| Civics Group | Index Number | Name (use BLOCK LETTERS) | **H2** |
|---|---|---|---|

**ST. ANDREW'S JUNIOR COLLEGE**
**2024 JC2 PRELIMINARY EXAMINATION**

**H2 BIOLOGY** **9744/04**

**Paper 4: Practical Exam**

Tuesday 20th August 2024 2 hours 30 minutes

**READ THESE INSTRUCTIONS FIRST**

Write your name, civics group and 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 a HB pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions in 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 working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

**IMPORTANT INFORMATION TO CANDIDATES:**

Candidates with access to **microscope** at the start of the paper are given the **first 1h 15 min** to use them. Please answer **QUESTION 3** within this time frame. Once you have finished working with the microscope, you can move on to **QUESTION 1 or 2**.

Candidates with no access to microscope at the start of the paper should proceed with **QUESTION 1 or 2** first. You will be given access to the microscope at **1h 15 min after the start of the paper**.

| **Shift** |
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| |
| **Laboratory** |
| |

| **For Examiner's Use** | |
|---|---|
| **1** | / 23 |
| **2** | / 12 |
| **3** | / 20 |
| **Total** | **/ 55** |

This document consists of **21** printed pages.

**[Turn over**

**Question 1**

Agar stained with universal indicator can be used to investigate diffusion.

When hydrochloric acid diffuses into the agar it changes the colour from green to pink.

You will investigate the diffusion of different concentrations of hydrochloric acid in agar.

You are provided with the materials shown in Table 1.1.

**Table 1.1**

| labelled | contents | hazard | volume/ $cm^3$ |
|---|---|---|---|
| **H** | 2.0 mol $dm^{-3}$ hydrochloric acid | irritant | 20.0 |
| **W** | distilled water | none | 40.0 |
| | 2 Petri dishes containing agar | none | - |
| **sheet T** | sheet T | - | - |

If **H** comes into contact with your skin, wash off immediately with cold water.

It is recommended that you wear suitable eye protection.

You will need to:

- prepare different concentrations of hydrochloric acid, **H**
- measure the diffusion distance for each concentration of hydrochloric acid.

You will need to carry out a serial dilution of the 2.0 mol $dm^{-3}$ hydrochloric acid, **H**, to reduce the concentration by half between each successive dilution.

You will need to prepare four concentrations of hydrochloric acid in addition to 2.0 mol $dm^{-3}$ hydrochloric acid, **H**.

After the serial dilution is completed, you will need to have 5.0 $cm^3$ of each concentration available to use.

**(a) (i)** Complete Fig. 1.1 to show how you will prepare your serial dilution.

Fig. 1.1 shows the beakers you will use.

For each beaker, add labelled arrows to show:

- the volume of hydrochloric acid transferred,
- the volume of distilled water, **W**, added.

