Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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10	
TOTAL	

AQA

General Certificate of Education
Advanced Level Examination
June 2015

Biology BIOL5R

Unit 5 Control in cells and in organisms

Wednesday 17 June 2015 9.00 am to 11.15 am

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 2 hours 15 minutes

R

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the boxes or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Advice
- You are advised to spend no longer than 40 minutes on the essay.

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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]

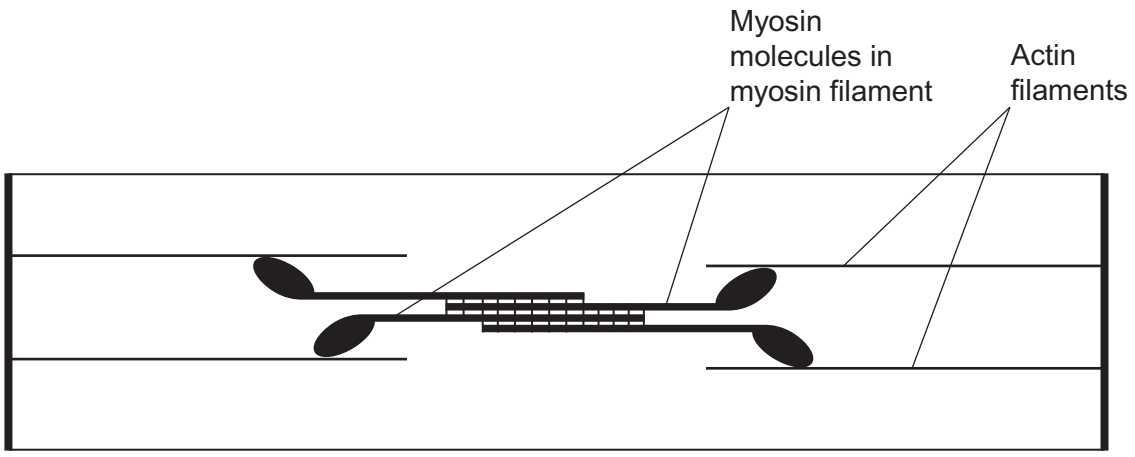
Table 1

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

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

[2 marks]

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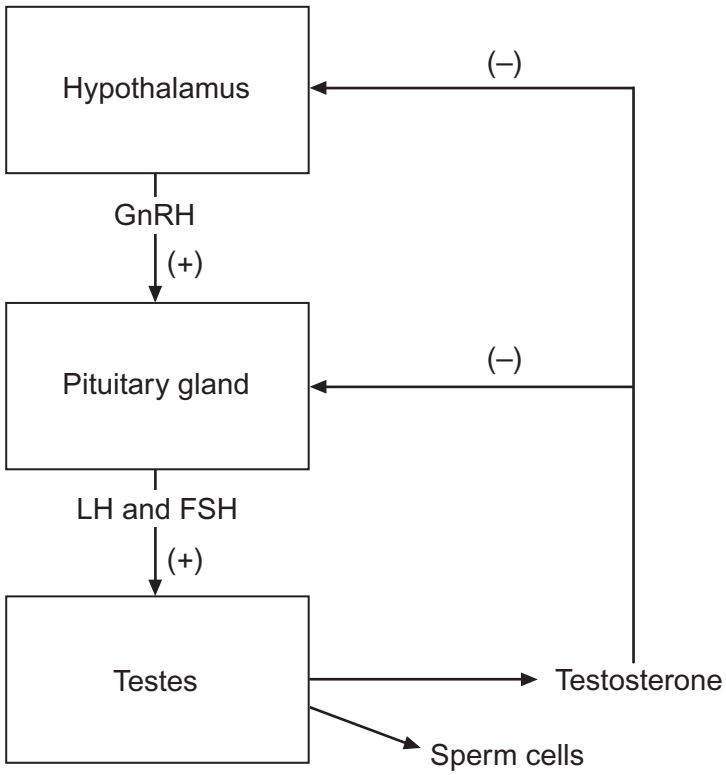
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Testosterone is a hormone produced by male testes.

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

Figure 2



Key
(+) stimulates
(–) inhibits

GnRH – gonadotropin-releasing hormone

LH – luteinising hormone

FSH – follicle-stimulating hormone

Do not write outside the box

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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ANSWER IN THE SPACES PROVIDED

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3 (a) (i) A mutation of a tumour suppressor gene can result in the formation of a tumour.

Explain how.

[2 marks]

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3 (a) (ii) Not all mutations result in a change to the amino acid sequence of the encoded polypeptide.

Explain why.

[1 mark]

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3 (b) Some cancer cells have a receptor protein in their cell-surface membrane that binds to a hormone called **growth factor**. This stimulates the cancer cells to divide.

Scientists have produced a monoclonal antibody that stops this stimulation.

Use your knowledge of monoclonal antibodies to suggest how this antibody stops the growth of a tumour.

[3 marks]

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4 Second-hand smoking (SHS) occurs when people breathe in air containing tobacco smoke. Scientists investigated the effect of SHS on expression of a specific gene. Expression of this gene prevents or reduces the risk of allergic reactions.

They recruited a large number of school students who were non-smokers.
For each student, they determined:

- whether the student's parents were smokers
- the amount of expression of this specific gene.

The scientists' results are shown in **Table 2**, in the form in which they were presented.

Table 2

	Mean amount of expression of gene / arbitrary units (± standard error)
School students whose parents smoke	4.80 (± 0.09)
School students whose parents do not smoke	7.20 (± 0.08)

4 (a) The data about parents' smoking habits were obtained using a questionnaire.

Suggest **two** ways in which the use of a questionnaire may have affected the reliability of these data.

[2 marks]

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4 (b) The scientists concluded that smoking by parents increases the risk of allergic reactions in their children.

Use the information provided to explain how these data support their conclusion.

[3 marks]

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4 (c) For each student, the scientists also determined how much methylation was present within the specific gene. DNA methylation is the attachment of substances called methyl groups to cytosine or adenine. This prevents transcription.

Suggest how methylation of DNA can prevent expression of a gene.

[3 marks]

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ANSWER IN THE SPACES PROVIDED

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

[3 marks]

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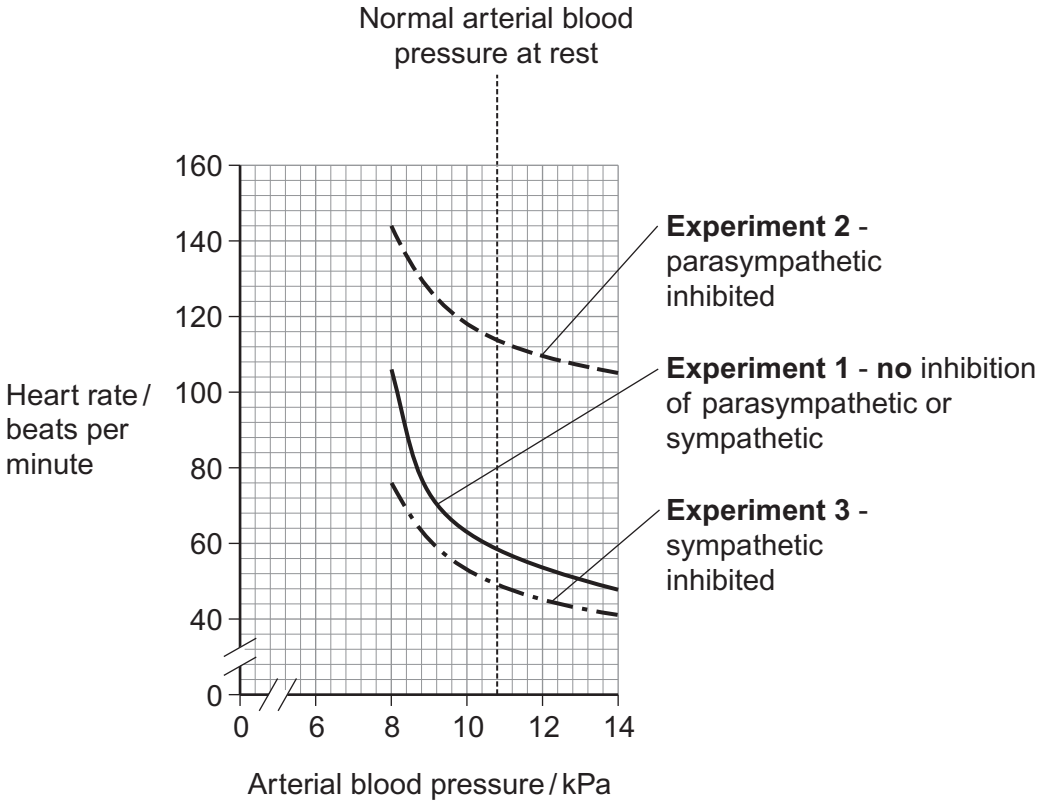
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Doctors investigated the relationship between heart rate and arterial blood pressure. They recruited healthy volunteers. For each volunteer, they recorded their normal arterial blood pressure at rest. With each volunteer, they then carried out the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



Do not write outside the box

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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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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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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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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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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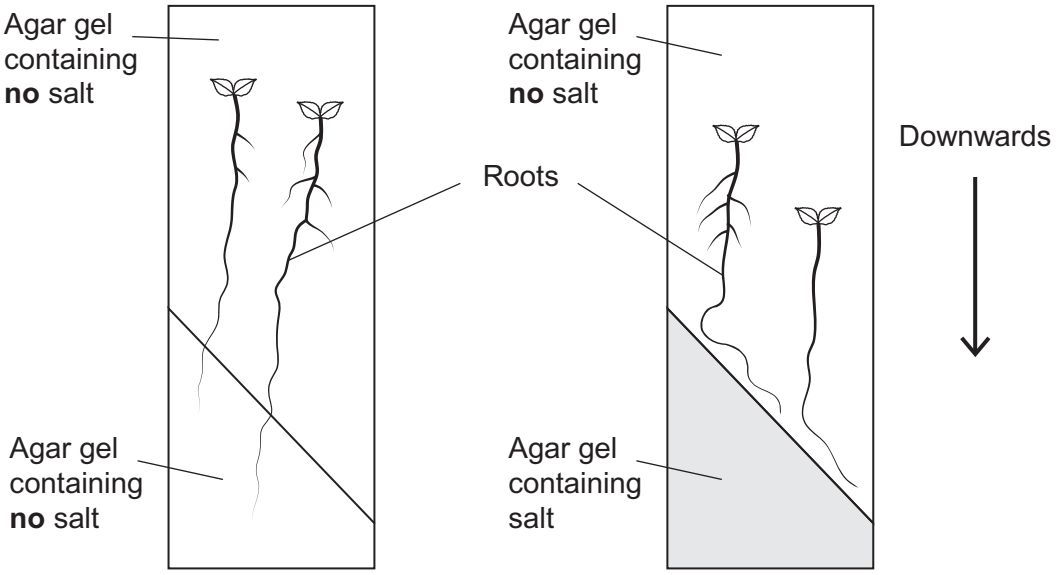
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Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 4**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made 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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Question 7 continues on the next page

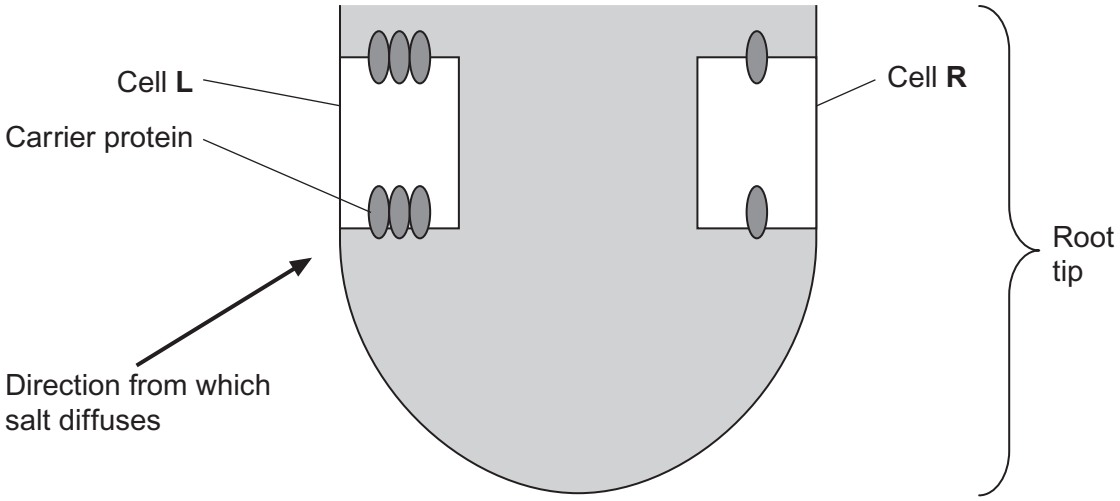
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7 (c) In root tips of tomatoes, IAA is transported **out** of the cells by a carrier protein. In roots of tomatoes, high concentrations of IAA inhibit cell elongation.

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 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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Question 8 continues on the next page

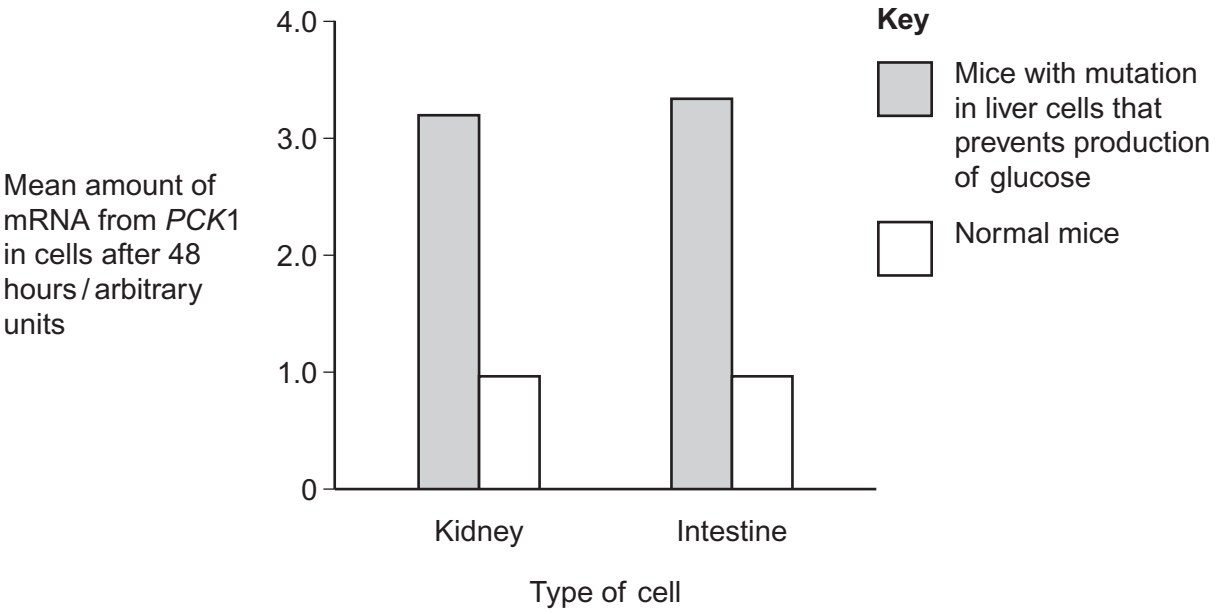
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The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal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



Do not write outside the box

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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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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9 Some populations of flies are becoming resistant to insecticides intended to kill them.

Scientists developed a method for finding out whether a fly was carrying a recessive allele, **r**, that gives resistance to an insecticide. The dominant allele, **R**, of this gene does not give resistance.

The scientists:
- crossed flies with genotype **RR** with flies with genotype **rr**
- obtained DNA samples from the parents and offspring
- used the same restriction endonuclease enzymes on each sample, to obtain DNA fragments.

9 (a) Explain why the scientists used the same restriction endonuclease enzymes on each DNA sample.

[2 marks]

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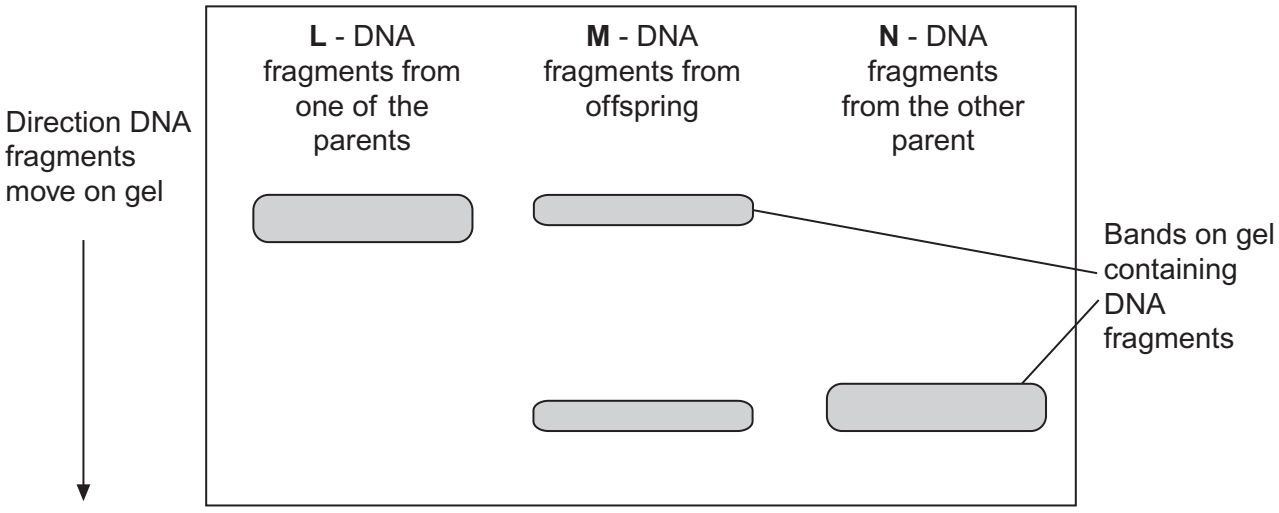
The scientists added two different primers to each sample of DNA fragments for the polymerase chain reaction (PCR).

- Primer A3 only binds to a 195 base-pair fragment from allele **r**.
- Primer A4 only binds to a 135 base-pair fragment from allele **R**.

The scientists separated the DNA fragments produced by the PCR on a gel where shorter fragments move further in a given time.

Their results are shown in **Figure 7**.

Figure 7



Do not write outside the box

9 (b) Explain why primer A3 and primer A4 only bind to specific DNA fragments.

[2 marks]

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9 (c) Use all the information given to explain the results in **Figure 7**.

[3 marks]

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9 (d) The scientists wanted to know on which chromosome the gene with alleles **R** and **r** was located. From the flies with genotype **RR**, they obtained cells that were in mitosis and added a labelled DNA probe specific for allele **R**. They then looked at the cells under an optical microscope.

