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Class	10th	Chapter	05
Subject	Biology	Board	Federal

Chapter 5: Nervous System

Section I: Multiple Choice Questions

1. Reaction to any stimulus is called: A) receptor B) Impulse **C) responses** D) effector

2. The unit of structure and function in the nervous system is: A) neuron B) muscle cell C) nephron D) cardiac cell

3. Thyroid gland has the ability to store: A) iodine B) chlorine C) fluorine D) zinc

4. Endocrine glands pour their secretion directly into: A) lymph **B) blood** C) organs D) muscles

5. Islet of Langerhans are parts of the: A) thyroid gland B) adrenal gland **C) pancreas** D) gonads

6. Nerve Impulse is best described as: A) chemical B) electrical C) osmotic **D) electrochemical**

7. When a person is frightened, which substance increases the blood sugar level? A) adrenaline B) amylase C) glycogen D) insulin

8. Which part of the brain detects temperature changes in the blood? A) cerebellum B) cerebral hemispheres **C) hypothalamus** D) medulla

10. In contrast to nerve impulse, the response produced by hormones takes longer because: A) hormones are specific in their action. **B) hormones are transported through blood.** C) hormones are produced in small amounts. D) the molecules of hormones are small in size.

11. Once released, neurotransmitter molecules typically produce signals in postsynaptic neurons by: A) entering the postsynaptic neuron B) attaching to vesicles C) binding to presynaptic receptors **D) binding to postsynaptic receptors**

12. The parts of brain represented by I and II are: *(Note: I points to the cerebellum and II points to the pons)* A) cerebellum / pons B) cerebrum / pons C) cerebellum / medulla oblongata D) cerebrum / medulla oblongata
(Correct Answer: **A**)

13. The components of this reflex arc are: *(Note based on standard reflex arc numbering: 1 = Receptor, 2 = Sensory neuron, 3 = Interneuron, 4 = Motor neuron, 5 = Effector)* A) Receptor /

Sensory neuron / Motor neuron / Interneuron / Effector B) Sensory neuron / Motor neuron / Interneuron / Receptor / Effector C) Receptor / Effector / Sensory neuron / Interneuron / Motor neuron **D) Receptor / Sensory neuron / Interneuron / Motor neuron / Effector** (Correct Answer: **D**)

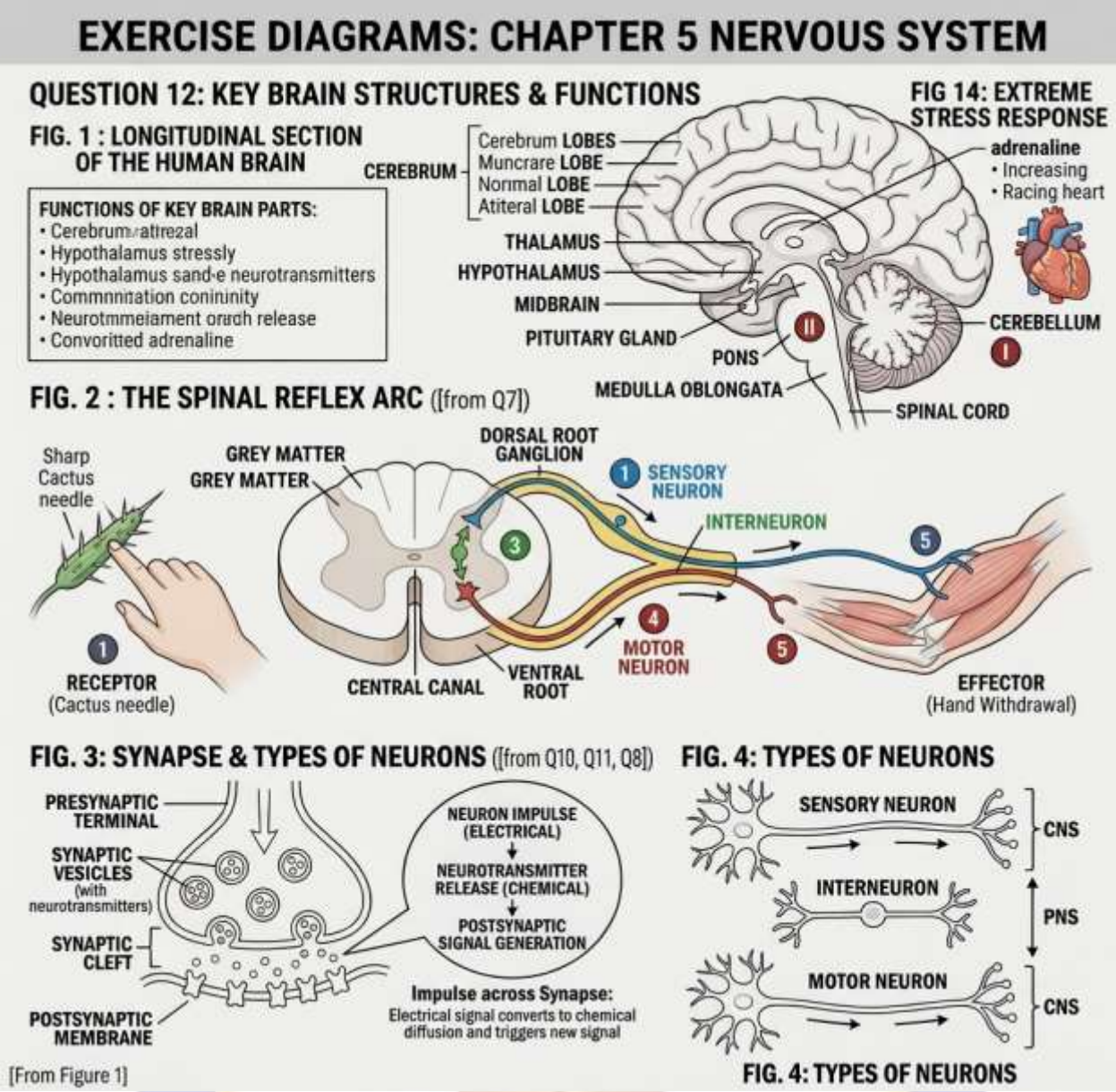
14. Four characters of a specific hormone are listed below:

- i. increased rate and intensity of heartbeat
- ii. increased blood pressure
- iii. Decreased blood flow to skin & alimentary canal
- iv. Increased blood flow to limb

15. Which is this hormone? A) adrenaline B) glucagon C) insulin D) testosterone

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Section II: Short Answer Questions

Q1. What is nervous system?

Answer:

The nervous system is an organ system containing a network of specialized cells called neurons that coordinate body actions and transmit signals between different parts of the body to respond to internal and external stimuli. It consists of two main parts: the Central Nervous System (CNS) and the Peripheral Nervous System (PNS).

Q2. What is the role of nervous system?

Answer:

The main functions/roles of the nervous system are:

1. **Sensory Perception:** Detects changes (stimuli) in the internal and external environment.

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2. **Integration:** Processes, interprets, and analyzes sensory input to formulate appropriate decisions.
3. **Motor Response:** Controls body activities by sending signals to effectors (muscles and glands).

Q3. Differentiate between central nervous system and peripheral nervous system.
Answer:

Feature	Central Nervous System (CNS)	Peripheral Nervous System (PNS)
Components	Consists of the brain and spinal cord.	Consists of cranial and spinal nerves.
Function	Acts as the main processing unit for integration and control.	Connects the CNS to organs, limbs, and skin.
Protection	Protected by skull (cranium), vertebral column, and meninges.	Lacks bony protection; sensory/motor fibers run throughout the body.

Q4. Name the parts of human brain.
Answer:
The human brain is divided into three main regions:

1. **Forebrain:** Consists of Cerebrum, Thalamus, and Hypothalamus.
2. **Midbrain:** Connects the forebrain to the hindbrain and acts as a relay center for visual and auditory information.
3. **Hindbrain:** Consists of Cerebellum, Pons, and Medulla Oblongata.

Q5. Write two functions of cerebellum.
Answer:

1. **Body Equilibrium:** Controls and coordinates precise muscle movements to maintain balance and posture.
2. **Motor Coordination:** Facilitates smooth, accurate voluntary movement patterns (e.g., walking, typing).

Q6. How are brain and spinal cord protected?
Answer:
The CNS (brain and spinal cord) is protected by three layers of defence:

1. **Bony Covering:** The brain is protected by the skull (**cranium**), while the spinal cord is protected by the **vertebral column**.
2. **Meninges:** Three protective membrane layers (*dura mater, arachnoid mater, pia mater*) enclosing both brain and spinal cord.

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3. **Cerebrospinal Fluid (CSF):** Fluid present between meningeal layers that cushions the CNS against mechanical shocks.

Q7. Describe peripheral nervous system.

Answer:

The Peripheral Nervous System (PNS) comprises all nerves extending outside the brain and spinal cord.

- **Cranial Nerves:** 12 pairs originating directly from the brain.
- **Spinal Nerves:** 31 pairs originating from the spinal cord.
- **Functional Divisions:**
    - **Somatic Nervous System:** Controls voluntary muscle movements.
    - **Autonomic Nervous System:** Controls involuntary visceral functions (divided into *Sympathetic* and *Parasympathetic* systems).

Q8. What are the types of neuron? What are their functions?

Answer:

1. **Sensory Neurons:** Transmit nerve impulses from sensory receptors to the CNS.
2. **Interneurons (Intermediate Neurons):** Located entirely within the CNS; process, analyze, and integrate sensory information.
3. **Motor Neurons:** Carry motor commands away from the CNS to effectors (muscles and glands).

Q9. Define stimulus with examples.

Answer:

- **Definition:** A stimulus is any detectable change in the internal or external environment that evokes a physiological or behavioral response in an organism.
- **Examples:** Heat, light intensity, sound, pressure, pain, and chemical concentration changes.

Q10. Define and sketch synapse.

Answer:

- **Definition:** A synapse is a microscopic junction between the axon terminal of one neuron (presynaptic cell) and the dendrite/cell body of an adjacent neuron (postsynaptic cell) across which nerve impulses pass chemical signals.
- **Labeled Diagram:**

Q11. How does an impulse cross a synapse?

Answer:

1. **Arrival of Impulse:** An electrical impulse reaches the axon terminal of the presynaptic neuron.
2. **Release of Neurotransmitter:** Vesicles fuse with the presynaptic membrane and release neurotransmitters into the synaptic cleft.
3. **Diffusion & Binding:** Neurotransmitters diffuse across the cleft and bind to specific receptor sites on the postsynaptic membrane.

4. **Signal Generation:** Binding triggers an electrical change (impulse) in the receiving postsynaptic neuron.

Q12. What action or change do neurotransmitters transmit to the target cell?

Answer:

Neurotransmitters can cause either:

- **Excitatory Action:** Depolarizes the target cell membrane, triggering a new nerve impulse or contraction.
- **Inhibitory Action:** Hyperpolarizes the target cell, preventing the generation of an impulse or dampening activity.

Q13. What happens to neurotransmitters after they deliver their message?

Answer:

After binding to postsynaptic receptors, neurotransmitters are rapidly removed from the synaptic cleft by:

1. **Enzymatic Degradation:** Broken down by specific enzymes (e.g., Acetylcholinesterase breaks down Acetylcholine).
2. **Reuptake:** Pumped back into the presynaptic neuron for recycling.
3. **Diffusion:** Simple diffusion away from the synaptic gap.

Q14. How many different types of neurotransmitters are there?

Answer:

There are over **100 known neurotransmitters** in the human nervous system, broadly classified into:

1. **Small Molecule Transmitters:** Acetylcholine, Monoamines (Dopamine, Serotonin, Adrenaline/Epinephrine, Noradrenaline).
2. **Amino Acids:** Glutamate, GABA (Gamma-aminobutyric acid), Glycine.
3. **Neuropeptides:** Endorphins, Substance P, Enkephalins.

Q15. What is a reflex action?

Answer:

A **reflex action** is an immediate, automatic, involuntary response to a specific stimulus without prior conscious thought, controlled primarily by the spinal cord.

- **Example:** Withdrawing a hand instantly upon touching a hot object.

Q16. Name the endocrine glands of man.

Answer:

The major human endocrine glands are:

1. Pituitary Gland
2. Thyroid Gland
3. Parathyroid Glands
4. Adrenal Glands
5. Pancreas (Islets of Langerhans)
6. Gonads (Testes in males, Ovaries in females)

7. Pineal Gland & Thymus Gland

Q17. Name the hormones secreted by each of the endocrine gland.

Endocrine Gland	Primary Hormones Secreted
Pituitary Gland	Somatotropin (STH/GH), Thyroid Stimulating Hormone (TSH), Vasopressin (ADH), Oxytocin
Thyroid Gland	Thyroxin, Calcitonin
Parathyroid Gland	Parathormone
Adrenal Gland	Adrenaline (Epinephrine), Cortisol, Aldosterone
Pancreas	Insulin, Glucagon
Testes (Male)	Testosterone
Ovaries (Female)	Estrogen, Progesterone

Q18. Differentiate between:

(a) Cerebrum and Cerebellum

Feature	Cerebrum	Cerebellum
Location	Largest part of Forebrain.	Part of Hindbrain.
Function	Controls intelligence, thinking, memory, speech, voluntary movement.	Controls body balance, muscle posture, and fine movement coordination.

