Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2010

Biology BIOL4

Unit 4 Populations and environment

Wednesday 16 June 2010 9.00 am to 10.30 am

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

Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- 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.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

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

1 Nitrogenase catalyses the reduction of nitrogen during nitrogen fixation. The reaction requires 16 molecules of ATP for each molecule of nitrogen that is reduced.

1 (a) Nitrogen gas is the usual substrate for this enzyme. Name the product.

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(1 mark)

1 (b) Nitrogenase also catalyses reactions involving other substances. Explain what this suggests about the shapes of the molecules of these other substances.

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(2 marks)

1 (c) (i) *Azotobacter* is a nitrogen-fixing bacterium. It produces the enzyme nitrogenase. The enzyme only works in the absence of oxygen.

Azotobacter has a very high rate of aerobic respiration compared with bacteria that do not fix nitrogen. Suggest **two** advantages of the very high rate of aerobic respiration.

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(2 marks)

1 (c) (ii) If scientists could transfer the gene that codes for nitrogenase to cereal plants, these cereal plants would be able to fix nitrogen. However, the scientists would expect these genetically engineered cereal plants to grow more slowly than cereal plants that get their nitrogen from fertiliser. Explain why they would grow more slowly.

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(2 marks)

7

Turn over for the next question

2 (a) Blue tits are small birds that live in woods. An ecologist estimated the size of the blue tit population visiting gardens near a wood in November.

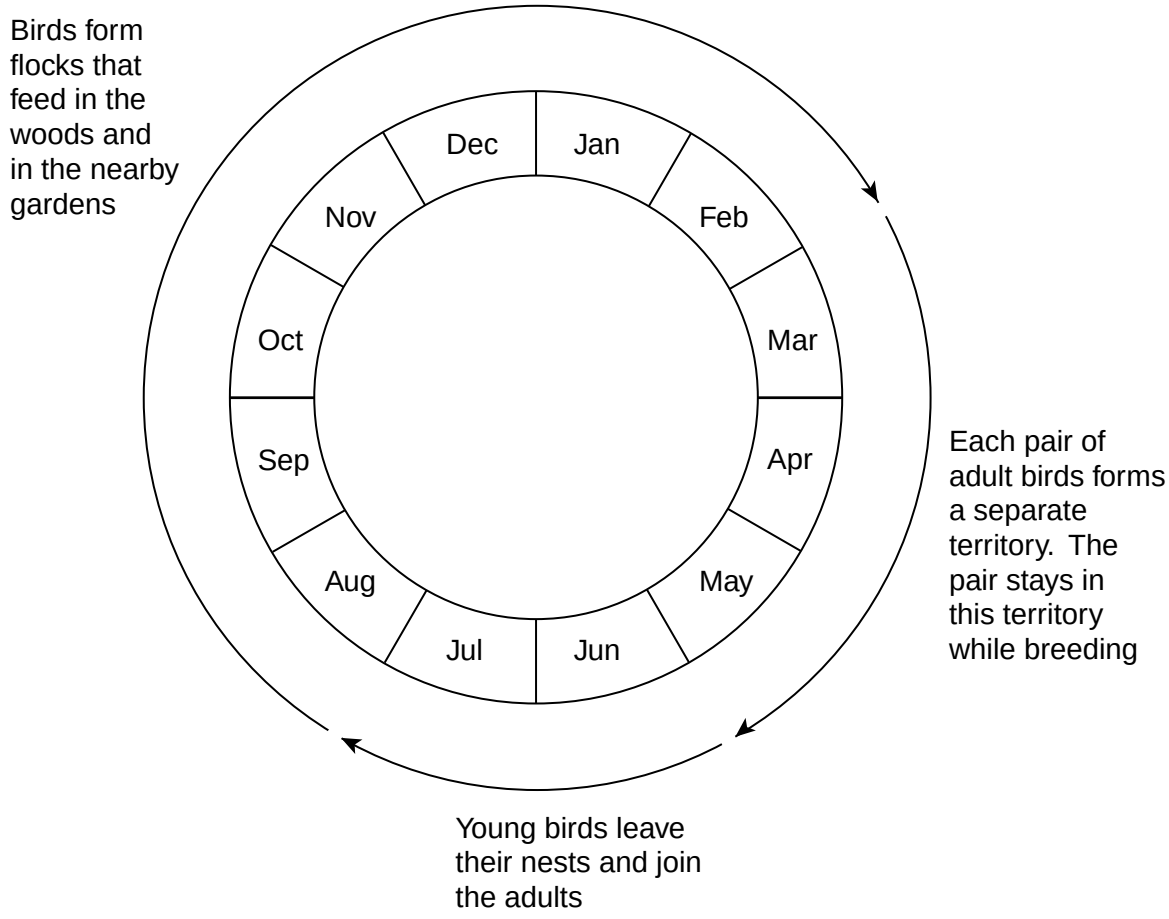
- She trapped 28 blue tits. She marked all of these birds with small metal rings on their legs.
- Two weeks later, she trapped another sample of blue tits. Of these birds, 18 were marked and 20 were not marked.

