

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Level Examination
June 2013

Human Biology

HBIO4

Unit 4 Bodies and cells in and out of control

Tuesday 11 June 2013 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 are expected to use a calculator where appropriate.
- 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	
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9	
10	
TOTAL	



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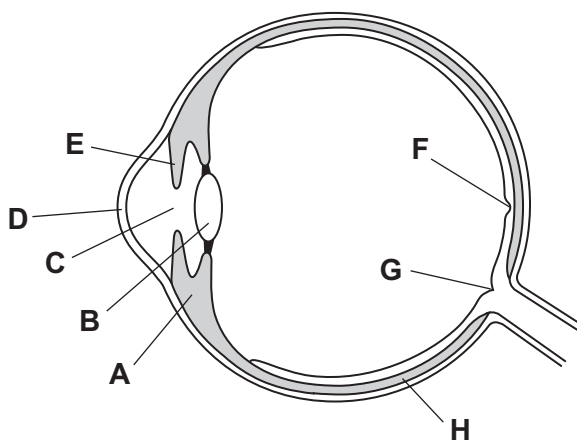
WMP/Jun13/HBIO4

HBIO4

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

1 **Figure 1** shows a section through the eye.

Figure 1



1 (a) Give the **letter** of the part of the eye which:

1 (a) (i) contains cone cells but **not** rod cells

(1 mark)

1 (a) (ii) contracts when focusing on a close object

(1 mark)

1 (a) (iii) causes most refraction (bending) of light rays.

(1 mark)

1 (b) (i) Explain why an image that falls on part **G** cannot be seen.

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(1 mark)

1 (b) (ii) Part **H** contains a black pigment.

Suggest how this helps a person to see clearly.

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(1 mark)



2 Regulation of the body's internal environment is co-ordinated by both the nervous and hormonal systems.

2 (a) Complete **Table 1** to show whether each effect is controlled by the sympathetic or the parasympathetic nervous system.

Put a tick (✓) in the correct box.

The first row has been completed for you as an example.

Table 1

Effect	Sympathetic	Parasympathetic
Constriction of bronchi and bronchioles		✓
Release of adrenaline from the adrenal gland		
Increased heart rate		
Dilation of arterioles leading to the skin		
Constriction of arterioles leading to the small intestine		

(2 marks)

2 (b) A steroid hormone takes longer than the nervous system to produce an effect.

Give **two** reasons why.

- 1
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- 2
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(2 marks)

4

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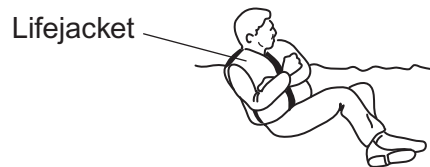
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3 An outdoor survival guide book contained the following instructions on how to avoid hypothermia.

- In the mountains, always carry spare dry clothes to change into in case the clothes you are wearing get wet.
- In a boat, always wear a lifejacket – this helps you to float if you fall in.
- If you fall from a boat into cold water, adopt the position shown in **Figure 2**.

Figure 2



(H.E.L.P. Heat
Escape Lessening
Posture)

- Do not swim, but wait to be rescued.

Explain how each of the following instructions helps the body to reduce heat loss and prolongs survival.

3 (a) Change out of wet clothes into dry clothes when in the mountains.

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(2 marks)



3 (b) Adopt the 'H.E.L.P.' position, as shown in **Figure 2**, and do not swim.

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(Extra space) (3 marks)

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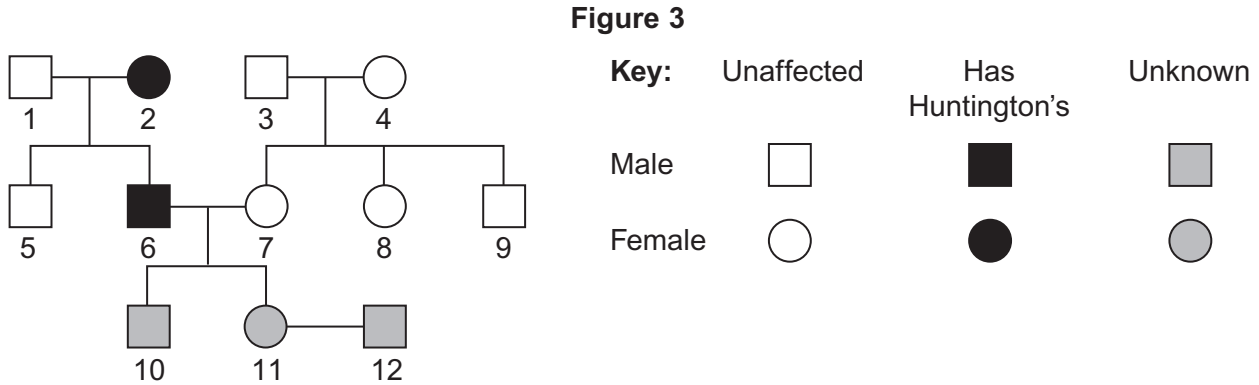
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- 4 (a)** Huntington's disease is caused by a dominant allele of a gene that is **not** sex-linked. People who have the dominant allele do not usually show any symptoms of Huntington's disease until they are at least 30 years of age.

