18 Neural Control and Coordination

An interesting work of nervous system is our senses. A good meal, like a good walk outside, can bring together several of your senses. Flavour is a term used to describe how food tastes. However, flavour is a combination of your taste and smell senses. For example, a pineapple slice isn't just sour. It has a tangy, sweet, and tart flavour.

Topic Notes

- *Structure and Function of Neural System*

STRUCTURE AND FUNCTION OF NEURAL SYSTEM

1

TOPIC 1

NEURAL SYSTEM

The human body has several organs. These organs cannot perform their function independently. So, each organ depends on other organs. In order to maintain normal physiology, functions of these organs must be coordinated so that they can work in a proper manner.

Coordination is the process through which two or more organs interact and complement the functions of each other. Integration is the process which makes two or more organs to work as a functional unit in a harmony. Thus, neural system (previously called nervous system) performs two functions:

(1) Co-ordination

(2) Integration

It involves control and coordination of various body functions through neuron.

The neural system and the endocrine system jointly coordinate and integrate functions of various body parts to maintain normal physiology. The neural system provides an organised network of nerve fibres which connect various organs for quick neural coordination. The endocrine system provides chemical integration through hormones.

The neural system is the control system of the body which consists of highly specialised cells called neurons. The neurons detect, receive and transmit different kinds of stimuli to the central nervous system (CNS) through sensory nerve fibres. The central neural system is composed of the brain and spinal cord.

In neural or nervous system is very simple in simple and lower invertebrates as compared to the multicellular organisms. For example, Sponges do not have neurons. In *Hydra*, all the neurons are similar and joined with one another to form a net forming "Primitive nervous system". The insects have a well better organised nervous system, where a brain is present along with a member of ganglia and nerves. The vertebrates have more developed neural system as compared to invertebrates. The brain is most complex and advanced in Primates, particularly in human beings. This complexity of the neural system has increased during the course of evolution. It is due to the development of complex organs and systems in animals.

TOPIC 2

HUMAN NEURAL SYSTEM

Human neural system is divisible into two main parts:

Central Neural System (CNS)

It is a hollow, dorsally placed structure lying along the mid-dorsal axis of the body. It comprises the brain and spinal cord. The brain is lodged in the skull while spinal cord is enclosed by vertebral column.It is the main site of information processing and control.

Peripheral Neural System (PNS)

It comprises all the nerves of the body arising from the central nervous system (Brain and spinal cord) that constitute the peripheral neural system. The nerves originate from the brain and spinal cord and are known as cranial nerves and spinal nerves respectively.

Based on the function the nerves fibres of PNS are divided into two types:

(1) **Afferent fibres (Sensory):** These fibres transmit sensory impulses from tissue/organs to the CNS and form the afferent pathway.

(2) **Efferent fibres (Motor):** These fibres transmit regulatory impulses from the CNS to the concerned tissues/organs and form the efferent pathway.

The PNS is divided into two subdivisions:

Somatic neural system

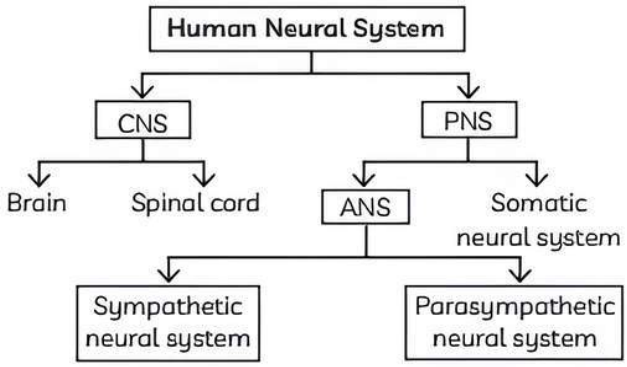
It is also known as voluntary nervous system. It carries impulses from the CNS to skeletal muscles. Thus it controls the movement of the body by acting on skeletal muscles.

Autonomic neural system

This system sends impulses from the CNS to the involuntary organs. The organs that are under involuntary control are controlled and coordinated by this system. It is split into two parts: Sympathetic neural system and Parasympathetic neural system.

Visceral nervous system

It is the part of peripheral nerves (PNS). It is the entire network of nerves, fibres, ganglia, and plexus that carry impulses from the central nervous system to the viscera and *vice versa*.



Classification of human neural system

Example 1.1: **Differentiate between CNS and PNS.** **[NCERT]**

Ans.

S. No.	Central neural system (CNS)	Peripheral neural system (PNS)
(1)	It lies in the centre of body.	It lies in the periphery of the body.
(2)	CNS consists of the brain and spinal cord.	PNS comprises all the nerves of the body arising from the CNS.
(3)	CNS acts as the site of information processing and control.	PNS receive and transmit impulses from tissue/organ to CNS and from CNS to concerned tissue/organ.

