AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

A-level BIOLOGY

Unit 4 Populations and environment

Monday 12 June 2017 Afternoon Time allowed: 1 hour 30 minutes

Materials

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

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.

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

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

1 (a) Explain what is meant by the ecological term population.

[1 mark]

1 (b) Four factors may affect the size of a human population. They are:

- birth rate (**B**)
- death rate (**D**)
- emigration rate (**E**)
- immigration rate (**I**)

1 (b) (i) Which formula shows a population that stays the same size?
Tick (✓) **one** box next to the correct formula.

[1 mark]

B + **E** = **D** + **I** ☐

B + **I** = **D** + **E** ☐

B + **D** = **I** + **E** ☐

B + **D** + **I** + **E** = 0 ☐

1 (b) (ii) Which formula shows a population that is increasing in size?
Tick (✓) **one** box next to the correct formula.

[1 mark]

B + **D** + **I** + **E** > 0 ☐

B – **D** > **I** – **E** ☐

B + **I** < **D** + **E** ☐

B + **I** > **D** + **E** ☐

Question 1 continues on the next page

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

Table 1

Feature	Country	
	Mexico	**Italy**
Total population / millions	119.9	60.2
Birth rate per 1000 population	19.4	9.3
Death rate per 1000 population	4.8	9.7

1 (c) (i) Use the information in **Table 1** to calculate the size of the population of Mexico in 2011. Show your working.

[2 marks]

Answer _____

1 (c) (ii) These two countries are at different stages of demographic transition.

Describe the evidence for this.

[1 mark]

_____

_____

_____

6

2 Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

An anaerobic digester is a large, sealed tank, in which microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

2 (a) (i) Suggest **two** advantages of processing waste in an anaerobic digester rather than in a tank with an open top.

[2 marks]

1 _____

_____

2 _____

_____

2 (a) (ii) Anaerobic digesters require a cooling system. Without this cooling system the digester would soon stop working.

Explain why.

[2 marks]

_____

_____

_____

_____

_____

Question 2 continues on the next page

2 (b) (i) The over-application of fertiliser increases the rate of leaching.

Explain the consequences of leaching of fertiliser into ponds and lakes.

[3 marks]

[Extra space]

2 (b) (ii) Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

[1 mark]

8

Turn over for the next question

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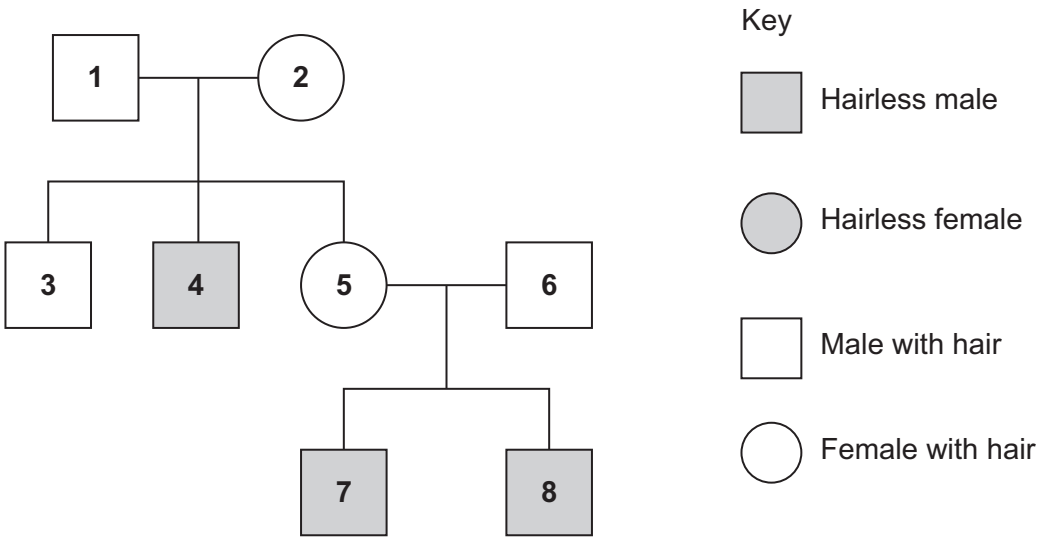
ANSWER IN THE SPACES PROVIDED

3 A single gene controls the presence of hair on the skin of cattle. The gene is carried on the X chromosome. Its dominant allele causes hair to be present on the skin and its recessive allele causes hairlessness.

