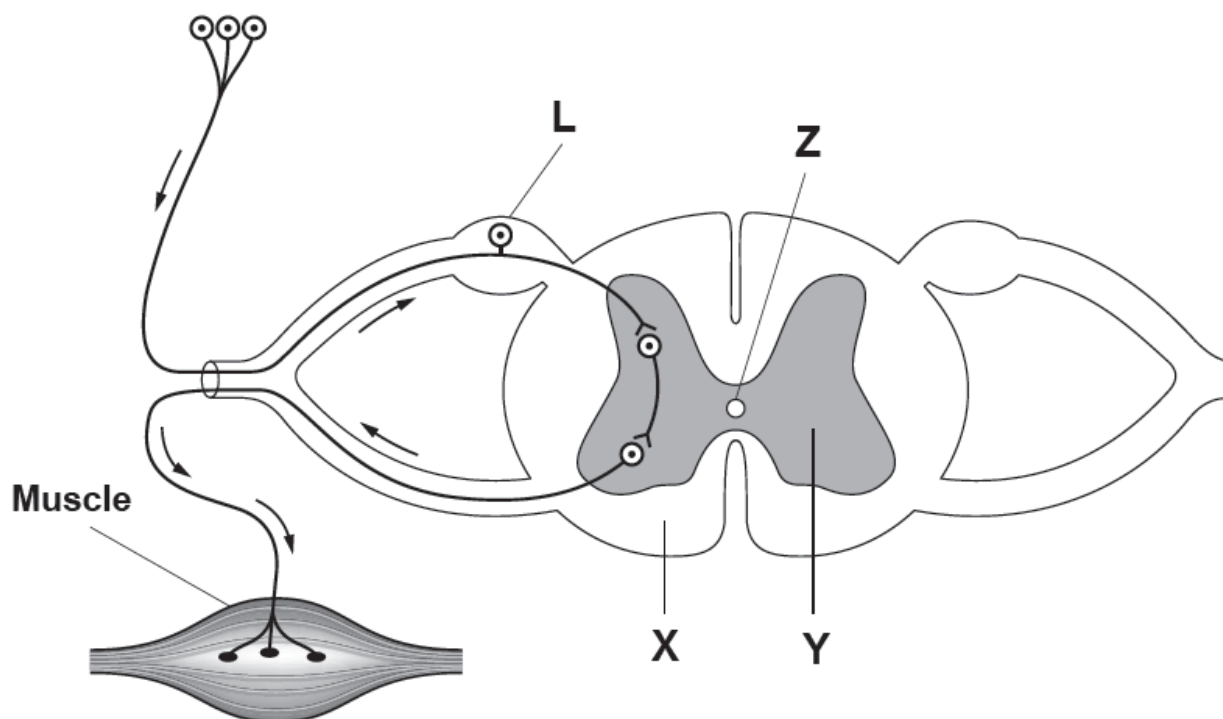


WJEC (Eduqas) Biology A-level
Topic 3.5: The Nervous System
Questions by Topic

1. The diagram below shows a transverse section of spinal cord and an associated reflex arc.



- (a) (i) Identify **X** and **Y** shown on the diagram above and explain why there is a difference in colour in these two areas.

[2]

X

.

Y

.

Explanation

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- (ii) Identify **L** and **Z** shown on the diagram above.

[2]

L

.

Z

(b) (i) What is the name given to:

[2]

I the cells which partially cover neurons

II the material which the cells produce to cover the axon

(ii) What is the function of this material in the conduction of an action potential?

[2]

(iii) Multiple sclerosis is a progressive, degenerative disease of the nervous system in which the material referred to in (b)(i) is destroyed. Symptoms include increasing muscle weakness and loss of vision. Suggest an explanation for these symptoms.

[2]

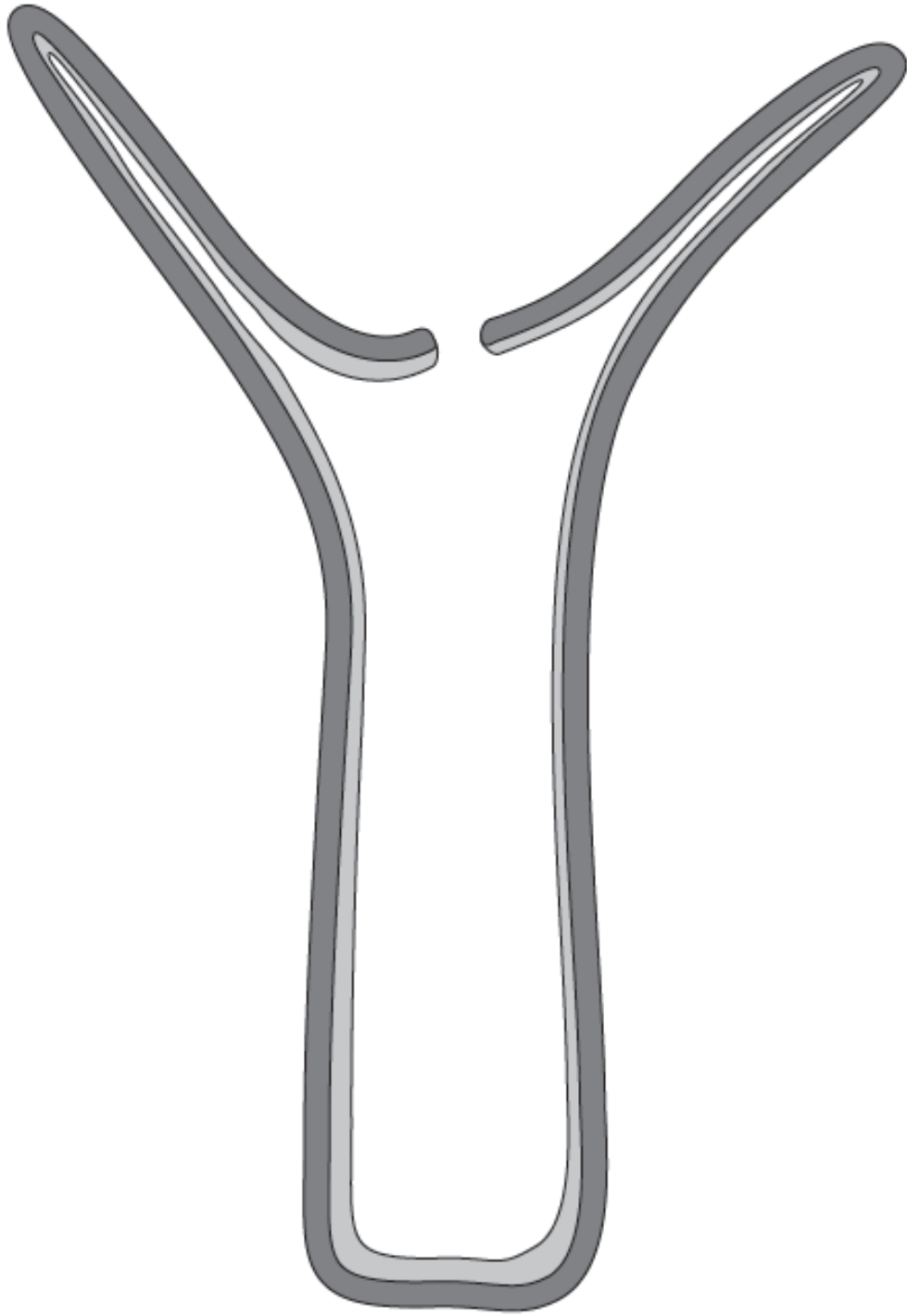
(iv) Suggest a possible medical treatment for multiple sclerosis.

[1]

(c) Nerve nets are common in some animal groups.

(i) Complete the diagram below to show a nerve net as would be seen in Hydra.

