Helicate

HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.6.2 Nervous coordination

Topic question bank

Version 1 · 14 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
8	61	No time limit	/ 61

Contents

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Total		**61**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA A-level Biology (7402), specification section 3.6.2. Not affiliated with or endorsed by AQA.

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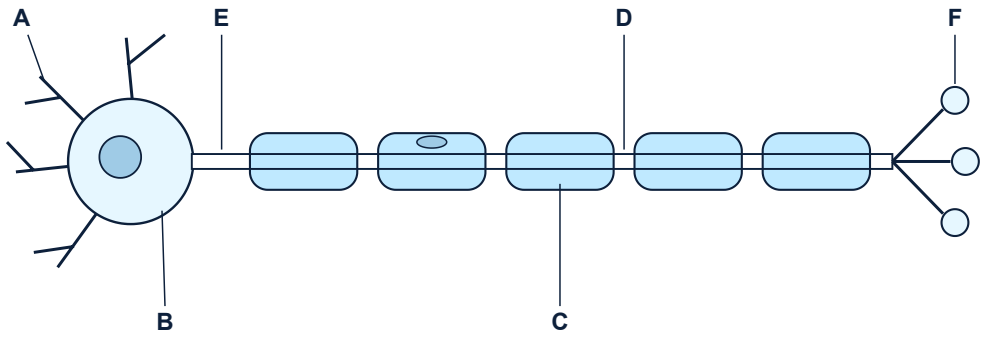
Neurones and the resting potential 3.6.2.1

Figure 1 shows a myelinated motor neurone.

Figure 1



0 1 . 1 Complete the table by giving the letter from Figure 1 that matches each description.

[2 marks]

Description	Letter
Contains the nucleus of the neurone	
Provides electrical insulation	
Where depolarisation occurs during saltatory conduction	
Releases neurotransmitter	

Question 1 continues on the next page

Do not write outside the box

Table 1 shows the concentrations of sodium ions and potassium ions inside and outside the axon of a neurone at rest. The resting potential of the axon is −70 mV.

Table 1

Ion	Concentration / mmol dm^{-3}	
	Inside the axon	**Outside the axon**
Sodium ions	12	145
Potassium ions	140	4

0 1 . 2 Use Table 1 and your knowledge of membrane permeability to explain why the inside of the axon is negative compared with the outside.

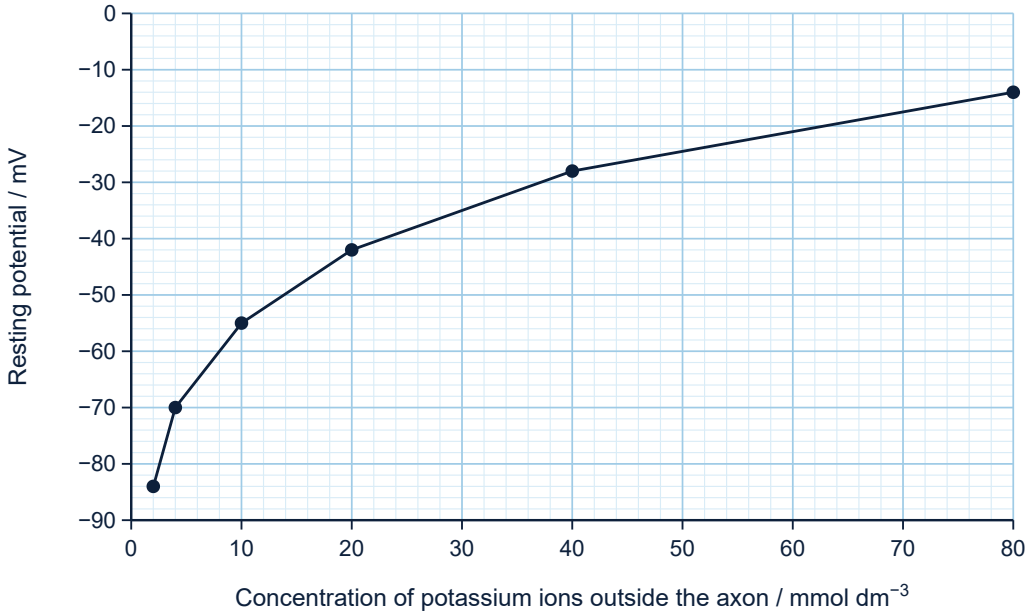
[3 marks]

Question 1 continues on the next page

Do not write outside the box

Scientists placed axons in solutions containing different concentrations of potassium ions and measured the resting potential of each axon. Figure 2 shows their results.