Figure 1 shows the pattern of inheritance of these alleles in a group of cattle.

Figure 1



3 (a) (i) Explain how **Figure 1** shows hairlessness is caused by a recessive allele.

[2 marks]

3 (a) (ii) Explain how **Figure 1** supports the statement that hairlessness is caused by a gene on the X chromosome.

[1 mark]

3 (b) What is the probability of the next calf born to animals **5** and **6** being hairless? Complete the genetic diagram to show how you arrived at your answer.

[4 marks]

Phenotypes of parents Female with hair Male with hair

Genotypes of parents _____ _____

Gametes _____ _____

Genotypes of offspring _____

Phenotypes of offspring _____

Probability of next calf being hairless _____

7

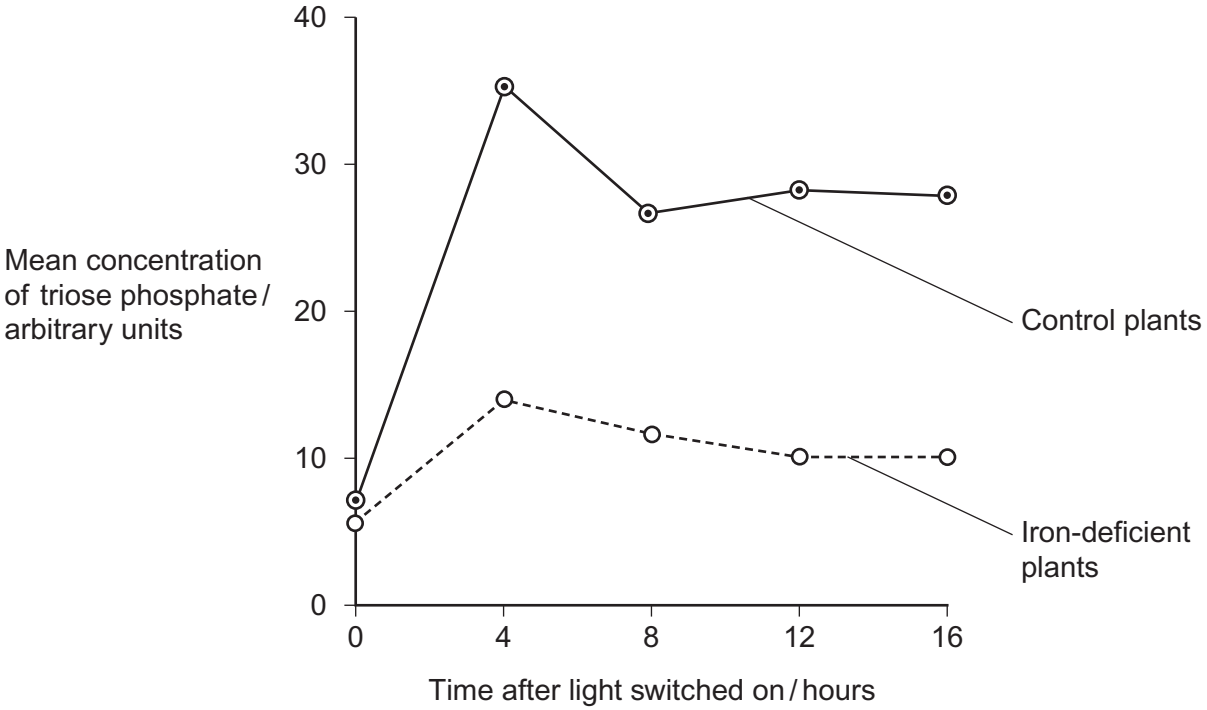
Turn over for the next question

4 Scientists investigated the effect of iron deficiency on the production of triose phosphate in sugar beet plants. They grew the plants under the same conditions with their roots in a liquid growth medium containing all the necessary nutrients. Ten days before the experiments, they transferred half the plants to a liquid growth medium containing no iron. The scientists measured the concentration of triose phosphate produced in these plants and in the control plants:

- at the end of 6 hours in the dark (this is recorded as time zero)
- then for 16 hours in the light.

