EXAM PAPERS PRACTICE

Carbohydrates 1

Level: AQA AS 7401
Subject: Biology
Exam Board: Suitable for all boards
Topic: Carbohydrates 1
Type: Questionnaire

To be used by all students preparing for AQA AS Biology 7401 foundation or higher tier but also suitable for students of other boards.

1 Read the following passage.

Human milk contains all the nutrients a young baby needs in exactly the right proportions. It is formed in the mammary glands by small groups of milk-producing cells. These cells absorb substances from the blood and use them to synthesise the lipids, carbohydrates and proteins found in milk. Milk-producing cells are roughly cube-shaped and have a height to breadth ratio of approximately 1.2 : 1.

The main carbohydrate in milk is lactose. Lactose is a disaccharide formed by the condensation of two monosaccharides, glucose and galactose. (A molecule of galactose has the same formula as a molecule of glucose – the atoms are just arranged in a different way.)

Lactose is synthesised in the Golgi apparatus and transported in vesicles through the cytoplasm. Because lactose is unable to escape from these vesicles, they increase in diameter as they move towards the plasma membrane. The vesicle membranes fuse with the plasma membrane and the vesicles empty their contents out of the cell.

Use the information from the passage and your own knowledge to answer the following questions.

(a) (i) The breadth of a milk-producing cell is 26 µm. Calculate the height of this cell.

Height = _____ µm

(1)

(ii) Describe and explain how you would expect the height to breadth ratio of an epithelial cell from a lung alveolus to differ from the height to breadth ratio of a milk-producing cell.

_____

_____

_____

_____

(2)

(b) How many oxygen atoms are there in a molecule of

(i) galactose;

_____

(1)

(ii) lactose?

_____

(1)

(c) The lactose-containing vesicles increase in diameter as they move towards the plasma membrane of the milk-producing cell (lines 11-12). Use your knowledge of water potential to explain why.

(2)

(d) Suggest **one** advantage of milk-producing cells containing large numbers of mitochondria.

(2)

(e) Some substances pass through the plasma membrane of a milk-producing cell by diffusion. Describe the structure of a plasma membrane and explain how different substances are able to pass through the membrane by diffusion.

(6)

(Total 15 marks)

2 (a) Name the monomers from which a maltose molecule is made.

_____

(1)

(b) Name the type of chemical bond that joins the **two** monomers to form maltose.

_____

(1)

A student wanted to produce a dilution series of a maltose solution so he could plot a calibration curve. He had a stock solution of maltose of concentration 0.6 mol dm^{-3} and distilled water. He made a series of dilutions from 0.1 to 0.6 mol dm^{-3}.

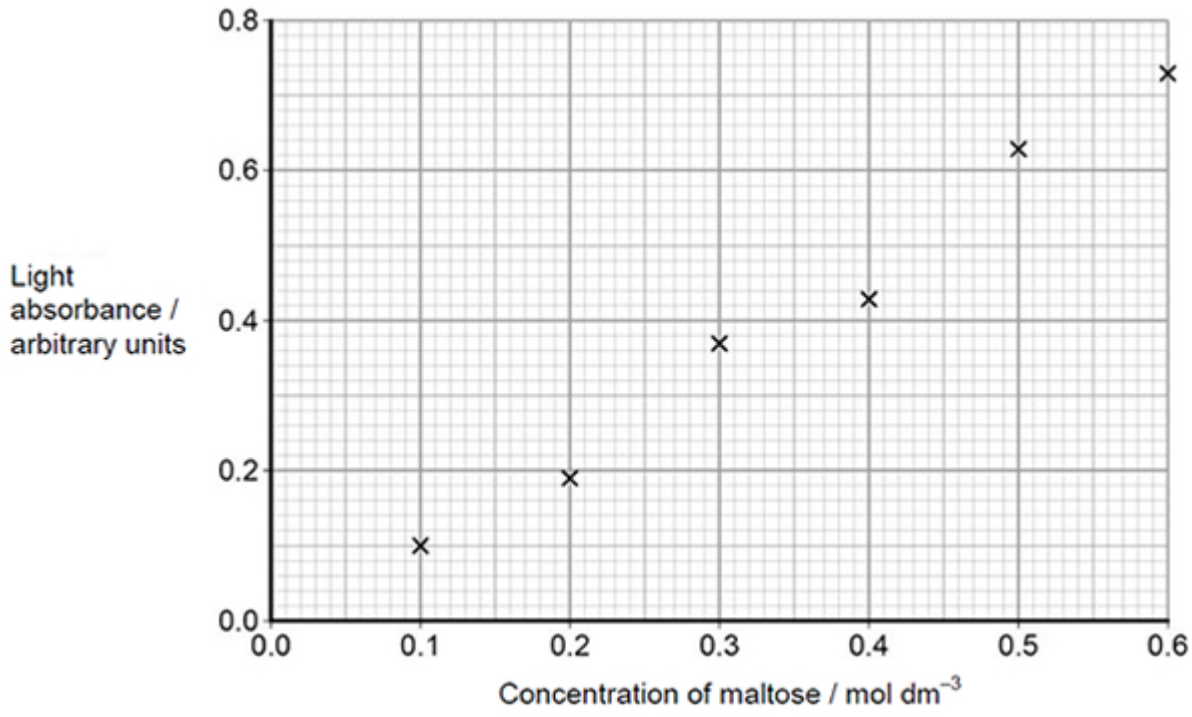
(c) Complete the table below by giving all headings, units and the concentration of the maltose solution produced.

Concentration of maltose solution / _____	**Volume of 0.6 mol dm^{-3} maltose solution / cm^3**	**_____ / _____**
_____	5	10

(2)

The student performed the Benedict's test on six maltose solutions ranging from 0.1 mol dm^{-3} to 0.6 mol dm^{-3}. He placed a sample of each solution in a colorimeter and recorded the light absorbance.

His results are shown in the graph below.



(d) Explain how you would use the graph to determine the maltose concentration with a light absorbance of 0.45 arbitrary units.

(2)

(Total 6 marks)

3 A student investigated the effect of chewing on the digestion of starch in cooked wheat.

He devised a laboratory model of starch digestion in the human gut. This is the method he used.

1. Volunteers chewed cooked wheat for a set time. The wheat had been cooked in boiling water.
2. This chewed wheat was mixed with water, hydrochloric acid and a protein-digesting enzyme and left at 37 °C for 30 minutes.
3. A buffer was then added to bring the pH to 6.0 and pancreatic amylase was added. This mixture was then left at 37 °C for 120 minutes.
4. Samples of the mixture were removed at 0, 10, 20, 40, 60 and 120 minutes, and the concentration of reducing sugar in each sample was measured.
5. Control experiments were carried out using cooked wheat that had been chopped up in a blender, not chewed.

(a) What reducing sugar, or sugars, would you expect to be produced during chewing? Give a reason for your answer.

(2)

(b) In this model of digestion in the human gut, what other enzyme is required for the complete digestion of starch?

(1)

(c) What was the purpose of step 2, in which samples were mixed with water, hydrochloric acid and pepsin?

_____

_____

(1)

(d) In the control experiments, cooked wheat was chopped up to copy the effect of chewing.

Suggest a more appropriate control experiment. Explain your suggestion.

_____

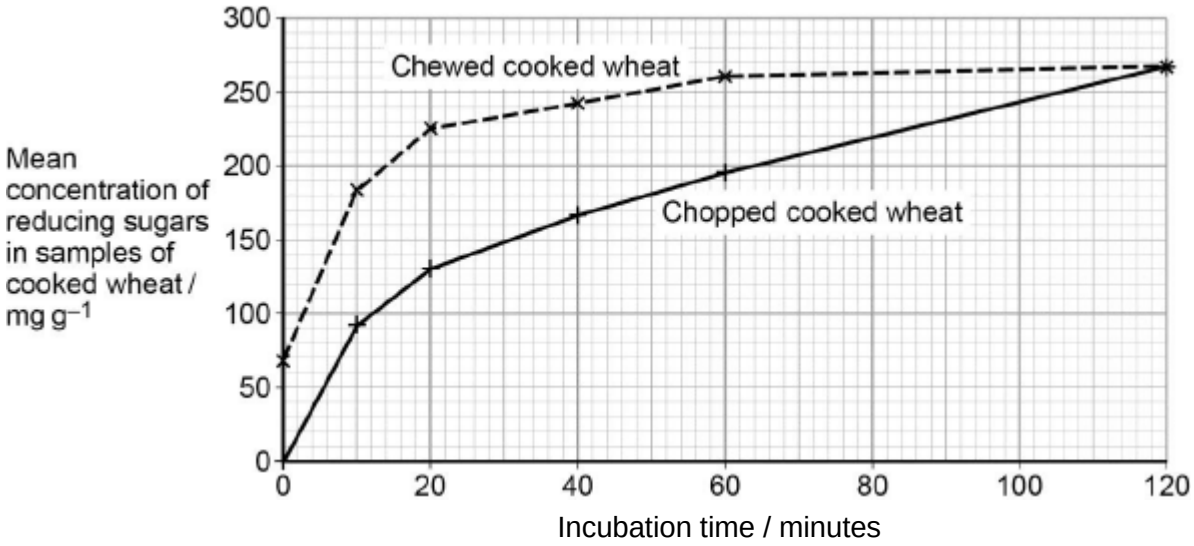
_____

_____

_____

(2)

(e) The figure below shows the student's results.



