Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2012

Biology BIOL5

Unit 5 Control in cells and in organisms

Friday 22 June 2012 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

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.

Do not write outside the box

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

1 The black mamba is a poisonous snake. Its poison contains a toxin.

The table shows the base sequence of mRNA that codes for the first two amino acids of this toxin.

Base sequence of anticodon on tRNA						
Base sequence of mRNA	**A**	**C**	**G**	**A**	**U**	**G**
Base sequence of DNA						

Complete the table to show

1 (a) (i) the base sequence of the anticodon on the first tRNA molecule that would bind to this mRNA sequence *(1 mark)*

1 (a) (ii) the base sequence of the DNA from which this mRNA was transcribed. *(1 mark)*

1 (b) The length of the section of DNA that codes for the complete toxin is longer than the mRNA used for translation. Explain why.

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(1 mark)

1 (c) A mutation in the base sequence of the DNA that codes for the toxin would change the base sequence of the mRNA.

Explain how a change in the base sequence of the mRNA could lead to a change in the tertiary structure of the toxin.

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(1 mark)

Do not write outside the box

1 (d) The black mamba's toxin kills prey by preventing their breathing. It does this by inhibiting the enzyme acetylcholinesterase at neuromuscular junctions. Explain how this prevents breathing.

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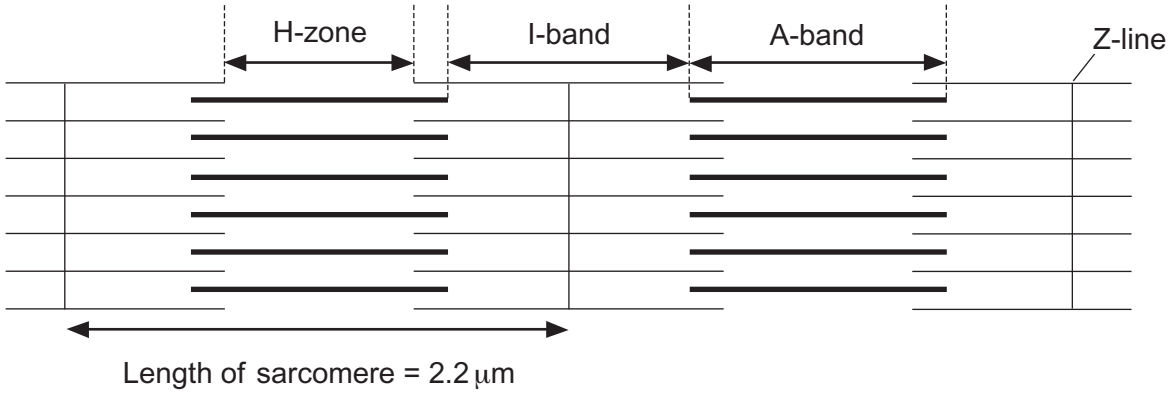
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Turn over for the next question

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2 The diagram shows two relaxed sarcomeres from skeletal muscle.



2 (a) When the sarcomeres contract, what happens to the length of

2 (a) (i) the I-band

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(1 mark)

2 (a) (ii) the A-band?

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(1 mark)

2 (b) The length of each sarcomere in the diagram is 2.2 μm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification .....

(2 marks)

