

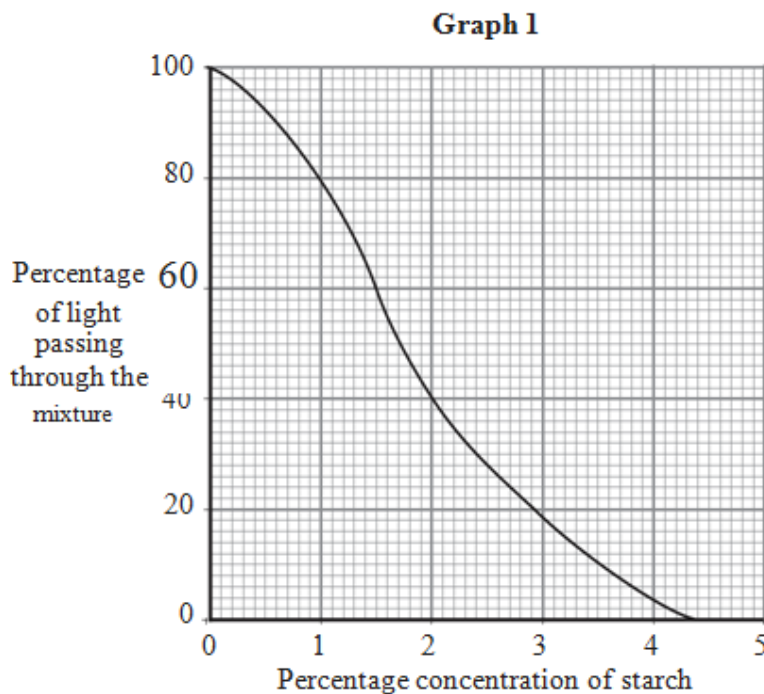
Enzymes and Digestion 2

Q:1 A manufacturer of slimming foods is investigating the effectiveness of carbohydrases from different microorganisms.

Iodine solution is a pale golden brown, transparent solution. Starch reacts with iodine to form a dark blue mixture.

Known concentrations of starch are added to iodine solution. The mixture is placed in a colorimeter which measures the percentage of light passing through the mixture.

Graph 1 shows the results.



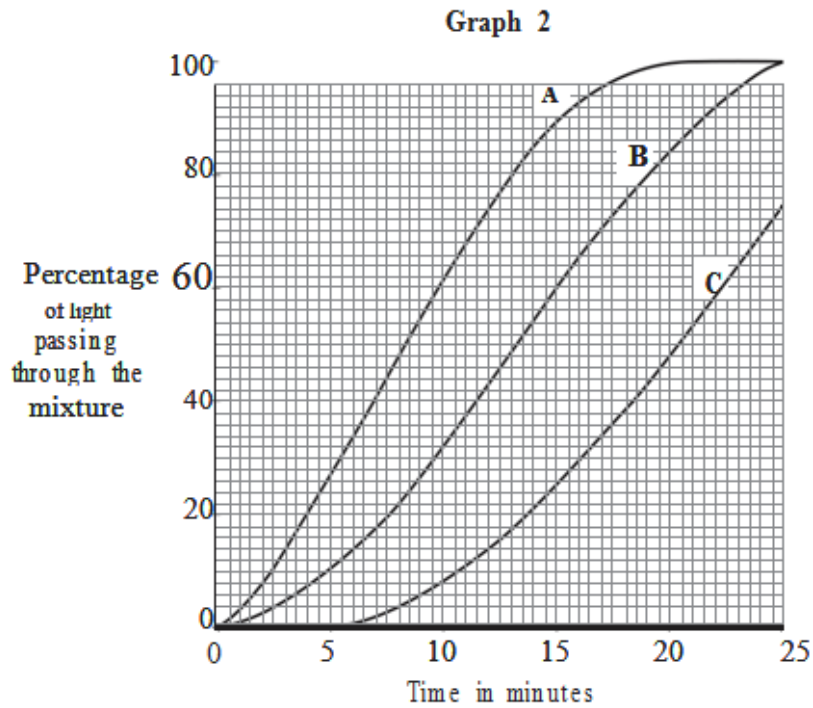
(a) Explain why less light passes through the mixture when the starch is more concentrated.

(1 mark)

(b) The manufacturer adds carbohydrase from each of three different microorganisms, A, B and C, to starch in flasks at 40 °C.

Every minute a sample of the mixture is added to iodine solution and placed in the colorimeter.

Graph 2 shows these results.



(b)(i) When the concentration of starch reaches 2 %, digestion is considered to be sufficient for the next stage in the manufacture of the slimming food.

How long does this take for the most effective carbohydrase?

Show clearly how you work out your answer.

_____ minutes

(2 marks)

(b)(ii) Explain why the manufacturer carried out the investigation at 40 °C.

(2 marks)

(c) Carbohydrases convert starch into glucose. To complete the manufacture of the slimming food the glucose should be converted into fructose.

(c)(i) Name the enzyme which would be used to convert glucose into fructose.

(1 mark)

(c)(ii) Explain why fructose, rather than glucose, is used in slimming foods.

(2 marks)

Q:2 A group of pupils investigated the digestion of fat by the enzyme lipase.

(a) What two substances are produced when fats are digested? Tick (☑) two boxes.

Glucose

Fatty acids

Glycerol

Amino acids

(2 marks)

In the investigation:

- the pupils set up five test tubes
- each tube contained 1 cm³ of fat and 10 cm³ of lipase solution
- each tube was kept at a different temperature for 24 hours.

(b)(i) Give one control variable in this investigation.

(1 mark)

(b) (ii) What was the independent variable being investigated?

(1 mark)

(c) The pH of the solution in each tube was tested at the beginning of the investigation and after 24 hours.

The results of the pupils' investigation are shown in the table.

Tube	Temperature in °C	pH at the beginning	pH after 24 hours
1	0	Neutral	Neutral
2	20	Neutral	'Weak' acid
3	40	Neutral	'Strong' acid
4	60	Neutral	'Weak' acid
5	80	Neutral	Neutral

One pupil said, "We might not have found the best temperature for the lipase to work".

What more could they do to find the best temperature?

(2 marks)

(d) The pupils then placed Tube 1 into a water-bath kept at 40 °C. The tube was left in the water-bath for 24 hours.

(d)(i) What pH would you expect the contents of the tube to be after the extra 24 hours?

Tick (☑) one box.

Neutral

'Strong' acid

'Weak' acid

(1 mark)

(d)(ii) Give the reason for your answer.

(1 mark)

Q:3 Starch is broken down into sugar by amylase. Amylase is produced in the salivary glands.

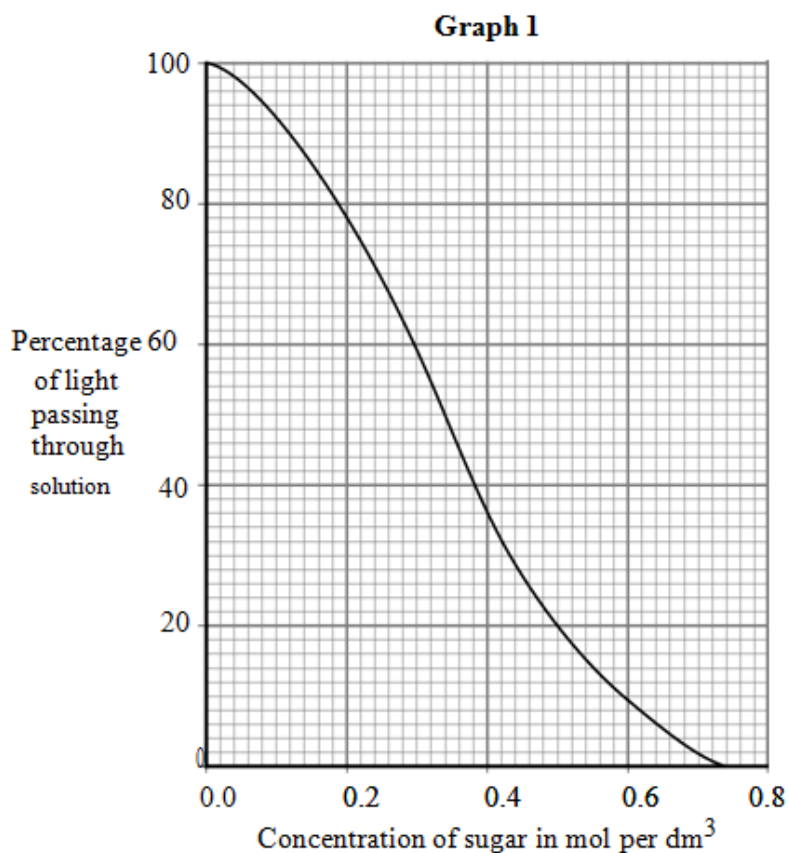
(a) Name two other organs in the digestive system which produce amylase.

_____ and _____

(2 marks)

(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 cm³ samples of amylase from P and Q and placed them into a water-bath at 40 °C.

Two test tubes containing 10 cm³ 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.

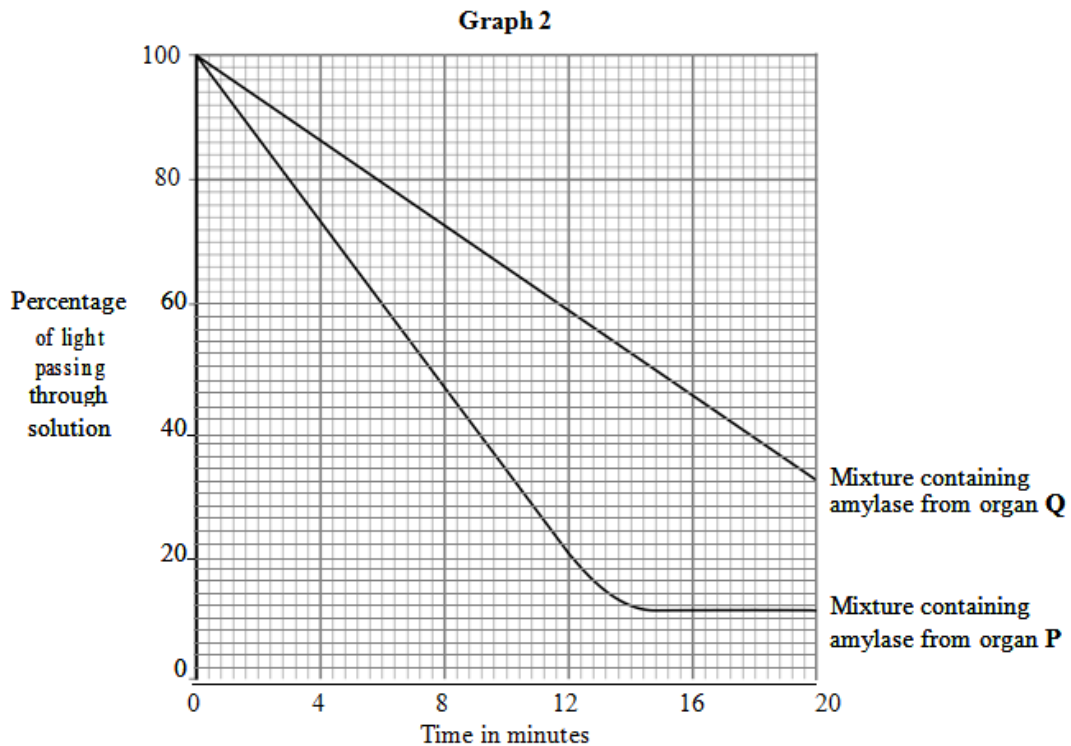
Every minute, a few drops were taken from each tube, the test reagent was added and the percentage of light passing through this solution was measured in the colorimeter.

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.

(2 marks)

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



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

Answer _____ mol per dm³

(1 mark)

(c)(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.

Answer _____ mol per dm³ per minute

(2 marks)

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

(1 mark)

(c)(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 °C.

This would not have been the case. Explain why.

(2 marks)

Q:4 Denim jeans can be coloured with blue dye. The dye joins on to the fibres of the material. Some people like their denim jeans to look faded. This is called 'stonewashed'. There are two different ways to make denim material look faded.

Traditional stone washing

Denim material is put in a slowly spinning container with large stones. Very hot water is added.

Washing takes up to five hours.

Washing breaks some of the denim fibres and lets the dye come out from the fibres. Washing will work with any dye.

Bio-stonewashing

- Denim material is washed with enzymes in warm water.
- Washing takes half an hour.
- The enzymes let the dye come out from the fibres.
- Different enzymes are needed for different dyes.
- The enzymes are expensive.
- After the treatment the enzymes have to be removed from the denim.

(a) Use only the information above to answer this question.

(a) (i) Suggest two advantages of using the bio-stonewashing method instead of the traditional stonewashing method.

1 _____

2 _____

(2 marks)

(a) (ii) Suggest two disadvantages of using the bio-stonewashing method instead of the traditional stonewashing method.

1 _____

2

(2 marks)

(b) Some blue dyes are made of protein.

What type of enzyme would be used to remove these blue dyes from denim?

Draw a ring around one answer.

carbohydrase lipase protease

(1 mark)

Q:5 There are enzymes in biological washing powders. Biological washing powder has to be used at temperatures below 45 °C.

(a) The enzymes in biological washing powders do not work on the stains on clothes at temperatures above 45 °C.

Explain why.

(2 marks)

(b) Some bacteria, called thermophilic bacteria live in hot springs at temperatures of 80 °C.

Scientists have extracted enzymes from these thermophilic bacteria. These enzymes are being trialled in industrial laundries.

The laundries expect to increase the amount of clothes they can clean by using enzymes from thermophilic bacteria instead of using the biological washing powders the laundries use now.

(b) (i) The laundries expect to be able to increase the amount of clothes that they can clean each day.

Suggest why.

(2 marks)

(b) (ii) Using washing powders with enzymes from thermophilic bacteria may be more harmful to the environment than using the biological washing powders that laundries use now.

Suggest why.

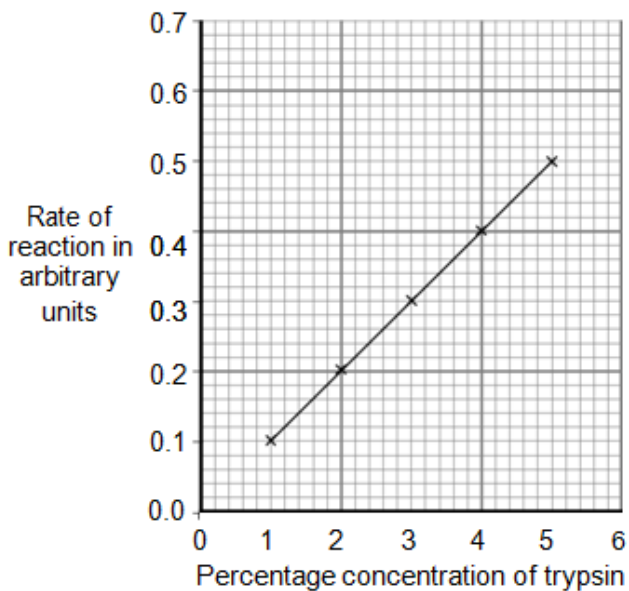
(2 marks)

Q:6 Trypsin is a protease enzyme. Trypsin will digest a protein called gelatine which covers the surface of photographic film.

Some students investigated the time taken to digest the gelatine with trypsin. The students used five different concentrations of trypsin.

The rate of reaction was calculated from the time taken for the gelatine to be digested.

The graph shows the students' results.



(a) (i) Describe the relationship between the concentration of trypsin and the rate of reaction.

(2 marks)

(a) (ii) Use the graph to predict the rate of reaction with 6 % trypsin.

_____ . arbitrary units

(1 mark)

(b) In industry, trypsin is used to pre-treat some baby foods.

In their experiment, the students used 1– 5 % trypsin at 20 °C.

The baby food manufacturers make most profit if they use 0.5 % trypsin at 35 °C.

Suggest why the manufacturers make most profit with these conditions.

(4 marks)

(c) (i) Describe the effect trypsin would have on the baby food.

(2 marks)

(c) (ii) Apart from protease enzymes, give one other use of a named enzyme in industry.

(2 marks)

TOTAL MARKS=48