



Physiology

3<sup>rd</sup> stage

Lec.3

The nervous system

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## The nervous system

Nervous system, organized group of cells specialized for the conduction of electrochemical stimuli from sensory receptors through a network to the site at which a response occurs. It consists of the brain, spinal cord and a huge network of nerves.

The nervous system is one of the most complex systems of the body in the animal world, the central nervous system contains more than 100 billion neurons, and it is estimated in humans about  $10^{10}$ - $10^{11}$  neurons.

## Function of nervous system

The nervous system plays a leading role in:

- 1- regulating the physiological processes that occur in the body (Movement - Feeling - Breathing - Digestion – Thinking).
- 2- linking the organism to the external environment surrounding it.
- 3- linking the various body systems with each other.
- 4- ensuring balance between the organism and the external environment.

This task is achieved by controlling (1) contraction of appropriate skeletal muscles throughout the body, (2) contraction of smooth muscle in the internal organs, and (3) secretion of active chemical substances by both exocrine and endocrine glands in many parts of the body.

These activities are collectively called motor functions of the nervous system, and the muscles and glands are called effectors.

Messages carried by nervous system are electrical signals called impulses. Cells that transmit these impulses are called neurons (basic units of nervous system).

## Neuron Parts

### 1- Cell Body:

- Largest part; contains nucleus and most of cytoplasm.
- Most metabolic activities occur here.

### Dendrites:

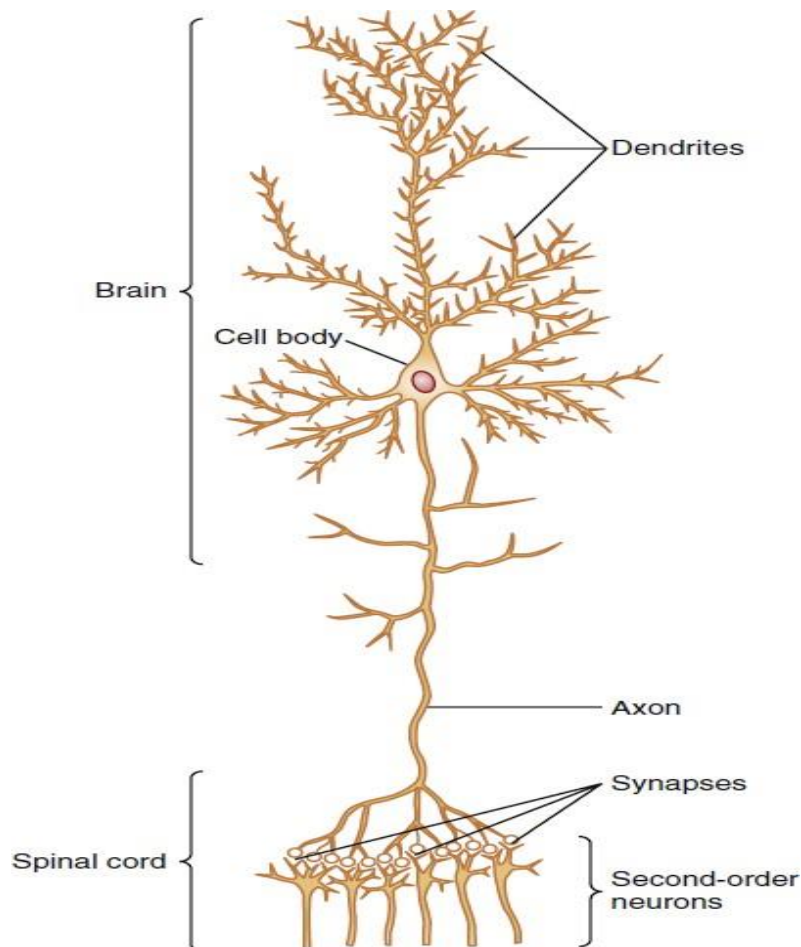
- Short, branched extensions.
- Carry impulses from environment or other neuron toward cell body.
- Neurons can have several dendrites.

### 2- Axon:

- Long fiber which carries impulses away from cell body.
- Ends in axon terminals, located a distance away from cell body.
- Neurons only have one axon.

