

Surname					Other Names				
Centre Number					Candidate Number				
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General Certificate of Education
Advanced Level Examination

HUMAN BIOLOGY**Bodies and Cells in and out of control****HBIO4**

Specimen Paper

In addition to this paper you will require

- a ruler with millimetre measurements.

You may use a calculator.

Time allowed: 2 hours

Instructions

- Use black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- If you need additional space, you should continue your answers at the end of this book, indicating clearly which question you are answering.

Information

- The maximum mark for this paper is 95.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in all answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		8	
2		9	
3		10	
4		11	
5			
6			
7			
Total (Column 1)			
Total (Column 2)			
Quality of Written Communication			
TOTAL			
Examiner's Initials			

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

1 In the polymerase chain reaction, explain the reason for each of the following,

(a) raising the temperature to 95°C

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(1 mark)

(b) cooling to 40°C

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(1 mark)

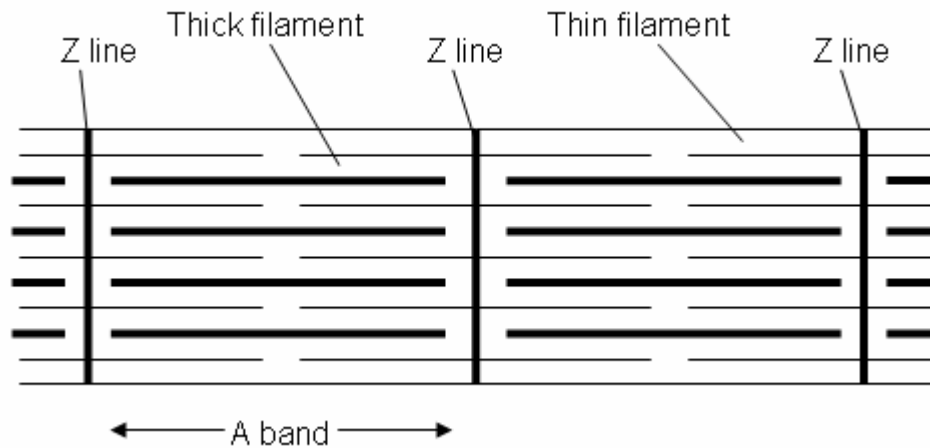
(c) the use of primers

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(1 mark)

(d) raising the temperature of the reaction mixture to 72°C for the replication phase.

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(2 marks)

2 The diagram shows two sarcomeres in a myofibril from a skeletal muscle.



(a) Describe **two** features, visible in the diagram, which show that the myofibril is contracted.

- 1.....
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2.....
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(2 marks)

(b) Explain the role of each of the following in muscle contraction

(i) calcium ions

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(2 marks)

(ii) ATP

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(2 marks)

3 A cross-sectional study into the growth of girls produced the following data.

Age / years	Mean body mass / kg
0	4
2	12
4	16
6	21
8	26
10	32
12	40
14	48
16	53
18	54
20	54

(a) (i) What is a cross-sectional study?

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 (1 mark)

(ii) By what percentage is the mean growth rate between ages 10 and 14 greater than the mean growth rate between ages 0 and 6? Show your working.

Answer.....%(2 marks)

(b) Explain the increase in growth rate between ages 10 and 14.

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 (2 marks)

- 4 (a) Mutations are the source of genetic variation. Explain why.

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(1 mark)

- (b) What is meant by each of the following

(i) continuous variation
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(1 mark)

