UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

4950993262

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black ink.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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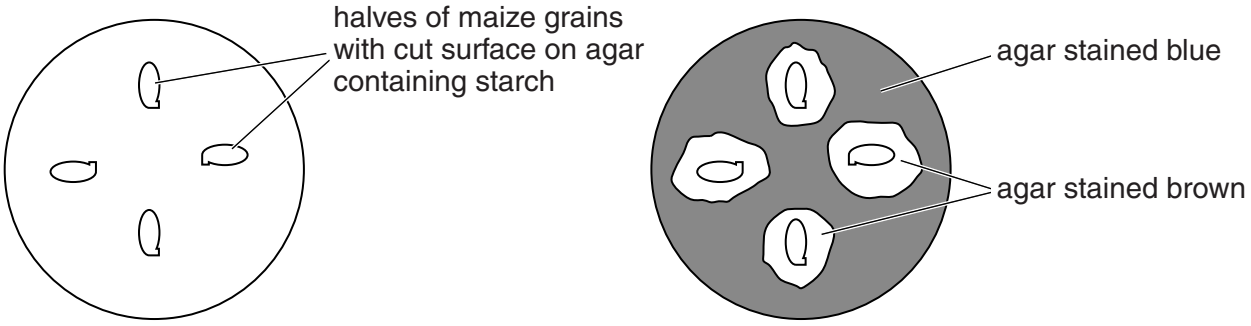
1 **(a)** A group of students was given the task of planning a method to find the effects of the growth regulator gibberellin (GA) on the germination of maize grains.

The students looked up information about investigations into the germination of maize. The information that the students found is listed below.

- Maize needs to be soaked in water for 24 hours to stimulate germination.
- Maize starts to germinate 48–72 hours after soaking.
- GA promotes germination by activating a gene that causes the synthesis of the enzyme amylase.
- The range of concentrations at which GA is found in plants is between 1–10 μmol dm^{-3}.
- Amylase is released by the aleurone layer into the endosperm of the maize grain to hydrolyse the starch reserves.
- The activity of amylase can be estimated by cutting the maize grains lengthways into two halves and placing the cut sides onto agar containing starch in Petri dishes.
- After incubation at a constant temperature, iodine solution is used to test the agar for the presence of starch.

The students carried out a preliminary investigation using maize grains that had been soaked in a 3 mmol dm^{-3} solution of GA.

Fig. 1.1 shows the arrangement of cut maize grains that the students decided to use for their main investigation and the results of testing the agar for starch using iodine solution after incubation.



arrangement of maize grains on agar containing starch in a Petri dish

results of testing the agar with iodine solution after incubation with halves of maize grains

Fig. 1.1

The students thought that the area stained brown was proportional to the activity of the amylase and could be used to test the hypothesis:

The greater the concentration of gibberellin (GA) to which the maize is exposed, the greater the activity of amylase.

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(i) Identify the independent and the dependent variables in the students' preliminary investigation.

independent variable ....

....

dependent variable ....

.... [2]

(ii) The students were provided with a 3 mmol dm^{-3} GA solution.
Describe how the students could use the method from their preliminary investigation to test their hypothesis. Your method should be detailed enough for another person to use.

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(b) The students decided to plot a graph of their results.

Suggest labels, including units, for the axes of this graph.

x-axis .....

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y-axis .....

.....[2]

(c) **(i)** The students thought that the area stained brown was proportional to the activity of the amylase.

Suggest three limitations of using this way to estimate amylase activity.

1. .....

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2. .....

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(ii) For **one** of these limitations, suggest how the estimation of amylase activity could be improved.

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.....[2]

[Total: 17]

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2 In an area where an open cast or surface mine was to be developed, the soil was removed and stored in a large heap. After the mining was finished, the area was reclaimed and the soil spread over the surface.

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Studies were carried out on the aerobic and anaerobic bacteria living in the soil while it was stored.

Samples were taken at different depths, 1 month and 6 months after the soil was put into the large heap for storage.

