OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL A-LEVEL

BIOLOGY (9610)

Unit 5 Synoptic paper

Thursday 18 January 2024 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	

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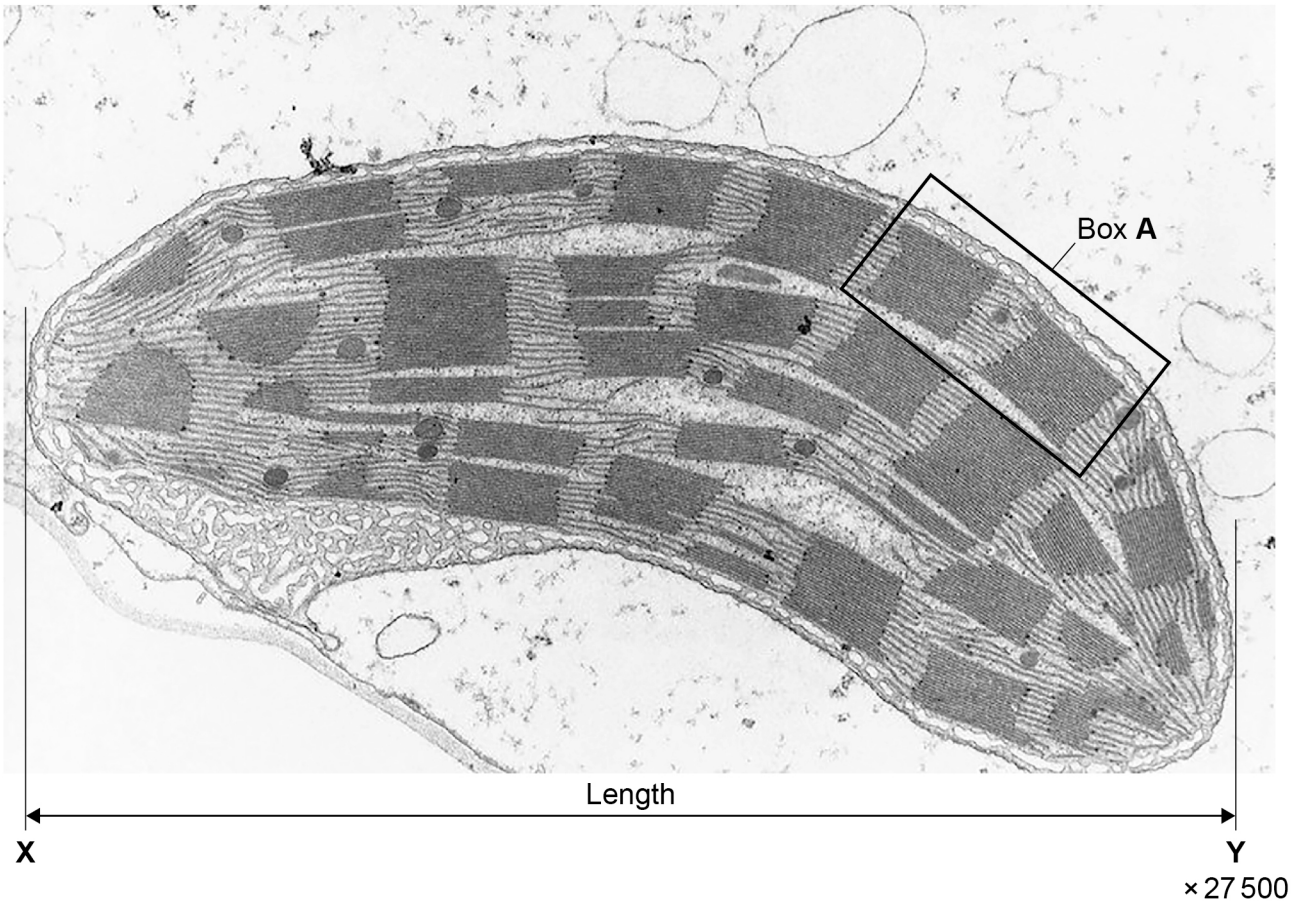
Answer **all** questions in the spaces provided.

0 1 Chloroplasts are cell organelles found in many eukaryotes.

Figure 1 shows a chloroplast from the leaf of a corn plant.

Figure 1



0 1 . 1 Scientists produced the image in **Figure 1** using a transmission electron microscope (TEM).

Give **two** pieces of evidence from **Figure 1** that a TEM was used.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

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0 1 . 2 Draw a large, clear diagram of the structures in box **A** in **Figure 1**.

[3 marks]

0 1 . 3 The magnification of **Figure 1** is ×27 500

Calculate the length, **X**–**Y**, of the actual chloroplast.

Give your answer in micrometres.

[2 marks]

Length of the actual chloroplast, **X**–**Y** = _____ μm

Question 1 continues on the next page

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Students investigate the **light-dependent** reaction of photosynthesis.

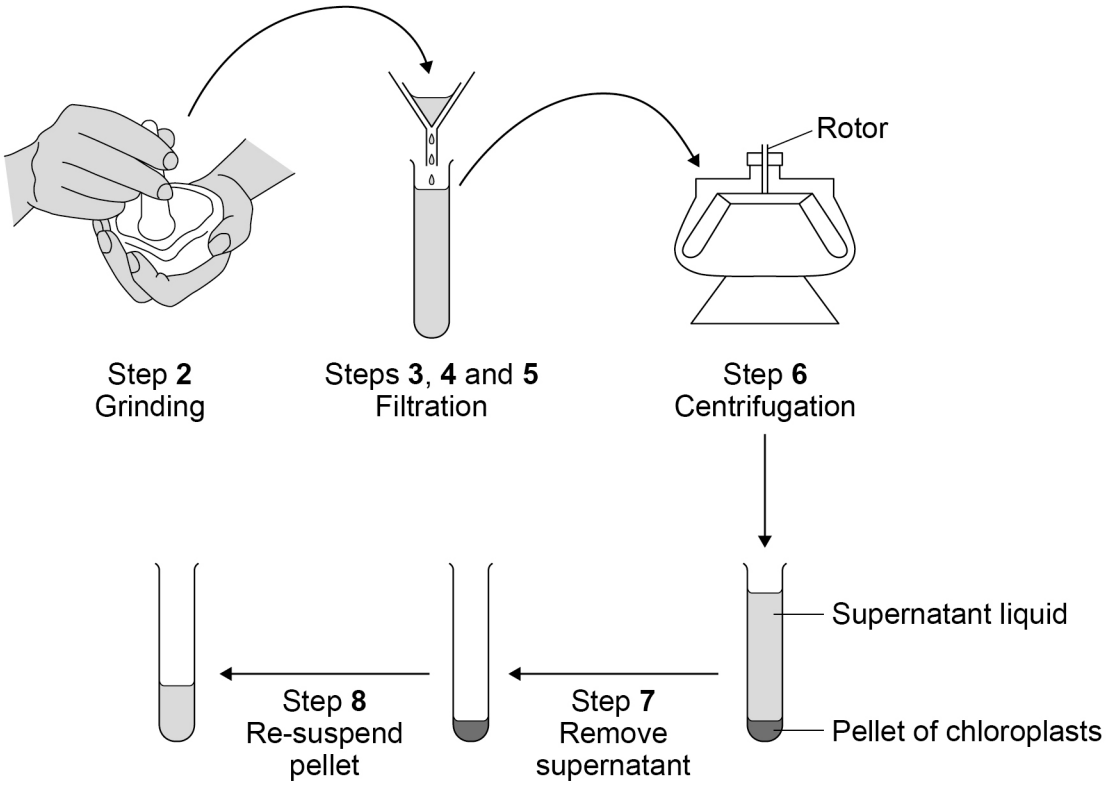
The students first make a preparation of chloroplasts.

This is the method the students use.

1. Cut 3 small leaves into pieces with scissors.
2. Put the pieces of leaf into a mortar at 4 °C, add 20 cm^3 of a cold isolation solution and grind the pieces of leaf with a pestle.
3. Put 4 layers of thin cloth in a funnel and wet the cloth with cold isolation solution.
4. Put several centrifuge tubes in a beaker of ice + salt + water and filter the mixture from step **2** into each centrifuge tube.
5. Check that each centrifuge tube contains the same volume of filtrate.
6. Spin the centrifuge tubes for 10 minutes in a bench centrifuge to give a green pellet of chloroplasts in each tube.
7. Pour off the supernatant liquid from each centrifuge tube.
8. Re-suspend the pellet of chloroplasts by mixing with 2 cm^3 of cold isolation solution and store in a beaker of ice + salt + water.

Figure 2 gives a summary of the students' method.

Figure 2



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The isolation solution (steps **2**, **3** and **8**) is a buffer solution at pH 7.0 and contains 0.4 mol dm^{-3} sucrose.

0 1 . 4 Give the reason why the students use a solution at pH 7.0 for isolating the chloroplasts.

[1 mark]

0 1 . 5 The 0.4 mol dm^{-3} sucrose solution has a water potential only slightly lower than the stroma inside the chloroplasts.

Explain why the students included 0.4 mol dm^{-3} sucrose in the isolation solution.

[2 marks]

0 1 . 6 Explain why the students check that each centrifuge tube contains the **same** volume of filtrate (step **5**) before placing the tubes in the centrifuge.

[2 marks]

Question 1 continues on the next page

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The students use a reagent called DCPIP to see if the light-dependent reaction will occur under different conditions.

DCPIP solution is blue but becomes colourless when it combines with hydrogen atoms:

$$\underset{\text{(blue)}}{\text{DCPIP}} + 2H^+ + 2\text{ electrons} \longrightarrow \underset{\text{(colourless)}}{\text{reduced DCPIP}}$$

Table 1 shows how the students set up four test tubes and also shows the results.

Table 1

Tube	Tube Contents				Condition	Results	
	Chloroplast preparation / cm^3	Isolation solution / cm^3	Water / cm^3	DCPIP solution / cm^3	Light or dark	Colour at start	Colour after 15 mins
1	0.5	–	–	5	Light	Blue	Green
2	–	0.5	–	5	Light	Blue	Blue
3	0.5	–	–	5	Dark	Blue	Blue
4	0.5	–	5	–	Light	Green	Green

0 1 . 7 Each of tubes **2**, **3** and **4** is a control.

Explain how these tubes act as controls.

[2 marks]

Do not write outside the box

0 1 . 8 Explain why the contents of **Tube 1** change from blue to green.

Use your knowledge of the light-dependent reaction.

[4 marks]

18

Turn over for the next question

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0 2 Students investigate the effect of substrate concentration on the activity of the enzyme catalase.

Catalase catalyses the reaction:

Hydrogen peroxide ⟶ water + oxygen

The students:

- grind up 150 grams of potato tissue in 100 cm^3 of water
- filter the mixture and use the filtrate as their source of catalase
- collect the oxygen produced in the reaction in a 10 cm^3 syringe.

Figure 3 shows the equipment the students use.

Figure 3

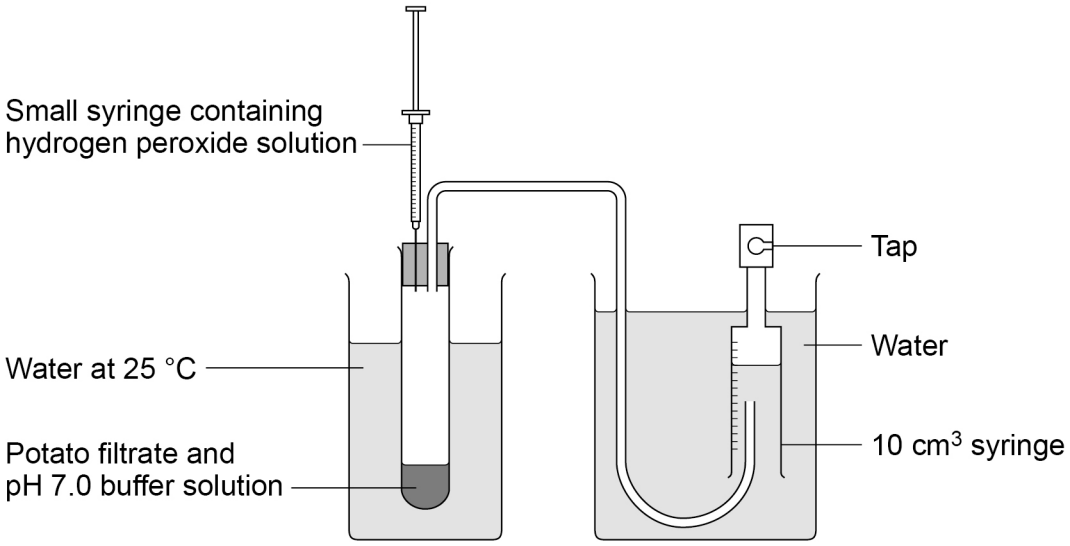

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Table 2 shows the students' results.

Table 2

Concentration of hydrogen peroxide / %	Mean volume of oxygen collected ± SD / cm^3
100	9.6 ± 0.24
80	9.5 ± 0.12
60	9.2 ± 0.62
40	8.0 ± 0.61
20	4.6 ± 0.36
10	2.4 ± 0.28
0	0.0 ± 0.00

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0 2 . 1 Describe in detail how the students could use the equipment shown in **Figure 3** to obtain the results shown in **Table 2**.

[7 marks]

Question 2 continues on the next page

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0 2 . 2 Describe how the students should display their results in a graph.

Give a reason for your choice of graph.

[3 marks]

0 2 . 3 One student states:

'There is no significant difference between the results with 40% hydrogen peroxide and 60% hydrogen peroxide.'

Use data from **Table 2** to give evidence to support the student's statement.

[2 marks]

12

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0 3 Scientists can produce fragments of DNA using different methods.

0 3 . 1 In one method, the scientists produce complementary DNA (cDNA) from mRNA.

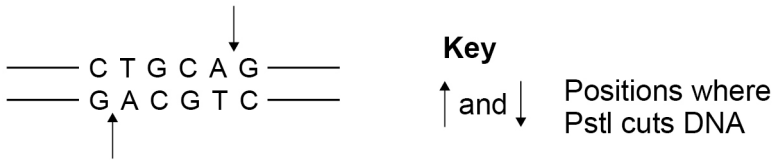
Name the type of enzyme that produces cDNA from mRNA.

[1 mark]

In another method, the scientists use an enzyme that cuts DNA into smaller fragments.

An enzyme called PstI cuts DNA at the specific base sequence shown in **Figure 4**.

Figure 4



0 3 . 2 What general name is given to enzymes such as PstI?

[1 mark]

0 3 . 3 PstI produces DNA fragments with sticky ends.

Why are sticky ends useful in genetic engineering?

[1 mark]

Question 3 continues on the next page

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The scientists prepare a sample containing many identical molecules of DNA.

The DNA molecules are linear (non-circular).

The scientists treat a sample of the DNA with PstI (**Sample 1**).
The scientists leave a second sample of the DNA untreated (**Sample 2**).

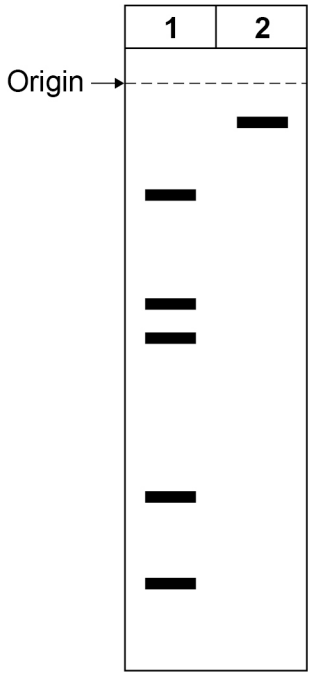
The scientists carry out gel electrophoresis on each of the two samples.

Gel electrophoresis separates pieces of DNA depending on their electrical charge and their mass.

Small pieces of DNA move further from the origin than large pieces of DNA.

Figure 5 shows the results.

Figure 5



Key

Sample 1 = DNA treated with PstI

Sample 2 = Untreated DNA

0 3 . 4 How many times did the base sequence **CTGCAG** occur in the untreated DNA?
GACGTC

[1 mark]

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0 3 . 5 In a certain genetic condition, **one** of the **CTGCAG** sequences is changed.

GACGTC

Predict how this would change the appearance of **Sample 1** in **Figure 5**.

[2 marks]

_____

_____

_____

_____

_____

_____

6

Turn over for the next question

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0 4 In domestic cats, some fur colours are controlled by a gene on the X chromosome.

A scientist crosses black cats with orange cats.

The results are different depending on which parent is black and which is orange.

Cross 1: Black male cats are crossed with orange female cats. All the male offspring are orange and all the female offspring are 'tortoiseshell' (a mixture of black and orange fur).

Cross 2: Orange male cats are crossed with black female cats. All the male offspring are black and all the female offspring are, again, tortoiseshell.

In Questions **04.1** and **04.2**, use the following symbols:

$\mathbf{X^B}$ = an X chromosome with the allele for black fur
$\mathbf{X^b}$ = an X chromosome with the allele for orange fur
Y = a Y chromosome.

0 4 . 1 Complete the **two** genetic diagrams to explain the scientist's results.

[4 marks]

Cross 1		**Cross 2**	
Black male × orange female		**Orange male × black female**	
Parental genotypes	_____	Parental genotypes	_____
Gametes	_____	Gametes	_____
Offspring genotypes	_____	Offspring genotypes	_____
Offspring phenotypes	_____	Offspring phenotypes	_____
Offspring sex	_____	Offspring sex	_____

Do not write outside the box

0 4 . 2 The scientist then crosses orange male cats with tortoiseshell female cats.

Table 3 shows the offspring.

Table 3

Black male	Orange male	Orange female	Tortoiseshell female
12	7	13	8

The scientist expected a 1 : 1 : 1 : 1 ratio of phenotypes.

The scientist uses the χ^2 (chi-squared) test to analyse the results.