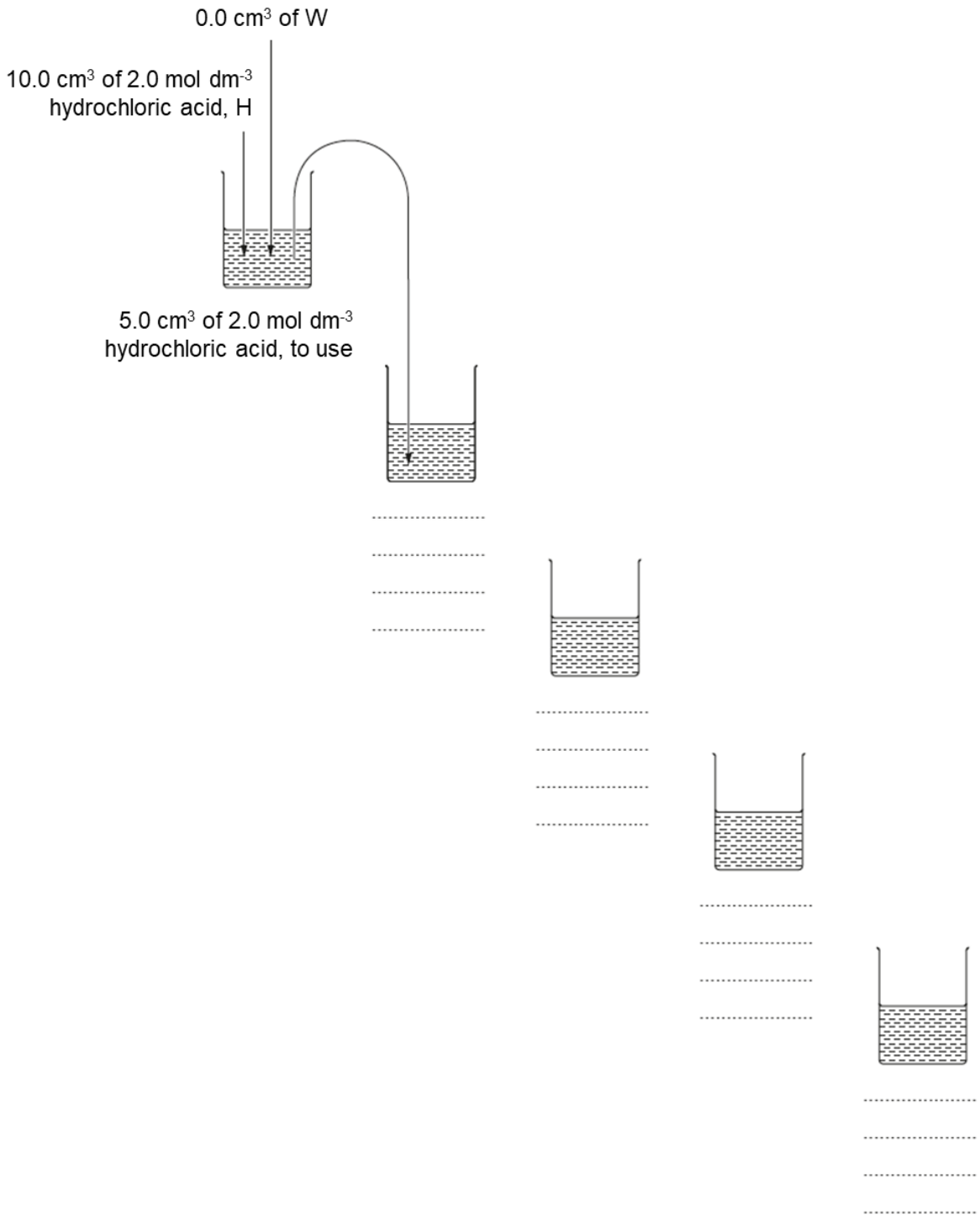
0.0 cm3 of W
10.0 cm3 of 2.0 mol dm-3 hydrochloric acid, H
5.0 cm3 of 2.0 mol dm-3 hydrochloric acid, to use

**Fig. 1.1**

[3]

**Proceed as follows.**

**1** Prepare the concentrations of hydrochloric acid, as decided in **(a)(i)**, in the beakers provided.

The different concentrations of hydrochloric acid will be put into wells cut into the agar. The position of one well is shown in Fig. 1.2.

You need to decide where to put **four** more wells in the agar in each Petri dish so that the wells are positioned away from each other and away from the edge of the Petri dish. Hydrochloric acid will diffuse into the agar around each well.

**(ii)** Complete Fig. 1.2 by:

- drawing **four** small circles to show where you have decided the wells should be positioned in the agar
- labelling the **five** small circles in Fig. 1.2 with the concentrations of hydrochloric acid you prepared in step 1.

