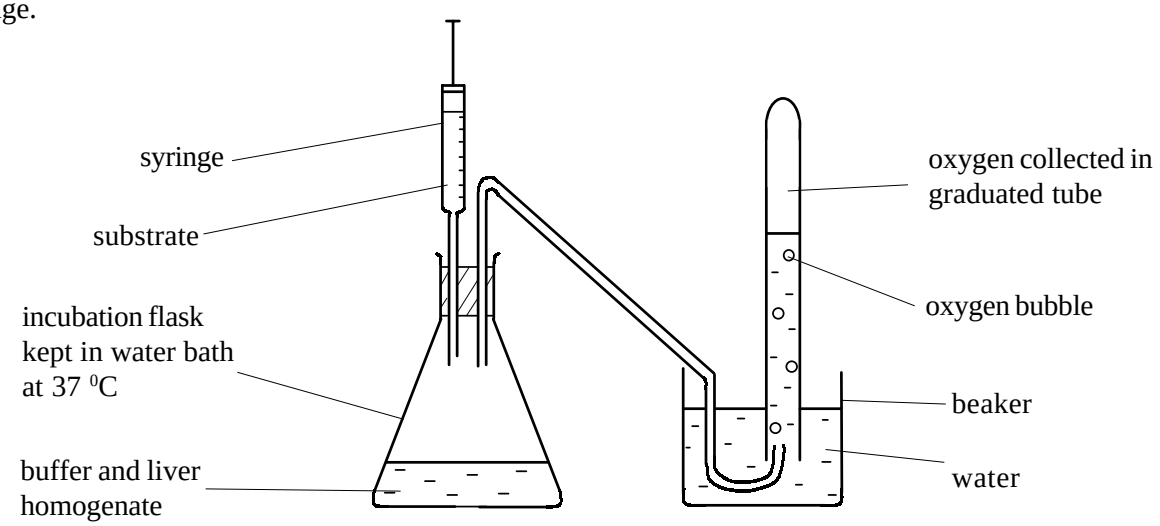
# ENZYMES

QUESTIONSHEET 1

*Do not write in margin*

The apparatus illustrated below can be used to investigate the activity of the enzyme catalase, which is found in liver. The liver tissue has been ground up and mixed with a buffer solution. The substrate may be added via the syringe.




(a) Name the substrate upon which catalase acts.

.....

[1]

(b) (i) Why is it necessary to grind up the liver tissue?

.....

[1]

(ii) State two precautions you would take when preparing a standard homegenate of liver tissue.

1: .....

2: .....

[2]

(c) Describe how you would use this apparatus to investigate the effect of temperature on the activity of catalase.

.....

.....

.....

.....

.....

[5]

(d) Suggest two possible sources of error in your investigation.

1. .....

2. .....

[2]

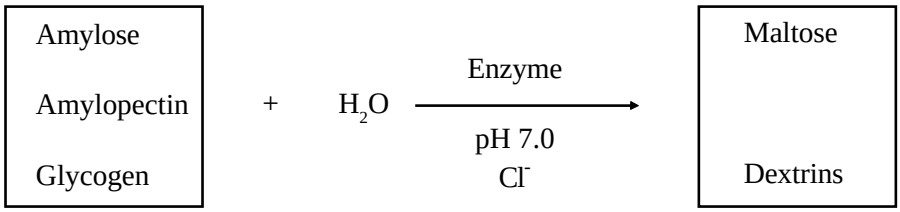
TOTAL / 11

# ENZYMES

QUESTIONSHEET 2

*Do not write in margin*

The equation shows the effect of an enzyme on carbohydrates in the buccal cavity.




(a) Identify the enzyme involved in this reaction.

.....

[1]

(b) Explain:

(i) the role of the chloride ions in this reaction.

.....

.....

[2]

(ii) why this reaction does not continue in the stomach.

.....

.....

[2]

(c) Maltose digestion is completed elsewhere in the gut. Name the enzyme involved, the digestive juice which contains the enzyme and the end product.

Enzyme: .....

Digestive juice: .....

Product: .....

[3]

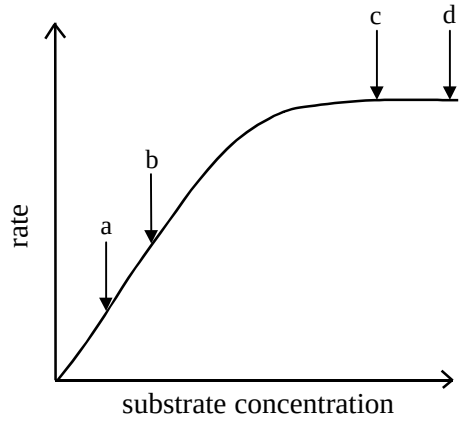
TOTAL / 8

# ENZYMES

QUESTIONSHEET 3

*Do not write in margin*

The graph shows the effect of substrate concentration on the rate of an enzyme controlled reaction.