Figure 2



0 1 . 3 Explain the effect of the concentration of potassium ions outside the axon on the resting potential shown in Figure 2.

[3 marks]

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 In every solution, the scientists kept the concentration of sodium ions the same. Explain why.

[1 mark]

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9

Turn over for the next question

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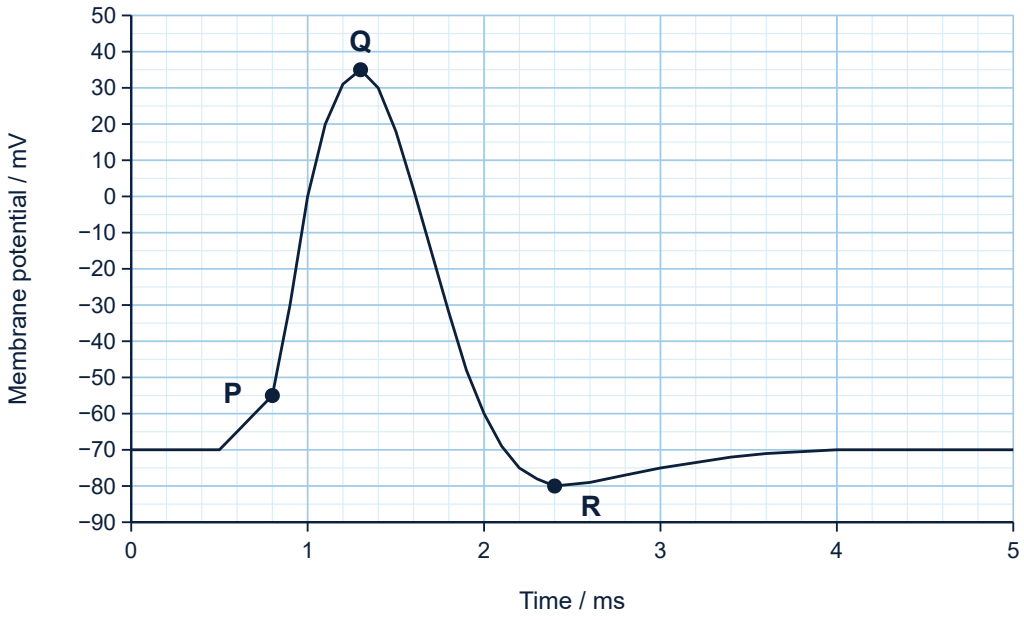
Action potentials and the refractory period 3.6.2.1

Scientists used a microelectrode to record the membrane potential of an axon. They gave the axon one stimulus. Figure 3 shows the changes in membrane potential that followed.

Figure 3



0 2 . 1 Which ion movement causes the change in membrane potential between P and Q?

Tick (✓) one box.

[1 mark]

Sodium ions diffuse into the axon. ☐

Potassium ions diffuse out of the axon. ☐

Sodium ions are actively transported out of the axon. ☐

Potassium ions are actively transported into the axon. ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 Explain the change in membrane potential between Q and R.

[2 marks]

The scientists then gave the axon single stimuli of increasing voltage. For each stimulus, they recorded the highest membrane potential reached and whether an action potential was produced. Table 2 shows their results.

Table 2

Stimulus / V	Highest membrane potential reached / mV	Action potential produced?
0.5	−66	No
1.0	−61	No
1.5	+35	Yes
2.0	+35	Yes
2.5	+35	Yes
3.0	+35	Yes

0 2 . 3 Explain how the results in Table 2 show the all-or-nothing principle.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 The refractory period of a different neurone is 2.5 ms.
Calculate the maximum frequency of impulses that this neurone can transmit.

