B. A program in Physical Education (Semester 2)

College: Raniganj Girls College (K.N.U)

Department: Physical Education

Nervous system

Introduction: - The nervous system is the major **controlling, regulatory, and communicating system** in the body. It is the center of all mental activity including thought, learning, and memory. Together with the endocrine system, the nervous system is responsible for regulating and maintaining homeostasis. Through its receptors, the nervous system keeps us in touch with our environment, both external and internal.

Like other systems in the body, the nervous system is composed of organs, principally the **brain, spinal cord, nerves, and ganglia.** These, in turn, consist of various tissues, including nerve, blood, and connective tissue. Together these carry out the complex activities of the nervous system.

The various activities of the nervous system can be grouped together as three general, overlapping functions:

- **Sensory**
- **Integrative**
- **Motor**

Millions of sensory receptors detect changes, called stimuli, which occur inside and outside the body. They monitor such things as temperature, light, and sound from the external environment. Inside the body, the internal environment, receptors detect variations in pressure, pH, carbon dioxide concentration, and the levels of various electrolytes. **All of this gathered information is called sensory input.**

Sensory input is converted into electrical signals called nerve impulses that are transmitted to the brain. There the signals are brought together to create sensations, to produce thoughts, or to add to memory; **Decisions are made each moment based on the sensory input. This is integration.**

Based on the sensory input and integration, the nervous system responds by sending signals to muscles, causing them to contract, or to glands, causing them to produce secretions. **Muscles and glands are called effectors because they cause an effect in response to directions from the nervous system. This is the motor output or motor function.**

The brain and spinal cord

The **brain** is a complex organ made up of specialized nerve and supportive tissues. It's surrounded by many bones that together form the skull. **The part of the skull where the brain sits is called the cranium**. The base, or lower part, of the brain is connected to the spinal cord. Together, the brain and spinal cord are known as the **central nervous system (CNS).** Many nerves send electrical signals to and from the brain and spinal cord.

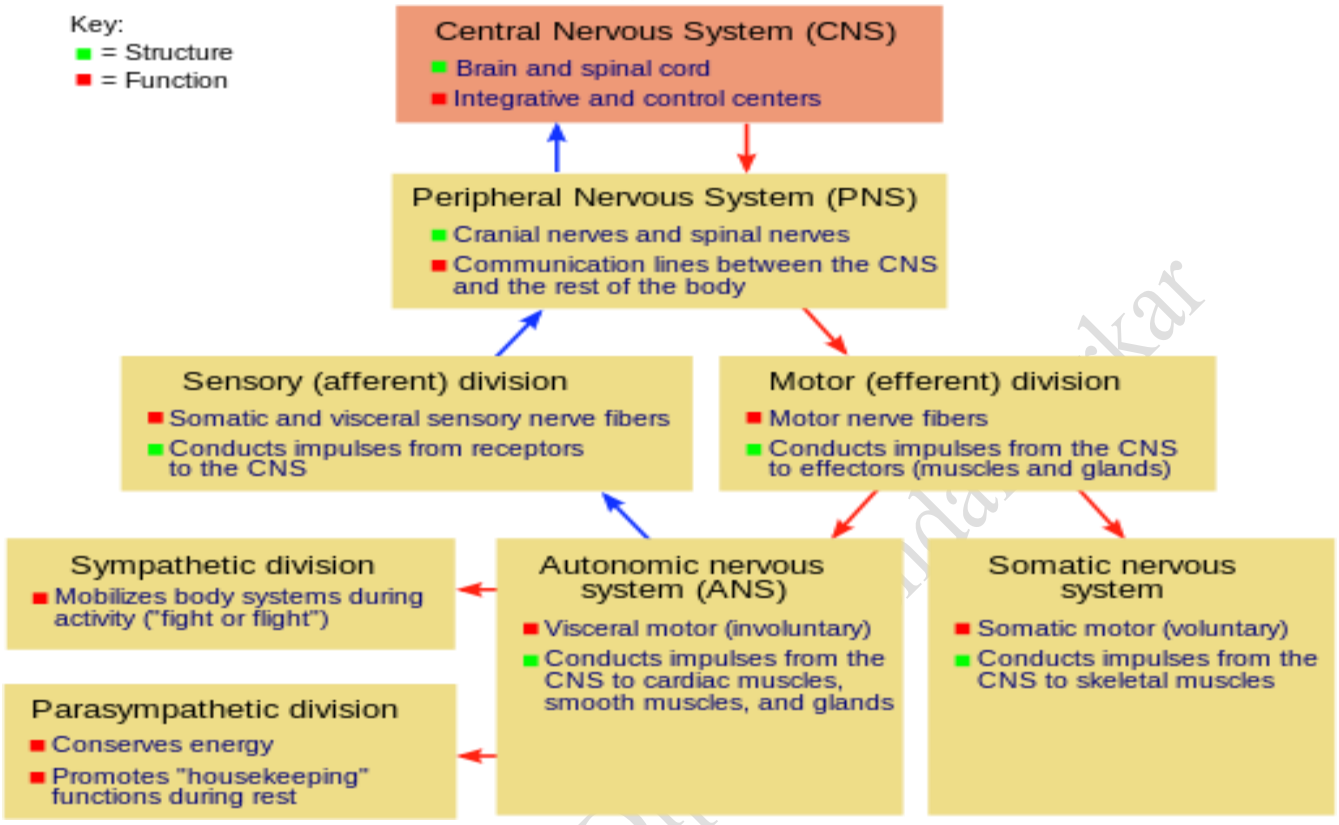
Structure and function of the brain: - The brain is the body's control centre. It constantly receives and interprets nerve signals from the body and sends new signals based on this information. Different parts of the brain control movement, speech, emotions, consciousness and internal body functions, such as heart rate, breathing and body temperature.

