

**ADVANCED GCE****HUMAN BIOLOGY**

Genetics, Homeostasis and Ageing

**2867**

Candidates answer on the question paper

**OCR Supplied Materials:**

None

**Other Materials Required:**

- Electronic calculator
- Ruler (cm/mm)

**Thursday 29 January 2009****Afternoon****Duration: 2 hours**Candidate  
ForenameCandidate  
Surname

Centre Number

Candidate Number

**INSTRUCTIONS TO CANDIDATES**

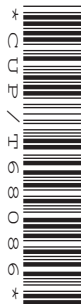
- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **120**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **24** pages. Any blank pages are indicated.

**FOR EXAMINER'S USE**

Qu.	Max.	Mark
1	16	
2	17	
3	18	
4	24	
5	17	
6	12	
7	16	
<b>TOTAL</b>	<b>120</b>	



Answer **all** the questions.

- 1** As people live longer, the prevalence of chronic diseases is likely to increase. Diseases such as chronic kidney disease will increase the demand for organs for transplant.

- (a)** In the experimental stages of organ transplantation, baboon organs were used. These organs improved the patients' condition for a few weeks but then failed because the baboon organs were rejected.

- (i)** Explain the meaning of the phrase *prevalence of chronic diseases*.

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..... [3]

- (ii)** Explain why the baboon organs were rejected.

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..... [3]

- (b)** Taxonomic grouping is of importance when considering non-human organs for transplant.

- (i)** State what is meant by the terms *genus* and *species*.

*genus* .....

.....

..... [1]

*species* .....

.....

.....

..... [2]

- (ii) The baboon is a primate.

Suggest why it was thought that baboon organs might be suitable for donation to humans.

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..... [2]

- (c) Organ transplants are now more successful.

Some potential sources of donated organs are listed in Table 1.1.

**Table 1.1**

	potential source of donated organ
<b>W</b>	fraternal twin
<b>X</b>	identical twin
<b>Y</b>	genetically engineered pig
<b>Z</b>	mother or father

- (i) State which of the letters **W** to **Z** represent the **two** best sources for successful organ donation.

..... [1]

- (ii) For each of the organ sources in Table 1.1, give **one genetic** reason why they may be suitable sources of donated organs.

**W** .....

.....

**X** .....

.....

**Y** .....

.....

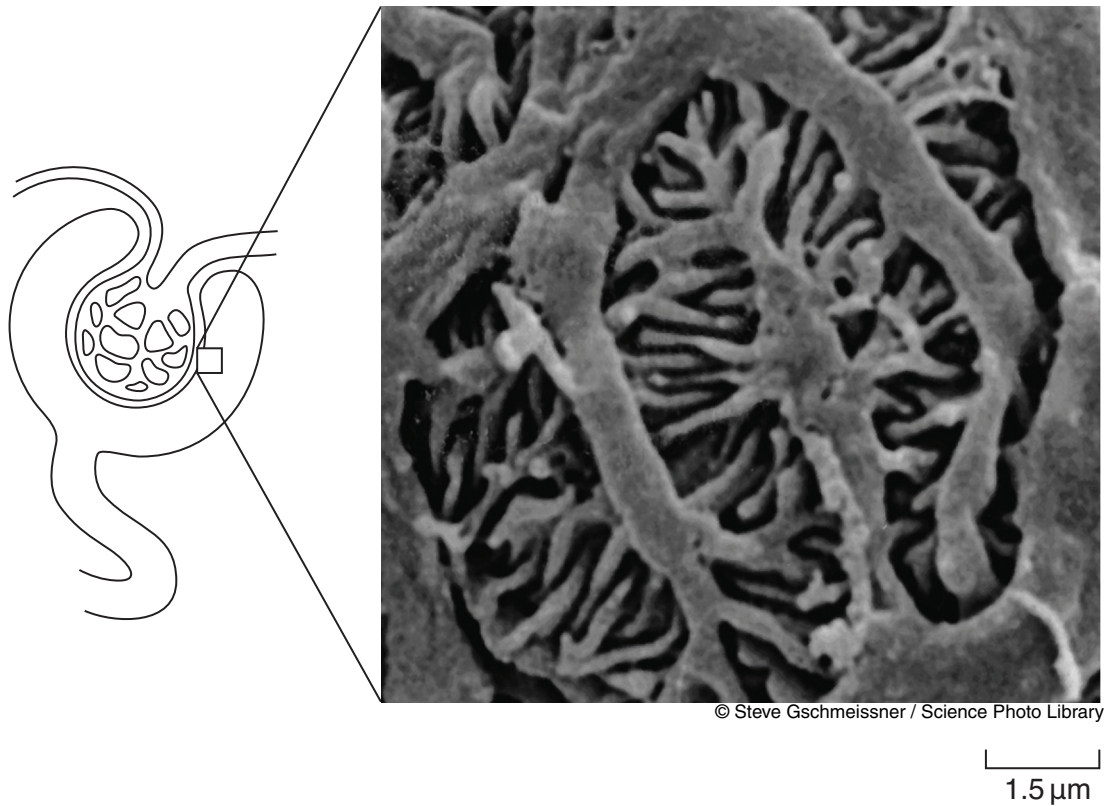
**Z** .....