Example 1.2: **Differentiate between Afferent and Efferent neurons.** **[NCERT]**

Ans.

S. No.	Afferent neuron	Efferent neuron
(1)	They conduct impulses from receptors to the CNS.	They conduct impulses from the CNS to efferents.
(2)	They are sensory in nature.	They are motor in nature.
(3)	Information is picked up by dendrite terminals.	Impulse is passed on to the effector by the axon terminal.

TOPIC 3

NEURONS

Neuron as Structural and Functional Unit of Neural System

Neuron is a structural and functional unit of the neural tissue and hence the neural system. Neurons comprise three major parts—cell body, dendrites and axon.

Cell body (Soma or Cyton)

It contains cytoplasm and a large spherical nucleus. The cytoplasm has cell organelles and Nissl's granules (granular bodies) (irregular mass of RER with attached and free ribosomes and polysomes).

Dendrites

They are the shorter and highly branched process projecting out of the cell body. They also contain Nissl's granules neurofibrils and neurotubules. They conduct-nerve impulses towards the cell body and are called afferent processes.

Axon

Axon is a single long fibre. The distal end of the axon is branched. Each branch terminates as a bulb-like structure called a synaptic knob. The synaptic knob contains synaptic vesicles which are secretory and filled with a chemical called neurotransmitters. The axon conducts nerve impulses away from the cell body to a synapse or a neuro-muscular junction. Axons are of two types—myelinated and non-myelinated. The Schwann cells form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier. Myelinated nerve fibres are found in spinal and cranial nerves. In non-myelinated nerve fibres, Schwann cells do not form myelin sheath. It is found in autonomous and the somatic neural systems.

Types of Neurons on the basis of Structure

Multipolar

In multipolar type of neurons, many dendrites and a single axon are present. They are found in the cerebral cortex.

Bipolar

Body consists of one axon and one dendrite. They are present in the retina of the eye.

Unipolar

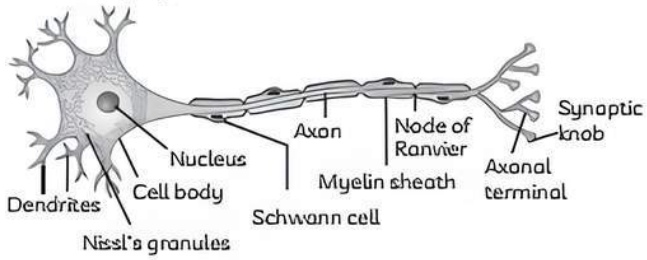
Only one axon is present. They are present in the embryonic stage.

Pseudo-unipolar

Single process arises from the cyton and then divides into axon and dendrite. It is found in dorsal root ganglia of spinal nerve.

Non-polar

These are found in cnidarians (*Hydra*). They have branched projections but no dendrites and axons.



Structure of a neuron

Example 1.3: Differentiate between Myelinated axon and Non-myelinated axon. [NCERT]

Ans.

S. No.	Myelinated Axon	Non–myelinated Axon
(1)	Myelin sheath is present.	Myelin sheath is absent.
(2)	Nodes of Ranvier are present.	Nodes of Ranvier are absent.
(3)	They carry impulses faster than non - medullated nerve fibres.	They carry impulses slower than medullated nerve fibres.
(4)	It is found in spinal and cranial nerves.	It is found in autonomous and the somatic neural systems.

Generation and Conduction of Nerve Impulse

The process of generation and conduction of nerve impulses is divisible into two phases: Resting membrane potential of nerve and action membrane potential of nerve.

Resting potential (polarisation)

