Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

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7468430678

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

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[Turn over

1 Baker's yeast, *Saccharomyces cerevisiae*, has two metabolic pathways for the production of ATP, aerobic respiration and fermentation. Oxygen is **not** used in fermentation.

These pathways are summarised in Fig. 1.1.

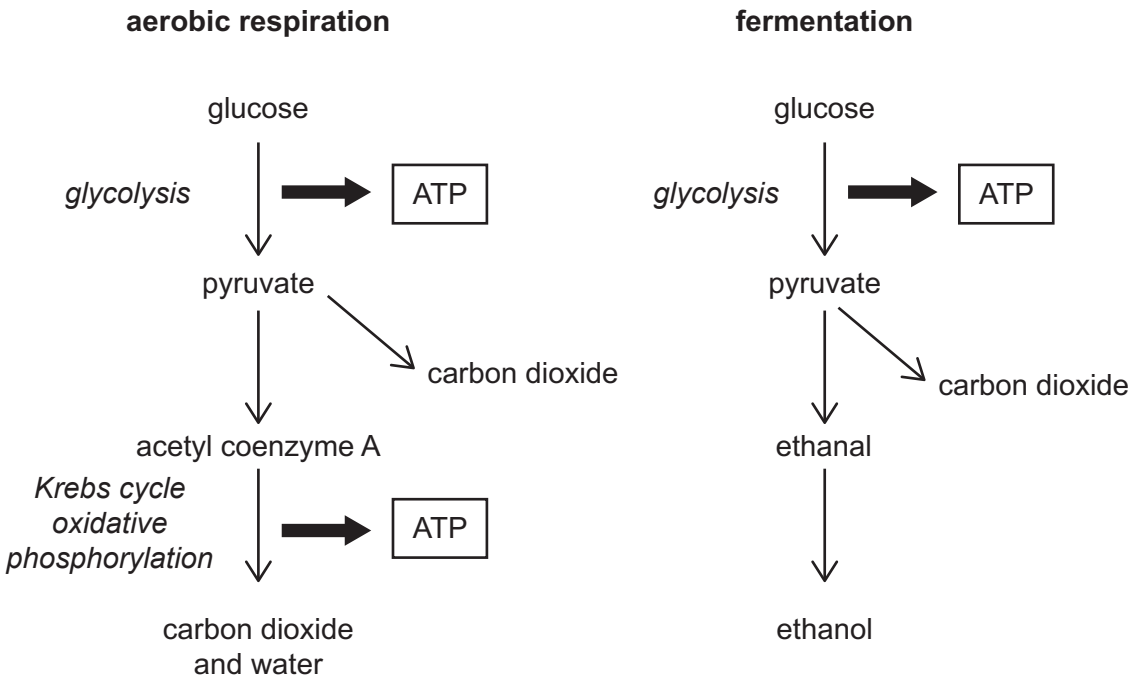


Fig. 1.1

Some students were researching details of the respiration of yeast. In their research, the students found information about the Crabtree effect. This effect occurs when yeast is kept in high concentrations of glucose. The yeast gains sufficient ATP from substrate-linked phosphorylation during glycolysis. Yeast does not carry out the Krebs cycle or oxidative phosphorylation and therefore does not use oxygen.

The students wanted to investigate the effect of temperature on the activity of yeast and decided to use yeast solutions in which the yeast obtained all of its ATP by fermentation.

- The students made a suspension of yeast from 1 g of dried yeast and 25 cm^3 of water.
- The suspension was left for 2 hours at 20 °C.
- After 2 hours, 25 cm^3 of glucose solution was added to the yeast suspension and the mixture was stirred.
- Some of the mixture was added immediately to the apparatus shown in Fig. 1.2.

The students measured the volume of carbon dioxide produced by yeast fermentation.

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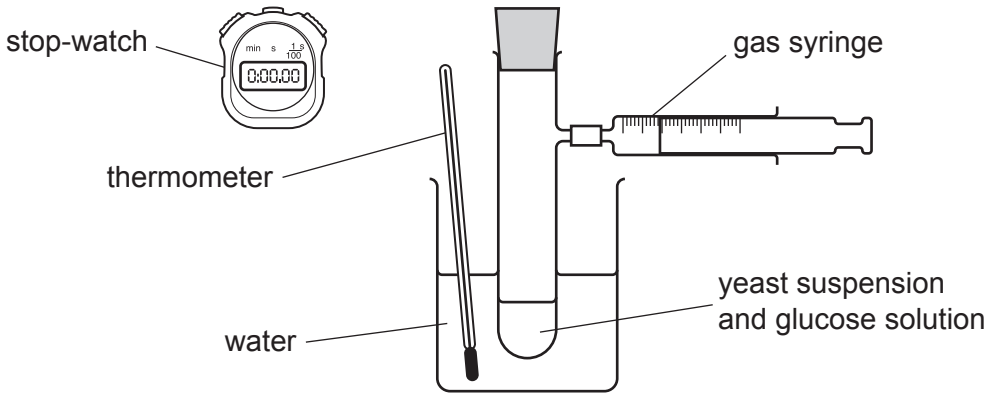


Fig. 1.2

(a) (i) State the independent variable **and** the dependent variable in this investigation.

independent variable .....

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dependent variable .....

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[2]

(ii) Explain why the students stirred the mixture of yeast and glucose before adding it to the tube in the apparatus in Fig. 1.2.

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..... [1]

(iii) Describe a method using the apparatus, set up as shown in Fig. 1.2, that the students could use to find the temperature at which yeast carries out fermentation at its maximum rate.

Your method should be set out in a logical order and be detailed enough for another person to follow.

You should **not** include details of how to make the yeast suspension or how to set up the apparatus.

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(iv) Complete the sketch graph to predict the results that you would expect from the method that you have given in part **(iii)**. Include axes labels with units in your answer.



[2]

(b) Scientists have discovered that some other species of yeast show the Crabtree effect.

The Crabtree effect means that in high concentrations of glucose **and** with oxygen present, pyruvate is not metabolised in mitochondria so aerobic respiration does not occur.

Yeast species that are able to maintain their levels of ATP production when conditions suddenly change and **no** oxygen is available show the Crabtree effect.

An investigation compared *S. cerevisiae* with the yeast *Candida tropicalis* to see if this other species also shows the Crabtree effect.

Three flasks containing suspensions of *S. cerevisiae* in a growth medium were initially kept in different conditions (conditions for growth).

After a set time, the yeast in each flask was transferred to a flask containing a fresh medium with high glucose concentration and **no** oxygen (experimental conditions). All other conditions were standardised.

The same procedure was repeated for *C. tropicalis*.

