Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
June 2007
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Tuesday 19 June 2007 9.00 am to 10.30 am

For this paper you must have:
- a ruler with millimetre measurements.

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.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You will be marked on your ability to use good English, to organise information clearly and to use accurate scientific terminology where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 (a) The table gives some features of the cells of organisms from three different kingdoms.

Structure	Animal cell	Plant cell	Prokaryote cell
Mitochondrion			
Cellulose cell wall			
Ribosome			
Large, permanent vacuole			

(i) Complete the table. Put a tick in the box if the structure is present. Put a cross in the box if the structure is not present.

(3 marks)

(ii) Give **one** other structure, **not** shown in the table, which is present in cells of organisms in the kingdoms Fungi, Prokaryotae and Protoctista.

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(1 mark)

(b) Complete the list to show the different taxonomic groups into which a kingdom can be divided. Write your list in the correct order.

1 Kingdom

2 .....

3 .....

4 .....

5 .....

6 .....

7 Species

(1 mark)

5

2 (a) Photolysis of water occurs in photosynthesis. Describe what happens during photolysis.

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(3 marks)

(b) The following process is part of the light-independent reactions of photosynthesis.

Glycerate 3-phosphate (GP) ⟶ Triose phosphate

This process requires **two** substances produced in the light-dependent reactions. Name these **two** substances. Describe the role of each in the conversion of GP to triose phosphate.

1 .....

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2 .....

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(4 marks)

7

3 Meiosis produces cells with half the number of chromosomes.

(a) What is the biological importance of these cells having half the number of chromosomes?

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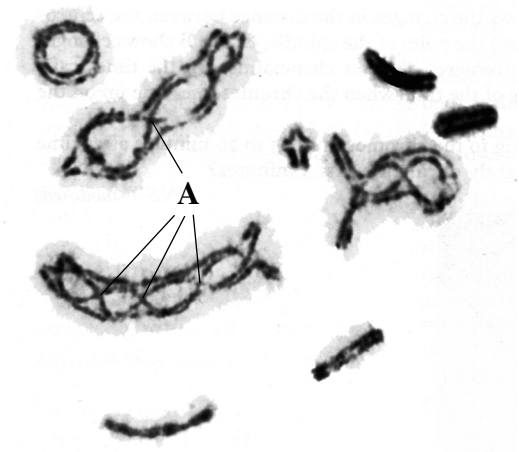
(1 mark)

(b) The photograph shows the chromosomes from one cell during meiosis.



(i) Name the phase of meiosis shown in the photograph.

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(1 mark)

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

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(1 mark)

(c) (i) What has happened at the points labelled **A** in the photograph? Explain how this causes genetic variation in the gametes.

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(2 marks)

(ii) Give **one** other feature of meiosis which causes genetic variation in the gametes.

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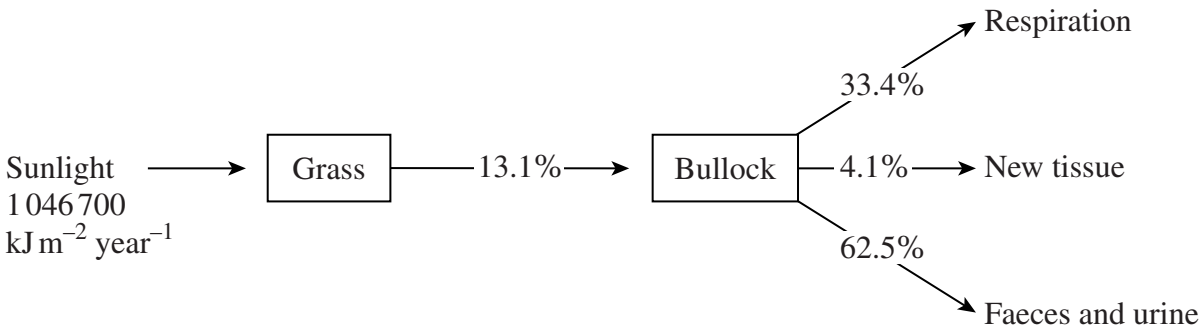
(1 mark)

6

4 The diagram shows the transfer of energy from sunlight to a bullock feeding on grass.



(a) The energy stored in new tissue of the bullock each year is 125 kJ m^{-2} year^{-1}. Calculate the amount of energy trapped in photosynthesis each year by each square metre of grass. Show your working.

Answer ..... kJ *(2 marks)*

(b) The carbon present in organic compounds in the bullock's faeces is recycled and made available to the grass. Describe how.

