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EB Education Revision Guide

How to work with Enzymes: Part 1

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Enzymes

What are they?

Enzymes are proteins that act as biological catalysts. They speed up chemical reactions but do not get used up.

Living organisms use enzymes to help break down large molecules, and to build larger molecules.

There are thousands of chemical reactions happening inside living organisms all the time, and these need to be controlled.

How do they work?

Enzymes work on a molecule known as a substrate. The molecules formed in the reaction are known as products.

Every enzyme has an active site – the part where the enzyme will join on to its substrate.

The enzyme's active site and its substrate are complementary in shape. This means the enzyme will only work on one substrate. It is substrate specific.

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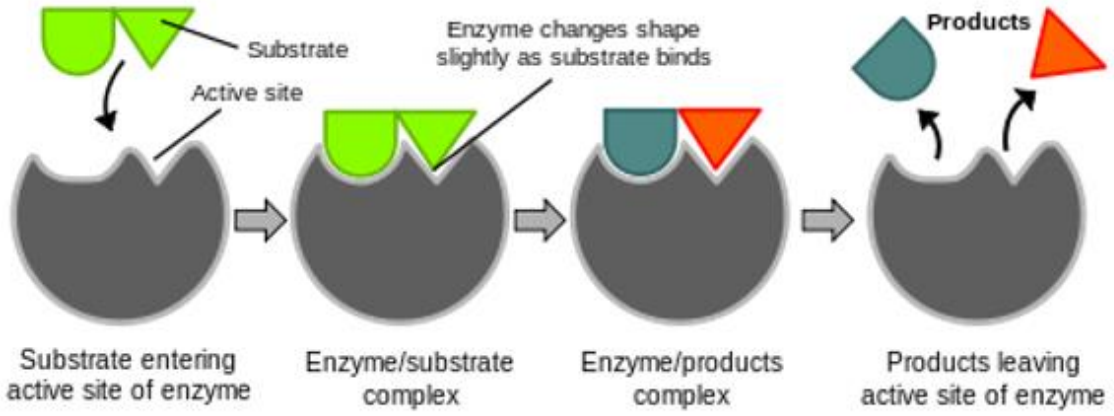
Lock and Key Model

When enzymes and substrates collide they form an enzyme-substrate complex.

It is within this complex that the reaction takes place and the product is released, leaving the enzyme free to act again.

This is called the ‘lock and key’ mechanism, because the substrate fits into the enzyme like a key fits into a lock.

Diagram



Increasing temperature

What happens?

Increasing the temperature will change the rate of reaction.

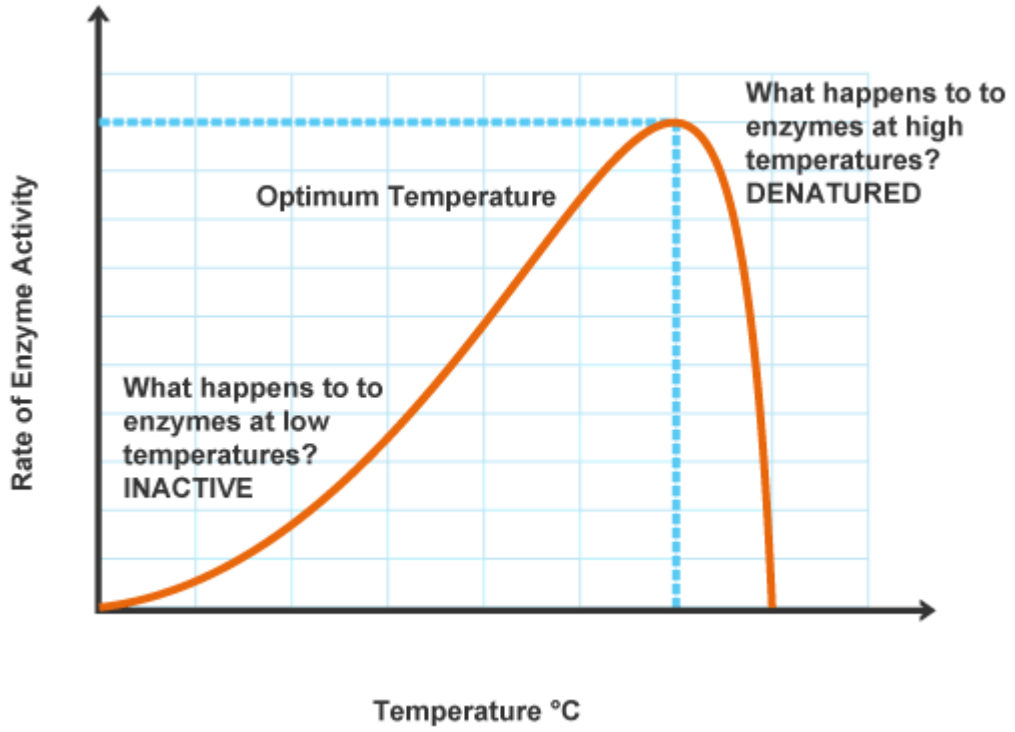
As temperature is increased, the rate of reaction increases, as the molecules have more energy, so there are more collisions.

If the temperature continues to increase, some of the bonds holding the enzyme together will break.

The shape of the active site will change, meaning the substrate cannot fit any more. The enzyme has been denatured.

All enzymes have an optimum temperature, when they work best. In humans enzymes will denature at around 45°C

Diagram



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Changing pH

What happens?

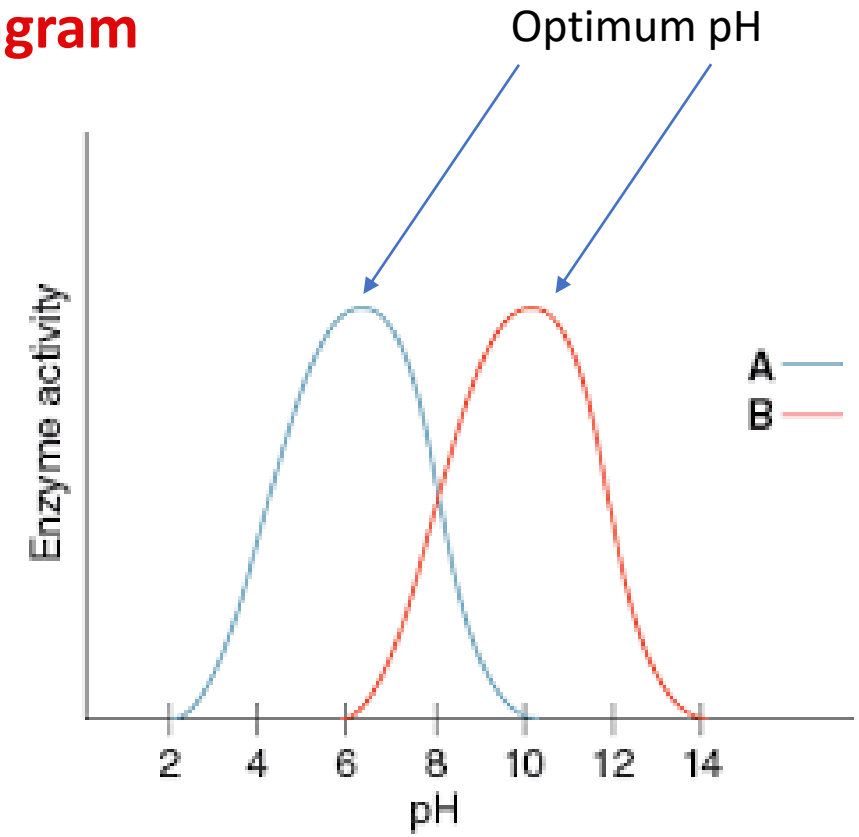
The pH will also affect how well enzymes work.

If the pH is too high, or too low, the pH interferes with the bonds holding the enzyme together.

This will change the shape of the active site and denature the enzyme.

All enzymes have an optimum pH. Many enzymes work best at a neutral pH, but there are some that work best in different conditions. The enzyme which is active in the stomach is called pepsin. As there is hydrochloric acid in the stomach, this enzyme works best in acidic conditions, at around pH 2.

Diagram



Substrate concentration

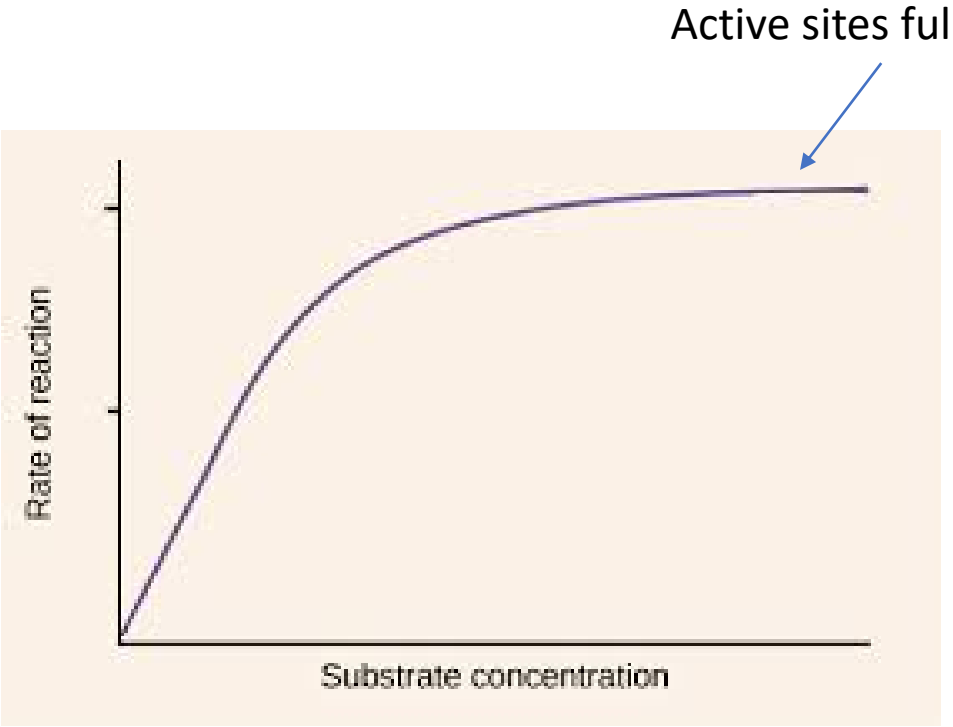
What happens?

The concentration of substrate will also affect the rate of reaction.

The higher the concentration, the faster the reaction up to a certain point.

Once all the active sites of the enzymes are full, increasing the concentration will make no difference to the rate of reaction.

Diagram



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Your turn:

(b) DNA can code for the amino acids in the active site of an enzyme.

Explain the role of the active site of an enzyme.

(2)

Figure 10 shows these results.

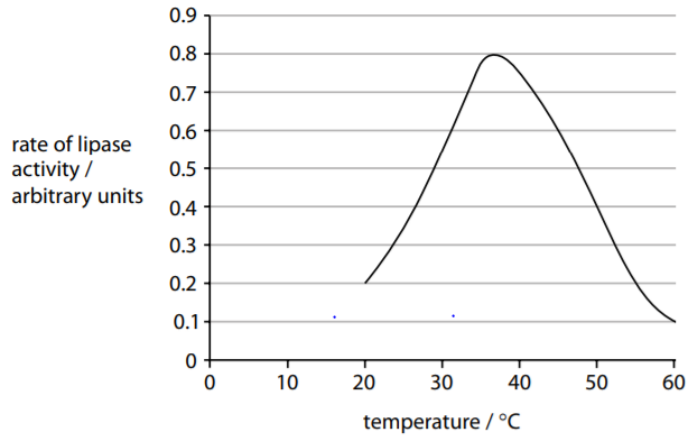

Figure 10

(ii) Describe the effect of temperature on the activity of lipase, as shown in Figure 10.

