



Oxford Cambridge and RSA

Wednesday 21 June 2023 – Morning

A Level Biology A

H420/03 Unified biology

Time allowed: 1 hour 30 minutes



You can use:

- a scientific or graphical calculator
- a ruler (cm/mm)



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

| | | | | |
|--|--|--|--|--|
| | | | | |
|--|--|--|--|--|

Candidate number

| | | | |
|--|--|--|--|
| | | | |
|--|--|--|--|

First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

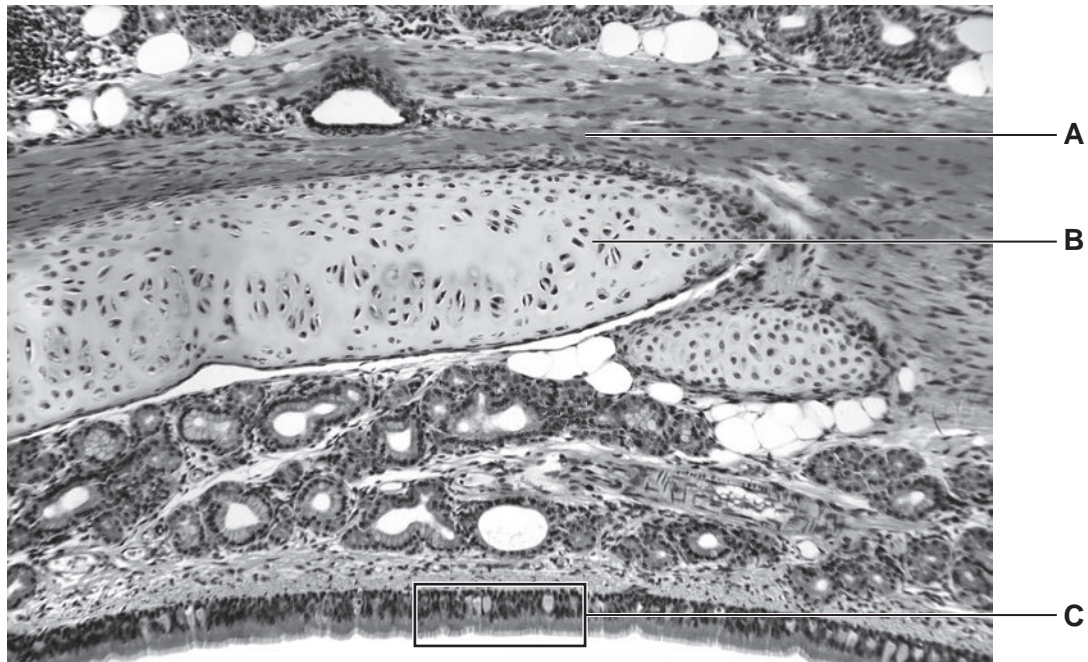
ADVICE

- Read each question carefully before you start your answer.

1 Cats are mammals.

(a) A light micrograph of a section through the trachea of a cat is shown in **Fig. 1.1**.

Fig. 1.1



(i) Name the tissues labelled **A** and **B** in **Fig. 1.1**.

A

B

[2]

(ii) Name the **two** types of cell in the box labelled **C** in **Fig. 1.1** and outline their functions.

1 Name

Function

2 Name

Function

[2]

3

(b) Alveoli increase the surface area to volume ratio (SA:V) in the lungs of cats and other mammals.

- (i) An alveolus in the lung of a cat has:
- a spherical shape
 - a diameter of 0.13 mm
 - a surface area of 0.053 mm².

Calculate the SA:V of this alveolus.

