Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*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.
- Do **not** use an erasable pen or correction fluid.
- 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 [ ].

This document has **12** pages.


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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.

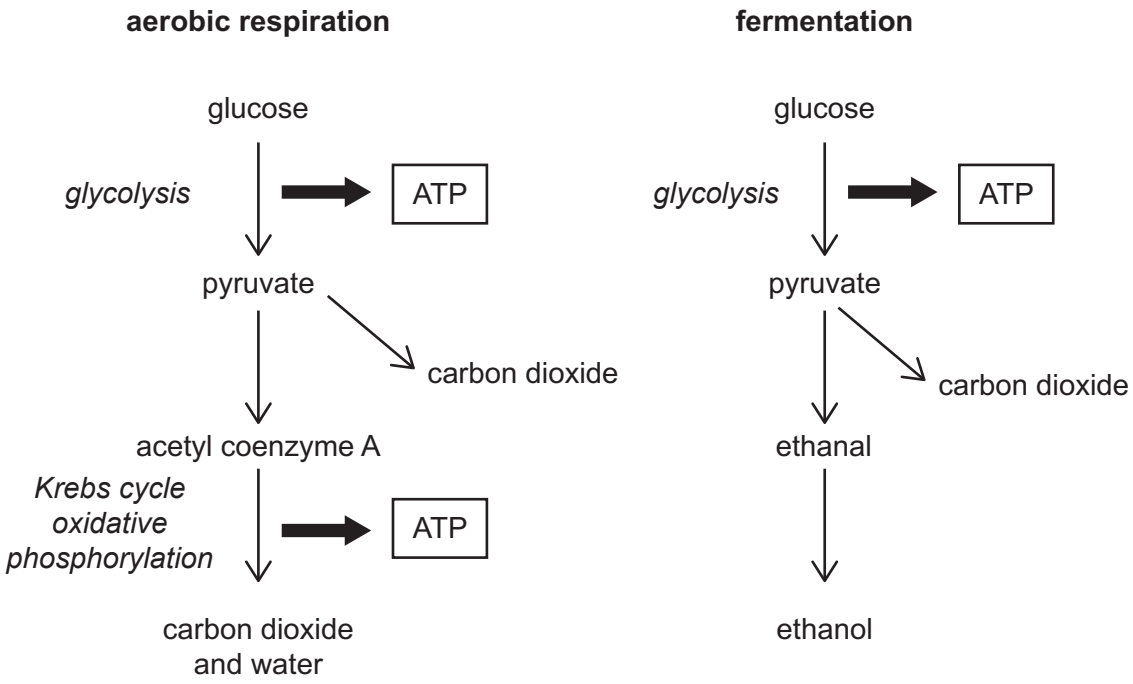



**Fig. 1.1**

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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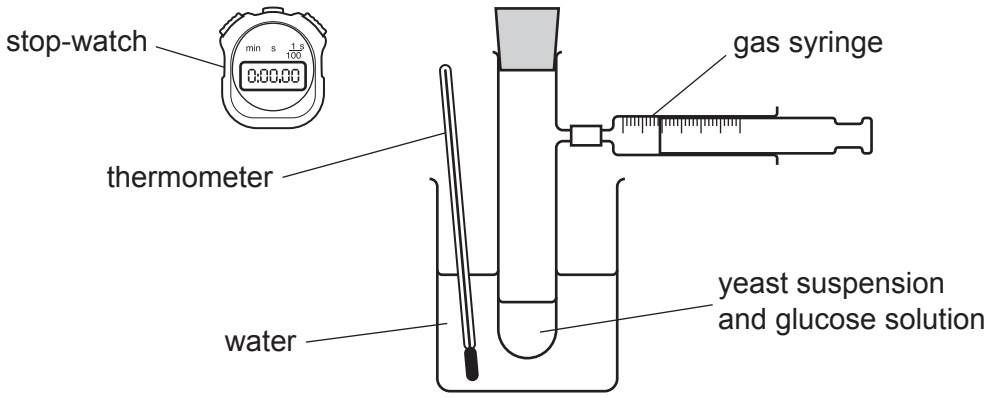