(2)

(iii) Explain why the activity of lipase changes above a temperature of 40 °C.

(2)

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Your turn:

(c) Different enzymes catalyse specific reactions.

Explain why enzymes can only catalyse specific reactions.

(2)

(c) Explain how the lock and key hypothesis models how enzymes work.

You may use labelled diagrams in your answer.

(3)

*(d) Describe how named factors affect the rate of enzyme-catalysed reactions.

(6)

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Answers:

(b) DNA can code for the amino acids in the active site of an enzyme.

Explain the role of the active site of an enzyme.

(2)

It has a specific shape, complementary to the substrate, An enzyme – substrate complex will be formed which will catalyse the reaction. This is the lock and key mechanism.

Figure 10 shows these results.

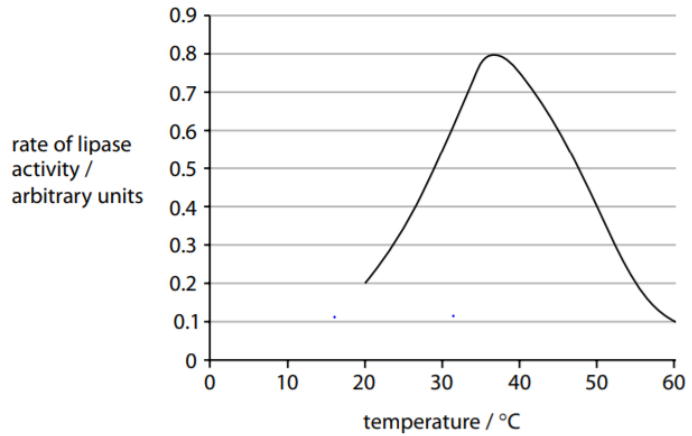

Figure 10

(ii) Describe the effect of temperature on the activity of lipase, as shown in Figure 10.

(2)

As the temperature increases from 20°C to 37 °C , the rate of lipase activity increases (from 0.2 to 0.8). The rate of lipase activity is optimal at 37 °C . Above 37 °C, the rate of activity decreases (from 0.8 to 0.1)

(iii) Explain why the activity of lipase changes above a temperature of 40 °C.

(2)

An increase in temperature above 40°C causes changes in the shape of the active site of the enzyme. The enzyme becomes denatured, and the substrate can no longer fit, so the enzyme no longer functions.

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Answers:

(c) Different enzymes catalyse specific reactions.

Explain why enzymes can only catalyse specific reactions.

(2)

The active site of an enzyme has a specific shape due to the order of the amino acids. The substrate must have a complementary shape to fit into the active site.

(c) Explain how the lock and key hypothesis models how enzymes work.

You may use labelled diagrams in your answer.

(3)

The active site of an enzyme has a specific shape. The substrate has a complementary shape to fit into the active site. An enzyme – substrate complex is formed. Enzymes break or form chemical bonds to cause reactions/make products. The products leave the active site allowing it to be used again.

*(d) Describe how named factors affect the rate of enzyme-catalysed reactions.

(6)

Temperature:

Too low – not enough energy to make reactions occur. All enzymes have an optimum temperature, in humans it is 37° C. Over this the active site changes shape, and the rate of reaction decreases and then stops. The enzyme has been denatured and the substrate cannot fit in any more.

pH:

Optimum pH is around neutral for most enzymes, some enzymes eg pepsin (pH 2) have different optimum pH. pH on either side of the optimum will interfere with the hydrogen bonds and cause the active site to change shape. The enzyme is denatured.

Substrate/enzyme concentration:

Higher concentrations mean faster reactions due to more collisions, until a maximum rate is reached where all active sites are full.

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For more help and resources, or to work with us as a tutor, please contact us

www.ebeducationservices.co.uk

contact@ebeducationservices.co.uk

0161 442 5270

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