(a) Explain the shape of the graph between:

(i) a and b.

.....

.....

.....

[3]

(ii) c and d.

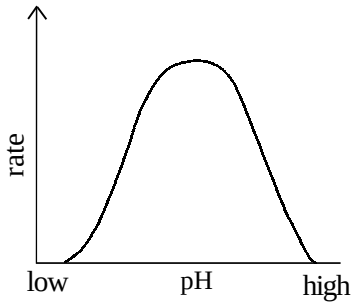
.....

.....

.....

[3]

The figure shows the effect of pH on the rate of an enzyme controlled reaction.




(b) Explain the shape of the curve.

.....

.....

.....

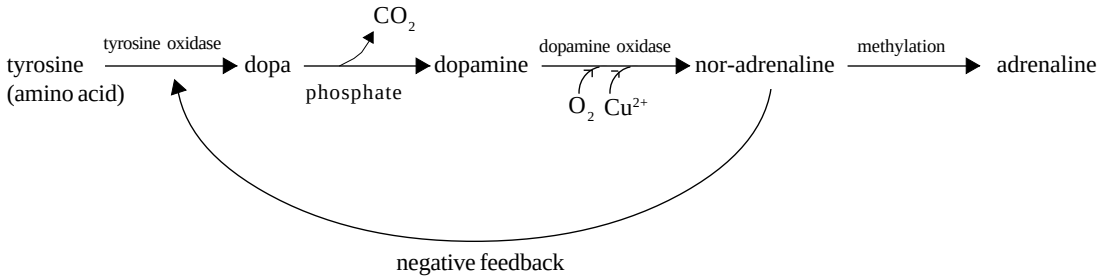
.....

[4]

TOTAL / 10

*Do not write in margin*

The figure shows some of the enzyme-controlled steps involved in the synthesis of nor-adrenaline and adrenaline.




(a) Explain the term 'metabolic pathway'.

.....

.....

[2]

(b) What is the action of the enzyme which is involved in the conversion of Dopa into Dopamine?

.....

[1]

(c) Suggest one function of the phosphate in the reaction.

.....

[1]

(d) Using information in the diagram explain how the body regulates the amount of adrenaline which is produced.

.....

.....

.....

[2]

(e) Suggest a site in the body where the above metabolic pathway would occur.

.....

[1]

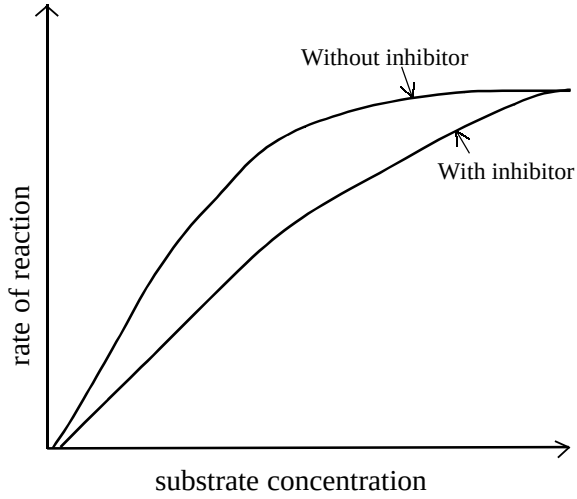
TOTAL / 7

# ENZYMES

QUESTIONSHEET 5



The graph shows the effect of substrate concentration on the rate of an enzyme-controlled reaction with and without the addition of a competitive inhibitor.




(a) Define the term 'competitive inhibitor'.

.....

.....

.....

[2]

(b) Suggest an explanation for the effect of the inhibitor on the rate of reaction when substrate concentration is high.

.....

.....

.....

[2]

(c) State three differences between competitive and non-competitive inhibitors.

1: .....

2: .....

3: .....

[3]

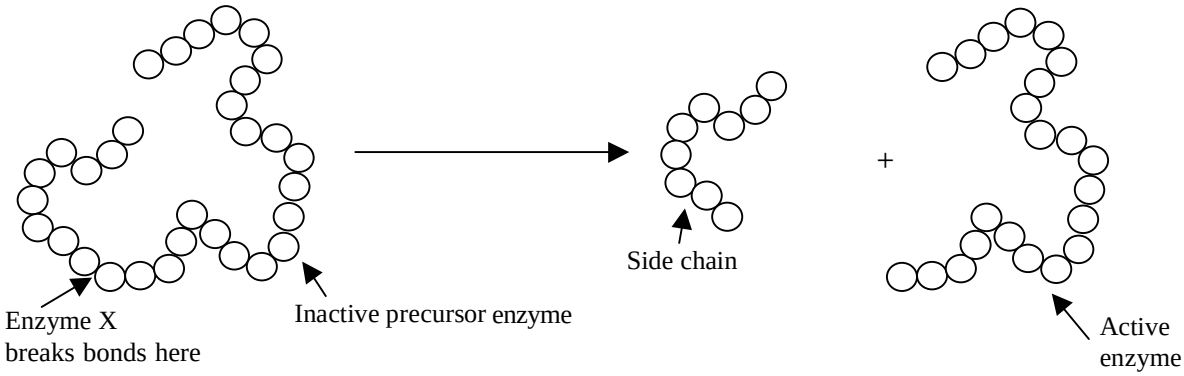
TOTAL / 7

# ENZYMES

QUESTIONSHEET 6

*Do not write in margin*

The diagram shows how a hydrolytic enzyme (X) converts an inactive precursor enzyme into an active form.