[2 marks]

Answer _____ **impulses s^{-1}**

0 2 . 5 Explain the importance of the refractory period in the transmission of nerve impulses.

[2 marks]

9

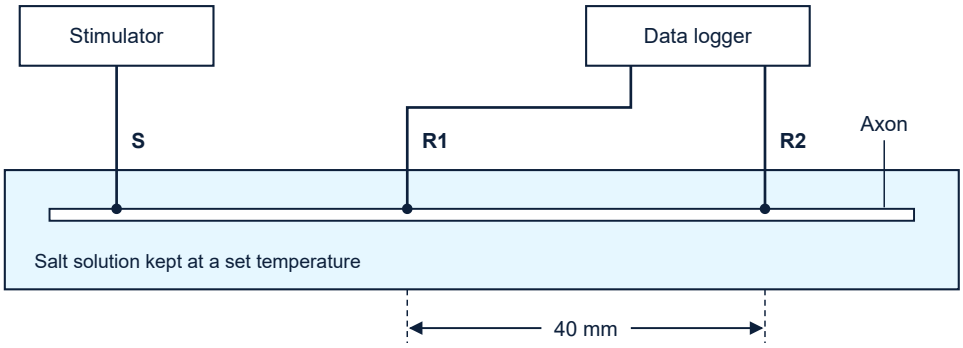
Turn over for the next question

Do not write outside the box

Speed of conduction 3.6.2.1

Scientists investigated the speed of conduction along a myelinated axon from a frog. Figure 4 shows their apparatus. They stimulated the axon with electrode S. A data logger recorded when each action potential reached two recording electrodes, R1 and R2.

Figure 4



0 3 . 1 At 20 °C, an action potential took 1.6 ms to travel from R1 to R2.
Calculate the speed of conduction in m s^{-1}.

[2 marks]

Answer ..... **m s^{-1}**

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 The scientists used the time taken for the action potential to travel from R1 to R2, rather than the time from the stimulus at S to its arrival at R2.
Suggest why.

[2 marks]

Question 3 continues on the next page

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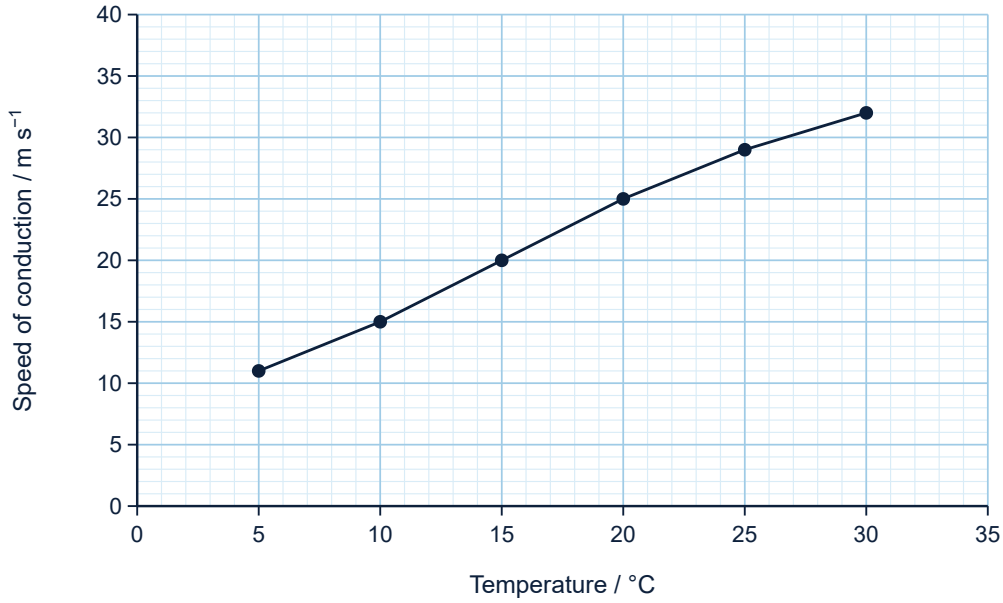
The scientists repeated the measurement at different temperatures. Figure 5 shows their results.