The conditions for growth and the experimental conditions in the flasks are summarised in Table 1.1.

Table 1.1

flask	conditions for growth	experimental conditions
flask 1	high glucose concentration with no oxygen	high glucose concentration with no oxygen
flask 2	high glucose concentration with oxygen	high glucose concentration with no oxygen
flask 3	water (no glucose) with oxygen	high glucose concentration with no oxygen

Samples taken from the flasks kept in the experimental conditions were put into the apparatus shown in Fig. 1.2 to measure the volume of carbon dioxide produced by the two yeast species.

The results are shown in Fig. 1.3.

The final volume of carbon dioxide produced by the sample of yeast from flask 1 at 30 minutes is shown as a maximum volume of 100% in Fig. 1.3. All other volumes were calculated as a proportion of this maximum. This allows a direct comparison to be made between the two species.

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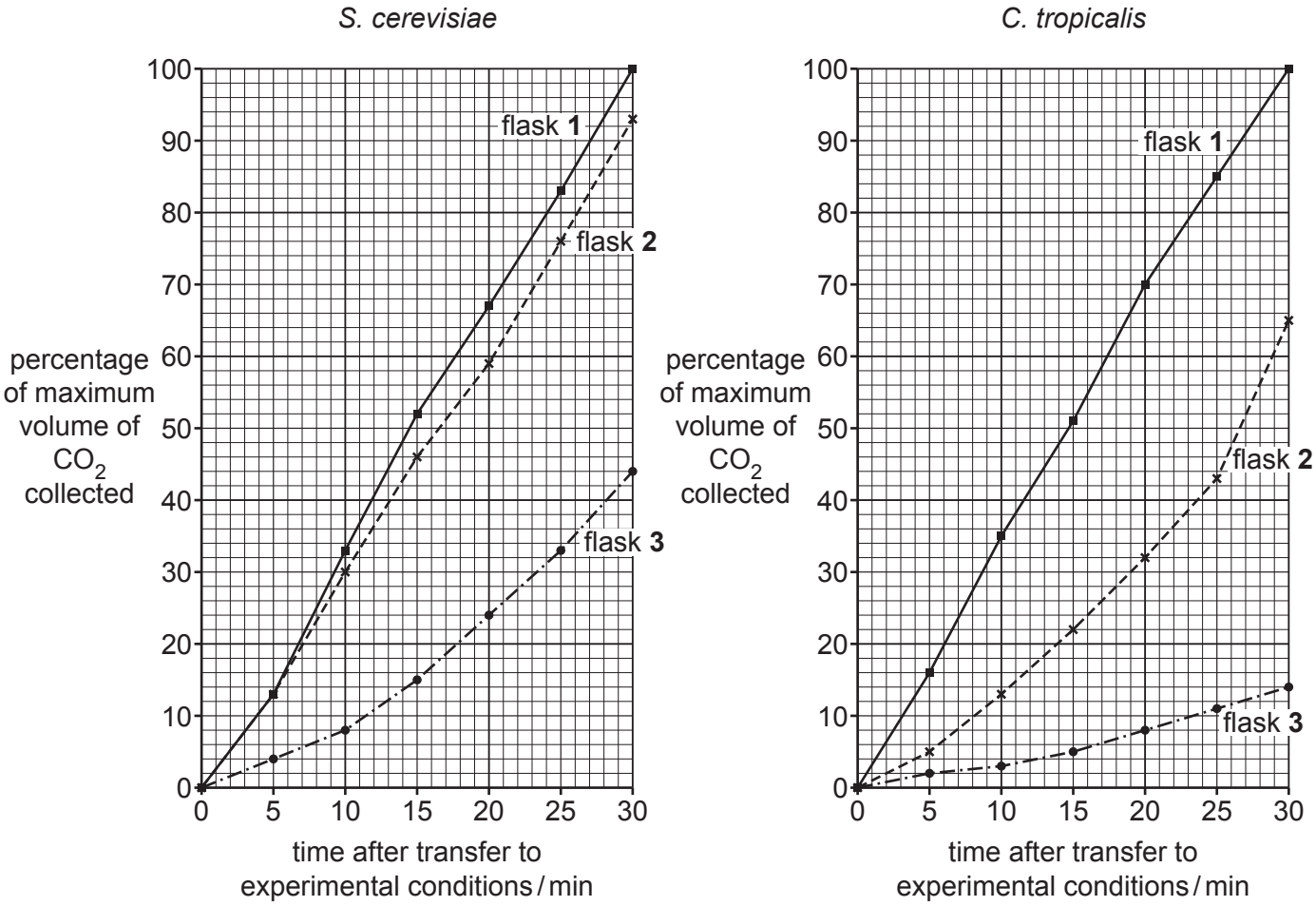


Fig. 1.3

State **and** explain the evidence in Fig. 1.3 that supports the idea that *C. tropicalis* does **not** show the Crabtree effect.

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[Total: 15]

2 Species diversity is often used as a simple way to compare the biodiversity of different regions of the world.

A student read that species diversity decreases with increasing distance from the equator. The latitude at the equator is 0°. Latitudes increase north and south of the equator.

The student selected data from a database which holds records of the annual bird count in North America.

This annual count is carried out each year during one day in the winter. Volunteers count all the species of birds that they observe in each location. The area of each location is the same size.

The student found data from 17 sample locations within the Delmarva Peninsula on the east coast of the USA for 2005.

Fig. 2.1 shows the 17 locations within the Delmarva Peninsula.

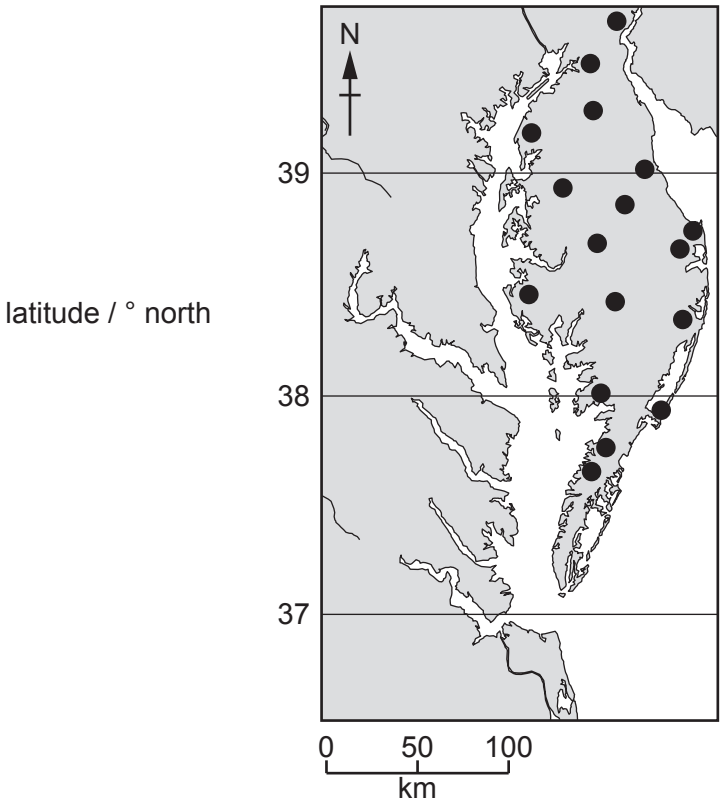


Fig. 2.1

The student used the data to see if there was any relationship between the latitudes of the sample locations and the number of species recorded at each location.

