The central nervous system (CNS) consists of the brain and spinal cord. The CNS directly or indirectly influences nearly every internal organ system, whether related to respiration, digestion, excretion, circulation or reproduction. , **the brain and spinal cord** are encased in bony cavities, with the brain residing within the skull, and the vertebral column protecting the spinal cord. Three membranous coverings, called the meninges, provide mechanical support and protection to the central nervous system. These meninges are called pia mater, arachnoid mater and dura mater. Pia mater is the layer closest to the nervous tissue and dura mater lies next to the bone.

Additionally, cerebrospinal fluid (CSF), produced in the four ventricular cavities of the brain, flows between the pia mater and arachnoid mater, providing protection from pathogens and mechanical support to the entire central nervous system. Special glial cells called ependymal cells produce CSF.

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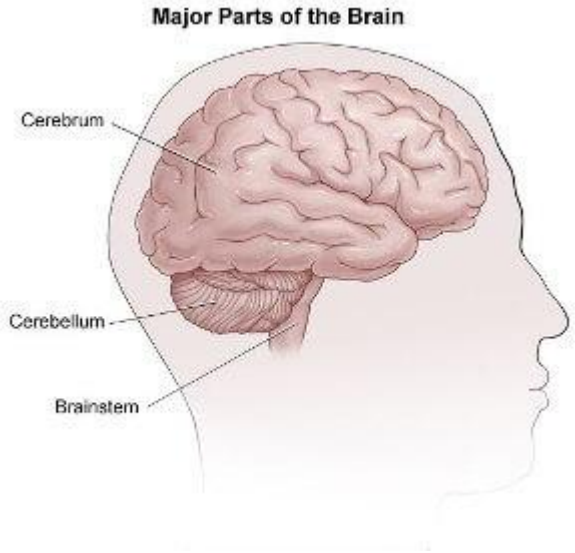
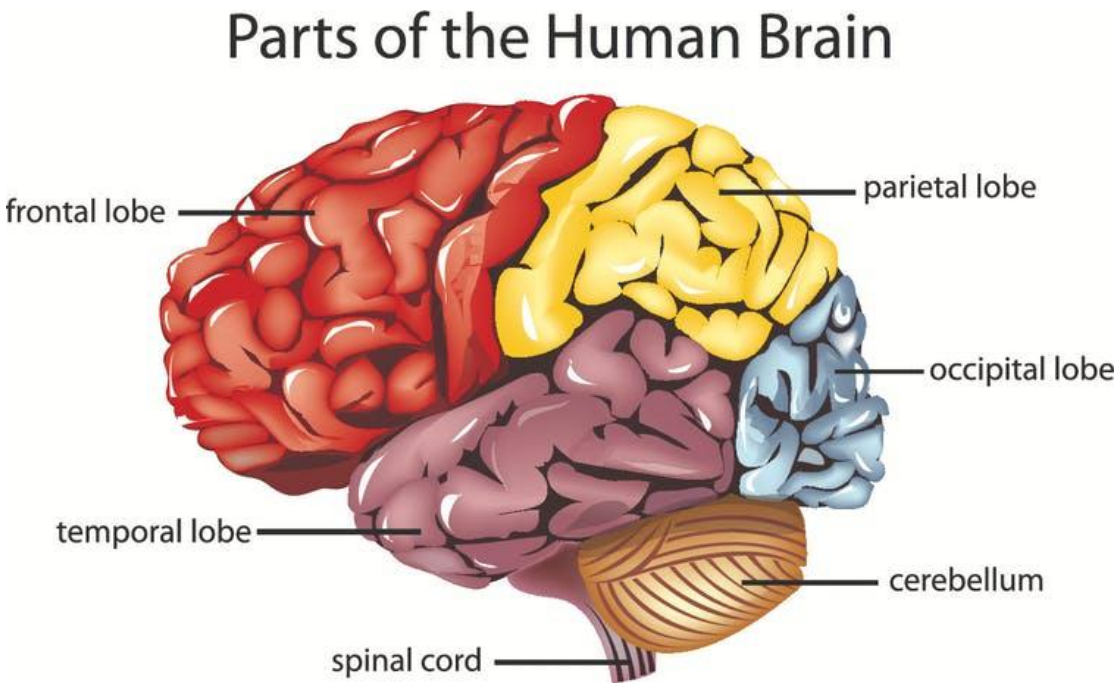
The Brain The brain has three main parts:



- **Cerebrum**
- **Cerebellum**
- **Brain stem**

The cerebrum: the large outer part of the brain The cerebrum controls reading, thinking, learning, speech, emotions and planned muscle movements like walking. It also controls vision, hearing and other senses The outer layer of the cerebrum is called the cerebral cortex and this is usually pinkish grey in color and contains neural cell bodies

. The cerebrum consists of two large hemispheres(halves) left and right. The right half controls the left side of the body. The left half controls the right side of the body.The two hemispheres demarcated by a thick band of nerve fibers called the corpus callosum. Each of the hemispheres can be divided into four lobes. These are named the frontal, parietal, temporal and occipital lobes.