Table 2.1 shows the numbers of aerobic and anaerobic bacteria at different depths in the stored soil.

Table 2.1

depth in soil store / m	mean number of bacteria per gram of stored soil $\times 10^7$			
	aerobic bacteria		anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0.0	12.4	12.5	0.4	0.6
0.5	10.1	8.3	0.6	1.0
1.0	9.8	5.9	0.8	3.8
1.5	9.7	3.1	0.8	7.6
2.0	10.5	0.8	0.7	8.1
2.5	10.8	0.7	0.8	8.5
3.0	10.2	0.9	0.6	8.8

(a) Describe the trends shown by the distribution of the two types of bacteria in the stored soil after 6 months and suggest reasons for these trends.

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(b) In a further study, soil samples were taken at two depths, **A** and **B**, in the soil store. The samples were taken at intervals over six years. Soil samples of equal mass were used to determine the activity of dehydrogenase enzymes in the Krebs cycle of the **aerobic** bacteria.

Fig. 2.1 shows the mean dehydrogenase activity of the bacteria in these samples.

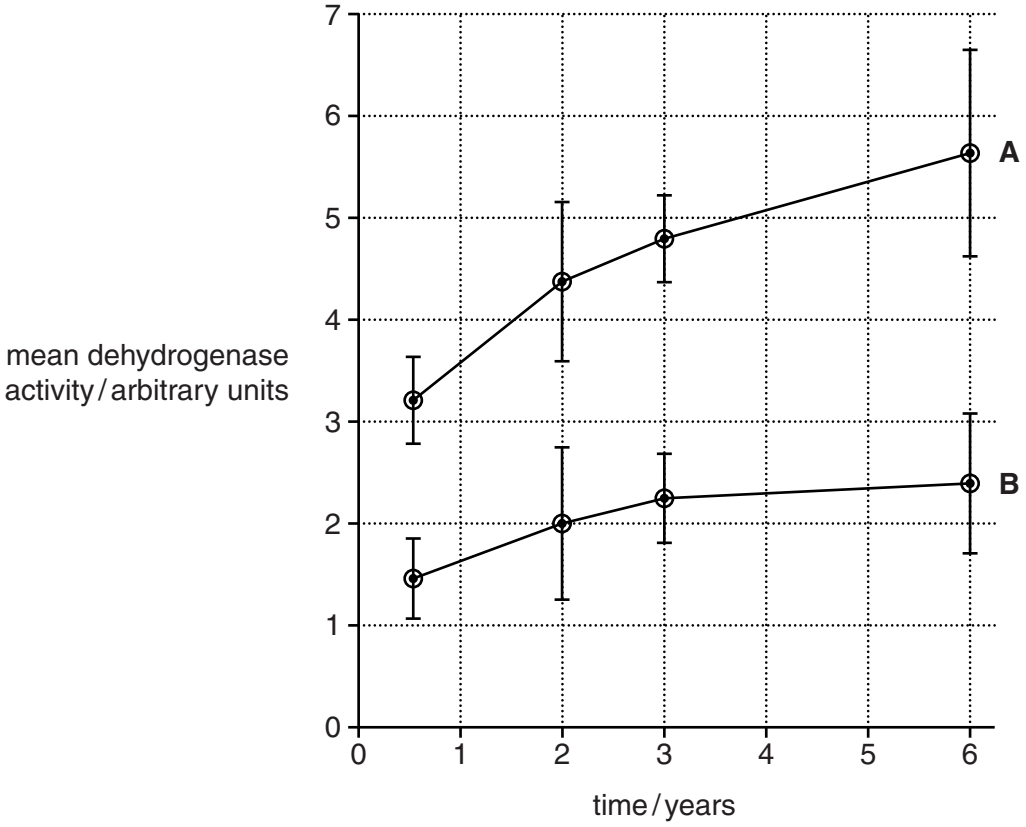


Fig. 2.1

(i) State the evidence from Fig. 2.1 that samples in **B** were taken at a greater depth than samples in **A**.

.....

