

# ENZYMES - breaking it down with biological catalysts

## Background:

What would happen to your cells if they made a poisonous chemical? You might think that they would die. In fact, your cells are always making poisonous chemicals. They do NOT die because your cells use enzymes to break down these poisonous chemicals into harmless substances. **Enzymes are proteins that speed up the rate of chemical reactions that occur in your body.** You have hundreds of different enzymes in each of your cells. Each enzyme is responsible for ONE particular reaction. In this lab you will study an enzyme called **catalase**. Its job is to speed up the reaction which quickly breaks down **hydrogen peroxide** (a poisonous chemical made by your body) into two harmless substances - **water** and **oxygen**. If cells do not break down the hydrogen peroxide, they will be poisoned and die...(sad face).

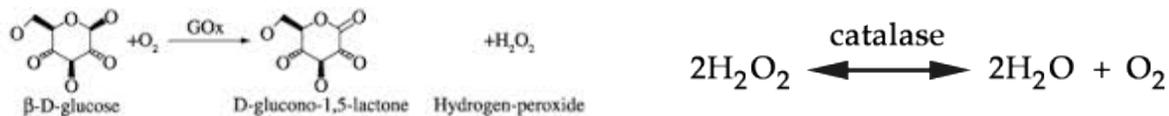
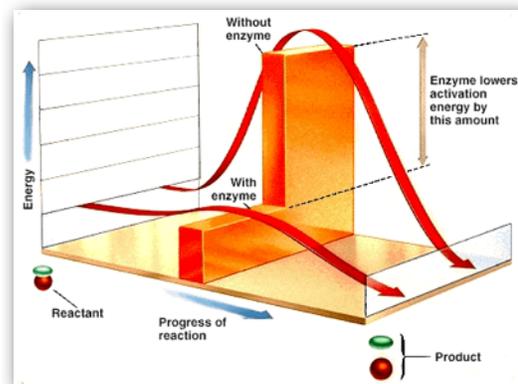
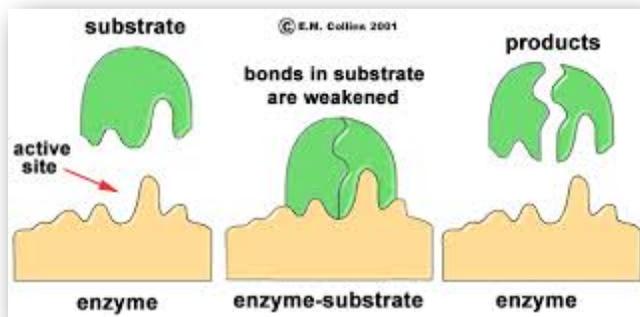


Chart 1. The enzymatic reaction catalysed by glucose oxidase (GOx).

When glucose is broken down in your body to provide ENERGY - one of the byproducts of this reaction is hydrogen peroxide. Sad face you say! Don't worry CATALASE is here to save the day!!!

**Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>)** is a highly active chemical. In this reaction, the substance at the beginning of the process (hydrogen peroxide) is called the **substrate**. The **enzyme** converts the substrate into different molecules called the **products** (water and oxygen). Enzymes work to speed up a chemical reaction by **lowering the activation energy** (how much energy is required to start a reaction). Some enzymes are used commercially, for example, enzymes in biological washing powders break down protein or **fat** stains on clothes; enzymes in steak tenderizers break down long meat proteins, making them easier to chew.



Enzyme activity is also affected by **temperature**, **pH**, and how much substrate there is to break down. **Denaturation** is when a protein changes shape through some form of external stress, for example, by heating, or exposing to acids or bases. The protein's shape changes in such a way that it will **no longer be able to carry out its cellular function**. Most biological proteins lose their function when denatured, For example, **enzymes** when heated, lose their ability to speed up reactions. When food is cooked, some of its proteins become denatured. This is why boiled eggs become hard and white, and cooked meat becomes firm. Check out this [website interactive](#) to see how denaturing an enzyme effects its ability to function.

In this lab you will observe the activity of the enzyme, **catalase**, a biological catalyst found in varying concentrations in the cells of almost all living organisms. For this lab we are using liver, chicken meat, carrot root, and potato root. Seems strange to use "dead cells" but enzymes remain intact and active as long as the meat is kept refrigerated and not cooked.

## Pre-lab questions:

1. What do enzymes **do** in your body? \_\_\_\_\_
2. What enzyme are we studying in this lab? \_\_\_\_\_
3. Name **1** thing that affects an enzyme's ability to speed up a reaction. \_\_\_\_\_
4. What is **denaturation**? \_\_\_\_\_
5. What are **1** thing that cause a protein to be denatured? \_\_\_\_\_
6. How do enzymes used in laundry detergent work to get out stains? \_\_\_\_\_  
\_\_\_\_\_
7. Explain what happens to meat and eggs when cooked? \_\_\_\_\_  
\_\_\_\_\_
8. Where is catalase found in nature? \_\_\_\_\_

When finished with the pre-lab:

**Wait for lab groups to be assigned.**

Go to lab station and, as a lab group, check-off that all lab materials are present, clean, and ready to roll.

## Materials:

**Each lab station should have the following - check these off the list before beginning your lab procedures.**

- |   |   |
|---|---|
| <input type="checkbox"/> 6 test tubes                 | <input type="checkbox"/> Chicken cubes (fresh & cooked) |
| <input type="checkbox"/> Tweezers (forceps)           | <input type="checkbox"/> Potato cubes                   |
| <input type="checkbox"/> Hydrogen peroxide            | <input type="checkbox"/> Carrot cubes                   |
| <input type="checkbox"/> Liver cubes (fresh & cooked) |   |

## Procedure:

**Be sure to use about the same size amounts for all the tests.**

1. Arrange the test tubes in the rack and number them 1-6.

**After each** of the following **steps, record** your **observations**.

2. Using forceps select a piece of **fresh liver** and drop it into **Tube 1**. Observe and record any change.

3. Place a piece of **cooked liver** that into **Tube 2**. Observe and record any change.

4. In **Tube 3**, place a small piece of **fresh chicken**. Observe and record any change.

5. In **Tube 4**, place a piece of **cooked chicken**. Observe and record any change.

6. Into **Tube 5**, place a small cube of **potato**. Observe and record any change.

7. In **Tube 6**, place a piece of **carrot**. Observe and record any change.

## THE DATA:

**Symbols for tube reaction data**

0	no reaction
+	very mild reaction (slight bubbling)
++	good reaction ( bubbling)
+++	best reaction (violent bubbling)

Tube Number	1	2	3	4	5	6
<b>Liquid</b>						
<b>Substance</b>						
<b>Tube Reaction Rating</b>						

## Post-Lab Questions

1. The bubbling indicates that the hydrogen peroxide is being broken down.  
**What are the products of the breakdown of  $H_2O_2$ ?**
2. What caused the reaction when you put the liver into tube 1?
3. How do you explain the difference in activity between the fresh piece of liver the cooked piece of liver - and the fresh chicken and cooked chicken?
4. Based on your observations in tube 5 & 6, do plants cells contain **catalase**.
5. Write a summary paragraph of **what an enzyme is** and **what its main function is**.

*Explain which of your foods tested positive for enzymes.*

*Explain why cooked meats **do not** test positive for the enzyme **catalase** but raw meat do.*