UNIT 7- NERVOUS SYSTEM

UNIT STRUCTURE

7.1 Learning Objectives
7.2 Introduction
7.3 Brain and Spinal Cord: Its parts, functions and importance
7.4 Autonomic Nervous System
7.5 Effect of Yogic Practices on Nervous system
7.6 Let Us Sum Up
7.7 Further Reading
7.8 Answers to Check Your Progress
7.9 Model Questions

7.1 LEARNING OBJECTIVES

After going through this Unit, you will be able to

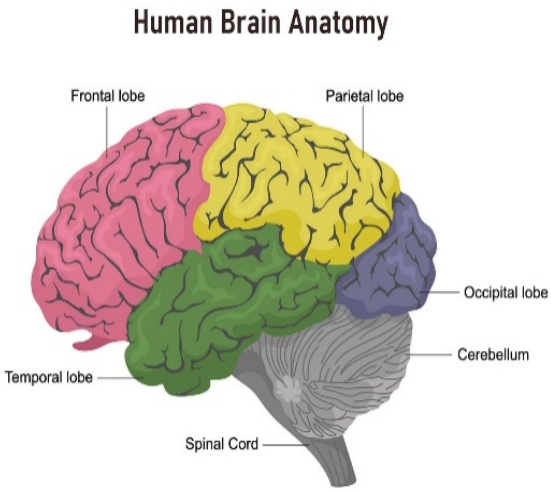
- Understand the structure and components of the Central Nervous System (CNS).
- Learn the functions of the CNS.
- Explain how the brain and spinal cord communicate to control bodily functions and respond to stimuli.
- Explain the effect of yogic practices on nervous system

7.2 INTRODUCTION

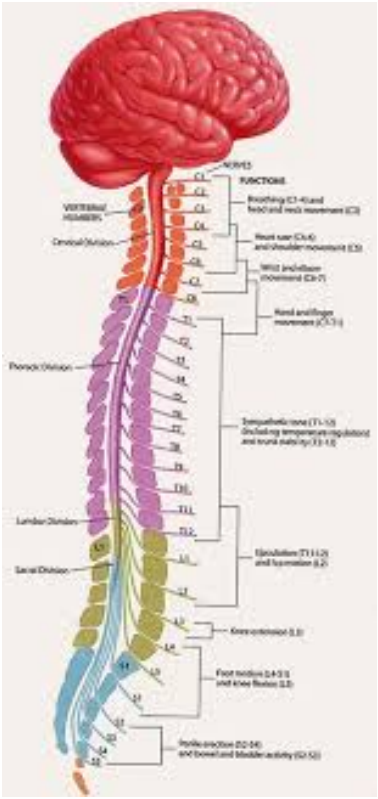
The central nervous system (CNS) is the main control system of the human body, made up of the brain and spinal cord. It receives information from sense organs, interprets it, and produces appropriate responses.

- **The Brain**: The brain is the primary organ of the CNS and is responsible for higher functions such as thought, memory, emotions, and decision-

making, as well as regulating basic life-sustaining functions like heartbeat and breathing.



- **The Spinal Cord:** The spinal cord is a cylindrical structure that extends from the brainstem down the back. It acts as a communication highway, transmitting messages between the brain and the rest of the body while also managing reflexes independently.



Together, they regulate vital activities like breathing, heartbeat, balance, and coordination. The CNS helps the body adapt to internal and external changes, ensuring proper functioning and survival through constant communication between neurons and supporting structures effectively.

The CNS is protected by the skull, vertebral column, meninges, and cerebrospinal fluid (CSF), ensuring its safety and functionality. It plays a critical role in maintaining homeostasis and responding to external stimuli, enabling humans to interact with their environment effectively.

