OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY

2805/02

Applications of Genetics

Monday **31 JANUARY 2005** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator
Ruler (cm/mm)

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 provided on the question paper.
- Read the questions 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	15	
3	15	
4	15	
5	15	
6	15	
TOTAL	90	

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

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For Examiner's Use

Answer **all** the questions.

1 **(a)** Cats with either black or white fur are common in Britain; brown fur is rarer. The dominant allele, **B**, of one gene gives black fur and the recessive allele, **b**, brown fur.

Many of the white cats carry a dominant allele, **A**, of a second gene which inhibits pigment production no matter which pigment-producing alleles are present in the genotype. The recessive allele, **a**, has no effect on fur colour.

Genes **A/a** and **B/b** are not linked and neither is on the X chromosome.

(i) State the fur colour of cats with the following genotypes:

AaBB.....

aaBB .....

Aabb .....

aabb .....[4]

(ii) State the name given to this type of gene interaction.

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(iii) Suggest how one gene may inhibit the action of another.

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(b) Two white cats produced a litter of kittens with three different coat colours: white, black and brown.

(i) State **one** possible genotype for **each** of the two white parents and explain the reasons for your choice.

You may use the space below for rough work, if needed.

genotypes of parents .....

explanation .....

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(ii) State the ratio of phenotypes this pair of cats would be expected to produce in time, when the fur colour of several litters of kittens could be recorded.

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[Total: 15]

For Examiner's Use

2 A variety of watermelon with small, sweet, seedless fruit has been produced by selective breeding in the USA. The melons, which also have thin skin and a uniform flavour throughout the fruit, first went on sale in 2002. The selective breeding programme followed the sequence shown in Fig. 2.1.

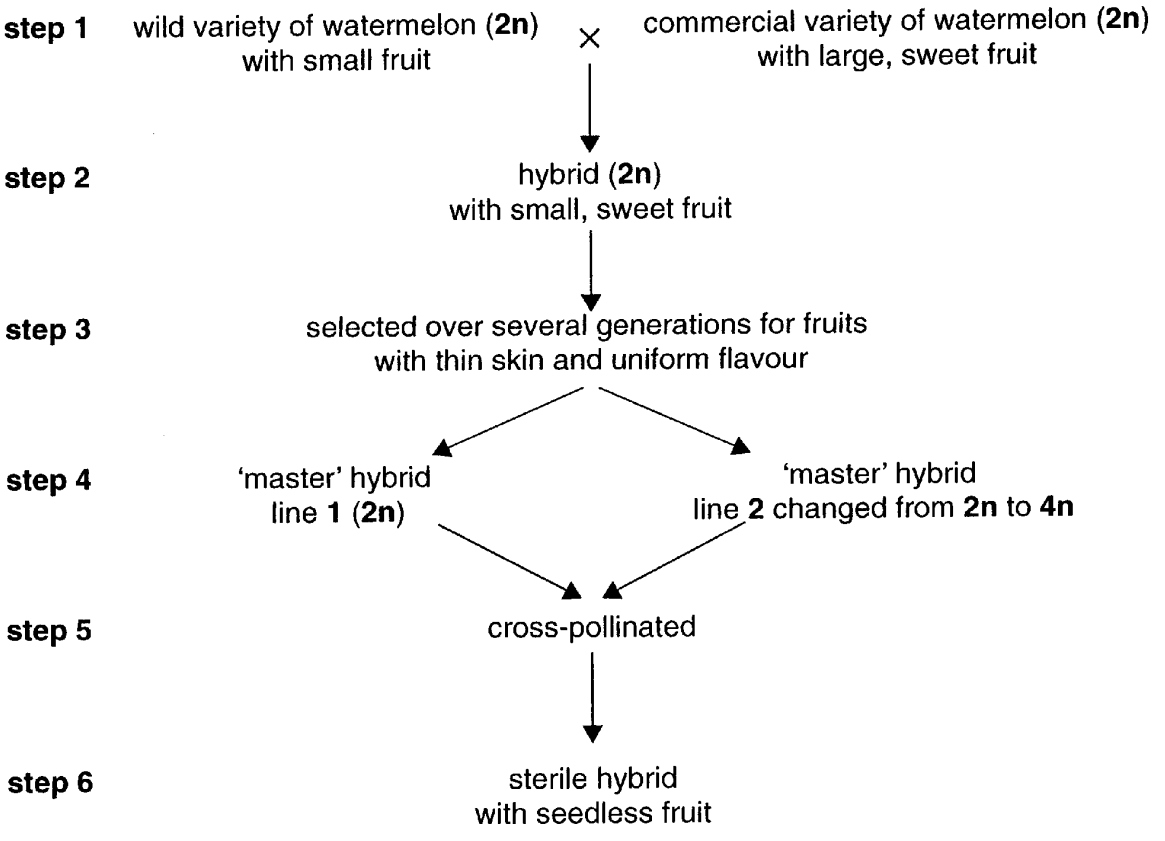

Fig. 2.1

(a) With reference to Fig. 2.1,

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

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

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

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

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

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[Total: 15]

For Examiner's Use

3 **(a)** Japanese Wagyu bulls are selected for breeding after progeny testing their male offspring for meat quality and quantity.

Explain what is meant by *progeny testing.*

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(b) Estimates of heritability for various phenotypic traits in Wagyu cattle are shown in Table 3.1.

Table 3.1

phenotypic trait	heritability
A 'marbling' of meat with fat	0.49
B growth rate	0.38
C thickness of subcutaneous fat	0.15
D area of 'rib eye' meat	0.02

State which of the Wagyu phenotypic traits shown in Table 3.1 could most easily be improved by selective breeding. Explain your answer.

phenotypic trait .....

explanation .....