Use the data to estimate the size of the blue tit population. Show your working.

Size of population .....

(2 marks)

2 (b) The diagram shows some features of blue tit behaviour at different times of the year.



2 (b) (i) Using mark-release-recapture to estimate the size of a blue tit population in June would **not** give reliable results. Explain why.

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(2 marks)

2 (b) (ii) Using mark-release-recapture to estimate the size of a blue tit population in March would **not** give reliable results. Explain why.

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(2 marks)

2 (c) Whales spend most of their time deep in the sea but they come to the surface to breathe. When they are at the surface, scientists obtain small samples of their skin. The scientists find the base sequence in some of the DNA from these samples. The base sequence is different in each whale.

You could use the information about the base sequence to estimate the size of the whale population by using mark-release-recapture. Explain why.

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(2 marks)

8

3 (a) What does the Hardy–Weinberg principle predict?

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(3 marks)

(Extra space) .....

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The table shows the frequencies of some alleles in the population of cats in three cities.

City	Frequency of allele			
	White	Non-agouti	Blotched	Long-haired
Athens	0.001	0.72	0.25	0.50
Paris	0.011	0.71	0.78	0.24
London	0.004	0.76	0.81	0.33

3 (b) White cats are deaf. Would the Hardy–Weinberg principle hold true for white cats? Explain your answer.

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(2 marks)

3 (c) What is the evidence from the table that non-agouti and blotched are alleles of different genes?

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(1 mark)

3 (d) Hair length in cats is determined by a single gene with two alleles. The allele for long hair (h) is recessive. The allele for short hair (H) is dominant.

Use the information in the table and the Hardy–Weinberg equation to estimate the percentage of cats in London that are heterozygous for hair length. Show your working.

Answer .....

(2 marks)

8

Turn over for the next question

4 Scientists constructed a mathematical model. They used this model to estimate the transfer of energy through consumers in a natural grassland ecosystem. The table shows their results.

	Energy transferred as percentage of energy in biomass of producers				
	Ingested food (**F**)	Absorbed from gut (**A**)	Egested (**E**)	Net production (**P**)	Respired (**R**)
Primary consumers					
Mammals	25.00	12.50	12.50	0.25	12.25
Insects	4.00	1.60	2.40	0.64	0.96
Secondary consumers					
Mammals	0.16	0.13	0.03	0.003	0.127
Insects	0.17	0.135	0.035	0.040	0.095

4 (a) Complete the equation to show how net production is calculated from the energy in ingested food.

P =

(1 mark)

4 (b) Describe and explain how intensive rearing of domestic livestock would affect

4 (b) (i) the figure for **A** in the first row of the table

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(1 mark)

4 (b) (ii) the figure for **R** in the first row of the table.

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(1 mark)

4 (c) (i) Calculate the ratio of **R** : **A** for mammalian primary consumers.

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(1 mark)

4 (c) (ii) The **R** : **A** ratio is higher in mammalian primary consumers than in insect primary consumers. Suggest a reason for this higher value.

