Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Thursday 9 January 2003 Morning Session

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

You may use a calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B** 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 66.
- Mark allocations are shown in brackets.
- Answers for **Section A** are expected to be short and precise.
- Questions in **Section B** should be answered in continuous prose where appropriate. Quality of Written Communication will be assessed in these answers.
- In addition to the mark allocation indicated within **Section B**, 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 degree of legibility of your handwriting and the level of 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			
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6			
7			
8			
QWC			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

SECTION A

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

1 The diagram shows four stages of mitosis in the cells of a crocus plant.

Stage 1

Stage 2

Stage 3

Stage 4

(a) Name **Stage 1**.

.....

(1 mark)

(b) Describe what happens after **Stage 4** to complete the process of cell division.

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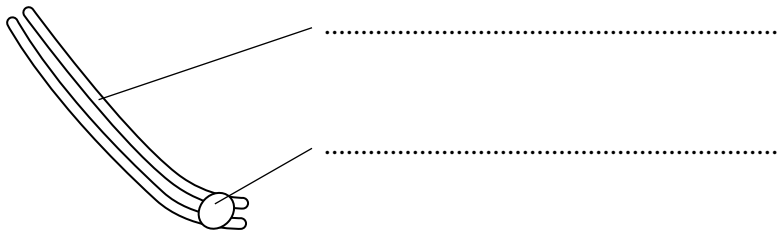
(2 marks)

(c) Label the diagram below which shows one of the chromosomes from **Stage 2**.



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(2 marks)

(d) What is the diploid number of the crocus?

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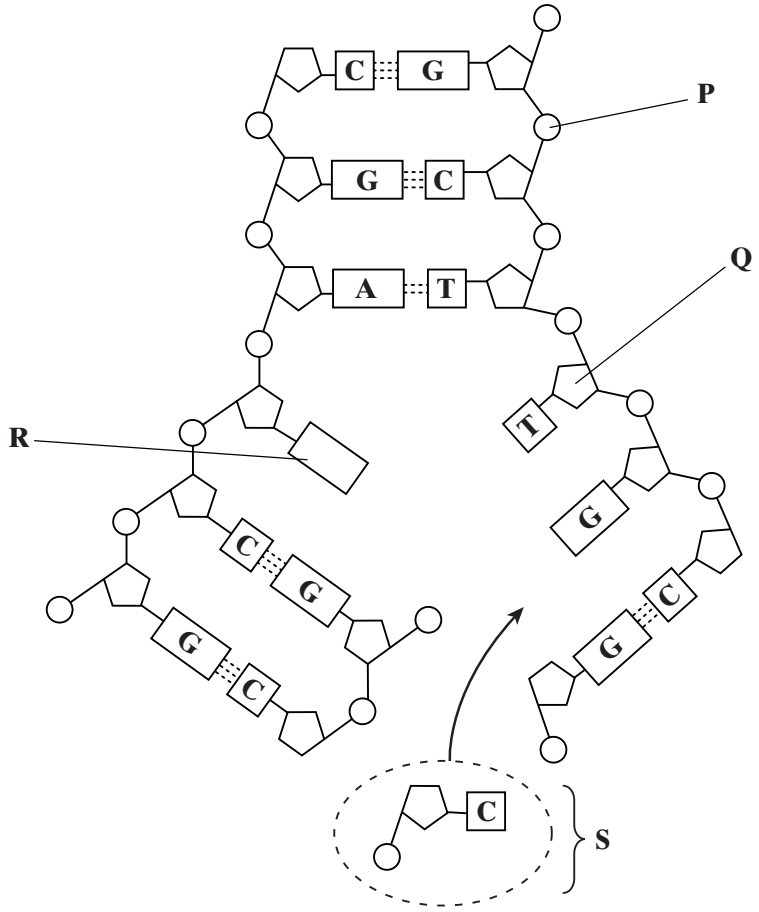
(1 mark)

6

TURN OVER FOR THE NEXT QUESTION

2 The diagram shows part of a DNA molecule in the process of replication.



(a) Name parts **P** to **S**.

P .....

Q .....

R .....

S .....

(4 marks)

(b) Which enzyme joins part **S** to the new DNA strand?

.....

(1 mark)

(c) During which stage of the cell cycle does DNA replication occur?

.....

(1 mark)

6

3 In gene therapy, normal genes are put into cells which contain defective genes. In attempts to treat cystic fibrosis, a virus has been used to put the normal gene into cells.

(a) (i) Give **one** reason for using a virus to introduce genes into cells.

.....

.....

(1 mark)

(ii) Give **one** disadvantage of using a virus to introduce genes into cells.

