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)

Monday 25 January 2010
Afternoon

Duration: 1 hour 30 minutes

OCE/12613

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 may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **16** pages. Any blank pages are indicated.

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

Answer **all** the questions.

1 Three anthocyanin pigments, responsible for flower colour in several different species of plants, are synthesised by the same metabolic pathway.

The pathway is shown in Fig. 1.1.

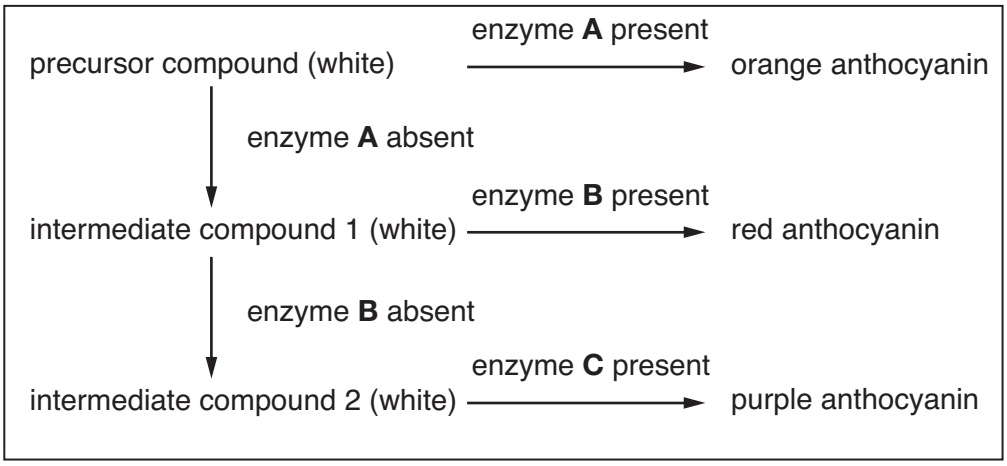

Fig. 1.1

Enzymes **A**, **B** and **C** are coded for by the dominant alleles of the three genes ***A/a***, ***B/b*** and ***C/c*** respectively.

(a) With reference to Fig. 1.1, deduce the flower colours of plants with the following genotypes:

genotype	*flower colour*
AaBbCC	.....
aaBbcc	.....
aabbcc	.....

[3]

(b) Enzyme **A** is not found in *Petunia* plants. In order to produce *Petunia* plants with orange flowers, allele ***A*** was transferred from maize plants to *Petunia* plants known to have the genotype ***bbcc***.

(i) Explain why the genotype ***bbcc*** of *Petunia* was chosen for this procedure.

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(ii) Suggest **two** reasons why genetic engineering, rather than selective breeding, was used to produce orange-flowered *Petunia* plants.

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

The flower colours produced by the metabolic pathway shown in Fig. 1.1 are an example of **discontinuous** variation of the phenotype.

Describe the difference between continuous and discontinuous variation **and** explain the genetic basis of each.

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Quality of Written Communication **[1]**

[Total: 15]

2 When cattle are selectively bred for high milk yield, the sequence of events shown below may be followed.

a pedigree bull is selected by means of progeny testing
↓
sperm samples are collected from the bull and stored
↓
a pedigree cow with high milk yield is induced to superovulate
↓
the cow is artificially inseminated
↓
embryos are collected from the uterus
↓
the embryos are implanted into surrogate cows

(a) Explain how progeny testing can be used to select a bull for this breeding programme.

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(b) Describe how samples of sperm are stored.

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(c) Explain how surrogate cows are prepared to ensure successful implantation of an embryo.

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(d) Explain why it is important for the breeder to know that the heritability of milk yield in cattle is about 0.45.

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(e) State two **differences** between the processes of selective breeding and evolution.

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[Total: 15]

3 **(a)** One of the uses of cloning plants from tissue culture is as a gene bank.

Explain:

(i) what is meant by a *gene bank*;

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(ii) why growing plantlets from a callus in tissue culture results in a clone.

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(b) Equal masses of tobacco plant callus were cultured for four weeks on media containing different concentrations of two plant growth regulators, auxin and cytokinin. The results are shown in Table 3.1.

