AQA A-LEVEL BIOLOGY

BIOLOGY



EXAM QUESTION PACK

UNIT 4 OLD SPECIFICATION PAPERS

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AQA

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A-level BIOLOGY

Unit 4 Populations and environment

Thursday 16 June 2016 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.

Do not write outside the box

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

1 (a) What term is used to describe populations of different species living in the same habitat?

[1 mark]

_____

1 (b) Different species occupy different ecological niches.

Explain the advantage of species occupying different niches.

[1 mark]

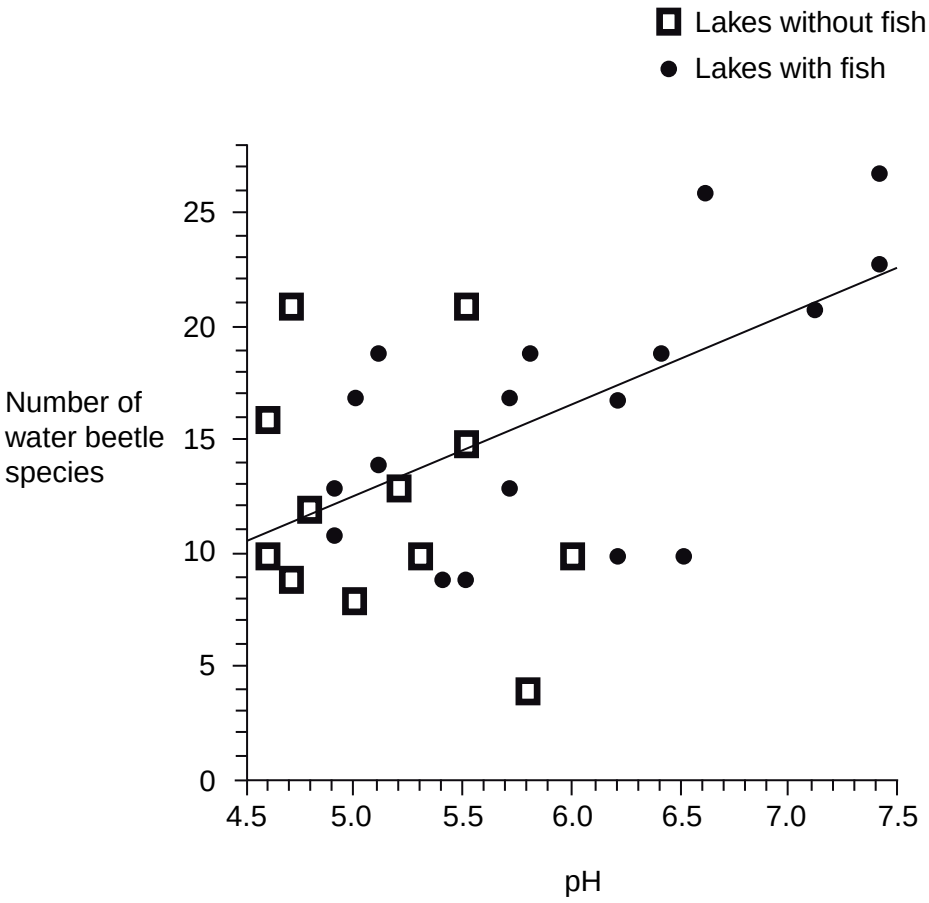
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Scientists recorded the number of water beetle species in 30 lakes. In each lake, they measured the pH of the water and recorded whether there were any fish present.

Figure 1 shows their results.

Figure 1



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1 (c) A student concluded that a decrease in acidity caused an increase in the number of water beetle species.

Evaluate this conclusion.

[3 marks]

1 (d) Explain how the presence of fish in a lake could cause an increase in the number of water beetle species.

[1 mark]

6

Turn over for the next question

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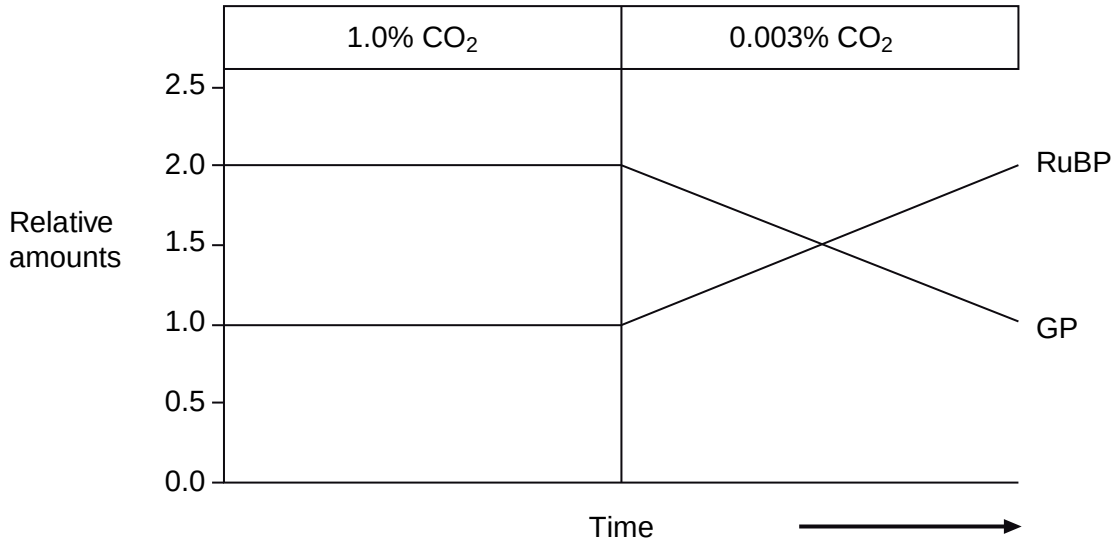
2 (a) Where precisely in a cell does the Calvin cycle take place?

[1 mark]

2 (b) A scientist investigated the effect of changing the carbon dioxide concentration on the amounts of glycerate-3-phosphate (GP) and ribulose bisphosphate (RuBP) in photosynthesising cells.

Figure 2 shows the results obtained when the carbon dioxide concentration was reduced.

Figure 2



2 (b) (i) Explain the decrease in the amount of GP after the carbon dioxide concentration was reduced.

[1 mark]

Do not write outside the box

2 (b) (ii) The scientist carried out a similar experiment but increased the carbon dioxide concentration from 1% to 2%. The relative amounts of GP and RuBP remained the same.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

2 (c) Some bacteria use hydrogen sulfide, H_2S, to produce organic compounds. The hydrogen sulfide has a similar role to that of water in photosynthesis.

A simple equation for this process in bacteria is shown below:

hydrogen sulfide + carbon dioxide $\longrightarrow$ glucose + sulfur + water

Suggest what the hydrogen sulfide is used for in these bacteria.

[2 marks]

_____

_____

_____

_____

6

Turn over for the next question

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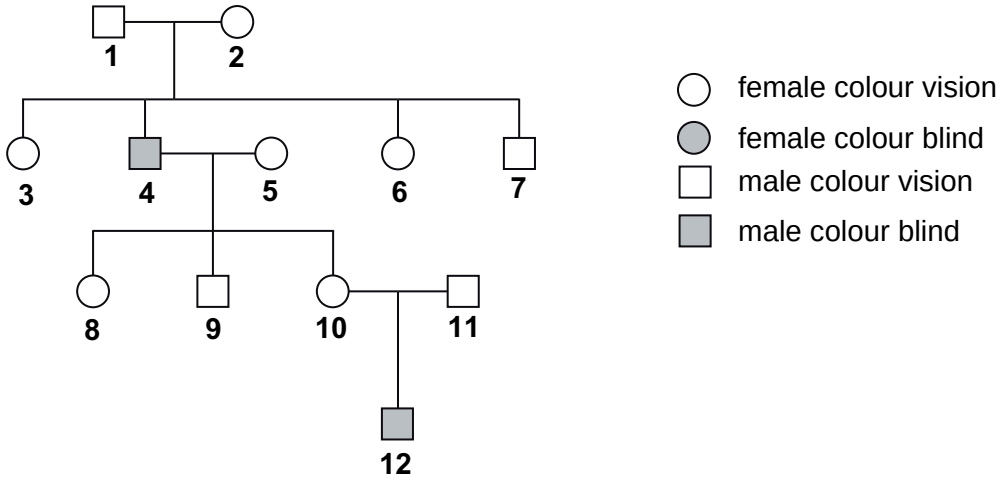
3 (a) Explain what is meant by the term phenotype.

[2 marks]

3 (b) One type of colour blindness is controlled by a gene carried on the X chromosome. The allele for this type of colour blindness, **b**, is recessive to the allele for colour vision, **B**.

Figure 3 shows the phenotypes in a family tree for this sex-linked condition.

Figure 3



3 (b) (i) Explain **one** piece of evidence from **Figure 3** which shows that colour blindness is recessive.

[2 marks]

Do not write outside the box

3 (b) (ii) Give the genotype of individual **8**.

[1 mark]

_____

3 (c) (i) The allele for tongue-rolling, **T**, is dominant to the allele for non-tongue rolling, **t**.

The gene controlling tongue-rolling is **not** sex-linked. Individuals **10** and **11** are both heterozygous for tongue-rolling.

What is the probability that individuals **10** and **11** will produce a male child who is colour blind and a non-tongue roller?

[2 marks]

Answer = _____

3 (c) (ii) In a population, the frequency of the allele for tongue-rolling, **T**, is 0.4.

Use the Hardy-Weinberg equation to calculate the percentage of people in this population that are heterozygous for tongue-rolling.

[2 marks]

Answer = _____ %

9

Turn over for the next question

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4 There are nine subspecies of giraffe. These subspecies evolved when populations of giraffe were separated for long time periods. Each subspecies has distinct coloured skin markings. Some biologists have suggested that up to six of these subspecies should be classified as different species.

4 (a) Explain how different subspecies of giraffe may have evolved from a common ancestor. Use information from the passage in your answer.

[5 marks]

4 (b) Biologists compared the mitochondrial DNA of the different subspecies of giraffe. They used the results from comparing this DNA to conclude that six of the nine subspecies are separate species.

Suggest how they came to this conclusion.

[2 marks]

7

Turn over for the next question

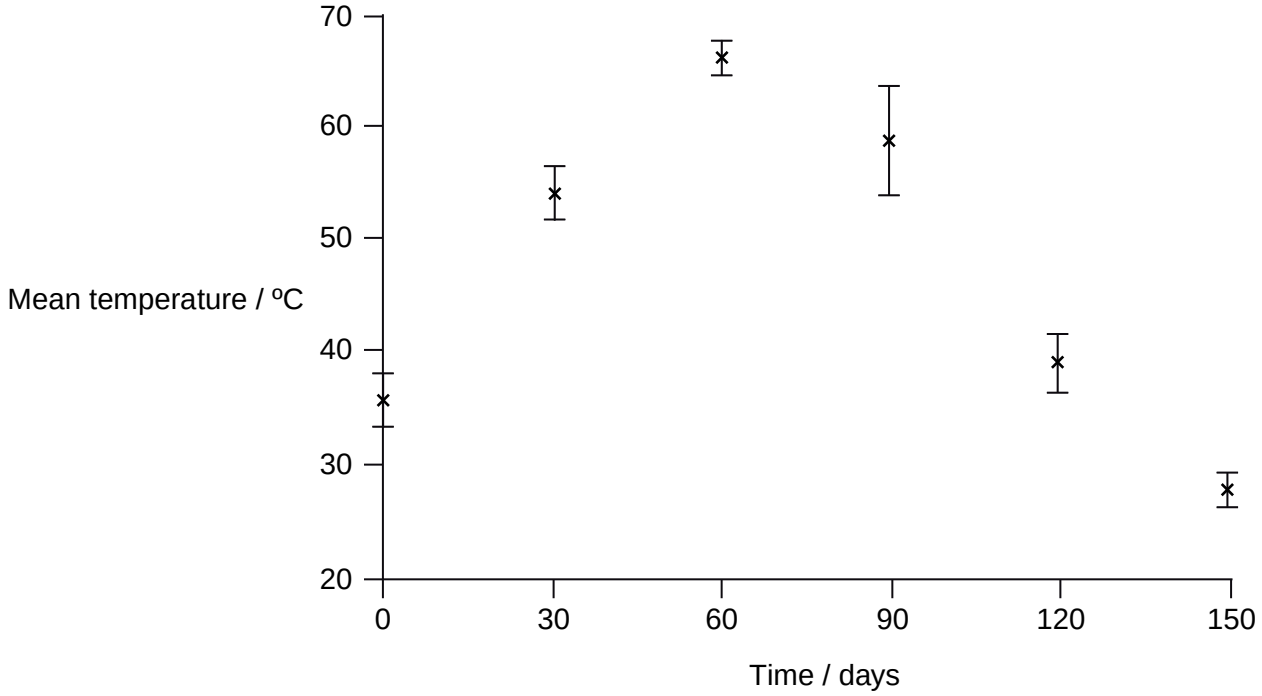
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ANSWER IN THE SPACES PROVIDED

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5 The organic material in household waste can be used to make compost for use as a fertiliser. Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 4 shows the results they obtained. The vertical bars show standard deviations.

Figure 4



5 (a) Explain how microorganisms contributed to the increase in temperature during processing of organic waste.

[2 marks]

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5 (b) Explain the advantage of showing the data using standard deviations rather than ranges.

[2 marks]

5 (c) Suggest **two** advantages of rotating the containers during the process.

[2 marks]

1

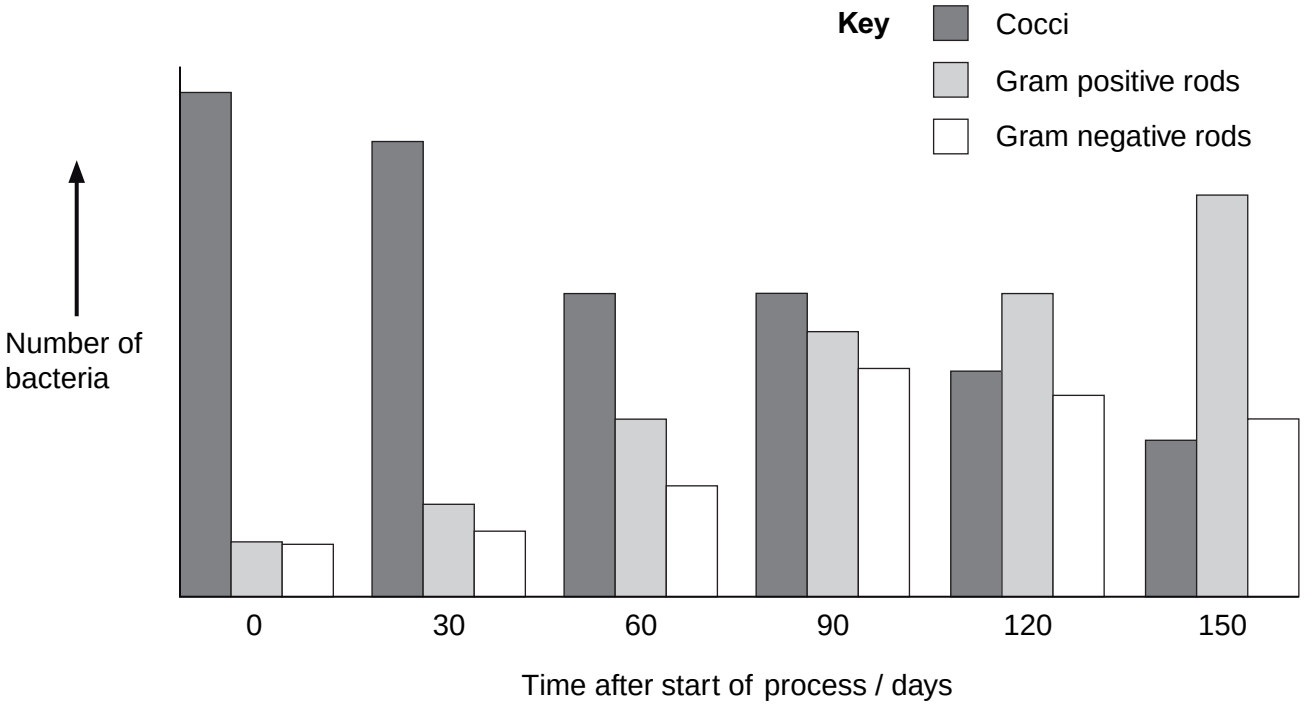
2

Question 5 continues on the next page

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5 (d) The scientists took a sample of the waste at the start of the process. They then took samples every 30 days. In each sample, they determined the numbers of particular types of bacteria.
Figure 5 shows the changes in the number of three types of bacteria during the process.

Figure 5



The scientists concluded that the results in **Figure 4** and **Figure 5** are evidence for a form of succession during the process.

Use the information to suggest how they reached this conclusion.

[3 marks]

9

Turn over for the next question

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6 Some plant seeds can respire aerobically and anaerobically. A summary of the process of anaerobic respiration is shown below.

glucose $\xrightarrow{\textbf{stage 1}}$ pyruvate $\xrightarrow{\textbf{stage 2}}$ ethanol and carbon dioxide

6 (a) (i) Where in a cell does **stage 1** occur?

[1 mark]

_____

6 (a) (ii) Explain how **stage 2** enables **stage 1** to continue.

[2 marks]

_____

_____

_____

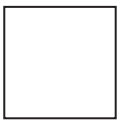
_____

6 (b) The Respiratory Quotient (RQ) can provide information on the type of respiration taking place in an organism. The following equation is used to calculate the RQ.

$$\text{RQ} = \frac{\text{volume of carbon dioxide produced during respiration}}{\text{volume of oxygen used during respiration}}$$

6 (b) (i) What would be the RQ for aerobic respiration of glucose?

[1 mark]



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6 (b) (ii) A student calculated that the RQ of germinating seeds was 1.8.

Use the information provided to explain this result.

[2 marks]

_____

_____

_____

_____

6 (c) Aerobic respiration produces more ATP per molecule of glucose than anaerobic respiration.

Explain why.

[2 marks]

_____

_____

_____

_____

8

Turn over for the next question

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7 Algae are photosynthesising organisms. Some grow on rocky shores. Scientists investigated the abundance of different species of algae at two sites, **A** and **B**, on a rocky shore. Site **A** was on the upper shore and site **B** was on the lower shore. **Figure 6** shows the location of sites **A** and **B** on the rocky shore.

Table 1 shows some of the results the scientists obtained.

Figure 6

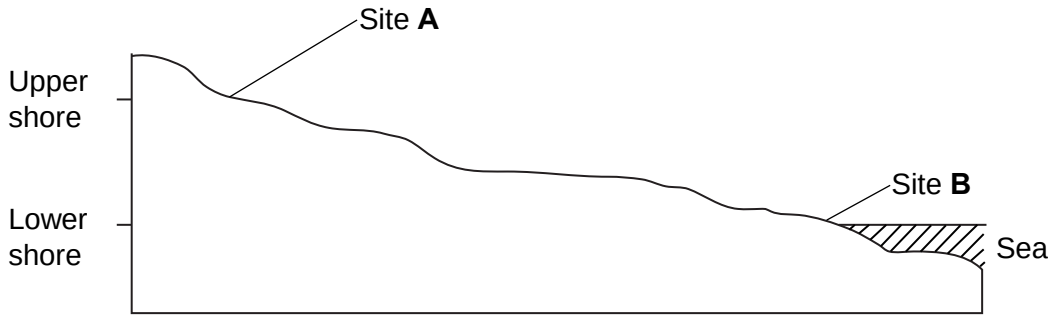


Table 1

	Site A Upper shore	**Site B Lower shore**
Species of algae with percentage cover more than 1%	*Gigartina leptorhynchos* *Gigartina canaliculata* *Gelidium coulteri* *Rhodoglossum affine*	*Gigartina spinosa* *Rhodoglossum affine* *Laurencia pacifica* *Gastroclonium coulteri* *Centroceros clavulatum* *Gigartina canaliculata* *Corallina vancouveriensis*

7 (a) The scientists recorded data from 40 large rocks at each site.

Describe **one** method that the scientists could have used to ensure that the large rocks were chosen without bias.

[2 marks]

Do not write outside the box

7 (b) The scientists used percentage cover rather than frequency to record the abundance of algae present.

Suggest why.

[1 mark]

_____

_____

7 (c) Apart from availability of water, describe and explain how **two** abiotic factors may have caused differences in the species of algae growing at sites **A** and **B**.

[2 marks]

Factor 1 _____

Explanation _____

_____

Factor 2_____

Explanation _____

_____

7 (d) Use the information provided in **Table 1** to explain why the diversity of consumers will be greater at site **B**.

[2 marks]

_____

_____

_____

_____

Question 7 continues on the next page

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7 (e) The scientists also investigated the algae eaten by two consumers found on the rocky shore, the sea slug and the shore crab. The scientists carried out their investigation in a laboratory.

- They put each consumer into a separate tank through which aerated seawater flowed slowly.
- Each tank contained 5 grams of one species of alga.
- After 50 hours, they measured the mass of the alga remaining in each tank.
- They repeated this procedure several times using a different sea slug and a different shore crab each time.

The scientists then calculated the mean mass of each species of alga eaten by the consumers. They used a statistical test to determine the P value.

Table 2 shows some of the results they obtained.

Table 2

Species of alga	Mean mass eaten / g		P value
	Sea slug	Shore crab	
Laurencia pacifica	4.42	0.22	<0.01
Egregia leavigata	0.12	0.08	>0.05
Microcystis pyrifera	0.19	0.14	>0.05
Cystoseira osmondacea	0.17	0.04	<0.05

7 (e) (i) The consumers were starved for 5 days before the investigation.

Explain why.

[2 marks]

Do not write outside the box

7 (e) (ii) The data in **Table 2** for the mean mass of alga eaten were adjusted for loss of mass by the alga due to respiration.

Suggest how the scientists were able to determine the loss of mass due to respiration of a sample of alga.

[3 marks]

7 (e) (iii) Suggest what conclusions the scientists could have made from this investigation when using the probability values in **Table 2**.

[3 marks]

15

Turn over for the next question

Do not write outside the box

8 (a) Crops use light energy to produce photosynthetic products.

Describe how crop plants use light energy during the light-dependent reaction.

[5 marks]

Extra space

Do not write outside the box

8 (b) Describe the advantages and disadvantages of using chemical pesticides to control pests of crops.

[5 marks]

Extra space

Question 8 continues on the next page

Do not write outside the box

8 (c) After harvesting, the remains of crop plants are often ploughed into the soil.

Explain how microorganisms in the soil produce a source of nitrates from these remains.

[5 marks]

Extra space

END OF QUESTIONS

15

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A-LEVEL

Biology

BIOL4 – Populations and environment

Mark scheme

2410
June 2016

Version: 1.0 Final

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Question	Marking Guidance	Mark	Comments
1(a)	Community;	1	
1(b)	(Less) competition for food/resource;	1	Ignore: competition for niche/habitat. Accept: space/named resource. Reject: intraspecific competition.
1(c)	1. Correlation **but** does not mean a causal effect; 2. Other abiotic/biotic/named factor involved; 3. Variation in numbers of beetles species at same/similar particular pH; 4. Large sample;	3 max	1. Ignore: positive/ negative (correlation). 2. Accept: due to presence/absence of fish. 2. Reject: 'other factors' unless further qualified. 3. Accept: same number of beetles at different pHs. 3. Accept: 'scattered results' / 'anomalies' / 'spread of results'.
1(d)	Fish feed on predator/consumer of water beetle;	1	Accept: beetles feed on fish/faeces.

Question	Marking Guidance	Mark	Comments
2(a)	Stroma (of chloroplasts);	1	Reject: stoma. Reject: stroma of chlorophyll or any reference to chlorophyll. Accept: stroma of chloroplasts.
2(b)(i)	(Less) RuBP combines with carbon dioxide;	1	Accept: binds/joins.
2(b)(ii)	1. Temperature is a limiting factor/below optimum; 2. Light is a limiting factor/below optimum; 3. Limited by RuBP (available/produced); 4. Limited by enzyme;	2 max	2. Accept: limited by reduced NADP or ATP. 3. Accept: RuBP will always give 2 GP (at high CO_2). 4. Accept: limited by Rubisco.
2(c)	1. (Provides) hydrogen / protons/H^+ **and** electrons/e^-; 2. For reduction; 3. Source of electrons for chlorophyll/electron transfer chain;	2 max	1. Ignore: if water is used as source of hydrogen. 2. Reject: reduction of NAD. 2. Reject: reduction by H^+ or protons on their own. 3. Accept: electrons for photophosphorylation. 3. Ignore: photosystems. 1, 2 and 3. Reject: reference to respiration/mitochondria.

Question	Marking Guidance	Mark	Comments
3(a)	1. (Expression/appearance/characteristic) due to) genetic constitution/genotype/allele(s); 2. (Expression/appearance/characteristic due to) environment;	2	1. Accept: named characteristic. 1. Accept: homozygous/ heterozygous/genes/DNA. 1. Ignore: chromosomes.
3(b)(i)	1. (Individual) 2 has colour vision but 4 is colour blind / 10 has colour vision but 12 is colour blind **OR** 4/12 is colour blind but parents have colour vision; 2. So 2/10 must be heterozygous/carriers;	2	Accept: (1), 2 and 4 **or** 10, (11) and 12. Accept: any suitable description and explanation equivalent to points 1 and 2. 2. Reject: (both) parents heterozygous/carriers. 2. Accept: correct genotypes for 2 and 10. Accept: for 2 marks, if it was dominant the daughters (8 and 10) of individual 4 would be colour blind.
3(b)(ii)	X^BX^b **or** X^bX^B**;**	1	Reject: Bb / bB Accept: XBXb or XbXB; Accept use of other letter than B e.g. X^RX^r**,** X^HX^h**.**
3(c)(i)	2 marks for the correct answer of 0.0625 / 6.25% / $^1/_{16}$;; 1 mark for incorrect answer but shows 0.03125 / 3.125% / $^1/_{32}$;	2	Accept: 0.063 / 0.06 / 6.3% / 6% for 2 marks. Accept: incorrect answer but shows / 0.0313 / 0.031 / 0.03 / 3.13% / 3.1% / 3% / $^1/_4$ x $^1/_4$ / 0.25 x 0.25 for 1 mark. Note: If probability is calculated as a percentage but no % shown in the answer then deduct one mark. For example 6 .25 = one mark, 3.125 = zero.

3(c)(ii)	2 marks for the correct answer of 48(%);; 1 mark for an incorrect answer but shows understanding that 2pq = heterozygous or attempts to calculate 2pq;	2	1 mark maximum for the answer of 0.48.

Question	Marking Guidance	Mark	Comments
4(a)	1. No interbreeding / gene pools are separate / geographic(al) isolation; 2. Mutation linked to (different) markings/colours; 3. Selection/survival linked to (different) markings/colours; 4. Adapted organisms breed / differential reproductive success; 5. Change/increase in allele frequency/frequencies;	5	1. Accept: reproductive isolation as an alternative to no interbreeding. 4. Note: 'passed on to offspring' on its own is not sufficient for reproduction.
4(b)	1. (Compare DNA) base sequence / base pairing / (DNA) hybridisation; 2. Different in six (species) /different in different species / similar in three (subspecies) /similar in same species/subspecies;	2	1 and 2. Ignore: compare chromosomes / 'genetic make-up'. 1. Accept: (compare) genes / introns / exons. 1. Note: reference to **only** comparing alleles is 1 max. 2. Reject: '<u>same</u> alleles/ <u>same</u> DNA bases in three species/subspecies'. 2. Note: mark point 2 can be awarded without mark point 1.

Question	Marking Guidance	Mark	Comments
5(a)	1. Respiration/metabolism/ammonification; 2. (Releases/produces) heat;	2	2. Reject: 'produces energy'.
5(b)	1. SD is spread of data around the mean; 2. (SD) reduces effect of anomalies/ outliers; 3. (SD) can be used to determine if (difference in results is) significant/not significant/due to chance /not due to chance;	2 max	1. Accept: variation around the mean. 1. Accept: range is difference between highest and lowest values/extremes **or** range includes anomalies/outliers. 2. Reject: (SD) removes anomalies/outliers. Ignore: reliability/accuracy/validity.
5(c)	1. Distributes heat / prevents 'hot' spots; 2. Distributes microorganisms; 3. More enzyme-substrate complexes; 4. Increases rate of decomposition; 5. Aeration/provides oxygen;	2 max	4. Accept: increases nitrification/ammonification or 'breaks down waste faster'.
5(d)	1. Microorganisms change the abiotic conditions/temperature/organic waste /provide nutrients; 2. Less <u>hostile</u> conditions; 3. Decline in Cocci **and** increase in rods; 4. Gram positive outcompete / better competitors;	3 max	1. Must refer to microorganisms or bacteria/named bacteria causing the change. 1. Ignore: change the environment. 3. Accept: 'decrease in cocci, others are going up'. 3. Accept: decrease in cocci and increase in either rod type or increase in both types. 4. Accept: rods outcompete (cocci) / better competitors.

Question	Marking Guidance	Mark	Comments
6(a)(i)	Cytoplasm/cytosol;	1	
6(a)(ii)	1. Regenerates/produces NAD / oxidises reduced NAD; 2. NAD reduced in stage 1/glycolysis / NAD accepts hydrogen in stage 1/glycolysis;	2	Note: penalise use of NADP for first marking point obtained. Do not accept NAD accepts only protons but allow accepts protons and electrons.
6(b)(i)	1/one/1.0;	1	
6(b)(ii)	1. Aerobic and anaerobic respiration occurring; 2. More carbon dioxide produced than oxygen uptake;	2	1. Accept: some/mainly anaerobic respiration occurring.
6(c)	1. Oxygen is final/terminal (electron) acceptor / oxygen combines with electrons and protons; 2. (Aerobic respiration) oxidative phosphorylation / electron transfer chain ; 3. Anaerobic (respiration) only glycolysis occurs / no Krebs / no link reaction;	2 max	Ignore: number of ATP produced. 3. Accept: without oxygen. 3. Ignore: converse.

Question	Marking Guidance	Mark	Comments
7(a)	1. (Use) coordinates / number the rocks/sites/squares; 2. Method of generating/finding random numbers e.g. calculator/computer/random number generator/random numbers table;	2	1. Ignore: references to grid, tape measures, metre rulers etc. 2. Accept: numbers out of a hat / use of dice.
7(b)	Difficult/too many to count / individual organisms not identifiable / too small to identify/count / grows in clumps;	1	Ignore: easier/quicker/representative/ more accurate, unless qualified.
7(c)	Any suitable factor with valid explanation = 1 mark 1. Wave action - firmer grip on rock is necessary (at either site); 2. Wind/air movement/less humid - more evaporation at site A / more (physical) damage; 3. Light – (linked to) photosynthesis (at either site); 4. Temperature – (linked to) photosynthesis/respiration/enzymes/ evaporation (at either site); 5. pH – (linked to) enzymes/proteins;	2 max	Note: other common factors include salt (salinity) linked to water potential / named nutrient e.g. nitrate linked to protein/DNA. Ignore: carbon dioxide /oxygen/pollution/rainfall/food /nutrients. Reject: biotic factors e.g. predation.
7(d)	1. Greater variety of food / more food sources; 2. More/variety of habitats/niches;	2	1. Ignore: more food. 2. Ignore: homes/shelters. 2. Accept: different habitats.
7(e)(i)	1. (So they were) hungry/not full; 2. (Allows) comparison;	2	1. Accept: description of hunger e.g. appetite / 'empty stomach'/'so they eat'.
7(e)(ii)	1. Alga without consumer/named consumer/animal; 2. (Find change in mass) in dark; 3. For 50 hours;	3	1. Accept: repeat experiment without consumer. 1. Accept: in separate tank / in tank where not eaten. 3. Accept: 'same time as in experiment'. 3. Accept: For lower time period then scaled up to 50.

7(e)(iii)	1. For *Laurencia pacifica* **and** *Cystoseira osmondacea* (difference in results) significant /reject null hypothesis / not due to chance / less than 5%/0.05 probability due to chance; *2.* For *Egregia leavigata* **and** *Microcystis pyrifera* no significant (difference in results)/accept null hypothesis / is due to chance/more than 5%/0.05 probability due to chance; 3. (Difference in results) for *Laurencia pacifica* is the most significant;	3	1, 2 and 3. Accept: abbreviations for all species. 1. Accept: for *Laurencia pacifica* 'less than 1%/0.01 probability'. 2. Accept: 'insignificant' for 'no significant difference'. 3. Note: reference to probabilities on their own is not sufficient.

Question	Answers	Mark	Comments
8(a)	1. Excites electrons / electrons removed (from chlorophyll); 2. Electrons move along carriers/electron transfer chain releasing energy; 3. Energy used to join ADP and Pi to form ATP; 4. Photolysis of water produces protons, electrons and oxygen; 5. NADP reduced by electrons / electrons and protons / hydrogen;	5	1. Accept: higher energy level as 'excites'. 2. Accept: movement of H^+/protons across membrane releases energy. 2. and 3. Reject: 'produces energy' for either mark but not for both. 3. Accept energy used for phosphorylation of ADP to ATP 3. Do not accept P as Pi but accept phosphate. 5. Accept NADP to NADPH (or equivalent) by addition of electrons/hydrogen. 5. Do not accept NADP reduced by protons on its own.
8(b)	(Advantages) 1. Acts quickly; 2. Can apply to particular area; 3. Kills all/most/wide variety of pests; (Disadvantages) 4. Needs to be re-applied; 5. Not specific; 6. Pests can develop resistance; 7. (Bio)accumulation;	5 max	Max 3 for advantages or disadvantages. Ignore: references to cost or chemicals being specific. Ignore: references to organic farming/crops. 5. Accept: kills non-target/beneficial insects. 5. Ignore: affects food chain/s. 7. Ignore: references to leaching, eutrophication.

8(c)	1. Protein/amino acids/DNA into ammonium compounds / ammonia; 2. By saprobionts; 3. Ammonium/ammonia into nitrite; 4. Nitrite into nitrate; 5. By nitrifying bacteria/microorganisms;	5	1. Accept: any named nitrogen containing compound e.g. urea. 2. Accept: saprophytes. 1, 3 and 4. Accept: marks for conversion even if incorrect type of bacteria named as being involved. 2 and 5. Reject: marks for type of bacteria if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts. 3 and 4. Accept: for one mark ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded. Note: there are no marks for the role of nitrogen-fixing bacteria as the question refers to producing a source of nitrates from the remains of crops. 5. Reject: nitrifying bacteria in root nodules.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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6	
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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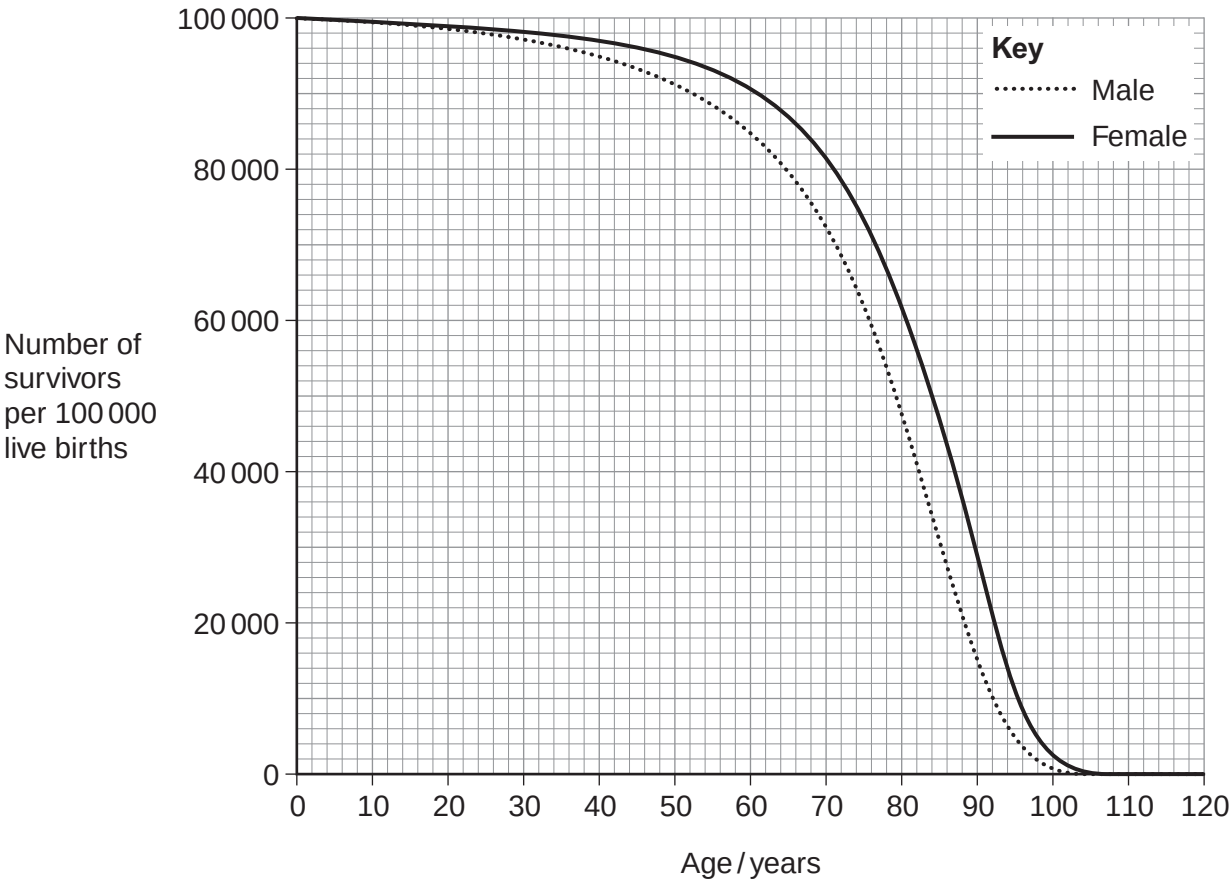
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1 (b) **Figure 1** shows the survival curves for males and females in the USA in 2010.

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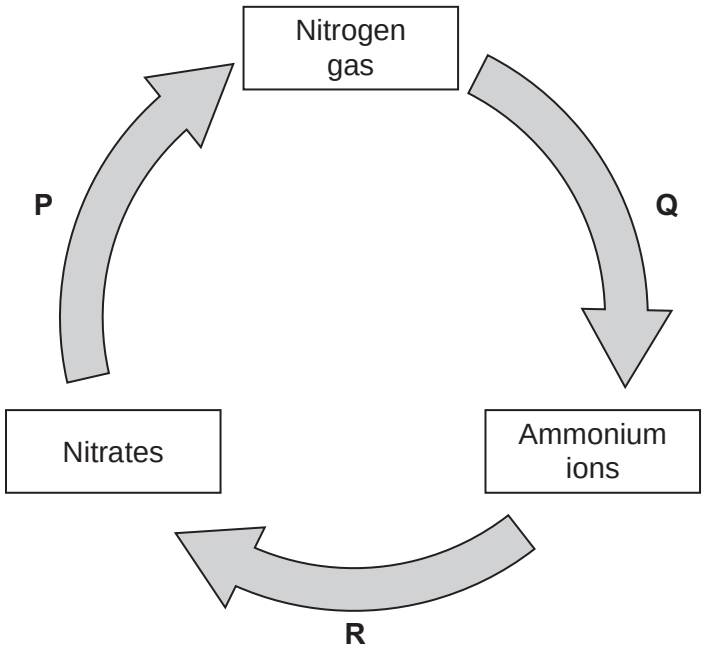
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2 **Figure 2** shows part of the nitrogen cycle.

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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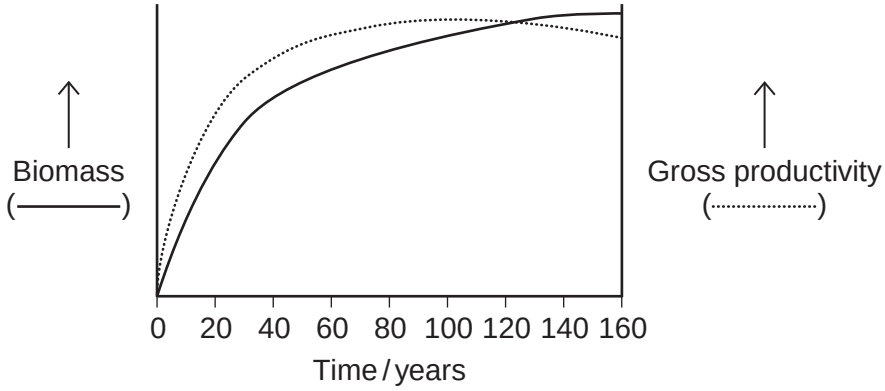
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Turn over for the next question

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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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Do not write outside the box

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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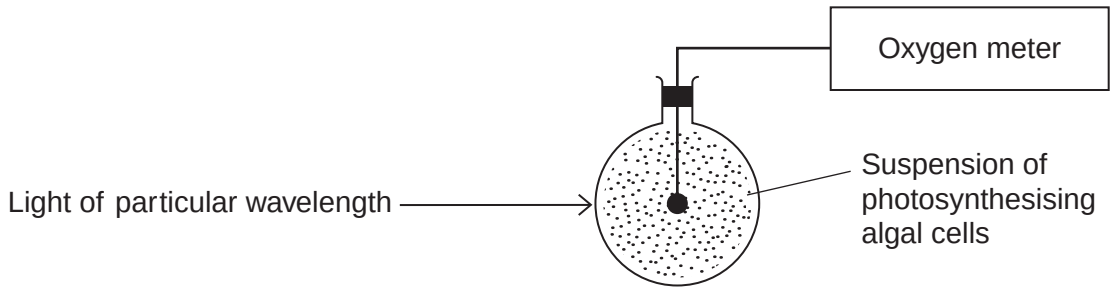
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Turn over for the next question

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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 .....

2 .....

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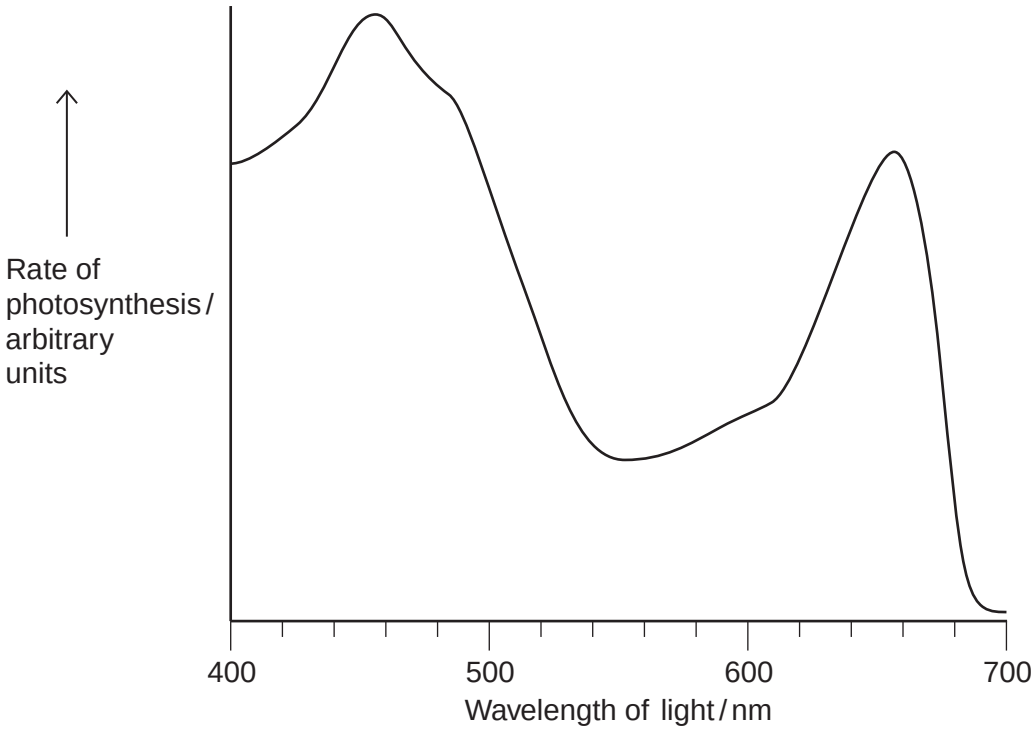
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5 (d) **Figure 5** shows the student's results.

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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Turn over for the next question

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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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Question 7 continues on the next page

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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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A- LEVEL

Biology

BIOL4 – Populations and environment

Mark scheme

2410

June 2015

Version: 1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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Question	Marking Guidance	Mark	Comments
1(a)(i)	Birth rate and death rate fall and then level out/remain low/fluctuates/stabilises;	1	
1(a)(ii)	Population increases then levels out/falls/fluctuates/stabilises;	1	
1(b)(i)	1. 79/80 and 84 / (indicates difference of) 5 or 4; 2. 4.76(%) / 4.8(%) / 5(%) / 5.9(%) / 5.95(%) / 6(%) / 6.3(%);	2	Note: answers must show working (as indicated in rubric) to obtain full marks. 2. Accept: all answers which would round up/down to give equivalent answers e.g. 6.329%
1(b)(ii)	Named disease / named risk factor which may cause higher death rate e.g. heart disease/ prostate cancer / obesity / stress / exercise / driving / war / smoking / alcohol / less likely to visit doctor;	1	Accept: sex-linked disease Neutral: unqualified answers e.g. 'females have better health/fitness/life style/genetics', 'males have dangerous/physical jobs', 'drink more', 'poor diet'

Question	Marking Guidance	Mark	Comments
2(a)	R;	1	
2(b)	1. Protein/amino acids broken down (to ammonium ions/ammonia); 2. By saprobionts / saprobiotic (microorganisms);	2	1. Accept: nucleic acids/RNA/DNA/urea/any named nitrogen containing compound as an alternative to protein/amino acids 1. Accept: saprophytes/saprotrophs 2. Neutral: decomposers 2. Reject: answers where incorrect type of bacteria given as saprobionts e.g. Nitrogen fixing bacteria
2(c)	1. (Fertility increased as) more nitrate formed / less nitrate removed/broken down; 2. Less/no denitrification / process P is decreased / fewer denitrifying bacteria;	2	1. Accept: Nitrate remains 2. Accept: more nitrification / more nitrifying bacteria / process R is increased
2(d)	1. Grow crops/plants with nitrogen-fixing (bacteria); 2. (Different crops use) different minerals/salts/nutrients/ions (from the soil); 3. (Different crops have) different pests/pathogens/diseases;	2 max	1. Accept: grow legumes / named example e.g. peas, beans, clover 1. Accept: <u>fallow</u> year 1. Accept: use different amounts of ions/nutrients

Question	Marking Guidance	Mark	Comments
3(a)(i)	Unit of energy/mass, per area, per year;	1	
3(a)(ii)	1. Less light / more shading / more competition for light; 2. Reduced photosynthesis;	2	Neutral: references to animals Accept: no photosynthesis
3(b)	1. Pioneer species; 2. Change in abiotic conditions / less hostile / more habitats/niches; 3. Increase in number/amount/diversity of species/plants/animals;	3	2. Accept: named abiotic change or example of change e.g. formation of soil/humus / organic matter / increase in nutrients 2. Neutral: reference to change in environment unqualified 2. Neutral: more hospitable / habitable / homes / shelters 3. Accept: other/new species (colonise)
3(c)	1. Net productivity = gross productivity minus respiratory loss; 2. Decrease in gross productivity/photosynthesis / increase in respiration;	2	
3(d)	1. Conserving/protecting habitats/niches; 2. Conserving/protecting (endangered) species / maintains/increases (bio)diversity; 3. Reduces global warming/greenhouse effect/climate change / remove/take up carbon dioxide; 4. Source of medicines/chemicals/wood; 5. Reduces erosion/eutrophication;	1 max	Accept: tourism / aesthetics / named recreational activity

Question	Marking Guidance	Mark	Comments
4(a)	Both alleles are expressed/shown (in the phenotype);	1	Accept: both alleles contribute (to the phenotype) Neutral: both alleles are dominant
4(b)	Only possess one allele / Y chromosome does not carry allele/gene / can't be heterozygous;	1	Accept: only possess one gene (for condition) Neutral: only 1 X chromosome (unqualified)
4(c)	1. X^GX^B, X^BX^B, X^GY, X^BY; 2. Tortoiseshell female, black female, ginger male, black male; 3. (Ratio) 1:1:1:1;	3	1. Accept: equivalent genotypes where the Y chromosome is shown as a dash e.g. X^G-, or is omitted e.g. X^G 1. Reject: GB, BB, GY, BY as this contravenes the rubric 2 and 3. Award one mark for following phenotypes tortoiseshell, black, (black) ginger in any order with ratio of 1:2:1 in any order. Allow one mark for answers in which mark points 1, 2 and 3 are not awarded but show parents with correct genotypes i.e. X^GX^B and X^BY or gametes as X^G, X^B and X^B, Y 3. Neutral: percentages and fractions 3. Accept: equivalent ratios e.g. for 1:1:1:1 allow 0.25 : 0.25 : 0.25 : 0.25
4(d)(i)	Correct answer of 0.9 = 2 marks;; Incorrect answer but shows $q^2 = 0.81$ = one mark;	2	Note: 0.9% = one mark
4(d)(ii)	Homozygous dominant increases and homozygous recessive decreases;	1	

Question	Marking Guidance	Mark	Comments
5(a)	Oxygen production/concentration <u>and</u> time;	1	Accept: oxygen volume/concentration Reject: oxygen uptake Neutral: reference to carbon dioxide uptake
5(b)	1. Intensity of light; 2. Amount/number/mass/species of algae/photosynthesising cells; 3. Carbon dioxide (concentration/partial pressure); 4. Time;	2 max	1. Accept: distance from light
5(c)	1. (pH) increases; 2. As (more) carbon dioxide removed (for photosynthesis);	2	1. Neutral: becomes more alkaline/less acidic
5(d)	1. Less absorption / (more) reflection (of these wavelengths of light); 2. (Light required) for light dependent (reaction)/photolysis 3. (Represents) green light / colour of chlorophyll;	2 max	1. Reject: no absorption or cannot absorb unless in context of green light. Note: no green light absorbed <u>or</u> green light reflected = 2 marks. 2. Accept: for excitation/removal of electrons (from chlorophyll)

Question	Marking Guidance	Mark	Comments
6(a)	1. Oxidation of/hydrogen removed from pyruvate and carbon dioxide released; 2. Addition of coenzyme A;	2	Accept: NAD reduced for oxidation
6(b)(i)	1. Change (in shape) of active site / active site moulds around the substrate; 2. (Substrate/active site) now complementary;	2	1. Reject: reference to inhibitor 1. Accept: change in tertiary structure affecting active site Neutral: references to two active sites
6(b)(ii)	1. Is a competitive inhibitor / attaches to active site; 2. Reduces/prevents enzyme-substrate/E-S complex forming;	2	1. Neutral: reference to inhibitor forming an enzyme-substrate complex 2. Accept: Reduces/prevents acetylcoenzyme A binding to enzyme/citrate synthase
6(c)(i)	1. Regenerates/produces NAD / oxidises reduced NAD; 2. (NAD used) in glycolysis;	2	2. Accept: description of glycolysis 2. Accept: glycolysis can continue/begin
6(c)(ii)	(Pyruvate used) in aerobic respiration / (lactate/lactic acid) is toxic/harmful/causes cramp/(muscle) fatigue;	1	Accept: (pyruvate) can enter link reaction Accept: reduces cramp/(muscle) fatigue Neutral: 'reduces muscle aches'

Question	Marking Guidance	Mark	Comments
7(a)	1. Increase in temperature / (global) warming; 2. Evaporation (of water from the soil) / flooding by sea water / less rainfall;	2	1. Neutral: increase in sea temp 2. Reject: evaporation of sea water 2. Accept: increase in sea level with effect on land / coastal flooding
7(b)	1. Soil has reduced/low(er) water potential / crop/plant/roots have higher water potential; 2. Osmosis from plant / diffusion of water from plant;	2	1. Reference to water potential gradient is sufficient if correct direction of gradient or water movement is outlined 2. Accept: WP or Ψ for water potential 2. Accept: plant/crop takes up less/no/not enough water by osmosis 2. Reference to movement of minerals by osmosis negates mark
7(c)(i)	1. Different strains of (fungus/cucumber) / representative (of population/strains); 2. Natural/normal conditions / (these) cucumbers grow in salinated soils / optimum for growth;	2	1 and 2. Accept: in context of fungus or cucumber 1. Accept: genetically different / different types/forms/varieties 1. Accept: grow at 1.5% Neutral: bias/reliability
7(c)(ii)	1. Mean/number (of diseased plants) decreased by all (bacteria); 2. *S. rhizophila* is most effective and *S. plymuthica* is least effective; 3. Overlap of SE of *S. plymuthica* with control (B) / overlap of SE of *S. rhizophila* with *P. extremorientalis* / no overlap of SE of *S. rhizophila/P. fluorescens/P. extremorientalis* with control (B); 4. No overlap of (2x) SE indicates	4	2. Accept: reference to figures (10 and 42) 2. Accept: equivalent terminology to effectiveness 3. Neutral: SE of all treatments overlap 3. Neutral: overlap of SE of PF and PE on its own 3. and 4. Penalise reference to SD instead of SE in context of these mark points only once

	difference is significant/not down to chance / overlap of (2x) SE indicates difference is not significant/is due to chance;		i.e. use of SD = max one for mp 3 and mp 4. Do not penalise SD in any other context 4. Accept: 'results are significant' as equivalent to difference is significant Neutral: reference to other factors or sample size

7(c)(iii)	1. Comparison / (is a) benchmark/standard/baseline: 2. To see effect of added/no fungus / (compare to) control B / (control A) shows effect of fungus in soil / shows natural/normal infection/disease;	2	1. Accept: CFRR as equivalent to fungus 1. Reject: if comparison is made to factors not part of this investigation e.g. pesticides 2. Neutral: to see effect of treatments/bacteria/biological agents/other factors 1 and 2. Note: Compare to control B = 2 marks
7(d)(i)	(Bacteria) are nitrogen fixing/nitrifying / reduce infection/pathogens / produce growth stimulating substance;	1	Accept: description of nitrogen-fixing or nitrification but not 'produce nitrate' unqualified Accept: produce antibiotics
7(d)(ii)	1. Compete for/use minerals/salts/ions/nutrients/light; 2. Would reduce/affect growth/productivity/(dry) mass of cucumber;	2	1. Accept: named example of minerals/nutrients e.g. nitrates 1. Accept: weeds may introduce/carry pathogens/disease 1. Accept: water 1. Neutral: food/space/resource

Question	Marking Guidance	Mark	Comments
8(a)	1. Geographic(al) isolation; 2. Separate gene pools / no interbreeding/gene flow (between populations); 3. Variation due to mutation; 4. Different selection pressures / different abiotic/biotic conditions/ environments/habitats; 5. Different(ial) reproductive success / selected organisms (survive and) reproduce; 6. Leads to change/increase in allele frequency;	6	2. Accept: reproductive isolation 2. This mark should only be awarded in context of during the process of speciation. Do not credit if context is after speciation has occurred. 4. Neutral: different conditions/ /climates if not qualified 4. Accept: named abiotic/biotic conditions 5. Accept: pass on alleles/genes to next generation as equivalent to reproduce 6. Accept: increase in proportion/percentage as equivalent to frequency
8(b)	1. Capture/collect sample, mark and release; 2. Method of marking does not harm lizard/make it more visible to predators; 3. Leave sufficient time for lizards to (randomly) distribute (on island) before collecting a second sample; 4. (Population =) number in first sample × number in second sample divided by number of marked lizards in second sample/number recaptured;	4	
8(c)	1. High concentration of/increase in carbon dioxide linked with respiration at night/in darkness; 2. No photosynthesis in dark/night / photosynthesis only in light/day; 3. In light net uptake of carbon dioxide / use more carbon dioxide than produced / (rate of) photosynthesis greater than rate of respiration; 4. Decrease in carbon dioxide concentration with height;	5	2. Neutral: less photosynthesis 4. More carbon dioxide absorbed higher up 4. Accept: less carbon dioxide higher up / more carbon dioxide lower down 5. Neutral: less leaves unqualified or reference to animals

	5. (At ground level) less photosynthesis / less photosynthesising tissue / more respiration / more micro-organisms / / micro-organisms produce carbon dioxide;		

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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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.

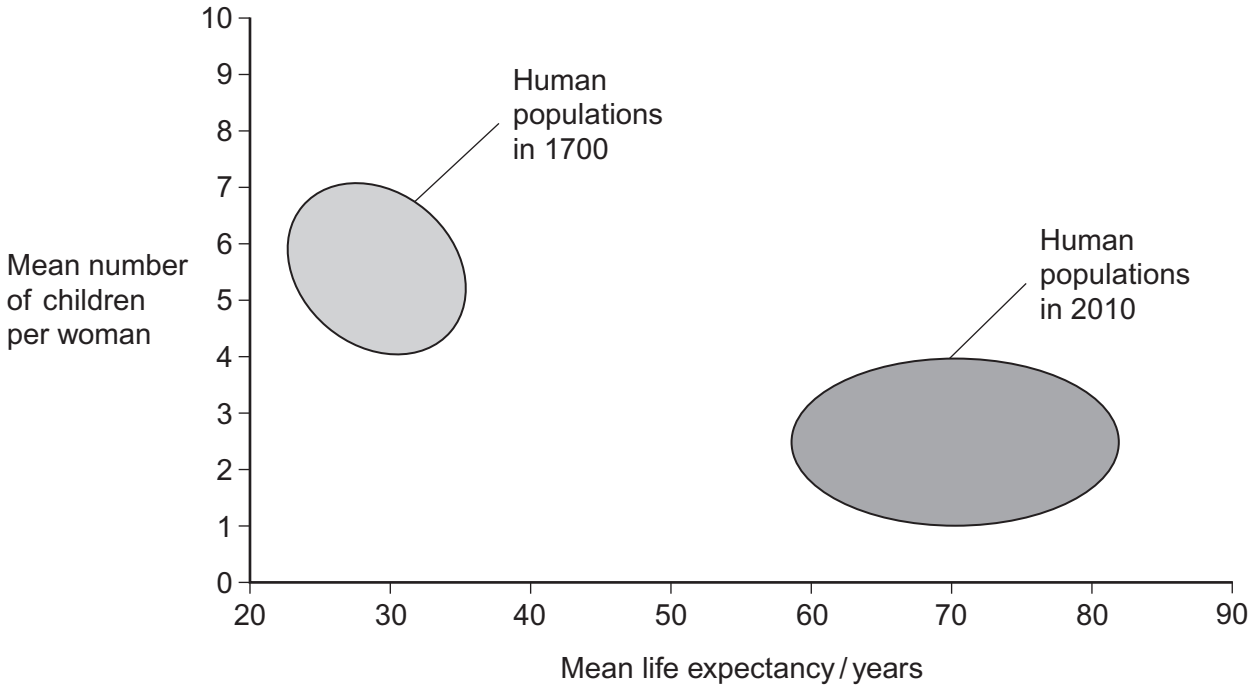
Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise 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]

1 .....

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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

Turn over ▶

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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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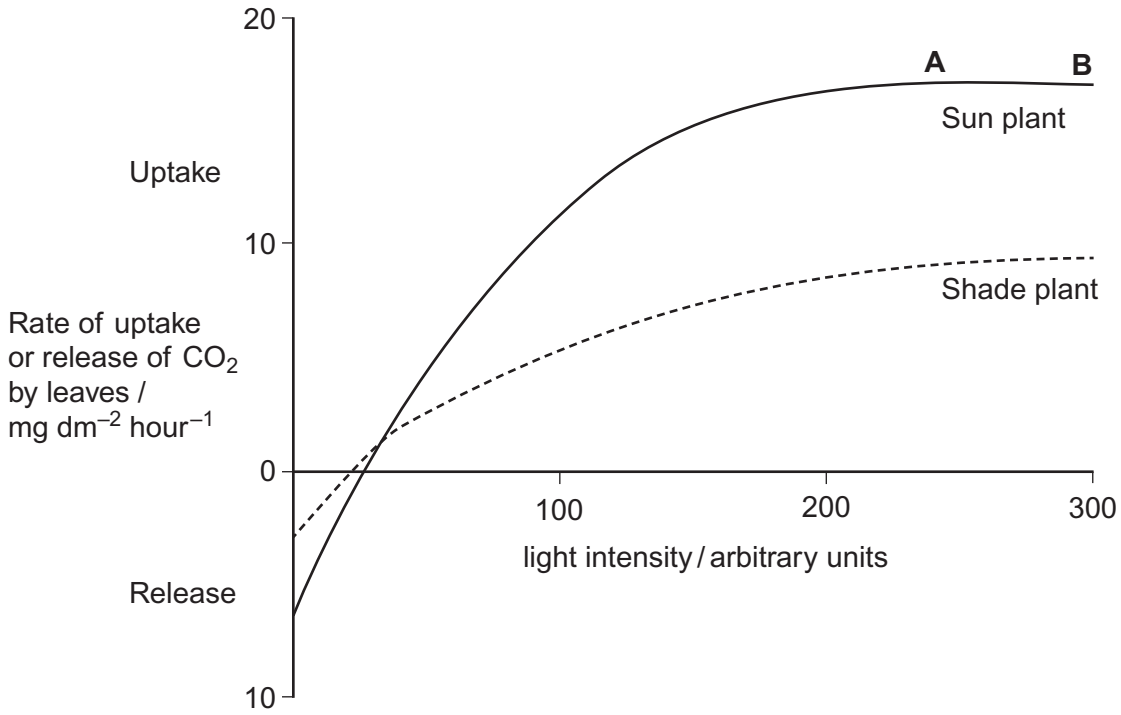
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Question 3 continues on the next page

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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



Do not write outside the box

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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8

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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]

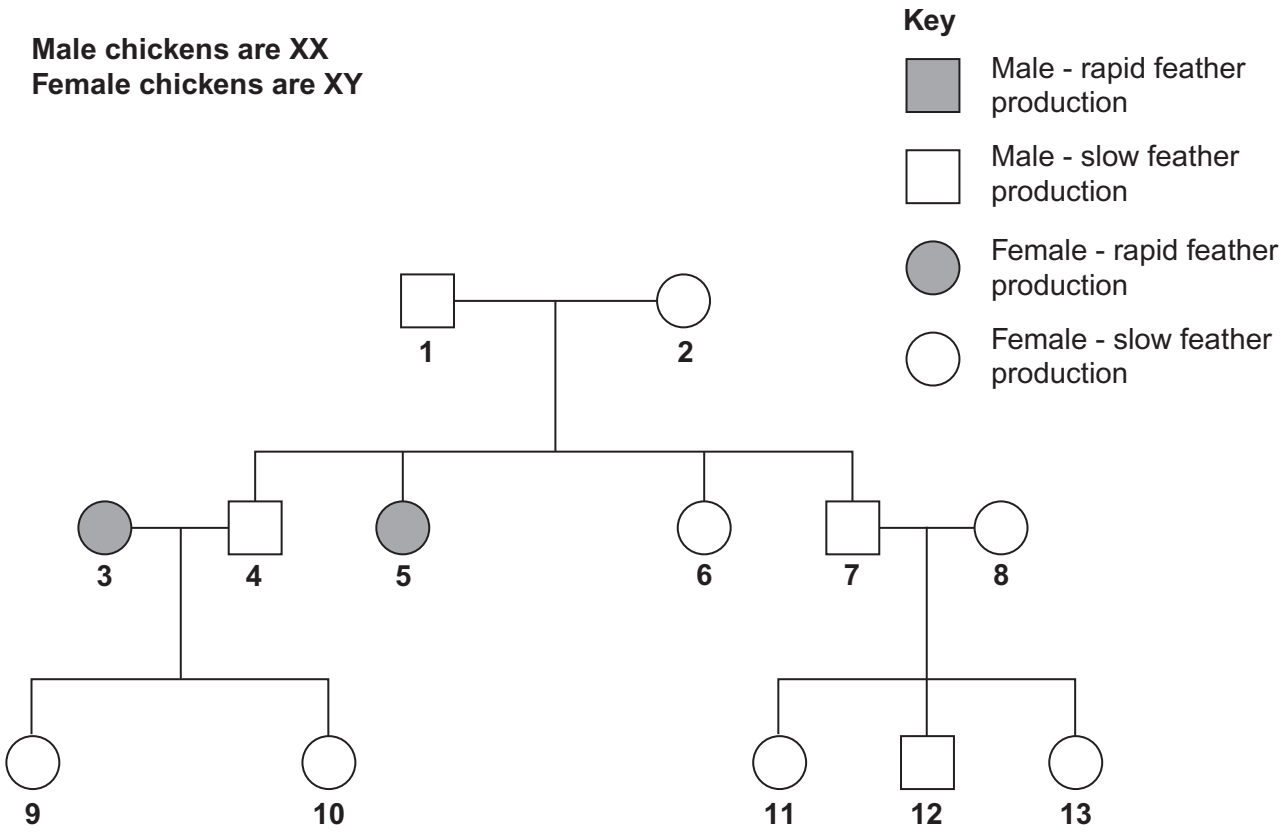
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4 (b) In chickens, a gene on the X chromosome controls the rate of feather production. The allele for slow feather production, **F**, is dominant to the allele for rapid feather production, **f**. **Figure 3** shows the results produced from crosses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

Do not write outside the box

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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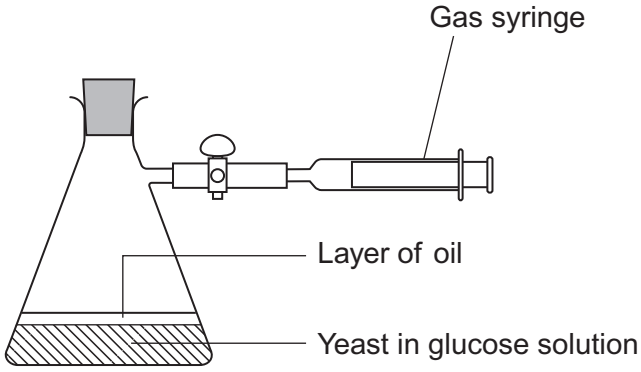
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Turn over for the next question

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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

Do not write outside the box

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]

1.....

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2.....

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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]

1.....

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2.....

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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

Do not write outside the box

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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Question 7 continues on the next page

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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.

[6 marks]

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Question 8 continues on the next page

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

[4 marks]

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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

15

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A-LEVEL
BIOLOGY

BIOL4 – Populations and environment
Mark scheme

2410
June 2014

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidance	Mark	Comments
1(a)	1. Higher mean/average number of children (per female) in 1700; 2. Higher life expectancy in 2010 / higher proportion/percentage of older people in 2010; 3. Greater range/spread/variation of life expectancies in 2010;	2 max	Accept: converse answers for all mark points. Accept: use of figures for all mark points. Neutral: birth rate / death rate.
1(b)	Two suitable suggestions e.g. 1. Medical/health care / vaccination / antibiotics / lower infant mortality; 2. Diet / nutrition / food availability; 3. Sanitation / water supply / sewage treatment; 4. Contraception / birth control; 5. Work related example / occupation / education; 6. Financial considerations of having children; 7. Government/state policy; 8. War;	2 max	Neutral: better living conditions / improved economy.
1(c)	The following answers = 2 marks;; 60,175,920 / 60.1759 million / 60.176 million / 60.18 million;; Incorrect answer with following working = 1 mark 60 200 × 0.4 / 24 080 / 583 940 / 559 860;	2	Reject: 60,199,600 and reject 60.2 million if rounded up from 60,199,600. Accept: 60.2 million for two marks if rounded up from correct answer shown in working. 60.2 million without indication if derived from correct or incorrect answer = 1 mark. Accept: 60.18 / 60.176 for one mark. Accept: 60.175 million for one mark but 60.175 = no marks.

Question	Marking Guidance	Mark	Comments
2(a)(i)	1. Amino acid/protein/enzyme/urea/nucleic acid/chlorophyll/DNA/RNA//ATP/ADP/AMP/ NAD/NADP; 2. DNA/RNA/nucleic acid/ATP/ADP/AMP/ NADP/TP /GP/ RuBP /phospholipids;	2	1. and 2. Accept any named equivalent examples e.g. nucleotides. Neutral: ammonia/nitrite /nitrate/ phosphate.
2(a)(ii)	1. Saprobiotic (microorganisms/bacteria) break down remains/dead material/protein/DNA into ammonia/ammonium; 2. Ammonia/ammonium ions into nitrite and then into nitrate; 3. (By) Nitrifying bacteria / nitrification;	3	1. Accept: saprobionts /saprophytes/saprotrophs 1. Neutral: decomposer 2. Allow correct chemical symbols. 2. Accept: correct answers which use incorrect bacteria e.g. nitrogen-fixing but then reject m.p. 3.
2(b)	1. Nitrate/phosphate/named ion/nutrients for growth of/absorbed/used by plants/algae/producers; 2. More producers/consumers/food **so** more fish / fish reproduce more / fish grow more / fish move to area;	2	2. Must have idea of more plants related to some increase in fish.

