Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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6	
7	
8	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2014

Biology BIOL4

Unit 4 Populations and environment

Friday 13 June 2014 1.30 pm to 3.00 pm

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.
- You are expected to use a calculator, where appropriate.
- 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.

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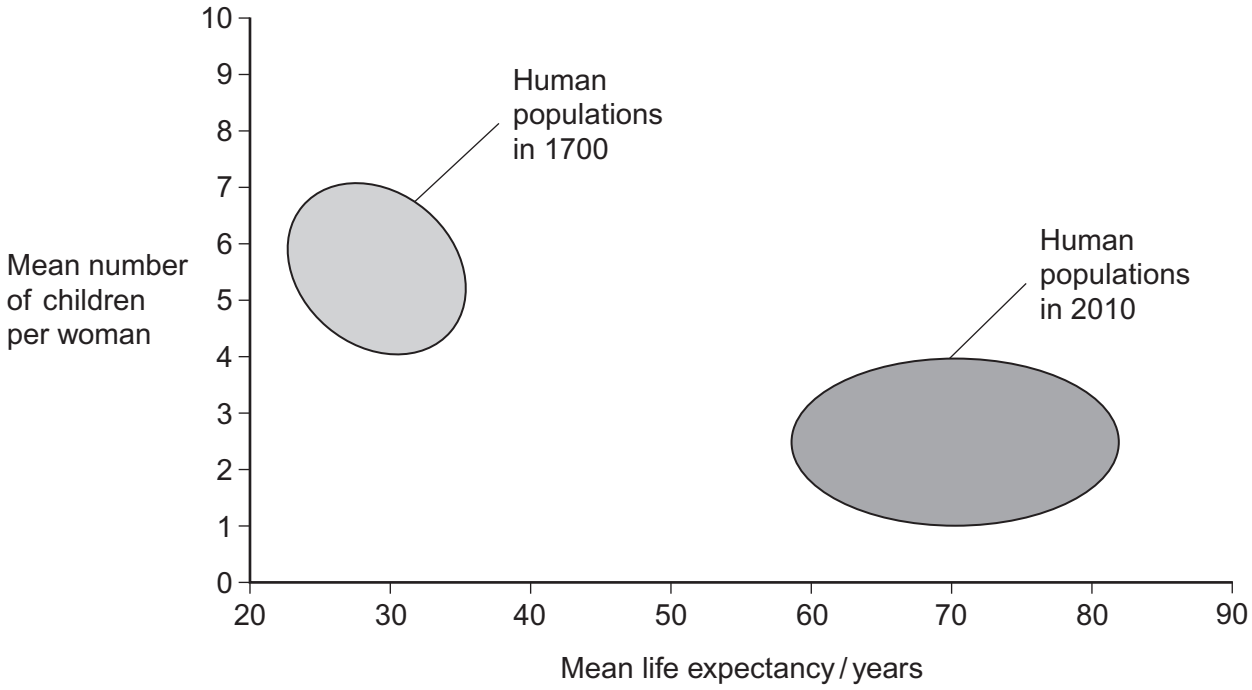
Answer **all** questions in the spaces provided.

1 **Figure 1** shows certain features of human populations in 1700 and 2010.

Figure 1



1 (a) Give **two** differences between the populations in 1700 and 2010.

[2 marks]

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1 (b) Suggest **two** reasons for the differences between the populations in 1700 and 2010.

[2 marks]

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1 (c) **Table 1** shows some features relating to the human population in Italy in 2010.

Table 1

Feature	
Total population / millions	60.2
Birth rate per 1000 population	9.3
Death rate per 1000 population	9.7

Use the information in **Table 1** to calculate the size of the population of Italy in 2011. Show your working.

[2 marks]

Answer = ...

6

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2 Upwelling is a process where water moves from deeper parts of the sea to the surface. This water contains a lot of nutrients from the remains of dead organisms.

2 (a) (i) Nitrates and phosphates are two of these nutrients. They provide a source of nitrogen and phosphorus for cells.

Give a biological molecule that contains:

[2 marks]

1. nitrogen .....

2. phosphorus .....

2 (a) (ii) Describe the role of microorganisms in producing nitrates from the remains of dead organisms.

[3 marks]

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2 (b) Upwelling often results in high primary productivity in coastal waters.
Explain why some of the most productive fishing areas are found in coastal waters.

[2 marks]

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3 Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

3 (a) Name the process that resulted in the development of woodland from farmland.

[1 mark]

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3 (b) Explain the increase in the diversity of birds as the woodland developed.