### 3- Myelin Sheath:

- Insulating membrane surrounding axon.

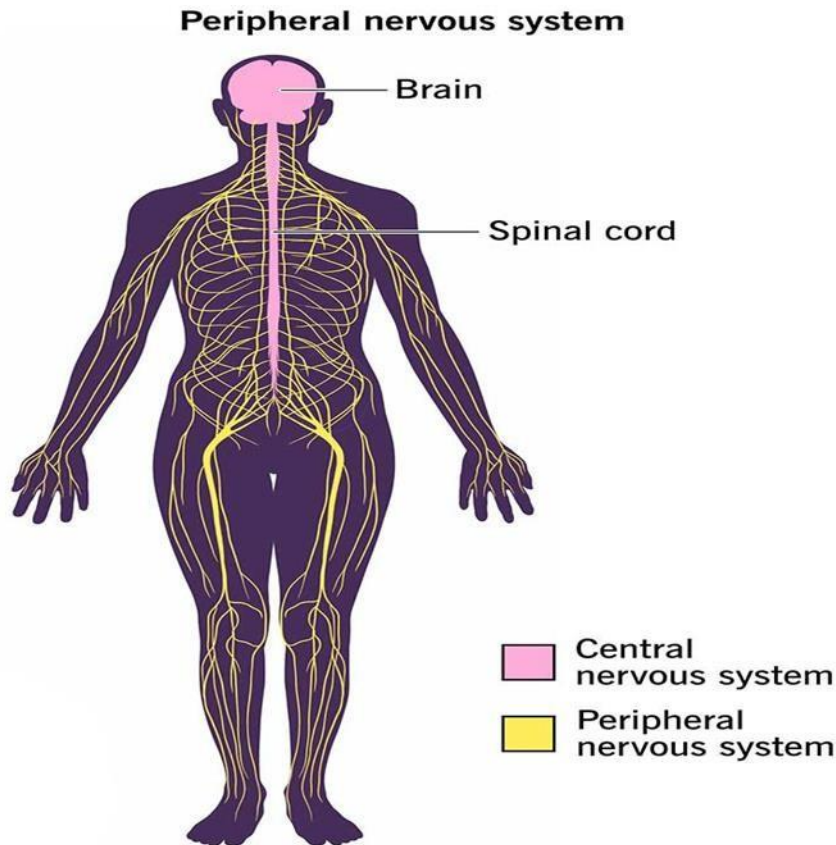


**Figure 1.** Structure of a large neuron in the brain showing its important functional parts.

## Structure of the nervous system

The nervous system consists of two main parts:

- 1 - Central nervous system.
- 2- Peripheral nervous system.



### 1 - Central nervous system (CNS):

Relays messages, processes info and analyzes info, It consists of the brain and spinal cord.

1. **Brain** (body control center and regulates all processes, thoughts, behaviors, and emotions).

#### **Brain (Cerebrum, Cerebellum, Brain Stem)**

The cerebrum: the major portion of the brain is the cerebrum, which divides the left and right.

- Control of voluntary movements of the body (walking, sitting, running).

- Receive sensory impulses from the sense organs.
- Contain the centers of thought and memory
- Made of 50-100 billion neurons and have four lobes or regions:
  - Frontal Lobe- memory, judgment, inhibitions, personality.
  - Temporal Lobe- Long term memory, auditory processing.
  - Occipital Lobe- Vision processing.
  - Parietal Lobe- Sensory integration.

