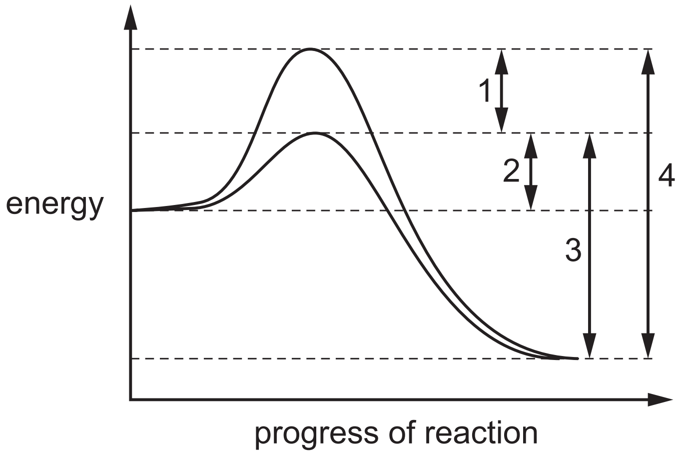
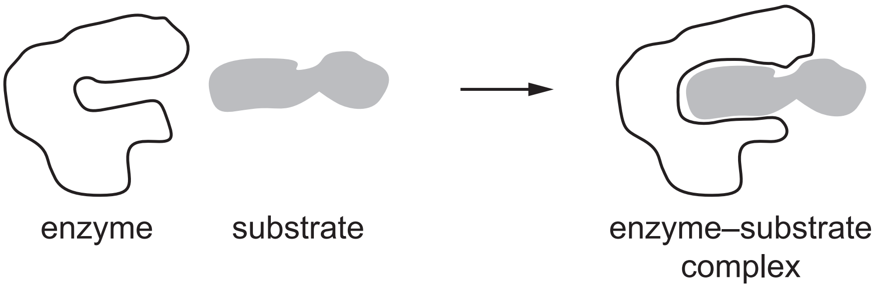
13 The graph shows energy changes in a chemical reaction.



What is the activation energy when an enzyme is added?

A 1 + 2 **B** 2 only **C** 3 – 2 **D** 4

14 The diagram shows an enzyme, its substrate and an enzyme–substrate complex.



Which statement explains how this substrate is able to enter the active site of this enzyme?

A Contact between the substrate and the enzyme causes a change in the enzyme shape.

B The shape of the active site and the shape of the substrate are complementary.

C The substrate within the active site forms hydrogen bonds with amino acids.

D When the enzyme–substrate complex forms, the tertiary structure of the enzyme changes.

9 Enzyme P has been found in a tropical grass.

- The enzyme catalyses the hydrolysis of the fungal polysaccharide, chitin, into amino sugars.
- It also inhibits the activity of an enzyme in locust guts which catalyses the digestion of amylose.

Which row describes the actions of enzyme P?

	reaction catalysed	reaction inhibited
A	hydrolysis of glycosidic bonds	condensation of glycosidic bonds
B	hydrolysis of glycosidic bonds	hydrolysis of glycosidic bonds
C	hydrolysis of peptide bonds	condensation of glycosidic bonds
D	hydrolysis of peptide bonds	hydrolysis of glycosidic bonds

13 What is the effect of an enzyme in an enzyme-catalysed reaction?

A decreases the activation energy and decreases the energy yield

B decreases the activation energy and has **no** effect on the energy yield

C increases the activation energy and increases the energy yield

D decreases the activation energy and increases the energy yield

A-Level Biology: **w25 13**

15 Which descriptions of enzymes that use the lock-and-key hypothesis are correct?

1 The active site is complementary to the substrate the enzyme acts on.

2 Bonds that form in the enzyme–substrate complex change the shape of the active site.

3 Most of the amino acids in an enzyme help to maintain the specific shape of the enzyme.

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

A-Level Biology: **w25 14**

13 Which statements describe the action of an extracellular enzyme?

1 synthesis of a polynucleotide in the nucleus during DNA replication

2 digestion of macromolecules in the lumen of the small intestine

3 synthesis of ATP molecules in the mitochondria

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

14 Which statement about the induced-fit hypothesis of enzyme action is correct?

A An enzyme that uses the induced-fit mechanism will increase the activation energy of a reaction.

B The binding of a substrate causes conformational changes in an enzyme.

C The active site of an enzyme changes to become the same shape as the substrate.

D An enzyme that uses an induced-fit mechanism has decreased specificity to the substrate.

3 **(a)** The lock-and-key hypothesis and the induced-fit hypothesis are used to describe the interaction of enzymes and their substrates.