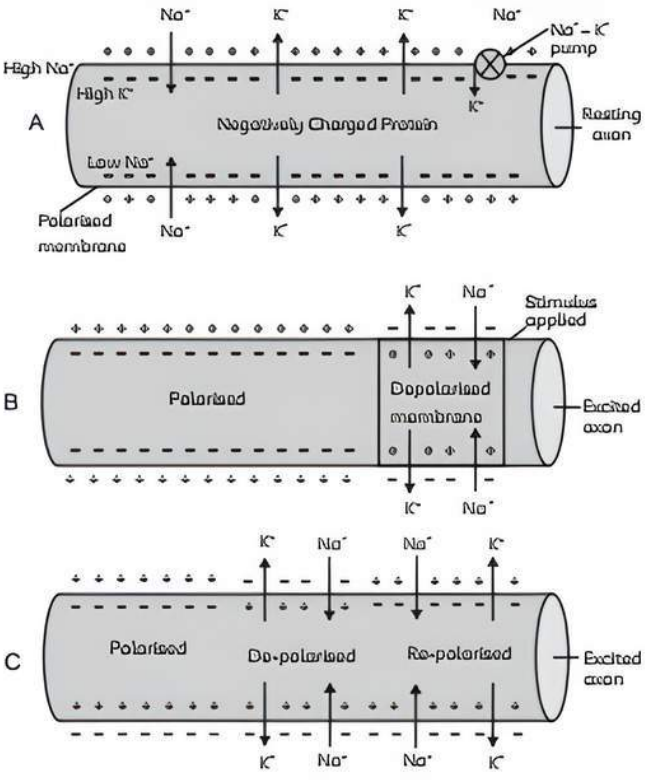
A nerve fibre or neuron is said to be resting if it is not conducting any impulses. Axoplasm has a high concentration of K^+ and negatively charged proteins and a low concentration of Na^+. At the same time, fluid present outside axon contains low concentration of K^+ and a high concentration of Na^+. Due to this a concentration gradient is formed. These ionic gradients are maintained across the resting membrane by the sodium-potassium pump, which pumps $3Na^+$ outwards for $2K^+$ into the cell. As a result, the outside surface of the axonal membrane becomes positively charged, while the inner surface becomes negatively charged and membrane is thus in a polarised state. The resting potential is the electrical potential difference across the resting plasma membrane.

Depolarisation

When a threshold stimulus is provided to a polarised membrane at point A, the membrane at that point becomes freely permeable to Na^+. As a result, there is a quick influx of Na^+. The polarity of the membrane at site A is altered. Outer surface of the membrane becomes negatively charged, while the interior surface becomes positively charged.

Depolarisation occurs when the polarity of the membrane is reversed at site A. This electrical potential difference across the plasma membrane at site A is called an action potential. This is a nerve impulse. The outside membrane is positively charged at site B, while the inner surface is negatively charged. On the inside surface, current flows from site A to B, while on the outside surface, current flows from site B to A. As a result, polarity is reversed at this site, and an action potential is formed at site B.

Thus, the impulse that originated at site A has now reached site B. As a result, the sequence is repeated along the entire length of the axon, and an impulse is generated. The stimulus-induced increase in permeability is only temporary. Permeability to increase in a fraction of a second diffuses outside the membrane, and repolarisation restores the membrane's resting potential at the point of excitation.



Impulse conduction through an axon

Example 1.4: Compare resting potential and action potential. [NCERT]

Ans.

	Resting potential	Action potential
(1)	The electrical potential difference across the resting plasma membrane is called resting potential.	The electrical potential difference across the stimulated membrane is called an action potential.
(2)	An active sodium-potassium pump operates.	No sodium pump is operating.
(3)	At resting potential, a nerve fibre is not conducting an impulse. Both the Na^+ and K^+ channels are closed but the membrane is moderately permeable to Na^+ and more to K^+.	The neuron membrane is more permeable to sodium due to the opening of Na^+ channels.

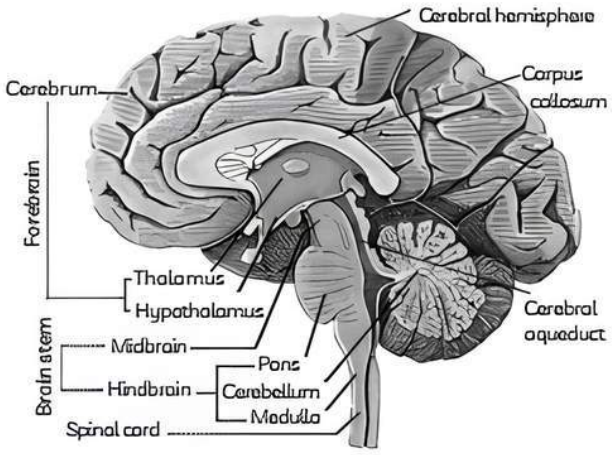
Example 1.5: Explain the conduction of a nerve impulse along a nerve fibre. [NCERT]

Ans. When the stimulus is applied at a certain point (A) on the polarised membrane, the membrane becomes freely permeable to Na^+. So, this leads to a rapid influx of Na^+. This changes the polarity of the membrane. The outer surface of the membrane becomes negatively charged whereas the inner membrane is positively charged. The membrane is reversed and hence, it is called depolarised. The electrical potential difference across the plasma membrane is called the action potential, which is in fact termed as a nerve impulse. At the next point ahead to the previous one (say B) the outer membrane is positively charged and the inner surface of the membrane is negatively charged. This creates the flow of current on the inner surface from site A to B and from site B to A on the outer surface. Thus, the polarity at this site is reversed and an action potential is generated at site B. The impulse which is generated at site A now arrives at site B. Thus, the sequence is repeated along the whole length of axon and consequently, the impulse is conducted.

