Investigation 13: Enzyme Activity

Learning Objectives

• To understand the relationship between enzyme structure and function.

• To make some generalization about enzymes by studying just one enzyme in particular.

• To determine which factors can change the rate of an enzyme reaction.

• To determine which factors that affect enzyme activity could be biologically important.

Background

• Enzymes are the catalysts of biological systems. They speed up chemical reaction in biological system by lowering the activation energy, the energy needed for molecules to begin reacting with each other.

The energies of the stages of a chemical reaction. Substrates need a lot of potential energy to reach a transition state, which then decays into products. The enzyme stabilizes the transition state, reducing the energy needed to form products.

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Background

• Enzyme form an enzyme-substrate complex that reduces energy required for the specific reaction to occur.

• Enzyme have specific shapes and structure that determine their functions.
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**Background**
- Enzymes are fundamental to the survival of any living system and are organized into a number of groups depending on their specific activities.
  - **Catabolic enzymes** - break down:
    - proteases breaks down proteins
    - lactase breaks down milk sugars
  - **Anabolic enzymes** - to build:
    - ATP Synthase the enzyme that stores cellular energy in ATP by combining ADP and phosphate
    - Rubisco the enzyme involved in the building of sugar molecules in the Calvin cycle of photosynthesis

**Catalase** is a common enzyme found in nearly all living organisms exposed to oxygen. It catalyzes the decomposition of hydrogen peroxide to water and oxygen.

\[ 2 \text{H}_2\text{O}_2 \xrightarrow{\text{catalase}} 2 \text{H}_2\text{O} + \text{O}_2 \]

Catalase enzyme can catalyze the decomposition of hydrogen peroxide, converting millions of molecules of hydrogen peroxide to water and oxygen a second.

Once a baseline reaction rate is determined, you will design an experiment to test how abiotic or biotic factors influence the rates of enzymatic reactions.

**PreLab**
- Complete **LabBench Activity Lab 2: Enzyme Catalysis** in your Comp Book
- View BozemanScience.com: AP Biology Lab 2 Enzyme Catalysis **(Float Disc Method)**
  - [http://www.bozemanscience.com/ap-bio-lab-3-enzyme-catalysis](http://www.bozemanscience.com/ap-bio-lab-3-enzyme-catalysis)
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Designing and Conducting Your Investigation: Yeast Catalase Experiment

- Read Yeast Catalase Experiment (handout)
- Copy Table 1: Catalase Reaction Rate Baseline RXN (GROUP)
- Copy Table 2: Catalase Reaction Rate Baseline RXN (CLASS)
- Complete Yeast Catalase Experiment - Part 1: Baseline Activity for the standard yeast solution and 3% hydrogen peroxide.

Table 1: Catalase Reaction Rate Baseline RXN (GROUP)

<table>
<thead>
<tr>
<th>Trial</th>
<th>Float Time (sec.)</th>
<th>Rate (1/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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</tbody>
</table>

Group Average

Class Average

Table 2: Catalase Reaction Rate Baseline RXN (CLASS)

<table>
<thead>
<tr>
<th>Group</th>
<th>Group Average Float Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>6</td>
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</tbody>
</table>

Class Average

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Part II: Independent Experiment

- Purpose: method that will be used, independent and dependent variable.
- Hypothesis: If (rational for the investigation), then (outcome that you would expect).
- Procedure: Steps discussing how you will modify the procedure: independent (levels), dependent, control, and standardized variables.
- Data: table(s) to record findings
- Approval by Instructor 😊
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Designing and Conducting Your Investigation:

• Analyze your results by graphing the data collected.
  - Remember in order to express the rate as a number with a direct relationship to the rate, take the number (or average number) of seconds it took the disc to float and invert it.
  - For example, if it took 5.48 seconds, the rate would be expressed as 1/5.48, which equals 0.18 (round to hundredths).

Whiteboard Presentation:

• Purpose: method that will be used, independent and dependent variable.
• Hypothesis: If (rational for the investigation), then (outcome that you would expect).
• Procedure: Steps discussing how you modified the Floating Disk procedure. Discuss the different levels of the independent variable in your design.
• Analysis:
  - Graph: Catalase Reaction Rate …your variable…
• Summary Statement: Describe: HOW your IV influences the DV. Compare your experimental data to the baseline rate. Explain: WHY did your IV effect/not effect the baseline rate.

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Post Lab Questions (1-7)

1. What is the function of enzymes in a living system?
2. Different enzymes work better under different conditions. Where in a human body might it be beneficial to have enzymes that work well in very acidic environment? Explain your answer.
3. There is a large amount of catalase found in a human liver. Would the liver break down more hydrogen peroxide in the summer or winter? Explain your answer.
4. Of the thousands of enzymes known, there is a family of enzymes called proteases that catalyze a reaction which breaks down proteins. What do you think would happen if you added a protease to your sample of catalase before proceeding with your experiment? Explain why you came to this conclusion.
5. Copy the graph show in Figure 1 to your paper. Using different colors, draw how you would expect the reaction rate to change if the substrate (H₂O₂) concentration was increased and if it were decreased.

6. Explain what is going on in Figure 2. Why does the reaction rate make a bell-shaped curve?

7. Explain what is going on in Figure 3. Why are there three different bell-shaped curves on this graph?