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TEMASEK JUNIOR COLLEGE

2023 JC2 PRELIMINARY EXAMINATION

Higher 2

CANDIDATE NAME									
CENTRE NUMBER	S					INDEX NUMBER				

BIOLOGY 9744/04

Paper 4 Practical

30 August 2023

2 hour 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your name, CG, Centre number, index number on all the work you hand in.
Give details of the practical shift and laboratory, where appropriate, in the boxes provided.

Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, 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 work or if you do no use appropriate units.

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.

Shift
Laboratory

For Examiner's Use	
1	/ 17
2	/ 17
3	/ 21
Total	/ 55

Answer **all** questions**.**

1 (a) You will investigate the effect of different temperatures on the permeability of the cell surface membrane of beetroot cells.

Beetroot is a vegetable that contains a red pigment in its cells.

When beetroot tissue is put into water, the red pigment can move out of the cells through the cell surface membrane, changing the water to a red colour.

You are provided with:

labelled	contents	hazard	volume / cm^3
B	4 pieces of beetroot	none	-
W	distilled water	none	100.0

The red pigment in beetroot cells can stain clothing and skin. Use blunt forceps to handle beetroot tissue and, if any pigment comes into contact with your skin, wash it off immediately under cold water.

It is recommended that you wear suitable eye protection.

You will need to:

- put beetroot tissue in water at different temperatures
- leave the beetroot tissue in the water for a period of time
- record the intensity of colour in the water at each temperature.

(i) The temperature range that you will use must include a minimum temperature of 25˚C and a maximum temperature of 65˚C.

State **other** temperatures that you will use in your investigation.

…… [1]

*Read step **1** to step **13** before proceeding.*

Proceed as follows.

1 Cut the beetroot pieces into 2 mm thick discs. You will need at least 25 discs.

2 Put all the discs that you have cut into the beaker labelled **D** and cover them with approximately 30 cm^3 distilled water, **W**.

3 Stir with a glass rod.

4 Pour off the water into the beaker labelled **For waste**, leaving the discs in the beaker labelled **D**.

5 Put all the discs on a paper towel and blot them to remove excess water.

6 Set up and maintain a water-bath at 25˚C, using the beaker labelled **water-bath**. The water-bath will be needed in step 9.

7 Put five discs into **one** test-tube.

8 Put 10 cm^3 of distilled water, **W**, into the test-tube with the five discs.

9 Put this test-tube into the water-bath for four minutes. You will need to maintain the water-bath at the correct temperature throughout these four minutes.

10 After four minutes, remove the test-tube with the discs from the water-bath.

11 Pour the water from this test-tube into a second test-tube, leaving the discs in the first test-tube.

12 Repeat step 1 to step 11 until all of the temperatures stated in **(a)(i)** have been tested, finishing with the maximum temperature of 65˚C.

13 Observe the colour intensity of the water in each of the test-tubes in the test-tube rack.

14 Using only the symbols shown in Table 1.1 to represent intensity of colour, decide the intensity of colour in each of the test-tubes in the test-tube rack. Record your results in **(a)(ii)**.

Table 1.1

intensity of colour	symbol
dark red	++++++
↓ decreasing intensity of red colour	+++++
	++++
	+++
	++
no colour	+

(ii) Record your results in an appropriate table, using only the symbols shown in Table 1.1.

[4]

(iii) Use your knowledge of cell surface membranes to explain the results that you recorded in **(a)(ii)**.

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(iv) Identify **three** significant sources of error in this investigation.

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(v) Suggest how you would make improvements to reduce **two** of the sources of error identified in **(a)(iv)**.

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(b) A scientist investigated changes in the mean width of stomata in the leaves of a plant growing in hot, dry conditions. The scientist measured the widths of stomata at different times of day, from dawn to midnight.

Fig. 1.1 shows where the scientist measured the width of each stoma.

