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MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Ordinary Level

PASTE YOUR BARCODE LABEL HERE

PLACEHOLDER FOR CANDIDATE
BARCODE LABEL

(NAME, SCHOOL NAME, INDEX NO.)

BIOLOGY

6093/03

Paper 3 Practical Test

October/November 2023

1 hour 50 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Please check that your name, school name and Centre number/index number are printed **CORRECTLY** on the barcode label.
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, correction fluid or highlighters.
DO **NOT** WRITE ON ANY BARCODES.

Shift
Laboratory

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 working 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 brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
Total	

This document consists of **13** printed pages and **3** blank pages.

Singapore Examinations and Assessment Board

Cambridge Assessment International Education

1 **You are advised to read the whole question before you start.**

Yeast respires in both aerobic and anaerobic conditions. Respiration in yeast is an enzyme-controlled process that breaks down glucose to release carbon dioxide under both conditions.

Carbon dioxide can be detected by using a pH indicator which changes colour when the pH becomes more acidic.

You are going to investigate the effect of different concentrations of glucose on the rate of respiration in a suspension of yeast cells.

You are provided with:

- suspension of yeast cells prepared in a 15% glucose solution (labelled **A**)
- suspension of yeast cells prepared in a 10% glucose solution (labelled **B**)
- a pH indicator solution (labelled **C**)
- a beaker of tap water (labelled **tap water**)
- a beaker of warm water (labelled **warm water**)
- an empty beaker (labelled **water-bath**)
- a 10 cm^3 syringe with tubing attached
- a 5 cm^3 syringe
- the base of a Petri dish
- a test-tube rack containing five empty test-tubes and a test-tube labelled **D**, which contains 3 cm^3 of pH indicator solution **C**
- a thermometer
- a drinking straw
- a stop-watch.

You are advised to wear gloves and eye protection throughout the investigation.

Proceed as follows:

Use the warm water and the tap water provided to make a water-bath at 35 °C ± 2 °C in the beaker labelled **water-bath**. To prevent your water-bath from overflowing, do not add more than 100 cm^3 of water to the water-bath.

Place the container labelled **A** into the water-bath and cover with the Petri dish base provided.

If required, use the beaker labelled **warm water** to collect more warm water from where it is provided in the laboratory.

Part 1

Read all of Part 1 before beginning the experiment.

Use the straw provided to blow gently into the solution in test-tube **D**, which contains 3 cm^3 of the pH indicator solution. Look carefully at the colour of the pH indicator solution each time you blow into the solution. Continue to blow into the solution until the pH indicator stops changing colour and remains yellow/dark yellow.

For safety reasons, wear gloves and eye protection and do not suck in any solution from test-tube D. If any pH indicator solution comes into contact with your skin, wash the area with soap and plenty of running tap water. If any pH indicator solution comes into contact with your mouth, immediately rinse your mouth under running tap water and alert the Invigilators in the room.

Leave the test-tube of pH indicator solution in the test-tube rack as you will need it in **Part 2**.

(a) Explain why the pH indicator solution changes colour.

Exhaled air contains carbon dioxide gas;

carbon dioxide gas dissolved in water to form carbonic acid / is an acidic gas, changes the colour of pH indicator from green to yellow

..... [2]

Part 2

When you start the stop-watch in step 5, leave it running throughout the whole investigation. You will need to record times from the stop-watch during the course of the investigation.

Step 1 Label the empty test-tubes **1** to **5**. Put each labelled test-tube back into the test-tube rack.

Step 2 Use the 5 cm^3 syringe to put 3 cm^3 of the pH indicator solution **C** into each of the test-tubes **1** to **5**.

Step 3 Remove the container labelled **A** from the water-bath. Use the warm water to return the temperature of the water-bath to 35 °C ± 2 °C. Place the container labelled **B** into the water-bath and cover with the Petri dish base.

Step 4 Measure the temperature of the yeast suspension in the container labelled **A** and record it in the space above Table 1.1.

Step 5 Start the stop-watch. **Remember to leave the stop-watch running throughout the whole investigation.**

Step 6 Use a glass rod to thoroughly stir the yeast suspension in the container labelled **A**. Froth will form on the surface of the yeast suspension. You may dispose of any froth that overflows the container with a spatula.

Step 7 Remove the tubing from the 10 cm^3 syringe. Push the plunger to the bottom of the syringe. Hold the syringe with the nozzle about halfway into the yeast suspension in the container labelled **A** and below any froth.

Take up 8 cm^3 of the yeast suspension making sure that you keep the nozzle in the yeast suspension.

Step 8 Remove the syringe from the yeast suspension and hold the barrel with the nozzle pointing upwards. Pull out the plunger to the 10 cm^3 mark. Do **not** press the plunger. There will now be 2 cm^3 of air in the syringe.

Step 9 Keeping the syringe pointing upwards, make sure the yeast suspension does not enter the nozzle. Wipe off any yeast suspension from the syringe with a paper towel. Replace the tubing tightly onto the nozzle of the syringe.

Step 10 Put the free end of the tubing into test-tube **1** in the test-tube rack as shown in Fig. 1.1. Note the start time and record it in minutes and seconds in Table 1.1.

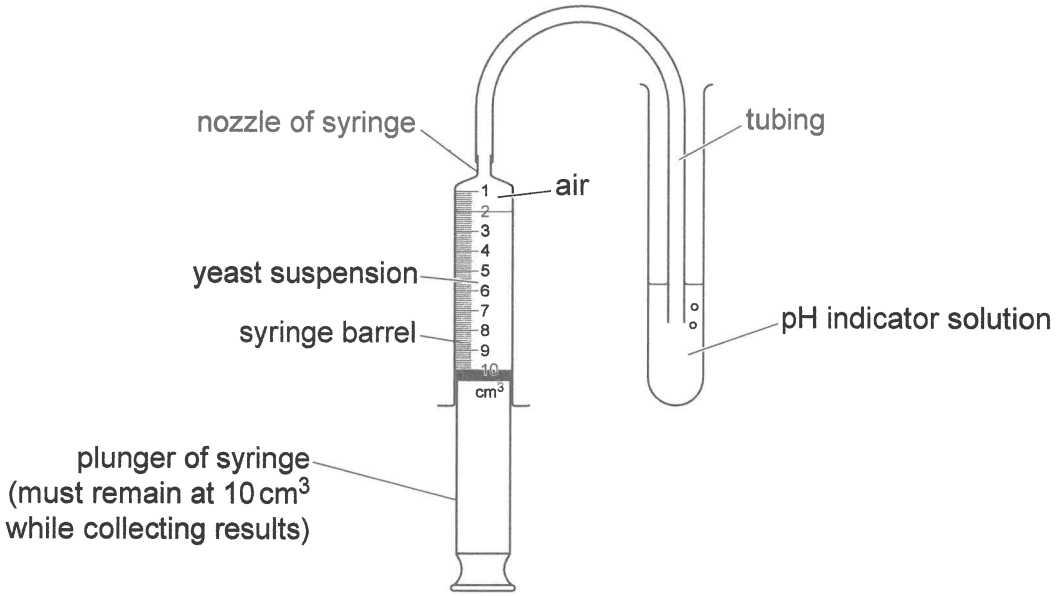


Fig. 1.1

Step 11 **Keep the free end of the tubing in the pH indicator solution.**

Gently shake both the syringe barrel and test-tube **1** until the pH indicator solution turns the same yellow as seen in test-tube **D** in **Part 1**.

As soon as this happens, note the end time and record it in minutes and seconds in Table 1.1.

Step 12 Remove the tubing from test-tube **1** and place it into test-tube **2**, noting and recording the start time in Table 1.1.

Step 13 Repeat steps 11 and 12 with test-tube **2** and with the remaining three test-tubes **3**, **4** and **5**, recording the times when you put the tubing into the pH indicator solution (start time) **and** each time the pH indicator solution turns yellow (end time).

Step 14 Pour out the pH indicator solution from each of the test-tubes **1** to **5** and rinse each test-tube under running water from the tap. Use the 5 cm^3 syringe to put 3 cm^3 of pH indicator solution **C** into each of the test-tubes **1** to **5**.

Step 15 Remove the tubing from the syringe and wash out the syringe thoroughly under running water from the tap.

Step 16 Remove the container labelled **B** from the water-bath. Stir the yeast suspension thoroughly. Measure the temperature of the yeast suspension in the container labelled **B** and record it in the space provided above Table 1.2.

Step 17 Repeat steps 7 to 13 with the yeast suspension in the container labelled **B**. Record the times in Table 1.2.

