Enzymes

The fundamental life processes depend on the physical structure and the chemical activities of the cell.

Students will be able to identify the best enzyme for juice production and variables that affect the ability of an enzyme to function.

Introduction:

A Connecticut company is in the business of making and selling apple juice. To make apple juice, apple sauce is strained through filters to remove the juice. The company would like your help in testing the impact of different enzymes on the production of the apple juice. You will investigate the ability of these enzymes to remove more juice during this process and decide the most cost effective plan to increase juice production. The following is a list of the enzymes along with their prices:

- **Pectinase:** $50 per liter
- **Cellulase:** $100 per liter

Enzymes are proteins that catalyze chemical reactions in the cells of all living organisms. Enzymes control many vital functions in the cell, including the release of energy during the breakdown of nutrients into smaller molecules and the synthesis of complex cell materials from the small molecules. In this lab you will work with two plant enzymes – cellulase and pectinase.

Your Task:

You and your lab partner(s) **will design and conduct an experiment to determine which enzyme or combination of the two enzymes maximizes juice production**. Once you complete the laboratory investigation, you will write a lab report that evaluates which enzyme will be the **most cost effective** to use in juice production.

You have been provided with the following materials and equipment. It may not be necessary to use all of the equipment that has been provided.

- apple sauce
- graduated cylinder
- stirring rods
- droppers
- filter paper
- pectinase enzyme
- cellulase enzyme
- funnels
- access to tap water
- paper cups
- lab aprons
- access to a watch or clock
- splash-proof goggles
- access to a balance
- paper towels for cleanup

1. State the problem you are going to investigate.

2. Write a hypothesis using an "If (enzyme name) is … then … because …" statement that describes what you expect to find and why.

3. Identify the independent variable: _____

4. Identify the dependent variable: _____

5. Design an experiment to test the problem. Your experimental design should match the statement of the problem and should be clearly described so that someone else could easily replicate your experiment. Include a control if appropriate and state which variables need to be held constant. *Note: The enzyme(s) must be well mixed into the apple sauce to be effective. Use 5 drops of enzyme per 50 grams of apple sauce.*

6. Create a data table where you will record data during the experiment

7. Review your design with your teacher **before** you begin your experiment.

8. Conduct your experiment. While conducting your experiment, take notes on your observations and record your data in your table.
   Safety note: As in any laboratory experiment, you must not eat or taste any of the materials. Students must wear approved safety goggles and follow all safety instructions at all times during the lab.

Apple Juice Lab Report Rubric

Student Name:	Due Date:

If the task has been completed, all points are awarded. If the task is incomplete half points may be awarded. No points are awarded if the task is not complete.

Category	Scoring Criteria	Points	Student Evaluation	Teacher Evaluation
Lab Introduction ***12 points***	The question to be answered during the lab is stated.	3		
	The hypothesis clearly shows it is based on facts.	3		
	A connection is made between the lab and the "real world"	3		
	A brief summary of your experimental approach	3		
Methods ***10 points***	Procedures reflect what you actually did, written in paragraph form	7		
	Procedure is detailed and complete (no missing steps).	3		
Results ***17 points***	Measurements show proper units.	2		
	A before diagram of your beakers and apple sauce	3		
	An after diagram of your beakers and apple sauce	3		
	Data Table of your group results	3		
	Data Table of the class results	3		
	A bar graph of your results compared to the class data	3		
Graphs 10 points	The graph properly displays all of your data	5		
	On graph paper (or printed), used ruler, proper units and headings	5		
Discussion 35 ***points***	Summarize the lab data. (come to a conclusion)	10		
	Show how the data answers the lab question from the introduction.	15		
	Discuss the reliability of your data and any factors that contribute to a lack of validity of your conclusions.	5		
	Last sentence restates the final conclusion	5		
Presentation ***15 points***	Report is printed in black ink on white paper using 12 point font. Paragraphs are double spaced with 1 inch margins on all sides with no visible corrections.	5		
	A diagram of the lab apparatus used in the experiment is drawn in the largest available white space on the front of the lab report (or cover).	5		
	Report is written so that other students could accurately duplicate the experiment.	5		
Participation ***5 points***	No group members were cited for safety or participation violations.	5		
Score	Total Points	104		
Self-evaluation	If the difference between the student evaluation and the teacher evaluation is less than 5 points, 5 points will be added to the teacher's score when the grade is recorded.			
Deadline	Reports turned in after the beginning of class on the due date will lose 10 points.			

Enzymes and Apple Juice Lab Report

Lab Reports should follow the following format.

1. **Introduction:** Include the problem you were asked to test "**Which enzyme or combination of the two enzymes maximizes juice production?"** Next include **y**our specific hypothesis you investigated. Follow that with your prediction. You should include background information for the problem including an explanation the enzymes and their role in apple juice production along with how the problem relates to you, and the world. Conclude this section with a brief summary of your experimental approach to the problem, along with a one sentence summary of your final results.

2. **Methods and materials:** This section tells the reader how and with what "stuff" the experiment was done. You should try to strike a balance between an over-detailed description of the most trivial items and a very sketchy statement that provides insufficient information. The important guideline is that another student of similar training and ability following your description should get the same results. This section should be written as a description of what you did, **not** as a set of numbered instructions. Make sure you alert the reader to any dangerous substances or necessary safety procedures.

3. **Results:** In this section you should **describe** the important qualitative and quantitative observations is your work. You are **not yet** drawing conclusions from you data. Data should be tabulated, graphed and described. One of the common errors in report writing is to say, "The data are plotted in Fig. 1" without saying something like, "As can be seen in the graph, the rate of protein digestion over 5 days was slow for the first three days after which a sharp rise is noted." Be aware that tables and graphs are not self-explanatory, and must be summarized for the reader. All graphs and tables should be numbered and provided with a title. Any additional information that makes the data more comprehendible should be provided as needed.

Required Diagrams

- A diagram of your beakers (including solutions) with measurements before you began
- A diagram of your beakers (including solutions) with measurements after your lab.

Required Graphs

- A graph of your results compared to the class data

Required Data Tables

- Your group results
- Class results

4. **Discussion and conclusions:** This section serves two functions. First, it provides a place where the data may be fully discussed and interpreted and a final conclusion is made (you answer all the WHYS and HOWS), and second, it allows the author to delve into the realms of speculation. Here one may address questions like "why did something unexpected happen?" or "what would happen if the pectinase solution was of higher concentration" or "why did the expected results not materialize?" In this section the author should suggest improvements in methodology. You should also explain the reliability and validity of your data and suggest one major source of experimental error. This could be as simple as "we could not measure accurately because..." To concepts as complicated as denaturing of enzymes at high temperatures or low pH. Make sure you end this section with a final conclusion statement that provides the answer to the problem your stated back in the introduction.

5. **References:** You will need to use sources to provide background information. Cite them.