

APOLLO

# Neural signalling

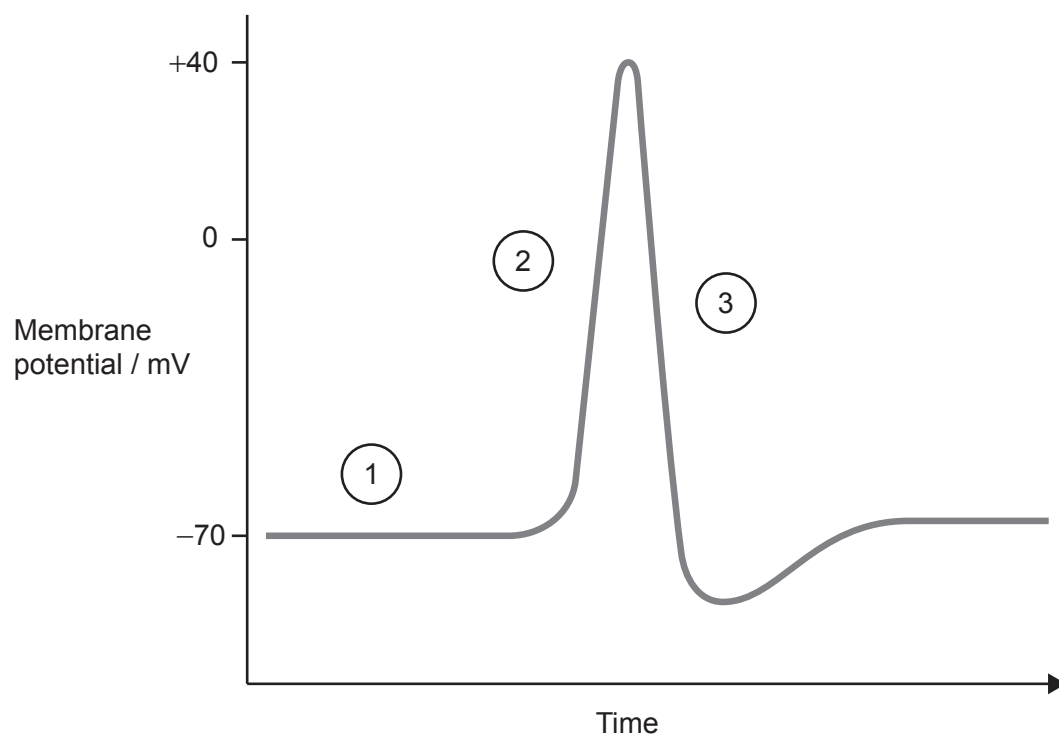
## HL

Biology

First assessment 2025

16 questions | questions

17. The graph below shows an action potential.



Where on the graph do the sodium channels open?

- A. At 1
- B. Between 1 and 2
- C. At 2
- D. Between 2 and 3

Turn over

- 18.** What effect does cocaine have on neural signalling?
- A. Blocks the reuptake of neurotransmitters in the synapse
  - B. Opens channels for positively charged ions to initiate an action potential
  - C. Acts as a non-competitive inhibitor of the sodium–potassium pump
  - D. Triggers an increase in saltatory conduction in the nodes of Ranvier

**26.** Which of these structures is most likely to be the effector in a pain reflex arc?

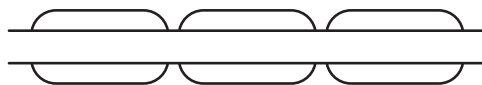
- A. Grey matter
- B. Skeletal muscle
- C. Motor neuron
- D. Pineal gland

- 17.** What is the action of neonicotinoids on the synapse of an insect?
- A. They prevent the release of acetylcholine from the presynaptic membrane.
  - B. They increase the permeability of the presynaptic neuron to sodium ions.
  - C. They bind to the acetylcholine receptor on the postsynaptic neuron.
  - D. They block the uptake of acetylcholine in vesicles in the presynaptic neuron.

