Introduction to the Nervous System

Think about the last time you touched an object that was too hot. How did your body react? You may have immediately moved your hand away. What may have happened if you had left your hand on the hot object?

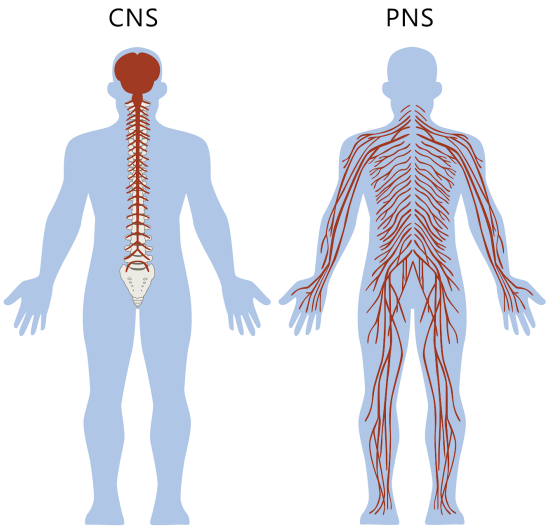
Your skin is lined with millions of special cells called neurons. These cells are able to detect changes in the environment outside your body. The neurons then send signals to the brain, so that your brain can appropriately respond to the change. Think of the neurons as students in a classroom. When the temperature inside the class becomes too hot, the change is detected by the students who begin to sweat. The students tell their teacher and the teacher responds by turning up the air conditioning. In this example the teacher is the brain which responded to the change detected by the neurons, the students.

In our body the nervous system detects and responds to changes from normal functions both inside and outside the body. It is a complex system made up of the brain, spinal cord and the billions of neurons.

Keep reading to learn more about the divisions of the nervous system, the structures of the nervous system and how messages are transmitted through the nervous system.

Divisions of the Nervous System

The nervous system consists of several divisions carrying out various functions. Use the interactive diagram below to learn more about the divisions.



Central Nervous system (CNS)

- The CNS is made up of the brain and spinal cord. This division of the nervous system controls the regulation of body systems as well as the processing and creation of memories.

Peripheral Nervous System (PNS)

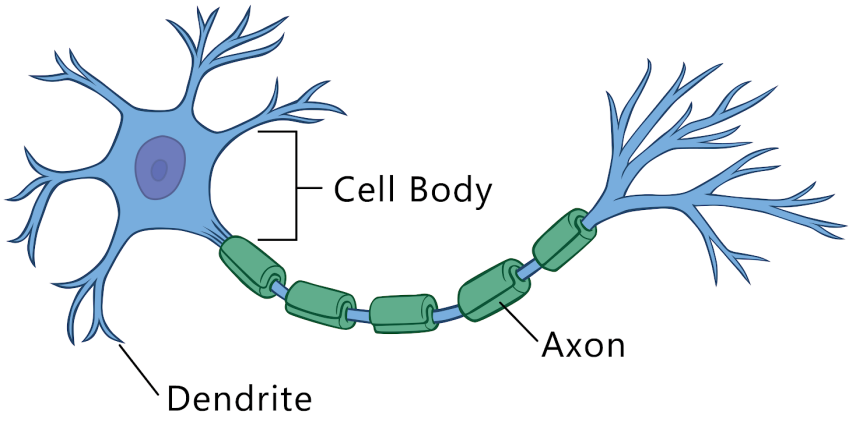
- The PNS is made up of all the neurons connecting the CNS to the rest of the body. The PNS sends messages from the body to the spinal cord and/or brain and back.
- The PNS is divided into two sections: the Autonomic Nervous System (ANS) and the Somatic Nervous System (SNS). The ANS is involved with the unconscious control of body parts. That is the ANS controls all the body functions that takes place without us thinking about it. For example, the ANS controls our breathing, heart beat, blinking, and the digestion of food. On the other hand, the SNS is involved with the conscious control of the body. For example, whenever we think about raising our hand or kicking a football the SNS sends signals from the brain to our muscles telling them what to do.