.....

.....

(1 mark)

(b) Genetic engineering could be used to replace the defective gene in either body cells or gametes. At present, gene therapy is limited to replacing genes in body cells.

(i) Suggest **one** advantage of replacing a defective gene in a gamete rather than in a body cell.

.....

.....

(1 mark)

(ii) Suggest why replacing genes in gametes is not allowed in the United Kingdom.

.....

.....

(1 mark)

(c) Some people are concerned about using gene therapy to treat genetic disorders in humans.

Give **one** possible argument against the treatment of disorders by gene therapy.

.....

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(1 mark)

5

4 (a) Explain the advantage to animals of producing

(i) many more sperms than egg cells;

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(2 marks)

(ii) egg cells which are much larger than sperms.

.....

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(2 marks)

(b) Explain why a sperm has a large number of mitochondria.

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(2 marks)

6

5 Date palms have separate male and female plants. Growers want many female plants but only a few male plants.

(a) One method of obtaining a large number of female date palms is to take cells from a leaf of a mature female plant, and grow them in a culture medium. These cells divide to produce young plants.
Explain how this method will produce only female plants.

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(2 marks)

Date palms may also be grown from seeds, but until recently it has not been possible to determine the sex of a date palm until it is about 10 years old. However, it is now possible to determine the sex of a date palm seedling using the polymerase chain reaction (PCR). This process uses primers which attach to the DNA. The DNA between the primers is then replicated by an enzyme, and a large number of these DNA fragments is produced. The fragments from male and female seedlings are different sizes.

(b) What is a primer?

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(2 marks)

(c) Explain how the different sized DNA fragments could be separated from each other.

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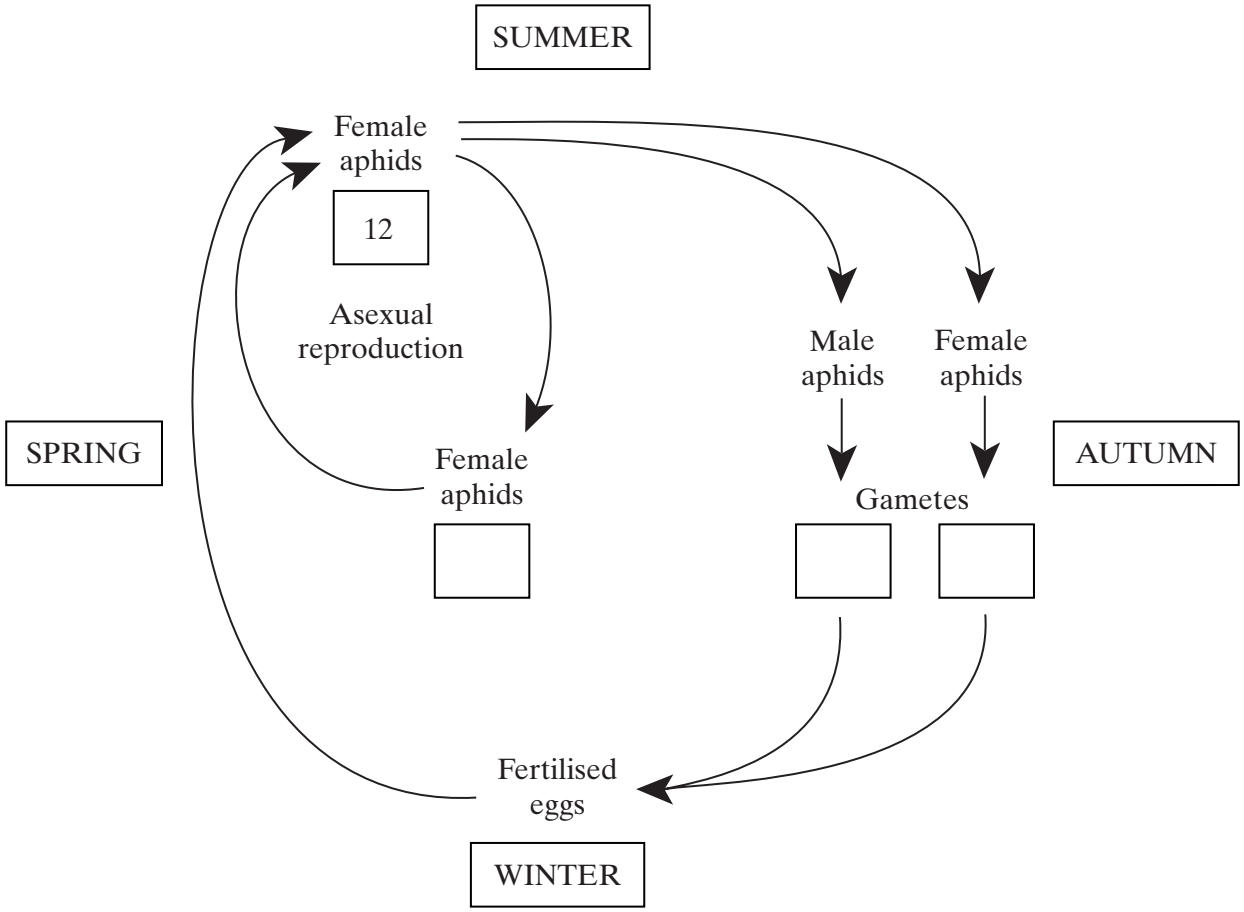
(2 marks)

