OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **2805/02**

BIOLOGY

Applications of Genetics

MONDAY 28 JANUARY 2008 Morning

Time: 1 hour 30 minutes

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

CUP/T37651

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or 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.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question 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.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**15**	
2	**15**	
3	**15**	
4	**15**	
5	**15**	
6	**15**	
TOTAL	**90**	

This document consists of **16** printed pages.

[Turn over

Answer **all** the questions.

1 **(a)** The presence or absence of red pigmentation in the outer scales of onion bulbs is controlled by two genes, **A/a** and **B/b**.

- The dominant allele, **A**, codes for the production of a red anthocyanin pigment.
- Onion bulbs homozygous for the recessive allele, **a**, produce no pigment and are white.
- The dominant allele, **B**, inhibits the expression of allele **A**.
- The recessive allele, **b**, allows anthocyanin production.

(i) Describe the effect of allele **B** on allele **A**.

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(ii) Two onion plants with the genotypes **AABB** and **aabb** were cross-pollinated and the resulting $\mathbf{F_1}$ generation interbred to give an $\mathbf{F_2}$ generation.

Draw a genetic diagram of this cross, on page 3, to show:

- the phenotypes of the parent plants
- the gametes
- the genotypes and phenotypes of the $\mathbf{F_1}$ and $\mathbf{F_2}$ generations
- the ratio of phenotypes expected in the $\mathbf{F_2}$ generation.

genetic diagram

ratio of phenotypes expected in the F_2 *generation* .....

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(b) Most red-scaled onion bulbs produce a colourless substance which makes them resistant to a fungal infection called 'smudge'.

Most white onion bulbs are susceptible to 'smudge'.

Suggest why:

(i) resistance to 'smudge' is almost always inherited together with red pigmentation;

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(ii) some white onion bulbs are resistant to 'smudge'.

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[Total: 15]

2 (a) (i) State what is meant by *heritability*.

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(ii) Explain briefly the importance of knowing the heritability of a trait in a selective breeding programme.

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(iii) The heritability of some human illnesses is shown in Table 2.1.

Table 2.1

illness	heritability
type 1 diabetes	0.7
high blood pressure	0.6
rheumatoid arthritis	0.3
type 2 diabetes	0.2

Explain briefly what the information in Table 2.1 indicates about the inheritance of these illnesses.

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

Fig. 2.1 shows the outlines of four ivy leaves, **A** to **D**.

Leaves **A** and **B** were taken from different parts of the same plant, all of whose leaves were entirely green.

Leaves **C** and **D** were taken from the same relative positions of a second plant, growing close to the first. All the leaves of the second plant were variegated, with white edges.

All four leaves are drawn to the same scale.

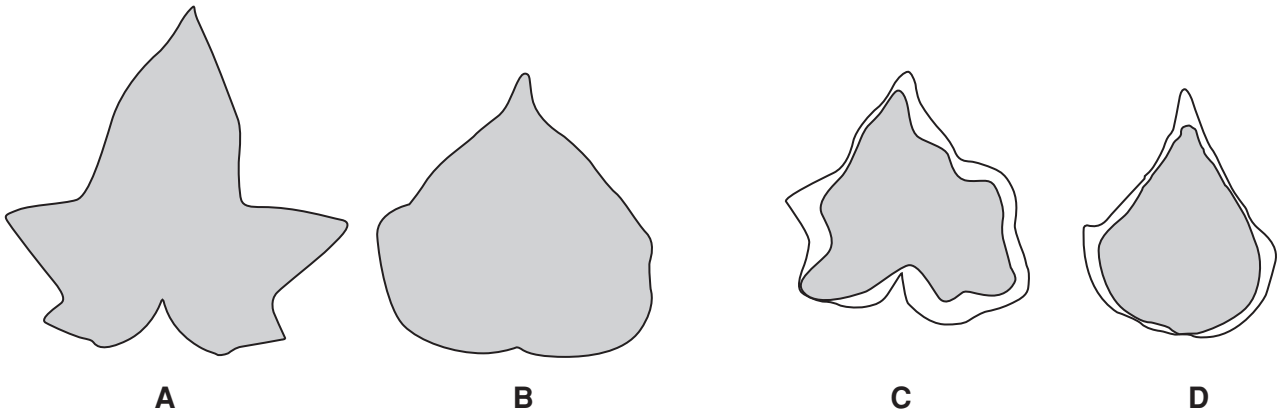

Fig. 2.1

Discuss the factors involved in the variation in leaf shape, colour and size shown in Fig. 2.1.

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Quality of Written Communication [1]

[Total: 15]

3 Plant breeders may wish to suppress pollen production in some of their plants.

Such **male sterility** has been produced in some tobacco plants by genetic engineering.

In fertile plants, some acetyl coenzyme A (acetyl CoA) is diverted from the respiratory pathway and converted by an enzyme, **E1**, into a fatty acid that allows correct development of anthers and pollen grains.