**Fig. 1.2**

**(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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**(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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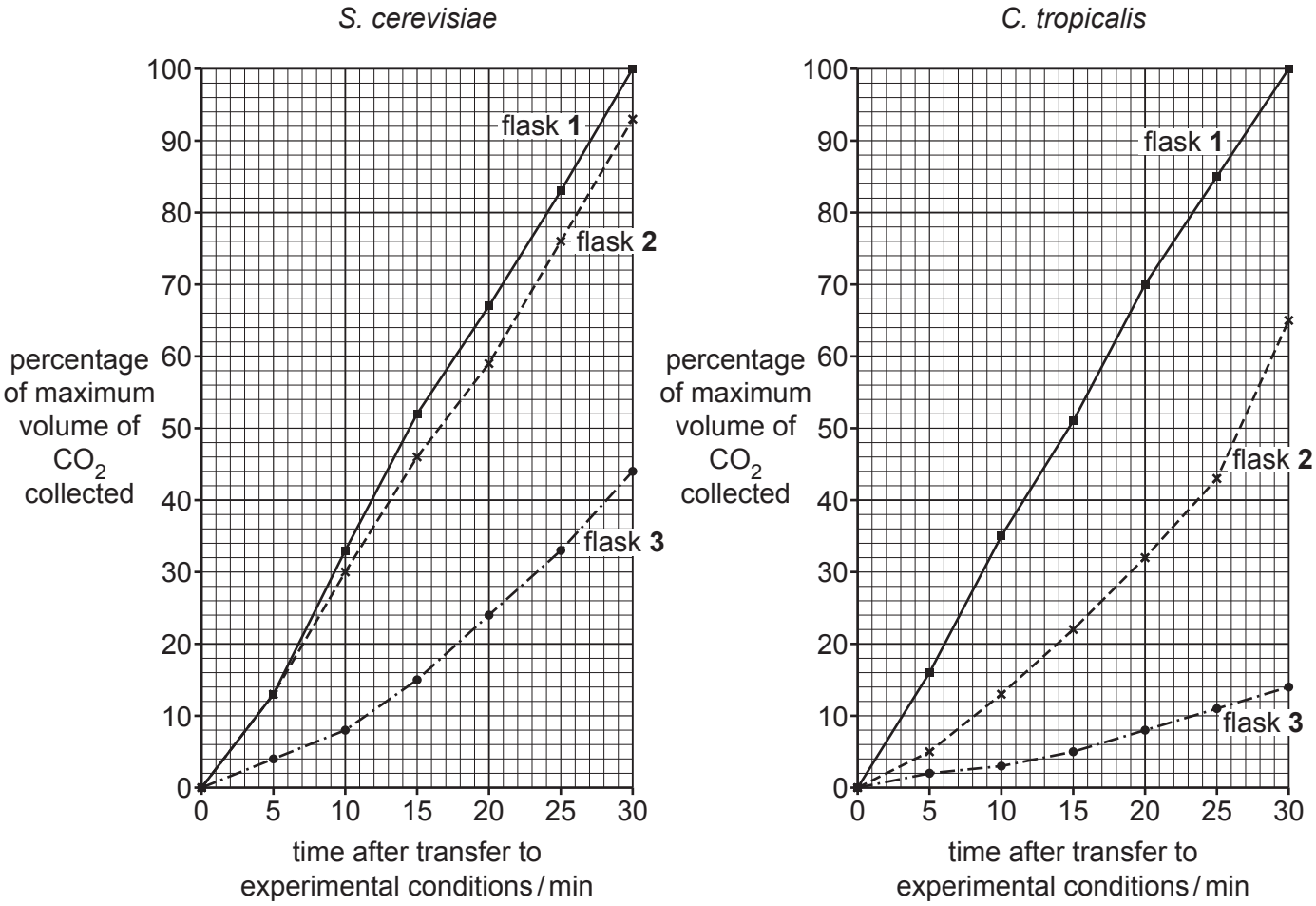



**Fig. 1.3**

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.

