OXFORD

INTERNATIONAL
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Please write clearly in block capitals.

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I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 3 Populations and Genes

Thursday 14 January 2021 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 A single gene with four alleles controls the timing of flowering in pea plants.

The alleles show a **dominance hierarchy**. This means:

- one allele is dominant over the other three alleles
- some alleles are dominant over either one or two of the others.

0 1 . 1 Define the term **dominant**.

[1 mark]

_____

_____

_____

The four alleles of the gene are $\mathbf{F^{VE}}$, $\mathbf{F^{E}}$, $\mathbf{F^{L}}$, $\mathbf{F^{VL}}$.

Table 1 shows the timing of flowering of pea plants with different genotypes.

Table 1

Genotype	**Timing of flowering**			
	Very early	Early	Late	Very late
$F^{VE}\ F^{VE}$	✓			
$F^{VE}\ F^{E}$		✓		
$F^{E}\ F^{E}$		✓		
$F^{VE}\ F^{L}$			✓	
$F^{E}\ F^{L}$			✓	
$F^{L}\ F^{VL}$				✓
$F^{VL}\ F^{VL}$				✓

0 1 . 2 The expression $F^{A} > F^{B}$ means that the allele F^{A} is dominant over the allele F^{B}.

Give the dominance hierarchy for the alleles F^{VE}, F^{E}, F^{L} and F^{VL}.

Use the definition of dominance hierarchy and information from **Table 1**.

[1 mark]

_____ > _____ > _____ > _____

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0 1 . 3 A scientist crosses a **late** flowering plant with an **early** flowering plant.

Draw a genetic diagram to show how this cross could produce **very early** flowering offspring.

[3 marks]

Parent phenotypes	**Late flowering**	**Early flowering**
Parent genotypes		
Gametes		
Offspring genotypes		
Offspring phenotypes		

0 1 . 4 The scientist counts the number of each phenotype of plant produced by the cross.

Name a statistical test the scientist should use to analyse the results.

Give a reason for your choice.

[2 marks]

_____

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Question 1 continues on the next page

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0 1 . 5 The scientist uses the statistical test and obtains a P value of 0.06

Explain what the scientist can conclude from this result.

[2 marks]

9

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 2 Thalassaemia is an inherited blood disorder caused by a recessive allele.

Scientists investigate the thalassaemia allele frequency in a population.

0 2 . 1 Define the term **allele frequency**.

[1 mark]