(a) Explain:

(i) the effect of enzyme X.

.....

.....

.....

.....

[3]

(ii) why enzyme X always acts on the same part of the inactive precurser.

.....

.....

.....

[2]

(iii) why enzymes may be held in inactive forms.

.....

.....

[1]

(b) State an example of an enzyme that is secreted in inactive form and name the agent that activates it.

name of enzyme: .....

name of activator: .....

[2]

TOTAL / 8

# ENZYMES

QUESTIONSHEET 7



Sucrose is a disaccharide which is broken down into glucose and fructose by the enzyme sucrase. An investigation was carried out into the effect of temperature on sucrase activity. A measured volume of sucrase solution was added to and mixed with a known volume of sucrose solution. At 60 second intervals for 5 minutes, 1cm$^3$ samples of the mixture were removed and tested with Benedicts reagent. The investigation was repeated at 25$^o$C, 40$^o$C and 65$^o$C.

(a) Describe how you would set up and maintain a mixture of sucrose and sucrase at 65$^o$C.

.....

.....

.....

.....

[4]

(b) Explain how the Benedicts reagent would indicate the activity of the enzyme.

.....

.....

.....

[2]

(c) A student's recording of the first three minutes of this investigation are shown below.

| Time/seconds | Temperature/$^o$C | | |
|---|---|---|---|
| | 25 | 40 | 65 |
| 30 | Blue solution | Pale green-yellow solution | Pale blue-green solution |
| 60 | Pale green solution | Orange-red solution | Pale blue-green solution |
| 90 | Yellow solution | Brick red precipitate | Blue solution |
| 120 | Orange solution | Brick red precipitate | Blue solution |
| 150 | Brick red precipitate | Brick red precipitate | Blue solution |
| 180 | Brick red precipitate | Brick red precipitate | Blue solution |

(i) Explain the difference between the results obtained at 25$^o$C and 40 $^o$C.

.....

.....

[2]

(ii) Explain the results obtained at 65 $^o$C.

.....

.....

[3]

TOTAL / 11

# ENZYMES

QUESTIONSHEET 8



Catalase is an enzyme which breaks down hydrogen peroxide into water and oxygen. Hydrogen peroxide is a highly toxic waste product of metabolism.

An investigation was carried out to determine the relative amounts of catalase in samples of potato, liver and apple. Samples of each tissue were ground up using an homogeniser. Samples of these tissues were then added to hydrogen peroxide solution in a measuring cylinder. The table below shows the height of the resulting effervescence in each cylinder.

| | Sample | | |
|---|---|---|---|
| | Potato | Liver | Apple |
| Height of effervescence/$cm^3$ | 4 | 9 | 1 |

(a) State four precautions which should have been taken in this investigation.

1. .....

2. .....

3. .....

4. .....

[4]

(b) (i) Which tissue appeared to contain the most catalase?

.....

[1]

(ii) Suggest an explanation for this.

.....

[1]

(c) Explain why an increase in enzyme concentration usually increases the rate of reaction.

.....

.....

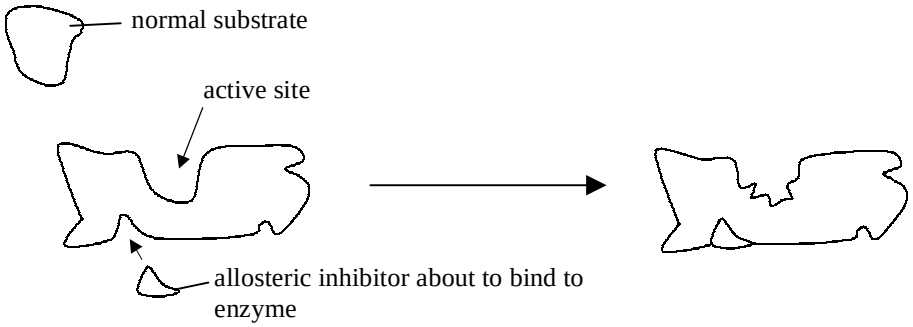
.....

[2]

TOTAL / 8

*Do not write in margin*

The diagram shows the effect of an allosteric inhibitor on an enzyme.




(a) What is the effect of the allosteric inhibitor on the enzyme?

