

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Level Examination
January 2012

Human Biology

HBIO4

Unit 4 Bodies and cells in and out of control

Wednesday 25 January 2012 9.00 am to 11.00 am

For this paper you must have:

- a ruler with millimetre measurements
- a calculator.

Time allowed

- 2 hours

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.
- 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 90.
- You will be marked on your ability to:
 - use good English
 - organise information clearly
 - use scientific terminology accurately.

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



J A N 1 2 H B I O 4 0 1

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

- 1 (a)** Describe how a resting potential is maintained across a neurone membrane.

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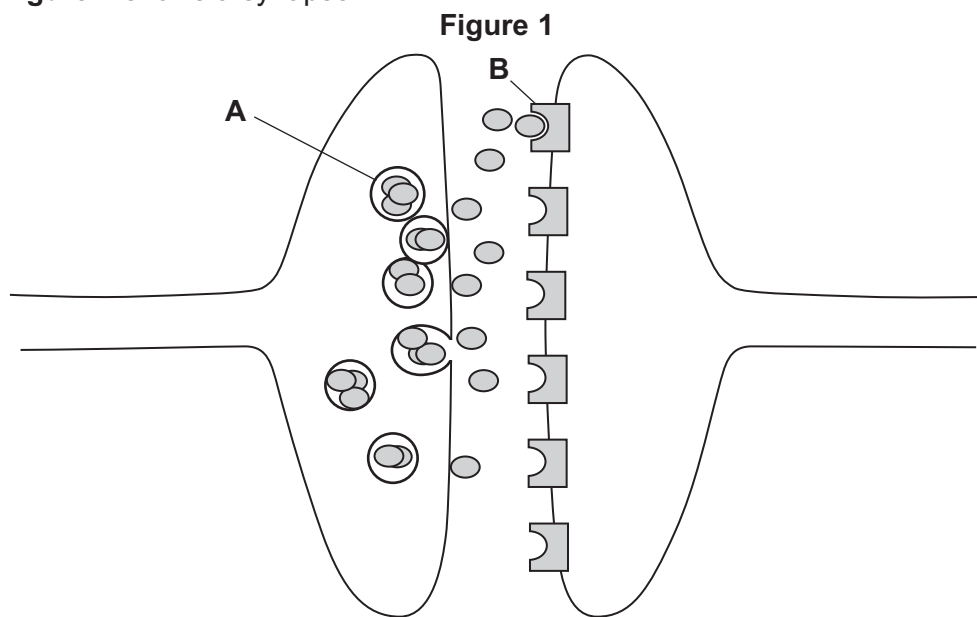
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(2 marks)

- 1 (b)** Figure 1 shows a synapse.



Describe how **A** and **B** are involved in the transmission of information across the synapse.

A

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B

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(4 marks)

6



2 (a) Give **two** methods used in genetic engineering to obtain a gene.

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2

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(2 marks)

2 (b) (i) What is a genetically modified organism?

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(1 mark)

2 (b) (ii) What is a genetic marker?

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(1 mark)

2 (c) The human genome includes non-coding DNA and regulatory genes.

2 (c) (i) Give **one** example of non-coding DNA.

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(1 mark)

2 (c) (ii) What is meant by a regulatory gene?

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(1 mark)



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- 3 (a)** Other than actin and myosin, name **one** substance involved in the contraction of a myofibril. Describe the part played by this substance in contraction.

Substance

Role in contraction

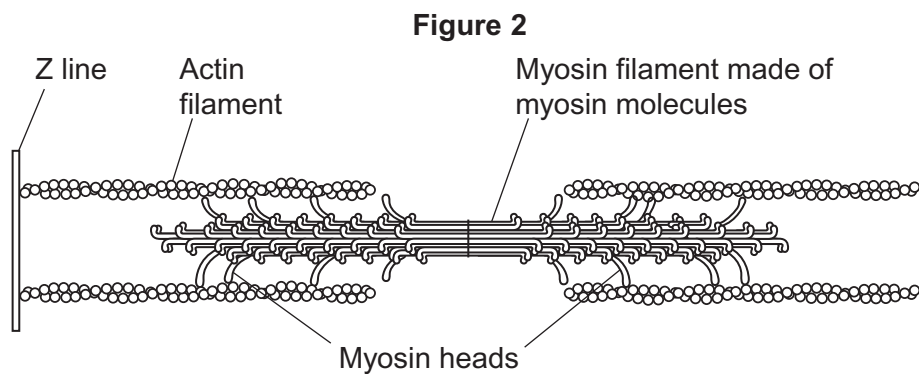
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(3 marks)

- 3 (b)** **Figure 2** shows the arrangement of actin and myosin in a sarcomere.