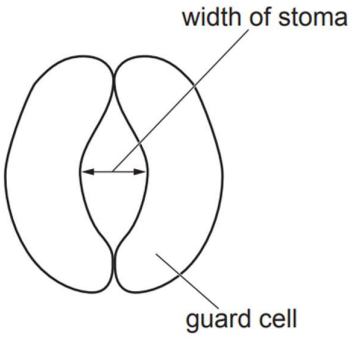


Fig. 1.1

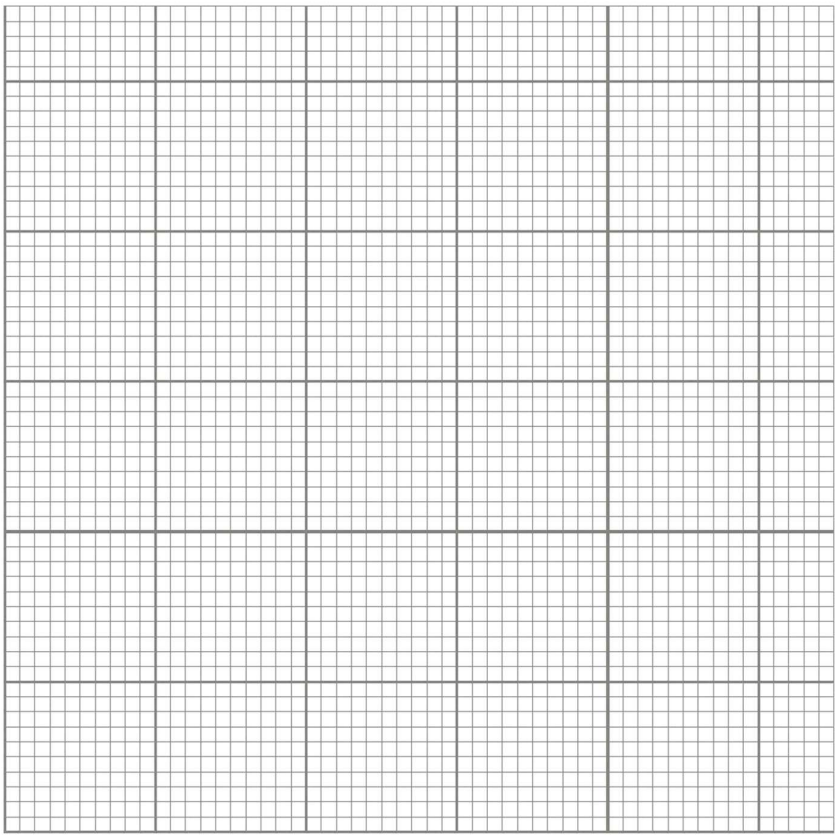
The scientist calculated the mean width of stomata for each time of day.

The results are shown in Table 1.2.

Table 1.2

time of day	mean width of stomata / arbitrary units (au)
dawn	86
morning	36
noon	10
evening	6
midnight	95

Use the grid provided to plot a graph in an appropriate form to display the data shown in Table 1.2. [4]



[Total: 17]

2 **(a)** A group of students were given two species of plants, Species **A** and Species **B**. Their teacher also shared that one species is classified as a shade plant while the other is classified as a sun plant.

By measuring the rate of decolorization of DCPIP, describe how the students could design an experiment to investigate which species belongs to which category.

You must use:

- 50 g of leaves from Species **A** and Species **B**,
- 5 cm^3 of DCPIP solution,
- blender,
- 50 cm^3 cold extraction buffer solution,
- capillary tubes,
- aluminium foil,
- card tent,
- lamp which emits very little heat,
- timer, e.g. stopwatch
- ruler

You may select from the following apparatus and use appropriate additional apparatus:

- normal laboratory glassware e.g. test-tubes, beakers, measuring cylinders, graduated pipettes, glass rods, etc.
- syringes.

Your plan should:

- have a clear and helpful structure such that the method you use is able to be repeated by anyone reading it
- be illustrated by relevant diagram(s), if necessary
- identify the independent and dependent variables
- describe the method with the scientific reasoning used to decide the method so that the results are as accurate and repeatable as possible
- include layout of results tables and graphs with clear headings and labels
- use the correct technical and scientific terms
- include reference to safety measures to minimise any risks associated with the proposed experiment.

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[13]

(b) The students also found a published investigation on the effect of light intensity on stomatal density in the species *Lycopersicon esculentum.*

Two plants of *Lycopersion esculentum* were selected. One was grown in high light intensity and the other was grown in low light intensity.

The results are shown in Table 2.1.

Table 2.1

leaf number	high light intensity			low light intensity		
	number of stomata × 10^3		leaf area / cm^2	number of stomata × 10^3		leaf area / cm^2
	upper surface	lower surface		upper surface	lower surface	
1	1634	3131	496	18	1277	160
2	1482	5072	509	10	906	115
3	1865	6365	637	14	1398	171
mean	1660	4856	547	14	1194	149

(i) Calculate the percentage decrease in mean leaf area for leaves grown in low light intensity compared with those grown in high light intensity.

Your answer should be expressed as a whole number.

…… % [1]

(ii) The scientists who carried out the published investigation concluded that:

> plants grown in higher light intensity have higher stomatal density **only** on the upper surface of the leaves compared to plants grown in lighter light intensity.

