Control and Coordination in Mammals (15.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 71 marks · about 85 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 4 · May/June 2023 (42) · Q9(a) · 6 marks

9 (a) The passage outlines the endocrine system.

Complete the passage by using the most appropriate scientific terms.

The endocrine system consists of tissues and ..... , which secrete hormones such as insulin, glucagon and antidiuretic hormone (ADH). Glucagon only affects target cells that have complementary receptors, which are located on the ..... . Glucagon binds to these receptors and this leads to the production of a ..... , which transfers the signal throughout the cytoplasm. The target cells for insulin are in the liver, ... and adipose tissue. The target cells for ADH are those of the distal convoluted tubule and the ..... of the kidney nephron. These hormones are involved in ..... , which is the maintenance of a constant internal environment. [6]

Question 2 · Paper 4 · October/November 2023 (42) · Q9(b) · 4 marks

(b) Outline the differences between the endocrine system and the nervous system.

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Question 3 · Paper 4 · February/March 2023 (42) · Q7(b) · 3 marks

(b) Describe the differences in structure **and** function between sensory neurones and motor neurones.

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Question 4 · Paper 4 · May/June 2024 (42) · Q8(a)(i) · 1 mark

8 **(a)** Fig. 8.1 is a diagram of a sensory neurone.

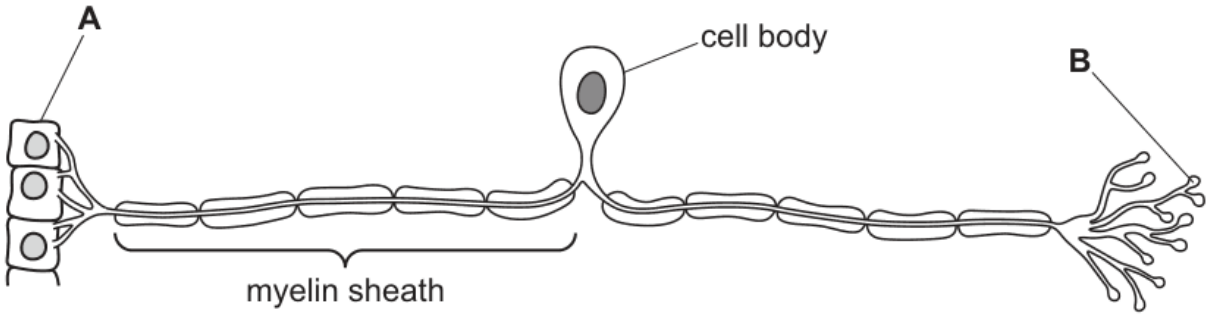


Fig. 8.1

(i) Name the type of cell represented by cell **A**.

Question 5 · Paper 4 · May/June 2024 (42) · Q8(a)(ii) · 1 mark

(ii) Name a type of cell that forms a synapse with structure **B**.

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Question 6 · information from earlier in the question

8 The role of sensory receptor cells in mammals is to detect stimuli and generate action potentials in sensory neurones.

Human taste buds on the tongue contain chemoreceptor cells. Different chemoreceptor cells respond to different chemical stimuli.

Fig. 8.1 is a diagram of chemoreceptor cells in a taste bud.

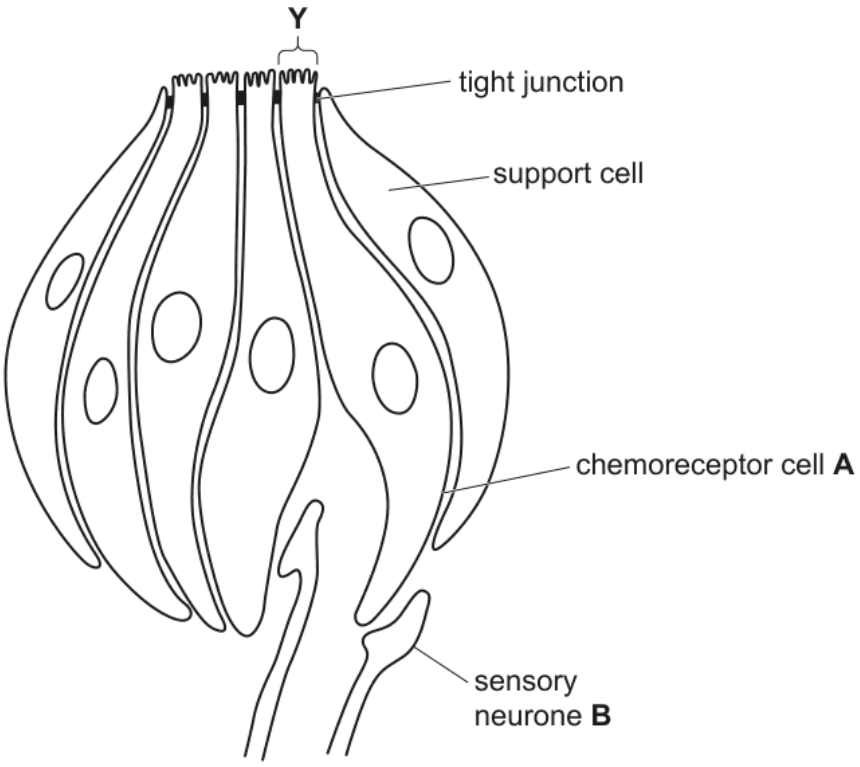


Fig. 8.1

Question 6 · Paper 4 · May/June 2022 (42) · Q8(b) · 1 mark

(b) Suggest a reason for the tight junctions between the chemoreceptor cells.

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Question 7 · Paper 4 · May/June 2022 (42) · Q8(c) · 7 marks

(c) Chemoreceptor cell **A** responds to sodium ions (Na^+) in salt.

Describe how the contact of cell **A** with Na^+ can result in an action potential in sensory neurone **B**.

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Question 8 · Paper 4 · May/June 2025 (42) · Q7(a) · 6 marks

7 **(a)** An axon membrane is described as being at its resting potential when an action potential is **not** occurring.

Describe **and** explain how a resting potential of an axon membrane is maintained.

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Question 9 · Paper 4 · February/March 2022 (42) · Q2(a)(i) · 2 marks

2 Giant axonal neuropathy (GAN) is a rare autosomal recessive disease, which affects neurones.

(a) Mitochondria can move freely within the axons of neurones.

In GAN, the axons of neurones become enlarged and blocked by the accumulation of specific proteins. This prevents the free movement of mitochondria and affects the transmission of action potentials along the axon membrane.

(i) Suggest **and** explain why preventing the free movement of mitochondria within the cytoplasm of the axon affects the transmission of action potentials along the axon membrane.

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9 (a) Voltage-gated channels are involved in the generation of an action potential.

Fig. 9.1 is a diagram of the voltage-gated channels of sodium ions and potassium ions in the membrane of an axon. The channels are shown in three different states, **1**, **2** and **3**.

