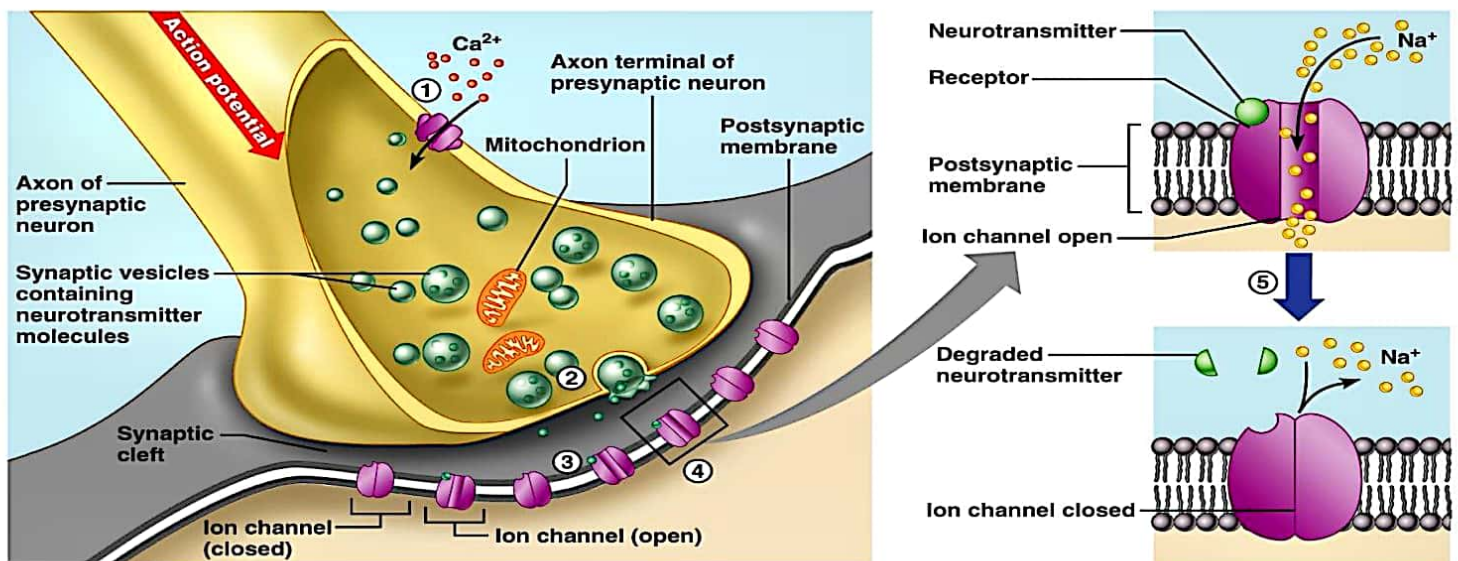
Synapse

- A synapse is the junction between two neurons, or between a neuron and an effector organ (muscle or gland). Each synapse consists of:

Presynaptic neuron = that sends an impulse to the synapse.

Axon – the nerve fiber extends from the presynaptic neuron, that propagates the impulse to the synapse

Synaptic knobs - the round endings of the axon.



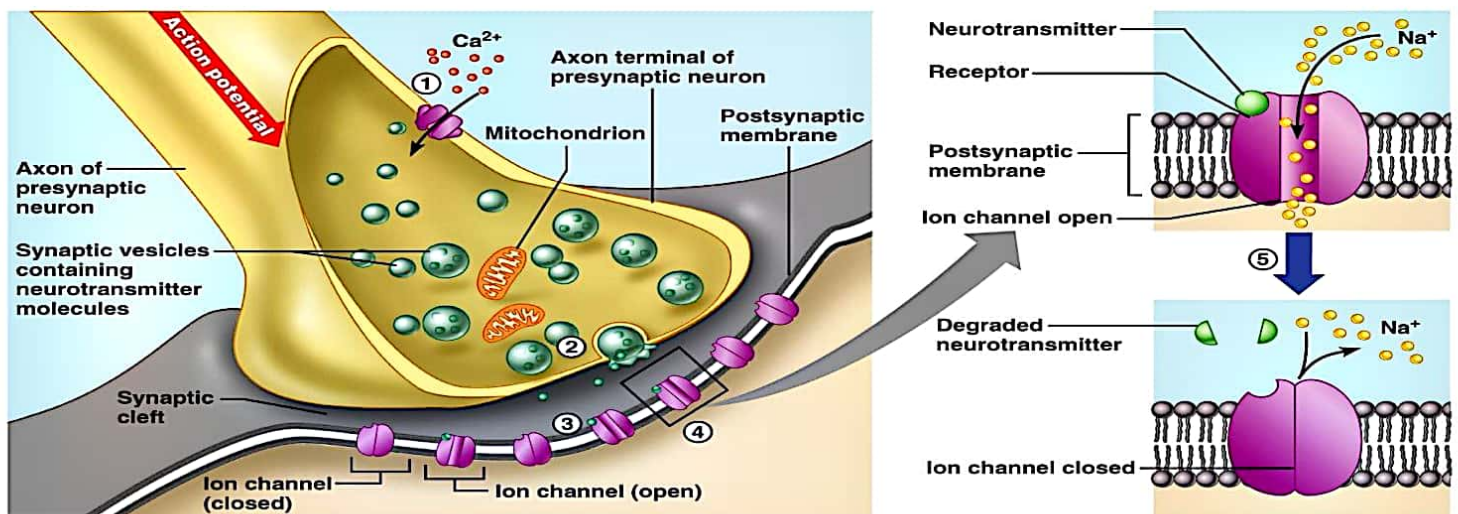
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Synaptic vesicles - membranous sacs that contain a neurotransmitter (e.g. acetylcholine, norepinephrine, dopamine), located in the synaptic knobs.

