Dr. Bbosa Science

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A-level Biology

Coordination and control in animals

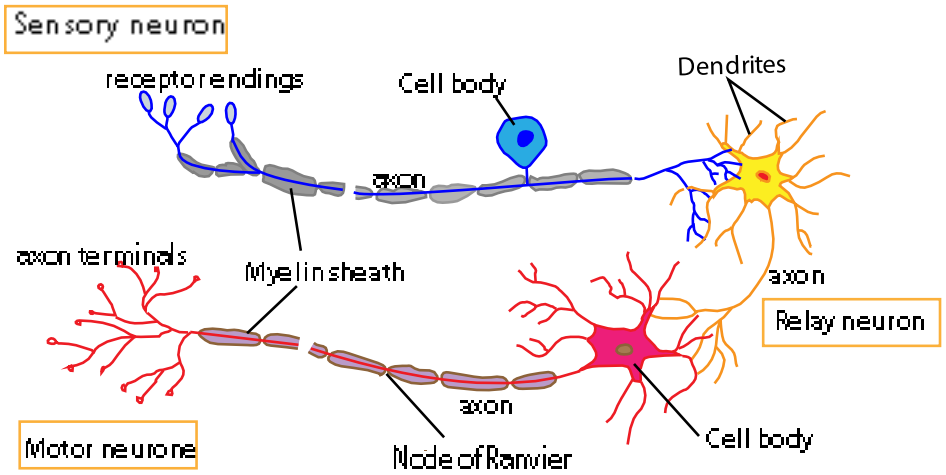
Coordination means to cause the part to function together or in proper order.
Coordination and control in animals is performed by the nervous system and endocrine system.

Difference between nervous and endocrine system

	Nervous system	Endocrine system
1.	Fast acting	slow acting
2.	It's effects are localized	It's effects are diffuse
3.	Transmission are electrical and Chemical theory cell fibre	Relies on chemical transmission through circulatory system
4.	Transmission occur in nerve	It occurs in blood

The nervous system.

The nervous system is composed of highly differentiated cells called **nerve cells** or **neurons**. Those that carry impulses from receptors to the control nervous system are called **sensory neurons** while those that carry impulses from the CNS to effector are called **effector neurons**.



Differences between effector and sensory neuron

	Effector neurons	Sensory neuron
1.	Transmit impulse from CNS to the effector	Transmit impulse from sense organ or receptor to the CNS cell body in the middle of axon
2.	Cell body at the end of the axon	Cell body in the middle of axon
3.	Cell body located in grey matter of spinal cord	Cell body located in dorsal root ganglion of the spinal chord

Structure of the nerve cell

1. The cytoplasm contains the same organelles as the other body cell; mitochondria, nucleus cell membrane and ribosome grouped in Nissl's granules.

2. Along nerve fibre axon extend from the cell body in effector neurons or either sides of the cell body in sensory neuron to transmits impulses. The axon enclosed within a fatty **myelin sheath** which is not part of the neuron but another cell Schwann cell which wraps itself repeatedly round the axon. The myelin sheath protects the axon, but also insulates the axon and speeds up transmission of impulse.

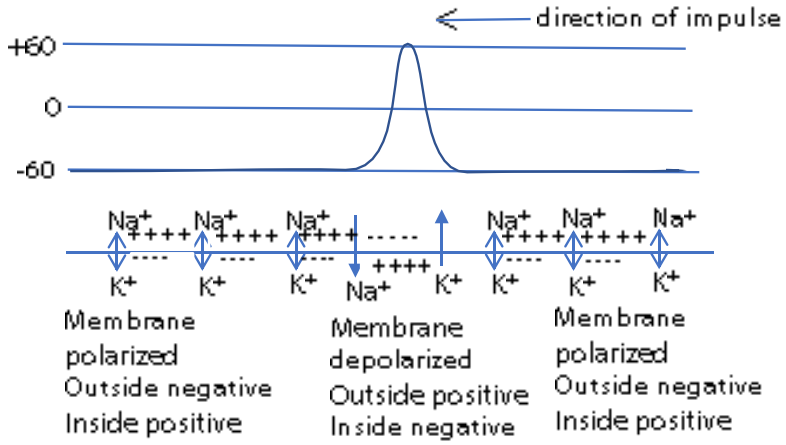
Transmission of impulse.

The resting potential of axon

A potential difference is maintained between the inside and outside of undisturbed axon. The inside being negatively charged [about- 70 ml] with respect to the outside. In this state the membrane is said to be polarized. The resting membrane potential is maintained by the sodium / potassium pump using energy derived from ATP and it pumps ions against their concentration gradient pumping sodium ions are pumped out of the neuron in exchange for potassium ion (K^+). K^+ ions and organic ions is higher inside the neuron whereas Na^+ and Cl^- ion concentration is higher outside the neuron

The impulse

An **impulse or action potential** is a temporary and local reversal of the resting membrane potential, arising when an axon is stimulated. The term used during the electrical change which occur during the passage of action potential is depolarization, and axon is said to be depolarized. The action potential is short- lived lasting about a millisecond, after which the resting membrane potential is restored. Events occurring into axon during the transmission of action potential are show in the figure below.



Information is transmitted through the nervous system as a series of impulse which travel as action potential.

Properties of nerves and impulses

Stimulation
In normal circumstance impulse are set up in nerve cell as a result of excitation of receptor. But an impulse can be set up in nerve by applying any stimulus which opens the sodium channels and cause depolarization of the membrane. In general nerve can be stimulate by mechanical, osmotic, chemical, thermal and electrical stimuli.

All or nothing law
An excitable tissue will only be excited by a stimulus above a certain threshold stimulus intensity. For any given neuron the amplitude of the action potential is always constant and increasing the strength or number of stimuli has no effect on this. For this reason, potentials are described as all or nothing event. The all- or-nothing law states that the response of excitable unit (axon) is independent of the intensity.

