OXFORD AQA
INTERNATIONAL QUALIFICATIONS

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

Thursday 4 January 2024 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

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

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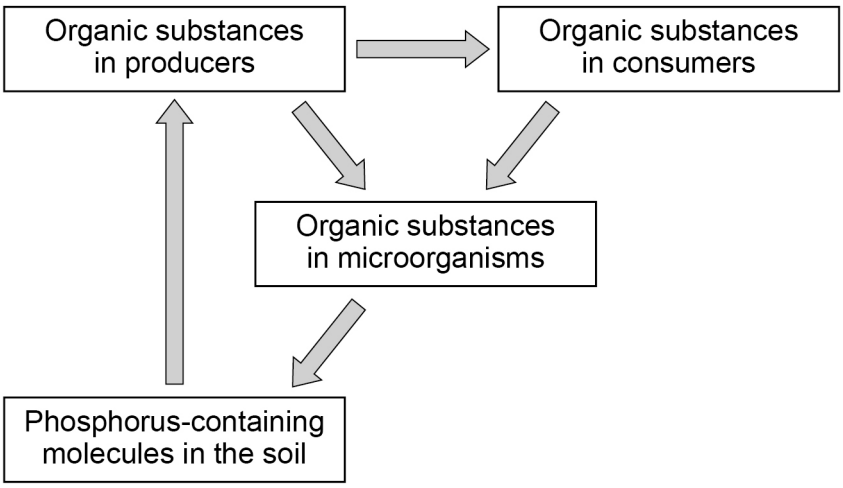
Answer **all** questions in the spaces provided.

0 1 Phosphorus is a chemical element found within organic substances in living organisms.

Figure 1 shows part of the phosphorus cycle.

Figure 1



0 1 . 1 Describe how phosphorus from organic substances in producers becomes part of organic substances in consumers.

[2 marks]

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0 1 . 2 Describe the role of microorganisms in making phosphorus from consumers available to producers.

[3 marks]

5

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 Glycolysis is a process that happens in both aerobic and anaerobic respiration.

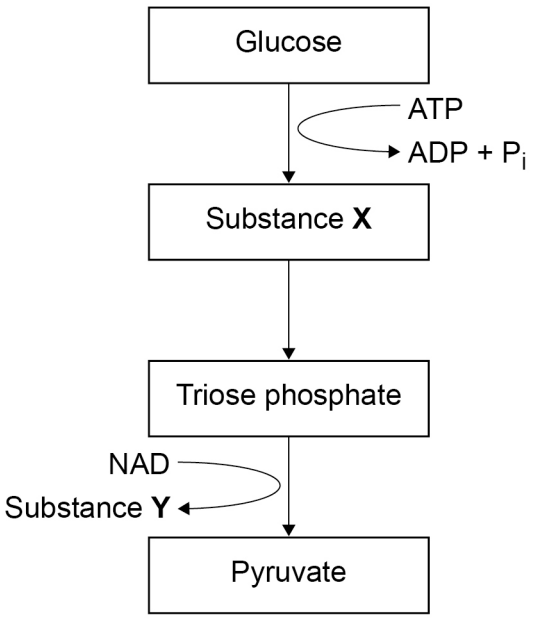
0 2 . 1 Name the part of a cell where glycolysis happens.

[1 mark]

_____

Figure 2 shows some of the stages of glycolysis.

Figure 2



0 2 . 2 Name substances **X** and **Y**.

[1 mark]

Substance **X** _____

Substance **Y** _____

0 2 . 3 Add an arrow and a label to **Figure 2** to show where ATP is produced.

[1 mark]

Question 2 continues on the next page

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0 2 . 4 There is a net gain of ATP in glycolysis.

Define **net gain**.

[1 mark]

_____

_____

_____

Scientists investigate the effect of lactate on the contraction force generated by muscle from a rat.

The scientists:

- put a muscle in a control solution at 30 °C for 15 minutes
- put another muscle in a test solution of 20 mmol dm^{-3} lactate at 30 °C for 15 minutes
- after 15 minutes, stimulate each muscle using electrodes
- measure the contraction force in newtons (N) every 30 seconds for 5 minutes
- repeat the investigation 9 times and calculate the mean contraction force for each muscle for the control solution and for the test solution.