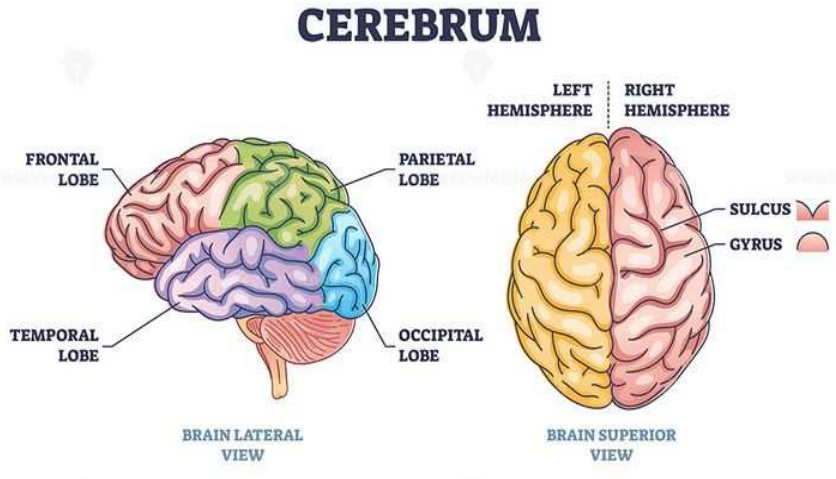
7.3 BRAIN AND SPINAL CORD:

ITS PARTS, FUNCTIONS AND IMPORTANCE

PARTS OF THE BRAIN

The brain is a complex organ divided into several regions, each with distinct functions crucial for the body's overall operation.The brain is an incredibly intricate organ, and each part of it plays a vital role in maintaining the body's functions, controlling behaviour, and allowing us to experience and interact with the world. Here's an overview of the importance of the major parts of the brain and their functions:

Cerebrum–



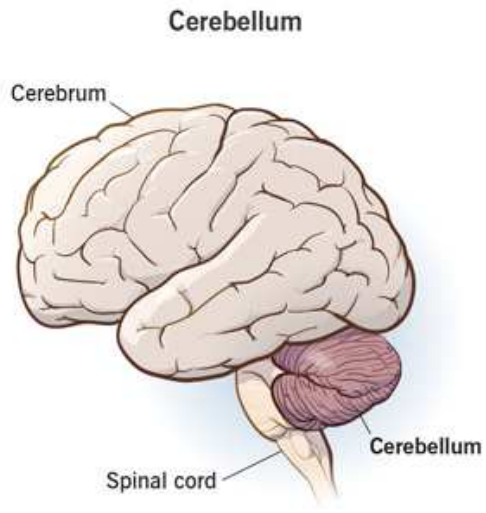
Function: The largest part of the brain, the cerebrum is responsible for higher functions such as thought, memory, voluntary movement, and sensory processing.

Importance:

a. Cognition: It controls mental processes like learning, reasoning, and memory. It allows us to think, make decisions, and engage in problem-solving.
b. Emotions and Behaviour: The cerebrum plays a role in processing emotions and regulating social behaviours, helping us interact with others and make choices based on our feelings and experiences.
c. Movement Control: The cerebrum, particularly the motor cortex, is essential for voluntary movements (e.g., walking, talking, writing).
d. Sensory Processing: It receives and interprets sensory information from the body (e.g., touch, vision, hearing), helping us perceive the environment around us.

The cerebrum is divided into two hemispheres, each controlling the opposite side of the body. The left hemisphere is often linked to logical thinking, language, and analytical skills, while the right hemisphere is associated with creativity, spatial awareness, and intuition.