A gene, from a bacterium, codes for a different enzyme, **E2**, whose substrate is also acetyl CoA. This gene can be combined with a promoter sequence of DNA and inserted into tobacco plant chloroplasts. **E2** accumulates in the transgenic plants, outcompetes **E1** for its substrate and produces a different fatty acid. This results in plants with distorted anthers and no pollen production.

(a) Explain why plant breeders may wish to suppress pollen production in some of their plants.

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(b) Describe how a gene can be combined with a promoter sequence of DNA.

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(c) Suggest advantages of putting a foreign gene into the DNA of the chloroplasts of a plant cell, rather than into the nucleus.

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(d) Describe what would normally happen to acetyl CoA in mitochondria, when it is **not** diverted from the respiratory pathway.

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(e) Suggest how enzyme **E2** can outcompete enzyme **E1** for acetyl CoA.

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[Total: 15]

4 In 1994, a small population of pine trees, of a type that was thought to be extinct, was found in the Wollemi wilderness area of Australia. The population is now protected to conserve it.

In 2005, the first plants that had been propagated from cuttings or from tissue culture were sold to fund further conservation efforts. The cuttings and material for tissue culture had been taken from as many trees of the original population as was possible.

Botanic gardens around the world, including The Royal Botanic Gardens at Kew and Wakehurst Place, were given plants to test their hardiness in different environmental conditions. In their native environment they are subject to temperatures ranging from –5 °C to +45 °C.

(a) Outline a procedure for cloning plants from tissue culture.

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(b) Explain why cuttings and material for tissue culture were taken from as many of the original trees as was possible.

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(c) Explain why it is important to maintain populations of rare plants, such as the Wollemi pine.

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(d) Suggest why it is considered necessary to test the hardiness of the plants in different conditions.

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(e) Describe how a seed bank to protect a rare species of plant, such as the Wollemi pine, could be maintained **and** used.

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[Total: 15]

5 **(a)** Cells from a developing human fetus with a suspected genetic condition were grown in culture and examined at metaphase of mitosis, after staining the chromosomes.

A drawing, shown in Fig. 5.1, was made of the ten smallest chromosomes of one cell. In the drawing, one of each of the different chromosomes, 19 to 22 and Y, is identified.

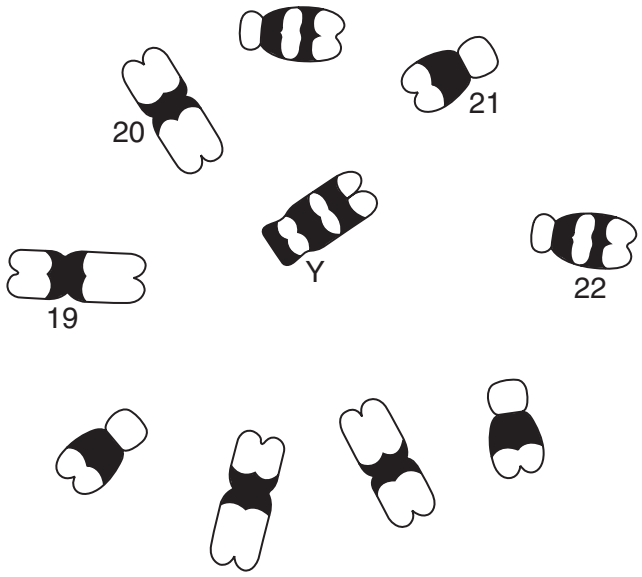

Fig. 5.1

With reference to Fig. 5.1:

(i) state the genetic condition which can be identified by the chromosome analysis, giving a reason for your answer.

condition .....

reason .....

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(ii) explain how such a condition occurs.

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

One method of genetic screening is based on the principle that every fetal cell should have two full copies of its DNA. The test scans for regions of fetal DNA that have too much or too little DNA. These regions correspond to parts of the genome that have been duplicated or deleted.

The procedure can be used as a prenatal test for more than 150 chromosomal abnormalities.

However, research into human genetic diversity has found many apparently healthy people with duplications and deletions in their DNA.

With reference to this information, discuss the advantages **and** disadvantages of genetic screening.

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Quality of Written Communication [1]

[Total: 15]

6 **(a)** A patient with kidney failure may wait a long time for a suitable transplant, especially if there is no donor available from the patient's family.

Explain why it may take a long time to find a suitable transplant for a patient.

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(b) *Escherichia coli* cells that have been genetically modified to express a gene for the enzyme urease are a potential treatment for kidney failure.

The genetically modified bacteria can be placed in microcapsules, which, as they travel through the gut, break down urea which has diffused from the blood into the gut. This reduces the concentration of urea in the blood.

