Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
June 2005
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY (SPECIFICATION B) BYB2
Unit 2 Genes and Genetic Engineering

Monday 6 June 2005 Morning Session

In addition to this paper you will require:
- a ruler with millimetre measurements.

You may use a calculator.

Time allowed: 1 hour

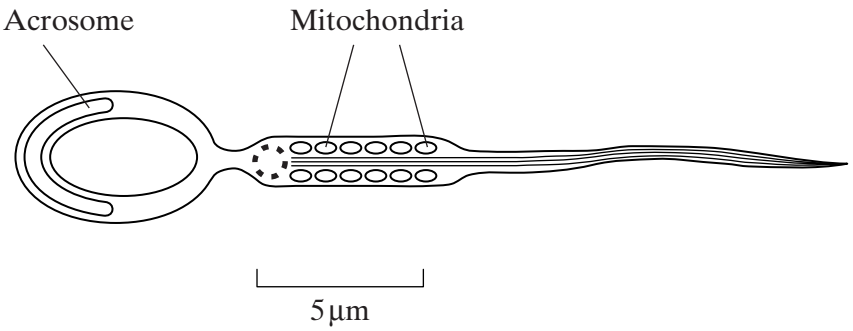
Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 54.
- Mark allocations are shown in brackets.
- Answers for **Questions 1** to **6** are expected to be short and precise.
- **Question 7** should be answered in continuous prose. Quality of Written Communication will be assessed in the answer. You will be awarded up to 1 mark for your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate. The legibility of your handwriting and the accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
QWC			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 The diagram shows a human sperm.



(a) Calculate the actual length of the sperm in µm.

Answer .....µm
(1 mark)

(b) The acrosome contains enzymes. Suggest the function of these enzymes in fertilisation.

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(2 marks)

(c) What is the function of the mitochondria in the sperm?

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(2 marks)

(d) Many animals produce a large number of sperms. Explain the advantage of producing a large number of sperms.

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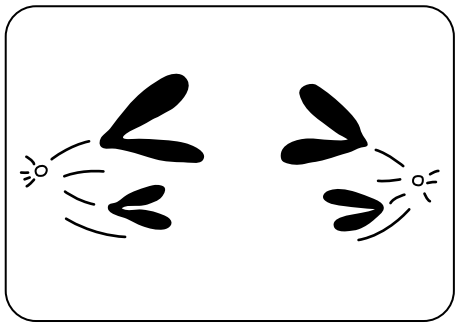
(2 marks)

7

TURN OVER FOR THE NEXT QUESTION

2 (a) The drawing shows a stage of mitosis in an animal cell.



(i) Name this stage of mitosis.

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(1 mark)

(ii) Describe and explain what happens during this stage which ensures that two genetically identical cells are produced.

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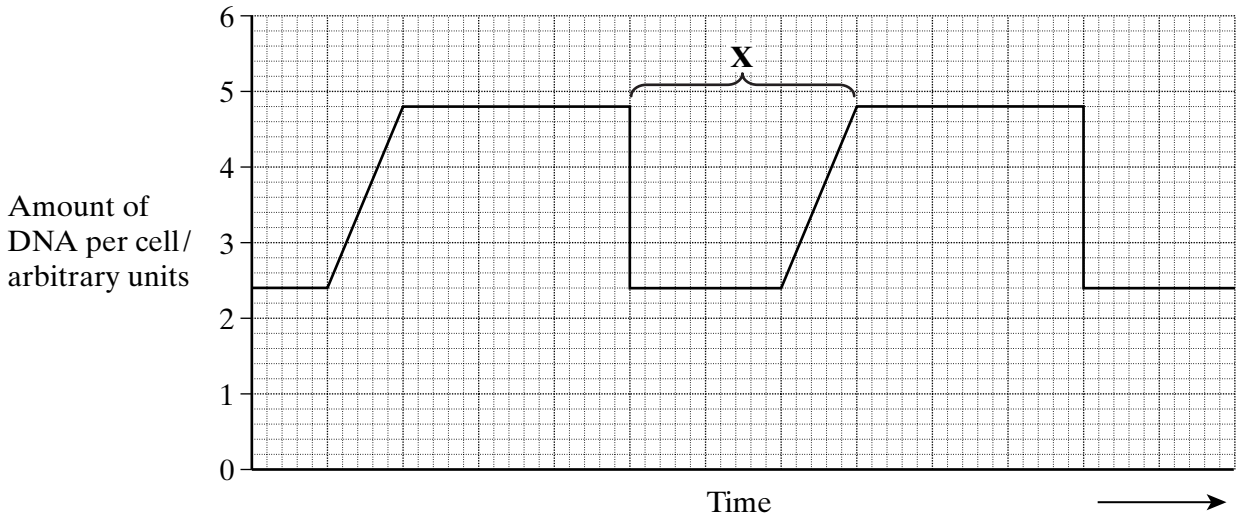
(2 marks)

(b) The graph shows the relative amounts of DNA per cell during two successive cell divisions in an animal.