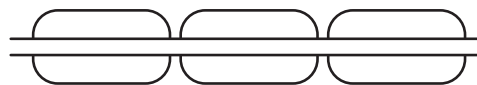
**Turn over**

17. The diagrams represent sections through different axons. Which axon has the slowest speed of impulse?

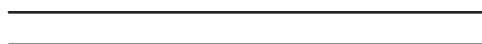
A.



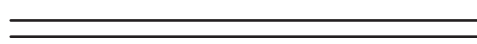
B.



C.

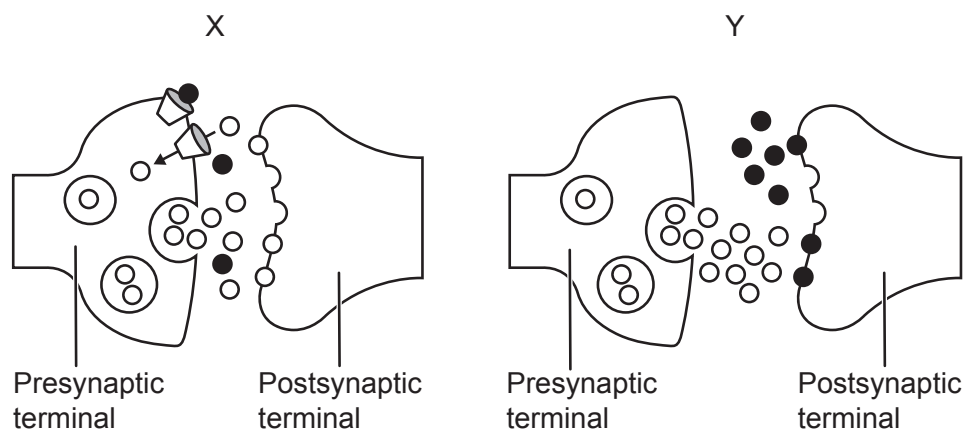


D.



Turn over

18. Diagrams X and Y show the possible action on synaptic transmission of two exogenous chemicals.



**Key:**

- neurotransmitter      ● neonicotinoid or cocaine

Cocaine and neonicotinoids have different modes of action. Which statement identifies the correct mode of action of one of these chemicals?

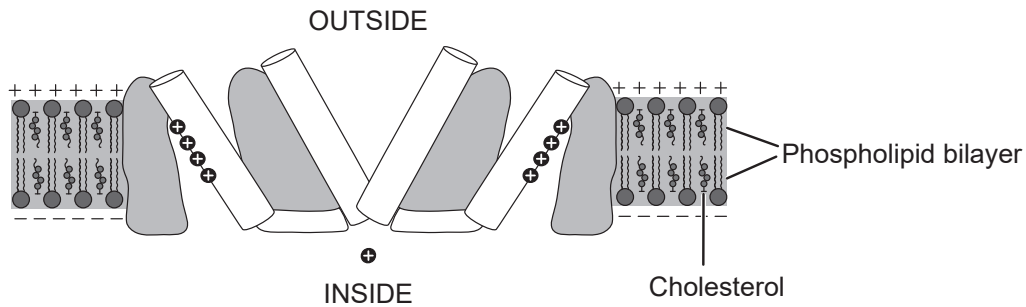
- A. Y shows cocaine because it prevents binding of the neurotransmitter to the postsynaptic membrane.
- B. X shows neonicotinoid because it is taken up by the presynaptic terminal.
- C. Y shows neonicotinoid because it binds to the neurotransmitter.
- D. X shows cocaine because the neurotransmitter cannot be taken up by the presynaptic terminal.

## Section A

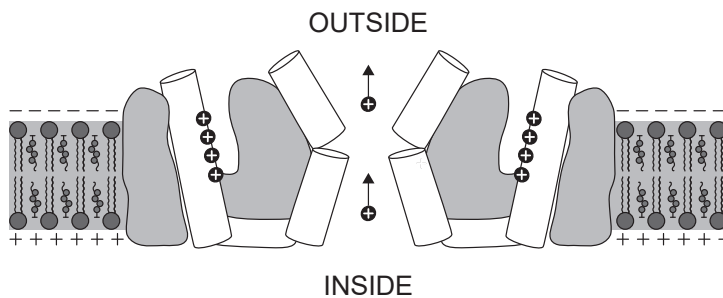
Answer **all** questions. Answers must be written within the answer boxes provided.