TOPIC 4

CENTRAL NEURAL SYSTEM

The CNS is made up of the brain and spinal cord. Our brain serves as the primary command and control system. It takes in all of the data and processes it. It regulates voluntary movements, body balance, the functioning of critical involuntary organs (such as the lungs, heart, and kidneys), thermoregulation, hunger and thirst, our body's circadian (24-hour) rhythms, the activity of various endocrine glands, and human behaviour. It is also where vision, hearing, speech, memory, intelligence, emotions, and thoughts are processed.



Sagittal section of the human brain

The human brain is well protected by the skull. Inside the skull, it is covered by three membranes or meninges (cranial meninges).

(1) Dura mater (outermost layer).

(2) Arachnoid (thin middle layer).

(3) Pia mater (innermost layer and in contact with the brain tissue).

The brain is divisible into three parts.

Forebrain

Forebrain includes cerebrum, thalamus and hypothalamus. The cerebrum is the largest and most complicated portion of the brain. It is made up of a tract of nerve fibres called the corpus callosum that connects the left and right hemispheres.

The cerebral cortex is the outermost layer of the cerebrum. It is responsible for the grey matter of the cerebrum. Neuron cell bodies give the area a grey appearance. Medullated nerve fibres occupy the inner region of the cerebrum. The white matter is so named because it has an opaque white look. Sensory motor and association areas make up the different functional areas of the cerebral cortex. Complex processes like inter sensory connections, memory, and communication are handled by these association areas.

The thalamus is a structure that wraps around the cerebrum. It is the main hub for sensory and motor signal coordination. It is also called relay centre of the brain.

Hypothalamus lies at the base of the thalamus. It is the major centre for regulation of body temperature, thirst, hunger, *etc.* It secretes several hormones. Because it contains neurosecretory cells which secrete hormones called hypothalamia hormones.

Important

➥ *Limbic system: The limbic system is made up of parts of the cerebrum and diencephalon. Its key components are the Hippocampus, Amygdala, and others. It is involved in the control of sexual behaviour, the expression of emotional reactions (e.g., excitement, pleasure, fury, and fear), and motivation, along with the hypothalamus.*

Midbrain

The midbrain is the forwardmost portion of the brain stem that connects the pons and cerebellum with the forebrain. Midbrain lies between the thalamus and hypothalamus of forebrain and pons of hindbrain. It aids information transmission from the hindbrain to the forebrain. The dorsal surface of midbrain consists of superior and inferior corpora bigemina and four round lobes called corpora quadrigemina. A canal known as a cerebral aqueduct passes through the midbrain. The medulla of the brain is connected to the spinal cord.

Hindbrain

There are three main parts of the hindbrain—Pons, cerebellum and medulla oblongata.

(1) Pons consists of fibre tracts that lie between the midbrain and medulla oblongata.

(2) Cerebellum is the second largest part of the human brain. It consists of two cerebellar hemispheres. They show a tree-like branching arrangement of grey and white matter called arbor vitae. Its surface is convoluted to add more neurons.

(3) Medulla oblongata extends from pons Varolii above and is continuous with the spinal cord. It contains centres that regulate respiration, breathing, swallowing, cardiovascular reflexes and gastric secretions.

Important

➥ *Brainstem = Midbrain + Pons Varolii + Medulla Oblongata.*

Example 1.7: **Differentiate between the thalamus and hypothalamus.** **[NCERT]**

Ans.

S. No	Thalamus	Hypothalamus
(1)	It is present below the cerebrum.	It is present in the lower part of thalamus.
(2)	It is a major coordinating centre for sensory and motor signalling.	It is a major centre for regulation of body temperature, thirst, hunger, *etc.*
(3)	It does not secrete any hormone.	It secretes several hormones.

Example 1.8: **Case Based:**

Rekha is a doctor. She is a brain specialist. She went to a school for a lecture about the most important and delicate part of our body. It is about the brain. She is curious to teach students what exactly the brain is and how it works. She teaches them with 3D pictures so that they can understand them easily. Brain is the most important part of our body and it is the main information-processing area. It controls and commands the whole body. Brain is covered by 3 layers: Outermost dura mater, middle arachnoid, and innermost pia mater. Brain is divisible into three parts, forebrain, midbrain and hindbrain.

(A) What is the function of brain?

(a) It controls the body in only an emergency situation.

(b) It does not control the body in emergency situations.

(c) It controls and commands the whole body.

(d) It does not control and command the whole body.

(B) The brain stem does not include:

(a) Pons Varolii

(b) Cerebrum

(c) Medulla oblongata

(d) Midbrain

(C) Where is the brain present in the body?

(D) What is the order of membranes of the brain from inner to outer?

(E) Assertion (A): Brain is the main information -processing part of the body.

Reason (R): Dura mater is the outermost layer, pia mater middle and arachnoid is the innermost.