Figure 5



0 3 . 3 Use Figure 5 to calculate the mean rate of increase in the speed of conduction between 5 °C and 30 °C.
Give the unit for your answer.

[2 marks]

Answer .....

Unit .....

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 Use your knowledge of ion movement to explain the effect of temperature on the speed of conduction shown in Figure 5.

[2 marks]

0 3 . 5 At 50 °C no action potentials were recorded.
Suggest why.

[1 mark]

9

Turn over for the next question

Do not write outside the box

Table 3 shows the speed of conduction of nerve impulses along axons from different animals.

Table 3

Animal	Myelinated?	Diameter of axon / μm	Temperature during measurement / °C	Speed of conduction / m s^{-1}
Shore crab	No	30	18	5
Squid	No	500	18	25
Cat	Yes	4	37	24
Cat	Yes	15	37	90

0 4 . 1 How many times greater is the diameter of the squid axon than the diameter of the 4 μm cat axon?

[1 mark]

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Answer .....

Question 4 continues on the next page

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0 4 . 2 The 4 μm cat axon conducts impulses at about the same speed as the squid axon.
Use Table 3 and your knowledge of how nerve impulses pass along axons to explain why.

[4 marks]

0 4 . 3 Suggest **three** reasons why the data in Table 3 may not give a valid comparison of the speed of conduction in myelinated and non-myelinated axons.

[3 marks]

1

2

3

8

Turn over for the next question

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Synaptic transmission 3.6.2.2

0 5 . 1 Which row shows where calcium ion channels and acetylcholine receptors are found at a cholinergic synapse?

Tick (✓) one box.

[1 mark]

Calcium ion channels	Acetylcholine receptors	
Presynaptic membrane	Postsynaptic membrane	☐
Postsynaptic membrane	Presynaptic membrane	☐
Presynaptic membrane	Membrane of synaptic vesicles	☐
Membrane of synaptic vesicles	Postsynaptic membrane	☐

Question 5 continues on the next page

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0 5 . 2 At a cholinergic synapse, the neurotransmitter is acetylcholine. A student wrote:

"An impulse can cross a cholinergic synapse in either direction, because acetylcholine can diffuse either way across the synaptic cleft."

Describe how the arrival of an action potential at the synaptic knob leads to depolarisation of the postsynaptic membrane. Use your description to explain why the student is wrong.

[5 marks]

Question 5 continues on the next page

Do not write outside the box

Neurone X in the spinal cord receives synapses from three presynaptic neurones, A, B and C. Neurones A and B form excitatory cholinergic synapses with X. Neurone C forms an inhibitory synapse with X. The resting potential of X is −70 mV and its threshold is −55 mV.

Scientists stimulated neurones A, B and C in different combinations and recorded the response of neurone X. Table 4 shows their results.

Table 4

Experiment	Presynaptic neurone(s) stimulated	Response of neurone X
1	A, once	Depolarised to −62 mV
2	A, four times in quick succession	Action potential
3	A and B, once each at the same time	Action potential
4	C, once	Hyperpolarised to −76 mV
5	A, B and C, once each at the same time	Depolarised to −59 mV

0 5 . 3 Explain why an action potential was produced in experiment 2 but not in experiment 1.

[2 marks]

0 5 . 4 Name the type of summation shown in experiment 3.

[1 mark]

Question 5 continues on the next page

Do not write outside the box

0 5 . 5 Use Table 4 to explain why no action potential was produced in experiment 5.

[3 marks]

12

Turn over for the next question

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Neuromuscular junctions and drugs 3.6.2.2

0 6 Give **two** differences between transmission across a neuromuscular junction and transmission across a cholinergic synapse between two neurones.

[2 marks]

1 .....

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2 .....

