Neural Control and Coordination

OBJECTIVE TYPE QUESTIONS

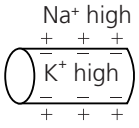
Multiple Choice Questions (MCQs)

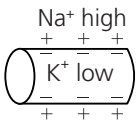
1. By which nervous system, the blood is supplied into visceral organs?
(a) Sympathetic nervous system, voluntary
(b) Sympathetic nervous system, involuntary
(c) Parasympathetic nervous system, involuntary
(d) Both (b) and (c)

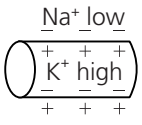
2. Intercellular communication in multicellular organism occurs through
(a) digestive system only
(b) respiratory system only
(c) nervous system only
(d) both nervous and endocrine system.

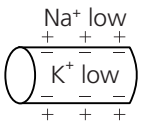
3. Which of the following statement is correct about node of Ranvier of neuron?
(a) Neurilemma is discontinuous.
(b) Myelin sheath is discontinuous.
(c) Both neurilemma and myelin sheath are discontinuous.
(d) Covered by myelin sheath.

4. Which of the following options illustrates the distribution of Na^+ and K^+ ions in a section of non-myelinated axon which is at resting potential?

(a) 

(b) 

(c) 

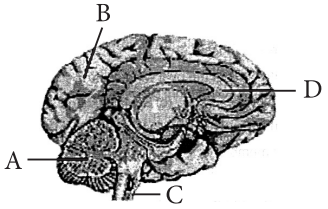
(d) 

5. Motor end plate junction is present between
(a) neuron and muscle (b) neuron and neuron
(c) muscle and muscle (d) none of these.

6. Pre-synaptic membrane is part of
(a) dendron (b) axon hillock
(c) telodendria (d) soma.

7. Four healthy people in their twenties got involved in injuries resulting in damage and death of few cells of the following. Which of the cells are least likely to be replaced by new cells?
(a) Osteocytes
(b) Malpighian layer of the skin
(c) Liver cells
(d) Neurons

8. Which labelled part in the given diagram controls the process of breathing?

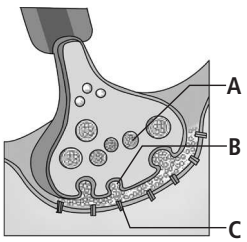


(a) A (b) B
(c) C (d) D

9. Which part of neuron is highly branched and afferent?
(a) Axon (b) Dendrite
(c) Cyton (d) Both (a) and (b)

10. Select the incorrect statement.
(a) The Nissl's granules probably synthesise fats for the cell
(b) Ageing neuron contain a pigment lipofuscin
(c) Nissl's granules are irregular masses of rough endoplasmic reticulum
(d) None of these

11. The given diagram shows axon terminal. Select the option that correctly matches the steps in transmission of impulses (list i – vii) with the labellings (A – C) in diagram.



(i) Chemicals called neurotransmitters are released in the synaptic cleft through ion channels.

(ii) When an impulse arrives at the axon terminal, it stimulates the movement of synaptic vesicles.
(iii) Neurotransmitters are endocytosed into the neurons.
(iv) The ion channels close with the binding of neurotransmitters to their specific receptors vesicles.
(v) Synaptic vesicles move towards the membrane where they fuse with the plasma membrane.
(vi) Neurotransmitters are released in the synaptic cleft.
(vii) The released transmitters bind to their specific receptors on post-synaptic membrane.

	A	B	C
(a)	(ii)	(iii)	(i)
(b)	(v)	(vi)	(iv)
(c)	(ii)	(vi)	(vii)
(d)	(v)	(iii)	(iv)

12. Nerve fibre gets depolarised when it acquires
(a) +ve charges on inner side
(b) +ve charges on outer side
(c) –ve charges on inner side
(d) Na^+ and K^+ from outside.

13. Read the given statements and select the correct option.
I. The continuity between the pre-synaptic and post-synaptic neurons is provided by gap junctions in chemical synapses.
II. Release of calcium ions from pre-synaptic knob stimulates the release of neurotransmitter into synaptic cleft.
III. More energy is required for impulse conduction through myelinated neurons due to saltatory conduction.
IV. After transmission of impulse, neurotransmitter is hydrolysed by an enzyme present at synapse.
(a) I and II are correct but III and IV are incorrect.
(b) I and IV are correct but II and III are incorrect.
(c) I, II and III are correct but IV is incorrect.
(d) I, II and III are incorrect, but IV is correct.

14. Which one of the following is an inhibitory neurotransmitter?
(a) GABA (b) Nor adrenaline
(c) Epinephrine (d) Acetylcholine

15. Transmission of nerve impulse, across a synapse, is accomplished by
(a) release of phosphorus ion only
(b) movement of Na^+ and K^+
(c) release of neurotransmitters
(d) movement of water level.

16. Read the following five statements (i) to (v) regarding left cerebral hemisphere and select the option that correctly states the true (T) and false (F) statements.
(i) It receives most modalities of sensory information from the right side of the body.
(ii) It is usually larger than the right cerebral hemisphere.
(iii) It is the dominant cerebral hemisphere in most individuals.
(iv) It is connected to the right cerebral hemisphere by the corpus callosum.
(v) It contains the main areas for the understanding and production of speech in most individuals.

	(i)	(ii)	(iii)	(iv)	(v)
(a)	T	T	F	F	F
(b)	F	T	T	F	T
(c)	T	F	T	T	T
(d)	F	F	T	T	T

17. Opening that connects the IV ventricle of the brain to the outside is
(a) foramen of Monro
(b) foramen of Magendie
(c) foramen ovale
(d) foramen magnum.

18. Column I lists the parts of the human brain and column II lists the functions. Match the two columns and select the correct option.

	Column I	Column II
A.	Cerebrum	p. Controls the pituitary
B.	Cerebellum	q. Controls vision and hearing
C.	Hypothalamus	r. Controls the rate of heart beat
D.	Midbrain	s. Seat of intelligence
		t. Maintains body posture

(a) A-t; B-s; C-q; D-p (b) A-s; B-t; C-q; D-p
(c) A-t; B-s; C-p; D-q (d) A-s; B-t; C-p; D-q

19. Cell bodies of neurons bringing afferent information into the spinal cord are located in
(a) gray matter of spinal cord
(b) white matter of spinal cord
(c) dorsal root ganglia
(d) ventral root ganglia.

20. Which of the following pair is incorrect?

	Cerebral lobe	**Function**
(a)	Parietal lobe	– Integrating sensory input
(b)	Occipital lobe	– Interpretation of shape and colour
(c)	Frontal lobe	– Judgement and decision making
(d)	Temporal lobe	– Controls intellectual ability

21. Choroid plexus is a network of

(a) capillaries (b) medulla oblongata
(c) cerebellum (d) spinal cord.