(a) **Both A and R are true and R is the correct explanation of A.**

(b) **Both A and R are true and R is not the correct explanation of A.**

(c) **A is true but R is false.**

(d) **A is false but R is true.**

Ans. (A) *(c) It controls and commands the whole body.*

Explanation: Brain controls and commands the whole body. Other options are not correct as the brain controls the body in all situations.

(B) *(b) Cerebrum*

Explanation: Brainstem comprises of midbrain, pons Varolii and medulla oblongata.

(C) Human brain is present in the cranium (cranial cavity) of the skull. Brain is well protected by the skull. Inside the skull, it is covered by three membranes or meninges.

(D) Inner to outer the order of membranes is:

Piamater (inner), arachnoid (middle) and dura mater (outer).

(E) *(c) A is true but R is false.*

Explanation: The brain is the main information-processing part of the body. Our brain serves as the primary command and control system. It takes in all of the data and processes it. The arrangement of cranial membranes from inner to outer is Piamater (inner), arachnoid (middle) and dura mater (outer).

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Depolarisation of axolemma during nerve conduction takes place because:

(a) **Only K^+ moves inside.**

(b) **Equal amount of Na^+ and K^+ moves out across axolemma.**

(c) **More Na^+ move outside than K^+ moving outside**

(d) **Only Na^+ moves inside.**

Ans. *(d) Only Na^+ moves inside.*

Explanation: During depolarisation, Na^+ channel opens and Na^+ rush into the axon. Other options are incorrect. This membrane depolarisation causes the opening of voltage-gated Na^+ channels, allowing K^+ to exit.

2. The correct sequence of meninges from the inner to outer side is:

(a) **Dura mater, arachnoid membrane, pia mater**

(b) **Dura mater, pia mater, arachnoid membrane**

(c) **Pia mater, arachnoid, dura mater**

(d) **Arachnoid, dura mater, pia mater**

Ans. *(c) Pia mater, arachnoid, dura mater.*

Explanation: Pia mater (innermost layer and in contact with the brain tissue).

Arachnoid (thin middle layer).

Dura mater (outermost membrane).

In other options, the sequence of membranes is not correct.

3. The function of our visceral organs is controlled by:

(a) **Sympathetic and somatic neural system**

(b) **Sympathetic and parasympathetic neural system**

(c) **Central and somatic neural system**

(d) **None of the above** **[NCERT Exemplar]**

Ans. *(b) Sympathetic and parasympathetic neural system.*

Explanation: The function of our visceral organs is controlled by sympathetic and parasympathetic neural systems as these are the parts of an autonomous neural system. ANS controls and coordinates such organs which are under involuntary control. Other options are incorrect as the somatic neural system includes nerves supplying the skeletal muscle. Central neural system includes the brain and spinal cord and it is the site of information processing and control.

4. Neurons in sponges are:

(a) **Unipolar** (b) **Bipolar**

(c) **Multipolar** (d) **Absent**

Ans. *(d) Absent*

Explanation: Sponges do not have neurons. The neural organisation is very simple in lower invertebrates.

Caution

In multipolar neurons, many dendrites and a single axon are present. They are found in the cerebral cortex. Whereas bipolar neuron consists of one axon and one dendrite. They are present in the retina of the eye. And in unipolar neurons, only one axon is present. They are present in the embryonic stage.

5. **Potential difference across resting membrane is negatively charged. This is due to the differential distribution of the following ions.**

(a) Na^+ and K^+ ions (b) Co^{3+} and Cl^- ions

(c) Ca^+ and Mg^{2+} ions (d) Ca^{4+} and Cl^- ions

[NCERT Exemplar]

Ans. *(a) Na^+ and K^+ ions*

Explanation: Potential difference across resting potential is negatively charged due to the Na^+ and K^+ ions. To maintain resting potential, sodium-potassium pumps operate. Other given options are incorrect as these ions are not involved in maintaining the potential difference across membranes.

6. **An area in the brain which is associated with strong emotions is:**

(a) Cerebral cortex (b) Cerebellum

(c) Limbic system (d) Medulla [Diksha]

Ans. *(c) Limbic system*

Explanation: It is the limbic system which is involved in the control of sexual behaviour, the expression of emotional reactions (*e.g.*, excitement, pleasure, fury, and fear), and motivation, along with the hypothalamus. Other options are not correct.

Related Theory

The limbic system activates the fight or flight response in the body in reaction to strong emotions like fear and anger because of emerging research demonstrating the role of freezing in reaction to danger. this response is now known as the fight, flight, or freeze response.

7. **Two neurons, A and B, synapse onto a third neuron, C. If neurotransmitter from A opens ligand-gated channels permeable to Na^+ and K^+ and neurotransmitter from B opens ligands-gated Cl^- channels, which of the following statement is true?**

(a) An action potential in neuron A causes depolarisation in neuron B.