The brain has 3 main parts: cerebrum, cerebellum and brain stem.

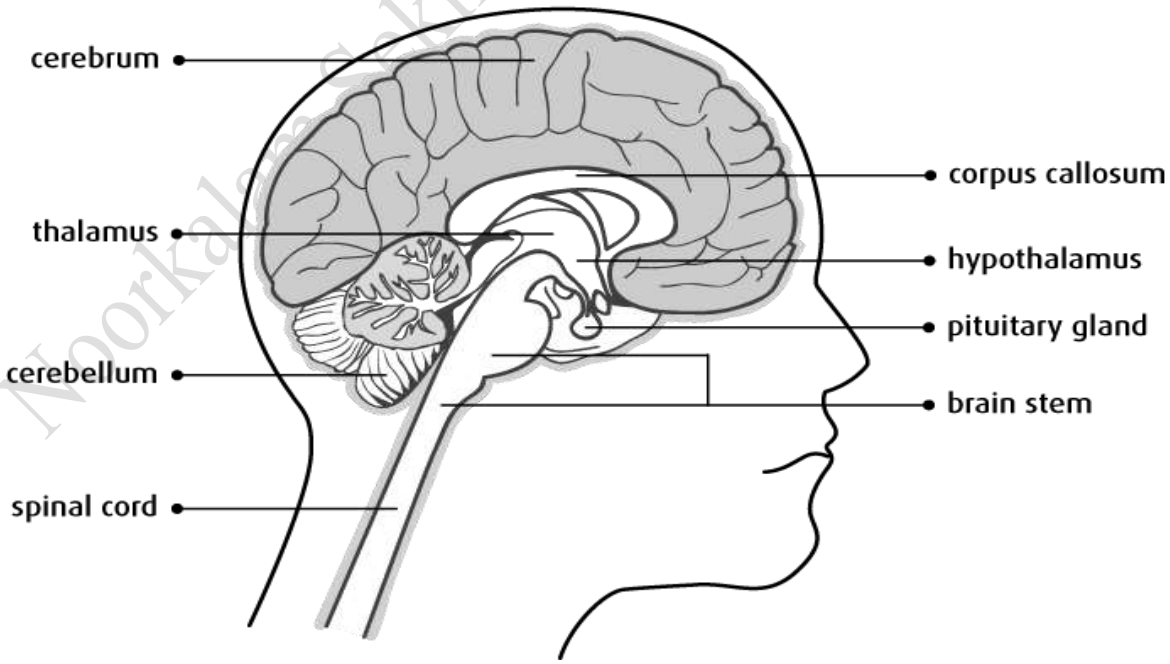
B. A program in Physical Education (Semester 2)

College: Raniganj Girls College (K.N.U)