.....

[1]

(b) (i) What is the effect of the allosteric inhibitor on the catalytic activity of the enzyme.

.....

[1]

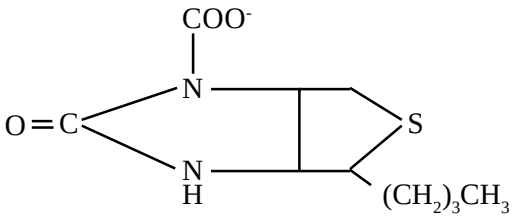
(ii) Explain why this occurs.

.....

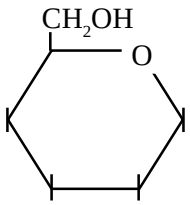
.....

[2]

Substances X and Y, shown below, are inhibitors of glucose phosphorylase.




X




Y

(c) Which substance is likely to be a competitive inhibitor of glucose phosphorylase?
Explain your answer.

.....

.....

.....

[3]

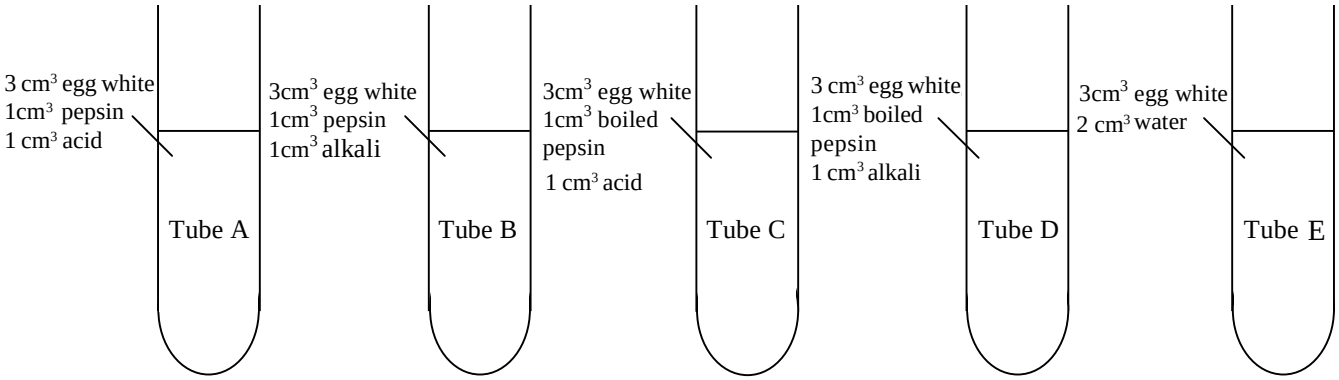
TOTAL / 7

# ENZYMES

QUESTIONSHEET 10



Pepsin is a protease, an enzyme which breaks proteins into peptide fragments. Pepsin works in the human stomach. A student carried out an investigation into some of the factors which affect the ability of pepsin to digest the protease in a suspension of egg white. Four test tubes were set up as follows.




The student found that only the mixture in Tube A clarified.

(a) Suggest why the mixture remained cloudy in tubes,

(i) B.

.....

.....

[2]

(ii) C and D.

.....

.....

[2]

(iii) E.

.....

.....

[1]

A friend of the student suggested that the pepsin in Tube A would have been used up in the reaction.

(b) Suggest how the student could show that this had not happened.

.....

.....

[1]

(c) Why was it necessary to include both tubes C and D in the investigation?

.....

[1]