[1]

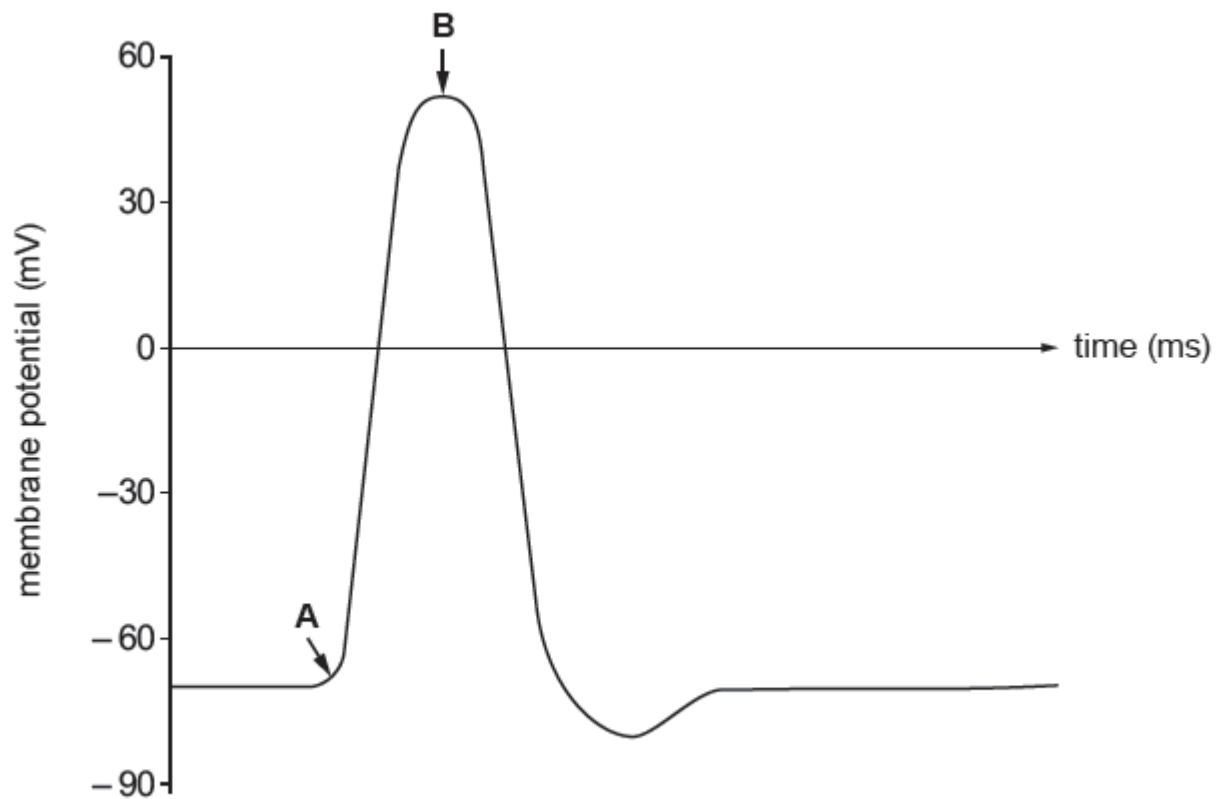


(ii) Give **two** ways in which the nerve net, as seen in Hydra, differs from that of the nervous system of a vertebrate.

[2]

2. The diagram shows the changes in the potential difference across the membrane of a neurone during the passage of

an action potential.



(a) Describe how the resting potential is maintained in the neurone.

[3]

(b) Describe the changes which are taking place in the membrane at points **A** and **B**.

[5]

A

B

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(c) Multiple sclerosis is caused by the immune system destroying the myelin sheath of neurones. Explain why this condition leads to a slowing down of the transmission of a nerve impulse.

[3]

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(d) Some chemicals such as organophosphorous insecticides increase the activity of the nervous system and others such as Beta-blockers reduce the activity of the nervous system.

Suggest two ways in which the chemicals could **increase** the activity of the nervous system and two ways in which the activity could be **decreased**.

[4]

(i) Increase in activity.

I

.....

II

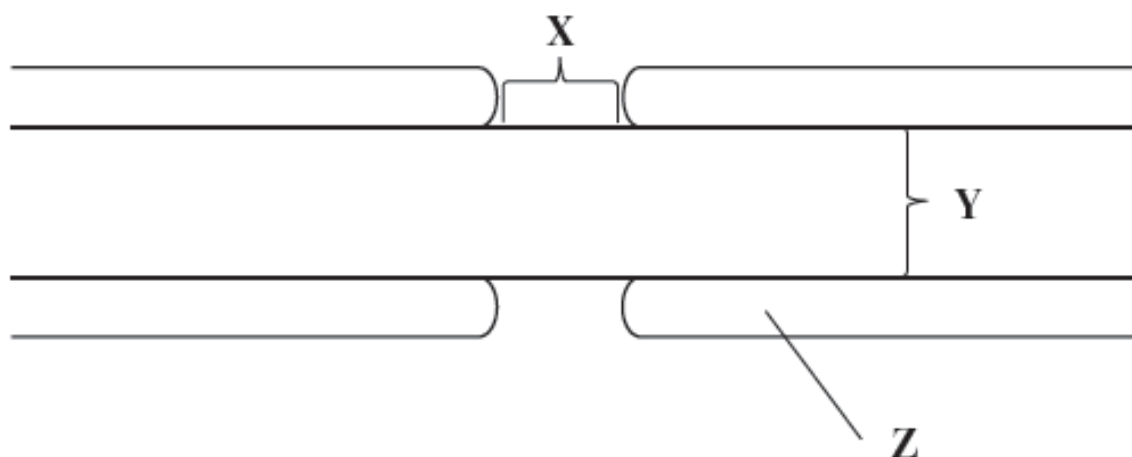
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(ii) Decrease in activity.

I

II

3. The diagram below represents part of a myelinated neurone.



(a) Name **X** and **Y** shown on the diagram above.

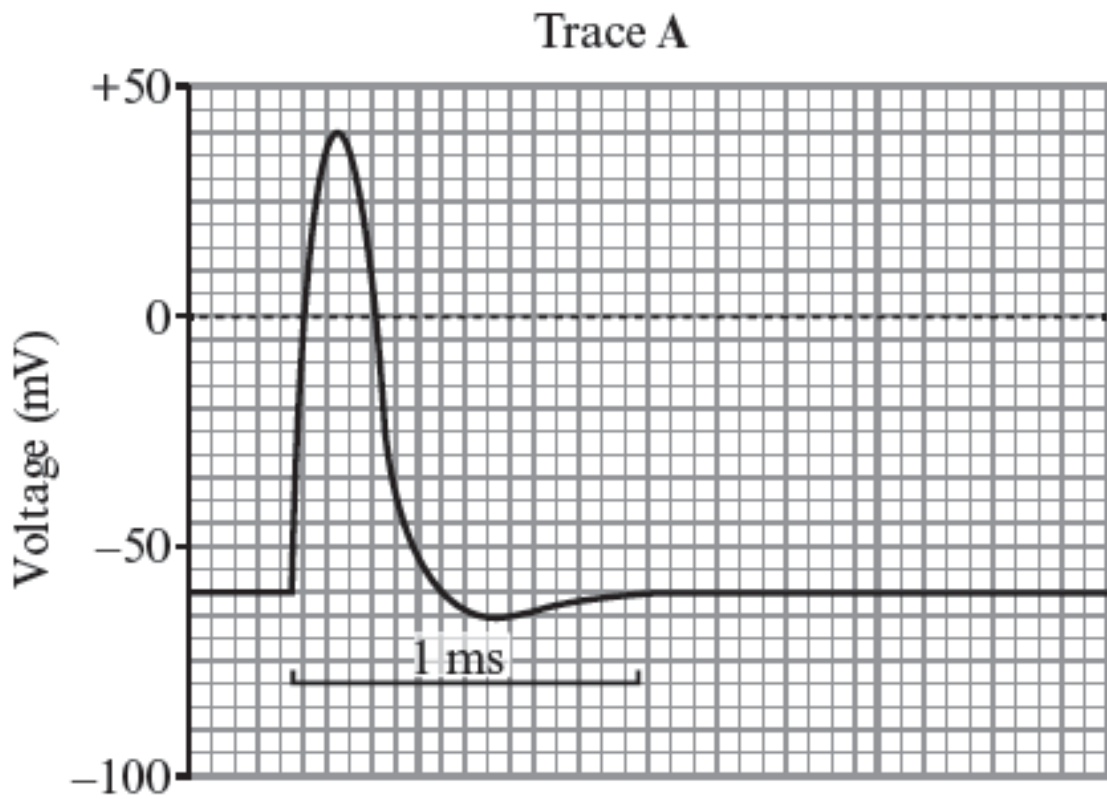
[2]

X **Y**

(b) Name the cell type that forms layer **Z**.

