
AQA A2 BIOLOGY

TOPIC 6

ORGANISM RESPONSE TO THE ENVIRONMENT



1

(a) The following statements are about events during an action potential.

- A Potassium ions diffuse out across the neurone membrane.
- B Sodium ions diffuse in across the neurone membrane.
- C Sodium ion channels open.
- D Active transport of sodium and potassium ions restores resting potential.
- E Potassium ion channels open.
- F Hyperpolarisation of the membrane occurs.

(i) Which of the events, **A** to **F**, starts depolarisation?
Put the correct letter in the box.

(1)

(ii) Which of the events, **A** to **F**, requires the hydrolysis of ATP?
Put the correct letter in the box.

(1)

(b) Synaptophysin is a protein involved in the production of synaptic vesicles.

Scientists can use the presence or absence of synaptophysin to identify presynaptic and postsynaptic membranes in synapses.

Explain why they are able to use synaptophysin for this purpose.

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(1)

(c) Dopamine is a neurotransmitter. Production of too much dopamine is associated with schizophrenia. A drug used to treat schizophrenia binds to dopamine receptors in synapses. This binding does not lead to the formation of an action potential.

(i) Suggest why the drug used to treat schizophrenia is able to bind to the same receptor as dopamine.

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(1)

(ii) Suggest why binding of the drug does **not** lead to production of an action potential.

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(2)
(Total 6 marks)

2

(a) What is the role of ATP in myofibril contraction?

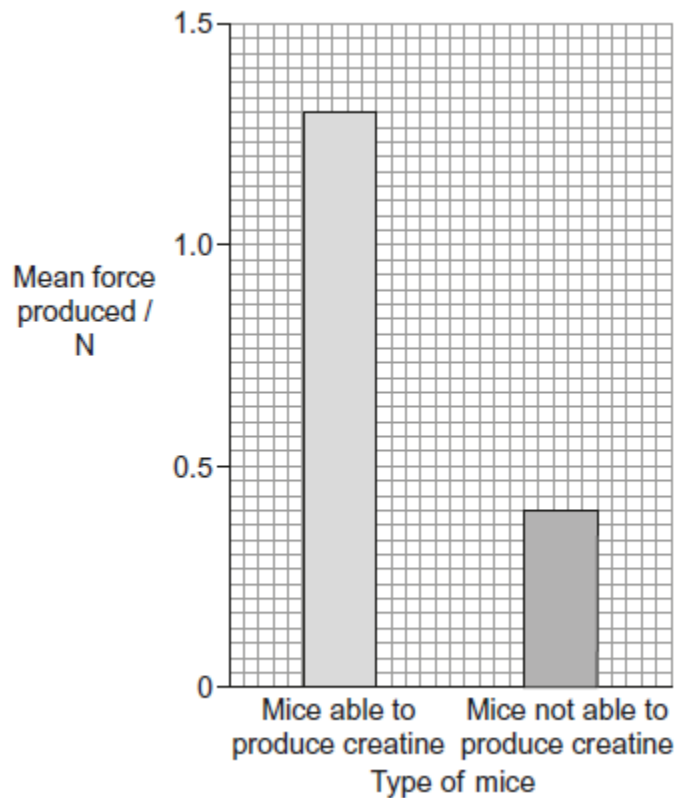
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(2)

(b) Scientists investigated the effect of not being able to produce creatine on the force produced by muscle. They used mice with a mutation that made them not able to produce creatine.

The force produced when these mice gripped with their paws was compared with the force produced by normal mice that were able to produce creatine.

The graph shows the scientists' results.



- (i) What was the percentage fall in the mean force produced by mice not able to produce creatine, compared with the normal mice? Show your working.

Answer %

(2)

- (ii) Suggest an explanation for these results.

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(2)

- (c) The mice that were not able to produce creatine were homozygous for a recessive allele of a gene. Mice that are heterozygous for this allele are able to produce forces similar to those of normal mice that are homozygous for the dominant allele of the same gene.

