Enzymes

Model Answers 2

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Foundations in Biology
Topic	Enzymes
Booklet	Model Answers 2

Time allowed: **49 minutes**

Score: **/36**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

What is the correct definition of the term **coenzyme**?

A. An inorganic ion that forms the centre of a globular protein.

B. A molecule that binds to the enzyme, changing the shape of the active site, preventing an enzyme substrate complex from forming.

C. A non-protein organic molecule, not permanently attached to an enzyme, but needed to allow the enzyme to function.

D. A metal ion that attaches to the enzyme, changing the shape of the active site, increasing the likelihood of a reaction.

[1]

Co enzymes attach to enzymes but they are not protein. A typical function of a coenzyme could be supplying hydrogen attached to reduced NAD, or accepting hydrogen delivered by reduced NAD.

Question 2

Some inorganic ions have roles in enzyme-controlled reactions.

Which of the rows, **A** to **D**, in the table below is correct?

	Role of ion	
	Cofactor for amylase	**Prosthetic group for carbonic anhydrase**
A	Zn^{2+}	Cl^{-}
B	Zn^{+}	Cl^{-}
C	Cl^{2-}	Zn^{+}
D	Cl^{-}	Zn^{2+}

[1]

This section is early in the spec but easy to ignore. The role of ions in organisms.

Question 3

Zinc ions are necessary for the enzyme carbonic anhydrase to work.

Which statement correctly describes the nature and function of zinc ions in their interaction with carbonic anhydrase?

A inorganic ions and coenzymes

B vitamins and prosthetic groups

C inorganic ions and prosthetic groups

D vitamins and coenzymes

[1]

Zinc ions are inorganic ions. That narrows it down to A and C

Prosthetic groups are non protein groups that bind with ions such as zinc.

Iron II combines with the haem or prosthetic group of haemoglobin

Question 4

Enzymes are important molecules in living organisms.

(a) (i) A student decided to use the biuret test to detect the presence of enzyme in a solution.

Outline the procedure the student should follow in order to detect the presence of enzyme in a solution using the biuret test. **[2]**

To detect enzyme using the biuret test:

- add biuret solution (NaOH and $CuSO_4$)
- observe colour

The biuret reagent detects for the presence of protein. Enzymes are proteins. A positive result would turn lilac.

(ii) State why the structure of enzyme molecules allows them to be detected **in solution** using the biuret test. **[1]**

Enzymes can be detected in solution because:

- enzymes are globular proteins
- water soluble R-groups can be found on the outside of enzyme

(b) The student wished to determine the mass of enzyme in 250 cm^3 of an enzyme solution of unknown concentration.

To determine the concentration of this enzyme solution, the student first carried out the biuret test on three enzyme solutions of known concentration:

- solution **1** 0.5 mg cm^{-3} of enzyme
- solution **2** 1.0 mg cm^{-3} of enzyme
- solution **3** 2.0 mg cm^{-3} of enzyme

After completing the biuret tests, the absorbance of light by each solution was measured using a colorimeter. The student plotted a graph of the results. The graph is shown in Fig. 3.1.