Explain why they used cells that were in mitosis.

[2 marks]

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Question 9 continues on the next page

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9 (e) Another group of scientists thought that pesticide resistance in some flies was related to increased activity of an enzyme called P450 monooxygenase (PM).
This enzyme breaks down insecticides.

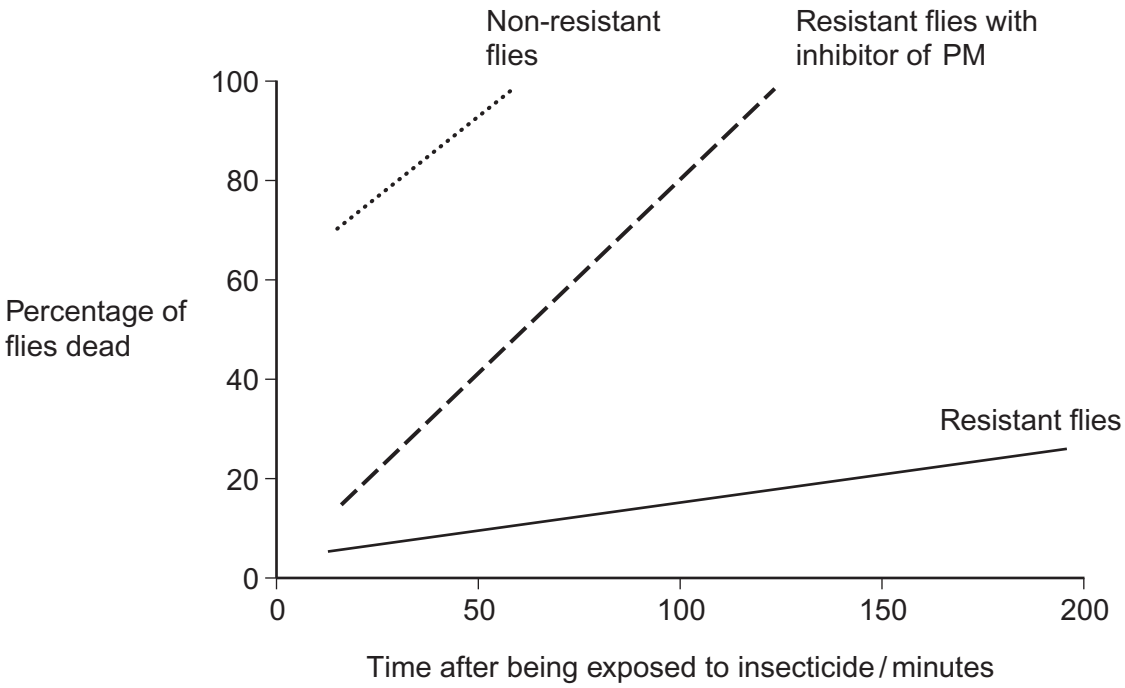
The scientists obtained large numbers of resistant and non-resistant flies. They then set up the following experiments.

- Non-resistant flies exposed to insecticide.
- Resistant flies exposed to insecticide.
- Resistant flies treated with an inhibitor of PM and then exposed to insecticide.

They then determined the percentage of flies that were dead at different times after being exposed to insecticide.

Figure 8 shows their results.

Figure 8



9 (e) (i) Explain why the scientists carried out the control experiment with the non-resistant flies.
[2 marks]

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9 (e) (ii) The scientists concluded that the resistance of the flies to the insecticide is partly due to increased activity of PM but other factors are also involved.

Explain how these data support this conclusion.

[4 marks]

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Turn over for the next question

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Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) The importance of responses to changes in the internal and external environment of an organism.

[25 marks]

OR

10 (b) The importance to humans of the control of growth, reproduction and development of organisms, including themselves.

[25 marks]

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END OF QUESTIONS

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