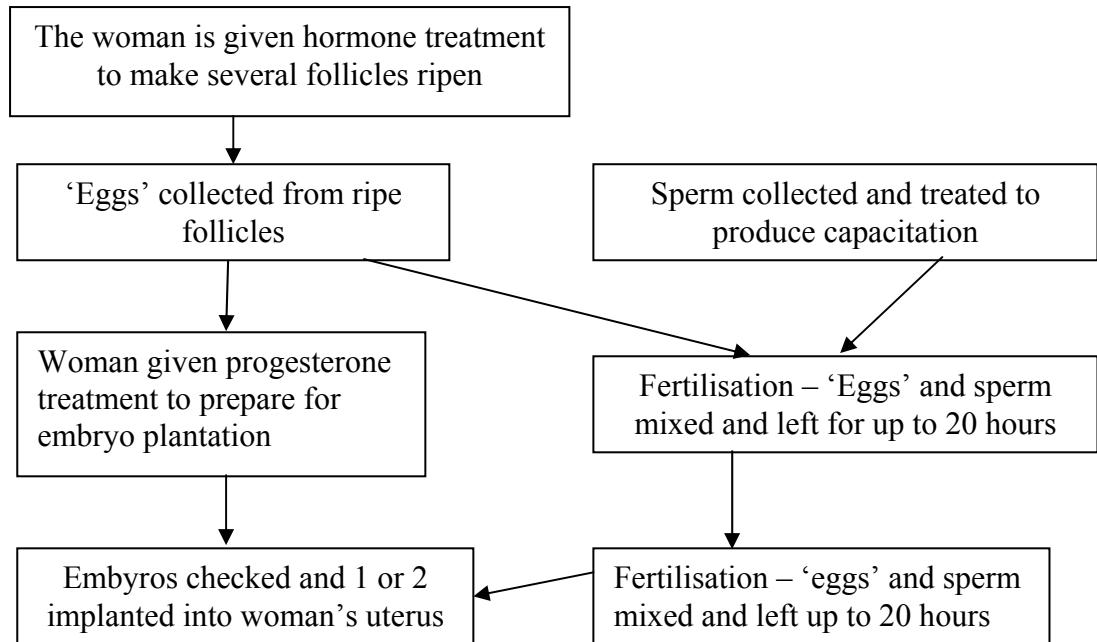
(ii) discontinuous variation.....
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(1 mark)

- (c) Scientists investigated the causes of schizophrenia, a type of mental illness. They looked at the development of schizophrenia in sets of identical and non-identical twins.

(i) Explain why the identical twins were studied.
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(1 mark)

(ii) Explain why the non-identical twins were studied.
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(1 mark)

- 5 (a) The flow chart shows the stages in IVF.



- (i) Name the hormone given to make follicles ripen.

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(1 mark)

- (ii) The flow chart shows 'eggs' collected from follicles. What is actually collected?

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(1 mark)

- (iii) What is capacitation?

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(1 mark)

- (iv) Give **one** reason for the treatment with progesterone.

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(1 mark)

- (b) Some IVF clinics in Britain now have success rates of up to 40 percent. This is a big improvement compared with several years ago. Part of the improvement is due to better control of temperature. When eggs and sperm are left for fertilisation to take place the dish is kept at a constant temperature.

If the dish is allowed to cool, the chance of obtaining embryos for implantation is reduced. Suggest **one** reason why.

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(2 marks)

6

Turn over for the next question

- 6 (a) Three alleles of one gene control the ABO blood group.

Allele	Antigen	Antibody produced
I ^A	A	
I ^B	B	
I ^O		

Complete the table.

(2 marks)

- (b) Some people, called *secretors*, release ABO antigens in their body fluids, including breast milk and fluids released into the gut. *Non-secretors* do not release these antigens. Secretion is controlled by two alleles of the same gene.

- (i) A mother and father who are both *secretors* have a child who is a *non-secretor*. Complete the genetic diagram to show the genotypes and phenotypes of the children this couple could produce.

<i>Parental phenotypes</i>	Secretor	Secretor
<i>Parental genotypes</i>
<i>Gametes</i>
<i>Offspring genotypes</i>	
<i>Offspring phenotypes</i>	

(3 marks)

- (ii) Noroviruses cause many cases of gastroenteritis in babies. The virus infects the baby by binding to ABO antigens on the surface of epithelial cells in the gut. Babies who are *secretors* are at risk from the virus. The breast milk of a *secretor* mother will give some protection to a baby who is a *secretor*. Suggest how.

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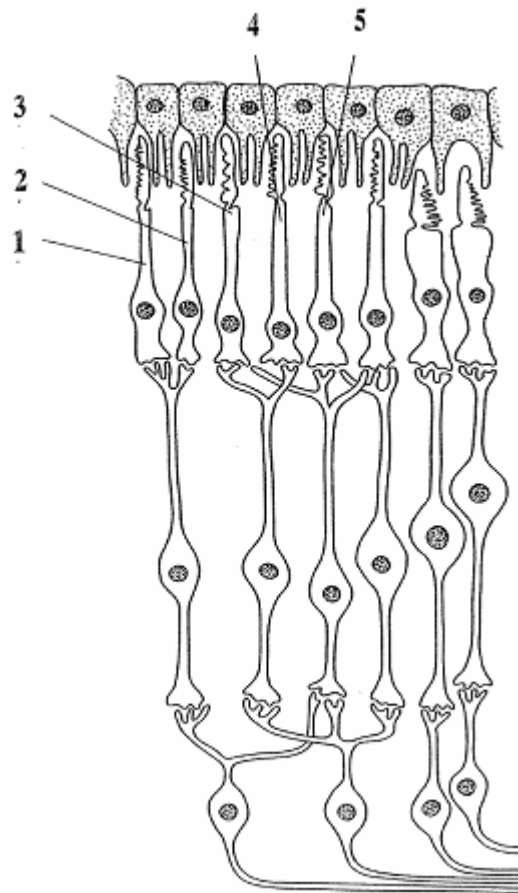
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(2 marks)