Do not write outside the box

2 (c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

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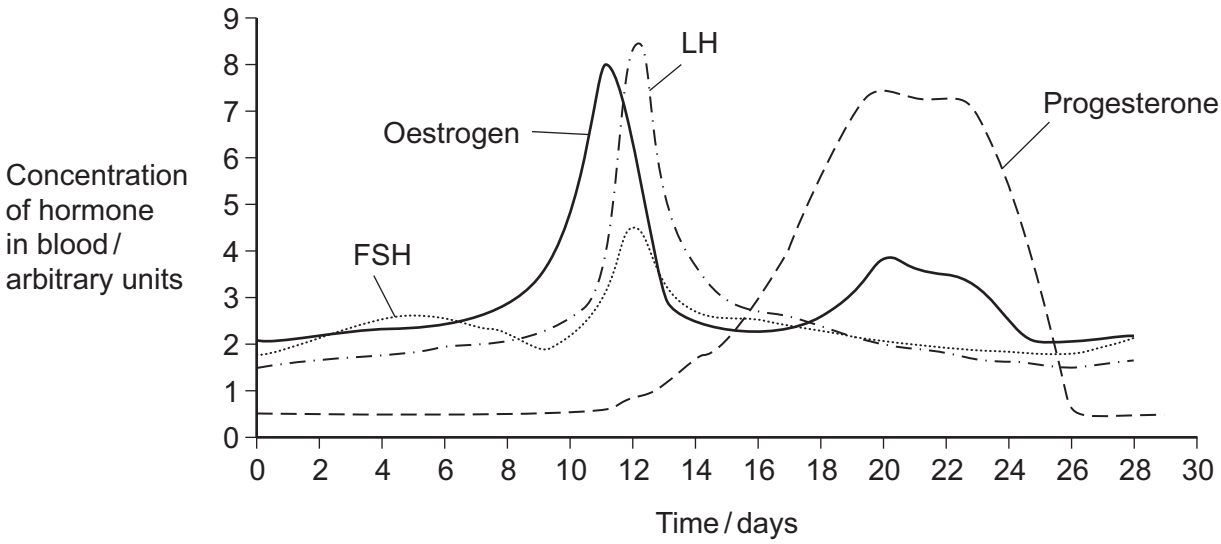
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Turn over for the next question

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3 The graph shows the concentration of four hormones in a woman's blood during one oestrous cycle.



3 (a) Explain how the graph supports the following statements.

3 (a) (i) Oestrogen causes the release of LH.

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(1 mark)

3 (a) (ii) The woman did **not** become pregnant during this cycle.

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(1 mark)

Do not write outside the box

3 (b) Implanon is a contraceptive device that is inserted under a woman's skin and prevents pregnancy for up to three years. It is a small rod that continuously releases progesterone into her blood. This progesterone prevents fertilisation from taking place.

3 (b) (i) Explain how Implanon prevents fertilisation from taking place.

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(4 marks)

(Extra space) .....

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3 (b) (ii) Suggest **one** advantage of using Implanon rather than an oral contraceptive.

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(1 mark)

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Do not write outside the box

4 (a) Increased intensity of exercise leads to an increased heart rate. Explain how.

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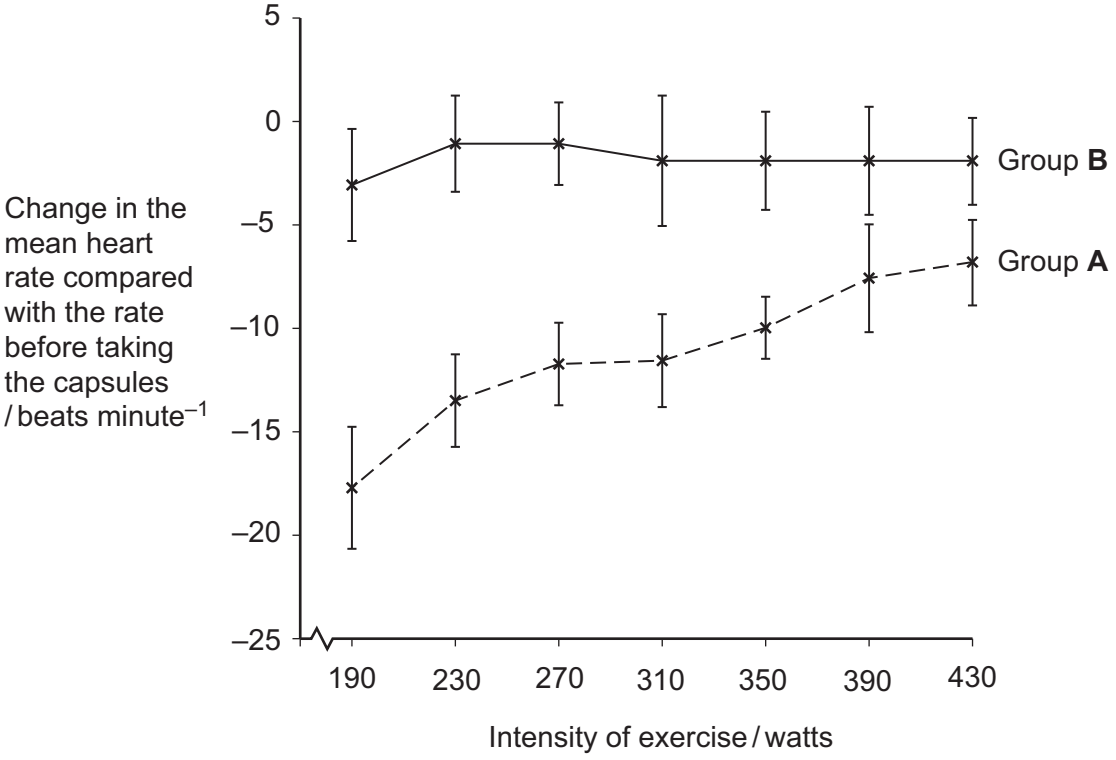
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4 (b) Scientists investigated the effect of taking omega-3 fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **A** and **B**. For each group, they measured the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- Group **A** was given capsules containing omega-3 fatty acids in fish oil.
- Group **B** was given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. The graph shows their results. The bars represent the standard deviations.



