Enzymes Review

Enzymes are special proteins, which are comprised of amino acids, and they are very important macromolecules found in every cell. **Enzymes generally act as catalysts** that increase the rate at which substances in a cell are converted into other substances. Without enzymes, some reactions would take place too slowly—or might not take place at all.

As discussed in class, enzymes play a pivotal role in a cell's regulatory capacity and are one of the means by which cells "feedback" on metabolism in order to achieve **homeostasis**. Homeostasis is the ability of the body or a cell to seek and maintain a condition of equilibrium or stability within its internal environment when dealing with external changes

Each enzyme has a different job and many enzymes work synchronously to keep an organism alive and healthy. In the liver, for example, there are multiple enzymes that act on toxic or poisonous compounds, and detoxification is one of the primary functions of the liver. One of the most common "poisons" is **hydrogen peroxide** (H2O2), which is very reactive and harmful to membranes in particular.

As a poison, H2O2 accumulates in the body due to natural events (e.g., aging; aerobic metabolism; exercise) and other processes (e.g., smoking; air pollution). Fortunately, there is an enzyme in the liver that breaks down the H2O2 into water and oxygen. This enzyme is known as catalase. The catalase enzyme reduces the substrate - H2O2 - to two products, H2O and oxygen (O2), by the following decomposition reaction:

$$2\ H_2O_2 \xrightarrow{\text{Catalase}} 2\ H_2O + O_2$$

Like all enzymes, catalase helps the reaction but it is not consumed in the reaction; this is a characteristic of a catalysis reaction. Also like other enzymes, catalase must have a proper environment in which to work. For example, catalase works best when the temperature is normal (around 37°C) and when the pH is between 7.3 and 7.4. If the environmental conditions are outside this range, catalase is less effective in decomposing H2O2 to H2O + O2.

Proteins can be denatured through exposure to heat or chemicals. Denatured proteins lose their three dimensional structure and thus their function. Cooking food denatures the proteins found in the food and makes digestion more efficient which is good for us. However enzymes are proteins, which means that enzymes can also be denatured.

Proteins are chains of amino acids. The sequence of amino acids in a chain is known as the primary structure of a protein. The chains fold up to form complex three-dimensional shapes. The chains can fold on themselves locally (secondary structure) and wrap around themselves to form a specific three-dimensional shape (tertiary structure). The secondary/tertiary structure of a folded protein is directly related to the function of that protein.

For example, enzymes are proteins that catalyze reactions. They have binding sites that interact with other molecules. These binding sites are created through the folding of the amino acid chains that gives rise to the three dimensional shape of the enzyme. If the enzyme is denatured then the binding site will become inactive.

Use the Data Tables on the back of this sheet to collect your class data.

Enzymes and Reaction Rate Pre-Lab – Vernier Probe Method

You know several things about the reaction rate of enzymes based on your previous knowledge:

1) Enzymes are not used up in the reactions they catalyze
2) The reaction rate of enzymes depends on several factors such as temperature, pH, and enzyme availability.
3) Enzymes have optimum conditions at which they operate most efficiently.

Purpose:

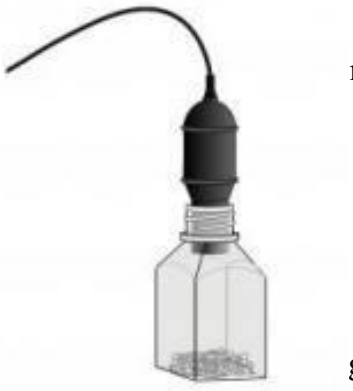
In this part of the lab, you are going to see how different factors change the speed at which catalase breaks down hydrogen peroxide. These factors are temperature (how hot or cold) and the enzyme concentration (the amount of enzyme present).

How do we know how fast the reaction is occurring? Since we cannot see catalase decomposing hydrogen peroxide, we will be measuring the amount of oxygen produced when H_2O_2 breaks down.

Overview:

For this experiment, you will be mixing together hydrogen peroxide and catalase (obtained from beef liver) in a Nalgene bottle (plastic bottle with whitish cover). The flask will be plugged with a Vernier Oxygen Sensor to measure the amount of Oxygen gas that is produced by the decomposition of the hydrogen peroxide. This is how you will measure the amount of oxygen produced. As the hydrogen peroxide is broken down into oxygen, the oxygen will bubble in the Nalgene bottle and will be measured electronically by the Vernier Oxygen sensor. The data will be automatically recorded in the probe (handheld device) and you will be copying the data on your sheet of paper.

Vernier Probe – handheld device



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gene bottle

This will be done under different conditions to see how they affect the reaction rate. As previously mentioned, these conditions are temperature and enzyme concentration. Each of these variables will be adjusted for each experiment.

To adjust the temperature for freezing temperature 0°C use liver and hydrogen peroxide in Ice Bath, room temperature 25°C use liver and hydrogen peroxide at room temperature, body temperature 37°C use liver and hydrogen peroxide from hot plate, and boiling temperature 100°C use liver and hydrogen peroxide from boiling water.

To change the enzyme concentration, different amounts of liver pieces will be added to the hydrogen peroxide

Pre-lab Questions

1) What is the purpose of this lab?
2) Identify the different experimental variables for the 2 different experiments in the table below:

Experiment 1	Experiment 2

3) How are you planning to test your independent variable for experiment 1? What about for experiment 2? (describe and diagram your experiment)
4) Diagram the setup of the experiment. Include the flow of oxygen in your diagram.
5) Explain how you will determine the reaction rate of the experiment.
6) How will you mimic the different temperatures of hot, room temperature, body temperature, and cold?
7) How will you adjust the enzyme concentration?
8) What do you expect to happen for experiment 1? How about experiment 2?