Explain what these results suggest about the effect of chewing on the digestion of starch in wheat.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

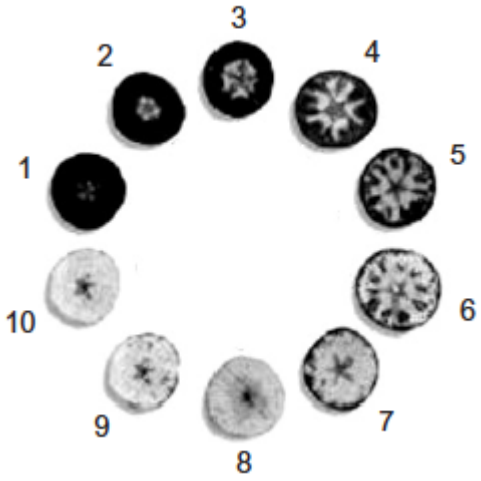
4 Apple farmers want to harvest their fruit when it is ripe enough for eating but also when it can be stored to sell later.

One method apple farmers use to decide when to harvest their fruit is to determine the starch content. As apples ripen, starch in the apple is converted into soluble sugars that make them taste sweet.

Scientists investigated the best time to harvest apples for storage before being sold.

To determine the starch content, they picked samples of apples. They cut each apple in half and covered the cut surface with iodine solution. They left it for 1 minute and then compared it with the diagram below to give it a starch index score between 1 and 10.

Figure 1

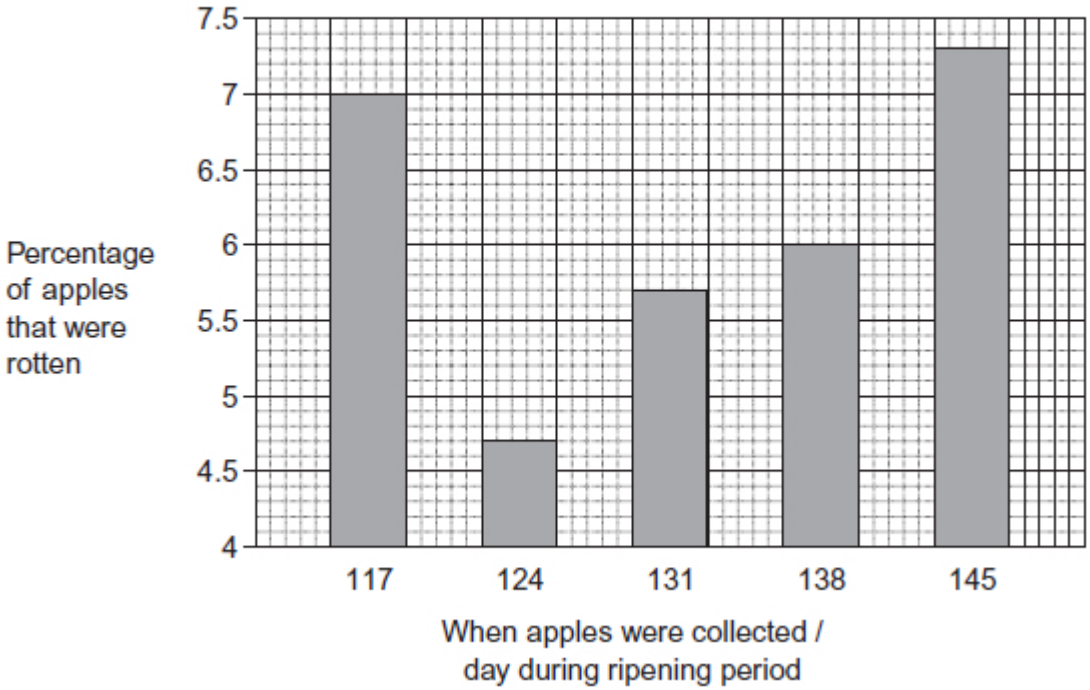


They collected samples of apples at 5 different days during the ripening period and tested them for starch content. These results are shown in the table below.

When apples were collected / day during ripening period	Mean starch index
117	3.7
124	4.4
131	6.3
138	7.7
145	8.2

The scientists stored samples of apples from each collection day for 180 days. They then determined the percentage of apples that were rotten. These results are shown in the graph below.

Figure 2



(a) The cut surface of the apple covered with iodine solution is left for 1 minute before being compared to **Figure 1**.
Explain why each apple must be left for the same length of time.

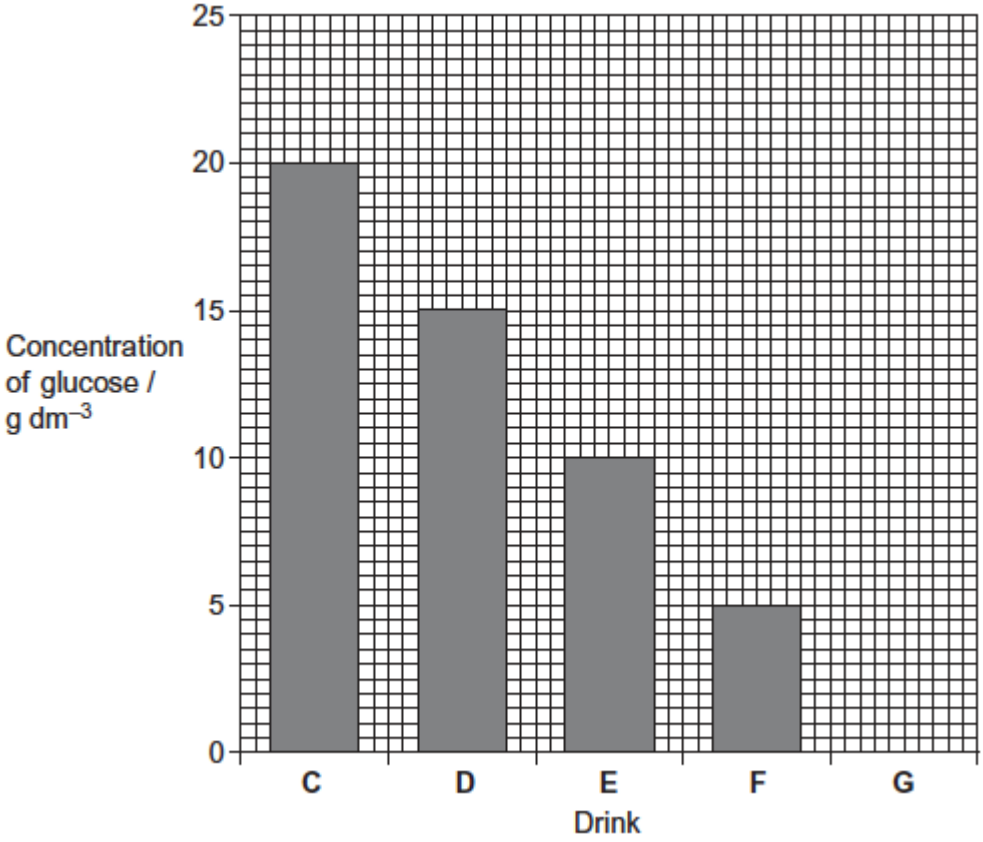
(2)

(b) Describe and explain the change in appearance of the cut surface of the apple when treated with iodine solution from underripe (starch index 1) to overripe (starch index 10).

(3)

(Total 5 marks)

5 A student investigated the glucose concentration in five different drinks.
His results are shown below.



(a) Using the data, calculate how many grams of glucose would be in 220 cm^3 of drink **F**.

Answer = _____ g

(1)

(b) Calculate how much more glucose is in drink **C** than in drink **F**. Show your answer as a percentage.

Answer = _____ %

(1)

(Total 2 marks)

6 Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

Scientists investigated the effect of a sports drink on the performance of runners in 5 km races. They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

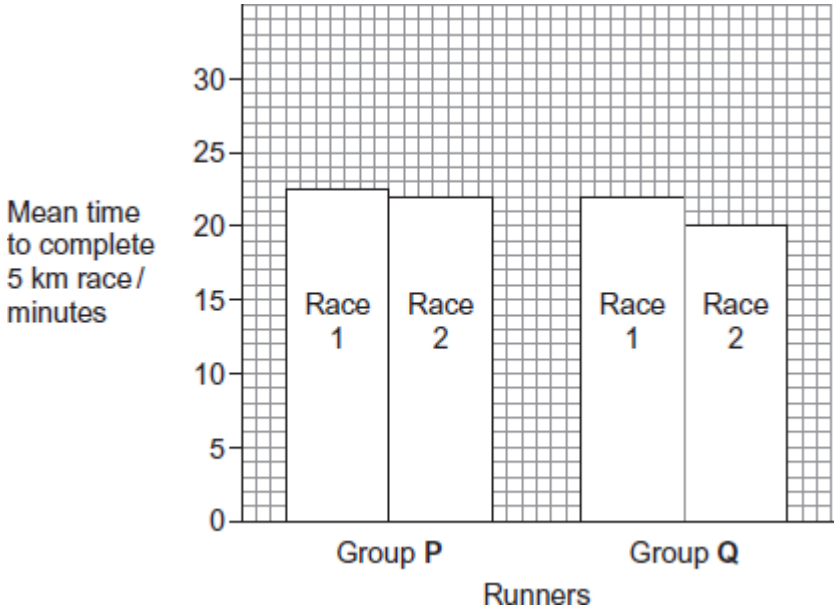
The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

- group **P** had water available
- group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

Figure 1 shows their results.