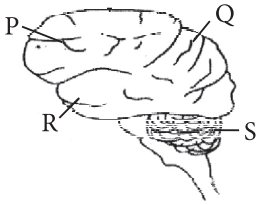
22. Brain depends on blood for the supply of

(a) oxygen and ATP
(b) oxygen and electrolytes
(c) oxygen and glucose
(d) ATP and glucose.

23. Thermoregulatory centre in brain of man is

(a) pituitary (b) diencephalon
(c) hypothalamus (d) none of these.

24. Select the incorrect option regarding the given figure.



(a) Q is parietal lobe which registers sensory perceptions.
(b) P is occipital lobe which decodes and interprets visual information.
(c) R is temporal lobe which is associated with memory and emotion.
(d) S is cerebellum which controls muscular activities.

25. Cerebrospinal fluid is present

(a) beneath the pia mater
(b) between pia mater and arachnoid mater
(c) between arachnoid and dura mater
(d) between the dura mater and cranium.

26. The respiratory and cardiac centres are located in

(a) cerebrum (b) diencephalon
(c) crura cerebri (d) medulla oblongata.

27. Not a part of limbic lobe or limbic system of brain is

(a) amygdala (b) hippocampus
(c) cerebellum
(d) inner parts of cerebrum.

28. Which of the following statements is/are correct?

I. Grey matter contains medullated nerve fibres.
II. Grey matter lacks myelin.
III. Grey matter contains cell bodies.

(a) Only I (b) Only II
(c) I, II, and III (d) Only II and III

29. Movement of shoulder muscle and bone is controlled by which nerve?

(a) Spinal accessory (b) Vagus
(c) Glossopharyngeal (d) Hypoglossal

30. Read the given statements and select the option stating which ones are true (T) and which ones are false (F).

I. Ageing neurons contain a pigment made up of a residual bodies derived from lysosomes.
II. Axon and cyton contains numerous mitochondria, Golgi apparatus, lysosomes, etc.
III. Cyton depends on axon for supply of proteins synthesised by Nissl's granules.

	I	**II**	**III**
(a)	T	T	F
(b)	T	F	F
(c)	F	T	T
(d)	F	F	T

31. Injury to vagus nerve in humans is not likely to affect

(a) tongue movements
(b) gastrointestinal movements
(c) pancreatic secretion
(d) cardiac movements.

32. Each spinal nerve in a mammal arises from the spinal cord by two roots, a dorsal and a ventral. Of these the ventral root is composed of

(a) somatic motor and visceral motor fibres
(b) somatic motor and visceral sensory fibres
(c) somatic sensory and visceral motor fibres
(d) somatic sensory and visceral sensory fibres.

33. One function of parasympathetic nervous system is

(a) contraction of hair muscles
(b) stimulation of sweat glands
(c) acceleration of heart beat
(d) constriction of pupil.

34. Which one of the following is the example of the action of the autonomous nervous system?

(a) Swallowing of food (b) Pupillary reflex
(c) Peristalsis of the intestine
(d) Knee-jerk response

35. The sympathetic nervous system (SNS) work through secretion of
(a) noradrenaline which stimulates the organ
(b) acetylcholine which stimulates the organ
(c) adrenaline which inhibits the organ
(d) acetylcholine which inhibits the organ.

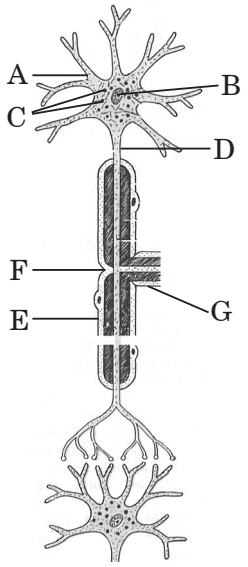
36. Tree of life is
(a) arbor vitae (b) pons varolii
(c) organ of Corti (d) diencephalon.

37. Five events in the transmission of nerve impulse across the synapse are given.
A. Opening of specific ion channels allows the entry of ions, a new action potential is generated in the post-synaptic neuron.
B. Neurotransmitter binds to the receptor on post synaptic membrane.
C. Synaptic vesicle fuses with pre-synaptic membrane, neurotransmitter releases into synaptic cleft.
D. Depolarisation of pre-synaptic membrane.
E. Arrival of action potential at axon terminal.
What is the sequence of events in transmission of nerve impulse?
(a) E → D → C → B → A
(b) A → B → C → D → E
(c) A → B → D → C → E
(d) E → D → C → A → B

38. How many layers of cell are present in cerebellum?
(a) 1 (b) 3
(c) 5 (d) 7

Case Based MCQs

Case I : Refer to the diagrammatic structure of a neuron and answer the questions from 39 to 43 given below.



39. Which of the following is not a part of cell body of neuron?
(a) B (b) C
(c) G (d) A

40. Find the incorrect pair.
(a) Non polar neurons - *Hydra*
(b) Pseudounipolar neurons - Dorsal root ganglia of spiral nerves
(c) Bipolar neurons - Retina of eye
(d) Multipolar neurons - Embryonic stage

41. Most sensitive part of neuron is
(a) D (b) F
(c) E (d) G

42. Which of the following is absent in mature neurons?
(a) Centrioles
(b) Rough endoplasmic reticulum
(c) Lysosomes (d) Golgi apparatus

43. Normal E is replaced by a hard tissue in
(a) meningitis (b) Parkinson disease
(c) Alzhimer's disease (d) multiple sclreosis.

Case II : Read the following passage and the given table and answer the questions from 44 to 48 given below.

Human brain protected by the skull is the central information processing organ of our body and acts as the command and control system.

Brain is divided into three major parts : (i) Forebrain, (ii) Midbrain and (iii) Hindbrain.

Parts of brain	Functions
A	Memory and communication
B	Controls respiration and gastric secretion
C	Regulation of sexual behaviour
D	Controls rapid muscular activities

44. Which of the following functional areas of cerebrum are involved in memory and learning?

(a) A (b) B
(c) C (d) D

45. A person is able to understand written or spoken words but unable to speak fluently. Which area of brain is affected in this condition?

(a) Temporal lobe of cerebrum
(b) Frontal lobe of cerebrum
(c) Parietal lobes of cerebrum
(d) Occipital lobe of cerebrum.

46. Part of brain that contains centres for breathing, swallowing, sneezing, blood pressure is

(a) A (b) B
(c) C (d) D

47. Select the incorrect statement regarding D.

(a) It is the second largest part of human brain.
(b) It is sometimes called as emotional brain.
(c) All of the activities are involuntary.
(d) Both (b) and (d)

48. Apart from the given functions which of the following is/are controlled by C?

(A) Respiration (B) Appetite
(C) Body temperature (D) Learning
(a) A, B, C (b) B, C, D
(c) A, C, D (d) A, B, D

Assertion & Reasoning Based MCQs

For question numbers 49-58, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

49. Assertion : The chemicals stored in the synaptic vesicles are termed as neurotransmitters.

Reason : Synaptic vesicles release these chemicals in the synaptic cleft.