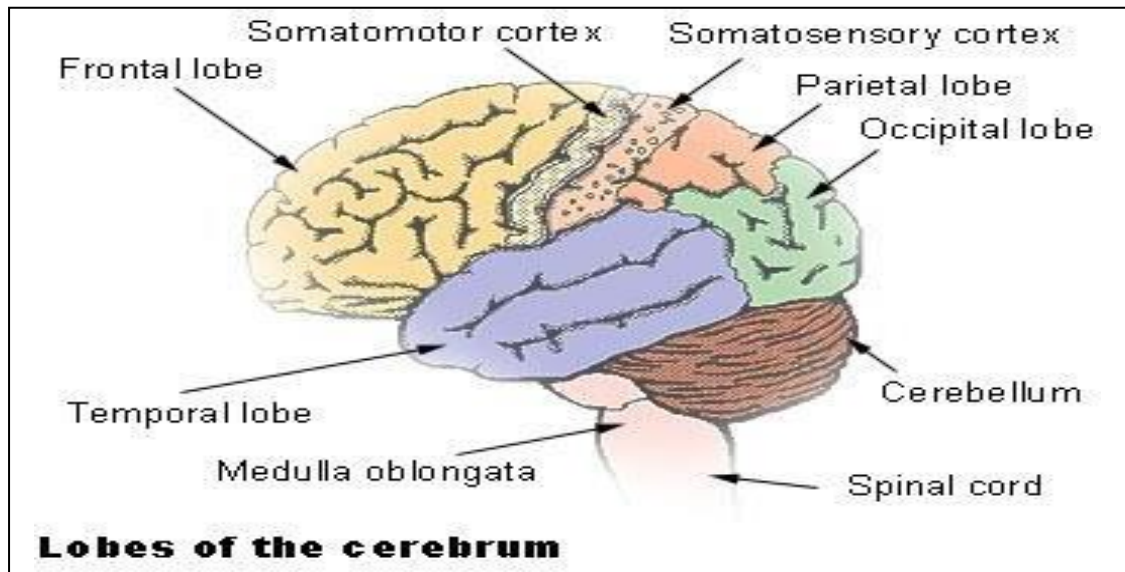


Figure 2. Lobes of the cerebrum.

### The cerebellum

The largest of the hindbrain is the cerebellum. Maintains body balance during movement.

### The brainstem

The cerebellum and spinal cord are connected to the cerebral hemispheres by the brainstem. The brain stem can be classified into four distinct sections that include the diencephalon, midbrain, pons, and medulla oblongata.