Refractory period.
After an axon has transmitted an impulse, it cannot transmit another one straight way. The axon has to be recovered first. The membrane has to be repolarized and first.
The period of under which the nerve cannot transmit an impulse following the transmission of first one is called **refractor period** and typically lasts about 3 milliseconds. It can be divided into **absolute** refractory period during which the axon is totally incapable of transmitting an impulse, followed by a somewhat longer **relative** refractory period during which it's possible to generate an impulse in the axon provided that the stimulus is stronger than usual.
The importance of the refractory period, together with transmission speed, it determines the maximum frequency at which the axons can transmit impulses. For most axons the maximum frequency is about 500 per second, though some neurons can reach 1000 per second.

Factors that affect nerve conduction velocity

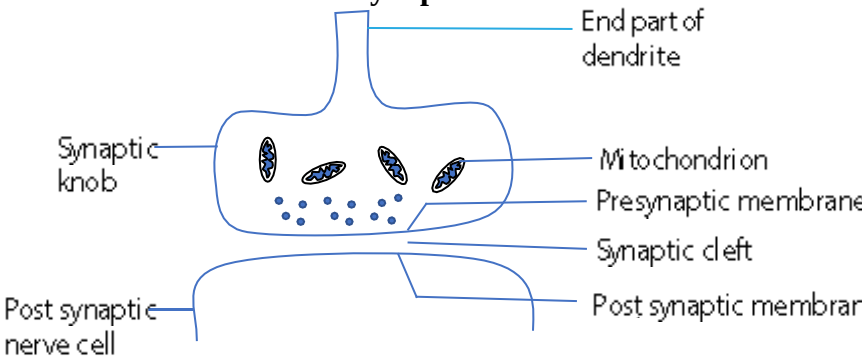
1. Axon diameter:
   (i) Impulses move faster in an axon with larger diameter because longitudinal resistance of exoplasm decreases with increasing diameter of axon, which increases the length of the membrane influenced by local circuit as the distance between adjacent depolarizations increases; causing increased conduction velocity.
   (ii) Small cells or cells with large surface area: volume ratio or ion leakage weakens membrane.
   (iii) Myelin sheath stops ion leakage; therefore, large diameter only important for unmyelinated neurons
2. Myelination and saltatory conduction:
   (i) Myelination speeds up conduction. In a myelinated neuron, the conduction velocity is directly proportional to the fiber diameter.
   (ii) Schwann cells prevent diffusion of ions; flow of current occurs only between adjacent nodes of Ranvier
   (iii) Therefore, depolarization only at nodes of Ranvier because action potential jumps from node to node
3. Temperature: Homoiotherms with steady body temperature have faster impulse propagation than poikilotherms which have fluctuating body temperature.

4. Resting membrane potential: Effect of RMP changes on conduction velocity is quite variable. Usually, any change in the RMP in either direction (hyper polarization or depolarization) slows down the conduction velocity.

The Synapse.

This a functional area, where an axon come into contact with another for the purpose of transferring information. These are two types of synapse, electrical and chemical, depending on the nature of transfer of information across the synapse, A structurally dissimilar but functionally similar synapse exists between the terminal of a motor neuron and the surface of a muscle fibre and this is called neuromuscular junction.

Structure of the chemical synapse



Transmission across a synapse.

(i) Arrival of an impulse at the synaptic causes an influx of Ca^{2+} ions into the knob from the synaptic cleft.

(ii) The Ca^{2+} ion causes the synaptic vesicles to move towards the pre-synaptic membrane.

(iii) The vesicles fuse with the pre- synaptic membrane and release a transmitter substance into the synaptic cleft by exocytosis.

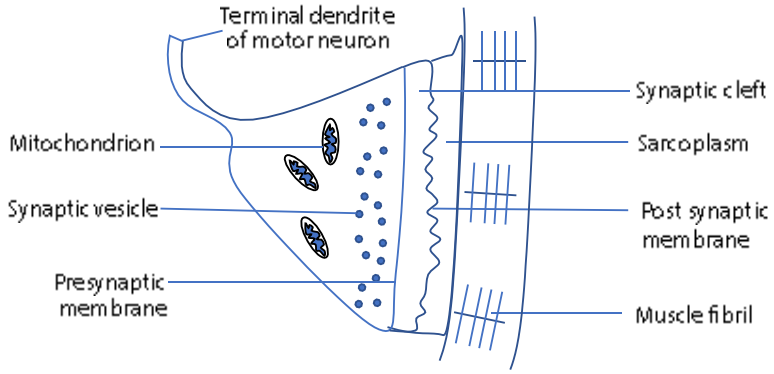
(iv) The transmitter substance diffuses across the synaptic cleft and attaches to specific receptor sites on the post synaptic membrane.

(v) This causes an influx of Na^{+} ion into post- synaptic membrane, resulting in local depolarization of the membrane. If the Na^{+} ion surge is large enough, an action potential (impulse) is generated in the post –synaptic neuron.

The transmitter substance.

The transmitter substance at the majority of synapse is acetylcholine an ammonium base which has an effect on the permeability of the nerve membrane. After its effect, it's inactivated by an enzyme cholinesterase to enable successive impulse to be kept separate. The products of this hydrolysis pass back into the synaptic knob where they are resynthesized into Acetylcholine using energy from ATP.

The Nerve- muscle junction or Neuromuscular.



Transmission across the neural muscular junction is the same as in any other chemical synapse. When an impulse arrives at the nerve muscular junction, acetylcholine is discharged from synaptic vesicle into synaptic cleft. The acetylcholine diffuses across the gap and depolarize the muscle end plate.

The action of drugs and poisons.

Chemicals that destroys acetylcholine, inhibits it's formation or prevents it's action, will stop synaptic transmission.

Atropine, for example doesn't prevent acetylcholine being formed but it stops it depolarizing the post- synaptic membrane and therefore cause synaptic block.

Curare, the poison used on the tips of arrows by south Americans Indians has a similar effect specially on nerve muscle junction.

On the other hand chemicals (e.g. serine) nerve gases that destroy or prevent the formation or action of cholinesterase will be expect to enhance and prolong the effects of acetylcholine.