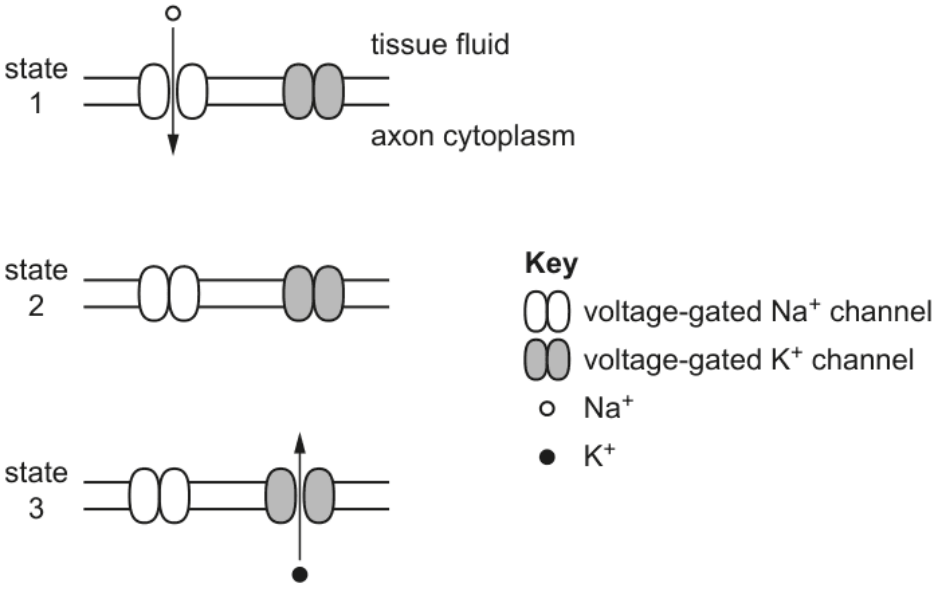


Fig. 9.1

Fig. 9.2 is a diagram of different phases of an action potential in an axon. The phases are labelled **A**, **B**, **C**, **D**, **E**, **F** and **G**.

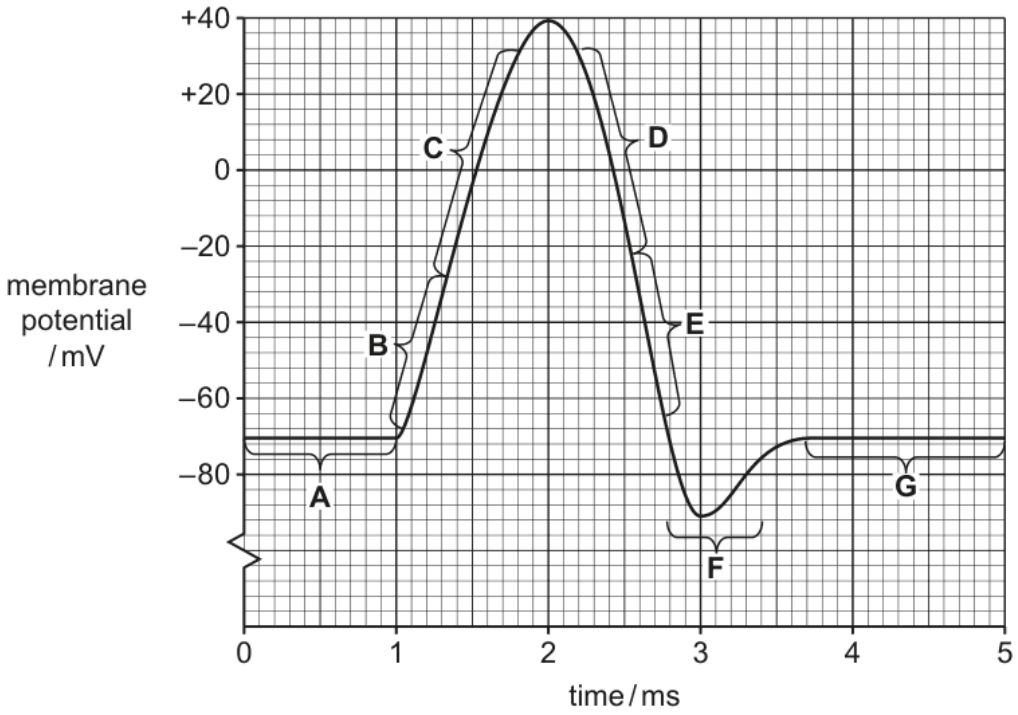


Fig. 9.2

Complete Table 9.1 to match each of the listed phases of the action potential with the appropriate state of the voltage-gated channels: **1**, **2** or **3**.

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Question 11 · Paper 4 · October/November 2022 (42) · Q9(b) · 3 marks

(b) Many neurones are surrounded by myelin sheaths.

Describe **and** explain the role of the myelin sheath in the transmission of an action potential.

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Question 12 · Paper 4 · May/June 2024 (43) · Q10(c) · 4 marks

(c) Table 10.1 shows the axon diameter, myelination and transmission speed of impulses of motor neurones for three animals: squid, cockroach and cat.

