YUYING SECONDARY SCHOOL

PRELIMINARY EXAMINATION
Secondary 4

NAME

CLASS **REG. NO**

BIOLOGY
Paper 2

6093/2
23 August 2024
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer **one** question in the spaces provided on the Question Paper.

The use of an approved calculator is expected, where appropriate.
The number of marks is given in brackets [ ] at the end of each question or part question.

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Total	

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This document consists of **20** printed pages.

Section A

Answer **all** the questions in this section.
The total mark for this section is 70.

1 **(a)** A researcher investigated the effect of temperature on two different biological washing powders, **A** and **B**.

Two identical pieces of clothing were stained with the same type of food.

The researcher timed how long each washing powder took to remove the stains, at different temperatures.

Fig. 1.1 is a graph of the results.

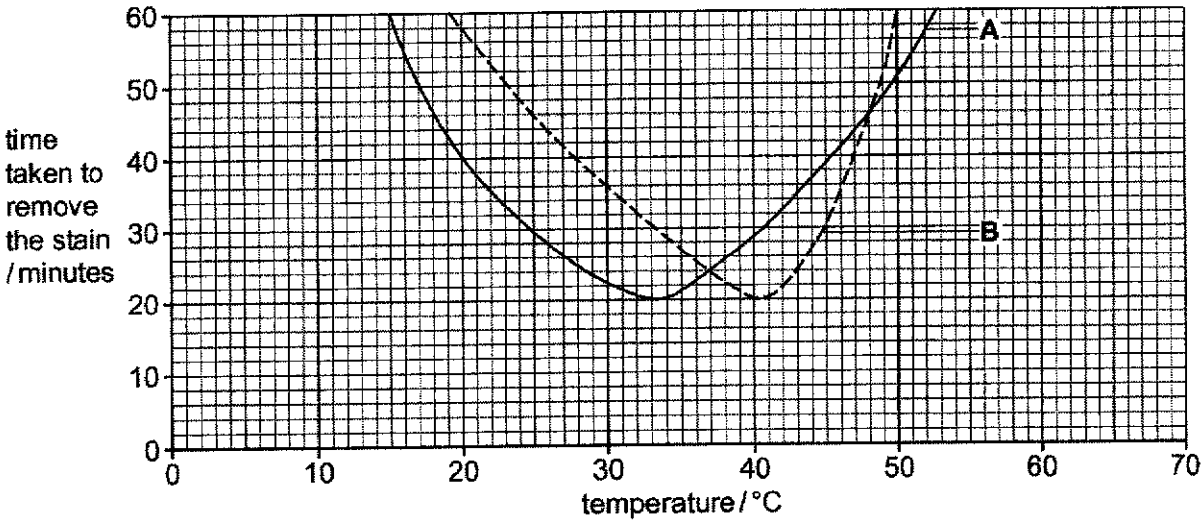


Fig. 1.1

(i) Determine the time taken for washing powder **A** to remove the stain at 20 °C.

..... minutes [1]

(ii) Describe **and** explain the effectiveness of washing powder **B** between 20 °C and 40 °C.

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..... [4]

(iii) A student stated some conclusions for the results shown in Fig. 1.1.

Tick (✓) **two** boxes that show two correct conclusions for the results shown in Fig. 1.1.

Washing powders **A** and **B** do not work at 50 °C.	
Washing powders **A** and **B** have the same activity at 37 °C.	
Washing powder **A** can remove the stain in 15 minutes.	
Washing powder **A** is more effective at lower temperatures than washing powder **B**.	
Washing powder **B** is active over a greater range of temperatures than washing powder **A**.	

[2]

(b) Fig. 1.2 is a diagram showing the action of an enzyme.

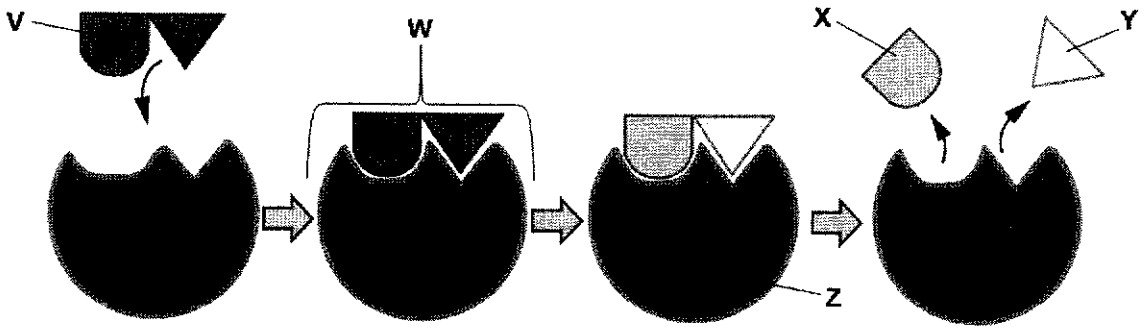


Fig. 1.2

State the letter or letters from Fig. 1.2 that represent(s) the:

substrate .....

enzyme .....

[2]

[Total: 9]

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2 **(a)** Fig. 2.1 is a photomicrograph of a sample of human blood.

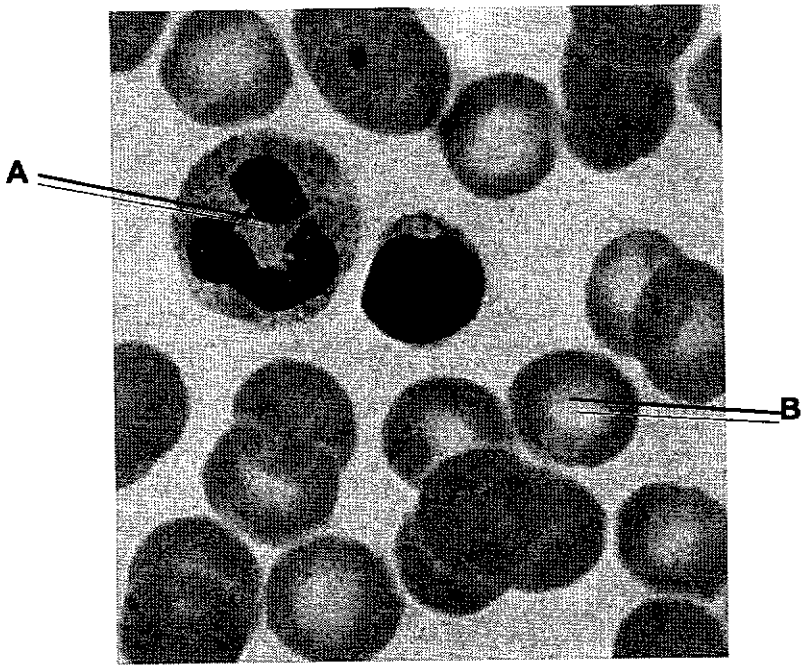


Fig. 2.1

Identify and describe the functions of the cells labelled **A and B** in Fig. 2.1.

cell **A** .....

.....

.....

.....

cell **B** .....

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.....

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[4]

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(b) Fig. 2.2 is a diagram of a section through the heart of a mammal. The arrows show the direction of blood flow through the heart and blood vessels.

