Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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7	
8	
TOTAL	

General Certificate of Education
Advanced Level Examination
June 2015

Biology BIOL4

Unit 4 Populations and environment

Monday 8 June 2015 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.

Do not write outside the box

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

1 (a) There are changes in the birth rate, death rate and size of the population during demographic transition.

1 (a) (i) Describe the changes that occur in the birth and death rates during demographic transition.

[1 mark]

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1 (a) (ii) Describe the changes that occur in the size of the population during demographic transition.

[1 mark]

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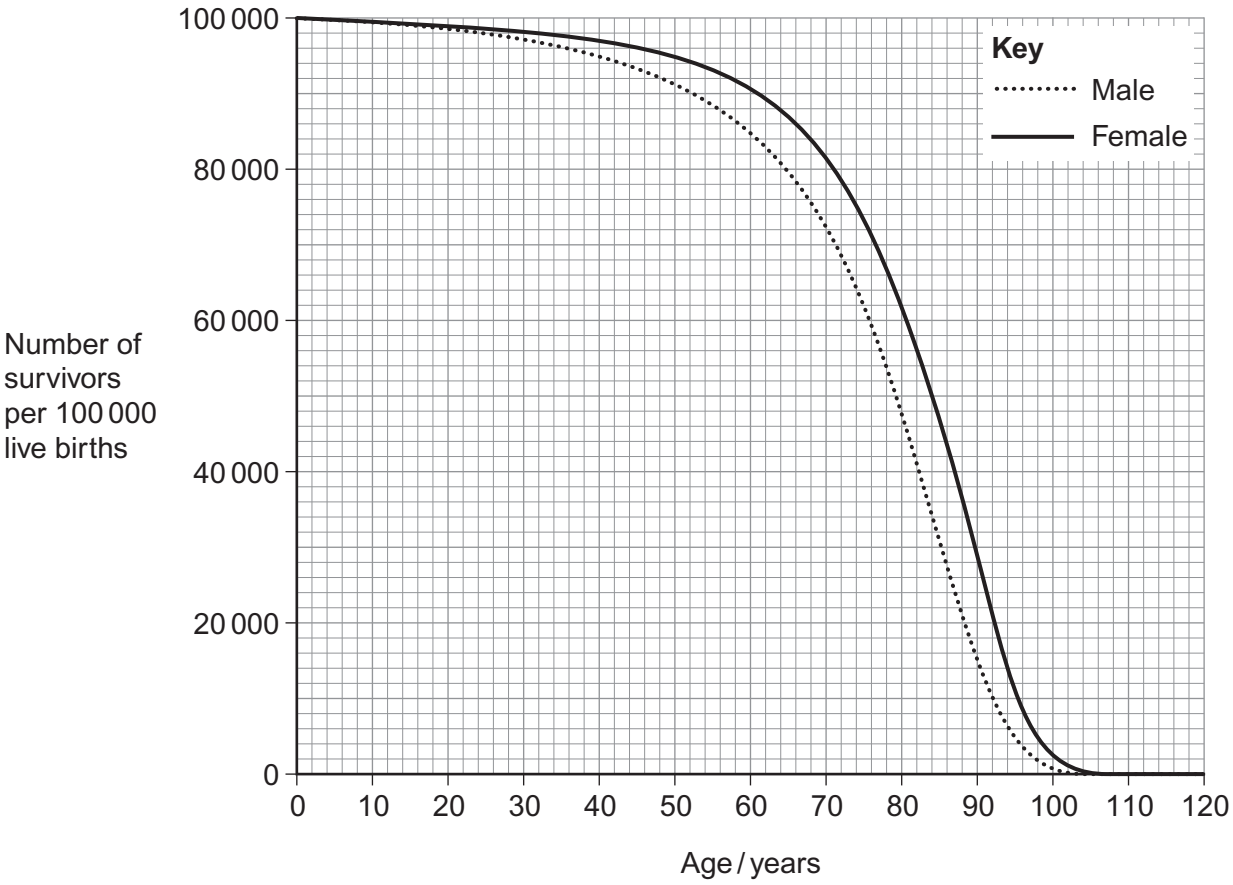
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1 (b) **Figure 1** shows the survival curves for males and females in the USA in 2010.

Figure 1



1 (b) (i) Calculate the percentage difference in the average life expectancy for females compared with males in the USA in 2010.
Show your working.

[2 marks]

Answer = ... %

1 (b) (ii) Suggest **one** reason for the difference in the average life expectancy for males and females in the USA in 2010.

[1 mark]

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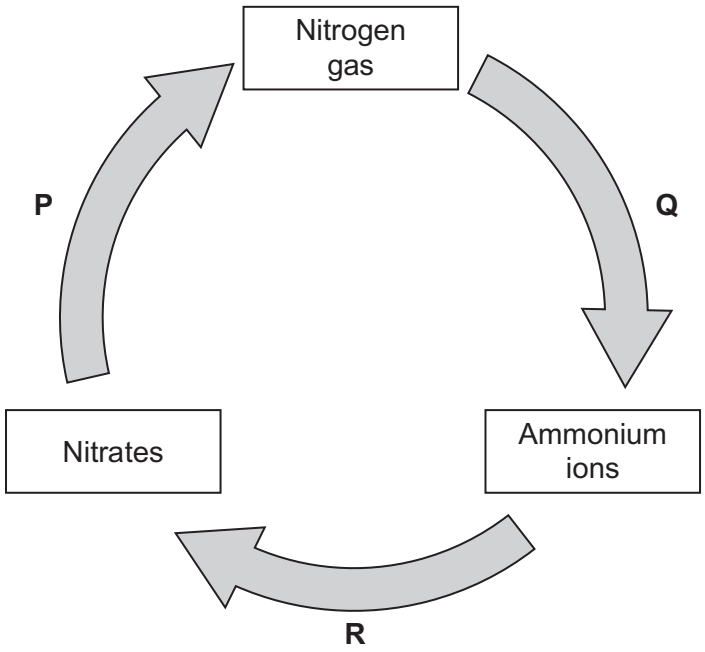
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2 **Figure 2** shows part of the nitrogen cycle.

Figure 2



2 (a) Which **one** of the processes **P**, **Q** or **R** involves nitrification?

[1 mark]

2 (b) **Figure 2** includes one process in which microorganisms add ammonium ions to soil.

Describe another process carried out by microorganisms which adds ammonium ions to soil.

[2 marks]

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2 (c) Denitrification requires anaerobic conditions. Ploughing aerates the soil. Explain how ploughing would affect the fertility of the soil.

[2 marks]

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2 (d) One farming practice used to maintain high crop yields is crop rotation. This involves growing a different crop each year in the same field.

Suggest **two** ways in which crop rotation may lead to high crop yields.

[2 marks]

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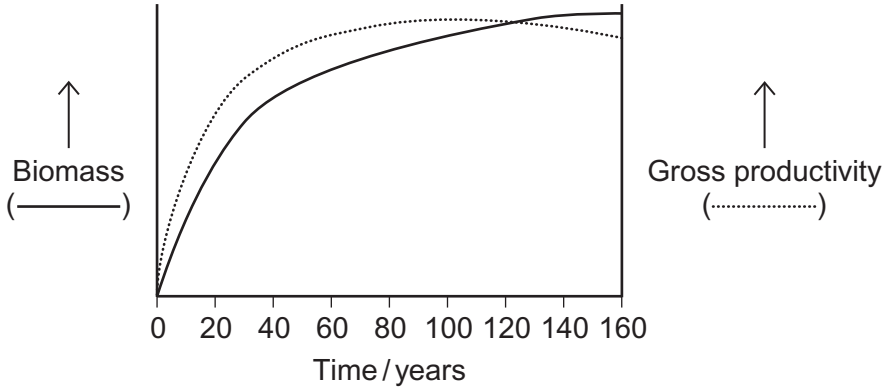
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3 **Figure 3** shows how gross productivity and biomass in an area changed with time in the succession from bare soil to mature woodland.

Figure 3



3 (a) (i) Suggest appropriate units for gross productivity.

[1 mark]

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3 (a) (ii) Explain the decrease in gross productivity as the woodland matures.

[2 marks]

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3 (b) Use your knowledge of succession to explain the increase in biomass during the first 20 years.

[3 marks]

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3 (c) Use the information in **Figure 3** and your knowledge of net productivity to explain why biomass shows little increase after 100 years.

[2 marks]

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3 (d) Suggest **one** reason for conserving woodlands.

[1 mark]

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4 In cats, males are XY and females are XX. A gene on the X chromosome controls fur colour in cats. The allele **G** codes for ginger fur and the allele **B** codes for black fur. These alleles are codominant. Heterozygous females have ginger and black patches of fur and their phenotype is described as tortoiseshell.

4 (a) Explain what is meant by **codominant** alleles.

[1 mark]

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4 (b) Male cats with a tortoiseshell phenotype do **not** usually occur. Explain why.

[1 mark]

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4 (c) A tortoiseshell female was crossed with a black male. Use a genetic diagram to show all the possible genotypes and the ratio of phenotypes expected in the offspring of this cross.

Use $\mathbf{X^G}$ to indicate the allele **G** on an X chromosome.
Use $\mathbf{X^B}$ to indicate the allele **B** on an X chromosome.

[3 marks]

Genotypes of offspring .....

Phenotypes of offspring .....

Ratio of phenotypes .....

Do not write outside the box

4 (d) Polydactyly in cats is an inherited condition in which cats have extra toes. The allele for polydactyly is dominant.

4 (d) (i) In a population, 19% of cats had extra toes. Use the Hardy-Weinberg equation to calculate the frequency of the recessive allele for this gene in this population. Show your working.

[2 marks]

Answer = ...

4 (d) (ii) Some cat breeders select for polydactyly. Describe how this would affect the frequencies of the homozygous genotypes for this gene in their breeding populations over time.

[1 mark]

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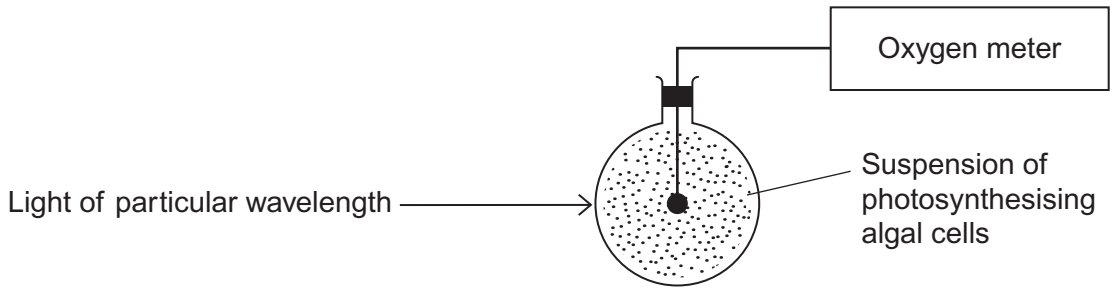
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5 A student investigated the effect of different wavelengths of light on the rate of photosynthesis. She used the apparatus shown in **Figure 4**.

Figure 4



5 (a) What measurements should the student have taken to determine the rate of photosynthesis?

[1 mark]

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5 (b) Other than temperature and pH, give **two** factors which should be kept constant during this investigation.

[2 marks]

1 .....

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5 (c) The student did **not** use a buffer to maintain the pH of the solution.
Explain what would happen to the pH of the solution during this investigation.

[2 marks]

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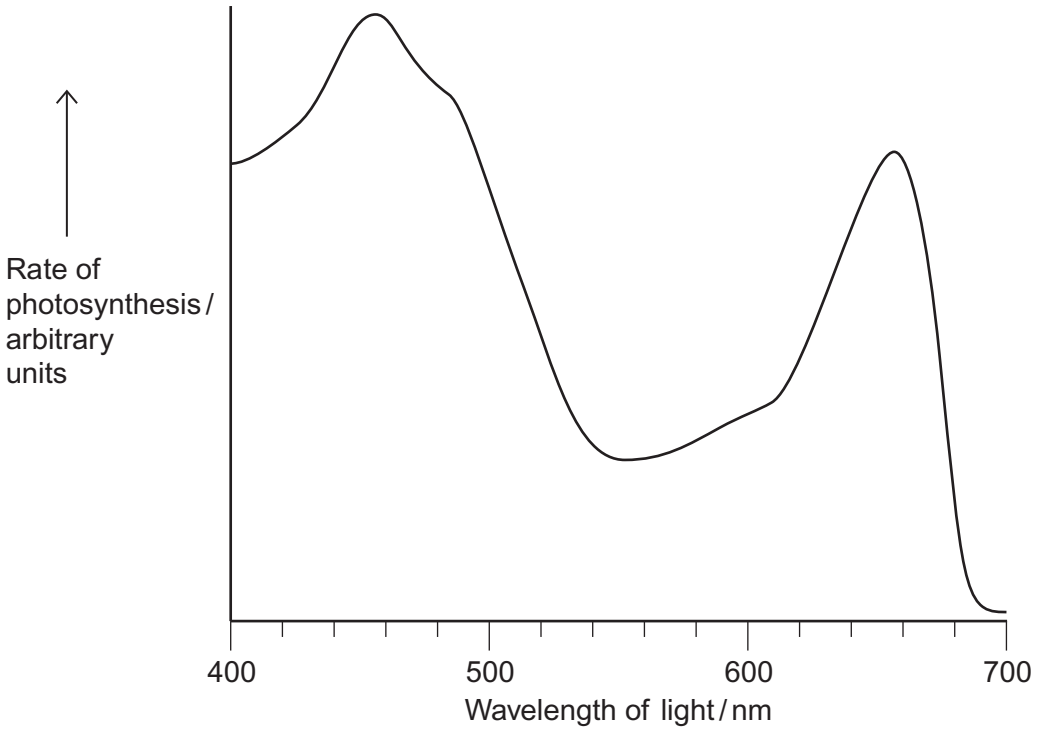
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5 (d) **Figure 5** shows the student's results.

Figure 5



Suggest and explain why the rate of photosynthesis was low between 525 nm and 575 nm wavelengths of light.

[2 marks]

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6 (a) Describe how acetylcoenzyme A is formed in the link reaction.

[2 marks]

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6 (b) In the Krebs cycle, acetylcoenzyme A combines with four-carbon oxaloacetate to form six-carbon citrate. This reaction is catalysed by the enzyme citrate synthase.

6 (b) (i) Oxaloacetate is the first substrate to bind with the enzyme citrate synthase. This induces a change in the enzyme, which enables the acetylcoenzyme A to bind.

Explain how oxaloacetate enables the acetylcoenzyme A to then bind to the enzyme.

[2 marks]

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6 (b) (ii) Another substance in the Krebs cycle is called succinyl coenzyme A. This substance has a very similar shape to acetylcoenzyme A.

Suggest how production of succinyl coenzyme A could control the rate of the reaction catalysed by citrate synthase.

[2 marks]

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6 (c) In muscles, pyruvate is converted to lactate during anaerobic respiration.

6 (c) (i) Explain why converting pyruvate to lactate allows the continued production of ATP during anaerobic respiration.

[2 marks]

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6 (c) (ii) In muscles, some of the lactate is converted back to pyruvate when they are well supplied with oxygen. Suggest **one** advantage of this.

[1 mark]

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7 Climate change has resulted in an increase in the concentration of salt (salinity) in soil water in some parts of the world. Crop plants do not grow when soil salinity is 2% or higher.

7 (a) Suggest how climate change could cause an increase in soil salinity.

[2 marks]

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7 (b) Explain why crop plants do **not** grow when soil salinity is 2% or higher.

[2 marks]

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Question 7 continues on the next page

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7 (c) Cucumber is a crop plant which can grow in soils with a salinity of 1.5%. Cucumber can be damaged by a fungal disease called cucumber foot and root rot (CFRR). Scientists investigated the use of four species of bacterium as biological control agents against CFRR. Two belonged to the genus *Serratia* and two belonged to the genus *Pseudomonas*.

The scientists grew cucumber plants from seeds in separate pots containing salinated soil from a crop field. In four of the treatments, the cucumber seeds were coated with one of the four species of bacterium. Two different controls were set up. The CFRR fungus was added to all pots except control **A**.

Some of the results obtained by the scientists are shown in **Table 1**.

Table 1

Treatment of cucumber seeds	**Mean number of diseased plants (± 2 × standard error)**
Control **A** with **no** CFRR fungus	17 (± 6.8)
Control **B** with CFRR fungus	54 (± 10.7)
S. plymuthica with CFRR fungus	42 (± 6.8)
S. rhizophila with CFRR fungus	10 (± 7.9)
P. fluorescens with CFRR fungus	29 (± 8.3)
P. extremorientalis with CFRR fungus	19 (± 7.9)

7 (c) (i) The CFRR fungus used was isolated from several cucumber plants growing in salinated soils.

Explain why the CFRR fungus was isolated from several cucumber plants and why these plants were grown in salinated soils.

[2 marks]

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7 (c) (ii) Use the results from control **B** and the bacterial treatments to evaluate the effectiveness of the bacteria as biological control agents.

[4 marks]

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7 (c) (iii) Explain why the scientists set up control **A**.

[2 marks]

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7 (d) The scientists also investigated the ability of these bacteria to stimulate growth of cucumber plants without the CFRR fungus present. They measured the effect of each species of bacterium on the increase in dry mass of cucumber plants.

7 (d) (i) Suggest **one** way in which these bacteria could stimulate an increase in dry mass of cucumber plants.

[1 mark]

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7 (d) (ii) The scientists grew the cucumber plants in pots. They removed any weeds which grew in the pots during the investigation. Explain why they removed the weeds.

[2 marks]

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8 (a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

[6 marks]

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Question 8 continues on the next page

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8 (b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

[4 marks]

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8 (c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

[5 marks]

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END OF QUESTIONS

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