OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY 2805/02

Applications of Genetics

Thursday **20 JUNE 2002** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers, in blue or black ink, in the spaces on the question paper.
- Read each question carefully before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks 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	15	
2	16	
3	14	
4	14	
5	15	
6	16	
TOTAL	90	

This question paper consists of 15 printed pages and 1 blank page.

Registered Charity Number: 1066969
[Turn over

Answer **all** questions.

1 **(a)** Explain briefly what is meant by the term *epistasis*.

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In *Primula*, the dominant allele, **A**, of a gene for anthocyanin pigment production gives magenta coloured flowers. The recessive allele, **a**, gives yellow coloured flowers. The dominant allele, **B**, of another unlinked gene inhibits the effect of allele **A**, whilst the recessive allele, **b**, has no effect. Plants in which allele **A** is inhibited by allele **B** have yellow flowers.

A magenta-flowered plant with the genotype **AAbb** was crossed with a yellow-flowered plant with the genotype **aaBB**. The resulting $\mathbf{F_1}$ generation were interbred to give an $\mathbf{F_2}$ generation.

(b) Draw a genetic diagram to show the gametes and the genotypes and phenotypes of the $\mathbf{F_1}$ **and** $\mathbf{F_2}$ generations of this cross.

[10]

In a different cross, a magenta-flowered plant with the genotype **AAbb** was crossed with a yellow-flowered plant, giving offspring with magenta or yellow flowers in a ratio of 1 : 1.

(c) State **one** possible genotype of the yellow-flowered parent in this cross.

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(d) Explain briefly **one** mechanism by which allele **B** could inhibit the expression of allele **A**.

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[Total : 15]

2 The Human Fertilisation and Embryology Authority (HFEA) recommends that three embryos or fewer should be transferred into the uterus after *in vitro* fertilisation (IVF) procedures. The single and multiple pregnancies that occurred in the UK in 1999 as a result of embryo transfers are shown in Table 2.1.

Table 2.1

number of embryos transferred	number of attempted implantations	number of pregnancies			pregnancies / % of attempted implantations	multiple pregnancies / % of pregnancies
		single	twin	triplet or greater		
1	2864	253	5	0	9.0	
2	11984	2083	656	11	23.0	
3	13742	2347	974	271	26.0	34.7

(a) Complete Table 2.1 by calculating multiple pregnancies as a percentage of pregnancies. Write your answers in the shaded part of Table 2.1. [2]

(b) With reference to Table 2.1, explain

(i) why clinics transfer three embryos if they are available;

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(ii) why the HFEA hopes to reduce the maximum number of embryos transferred from three to two.

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(c) Describe the techniques used in embryo transplantation in humans and other mammals. (*In this question, 1 mark is available for the quality of written communication.*)

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QWC [1]

[Total : 16]

3 **(a)** Explain how inbreeding may produce the harmful effects known as inbreeding depression.

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Inbreeding depression was investigated in two closely related species of annual plants. *Mimulus micranthus* usually reproduces by self-fertilisation, but *M. guttatus* is normally an outbreeder.

Seeds from each species were collected from wild plants and then self-fertilised for several generations. Five features of the final generations were measured for the presence or absence of inbreeding depression, by comparison with the original wild plants. The results are shown in Table 3.1.

Table 3.1

	presence or absence of inbreeding depression	
features measured	*M. micranthus*	*M. guttatus*
total flowers produced	present	present
above-ground biomass	present	present
ovule production	absent	present
pollen viability	absent	present
pollen production	absent	present

(b) With reference to the passage and to Table 3.1, explain why *M. micranthus* shows fewer signs of inbreeding depression than *M. guttatus*.

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One way of counteracting inbreeding depression is by establishing a gene bank.

(c) List **four** different ways of maintaining a gene bank.

1. .....

2. .....

3. .....

4. ..... [4]

(d) Explain briefly why it is desirable to maintain gene banks.

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[Total : 14]

4 Crop plants genetically engineered to express an insecticidal toxin (*Bt* toxin) derived from a bacterium, *Bacillus thuringiensis*, are grown on millions of hectares in the USA.

The pink bollworm moth, which is a major pest of cotton plants, shows resistance to *Bt* toxin produced by genetically engineered cotton plants (*Bt* cotton). Resistance to *Bt* toxin in the moth is caused by a **recessive** allele of a gene.

Resistance is more usually caused by a dominant allele.

(a) Compare the spread in a population of resistance that is caused by a recessive allele with that caused by a dominant allele.