Cerebellum–

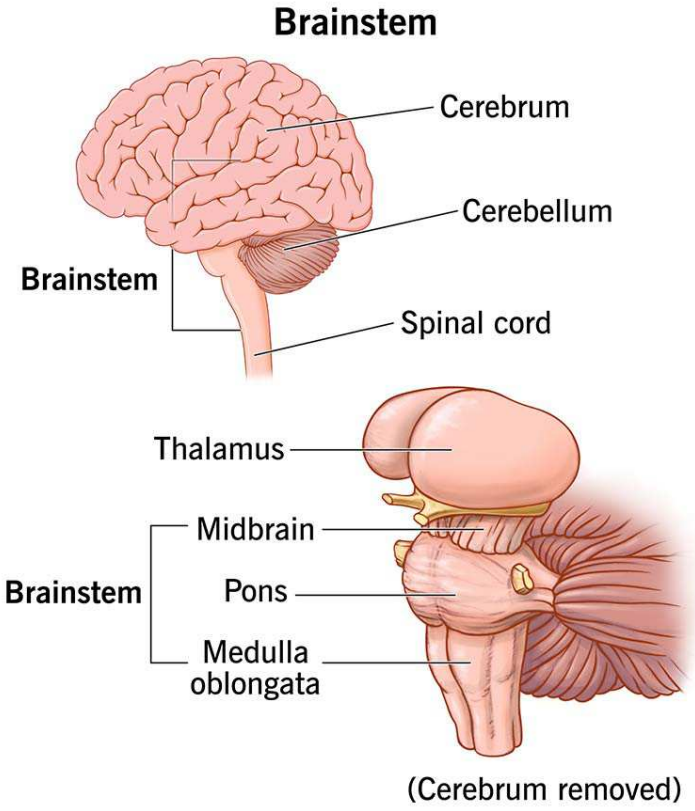


Function: Located at the back of the brain, the cerebellum is responsible for coordination, balance, and fine motor control.

Importance:

a. Movement Coordination: The cerebellum ensures that voluntary movements are smooth and coordinated. It fine-tunes motor skills, helping us perform tasks such as typing, playing musical instruments, and walking.
b. Balance and Posture: The cerebellum helps maintain posture and balance, allowing us to stand, walk, or run without falling. It continuously adjusts motor output to keep us stable.
c. Motor Learning: It also plays a key role in learning new motor tasks, such as riding a bicycle or learning how to dance.

Brainstem–



Function: The brainstem connects the brain to the spinal cord and is responsible for controlling basic life-sustaining functions, such as heart rate, breathing, and digestion.

Importance:

a. Autonomic Functions: The brainstem controls involuntary functions like heartbeat, breathing, swallowing, and digestion, which are essential for survival. It acts as the brain's "control center" for automatic body processes.
b. Alertness and Sleep: The brainstem regulates the sleep-wake cycle and levels of consciousness through structures like the reticular formation, which controls alertness and attention.
c. Reflexes: The brainstem is involved in many reflexes, such as coughing, sneezing, and blinking, protecting the body from potential harm.

The brainstem consists of the midbrain, pons, and medulla oblongata, each with specific functions related to movement, respiration, and regulation of vital signs.

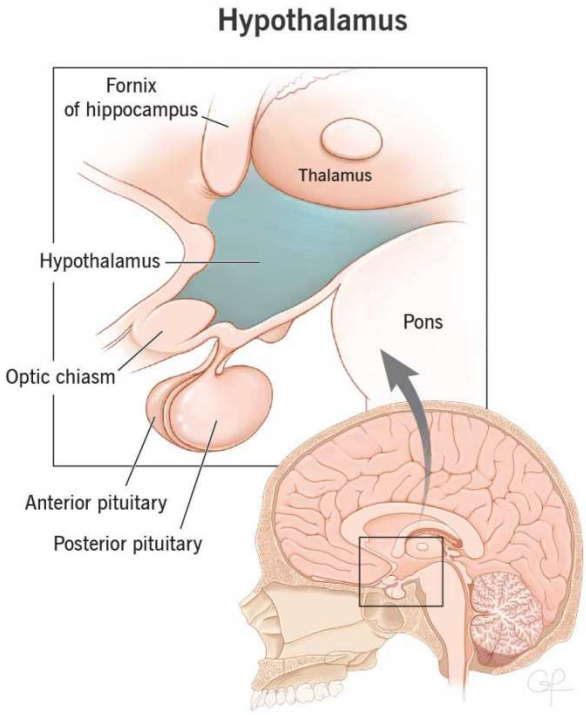
Thalamus -

Function: The thalamus acts as the brain's sensory relay station, sending sensory information (except smell) to the appropriate part of the cerebral cortex for processing.

Importance:

a. Sensory Integration: The thalamus helps to integrate and relay sensory signals from the body, ensuring that the brain receives the necessary data to perceive the environment (e.g., touch, sight, sound).
b. Motor Control: It also plays a role in motor control by transmitting motor information from the basal ganglia and cerebellum to the motor cortex.
c. Consciousness and Sleep: The thalamus is involved in regulating states of consciousness and is important for sleep and wakefulness.