The data are shown in Fig. 2.2.

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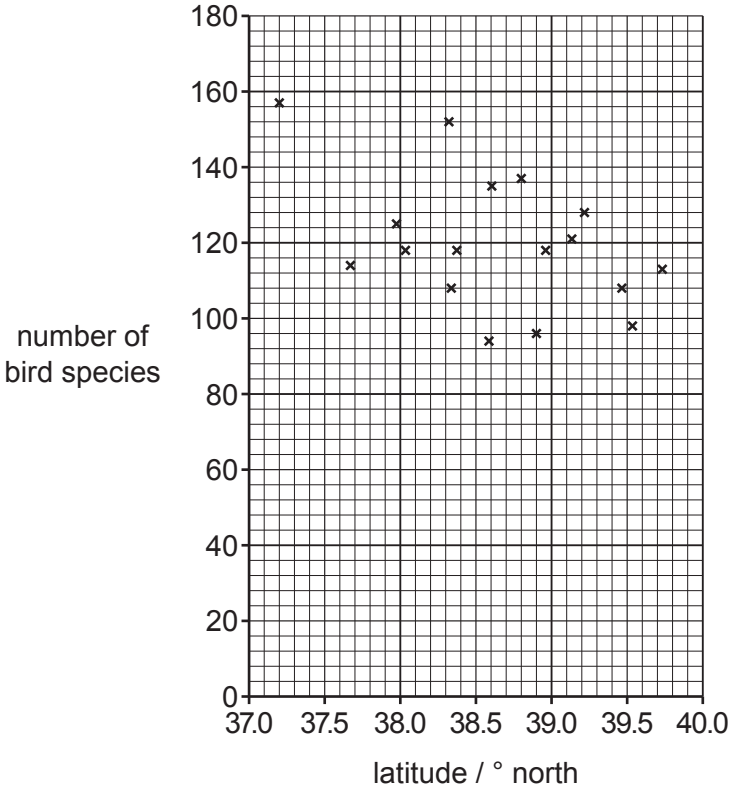


Fig. 2.2

(a) Describe the trend shown by the scatter graph in Fig. 2.2.

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(b) The student analysed the data using Spearman's rank correlation test.

(i) State **three** reasons why this statistical test is a suitable way to analyse the data about species diversity in Fig. 2.2.

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(ii) State the null hypothesis for this investigation.

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(iii) The student calculated the value of Spearman's rank correlation coefficient, r_s, as **-0.359**.

Table 2.1 shows the probability table for Spearman's rank correlation test.

Table 2.1

number of pairs of measurements	critical values	
	p = 0.05 (5%)	p = 0.01 (1%)
15	0.521	0.654
16	0.503	0.635
17	0.485	0.615
18	0.472	0.600
19	0.460	0.584
20	0.447	0.570

Discuss, with reference to Table 2.1, the conclusions that can be made from the analysis of the data collected by the student.

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(c) The student was investigating the statement 'species diversity decreases with increasing distance from the equator'.

Discuss the limitations of the sampling method and of the data collected in supporting this statement.

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Turn over for question 2(d).

Small birds such as the ruby-crowned kinglet, *Regulus calendula*, are found throughout North America.

Fig. 2.3 shows a ruby-crowned kinglet caught in a mist net. Mist nets are used in surveys of bird populations.



Fig. 2.3

(d) Describe how the mark-release-recapture method can be used to estimate the population size of small birds, such as the ruby-crowned kinglet.

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[Total: 15]

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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5643531812

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2021**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
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INFORMATION

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1 Some students researched how yeast, *Saccharomyces cerevisiae*, is used in the food industry. The students found that in different manufacturing processes yeast is provided with different types of sugar. These sugars are either monosaccharides or disaccharides.

The students decided to compare the effect of supplying yeast with glucose or with maltose.

Glucose is a monosaccharide. Maltose is a disaccharide composed of two glucose molecules joined by a glycosidic bond.

- The students made a standard yeast suspension using 100 g of dried yeast and 1 dm^3 of deionised water.
- The suspension was left at 20 °C for two hours. During this time the yeast became active.
- After two hours the yeast culture was divided into two samples.
- Sample **A** was provided with glucose and sample **B** was provided with maltose.
- The apparatus shown in Fig. 1.1 was set up for each sample separately.

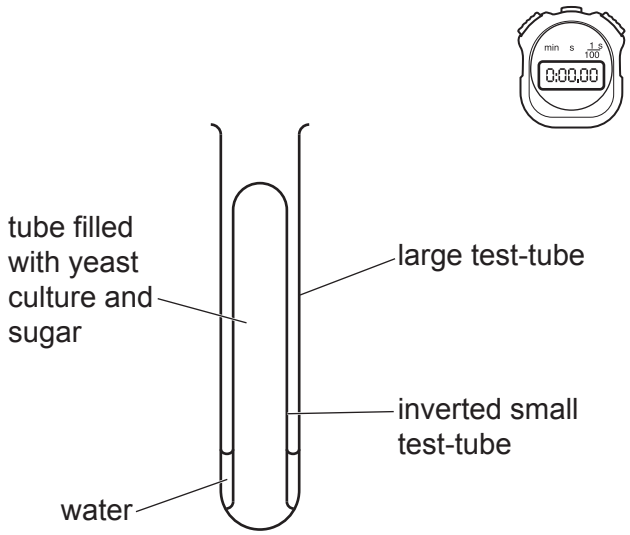


Fig. 1.1

- As the yeast respired, gas collected at the top of the small test-tubes, as shown in Fig. 1.2.