(i) What stage of the cell cycle is shown by **X**?

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.....

(1 mark)

(ii) Apart from an increase in the amount of DNA, give **one** process which occurs during stage **X** which enables nuclear division to occur.

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.....

(1 mark)

(iii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

.....

(1 mark)

(c) The table shows the average duration of each stage of the cell cycle in the cells of a mammalian embryo.

Stage	**Mean duration / minutes**
Interphase	12
Prophase	50
Metaphase	15
Anaphase	10
Telophase	42

Give **one** piece of evidence from the table which indicates that these cells are multiplying rapidly.

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(1 mark)

7

3 (a) The mRNA codon for the amino acid tyrosine is UAU.

(i) Give the DNA triplet for tyrosine.

.....

(1 mark)

(ii) Give the tRNA anticodon for tyrosine.

.....

(1 mark)

(b) Give **two** ways in which the structure of a molecule of tRNA differs from the structure of a molecule of mRNA.

1 .....

.....

2 .....

.....

(2 marks)

(c) One group of antibiotics, the aminoglycosides, prevent the growth of bacteria by allowing any tRNA molecule to bind to any codon on a mRNA molecule.

(i) Name the site of action of aminoglycosides in a bacterial cell.

.....

(1 mark)

(ii) Use the information provided to explain how aminoglycosides prevent the growth of bacteria.

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(2 marks)

7

4 New alleles arise as a result of mutations in existing genes. These mutations may occur during DNA replication.

(a) Explain what is meant by an allele.

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(1 mark)

(b) Explain how DNA replicates.

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(4 marks)

(c) Explain why a mutation involving the deletion of a base may have a greater effect than one involving substitution of one base for another.

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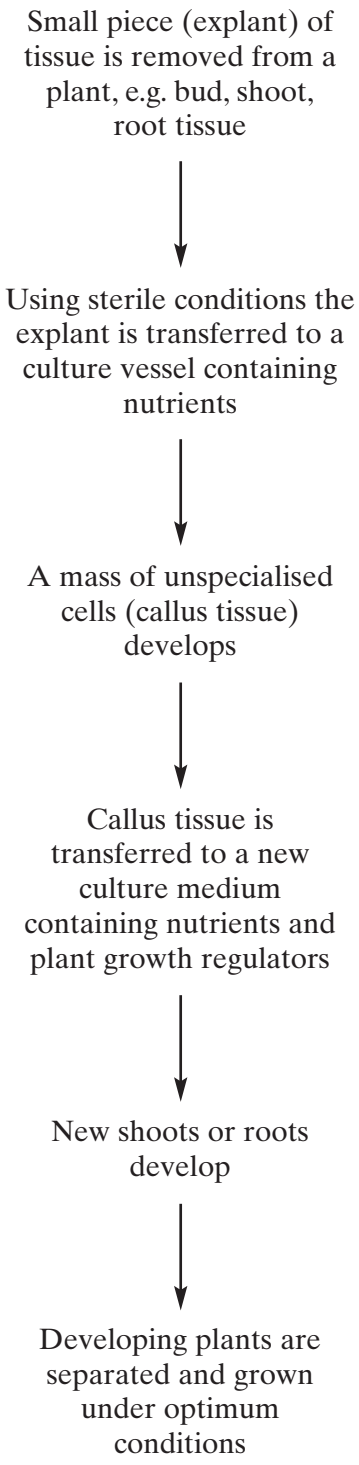
(3 marks)

8

5 Plant tissue culture is a method used to propagate plants. The flow diagram shows one method of plant tissue culture.



(a) Name the type of reproduction involved in plant tissue culture.

.....

(1 mark)

(b) Give **two** advantages of producing plants using this method rather than from seeds.

1 .....

.....

2 .....

.....

(2 marks)

(c) Why is a viral infection more likely to destroy a complete batch of plants grown by plant tissue culture than a batch of plants grown from seeds?