Question	Marking Guidance	Mark	Comments
3(a)	Succession;	1	Ignore any word in front of succession e.g. secondary/ecological succession. Neutral 'forestation'
3(b)	1. Greater variety/diversity of plants/insects / more plant/insect species; 2. More food sources / more varieties of food; 3. Greater variety/more habitats/niches;	3	1. Neutral: more plants 2. Neutral: more food / more/greater food source (singular) 3. Accept: more nesting sites 3. **Q** Neutral: more homes/shelters.
3(c)(i)	Temperature and carbon dioxide;	1	Neutral: water, chlorophyll
3(c)(ii)	Shows (gross) photosynthesis/productivity minus respiration / more carbon dioxide used in photosynthesis than produced in respiration;	1	1. Correct answers are often shown as: net productivity = (gross) photosynthesis – (minus) respiration.
3(c)(iii)	1. (Shade plant) has lower (rate of) respiration/ respiratory losses; 2. (Shade plant) less CO_2 released at 0 light intensity/in dark; 3. Greater (net) productivity / less sugars/glucose used / more sugars/glucose available;	2	1. Accept use of figures. 1. Accept: lower compensation point. Neutral: any references to rate of photosynthesis.

Question	Marking Guidance	Mark	Comments
4(a)	(Recessive) allele is always expressed in females / females have one (recessive) allele / males need two recessive alleles/ males need to be homozygous recessive / males could have dominant and recessive alleles/be heterozygous/carriers;	1	Accept: Y chromosome does not carry a dominant allele. Other answers must be in context of allele not chromosome or gene.
4(b)(i)	1. 1, (2) and 5; 2. 1 must possess/pass on the recessive allele / 1 must be a carrier / heterozygous / if slow (feather production) is recessive all offspring of (1 and 2) would be slow (feather production) / if rapid (feather production) was dominant 1 would have rapid (feather production);	2	1. Accept: for 1 mark that 1 and 2 have slow (feather production) but produce one offspring with rapid (feather production). Neutral: any reference to 3 being offspring of 1. 2. Reject: both parents must be carriers / possess the recessive allele. 2. Reject: one of the parents (i.e. not specified) must be a carrier/heterozygous.
4(b)(ii)	5 = X^fY / X^fY^- / f / f- / fY ; 7 = X^FX^f **and** X^FX^F (either way round) / **or** X^fX^F **and** X^FX^F (either way round) / **or** X^FX^f, X^fX^F **and** X^FX^F(in any order)**;**	2	Note: allow 5 = X^fY, X^fY. Accept: for both 5 and 7 a different letter than F. However, lower case and capital letter must correspond to that shown in the answer. For example accept 7 = X^RX^r and X^RX^R.
4(b)(iii)	X^FX^f **and** X^fY **or** X^fX^F **and** X^fY **or** X^FX^f **and** X^fY^- **or** X^fX^F **and** X^fY^- / **or** Ff **and** fY / **or** Ff **and** fY^- / **or** Ff **and** f- / **or** Ff **and** f;	1	Accept: a different letter than F. However, lower case and capital letter must correspond to that shown in the answer. Accept: each alternative either way round.

4(c)	Correct answer of 32 (%) = 3 marks;;; If incorrect answer, allow following points 1. p^2/q^2 = 4%/0.04/ or p/q = 0.2; 2. Shows understanding that 2pq = heterozygotes / carriers;	3	Accept: 0.32 = 2 marks 2. Accept: answer provided attempts to calculate 2pq. This can be shown mathematically i.e. 2 x two different numbers.

Question	Marking Guidance	Mark	Comments
5(a)	1. Allows (valid) comparison; 2. Number/sample size may vary;	2	
5(b)	1. Increased chance of (severe malaria) with blood group A **/** decreased chance of (severe malaria) with sickle cell; 2. One mark for one of the following: almost equal chance with blood group O /slightly greater chance of mild malaria with O /slightly lower chance of severe malaria with O /2.5 x/2.48 x/more than twice the chance of severe with blood group A /(almost) 50%/half the chance of severe malaria with sickle cell /twice the chance of mild malaria with sickle cell;	2	1. Accept: converse for mild malaria i.e. increased chance of mild malaria with sickle cell / decreased chance of mild malaria with blood group A. 1. Accept: if answer is comparative e.g. greatest risk of severe malaria with blood group A. 2. Neutral: answers which only refer to or use ratios.
5(c)	1. Individuals with the **Hb^C** (allele) reproduce; 2. Pass on **Hb^C** (allele) which increases in frequency; 3. **Hb^A Hb^A** individuals less likely to survive/reproduce / frequency of **Hb^A** (allele) decreases;	3	

Question	Marking Guidance	Mark	Comments
6(a)	Prevents <u>oxygen</u> being taken up/entering/being absorbed;	1	Accept: any idea of no contact with oxygen. Neutral: for anaerobic respiration / anaerobic conditions. Neutral: prevents entry of air. Reject: prevents entry of oxygen and another named gas.
6(b)(i)	0.0155 / 0.016 = 2 marks;; 0.0775 / 0.077 / 0.078 / 0.08 = 1 mark / 0.62 = 1 mark	2	
6(b)(ii)	Glucose decreases/is a limiting factor / increase in ethanol / yeast/cells die / toxins build up;	1	Accept: glucose is used up.
6(b)(iii)	1. (Stays the) same/level/(relatively) constant; 2. Same volume/amount of oxygen uptake and carbon dioxide release;	2	Note: if m.p.1 is awarded m.p 2 can be obtained without referring to 'same volume/amount'
6(c)	1. Oxygen is final/terminal (electron) acceptor / oxygen combines with electrons and protons; 2. Oxidative phosphorylation / electron transport chain provides ATP; 3. Only glycolysis occurs without oxygen / no Krebs / no link reaction;	2 max	

Question	Marking Guidance	Mark	Comments
7(a)	1. No/few consumers/pests/pathogens; 2. Outcompetes/better competitor for resources/light/CO_2/abiotic factor / ideal niche;	2	1. Accept: No/few predators. 1. Accept: description of competition for a named resource with reference to 'other species'. 1. Accept: More resistance to disease 2. Neutral: competition for food.
7(b)	1. (Cost of) control/removal; 2. (Cost of) restoring habitat / conservation; 3. (Loss of income) from fishing; 4. (Loss of income) from boating/tourism/recreation;	2 max	4. Accept: any valid recreational activity e.g. canoeing.
7(c)(i)	1. Removes water; 2. Water content can vary in sample/plant;	2 max	Note: Reweighing/constant mass indicates all water removed = 2 marks. ;
7(c)(ii)	1. 0.5 is not effective/has little effect / 1.0 is less effective (than 5.0) /concentrations below 5.0 less effective; 2. At 5.0 biomass/growth is reduced; 3. Small difference between using 5.0 and 25.0; 4. Using 5.0 is cost effective / using 25.0 is expensive; 5. 25.0/high concentrations may affect the environment / other organisms / chemical may remain in habitat / bioaccumulation;	4 max	Accept: for first 3 mark points effect on growth/biomass as a measure of effectiveness. Accept: references to 'this concentration' = 5.0. 1. Accept: 5.0 is the minimum effective concentration. 1. and 2. 5.0 is the minimum effective concentration that reduces growth = 2 marks. 5. Accept: any impact on the habitat e.g. contaminate water supply.

7(d)(i)	To compare/see effect with/without fungus/fluridone/control agent/s;	1	Neutral: for comparison on its own. Neutral: to see effect of variables/results/treatments /factors without further qualification.
7(d)(ii)	1. Is specific / grows/survives in Hydrilla/habitat; 2. Can reproduce / only one application required; 3. Does not become a pest;	2	1. Accept: 'known to work'
7(d)(iii)	1. Fluridone/chemical acts quickly / quickly reduces Hydrilla; 2. Fungus/biological control keeps Hydrilla in low numbers; 3. Fungus/biological control works over a long time/can reproduce 4. Resistance does not develop against fungus/biological control;	2 max	3. Neutral: only one application as not always valid for integrated pest management.

Question	Marking Guidance	Mark	Comments
8(a)	1. Carbon dioxide combines with ribulose bisphosphate/RuBP; 2. Produces two glycerate (3-)phosphate/GP; 3. GP reduced to triose phosphate/TP; 4. Using reduced NADP; 5. Using <u>energy</u> from ATP; 6. Triose phosphate converted to glucose/hexose/RuBP/ ribulose bisphosphate/named organic substance;	6 max	2. Accept: any answer which indicates that 2 x as much GP produced from one RuBP. 3. Must have idea of reduction. This may be conveyed by stating m.p. 4. 4. **Reject**: Any reference to reduced NAD for m.p.4 but allow reference to reduction for m.p. 3. 5. Must be in context of GP to TP.
8(b)	1. Carbon dioxide is a greenhouse gas; 2. Deforestation/trees removed so less carbon dioxide removed by photosynthesis; 3. Burning/combustion releases/produces carbon dioxide; 4. Methane is a greenhouse gas; 5. Any valid reference to source of methane, e.g. rice fields, landfills, cattle;	4 max	1. Accept: carbon dioxide contributes to greenhouse effect. 4. Accept: methane contributes to greenhouse effect. Neutral: any references to other gases.
8(c)	1. Use a grid / split area into squares/sections; 2. Method of obtaining random coordinates / numbers, e.g. calculator/computer/random numbers table/random number generator; 3. Count number/frequency of plants in a quadrat; 4. Calculate mean/average number (per quadrat/section); 5. Valid method of calculating total number of bluebells/plants. e.g. mean number of plants per quadrat/section/m^2 multiplied by number of quadrats/sections/m^2 in wood;	5	Neutral: any reference to using belt/line transects. 1. Accept: use of tape measures/map/area with coordinates. 3. Accept: determine percentage cover. 4. Accept: method of calculating mean. 5. Neutral: 'scale up' without further qualification.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
January 2013

Biology BIOL4

Unit 4 Populations and environment

Friday 11 January 2013 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

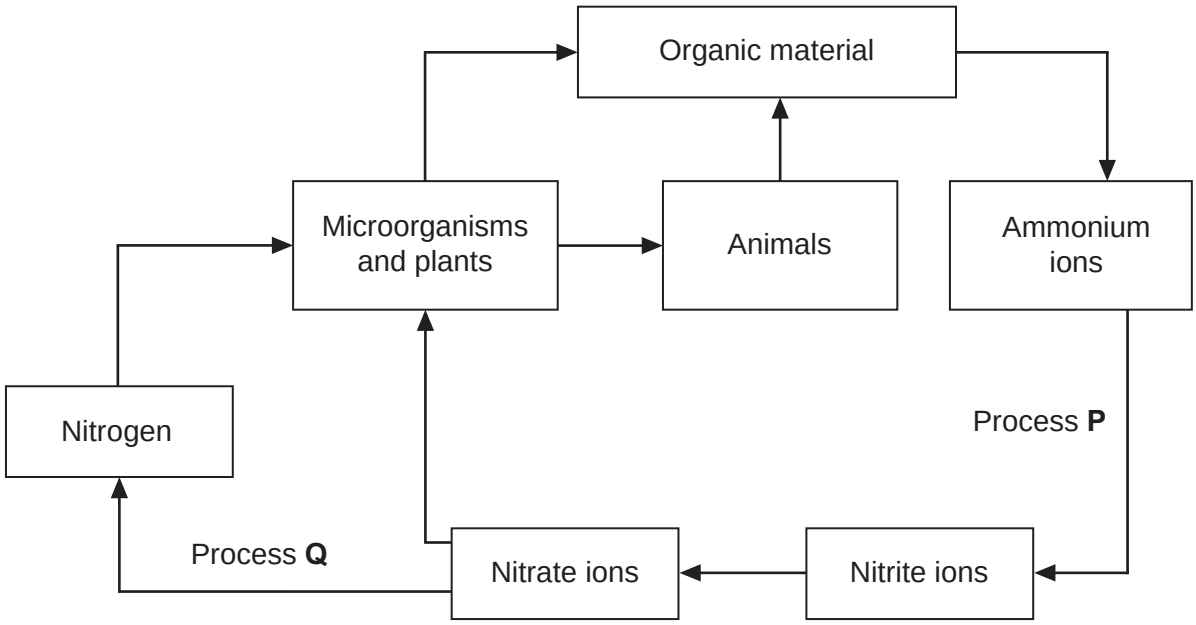
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured 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.
- 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 The diagram shows the nitrogen cycle.



1 (a) (i) Name process **P**.

.....

(1 mark)

1 (a) (ii) Name process **Q**.

.....

(1 mark)

1 (b) Leguminous crop plants have nitrogen-fixing bacteria in nodules on their roots. On soils with a low concentration of nitrate ions, leguminous crops often grow better than other types of crop. Explain why.

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(2 marks)

Do not write outside the box

1 (c) Applying very high concentrations of fertiliser to the soil can reduce plant growth. Use your knowledge of water potential to explain why.

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(2 marks)

6

Turn over for the next question

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

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(1 mark)

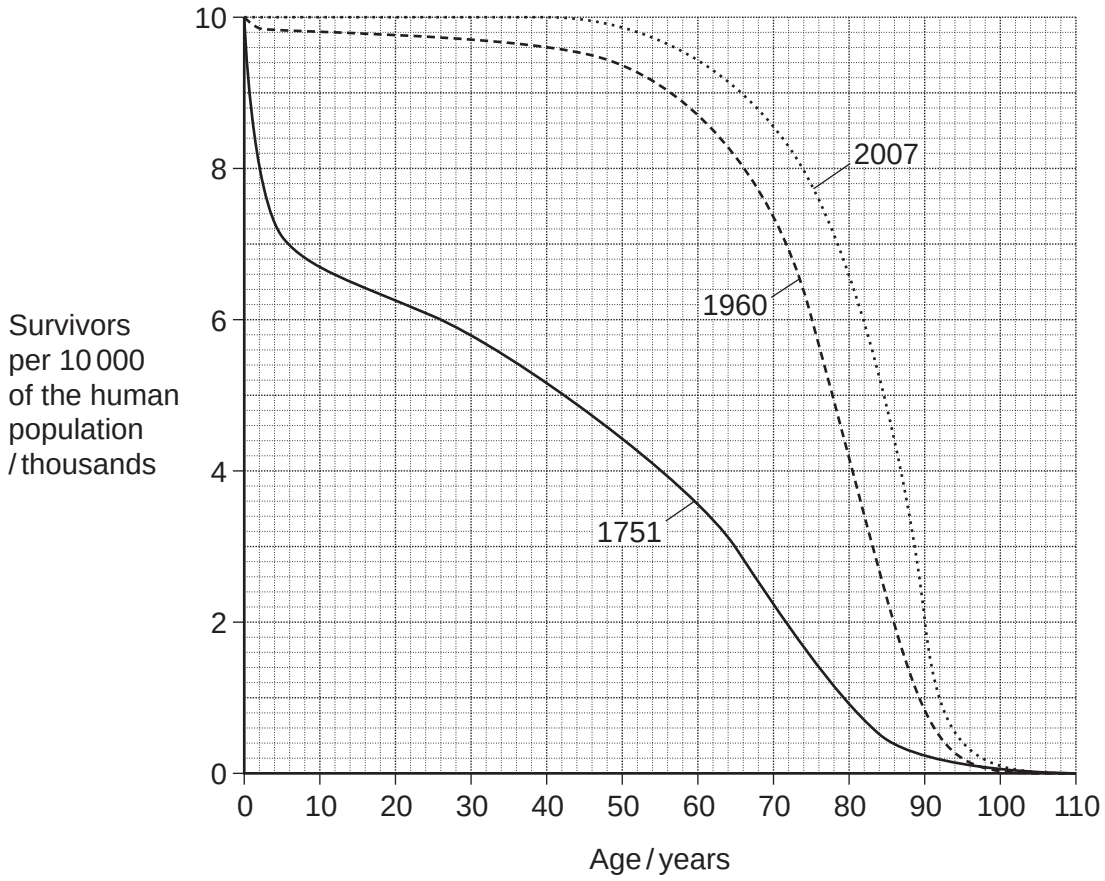
2 (b) Give **two** factors which could lead to a decrease in the death rate in a human population.

1 .....

2 .....

(1 mark)

The graph shows survival curves for human populations of the same country in different years.



Do not write outside the box

2 (c) Calculate the percentage increase from 1751 to 2007 in the number of people who survived to 70 years of age. Show your working.

Answer = ... %

(2 marks)

2 (d) The changes in the survival curves between 1751 and 1960 show that a demographic transition has taken place in this country. Explain how the changes show this.

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(2 marks)

6

Turn over for the next question

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3 The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

3 (a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

1 .....

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2 .....

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(2 marks)

3 (b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

3 (b) (i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female	×	white-eyed male
Genotype of parents	.....		.....
Gametes	..... and		..... and .....
Phenotypes of offspring	red-eyed females	and	red-eyed males
Genotype of offspring	.....		.....

(3 marks)

Do not write outside the box

3 (b) (ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

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(1 mark)

3 (c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

4 A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

4 (a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

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(3 marks)

(Extra space) .....

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4 (b) The diversity of animal species is higher at **E** than **A**. Explain why.

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(2 marks)

4 (c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

4 (c) (i) Give **two** conditions for results from mark-release-recapture investigations to be valid.

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2 .....

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(2 marks)

4 (c) (ii) Calculate the number of sand lizards on this area of moorland. Show your working.

Answer = ...

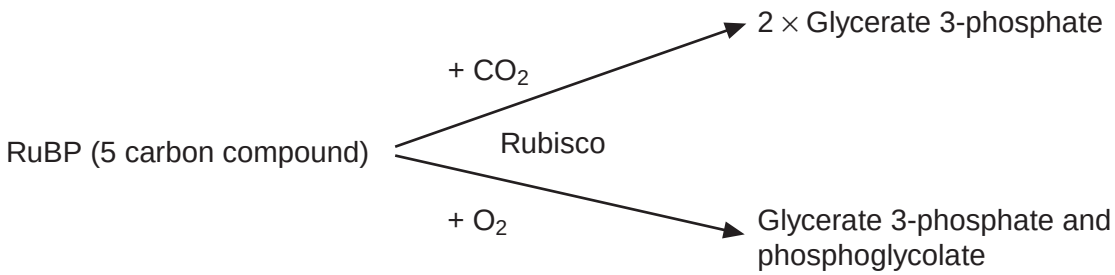
(2 marks)

9

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5 During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



5 (a) (i) Where exactly in a cell is the enzyme Rubisco found?

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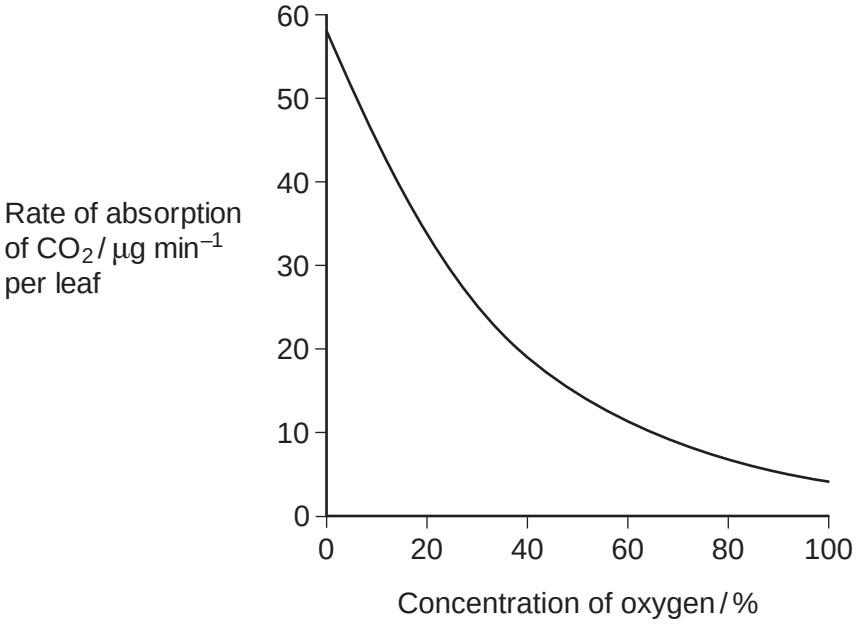
(1 mark)

5 (a) (ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

(1 mark)

5 (b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



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Use **Figure 1** to explain the results obtained in **Figure 2**.

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(2 marks)

5 (c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

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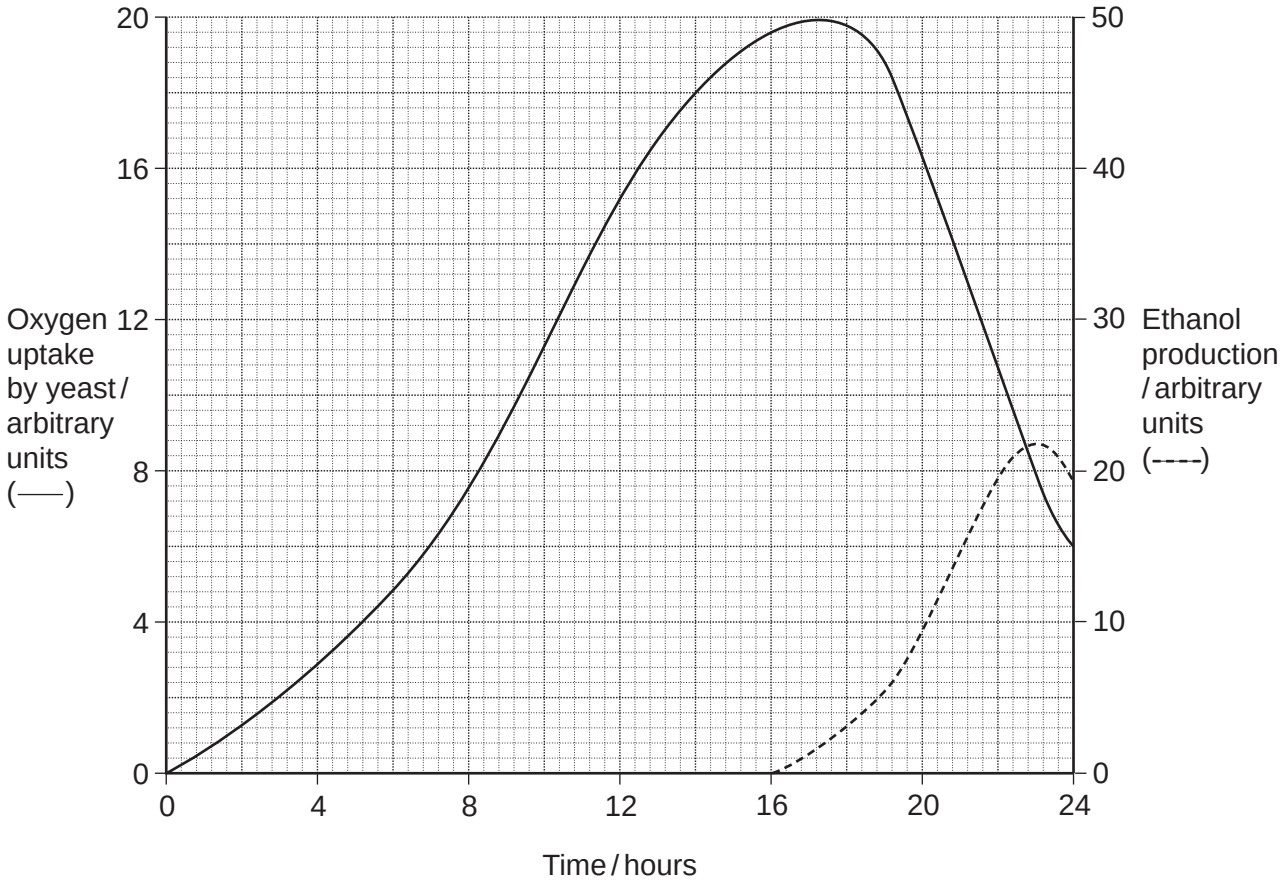
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6 Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



6 (a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer ..... arbitrary units per hour

(1 mark)

6 (b) (i) Use the information provided to explain the changes in oxygen uptake during this investigation.

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(3 marks)

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6 (b) (ii) Use the information provided to explain the changes in production of ethanol during this investigation.

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(2 marks)

6 (c) Sodium azide is a substance that inhibits the electron transport chain in respiration. The student repeated the investigation but added sodium azide after 4 hours. Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

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(3 marks)

(Extra space) .....

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7 Scientists investigated the effect of a pesticide called malathion on the survival of tadpoles of species of toads found in the USA. The scientists determined the LC50 for the tadpoles of each species over a 16-day period in an aquarium. The LC50 is the concentration of malathion that killed 50 percent of a population of tadpoles. The scientists also investigated whether the presence of a predator of tadpoles changed the effect of malathion.

7 (a) Suggest **two** advantages of using the LC50 to determine the effect of a pesticide.

1 .....

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2 .....

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(2 marks)

The scientists looked at previous studies on the effects of various pesticides on tadpoles.

They found that most of these studies:

- were carried out on tadpoles of the African clawed toad
- measured the LC50 of each pesticide over 1 to 4 days in the absence of any biotic factor.

7 (b) The scientists concluded that these previous studies were of limited use when trying to assess the effects of malathion on the tadpoles of toads found in the USA. Suggest why the scientists reached this conclusion.

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(3 marks)

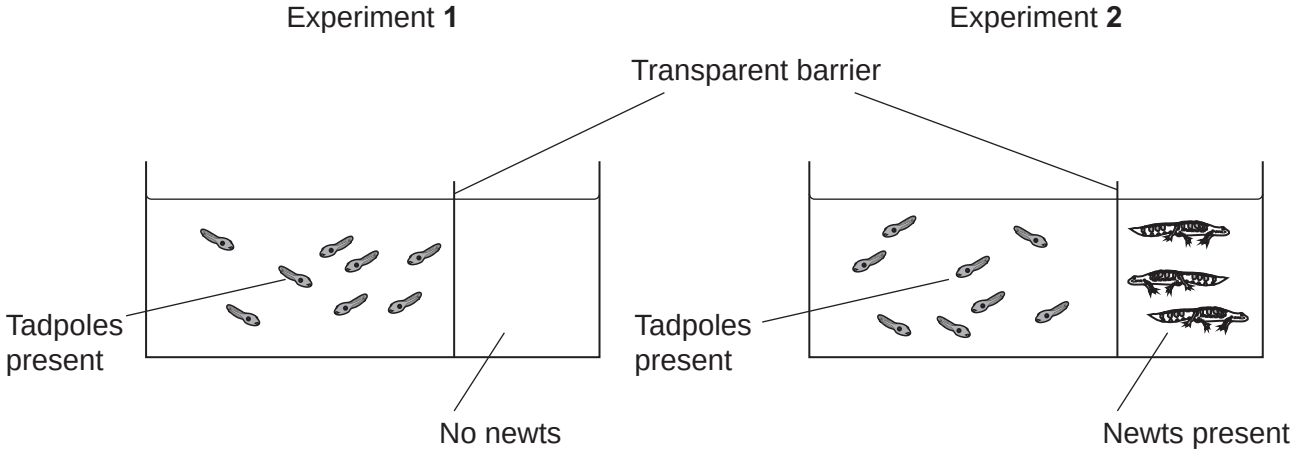
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7 (c) Malathion affects the nervous system of tadpoles. The scientists investigated whether the stress caused by the presence of a predator changed the effect of malathion on the tadpoles. The scientists used newts which are predators of tadpoles. They carried out two experiments, as shown in the diagram.



7 (c) (i) Explain why the scientists carried out experiment **1**.

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(2 marks)

7 (c) (ii) Explain why the scientists used a transparent barrier in experiment **2**.

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(2 marks)

Question 7 continues on the next page

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7 (d) Adult toads spend most of their time on land but lay their eggs in water. These eggs hatch into tadpoles, which live in water and develop into adults. The tadpoles are much smaller than adult toads. Use this information to explain why the tadpoles are affected more rapidly by pesticides in water than adult toads.

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(2 marks)

7 (e) When malathion is used as a pesticide, it is often sprayed onto aquatic habitats at concentrations of 0.1 to 1.6 mg dm^{-3}. The scientists tested the effect of malathion at concentrations of 0.001 to 10 mg dm^{-3}.
Suggest why.

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(2 marks)

7 (f) As a result of this investigation, the scientists concluded that more studies on pesticides should be carried out in natural habitats rather than under laboratory conditions. Suggest **two** advantages of carrying out such investigations in natural habitats.

1 .....

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2 .....

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(2 marks)

15

Do not write outside the box

8 (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

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(5 marks)

(Extra space) .....

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Question 8 continues on the next page

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8 (b) Describe the reasons for the low efficiency of energy transfer through ecosystems.

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(5 marks)

(Extra space) .....

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Do not write outside the box

8 (c) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

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15

END OF QUESTIONS

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General Certificate of Education (A-level)
January 2013

Biology BIOL4

(Specification 2410)

Unit 4: Populations and Environment

Final

Mark Scheme

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It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidelines	Mark	Comments
1(a)(i)	Nitrification/oxidation;	1	Accept 'nitrifying'
1(a)(ii)	Denitrification;	1	Accept 'denitrifying'
1(b)	1. (Nitrogen) to ammonia/NH_3/ammonium; 2. Produce protein/amino acids/ named protein/DNA/RNA;	2	1. Do not disqualify mark for any references to ammonia being converted to nitrite, nitrate etc 2. Do not disqualify mark for any references to protein being formed from nitrogen, nitrite or nitrate
1(c)	1. Soil has low(er) water potential / plant/roots have higher water potential; 2. Osmosis from plant / diffusion of water from plant;	2	1. Reference to water potential gradient is sufficient if correct direction of gradient or water movement is outlined 1. Accept WP or Ψ for water potential 2. Accept plant takes up less/not enough water by osmosis 2. Reference to movement of minerals by osmosis negates mark

Question	Marking Guidelines	Mark	Comments
2(a)	Organisms/individuals of one species in a habitat / same place;	1	Accept 'same gene pool' as 'species'
2(b)	Any two factors for one mark e.g. Improved medical care, improved nutrition, more food, improved sanitation, less disease, improved living conditions, improved economy, war ends;	1	Accept two related factors e.g. vaccination and better health care
2(c)	Correct answer in range of 269-291 (%);; One mark for incorrect answer but shows change of 6.2 (× 1000) / 6.3 (× 1000) / 6.4 (× 1000);	2	
2(d)	1. Increase in (average) life expectancy; 2. Low death rate / decrease in death rate / few(er) deaths / more survivors / fewer babies/infants die / more old(er) people;	2	Allow **one maximum mark** if candidate provides correct answer using 2007 curve 2. Allow any description which suggests more survivors or fewer deaths

Question	Marking Guidelines	Mark	Comments
3(a)	1. Large number of eggs/offspring/flies (therefore) improves reliability / can use statistical tests/ are representative / large sample (size) / reduces sampling error; 2. Small size / (breed) in small flasks / simple nutrient medium (therefore) reduces costs/easily kept/stored; 3. Size / markings / phenotypes (therefore) males/females easy to identify; 4. Short generation time / 7-14 days / develop quickly / reproduce quickly (therefore) results obtained quickly / saves times / many generations;	2 max	Each mark point requires a feature linked in mark scheme (by therefore) to an explanation 1. Do not accept a large number of eggs produces a large number of flies unless the term sample is used 1. Ignore references to accuracy or precision 2. Accept small size so can be kept in small flasks 3. Answers must relate to size, markings or use the term phenotype
3(b)(i)	1. X^RX^R and X^rY; 2. X^R and X^R plus X^r and Y; 3. X^RX^r and X^RY; ***OR*** 1. X^RX^r and X^rY; 2. X^R and X^r plus X^r and Y; 3. X^RX^r and X^RY;	3	All marking points are completely independent. Allow crosses from the following parents for a possible three marks: X^RX^R and X^r- X^RX^R and X^rY; RR and rY / rY^- RR and r- or RR and r ***OR*** X^RX^r and X^r- X^RX^r and X^rY; Rr and rY / rY^- Rr and r- or Rr and r Accept different symbols e.g. W and w 2. Accept gametes in a punnet square
3(b)(ii)	Fertilisation is random / fusion of gametes is random / small/not large population/sample / selection advantage/disadvantage / lethal alleles;	1	Mutation = neutral Random mating = neutral Accept fertilisation/fusion of gametes is due to chance

3(c)	1. Males have one allele; 2. Females need two recessive alleles / must be homozygous recessive / could have dominant and recessive alleles / could be heterozygous/carriers;	2	Answers should be in context of alleles rather than chromosomes

Question	Marking Guidelines	Mark	Comments
4(a)	1. Decrease in (percentage cover) of bare ground/water linked to more plants/species / increase in plant coverage; 2. Change in diversity / number of plant/species/named (species) as abiotic conditions altered / due to competition / more soil / less hostile; 3. Increase in depth of soil as plants die / humus formed;	3	Allow **one maximum mark** for answers which describe all three changes **without** a suitable explanation for any change 1. Must be idea of more/increase not just change in species/plants 2. Accept pioneer species replaced due to competition 2. Accept description of change in species 2. Accept 'more suitable' = less hostile
4(b)	1. Greater variety of food / more food sources; 2. More/variety of habitats/niches;	2	1. 'More food' = neutral 2. Ignore 'more homes' or reference to 'shelters'
4(c)(i)	1. Marking is not removed / marking does not affect survival/predation; 2. Limited/no immigration/emigration; 3. Sufficient time for (marked) individuals to mix (within the population); 4. No/little births/deaths/breeding; 5. Sampling method is the same;	2 max	2. Accept 'migration' and descriptions of immigration/emigration 2. and 4. Increase/decrease in population is not sufficient – there must be a reason 3. Accept – 'For mixing to occur between samples' 5. Ignore 'random sampling'
4(c)(ii)	Correct answer of ...34 = 2 marks;; Incorrect answer but shows correct formula in words or numbers e.g. 17 × 20 ÷ 10;	2	1. Allow **one mark** for an answer of 51 as candidate has misinterpreted the second sample as being = 30 2. Reject correct formula multiplied by 100

Question	Marking Guidelines	Mark	Comments
5(a)(i)	Stroma (of chloroplasts);	1	Reject: stoma
5(a)(ii)	2;	1	
5(b)	1. As oxygen (concentration) increases less Rubisco/RuBP reacts/binds with carbon dioxide; 2. Competitive inhibition / competition between oxygen and carbon dioxide for rubisco/enzyme/active site; 3. Less RuBP formed/regenerated (to join with carbon dioxide);	2 max	1. Accept - as oxygen (concentration) increases more Rubisco/RuBP reacts/binds with oxygen 1. Accept – less GP/more phosphoglycolate formed as oxygen (concentration) increases 2. Accept oxygen and carbon dioxide are complementary to active site
5(c)	1. Less glycerate 3-phosphate/GP produced; 2. (Less) triose phosphate to form sugars/protein/organic (product)/any named photosynthetic product; 3. Less RuBP formed/regenerated;	3	1. Accept one GP formed rather than two GP 3. Accept RuBP takes longer to form

Question	Marking Guidelines	Mark	Comments
6(a)	0.8;	1	
6(b)(i)	1. Aerobic respiration; 2. Increase in uptake (of oxygen) with growth/reproduction/division of yeast cells; 3. Glucose/nutrients/oxygen decreases/becomes limiting / cells die / ethanol/toxins form / heat produced / anaerobic respiration occurs;	3	1. Allow description e.g. respiration using oxygen 1. Accept 'oxidative phosphorylation' 3. Ignore any reference to time 3. Accept decrease in oxygen being linked to oxygen being 'used up' or equivalent
6(b)(ii)	1. (Ethanol produced) by anaerobic respiration / from pyruvate in anaerobic conditions; 2. (Ethanol / anaerobic respiration) increases as oxygen (uptake/concentration) decreased; 3. Decreases as glucose is used up / ethanol kills cells;	2 max	1. 'Fermentation' is not enough on its own
6(c)	1. Oxygen uptake decreases/stopped; 2. Oxygen is final (electron) acceptor/combines with electrons (and protons); 3. Ethanol produced sooner / more ethanol produced;	3	3. Accept ethanol produced at any specified time before 16 hours

Question	Marking Guidelines	Mark	Comments
7(a)	1. Provides a standard/benchmark; 2. Can compare (different pesticides/chemicals); 3. Does not kill all the tadpoles/organisms/population;	2 max	3. Accept 'kills 50% of tadpoles'
7(b)	1. Only carried out on one species of toad/African toad / not carried out on USA toads/tadpoles/species; 2. Only tested for 1-4 days/short term / not 16 days/long term; 3. Did not look at effect of predator/predation; 4. Used various pesticides / may not have used malathion;	3 max	1. Accept not carried out on all species of toad 1. Accept carried out on different species 1. Do not accept one type of toad 3. Do not accept biotic factor on its own, there must be a reference to the predator 4. Accept 'did not use malathion'
7(c)(i)	1. (See) effect of pesticide/malathion; 2. Without predator/newts/stress / to compare/see effect with predator/newts/stress present (in experiment **2**);	2	
7(c)(ii)	1. Tadpoles not killed/eaten; 2. Newts are seen/detected;	2	
7(d)	1. Large surface area to volume ratio; 2. Rapid/more diffusion / shorter diffusion pathway; 3. Longer time exposure to pesticide / adults/toads live in and out of water / tadpoles remain/stay in water;	2 max	

7(e)	1. Link between using less (pesticide) and cost/less effect on environment/organisms; 2. Pesticide/malathion diluted (in water); 3. Concentrated due to evaporation; 4. Concentrated in food chains/webs/tadpoles/habitat;	2 max	1. Accept answers which link concentration (of pesticide) to being 'cost effective' 4. Accept (pesticide) 'builds up' in the environment / bioaccumulation / biomagnification
7(f)	1. Can see effect of other biotic factors / effect on other organisms; 2. Can see effect of abiotic factors / named abiotic factor;	2	

Question	Marking Guidelines	Mark	Comments
8(a)	1. Chlorophyll absorbs light energy; 2. Excites electrons / electrons removed (from chlorophyll); 3. Electrons move along carriers/electron transport chain releasing energy; 4. Energy used to join ADP and Pi to form ATP; 5. Photolysis of water produces protons, electrons and oxygen; 6. NADP reduced by electrons / electrons and protons / hydrogen;	5 max	1. Accept light energy 'hits' chlorophyll 1. Accept photon for light energy 2. Accept higher energy level as 'excites' 3. Accept movement of H^+/protons across membrane releases energy 3. and 4. Negate 'produces energy' for either mark but not for both 4. Accept energy used for phosphorylation of ADP to ATP 4. Do not accept P as Pi 6. Accept NADP to NADPH (or equivalent) by addition of electrons/hydrogen 6. Do not accept NADP reduced by protons on their own
8(b)	1. Some light is reflected / not of appropriate wavelength; 2. Some light misses leaves/ photosynthetic tissue/chloroplasts/chlorophyll; 3. Heat loss; 4. (Energy loss via) respiration; 5. Loss via faeces/undigested food/part of organism not eaten; 6. Excretion/named excretory product;	5 max	1. Light not absorbed is not enough on its own 3. Accept (energy used to) maintain body temperature but do not accept to keep warm or warm blooded 4. Do not accept 'energy used in respiration'

8(c)	1. Variation/variety; 2. Mutation; 3. Some plants have <u>allele</u> to survive/grow/live in high concentration of copper/polluted soils; 4. (Differential) reproductive success / adapted organisms reproduce; 5. Increase in frequency of <u>allele;</u> 6. No interbreeding (with other populations) / separate gene pool / gene pool differs (from other populations);	5 max	2. Do not accept answers which suggest the mutation is caused by copper 3. Reference to immunity disqualifies this mark 3. Do not disqualify mark for references to allele providing resistance to copper 6. Accept reproductive isolation

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 2013

Biology BIOL4

Unit 4 Populations and environment

Tuesday 11 June 2013 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.
- You are expected to use a calculator, where appropriate.
- 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.