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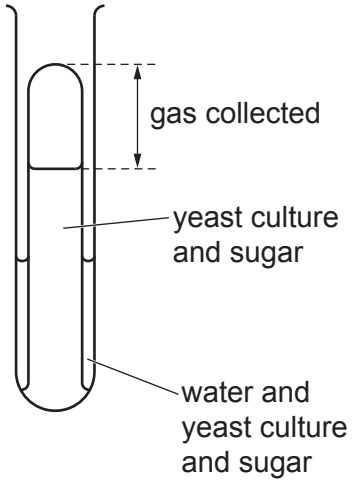


Fig. 1.2

The students used the apparatus to test the hypothesis:

Yeast has a higher rate of respiration when supplied with glucose than when supplied with maltose.

(a) (i) State the independent variable **and** the dependent variable in this investigation.

independent variable .....

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dependent variable .....

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[2]

(ii) The students stirred the yeast suspension before dividing it into the two samples.

Explain why it is important to stir the suspension.

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(iii) Describe a method using the apparatus set up as shown in Fig. 1.1 that the students could use to test their hypothesis.

Your method should be set out in a logical order and be detailed enough for another person to follow.

You should **not** include details of how to make the yeast suspension or how to set up the apparatus.

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Question 1 continues on page 6.

(b) Other students used a gas syringe to measure the volume of gas produced when a suspension of yeast was supplied with glucose or maltose.

Fig. 1.3 shows their results.

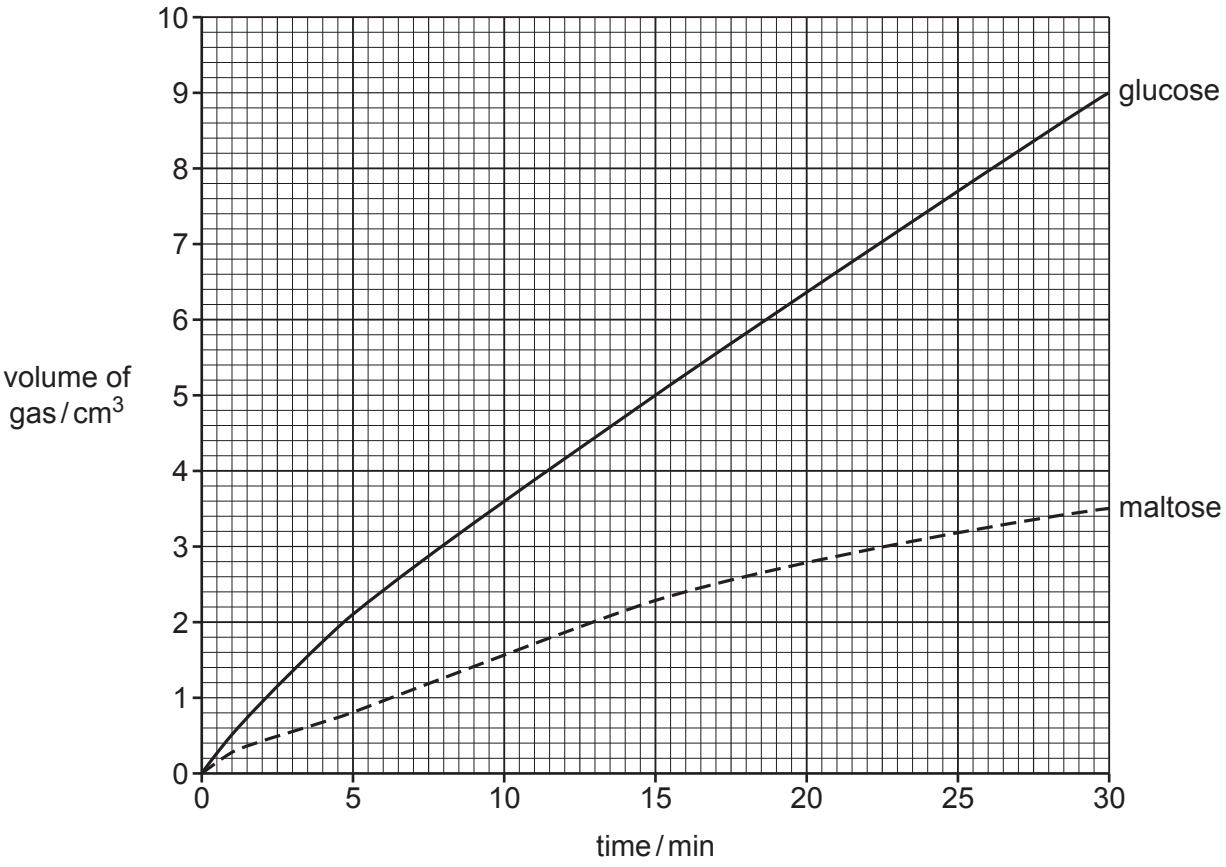


Fig. 1.3

(i) State how the students could calculate the rate of respiration from the results shown in Fig. 1.3.

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(ii) State **and** explain the conclusions that can be made for the results in Fig. 1.3.

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(c) When the students evaluated their method they thought that they could measure the change in pH in the yeast suspension as the gas produced by yeast is carbon dioxide.

One student suggested using an indicator solution and colour chart. Another student suggested using a pH meter.

Suggest the advantages of using a pH meter rather than an indicator solution and colour chart.

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[Total: 17]

2 Fig. 2.1 shows a gray tree frog, *Dryophytes versicolor*.

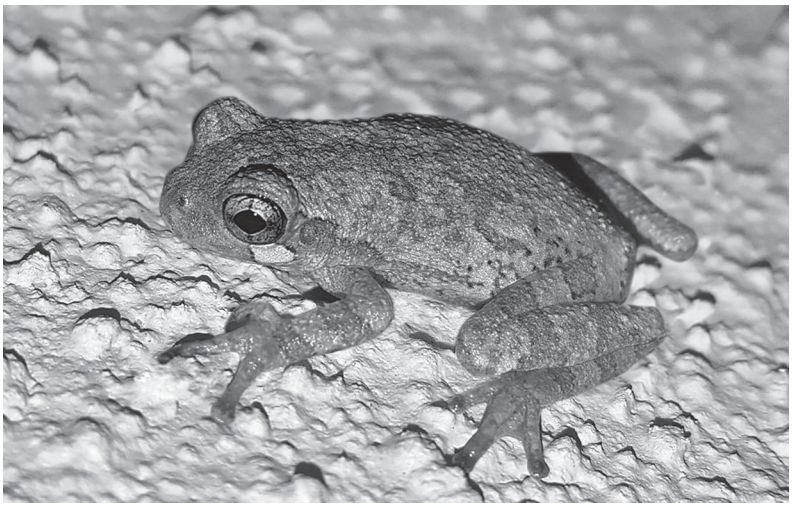


Fig. 2.1

Males of this species make a very distinctive mating call.

