Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2002
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Wednesday 23 January 2002 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) Living organisms are classified into five kingdoms. Identify each of the following three kingdoms.

(i) Single-celled organisms with a cell wall but no nuclear envelope. Some can photosynthesise but most do not.

Kingdom: .....

(1 mark)

(ii) Organisms composed of thread-like hyphae which contain membrane-bound nuclei. The cell wall is not made of cellulose. No chlorophyll is present and nutrition is heterotrophic.

Kingdom: .....

(1 mark)

(iii) Multicellular organisms with no cell walls. Cells have membrane-bound nuclei. No chlorophyll is present and nutrition is heterotrophic.

Kingdom: .....

(1 mark)

(b) The table gives some of the groups into which the buttercup, *Ranunculus bulbosus*, is classified.

Name of group	**Group**	**Sequence**
Angiospermophyta	Phylum	
bulbosus	Species	
Dicotyledoneae	Class	
Ranales		
Ranunculaceae	Family	
Ranunculus	Genus	

Complete the table, as follows.

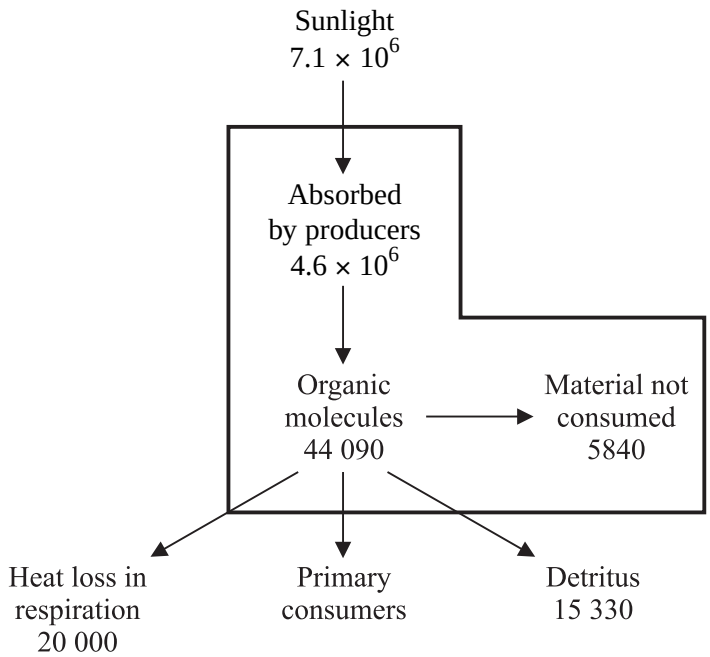
(i) Give the name of the missing group in column 2.

(1 mark)

(ii) Write the numbers 1 to 6 in column 3 to show the correct sequence of the groups, where 1 is the largest group and 6 is the smallest.

(1 mark)

2 The diagram shows the annual transfer of energy in a forest ecosystem. The figures are in $kJ\,m^{-2}$.



(a) Although the producers absorb $4.6 \times 10^6\ kJ\,m^{-2}$, only about 1% of this is transferred to organic molecules. Suggest **one** reason for this.

.....

(1 mark)

(b) Calculate the energy transferred to primary consumers in this ecosystem.

..... $kJ\,m^{-2}$

(1 mark)

(c) Nitrogen compounds in the detritus are broken down by bacteria to ammonium ions (NH_4^+). Describe how ammonium ions are converted into a form that can be readily absorbed by the producers.

.....

.....

.....

.....

.....

.....

(3 marks)

3 The drawing shows the chromosomes from a cell during meiosis.

(a) Name the phase of meiosis shown in the drawing. Give evidence for your answer.

.....

.....

(2 marks)

(b) What is the haploid chromosome number in this species?

.....

(1 mark)

(c) At the time shown in the diagram, this cell contained 8 picograms of DNA. How much DNA would be present in each gamete produced from this cell?

..... picograms.

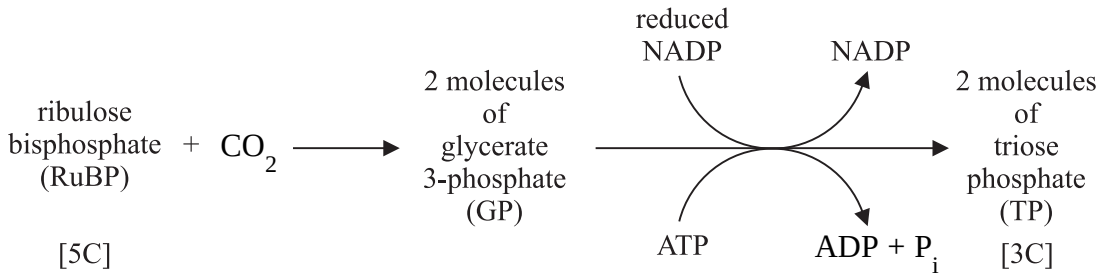
(1 mark)

(d) In gamete production, what is the advantage of changing diploid cells into haploid cells?

.....

(1 mark)

4 (a) The diagram shows part of the light-independent reaction of photosynthesis.



(i) How many carbon atoms are there in one molecule of glycerate 3-phosphate?

.....

(1 mark)

(ii) What is the function of each of the following in the reactions shown in the diagram?

Reduced NADP .....

.....

ATP .....

.....

(2 marks)

(b) Radioactive carbon dioxide was supplied to a culture of photosynthesising single-celled algae. At 5-second intervals, samples of the culture were dropped into boiling alcohol to stop all chemical reactions. The radioactive substances identified in these samples are given in the table.

Time / s	Radioactive substances identified
0	carbon dioxide
5	GP
10	GP, TP
15	GP, TP, ribulose phosphate, glucose
20	GP, TP, ribulose phosphate, glucose, RuBP

Explain how information in the table provides evidence for the following.

(i) Glycerate 3-phosphate is converted into triose phosphate.

.....

(1 mark)

(ii) The reactions given in part (a) form part of a *cycle* of reactions.

.....

(1 mark)

5 (a) Explain **two** environmental problems that are normally associated with large-scale deforestation.

1. .....

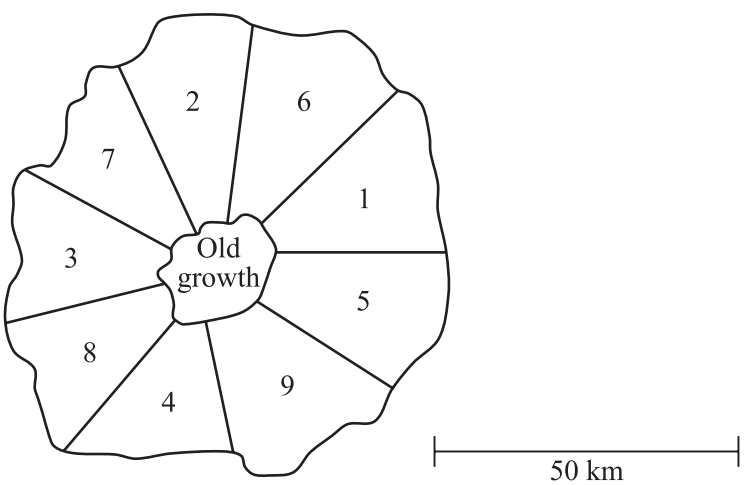
.....

2. .....

.....

(2 marks)

(b) Logging is the removal of mature trees from a forest. The diagram shows a method of sustainable logging of an area of tropical rainforest. Each of sectors 1 to 9 is logged in sequence and the "old growth" area is never felled. Felling in each sector takes about 35 years.



Explain how the pattern of logging shown in the diagram would help to conserve the rainforest community.

.....

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(3 marks)

5

6 In cats, some aspects of the inheritance of fur colour are sex linked.
When a ginger male cat was crossed with a black female, all the female kittens were tortoiseshell (a pattern of black hairs and ginger hairs) and all the male kittens were black. However, in the reciprocal cross, although all the female kittens were again tortoiseshell, the male kittens were ginger.

(a) Complete the following genetic diagrams to explain the results of these two crosses.
Use the following symbols:

$\mathbf{X}^{B}$ = an X-chromosome carrying an allele for black hair.
$\mathbf{X}^{G}$ = an X-chromosome carrying an allele for ginger hair.

	Cross 1			**Cross 2**		
Parental phenotypes	Ginger male	x	Black female	Black male	x	Ginger female
Parental genotypes	.....		.....	.....		.....
Gametes	.....		.....	.....		.....
Offspring genotypes	.....			.....		
Offspring phenotypes	.....			.....		
	.....			.....		

(4 marks)

(b) Why were no male tortoiseshell cats produced in these crosses?

.....

.....

(1 mark)

5

7 The community present in a roadside ecosystem was investigated.

(a) Explain what is meant by:

(i) *community*; .....

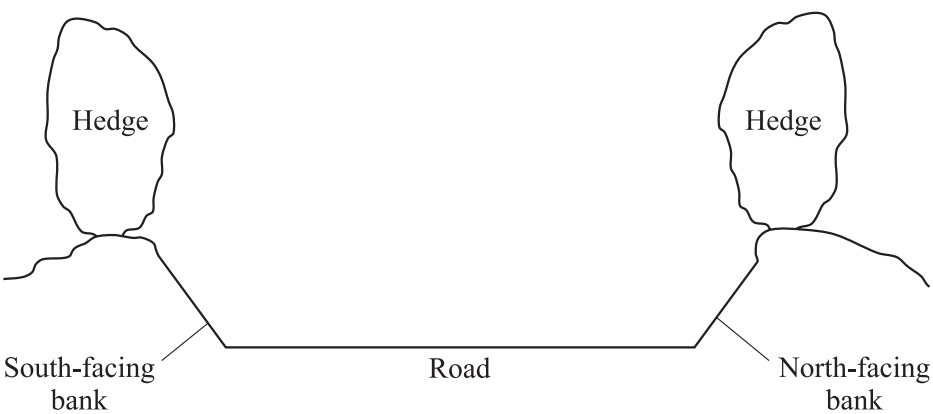
.....