Table 10.1

animal	axon diameter /mm	myelination	transmission speed /m s^{-1}
squid	1.5	no	30
cockroach	0.05	no	10
cat	0.02	yes	100

Describe **and** suggest explanations for the results shown in Table 10.1.

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Question 13 · Paper 4 · October/November 2025 (42) · Q7(b) · 3 marks

(b) Action potentials are produced by the Venus fly trap during the closure of a leaf. Each action potential is also associated with a refractory period. This is similar to the action potential and refractory period observed in a mammalian neurone during nerve impulse transmission.

Explain the role played by the refractory period in the transmission of an impulse in a mammalian neurone.

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(b) Fig. 7.1 is a diagram of synapses between a postsynaptic neurone and two presynaptic neurones, **X** and **Y**.

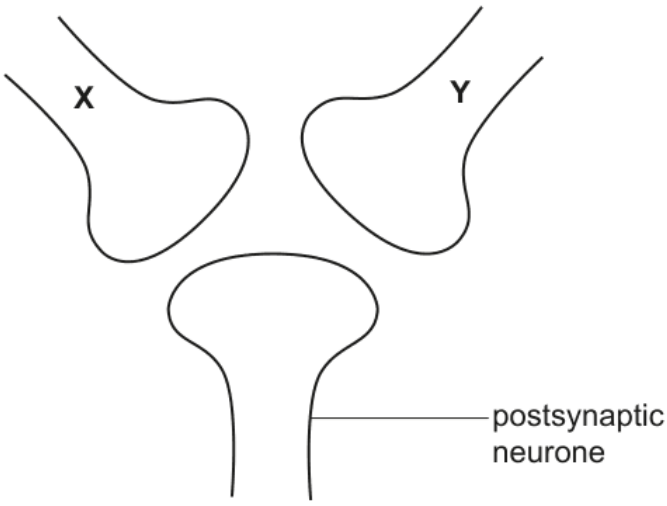


Fig. 7.1

- Neurone **X** releases the neurotransmitter acetylcholine.
- Neurone **Y** releases the neurotransmitter glutamate.
- Both neurotransmitters bind to channel proteins in the membrane of the postsynaptic neurone.
- Acetylcholine binding results in an influx (entry) of sodium ions.
- Glutamate binding results in an influx of chloride ions.

A student made three statements:

1. When only neurone **X** is stimulated, an action potential **will** occur in the postsynaptic neurone.
2. When only neurone **Y** is stimulated, an action potential **will** occur in the postsynaptic neurone.
3. When neurone **X** and neurone **Y** are stimulated at the same time, an action potential **will not** occur in the postsynaptic neurone.

Explain whether or not you agree with these statements.

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(c) Opioids are therapeutic drugs that are used to relieve pain. Morphine is an example of an opioid. It affects the functioning of synapses.

Fig. 8.2 is a diagram of a cholinergic synapse.

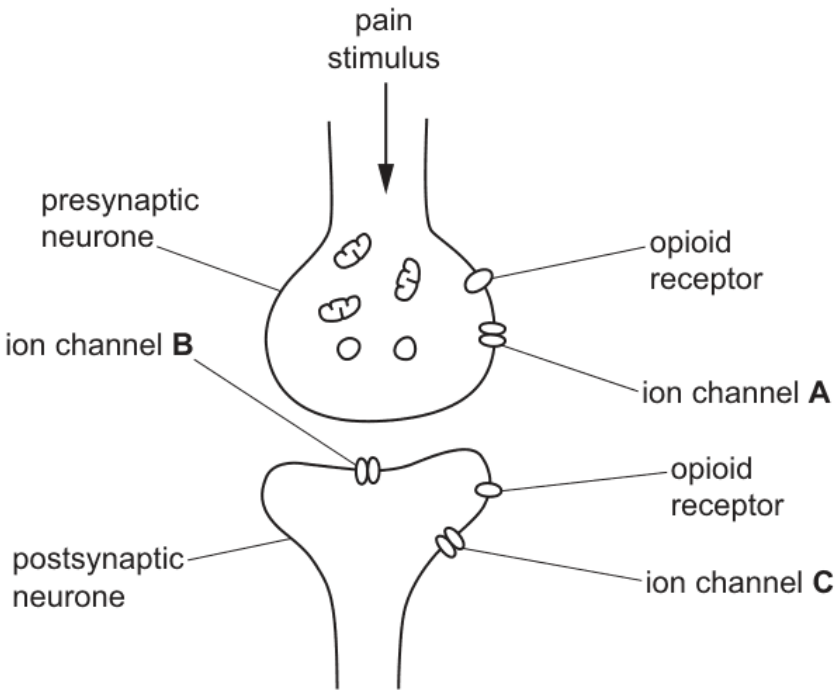


Fig. 8.2

(i) With reference to Fig. 8.2, describe the differences between ion channel **A** and ion channel **B**.

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Question 16 · Paper 4 · May/June 2024 (42) · Q8(c)(ii) · 4 marks

(ii) Morphine binds to the opioid receptor in the presynaptic membrane. This stops the ion channel **A** from opening.

Suggest **and** describe the effects of the binding of morphine to this opioid receptor on the functioning of the cholinergic synapse.

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Question 17 · Paper 4 · May/June 2024 (42) · Q8(c)(iii) · 2 marks

(iii) Morphine also binds to the opioid receptor in the postsynaptic membrane. This results in the opening of ion channel **C**, allowing potassium ions to diffuse out of the cell.

Suggest how this would affect the synapse.

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Question 18 · Paper 4 · February/March 2023 (42) · Q9(a)(i) · 2 marks

9 **(a)** Fig. 9.1 is a diagram of a relaxed sarcomere in striated muscle.

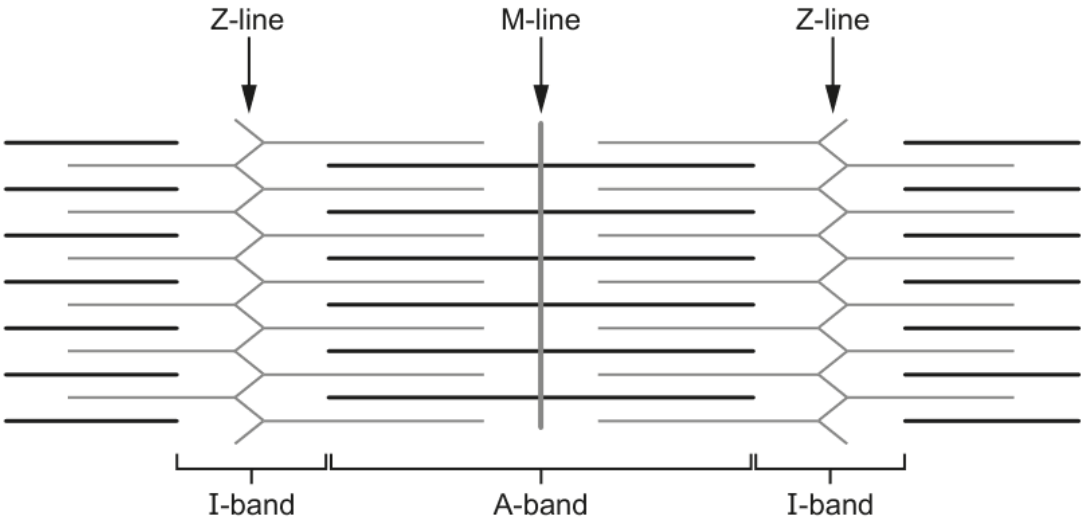


Fig. 9.1

(i) On Fig. 9.1, use label lines and letters to label:
- an actin filament with the letter **P**
- a myosin filament with the letter **R**.

[2]

Question 19 · Paper 4 · February/March 2023 (42) · Q9(a)(ii) · 2 marks

(ii) State what happens to the A-band and the I-band when the sarcomere contracts.

A-band .....

I-band .....

[2]

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Question 20 · Paper 4 · February/March 2023 (42) · Q9(b)(i) · 4 marks

(b) The plant *Strychnos toxifera* produces the toxin curare, which can cause muscle paralysis in mammals.