Department: Physical Education



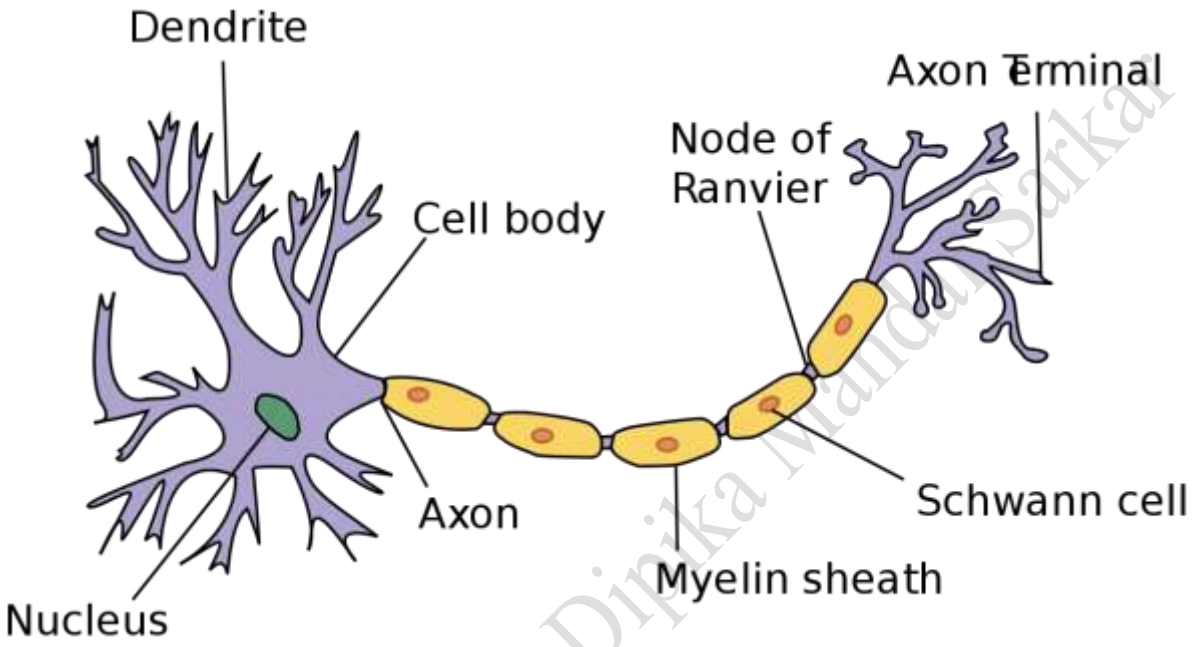
The Central Nervous System

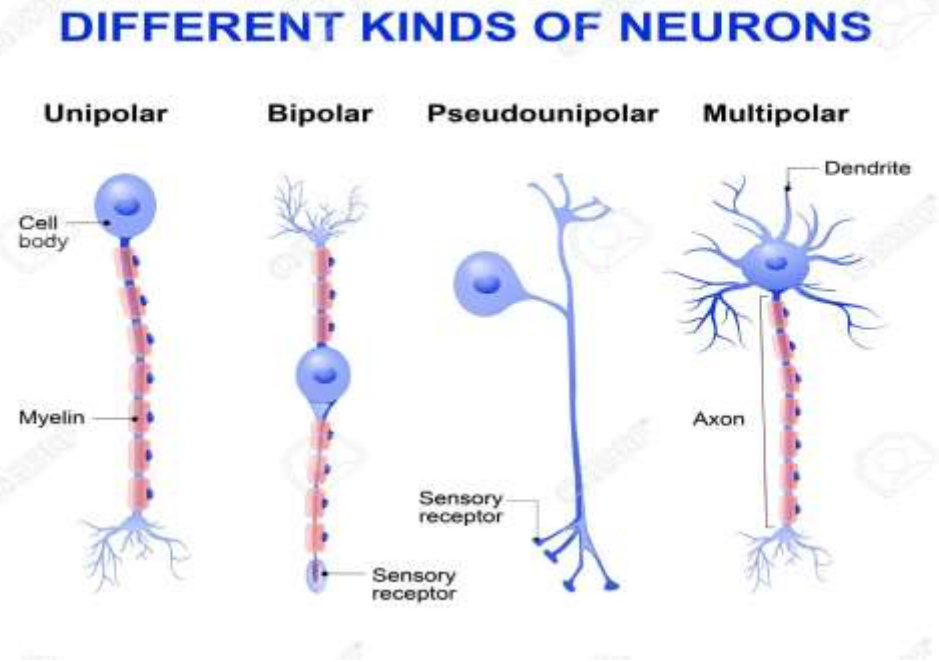


Types of cells in the brain

The brain is made up of 2 main types of cells:

1. Nerve cells (neurons) are cells that carry the electrical signals that make the nervous system work. They cannot be replaced or repaired if they are damaged. They are the longest cells in the body.





A single branch leaves the cell body of a Unipolar Neuron. This single branch then splits close to the cell body into a trunk to supply the branching dendrites for incoming signals and an axon for outgoing signals. Unipolar neurons are typically sensory neurons with receptors located within the skin, joints, muscles, and internal organs. The axons of such neurons are usually long, terminating in the spinal cord. The length of the dendritic trunk varies.

Two branches leave the cell body of a Bipolar Neuron. In this neuron, the dendritic tree emerges from one end of the cell body, while the axon emerges from the opposite end. The dendritic branching of bipolar neurons is typically limited, and the axons of such neurons are usually short in length. Bipolar neurons are often sensory neurons associated with receptor organs of the visual and auditory systems. The narrow fields created by the short dendrites of these neurons underlie the concise encoding of visual and auditory information representing physical signals from the external world. Without this narrow encoding of sensory information, the resolution of vision and hearing would be reduced.

A pseudounipolar neuron is a type of neuron which has one extension from its cell body. This type of neuron contains an axon that has split into two branches; one branch travels to the peripheral nervous system and the other to the central nervous system.

Multiple branches leave the cell body of a Multipolar Neuron. The many dendrites of the multipolar neuron allow for extensive integration of information coming from many other neurons. The axons of such neurons are usually long in length, allowing this integrated information to affect distant regions of the nervous system. The majority of neurons have multiple branches from the cell body.

2. Glial cells (neuroglia cells) are cells that support, feed and protect the nerve cells. The different types of glial cells are:

- astrocytes
- oligodendrocytes
- ependymal cells
- microglial cells

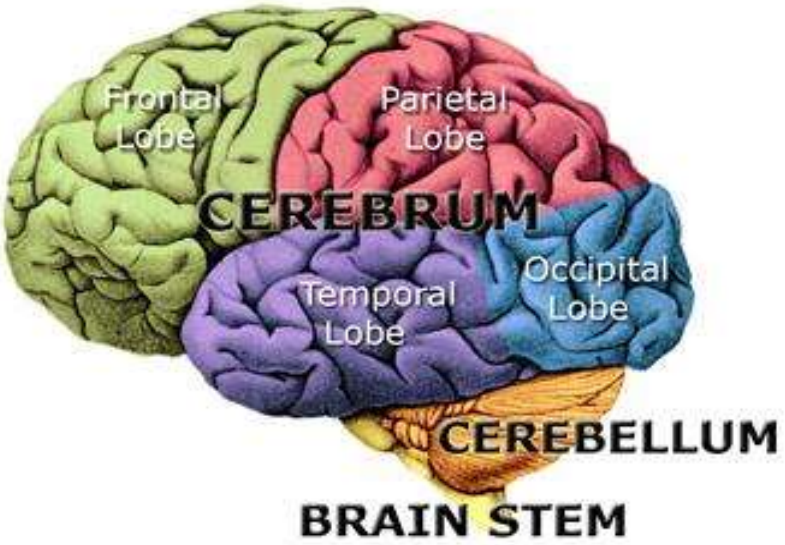
Cerebrum

The cerebrum is the largest part of the brain. It is divided into 2 halves called the left and right cerebral hemispheres. The 2 hemispheres are connected by a bridge of nerve fibres called the corpus callosum.

The right half of the cerebrum (right hemisphere) controls the left side of the body. The left half of the cerebrum (left hemisphere) controls the right side of the body.

The cerebral cortex is the outer, folded part of the brain. It is also called the grey matter. The cerebral cortex is mostly made up of the cell bodies and dendrites of nerve cells (neurons). Cell bodies contain the nucleus and other main parts of the cell. Dendrites are the short branching fibres that receive signals from other nerve cells. The inner part of the cerebrum is called the white matter. It is mostly made up of the long fibres of a nerve cell (called axons) that send signals to and from the brain to the rest of the body. The fatty coating that surrounds axons (called myelin) gives this part of the brain a whitish appearance.

Each hemisphere is divided into 4 sections called lobes. These include the frontal, parietal, temporal and occipital lobes.

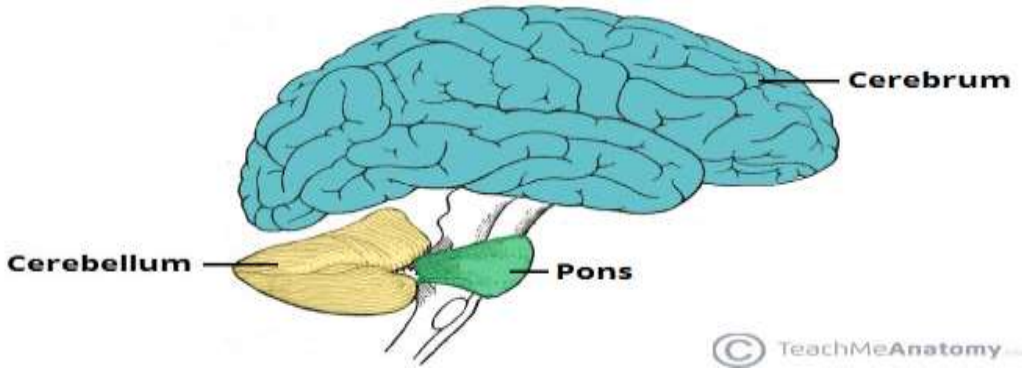


Each lobe has different functions:

- **The frontal lobe** controls movement, speech, behaviour, memory, emotions and intellectual functions, such as thought processes, reasoning, problem solving, decision-making and planning.
- **The parietal lobe** controls sensations, such as touch, pressure, pain and temperature. It also controls the understanding of size, shape and direction (called spatial orientation).
- **The temporal lobe** controls hearing, memory and emotions. The dominant (left side in most right-handed people) temporal lobe also controls speech.
- **The occipital lobe** controls vision.

Cerebellum

The **cerebellum** is located under the cerebrum at the back of the brain. It is divided into 2 parts or hemispheres and also has grey and white matter.

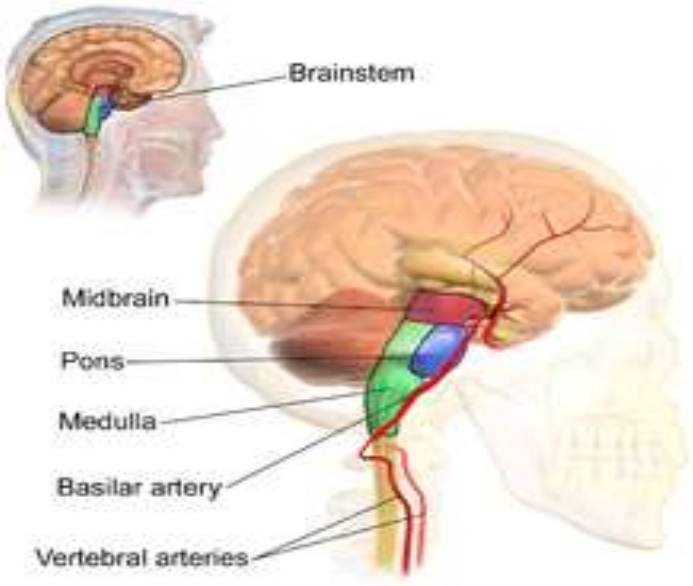


The cerebellum is responsible for:

- movement
- posture
- balance
- reflexes
- complex actions (walking, talking)
- collecting sensory information from the body

Brain stem

The brain stem is a bundle of nerve tissue at the base of the brain. It connects the cerebrum and cerebellum to the spinal cord.



The brain stem has 3 areas:

- midbrain (also called the mesencephalon)
- pons
- medulla oblongata

The brain stem sends information to and from the other parts of the brain to the rest of the body and controls:

- breathing
- body temperature

- blood pressure
- heart rate
- hunger and thirst
- digestion of food

Cerebrospinal fluid (CSF)

The cerebrospinal fluid (CSF) is a clear, watery liquid that surrounds, cushions and protects the brain and spinal cord. The CSF also carries nutrients in the blood to (and removes waste products from) the brain. It circulates through chambers called ventricles and over the surface of the brain and spinal cord.

Meninges

The brain and spinal cord are covered and protected by 3 layers of tissue (membranes) called the meninges:

- dura mater – thickest outer membrane
- arachnoid layer – middle, thin membrane
- pia mater – inner, thin membrane

The CSF flows in the space between the arachnoid layer and the pia mater. This space is called the subarachnoid space.

Corpus callosum

The corpus callosum is a bundle of nerve fibres that allows communication between the 2 cerebral hemispheres. It is the largest fibre bundle in the brain.

Thalamus

The thalamus is a structure in the middle of the brain that has 2 lobes or sections. It acts as a relay station for almost all information that comes and goes between the brain and the rest of the nervous system in the body.

Hypothalamus

The hypothalamus is a small structure in the middle of the brain below the thalamus. It plays a part in controlling body temperature, hormone secretion, blood pressure, emotions, appetite and sleep patterns.

Pituitary gland

The pituitary gland is a small, pea-sized organ in the centre of the brain. It is attached to the hypothalamus and makes a number of different hormones that affect other glands of the body's endocrine system. It receives messages from the hypothalamus and releases hormones that control the thyroid and adrenal gland, as well as growth and physical and sexual development.

Pineal gland

The pineal gland is a very small gland in the third ventricle of the brain. It produces the hormone melatonin, which influences sleeping and waking patterns and sexual development.

Choroid plexus

The choroid plexus is a small organ in the ventricles that makes CSF.

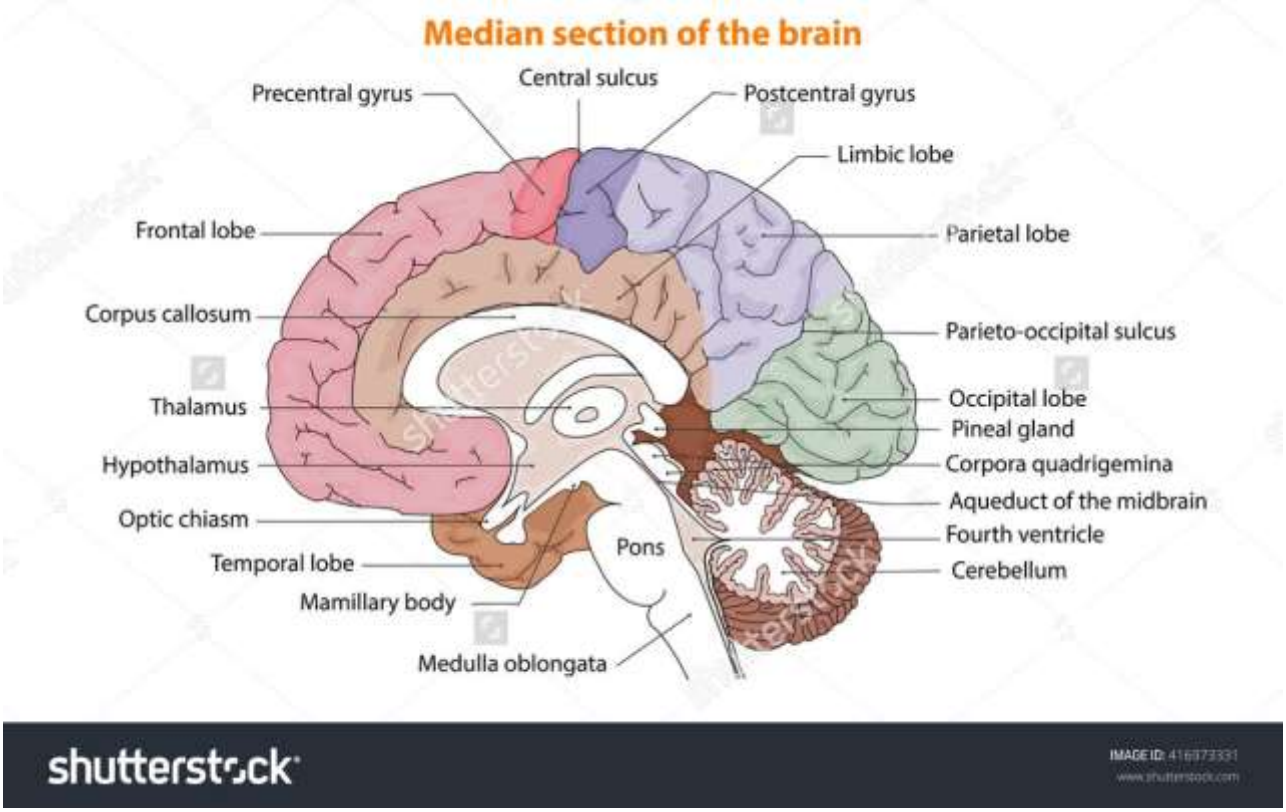
Cranial nerves

There are 12 pairs of cranial nerves that perform specific functions in the head and neck, including giving us our sense of smell, sight (vision), hearing, taste, speech, feeling in the face and movement of the muscles in the face, eyes and tongue. One pair of nerves starts in specialized cells in the roof of the nose and another pair starts in the retina of the eye. The other 10 pairs start in the brain stem.

Blood-brain barrier (BBB)

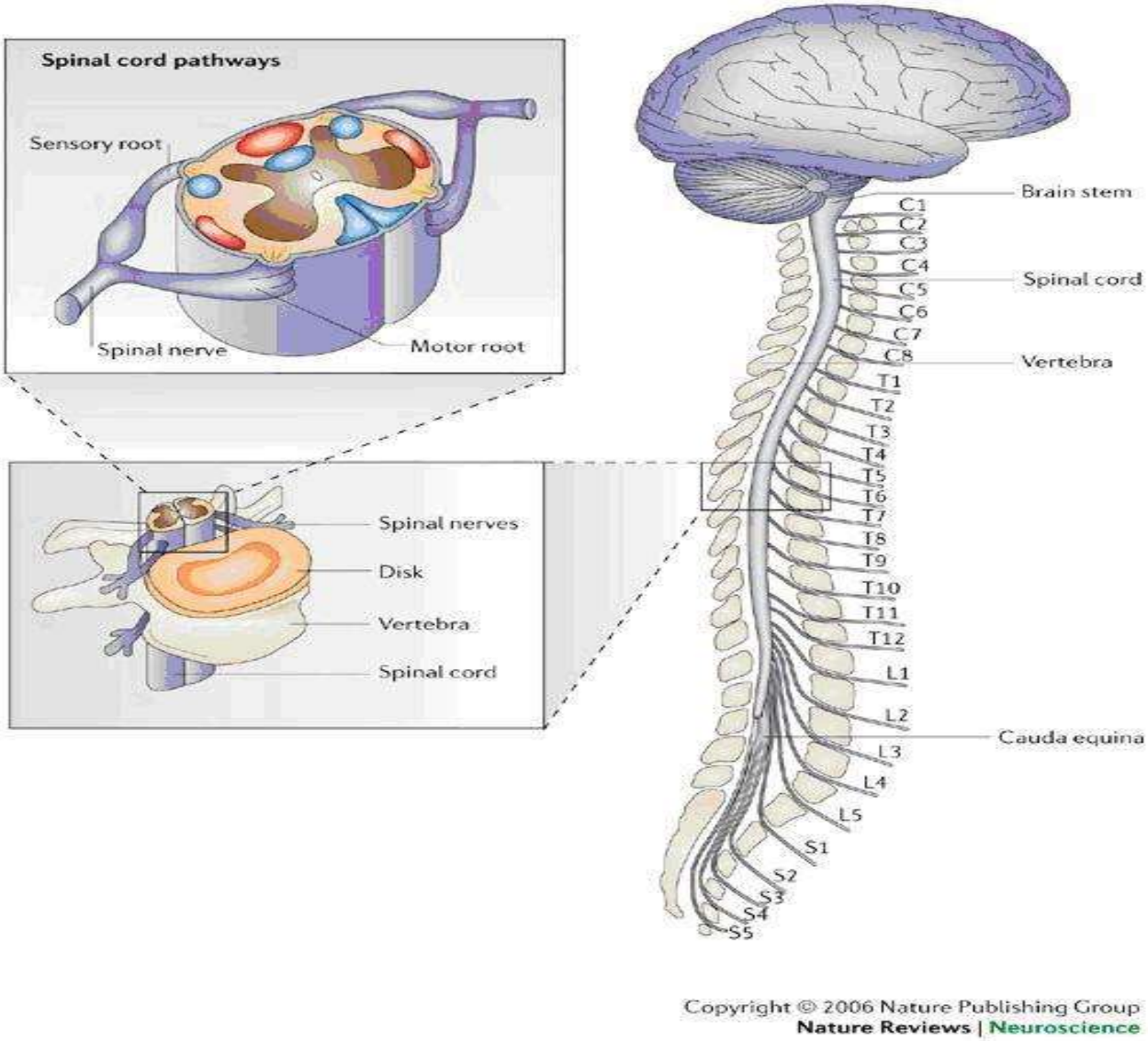
The blood-brain barrier (BBB) is a specialized system of cells lining blood vessels in the brain. The BBB prevents most substances in the blood from passing into the brain and helps maintain a constant environment so the nerve cells in the brain can work properly.