The myosin filament consists of many myosin molecules.

Use **Figure 2** to explain how the arrangement of the myosin molecules in the myosin filament leads to the Z lines being pulled towards each other when the sarcomere contracts.

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(3 marks)

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- 4** The inheritance of ABO blood groups involves three alleles, I^A , I^B and I^O , of the ABO gene.
The I^A and I^B alleles code for slightly different forms of a functional enzyme. These alleles differ by a few single-base substitutions, where one base in the DNA of the gene is replaced by another.
The I^O allele codes for a non-functional enzyme. This allele has a single-base deletion, where one base in the DNA of the gene is missing.

- 4 (a)** Explain why the I^A and I^B alleles both code for a functional enzyme but the I^O allele codes for a non-functional enzyme.

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- 4 (b)** A mother with group A blood and a father with group B blood have a child with group O blood.

What is the probability that their next child will have group AB blood?

Complete the genetic diagram to explain your answer.

Use the symbols I^A , I^B and I^O for the alleles involved.

Parental phenotypes

Group A

Group B

Parental genotypes

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Genotypes of gametes

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Offspring genotypes

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Offspring phenotypes

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Probability of child with group AB blood

(4 marks)

8

Turn over ►



5 (a) Describe how the image of an object is focused onto the retina of the eye.

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(3 marks)

(Extra space)

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The *blind spot* is an area of the retina where there are no rod or cone cells. If light falls on the *blind spot*, no nerve impulses are sent to the visual cortex of the brain.

A student investigated the *blind spot* in her left eye. She closed her right eye and looked at a line on a piece of paper with a gap in it. This is what she saw.



She moved the paper towards her eye until the gap in the line seemed to disappear. This happened when the image of the gap was focused on the *blind spot*. This is what she saw.



- 5 (b)** When the gap in the line seemed to disappear; this was because of *top down* visual perception in the brain. Explain how *top down* visual perception by the brain made the gap seem to disappear.

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(2 marks)

- 5 (c)** If the student had kept her right eye open as well, the gap would **not** have disappeared. Explain why.

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(2 marks)



- 6 (a)** Prader-Willi syndrome is an example of epigenetic imprinting. What is *epigenetic imprinting*?

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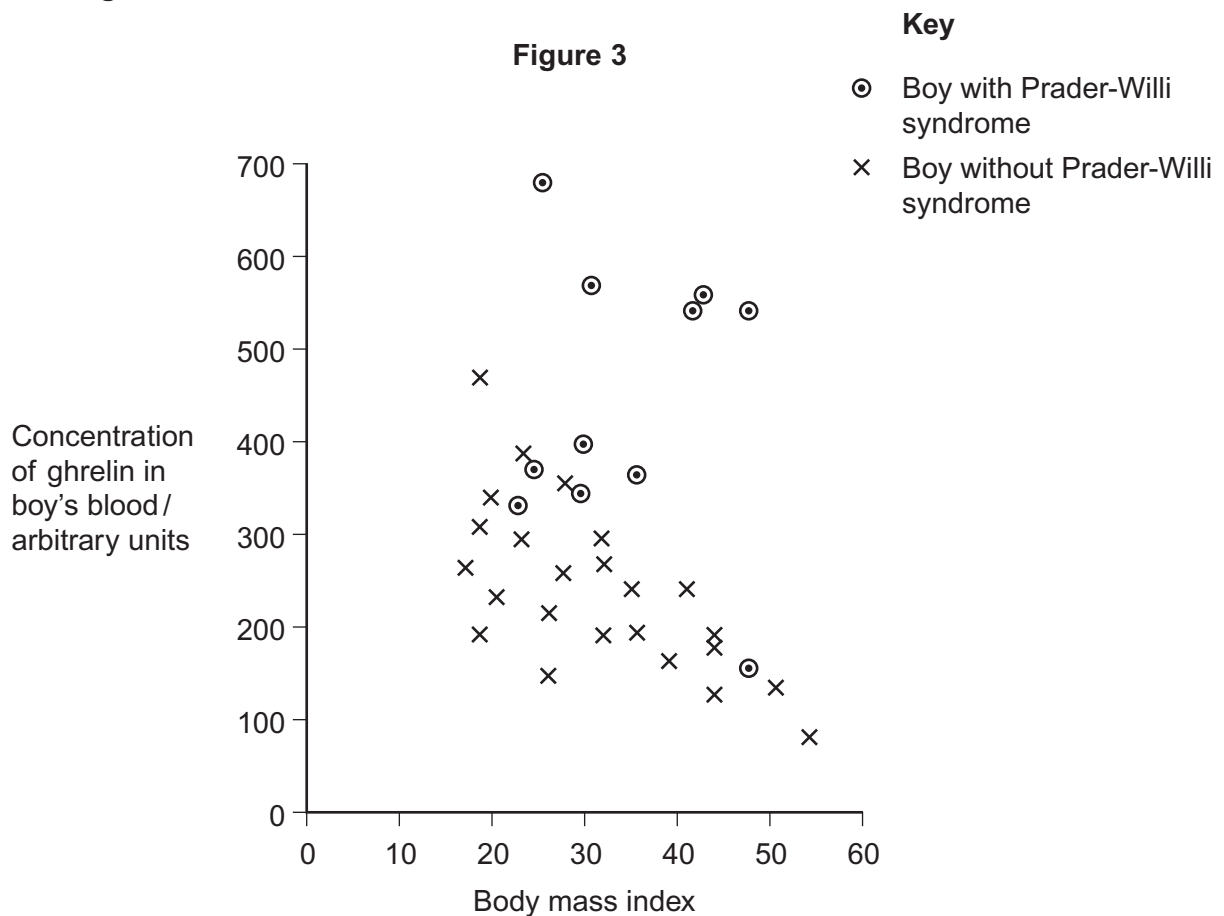
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(2 marks)