(ii) *ecosystem*. .....

.....

(2 marks)

(b) The diagram shows a section through a road which has a sloping bank and hedge on each side.



The following plant species were found growing on 10-metre lengths of the north-facing and south-facing road banks.

Plant species	Number of plants	
	South-facing road bank	North-facing road bank
White deadnettle	23	0
Lesser celandine	18	8
Dandelion	8	4
Ragwort	10	0
Cow parsley	7	10
Thistle	5	1
Groundsel	15	10
Index of diversity	5.94	

(i) Use the formula $d = \frac{N(N-1)}{\Sigma\, n(n-1)}$

where d = index of diversity
N = total number of organisms of all species
n = total number of organisms of a particular species

to calculate the index of diversity for the plants growing on the north-facing road bank. Show your working.

Index of diversity = ...

(2 marks)

(ii) Give **one** advantage of calculating the index of diversity rather than just recording the number of species present.

.....

.....

(1 mark)

(iii) Suggest and explain how **one** abiotic factor might have caused differences in plant growth on the two road banks.

.....

.....

.....

.....

(2 marks)

(iv) Explain why the south-facing road bank is likely to show greater ecological stability than the north-facing road bank.

.....

.....

.....

.....

(3 marks)

QUESTION 7 CONTINUES ON THE NEXT PAGE

(v) The south-facing road bank would also be expected to have a higher diversity of animals. Suggest **one** reason for this.

.....

.....

(1 mark)

(c) In order to estimate the population of woodlice living on the north-facing road bank, four pitfall traps were set in the ground at 2-metre intervals and left for 24 hours. All the woodlice that had fallen into the traps were marked on their underside with quick-drying paint and released back into their habitat. The next day the traps were examined again and the numbers of marked and unmarked woodlice were counted. The results are shown in the table.

	Trap number			
	1	**2**	**3**	**4**
Number of woodlice marked and released	2	28	0	10
Number of marked woodlice in 2nd catch	0	4	0	2
Number of unmarked woodlice in 2nd catch	5	17	3	11

(i) Use the data to estimate the woodlouse population in this area. Show your working.

Population = ...

(2 marks)

(ii) Suggest **two** reasons why it is not possible to make a reliable estimate of the woodlouse population size from these data.

1. .....

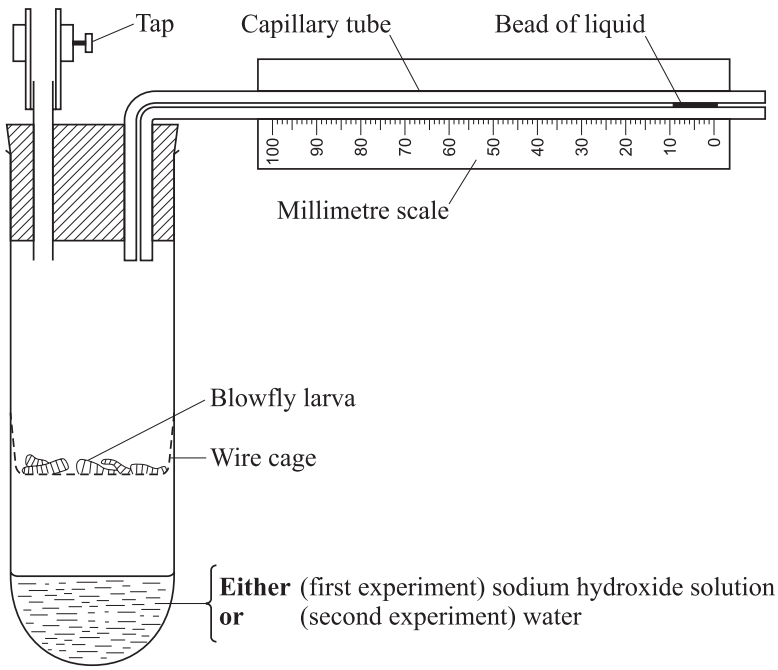
.....

2. .....

.....

(2 marks)

8 The apparatus shown in the diagram was used to determine the rate of respiration and the respiratory quotient (RQ) of some blowfly larvae.