Describe **one** similarity and **one** difference between the lock-and-key hypothesis and the induced-fit hypothesis.

similarity ....

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difference ....

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(b) Phosphorylase enzymes can catalyse the synthesis of starch **and** the breakdown of starch in some plant tissues. A reaction catalysed by starch phosphorylase is shown in Fig. 3.1.

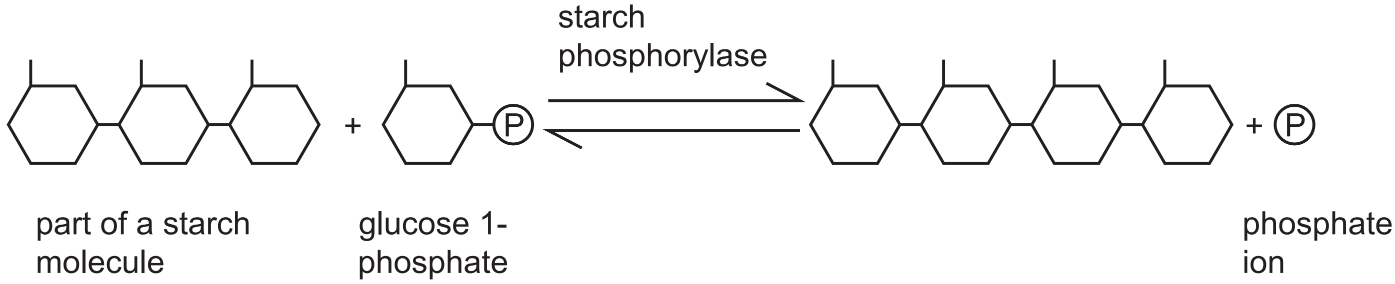

Fig. 3.1

A student carried out an experiment to study the synthesis of starch by phosphorylase found in potato tissue.

The student was provided with a solution, **E**, extracted from potato tissue. The extract was filtered to remove all the starch grains.

Extract **E** contained biological molecules from the potato tissue including phosphorylase but **no** starch.

(i) Iodine solution was used to confirm that starch was **not** present in extract **E**.

State the colour observed when iodine solution was added to a sample of extract **E**.

.... [1]

The student added a small drop of a dilute starch solution and a solution of glucose 1-phosphate to a test-tube containing extract **E**.

Samples of the reaction mixture in the test-tube were removed every minute and a drop of iodine solution was added to each.

The student used a colorimeter to measure the absorbance of the solution in each sample.

The results are shown in Fig. 3.2.