.....[1]

(ii) Suggest two variables that should be standardised when the dehydrogenase activity is determined.

1. .....

2. ..... [2]

(iii) Suggest a control for the determination of dehydrogenase activity in the bacteria in the soil samples.

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.....[1]

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(c) The error bars on Fig. 2.1 are two standard error units above and below the mean.

(i) Using evidence from Fig. 2.1 state what these error bars show about the reliability of the data.

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.....[2]

(ii) A *t*-test was carried out between each of the following sets of data from the samples at depth **A**:

6 months and 2 years;	6 months and 3 years;	6 months and 6 years;
2 years and 3 years;	2 years and 6 years;	3 years and 6 years.

Identify **two** *t*-tests in which the difference in dehydrogenase activity is likely to be significant. Show your answer by underlining the tests. [1]

Give a reason for your answer.

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.....[1]

(d) Table 2.2 shows the dehydrogenase activity and the number of aerobic bacteria present in six soil samples.

Table 2.2

dehydrogenase activity / arbitrary units	number of aerobic bacteria per gram of soil $\times 10^7$
13.5	12.2
9.6	9.1
5.8	7.0
3.0	4.6
2.5	3.2
0.6	0.9

The dehydrogenase activity of 1 g of another soil sample was measured.
Explain how the data in Table 2.2 could be used to predict the number of aerobic bacteria in this soil sample.

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[Total: 13]

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General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2236760819

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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1 A student saw an advertisement about using the plant growth regulator gibberellin (GA) to stimulate the germination and early growth of seeds.

The student obtained some of the advertised growth regulator.

The information on the packet received from the supplier gave the following information.

1. The GA is supplied as a stable powder in pre-weighed sachets.
2. The contents of each sachet when dissolved in $1\,dm^3$ water gives a concentrated solution of $1\,g\,dm^{-3}$ ($3\,mmol\,dm^{-3}$).
3. The concentrated solution can be diluted according to the type of seed germinated.
4. Seeds should be soaked in the concentration required for the particular type of seed before planting.

The student decided to test the growth regulator on barley to find out if the advertisement was true.

Research into the germination of barley provided the following information.

- Barley needs to be soaked in water for 24 hours before germinating.
- Barley germinates best at a temperature between 15–20 °C and without light.
- Embryos will develop into young plants with visible roots in 3 days and a shoot within 7 days.
- Germinating barley dries out very quickly and dies.
- The concentration of GA in barley tissue is normally $1\ \mu mol\ dm^{-3}$.
- Food stores in the endosperm of barley are hydrolysed by enzymes stimulated by GA and translocated into the developing embryo.

Fig. 1.1 shows a germinated barley grain.

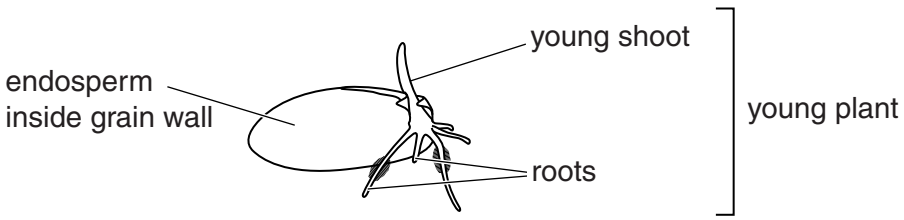


Fig. 1.1

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The student tested the hypothesis:

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As the concentration of GA increases to an optimum the rate of germination of barley grains and the early growth of the young plants increases.

(a) Sketch a curve to show the expected results if the student's hypothesis is correct.



[2]

(b) (i) Identify the independent and the dependent variables in this investigation.

independent variable .....

dependent variable ..... [2]

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(ii) Describe a method the student could use to test the hypothesis.

Your method should be detailed enough for another person to use.

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(c) To find the effect of GA on the growth of the young plants, the student calculated the percentage difference in growth of young plants from barley that had been soaked in water (untreated barley) and the young plants from each of the experimental groups of barley.

(i) State how percentage difference is calculated.

