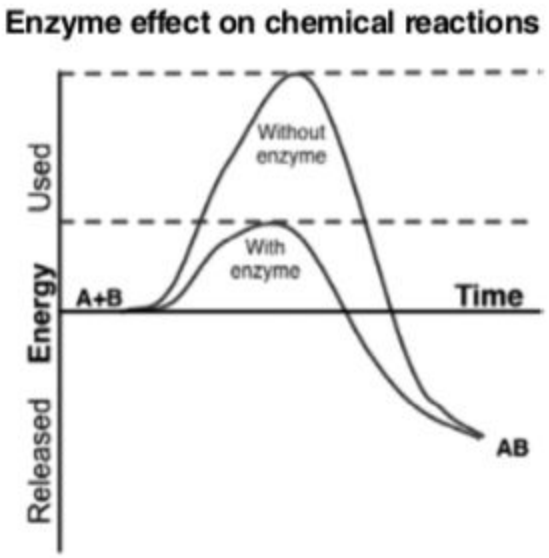
Lab 8: Enzymes: How Do Changes in Temperature and pH Levels Affect Enzyme Activity?

Introduction



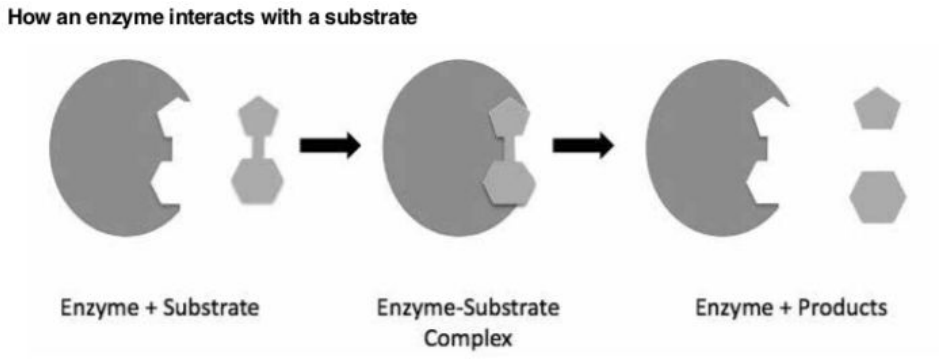
Sugars are vital to all living organisms and are used to produce the energy (in the form of adenosine triphosphate, or ATP) an organism needs for survival. All sugars are carbohydrates, which are molecules that contain the elements carbon, hydrogen, and oxygen. Living organisms use carbohydrates as sources of energy. Different types of sugars are found in different kinds of foods, but not all of these sugars can be used as energy sources by every type of organism. In order for an organism to make use of a sugar as an energy source, it must be capable of transporting the sugar into its cells and it must have the proper enzymes to break down the chemical bonds of the sugar to release the energy stored inside the molecule. For example, humans cannot digest lactose, or milk sugar, unless they have an enzyme called lactase. People who are lactose-intolerant do not make that enzyme and therefore, cannot digest lactose unless they ingest lactase-containing pills prior to eating lactose.

Enzymes are proteins that are involved in almost every chemical reaction that take place within an organism. They act as catalysts, substances that speed up chemical reactions without being destroyed or altered during the process. The figure above illustrates how an enzyme lowers the amount of energy needed for a reaction to take place, and the figure on the next page illustrates how an enzyme interacts with a substrate. Although most reactions can occur without enzymes, the rate of the reaction would be far too slow to be useful.

An example of an important enzyme in animals is catalase, which is produced in the liver and is used to catalyze the breakdown of hydrogen peroxide (H_2O_2). H_2O_2 is a toxic chemical that is produced as a natural by-product of many reactions that take place within your cells. Because it is toxic, it must be destroyed before it can do too much damage. To destroy H_2O_2, cells convert it into oxygen gas and water based on the following reaction:

H_2O_2 (liquid) + catalase → H_20 (liquid) + O_2 (gas) + catalase

Environmental conditions, such as temperature or pH level, can affect the function of enzymes. In this investigation, you will explore how these two environmental conditions affect enzyme activity by measuring the rate at which O_2 is produced when H_2O_2 is exposed to catalase at different pH levels and temperatures.



Your Task

Design two controlled experiments to determine how changes in temperature and pH levels affect the activity of the enzyme catalase. The guiding question of this investigation is: ***How do changes in temperature and pH levels affect enzyme activity?***

Materials

You may use any of the following materials during your investigation:

- Catalase solution
- 3% H_2O_2 solution
- Acidic solution
- Basic solution
- Distilled water
- Graduated cylinder (25 ml)
- 6-8 test tubes
- Test tube rack
- 2 Beakers (each 600 ml)
- Hot plate
- Ice
- Thermometer
- pH paper
- Plastic pipettes

Getting Started

To answer the guiding question, you will need to design and conduct two experiments. For each experiment, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it.

To determine *what type of data you need to collect*, think about the following questions:

- What will serve as your independent (manipulated) variable and dependent (responding) variables during each of your experiments?
- What type of measurements or observations will you need to record during each of your experiments? How will you measure your variables?

To determine *how you will collect your data*, think about the following questions:

- What will serve as a control (or comparison) condition? What types of treatment conditions will you need to set up and how will you do it? How many trials will you need to do?
- How often will you collect data and when will you do it?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data*, think about the following questions:

- How will you determine if there is a difference between the treatment conditions and the control condition?
- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question were you trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.