AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level BIOLOGY

Unit 5 Control in cells and in organisms

Thursday 23 June 2016 Morning Time allowed: 2 hours 15 minutes

Materials

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

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 box around each page 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.

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

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.

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

[1 mark]

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

[1 mark]

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.

[1 mark]

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.

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

[1 mark]

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

[2 marks]

6

Turn over for the next question

2 (a) It is important that mammals maintain a constant core temperature.

Explain why.

[3 marks]

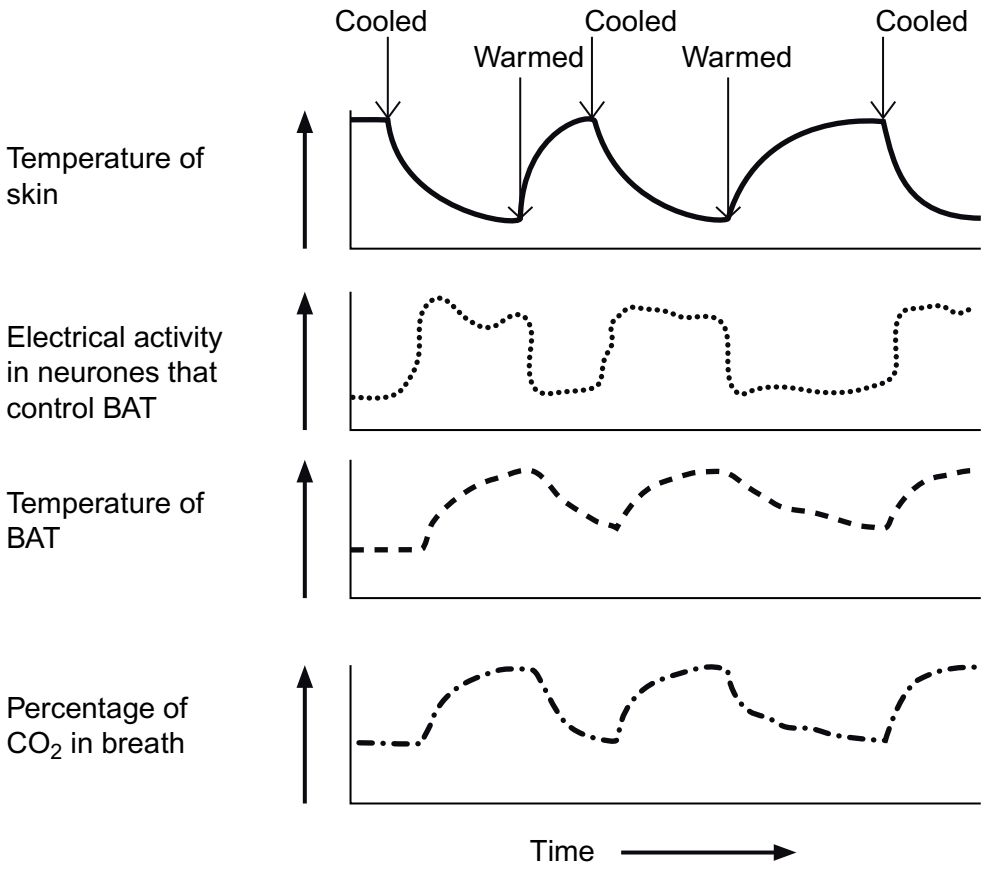
2 (b) Scientists investigated control of body temperature in rats. Rats have two patches of brown adipose tissue (BAT) under the skin of their shoulders. In BAT, respiration takes place in mitochondria but no ATP is formed. The scientists looked at the response of BAT to cooling of the rat's skin.

The scientists cooled and warmed an area of a rat's skin. At the same time, they recorded the following.

- Electrical activity in neurones that control the activity of BAT.
- The temperature of the BAT.
- The percentage of carbon dioxide in the rat's breath.

Figure 1 shows their results.

Figure 1



The response involving BAT raises the rat's core temperature if the skin becomes cooler.

Use evidence from **Figure 1** to suggest and explain how.