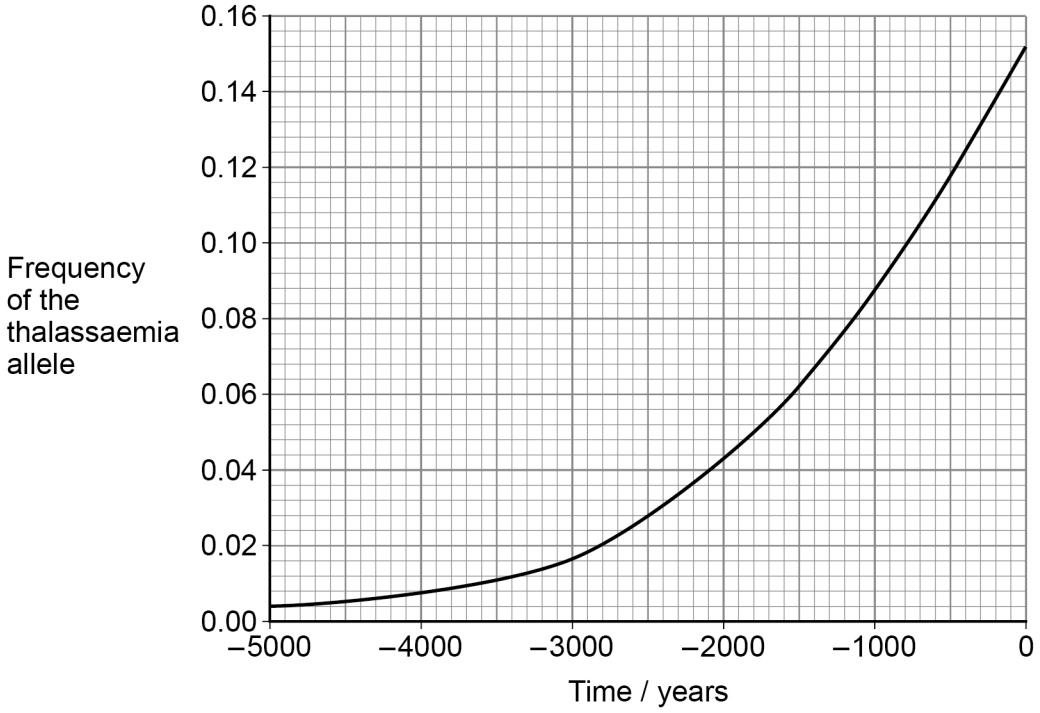
_____

_____

_____

Figure 1 shows how the frequency of the thalassaemia allele in a population has changed during the last 5000 years.

Figure 1



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0 2 . 2 Calculate the percentage of the population that are now heterozygous for the allele for thalassaemia.

Use **Figure 1** and the Hardy–Weinberg equation.

Give your answer to 3 significant figures.

[3 marks]

Percentage = _____ %

0 2 . 3 The Hardy–Weinberg principle predicts that allele frequencies will not change from generation to generation.

Give **two** conditions needed for the Hardy–Weinberg principle to apply.

[2 marks]

1 _____

_____

_____

2 _____

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Question 2 continues on the next page

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0 2 . 4 **Figure 1** (on page 6) shows that the frequency of the thalassaemia allele has increased.

The increase in allele frequency from 5000 years ago to 4000 years is 0.004

The increase from 1000 years ago to 0 years is greater.

Calculate how many times greater.

Use data from **Figure 1**.

[2 marks]

Number of times greater = _____

0 2 . 5 People who are heterozygous for the thalassaemia allele do not have symptoms of thalassaemia. They are also less likely to get the disease malaria.

People can die from malaria.

The data shown in **Figure 1** (on page 6) are for a population that is affected by malaria.

Explain the change in allele frequency shown in **Figure 1**.

[2 marks]

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0 3 A scientist investigates the effect of temperature on the rate of carbon dioxide released by insects.

The scientist uses locusts in the investigation.

The scientist:

- uses a temperature-controlled box set at 38 °C
- puts a locust in the box for 48 hours
- takes no measurements for the first 24 hours
- measures the volume of carbon dioxide released in the second 24 hours
- repeats the investigation with temperatures from 18 to 36 °C at 2 °C intervals
- repeats the investigation with 12 locusts for each temperature.

0 3 . 1 Suggest **one** reason why the scientist takes no measurements for the first 24 hours.

[1 mark]

_____

_____

_____

0 3 . 2 Give **two** precautions the scientist should take to reduce the risk of harm when handling living insects in the investigation.

[2 marks]

1 _____

_____

_____

2 _____

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_____

Question 3 continues on the next page

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0 3 . 3 Give reasons why the scientist did not use temperatures lower than 18 °C or higher than 38 °C

[2 marks]

