

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Level Examination
June 2010

Human Biology

HBIO4

Unit 4 Bodies and cells in and out of control

Wednesday 16 June 2010 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.
- 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 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	
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5	
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9	
10	
11	
TOTAL	



JUN10HBIO104

WMP/Jun10/HBIO4

HBIO4

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

1 Protein synthesis involves transcription, followed by translation, of a triplet code.

Explain what is meant by each of the following.

1 (a) a triplet code

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.....
(1 mark)

1 (b) transcription

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.....
.....
(2 marks)

1 (c) translation

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.....
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(2 marks)

5

Turn over ►



2 When a person looks directly at an object, its image is focused on the fovea.

2 (a) When the image is focused on the fovea, the person sees the object in colour.
Explain why.

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(3 marks)

(Extra space)

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2 (b) Vision using the fovea has high visual acuity but low sensitivity to light compared with vision using other parts of the retina.

2 (b) (i) Explain why vision using the fovea has high visual acuity.

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(1 mark)



2 (b) (ii) Explain why vision using other parts of the retina has high sensitivity to light.

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(3 marks)

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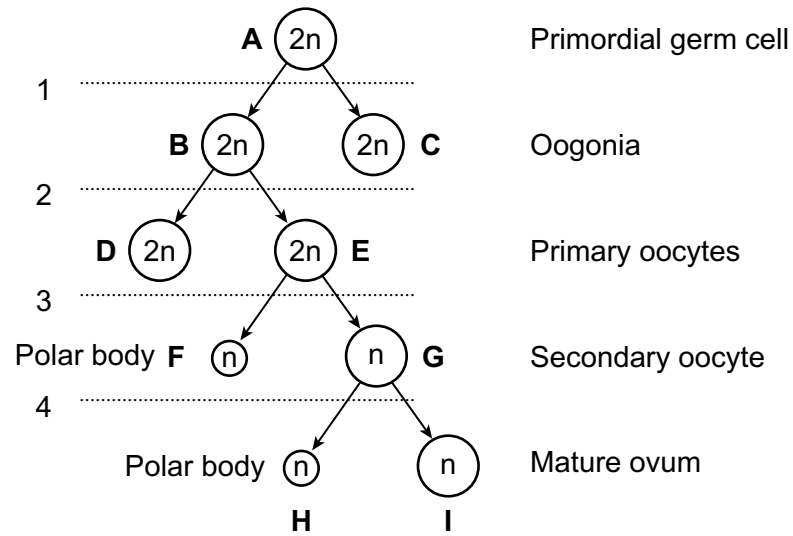
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Turn over for the next question

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- 3 The diagram shows oogenesis. In the diagram, the letters **A** to **I** represent different cells. The numbers show where cell divisions occur.



- 3 (a) (i) Give **one** number which represents mitosis. (1 mark)

- 3 (a) (ii) Give the number which represents the first division of meiosis. (1 mark)

- 3 (a) (iii) Give **one** letter which represents a cell that is released from the ovary during ovulation. (1 mark)



3 (b) (i) Give the letters of **two** cells that are genetically identical.

and

(1 mark)

3 (b) (ii) Polar body **F** and cell **G** are genetically different.
Give **two** reasons why.

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2.....

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(2 marks)

3 (c) In IVF treatment, hormones are injected into a woman to stimulate ovulation.
Name **one** hormone that could be injected to stimulate ovulation.