The results are shown in **Figure 2**.

Figure 2



4 (a) (i) Explain why the experiments were carried out at a high carbon dioxide concentration.

[1 mark]

4 (a) (ii) Explain why the plants were left in the dark for 6 hours before the experiment.

[1 mark]

4 (b) Iron deficiency reduces electron transport.

Use this information and your knowledge of photosynthesis to explain the decrease in production of triose phosphate in the iron-deficient plants.

[4 marks]

[Extra space]

4 (c) Explain why iron deficiency results in a decrease in the uptake of carbon dioxide.

[2 marks]

8

5 Wolves were eradicated from Yellowstone National Park in the USA early in the 20th century. In the 1990s a small number of wolves were removed from their groups in Canada and released into Yellowstone National Park. Within five years the wolves had established a population of around 100 individuals living in approximately 10 groups.

Several years after reintroduction, scientists studied the frequencies of two alleles of a gene in the population of Yellowstone wolves. The dominant allele, **B**, results in black coat colour. The recessive allele, **b**, results in homozygous recessive wolves having a grey coat colour.

In the population of wolves, the allele frequency for the recessive allele, **b**, was found to be 0.79.

5 (a) (i) Use the Hardy-Weinberg equation to calculate the percentage of grey wolves in the population. Show your working.

[2 marks]

Answer _____%

5 (a) (ii) What does the Hardy-Weinberg principle predict about the frequency of the **b** allele after another 10 generations?

[1 mark]

_____

_____

5 (a) (iii) Use the information provided to suggest **two** reasons why the Hardy-Weinberg principle is unlikely to apply in these circumstances.

[2 marks]

1 _____

_____

2 _____

_____

5 (b) Several years later, scientists repeated their study on this population. They found that the frequency of the recessive allele had decreased.

What type of natural selection appears to have occurred in this population of wolves? Explain how this type of selection led to a change in allele frequency.

[2 marks]

Type of selection _____

Explanation _____

_____

_____

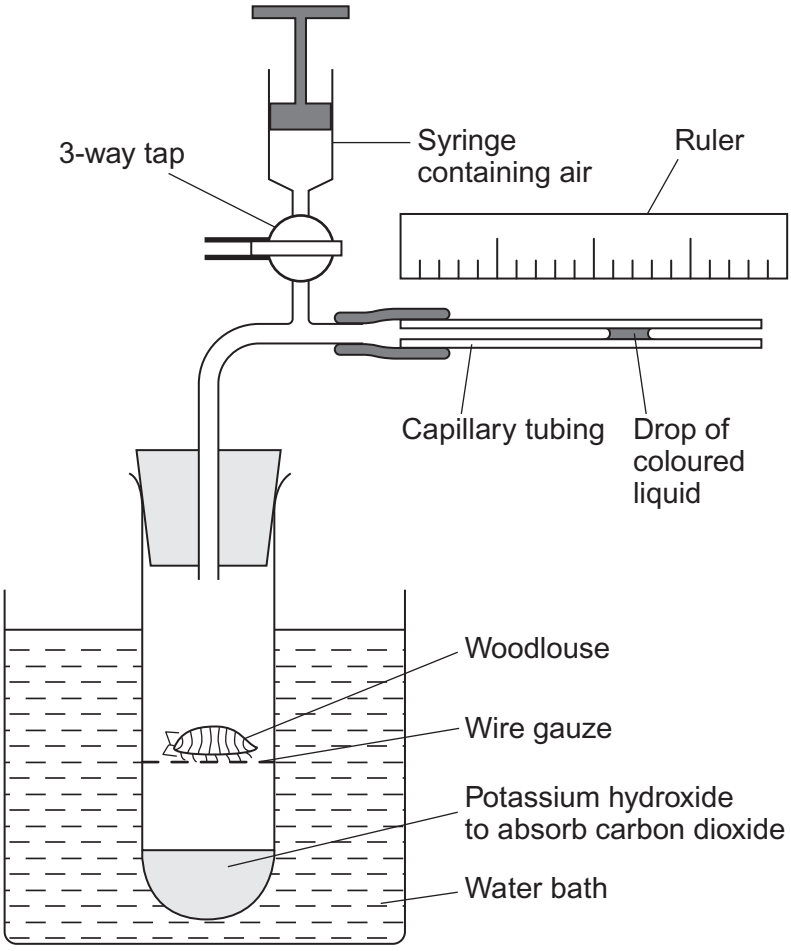
_____

7

Turn over for the next question

6 (a) A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in **Figure 3**.