Figure 3 shows the inheritance of Huntington's disease in one family.



Persons **2** and **6** developed symptoms of Huntington's disease after they had had their children.

Complete the genetic diagram below to find the probability that person **11** will have Huntington's disease.

Use the following symbols:

H = dominant allele

h = recessive allele

	6	7
<i>Parental phenotypes</i>	Affected	Unaffected
<i>Parental genotypes</i>		
<i>Gametes</i>		
<i>Offspring genotypes</i>		
<i>Offspring phenotypes</i>		
Probability that person 11 will have Huntington's disease =		

(4 marks)



- 4 (b)** In another family, with no history of Huntington's disease, a man developed Huntington's disease.

Suggest **two** possible explanations for this.

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(2 marks)

- 4 (c)** The Huntington's allele has a harmful effect on those people who have it in their genotype.

This allele has not been lost from the population by natural selection.

Explain why.

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(2 marks)

8

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- 5 **Figure 4** shows how biologists cut transverse and longitudinal sections through a myofibril.

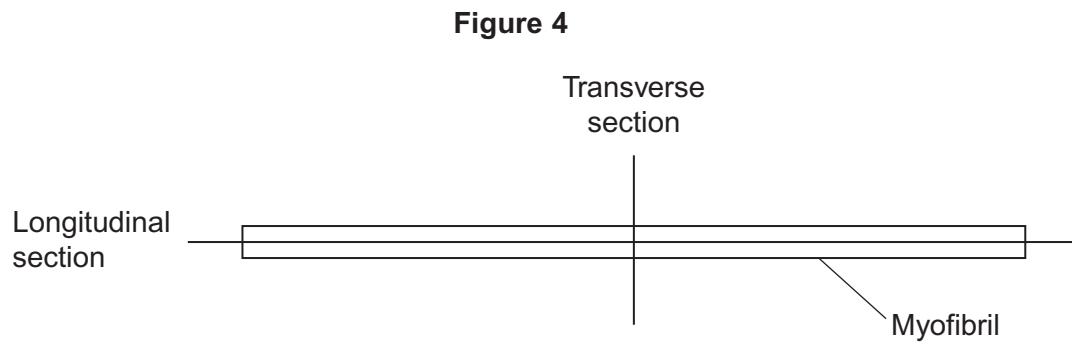
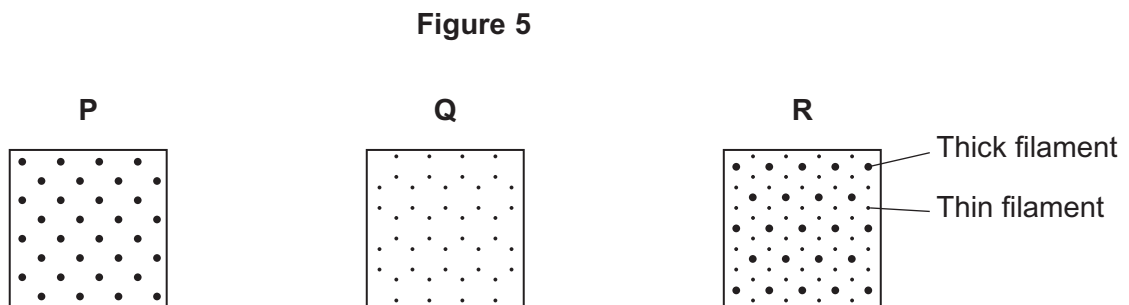


Figure 5 shows transverse sections through three different regions of one sarcomere in a relaxed myofibril of a skeletal muscle.



- 5 (a) In the space below, make a simple drawing of a longitudinal section through **one** sarcomere. Show how the thick and thin filaments are arranged.

Label your drawing clearly to show where each of sections **P**, **Q** and **R** was cut.

(4 marks)



- 5 (b)** When the myofibril is fully contracted, one of the regions, **P**, **Q** or **R**, disappears.

Which region disappears?

Explain what happens to the thick and thin filaments to cause this region to disappear.

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(2 marks)

- 5 (c)** Describe the part played by calcium ions in the contraction of skeletal muscle.