The toxin acts by binding to receptors on the cell surface membranes (sarcolemma) of muscle cells at neuromuscular junctions.

(i) Suggest how binding of curare to receptors may cause muscle paralysis.

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Question 21 · Paper 4 · May/June 2023 (42) · Q7(a) · 4 marks

7 **(a)** A striated muscle cell (muscle fibre) will contract when stimulated by a motor neurone at a neuromuscular junction.

Air temperature can affect the temperature of striated muscle cells.

Investigations have shown that the efficiency of contraction of striated muscle cells decreases when the air temperature decreases.

Suggest reasons why a reduction in temperature can decrease the efficiency of contraction of striated muscle cells.

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Question 22 · Paper 4 · February/March 2024 (42) · Q10(a) · 4 marks

10 (a) Striated muscle is composed of myofibrils. Myofibrils contain several structural proteins including troponin, tropomyosin, actin and myosin.

Outline the roles of these four structural proteins in the contraction of a sarcomere.

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Mark schemes

Question 1 · Paper 4 · May/June 2023 (42) · Q9(a) · 6 marks

9(a)	glands ; cell surface membrane / plasma membrane ; **A** liver (cells) second messenger / cAMP ; **A** enzyme cascade / phosphorylation of enzymes / signalling cascade (striated) muscles ; collecting duct ; homeostasis ;	**6**

Question 2 · Paper 4 · October/November 2023 (42) · Q9(b) · 4 marks

9(b) *any **four** from:* **4**

		nervous system		endocrine system
1	communication	action potential / impulse	and	hormone ;
2	nature of communication	electrical (and chemical)	and	chemical ;
3	mode of transmission	neurone	and	blood ;
4	response destination	muscle	and	target, organs / tissue / cells ;
5	transmission speed	fast(er)	and	slow(er) ;
6	location of effect	specific / localised	and	(can be) widespread ;
7	response speed	fast(er)	and	slow(er) ;
8	duration of effect	short-lived / temporary	and	can be long-lasting / permanent ;

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Question 3 · Paper 4 · February/March 2023 (42) · Q7(b) · 3 marks

7(b) *any **three** from:* **3**

	sensory		motor
1	cell body, between dendron and axon / in ganglion	**and**	cell body, at end / in CNS ;
2	has dendron and axon	**and**	has (long) axon ;
3	no dendrites from cell body	**and**	dendrites extend from cell body ;
4	carries impulses from receptor to, CNS / intermediate neurone	**and**	carries impulses from, CNS / intermediate neurone, to effector ;

Question 4 · Paper 4 · May/June 2024 (42) · Q8(a)(i) · 1 mark

8(a)(i)	receptor ;	1

Question 5 · Paper 4 · May/June 2024 (42) · Q8(a)(ii) · 1 mark

8(a)(ii)	intermediate neurone ; **A** relay neurone / motor neurone	1

Question 6 · Paper 4 · May/June 2022 (42) · Q8(b) · 1 mark

8(b)	no movement of, chemicals / substances / ions, between the, chemoreceptor / cells / (cells) **A** ; **Ignore** food **A** named dissolved substance	1

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Question 7 · Paper 4 · May/June 2022 (42) · Q8(c) · 7 marks

8(c)	*any **seven** from:* 1. Na^+ ions enter, (chemo)receptor cell / **A**, through, microvilli / **Y** / channel (proteins) ; 2 cell **surface** membrane depolarised ; 3 receptor potential ; 4 *ref. to* threshold ; 5 (voltage-gated) Ca^{2+} / calcium, channels open ; 6 Ca^{2+} ions enter, cytoplasm / cell / **A** ; **A** presynaptic knob 7 vesicles (of neurotransmitter), move towards / fuse with, cell **surface** membrane / presynaptic membrane ; 8 exocytosis (described) / secretion, of (named) neurotransmitter ; 9 neurotransmitter binds to receptor on, postsynaptic / (sensory) neurone / **B**, membrane ; 10 Na^+ / sodium, channels open **or** Na^+ enter (sensory) neurone / **B** ; 11 postsynaptic membrane / (sensory) neurone membrane, depolarised ; 12 *ref. to* threshold ; *allow either mp4 or mp12*	**7**