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. Each lobe controls specific functions. For example, the frontal lobe controls personality, decision-making and reasoning, while the temporal lobe controls, memory, speech, and sense of smell.

The cerebellum

The cerebellum is smaller than the cerebrum, in the back of the brain, controls balance, coordination and fine muscle control (e.g., walking). It also functions to maintain posture and equilibrium.

The brain stem

The **brain stem**, at the bottom of the brain, connects the **cerebrum** with the **spinal cord**. It includes the **midbrain**, the **pons**, and the **medulla**. It controls fundamental body functions such as breathing, eye movements, blood pressure, heartbeat, and swallowing.

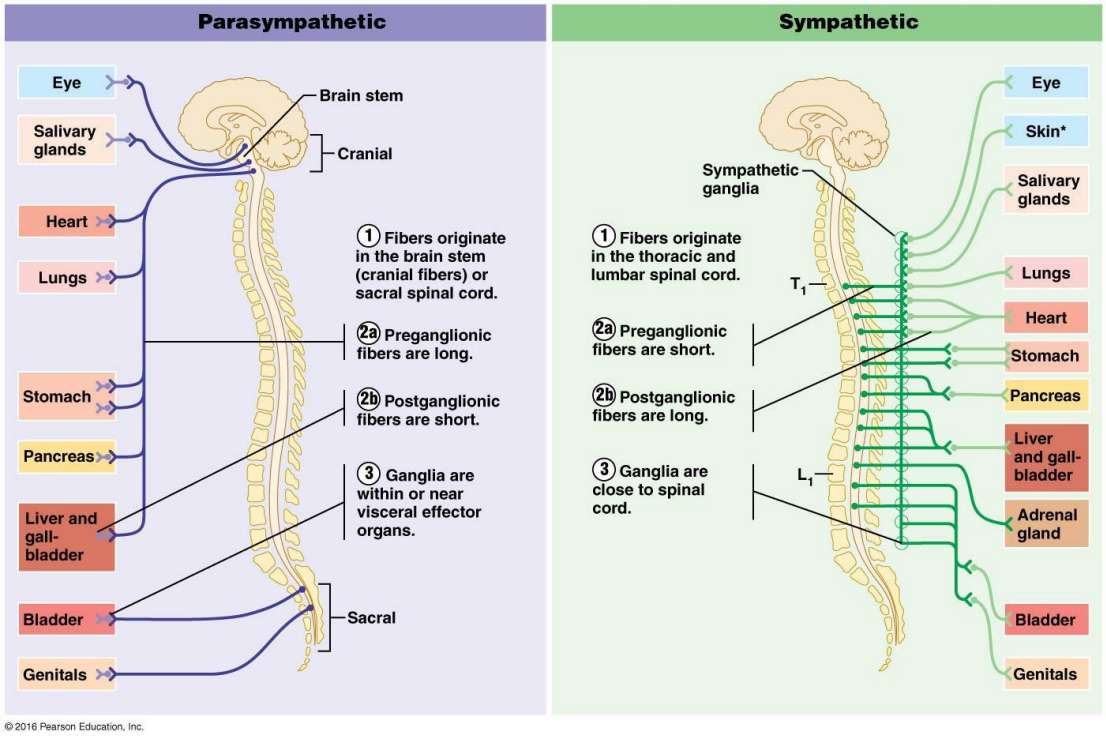
The spinal cord

The spinal cord continues from the brainstem. It also has the ability to generate commands but for involuntary processes only, i.e. reflexes. However, its main function is to pass information between the CNS and periphery

The spinal cord is about 17 inches in length, tapering along the length of the vertebral column in humans, beginning near the occipital bone and ending at the lumbar region of the spine. **It connects the brain with most parts of the body while also containing independent neural networks for pattern generation and for executing reflexes.**

Cerebrospinal fluid is a watery fluid that flows in and around the four hollow spaces of the brain (called ventricles) and the spinal cord, and between two of the meninges.

The autonomic nervous system



The autonomic nervous system regulates certain body processes, such as blood pressure and the rate of breathing. This system works automatically (autonomously), without a person's conscious effort.

Anatomy of the autonomic nervous system

The autonomic nervous system is the part of the nervous system that supplies the internal organs, including the blood vessels, stomach, intestine, liver, kidneys, bladder, genitals, lungs, pupils, heart, and sweat, salivary, and digestive glands.