[4 marks]

7

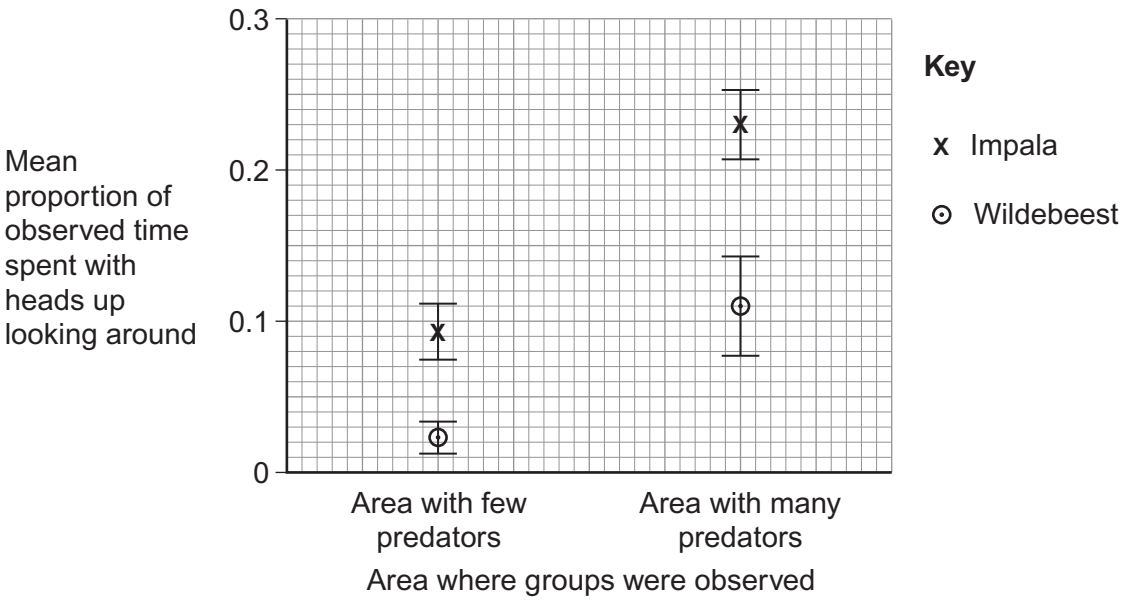
Turn over ▶

3 Impala and wildebeest are species of herbivore that live in large groups. They spend most of their time feeding with their heads near the ground.

Scientists investigated the relationship between the number of predators in an area and the mean proportion of time these herbivores spent with their heads up, looking around rather than feeding. They obtained data from groups of impala and wildebeest in two areas. In one area there were few predators and in the other area there were many predators.

Figure 2 shows their results. The bars show standard deviations.

Figure 2



3 (a) The scientists observed both groups of animals for 75 hours.

Use data from **Figure 2** to calculate the difference in the mean number of hours spent by each species looking around in the area where there were **many** predators.

Show your working.

[2 marks]

Difference _____ hours

3 (b) The scientists concluded that these herbivores spend more time looking for predators in areas where there are many predators.

Do these data support this conclusion? Give reasons for your answer.

[4 marks]

3 (c) The behaviour of the herbivores in having their heads up has a benefit but it also has costs. The benefit is being able to see, and escape from, predators.

Suggest and explain **one** cost to the herbivores of this behaviour.

[2 marks]