Explain why the heterozygous mice can produce forces similar to those of normal mice.

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(2)
(Total 8 marks)

3

(a) Give **two** ways in which people with type 1 diabetes control their blood glucose concentration.

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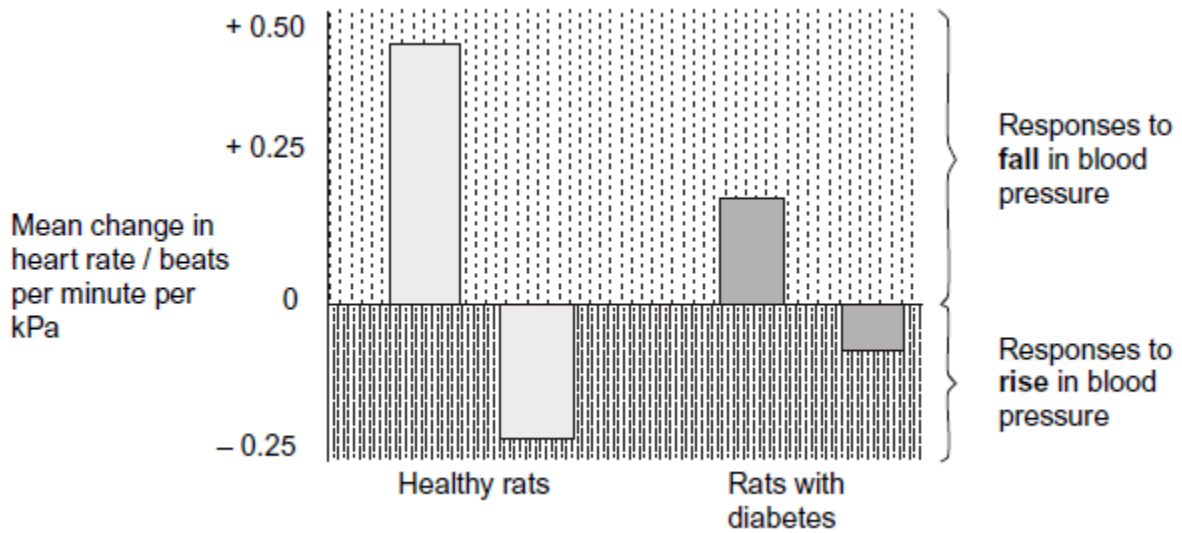
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(2)

- (b) Scientists investigated the effect of diabetes on the control of heart rate in response to changes in blood pressure in rats.

The scientists found the mean changes in heart rates of healthy rats and rats with diabetes in response to rises or falls in blood pressure.

The diagram shows their results in the form they were presented.



Diabetes can damage the nervous system. The response of the rats with diabetes is different from the response of the healthy rats. Use your knowledge of the control of heart rate by the nervous system to suggest an explanation for these results.