(b) An action potential in neuron B causes depolarisation in neuron C.

(c) Simultaneous action potentials in A and B will cause hyperpolarisation of neuron C.

(d) Simultaneous action potentials in A and B will cause less polarisation of neuron C than if only neuron A fired an action potential.

Ans. *(d) Simultaneous action potentials in A and B will cause less polarisation of neuron C than if only neuron A fired an action potential.*

Explanation: Neurotransmitters diffuse across the cleft once they are released from the pre-synaptic axon terminal. This causes neurotransmitters to bind to receptors and specific ion channels in the post-synaptic plasma membrane to open or close. Channels in the post-synaptic cell that are permeable to Na^+, K^+, and other tiny positive ions usually open at an excitatory synapse, but Na^+ flux dominates since it has the largest electrochemical gradient. Channels to Cl^- or K^+ at inhibitory synapses. In the above case, neuron B delivers inhibitory pre-synaptic signals to post-synaptic neuron C, which sums to the amplitude of neuron A's excitatory pre-synaptic signal. As a result, the amplitude of depolarisation will be reduced.

8. **Statement A: Cerebellum is large, lobed and convoluted in active animals.**

Statement B: Cerebellum coordinates involuntary movements.

(a) Both A and B are correct.

(b) Both A and B are incorrect.

(c) Only A is correct.

(d) Only B is correct.

Ans. *(c) Only A is correct.*

Explanation: All vertebrates have a cerebellum, which is a prominent component of the hindbrain. The cerebellum is a key component of human motor control. Although its movement-related functions are the most well-established, it may also be involved in some cognitive processes like attention and language as well as emotional control processes like regulating fear and pleasure responses. The human cerebellum does not start a movement, but it does help with coordination, precision, and correct timing by receiving information from other areas of the brain and from sensory systems in the spinal cord and integrating it to control motor activity. In humans, cerebellar injury results in abnormalities in posture, fine motor coordination, equilibrium, and motor learning.

9. **Statement A: Medulla oblongata doesn't cause reflex actions like vomiting, coughing and sneezing.**

Statement B: It has many nerve cells which control autonomic reflexes.

(a) Both A and B are correct.

(b) Both A and B are incorrect.

(c) Only A is correct.

(d) Only B is correct.

Ans. *(d) Only B is correct.*

Explanation: The cone-shaped neuronal mass of cells known as the medulla oblongata is located in the hindbrain. It regulates the body's involuntary motions. It transmits messages from the spinal cord to the brain's thalamus. The medulla oblongata regulates automatic processes like breathing, heart rate, digesting, vomiting, and sneezing. These motions are a result of the autonomic nervous system's nerve cells or autonomic reflexes. The peripheral nervous system's autonomic nervous system regulates involuntary reactions.

10. Based on which of the following, the neurons are divided into three major types?

(a) Based on the size of neurons.

(b) Based on the length of neurons.

(c) Based on the number of axons and dendrites.

(d) Based on the power of their division.

Ans. *(c) Based on the number of axons and dendrites.*

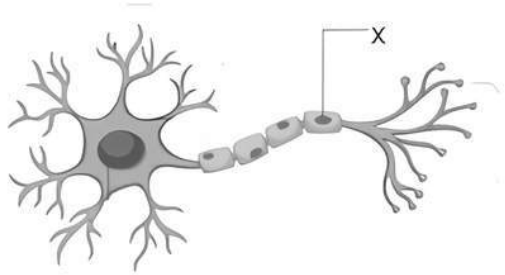
Explanation: Based on the number of axons and dendrites, the neurons are divided into three major types:

(1) Multipolar neurons with one axon and two or more dendrites.

(2) Bipolar with one axon and one dendrite.

(3) Unipolar-cell body with one axon only.

11. Identify the structure shown in the diagram.



Structure of Neuron

(a) Synaptic knob

(b) Node of Ranvier

(c) Nissl's granule

(d) Schwann cell

Ans. *(d) Schwann cell*

Explanation: The given diagram is that of a neuron or nerve cell. The indicated structure 'X' is identified to be a Schwann cell. Schwann cells form the myelin sheath which envelops the axon and helps in the transmission of impulses.

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

12. Assertion (A): Multipolar neurons have two or more axons and one dendrite.

Reason (R): Multipolar neurons are found usually in the cerebral cortex.

Ans. *(d) A is false but R is true.*

Explanation: Multipolar neurons have many dendrites and a single axon. They are found in the cerebral cortex.

13. Assertion (A): The PNS comprises all the nerves of the body associated with CNS.

Reason (R): PNS is the site of information processing and control.

