OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

BIOLOGY 2805/02

Applications of Genetics

Friday **24 JUNE 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.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 **(a)** The colour of the spines on the stems of raspberry plants are controlled by two genes, **A/a** and **B/b**. The genes are on different pairs of chromosomes.

Allele **A** produces a pink anthocyanin pigment in the spines. Allele **B** has no effect by itself, but increases the colour produced by allele **A** to give red spines. Alleles **a** and **b** have no effect on spine colour. In the absence of anthocyanin, the spines are green.

(i) State the colour of the spines of raspberry plants with the following genotypes:

Aabb .....

aaBB .....[2]

(ii) Suggest how allele **B** may alter the expression of allele **A**.

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(b) Plants with the genotypes **AaBb** and **aabb** were cross-pollinated. The resulting seeds were sown and the seedlings grown until their stems developed spines.

(i) Draw a genetic diagram of this cross to show:

- the phenotypes of the parents
- the gametes
- the genotypes and phenotypes of the offspring
- the ratio of different phenotypes expected in the offspring.

For Examiner's Use

ratio of phenotypes of offspring .....

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(ii) Explain what differences in the phenotypic ratio would be expected if genes **A/a** and **B/b** were on the same homologous pair of chromosomes, as shown in Fig. 1.1.

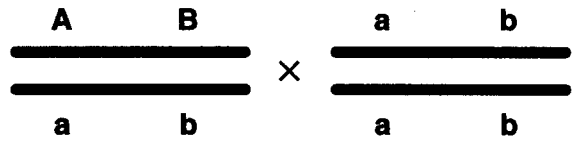

Fig. 1.1

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[Total: 15]

2 Much of the world's irrigated farmland has become too salty for growing many crops.

Two varieties of tomato plant have been found that are tolerant of salty soil.

- Variety 1 can tolerate high concentrations of NaCl in its tissues but has little ability to prevent the ions from entering the plant. The tomatoes produced are large, but not very tasty.
- Variety 2 cannot tolerate high concentrations of NaCl in its tissues, but is able to prevent excess ions from entering the plant. The tomatoes produced are small, but tasty.

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

Describe a programme for selectively breeding these two varieties to give tomato plants with high salt tolerance and large, tasty tomatoes.

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Quality of Written Communication [1]

(b) Another variety of tomato plant has been genetically engineered to grow in a concentration of 0.2 mol dm^{-3} NaCl by increasing the expression of a gene coding for a protein in the vacuole membrane that pumps excess Na^+ into the vacuoles of the leaf cells.

(i) Explain how such proteins pump ions into a plant cell vacuole.

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(ii) Describe the advantages of producing salt tolerant tomato plants by genetic engineering rather than by selective breeding.

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[Total: 15]

3 **(a)** By the 1960s, the grey wolf was considered to be extinct in southern Scandinavia, although populations existed in Finland and Russia.

In the early 1980s, a small breeding pack was started by one male and one female about 1000 km from the other known wolf populations. The pack remained at about 10 individuals for some years and showed the effects of inbreeding.

Describe the effects of inbreeding within a small population.

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In 1991, this wolf population suddenly started to increase and by 2002 consisted of about 100 wolves. Genetic fingerprinting showed that 68 of the 72 wolves born between 1993 and 2002 can trace their ancestry to a single immigrant male.

(b) Suggest **two** different reasons for the sudden increase in population numbers after the arrival of this single immigrant male.

1 .....

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2 .....

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

Describe the process of genetic fingerprinting and explain how it can show that individuals share a common ancestry.

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For Examiner's Use

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Quality of Written Communication [1]

[Total: 15]

4 **(a)** Explain the need to maintain gene banks of frozen mammalian spermatozoa (sperm) for future use.

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(b) An experiment was performed into the sensitivity of human sperm to different rates of cooling to −196 °C.

The mean percentage of sperm with normal mitochondrial activity and normal motility after freezing and thawing was determined. All sperm were thawed at a constant rate of 1 °C per minute.

The results are shown in Fig. 4.1.

