

**ADVANCED GCE
HUMAN BIOLOGY**

Genetics, Homeostasis and Ageing

WEDNESDAY 18 JUNE 2008

2867

Afternoon
Time: 2 hours

Candidates answer on the question paper
Additional materials (enclosed): None

Additional materials (required):
Electronic calculator
Ruler (cm/mm)



Candidate Forename

Candidate Surname

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or 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.

INFORMATION FOR CANDIDATES

- The number of marks for each question 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.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	17	
2	16	
3	20	
4	14	
5	22	
6	18	
7	13	
TOTAL	120	

This document consists of **24** printed pages.

Answer **all** the questions.

1 60% of human body mass is water. It forms the body fluids, which are complex aqueous solutions containing many dissolved substances including mineral ions.

(a) (i) Blood is an example of a body fluid.

Name **two other** body fluids.

1

2 [2]

(ii) Outline the advantages of having the body fluids composed mainly of water.

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

(iii) Name **two** components of the blood which are suspended in, rather than dissolved in, the water in the blood.

1

2 [2]

- (b) It is important that the concentration of the body fluids remains within narrow limits. This is one of the homeostatic functions of the kidney.

Fig. 1.1 shows the structure of a nephron.

- (i) Mark, with an **X** on Fig. 1.1, the part of the nephron where the concentration of the body fluids is adjusted by regulating the water balance.

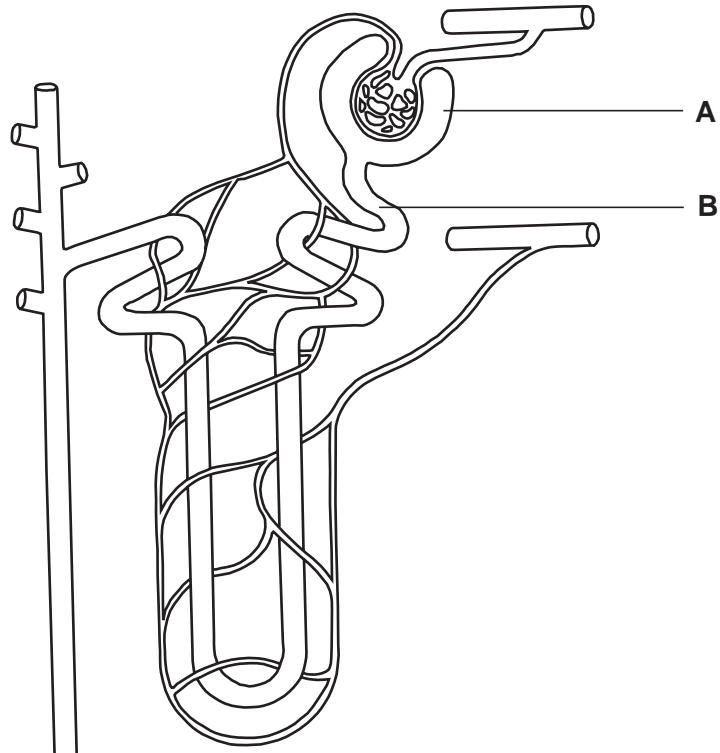


Fig. 1.1

[1]

- (ii) Name the structures **A** and **B**.

A

B [2]

- (c) The homeostatic mechanism which controls the concentration of the body fluids is called osmoregulation.

The table below shows some of the structures involved in osmoregulation.

Complete the table by stating **one** function of each structure.

The first one has been done for you.

structure	function
hypothalamus	contains the osmoreceptors
posterior pituitary gland	
osmoreceptors	
loop of Henle	

[3]

- (d) Explain why it is important to maintain the concentration of the body fluids within narrow limits.

.....

.....

.....

.....

.....

.....

..... [4]

2 The prevalence of Type 2 diabetes is expected to double by 2050. In many cases, this condition is associated with obesity.

(a) The results of an investigation suggested that large quantities of potatoes in the diet may increase the risk of developing Type 2 diabetes.

- The portions of potato eaten by 84 555 healthy women were recorded for twenty years.
- The number of portions eaten ranged from zero to six portions per day.
- During the investigation, 4 496 women developed Type 2 diabetes.
- The development of Type 2 diabetes showed a positive correlation with the quantity of potato eaten.

(i) Calculate the percentage of women in the sample who developed Type 2 diabetes.

Show your working.

Give your answer to the **nearest whole number**.

Answer =% [2]

(ii) List **three** variables which should have been controlled in this investigation.

- 1
- 2
- 3 [3]

(b) (i) Suggest how potatoes may contribute to the **development** of Type 2 diabetes.

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

(ii) How does the development of **Type 1** diabetes differ from the development of Type 2 diabetes?

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

(c) Obesity is regarded as the main risk factor for the development of Type 2 diabetes.

In some cases, obesity may have a genetic basis.

An investigation found that mice with a mutation in the gene controlling the production of a hormone called leptin became obese.

Leptin is produced in the adipose tissue (fat cells) of the body and acts on the hypothalamus to decrease appetite.

The absence of leptin may cause an uncontrollable appetite.

Some obese humans have normal blood leptin concentrations but are insensitive to its effects.

Fig. 2.1 shows the homeostatic control of leptin production.

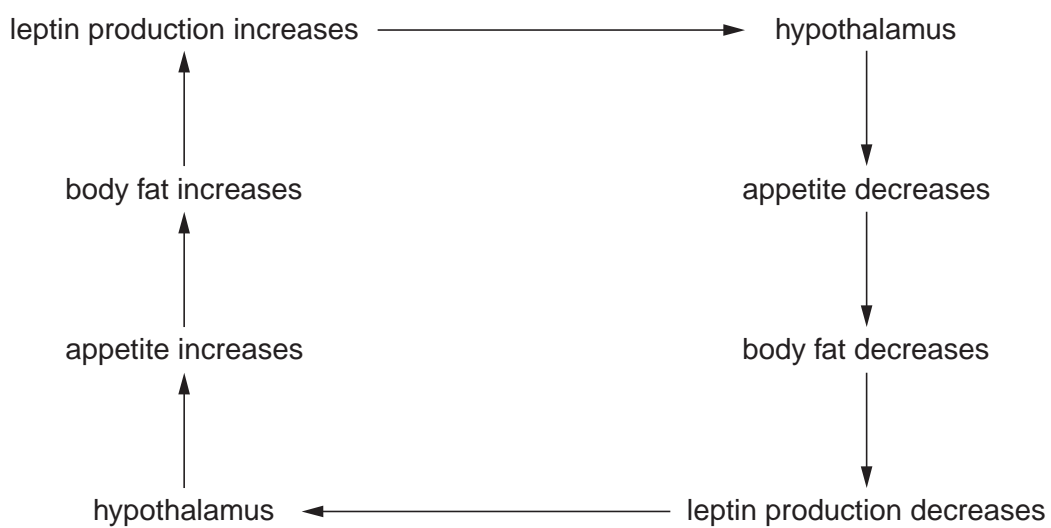


Fig. 2.1

3 An elderly woman was found in considerable pain having had a fall.

She appeared to have broken her arm and so was taken to the fracture clinic of the local hospital.

As she had attended the fracture clinic before, the clinic suspected that she had osteoporosis and made an appointment for her to have a bone density test.

(a) Outline how a bone density test is carried out **and** used to detect osteoporosis.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) Osteoporosis is most common in post-menopausal women.

Fig. 3.1 shows how the bone density of women changes as they age.

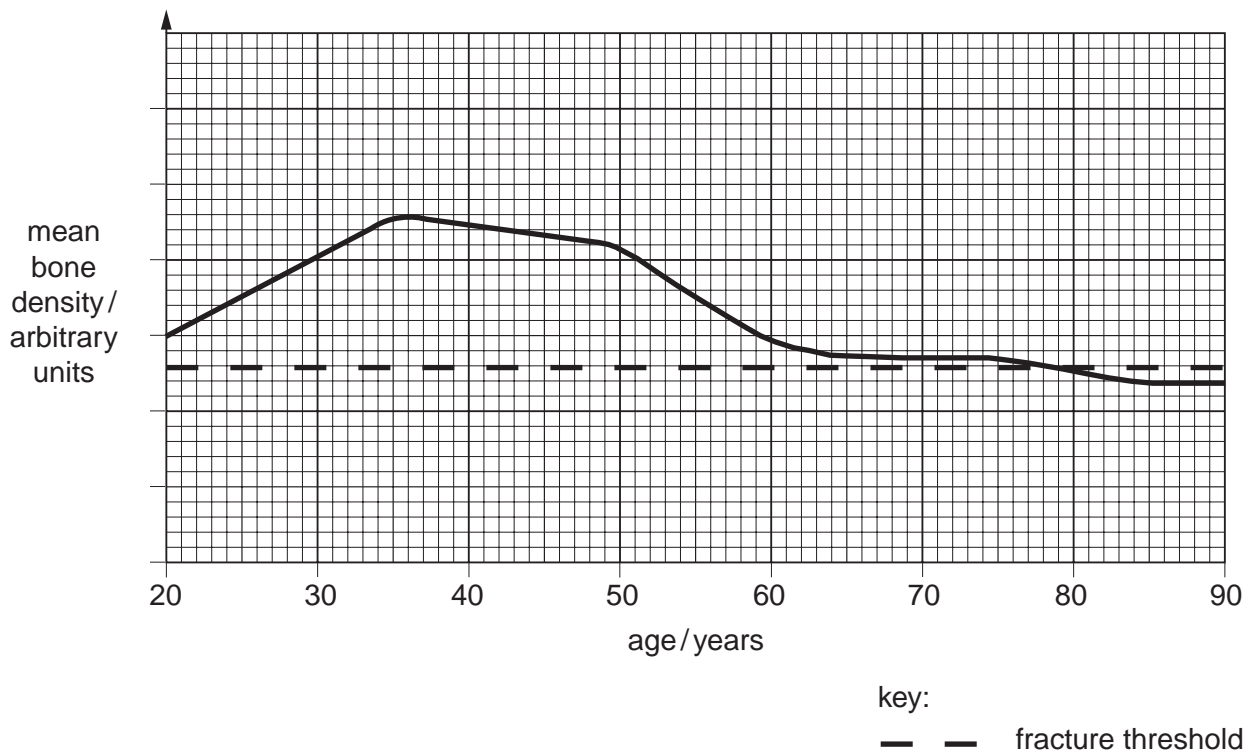


Fig. 3.1

(i) Describe how the bone density of women changes as they age.

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

(ii) Explain the significance of the fracture threshold.

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

(iii) State **three social** consequences of osteoporosis for the **individual**.

1
.....
2
.....
3
..... [3]

(c) Explain why osteoporosis is more common in post-menopausal women.

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

4 The hormone thyroxine increases the metabolic rate.

(a) Explain what is meant by the term *metabolic rate*.

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

(b) In some adults, the thyroxine concentration of their blood becomes too low. This is due to a decrease in the activity of the thyroid gland as they age and is known as myxoedema or hypothyroidism.

The signs and symptoms of this condition are:

- mental and physical slowing down
- tiredness
- feeling cold.

Explain why a lack of thyroxine (hypothyroidism) produces the signs and symptoms stated above.

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

(c) Thyroxine is a small molecule which is carried in the blood, bound tightly to a plasma protein.

Suggest why thyroxine is carried to the cells in this way.

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

- (d) Patients with hypothyroidism are usually treated with thyroxine tablets. Their blood thyroxine concentration is monitored regularly.

Suggest why the blood thyroxine concentration is monitored regularly.

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

- (e) The cause of hypothyroidism in ageing adults is not always known.

One possible cause is the accumulation of autoimmune antibodies, some of which prevent the thyroid stimulating hormone (TSH) receptors from functioning, so that thyroxine is not produced.

- (i) State where in the body the TSH receptors are found.

..... [1]

- (ii) Suggest how the *autoimmune antibodies* could prevent the TSH receptors from functioning.

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

- (iii) Autoimmune antibodies are often found in individuals who have haplotypes that include HLA-DR5 and HLA-B8.

