

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 9: CONTROL SYSTEMS
NERVOUS TRANSMISSION

SCORE

/148

PERCENTAGE

%

STEMUP

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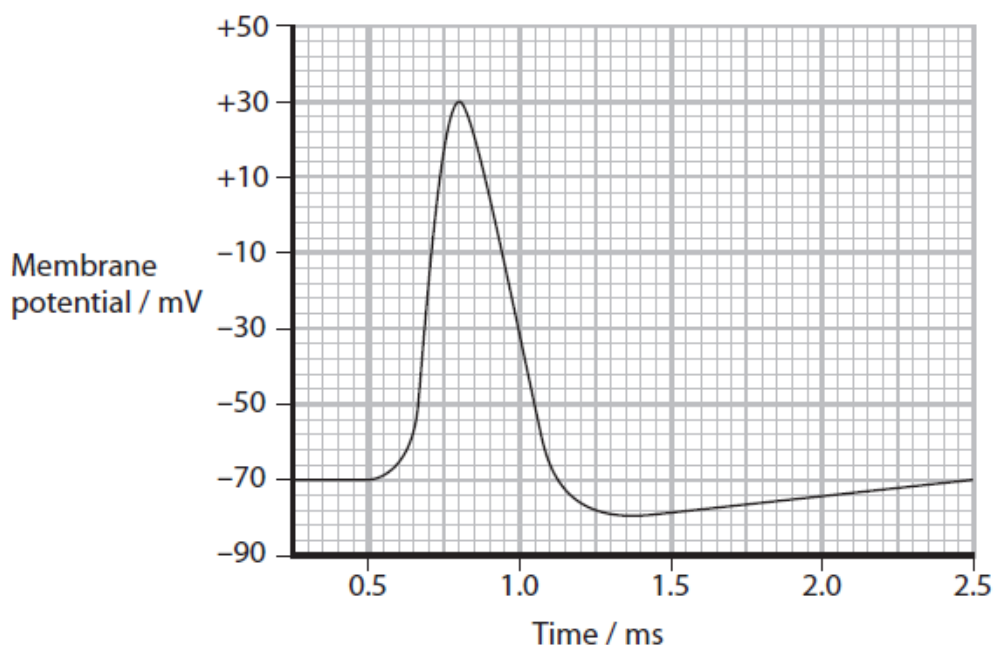
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Q1.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The speed of a nerve impulse along a neurone depends on the diameter and the presence or absence of myelin.

The graph shows an action potential in a neurone.



When are voltage-gated sodium channels open?

(1)

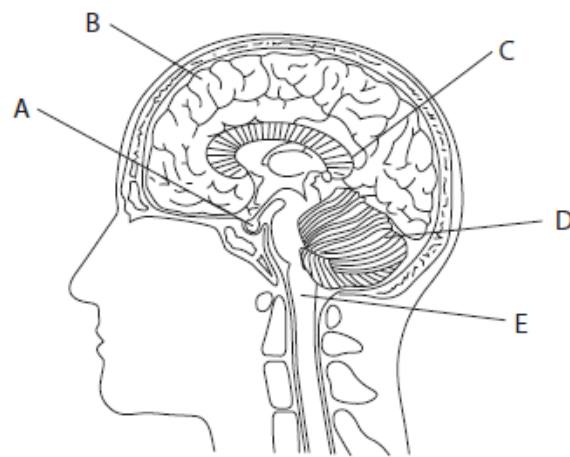
- ☒ **A** 0.25 ms
- ☒ **B** 0.75 ms
- ☐ **C** 1.00 ms
- ☐ **D** 1.25 ms

(Total for question = 1 mark)

Q2.

The human brain controls many functions.

The diagram shows a section through a human brain with parts labelled A to E.



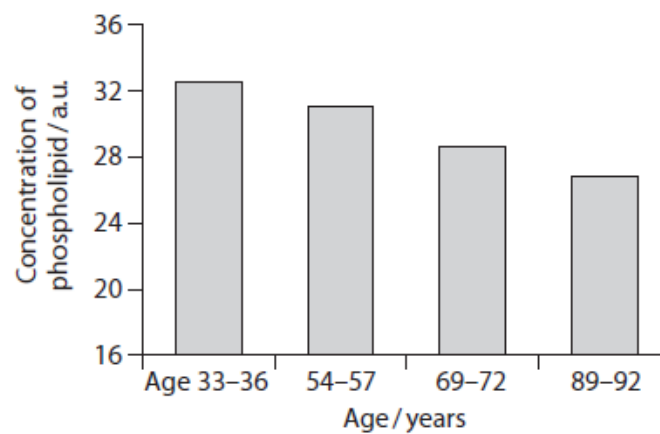
The human brain consists of 100 billion neurones.

The function of these neurones is affected by many factors.

The concentration of phospholipid in neurones from one part of the brain was measured.

This was carried out in people from different age ranges.

The graph shows the results.



Explain how age might affect the structure of a neurone and the speed of transmission of an impulse.

(3)

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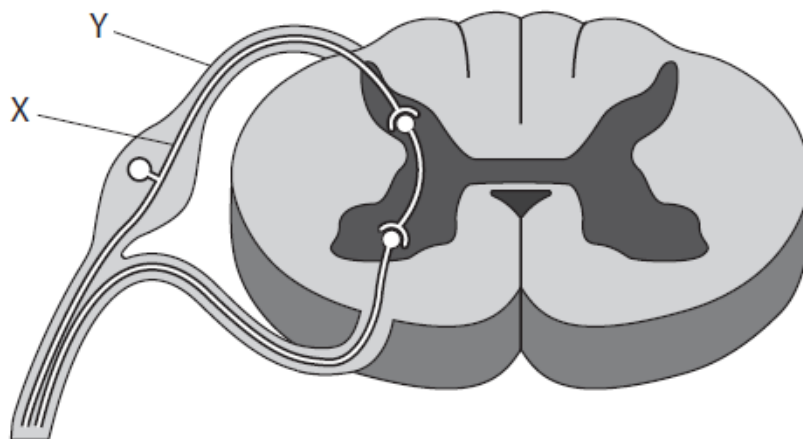
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(Total for question = 3 marks)

Q3.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

(i) The diagram shows a section through the spinal cord.



Which row correctly names the structures labelled X and Y?

(1)

	X	Y
☐ A	motor neurone	dorsal root
☐ B	motor neurone	ventral root
☐ C	sensory neurone	dorsal root
☐ D	sensory neurone	ventral root

(ii) Which region of the brain only controls breathing and heart rate?

(1)

- ☐ A cerebellum
- ☐ B cerebrum
- ☐ C hypothalamus
- ☐ D medulla oblongata

Q4.

The photograph shows a blue-ringed octopus.

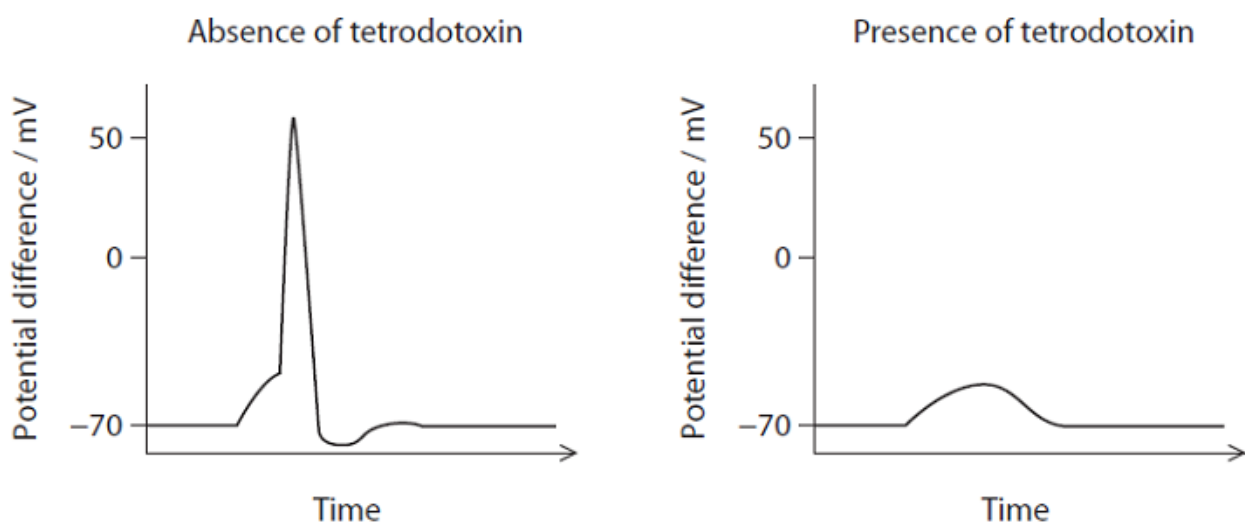


This octopus produces tetrodotoxin that it uses to paralyse its prey.

The effects of tetrodotoxin on a neurone were investigated.

A neurone was stimulated in the absence of and in the presence of tetrodotoxin.

The graphs show the results of this investigation.



Comment on how tetrodotoxin affects the potential difference of a neurone when the prey of the octopus is paralysed.

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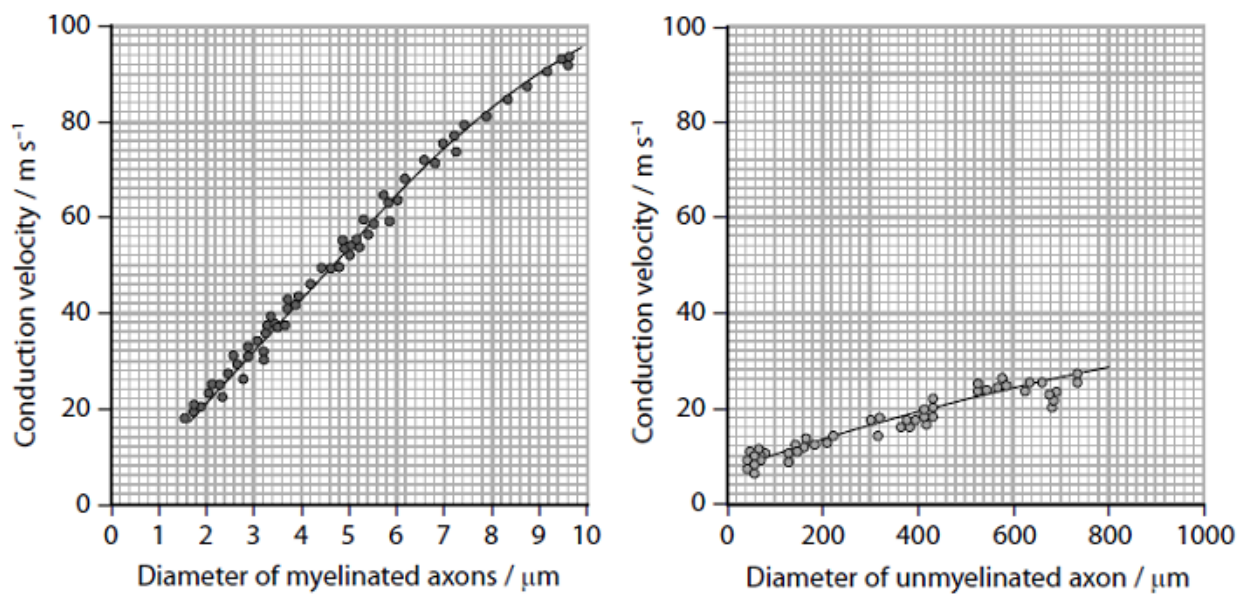
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(Total for question = 4 marks)

Q5.

The graphs below show the conduction velocity and diameter of myelinated and unmyelinated axons.



(Source: <http://blp6.atw.hu/BLP6/HTML/C0059780323045827.htm>)

(i) Calculate the time it would take for a nerve impulse to travel 80 cm in a myelinated axon with a diameter of 7 μm.

(2)

Answer s

*(ii) Analyse the data to explain the conduction velocity in the myelinated and the unmyelinated axons.

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(Total for question = 8 marks)

Q6.

Voltage-gated K^+ and Na^+ channels are involved in the transmission of impulses in sensory and motor neurones.

Describe the differences in the structure of a myelinated sensory neurone and a myelinated motor neurone.

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Q7.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Acetylcholine is a neurotransmitter released by neurones in the autonomic nervous system.

(i) Which of the following substances bind to acetylcholine receptors?

(1)

1. cobra venom

2. nicotine

3. lidocaine

☐ **A** 1 and 2

☐ **B** 1 and 3

☐ **C** 1, 2 and 3

☐ **D** 2 and 3

(ii) Which row is correct for acetylcholine?

(1)

	Type of neurone that releases acetylcholine	Effect of acetylcholine
☐ A	parasympathetic neurone	increases heart rate
☐ B	parasympathetic neurone	decreases heart rate
☐ C	sympathetic neurone	increases heart rate
☐ D	sympathetic neurone	decreases heart rate

(iii) Describe the events that lead to the release of acetylcholine at a synapse.

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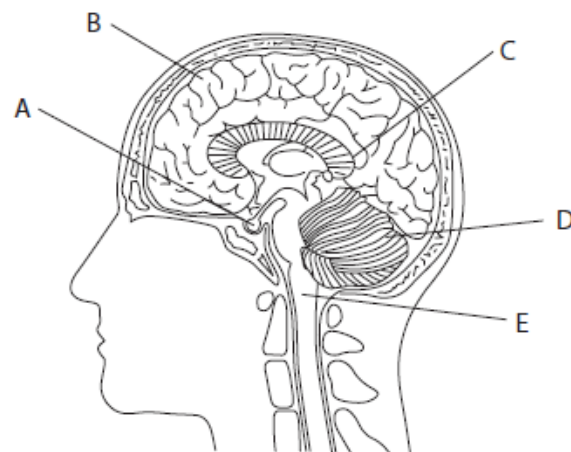
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(Total for question = 5 marks)

Q8.

The human brain controls many functions.

The diagram shows a section through a human brain with parts labelled A to E.



Poisons can also affect the function of neurones in the brain.

The photograph shows a pufferfish, a traditional food delicacy in Japan.



Pufferfish have to be carefully prepared by a chef to remove a poison called tetrodotoxin. This poison causes muscle paralysis.

Neurones were placed in a solution containing tetrodotoxin and in a control solution.

The neurones were stimulated and the potential difference across the axon membrane was measured.

The table shows the results.

Solution	Potential difference after stimulation / mV
tetrodotoxin	-70
control	+40

Analyse the data to explain the effect of tetrodotoxin on the neurone.

(4)

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(Total for question = 4 marks)

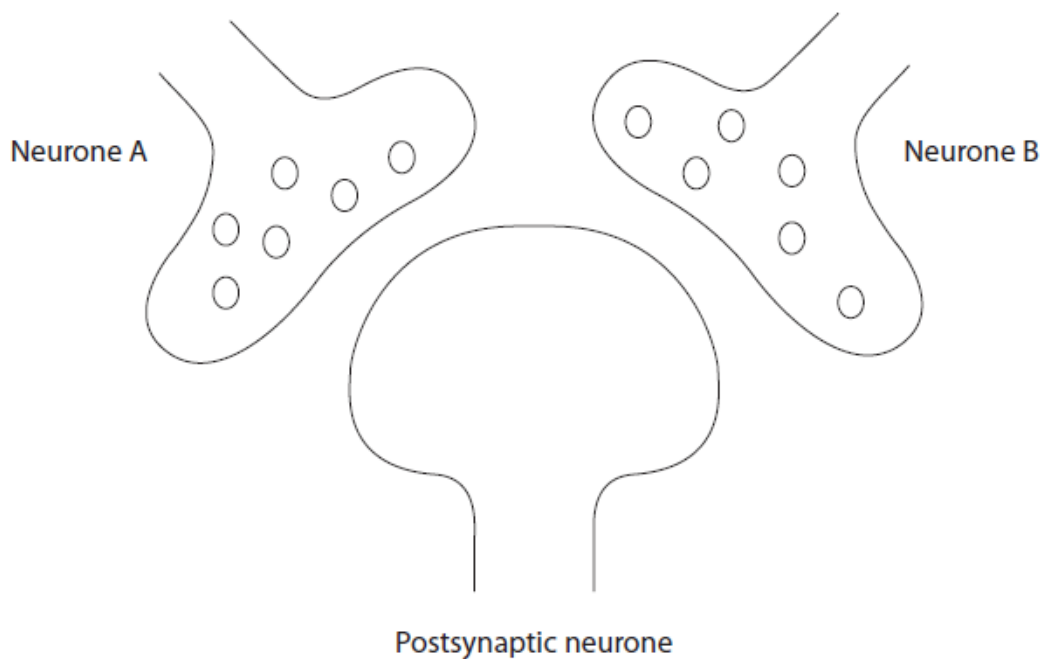
Q9.

The diagram shows the structure of a synaptic junction between three neurones.

Neurone A releases the excitatory neurotransmitter acetylcholine.

Neurone B releases the inhibitory neurotransmitter glutamate.

Glutamate causes chloride ions to move into the postsynaptic neurone.



(i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

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(ii) Which of the following rows correctly describes the action of each substance on this postsynaptic neurone?

(1)

	Nicotine	Lidocaine	Cobra venom
☒ A	excitatory	excitatory	excitatory
☒ B	excitatory	inhibitory	inhibitory
☒ C	inhibitory	excitatory	excitatory
☒ D	inhibitory	inhibitory	inhibitory

(Total for question = 5 marks)

Q10.

Explain how the resting potential is maintained in a neurone.

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(Total for question = 4 marks)

Q11.

Acetylcholine is a neurotransmitter produced by the parasympathetic nervous system.

Describe the process by which acetylcholine is released from a synapse.

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(Total for question = 4 marks)

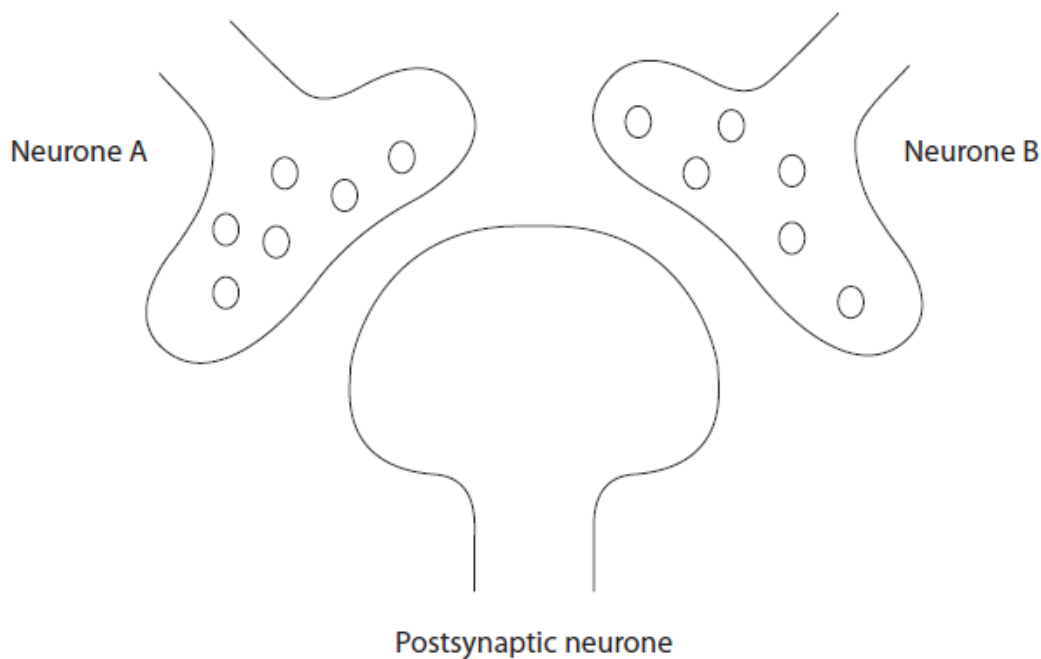
Q12.