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(3 marks)

5

5 One variety of domestic chicken has either black feathers or barred feathers. This is controlled by a gene on the X chromosome. The recessive allele, **b**, leads to feathers that are black. The dominant allele, **B**, leads to barred feathers, that are black with white bars.

(a) A breeder crossed a black female with a barred male. Twelve offspring were produced:

3 barred males,
2 barred females,
4 black males,
3 black females.

Complete the genetic diagram to explain this.

Use the following symbols

$\mathbf{X^B}$ = an X chromosome with the allele for barred feathers
$\mathbf{X^b}$ = an X chromosome with the allele for black feathers
Y = a Y chromosome

In birds, it is the female, **XY**, which is the heterogametic sex. The male, **XX**, is homogametic.

Parental phenotypes	Black female	Barred male
Parental genotypes	……	……
Gamete genotypes	……	……

Offspring genotypes .....

Offspring phenotypes .....

(4 marks)

(b) It is quite difficult to tell the sex of newly hatched chicks. The breeder wished to have an easy method by which he could tell the sex of the chicks. Draw a genetic diagram to explain what colours of adult birds should be crossed to enable him to do this.

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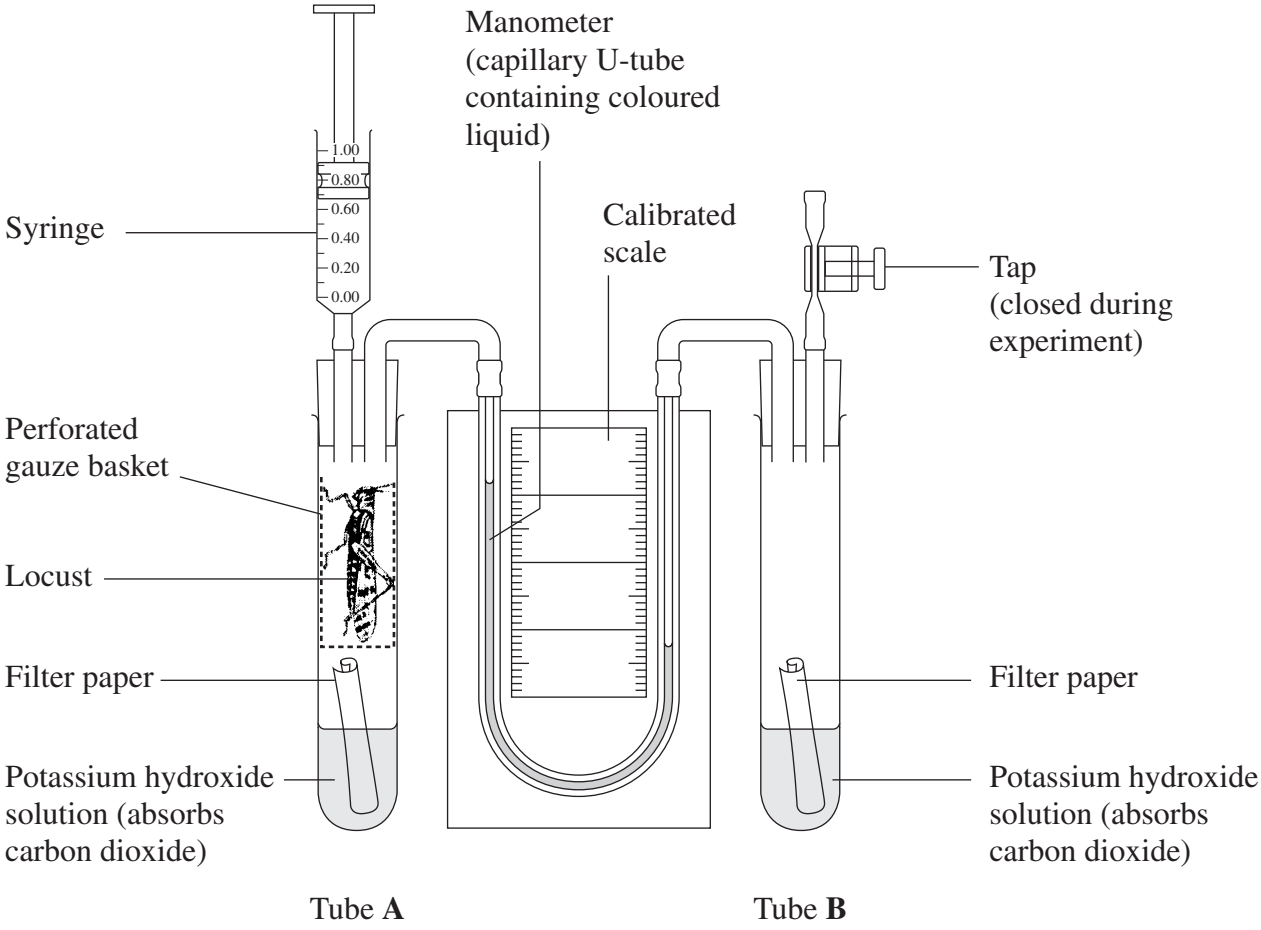
(3 marks)