(b) Complete Tables 1.1 and 1.2 by:

- recording the temperatures of both of the yeast suspensions
- calculating the length of time for the yellow/dark yellow colour to appear in each test-tube, in seconds
- choosing **at least two** results to calculate the mean time for the yellow/dark yellow colour to appear with each concentration of glucose
- circling the results that you have chosen to calculate the mean.

Table 1.1

yeast suspension in 15% glucose solution

temperature of yeast suspension = 35.0 °C

test-tube	time at start in min and s	time at end in min and s	length of time / s	mean time for the pH indicator solution to turn yellow / s
1	2 min 15 s	2 min 32 s	17	$\frac{15 + 13 + 13 + 3}{4}$ = 14
2	2 min 40 s	2 min 55 s	(15)	
3	3 min 30 s	3 min 43 s	(13)	
4	3 min 57 s	4 min 10 s	(13)	
5	4 min 35 s	4 min 48 s	(13)	

Table 1.2

yeast suspension in 10% glucose solution

temperature of yeast suspension = 35.0 °C

test-tube	time at start in min and s	time at end in min and s	length of time / s	mean time for the pH indicator solution to turn yellow / s
1	11 min 55 s	12 min 48 s	53	$\frac{53 + 52 + 48}{3}$ = 51
2	13 min 2 s	13 min 54 s	52	
3	14 min 10 s	14 min 50 s	48	
4	15 min 30 s	16 min 3 s	33	
5	16 min 18 s	16 min 35 s	15	

[6]

(c) Using the results in Tables 1.1 and 1.2, suggest why the mean should **not** be calculated from all of the results for each concentration of glucose.

Time for all test-tubes not consistent / similar / varies; .....

OR first test tube for each yeast suspension takes a longer time compared to the rest of the test tubes; .....

OR some results are anomalous / outliers; .....

relevant data, i.e timing quoted from table .....

..... [2]

(d) The rate of respiration can be determined by calculating $\frac{1000}{t}$

where t = the time taken in **seconds** for the pH indicator solution to turn yellow.

Use your mean results from Tables 1.1 and 1.2 to calculate the rate of respiration for the two concentrations of glucose.

Record your answers in Table 1.3 to **three significant figures**.

Mean rate of respiration for 15% glucose = 1000 / 14 = 71.4

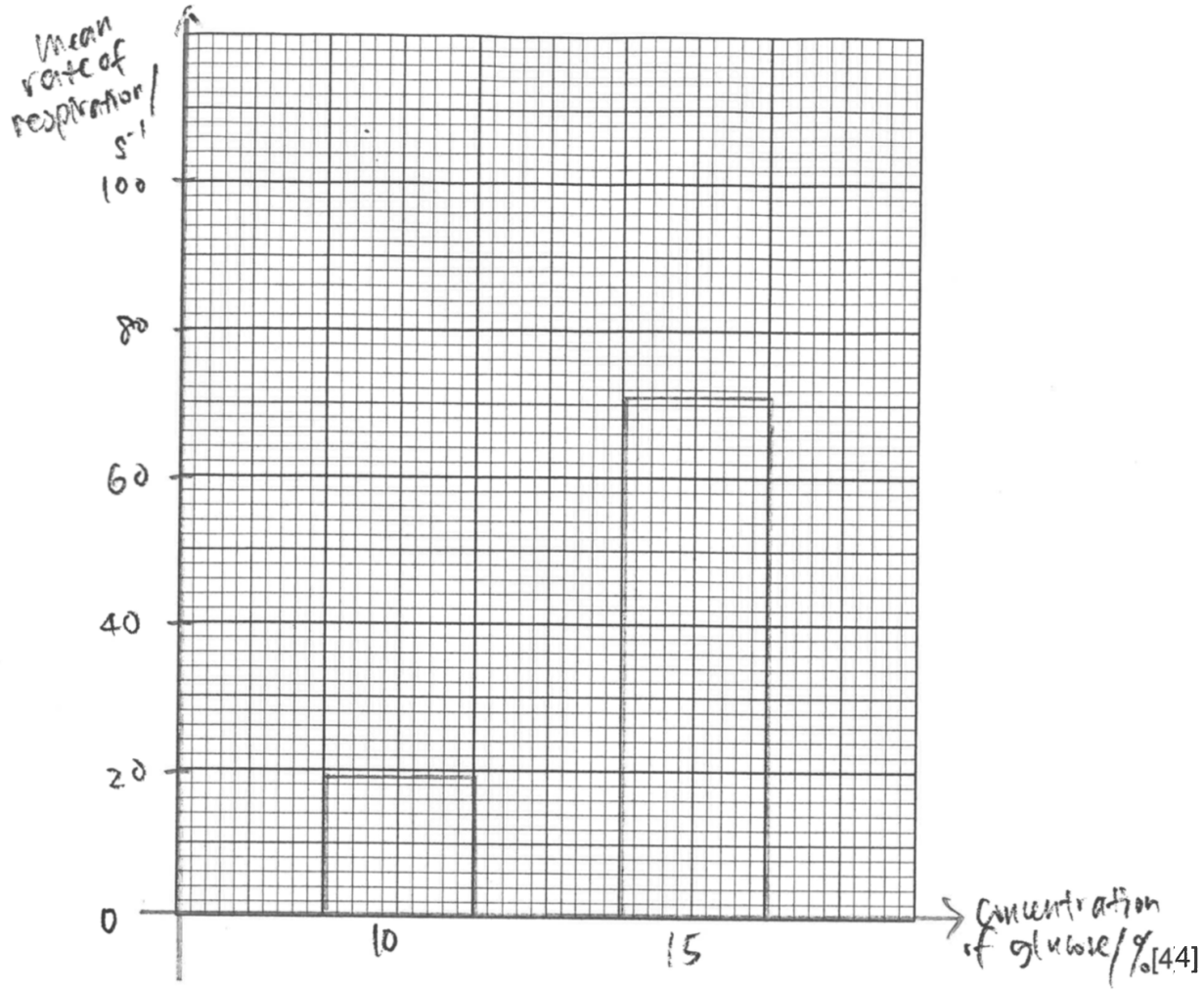
Mean rate of respiration for 10 % glucose = 1000 / 51 = 19.6