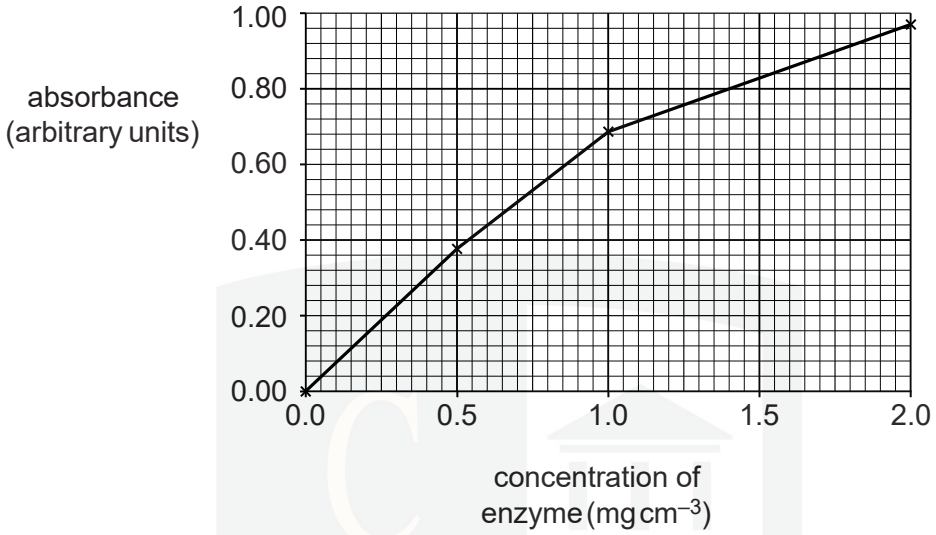


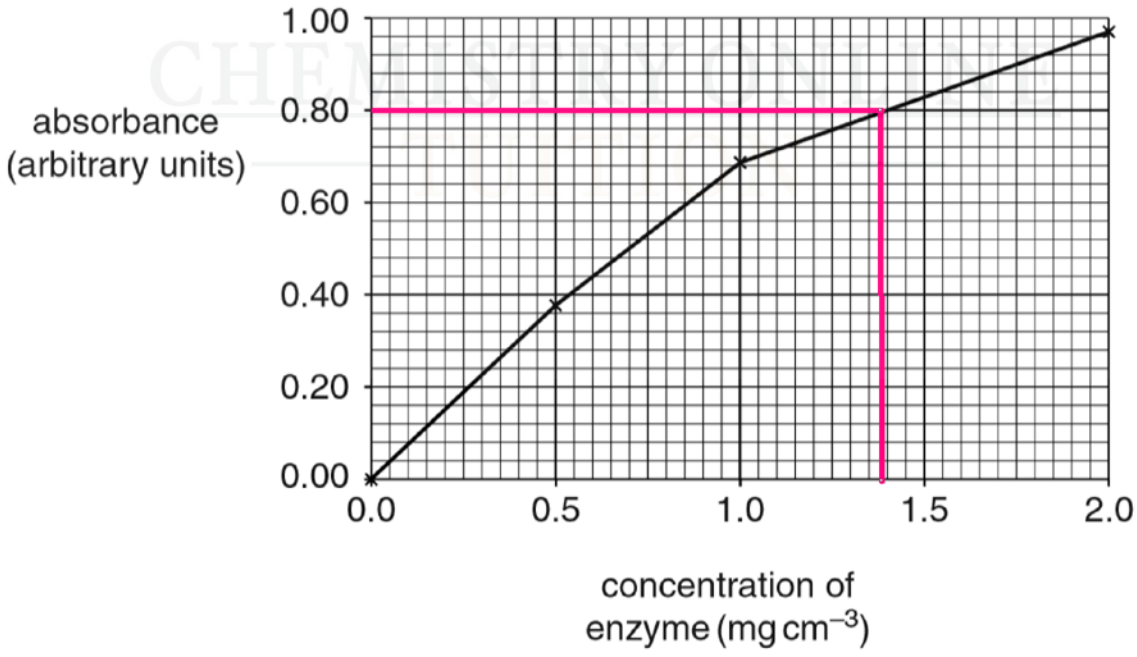
Fig. 3.1

(i) The student then carried out the same procedure on the enzyme solution of unknown concentration.

The absorbance reading on the colorimeter was 0.8 arbitrary units.

Using the line drawn by the student in Fig. 3.1, determine the concentration of the enzyme solution.

Calculate the **mass** of enzyme, **in grams**, in 250 cm^3 of the enzyme solution.
Show your working. Give your answer to **two** decimal places. **[2]**



Draw a line across at an absorbance of 0.8. Read off the graph at the bottom:

- 1.4 $mg.cm^{-3}$

If 1.4 mg in $1cm^3$, therefore in 1.4x 250 in $250cm^3$ = 3500mg

3500mg / 1000 =

- 0.35mg

(ii) The student performed the calculation correctly. However, the teacher said that the value for the mass of enzyme given by the student was inaccurate.

Explain how the student's **method** could be improved to increase the accuracy of this value. **[2]**

The student's method can be altered to improve accuracy by:

- test more concentrations
- near 1.4

Accurate results are ones that lie close to the true value. The more repeats taken around this value, the closer the mean will be to the true value.

(iii) Outline the practical procedures the student would have taken to generate the point on the graph at the origin (0.0, 0.00). **[2]**

To gain the result at 0,0, the student would have to:

- carry out Biuret test again
- using no enzyme (distilled water instead)
- set colorimeter to zero

This is a control test to show that it is the presence of the enzyme that causes the absorbance to change.

(c) Some enzymes work better in the presence of other molecules or ions.