The diagram shows the structure of a synaptic junction between three neurones.

Neurone A releases the excitatory neurotransmitter acetylcholine.

Neurone B releases the inhibitory neurotransmitter glutamate.

Glutamate causes chloride ions to move into the postsynaptic neurone.



A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	yes

Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

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(Total for question = 3 marks)

Q13.

Scientists investigated the effect of stimulating an axon with different voltages and measured the response.

The table shows the results of this investigation.

Stimulus voltage / mV	Response
25	No action potential
35	No action potential
45	No action potential
55	Action potential
65	Action potential
75	Action potential

Analyse the data to describe the conclusions which can be drawn.

(2)

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(Total for question = 2 marks)

Q14.

The brain is involved in many homeostatic mechanisms.

An action potential results from the depolarisation of the membrane of a neurone.

Which row of the table shows the correct state of the ion channels during this depolarisation?

(1)

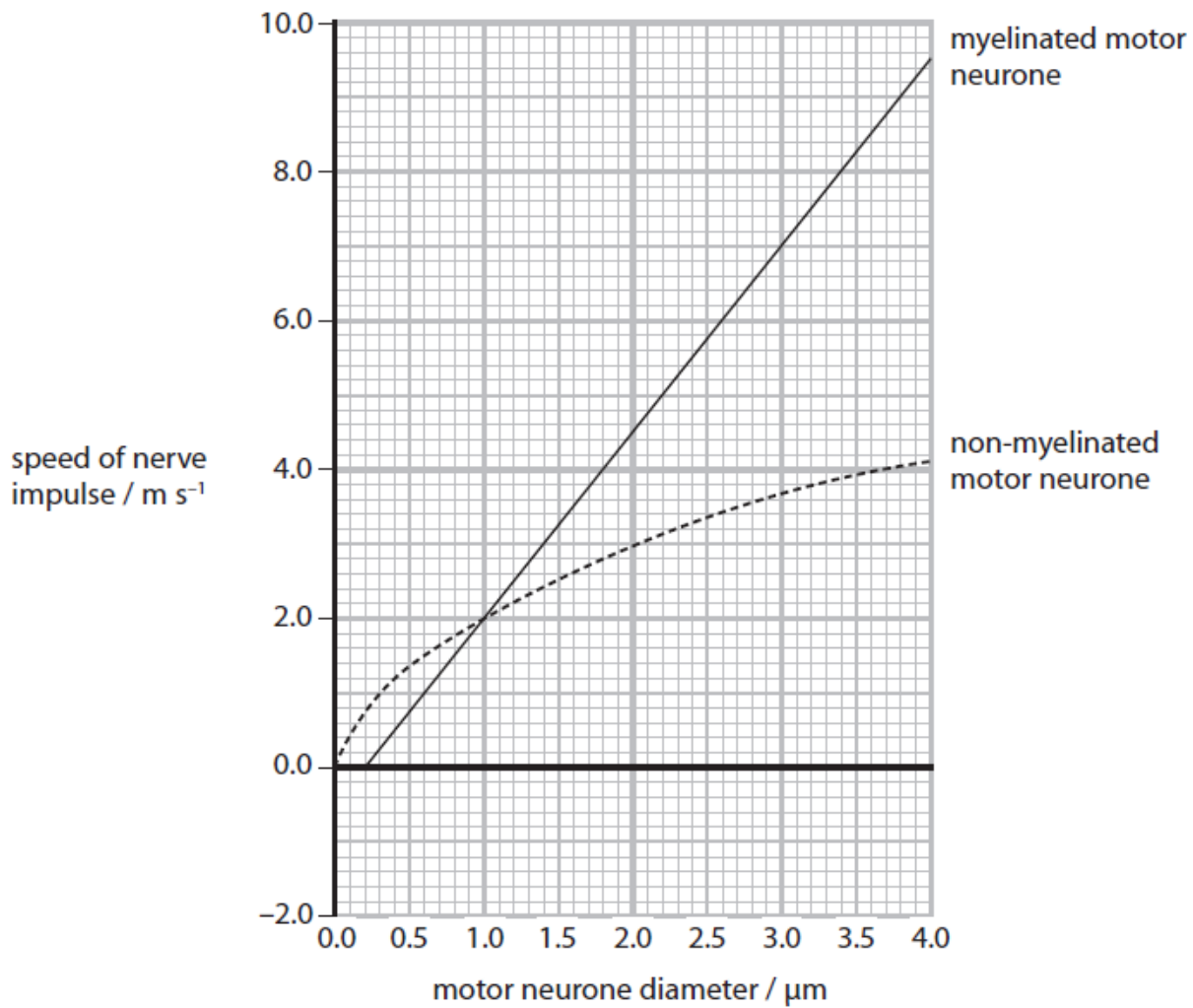
	Na ⁺ channels	K ⁺ channels
☐ A	closed	closed
☐ B	closed	open
☐ C	open	closed
☐ D	open	open

(Total for question = 1 mark)

Q15.

The speed of a nerve impulse along a neurone depends on the diameter and the presence or absence of myelin.

The graph shows the relationship between the diameter of the neurone and the speed of nerve impulses along myelinated and non-myelinated motor neurones.



(i) Compare and contrast the effect of diameter on the speed of an impulse in myelinated and non-myelinated motor neurones.

(4)

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(ii) Determine the speed of a nerve impulse along a myelinated motor neurone with a diameter of 5 μm .

The equation for a linear relationship is $y = mx + c$

(3)

Answer

(iii) Multiple sclerosis (MS) is a disease that results in the loss of myelin around motor neurones.

Explain why the speed of nerve impulses along axons is slower in people with MS.

(3)

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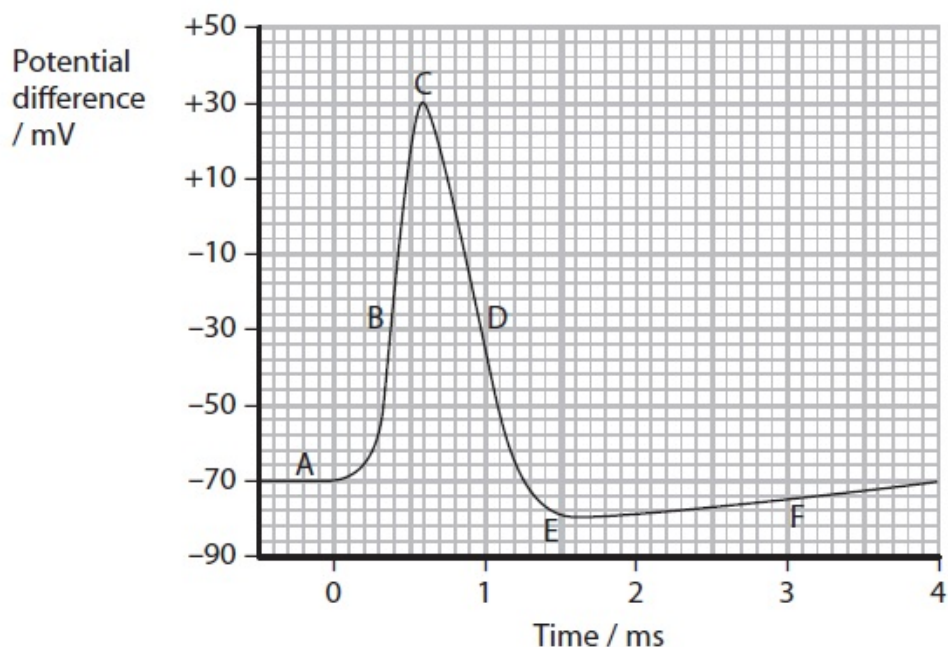
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(Total for question = 10 marks)

Q16.

(a) The graph below shows the changes in potential difference across the membrane of a neurone after stimulation.



(i) Using the information in the graph, state the maximum change in potential difference across the membrane of this neurone during depolarisation.

(1)

..... mV

(ii) The table below describes three of the stages shown in the graph.

Place a cross in the box (☒) below the letter that correctly links the description to one of the labels on the graph above.

(3)

Description	A	B	C	D	E	F
Stage when the concentration of positive ions is greatest inside the axon	☐	☐	☒	☒	☐	☐
Stage when hyperpolarisation first occurs	☐	☐	☒	☒	☐	☐
Stage showing the resting potential	☐	☐	☒	☒	☐	☐

*(b) When a nerve impulse reaches a synapse, calcium ions enter the neurone through the pre-synaptic membrane. This causes a neurotransmitter, such as acetylcholine, to be released.

Describe and explain the sequence of events that occurs at the synapse, after a neurotransmitter has been released.

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(Total for question = 9 marks)

Q17.

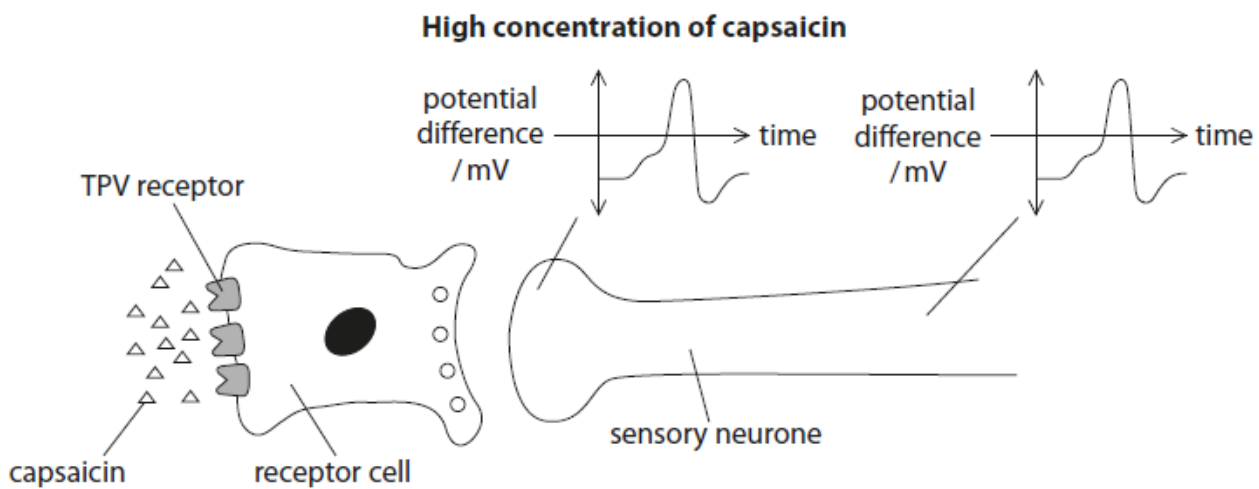
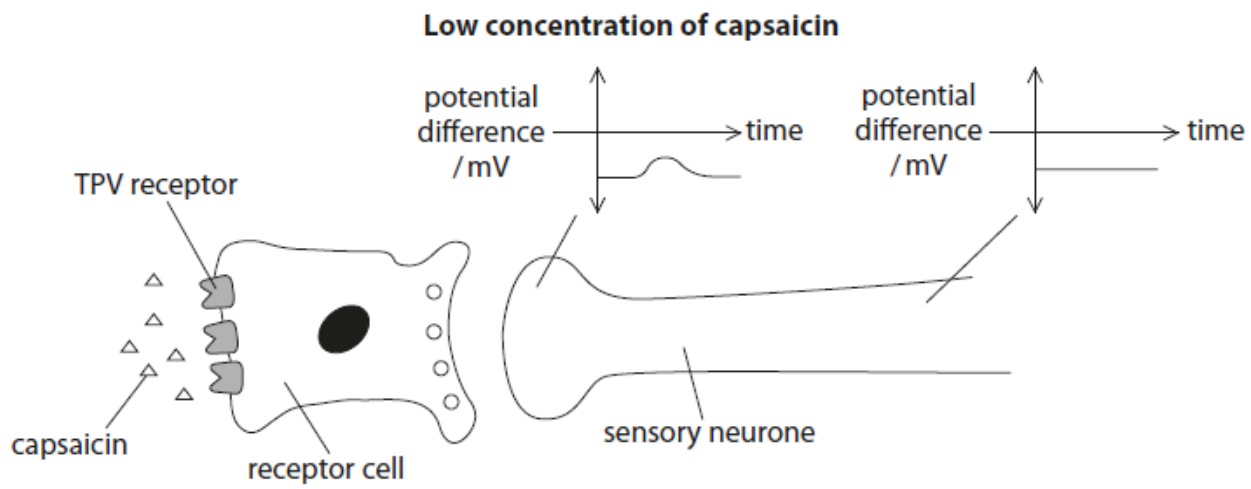
Acetylcholine is a neurotransmitter released by neurones in the autonomic nervous system.

Capsaicin is a substance found in chilli plants that makes them taste 'hot.'

Capsaicin binds to temperature receptor proteins called TPV receptors. This stimulates impulses along sensory neurones that send impulses to the brain.

The effect of capsaicin on the depolarisation of the membrane of a sensory neurone was investigated. The potential difference across the membrane was measured at two places on the sensory neurone after adding capsaicin.

The results for a high concentration and a low concentration of capsaicin are shown in the diagram.



(i) Explain the effect of capsaicin on the depolarisation of the sensory neurone.

(3)

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*(ii) Capsaicin affects sweat production. It has been suggested that capsaicin could be used to lower the temperature of people with fevers.

The effect of three different doses of capsaicin on sweat production was investigated.

Five students took one 10 mg tablet of capsaicin each day, for one week.

The mass of sweat produced from a 10 cm² area of skin was measured one hour after taking each tablet of capsaicin.

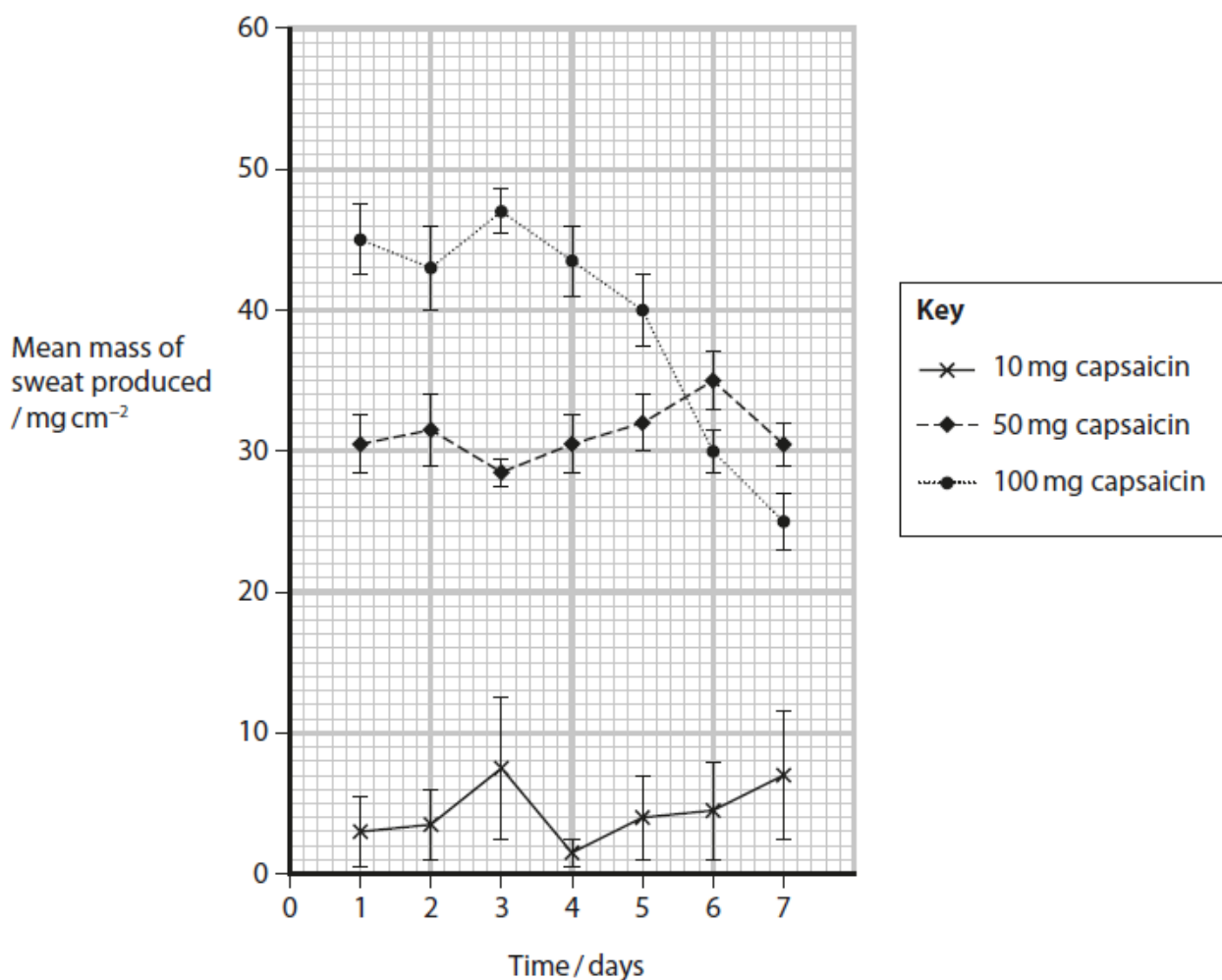
The mean mass of sweat per square centimetre of skin for the group of students was calculated for each day.

This was repeated with different groups of students taking 50 mg of capsaicin and taking 100 mg of capsaicin.

Most of the students who were given 100 mg of capsaicin reported a burning sensation and redness of the skin.

The results are shown in the graph.

Error bars represent standard deviations.



Analyse the data to discuss the use of capsaicin to lower the temperature of people with fevers.

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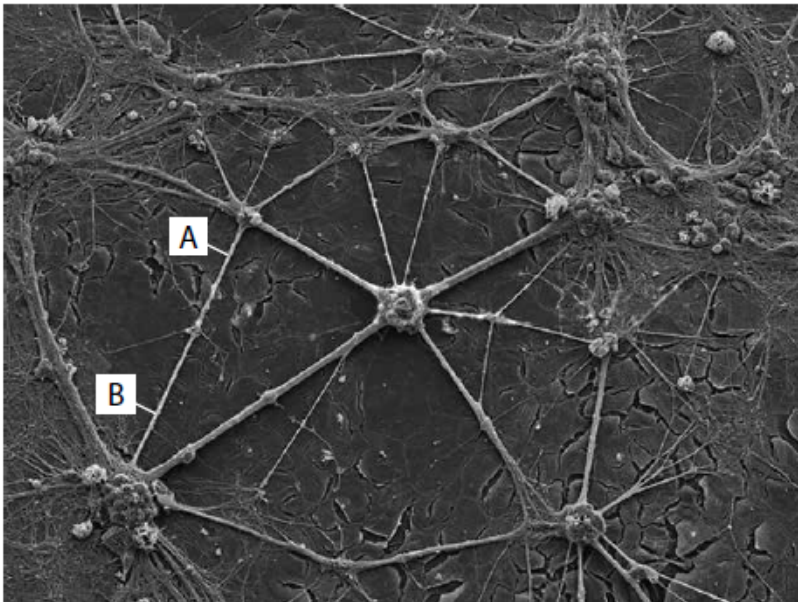
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(Total for question = 9 marks)

Q18.

The photomicrograph below shows myelinated neurones.



© C016/7131 David Scharf/Science Photo Library

Magnification $\times 226$

(a) The time taken for an impulse to travel between two electrodes placed at the points labelled **A** and **B** was measured as 0.02 milliseconds.