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(1 mark)

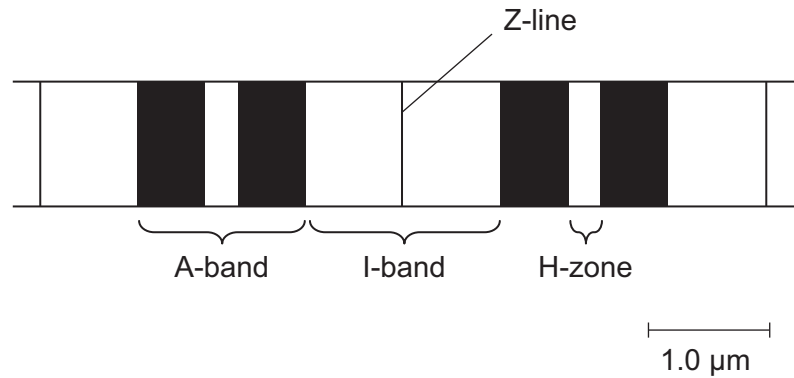
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- 4 The diagram shows part of a relaxed myofibril.



- 4 (a) When the myofibril contracts, which of the A-band, I-band and H-zone will
- 4 (a) (i) remain unchanged in length.....
- 4 (a) (ii) decrease in length?
(2 marks)
- 4 (b) The whole myofibril is 21 mm long when relaxed. Use information from the diagram, and the scale provided, to calculate the number of sarcomeres in the myofibril.
- Show your working.

Number of sarcomeres =
(2 marks)



- 4 (c)** Calcium ions are involved in myofibril contraction.
Describe how.

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(3 marks)

(Extra space)

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7

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5 Crop plants, such as maize and oil-seed rape, can be genetically modified to make them resistant to the herbicide glyphosate.

5 (a) It is useful to produce herbicide-resistant crop plants.
Explain why.

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(2 marks)

5 (b) There is concern that the use of herbicides, and herbicide-resistant crop plants, may lead to weeds becoming resistant to herbicides.

5 (b) (i) Herbicide resistance may spread from herbicide-resistant crop plants to weeds.
Suggest how.

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(1 mark)

5 (b) (ii) Sometimes weeds become resistant to herbicides when there are no herbicide-resistant crop plants present.
Suggest how.

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(1 mark)

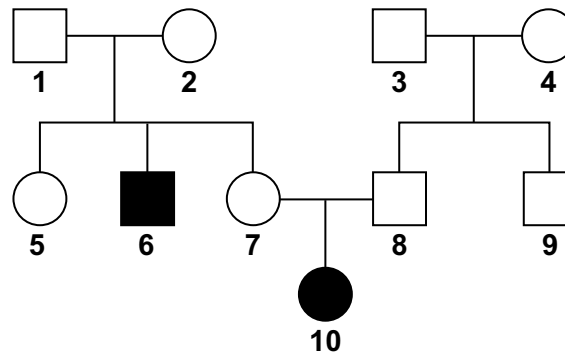
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6

The diagram shows the inheritance of cystic fibrosis in one family.



Key:  = Male with cystic fibrosis
 = Unaffected male
 = Female with cystic fibrosis
 = Unaffected female

6 (a)

Cystic fibrosis is caused by a recessive allele.
 Explain the evidence for this given in the diagram.

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(2 marks)



6 (b)Couple **7** and **8** decide to have another child.

What is the probability that this child will be a girl with cystic fibrosis?

Complete the genetic diagram to explain your answer.

Use the symbols **N** for the dominant allele and **n** for the recessive allele.

	7	8
<i>Parental phenotypes</i>	Unaffected	Unaffected
<i>Parental genotypes</i>		
<i>Genotypes of gametes</i>		
<i>Offspring genotypes</i>		
<i>Offspring phenotypes</i>		
<i>Probability of girl with cystic fibrosis</i>		

(4 marks)