8

Turn over for the next question

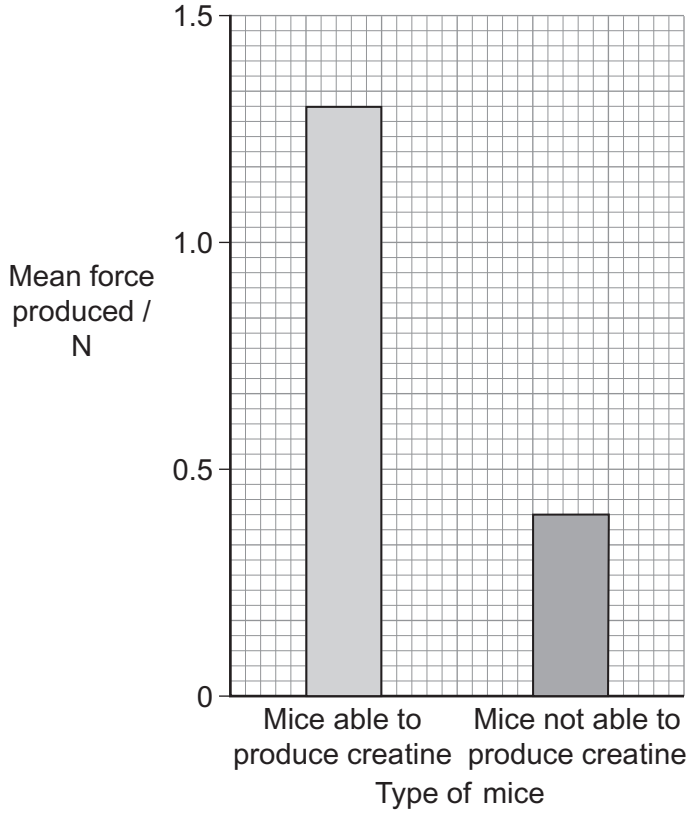
4 (a) What is the role of ATP in myofibril contraction?

[2 marks]

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.

Figure 3 shows the scientists' results.

Figure 3



4 (b) (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.

[2 marks]

Answer _____ %

4 (b) (ii) Suggest an explanation for these results.

[2 marks]

_____

_____

_____

_____

4 (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.

[2 marks]

_____

_____

_____

_____

8

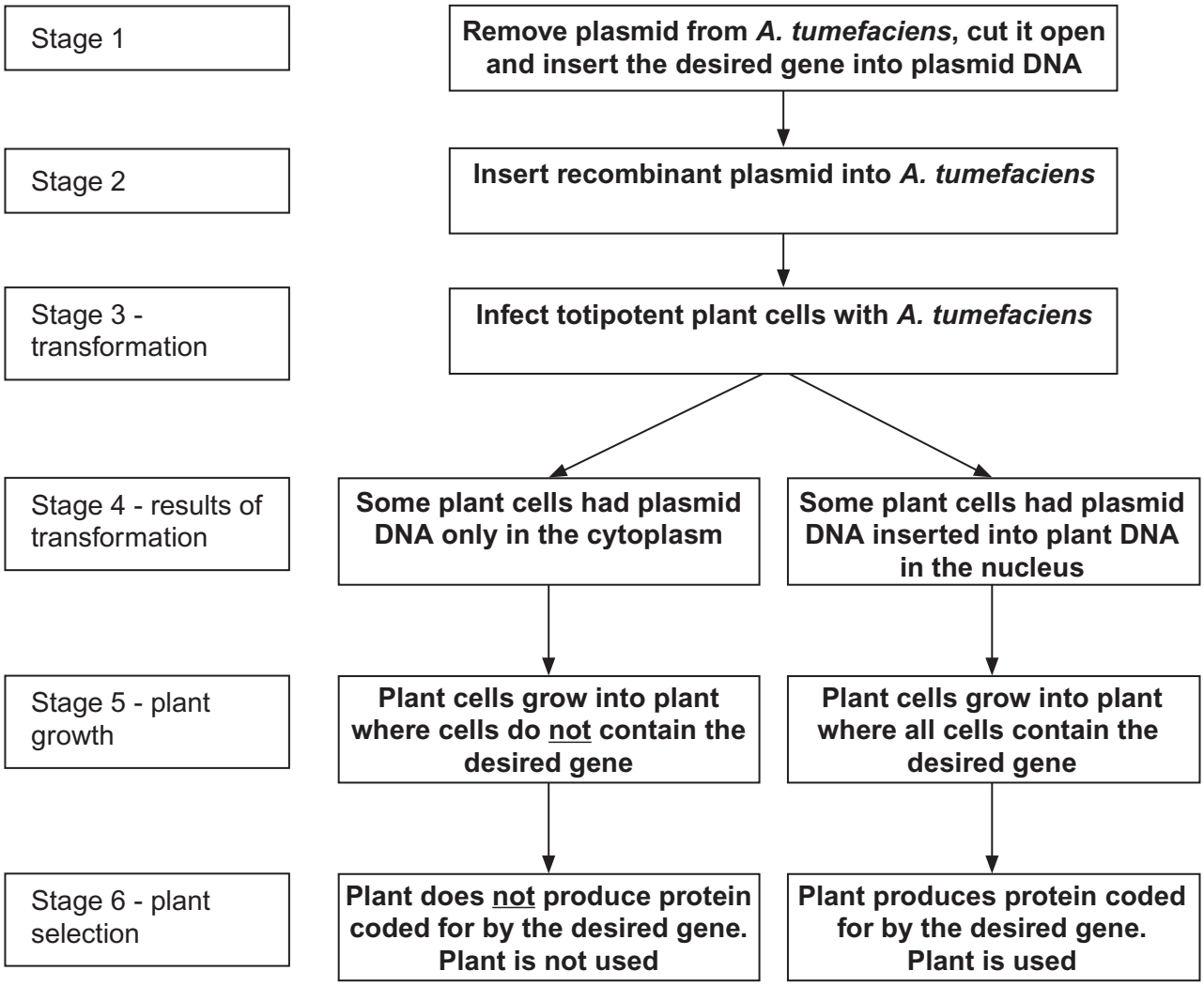
Turn over for the next question

5 *Agrobacterium tumefaciens* is a bacterium that is often used in recombinant DNA technology to produce transformed plants that benefit humans.

A. tumefaciens contains a plasmid which can be used as a vector to transfer a desired gene into plant cells. These plant cells may then develop into plants which produce the protein coded for by the desired gene.

Figure 4 outlines this process.

Figure 4



5 (a) (i) In stage 1, an enzyme is used to cut open the plasmid.
Name the type of enzyme used to cut open the plasmid.

[1 mark]

5 (a) (ii) In stage 1, another enzyme is used to insert the desired gene into the plasmid DNA.
Name the type of enzyme used to insert the gene into the plasmid.

[1 mark]

5 (b) In stage 4, some plant cells had plasmid DNA only in their cytoplasm. In other plant cells, the plasmid DNA had become inserted into plant DNA in the nucleus.

In stage 5, only cells with plasmid DNA inserted into the plant DNA in the nucleus grew into plants where all the cells contained the desired gene.

Explain why some of the plants in stage 5 contained the desired gene in all of their cells and others did not.

[3 marks]

5 (c) The **desired gene** in **Figure 4** was from an insect. In stage 6, the plant containing this gene was able to use it to synthesise an insect protein.

The plant is able to synthesise the insect protein. Explain why this is possible.

[3 marks]

8

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

[2 marks]

1 _____

_____

_____

2 _____

_____

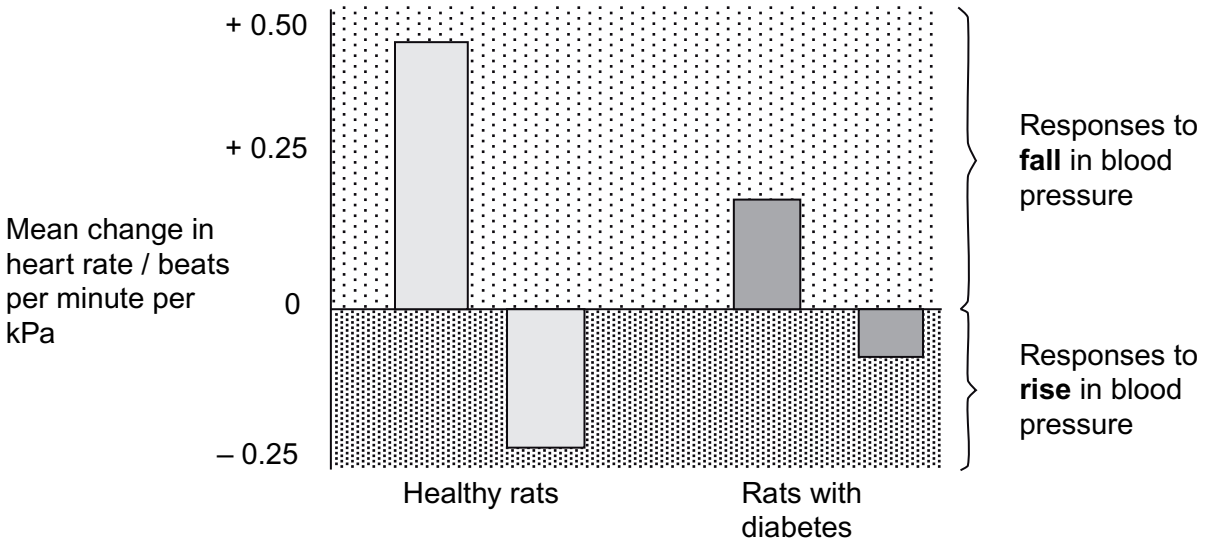
_____

6 (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.

Figure 5 shows their results in the form they were presented.

Figure 5



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.

[4 marks]

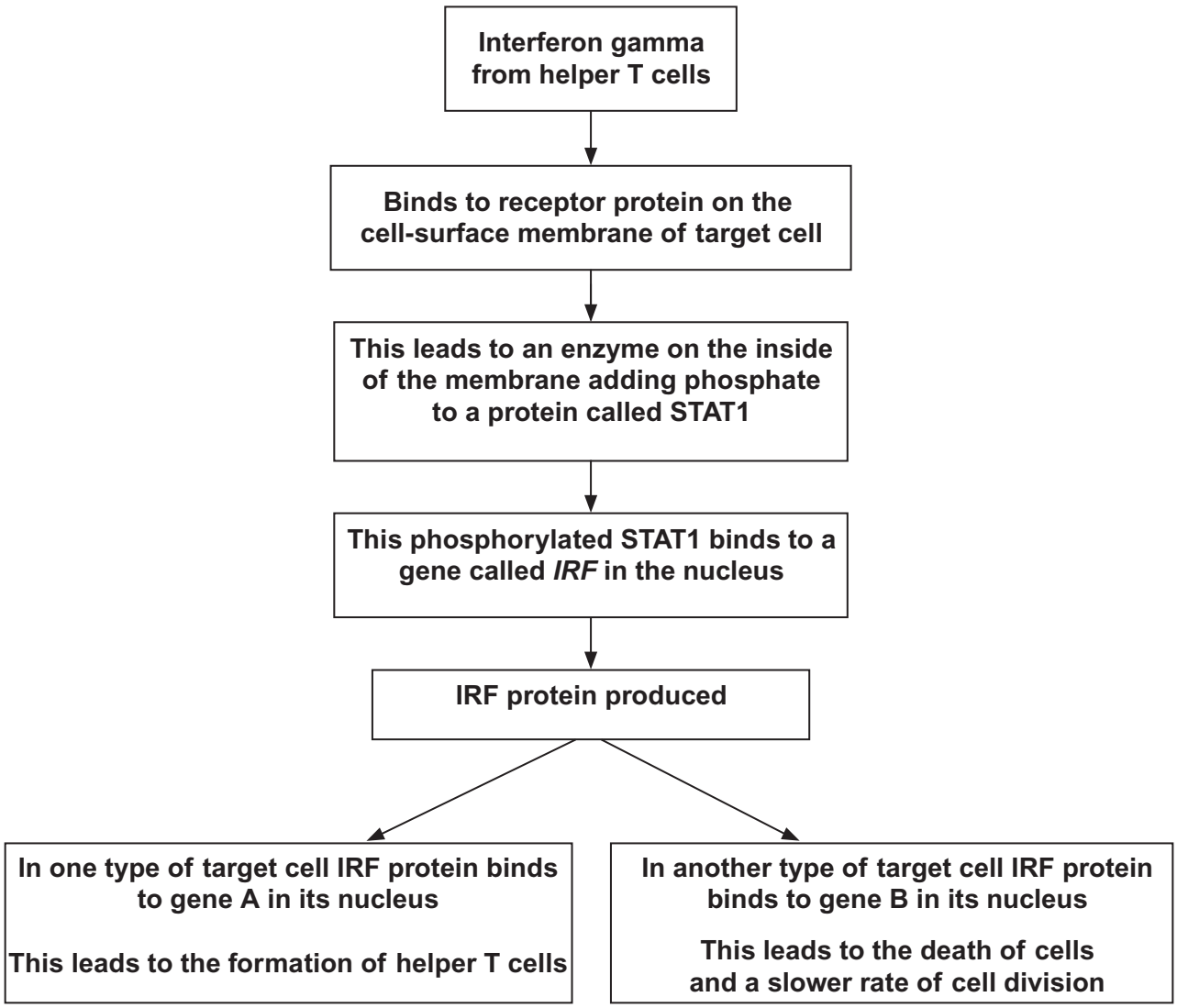
6

Turn over for the next question

7 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.

Figure 6 shows how interferon gamma regulates three genes.

Figure 6



7 (a) Use information in **Figure 6** to suggest how the binding of interferon gamma to its receptor protein leads to the production of phosphorylated STAT1.

[2 marks]

7 (b) Name the **two** transcription factors in **Figure 6**.

[2 marks]

1 _____

2 _____

7 (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.

[2 marks]

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

Use the information in **Figure 6** to explain how the *IRF* gene acts as a tumour suppressor gene.

[3 marks]

9

8 *Mycobacterium tuberculosis* causes tuberculosis. The DNA of *M. tuberculosis* contains a direct repeat (DR) region. The DR region consists of 43 different, non-coding base sequences called spacers. Each spacer is found in a specific place in the DR region. In different strains of *M. tuberculosis*, some of these spacers have been lost.

8 (a) (i) The DR region consists of non-coding base sequences.

What is meant by a non-coding base sequence?

[1 mark]

8 (a) (ii) Name the process by which the base sequence of a spacer is lost from a DR region.

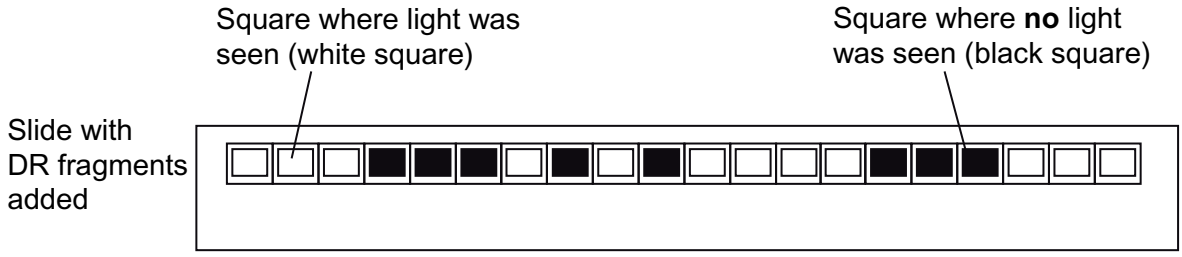
[1 mark]

Scientists investigated the DR regions of different strains of *M. tuberculosis*. They produced a DNA probe for each of the 43 spacer sequences. Each probe was:

- labelled with a fluorescent marker that gave off light if the probe attached to its complementary spacer
- attached to a particular square on a slide.

They obtained samples of the DR region from each strain. These were cut into small single-stranded DNA fragments. The fragments from each strain were added to a slide with the DNA probes attached. **Figure 7** shows their results for one strain of *M. tuberculosis* with 20 of the probes.

Figure 7



8 (b) The scientists cloned the DR region DNA *in vitro* before testing for the presence of spacers.

Give the name of the method they used to clone the DNA *in vitro*.

[1 mark]

8 (c) Explain how the use of DNA probes produced the results in **Figure 7**.

