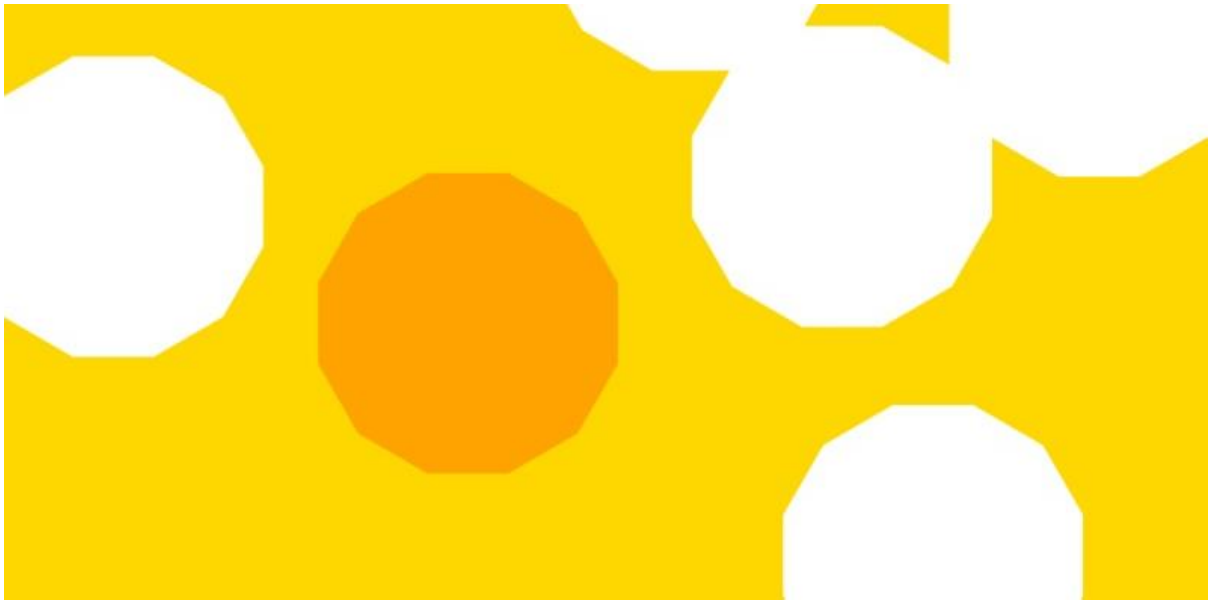
FOR STUDENTS – GUIDE TO THE EXPERIMENT



We want you to design an experiment to find out what affects how an enzyme works.

Below, we've detailed a basic experiment which will let you calculate the rate of an enzyme-controlled reaction. Once you understand how to find this rate of reaction, you can look at what affects it – and figure out what's affecting how well your enzyme works.

The experiment

Below is a way to look at how well the enzyme catalase (which is found in high quantities in potatoes) is working.

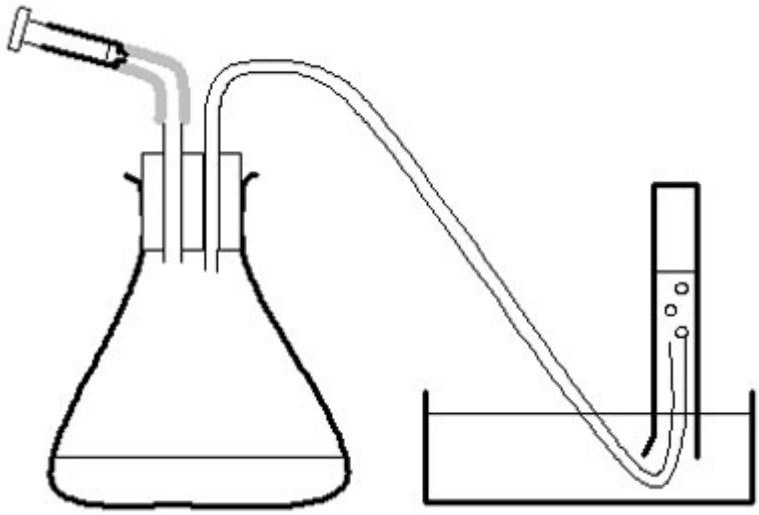
This investigation looks at the rate of oxygen production by the catalase, by collecting the oxygen produced over a 30-second period.

Enzymes work quickly –and in fact, catalase might be one of the fastest enzymes that exist. You can calculate its rate of reaction using the experiment below.

Guide to your experiment:

You need:

- Clamp stand
- Conical flask
- 50cm^3 measuring tube
- Pen that can write on measuring tube (ideally)
- Two-holed rubber bung
- Pureed potato
- 2cm^3 Hydrogen peroxide solution
- Measuring syringe
- Stopwatch



SAFETY NOTE: Wear eye protection and protect your clothing from hydrogen peroxide. Rinse any splashes of peroxide and pureed potato off your skin as quickly as possible.

Setting up:

You need to collect the oxygen gas produced by the reaction – this is how you'll measure how the enzyme is working.

