The nervous system

The nervous system plays a leading role in regulating the physiological processes that occur in the body, linking the organism to the external environment surrounding it, linking the various body systems with each other, and ensuring balance between the organism and the external environment. Messages carried by nervous system are electrical signals called impulses. Cells that transmit these impulses are called neurons (basic units of nervous system).

The central nervous system contains more than 100 billion neurons. Figure 1 shows a typical neuron of a type found in the brain motor cortex. Incoming signals enter this neuron through synapses located mostly on the neuronal dendrites, but also on the cell body. For different types of neurons, there may be only a few hundred or as many as 200,000 such synaptic connections from input fibers. Conversely, the output signal travels by way of a single axon leaving the neuron. Then, this axon may have many separate branches to other parts of the nervous system or peripheral body. A special feature of most synapses is that the signal normally passes only in the forward direction, from the axon of a preceding neuron to dendrites on cell membranes of subsequent neurons. This feature forces the signal to travel in required directions to perform specific nervous functions.

Parts of a Neuron

1- Cell Body:

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

2- Dendrites:

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

3- 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.

4- Myelin Sheath:

- Insulating membrane surrounding axon.

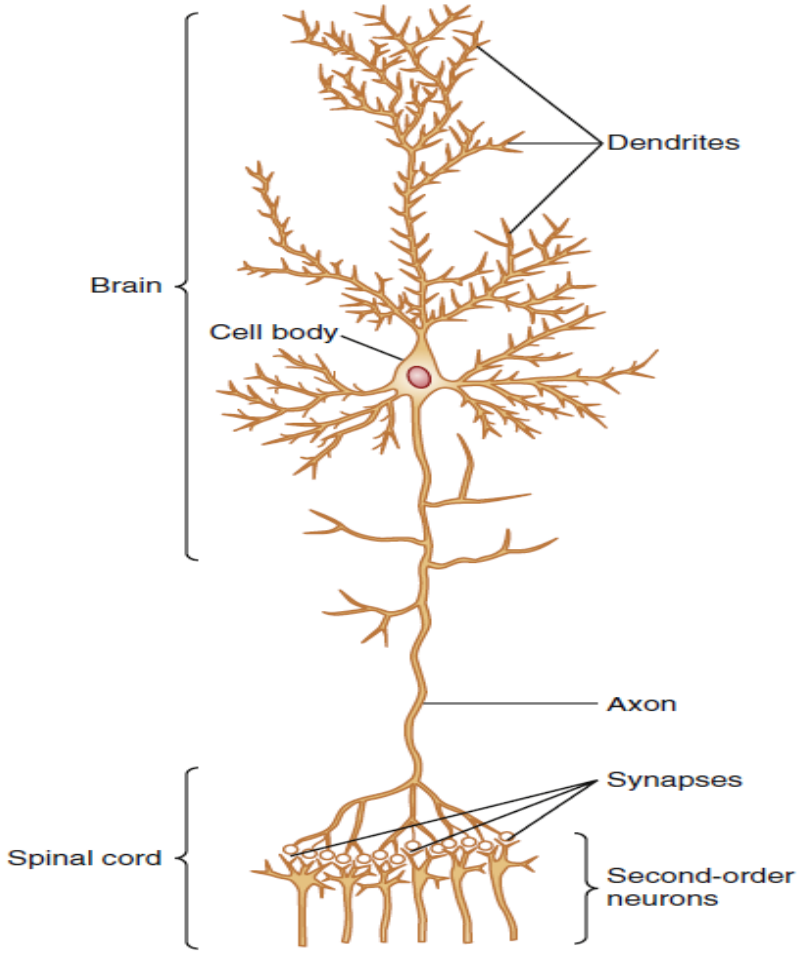


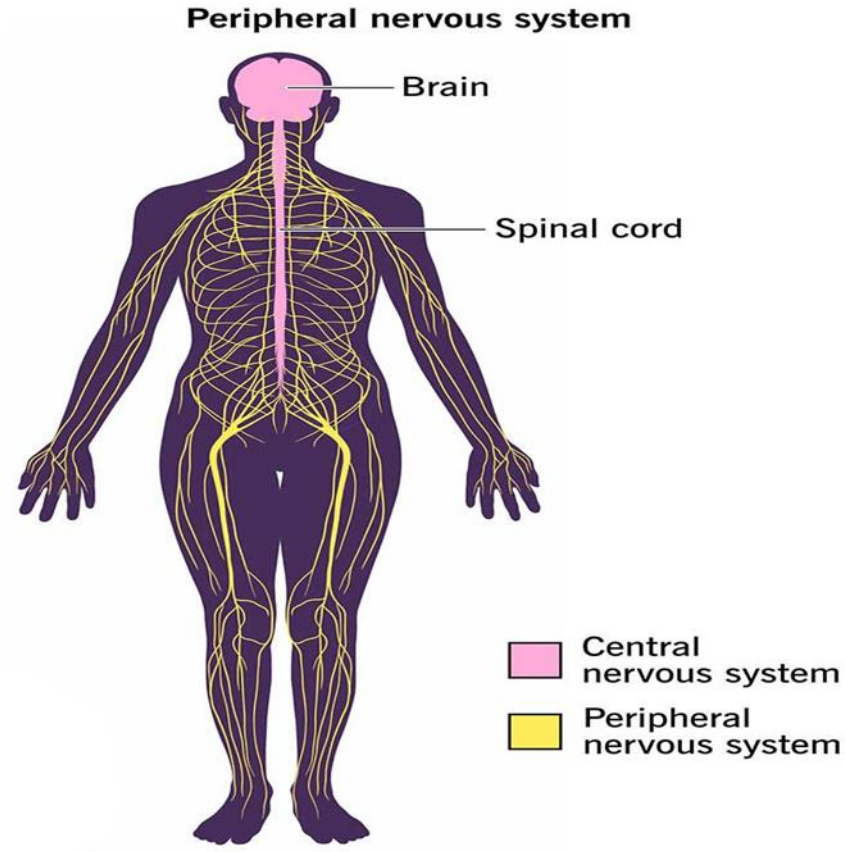
Figure 1. Structure of a large neuron in the brain showing its important functional parts.