3. Voltage-gated ion channels are proteins that are embedded in the phospholipid bilayer of plasma membranes. They conduct ions at high rates, regulated by the voltage across the membrane. The diagram shows a typical voltage-gated potassium ( $K^+$ ) channel when it is closed and when it is open.

Closed:



Open:



- (a) Explain the action of the voltage-gated potassium channel during a nerve impulse. [3]

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**(Question 3 continued)**

(b) State another type of gated ion channel. [1]

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(c) Outline the amphipathic characteristic of phospholipid bilayers. [1]

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(d) Outline the effect of cholesterol on the fluidity of membranes. [1]

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(e) Outline the effect of fatty acids on the fluidity of membranes. [1]

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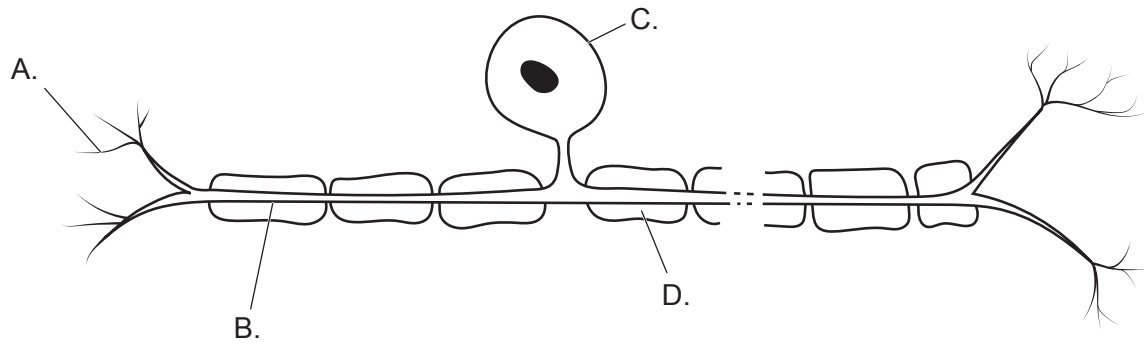


**Turn over**

15. The table shows two types of gated ion channels in neurons. How are they gated?

|    | Nicotinic acetylcholine receptors | Potassium channels |
|----|-----------------------------------|--------------------|
| A. | voltage                           | neurotransmitter   |
| B. | neurotransmitter                  | voltage            |
| C. | voltage                           | voltage            |
| D. | neurotransmitter                  | neurotransmitter   |

18. The image shows a neuron. Which letter shows a dendrite?



**26.** Which is the effector in a pain reflex arc?

- A. Skeletal muscle
- B. Sensory nerve ending
- C. Pituitary gland
- D. Grey matter of spinal cord

18. The conduction velocity of electrical impulses was measured in different myelinated nerve fibres.

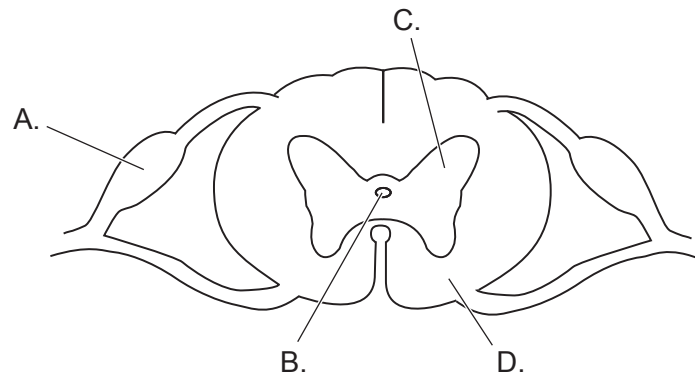
| Type of nerve fibre | Conduction velocity / $\text{m s}^{-1}$ |
|---------------------|-----------------------------------------|
| P                   | 3–10                                    |
| Q                   | 30–70                                   |
| R                   | 80–110                                  |

Which hypothesis would explain the higher conduction velocity of nerve fibre R, compared to nerve fibres P and Q?

- A. It is the longest.
- B. It has the thinnest myelin sheath.
- C. It has the largest diameter.
- D. It has the greatest number of mitochondria.

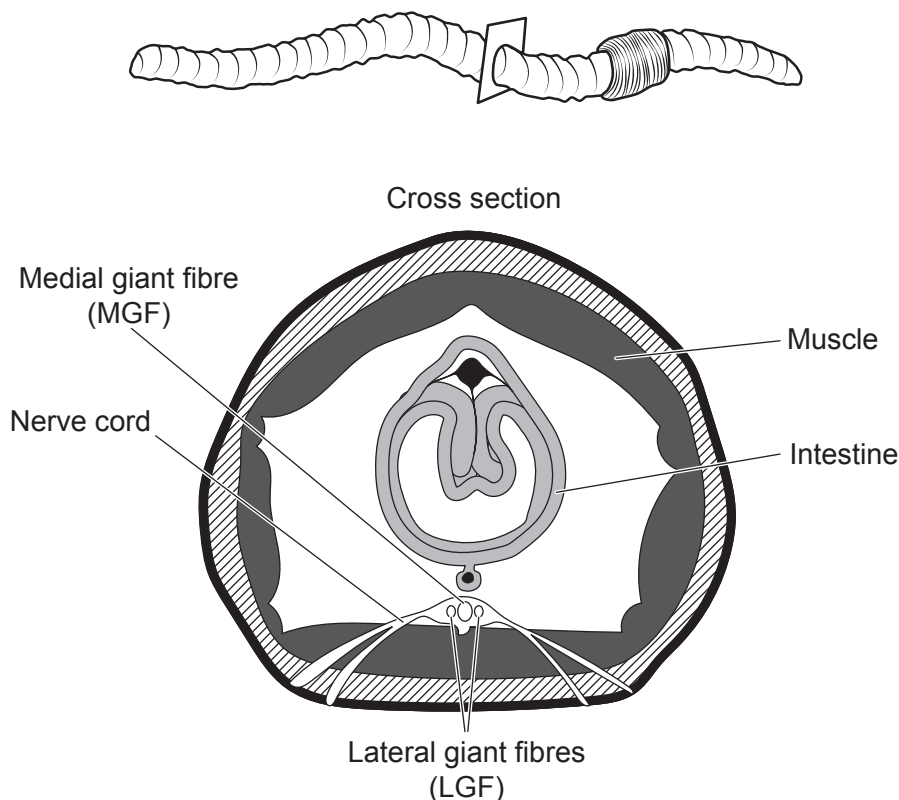
- 28.** The spinal cord is involved in the coordination of involuntary actions such as the pain reflex.

Where are synapses between sensory neurons and interneurons found?



3. Earthworms (*Lumbricus terrestris*) have a nerve cord on the ventral (underside) side of their body. It contains three nerve fibres (axons), each with a very large diameter, which extend along the whole length of the nerve cord. There is one medial giant fibre (MGF) and two lateral giant fibres (LGFs). The diameter of the MGF is 1.4 times larger than the LGF.

Scientists developed a non-invasive method to record giant nerve fibre activity. The response from the MGF was measured by the electrical activity produced when touching the front segments of the earthworm while the LGF was measured when touching the back segments.



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(Question 3 continued)

The table shows the mean conduction rates, standard deviation (SD) and number of individual measurements of MGF and LGF action potentials in each earthworm. At the end of the table, the mean and standard error (SE) for 9 of the earthworms are shown.