Not lower than 18 °C _____

_____

_____

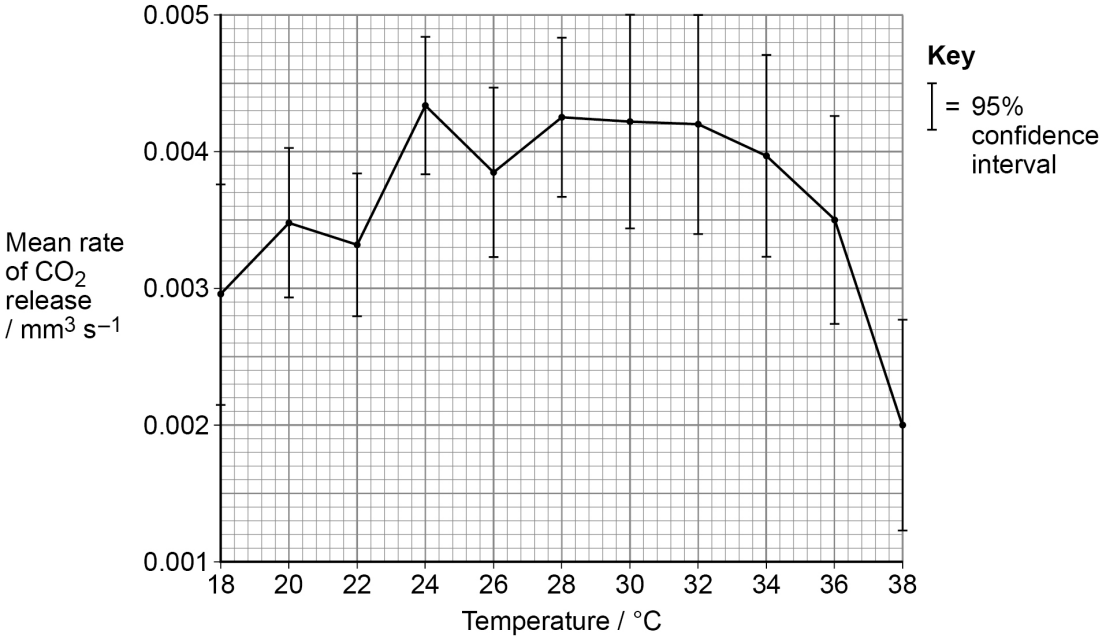
Not higher than 38 °C _____

_____

_____

Figure 2 shows the scientist's results.

Figure 2



0 3 . 4 **Figure 2** shows the points joined with straight lines.

Give **one** reason why the scientist joined the points with straight lines rather than a curve of best fit.

[1 mark]

_____

_____

_____

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0 3 . 5 The error bars on **Figure 2** represent 95% confidence intervals.

Give the reason why the scientist displayed his results in this way.

[1 mark]

_____

_____

_____

0 3 . 6 Calculate the change in the rate of carbon dioxide release from 36 °C to 38 °C

Include a suitable unit for the change in the rate.

[2 marks]

Change in rate = _____

Unit = _____

Question 3 continues on the next page

Do not write outside the box

0 3 . 7 A student concludes that the optimum temperature for insect respiration is in the range 23 °C to 35 °C

Evaluate the student's conclusion.

Use information from the scientist's method and from **Figure 2** (on page 10).

[4 marks]

13

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0 4 Algae are photosynthetic organisms.

Different colours of algae contain different photosynthetic pigments.

All algae contain the pigment chlorophyll.

0 4 . 1 Describe the role of chlorophyll in the light-dependent reaction of photosynthesis.

[3 marks]