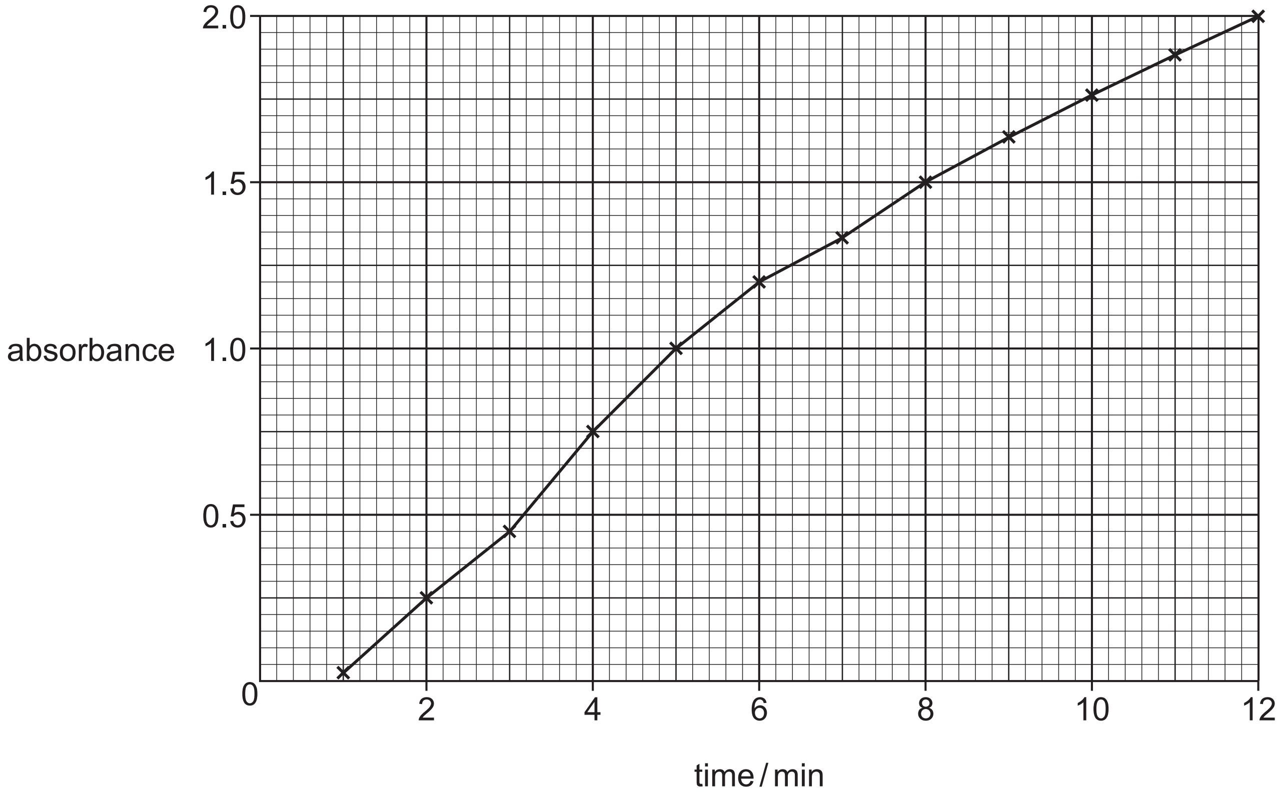

Fig. 3.2

(ii) Explain the results shown in Fig. 3.2.

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(iii) After 12 minutes, the student added a solution containing phosphate ions to the reaction mixture. The student continued taking samples every minute, adding iodine solution to each sample.

The absorbance of the solution in each of these samples was measured. The results showed that the absorbance decreased over time.

Suggest why the absorbance decreased.

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(c) Muscle cells contain glycogen phosphorylase.

Fig. 3.3 shows the effect of caffeine on the activity of glycogen phosphorylase at different concentrations of substrate.