Structure of the Nervous System

Neurons

Neurons or nerve cells carry signals throughout the nervous system. Groups of nerve cells get together to form the nerve tissue or nerves. A signal can pass through a nerve cell with a speed of 265 miles/hour. Even though signals pass through one neuron with such speed, having a group of neurons or nerves helps the signal travel through faster and with more strength.

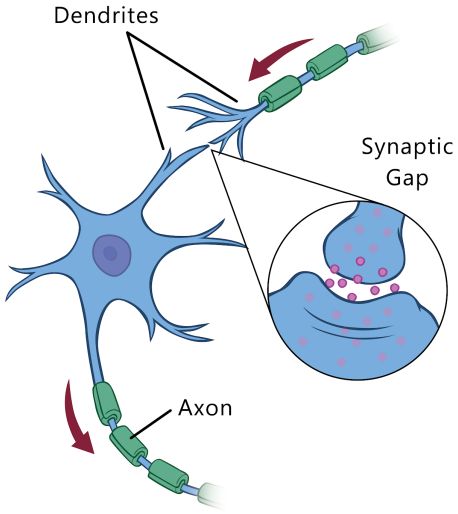
Every neuron has a basic structure consisting of three main parts: the dendrites, cell body, and axon. The diagram outlines the structure of a basic nerve cell.



The main part of a nerve cell is the **cell body.** The cell body contains the main control center of the cell, the nucleus and all the other structures found in any typical body cell. The cell body controls the cell's functions. For example, it supplies the rest of the cell with food and energy and controls the elimination of waste products.

From the cell body extends several hair-like branches called **dendrites** (singular: dendrite)**.** These structures carry signals to the cell body from other neurons or the environment. Attached to the cell body is another long, thick, tail-like structure called the **axon** (plural: axons). The axon carries the signals away from the cell body. The dendrites and axons are called nerve fibers.

A neuron receives a signal through the dendrites, which is then transmitted to the cell body and then through the axon. Once at the end of the axon the signal will be transmitted to the next neuron. No two neurons touch each other. A space called the **synaptic gap** separates the dendrites of one neuron from the axon of another neuron.



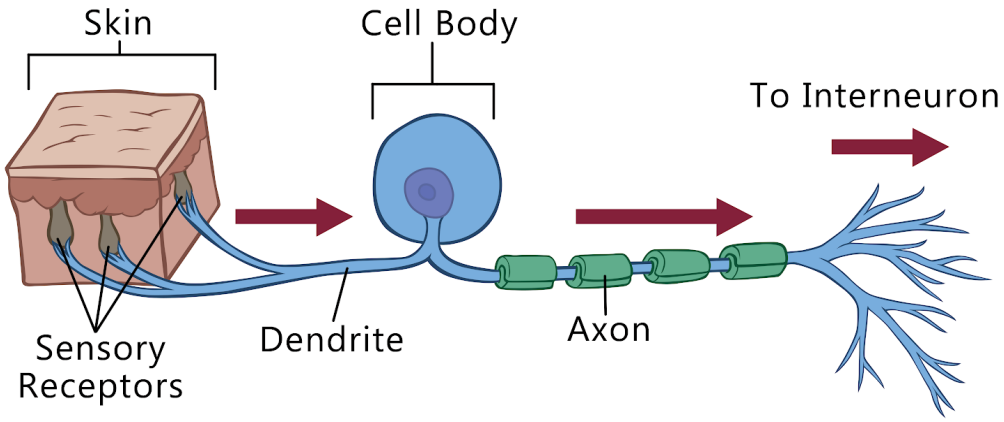
A protective covering called the **myelin sheath** surrounds all the dendrites and the axon. The myelin sheath is a fatty layer that acts as a layer of insulation. This layer prevents the nerve signals of one neuron from interfering with that of another neuron. Think of this covering as the layer of insulation around an electrical wire.

The nerve cells of the PNS have another protective covering on top of the myelin sheath. This layer, called the **neurilemma,** is made up of living cells. The neurilemma helps damaged nerve fibers regrow and recover. Many of the nerve cells of the brain and the spinal cord do not have a myelin sheath nor a neurilemma.