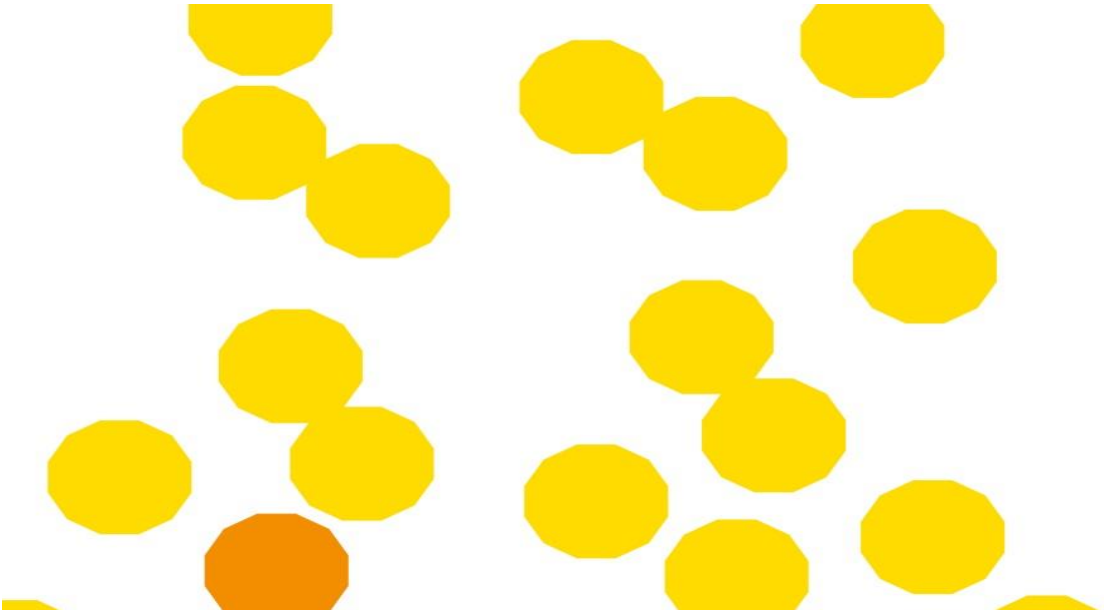
- Start by filling your boiling tube with water, then quickly inverting it over the water tank. Have a friend clamp it in position.
- Measure 20cm^3 pureed potato into the conical flask.
- Make sure that the bung is tightly inserted, and that one end of the tube goes into the water bath, and into the upheld boiling tube.

Doing the experiment

- Measure out 2cm^3 of the hydrogen peroxide solution,
- Add it to your conical flask through the tube. You will need to work quickly after this! Watch what happens to the potato – you should see bubbles as oxygen is produced.

- Note where the oxygen level has got too in your boiling tube after 30 seconds.
- Calculate the rate of reaction. Divide the cm^3 of oxygen you collect by the time in seconds it took to produce. This will give you a rate of reaction in cm^3/s.

$$\text{Rate of oxygen production} = \frac{cm^3 \text{ of oxygen collected}}{\text{time in seconds it took to produce}}$$



Designing your Experiment

In this competition, you can design your own experiment to change some of the experimental conditions, and see how they affect the rate the enzyme works. Each type of enzyme has its own specific optimum conditions under which it works best.

You'll need a hypothesis - a prediction of what you think your experiment will show. Then you think of a way to test it.

You can do this by changing the variables – change something about the experiment. Think about what you'll record and how you'll display it to show that your hypothesis was right.

You could even do preliminary experiments, to suggest what might be interesting to test.

Collecting and analysing your results

- Before you start, think about what data to collect – if you're changing a variable, you need to keep a record of how you changed it.

- Collect your data in a sensible way as the experiment progresses. If you're collecting multiple oxygen readings, use a stopwatch to time the intervals between them, for example.

- Think about how you'll display your data afterward. We suggest plotting a line graph.

- The variable you are changing should go on the x axis – it is the independent variable, and because you're changing it, you know it won't change based on what happens in the experiment. The variable you're measuring should go on the Y axis – in this case, it's probably going to be the rate of reaction you calculated before.

Some examples to get you thinking:

- Does time make a difference? Will the experiment eventually stop producing oxygen? Why would that occur?

- Does the concentration of hydrogen peroxide, the substrate, make a difference to the initial rate of reaction? What if you increase the amount of substrate until it is more than the available catalyst?

- Generally, the concentration of enzyme is important - the more enzymes there are to catalyse a reaction, the quicker the overall reaction. Does the concentration of pureed potato variable make a difference? If not, why not? What might you need to change to see it making a difference?

- What happens if you try a new type of potato?

- Temperature is a key factor – if the experiment is too cold, there's not enough energy for a reaction. But too much heat can also be bad for enzymes, changing the shape of their active site.

- If you do a preliminary experiment, you might notice that the basic experiment itself is exothermic – it heats up. Could different temperatures effect how the experiment progresses?

- Each particular enzyme works best at a particular pH. If the conditions are too alkaline or acidic then the activity of the enzyme is affected. This happens because the enzyme's shape – particularly the active site - is changed. It is denatured, and cannot hold the substrate molecule.

- Enzymes can degrade when cells are mashed up and exposed to the air. Does how fresh your potato is affect the reaction?

- Sometimes, if too much product accumulates, the reaction can also be slowed down. The products of this reaction are oxygen and water. Is this a factor here?

- Enzymes are not changed by the reaction they catalyse. That means they should be reusable. What happens if you keep adding more hydrogen peroxide?