Do not write outside the box

4 (b) (i) Group **B** was given capsules containing olive oil. Explain why.

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(1 mark)

4 (b) (ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise. Explain how the information in the graph supports this conclusion.

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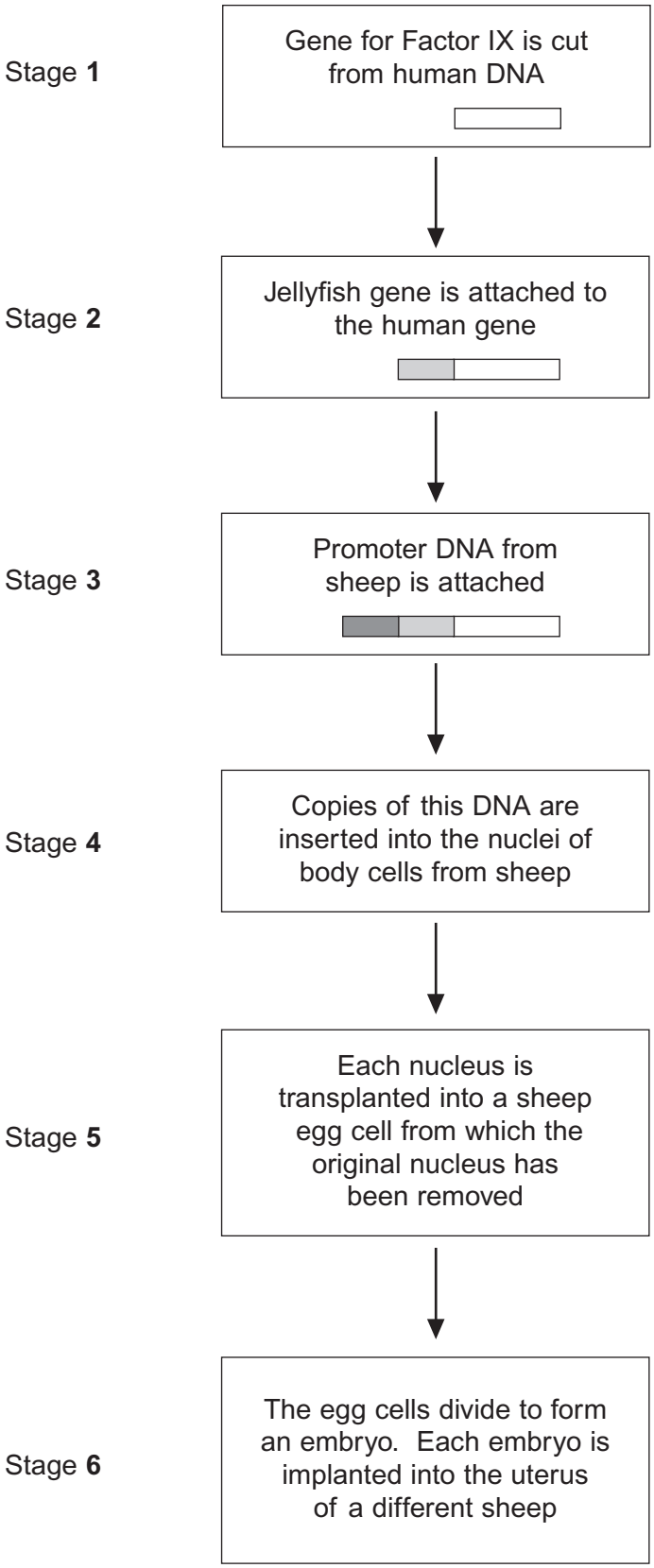
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Turn over for the next question

Do not write outside the box

5 Haemophilia is a genetic condition in which blood fails to clot. Factor IX is a protein used to treat haemophilia. Sheep can be genetically engineered to produce Factor IX in the milk produced by their mammary glands. The diagram shows the stages involved in this process.