0 2 . 5 The scientists use a statistical test to analyse their results.

Name the statistical test the scientists should use.

Give the reason for your choice.

[2 marks]

Name of statistical test _____

Reason for choice _____

_____

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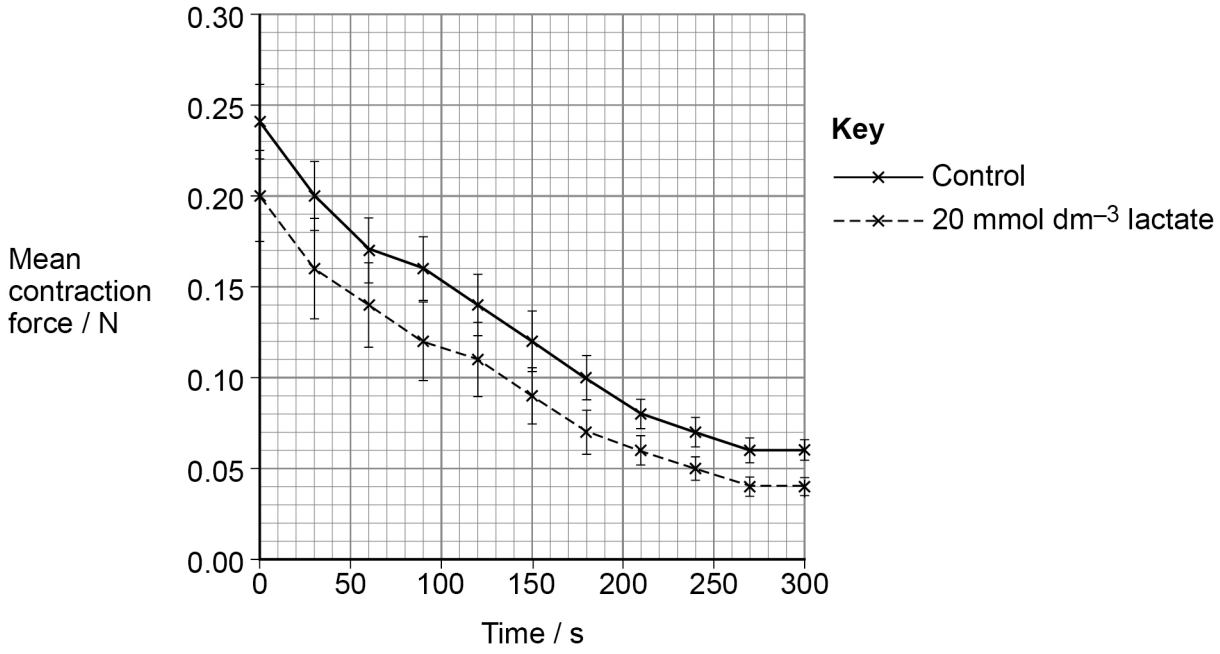
Figure 3 shows the scientists' results.

The values show the mean contraction force ± standard error.

Figure 3



0 2 . 6 A student concludes that lactate decreases the contraction force of muscle in animals.

Give **three** reasons why the student's conclusion may **not** be valid. Use the scientists' method and the results from **Figure 3**.

[3 marks]

1 _____

_____

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2 _____

_____

_____

3 _____

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Question 2 continues on the next page

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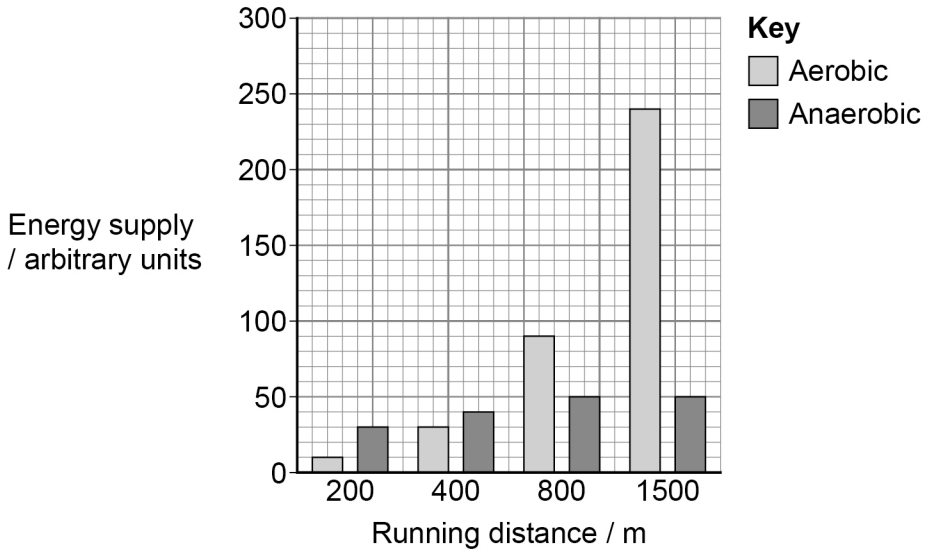
A sports scientist investigates the contribution of aerobic and anaerobic respiration to the total energy supply for athletes running different distances.