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(1 mark)

(d) Callus tissue develops into either shoots or roots depending on the relative concentration of the plant growth regulators used. Use your knowledge of genes to suggest how these plant growth regulators determine the type of plant tissue formed.

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(1 mark)

5

6 One technique used to determine the sequence of nucleotides in a sample of DNA is the Sanger procedure. This requires four sequencing reactions to be carried out at the same time. The sequencing reactions occur in four separate tubes. Each tube contains

- a large quantity of the sample DNA
- a large quantity of the four nucleotides containing thymine, cytosine, guanine and adenine
- DNA polymerase
- radioactive primers

A modified nucleotide is also added to each tube, as shown in **Figure 1**.

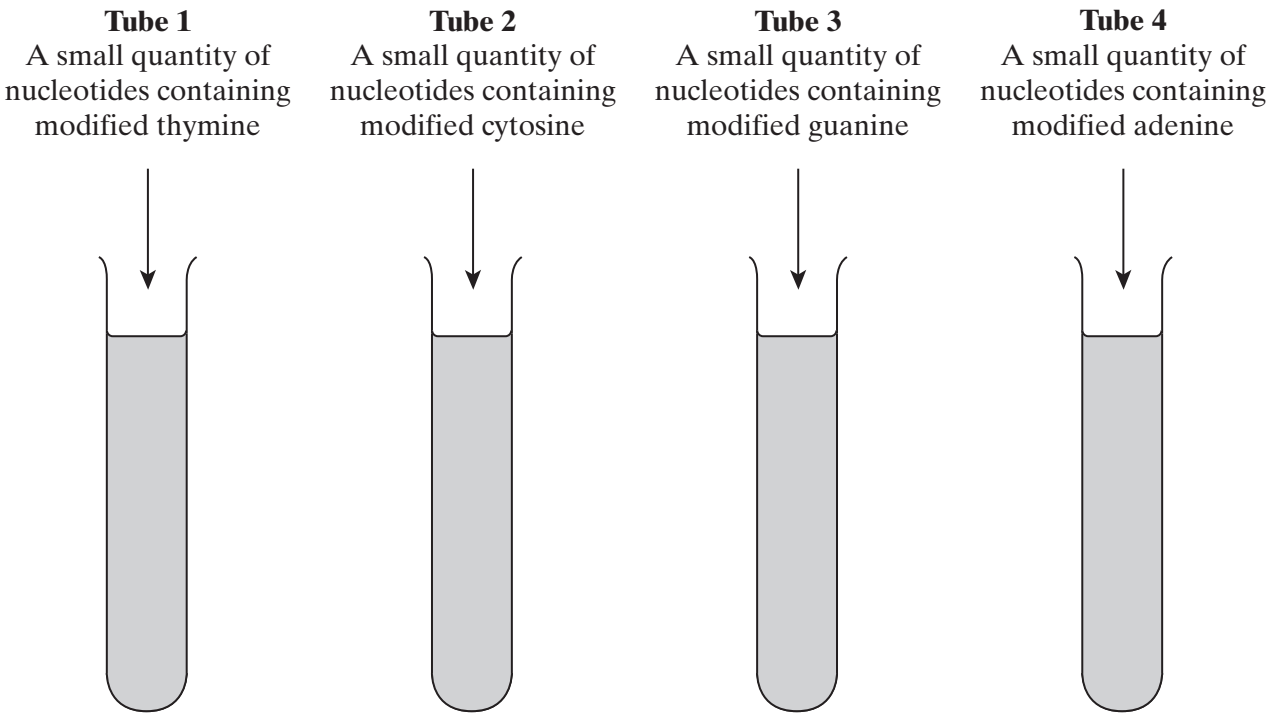

Figure 1

(a) A large quantity of the DNA sample is required for this procedure. Name the reaction used to amplify small amounts of DNA into quantities large enough for this procedure.

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(1 mark)

(b) Explain the reason for adding each of the following to the tubes.

(i) DNA polymerase

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(1 mark)

(ii) Primers

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(1 mark)

(c) (i) When a modified nucleotide is used to form a complementary DNA strand, the sequencing reaction is terminated. Suggest how this sequencing reaction is terminated.

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(1 mark)

(ii) A sample of DNA analysed by this technique had the following nucleotide base sequence.

T G G T C A C G A

Give the base sequence of the shortest DNA fragment which would be produced in **Tube 2**.

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(1 mark)

QUESTION 6 CONTINUES ON THE NEXT PAGE

(d) A different sample of DNA was then analysed. The DNA fragments from the four tubes were separated in a gel by electrophoresis and analysed by autoradiography. **Figure 2** shows the banding pattern produced.