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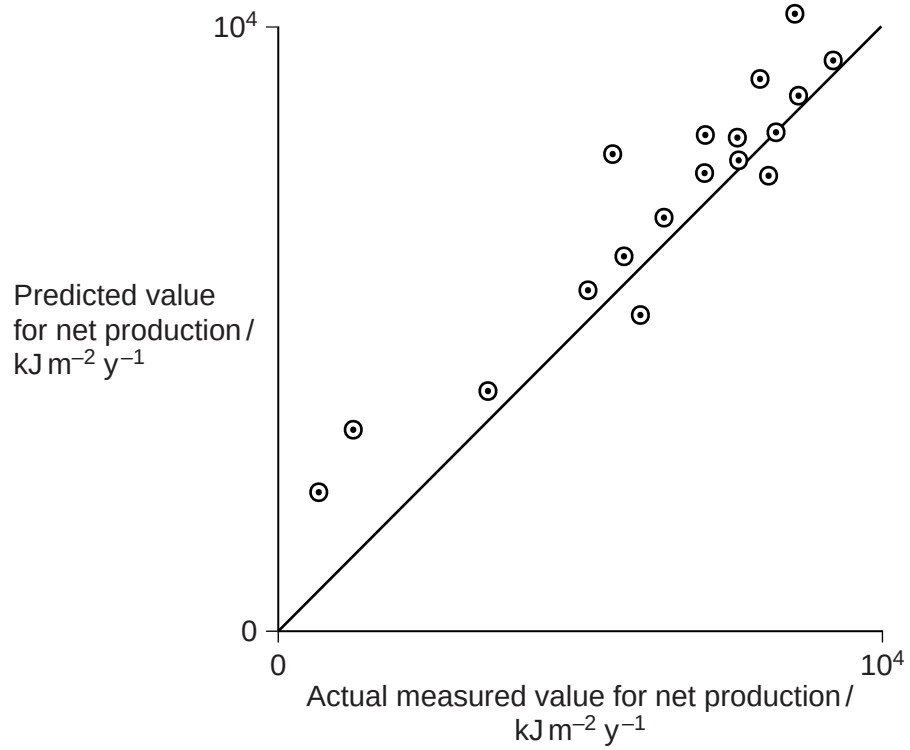
(1 mark)

4 (d) The scientists tested their model by comparing the values it predicted with actual measured values. The graph shows their results.



Are the values predicted by the model supported by the actual measured values? Evaluate the evidence in the graph.

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(3 marks)

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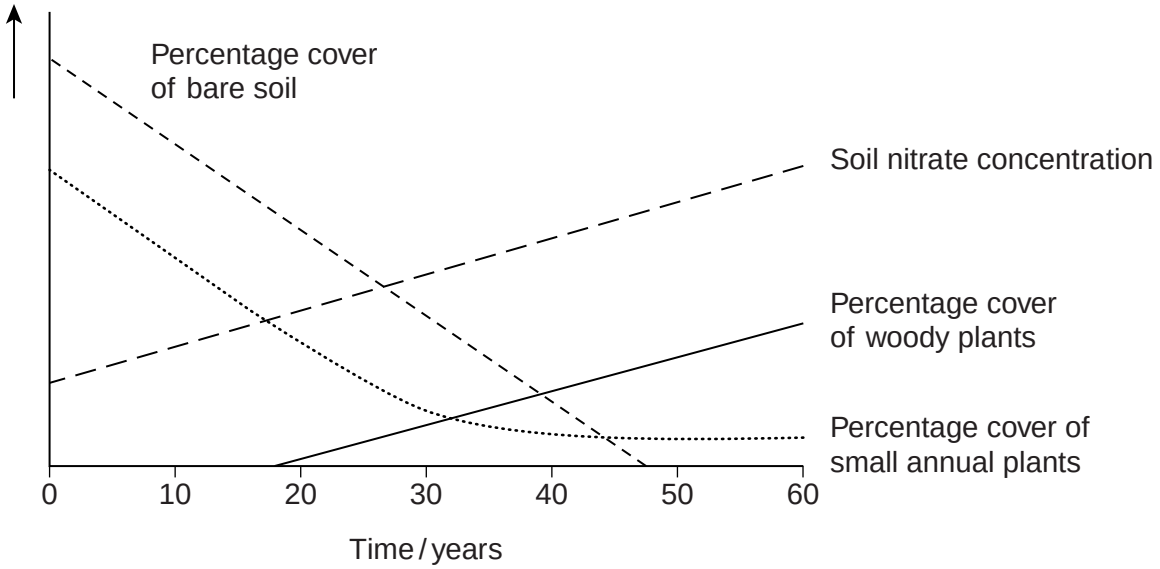
5 Ecologists investigated succession in some abandoned crop fields. The data that they collected are shown in the graph. The curves show the trends that occurred over a period of 60 years.



