

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

INTERNATIONAL A-LEVEL BIOLOGY (9610)

Unit 5 Synoptic paper

Tuesday 21 January 2020 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a pencil
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.
- In question 6, 2 marks will be awarded for the quality of your written communication.

You will be marked on your ability to:

- use good English
- organise information clearly
- use specialist vocabulary where appropriate.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	



Answer **all** questions in the spaces provided.

0 1

Students investigate the effect of different concentrations of sucrose solution on epidermal cells from a red onion bulb.

The students dilute a 1.0 mol dm^{-3} sucrose solution with water to give a range of sucrose concentrations.

0 1 . 1

Complete **Table 1** to show the volumes of 1.0 mol dm^{-3} sucrose solution and water needed to produce 20 cm^3 of each concentration of sucrose.

[2 marks]

Table 1

Concentration of sucrose solution / mol dm^{-3}	0	0.2	0.4	0.6	0.8	1.0
Volume of 1.0 mol dm^{-3} sucrose solution / cm^3	0					20
Volume of water / cm^3	20					0



The students put pieces of epidermis in the different concentrations of sucrose solution on microscope slides.

The students put a graticule in the eyepiece of the microscope before observing the cells. A graticule is a glass disc with a numerical scale on it.

Figure 1 is a photograph of some epidermal cells in water, seen through the eyepiece graticule.

Figure 1

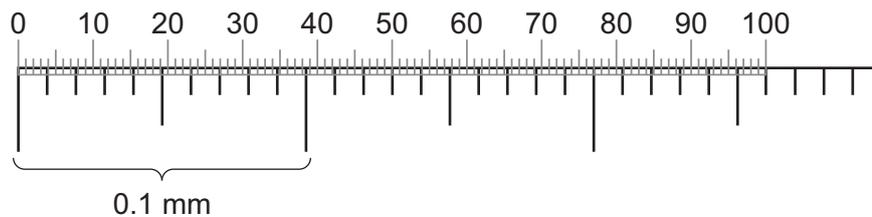
Figure 1 cannot be reproduced here due to third-party copyright restrictions.

To calibrate the graticule, the students:

- use a special slide with a millimetre scale marked on it
- put this special slide on the stage of the microscope
- look at the slide through the graticule in the eyepiece.

Figure 2 shows what one student sees.

Figure 2



0 1 . 2

What is the real length of cell **A**?

- Use information from **Figure 1** and **Figure 2**.
- Give your answer in micrometres (μm), correct to the nearest whole number.

[2 marks]

Length of cell **A** = _____ μm

Turn over ►



Figure 3 shows the same epidermal cells when the students replace the water with 1.0 mol dm^{-3} sucrose solution.

Figure 3

Figure 3 cannot be reproduced here due to third-party copyright restrictions.

0 1 . 3 Draw a diagram of cell **A** from **Figure 3**.

[2 marks]



The students observe the onion epidermal cells in each of the six concentrations of sucrose given in **Table 1**.

Cells that look similar to cell **A** in **Figure 3** are described as 'plasmolysed'.

The students look at 20 cells in each concentration of sucrose and count how many are plasmolysed. The students calculate the percentage of plasmolysed cells for each concentration of sucrose.

Figure 4 shows the students' results.

Figure 4

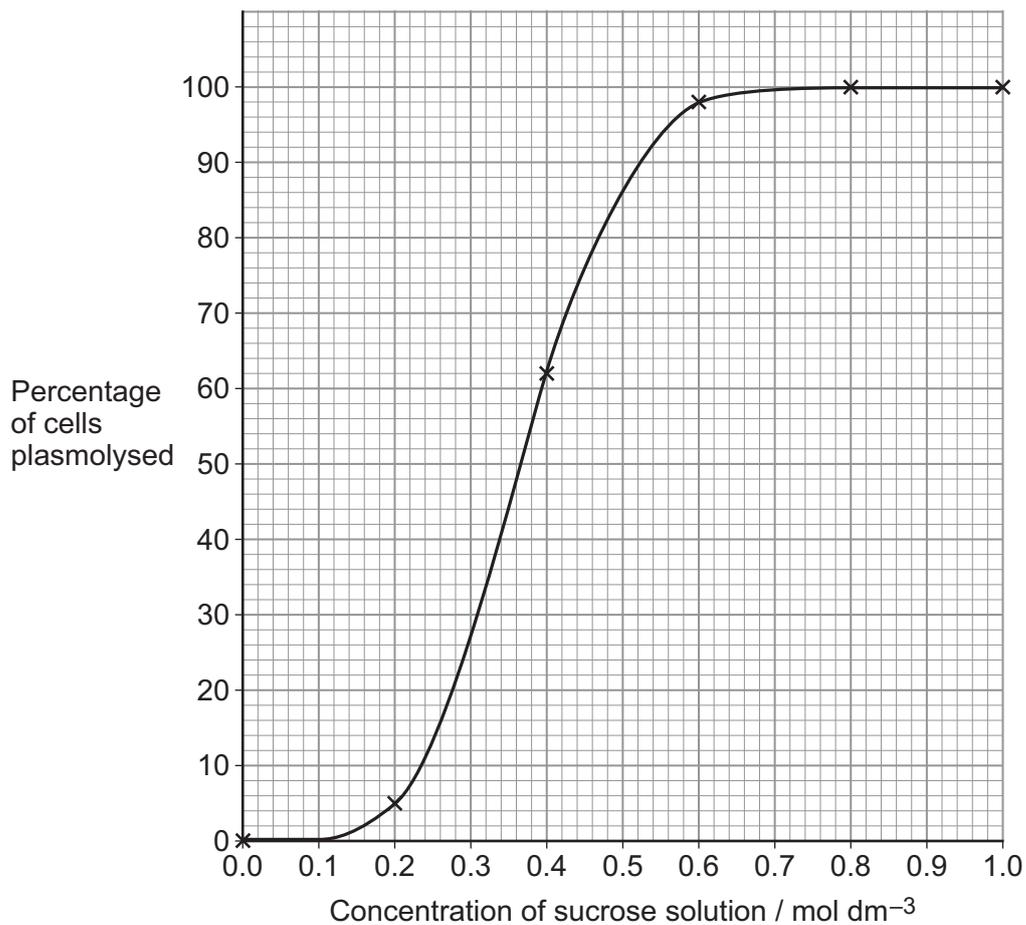


Table 2 gives the osmotic potential of each concentration of sucrose solution.

Table 2

Concentration of sucrose solution / mol dm⁻³	0	0.2	0.4	0.6	0.8	1.0
Osmotic potential / kPa	0	-540	-1120	-1800	-2580	-3510



0 1 . 5

At equilibrium, 50% of the cells are plasmolysed. At equilibrium, the osmotic potential of the onion cells equals the osmotic potential of the sucrose solution surrounding the cells.

What is the approximate osmotic potential of the onion cells?

Use information from **Figure 4** and **Table 2**.

[1 mark]

Tick (✓) **one** box.

-2580 kPa

-1030 kPa

0 kPa

0.37 kPa

0 1 . 6

Suggest **two** improvements the students could make to find a more accurate value for the osmotic potential of the onion cells.

[2 marks]

1 _____

2 _____

12

Turn over for the next question

Turn over ►

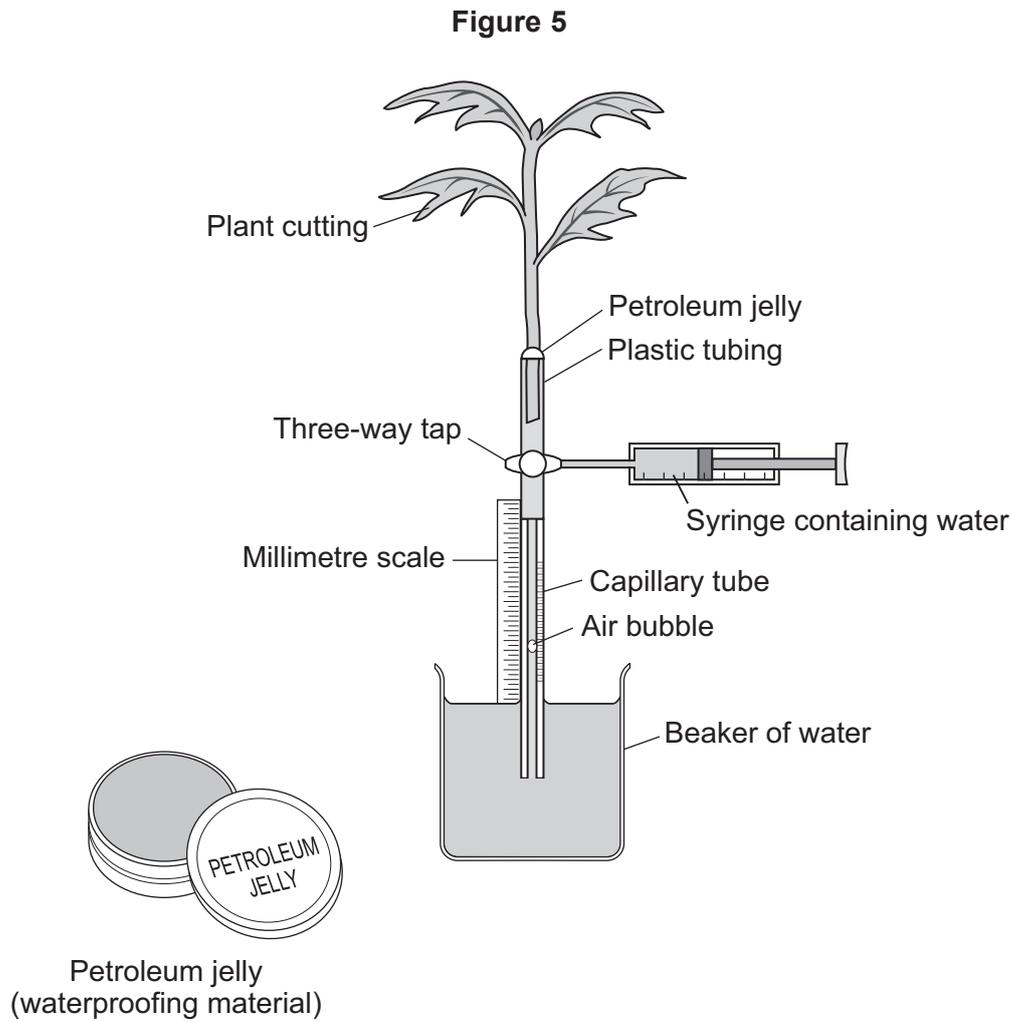


0 2

Water moves upwards through a plant's stem. Much of the water is lost by evaporation from the plant's leaves.

A potometer can be used to measure the rate of water uptake by a cutting from a leafy plant.

Figure 5 shows a potometer.



0 2 . 2

Draw a sketch graph to show the pattern of results you would expect from the investigation you planned in question **02.1**.

Give **one** reason for the type of graph you have drawn.

[3 marks]

Reason _____

8



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0 3

Guinea pigs are small mammals, often kept as pets.
Guinea pigs may have short hair or long hair.
The colour of the hair can be black or white.

A breeder has two guinea pigs with short, black hair.

The male guinea pig is homozygous for hair length, but heterozygous for hair colour. The female guinea pig is heterozygous for hair length, but homozygous for hair colour.

The breeder mates the guinea pigs several times.
All of the offspring have short, black hair.

0 3 . 1

Choose suitable symbols to represent the alleles for hair length and hair colour. Your symbols should show which alleles are dominant and which alleles are recessive.

[1 mark]

Allele for short hair = _____ Allele for long hair = _____

Allele for black hair = _____ Allele for white hair = _____

0 3 . 2

Complete the genetic diagram to explain the breeder's results. Use the symbols from your answer to question 03.1.

[3 marks]

	Male	Female
Parental phenotypes	Short, black hair	Short, black hair
Parental genotypes	_____	_____
Gamete genotypes	_____	_____
Offspring genotypes	_____	
Offspring phenotypes	All short, black hair	



The breeder then crosses the same female guinea pig with a different male. This male has long, white hair. After several crosses, 11 short, black-haired offspring and 5 long, black-haired offspring are produced. The breeder expected a 1:1 ratio of these phenotypes.

The breeder analyses the results using a χ^2 test.

0 3 . 3

Why does the breeder use a χ^2 test, and **not** use standard errors and 95% confidence limits?

[2 marks]

0 3 . 4

A statistical test helps to determine the probability of a null hypothesis being correct.

State a suitable null hypothesis for this investigation.

[1 mark]

Question 3 continues on the next page

Turn over ►



0 3 . 5 The calculated value of χ^2 for this investigation is $\chi^2 = 2.25$

Table 3 gives probability values for different values of χ^2 .

Table 3

Degrees of freedom	Probability value					
	0.99	0.95	0.10	0.05	0.01	0.001
1	0.0002	0.0039	2.71	3.84	6.63	10.83
2	0.020	0.103	4.61	5.99	9.21	13.82
3	0.115	0.352	6.25	7.81	11.34	16.27
4	0.297	0.711	7.78	9.49	13.28	18.47

Explain if the observed results fit the expected 1:1 ratio.

Use the calculated value of $\chi^2 = 2.25$ and data from **Table 3**.

[3 marks]



0 4

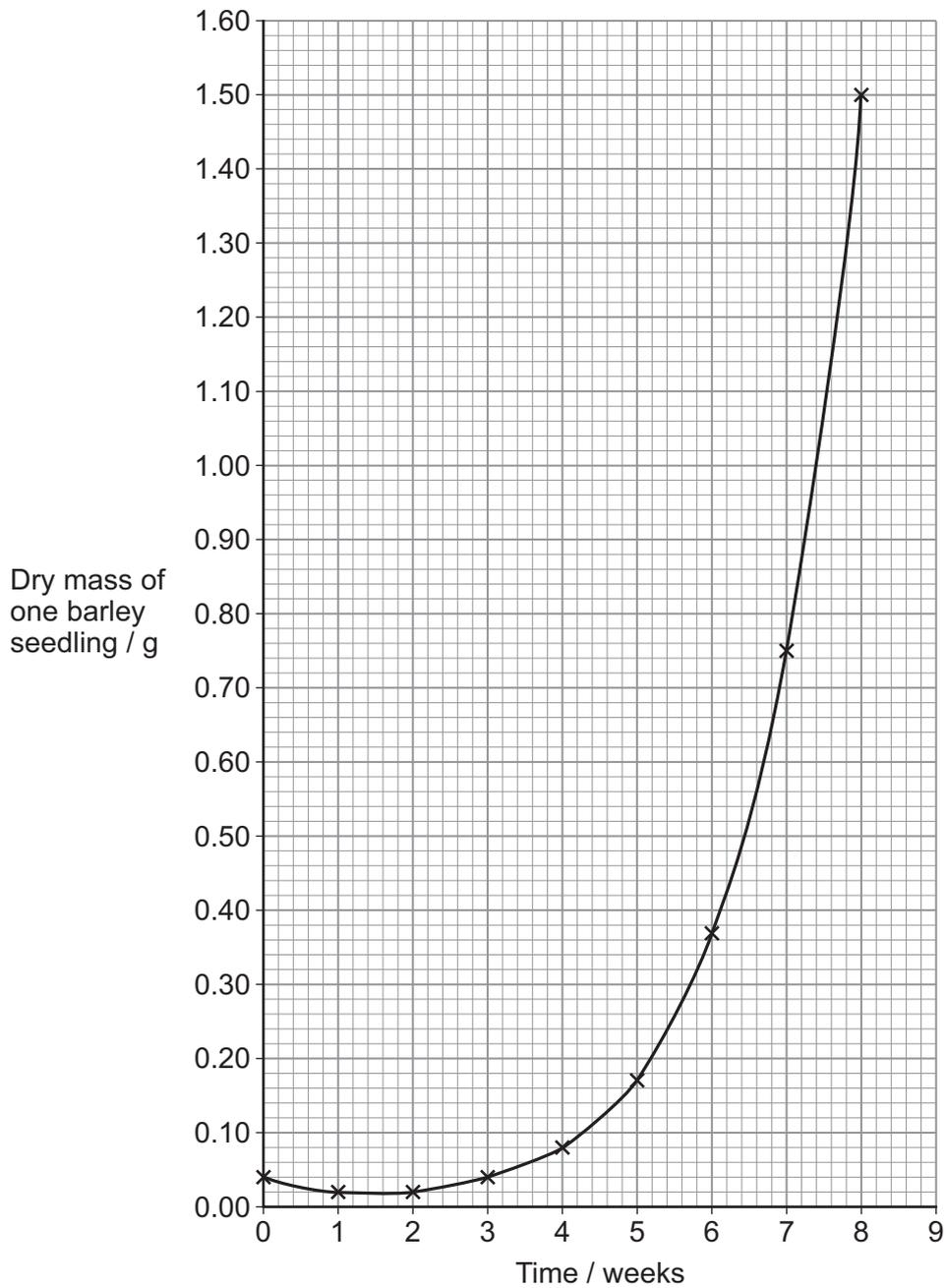
A student investigates the growth of barley seedlings.