Ans. *(c) A is true but R is false.*

Explanation: Nerves arising from the central nervous system (brain and spinal cord) constitute the peripheral neural system. The PNS comprises all the nerves of the body associated with CNS but the reason is not true as CNS is the site of information processing and control.

14. Assertion (A): Medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.

Reason (R): Medulla contains several neurosecretory cells which secrete hormones.

Ans. *(c) A is true but R is false.*

Explanation: Medulla oblongata extends from pons Varolii and is continuous with spinal cord. It contains centres that regulate respiration, breathing, swallowing, cardiovascular reflexes and gastric secretions. Reason is not true as it is hypothalamus which contains several neuro-secretory cells which secrete hormones.

Related Theory

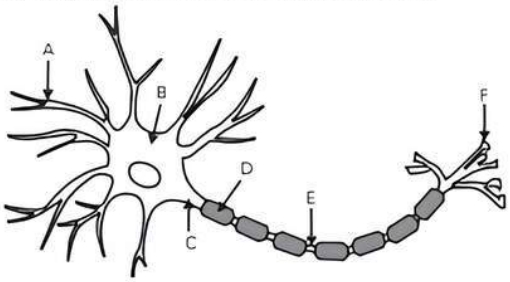
Hypothalamus contains a group of neurosecretory cells that produce hormones called hypothalamic hormones, the hypothalamus also plays a neuro-endocrine role.

CASE BASED Questions (CBQs)

[4 & 5 marks]

15. Read the following passage and answer the questions that follow:

Dendrites are the short fibre which is extended out of the cell body. Cell body contains Nissl's granules. It also contains cytoplasm and a large nucleus. The axon conducts nerve impulses away from the cell body to a synapse or a neuromuscular junction. Axons are of two types, myelinated and non-myelinated.



(A) Why axon hillock is the most sensitive part of the neuron?

(B) Why are centrioles absent in mature neurons?

(C) Identify A, B, C, D, E and F

Ans. (A) Due to the presence of sodium channels, axon hillock is known as the most sensitive part of the neuron.

(B) Centrioles are absent in mature neurons which prevents them from dividing mitotically. Because they are difficult to replace.

(C) A represents dendrites; B represents cell body; C represents axon hillock; D represents axon; E represents node of Ranvier and F represents synaptic knob.

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

16. How will you define a synapse and where it is located?

Ans. Synapse is an area of functional contact between one neuron and another for the purpose of transferring information. Synapses are usually found between the fine terminal branches of the axon of one neuron and the dendrites or cell bodies of another neuron.

Related Theory

Synaptic cleft is the fluid-filled space present between the membranes of pre and post-synaptic membrane.

17. Brain stems consist of some regions. What are they?

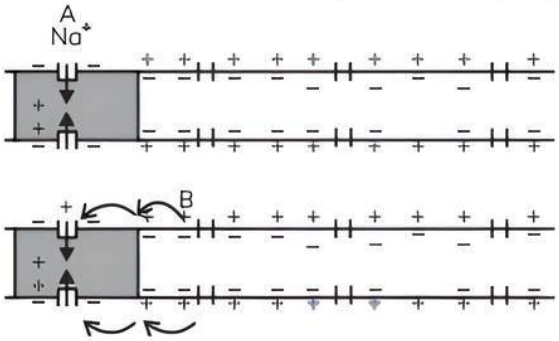
Ans. Brain stem is made up of three regions; midbrain, pons Varolii and medulla oblongata.

It forms the connection between the brain and spinal cord.

18. During resting potential, the axonal membrane is polarised, indicate the movement of +ve and –ve ions leading to polarisation diagrammatically.

[NCERT Exemplar]

Ans.



Because their membranes are polarised, neurons are excitable cells. Ion channels of various sorts can be found on neural membranes.

Caution

Students should know that the axonal membrane's outer side has a positive charge, whereas the inner surface has a negative charge and is thus polarised.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

19. Hypothalamus performs multiple functions in human body. Mention few of them.

Ans. A multitude of centres in the hypothalamus control thirst, appetite, body temperature

and other functions. It also keeps the body in a state of balance. Because it contains groupings of neurosecretory cells that produce hormones called hypothalamic hormones, the hypothalamus also plays a neuroendocrine role.

Related Theory

The hypothalamus transits hormones to the pituitary gland, a component of your brain that releases hormones to control all glands in our bodies. This is why pituitary gland is called master gland.

20. What do grey and white matter in the brain represent? [NCERT Exemplar]

Ans. The outer surface of the cerebrum is called the cerebral cortex. It makes the grey matter of the cerebrum. This greyish appearance is due to neuron cell bodies/ cyton/ soma. Inner part of the cerebrum is filled with medullated nerve fibres. They give an opaque white appearance and hence are called the white matter.