Use the formula: volume of sphere = $\frac{4}{3}\pi r^3$

SA:V = [3]

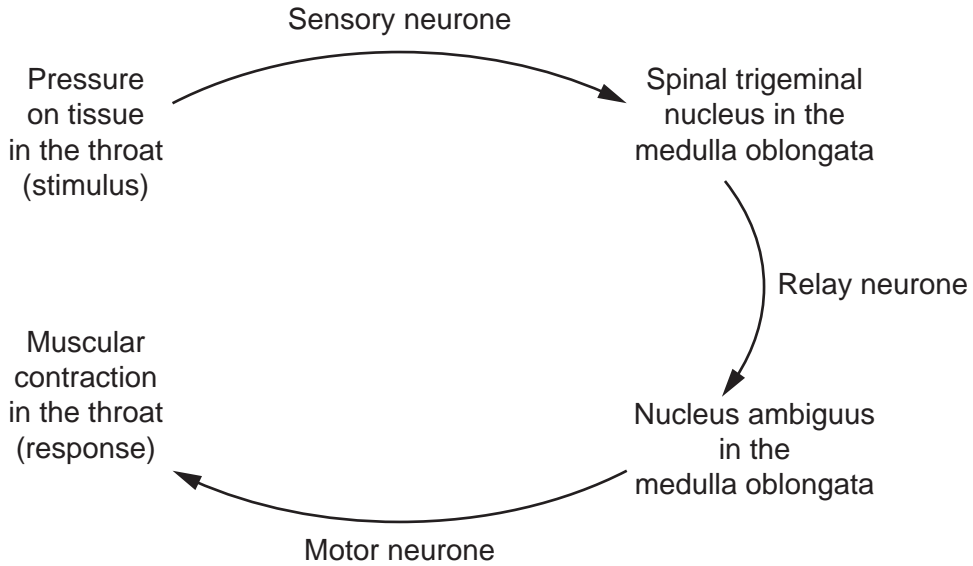
- (ii) Explain why the large SA:V of alveoli is an advantage to mammals.

.....
.....
..... [1]

- (c) The nervous system of a cat coordinates a response to stop objects becoming stuck in their throat.

Sensory receptors at the back of the throat detect the stimulus of a large piece of food or a ball of hair pressing on the tissue. The response is shown in **Fig. 1.2**.

Fig. 1.2



Explain **two** conclusions that can be drawn from **Fig. 1.2** about the type of nervous response shown.

.....

.....

.....

.....

.....

..... [2]

5

2 Vitamins are molecules that are consumed in the diet of animals and have essential roles in the body.

(a) Thin layer chromatography (TLC) was used to separate a mixture of vitamins from a vitamin supplement tablet.

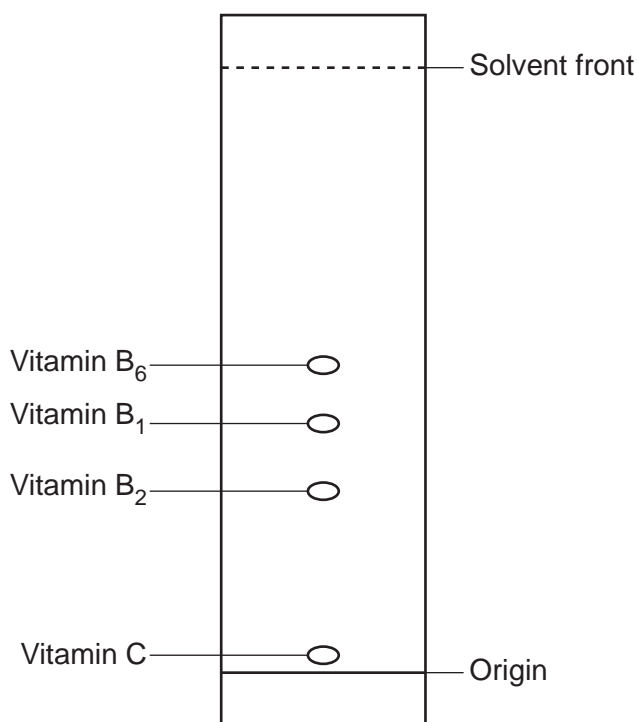
(i) Most vitamins are colourless.

Suggest **one** method for visualising the vitamins in TLC.

.....
 [1]

(ii) The results of the TLC are shown in the chromatogram in **Fig. 2.1**.

Fig. 2.1

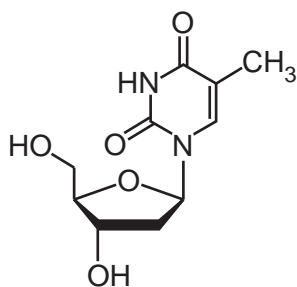


Use **Fig. 2.1** to calculate the R_f value of vitamin B₂.

$R_f =$ [2]

(b) Vitamin B₉ is needed for the synthesis of molecule **D**, shown in **Fig. 2.2**.

Fig. 2.2



Molecule **D**

Molecule **D** is a component in the structure of DNA.

A deficiency of vitamin B₉ in the diet can cause interphase to stop in some cells.

Use **Fig. 2.2** to explain why a deficiency of vitamin B₉ can cause interphase to stop.

.....

.....

.....

.....

.....

..... [2]

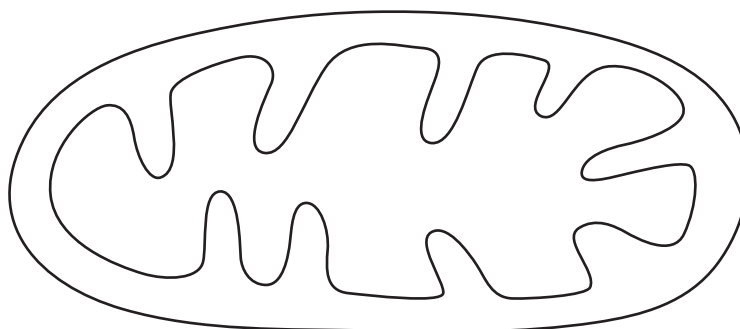
(c) Vitamin B₂ is used by the body to make FAD. Vitamin B₃ is used by the body to make NAD.

(i) A mitochondrion is shown in **Fig. 2.3**.

Label **Fig. 2.3** to show the locations where FAD gains H atoms and where FAD releases H atoms during respiration.

- Use the letter **E** to show where FAD gains H atoms.
- Use the letter **F** to show where FAD releases H atoms.

Fig. 2.3



[2]

7

- (ii) The table lists features that are correct for FAD, NAD, both or neither.

Complete the table by adding a tick (✓) to a box where the feature is correct and a cross (✗) where the feature is incorrect. You should add either a tick or a cross to every box in the table.

| Feature | FAD | NAD |
|--|-----|-----|
| Is a prosthetic group | | |
| Is reduced in the link reaction | | |
| Oxidises molecules in the electron transport chain | | |

[2]

- (iii) ATP is produced in respiration. Some of these molecules of ATP are used to release energy for processes in respiration. For example, ATP is used in the early stages of glycolysis.

Suggest **one other** way in which ATP contributes to the process of respiration.

.....
 [1]

- (d) Vitamin C affects the activity of enzymes in different ways.

- (i) Vitamin C acts as a coenzyme for several enzymes in the synthesis of collagen.

Outline the role of coenzymes in biological reactions.

.....

 [2]

8

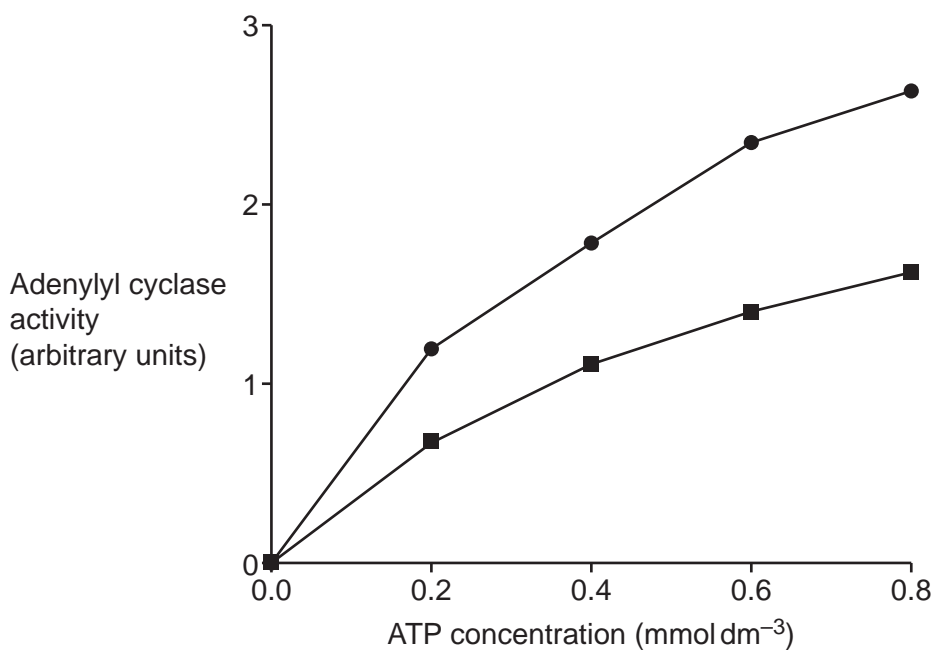
- (ii) A scientist investigates the effect of vitamin C on the activity of the enzyme adenylyl cyclase.

Adenylyl cyclase catalyses the conversion of ATP to cAMP.

The scientist measures the activity of adenylyl cyclase without vitamin C and with 1 mmol dm^{-3} of vitamin C.

The scientist's results are shown in **Fig. 2.4**.

Fig. 2.4



Key: —●— Without vitamin C
—■— 1 mmol dm^{-3} vitamin C

Explain what can be concluded from the results in **Fig. 2.4** about the effect of vitamin C on the activity of adenylyl cyclase.

.....

.....

.....

.....

..... [2]

3 Genetic modification and selective breeding can be used to improve the characteristics of crop plants, such as maize.

(a) In high light intensity, photosystem II absorbs excess light energy.

A process called nonphotochemical quenching (NPQ) converts the excess light to heat energy.

NPQ can continue when light intensity is no longer in excess. This makes photosynthesis inefficient.

Scientists genetically modified (GM) crop plants to limit NPQ.

The scientists exposed unmodified plants and GM plants to a period of high light intensity followed by lower light intensity. The scientists then compared the rate of NPQ and the rate of carbon dioxide (CO₂) fixation in unmodified plants and GM plants.

Some of the results are shown in the table.

| Time after decrease in light intensity (s) | Rate of NPQ (arbitrary units) | | Rate of CO ₂ fixation (mmol CO ₂ m ⁻² s ⁻¹) | |
|--|-------------------------------|----------|--|----------|
| | Unmodified plant | GM plant | Unmodified plant | GM plant |
| 0 | 1.00 | 1.00 | 26 | 26 |
| 150 | 0.35 | 0.25 | 11.5 | 13.2 |

(i) State **one** dependent variable in this investigation.

..... [1]

(ii) Explain the effect of genetic modification on the rate of CO₂ fixation after 150 seconds of low light intensity.

.....

 [2]

(iii) Often a single company holds the patent for a GM crop plant.

Suggest a potential ethical issue that may exist if one company holds the patent for a GM crop plant.

.....
 [1]

11

Two maize plants are crossed.

- One parent plant is purple and smooth and heterozygous for both genes.
- One parent plant is yellow and smooth and heterozygous for gene **B/b**.

Complete the answer lines below to show this genetic cross.

Parental genotypes: ×

Gametes:

Expected offspring phenotypes:

.....

Expected phenotypic ratio:

[4]

4 The Convention on International Trade in Endangered Species (CITES) came into effect in 1975.

(a)* **Fig. 4.1** shows the percentage of species threatened with extinction that have been protected under CITES.

Fig. 4.1

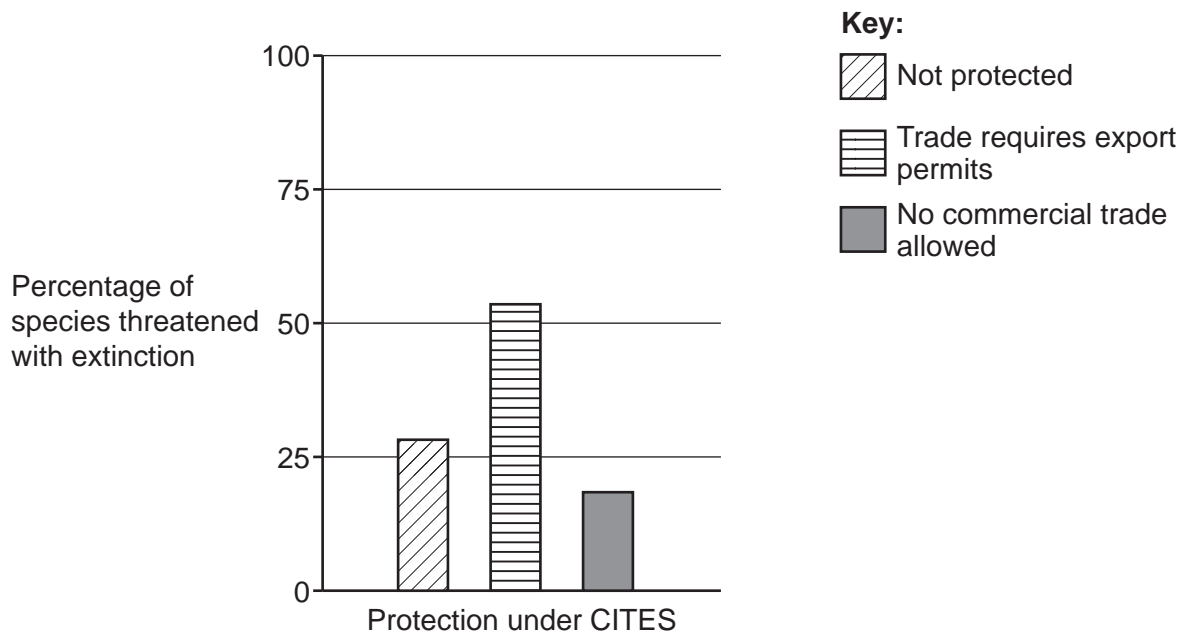
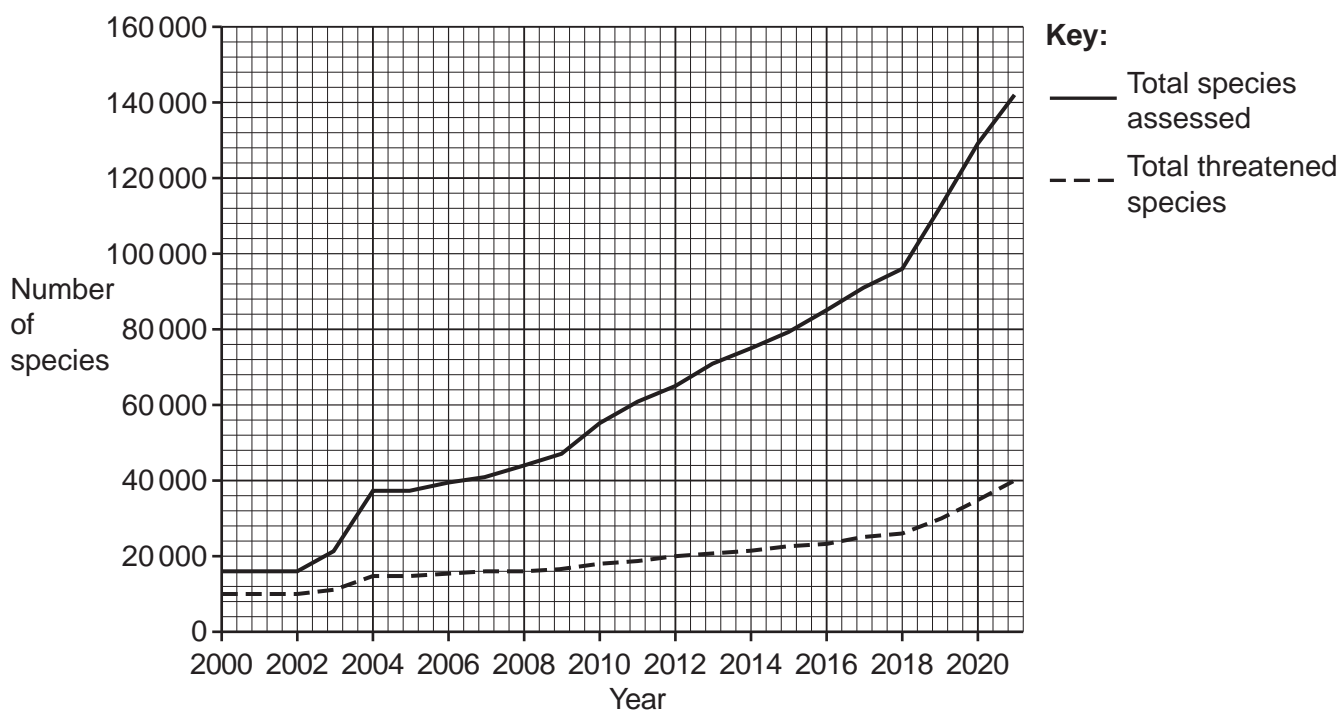