The student:

- measures the dry mass of a barley seed
- plants eight more barley seeds, each in a different pot of soil
- adds the same volume of water to each pot every day
- measures the dry mass of one of the barley seedlings every week.

Figure 6 shows the student's results.

Figure 6



0 4 . 1

Explain why the dry mass of the barley seedlings decreases during the first week. **[2 marks]**

0 4 . 2

Calculate the rate of growth of the barley seedlings at 5 weeks.

Measure the rate of growth by drawing a tangent to the curve in **Figure 6**.

Give your answer in milligrams per day, correct to the nearest milligram.

[2 marks]

Rate of growth at 5 weeks = _____ mg day⁻¹

Question 4 continues on the next page

Turn over ►

Groundsel is a common weed found growing in barley fields.

The student investigates the effect of groundsel on the growth of barley seedlings. The student repeats the first investigation but includes three groundsel seeds in each pot of soil as well as the barley seed.

At 5 weeks, the student measures the rate of growth of the barley seedlings as 6 mg day^{-1}

0 4 . 3

Suggest **one** reason for the decreased rate of growth of the barley seedlings with groundsel.

[1 mark]

0 4 . 4

Suggest **two** improvements to the student's investigation of the effect of groundsel on the growth of barley seedlings.

[2 marks]

1 _____

2 _____

7



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0 5

People with Type 2 diabetes often have a higher concentration of glucose in their blood than people who do not have diabetes.

Doctors measured the concentrations of glucose and of insulin in the blood of two groups of people:

- patients with Type 2 diabetes
- a control group of people without Type 2 diabetes.

Table 4 shows the doctors' results.

Table 4

	Mean value (\pm standard deviation)	
	With Type 2 diabetes	Without Type 2 diabetes
Glucose concentration / mmol dm^{-3}	10.87 (\pm 3.76)	4.49 (\pm 0.53)
Insulin concentration / mUnits dm^{-3}	25.39 (\pm 3.51)	15.03 (\pm 1.46)

0 5 . 1

The two groups are matched for a number of factors, including age.

Suggest **two** other factors.

[2 marks]

1 _____

2 _____

0 5 . 2

Describe **two** ways that the results for patients with Type 2 diabetes are different from the results for the people without Type 2 diabetes.

[2 marks]



0 5 . 3

Table 4 gives each result as a mean value \pm standard deviation.

Explain why it is better to give the mean value \pm standard deviation rather than the range of the results.

[2 marks]

Some of the glucose in the blood combines with haemoglobin to form a stable compound called 'HbA1c'. Because HbA1c is stable, the percentage of HbA1c in a blood sample is a measure of the glucose concentration in the blood over the previous few weeks.

0 5 . 4

The percentage of HbA1c is a more useful measurement for diagnosing Type 2 diabetes than measuring the actual glucose concentration in a blood sample.

Explain why.

[3 marks]

Question 5 continues on the next page

Turn over ►



A group of scientists investigate the use of drugs to reduce the blood glucose concentration of people with Type 2 diabetes.

