Answer **all** questions in the spaces provided.

1 (a) A sarcomere is made up of different molecules.
Complete **Table 1** by naming the molecule that carries out the function described.

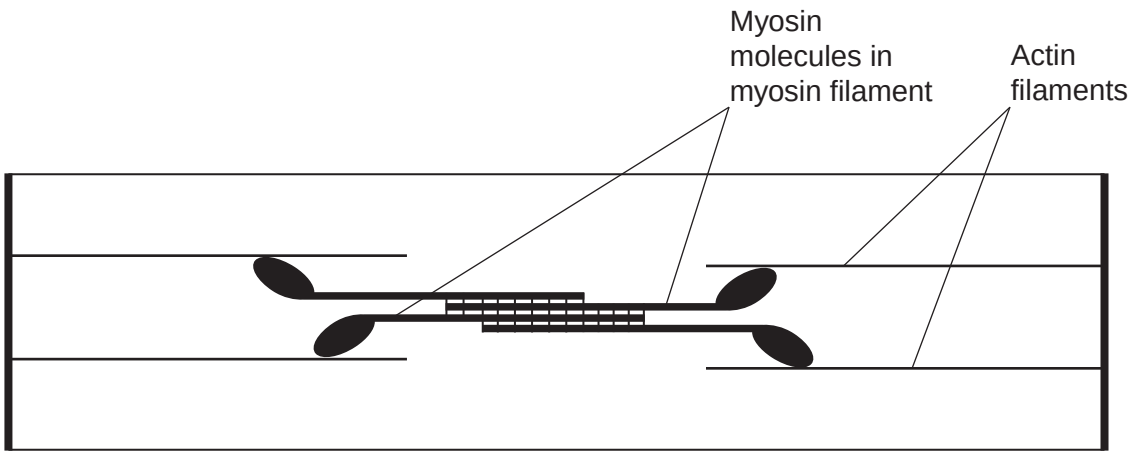
[3 marks]

Table 1

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

1 (b) The diagram in **Figure 1** shows the arrangement of actin and myosin in a sarcomere.

Figure 1



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 **Figure 1** and your knowledge of how muscles contract to suggest why.

[3 marks]

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[Extra space] .....

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6

2 (a) Describe how LH is involved in the control of the mammalian oestrous cycle.

[2 marks]

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[Extra space] .....

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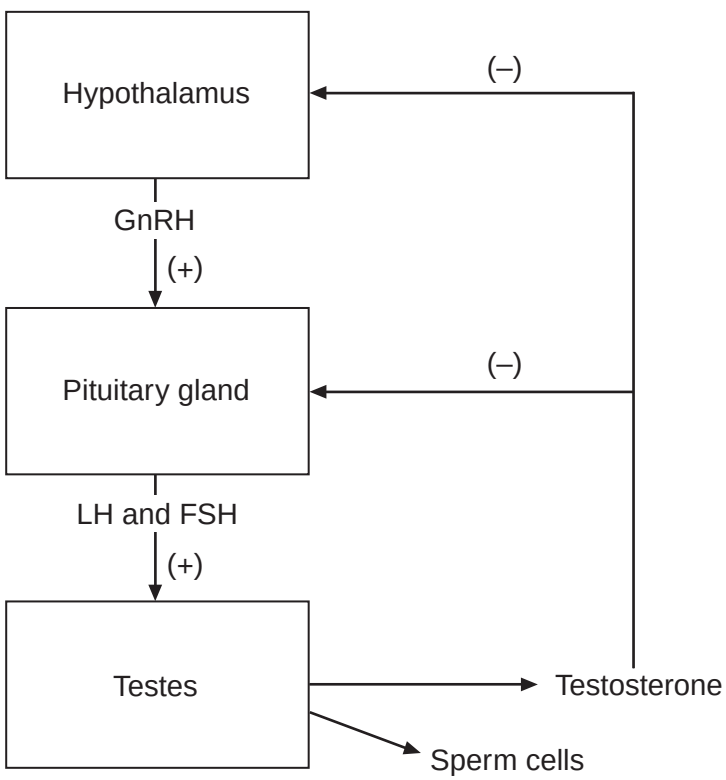
Testosterone is a hormone produced by male testes.

