Please write clearly in block capitals.

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

Surname ______________________________

Forename(s) ______________________________

Candidate signature ______________________________
I declare this is my own work.

AS
BIOLOGY

Paper 2

Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

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).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 75.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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

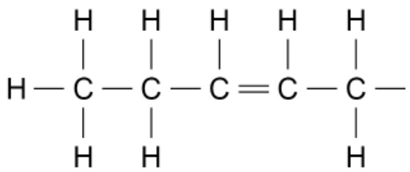
0 1 . 1 The general structure of a fatty acid is RCOOH.

Name the group represented by COOH.

[1 mark]

0 1 . 2 **Figure 1** shows the structure of a fatty acid R group.

Figure 1



Name the type of R group shown in **Figure 1**.

Explain your answer.

[2 marks]

Type of R group

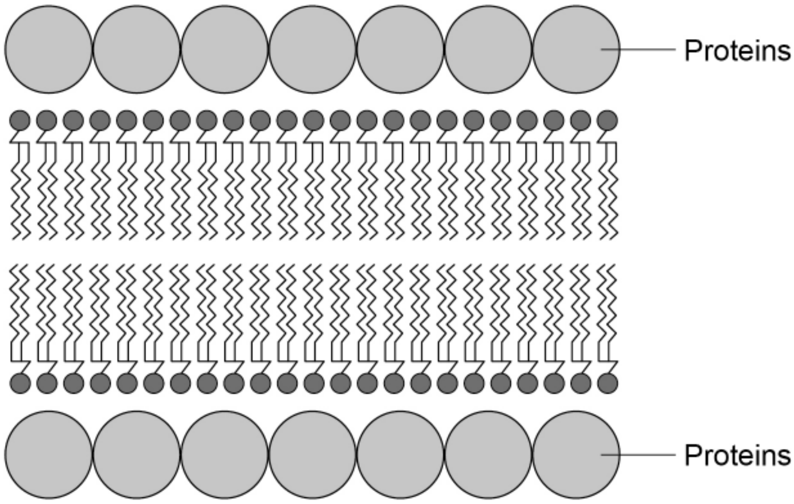
Explanation

0 1 . 3 Describe how you would test for the presence of a lipid in a liquid sample of food.

[2 marks]

In 1935, scientists suggested a model for the chemical structure of a cell-surface membrane. **Figure 2** shows the membrane structure the scientists suggested.

Figure 2



0 1 . 4 Give **one** similarity and **two** differences between the membrane structure shown in **Figure 2** and the fluid-mosaic model of membrane structure.

[3 marks]

Similarity ____

____

Difference 1 ____

____

Difference 2 ____

____

8

Turn over for the next question

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0 2 . 1 Describe and explain **one** feature of the alveolar epithelium that makes the epithelium well adapted as a surface for gas exchange. Do **not** refer to surface area or moisture in your answer.

[2 marks]

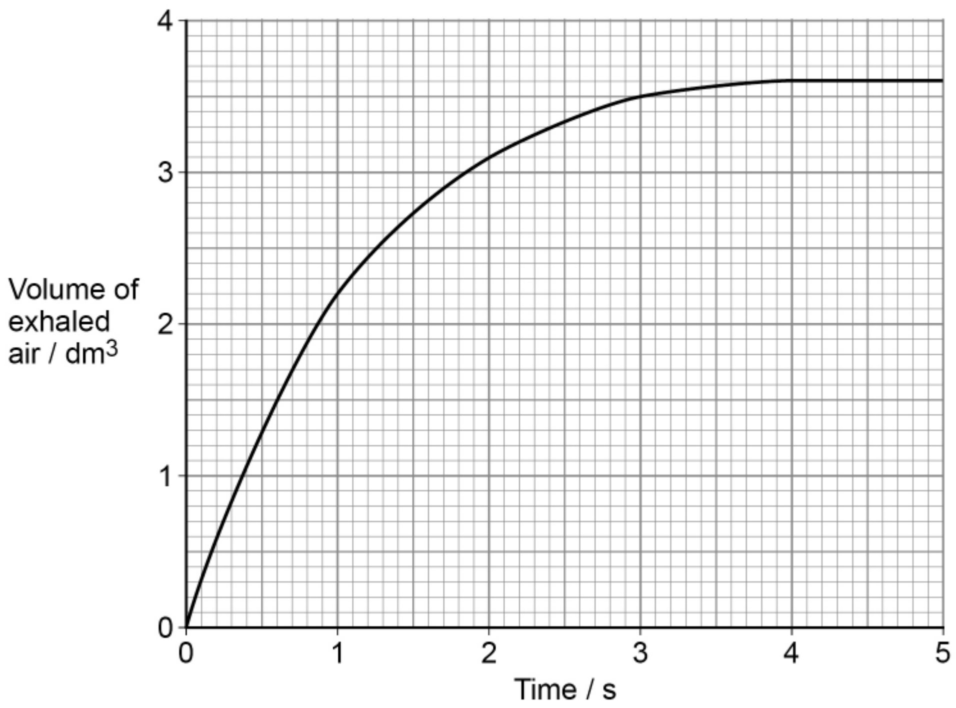
Doctors measure the health of lungs by calculating the FEV_1:FVC ratio.

- FEV_1 is the maximum volume of air exhaled in one second.
- FVC is the maximum volume of air exhaled in one breath.

The minimum FEV_1:FVC ratio of healthy lungs is 0.7:1

A man with the lung disease emphysema inflated his lungs fully. He then exhaled as much of this air as quickly as possible in one breath. **Figure 3** shows how the volume of exhaled air changed during this breath.

Figure 3



0 2 . 2 Use the information provided to determine the FEV_1:FVC ratio of this man's lungs.

Go on to determine how many times greater the minimum ratio of healthy lungs is than his ratio.

[2 marks]

FEV_1:FVC ratio of man's lungs = ____________________

How many times greater? ____________________

Question 2 continues on the next page

Turn over ►

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0 2 . 3 Tidal volume is the volume of air inhaled and exhaled during a single breath when a person is resting. The tidal volume in a person with emphysema is reduced compared with the tidal volume in a healthy person.

Suggest and explain how a reduced tidal volume affects the exchange of carbon dioxide between the blood and the alveoli.

[3 marks]

7

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ANSWER IN THE SPACES PROVIDED

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0 3 . 1 In taxonomy, an organism is identified by referring to the species name and the genus name.

What term is used to describe this method of naming organisms?

[1 mark]

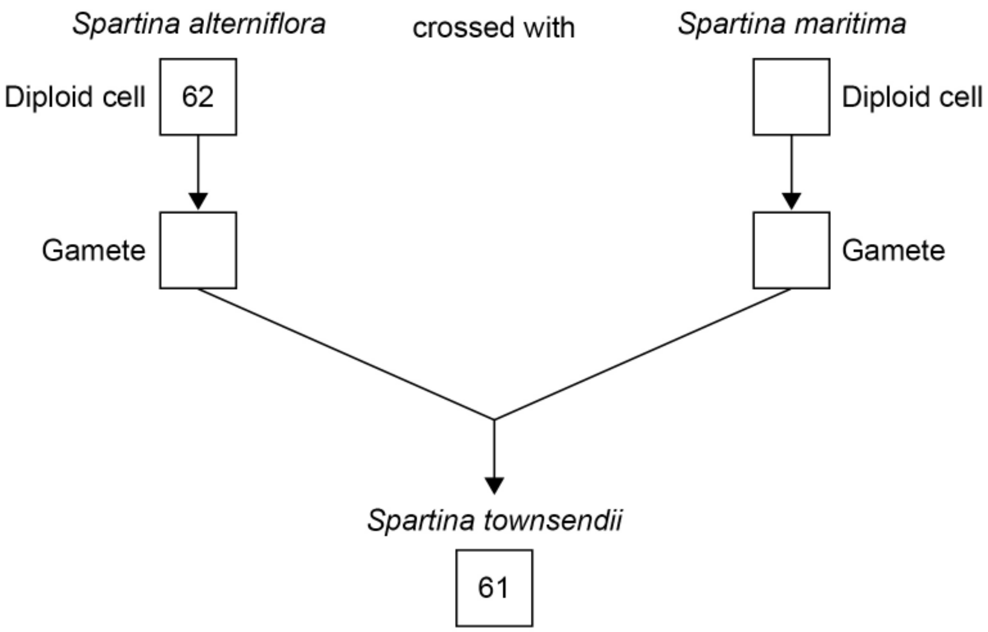
0 3 . 2 Define the term mutagenic agent.