[3 marks]

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Question 3 continues on the next page

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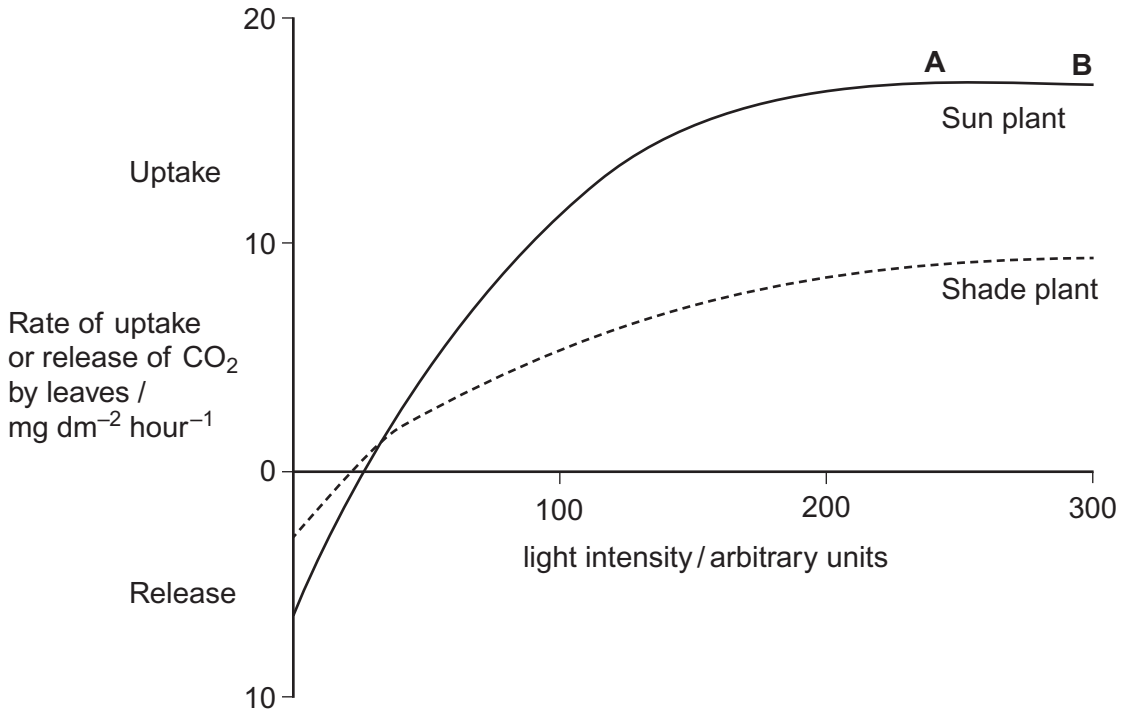
3 (c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in **Figure 2**.

Figure 2



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3 (c) (i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on **Figure 2**.

[1 mark]

1.....

2.....

3 (c) (ii) Explain why CO_2 uptake is a measure of net productivity.

[1 mark]

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[Extra space] .....

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3 (c) (iii) Use the information in **Figure 2** to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

[2 marks]

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4 In birds, **males are XX** and **females are XY**.

4 (a) Use this information to explain why recessive, sex-linked characteristics are more common in female birds than in male birds.

[1 mark]