Rats with partial kidney failure were given the genetically modified *E. coli* bacteria in microcapsules daily for 21 days. The concentration of urea in their blood was measured before, during and after treatment and compared with that of normal rats.

The results are shown in Fig. 6.1 on page 15.

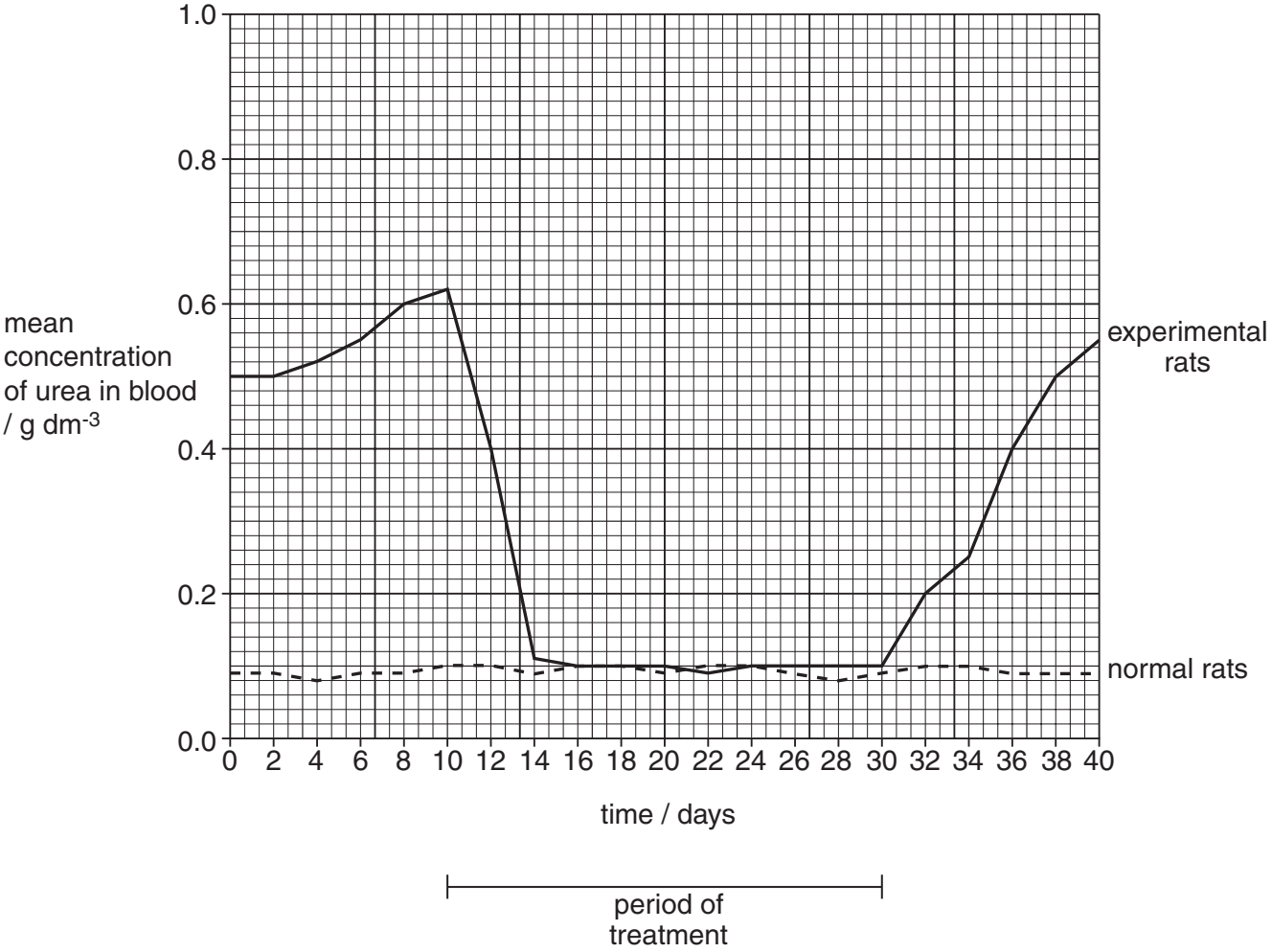

Fig. 6.1

(i) With reference to the information in Fig. 6.1, describe the effect of treating rats with partial kidney failure with genetically modified *E. coli*.

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(ii) A suitable control for the experiment would be to give rats with partial kidney failure encapsulated *E. coli* that had **not** been genetically modified to express the gene for urease.

Draw onto Fig. 6.1 a line showing the likely concentration of urea in the blood of such control rats from day 10 to day 40. [1]

(iii) Urease hydrolyses urea to ammonia and carbon dioxide.

State **and** explain the problem that may arise from using urease to lower the urea concentration in the blood.

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(iv) Suggest why there may be some reluctance to allow the use of genetically modified bacteria in the treatment of human patients.

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[Total: 15]

END OF QUESTION PAPER