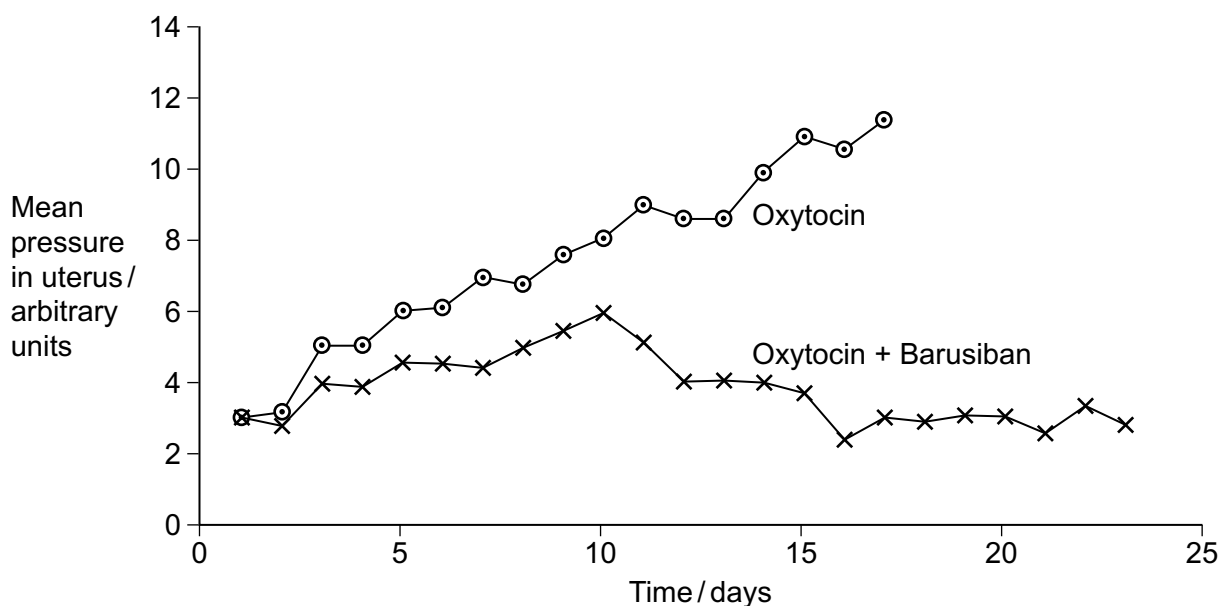
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- 7 When a pregnant woman goes into labour, the pressure in her uterus rises. If this happens too early in pregnancy, it is called 'pre-term labour'. Scientists think there is a link between the concentration of oxytocin in the blood of pregnant women and pre-term labour.

The drug *Barusiban* has been developed for treating pre-term labour. Scientists studied two groups of monkeys near the end of pregnancy. They gave daily injections of oxytocin to one group. They gave daily injections of oxytocin and Barusiban to the other group. They then measured the pressure developed in the uterus of each monkey.

The mean results for each group of monkeys are shown in the graph.



- 7 (a) The graph shows a gradual increase in pressure in the uterus in the oxytocin-treated monkeys. Explain how oxytocin treatment causes pressure increase in the uterus.

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(1 mark)



- 7 (b)** The scientists concluded that Barusiban might be used to prevent pre-term labour in humans. Evaluate this conclusion.

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(3 marks)

(Extra space)

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- 7 (c)** When a baby sucks on its mother's nipple, it causes her to release milk. Explain how.

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(3 marks)

(Extra space)

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7

Turn over ►



8 In women, oestrogen production decreases at the menopause.

8 (a) Give **two** effects of this decrease in oestrogen production.