Do not write outside the box

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

1 (a) What information is required in order to calculate the growth rate of a population?

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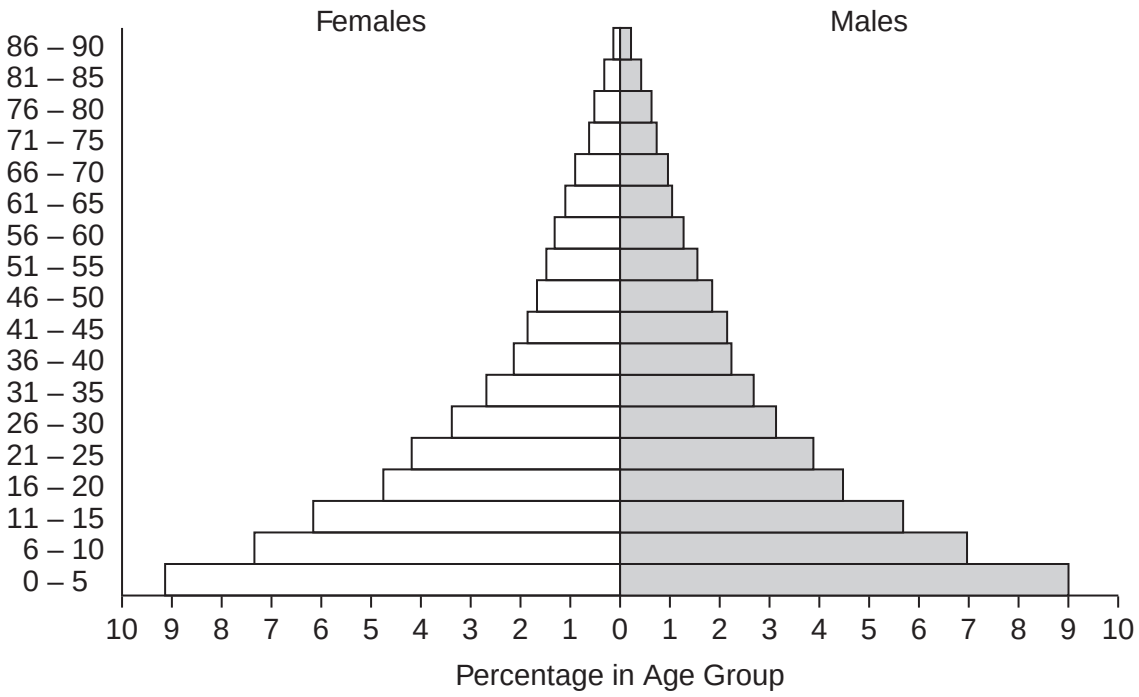
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(2 marks)

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1 (b) The diagram shows an age population pyramid for humans in a country.



This country is at an early stage of demographic transition. Describe the evidence for this.

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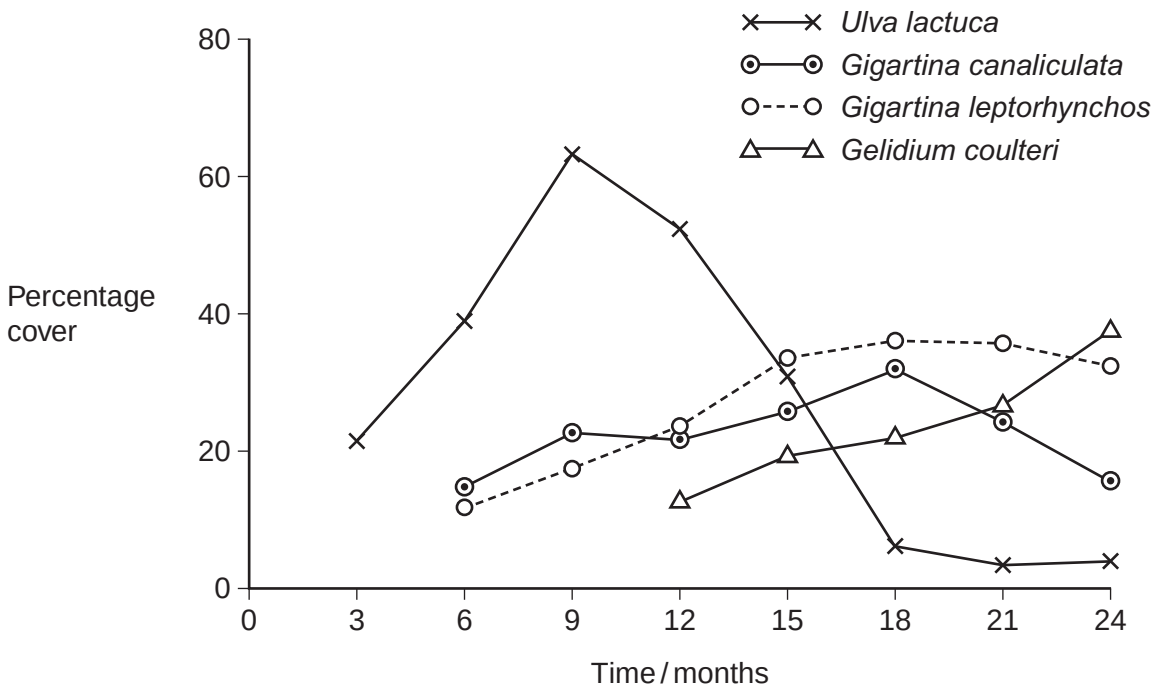
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(2 marks)

4

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2 Algae are photosynthesising organisms. Some algae grow on rocky shores. A scientist investigated succession involving different species of algae. He placed concrete blocks on a rocky shore. At regular intervals over 2 years, he recorded the percentage cover of algal species on the blocks. His results are shown in the graph.



2 (a) Name the pioneer species.

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(1 mark)

2 (b) (i) The scientist used percentage cover rather than frequency to record the abundance of algae present. Suggest why.

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(1 mark)

Do not write outside the box

2 (b) (ii) Some scientists reviewing this investigation were concerned about the validity of the results because of the use of concrete blocks.
Suggest **one** reason why these scientists were concerned about using concrete blocks for the growth of algae.

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(1 mark)

2 (c) Use the results of this investigation to describe and explain the process of succession.

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(4 marks)

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7

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3 (a) Explain what is meant by the term phenotype.

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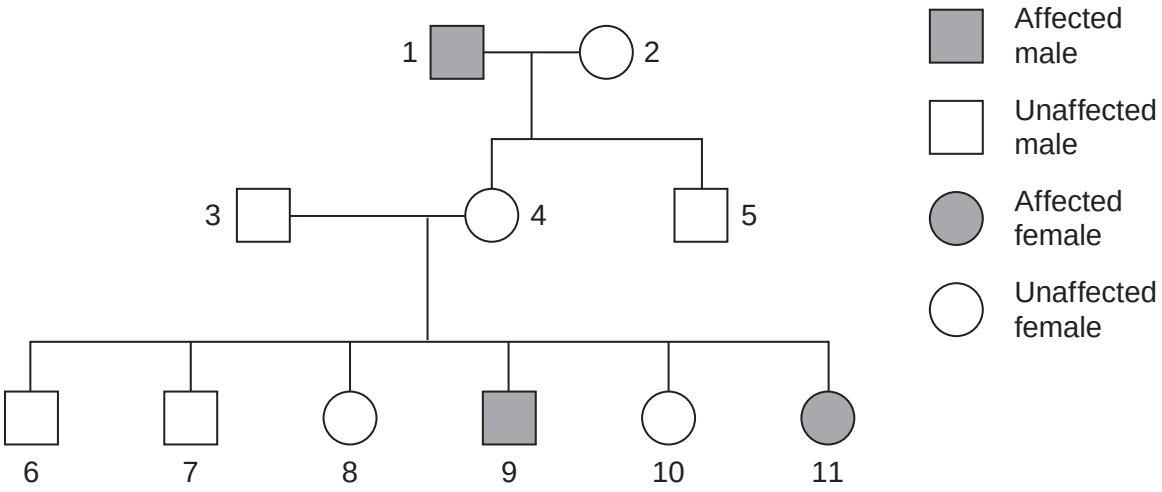
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(2 marks)

3 (b) Tay-Sachs disease is a human inherited disorder. Sufferers of this disease often die during childhood. The allele for Tay-Sachs disease **t**, is recessive to allele **T**, present in unaffected individuals. The diagram shows the inheritance of Tay-Sachs in one family.



3 (b) (i) Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is recessive.

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(2 marks)

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3 (b) (ii) Explain **one** piece of evidence from the diagram which proves that the allele for Tay-Sachs disease is **not** on the X chromosome.

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(2 marks)

3 (c) (i) In a human population, one in every 1000 children born had Tay-Sachs disease. Use the Hardy-Weinberg equation to calculate the percentage of this population you would expect to be heterozygous for this gene. Show your working.

Answer = ... %

(3 marks)

3 (c) (ii) The actual percentage of heterozygotes is likely to be lower in future generations than the answer to part **(c)(i)**. Explain why.

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(1 mark)

10

Do not write outside the box

4 (a) The table contains statements about three stages of respiration.

Complete the table with a tick if the statement in the first column is true for each stage of respiration in an animal.

	Glycolysis	**Link reaction**	**Krebs cycle**
Occurs in mitochondria			
Carbon dioxide produced			
NAD is reduced			

(3 marks)

4 (b) The following reaction occurs in the Krebs cycle.

Succinate $\xrightarrow{\text{Enzyme}}$ Fumarate

A scientist investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is very similar to the structure of succinate. The scientist added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

4 (b) (i) Explain why the scientist did not use glucose as the respiratory substrate for these isolated mitochondria.

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(2 marks)

Do not write outside the box

4 (b) (ii) Explain how malonate inhibits the formation of fumarate from succinate.

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(2 marks)

4 (b) (iii) The scientist measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added. Explain why.

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(2 marks)

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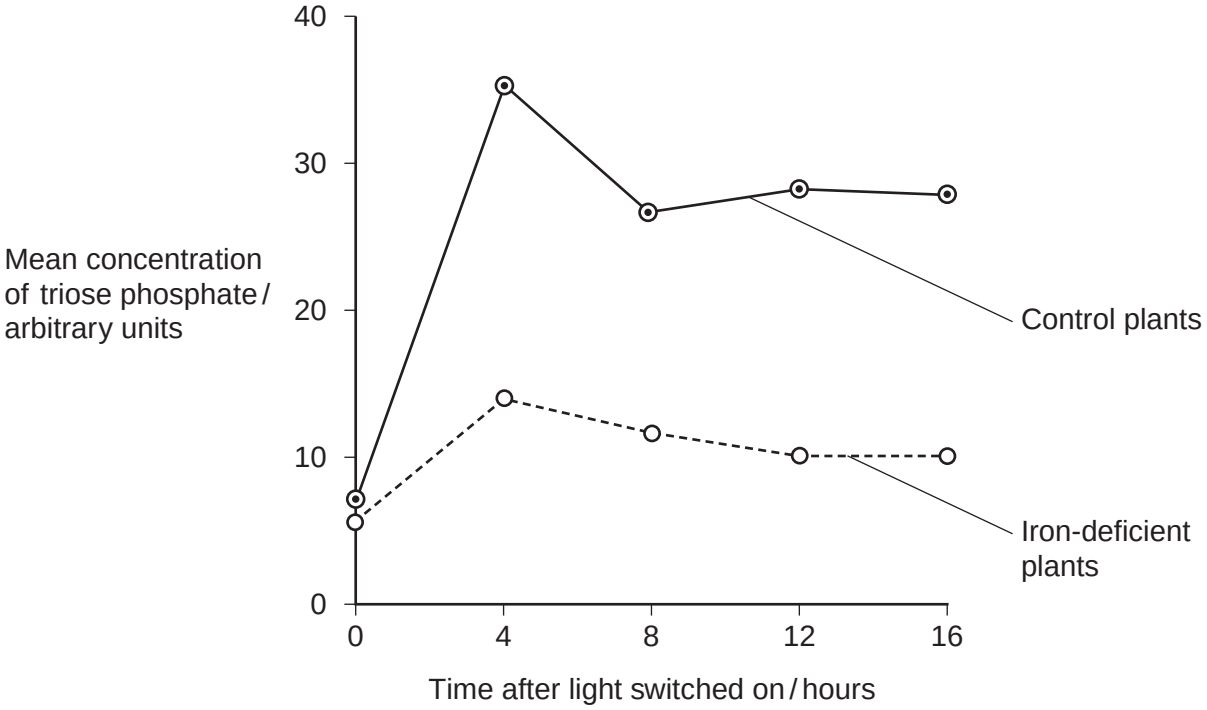
Turn over for the next question

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5 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
- then for 16 hours in the light.

Their results are shown in the graph.



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

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(1 mark)

5 (a) (ii) Explain why it was important to grow the plants under the same conditions up to ten days before the experiment.

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(1 mark)

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5 (a) (iii) The plants were left in the dark for 6 hours before the experiment. Explain why.

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(1 mark)

5 (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.

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(4 marks)

(Extra space) .....

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

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(2 marks)

9

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6 The Amazonian forest today contains a very high diversity of bird species.

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
- Different plant communities developed in each of these smaller forests.
- Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.

6 (a) Use the information provided to explain how a very high diversity of bird species has developed in the Amazonian forest.

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(5 marks)

(Extra space) .....

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6 (b) Speciation is far less frequent in the reformed Amazonian forest. Suggest **one** reason for this.

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(1 mark)

6

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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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.

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(1 mark)

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

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(2 marks)

7 (a) (iii) The population number of both species of lizard varied at different times of the year. Suggest **two** reasons why.

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2 .....

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(2 marks)

Question 7 continues on the next page

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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 the table.

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.

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(2 marks)

7 (c) A preliminary study suggested that malarial infections were more common at higher elevations. Use the information provided to evaluate this suggestion.

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(2 marks)

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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 provided to explain how they reached this conclusion.

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(2 marks)

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.

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(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 for P of < 0.01.

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

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(2 marks)

15

Do not write outside the box

8 (a) Rather than use chemical pesticides or biological agents, farmers often use an integrated system of chemical pesticides and biological agents to control agricultural pests. Explain the advantages of using an integrated system to control agricultural pests.

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(6 marks)

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8 (b) Nitrate from fertiliser applied to crops may enter ponds and lakes. Explain how nitrate may cause the death of fish in fresh water.

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(5 marks)

(Extra space) .....

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Question 8 continues on the next page

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8 (c) Explain how the intensive rearing of domestic livestock increases net productivity.

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(4 marks)

(Extra space) .....

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15

END OF QUESTIONS

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General Certificate of Education (A-level)
June 2013

Biology BIOL4

(Specification 2410)

Unit 4: Populations and Environment

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidelines	Mark	Comments
1(a)	Birth rate and death rate = 2 marks;; ***OR*** 1. Change in population / births and deaths / population at start and end; 2. In a given time;	2	Neutral: any reference to per or times by a number eg per 1000 / × 100 Neutral: ignore any reference to immigration and emigration unless context is incorrect
1(b)	1. High birth rate / high proportion/percentage/number of young/children; 2. High death rate / low proportion/percentage/number of elderly/older people/low life expectancy;	2	1 and 2. Both points must be clearly stated. Do not award other mark by implication 1 and 2. Accept appropriate use of percentage/number as alternatives 1. Accept: 'wide base' or any equivalent description of high proportion/number of young children 2. Accept: 'narrow at top' or any equivalent description of low proportion of older people 2. Accept high death rate in context of any age group

Question	Marking Guidelines	Mark	Comments
2(a)	*Ulva lactuca*;	1	Reject: *Ulva* on its own Accept: *lactuca* on its own Accept: Incorrect spelling
2(b)(i)	Difficult/too many/too many to count / individual organisms not identifiable / too small to identify / grows in clumps;	1	Neutral: easier/quicker/representative/more accurate, unless qualified
2(b)(ii)	Any described feature of concrete eg texture / flat / composition chemicals / nutrients etc;	1	Neutral: not natural / man made / are different, without further qualification
2(c)	1. Pioneer species/*Ulva* increases then decreases; 2. Principle of a species changing the conditions / a species makes the conditions less hostile; 3. New/named species better competitor / previous/named/pioneer species outcompeted; 4. *G. coulteri*/*Gelidium* increases <u>and</u> other/named species decreases;	4	1 and 4. Growth/reproduces = increases. Dies = decrease 2. Accept description of change in conditions eg soil/humus forms, nutrients increased Pioneer species grows, dies and forms humus = 2 marks *G. coulteri*/*Gelidium* outcompetes other/named species = 2 marks

Question	Marking Guidelines	Mark	Comments
3(a)	1. Expression / appearance / characteristic due to genetic constitution/genotype/allele(s); 2. (Expression / appearance / characteristic) due to environment;	2	1 Accept: named characteristic 1 Accept: homozygous / heterozygous / genes / DNA 1 Neutral: chromosomes
3(b)(i)	1. 3 <u>and</u> 4 <u>and</u> 9/11/affected offspring; 2. Both 3 and 4 are carriers/heterozygous; ***OR*** If dominant at least one of 3 and 4 would be affected;	2	1 Accept: 9/11 and their parents 1 Accept: unaffected parents have affected children 2 Accept: if 3 and 4 are unaffected all their children will be unaffected
3(b)(ii)	1. 11 is affected, 3 is not; 2. 3/father of 11 does not have a recessive allele on his X chromosome/ X^t; ***OR*** (If on X) 11/affected female would not receive the recessive allele on X chromosome/X^t from 3/father; ***OR*** (If on X) 3/father (of 11) would pass on the dominant allele on his X chromosome/X^T;	2	1 Accept: 3/unaffected father/parents produce an affected daughter 1 Accept: 3 and 4 would only produce unaffected females 2 Answers must be in context of alleles Reject: recessive/dominant chromosomes
3(c)(i)	Answer in range of 5.8 - 6.2% = 3 marks;;; If incorrect answer, then 2 max of following points 1. q^2/p^2/tt = 0.001 or 1 divided by 1000; 2. p/q/T = 0.968 – 0.97; 3. Understanding that heterozygous = 2pq;	3 max	Answers in range of 0.058 - 0.062 = 2 marks 3. This can be shown mathematically ie 2 × two different numbers 3. Accept: answer provided attempts to calculate 2pq

3(c)(ii)	Affected individuals (usually) do not reproduce/die during childhood/do not pass on allele/genetic screening;	1	

<table>
<tr><th>Question</th><th>Marking Guidelines</th><th>Mark</th><th>Comments</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th></th><th>Glycolysis</th><th>Link reaction</th><th>Krebs Cycle</th></tr>
<tr><td>Occurs in mitochondria</td><td></td><td>√</td><td>√</td></tr>
<tr><td>Carbon dioxide produced</td><td></td><td>√</td><td>√</td></tr>
<tr><td>NAD is reduced</td><td>√</td><td>√</td><td>√</td></tr>
</table>
Mark horizontally
</td><td>3</td><td></td></tr>
<tr><td>4(b)(i)</td><td>1. Glucose is used/broken down during glycolysis/in cytoplasm;
2. Glucose cannot cross mitochondrial membrane(s) / pyruvate can cross mitochondrial membrane(s);</td><td>2</td><td>1 Accept: glucose to pyruvate or glucose not converted to pyruvate for one mark</td></tr>
<tr><td>4(b)(ii)</td><td>1. Is a competitive inhibitor / attaches to active site;
2. Reduces/prevents enzyme-substrate/E-S complex forming;</td><td>2</td><td>1 Accept: inhibitor/malonate attaches to active site to form an enzyme-substrate complex
2 Accept: substrate/succinate cannot bind to enzyme
2 Accept mark point 2, but not mp1 in context of non-competitive inhibition</td></tr>
<tr><td>4(b)(iii)</td><td>1. Krebs cycle inhibited;
2. NAD/Coenzyme/FAD not/less reduced;
3. Hydrogens not passed to ETC;
4. Oxygen used as final/terminal (electron) acceptor;</td><td>2 max</td><td>4 Accept: oxygen combines with electrons and protons/hydrogen ions without reference to final acceptor
Neutral: oxygen is used in the Krebs cycle</td></tr>
</table>

Question	Marking Guidelines	Mark	Comments
5(a)(i)	So it/CO_2 is not a limiting factor (on growth/photosynthesis);	1	Accept: CO_2 is a limiting factor
5(a)(ii)	So any difference is due to iron (deficiency);	1	Accept: iron is the variable
5(a)(iii)	Amount of triose phosphate/TP will be similar/same/low (at start);	1	Accept: to allow triose phosphate to stabilise / become constant Reject: so all triose phosphate is used up Reject: so no triose phosphate
5(b)	1. (Less) ATP produced; 2. (Less) reduced NADP produced; 3. ATP/reduced NADP produced during light-dependent reaction; 4. (Less) GP to triose phosphate/TP;	4	Accept: alternatives for reduced NADP ie NADP with hydrogen/s attached
5(c)	1. Less triose phosphate converted to RuBP; 2. CO_2 combines with RuBP;	2	Accept: less triose phosphate so less RuBP

Question	Marking guidelines	Mark	Comments
6(a)	1. No interbreeding / gene pools are separate / <u>geographic(al)</u> isolation; 2. Mutation; 3. Different selection pressures / different foods/niches/habitats; 4. Adapted organisms survive and breed / differential reproductive success; 5. Change/increase in allele frequency/frequencies;	5	Accept: all marks if answer written in context of producing increased diversity of plants 1 Do not award this mark in context of new species being formed and then not interbreeding 1 Accept reproductive isolation as an alternative to no interbreeding 2 Accept: genetic variation 3 Accept: different environment / biotic/abiotic conditions or <u>named</u> condition 3 Neutral: different climates
6(b)	Similar/same environmental/abiotic/biotic factors / similar/same selection pressures / no isolation / gene flow can occur (within a species);	1	Accept: same environment

Question	Marking Guidelines	Mark	Comments
7(a)(i)	Reliable / representative / for statistical tests;	1	Accept: identify anomalies Neutral: accurate/valid/bias
7(a)(ii)	1. Find coordinates (on a grid) / split area into squares / number the sites; 2. Method of generating/finding random numbers eg calculator/computer/random number generator/random numbers table;	2	1. Ignore references to tape measures, metre rulers etc 2. Accept: numbers out of a hat / use of dice
7(a)(iii)	1. Breeding (of lizards); 2. Food source/prey; 3. Predator; 4. Variation in malarial infection; 5. Temperature variation; 6. Availability of water eg drought/'rainy season'	2 max	Neutral: weather / climate / hurricanes / hibernation / migration / emigration / immigration
7(b)	1. Number in sample varies; 2. Allow a (valid) comparison;	2	
7(c)	1. (Overall) positive correlation (for either/both species); 2. Reference to (site) 5 / 300 metres; 3. Limited results for *A.wattsi* / small sample/number/percentage infected for *A.wattsi*;	2 max	Neutral: only one study / no repeats
7(d)(i)	1. Fewer *A.wattsi* infected / more *A.gingivinus* infected; 2. Higher number of *A.wattsi* present when higher percentage/number of *A.gingivinus* infected; 3. No *A.wattsi* present when *A.gingivinus* has zero infection;	2 max	

7(d)(ii)	1. Reduced immunity / increased susceptibility to disease; 2. Reduced oxygen transport/uptake/respiration / reduced activity/movement;	2	1. Accept: idea that energy/ resources are used to combat malaria
7(d)(iii)	1. There is a <u>probability</u> of less than 1% / 0.01; 2. That result(s)/correlation/it is due to chance; ***OR*** 3. There is a <u>probability</u> of more than 99%/0.99; 4. That result(s)/correlation/it is not due to chance;	2	1. Reject: probability is/equal to 1%/0.01; 1. Reject 0.01%/5%/0.05/0.05% 2. Allow correct interpretation using above (incorrect) figures eg there is a probability of less than 5% that the results are due to chance =1 mark Note: there is a probability of more than 5% that the results are due to chance =0 marks 3. Reject: probability is/equal to 99%/0.99; 3. Reject 0.99%/95%/0.95/0.95 % 4. Allow correct interpretation of above figures ie 0.99%/95%/0.95/0.95 % but reject if less than

Question	Marking Guidelines	Mark	Comments
8(a)	(Biological Agents) 1. Only needs one application/ reproduces; 2. Specific; 3. Keeps/maintains low population; 4. Pests do not develop resistance; 5. Can use less chemicals / reduces chemical residues / no bioaccumulation; (Chemical pesticides) 6. Acts quickly; 7. Can apply to specific area; 8. Kills all/most/greater variety of pests;	6 max	Assume advantages are in context of correct type of control (chemical or biological) unless stated otherwise 4. Reject reference to immunity
8(b)	1. Growth of algae/surface plants/algal bloom blocks light; 2. Reduced/no photosynthesis so (submerged) plants die; 3. Saprobiotic (microorganisms/bacteria); 4. Aerobically respire / use oxygen in respiration; 5. Less oxygen for fish to respire / aerobic organisms die;	5	3. Accept: Saprobiont/saprophyte/ saprotroph 3. Neutral: decomposer

8(c)	1. Slaughtered when still growing/before maturity/while young so more energy transferred to biomass/tissue; 2. Fed on concentrate /controlled diet / so higher proportion of food absorbed/digested/assimilated / used for biomass/tissue / lower proportion lost in faeces; 3. Movement restricted so less heat/energy/respiratory loss; 4. Heating/Kept warm/ inside so less heat/energy/respiratory loss/maintain body temperature; 5. Genetically selected / selective breeding (for high productivity);	4 max	**Q** 1-4 The principle here is one mark for identifying a relevant point <u>and</u> offering an explanation 2. Accept: named diets for controlled diet, eg high protein diet 2. Neutral: loss in excretion 2. Neutral: for growth Neutral: reference to predators

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Other Names										
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For Examiner's Use	
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General Certificate of Education
Advanced Level Examination
January 2012

Biology BIOL4

Unit 4 Populations and environment

Wednesday 25 January 2012 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.

Do not write outside the box

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

1 Ecologists studied a community of fish in a lake.

1 (a) Explain what is meant by a community.

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(1 mark)

1 (b) (i) The ecologists could have used the mark-release-recapture method to estimate the number of one species of fish in the lake. Describe how.

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(3 marks)

(Extra space) .....

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Do not write outside the box

1 (b) (ii) This species of fish breeds at a certain time of the year. During this fish-breeding season, the mark-release-recapture technique might **not** give a reliable estimate. Suggest **one** reason why.

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(1 mark)

1 (c) The ecologists found that each species of fish had adaptations to its niche. One of these adaptations was the shape of its mouth.

Suggest how the shape of mouth is an adaptation to its niche.

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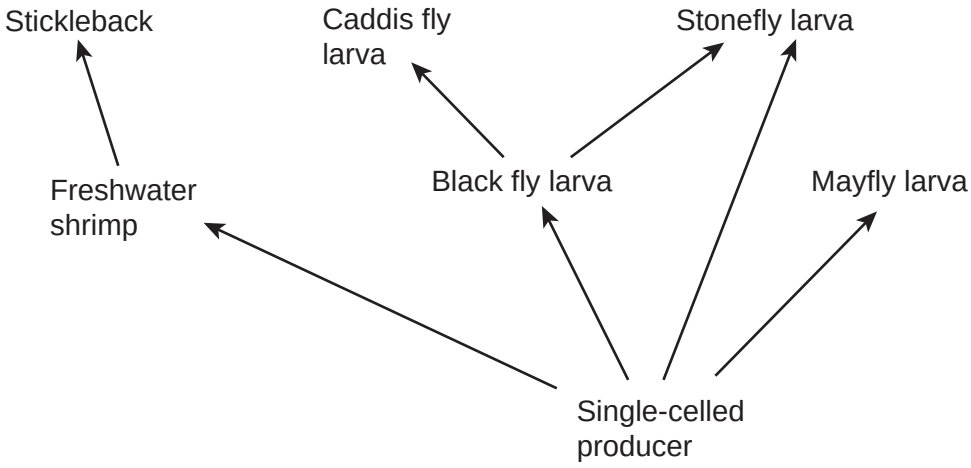
(2 marks)

7

Turn over for the next question

Do not write outside the box

2 The diagram shows organisms in a food web.



2 (a) (i) Name **all** the secondary consumers in this food web.

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(1 mark)

2 (a) (ii) Use the diagram to explain the likely effect of a sudden decrease in the stickleback population on the population of mayfly larvae.

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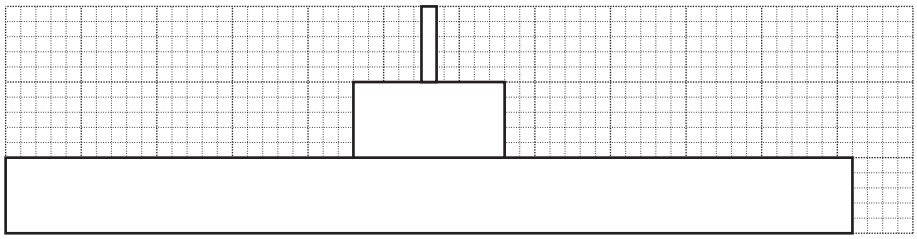
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(2 marks)

Do not write outside the box

2 (b) A pyramid of energy for this food web is shown below. The bars are drawn to the same scale.



2 (b) (i) Use the pyramid of energy to calculate the percentage efficiency of energy transfer between producers and primary consumers. Show your working.

efficiency = ... %

(2 marks)

2 (b) (ii) The average efficiency of energy transfer between producers and primary consumers in pyramids of energy is around 10 %.

Suggest why the efficiency of energy transfer from producers to primary consumers in this food web is higher than 10 %.

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(2 marks)

2 (c) Energy from the sun may ultimately end up in dead plant matter. Describe how.

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(2 marks)

9

Do not write outside the box

3 The photograph shows marram grass growing on a sand dune.



3 (a) Describe how you would investigate the distribution of marram grass from one side of the dune to the other.

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(3 marks)

(Extra space) .....

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3 (b) Marram grass is a pioneer species that grows on sand dunes. It has long roots and a vertically growing stem that grows up through the sand.
Sand dunes are easily damaged by visitors and are blown by the wind. Planting marram grass is useful in helping sand dune ecosystems to recover from damage.

Use your knowledge of succession to explain how.

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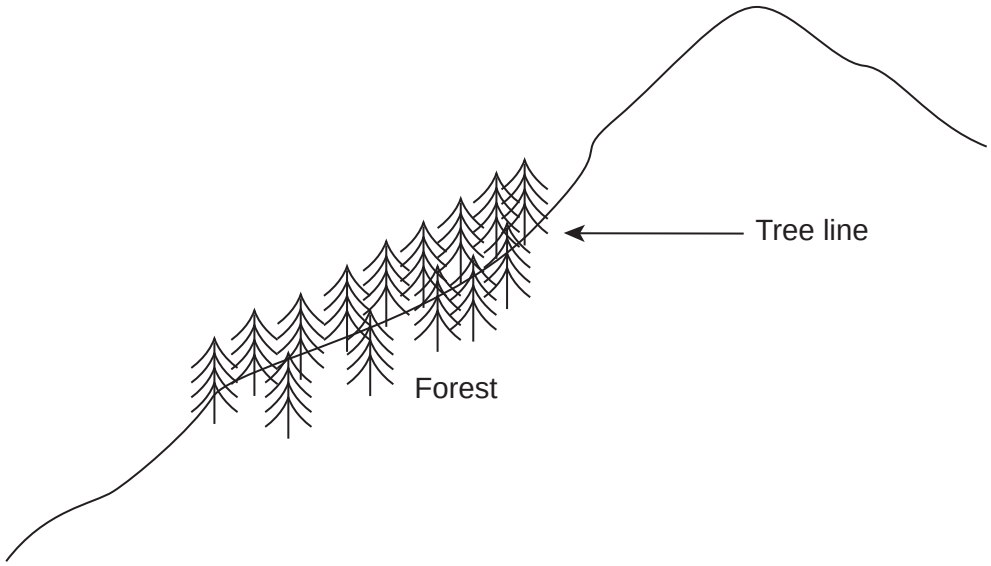
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(2 marks)

5

Do not write outside the box

4 Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



4 (a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

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(1 mark)

4 (a) (ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

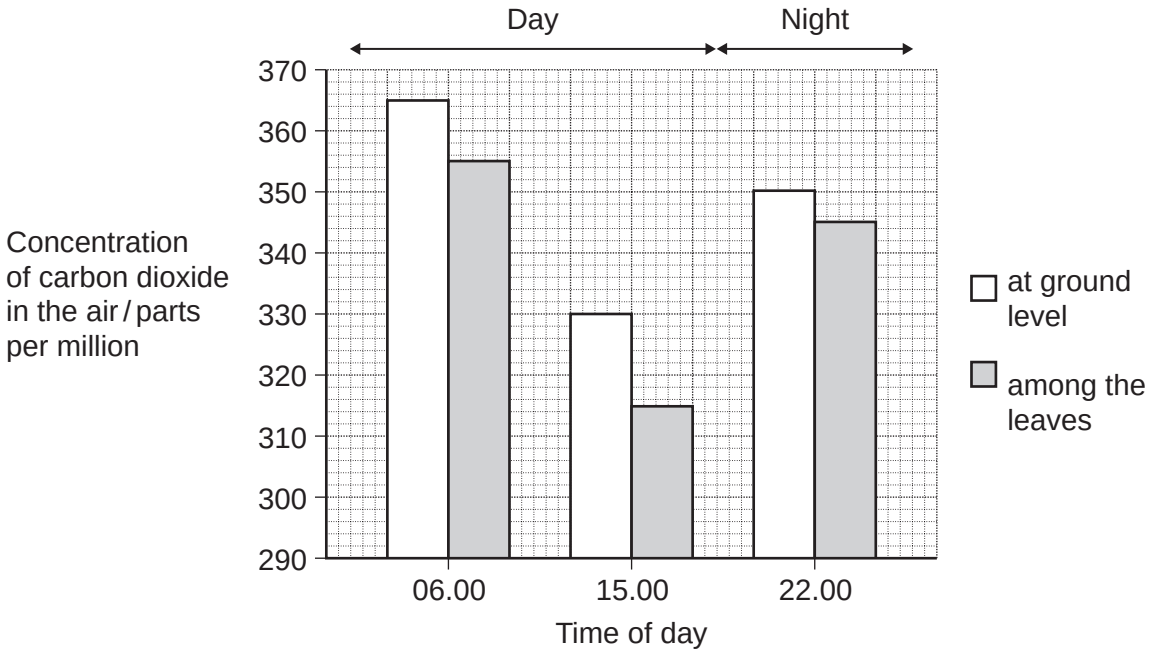
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(1 mark)

Question 4 continues on the next page

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4 (b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

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(4 marks)

(Extra space) .....

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Do not write outside the box

4 (c) The population of trees in the forest evolved adaptations to the mountain environment. Use your knowledge of selection to explain how.

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(3 marks)

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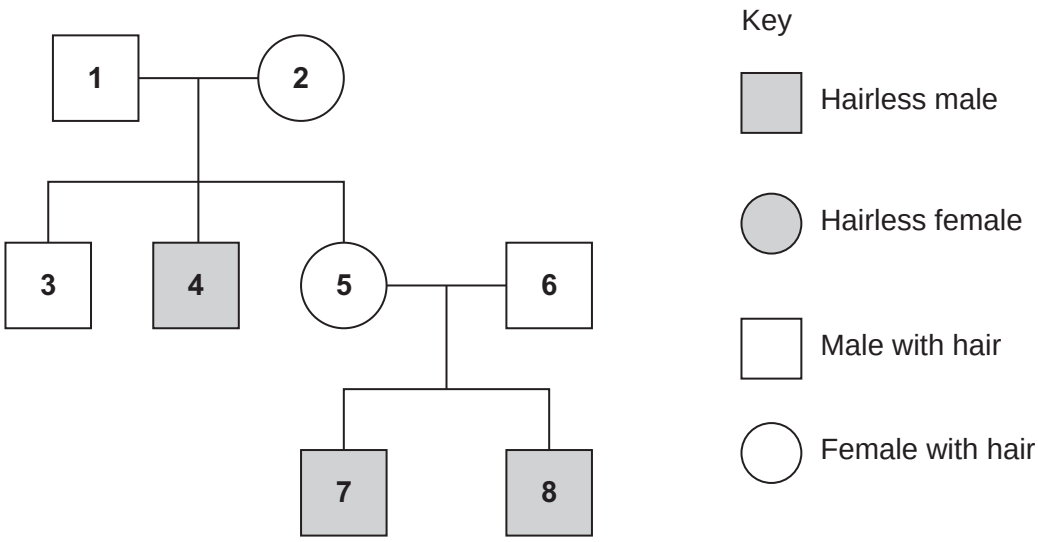
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Turn over for the next question

Do not write outside the box

5 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.

The diagram shows the pattern of inheritance of these alleles in a group of cattle.



5 (a) Use evidence from the diagram to explain

5 (a) (i) that hairlessness is caused by a recessive allele

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(2 marks)

5 (a) (ii) that hairlessness is caused by a gene on the X chromosome.

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(1 mark)

Do not write outside the box

5 (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.

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 .....

(4 marks)

7

Turn over for the next question

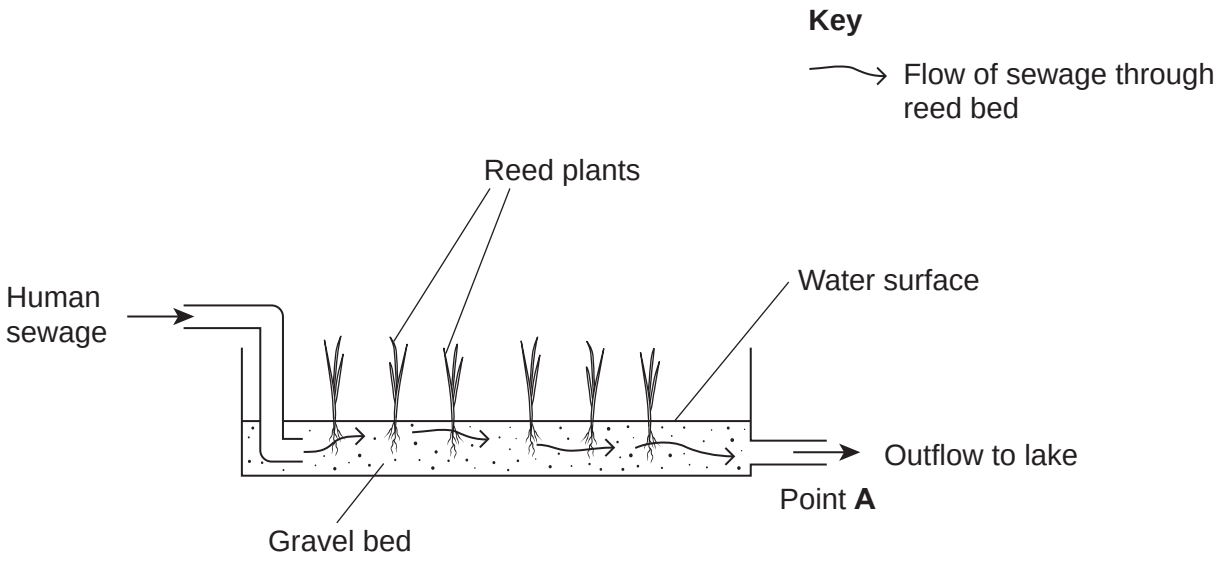
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6 (a) Name the process by which some bacteria oxidise ammonia to nitrate.

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(1 mark)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



6 (b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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(2 marks)

Do not write outside the box

6 (c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

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(2 marks)

6 (c) (ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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(3 marks)

(Extra space) .....

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8

Do not write outside the box

7 In some countries, pigs are reared in intensive units in which the temperature is controlled. Agricultural scientists investigated the effect of temperature on pig growth and on the efficiency with which the pigs converted food to biomass.

7 (a) (i) In the investigation, the scientists used pigs of the same breed, with similar genotypes. Explain why.

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(2 marks)

7 (a) (ii) The pigs were allowed to eat as much food as they wanted.
How could this have decreased the reliability of any conclusions drawn from the investigation?

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(2 marks)

The table shows the results of this investigation.

Temperature / °C	Mean growth rate / kg per day	Efficiency of conversion of food to biomass / %
0	0.54	19
10	0.80	42
20	0.85	48
30	0.45	37
35	0.31	37

7 (b) (i) Describe the effect of temperature on mean growth rate.

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(1 mark)

Do not write outside the box

7 (b) (ii) A student concluded from these data that the mean growth rate of the pigs was fastest at 20 °C. Do you agree with this conclusion? Explain your answer.

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(2 marks)

7 (c) (i) Pigs can survive at temperatures above 35 °C. Use the data to suggest why scientists did **not** carry out any investigations at temperatures higher than 35 °C.

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(2 marks)

7 (c) (ii) The efficiency of conversion of food to biomass is lower at 0 °C than it is at 20 °C. Suggest an explanation for the lower efficiency.

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(2 marks)

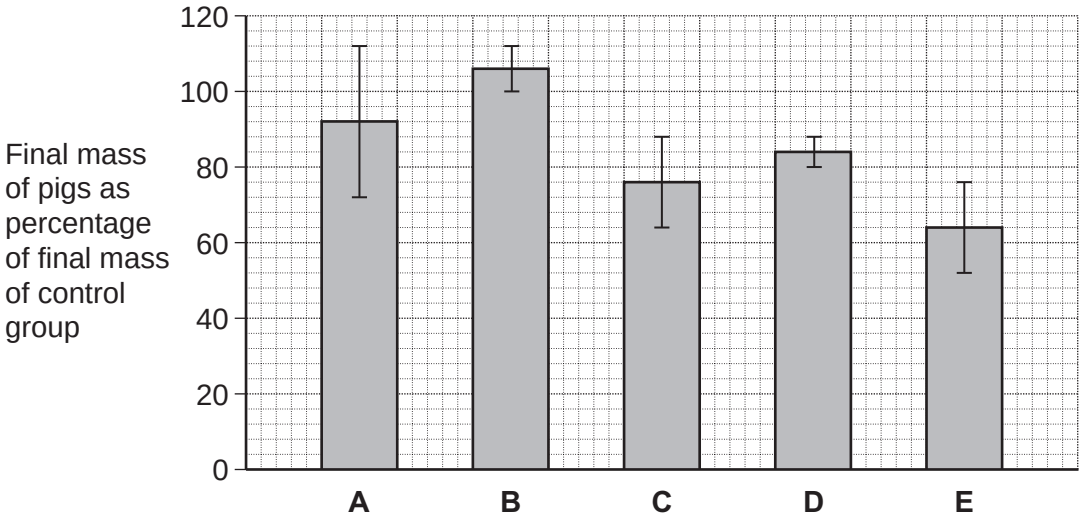
Question 7 continues on the next page

Do not write outside the box

7 (d) Pigs require a mixture of fibre and protein in their food. The greater the ratio of fibre to protein, the less the food costs.

Scientists took five large groups of pigs. They fed each group a different high-fibre food. Each of the foods contained fibre from different plant species, but they all had the same energy content. The scientists fed a control group of pigs a low-fibre food with the same energy content. After 10 days, the scientists compared the masses of the pigs fed on high-fibre food to those fed on low-fibre food.

The graph shows the results of the investigation. The bars represent ±2 standard errors of the mean.



A farmer saw these results and concluded that he should replace his pigs' usual food with food **B**. Evaluate this conclusion.

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(4 marks)

(Extra space) .....

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15

Do not write outside the box

8 (a) ATP is useful in many biological processes. Explain why.

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(4 marks)

(Extra space) .....

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Question 8 continues on the next page

Do not write outside the box

8 (b) Describe how ATP is made in mitochondria.

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(6 marks)

(Extra space) .....

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Do not write outside the box

8 (c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

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(5 marks)

(Extra space) .....

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15

END OF QUESTIONS

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ACKNOWLEDGEMENTS

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Version 1.0



General Certificate of Education (A-level)
January 2012

Biology BIOL4

(Specification 2410)

Unit 4: Populations and Environment

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking guidelines	Mark	Comments
1(a)	All the fish/all the species/all the populations/all the organisms;	1	Must indicate all/every species. Reject answers that suggest other fish/organisms might be present.
1(b)(i)	1. Capture sample, mark and release; 2. Appropriate method of marking suggested / method of marking does not harm fish; 3. Take second sample and count marked organisms; 4. $\text{Population} = \frac{\text{No in sample}_1 \times \text{No in sample}_2}{\text{Number marked in sample}_2}$;	3 max	2. E.g. Cutting a fin/attaching a tag/paint/marker. 3. May be awarded from equation if not given here. 4. Accept any valid alternative to equation or answer expressed as a ratio.
1(b)(ii)	One suitable reason; E.g. population increases/changes (between first and second sample)	1	Accept other valid answers, which must, however, relate to breeding/only works if population constant.
1(c)	1. With different mouth eats different food / has different way of feeding / specific mouth shape for specific food; 2. Competition between species/interspecific competition is reduced;	2	1. Catches more food and gas exchange are neutral 2. Reject intraspecific

Question	Marking guidelines	Mark	Comments
2(a)(i)	Stickleback + caddis fly (larva) + stonefly (larva);	1	All three required for mark. In any order.
2(a)(ii)	1. (With fewer fish) reduced predation / not being eaten results in more freshwater shrimps; 2. Increased competition for food/resources / more producers eaten by shrimps / more shrimps eating producers; 3. Less food/resources for mayfly;	2 max	Principles 1. Effect of fish on shrimps 2. Effect of shrimps on producer 3. Effect of food on mayfly
2(b)(i)	1. Two marks for correct answer in range 16.8 to 18.9;; 2. One mark for incorrect answer in which candidate divides 19 to 21 by 111 to 113;	2	Ignore additional decimal places. Working shown in mm. Accept working in cm/2mm squares (10/56) for 1 mark.
2(b)(ii)	1. Single-celled producers are more digestible / contain less cellulose (than plants) / less energy lost in faeces; 2. All of producer eaten/parts of plant not eaten; 3. Less heat/energy lost / less respiration;	2 max	3. May refer to either trophic level
2(c)	1. Photosynthesis/light dependent reaction/light independent reaction; 2. Carbon-containing substances;	2	Allow organic substance or named organic substance

Question	Marking guidelines	Mark	Comments
3(a)	1. Transect/lay line/tape measure (from one side of the dune to the other); 2. Place quadrats at regular intervals along the line; 3. Count plants/percentage cover/abundance scale (in quadrats) **OR** Count plants and record where they touch line/transect;	3 max	1&2. Reject random in context of placing transect/quadrats 2. Accept references to stratified sampling/different seral stages 3. Accept abundance scale
3(b)	1. Stabilises sand / stops sand shifting; 2. Forms/improves soil / makes conditions less hostile;	2	2. Allow credit for example of making conditions less hostile such as: Adds nutrients Improves water retention

Question	Marking guidelines	Mark	Comments
4(a)(i)	Non-living/physical/chemical factor/non biological;	1	Do not accept named factor unless general answer given.
4(a)(ii)	Accept an abiotic factor that may limit photosynthesis/growth; E.g. Water Named soil factor Light Carbon dioxide Incline/aspect Wind/wind speed	1	Reject altitude/height Not “soil” / “weather” Accept Oxygen
4(b)	1. Correct explanation for differences between day and night e.g. photosynthesises only during the daytime / no photosynthesis/only respiration at night; 2. Net carbon dioxide uptake during the day/in light ***OR*** No carbon dioxide taken up at night/in dark / carbon dioxide released at night/in dark; 3. At ground level <u>more</u> respiration / in leaves <u>more</u> photosynthesis; 4. Carbon dioxide produced at ground level/carbon dioxide taken up in leaves;	4	Principles **Comparing day and night/light and dark** 1. Explanation in terms of photosynthesis/respiration 2. Effect on carbon dioxide production/uptake **Comparing leaves with ground level** 3. Explanation in terms of photosynthesis/respiration 4. Effect on carbon dioxide production/uptake 2 and 4 must relate to why the change occurs
4(c)	1. Variation in original colonisers / mutations took place; 2. Some better (adapted for) survival (in mountains); 3. Greater reproductive success; 4. <u>Allele</u> frequencies change;	3 max	2. Allow “advantage so able to survive” 4. Reject gene/genotype

Question	Marking guidelines	Mark	Comments
5(a)(i)	1. Animal 2 / 5 has hair but offspring do not; 2. So 2 / 5 parents must be heterozygous/carriers; **OR** 3. 4/7/8 are hairless but parents have hair; 4. So 2 / 5 must be heterozygous/carriers;	2	Accept parents as alternative to animals 2 and 5 1 + 3: Allow reference to children/offspring for animals 7 + 8 Ignore reference to individuals 1 and 6
5(a)(ii)	Hairless males have fathers with hair / 4 is hairless but 1 is hairy / 7 and/or 8 are hairless but 6 is hairy / only males are hairless;	1	Ignore references to other individuals Ignore reference to genotypes Allow credit for candidate who states that evidence is not conclusive/pedigree possible with autosomal character;
5(b)	1. Parental genotypes X^HX^h and X^HY Gametes X^H X^h X^H Y; 2. Genotypes of offspring X^HX^H, X^HY, X^HX^h, X^hY; 3. Phenotypes of offspring female with hair male with hair male hairless; 4. 0.25 / ¼ / 1 in 4 / 25%;	4	Accept any letter for gene but capital letter must represent dominant allele. 1. Both parental genotypes and gametes must be correct 2. Allow for offspring genotypes correctly derived from <u>gametes</u> given by candidate; 3. Allow phenotypes correctly derived from offspring genotype Allow H ≡ X^H, h ≡ X^h 4. Ignore 1:3 in context of correct probability Reject 1:4

Question	Marking guidelines	Mark	Comments
6(a)	Nitrification;	1	Accept nitrifying. Do not accept nitrogen fixing.
6(b)	1. Uptake (by roots) involves active transport; 2. Requires ATP/ aerobic respiration;	2	Reject all references to bacteria
6(c)(i)	1. Not enough time / fast flow washes bacteria away; 2. (Not all/less) ammonia converted to nitrate/less nitrification;	2	"Not enough time for bacteria to convert all the ammonia to nitrate" gains 2 marks
6(c)(ii)	1. Algal bloom / increase in algae; 2. Algae block light / plants/algae die; 3. Decomposers/saprobionts/bacteria break down dead plant materials; 4. Bacteria/decomposers/saprobionts use up oxygen in respiration / increase BOD; 5. Fish die due to lack of oxygen;	3 max	4. Accept alternatives such as microbes/ saprophytes.

Question	Marking guidelines	Mark	Comments
7(a)(i)	1. Same breed so similar alleles; 2. Controls/removes variable/so genes not a factor / only temperature affects results / rate of growth affected by genes;	2	1. Allow different alleles have different effects 2. Accept idea worded in such terms as inherited.
7(a)(ii)	1. Different growth rates / gained different biomass / grew different amount; 2. Not due to temperature / the independent variable;	2	Allow “more food for growth” Ignore references to efficiency of conversion.
7(b)(i)	Rise then fall with peak at 20 °C;	1	Do not accept 0.85 as alternative to 20.
7(b)(ii)	1. Temperature may be between 10 and 30/10 and 20/20 and 30; 2. Intervals are 10 °C/large/not small/should be smaller/should be intermediates;	2	No mark for yes or no.
7(c)(i)	1. Growth rate decreasing / conversion staying same/ decreasing; 2. (Scientists would be) looking for high growth rate/ conversion / data shows unlikely to improve growth/yield; 3. Wastes time/resources/would not relate to farming conditions;	2 max	3. Ignore cruelty to pigs
7(c)(ii)	1. Will lose more heat / not as much energy used to maintain body temperature; 2. Heat resulting from respiration/more respiration; 3. More food used in respiration;	2 max	1. Must be a comparative statement Accept energy as equivalent to heat in the context of this question 2. Do not credit answers relating to energy made in respiration

7(d)	**In support** 1. Food **B** produces greater mass than control/greater than 100%; **But** 2. Error bars for **B** mean **B** could be no better / not different from control; 3. Overlap of error bars for **B** and **A**; 4. **A** no better than/not different from **B**; **Experimental limitations** 5. Experiment only ran for 10 days; 6. Experimental conditions /breed of pig may not be the same as on the farm; 7. No information about cost;	4 max	Read standard deviation as standard error 1. Must refer to control 4. Neutral: "Results not significant". Mark must compare **A** to **B**

Question	Marking guidelines	Mark	Comments
8(a)	1. Releases energy in small / manageable amounts; 2. (Broken down) in a one step / single bond broken; 3. Immediate energy compound/makes energy available rapidly; 4. Phosphorylates/adds phosphate; 5. Makes (phosphorylated substances) more reactive / lowers activation energy; 6. Reformed/made again;	4 max	1. Accept less than glucose 2. Accept easily broken down 4. Do not accept phosphorus or P on its own 6. Must relate to regeneration
8(b)	1. Substrate level phosphorylation / ATP produced in Krebs cycle; 2. Krebs cycle/link reaction produces reduced coenzyme/reduced NAD/reduced FAD; 3. Electrons released from reduced /coenzymes/ NAD/FAD; 4. (Electrons) pass along carriers/through electron transport chain/through series of redox reactions; 5. Energy released; 6. ADP/ADP + Pi; 7. Protons move into intermembrane space; 8. ATP synthase;	6 max	Accept alternatives for reduced NAD 2. Accept description of either Krebs cycle or link reaction 5. Allow this mark in context of electron transport or chemiosmosis 6. Accept H^+ or hydrogen ions and cristae 7. Allow description of movement through membrane 8. Accept ATPase. Reject stalked particles

8(c)	1. In the dark no ATP production in photosynthesis; 2. Some tissues unable to photosynthesise/produce ATP; 3. ATP cannot be moved from cell to cell/stored; 4. Plant uses more ATP than produced in photosynthesis; 5. ATP for active transport; 6. ATP for synthesis (of named substance);	5 max	1. In context of in photosynthetic tissue/leaves

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
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General Certificate of Education
Advanced Level Examination
June 2012

Biology BIOL4

Unit 4 Populations and environment

Friday 15 June 2012 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.
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- 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.
- You are expected to use a calculator where appropriate.
- 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.

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Question 1 starts on the next page

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ANSWER IN THE SPACES PROVIDED

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

1 The diagram shows the dominant plants in communities formed during a succession from bare soil to pine forest.



Time in years	1	2 – 4	5 – 24	25 – 100
	Bare field	Grassland	Shrub	Forest

Key

Crabgrass


Aster


Broomsedge


Dogwood


Pine

1 (a) Name the pioneer species shown in the diagram.

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(1 mark)

1 (b) The species that are present change during succession. Explain why.

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(2 marks)

1 (c) The pine trees in the forest have leaves all year. Explain how this results in a low species diversity of plants in the forest.

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(1 mark)

4

Turn over ▶

Do not write outside the box

2 In a species of snail, shell colour is controlled by a gene with three alleles. The shell may be brown, pink or yellow. The allele for brown, $\mathbf{C^B}$, is dominant to the other two alleles. The allele for pink, $\mathbf{C^P}$, is dominant to the allele for yellow, $\mathbf{C^Y}$.

2 (a) Explain what is meant by a *dominant* allele.

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(1 mark)

2 (b) Give **all** the genotypes which would result in a brown-shelled snail.

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(1 mark)

2 (c) A cross between two pink-shelled snails produced only pink-shelled and yellow-shelled snails. Use a genetic diagram to explain why.

(3 marks)

Do not write outside the box

2 (d) The shells of this snail may be unbanded or banded. The absence or presence of bands is controlled by a single gene with two alleles. The allele for unbanded, **B**, is dominant to the allele for banded, **b**.

A population of snails contained 51 % unbanded snails. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for this gene. Show your working.

Answer ..... %

(3 marks)

8

Turn over for the next question

Do not write outside the box

3 (a) Explain what is meant by the ecological term community.

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(1 mark)

3 (b) Scientists investigated the distribution of three species of fish in a lake. They recorded the range of depths where each species was found. The table shows their results.

Species of fish	Range of depths / m
White bass	0 to 8.4
Walleye	6.8 to 10.0
Sauger	7.2 to 14.6

3 (b) (i) Use information from the table to give the range of depths at which all three species of fish may be found living together.

Answer ..... m

(1 mark)

3 (b) (ii) Suggest and explain **one** advantage to the fish of occupying different depths in the lake.

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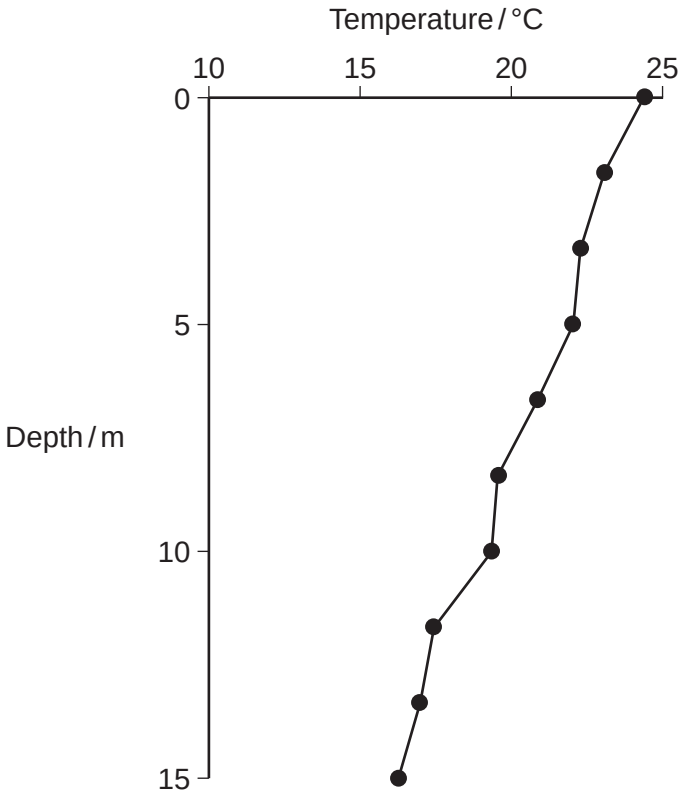
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(2 marks)

Do not write outside the box

3 (c) The graph shows the relationship between the depth and the temperature of the water in the lake.



A student concluded that the temperature of the water in the lake determined the depth at which the species of fish were found. Use the table and the graph to evaluate this conclusion.

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(3 marks)

(Extra space) .....

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7

Turn over ▶

Do not write outside the box

4 A scientist investigated the uptake of radioactively labelled carbon dioxide in chloroplasts. She used three tubes, each containing different components of chloroplasts. She measured the uptake of carbon dioxide in each of these tubes. Her results are shown in the table.

Tube	Contents of tube	Uptake of radioactively labelled CO_2 / counts per minute
A	Stroma and grana	96 000
B	Stroma, ATP and reduced NADP	97 000
C	Stroma	4 000

4 (a) Name the substance which combines with carbon dioxide in a chloroplast.

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(1 mark)

4 (b) Explain why the results in tube **B** are similar to those in tube **A**.

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(1 mark)

4 (c) Use the information in the table to predict the uptake of radioactively labelled carbon dioxide if tube **A** was placed in the dark. Explain your answer.

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(2 marks)

Do not write outside the box

4 (d) Use your knowledge of the light-independent reaction to explain why the uptake of carbon dioxide in tube **C** was less than the uptake in tube **B**.

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(2 marks)

4 (e) DCMU is used as a weed killer. It inhibits electron transfer during photosynthesis. The addition of DCMU to tube **A** decreased the uptake of carbon dioxide. Explain why.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

5 (a) Insect pests of crop plants can be controlled by chemical pesticides or biological agents.
Give **two** advantages of using biological agents.

1 .....

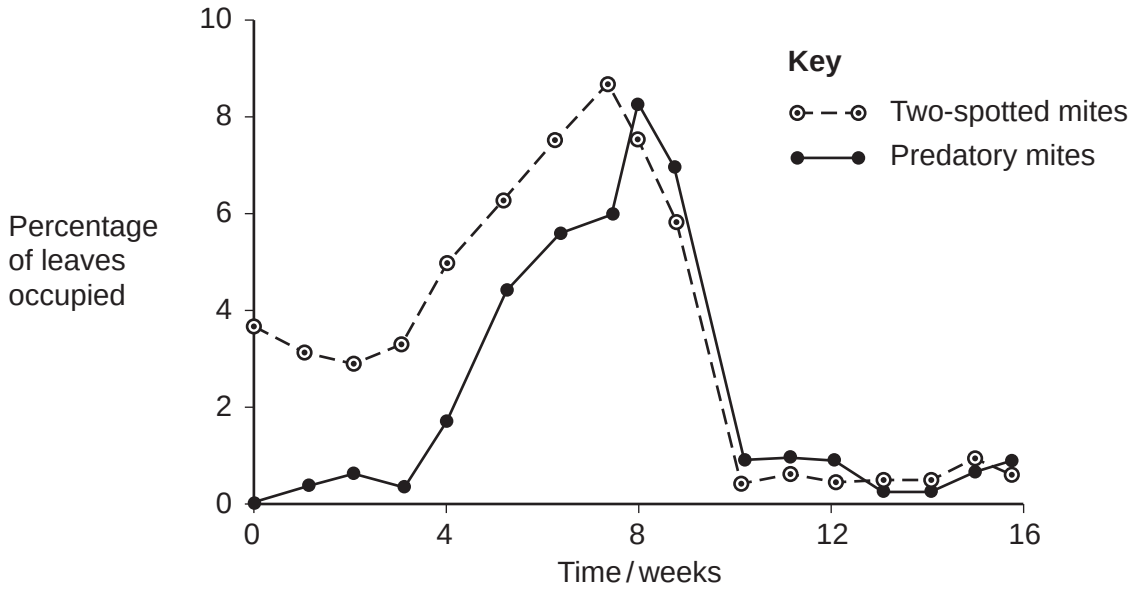
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2 .....

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(2 marks)

Two-spotted mites are pests of strawberry plants. Ecologists investigated the use of predatory mites to control two-spotted mites. They released predatory mites on strawberry plants infested with two-spotted mites. They then recorded the percentage of strawberry leaves occupied by two-spotted mites and by predatory mites over a 16-week period. The results are shown on the graph.



5 (b) Describe how the percentage of leaves occupied by predatory mites changed during the period of this investigation.

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(2 marks)

Do not write outside the box

5 (c) The ecologists concluded that in this investigation control of the two-spotted mite by a biological agent was effective. Explain how the results support this conclusion.

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(2 marks)

5 (d) Farmers who grow strawberry plants and read about this investigation might decide **not** to use these predatory mites. Suggest **two** reasons why.

1 .....

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2 .....

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(2 marks)

5 (e) The ecologists repeated the investigation but sprayed chemical pesticide on the strawberry plants after 10 weeks. After 16 weeks no predatory mites were found but the population of two-spotted mites had risen significantly. Suggest an explanation for the rise in the two-spotted mite population.

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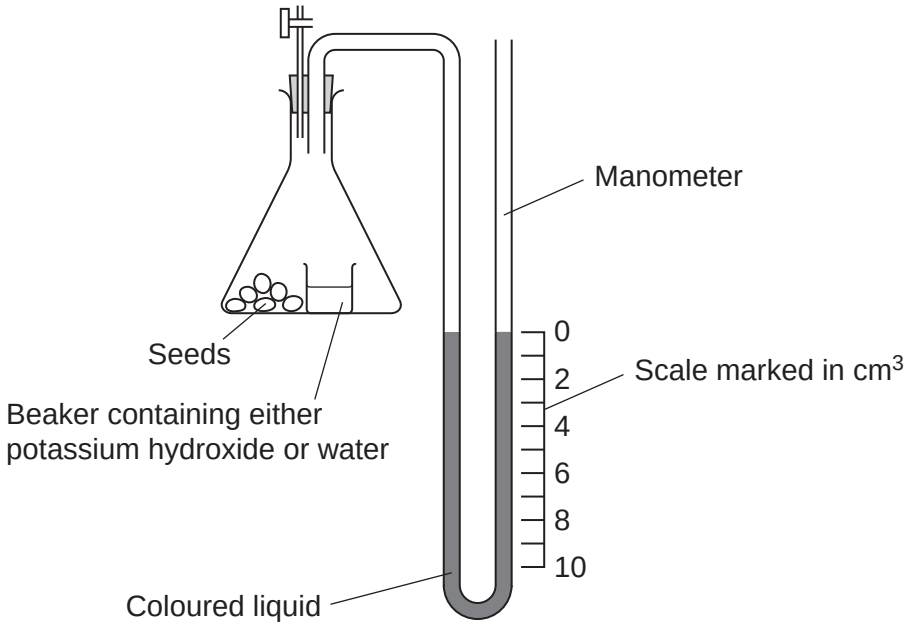
(2 marks)

10

Do not write outside the box

6 A student investigated the rate of gas exchange in aerobically respiring seeds using the apparatus shown in the diagram. She carried out two experiments.