Synaptic cleft - a gap between the two neurons in the synapse.

Dendrite – the nerve fiber that continues to propagate the nerve impulse to the second neuron (postsynaptic neuron). Receptors on this dendrite receive the neurotransmitter from the axon.

Postsynaptic neuron - the neuron that receives the nerve impulse from the presynaptic neuron, through the synapse.



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Classification of neurons

Classification based on structure:

a) **unipolar neuron** - a single nerve fiber is extended from the soma, and it divides into a dendrite and an axon (sensory neurons that conduct reflexes or detect various stimuli).

b) **bipolar neuron** - a dendrite and an axon extend from the soma independently (sensory neurons involved in special senses such as vision, olfaction, and hearing).

c) **multiple neuron** - one axon and many dendrites extend from the soma (interneurons located inside the brain and spinal cord).

TABLE 11.1 Comparison of Structural Classes of Neurons

NEURON TYPE

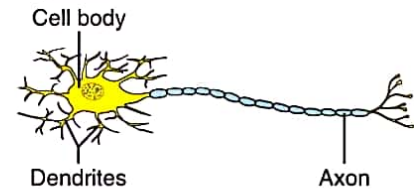
MULTIPOLAR

BIPOLAR

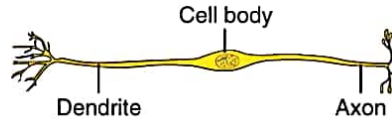
UNIPOLAR (PSEUDOUNIPOLAR)

STRUCTURAL CLASS: NEURON TYPE ACCORDING TO THE NUMBER OF PROCESSES EXTENDING FROM THE CELL BODY

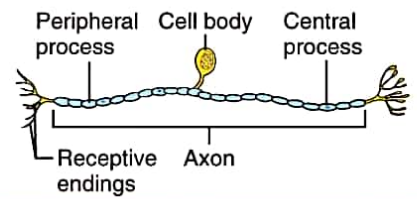
Many processes extend from the cell body; all are dendrites except for a single axon.



Two processes extend from the cell body: one is a fused dendrite, the other is an axon.

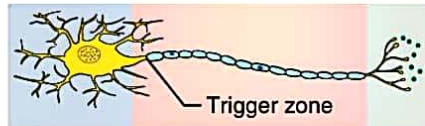


One process extends from the cell body and forms central and peripheral processes, which together comprise an axon.

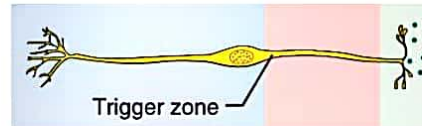


RELATIONSHIP OF ANATOMY TO THE THREE FUNCTIONAL REGIONS

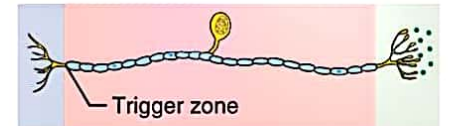
= Receptive region (receives stimulus). Plasma membrane exhibits chemically gated ion channels.



= Conducting region (generates/transmits action potential). Plasma membrane exhibits voltage-gated Na⁺ and K⁺ channels.



= Secretory region (axon terminals release neurotransmitters). Plasma membrane exhibits voltage-gated Ca⁺ channels.