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A strategy to prevent the evolution of *Bt* resistance in the pink bollworm moth is to plant 'refuges' of *non-Bt* cotton amongst the genetically engineered cotton.

(b) Explain how such a strategy could help to slow down the evolution of resistance.

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The time taken for emergence of pink bollworm moths resistant to *Bt* toxin was investigated on *Bt* cotton and *non-Bt* cotton and compared with that of susceptible (non-resistant) moths on *non-Bt* cotton. The results of the investigation are shown in Fig. 4.1.

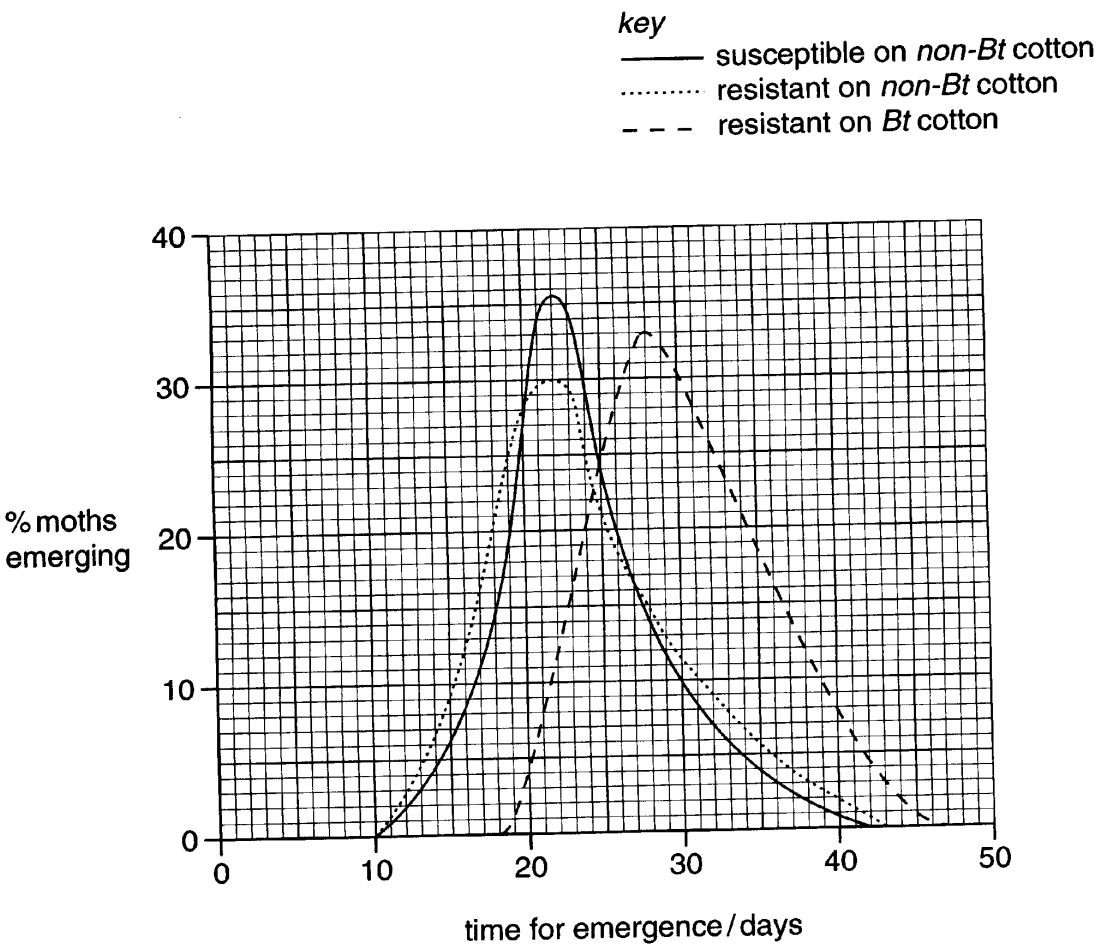

Fig. 4.1

(c) With reference to Fig. 4.1, compare times taken for emergence of

(i) susceptible and resistant moths on *non-Bt* cotton;

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(ii) susceptible moths on *non-Bt* cotton and resistant moths on *Bt* cotton.

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The average survival time of male pink bollworm moths is less than a week and 80% of moths mate within three days of emerging. The time of emergence of the different populations will determine their ability to interbreed.

(d) State **two** implications of this for the spread of *Bt* resistance in pink bollworm moths.

1. .....

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2. .....

..... [2]

[Total :14]

5 **(a)** **(i)** Explain briefly what is meant by *recombinant DNA*.

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(ii) Outline the role of restriction enzymes (restriction endonucleases) in forming recombinant DNA.

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(b) Describe **one** use of genetic engineering in agriculture, including reference to **one** potential benefit and **one** potential hazard. (*In this question, 1 mark is available for the quality of written communication.*)

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QWC [1]

[Total : 15]

6 **(a)** Describe the symptoms of Huntington's disease (HD) and explain briefly how HD is inherited.

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Some mice show the symptoms of Huntington's disease (HD mice). Normal and HD mice were 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 seeing 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.

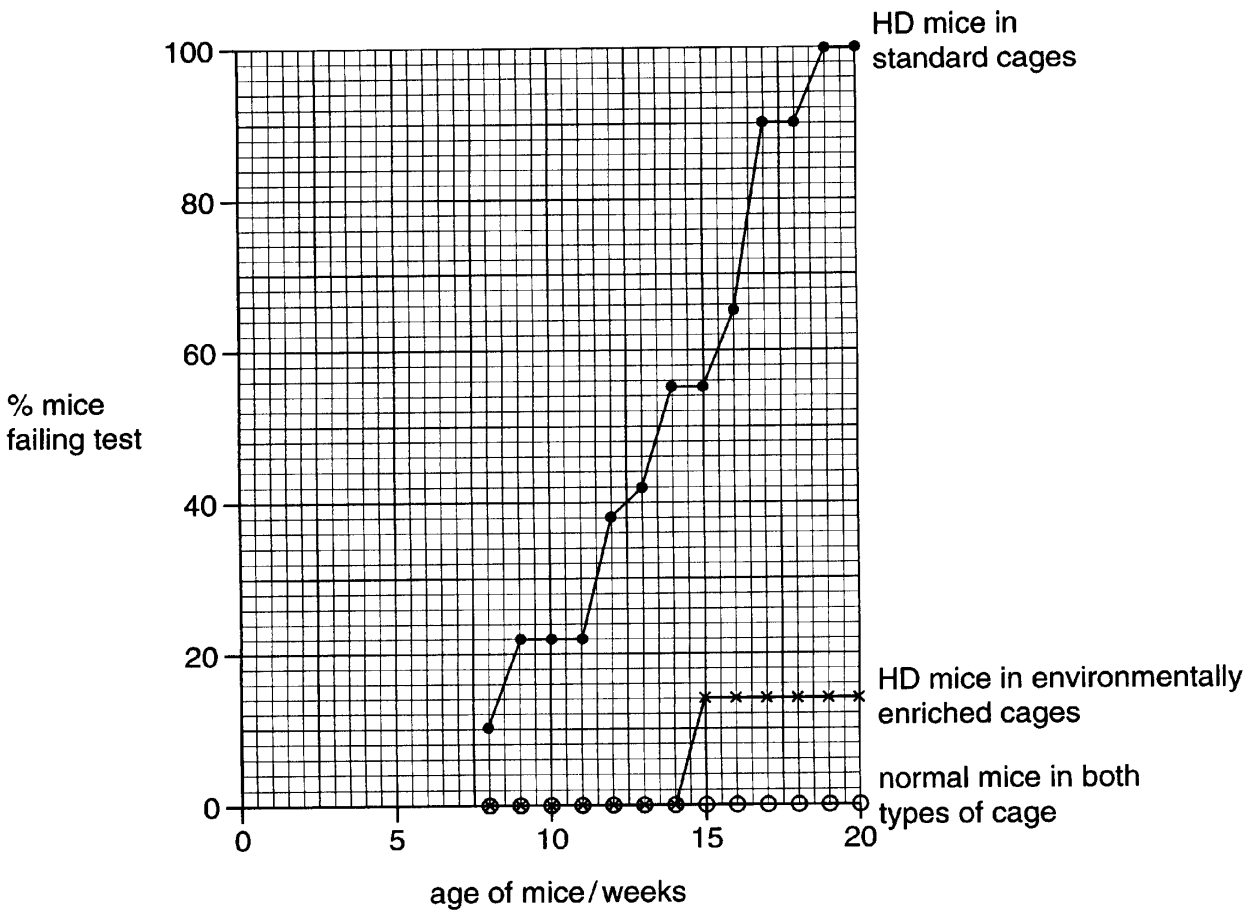

Fig. 6.1

(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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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.

(d) State **one** advantage and **one** disadvantage of genetic screening for HD in this family.

advantage .....

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disadvantage .....

..... [2]

[Total : 16]