7

Turn over for the next question

6 The diagram shows apparatus used for measuring the rate of oxygen consumption in respiration by a locust.



(a) At the start of the investigation, tubes **A** and **B** were placed in a water bath at 30 °C for 10 minutes. During this time the syringe was removed from tube **A** and the tap attached to tube **B** was left open.

Give **two** reasons why the apparatus was left in this way for 10 minutes when it was first placed in the water bath.

1 .....

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2 .....

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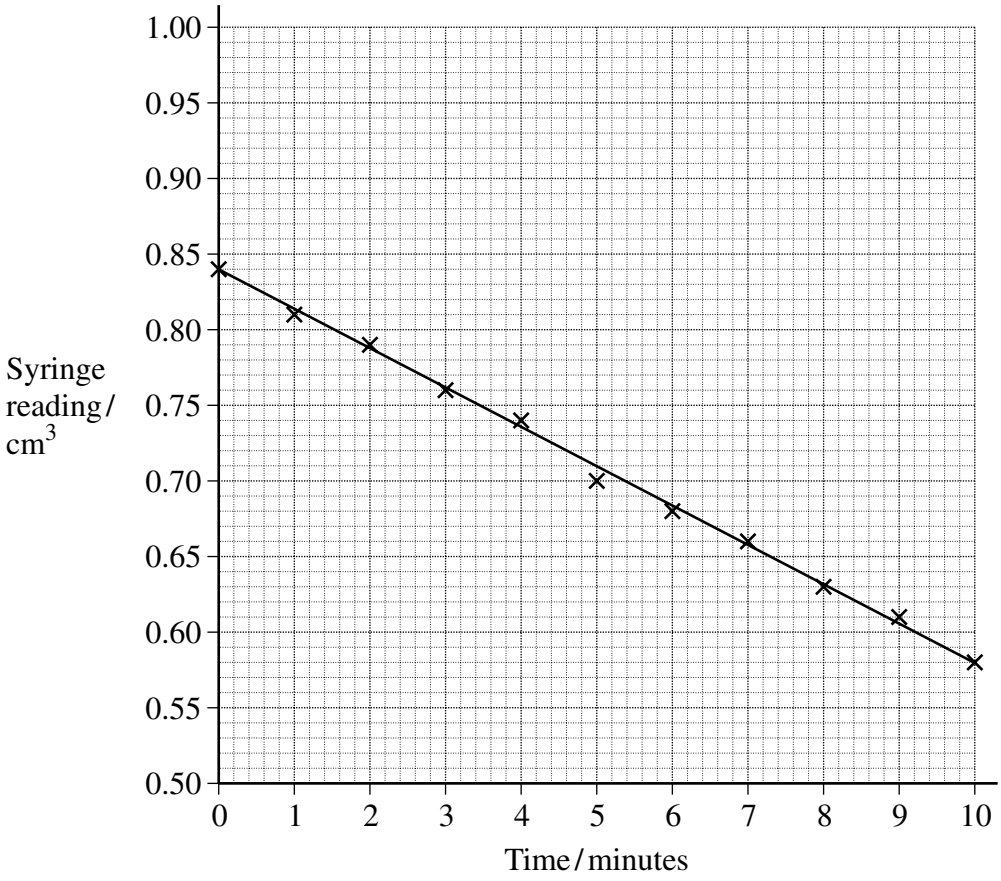
(2 marks)

(b) The syringe was then attached to tube **A** and the tap on tube **B** was closed. Every minute, the syringe plunger was moved until the levels of coloured liquid on each side of the manometer U-tube were the same. The reading on the syringe volume scale was then recorded.

The results are shown in the graph.



(i) During the investigation, the coloured liquid in the manometer moved towards tube **A**. Explain what caused this.

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(3 marks)

(ii) The mass of the locust was 1.6 g. Use the graph to calculate the rate of oxygen consumption by the locust. Give your answer in $cm^3\ g^{-1}\ hour^{-1}$. Show your working.