Boys with Prader-Willi syndrome are always hungry and, as a result, often become obese.

Ghrelin is a hormone that makes a person feel hungry. Doctors investigated the concentration of ghrelin in the blood of boys with Prader-Willi syndrome and boys without the syndrome. They also calculated the body mass index (BMI) of each boy. A boy with a BMI of 30 or more was classed as obese.

Figure 3 shows their results.



- 6 (b)** Describe the relationship between the concentration of ghrelin in the blood and obesity in boys **without** Prader-Willi syndrome.

Give the reason for your answer.

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(2 marks)

- 6 (c)** The doctors concluded that one reason why boys with Prader-Willi syndrome are often obese is because of high concentrations of ghrelin in their blood.
Do these data support this conclusion? Give reasons for your answer.

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(3 marks)

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Turn over ►



7 (a) Give **one** reason why hormonal control takes longer than nervous control.

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(2 marks)

Doctors investigated the effects of stress on two groups of students, **L** and **H**. Psychological tests had identified group **L** as low responders to stress and group **H** as high responders.

The doctors exposed both groups to stress by asking them to solve problems in front of a large audience. For each group they calculated mean increases in the following factors as a result of this stress.

- Concentration of ACTH in the blood.
- Concentration of adrenaline in the blood.
- Heart rate.

ACTH is a hormone that stimulates the adrenal gland. The release of ACTH is controlled by the hypothalamus.

Their results are shown in **Figure 4**

Figure 4

Factor	Mean increase	
	L (Low responders)	H (High responders)
Concentration of ACTH in blood / pg cm^{-3}	19.5	52.0
Concentration of adrenaline in blood / pg cm^{-3}	18.6	28.4
Heart rate / beats per minute	23.3	30.0



- 7 (b)** Use the information provided to explain why heart rate increases in response to stress.

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(5 marks)

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- 7 (c)** In the same situation, the high responders' concentration of ACTH in the blood increases more than the low responders. Suggest why.

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(2 marks)



8 (a) FSH is used in IVF treatment. Explain why.

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(2 marks)

Levonorgestrel is a drug used for emergency contraception for women who have had unprotected sexual intercourse.