Hypothalamus–

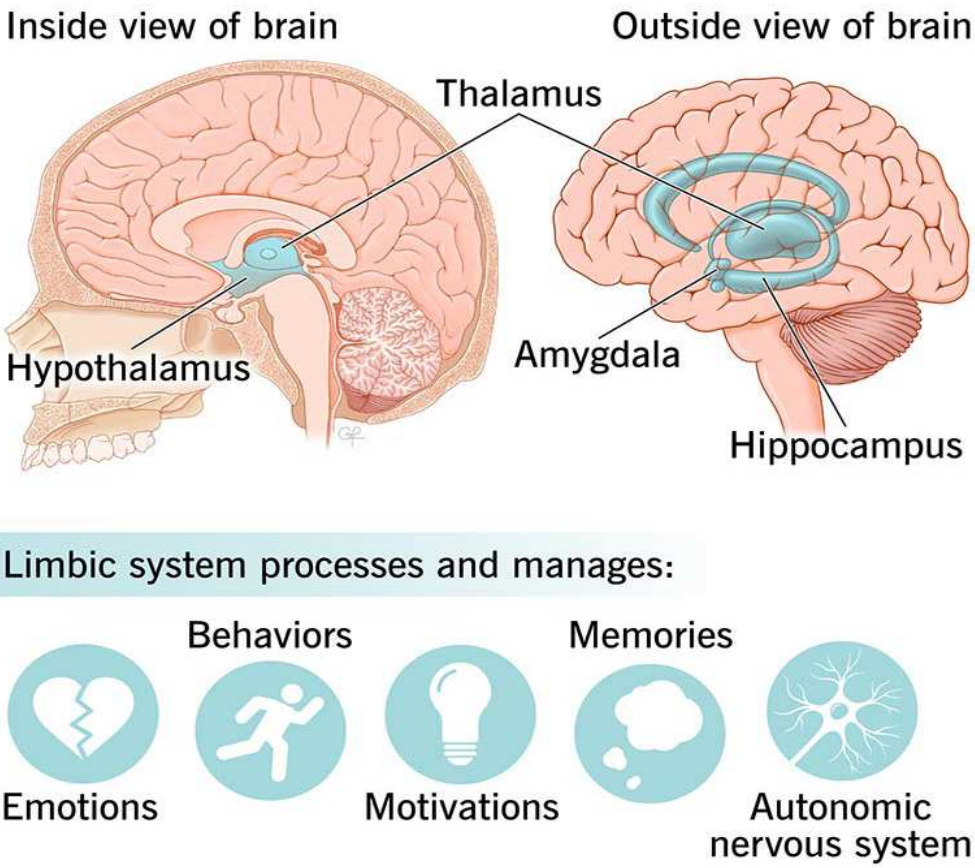


Function: The hypothalamus is a small but crucial part of the brain that regulates the body's autonomic functions, such as temperature, hunger, thirst, and circadian rhythms.

Importance:

a. Homeostasis: The hypothalamus helps maintain balance within the body by regulating temperature, hunger, thirst, and fluid balance. For example, it signals the body to start sweating when it's too hot or to feel hungry when it needs food.
b. Endocrine System: It controls the release of hormones through the pituitary gland, impacting growth, metabolism, and stress responses.
c. Emotional Response: The hypothalamus is involved in emotional processing and stress responses, often working in conjunction with the limbic system.

Limbic System–

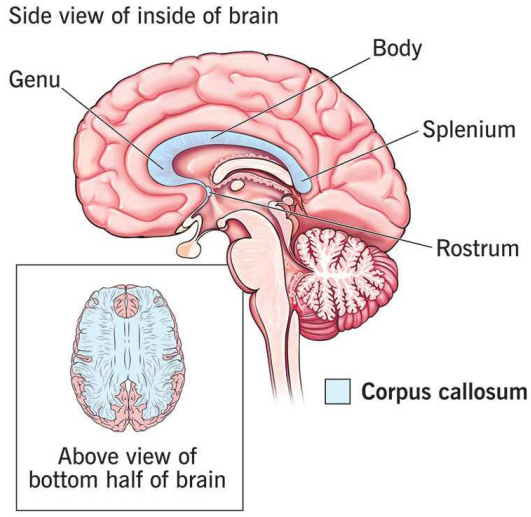


Function: The limbic system, which includes the amygdala, hippocampus, and other structures, is involved in emotion, memory, and behaviour.

Importance:

a. Emotion Regulation: The amygdala processes emotions like fear, pleasure, and anger. It is crucial for emotional responses and forming emotional memories.
b. Memory Formation: The hippocampus is essential for memory formation, particularly long-term memory and spatial memory. It helps in learning new information and remembering personal experiences.
c. Behaviour and Motivation: The limbic system helps regulate motivated behaviours, including appetite, sex drive, and social bonding.

Corpus Callosum–

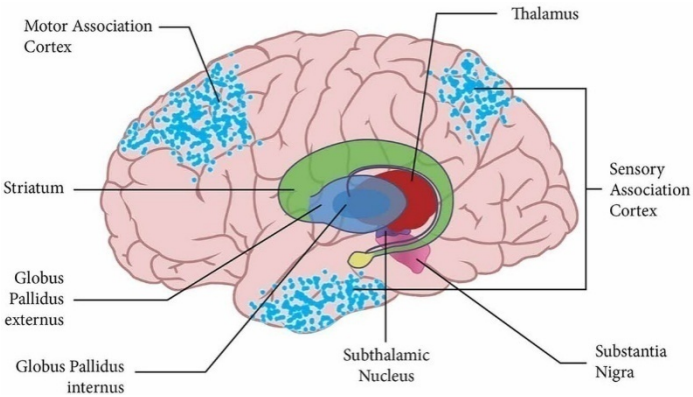


Function: The corpus callosum is a thick band of nerve fibres that connects the left and right hemispheres of the brain, allowing communication between them.

Importance:

a. Interhemispheric Communication: It enables the two halves of the brain to work together, ensuring that information from one hemisphere is shared with the other. This allows for coordinated actions and processing of complex tasks.
b. Coordination of Function: It plays a crucial role in integrating motor control, sensory input, and cognitive tasks across both hemispheres.

Basal Ganglia–

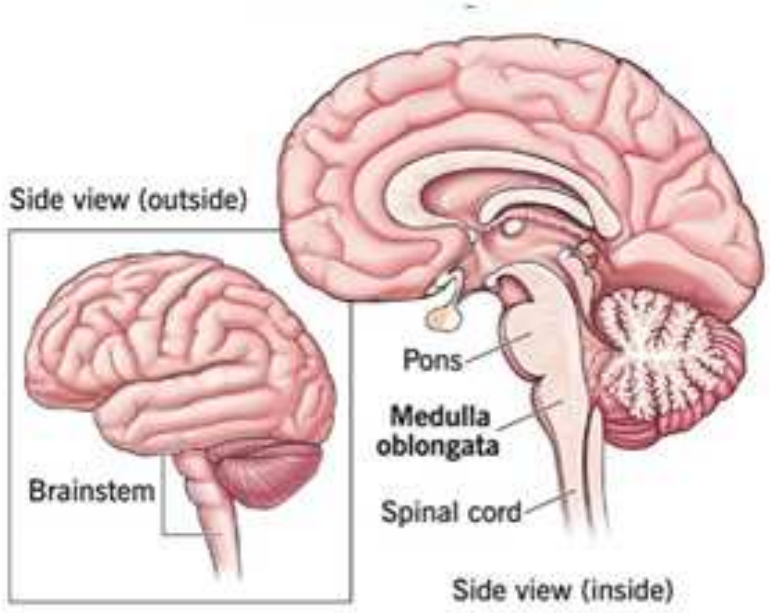


Function: The basal ganglia are a group of structures involved in motor control, procedural learning, and the regulation of voluntary movement.

Importance:

a. Movement Regulation: The basal ganglia help smooth out and coordinate voluntary movements, playing a critical role in motor planning and execution.
b. Parkinson's Disease: Dysfunction in the basal ganglia is associated with movement disorders such as Parkinson's disease, where a person experiences tremors, rigidity, and difficulty in initiating movements.