[1]

Trace **A** below is an oscilloscope recording of changes in voltage across the membrane of a myelinated neurone during an action potential.



(c) Use Trace **A** to estimate the resting potential of **this neuron**.

[1]

(d) (i) Explain, in terms of movement of ions, what causes the rise in membrane potential seen in Trace **A** opposite.

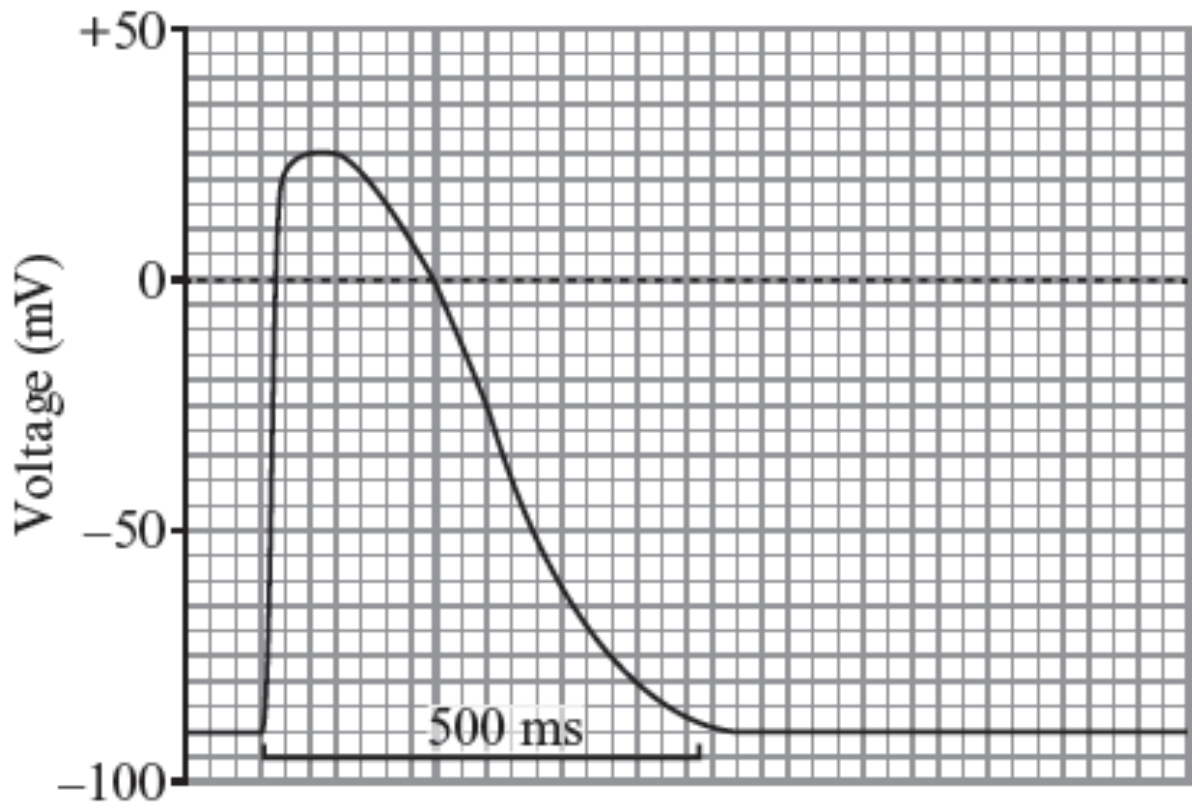
[2]

(ii) State the name given to the rapid fall in membrane potential seen in Trace **A**.

[1]

Trace **B** is another oscilloscope recording, showing changes in voltage across the membrane of a cardiac muscle fibre.

Trace B



(e) Compare Trace **A** and Trace **B** by giving two differences between them.

[2]

1.

2.

(f) Suggest how cardiac muscle fibres would respond when the voltage across the membrane rises.

[1]

(g) The cardiac muscle fibres used to obtain the oscilloscope trace were obtained from a frog's heart. Consider the

ethics of killing a frog to obtain cardiac muscle fibres by giving **one** argument in favour and **one** against.

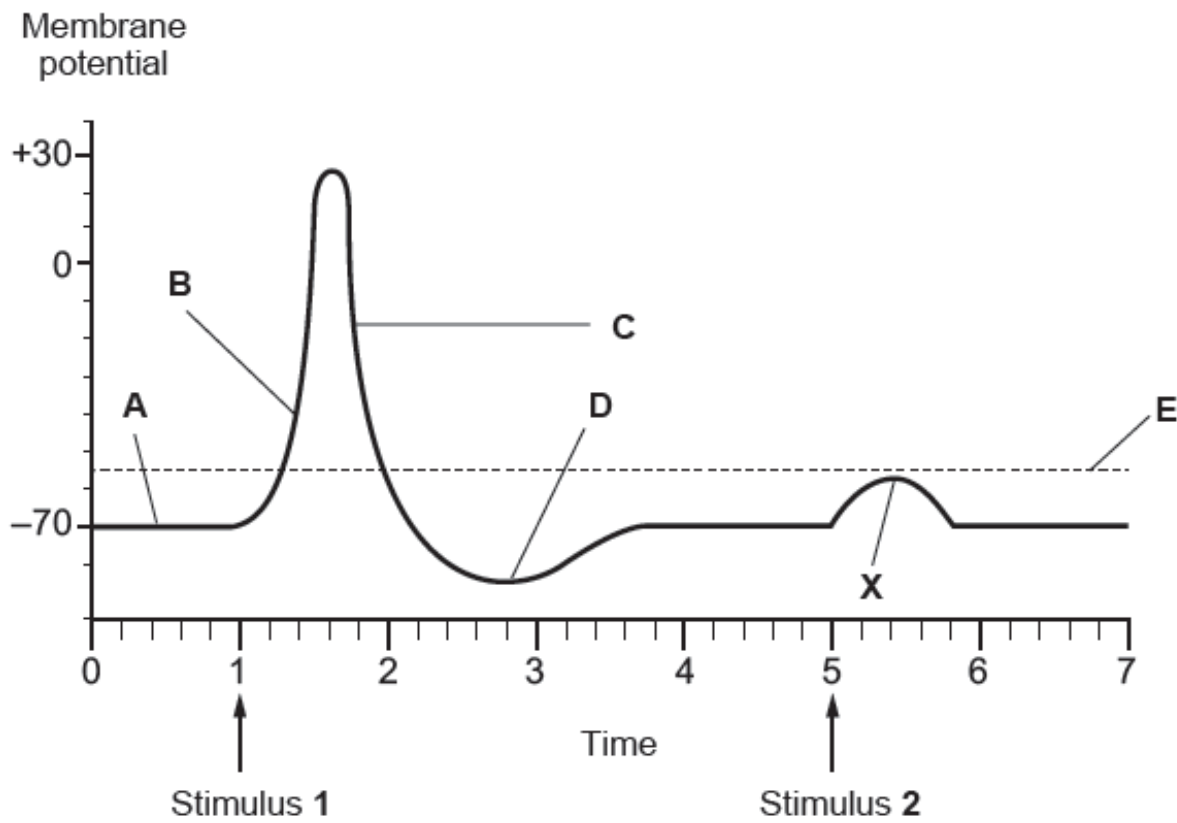
[2]

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4. An action potential is illustrated in the following graph



(a) What units should be used on the two axes of the graph shown above?