TOTAL / 7

# ENZYMES

QUESTIONSHEET 11

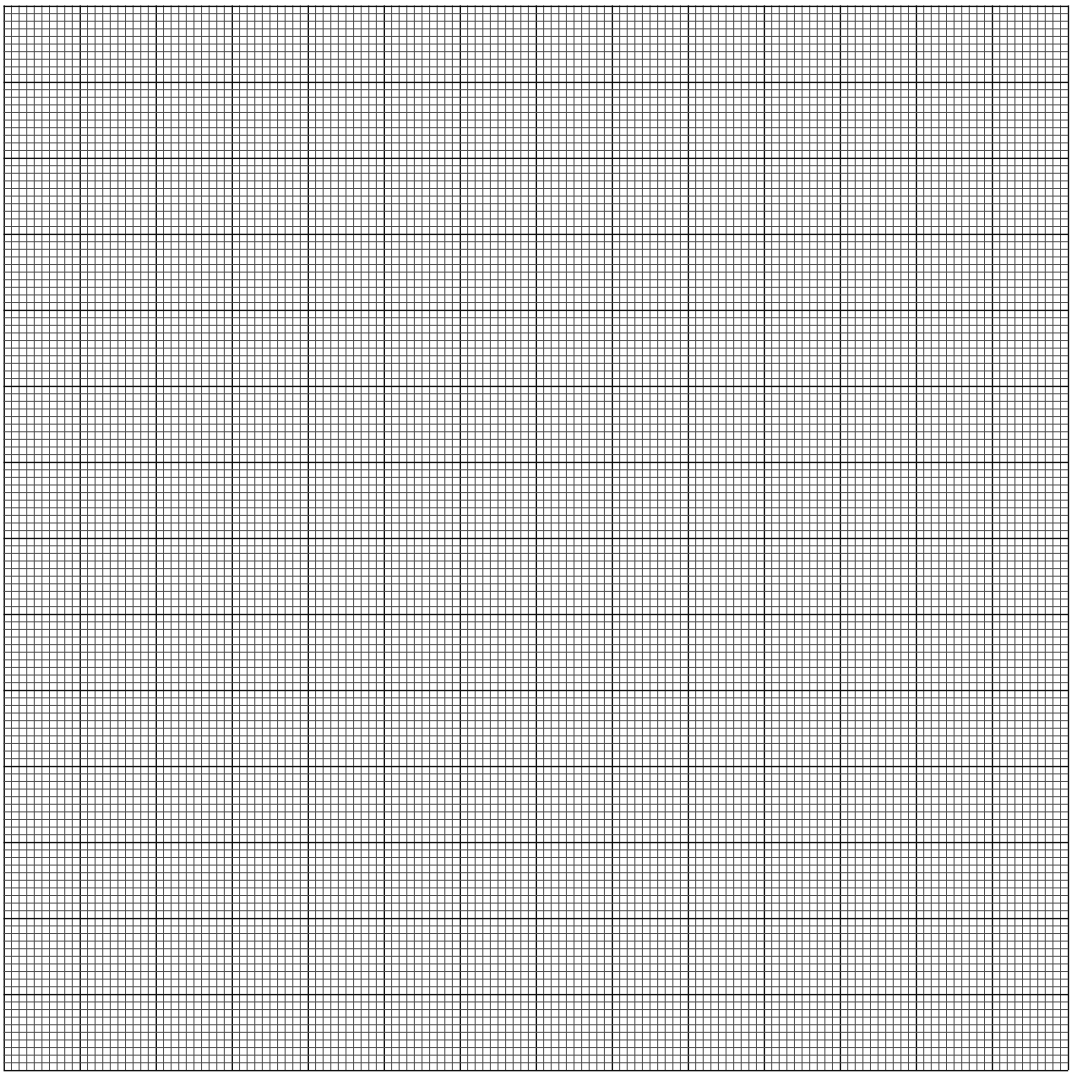


The activity of trypsin can be determined experimentally by measuring the rate at which amino acids are formed by the hydrolysis of a protein such as albumin.

An experiment was carried out to investigate the effect of trypsin concentration on its activity. Two solutions of trypsin, A and B, of differing concentrations, were incubated with a dilute albumin solution. The concentration of amino acids produced was measured every two minutes for fourteen minutes. The results are shown in the table below.

| Time/min | Concentration of amino acids produced /micromoles $dm^{-3}$ | |
|---|---|---|
| | Trypsin solution A | Trypsin solution B |
| 0 | 0.2 | 0.2 |
| 2 | 1.2 | 0.4 |
| 4 | 2.3 | 0.7 |
| 6 | 3.4 | 1.0 |
| 8 | 4.4 | 1.2 |
| 10 | 5.3 | 1.3 |
| 12 | 6.2 | 1.4 |
| 14 | 7.1 | 1.5 |

(a) Plot the results on graph paper below.



[5]

(*Continued...*)

*Do not write in margin*

(b) From your graph find the mean rate of amino acid production in A between 3 and 11 minutes. Show your working.

Answer ..... [2]

(c) (i) Which of the two solutions contained the highest concentration of trypsin? Explain your answer.

.....
[1]

(ii) State two conditions which should be kept constant in this experiment and in each case, say how.

1. .....

..... [2]

2. .....

..... [2]

(d) State two commercial applications of the use of protease enzymes.

1 ..... [1]

2 ..... [1]