..... [4]

[Total: 16]

- 2 The functional unit of the kidney is the nephron or kidney tubule. At the start of each nephron is the Bowman's capsule, which receives the glomerular filtrate.

Fig. 2.1 is an electron micrograph of the wall of a Bowman's capsule.



**Fig. 2.1**

- (a) (i) Name the process that occurs in the Bowman's capsule.

..... [1]

- (ii) Using the scale bar in Fig. 2.1, calculate the magnification of the electron micrograph.

Show your working.

Magnification =  $\times$  ..... [2]

- (iii) Describe how the structure of the Bowman's capsule is adapted to its function.

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..... [5]

- (b) The glomerular filtration rate (GFR) is the rate at which a substance in the glomerular filtrate is filtered from the glomerulus into the Bowman's capsule. It is an important indicator of how healthy the kidney is.

To measure GFR:

- a patient is given an inert test substance called inulin
- the patient's urine is tested at intervals for inulin
- the concentration of inulin in the urine is recorded.

The GFR is equal to the rate at which inulin appears in the urine.

- (i) Suggest what is meant by an inert substance.

.....  
 ..... [1]

- (ii) The GFR of inulin is calculated using the following formula :

$$\text{GFR of inulin} = \frac{P}{Q} \times R$$

When a patient was tested, the following results were obtained:

the concentration of inulin in  $1 \text{ cm}^3$  urine,  $P = 120 \text{ mg cm}^{-3}$

the concentration of inulin in  $\text{cm}^3$  of plasma,  $Q = 1.5 \text{ mg cm}^{-3}$

and the volume of urine formed per minute,  $R = 2.0 \text{ cm}^3 \text{ min}^{-1}$

Calculate the GFR for inulin.

Show your working.

Answer = .....  $\text{cm}^3 \text{ min}^{-1}$  [2]

- (iii) State **two** differences between the glomerular filtrate and blood.

1 .....  
 .....  
 2 .....  
 ..... [2]

- (c) Caffeine, a substance found in some coffee and tea, causes vasodilation of the afferent arterioles of the glomerulus.

State **one** effect caffeine would have on the GFR and explain your answer.

*effect* .....

*explanation* .....

.....

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..... [3]

- (d) The size of the haemoglobin molecule is small enough to allow it to pass into the glomerular filtrate. However, haemoglobin does not usually appear in the glomerular filtrate.

State why haemoglobin does not usually appear in the glomerular filtrate.

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..... [1]

[Total: 17]

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3 Haemophilia is a genetic disease that is inherited.

(a) (i) State what is meant by the term *inherited*.

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..... [1]

(ii) Give **two** reasons why some genetic abnormalities are **not** inherited.

1 .....  
.....  
2 .....  
..... [2]

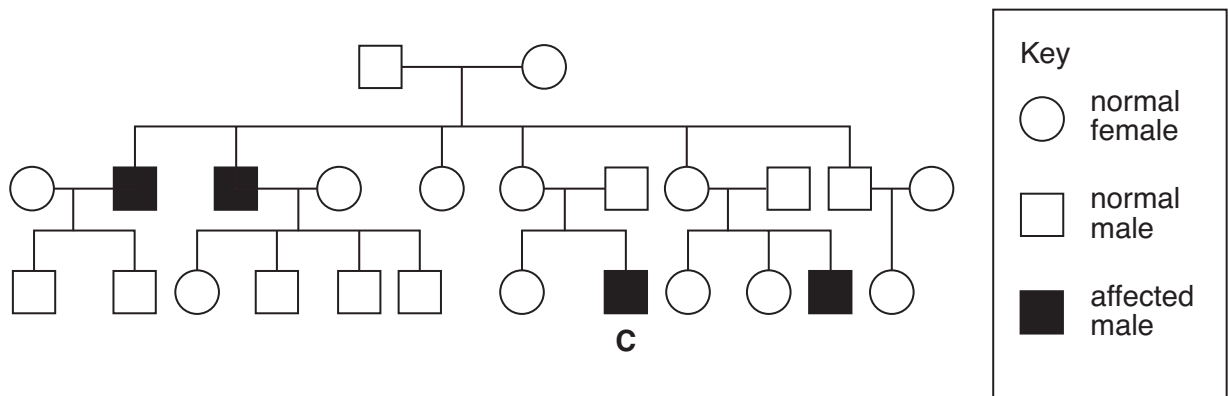
(iii) Suggest how a geneticist could establish whether a genetic abnormality is inherited.

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.....  
..... [2]

A young man with haemophilia wished to have children and consulted a genetic counsellor to discover if, and how, the disease could be passed to his children.

The genetic counsellor constructed a pedigree in order to give the young man the information he required.

Fig. 3.1 shows the man's family pedigree for haemophilia. The young man himself is marked with a **C**.



**Fig. 3.1**

Explain how the genetic counsellor would use the pedigree in Fig. 3.1 to inform the young man if and how the disease could be passed to his children.

This image shows a blank sheet of white paper with horizontal ruling lines. There are ten sets of lines across the page. Each set consists of three lines: a solid black line at the top, a dashed black line in the middle, and another solid black line at the bottom. The lines are evenly spaced and extend across the entire width of the page.

**(c)** The excessive bleeding caused by haemophilia may be prevented by using injections of the genetically engineered blood clotting protein, Factor VIII. Before 1988, the only source of Factor VIII was as an extract from donated blood.

- 1 .....
- 2 ..... [2]

- (ii) A person with haemophilia usually receives injections of Factor VIII two to three times a week, whether they are bleeding or not.

Suggest why a haemophiliac needs this treatment so regularly.

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..... [3]

[Total: 18]

- 4 The human body is a dynamic system existing in a constantly changing environment. If the body is to function well, it must adjust its metabolism in response to these changes, using homeostatic mechanisms.

(a) Describe how homeostatic mechanisms operate.

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..... [3]

[8]

**Turn over**

- (c) If a person with Type 1 diabetes experiences 'low blood sugar' their condition may become serious.

(i) State the correct name for 'low blood sugar' in a person with Type 1 diabetes.

..... [1]

(ii) Suggest **three** causes of 'low blood sugar' in a person with Type 1 diabetes.

1 .....

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2 .....

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3 .....

..... [3]

(iii) Explain why 'low blood sugar' in a person with Type 1 diabetes may have serious effects on the body.

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..... [2]

- (d) Type 1 diabetes is caused by the patient's own immune system destroying the endocrine cells in the pancreas.

A research trial was conducted to see if it was possible to cure individuals with Type 1 diabetes using stem cells.

(i) The patients used for the trial had just been diagnosed with Type 1 diabetes.

Suggest why patients who had **just** been diagnosed were used for this trial.

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..... [1]

- (ii) The patients in the trial were first given chemotherapy, like that used to destroy cancer cells, to suppress their immune system.

State how chemotherapy may suppress a patient's immune system.

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..... [1]

- (iii) Stem cells, which normally produce leucocytes, were harvested from the patients.

State where these stem cells are normally found.

..... [1]

- (iv) After chemical manipulation, the stem cells were returned to the patients' bodies.

All the patients showed some return to normal endocrine cell function, lasting up to three years.

Explain why:

- stem cells were used in the trial
- the patients' own stem cells were so suitable for this task.

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..... [3]

[Total: 24]

5 The blink reflex test is a useful technique to determine the effect of ageing on the brain.

(a) Fig. 5.1 shows the results of the blink reflex test carried out on 10-year-olds, 18-year-olds and 80-year-olds.

- Each person in each age group was given 100 blink reflex tests.
- Each person's blink responses to the test were recorded.
- The test was repeated eight times for each person in each age group.