50. Assertion : Nerve impluse can be transmitted from dendrite of one neuron to the axon of the next neuron, across a synapse.

Reason : This happens because of the synaptic delay at each synapse.

51. Assertion : Brain and spinal cord has a common covering.

Reason : Both the brain and spinal cord possess meninges.

52. Assertion : Nerve impulse is originated from threshold stimulus.

Reason : Threshold stimulus is the minimum strength of stimulus which is applied to the nerve fibre to stimulate it effectively.

53. Assertion : Cerebrospinal fluid is present in the space between the pia and arachnoid maters.

Reason : It serves to maintain a constant pressure inside the cranium.

54. Assertion : Some areas of the brain and spinal cord look white.

Reason : This is because cell bodies of neurons are situated in those areas.

55. Assertion : All motor neurons are efferent neurons.

Reason : Motor neurons conduct nerve impulses from the spinal cord to the brain.

56. Assertion : All of the cranial nerves are said to be mixed nerves.

Reason : Mixed nerves carry both sensory and motor nerve fibres simultaneously.

57. Assertion : The PNS comprises of all the nerves of the body associated with CNS.

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

58. Assertion : Medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.

Reason : Medulla contains several neurosecretory cells which secrete hormones.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (VSA)

1. What is the function of neurons as specialised cells in animals?

2. Comment on the nervous system of insects.

3. What do you mean by resting potential of a neuron?

4. What are the structures that protect brain?

5. Which area of the brain is called as "emotional brain"?

6. How are the left and right cerebral hemispheres connected?

7. Our reactions like aggressive behaviour, use of abusive words, restlessness, etc., are regulated by brain. Name the parts involved.

8. What does nervous system of earthworm comprise of?

9. Where are the Nissl's granules located?

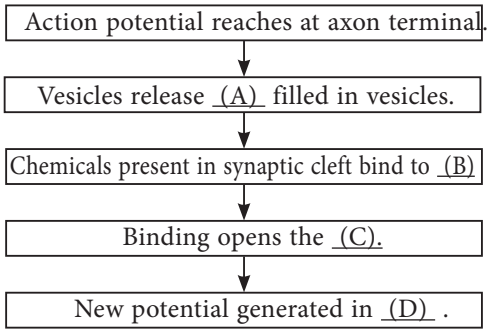
10. Which type of impulse conduction occurs along a myelinated nerve fibre?

Short Answer Type Questions (SA-I)

11. Compare the central nervous system (CNS) with peripheral nervous system (PNS).

12. What is the difference between electrical transmission and chemical transmission?

13. Fill in the blanks at (A), (B), (C) and (D).



14. Briefly describe the thirst centre located in human brain.

15. If someone receives a blow on the back of neck, what would be the effect on the person's CNS?

16. Name the following.

(a) The part of the human brain that is most developed.

(b) Part of our central nervous system that acts as a master clock.

(c) The scattered masses of grey matter.

(d) The additional space lying above the duramater.

17. Give a specific term for each of the following.

(a) Gap between adjacent myelin sheaths.

(b) Bulb-like structure present at the axon terminal.

(c) A long dendrite extends from the cell body of a neuron.

(d) Chemicals released from a pre-synaptic neuron that interact with specific receptor sites of a post-synaptic neuron.

18. Neural system and computers share certain common features. Comment in five lines. (Hint: CPU, input-output devices).

19. What do grey and white matter in the brain represent?

20. State the functions of nervous system.

Short Answer Type Questions (SA-II)

21. Compare the effect of sympathetic and parasympathetic nerves on the heart, blood vessels/pressure, liver and pupil.

22. What do you understand by neural coordination in living organisms? Explain with an example why is it necessary.

23. (a) Comment on the position and characteristic content of synaptic knob.

(b) What is motor end plate?

(c) What is the direction of impulse transmission in an axon?

24. Explain how the transmission of nerve impulse takes place at chemical synapse.

25. How are neurons classified on the basis of number of axons and dendrites?

26. Draw a well labelled diagram of myelinated neuron.

27. Axons and dendrites are the two neurites of neuron. How do they differ from each other?

28. (a) Write down the differences between thalamus and hypothalamus.
(b) It is said that damage to medulla can cause death of a person. Justify this statement.

29. Write a brief note on limbic system.

30. Briefly describe the spinal cord.

31. Briefly describe the main divisions of human nervous system?

32. What are the differences between myelinated and non-myelinated axons?

33. Distinguish between cerebrum and cerebellum.

34. Distinguish between cranial nerves and spinal nerves.

Long Answer Type Questions (LA)

35. Briefly describe the structure of human brain.

36. Explain the detailed structure of a neuron with a suitable diagram.

37. Explain the process of the transport and release of a neurotransmitter with the help of a labelled diagram showing a complete neuron, axon terminal and synapse.

38. Name the parts of human forebrain indicating their respective functions.

ANSWERS

OBJECTIVE TYPE QUESTIONS

1. (d) : The blood is supplied into visceral organs by both SNS (sympathetic nervous system) and PNS (parasympathetic nervous system) involuntarily.

2. (d) : Animals have two system of coordination, *i.e.*, nervous system and endocrine system. Neurons are the basic structural and functional units of the nervous system which spread throughout the organism forming a complex communication network. Endocrine system release hormones for intercellular communication.

3. (b) : At the level of node of Ranvier, the myelin sheath is discontinuous but not the neurilemma lining.

Actually myelin sheath is an integral part of Schwann cell, which forms a continuous neurilemmal covering. Each Schwann cell wrap around the neurite to form concentric layers of plasma membrane. But at the level of junction between two Schwann cells myelin cannot be formed and thus a gap appears.

4. (a) : When a neuron is at resting potential, *i.e.*, not conducting any impulse, the axonal membrane is comparatively more permeable to K^+ ions and nearly impermeable to Na^+ ions. Consequently, the axoplasm inside the axon contains high concentration of K^+ ions. In contrast, the fluid outside the axon has a high concentration of Na^+ ions and thus, forms a concentration gradient.

5. (a) : The skeletal muscle fibre are innervated by large, myelinated nerve fibres that originate from large motor neurons in the anterior horns of spinal cord. Each nerve ending makes a junction, called the neuromuscular junction with the muscle fibre near its midpoint. The area of the plasma membrane of a muscle cell that lies immediately beneath a motor nerve ending at a neuromuscular junction is called motor end plate junction. The action potential initiated in the muscle fibre by the nerve signal travel towards the muscle fibre ends.

6. (c) : An axon can divide into many branches called telodendria at the end of each telodendria there is an axon terminal that possess presynaptic membrane.

7. (d) : Neurons the specialised cells of nervous system. In nervous system, neuron has no power of regeneration.

8. (c) : Part 'C' is medulla oblongata that controls breathing.