Strychine also enhance synaptic transmission to such an extent that a person suffering from strychnine poisoning will give convulsive muscular contraction upon slightest stimulation.

Noradrenaline
This another neural transmitter substance in sympathetic nervous system of vertebrates. Nerve that produce acetylcholine are called cholinergic nerve and those producing noradrenaline are called adrenergic.

Function of synapse
1. Ensure unidirectional flow of impulse from neuron to the next.

2. Amplifies the impulses by producing sufficient acetylcholine to excite.

3. Adaptation or accommodation;
   The amount of transmitter substances released by a synapse steadily falls off in the response to constant stimulation until the supply of transmitter substance is exhausted and the synapse is described as fatigued. Further information passing along this pathway is inhibited and the adaptive significance of fatigue in the prevention of damage effect due to over stimulation.

4. Integration;
   A post synaptic neuron receives stimuli from a variety of source and integrates them and produce a coordinated response.

5. Discrimination;
   Temporal summation at synapse enable weak background stimuli to be filtered out before it reaches the brain.eg information from receptor in the skin, the eyes and ears receive constant stimuli from the environment which has little immediate importance for the nervous system. Only changes in the intensity of stimuli are significant to the nervous system and these increase the frequency of stimuli and pass across the synapse and evoke a response.

6. Inhibition;
   The transmission of information across a synapse and neuromuscular function may be prevented post-synaptically by the activity of certain chemical blocking agents or pre-synaptically.

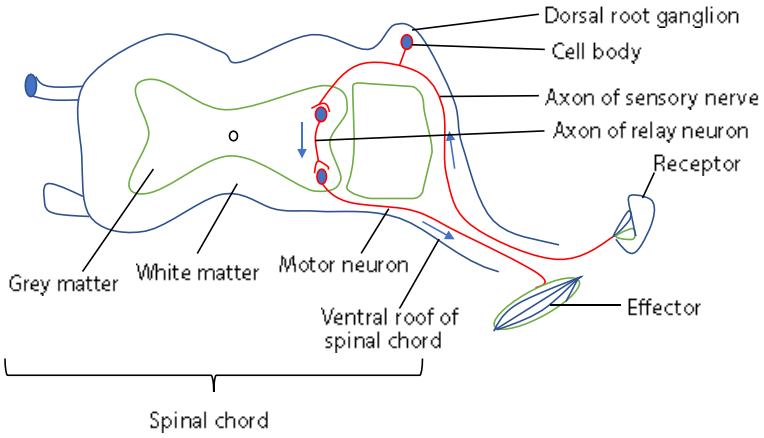
The vertebrate nervous system.

The nervous system of vertebrate is characterized by the structural and functional diversity of neurons and their complex organization with the body. The nervous system is subdivided into two main parts, the central nervous system [CNS] and peripheral nervous system.

The central nervous system consists of brain and spinal cord while peripheral nervous system consists of numerous nerves which link the CNS with the receptors and effectors.

Reflex action and reflex arch.
The reflex action in a rapid, automatic stereotyped response to a stimulus which is not under the conscious control of the brain. It's also described as involuntary action. The neurons forming the pathway taken by the nerve impulse in reflex action is referred to as reflex arch. Illustrated below.

The reflex arc



Conditioned reflex arch
This is a form of reflex action where the response is modified by the past experience, it's coordinated by the brain. Learning for the basis of all conditioned reflexes such as salivation at sight or smell of food.

The autonomic nervous system
The autonomic nervous system is the part of the peripheral nervous controlling activities of the internal environment that normally involuntary such as heart rate, peristalsis and sweating.

The autonomic system is divided into two parts;

The sympathetic and parasympathetic system. Both contain nerve fibres serving structures over which the body has little or no voluntary control. In both cases nerve fibre emerge from the brain or spinal cord and pass to the organs concerned. There are many pathways in each of the two systems. Along the course of each pathway there is a complex set of synapses constituting a ganglion. The nerve fibres on the proximal side of the ganglion are called pre-ganglionic fibre, those on the distal side post- ganglionic fibres,

The main structural difference between the parasympathetic and sympathetic system relate

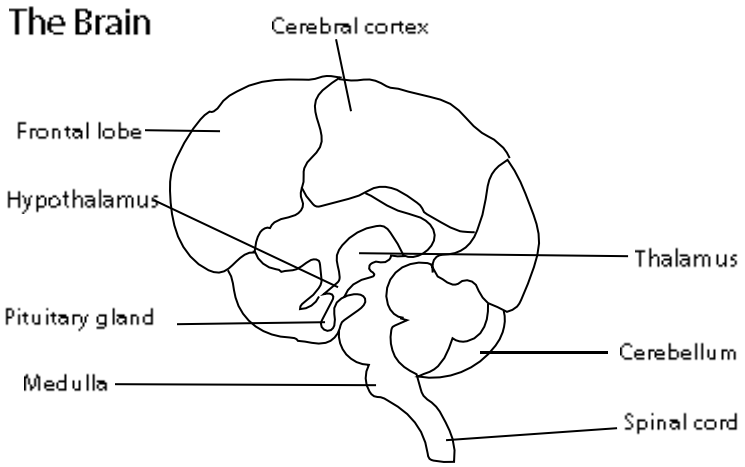
the position the ganglion and are given below.

	Sympathetic	Parasympathetic
	Structural differences	
1.	ganglia lie close to the vertebrate	Ganglia are embedded in the walls of the effector
2.	Preganglionic fibre short	Long preganglionic fibre
3.	Long post ganglionic fibre	Short post ganglionic fibre
	Functional differences	
4	Transmitter is noradrenaline	Transmitter substance is acetylcholine
5.	Accelerates heart beat	Slow heart beat
6.	Dilate bronchioles	Constricts bronchioles
7.	Dilates iris	Constricts iris
8.	Slows gut	Speeds up gut movement
9.	Constricts bladder and anal sphincter	Relaxes bladder and anal sphincter
10	Cause relaxation of bladder	Causes contraction of bladder
11.	Contracts erector pili muscles	-
12.	Increase sweat secretion	-
13.	-	Stimulates tear glands
14	-	Causes flow of saliva and other secretion

The brain

The brain is swollen anterior end of the vertebrate neural tube which has the over role of the coordination and control of the activities of the whole nervous system. To accomplish this there are special centers or nuclei in the different parts of the brain for dealing with specific functions such as locomotion, balancing and so on

Functions of the brain
1.Recieves impulses from receptors
2.Intergrates these impulses
3.sends out new impulses to the appropriate effect.