Question 4 continues on the next page

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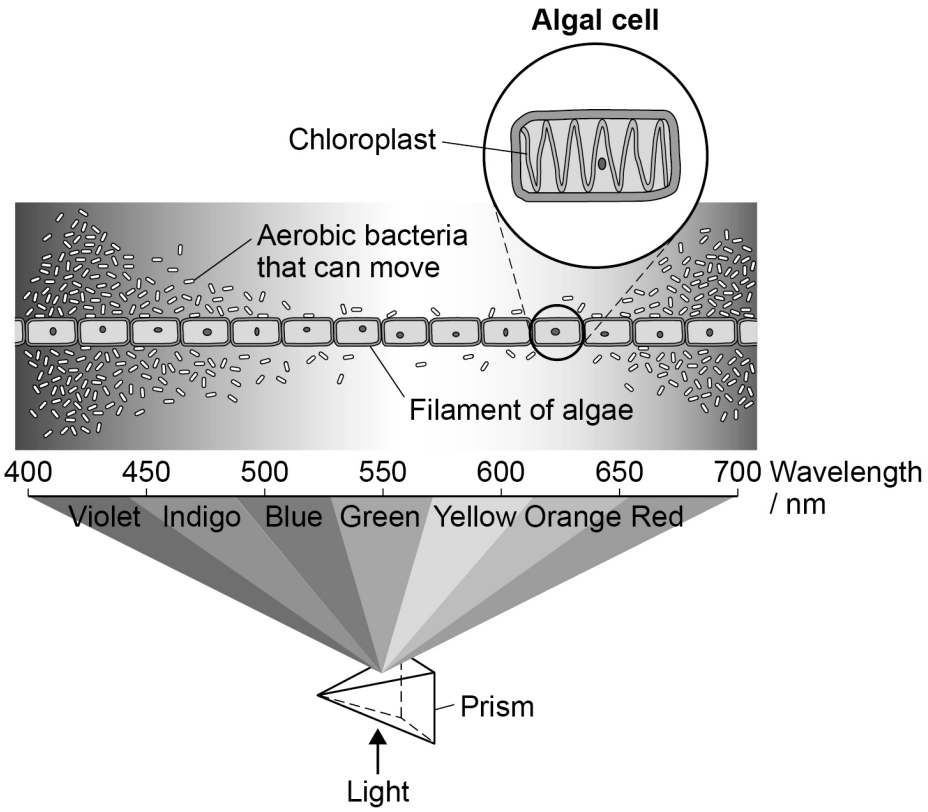
A scientist investigates the effect of the wavelength of light on the production of oxygen during photosynthesis.

The scientist:

- puts a filament of green algae on a slide
- adds aerobic bacteria that can move
- shines light onto the slide through a prism to split the light into different wavelengths
- uses a microscope to observe the distribution of the bacteria.

Figure 3 shows the distribution of the bacteria on the slide.

Figure 3



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0 4 . 2 Explain the distribution of the bacteria shown in **Figure 3**.

[2 marks]

0 4 . 3 Describe a suitable control experiment that the scientist could use in the investigation.

[2 marks]

Question 4 continues on the next page

Do not write outside the box

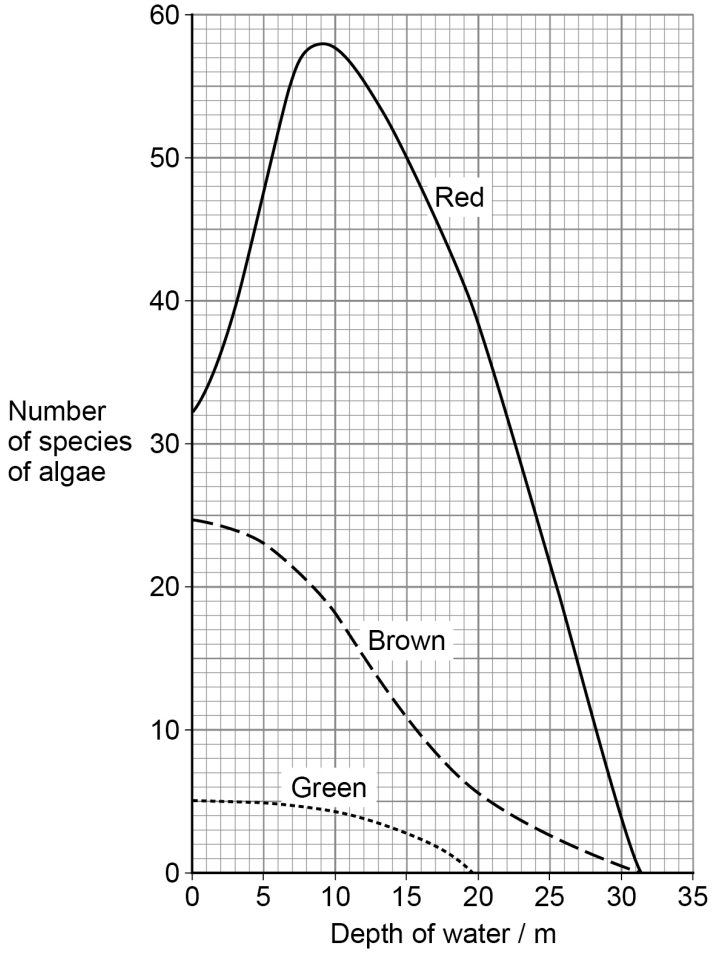
There are different phyla of algae in the sea: red algae, green algae and brown algae. Some scientists investigate how the depth of water affects which phyla of algae live there.

The scientists:

- collect samples of water from different depths in the sea
- count the number of species of red, green and brown algae in each water sample.

Figure 4 shows the scientists' results.

Figure 4



0 4 . 4 Suggest **one** way the scientists should standardise the sampling technique.

[1 mark]

_____

_____

_____

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0 4 . 5 Blue light penetrates more deeply through water than red light.

Suggest **one** reason for the phyla of algae found at a depth of 25 m

[1 mark]

_____

_____

_____

_____

9

Turn over for the next question

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0 5 In 1980, a volcano called Mount St Helens erupted.

The forest surrounding the volcano was destroyed.

Scientists investigated the changes in the plant species growing around the volcano in the years after the eruption.

The scientists:

- selected 103 plots of land, each of area 250 m^2, around the volcano
- recorded the percentage of plots containing each plant species for 20 years after the eruption.

Table 2 shows the scientists' results.

Table 2

Plant species	**Percentage of plots containing plant species in different years after the eruption**			
	1983	1989	1994	2000
Wood groundsel	59	14	10	7
Rough bentgrass	5	16	72	29
Prairie lupine	3	26	48	54
Red alder tree	0	7	68	84
Douglas fir tree	0	0	3	9

0 5 . 1 Explain how succession has occurred around the volcano.

Use information from **Table 2**.

[4 marks]

Do not write outside the box

0 5 . 2 Calculate the ratio of wood groundsel to red alder in 1989 **and** the ratio in 2000.

[2 marks]

Ratio in 1989 = 1:_____

Ratio in 2000 = 1:_____

0 5 . 3 Give **one** reason for the change in the ratio of wood groundsel to red alder from 1989 to 2000.

[1 mark]

_____

_____

_____

0 5 . 4 The diversity of plants around Mount St Helens volcano increased between 1983 and 2000.

This caused the diversity of animals to increase.

Give **two** possible reasons for this increase in animal diversity.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

9

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0 6 Scientists investigate the possible effects of climate change on the heather beetle, an insect pest of heather plants.

The scientists create an artificial study area divided into four sections with different environmental conditions:

1. control with standard conditions
2. increased carbon dioxide in the air
3. decreased rainfall
4. increased temperature.

The scientists add the same large number of heather beetles to each section.

Every week for 4 weeks the scientists measure:

- the number of beetles surviving in each section
- the masses of the surviving beetles.

0 6 . 1 The scientists removed dead organic matter from the four sections at the start of the investigation before adding the beetles.

Explain why the dead organic matter could have caused a change in the environmental conditions.

[3 marks]

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The scientists calculate the change in the risk of death of the beetles in each section compared with the control section.

The scientists' results are shown in **Table 3**.

Table 3

Environmental condition	Change in risk of death	P value
Increased carbon dioxide	3.5 times higher	<0.001
Decreased rainfall	2.6 times higher	<0.01
Increased temperature	1.2 times higher	0.6

0 6 . 2 Do the environmental conditions have a significant effect on the risk of death of the beetles?

Give evidence for your answer from **Table 3**.

[3 marks]