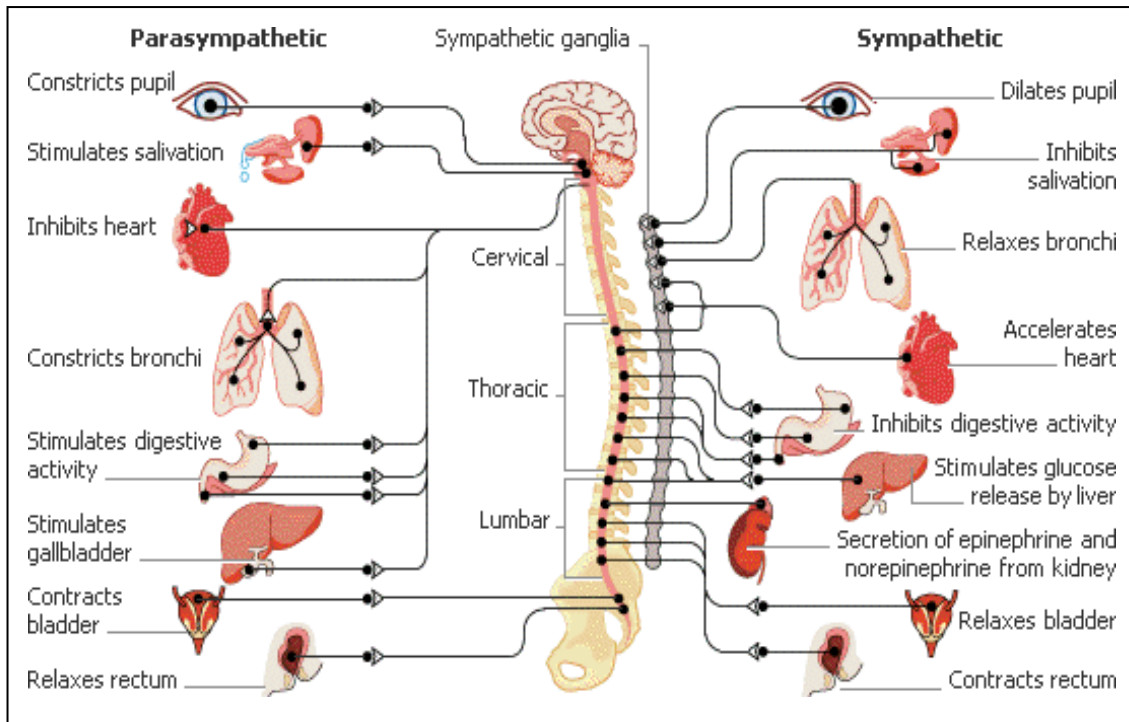
## 2. Spinal Cord

- Main communications link between the brain and the rest of the body
- Certain kinds of info (reflexes) are processed in spinal cord
- Reflex is a quick, automatic response to a stimulus
- Sneezing and blinking
- Allows your body to respond to danger immediately without thinking

### 2- Peripheral nervous system (PNS):

Receives information from the environment and relays commands from the CNS to organs and glands. Consists of:

- A- Cranial nerves: They are the 12 pairs of nerves that emerge from the brain or brain stem.
  - B- Spinal nerves: They are the 31 pairs of nerves that come out of the spinal cord.
  - C- sympathetic and parasympathetic nerves: the nerves that form the autonomic nervous system, which is responsible for controlling the involuntary organs in the body.
  - Cranial nerves divided into 2 divisions:
    - i. **Sensory**
    - ii. **Motor**
  - Sensory division:
    - transmits impulses from sense organs to the CNS
  - Motor division:
    - transmits impulses from CNS to muscles and glands
    - 1- somatic nervous system- regulates conscious controlled activities.
    - 2- autonomic nervous system- regulates activities that are automatic or involuntary.
- Divided into sympathetic and parasympathetic nervous system.