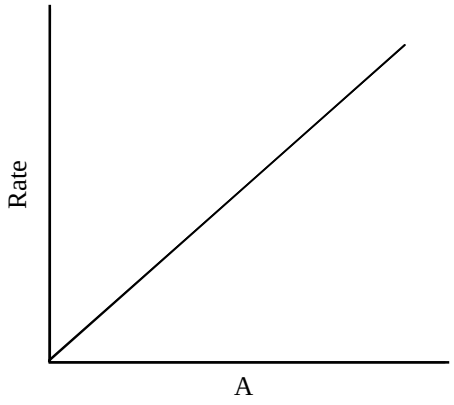
TOTAL / 14

# ENZYMES

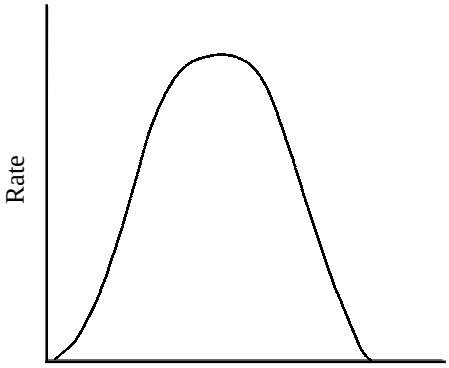
QUESTIONSHEET 12



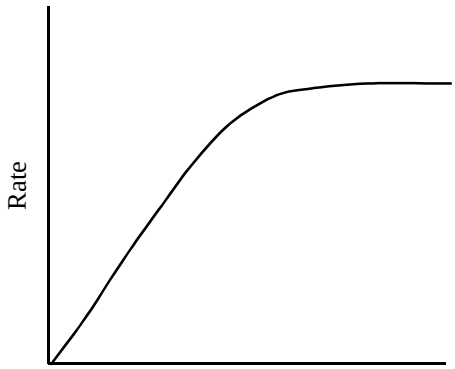
The graphs below show the effect of a number of factors on the rate of enzyme controlled reactions.



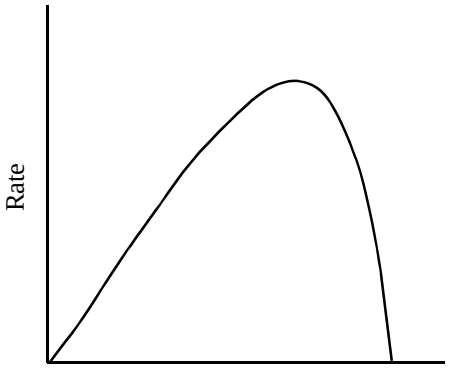

A




B




C




D

(a) Which graph shows the most likely effect of changing:

(i) substrate concentration?

.....

[1]

(ii) temperature?

.....

[1]

(iii) pH?

.....

[1]

(iv) enzyme concentration when substrate is unlimited?

.....

[1]

(b) Name a competitive inhibitor and the enzyme it inhibits.

.....

.....

.....

[2]

TOTAL / 6

# ENZYMES

QUESTIONSHEET 13



The table below refers to the enzymes amylase and lactic dehydrogenase. If the feature is correct, place a tick (✓) in the appropriate box and if the feature is incorrect, place a cross (✕) in the appropriate box.

| Feature | Amylase | Lactic dehydrogenase |
|---|---|---|
| Will breakdown lactose | | |
| Found only in animals | | |
| Requires NAD as coenzyme | | |
| Is classed as a hydrolase | | |
| Can be manufactured by genetic engineering | | |
| Can be used to make yoghurt | | |

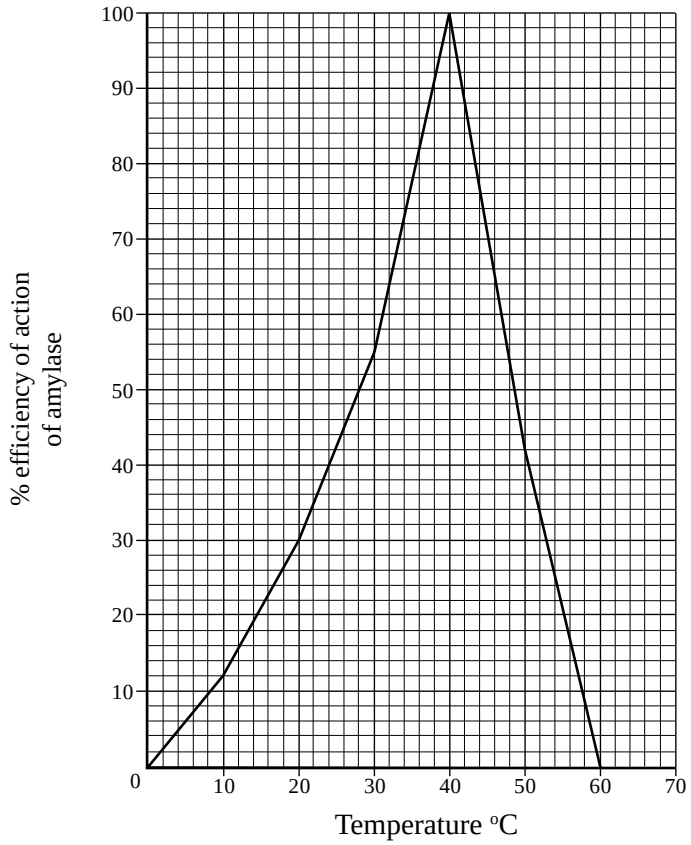
TOTAL / 6

# ENZYMES

QUESTIONSHEET 14



The graph below shows the effect of temperature change on the efficiency of action of the enzyme salivary amylase from the parotid salivary gland.




(a) From the graph find the efficiency of salivary amylase at 25°C.