9. (b)

10. (a) : The Nissl's granules probably synthesise proteins for cell.

11. (c)

12. (a) : When a stimulus of adequate strength (threshold stimulus) is applied to a polarised membrane, the permeability of the membrane to Na^+ ions is greatly increased at the point of stimulation. It is due to the fact that the Na^+ channels open and the K^+ channels remain closed. As a result, sodium channels permit the influx of Na^+ ions by diffusion. Since there are more Na^+ ions entering than leaving, the electrical potential of the membrane changes from –70 mV towards zero.

At 0 mV the membrane is said to be depolarised. Throughout depolarisation, the Na^+ ions continue to rush inside. Entry of Na^+ leads to depolarisation (reversal of polarity) of the nerve membrane, so that the nerve fibre contents become electropositive with respect to the extracellular fluid.

13. (d)

14. (a) : Neurotransmitters are chemicals released from a presynaptic neuron that interact with specific receptor sites of a postsynaptic neurons. There are two broad categories of neurotransmitters, neuroexcitatory and neuroinhibitory. Acetylcholine, epinephrine, norepinephrine, etc., are neurostimulatory while glycine, gamma amino butyric acid (GABA), etc, are neuroinhibitory. Besides these other neurotransmitters are dopamine, serotonin, histamine, glutamate, aspirate, substance hormone and nitric oxide.

15. (c) : The junction of an axon and dendrite is called synapse. It is usually found between the fine branches at the end of the axon of one neuron and the dendrites or cell body of another neuron. Through this junction nerve impulse transmits from one neuron to other.

A synapse consists of swelling at the end of nerve fibre called synaptic knob lying in close proximity to the membrane of dendrite whose cytoplasm contains numerous mitochondria (for energy) and small synaptic vesicles containing neurotransmitter, acetylcholine for the transmission of the nerve impulse across the synapse.

16. (c) : Left cerebral hemisphere is smaller than the right. Both function equally but left hemisphere is considered dominant because in majority of people, Wernicke's and Broca's areas are located in the left hemisphere. Also majority of people are right-handed.

17. (b) : The cavity of hindbrain, called fourth ventricle communicates the central canal of spinal cord by an opening called foramen of Magendie.

18. (d)

19. (c) : The dorsal root ganglion contains the cell bodies of sensory neurons that brings information from the periphery to the spinal cord.

20. (d) : Frontal lobe controls intellectual ability.

21. (a) : The thin roof of III ventricle (diocoel) is called epithalamus. The anterior part of epithalamus contains a highly coiled bunch of blood capillaries called anterior choroid plexus. The dorsal surface of metacoel also contains highly coiled bunch of blood capillaries called posterior choroid plexus.

22. (c) : Brain depends on blood for supply of oxygen and glucose.

23. (c)

24. (b) : P is the frontal lobe which controls intellectual ability to abstract, inner monitoring of complex thoughts, actions and creative ideas.

25. (b) : Subarachnoid space found between the arachnoid membrane and pia-mater, which is filled with cerebrospinal fluid.

26. (d) : Medulla oblongata is the most caudal part of the brain. It has many vital centres to control circulation, heart and lungs. Damage to any one of them can be fatal. The area in the medulla that is concerned with respiration has classically been called the respiratory centre and the activity of the heart is the result of autonomic reflex activity controlled by cardiac centre.

27. (c) : Certain components of the cerebrum and diencephalon constitute the limbic system. Its main components are the following (i) Hippocampus-Its shape roughly resembles the sea horse. It is located inside the temporal lobe (ii) Amygdala or Amygdaloid nucleus. It is almond shaped and is located in the tip of the temporal lobe. (iii) Septal nuclei - These are located within the septal area formed by the regions under corpus callosum and the paraterminal gyrus (a cerebral gyrus). (iv) Mammillary bodies - These are present behind the infundibulum. (v) Basal ganglia - They are scattered masses of gray matter.

28. (d) : Grey matter of the brain appears grey in colour due to the large collection of cyton and it lacks myelin.

29. (a) : Accessory nerve formerly it was called the spinal accessory nerves. It differs from all other cranial nerves because it originates from both the brain (medulla oblongata) and the spinal cord. It is formed by union of its cranial and spinal roots but these are associated for a short distance only. It arises from the side of the medulla oblongata. It is a motor nerve which innervates the muscles of the pharynx, larynx, neck and shoulder and controls the movements of these organs.

30. (b) : Axon is a single, usually very long process of uniform thickness. The part of cyton from where the axon arises is called axon hillock. Most sensitive part of neuron is axon hillock. The axon contains neurofibrils and neurotubules but does not have Nissl's granules, Golgi complex, ribosomes, pigment granules, fat globules, etc. In the absence of Nissl's granules, the axon depends on the cell body for the supply of proteins.

31. (a) : Vagus nerve arises from the side of medulla oblongata. It innervates the larynx, trachea, oesophagus, stomach, lungs, heart and intestines. It is a mixed nerve. It controls the visceral sensations and visceral movements, *i.e.*, heart beat, respiratory movements, peristalsis, sound production, etc. Movement of the tongue is controlled by hypoglossal nerve as it innervates the muscles of the tongue.

32. (a) : Each spinal nerve is a mixed nerve. It arises from the horns of the grey matter of spinal cord by two roots, purely sensory dorsal root and a purely motor ventral root.

33. (d) : The action of the parasympathetic nervous system is opposite to that of the sympathetic nervous system. If the sympathetic nervous system accelerates an action, the parasympathetic nervous system slows it. However, neither system is exclusively excitatory or inhibitory. The parasympathetic fibres constrict the pupil, decrease the rate and force of heart beat, dilate many blood vessels, lower the arterial blood pressure, quicken the peristaltic movements and contract the urinary bladder.

34. (c) : Autonomic nervous system is involved in peristalsis of intestine which is effected through mysenteric plexus.

Sympathetic fibres decrease peristaltic movements while parasympathetic fibres increase these movements.

35. (a) : Certain neurons of the sympathetic nervous system secrete a neurotransmitter called norepinephrine (noradrenaline) from their axon endings for transmitting the nerve impulse across a synaptic cleft. Such neurons are said to be adrenergic. Norepinephrine is inactivated by an enzyme monoamine oxidase.

36. (a) : Cerebellum shows a branching tree like arrangement of grey and white matter called arbor vitae ("tree of life").

37. (a)

38. (b)

39. (c) : A-Neuroplasm, B-Nucleus, C-Nissl's granules and G- Collateral fibres.

40. (d) : Unipolar neurons are usually found in embryonic stage. Multipolar neurons are found in cerebral cortex.

41. (a) : D-Axon hillock, E-Myelin sheath, F-Nodes of Ranvier, G-Collateral fibres.

42. (a) : Centrioles are absent in mature neurons and associated with the production and maintenance of microtubules.

43. (d) : Multiple sclerosis is a progressive degenerative disease of central neural system, so named because of the many sites in which hardened tissue has replaced the normal myelin sheaths of neurons.

44. (a) : A is association area of cerebrum which is involved in memory and learning.

45. (b) : The major functions of frontal lobe of cerebral lobes are :-

Inner monitoring of complex thoughts and actions, creative ideas, translation of perceptions and memories into plans of muscle movement, reality testing by judgement, decision making, expression of emotions, willpower and personality.

46. (b) : Medulla oblongata receives and integrates signals from spinal cord and sends resulting signals to the cerebellum and thalamus. It contains centres that regulate heart rate, blood pressure, breathing, swallowing, salivation, sneezing, vomiting and coughing and some other involuntary movements.

47. (b) : D is cerebellum which controls rapid muscular activities such as running, typing and even talking. All activities of the cerebellum are involuntary, but may involve learning in their early stages.

48. (a) : Hypothalamus (part-C) integrates and controls the visceral activities. It maintains homeostasis. It provides anatomical connection between the nervous and endocrine system by its relationship to the pituitary gland. Hypothalamus is thermoregulatory centre. Hence it is called "thermostat" of the body. It keeps body temperature at roughly 37°C by means of a complex thermostat system. It is also associated with behavioural activities. Appetite, thirst and satiety (feeling of being satisfied) centres are located in the hypothalamus. It also influences respiration and heart beat.

49. (b) : The axon terminal of the neuron contains many membrane bound vesicles called synaptic vesicles, in its cytoplasm. Within these vesicles, chemical substances such as adrenaline and acetylcholine remain stored. These chemicals are called neurotransmitters, because they help to transmit nerve impulses across the synapses. When a nerve impulse passes the axon terminal, its synaptic vesicles release their stored chemicals in the synaptic cleft.These diffuses through the cleft to reach the membrane of the next neuron, stimulating the latter. This causes the nerve impulse to be transmitted along the next neuron.

50. (c) : Normal pattern of conduction is transfer of depolarising wave from axon to dendrite but other forms of transmission like axo-axonic, dendro-axonic are also found and synaptic delay has nothing to do with it.

51. (a) : Both the brain and spinal cord are the main structures of central nervous system which are completely covered by three connective tissue membranes or meninges. These are called pia mater, arachnoid mater and duramater, respectively from within outward.

52. (b) : A minimum strength of stimulus, the threshold stimulus is applied to the nerve fibre. When the nerve fibre is effectively stimulated, its resting membrane potential undergoes a change - the inner side of the membrane now becomes electropositive to its outside. This potential change is called action potential, and is propagated along the nerve fibre as the nerve impulse.

53. (b) : Corpus callosum is present in the subarachnoid spaces between the pia and arachnoid maters. Pia and

arachnoid along with the dura mater are called meninges. These are connective tissue membranes which cover both the brain and spinal cord. Cerebrospinal fluid affords protection to the central nervous system (CNS) against mechanical injury and shock. The exchange of materials between it and the neurons help in their nutrition and excretion. The cerebrospinal fluid serves to maintain a constant pressure inside the cranium in spite of fluctuations in the volume and pressure of blood in the cranial vessels.

54. (c) : The brain and the spinal cord constitute the central nervous system. The areas of the CNS where the cell bodies of the neurons are situated, look grey and constitute the grey matter. Other areas look white and constitute the white matter of the CNS. The white matter contains only nerve fibres cruising from or to the nerve cells in the grey matter. It looks white due to the presence of myelin around the myelinated fibres. In most parts of the brain, the grey matter containing the nerve cells is situated on the surface while the white matter made of fibres is located deep inside the brain; but in the spinal cord, the grey matter is internal and white matter occurs outside.

55. (c) : The neurons and nerve fibres which conduct nerve impulses from the central nervous system (CNS) to the peripheral organs and tissues are called efferent neurons and efferent nerve fibres respectively. Some of the neurons and nerve fibres conduct nerve impulses to the muscles and glands to stimulate or inhibit their activities. Many of these nerve fibres cause movements of muscles. So, such neurons and nerve fibres are known as motor neurons and motor nerve fibres, respectively. The motor nerve fibres are the axons of motor neurons. All motor neurons are efferent neurons, because they conduct impulses from the CNS system to the peripheral tissues viz. muscles and glands. The nerve fibres which reach nerve impulses to the eye muscles to control their movements are motor fibres; so also are the fibres carrying impulses to the salivary glands and controlling their secretion.

The nerve impulses are conducted from the spinal cord to the brain by ascending nerve tracts which are the bundles of nerve fibres ascending along the white matter of the spinal cord.

56. (d) : The nerves arising from different parts of the brain are called cranial nerves. Man possesses twelve pairs of cranial nerves. A nerve which carries only sensory nerve fibres is called a sensory nerve and a nerve carrying only motor nerve fibres is called a motor nerve. Those nerves which carry simultaneously both sensory and motor nerve fibres are called mixed nerves. Out of twelve pairs of cranial nerves, only four pairs are mixed nerves. Table below gives the names, nature and major functions of the cranial nerves.

No.	Name	Fibres	Functions
Ist	Olfactory	Sensory	Smell
2nd	Optic	Sensory	Vision
3rd	Oculomotor	Motor	Eyeball movements
4th	Trochlear	Motor	Eyeball movement
5th	Trigeminal	Mixed	Cutaneous sensation, muscle movements
6th	Abducens	Motor	Eyeball movement
7th	Facial	Mixed	Taste salivation, muscles movements, tear secretion
8th	Auditory	Sensory	Hearing, equilibrium sense
9th	Glosso-pharyngeal	Mixed	Taste, salivation, swallowing
10th	Vagus	Mixed	Gastric and pancreatic secretion, cardiac gastrointestinal movements, respiratory reflexes, vasomotor reflexes,visceral
11th	Spinal	Motor	Muscle movements, visceral reflexes accessory
12th	Hypoglossal	Motor	Tongue movements

57. (c) : The CNS includes the brain and the spinal cord and is the site of information processing and control. The PNS comprises of all the nerves of the body associated with the CNS.

58. (c) : The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions. The hypothalamus is the basal part of diencephalon (forebrain) which contains several groups of neurosecretory cells called nuclei that produce hormones.

SUBJECTIVE TYPE QUESTIONS

1. Neurons can detect, receive and transmit different kinds of stimuli in animal body.

2. Insects have an organised nervous system with a brain along with a number of ganglia and neural tissues.

3. The resting membrane potential of the axon of a neuron is the potential difference between inside and outside when the axon is "resting," *i.e.*, not actively conducting impulses.

4. The brain is protected by the skull. Inside the skull, the brain is covered by cranial meninges consisting of an outer layer called duramater, a very thin middle layer called arachnoid mater and an inner layer (which is in contact with the brain tissue) called pia mater.

5. Certain components of the cerebrum and diencephalon constitute the limbic system. It is sometimes called the "emotional brain" because it controls emotional behaviour expressed in the form of joy, sorrow, fear, fight, friendship, liking and disliking.

6. The left and right cerebral hemispheres are connected by a large bundle of myelinated fibres called corpus callosum.

7. Inner parts of cerebral hemispheres and group of associated deep structures like amygdala, hippocampus and hypothalamus regulates reactions like aggressive behaviour, use of abusive words, restlessness etc.

8. Earthworm has a nervous system consisting of well developed ventral nerve cord, paired segmental ganglia and segmental nerves.

9. Nissl's granules are located in the cytoplasm of cell body and dendrites.

10. Saltatory conduction

11. Central Nervous system (CNS) comprises of brain and the spinal cord. It is the site of information processing and control. Peripheral nervous system (PNS) consists of neurons. Some peripheral neurons (called afferent neurons) collect information from the tissue/organs and transmit it to the CNS and other neurons transmit regulatory information from the CNS to the concerned tissue or organ.

12. Differences between electrical and chemical transmission are as follows :

	Electrical transmission	Chemical transmission
(i)	Electrical synapse is present.	Chemical synapse is present.
(ii)	Membranes of pre- and post-synaptic neurons are in very close proximity provided by the gap junction.	Membranes of pre-and post-synaptic neurons are separated by a fluid-filled space called synaptic cleft.
(iii)	Impulse transmission across an electrical synapse is fast.	Impulse transmission across a chemical synapse is slow.
(iv)	No neurotrans-mitter is involved.	Neurotransmitter is involved.
(v)	Electrical synapses are relatively rare.	Chemical synapses are common.

13. (A) – Neurotransmitter
(B) – Specific receptors
(C) – Ion channels
(D) – Postsynaptic neuron

14. Hypothalamus is the thirst centre present in human brain. It is located in the forebrain. It links nervous system to endocrine system (via hypothalamus - hypophyseal axis) and exercises a regulatory control on the functioning of endocrine glands by secreting neurohormones. It contains higher centres of autonomic nervous system controlling hunger, thirst, sleep, fatigue, emotions, satisfaction, anger, pleasure, etc. It also controls carbohydrates and fat metabolism, body temperature, blood pressure and water balance.

15. If someone receives a blow on the back of the neck, then his medulla oblongata would get hurt, as this is the place where it is located. The person might die as medulla controls respiration, cardiovascular reflexes and gastric secretions.

16. (a) Cerebrum (cerebral hemispheres).
(b) Pineal gland
(c) Basal ganglia
(d) Epidural space

17. (a) Node of Ranvier
(b) Synaptic knob
(c) Axon
(d) Neurotransmitters

18. Neural system consists of sensory organs that detect changes in the external environment and sensory nerves carry sensory impulses from these organs to CNS. These sensory organs and sensory nerves can be compared to input devices of computer. This information is processed in CNS which can be compared to CPU of computer. Then, motor nerves carry motor impulses from CNS to target tissues/organs which then act accordingly. These motor nerves and target tissues/organs can be compared to output devices of computer.

19. The cerebral cortex is referred to as the grey matter due to its greyish appearance because of the colour provided by neuron cell bodies. The inner part of the cerebral hemisphere consists of fibres of the tracts covered with myelin sheath which give an opaque white appearance to the tissue and hence it is called the white matter.

20. The functions of nervous system are as follows:

(i) It gathers information from the outside of the body (called sensory function).

(ii) It transmits the information to the processing area of the brain and spinal cord.

(iii) It processes the information to determine the best response (called integrative function).

(iv) It sends information to muscle glands and organs (effectors) so they can respond correctly (called motor function).

21. Following table shows the comparative actions of sympathetic and parasympathetic nerves.

	Sympathetic nerves	Parasympathetic nerves
(i)	Accelerate rate of heart beat	Decrease rate of heart beat

(ii)	Constrict arteries and increase blood pressure	Dilate arteries and decrease blood pressure
(iii)	Promote sugar release and decrease bile production in liver	Promote glycogen formation and increase bile production in liver
(iv)	Cause dilation of pupil of eye	Cause constriction of pupil of eye

22. Coordination is the process through which two or more organs interact and complement the functions of each other. The neural system provides an organised network of point-to-point connections for a quick coordination.

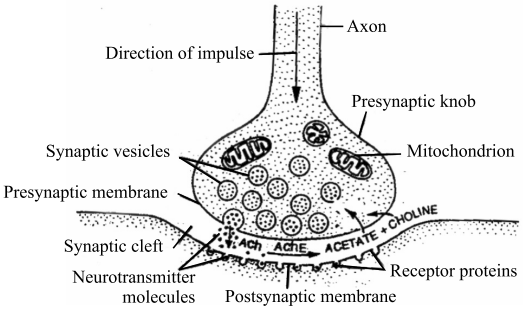
It is necessary to maintain homeostasis. For example, when we do physical exercise, the energy demand is increased for maintaining an increased muscular activity. The supply of oxygen is also increased. The increased supply of oxygen necessitates an increase in the rate of respiration, heart beat and increased blood flow via blood vessels. When physical exercise is stopped, the activities of nerves, lungs, heart and kidney gradually return to their normal conditions.

23. (a) Synaptic knob is present at the axon terminal that contains mitochondria. It also contains synaptic vesicles that have neurotransmitters for nerve conduction.

(b) Motor end plate is defined as the part of sarcolemma that lies beneath the axon terminals.

(c) In an axon, nerve impulse are transmitted away from the cell body to a synapse or to a neuromuscular junction.

24. Synapse is the junction between two neurons, across which the impulse passes from one neuron to the next. A synapse is formed by the membranes of a pre-synaptic neuron and a post-synaptic neuron, which may or may not be separated by a gap called synaptic cleft. At a chemical synapse, when an impulse arrives at a pre-synaptic knob, calcium ions from the synaptic cleft enter the cytoplasm of the pre-synaptic knob. The calcium ions cause the movement of synaptic vesicles to the surface of the knob. The synaptic vesicles are fused with the pre-synaptic membrane and get ruptured to discharge their content (neurotransmitters) into the synaptic cleft.



The neurotransmitter of the synaptic cleft binds with protein receptor molecules on the post-synaptic membrane. This binding action changes the membrane potential of the post-synaptic membrane, opening channels in the membrane and allowing sodium ions to enter the cell. This causes the depolarisation and generation of action potential in the post-synaptic membrane. Thus, the impulse is transferred to the next neuron.

25. On the basis of number of axons and dendrites, neurons are classified as :

(i) Non-polar neurons : Each neuron has several branched processes (projections). These neurons are rare in vertebrates but occur in cnidarians (coelenterates), *e.g., Hydra.*

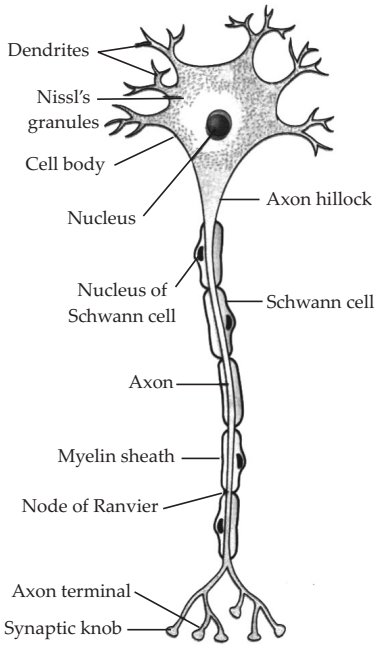
(ii) Unipolar neurons : The body has only one axon and is found usually in the embryonic stage.

(iii) Pseudounipolar neurons : In this, a single process arises from the cyton and then divides into axon and dendrite. They are found in dorsal root ganglia of spinal nerves.

(iv) Bipolar neurons : Each bipolar neuron has one axon and one dendrite and are present in the retina of eye.

(v) Multipolar neurons : They have several dendrites and an axon. They are found in cerebral cortex.

26. Diagrammatic representation of myelinated neuron is as follows:



27. Axons and dendrites can be differentiated as follows:

	Axons	Dendrites
(i)	Single axon per neuron.	Many dendrites per neuron.
(ii)	Arise from a conical projection, the axon hillock.	Arise directly from the receiving surface of the neuron.

(iii)	Long cellular process with uniform thickness and smooth surface.	Short cellular process, lack uniform thickness and smooth surface due to tiny projections called dendritic spines.
(iv)	Branched at the distal end only.	Much branched, practically all along.
(v)	Terminal branches enlarged to form synaptic knobs at the tips.	No such knobs are present at the tips of the branches.
(vi)	Have neurotransmitter containing vesicles in the knobs.	Do not have such vesicles.
(vii)	Conduct impulses away from the cyton.	Conduct impulses towards the cyton.
(viii)	Myelin sheath, nodes of Ranvier and ribosomes are present.	Lack myelin sheaths, nodes of Ranvier and ribosomes.

28. (a) Thalamus and hypothalamus can be differentiated as follows:

	Thalamus	Hypothalamus
(i)	It is present on the right and left sides of the third ventricle.	It is present at the floor of the third ventricle.
(ii)	Each thalamus acts as a relay centre for sensory impulses.	The hypothalamus contains centres for many critical internal body functions.
(iii)	Centre for crude sensation such as extremes of heat, cold, pain, etc.	Controls hunger, thirst, sexual arousal, and feeling of pain, pleasure, anger and fear; and controls the hypophysis.

(b) Several medullary centres (reflex centres) are present for controlling the functions of important organs, *e.g.,* cardiac centre (heart), respiratory centre, vasomotor centre (for regulating diameter of blood vessels) and reflex centres (for swallowing, vomiting, peristalsis, secretions and activity of alimentary canal, salivation, coughing etc.). Therefore, damage of medulla can be fatal.

29. The limbic system is a group of brain structures that are involved in various emotions such as aggression, fear, pleasure and also in the formation of memory. It controls food habits necessary for survival of the individual. It also controls sex behaviour necessary for survival of the species. The limbic system affects the endocrine system and the autonomic nervous system. This system consists of several subcortical structures located around the thalamus such as: hippocampus involved in the formation of long-term memory; amygdala involved in aggression and fear; cingulate gyrus, fornicate gyrus; archicortex and hypothalamus that controls the autonomic nervous system and regulates blood pressure, heart rate, hunger, thirst, sexual arousal and the sleep/wake cycle.

30. Spinal cord forms the posterior part of the CNS, running mid dorsally in the neural canal of the vertebral column. The spinal cord is formed of two types of nervous tissue : grey matter and white matter. The grey matter is internal, *i.e.*, surrounds the central canal. It has the form of letter H in cross-section. The arms of H are called posterior and anterior grey columns. Portions of the grey matter present behind and in front of the central canal are called posterior and anterior grey commissures. At certain levels, the grey matter has lateral columns. The grey matter is composed of association neurons and cell bodies of motor neurons. The columns of the grey matter are continued into the roots of the spinal nerves. The white matter is outside the grey matter. It consists of bundles of medullated nerve fibres.

Spinal cord conducts impulses to and from the brain and controls most of the reflex activities and provides a means of communication between spinal nerves and the brain.

31. The human nervous system consists of two sub-systems: The central nervous system (CNS) that consists of brain and spinal cord and the peripheral nervous system (PNS) which comprises of nerve pathways of the body outside brain and spinal cord.

Peripheral nervous system is further divided into two main parts:

(i) Voluntary or somatic nervous system is under voluntary control of brain that consists of the nerves supplying the skeletal muscles.

(ii) Visceral or autonomic nervous system controls and coordinates those organs which are under involuntary control. This system is further divided into two—sympathetic nervous system (SNS), which has mainly excitatory effects on the body and parasympathetic nervous system, which acts antagonistically to the SNS and has mainly calming influences.

32. The differences between myelinated and non-myelinated axons are as follows :

	Myelinated axons	Non-myelinated axons
(i)	They are enveloped with Schwann cells which form myelin sheath around them.	They are enclosed by Schwann cells that do not form a myelin sheath around them.
(ii)	Node of Ranvier is present between two adjacent myelin sheath.	Node of Ranvier is absent.
(iii)	They are found in spinal and cranial nerves of peripheral nervous system.	They are found in autonomous and somatic nervous system.
(iv)	Saltatory conduction occurs.	Saltatory conduction is absent.

(v)	Impulses travel with greater speed due to saltatory conduction.	Impulses travel relatively slower (≈ 50 times slower) than myelinated axons.

33. Cerebrum and cerebellum can be differentiated as follows:

	Cerebrum	Cerebellum
(i)	It is the largest part of the brain, forming four-fifth of its weight.	It is the second largest part of the brain, forming one-eighth of its mass.
(ii)	It is a part of the forebrain.	It is a part of the hindbrain.
(iii)	It consists of two cerebral hemispheres each comprising 4 lobes : frontal, occipital, parietal, temporal.	It consists of two cerebellar hemispheres and a median vermis.
(iv)	White matter does not form arbor vitae.	White matter forms arbor vitae.
(v)	It initiates voluntary movements and is a seat of will, intelligence, memory, etc.	It maintains posture and equilibrium.

34. Differences between cranial and spinal nerves are as follows:

	Cranial nerves	Spinal nerves
(i)	These nerves also called cerebral nerves arise from or join the brain.	These nerves arise from the spinal cord.
(ii)	There are 12 pairs of cranial nerves in humans.	There are 31 pairs of spinal nerves in humans.
(iii)	They are numbered I to XII in Roman numerals.	They are classified into five groups cervical 8 pairs; thoracic 12 pairs; lumbar 5 pairs; sacral 5 pairs and coccygeal 1 pair.
(iv)	Functions are concerned mainly with the activities associated with head and neck (except vagus nerve).	Functions are associated with all the body parts below the neck.
(v)	Most of these are mixed nerves except olfactory, optic and vestibulocochlear nerves.	All of these are mixed nerves.

35. Brain acts as control and command system of the body. It is protected by skull and is covered by three meninges. It is divisible into three main regions: forebrain, midbrain and hindbrain.

(i) Forebrain consists of three regions:

(a) Olfactory lobes are a pair of very small, solid club-shaped bodies which are widely separated from each other. They are fully covered by cerebral hemispheres.

(b) Cerebrum is the largest and most complex of all the parts of human brain. A deep cleft divides the cerebrum into right and left cerebral hemispheres, connected by myelinated fibres, the corpus callosum.

(c) Diencephalon encloses a slit-like cavity, the third ventricle. The thin roof of this cavity is known as the epithalamus, the thick right and left sides as the thalami and floor as the hypothalamus.

(ii) Midbrain is located between thalamus/hypothalamus of forebrain and pons of hindbrain. Its upper surface has two pairs of rounded protrusious called corpora quadrigemina and two bundles of fibres called crura cerebri.

(iii) Hindbrain consists of three regions :

(a) Cerebellum is the second largest part of the human brain. It consists of two lateral cerebellar hemispheres and central worm-shaped part, the vermis. It has its grey matter on the outside, comprising three layers of cells and fibres. It also has Golgi cells, basket cells and granule cells.

(b) Pons varolii is an oval mass lying above the medulla oblongata. It consists mainly of nerve fibres which interconnect different regions of the brain.

(c) Medulla oblongata extends from the pons varolii above and is continuous with the spinal cord below. The mid brain, pons varolii and medulla oblongata are collectively called brain stem.

36. A neuron (nerve cell) is the structural and functional unit of the neural system. Neurons with longer processes (projections) are the longest cells in the body. Fully formed neurons never divide and remain in interphase stage throughout life. Shortly after birth, new neurons do not develop. A neuron is a microscopic structure composed of three major parts, namely, cell body, dendrites and axon.

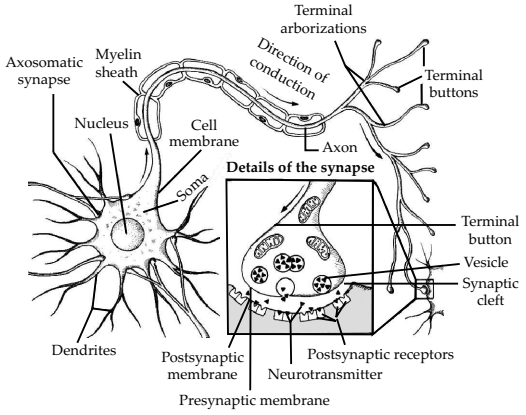
(i) Cell body (Cyton or Soma) : Like a typical cell, it consists of cytoplasm, nucleus and cell membrane. It has abundant cytoplasm called neuroplasm and a relatively large spherical central nucleus with a distinct nucleolus. The cytoplasm has mitochondria, Golgi apparatus, rough endoplasmic reticulum, ribosomes, lysosomes, fat globules, pigment granules, neurofibrils, neurotubules and Nissl's granules. Cyton is concerned with metabolic maintenance and growth. The processes of neurons are called neurites that are divided further into dendrites and axons.

(ii) Dendrites are usually shorter, tapering and much branched processes that may be found here one to several. They conduct nerve impulse towards the cell body and are called afferent processes.

(iii) Axon is a single, usually very long process of uniform thickness. The part of cyton from where the axon arises is called axon hillock. It is the most sensitive part of neuron. The axon contains neurofibrils and neurotubules but lacks

Nissl's granules, Golgi complex, ribosomes, pigment granules, fat globules, etc. The cell membrane of the axon is called axolemma and its cytoplasm is known as axoplasm. The axon ends in a group of branches, the terminal arborisations which when meet the dendrites of another neuron to form a synapse, form synaptic knobs or end plates. The synaptic knobs contain mitochondria and secretory vesicles. The part of the sarcolemma (muscle plasma membrane) that lies beneath the axon terminal/nerve endings, is called motor end plate. The axon conducts nerve impulses away from the cell body, therefore, called an efferent process. There are two types of nerve fibres namely myelinated and non-myelinated. The myelinated nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon. The gaps between two adjacent myelin sheaths are called nodes of Ranvier. Non-myelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon. For labelled diagram of a neuron *refer to answer 26*.

37. Chemicals called neurotransmitters are involved in the transmission of impulses at chemical synapses. The axon terminals contain vesicles filled with these chemicals. When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards the membrane where they fuse with the plasma membrane and release their neurotransmitters in the synaptic cleft. The released neurotransmitters bind to their specific receptors, present on the post-synaptic membrane. This binding opens ion channels allowing the entry of ions which can generate a new potential in the post-synaptic neuron. The given diagram shows neuron, axon terminal and synapse.



38. Forebrain consists of olfactory lobes, cerebrum and diencephalon. Olfactory lobes are a pair of solid club shaped structures present on the inferior surface of cerebrum having an olfactory bulb and an olfactory tract for relaying sense of smell to temporal lobes. Olfactory lobes receive information about smell. In lower animals each olfactory lobe has a cavity called rhinocoel (1st ventricle). It is absent in human beings. Cerebrum is the largest and complex part. It consists of the left and right hemispheres connected by a bundle of myelinated fibres called corpus callosum.

The left part of cerebrum controls the functions of right parts of the body while right part of cerebrum commands functions of left side of the body.

The interior of each cerebral hemisphere contains a lateral ventricle (= paracoel, first and second ventricles) filled with cerebrospinal fluid. The two ventricles open into third ventricle by a common aperture called foramen of Monro.

Diencephalon lies between cerebrum and mesencephalon. Its cavity is called third ventricle or diocoel. It communicates anteriorly with the lateral ventricles and posteriorly with iter. It contains epithalamus, thalamus and hypothalamus.

Epithalamus is non – nervous part which is fused with piamater to form anterior choroid plexus. Just behind this the epithelium forms a short stalk called pineal stalk which has rounded body called pineal body. Pineal body is endocrine in function and secretes a hormone named melatonin.

Epithalamus forms the roof of third ventricle.

Thalamus forms the lateral walls of the third ventricle and directs sensory impulses from the lower parts of the brain and spinal cord to appropriate parts of the cerebrum. Just beneath the thalamus, hypothalamus forms the floor and the part of the lateral walls of the third ventricle.

Hypothalamus links nervous system to endocrine system (*via* hypothalamus - hypophyseal axis) and exercises a regulatory control on the functioning of endocrine glands by secreting neurohormones.

It contains higher centres of autonomic nervous system controlling hunger, thirst, sleep, fatigue, emotions, satisfaction, anger, pleasure etc.