| H | NATIONAL JUNIOR COLLEGE, SINGAPORE<br>Senior High 2<br>Preliminary Examination<br>Higher 2 |
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| CANDIDATE NAME | | | |
|---|---|---|---|
| BIOLOGY CLASS | 2bi2_____ | REGISTRATION NUMBER | |

# Biology

**9744/04**

Paper 4 Practical

**17 August 2023**

**2 hours 30 minutes**

**READ THESE INSTRUCTIONS FIRST**

Write your name, Biology class, and registration number on all the work you hand in.
Give details of the practical shift and laboratory in the boxes provided.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your workings or if you do not use appropriate units.

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

| Shift | | | |
|---|---|---|---|
| 1 | 2 | 3 | |
| Laboratory | | | |
| BI23 | BI24 | CM43 | CM44 |

| For Examiner's Use | |
|---|---|
| 1 | /19 |
| 2 | /17 |
| 3 | /19 |
| Total | /55 |

This document consists of **18** printed pages and **2** blank pages.

Answer **all** questions.

**1** Baker's yeast, *Saccharomyces cerevisiae*, converts sugars to ethanol and carbon dioxide under anaerobic conditions.

You will investigate the effects of different concentrations of ethanol on the rate of respiration in yeast.

**(a)** Describe and explain the expected effect of increasing ethanol concentration on the rate of respiration in yeast.

[4]

You will set up the apparatus as shown in Fig. 1.1.

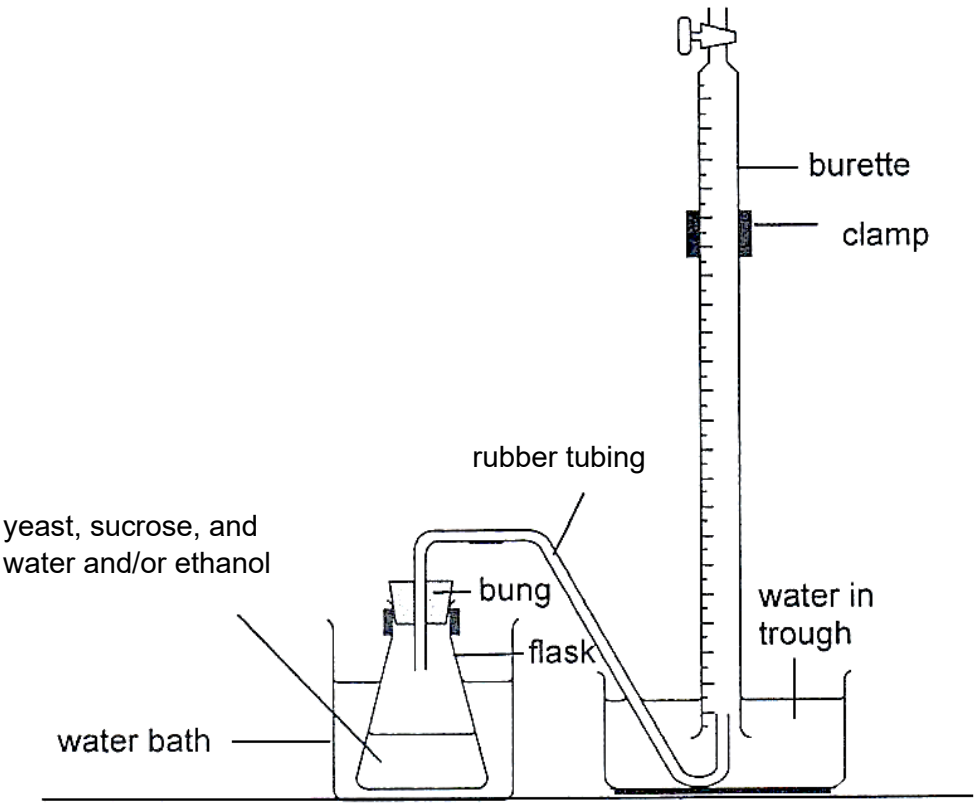



**Fig. 1.1**

You are provided with:

