

## Introduction to The Nervous System Physiology

The nervous system comprises all neural tissue in the body. It functions as the **master control and communication system**, coordinating rapid responses to internal and external stimuli. Despite accounting for only about **3 percent of total body weight**, it is vital for maintaining homeostasis, regulating bodily functions, and enabling interaction with the environment.

Neurons (nerve cells) and supporting glial cells communicate through **electrical impulses and chemical neurotransmitters**. These signals are **rapid, specific, and usually lead to immediate physiological responses**.

### Major Functions of the Nervous System

The nervous system performs three main, overlapping functions:

#### 1. Sensory Function (Receiving Stimuli)

- Specialized **sensory receptors** detect changes in the **internal** (e.g., blood pressure, pH) and **external** (e.g., temperature, light, pain) environments.
- These receptors generate signals that are transmitted via **afferent (sensory) neurons** to the **central nervous system (CNS)**.
- This gathered data is referred to as **sensory input**.

#### 2. Integrative Function (Deciding About Stimuli)

- The CNS processes and interprets the sensory input.
- This step involves **integration**, where information is:
  - Used to initiate **immediate motor responses**
  - **Stored in memory** for future use
  - Utilized in **higher cognitive functions** like reasoning, learning, and emotion

#### 3. Motor Function (Reacting to Stimuli)

- After processing, the CNS sends instructions via **efferent (motor) neurons** to **effector organs**.
- Effectors include **muscles** (for contraction) and **glands** (for secretion).
- The outcome is a **motor response** that may be voluntary or involuntary depending on the system involved.

### Divisions of the Nervous System

The nervous system is broadly categorized into two main divisions:

#### 1. Central Nervous System (CNS)

- Composed of the **brain** and **spinal cord**
- Acts as the **integration and control center**
- Responsible for interpreting sensory input and formulating motor output

## 2. Peripheral Nervous System (PNS)

- Includes **cranial nerves** and **spinal nerves**
- Connects the CNS to the limbs and organs
- Subdivided into:

### a. Somatic Nervous System (SNS)

- Controls **voluntary movements**
- Innervates **skeletal muscles**

### b. Autonomic Nervous System (ANS)

- Regulates **involuntary functions** such as heart rate, digestion, and glandular activity
- Subdivided into:
  - **Sympathetic Division** : Prepares the body for "fight or flight"
  - **Parasympathetic Division** : Promotes "rest and digest" activities

## Sensory Physiology

### Types of Sensory Receptors

- **Mechanoreceptors** : Detect pressure, vibration, and touch
- **Thermoreceptors** : Detect temperature changes
- **Nociceptors** : Detect pain (physical or chemical damage)
- **Photoreceptors** : Detect light (in the retina of the eye)
- **Chemoreceptors** : Detect chemical stimuli (e.g., in taste buds or carotid bodies)

### Signal Transmission

1. Receptors transduce stimuli into **electrical impulses**
2. Impulses are transmitted via **afferent neurons**
3. Signals reach the CNS where they are interpreted

## Integrative Physiology

### Role of the CNS in Integration

- The **spinal cord** handles simple reflexes and relays information to the brain
- The **brain** performs complex processing including memory, emotion, reasoning, and voluntary control
- The **thalamus** acts as a relay station
- The **cerebral cortex** is the main site of conscious perception, thought, and decision-making

## Motor Physiology

### Somatic Motor Control

- **Motor cortex** initiates voluntary movement
- **Upper motor neurons** send signals to **lower motor neurons** in the spinal cord
- Lower motor neurons stimulate **skeletal muscle contraction**

### Autonomic Motor Control

- Involves two-neuron pathways (preganglionic and postganglionic neurons)
- Controls **smooth muscle, cardiac muscle, and glands**
- Balance between **sympathetic** and **parasympathetic** output regulates internal organ function

## Neurotransmitters and Synaptic Physiology

- **Synapses** are the sites of communication between neurons or between neurons and effectors
- Electrical impulses trigger the release of **neurotransmitters** such as:
  - **Acetylcholine (ACh)** : Common in somatic and parasympathetic pathways
  - **Norepinephrine (NE)** : Major sympathetic neurotransmitter
  - **Dopamine, serotonin, GABA** : Modulate mood, behavior, cognition, and inhibition

## Reflex Arcs

- A **reflex arc** is a simple neural circuit involving:
  1. **Receptor**
  2. **Sensory neuron**
  3. **Integration center** (spinal cord or brainstem)
  4. **Motor neuron**
  5. **Effector**
- Reflexes are rapid, involuntary, and protective

**Example** : Patellar tendon reflex or withdrawal from a hot surface

## Clinical Correlation

| Condition                      | Description   |
|--------------------------------|---|
| <b>Stroke</b>                  | Disruption of blood flow to brain leading to sensory and motor deficits |
| <b>Parkinson's disease</b>     | Loss of dopamine-producing neurons causing motor impairment             |
| <b>Multiple sclerosis (MS)</b> | Autoimmune demyelination affecting nerve conduction                     |
| <b>Peripheral neuropathy</b>   | Nerve damage leading to numbness or weakness, often due to diabetes     |
| <b>Autonomic dysfunction</b>   | Abnormal regulation of involuntary functions such                       |

Condition

Description  
as blood pressure and heart rate