



Home Science Resources:

Video 2 – Enzymatic browning

Part 1 of this video explores **enzymes as biological catalysts**, with part 2 looking at **polyphenol oxidase** specifically as an important enzyme involved in the **browning process of fruits and vegetables**. Part 3, gives you the chance to **run your own experiment** and **understand why fruits and vegetables go brown when they are exposed to oxygen in the air**.

By the end of the video you will have an understanding of:

- What enzymes are
- How enzymes are involved in digesting your food
- How enzymes work, including the lock and key mechanism
- Polyphenol oxidase as a specific enzyme, and the reaction it catalyses
- Setting up an experiment to determine the effect of pH on the browning reaction
- Why polyphenol oxidase is important in the food industry, and to plants

What will you need for the enzymatic browning experiment?

- A **chopping board** and **knife**
- **1 apple/potato/lettuce/banana** (apple or potato would be best)
- **5 glasses/bowls/ramekins/plates** to put your fruit and veg in
- **Bicarbonate of soda, milk, fruit juice, vinegar** and **lemon juice**

How does this practical fit with the curriculum, and what skills will you learn?

Skills learnt:

- **EXPERIMENTAL SET UP:** listing hypotheses, independent and dependent variables and the variables to control during the experiment.
- **PROBLEM SOLVING:** working out what your hypothesis is
- **INDEPENDENT LEARNING:** setting up your own experiment, observing results and comparing it to the hypothesis

Fit with the curricula:

- Investigation into the **effect of a named variable on the rate of an enzyme-controlled reaction** (A-level bio)
- Describe **nature of enzyme molecules** and relate to **temperature/pH**, know that enzymes catalyse specific reactions due to shape of their active site (related to structure) (GCSE Bio)
- Understand that **enzymes act as catalysts in biological systems**, giving examples of **specific systems** (GCSE Bio)
- Understand the **pH scale**: H⁺ ions lead to acidity and OH⁻ ions lead to alkalinity (GCSE chem)

Health and Safety: Make sure you have help using the knife if you need to, and don't touch your eyes after using vinegar and lemon juice. Wash your hands afterwards!

We'd love to know how you got on!



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Glossary

In case you need a recap of some of those words in the video

Acidity – a low pH, when something contains a lot of hydrogen ions (H^+) it is said to be very acidic which provides a sour taste in foods.

Active site – the specific part of an enzyme where the substrate binds, so that the chemical reaction can occur. The active site shape is specific to the enzyme.

Alkalinity – a high pH, when something contains a lot of OH^- ions it is said to be very alkaline.

Amylase – an enzyme which catalyses the breakdown of starch into simple sugars. It is found in the saliva of humans, and kickstarts the digestion process.

Antioxidant – a substance that inhibits the oxidation reaction, common antioxidants include Vitamin C (ascorbic acid) and Vitamin E.

Ascorbic acid – the chemical name for vitamin C, which is found in many foods such as kiwi and oranges.

Carbohydrase – a set of enzymes which catalyse the breakdown of carbohydrates into simple sugars.

Catalyst – a substance that speeds up the rate of a chemical reaction, without being used up itself.

Controlled variable – elements of a scientific experiment, which will remain constant, throughout the experiment. Controlling these variables will allow the experiment to be as fair as possible.

Dependent variable – what you are going to measure during your experiment

Digestive enzymes – enzymes found in your digestive system which break up complex food molecules into simple molecules which can be absorbed by the bloodstream.

Enzyme – a biological catalyst; a biological molecule that speeds up a reaction without being used up itself. They are found in washing powder, your digestive system, and used extensively in the food industry.

Enzyme-substrate complex – a temporary molecule formed when the enzyme and substrate come into contact, when both are a perfect fit, this leads to product formation.

Enzyme inhibition – a decrease in enzyme activity, and therefore product formation, usually due to a molecule blocking the active site so an enzyme substrate complex cannot be formed.

Hypothesis – a proposed explanation for an observation, that can be tested. Generally it is based on a previous knowledge or observation.

Independent Variable – what you are going to change during your experiment

Lactase – an enzyme which converts the sugar lactose, into simple sugars glucose and galactose. People who are lactose intolerant, do not have this enzyme.

Lactose – the sugar found in dairy products, such as cheese and milk.

Lipase – an enzyme which catalyses the hydrolysis of lipids (fats) into glycerol and fatty acids

Lock and key mechanism – used to describe how an enzyme works, the active site (the lock) will only be suitable for the specific substrate (the key).

Melanins – brown coloured pigments produced via the PPO reaction that give brown colour to fruits and vegetables.

pH scale – a logarithmic scale which measures the concentration of hydrogen ions in a solution, the left hand side of the scale represents acidity (more H^+ ions) and the right hand side represents alkalinity (more OH^- ions).

Polyphenol oxidase (PPO) – an enzyme found in fruits and vegetables, responsible for the browning reaction occurring when these products are damaged.

Polyphenols – naturally occurring compounds found in fruits, vegetables, cereals and beverages, that are suggested to provide health benefits to humans. Different types of polyphenols provide colour to fruits and vegetables e.g. blueberries.

Protease – an enzyme which catalyses the hydrolysis of proteins into amino acids or smaller peptides.

Substrate – a molecule specific to an enzyme, that allows a chemical reaction to be catalysed. The substrate will bind to the enzyme's active site.

Vacuole – a part of a plant cell, used to store food and nutrients, that also contains the enzyme polyphenol oxidase.