- In Experiment **1**, she put potassium hydroxide solution in the beaker. Potassium hydroxide solution absorbs carbon dioxide.
- In Experiment **2**, she put water in the beaker.



6 (a) Both experiments were carried out at the same temperature. Explain why.

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(2 marks)

6 (b) (i) The level of coloured liquid in the right-hand side of the manometer tube went down during Experiment **1**. Explain why.

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(3 marks)

Do not write outside the box

(Extra space) .....

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The results from both experiments are shown in the table.

Experiment	Solution in beaker	Fall in volume of coloured liquid in right-hand side of manometer / cm^3
1	Potassium hydroxide	5
2	Water	1

6 (b) (ii) Use these results to calculate the volume of carbon dioxide produced during Experiment **1**.

Answer = ... cm^3

(1 mark)

6 (c) The student repeated Experiment **1** using seeds which were respiring anaerobically. What would happen to the level of coloured liquid in the right-hand side of the manometer tube? Explain your answer.

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(2 marks)

8

Do not write outside the box

7 Biofuels are fuels which can be produced from plants. Scientists have developed a standard method called net life-cycle carbon dioxide production (NLP) to find the overall effect of producing and using particular biofuels on carbon dioxide production.

7 (a) Petroleum is used as a comparison when evaluating NLPs of biofuels. Suggest **two** reasons why.

1 .....

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2 .....

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(2 marks)

7 (b) Biofuels are produced by a variety of different companies. The scientists who developed the method of calculating NLPs are funded by the government's environmental agency.
Suggest **two** advantages of this method being developed by these scientists.

1 .....

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2 .....

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(2 marks)

Do not write outside the box

Scientists compared the percentage change in carbon dioxide production if different biofuels replaced petroleum. Their results are shown in the table.

Biofuel	Percentage change in carbon dioxide production if this fuel replaced petroleum
Corn ethanol	–18
Soy-based biodiesel	+4
Switch-grass ethanol	–124
Sugar-cane ethanol	–26

7 (c) (i) The scientists suggested that using biofuels would have a great effect on limiting climate change. Use the data in the table to evaluate this suggestion.

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(4 marks)

(*Extra space)* .....

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Question 7 continues on the next page

Do not write outside the box

7 (c) (ii) Producing and using biofuels from corn ethanol results in a negative percentage change in carbon dioxide production. Explain why.

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(2 marks)

7 (d) Ethanol can be produced from cellulose. It is produced by anaerobic respiration of cellulose-based biomass by microorganisms. The cellulose is pre-treated by adding cellulose-digesting enzymes before it is used in anaerobic respiration. Suggest why pre-treatment is necessary.

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(3 marks)

(Extra space) .....

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7 (e) Large areas of land have to be used to grow the plants to make biofuels. Ecologists have suggested that changes in land use could lead to a decrease in biodiversity. Suggest how changes in land use could lead to a decrease in biodiversity.

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(2 marks)

15

Do not write outside the box

8 (a) Explain how farming practices increase the productivity of agricultural crops.

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(5 marks)

(Extra space) .....

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Question 8 continues on the next page

Do not write outside the box

8 (b) Describe how the action of microorganisms in the soil produces a source of nitrates for crop plants.

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(5 marks)

(Extra space) .....

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Do not write outside the box

8 (c) Explain how the use of pesticides can result in resistant strains of insect pests.

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(5 marks)

(Extra space) .....

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15

END OF QUESTIONS

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General Certificate of Education (A-level)
June 2012

Biology **BIOL4**

(Specification 2410)

Unit 4: Populations and Environment

Post-Standardisation

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidelines	Mark	Comments
1(a)	Crabgrass;	1	Reject: grass or grassland Reject: crabgrass if another organism is also included
1(b)	1. Species/plants/animals change the environment/conditions/add humus/nutrients etc.; 2. Less hostile (habitat); 3. Species/plants better competitors;	2 max	Accept 'they' for species/plants in mark points 1 and 3 Allow 'more hospitable' or equivalent for mark point 2
1(c)	(Only) plants which can photosynthesise with less light (remain);	1	Accept converse but do not award mark for idea that plants cannot photosynthesise and die because there is no light Answers must be in context of being or not being able to photosynthesise with less light

Question	Marking Guidelines	Mark	Comments
2(a)	Is always expressed/shown (in the phenotype);	1	Reject 'is always present' without further qualification
2(b)	C^BC^B, C^BC^P and C^BC^Y; Or C^BC^B, C^PC^B and C^YC^B;	1	All three are required for the mark Accept C^BC^B, C^BC^P, C^BC^Y, C^YC^B and C^PC^B Accept BB, BP and BY or BB, BP, BY, YB and PB
2(c)	1. Two genotypes (as parents) shown as C^P C^Y Or Two sets of gametes shown as C^P and C^Y; 2. Genotypes of offspring shown as C^P C^Y, C^P C^P and C^Y C^Y; 3. Above genotypes of offspring correctly linked to phenotypes i.e. pink and yellow;	3	Award **one mark maximum** for candidates who have misread the question and complete a correct genetic cross between a pink snail, C^PC^Y and a yellow snail, C^YC^Y to give pink and yellow offspring Accept ratio (or equivalent) of 3 pink: 1 yellow for mark point 3
2(d)	1. Correct answer of 42%;;; = 3 marks 2. q^2 = 0.49/49% ***OR*** q = 0.7/70%; 3. Shows understanding that 2pq = heterozygotes / carriers / shows answer is derived from 2pq;	3	Answer of 0.42 = 2 marks Award **one mark maximum** for answer of 49.9/49.98/50% or 0.49/0.5 Award **one mark maximum** for answer of 40.8/41% or 0.41 Accept: b^2 = 0.49/49% or b = 0.7/70% for mark point 2

Question	Marking Guidelines	Mark	Comments
3(a)	All/group of species / all/group of populations / all the organisms;	1	Accept equivalent terms for group. Answers which only refer to organisms must have idea of **all** the organisms not just a group of organisms Reject answers which include 'environment' or abiotic factors as part of the definition
3(b)(i)	7.2 – 8.4 (metres);	1	Accept answer of 1.2
3(b)(ii)	1. Food / prey / oxygen; 2. Less/no competition;	2	Do not accept 'resource' for mark point 1 unless this is qualified as food/prey/oxygen Reference to light and CO_2 as a resource negates mark point 2 Ignore intraspecific/interspecific for mark point 2
3(c)	1. Increase in depth linked to decrease in temperature / decrease in depth linked to increase in temperature; 2. Correlation/relationship between temperature and fish distribution does not indicate a causal effect; 3. Overlap in ranges / different fish/species occupy same depth; 4. Other abiotic/biotic/named factor involved;	3 max	Accept increase or decrease in temperature is related to 'higher depth' or 'lower depth due to ambiguity of these terms Ignore any reference to correlation unless it is clearly in context of temperature and fish distribution Temperature does not determine fish distribution is not sufficient for idea of causal effect Reject: 'casual' for mark point 2 Reject 'other factors' for mark point 4 unless further qualified

Question	Marking Guidelines	Mark	Comments
4(a)	Ribulose bisphosphate/RuBP;	1	Accept Ribulose biphosphate or Ribulose diphosphate Accept phonetic spellings Accept any variation in upper or lower case for RuBP
4(b)	ATP and reduced NADP are produced in grana/thylakoids/ present in A/both tubes;	1	Must be reduced NADP but accept any alternative which show hydrogen attached to NADP Must be reduced NADP not reduced NAD
4(c)	1. 4 000; 2. Light-dependent reaction does not occur /ATP and reduced NADP are not produced;	2	Accept 'same as in (tube) C', but not 'same' on its own Accept converse for mark point 2
4(d)	1. (Less) GP converted to TP; 2. (Less) TP converted to RuBP;	2	GP = glycerate 3-phosphate TP = triose phosphate but abbreviations are sufficient Accept GALP as TP
4(e)	1. No/less ATP / ATP produced (during electron transport); 2. No/less reduced NADP / reduced NADP produced (during electron transport);	2	Must be reduced NADP but accept any alternative which shows hydrogen attached to NADP

Question	Marking Guidelines	Mark	Comments
5(a)	1. Specific (to one pest); 2. Only needs one application/ reproduces; 3. Keeps population low; 4. Pests do not develop resistance; 5. Does not leave chemical in environment/on crop / no bioaccumulation; 6. Can be used in organic farming;	2 max	Ignore reference to leaching or eutrophication Reference to immunity disqualifies mark point 4
5(b)	1. Increases, rapid decrease, constant/level/fluctuates; 2. Accept any one of increases at 3/4 weeks / increases to 8 weeks / peaks at 8 weeks / levels at 10 weeks;	2	Allow equivalent terms for description of the three main changes described in mark point 1 Ignore any reference to initial decrease Allow steep decrease as equivalent to rapid decrease in mark point 1 but reject large/significant decrease unless further qualified Accept any one of following for mark point 2 Increases to any value between 8 and 9% / peaks at any value between 8 and 9% / decreases to any % below 2%
5(c)	1. Decrease number of pests / (two-spotted) mite / decrease in % (of leaves occupied); 2. Remains at low numbers / remains below 2%;	2	Accept any % below 2% for mark point 2

5(d)	1. Cost of treatment/biological control; 2. Takes (a long) time to act; 3. Pest/two-spotted mite is not completely removed; 4. May become a pest/damage/eat crop;	2 max	
5(e)	1. Pesticide kills predatory mites / other predators / two-spotted mites are <u>resistant</u>; 2. Two-spotted mite reproduces;	2	Accept breed/multiply for mark point 2

Question	Marking Guidelines	Mark	Comments
6(a)	1. Affects <u>enzymes</u>; 2. Affects respiration; <u>Or</u> 3. Affects volume/pressure of gases; 4. Affects readings;	2 max	'respiration involves enzymes' = two marks Ignore reference to controlling a variable Mark point 4 can only be awarded if mark point 3 has been credited
6(b)(i)	1. <u>Oxygen</u> taken up/used (by seeds); 2. <u>Carbon dioxide</u> (given out) is absorbed by solution/potassium hydroxide; 3. Decrease in volume / pressure (inside flask);	3	Reject air is taken up for mark point 1 Reference to vacuum negates mark point 3
6(b)(ii)	4;	1	
6(c)	1. Remains the same; 2. No oxygen uptake/used;	2	Any reference to 'carbon dioxide **not** being produced' disqualifies mark point 2

Question	Marking Guidelines	Mark	Comments
7(a)	1. Is widely/commonly used; 2. Provides a standard/benchmark/reference; 3. Produces large amount of carbon dioxide; 4. Is a decreasing resource / could be replaced by biofuel;	2 max	Allow a variety of descriptors for marking point 2 e.g. 'provides a base line', 'produces known amount of carbon dioxide' Mark point 2, do not accept 'for comparison' on its own as 'comparison' is in stem of question Ignore reference to a control
7(b)	1. Independent / no bias / trustworthy; 2. Non-profit making; 3. (Focused on) effect on environment/climate;	2 max	
7(c)(i)	1. Most/3 biofuels show reduction in CO_2/negative % change in CO_2; 2. (But) soy-based biodiesel is positive/ shows an increase in CO_2; 3. CO_2 is a greenhouse gas; 4. Global warming (affected); 5. Other 'greenhouse gases'/ methane/nitrous oxide/water vapour etc. (affect climate);	4 max	Allow reference to figures for mark points 1 and 2 Must show that so-based biodiesel is positive or increases rather than simply 'it doesn't decrease'
7(c)(ii)	1. CO_2 taken up in <u>photosynthesis</u>; 2. More taken up than produced (when it is used); 3. Less CO_2 produced than petrol;	2 max	

7(d)	1. (These microorganisms) don't have (cellulose-digesting) enzymes; 2. (Cellulose) is a polysaccharide/polymer/long (molecule/chain); 3. (Cellulose) is insoluble / glucose/product of digestion is soluble; 4. Broken down into glucose/monomers /monosaccharides; 5. Sugars/glucose used in glycolysis / glucose can be converted to pyruvate; 6. Produces more ethanol/fuel produces ethanol/fuel quicker;	3 max	Accept 'don't make enough of these enzymes' for mark point 1 Accept' large' for mark point 2 Ignore (alpha) glucose for mark point 4. Do not accept sugars for mark point 4 Accept 'speeds up process' for mark point 6
7(e)	1. Removes species / fewer species / growth of single crop / single plant species / monoculture; 2. Removes habitats / fewer habitats/niches /only one habitat; 3. Removes variety of food sources / fewer food sources / only one food source;	2 max	Deforestation or removal of hedges on its own should not be credited

Question	Marking Guidelines	Mark	Comments
8(a)	1. Fertilisers/minerals/named ion (added to soil); 2. Role of named nutrient or element e.g. nitrate/nitrogen for proteins / phosphate/phosphorus for ATP/DNA; 3. Pesticides/biological control prevents damage/consumption of crop; 4. Pesticides/weed killers /herbicides/weeding remove competition; 5. Selective breeding / genetic modification (of crops); 6. Glass/greenhouses enhance temp/CO_2/ light; 7. Ploughing aerates soil/improves drainage; 8. Ploughing/aeration allows nitrification/decreases denitrification; 9. Benefit of crop rotation in terms of soil nutrients/fertility/pest reduction; 10. Irrigation/watering to remove limiting factor; 11. Protection of crops from birds/pests/frost by covers/netting etc.;	5 max	Accept any named examples of natural fertilisers for mark point 1 e.g. manure, bone meal etc. Ignore named elements Accept fertilisers/minerals/ named nutrient/element removes limiting factor for mark point 2 Accept any type of pesticide e.g. fungicides for mark point 3 Accept seeding method reduces competition for mark point 4 Accept idea of choosing particular variety of crop for mark point 5 Allow rotivation, harrowing, hoeing as alternatives terms for ploughing in mark points 7 and 8 Accept addition of organic material (mark point 1) improves soil structure/drainage or effect of lime on pH for mark point 7 Accept activity/number of nitrifying bacteria increased / denitrifying bacteria decreased in mark point 8. Ignore nitrogen fixation

8(b)	1. Protein/amino acids/DNA into ammonium compounds / ammonia; 2. By saprobionts; 3. Ammonium/ammonia into nitrite; 4. Nitrite into nitrate; 5. By nitrifying bacteria/microorganisms; 6. Nitrogen to ammonia/ammonium; 7. By nitrogen-fixing bacteria/microorganisms in soil;	5 max	Accept any named nitrogen containing compound e.g. urea for mark point 1 Accept saprophytes for mark point 2 Accept marks for conversion i.e. mark points 1, 3, 4 and 6 even if incorrect type of bacteria named as being involved However, reject marks for type of bacteria i.e. mark points 2, 5 and 7 if linked to incorrect process e.g. nitrite converted to nitrate by saprobionts Award one mark for ammonia/ammonium into nitrate if neither mark point 3 or 4 awarded Ignore reference to nitrogen-fixing bacteria in root nodules. If not specified, assume nitrogen-fixing bacteria are in the soil
8(c)	1. Variation/variety in pest population; 2. Due to mutation; 3. Allele for resistance; 4. Reference to selection; 5. Pests with resistance (survive and) breed / differential reproductive success; 6. Increase in frequency of allele;	5 max	Reference to 'immune' negates mark point 3 or 5 but not both Ignore 'vertical gene transmission' Must be increase in frequency of allele for mark point 6 do not credit answers which only refer to 'change'

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

General Certificate of Education
Advanced Level Examination
January 2011

Biology BIOL4

Unit 4 Populations and environment

Monday 24 January 2011 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.
- 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) Explain what is meant by the ecological term population.

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(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**).

Use all the letters **B**, **D**, **E** and **I** to write a formula showing

1 (b) (i) a population that stays the same size

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(1 mark)

1 (b) (ii) a population that is increasing in size.

.....

(1 mark)

Do not write outside the box

1 (c) The table shows some features relating to the human population of Mexico in 2007.

Feature	
Total population / millions	107
Birth rate per 1000 population	20
Death rate per 1000 population	5
Life expectancy / years	76

1 (c) (i) In 1990 the life expectancy was 70 years. Suggest **one** reason for the change in life expectancy since 1990.

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(1 mark)

1 (c) (ii) Use the information in the table to calculate the size of the population of Mexico in 2008. Show your working.

Answer .....

(2 marks)

6

Turn over for the next question

Do not write outside the box

2 (a) (i) Explain what is meant by a **recessive** allele.

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(1 mark)

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

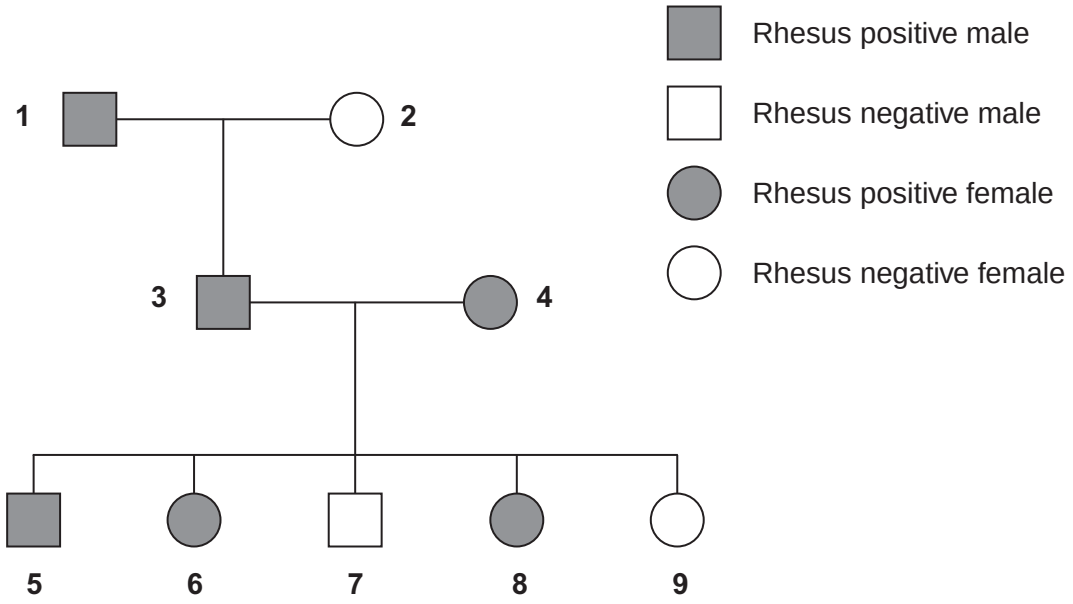
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(1 mark)

2 (b) The Rhesus blood group is genetically controlled. The gene for the Rhesus blood group has two alleles. The allele for Rhesus positive, **R**, is dominant to that for Rhesus negative, **r**. The diagram shows the inheritance of the Rhesus blood group in one family.



Do not write outside the box

2 (b) (i) Explain **one** piece of evidence from the diagram which shows that the allele for Rhesus positive is dominant.

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(2 marks)

2 (b) (ii) Explain **one** piece of evidence from the diagram which shows that the gene is **not** on the X chromosome.

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(2 marks)

2 (c) Sixteen percent of the population of Europe is Rhesus negative. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for the Rhesus gene.
Show your working.

Answer .....

(3 marks)

9

Do not write outside the box

3 Urea from animal waste can be used as a fertiliser. Some bacteria in the soil secrete the enzyme urease which hydrolyses urea into ammonia. Some of this ammonia is released into the atmosphere. NBPT is an inhibitor of urease and can be added to urea fertiliser to reduce the loss of ammonia to the atmosphere.

3 (a) A molecule of NBPT has a similar structure to a molecule of urea. Use this information to suggest how NBPT inhibits the enzyme urease.

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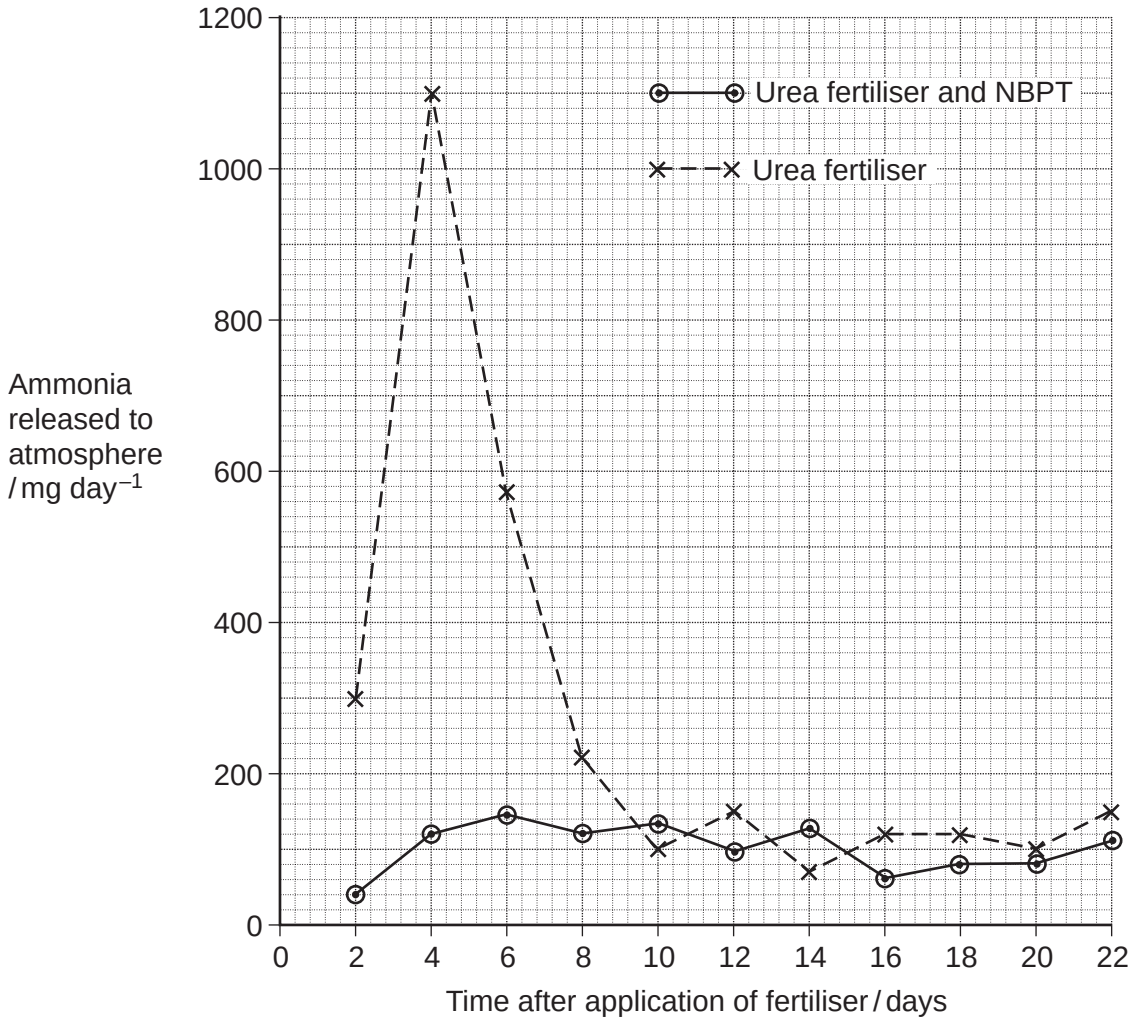
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(2 marks)

Scientists investigated the effect of NBPT on the release of ammonia from urea fertiliser added to the soil. A control experiment was carried out. This involved adding urea fertiliser only. The graph shows their results.



Do not write outside the box

3 (b) (i) Describe how NBPT affected the loss of ammonia from urea fertiliser.

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(1 mark)

3 (b) (ii) Suggest an explanation for the increase in mass of ammonia released over the first four days in the control experiment.

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(2 marks)

3 (c) Suggest how the addition of NBPT to urea fertiliser could result in increased growth of crop plants.

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(3 marks)

(Extra space) .....

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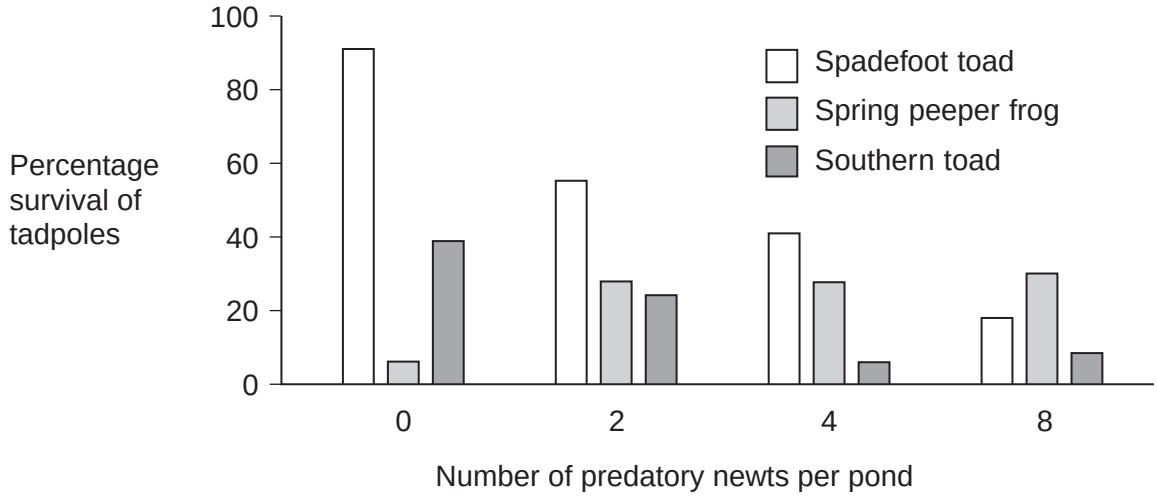
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4 The young of frogs and toads are called tadpoles. Ecologists investigated the effect of predation on three species of tadpole. They set up four artificial pond communities. Each community contained

- 200 spadefoot toad tadpoles
- 300 spring peeper frog tadpoles
- 300 southern toad tadpoles.

The ecologists then added a different number of newts to each pond. Newts are predators. **Figure 1** shows the effect of increasing the number of newts on the percentage survival of the tadpoles of each species.

Figure 1



4 (a) (i) Describe the effect of an increase in the number of newts on the percentage survival of the tadpoles of each of the **toad** species.

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(2 marks)

Do not write outside the box

4 (a) (ii) Suggest an explanation for the effect of an increase in the number of newts on the percentage survival of the tadpoles of spring peeper frogs.

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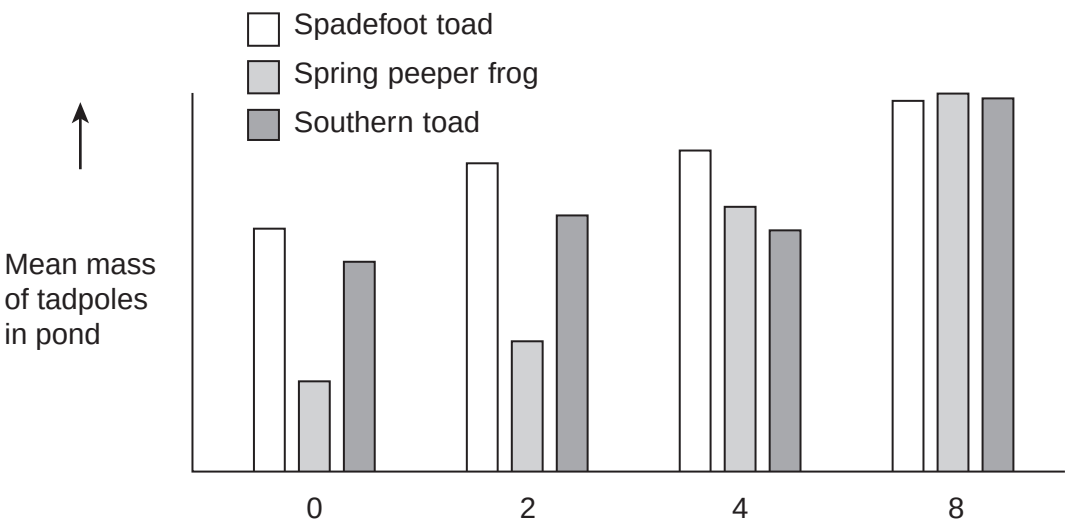
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(2 marks)

Figure 2 shows how the masses of the tadpoles were affected in each pond during the investigation.

Figure 2



4 (b) Using the information provided in **Figure 1** explain the results obtained in **Figure 2**.

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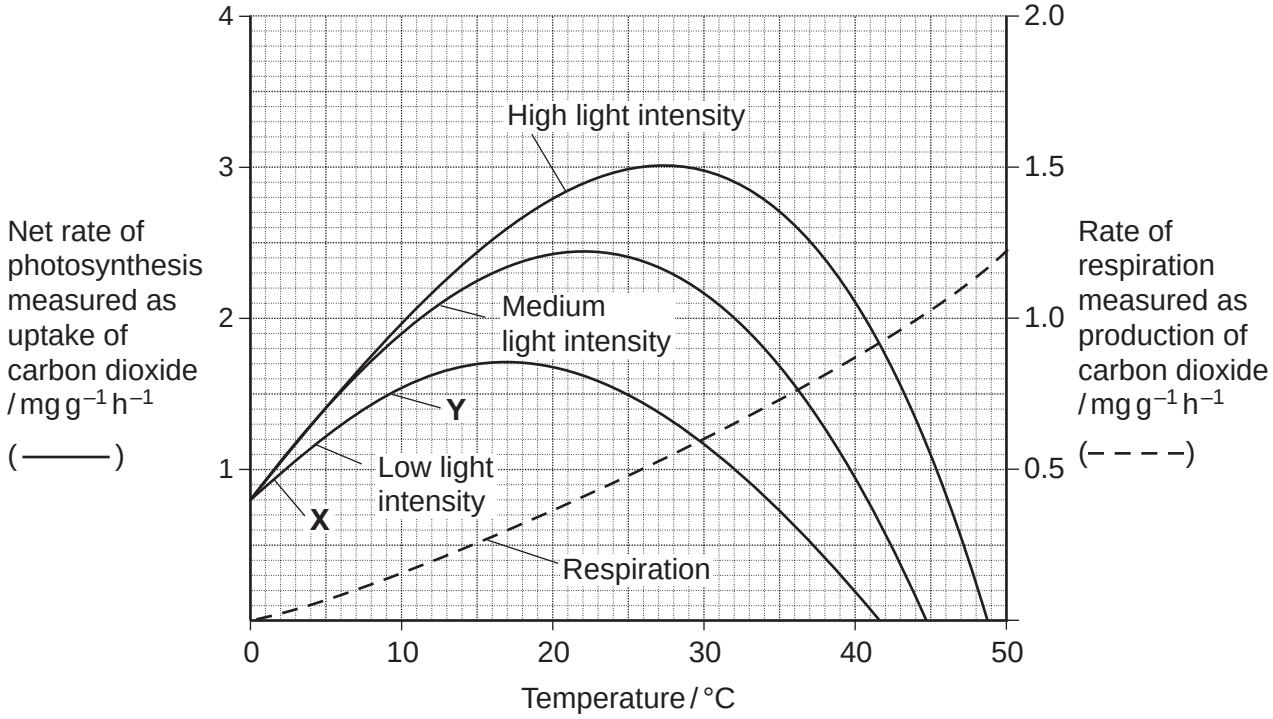
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(2 marks)

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5 Scientists investigated the effects of temperature and light intensity on the rate of photosynthesis in creeping azalea. They investigated the effect of temperature on the net rate of photosynthesis at three different light intensities. They also investigated the effect of temperature on the rate of respiration. The graph shows the results.



5 (a) (i) Name the factors that limited the rate of photosynthesis between **X** and **Y**.

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(1 mark)

5 (a) (ii) Use information from the graph to explain your answer.

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(2 marks)

Do not write outside the box

5 (b) Use information from the graph to find the gross rate of photosynthesis at 20°C and medium light intensity.

Answer .....

(1 mark)

5 (c) Creeping azalea is a plant which grows on mountains. Scientists predict that in the area where this plant grows the mean summer temperature is likely to rise from 20°C to 23°C. It is also likely to become much cloudier. Describe and explain how these changes are likely to affect the growth of creeping azalea.

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(3 marks)

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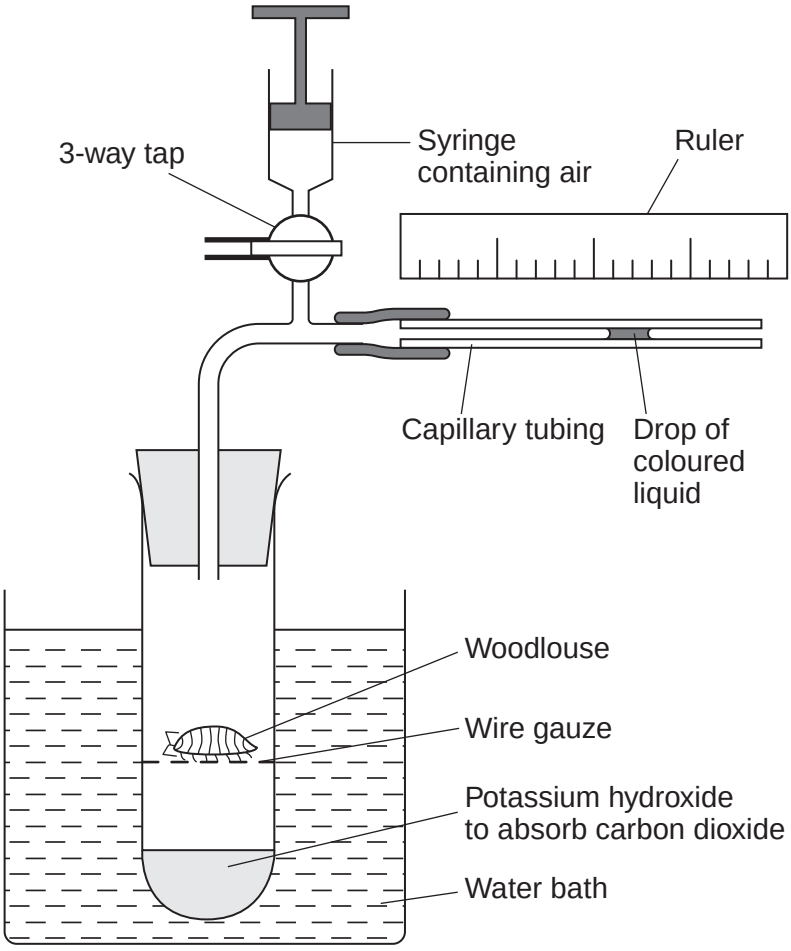
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7

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



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.

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(3 marks)

(Extra space) .....

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Do not write outside the box

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}?

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(3 marks)

(Extra space) .....

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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.

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(3 marks)

(Extra space) .....

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Do not write outside the box

7 Residual food intake (RFI) is the difference between the amount of food an animal actually eats and its expected food intake based on its size and growth rate. Scientists have selectively bred cattle for low RFI.

7 (a) (i) Explain the advantage to farmers of having cattle with a low RFI.

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(2 marks)

7 (a) (ii) When RFI is calculated, low values are negative. Explain why they are negative.

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(1 mark)

7 (b) Scientists have developed a standard procedure for comparing RFI in cattle. They control **two** factors. These are type of food and environmental temperature. Explain why each of these factors needs to be controlled.

Type of food

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Environmental temperature

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(4 marks)

Do not write outside the box

7 (c) Bacteria in the digestive systems of cattle break down food and produce methane. Scientists investigated the relationship between RFI and methane production. They measured the rate of methane production of 76 cattle over a fifteen-day period. Some of the results are shown in **Figure 3**.

Figure 3

	Low RFI	High RFI
Mean rate of methane production / g day^{-1}	142.3	190.2

7 (c) (i) Suggest a null hypothesis for this investigation.

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(1 mark)

7 (c) (ii) Selectively breeding cattle with a low RFI may help to limit global warming. Use the information in **Figure 3** to explain how.

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(2 marks)

Question 7 continues on the next page

Do not write outside the box

7 (d) Other scientists investigated the release of methane from rice fields. They investigated the effect of adding organic material (straw) and inorganic substances on the release of methane from rice fields. The results are shown in **Figure 4**.

Figure 4

Inorganic substance added to soil	Total methane released over 30 days / μmol kg^{-1} soil	
	Without straw	With straw
None	1179	25 492
Nitrate	63	764
Sulfate	19	144
Iron oxide	39	313
Manganese oxide	53	475

7 (d) (i) Which treatment is most effective in reducing release of methane from rice fields?

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(1 mark)

7 (d) (ii) Research findings are not always of direct use to farmers. What else would rice farmers need to know before acting on the results of this investigation?

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(2 marks)

7 (d) (iii) Methane is produced by anaerobic microorganisms in the soil. The scientists found that rice fields that are not flooded do not produce large amounts of methane. Suggest why.

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(2 marks)

15

Do not write outside the box

8 (a) Succession occurs in natural ecosystems. Describe and explain how succession occurs.

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Question 8 continues on the next page

Do not write outside the box

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.

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(5 marks)

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8 (c) Changes in ecosystems can lead to speciation. In Southern California 10 000 years ago a number of interconnecting lakes contained a single species of pupfish. Increasing temperatures caused evaporation and the formation of separate, smaller lakes and streams. This led to the formation of a number of different species of pupfish. Explain how these different species evolved.

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15

END OF QUESTIONS

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Version 1.0



General Certificate of Education (A-level)
January 2011

Biology BIOL4

(Specification 2410)

Unit 4: Populations and Environment

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidance	Mark	Comments
1(a)	(Number of) organisms of one species in a habitat / same place;	1	
1(b)(i)	B + I = D + E **/** (B + I) – (D + E) = 0 **/** / (B - D) +(I - E) = 0;	1	Allow word equations.
1(b)(ii)	B + I > D + E **/** (B - D) +(I - E) > 0 / / (B + I) - (D + E) > 0;	1	
1(c)(i)	Improved medical care / improved nutrition / improved sanitation/water treatment / lower infection rates / less disease;	1	Allow any specific examples of improved health or medical care e.g. vaccinations, health education
1(c)(ii)	Correct answer of 108 605 000 = 2 marks;; 107 000 x 15 / 107 million x 0.015 **/** 1605 000 / (deaths) 535 000 and (births) 2140 000;	2	

Question	Marking Guidance	Mark	Comments
2(a)(i)	Only expressed/shown (in the phenotype) when homozygous / two (alleles) are present / when no dominant allele / is not expressed when heterozygous;	1	
2(a)(ii)	Both alleles are expressed/shown (in the phenotype);	1	Allow both alleles contribute (to the phenotype).
2(b)(i)	Evidence (not a mark) 3 and 4 / two Rhesus positives produce Rhesus negative child/children / 7 / 9; Explanation (not a mark) Both Rhesus positives/3 and 4 carry recessive (allele)/ are heterozygous / if Rhesus positive was recessive, all children (of 3 and 4) would be Rhesus positive/recessive;	2	Do not negate mark if candidate refers to gene rather than allele. Answers including correct and incorrect evidence = zero marks evidence and explanation.

2(b)(ii)	Evidence (not a mark) 3 would not be/is Rhesus positive / would be Rhesus negative; Explanation (not a mark) 3 would receive Rhesus negative (allele) on X (chromosome) from mother / 3 could not receive Rhesus positive (allele) from mother / 3 would not receive Rhesus positive (allele)/X (chromosome) from father/1 / 3 will receive Y (chromosome) from father/1; ***OR*** Evidence (not a mark) 9 would be Rhesus positive / would not be/is Rhesus negative / 8 and 9/all daughters of 3 and 4 would be Rhesus positive; Explanation (not a mark) As 9 would receive X chromosome/dominant allele from father/3;	2	Do not negate mark if candidate refers to gene rather than allele. One mark for evidence and one mark for explanation linked to this evidence. Any reference to allele being on Y chromosome negates mark for explanation.
2(c)	Correct answer of 48(%) = 3 marks;;; q^2/ p^2= 16%/0.16 / p/q = 0.4; Shows that 2pq = heterozygotes / carriers;	3	Final answer of 0.48 = 2 marks Allow mark for identifying heterozygotes if candidate multiplies incorrect p and q values by 2.

Question	Marking Guidance	Mark	Comments
3(a)	Complementary to / fits / binds to active site; Competitive / competes / 'prevents' enzyme-substrate complexes / 'prevents' urea attaching;	2	Max one mark if candidate suggests that active site/enzyme is damaged destroyed or useless. Allow inhibitor 'prevents' or 'stops' urea/substrate attaching unless candidate clearly indicates this is permanent. Ignore reference to inhibitor forming an enzyme/substrate complex.
3(b)(i)	Reduces loss of ammonia up to day8/9;	1	
3(b)(ii)	Increase in urease / temperature; More enzyme-substrate complexes; More bacteria;	2max	
3(c)	Less urea/ammonia lost (from soil) / less urea broken down; Urea/ammonia converted to nitrite/nitrate; Used to produce protein / amino acids / DNA / bases / nucleotides;	3	Reference to incorrect bacteria (e.g. denitrifying) producing nitrite/nitrate negates second marking point.

Question	Marking Guidance	Mark	Comments
4(a)(i)	Decrease in spadefoot toad; Decrease in southern toad up to 4 newts per pond, then increase (at 8 newts per pond);	2	Allow one mark for answers stating decrease in both toad species;
4(a)(ii)	Predators/newts eat/feed/prey on toad (tadpoles); Less competition more food/resources / fewer toads feeding on frogs;	2	Allow first mark if reference is made to either toad species being eaten. For first mark candidate must clearly indicate that the newts are feeding on the toads. Answers simply stating that newts are increasing and toads are decreasing are not sufficient.
4(b)	Fewer toads/tadpoles (as number of predators increases in Figure 1); More food, so are larger / grow more / increase in mass;	2	If candidate clearly indicates fewer frog tadpoles survive, negate the first marking point. However, accept decrease in overall number of tadpoles which may include frog tadpoles.

Question	Marking Guidance	Mark	Comments
5(a)(i)	Temperature and light;	1	
5(a)(ii)	Increase in temperature causes increase in rate of photosynthesis / uptake of carbon dioxide; Increase in light/ more/medium/high light (intensity) causes increase in rate of photosynthesis / uptake of carbon dioxide;	2	
5(b)	2.75 - 2.81 (mg g^{-1} hr^{-1})	1	Accept answers in range 2.75 - 2.81;
5(c)	1. Growth will decrease (at higher temperature); 2. Rate of respiration will increase at higher temperature; 3. Photosynthesis decreases as limited by light/ as there is less light;	3	Ignore references to effect of temperature on rate of photosynthesis;

Question	Marking Guidance	Mark	Comments
6(a)(i)	1. Oxygen taken up/used (by woodlouse); 2. Carbon dioxide (given out) is absorbed by solution/potassium hydroxide; 3. Decrease/change in pressure;	3	Reference to vacuum negates last marking point; Reject reference to pressure increasing inside tube.
6(a)(ii)	1. Distance (drop moves) and time; 2. Mass of woodlouse; 3. Diameter/radius/bore of tubing/lumen / cross-sectional area;	3	If answer refers to measuring volume using the syringe allow 2 max – one mark for measuring volume; one mark for mass of woodlouse;
6(b)	1. Less/no proton/H^+ movement so less/no ATP produced; 2. Heat released from electron transport/redox reactions / / energy not used to produce ATP is released as heat; 3. Oxygen used as final electron acceptor/combines with electrons (and protons);	3	

Question	Marking Guidance	Mark	Comments
7(a)(i)	Reduced cost; Less feed / less land use / more growth rate with same amount of food;	2	Allow is 'cost effective'
7(a)(ii)	Amount of food taken in less than expected.	1	Allow 'expected food intake is higher, Allow 'food intake is lower than it should be'
7(b)	<u>Type of food</u> (not a mark) 1. May vary in protein/fat/carbohydrate/fibre/roughage/ vitamins/minerals; 2. May affect absorption / digestibility / energy value / tastiness / growth / overall food intake; <u>Temperature</u> (not a mark) 3. Will affect <u>heat</u> loss/gain/respiration/metabolism; 4. (Need) to maintain/regulate body temperature; 5. More food/energy can be used for growth;	4 max	For mark point 1 allow appropriately named food compound e.g. cellulose, glucose For mark point 2 it must be clear that these factors are affected by the type of food. Note: two maximum marks for effect of temperature.
7(c)(i)	RFI does not affect methane production / There is no difference in the rate of methane production for low and high RFI values / The difference between the rates of methane production is due to chance / No correlation/relationship/link between RFI and methane production;	1	Any clear statement that there is no link between RFI and methane production should be credited.

7(c)(ii)	(Cattle with low RFI) produce less methane; Methane linked to greenhouse effect;	2	
7(d)(i)	Sulfate without straw;	1	
7(d)(ii)	1. May affect yield / damages rice crop; 2. Substance/treatment may affect other organisms/ environment; 3. Cost of substance/application/labour; 4. Method/frequency/timing of application / amount of substance required;	2 max	
7(d)(iii)	Not flooded aerobic conditions/more oxygen / with flooding anaerobic conditions/less oxygen; Not flooded fewer/less active anaerobic microorganisms/respiration / not flooded more/more active aerobic microorganisms/respiration;	2	

Question	Marking Guidance	Mark	Comments
8(a)	1. (Colonisation by) pioneer (species); 2. Change in environment / example of change caused by organisms present; 3. Enables other species to colonise/survive; 4. Change in diversity/biodiversity; 5. Stability increases / less hostile environment; 6. Climax community;	5 max	Example of change e.g. formation of soil/humus/ organic matter / increase in nutrients; Do not accept genetic diversity for mark point 4.
8(b)	Advantages 1. Specific (to one pest); 2. Only needs one application/ reproduces; 3. Keeps/maintains low population; 4. Pests do not develop resistance; 5. Does not leave chemical in environment/on crop / no bioaccumulation; 6. Can be used in organic farming; Disadvantages 7. Does not get rid of pest completely; 8. May become a pest itself; 9. Slow acting/ lag phase/ takes time to reduce pest population;	5 max	Max 3 for advantages or disadvantages. Ignore references to leaching, eutrophication. Ignore references to cost.

8(c)	1. Geographical isolation; 2. Separate gene pools / no interbreeding (between populations); 3. Variation due to mutation; 4. Different environmental/abiotic/biotic conditions / selection pressures; 5. Selection for different/advantageous, features/characteristics/mutation/ /allele; 6. Differential reproductive success / (selected) organisms survive and reproduce; 7. Leads to change in allele frequency; 8. Occurs over a long period of time;	5 max	In this question must refer to allele where appropriate, not gene.

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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TOTAL	

General Certificate of Education
Advanced Level Examination
January 2010

Biology BIOL4

Unit 4 Populations and environment

Monday 25 January 2010 1.30 pm to 3.00pm

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. Answers written in margins or on blank pages will not be marked.
- 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 accurate scientific terminology.

Areas outside the box will not be scanned for marking

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

1 Snow geese fly north to the Arctic in the spring and form breeding colonies. Different colonies form at different latitudes. The greater the latitude, the further north is the colony. The further north a breeding colony forms, the colder the temperature and the greater the risk of snow.

1 (a) There is a positive correlation between the size of snow geese and how far north they breed. A large size results in snow geese being adapted for breeding in colder conditions. Explain how.

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(2 marks)

Snow geese are either white or blue in colour. The table shows the percentage of white snow geese in colonies at different latitudes at different times over a 40-year period. The blank cells in the table are years for which no figures are available.

Colony	**Latitude in degrees north**	**Percentage of white snow geese each year**			
		1930	**1950**	**1960**	**1970**
A	72	100		100	100
B	71		>99	>99	>99
C	66	95	85	76	
D	63	86	75	67	65
E	55		62		28

1 (b) (i) Describe how the percentage of white snow geese varies with distance north.

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(1 mark)

Areas outside the box will not be scanned for marking

1 (b) (ii) The further north, the greater the risk of snow. Use this information to explain how natural selection might have accounted for the effect of latitude on the percentage of white snow geese.

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(3 marks)

(Extra space) .....

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1 (c) The percentage of white snow geese in these colonies changed over the period shown in the table. Use your knowledge of climate change to suggest an explanation.

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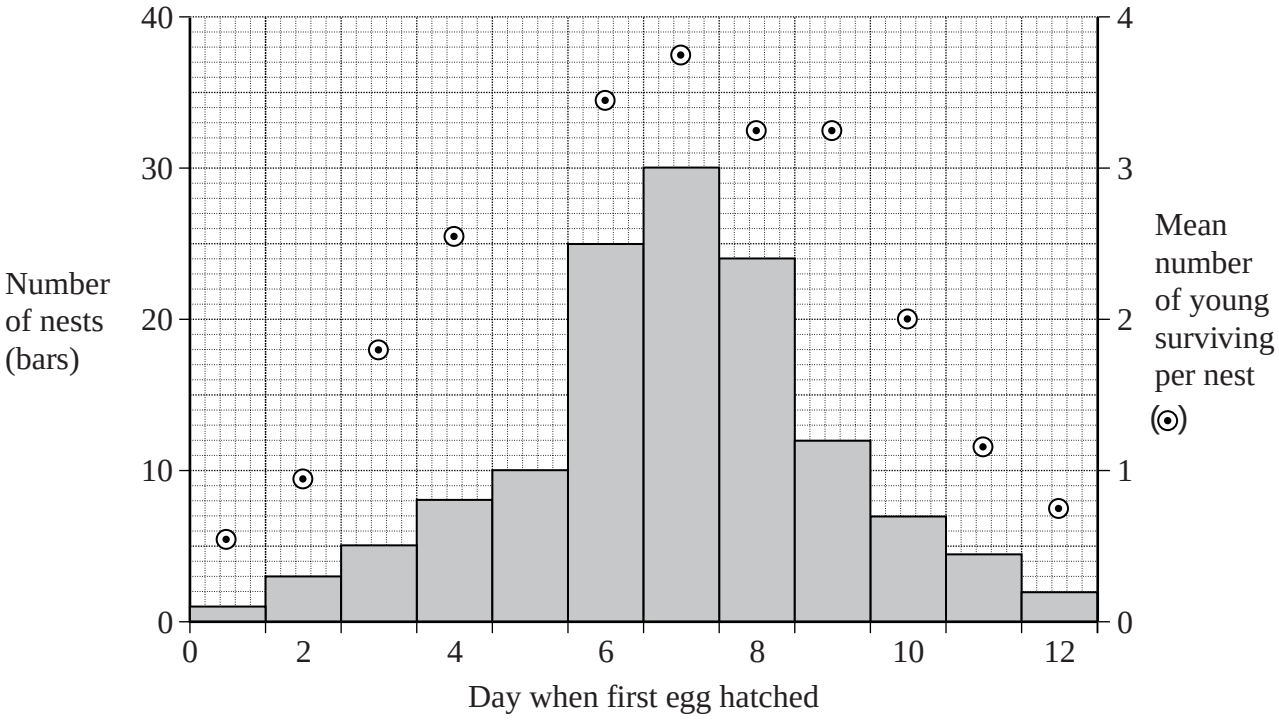
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(2 marks)

Question 1 continues on the next page

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1 (d) Snow geese breed in large colonies. Scientists studied the nests in one colony. For each nest, they recorded the day on which the first egg hatched. They also recorded the number of young that survived from the nest. They used the data to plot a graph.



1 (d) (i) What type of natural selection is shown in the graph?

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(1 mark)

1 (d) (ii) Describe the evidence for your answer.

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(1 mark)

10

Turn over for the next question

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2 (a) Dead leaves contain starch. Describe how microorganisms make carbon in starch available to plants.

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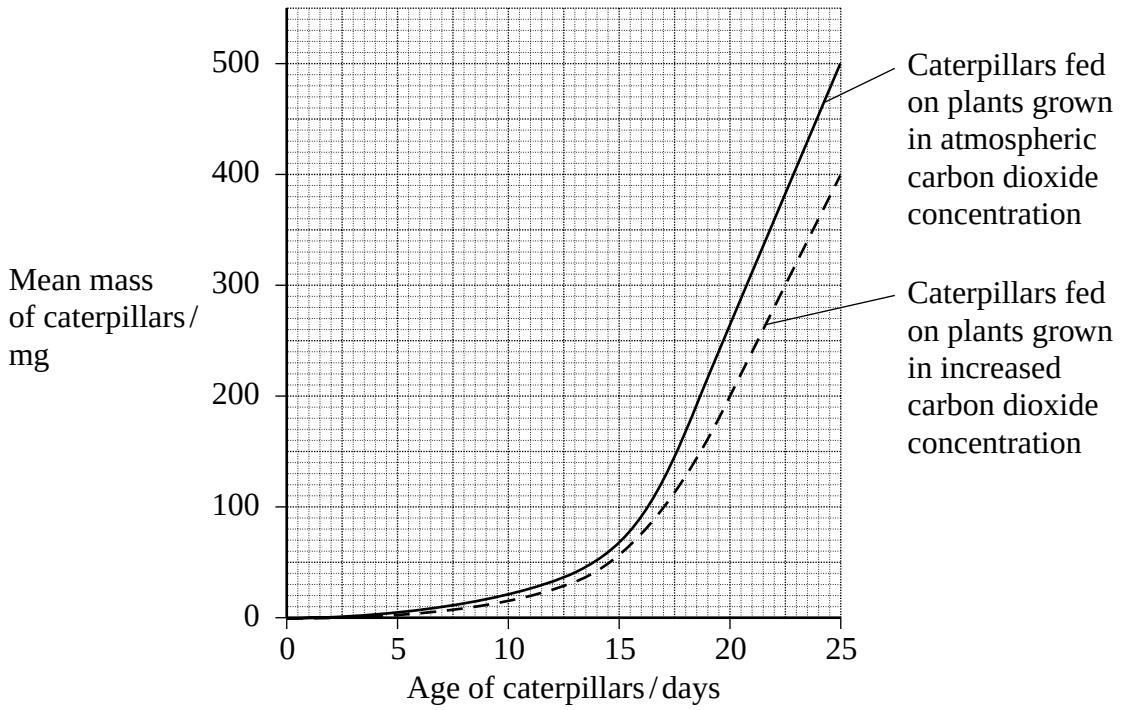
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(2 marks)

Scientists grew groups of the same species of crop plant in a greenhouse in two different concentrations of carbon dioxide. They fed caterpillars on plants from each group and measured the growth of the caterpillars. The results of their investigation are shown in the graph.



2 (b) Calculate the maximum rate of growth of the caterpillars on the plants grown in the increased carbon dioxide concentration. Show your working.

Answer ..... mg day^{-1}

(2 marks)

Areas outside the box will not be scanned for marking

2 (c) Other scientists showed that plants grown in an increased concentration of carbon dioxide have a higher carbon : nitrogen ratio than plants grown in atmospheric carbon dioxide concentration. What does this suggest about the protein concentration in the plants grown in the increased concentration of carbon dioxide? Explain your answer.

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(2 marks)

2 (d) It would not be valid to conclude from the investigations described in this question that an increase in carbon dioxide concentration would reduce crop losses due to caterpillars. Give **two** reasons why this conclusion might not be valid in field conditions.

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(2 marks)

8

Turn over for the next question

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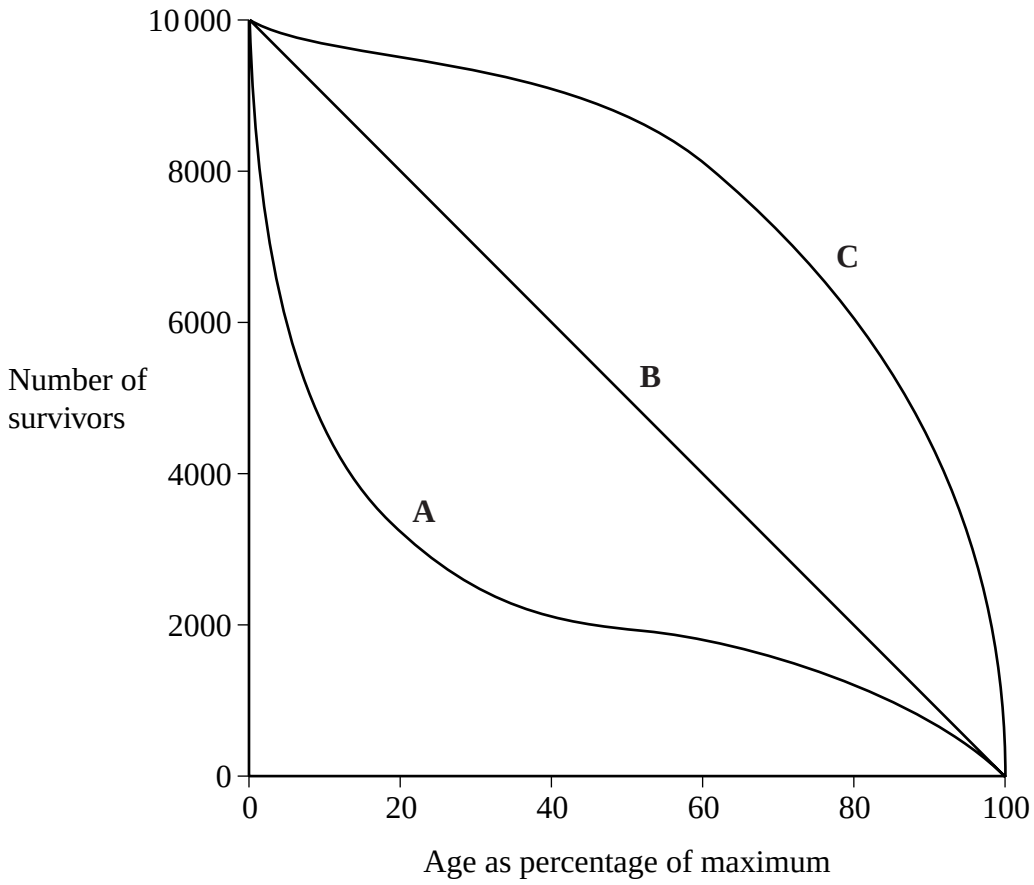
3 (a) Explain what is meant by the ecological term, population.

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(1 mark)

3 (b) The diagram shows three survival curves, **A**, **B** and **C**.



Areas outside the box will not be scanned for marking

3 (b) (i) Assume that the maximum age of a person living in a developed country is 95 years.

The diagram can be used to find the average life expectancy of people living in developed countries. Explain how.

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(3 marks)

(Extra space) .....

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3 (b) (ii) Curve **A** is a survival curve for people living in the UK in 1750. Explain why the curve is this shape.

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(2 marks)

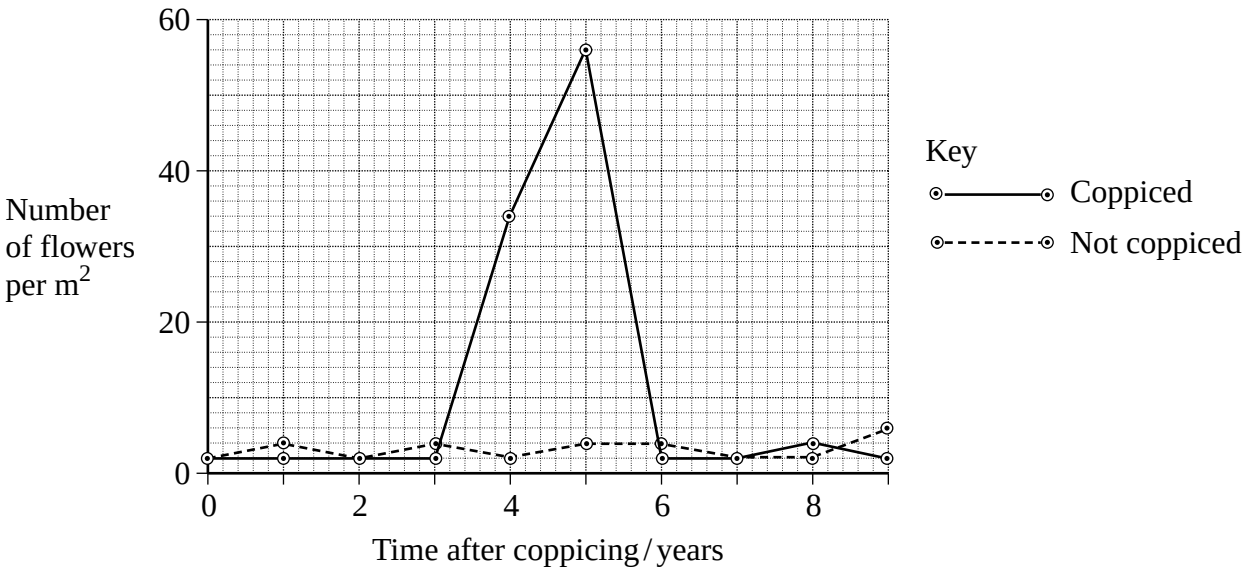
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Areas outside the box will not be scanned for marking

4 Woods can be coppiced to provide a continuous supply of useful logs and poles. Coppicing involves cutting down some trees in a wood to leave stumps. New shoots grow from the stumps. After about 15 years, these trees can be coppiced again.

Because coppicing produces a wood with patches of light and shade, the diversity of plants and animals in a coppiced wood is high.

Ecologists investigated the effect of coppicing on the flowering of wild daffodils growing in a wood in Cumbria. Some areas of the wood were coppiced and some areas were not. The graph shows some results from this investigation.



4 (a) You could collect data for the coppiced plots by using quadrats.

4 (a) (i) Describe how you would place the quadrats at random.

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(2 marks)

4 (a) (ii) Describe how you would decide the number of quadrats to use in order to collect representative data.

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(2 marks)

Areas outside the box will not be scanned for marking

4 (b) Members of the public visit this wood to see wild daffodils in flower. Explain how the information in the graph could help the owners to manage the wood so that there were many wild daffodils in flower every year.

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(2 marks)

4 (c) The ecologists analysed the relationship between the number of daffodils in flower in the whole wood and data collected from a nearby weather station for the previous year. They used the Spearman rank correlation test. The table shows their results.

Month	Climatic factor	Correlation coefficient	Statistical significance
July	Total rainfall	+0.65	significant
August	Total rainfall	+0.74	significant
July	Monthly mean temperature	−0.78	significant
August	Monthly mean temperature	−0.65	significant

The ecologists concluded that a wet, cool summer produces good flowering the following spring. Do you support this conclusion? Use the data in the table to explain your answer.

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(2 marks)

8

Areas outside the box will not be scanned for marking

5 (a) The biochemical pathway of aerobic respiration involves a number of different steps. Name **one** step in which carbon dioxide is produced.

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(1 mark)

In an investigation, scientists transferred slices of apple from air to anaerobic conditions in pure nitrogen gas. They measured the rate of carbon dioxide production.

5 (b) The scientists kept the temperature constant throughout the investigation. Explain how a decrease in temperature would affect the rate of carbon dioxide production.

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(2 marks)

5 (c) When the apple slices were transferred to nitrogen, the following biochemical pathway took place.



Pyruvic acid Ethanol

Use this pathway to explain the part played by reduced NAD when the apple slices were transferred to nitrogen.

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(2 marks)

Areas outside the box will not be scanned for marking

5 (d) The rate of carbon dioxide production was higher when the apple slices were in nitrogen than when they were in the air. Explain why.

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(3 marks)

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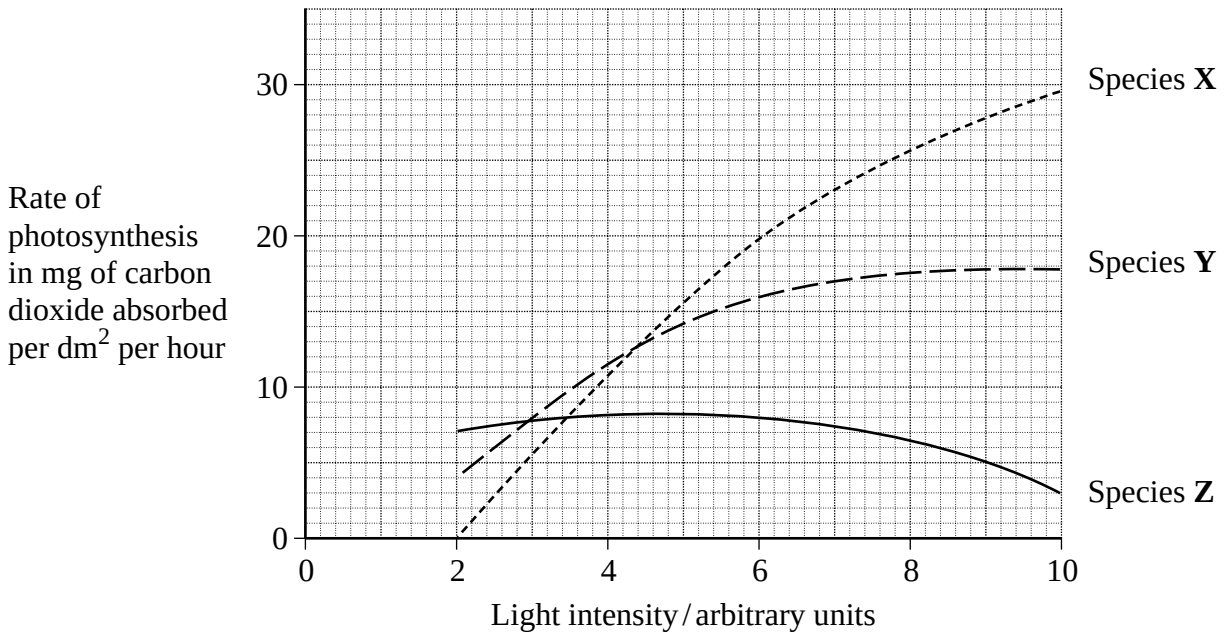
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8

Turn over for the next question

Areas outside the box will not be scanned for marking

6 The graph shows the effects of light intensity on the rate of photosynthesis of three species of tree, **X**, **Y** and **Z**. Each of these species occurs at a different stage in succession.



6 (a) Species **X** is the first tree to become established in the succession. Use the graph to explain why it is likely to become established earlier in the succession than **Y** or **Z**.

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(3 marks)

(Extra space) .....

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Areas outside the box will not be scanned for marking

6 (b) Species **X** may change the environment so that it becomes more suitable for species **Z**. Use the graph to explain why.

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(2 marks)

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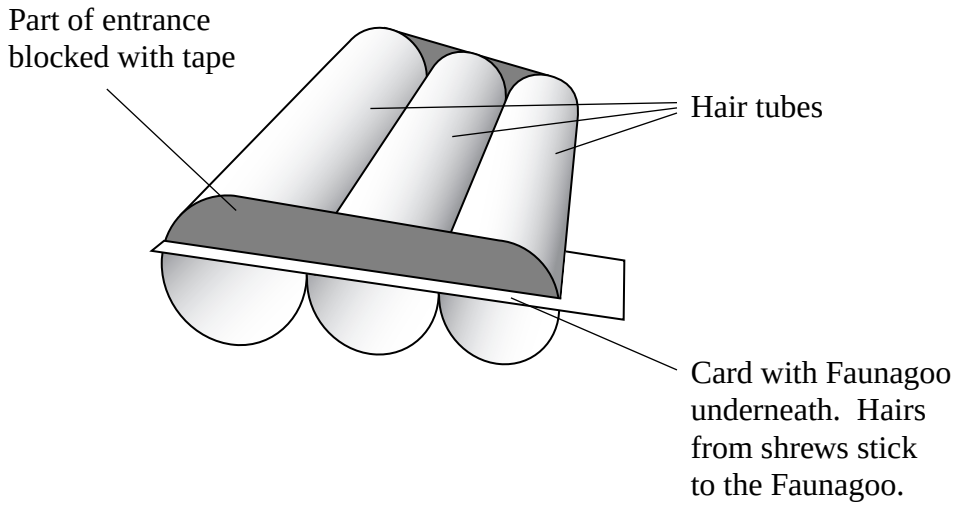
Turn over for the next question

Areas outside the box will not be scanned for marking

7 Shrews are small mammals. Three species of shrew live in mainland Britain. The table shows some features of these shrews.

Species	Mean body mass / g	Mean length of head and body / mm	Food
Common shrew	10	79	Mainly insects and other small invertebrates
Pygmy shrew	5	58	
Water shrew	13	85	

A team of biologists investigated a method of estimating the abundance of shrews. They used plastic tubes, called hair tubes. Some of the hairs from a shrew that enters one of these tubes stick to glue in the tube. These hairs can be used to identify the species of shrew. The diagram shows a set of these hair tubes.



7 (a) (i) Faunagoo is a glue that remains sticky after wetting and drying. Explain the advantage of using Faunagoo in these hair tubes.

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(1 mark)

7 (a) (ii) The diagram shows that the biologists partly blocked the entrances to the tubes with tape. Suggest why they partly blocked the entrances.

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(1 mark)

Areas outside the box will not be scanned for marking

7 (b) The biologists needed to find a way of distinguishing between the hairs of the three species of shrew. They collected hairs from shrews of each species. For each species, they selected hairs at random and made different measurements.

Explain why the biologists selected the hairs at random.