Figure 4 shows the scientist's results.

Figure 4



0 2 . 7 Describe the trends the scientist's results show.

Use data from **Figure 4**.

[3 marks]

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0 2 . 8 Calculate the ratios of aerobic to anaerobic respiration at 200 m **and** at 800 m.

[2 marks]

Ratio at 200 m _____ : 1

Ratio at 800 m _____ : 1

0 2 . 9 During a 200 m race, athletes run very quickly.

Explain why most of the energy supply is from anaerobic respiration during the 200 m race.

[2 marks]

_____

_____

_____

_____

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16

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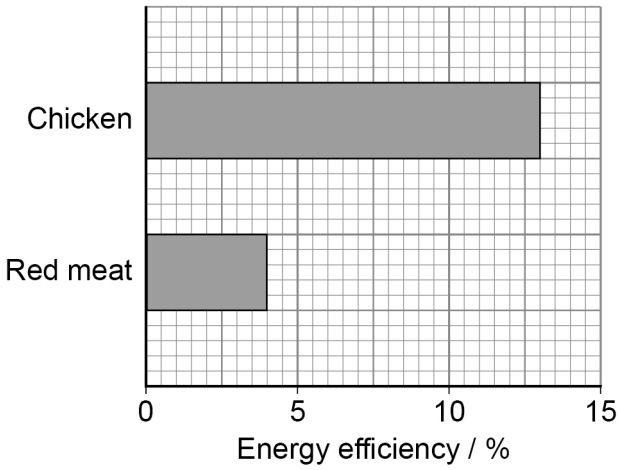
0 3 The energy efficiency of meat production is calculated from the energy input of food that is converted to animal product.

Figure 5 shows the energy efficiency of meat production for two different types of meat:

- chicken
- red meat.

Figure 5



0 3 . 1 Calculate how many times more efficient chicken production is than red meat production.

Use data from **Figure 5**.

[1 mark]

Times more efficient = _____

0 3 . 2 Chickens are often kept indoors.

Suggest **one** reason why this makes chicken production more efficient.

[1 mark]

_____

_____

_____

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Land use for agriculture leads to deforestation and loss of biodiversity.

Scientists study the effect of five different types of diet on global land use.

Table 1 shows the five diets.

✓ = included in diet
X = **not** included in diet.

Table 1

Diet	Red meat	Dairy (milk-based)	Chicken	Eggs	Fish	Plant products
A	✓	✓	✓	✓	✓	✓
B	X	✓	✓	✓	✓	✓
C	X	X	✓	✓	✓	✓
D	X	X	X	✓	✓	✓
E	X	X	X	X	X	✓

Figure 6 shows the scientists' results.

1 hectare is 10 000 m^2

Figure 6

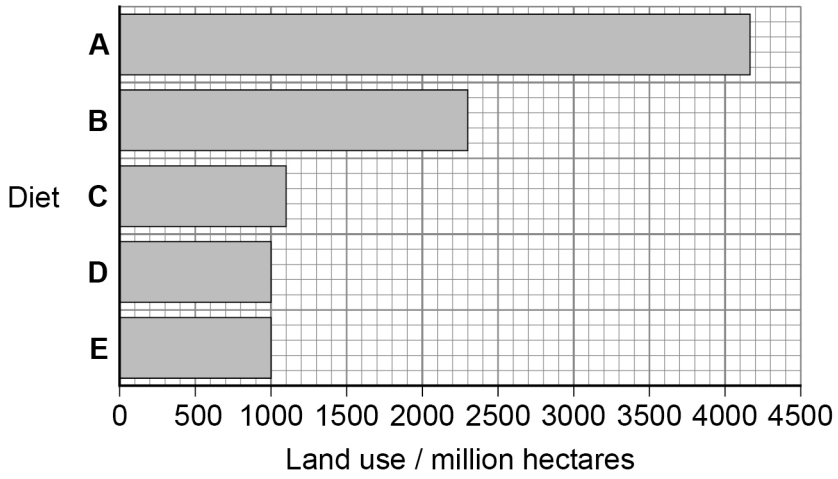

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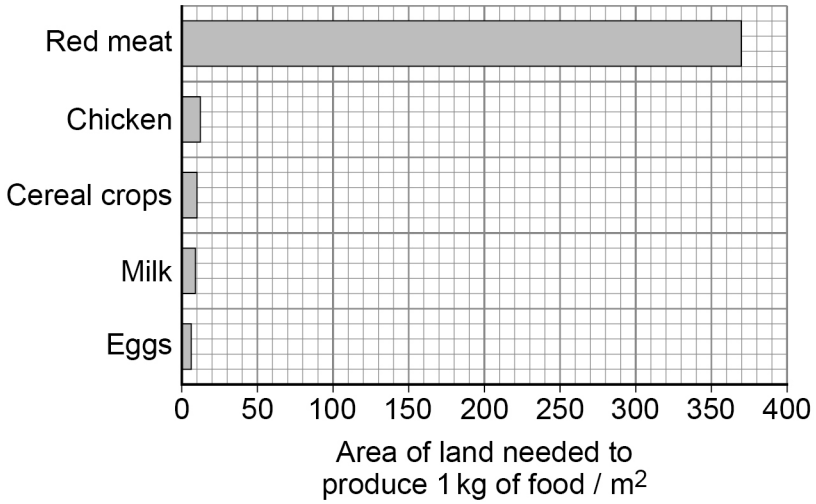
Figure 7 shows the area of land needed to produce 1 kilogram of five different food products.

Figure 7



0 3 . 3 One conclusion from the scientists' study is that everyone should eat diet **E** (only plant products) rather than diet **A** (current global diet).

Evaluate this conclusion using information from **Table 1**, **Figure 6** and **Figure 7**.

[4 marks]

6

Turn over for the next question

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0 4 Alpacas are hairy mammals that can be found in South America.

Figure 8 shows an alpaca.

Figure 8

The hair colour of alpacas is controlled by a number of different genes.

Two genes controlling the hair colour of alpacas are **ASIP** and **MC1R**.

Alleles of ASIP are:
A = allele for yellow pigment
a = allele for no yellow pigment.

Alleles of MC1R are:
E = allele for black pigment
e = allele for no black pigment.

Black alpacas are homozygous recessive at the ASIP locus, and homozygous dominant or heterozygous at the MC1R locus.

Brown alpacas are homozygous dominant or heterozygous at the ASIP locus, and heterozygous at the MC1R locus.

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0 4 . 1 Define **locus**.

[1 mark]

_____

0 4 . 2 Give the **two** possible genotypes of a black alpaca.

[1 mark]

_____ and _____

0 4 . 3 A brown alpaca has the genotype Aa Ee.

Give **all** the possible gametes this alpaca could produce.

[1 mark]

_____

Question 4 continues on the next page

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0 4 . 4 A different gene affects the amount of pigment in alpaca hair.

The dominant allele of this gene, **G**, produces grey hair by reducing the amount of black pigment.

Some genotypes are lethal and an organism with this genotype will die at an early stage of development.

Genetic crosses between heterozygous grey alpacas with genotype **Gg** result in a ratio of 2 grey : 1 black offspring.

Explain how this ratio shows that the inheritance of the homozygous dominant genotype is lethal.

Only include the alleles **G** and **g** in your answer.

[3 marks]

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0 4 . 5 Alpacas have two different lengths of hair caused by a single gene.

The dominant allele causes long hair and the recessive allele causes short hair.