Calculate the speed of the impulse.

(3)

Answer ms^{-1}

(b) The neurones of the retina are not usually myelinated. However in some eye conditions, myelination does occur.

Explain why the presence of myelinated neurones in the retina might mean that a clear image will not be formed.

(3)

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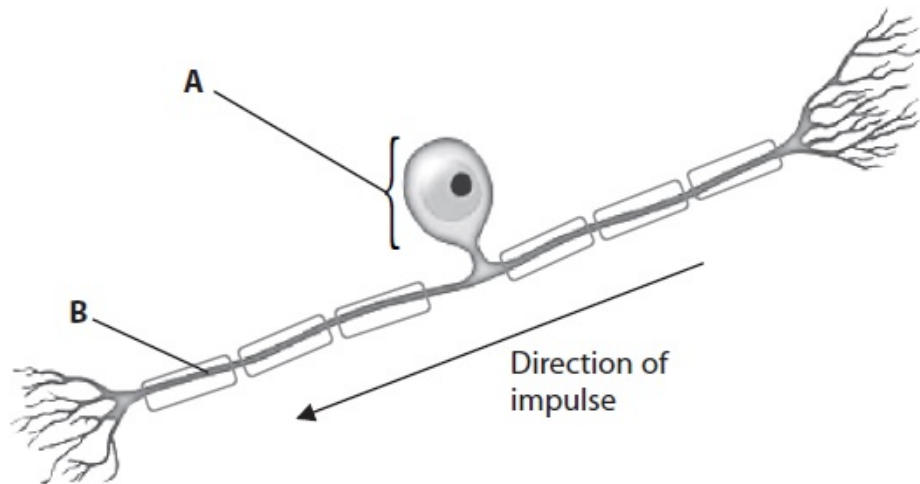
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(Total for question = 6 marks)

Q19. The diagram below shows a sensory neurone.



(a) Name the structures labelled **A** and **B**.

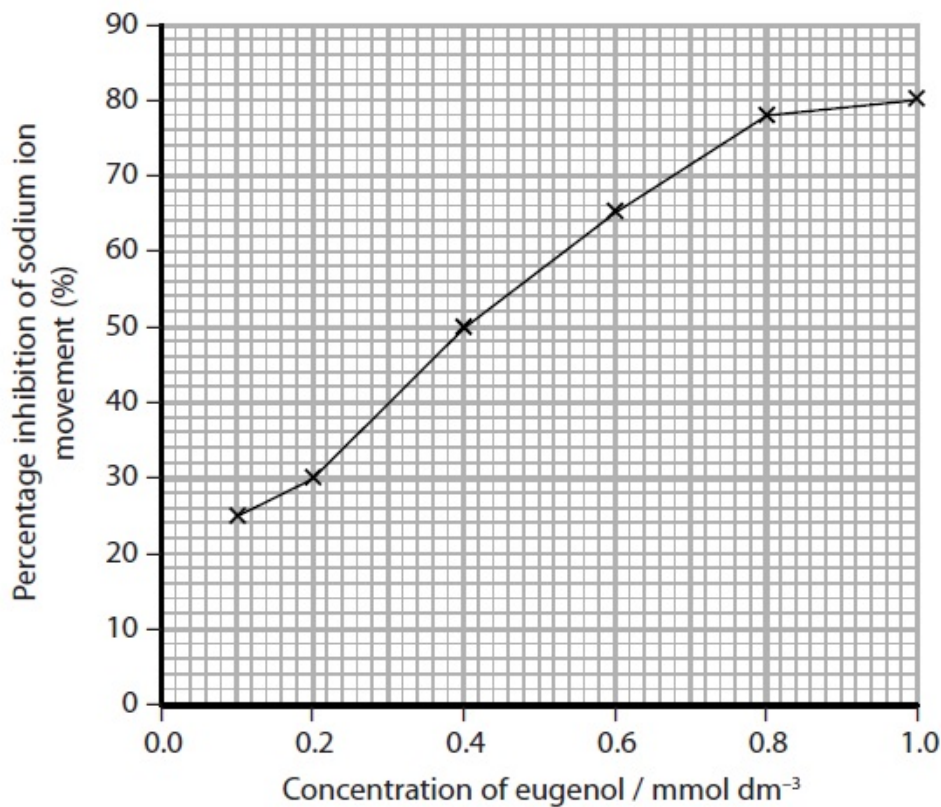
(2)

A.....

B.....

(b) Eugenol is a drug that inhibits the movement of sodium ions and calcium ions through the cell surface membranes of sensory neurones.

The graph below shows the effect of eugenol concentration on the percentage inhibition of sodium ion movement.



(i) Describe the relationship between the concentration of eugenol and the percentage inhibition of sodium ion movement.

(2)

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*(ii) Eugenol can be used to reduce pain.

Suggest an explanation for how eugenol affects the movement of calcium ions and reduces pain.

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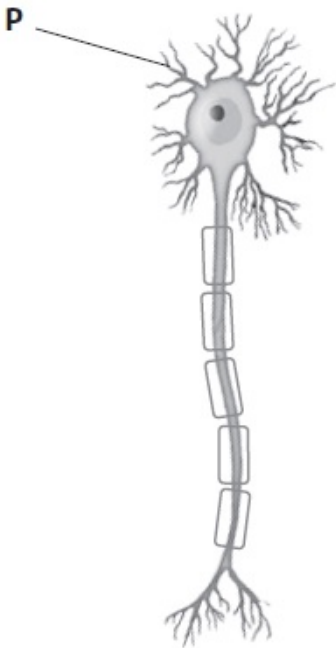
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(Total for Question = 10 marks)

Q20. (a) The diagram below shows a motor neurone.



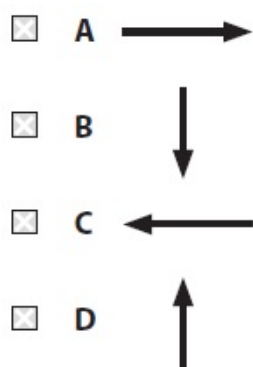
(i) Name the structure labelled **P**.

(1)

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(ii) Place a cross ☒ in the box to identify the direction of the nerve impulse in the axon of this motor neurone.

(1)



(b) Eugenol is a drug that inhibits the movement of sodium ions through the cell surface membranes of sensory neurones.

The table below shows the effect of eugenol concentration on the percentage inhibition of sodium ion movement.

Concentration of eugenol / mmol dm^{-3}	Percentage inhibition of sodium ion movement (%)
0.2	30
0.4	50
0.6	65
1.0	80

(i) Describe the effect of eugenol on the percentage inhibition of sodium ion movement.

(2)

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(ii) Using information from the table, calculate the percentage inhibition of sodium ion movement at a concentration of eugenol of 0.8 mmol dm^{-3} .

Show your working.

(2)

Answer.....%

*(c) Eugenol can be used to reduce pain.

Suggest an explanation for how eugenol affects the movement of sodium ions and reduces pain.

(6)

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(Total for Question = 12 marks)

Q21.

Voltage-gated K⁺ and Na⁺ channels are involved in the transmission of impulses in sensory and motor neurones.

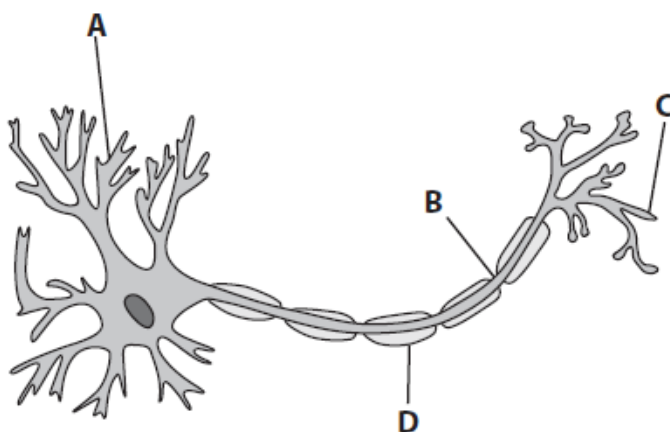
(i) The table below identifies two stages in the transmission of an impulse in a sensory neurone.

Place a tick (✓) in each box that correctly identifies whether the channels are open or closed during these two stages.

(2)

Stage	Voltage-gated K ⁺ channels open	Voltage-gated K ⁺ channels closed	Voltage-gated Na ⁺ channels closed
Depolarisation			
Repolarisation			

(ii) The diagram below shows a myelinated motor neurone.



Place a cross in the box ☐ that labels the site where neurotransmitters bind and initiate depolarisation.

(1)

☐ A

☐ B

☐ C

☐ D

Q22. The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in starch. Starch can be a combination of amylose and amylopectin.

Give **two** structural differences between amylose and amylopectin.

(2)

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(b) Explain why a colony of naked mole rats is considered 'a eusocial society' (paragraph 4).

(2)

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(c) Naked mole rats show evidence of poikilothermy (paragraph 5).

(i) Explain what is meant by the term **poikilothermic**.

(1)

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(ii) Suggest how each of the following 'contribute to poikilothermic responses to changing temperature of this mammal'.

(2)

'Lack of an insulating layer'

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'A marked reduction in sweat glands'

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(d) Suggest a mechanism that could have been used to genetically modify cells from mice with cancer-causing genes (paragraph 13).

(2)

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*(e) Whilst naked mole rats are 'impervious to chemical pain' they do feel 'acute pain such as cuts and burns' (paragraph 31).

Touching something hot, which could lead to a burn, can cause nerve impulses to travel along myelinated sensory neurones very rapidly.

Explain how myelination increases the speed of transmission of nerve impulses in a sensory neurone.

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(f) Explain how a heart attack can temporarily reduce the oxygen concentration in brain tissue (paragraph 36).

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(g) Using the information in paragraph 48, name **one** hormone **and** state its function.

Hormone:

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Function:

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(h) Suggest how a change in the mid region of the sperm may make it non-motile (paragraph 48).