Table 3.1

treatment	concentration of plant growth regulators / mg dm^{-3}		effect of plant growth regulators on callus growth
	auxin	cytokinin	
A	2.00	0.00	little or no growth
B	2.00	0.02	growth of roots
C	2.00	0.20	increased growth of callus with no differentiation
D	2.00	0.50	growth of shoots
E	0.00	0.20	little or no growth

With reference to Table 3.1,

(i) describe the effects of auxin and cytokinin on callus growth;

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(ii) suggest how shoots, developed from callus in treatment **D**, can be turned into plantlets.

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(c) When taking samples of plant tissue for storage in a gene bank, it is essential to avoid fungal or bacterial contamination. This is particularly difficult when samples are being taken in the wild in tropical countries.

Two different sampling methods were compared in Trinidad:

- discs were cut from leaves that had been wiped with a dilute solution of bleach
- stem tissues were extracted in a sterile hypodermic syringe.

Samples were taken at three different times of year and placed on a growth medium containing **no** fungicide or antibiotic. The results are shown in Table 3.2.

Table 3.2

sample	time of year	percentage of cultured samples with fungal or bacterial contamination
leaf disc	January	91
	April	92
	August	95
stem tissue	January	26
	April	40
	August	36

Compare the effects of the different methods **and** times of sampling on fungal or bacterial contamination of the cultured samples.

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[Total: 15]

4 Common groundsel, *Senecio vulgaris*, is a weed that is often found in large numbers on cultivated land. It was the first plant species to develop resistance to triazine herbicides. This resistance is the result of a gene mutation in the chloroplast DNA. Since its first appearance, triazine resistance has spread very rapidly in groundsel populations.

(a) Explain the rapid spread of herbicide resistance in a weed such as groundsel.

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(b) Each chloroplast in a plant leaf contains many copies of chloroplast DNA. This DNA can be extracted, treated with a restriction enzyme and then subjected to electrophoresis.

Describe:

(i) the action of a restriction enzyme;

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(ii) what happens to samples of DNA during electrophoresis.

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(c) DNA was extracted from the chloroplasts of triazine-susceptible and triazine-resistant groundsel plants. Equivalent lengths of DNA, including the site of the mutation, were isolated from each extract and then treated with the restriction enzyme *Mae*I prior to electrophoresis. The resulting electrophoresis gel, after staining the DNA, is shown in Fig. 4.1.

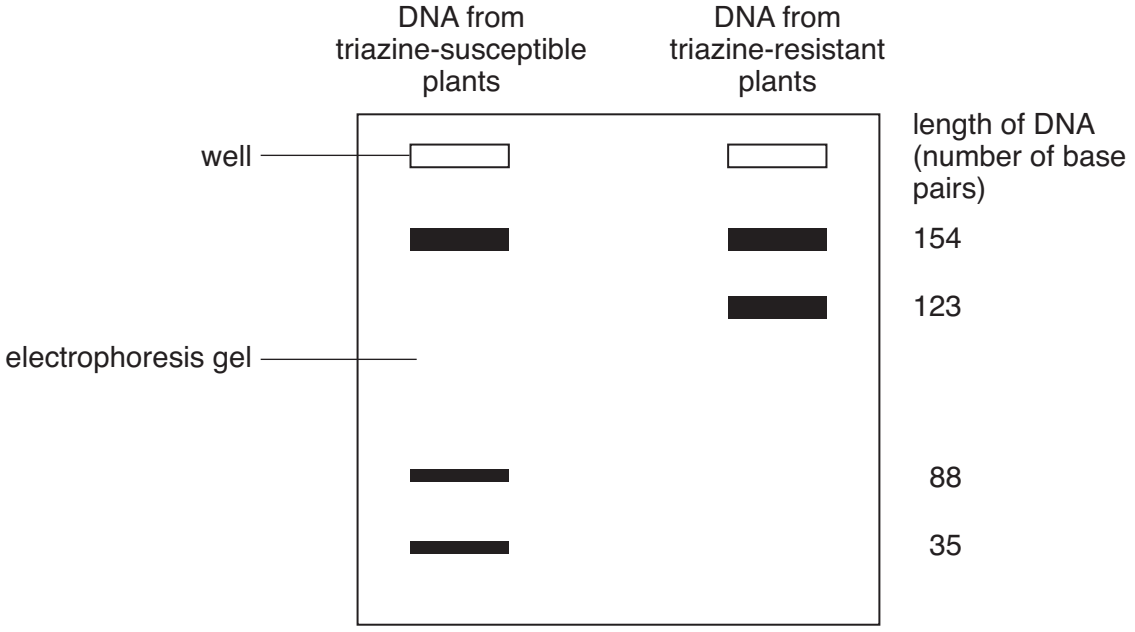

Fig. 4.1

With reference to Fig. 4.1,

(i) state, giving a reason, whether the mutation giving resistance to triazine is a deletion, a substitution or an addition;

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(ii) explain the difference in banding pattern between DNA from triazine-susceptible and triazine-resistant plants;

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(iii) suggest **one** way in which the mutation could give resistance to triazine.

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[Total: 15]

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

Describe the inheritance of cystic fibrosis (CF) in humans.

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Quality of Written Communication **[1]**

(b) Heterozygotes for the most common mutation causing CF may be more resistant to bacterial infections of the gut than homozygotes for the normal allele.

The bacterium, *Salmonella typhi*, which causes typhoid fever in humans can infect mouse gut cells. Mouse gut epithelial cells were genetically engineered to express either the normal or the mutant allele of the human CF gene. The two types of cell were grown in tissue culture. Cultures of each cell type were separately incubated with three different strains of *S. typhi*.

The numbers of bacteria taken up by the cells are shown in Fig. 5.1.

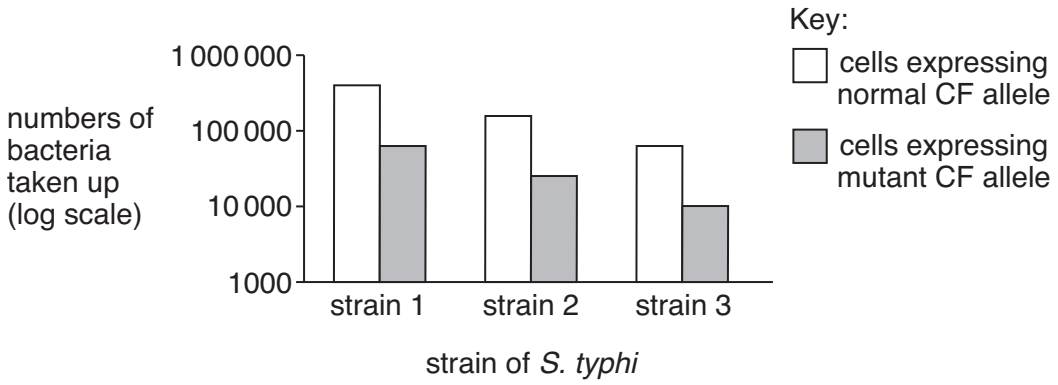

Fig. 5.1

With reference to Fig. 5.1,

(i) compare the effects of the normal and mutant alleles of the human CF gene on the number of bacteria taken up by mouse gut epithelial cells;

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(ii) suggest how the **different** alleles of the human CF gene affect the number of bacteria taken up by mouse gut epithelial cells.

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[Total: 15]

6 **(a)** Many cases of the genetic disease β-thalassaemia result from a large deletion in the gene for β-globin. One therapy for β-thalassaemia is to transplant bone marrow cells from a genetically-compatible donor into the patient.

Explain the role of the major histocompatibility (HLA) system in genetic compatibility.

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(b) A potential gene therapy for β-thalassaemia involves adding the normal, dominant, allele for β-globin to the patient's bone marrow cells that have the recessive mutant allele.

Explain why it is theoretically easier to perform gene therapy when the mutant allele is recessive rather than when it is dominant.

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(c) The gene therapy described in **(b)** has been tested in mice. Bone marrow cells were removed from normal mice and from mice heterozygous for the deletion causing β-thalassaemia. The normal allele of the human β-globin gene was inserted into both types of cell and the cells replaced into the mice from which they were taken.

Twenty four weeks later, the percentage of haemoglobin containing two human β-globin chains was measured in both types of mouse. The results are shown in Table 6.1.

Table 6.1

type of mouse	percentage of mouse haemoglobin with two human β-globin chains
normal	13
heterozygous for the deletion causing β-thalassaemia	24

With reference to Table 6.1, suggest why the human gene is expressed differently in the two types of mice.

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(d) Describe **one** possible benefit and **one** possible hazard of gene therapy.

benefit .....

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hazard .....

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

[Total: 15]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE