3. Enzymes

3.1 Mode of action of enzymes

Paper 1

Question Paper

1 The diagram shows a simple metabolic pathway.

$$W \rightarrow X \rightarrow Y \rightarrow Z$$

The letters W, X, Y and Z represent four different substances. At each step in the diagram the substrate undergoes a chemical reaction catalysed by an enzyme. The reaction produces the next substance in the pathway.

Which statements correctly describe the enzymes taking part in this metabolic pathway?

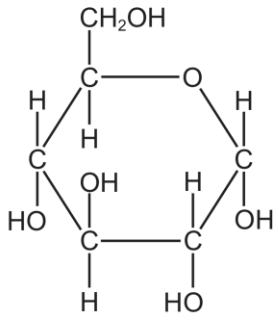
1 They are all globular proteins.

2 They all have the same tertiary structure.

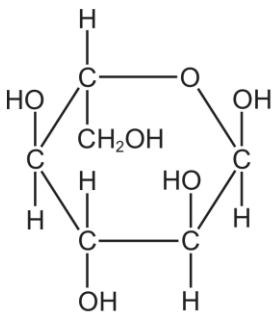
3 They all contain hydrogen atoms in their structure.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 only

2 The diagram shows naturally occurring D-glucose and a form of glucose that can be synthesised in the laboratory, known as L-glucose.



D-glucose



L-glucose

The enzyme glucose oxidase catalyses the oxidation of D-glucose. The enzyme **cannot** catalyse the oxidation of L-glucose.

Which statement about L-glucose explains this?

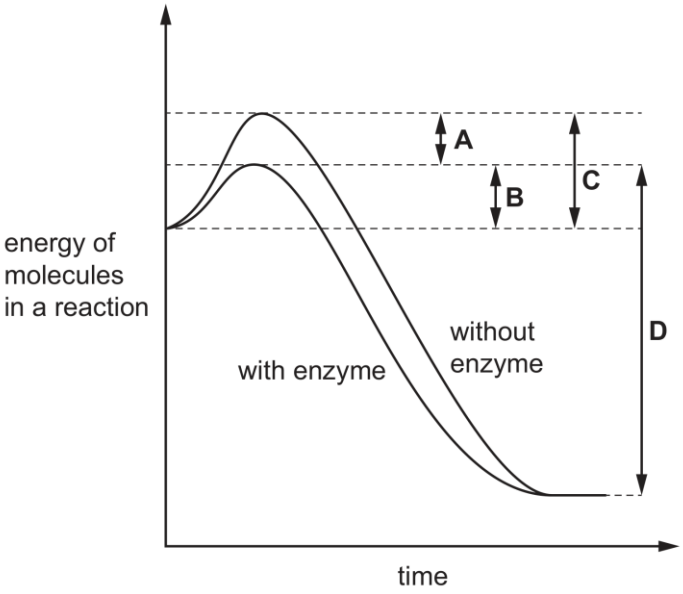
A L-glucose does **not** fit into the active site of glucose oxidase.

B L-glucose has a different structural formula to D-glucose.

C L-glucose is a synthetic sugar.

D L-glucose is the mirror image of D-glucose.

3 Which region on the graph shows the activation energy of an enzyme-catalysed reaction?



4 CYP3A4 is an important enzyme in the human digestive system where it is needed to break down a range of different toxins. The activity of CYP3A4 has been shown to be reduced by substances called furanocoumarins. Furanocoumarins are found in some fruits and so dangerous concentrations of toxins may develop in the human digestive system when fruits containing furanocoumarins are eaten.

From the information provided, what can be concluded about molecules of the enzyme CYP3A4?

A They lower the activation energy of the toxin breakdown reactions.