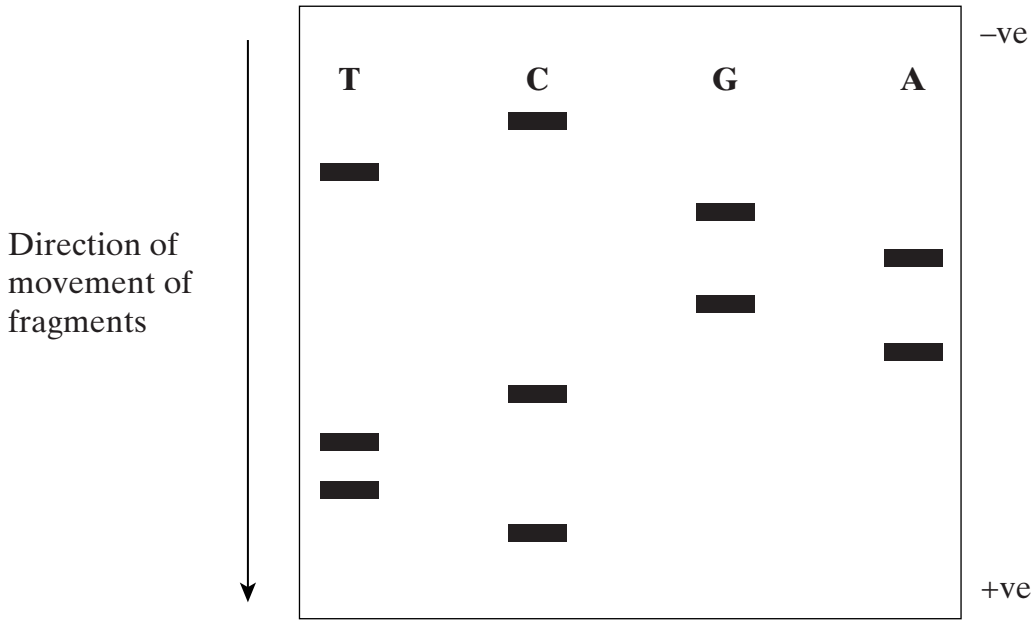

Figure 2

(i) Explain why the DNA fragments move different distances in the gel.

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(1 mark)

(ii) What makes the DNA fragments visible on the autoradiograph?

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(1 mark)

(iii) Use **Figure 2** to determine the sequence of nucleotides in this sample of DNA.

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(1 mark)

8

Question 7 should be answered in continuous prose.
Quality of Written Communication will be assessed in these answers.

7 (a) Explain how the presence of an altered protein in people with cystic fibrosis results in the production of very thick and sticky mucus, and how this accounts for the symptoms of this disorder.

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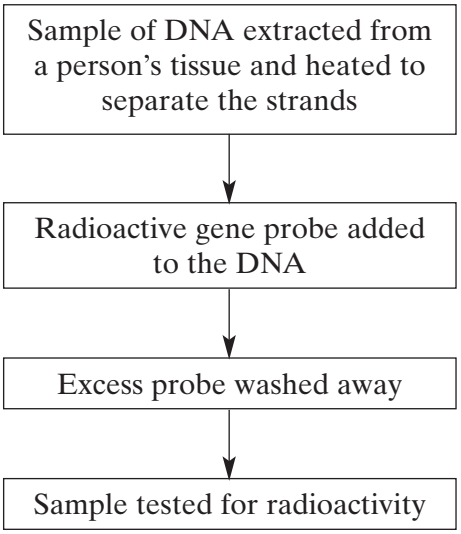
(5 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

(b) Cystic fibrosis can be caused by any one of several mutant alleles of the cystic fibrosis gene. The most common of these mutant alleles accounts for about 70% of cases of cystic fibrosis. The use of gene probes can identify individuals carrying this allele. Gene probes are single strands of DNA which are radioactively labelled. They have a base sequence that is complementary to a mutant allele. The main stages in using a gene probe are shown in the diagram.



Using the information given, explain how the use of a gene probe could enable the presence of a mutant allele of the cystic fibrosis gene to be detected.

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(4 marks)

(c) Sheep have been genetically engineered to produce alpha-1-antitrypsin which is used to treat cystic fibrosis. Use your knowledge of this process to explain **one** argument for and **one** against using sheep in this way.

For

.....

.....

Against

.....

.....

(2 marks)

11

END OF QUESTIONS

QWC

1

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE