AQA

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.

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

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

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

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

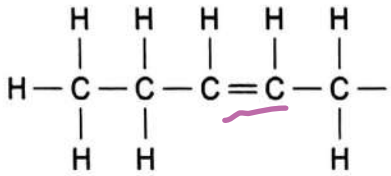
Name the group represented by COOH.

[1 mark]

Carboxyl

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 unsaturated fatty acid

Explanation as it contains a carbon to carbon double bond.

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

[2 marks]

The emulsion test:

add ethanol and then water and shake together.

If lipids are present a white / milky emulsion is produced.

sample + ethanol ↓ mix in H_2O

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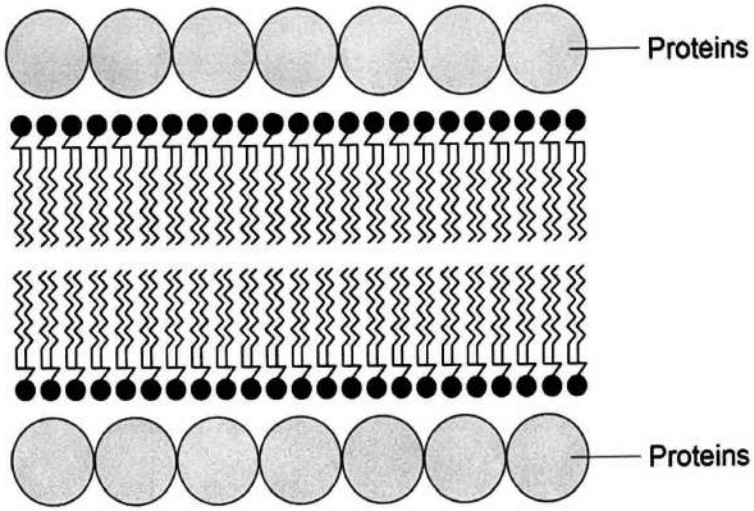
In 1935, scientists suggested a model for the chemical structure of a cell-surface membrane. **Figure 2** shows the membrane structure the scientists suggested.

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 Both have a phospholipid bilayer as its part.

Difference 1 No cholesterol like in fluid-mosaic model. no intrinsic proteins

Difference 2 No glycoprotein or glycolipids present like in fluid-mosaic model.

8

Turn over for the next question

Do not w outside t box

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]

It has flattened thin cells and the wall is only one cell thick. This reduces the diffusion pathway over which gases have to diffuse across. So the rate of diffusion is much faster.

Do not write outside the box

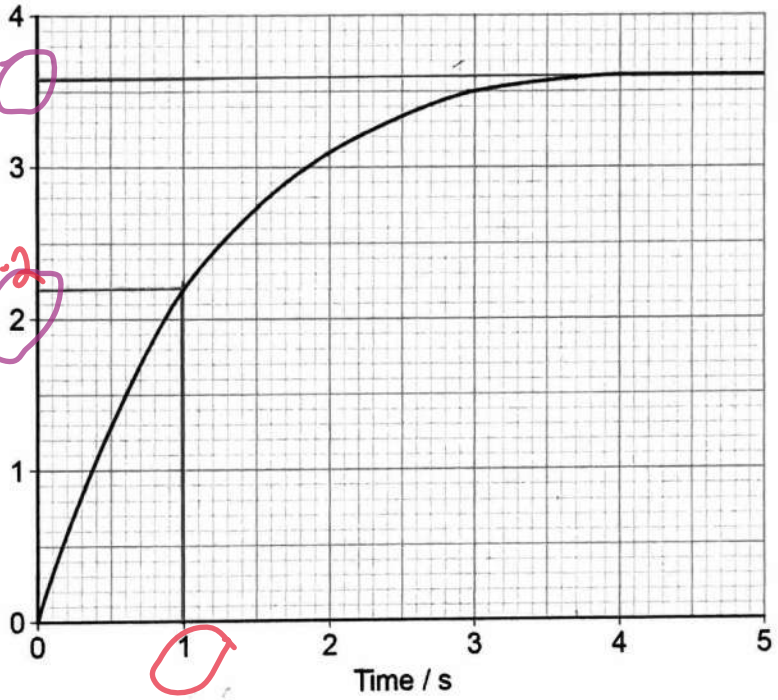
Doctors measure the health of lungs by calculating the FEV_1:FVC ratio.

