

2.4 Enzymes

Question Paper

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.4 Enzymes
Difficulty	Hard

Time allowed: 70
Score: /52
Percentage: /100

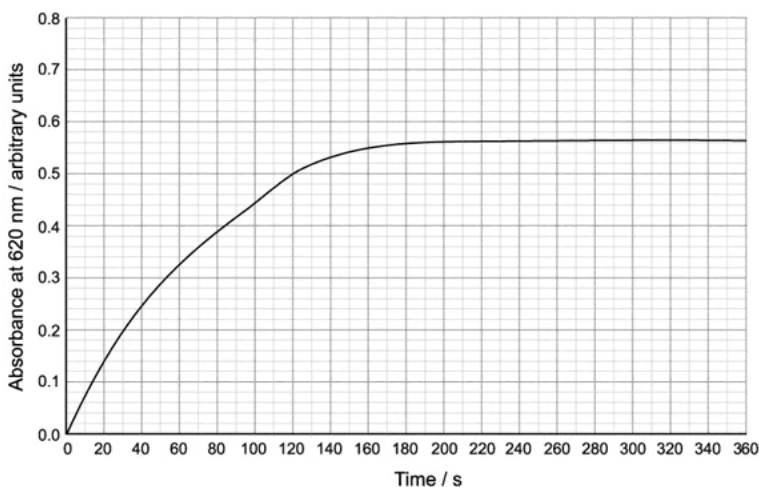
Question 1a

a)

Certain plants that reproduce sexually contain an enzyme called pyrophosphatase. This enzyme plays a role in ensuring self-incompatibility, which is a mechanism that prevents a plant from fertilising itself. The selective advantage of self-incompatibility is that more cross-breeding can occur within a species, which has long term benefits for evolution and for maintaining a large pool of alleles.

Known volumes of pyrophosphatase and substrate can be mixed in a cuvette with a dye that starts as colourless and develops into a blue colour over time. The rate of colour development can be measured in a colorimeter by measuring the absorbance of light at a wavelength of 620 nm (red light).

The graph shows the mean rate of reaction of pyrophosphatase measured over five repeats at 20°C.



State why the wavelength of 620 nm was selected for this experimental measurement.

[1 mark]

[1 mark]

Question 1b

b)

Use the graph from part (a) to calculate the rate of the reaction at 100 seconds. Give your answer in suitable units.

[3 marks]

[3 marks]

Question 1c

c)

i)

Predict the effect that a higher enzyme concentration at the start of the experiment would have on the results calculated in part (b).

[1 mark]

ii)

Explain your answer in part (i).

[1 mark]

[2 marks]

Question 1d

d)

As the temperature increases, the rate at which pyrophosphatase works also increases up to a point, before decreasing.

Explain why these changes in the reaction rate take place.

[3 marks]

[3 marks]

Question 2a

a)
In humans, the enzyme sucrase hydrolyses sucrose. This reaction occurs in the small intestine at 37°C.

i)
Explain why sucrase can only hydrolyse sucrose.

[2 marks]

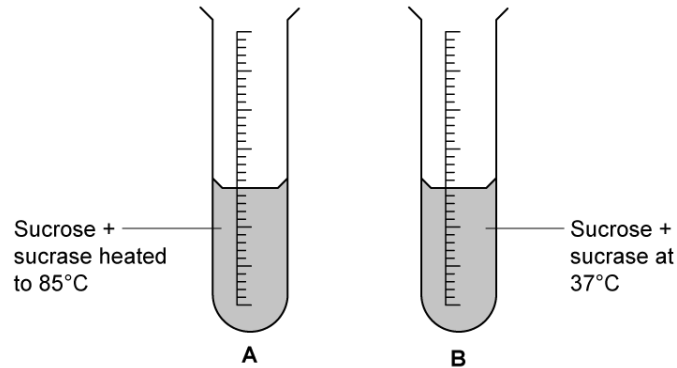
ii)
Describe how sucrase enables this reaction to take place at normal body temperature.

[2 marks]**[4 marks]**

Question 2b

b)

A solution containing sucrose and sucrase was divided equally between two test tubes. One test tube (**A**) was heated to a temperature of 85°C, and the other (**B**) was kept at 37°C, as shown in the diagram below. Both test tubes were monitored for 30 minutes.



i)

Identify which test tube(s) would contain monosaccharides.

[1 mark]

ii)

Explain your answer in part (i).

[2 marks]

[3 marks]

Question 2c

c)

Suggest **two** sources of error that could arise from an experiment to measure the effect of temperature on the rate of an enzyme-controlled reaction.

Assume that in this experiment, the dependent variable is measured as the volume of a gas produced.

[2 marks]

[2 marks]

Question 3a

a)

A significant amount of research has been conducted on the enzyme composition of extremophile microorganisms, in order to discover new enzymes that can be used in the home in extreme conditions. One such organism, *Planococcus halocryophilus*, is a psychrophile (it grows at cold temperatures around 0°C). Trials with the enzymes of *P. halocryophilus* have discovered applications of these enzymes in the detergent industry.

Suggest how these trial results are encouraging for the laundry detergent industry.

[3 marks]

[3 marks]

Question 3b

b)

Many commercially-produced biological laundry detergents contain a range of different enzymes.

Explain why a range of enzymes can improve the detergent's performance in the home.

[3 marks]

[3 marks]

Question 3c

c)

Papain is a proteolytic enzyme derived from the papaya fruit. It has been used in contact lens cleaning solutions to remove denatured protein-containing deposits that accumulate on the surfaces of contact lenses during long periods of wear. The periodic removal of protein deposits increases wearer comfort and extends the wearing time.

The main protein component of tear film fluid is lysozyme.

Suggest a reason for the presence of lysozyme in tear film fluid.

[2 marks]

[2 marks]

Question 3d

d)

Lysozyme and other proteins present in tear film fluid can denature rapidly when in contact with contact lens material. This denatured material loses its original function and forms deposits on the lens surface.

i)

Describe the mode of action of papain against the denatured protein deposits on the surfaces of the contact lenses.

[1 mark]

ii)

Explain the effect that the action of papain would have on these contact lens deposits.

[1 mark]

[2 marks]

Question 4a

a)

The enzyme glucoamylase is a catabolic enzyme that hydrolyses the α -1,4 glycosidic bonds in starch to produce glucose for use in industry.

The enzyme used in this process can be covalently bonded to a substrate of beads to become immobilised. Once immobilised they are able to be used in 11 successive cycles before they need to be replaced.

Suggest a potential method that could be used to determine whether the immobilised enzymes need to be replaced.

[1 mark]

[1 mark]

Question 4b

b)

Glucoamylase has an optimum temperature of 60°C when free in solution, however when it is immobilised the optimum temperature is raised to between 60°C and 80°C.

Explain why this is an advantage to the manufacturers using this immobilised enzyme to produce glucose.

[4 marks]

[4 marks]

Question 4c

c)

Some scientists think that the reason for the increase in optimum temperature of the immobilised enzyme is due to the covalent bonding between the enzyme and the beads that hold them in position. They believe that covalent bonding helps to reduce the influence of high kinetic energy on the bonds within the enzyme structure.

Suggest how this would cause the enzyme to have a higher optimum temperature.

[2 marks]

[2 marks]

Question 4d

d)

One of the sources of glucoamylase for this process is from a species of fungi called *Aspergillus niger*.

Aspergillus niger is a saprotroph.

Suggest **two** advantages of using saprotrophic fungi as a source of enzymes for the industry.

[2 marks]

[2 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a)

Outline how changes in substrate concentration affects the rate of enzyme action.

[3 marks]

[3 marks]

Question 5b

b)

Sometimes the active site of enzymes can be blocked or "inhibited" by substances that aren't the specific substrate for that enzyme.

Suggest how this would affect the rate of reaction of an enzyme-catalysed reaction **as well as** some possible uses of enzyme inhibitors in medicine.

[5 marks]

[5 marks]

Question 5c

c)

Plan an investigation to determine how changing the temperature of amylase affects the rate of reaction of the digestion of starch to maltose.

[7 marks]

[7 marks]

