



# **A-Level Biology**

## **Nervous Impulses**

### **Question Paper**

**Time available: 61 minutes**

**Marks available: 48 marks**

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**1.**

(a) Explain how a resting potential is maintained across the axon membrane in a neurone.

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**(3)**

(b) Explain why the speed of transmission of impulses is faster along a myelinated axon than along a non-myelinated axon.

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**(3)**

- (c) A scientist investigated the effect of inhibitors on neurones. She added a respiratory inhibitor to a neurone. The resting potential of the neurone changed from  $-70$  mV to  $0$  mV.

Explain why.

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**(3)**

**(Total 9 marks)**

2.

Guillain–Barré syndrome is a rare disease in which the immune system damages the myelin sheath of neurones. Myelin sheath damage can cause a range of symptoms, for example numbness, muscular weakness and muscular paralysis. Sometimes, neurones of the autonomic nervous system are affected, causing heart rate irregularities.

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Huntington’s disease is a disorder caused when a protein called huntingtin damages the brain. Huntingtin is produced because of a dominant, mutant allele.

The first successful drug trial to reduce concentrations of huntingtin in the human brain involved 46 patients. The patients received the drug for 4 months. The concentration of huntingtin was reduced in all the patients. The drug was injected at the base of the spine into the cerebrospinal fluid bathing the brain and spinal cord. The drug contains single-stranded DNA molecules. These single-stranded molecules inhibit the mRNA needed to produce huntingtin.

10

Symptoms of Huntington’s disease can start at any time, but usually develop between 30 and 50 years of age. The likelihood and age when symptoms start are linked to the number of CAG base sequence repeats in the gene for Huntington’s disease. However, recent studies have suggested that epigenetics may also affect the age when symptoms first start.

15

(a) Damage to the myelin sheath of neurones can cause muscular paralysis (lines 2–4).

Explain how.

Horizontal lines for writing the explanation.

(3)

(b) Sometimes Guillain–Barré syndrome causes heart rate irregularities (lines 4–5).

Suggest and explain why.

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**(3)**

(c) The first successful drug trial to reduce concentrations of huntingtin in the brain used single-stranded DNA molecules (lines 13–14).

Suggest and explain how this drug could cause a reduction in the concentration of the protein huntingtin.

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**(3)**

- (d) Scientists from the first successful drug trial to reduce concentrations of huntingtin (lines 9–11) reported that the drug is not a cure for Huntington’s disease.

Suggest **two** reasons why the drug should not be considered a cure.  
Do **not** include repeats of the drug trial in your answer.

1 \_\_\_\_\_

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2 \_\_\_\_\_

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(2)

- (e) Suggest **two** reasons why people had the drug injected into the cerebrospinal fluid (lines 12–13) rather than taking a pill containing the drug.

1 \_\_\_\_\_

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2 \_\_\_\_\_

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(2)

- (f) Suggest and explain **one** way epigenetics may affect the age when symptoms of Huntington’s disease start.

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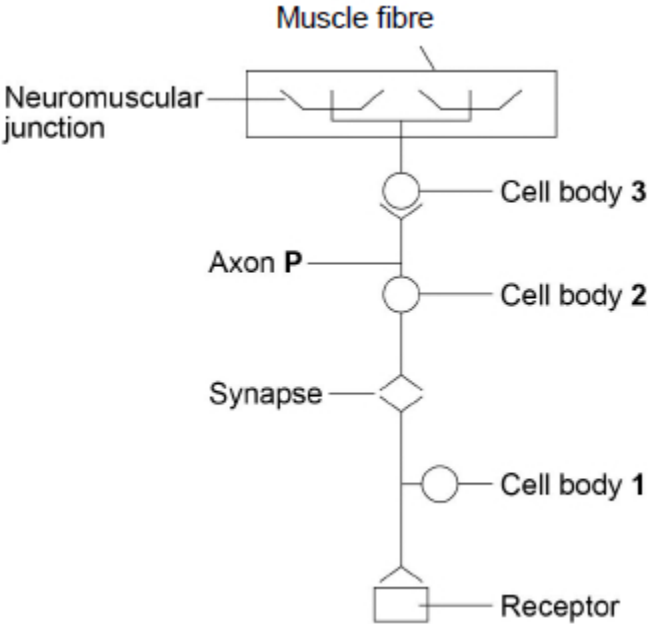
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(2)

(Total 15 marks)

3.