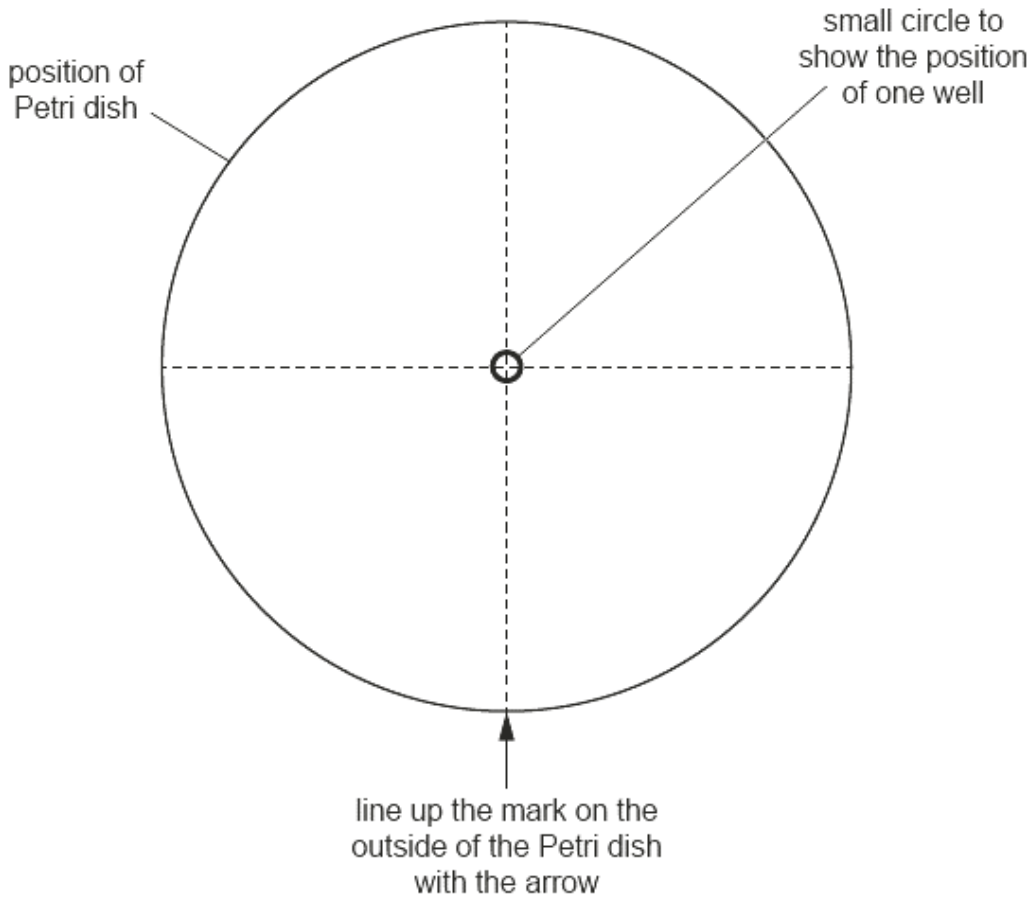


**Fig. 1.2**

[1]

Carry out steps 2 - 14.

**2** Draw a mark on the outside edge of one of the Petri dishes containing agar.

**3** Put the Petri dish on Fig. 1.2 so that the mark on the edge of the Petri dish lines up with the arrow in Fig. 1.2. Keep the Petri dish in this position over Fig. 1.2 for the whole of Step 4.

**4** Use a straw to cut wells in the agar at the positions of the small circles on Fig. 1.2:

- put the end of a straw on the surface of the agar over the centre small circle
- carefully push the straw into the agar
- lift up the straw to leave a well in the agar
- hold the straw over the container labelled **For waste**
- blow gently through the straw to remove the agar from the end of the straw
- if the small circle of agar is **not** lifted by the straw, use a scalpel or mounted needle to carefully remove the agar and put it in the container labelled **For waste**.

**5** Remove the Petri dish from Fig. 1.2 and leave it for use in step 7.

**6** Repeat step 2 to step 4 with the other Petri dish containing agar. You are provided with **sheet T** for use in step 7 and step 8.

**7** Put one of the Petri dishes on circle **A** on **sheet T** so that the mark on the edge of the Petri dish lines up with the arrow.

**8** Put the other Petri dish on circle **B** on **sheet T** so that the mark on the edge of the Petri dish lines up with the arrow.

**9** For each Petri dish, **A** and **B**, use a Pasteur pipette to carefully put 2.0 mol $dm^{-3}$ hydrochloric acid, **H**, into the appropriate well in the agar, as labelled in Fig. 1.2.

**10** Repeat step 9 for the other concentrations of hydrochloric acid labelled in Fig. 1.2. Do **not** move the Petri dishes after the wells have been filled with the hydrochloric acid.

**11** Start timing.

Between step 11 and step 12, you will be leaving the Petri dishes on **sheet T** for 20 minutes.
Use this time to continue with other parts of Question 1.

**12** After leaving the Petri dishes for 20 minutes, use a Pasteur pipette to remove the hydrochloric acid from the wells in both Petri dishes. Put this hydrochloric acid into the beaker labelled **For waste**.

**13** Measure the diffusion distance, as shown in Fig. 1.3, for each concentration of hydrochloric acid in both Petri dishes.

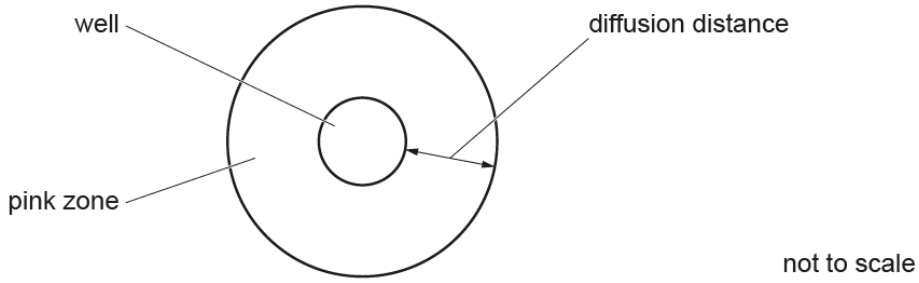


**Fig. 1.3**

**14** Record your results in **(a)(iii)**.

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

[4]

**(iv)** Calculate the rate of diffusion for 2.0 mol $dm^{-3}$ hydrochloric acid, **H**.

Show your working and use appropriate units.

rate = ..... [2]

**(v)** A student observed that the rate of diffusion was **not** constant during the investigation. Suggest how the student could modify the procedure to investigate the change in the rate of diffusion.

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[3]

**(vi)** Identify one significant source of error in this experiment. Suggest an improvement to eliminate this error.

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[2]

**(b)** A scientist studied the rate of absorption of the amino acid alanine through the wall of the small intestine.

A concentration gradient was maintained throughout the investigation and all other variables were kept constant.

The results are shown in Table 1.2.

**Table 1.2**

| percentage concentration of alanine | rate of absorption / μm $h^{-1}$ |
|---|---|
| 5 | 300 |
| 14 | 950 |
| 30 | 1625 |
| 50 | 1750 |
| 70 | 1775 |