Figure 1

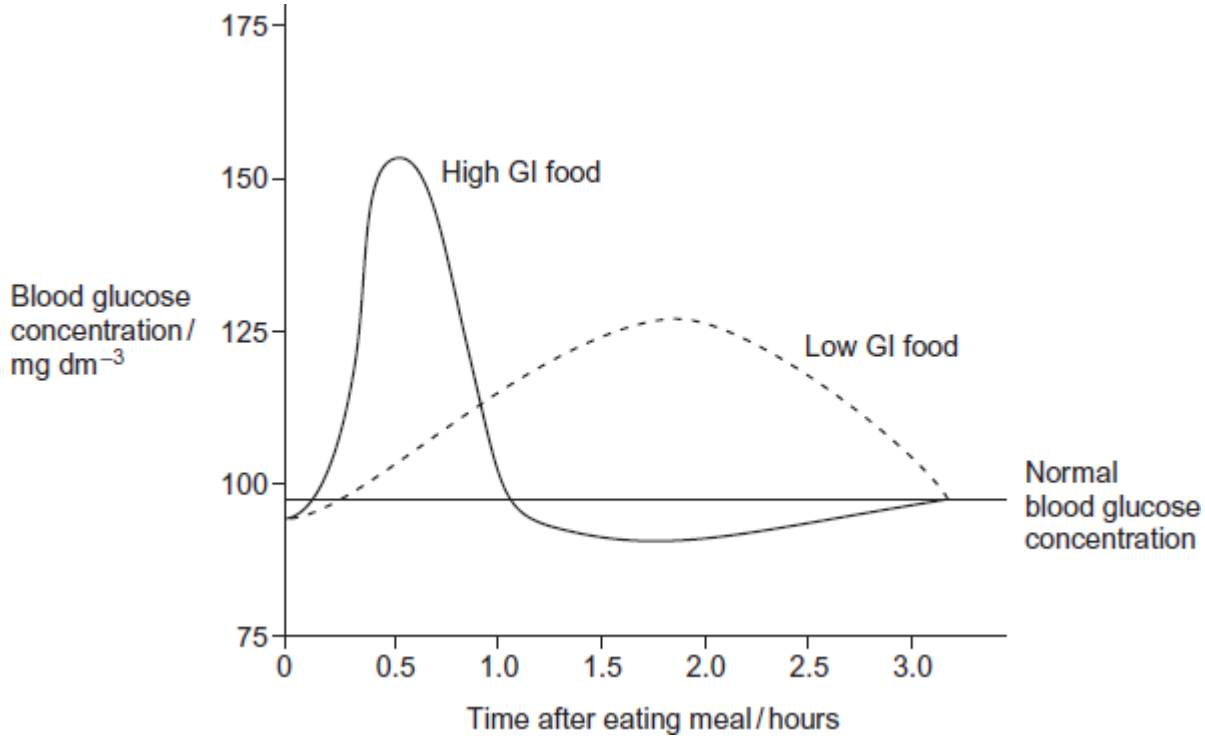


The glycaemic index (GI) is a measure of the increase in blood glucose concentration after eating a given mass of a food compared with eating the same mass of pure glucose. The GI of pure glucose has a value of 100.

The GI of a food depends on several factors such as how much starch and sugars it contains. High GI foods include those containing lots of simple sugars or white flour. The carbohydrates in these foods are rapidly digested and absorbed. Low GI foods include wholegrain bread and breakfast cereals that contain a lot of fibre. The carbohydrates in these foods are digested and absorbed more slowly.

Figure 2 shows changes in blood glucose concentration after eating meals of high GI food and meals of low GI food.

Figure 2



Explain how a sports drink could provide an energy boost when running.

(Extra space)

(3)

(Total 3 marks)

7 Read the following passage.

Some insect species feed on the leaves of plants. These leaf-chewers bite off pieces of leaves. Other insect species feed on sap from phloem or xylem. These sap-feeders have sharp, piercing mouthparts that they insert directly into either xylem or phloem. Leaf-chewers and insects that feed on xylem sap are active feeders; this means they use their jaw muscles to obtain their food. In contrast, insects that feed on phloem sap are passive feeders; this means they do not use their jaw muscles to take up sap from phloem.

Feeding on phloem sap presents two problems. Firstly, phloem sap has sa high sugar concentration. This could lead to a high pressure of liquid in the insect's gut because of water entering the gut from the insect's body tissues. A phloem-sap-feeder polymerises some of these sugars into polysaccharides which are passed out of its anus as 'honey dew'. The second< >problem is that phloem sap has a low concentration of amino acids. Phloem-sap-feeding insects rely on bacteria in their guts to produce amino acids. Each phloem-sap-feeding insect receives a few of these bacteria from its parent. This has resulted in a reduction in the genetic diversity of the bacteria found within these insects.

A scientist investigated the effect of three different insects on the growth of a plant called the goldenrod. He found that leaf-chewing insects and xylem-sap-feeding insects caused a much greater reduction in total leaf area than did phloem-sap-feeding insects.

Use the information from the passage and your own knowledge to answer the following questions.

(a) Phloem-sap-feeders are passive feeders (lines 6–7).
Phloem-sap-feeders do not use their jaw muscles to take up sap from phloem.

Explain why they can take up sap without using their jaw muscles.

(3)

(b) A phloem-sap-feeder polymerises some of these sugars into polysaccharides (line 12-13). Suggest the advantage of this.

(2)

(c) Each phloem-sap-feeding insect receives a few of these bacteria from its parent. (lines 16–17).

Suggest how this has caused a reduction in genetic diversity of the bacteria.

(2)

(d) A scientist found that leaf-chewers and xylem-sap-feeders had a greater effect on plant growth than phloem-sap-feeders (lines 20–22).

Other than environmental factors, give **two** features the scientist would have controlled in his experiment to ensure this conclusion was valid.

1.

2.

(2)

(e) The scientist used the reduction in total leaf area of the experimental plants as an indicator of plant growth.

Outline a method by which you could find the area of a plant leaf.

_____

_____

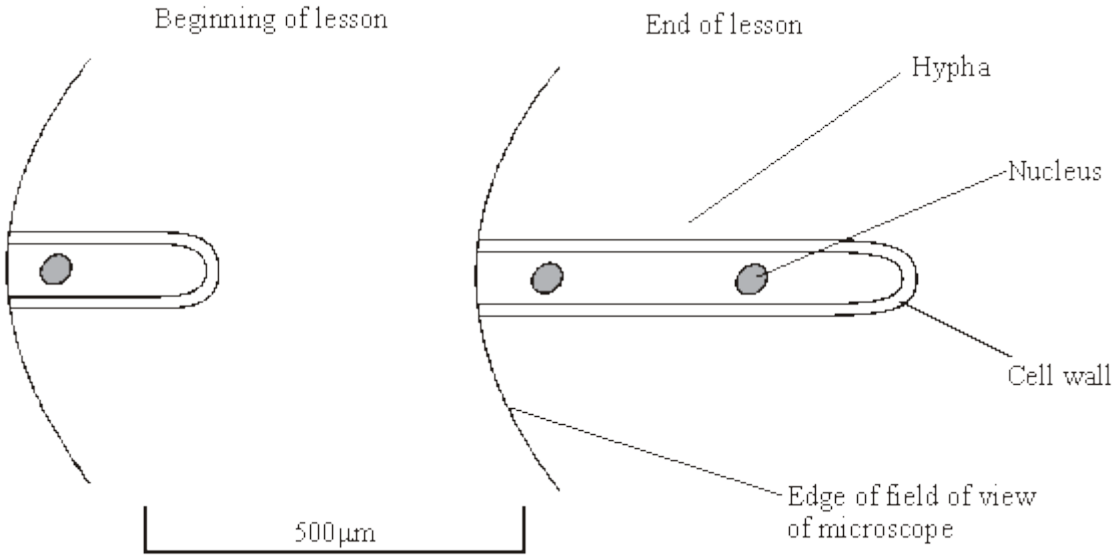
_____

(1)

(Total 10 marks)

8 Moulds belong to a group of organisms called fungi. When mould is examined with a microscope it is seen to consist of long, colourless threads called hyphae.

A student investigated the growth of fungal hyphae. The diagram shows part of a hypha seen under a microscope at the beginning of a lesson and again at the end of the lesson.



(a) Give **one** piece of evidence from the diagram that fungi are eukaryotic.

_____

_____

(1)

(b) (i) By how much had the hypha grown during the lesson? Show your working.

Answer: _____ µm

(2)

(ii) Explain how you could use your answer to calculate the rate of growth of this hypha.

_____

_____

(1)

(c) Under the microscope, small granules were seen in the hypha. Describe how you could show that these granules consisted of starch.

_____

_____

_____

_____

(2)

(Total 6 marks)

9 Read the following passage.

Straw consists of three main organic substances – cellulose, hemicellulose and lignin. Cellulose molecules form chains which pack together into fibres. Hemicellulose is a small molecule formed mainly from five-carbon (pentose) sugar monomers. It acts as a cement holding cellulose fibres together. Like hemicellulose, lignin is a polymer, but it is not a carbohydrate. It covers the cellulose in the cell wall and supplies additional strength. In addition to these three substances, there are small amounts of other biologically important polymers present.

The other main component of straw is water. Water content is variable but may be determined by heating a known mass of straw at between 80 and 90°C until it reaches a constant mass. The loss in mass is the water content.

Since straw is plentiful, it is possible that it could be used for the production of a range of organic substances. The first step is the conversion of cellulose to glucose. It has been suggested that an enzyme could be used for this process. There is a difficulty here, however. The lignin which covers the cellulose protects the cellulose from enzyme attack.

Use information from the passage and your own knowledge to answer the following questions.

(a) (i) Give **one** way in which the structure of a hemicellulose molecule is similar to the structure of a cellulose molecule.

_____

_____

(1)

(ii) Complete the table to show **two** ways in which the structure of a hemicellulose molecule differs from the structure of a cellulose molecule.

Hemicellulose	Cellulose
_____ _____	_____ _____
_____ _____	_____ _____

(2)

(b) Name **one** biologically important polymer, other than those mentioned in the passage, which would be found in straw.

_____

(1)

(c) Explain why the following steps were necessary in finding the water content of straw:

(i) heating the straw *until it reaches constant mass* (line 9);

_____

_____

_____

(1)

(ii) not heating the straw above 90°C (line 9).

_____

_____

_____

_____

(2)

(d) A covering of lignin protects cellulose from enzyme attack (line 14). Use your knowledge of the way in which enzymes work to explain why cellulose-digesting enzymes do not digest lignin.

(2)

(e) Describe the structure of a cellulose molecule and explain how cellulose is adapted for its function in cells.

(6)

(Total 15 marks)

10 (a) Describe how you would test a sample of food for the presence of starch.

(2)

(b) The concentration of glucose in the blood rises after eating a meal containing carbohydrates.

The rise is slower if the carbohydrate is starch rather than sucrose. Explain why.

(Extra space)

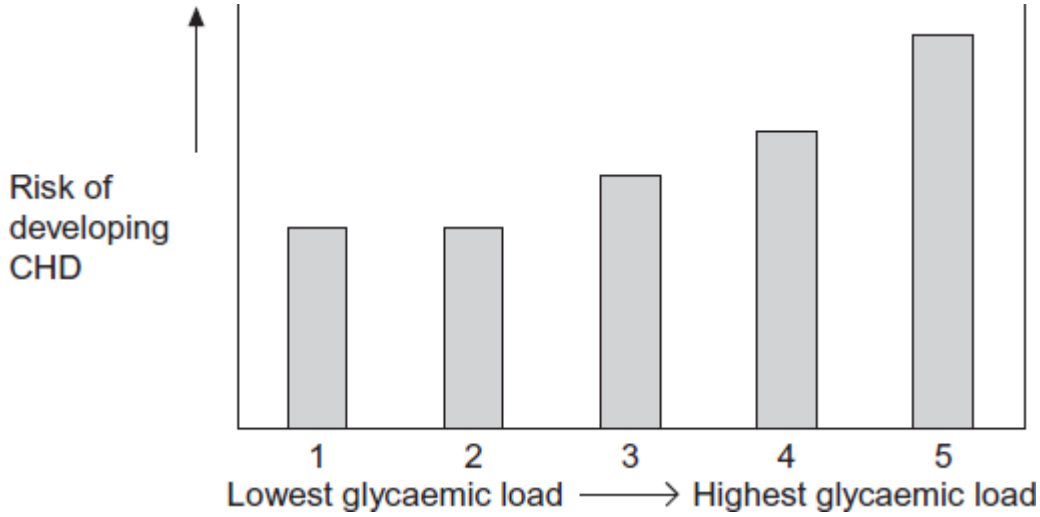
(3)

The glycaemic load (GL) of a diet is a measure of how much digestible carbohydrate it contains. The higher the GL of a diet the more quickly it raises the blood glucose concentration after a meal. A diet with a high GL also increases the concentration of harmful lipids in the blood.

Scientists investigated the relationship between diets with different glycaemic loads and the risk of developing coronary heart disease (CHD) in women.

The scientists determined the glycaemic loads of the diets of a large number of women. They then divided the women into 5 groups. Group 1 had diets with the lowest glycaemic load and group 5 had diets with the highest glycaemic load. The scientists determined the risk of developing CHD in each group.

The graph shows their results.



(c) The scientists excluded women who smoked from the study. Explain why.

_____

_____

_____

(1)

(d) (i) What do these data show about the effect that glycaemic load of the diet has on the risk of developing CHD?

_____

_____

_____

(1)

(ii) Use the information provided to explain the effect that glycaemic load of the diet has on the risk of developing CHD.

_____

_____

_____

_____

(2)

(Total 9 marks)

11 Doctors compared two tests for lactase deficiency.

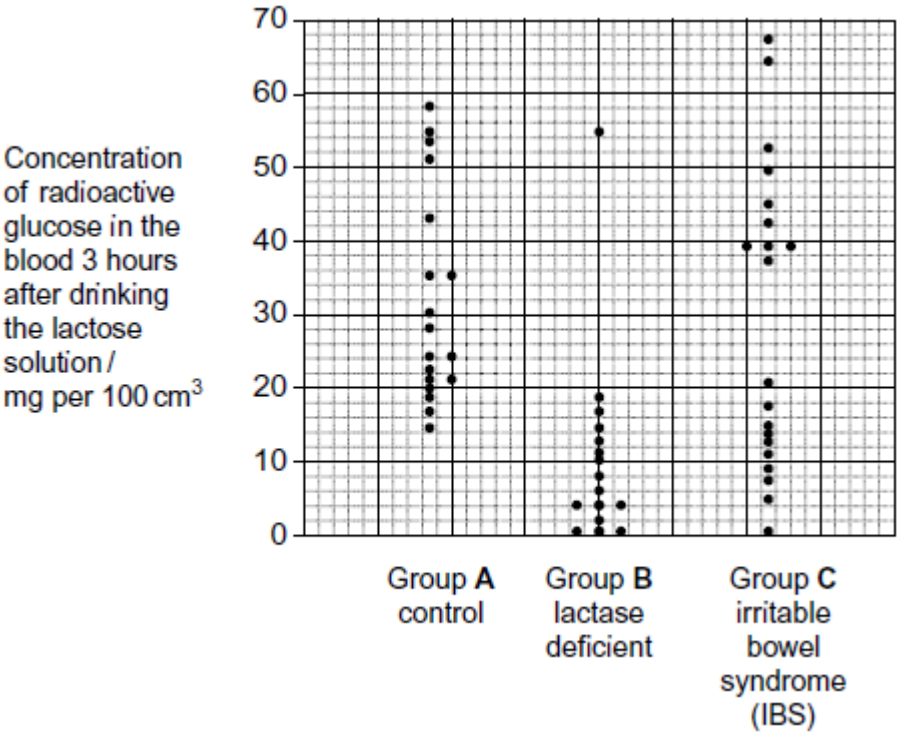
Doctors investigated three groups of people. The people in all three groups were not allowed to eat or drink for 8 hours before the test. They each then drank a solution containing 50 g of lactose made with a radioactive form of carbon called ^{14}C.

- Group **A** were the control group
- Group **B** were lactase deficient
- Group **C** had irritable bowel syndrome (IBS)

Both lactase deficieny and irritable bowel syndrome have similar symptoms.

The lactose tolerance test

The doctors measured the concentration of radioactive glucose in the blood of each person. The figure below shows the results. Each point shows the result for one person 3 hours after drinking the lactose solution.



(a) (i) Give the range of results for the control group (group **A**)

_____

(1)

(ii) Each person in the control group was given 50 g of lactose containing the same amount of radioactive carbon. All the products of lactose digestion were absorbed into their blood. The concentration of glucose was measured in mg per 100 cm^3 of blood.

Explain why the variation in the results may be due to differences in body mass.

_____

_____

_____

_____

(2)

(b) In the test the doctors obtained different results for the three groups.

Would this test be useful to identify people who were lactase deficient? Use the data from all three groups to explain your answer.

(Extra space)

(3)

(Total 6 marks)

12 Doctors compared two tests for lactase deficiency.

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- Group **A** were the control group
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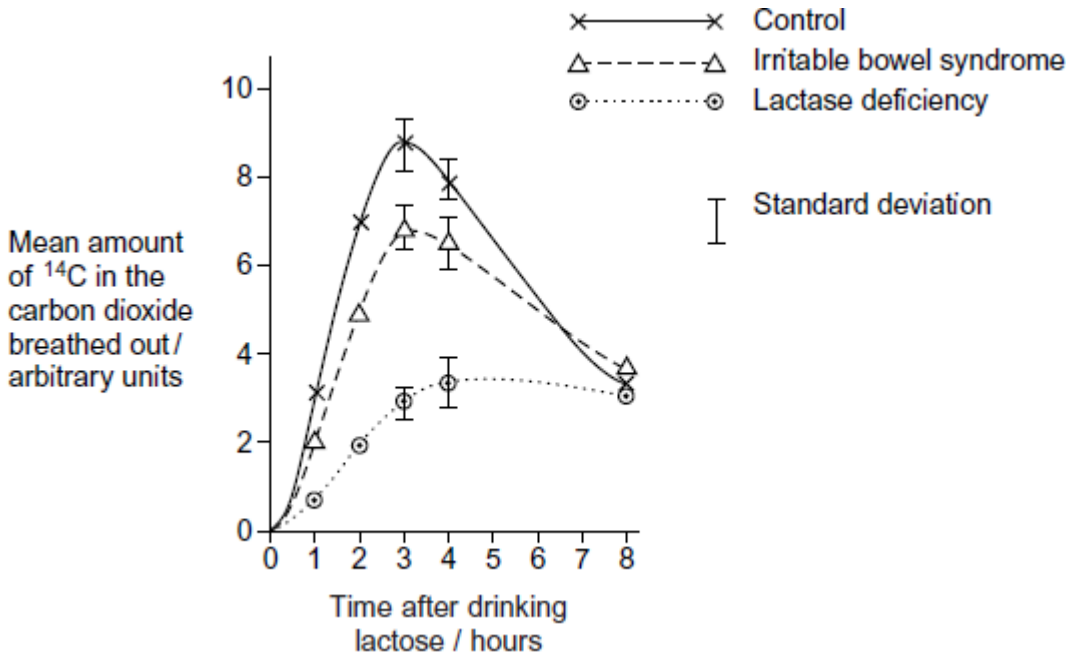
- Group **C** had irritable bowel syndrome (IBS)

Both lactase deficieny and irritable bowel syndrome have similar symptoms.

The carbon dioxide breath test

In this test the doctors measured the amount of ^{14}C in the carbon dioxide breathed out. The doctors took measurements at intervals for 8 hours after each volunteer had drunk the lactose solution. The following figure shows the mean results for each group.



(a) Describe the common trend shown by **all** the curves in the figure.

_____

_____

_____

(1)

(b) Explain why the doctors stopped measuring the amounts of ^{14}C in the carbon dioxide breathed out after 8 hours.

_____

_____

_____

_____

(2)

(c) Carbon dioxide in the breath contained the radioactive form of carbon, ^{14}C. Explain how ^{14}C in carbon dioxide came from ^{14}C in glucose in the blood.

(2)

(d) The doctors concluded that measuring the amount of ^{14}C in the carbon dioxide in the breath after 3 hours was a better way of diagnosing lactase deficiency than the lactose tolerance test. Do you agree with the doctors' conclusion? Give the reasons for your answer.

(2)

(Total 7 marks)

13 Some people are lactose intolerant. The lactose in milk and milk products, such as cheese, causes digestive discomfort in these people.
Scientists gave 159 adult volunteers, who had dia gnosed themselves as lactose intolerant, a questionnaire to complete. The volunteers were asked,

- do you eat the food?
- if you eat the food, do you feel discomfor t after eating it?

The results are shown in the table.

Food	**Typical lactose content / g per serving**	**Percentage of people who**			
		A do not eat the food	**B** feel discomfort after eating the food	**C (= A + B)** do not eat the food or feel discomfort after eating the food	**D** feel no discomfort after eating the food
Hard cheese	1.2	11.1	39.9	51.0	49.0
Pizza	3.0	10.4	57.8	68.2	31.8
Soft cheese	3.6	25.1	53.0	78.1	21.9
Ice cream	6.0	14.6	68.2	82.8	17.2
Milk	9.9	27.0	67.1	94.1	5.9

(a) The scientists investigated the relationship between the lactose content of the food and the amount of digestive discomfort.

(i) The figures in columns **A** and **B** were used to produce those in column **C**.
The scientists used column **C** rather than column **B** in their analysis. Suggest why.

_____

_____

(1)

(ii) Describe the relationship between the lactose content of the food and the data in column **C**.

_____

_____

(1)

(iii) The scientists could **not** conclude that the discomfort was caused by the increase in lactose content of the food. Explain why.

_____

_____

_____

_____

_____

(2)

(b) Suggest **two** reasons why the data in this table may be unreliable.

1. _____

_____

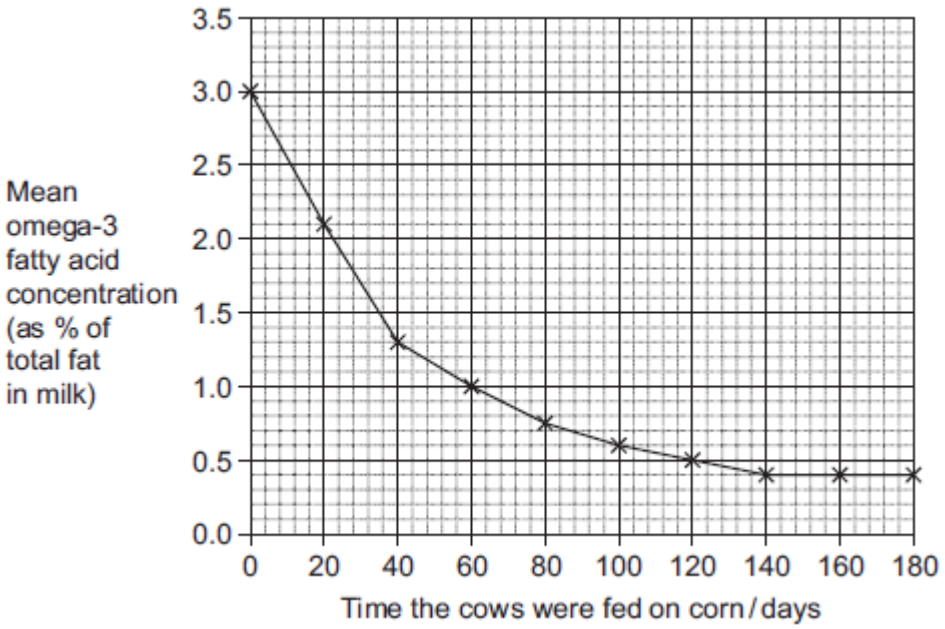
2. _____

_____

(2)

(Total 6 marks)

14 Omega-3 fatty acids are found in cows' milk. Scientists investigated changes in the concentration of omega-3 fatty acids in milk when cows were moved from eating grass in fields to eating corn in cattle sheds. The following figure shows the results of one investigation.



(a) The concentration of omega-3 fatty acids in milk changed when cows were fed on corn instead of grass. Describe how.

_____

_____

_____

_____

(2)

(b) (i) Calculate the rate of decrease in the mean omega-3 fatty acid concentration between 0 and 40 days.
Show your working.

Answer _____ % per day

(2)

(ii) The omega-3 fatty acid concentration is expressed as a percentage of total fat. Explain the advantage of this.

(2)

(iii) One farmer concluded from the graph that feeding cows on corn reduces the omega-3 fatty acid content in milk. Evaluate this conclusion.

Extra space

(4)

(Total 10 marks)

15 Biologists divided new-born rats randomly into four groups.

They fed the rats in each group on a standard diet which only differed in the carbohydrate content. When these rats were adult, the biologists measured the activity of lactase in the digestive system of the rats. The following table shows the mean results for each group.

Diet	Mean lactase activity / μ mol of lactose digested per hour (± standard deviation)
Low sucrose	57.9 (± 14.5)
High sucrose	184.2 (± 30.8)
Low starch	86.9 (± 13.3)
High starch	221.4 (± 25.4)

(a) Give **one** piece of evidence from the table that indicates lactase activity is affected by diet.

_____

_____

(1)

(b) Some students suggested from these data that increasing starch in the diet was the most effective way to increase lactase activity in lactase deficient people. Is this conclusion valid? Explain your answer.

_____

_____

_____

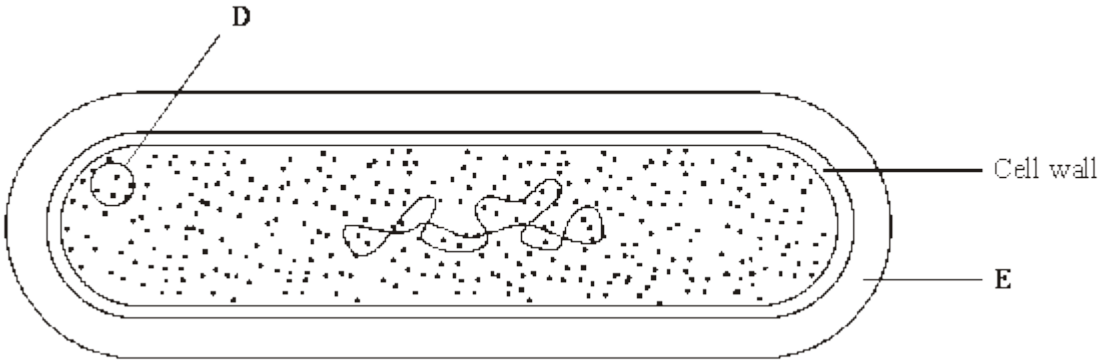
_____

_____

(2)

(Total 3 marks)

16 (a) The diagram shows a bacterial cell.



(i) Name the parts labelled **D** and **E.**

D _____

E _____

(2)

(ii) Give **one** function of the cell wall.

_____

_____

(1)

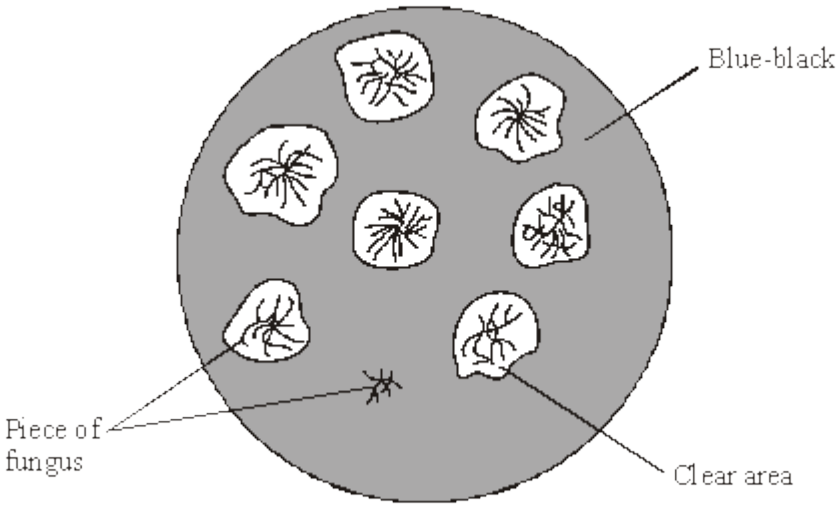
(b) Name **two** structures present in eukaryotic cells that are not present in the cells of prokaryotes.

1. _____

2. _____

(2)

(c) Several small pieces of a saprophytic fungus were placed on a starch agar plate. After 48 hours the iodine solution was poured over the starch agar. The result is shown in the diagram below.



(i) Explain why there is a clear area around most of the pieces of fungus.

_____

_____

_____

_____

(2)

(ii) Suggest why one piece of fungus has no clear area round it.

_____

_____

(1)

(Total 8 marks)

17 (a) Name the substance that muscles use as their immediate energy source.

_____

(1)

(b) Sports scientists investigated the change in energy sources used during exercise.
They measured the percentage of energy obtained from carbohydrate and the percentage of energy obtained from fat in two groups of athletes.

- **Group A** exercised at different intensities for the same time.
- **Group B** exercised at the same intensity for different times.

They calculated the intensity of the exercise as a percentage of VO_2 max.
VO_2 max is the maximum volume of oxygen the athletes can take in per minute.

The results for **Group A** are shown in **Figure 1** and the results for **Group B** are shown in **Figure 2**.

Figure 1

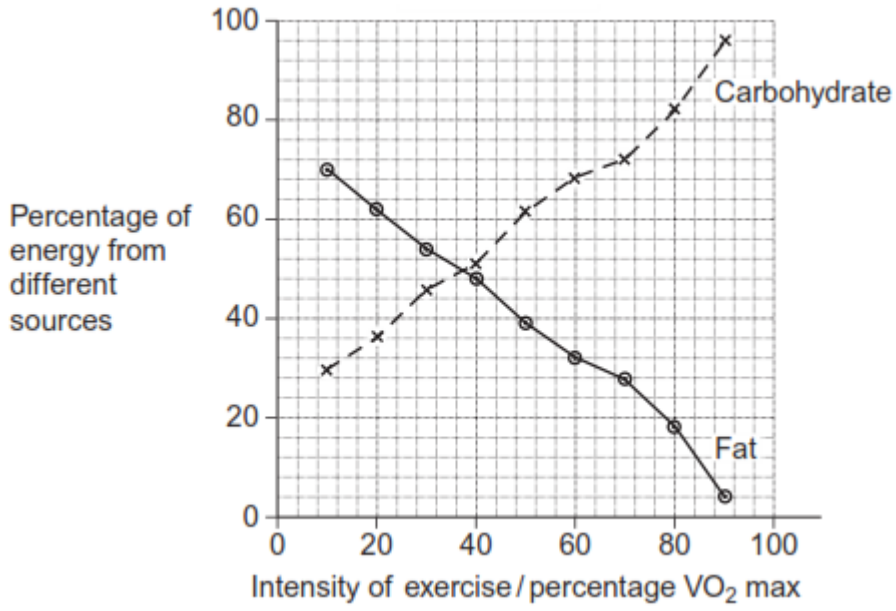
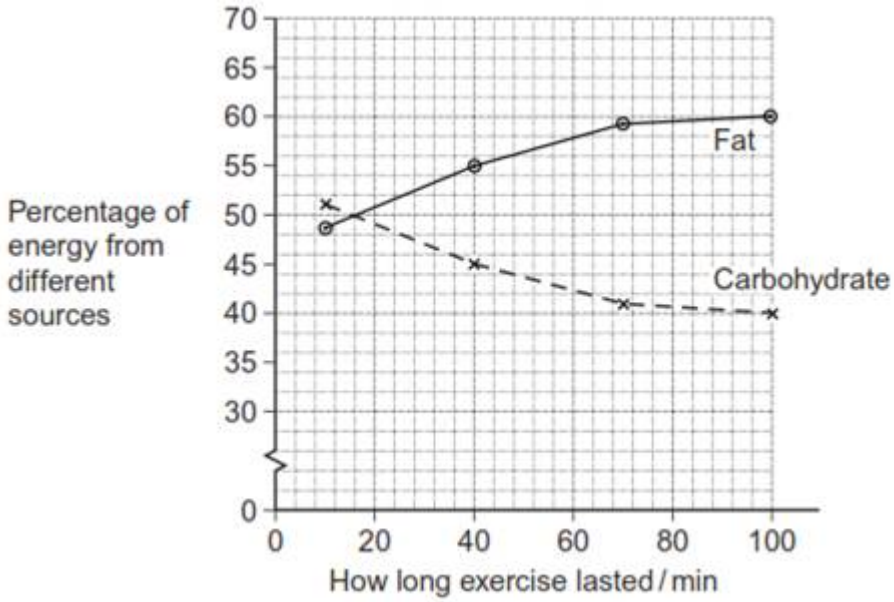


Figure 2



(i) Calculate the ratio of the percentage of energy from carbohydrate to the percentage of energy from fat when the intensity of exercise is 70% VO_2 max. Show your working.

Answer _____

(2)

(ii) A person wishes to lose some body fat by exercising. What sort of exercise would be most effective? Use the information in **Figures 1** and **2** to explain your answer.

(*Extra space*) _____

(3)

(Total 6 marks)

18 (a) Describe how the structures of starch and cellulose molecules are related to their functions.

(5)

(b) Describe the processes involved in the transport of sugars in plant stems.

(5)

(Total 10 marks)

19 (a) In humans, the enzyme maltase breaks down maltose to glucose.
This takes place at normal body temperature.

Explain why maltase:

- only breaks down maltose
- allows this reaction to take place at normal body temperature.

(Extra space)

(5)

(b) Scientists have investigated the effects of competitive and non-competitive inhibitors of the enzyme maltase.

Describe competitive and non-competitive inhibition of an enzyme.

(Extra space) _____

(5)

(Total 10 marks)

20 (a) Describe the role of the enzymes of the digestive system in the complete breakdown of starch.

(5)

(b) Describe the processes involved in the absorption of the products of starch digestion.

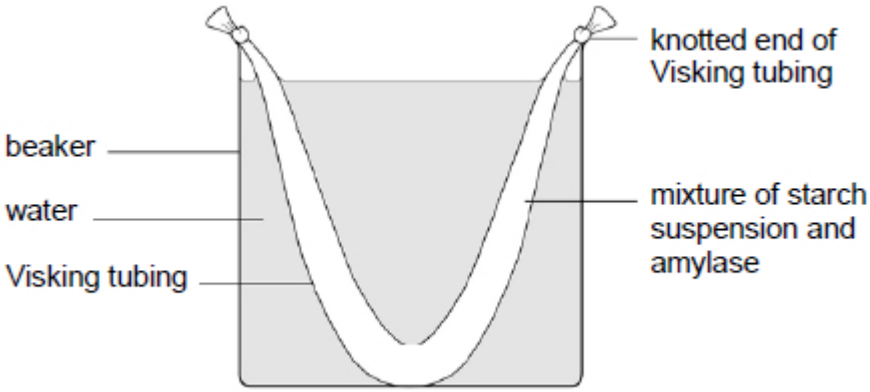
(5)

(Total 10 marks)

21 (a) Cells lining the ileum of mammals absorb the monosaccharide glucose by co-transport with sodium ions. Explain how.

(3)

A student set up the experiment shown in the diagram below.



The material from which Visking tubing is made is partially permeable.

After 15 minutes, the student removed samples from the liquid in the beaker and from the liquid inside the Visking tubing. She carried out biochemical tests on these samples. She drew the table below to record her results.

(b) Complete the table by placing a tick (✓) in each box that you expect to have shown a positive result.

Biochemical test	**Liquid from beaker**	**Liquid inside Visking tubing**
Biuret reagent		
Iodine in potassium iodide		
Benedict's solution		

(3)

(c) Justify your answers to part **(b)**.

(3)

(Total 9 marks)

22 (a) Describe the induced-fit model of enzyme action.

_____

_____

_____

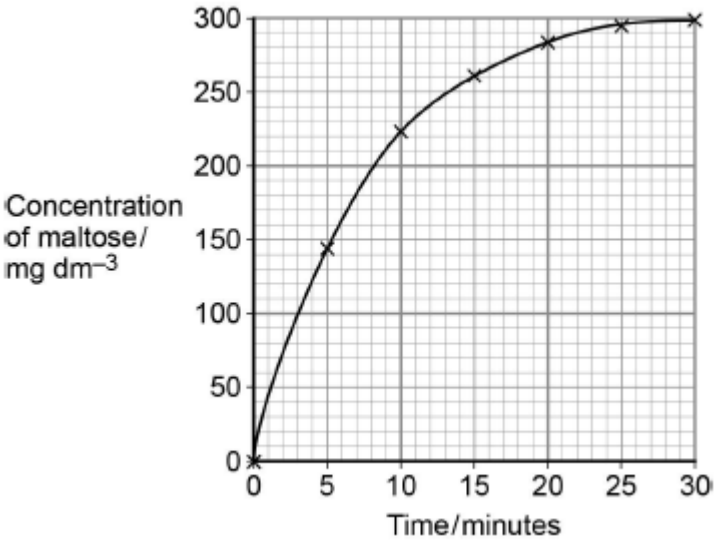
_____

_____

(2)

(b) A scientist investigated the hydrolysis of starch.
He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Determine the rate of the reaction **at** 10 minutes.
Show how you obtained your answer.

Rate of reaction _____ mg dm^{-3} min^{-1}

(2)

(c) Explain the results shown in the graph.

(2)

(d) A quantitative Benedict's test produces a colour whose intensity depends on the concentration of reducing sugar in a solution. A colorimeter can be used to measure the intensity of this colour.

The scientist used quantitative Benedict's tests to produce a calibration curve of colorimeter reading against concentration of maltose.

Describe how the scientist would have produced the calibration curve and used it to obtain the results in the graph.

Do **not** include details of how to perform a Benedict's test in your answer.

(3)

(Total 9 marks)

23 (a) Starch and protein are biologically important polymers.

(i) Explain what is meant by a polymer.

_____

_____

(1)

(ii) Give **one** example of a biologically important polymer other than starch or protein.

_____

(1)

(b) In an investigation, the enzyme amylase was mixed in a test tube with a buffer solution and a suspension of starch. The amylase broke down the starch to maltose. When all the starch had been broken down, a sample was removed from the test tube and tested with biuret reagent.

(i) Explain why a buffer solution was added to the amylase-starch mixture.

_____

_____

_____

(2)

(ii) What colour would you expect the sample to go when tested with biuret reagent?

_____

(1)

(iii) Give an explanation for your answer to part (ii)

_____

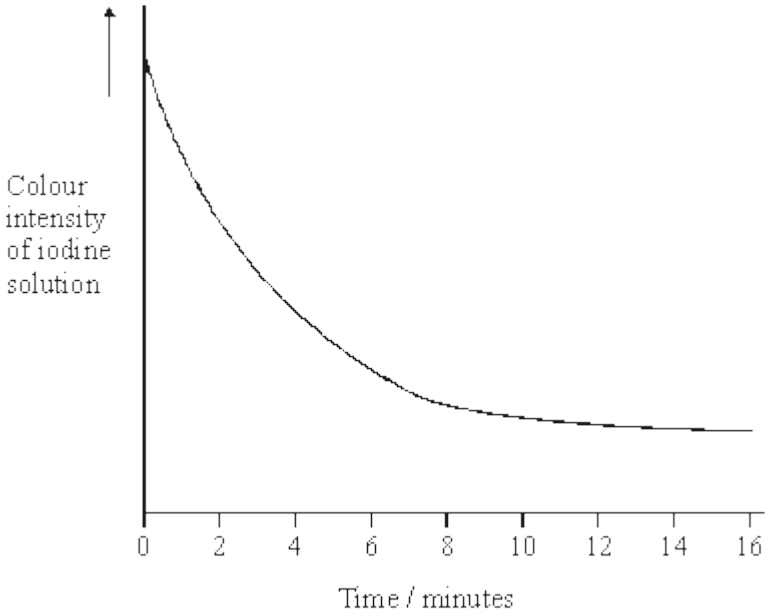
_____

_____

(2)

(Total 7 marks)

24 In an investigation into carbohydrase activity, the contents from part of the gut of a small animal were collected. The contents were added to starch solution at pH 7 and kept in a water bath at 25°C. At one-minute intervals, samples were removed and added to different test tubes containing dilute iodine solution. The colour intensity of each sample was determined. The graph shows the results.



(a) Explain the change in colour intensity.

_____

_____

_____

_____

(2)

(b) Draw clearly labelled curves on the graph to show the expected result if the experiment was repeated

(i) at 35 °C;

(ii) at pH 2.

(2)

(c) Explain how

(i) raising the temperature to 35 °C affects carbohydrase activity;

(ii) decreasing the pH affects carbohydrase activity.

(7)

(Total 11 marks)

25 **S** In an investigation, the effects of caffeine on performance during exercise were measured. One group of athletes (**A**) was given a drink of decaffeinated coffee. Another group (**B**) was given a drink of decaffeinated coffee with caffeine added. One hour later the athletes started riding an exercise bike and continued until too exhausted to carry on. Three days later the same athletes repeated the experiment, with the drinks exchanged.

(a) (i) The researchers added caffeine to decaffeinated coffee. Explain why they did not just use normal coffee.

_____

_____

(1)

(ii) The performance of the athletes might have been influenced by how they expected the caffeine to affect them. How could the researchers avoid this possibility?

_____

_____

(1)

During the exercise the concentrations of glycerol and fatty acids in the blood plasma were measured. The results are shown in the table.

Drink	Mean time to exhaustion /minutes	Mean concentration of blood glycerol/ mmol dm^{-3}	Mean concentration of blood fatty acids/ mmol dm^{-3}
With caffeine	90.2	0.20	0.53
Without caffeine	75.5	0.09	0.31

(b) (i) Describe the effect of caffeine on exercise performance.

_____

_____

(1)

(ii) Suggest **one** explanation for the higher glycerol and fatty acid concentrations in the blood plasma of the athletes after they were given caffeine.

_____

_____

_____

_____

(2)

(c) The researchers measured the volumes of carbon dioxide exhaled and oxygen inhaled during the exercise. From the results they calculated the respiratory quotient (RQ), using the formula

$$RQ = \frac{\text{volume of carbon dioxide exhaled per minute}}{\text{volume of oxygen inhaled per minute}}$$

When a person is respiring carbohydrate only, RQ = 1.0

When a person is respiring fatty acids only, RQ = 0.7

(i) The basic equation for the respiration of glucose is

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Explain why the RQ for glucose is 1.0.

_____

_____

_____

_____

(2)

(ii) The researchers found that, when the athletes were given the drink containing caffeine, their mean RQ was 0.85. When given the drink without caffeine their mean RQ was 0.92.

The researchers concluded that when the athletes had caffeine they used glycogen more slowly than when they did not have caffeine, and that the store of glycogen in their muscles was used up less quickly during the exercise.

Explain the evidence from the information above and from the table which supports these conclusions.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

26 Lactose is a disaccharide sugar which can be broken down by the enzyme lactase into two monosaccharides, glucose and galactose.

$$\text{lactose + water} \xrightarrow{\text{lactase}} \text{glucose + galactose}$$

(a) The formula for galactose is $C_6H_{12}O_6$. What is the formula for lactose?

_____

(2)

(b) A solution containing the enzyme lactase was added to a lactose solution. The solution was incubated at 40 °C for one hour. Sample **A** was removed from the tube before incubation. Sample **B** was removed after one hour.

(i) Describe a chemical test you could carry out on sample **A** to show that lactose is a reducing sugar.

_____

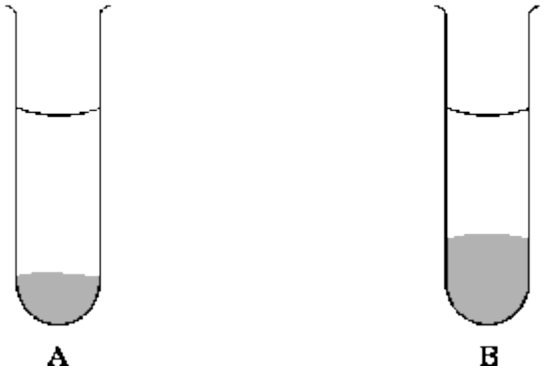
_____

_____

_____

(2)

(ii) This chemical test was carried out on samples **A** and **B**. All experimental variables were the same in the testing of the two samples. Both tubes were left for ten minutes to allow the precipitate to settle. The diagram shows the result.



Is galactose a reducing sugar? _____

Explain how the results in the diagram support your answer.

_____

_____

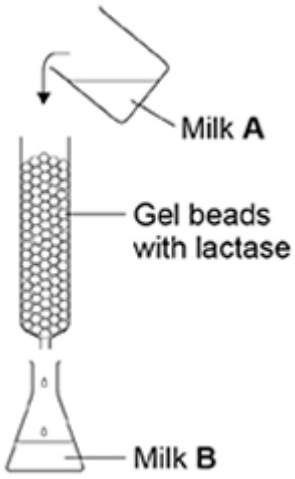
_____

_____

(2)

(Total 6 marks)

27 Many humans are unable to digest lactose. A scientist investigated the production of lactose-free milk. He produced gel beads containing the enzyme lactase and placed the beads in a column. He poured milk (Milk **A**) into the column and collected the milk (Milk **B**) after it had moved through the column over the beads. This is shown in the diagram below.



(a) Milk **A** contains no glucose. Milk **B** contains glucose. Explain why Milk **B** contains glucose.

_____

_____

_____

(1)

(b) The enzyme was trapped within the gel beads. Suggest **one** advantage of trapping the enzyme within the gel beads.

_____

_____

_____

(1)

The scientist varied the flow rate of the milk through the column. The effect of flow rate on the concentration of glucose in Milk **B** is shown in the table below.

Flow rate of milk through the column / cm^3 $minute^{-1}$	**Concentration of glucose in Milk B / arbitrary units**
50	45
100	6

(c) Explain the difference in the results in the table.

_____

_____

_____

(1)

(d) The gel beads were all similar sizes. Use the formula below to calculate the volume of one of the beads with a 3.0 mm diameter.

Volume of sphere = $\frac{4}{3}\pi r^3$

Volume = _____ mm^3

(1)

(e) Galactose has a similar structure to part of the lactose molecule.
Explain how galactose inhibits lactase.

(2)

(Total 6 marks)

28 Starch and cellulose are two important plant polysaccharides.

The following diagram shows part of a starch molecule and part of a cellulose molecule.

Starch

Cellulose

(a) Explain the difference in the structure of the starch molecule and the cellulose molecule shown in the diagram above.

(2)

(b) Starch molecules and cellulose molecules have different functions in plant cells. Each molecule is adapted for its function.

Explain **one** way in which starch molecules are adapted for their function in plant cells.

(2)

(c) Explain how cellulose molecules are adapted for their function in plant cells.

(Extra space)

(3)

(Total 7 marks)

29 (a) Glucose is a monosaccharide. Two glucose molecules join together to form a disaccharide.

(i) Name the products of this reaction.

(2)

(ii) Name the type of reaction that joins the glucose molecules together.

(1)

(Total 3 marks)

30 (a) Most blood glucose comes from starch and disaccharides in the diet.
Describe a test you could use to check if food in the diet contained starch.

(2)

(b) Explain how digestion of starch in the gut (small intestine) leads to an increase in the concentration of glucose in the blood. Details of co-transport are **not** required.

(3)

(c) Suggest a method you could use to estimate the concentration of glucose in several different solutions that all turned brick red with Benedict's reagent in 3 minutes.

(1)

(Total 6 marks)

31 (a) The letters **P**, **Q**, **R**, **S** and **T** represent ways substances can move across membranes.

- **P** – diffusion through the phospholipid bilayer
- **Q** – facilitated diffusion
- **R** – active transport
- **S** – co-transport
- **T** – osmosis

For each of the following examples of transport across membranes, select the letter that represents the way in which the substance moves across the membrane.

Write the appropriate letter in each box provided.

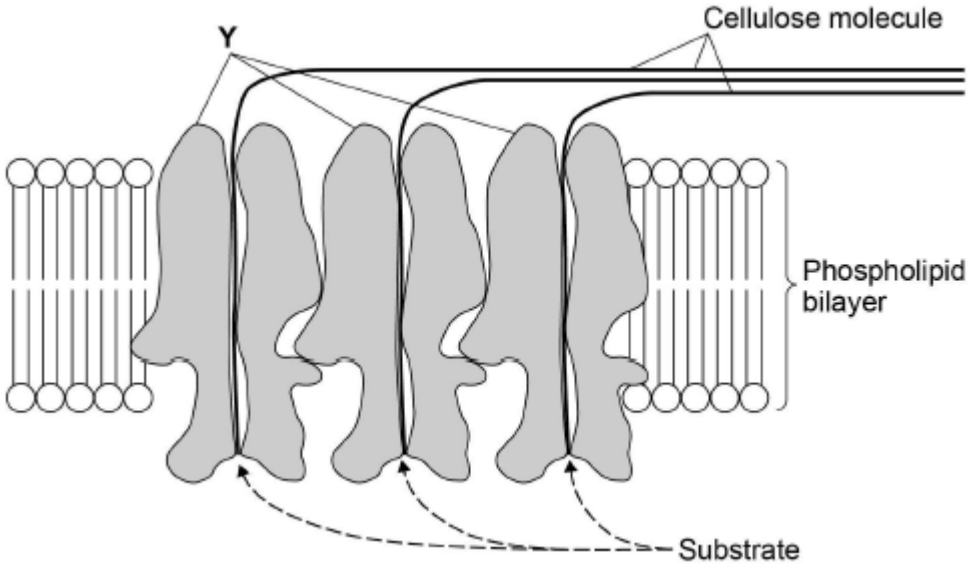
Transport through a channel protein ☐

Transport of small, non-polar molecules ☐

Transport of glucose with sodium ions ☐

(3)

The diagram shows how a plant cell produces its cell wall.



(b) **Y** is a protein. One function of **Y** is to transport cellulose molecules across the phospholipid bilayer.

Using information from the diagram, describe the other function of **Y**.

_____

_____

_____

_____

_____

(2)

(c) What is the evidence in the diagram that the phospholipid bilayer shown is part of the cell-surface membrane?

_____

_____

(1)

(d) In the cell wall, bonds hold the cellulose molecules together side by side.

Tick (✓) **one** box that describes the type of bond that holds the cellulose molecules together side by side.

Ester	☐
Hydrogen	☐
Ionic	☐
Peptide	☐

(1)

(Total 7 marks)

32 Scientists investigated the hydrolysis of sucrose in growing plant cells by an enzyme called SPS.

(a) Name the products of the hydrolysis of sucrose.

1. _____

2. _____

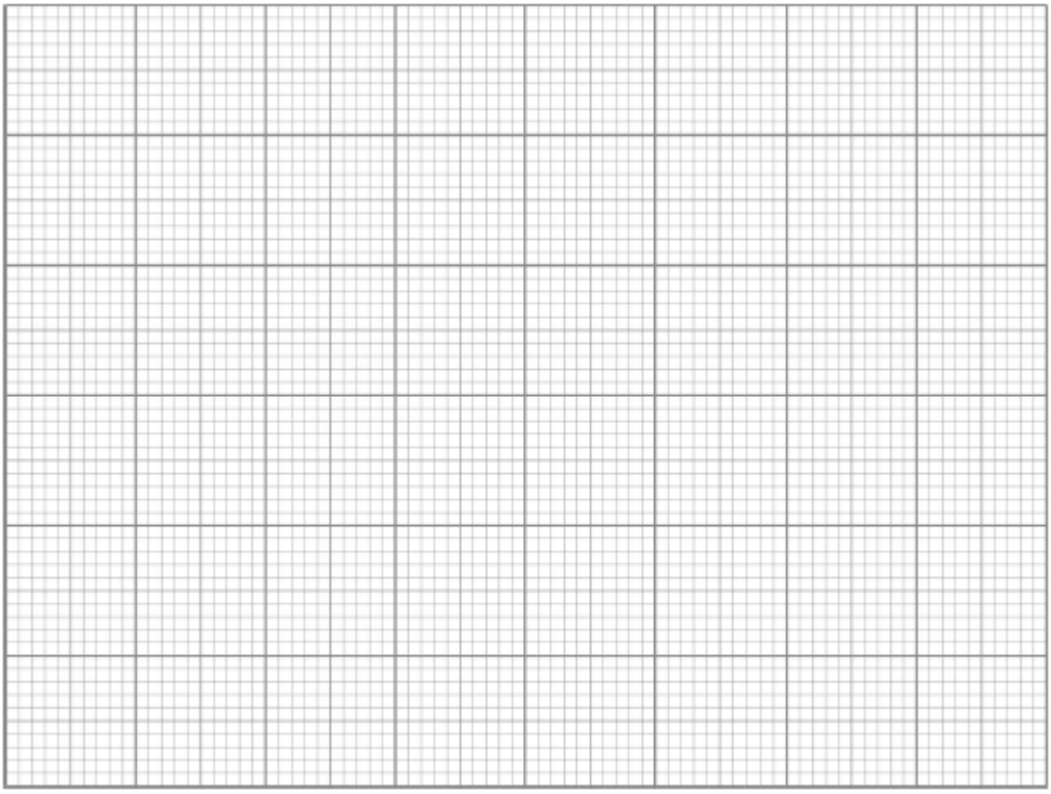
(2)

(b) The scientists grew plant cells in a culture for 12 days. At the start, there were only a few cells in the culture. Each day, they determined the mass of sucrose hydrolysed by SPS in the plant cells in **1 hour**.

The following table shows their results.

Day	**Mass of sucrose hydrolysed by SPS in 1 hour / µg**	**Rate of hydrolysis of sucrose by SPS**
0	0.07	
2	0.09	
4	0.11	
6	0.15	
8	0.20	
10	0.24	
12	0.24	

For each day, calculate the rate **per minute** of the reaction catalysed by SPS.
Record the rates in standard form and plot a suitable graph of your processed data.



(3)

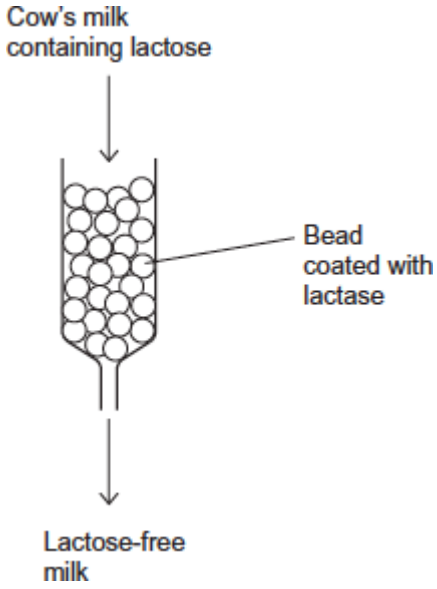
(c) What can you conclude about the growth of the plant cells from these data? Explain how you reached your conclusions.

(3)

(Total 8 marks)

33 Cow's milk contains the sugar lactose. Many cats are unable to digest cow's milk because they are lactose intolerant.

Cow's milk can be made suitable for these cats by treating it with the enzyme lactase to hydrolyse lactose. This makes the cow's milk lactose-free. Beads are coated with lactase and placed in a tube, as shown in the diagram below. Cow's milk flows over the beads and the lactose is hydrolysed.



(a) Attaching lactase to the beads is a more efficient use of lactase than adding the lactase directly to cow's milk.

Suggest **three** reasons why it is more efficient to attach lactase to the beads.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) Monosaccharides and disaccharides taste sweet.
The lactose-free milk made after hydrolysis with lactase tastes sweeter than the cow's milk containing lactose.
Suggest why.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

34 (a) (i) Give **two** ways in which the structure of starch is **similar** to cellulose.

1. _____

2. _____

(2)

(ii) Give **two** ways in which the structure of starch is **different** from cellulose.

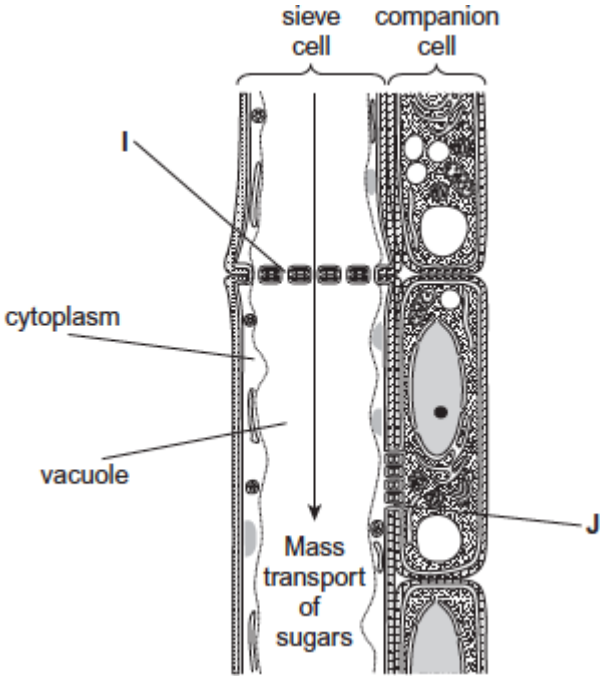
1. _____

2. _____

(2)

(b) In plants, mass transport of sugars takes place through columns of sieve cells in the phloem. Other cells, called companion cells, transport sugars into, and out of, the sieve cells.

The diagram shows the structure of phloem.



Structures **I** and **J** allow the transport of sugars between cells.

(i) Using the diagram, suggest and explain **one** other way in which sieve cells are adapted for mass transport.

(2)

(ii) Using the diagram, suggest and explain **one** other way in which companion cells are adapted for the transport of sugars between cells.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)