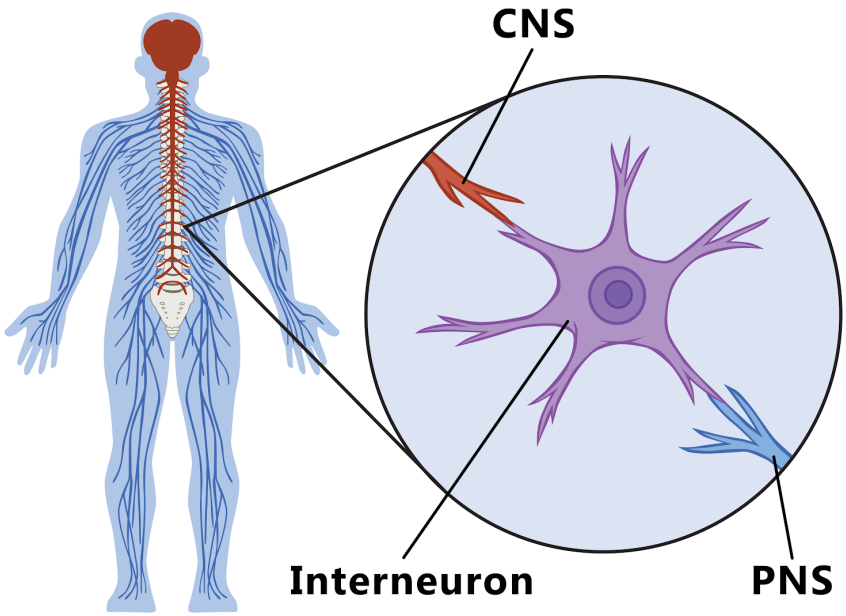
There are three types of neurons classified according to their function. While the basic structure of these neurons are the same, they have slight variations to help them maximize their functions. The diagram below shows three main types of neurons.

1. **Sensory neurons** carry signals from the body to the brain and/or spinal cord. Sensory neurons are found in our sensory organs such as our skin, tongue, ears, eyes and nose. We can tell the shape of a fruit, its taste and smell because of the sensory neurons. Some of

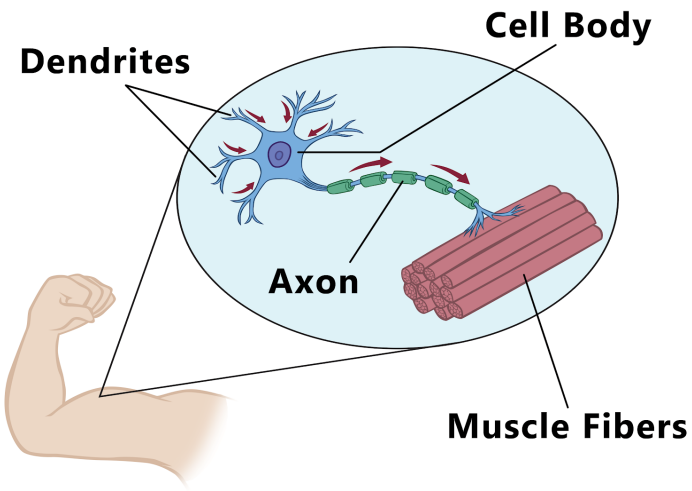
these special neurons are also found in our muscles or the lining of our organs. These cells help us feel pain or discomfort when parts of our body are not functioning correctly. For example, a stomach ache.



2. **Interneurons** connect the sensory neurons with the motor neurons.



3. **Motor neurons** carry signals from the brain and/or the spinal cord to the muscles and glands of the body. For example, the motor neurons control chewing by controlling the muscles in our jaw.