Explain how these molecules or ions increase the activity of enzymes. **[5]**

Molecules or ions affect activities of enzymes by:

- acting as cofactors / coenzymes / prosthetic groups
- which bind to the active site or an allosteric site
- cofactors / coenzymes bind to the enzyme temporarily
- and change the shape of the active site
- they also affect charges on active site
- they may interact with substrate
- increase likelihood of the substrate binding to active site

Diagram to show the functioning of a cofactor:

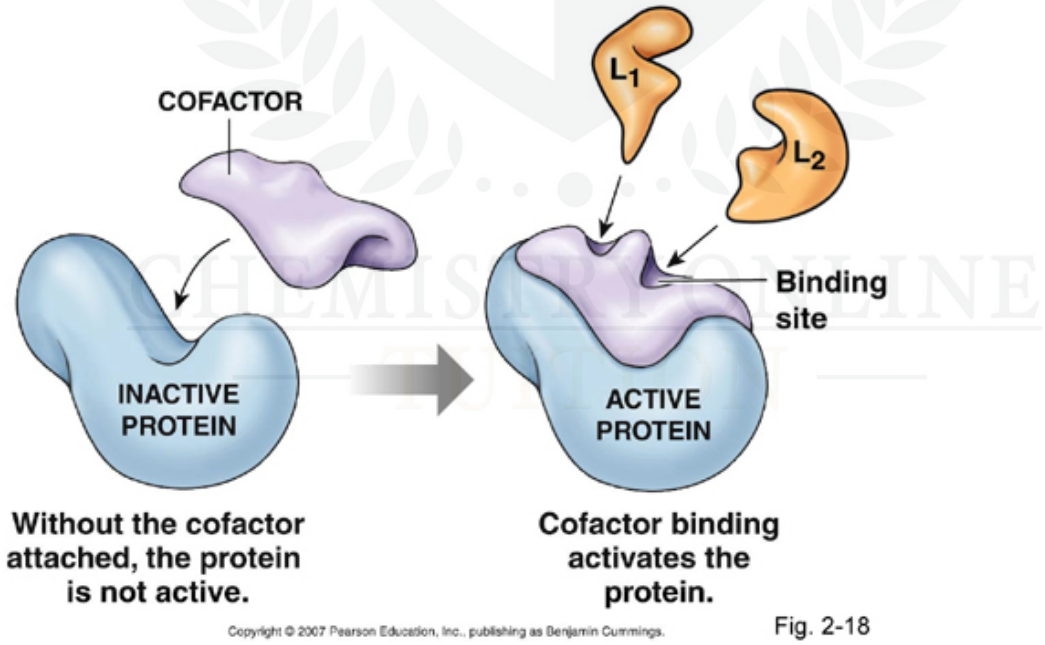


Fig. 2-18

[Total: 14]

Question 5

Pepsin is an enzyme that digests protein foods in the mammalian stomach.

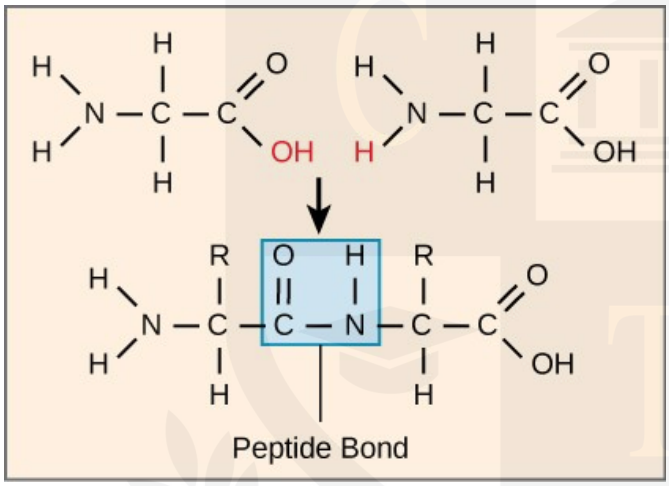
(a) Protein molecules are made from chains of amino acids.