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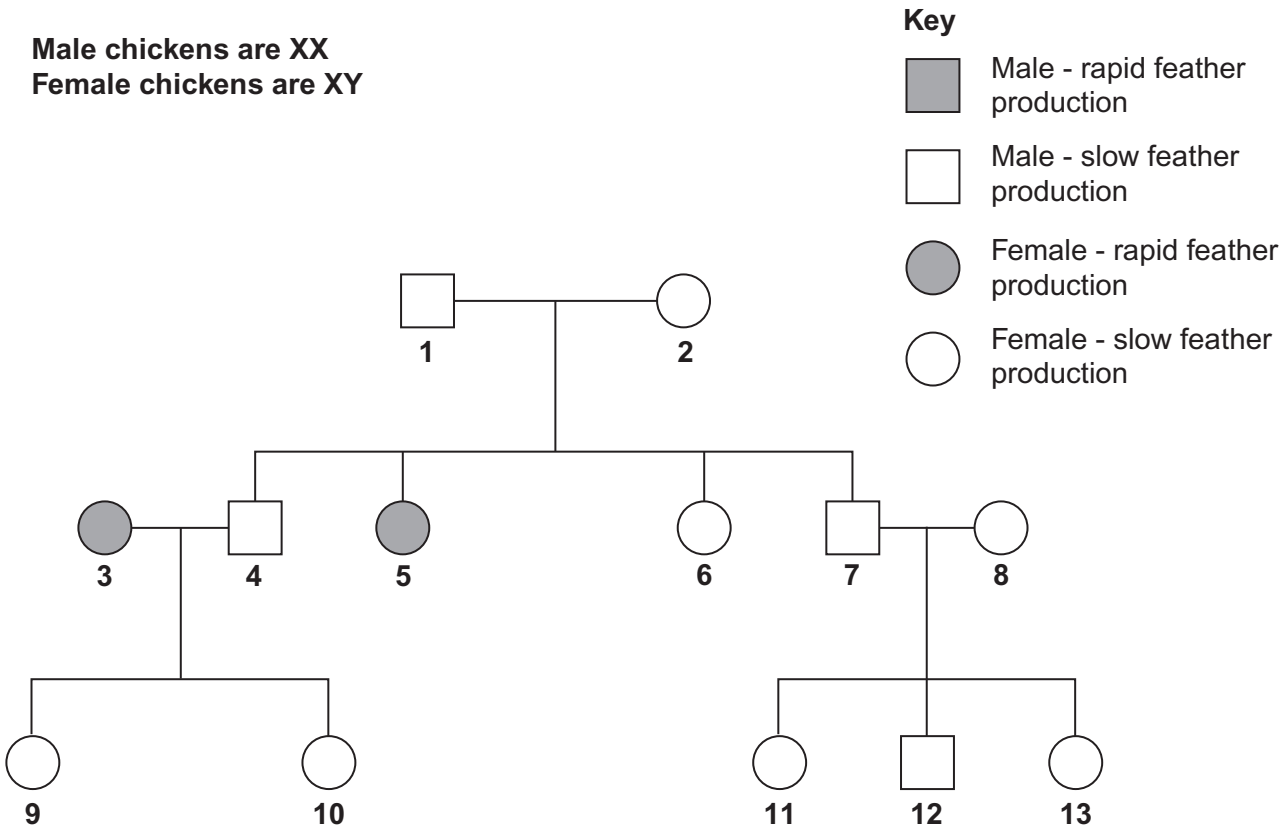
4 (b) In chickens, a gene on the X chromosome controls the rate of feather production. The allele for slow feather production, **F**, is dominant to the allele for rapid feather production, **f**. **Figure 3** shows the results produced from crosses carried out by a farmer.

Figure 3

Male chickens are XX
Female chickens are XY



4 (b) (i) Explain **one** piece of evidence from **Figure 3** which shows that the allele for rapid feather production is recessive.

[2 marks]

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4 (b) (ii) Give all the possible genotypes of the following chickens from **Figure 3**.

[2 marks]

Chicken 5 .....

Chicken 7 .....

4 (b) (iii) A cross between two chickens produced four offspring. Two of these were males with rapid feather production and two were females with slow feather production. Give the genotypes of the parents.

[1 mark]

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4 (c) Feather colour in one species of chicken is controlled by a pair of codominant alleles which are **not** sex-linked. The allele $\mathbf{C^B}$ codes for black feathers and the allele $\mathbf{C^W}$ codes for white feathers. Heterozygous chickens are blue-feathered.

On a farm, 4% of the chickens were black-feathered. Use the Hardy–Weinberg equation to calculate the percentage of this population that you would expect to be blue-feathered. Show your working.

[3 marks]

Answer ..... %

9

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5 Malaria is a disease that destroys red blood cells. Scientists investigated whether certain red blood cell phenotypes were associated with developing severe or mild malaria. They compared the red blood cell phenotypes of hospital patients suffering from severe malaria with the red blood cell phenotypes of patients suffering from mild malaria. The results are shown in **Table 2**.

Table 2

Red blood cell phenotype	Ratio of patients with severe malaria : patients with mild malaria
Sickle cell trait	0.48 : 1
Blood group A	2.45 : 1
Blood group O	0.96 : 1

5 (a) Explain the advantage of presenting the results as a ratio.

[2 marks]

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5 (b) What do these data show about the effect of red blood cell phenotypes on the chance of developing severe malaria rather than mild malaria?

[2 marks]

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5 (c) The allele for normal haemoglobin in red blood cells is $\mathbf{Hb^A}$. In some parts of Africa where malaria occurs there is a high frequency in the population of the allele $\mathbf{Hb^C}$. Individuals possessing the $\mathbf{Hb^C}$ allele have a lower chance of developing severe malaria. Severe malaria causes a large number of deaths in Africa.

Explain the high frequency of the $\mathbf{Hb^C}$ allele in areas where malaria occurs.

[3 marks]

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Turn over for the next question

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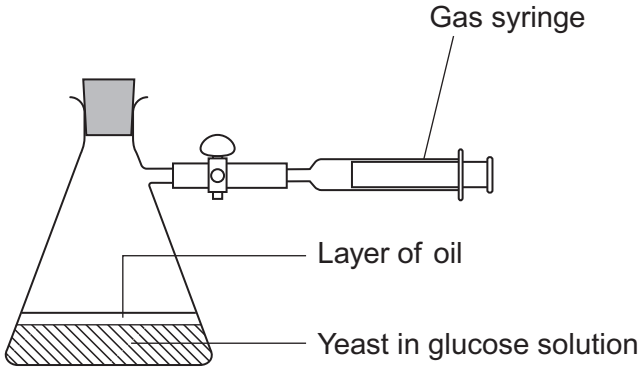
6 A student investigated the rate of anaerobic respiration in yeast. She put 5 g of yeast into a glucose solution and placed this mixture in the apparatus shown in **Figure 4**. She then recorded the total volume of gas collected every 10 minutes for 1 hour.