The BBB is made up of very small blood vessels (capillaries) that are lined with thin, flat endothelial cells. In other parts of the body, endothelial cells have small spaces between them that allow substances to move in and out of the capillary so they can reach other cells and tissues. In the brain, the endothelial cells are packed tightly together so substances cannot pass out of the bloodstream into the brain



Structure and function of the Spine

The spine is made up of 26 or 33 bones divided into 5 sections. These bones surround and protect the spinal cord. This includes 24 vertebrae (divided into cervical, thoracic and lumbar regions), the sacrum and the coccyx.



Cervical region – These are 7 vertebrae at the top of the spine that run from the base of the skull to the lowest part of the neck.

Thoracic region – These are 12 vertebrae that run from the shoulders to the middle of the back.

Lumbar region – These are 5 vertebrae that run from the middle of the back to the hips.

Sacrum – This is a large section of fused vertebrae at the base of the spine.

Coccyx (tail bone) – This is a small, thin section of fused vertebrae at the end of the spine.

Between the vertebrae are the discs (intervertebral discs).

Disc – A layer of cartilage found between the vertebrae. Discs cushion and protect the vertebrae and spinal cord.

Spinal cord

The spinal cord is a long bundle of nerves and cells that extends from the lower portion of the brain to the lower back. It carries signals between the brain and the rest of the body. The length of the spinal cord varies from person to person. According to some estimates, females have a spinal cord of about 43 centimeters (cm), while males have a spinal cord of about 45 cm.

Three layers of tissue protect the spinal cord: the **dura mater, arachnoid mater, and pia mater.** Doctors call these layers "meninges." The layers are as follows:

Dura mater: This is the outermost layer of the spinal cords meninges. It is a tough, protective coating.

Epidural space: Between the dura and arachnoid space is the epidural space. This is where doctors may insert local anesthetic to reduce pain during childbirth and some surgical procedures, such as those to operate on a lung or abdominal aneurysm.

Arachnoid mater: The arachnoid mater is the middle layer of spinal cord covering.

Subarachnoid space: This is located between the arachnoid mater and pia mater. Cerebrospinal fluid (CSF) is located in this space. Sometimes, a doctor has to sample CSF to test for the presence of infection, such as meningitis. They can also inject local anesthetic into this space for some surgical procedures, such as a cesarean delivery or a knee replacement.

Pia mater: The pia mater is the layer that directly covers the spinal cord.

Functions of Spinal Cord

The spinal cord plays a vital role in various aspects of the body's functioning. Examples of these key functions include:

Carrying signals from the brain: The spinal cord receives signals from the brain that control movement and autonomic functions.

Carrying information to the brain: The spinal cord nerves also transmit messages to the brain from the body, such as sensations of touch, pressure, and pain.

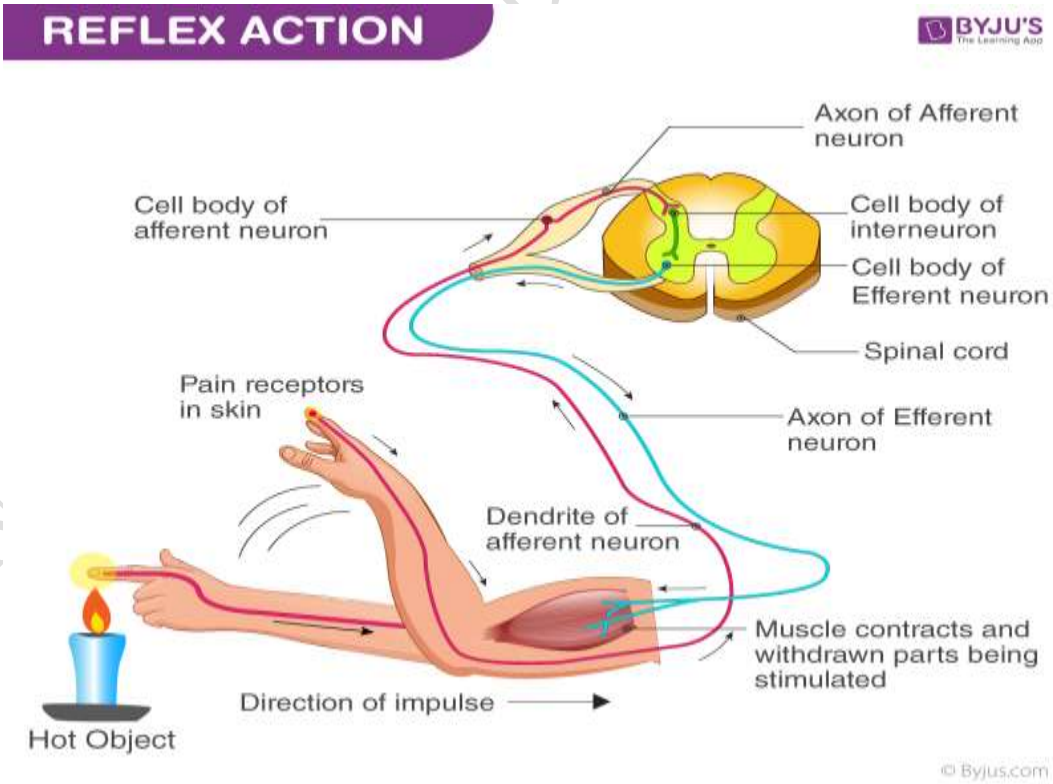
Reflex responses: The spinal cord may also act independently of the brain in conducting motor reflexes. One example is the patellar reflex, which causes a person's knee to involuntarily jerk when tapped in a certain spot.