Explain the meaning of the phrase '*...individuals who have haplotypes that include HLA-DR5 and HLA-B8.*'

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

[Total: 14]

- 5 Cystic fibrosis is an inherited disease of the respiratory system. This disease also involves other organs that normally produce mucus.

The allele involved in cystic fibrosis is found on chromosome 7.

Fig. 5.1 is a photomicrograph showing the contents of a cell nucleus of a patient with cystic fibrosis.

P marks the position of chromosome pair 7.



© J C Revy / Science Photo Library

Fig. 5.1

- (a) Explain why **both** chromosomes in pair 7 are involved in cystic fibrosis.

.....

.....

..... [2]

- (b) The gene locus on chromosome 7 that is involved in cystic fibrosis controls the formation of protein channels in cell membranes called CFTR channels.

The CFTR protein channels normally transport chloride ions out of cells through the cell membrane.

In patients with cystic fibrosis, the CFTR protein channels in mucus-producing cells are altered.

The mucus produced by these cells becomes abnormally thick and sticky after it has been secreted.

- (i) Name the **type** of cell that produces mucus in the respiratory system.

..... [1]

- (ii) Suggest why the mucus secreted by cells with altered CFTR protein channels becomes abnormally thick and sticky.

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

- (iii) Suggest why the production of abnormally thick and sticky mucus in the **male reproductive system** can lead to lower rates of fertility.

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

(c) Information about the inheritance of cystic fibrosis is shown in the table below.

Fill in the shaded boxes in the table to show the possible **genotypes** of the mother and the children.

Use the symbols **F** and **f** for the alleles involved.

One has been done for you.

father without cystic fibrosis		mother without cystic fibrosis	
Ff			
child without cystic fibrosis		child with cystic fibrosis	

[4]

(d) As the body ages, the tissue of the lungs may become less efficient.

(i) Complete the table below to show the potentially harmful effects on lung function of some of the changes associated with ageing.

change associated with ageing	potentially harmful effects on lung function
air spaces enlarge	
elasticity of the alveoli decreases	
immune system becomes less active	

[6]

(ii) Suggest how an elderly person could delay the deterioration in lung function as their body ages.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 22]

6 Mr X is a fifty-year-old teacher who has not been enjoying life as much lately. He is constantly tired and can no longer keep up with his pupils on the games field.

He goes to see his doctor complaining of constant fatigue and shortness of breath.

The doctor discovers that his blood pressure is '150 over 100'.

This causes the doctor some concern, especially as he also notices that Mr X's skin is slightly blue around his lips and nail beds.

(a) (i) Explain what '150 over 100' means.

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

(ii) Explain why Mr X's blood pressure causes the doctor some concern.

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

(b) In this question, one mark is available for the quality of spelling, punctuation and grammar.

The doctor refers Mr X to the cardiac unit of the local hospital.

Further tests reveal that his heart is greatly enlarged and is not pumping blood very well. In addition, his lungs have been damaged.

It is decided that the ideal solution for Mr X would be a heart-lung transplant.

Fig. 6.1 shows the number of donated organs, the number of organ transplants, and the waiting list for organ transplants in the United Kingdom, from 1991 to 2000.