Fig. 4.2 shows the number of species assessed and the number of species categorised as threatened with extinction by the International Union for Conservation of Nature (IUCN) each year.

Fig. 4.2



- (b) The kakapo, shown in **Fig. 4.3**, is an endangered species of flightless bird that lives in New Zealand. The population size of kakapos has experienced a large decrease over the past few hundred years. There are now fewer than 250 kakapos living in the wild.

Fig. 4.3



- (i) State the term for a large decrease in population size that reduces the gene pool.

..... [1]

- (ii) Adaptations can be categorised into three different types:

- anatomical
- behavioural
- physiological.

The table lists four traits that kakapos have evolved.

Complete the table by naming the type of adaptation represented by each of the four kakapo traits.

| Kakapo trait | Type of adaptation |
|---|---------------------------|
| Active at night to avoid predators | |
| Green feathers that camouflage with its surroundings | |
| Slow digestion to extract nutrients from a high-fibre, low-protein diet | |
| Strong beak and claws to climb trees | |

[2]

(iv) New Zealand has a high species biodiversity compared to many countries.

Species biodiversity includes the concepts of species richness and species evenness.

Explain the difference between species richness and species evenness.

.....

.....

.....

.....

..... [2]

17
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

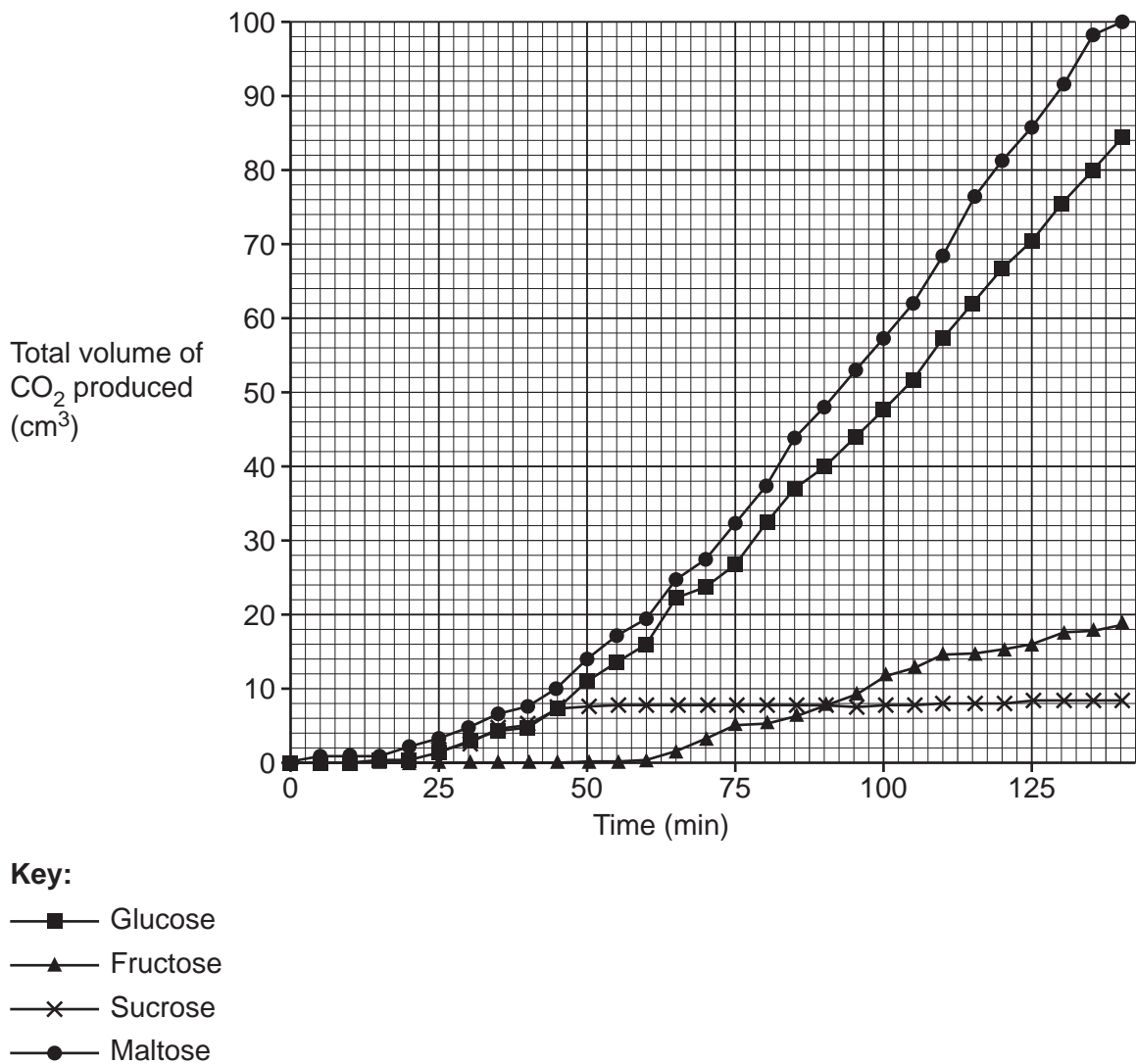
5 Yeast can respire aerobically or anaerobically.