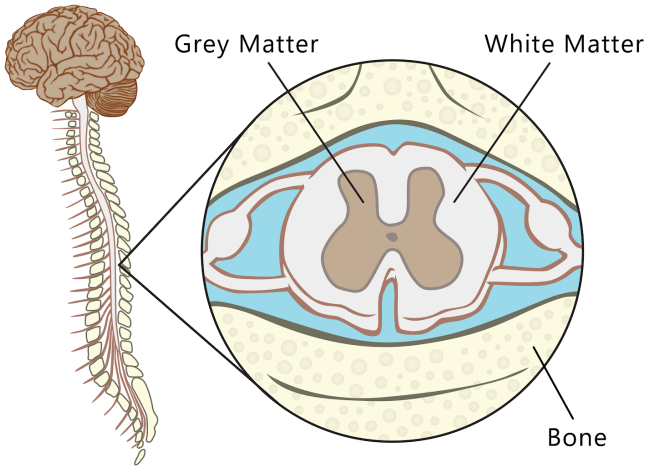


Many of the cells in our body can grow and multiply as the body grows. Our skin, for example, is constantly creating new cells to replace the cells lost from the top layer of the skin. Similarly, blood cells are replaced daily and new bone cells are created as we grow. However, nerve cells cannot be replaced. A baby is born with over one trillion neurons. As the baby grows, so do the neurons. The dendrites and axons become longer and longer making new connections with other neurons. After a person has reached adulthood, some nerve cells begin to die. Since neurons cannot be replaced, the amount of nerve cells in the body begin to reduce. This is why our grandparents tend to forget information often, or are unable to move parts of their body like they used to when they were younger. Moreover, nerves that are killed due to an injury cannot be replaced. In such an instance the person would have **brain damage** or would become **paralyzed.**

Spinal Cord

The spinal cord connects the brain to the rest of the body. It is a long rope-like structure made up of several nerve cells. The spinal cord contains both neurons with a myelin sheath and those without. Nerve cells without the myelin sheath appear grey and form the **grey matter.** Neurons with the myelin sheath form the **white matter** and appear

white in color. If the spinal cord is cut in half horizontally the grey matter is found in the middle surrounded by the white matter. The **vertebral column** or backbone, which is made of bone, provides a strong hard layer of protection.



At various points on the spinal cord are large branches of nerves called **spinal nerves**. Our body has 31 spinal nerves. Each spinal nerve consists of several sensory and motor neurons carrying information to and from the spinal cord. The axons of these neurons can vary in length.

The spinal nerves at the top of the spine send messages from the head, neck and arms to the brain and back. The nerves in the chest region control the heart, lungs and muscles in that area. The spinal nerves in the lower part of the spinal cord control the abdominal area and lower extremities. For example, if the **sciatic nerve** found in the lower region of the spine gets injured then paralysis in the legs takes place.

Much of the functions of the spinal cord are involved with carrying signals from the sensory neurons to the brain, which determines a response. Then, the brain sends the response signals back down the spinal cord and to the organs through the motor neurons. However, there are instances when the spinal cord interprets the signal and sends a response without consulting the brain. Such a reaction is called a **reflex action.** For example, when you place your hand on a hot object you automatically or unconsciously respond by removing your hand immediately. Reflex action allows your body to react to drastic situations to prevent injury to the body.

Brain

The brain is the central control center for the body. Every bodily function is controlled by the brain whether consciously, like bending your arms to pick up an object, or unconsciously such as breathing or blinking. Your brain is part of the central nervous system and is connected with the rest of the body by nerves that run along the spinal cord.