Question 8 · Paper 4 · May/June 2025 (42) · Q7(a) · 6 marks

7(a)	*any **six** from:* 1 sodium–potassium pumps (in axon membrane) ; 2 transport, sodium ions / Na^+, out and, potassium ions / K^+, in ; 3 by active transport / uses ATP ; 4 three, sodium ions / Na^+, and two, potassium ions / K^+ ; 5 sets up an electrochemical gradient ; 6 potassium ions / K^+, diffuse out through channels ; 7 membrane more permeable to K^+ / membrane has more K^+ channels ; 8 (so) more, potassium ions / K^+, move out of axon than, sodium ions / Na^+, move in ; 9 *ref. to* anions / negatively charged ions / negatively charged proteins, inside ; 10 inside negative (relative to outside) ; 11 -60 mV to -70 mV ;	**6**

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Question 9 · Paper 4 · February/March 2022 (42) · Q2(a)(i) · 2 marks

2(a)(i)	*any **two** from:* 1 no / less, ATP for the, sodium-potassium pump / active transport of Na^+ and K^+ ; 2 reduces / prevents, (re-establishment of) resting potential ; 3 reduces transmission of action potential (along the axon) ;	**2**

Question 10 · Paper 4 · October/November 2022 (42) · Q9(a) · 3 marks

9(a) **3**

phase of action potential	state of voltage-gated channels
A	2
C	1
E	3
F	3
G	2

;;;

5 correct = 3 marks
3/4 correct = 2 marks
1/2 correct = 1 mark

Question 11 · Paper 4 · October/November 2022 (42) · Q9(b) · 3 marks

9(b)	*any **three** from:* 1 Schwann cells, wrap around the axon / form the myelin sheath ; 2 insulates (axon) / prevents movement of ions ; 3 depolarisation / action potentials, can only occur at nodes (of Ranvier) ; 4 *ref. to* long(er) local circuits / (nodes are) 1–3 mm apart ; 5 action potentials, move by saltatory conduction / jump from node to node ; 6 speed of transmission is, fast(er) / 100 m s^{-1} ;	**3**

Question 12 · Paper 4 · May/June 2024 (43) · Q10(c) · 4 marks

10(c)	*any **four** from:* *description* 1 myelinated axon / myelination, produces faster transmission speed (than unmyelinated) ; 2 a larger the diameter (for unmyelinated) results in a faster transmission speed ; **ora** 3 myelination has a greater effect on transmission speed than axon diameter ; *explanation* 4 (myelinated faster due to) saltatory conduction **or** action potential jumps from node (of Ranvier) to node ; 5 axons with wider diameter have, less ion leakage / larger surface area / lower resistance ;	**4**

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Question 13 · Paper 4 · October/November 2025 (42) · Q7(b) · 3 marks

7(b)	*any **three** from :* 1 impulses / action potentials, are discrete events / AW ; 2 impulses / action potentials, are unidirectional ; 3 determines / limits, the frequency of, impulses / action potentials ; 4 AVP ; e.g. 200-300 action potentials per second	**3**

Question 14 · Paper 4 · October/November 2023 (42) · Q7(b) · 3 marks

7(b)	**X** – agree, because Na^+ influx leads to depolarisation ; **Y** – disagree, because Cl^- influx leads to hyperpolarisation / description **or** disagree, because no Na^+ influx so no depolarisation ; **X** and **Y** – agree, because Na^+ (influx) is balanced by Cl^- (influx) / AW ;	**3**

Question 15 · Paper 4 · May/June 2024 (42) · Q8(c)(i) · 2 marks

8(c)(i)	1 **A** voltage-gated <u>and</u> **B** ligand-gated / not voltage-gated **or** **A** opens in response to, depolarisation / arrival of an action potential <u>and</u> **B** opens in response to binding of, acetylcholine / neurotransmitter ; 2 **A** for calcium ions <u>and</u> **B** for sodium ions ;	**2**

