Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.2 Carbohydrates

Topic question bank

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
9	60	No time limit	/ 60

Contents

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Do not write outside the box

Monosaccharides, disaccharides and glycosidic bonds 3.1.2

0 1 . 1 Which row correctly shows a disaccharide **and** the monosaccharides produced when it is hydrolysed?

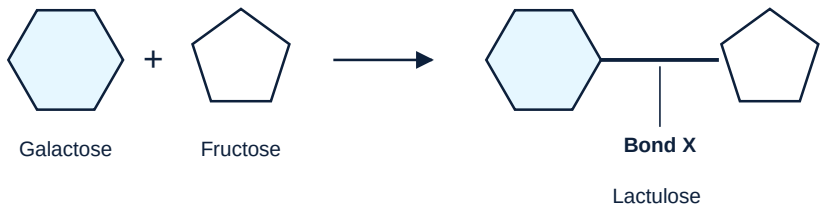
Tick (✓) one box.

[1 mark]

Disaccharide	Monosaccharides produced	
Lactose	Glucose and fructose	☐
Maltose	Glucose and galactose	☐
Sucrose	Glucose and fructose	☐
Lactose	Galactose and galactose	☐

Lactulose is a disaccharide made commercially for use as a medicine. Figure 1 shows how it is formed from its two monomers.

Figure 1



0 1 . 2 Galactose and fructose both have the molecular formula $C_6H_{12}O_6$.
Give the molecular formula of lactulose.

[1 mark]

.....

0 1 . 3 Name the type of reaction shown in Figure 1 **and** name bond **X**.

[2 marks]

Type of reaction .....

Bond X .....

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 Lactulose is used to treat constipation, because it increases the volume of water in the faeces. Lactulose passes through the small intestine without being absorbed.

Use your knowledge of enzymes and water potential to explain why taking lactulose by mouth leads to more water in the faeces.

[4 marks]

8

Turn over for the next question

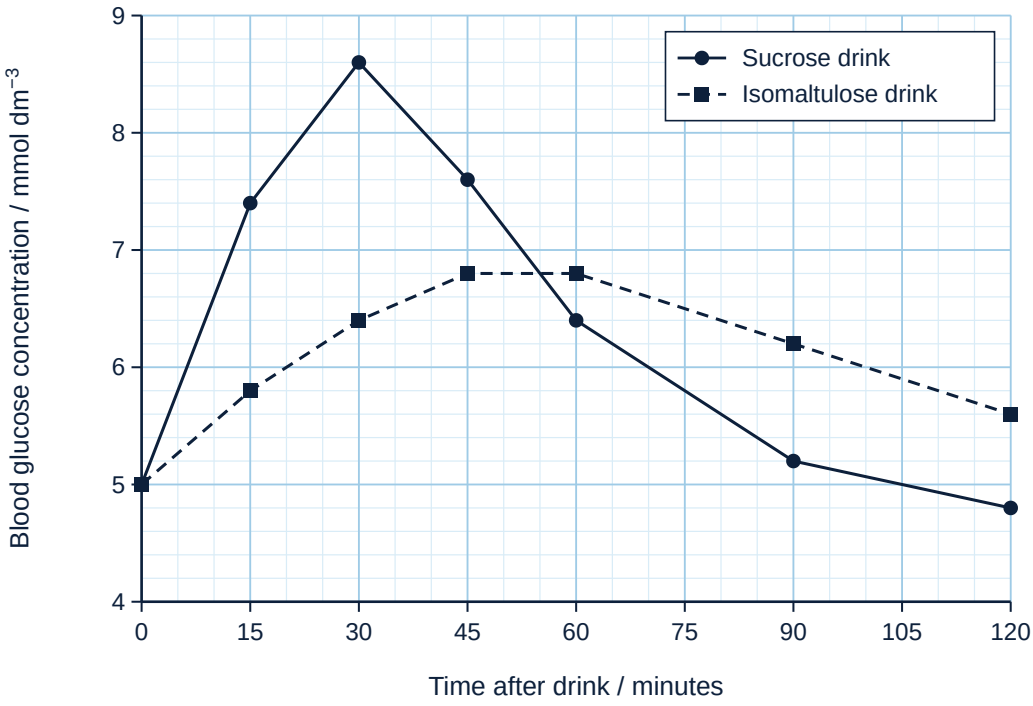
Do not write outside the box

Isomaltulose is a disaccharide used as a sweetener in some drinks. Like sucrose, isomaltulose is made of one glucose and one fructose. In isomaltulose, the glycosidic bond joins the glucose to a different carbon atom of the fructose from the bond in sucrose.

Scientists gave each of 10 volunteers a drink containing 50 g of sucrose on one day, and a drink containing 50 g of isomaltulose on another day. The volunteers had not eaten for 10 hours before each drink. The scientists measured each volunteer's blood glucose concentration at intervals after the drink.

Figure 2 shows the mean results.

Figure 2



0 2 . 1 Calculate the percentage increase in the mean blood glucose concentration from the time of the sucrose drink to the highest value after the sucrose drink.

[2 marks]

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.....

Answer ..... **%**

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 Use your knowledge of enzymes to suggest an explanation for the differences between the blood glucose concentrations after the two drinks.

[3 marks]

0 2 . 3 A company that sells a drink containing isomaltulose claims that isomaltulose 'releases energy more slowly and for longer than sucrose'.
Evaluate this claim. Use Figure 2.

[3 marks]

8

Turn over for the next question

Polysaccharides: structure and function 3.1.2

In the liver, glucose is stored as glycogen. Between meals, liver cells hydrolyse glycogen and release glucose into the blood. One of the enzymes involved removes glucose monomers, one at a time, from the ends of the chains in a glycogen molecule.

In glycogen storage disease type IV (GSD IV), the enzyme that forms the branches in glycogen does not work properly. Some people with GSD IV have a low blood glucose concentration between meals.

Scientists extracted glycogen from the liver of a healthy person and from the liver of a person with GSD IV. To measure the rate of glucose release, they added the same concentration of the glucose-removing enzyme to 1 mg of each type of glycogen, under the same conditions, and measured the glucose released over time. Table 1 shows their results.

Table 1

Source of glycogen	Mean number of glucose monomers between branch points	Rate of glucose release from 1 mg of glycogen / nmol min^{-1}
Healthy person	12	4.8
Person with GSD IV	38	1.6

0 3 . 1 Calculate the percentage decrease in glucose release rate for the glycogen of the person with GSD IV, compared with the glycogen of the healthy person.

[2 marks]

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.....

Answer ..... **%**

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 Use Table 1 to explain why some people with GSD IV have a low blood glucose concentration between meals.

[3 marks]

0 3 . 3 The scientists used the same mass of glycogen from each person.
Explain why.

[1 mark]

6

Turn over for the next question

Paper is made from plant fibres, which are mostly cellulose from cell walls. Each time paper is recycled, the fibres are pulped in water and some cellulose molecules are broken into shorter molecules.

Scientists recycled a batch of paper five times. After each cycle, they measured:

- the mean number of monomers in each cellulose molecule
- the force needed to tear a strip of the paper of standard width.

Table 2 shows their results.

Table 2

Number of times paper recycled	Mean number of monomers in each cellulose molecule	Force needed to tear a strip of paper / N
0	1400	62
1	1250	55
2	1110	50
3	1000	46
4	900	43
5	830	41

0 4 . 1 Name the monomer of cellulose.

[1 mark]

.....

0 4 . 2 Which feature do glycogen and cellulose both have?
Tick (✓) one box.

[1 mark]

Branched chains ☐

Helical (coiled) chains ☐

Glycosidic bonds between monomers ☐

α-glucose monomers ☐

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 Calculate the percentage decrease in the mean number of monomers in each cellulose molecule after the paper had been recycled five times.

[2 marks]

Answer ..... **%**

0 4 . 4 Use your knowledge of the structure of cellulose to suggest why paper made from longer cellulose molecules is stronger.

[3 marks]

0 4 . 5 A student concluded that the decrease in the force needed to tear the paper is caused by the decrease in the length of the cellulose molecules.
Evaluate this conclusion.

[2 marks]

9

Turn over for the next question

Do not write outside the box

Pea seeds store energy as starch in the cells of their seed leaves. Each of these cells is surrounded by a cell wall containing cellulose. When the seed germinates, the starch is hydrolysed and the glucose produced is used in respiration.

0 5 . 1 A student crushed a pea seed in a little water.
Describe how the student could test the crushed seed for starch **and** give the result if starch is present.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 2 Explain how the structures of starch **and** cellulose are related to their functions in the pea seed.

[6 marks]

8

Turn over for the next question

Biochemical tests for carbohydrates 3.1.2

A student carried out three tests on a solution. The solution contained only one carbohydrate. Table 3 shows the results.

Table 3

Test	Result
Heated with Benedict's solution	Stayed blue
Heated with dilute hydrochloric acid, neutralised, then heated with Benedict's solution	Red precipitate
Iodine/potassium iodide solution added	Stayed orange-brown

0 6 . 1 Which carbohydrate did the solution contain?
Tick (✓) one box.

[1 mark]

Glucose ☐

Starch ☐

Sucrose ☐

Maltose ☐

Lactose-free milk is made by adding the enzyme lactase to milk. Lactase hydrolyses lactose.

0 6 . 2 Describe how a student could test a sample of milk for reducing sugar **and** give the result if reducing sugar is present.

[2 marks]

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Question 6 continues on the next page

Do not write outside the box

0 6 . 3 A student tested some lactose-free milk with Benedict's solution and got a positive result. The student concluded that all the lactose in the milk had been hydrolysed.
Explain why this conclusion is **not** valid.

[2 marks]

5

0 7 A sports drink contains glucose. A student wanted to find out whether the drink also contained a non-reducing sugar.
Describe how the student could use Benedict's solution to do this. Explain how the results would show whether a non-reducing sugar was present.

[5 marks]

5

Turn over for the next question

Separating and measuring sugars 3.1.2 (AT c, AT g)

A student identified three disaccharides, **X**, **Y** and **Z**, using this method.

- Boil each disaccharide with dilute acid to hydrolyse it, then neutralise.
- Spot each hydrolysed disaccharide on a pencil line (the origin) on a thin-layer chromatography plate, and stand the plate in a solvent.
- Spray the plate to make the sugars visible, and measure how far each spot and the solvent moved.

The solvent moved 7.5 cm from the origin. Table 4 shows the distances moved by the spots.

Table 4

Hydrolysed disaccharide	Distance moved by each spot from the origin / cm
X	1.8 and 2.4
Y	2.4
Z	2.4 and 2.9

Table 5 shows R_f values for three monosaccharides in the same solvent, where R_f = distance moved by spot ÷ distance moved by solvent.

Table 5

Monosaccharide	Fructose	Galactose	Glucose
R_f value	0.39	0.24	0.32

Question 8 continues on the next page

Do not write outside the box

0 8 . 1 Identify disaccharides **X**, **Y** and **Z**.
Show your working.

[3 marks]

X .....

Y .....

Z .....

0 8 . 2 Only one spot was seen for **Y**. Another student suggested that **Y** might contain two different monosaccharides that had not separated.
Suggest how the student could test this suggestion.

[1 mark]

4

Turn over for the next question

Do not write outside the box

A student estimated the concentration of glucose in a sample of flower nectar. The student:

- made glucose solutions of 0, 2, 4, 6, 8 and 10 mmol dm^{-3} by diluting a 10 mmol dm^{-3} glucose solution with distilled water
- added 2 cm^3 of Benedict's solution to 2 cm^3 of each glucose solution, and heated each tube in a boiling water bath for 5 minutes
- shook each tube to suspend the precipitate, measured its absorbance using a colorimeter, and plotted a calibration curve
- made up 1.0 cm^3 of nectar to 100.0 cm^3 with distilled water, and tested 2 cm^3 of the diluted nectar in the same way.

0 9 . 1 Give the volumes the student should use to make 10 cm^3 of the 4 mmol dm^{-3} glucose solution.

[1 mark]

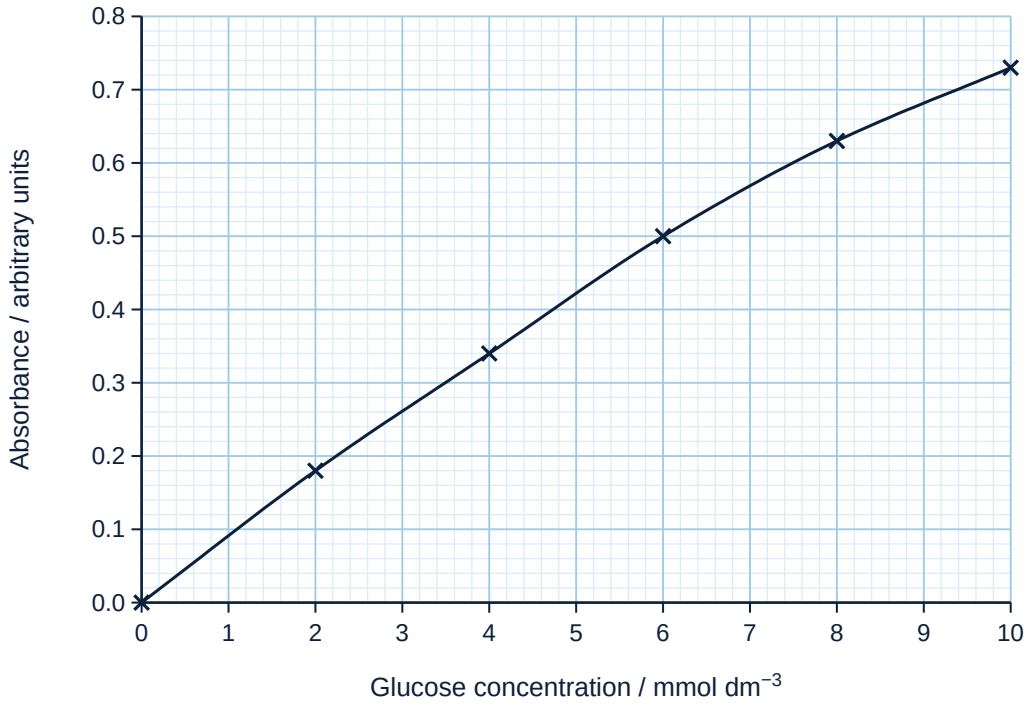
Volume of 10 mmol dm^{-3} glucose solution (cm^3) .....

Volume of distilled water (cm^3) .....

Question 9 continues on the next page

Figure 3 shows the student's calibration curve.

Figure 3



The absorbance of the diluted nectar was 0.42

0 9 . 2 Use Figure 3 to calculate the concentration of glucose in the undiluted nectar.

[2 marks]

Answer ..... **mmol dm^{-3}**

0 9 . 3 Suggest why the student diluted the nectar before testing it.

[1 mark]

Question 9 continues on the next page

Do not write outside the box

0 9 . 4 A second sample of diluted nectar had an absorbance of 0.70
Explain why the glucose concentration estimated from this reading would be less precise than the estimate from an absorbance of 0.30

[2 marks]

0 9 . 5 Suggest why the student's method may give a value higher than the true concentration of glucose in the nectar.

[1 mark]

7

END OF QUESTIONS