Figure 4



6 (a) Explain why a layer of oil is required in this investigation.

[1 mark]

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6 (b) The student's results are shown in **Table 3**.

Table 3

Time / minutes	Total volume of gas collected / cm^3
10	0.3
20	0.9
30	1.9
40	3.1
50	5.0
60	5.2

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6 (b) (i) Calculate the rate of gas production in $cm^3\ g^{-1}\ min^{-1}$ during the first 40 minutes of this investigation. Show your working.

[2 marks]

Answer = ... $cm^3\ g^{-1}\ min^{-1}$

6 (b) (ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

[1 mark]

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6 (b) (iii) Yeast can also respire aerobically. The student repeated the investigation with a fresh sample of yeast in glucose solution, but without the oil. All other conditions remained the same.
Explain what would happen to the volume of gas in the syringe if the yeast were only respiring aerobically.

[2 marks]

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6 (c) Respiration produces more ATP per molecule of glucose in the presence of oxygen than it does when oxygen is absent. Explain why.

[2 marks]

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7 Hydrilla (*Hydrilla verticillata*) is an aquatic plant which has become a major pest of waterways in parts of the USA. Hydrilla is not a native species of the USA. It was introduced into natural habitats from aquariums. In many freshwater habitats it has rapidly become the dominant plant species.

7 (a) In many freshwater habitats Hydrilla has rapidly become the dominant plant species. Suggest **two** reasons why.

[2 marks]

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7 (b) The spread of Hydrilla has had economic consequences for commercial activities and for the government's environmental agency.
Suggest **two** economic consequences of the spread of Hydrilla.

[2 marks]

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7 (c) Scientists investigated the effect of the chemical fluridone as a method of controlling Hydrilla. The study was carried out using samples of Hydrilla grown under controlled laboratory conditions. Several samples of the plant were grown at different concentrations of fluridone. The results are shown in **Table 4**.

Table 4

	Days of treatment			
	0	20	40	60
Concentration of fluridone / µg dm^{-3}	**Mean biomass of Hydrilla / g**			
0.0	5.0	16.4	20.9	33.4
0.5	5.0	14.1	18.2	31.3
1.0	5.0	9.7	8.9	7.4
5.0	5.0	4.6	2.8	1.3
25.0	5.0	3.2	1.6	0.4

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7 (c) (i) The scientists obtained the biomass of each sample by heating it at 75 ºC for 2 hours. They then weighed the sample, reheated it for 15 minutes and weighed it again. They continued this cycle of reheating and weighing until they found the sample had a constant mass.

Explain how this method helped to provide a reliable measurement of the biomass.

[2 marks]

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7 (c) (ii) A scientist reviewed the results of this investigation. He suggested that fluridone should be used in the habitat at a concentration of 5.0 μg dm^{-3} rather than at the other concentrations tested. Use the information provided and your knowledge of chemical control to explain why he made this suggestion.

[4 marks]

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7 (d) Scientists have also investigated the use of an integrated system to control Hydrilla. This involved using fluridone and a fungus as a biological control agent. They set up four different experiments.

- Experiment **1** – Hydrilla left untreated
- Experiment **2** – Hydrilla treated with the fungus
- Experiment **3** – Hydrilla treated with fluridone
- Experiment **4** – Hydrilla treated with both fluridone and the fungus.

The scientists determined the biomass of Hydrilla at the end of each experiment.

7 (d) (i) Experiment **1** acted as a control. Explain why the scientists carried out experiment **1**.

[1 mark]

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7 (d) (ii) The scientists isolated the fungus from the tissue of Hydrilla growing in its country of origin. Suggest **two** possible advantages of using this fungus as the biological control agent.

[2 marks]

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7 (d) (iii) The treatment in experiment **4** was the most effective. Use your knowledge of integrated pest control systems to suggest why the treatment in experiment **4** was the most effective.

[2 marks]

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8 (a) During the light-independent reaction of photosynthesis, carbon dioxide is converted into organic substances. Describe how.

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8 (b) Explain how human activities have contributed to global warming.

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8 (c) The bluebell is a flowering plant found in woodlands. Global warming has been associated with a change in the population of bluebells. Describe how you could estimate the number of bluebells in a small woodland.

[5 marks]

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END OF QUESTIONS

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