[3 marks]

8 (d) Doctors can use the method with DNA probes to identify the specific strain of *M. tuberculosis* infecting a patient. This is very important when there is an outbreak of a number of cases of tuberculosis in a city.

Suggest and explain why it is important to be able to identify the specific strain of *M. tuberculosis* infecting a patient.

[2 marks]

8

Turn over for the next question

9 Multiple sclerosis (MS) is a condition caused when the body's own immune system attacks the myelin sheath around axons. The cell bodies of the neurones themselves can also be damaged or destroyed. People with MS usually have periods of time when their MS gets no worse, followed by relapses when it gets worse.

Scientists investigated the effects on neurones of damage to myelin. The scientists obtained a modified antigen from the myelin sheath of humans and injected it into mice. After a number of days, this injection of antigen resulted in the myelin sheaths in the mice being damaged. Some cell bodies of neurones were also damaged.

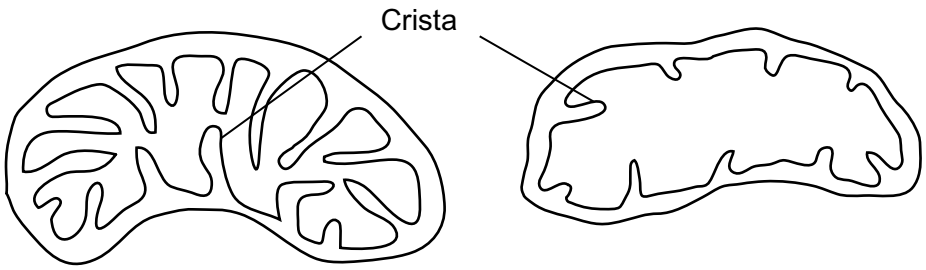
9 (a) Suggest how the injection of the antigen resulted in the myelin sheaths being damaged.

[3 marks]

9 (b) The scientists compared the ultrastructure of normal and damaged neurones. They found that damaged neurones contained many mitochondria with an unusual ultrastructure.

Figure 8 shows a mitochondrion with normal ultrastructure and one with the unusual ultrastructure.

Figure 8



Mitochondrion with normal ultrastructure

Mitochondrion with unusual ultrastructure

Suggest why having a large number of mitochondria with this unusual ultrastructure could lead to neurones dying.

[3 marks]

9 (c) The scientists took a large number of photographs of thin sections through neurones. Using these photographs, they found that 40% of mitochondria had the unusual ultrastructure in damaged neurones.

9 (c) (i) What sort of microscope would the scientists use to take the photographs? Give **one** reason for your answer.

[1 mark]

Type of microscope _____

Reason _____

9 (c) (ii) Suggest how the scientists found the percentage of mitochondria with the unusual ultrastructure.

[3 marks]

9 (d) Another group of scientists investigated the use of a drug called teriflunomide to treat MS. They recruited a large number of volunteers who had MS and divided them into three groups, **A**, **B** and **C**, at random. For each group, they recorded factors such as age, how many relapses they had and how long it was since they were diagnosed with MS.

9 (d) (i) Explain why the scientists made these comparisons.

[1 mark]

9 (d) (ii) Each group of volunteers was given a different treatment for 2 years. The treatment given to each group was as follows.

- **Group A** was given a placebo that contained no drug.
- **Group B** was given 7 mg of teriflunomide per day.
- **Group C** was given 14 mg of teriflunomide per day.

The scientists determined the mean number of relapses per person, per year for each group.

Table 1 shows their results.

Table 1

Group	**Mean number of relapses of MS per person per year (± 95% confidence limits)**
A (placebo)	0.55 (± 0.10)
B (7 mg teriflunomide)	0.37 (± 0.07)
C (14 mg teriflunomide)	0.36 (± 0.06)

The scientists concluded that teriflunomide was effective in the treatment of MS.
Evaluate this conclusion.

[4 marks]

15

Turn over for the next question

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 control of processes in cells and the importance of these controls.

[25 marks]

OR

10 (b) The importance of ions in biology.

[25 marks]

END OF QUESTIONS

25