The frequency of the recessive allele in a population is 0.295

Calculate the percentage of the population that are heterozygous for hair length.

Use the Hardy–Weinberg equation.

[3 marks]

Percentage of the population that are heterozygous = _____%

9

Turn over for the next question

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0 5 A student investigates the effect of competition on the growth of carrot plants.

The student:

- plants different numbers of carrot seeds outside in 1 m^2 areas of soil
- grows the carrot plants for 12 weeks
- measures the dry mass of the carrot plants after 12 weeks.

0 5 . 1 Name the type of competition the student is investigating.

[1 mark]

_____

0 5 . 2 Give **two** variables the student should control.

[2 marks]

Control variable 1 _____

_____

Control variable 2 _____

_____

0 5 . 3 Give the reason why the student measures the dry mass of the carrot plants instead of the fresh mass.

[1 mark]

_____

_____

_____

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Question 5 continues on the next page

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Table 2 shows the student's results.

Table 2

Population density / plants m^{-2}	Dry mass of carrot plants / kg m^{-2}	Dry mass per carrot plant / kg
5	0.9	0.18
10	1.8	0.18
20	3.1	
30	3.7	
40	3.8	0.10

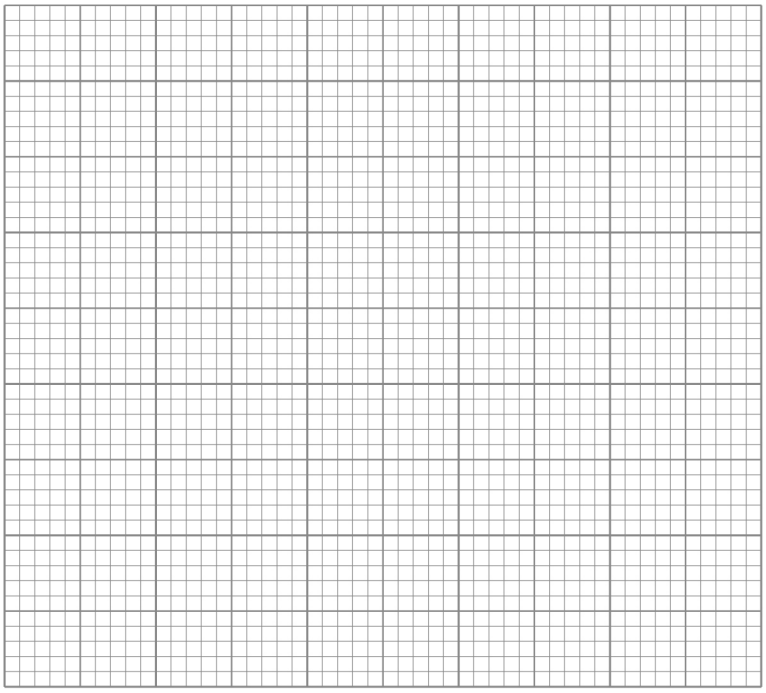
0 5 . 4 Complete **Table 2** by calculating the dry mass per carrot plant for population densities of 20 plants per square metre **and** 30 plants per square metre.

[2 marks]

0 5 . 5 Plot a graph of the student's results to show the relationship between **population density** and the **dry mass per carrot plant**.

Draw a line of best fit on your graph.

[4 marks]



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0 5 . 6 The student concludes that the optimum population density for growing carrots is 10 plants per square metre.

Evaluate the student's conclusion.

Use information from the student's method and results.

[4 marks]