Do not write outside the box

5 (a) Name the type of enzyme that is used to cut the gene for Factor IX from human DNA (Stage **1**) .

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(1 mark)

5 (b) (i) The jellyfish gene attached to the human Factor IX gene (Stage **2**) codes for a protein that glows green under fluorescent light. Explain the purpose of attaching this gene.

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(2 marks)

5 (b) (ii) The promoter DNA from sheep (Stage **3**) causes transcription of genes coding for proteins found in sheep milk.

Suggest the advantage of using this promoter DNA.

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(2 marks)

(Extra space) .....

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Question 5 continues on the next page

Do not write outside the box

5 (c) Many attempts to produce transgenic animals have failed. Very few live births result from the many embryos that are implanted.

5 (c) (i) Suggest **one** reason why very few live births result from the many embryos that are implanted.

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(2 marks)

(Extra space) .....

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5 (c) (ii) It is important that scientists still report the results from failed attempts to produce transgenic animals. Explain why.

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(2 marks)

9

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ANSWER IN THE SPACES PROVIDED

Turn over for Question 6

Do not write outside the box

6 (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

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(2 marks)

(Extra space) .....

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6 (b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

6 (b) (i) The rats were not fed for at least 6 hours before their blood glucose concentration was measured. Explain why.

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(1 mark)

6 (b) (ii) The rats used in the investigation had type I diabetes. This form of gene therapy may be less effective in treating rats that have type II diabetes. Explain why.

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(1 mark)

Do not write outside the box

6 (b) (iii) Research workers have suggested that treating diabetes in humans by this method of gene therapy would be better than injecting insulin. Evaluate this suggestion.

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(4 marks)

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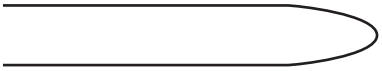
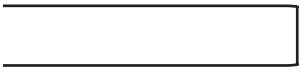
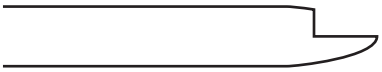
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Turn over for the next question

Do not write outside the box

7 Scientists investigated the response of the roots of pea seedlings to gravity.

They took three samples of seedlings, **A**, **B**, and **C**, and placed them so that their roots were growing horizontally. The root tips of each sample had been given different treatments. After a set time, the scientists recorded whether the roots of the seedlings had grown upwards or downwards and the amount of curvature. The table shows the treatment they gave to each sample and their results.

Treatment	Results	
	Direction of growth	**Mean amount of curvature / degrees**
A None 	Downwards	60
B Root tip removed 	Continues to grow horizontally	0
C Upper half of root tip removed 	Downwards	30

7 (a) The pea seedlings were kept in the dark after each treatment. Explain why this was necessary.

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(1 mark)

7 (b) What conclusion can be made from the results for treatment **B**?

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(1 mark)

Do not write outside the box

7 (c) Suggest how indoleacetic acid (IAA) could have caused the results for

7 (c) (i) treatment **A**

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(2 marks)

7 (c) (ii) treatment **C**.

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(2 marks)