[2]

Membrane potential

Time

(b) Identify the stages of the action potential indicated by **A**, **B**, **C** and **D**.

[4]

A

B

C

D

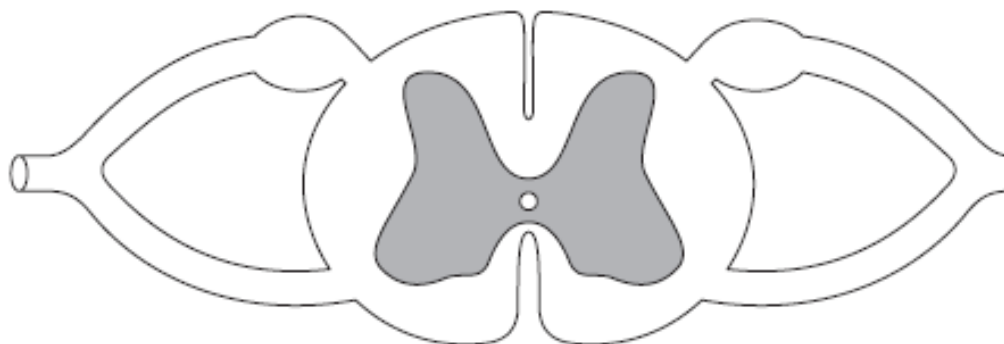
(c) (i) What is represented by line E on the graph above?

[1]

(ii) Explain why stimulus 2 failed to initiate an action potential as seen at point X.

[2]

5. The diagram shows a transverse section of the spinal cord.

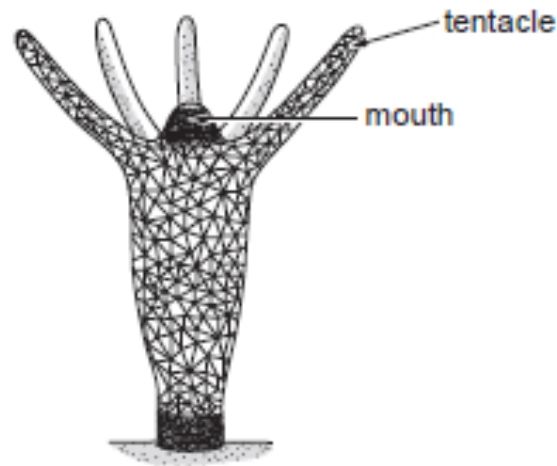


(a) (i) **Draw and label the position** of a sensory neurone and a motor neurone and label the cell bodies. [3]

(ii) When a person touches a hot object with their finger they will move away from the heat. State the advantage to humans of having this type of response to an external stimulus. [1]

- (b) Cnidaria is a phylum of invertebrate animals that are found in aquatic habitats. Their bodies consist of a jelly like substance sandwiched between two epithelial layers.

The diagram below shows the nervous system of a Cnidarian.



- (i) State the name given to this type of nervous system. [1]

- (ii) Explain why the non-myelinated neurones of Cnidarians result in slower nerve impulses than in mammals. [2]

6. Acetyl cholinesterase is one of many enzymes needed for the functioning of the nervous systems of vertebrates and insects. Certain chemical classes of pesticides, such as organophosphates, work against pests by inhibiting cholinesterase. While the effects of cholinesterase-inhibiting products are intended for insect pests, these chemicals can also be toxic to humans. In severe cases of exposure to organophosphates, symptoms include uncontrollable muscular tremors, breathing difficulty and possible death.

(a) Explain the toxic effects of the organophosphates. [5]

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(b) Psychoactive drugs can affect synaptic transmission in a number of different ways. Suggest some different mechanisms by which psychoactive drugs could decrease the rate of synaptic transmission. [4]

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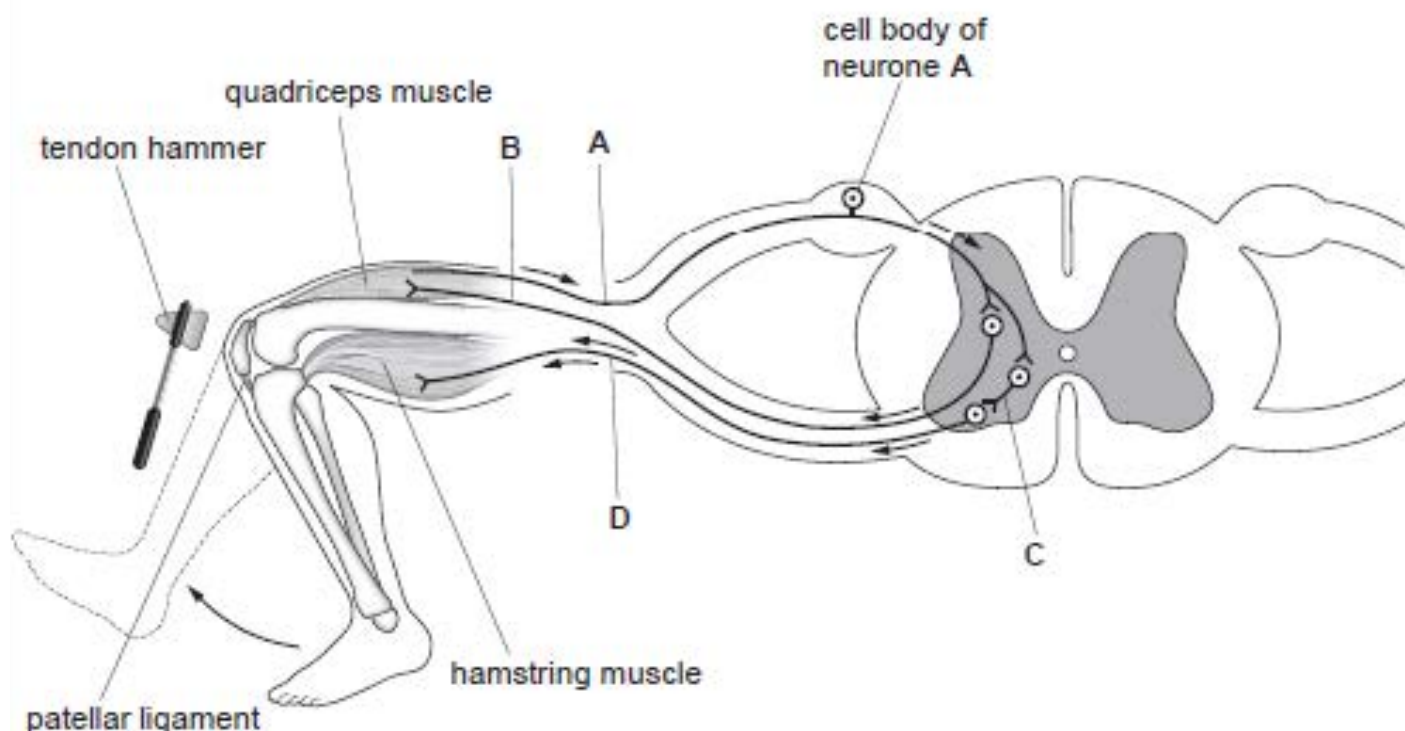
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7.

The patellar reflex (commonly known as the knee-jerk reflex) can be used to identify problems in neural communication between the quadriceps muscle and the spinal cord. The patellar ligament joins the quadriceps muscle to the lower leg bone. Normally, when the leg is tapped sharply on the patellar ligament (just below the knee cap) the quadriceps muscle contracts involuntarily. Contraction of the hamstring then returns the lower leg to its original position.



(a) Four neurones, A, B, C and D, are labelled on the diagram above.

(i) Using the letters A to D, identify the neurones involved in the reflex arcs involving: [1]

I. the quadriceps muscle

II. the hamstring muscle

(ii) With reference to the neurones involved, explain why the contraction of the hamstring muscle occurs after the quadriceps muscle, in response to the same stimulus. [2]

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- (b) Impulses are transmitted through the neurones as a wave of action potentials. Explain how the movement of ions results in the generation of an action potential. [4]

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- (c) An experiment was carried out to determine the time taken for a person to kick their leg in response to the following stimuli:

Stimulus 1. direct stimulus of the patellar ligament by the tendon hammer

Stimulus 2. hearing the tendon hammer hitting the table

The reaction times to both stimuli were collected for a group of ten people. Mean reaction times were calculated and used to calculate the standard deviations for each stimulus. A t-test value was calculated to assess whether any difference in the results was significant. The results are summarised in the table below.

	STIMULUS 1	STIMULUS 2
mean reaction time / s	0.026	0.236
number of measurements	$n_1 = 10$	$n_2 = 10$
standard deviation	0.006	0.108
t-test value	2.41	

- (i) Explain why a t-test was used to assess the significance of the differences in the results and not a Chi-squared test. [2]

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- (ii) The null hypothesis for this experiment was that *'there was no significant difference between the results for Stimulus 1 and Stimulus 2'*. The degrees of freedom for this t-test were 18.

Use the t-test value and the information given in the table below to decide whether to accept or reject the null hypothesis at a suitable probability level. Explain your answer. [4]

degrees of freedom	probability			
	0.1	0.05	0.01	0.005
1	6.31	12.71	63.66	127.32
5	2.02	2.57	4.03	4.77
8	1.86	2.31	3.36	3.83
10	1.81	2.23	3.17	3.58
18	1.73	2.10	2.88	3.20
20	1.73	2.09	2.85	3.15

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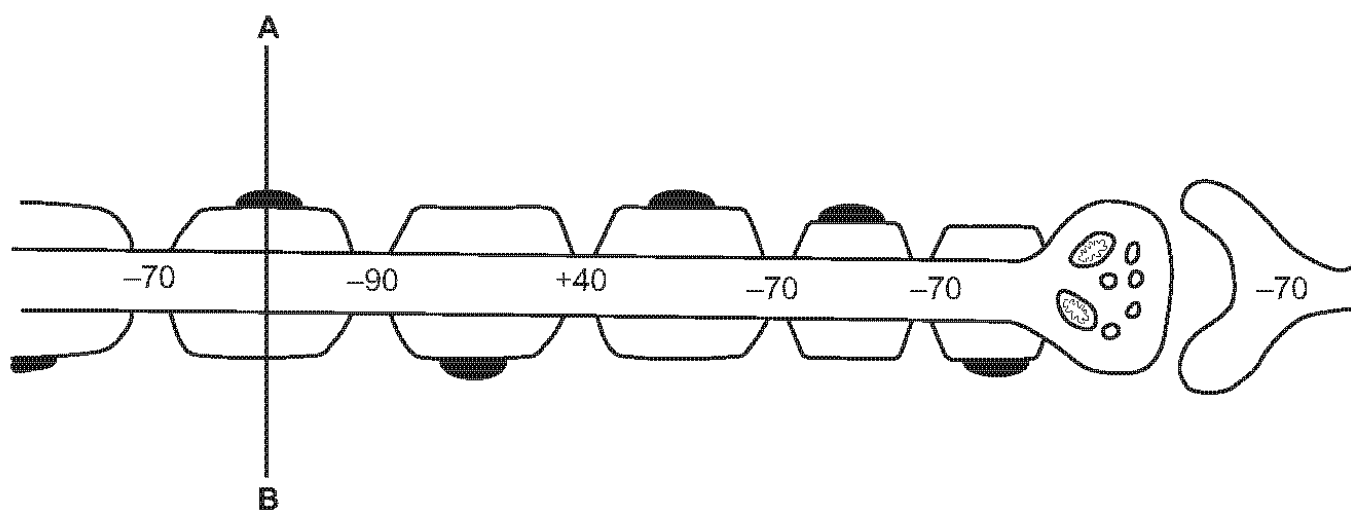
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8.

The diagram shows part of two nerve fibres and a synapse. The figures indicate the potential difference across the membrane between the cytoplasm of each fibre and the extracellular fluid at intervals along the fibre.



Figures represent potential difference across membrane in mV

- (a) Draw a circle around one region of the diagram where an action potential exists. Explain your choice. [2]

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- (b) Give two reasons shown on the diagram which would prevent the nerve impulse travelling in the opposite direction. [2]

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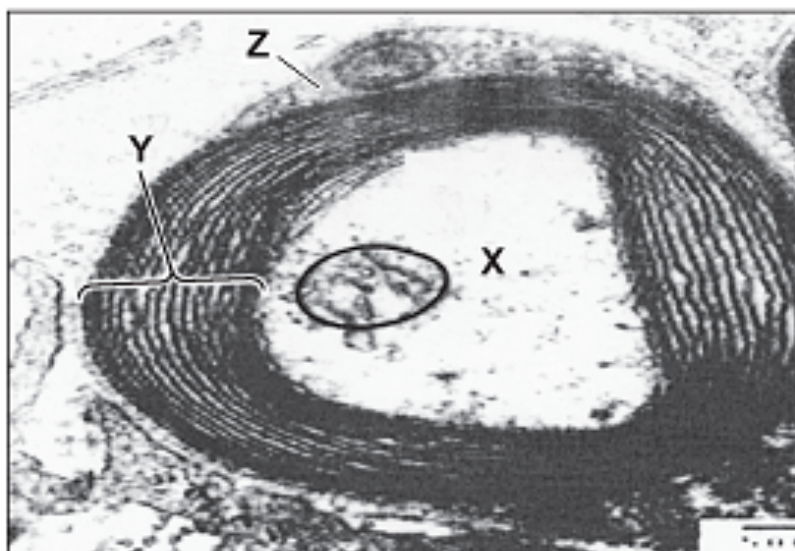
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- (c) The electron micrograph below shows a transverse section of the nerve fibre through A – B on the diagram on page 8.



- (i) Identify cell Z and structures X and Y.

[3]

cell Z

structure X

structure Y

- (ii) Explain what would happen to the rate of transmission of the nerve impulse if structure Y was damaged. [2]

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(d) Curare is a poisonous plant extract used by South American Indians on the tips of blowpipe arrows. It causes muscle paralysis in the victim by acting on the post synaptic membrane, preventing the transmission of the nerve impulse across a neuromuscular junction.

- (i) Suggest and explain how curare may prevent the transmission of the impulse across the neuromuscular junction. [3]

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- (ii) Suggest why curare has no effect on the contraction of the muscles of the heart. [1]

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9. Complete the following table indicating whether the statement is true or false by placing a tick (✓) in the correct box. [4]

Statement	True	False
Motor neurones have only a single dendrite.		
Motor neurones have many axons.		
Dendrites receive and integrate impulses.		
Dendrites of motor neurones are rarely myelinated.		

4

10.