[1 mark]

0 3 . 3 **Figure 4** shows how the species *Spartina townsendii* is produced.

The number of chromosomes in cells is shown in some of the boxes.

Figure 4



Complete **Figure 4** by giving the correct number of chromosomes in each of the boxes.

[1 mark]

A mutation in the number of chromosomes in a *S. townsendii* cell produced a new species, *Spartina anglica*.

Figure 5 shows the number of chromosomes in leaf cells of these species.

Figure 5

S. townsendii	*S. anglica*
61	122

0 3 . 4 Name the type of mutation that changed the number of chromosomes in *S. townsendii* to produce *S. anglica*. Explain your answer.

[3 marks]

Name of mutation ____

Explanation ____

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0 3 . 5 Genetic variation within a species is increased during meiosis by crossing over and the independent segregation of homologous chromosomes.

Apart from mutation, explain **one** other way genetic variation within a species is increased.

[2 marks]

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0 4 . 1 Give **two** structures found in all prokaryotic cells and in all eukaryotic cells.

[2 marks]

1 ______________________________

2 ______________________________

All prokaryotic cells contain a circular DNA molecule and some prokaryotic cells contain plasmids.

0 4 . 2 Scientists have found that the rate of plasmid replication is faster in cells growing in a culture with a high concentration of amino acids than in a culture with a lower concentration of amino acids.

Suggest **one** explanation for the faster rate of plasmid replication in cells growing in a culture with a high amino acid concentration.

[2 marks]

Question 4 continues on the next page

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ANSWER IN THE SPACES PROVIDED

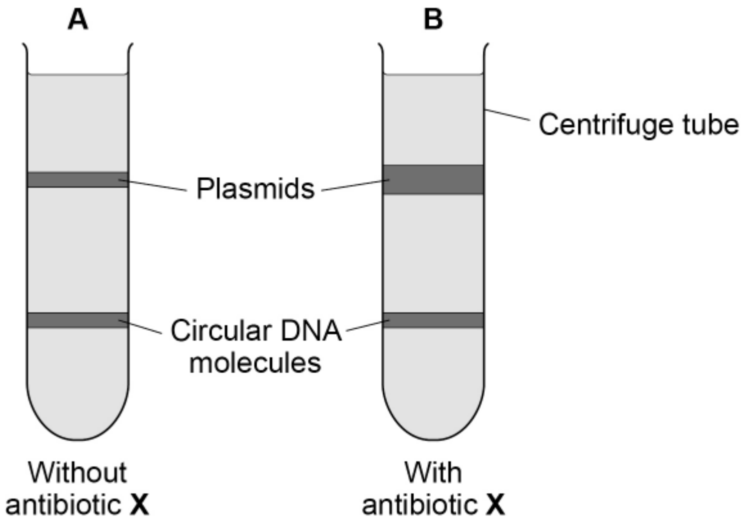
Turn over ►

A scientist prepared a culture of a bacterial species.

- She extracted the plasmids and the circular DNA molecules from a sample of cells taken from this culture (**A**).
- She then added antibiotic **X** to the culture and let the cells divide for 4 hours.
- She then extracted the plasmids and the circular DNA molecules from a sample of these cells (**B**).
- The scientist separated the plasmids from the circular DNA molecules in **A** and in **B** using ultracentrifugation.

Figure 6 shows her results.

Figure 6



0 4 . 3 What can you conclude from **Figure 6** about a structural difference between the plasmids and the circular DNA? Explain your answer.

[2 marks]

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0 4 . 4 What can you conclude from **Figure 6** about the effect of antibiotic **X** on plasmid replication and on circular DNA replication? Explain your answer.

[2 marks]

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8

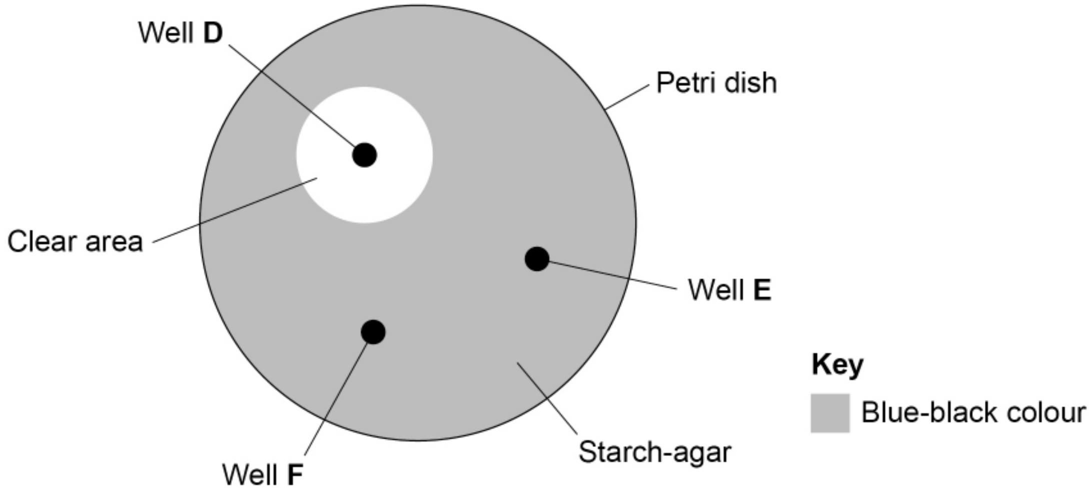
Turn over for the next question

0 5 A student investigated the activity of the enzyme amylase. He cut three identical wells (**D**, **E** and **F**) in starch-agar in a Petri dish. He added 0.2 cm^3 of:

- amylase solution to well **D**
- boiled amylase solution to well **E**
- water to well **F**.

After 60 minutes, he covered the starch-agar with iodine solution.
Figure 7 shows his results.

Figure 7



0 5 . 1 Explain the appearance of the agar in the clear area surrounding well **D**.

[2 marks]

0 5 . 2 What can you conclude about the activity of amylase from the appearance of the agar surrounding well **E** and well **F** in **Figure 7**?

[2 marks]

0 5 . 3 The student cut out a piece of agar from the clear area surrounding well **D**. He obtained a solution of the substances contained in this piece of agar.

Describe a different biochemical test the student could use with this solution to confirm that amylase had affected the starch in the clear area surrounding well **D**.

[2 marks]

Question 5 continues on the next page

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The diameter of the clear area around well **D** is 18 mm

In a different investigation, the student prepared a dilution of the amylase solution. He did this by mixing amylase solution and water in the volumes shown in **Table 1**.

Table 1

Amylase solution / cm^3	**Water / cm^3**
1.6	2.4

He prepared a starch-agar Petri dish identical to **Figure 7**, but with a single well. He added 0.2 cm^3 of the diluted amylase solution to this well and left the Petri dish for 60 minutes.

0 5 . 4 Use all of this information to predict the diameter of the clear area that will form around the well containing the diluted amylase solution.

Give your answer to the nearest whole number.

Show your working.

[2 marks]

Answer ________________ mm

0 5 . 5 The student used a ruler to measure the diameter in mm of the clear area around well **D** in **Figure 7**.

Use this information to explain why the answer to Question **05.4** should be given to the nearest whole number.

[1 mark]

____

____

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9

Turn over for the next question

Turn over ►

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0 6 The fruit fly is a species of small insect.

The fruit fly has a gene that codes for an enzyme called alcohol dehydrogenase (AD). AD catalyses the breakdown of alcohol when alcohol is in the insects' food.

The gene coding for AD has two alleles, $\mathbf{AD^F}$ and $\mathbf{AD^S}$.

0 6 . 1 The enzyme encoded by the $\mathbf{AD^F}$ allele catalyses the breakdown of alcohol **faster** than the enzyme encoded by the $\mathbf{AD^S}$ allele. Suggest why.

[3 marks]

A scientist took a random sample of adult fruit flies from a population. He measured the frequency of the $\mathbf{AD^F}$ allele in this sample (generation 0). He then:

- selected 100 of these insects at random and kept them in a container
- fed the insects food containing alcohol
- let the insects reproduce
- repeated these steps for 45 generations of fruit fly reproduction.

The scientist measured the frequency of the $\mathbf{AD^F}$ allele in the 45th generation.

0 6 . 2 Suggest why the scientist took his sample from the population at random.

[1 mark]

Do not write outside the box

Table 2 shows the scientist's results.

Table 2

Generation of fruit fly reproduction	Frequency of AD^F
0	0.20
45	0.74

0 6 . 3 Alcohol is toxic to fruit flies. Suggest and explain why the frequency of the **AD^F** allele changed during the 45 generations.

[4 marks]

0 6 . 4 Identify the type of selection investigated in the 45 generations of fruit fly reproduction. Tick (✓) **one** box.

[1 mark]

No selection ☐

Directional selection ☐

Random selection ☐

Stabilising selection ☐

9

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0 7 . 1 Describe how an ATP molecule is formed from its component molecules.

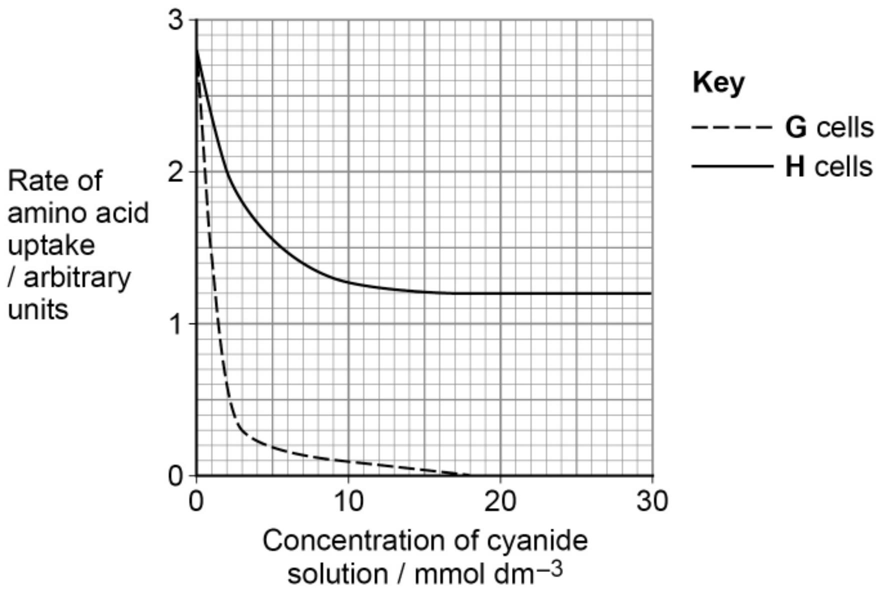
[4 marks]

A scientist investigated the effect of cyanide on the rate of amino acid uptake in two types of *Escherichia coli*, **G** and **H**.

- **G** cells produce enzymes involved in ATP production **only** on their cell-surface membrane.
- **H** cells produce enzymes involved in ATP production on their cell-surface membrane **and** in their cytoplasm.

Figure 8 shows her results.

Figure 8



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0 7 . 2 Use **Figure 8** to calculate the percentage decrease in the rate of amino acid absorption by **H** cells in 30 mmol dm^{-3} cyanide solution.

[1 mark]

Answer ________________%

0 7 . 3 Using **Figure 8** and the information provided, what can you conclude about amino acid uptake by **G** cells and by **H** cells?

[3 marks]

8

Turn over for the next question

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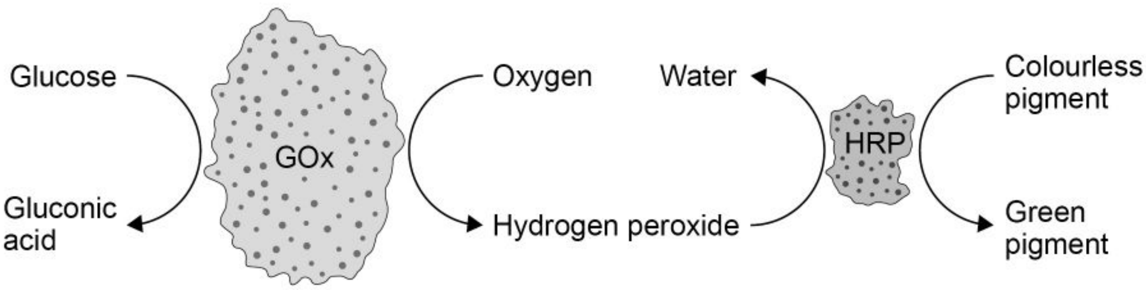
0 8 A scientist investigated a sequence of reactions catalysed by **two** enzymes, GOx and HRP. **Figure 9** shows this sequence of reactions.

Figure 9



0 8 . 1 Use **Figure 9** to identify all of the products formed when this sequence of reactions is completed.

[1 mark]

____

____

0 8 . 2 The scientist joined DNA molecules together to make tiny cages. The cages are exactly 20 nm long, 20 nm wide and 17 nm deep.

He trapped **one** GOx molecule and **one** HRP molecule together in each cage. The GOx molecule and HRP molecule fill 9% of the cage volume.

The volume of a GOx molecule is eight times larger than an HRP molecule.

Use this information to calculate the volume of a GOx molecule. Give the appropriate unit with your answer.

Show your working.

[3 marks]

Answer ____________________

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Question 8 continues on the next page

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The scientist investigated the activity of GOx and HRP enzymes when they are:

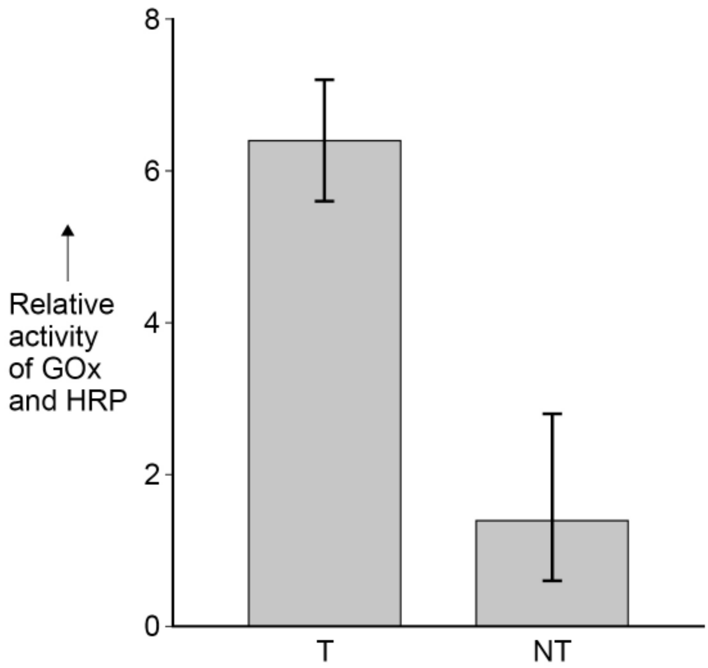
- trapped inside cages (**T**) and
- not trapped (**NT**), but free in solution with **no** cages.

Figure 10 shows his results.

The error bars show ± 2 standard deviations.

± 2 standard deviations include 95% of the data.

Figure 10



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0 8 . 3 What can you conclude from **Figure 10** about the effect of trapping GOx and HRP inside cages?

[3 marks]

0 8 . 4 The design of the scientist's investigation did **not** include a suitable control.

Suggest a suitable control.

[1 mark]

8

Turn over for the next question

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0 9 . 1 Explain **five** properties that make water important for organisms.

[5 marks]

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0 9 . 2 Describe the process of semi-conservative replication of DNA.

[5 marks]

10

END OF QUESTIONS

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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