(i) Name the covalent bond between two adjacent amino acids in a chain of amino acids. **[1]**

The type of bond between two amino acids is called a:

- Peptide bond

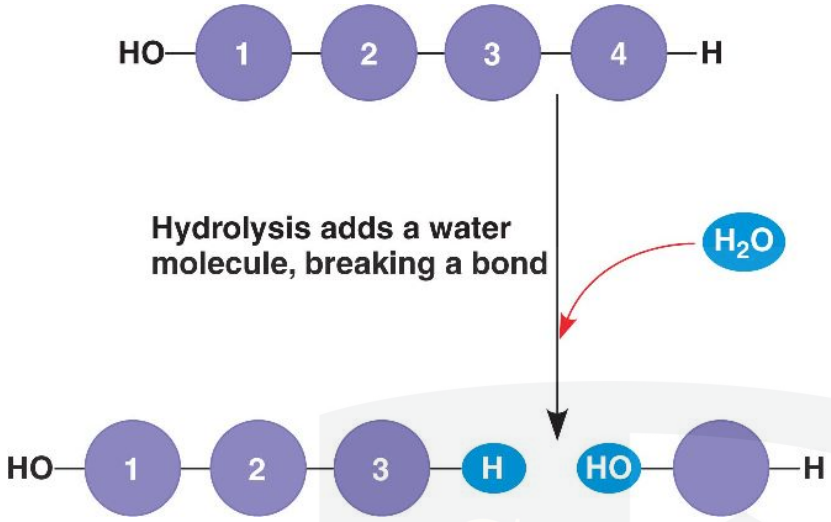
Diagram of the formation of a peptide bond:



(ii) Name the type of reaction involved in breaking this bond **and** describe what happens in this reaction. **[2]**

- hydrolysis
- water is added

Hydrolysis reactions break large molecules into smaller ones, whereas condensation reactions build up large molecules from smaller ones.

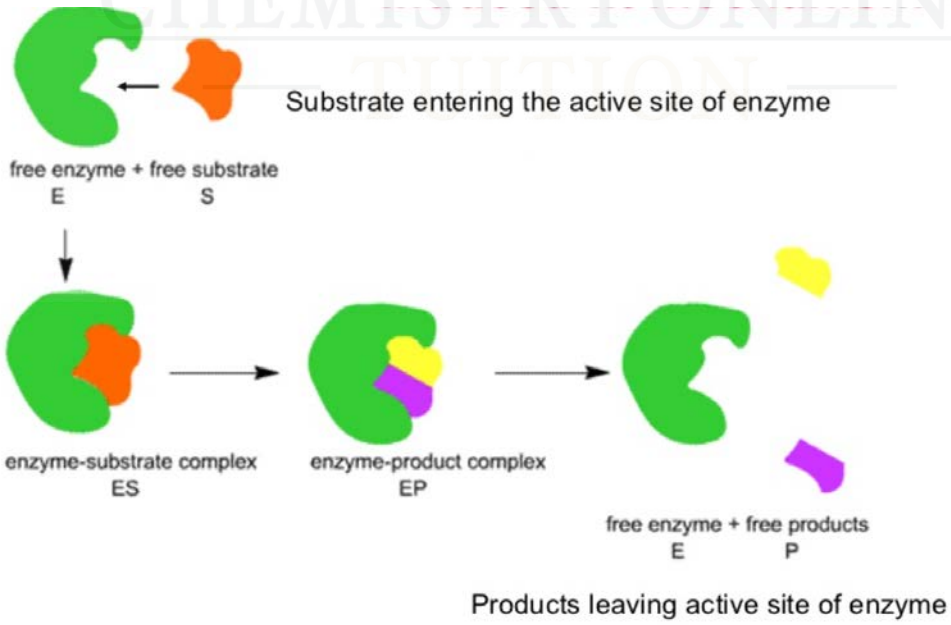


(b) Describe how an enzyme, such as pepsin, breaks down a substrate. **[5]**

Enzymes break down substrates by:

- substrate shape is complementary to the active site
- substrate fits into the active site
- by induced fit
- forming an enzyme-substrate complex
- this destabilises the bonds in the substrate
- products then leave the active site

Diagram to show the functioning of an enzyme on a substrate:



(c) A student investigated how changing the pH affected the activity of pepsin.

- He used a blender to make a suspension of egg white (protein) in water.
- At the start of the investigation the suspension was cloudy.
- He prepared fixed concentrations of egg white suspension, acid and pepsin to add to each of six test-tubes.
- He removed 0.1 cm^3 of the mixture from each test-tube and used universal indicator to measure the pH of each mixture.
- He incubated each test-tube in a water bath at 35 °C and timed how long it took for the egg white suspension in each tube to clear.
- He prepared a table in which he recorded his results (Table 1.1).