Some male gray tree frogs were kept in the laboratory at different temperatures. Their mating calls were recorded. Each call consists of a number of pulses. The calls are repeated at intervals.

Fig. 2.2 shows four calls recorded at 20 °C. Each vertical line represents a single pulse.

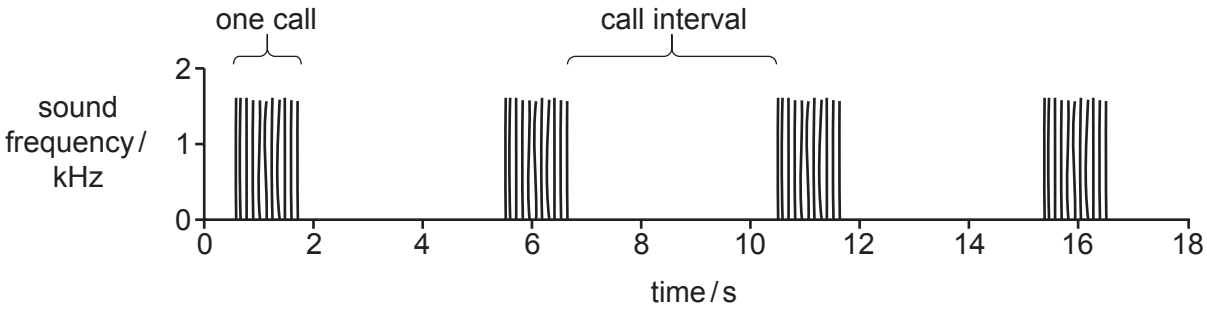


Fig. 2.2

A scientist wanted to find out if there was a relationship between body temperature and the interval between calls.

The scientist put each frog in a temperature-controlled environment. The scientist took the body temperature of each frog before recording the mating calls.

(a) State **one** variable, **other than** temperature, that should be standardised while making the recordings of the male gray tree frogs.

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(b) Recordings were made of 50 frogs with body temperatures between 9.0 °C and 33.5 °C.

The scientist measured the length of time of the intervals between the calls made by each frog. The results are shown in the scatter graph in Fig. 2.3.

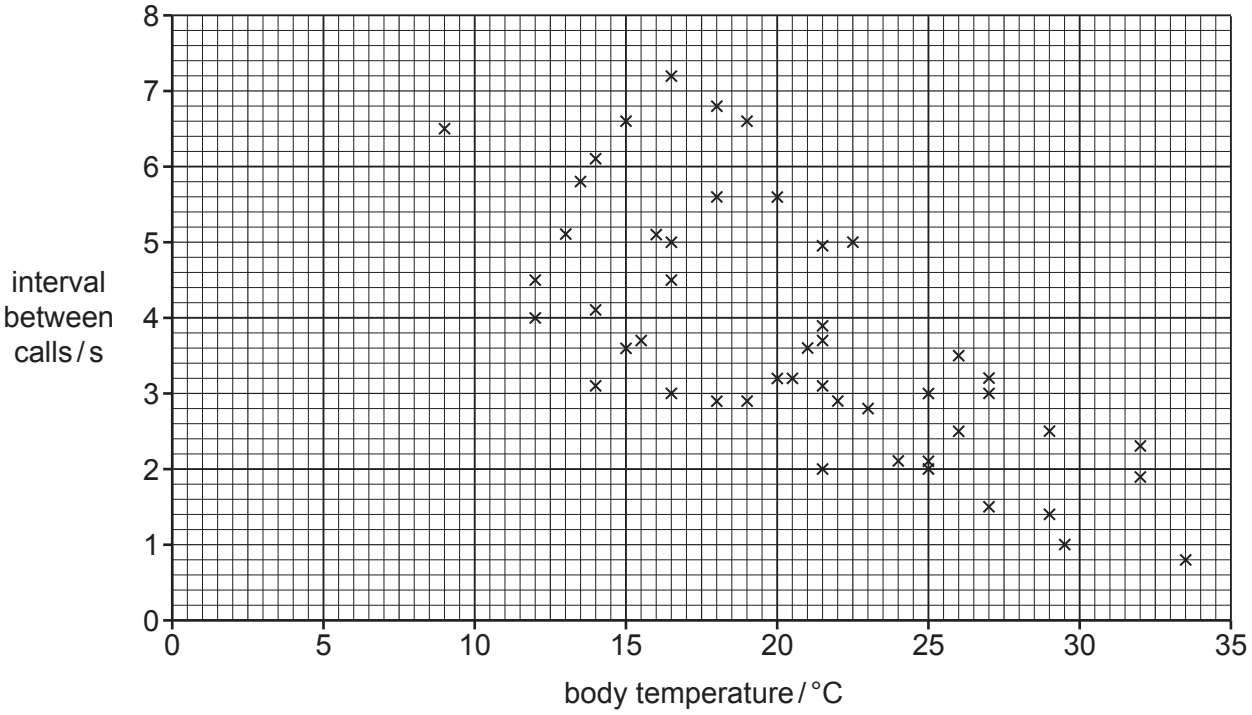


Fig. 2.3

Describe the trend shown by the scatter graph in Fig. 2.3.

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(c) The scientist analysed the data in Fig. 2.3 by using Pearson's linear correlation test.

(i) State **three** reasons why this statistical test is a suitable way to analyse the data.

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(ii) State a null hypothesis for this investigation.

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(iii) The scientist calculated the value of Pearson's correlation coefficient, ***r***, to be **–0.717**.

Table 2.1 shows the probability table for Pearson's linear correlation test.

Table 2.1

numbers of pairs of measurements	**critical values**	
	p = 0.05 (5%)	p = 0.01 (1%)
48	0.285	0.368
49	0.282	0.365
50	0.279	0.361
51	0.276	0.358
52	0.273	0.354

Use the calculated value of ***r*** and Table 2.1 to explain whether the correlation is significant.

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(d) The scientist extended the study by investigating other features of the mating calls of male gray tree frogs.

Fig. 2.4 shows recordings of the mating calls from two male gray tree frogs kept at different temperatures. Each vertical line represents a single pulse.

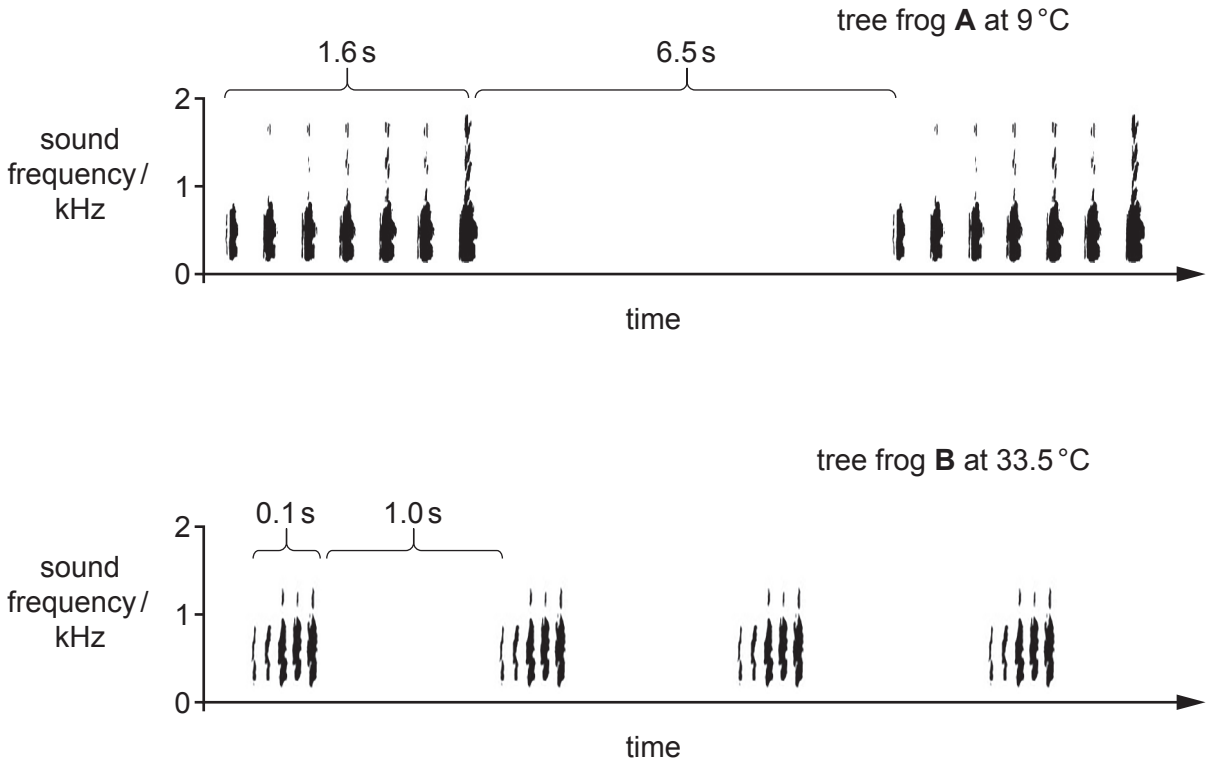


Fig. 2.4

Describe **two** features of the mating calls shown in Fig. 2.4, **other than** length of time between the calls, that could be studied.

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(e) Other scientists have studied gray tree frogs in the wild. Their first task in these studies is to gain an estimate of the population in each study area.

Describe how a population of frogs, such as *D. versicolor*, could be estimated by using the mark-release-recapture method.

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[Total: 13]

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BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2021**

1 hour 15 minutes

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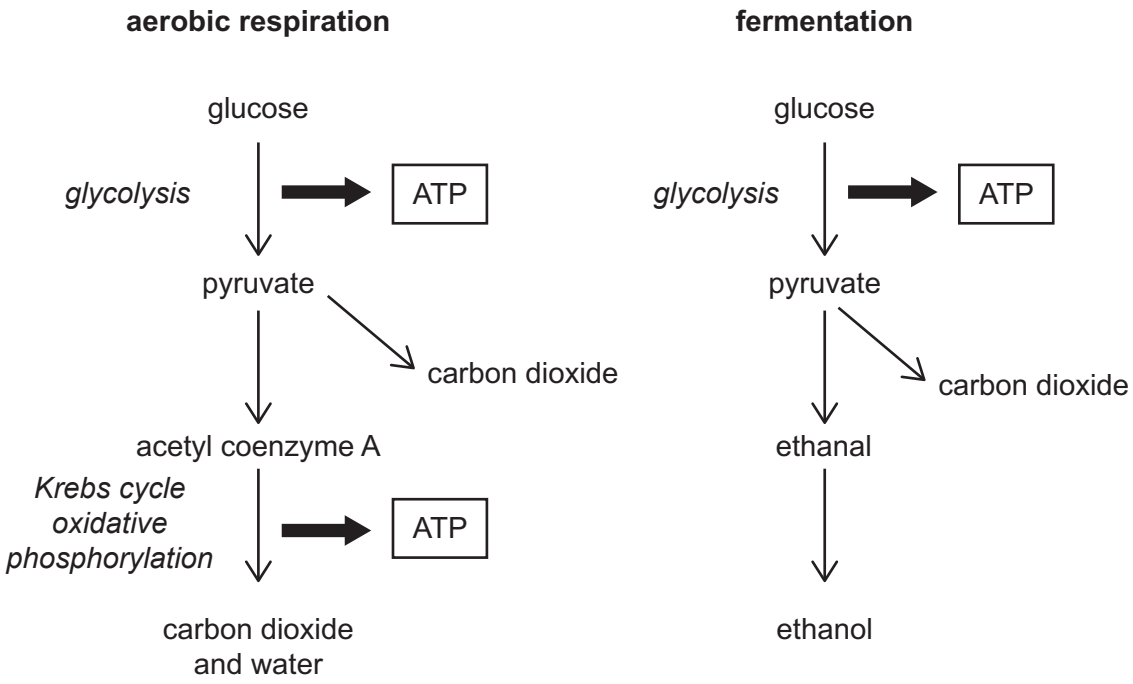


Fig. 1.1

Some students were researching details of the respiration of yeast. In their research, the students found information about the Crabtree effect. This effect occurs when yeast is kept in high concentrations of glucose. The yeast gains sufficient ATP from substrate-linked phosphorylation during glycolysis. Yeast does not carry out the Krebs cycle or oxidative phosphorylation and therefore does not use oxygen.

The students wanted to investigate the effect of temperature on the activity of yeast and decided to use yeast solutions in which the yeast obtained all of its ATP by fermentation.

- The students made a suspension of yeast from 1 g of dried yeast and 25 cm^3 of water.
- The suspension was left for 2 hours at 20 °C.
- After 2 hours, 25 cm^3 of glucose solution was added to the yeast suspension and the mixture was stirred.
- Some of the mixture was added immediately to the apparatus shown in Fig. 1.2.

The students measured the volume of carbon dioxide produced by yeast fermentation.

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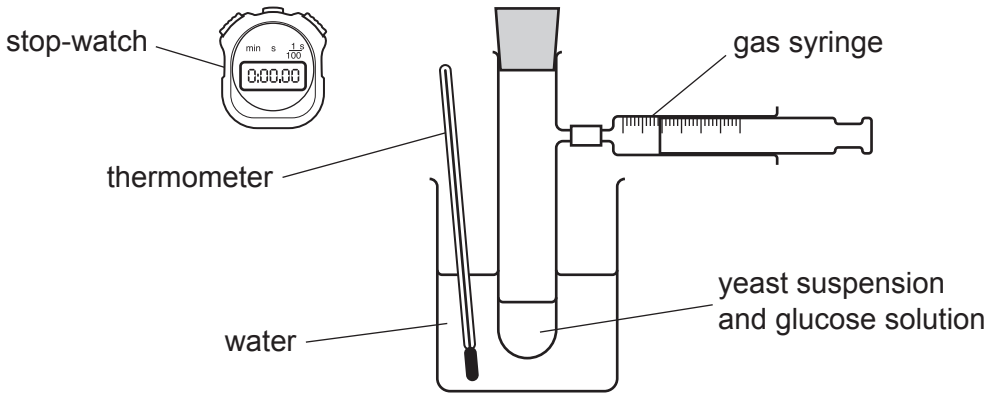


Fig. 1.2

(a) (i) State the independent variable **and** the dependent variable in this investigation.

independent variable .....

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dependent variable .....

.....

[2]

(ii) Explain why the students stirred the mixture of yeast and glucose before adding it to the tube in the apparatus in Fig. 1.2.

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..... [1]

(iii) Describe a method using the apparatus, set up as shown in Fig. 1.2, that the students could use to find the temperature at which yeast carries out fermentation at its maximum rate.

Your method should be set out in a logical order and be detailed enough for another person to follow.

You should **not** include details of how to make the yeast suspension or how to set up the apparatus.

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(iv) Complete the sketch graph to predict the results that you would expect from the method that you have given in part **(iii)**. Include axes labels with units in your answer.



[2]

(b) Scientists have discovered that some other species of yeast show the Crabtree effect.

The Crabtree effect means that in high concentrations of glucose **and** with oxygen present, pyruvate is not metabolised in mitochondria so aerobic respiration does not occur.

Yeast species that are able to maintain their levels of ATP production when conditions suddenly change and **no** oxygen is available show the Crabtree effect.

An investigation compared *S. cerevisiae* with the yeast *Candida tropicalis* to see if this other species also shows the Crabtree effect.

Three flasks containing suspensions of *S. cerevisiae* in a growth medium were initially kept in different conditions (conditions for growth).

After a set time, the yeast in each flask was transferred to a flask containing a fresh medium with high glucose concentration and **no** oxygen (experimental conditions). All other conditions were standardised.

The same procedure was repeated for *C. tropicalis*.

The conditions for growth and the experimental conditions in the flasks are summarised in Table 1.1.

Table 1.1

flask	conditions for growth	experimental conditions
flask 1	high glucose concentration with no oxygen	high glucose concentration with no oxygen
flask 2	high glucose concentration with oxygen	high glucose concentration with no oxygen
flask 3	water (no glucose) with oxygen	high glucose concentration with no oxygen

Samples taken from the flasks kept in the experimental conditions were put into the apparatus shown in Fig. 1.2 to measure the volume of carbon dioxide produced by the two yeast species.

The results are shown in Fig. 1.3.

The final volume of carbon dioxide produced by the sample of yeast from flask 1 at 30 minutes is shown as a maximum volume of 100% in Fig. 1.3. All other volumes were calculated as a proportion of this maximum. This allows a direct comparison to be made between the two species.

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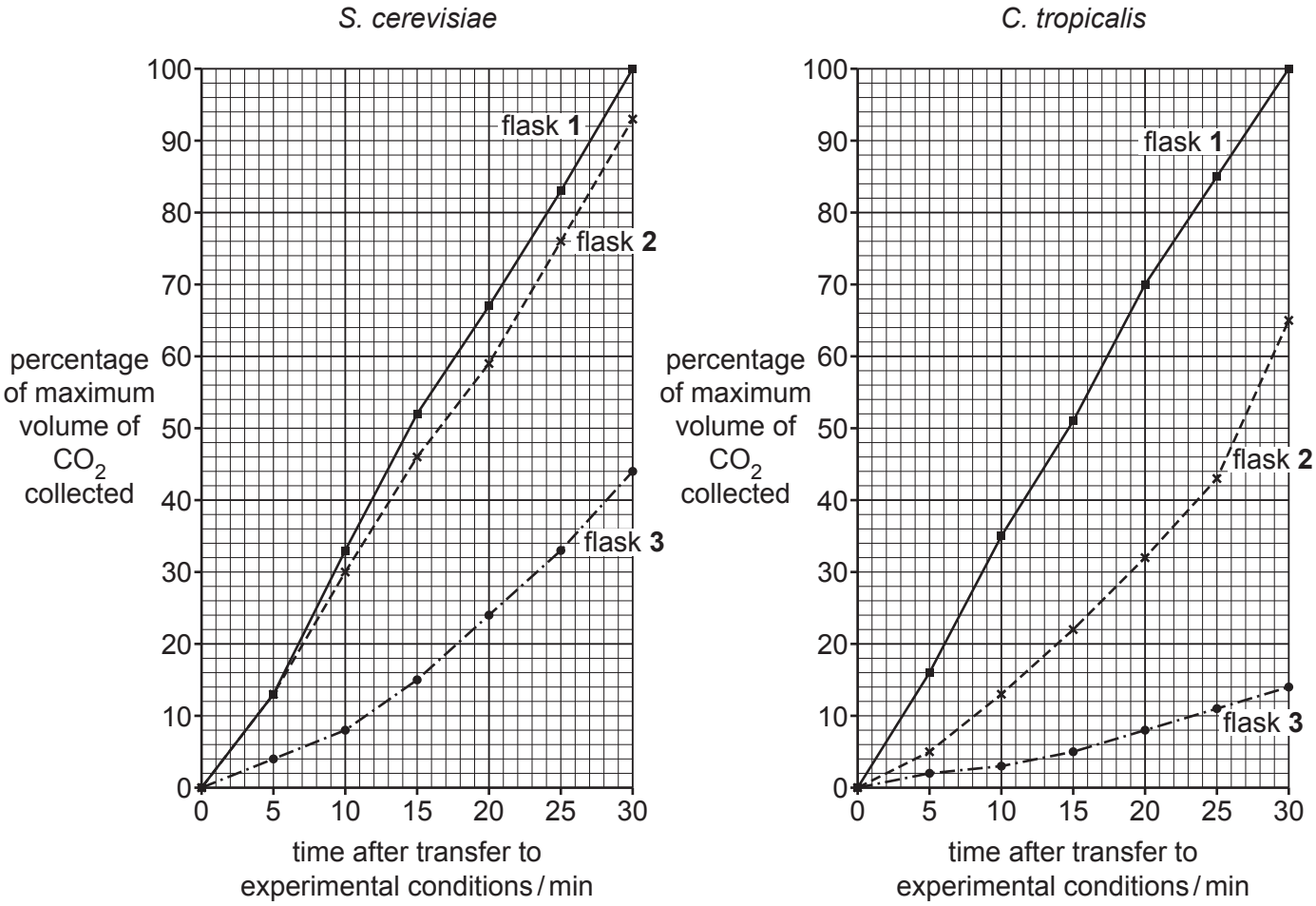


Fig. 1.3

State **and** explain the evidence in Fig. 1.3 that supports the idea that *C. tropicalis* does **not** show the Crabtree effect.

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..... [3]

[Total: 15]

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Fig. 2.1 shows the 17 locations within the Delmarva Peninsula.

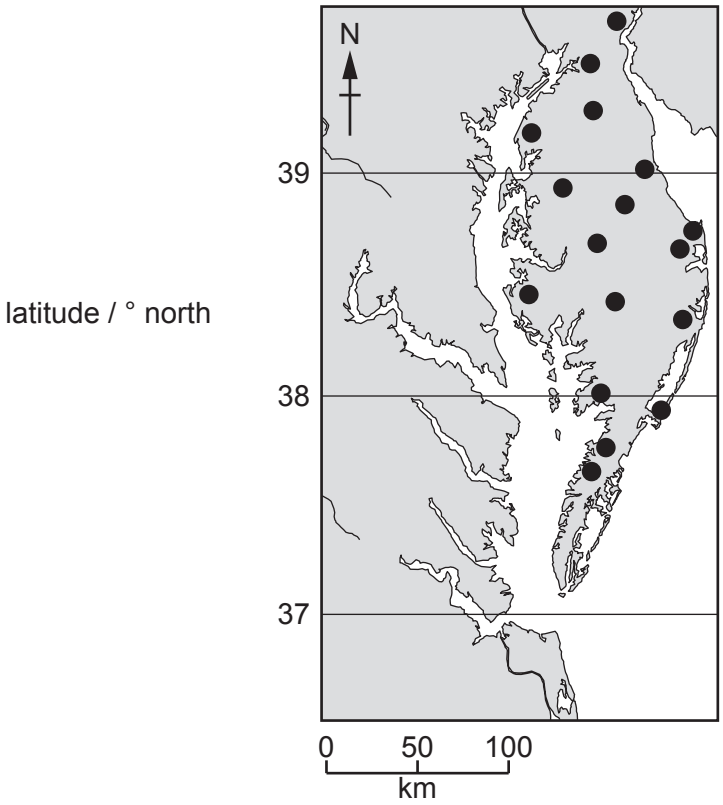


Fig. 2.1

The student used the data to see if there was any relationship between the latitudes of the sample locations and the number of species recorded at each location.

The data are shown in Fig. 2.2.

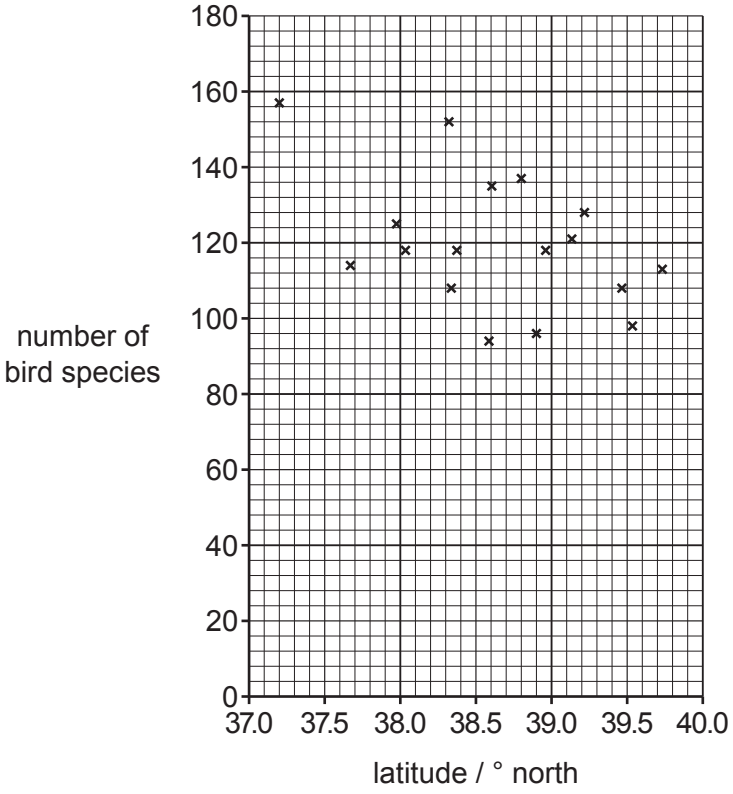


Fig. 2.2

(a) Describe the trend shown by the scatter graph in Fig. 2.2.

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..... [1]

(b) The student analysed the data using Spearman's rank correlation test.

(i) State **three** reasons why this statistical test is a suitable way to analyse the data about species diversity in Fig. 2.2.

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..... [3]

(ii) State the null hypothesis for this investigation.

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..... [1]

(iii) The student calculated the value of Spearman's rank correlation coefficient, r_s, as **-0.359**.

Table 2.1 shows the probability table for Spearman's rank correlation test.

Table 2.1

number of pairs of measurements	critical values	
	p = 0.05 (5%)	p = 0.01 (1%)
15	0.521	0.654
16	0.503	0.635
17	0.485	0.615
18	0.472	0.600
19	0.460	0.584
20	0.447	0.570

Discuss, with reference to Table 2.1, the conclusions that can be made from the analysis of the data collected by the student.

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..... [4]

(c) The student was investigating the statement 'species diversity decreases with increasing distance from the equator'.

Discuss the limitations of the sampling method and of the data collected in supporting this statement.

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..... [3]

Turn over for question 2(d).

Small birds such as the ruby-crowned kinglet, *Regulus calendula*, are found throughout North America.

Fig. 2.3 shows a ruby-crowned kinglet caught in a mist net. Mist nets are used in surveys of bird populations.



Fig. 2.3

(d) Describe how the mark-release-recapture method can be used to estimate the population size of small birds, such as the ruby-crowned kinglet.

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..... [3]

[Total: 15]

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