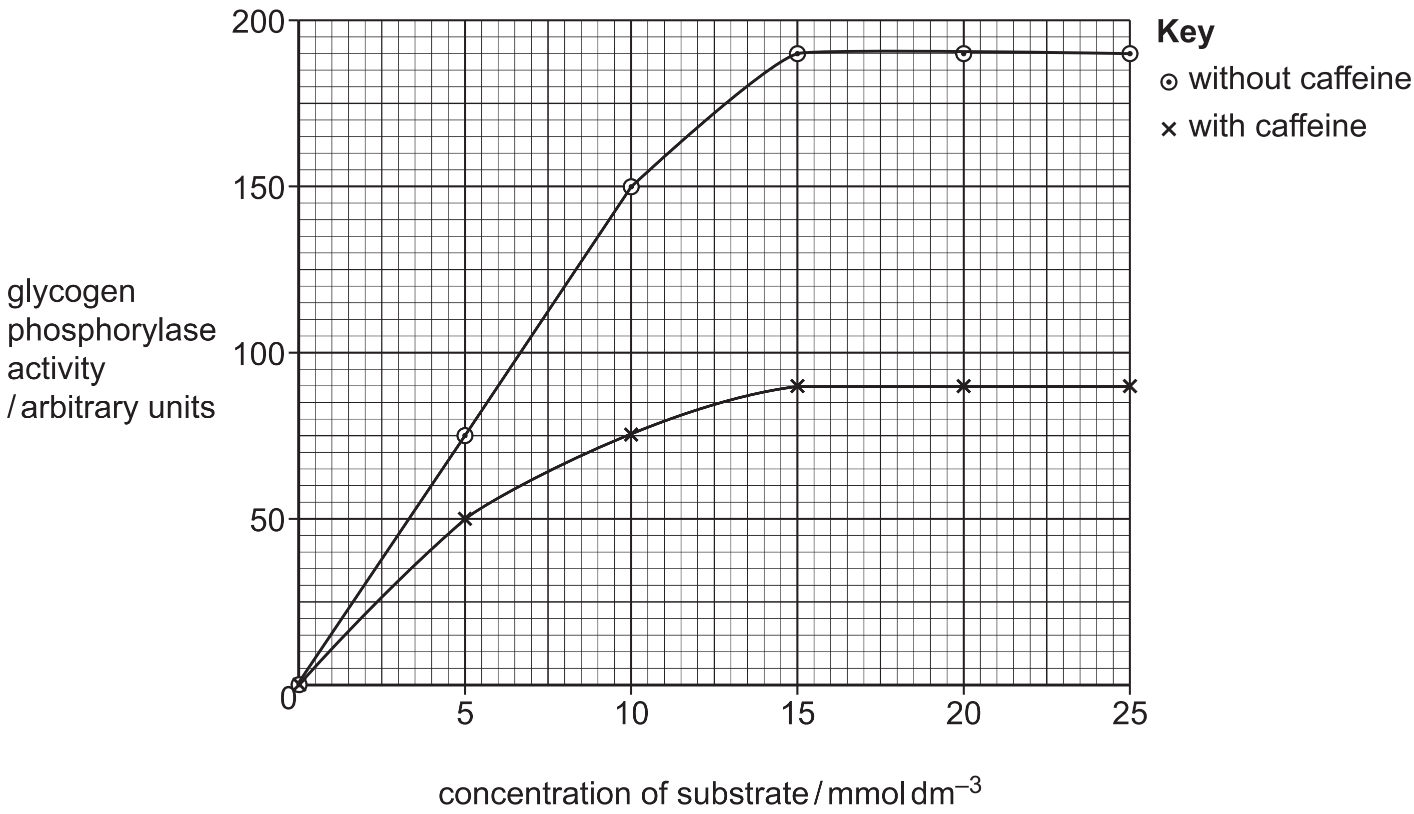

Fig. 3.3

A student concluded that caffeine acts as a non-competitive inhibitor of glycogen phosphorylase.

Explain how the results in Fig. 3.3 support this conclusion.

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[Total: 10]

3 **(a)** Describe the induced-fit hypothesis of enzyme action.

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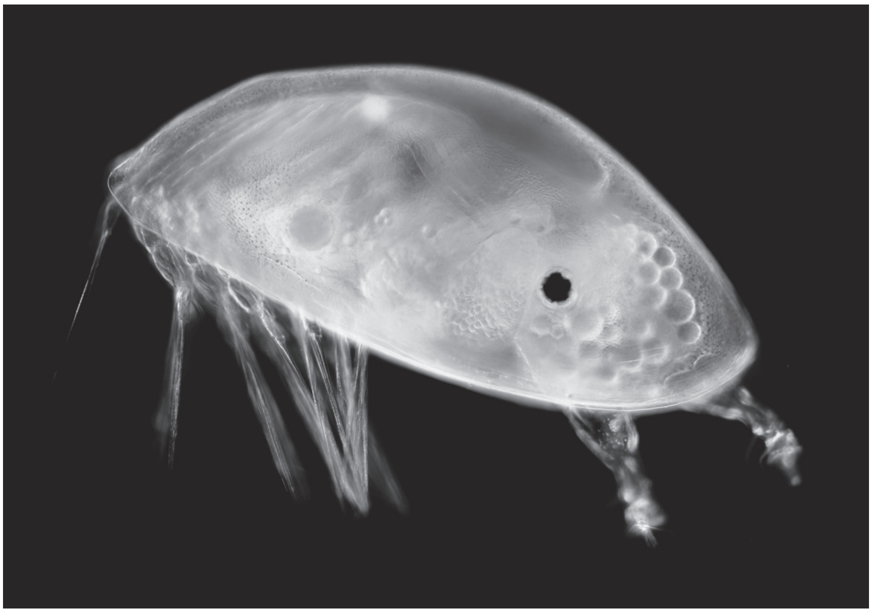
(b) Many marine organisms can become attached to hard surfaces such as rocks or the surfaces of ships. These organisms are known as fouling organisms.

The larva of the acorn barnacle, *Amphibalanus amphitrite*, is an example of a fouling organism. One of these barnacle larvae is shown in Fig. 3.1.



magnification ×160

Fig. 3.1

The larvae of *A. amphitrite* use a protein to attach themselves to the surfaces of ships.

It is expensive to remove fouling organisms from ships. Scientists have developed substances to prevent the attachment of larvae. However, some of these substances are toxic and have been responsible for a decrease in marine biodiversity.

Scientists investigated the effect of using an immobilised protease, subtilisin A, to prevent the attachment of the larvae of *A. amphitrite* to surfaces.

The scientists used 4 different concentrations of subtilisin A which had been immobilised onto the surface of a polymer film. As a control they used denatured subtilisin A immobilised onto the surface of the same polymer. Glass slides were also used as a control.

The larvae were released into 6 tanks of artificial sea water:

- 4 tanks, each with a polymer surface and a different concentration of immobilised subtilisin A
- 1 tank with a polymer surface and denatured immobilised subtilisin A
- 1 tank with glass slides instead of a polymer surface.

The number of larvae that attached to the different surfaces in the tanks was counted after 24 hours and again after 48 hours.