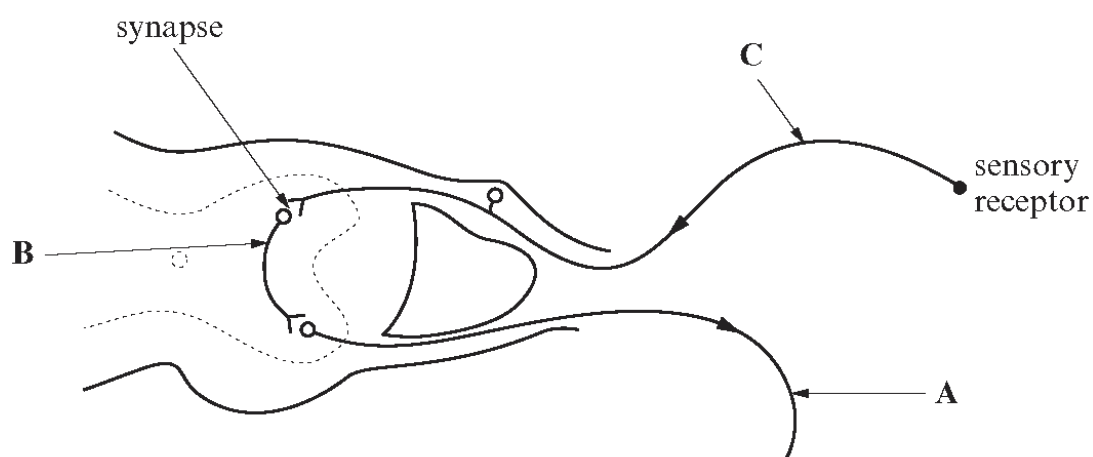
(a) What is a reflex action?

[2]

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(b) The diagram shows the neurones in a reflex arc.



Name the types of neurone labelled **A**, **B** and **C**.

[1]

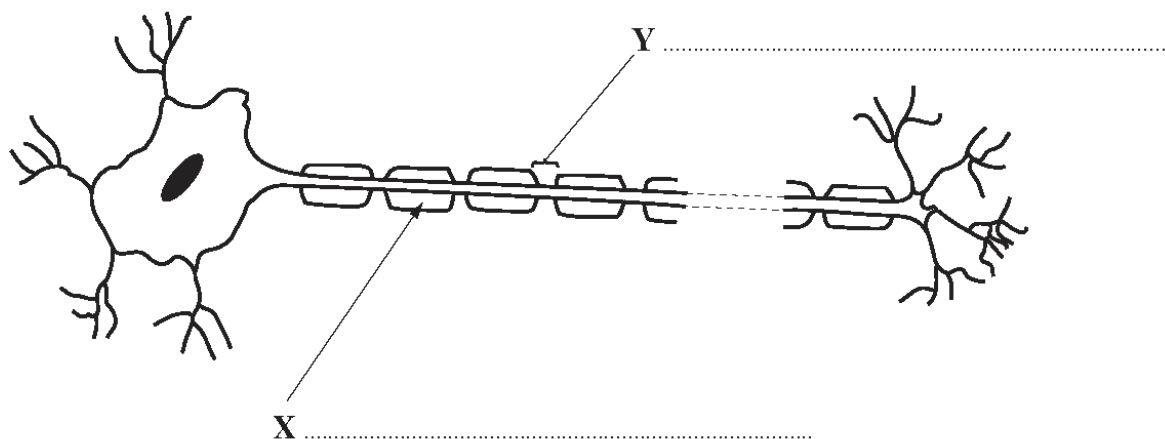
A

B

C

(c) The diagram below represents a neurone.
On the diagram, label the structures **X** and **Y**.

[2]



- (d) (i) Describe how a resting potential is maintained in a neurone. [2]

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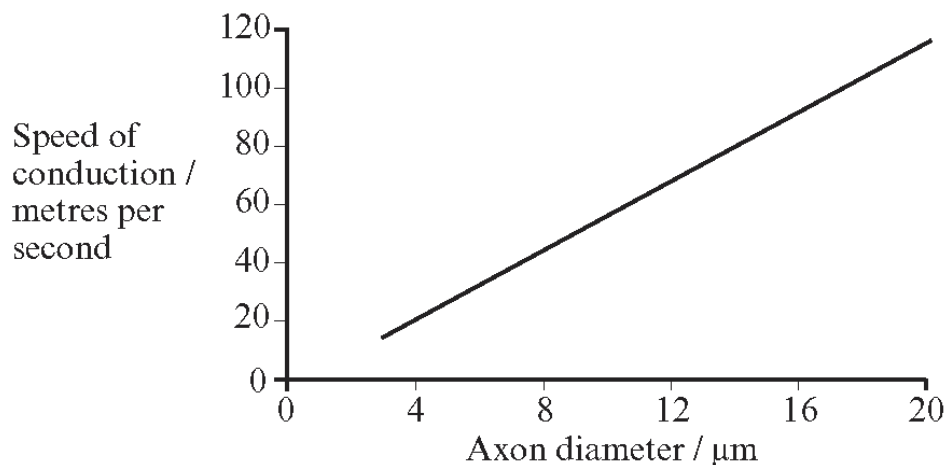
- (ii) Describe how the potential across the membrane is reversed when an action potential is produced. [2]

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- (e) The graph shows the relationship between the diameter of the axon and the speed of conduction of nerve impulses in myelinated axons of a cat.



- (i) Describe the relationship between the diameter of the axon and the speed of conduction. [1]

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- (ii) Suggest an explanation for this increase in speed of conduction. [2]

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- (iii) Explain why a myelinated axon uses less ATP to transmit a nerve impulse than a non-myelinated axon of the same diameter. [2]

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11. The diagram represents the spinal cord and structures involved in the hand withdrawal reflex. (Not drawn to scale).



- (a) Draw and **label** on the diagram a sensory, relay and motor neurone involved in the reflex action when a hand is withdrawn from a hot object. [3]
- (b) Explain giving **two** reasons, why nerve impulses can only travel in one direction. [2]

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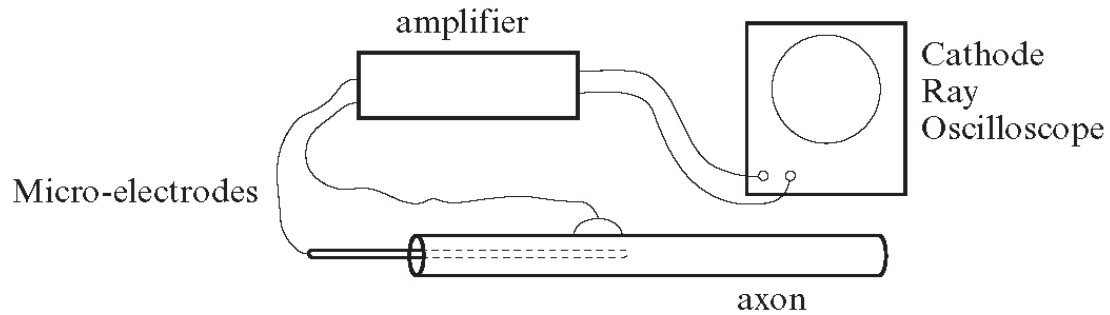
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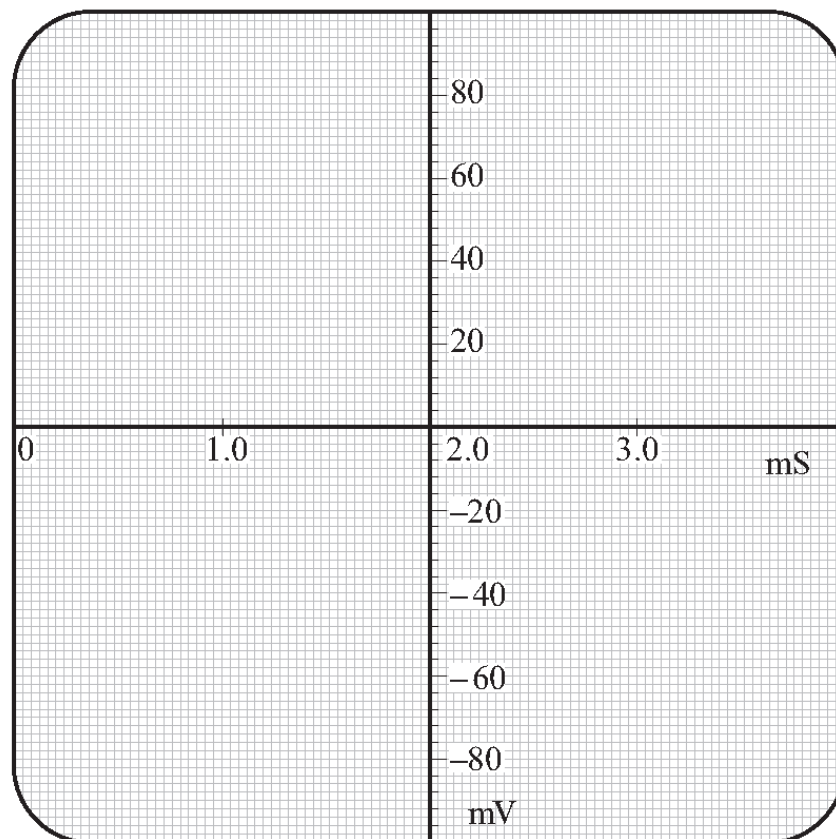
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- (c) The equipment shown in the diagram below is used to measure electrical potential across the membrane of squid giant axons.