- 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 = 0.6 : 1

How many times greater? 1.15

Question 2 continues on the next page

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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]

As there is reduced volume of air exhaled there is more carbon dioxide remaining in the lungs. This makes the concentration of carbondioxide in the lungs higher, reducing the concentration gradient along which it diffuses out of the blood into the alveoli. This causes slower diffusion rate and more carbon dioxide remaining in the blood.

7

Do not write outside the box

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]

2 names

Binomial

0 3 . 2 Define the term mutagenic agent.

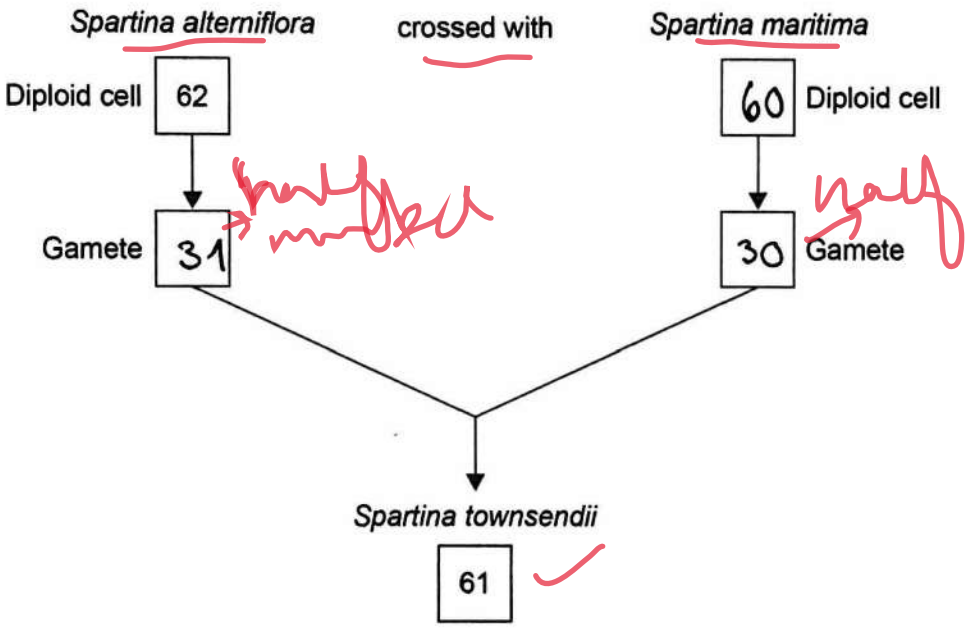
[1 mark]

A factor that increases the rate at which mutations occur.

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]

Do not write outside the box

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

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 Non-disjunction → chromosome fails to separate

Explanation At the stage of meiosis when sex cells are being produced chromosomes are not separated remaining together in the same cell

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]

Random fertilisation creates a unique / random combination of maternal and paternal chromosomes.

8

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

[2 marks]

1 Cytoplasm ✓

2 Cell surface membrane ✓

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]

Amino acids are used for protein synthesis, so with more amino acids more proteins are produced. Enzymes involved in DNA replication are proteins, so more of these enzymes will lead to faster DNA replication

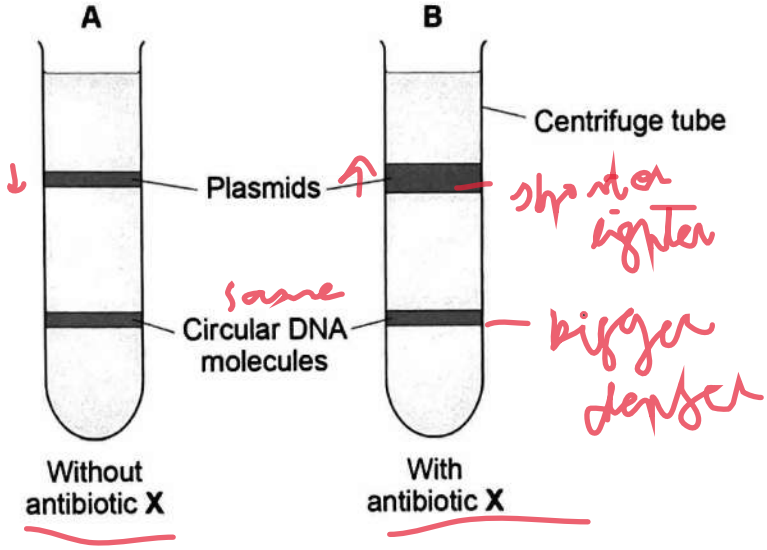
Do not write outside the box

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]

Circular DNA is bigger and denser as it's lower down the column towards the bottom.

Do not write outside the box

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]

As the circular DNA band is the same width in A and B, this suggest its replication stops. However for plasmid replication, it continues and increases as the band for plasmids is wider in B ~~after~~ with X present than without in A.

8

Turn over for the next question

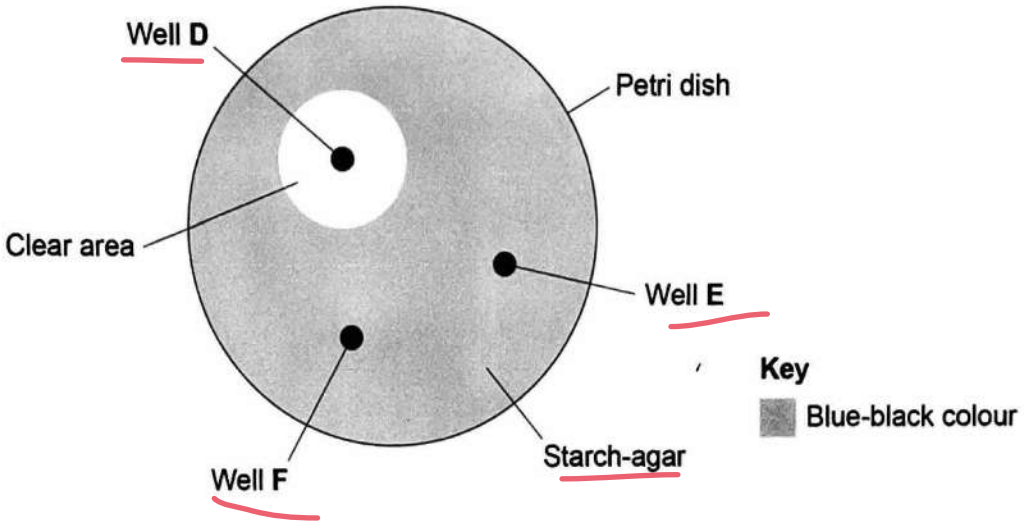
0 5 A student investigated the activity of the enzyme amylase. He cut three identical wells (**D**, **E** and **F**) in starch-agar in a Petri dish. He added 0.2 cm^3 of:

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

enzyme degraded

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]

Amylase hydrolyses starch into more simple molecules like maltose.

Iodine solution stains starch blue-black while maltose doesn't, so where amylase has broken down the starch a clear area is created.

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]

Water is used as a control in well F, as there is no amylase there is no hydrolysis of starch, so breakdown is due to amylase.

In E, enzyme is denatured as it has been heated shortly while boiling, so it is unable to break down starch.

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]

If starch has been broken down by amylase it's hydrolysed into maltose, which can be detected by the Benedicts reagent. Add Benedicts solution to the liquid and heat to at least 80°C. If simple sugars like maltose is present we will see a colour change red/green/orange.

Question 5 continues on the next page

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]

$1.6 + 2.4 = 4$

$\Rightarrow 4\,cm^3$ of solution is made

of this $4\,cm^3$ $1.6\,cm^3$ is amylase

$\frac{1.6}{4} = 0.4$ so 40% of solution is amylase

when 100% is amylase 18mm diameter

$\times 0.4$ (100% = 18mm ; 40% = 7.2) $\times 0.4$

$\Rightarrow 7$

Answer 7 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]

The resolution of a ruler is down to ±1mm so cannot calculate value to higher accuracy.

smallest divisions are separated by 1mm (interval)

9

Do not wr outside li box

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, AD^F and AD^S.

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

[3 marks]

Different genes code for different primary structure of sequence of amino acids. Therefore, when proteins are folded this difference in primary structure will cause different bonds to form, leading to a different tertiary or even quaternary structure. This determines the shape of an enzyme including its active site. AD^F codes for an enzyme that probably has a better shape to bind to substrate easier / faster, so more enzyme - substrate complexes formed in a given time.

A scientist took a random sample of adult fruit flies from a population. He measured the frequency of the 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 AD^F allele in the 45th generation.

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

[1 mark]

Avoid any bias in which individuals are sampled.

Sample will naturally reflect variation of a population

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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]

Flies with AD^F gene can break down alcohol that is a risk to them. This means they have a selective advantage over AD^S who are less efficient at it. This advantage allows AD^F gene carrying individuals to ~~reproduce~~ survive better and reproduce better than AD^S individuals. By doing this they are passing on their AD^F genes to next generation. Over generations this changes the allele frequency in the population, to make the AD^F gene more frequent.

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 ☐

selection towards getting better at breaking down alcohol.

9

Do not write outside the box

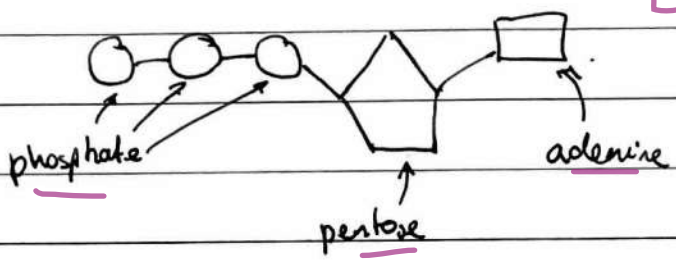
0 7 . 1 Describe how an ATP molecule is formed from its component molecules. **[4 marks]**

Ribose

ATP is made up from a pentose sugar, an adenine base and three phosphate.

It is formed from ADP which is different by having only 2 phosphates. ADP is converted into ATP by ATP synthase through a condensation reaction.

↳ removal of H_2O

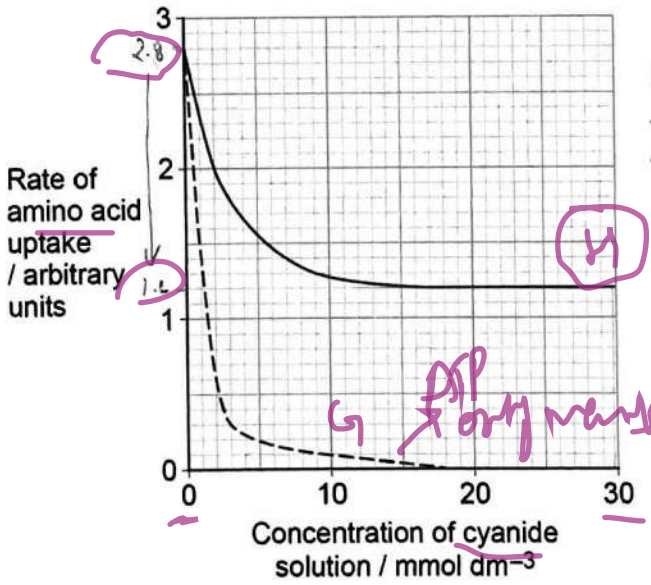


A scientist investigated the effect of cyanide on the rate of amino acid uptake in two types of *Escherichia coli*, **G** and **H**.

- **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



show

ATP made in cyto →

↳ ATP formed → A.A. rapid

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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]

at no cyanide 2.8 units of amino acid absorbtion
this drops to 1.2 at 30mmol dm^{-3}

$2.8 - 1.2 = 1.6$

$2.8 \rightarrow 1.6$ So $\frac{1.6}{2.8} = 0.571428$ Answer 57.1 %

$\Rightarrow$ 57.1 %

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]

Amino acid uptake is done by active transport by the cell. Cyanide has an effect of reducing and at high enough concentrations stoping amino acid uptake. As G cells that can only produce ATP at the membrane stop taking up amino acids it suggest cyanide stops ATP production of ATP at the membrane which would be needed for active transport. But in H cells ATP production can carry on in the cytoplasm for some more time.

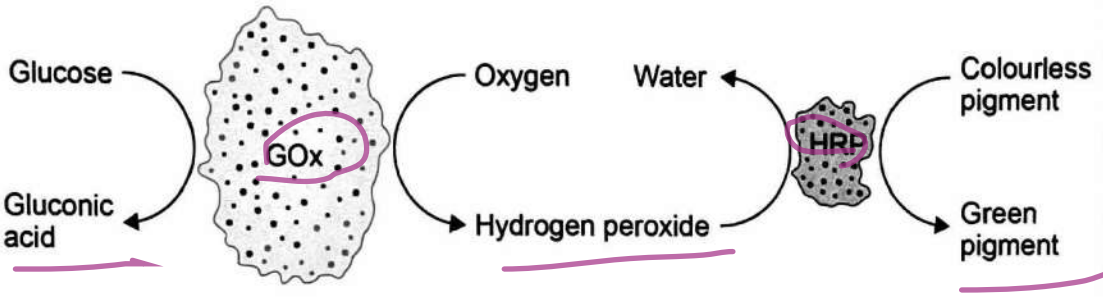
8

Turn over for the next question

Do not wri outside th box

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]

Gluconic acid, green pigment and water.

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.

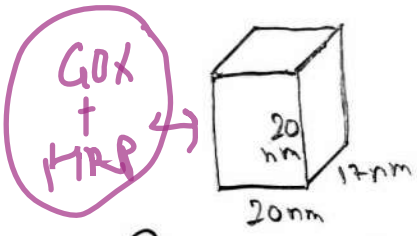
The volume of a GOx molecule is eight times larger than an HRP molecule.

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

Show your working.

[3 marks]

GOx + HRP



GOx : HRP (×8)

GOx + HRP = 9% of cage.

① Volume = 20 × 20 × 17 = 6800 nm³

② $\frac{6800\text{ nm}}{100} \times 9 = 612\text{ nm}^3$

③ $\frac{612}{9} \times 8 = 544\text{ nm}^3$

Answer 544 nm³

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

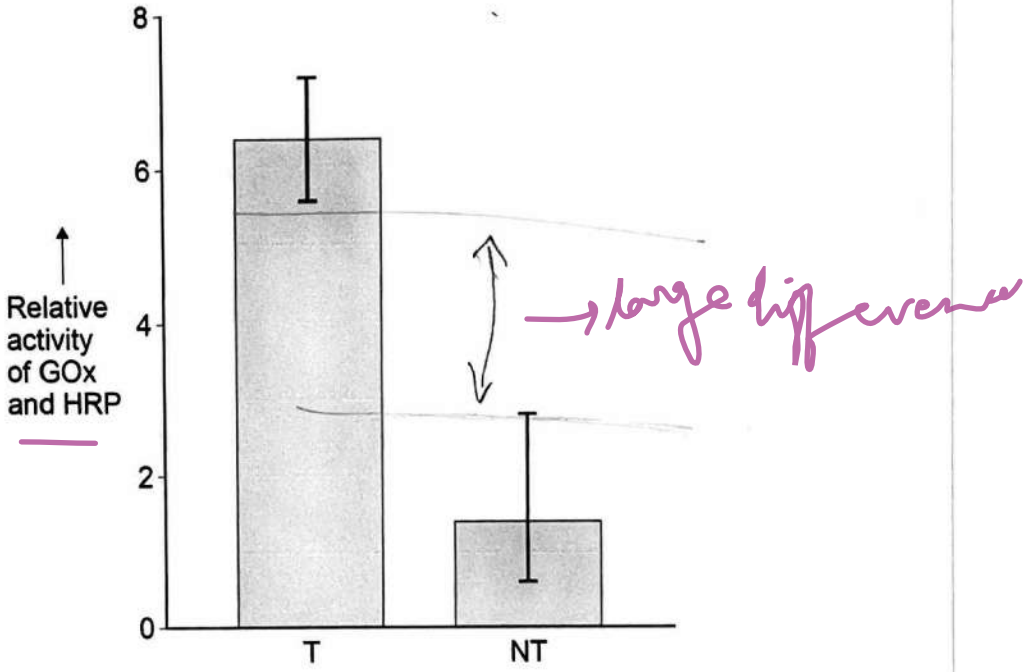
- trapped inside cages (**T**) and
- not trapped (**NT**), but free in solution with **no** cages.

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]

large difference

As the error bars dont overlap we can see there is a significantly higher relative activity when the enzymes are trapped. The error bars represent the standard deviations that also dont overlap.

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

Suggest a suitable control.

only DNA cages

[1 mark]

A treatment where there is no enzyme activity, so a denatured form of the enzymes.

8

Turn over for the next question

Do not w outside t box

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

[5 marks]

Water is important to all forms of life. This is due to its properties like being a great solvent, so metabolic reactions can occur it it easies.

It also has a high heat capacity, this allows organisms a buffer from ~~fluctuat~~ fluctuations to temperature change.

Water molecules have a high level of cohesion between them. This helps to support water columns in plants, which they rely on for ~~suppot~~ structure. It also produces surface tension supporting the structure of small organisms as well.

Lastly but not least its an important metabolite itself, used in hydrolysis reactions as well as in photosynthesis.

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

[5 marks]

break

DNA is found in a double helix that needs to have its hydrogen bonds broken between base pairs before replication. This is done by DNA helicase. Once the two strands are seperated each strand can be used as a template to use in semi conservative replication. This means that on replicated DNA one strand of the DNA will be from the original DNA molecule, while the other strand was built by other nucleotides, based on the original as a template. You can use the original strands as a ~~template~~ template as nucleotides line up complementary to their base pairs. A pairs with T and C pairs with G and vise versa. When free nucleotides have lined up complementary in base pairing to the template strand DNA polymerase joins these nucleotides together to form the second strand. These nucleotides are joined by the formation of phosphodiester bonds.

10

END OF QUESTIONS