Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2003
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA5
Unit 5 Inheritance, Evolution and Ecosystems

Thursday 23 January 2003 Morning Session

No additional materials are required.
You may use a calculator.

Time allowed: 1 hour 30 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 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 75.
- Mark allocations are shown in brackets.
- You will be assessed on 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			
5			
6			
7			
8			
9			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 (a) Complete the table by placing a tick in the box if the statement is true or a cross in the box if the statement is not true.

Statement	Plantae	Fungi	Protoctista
Cell wall is present in some or all organisms			
Kingdom includes autotrophic organisms			
All organisms are multicellular			
Cells contain membrane-bound organelles			

(3 marks)

(b) Identify **two** features of prokaryotes which distinguish them from members of all other kingdoms.

1 .....

2 .....

(2 marks)

5

2 **Figure 1** shows the base sequence on the sense strand from a length of DNA.

A C T G A G C T A

Figure 1

Figure 2, **Figure 3** and **Figure 4** show the same length of DNA following gene mutation.

A C T G G A G C T A

Figure 2

A C T A G C T A

Figure 3

A C T T A G C T A

Figure 4

(a) Name the type of gene mutation in

Figure 2; .....

Figure 3; .....

Figure 4. .....

(3 marks)

(b) A gene mutation may cause no change in the structure of the protein coded for. Explain why.

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(2 marks)

5

3 In humans, cystic fibrosis is caused by a recessive allele, **f**.

(a) What is an *allele*?

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(1 mark)

(b) A man and woman are both heterozygous for the cystic fibrosis allele. They have one healthy son but would like to have another child. What is the probability that they will produce a girl who has cystic fibrosis? Show your working.

Probability = ...

(2 marks)

(c) Sperms are produced by meiosis. Give **two** ways in which differences in sperms are a result of meiosis.

1. .....

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2. .....

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(2 marks)

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4 (a) What is meant by *reproductive isolation*?

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(1 mark)

(b) Explain how geographical isolation can lead to the formation of new species.

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(4 marks)

5

TURN OVER FOR THE NEXT QUESTION

5 The table shows some results from a study of the transfer of energy in some primary consumers in a grassland ecosystem. All figures are in arbitrary units.

Amount of energy		Type of organism	
		mammals	**insects**
consumed in food	**(C)**	25.00	4.00
absorbed from the gut	**(A)**	12.50	1.60
in faeces	**(F)**	12.50	2.40
in new body mass	**(P)**	0.25	0.64
lost in respiration	**(R)**	12.25	0.96

(a) (i) The ratio of the amount of energy lost in respiration to the amount of energy consumed in food in the mammals is 0.49 : 1. Calculate the ratio of the amount of energy lost in respiration to the amount of energy consumed in food in the insects.

Answer .....

(1 mark)

(ii) Suggest an explanation for the difference between these two ratios.

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(2 marks)

(b) Use the letters **C**, **F** and **P** to complete the equation

R = ...

(1 mark)

(c) A higher proportion of the energy consumed in food is absorbed from the gut in secondary consumers than in primary consumers. Suggest an explanation for this.

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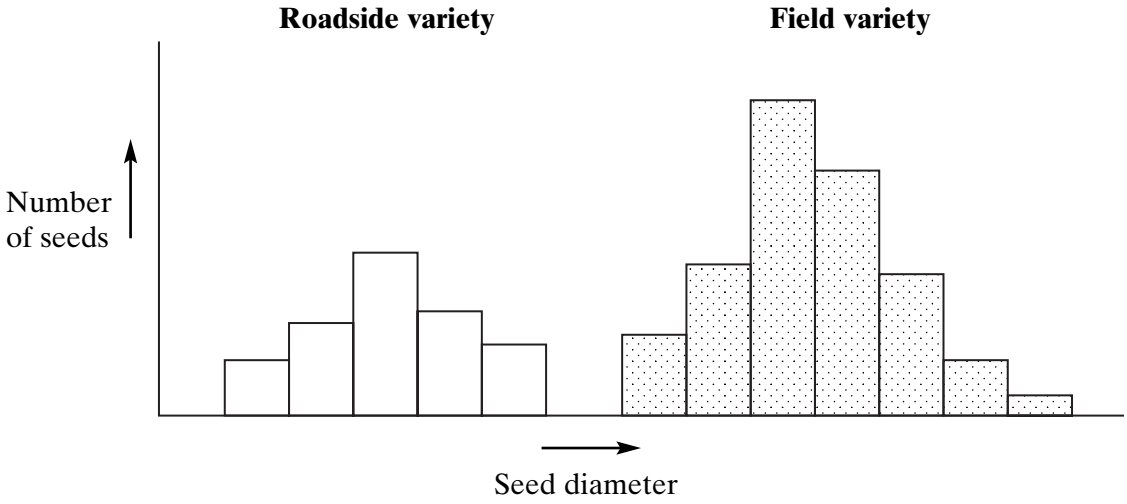
(1 mark)