(2)

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(i) Disperser naked mole rats 'are laden with fat' (paragraph 50).

Suggest why it may be advantageous for disperser naked mole rats to have high levels of fat.

(3)

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(j) Explain the statement that 'a preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance' (paragraph 52).

(2)

Explain what is meant by the term **genome sequenced**.

(I) 'With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs' (paragraph 53).

Using information from the article, describe **two** adaptations of naked mole rats. For each adaptation, explain why it could be of interest in a medical research laboratory.

(4)

Q23.

The scientific article you have studied is adapted from articles in *Nature* and *Scientific American*.

Use the information from the article and your own knowledge to answer the question.

Octopamine is a neurotransmitter (paragraph 24). Libersat and his team believe that wasp venom probably blocks octopamine receptors in the central nervous system of the cockroach.

Suggest **two** ways that the 'compound that reactivates octopamine receptors' (paragraph 25) could work.

(2)

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Q24.

Nerve impulses are transmitted along neurones.

(i) In the time period between two nerve impulses, the potential difference across the membrane is -70 mV .

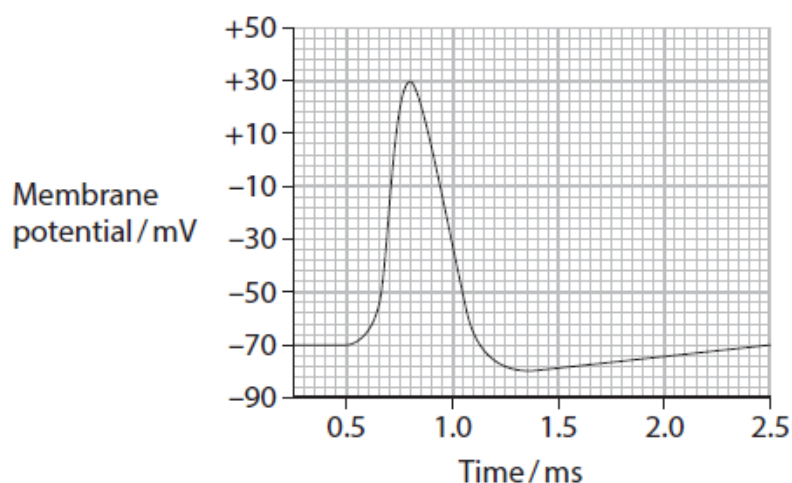
State the term given to this potential difference.

(1)

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(ii) When the neurone is stimulated, an action potential may occur in the axon, due to the change in permeability of the membrane to ions.

The graph shows an action potential.



Describe what happens in the axon membrane to cause the change in potential difference between 0.55 ms and 0.80 ms.

(4)

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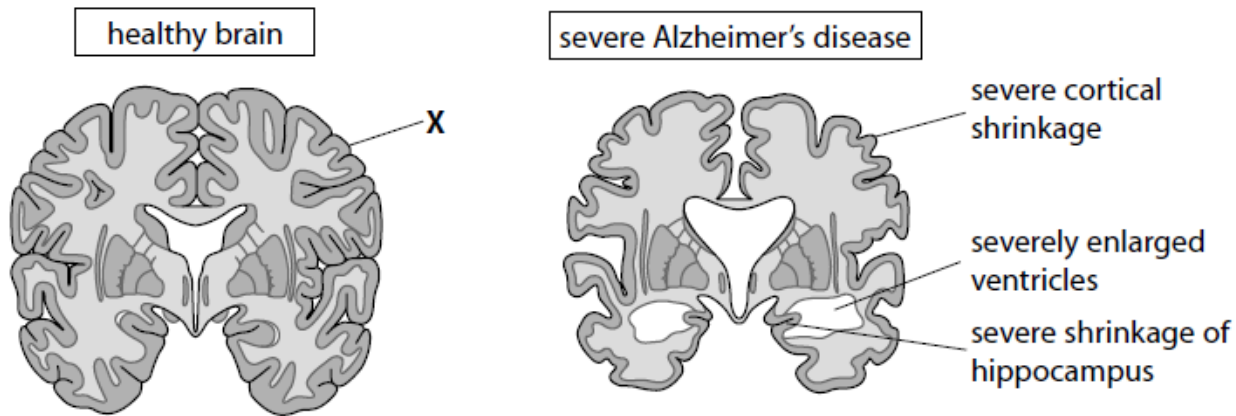
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(Total for question = 5 marks)

Q25.

The diagrams below show a horizontal cross section of a healthy human brain and a brain from a person with severe Alzheimer's disease.



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Drug treatments are available to reduce the symptoms of Alzheimer's disease.

One of the drugs available works as a non-competitive inhibitor of cholinesterase, the enzyme that breaks down acetylcholine in the synapse.

Describe how the action of this drug helps reduce the symptoms of Alzheimer's disease.

(3)

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(Total for question = 3 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	B 0.75 ms A is incorrect because at 0.5s it is a resting potential C is incorrect because sodium channels are closed D is incorrect because sodium channels are closed		1

Q2.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • slows {transmission / impulse} (1) • because reduced {myelin sheath / Schwann cells} (1) • affects saltatory conduction / affects jumping between nodes of Ranvier (1) • (change to membrane) affects action potential / ion movement / ion channels (1)		(3)

Q3.

Question Number	Answer	Mark
(i)	The only correct answer is C sensory neurone and dorsal root <i>A is incorrect because X is a sensory neurone</i> <i>B is incorrect because X is a sensory neurone and Y is the dorsal root</i> <i>D is incorrect because Y is the dorsal root</i>	1

Question Number	Answer	Mark
(ii)	The only correct answer is D medulla oblongata <i>A is incorrect because the cerebellum does not control breathing and heart rate</i> <i>B is incorrect because the cerebrum does not control breathing and heart rate</i> <i>C is incorrect because the hypothalamus does not control breathing and heart rate</i>	1

Q4.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: - change in {potential difference} in tetrodotoxin is small(er) / (1) - no action potential / less depolarisation (1) (voltage gated) sodium channels {not open / closed / blocked} (1) - sodium (ions) cannot pass through membrane / sodium (ions) cannot enter neurone (1) - no nerve impulse to muscles / muscles not stimulated / muscles cannot contract (1)	ACCEPT no depolarisation ACCEPT less sodium ions enter ACCEPT effector for muscle	4

Q5.

Question Number	Correct Answer	Additional guidance	Mark
(i)	velocity of myelinated axon = 76 m s^{-1} (1) $0.8 \div 76 = 0.01$ (1)	Accept answer derived from range 74 to 76 m s^{-1} Accept 0.011 or answers with more decimal places Correct answer gains full marks	(2)

Question Number	Indicative content	
*(ii)	Answers will be credited according to the candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The Indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Increase in diameter increases conduction velocity in both axon types • More surface area for ion movement and therefore depolarisation • Conduction velocity is greater in the myelinated axon compared to the unmyelinated axon • Myelinated axons have a much smaller diameter than unmyelinated • Greater efficiency of myelinated neurones compared to unmyelinated axons • Impulse jumps from node to node / saltatory conduction • The myelin insulates • The insulation is discontinuous at nodes of Ranvier • Depolarisation only at nodes	
Level	Mark	Descriptor
	0	No awardable content
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.
Level 3	5-6	An explanation is made, which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.

Q6.

Question Number	Answer	Additional Guidance	Mark
	In sensory neurone: 1. dendron longer; 2. dendron myelinated ; 3. axon shorter ; 4. {cell body / eq} {not at the end / towards the middle / to the side / eq} ; 5. reference to no {motor end plate / eq} ;	ALLOW converse for motor neurone 4. ACCEPT centron / nucleus for cell body	(3)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	A 1 and 2 <i>B is incorrect because lidocaine binds to voltage gated sodium channels</i> <i>C is incorrect because lidocaine binds to voltage gated sodium channels</i> <i>D is incorrect because lidocaine binds to voltage gated sodium channels</i>		1
(ii)	B parasympathetic neurone reduce <i>A is incorrect because acetylcholine reduces the heartrate</i> <i>C is incorrect because acetylcholine is released by parasympathetic neurones</i> <i>D is incorrect because acetylcholine is released by parasympathetic neurones</i>		1
(iii)	An answer that makes reference to three from: • action potential / impulse arrives at pre-synaptic {terminal / knob}(1) • calcium channels open and calcium ions diffuse in(1) • vesicles move to membrane (1) • vesicles fuse with membrane and release acetylcholine (1)	Allow action potential stimulates presynaptic membrane Allow Ca²⁺ Allow exocytosis	3

Q8.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: - neurone at resting potential (1) - because (voltage gated) sodium (ion) channels {closed / blocked} (1) - therefore no movement of sodium (ions) into neurone / into cell / into axon / across membrane (1) - therefore prevents {depolarisation / action potential} (1)	ACCEPT not open DO NOT ACCEPT nerve	(4)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to four of the following: • arrival of {action potential / impulse} at presynaptic {knob / terminal} (1) • calcium channels open / calcium ions enter (presynaptic knob) (1) • vesicles {move to / fuse with} presynaptic membrane (1) • acetylcholine {diffuses across / released into} the {synapse / cleft} (1) • binding to receptors on postsynaptic membrane {opening sodium channels / allowing sodium ions to enter} (1)	Accept calcium ions pass through membrane Do not accept calcium ions enter membrane Accept neurotransmitters for acetylcholine	(4)

Question Number	Answer	Additional Guidance	Mark
(ii)	The only correct answer is B (excitatory, inhibitory, inhibitory) A is not correct because lidocaine is inhibitory affecting the Na⁺/K⁺ ATPase pump, and cobra venom is inhibitory, blocking acetylcholine receptors C is not correct because nicotine is excitatory, mimicking acetylcholine, lidocaine is inhibitory affecting the Na⁺/K⁺ ATPase pump, and cobra venom is inhibitory, blocking acetylcholine receptors D is not correct because nicotine is excitatory, mimicking acetylcholine		(1)