7 The diagram shows part of the retina in a human eye.



(a) Explain each of the following observations.

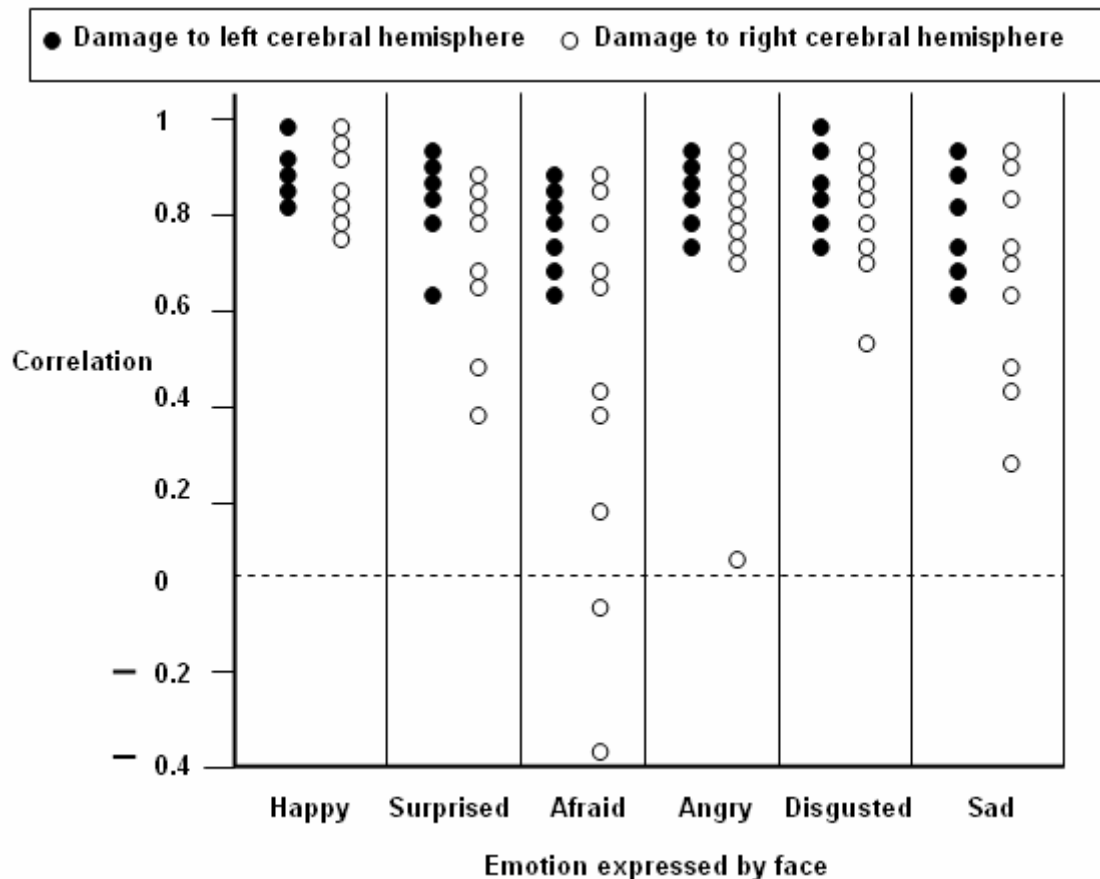
- (i) When light falls on cells **1** and **2**, only one spot of light is seen. But when light falls on cells **2** and **3**, two spots of lights are seen.

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.....
(1 mark)

- (ii) When one unit of light energy falls on cell **3**, no light is seen. But, when one unit of light energy falls on cell **4** and one unit falls on cell **5**, light is seen.

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(3 marks)

- (b) Scientists showed a series of pictures of different facial expressions to patients who had suffered a stroke and asked them to identify the emotion shown by each expression. The scientists recorded the number of correct identifications by each patient. In each case the stroke had damaged either the right or left cerebral hemisphere of the brain. None of the patients had any damage to their eyes or visual cortex. The chart shows the results. Each circle is the average result for one patient. A correlation of 1 means that the patient always correctly identified an expression.



- (i) The scientists concluded that the right cerebral hemisphere of the brain is involved in perception of facial expressions. Do the results support this conclusion? Explain your answer.

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(2 marks)

- (ii) Patients who often make mistakes in their perception of facial expressions find this a serious handicap. Suggest why.

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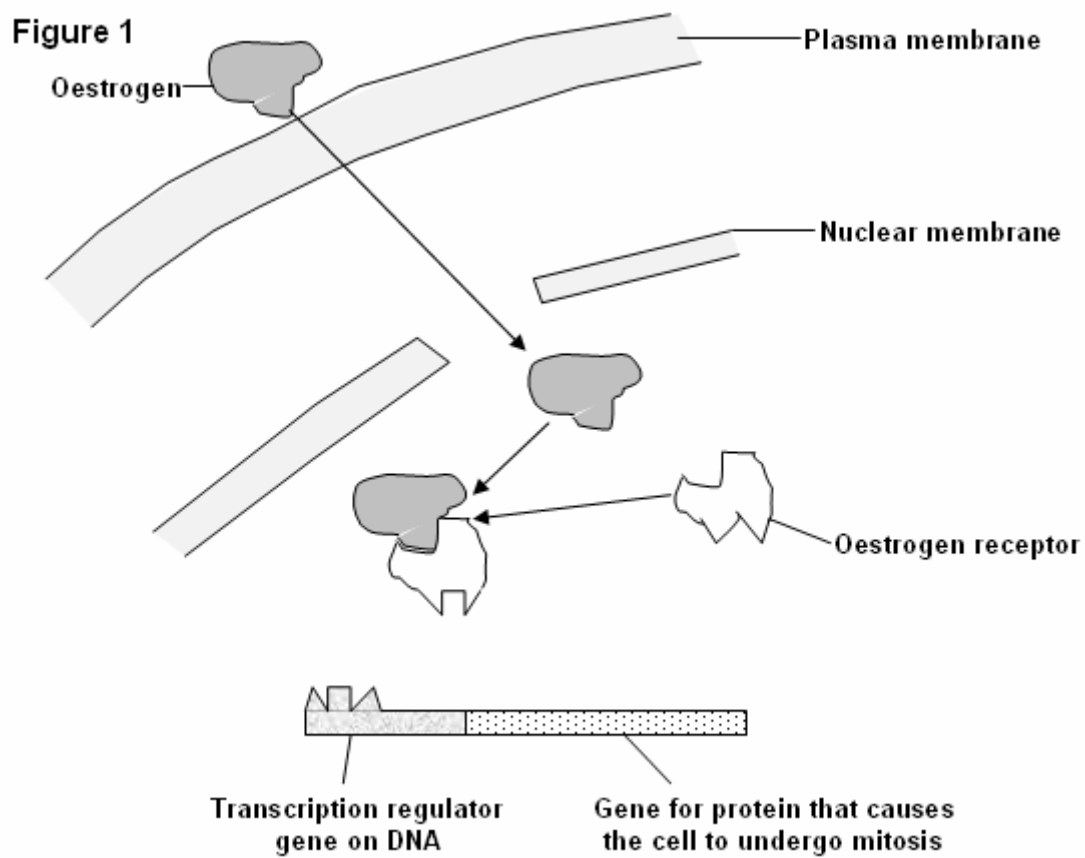
(2 marks)

8

Turn over for the next question

- 8 The growth of some breast cancers is increased by oestrogen. Oestrogen is a steroid hormone. Steroids are lipids.

Figure 1 shows part of a cancer cell.



- (a) Using all the information, explain how oestrogen affects this cancer cell.

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(4 marks)

- (b) **Figure 2** shows a molecule of oestrogen and a molecule of tamoxifen. Tamoxifen is used to treat breast cancer.

Figure 2



Oestrogen



Tamoxifen

- (i) Explain how tamoxifen reduces the effect of oestrogen on cancer cells.

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(2 marks)

- (ii) Tamoxifen can produce side-effects involving changes in the physiology of other cells in the body. Suggest how.

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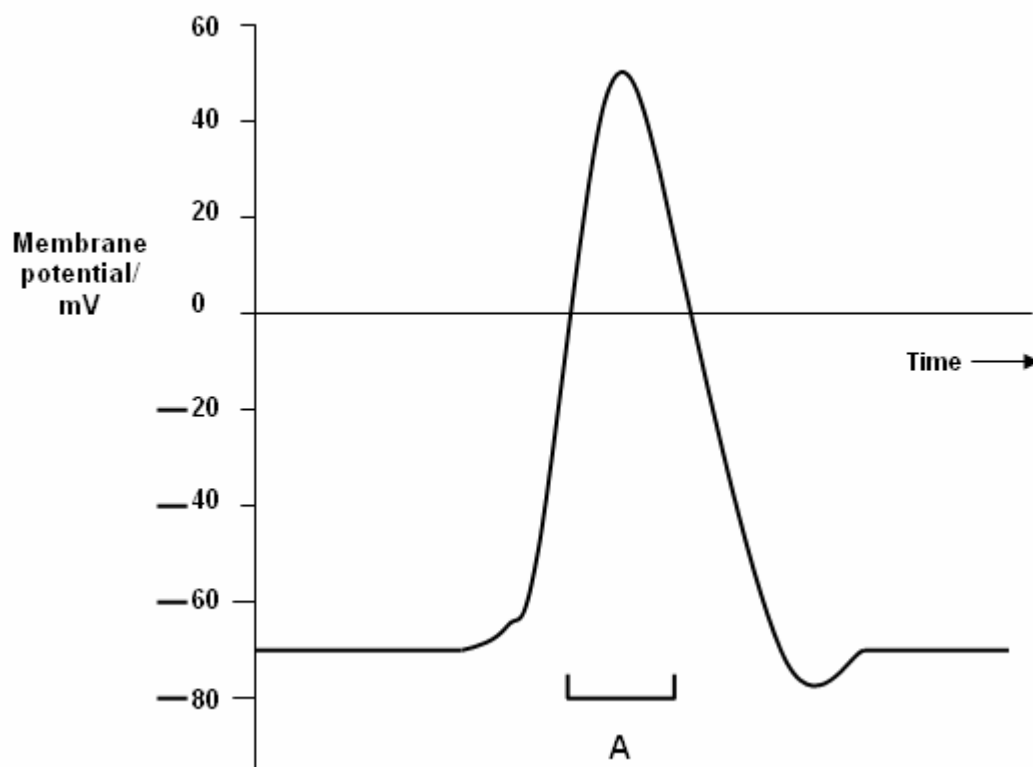
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(2 marks)

- 9 (a) **Figure 1** shows the changes in the membrane potential at one point of a neurone as a nerve impulse is transmitted.



- (i) Explain the changes that take place in the portion of the graph labelled A.

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(3 marks)

- (ii) Data on nerve impulses were initially obtained from experiments on live animals. Suggest advantages and disadvantages of using live animals.

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(2 marks)

- (b) The *reward centre* in the brain is responsible for pleasurable feelings. The synapses here use a neurotransmitter called dopamine that binds to receptors on the postsynaptic membrane. To remove the dopamine, it is transported back through the presynaptic membrane. Cocaine binds to the protein that transports dopamine. Using this information, explain what makes cocaine addicts seek repeated doses of the drug.

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(2 marks)

- (c) Patterns of brain activity can be analysed using MRI and PET scans. Give **two** advantages of PET scans compared to MRI scans.

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(2 marks)

- 10** Doctors investigated factors related to hypothermia in old people. They measured the temperature of patients over the age of 65 at the Accident and Emergency (A and E) Department of a hospital during October, November and December. This included patients with hypothermia.
The table shows information about the patients.

	Number of patients	Median age/years	Median core body temperature/°C
Patients with hypothermia	48	79	34.6
Patients without hypothermia	910	72	36.3

- (a) (i) Describe the results.

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(2 marks)

- (ii) The doctors defined hypothermia as a body temperature below 35°C. If hypothermia is not treated, the body temperature will usually continue to fall. Explain why.

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(2 marks)

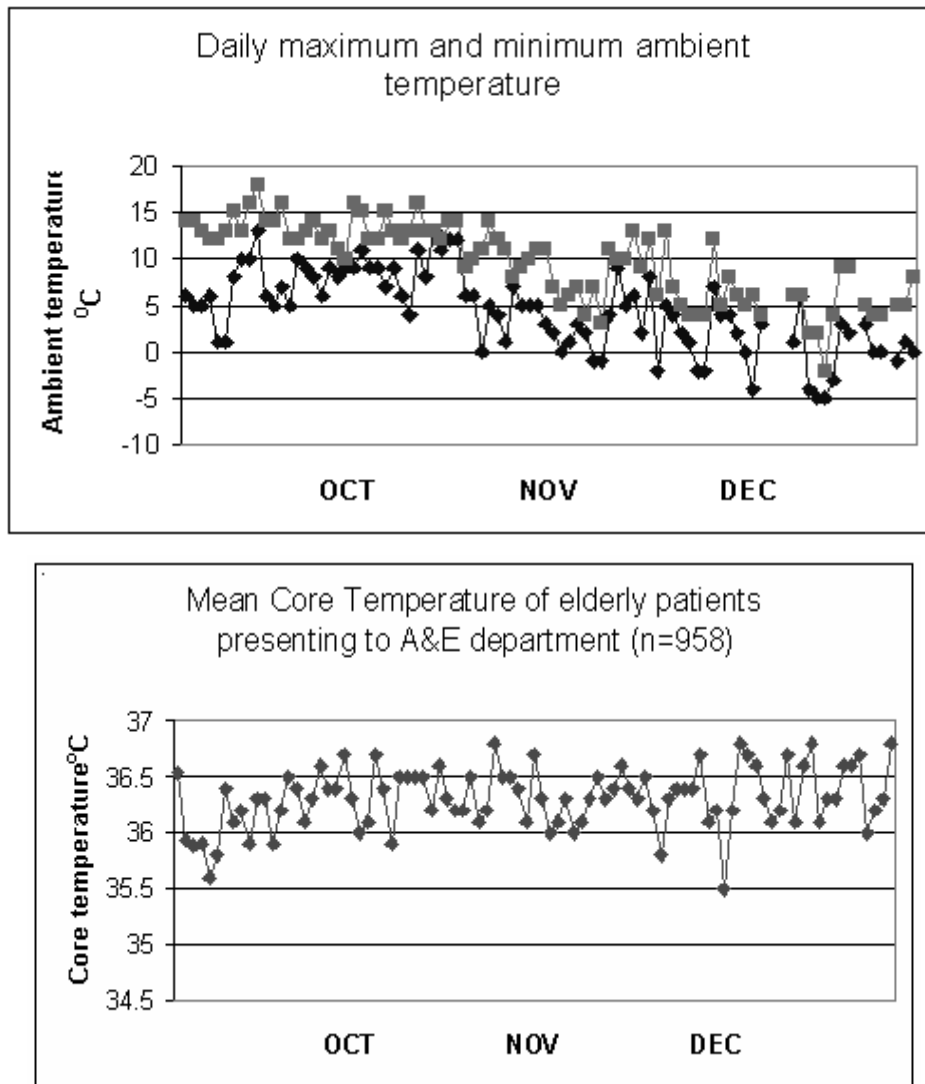
- (iii) The doctors calculated the median age and temperatures, rather than the mean. Suggest why.

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(1 mark)

The doctors plotted a graph of the maximum and minimum outdoor temperatures (ambient temperatures) for the same period. They also plotted a graph of the mean core body temperature of all patients aged over 65. The graphs are shown below as they were published.



- (b) (i) Give **two** criticisms of the ways in which these data are presented.

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2

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(2 marks)

- (ii) The doctors noted that many of the patients with hypothermia were treated at the start of October and December. They correlated this to periods of unusually cold weather. Does the information in the graphs support this statement? Explain your answer.

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(2 marks)

- (c) 44 of the 48 patients with hypothermia were taken to hospital from their own homes. Only 4 patients were taken ill out of doors. The doctors tried to assess the effect of social deprivation on the chances of getting hypothermia. They used a *social deprivation score*, based on the area where each patient lived. The table shows the results.

Social deprivation score	Percentage of the hypothermic patients
1-3 relative affluence	29
4-6 relative poverty	71

Suggest and explain **one** reason for the results.

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(2 marks)

- 11 Human oestrogen may be released in very low concentrations into rivers in water from sewage works. A genetically engineered yeast has been produced to detect this oestrogen.

Two plasmids were inserted into the yeast. One plasmid carried the gene for a human oestrogen receptor protein. The other plasmid carried a promoter gene and the gene for an enzyme, beta-galactosidase.

When oestrogen enters the yeast cell it binds to the receptor protein, forming a complex. This complex binds to the promoter gene which then causes transcription of the beta-galactosidase gene. The higher the concentration of oestrogen, the greater the amount of enzyme produced. The enzyme reacts with a colourless indicator called ONPG. A yellow compound is produced when ONPG is broken down by the enzyme.

beta-galactosidase + BAPNA (colourless) \longrightarrow yellow compound

The concentration of the enzyme was measured by the time it took for a particular depth of yellow colour to form.

- (a) Scientists have recorded many cases of abnormal sexual development in male animals living in rivers. Some scientists have linked this abnormal development to the presence of oestrogen in rivers. Suggest and explain why.

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(2 marks)

- (b) There has been an increase in the amount of oestrogen in rivers over the past forty years. Suggest **two** reasons why.

1.....
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(2 marks)

- (c) Give **two** ways in which the gene for controlling the production of the oestrogen receptor protein might be isolated.

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(2 marks)

- (d) This yeast test is very specific for oestrogen. Explain why.

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(2 marks)

- (e) When carrying out this test, suggest **two** variables which have to be controlled. Explain why each variable has to be controlled.

Factor

Explanation

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(2 marks)

Factor

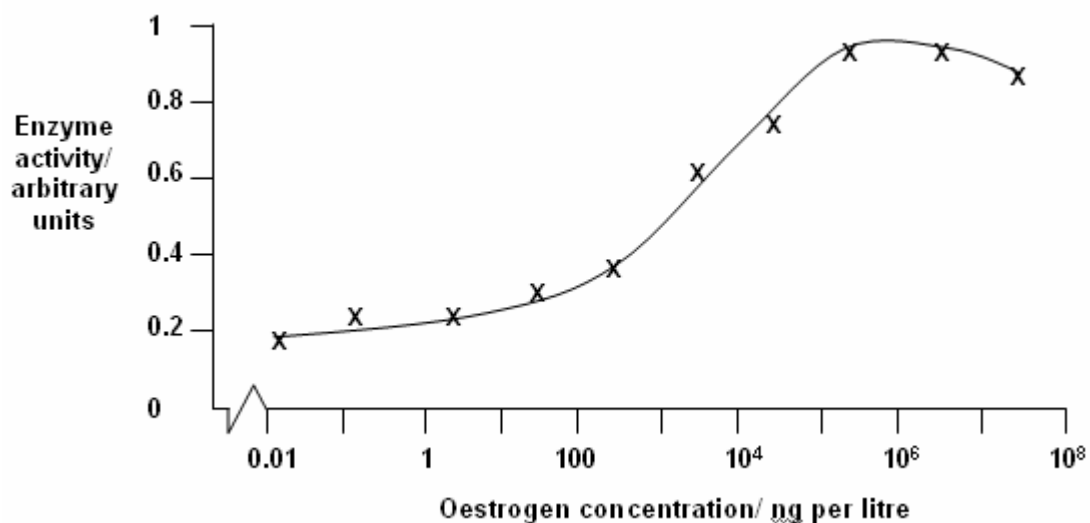
Explanation

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(2 marks)

- (f) The yeast test was calibrated using known concentrations of oestrogen. The graph shows the enzyme activity produced by different concentrations of oestrogen. The concentrations are measured in ng per litre. A ng is 10^{-9} grammes.



The test is only accurate for a certain range of concentrations of oestrogen. Suggest what the range is and explain your answer.

Range from.....to.....ng per litre
(1 mark)

Explanation

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(2 marks)

- (g) Low concentrations of oestrogen cause the yeast cells to produce large numbers of enzyme molecules. Suggest how.

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(3 marks)

- (h) Describe how you would carry out an investigation to find the optimum temperature at which to carry out the test.

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(3 marks)

- (i) The hepatitis B virus causes a life-threatening disease in humans. One vaccine for hepatitis B contains inactivated viruses. Scientists have produced a different vaccine using a strain of yeast that has been genetically engineered to produce a protein of the hepatitis B virus. The protein is purified and used as a vaccine.

The scientists believe that the vaccine produced by the yeast cells is safer and at least as effective as the vaccine containing inactivated virus.

Suggest why they believe the vaccine from yeast is better.

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(4 marks)

END OF QUESTIONS

25