

**ADVANCED GCE
HUMAN BIOLOGY**

Genetics, Homeostasis and Ageing

WEDNESDAY 31 JANUARY 2007

2867

Afternoon

Time: 2 hours

Additional materials:
Electronic calculator
Ruler (cm/mm)



Candidate
Name

Centre
Number

--	--	--	--	--

Candidate
Number

--	--	--	--

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate Number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- **WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.**

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- 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.

For Examiner's Use		
Qu.	Max.	Mark
1	17	
2	16	
3	15	
4	18	
5	20	
6	19	
7	15	
Total	120	

This document consists of **20** printed pages.

Answer **all** the questions.

- 1 An increased understanding of human genetics has led to rapid advances in the treatment of some genetic diseases.

(a) Some definitions of common genetic terms are given below.

- A** the alleles of a gene or genes possessed by an organism
- B** an alternative form of a gene
- C** the inheritance of two genes
- D** the position of a gene on a chromosome
- E** the visible or measurable characteristics of an organism
- F** a length of DNA which codes for a polypeptide

Match each of the following terms with the correct definition from the list above.

The first one has been done for you.

term	definition
gene	F
allele	
locus	
genotype	
phenotype	
dihybrid	

[5]

- (b) Fig. 1.1 is a photograph of a blood film, as seen under the light microscope, from a patient who has a genetic disease affecting the red blood cells.



© Eric Grave / Science Photo Library

Fig. 1.1

Using the information in Fig. 1.1,

- (i) Describe the characteristic features of this genetic disease.

.....

.....

.....

.....

.....

.....

.....[3]

- (ii) State the genotype of this individual and describe the type of inheritance shown by this disease. Give reasons for your answer.

genotype

type of inheritance

reasons for your answer

.....

.....[3]

(c) Describe **two** ways by which the frequency of this mutant allele in a population may be changed (increased or decreased).

1 how the frequency of the mutant allele changes.

cause

.....

.....

.....

2 how the frequency of the mutant allele changes.

cause

.....

.....

..... [4]

(d) State **one environmental factor** that may cause abnormal blood cells to be produced. Describe the appearance of these abnormal cells when seen on a blood film under the light microscope.

environmental factor

appearance of abnormal cells

.....

..... [2]

[Total: 17]

2 Maintaining the flow of blood around the body is essential if the organs of the body are to survive and function normally. Some body organs, such as the kidneys, require a particularly high flow of blood.

(a) Explain why the blood flow to the kidneys needs to be high.

.....

[2]

(b) Table 2.1 shows the distribution of blood flow to the kidneys and the skeletal muscle.

Table 2.1

organ	mass/kg	blood flow/cm ³ min ⁻¹	
		total	per 100g tissue
kidneys	0.4	1600	400
skeletal muscle	26.0	780	

(i) Calculate the blood flow to the skeletal muscle per 100g of tissue.

Show your working.

Answer = cm³ min⁻¹ 100g⁻¹ [2]

(ii) Describe how the blood flow to the kidneys and the skeletal muscle would change during exercise. Give a reason for your answer.

.....

[3]

- 3 Advances in health care have considerably increased the life expectancy of the population. As the body ages, disability may become more common. It is therefore important to recognise and evaluate some of the disabilities that may be experienced by older people.

Table 3.1 shows the prevalence of some types of disability that affect adults, in two age groups, per 1000 of the population in each group.

Table 3.1

A table has been removed due to third party copyright restrictions

Details:

A table showing the prevalence of some types of disability that affect adults.
Including locomotion, dexterity, vision and hearing

© B Davey, Birth to Old Age: Health in Transition, 2001, OUP, Reproduced with the kind permission of the Open University Press / McGraw-Hill Publishing Company

- (a) (i) Explain what is meant by the term prevalence .

.....

.....

.....

..... [2]

- (ii) Describe and explain the main changes in the body that may cause the disabilities shown in Table 3.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) A rare genetic disease may cause premature ageing.

At first it was thought that this disease was caused by a **recessive** allele but it is now thought that the disease may be caused by a random **dominant** allele.

(i) Explain how a dominant or a recessive allele affects the way in which the allele is inherited.

if the allele is **dominant**

.....

.....

.....

if the allele is **recessive**

.....

.....

.....[3]

(ii) Explain the cause of a *random* genetic disease.

.....

.....

.....

.....[2]

(iii) If this disease is caused by a dominant allele, suggest why it is **not** more common in the population.

.....

.....

.....[1]

- (c) One of the most obvious symptoms of this disease is wrinkling of the skin at an early age in spite of the fact that skin cells are renewed regularly.

In an investigation, a sample of normal foetal skin cells was grown in a flask with a suitable medium until the cells stopped dividing.

The sample was then split into two new flasks, after which the cells started growing again. After a while the cells again stopped dividing.

The process was repeated until no further divisions occurred on transfer to two new flasks.

The results of this investigation are shown in Fig. 3.1.



Fig. 3.1

Using the information in Fig. 3.1, suggest an explanation for the wrinkling of the skin in premature ageing.

.....

.....

.....

.....

.....

.....

.....

.....

.....

[2]

[Total: 15]

[Turn over

(b) Explain why it is difficult to **confirm** the diagnosis of Alzheimer’s disease.

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

(c) A recent study in America involved eight patients with Alzheimer’s disease. Scientists removed skin cells from each patient and genetically modified the cells so they would produce nerve growth factor (NGF). NGF is a natural substance which prevents the death and stimulates the function of neurones. The genetically modified cells were then implanted deep in the patients’ brains. The following results were observed:

- the rate at which cognitive function was lost slowed by between 33% and 51%
- the use of glucose by the patients’ brains increased.

(i) Explain the results of this procedure.

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

(ii) Comment on the **reliability** of this procedure as a scientific investigation.

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

(iii) Discuss the **potential hazards** associated with this procedure.

.....
.....
.....
.....[3]

(iv) Suggest **one** other use of NGF.

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

[Total: 18]

[Turn over

5 The kidney produces erythropoietin (EPO) if

- the oxygen concentration of the blood falls, or
- the volume of the blood plasma increases.

EPO is a hormone that causes the bone marrow to increase its production of red blood cells. Once the oxygen concentration of the blood returns to normal, the production of EPO drops.

(a) Suggest why an increase in blood volume has the same effect on EPO production as a decrease in oxygen concentration.

.....

.....

.....[1]

(b) Fig. 5.1 shows part of the negative feedback loop involved in the regulation of blood oxygen concentrations by the kidney.

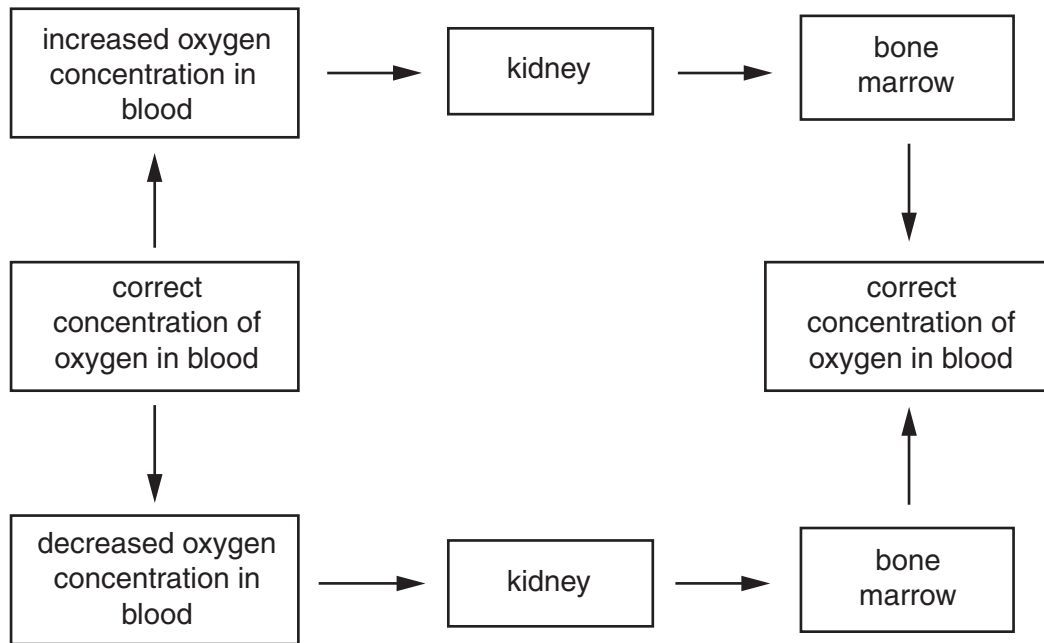


Fig. 5.1

- (i) Complete Table 5.1 by giving the name of each structure involved in the feedback loop and describing its function.

Table 5.1

	structure	function
effector		
receptor		

[4]

- (ii) Explain how the sequence shown in Fig. 5.1 illustrates negative feedback.

.....
.....
.....
.....
.....[3]

- (c) Although the procedure is banned, some athletes may inject recombinant human erythropoietin (RhEPO) in order to increase their performance.

- (i) Explain why injecting RhEPO would increase the performance of an athlete.

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

- (ii) Describe what is meant by the term *recombinant erythropoietin*.

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

- (iii) Suggest the risks involved in injecting RhEPO.

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

(d) Table 5.2 shows the results of red blood cell counts from two groups, **A** and **B**, of 20 year old male athletes.

Table 5.2

sample number	red cell count /million dm ⁻³	
	A	B
1	4.8	6.0
2	5.6	6.3
3	4.6	6.4
4	6.0	6.7
5	5.5	6.1
6	4.8	6.0
7	5.2	6.8
8	5.0	6.6
9	5.6	7.0
10	4.7	6.9
mean	5.2	6.5

(i) Suggest the possible causes of the difference in the mean red blood cell count between the two groups.

.....

.....

.....

.....

.....

.....[3]

A statistical test (the *t*-test) was carried out to see if the difference between the means of the two groups was significant.

The *t*-test gave a calculated value for *t* of 2.32.

Table 5.3

degrees of freedom	probability values			
	0.10	0.05	0.01	0.001
14	1.76	2.15	2.98	4.14
16	1.75	2.12	2.92	4.02
18	1.73	2.10	2.88	3.92
20	1.72	2.09	2.85	3.85

- (ii) Use the calculated value of *t* and Table 5.3 above, to find the probability of the means for **A** and **B** being different due to chance.

degrees of freedom

probability [2]

- (iii) State the conclusion that may be drawn from the probability found in (d) (ii).

.....

 [2]

[Total: 20]

6 (a) Elderly people are particularly at risk of hypothermia. This is a potentially dangerous condition so it is important to recognise the symptoms.

(i) Explain why elderly people are particularly at risk of hypothermia.

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

(ii) **Describe** and **explain** how a low body temperature causes the symptoms of hypothermia.

.....
.....
.....
.....
.....[3]

(iii) Explain how hypothermia should be treated.

.....
.....
.....
.....
.....
.....
.....[3]

(b) (i) Why is core temperature the most accurate measure of body temperature?

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

(ii) Describe how core temperature is measured **indirectly**.

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

- (c) An investigation was carried out to determine the effect of external air temperature on metabolic rate. The metabolic rate was measured as the rate of oxygen consumption.

Fig. 6.1 shows the results of this investigation.

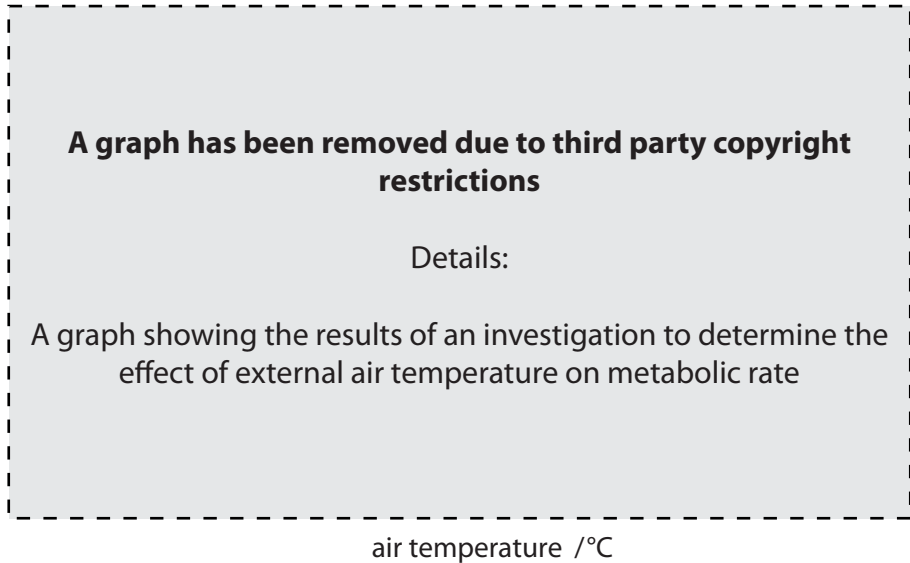


Fig. 6.1

- (i) Describe and explain the data shown in Fig. 6.1.

describe

.....

.....

.....

explain

.....

.....

.....

..... [5]

- (ii) Outline one technique that would be suitable for measuring oxygen consumption in this investigation.

.....

.....

.....

.....

.....

..... [3]

[Total: 19]

- 7 The prostate gland grows in men at puberty. It then remains a constant size until about the age of forty, when it begins to grow again.

Benign prostatic hyperplasia (BPH) is the medical term for an enlarged prostate gland. 50% of men aged 60 have some enlargement of the prostate gland and this rises to 90% at the age of 80. Fig. 7.1 shows the position of the prostate gland.



Fig. 7. 1

- (a) BPH does not always cause symptoms, but in some men it may cause enough symptoms to require treatment.
 - (i) Suggest the symptoms that may be experienced by some men with BPH. You may use Fig. 7.1 to help you with your answer.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) Suggest what is meant by the term *benign*, as used in the introduction to this question on page 18.

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

(b) The most important risk factor for BPH is age. However, it has been noted that men who are born without a substance called 5-alpha reductase very rarely develop BPH.

Fig. 7.2 shows one of the pathways that involves 5-alpha reductase.

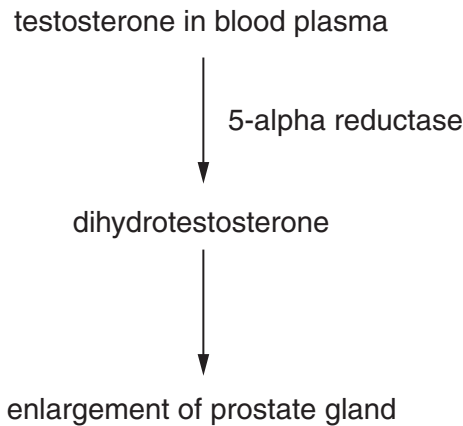


Fig. 7.2

Current research suggests that dihydrotestosterone is 2 to 3 times more potent than testosterone in enlarging the prostate gland.

(i) Suggest what type of chemical 5-alpha reductase is.

.....[1]

(ii) Drugs that inhibit 5-alpha reductase may be used to treat BPH.

Suggest how 5-alpha reductase may be inhibited by drugs.

.....
.....
.....
.....
.....
.....[4]

Question 7 continues on page 20

- (iii) BPH may also be prevented by using drugs that inhibit the production of interstitial cell stimulating hormone (ICSH), also known as luteinising hormone (LH).

Suggest why drugs that inhibit ICSH will prevent benign prostatic hyperplasia (BPH).

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

- (c) Many of the symptoms of BPH are similar to those for cancer of the prostate gland. However, there are important differences and BPH does not develop into cancer.

Describe an investigation which may be conducted to discover whether these symptoms are caused by BPH or cancer of the prostate gland.

.....
.....
.....
.....
.....
.....[3]

[Total: 15]

END OF QUESTION PAPER

Copyright Acknowledgements:

Fig. 1.1 image	© Eric Grave / Science Photo Library
Table 3.1	© B Davey, <i>Birth to Old Age: Health in Transition</i> , 2001, OUP. Reproduced with the kind permission of the Open University Press / McGraw-Hill Publishing Company
Fig. 3.1 adapted graph	© Boyle, Indge, Senior, <i>Human Biology</i> , Collins Educational, 1999. Reproduced with kind permission of Collins Educational.
Fig. 6.1 graph	Adapted graph from Figure 1(B), Temperature regulation, <i>Biological Sciences Review</i> , Volume 17, Number 2, November 2004, Philip Allan Updates

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.