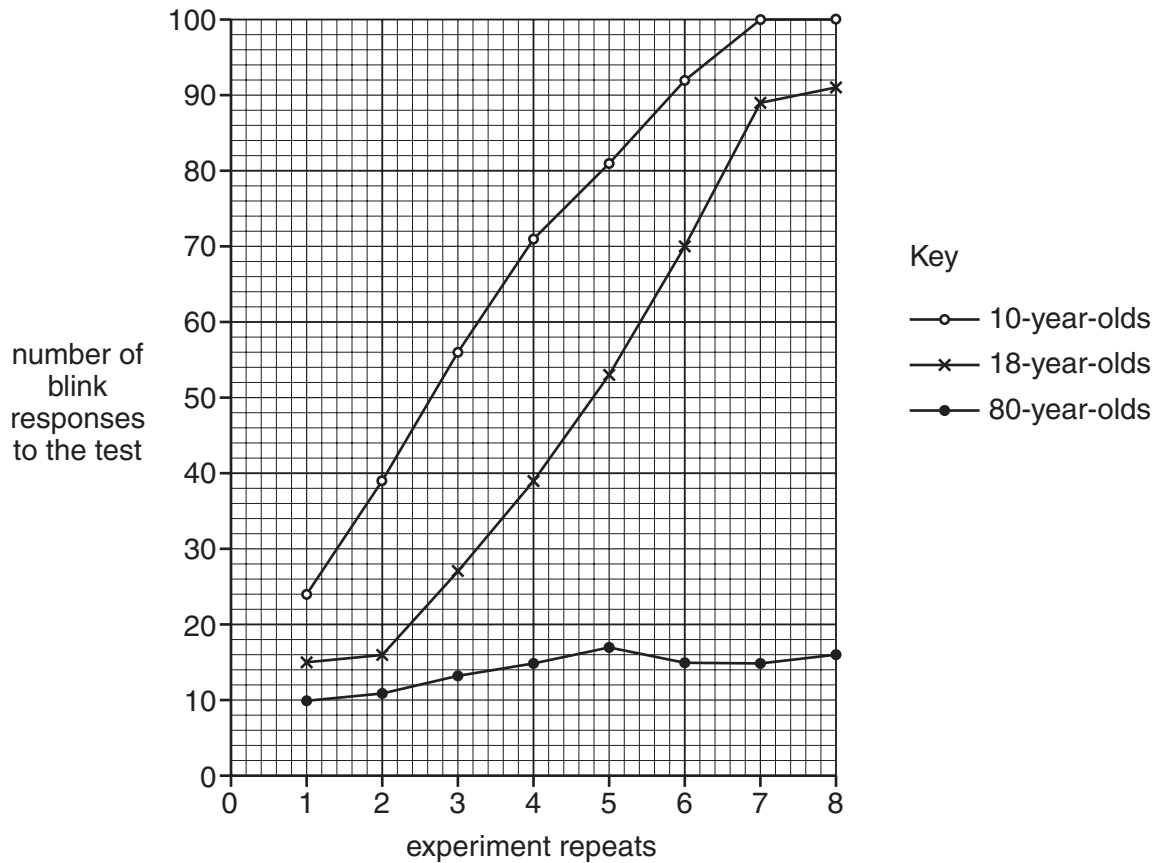


Fig. 5.1

(i) **Describe** the results of this experiment.

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[3]



(ii) **Explain** the results of this experiment.

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..... [3]

(iii) Explain why the blink reflex test is such a useful test when determining the effect of ageing on the Central Nervous System (CNS).

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..... [3]

(iv) Suggest a suitable stimulus for the blink reflex test.

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..... [1]

(b) (i) Describe in detail **one** cause of poor vision in the elderly **other than** a change in the CNS.

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..... [4]

- (ii) Suggest some of the social problems that may be experienced by an elderly person with poor vision.

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..... [3]

[Total: 17]

- 6 Chromosomal mutations usually cause a wide range of abnormalities and are difficult to treat.

- (a) (i) Explain the term *chromosomal mutation*.

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..... [2]

- (ii) Suggest why chromosomal mutations usually cause a wide range of abnormalities.

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..... [1]

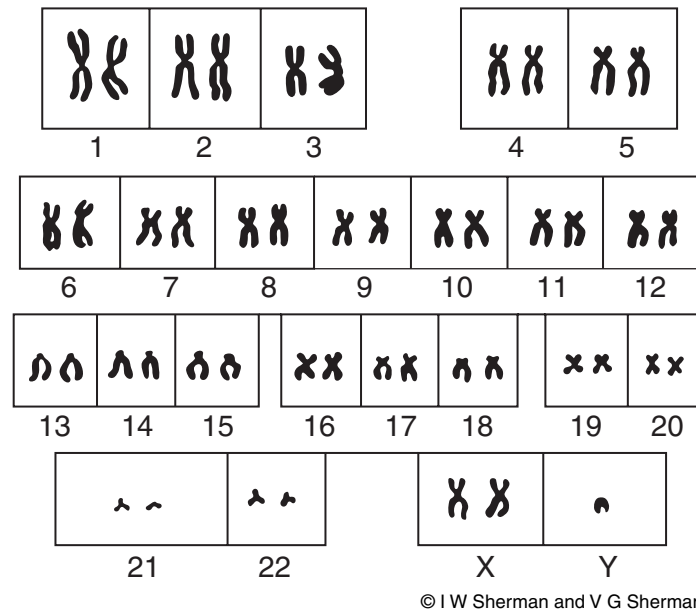
- (iii) Suggest why chromosomal mutations are difficult to treat.