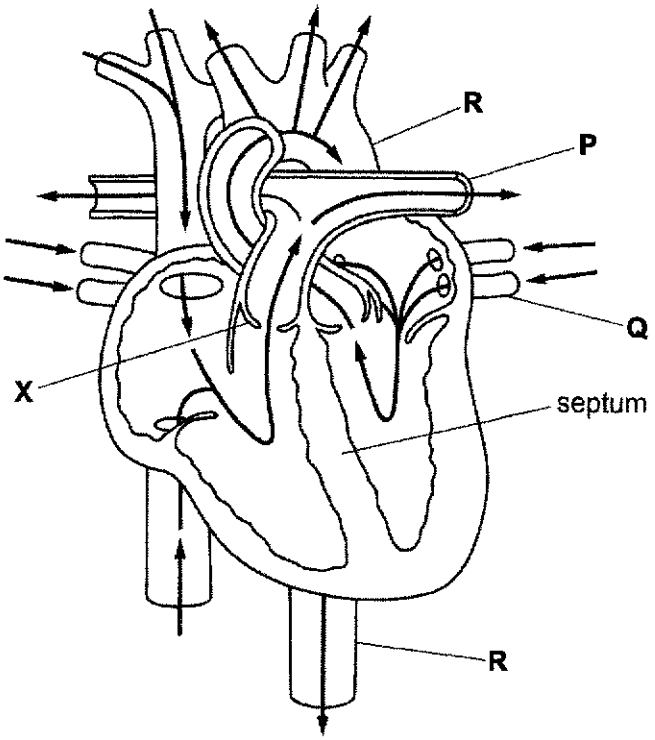


Fig. 2.2

(i) Name structures **P**, **Q** and **R**.

P .....

Q .....

R .....

[3]

(ii) Identify the structure labelled **X** in Fig. 2.2 **and** describe what happens to it during the cardiac cycle, making reference to the structures of the heart involved.

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..... [3]

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[Total: 10]

3 **(a)** Fig. 3.1 is a photomicrograph of some cells lining the trachea.

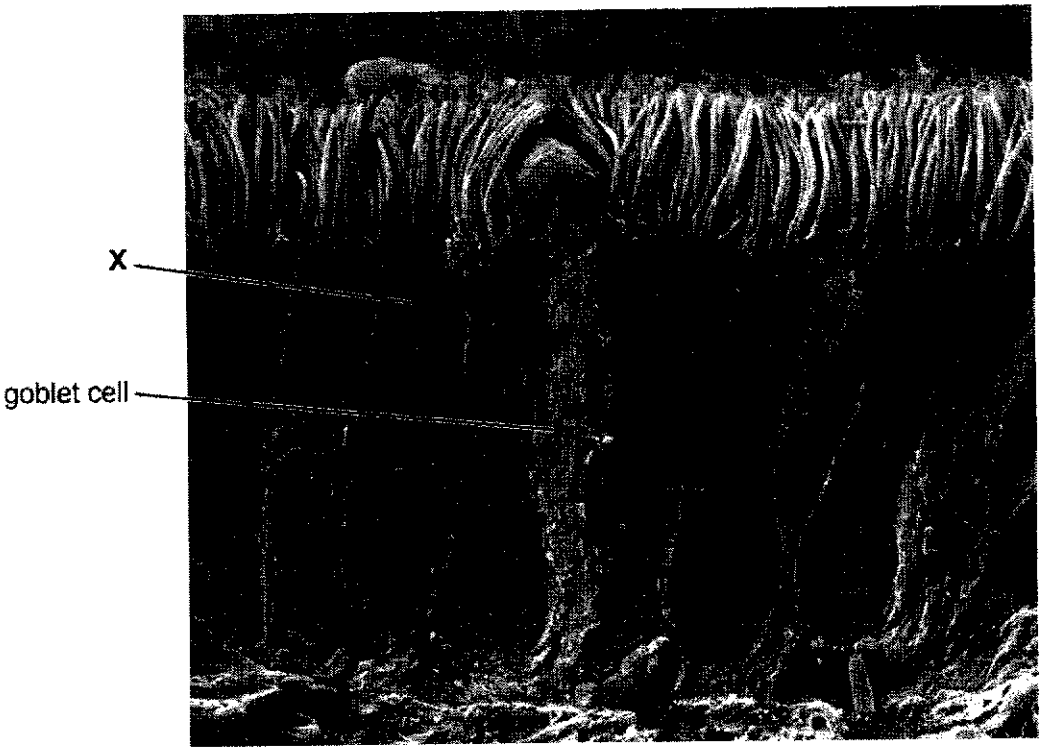


Fig. 3.1

(i) The goblet cell is responsible for the production of mucus.

Explain how the goblet cell and the cell labelled **X** in Fig. 3.1 work together to perform their function in the trachea.

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..... [3]

(ii) Explain how cigarette smoke may affect the functioning of the cells mentioned in **(i)** and how it would affect a smoker's health.

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..... [2]

(b) A scientist monitored the changes in the pH in muscles before, during and after two minutes of vigorous exercise. The changes in pH are due to the production of lactic acid. The results are as shown in Fig. 3.2

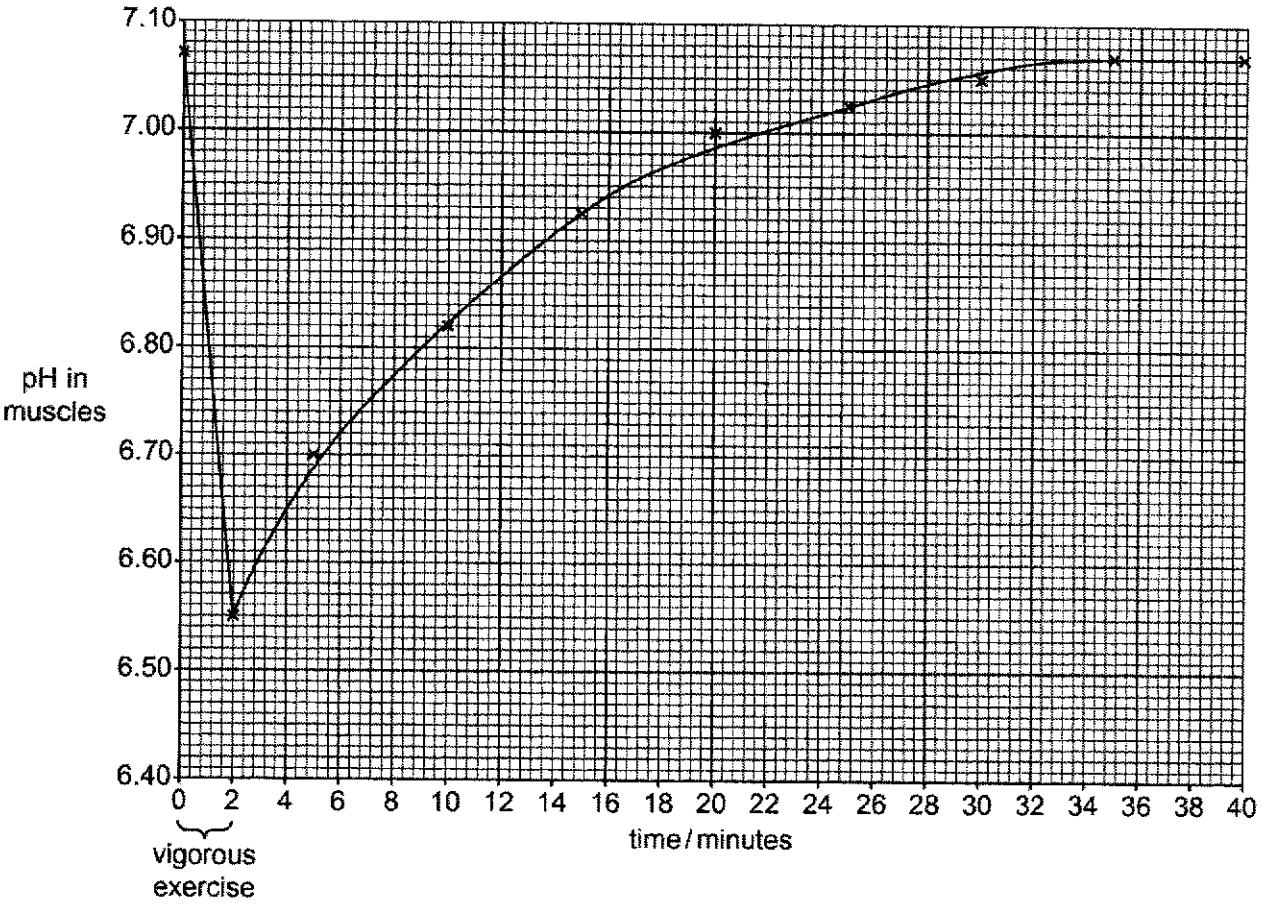


Fig. 3.2

Describe **and** explain the results shown in Fig. 3.2.

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[5]

[Total: 10]

4 Insulin is a hormone that regulates the concentration of glucose in the blood.

(a) Describe what is meant by the term hormone.

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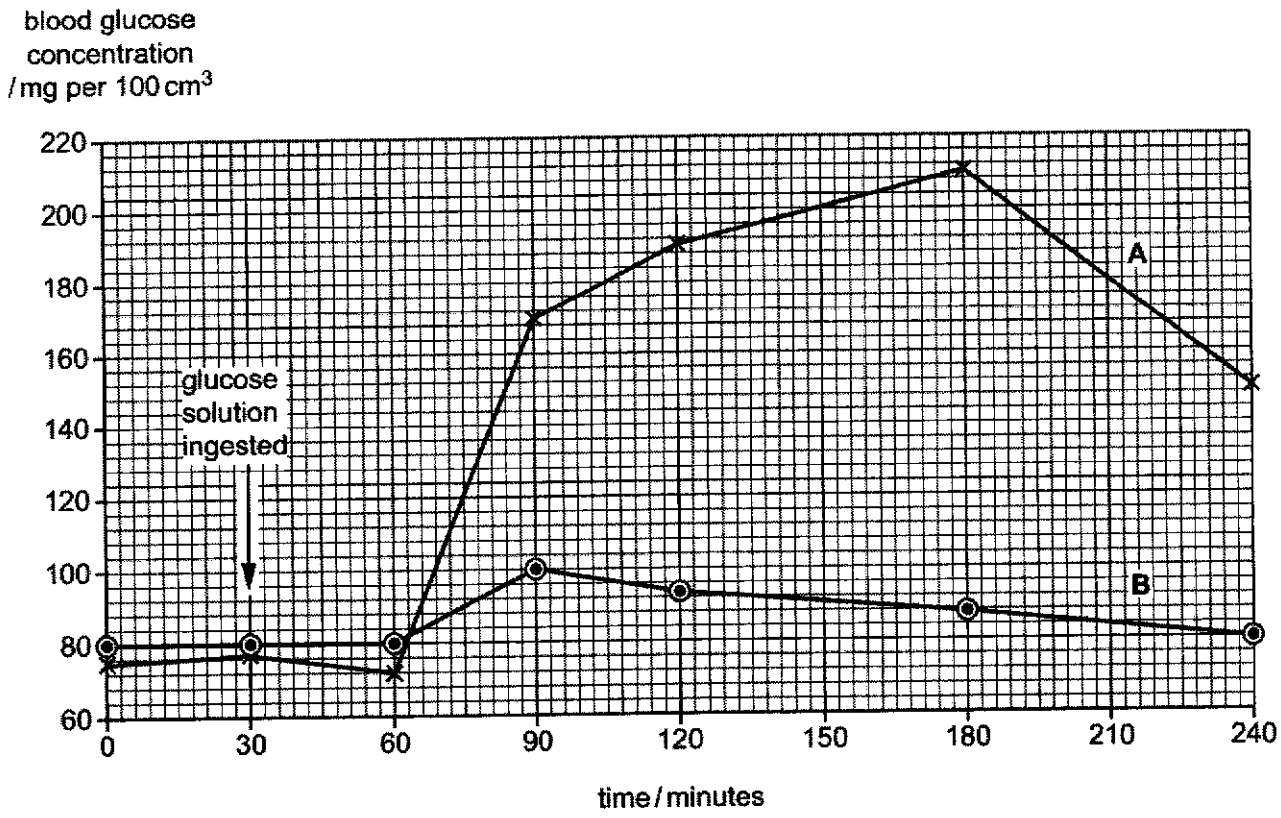
[3]

(b) Persons **A** and **B** were monitored to see how well they could control their blood glucose concentration.

They did not eat or drink anything other than water for eight hours before the monitoring began. They then drank a glucose solution 30 minutes after monitoring began.

Blood samples were taken at 30-minute intervals and tested for glucose concentration.

The results are shown in Fig. 4.1.



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Fig. 4.1

(i) Calculate the percentage increase in the blood glucose concentration in person **A** between 60 and 90 minutes.

.....% [2]

(ii) Using Fig. 4.1, describe **and** compare the response of person **A** with the response of person **B** after the ingestion of glucose.

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..... [3]

(iii) Using Fig. 4.1, describe **and** explain the response of person **B** after 90 minutes.

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..... [3]

[Total: 11]

5 Cystic fibrosis is a disease caused by a mutation in the genes. One of the symptoms of cystic fibrosis is the build-up of thick, sticky mucus on various organ membranes.

(a) The bile and pancreatic ducts are among the regions affected by cystic fibrosis.

Suggest **and** explain the effects this disease would have on digestion.

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[3]

(b) Fig. 5.1 shows the pedigree diagram of a family that has two people who have cystic fibrosis.