Table 1.3

concentration of glucose / %	mean rate of respiration / s^{-1}
15	71.4
10	18.6

[2]

(e) Use the grid provided to draw a bar chart of your results in Table 1.3.



[4]

(f) **(i)** Explain why it was necessary to record the temperature of the yeast suspension during the investigation.

Respiration is an enzyme-controlled reaction + temperature affects enzyme activity. .....

Hence, temperature affects rate of respiration .....

..... [1]

(ii) Identify **one** significant error, **other than** any change in temperature, in the method to determine the rate of respiration of yeast **and** state its effect on the accuracy of the results.

The exact timing / moment when solution turns yellow is subjective or difficult to be consistent in deciding/ determining the timing the solution turns yellow; .....

Hence recorded time / results are inconsistent or longer or shorter than the actual end-point .....

.....

.....

..... [2]

(iii) A student carried out the same investigation and found that the rate of respiration at 15% glucose was higher than at 10% glucose. Explain this result.

15% glucose has a higher substrate concentration + higher frequency of collisions between glucose and enzyme + higher rate of enzyme-substrate formation. ....

.....

..... [1]

(iv) The original investigation used a pH indicator to determine the rate of respiration.

The student wished to repeat the investigation and use a different way to determine the rate of respiration that would give a higher degree of precision.

Suggest **one** way to determine the rate of respiration of a suspension of yeast cells that would give results with a higher degree of precision.

Use a gas syringe to measure volume of gas produced in a fixed duration of time

.....

..... [1]

(g) Aerobic respiration occurs in the mitochondria of yeast cells. Glucose is broken down and used by the mitochondria to release carbon dioxide and water.

A student wanted to investigate the effect of temperature on the activity of mitochondria.

The student prepared a suspension of mitochondria extracted from yeast cells. He used the same procedure as described in **Parts 1** and **2**, replacing the yeast suspension with one of mitochondria.

(i) Suggest **one** suitable control experiment that the student should include in the investigation **and** explain why it is essential to include control experiments in the investigation.

Use boiled and cooled mitochondria suspension / water instead of mitochondria suspension; ...

In the control set up, carbon dioxide is not produced and the indicator should not change in colour. ... This shows that mitochondria is the only source carbon dioxide.

.....

.....

..... [2]

(ii) State **two** variables that must be kept constant throughout the investigation.

1 . Volume of mitochondria suspension / glucose .....

Concentration / mass of glucose used to prepare mitochondria suspension;

.... Concentration of mitochondria suspension ; .....

2 . pH of mitochondria suspension ; .....

.... Length of time taken before the results is taken; .....