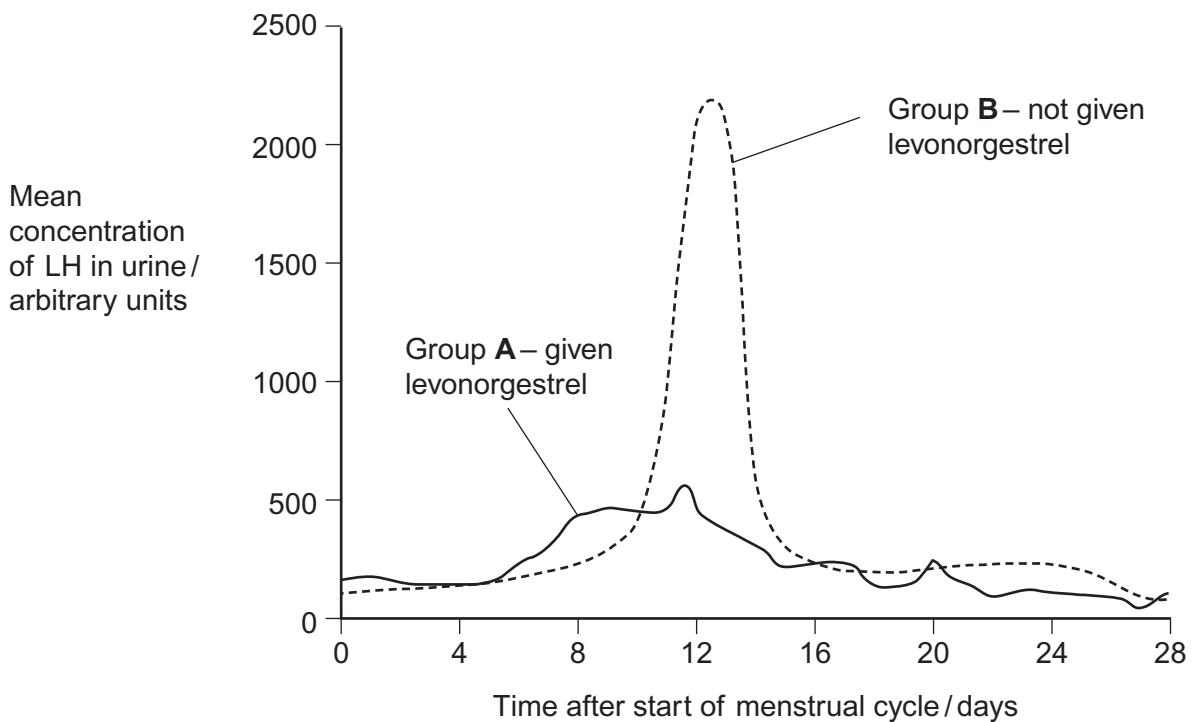
Doctors investigated the effect of levonorgestrel on two large groups of volunteers, Group **A** and Group **B**.

- Group **A** were given levonorgestrel two days before ovulation.
- Group **B** were not given levonorgestrel.

The doctors measured the mean concentration of LH in the urine of each group during their menstrual cycles.

Figure 5 shows their results.

Figure 5



- 8 (b)** Use this information to explain how levonorgestrel prevents a woman becoming pregnant.

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(3 marks)

(Extra space)

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- 8 (c)** An IUD can be used as a form of emergency contraception. Many women find an IUD a less acceptable form of emergency contraception than levonorgestrel.

Suggest **one** reason why.

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(2 marks)

7

Turn over ►



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9 (a) (i) What is a tumour?

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9 (a) (ii) What is cancer?

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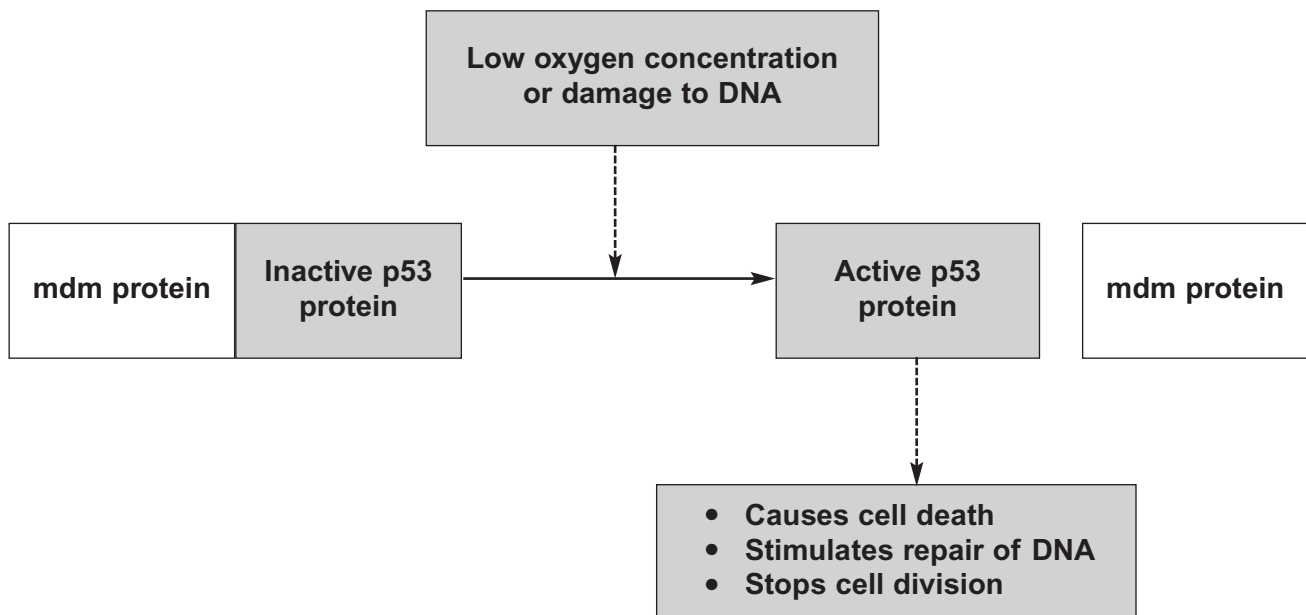
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(2 marks)