14

Turn over for the next question

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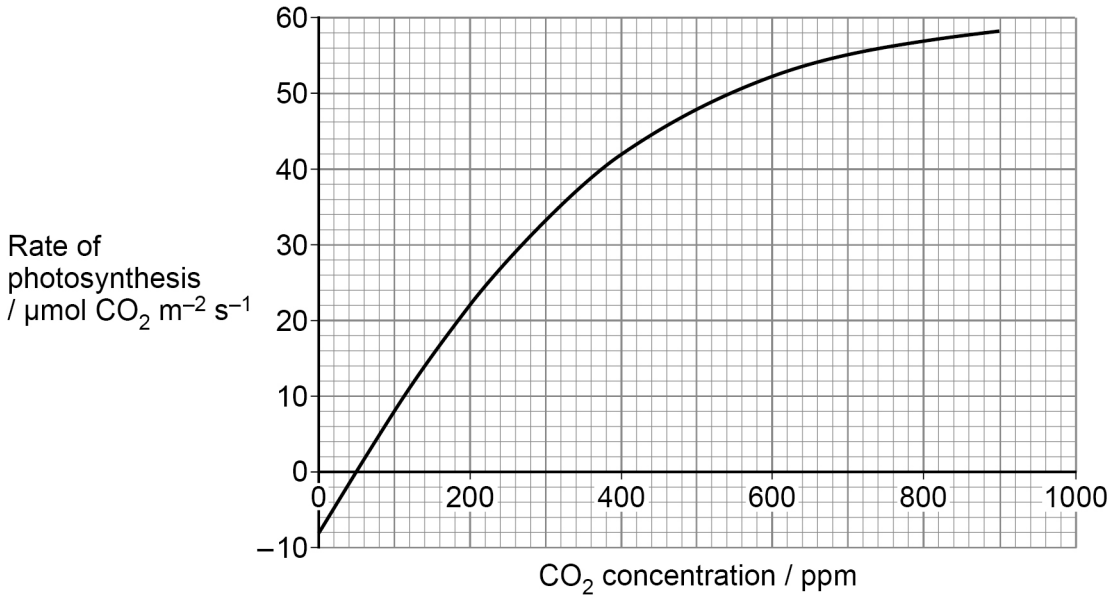
0 6 Scientists investigate the effect of carbon dioxide concentration in the air on the rate of photosynthesis by a plant.

The scientists use the amount of carbon dioxide fixed per leaf area per second as a measure of the rate of photosynthesis.

The scientists measured the carbon dioxide concentration in parts per million (ppm).

Figure 9 shows the scientists' results.

Figure 9



0 6 . 1 **Figure 9** shows a negative value for the rate of photosynthesis at carbon dioxide concentrations below 50 ppm

Explain why.

[2 marks]

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0 6 . 2 Explain how increasing the carbon dioxide concentration would increase the production of organic substances in a plant.

Use your knowledge of the light-independent reaction.

[4 marks]

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0 6 . 3 Calculate the percentage change in the rate of photosynthesis from 100 to 200 ppm

Use data from **Figure 9**.

[2 marks]

Percentage change in rate = _____ %

Question 6 continues on the next page

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0 6 . 4 The percentage change in the rate of photosynthesis between 800 and 900 ppm is 1.75%

This value is much lower than the percentage change in rate between 100 and 200 ppm

Explain why.

[2 marks]

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10

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0 7 Mitochondria are the sites of aerobic respiration.

0 7 . 1 Describe how ATP is synthesised inside mitochondria during aerobic respiration.

[5 marks]

Question 7 continues on the next page

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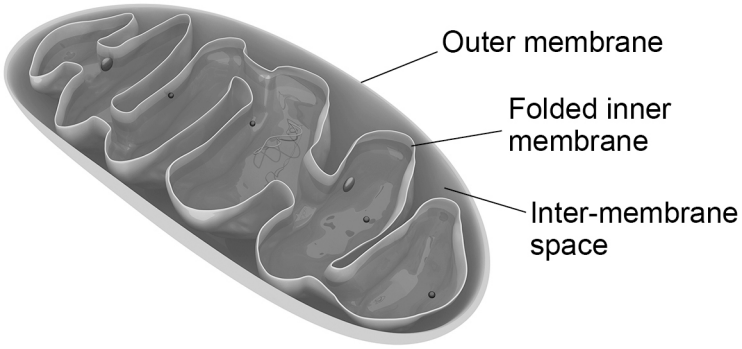
Figure 10 shows the structure of a mitochondrion.

Figure 10



0 7 . 2 Explain how each of the following features helps a mitochondrion to function:

- inter-membrane space
- folded inner membrane
- pyruvate carrier proteins in the membranes.

[6 marks]

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0 7 . 3 Cytochrome c is a protein involved in aerobic respiration in mitochondria.

The molecular structure of cytochrome c varies in different species.

Describe how a difference in the molecular structure of cytochrome c could become more frequent in a small, geographically isolated population.

[4 marks]

15

END OF QUESTIONS

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