21. Trisha's teacher taught her about a system known as limbic system. What is it?

Ans. The limbic system is made up of parts of the cerebrum and diencephalon. Its key components are the Hippocampus, Amygdala, and others. Along with hypothalamus, it is involved in the control of sexual behaviour, the expression of emotional reactions (*e.g.* excitement, pleasure, rage and fear), and motivation.

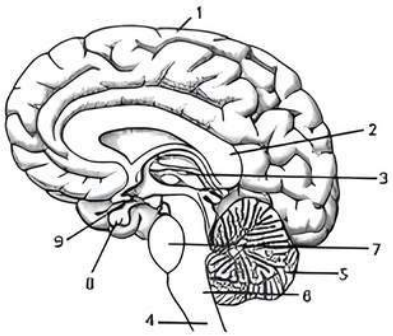
SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

22. Explain the role of sodium potassium in generation and conduction of nerve impulses.

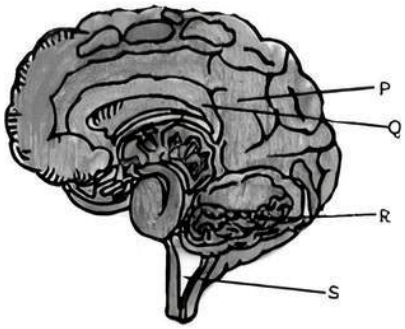
Ans. When a neuron is in a resting state it is not conducting any impulse. In the resting stage, the outer surface of the membrane is positively charged and inner surface of the membrane is negatively charged. Outer membrane of axon contains a low concentration of $K^{\oplus}$ and a high concentration of $Na^{\oplus}$ thus form a concentration gradient. The sodium–potassium pump actively transports ions across the resting membrane to sustain these ionic gradients.

23. Identify the parts of the given diagram.



Ans. This diagram represents the human brain.
1 – Cerebrum; 2 – Corpus Callosum; 3 – Thalamus; 4 – Spinal cord; 5 – Cerebellum; 6 – Medulla oblongata; 7 – Pons Varolii; 8 – Pituitary gland; 9 - Hypothalamus.

24. Observe the diagram given below and answer the following questions:



(A) Identify the Labelled the parts P, Q, R and S.
(B) Give the function of R and S.
(C) Name the layers which wrap this organ.
[Delhi Gov. QB 2022]

Ans. (A) P : Cerebrum, R : Cerebellum
Q : Corpus callosum, S : Medulla oblongata
(B) R : Balancing of body and maintaining posture
S : Vomiting, coughing, breathing, salivation or any other correct answer. (*Anyone*)
(iii) Pia mater, arachnoid and dura mater.

LONG ANSWER Type Questions (LA)

[4 & 5 marks]

25. Explain the following processes.
(A) Polarisation of the membrane of a nerve fibre.
(B) De-polarisation of the membrane of a nerve fibre.

Ans. (A) The term "resting nerve fibre" refers to a nerve fibre or neuron that is not transmitting any impulses. Axoplasm has a high concentration of K^+, negatively charged proteins and a low concentration of Na^+ and positively charged proteins. A concentration gradient exists because the outer membrane of the axon contains a low concentration of K^+ and a high concentration of Na^+. These ionic gradients are maintained across the resting membrane by the sodium-potassium pump, which pumps 3 Na^+ outward for 2 K^+ into the cell. As a result, the outside surface of the axonal membrane becomes positively charged, while the inner surface becomes negatively charged and membrane is called polarised. The resting potential is the electrical potential differential across the resting plasma membrane. The state of the resting membrane is called polarised state.

(B) When the stimulus is applied at a certain point on the polarised membrane, the membrane at that point becomes freely permeable to Na^+. So, this leads to a rapid influx of Na^+. This changes the polarity of the membrane at that point. The outer surface of the membrane becomes negatively charged whereas the inner surface of the membrane is positively charged. As the polarity of the membrane is reversed at that point, it is called depolarised.

26. (A) How could it affect a person's CNS if he is attacked by a blow on the back of the neck?

(B) Arrange the following in the accurate order of their association in electrical impulse movement – Synaptic knob, Axon terminal, Axon, dendrites, Cell body.

(C) Write the similarities between computers and neural system. (Hint: CPU, input-output devices).

Ans. (A) It would lead to an impairment of cognitive abilities or dysfunctionalities physically. Furthermore, it can also cause disturbance of emotional or behavioural functioning. Cervical damage can lead to tetraplegia.

(B) Dendrites, Cell body, Axon, Axon terminal, Synaptic knob.

(C) Various organs possess sensory neurons which sense the surroundings and send across the communication to the brain which is similar to the input device in computers. The human brain can be compared to the Central Processing Unit (CPU). The data that is gathered by the sensory neurons is processed by the brain which further commands the specific organ to work in accordance. Finally, the message is picked by the motor neurons that are similar to output devices.