The scientist calculates a value of $\chi^2 = 2.60$

Table 4 gives probability values for different values of χ^2

Table 4

Degrees of freedom	Probability value					
	0.99	**0.95**	**0.10**	**0.05**	**0.01**	**0.001**
1	0.002	0.004	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 scientist's results in **Table 3** fit the expected ratio.

Use the calculated value of $\chi^2 = 2.60$ and data from **Table 4**.

[3 marks]

7

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0 5 Leukaemia is a cancer of the blood cells.

Vincristine and resveratrol are two drugs that might be useful in treating leukaemia.

- Vincristine – an inhibitor of microtubule formation.
- Resveratrol – an antioxidant.

0 5 . 1 Microtubules are components of spindle fibres.

Explain how an inhibitor of microtubule formation could be useful in cancer treatment.

[2 marks]

0 5 . 2 An antioxidant is a chemical that prevents free radical formation.

Free radicals can damage DNA.

Suggest **one** way an antioxidant might help to prevent cancer.

[1 mark]

Question 5 continues on the next page

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Scientists investigate the effects of vincristine and resveratrol on one type of leukaemia.

The scientists put human leukaemia cancer cells into 48 mice.

The scientists then divide the mice into 3 groups of 16 mice.
The scientists treat the mice once every 2 days for 4 weeks, as follows:

Group 1: inject the mice with vincristine (0.5 mg kg^{-1} body mass)
Group 2: inject the mice with resveratrol (10.0 mg kg^{-1} body mass), dissolved in dimethyl sulfoxide (DMSO)
Group 3: inject the mice with DMSO only.

0 5 . 3 The scientists inject a certain mass of each drug per kilogram body mass into each mouse instead of the same mass into each mouse.

Explain why.

[3 marks]

0 5 . 4 Explain why the scientists include group **3** in the investigation.

[2 marks]

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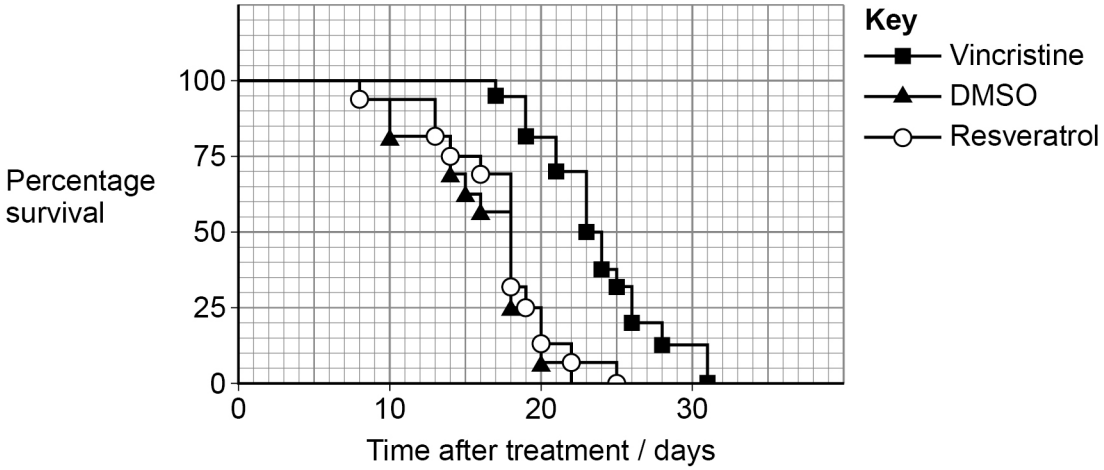
The scientists calculate the percentage survival of the mice after the treatment.

Figure 6 shows the results.

Figure 6



0 5 . 5 Evaluate the use of vincristine and resveratrol in treating cancer.

Use information from the scientists' method and from the results in **Figure 6**.

[4 marks]

12

Turn over ►

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You are reminded that **2** marks will be awarded
for the quality of your written communication in **Question 6**.

0 6 Carbohydrates are used by all living organisms.

0 6 . 1 The human diet includes carbohydrates.

Describe how carbohydrates in the diet:

- are made available to the body's cells
- are used by the body's cells.

Do **not** refer to hormones in your answer.

[6 marks]

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0 6 . 2 You are given a cloudy white suspension in a test tube.

Describe how you would show that the suspension is a mixture of:

- starch
- reducing sugar
- non-reducing sugar.

Include full experimental details of your procedure.

[6 marks]

Question 6 continues on the next page

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0 6 . 3 Although glucose enters and leaves the blood at variable rates, the concentration of glucose in the blood is kept between 4.4 and 6.6 mmol dm^{-3}

Describe how hormones control the concentration of glucose in the blood.

[6 marks]

20

Quality of written communication [2 marks]

END OF QUESTIONS

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