Tube	Volume of egg white suspension	Volume of acid added (cm^3)	Amount of pepsin added (cm^3)	Measured pH	Time for suspension to clear (m)
1	5	2.0	3.0	1	
2	5	1.5	3.0	2	
3	5	1.0	3.0	3	
4	5	0.5	3.0	4	
5	5	0.0	3.0	5	
6	5	2.0	0.0	1	

Table 1.1

(i) Identify **three** errors the student made in the preparation of his **table** before he recorded his results. **[3]**

Errors made in the table are:

- no units for second column
- 'amount' rather than 'volume' in 4th column
- incorrect unit in final column

There should always be units in the heading of a table (but not in the body).

The word 'amount' can always be replaced by something more specific, such as 'volume', 'concentration' or 'mass'.

The correct unit for measuring time is in seconds (s)

(ii) Identify a change the student could make to his procedure that would increase the **validity** of the investigation. **[1]**

To increase the validity, the student could:

- add equal volumes to each tube
- add buffer to control pH

A valid experiment in one that gains reliable results and can answer the question being posed. Therefore, other control variables must be kept the same.

(iii) State the term that best describes the purpose of **tube 6**. **[1]**

The purpose of tube 6 is to act as a:

- control

This shows that it is the enzyme that it is in fact the enzyme that is making the solution turn clear.

(iv) Another student suggested that he should repeat the investigation at least twice.

How would this have improved the investigation? **[2]**

This would have improved the experiment by:

- improving reliability
- assessing the spread of results
- allowing the calculation of mean

Repeating results allows more data points to be collected. Therefore variability and anomalies can more easily be seen, and a mean calculated

(d) Fig. 1.1 shows the effect of increasing the substrate concentration on the rate of activity of pepsin.

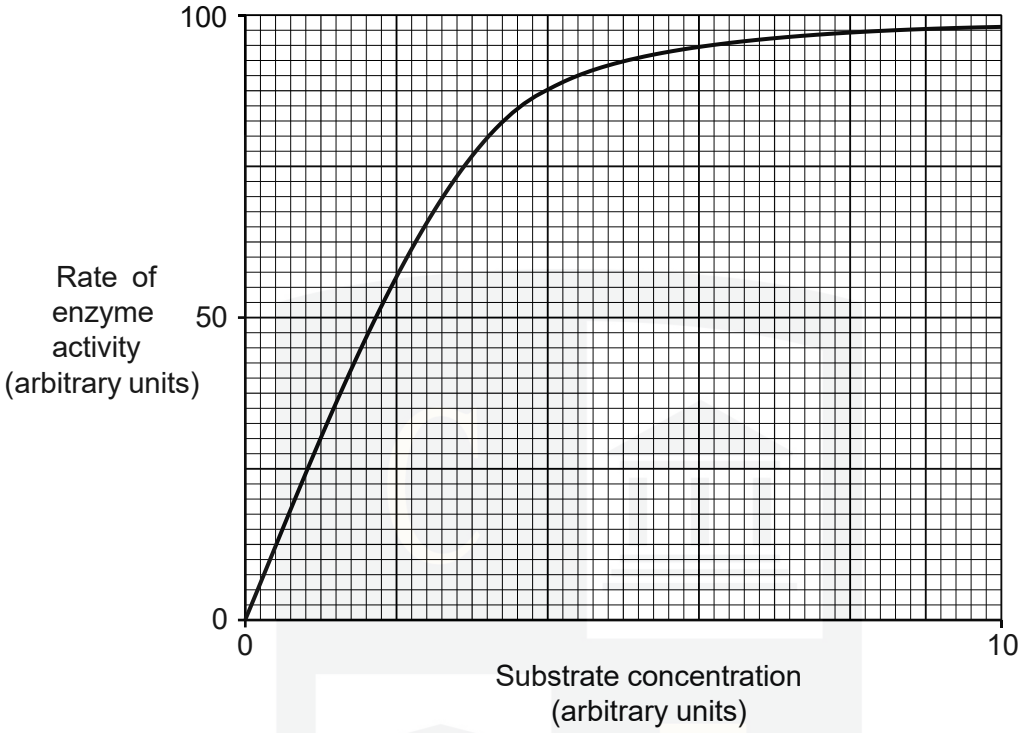
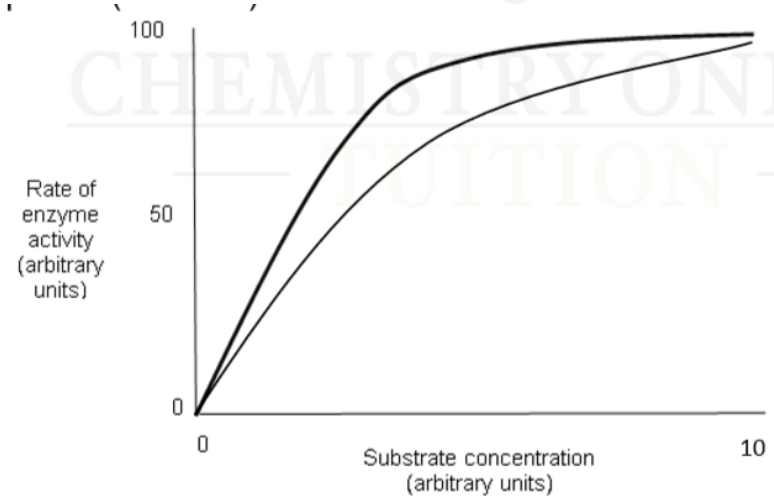