The diagram below shows a nerve pathway in an animal.



(a) The nerve pathway shown in the diagram may be regarded as a simple reflex arc. Use the diagram to explain why.

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(1)

(b) Suggest **two** advantages of simple reflexes.

1. \_\_\_\_\_

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2. \_\_\_\_\_

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(2)

- (c) In the nerve pathway in the diagram, synapses ensure that nerve impulses only travel towards the muscle fibre.

Explain how.

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(2)

- (d) Axon **P** was found to conduct impulses much faster than other axons in the nerve pathway shown in the diagram.

Describe and explain **one** feature of axon **P** that might cause this difference.

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(2)

(Total 7 marks)

4.

Multiple sclerosis (MS) is a disease that involves damage to the myelin sheaths of neurones. Movement in MS sufferers may be jerky or slow.

- (a) Damage to the myelin sheaths of neurones can lead to problems controlling the contraction of muscles.

Suggest **one** reason why.

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(2)



Scientists investigated the use of substances called cannabinoids to control muscle problems caused by MS.

- (b) Cannabinoids are hydrophobic molecules. In the body, they easily pass into neurones. Explain why.

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(1)

- (c) Cannabinoid receptors are found in the **pre-synaptic** membrane of neuromuscular junctions. When a cannabinoid binds to its receptor, it closes calcium ion channels.

Suggest how cannabinoids could prevent muscle contraction.

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(4)

- (d) Cannabinoids include substances found in cannabis that can enter brain tissue. Scientists are developing artificial cannabinoids that can enter neuromuscular junctions but cannot enter brain tissue.

Suggest why these artificial cannabinoids would be better to use than cannabis when treating someone with MS.

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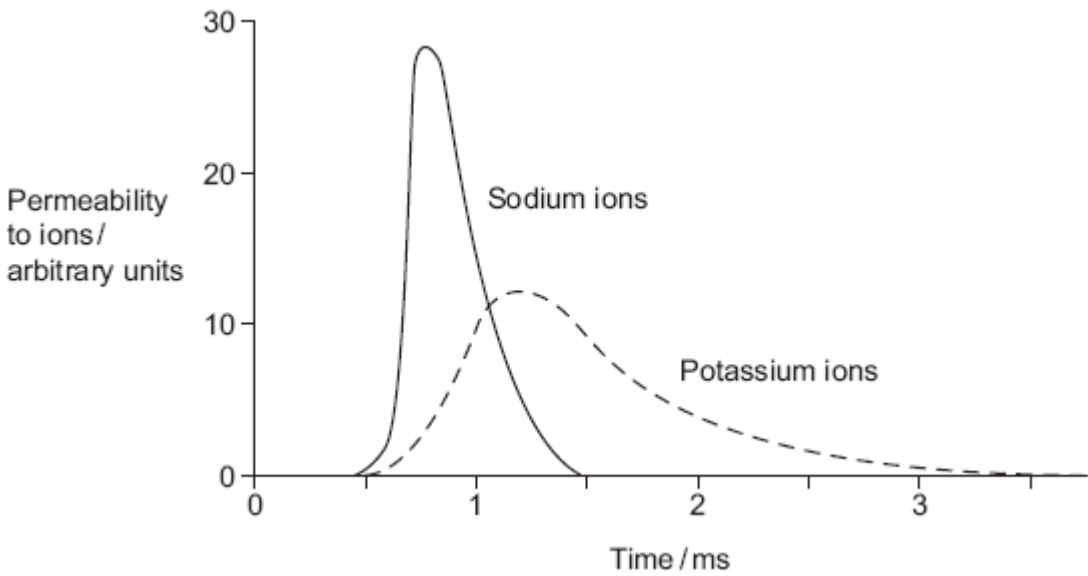
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(2)

(Total 9 marks)

5.

During an action potential, the permeability of the cell-surface membrane of an axon changes. The graph shows changes in permeability of the membrane to sodium ions ( $\text{Na}^+$ ) and to potassium ions ( $\text{K}^+$ ) during a single action potential.



(a) Explain the shape of the curve for sodium ions between 0.5 ms and 0.7ms.

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(3)

(b) During an action potential, the membrane potential rises to +40 mV and then falls. Use information from the graph to explain the fall in membrane potential.

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(3)

- (c) After exercise, some ATP is used to re-establish the resting potential in axons. Explain how the resting potential is re-established.

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**(2)**

**(Total 8 marks)**