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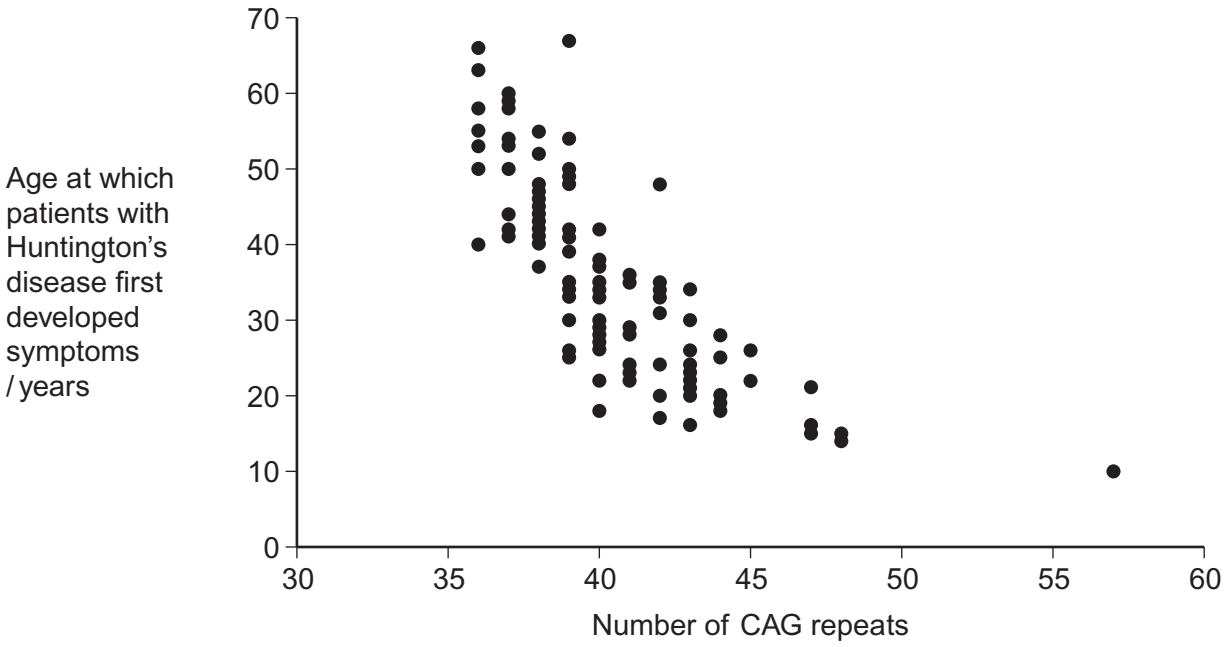
Turn over for the next question

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8 Huntington's disease is a genetic condition that leads to a loss in brain function. The gene involved contains a section of DNA with many repeats of the base sequence CAG. The number of these repeats determines whether or not an allele of this gene will cause Huntington's disease.

- An allele with 40 or more CAG repeats will cause Huntington's disease.
- An allele with 36 – 39 CAG repeats may cause Huntington's disease.
- An allele with fewer than 36 CAG repeats will not cause Huntington's disease.

The graph shows the age at which a sample of patients with Huntington's disease first developed symptoms and the number of CAG repeats in the allele causing Huntington's disease in each patient.



Do not write outside the box

8 (a) (i) People can be tested to see whether they have an allele for this gene with more than 36 CAG repeats. Some doctors suggest that the results can be used to predict the age at which someone will develop Huntington's disease.

Use information in the graph to evaluate this suggestion.

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(3 marks)

(Extra space) .....

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8 (a) (ii) Huntington's disease is always fatal. Despite this, the allele is passed on in human populations. Use information in the graph to suggest why.

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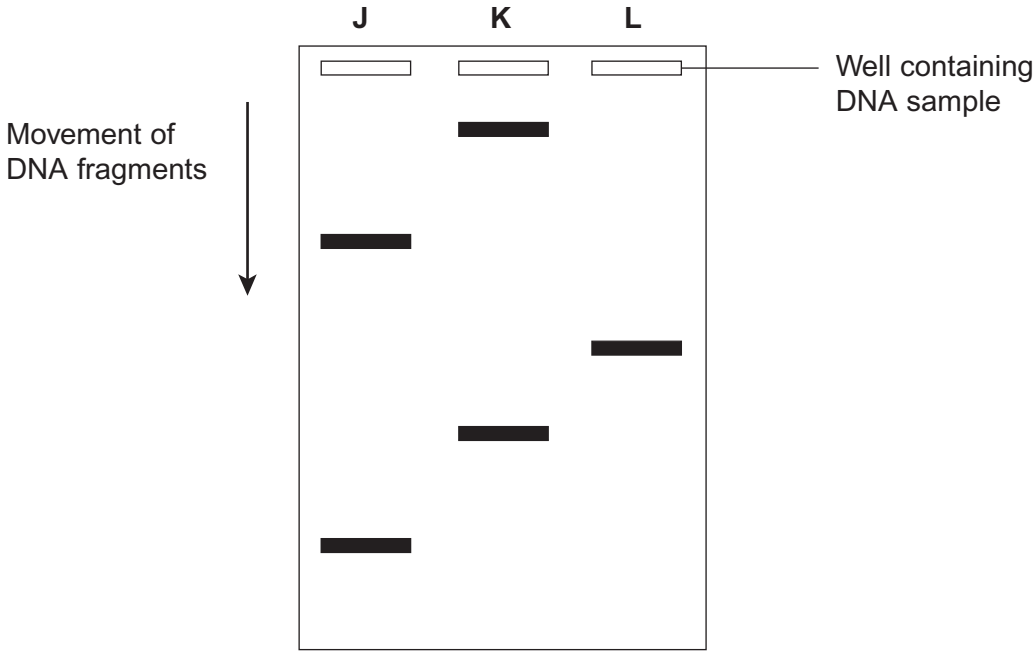
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(2 marks)