These functions of the spinal cord transmit the nerve impulses for movement, sensation, pressure, temperature, pain, and more.

Reflex actions

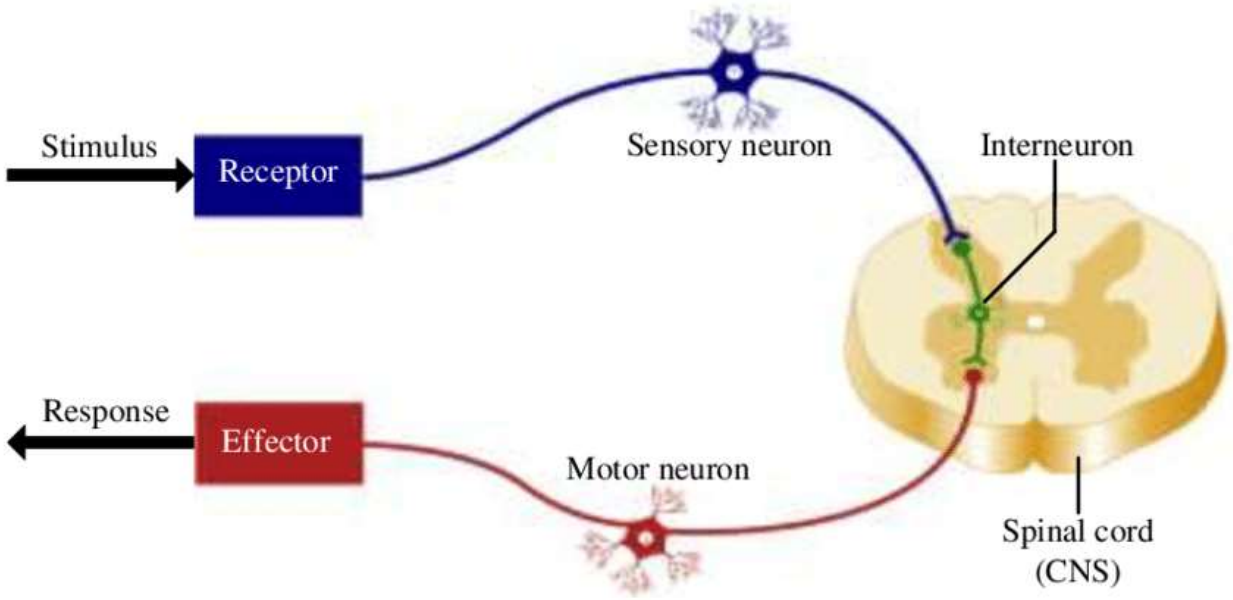
A reflex action is an automatic (involuntary) and rapid response to a stimulus, which minimizes any damage to the body from potentially harmful conditions, such as touching something hot. Reflex actions are therefore essential to the survival of many organisms.

. A reflex action follows this general sequence and does not involve the conscious part of the brain. This is why the response is so fast.



Reflex arcs

The nerve pathway followed by a reflex action is called a reflex arc. For example, a simple reflex arc happens if we accidentally touch something hot.



- Receptor in the skin detects a stimulus (the change in temperature).
- Sensory neuron sends electrical impulses to a relay neuron, which is located in the spinal cord of the CNS. Relay neurons connect sensory neurons to motor neurons.
- Motor neuron sends electrical impulses to an effector.
- Effector produces a response (muscle contracts to move hand away).

Organisms are able to modify a reflex action and overcome it, but this uses the brain and has to be learnt. For example, keeping hold of a hot object requires a nerve impulse to be sent to the motor neuron of the reflex arc to interfere with the normal reflex action to drop the object

---