- 5.0 g dried yeast **Y**, in a container labelled **Y**
- 10.0 g sucrose **S**, in a container labelled **S**
- 120 $cm^3$ 5.0 % ethanol **E1**, in a container labelled **E1**
- 120 $cm^3$ 10.0 % ethanol **E2**, in a container labelled **E2**
- 200 $cm^3$ distilled water **W**, in a beaker labelled **W**

**E1 and E2 contain ethanol, which is harmful and flammable. Suitable eye protection should be worn. The lid on the plastic vial should be kept on, when not in use.**

Read steps **1-11**.

**Proceed as follows.**

**1** Set up a water bath and maintain it at about 37 °C.

**2** Measure 100 $cm^3$ of **W** and pour it into a conical flask.

**3** Weigh 1.0 g of **Y** and 2.0 g of **S** and add them to the conical flask. Shake to mix the content.

**4** Incubate the conical flask in the water bath for 5 minutes.

**5** Fill the burette with water. Invert the burette and clamp it on a retort stand, as shown in Fig 1.1.

**6** Attach the rubber bung (with the rubber tubing) to the conical flask.

**7** Insert the rubber tubing through the open end of the burette. Ensure that the apparatus is set up as shown in Fig. 1.1.

**8** After 5 minutes of incubation, note the initial volume of water in the burette.

**9** Measure the volume of carbon dioxide given off for 8 minutes by the amount of water displaced.

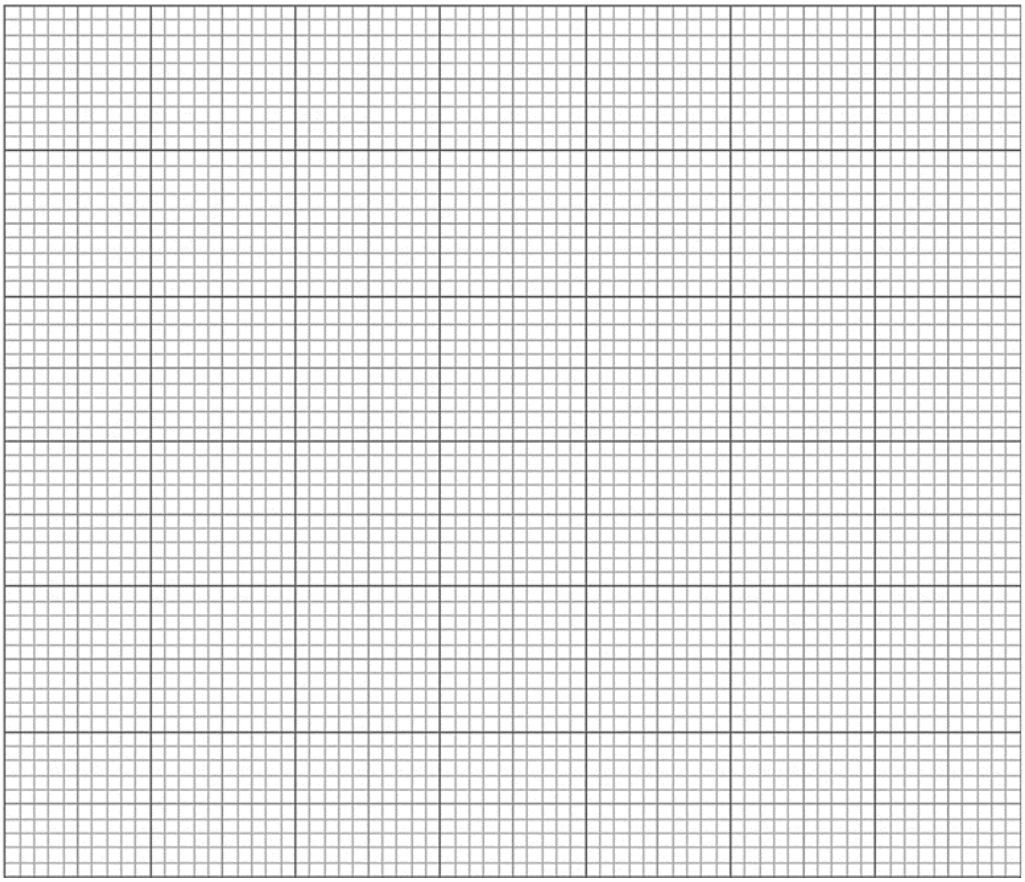
**10** Repeat steps **1**-**9** using 100 $cm^3$ of **E1**.

**11** Repeat steps **1**-**9** using 100 $cm^3$ of **E2**.

**(b)** Record your results in an appropriate table.

[3]

**(c)** Use the grid provided to display your results.



[4]

**(d)** Without quoting numerical values, explain how this experiment allows you to monitor respiration in yeast.

[3]

**(e)** Describe **two** main sources of error in the procedure and discuss how they may reduce the confidence in your results recorded in **(b)**.

[4]

**(f)** Suggest a negative control for this experiment to prove the action of yeast in converting sugars to ethanol and carbon dioxide.

[1]

[Total: 19]

**2** Fig. 2.1 shows *Elodea canadensis* (Canadian pondweed) which is an aquatic plant commonly used in aquarium tanks to help control algae and keep the water clear.

**Fig. 2.1**

Fig. 2.2 shows how *Elodea* form dense mats on the surface of water in an aquarium tank.

**Fig. 2.2**

Studies suggest that one mechanism by which *Elodea* inhibits algae is via competing for light for photosynthesis.

**(a) (i)** Design an experiment to show that the rate of photosynthesis in *Elodea* is dependent on light intensity.

In your plan you must use:

- a room which can be made dark
- table lamp
- *Elodea* (Canadian pondweed)
- ruler
- scalpel
- sodium hydrogen carbonate powder
- weighing balance
- measuring cylinder
- distilled water
- boiling tube
- delivery tube
- gas syringe
- rubber bung
- thermometer
- stopwatch
- beaker
- retort stand

Your plan should:

- identify the dependent variable and independent variable
- identify variables you will need to control
- have a clear and helpful structure so that the method described could be repeated by anyone reading it
- be illustrated by relevant diagrams, if necessary
- include details to ensure that results are accurate and repeatable as possible
- indicate how results will be recorded and analysed
- use the correct technical and scientific terms
- include reference to safety measure to minimise any risks associated with the proposed experiment

[8]

**(ii)** Explain how the growth rate of organisms like plants and algae is correlated with the rate of photosynthesis.

[2]

**(iii)** Besides competing for light, suggest one other mechanism by which *Elodea* controls algae growth in aquarium tanks.

[1]

**(b)** An aquarium company has claimed that their biological fertiliser 'Swamp Thing' is superior to current market products in enhancing the growth of aquatic plants.

An NJC student set out to test this claim. He carried out an experiment to measure the mass of two groups of *Elodea* after a 10-weeks period of growth. One group was grown in tanks that were treated with 'Swamp Thing'. The other group was grown with 'Groot', a well-established fertiliser developed by another reputable Aquarium company. All other variables were controlled.

His results are enclosed in Table 2.1

**Table 2.1**

| sample number | mass of *Elodea* / g | |
|---|---|---|
| | 'Swamp Thing' | 'Groot' |
| 1 | 1.76 | 0.49 |
| 2 | 1.45 | 0.85 |
| 3 | 1.03 | 1.00 |
| 4 | 1.53 | 1.54 |
| 5 | 2.34 | 1.01 |
| 6 | 1.96 | 0.75 |
| 7 | 1.76 | 2.11 |
| 8 | 1.27 | 0.92 |
| mean ($\bar{x}$) | | |

**(i)** Complete Table 2.1 by calculating the mean for the mass of both *Elodea* groups.

[2]

**(ii)** A t-test was carried out to see if *Elodea* grown with 'Swamp Thing' was significantly greater in mass compared to those grown with 'Groot'.

Suggest a null hypothesis for this statistical test.

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--- [1]

**(iii)** Table 2.2 shows the critical values for t at different probabilities and degrees of freedom for one-tailed and two-tailed tests.

**Table 2.2**

| degrees of freedom | probability, *p*, for one-tailed test | | | |
|---|---|---|---|---|
| | 0.25 | 0.05 | 0.025 | 0.005 |
| | probability, *p*, for two-tailed test | | | |
| | 0.5 | 0.1 | 0.05 | 0.01 |
| | | | | |
| 1 | 1.00 | 6.31 | 12.71 | 63.66 |
| 2 | 0.82 | 2.92 | 4.30 | 9.92 |
| 3 | 0.76 | 2.35 | 3.18 | 5.84 |
| 4 | 0.74 | 2.13 | 2.78 | 4.60 |
| 5 | 0.73 | 2.02 | 2.57 | 4.03 |
| 6 | 0.72 | 1.94 | 2.45 | 3.71 |
| 7 | 0.71 | 1.89 | 2.36 | 3.50 |
| 8 | 0.71 | 1.86 | 2.31 | 3.36 |
| 9 | 0.70 | 1.83 | 2.26 | 3.25 |
| 10 | 0.70 | 1.81 | 2.23 | 3.17 |
| 11 | 0.70 | 1.80 | 2.20 | 3.11 |
| 12 | 0.70 | 1.78 | 2.18 | 3.05 |
| 13 | 0.69 | 1.77 | 2.16 | 3.01 |
| 14 | 0.69 | 1.76 | 2.14 | 2.98 |
| 15 | 0.69 | 1.75 | 2.13 | 2.95 |
| 16 | 0.69 | 1.75 | 2.12 | 2.92 |
| 17 | 0.69 | 1.74 | 2.11 | 2.90 |
| 18 | 0.69 | 1.73 | 2.10 | 2.88 |
| 19 | 0.69 | 1.73 | 2.09 | 2.86 |
| 20 | 0.69 | 1.72 | 2.09 | 2.85 |

The calculated t-value was determined to be 3.04.

Using the t-distribution table above, explain what conclusions can be drawn from the calculated t-value.

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--- [3]

[Total: 17]

**3** For this question, you will require access to a microscope, slide **S1** and specimen **S2**.

You will observe and compare the structures of the stem of two different climbing plants. A climbing plant is a plant that attaches itself to a structure, such as a fence, as it grows.

*Cucurbita* is a genus of herbaceous vines consisting of squash, pumpkin, gourd, etc. It is a climbing plant that can produce stems up to 5 metres long (Fig. 3.1).

**Fig. 3.1**

**S1** is a slide containing both a stained transverse section and a stained longitudinal section of a stem of *Cucurbita*.

You are not expected to be familiar with these specimens.

**(a)** Use the microscope to observe the different tissues in the transverse section of the stem on **S1**.

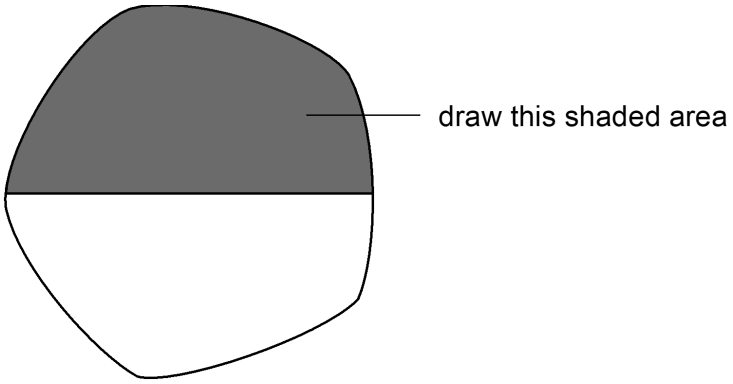


**Fig. 3.2**

Draw a large plan diagram of half of the transverse section as shown in Fig. 3.2.