**(i)** Plot a graph of the data shown in Table 1.2 on the grid in Fig. 1.4.
Use a sharp pencil.

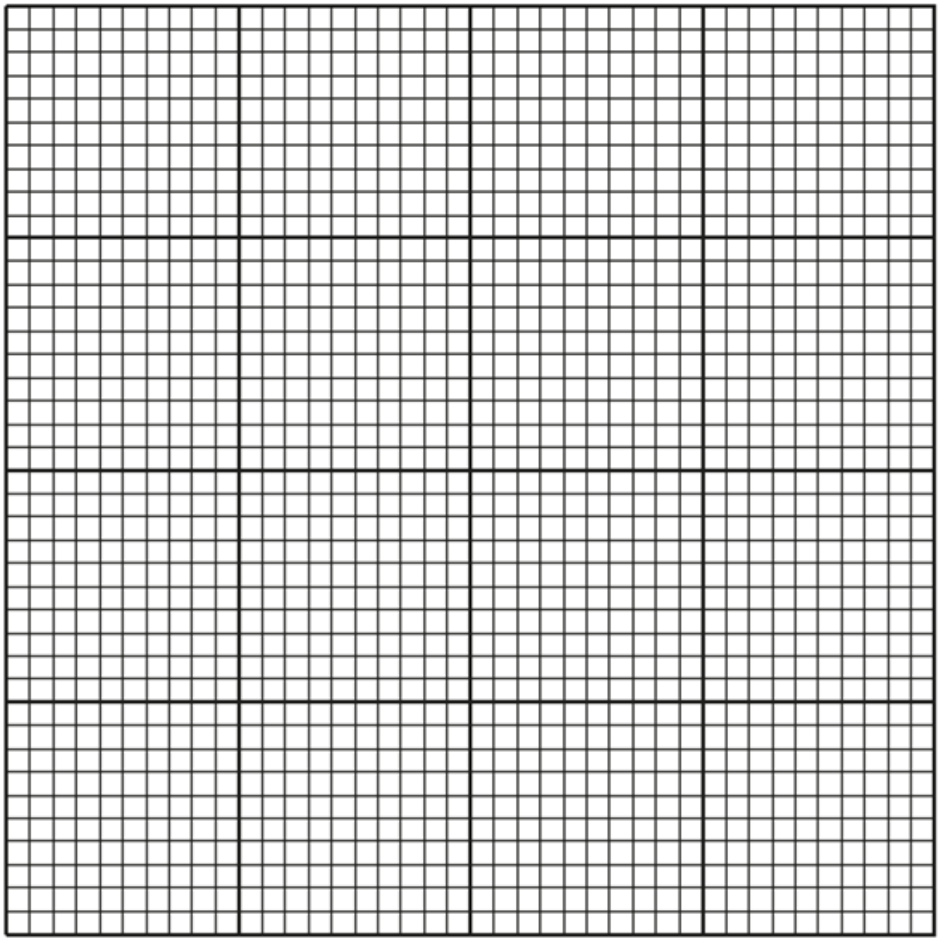

**Fig. 1.4**

[4]

**(ii)** Amino acids are transported into cells by facilitated diffusion.
Explain the shape of your graph in Fig. 1.4.

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[4]

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**Question 2**

The enzyme urease catalyses the breakdown of urea into carbonate ions and ammonium ions as shown in Fig. 2.1.

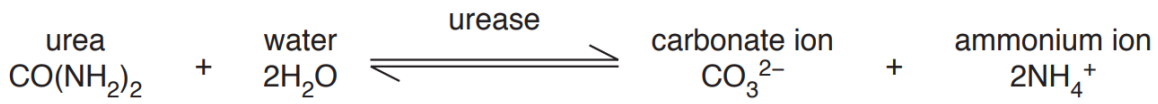


**Fig. 2.1**

A solution of urea does not conduct electricity, but a solution of the two ions does conduct electricity.

An increase in ions increases conductivity, so the rate of reaction is proportional to the conductivity.

A meter measures conductivity in microsiemens per centimetre ($\mu Scm^{-1}$). The conductivity meter also records temperature.

Fig. 2.2 shows the experimental set-up during the course of a reaction.

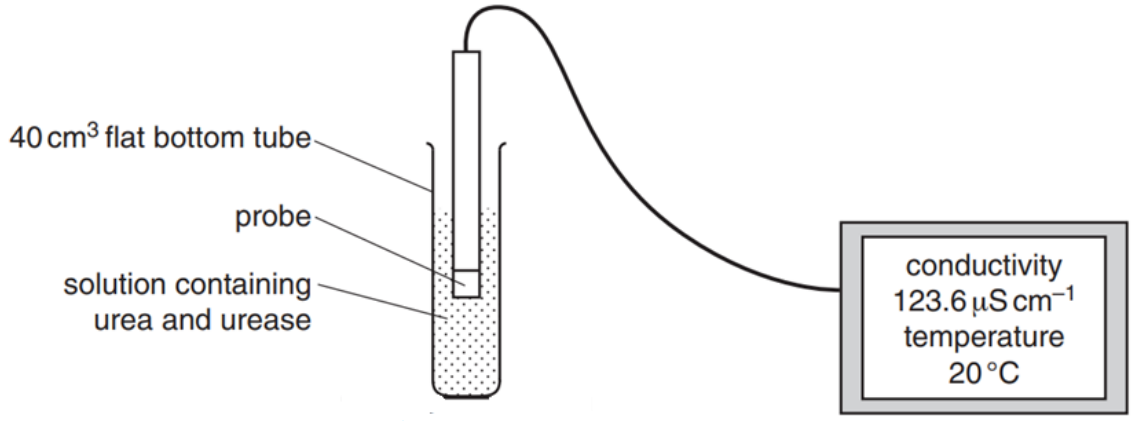


**Fig. 2.2**

Design an experiment, based on measuring the conductivity, to test whether or not the inhibition of urease by acetic acid is competitive.

In your plan you must use:

- 0.25 $moldm^{-3}$ solution of urea
- 0.05 $moldm^{-3}$ acetic acid
- 1 g per 10 $cm^3$ urease solution
- a conductivity meter to measure the initial rate of reaction at each temperature.

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 diagrams, if necessary
- identify the dependent variable and the independent variable
- identify the variables you will need to control
- use the correct technical and scientific terms
- indicate how the results will be recorded and analysed
- include reference to safety measures to minimise any risks associated with the proposed experiment.