Medulla Oblongata–



Function: Located at the base of the brainstem, the medulla oblongata is responsible for regulating vital functions such as heart rate, blood pressure, and breathing.

Importance:

a. Vital Autonomic Functions: It controls essential life-sustaining processes, ensuring that the body can maintain vital functions like breathing and circulation without conscious effort.
b. Reflexes: The medulla also plays a role in reflexes like coughing, sneezing, and vomiting

PARTS OF THE SPINAL CORD

The spinal cord is a crucial part of the central nervous system (CNS) that serves as the communication pathway between the brain and the rest of the body. It is a long, cylindrical structure made up of nervous tissue and runs from the brainstem down through the vertebral column. The spinal cord is responsible for relaying sensory information from the body to the brain and transmitting motor commands from the brain to muscles and glands.Here's an overview of its functions and importance:

Transmission of Sensory Information-

- The spinal cord receives sensory input from various parts of the body, such as the skin, muscles, and organs, and transmits this information to the brain for processing. This includes sensations like touch, pain, temperature, and pressure.
- **Example**: If you touch something hot, the sensory neurons in your skin send signals to the spinal cord, which then relays them to the brain, allowing you to feel the pain and react accordingly.

Transmission of Motor Commands-

- The spinal cord transmits **motor signals** from the brain to the muscles and glands. These signals control voluntary movements, such as walking or moving your hand, and involuntary movements, like breathing.
- **Example**: When you decide to move your hand, the brain sends motor commands through the spinal cord to the muscles in your arm, initiating movement.

Reflex Actions-

- One of the most important functions of the spinal cord is its role in **reflexes**. Reflexes are automatic, rapid responses to stimuli that do not require input from the brain. The spinal cord processes these responses almost immediately.
- **Example**: If you accidentally touch something sharp, the spinal cord can trigger a reflex to pull your hand away before the pain signals reach the brain.

Coordination of Movement-

- The spinal cord coordinates voluntary movement by transmitting motor signals from the brain and adjusting for balance and posture.
- **Example**: While walking, the spinal cord coordinates muscle contractions to ensure that your body remains balanced and moves smoothly.

Autonomic Function Regulation-

- The spinal cord is involved in regulating many **autonomic (involuntary) functions**, such as heart rate, digestion, and breathing. These functions are critical for maintaining the body's homeostasis.
- **Example**: The spinal cord sends signals that regulate the autonomic nervous system, ensuring that heart rate and blood pressure remain stable.

IMPORTANCE OF THE SPINAL CORD

Communication Pathway-

- The spinal cord acts as the primary communication pathway between the brain and the peripheral nervous system (PNS). It transmits sensory information from the body to the brain and motor commands from the brain to the muscles.
- This communication is essential for everyday functioning, allowing us to interact with our environment and control our movements.

Protection Through Reflexes-

- The spinal cord plays an important protective role through **reflex actions**. These are rapid, automatic responses that help protect the body from harm. Reflexes bypass the brain to allow quicker responses to dangerous situations.
- **Example**: If you step on a sharp object, the spinal cord can initiate a reflex to immediately lift your foot away, minimizing injury.

Motor Control and Coordination-

- The spinal cord is essential for controlling **voluntary and involuntary movements**, such as walking, running, and fine motor skills (like writing).
- It enables coordination of complex movements by transmitting signals from the brain to the muscles, ensuring the proper execution of motor tasks.

Autonomic Regulation-

- The spinal cord is crucial for maintaining basic bodily functions by regulating the **autonomic nervous system**. It helps control involuntary functions like heart rate, blood pressure, digestion, and respiration, all of which are essential for life.
- **Example**: It adjusts the dilation of blood vessels and controls breathing patterns based on the body's needs.

Segmentation and Functional Organization-

- The spinal cord is organized into segments, with each segment responsible for different parts of the body. This organization allows for the efficient transmission of sensory and motor information to and from specific regions.
- For instance, the cervical region of the spinal cord controls the neck and upper limbs, while the lumbar region controls the lower limbs.