The p53 gene is a tumour suppressor gene that codes for p53 protein. The p53 protein is inactive when it has another protein called mdm binding to it.

Figure 6 shows how p53 protein becomes active and what it does.

Figure 6



9 (b) Explain why the mdm protein binds only to p53 protein.

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(2 marks)

Question 9 continues on the next page

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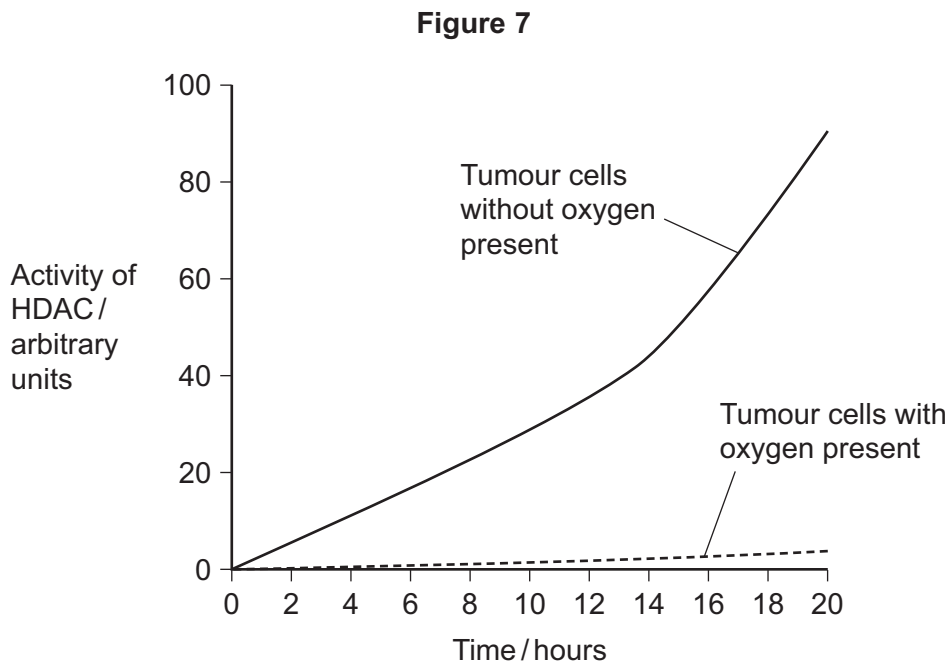


HDAC is an enzyme that inhibits the transcription of the p53 gene.

When a tumour starts to grow, it forms a mass of cells with few blood vessels and a poor blood supply.

Scientists investigated the activity of HDAC in cultures of tumour cells grown with or without oxygen present.

Figure 7 shows their results.



[illegible]

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Turn over ►



10 (a) Describe how insulin leads to lowering of the concentration of glucose in blood.

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Doctors investigated the effect of frequent, individual advice about diet and exercise on the chances of developing Type 2 diabetes. They recruited 870 people who had been identified as being obese and thus having a high risk of developing Type 2 diabetes. The volunteers were divided into two groups, **A** and **B**, at random.

- The volunteers in group **A** were given frequent, individual advice about diet and exercise over six years.
- The volunteers in group **B** were only given general advice about diet and exercise once a year for six years.

