**Student Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Course and Section Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Lab Assignment: Enzymes**

**Instructions:** After completing the *Enzymes* lab on [this website](https://camosunbiolabs.opened.ca/biology-103-labs/enzymes/), answer the questions below. Please type your responses in different coloured font into the spaces provided. Submit your assignment as directed by your instructor.

**\_\_\_\_\_**

**Part 1: Qualitative Enzyme Experiment**

1. Complete Table 1 below with your predictions and results from the four experimental conditions. (4 marks)

**Table 1**. Predictions and experimental results of placing finely chopped turnip pieces into various experimental conditions in the presence of hydrogen peroxide. – Control = no turnip, + Control = turnip, Low pH = lemon juice, High Temp = boiling water.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | - Control | | + Control | | Low pH | | High Temp | |
|  | Prediction | Result | Prediction | Result | Prediction | Result | Prediction | Result |
| Will oxygen form? How much? |  |  |  |  |  |  |  |  |

2. Paste the photo of your four Ziploc bags 10 minutes after adding hydrogen peroxide in the space below. Include a descriptive figure caption (Figure 1. DESCRIPTION) below the image. (2 marks)

3. State whether the **hypothesis** was supported or not. Explain how your qualitative data supports or does not support the hypothesis. (2 marks)

4. Based on the results of your experiment, answer the following questions: (to get full marks, consider what is happening at the molecular level and use the terms “active site”, “enzyme”, “substrate”, and “product” when appropriate) (4 marks – 1 mark each)

a. Explain your results in the “- Control” condition.

b. Explain your results in the “+ Control” condition.

c. Explain your results in the “Low pH” condition.

d. Explain your results in the “High Temp” condition.

**Part 2: Quantitative Enzyme Data Analysis**

A quantitative version of the experiment in Part 1 can also be performed in a laboratory setting. This involves using **turnip homogenate** (made by pureeing turnip in a blender) as the source of catalase. Hydrogen peroxide can be added to the turnip homogenate in different environmental conditions, with the amount of oxygen production measured numerically over 4 minutes. As before, oxygen is a product of the reaction and therefore indicates the activity of the catalase enzyme in each experimental condition. The following environmental conditions can be varied to determine the effects on enzyme activity:

* Enzyme concentration (how much turnip homogenate is added)
* Substrate concentration (how much hydrogen peroxide is added)
* Temperature
* pH
* Presence or absence of copper sulfate (an enzyme inhibitor)

The tables of quantitative data below showing the average oxygen produced (in mL) after 4 minutes in each experimental condition. Review the data and answer the questions that follow.

**Table 1.** Volume of oxygen (mL) produced after 4 minutes of turnip homogenate reacting with hydrogen peroxide under varying environmental conditions.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Volume of H2O2 (mL) | Volume of O2 (mL) |  | Volume of Turnip Homogenate (mL) | Volume of O2 (mL) |  | pH | Volume of O2 (mL) |
| 0 | 0 |  | 0 | 0 |  | 3 | 0 |
| 0.5 | 4 |  | 0.5 | 3 |  | 5 | 7 |
| 1 | 9 |  | 1 | 7 |  | 7 | 19 |
| 2 | 17 |  | 1.5 | 18 |  | 9 | 22 |
| 5 | 30 |  | 2 | 25 |  | 11 | 20 |
|  |  |  |  |  |  | 13 | 0 |
| Temperature (°C) | Volume of O2 (mL) |  | Copper Sulfate | Volume of O2 (mL) |  |  |  |
| 0 | 11 |  | Absent | 35 |  |  |  |
| 20 | 25 |  | Present | 0 |  |  |  |
| 37 | 28 |  |  |  |  |  |  |
| 80 | 0 |  |  |  |  |  |  |

1. Based on the data in the tables above, write a brief statement and explanation for each variable tested (what trend is observed and WHY). Be sure to use terminology such as “enzyme”, “substrate”, “active site”, “product”, and “denature” in your answers as appropriate. (5 marks – 1 mark each)

Substrate concentration:

Enzyme concentration:

pH:

Temperature:

Inhibitor:

2. Choose ONE of the variables that was tested and create a graph of the data using Microsoft Excel (or a similar program). The graph will demonstrate the average volume of oxygen produced (on the y-axis) as a function of the change in the independent variable (either enzyme concentration, substrate concentration, temperature, pH, or presence of copper sulfate) (on the x-axis). The majority of these options will be line graphs, with the copper sulfate data being better suited to a bar graph. Please refer to the graph formatting requirements described in the [Science, Data, & Graphs](https://camosunbiolabs.opened.ca/biology-103-labs/science-data-graphs/) lab as you create your graph. Paste your graph in the space below, and be sure to include a descriptive figure caption. (5 marks)