**Figure 3.** sympathetic and parasympathetic nervous system.

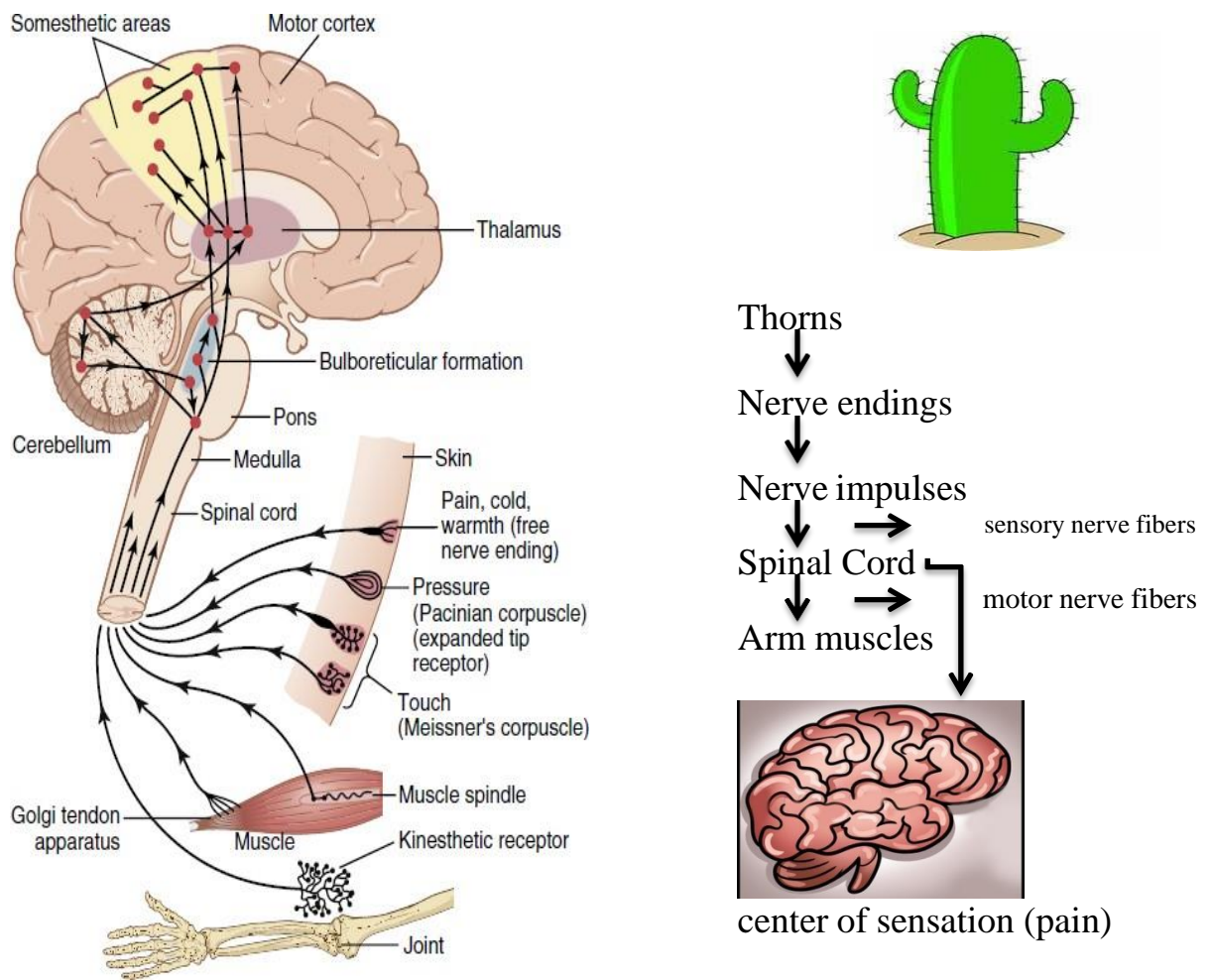
### Three types of neurons

- 1- **Sensory:** Carry impulses from sense organs (eyes, ears, etc) to the spinal cord and brain.
- 2- **Motor:** carry impulses from the brain and spinal cord to muscles and glands.
- 3- **Interneurons:** connect sensory and motor neurons and carry impulses between them.

### The sensory part of the nervous system—sensory receptors

Most activities of the nervous system are initiated by sensory experiences that excite sensory receptors, whether visual receptors in the eyes, auditory receptors in the ears, tactile receptors on the surface of the body, or other kinds of receptors. These sensory experiences can either cause immediate reactions from the brain, or memories of the experiences can be stored in the brain for minutes, weeks, or years and determine bodily reactions at some future date.





**Figure 4.** Somatosensory axis of the nervous system.

## Nerve receptors

**Nerve receptors:** They are special compounds found at the terminal ends of the nerves that respond to the changes that occur in the external or internal medium, and thus the receptors are divided into:

**1- Internal receptors:** receptors that respond to changes and influences that occur inside the body, such as receptors in blood vessels, in the respiratory system, and others.

**2- External receptors:** receptors that respond to external variables and stimuli and are found in or near the surface of the body, such as receptors for touch, pain, temperature, smell, hearing, and others.





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## Role of synapses in processing information

- 1- The synapse is the junction point from one neuron to the next.
  - 2- The synapses determine the directions that the nervous signals will spread through the nervous system.
  - 3- Control in transmission.
  - 4- The synapses perform a selective action, often blocking weak signals while allowing strong signals to pass.
  - 5- The synapses often channeling these signals in many directions rather than in only one direction.
- An impulse begins when a neuron is stimulated by another neuron or the environment.
  - Neurotransmitters are chemicals used by neurons to transmit an impulse across the synapse.

**Processing of information— integrative function of the nervous system** One of the most important functions of the nervous system is to process incoming information in such a way that appropriate mental and motor responses will occur. Thus, if a person places a hand on a hot stove, the desired instantaneous response is to lift the hand. Other associated responses follow, such as moving the entire body away from

## Physiological properties of nerves

- 1- **Sensitivity to signal:** It is the ability of the protoplasm of the nerve cell to respond to excitations, and neuronal receptors have a high ability to respond to various stimuli.
- 2- **Conductivity:** It is the ability of nerves to transmit and conduct a nerve excitation wave from one place to another . The ability of nerves to transmit and conduct nerve signals is directly proportional to the thickness of the nerve, for example, the speed of conduction in some nerves may reach 120 m/s, and in some nerves it decreases to reach 0.5 m/s or less.