

Laboratory Investigation: Enzyme activity on proteins

BACKGROUND: Protein digestion in humans normally takes place in the stomach and small intestine. Enzymes in these organs break down protein into a useable form. Because of their shapes, enzymes bind to specific substrates. In the chemical reaction in which amylase catalyzes the breakdown of starch to glucose, starch is the substrate. At an optimum temperature and pH, the shape of amylase fits the shape of starch, starch binds to amylase, and the chemical reaction that converts starch to glucose is accelerated. .

In this assessment you will investigate some of the properties of the enzyme pepsin produced by the stomach to aid in protein digestion. For our purposes protein digestion will occur in a test tube rather than a live stomach. I wouldn't want any of you to experiment on my stomach!!!

Objectives: After reading the background, you will be expected to do the following:

- Identify factors that affect the shape and action of an enzyme
- Formulate a hypothesis about the factors affecting the activity of pepsin
- Design and conduct an experiment to test your hypothesis
- Organize the data from your experiment in a table and graph
- Evaluate your hypothesis based upon your data
- Evaluate and discuss factors affecting enzyme tested by other groups

Problem: Consider the following problem based on the background information.

What factors impact enzyme activity?

Experiment:

1. Hypothesis. In the space below, write a hypothesis for the problem stated above. Make sure that groups have decided on which factors they will investigate. Be sure to write your hypothesis as an "If (independent variable) then (dependent variable)." statement.

2. Materials: Review the list of available materials and equipment given to you by the teacher. Think about how you would design a controlled experiment to test your hypothesis using these materials. Do not use or touch any of materials yet. In the space below, list the materials you will use in your experiment. **NOTE:** Reactions will occur overnight. The substrate (egg white) will already be in a capillary tube and the amount of reactants should not exceed 10 ml of solution.

3. Procedure:

Draw a sketch of how you will set up an experiment that will test your hypothesis, and label all parts of your experimental and control setups.

In the space below, enumerate the steps of the procedure you will follow. Be sure to include a control group in your experiment. Be sure to follow safety precautions!!!

In the space below, list the types of observations and/or the measurements you will make during the experiment.

4. Data:

Make a data table in the space below that you can use to record your observation. Make sure your table has descriptive headings.

5. Analysis:

Using graph paper, create a graph that properly displays all of your data. Be sure to include proper headings. In the space below write your interpretation of your data

Write down the most efficient chemical reaction you found for protein digestion.

1. What was used in this investigation as the protein? _____
2. Why was pepsin used in this experiment? _____
3. Which tube shows the greatest amount of protein digestion? _____
4. Did any other tubes show any amount of protein digestion? _____
5. If yes, which one(s)? _____
6. Which group was considered your control group? Why? _____

7. Which group was considered your experimental group? Why? _____

6. Conclusion. In the space below, state whether your data supports or refutes your hypothesis. Include any sources of error. Be sure to use data in your conclusion to support your conclusion.

7. Class Conclusions:

Use the chart to discuss other factors affecting enzymes that were tested by other groups. List all that apply

	Hypothesis	Result
Group __		
Group __		
Group __		
Group __		
Group __		

Class Conclusion: From the information of the entire class, what would be the ideal conditions for initial protein digestion in the stomach?

Based on the class results and the results of your own experiment, suggest a new problem that could be pursued as an extension of this investigation?

Protein digestion lab materials list

All groups will receive capillary tubes filled with cooked egg whites, goggles and gloves

Available materials for the protein digestion lab (you may use some or all or ask for things not listed)

Graduated cylinders

Test tubes

250 ml Beakers

Electronic balance

Rulers with millimeter increments

Pepsin in aqueous solution

HCl (hydrochloric acid)

Tap water

Salt Solution

Hot water bath

Incubator

Fluorescent light source with timer

Wall clock

Dissecting microscopes

Wax marking pencils

PROTEIN DIGESTION LAB REPORT RUBRIC

Student Names:	Due Date:
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This analytic rubric is used to verify specific tasks performed when producing a lab report. 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 <i>15 points</i>	The question to be answered during the lab is stated.	5		
	The hypothesis clearly shows it is based on facts.	5		
	A connection is made between the lab and the "real world" (how might data from this lab improve life?)	5		
Methods <i>15 points</i>	Procedures are written during pre-lab preparation and clearly state what is planned. (<i>should reflect what you actually did, should be written as a paragraph not a list</i>)	10		
	There are no "understood" procedures. (<i>Such as: place egg whites in test tubes.</i>)	3		
	Specific formulas or equations for reactions during the lab are shown. (<i>Write these as part of your method.</i>)	2		
Results <i>15 points</i>	Results of the procedure are clearly recorded. (<i>Usually presented in a data table</i>)	10		
	Measurements, when required, show proper units.	3		
	Calculations, when required, are clearly shown. (<i>Write these as observations on the lab report.</i>)	2		
Graphs <i>10 points</i>	The graph properly displays all of your data	7		
	On graph paper, used ruler, proper units and headings	3		
Discussion <i>30 points</i>	Summarize the essential lab data. (come to a conclusion)	10		
	Show how the essential data answers the lab question.	15		
	Identify the one area of the lab most likely responsible for measurable experimental error. (<i>Think carefully.</i>)	5		
Presentation <i>15 points</i>	Report is printed in black ink on white paper using 12 point Times New Roman or Arial font. Paragraphs are double spaced with 1 inch margins on all sides with no visible corrections (Warning: this is not Word's default).	5		
	A diagram of the essential 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 in such a way that other students could accurately duplicate the experiment.	5		
Lab Participation <i>10 points</i>	No group members were cited for safety or participation violations.	10		
Score	Total Points	110		
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 will be accepted after the beginning of class for 3/4 credit. Papers turned after that time will be mulched for use in the greenhouse and receive ¼ credit.			

PROTEIN DIGESTION LAB REPORT LAB REPORT

Lab Reports should follow the following format.

1. **Introduction:** Include the essential question “**What factors impact enzyme activity?**” Your specific statement of the problem you investigated and why you choose that problem to work on, include the background information of the problem including an explanation of how the problem relates to you, and the world. Conclude this section with a brief summary statement of the general method of approach to the problem, your hypothesis and prediction.

2. **Methods and materials:** This section tells the reader how and with what “stuff” the work was done. You should try to strike a balance between an over-detailed description of even the most trivial items and a very sketchy statement that provides insufficient information. The important guideline is that another worker 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:** Here is the real meat of a report. In this section you should **describe** the important qualitative and quantitative observations in your work. You are **not yet** drawing conclusions from your data. Data should be tabulated and/or 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 comprehensible should be provided as needed.

4. **Discussion and conclusions:** This section serves two functions. First, it provides a place where the data may be fully discussed and interpreted (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 HCl solution was of higher concentration” or “why did the expected results not materialize?” In this section the author may (discretely) pat him- or her-self on the back, criticize other workers results, suggest improvements in methodology, etc. You should also find and explain one major source of experimental error. This could be as simple as “we did not measure accurately because...” To concepts as complicated as denaturing of enzymes at high temperatures.

5. **References:** Some papers have no references while others have 200 or more.

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.

Be sure you address the following in your lab report:

- Experimental error (human or otherwise)
- Your conclusion for the effect of __your variable here__ on protein digestion.
- A labeled graph of your results