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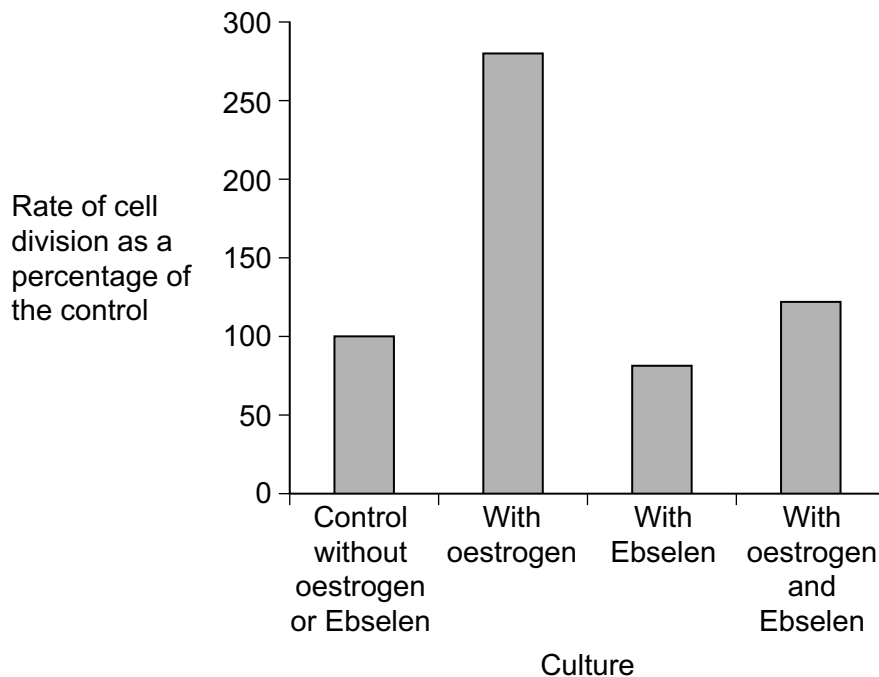
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(2 marks)

8 (b) Women in the menopause may take oestrogen in tablet form as part of hormone-replacement therapy (HRT). There is some evidence that oestrogen may increase the risk of breast cancer.

Pre-cancerous cells divide and behave normally but can become cancer cells under certain conditions. Doctors took samples of pre-cancerous cells from breast tissue and grew them in tissue culture. The doctors investigated the effects of oestrogen and of a drug called Ebselen on the rate of cell division of these pre-cancerous cells.

The graph shows their results.



- 8 (b) (i)** Do these data support the idea that oestrogen increases the risk of breast cancer?
Give reasons for your answer.

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(2 marks)

- 8 (b) (ii)** Ebselen is used to treat some women who have breast cancer.
Use information from the graph to explain why.

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(1 mark)

- 8 (b) (iii)** Most women who receive HRT do not develop breast cancer.
Suggest why.

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(2 marks)

- 8 (c)** Peroxides are chemicals that can cause changes in DNA. Ebselen reacts with peroxides and breaks them down.

Use this information, and information from the graph, to suggest how oestrogen may increase the risk of breast cancer.

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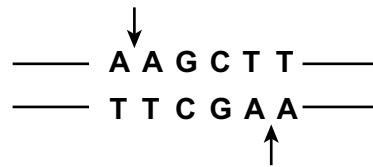
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(2 marks)



- 9 *Hind*III is an enzyme that cuts DNA into smaller fragments. The enzyme cuts DNA at the specific base sequence shown in **Figure 1**.

Figure 1



↑ and ↓ = positions where DNA is cut

- 9 (a) What general name is given to enzymes such as *Hind*III?

(1 mark)

- 9 (b) *Hind*III produces DNA fragments with sticky ends.

- 9 (b) (i) Use information from **Figure 1** to give the base sequence of one of these sticky ends.

(1 mark)

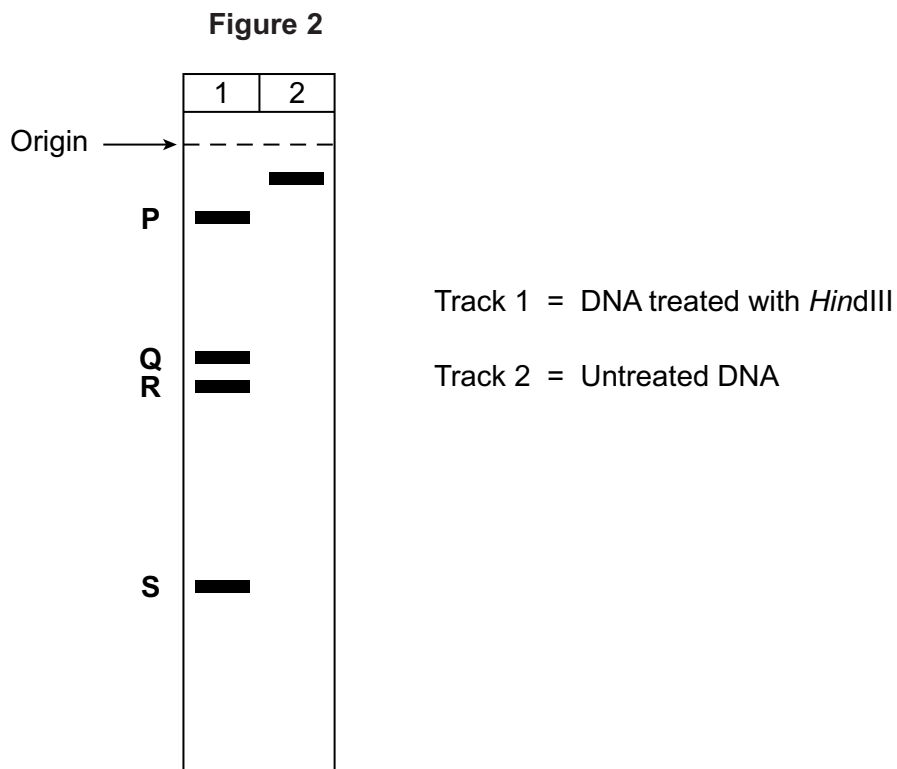
- 9 (b) (ii) Sticky ends are useful in genetic engineering. Explain how.

(2 marks)

- 9 (c) Scientists prepared a sample containing many identical molecules of DNA. The DNA molecules were linear (non-circular).

They divided the sample into two portions. They treated one portion with *Hind*III but did not treat the other portion. They then carried out gel electrophoresis on each portion.

The results are shown in **Figure 2**.



- 9 (c) (i)** The lengths of the fragments produced from the DNA treated with *Hind*III were 287, 1232, 1550 and 4943 base pairs.
How many base pairs are there in fragment **P**?

P = base pairs (1 mark)

- 9 (c) (ii)** How many times did the base sequence, **AAGCTT** occur in the DNA?
TTCGAA

..... (1 mark)

- 9 (c) (iii)** In a certain genetic condition, **one** of these **AAGCTT** sequences is changed.
TTCGAA

Predict what effect this would have on the appearance of the gel in Track **1** of **Figure 2**.

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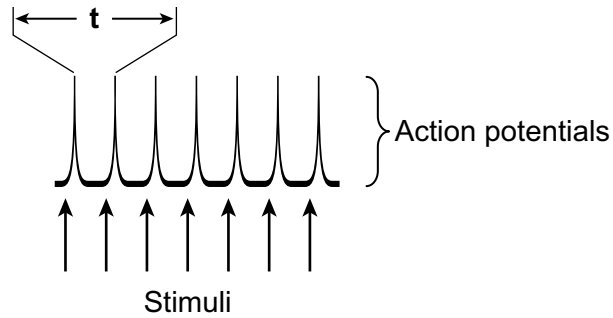
(2 marks)



- 10 Scientists investigated the effect of different frequencies of stimulation on the production of action potentials by a neurone.

- 10 (a) **Figure 3** shows a recording of the action potentials produced when the frequency of stimulation was 160 per second. At this frequency, each stimulus produced one action potential.

Figure 3



The time needed to complete one action potential is **t**, as shown in **Figure 3**. Calculate the value of **t**. Give your answer in milliseconds.