Function of the main parts of the brain the human brain.

1. **Medulla oblongata** is the most posterior part of the brain. It contains centers controlling breathing, circulation, swallowing salivation and vomiting.

2. The **cerebellum** coordinates voluntary movements such as posture, balance, coordination, and speech, resulting in smooth and balanced muscular activity. It is also important for learning motor behaviors
3. **The thalamus and associated structures**: contain centers controlling such function as sleep, aggression, feeding, drinking, osmoregulation, temperature regulation, speech and sexual activity.

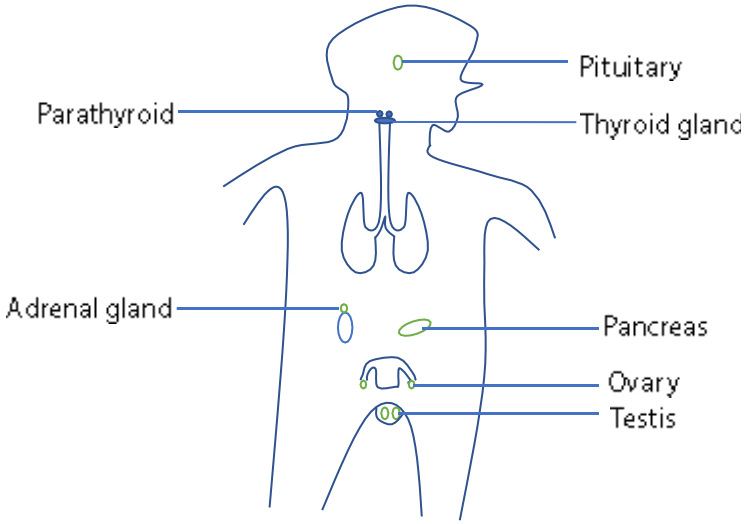
4. **Pituitary** is an endocrine gland that secretes a wide range of hormones controlling such function as water and salt balance, growth, metabolism and sexual development.

5. **The cerebral hemispheres** coordinate all voluntary response.

Hormonal communication.

Hormones are organic compounds produced in one part of the body, from which is transported - usually in the blood stream – to another part when it evokes a response.
In the human and other vertebrate hormones are secreted into the blood stream by endocrine glands.

Position of the main endocrine gland in a human body



The principle endocrine glands of mammal, hormones and functions of the hormones

	Gland	Hormone	main function
a.	Thyroid	Thyroxine	Raise basal metabolic rate
		Calcitonin	Opposes action of parathormone
b.	Parathyroid	Parathormone	Controls concentration of calcium and phosphate ions in blood
c.	Pancreas	insulin	lows blood sugar concentration
d.	Adrenal medulla	adrenaline	prepare body for emergency; metabolic rate increases,
e.	Adrenal cortex	Aldosterone	Controls concentration of K^+ and Na^+ in blood
		Cortisol	Prevent excessive immune response
		androgens	Promotes development of testes and secondary sexual characteristics
F	Pineal body	melatonin	causes concentration of melanin in frog's skin; promote sexual development in mammal
g.	Testes	Androgens	Promotes development of testes and secondary sexual characteristics
h.	Ovaries	Estrogens	promotes development of ovaries secondary sexual characteristic of female control menstrual cycle and pregnancy.
I	Pituitary (anterior lobe)	Thyroid stimulating hormone	Causes the thyroid gland to secrete thyroxine
		Adreno - corticotrophin (ACTH)	Cause adrenal cortex to secrete adrenal cortical hormones
		Growth hormones	Stimulate growth
		prolactin	Causes mammary gland to secrete milk
		Follicle stimulating hormone	Controls testes and ovary
		Luteinizing hormone	Controls testes and ovaries
	Pituitary (posterior lobe)	Antidiuretic hormone (ADH)	Causes reabsorption of water in kidney
		oxytocin	Causes contraction of uterus at birth

How hormones control cells

When a hormone molecule reaches a target cell, it binds to the plasm membrane at a specific receptor site. The receptor site is located on the outer surface of the membrane and is associated with a molecule of adenylate cyclase. The binding of hormone to the membrane increases the activity of adenylate cyclase, causing ATP to convert into cyclic AMP. The cyclic AMP [Adenosine monophosphate] then activate enzymes which bring about the appropriate response with in the cell. The extent of the particular response is determined by the concentration of cyclic AMP which in turn depends on a delicate balance between adenylate cyclase responsible for synthesis, and another enzyme phosphodiesterase - which destroys it.