7.4 AUTONOMIC NERVOUS SYSTEM

The Autonomic Nervous System (ANS) is a vital component of the peripheral nervous system responsible for regulating involuntary physiological activities, including the functions of internal organs, smooth muscles, cardiac muscles, and glands. It operates continuously, maintaining homeostasis, which ensures stable internal conditions despite external changes, and controls essential life processes such as heart rate, blood pressure, respiration, digestion, metabolism, body temperature, and glandular secretions without conscious effort.

The ANS is divided into two primary components: the Sympathetic Nervous System, which activates the "fight or flight" response during stress, and the Parasympathetic Nervous System, which promotes "rest and digest" activities for recovery and energy conservation. The balance between these systems is essential for physical health, emotional stability, and overall well-being.

Sympathetic Nervous System

The Sympathetic Nervous System (SNS) is a division of the autonomic nervous system that prepares the body to respond to stress, fear, or emergency situations. It is commonly referred to as the “fight or flight” system because it mobilizes the body’s energy resources to face or escape from threatening conditions. The sympathetic nervous system originates from the thoracolumbar region of the spinal cord (T1–L2 segments). Its nerve fibers innervate various organs, smooth muscles, cardiac muscles, and glands. The primary neurotransmitter released by the postganglionic neurons is noradrenaline (norepinephrine).

Functions of the Sympathetic Nervous System -

1. Raises cardiac contraction force and heart rate.
2. It causes blood vessels to narrow, which raises blood pressure.
3. Increases vision by dilating the pupils (mydriasis).
4. Increases the intake of oxygen by dilating the bronchi
5. Suppresses salivary flow and digestion.

6. Encourages the liver to release glucose for energy.
7. Raises body temperature and stimulates sweat glands.

Parasympathetic Nervous System

The autonomic nervous system's parasympathetic nervous system (PNS) aids in the body's recuperation, rest, and relaxation. Because it preserves energy and aids in the body's regular maintenance processes, it is frequently referred to as the "rest and digest" system. The craniosacral region is the source of the parasympathetic nervous system, which includes the sacral segments of the spinal cord (S2–S4) and the cranial nerves (III, VII, IX, and X). Acetylcholine is the main neurotransmitter that both preganglionic and postganglionic neurons release.

Functions of the Parasympathetic Nervous System –

1. Decrease heart rate and blood pressure.
2. Constricts pupils (miosis) and bronchi.
3. It stimulates digestion and intestinal motility.
4. Increase salivary, gastric, and pancreatic secretions.
5. Promotes energy storage and nutrient absorption.
6. Facilitates urination and defecation.
7. Supports tissue repair and immune function.

The autonomic nervous system (ANS) is crucial for controlling involuntary physiological processes that are necessary for life, including blood pressure, heart rate, respiration, digestion, and glandular activity. The sympathetic and parasympathetic nervous systems, which make up the ANS's two complementary divisions, guarantee the body's capacity to react to stress as well as to relax, recuperate, and store energy. To preserve homeostasis, physical well-being, and emotional stability, these divisions must be properly balanced.

7.5 EFFECT OF YOGIC PRACTICES ON NERVOUS SYSTEM

7.5.1 Effect of Asanas on the Nervous System

Asanas enhance neuromuscular coordination and fortify the link between the brain and muscles. Asanas improve posture, ease tense muscles, and increase blood flow to the brain and spinal cord. The nervous system is calmed, spinal nerve health is enhanced, and nerve endings are stimulated by forward and backward bends, twists, and balancing positions. Frequent practice fosters mental stability and lessens nervous excitability.

7.5.2 Effect of Pranayama on the Nervous System

Through deliberate breathing, pranayama is essential for controlling nervous system activity. Heart rate variability is improved, parasympathetic dominance is increased, and the vagus nerve is stimulated via techniques like Nadi Shoshani, Bhramari and slow, deep breathing. These techniques lower blood pressure, quiet the mind, and lessen stress chemicals like cortisol. Additionally, pranayama increases the amount of oxygen that reaches brain cells, which improves mental clarity, focus, and emotional regulation.