5

6 One variety of the plant false flax grows in fields. A second variety grows on roadsides. False flax plants from the two habitats differ in the size of their seeds. In an investigation, seeds were collected from the two habitats and their diameters were measured. The results are shown in the graph.



(a) The two varieties of false flax have evolved by disruptive selection.

(i) Use information in the graph to explain what is meant by *discontinuous variation*.

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(1 mark)

(ii) Suggest how disruptive selection might have given rise to the distribution of seed diameter as shown in the graph.

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(2 marks)

(b) Describe how you could show that both varieties of false flax belong to the same species.

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(2 marks)

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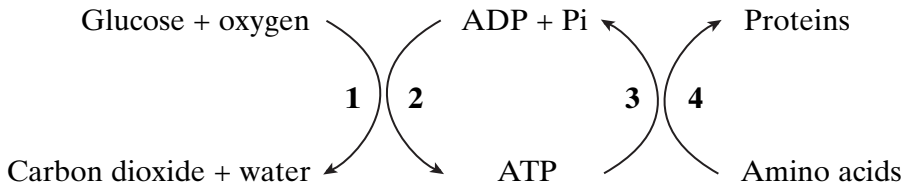
7 ATP links energy-releasing (exergonic) reactions with energy-requiring (endergonic) reactions. The diagram shows some of these reactions.



(a) Give the numbers in the diagram that correspond to *exergonic* reactions.

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(1 mark)

(b) Explain why the total energy released from an exergonic reaction is not all available for the linked endergonic reaction.

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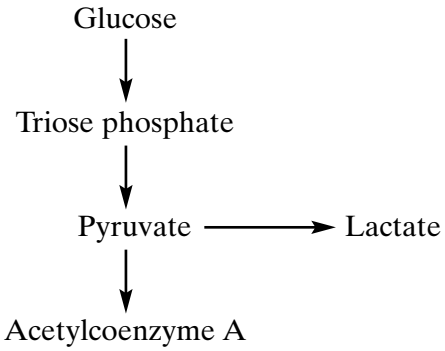
(1 mark)

(c) The diagram shows some of the reactions of respiration.



On the diagram, draw and label **one** arrow to show a reaction that

(i) requires ATP (label this arrow **ATP in**);

(ii) produces ATP (label this arrow **ATP out**).

(2 marks)

(d) The table shows the maximum number of ATP molecules that can be produced from a single molecule of glucose during the stages of respiration.

Stage	Maximum number of molecules of ATP produced during stage
Glycolysis	4
Krebs cycle	2
Oxidative phosphorylation	34

How many of these molecules of ATP are produced in the cytoplasm?

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(1 mark)

(e) In a photosynthesising leaf, reduced NADP is produced during the light-dependent reactions.

(i) Where in chloroplasts do the light-dependent reactions take place?

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(1 mark)

(ii) Describe how reduced NADP is involved in the light-independent reactions of photosynthesis.

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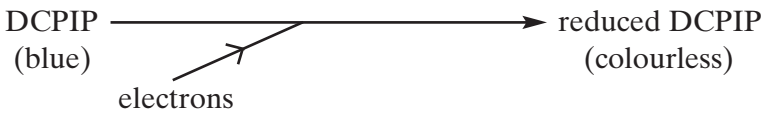
(2 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

DCPIP is a blue dye that can be converted to colourless reduced DCPIP by gaining electrons. This is summarised below.