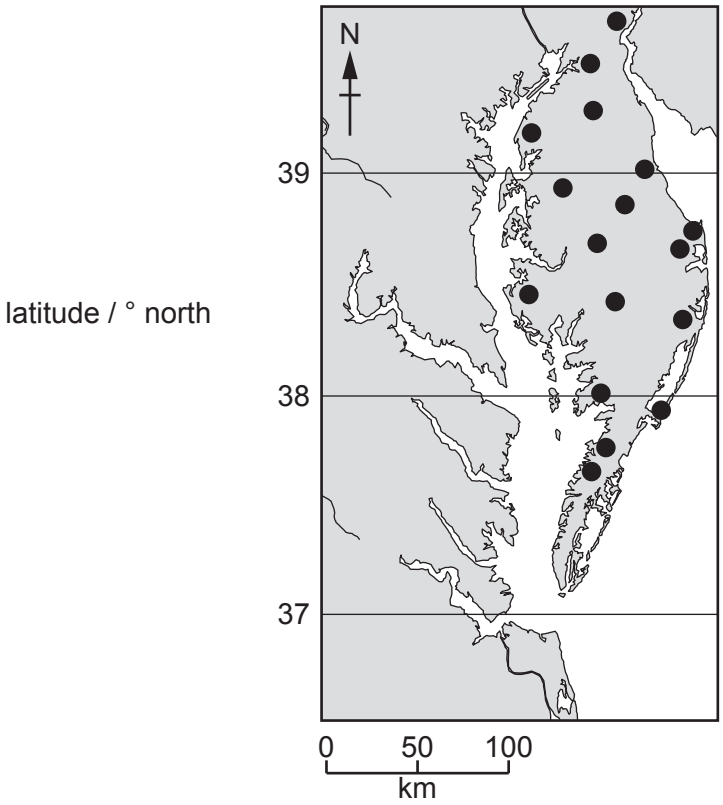



**Fig. 2.1**

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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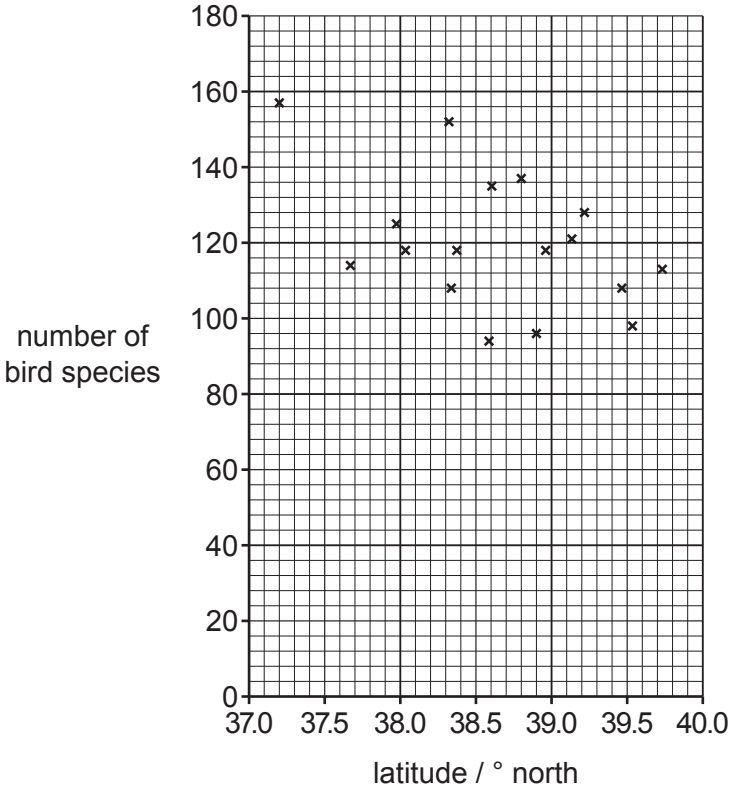



**Fig. 2.2**

**(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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