.....

[1]

(b) (i) Name another mammalian organ which secretes amylase.

.....

[1]

(ii) Suggest one reason why this organ produces hydrogen carbonate ions.

.....

[1]

(c) With reference to amylase explain why germinating seeds require warmth.

.....

.....

.....

[3]

(d) Explain the fall in efficiency at temperatures above 40°C.

.....

.....

[2]

TOTAL / 8

# ENZYMES

QUESTIONSHEET 15



Read through the following account about enzymes and then fill in the gaps with the most appropriate word or words.

A ligase is a class of enzyme that uses the energy from ..... to assemble a bond, such as a peptide bond between two amino acids or a ..... bond between two sugar molecules. Digestive enzymes are usually classed as ..... since they split food molecules by the addition of ..... . Dehydrogenase enzymes are classed as ..... and generally work together with a specific coenzyme. The dehydrogenases involved with the Kreb's cycle require..... as coenzyme. The dehydrogenases involved with photosynthesis require.....as coenzyme. Enzymes generally work by lowering the ..... required to make a reaction work. [8]

TOTAL / 8

# ENZYMES

QUESTIONSHEET 16



The enzyme pectinase is used commercially to clarify wines and fruit juices.

(a) Suggest how pectinase helps to clarify fruit juice.

.....

.....

.....

.....

[3]

(b) Apple juice is produced by crushing ripe apples to squeeze out the juice which can then be separated by filtration. Design an experiment, which you could perform in the laboratory, to show that use of pectinase will increase the volume and clarity of apple juice released.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[8]

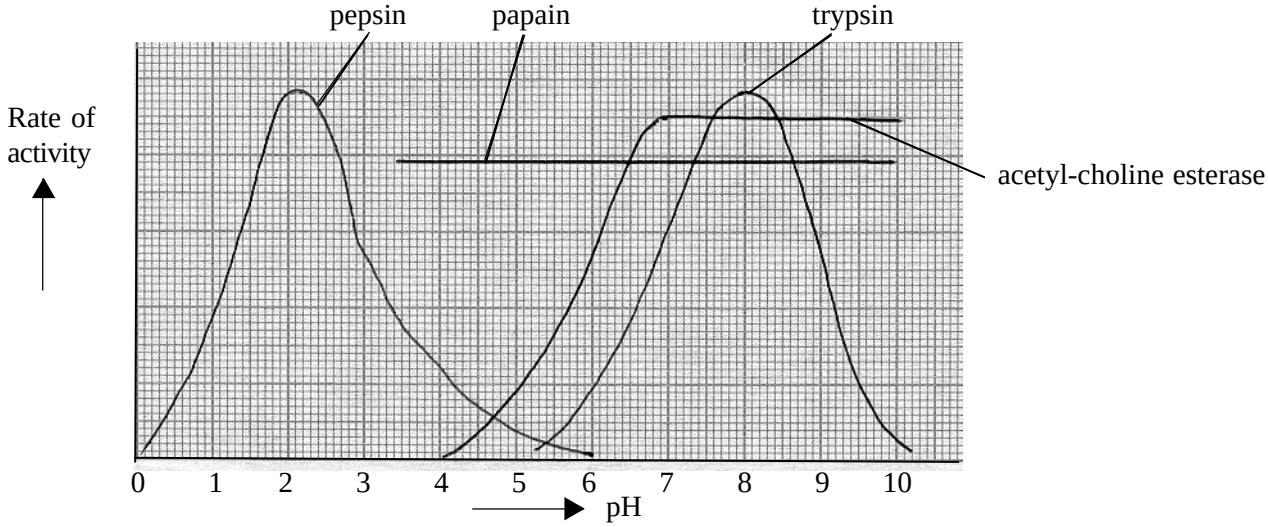
TOTAL / 11

# ENZYMES

QUESTIONSHEET 17



The graph below shows the pH-activity profiles of some enzymes.




(a) With reference to pepsin explain the effects of pH on enzyme activity.

.....

.....

.....

.....

.....

..... [5]

(b) The optimum pH of trypsin when digesting egg albumin is about 7.9 but when it digests haemoglobin the optimum pH is about 8.1. Suggest why these values are different.

.....

.....

.....

..... [3]

(c) Suggest why the pH-activity profile of acetylcholine esterase makes it suitable for its function in the body.

.....

.....

..... [2]

(d) Papain is found in fruits such as pineapples. It is commonly used as a meat tenderiser. Suggest why it is more suitable for this than pepsin.

.....

.....