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(4 marks)

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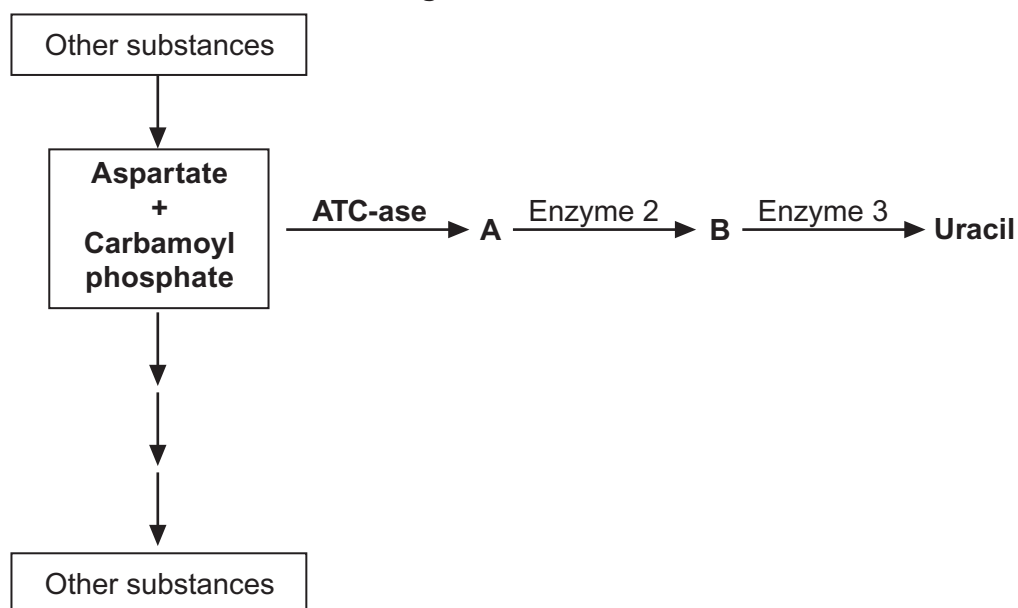
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6 Uracil is a base found in RNA.

Figure 6 shows a metabolic pathway that produces uracil.

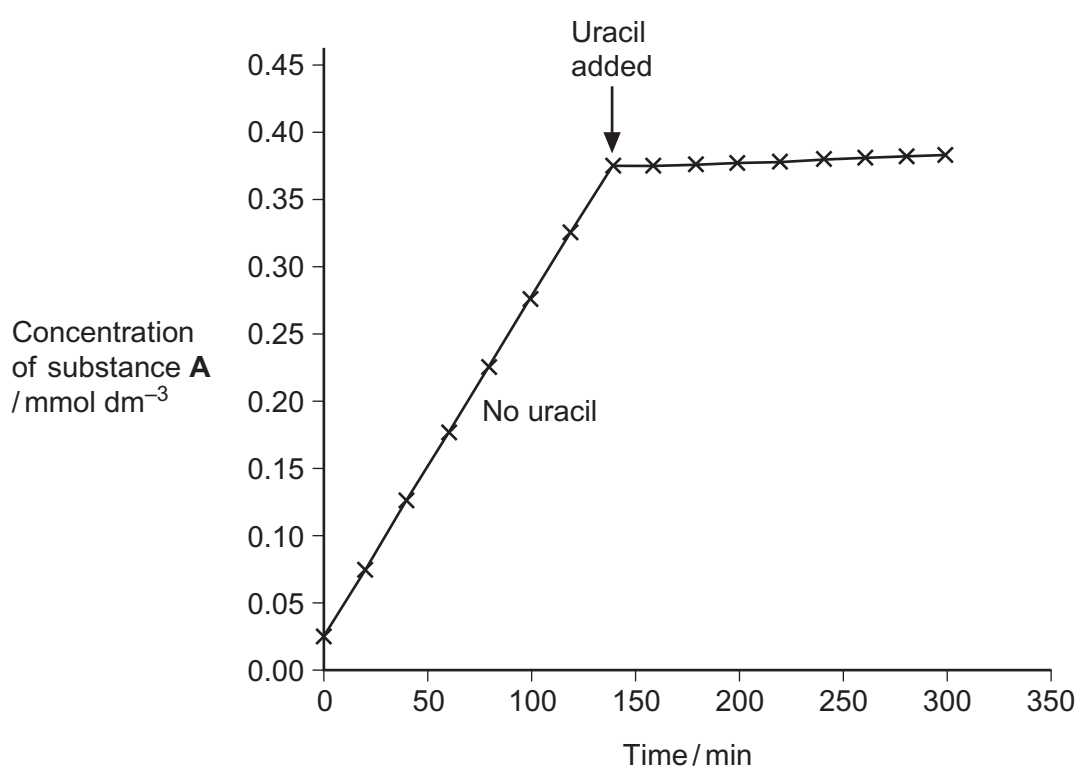
Figure 6



Scientists investigated the effect of uracil on the activity of the enzyme **ATC-ase** in a bacterium. The scientists used a mutant bacterium that was unable to make **Enzyme 2**. They measured the concentration of substance **A** that was produced in the absence of uracil and then when uracil was added.

Figure 7 shows the scientists' results.