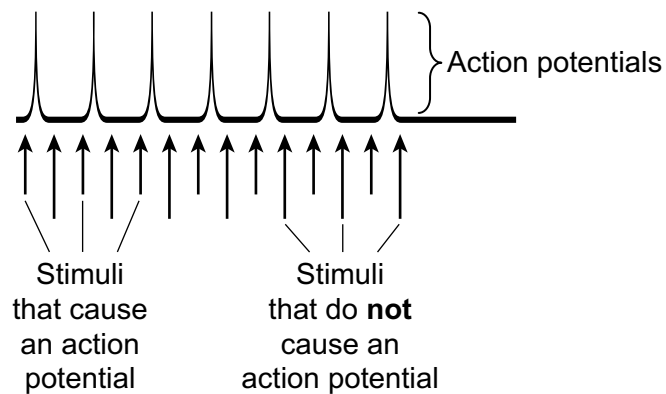
Show your working.

t = milliseconds
(2 marks)



10 (b) **Figure 4** shows the results when the frequency of stimulation was 200 per second.

Figure 4



Not every stimulus in **Figure 4** produced an action potential.
Explain why.

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(3 marks)

(Extra space)

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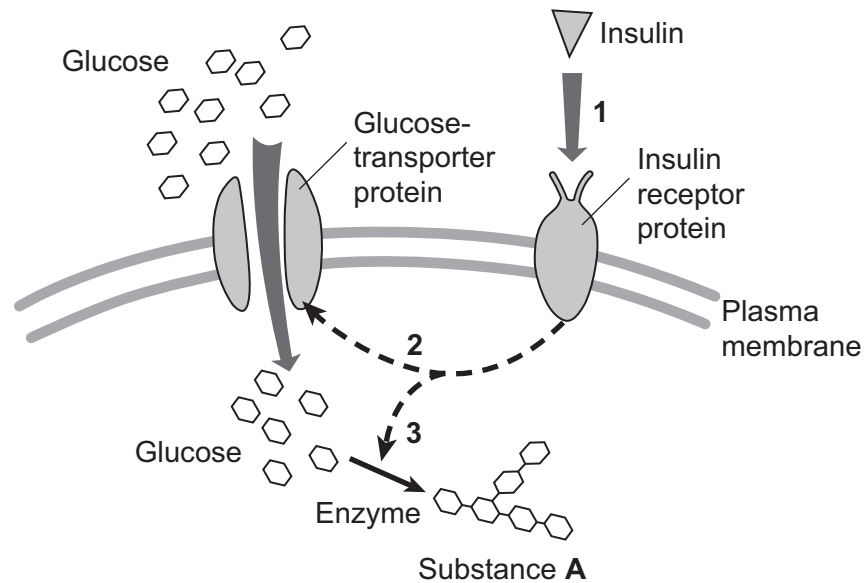
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11 (a) **Figure 5** shows how insulin affects a target cell.

Figure 5



Insulin binds to a receptor protein in the plasma membrane (step 1). This causes more glucose-transporter proteins to be placed in the plasma membrane (step 2). It also leads to activation of an enzyme that converts glucose into substance A (step 3).

11 (a) (i) The insulin receptor protein binds to insulin molecules but not to the molecules of any other substance. Explain why.

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(2 marks)

11 (a) (ii) Name substance A.

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(1 mark)

Question 11 continues on the next page

Turn over ►



- 11 (a) (iii)** Glucose enters a cell through glucose-transporter proteins. Explain why glucose can only enter a cell in this way.

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(3 marks)

(Extra space)

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- 11 (b)** Adiponectin is a hormone. Scientists measured the concentrations of glucose, insulin and adiponectin in the blood of patients with type 2 diabetes and in a control group of non-diabetics. The results are shown in **Figure 6**.

Figure 6

	Mean value ($\pm$ standard deviation)	
	Type 2 diabetics	Non-diabetics
Glucose / mg per 100 cm ³	195.68 ($\pm$ 67.63)	80.85 ($\pm$ 9.53)
Insulin / mUnits per dm ³	25.39 ($\pm$ 3.51)	15.03 ($\pm$ 1.46)
Adiponectin / μ g per cm ³	5.97 ($\pm$ 1.44)	8.39 ($\pm$ 1.2)

- 11 (b) (i)** The two groups of patients were matched for a number of factors, such as age. Give **two** other factors for which they should have been matched.