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):

It includes all the nerve formations located in the cranial cavity and vertebral canal, and consists of the brain, cerebrum, and spinal cord.

1. **Brain (Cerebrum, Cerebellum, Brain Stem, Thalamus and hypothalamus)**

- 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.

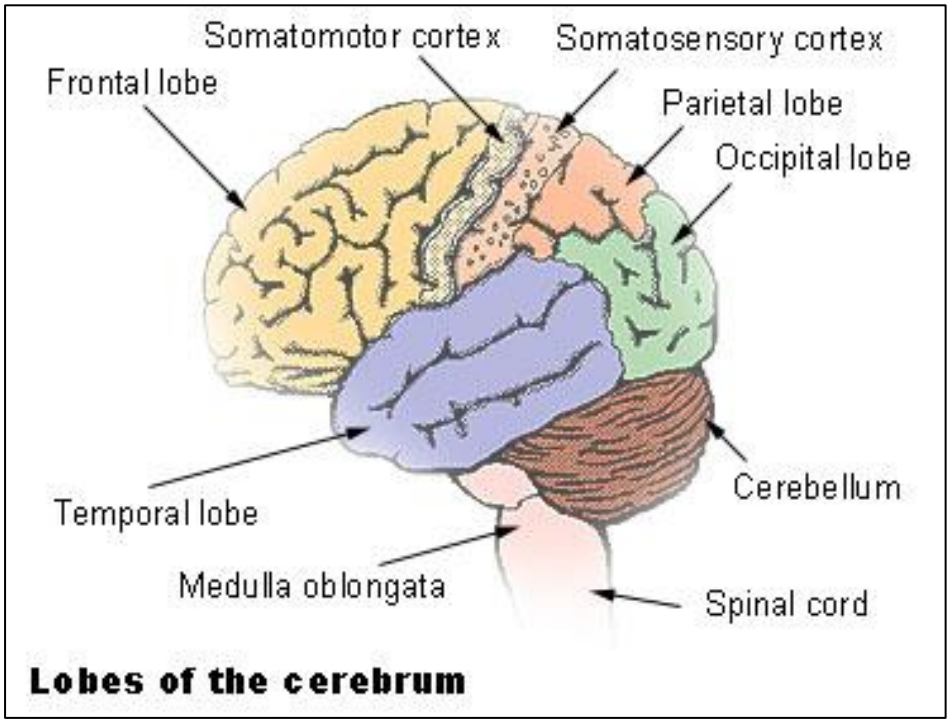


Figure 2. Lobes of the cerebrum.

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):**It includes all the nerve formations located outside the cranial cavity and outside the vertebral canals, and 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.