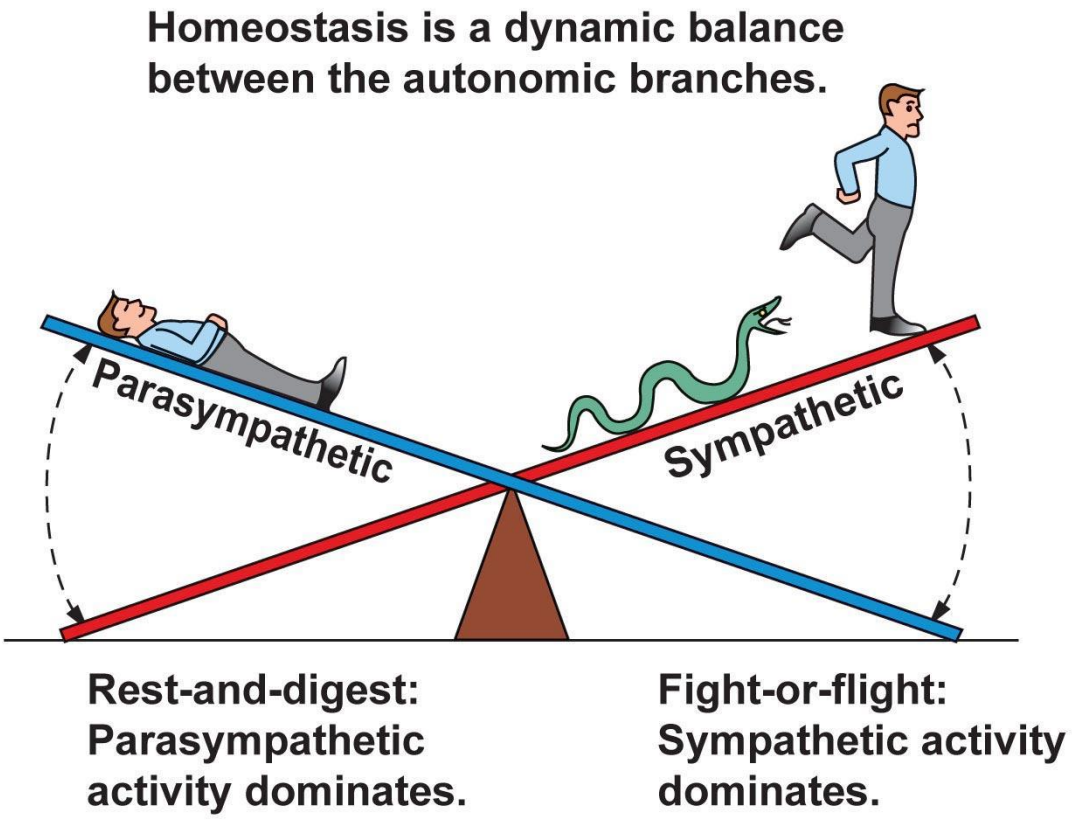
- The autonomic nervous system has two main divisions:
- Sympathetic
- Parasympathetic

After the autonomic nervous system receives information about the body and external environment, it responds by stimulating body processes, usually through the sympathetic division, or inhibiting them, usually through the parasympathetic division.

An autonomic nerve pathway involves two nerve cells. One cell is located in the brain stem or spinal cord. It is connected by nerve fibers to the other cell, which is located in a cluster of nerve cells (called an autonomic ganglion). Nerve fibers from these ganglia connect with internal organs. Most of the

ganglia for the sympathetic division are located just outside the spinal cord on both sides of it. The ganglia for the parasympathetic division are located near or in the organs they connect with. Many organs are controlled primarily by either the sympathetic or the parasympathetic division. Sometimes the two divisions have opposite effects on the same organ. For example, the sympathetic division increases blood pressure, and the parasympathetic division decreases it. Overall, the two divisions work together to ensure that the body responds appropriately .

sympathetic system is activated in emergencies, flight– or– fight reaction, in the sense that the body can either quickly flee or "take a stand".



Neurotransmitters & Receptor

Neurotransmitters

1-Acetylcholine

Acetylcholine (ACh) is neurotransmitter in both the peripheral nervous system (PNS) and central nervous system (CNS) in humans. Acetylcholine is one of many neurotransmitters in the autonomic nervous system (ANS) and the only neurotransmitter used in the motor division of the somatic nervous system .

2- catecholamines norepinephrine (noradrenaline), and epinephrine (adrenaline).

Receptors

Cholinergic Receptors:

- **Nicotinic receptors:**

- Are all excitatory.

- **Muscarinic receptors:**

- Either excitatory or inhibitory , depending on the target organ .

- Have distinct subtypes (M1 , M2 , M3).

Adrenergic receptors

alpha - receptors

beta - receptors

in General, NE or epinephrine binding to alpha- receptors are stimulatory while their binding to beta- receptors are inhibitory.

Both receptors have distinct subtypes (alpha 1 , 2 , beta 1, 2).

Functions of ANS

Sympathetic	Parasympathetic
▸ Heart ▸ ↑ heart rate ▸ ↑ force of contraction ▸ Blood vessels ▸ *Constriction* ▸ Lungs ▸ Bronchodilation ▸ GIT ▸ ↓ motility ▸ Sphincter contraction ▸ Decreased secretions	▸ Heart ▸ ↓ heart rate ▸ ↓force of contraction ▸ Blood vessels ▸ No effect ▸ Lungs ▸ Bronchoconstriction ▸ GIT ▸ ↑ motility ▸ Sphincter relaxation ▸ Increased secretions

Comparison of Somatic and Autonomic Systems