teacher guide

Reaction rates 4: Enzymes

Components

	NAME	DESCRIPTION	AUDIENCE
	*Enzymes* teacher guide	This explains the use of various teaching resources and gives practical information about the enzyme demonstration in the procedure sheet, *Catalyst experiment*.	teachers
	*Catalyst experiment* procedure sheet	An experiment shows enzymes catalysing the decomposition of hydrogen peroxide.	students
	*Enzymes in the body* fact sheet	This fact sheet explains how enzymes work, and highlights research work at The University of Western Australia on catalase and aging in mice.	students

Purpose

To **Elaborate** on student understandings of reaction rates, by examining enzymes and iron(III) nitrate as an examples of catalysts.

Outcomes

Students:

- explain how enzymes and iron(III) nitrate function as catalysts;
- explain that a catalyst works by providing an alternate pathway with lower activation energy, for a chemical reaction;
- draw energy profile diagrams for a reaction, with or without a catalyst; and
- observe changes in how an enzyme functions when factors such as temperature and pH are modified.

Activity summary

ACTIVITY	POSSIBLE STRATEGY
Either, teacher demonstration to show how catalase, an enzyme present in fresh liver, catalyses the decomposition of hydrogen peroxide, or students perform the experiment described on procedure sheet, *Catalyst experiment*.	whole class or pairs
Students complete the worksheet based on the experiment.	individuals
Students read the fact sheet, *Enzymes in the human body*.	individuals

Teacher notes

The catalase investigation described in *Catalyst experiment* may be done either as a student experiment or a teacher demonstration. In either case, questions on the procedure sheet may be used as a follow-up activity.

Catalase enzyme may be purchased from SIGMA pharmaceuticals as an alternative to using liver. Fresh liver is used, as catalase may be deactivated by freezing. Boiled liver is included, to demonstrate that enzymes become inactive after being denatured by temperature extremes.

In the procedure sheet, *Catalyst experiment*, the test tube 'D' is included as a control, and may lead to discussion of experimental design.

During the catalysis by iron(III) nitrate, colour changes from yellow to black, and then back to yellow. The black colour generated when H_2O_2 is added to the catalyst solution is due to an intermediate Fe-H_2O_2 complex that is believed to form during the reaction. Catalysis depends upon the presence of Fe^{3+}, so take care to use freshly prepared Fe(III) nitrate solution.

The effect of temperature and pH on enzyme is an optional part of the activity. As with most mammalian enzymes, the optimum temperature of catalase is close to body temperature and the optimum pH close to the pH of the particular animals' organ. In cattle, the normal body temperature is slightly higher than in humans, around 38–39°C, so for bovine catalase, optimum conditions are 40 °C and pH 7. Catalase is active in acidic conditions as low as pH 4, and will still be active at normal room temperatures.

Information about enzymes is included in the worksheet students complete after the demonstration or practical experiment.

Using the fact sheet, *Enzymes in the human body*

It is assumed students have completed the worksheet on enzymes, with either a practical or demonstration, before reading the fact sheet. If this is not the case, some introduction to enzymes needs to be provided by the teacher. After reading the fact sheet, students can summarise the information in a 'Let's consider' format. To do this they complete four statements, beginning:

- I never knew that …
- I've changed my mind about …
- The most important thing I'll remember is …
- I'm still wondering about …

Technical requirements

The guide, procedure sheet and fact sheet require Adobe Reader (version 5 or later), which is a free download from adobe.com. The procedure sheet is also provided in Microsoft Word format.

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SPICE resources and copyright

All SPICE resources are available from the Centre for Learning Technology at The University of Western Australia ("UWA"). Selected SPICE resources are available through the websites of Australian State and Territory Education Authorities.

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Associated SPICE resources

Reaction rates 4: Enzymes may be used with related SPICE resources to address the broader topic of reaction rates.

DESCRIPTION	LEARNING PURPOSE
Reaction rates (overview) This learning pathway shows how a number of SPICE resources can be combined to teach the topic of reaction rates.	
Reaction rates 1: Photochemical smog A video shows how environmental factors can increase chemical reactions that occur in the atmosphere, to produce photochemical smog.	**Engage**
Reaction rates 2: Investigating reaction rates Students investigate how they can change the rate of a real-life chemical reaction in the laboratory.	**Explore**
Reaction rates 3: Controlling reactions An interactive learning object explains relationships between reaction rates, collision theory, energy profile diagrams and kinetic energy distribution graphs.	**Explain**
Reaction rates 4: Enzymes Students extend their knowledge of catalysts by studying how enzymes work.	**Elaborate**