(Many bipolar neurons do not generate action potentials and, in those that do, the location of the trigger zone is not universal.)

classification based on function:

a) **sensory or afferent neuron:**

- conducts nerve impulses from the body to the brain or spinal cord.
- endings of its dendrite may be modified to become nerve receptors.
- usually unipolar in structure.

b) **interneuron:**

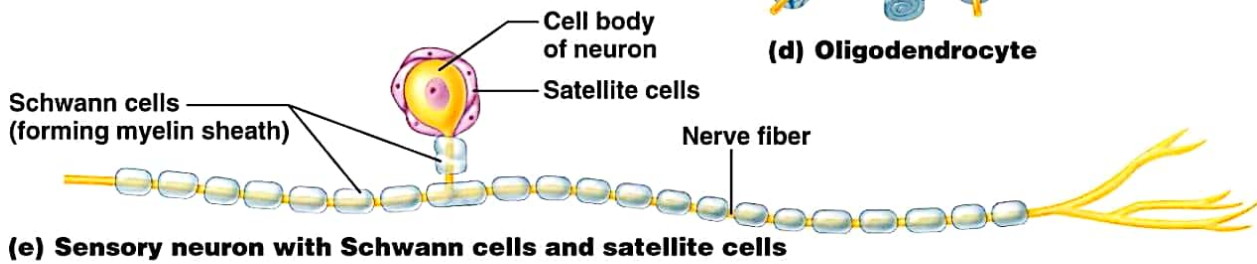
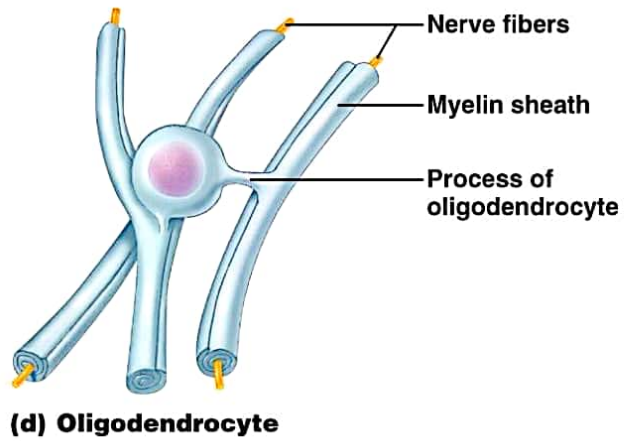
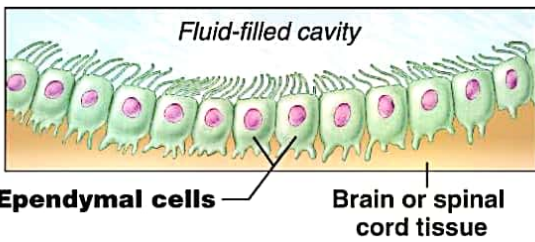
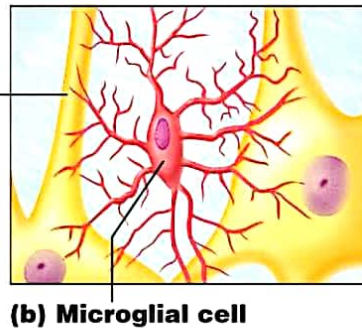
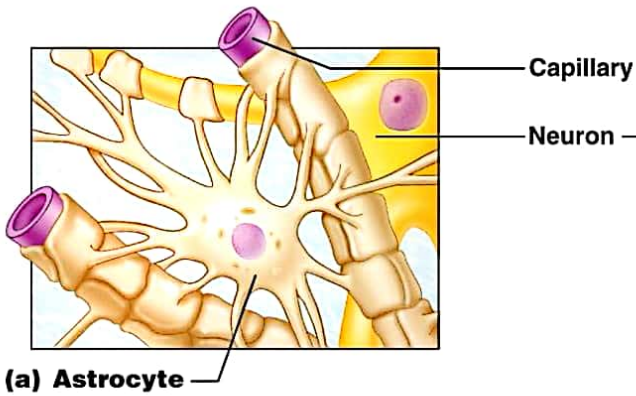
- relays nerve impulse from sensory neuron to motor neuron .
- located totally inside the tissues of the brain or spinal cord.
- involved in the processing and integration in the nervous system.
- usually multipolar in structure.

c) **motor or efferent neuron:**

- conducts nerve impulses from the brain or spinal cord to the effector organ (muscles or glands).
- usually multipolar in structure.
- **accelerator motor neurons** cause an increase of activity in the effector organ; while **inhibitory motor neurons** cause a decrease of activity in the effector organ.