A plan diagram shows the arrangement of different tissues. Your drawing should show the correct shapes and proportions of different tissues.

Outline all the vascular bundles but do not include any details of them. Your drawing should accurately show the numbers of the bundles, their sizes and positions.

No cells should be drawn.

[5]

**(b)** The distribution of the different tissues in the vascular bundle in the stem of *Cucurbita* is unusual in that there are two regions of phloem in each vascular bundle in the stem of *Cucurbita*. The distribution is shown in Fig. 3.3.

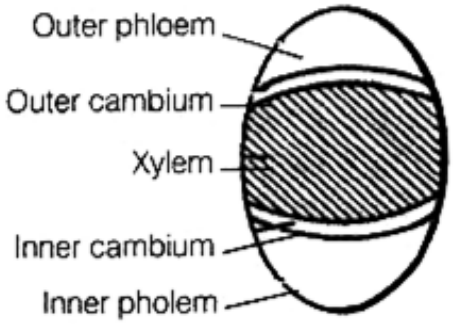


**Fig. 3.3**

Examine the transverse section of the stem on **S1** using high power objective of your microscope. Find a vascular bundle and observe the distribution of the different tissues in the vascular bundle.

**(i)** Select a group of cells consisting of one large xylem vessel and one layer of adjacent cells touching the large xylem vessel.

Make a large drawing of this cluster of cells.

Labels are **not** required.

[4]

**(ii)** Calibrate your eyepiece graticule at high power (x40 objective lens), using a stage micrometer.

Calculate the absolute dimensions of one eyepiece graticule unit based on this calibration.

Show your working.

1 eyepiece graticule unit = ……μm [2]

**(iii)** Using the calibrated eyepiece graticule in **(b)(ii)**, measure and calculate the diameter of the large xylem vessel drawn in **(b)(i)**.

diameter of large xylem vessel = ……μm [1]

**(iv)** Calculate the magnification of the large xylem vessel drawn in **(b)(i)**.

magnification = x …… [1]

Examine the longitudinal section of the stem on **S1**, using your microscope.

**(c) (i)** On your drawing in **(a)**, indicate one possible position at which the longitudinal section could have been cut. Label this "*position of l.s.*". [1]

**(ii)** Give a reason for your decision in **(c)(i)** based on your observation of both the transverse and longitudinal sections.

.....

..... [1]

**(iii)** Pith is the soft spongy tissue in the central region of vascular plant stems. In *Cucurbita*, the central part of the pith disintegrates to produce a cavity, as seen from the large gap in the middle of the longitudinal section on **S1**. This cavity is called the pith cavity, which is an important adaptation in some climbing plants.

Suggest one benefit to a climbing plant for having a hollow stem instead of a solid stem.

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..... [1]

**(d)** *Epipremnum aureum*, commonly known as money plant, is another type of climbing plant.

Proceed as follows to prepare a transverse section of the stem of **S2**.

**1** Use a sharp penknife to cut a few very thin (< 1mm thick) transverse section slices of the stem of **S2**. **Be careful when handling the sharp penknife.**

**2** Place one of the thinnest slices in the middle of a clean slide.

**3** Add 1-2 drops of water and then apply a cover slip.

The stem of *Cucurbita* (**S1**) is hollow while the stem of **S2** is often, but not always, expected to be completely filled with cells.

Identify three **other** observable structural differences between the stem of *Cucurbita* (**S1**) and *Epipremnum aureum* (**S2**).

Record these **three** observable differences in Table 3.1.

**Table 3.1**

| feature | *Cucurbita* (S1) | *Epipremnum aureum* (S2) |
|---|---|---|
| | | |
| | | |
| | | |

[3]

[Total: 19]

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