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.

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	

Do not write outside the box

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

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

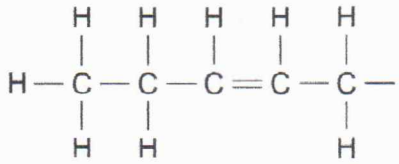
Name the group represented by COOH.

[1 mark]

Carboxyl group.

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 Because it has a carbon-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]

Add ethanol to the sample and then add water and shake to mix. A positive test would result in a white or milky emulsion. In a negative test an emulsion would not form.

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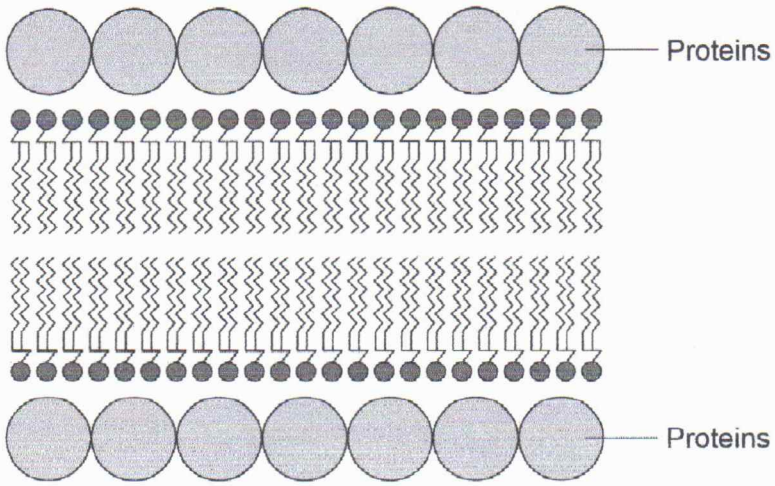
In 1935, scientists suggested a model for the chemical structure of a cell-surface membrane. **Figure 2** shows the membrane structure the scientists suggested.

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 of them have phospholipid bi-layer. with hydrophobic tails and hydrophylic heads.

Difference 1 No Channel proteins in suggested model while they are present in fluid-mosaic model

Difference 2 In this model protein layer covers the phospholipid heads in mosaic model proteins are dotted

(3) Cholesterol is present in fluid mosaic model not present in this proposed model.

(4) Glycoproteins are present in fluid mosaic model and are absent in this model

(5) Glycolipids are present in fluid mosaic model, they are absent in this proposed model.

8

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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]

They are flattened single layer of cells. This reduces the diffusion distance. The cells are also permeable to both oxygen and carbon dioxide allowing diffusion to take place efficiently

Do not write outside the box

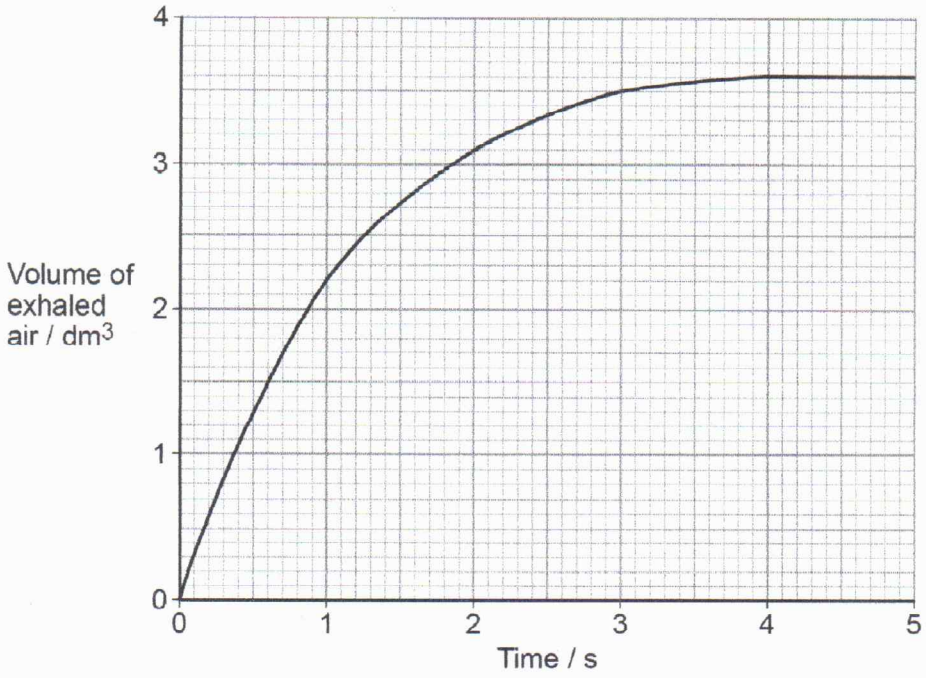
Doctors measure the health of lungs by calculating the FEV_1:FVC ratio.

- 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]

$FEV_1 = 2.2$
$FVC = 3.6$
ratio $= \frac{2.2}{3.6} = 0.6 : 1$

FEV_1:FVC ratio of man's lungs = 0.6 : 1

How many times greater? 1.16

Question 2 continues on the next page

Do not write outside the box

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]

With reduced tidal volume less carbon dioxide is exhaled, therefore some carbon dioxide remain in the lungs. This lowers the concentration gradient between the blood in alveolar capillaries and the air in the alveolar space, consequently diffusion of carbon dioxide from the blood into the alveolar space decrease. If more carbon dioxide remain 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]

Binomial nomenclature.

0 3 . 2 Define the term mutagenic agent.

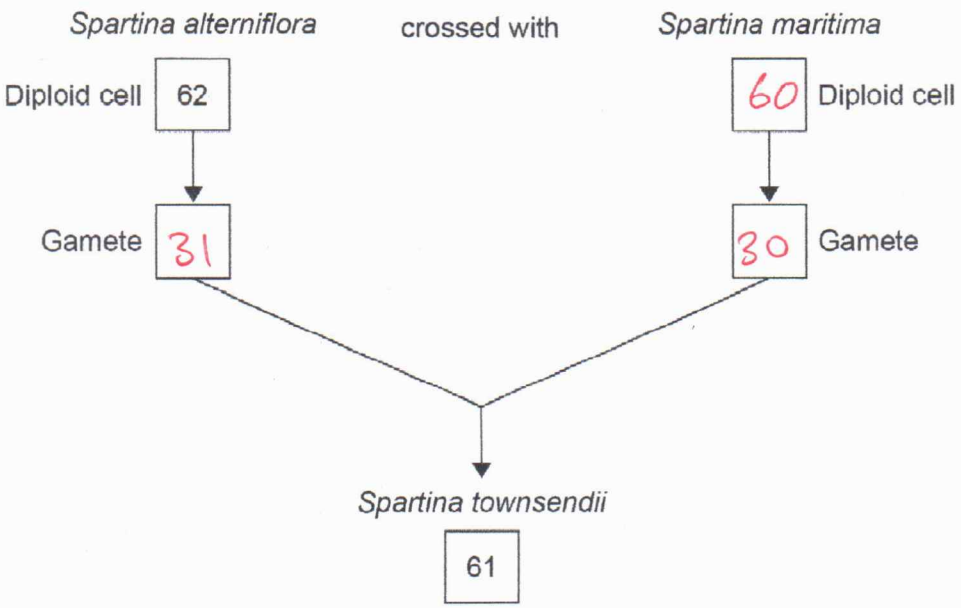
[1 mark]

A mutagenic agent is any factor that increase the rate of mutations.

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

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 Non-disjunction.

Explanation Non-disjunction happens during the 1st meiotic division when a pair of homologous chromosome do not separate before being distribute into two daughter cells. In the resulting cells (gamete) one cell has two copies of the same chromosome while the other cell has no copies of the same chromosome.

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]

Two mating individuals have the same kinds and same number of chromosomes, but these chromosomes are not exactly identical. Individuals posses different variations of genes, the random fusion of gametes during fertilization results in more genetic variety in the offspring.

8

Do not write outside the box

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

[2 marks]

1 Ribosomes

2 DNA (deoxyribonucleic acid)

(3) cell surface membrane

(4) cytoplasm.

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 in protein synthesis. Therefore with high amino acid concentration in cytosol more proteins eg enzymes may be synthesised with more enzymes eg enzymes for Plasmid replication faster rate of plasmid of plasmid replication in cell is possible.

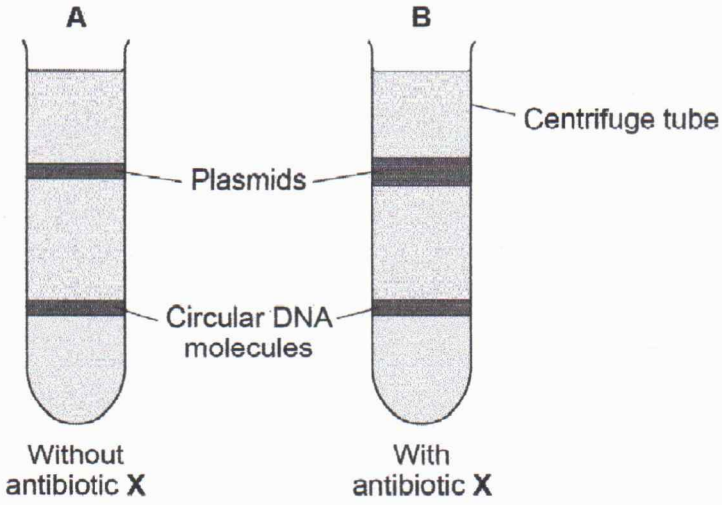
Do not write outside the box

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 heavier than plasmid DNA. This is because after centrifuging circular DNA moves closer to the bottom of the tube than plasmid DNA. Implying that circular DNA is denser than plasmid DNA.

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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]

Antibiotic X inhibits circular DNA replication this because after applying antibiotic X the DNA remains the same. On the other hand antibiotic X does not inhibit replication of plasmid DNA, This is because the DNA doubles in tube B which has antibiotic.

8

Turn over for the next question

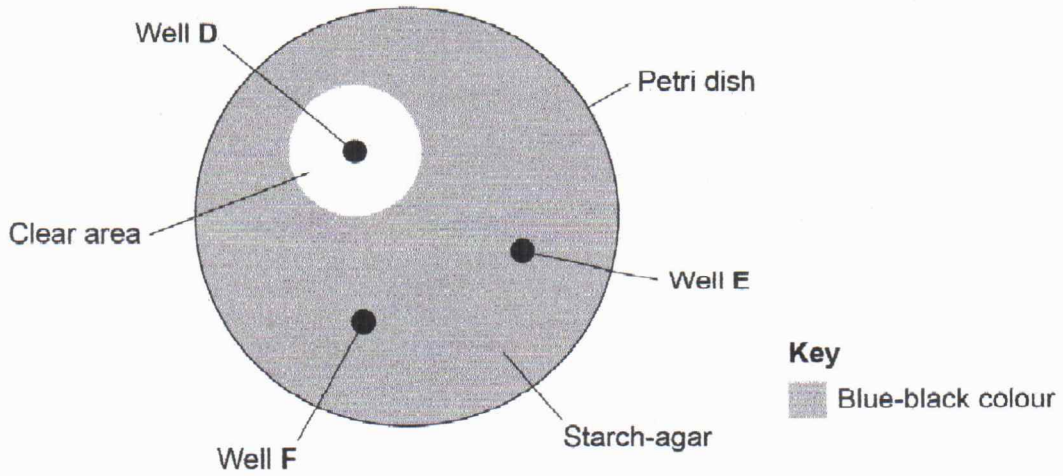
Do not write outside the box

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]

Starch produces a blue black color with iodine. In the area around well D blue black color did not appear. This indicates absence of starch. This is because starch had been hydrolysed by amylase to maltose.

Do not write outside the box

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]

In well E boiled amylase was added. This means the enzyme had been denatured & the active site had been altered and therefore substrate molecule could not fit, and as such starch was not hydrolysed. In well E only plain water was added, water alone cannot hydrolyse 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]

Add Benedicts solution to the solution obtained from the substances in the agar. Heat the solution and observe the colour change. a green, yellow, orange or brick red colour indicates presence of a reducing sugar eg maltose. If the solution remains blue there is no reducing sugar.

Question 5 continues on the next page

Do not write outside the box

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]

$1.6 + 2.4 = 4$

$\frac{1.6}{4} \times 100 = 40\%$ dilution

$0.2\ cm^3 = 18$

40% of 18

$= \frac{18 \times 40}{100} = 7.2$

Answer 7.2 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]

To reduce human error, this is because for a ruler measurement the uncertainty is ± 1(mm).

9

Do not write outside the 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]

The two have different primary structure ie the amino acid sequence in the polypeptide chain is different. As a consequence the have different tertiary structure. This means the shape of the active sites are different. With AD^F than enzyme complexes are more likely to form than with AD^S therefore more products will be formed with AD^F than with AD^S and as such AD^S enzymes are faster in breaking down alcohol.

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]

To avoid bias. This makes the results likely to be more reliable.

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]

Flies with AD^F allele had a selective advantage with alcohol, as a result these insects were more likely to survive alcohol treatment. They reproduce and pass on the allele to their offspring. As a result the frequency of AD^F allele will increase in the population.

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

[1 mark]

Directional selection occurs when individuals with traits on one side of the mean in the population survive better or reproduce more than those on the other.

- No selection ☐
- Directional selection ☒
- Random selection ☐
- Stabilising selection ☐

9

Do not write outside the box

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

[4 marks]

ATP is a nucleotide made up of three components which include.

(a) ribose sugar.

(b) Adenine

(c) Three phosphates.

To to synthesis ATP a condensation reaction takes place between ADP and phosphate with the help of an enzyme called ATP Synthase

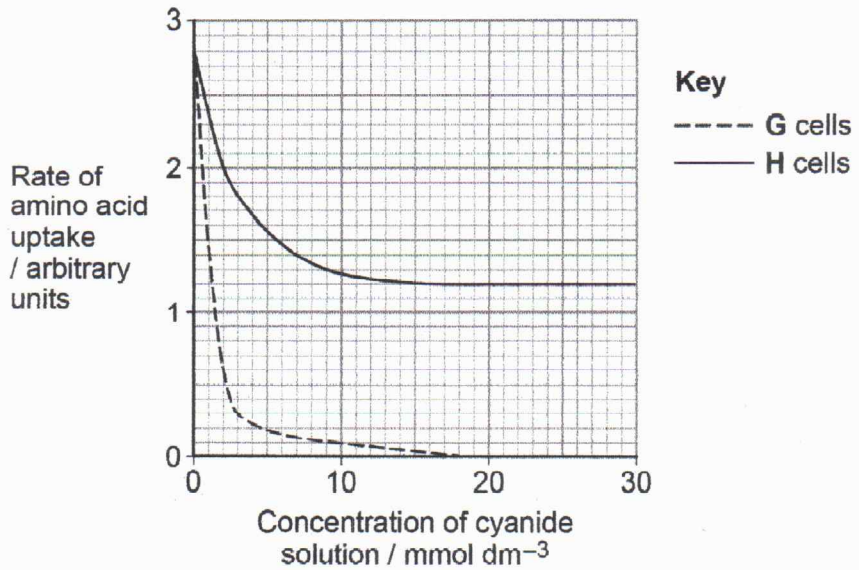
ADP + Pi → ATP.

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



Do not write outside the box

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]

$2.8 - 1.2 = 1.6$

$\therefore \frac{1.6}{2.8} \times 100 = 57.14$

Answer 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 acids are taken up by active transport. Cells G produce enzymes on membrane and cyanide stops this. Without ATP production amino acid uptake stops on membranes. In cell H ATP synthesis / production stops on the membrane but continues in the cytoplasm. Therefore enzymes are active in the cytoplasm and as a result amino acid uptake by cell H drops without completely stopping.

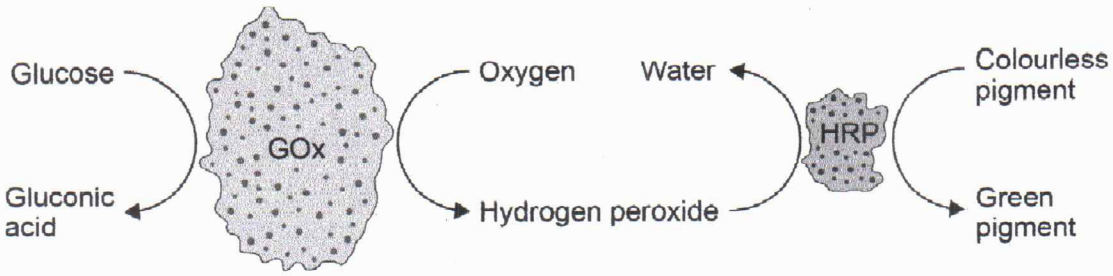
8

Turn over for the next question

Do not write outside the 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, water, green pigment

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]

Volume of cage = $20 \times 20 \times 17 = 6800\ nm^3$

Volume occupied by enzyme = $\frac{6800 \times 9}{100} = 612\ nm^3$

Volume of HRP = $\frac{612}{9} = 68\ nm^3$

Volume of GOx = $612 - 68 = 544\ nm^3$

Answer $544\ nm^3$.

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

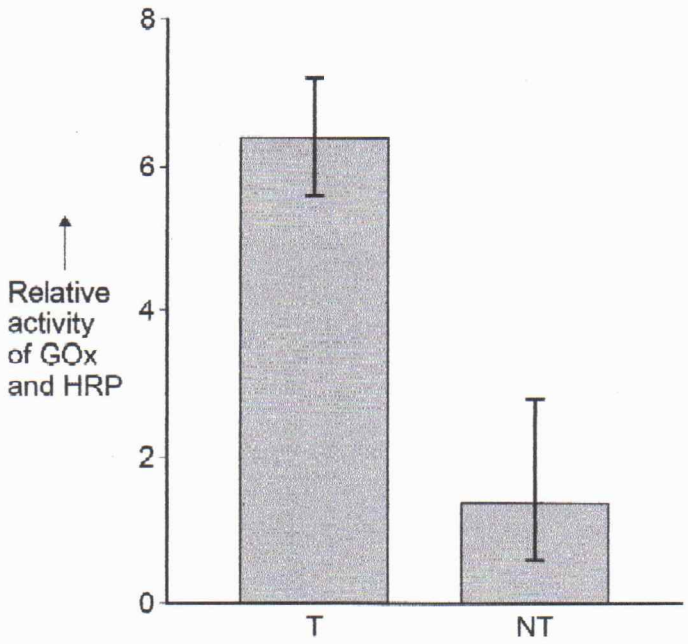
- trapped inside cages (**T**) and
- not trapped (**NT**), but free in solution with **no** cages.

Figure 10 shows his results.

The error bars show ± 2 standard deviations.

± 2 standard deviations include 95% of the data.

Figure 10



Do not write outside the box

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

[3 marks]

Trapping GOX and HRP increases their activity. The increase in activity is significant and cannot be due to chance because the standard deviations do not overlap.

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

Suggest a suitable control.

[1 mark]

A suitable control would be a set up with enzymes that have been denatured.

8

Turn over for the next question

Do not write outside the box

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

[5 marks]

⇒ Water as a solvent. This depend on the fact that it a polar molecule. Water is a good solvent for many substances. Ionic solids like salts and polar molecules such as sugars and amino acids dissolve in it and can be transported in water.

⇒ Water is a metabolite in photosynthesis where it is a raw material. It a metabolic in hydrolysis reactions where it used in breaking bonds

⇒ High Specific heat capacity. This means a large increase in Thermal energy results in comparatively small rise in temperature of water. This means water is good at maintaining it's temperature at a steady level irrespective of fluctuations in temperature of surrounding environment

⇒ Water cohesion force. At everyday temperature water has the highest cohesion force of any liquid besides mercury. Cohesion force holds the molecules of a liquid together. The strong cohesive force between water molecules plays a role in movement of water upwards in xylem.

⇒ Surface tension produced by the cohesive force between water molecules allows the surface film of standing water to support and provide a habitat for certain aquatic organisms eg pond skaters.

Do not write outside the box

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

[5 marks]

In semi-conservative replication the two old strands of DNA are used to template to build two new strands. Replication starts with DNA unzipping along the line of hydrogen bonds, and the two strands separate. This is brought about by the enzyme DNA helicase.

When the two strands are separated DNA nucleotides from the cytoplasm enter the nucleus and use the two separate strands as templates hydrogen bonds are formed between old nucleotides and new nucleotides using base pairing rule. DNA polymerase lines up and catalyse the linking up of nucleotides along the template strand. DNA ligase catalyses the formation of phosphodiester bonds between the two strands of DNA. The result is two new strands of DNA identical with the original piece.

10

END OF QUESTIONS