..... [2]

TOTAL / 12

# ENZYMES

QUESTIONSHEET 18

*Do not write in margin*

The table below shows the results of an investigation of the effects of two inhibitors, A and B on the activity of an enzyme. Each incubation was carried out in the same standard way.

| **Substrate concentration /mM dm$^{-3}$** | | **2.0** | **3.0** | **4.0** | **5.0** | **6.0** | **7.0** | **8.0** | **9.0** | **10.0** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Product yield/ μg hr$^{-1}$** | **No inhibitor** | 140 | 175 | 215 | 250 | 275 | 295 | 312 | 325 | 330 |
| | **Inhibitor A 5.0 mM dm$^{-3}$** | 25 | 30 | 35 | 40 | 80 | 120 | 230 | 290 | 305 |
| | **Inhibitor B 5.0 mM dm$^{-3}$** | 45 | 50 | 56 | 63 | 70 | 80 | 90 | 112 | 123 |

(a) (i) Plot the results shown in the table in a suitable graphical form. [5]

(ii) State four precautions which would have to be taken to ensure a standardised experiment.

1: .....

2: .....

3: .....

4: ..... [4]

(b) Inhibitors may be competitive or non-competitive. What do the results suggest about the nature of A and B as inhibitors? Explain your answers.

1. nature of A: .....

explanation: .....

.....

..... [3]

2. nature of B: .....

explanation: .....

.....

..... [3]

(c) Name an enzyme, its normal substrate and product, and a substance that competitively inhibits the reaction.

enzyme: ..... substrate: .....

product: ..... inhibitor: ..... [4]

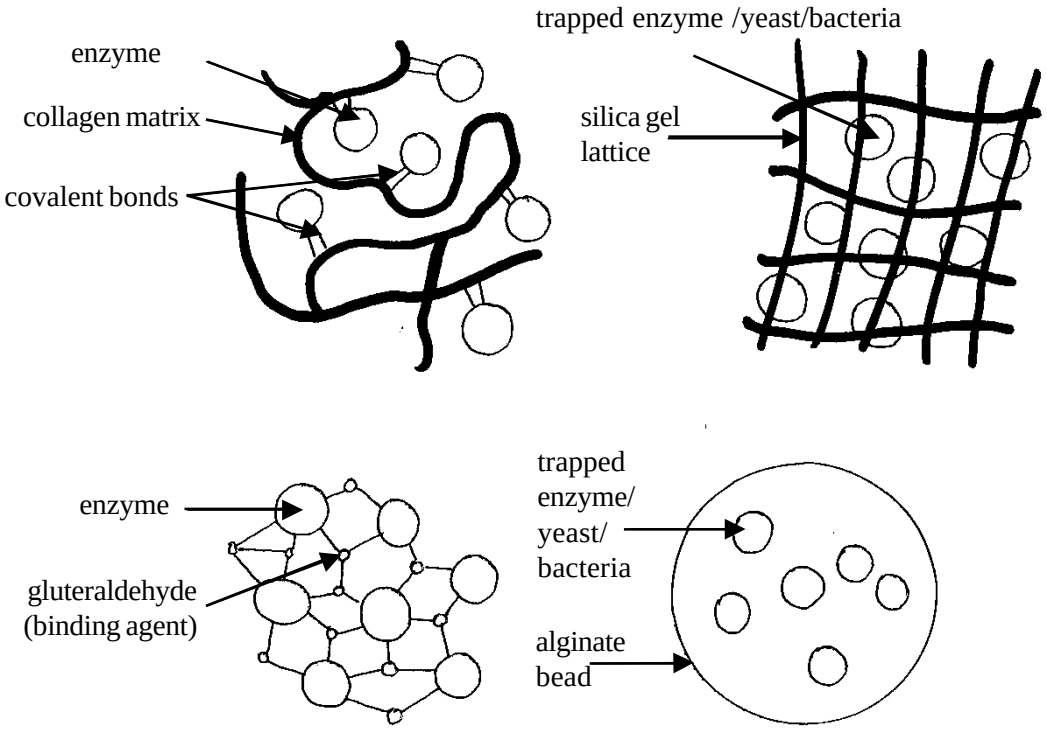
TOTAL / 19

# ENZYMES

QUESTIONSHEET 19



The drawings below show some methods of immobilising enzymes.




(a) Explain what is meant by the expression 'immobilised enzymes'.

.....

.....

.....

..... [3]

(b) State and explain three advantages of using immobilised enzymes.

1: .....

.....

2: .....

.....

3: .....

..... [6]

(c) State two examples of the use of immobilised enzymes.

1: .....

2: ..... [2]

TOTAL / 11

# ENZYMES

QUESTIONSHEET 20



Suggest reasons for the following:

(a) The optimum pH of an intracellular enzyme is not necessarily identical with the pH of the intracellular surroundings.

.....

.....

.....

.....

..... [2]

(b) Carbonic anhydrase has a huge turnover number of 36,000,000 (the highest known) but succinic dehydrogenase only has a turnover number of 1,150. (The 'turnover number' of an enzyme is the number of substrate molecules transformed per minute by a single enzyme molecule when the enzyme is limiting the rate).

.....

.....

.....

.....

..... [2]

TOTAL / 4