After one year, the doctors asked the volunteers to answer a questionnaire about changes in factors relating to diet and exercise. **Figure 8** shows the results.

Figure 8

Factor	Percentage reporting this change		Probability value
	Group A	Group B	
Decrease in fat eaten	87	70	0.001
Decrease in sugar eaten	55	40	0.001
Decrease in alcohol drunk	26	23	0.43
Increase in exercise	36	16	0.001

The doctors used a statistical test to see whether there were significant differences between the results for each group. The probability values they obtained are also shown in **Figure 8**.



- 10 (b)** Suggest how the factors in **Figure 8** are linked to the risk of someone developing Type 2 diabetes.

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- 10 (c)** Suggest **one** reason why these results may **not** be reliable.

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(1 mark)

Question 10 continues on page 23

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- 10 (d)** What do the data in **Figure 8** show about the effect that frequent, individual advice about diet and exercise had on the lifestyle of people in Group **A**, compared with those in Group **B**?

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- 10 (e)** One journalist concluded that this investigation was unethical. Do you agree with this conclusion? Give **one** reason for your answer.

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Question 10 continues on the next page

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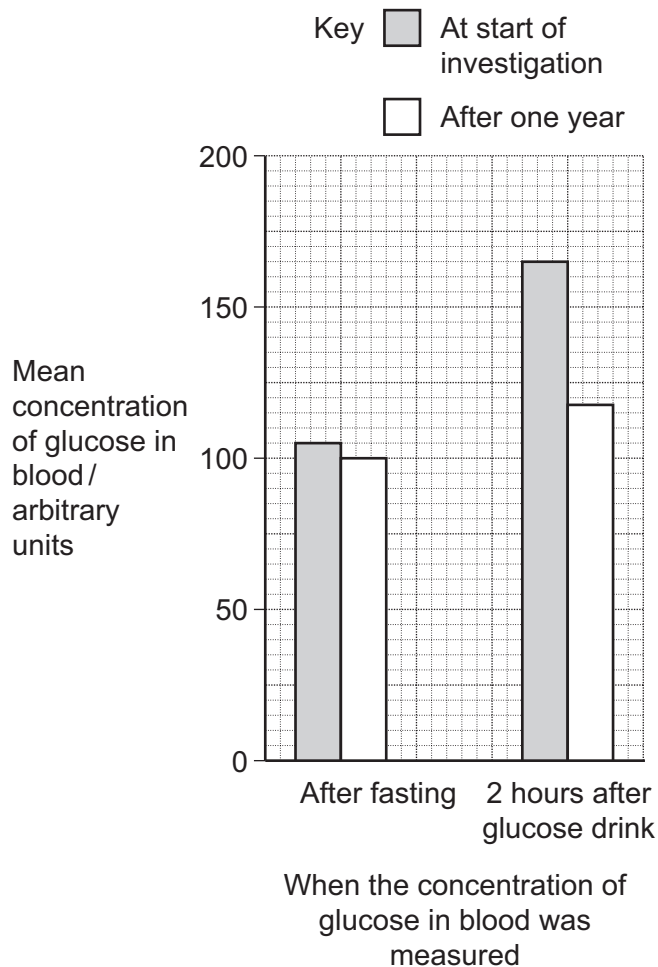
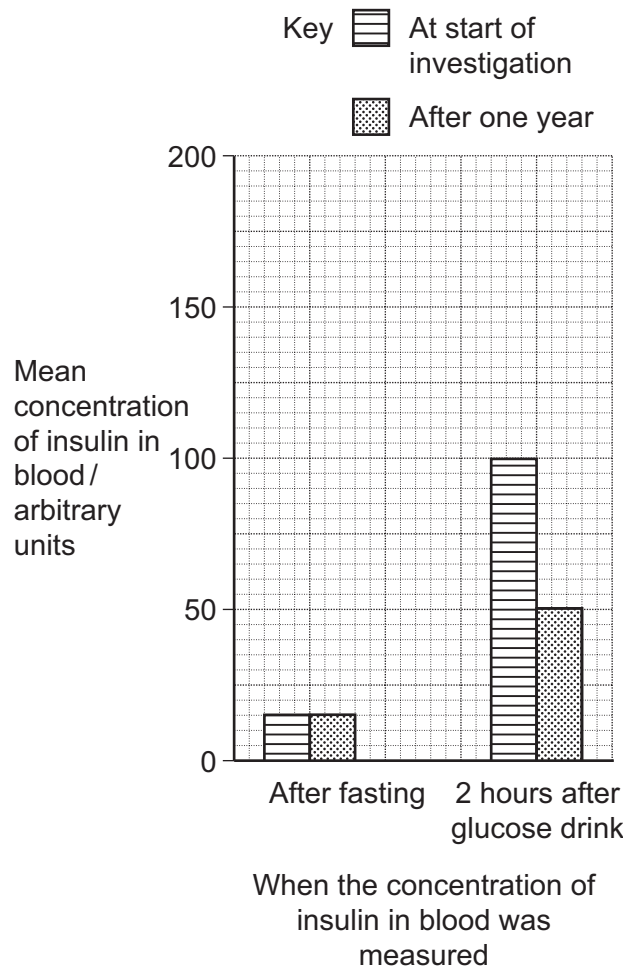