Q10.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: - sodium potassium pump (1) - therefore sodium (ions) move out and potassium (ions) move in (1) - potassium (ions) move out through potassium channels (1) - sodium channels close / membrane is impermeable to sodium (ions) / sodium (ions) do not move in (1) - outside more positive than inside (1)	ACCEPT Na⁺ for sodium ions and K⁺ for potassium ions DO NOT ACCEPT potassium channels are open so potassium ions enter ACCEPT only a few sodium channels are open / only a few sodium ions move in ACCEPT outside becomes positive AND inside becomes negative	4

Q11.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to four of the following: {action potential / impulse} arrives at (presynaptic) terminal / membrane / synaptic knob (1) - calcium channels open (1) - calcium ions diffuse into the neurone (1) - vesicles move towards the (presynaptic) membrane (1) - vesicles fuse with presynaptic membrane / exocytosis occurs (1)		4

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: - an action potential only occurs {when stimulation of A is high and B is low / when threshold is reached} (1) - because the levels of acetylcholine are high and the levels of glutamate are low (1) - an action potential does not occur when levels of glutamate are high (1) - because movement of chloride ions causes {hyperpolarisation / reduces depolarisation} (1)	Accept EPSP is greater than IPSP Accept because enough sodium ions enter the neurone / enough sodium channels open Accept excitatory transmitter for acetylcholine Accept IPSP is greater than EPSP Accept inhibitory transmitter for glutamate Accept description of hyperpolarisation e.g. inside becomes more negative	(3)

Q13.

Question Number	Answer	Additional Guidance	Mark
	An answer that includes the following - there is no action potential until the stimulus is greater than 45 (mV) (1) - this is the threshold value (1)	Accept range between 45-55 mV / 46 -55mV Accept converse Accept this is where depolarisation occurs / Na channels open Ignore optimum voltage	Exp (2)

Q14.

Question Number	Answer	Additional Guidance	Mark
	The only correct answer is C (open, closed) A is not correct because Na^+ channels are open not closed B is not correct because Na^+ channels are open, not closed and K^+ channels are closed not open D is not correct because K^+ channels are closed not open		(1)

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to four from the following: similarity • same speed at $1\ \mu\text{m}$ • speed increases for myelinated and unmyelinated axons (1) differences (max 3) • for axon diameters of more than $1\ \mu\text{m}$, myelinated are faster (1) • myelinated have a steeper / greater increase (1) • myelinated axons are slower below $1\ \mu\text{m}$ in diameter (1) • myelinated is linear relationship	At least one similarity and one difference Accept converse Accept ref to numerical comparison Accept converse Accept proportional increase / Accept converse for non-myelinated	4

Question Number	Answer	Additional Guidance	Mark
(ii)	- correct extrapolation to y axis to calculate c (1) - correct calculation of gradient - correct calculation of speed at 5 μm diameter (1)	-0.5 (Accept -0.4 to -0.6) $2/0.8 = 2.5$ 12 m s^{-1} (Accept between 11.9 and 12.1) Accept 12 for two marks Correct answer gains full marks	3

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to three of the following: - saltatory transmission does not occur (1) - because there are {fewer / no} nodes of Ranvier (1) - so impulse does not jump (between nodes) (1) - and sodium channels have to stimulate local current flow along each section of membrane / sodium channels have to open in every part of membrane / depolarisation has to occur along the whole length (1)		3

Q16.

Question Number	Answer	Mark
(a)(i)	100 (mV) ;	(1)

Question Number	Answer	Mark																												
(a)(ii)	<table><tr><th>Description</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr><tr><td>Stage when the concentration of positive ions is greatest inside the axon</td><td></td><td></td><td>☒</td><td></td><td></td><td></td></tr><tr><td>Stage when hyperpolarisation first occurs</td><td></td><td></td><td></td><td></td><td>☒</td><td></td></tr><tr><td>Site showing the resting potential</td><td>☒</td><td></td><td></td><td></td><td></td><td></td></tr></table>	Description	A	B	C	D	E	F	Stage when the concentration of positive ions is greatest inside the axon			☒				Stage when hyperpolarisation first occurs					☒		Site showing the resting potential	☒						(3)
	Description	A	B	C	D	E	F																							
	Stage when the concentration of positive ions is greatest inside the axon			☒																										
	Stage when hyperpolarisation first occurs					☒																								
	Site showing the resting potential	☒																												

Question Number	Answer	Mark
*(b)	QWC – Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence 1. diffuses across {gap /eq} ; 2. binds to (receptors on) post-synaptic membrane / eq ; 3. idea of gated-channels opening or Na^+ travels through post-synaptic membrane ; 4. causing a depolarisation / eq ; 5. (if sufficient present) an action potential is set up in {post-synaptic membrane/adjacent cell / eq} ; 6. details such as temporal or spatial summation ; 7. idea that allows coordination / one way flow of information ; 8. idea that it allows integration in post-synaptic cell ; 9. neurotransmitter broken down (by enzyme) / eq ; 10. so that do not get {prolonged /eq} action potential in post-synaptic membrane / make receptors available again ; 11. credit reference to fate of products e.g. reabsorbed through pre-synaptic membrane OR to be re-synthesised into neurotransmitter substance ;	(5)

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three from: - capsaicin binds to (TPV) receptors in membrane of receptors cells (1) - this causes neurotransmitter (from receptors) to be released onto sensory neurone {generating an epsp / opening sodium channels / causing sodium ions to flow in} (1) - high concentrations of capsaicin generate an epsp that) overcomes threshold to form an {action potential} (1) - action potential moves along the neurone by (opening sodium channels) (1)	Allow low concentrations does not overcome threshold Allow high concentrations opens voltage gated sodium channels	3

Question Number	Indicative content	
(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Descriptions • 100 mg / 50 mg / higher doses / of capsaicin increase mass of sweat produced D • sweat production from 100 mg decreases after 5 days D • 10 mg has less effect D • 10 mg / 50mg have same effect for all seven days D • 100 mg effect decreases after 3/4/5 days D • 100 mg generates less sweat than 50 mg after 5/6 days D Explanation / Optimal Dose • increased sweating and evaporation of water E • evaporation of water requires heat energy E • latent heat of vaporisation is high for water so sweating removes a lot of heat energy E • 50 mg is optimal dose E • because there 100 mg begins to lose effect after 3/4/5 days E • and 100 mg produces more side effects / burning sensations / red rash E Validity of data • 50 mg dose has consistent sweat production as error bars all overlap V • 100 mg and 50 mg are significantly higher than 10 mg as error bars do not overlap V • 10 mg has a high variation between responses of volunteers V	6

		- no control experiment has been carried out V - sample size is small V - capsaicin may interfere with other medicines / may make illness worse / no tests done on illpeople V	
Level	Marks		
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made. Basic description of the effects of each dose one mark: any one from D, E, V two marks: 3D, 2D + 1E, 2D + 1V	
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made. Detailed description and either E or V three marks: at least four points from D + E or D + V four marks: at least five points from D + E or D + V	

Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made. Must have elements of D, E and V. five marks: at least six points from D, E and V six marks: at least seven points from D, E and V AND must refer to standard deviations	
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Q18.

Question Number	Correct Answer	Additional guidance	Mark
(a)	Measurement from diagram: 2.1 cm = 0.021 m (1) Actual distance: $0.021 \text{ m} \div 226 = 9.2 \times 10^{-4} \text{ m}$ (1) Calculate speed: $0.02 \text{ ms} = 2.0 \times 10^{-5} \text{ s}$ $9.2 \times 10^{-4} \text{ m} \div 2.0 \times 10^{-5} \text{ s} = 4.65 \text{ ms}^{-1}$ (1)	e.c.f. at any stage penalise once only Correct answer gains full marks with no working	(3)

Question Number	Correct Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: • myelin may absorb / reflect light (1) • therefore less light passes to light sensitive cells (1) • hence some rod / light sensitive cells not stimulated / bleached (1)		(3)

Q19.

Question Number	Answer	Additional guidance	Mark
(a)	A - cell body ; B - axon ;		(2)

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. increasing Eugenol concentration increases percentage inhibition / positive correlation ; 2. description of non linear correlation ; 3. credit correct manipulation of the data e.g. between 0.1 and 1.0 mmol dm³ percentage inhibition to increase by 55% ;	ACCEPT 2 – e.g. greatest increase in inhibition is between eugenol concentration of 0.2 and 0.4 mmol dm⁻³	(2)

Question Number	Answer	Additional guidance	Mark
* (b)(ii)	QWC – Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence) 1. {reduced / eq} Ca^{2+} enters { <i>presynaptic membrane</i> / into <i>sensory neurone</i> } ; 2. due to Ca^{2+} channel not opening / decreased sensitivity of <i>membrane</i> to Ca^{2+} ; 3. fewer <i>vesicles</i> {move towards / fuse} with <i>presynaptic membrane</i> ; 4. less <i>neurotransmitter</i> {released into / less diffuses across} {<i>synaptic gap</i> / eq} ; 5. less <i>neurotransmitter</i> binds to receptors on {<i>post-synaptic membrane</i> / adjacent neurone} ; 6. idea of reduced depolarisation / less Na^+ or cation channels open ; 7. idea of { threshold intensity / <i>action potential</i> / <i>impulse</i> } less likely to occur ; 8. idea of pain not being sensed as impulse {stopped before entering CNS / leaving the <i>sensory neurone</i>} ;	ACCEPT 1 – into <i>synaptic knob</i> / pre-synaptic neurone ACCEPT 4 (& 5) - named neurotransmitter example ACCEPT 7 - not reached as alternative to less likely to be reached	(6)

Q20.