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..... [1]

(b) Fig. 6.1 shows the karyotype of a man with Klinefelter's syndrome.



**Fig. 6.1**

Using Fig. 6.1, state the chromosomal mutation which causes Klinefelter's syndrome.

..... [1]

(c) A man with Klinefelter's syndrome may have small testes.

(i) Suggest why Klinefelter's syndrome may produce this effect.

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 .....  
 ..... [2]

(ii) Discuss the fertility treatments available to a man with Klinefelter's syndrome.

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- (iii) Discuss **two ethical** issues involved in treating low fertility in a man with Klinefelter's syndrome.

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2 .....

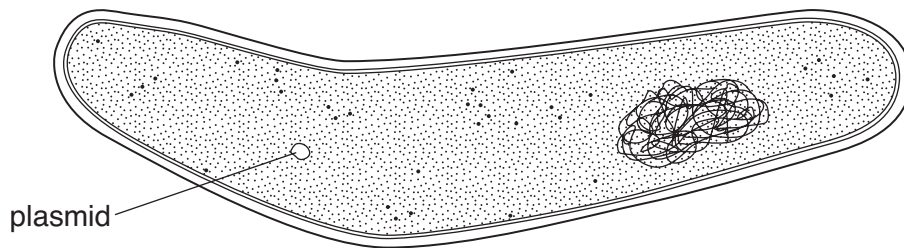
..... [2]

[Total: 12]

- 7 Genetic engineering has the potential to prevent or treat genetic disease.

If genes are to be used in this way, it is necessary to understand the biology of suitable vectors, such as bacterial plasmids.

- (a) Fig. 7.1 is a diagram of a bacterium.



**Fig. 7.1**

Describe the structure of bacterial plasmids **and** explain why they make good vectors.

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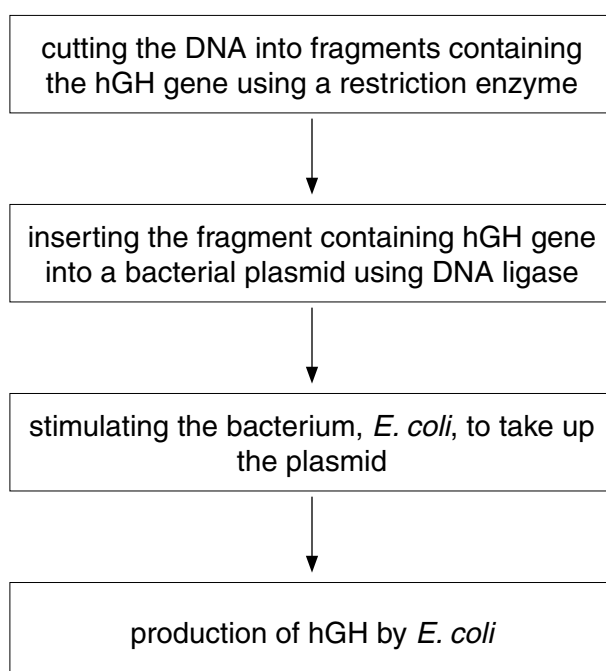
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..... [4]

- (b) Fig. 7.2 is a flow diagram that shows some of the steps in engineering the bacterium *Escherichia coli* to produce human growth hormone (hGH).



**Fig. 7.2**

- (i) Describe the important features of a restriction enzyme.

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..... [2]

- (ii) Explain in detail how the enzyme DNA ligase catalyses the insertion of the hGH gene into the bacterial plasmid.

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..... [3]

- (iii) How can *E. coli* be stimulated to take up plasmids?

..... [1]

(c) Progress in the use of genetic engineering to treat human genetic disease has been greatly accelerated by the Human Genome Project.

(i) Suggest how the Human Genome Project has contributed to the use of genetic engineering to treat genetic diseases.

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..... [2]

(ii) State the ways in which the information gained from the Human Genome Project and the development of genetic engineering could create social **and** ethical issues.

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..... [4]

[Total: 16]

**END OF QUESTION PAPER**

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*Copyright acknowledgements:*

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Fig. 6.1                      © I W Sherman and V G Sherman, *Biology: A Human Approach*, p442, Oxford University Press, 1983. Reproduced by kind permission of I W Sherman.

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