(b) Sensory and Motor Neuron

Feature	Sensory Neuron	Motor Neuron
Direction	Carries impulses from receptors **to CNS**.	Carries impulses **from CNS** to effectors.

Feature	Sensory Neuron	Motor Neuron
Structure	Long dendrite, short axon; cell body in dorsal root ganglion.	Short dendrites, long axon; cell body inside CNS.

(c) Voluntary and Involuntary Action

Feature	Voluntary Action	Involuntary Action
Control	Under conscious control of the cerebrum.	Under automatic control (medulla/spinal cord); no conscious control.
Example	Reading, writing, walking.	Heartbeat, peristalsis, reflex actions.

(d) Nerve Impulse and Hormonal Transmission

Feature	Nerve Impulse Transmission	Hormonal Transmission
Medium	Electrochemical signal along nerve fibers.	Chemical signals transported via bloodstream.
Speed & Duration	Very fast; short-lived effect.	Slower; long-lasting effect.

(e) Endocrine Glands and Exocrine Glands

Feature	Endocrine Glands	Exocrine Glands
Ducts	Ductless glands.	Possess specialized ducts.
Secretion	Secretes hormones directly into blood.	Secretes enzymes/fluids to specific target sites (e.g., salivary, sweat glands).

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Section III: Extensive Answer Questions

1. Describe the nervous system and its role in human.

Answer:

Introduction

The human nervous system is an intricate regulatory network designed for rapid coordination and communication within the body. It enables humans to perceive external stimuli, integrate information, and execute appropriate anatomical responses.

Structural Organization

1. **Central Nervous System (CNS):**
    - **Brain:** Main coordination center, responsible for processing sensory data, cognitive thoughts, memory, and voluntary controls.
    - **Spinal Cord:** Conduit for signal transmission between brain and peripheral nerves; also serves as the main center for spinal reflex actions.
2. **Peripheral Nervous System (PNS):**
    - **Somatic Nervous System:** Relays signals to skeletal muscles (voluntary movements).
    - **Autonomic Nervous System:** Controls involuntary organs (cardiac muscle, smooth muscle, glands). It operates via:
        - *Sympathetic Division:* Prepares body for "fight or flight" during stress.
        - *Parasympathetic Division:* Controls "rest and digest" activities under normal conditions.

Core Roles in Humans

- **Homeostasis Maintenance:** Continuously monitors internal variables (temperature, arterial pressure) and regulates physiological responses.
- **Sensory Processing:** Transforms external energy (light, sound) into neural inputs for conscious perception.
- **Higher Cognitive Function:** Governs learning, memory, emotions, and decision-making processes.

2. Draw a vertical section of human brain and label it. Write the functions of each part.

Diagram: Vertical Section (Sagittal Section) of Human Brain

Functions of Key Brain Parts

- **Forebrain:**
    - **Cerebrum:** Coordinates voluntary actions, sensory perception, intelligence, speech, and memory storage.
    - **Thalamus:** Acts as a relay station for sensory pathways heading to the cerebrum.
    - **Hypothalamus:** Regulates body temperature, hunger, thirst, sleep, and controls the pituitary gland secretions.
- **Midbrain:**

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- Relays sensory information from eyes and ears to forebrain; controls visual and auditory reflexes.

- **Hindbrain:**
  - **Cerebellum:** Coordinates precise skeletal muscle movements and maintains posture/balance.
  - **Pons:** Assists medulla in regulating breathing rates; serves as a pathway between cerebrum and cerebellum.
  - **Medulla Oblongata:** Controls vital involuntary functions like heart rate, breathing, blood pressure, and swallowing.

3. Draw, label cross section of human spinal cord and write its structure and function.
Diagram: Cross-Section of Spinal Cord

Structure of Spinal Cord

- **Grey Matter:** Inner butterfly-shaped region made of cell bodies, unmyelinated interneurons, and neuroglia. It contains *dorsal horns* (sensory input) and *ventral horns* (motor output).
- **White Matter:** Outer region composed of myelinated axon bundles forming ascending (sensory) and descending (motor) tracts.
- **Central Canal:** Runs down the center of grey matter, containing cerebrospinal fluid (CSF).

Functions of Spinal Cord

1. **Conduction Pathway:** Links the peripheral nerves to the brain for sensory input and motor output.
2. **Reflex Center:** Serves as the primary center for processing simple spinal reflex actions independently of the brain.

4. Outline the types of neuron with diagram.
Classification and Structure
1. SENSORY NEURON 2. INTERNEURON 3. MOTOR NEURON

Sensory Neurons:
  - **Structure:** Single long dendrite leading to cell body; short axon exiting towards CNS.
  - **Role:** Conduct impulses from sensory organs to CNS.

2. **Interneurons:**
  - **Structure:** Highly branched dendrites and multiple short axons; found strictly inside CNS.
  - **Role:** Interpret sensory inputs and initiate motor outputs.

3. **Motor Neurons:**
  - **Structure:** Multiple short dendrites attached directly to cell body; long myelinated axon running away from CNS.

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- **Role:** Transmit motor instructions from CNS to muscles or glands.

5. Explain that nerve impulses are electrical that travel across neuron.

Electrochemical Nature of Nerve Impulse

A nerve impulse is a wave of **electrochemical change** passing rapidly along the neuron's membrane. It operates through selective movement of ions (Na^+ and K^+) across the axonal membrane.

1. **Resting Membrane Potential (RMP):**
   - When a neuron is at rest (not conducting impulses), the inside of the cell membrane is negatively charged relative to the outside (~ -70 mV).
   - Maintained by active transport of Na^+/K^+ pumps (3 Na^+ pumped out, 2 K^+ pumped in).
2. **Action Potential (Depolarization):**
   - When a threshold stimulus is received, voltage-gated Na^+ channels open, allowing rapid influx of sodium ions (Na^+) into the axon.
   - The interior becomes positively charged relative to the outside ($\sim +30$ mV).
3. **Propagation of Wave:**
   - This localized electrical change causes adjacent voltage-gated channels to open, propagating the action potential along the length of the axon.
4. **Repolarization:**
   - Immediately following impulse passage, K^+ channels open and potassium exits the cell, restoring negative interior resting potential.

6. What are neurotransmitters?

Answer:

Definition

Neurotransmitters are specialized endogenous chemical messengers synthesized by neurons and stored within synaptic vesicles at axon terminals.

Mechanism of Action

1. When an action potential arrives at an axon terminal, presynaptic vesicles release neurotransmitters into the **synaptic cleft** via exocytosis.
2. Transmitters diffuse across the gap ($\approx$ 20 nm) and bind specifically to complementary **postsynaptic membrane receptors**.
3. Binding opens ion channels, altering postsynaptic membrane potential to trigger or inhibit a new signal.

Common Examples & Roles

- **Acetylcholine (ACh):** Stimulates skeletal muscle contractions.
- **Adrenaline / Epinephrine:** Increases heart rate and blood flow during stress responses.
- **Dopamine:** Involved in motor control, motivation, and reward pathways.
- **Serotonin:** Regulates mood, sleep, and appetite.

7. Explain reflex action with diagram.

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Description

A **reflex action** is an immediate, automatic, involuntary response to a stimulus. The neural pathway that controls this response is called a **reflex arc**.

Step-by-Step Mechanism

1. **Receptor:** Detects stimulus (e.g., heat on skin) and converts it into a nerve impulse.
2. **Sensory Neuron:** Transmits the impulse via dorsal root into the spinal cord.
3. **Interneuron:** Processes signal in spinal cord grey matter and transfers command directly to motor neuron.
4. **Motor Neuron:** Relays impulse out of spinal cord via ventral root.
5. **Effector:** Target muscle contracts, instantly removing body part from hazard.

8. Identify the major endocrine hormones with their functions.

Answer:

Endocrine Gland	Primary Hormone	Key Physiological Function
Pituitary Gland	**Somatotropin (GH)**	Stimulates body growth and cell division.
	Oxytocin	Stimulates uterine contractions during childbirth and milk ejection.
	Vasopressin (ADH)	Promotes water reabsorption in renal tubules.
Thyroid Gland	**Thyroxin**	Increases basal metabolic rate (BMR) and cellular energy output.
	Calcitonin	Lowers blood calcium levels by promoting deposition into bone.
Parathyroid	**Parathormone**	Increases blood calcium levels by releasing calcium from bones.
Adrenal Gland	**Adrenaline**	Triggers "fight or flight" response; raises heart rate, blood pressure, and sugar levels.
	Cortisol	Regulates glucose metabolism and suppresses inflammation.

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Endocrine Gland	Primary Hormone	Key Physiological Function
Pancreas	**Insulin**	Decreases blood glucose level by facilitating cell uptake and glycogen conversion.
	Glucagon	Increases blood glucose level by stimulating glycogen breakdown in liver.
Gonads (Testes)	**Testosterone**	Controls male secondary sexual characteristics and sperm development.
Gonads (Ovaries)	**Estrogen / Progesterone**	Regulate female menstrual cycle and female secondary sexual characteristic

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