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(ii) Explain why the student used percentage difference instead of the actual difference between young barley plants.

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(d) The student used separate *t*-tests to find out if the percentage difference between the young plants grown from untreated barley and any of the young plants grown from the experimental barley, was significant.

(i) State **one** reason why the *t*-test is a suitable statistical test to use for the student's data.

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.....[1]

(ii) Suggest a null hypothesis for these tests.

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.....[1]

[Total: 17]

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[Turn over

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2 The effect of oxygen on the growth of a species of bacterium, *Aerobacter aerogenes*, was investigated. The procedure used is listed below.

- A container of sterile growth medium was inoculated with 2.5×10^6 cells per cm^3 of the bacterium.
- The growth medium was maintained at a constant temperature and pH.
- The culture was stirred constantly at a low speed.
- The bacteria were grown at first in anaerobic conditions.
- After a period of time a stream of air was passed through the culture at a constant rate.
- Samples of the culture were removed at intervals and the population of bacteria estimated in each sample.

(a) Identify the **independent** variable in this investigation.

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(b) Three of the precautions taken in this procedure were:

- the pH was kept constant
- a sterile medium was used
- the culture was stirred constantly at a low speed.

Explain why each of these precautions was necessary.

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Fig. 2.1 shows the surface view of a counting grid for a light microscope used to estimate the number of bacteria in each sample.

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The depth of the grid is 0.1 mm.

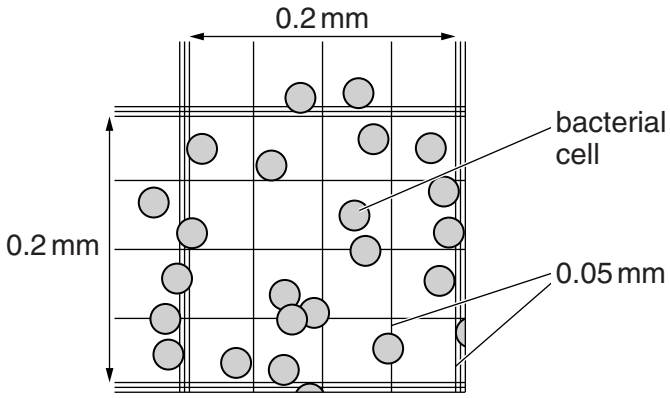


Fig. 2.1

(c) Suggest how this apparatus could be used to estimate the number of cells per cm^3 of culture.

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Question 2 continues on Page 8

Table 2.1 shows the results of the investigation.

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Table 2.1

time since inoculation of growth medium / min	100	130	160	190	220	250	280	310	340	370
population of bacteria / 10^6 cells cm^{-3}	14	23	40	66	78	224	463	812	1122	1148

(d) Suggest why the results in Table 2.1 may not be reliable.

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(e) Suggest an explanation for the results of the investigation into the growth of *Aerobacter aerogenes* show in Table 2.1.

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[Total: 13]

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General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0349244349

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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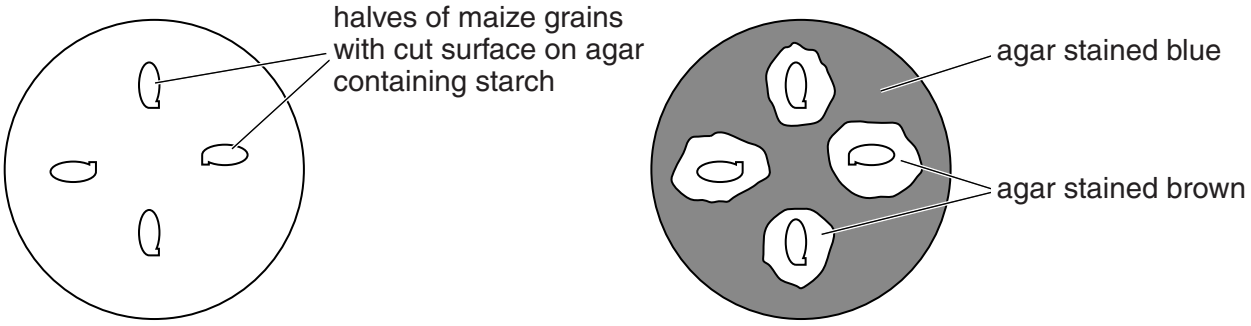
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- Maize needs to be soaked in water for 24 hours to stimulate germination.
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- The range of concentrations at which GA is found in plants is between 1–10 μmol dm^{-3}.
- Amylase is released by the aleurone layer into the endosperm of the maize grain to hydrolyse the starch reserves.
- The activity of amylase can be estimated by cutting the maize grains lengthways into two halves and placing the cut sides onto agar containing starch in Petri dishes.
- After incubation at a constant temperature, iodine solution is used to test the agar for the presence of starch.