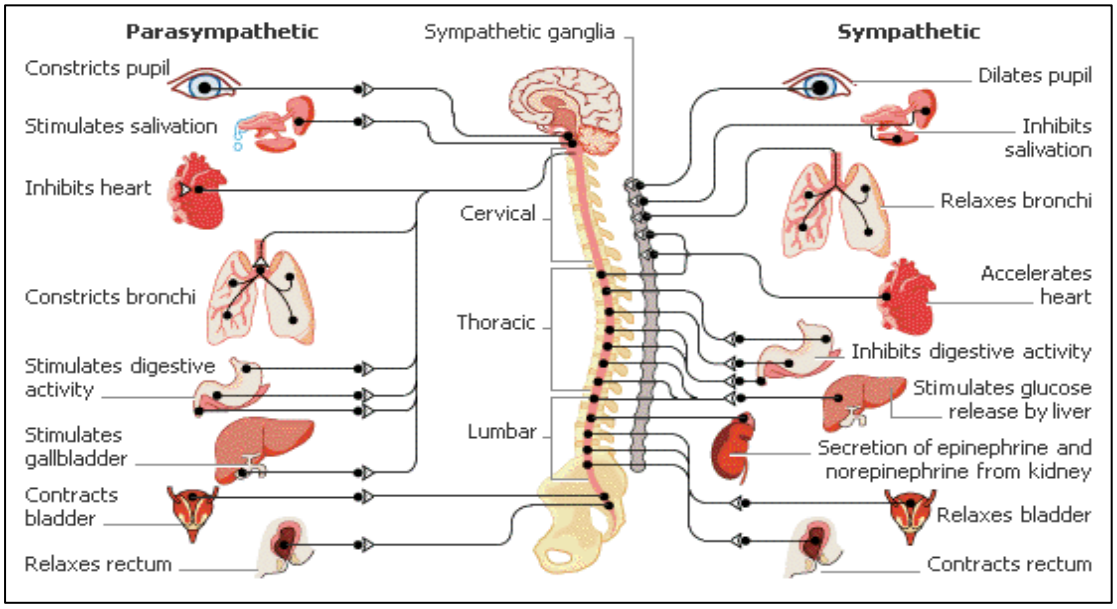


Figure 3. sympathetic and parasympathetic nervous system.

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 shows the somatic portion of the sensory system, which transmits sensory information from the receptors of the entire body surface and from some deep structures. This information enters the central nervous system through peripheral nerves and is conducted immediately to multiple sensory areas in (1) the spinal cord at all levels; (2) the reticular substance of the medulla, pons, and mesencephalon of the brain; (3) the cerebellum; (4) the thalamus; and (5) areas of the cerebral cortex.

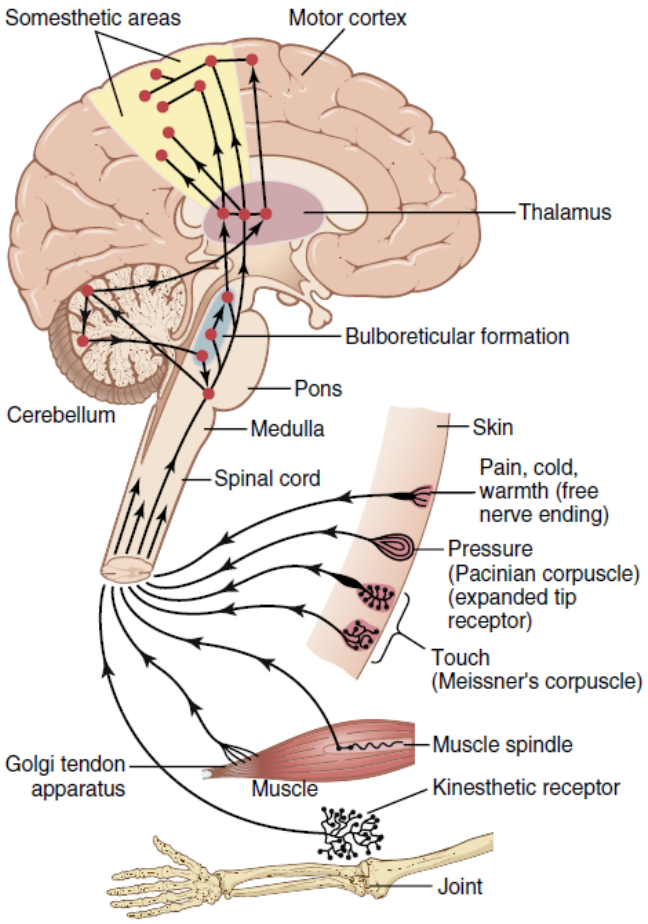


Figure 4. Somatosensory axis of the nervous system.

The motor part of the nervous system—effectors

The most important eventual role of the nervous system is to control the various bodily activities. 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 because they are the actual anatomical structures that perform the functions dictated by the nerve signals.

Nerve receptors

The nervous system is unique in the vast complexity of thought processes and control actions it can perform. Each minute it receives literally millions of bits of information from the different sensory nerves and sensory organs and then integrates all these to determine responses to be made by the body.

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.

Role of synapses in processing information

The synapse is the junction point from one neuron to the next. that synapses determine the directions that the nervous signals will spread through the nervous system. Some synapses transmit signals from one neuron to the next with ease, whereas others transmit signals only with difficulty. Also, facilitatory and inhibitory signals from other areas in the nervous system can control synaptic transmission, sometimes opening the

synapses for transmission and, at other times, closing them. In addition, some postsynaptic neurons respond with large numbers of output impulses, and others respond with only a few. Thus, the synapses perform a selective action, often blocking weak signals while allowing strong signals to pass but, at other times, selecting and amplifying certain weak signals and 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.

Nervous system functions

1- Regulating the activity of different organs and the activity of the organism as a whole.
2- Connect the different parts of the body together.
3- Securing a balance between the organism and the environment surround it.

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.

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. More than 99% of all sensory information is discarded by the brain as irrelevant and unimportant. For example, one is ordinarily unaware of the parts of the body that are in contact with clothing, as well as the seat pressure when sitting. Likewise,

attention is drawn only to an occasional object in one's field of vision, and even the perpetual noise of our surroundings is usually relegated to the subconscious. However, when important sensory information excites the mind, it is immediately channeled into proper integrative and motor regions of the brain to cause desired responses. This channeling and processing of information is called the integrative function of the nervous system. 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 the stove and perhaps even shouting with pain.