Question 16 · Paper 4 · May/June 2024 (42) · Q8(c)(ii) · 4 marks

8(c)(ii)	*any **four** from:* 1 no Ca^{2+} enter (presynaptic, knob / neurone) ; 2 vesicles do not, move towards / fuse with, presynaptic membrane ; 3 no, ACh / neurotransmitter, released **or** no exocytosis of, ACh / neurotransmitter ; 4 ACh / neurotransmitter, does not bind to, receptor / ion channel **B** ; 5 Na^+ does not enter postsynaptic neurone / ion channel **B** does not open ; 6 postsynaptic membrane not depolarised **or** no action potential generated **or** impulse not transmitted ;	**4**

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Question 17 · Paper 4 · May/June 2024 (42) · Q8(c)(iii) · 2 marks

8(c)(iii)	*any **two** from:* 1 inside more negative (charge) **or** membrane hyperpolarised / membrane potential decreases / potential difference increases ; 2 harder to / cannot, reach threshold ; 3 no depolarisation of membrane / harder to depolarise membrane **or** no / fewer / harder to generate, action potentials / impulses ;	**2**

Question 18 · Paper 4 · February/March 2023 (42) · Q9(a)(i) · 2 marks

9(a)(i)	**P** pointing to thin filament ; **R** pointing to thick filament ;	**2**

Question 19 · Paper 4 · February/March 2023 (42) · Q9(a)(ii) · 2 marks

9(a)(ii)	A-band – stays the same ; I-band – gets narrower ;	**2**

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Question 20 · Paper 4 · February/March 2023 (42) · Q9(b)(i) · 4 marks

9(b)(i)	*any **four** from:* 1 competes with, acetylcholine / neurotransmitter **or** acetylcholine cannot bind to receptors **or** blocks receptors ; 2 Na^+ channels do not open **or** no / fewer, sodium ions enter (muscle fibre) ; 3 so, no / less, depolarisation of sarcolemma ; 4 no / fewer, action potentials / impulses (spread across muscle fibre) ; 5 Ca^{2+} (voltage-gated) channels do not open in sarcoplasmic reticulum **or** no / fewer, Ca^{2+} ions released by sarcoplasmic reticulum ; 6 no / fewer, Ca^{2+} ions bind to troponin **or** no exposing of binding sites **or** no / fewer, cross bridges / AW ;	**4**

Question 21 · Paper 4 · May/June 2023 (42) · Q7(a) · 4 marks

7(a)	*any **four** from:* 1 respiration rate decreases / less ATP produced ; 2 reduces activity of (named) enzymes / description ; 3 reduces movement of, Ca^{2+} / Na^+ / ACh / neurotransmitter ; 4 (*in neuromuscular junction*) less / no, acetylcholine broken down acetylcholine remains attached to receptors acetylcholinesterase, less active / inactive ; 5 (*in sarcomere*) fewer / no, Ca^{2+} bind to troponin fewer / no, cross bridges formed fewer / no, power stokes ; 6 (*in sarcomere*) less / no, detachment of myosin heads (from actin) fewer / no, cross bridges broken ATPase / myosin head, less active / inactive hydrolysis of ATP, slower / stops ; 7 AVP ; e.g. shivering / reduced blood flow to muscle / energy diverted for thermoregulation (*idea*)	**4**

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Question 22 · Paper 4 · February/March 2024 (42) · Q10(a) · 4 marks

10(a)	*any **four** from:*	**4**
	1 **troponin** binds Ca^{2+} and changes shape **;**	
	2 (so) **tropomyosin** moves away from the binding sites on **actin ;**	
	3 **myosin heads**, bind to / form cross-bridges, with **actin ;**	
	4 **myosin head**, pulls **actin** / performs power stroke, to, **either** shorten / contract, sarcomere **or** cause Z lines to move closer together / Z lines move closer to M lines **;**	
	5 **myosin head,** is ATPase / binds to ATP, to allow detachment **;**	

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