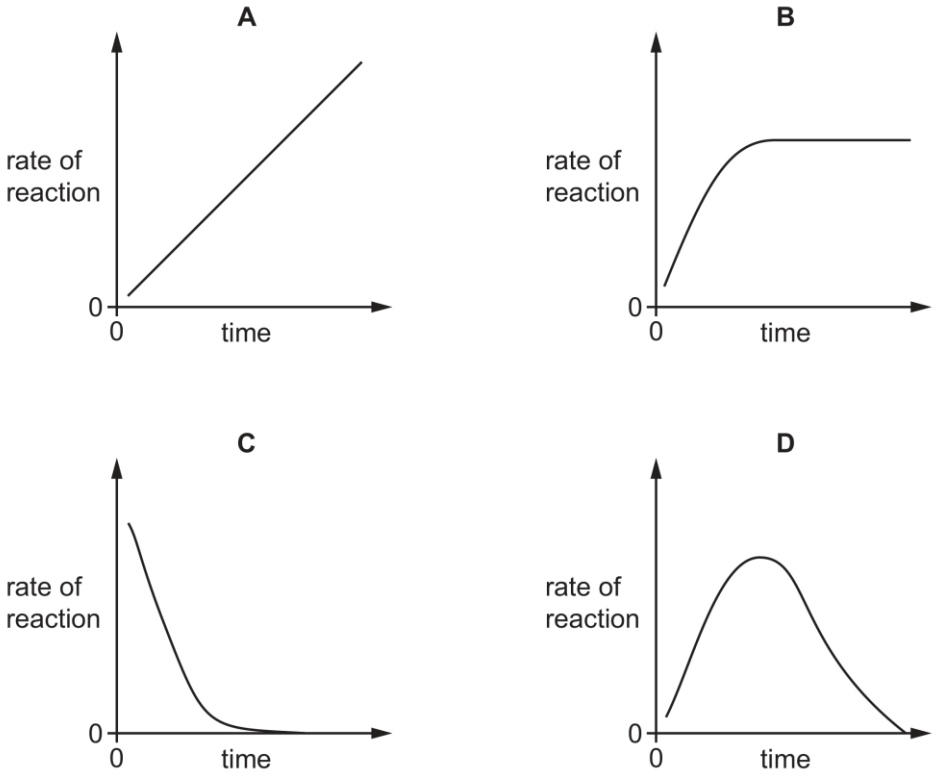
B They bind specifically through the active site to a substrate found in some fruits.

C They change permanently when acted upon by furanocoumarin molecules.

D They resume normal activity when concentrations of furanocoumarins decrease.

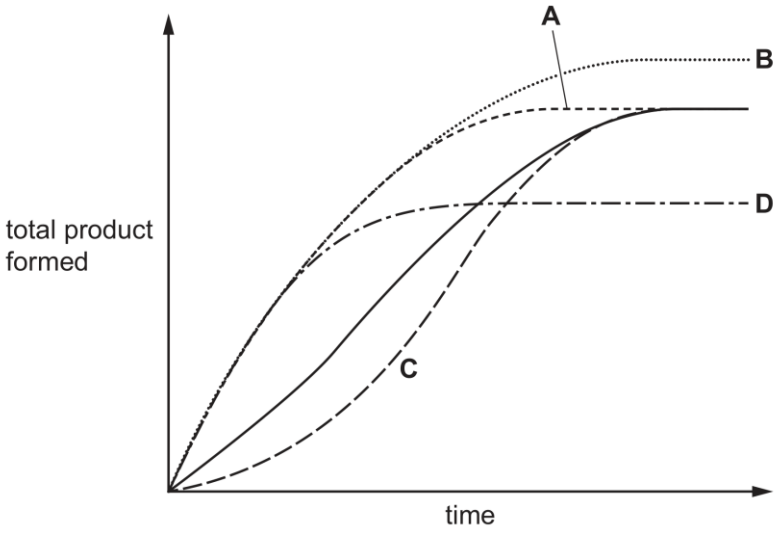
5 A fixed volume and concentration of substrate and enzyme were mixed. All other variables were kept constant. The enzyme-catalysed reaction was left until it was complete.

Which graph shows how the rate of reaction changes with time?

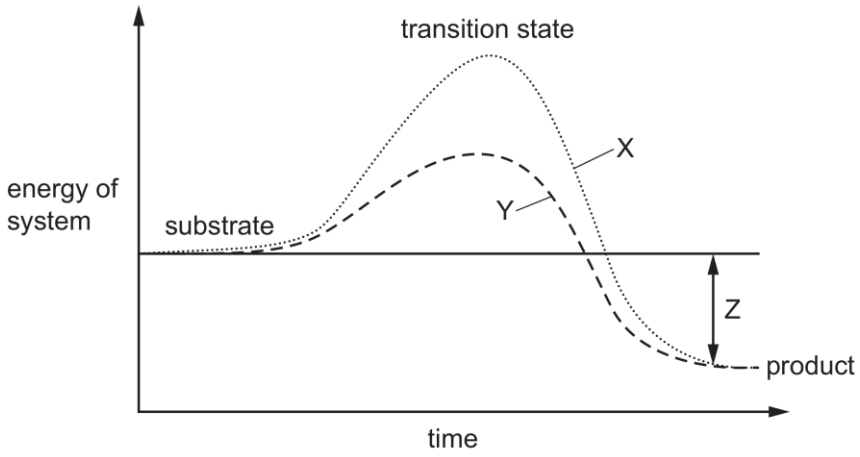


6 The solid line on the graph represents the product formed over time for a reaction in a cell.

Which other line represents the effect of adding the enzyme for this reaction?



7 The graph shows the effect of an enzyme on a reaction.



Which row identifies X, Y and Z?

	X	Y	Z
A	catalysed reaction	uncatalysed reaction	energy lost by product
B	catalysed reaction	uncatalysed reaction	overall energy lost during reaction
C	uncatalysed reaction	catalysed reaction	energy gained by product
D	uncatalysed reaction	catalysed reaction	overall energy released during reaction

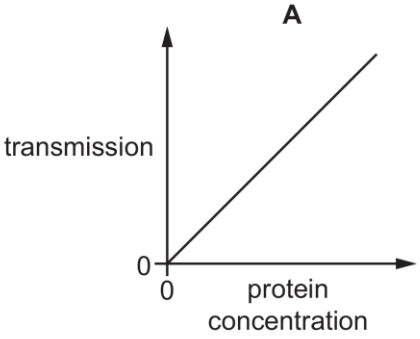
8 A student used colorimetry to monitor the hydrolysis of a protein by a protease enzyme.

The student used biuret solution to determine the concentration of protein in the hydrolysis reaction.

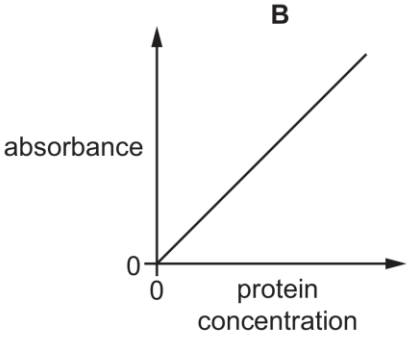
The student produced a calibration curve using known concentrations of protein.

Which diagram shows the calibration curve?

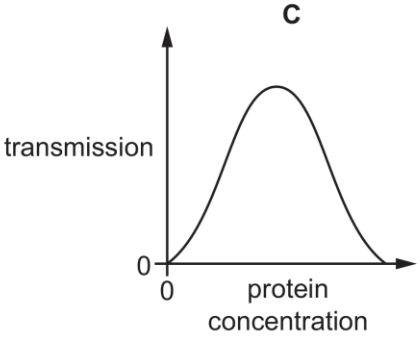
A



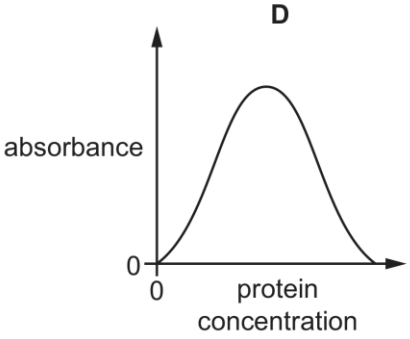
B



C



D



9 A student was provided with two test-tubes, one containing 10 cm^3 of solution P and one containing 10 cm^3 of solution Q. When these solutions were mixed together and left for 24 hours, the concentration of P decreased but the concentration of Q remained the same.

The student wrote the following conclusions.

1 P may break down over time.

2 Q may be a biological catalyst.

3 P may be the substrate for Q.

Which conclusions could be supported by the information?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 only **D** 2 and 3 only

10 Which statements are correct for the lock and key hypothesis **and** the induced fit hypothesis of enzyme action?

1 The substrate is the same shape as the active site.

2 The substrate is held in place in the active site by temporary bonds.

3 The enzyme and sometimes the substrate change shape slightly as the substrate molecule enters the enzyme.

A 1 and 2 **B** 1 and 3 **C** 2 only **D** 3 only

11 Which property of the tertiary structure of a globular protein enables it to catalyse a metabolic reaction?

A It has hydrophobic amino acid R groups on the outside.

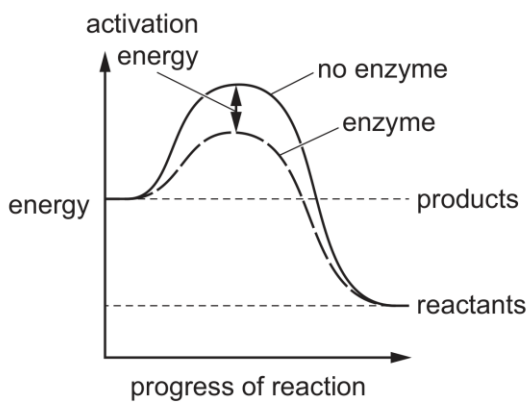
B It will be denatured by high temperatures.

C The R groups of some amino acids form bonds with a substrate.

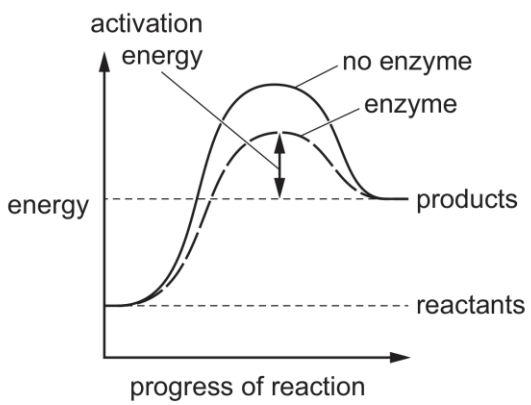
D The three-dimensional shape depends on hydrogen bonding.

12 Which graph correctly shows the activation energy of a reaction when an enzyme is added?

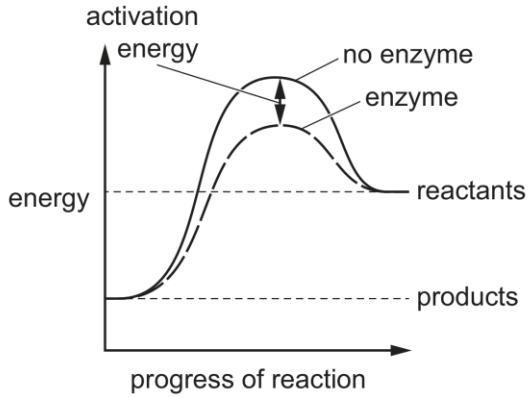
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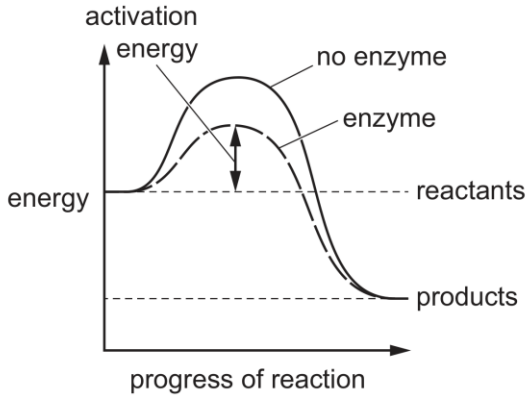
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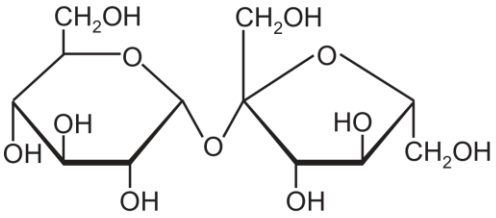
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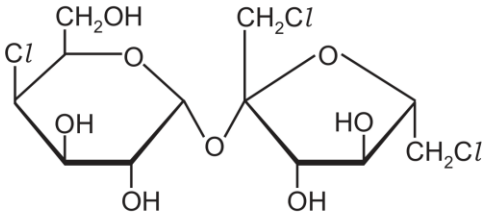
D



13 The diagram shows sucrose and sucralose.



sucrose



sucralose

The enzyme sucrase breaks down sucrose but cannot break down sucralose. Four students were asked to suggest why sucrase can break down sucrose but not sucralose.

Three of the students gave correct suggestions.

Which suggestion **cannot** be correct?

A The Cl atoms change the shape of the sucralose molecule so it is not the same shape as the active site of sucrase.

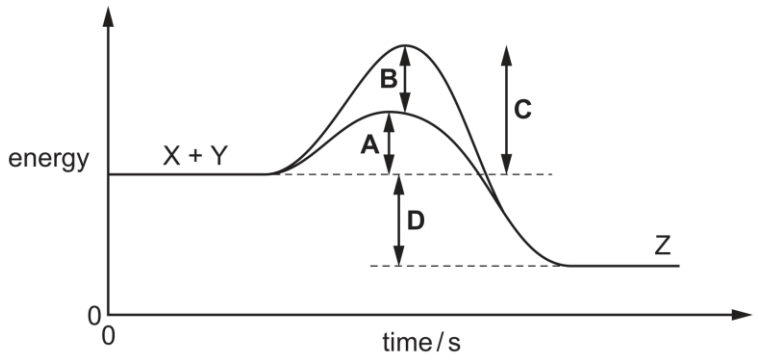
B The Cl atoms of the modified fructose cannot bind to the active site of sucrase.

C The Cl atoms cannot cause an induced fit, so sucralose does not enter the active site of sucrase.

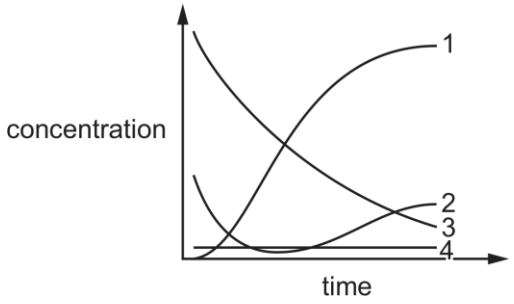
D The Cl atoms cause fewer temporary hydrogen bonds between sucralose and the active site of sucrase.

14 The graph shows the energy levels involved in an enzyme-catalysed reaction. Substrate molecules X and Y combine to give product Z.

Which arrow shows the reduction in activation energy due to the enzyme?



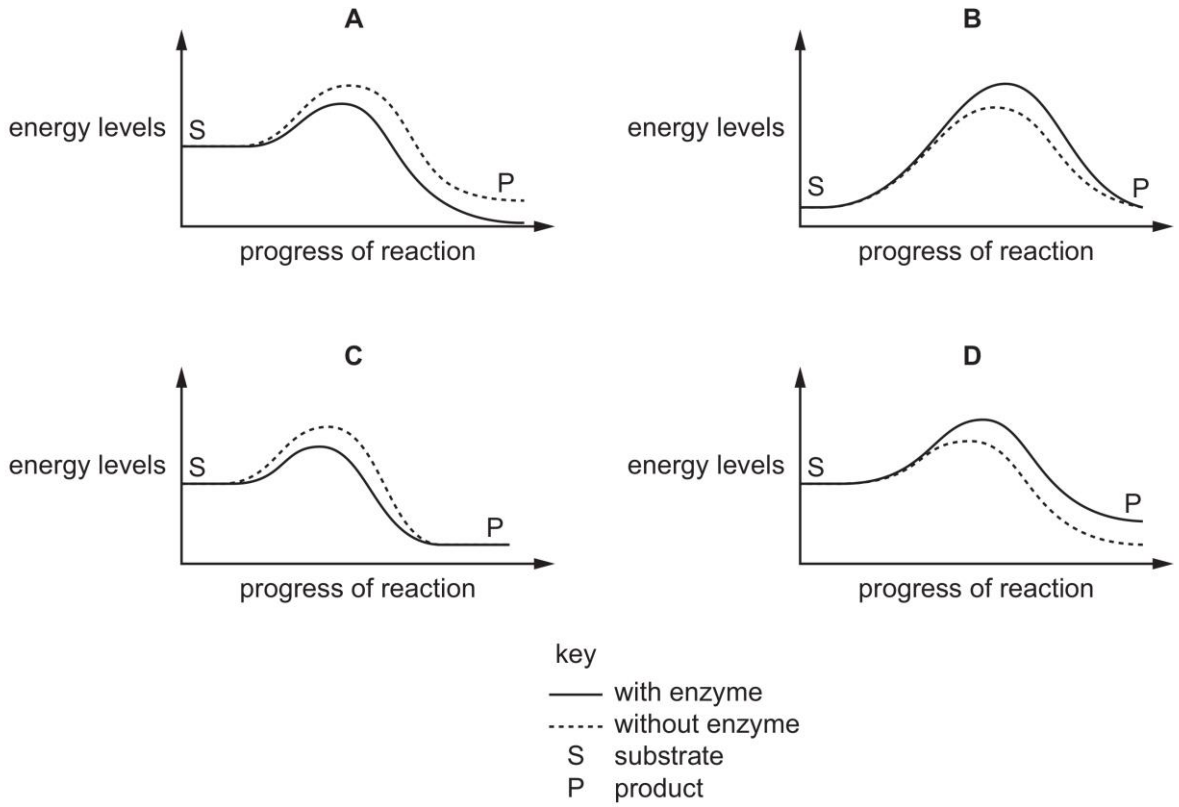
15 The graph shows how the concentrations of four components, 1, 2, 3 and 4, of an enzyme-catalysed reaction change with time.



Which component is the enzyme–substrate complex?

A 1 **B** 2 **C** 3 **D** 4

16 Which graph correctly shows possible changes in energy levels as a chemical reaction progresses with or without an enzyme?



17 Protease enzymes are found in many locations inside and outside the cells. Four of these locations are listed.

1 lysosomes

2 lumen of the stomach

3 at a telophase spindle

4 mucus in the trachea

Which of these locations are sites of intracellular hydrolysis?

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1 and 3 only

D 2 and 4 only

18 Which enzyme is extracellular?

A Amylase in saliva is an enzyme that catalyses the breakdown of starch in the mouth.

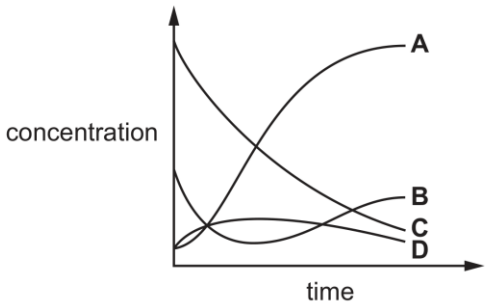
B ATP synthetase is an enzyme found in mitochondria that synthesises ATP.

C DNA polymerase is an enzyme that helps build DNA molecules by assembling nucleotides.

D RNA polymerase is an enzyme involved in the process of gene transcription.

19 The graph shows how the concentration of components of an enzyme-catalysed reaction changes with time.

Which line represents enzymes with empty active sites?



20 Which statements describe some enzyme actions?

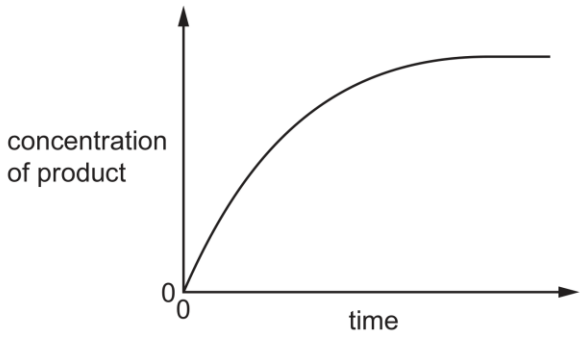
1 Enzymes hold reacting molecules so that their reactive groups are close together.

2 In an enzyme-catalysed reaction, more molecules have sufficient energy to react than in the absence of the enzyme.

3 Reactions catalysed by enzymes take place at a lower temperature than they would without the enzyme.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

21 A fixed volume of the enzyme catalase was added to a fixed volume of hydrogen peroxide solution. The diagram shows how the concentration of product changed over the course of the reaction.



What explains the shape of this graph?

A The active sites become saturated.

B The enzyme was denatured.

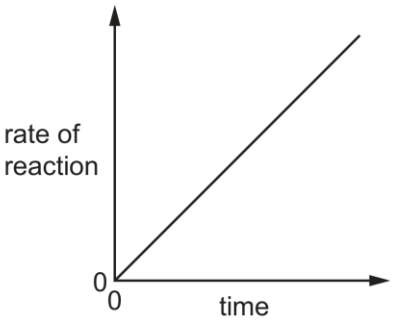
C The hydrogen peroxide inhibited the reaction.

D The substrate molecules were used up.

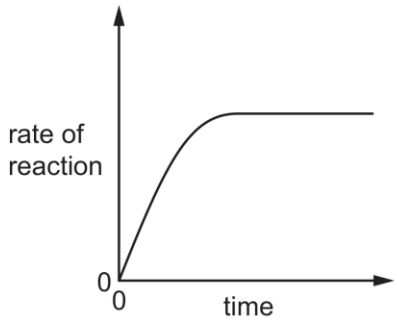
22 A fixed volume and concentration of substrate and enzyme were mixed. All other variables were kept constant. The enzyme-catalysed reaction was left until it was complete.

Which graph shows how the rate of reaction changes with time?

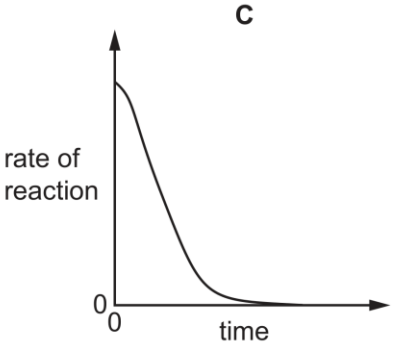
A



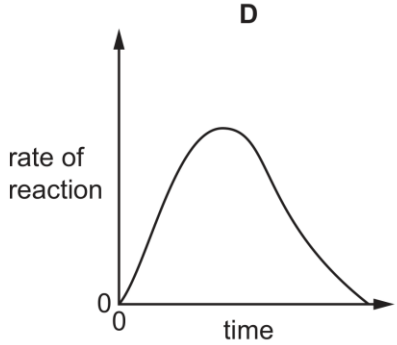
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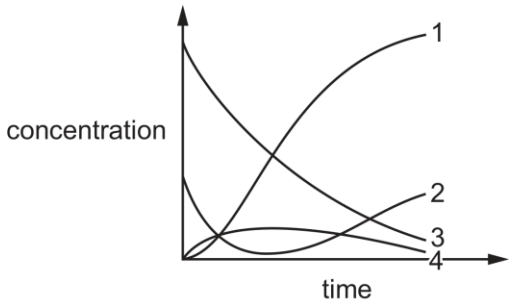
C



D



23 The graph shows how the concentration of components,1, 2, 3 and 4, of an enzyme-catalysed reaction changes with time.



Which row identifies the components of this reaction?

	component 1	component 2	component 3	component 4
A	enzyme–substrate complex	unbound enzyme	product	substrate
B	enzyme–substrate complex	product	substrate	unbound enzyme
C	product	enzyme–substrate complex	unbound enzyme	substrate
D	product	unbound enzyme	substrate	enzyme–substrate complex

24 Which statement about the active site of an enzyme is correct?

A It always has a specific fixed shape.

B It reduces the total energy of the product.

C It does not form chemical bonds with its substrate.

D It is determined by the primary structure of the enzyme.

25 A student investigated the hydrolysis of the lipid in high-fat milk, using the enzyme lipase.

- 1 cm^3 of enzyme solution was added to 10 cm^3 of high-fat milk.
- The temperature was kept constant.
- The pH of the reaction mixture was recorded at time 0 minutes and every minute for 20 minutes.

Which statements could be supported by the results of the investigation?

1 Less product is made as time proceeds because the substrate is decreasing.

2 The pH of the reaction mixture changes more rapidly in the first few minutes and then changes less rapidly.

3 The product gradually causes more lipase molecules to denature.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

26 A mutation occurred within the DNA sequence coding for an enzyme, causing a decrease in the rate of a reaction catalysed by this enzyme.

Which statements could explain the decrease in the rate of reaction?

1 An inhibitor for this enzyme has an increased affinity for the enzyme and forms an enzyme–inhibitor complex more easily.

2 The active site of the enzyme might have changed shape and so is no longer complementary.

3 The activation energy for the reaction with the mutated enzyme is greater than with the non-mutated enzyme.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only