Rate = ... $cm^3\ g^{-1}\ hour^{-1}$ *(2 marks)*

Question 6 continues on the next page

(c) The investigation was repeated, but with water replacing the potassium hydroxide solution in tubes **A** and **B**. The syringe reading at the start of the investigation was 0.92 cm^3.

(i) **On the graph**, draw a line to show the results you would expect if the respiratory quotient (RQ) of the locust were 1.0.

(1 mark)

(ii) Explain why an RQ of 1.0 would produce the results you drew in part (i).

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(3 marks)

(iii) What does an RQ of 1.0 indicate about the respiration of the locust?

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(2 marks)

(d) Respiration produces ATP. Give **two** ways in which a locust uses ATP.

1 .....

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2 .....

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(2 marks)

15

Turn over for the next question

7 (a) What is meant by each of the following ecological terms?

(i) Ecosystem .....

.....

(ii) Population .....

.....

(2 marks)

(b) An area of soil, 10 m × 10 m, was cleared of all vegetation and left uncultivated. One year later, the plant species present were recorded. The table shows the results.

Species	Mean number of plants per m^2
Daisy	3
Mayweed	2
Groundsel	21
Ragwort	8
Hairy bittercress	11
Fat hen	2
Forget-me-not	1
Field speedwell	3

These results are the mean values from ten 1 m^2 sites that were selected at random.

(i) Describe how the sites could be selected at random.

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(2 marks)

(ii) Why is it necessary to collect data from

a large number of sites, ...

.....

sites selected at random? .....

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(2 marks)

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

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

to calculate the index of diversity of the plants. Show your working.

Index of diversity = ... *(2 marks)*

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

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(1 mark)

(v) The area of soil was left for five years. During this time, the index of diversity fell to 3.75. Suggest an explanation for this fall.

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(4 marks)

(c) Suggest what effect a fall in plant diversity will have on the diversity of animals living in the same ecosystem. Explain your answer.

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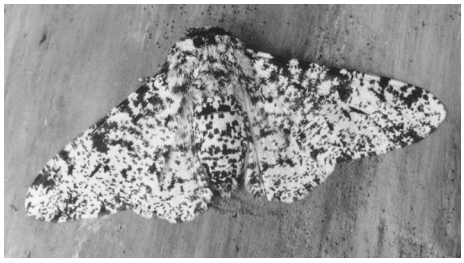
(2 marks)

8 The peppered moth, *Biston betularia*, is found in the UK. The photographs show three varieties of this moth.

carbonaria

insularia



typica

The colour of the moth is determined by a gene which has three alleles. The allele $\mathbf{C^C}$ results in the *carbonaria* variety and is dominant to the other two alleles. The allele $\mathbf{C^i}$ causes the *insularia* variety. $\mathbf{C^i}$ is dominant to the allele $\mathbf{C^t}$ which causes the *typica* variety.

(a) Explain how

(i) crosses between *insularia* moths could produce some *insularia* and some *typica* offspring, but no *carbonaria* offspring,

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(ii) crosses between *carbonaria* moths could produce offspring of all three phenotypes.

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(5 marks)

(b) A study was carried out in the middle of the 20th century. The frequencies of two of the varieties of the peppered moth were investigated in rural Dorset and in the industrial city of Birmingham. The results were as follows.

	Frequency of variety	
	carbonaria	***typica***
Dorset	0.000	0.946
Birmingham	0.850	0.102

At that time, many lichens on the bark of trees in Birmingham had been killed by industrial pollution. The tree bark and other surfaces were often blackened by soot. The area studied in Dorset was free of industrial pollution.

Peppered moths often rest on exposed surfaces during the daytime. Explain how the process of natural selection might have led to the different frequencies of the varieties of the peppered moth seen in Dorset and Birmingham.

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(5 marks)

(c) The three types of peppered moth are classified as varieties of the same species.

(i) How is it possible to show that the three varieties belong to the same species?

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(2 marks)

Question 8 continues on the next page

(ii) Over very long time periods, it is possible for varieties of one species to develop into separate species. Suggest how this could happen in moths such as the peppered moth.

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(3 marks)

15

END OF QUESTIONS

ACKNOWLEDGEMENT OF COPYRIGHT-HOLDERS AND PUBLISHERS

Question 2 Diagram from: MBV ROBERTS, *Biology: a functional approach-Students Manual*, Nelson 1986.

Question 8 Photos from: http://ukmoths.org.uk/images/Peppered180698.JPG
http://ukmoths.org.uk/images/PepperedMothRW.jpg
http://ukmoths.org.uk/images/PepperedMothtypica.jpg