Figure 2 shows the system controlling the concentration of testosterone in a man's body.

Figure 2



2 (b) If the concentration of testosterone in a man's blood starts to rise above normal, this system leads to a reduction in testosterone.

Use **Figure 2** to explain how.

[3 marks]

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2 (c) There have been trials with a male contraceptive pill that prevents a man producing sperm cells. This pill contains testosterone and is taken each day.

Use **Figure 2** to explain how this contraceptive pill prevents a man producing sperm cells.

[2 marks]

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7

QUESTION 3: N/A

QUESTION 4: N/A

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

[3 marks]

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[Extra space] .....

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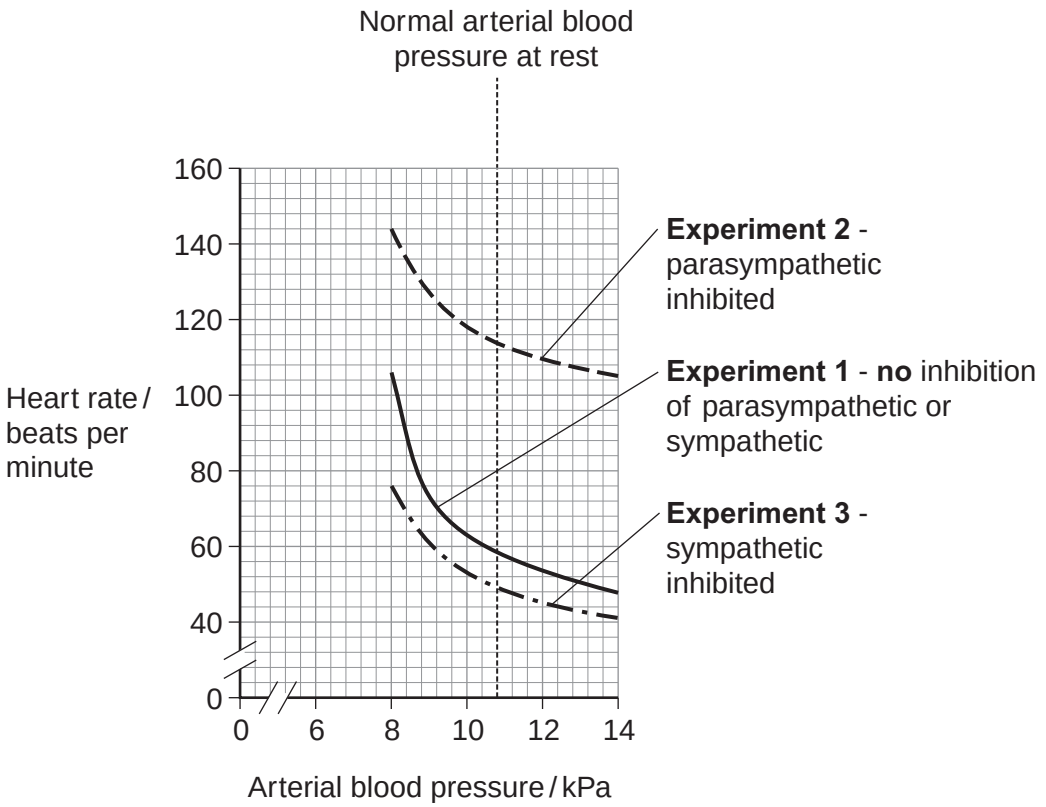
Question 5 continues on the next page

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.

Figure 3 shows the results for one volunteer.

Figure 3



5 (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.

[2 marks]

Answer = ...

5 (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?

[3 marks]

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8

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

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

Suggest **one** reason why.

[2 marks]

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[Extra space] .....

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

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

[1 mark]

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6 (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.

[4 marks]

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[Extra space] .....

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6 (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.

[2 marks]

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[Extra space] .....

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9

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

[2 marks]

Similarity .....

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Difference .....

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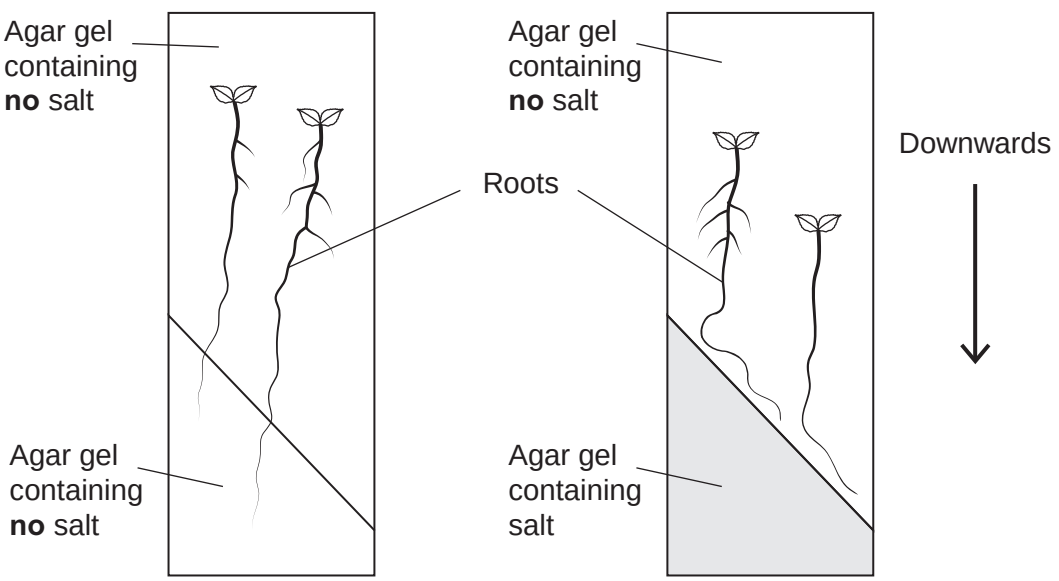
Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 4**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made of one of the following:

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

Typical results for growth of the roots are shown in **Figure 4**.

Figure 4



Do not write outside the box

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

[3 marks]

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[Extra space] .....

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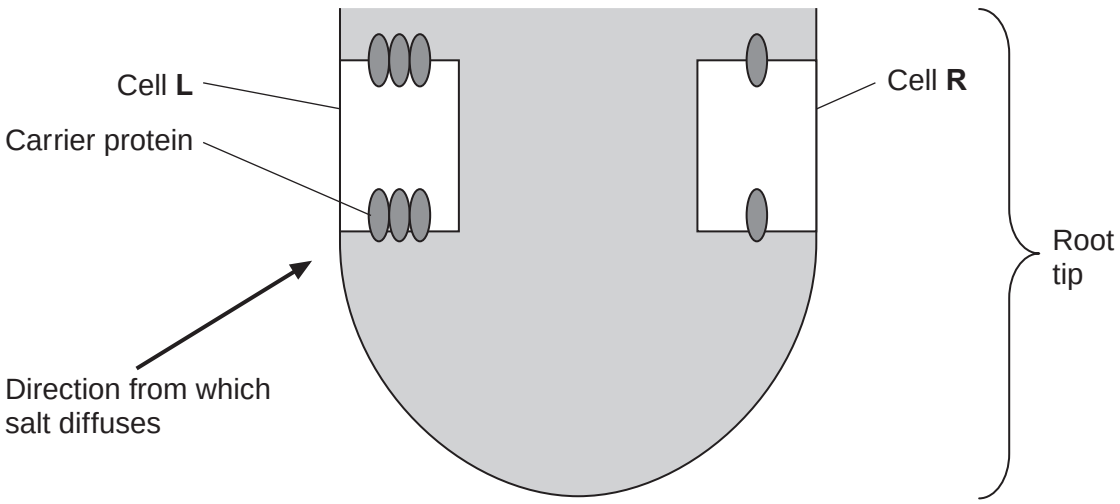
Question 7 continues on the next page

7 (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 5 shows two cells, **L** and **R**, in the root tip of a tomato plant.

Figure 5



Explain why this root tip would grow away from salt.

[3 marks]

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8

8 Scientists investigated the control of blood glucose concentration in mice. They kept a group of normal mice without food for 48 hours. After 48 hours, the blood glucose concentrations of the mice were the same as at the start of the experiment.

8 (a) Explain how the normal mice prevented their blood glucose concentration falling when they had **not** eaten for 48 hours.

[3 marks]

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[Extra space] .....

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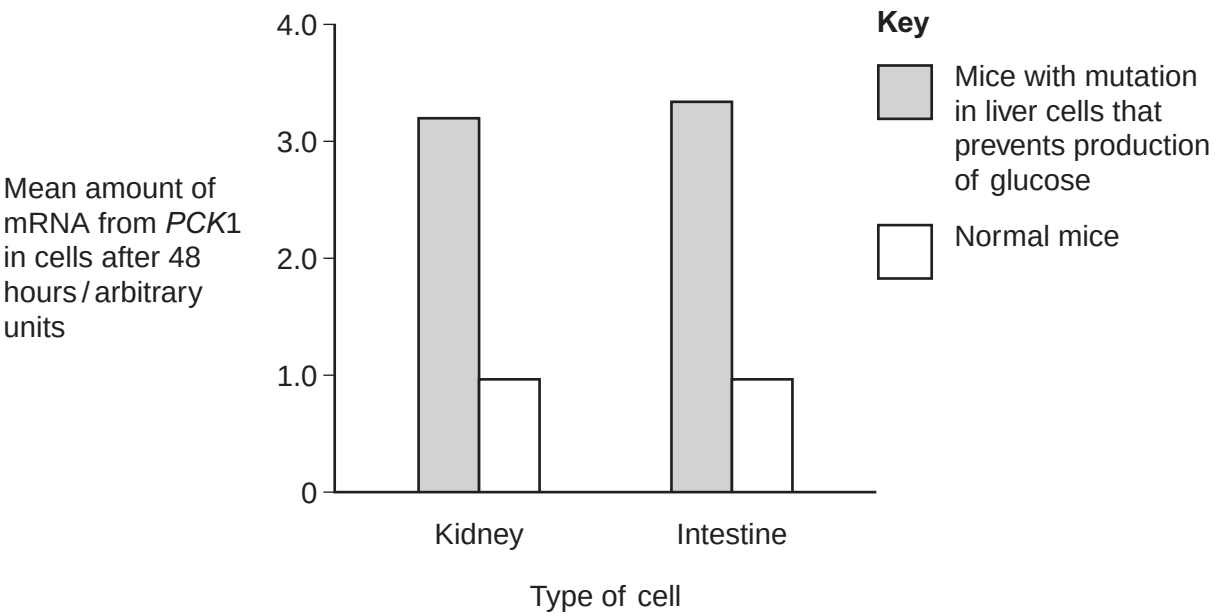
Question 8 continues on the next page

The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal mice were the same.

The scientists investigated how blood glucose concentration is controlled in these mutant mice. An enzyme required for synthesis of glucose is coded for by a gene called *PCK*1. The scientists measured the mean amount of mRNA produced from this gene in cells from the kidneys and intestines of normal mice and mutant mice.
They did this with mice that had previously been without food for 48 hours.

Figure 6 shows the scientists' results.

Figure 6



8 (b) Use information from **Figure 6** to suggest how blood glucose concentration is controlled in the mutant mice, compared with the normal mice.

[3 marks]

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[Extra space] .....

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8 (c) The scientists performed statistical tests on the data shown in **Figure 6**, to see whether the differences in the amount of mRNA in cells from normal and mutant mice were significant. Both the probability values they obtained were $p<0.01$.

Explain what this means about the differences in the amounts of mRNA produced.

[2 marks]

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[Extra space] .....

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