

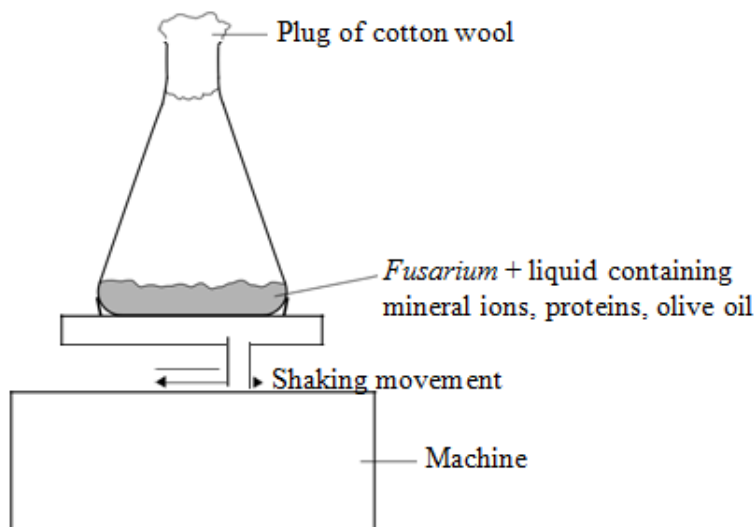
Enzymes and Digestion

Q:1 Lipase is an enzyme used in biological detergents. It catalyses the digestion of fats and oils.

Scientists investigated the production of lipase by the fungus, *Fusarium*.

The scientists made up different liquids containing mineral ions, proteins and olive oil. They mixed 90 cm³ of one of these liquids with a *Fusarium* culture in a flask.

The flask was then shaken on a machine throughout the investigation, as shown in the diagram.



The scientists carried out two investigations.

In each investigation, 10 cm³ of a high concentration of *Fusarium* was used.

In Investigation 1, they varied the concentration of protein.

In Investigation 2, they varied the concentration of olive oil.

In each investigation, they measured the amount of lipase produced in each flask over 72 hours.

They repeated each investigation three times.

(a)(i) The shaking movement mixed the liquid and the Fusarium.

Suggest one further reason why the flasks were shaken throughout the investigations.

(1 mark)

(a) (ii) The high concentration of Fusarium in each flask increased the rate of lipase production.

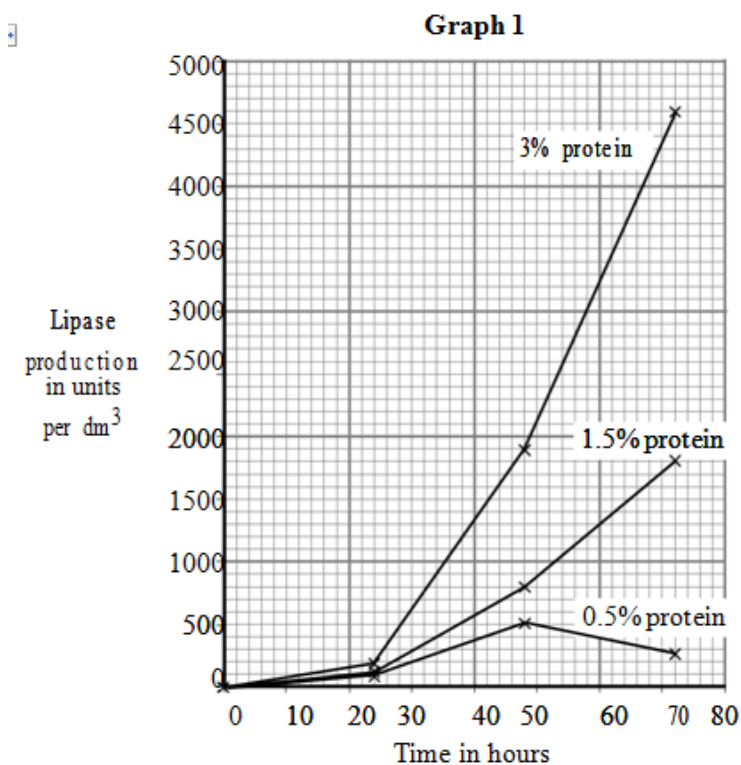
Suggest one other reason why a high concentration of Fusarium was used.

(1 mark)

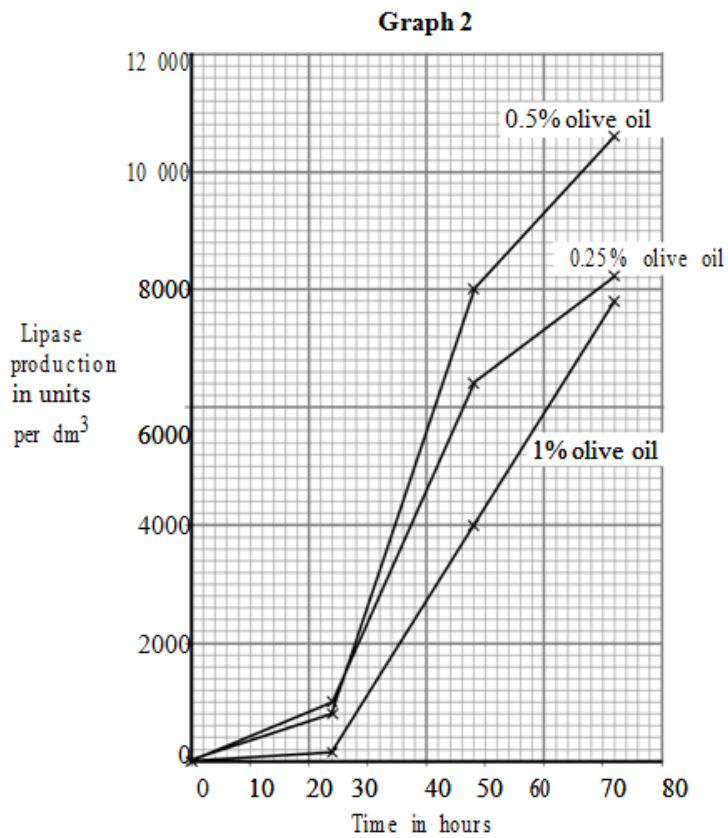
(b) Graphs 1 and 2 show the results of the two investigations.

Graph 1 shows lipase production at three different concentrations of protein.

Graph 2 shows lipase production at three different concentrations of olive oil.



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(b)(i) From Graph 2, calculate the maximum rate of lipase production per hour.

Show clearly how you work out your answer.

Answer = _____ units of lipase per dm³ per hour

(2 marks)

(b)(ii) Each point plotted on Graphs 1 and 2 is the mean of three values.

The scientists published only the mean results in their scientific paper. They did not include the actual measured values.

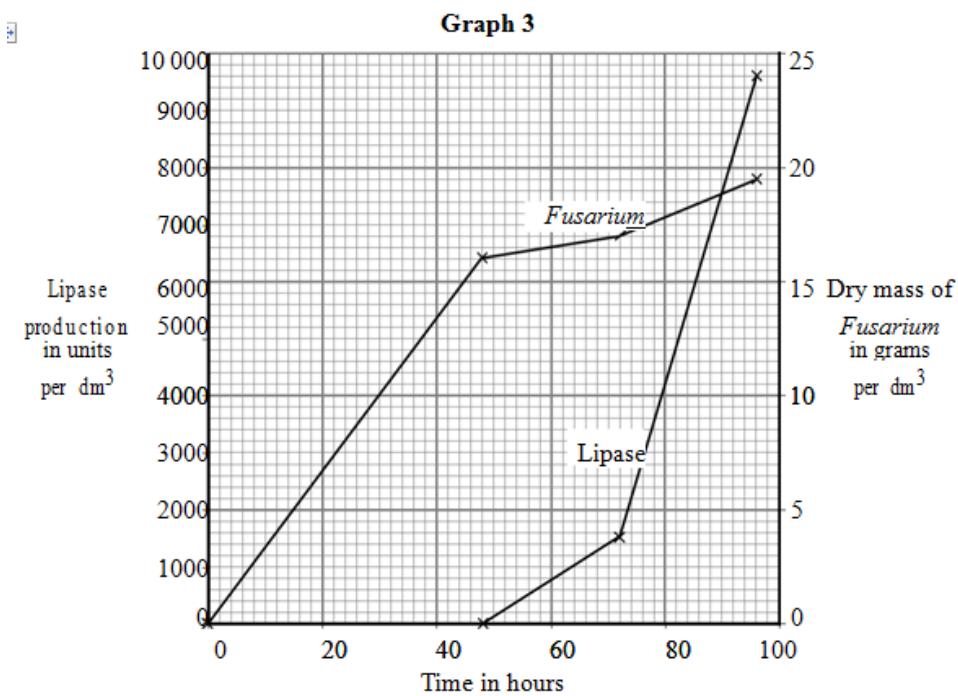
Why would it have been better to have included the actual measured values?

(2 marks)

(c) The scientists then carried out Investigation 3.

They used the results of Investigations 1 and 2 to provide optimum concentrations of protein and olive oil. They measured the dry mass of the *Fusarium* and the amount of lipase produced over 96 hours.

The results of Investigation 3 are shown in Graph 3.



(c)(i) Use information from Graph 3 to describe the relationship between the growth of *Fusarium* and the production of lipase.

(2 marks)

(c)(ii) Suggest an explanation for this relationship.

(2 marks)

Q:2 Microorganisms are often used in the industrial production of useful substances.

The fungus, *Penicillium chrysogenum*, can be used to make an enzyme that digests the sugar sucrose. When it is growing in a medium containing sucrose, the fungus releases this enzyme into the surrounding solution.

(a) Explain why it is useful to the fungus to release the enzyme into the surrounding solution.

(2 marks)

(b) Before setting up an industrial fermenter, laboratory-scale investigations are carried out to find the best conditions to use.

A manufacturer investigated the effect of changing several factors on the amount of enzyme produced by the fungus.

The results are shown in the table.

Condition	Concentration of enzyme produced in arbitrary units		
	24 hours	72 hours	120 hours
Amount of fungus added as %			
1	9.0	28.8	44.4
5	7.2	54.0	60.0
25	6.0	66.0	62.4
Aeration rate in arbitrary units			
0.5	9.0	36.0	45.8
1.0	7.2	54.0	60.0
2.0	10.8	43.2	52.8
Sucrose concentration at start as %			
4	7.2	54.0	60.0
8	3.0	29.7	48.3
12	0	54.0	21.6

The manufacturer decided to use the following conditions:

- amount of fungus = 5%
- aeration rate = 1.0 arbitrary units
- time = 72 hours.

Suggest an explanation for each of the following.

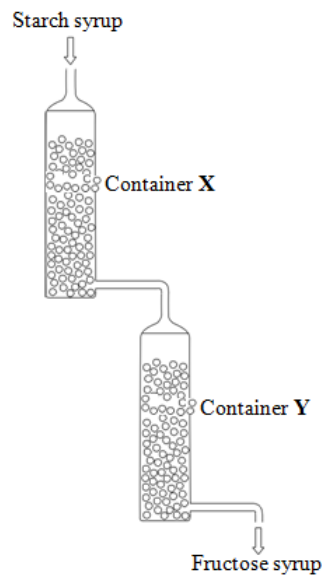
(b)(i) The manufacturer decided to add 5% fungus rather than 25%.

(2 marks)

(b)(ii) The concentration of enzyme produced at an aeration rate of 2.0 arbitrary units was less than the concentration at an aeration rate of 1.0 arbitrary units.

(2 marks)

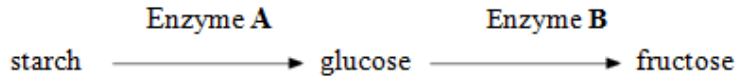
Q:3 The diagram shows an industrial process. Containers X and Y contain enzymes.



(a) Starch syrup slowly trickles into container X.

The enzymes in container X convert the starch into glucose (sugar). The enzymes in container Y convert the glucose into fructose.

The equation shows what happens in containers X and Y.



Choose words from the box to name enzyme A and enzyme B.

carbohydrase isomerase lipase protease

Enzyme A

Enzyme B

(2 marks)

(b) Fructose syrup is much sweeter than glucose syrup.

Why do manufacturers of slimming foods use fructose syrup rather than glucose syrup?

(1 mark)

(c) Here are some of the properties of enzymes: they all work at atmospheric pressures

they are easily broken down by high temperature or the wrong pH

they are soluble in water, so it may be difficult to separate them from products they are expensive to buy

they work well at 25–45 °C.

Use only the information above to answer these questions.

(i) Give two advantages of using enzymes in industry.

1 _____

2 _____

(2 marks)

(ii) Give two disadvantages of using enzymes in industry.

1 _____

2 _____

(2 marks)

Q:4 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.

(2 marks)

(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

(2 marks)

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

(2 marks)

Q:5 Enzymes have many uses in the home and in industry.

(a) Which type of organism is used to produce these enzymes? Tick (☑) one box.

Mammals

Microorganisms

Plants

(1 mark)

(b) Babies may have difficulty digesting proteins in their food. Baby food manufacturers use enzymes to 'pre-digest' the protein in baby food to overcome this difficulty.

Use words from the box to complete the sentences.

amino acids amylases proteases sugars

(b)(i) Proteins are 'pre-digested' using enzymes called _____

(1 mark).

(b)(ii) This pre-digestion produces _____

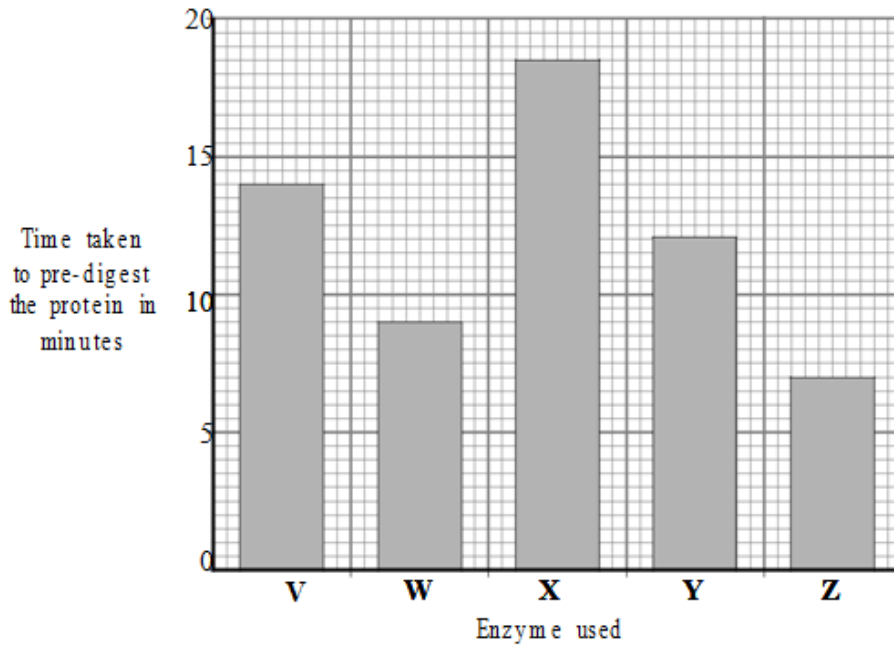
(1 mark).

(c) A baby food manufacturer uses enzyme V to pre-digest protein.

He tries four new enzymes, W, X, Y and Z, to see if he can reduce the time taken to pre-digest the protein.

The graph shows the time taken for the enzymes to completely pre-digest the protein.

The manufacturer uses the same concentration of enzyme and the same mass of protein in each experiment.



(c)(i) How long did it take enzyme V to pre-digest the protein?

_____ minutes

(1 mark)

(c)(ii) Which enzyme would you advise the baby food manufacturer to use?

Draw a ring around your answer.

enzyme V enzyme W enzyme X enzyme Y enzyme Z

Give a reason for your answer.

(2 marks)

(c)(iii) Give two factors which should be controlled in the baby food manufacturer's investigations.

Tick (☑) two boxes.

Oxygen concentration

Temperature

Light intensity

pH

(2 marks)

TOTAL MARKS=37