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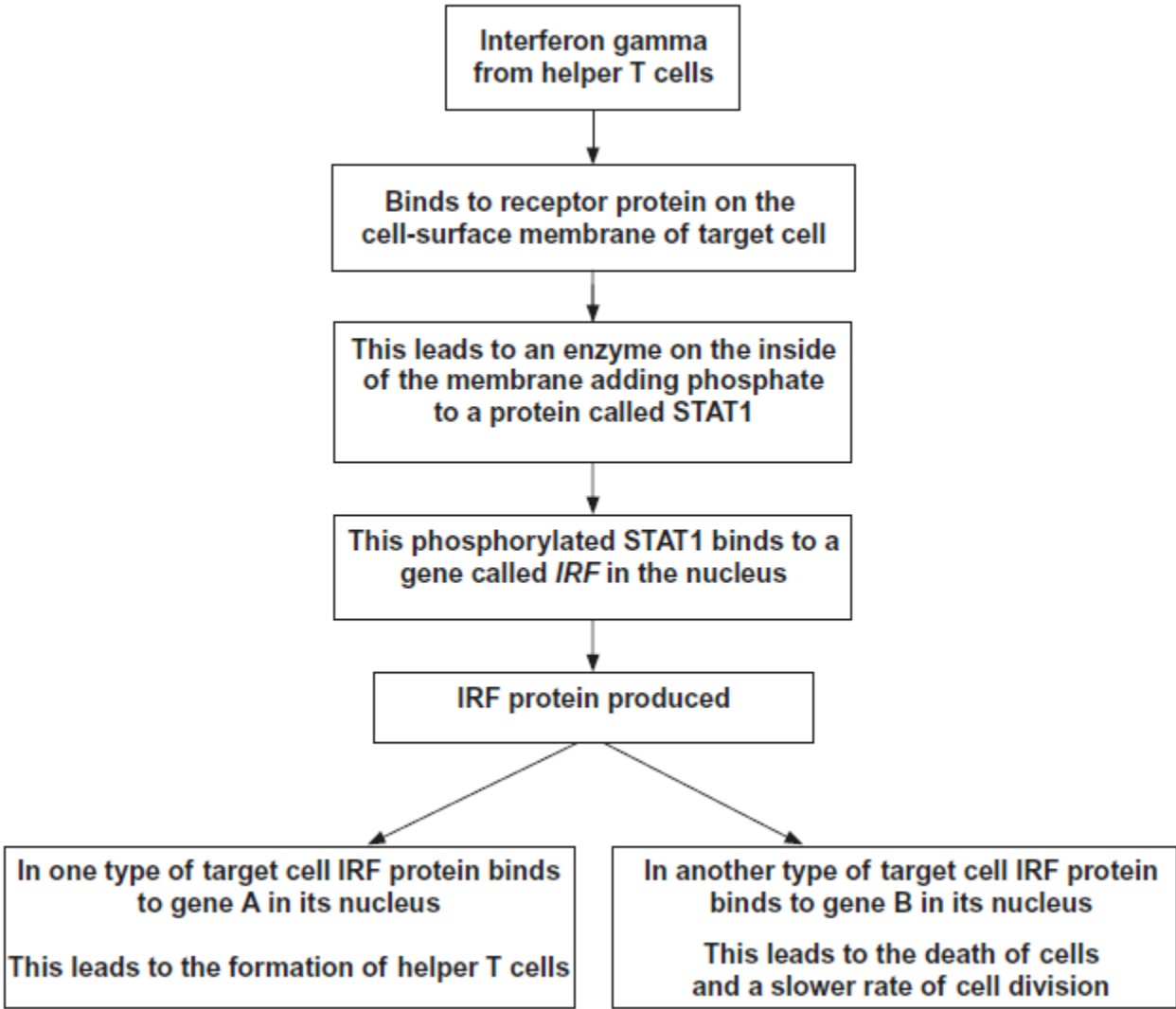
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(4)
(Total 6 marks)

4

Interferon gamma is a substance secreted by some types of white blood cells, including helper T cells. It regulates the production of a number of proteins by target cells. Which protein is produced depends on the type of target cell.

The diagram shows how interferon gamma regulates three genes.



(a) Use information in the diagram to suggest how the binding of interferon gamma to its receptor protein leads to the production of phosphorylated STAT1.

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(2)

(b) Name the **two** transcription factors in the diagram.

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(2)

- (c) The regulation of the formation of helper T cells by interferon gamma is an example of positive feedback.

Explain why it is an example of positive feedback.

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- (d) The *IRF* gene can be a tumour suppressor gene.

Use the information in the diagram to explain how the *IRF* gene acts as a tumour suppressor gene.

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(3)
(Total 9 marks)

5

(a) Describe the roles of calcium ions and ATP in the contraction of a myofibril.

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(b) ATP is an energy source used in many cell processes. Give **two** ways in which ATP is a suitable energy source for cells to use.

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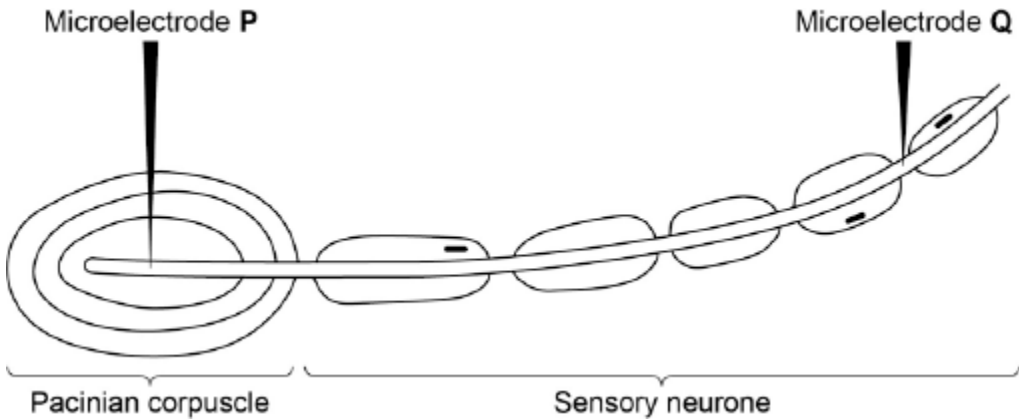
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6

A biologist investigated the stimulation of a Pacinian corpuscle in the skin of a fingertip. She used microelectrodes to measure the maximum membrane potential of a Pacinian corpuscle and its sensory neurone when different pressures were applied to the fingertip.

The figure below shows the Pacinian corpuscle, its sensory neurone and the position of the microelectrodes.



The table below shows some of the biologist's results.

Pressure applied to the fingertip	Membrane potential at P / millivolts	Membrane potential at Q / millivolts
None	-70	-70
Light	-50	-70
Medium	+30	+40
Heavy	+40	+40

(a) Explain how the resting potential of -70 mV is maintained in the sensory neurone when no pressure is applied.

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(b) Explain how applying pressure to the Pacinian corpuscle produces the changes in membrane potential recorded by microelectrode **P**.

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(c) The membrane potential at **Q** was the same whether medium or heavy pressure was applied to the finger tip. Explain why.

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(d) Multiple sclerosis is a disease in which parts of the myelin sheaths surrounding neurones are destroyed. Explain how this results in slower responses to stimuli.

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(Total 9 marks)