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**Question 3**

During this question you will require access to a microscope and a stage micrometer.

You are provided with two pieces of cherry tomato in a petri dish labelled **K1**.

**Proceed as follows.**

**1** Place the cherry tomato cut-side up on a white tile so that you are able to observe the cross-section of the cherry tomato.

**(a) (i)** Draw the cross section of the cherry tomato in the space provided.

Your drawing should show the arrangement of the different regions and their correct shapes and proportions.

No labels are required.

[4]

**(ii)** Calculate the magnification of your drawing in **(a)(i)**. Show all your working.

Magnification = …….. [2]

**2** Place the cherry tomato cut-side down on a white tile.

**3** Using a scalpel, cut the tomato as close to the skin as possible, leaving a small section uncut, as shown in Fig. 3.1(a).

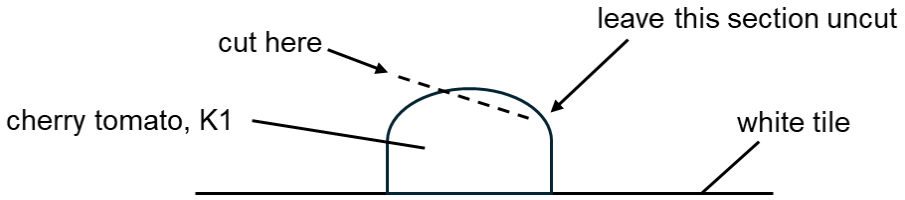


**Fig. 3.1(a)**

**4** Holding the cut piece, gently pull the specimen away as shown in Fig. 3.1(b). You should obtain a single layer of the skin.

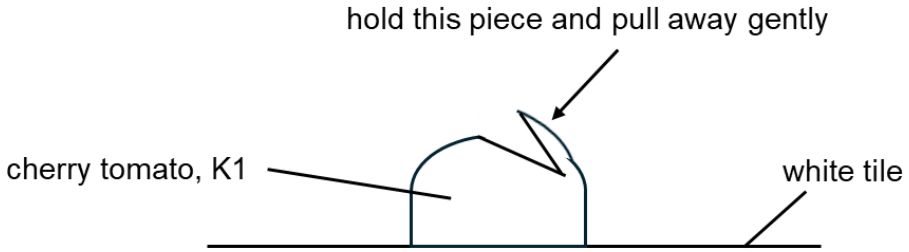


**Fig. 3.1(b)**

**5** Using the scalpel and white tile, cut a small piece of the single layer skin and place it on a microscope slide.

**6** Put one to two drops of distilled water on the thin piece of skin on the slide. You need to ensure that the skin is not folded.

**7** Add a coverslip to the slide and use a paper towel to absorb any excess fluid.

**8** Observe the slide with a microscope.

**(b)** **(i)** Using an appropriate objective lens, make a high power drawing of two touching cells.

At least **one** of these cells should have a nucleus. Label the nucleus.

[5]

**(ii)** A rough estimate of the area occupied by a cell observed in **(b)(i)** is given by **X** × **Y** as seen in Fig. 3.2.

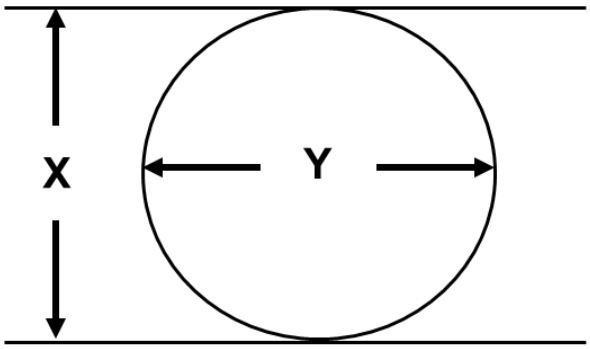


**Fig. 3.2**

Measure and record the dimensions of **X** and **Y** of one of the cell in **(b)(i)** in eyepiece graticule units.

**X** = …… eyepiece graticule units

**Y** = …… eyepiece graticule units

[1]

**(iii)** Using the same objective lens you used in **(b)(i)**, calibrate your eyepiece graticule using the 1 mm stage micrometer provided.

You should show all your working and use appropriate units.

1 eyepiece graticule unit = …….[2]

**(iv)** Using the measurement of length in eyepiece graticule units recorded in **(b)(ii)**, calculate the estimated area of the cell.

You should show all your working.

Area of the cell …….. $\mu m^2$ [2]

The **concentration** of ascorbic acid can be estimated in a fruit extract by carrying out a test using starch solution and iodine solution.

Iodine solution will be added one drop at a time using a syringe.

To practise releasing drops from a syringe:

**1** Fill a syringe with 1.0 $cm^3$ distilled water from beaker labelled **W** (from Question 1).

**2** Hold the syringe over an empty test-tube as shown in Fig. 3.3 and push the plunger slowly to release one drop.

**3** Repeat this until you can release one drop at a time.

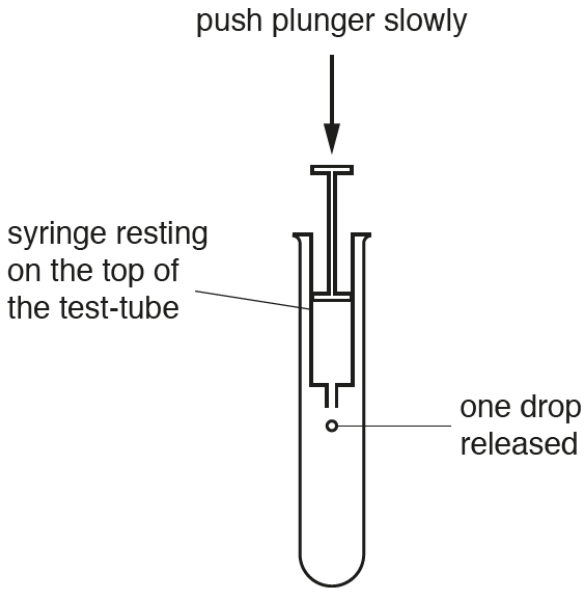


**Fig. 3.3**

You are provided with the materials shown in Table 3.1.

**Table 3.1**

| labelled | contents | hazard | volume/ $cm^3$ |
|---|---|---|---|
| **iodine** | iodine solution | none | 20.0 |
| **S** | starch solution | none | 20.0 |
| **X** | tomato extract | none | 20.0 |

If any solutions come into contact with your skin, wash off immediately under cold water.

It is recommended that you wear suitable eye protection.

You will now carry out a test on **X** to find the volume of iodine solution that needs to be added for the end-point to be reached.

The end-point is when the blue colour remains after 10 seconds.

**4** Put 1.0 $cm^3$ of **S** into a test-tube.

**5** Put 5.0 $cm^3$ of **X** into the same test-tube.

**6** Shake the test-tube gently to mix the contents.

**7** Fill a 1.0 $cm^3$ syringe with exactly 1.0 $cm^3$ of iodine.

**8** Wipe off any iodine from the outside of the syringe with a paper towel.

**9** Put one drop of iodine, as shown in Fig. 3.3, into the mixture of **S** and **X** in the test-tube.

**10** Mix gently and observe any colour change.

**11** Repeat step 9 and step 10 until a blue colour appears. You may need to refill the syringe with iodine as in step 7.

**12** When the blue colour appears, shake the test-tube gently for 10 seconds and see if the end-point has been reached.

**13** If the blue colour disappears then repeat step 9 to step 12 until the mixture stays blue for at least 10 seconds.

**14** Record in **(c)(i)** the volume of iodine solution added.

**15** Repeat steps 4 to 14 two more times and calculate average volume of iodine solution added.

**(c) (i)** Record your results in an appropriate table below.

[3]

Table 3.2 below shows the volume of iodine solution needed to reach the end-point at various concentration of ascorbic acid.

**Table 3.2**

| Concentration of ascorbic acid/ % | Volume of iodine solution needed to reach end-point/ $cm^3$ |
|---|---|
| 0.10 | 2.15 |
| 0.08 | 1.60 |
| 0.06 | 1.25 |
| 0.04 | 0.75 |
| 0.02 | 0.35 |

**(ii)** Using your result in **(c)(i)**, estimate the concentration of ascorbic acid in **X**.

Concentration of ascorbic acid = …… [1]

**[Total: 20m]**