The number of larvae attached in each tank was expressed as the percentage of the total number of larvae released in each tank. The results are shown in Fig. 3.2.

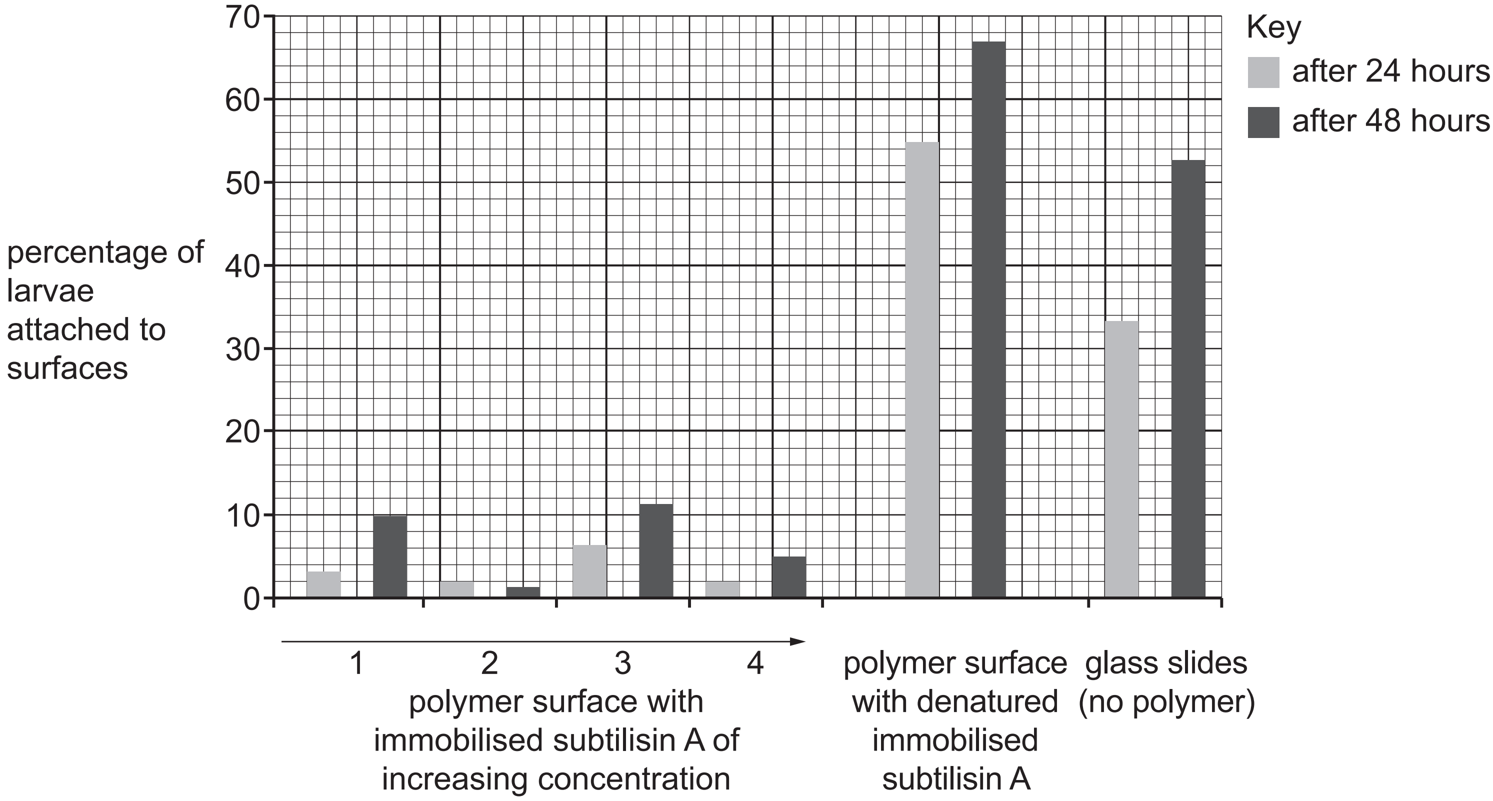


Fig. 3.2

(i) With reference to the data in Fig. 3.2, discuss whether subtilisin A is effective in preventing the attachment of the larvae.

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(ii) The scientists extended their investigation by applying the polymer with immobilised subtilisin A to the outside of the bottom of small ships.

Two factors that need to be taken into consideration in this type of investigation are the temperature and pH of the sea water.

Outline **two other** factors that need to be taken into consideration when investigating the suitability of immobilised subtilisin A as an anti-fouling agent for ships.

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[Total: 9]

Question 4 starts on page 12.