Fig. 1.1

(i) Pepstatin is a competitive inhibitor of pepsin.

On Fig. 1.1, draw a line to represent the effect of adding a fixed concentration of pepstatin on the rate of pepsin activity over the whole range of substrate concentrations. .**[2]**



- The line should be below the line on the graph
- The line should not peak or plateau

Pepstatin would compete for the active site of pepsin, thus lowering the rate of reaction for any given concentration of substrate. This is because there will be fewer active sites available for the substrate.

(ii) Pepstatin acts as a competitive inhibitor of pepsin.

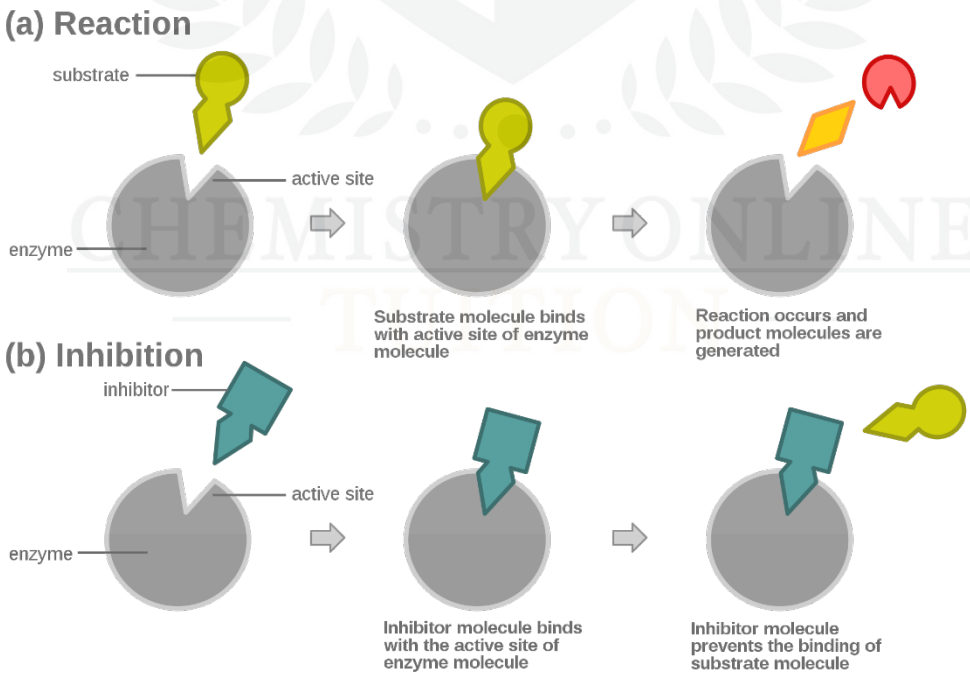
What can you conclude about the structure of pepstatin? **[2]**

The structure of pepstatin:

- Has a similar shape to the substrate
- Therefore has a complementary shape to the active site

Competitive inhibitors act by competing with the substrate for the active site. For this to occur, they must have a similar shape to the substrate.

Diagram to show how a competitive inhibitor affects enzyme-substrate-complex formation:



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