| Earthworm               | MGF                                     |                       |                        | LGF                                     |                       |                        |
|-------------------------|-----------------------------------------|-----------------------|------------------------|-----------------------------------------|-----------------------|------------------------|
|                         | Mean conduction rate / ms <sup>-1</sup> | SD / ms <sup>-1</sup> | Number of measurements | Mean conduction rate / ms <sup>-1</sup> | SD / ms <sup>-1</sup> | Number of measurements |
| 1                       | 38.1                                    | 5.1                   | 24                     | 13.7                                    | 2.0                   | 21                     |
| 2                       | 31.4                                    | 6.8                   | 17                     | 13.4                                    | 1.8                   | 13                     |
| 3                       | 29.2                                    | 4.7                   | 13                     | 11.4                                    | 2.2                   | 19                     |
| 4                       | 29.7                                    | 7.5                   | 17                     | 11.7                                    | 2.8                   | 12                     |
| 5                       | 29.7                                    | 4.1                   | 6                      | 11.4                                    | 1.6                   | 16                     |
| 6                       | 36.1                                    | 5.8                   | 23                     | 13.6                                    | 2.1                   | 16                     |
| 7                       | 30.1                                    | 4.9                   | 17                     | 12.8                                    | 2.7                   | 19                     |
| 8                       | 33.5                                    | 4.4                   | 16                     | 11.9                                    | 1.5                   | 18                     |
| 9                       | 32.2                                    | 5.3                   | 23                     | 13.7                                    | 2.1                   | 21                     |
| 10                      | 33.3                                    | –                     | 1                      | 15.5                                    | 2.0                   | 3                      |
| Mean / ms <sup>-1</sup> | 32.2                                    |                       |                        | 12.6                                    |                       |                        |
| SE / ms <sup>-1</sup>   |                                         | 1.0                   |                        |                                         | 0.3                   |                        |

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Turn over

**(Question 3 continued)**

- (a) State the apparatus used to show the resting and action potentials. [1]

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- (b) (i) Distinguish between SD and SE. [2]

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- (ii) Suggest **one** reason for not calculating the SD for earthworm 10. [1]

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- (c) (i) Calculate how many times faster the mean MGF is compared to the mean LGF. [1]

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- (ii) Suggest **one** possible reason that the conduction rate in the MGF is much faster than in the LGF. [1]

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**(Question 3 continued)**

(d) Explain saltatory conduction. [3]

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**Turn over**

## Section B

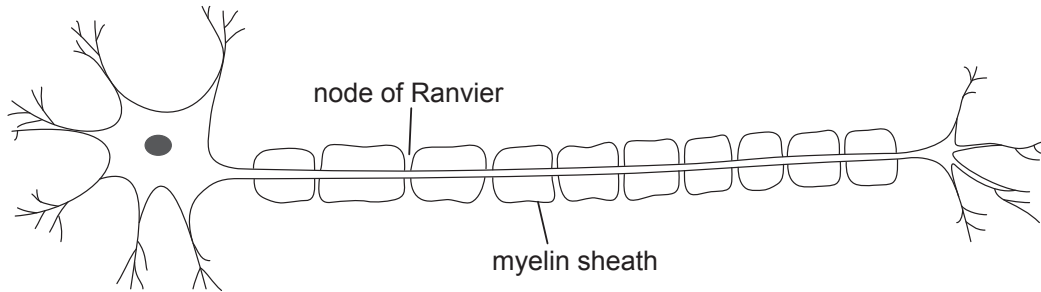
Answer **two** questions. One additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

8. Interactions in biological systems may have harmful or beneficial effects.
- (a) Explain, using an example, how competitive inhibitors interfere with enzyme activity. [4]
  - (b) Describe the role of neurotransmitters in synaptic transmission and how transmission can be disrupted by exogenous chemicals. [7]
  - (c) Discuss the consequences of infection with HIV. [4]

## Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

3. The diagram shows a cell from the nervous system.



- (a) Outline how the myelin sheath and nodes of Ranvier increase the speed of an action potential along a neuron. [2]

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- (b) Compare and contrast the movement of particles across plasma membranes by simple diffusion and facilitated diffusion. [2]

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- (c) Describe the effect of neonicotinoid pesticides on synaptic transmission in insects. [3]

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Turn over

**28.** How is involuntary peristalsis in the intestine directly controlled in humans?

- A. By the endocrine system
- B. By the central nervous system (CNS)
- C. By the sympathetic nervous system
- D. By the enteric nervous system (ENS)