5 (a) Explain the change in soil nitrate concentration shown on the graph.

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(2 marks)

5 (b) The pioneer plants had different characteristics from the plants that colonised the fields after 50 years.

5 (b) (i) The pioneer plants had seeds that germinate better when the temperature fluctuates. Explain the advantage of this to these pioneer plants.

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(2 marks)

5 (b) (ii) Explain the advantage to a plant that colonises after 50 years of having a high rate of photosynthesis at low light intensities.

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(1 mark)

5 (c) Conservation of grassland habitats involves management of succession. Use the data in the graph to explain why.

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(2 marks)

7

6 (a) Describe the part played by the inner membrane of a mitochondrion in producing ATP.

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(3 marks)

(Extra space) .....

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6 (b) A scientist investigated ATP production in a preparation of isolated mitochondria. He suspended the mitochondria in an isotonic solution and added a suitable respiratory substrate together with ADP and phosphate. He bubbled oxygen through the preparation.

6 (b) (i) Why was the solution in which the mitochondria were suspended isotonic?

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(1 mark)

6 (b) (ii) Explain why the scientist did **not** use glucose as the respiratory substrate.

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(2 marks)

6 (b) (iii) Explain why the oxygen concentration would change during this investigation.

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(1 mark)

7

Turn over for the next question

7 A Sri Lankan scientist investigated the effect of human disturbance on the organisms living on a rocky seashore. He chose three areas for the study. These areas had different amounts of human disturbance.

The scientist measured human disturbance by walking from one end of the beach to the other. He recorded the number of people he encountered.
Figure 1 shows his results.

Figure 1

	Site **R**	Site **G**	Site **U**
Mean number of people encountered per hour (± standard deviation)	2.2 (± 2.1)	17.6 (± 9.6)	34.6 (± 11.6)

7 (a) (i) What conclusions can you draw about the number of people visiting Site **R** compared with the number of people visiting the other two sites? Give evidence from **Figure 1** to support your answer.

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(2 marks)

7 (a) (ii) The scientist reported that the difference between the number of people visiting Site **R** and the number visiting the other two sites differed significantly ($p < 0.05$).

Use the words probability and chance to explain the meaning of *differed significantly ($p < 0.05$).*