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2

Turn over for the next question

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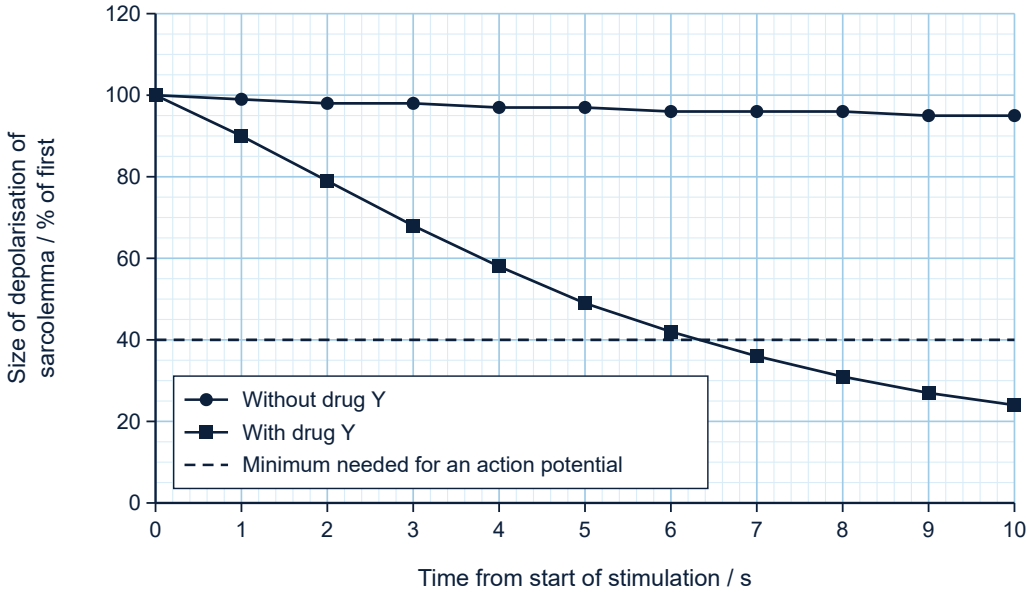
At a neuromuscular junction, the enzyme acetylcholinesterase hydrolyses acetylcholine into choline and ethanoate. A carrier protein in the presynaptic membrane takes choline back into the synaptic knob, where it is used to make new acetylcholine.

Drug Y binds to this carrier protein and stops it working. Scientists stimulated a motor neurone 50 times per second for 10 seconds, with and without drug Y. They recorded the size of each depolarisation of the sarcolemma of the muscle fibre, as a percentage of the first depolarisation. The muscle fibre produces an action potential only when the depolarisation is at least 40% of the first. An action potential in the muscle fibre causes it to contract.

Figure 6 shows their results.

Figure 6



Question 7 continues on the next page

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0 7 . 1 Use Figure 6 and the information given to explain the effect of drug Y on the muscle fibre during the 10 seconds of stimulation.

[6 marks]

0 7 . 2 The scientists recorded the size of each depolarisation as a percentage of the first depolarisation, rather than in mV.
Suggest why.

[2 marks]

8

Turn over for the next question

Do not write outside the box

0 8 . 1 Drug T binds to the same site on acetylcholine receptors as acetylcholine does. Drug T does not cause the receptor to change shape.
Which is an effect of drug T at a cholinergic synapse?
Tick (✓) one box.

[1 mark]

Fewer sodium ions enter the postsynaptic neurone. ☐

More calcium ions enter the synaptic knob. ☐

Acetylcholine is hydrolysed more slowly. ☐

The postsynaptic membrane is depolarised more often. ☐

0 8 . 2 GABA is a neurotransmitter released at inhibitory synapses in the brain. When GABA binds to its receptors, channels in the receptors open and the postsynaptic membrane becomes hyperpolarised. During an epileptic seizure, many neurones in the brain produce action potentials at a high frequency.
Drug V binds to GABA receptors and makes their channels stay open for longer each time GABA binds.
Explain how drug V could reduce epileptic seizures.

[3 marks]

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END OF QUESTIONS

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