[2]

[Total: 25]

2 You are advised to read the whole question before you start.

As in the human alimentary canal, the small intestines of mammals such as mice absorb the products of digestion.

Fig. 2.1 is a drawing of the alimentary canal of a mouse, *Mus musculus*. The dashed line indicates that there are more loops of the small intestine than drawn here.

Fig. 2.2 is a cross-section of the small intestine of a mouse viewed with a light microscope.

Fig. 2.3 is an enlarged image of part of the region shown in the box in Fig. 2.2.

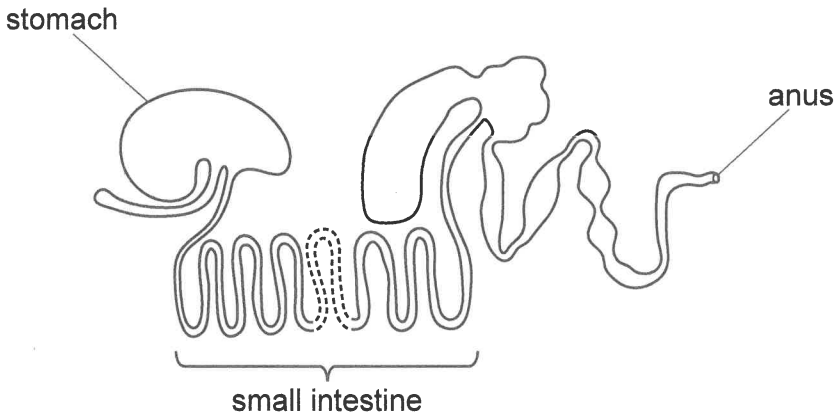


Fig. 2.1

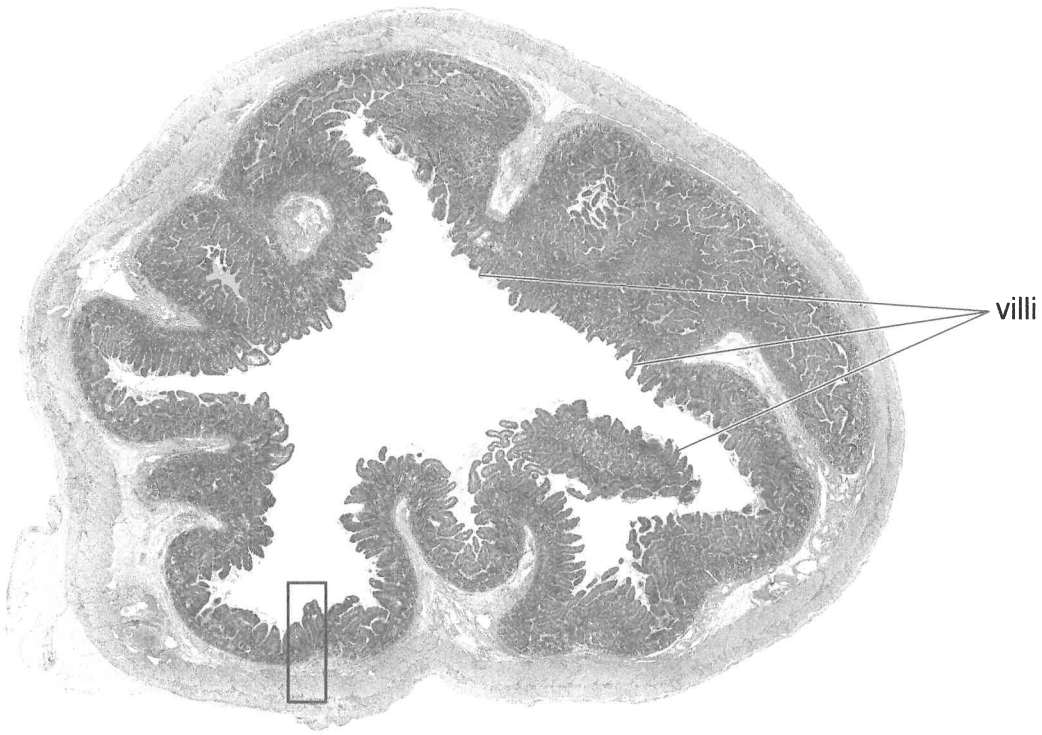


Fig. 2.2

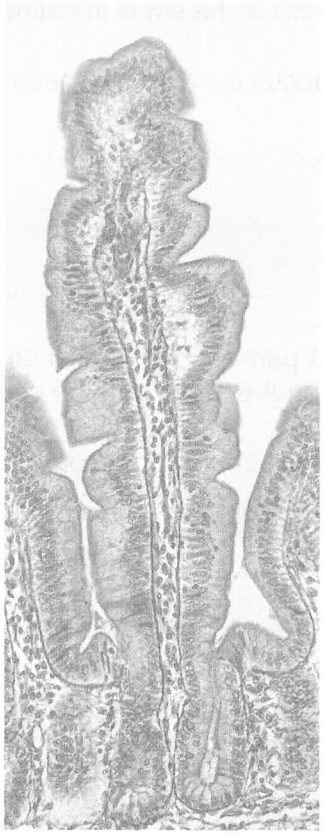
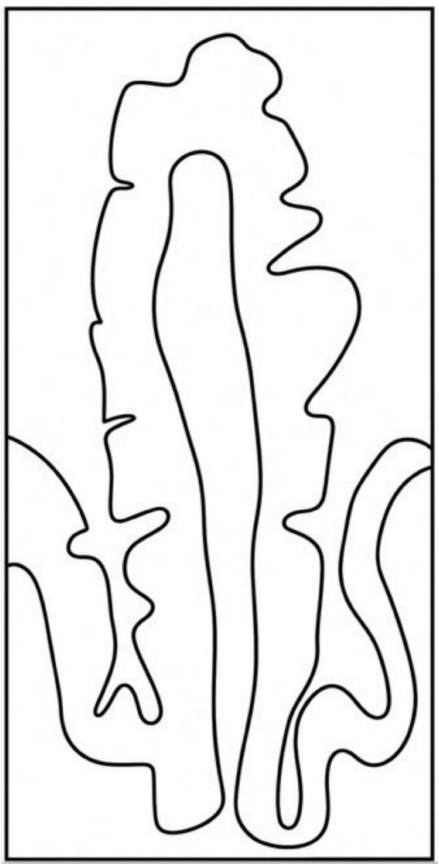


Fig. 2.3

(a) Make a line drawing of the part of the small intestine shown in Fig. 2.3. You should **not** add any labels.



Accuracy: number of grooves + shape;

Proportion: middle villi x2 longer
Left villi is slightly longer than right villi

Line

[3]

(b) Some of the cells that line the villi in the small intestine secrete mucus.

Suggest **one** function of the mucus secreted by these cells.

To protect the lining of small intestine from being damaged by hydrochloric acid from stomach;

To protect the lining of small intestine from being digested by enzymes in the intestinal juice;

To act as a barrier to protect the entry of microorganisms into the bloodstream

To act as a lubricant to help food to move along the intestine;

..... [1]

(c) Fig. 2.4 is an enlarged view of part of an epithelial cell from the lining of a villus in the small intestine. Microvilli are visible on the surface of the cell.

The image was made using an electron microscope.

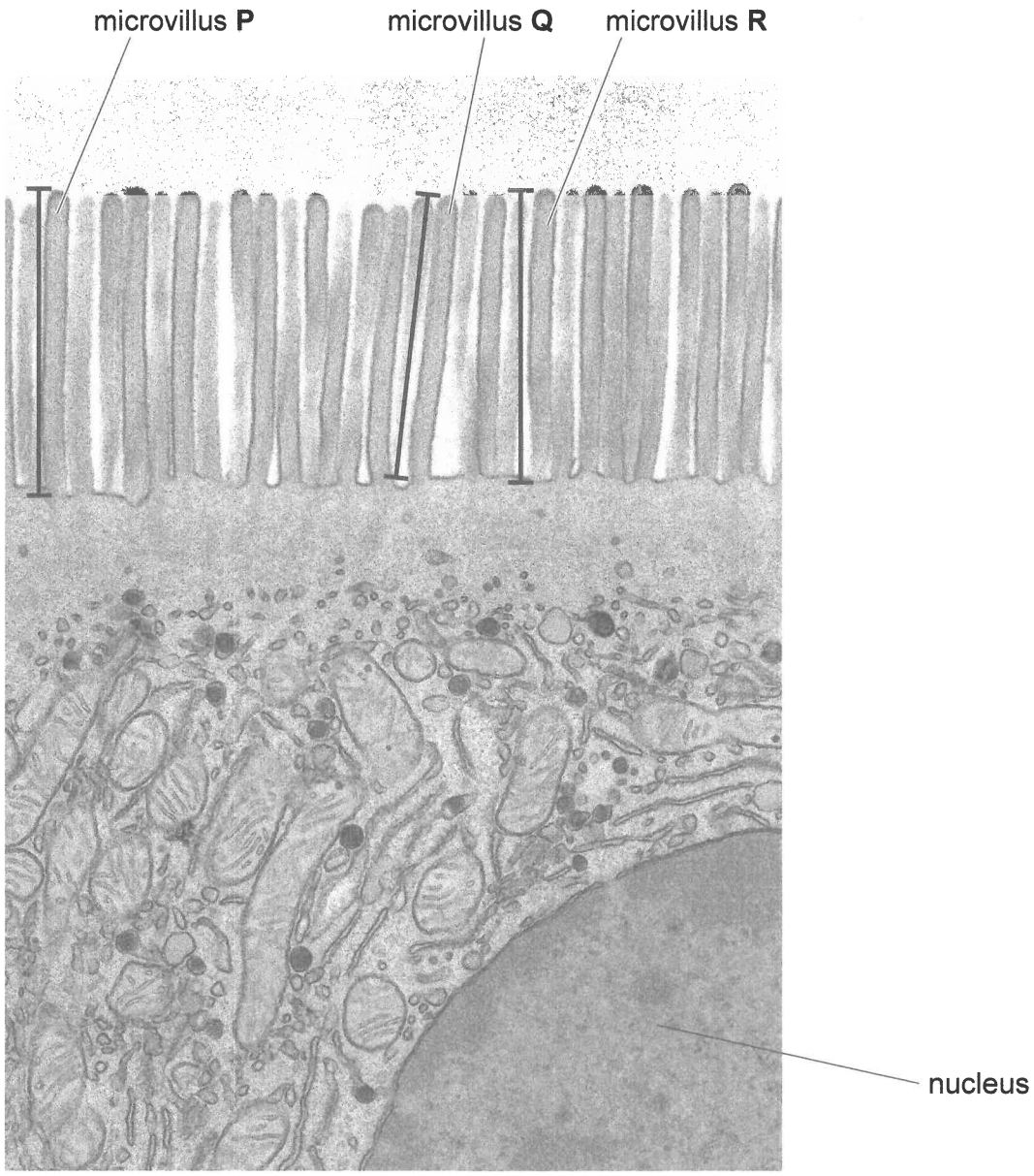


Fig. 2.4

(i) Measure **and** record the length in millimetres of the three microvilli in Fig. 2.4 labelled **P**, **Q** and **R**.

P = 42 mm

Q = 39 mm

R = 40 mm

[1]

(ii) Calculate the mean length of the three microvilli you have measured.

Give your answer to **one** significant figure.

$$\text{Mean length} = \frac{42 + 39 + 40}{3}$$
$$= 40\text{mm}$$

[2]

(iii) The magnification of the image in Fig. 2.4 is ×20 000.

The mean width of the three microvilli identified in Fig. 2.4 is 3 mm.

Calculate the actual mean length and actual mean width of the microvilli in micrometres (μm). 1 μm = 0.001 mm.

Show your working and give your answers to **one** significant figure.

$$\text{Actual mean length} = \frac{40\,000}{20\,000}$$
$$= 2$$

$$\text{Actual mean width} = \frac{3\,000}{20\,000}$$
$$= 0.15$$
$$= 0.2$$

actual mean length ..... 2 ..... μm

actual mean width ..... 0.2 ..... μm

[3]

(d) Microvilli on epithelial cells are one adaptation for absorption in the small intestine.

Using **only** the information visible in Fig. 2.1, Fig. 2.2, Fig. 2.3 and Fig. 2.4, explain how **other** structural features of the small intestine are adaptations for absorption.

small intestine is (very) long to increase time for absorption; .....

inner wall of small intestine is folded with many villi; .....

to increase surface area to volume ratio for higher rate of diffusion of digested food molecules .....

epithelial cells have many mitochondria; .....

Mitochondria releases/ provide energy via respiration for active transport of glucose and amino acids; .....

Villi is richly supplied with blood capillaries to transport digested food molecules from the small intestine to body cells; .....

maintain a steep concentration gradient for diffusion; .....

Presence of Lacteal to absorb fats; .....

....

..... [5]

[Total: 15]