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(2 marks)



- 11 (b) (ii)** What do these data show about the difference between type 2 diabetics and non-diabetics?

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(2 marks)

- 11 (b) (iii)** Why is it better in investigations like these to use mean and standard deviation values of the results rather than to use the range?

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(2 marks)

- 11 (c)** The scientists performed a statistical test to compare the mean value of blood insulin concentration for the diabetic group with the mean for the control group.

- 11 (c) (i)** Give a suitable null hypothesis.

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(1 mark)

- 11 (c) (ii)** The statistical test gave a probability value of less than 0.01.
What does this suggest about the difference in the mean blood insulin concentration between the two groups?

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(1 mark)

Question 11 continues on the next page

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Other scientists investigated how the adiponectin concentration in the blood varied with obesity and with blood insulin concentration. The scientists used the waist circumference as a measure of obesity. The results are shown in **Figure 7** and **Figure 8**.

Figure 7

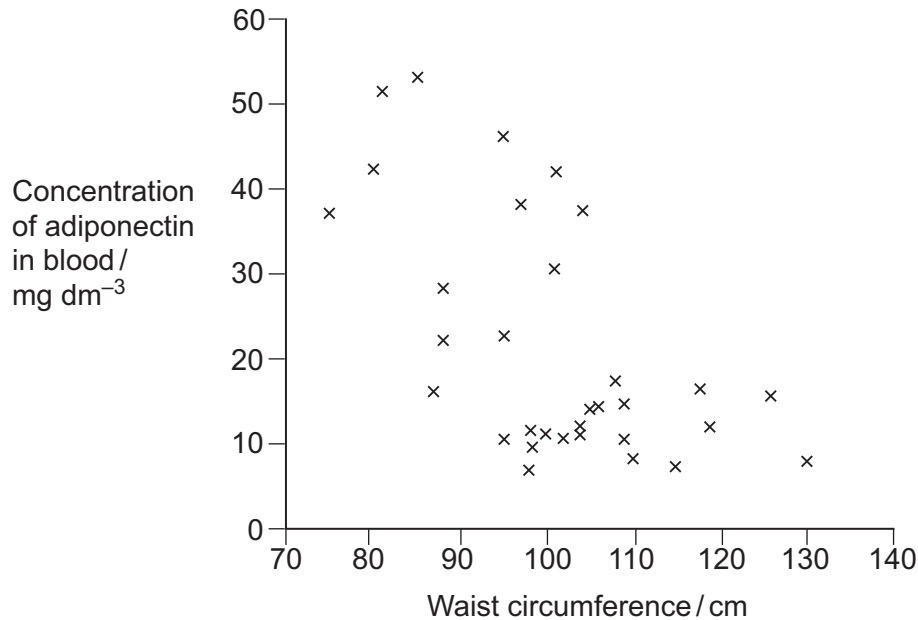
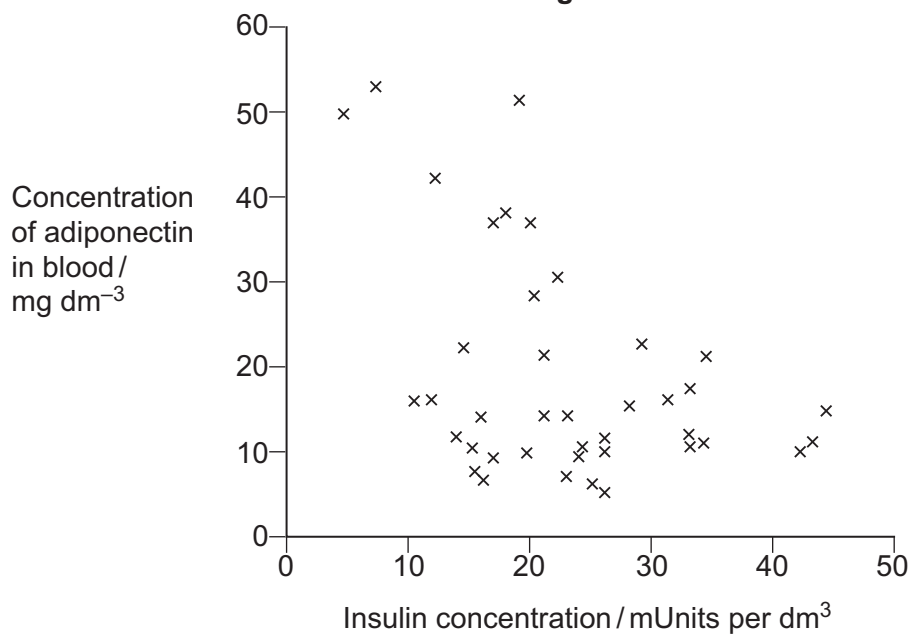