The students carried out a preliminary investigation using maize grains that had been soaked in a 3 mmol dm^{-3} solution of GA.

Fig. 1.1 shows the arrangement of cut maize grains that the students decided to use for their main investigation and the results of testing the agar for starch using iodine solution after incubation.



arrangement of maize grains on agar containing starch in a Petri dish

results of testing the agar with iodine solution after incubation with halves of maize grains

Fig. 1.1

The students thought that the area stained brown was proportional to the activity of the amylase and could be used to test the hypothesis:

The greater the concentration of gibberellin (GA) to which the maize is exposed, the greater the activity of amylase.

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(i) Identify the independent and the dependent variables in the students' preliminary investigation.

independent variable ....

....

dependent variable ....

.... [2]

(ii) The students were provided with a 3 mmol dm^{-3} GA solution.
Describe how the students could use the method from their preliminary investigation to test their hypothesis. Your method should be detailed enough for another person to use.

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(b) The students decided to plot a graph of their results.

Suggest labels, including units, for the axes of this graph.

x-axis .....

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y-axis .....

.....[2]

(c) **(i)** The students thought that the area stained brown was proportional to the activity of the amylase.

Suggest three limitations of using this way to estimate amylase activity.

1. .....

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2. .....

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3. .....

.....[3]

(ii) For **one** of these limitations, suggest how the estimation of amylase activity could be improved.

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[Total: 17]

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2 In an area where an open cast or surface mine was to be developed, the soil was removed and stored in a large heap. After the mining was finished, the area was reclaimed and the soil spread over the surface.

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Studies were carried out on the aerobic and anaerobic bacteria living in the soil while it was stored.

Samples were taken at different depths, 1 month and 6 months after the soil was put into the large heap for storage.

Table 2.1 shows the numbers of aerobic and anaerobic bacteria at different depths in the stored soil.

Table 2.1

depth in soil store / m	mean number of bacteria per gram of stored soil $\times 10^7$			
	aerobic bacteria		anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0.0	12.4	12.5	0.4	0.6
0.5	10.1	8.3	0.6	1.0
1.0	9.8	5.9	0.8	3.8
1.5	9.7	3.1	0.8	7.6
2.0	10.5	0.8	0.7	8.1
2.5	10.8	0.7	0.8	8.5
3.0	10.2	0.9	0.6	8.8

(a) Describe the trends shown by the distribution of the two types of bacteria in the stored soil after 6 months and suggest reasons for these trends.

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For Examiner's Use

(b) In a further study, soil samples were taken at two depths, **A** and **B**, in the soil store. The samples were taken at intervals over six years. Soil samples of equal mass were used to determine the activity of dehydrogenase enzymes in the Krebs cycle of the **aerobic** bacteria.

Fig. 2.1 shows the mean dehydrogenase activity of the bacteria in these samples.