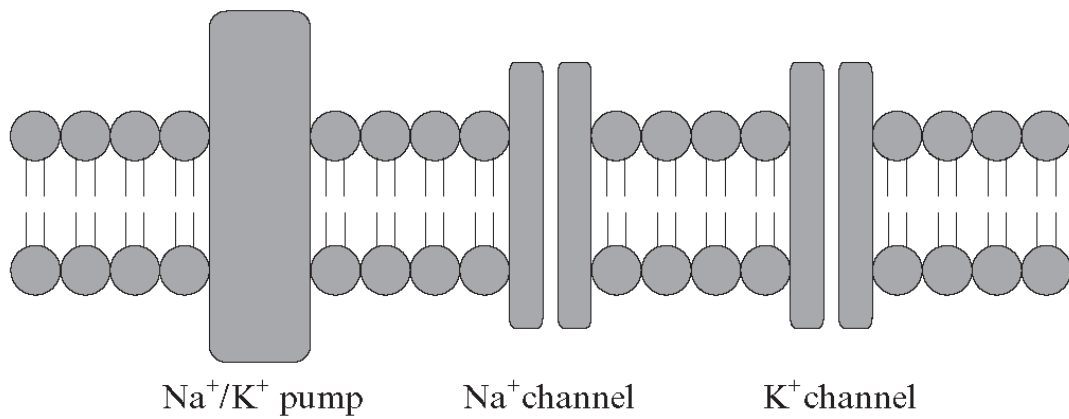


- (i) Use the grid below to draw a typical action as it would appear on the screen of the cathode ray oscilloscope. [2]



- (ii) Label your Action Potential to show, depolarisation and repolarisation. [1]

- (d) The diagram below shows the structural components of the axon membrane that are responsible for the potentials measured in part (c).



- (i) From which type of biological molecules are the following made?

pumps and channels [1]

the bilayer [1]

- (ii) With reference to the diagram, describe how the following events are brought about. [4]

Resting Potential

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Depolarisation

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- (e) Explain how impulses are transmitted across a synapse. [3]

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(Total 17 marks)

12.

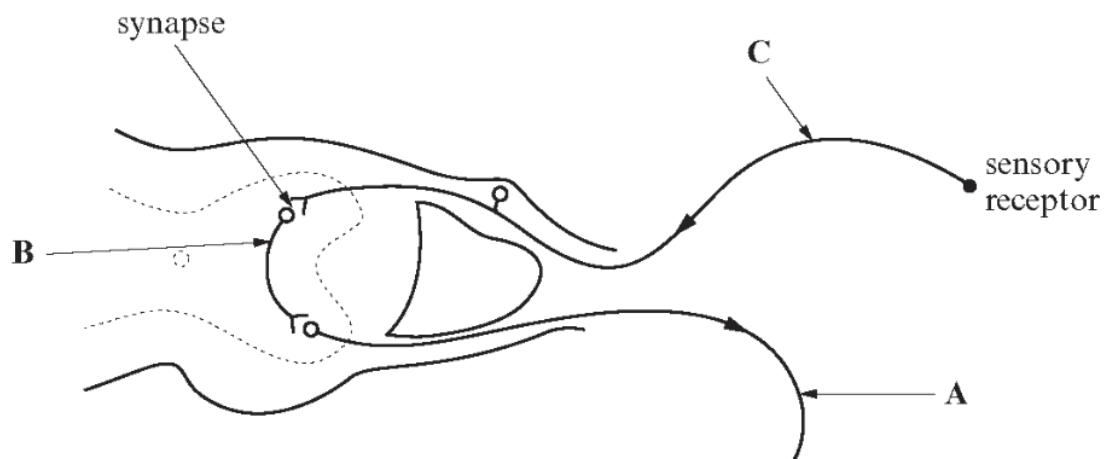
(a) What is a reflex action?

[2]

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(b) The diagram shows the neurones in a reflex arc.



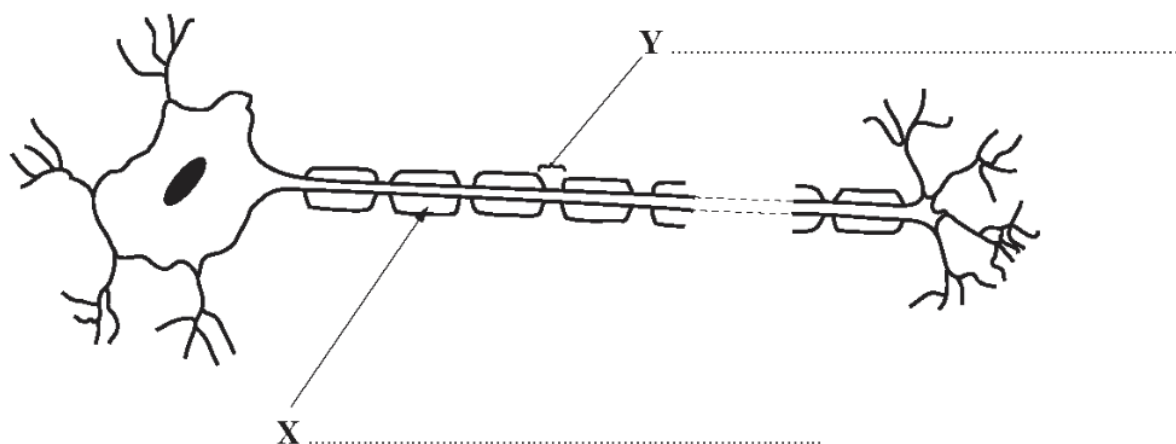
Name the types of neurone labelled **A**, **B** and **C**.

[1]

- A**
- B**
- C**

(c) The diagram below represents a neurone.
On the diagram, label the structures **X** and **Y**.

[2]



(d) (i) Describe how a resting potential is maintained in a neurone. [2]

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(ii) Describe how the potential across the membrane is reversed when an action potential is produced. [2]

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(e) One symptom of Alzheimer's disease is a reduction in the level of an enzyme in the brain that synthesises acetylcholine.