Figure 3



6 (a) (i) The student closed the tap. After thirty minutes the drop of coloured liquid had moved to the left.

Explain why the drop of coloured liquid moved to the left.

[3 marks]

[Extra space]

6 (a) (ii) What measurements should the student have taken to calculate the rate of aerobic respiration in mm^3 of oxygen g^{-1} h^{-1}?

[3 marks]

[Extra space]

Question 6 continues on the next page

6 (b) DNP inhibits respiration by preventing a proton gradient being maintained across membranes. When DNP was added to isolated mitochondria the following changes were observed:

- less ATP was produced
- more heat was produced
- the uptake of oxygen remained constant.

Explain how DNP caused these changes.

[3 marks]

[Extra space]

9

7 Malaria is a disease caused by a parasite. Scientists investigated the effect of malaria on competition between two species of *Anolis* lizard on a small Caribbean island. They sampled both populations by collecting lizards from a large number of sites on the island.

7 (a) (i) Explain the importance of collecting lizards from a large number of sites.

[1 mark]

7 (a) (ii) Describe **one** method the scientists could have used to ensure that the sites were chosen without bias.

[2 marks]

7 (a) (iii) The population number of both species of lizard varied at different times of the year.

Suggest **two** reasons why.

[2 marks]

1

2

Question 7 continues on the next page

The scientists investigated the percentage of lizards of both species that were infected with malaria at different sites on the island. They collected samples of both lizards at intervals of 3 months for 1 year. They also recorded the elevation (height above sea level) of each site. Some of their results are shown in **Table 2**.

Table 2

Site	Elevation of collection site / metres	Total number of *A. gingivinus* collected in one year	Percentage of *A. gingivinus* infected with malaria	Total number of *A. wattsi* collected in one year	Percentage of *A. wattsi* infected with malaria
1	10	13	0	0	0
2	80	30	0	0	0
3	120	35	23	3	0
4	200	40	30	7	0
5	300	52	46	12	0
6	315	35	31	13	1
7	370	155	37	79	2
8	414	124	44	68	4

7 (b) When analysing their results, the scientists used the percentage of lizards infected at each site, rather than the number of lizards infected.

Explain why.

[2 marks]

7 (c) A preliminary study suggested that malarial infections were more common at higher elevations.

Use the information in **Table 2** to evaluate this suggestion.

[2 marks]

7 (d) (i) As a result of this investigation, the scientists concluded that the presence of malaria provided a competitive advantage to *A. wattsi*.

Use the information in **Table 2** to explain how they reached this conclusion.

[2 marks]

Question 7 continues on the next page

7 (d) (ii) The malarial parasite of *Anolis* lizards destroys both red and white blood cells.

Suggest how an increase in the percentage of *A. gingivinus* infected with malaria could result in *A. wattsi* having a competitive advantage.

[2 marks]

7 (d) (iii) The scientists carried out a statistical test to determine whether the correlation between the number of *A. wattsi* collected and the percentage of *A. gingivinus* infected was significant. They obtained a value of $P < 0.01$.

Use the terms **probability** and **chance** to help explain what this means.

[2 marks]

15

8 (a) Succession occurs in natural ecosystems.

Describe and explain how succession occurs.

[5 marks]

[Extra space]

Question 8 continues on the next page

8 (b) Managed ecosystems such as wheat fields are prone to pest infestations.

Describe the advantages and disadvantages of using biological agents to control pests.

[5 marks]

[Extra space]

8 (c) Lower yields are produced in wheat fields if the oxygen concentration in the soil is low and the roots of the plants respire anaerobically.

Describe the process of anaerobic respiration and suggest why this may lead to lower yields.

[5 marks]

[Extra space]

END OF QUESTIONS

15

There are no questions printed on this page

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