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.....[3]

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

Many phenotypic traits of Japanese Wagyu cattle show continuous variation.

Describe the differences between continuous and discontinuous variation of the phenotype **and** explain the genetic basis of these differences.

Credit will be given for the use of examples.

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Quality of Written Communication [1]

[Total: 15]

For Examiner's Use

4 **(a)** Explain how embryo transplantation can be used to help preserve an endangered species of mammal.

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(b) The embryos of some species of mammal cannot be stored in liquid nitrogen because they are damaged by freezing and thawing. This may be related to the large number of lipid droplets in the cytoplasm of their cells.

Pig embryos at the two or four cell stage were centrifuged so that the lipid droplets formed a layer which was then removed by means of a micropipette. Lipid was not removed from a control group of embryos.

Some embryos were then frozen at the two or four cell stage. Others were allowed to develop to eight cells before being frozen. Some embryos were not frozen.

After thawing the frozen embryos, all were cultured *in vitro* to see if they could develop into a ball of cells suitable for implantation into a surrogate female.

The development of five groups of embryos, **A** to **E**, treated in different ways, is shown in Table 4.1. In the table, a tick (✓) indicates that the treatment was performed and a cross (✗) that it was not.

Table 4.1

	treatment of embryos			
group of embryos	lipid removal	freezing	stage of development when frozen	percentage of embryos that developed to a ball of cells
A	✓	✗	–	78
B	✓	✓	2 or 4 cell	31
C	✗	✓	2 or 4 cell	0
D	✓	✓	8 cell	64
E	✗	✓	8 cell	0

Using the data in Table 4.1,

(i) explain the role of the embryos forming group **A** in this investigation;

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(ii) describe the effect of lipid removal on the development of embryos after freezing and thawing;

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(iii) describe **and** explain the differences in subsequent development of freezing embryos with eight smaller cells, rather than two or four larger cells.

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(c) The storage of frozen mammalian embryos is one type of gene bank.

List **three** other types of gene bank.

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[Total: 15]

5 **(a)** A number of different crop plants have been genetically engineered to express a gene for an insecticidal toxin (*Bt* toxin) from a bacterium, *Bacillus thuringiensis*, that kills many insect species.

In China, *Bt* cotton has been grown since 1997. A survey at the end of 2001 showed that it was being grown by over two million farmers on fields totalling more than 7000 km^2.

Some further findings of the survey are shown in Table 5.1.

Table 5.1

survey finding	percentage of reported cases of insecticide poisoning among cotton farmers	cost of producing 1kg of cotton / US $
farmers growing non-*Bt* cotton	22	2.23
farmers growing *Bt* cotton	5	1.61

Comment on the findings of the survey.

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(b) Chinese scientists realise that it will only be a matter of time before insects develop resistance to *Bt* toxin.

Explain how resistance to *Bt* toxin could arise and spread in an insect population.

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(c) Wild sunflowers are considered to be weeds by many farmers in the USA. They hybridise readily with sunflowers grown as crops.

Two experiments involving wild sunflowers gave the following results:

- Up to 42% of the seeds produced by wild sunflowers growing at the margins of a commercial sunflower field were hybrids.
- The hybrid offspring of wild sunflowers and experimental sunflowers produced 50% more seeds than ordinary wild sunflowers. The experimental sunflowers had been genetically engineered to produce insecticide.

Discuss the potential ecological **hazards** of growing a genetically engineered crop, such as sunflowers.

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[Total: 15]

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

Describe **and** explain the significance of genetic compatibility in transplant surgery.

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Quality of Written Communication [1]

(b) Babies born with severe combined immune deficiency (SCID) have no defence against common infections and quickly become ill when the protection from maternal antibodies is lost.

SCID is caused by a mutant allele of the gene coding for an enzyme, adenosine deaminase (ADA).

Gene therapy for SCID has been carried out using the procedure shown in Fig. 6.1.

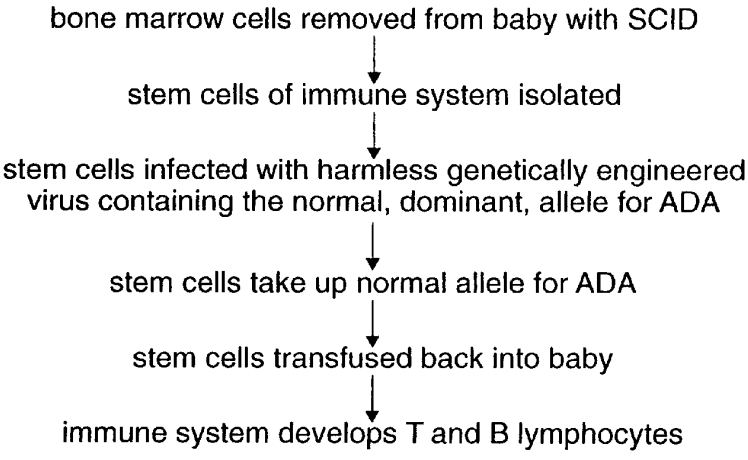

Fig. 6.1

(i) Describe how the DNA of the harmless virus referred to in Fig. 6.1 can be genetically engineered to carry the normal allele of the human gene for ADA.

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Question 6 continued over the page

(ii) Explain why it is easier to perform gene therapy when the normal allele is the dominant allele of the gene concerned.

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[Total: 15]

END OF QUESTION PAPER