6

6 The peach aphid is an insect pest. Its life cycle is shown in the diagram.



(a) Complete the boxes on the diagram to show the number of chromosomes present in cells of the peach aphids at various times in this life cycle. *(2 marks)*

(b) (i) Label an arrow on the diagram to show a stage when meiosis occurs. *(1 mark)*

(ii) Explain the importance of meiosis in a life cycle of this type.

.....

.....

(1 mark)

(c) Explain the advantage to the peach aphid of producing only female aphids during spring and summer.

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(2 marks)

(d) Suggest **one** advantage of producing both male and female aphids in the autumn.

.....

.....

(1 mark)

7

TURN OVER FOR THE NEXT QUESTION

SECTION B

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

Answers should be written in continuous prose, where appropriate.
Quality of Written Communication will be assessed in these answers.

7 (a) Starting from the base sequence of DNA, describe how a polypeptide is produced.

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(6 marks)

(b) The protein haemoglobin is formed from two types of polypeptide chain. In people with sickle cell anaemia, one type of polypeptide chain has one amino acid which is different from normal. This is due to a mutation which produces the base sequence CAT instead of CTT.

(i) Give **one** factor which may increase the frequency of mutation.

.....

(1 mark)

(ii) What type of gene mutation produced the sickle cell anaemia allele?

.....

(1 mark)

(c) Explain why the mutation resulted in only one different amino acid in the affected polypeptide chains.

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(2 marks)

(d) The table shows the mRNA codons for some amino acids.

mRNA codon	Amino acid
CAU	histidine
CAA	glutamine
GUA	valine
GAA	glutamic acid
CUU	leucine
GAU	aspartic acid

Use the information in the table to determine the change in the amino acid which occurred as a result of the mutation of the haemoglobin gene.

Amino acid present in normal haemoglobin.

.....

(1 mark)

Amino acid present in sickle cell haemoglobin.

.....

(1 mark)

QUESTION 7 CONTINUES ON THE NEXT PAGE

Turn over ▶

(e) People with sickle cell anaemia have brittle red blood cells that are able to carry less oxygen. Explain how changing one amino acid affects the properties of haemoglobin.

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(3 marks)

15

8 Bacteria can be genetically modified to produce insulin for human use. To achieve this, human insulin genes are transferred into bacteria. Plasmids containing two antibiotic resistance genes, one coding for resistance to tetracycline and one for resistance to ampicillin, are used to carry out this transfer.

A restriction enzyme was used to cut up the human DNA and plasmids. **Figure 1** shows the different fragments of human DNA and the type of cut plasmid that was produced.