In a clinical trial, the scientists give daily doses of the drug Linagliptin to 618 people with Type 2 diabetes and a placebo to another 617 people with Type 2 diabetes. Every 6 weeks, the scientists take a blood sample from each of the 1235 people. The scientists measure the percentage of HbA1c in each blood sample.

Table 5 shows the results.

Table 5

Time / weeks	Mean change in % HbA1c (\pm standard deviation)	
	Linagliptin	Placebo
0	0.00	0.00
6	-0.45 (\pm 0.04)	0.00 (\pm 0.04)
12	-0.65 (\pm 0.05)	+ 0.02 (\pm 0.06)
18	-0.68 (\pm 0.06)	+ 0.02 (\pm 0.06)
24	-0.65 (\pm 0.06)	+ 0.07 (\pm 0.05)

0 5 . 5

The scientists compare the results for Linagliptin with the results for the placebo using a statistical test. The test gives a probability value, $P < 0.0001$

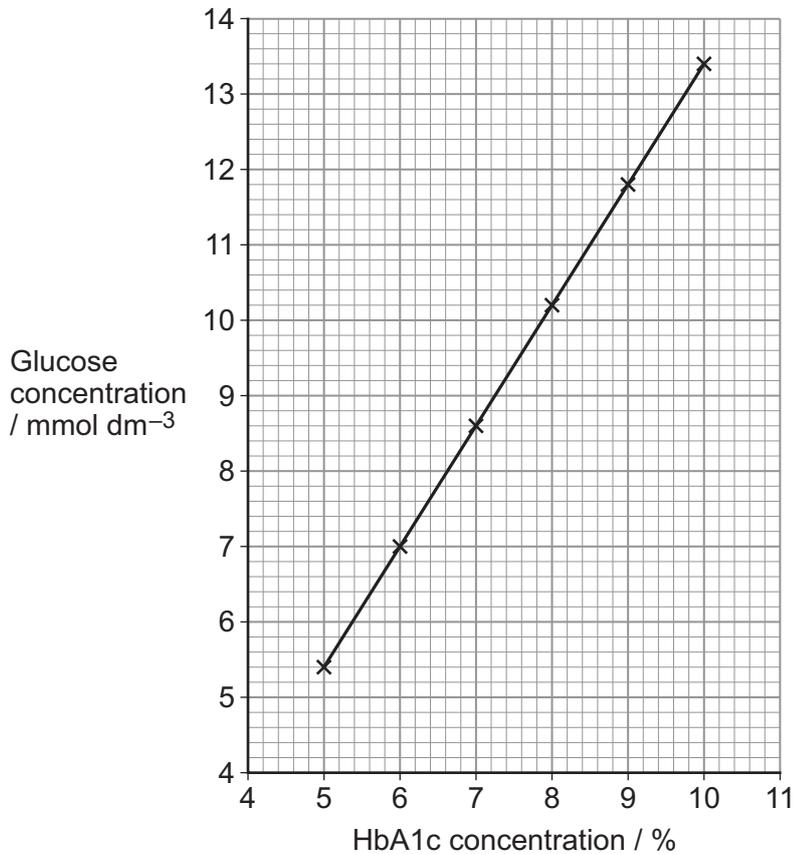
Explain what this means.

[2 marks]



Figure 7 shows the relationship between HbA1c concentration and glucose concentration in human blood.

Figure 7



The mean concentration of HbA1c for the people taking Linagliptin at the start of the trial is 8.3%.

0 5 . 6

What is the mean **glucose** concentration in the blood of the people taking Linagliptin at the start of the trial and after 24 weeks?

Use information from **Table 5** and **Figure 7**.

[2 marks]

Glucose concentration at the start = _____ mmol dm⁻³

Glucose concentration after 24 weeks = _____ mmol dm⁻³

0 5 . 7

The drug trial with Linagliptin does not bring the mean glucose concentration in the blood down into the healthy range.

Suggest **one** other way that people with Type 2 diabetes could lower their blood glucose concentration.

[1 mark]

14

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