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(1 mark)

7 (c) Repeatable measurements are measurements of the same feature that are very similar. In this investigation, each measurement was made by two observers. This helped the team to check the repeatability of these measurements.

7 (c) (i) Explain why it was important to check the repeatability of the measurements.

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(2 marks)

7 (c) (ii) You could use a scatter diagram to check the repeatability of measurements made by two observers. Describe how.

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(2 marks)

Question 7 continues on page 19

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ANSWER IN THE SPACES PROVIDED

Areas outside the box will not be scanned for marking

7 (d) The biologists used hair tubes to find the abundance of shrews along the edges of some fields. They also used traps that caught shrews without harming them. They selected areas where all three species of shrew were present.

- They put sets of hair tubes at 5 m intervals along the edges of the fields. They inspected the tubes one week later and recorded the number of sets of tubes that contained shrew hairs. They called this the hair tube index.
- At each site where they used hair tubes, they set traps immediately after using the hair tubes. They recorded the number of different shrews caught in these traps.

7 (d) (i) The research team found the hair tube index. Explain why they could not use the hair tubes to find the total number of shrews present.

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(1 mark)

7 (d) (ii) The research team set the traps immediately after using the hair tubes. Explain why setting the traps immediately after using the hair tubes would make comparisons between the two methods more reliable.

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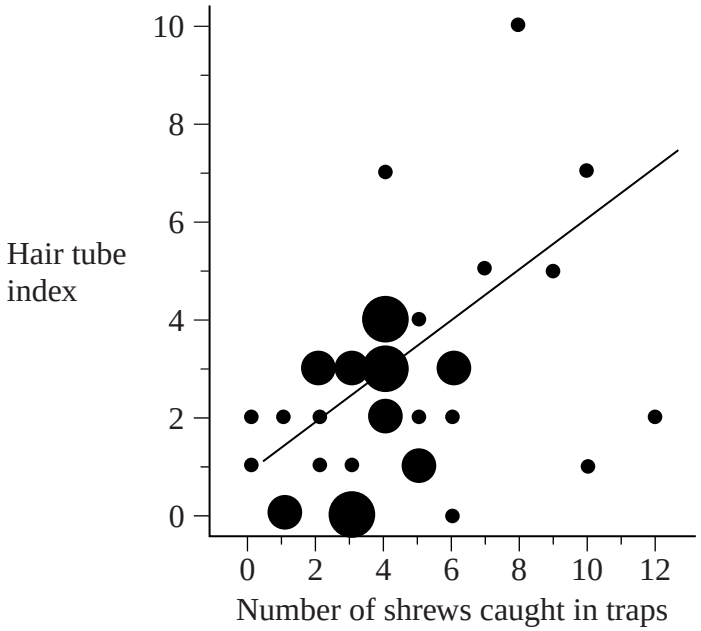
(2 marks)

Question 7 continues on the next page

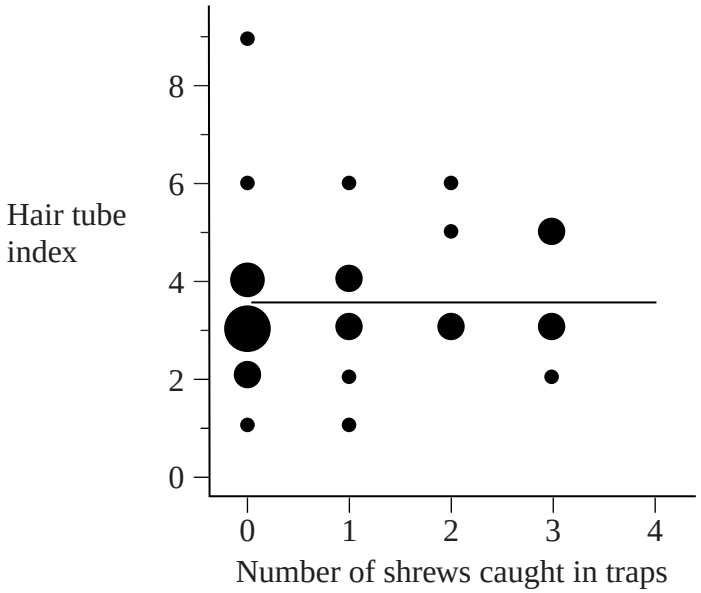
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The graphs are types of scatter diagram called bubble plots. They show hair tube index plotted against the number of shrews caught in traps. The area of the bubble is proportional to the number of records plotted.

Common shrew



Pygmy shrew



Areas outside the box will not be scanned for marking

7 (e) Explain why a statistical test was necessary in analysing the results for the common shrew. Use the terms chance and probability in your answer.

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(2 marks)

7 (f) (i) The biologists concluded that hair tubes were a reliable way of measuring the abundance of common shrews. Give evidence from the graph to support this conclusion.

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(1 mark)

7 (f) (ii) Use information in this question to evaluate the use of hair tubes as a way of measuring the abundance of pygmy shrews.

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(2 marks)

15

Areas outside the box will not be scanned for marking

8 (a) In the light-dependent reaction of photosynthesis, light energy generates ATP. Describe how.

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(5 marks)

(Extra space) .....

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Areas outside the box will not be scanned for marking

8 (b) Energy is transferred through an ecosystem.
Describe how and explain why the efficiency of energy transfer is different at different stages in the transfer.

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(6 marks)

(Extra space) .....

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Question 8 continues on the next page

Areas outside the box will not be scanned for marking

8 (c) Explain how the intensive rearing of domestic livestock increases net productivity.

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(4 marks)

(Extra space).....

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15

END OF QUESTIONS

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Version 1.0: 0909

General Certificate of Education

Biology 1411

BIOL4 Populations and Environment

Mark Scheme

2010 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Part	Marking Guidance	Mark	Comments
1	(a)	Small surface area to volume ratio / more fat; Lose less heat (to the environment) / for insulation; When they are sitting on eggs;	2 max	
1	(b)(i)	The further north/higher the latitude, the higher the percentage (of white snow geese);	1	
1	(b)(ii)	Snow lying longer/melts slower further north/at greater latitudes; White geese better camouflaged (further north); Predation linked to survival/reproductive success;	3	**Q** In order to gain the last marking point, candidates must explain how survival or reproductive success is affected.
1	(c)	Snow melts earlier/snow melts further north / less snow; White geese decreasing as less well camouflaged/at disadvantage/blue geese increasing as better camouflaged/at an advantage;	2	
1	(d)(i)	Stabilising;	1	Do not accept stable
1	(d)(ii)	Few geese survive at the extremes/most survive from the middle of the range;	1	

Question	Part	Marking Guidance	Mark	Comments
2	(a)	Extracellular digestion / releases enzymes; Starch to monosaccharides /glucose/sugars/smaller molecules ; Respire product of digestion; Produce carbon dioxide from respiration;	2 max	
2	(b)	Correct answer of 40;; Incorrect answer showing clearly that a difference in mass has been divided by time;	2	
2	(c)	Lower as plants contain a lower proportion of nitrogen/higher proportion of carbon/ higher C:N ratio; Nitrogen found (mainly) in protein/amino acids / nitrogen used to make protein;	2	

2	(d)	Investigation refers to a single species and other species might not respond in the same way; Investigation carried out in greenhouse where conditions controlled; Accept any other valid answers relating to how an increase in carbon dioxide concentration might increase caterpillar damage, e.g.: Caterpillars may eat more to compensate (for low nitrogen/ protein); Increased temperature (resulting from higher carbon dioxide concentration will increase rate of growth /reduce generation time; Other organisms interfere with results;	2 max	Remember question concerns caterpillar damage

Question	Part	Marking Guidance	Mark	Comments
3	(a)	All organisms of one species in a habitat/area/place/at one time;	1	Accept group
3	(b)(i)	From curve **C**; Find age as a percentage of a maximum/find value when 5000/50% still alive; (Use to) calculate as a percentage of 95/ Answer = 85 years;	3	**Q** This question tests quality of written communication. Marks may be awarded for calculating the answer but this must be supported by adequate explanation making the points listed. If curve A or B are given, figures for last mark point are A 8 B 50 All three +/- 2
3	(b)(ii)	More disease/poor food supplies/poor sanitation/poor medical care; High death rate among the young/in childhood / curve drops steeply at first/in first 40;	2	Overcrowding not enough Ignore ref to years or percentage

Question	Part	Marking Guidance	Mark	Comments
4	(a)(i)	Method of positioning quadrats, E.g. Find direction and distance from specified point/ find coordinates on a grid / split area into squares; Method of generating random numbers; E.g. From calculator/telephone directory/numbers drawn from a hat;	2	Last point represents minimum answer **Q** Do not credit any method that relies on throwing a quadrat
4	(a)(ii)	Calculate running mean/description of running mean; When enough quadrats, this shows little change/levels out (if plotted as a graph); Enough to carry out a statistical test; A large number to make sure results are reliable; Need to make sure work can be carried out in the time available;	2 max	Ignore terms that are not incorrect Regards large numbers as 10/10% +
4	(b)	Coppice different parts of the wood at different times; As data show many daffodils flowering 4/5 years after coppicing;	2	**Q** Second point needs specific reference to the graph, numbers and time after coppicing. Accept any correct answer that does this.
4	(c)	<u>Positive</u> correlation between rainfall and flowering/the higher the rainfall, the more daffodil flowers; <u>Negative</u> correlation/the higher the temperature the fewer daffodils in flower; All statistically significant so not likely to be/not due to chance;	2 max	

Question	Part	Marking Guidance	Mark	Comments
5	(a)	Krebs cycle/link reaction/pyruvate to acetylcoenzyme A;	1	**Q** Accept valid alternative for any of these steps.
5	(b)	(Respiratory reactions controlled by) enzymes; Rate decreases as less kinetic energy/fewer collisions (between substrate and active site) fewer E-S complexes formed;	2	
5	(c)	Requires hydrogen/electrons / is reduction; Hydrogens from reduced NAD/reduced NAD reduces (pyruvic acid) / reduced NAD oxidised;	2	Information may be on diagram
5	(d)	Respiring anaerobically; (Anaerobic respiration/respiration with nitrogen) less efficient/produces less ATP; More anaerobic respiration/ more glucose/substrate must be respired to produce same amount of ATP (so more carbon dioxide produced);	3	

Question	Part	Marking Guidance	Mark	Comments
6	(a)	Vegetation consists mainly of low growing species/herbs/annuals/ no/few tress; Species **X** has high rate of photosynthesis at high light intensity; Species **X** grow fastest at high rate of photosynthesis / at high light intensities; Will outcompete other species **Y**/**Z**;	3max	 Do not credit Species **X** is first tree
6	(b)	Produces shade/reduces light intensity; Species **Z** grows best/photosynthesis best/ in low light intensity / Species **Z** does not grow well / low rate of photosynthesis in high light intensity;	2	 Accept answers in terms of CO_2 absorption

Question	Part	Marking Guidance	Mark	Comments
7	(a)(i)	Will work in all weather conditions/hairs will stick to it even if shrew/animal is wet/ withstand rain;	1	
7	(a)(ii)	So shrews come into contact with glue;	1	
7	(b)	Avoids bias/allows statistical tests to be carried out;	1	Allow description
7	(c)(i)	Increases the reliability of the measurements; If measurements are repeatable, differences less likely to be due to measurement/personal error/ anomalies unlikely;	2	Accept advantages of repeatable results. E.g. identifying anomalies/remove errors
7	(c)(ii)	Plot graph/scatter diagram of one set of results against the other; Expect to see points lying close to line / Line should slope upwards/show positive correlation; OR Plot measurement against hair number; Look for overlying / corresponding points;	2	**Q** To gain first marking point, candidates must say what has been plotted. If what is being plotted is not clear, second point cannot be awarded.
7	(d)(i)	One mark for a valid explanation based on individual shrews entering more than one hair tube / many hairs from same shrew/ shrews enter without leaving hair;	1	
7	(d)(ii)	Rules out differences due to changes in population / changes in environmental conditions; That could be produced by births/deaths/migration/specific example of environmental conditions affects results;	2	

7	(e)	(A statistical test) determines the probability of results being due to chance; Enables null hypothesis/description of null hypothesis to be accepted/rejected; Determines whether correlation/result is significant;	2 max	
7	(f)(i)	(Curve/line of best fit shows) positive correlation/ description of positive correlation;	1	
7	(f)(ii)	Curve/line of best fit (almost) parallel to x-axis/horizontal / level/ no correlation / index is independent of number of shrews; Hair tubes with positive results when no shrews trapped; Small size of shrews means shrews may not trigger traps;	2 max	

Question	Part	Marking Guidance	Mark	Comments
8	(a)	1 Light (energy) excites/raises energy level of electrons in chlorophyll; 2 Electrons pass down electron transfer chain; 3 (Electrons) reduce carriers/passage involves redox reactions; 4 Electron transfer chain / role of chain associated with chloroplast membranes / in thylakoids / grana; 5 Energy released / carriers at decreasing energy levels; 6 ATP generated from ADP and phosphate/P_i / phosphorylation of ATP;	5 max	**Q** Accept any reasonable alternative for electron transfer chain. Example such as chemiosmosis;
8	(b)	1 Some light energy fails to strike/is reflected/not of appropriate wavelength; 2 Efficiency of photosynthesis in plants is low/approximately 2% efficient; 3 Respiratory loss / excretion / faeces / not eaten; 4 Loss as heat; 5 Efficiency of transfer to consumers greater than transfer to producers/approximately 10%; 6 Efficiency lower in older animals/herbivores/ primary consumers/warm blooded animals/homoiotherms; 7 Carnivores use more of their food than herbivores;	6 max	**Q** Accept figures below 5%. Accept figures over 5% but below 10% if clearly related to maximum efficiency.

8	(c)	1 2 3 4 5	Slaughtered when still growing/before maturity/while young so more energy transferred to biomass/tissue/production; Fed on concentrate /controlled diet /controlled conditions/so higher proportion of (digested) food absorbed/lower proportion lost in faeces / valid reason for addition; Movement restricted so less respiratory loss / less energy used; Kept inside/heating/shelter / confined so less heat loss / no predators; Genetically selected for high productivity;	4 max	**Q** The principle here is one mark for identifying a relevant point and offering an explanation. Accept other equivalent answers.

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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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.

Do not write outside the box

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)

Do not write outside the box

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

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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.

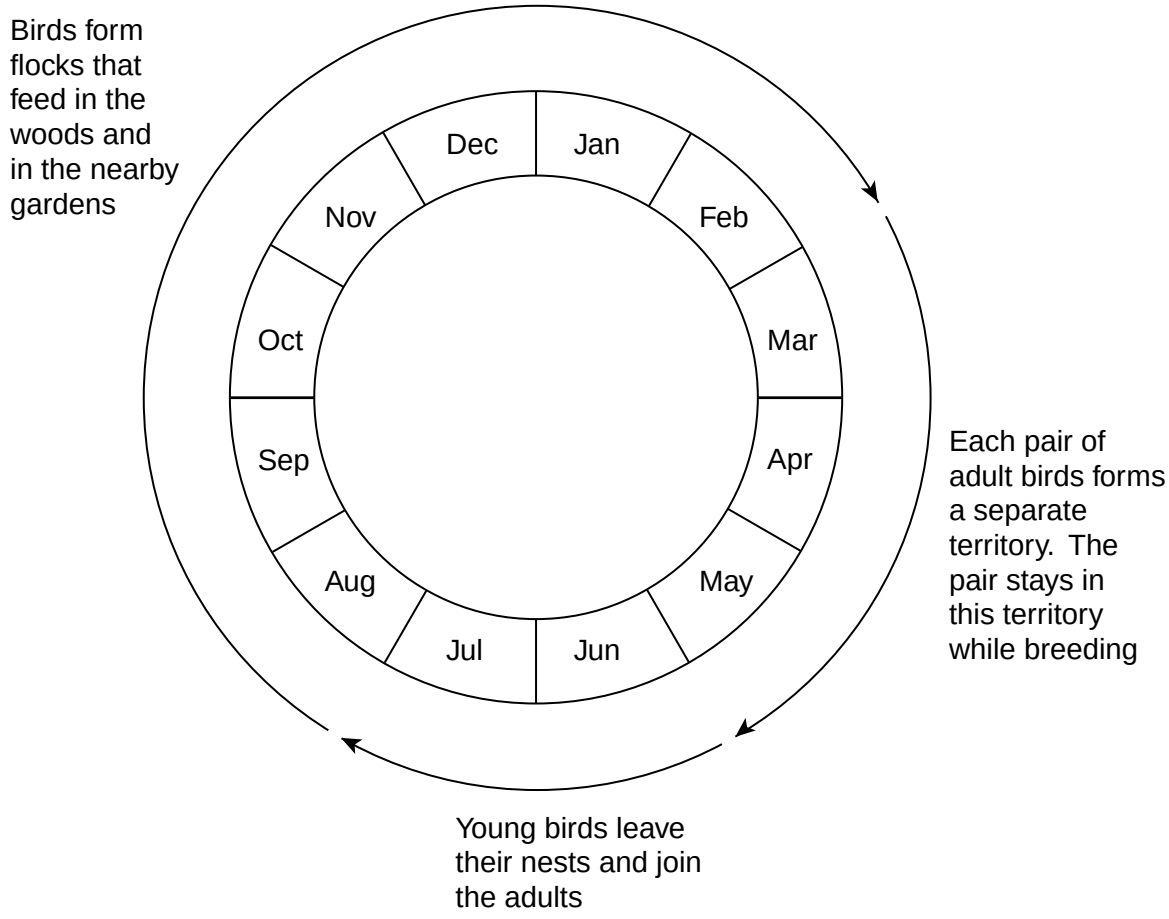
- She trapped 28 blue tits. She marked all of these birds with small metal rings on their legs.
- Two weeks later, she trapped another sample of blue tits. Of these birds, 18 were marked and 20 were not marked.

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.



Do not write outside the box

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

Do not write outside the box

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)

Do not write outside the box

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

Do not write outside the box

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.

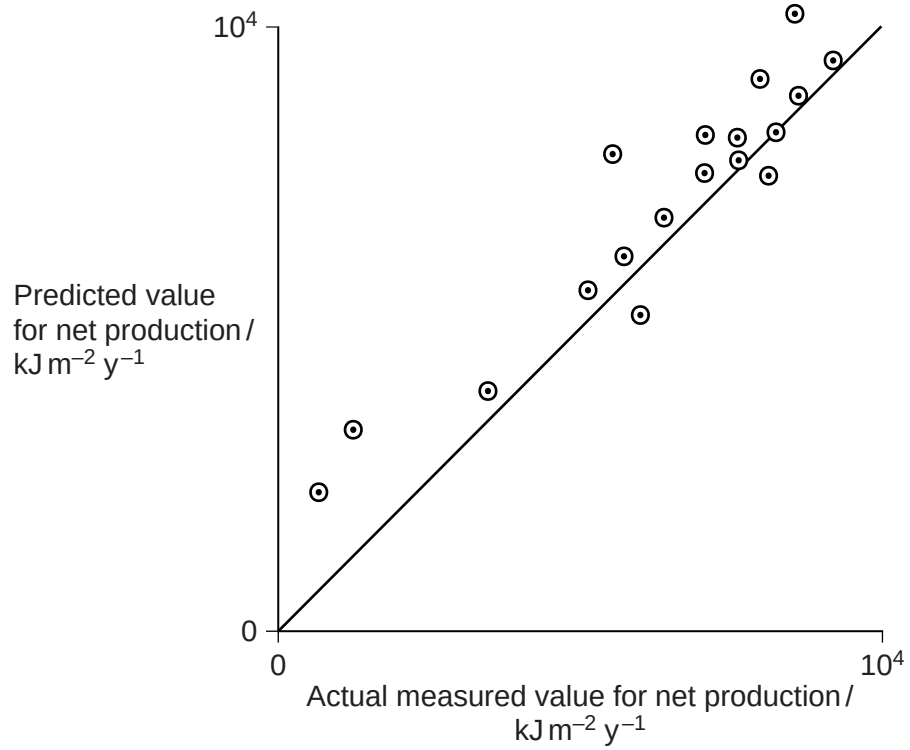
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(1 mark)

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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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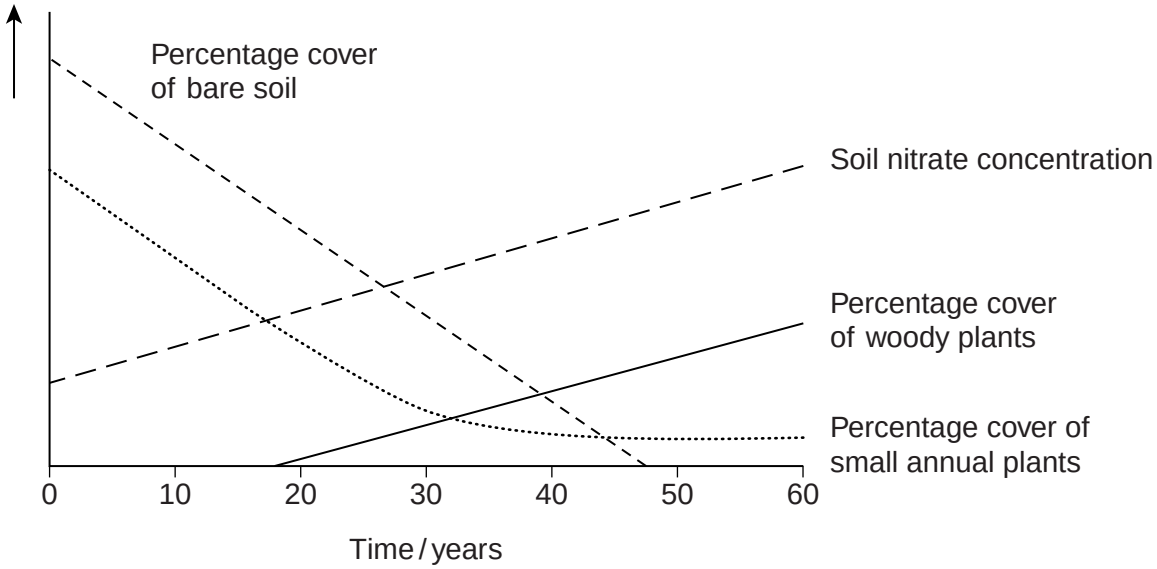
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8

Do not write outside the box

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)

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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

Do not write outside the box

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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Do not write outside the box

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

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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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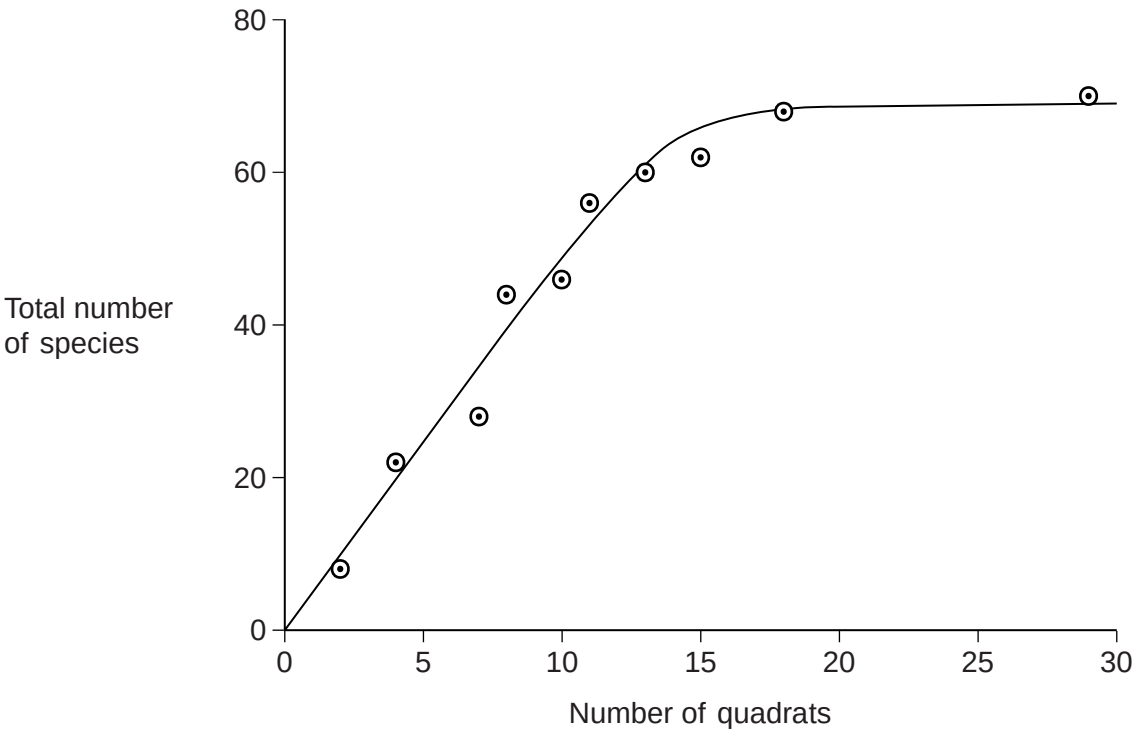
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(2 marks)

Do not write outside the box

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

Do not write outside the box

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)

Do not write outside the box

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)

(Extra space) .....

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15

Do not write outside the box

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)

(Extra space) .....

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Do not write outside the box

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

Do not write outside the box

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)

(Extra space) .....

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15

END OF QUESTIONS

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General Certificate of Education
June 2010

Biology **BIOL4**

Populations and environment

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Although specific marks are not awarded in this unit, marks awarded will take into account the quality of written communication. Credit will only be awarded where candidates have presented information clearly and coherently and used the specialist vocabulary indicated in the mark scheme for this unit. Specific references to quality of written communication are given in the comments column.

Question	Marking guidance	Mark	Comments
1 (a)	Ammonia/ammonium/NH_3/NH_4^+;	1	
1 (b)	Will have similar shape/tertiary structure (as substrate) / complementary shape (to active site); Fit/bind with active site / forms enzyme-substrate complex;	2	Neutral: same shape as substrate Reject: same shape as active site
1 (c) (i)	Provides ATP for the reaction/nitrogen fixation/reduction of nitrogen/formation of ammonia; Enzyme/nitrogenase produced quicker/<u>more</u> enzyme produced; Uses/removes oxygen (so nitrogenase works);	2 max	Accept: ATP or energy Ignore references to temperature Use of oxygen must be in the correct context
1 (c) (ii)	ATP used for/needed for nitrogen fixation/reduction of nitrogen/formation of ammonia/production of enzyme/nitrogenase; (So less ATP) available for growth/protein synthesis/production of new cells/production of biomass;	2	Accept: ATP or energy Accept: converse for those without fertiliser

Question	Marking guidance	Mark	Comments
2 (a)	Two marks for correct answer of 59/60;; One mark for incorrect answer clearly derived from figures of 18, 28 and 38;	2	Ignore: any figures after decimal point.
2 (b)(i)	Population changes; As young birds leave nest/join population;	2	Reject: population decreases Reject first point if (young) birds are leaving population/migrating
2 (b) (ii)	(Would be likely to) catch all birds (again) in second sample / sample sizes are the same; Birds (in territories and) not mixing with population; Only estimates number of birds in territories sampled / territory sample not representative (of population);	2 max	Neutral: references to breeding Accept: idea of the population is divided
2 (c)	(Recording) DNA / base sequence is like marking (animal)/wouldn't need to mark; (Finding identical/same base sequence) would show animal has been caught/recorded before;	2	

Question	Marking guidance	Mark	Comments
3 (a)	The frequency/proportion of alleles (of a particular gene); Will stay constant from one generation to the next/over generations / no genetic change over time; Providing no mutation/no selection/population large/population genetically isolated/mating at random/no migration;	3	The three principles for marking are: What feature What happens to it Providing . . . Accept: genotype/explanation of genotype Accept: alternative wording, e.g. there is no gene flow/genetic drift for genetically isolated.
3 (b)	White/deaf cats unlikely to survive/selected against; Will not pass on allele (for deafness/white fur) (to next generation)/will reduce frequency of allele;	2	Accept: alternative wording, e.g. have a disadvantageous phenotype Neutral: will not breed
3 (c)	In Paris/London frequencies (of these alleles) add up to more than 1;	1	Can be shown by correct figures to be more than 1 e.g. 0.71 + 0.78 = 1.49 Accept: more than100%
3 (d)	Two marks for correct answer of 44(.22);; One mark for incorrect answer in which p/frequency of H determined as 0.67 and q/frequency of h as 0.33 ***OR*** Answer given as 0.44(22);	2	

Question	Marking guidance	Mark	Comments
4 (a)	F – E – R/ F – (E + R);	1	Accept: F– (R + E) / F– R– E
4 (b) (i)	Increase because fed concentrates/food with high nutritive value/food with high digestibility/food with little waste/because less egested;	1	
4 (b) (ii)	Decrease because movement restricted/heat loss reduced;	1	Accept: less movement/less muscle contraction Ignore references to keeping warm
4 (c) (i)	0.98 : 1 / 98 : 100;	1	Answer must be this way round and expressed in its simplest terms Reject: 0.98
4 (c) (ii)	Mammals maintain (body) temperature/have high (body) temperature;	1	Accept: mammals are endotherms /warm-blooded Accept: converse for insects
4 (d)	(Results show) positive correlation/positive correlation described; Most/higher values close to line / curve shows good agreement; Lower values less close to line/less correlation; (Generally) predicted values are higher / actual values lower;	3 max	Reject: reference to line/curve of best fit Ignore reference to anomalies Reference to ‘predicted’ or ‘actual’ required

Question	Marking guidance	Mark	Comments
5 (a)	(Increase in) dead organisms/humus/decomposition; Leading to (increase in) nitrification/ammonia to nitrate/activity of nitrifying bacteria; Nitrogen fixation;	2max	Accept: pioneer species for plants
5 (b) (i)	Bare soil temperatures fluctuate; More bare soil, early/at start of succession/when few plants;	2	Reject: environmental temperature Accept: converse
5 (b) (ii)	Plant will grow/survive in the shade/when overshadowed (by taller plants)/when receiving less light;	1	Effect on plant with reason for effect Ignore reference to competition
5 (c)	(Grassland consists of) small/annual plants; Will be replaced by/outcompeted by woody plants; So these (woody plants) must be removed/have growth checked/grazed;	2 max	Must be in the context of grassland Need idea of replaced not just an increase in percentage cover

Question	Marking guidance	Mark	Comments
6 (a)	Electrons transferred down electron transport chain; Provide energy to take protons/H^+ into space between membranes; Protons/H^+ pass back, through membrane/into matrix/through ATPase; Energy used to combine ADP and phosphate/to produce ATP;	3 max	Accept: alternatives for electron transport chain.
6 (b) (i)	Prevent damage to mitochondria caused by water/osmosis/differences in water potential;	1	Accept: other terms that imply damage e.g. shrink/burst
6 (b) (ii)	Glucose is used/broken down during glycolysis; Breakdown of glucose/glycolysis in cytoplasm/not in mitochondria; Glucose cannot cross mitochondrial membrane/does not enter mitochondria;	2 max	Accept: 'glucose is converted to pyruvate' for description of breakdown Accept: only pyruvate can
6 (b) (iii)	Terminal/final acceptor (in electron transport chain) / used to make water;	1	Could be shown by symbols

Question	Marking guidance	Mark	Comments
7 (a) (i)	Fewest people at site R as mean is lowest; Standard deviations do not overlap so significant/not due to chance;	2	Accept use of mean values to show 2.2 is the lowest Accept use of values/description of standard deviation even in wording 'standard deviation' is not used
7 (a) (ii)	There was a probability of less than 0.05/ 5 in a hundred/5%; That the difference was due to chance;	2	In the context of less than Accept converse: probability of more than 95% Look for idea of difference (between sites)
7 (b) (i)	(Would not be reliable as) number of species is still increasing;	1	Accept: has not reached peak/maximum or if shown by values
7 (b) (ii)	Idea of curve has flattened/no more species found so no benefit/no point/takes unnecessary time/takes unnecessary effort / can get same results with fewer quadrats;	1	Basic idea is of minimising effort. If values used reward idea rather than accuracy of numbers
7 (c)	Combustion/ would burn/cause loss of substances (other than water)/named substance/cause loss of dry mass;;	1	Accept: only want water to be lost Ignore: reference to decomposition
7 (d)	Seaweeds/plants are producers/lower/first trophic level / animals are consumers/higher trophic level/feed on seaweeds; Loss of energy between trophic levels; As a result of respiration/ as heat;	2 max	Accept relevant position in food chain as trophic level Accept: energy transfer is inefficient Accept: description of trophic levels Accept: not all seaweed/eaten
7 (e) (i)	The site/site U with most people/34.6 has the largest ratio/3.24; (Large value of ratio due to) large biomass ÷ small number / large size ÷ small number/biomass greater than abundance;	2	Accept: as number of people increases, ratio increases Explanation of seaweed ratio

7 (e) (ii)	1. Fewer larger animals/more smaller animals where more people/more disturbance;	4 max	Principle
	2. 0.09 linked to 34.6/appropriate link between row 4 and row 1;:		Use of data
	3. Larger animals affected by human activity;		Accept: converse
	4. Smaller animals are young animals;		Accept: converse
	5. Fewer species of seaweed (with disturbance);		Accept if shown by figures
	6. (So) fewer niches /habitats (for large animals);		Accept idea of disturbance/damage to niche/habitat

Question	Marking guidance	Mark	Comments
8 (a)	1. High concentration of carbon dioxide linked with night/darkness; 2. No photosynthesis in dark/night / light required for photosynthesis/light-dependent reaction; 3. (In dark) <u>plants</u> (and other organisms) respire; 4. In light net uptake of carbon dioxide by plants/plants use more carbon dioxide than they produce/ rate of photosynthesis greater than rate of respiration; 5. Decrease in carbon dioxide concentration with height; 6. At ground level fewer leaves/less photosynthesising tissue/more animals/less light;	5 max	Accept: converse of low in day Ignore references to rate of photosynthesis in day/night Accept day = light Must be a reference to plants or <u>all</u> organisms Do not allow converse for this point Accept description of compensation point Accept: converse of increase closer to ground
8 (b)	1. Carbon dioxide combines with ribulose bisphosphate/RuBP; 2. To produce two molecules of glycerate 3-phosphate/GP; 3. Reduced to triose phosphate/TP; 4. Requires reduced NADP; 5. Energy from ATP;	5	This mark scheme is based on specification content. Accept alternate names such as NADPH Credit relevant diagrams Accept: description of ‘reduced’

8 (c)	1. Microorganisms are saprobionts/saprophytes; 2. Secrete enzymes (onto dead tissue) / extracellular digestion; 3. Absorb products of digestion/smaller molecules/named relevant substance; 4. Respiration (by microorganisms) produces carbon dioxide; 5. Carbon dioxide taken into leaves; 6. Through stomata;	5 max	Accept saprophytes although not strictly correct. Accept: description of absorption