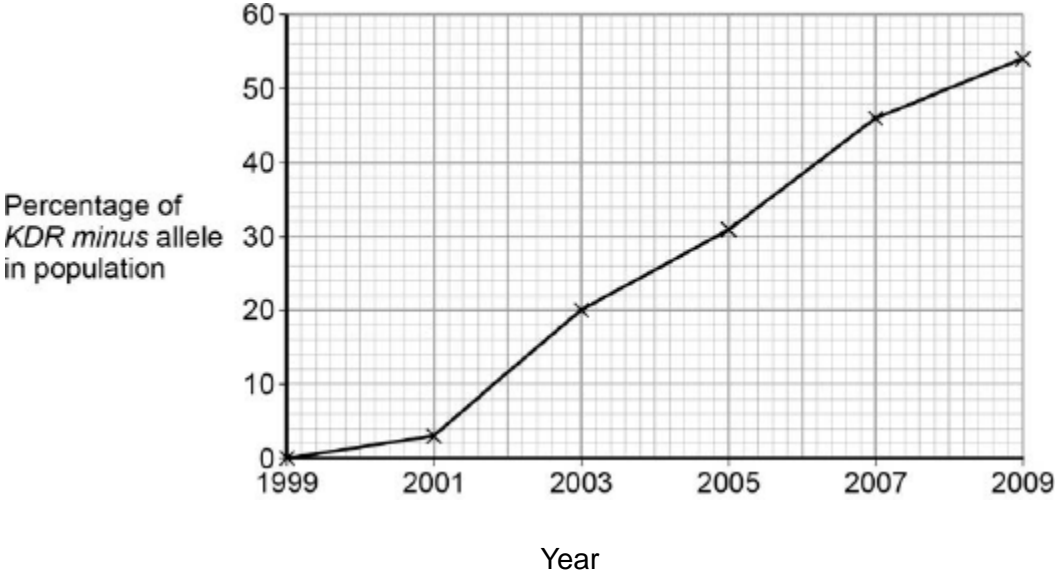
7

Malaria is a disease that is spread by insects called mosquitoes. In Africa, DDT is a pesticide used to kill mosquitoes, to try to control the spread of malaria.

Mosquitoes have a gene called *KDR*. Today, some mosquitoes have an allele of this gene, *KDR minus*, that gives them resistance to DDT. The other allele, *KDR plus*, does not give resistance.

Scientists investigated the frequency of the *KDR minus* allele in a population of mosquitoes in an African country over a period of 10 years.

The figure below shows the scientists' results.



- (a) Use the Hardy–Weinberg equation to calculate the frequency of mosquitoes heterozygous for the *KDR* gene in this population in 2003.

Show your working.

Frequency of heterozygotes in population in 2003

(2)

(b) Suggest an explanation for the results in the figure above.

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The *KDR plus* allele codes for the sodium ion channels found in neurones.

(c) When DDT binds to a sodium ion channel, the channel remains open all the time. Use this information to suggest how DDT kills insects.

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(d) Suggest how the *KDR minus* allele gives resistance to DDT.

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(Total 10 marks)

8

Osmoreceptors are specialised cells that respond to changes in the water potential of the blood.

(a) Give the location of osmoreceptors in the body of a mammal.

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(1)

(b) When a person is dehydrated, the cell volume of an osmoreceptor decreases. Explain why.

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(c) Stimulation of osmoreceptors can lead to secretion of the hormone ADH. Describe and explain how the secretion of ADH affects urine produced by the kidneys.

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The efficiency with which the kidneys filter the blood can be measured by the rate at which they remove a substance called creatinine from the blood. The rate at which they filter the blood is called the glomerular filtration rate (GFR).

In 24 hours, a person excreted 1660 mg of creatinine in his urine. The concentration of creatinine in the blood entering his kidneys was constant at 0.01 mg cm^{-3} .

- (d) Calculate the GFR in $\text{cm}^3 \text{ minute}^{-1}$.

Answer =

(1)

- (e) Creatinine is a breakdown product of creatine found in muscle tissues. Apart from age and gender, give **two** factors that could affect the concentration of creatinine in the blood.

1

2

(1)

(Total 9 marks)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A**

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Couple **B**

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(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

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(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

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(3)

- (e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

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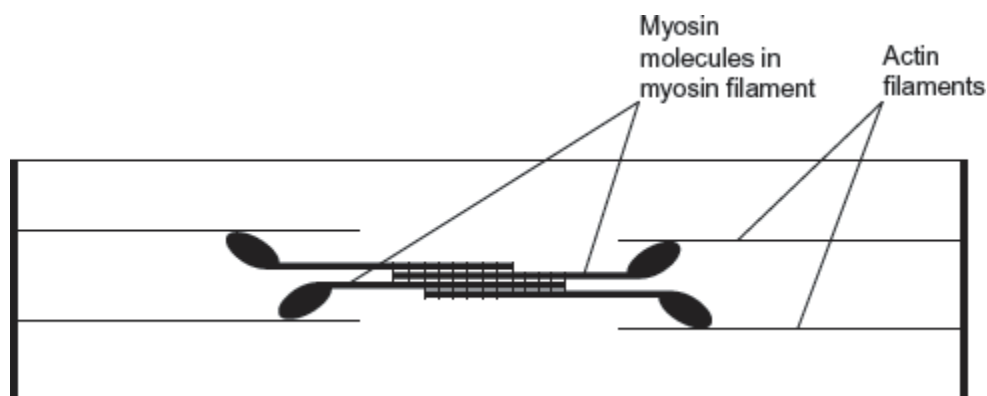
10

- (a) A sarcomere is made up of different molecules. Complete the table by naming the molecule that carries out the function described.

Function	Name
Attaches to Z line at the end of the sarcomere	
Breaks down ATP	
Covers binding site on actin in relaxed myofibril	

(3)

- (b) The diagram shows the arrangement of actin and myosin in a sarcomere.



One form of muscle disease is caused by a mutated allele of a gene. This leads to production of myosin molecules that are unable to bind to other myosin molecules.

If myosin molecules are unable to bind to other myosin molecules, this prevents muscle contraction.

Use the diagram and your knowledge of how muscles contract to suggest why.

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11

(a) Describe how a Pacinian corpuscle produces a generator potential when stimulated.

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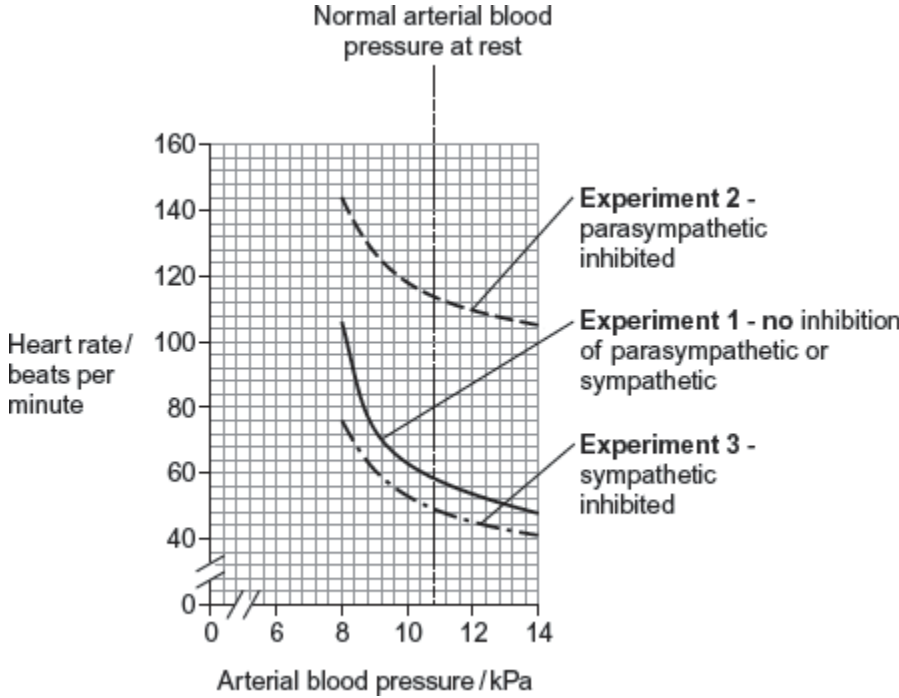
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(3)

Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each volunteer, they then carried out the following experiments.

- Experiment 1** They recorded heart rate at different blood pressures.
- Experiment 2** They repeated **experiment 1** after injecting a drug that inhibited the parasympathetic nervous system.
- Experiment 3** They repeated **experiment 1** after injecting a drug that inhibited the sympathetic nervous system.

The graph shows the results for one volunteer.



- (b) Calculate the ratio of heart rate in **experiment 2** to heart rate in **experiment 3** at an arterial blood pressure of 10 kPa.
Show your working.

Answer =

(2)

- (c) What do these data suggest about the control of heart rate by the parasympathetic and sympathetic nervous systems in response to changes in arterial blood pressure?

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12

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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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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(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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(2)
(Total 9 marks)

13

(a) Give **one** similarity and **one** difference between a taxis and a tropism.

Similarity.....