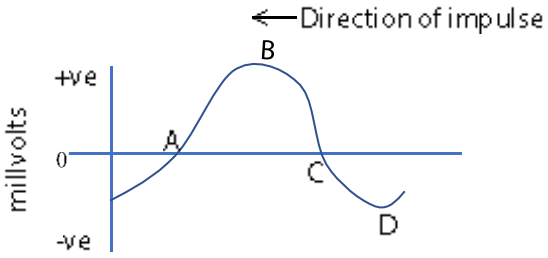
Exercise

1. Onset of depolarization of an axon occurs when the axoplasm temporarily become
   A. more negative
   B. less negative
   C. **m**ore positive
   D. less positive
2. Wearing a coarse shirt causes a tickling sensation but the sensation disappears. Which of the following is **not** explanation of this observation?
   A. Supply of transmitter substances get exhausted
   B. The discharge of impulses at afferent nerve ceases
   C. The membrane surrounding the generator region becomes less permeable to sodium ions
   D. Generator potential falls below threshold values
3. Which of the following occurs when the axon is depolarized?
   A. Sodium enters the axon, potassium leave
   B. Both sodium and potassium ions leave the axon
   C. Potassium enter the axon and sodium leave
   D. Both sodium and potassium ions enter the axon
4. A person who walks unsteadily may have a defect in the
   A. Cerebrum
   B. Cerebellum
   C. Medulla oblongata
   D. Hypothalamus
5. Which one of the following describes the sodium-potassium pump?
   A. Active pumping potassium ion out of the axon and sodium ions into it.
   B. Equal concentration of the ions on either side of the axon when at rest
   C. Inability of the axon to absorb the two ions passively
   D. Active pumping sodium ion out of the axon and potassium ions into it.
6. Which one of the following is not a transmitter substance?
   A. Acetylcholine
   B. Cholinesterase
   C. Atropine
   D. Noradrenaline
7. The principle function of the autonomic nervous system is to
   A. Innervate the internal organs
   B. Control the contraction of skeletal muscles.
   C. Regulate and control the peripheral nervous system
   D. Transmit impulses from the brain to the central nervous system
8. Which of the following represent the correct order of events that occurs at the synapse during impulse transmission?
   A. Ca^{2+} ion influx, release of transmitter substances, depolarization
   B. Depolarization, release of transmitter substance, Ca^{2+} ion influx
   C. Release of transmitter substances, Ca^{2+} ion influx, depolarization
   D. Release of transmitter substances, depolarization, Ca^{2+} ion influx

9. A likely effect of inhibiting the action of acetylcholinesterase at a synapse is
   A. Cessation of impulse transmission
   B. Speeding up of impulse transmission
   C. Continuous impulse transmission
   D. Slowing down of impulse transmission
10. Which one of the following occurs to the axon membrane during an action potential? It is
   A. Polarized with inside negative outside positive
   B. Depolarized with inside negative while outside positive
   C. Depolarized with inside positive while outside negative
   D. Polarized with inside positive while outside negative
11. Myelinated axons of a frog conduct impulses three times less fast as those of the same diameter in rat because the
   A. Myelin sheath in axons of frogs are thinner
   B. Rats are endothermic
   C. Neuron of a frog have more synapses
   D. Frog lives in water which is cold
12. Increased permeability of the post synaptic membrane to allow chloride ion in, and potassium ions out of the cell causes
   A. Depolarization of the cell membrane
   B. Polarization of the membrane
   C. Excitation of the membrane
   D. Hyper polarization of the membrane

13. After an action potential, repolarization of the membrane begins by
   A. Entry of sodium into the cell
   B. Sodium ion diffusing out of the cell
   C. Entry of potassium ions into the cell
   D. Potassium ions diffusing out the cell
14. Wearing a coarse shirt cause unpleasant sensation at first but latter the discomfort disappears because
   A. With continued stimulus, generator falls below threshold value
   B. The post synaptic surface fails to release the transmitter substance
   C. Nervous system stops carrying sensory impulse
   D. Continued stimulation leads to fusion of generator potential
15. Which one of the following is the correct statement about a neuron membrane during resting potential?
   A. The inside of neuron membrane is negatively charged
   B. The Na^+, K^+ and Cl^- ions are evenly distributed on either side of the membrane
   C. The concentration of Na^+ ions is greater inside the membrane
   D. The concentration of K^+ is greater outside the membrane
16. Which one of the following describes the state of the membrane during resting potential?
   A. Polarized
   B. Neutral
   C. Depolarized
   D. Discharged

17. Which one of the following is correct about the sympathetic nervous system?
    A. Nerve endings produce noradrenaline
    B. Preganglionic fibres are long and post ganglionic fibres are short
    C. Nerve endings produce acetylcholine
    D. Ganglia are embedded in the walls of the effector
18. The figure below shows changes in electrical potentials in an axon membrane when an impulse is transmitted.



At which stage of the electrical potential marked, is the axon most permeable to sodium?

19. Impulse crosses a synapse by means of
    A. Sodium ions
    B. Potassium ions
    C. Calcium ions
    D. Neurotransmitter chemicals
20. Impulse transmission in mammals is usually faster in mammals than it is in amphibians because
    A. Axons of amphibians lack myelin sheath
    B. Mammals have axons with larger diameter
    C. Mammals usually have high body temperature
    D. The distance between the node of Ranvier in mammals is short
21. Which one of the following would occur at the onset of an action potential in a neuron?
    A. Potassium ions enter
    B. Sodium ion leave
    C. Potassium ion leave
    D. Sodium ion enter
22. Which one of the following is caused by a high concentration of sodium ions outside the neuron?
    A. Production of successive action potentials
    B. Excitation of the neuron
    C. Inhibition of the release of the transmitter substance
    D. Polarization of the neuron

23 Which one of the following does **not** happen when an impulse reaches a synapse?
    A. Facilitating passage of subsequent impulses
    B. Being blocked
    C. Being reversed
    D. Inhibiting passage of subsequent impulses

24. During an action potential in a neuron,
    A. Potassium ions diffuse into the axon
    B. Sodium ions diffuse out of the axon
    C. Sodium ions diffuse into the axon
    D. Both sodium and potassium diffuse out

25. Which one of the following statement is true only of sympathetic nervous system?
    A. Nerve endings produce nor-adrenaline
    B. Preganglionic fibers are short
    C. Nerve ending produce acetylcholine
    D. Preganglionic fibers are long
26. Injection of thyroxine into laboratory mammal would cause
    A. Oxygen consumption to increase
    B. Metabolic rate to decrease
    C. Conversion of glucose into glycogen
    D. Thyroid gland to become more active
27 Wearing a coarse shirt, a tickling causes sensation but later the sensation disappears. Which one of the following is not an explanation of this observation?
    A. Supply of transmitter substances get exhausted
    B. Discharge of impulses of afferent nerve ceases
    C. The membrane surrounding the generator region become less permeable to sodium ions
    D. Generator potential falls below threshold value
28. Which one of the following occurs when the axon membrane depolarizes?
    A. Sodium ion enters the axon and potassium leave
    B. Both sodium and potassium ions leave the axon
    C. Potassium enter the axon and sodium leave
    D. Both sodium and potassium ions enter the axon

29. A mother, who lacked milk in her breasts at the birth of her baby was diagonized to have a brain damage. Which of the following parts of the brain is most likely to have been affected?
    A. Posterior lobe of the pituitary gland
    B. Pineal body
    C. Anterior lobe of pituitary gland
    D. Cerebrum
30. Which one of the following is not a transmitter substance?
    A. Acetylcholine
    B. Cholinesterase
    C. Atropine
    D. noradrenaline
31. The myelin sheath and the diameter of the axon of a neuron are important in that they
    A. Enable impulses to be transmitted from one node of Ranvier to another
    B. Increase the speed at which impulses are transmitted
    C. Maintain a constant strength of each impulse
    D. Allow quick exchange of ions

32. Which one of the following is correct about the refractory period in an axon of a nerve fibre?
A. Inhibitory postsynaptic potentials are generated
B. Voltage activated sodium channel open
C. The axon cannot transmit impulses
D. The axon can transmit impulses at higher voltage

33. Which one of the following describes the sodium-potassium pump?
A. Active pumping of potassium out of an axon and sodium into it.
B. Equal concentration of the ions on either side of the axon when at rest
C. Inability of the axon to absorb the two ions passively
D. Active pumping of sodium ions out of the axon and potassium into it

34. Which one of the following occurs when the axon membrane depolarizes?
A. Sodium ions enter the axon and potassium ion leave
B. Both sodium and potassium ions leave the axon
C. Potassium ions enter the axon and sodium ion leave
D. Both sodium and potassium ion enter the axon

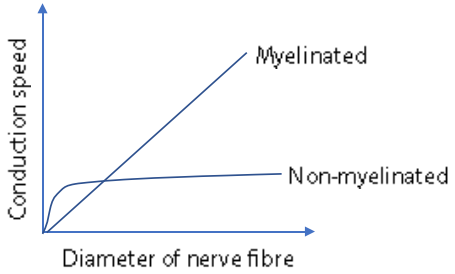
35. Which one of the following would be the best indicator that a cell is responding to a hormone?
A. High concentration of cyclic AMP
B. Low concentration of AMP in cell
C. Low concentration of adenyl cyclase in the cell
D. High amount of ATP in the cell

36. A person who walks unsteadily may have a defect in the
A. Cerebrum
B. Cerebellum
C. Medulla oblongata
D. Hypothalamus

Structured questions

37. (a) Give one function of synapse (01mark)
(b) When an action potential arrives at the synapse, calcium ions enters the neuron through presynaptic membrane.
(i) Explain how the calcium ions enter the neuron (02marks)
(ii) Describe the events which occur as a result of the entry of the calcium ions to cause depolarization of the post synaptic membrane. (05marks)

38. The figure below shows the variation of a nerve impulse conduction speed with total diameter, of myelinated and non-myelinated fibres



(a) Compare the variation of the speed of conduction with the diameter in the two types of fibres (4marks)

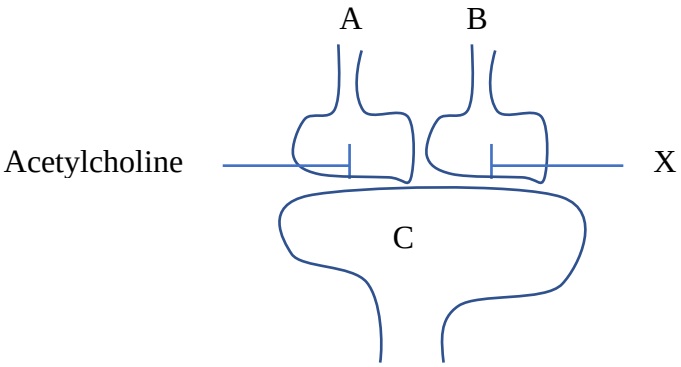
(b) Explain the difference in the conduction speed of the two fibres (2marks)

(c) Suggest the significance of the transmission speed in nervous communication.

(4marks)

39. (a) In the space below, draw a labeled structure of synapse (04marks)
(b) How does an impulse cross a synapse? (06marks)

40. The figure shows dendrites from neurons A and B forming synapse with neuron C



(a) Explain what would happen if

(i) Acetyl choline increased the permeability of the post synaptic membrane to Na^+ ions. (3marks)

(ii) X increased the permeability of the post synaptic membrane to Cl^- ions

(3marks)

(b) State a benefit of neuron C forming synapses with two neurons a and B. (1marks)

(c) State three function of synapse. (3marks)

41. The figure 3 shows changes in an axon as an impulse passes along the axon.

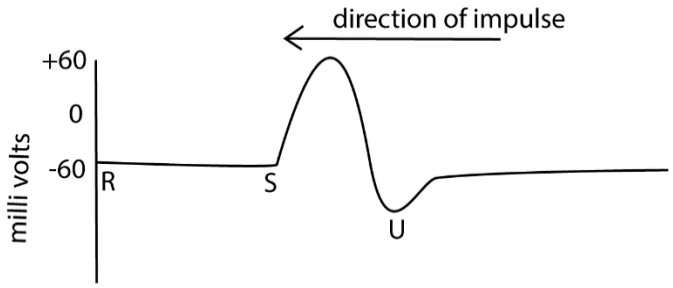
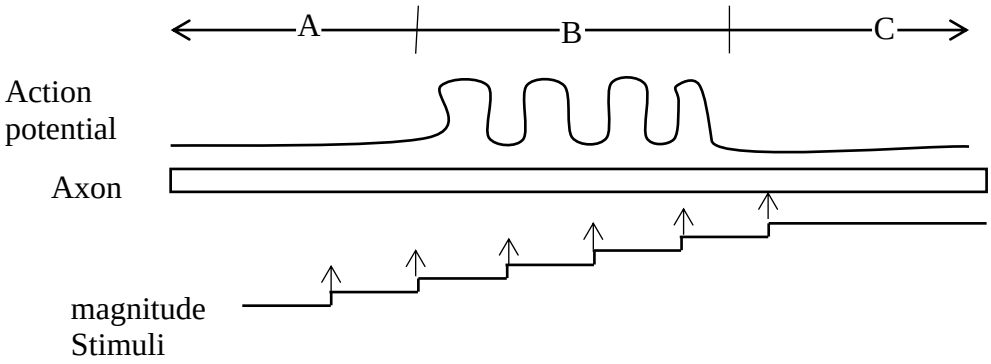


Fig.3

(a) What is the state of the axon membrane between
    (i) R and S (01mark)
        S and T (01mark)
(b) Describe the movement of ions across the axon membrane between
    (i) R and S (2marks)
    (ii) S and T
    (iii) T and U
(c) Why is it diffucult to stimulate an axon shortly after it has transmitted an impulse? (02marks)

42. The figure shows the result of one end of axono being stimilated with six electrical shocks of gradually increasing intensity and its response from other end. Study the figure and answer the following questions



(a) Describe the behavior of the axon in the regions labelled A, B,and C in relation to the magnitude of the stimulus given
Region A.....

Region B.....

Region C.....

(b) What principle does the behavior of the axon illustrate?
(c) What determines the speed at which an impulse it transmitted along an axon?
(d) what is the advantage to an organism of having its impulse transmitted rapidly>

Assay question

43. (a) Draw a fully labelled diagram of a neurotransmitter junction
    (b) Explain how the impulse are transmitted across the junction in (a) above
    (c) How is the transmission across the synapse controlled?

44. (a) Explain the following processes involved in transmission of impulses along a neuron
        (i) The formation of the resting potential
        (ii) The formation and transmission of an action potential
    (b) How does a retina transduce light energy into a nerve impulse

4	1997/1/42	.... (d) What determines the speed at which an impulse is transmitted along the axon? ....
	Paper 2 questions	
1.	1992/2/6	(a)
2.	1997/1/4	45.

Answers to objective type questions

1	C	11	B	21	D	31	B		
2	B	12	D	22	D	32	D		
3	A	13	D	23	A	33	D		
4	B	14	A	24	C	34	A		
5	D	15	A	25	A	35	A		
6	B	16	A	26	A	36	B		
7	A	17	A	27	D				
8	A	18	A	28	A				
9	C	19	D	29	C				
10	C	20	C	30	B				

37. (a) Function of the synapse are

Function of synapse

(i) Ensure unidirectional flow of impulse from neuron to the next.

(ii) Amplifies the impulses by producing sufficient acetylcholine to excite.

(iii) Adaptation or accommodation;
The amount of transmitter substances released by a synapse steadily falls off in the response to constant stimulation until the supply of transmitter substance is exhausted and the synapse is described as fatigued. Further information passing along this pathway is inhibited and the adaptive significance of fatigue in the prevention of damage effect due to over stimulation.

(iv) Integration;
A post synaptic neuron receives stimuli from a variety of source and integrates them and produce a coordinated response.

(v) Discrimination;
Temporal summation at synapse enable weak background stimuli to be filtered out before it reaches the brain.eg information from receptor in the skin, the eyes and ears receive constant stimuli from the environment which has little immediate importance for the nervous system. Only changes in the intensity of stimuli are significant to the nervous system and these increase the frequency of stimuli and pass across the synapse and evoke a response.

(vi) Inhibition;
The transmission of information across a synapse and neuromuscular function may be prevented post-synaptically by the activity of certain chemical blocking agents or pre-synaptically.

(b)(i) Arrival of impulse causes the calcium voltage gates to open leading to influx of calcium ions from the synaptic cleft.

(ii)

(a) The Ca^{2+} ion causes the synaptic vesicles to move towards the pre-synaptic membrane.
(b) The vesicles fuse with the pre- synaptic membrane and release a transmitter substance into the synaptic cleft by exocytosis.
(c) The transmitter substance diffuses across the synaptic cleft and attaches to specific receptor sites on the post synaptic membrane.
(d) This causes an influx of Na^{+} ion into post- synaptic membrane, resulting in local depolarization of the membrane. If the Na^{+} ion surge is large enough, an action potential (impulse) is generated in the post –synaptic neuron.

38. (a) In both myelinated fibre, the conduction speed increases with increase in the diameter of the nerve fibre.

In myelinated fibre. The conduction speed increases linearly with increase in the diameter of the nerve fibre while in non-myelinated fibre the increase is non-linear

Increase in the diameter of the nerve fibre beyond 1 arbitrary unit still causes a steep linear increase in the conduction speed in myelinated fibre while the conduction speed in non – myelinated fibre remain almost constant.

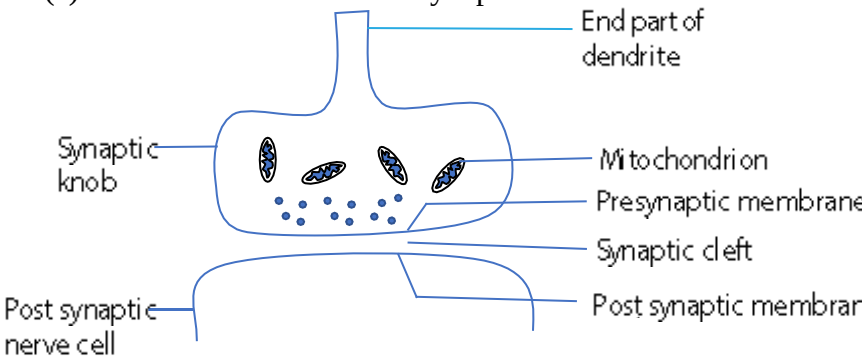
(b) Myelinated fibres are surrounded by myelin sheath (with high electrical resistant) which is interrupted at intervals by nodes of Ranvier (with low electrical resistance). Thus during impulse transmission, depolarization only occurs at nodes of Ranvier. This mean the action potential leaps from node to node thereby speeding up impulse conduction.

Note: the types of impulse conduction in which an action potential "jumps" from node to node along a myelinated axon is known as salutatory conduction.

(c) Fast transmission of impulse from receptor to muscles allow rapid responses to stimuli, thus enabling the animal to escape danger.

Quick impulse transmission enables an organism to respond rapidly to changes in the environment, which is important for its survival.

39 (a) Structure of the chemical synapse



(b) Transmission across a synapse.

(i) Arrival of an impulse at the synaptic causes an influx of Ca^{2+} ions into the knob from the synaptic cleft.

(ii) The Ca^{2+} ion causes the synaptic vesicles to move towards the pre-synaptic membrane.

(iii) The vesicles fuse with the pre- synaptic membrane and release a transmitter substance into the synaptic cleft by exocytosis.

(iv) The transmitter substance diffuses across the synaptic cleft and attaches to specific receptor sites on the post synaptic membrane.

(v) This causes an influx of Na^+ ion into post- synaptic membrane, resulting in local depolarization of the membrane. If the Na^+ ion surge is large enough, an action potential (impulse) is generated in the post –synaptic neuron.

40. (a) (i) Na^+ ions would move into the neuron C causing membrane depolarization. If the Na^+ ions surge into the neuron C is large enough, an action potential is generated in neuron C and an impulse is eventually transmitted from A and C.

(i) CI^- ions would move into neuron C making the membrane potential more negative. If the CI^- surge is large enough, hyperpolarization would prevent action potential to be elicited in C. This prevents transmission of an impulse from B to C

(b) It allows selective transmission of impulses to neuron C; A facilitating transmission while B inhibiting it.

(c) – all impulses to move in one direction

- They facilitate transmission of impulses from one neuron to another.
- They may inhibit transmission of certain impulses from one neuron to another.
- They control the transmission of impulses from neuron in the nervous system.
- They allow for summation of impulses.

41. (a)(i) membrane polarized

(ii) membrane depolarized

(b) (i) Sodium ions move out the cell while potassium ion move into of the cell actively against their concentration gradient by potassium/sodium pump.

(ii) Sodium channel open and sodium ion diffuse into axon causing depolarization.

(iii) Potassium gates open potassium ions diffuse out of axoplasm to polarise the membrane. Sodium gates close and permeability to sodium ions close.

(c) Time has to be allowed for the membrane to repolarise in order to respond to electrical impulse.

42. (a) Region A : axon is at resting membrane potential or polarized. No action potential is set up because the magnitude of the stimulus is below threshold

Region B: Action depolarized because magnitude of the stimulus is above threshold level.

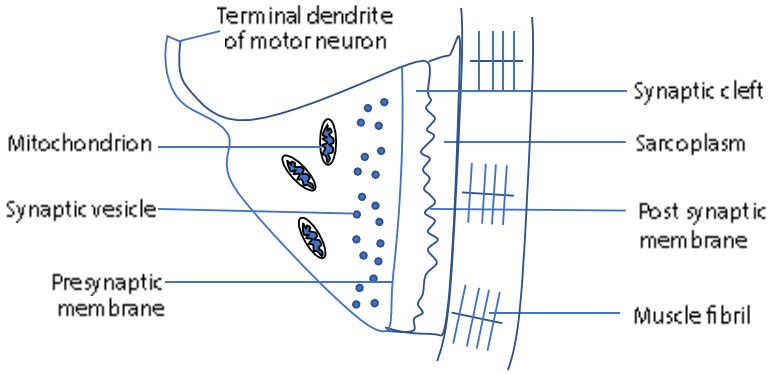
Region C: Axon repolarizing. No action potential is reversed despite the high magnitude if stimulus

(b) The all or nothing law

(c)(i) diameter of the axon, presence or absence of myelin sheath, temperature

(d) enable animal respond faster.

43 (a) Neuromuscular junction



(b) (i) Arrival of impulse causes the calcium voltage gates to open leading to influx of calcium ions from the synaptic cleft.

(ii) The Ca^{2+} ion causes the synaptic vesicles to move towards the pre-synaptic membrane.

(iii) The vesicles fuse with the pre- synaptic membrane and release a transmitter substance into the synaptic cleft by exocytosis.

(iv) The transmitter substance diffuses across the synaptic cleft and attaches to specific receptor sites on the post synaptic membrane.

(v) This causes an influx of Na^+ ion into post- synaptic membrane, resulting in local depolarization of the membrane. If the Na^+ ion surge is large enough, an action potential (impulse) is generated in the post –synaptic neuron.

(c) Regulation of neurotransmission

(i) the availability and rate-of-synthesis of the neurotransmitter,
(ii) the release of that neurotransmitter,
(iii) the baseline activity of the postsynaptic cell,
(iv) the number of available postsynaptic receptors for the neurotransmitter to bind to,
(v) deactivation of the neurotransmitter by enzymes or presynaptic reuptake.

44 (a) (i) Formation of resting membrane potential

A nerve cell when at rest, it membrane inside is negatively than on the outside by a potential difference about -70mV. The mechanism that helps to achieve that polarisation are sodium potassium pumps found in the cell's membrane. These use energy to actively pump 3 Sodium ions out of the cell for every 2 Potassium ions inside the cell.

(ii) The formation and transmission of an action potential

An **impulse or action potential** is a temporary and local reversal of the resting membrane potential, arising when an axon is stimulated. Information is transmitted through the nervous system as a series of impulse which travel as action potential.

(b) Transduction of light

(i) The retina has photoreceptor cell, the cone and rod that contain photopigment called rhodopsin

(ii) Rhodopsin contains a protein called opsin and a light sensitive molecule or chromophore; retinal an aldehyde of vitamin A.

(iii) When retinal is struck by light, retinal changes from cis to trans form. the change triggers electrical impulse to the brain

(iv) Retinal in cis form it then regenerated.