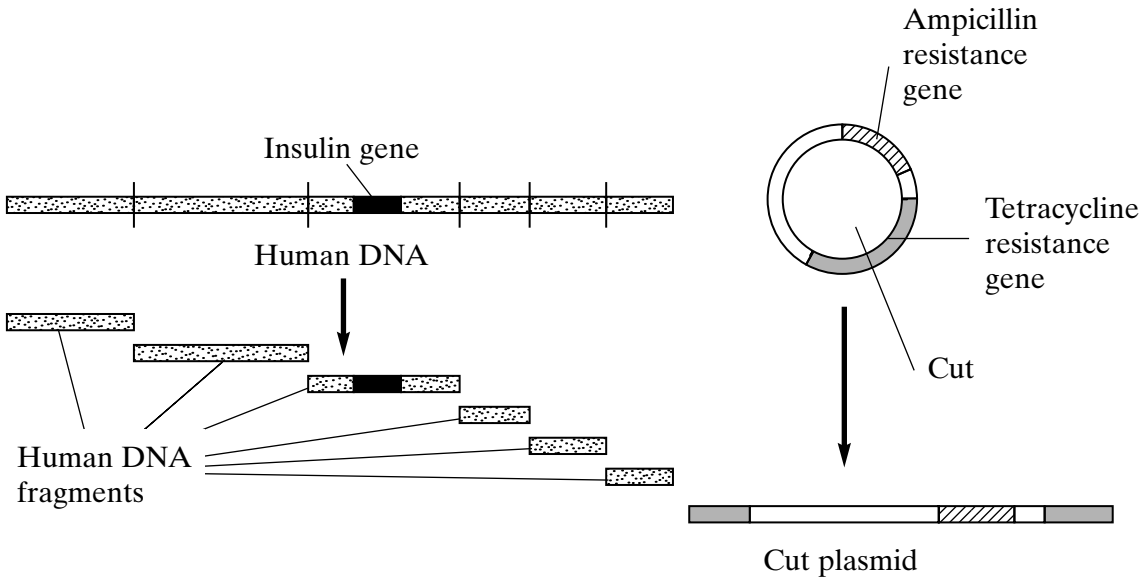

Figure 1

(a) Describe a plasmid.

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(2 marks)

(b) Suggest why the restriction enzyme has cut the human DNA in many places but has cut the plasmid DNA only once.

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

Turn over ▶

The fragments of human DNA and the cut plasmids were mixed together with DNA ligase. Several types of plasmid were formed. Some contained human DNA in the centre of the gene coding for resistance to tetracycline. The different types of plasmid are shown in **Figure 2**.

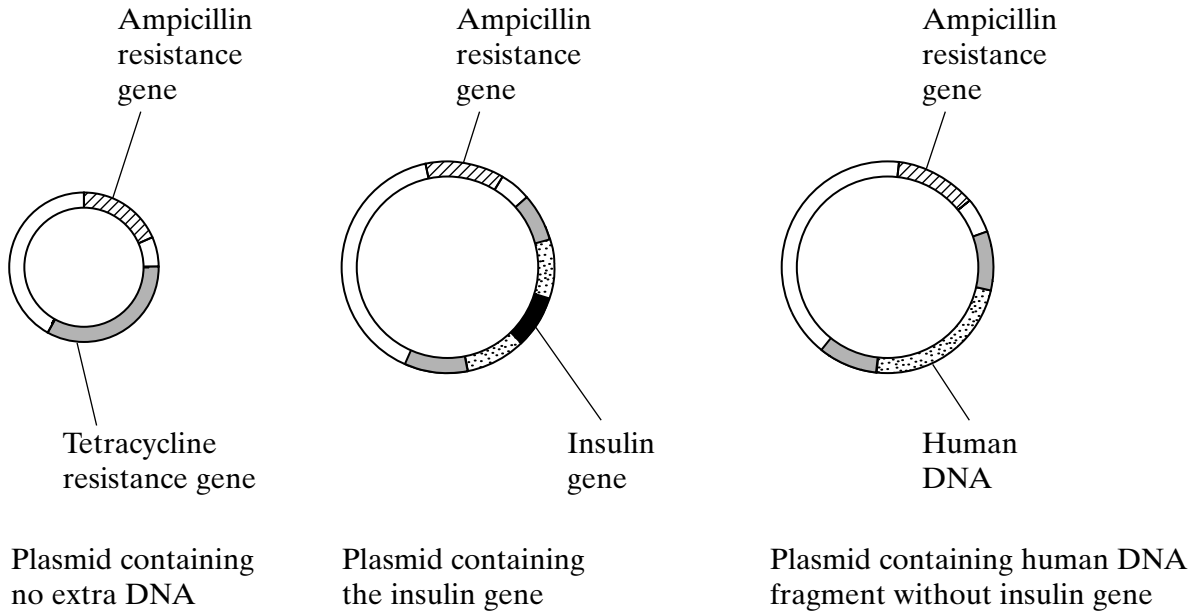

Figure 2

(c) Explain what causes several types of plasmid to be formed.

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(2 marks)

(d) The plasmids are mixed with the bacteria. Some bacteria take up the plasmids.

(i) Explain how it is possible to distinguish between bacteria which have taken up a plasmid with human DNA and those which have taken up a plasmid without any extra DNA.

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(4 marks)

(ii) How is it possible to determine which bacteria have taken up the human insulin gene?

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(1 mark)

(e) Describe how the bacteria containing the insulin gene are used to obtain sufficient insulin for commercial use.

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(3 marks)

14

END OF QUESTIONS

QWC

1

THERE ARE NO QUESTIONS ON THIS PAGE

ACKNOWLEDGEMENT OF COPYRIGHT-HOLDERS AND PUBLISHERS

Question 1 Adapted from Green N, Stout G and Taylor D *Biological Sciences 2* p800 (Cambridge) 1990