A Level · AQA · Biology

2 hours 15 questions

1.1 Biological Molecules: Carbohydrates

1.1.1 Biological Molecules: Key Terms / 1.1.2 Biological Molecules: Reactions / 1.1.3 Monosaccharides / 1.1.4 Glucose / 1.1.5 The Glycosidic Bond / 1.1.6 Chromatography: Monosaccharides / 1.1.7 Disaccharides / 1.1.8 Starch & Glycogen / 1.1.9 Cellulose / 1.1.10 Biochemical Tests: Sugars & Starch / 1.1.11 Finding the Concentration of Glucose

Easy (5 questions)	/34
Medium (5 questions)	/50
Hard (5 questions)	/60
Total Marks	**/144**

Scan here to return to the course
or visit savemyexams.com

Easy Questions

1 (a)

a) Name the monomer present in

i) Cellulose

ii) Starch

.....

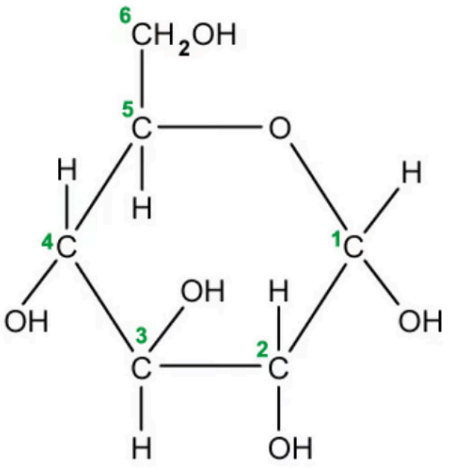
.....

(2 marks)

(b)

b) **Figure 1** shows a molecule of alpha glucose. Beta glucose is an isomer of alpha glucose.

Figure 1



i) Define the term isomer.

ii) Draw a molecule of beta glucose.

.....

.....

(2 marks)

(c) c) A disaccharide is formed by a condensation reaction between two monosaccharides. Complete the word equation below and state the bond present in the disaccharide.

Alpha glucose + _____ ⟶ Sucrose + _____

.....

.....

(2 marks)

(d) d) Cotton is a plant fibre used to make cloth. Explain how cellulose gives cotton its strength.

.....

.....

(2 marks)

2 (a) a) The equation shows the reaction catalysed by the enzyme maltase. State the name of the molecules **A** and **B**.

Maltose + A → Glucose + B

.....

.....

(2 marks)

(b) b) Name the type of chemical reaction shown in the equation in part (a).

.....

(1 mark)

(c) c) A laboratory assistant added Benedict's reagent to a solution of sucrose in a test tube and applied heat. Predict and explain the results.

.....

(1 mark)

(d) d) List **two** similarities and **two** differences between the structures of starch and glycogen.

.....

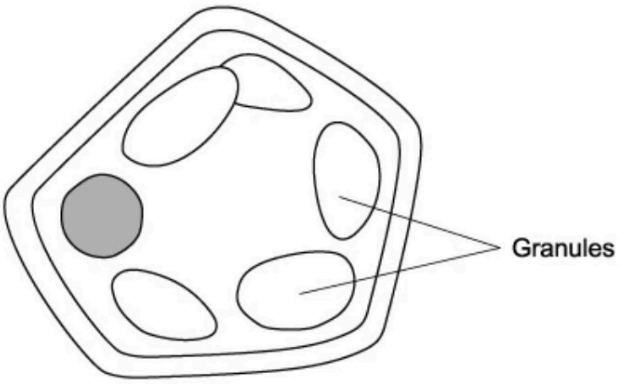
.....

(2 marks)

3 (a)

a) **Figure 1** shows a cell from a garden pea.

Figure 1



Describe how you could determine if the granules contained starch.

.....

(1 mark)

(b)

b) Name **one** polysaccharide other than starch found in a garden pea cell.

.....

(1 mark)

(c)

c) Glucose is converted into starch for storage within plant cells, describe the reaction that takes place for this to occur.