Evaluate whether the data in Table 1.1 supports this conclusion.

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[Total: 17]

3 **P1** is a slide of a stained transverse section through a plant stem.

You are not expected to be familiar with this specimen.

(a) Set up the microscope so that you can observe different tissues in the area of the stem on **P1** shown by the shaded region in Fig. 3.1.

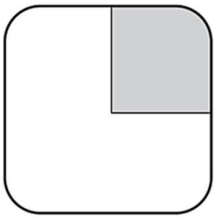

Fig. 3.1

You are required to use a sharp pencil for drawings.

(i) Draw a large plan diagram of the area of the stem on **P1** shown by the shaded region in Fig. 3.1.

Your drawing should show the correct shapes and proportions of the different tissues.

Use **one** ruled label line and label to identify the epidermis.

[5]

(ii) Observe the cells in the central tissue of the stem on **P1**.

Select **three** adjacent, touching cells of the central tissue.

Each cell that you select must touch at least two of the other cells.

- Make a large drawing of this group of **three** touching cells.
- Use **one** ruled label line and label to identify the cell wall of **one** cell.

[5]

(b) Fig. 3.2 is a photomicrograph of a stained transverse section through a stem of a different type of plant. This plant is adapted to live submerged in water.

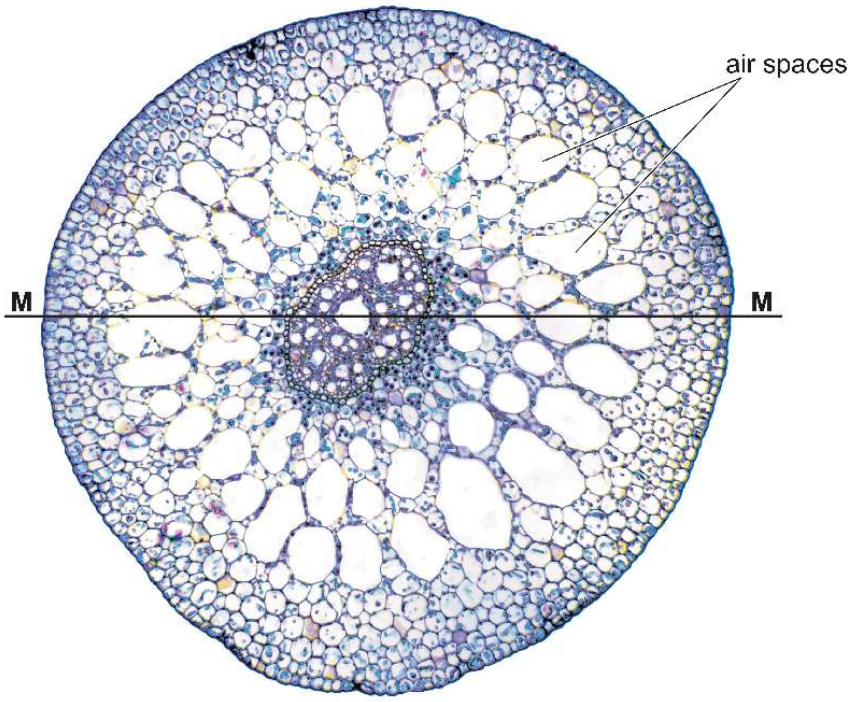

Fig. 3.2

(i) Calculate the total area, in mm^2, of the image of the stem shown in Fig. 3.2.

- Assume that the stem is circular in cross-section.
- Measure the diameter of the image of the stem along line **M–M**.
- Show your working.

The formula for calculating the area of a circle is:

area = $3.14 \times r^2$ (r = radius)

area = ... mm^2 [3]

(ii) In Fig. 3.2, the tissue that contains air spaces has an area in the image of 4500 mm^2.

Use your answer in **(b)(i)** to calculate the percentage area of the stem shown in Fig. 3.2 that contains air spaces.

percentage area = ... [1]

(iii) Describe how a more accurate measurement of the diameter of the stem can be obtained using the microscope. Include any additional apparatus that you might need.

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(iv) The presence of a large number of air spaces in the stem is one adaptation of the plant shown in Fig. 3.2 for living submerged in water.

Suggest a function of these air spaces.

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…… [1]

(v) One difference between the stem shown in Fig. 3.2 and the stem on slide **P1** is the presence of air spaces.

Identify **other** observable differences between the stem shown in Fig. 3.2 and the stem on slide **P1**.

Prepare the space below to record **two** of these observable differences.

[3]

[Total: 21]

End of Paper 4