16 Enzymes & COVID-19

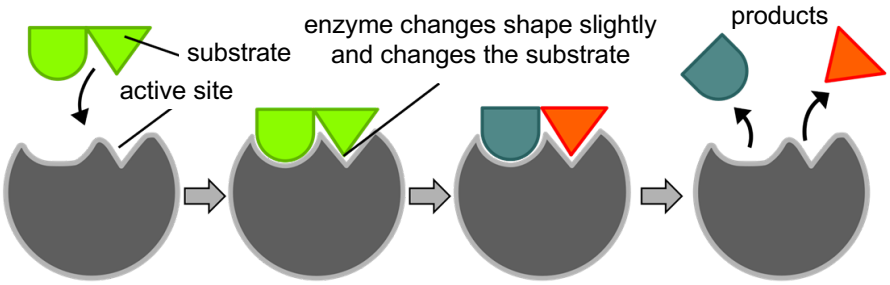
Links:
- *Exploring Science* 8Ad
- *Edexcel 9-1* CB1e/f/g

Catalysts

A substance that speeds up a chemical reaction is a **catalyst**. **Enzymes** are biological catalysts - they speed up reactions in organisms. For example, amylase is an enzyme in the digestive system. It breaks big starch molecules into smaller sugar molecules. A very simple model is to imagine it acting like scissors. The starch is the **substrate** for the enzyme. The sugars are the **products**.

Some enzymes build bigger molecules from smaller substrates. Other enzymes change their substrates in some way, without making them bigger or smaller.

An enzyme has a specific shape, the most important part of which is its **active site**. A substrate of the wrong shape will not fit the active site. Like keys fitting into locks, enzymes are very specific for their substrates. So, amylase cannot break down proteins because only starch fits its active site.



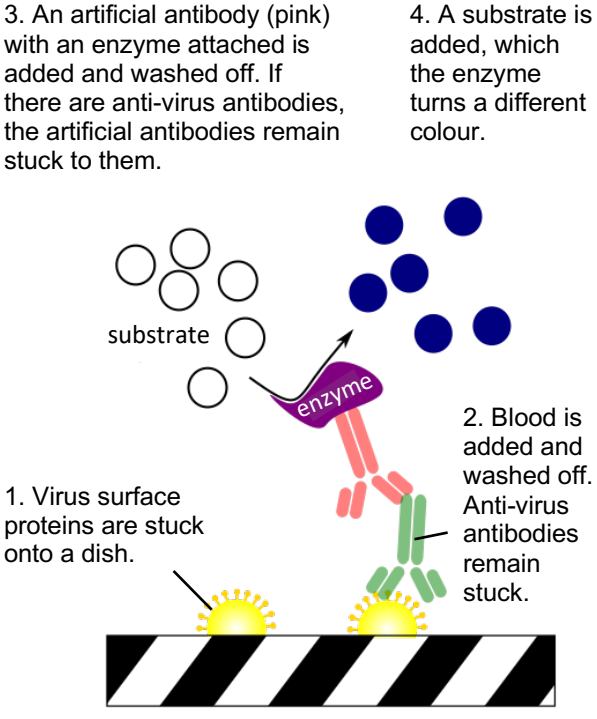
Temperature and pH both change the shape of an enzyme and its active site. If this happens the enzyme may not bind to its substrate properly and a reaction will not happen so quickly. Sometimes, an enzyme's shape is changed so much that it stops working. We say that it has been **denatured**.

SARS-CoV-2 enzymes

When SARS-CoV-2 enters a cell, it instructs the cell to make proteins. Some of these proteins are enzymes, which make molecules for new virus particles. Scientists are testing substances that stick to and block the active sites of virus enzymes to stop them working. These are enzyme inhibitors.

ELISA tests

After a person has had COVID-19, antibodies are left in the blood. The body has made these anti-virus antibodies with a specific shape that only matches and sticks to proteins from the virus. Enzymes are used in an ELISA test to detect these antibodies in a person's blood. The diagram shows how this works.



Find out

I. 1. What does ELISA stand for? _____

2. a. Name an inhibitor of the $3CL^{pro}$ enzyme from SARS-CoV-2. _____

b. What type of enzyme is $3CL^{pro}$? (tick one).

☐ amylase ☐ polymerase ☐ lipase ☐ protease

c. What do enzymes of this type do? _____

Test yourself

3. Explain why enzymes are described as biological catalysts. _____

_____

4. a. Name the process in humans for which amylase is important. _____

b. Explain why other enzymes are also needed to complete this process. _____

_____

5. Name a substance that enzymes are made of. _____

6. a. Explain why scientists think that some inhibitors could treat COVID-19 patients.

_____

b. Explain why it is important that these substances do not inhibit human enzymes.

_____

7. a. Give the reason why an ELISA test does not detect all the types of antibody in blood.

_____

b. In the diagram on page 1, state the colour that shows a positive test result. _____

c. Explain why there is no colour change in a negative result. _____

_____

d. Explain why doing an ELISA test at too high a temperature may give a 'false negative'.

_____

e. Name one other variable that needs to be controlled in an ELISA test. _____

Check-up

I. Check your answers.

II. Build a model to show the importance of the shape of an enzyme's active site. You might use plastic modelling bricks (e.g. LEGO®).

Answers

Note to home educators

This worksheet is designed to support understanding of enzymes. You may wish to share these objectives with students:

- Give examples of enzymes and where they are found in the human body.
- Define an enzyme as a biological catalyst.
- State that enzymes are proteins. (GCSE)
- Describe the role of the active site in enzyme function (including specificity). (GCSE)
- Use the lock-and-key model to develop explanations for enzyme activity. (GCSE)
- Describe the effects of temperature and pH on enzyme activity and explain how enzymes become denatured. (GCSE)

To fully access this sheet, students will need a knowledge of white blood cells and antibodies. It may be helpful for students to use Worksheets 7 and 8 before this one. Other sheets in the series are available: https://shwca.se/covid19science

It is suggested that students complete the worksheet independently, using the internet for questions 1 - 2. Questions 3 - 7 should be completed without help from additional sources.

Some material is drawn from the National Curriculum for Science for Key Stage 3 (for Years 8 and 9) but mainly from the GCSE 9-1 Science specifications (Years 10 and 11).

If you wish to check the answers, keep this part of the sheet away from the questions!

I. 1. enzyme-linked immunosorbent assay

2. a. many examples, e.g. herbacetin, rhoifolin, pectolinarin, lopinavir, ritonavir, darunavir, cobicistat, ASC09F, α-Ketoamides

b. protease

c. break down proteins/polypeptides

3. They speed up reactions, and are found in biology/organisms.

4. a. digestion

b. Enzymes are specific and a different one is needed to break down each substance in food.

5. proteins (or RNA but students are not expected to know this)

6. a. Two of these three points: they block virus enzymes; which stops the virus making copies of itself; which stops the virus infecting neighbouring cells.

b. The inhibitor would stop many important processes in the body.

7. a. Antibodies are specific for different shapes/antigens. (Only those that have been made to have the specific shape for a virus protein will stick.)

b. blue

c. There will be no enzyme present and so no change to the substrate.

d. The enzyme is denatured and so does not work/the substrate no longer fits the active site.

e. pH

II. The model needs to show that only a certain type of substrate can fit into the shape of the activity site of the enzyme.