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Student number

Name _____

Date _____

Attempt/Time taken _____

GCSE
BIOLOGY

Topic Paper: Enzymes (2.2 The human digestive system, 6.1.5 DNA structure) Part 1

Time allowed: 45 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a calculator, which you are expected to use where appropriate.

Instructions

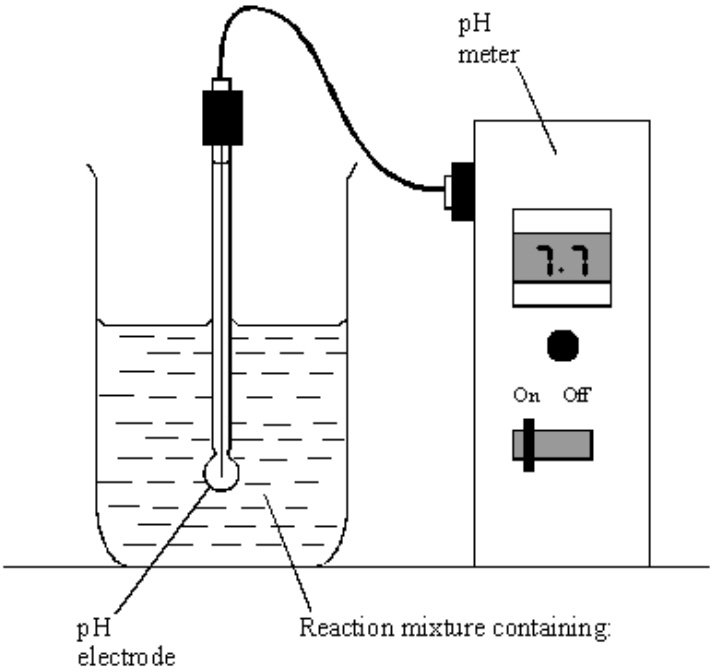
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The Periodic Table/Data Sheet is provided as in insert.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

42 Marks

Q1. The diagram shows the apparatus used to investigate the digestion of milk fat by an enzyme. The reaction mixture contained milk, sodium carbonate solution (an alkali) and the enzyme. In Experiment **1**, bile was also added. In Experiment **2**, an equal volume of water replaced the bile. In each experiment, the pH was recorded at 2-minute intervals.



Either: Experiment 1 **or: Experiment 2**

milk (contains fat)	milk (contains fat)
sodium carbonate solution	sodium carbonate solution
bile	water
enzyme	enzyme

The results of the two experiments are given in the table.

Time in minutes	pH	
	Experiment 1: with bile	Experiment 2: no bile
0	9.0	9.0
2	8.8	9.0
4	8.7	9.0
6	8.1	8.8
8	7.7	8.6
10	7.6	8.2

(a) Milk fat is a type of lipid. Give the name of an enzyme which catalyses the breakdown of lipids.

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(1)

(b) What was produced in each experiment to cause the fall in pH?

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(1)

(c) (i) For Experiment **1**, calculate the average rate of fall in pH per minute, between 4 minutes and 8 minutes. Show clearly how you work out your final answer.

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..... pH units per minute

(2)

(ii) Why was the fall in pH faster when bile was present?

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(1)

(Total 5 marks)

Q2. Bile is produced in the liver, stored in the gall bladder, then released into the small intestine.

(a) Explain how bile affects the digestion of food in the small intestine.

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(2)

(b) Bile contains bile pigments and cholesterol.

If the diet contains too much cholesterol, some of it may form 'gallstones' in the bile.

These gallstones may prevent bile from moving out of the gall bladder into the small intestine.

Bilirubin is a yellow-brown bile pigment. This pigment is produced by the liver from haemoglobin released by broken-down red blood cells.

Suggest how gallstones may produce the following symptoms:

(i) very pale faeces

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(2)

(ii) jaundice (a yellow tinge to the skin).