.....

.....

.....

(3 marks)

(d)

d) Explain **one** reason why pea cells use starch as a storage molecule rather than glucose.

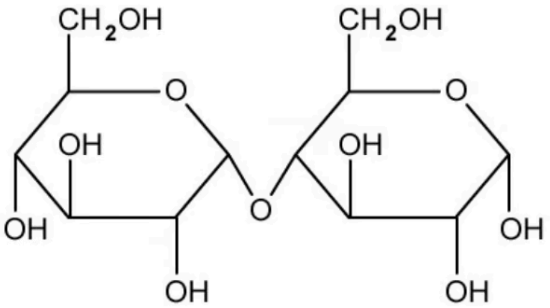
.....

(1 mark)

4 (a)

a) The glycosidic bond is broken in a hydrolysis reaction. Disaccharides and polysaccharides are broken down in hydrolysis reactions. **Figure 1** shows a molecule of maltose.

Figure 1



Draw the reaction that occurs when a single molecule of maltose is broken down via a hydrolysis reaction.

(2 marks)

(b)

b) State the chemical formula of maltose.

(1 mark)

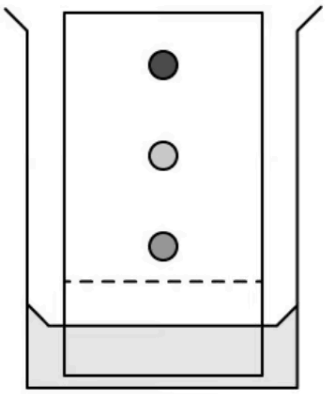
(c)

c) Describe how the student could separate a mixture of monosaccharides in solution.

(3 marks)

d) **Figure 2** shows a chromatogram with an unknown mixture of monosaccharides. Suggest how these monosaccharides could be identified.

Figure 2



(d)

.....

.....

(2 marks)

5 (a) a) Serial dilutions are created by taking a series of dilutions of a stock solution. The concentration decreases by the **same** quantity between each test tube. They can either be 'doubling dilutions' (where the concentration is halved between each test tube) or a desired range (e.g. 0, 2, 4, 6, 8, 10 mmol dm^{-3}).

Table 1

Glucose concentration / mmol dm^{-3}	Volume of distilled H_2O / cm^3	Volume of glucose stock solution / cm^3
0	5	
2	4	
4	3	
6	2	
8	1	
10	0	

Fill in **Table 1.**

(1 mark)

(b) b) Benedict's solution can be used to carry out a semi-quantitative test on a reducing sugar solution to determine the unknown concentration of reducing sugar present in a Sample. The intensity of any colour change seen relates to the concentration of reducing sugar present in the sample. Using serial dilution, standard solutions with known concentrations of a reducing sugar (such as glucose) are produced.

Each solution is then treated in the same way: the same volume of Benedict's solution is added to each sample and heat is applied. Any colour change observed for each solution of a known concentration in given time can be attributed to the concentration of reducing sugar present in that solution

The same procedure is carried out on a sample with an unknown concentration of reducing sugar which is then compared to the stock solution colours to estimate the concentration of reducing sugar present

The colour change intensity can be compared between samples by eye or by using a colorimeter. Describe the relationship between colour change intensity and glucose concentration.

(1 mark)

(c) c) Suggest why using a colorimeter to measure light absorbance would be favourable over a comparison done by eye.

.....

(1 mark)

(d) d) **Table 2** contains statements that could apply to three polysaccharides.

Complete the table with a tick (✓) in each box if the statement correctly applies.

Table 2

Statement	Glycogen	Cellulose	Starch
Contains 1-6 links			
Contains α-glucose			
Contains hydrogen bonds			

.....

.....

.....

(3 marks)

Medium Questions

1 (a) a) **Table 1** contains statements that could apply to three polysaccharides.

Complete the table with a tick (✓) in each box if the statement correctly applies.

