

I've Got That Sinking Feeling: An Investigation of Enzymes

Student-Centered Investigation

This document is divided into three sections. The first page provides teacher tips for leading the student-centered investigation. Pages two and three are instructions for the students and the last two pages provide a step-by-step guide for the students to develop their investigation.

Student-Centered Investigation Tips:

Students may need help identifying an appropriate student-centered laboratory investigation. If necessary encourage them by asking questions:

- Was there anything in the first experiment that we took for granted? How could we check that?
- What factors other than enzyme concentration can impact the rate of a chemical reaction?
- What do we know about living systems and homeostasis?
- What do we know about the effects of pollution on living systems?
- How is hydrogen peroxide used as a disinfectant?
- What is the function catalase in cells? Do all cells need catalase to survive?

Below is a list of feasible investigations regarding chemical reaction rates that students could pursue:

- Effect of substrate concentration/type of substrate
- Effect of pH
- Effect of temperature
- Effect of concentration/type of various common substances

Student-Centered Investigation Lab Prep:

Although it is impossible to anticipate all of the additional supplies' students might request for a self-directed experiment, following supplies are suggested:

- Additional water baths at various temperatures so that students can test the effect of temperature on enzyme activity/ chemical reaction rate
- Beakers so students can create "mini-water baths"
- Ice for water baths
- Various concentrations of hydrogen peroxide solutions
- Weak acid and base solutions
- Household substances such as liquid soap, detergent, toothpaste, food coloring, salt, spices, fruit juices, vinegar, etc.
- Other sources of catalase (potato, carrots, animal liver, etc.)
 - To extract potato catalase, put a potato in a blender, add 500 mL of water and blend to a smooth pulp. Strain the potato pulp through cheesecloth and use the resulting liquid as a 100% stock solution. This procedure can also be used to extract a catalase "enzyme mixture" from other sources. Students should test the stock solutions they prepare to ensure the reaction rate in the assay is between 5 and 10 seconds.
- Instructions for students to make solutions
- Vernier interface, oxygen gas probes, sample chambers.



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I've Got That Sinking Feeling

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Introduction:

In the I've Got That Sinking Feeling lab you investigated the effect of enzyme concentration on the rate of a chemical reaction. The rate was measured by the time it took a catalase-soaked disk to sink and then rise in a solution of substrate (hydrogen peroxide). For the second part of this lab, you will use scientific methods to address another question related to chemical reaction rates using the I've Got That Sinking Feeling experimental system. Scientific methods are principles and procedures used to pursue knowledge about the natural world. There is no one set way to do science, but scientific methods often involve:

- Making observations
- Asking questions
- Formulating hypotheses
- Test hypotheses with experiments or observational studies
- Collecting data
- Analyzing data and making conclusions
- Communicating results

Working with your lab group, brainstorm experimental questions about other factors that may or may not affect chemical reaction rates that you could investigate. Formulate a hypothesis and discuss with your group a possible experiment that would allow you to test your hypothesis. Discuss your ideas with the lab instructor to confirm availability of supplies. Once you have instructor approval, use the Student-Centered Investigation Lab Notebook worksheet to plan your experiment in detail.

Formulating a Hypothesis:

When formulating a hypothesis consider:

- Is your hypothesis testable?
- What are your dependent and independent variables?
- Is your hypothesis "directional?" Does it allow you to measure the dependent variable when the independent variable is manipulated?

Experimental Design:

As you develop your experiment design consider the following questions:

- What is your experimental control(s)? The initial experiment should have provided you with some information about what starting conditions you might want to consider for your control.
- What experimental procedure will you use?
- Calculate the amounts of all reagents you will need for your experiment ahead of time and record this information in the Lab Procedure section of your Lab Notebook handout.
- What experimental outputs will you measure? Consider both qualitative (descriptive) and quantitative (measured) data.
- How will you collect the data? Create a data collection table in the Experimental Data section of the handout.

- How will you analyze your results? Can you perform a quantitative or statistical analysis of your data?

Record your experimental design in the Student-Centered Investigation handout. Any steps that are the same as the I've Got That Sinking Feeling protocol may be listed as: SF (I've Got That Sinking Feeling) # (the number of the step you are using). Be sure to design an appropriate data collection table. Once you have completed your experimental design you may conduct your experiment! Be sure to gather all the required supplies and reagents (appropriate amounts) BEFORE you start to collect any data.

Post-Lab Analysis:

After conducting your experiment and collecting your data, you will need to analyze your data, interpret your results, and make final conclusions regarding your hypothesis:

Analyze data

- Can you perform a statistical analysis?
- Can you graph or chart your data?
- Can you organize descriptive data in a table?

Interpret results and make conclusions

- Did your experiment yield interpretable data? Does the data indicate changes that should be made to the experimental design?
- Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables based on the data you collected.
- Does your data answer your experimental question?
- Does your data support or refute your experimental hypothesis?
- What did you learn from doing this experiment?

I've Got That Sinking Feeling

Student-Centered Investigation

Lab Notebook

Date:

Student Scientists:

School:

Experimental Question:

Experimental Hypothesis:

Lab Procedure (List all experimental procedures):

Experimental Data (Record and organize your data):

Analyze Data (Use mathematical operations to summarize data):

Interpret Results and Make Conclusions (Describe the effect of the parameter on the chemical reaction rate):

What questions do you have about the experiment or the results?

Based on your results are there other experiments you would like to perform

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