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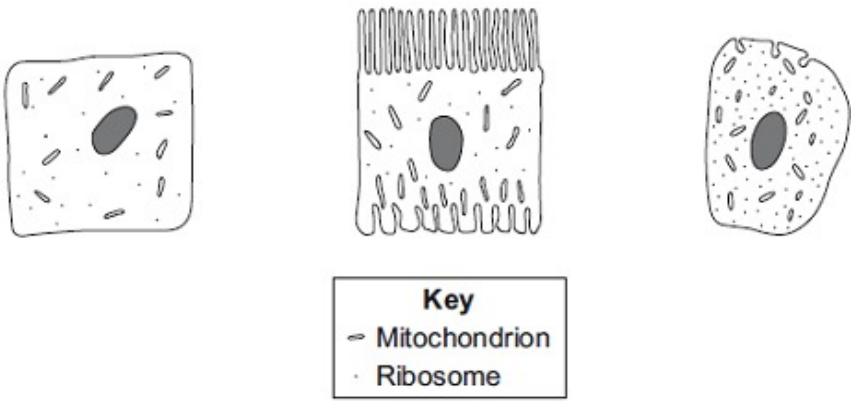
(2)

(Total 6 marks)

Q3. Diagrams **A**, **B** and **C** show cells from different parts of the human body, all drawn to the same scale.

A **B** **C**



(a) Which cell, **A**, **B** or **C**, appears to be best adapted to increase diffusion into or out of the cell? ☐

Give **one** reason for your choice.

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(1)

(b) (i) Cell **C** is found in the salivary glands.

Name the enzyme produced by the salivary glands.

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(1)

(ii) Use information from the diagram to explain how cell **C** is adapted for producing this enzyme.

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(2)
(Total 4 marks)

Q4. A manufacturer is trying to improve the quality of the biological detergent he produces.

Scientists at his company carried out the following experiments on enzymes:

Samples of lipase were collected from five different types of bacterium, **A**, **B**, **C**, **D** and **E**.
The samples were diluted to give the same concentration of lipase.
Agar jelly containing a lipid was prepared in a dish. This forms a cloudy mixture which becomes clear when the lipid is digested.
Five small holes were cut into the agar.
Two drops of lipase solution from bacterium **A** was added to hole **A**.
This process was repeated for each sample of lipase.

Diagram 1 shows the appearance of the dish.

Diagram 1

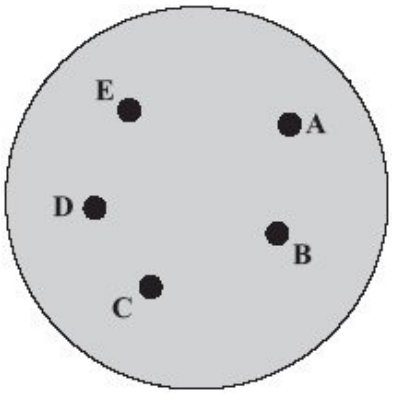
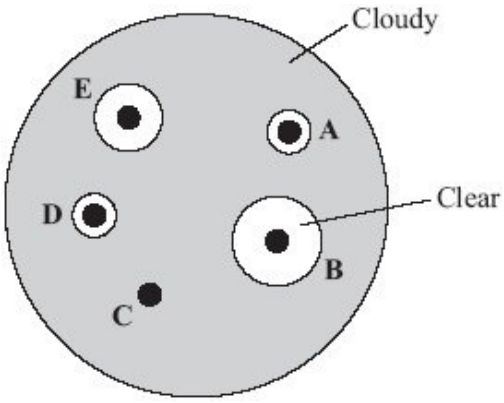


Diagram 2 shows the appearance of the dish 24 hours later.

Diagram 2



(a) (i) Which type of bacterium, **A**, **B**, **C**, **D** or **E**, produced the most effective lipase in this investigation?

Write your answer, **A**, **B**, **C, D** or **E**, in the box. ☐

(1)

(ii) Explain your answer.

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(1)

(b) The manufacturer plans to add the most effective lipase to the washing powders he produces.

Suggest **two** other factors he should investigate before deciding which lipase is the most effective.

1 .....

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2 .....

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(2)

(c) Many biological detergents cannot be used at high temperatures.

Explain why.

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(1)

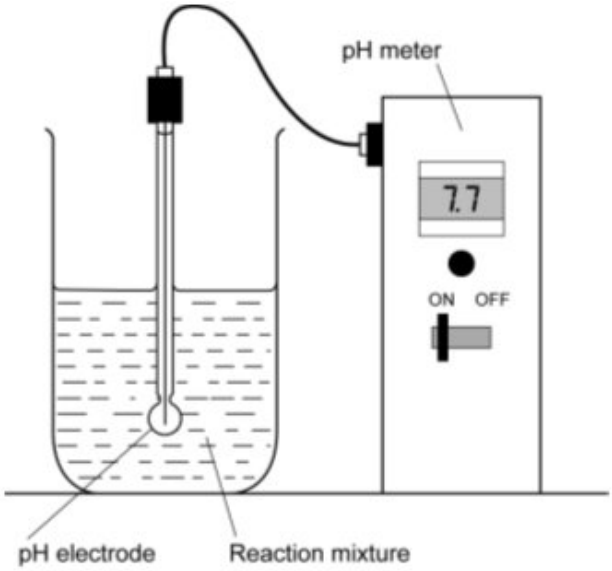
(Total 5 marks)

Q5. The diagram shows the apparatus used to investigate the digestion of milk fat by an enzyme. The reaction mixture contained milk and the enzyme.

In Experiment **1**, bile was also added.

In Experiment **2**, an equal volume of water replaced the bile.

In each experiment, the pH was recorded at 2 minute intervals.



The results of the two experiments are given in the table.

Time in minutes	pH	
	Experiment 1: with bile	Experiment 2: without bile
0	9.0	9.0
2	8.8	9.0
4	8.7	9.0
6	8.1	8.8
8	7.7	8.6
10	7.6	8.2

(a) Milk fat is a type of lipid.

Explain why the pH changed in experiment 2.

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(2)

(b) (i) For **Experiment 1**, calculate the average rate of fall in pH per minute, between 4 minutes and 8 minutes.

Show clearly how you work out your final answer.

.....

.....

..... pH units per minute

(2)

(ii) The average rate of fall in pH per minute for Experiment 2 was 0.1 units of pH per minute.

Explain the difference in the rate of fall in pH when bile is present.

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(1)

(Total 5 marks)

Q6. Fresh milk is a mixture of compounds including fat, protein and about 5 % lactose sugar. Lactose must be digested by the enzyme lactase, before the products can be absorbed.

Lactase can be added to fresh milk to pre-digest the lactose. This makes 'lactose-free' milk, which is suitable for people who do not produce enough lactase of their own.

A student investigated the effect of changing pH and temperature on the digestion of lactose in milk.

The results are shown in **Tables 1** and **2**.

Table 1
Effect of pH

pH	Time taken to digest lactose in minutes
4.0	20
5.0	18
6.0	13
7.0	7
8.0	5
9.0	6

Table 2
Effect of temperature

Temperature in℃	Time taken to digest lactose in minutes
30	20
35	14
40	11
45	6
50	12
55	23

(a) The label on a carton of lactose-free milk states:

'Lactase is normally produced in the stomach of mammals.'

The results in **Table 1** show that this statement is unlikely to be true.

Explain how.

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(2)

(b) Explain as fully as you can the results shown in **Table 2**.

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(3)

(c) Bile is produced in the liver and is released into the small intestine.

Explain how bile helps the digestion of milk.

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(2)
(Total 7 marks)

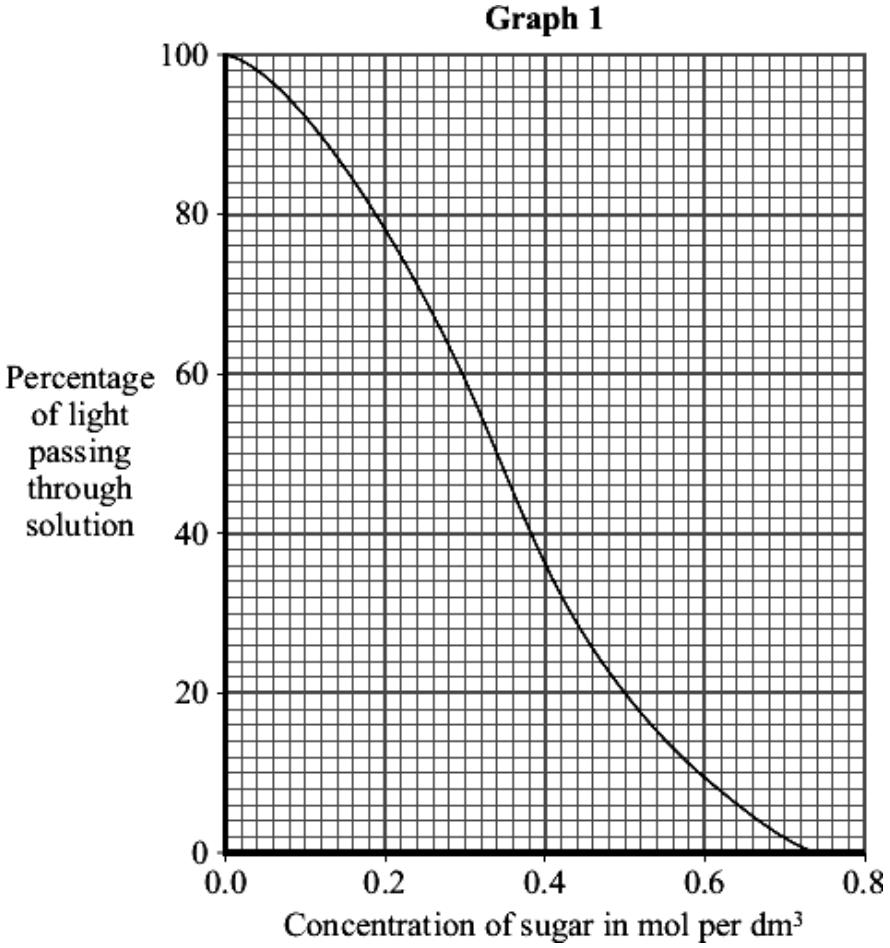
Q7. Starch is broken down into sugar by amylase. Amylase is produced in the salivary glands.

(a) Name **two** other organs in the digestive system which produce amylase.

..... and .....

(2)

(b) A colorimeter measures colour intensity by measuring the percentage of light that passes through a solution.
Graph 1 shows the percentage of light passing through sugar solutions of different concentrations to which a test reagent has been added.



Students used a colorimeter to compare the starch-digesting ability of amylase enzymes obtained from two organs, **P** and **Q**.

The students collected 5 cm^3 samples of amylase from **P** and **Q** and placed them into a water-bath at 40 ℃.

Two test tubes containing 10 cm^3 samples of starch solution were also placed into the water-bath.

All the tubes were left in the water-bath for 10 minutes.

Each amylase sample was added to one of the tubes containing the starch solution.

The test tubes were placed back into the water-bath.

Every minute, a few drops were taken from each tube, the test reagent was added and the percentage of light passing through this solution was measured in the colorimeter.

The tubes containing amylase samples and starch solution were left in the water-bath for ten minutes before the amylase was added to the starch.

Explain why.

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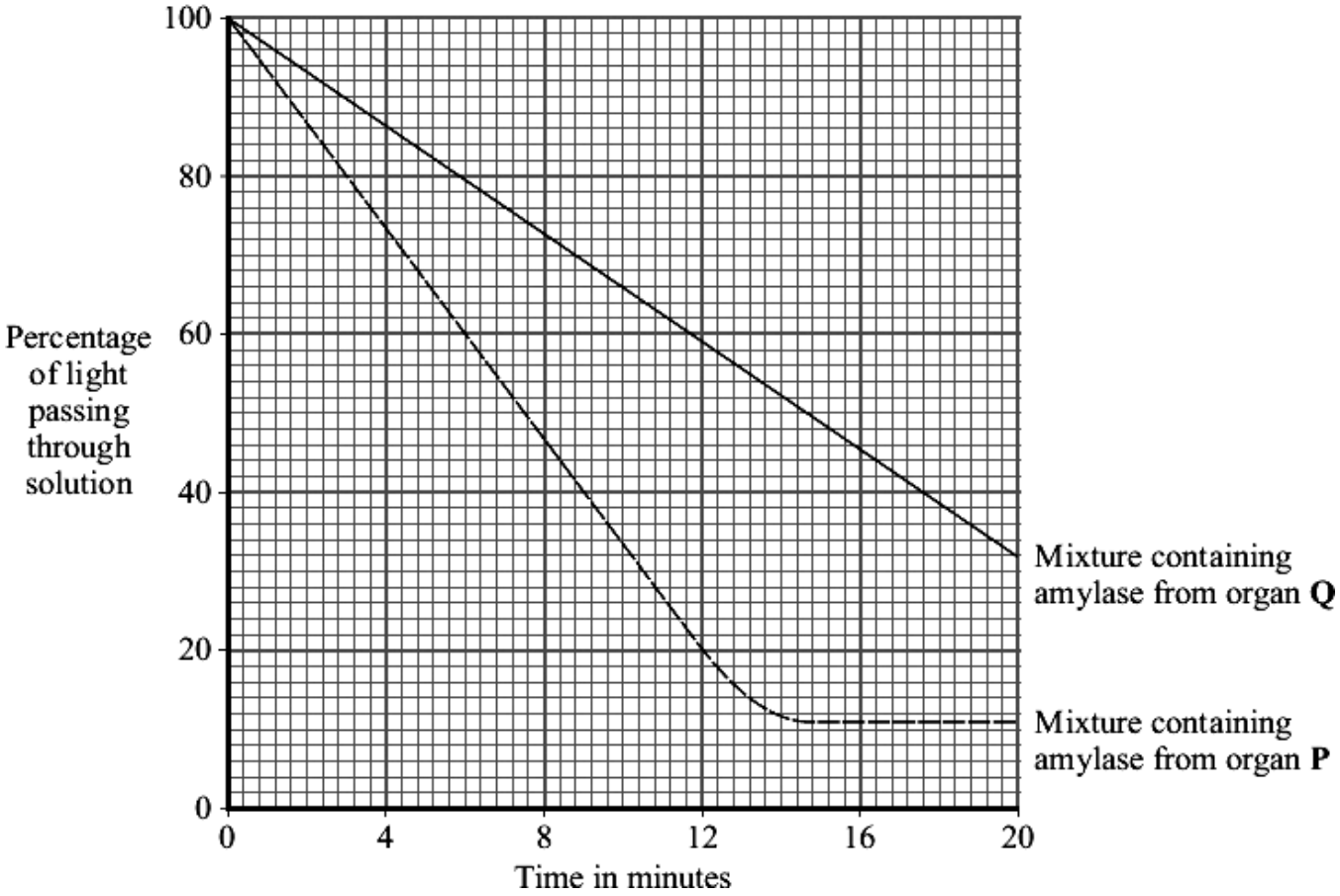
(2)

(c) **Graph 2** shows how the readings from the colorimeter changed over the next 20 minutes.

Graph 2



(i) Use **Graph 1** and **Graph 2** to determine the concentration of sugar in the mixture from organ **Q** after 20 minutes.

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Answer .....mol per dm^3

(1)

(ii) Use your answer to (c)(i) to calculate the rate at which sugar was produced in the mixture containing amylase from organ **Q**.

Show clearly how you work out your answer.

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Answer .....mol per dm^3 per minute

(2)

(iii) Suggest why the amount of light passing through the mixture from organ **P** did not change after 16 minutes.

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(1)

(iv) One of the students suggested that they could have completed their experiment more quickly if the temperature of the water-bath had been set at 80 ℃.

This would **not** have been the case.

Explain why.

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(2)
(Total 10 marks)