Table 1

Statement	Glycogen	Cellulose	Starch
Contains 1-6 links			
Contains α-glucose			
Contains hydrogen bonds			

(3 marks)

(b) b) Name the type of reaction that forms the carbohydrates in **Table 1** from their monomers.

(1 mark)

(c) c) Give **two** features of starch and explain how those features allow it to act as a storage substance.

(4 marks)

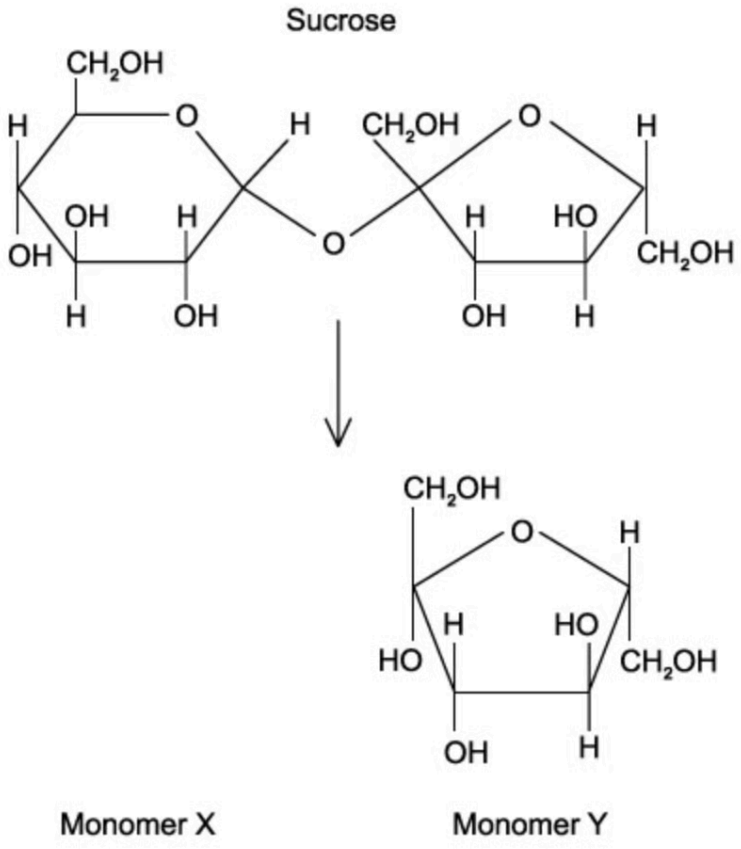
(d) d) A muscle cell was tested to detect the presence of starch. State and explain the result of this test.

(2 marks)

2 (a) a) Sucrose is formed from monomers **X** and **Y**.

Figure 1 shows the structure of sucrose and monomer **Y**.

Figure 1



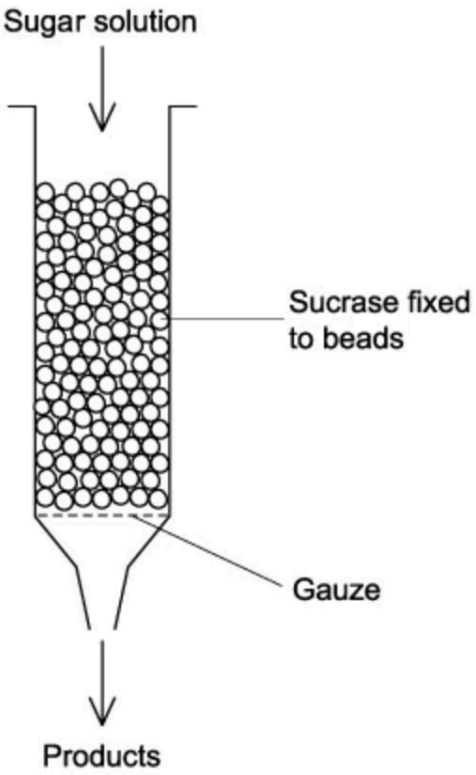
Draw monomer **X**.

.....

(1 mark)

b) **Figure 2** shows a column containing inert beads. The enzyme sucrase is fixed to these inert beads. A student pours a sugar solution containing sucrose, lactose and glucose into the top of the column.

Figure 2



(b) Name the compounds you expect to be present in the 'Products'?

.....

.....

(2 marks)

(c) c) Describe how the student could separate the compounds in the 'Product' solution.

.....

.....

.....

(3 marks)

(d) d) Within animal cells, fructose enters the gluconeogenesis pathway to form glucose.

Describe how glucose is stored within the cell.

.....

.....

.....

.....

(4 marks)

3 (a) a) What is a disaccharide?

.....

.....

(2 marks)

b) Maltose is a disaccharide which can be broken down by the enzyme maltase.

(b)

$$\text{Maltose + water} \xrightarrow{\text{maltase}} \text{\_\_\_\_\_} + \text{glucose}$$

The formula for glucose is $C_6H_{12}O_6$. What is the formula for maltose?

.....

(1 mark)

c) A solution of the enzyme maltase was added to a tube containing maltose solution. A sample (**1**) was taken from the tube after the solutions were mixed. The remaining solution was then incubated at 37°C. Sample **2** was removed after one hour of incubation.

(c)

Describe a chemical test you could carry out to show that maltose is a reducing sugar.

.....

.....

(2 marks)

d) The chemical test in part (c) was carried out on both samples **1** and **2**. All experimental variables were kept the same when testing both of the samples. Both tubes were left for 15 minutes to allow the precipitate to settle. State and explain how the result of sample **2** would differ from sample **1**.

(d)

.....

.....

(3 marks)

4 (a) a) Name the monomers from which a lactose molecule is made.

(2 marks)

(b) b) Describe what happens when lactose is broken down into its monomers.

(3 marks)

c) A teacher produces a dilution series of a lactose solution so they could plot a calibration curve. The teacher starts with a stock solution of lactose of concentration 0.75 mol dm^{-3} and distilled water with which they make a series of dilutions from 0.1 to 0.5 mol dm^{-3}.

Complete **Table 1** by giving all headings, units and the concentration of the lactose solution produced.

(c)

Table 1

Concentration of lactose solution / _____	**Volume of 0.75 mol dm^{-3} lactose solution / cm^3**	**_____ / _____**
_____	8	12

(2 marks)

d) The teacher performed Benedict's test on the five lactose dilutions ranging from 0.1 mol dm^{-3} to 0.5 mol dm^{-3}. A sample of each solution was placed in a colorimeter and the light absorbance was measured. **Table 2** below shows the light absorbance for each sample.

Table 2

Concentration of lactose / *units*	**Light Absorbance / a.u.**
0.1	0.05
0.2	0.21
0.3	0.25
0.4	0.48
0.5	0.74

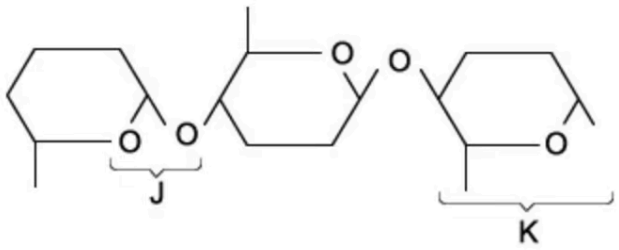
(d)

Use the data from **Table 2** to sketch a graph and predict the concentration of lactose that has a light absorbance of 0.4 arbitrary units.

(4 marks)

5 (a) a) **Figure 1** shows a section of a cellulose molecule.

Figure 1



Name parts **J** and **K**.

.....

.....

(2 marks)

(b) b) State the role of cellulose in plant cell walls and explain how it's structure is related to this role.

.....

.....

.....

(3 marks)

(c) c) Plants store sugars as starch. How can the presence of starch be detected in plant cells?

.....

.....

(2 marks)

(d) d) Describe **two** similarities and **two** differences between the structures of cellulose and starch.

.....

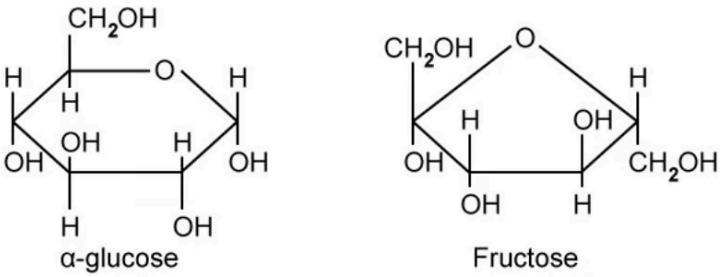
(4 marks)

Hard Questions

1 (a)

a) **Figure 1** shows the structures of two monosaccharides, ∝-glucose and fructose. These combine to form the disaccharide sucrose. In the space below, draw the structure of sucrose. Label the bond between the two monosaccharides and show any by-products.

Figure 1



(4 marks)

(b)

b) Sucrose can be hydrolysed with the enzyme invertase. In an experiment to measure the effect of temperature on human invertase activity, researchers treated solutions of sucrose with invertase solution and measured the quantity of glucose produced at various temperatures; 4°C, 25°C, 37°C, 80°C and 100°C. The measurement involves treating the experimental mixture with a dye and measuring its absorbance of visible light. The greater the absorbance, the higher the invertase activity observed.

Suggest **four** variables that the researchers would have to control, and state how each variable would be controlled.

(4 marks)

c) Use your knowledge of enzyme activity to predict the results that the researchers would have obtained. Complete **Table 1** below, using a system of zeros and crosses as follows:

0 = no activity
+ = minimal activity
++ = moderate activity
+++ = maximal activity

Table 1

(c)

Incubation temperature / °C	Enzyme activity / arbitrary units
4	
25	
37	
80	
100	

(3 marks)

(d) d) Explain your predictions in part 1 (c)

(4 marks)

2 (a) a) Glycogen is a very effective storage carbohydrate. Describe and explain **three** features of glycogen that make it well suited to its role as an energy store.

(6 marks)

(b) b) Starch is made of two polymers of ∝-glucose: amylose and amylopectin. Describe the structural differences between amylose and amylopectin and explain their effects on the starch molecule.

(4 marks)

(c) c) Outline one structural similarity and one structural difference between amylopectin and glycogen.

(2 marks)

d) Soluble forms of starch are used in laboratory experiments, despite the fact that starch is well documented as an insoluble molecule. Suggest how starch is altered for use as a soluble laboratory reagent.

(d)

.....

.....

(2 marks)

3 (a)

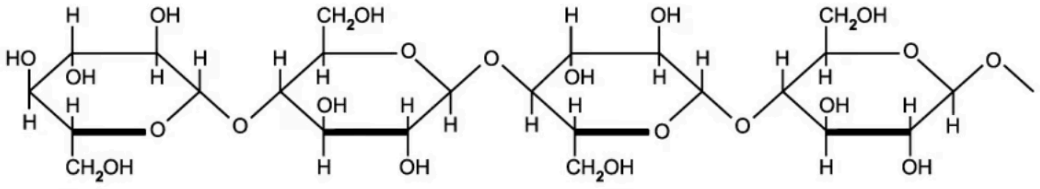
a) Cellulose is thought to be the world's most abundant carbohydrate. Humans and other large mammals do not possess the enzymes to extract the energy contained in cellulose. Use your knowledge of cellulose to explain why the biosphere is not overwhelmed with an accumulation of cellulose waste from dead plant matter.

(2 marks)

(b)

b) A section of a cellulose molecule is shown in **Figure 1**.

Figure 1



Describe and explain the feature of this structure that allows cellulose to form straight, strong fibres in biological tissues.

(2 marks)

(c)

c) The koala (*Phascolarctos cinereus*) is an herbivore that inhabits the forests of eastern Australia. The leaves of eucalyptus trees form the bulk of the koala's diet. The leaves have a low calorific content. Use your knowledge of carbohydrates to explain the following two aspects of koala behaviour:

- Koalas are largely sedentary, sleeping up to 20 hours per day;
- Infant koalas ingest their mother's faeces early in life.

(2 marks)

(d) d) Ruminants and other herbivores produce large volumes of methane which gets released into the atmosphere. Studies have shown that a cow produces 75 times more methane per kg of body mass than a human. Suggest why ruminants produce more methane per kg of body mass than humans.

.....

.....

(2 marks)

4 (a)

a) Participants and coaches involved in competitive sport have taken part in research into the optimum formulation of sports drinks. One such study is set out below.

Eight trained, competitive male cyclists took part in a study in which they fasted for 12 hours and were then given either water, glucose solution or a 2:1 glucose:fructose beverage immediately prior to competing in a 10-mile time-trial race. The results are shown in **Table 1**

Table 1

Drink	Total mass of monosaccharide ingested / g	Completion time of trial / minutes:seconds
Water	0	25:00
Glucose solution	30	23:32
2:1 glucose:fructose mixture	30	20:30

Calculate the percentage improvement in finishing time from using the 2:1 glucose:fructose mixture, to using glucose solution on its own.

.....

.....

(2 marks)

(b)

b) i) Explain the results in **Table 1**

ii) Criticise the scientific methods used in the study

.....

.....

.....

.....

(4 marks)

(c) c) Give one similarity and one difference between the structures of glucose and fructose.

(2 marks)

(d) d) High-fructose corn syrup (HFCS) is a widely used material in the food industry. Fructose is discerned as sweeter than glucose by human taste buds; this gives food manufacturers the opportunity to maintain food's sweetness by using less carbohydrate material. Fructose is not metabolised in all cells (as glucose is) but is metabolised in the liver to form glycogen and can be subsequently converted to fat. Health campaigners have claimed that increased use of HFCS promotes obesity. Suggest why humans have a mechanism for metabolising fructose.

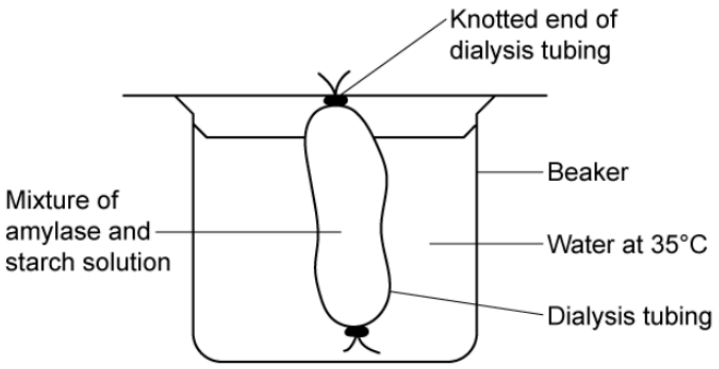
(2 marks)

5 (a) a) Briefly describe **two** experimental methods by which the glycosidic bond in a disaccharide can be broken.

(4 marks)

b) A biologist set up the apparatus as shown in **Figure 1**.

Figure 1



(b) Dialysis tubing is partially permeable. After leaving the experiment for 20 minutes, the biologist removed samples of liquid from inside the dialysis tubing and also from the water surrounding the tubing. The samples were added to several different reagents/indicators. The blank results table used to record their results is shown below. (**Table 1**).

Table 1

Biochemical test	Liquid from dialysis tubing	Liquid from the beaker
Biuret reagent		
Iodine solution		
Benedict's solution		

Predict the observations that the biologist would have made. Do **not** make reference to positive or negative tests.

.....

.....

.....

(3 marks)

(c) c) Justify the predictions that you have made in question 5 (c)

(3 marks)

(d) d) Starch is stored as granules inside plant cells such as potato tubers or carrot roots. Explain the advantages of storing food as starch, rather than as sugars, in plant cells.

(3 marks)