Question Number	Answer	Additional Comments	Mark
(a) (i)	(terminal) dendrite ;		(1)

Question Number	Answer	Additional Comments	Mark
(a) (ii)	B ;		(1)

Question Number	Answer	Additional Comments	Mark
(b) (i)	1. Increasing eugenol concentration increase percentage inhibition / positive correlation ; 2. Description of non linear correlation ; 3. Credit correct manipulation of the data e.g. 0.8 mmol dm^{-3} increase causes percentage inhibition to increase by {x2.7 / eq} ;	2. Ignore references to rate or speed Accept greatest increase is between 0.2 and 0.4	(2)

Question Number	Answer	Additional Comments	Mark
(b) (ii)	Correct answer gains 2 marks 72.5 / 73.0 / 75 (%) ;	Accept for 1 mark $(65 + 80) \div 2$ or $145 \div 2$ if answer incorrect	(2)

Question Number	Answer	Additional Comments	Mark
* (c)	QWC – Spelling of technical terms (shown in <i>italics</i>) must be correct and the answer must be organised in a logical sequence 1. higher concentration of Na⁺ outside of neurone / eq ; 2. sodium ions move in causing a depolarisation / eq ; 3. eugenol may affect { Na⁺ / voltage-dependent } gates / eq ; 4. eugenol reduces influx of Na⁺ / eq ; 5. (so) depolarisation less likely to occur / eq ; 6. no impulse transmitted along neurone / eq ; 7. idea of no transmission to next neurone ; 8. idea of pain not being sensed as impulse stopped before entering CNS ;	QWC emphasis is logical sequencing in the context of how <u>eugenol</u> affects the movement 6. Accept no action potential 7. Accept no release of neurotransmitter	(6)

Q21.

Question Number	Answer	Additional Guidance	Mark												
(i)	<table border="1"> <thead> <tr> <th>Stage</th><th>Voltage-gated K⁺ channel open</th><th>Voltage-gated K⁺ channel closed</th><th>Voltage-gated Na⁺ channel closed</th></tr> </thead> <tbody> <tr> <td>Depolarisation</td><td></td><td>✓</td><td></td></tr> <tr> <td>Repolarisation</td><td>✓</td><td></td><td>✓</td></tr> </tbody> </table>	Stage	Voltage-gated K ⁺ channel open	Voltage-gated K ⁺ channel closed	Voltage-gated Na ⁺ channel closed	Depolarisation		✓		Repolarisation	✓		✓	3 columns correct = 2 marks 2 columns correct = 1 mark	(2)
Stage	Voltage-gated K ⁺ channel open	Voltage-gated K ⁺ channel closed	Voltage-gated Na ⁺ channel closed												
Depolarisation		✓													
Repolarisation	✓		✓												

Question Number	Answer	Mark
(ii)	A ;	(1)

Q22.

Question Number	Answer	Additional Comments	Mark
(a)	1. only (alpha) 1-4 glycosidic bonds in amylose / (alpha) 1-6 only found in amylopectin ; 2. only amylopectin has side branches / only amylose is {coiled / eq} ; 3. Amylopectin is a {larger / eq} molecule than amylose ;	1. ACCEPT 1-6 and 1-4 in amylopectin	(2)

Question Number	Answer	Additional Comments	Mark
(b)	1. Different individuals in the {colony / eq} take on specific {roles / jobs / eq} ; 2. Example given e.g. queen produces offspring ;	1. Accept division of labour 2. Accept dominance by queen, {few of the males / kings} involved in breeding	(2)

Question Number	Answer	Additional Comments	Mark
(c) (i)	Idea that body temperature of animal mimics the ambient temperature ;	Accept body temp follows environmental temperature	(1)

Question Number	Answer	Additional Comments	Mark
(c) (ii)	1. Lack of insulating layer: Idea that does not impede transfer of heat energy / allows exchange of heat energy more easily ; 2. A marked reduction in sweat glands: Idea that they do not need to cool down OR less water lost ;	1. Accept enables heat transfer between environment and NMR	(2)

Question Number	Answer	Additional Comments	Mark
(d)	1. (Cancer causing) gene identified / eq ; 2. Gene {cut / isolated / eq} from DNA / eq ; 3. Using a {restriction / eq} enzyme / eq ; 4. Gene in {vector / named vector} ; 5. Mechanism for getting {gene/vector} into host cells (of mice) / eq ;	1. Accept screen for the gene 2. Accept extracted 3. Accept correctly named restriction enzyme e.g. EcoR1 4. Accept Named <u>egs</u> – retrovirus, virus, liposome, plasmid, bacteria 5. Accept reference to (micro)injection, <u>microprojectiles</u> , electroporation, gene gun, inhaler, transduction	(3)

Question Number	Answer	Additional Comments	Mark
* (e)	QWC – Spelling of technical terms (<i>shown in italics</i>) must be correct and the answer must be organised in a logical sequence 1. {<i>neurone</i> (cell) surface membrane exposed / no <i>myelination</i> / eq} at nodes of <i>Ranvier</i> ; 2. Nodes are the site of clusters of {<i>sodium-gated channel proteins</i> / <i>potassium channels</i>} ; 3. Which {open / close} when <i>impulse</i> arrives / eq ; 4. Allowing <i>depolarisation</i> at nodes / eq ; 5. idea that <i>myelin</i>/eq acts as an (electrical) <i>insulator</i> (on <i>neurone</i> surface between nodes) ; 6. reference to <i>Schwann</i> cell ; 7. idea that <i>impulse/depolarisation</i> 'jumps' to next node ; 8. Reference to this being <i>saltatory conduction</i> ; 9. idea that this happens between the <i>myelin</i> layers of the <i>Schwann</i> cell ;	QWC emphasis on spelling 3. Accept influx of sodium ions	(5)

Question Number	Answer	Additional Comments	Mark
(f)	1. idea of heart working less efficiently ; 2. idea of less oxygen absorbed at lungs / eq ; 3. less blood pumped to brain ; 4. concentration gradient (for oxygen) at brain reduced / eq ; 5. less oxygen in blood (in brain) diffuses into brain tissue / eq ; 6. idea of less oxygen in brain tissue due to continual (aerobic) respiration ;		(3)

Question Number	Answer	Additional Comments	Mark
(g)	~~gonadotrophin~~-releasing (hormone) stimulates ~~gonadotrophin~~ release / ~~gonadotrophin~~ stimulates ovulation / testosterone stimulates {sperm production / (male) secondary sexual characteristics / other named example} ;		(1)

Question Number	Answer	Additional Comments	Mark
(h)	1. Idea of effect on mitochondria ; 2. (therefore) reduced {energy / ATP / eq} for flagellum movement ;	1. Accept less efficient/fewer/ none 2. Accept tail for flagellum	(2)

Question Number	Answer	Additional Comments	Mark
(i)	1. idea that fat is an energy store ; 2. reduces dependence on external food source / eq ; 3. enables disperser to travel / eq ; 4. (metabolic) water is released (on oxidation) / eq ; 5. acts as a thermal insulator / eq ;	Accept energy-rich	(3)

Question Number	Answer	Additional Comments	Mark
(j)	1. idea that unfamiliar males are likely to be genetically different ; 2. idea that this is outbreeding ; 3. idea that this increases genetic diversity ;	3. Accept producing offspring that are genetically different	(2)

Question Number	Answer	Additional Comments	Mark
(k)	the order of the {bases / genes and non-coding sequences / eq} in the DNA (of the naked mole rats) is found / eq ;	Accept exons and introns Ignore genes unqualified	(1)

Question Number	Answer	Additional Comments	Mark
(l)	Paired responses: 1. reduced sensitivity to chemical pain / disconnection of 'pain nerves' ; 2. Idea of pain relief e.g. dealing with post traumatic pain, post surgical pain, joint pain after a knee operation ; 3. haemoglobin has higher affinity for oxygen ; 4. Idea of dealing with reduced oxygen situations such as due to a heart attack or stroke ; 5. Naked mole rat {incisors / eq} grow through skin (of lip) without damage ; 6. Idea of better prosthesis e.g. new {coatings / permanent seal} at {skin / bone / metal} interface, soft tissue not damaged, avoid infection ; 7. High protein stability / does not (easily) lose 3D shape ; 8. (so) reduced effect of oxidative {damage / stress} / reduced effect of oxygen-containing free radicals / live healthily into old age ; 9. Cell overcrowding early warning gene / ref. to two tiered contact inhibition / presence of gene p16 ; 10. Idea of cancer prevention e.g. cancer resistance, future cancer therapy ; 11. Naked mole rat neurones display immature {characteristics / physiological properties} / brain cells that cope with {low oxygen / hypoxia} ; 12. To treat people with temporary loss of oxygen to brain e.g. heart attack, stroke, drowning / to prevent permanent brain damage ; 13. High levels of oxytocin receptors in {brain / nucleus <u>accumbens</u> } ; 14. Idea of links to autism ; 15. Naked mole rats do not experience menopause ; 16. Ref to osteoporosis {treatment / prevention} (without side effects) ; 17. circadian rhythms / sleep patterns of naked mole rats ; 18. Idea that may help with sleep disorders ;	9. Accept anticancer mechanism	

Q23.

Question Number	Answer	Additional Guidance	Mark
	1. idea that it binds to wasp venom so it {is removed from / can no longer bind to} receptor ; 2. idea that breaks down wasp venom so it leaves receptor ; 3. idea that wasp venom binds more readily to it than to the receptor ; 4. idea of the nature of the compound e.g. enzyme ;		(2)

Q24.

Question Number	Answer	Additional Guidance	Mark
(i)	resting (potential) (1)		Clerical (1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer including four of the following • {sodium / Na} channels open (1) • sodium ions flow into {axon / cell / neurone} (1) • this causes depolarisation (1) • {sodium / Na} channels close at {0.8ms / 30mV} (1) • {potassium / K} channels open at {0.8ms / 30mV} (1)	Ignore how they are moving Accept sodium gates open Ignore membrane	Exp (4)

Q25.

Question Number	Correct Answer	Additional guidance	Mark
	A description that makes reference to three of the following: • binds to active site of cholinesterase (1) • acetylcholine remains / not broken down (1) • depolarisation of post synaptic membrane continues (1) • nerve impulse continues / action potential continues (1)		(3)