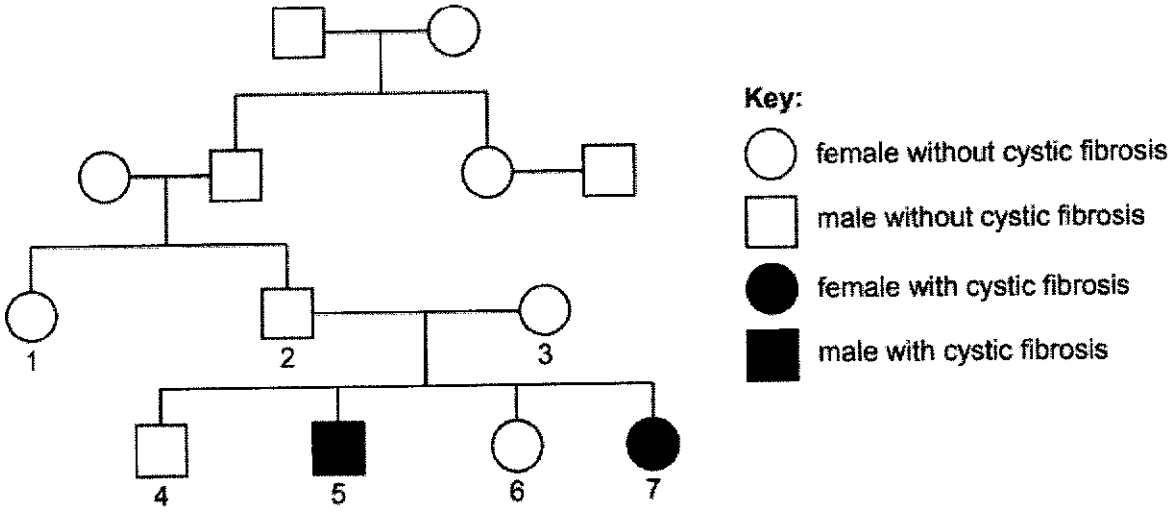


Fig. 5.1

(i) The allele that causes cystic fibrosis is a recessive allele.

Describe **and** explain the evidence shown in Fig. 5.1 that cystic fibrosis is caused by a recessive allele.

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..... [2]

(ii) Person 5 has a child with a woman who is heterozygous for cystic fibrosis.

Complete the genetic diagram to predict the probability of person 5 and the heterozygous woman having a child with cystic fibrosis.

Use the symbol **A** for the dominant allele and **a** for the recessive allele.

	father	x	mother
genotype of parents	.....		.....

gametes	.....	.....	.....	.....

genotype of offspring	.....	.....	.....	.....
phenotype of offspring	.....	.....	.....	.....
	.....	.....	.....	.....

probability of having a child with cystic fibrosis
.....

[5]

[Total: 10]

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6 A student investigated osmosis in potato plant cells.

He immersed cubes of potato tissue in water and different concentrations of sucrose solution for 30 minutes.

The masses of the potato cubes were measured before and after immersion. The percentage changes in mass were calculated.

Table 6.1 shows the results.

Table 6.1

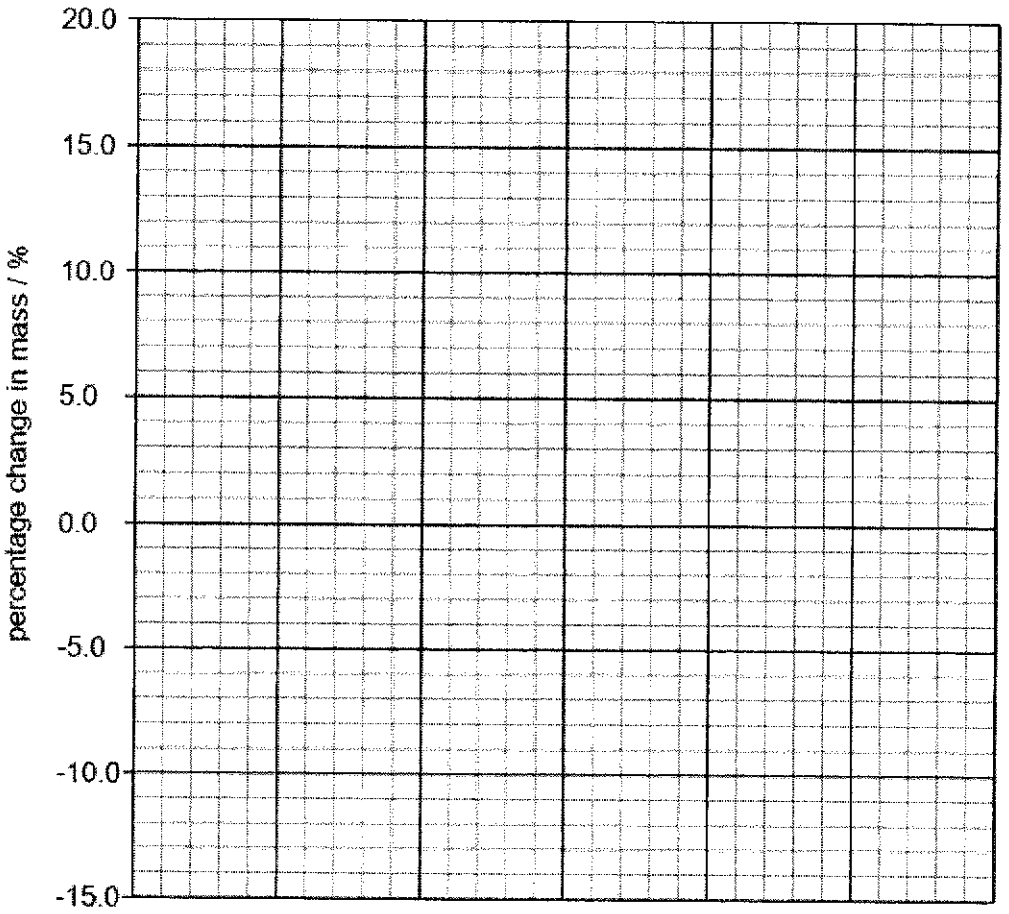
concentration of sucrose solution / mol dm^{-3}	mass of potato cube before immersion / g	mass of potato cube after immersion / g	percentage change in mass / %
0.0	1.32	1.50	13.6
0.2	1.34	1.49	11.2
0.4	1.30	1.34	3.1
0.6	1.33	1.28	-3.8
0.8	1.26	1.13	-10.3
1.0	1.28	1.11	

(a) (i) Using the information in Table 6.1, calculate the percentage change in mass at 1.00 mol dm^{-3}. Show your working clearly.

..... % [2]

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(ii) Plot a graph of the data from Table 6.1, including your answer from **(i)**, in the grid below.



[4]

(iii) Using your graph, determine the concentration of sucrose present in the potato cube.

..... mol dm^{-3} [1]

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(b) Describe **and** explain the expected appearance of a cell from a potato cube that has been immersed in 0.2 mol dm^{-3} sucrose solution for 30 minutes.

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[2]

(c) Describe how the process of active transport differs from the process of osmosis.

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[3]

[Total: 12]

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7 Fig. 7.1 shows part of a food web in a river.

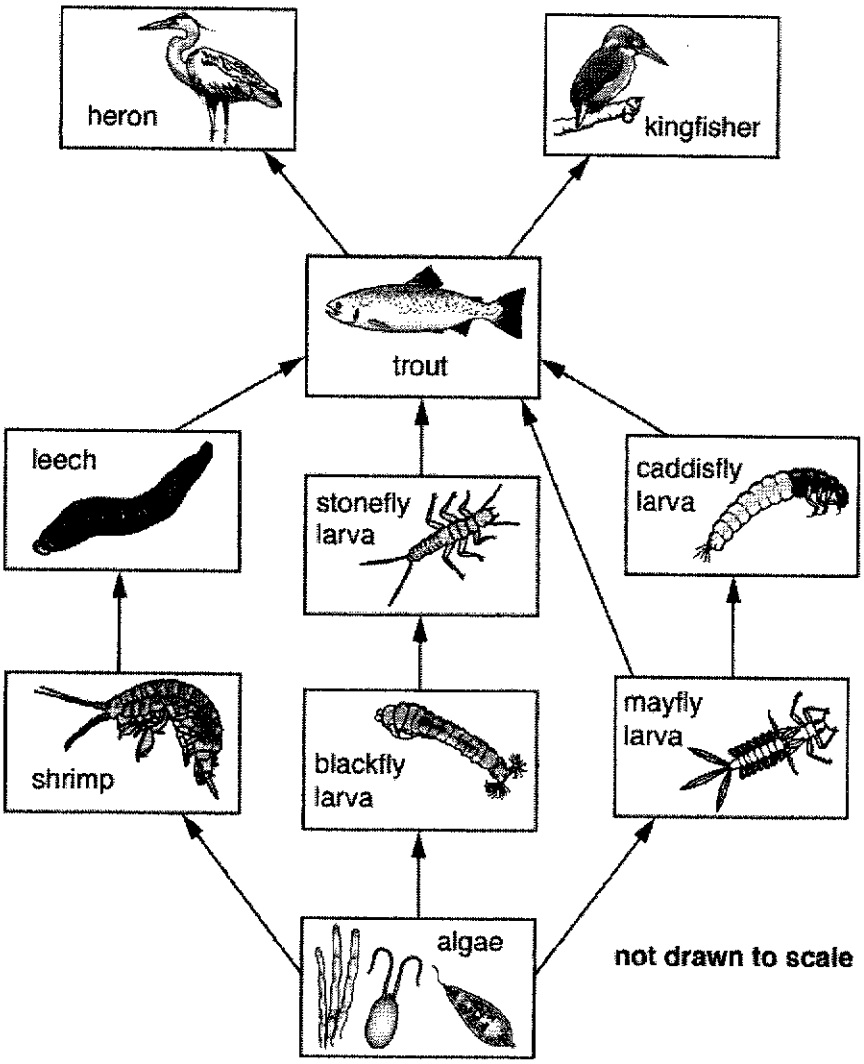


Fig. 7.1

(a) (i) Use the information from Fig. 7.1 to complete Table 7.1.

Table 7.1

role in the food web	name of organism
a producer	
an organism that is both a secondary and a tertiary consumer	

[2]

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(b) Several months ago, farms near the river have begun using insecticides on their crop plants.

Scientists have observed that the populations of herons and kingfishers have been decreasing at a very high rate.

(i) Explain why a higher proportion of herons and kingfishers have died compared to other organisms in the river.

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..... [3]

(ii) Predict **and** explain how the death of the birds will affect the populations of trout and caddisfly larva.

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..... [3]

[Total: 8]

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Section B

Answer **one** question from this section.
The total mark for this section is 10.

8 Fig. 8.1 shows a diagram of a typical bacterium cell.

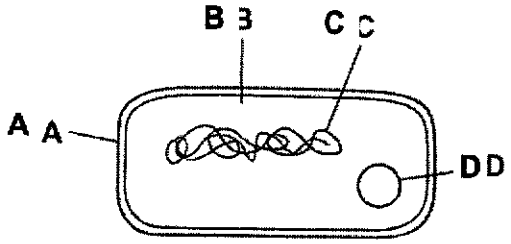


Fig. 8.1

(a) Use information from Fig. 8.1 to complete the table below.

description	part(s)
contains genetic material	
present in plant cells	

[2]

(b) Fig. 8.2 shows the process used to produce genetically modified plants.

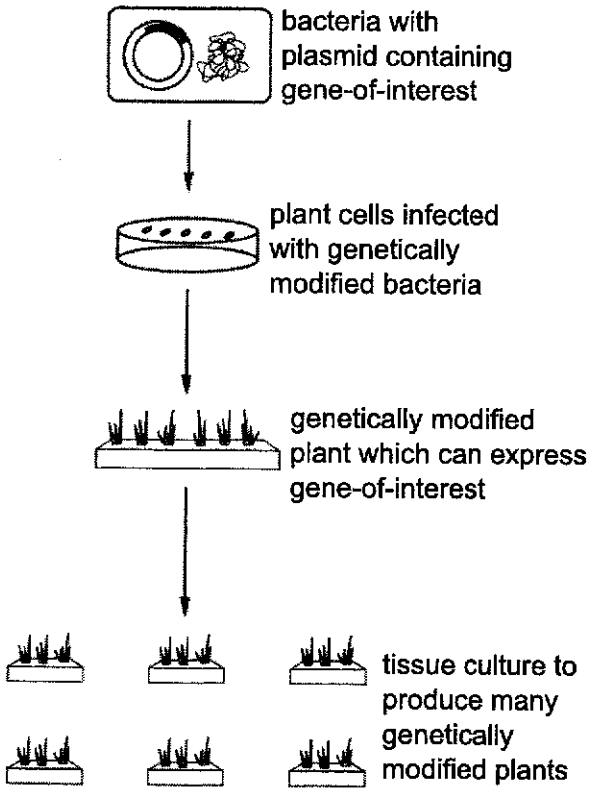


Fig. 8.2

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(i) Suggest which type of reproduction tissue culture represents.

..... [1]

(ii) Describe how an antibiotic resistance gene can be inserted into bacteria to produce genetically modified plants with antibiotic resistance.

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..... [5]

(iii) Explain why some people may be concerned about consuming genetically modified plants, such as those with antibiotic resistance, as a source of food.

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..... [2]

[Total: 10]

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9 **(a)** Define transpiration.

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..... [1]

(b) Marram grass is a type of grass that is almost exclusively found in coastal regions. It has various adaptations that help it survive in dry environments.

Fig. 9.1 shows the cross-section of a whole marram grass leaf.

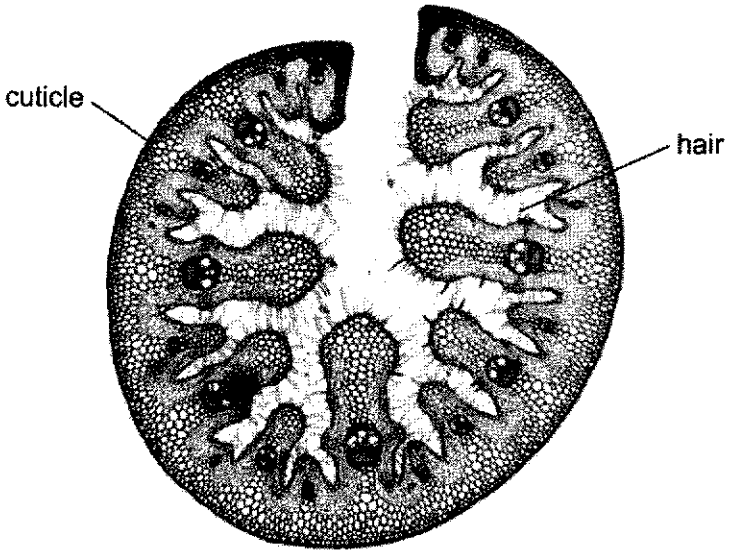


Fig. 9.1

With reference to the parts labelled and other observable features in Fig. 9.1, suggest **and** explain how adaptations of the marram grass help it survive in dry environments.

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..... [6]

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(c) Fig. 9.2 is a diagram of the marram grass flower.

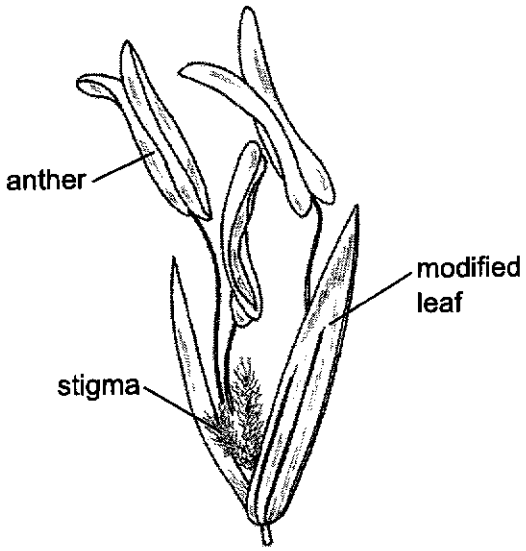


Fig. 9.2

Suggest if the marram grass flower relies on wind or insect pollination. Explain your answer using evidence from Fig. 9.2.

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..... [3]

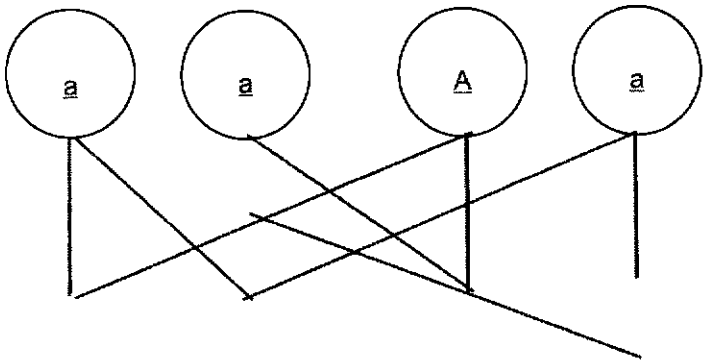
[Total: 10]

END OF PAPER

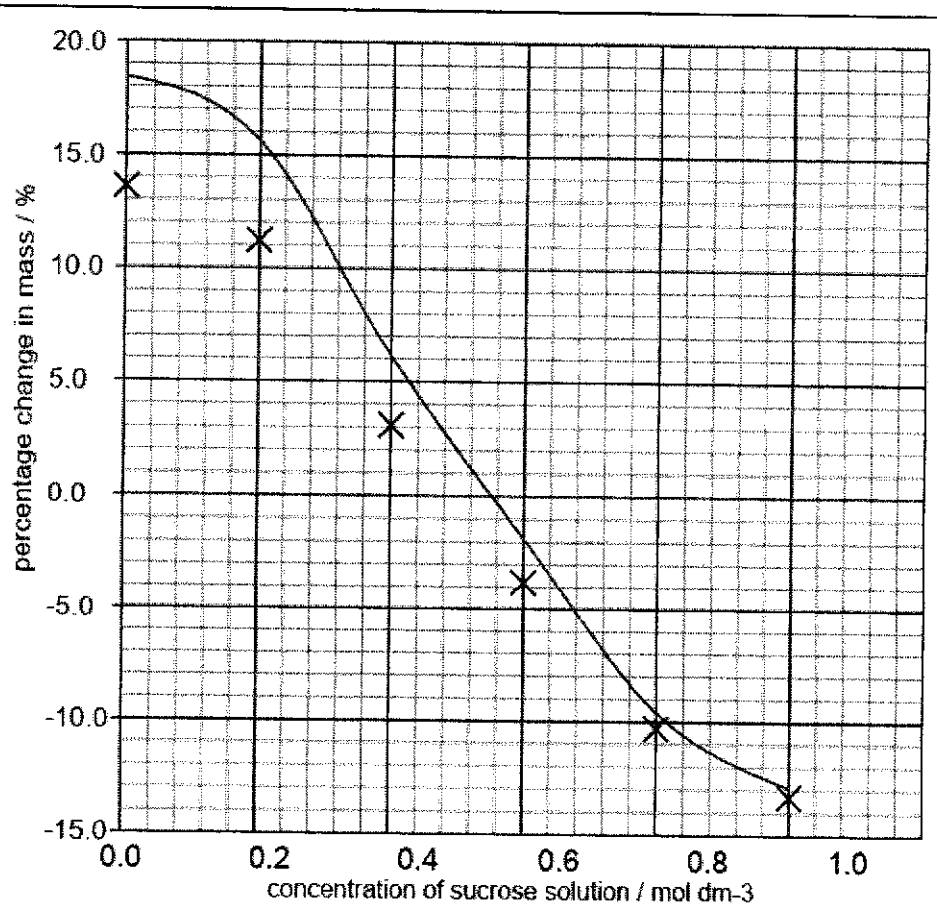
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	eventually destroyed in the liver.	[1]
4bi	Percentage increase = (170-72)/72 x 100% = 136%	[1] [1]
4bii	**Any 3** Both the blood glucose concentration of persons A and B began to increase 30 minutes after ingestion of the glucose solution. **(comparing trend)** Between 60-90min, blood glucose level of person A increased at a higher rate, from 72 to 170 mg per 100 cm^3, while blood glucose of person B increased at a gradual rate from 80 to 100 mg per 100 cm^3. **(comparing rate of increase)** While the peak blood glucose concentration of person A was 210 mg per 100 cm^3 at 180 minutes, the peak blood glucose concentration of person B was lower at 100 mg per 100 cm^3 at 90 minutes. **(comparing peak/fluctuation)** At 240 minutes, the blood glucose concentration of person A remained high at 150 mg per 100 cm^3, while the blood glucose concentration of person B recovered to normal levels of 80 mg per 100 cm^3. **(comparing end point)**	 [1] [1] [1] [1]
4biii	After 90 minutes, the blood glucose concentration of B gradually decreased from a peak of 100 mg per 100 cm^3 to the normal of 80 mg per 100 cm^3 at 240 minutes. When blood glucose concentration increases above the normal, the islets of Langerhans of the pancreas secrete more insulin into the bloodstream. Insulin stimulates liver and muscle cells to convert excess glucose into glycogen for storage, while also increases uptake of glucose in cells. This causes blood glucose level to return to normal levels.	[1] [1] [1]
5a	The build-up of mucus in the bile and pancreatic ducts may cause blockage, preventing/reducing secretions from the liver and pancreas from reaching the small intestine. Blocking of the bile duct prevents the release of bile into the small intestine. This results in lack of emulsification of fats prior to chemical digestion, which might lead to reduced rate of digestion of fats. Blocking of the pancreatic duct prevents the release of pancreatic enzymes such as amylase, lipase and trypsin (protease) in the small intestine, which might lead to reduced rate of digestion of starch, fats and proteins. (at least 2 enzymes named)	[1] [1] [1]
5bi	Individuals 2 and 3 both do not have cystic fibrosis, while having children with cystic fibrosis (5 and 7) This means that they must be heterozygous, each with only one copy of the recessive allele that causes cystic fibrosis. Or any reasonable explanation	[1] [1]

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5bii	father x mother genotype of parents: aa x Aa gametes: a, a, A, a  genotype of offspring: Aa, aa, Aa, aa phenotype of offspring: no cystic fibrosis, has cystic fibrosis, no cystic fibrosis, has cystic fibrosis probability of having a child with cystic fibrosis – 0.5 or 50%	[1] [1] [1] [1] [1]
6ai	percentage change in mass = (1.11-1.28)/1.28 x 100% = -13.3%	[1] [1]

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6aii	 scale [1], curve [1], axes [1], plot [1]	[4]
6aiii	0.49 mol dm^{-3} (based on graph)	[1]
6b	The cell will likely be turgid. Since the potato cube cell has a lower water potential than the 0.2 mol dm^{-3} sucrose solution, water entered the cell via osmosis.	[1] [1]
6c	Active transport is a process in which energy is required, while the process of osmosis does not require any energy. Active transport involves the movement of any particle, while osmosis only involves the movement of only water molecules. Active transport involves the movement of particles against its concentration gradient, while osmosis involves the movement of particles down a water potential gradient. Max 1m for stating of both definitions without any breakdown in comparisons.	[1] [1] [1]
7ai	producer – **algae** secondary and tertiary consumer - **trout**	[1] [1]
7bi	Insecticides are non-biodegradable and accumulate in fatty tissues of organisms that consume it over time. At low concentrations, the insecticides are not as harmful to the organisms.	[1]

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	They are passed down the food chain, with the concentration of insecticides increasing every trophic level, becoming highly concentrated in the bodies of the final consumers such as the herons and kingfishers At such concentrations, they become deadly to the birds, causing them to die and leading to population decreases.	[1] [1]
7bii	The populations of trout are expected to increase greatly due to the lack of predators that control their population. The populations of caddisfly are expected to drop sharply due to predation by an increased population of trout Furthermore, as mayfly are also consumed by trout, the food supply of caddisfly will be further limited, leading to further stress on caddisfly population.	[1] [1] [1]
8a	contains genetic material – **C and D** present in plant cells – **A and B**	[1] [1]
8bi	asexual reproduction	[1]
8bii	The antibiotic resistance gene is isolated cut with a restriction enzyme. A plasmid is removed from a bacterium and is cut with the same restriction enzyme. The sticky ends produced are complementary to those of the antibiotic resistance gene. The antibiotic resistance gene and the cut plasmid bind by complementary base pairing between their sticky ends. DNA ligase seals the gene to the plasmid, forming a recombinant plasmid. The recombinant plasmid is inserted into bacterial cells, producing transgenic bacteria. The transgenic bacteria are then used to infect plant cells, which are subsequently cultured to produce genetically modified plants with the antibiotic resistance.	[1] [1] [1] [1] [1]
8biii	New proteins in genetically modified plants may cause allergies or harm to us, resulting in health complications. The genes coding for antibiotic resistance may accidentally be transferred into pathogenic bacteria, resulting in future difficulties in treating diseases.	[1] [1]
9a	Transpiration is the loss of water vapour from the aerial parts of a plant, mainly through the stomata of the leaves.	[1]
9b	The waxy and transparent cuticle layer helps to reduce loss of water through evaporation from the outer surfaces of the leaf. The transparent cuticle also allows sunlight to pass through it, so that it can reach the mesophyll cells of the leaf, allowing it to perform photosynthesis. The presence of large numbers of hairs on the inner surface of the leaf helps to trap air/create a humid internal environment.	[1] [1] [1]

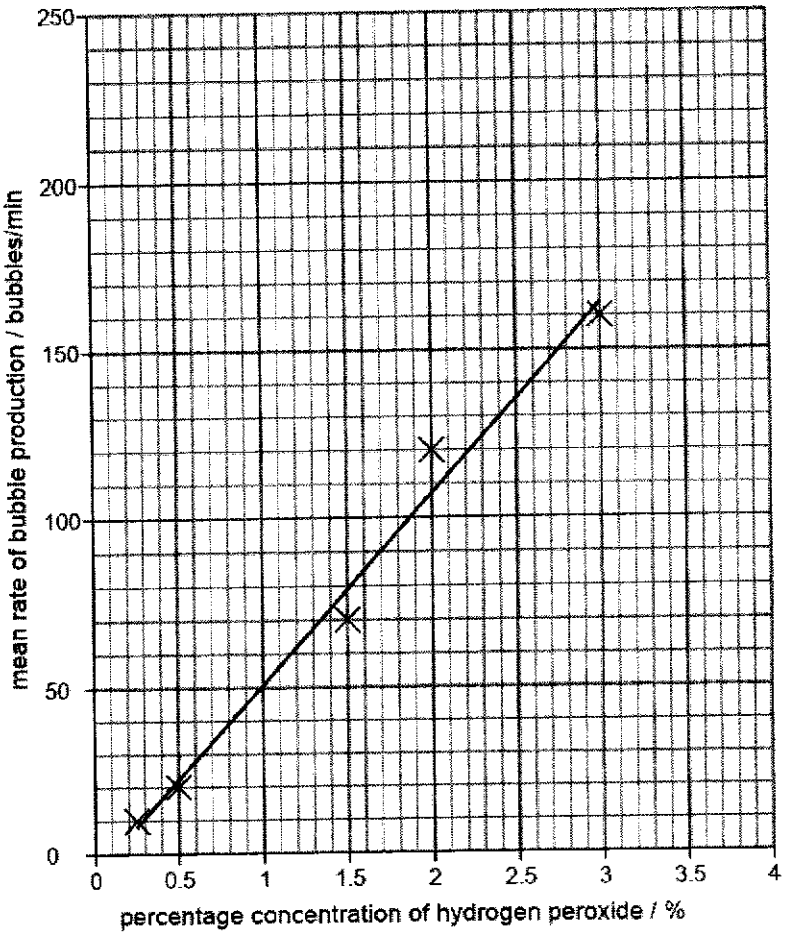
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	reducing the rate of diffusion of water vapour out of the plant via the stomata, lowering rate of transpiration. The curling of the leaf helps to reduce air movement against the inner side of the leaf, lowering rate of transpiration. The curling of the leaf also helps to reduce surface area of the leaf to sunlight, reducing the rate of transpiration and conserving water. OR any other reasonable answer	[1] [1] [1]
9c	Wind-pollination. Any 2 The flower has long (and pendulous) filaments and anthers which protrude out of the flower so that pollen can be blown out of the anther. It also has a stigma which is large and feathery, which can help to trap pollen that is blown in the wind. It has no petals, which are characteristic of wind-pollinated plants	[1] [2]

Paper 3

1a	Catalase is an enzyme with a specific 3D shape and has an active site which only hydrogen peroxide (has a shape that) is complementary to it. Others substances will not have a complementary shape to the active site of catalase, and will not be able to bind and be broken down by the enzyme.	[1] [1]
1b	<table><tr><th rowspan="2">percentage concentration of hydrogen peroxide / %</th><th colspan="3">number of bubbles in 30 sec</th><th rowspan="2">mean rate of bubble production / bubbles/min</th></tr><tr><th>count 1</th><th>count 2</th><th>count 3</th></tr><tr><td>3.0</td><td></td><td></td><td></td><td>160</td></tr><tr><td>2.0</td><td></td><td></td><td></td><td>120</td></tr><tr><td>1.5</td><td></td><td></td><td></td><td>70</td></tr><tr><td>0.5</td><td></td><td></td><td></td><td>20</td></tr><tr><td>0.25</td><td></td><td></td><td></td><td>10</td></tr></table>• Units in table • All recorded numbers (including mean) should be in whole numbers • All three repeats per concentration recorded	[6]

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1c	 Scale [1], line [1], axes [1], plot [1]	[4]
1di	Ensure that each $10cm^3$ syringe was <u>used for only one specific solution</u>, either water, 3% or 10% hydrogen peroxide solution. This ensures that there was <u>no contamination between the solutions</u>, which may have affected the accuracy of the concentrations of tubes 1-5. Ensure the volumes of solution drawn using the syringes were accurate by <u>reading syringe volumes at eye level</u>. This <u>prevents the presence of parallax error</u> and ensures that accurate volumes of solutions were added. Ensure that <u>no air bubbles were present in the syringes</u> when drawing the solutions by <u>making sure that the plunger was fully pressed down before drawing solutions</u>, and that the <u>tip of the syringe was fully submerged in the solution</u>. This ensures the volumes of solution drawn using the syringes were accurate.	Any 2 [2]
1dii	Stirring the yeast suspension <u>ensures that the concentration of yeast is consistent throughout the solution / is homogeneous</u> before adding it to the test-tube, <u>maintaining consistency across all readings</u>.	[1]

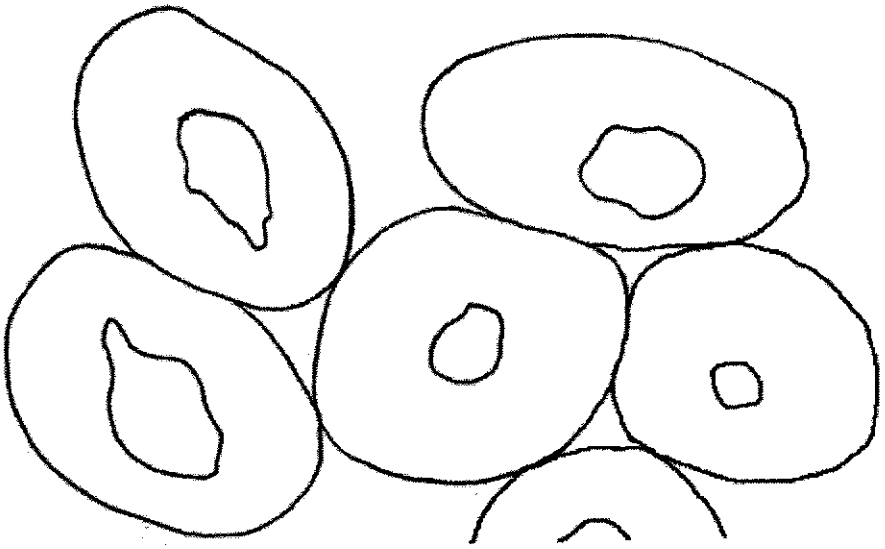
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<table>
<tr><td>1ei</td><td>A clicker/counter can be used for counting bubbles at it helps with accurate tracking the number of bubbles evolved at high concentrations, reducing the risk of human error from manual counting.</td><td>[1]</td></tr>
<tr><td>1eii</td><td>Repeating the investigation helps to account for the variability in the number bubbles produced by the yeast suspension at the same concentration due to minor differences in conditions across repeats. Obtaining an average reading from performing repeats helps to ensure that the results obtained are more reliable</td><td>[1]</td></tr>
<tr><td>1f</td><td>prediction – rate of bubble production will likely gradually decrease over time before eventually reaching zero.

explanation – The concentration of hydrogen peroxide will decrease over time as hydrogen peroxide is broken down by catalase. As substrate concentration decreases, the rate of reaction decreases, leading to decreased rate of bubble production. When all hydrogen peroxide is broken down, bubble production will stop.</td><td>[1]

[1]</td></tr>
<tr><td>1g</td><td>• Transfer 0.5 cm^3 of yeast suspension into the conical flask.
• Add 30 cm^3 of pH 3 buffer solution to the yeast suspension.
• Prepare the experimental setup as shown in Fig. 1.2
• Open the tap to release 10 cm^3 of 1.5% hydrogen peroxide into the conical flask
• Record the volume of gas collected in the syringe after 1 minute (dependent, [1])
• Repeat the above procedures by adding 30 cm^3 of buffer solutions of different pH to the yeast suspension, namely pH 5, pH 7, pH 9, pH 11. (independent, [1])
• Repeat the whole experiment for a total of three times for each pH reading to calculate the mean volume of gas collected per minute (repeats, [1])
• Factors such as concentration of hydrogen peroxide solution, yeast suspension used, and volume of buffer solution should remain constant throughout the experiment. (constants, [1])
• Record the results in a suitable table.
• Plot the results in a graph to show the relationship between pH and mean volume of gas collected per minute.
• The higher the mean volume of gas collected, the higher the activity of catalase. Hence, the optimum pH of yeast is when the volume of gas collected is the highest. (results and analysis, [1])</td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2a</td><td>
<table>
<tr><th>phenotype</th><th>number of fruit flies</th><th>percentage of F_2 offspring</th></tr>
<tr><td>normal wings</td><td><u>47</u></td><td><u>77</u></td></tr>
<tr><td>vestigial wings</td><td><u>14</u></td><td><u>23</u></td></tr>
<tr><td>total</td><td>61</td><td>100</td></tr>
</table>
</td><td>[1] per row</td></tr>
<tr><td>2b</td><td></td><td></td></tr>
</table>

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	<table><tr><td></td><td>A</td><td>a</td></tr><tr><td>A</td><td>AA</td><td>Aa</td></tr><tr><td>a</td><td>Aa</td><td>aa</td></tr></table> genotypic ratio – 1 AA : 2 Aa : 1 aa phenotypic ratio – 3 normal wing : 1 vestigial wing	[1] [1]
2c	The feature investigated had distinct, clear-cut phenotypes, either normal or vestigial wings with no intermediates. The features were also only affected by allele pairing/genotypes of the flies and not by the environment.	[1] [1]
2di	Total males in repeat 1 and 2 – 129+117+31+43=320 Total females in repeat 1 and 2 – 95+94+30+47=266 Ratio = 1.2 : 1	 [1] [1]
2dii	The expected ratio of 1:1 is based on probability as the fusion of gametes is a random process. (Statistically, the observed ratio of offspring becomes closer to the expected ratio when the population of offspring is large.) The population of fruit flies in this investigation is too small to obtain a statistically accurate ratio, hence observed ratios will differ from expected ratios.	[1] [1]
3a	 Size [1], scale [1] accuracy [1], clarity [1]	
3b	Diameter on figure = 30 mm Actual diameter = 30/110 = 0.27 mm	 [1] [1]

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