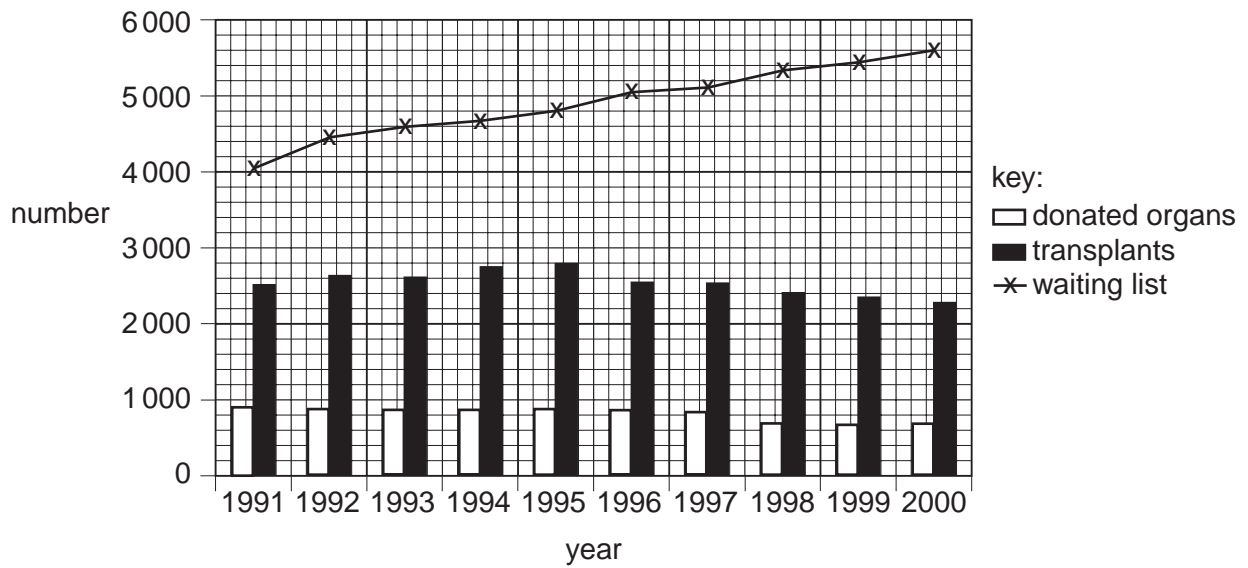


Fig. 6.1

Comment on the trends shown by the data in Fig. 6.1 **and** discuss the reasons why there is such a shortage of donated organs.

trends shown by data

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

reasons for shortage of donated organs

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

[7]

Quality of Written Communication [1]

(c) There are many potential sources of donated organs, each with their own advantages and disadvantages, as shown in the table below.

Complete the table.

source of organ	advantage	disadvantage
<p style="text-align: center;">animal</p>	<p>.....</p> <p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p>
<p style="text-align: center;">non-related living donor</p>	<p>.....</p> <p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p>
<p>.....</p> <p>.....</p>	<p style="text-align: center;">genetically identical</p>	<p style="text-align: center;">family pressure to donate</p>

[5]

[Total: 18]

7 Blood can be grouped using the ABO system and the Rhesus system.

Within the human population, 85% of people have a blood group which is Rhesus positive, whilst the remainder are Rhesus negative.

(a) Explain the meaning of the term *Rhesus positive*.

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

(b) The alleles which cause an individual to be Rhesus positive are autosomal dominant.

(i) Explain what is meant by *autosomal dominant*.

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

(ii) State the probability of a Rhesus negative mother and a heterozygous Rhesus positive father having a Rhesus positive child.

..... [1]

- (c) Individuals who are Rhesus negative lack anti-Rhesus antibodies in their plasma unless they have been exposed to Rhesus positive blood.

A Rhesus negative mother may be exposed to Rhesus positive blood while giving birth to a Rhesus positive child.

Anti-Rhesus antibodies may cross the placenta in the next Rhesus positive pregnancy. This may cause serious damage to the erythrocytes of the foetus, a condition known as haemolytic disease of the newborn.

The erythrocytes of the second Rhesus positive foetus are more seriously damaged than those of the first Rhesus positive foetus.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) If the Rhesus negative mother has a different ABO blood group from her foetus, the next Rhesus positive foetus may not develop haemolytic disease of the newborn.

For example:

- a mother is Rhesus negative and blood group O
- her first child is Rhesus positive and blood group A
- her second child is also Rhesus positive but does not develop haemolytic disease of the newborn.

Suggest why the second child does not develop haemolytic disease of the newborn.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 13]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE

Copyright Acknowledgements:

- Q.2a data Source: Thomas L Halton *et al.*, Potato and French fry consumption and risk of type 2 diabetes in women, *American Journal of Clinical Nutrition*, February 2006, vol. 83, pp. 284–290.
- Fig. 5.1 © J C Revy / Science Photo Library
- Fig. 6.1 Source: UK Transplant, www.uktransplant.org.uk

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 (OCR) 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.