Sodium hydroxide absorbs carbon dioxide from the air. In the first experiment, 5 cm^3 of concentrated sodium hydroxide solution was placed in the test tube and 10 blowfly larvae were placed in the wire cage. The assembled apparatus was placed in a water bath at 20 °C, with the tap left open. After 10 minutes, the tap was closed and the position of the bead of liquid was recorded at 1-minute intervals. A second experiment was carried out using 5 cm^3 of water instead of the sodium hydroxide solution. The results are shown in the table.

Time / minutes	Position of bead of liquid / mm	
	1st experiment	2nd experiment
0	11	40
1	23	40
2	34	40
3	47	40
4	60	40
5	71	40

(a) (i) Give **two** reasons why the apparatus was left for 10 minutes, with the tap open, when it was first placed in the water bath.

1. .....

.....

2. .....

.....

(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(ii) Explain why the bead of liquid moved along the scale in the first experiment but not in the second experiment.

.....

.....

.....

.....

.....

(3 marks)

(iii) Giving a reason for your choice, suggest a suitable control for these experiments.

.....

.....

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(2 marks)

(iv) The cross-sectional area of the capillary tube was 1 mm^2, and the 10 blowfly larvae had a total mass of 0.5 g. Calculate the rate of oxygen consumption of the blowfly larvae. Give your answer in $mm^3\ g^{-1}\ hour^{-1}$.

Rate = ... $mm^3\ g^{-1}\ hour^{-1}$

(2 marks)

(b) (i) Give the formula used for calculating the *respiratory quotient* (RQ).

.....

.....

(1 mark)

(ii) Explain how the results of the second experiment give an RQ = 1.0 for the blowfly larvae.

.....

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(1 mark)

(iii) What does an RQ value of 1.0 indicate about the respiratory substrate of the blowfly larvae?

.....

.....

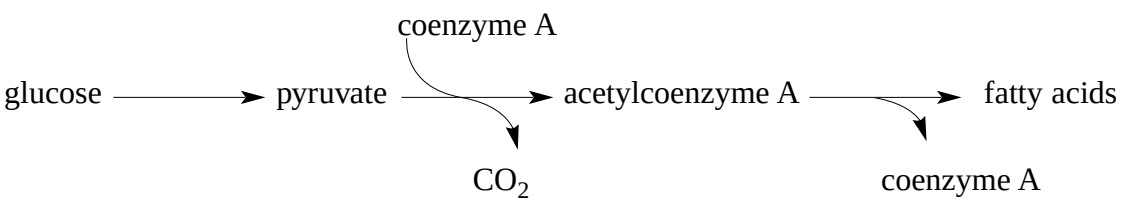
(1 mark)

(c) In humans, the RQ value just after a meal is also very close to 1.0 However, if nothing is eaten for around 7 to 10 hours, the RQ drops to about 0.7. Suggest why the RQ drops.

.....

(1 mark)

(d) When excess carbohydrate in the diet is converted into fat, the following chemical reactions occur:



Explain why this process would cause the measured RQ value to be higher than that expected for the respiration of glucose.

.....

.....

.....

.....

(2 marks)

15

TURN OVER FOR THE NEXT QUESTION

9 Read the following passage.

In the living world, success may be measured by reproductive capacity. But this brings its own problems: the more individuals there are, the greater the competition and struggle for survival.

In the early 1830s, Charles Darwin visited the Galapagos Islands, some 1000 km off the coast of Ecuador, where he discovered several different species of small birds, called ground finches. They all seemed to be related to similar birds found on the South American mainland and Darwin suggested that they might therefore have originated from a common ancestor and changed over the years to their present form. More recently, measurements have shown that there are variations, not only between, but also within each species. For instance, on one of the larger islands, called Albemarle, two species of ground finch share the same habitat. The beaks of one species, *Geospiza fortis*, range in depth from 11 to 16 mm, while the other, *Geospiza fuliginosa*, possesses beaks varying from 7 to 10 mm. On another island, *G. fuliginosa* is absent and here *G. fortis* has a range of beak depths from 9 to 12 mm.

What causes this divergence when living together? Perhaps competition is the answer. The two species specialised by feeding on different-sized seeds. As beak depths diverged, competition was reduced.

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

(a) The beak depths of *Geospiza fortis* living on Albemarle Island varied between 11 and 16 mm (line 10). How might the processes of meiosis and polygenic inheritance have contributed to this variation?

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(5 marks)

(b) Explain how the process of natural selection on the two islands might have led to the different ranges of beak depth in *G. fortis*.

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(7 marks)

(c) Genetic isolation is important in the production of new species by natural selection.

(i) What is the difference between *allopatric speciation* and *sympatric speciation*?

.....

.....

(1 mark)

(ii) For each of the following, suggest **one** way in which genetic isolation could have occurred if speciation of the Galapagos finches had been:

allopatric; .....

.....

sympatric. .....

.....

(2 marks)

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE