Biological Molecules, Food Tests and Enzymes

EDEXCEL 4BI1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Carbohydrates, lipids and proteins are three groups of biological molecules. Complete the table by writing the chemical elements that every molecule in each group contains. Use the chemical symbols.

Group	Elements present
Carbohydrate	?
Lipid	?
Protein	?

(a) Complete the table (use the table above). **(3)**

(b) Name the element that is present in proteins but is not present in carbohydrates or lipids. **(1)**

(Total for Question 1 is 4 marks)

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2 Large biological molecules are built from smaller units. Complete the table by naming the smaller units that make up each large molecule.

Large molecule	Smaller units it is made from
Starch	?
Protein	?
Lipid (triglyceride)	?

(Total for Question 2 is 3 marks)

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3 Starch and glycogen are both carbohydrates that act as energy stores.

(a) Name the organisms in which starch is stored, and the organisms in which glycogen is stored (choose from plants, animals). **(1)**

(b) State the simple sugar that starch and glycogen are both made from. **(1)**

(c) Starch and glycogen are insoluble in water. Explain why this makes them better for storage than glucose. **(2)**

(Total for Question 3 is 4 marks)

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4 A student has a colourless solution that may contain glucose. The student uses Benedict's solution to test it (required practical).

(a) Describe how the student should carry out the test and what result shows that glucose is present. **(3)**

(b) State one safety precaution the student should take and give a reason. **(1)**

(Total for Question 4 is 4 marks)

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5 A student tests four food samples, P, Q, R and S, with four reagents. The results below are invented for this question.

Sample	Iodine solution	Benedict's solution (heated)	Biuret reagent	Ethanol, then water
P	blue-black	stays blue	purple	stays clear
Q	orange-brown	brick-red precipitate	stays blue	stays clear
R	orange-brown	stays blue	stays blue	cloudy white
S	orange-brown	stays blue	stays blue	stays clear

(a) Identify the biological molecule or molecules shown to be present in each of samples P, Q and R. **(3)**

(b) State what the results show about sample S. **(1)**

(c) State the colour of the biuret reagent in a negative test. **(1)**

(Total for Question 5 is 5 marks)

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6 Describe how a student can test a food sample for lipids using the ethanol emulsion test, and the result that shows lipid is present.

(Total for Question 6 is 3 marks)

7 Explain how the shape of an enzyme makes it specific to one substrate.

(Total for Question 7 is 4 marks)

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8 A student investigates the effect of temperature on the enzyme amylase (required practical). The student mixes amylase with starch at five temperatures and records how long it takes for the starch to disappear, tested with iodine solution. The data are invented for this question.

Temperature in degrees C	Time for starch to disappear in s
20	300
30	150
40	75
50	120
60	no change after 600

(a) Calculate the rate of reaction at 30 degrees C using rate = 1 / time. Give your answer to 2 significant figures and include the unit. **(2)**

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(b) State the optimum temperature shown by the data. **(1)**

(c) Explain the result at 60 degrees C. **(2)**

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(Total for Question 8 is 5 marks)

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9 Describe how you would carry out a practical to find the effect of temperature on the rate at which amylase breaks down starch. Include how you would make the investigation valid and reliable.

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(Total for Question 9 is 6 marks)

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10 A student investigates how pH affects the enzyme catalase, which breaks down hydrogen peroxide into water and oxygen. The student measures the volume of oxygen collected in 60 s at five pH values and repeats each three times. The data are invented for this question.

pH	Trial 1 in cm3	Trial 2 in cm3	Trial 3 in cm3
3	5	4	3
5	17	19	18
7	41	45	40
9	20	23	21
11	2	3	1

(a) Calculate the mean volume of oxygen at pH 9. **(2)**

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(b) State the optimum pH shown by the data. **(1)**

(c) The mean volume at pH 7 is 42.0 cm^3 and the mean volume at pH 11 is 2.0 cm^3. Calculate the percentage decrease in the mean volume of oxygen from pH 7 to pH 11. **(3)**

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(Total for Question 10 is 6 marks)

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11 Using the results of the experiment in Question 10, explain why very little oxygen is collected at pH 11.

(Total for Question 11 is 3 marks)

12 A student repeats the amylase and starch experiment at 40 degrees C but first boils the amylase solution, then cools it to 40 degrees C before adding it to the starch.

(a) Predict what the student will observe when iodine solution is added to the mixture after 10 minutes. **(1)**

(b) Explain your prediction, and explain why cooling the enzyme to 40 degrees C does not restore its activity. **(3)**

(Total for Question 12 is 4 marks)

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Mark scheme · Biological Molecules, Food Tests and Enzymes

Question 1

(a) carbohydrate: carbon, hydrogen and oxygen (C, H, O) **B1**

(a) lipid: carbon, hydrogen and oxygen (C, H, O) **B1**

(a) protein: carbon, hydrogen, oxygen and nitrogen (C, H, O, N); accept sulfur (S) as an extra element for some proteins **B1**

(a) Answer: Carbohydrate: C, H, O. Lipid: C, H, O. Protein: C, H, O, N (sometimes S).

(b) nitrogen (accept N) **B1**

(b) Answer: Nitrogen

Question 2

starch: (many) glucose molecules / simple sugars **B1**

protein: amino acids **B1**

lipid: fatty acids and glycerol (both needed for the mark) **B1**

Answer: Starch: glucose (simple sugars). Protein: amino acids. Lipid: fatty acids and glycerol.

Question 3

(a) starch in plants and glycogen in animals (both needed; accept glycogen in animals and fungi) **B1**

(a) Answer: Starch: plants. Glycogen: animals.

(b) glucose **B1**

(b) Answer: Glucose

(c) insoluble molecules do not dissolve in the cell contents / do not change the water concentration of the cell **B1**

(c) so water does not enter the cell by osmosis (or the cell does not swell or burst); accept: a large molecule can be stored compactly **B1**

(c) Answer: Being insoluble they do not affect osmosis, so the cell does not take in water and swell.

Question 4

(a) add Benedict's solution (which is blue) to the sample in a test tube **B1**

(a) heat in a hot water bath (about 80 degrees C or hot, just below boiling) for a few minutes **B1**

(a) positive result: blue changes to green, yellow, orange or a brick-red precipitate (accept any of the colours of the sequence as the change, brick-red for a lot of sugar) **B1**

(a) Answer: Add Benedict's solution, heat in a hot water bath, and look for a change from blue to green, yellow, orange or brick-red.

(b) wear eye protection (goggles) in case hot liquid splashes; accept tongs/test tube holder because the tube is hot, or heat in a water bath instead of a flame so the liquid does not spit; the reason must match the precaution **B1**

(b) Answer: Wear goggles because hot solution could splash into the eyes.

Question 5

(a) P: starch and protein (both needed) **B1**

(a) Q: reducing sugar / glucose **B1**

(a) R: lipid (fat or oil) **B1**

(a) Answer: P: starch and protein. Q: a reducing sugar (glucose). R: a lipid.

(b) it does not contain starch, a reducing sugar, protein or a lipid (accept: none of the four molecules tested are present) **B1**

(b) Answer: None of the four molecules tested is present.

(c) blue **B1**

(c) Answer: Blue

Question 6

mix (crush or shake) the sample with ethanol so that any lipid dissolves **B1**

pour the ethanol solution (liquid part) into water **B1**

lipid present: a cloudy white emulsion forms **B1**

Answer: Dissolve the sample in ethanol, pour the solution into water, and a cloudy white emulsion shows lipid.

Question 7

the enzyme has an active site (a region with a particular shape) **B1**

the substrate has a shape that is complementary to (fits) the active site **B1**

so only that substrate can bind, forming an enzyme-substrate complex **B1**

the substrate is changed into products which leave the active site, and the enzyme is unchanged **B1**

Answer: Only a substrate with a shape complementary to the active site binds, forming an enzyme-substrate complex; products leave and the enzyme can be reused.

Question 8

(a) 1 / 150 **M1**

(a) 0.0067 per second (accept 0.0067 /s or s^{-1}); ignore trailing zeros **A1**

(a) Answer: 0.0067 per second

(b) 40 degrees C (accept: the temperature tested with the shortest time) **B1**

(b) Answer: 40 degrees C

(c) the enzyme is denatured (at 60 degrees C) **B1**

(c) the active site changes shape so the starch cannot bind and is not broken down (starch remained) **B1**

(c) Answer: The enzyme is denatured, its active site changed shape, so starch was not digested.

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Question 9

set up water baths at a range of different temperatures (for example 20, 30, 40, 50 and 60 degrees C) and check them with a thermometer	**B1**
warm the amylase and the starch separately to each temperature before mixing	**B1**
mix them and every 30 seconds take a sample onto a spotting tile with iodine solution, timing until the iodine stays orange-brown	**B1**
control variables: same volumes and concentrations of starch and amylase	**B1**
control pH using a buffer solution (accept: same pH)	**B1**
repeat at each temperature and calculate a mean (accept: repeat to identify anomalies)	**B1**

Answer: Several temperature water baths; pre-warm; mix and test samples with iodine on a spotting tile until no blue-black; keep volumes, concentrations and pH the same; repeat and take a mean.

Question 10

(a) (20 + 23 + 21) / 3 (= 64 / 3)	**M1**
(a) 21.3 cm^3 (accept 21 cm^3)	**A1**

(a) Answer: 21.3 cm^3

(b) pH 7	**B1**

(b) Answer: pH 7

(c) 42.0 - 2.0 = 40.0 cm^3 decrease	**M1**
(c) 40.0 / 42.0 x 100	**M1**
(c) 95.2 % (accept 95 %)	**A1**

(c) Answer: 95.2 %

Question 11

the enzyme (catalase) is denatured at pH 11 (too alkaline)	**B1**
the shape of the active site has changed	**B1**
so hydrogen peroxide (the substrate) can no longer bind, so little or no oxygen is made (accept: fewer enzyme-substrate complexes)	**B1**

Answer: At pH 11 the catalase is denatured, its active site changes shape, so the substrate cannot bind and little oxygen forms.

Question 12

(a) blue-black (starch is still present)	**B1**

(a) Answer: Blue-black colour

(b) boiling denatures the amylase	**B1**
(b) the active site has changed shape (so starch no longer fits)	**B1**
(b) denaturing is permanent (irreversible), so cooling does not return the original shape	**B1**

(b) Answer: Boiling denatures amylase and changes the active site; this is not reversible so cooling does not help.

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