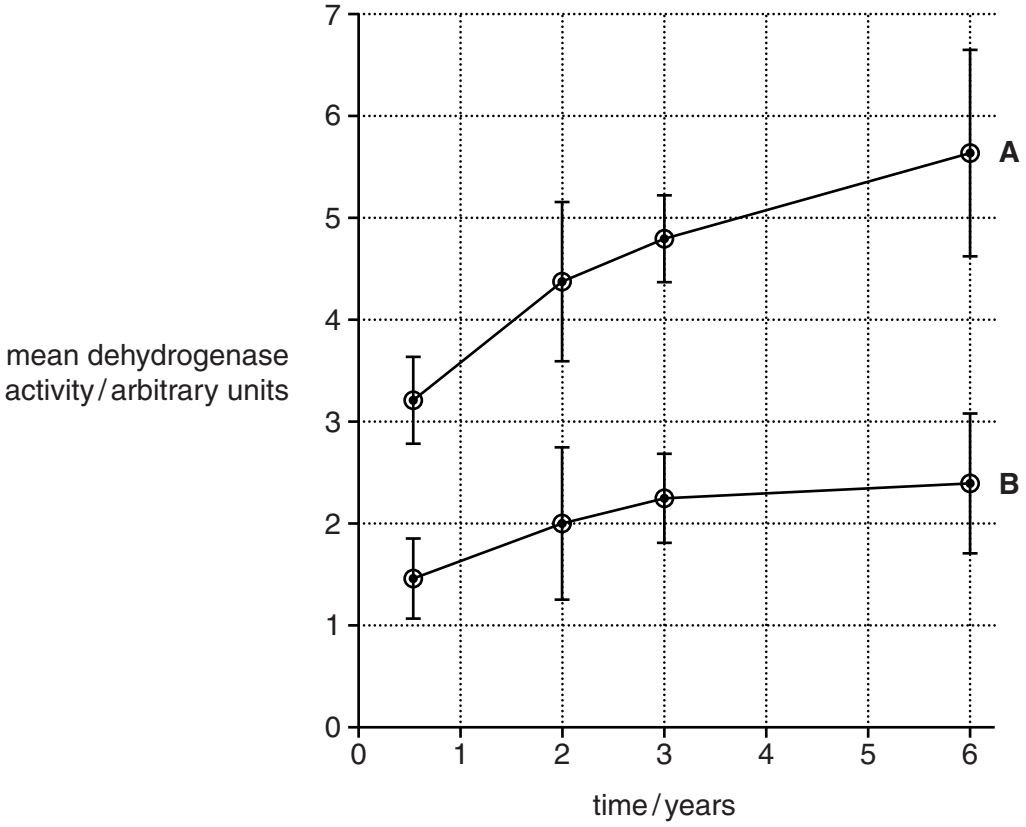


Fig. 2.1

(i) State the evidence from Fig. 2.1 that samples in **B** were taken at a greater depth than samples in **A**.

.....

.....[1]

(ii) Suggest two variables that should be standardised when the dehydrogenase activity is determined.

1. .....

2. ..... [2]

(iii) Suggest a control for the determination of dehydrogenase activity in the bacteria in the soil samples.

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.....[1]

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(c) The error bars on Fig. 2.1 are two standard error units above and below the mean.

(i) Using evidence from Fig. 2.1 state what these error bars show about the reliability of the data.

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.....[2]

(ii) A *t*-test was carried out between each of the following sets of data from the samples at depth **A**:

6 months and 2 years;	6 months and 3 years;	6 months and 6 years;
2 years and 3 years;	2 years and 6 years;	3 years and 6 years.

Identify **two** *t*-tests in which the difference in dehydrogenase activity is likely to be significant. Show your answer by underlining the tests. [1]

Give a reason for your answer.

.....

.....[1]

(d) Table 2.2 shows the dehydrogenase activity and the number of aerobic bacteria present in six soil samples.

Table 2.2

dehydrogenase activity / arbitrary units	number of aerobic bacteria per gram of soil $\times 10^7$
13.5	12.2
9.6	9.1
5.8	7.0
3.0	4.6
2.5	3.2
0.6	0.9

The dehydrogenase activity of 1 g of another soil sample was measured.
Explain how the data in Table 2.2 could be used to predict the number of aerobic bacteria in this soil sample.

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[Total: 13]

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