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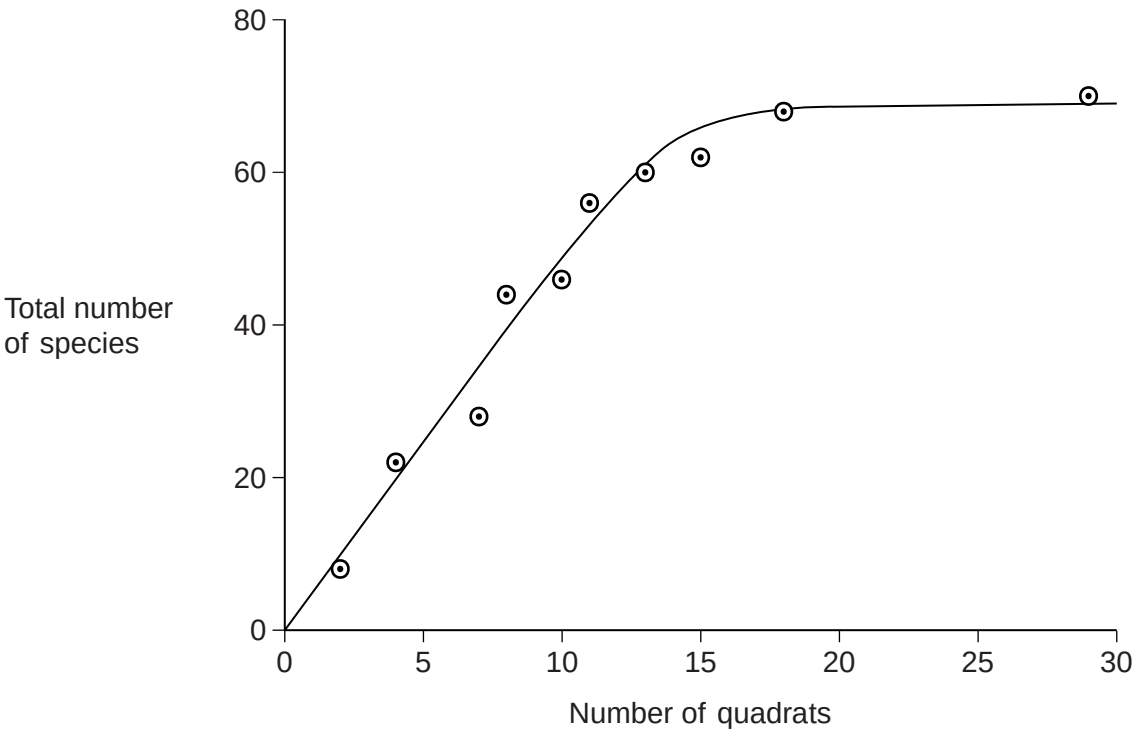
(2 marks)

7 (b) The scientist used quadrats to find the number of species at each of the three sites. He carried out a preliminary investigation and recorded the total number of species in an increasing number of quadrats. **Figure 2** shows the results.

Figure 2



7 (b) (i) Use **Figure 2** to explain why 10 would **not** be an appropriate number of quadrats to use.

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(1 mark)

7 (b) (ii) Use **Figure 2** to explain why 25 would **not** be an appropriate number of quadrats to use.

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(1 mark)

Question 7 continues on the next page

The scientist measured the dry biomass of seaweeds at each of sites **R**, **G** and **U**. He collected all the organisms of a particular species in a quadrat and incubated them in an oven at a temperature of 80 °C.

7 (c) The scientist incubated the seaweeds at 80 °C. Suggest why incubating them at a higher temperature would **not** produce valid results.

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(1 mark)

As well as measuring the dry biomass of the seaweeds, the scientist measured the dry mass of the animals present. He also measured the abundance of each species. **Figure 3** shows the data he collected.

Figure 3

	Site **R**	Site **G**	Site **U**
Mean number of people per hour	2.2	17.6	34.6
Mean number of species of seaweed per quadrat	4.2	2.1	1.3
Ratio of dry biomass of animals to dry biomass of seaweeds	0.15	0.06	0.03
Ratio of dry biomass of animals to abundance of animals	0.20	0.10	0.09
Ratio of dry biomass of seaweeds to abundance of seaweeds	0.79	1.57	3.24

7 (d) The ratio of the dry biomass of animals to the dry biomass of seaweeds is always a lot less than one. Explain why.

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(2 marks)

7 (e) (i) Conservation officers were working on the beaches used in this investigation. They noticed that there were fewer larger seaweeds on beaches used by a large number of people than on beaches visited by only a few people. Explain how the data in **Figure 3** support this.

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(2 marks)

7 (e) (ii) What conclusions can you draw from the data in **Figure 3** about the effect of human disturbance on the animals living on the seashore? Explain your answer.

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(4 marks)

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15

8 (a) The concentrations of carbon dioxide in the air at different heights above ground in a forest changes over a period of 24 hours. Use your knowledge of photosynthesis to describe these changes and explain why they occur.

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(5 marks)

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8 (b) In the light-independent reaction of photosynthesis, the carbon in carbon dioxide becomes carbon in triose phosphate. Describe how.

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(5 marks)

(Extra space) .....

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Question 8 continues on the next page

8 (c) Microorganisms make the carbon in polymers in a dead worm available to cells in a leaf. Describe how.

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(5 marks)

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END OF QUESTIONS