THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Applications of Genetics

2805/02

Candidates answer on the Question Paper

OCR Supplied Materials:
None

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)

Friday 25 June 2010
Afternoon

Duration: 1 hour 30 minutes

OCE/22537

2805022

Candidate Forename		Candidate 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 **90**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Examiner's Use Only:			
1			
2			
3			
4			
5			
6			
Total			

DC (GB/SW) 22537/2

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Answer **all** the questions.

1 Purple buds of the morning glory flower, *Ipomoea*, open into blue flowers. As the flower opens, the pH in the vacuoles of the flower epidermal cells increases.

A mutant purple-flowered morning glory plant carries recessive alleles of a gene, **I**/**i**, coding for a membrane-bound ion pump, and is unable to increase the pH in the vacuoles.

Both normal blue flowers and mutant purple flowers have the same anthocyanin pigment, coded by the dominant allele of the gene **A**/**a**. Plants with the genotype **aa** cannot produce anthocyanin and they have white flowers.

The genes **I**/**i** and **A**/**a** are **not** linked.

(a) List the genotypes of morning glory plants that result in,

(i) blue flowers

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

(ii) purple flowers.

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

(b) Morning glory plants with the genotypes **AAII** and **aaii** were crossed and the resulting F_1 generation were interbred to give an F_2 generation.

On the page opposite, draw a genetic diagram of this cross to show:

- the phenotypes of the parent plants
- the gametes
- the genotypes and phenotypes of the F_1 and F_2 generations.

Give the ratio of phenotypes expected in the F_2 generation on page 3.

genetic diagram:

ratio of F_2 phenotypes .....

..... **[8]**

(c) A small part of the DNA coding for the normal allele, **I**, and mutant allele, **i**, of the gene coding for the ion pump that may increase the pH of the vacuoles is shown below.

Normal allele, **I**: –TTA ATC CTG AGA TTT–

Mutant allele, **i**: –TTA ATC CTG CTG AGA TTT–

(i) State the effect of the mutant allele on the structure of the protein that forms the ion pump.

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

(ii) Explain the likely effects of the mutant allele on the functioning of the ion pump.

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

[Total : 15]

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2 A variety of watermelon with small, sweet, seedless fruit has been produced by selective breeding. The melons also have thin skin and a uniform flavour throughout the fruit.

The selective breeding programme followed the sequence shown in Fig. 2.1.

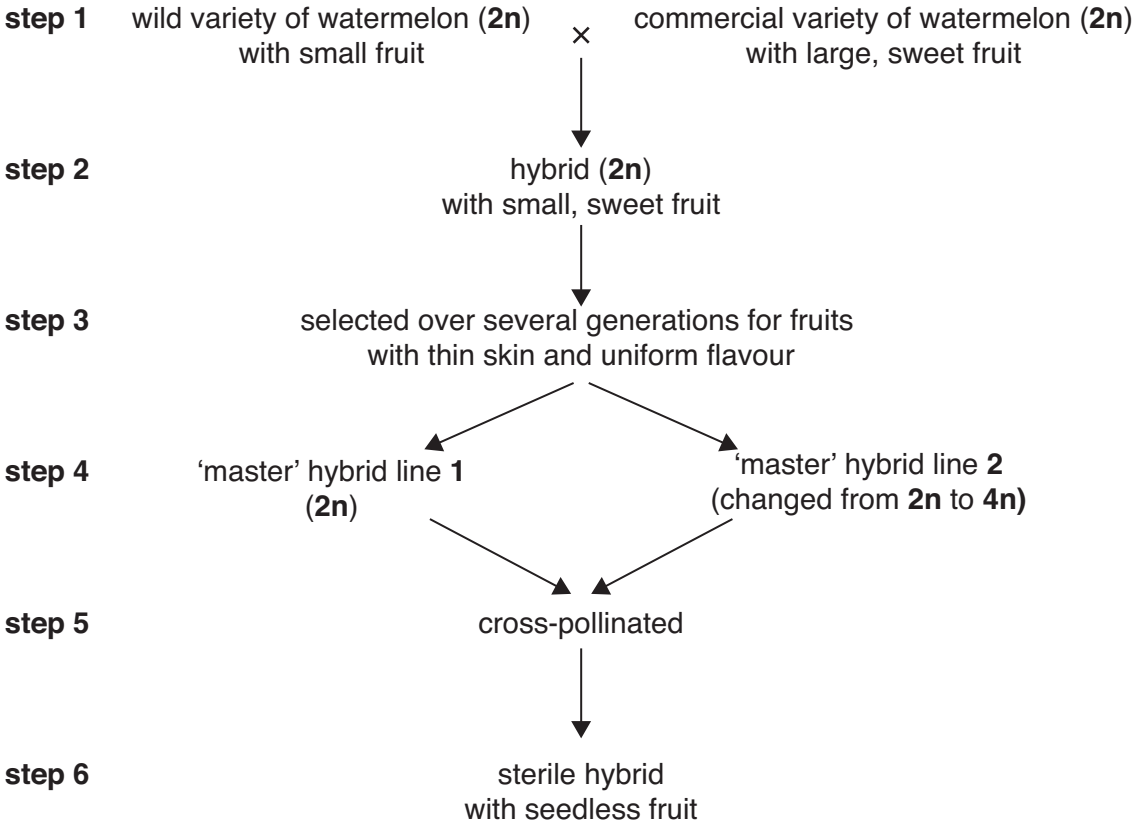

Fig. 2.1

(a) With reference to Fig. 2.1,

(i) explain why several generations were needed in **step 3**

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

(ii) suggest how, in **step 4**, 'master' hybrid line **2** was changed from **2n** to **4n**

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

(iii) describe the process of cross-pollination in **step 5**

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

(iv) explain why the hybrid produced in **step 6** is sterile and seedless.

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

(b) At first, the supply of seeds for growing sterile watermelons with seedless fruit (**step 6**) was very limited. Cloning plants from tissue culture allowed more of these melons to be grown.

(i) Outline the process of cloning plants from tissue culture.

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..... **[5]**

(ii) Explain how using this process could increase the supply of seedless watermelons.

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

[Total : 15]

3 **(a)** The herd of Chillingham cattle lives in isolation in a park in the north of England. The cattle have been studied extensively because the herd has remained viable and fertile despite at least 300 years of inbreeding.

The cattle have never been artificially selected.

Describe briefly the harmful genetic and other effects of inbreeding.

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

(b) DNA from 13 Chillingham cattle that died in one year was analysed at 25 'marker' sites, covering 15 of the 29 autosomal chromosome pairs. All samples showed identical homozygous genotypes at 24 of the 25 sites. Other breeds of cattle show about 70% heterozygosity at these sites.

Suggest, given their genetic homozygosity at the sites analysed, why the Chillingham cattle continue to be viable and fertile.

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(c) Explain the need to conserve rare breeds, such as Chillingham cattle.

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

(d) In this question, one mark is available for the quality of use and organisation of scientific terms.

One way of conserving rare breeds of mammals is by transplanting embryos of the rare breed into surrogate females.

Describe the techniques used in embryo transplantation.

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..... **[6]**

Quality of Written Communication **[1]**

[Total : 15]

4 Restriction enzymes cut DNA molecules only at specific target sites with particular base sequences.

The target sites for the enzymes ***Hae*III**, ***Hpa*II** and ***Sma*I** are shown in Table 4.1. The line drawn across each sequence shows where the enzyme cuts the DNA molecule.

Table 4.1

restriction enzyme	specific target base sequence of DNA
***Hae*III**	-G-G | C-C- -C-C | G-G-
***Hpa*II**	-C | C-G-G- -G-G-C | C-
***Sma*I**	-C-C-C | G-G-G- -G-G-G | C-C-C-

(a) The plasmid (loop of DNA) shown in Fig. 4.1 includes the target site for the enzyme ***Sma*I**.

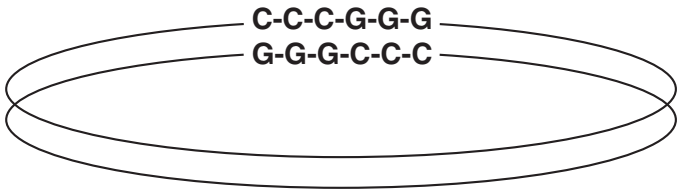

Fig. 4.1

Explain whether or not this sequence can also be cut by the enzymes ***Hae*III** and ***Hpa*II**.

***Hae*III** .....

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***Hpa*II** .....

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

(b) A genetic engineer cuts a plasmid with ***Hpa*II** in order to insert a human gene.

(i) Describe the steps that must then be carried out in order to insert the human gene into the plasmid.

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

(ii) Describe any **differences** in procedure that would be needed if the plasmid had been cut with ***Sma*I**.

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

(c) The human gene inserted into the plasmid codes for a protein growth factor which stimulates the growth of blood vessels. The plasmids are used as a form of gene therapy and are injected into the heart to encourage blood vessel growth in diseased heart muscle with a poor blood supply.

(i) Explain briefly what is meant by *gene therapy*.

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

(ii) Suggest **one** benefit and **one** potential hazard of the gene therapy described in **(c)**.

benefit .....

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hazard .....

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

[Total : 15]

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

Describe how antibiotic resistance arises **and** spreads in a bacterial population.

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Quality of Written Communication **[1]**

(b) An investigation was carried out to see whether the development of antibiotic resistance in bacteria is related to the extent of antibiotic use.

Penicillin belongs to a group of antibiotics called β-lactams. A record was kept of all the β-lactam antibiotics given to 484 young children over a two-year period. Nasal swabs were collected from the children at intervals. All bacteria found were tested for resistance to penicillin.

The results of the investigation are shown in Fig. 5.1.

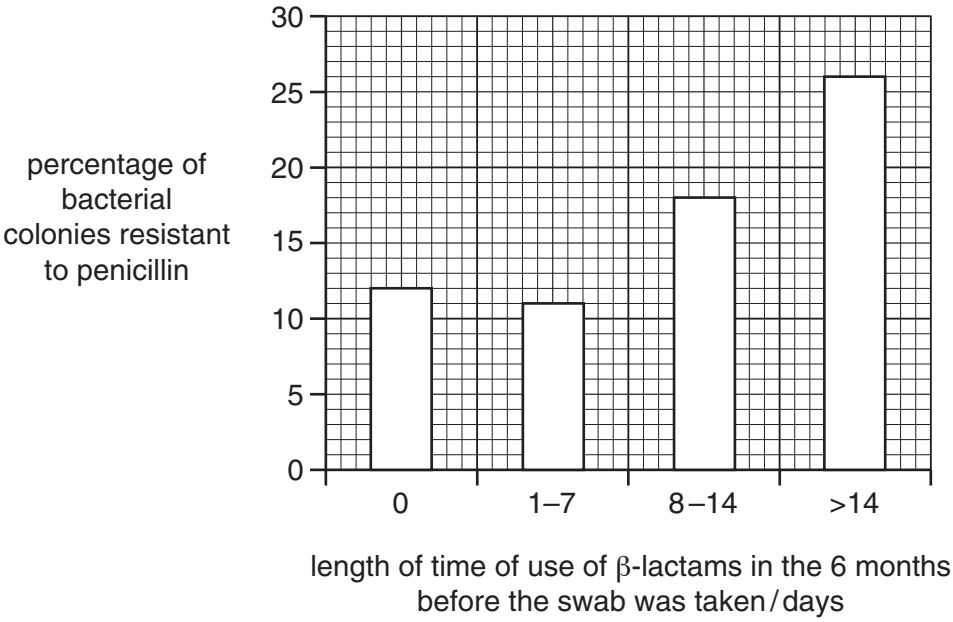

Fig. 5.1

Using the data in Fig. 5.1,

(i) describe the relationship between the length of time the β-lactam antibiotics were used and the percentage of penicillin-resistant bacterial colonies

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

(ii) explain the presence of penicillin-resistant bacteria in swabs from children that had **not** been treated with β-lactam antibiotics.

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(c) Suggest **two** ways of reducing the numbers of penicillin-resistant bacteria.

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2 .....

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[Total : 15]

6 **(a)** Explain how Huntington's disease (HD) is inherited.

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Some mice show the symptoms of Huntington's disease (HD mice). Normal mice and HD mice were both kept in two environments from the age of four weeks:

- standard cages
- 'environmentally-enriched' cages with cardboard, paper and plastic objects which were changed at two-day intervals.

Each mouse's coordination was tested at intervals, from eight weeks of age, by observing whether or not it could turn round when placed on a horizontal rod. The percentage of mice **failing** the test was recorded and is shown in Fig. 6.1.

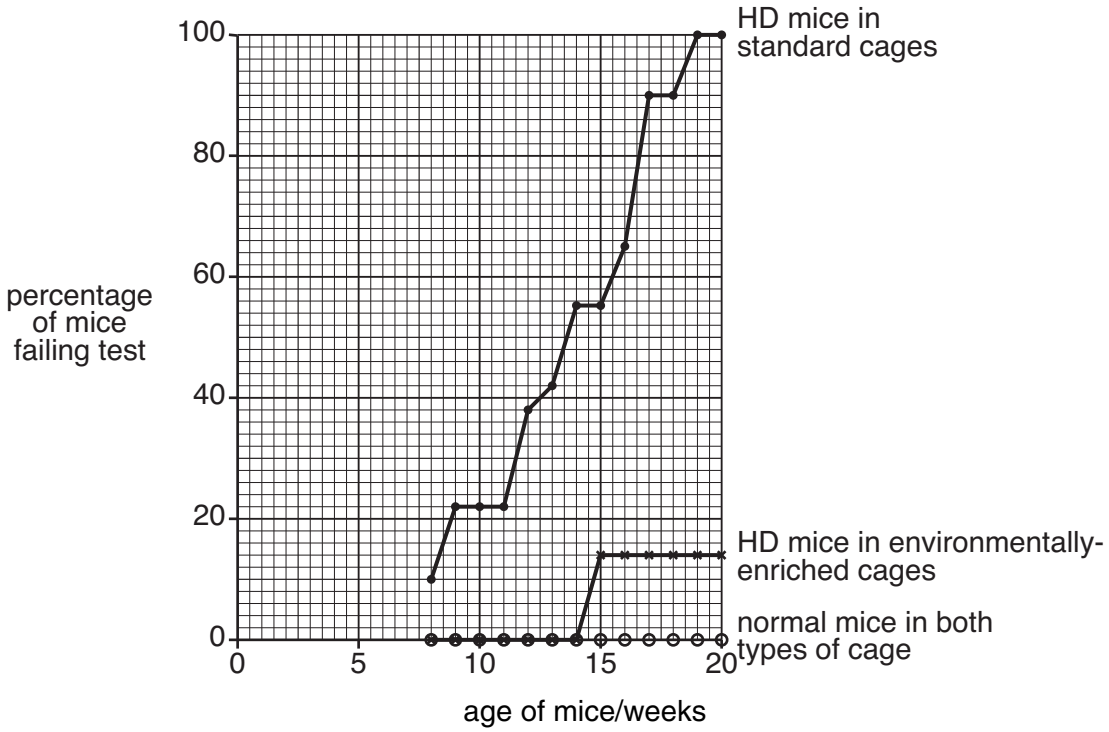

Fig. 6.1

(b) With reference to Fig. 6.1, compare the coordination of normal mice and HD mice.

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(c) Suggest how the results of this research might be applied to the treatment of the symptoms of HD in humans.

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

(d) A genetic test for HD exists. A young man whose paternal grandfather suffered from HD decides to be tested. His father does not have any symptoms of HD.

Describe **one** advantage and **one** disadvantage of genetic screening for HD in this family.

advantage .....

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disadvantage .....

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

[Total : 15]

END OF QUESTION PAPER

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