7.5.3 Effect of Meditation on the Nervous System

The neurological system is profoundly calmed by meditation. Frequent meditation improves emotional equilibrium, lowers worry, and lessens mental swings. According to scientific research, meditation raises the activity of alpha and theta brain waves, which are linked to creativity and relaxation. Meditation lessens the symptoms of stress, sadness, and sleeplessness while enhancing memory, attention span, and decision-making skills.

7.5.4 Effect of Relaxation Practices

The nerve system is profoundly relaxed by relaxation methods like Shavasana and Yoga Nidra. These techniques encourage parasympathetic activation, lessen neuromuscular tension, and slow down brain activity. In particular, yoga nidra aids in increasing the quality of sleep and relieving long-standing mental

tension. People with stress-related problems benefit most from relaxation techniques.

7.5.5 Effect of Shatkarmas on the Nervous System

Neti, Dhauti, and Trataka are examples of yogic cleaning techniques (Shatkarmas) that aid in the removal of sensory and physical obstacles. These exercises increase focus, lessen mental weariness, and improve sensory nerve function. For instance, by stabilizing cerebral connections, trataka enhances mental attention and fortifies optic nerves.

7.6 LET US SUM UP

• The Central Nervous System (CNS) consists of the brain and spinal cord, which are responsible for processing sensory information, controlling movement, and regulating bodily functions.

• The brain is the control centre of the body, overseeing cognitive functions like thinking, memory, and emotions, while also regulating basic life-sustaining functions such as breathing, heartbeat, and digestion.

• The spinal cord serves as the communication pathway between the brain and the rest of the body, transmitting sensory and motor signals to facilitate movement and sensation.

• The CNS is vital for coordinating physical actions, maintaining balance, processing sensory input, and ensuring proper functioning of the body's internal systems to maintain homeostasis.

• Protection of the CNS is provided by the skull, vertebral column, meninges, and cerebrospinal fluid, which shield the brain and spinal cord from injury and infection.

•The Autonomic Nervous System (ANS) is a part of the peripheral nervous system that regulates involuntary physiological activities such as heart rate, blood pressure, respiration, digestion, metabolism, and glandular secretion.

• The ANS functions continuously and automatically to maintain homeostasis, ensuring stable internal conditions despite changes in the external environment.

• The ANS is divided into two major divisions: the Sympathetic Nervous System, which prepares the body for stress and emergencies ("fight or flight"), and the Parasympathetic Nervous System, which promotes rest, recovery, and energy conservation ("rest and digest").

7.7 FURTHER READINGS

- Rishi, S. (2010). *Human Physiology*, 1st Edition, Motilal Banarsidass Publishers, Delhi, India.
- Rama, S. (2008). *The Science of Yoga and Health*, Yoga Publications Trust, Munger, Bihar, India.
- Saraswati, S.S. (2010). *The Power of Breath: The Art of Breathing*, Yoga Publications Trust, Munger, Bihar, India.
- Agarwal, S.S. (2011). *Human Anatomy & Physiology*, 2nd Edition, Shri Bhagwati Prakashan, Varanasi, India.
- Saraswati, S.N. (2009). *Yoga and Physiology*, Yoga Publications Trust, Munger, Bihar, India.

7.8 ANSWERS TO CHECK YOUR PROGRESS

Que. 1 What are the two important parts of Central Nervous System?
Anwer – Brain and Spinal cord

Que. 2 Which part of the body is called as control centre of the body?
Answer: Brain
Que. 3 Which part of the nervous system serves as the communication pathway between the brain and the rest of the body?
Answer: Spinal cord
Que. 4 What are the two major divisions of Autonomic Nervous System?
Answer: Sympathetic and Para-sympathetic Nervous System
Que. 5 Which part of the nervous system referred as the "fight or flight" system?

Answer: Sympathetic Nervous System

7.9 MODEL QUESTION

Q.1 What are the main functions of the Central Nervous System (CNS)?

Q.2 How do the brain and spinal cord communicate within the CNS?

Q.3 What are the differences between the central nervous system and the peripheral nervous system (PNS)?

Q.4 What are the main regions of the brain, and what are their specific functions?

Q.5 How does the CNS regulate homeostasis in the body?

*** ***** ***