Question 6 continues on the next page

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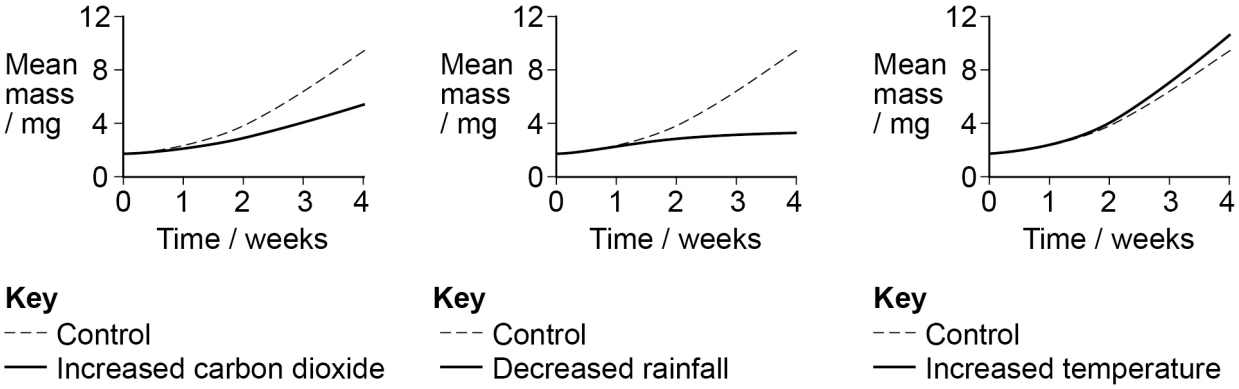
The scientists plot graphs of the mean mass of beetles in the sections with:

- increased carbon dioxide
- decreased rainfall
- increased temperature

compared with the mean mass of beetles in the control section.

Figure 5 shows the scientists' results.

Figure 5



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0 6 . 3 The scientists' artificial study area allowed them to investigate possible effects of climate change on heather beetles.

Increased carbon dioxide in the air, changes to rainfall and increased temperature are all linked to climate change.

One conclusion from the scientists' investigation is:

'Climate change causes a decrease in the mass of insect pests.'

Evaluate this conclusion.

Use information from the scientists' method and from **Figure 5**.

[4 marks]

10

Turn over for the next question

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0 7 . 1 A scientist measures the concentration of carbon dioxide in a lake.

The carbon dioxide concentration in the lake changes:

- during a 24-hour time period
- at different depths in the lake.

Explain what causes these changes in carbon dioxide concentration.

Use your knowledge of photosynthesis **and** respiration.

[5 marks]

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0 7 . 2 Explain the importance of ATP in photosynthesis **and** respiration.

[6 marks]

Question 7 continues on the next page

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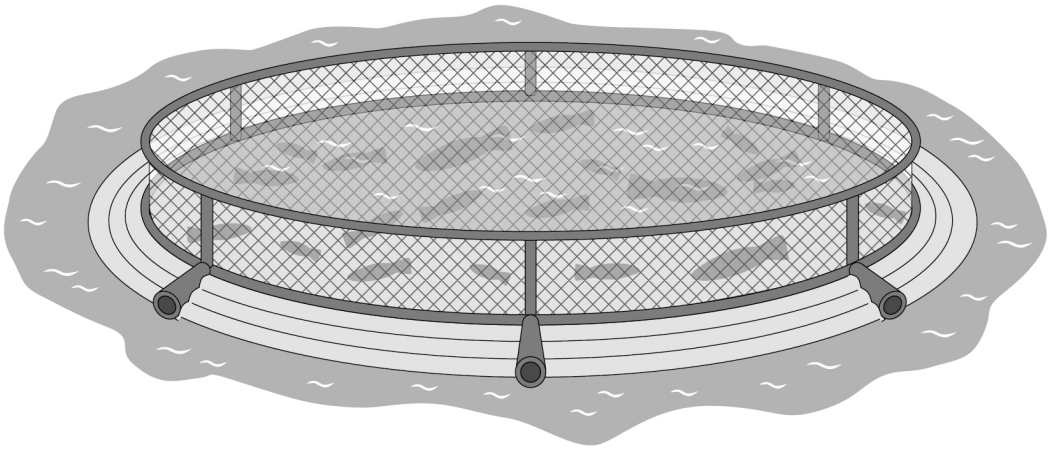
0 7 . 3 Salmon are a type of fish that can be farmed for food.

When they are farmed, young salmon are grown in cages.

Figure 6 shows some farmed salmon in a cage.

Figure 6



Explain how techniques used in fish farming can increase the efficiency of energy transfer to salmon.

[4 marks]

15

END OF QUESTIONS

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