(i) Describe the function of acetylcholine at a synapse. [5]

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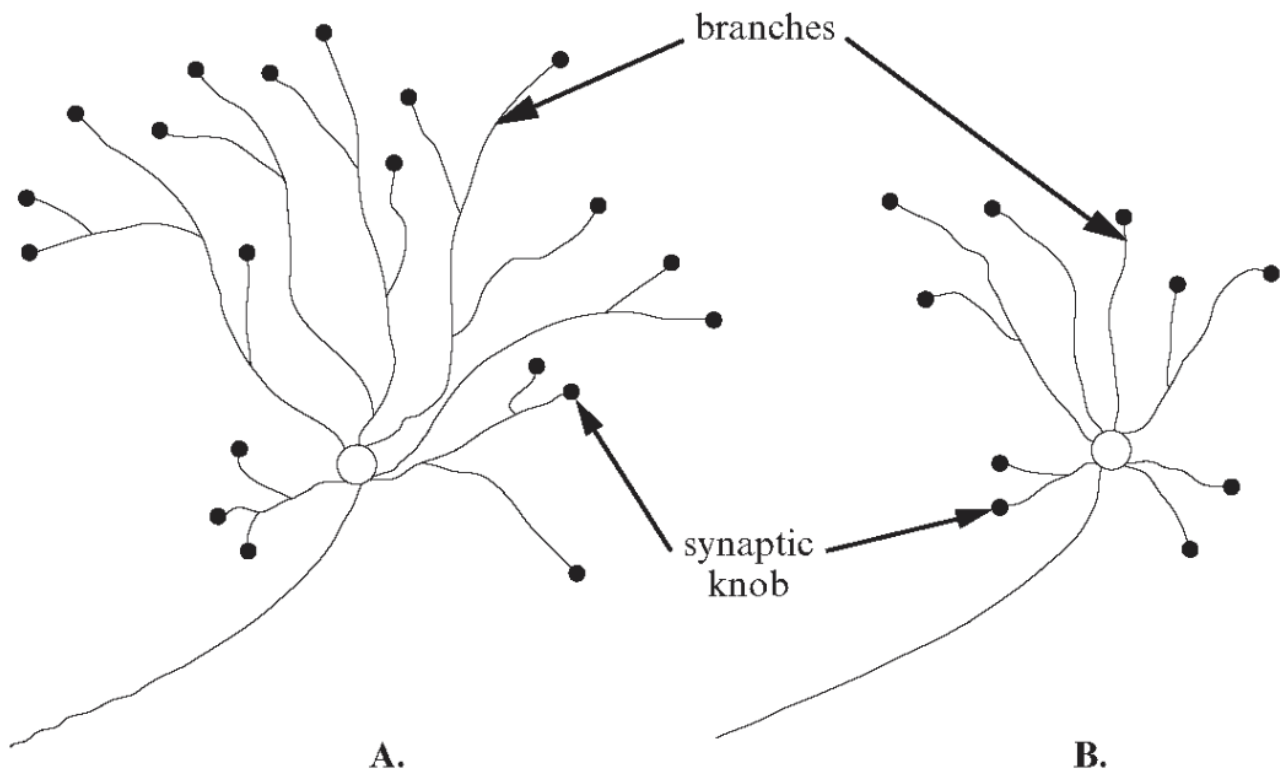
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The diagram below shows neurones from the brains of a healthy 70 year old, **A**, and a 70 year old with Alzheimer's disease, **B**.



(ii) State **two** differences between the neurones shown in the diagram. [2]

1.
2.

(iii) Suggest how **one** of the differences could account for the reduction in acetylcholine in a patient with Alzheimer's disease. [1]

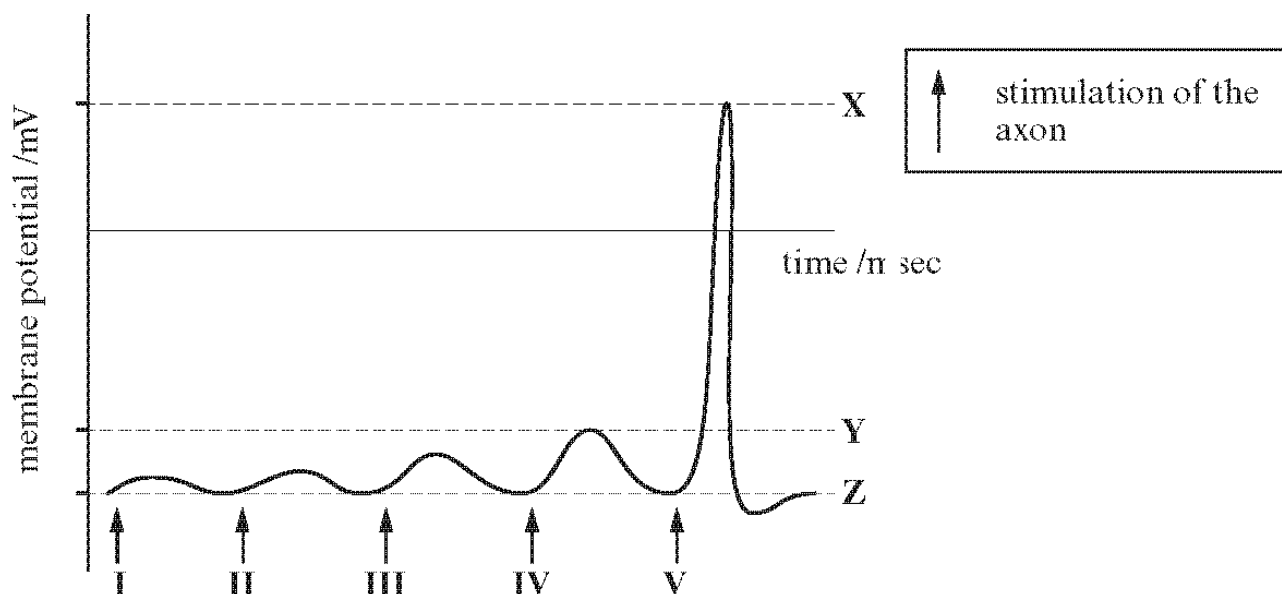
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(Total 17 marks)

13. (a) The axon of a motor neurone was stimulated using an intracellular electrode. The strength of each stimulus was increased by the same amount each time and the potential difference across the cell membrane was monitored using an oscilloscope.

The results of the experiment are shown in the graph below.



- (i) Suggest values for the membrane potential at: [1]

X mV and Z mV

- (ii) Generation of an action potential involves ion-channels.

Explain how opening and closing of ion channels results in the depolarisation and repolarisation of the axon membrane shown at point V on the graph.

- I. Depolarisation; [2]

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- II. Repolarisation. [2]

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- (iii) Explain why an action potential was not generated by stimuli **I** to **IV**. [2]

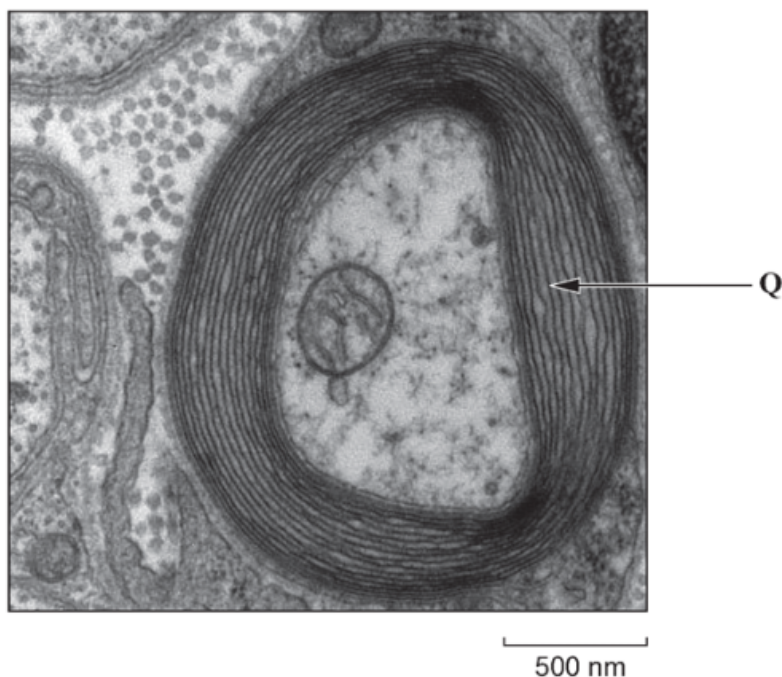
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- (b) The transmission electron micrograph below shows a cross section of the axon of a motor neurone.



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- (i) Name the substance you would expect to find at **Q** shown on the diagram above. [1]
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- (ii) Name the cell that produces this substance. [1]
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- (iii) Explain how the substance secreted by these cells and their arrangement along the neurone affect the speed of transmission of a nerve impulse. [4]

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