10 (f)

At the start of the investigation, the doctors measured how each volunteer's body responded to an increase in the concentration of glucose in the blood.

- They measured the concentrations of glucose and insulin in the blood after fasting (not eating for several hours).
- They then gave the volunteer a concentrated solution of glucose to drink.
- Two hours later, they measured the concentrations of glucose and insulin again.

A year later they repeated the trial. **Figure 9** and **Figure 10** show their results for Group A who received frequent, individual advice about diet and exercise.

Figure 9**Figure 10**

Describe what these data show about the changes in the response of Group **A** to an increase in the concentration of glucose in the blood after one year.

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Question 10 continues on page 27

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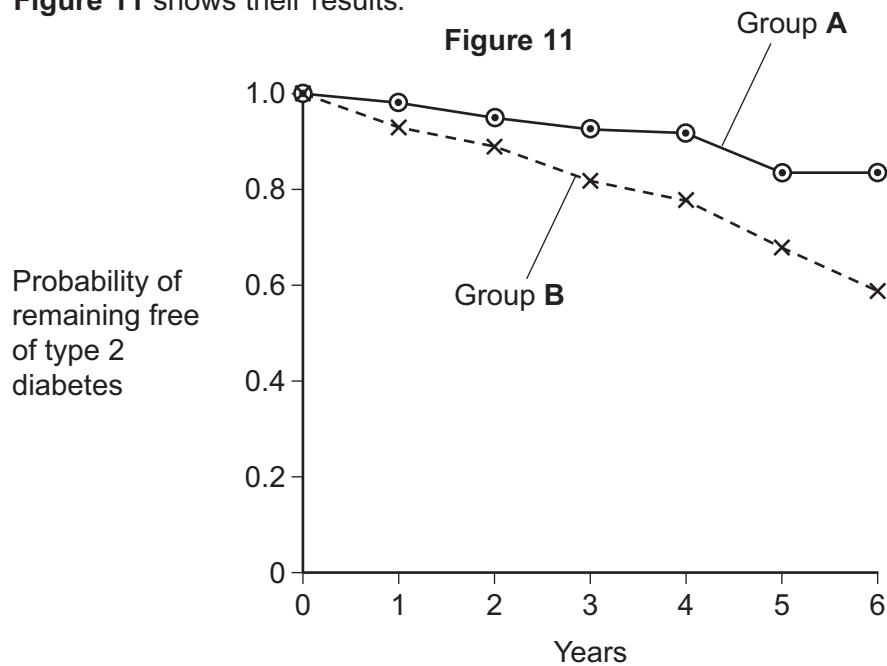
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10 (g)

The doctors recorded cases of Type 2 diabetes in Group A and Group B over six years. They used these data to calculate the probability of remaining free of Type 2 diabetes in each group.

Figure 11 shows their results.



The doctors concluded that frequent, individual advice about diet and exercise did affect the risk of developing Type 2 diabetes.

Evaluate this conclusion.

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Question 10 continues on the next page

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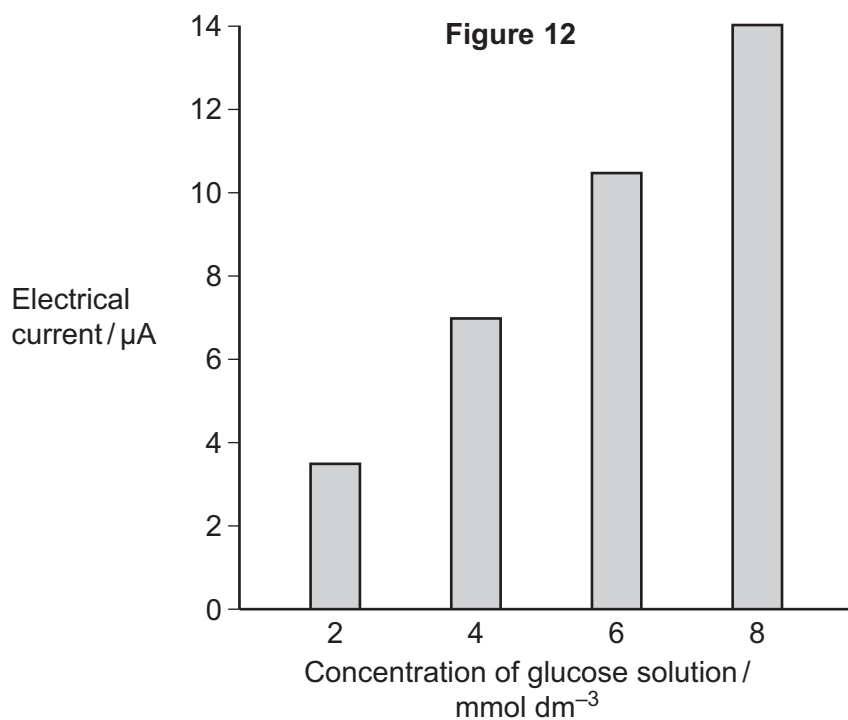


10 (h)

Scientists developed a device for measuring the concentration of glucose in blood. They attached the enzyme glucose oxidase to an electrode. When glucose is broken down by the enzyme, a small electrical current is produced which can be measured. The scientists carried out two tests on the device.

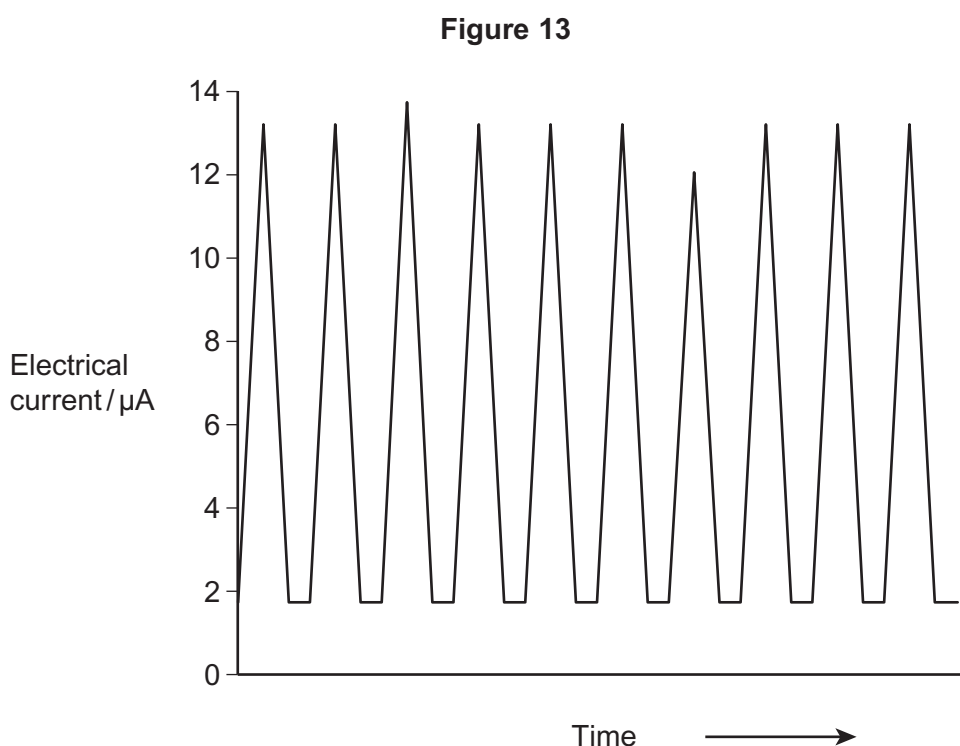
Test 1. They put the electrode into glucose solutions of known concentrations.

Figure 12 shows a typical set of results.



Test 2. They then put the electrode into each glucose solution ten times.

Figure 13 shows typical results for the 8.0 mmol dm⁻³ glucose solution.



Explain what each of these tests shows about either the accuracy or the reliability of this device for measuring the concentration of glucose in blood.

Test 1

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(2 marks)

Test 2

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(2 marks)

25

END OF QUESTIONS



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