- (a) A student investigated how the type of respiratory substrate affects the rate of aerobic respiration in yeast.

Four different populations of yeast were provided with fructose, glucose, maltose or sucrose as a respiratory substrate. The student measured the CO_2 produced by each population over 150 minutes.

The student's results are shown in **Fig. 5.1**.

Fig. 5.1



- (i) Compare CO₂ production when the substrate is glucose and CO₂ production when the substrate is maltose.

.....

.....

.....

.....

..... [2]

- (ii) The student wrote a note:

'The CO₂ production with fructose is approximately the same as the CO₂ production with sucrose'.

Explain whether you agree with the student's note.

.....

.....

.....

.....

..... [2]

20

(b) A student plans to compare the rate of anaerobic respiration in two species of yeast.

(i) The student uses glucose as the respiratory substrate in their experiment.

The student produces a 0.01 mol dm^{-3} glucose solution for each yeast population. This is the method that they use to produce each 0.01 mol dm^{-3} glucose solution:

- Make two 10-fold dilutions from a 1.0 mol dm^{-3} stock solution.
- In each dilution, use a measuring cylinder to measure the volume of water and a dropping pipette to transfer the glucose solutions.

Suggest **two** ways in which the student can reduce the percentage error in their measurements when producing the glucose solutions.

1

.....

.....

2

.....

.....

[2]

(ii) Complete the sentences using appropriate words or phrases.

This is the method that the student uses in their experiment:

- To avoid contamination, place the yeast in glucose solutions that are produced using water.
- Culture each species of yeast in different flasks.
- Ensure anaerobic conditions by using a flask.
- Use the rate of CO_2 production as a measure of respiration rate.
- Standardise all other variables.
- Repeat the measurements with 10 populations from each species and calculate two means and two
- Analyse the data using a Student's *t*-test.

[3]

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large area of lined paper for writing answers. It features a vertical margin line on the left side and horizontal dotted lines for writing. The lines are evenly spaced and extend across the width of the page.

A large rectangular area with a solid vertical line on the left and horizontal dotted lines, providing a space for writing answers.



Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of Cambridge University Press & Assessment, which is itself a department of the University of Cambridge.