Figure 8



- 11 (d)** Analysis of the data showed a negative correlation in **Figure 7** and in **Figure 8**. What is a *negative correlation*?

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(1 mark)



- 11 (e)** Type 2 diabetes is more common in obese people. The scientists put forward the hypothesis that adiponectin is involved in protecting the body against type 2 diabetes.

Do the data in **Figures 6, 7 and 8** support this hypothesis?
Give reasons for your answer.

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(3 marks)

(Extra space)

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- 11 (f)** Scientists have found that fewer molecules of glucose-transporter protein are made in cells when there is a low concentration of adiponectin in the blood.

Blood glucose and blood insulin concentrations are higher in type 2 diabetics.
Use information given in earlier sections of this question and your own knowledge to explain why.

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(3 marks)

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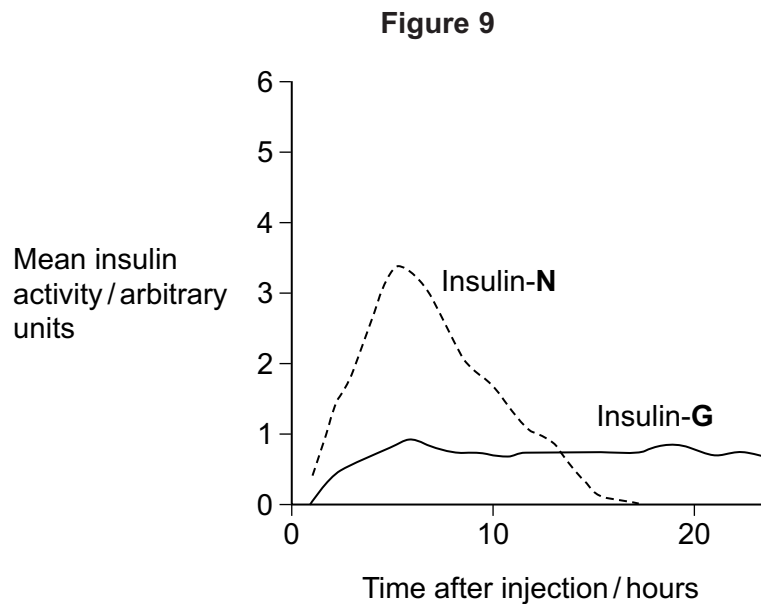


11 (g) Type 1 diabetics inject insulin.

Different forms of modified human insulin are available for diabetics to use.

Scientists investigated the activity in the blood of two modified forms of human insulin, **N** and **G**. One group of diabetics injected themselves with insulin-**N**. The second group injected themselves with insulin-**G**. The scientists then measured the activity of the insulin in blood samples taken from each group at hourly intervals over the next 24 hours.

Their results are shown in **Figure 9**.



11 (g) Suggest how each of these two types of insulin might be used to manage a patient's diabetes.

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(4 marks)

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25

END OF QUESTIONS



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