A chloroplast suspension was made by grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were prepared and treated in different ways. The colour of the tube contents was recorded at the start and after 15 minutes. This information is summarised in the table.

Tube	Contents	Treatment	Colour	
			at start	after 15 minutes
A	2 cm^3 chloroplast suspension 6 cm^3 DCPIP	tube kept in bright light	blue/green	green
B	2 cm^3 chloroplast suspension 6 cm^3 DCPIP	tube kept in dark	blue/green	blue/green
C	2 cm^3 buffer solution 6 cm^3 DCPIP	tube kept in bright light	blue	blue

(f) (i) Tube **C** was included as a control. Explain why this control was necessary in the investigation.

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(1 mark)

(ii) Explain the colour of tube **A** after 15 minutes.

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(3 marks)

(g) (i) The chloroplast suspension produced by centrifugation may also contain mitochondria. Explain the evidence from tube **B** that mitochondria are not responsible for reducing the DCPIP.

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(2 marks)

(ii) Suggest why conclusions made only on the basis of the data in the table may not be reliable.

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(1 mark)

15

TURN OVER FOR THE NEXT QUESTION

8 The inheritance of body colour in fruit flies was investigated. Two fruit flies with grey bodies were crossed. Of the offspring, 152 had grey bodies and 48 had black bodies.

(a) Using suitable symbols, give the genotypes of the parents. Explain your answer.

Genotypes .....

Explanation .....

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(2 marks)

(b) (i) Explain why a statistical test should be applied to the data obtained in this investigation.

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(2 marks)

(ii) The chi-squared (χ^2) test was applied to the data obtained. The formula is given below.

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Use the formula to determine the value of χ^2 for the results of this investigation. Show your working.

χ^2 = ...

(3 marks)

(iii) The null hypothesis in this investigation predicted that there would be no difference between the observed and expected values. Use the table to determine whether this hypothesis can be supported. Explain how you arrived at your answer.

Degrees of freedom	**Probability value**					
	0.99	**0.95**	**0.1**	**0.05**	**0.01**	**0.001**
1	0.0002	0.0039	2.71	3.84	6.63	10.83
2	0.020	0.103	4.61	5.99	9.21	13.82
3	0.115	0.352	6.25	7.81	11.34	16.27
4	0.297	0.711	7.78	9.49	13.28	18.47

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) A species of insect, only found on a remote island, has a characteristic controlled by a pair of codominant alleles, $\mathbf{C^M}$ and $\mathbf{C^N}$.

(i) What is meant by *codominant*?

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(1 mark)

(ii) There were 500 insects in the total population. In this population, 300 insects had the genotype $\mathbf{C^M\ C^M}$, 150 had the genotype $\mathbf{C^M\ C^N}$ and 50 had the genotype $\mathbf{C^N\ C^N}$. Calculate the *actual* frequency of the allele $\mathbf{C^N}$ by using these figures. Show your working.

Answer .....

(2 marks)

(iii) Use your answer to (c) (ii) and the Hardy-Weinberg equation to calculate the number of insects that would be *expected* to have the genotype $\mathbf{C^N\ C^N}$.

Answer .....

(3 marks)

15

9 Read the following passage.

Early settlers used a technique known as 'slash and burn' to clear land for growing crops. Trees were cut down and burned and seeds of crop plants were scattered on the cleared land. After a few years, crop growth was usually so poor that people would move on and repeat the process. At low human population densities there was no long-term damage to the forest as the cleared areas of land had a chance to recover once people had left.

With an increase in human population, and over periods of time, large areas of forest have been destroyed. Modern developments have made possible greater yields from an area of land and farming has become more intensive. To maintain soil fertility, farmers now add fertilisers to the soil.

Use information from the passage and your own knowledge to answer the following questions.

(a) Explain how the process of 'slash and burn' would affect the availability of carbon in the atmosphere.

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(2 marks)

(b) Explain how bare, cleared land could once again become forest.

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(3 marks)

(c) Fertiliser, such as manure, contains ammonium compounds. Explain how the presence of soil bacteria and the use of manure improve crop yield.

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(6 marks)

(d) Explain the advantages of conserving a forest ecosystem.

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(4 marks)

15

END OF QUESTIONS