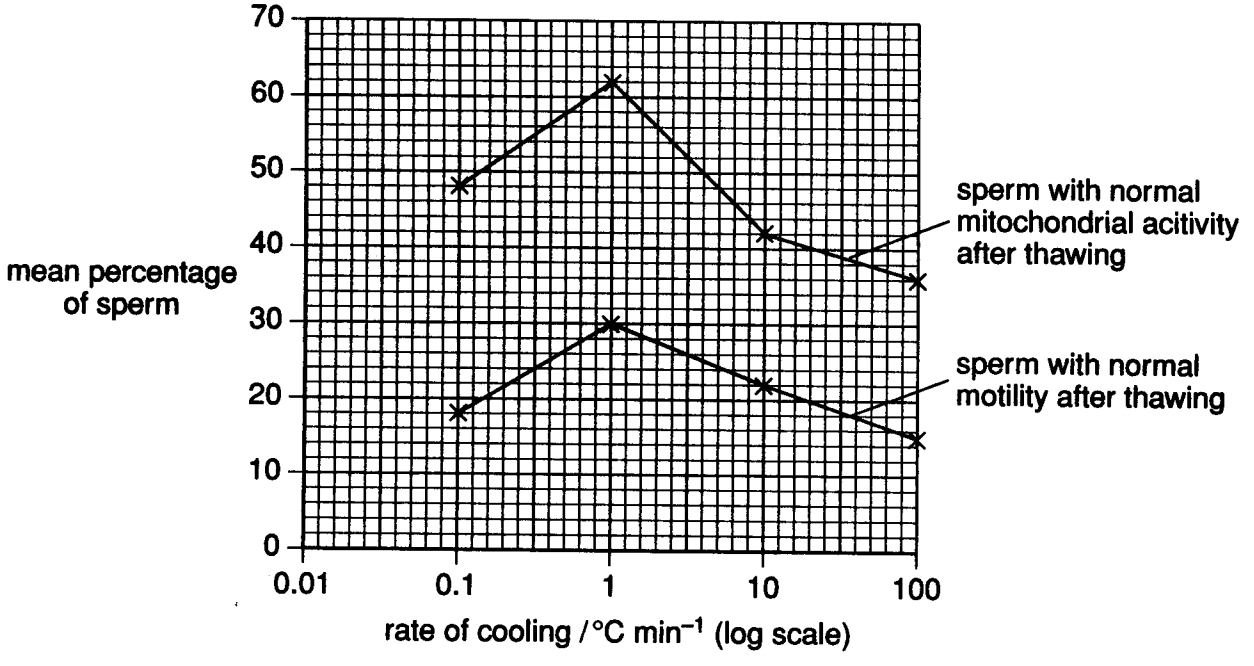

Fig. 4.1

With reference to the information in Fig. 4.1,

(i) state the optimum rate of cooling human sperm for storage and later use;

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(ii) describe how sperm may be damaged during the processes of freezing and thawing;

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(iii) suggest why the percentage of sperm with normal motility is lower than that with normal mitochondrial activity after freezing and thawing.

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(c) State **two** advantages and **two** disadvantages of using artificial insemination (AI) in breeding farm animals.

advantages

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2 .....

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disadvantages

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[Total: 15]

5 **(a)** **(i)** Outline how resistance to an insecticide (pesticide) can arise and spread in a population of mosquitoes.

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(ii) Explain briefly why efforts to control the spread of malaria are hindered by such insecticide resistance.

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(b) Malarial parasites infect mosquitoes and are then transmitted to humans. An artificial gene has been synthesised to reduce transmission of malarial parasites by mosquitoes. Recombinant DNA containing this gene was constructed using enzymes and inserted into mosquitoes.

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

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(ii) Describe briefly the use of enzymes in constructing recombinant DNA.

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6 (a) Cystic fibrosis (CF) in humans is caused by mutations of a gene coding for a transmembrane protein (CFTR) which acts as an ion pump. A large number of different mutations of the gene have been found.

(i) Explain what is meant by a *gene mutation*.

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(ii) Explain how CF is inherited.

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(iii) Describe briefly the symptoms of CF.

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(iv) Explain why genetic screening for CF may not confirm the presence of a mutation.

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(b) CFTR regulates the transport of hydrogencarbonate ions (HCO_3^-) across the plasma (cell surface) membrane. Tissues that express the normal CFTR allele secrete alkaline fluids, whereas the secretions of tissues expressing some mutant alleles are acidic.

The transport of HCO_3^- by epithelial cells expressing the normal CFTR allele was compared with that by epithetical cells expressing one of 10 different mutant CFTR alleles. The results are shown in Table 6.1.

In the table, normal digestive functioning of the pancreas associated with a particular allele is indicated by a tick (✓) and absence of normal functioning by a cross (✗).

Table 6.1

CFTR allele	percentage HCO_3^- transport in comparison with normal allele	normal digestive functioning of pancreas
normal	100	✓
mutation 1	6	✗
2	4	✗
3	0	✗
4	3	✗
5	1	✗
6	33	✓
7	41	✓
8	46	✓
9	37	✓
10	44	✓

With reference to the information given, explain why some mutant CFTR alleles allow normal digestive functioning of the pancreas and others do not.

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[Total: 15]

END OF QUESTION PAPER