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Difference

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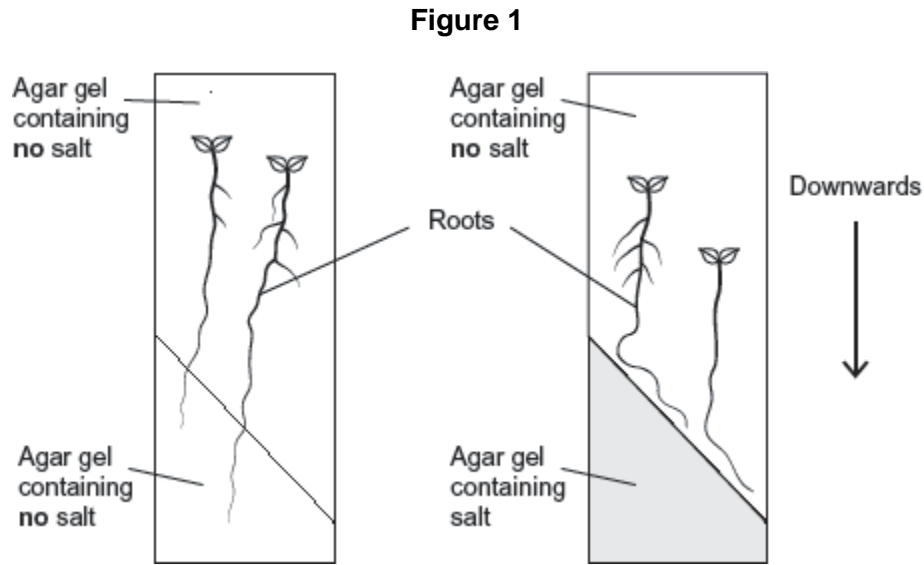
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(2)

Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 1**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made of one of the following:

- agar gel containing **no** salt
- agar gel containing salt.

Typical results for growth of the roots are shown in **Figure 1**.



(b) What do these results show about the responses of the roots of tomato plants to gravity and salt?

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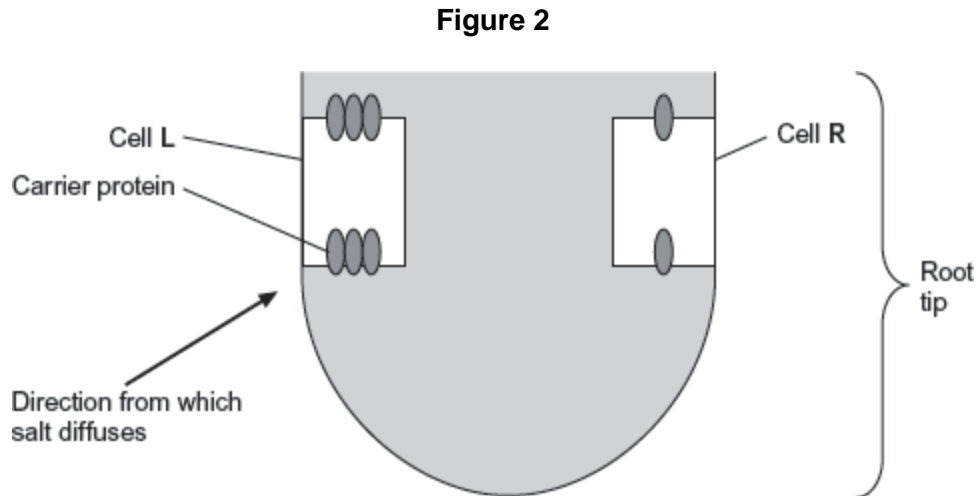
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(3)

- (c) In root tips of tomatoes, IAA is transported **out** of the cells by a carrier protein. In roots of tomatoes, high concentrations of IAA inhibit cell elongation.

The scientists' hypothesis was that salt causes a change in the number of IAA carrier proteins in cells in different parts of the root tip.

Figure 2 shows two cells, **L** and **R**, in the root tip of a tomato plant.



Explain why this root tip would grow away from salt.

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(3)
(Total 8 marks)