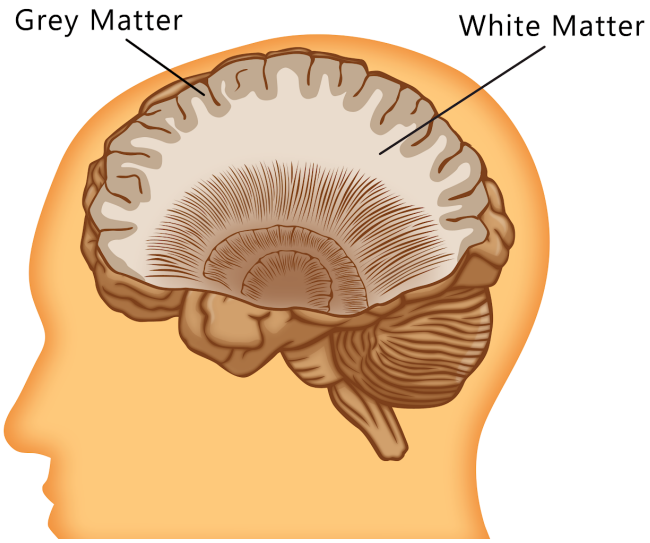
Protecting the Brain

The brain is a vital organ as it controls all the functions of the body. So it must be protected from injury. The **skull**, which is made of bone, like the vertebral column, forms the first and toughest layer of protection for the brain. Between the skull and the brain are three layers of membranes called **meninges**. Think of each membrane as a pillow case surrounding the brain. Finally, to prevent the brain from moving around violently inside the skull there is a fluid called **cerebrospinal fluid**.

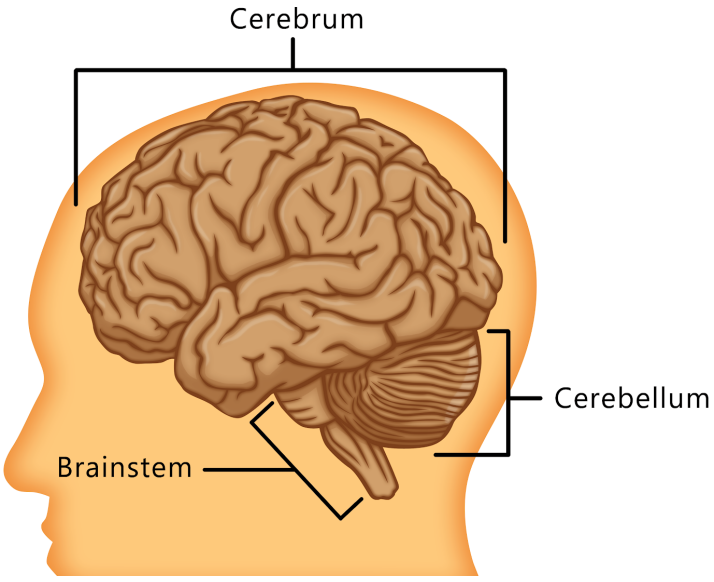
Structure of the Brain

By the time a baby is born, his/her brain would already have billions of nerve cells in it. As the child grows, new connections are constantly made between these nerve cells. The more we learn and make memories, the more connections formed between nerve cells.

There are two types of cells making up the brain: the neurons and the glial cells. As we already know, the neurons are the main participants that carry messages through the CNS and PNS. The glial cells, also called neuroglia, are support cells that provide the neurons with nutrition and help them function well. Like the spinal cord, the brain has both myelinated neurons and unmyelinated neurons. The neurons with the myelin sheath are found deep in the middle of the brain and appear white. The unmyelinated neurons located on the outer surface of the brain appear grey in color.



The brain is made of three main parts: the **brainstem, cerebellum,** and the **cerebrum**. Use the diagram to locate each of these three sections. The brainstem connects the spinal cord to the cerebellum and cerebrum. It contains the control centers for body functions that are automatically controlled.



Examples of these functions include breathing, swallowing, blinking and vomiting. The cerebellum found just above the brainstem controls muscle movements, maintains posture and balance. The cerebrum is the largest part of the brain and is divided into two sections: the left and right hemispheres. The cerebrum controls all higher thought

processes. This includes forming memories, interpreting signals received from the five senses and emotions.

How do neurons communicate with each other?

Neurons form pathways that relay information from the sensory organs to the brain or spinal cord. Interestingly, none of the neurons forming this pathway touch each other. Between the dendrites of one neuron and the axon of another neuron is a small gap called the **synaptic gap**. When a nerve cell is activated, the signal passes through the cell as an electrical signal. Think of this signal as an electrical current passing through a wire. Once the electrical signal arrives at the axon, it turns into a chemical signal so that it can pass through the synaptic gap and into the next neuron. Neurotransmitters are chemical substances produced at the ends of axons that carry the message through the synaptic gap. Some common examples of neurotransmitters are dopamine, serotonin and epinephrine.