Figure 7



- 6 (a) (i)** Uracil acts as an inhibitor of the enzyme ATC-ase.
What evidence is there for this in **Figure 7**?

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(2 marks)

- 6 (a) (ii)** In their investigation, the scientists used a mutant bacterium that was unable to make **Enzyme 2**.
Why was it important to use this mutant bacterium in the investigation?

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(2 marks)

- 6 (b)** The structure of a molecule of uracil is very different from the structure of either carbamoyl phosphate or aspartate.

- 6 (b) (i)** Uracil can act as an inhibitor of the enzyme ATC-ase.

Explain how.

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(2 marks)

Question 6 continues on the next page

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6 (b) (ii) It is useful in the metabolism of non-mutant bacteria that uracil inhibits ATC-ase.

Suggest why.

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(2 marks)

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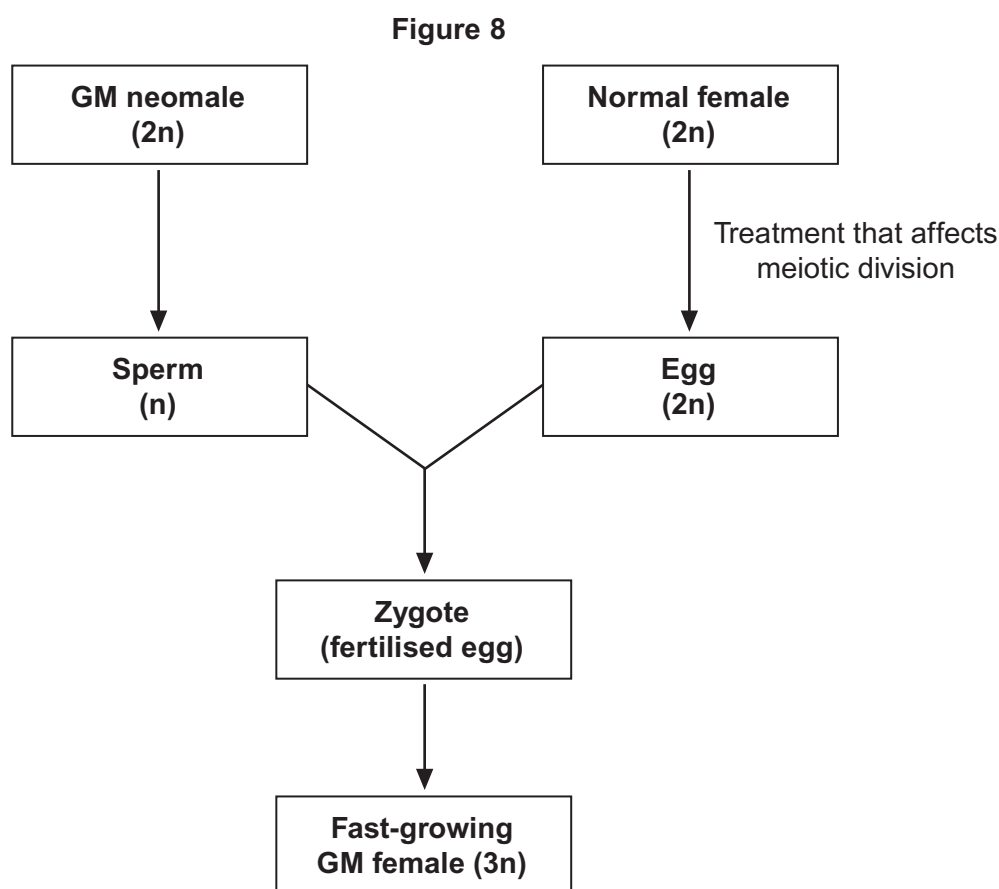


- 7 Scientists have produced a fast-growing, genetically-modified (GM) variety of the Atlantic salmon (a type of fish). These GM fish contain an extra gene for the production of growth hormone.

All the GM fish grown for market are triploid females (females with 3 copies of each chromosome).

Production of these triploid ($3n$) females involves crossing normal diploid ($2n$) females with diploid ($2n$) GM 'neomales'. These neomales are diploid GM females that have been treated with testosterone during development. As a result, they develop male reproductive organs and produce sperm.

Figure 8 shows how a GM triploid female fish is produced.



- 7 (a) The conversion of a female fish into a neomale by testosterone is an example of epigenetic control.

Suggest **one** type of change that testosterone could have caused in the fish's genetic material.

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(1 mark)



- 7 (b)** Sex determination in the Atlantic salmon involves X and Y chromosomes in the same way as in humans.

How many copies of the X chromosome will there be in

- 7 (b) (i)** the sperm

(1 mark)

- 7 (b) (ii)** the zygote?

(1 mark)

- 7 (c)** The triploid GM female fish is infertile.

- 7 (c) (i)** Use your knowledge of the process of meiosis to explain why a triploid fish is infertile.