Question 8 continues on the next page

Do not write outside the box

8 (b) Scientists took DNA samples from three people, **J**, **K** and **L**. They used the polymerase chain reaction (PCR) to produce many copies of the piece of DNA containing the CAG repeats obtained from each person. They separated the DNA fragments by gel electrophoresis. A radioactively labelled probe was then used to detect the fragments. The diagram shows the appearance of part of the gel after an X-ray was taken. The bands show the DNA fragments that contain the CAG repeats.



8 (b) (i) Only one of these people tested positive for Huntington's disease. Which person was this? Explain your answer.

Person .....

Explanation .....

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(2 marks)

Do not write outside the box

8 (b) (ii) The diagram only shows part of the gel. Suggest how the scientists found the number of CAG repeats in the bands shown on the gel.

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(1 mark)

8 (b) (iii) Two bands are usually seen for each person tested. Suggest why only one band was seen for Person **L**.

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(1 mark)

9

Turn over for the next question

Do not write outside the box

9 Cows suffer from heat stress when the environmental temperature is too high. Heat stress occurs when their core body temperature rises above 39.4 °C. The table shows how environmental temperature affects the food intake, water intake and milk production of cows in a fixed period of time.

Environmental temperature / °C	Food intake / kg	Water intake / dm^3	Milk production / dm^3
20	18.2	81.8	27.0
25	17.7	88.6	25.0
30	17.0	95.0	22.9
35	16.7	144.1	18.0

9 (a) Calculate the percentage decrease in milk production between the temperatures of 30 °C and 35 °C. Show your working.

Answer ..... %

(2 marks)

9 (b) Suggest how each of the following responses helps to maintain core body temperature.

9 (b) (i) The change in water intake as environmental temperature increases.

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(1 mark)

9 (b) (ii) The change in food intake as environmental temperature decreases.

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(2 marks)

Do not write outside the box

9 (c) Explain the change in milk production as environmental temperature increases.

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(1 mark)

9 (d) The rectal temperatures of cows are recorded to monitor heat stress. This is a better measurement of core body temperature than measuring the temperature of the skin. Explain why.

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(2 marks)

9 (e) Selective breeding can be used to produce cows with desirable features. This involves mating cows with bulls. Suggest how a bull is selected to increase the probability of producing cows with a high milk yield.

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(1 mark)

Question 9 continues on the next page

Do not write outside the box

Milk contains lactose. Human babies produce the enzyme lactase, which digests lactose. Many human adults do not produce lactase and are lactose intolerant.

People who are lactose intolerant can become very ill if they drink milk or eat dairy products, such as butter and cheese.

9 (f) Scientists have recorded the percentage of adults who are lactose intolerant in different countries. Explain the advantage of using percentages in this type of study.

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(2 marks)

9 (g) The scientists found that the percentage of people who can tolerate lactose is much higher in populations that drink a lot of milk and eat a lot of dairy products.

Use your knowledge of natural selection to explain this finding.

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(4 marks)

(Extra space) .....

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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 shapes fitting together in cells and organisms.

(25 marks)

OR

10 (b) How bacteria can affect the lives of humans and other organisms.

(25 marks)

If you want to make a plan write it here.

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END OF QUESTIONS

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