

See Lecture Question #'s 4, 7, and 9

\_\_\_\_\_ Teacher initials practice data collection \_\_\_\_\_ Teacher initials for procedures \_\_\_\_\_ Teacher initials for data collection

## Enzymes: How Do Changes in Environmental Conditions Affect Enzyme Activity?

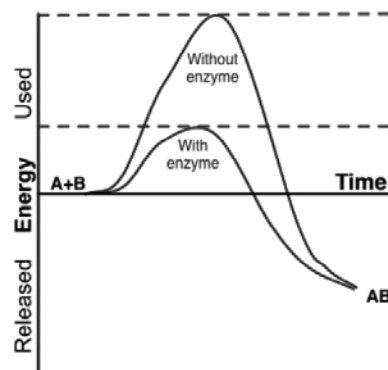
Pre-lab Annotate text and answer questions 1-12

| Annotating Text  |  |
|--|--|
| <input type="checkbox"/>   | <b>UNDERLINE</b> concepts you think might be useful for understanding or solving the problem |
| <input type="checkbox"/>   | <b>Box</b> information you think might be helpful for designing your investigation           |
| <input type="checkbox"/>   | ← Write <b>notes</b> in the left margin  |
| <input type="checkbox"/>   | → Write <b>questions and answers</b> in the right margin                                     |
| Each paragraph (including each step of the procedures) must have something underlined or boxed, <b>AND</b> have something written in the margins (a question and/or note). |  |

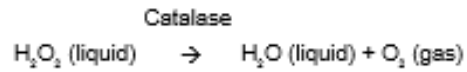
**Introduction**

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 with the general chemical formula of  $(CH_2O)_n$ , where  $n$  is 3 or more. 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 the chemical bonds of the sugar to release the energy stored inside the molecule.

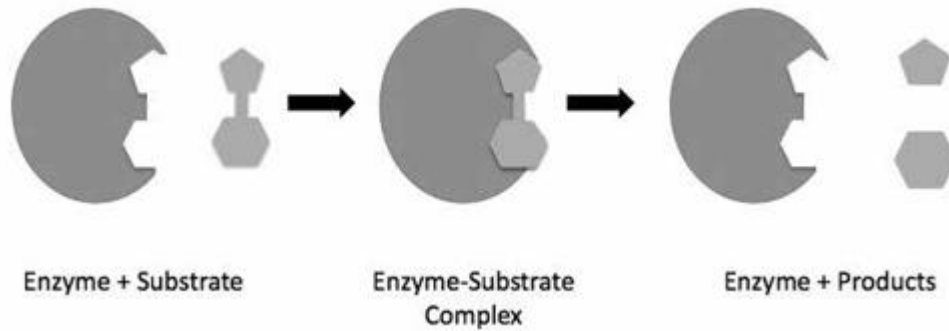
Enzymes are proteins that are involved in almost every chemical reaction that takes place within an organism. They act as catalysts, substances that speed up chemical reactions without being destroyed or altered during the process. The figure to the right illustrates how an enzyme lowers the amount of 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 sustain life.



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:



### How an enzyme interacts with a substrate



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  $\text{O}_2$  is produced when  $\text{H}_2\text{O}_2$  is exposed to catalase at different pH levels and temperatures.

### Your Task

Design a controlled experiment to determine how changes in temperature or pH levels affect the activity of the enzyme catalase.

The guiding question of this investigation is, **How do changes in environmental conditions affect enzyme activity?**

### Materials

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

- Catalase solutions (request desired pH)
- 3%  $\text{H}_2\text{O}_2$  solution
- Graduated cylinders
- Beakers
- Hot plate
- Ice
- $\text{O}_2$  gas sensor
- Sensor interface
- Thermometer
- pH paper
- Safety goggles

## Getting Started

To answer the guiding question, you will need to design and conduct an experiment. For your 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 will need to collect*, think about the following questions:

- 1) What will serve as your independent variable during your experiment?
- 2) What will serve as your dependent variable during each of your experiments?
- 3) What type of measurements or observations will you need to record during your experiment? (Hint: What information will you need to calculate a rate?)

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

- 4) What will serve as a control condition?
- 5) What types of treatment conditions will you need to set up and how will you do it?
- 6) How many trials will you need to conduct?
- 7) How often will you collect data and when will you do it?
- 8) How will you make sure that your data are of high quality (i.e., how will you reduce measurement error)?
- 9) 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:

10) How will you determine if there is a difference between the treatment conditions and the control condition?

11) What type of calculations will you need to make?

12) What type of graph could you create to help make sense of your data?

### **Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry.**

As you work through your investigation, be sure to think about

- the importance of identifying the underlying cause for observations;
- how energy and matter move within or through a system;
- how structure is related to function in living things;
- the nature and role of experiments in science; and
- how science, as a body of knowledge, develops over time.



Data table(s) and chart(s)

Guiding Question:

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Our Claim:

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**Our Evidence:**

Analysis: break it down (Illustrate and describe your data)

**Our Justification of the Evidence:**

Use your scientific knowledge and analysis to support your interpretation

Interpretation: What does the analysis mean?

## Checkout Questions

1. How do environmental factors, such as temperature and pH, affect enzyme function?

2. All investigations are experiments. True or False

Explain your answer, using information from your investigation about enzymes.

3. Scientific knowledge that is based on a well-designed experiment will not change. True or False

Explain your answer, using examples from your investigation about enzymes.

4. An important goal in science is to explain the underlying cause for observations. Explain why this is important, using an example from your investigation about enzymes.

5. Scientists often need to track how matter moves in, out, and through a system during an investigation. Explain why this is important, using an example from your investigation about enzymes.

6. Structure and function are related in living things. Explain why, using an example from your investigation about enzymes.