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(1 mark)

- 7 (c) (ii)** The fast-growing GM female fish are grown in netted areas in the sea. It is important that all the GM female fish produced are infertile.

Suggest why.

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(2 marks)

6

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- 8 (a)** The neurotransmitter released at an excitatory synapse can cause an action potential across the postsynaptic membrane.

Explain how.

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(3 marks)

(Extra space)

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- 8 (b)** Some synapses are inhibitory. In these synapses, the neurotransmitter released reduces the chance of an action potential being produced across the postsynaptic membrane.

Figure 9 shows what happens at an inhibitory synapse.

This synapse uses gamma-amino butyric acid (GABA) as its neurotransmitter.

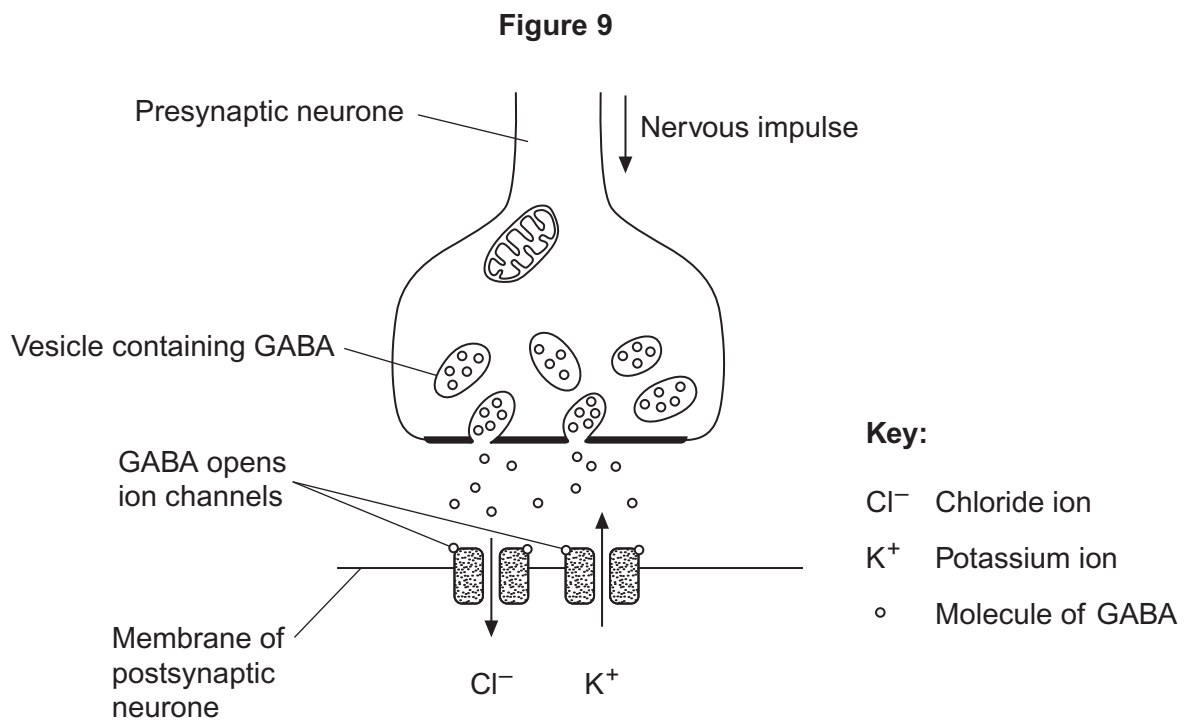
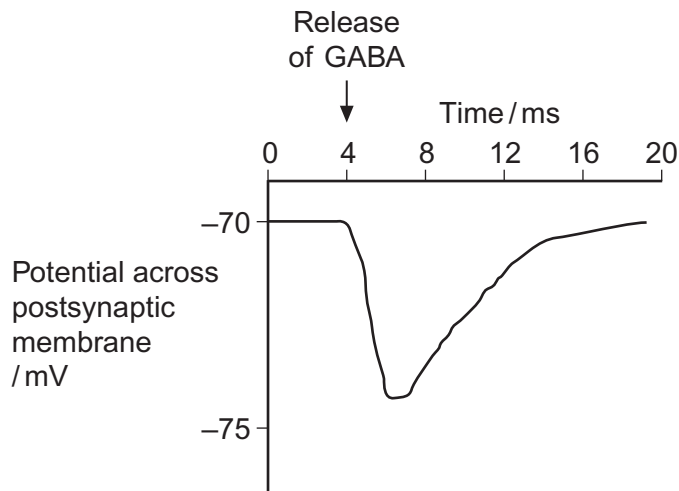


Figure 10 shows the effect of GABA on the potential across the postsynaptic membrane.

Figure 10



- 8 (b) (i)** Use information from **Figure 9** to explain the change in membrane potential shown in **Figure 10**.

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(3 marks)

(Extra space)

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Question 8 continues on the next page

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- 8 (b) (ii)** GABA reduces the chance of an action potential being produced across the postsynaptic membrane.

Explain how.

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(3 marks)

(Extra space)

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- 8 (c)** There are advantages to having both excitatory and inhibitory neurones forming synapses with the same postsynaptic neurone.

Suggest **one** advantage.

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(1 mark)

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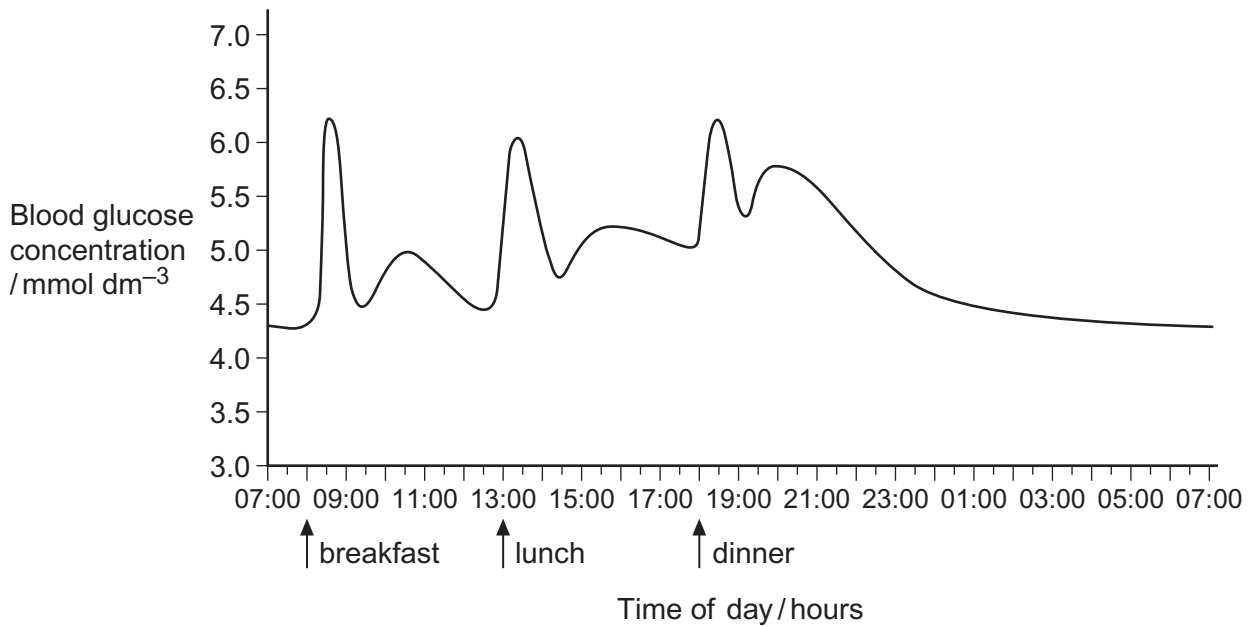
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- 9 (a) **Figure 11** shows how the blood glucose concentration of a healthy, non-diabetic person varied over 24 hours.

Figure 11



The person ate three carbohydrate-rich meals at the times shown in **Figure 11**.

- 9 (a) (i) Write the letter **X** on **Figure 11** to show **one** time when the insulin concentration in the blood would be highest.

(1 mark)

- 9 (a) (ii) Explain why you chose this time.

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(1 mark)

- 9 (a) (iii) **Figure 11** shows blood glucose concentration in a healthy, non-diabetic person. Describe **two** ways in which a similar graph, drawn for a diabetic person, would differ from this.

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(2 marks)



- 9 (b)** A man had a total of 20 grams of glucose dissolved in his blood and body fluids. The man's rate of energy use at rest was 480 kilojoules per hour. The breakdown of one gram of glucose releases 16 kilojoules of energy.

- 9 (b) (i)** How long would the 20 grams of glucose in the man's blood and body fluids last at rest?

Assume that all of the man's energy was supplied by the breakdown of glucose.

Give your answer in minutes.

Show your working.

Time = minutes
(2 marks)

- 9 (b) (ii)** The time between one meal and the next is greater than the time you calculated in part (b)(i).

Extra glucose can be made available during this time to supply the body's energy needs.

Explain how.

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(Extra space) (3 marks)

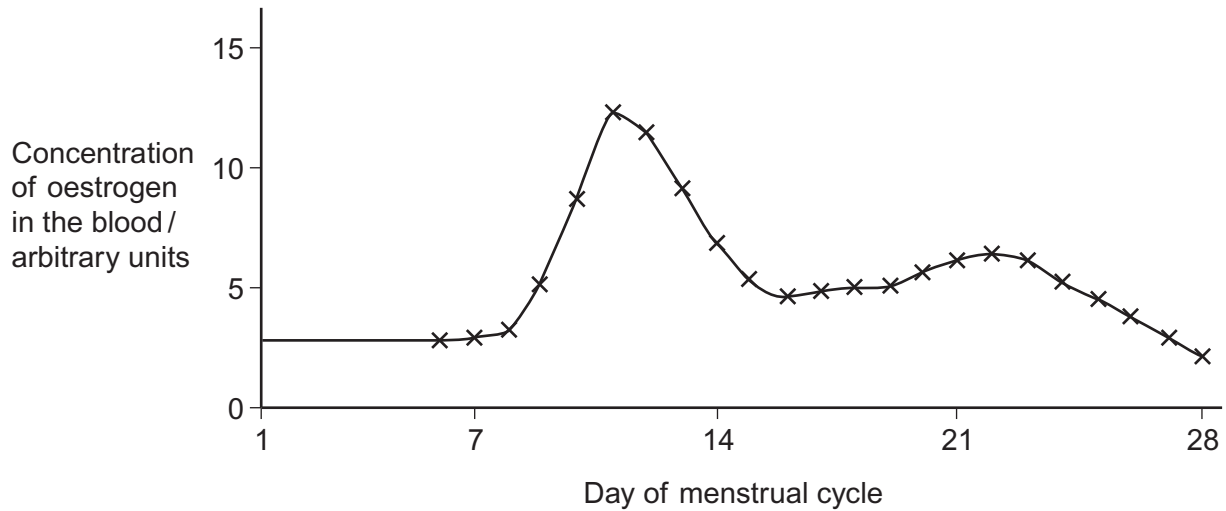
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- 10** **Figure 12** shows how the concentration of oestrogen in the blood changes during a typical menstrual cycle.

Figure 12



- 10 (a) (i)** What causes the change in oestrogen concentration between days 7 and 11?

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(3 marks)

(Extra space)

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10 (a) (ii) Describe the roles of oestrogen in the menstrual cycle.

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(4 marks)

(Extra space)

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10 (b) (i) Contraceptive pills usually contain two hormones.
Oestrogen is one of those hormones.

Name the other hormone
(1 mark)

10 (b) (ii) How does the use of this type of contraceptive pill prevent a woman becoming pregnant?

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(2 marks)

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Osteoporosis is a condition in which calcium is lost from the bones. This makes the bones more likely to fracture.

Osteoporosis is common in post-menopausal women and is caused by the decrease in oestrogen production that occurs at the menopause. Doctors often prescribe hormone replacement therapy (HRT) for these women. This therapy includes the use of oestrogen.

Long-term use of oestrogen in HRT can increase the risk of breast cancer for some women.

- 10 (c) (i)** Other than osteoporosis, give **two** effects of decreased oestrogen production at the menopause.

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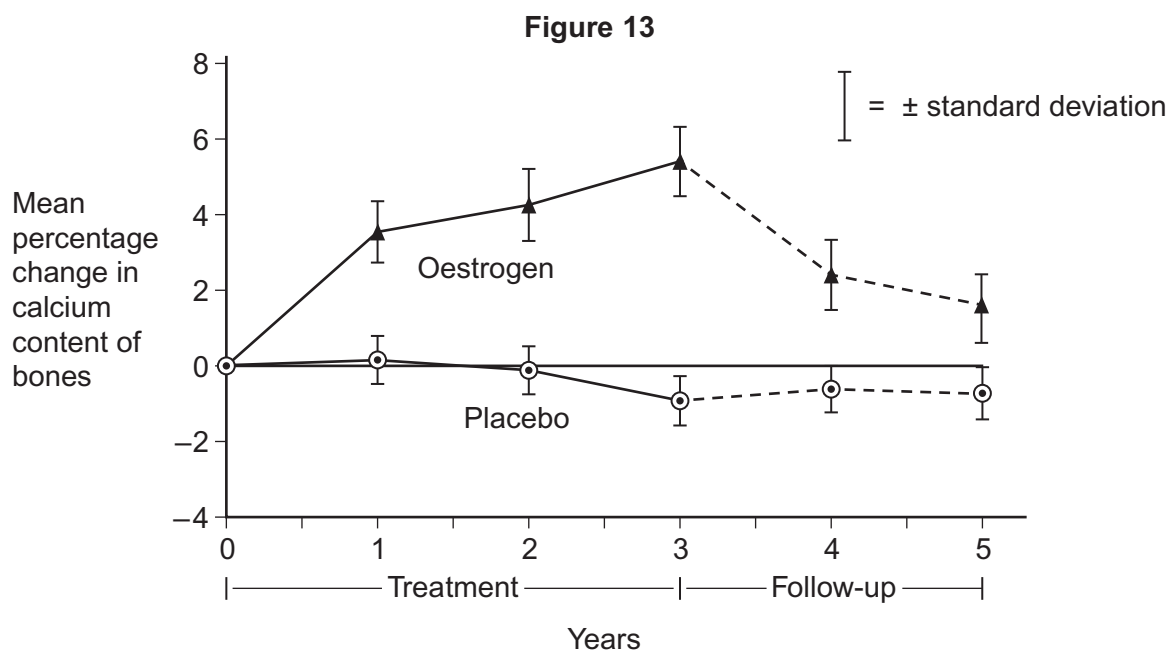
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(2 marks)

- 10 (c) (ii)** Scientists investigated the effect of oestrogen on the calcium content of the bones. They recruited a large number of post-menopausal women. Each day, half of the women took a pill containing a small amount of oestrogen. The other half took a placebo pill. At the end of three years, the treatment was stopped. The scientists continued to monitor the change in calcium content of the women's bones for a further two years.

Figure 13 shows the results.



What do the data in **Figure 13** show about the use of oestrogen replacement therapy to prevent osteoporosis in post-menopausal women?

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(4 marks)

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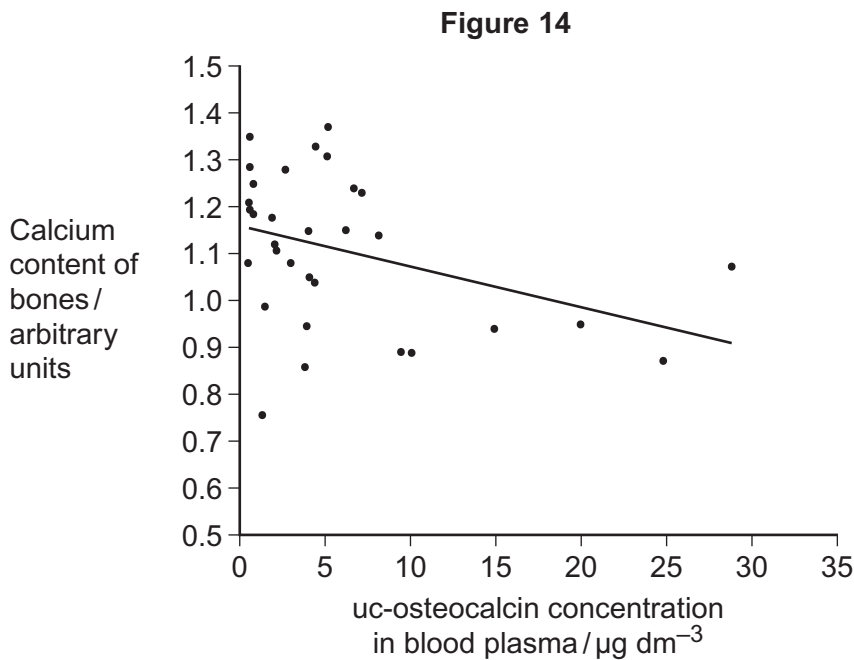


- 10 (d)** Oestrogen binds to an oestrogen receptor in cells to form an oestrogen-receptor complex. This complex activates specific genes. One of these genes controls production of a protein called osteocalcin in bone cells. Osteocalcin is found in two forms:

- c-osteocalcin that holds calcium ions in bones
- uc-osteocalcin that escapes from bone into blood plasma.

Scientists investigated the relationship between the concentration of uc-osteocalcin in blood plasma and the calcium content of the bones of 32 people.

Figure 14 shows the scientists' results.



- 10 (d) (i)** The scientists stated that their data had a correlation coefficient, $r = -0.375$. Tables of r -values showed that this had a probability value, $P < 0.05$.

What do these data suggest about the relationship between uc-osteocalcin concentration in blood plasma and the calcium content of the bones?

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(4 marks)



- 10 (d) (ii)** Raloxifene is a drug that can be used instead of oestrogen to treat some of the symptoms of the menopause.

The oestrogen-receptor complex can activate an oncogene called MYB.

Raloxifene can form a complex with the oestrogen receptor. This complex does **not** activate MYB but does activate the gene for osteocalcin.

Scientists investigated the effect of taking raloxifene tablets on the concentration of uc-osteocalcin in blood plasma. They compared these results to those for patients taking a placebo tablet. Their results are shown in the table.

Time / months	Mean percentage change in concentration of uc-osteocalcin	
	Raloxifene ($\pm$ standard deviation)	Placebo ($\pm$ standard deviation)
0	0	0
6	– 30 ($\pm$ 1.0)	– 10 ($\pm$ 1.5)
12	– 29 ($\pm$ 1.5)	– 6 ($\pm$ 1.0)
24	– 29 ($\pm$ 1.5)	– 8 ($\pm$ 2.0)
36	– 26 ($\pm$ 2.0)	– 8 ($\pm$ 0.5)

Suggest why raloxifene might be better than oestrogen as a treatment used by post-menopausal women.

Use information given on page 27, and in **Figures 13** and **14** in your answer.

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(5 marks)

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(Extra space)

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END OF QUESTIONS