Classification of Neuroglia

- Neuroglia: are the supporting cells of the nervous system.
 1. **Astrocytes**: star shaped cells found between neurons and blood vessels. They are the most abundant glial cells.
Function: structural support transport of substance between blood vessels and neurons, mop up excess ions (k) and neurotransmitters.
 2. **Microglial cells**: small ovoid cells.
Function: structural support and phagocytosis (immune protection).
 3. **Ependymal cells**: cuboidal or columnar shaped cells.
Function: form a porous layer through which substances diffuse between the interstitial fluid and the cerebrospinal fluid.
 4. **Oligodendrocytes**: resemble astrocytes but have less processes and arranged in rows along nerve fibers.
Function: produce myelin sheath within the brain spinal cord.

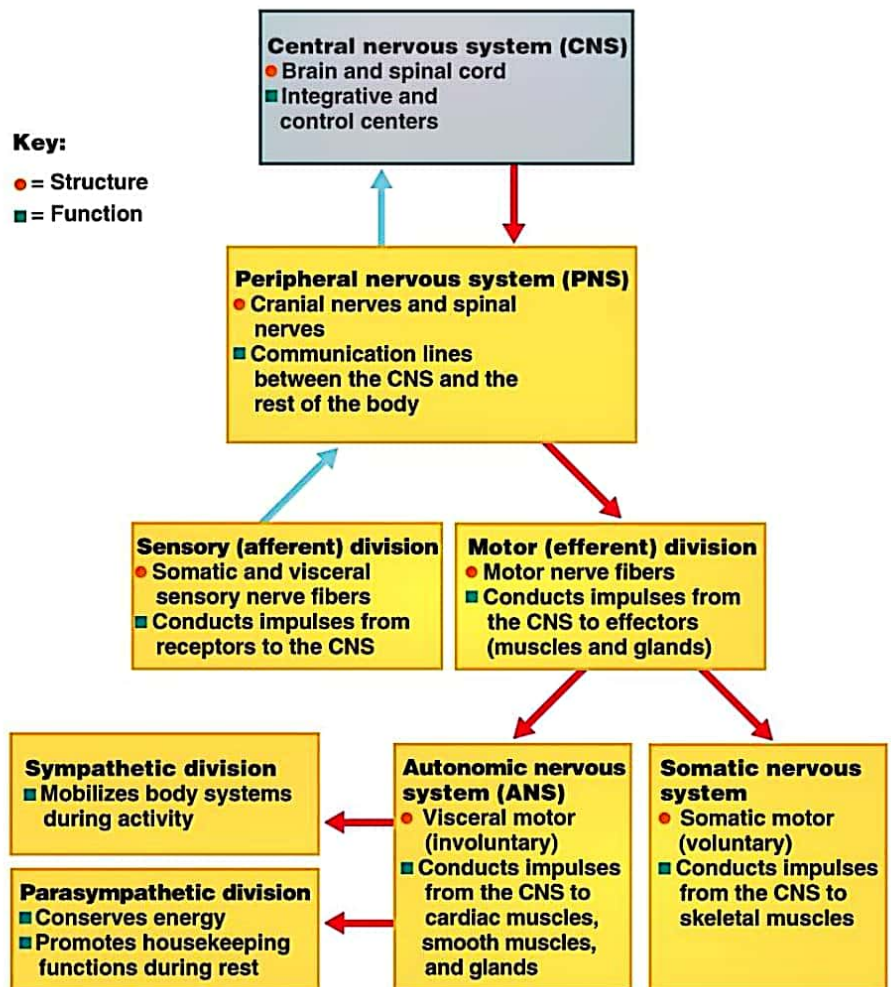


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Divisions of the Nervous System

1. The human nervous system consists of the **Central Nervous System (CNS)** and the **Peripheral Nervous System (PNS)**.
2. **CNS** is composed of the **brain** (located in the cranial cavity) and the **spinal cord** (located in the vertebral cavity), which serve as the main control centers for all body activities.
3. **PNS** is composed of nerves derived from the brain and spinal cord (12 pairs of **cranial nerves** and 31 pairs of **spinal nerves**), which serve as linkage between the CNS and the body.
4. PNS can be subdivided into **Sensory (afferent)** nerves and **Motor (efferent)** nerves. Sensory nerves send nerve impulse from the body to CNS, while motor nerves send impulse from CNS to effector organs.
5. Motor nerves are divided into the **Somatic Nervous system** (SNS) which regulates the voluntary contraction of skeletal muscles and **autonomic nervous system** (ANS) which regulates the involuntary control of smooth, cardiac muscles and glands.

6. Finally, the ANS can be divided into **Sympathetic** and **Parasympathetic** branches where in general sympathetic nerves stimulate activities of the effector organs (except digestive organs), and parasympathetic nerves inhibit activities of the effector organs (except digestive organs).



(a)

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