**NAME:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ PER:\_\_\_\_\_\_\_\_\_\_\_ DATE:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ SCORE:\_\_\_\_\_\_\_\_\_\_\_**

**BIOLOGY ENZYME PRE-LAB ASSIGNMENT**

**Introduction to Enzymes**

Enzymes are biological catalysts. They help to increase the rate of chemical reactions. In each cell of a human there are many chemical reactions taking place, performing the necessary functions for being a large, complex, multicellular organism. Chemical reactions involve the breaking and reforming of chemical bonds between molecules. Substrates, also known as the products, of the reaction are transformed into new molecules, often called the products. Chemical reactions can occur spontaneously (without added energy or intervention), some however, are not.

For example, to get energy out of a molecule of glucose, a series of chemical reactions break down stored glycogen into glucose molecules. Then a series of reactions must take place in a specific order to break the bonds between the carbons of the glucose molecule. If you had to rely on these reactions to take place spontaneously, you would wait a very long time – so long in fact you wouldn't be here! Enzymes catalyze chemical reactions so that they occur quickly and in order to produce a product.



Enzymes are most often proteins and their three-dimensional shape is important to their ability to function. Enzymes are very specific for the substrates that they will act upon since each substrate fits inside of an enzyme like a lock and a key. If an enzyme’s shape is changed due to a change in temperature or pH the enzyme can lose its ability to function.

You will conduct a series of experiments and observe the reaction that takes place in several test tubes. The reaction that we will be studying is the decomposition of 6% hydrogen peroxide into water and oxygen gas. This reaction will be catalyzed by the catalase enzyme found in liver. Catalase is an enzyme, which is found in many cells, but in highest levels in the liver because the liver often functions to break down toxins present in the blood.



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**PRE-LAB QUESTIONS (you must answer all questions before starting the lab):**

1. What is an enzyme? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What to enzymes do? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Define catalyst.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Complete the sentence: All enzymes are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but not all \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are enzymes.
2. In the equation above write the reactant(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_and the product(s) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What enzyme will we be observing in class?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What substrate will that enzyme be working on? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What indication will we have that the enzyme is working? (hint: Look at the products, what would having these together LOOK like?) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are two things that can decrease an enzymes ability to function?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What is the function of Catalyase in the body? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PRE-LAB QUESTIONS (you must answer all questions before starting the lab):**

1. What is an enzyme? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What to enzymes do? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Define catalyst.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Complete the sentence: All enzymes are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ but not all \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are enzymes.
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3. What enzyme will we be observing in class?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What substrate will that enzyme be working on? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period:\_\_\_\_\_\_\_\_\_\_\_ Score:\_\_\_\_\_\_\_\_\_\_\_\_**

**Exploring Enzymes with Liver!**

**Station 1:**

Scientific Question: Are Enzymes Specific?

Hypothesis:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Procedure: see station instructions on the lab tables

Independent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Data:

|  |  |
| --- | --- |
| **Test Tube** | **Description of Results** |
| A: Distilled Water |  |
| B: Acetic Acid |  |
| C: Carbonic Acid |  |
| D: Hydrogen Peroxide |  |

Analysis Questions:

1. Which substance(s) appeared to react with the liver homogenate?
2. Why was catalase only able to work on one of the test tubes?
3. What substrate did the enzyme catalase break down?
4. Are enzymes specific? What evidence do you have for your answer?
5. Explain how enzyme function is like a lock and key. (You may draw and label a diagram *in addition to* writing an explanation if that makes it easier for you.)

**Station 2:**

Scientific Question: How Does Temperature Affect Enzyme Function?

Hypothesis:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Procedure: see instructions on lab tables.

Independent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Data:

|  |  |  |
| --- | --- | --- |
| **Test Tube** | **Time for Complete Reaction** **(in seconds)** | **Description of Reaction** |
| A: Liver on Ice |  |  |
| B: Liver at Room Temp. |  |  |
| C: Liver, Boiled |  |  |

Analysis Questions:

1. What is the relationship between temperature and enzyme activity? Use evidence from your experiments to support your statement.
2. What happens to enzyme molecules in extreme temperatures?
3. Were any of your results surprising? Explain.
4. What might happen to a human being if a fever gets too high?

**Station 3:**

Scientific Question: How Do Changes in pH Affect Enzyme Function?

Hypothesis:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Procedure: see instructions on lab tables.

Independent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent Variable:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Data:

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Tube** | **pH** | **Time for Complete Reaction** **(in seconds)** | **Description of Reactions** |
| A: 3 drops HCl |  |  |  |
| B: 3 drops water |  |  |  |
| C: 3 drops NaOH |  |  |  |

Analysis Questions:

1. What pH level did catalase function the best? How do you know?
2. What is the relationship between pH and enzyme activity? Use evidence from your experiment to support your statement.
3. Stomach enzymes work best at a pH of 2. How might a pH of 4 in the stomach affect digestion?
4. Activation energy is the amount of energy needed to start a reaction. The lower the activation energy the faster a reaction will occur. Which of your reactions had the lowest activation energy? The highest activation energy? How do you know?
5. The function of the liver is to break down fats and build certain proteins. Cirrhosis of the liver is a disease which causes the liver to become thickened and “rubbery”. Hypothesize how enzyme function in the liver would be affected in a person with cirrhosis.
6. Why is it important for the accuracy of our experiment to maintain the same volume of water and hydrogen peroxide in each test tube?
7. Why did we need to have one test tube with only water?

**Lab Conclusions:**

Using the R.E.R.U.N.S. format below write a 2-3 paragraph conclusion. Do not write out the letters R.E.R.U.N.S. in your conclusion. Write your conclusion in the space provided below. If you need more space continue on another sheet of paper.

R.E.R.U.N.S format (2-3 paragraphs for the entire conclusion)

* **R**estate the problem (1 sentence)
* **E**xplain the experiment (summarize the procedures in 2-3 sentences)
* **R**esults (Write out all your data results with units and your analysis. Discuss what the results indicate about the lab.)
* **U**ncertainties (discuss what did or might go wrong during the lab and how that can affect your experiment’s results)
* **N**ew Ideas or Alternatives (suggest a similar experiment but with changes made)
* **S**how Understanding (Did your lab experiment support or reject your hypothesis? Explain why or why not?)

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**Station One Lab Procedure**

1. Label 4 test tubes A, B, C, and D.
2. Put 3 mL of liver homogenate in each tube.
3. Put 3 mL of the following substances in each tube as noted:
	1. distilled water
	2. acetic acid (vinegar)
	3. carbonic acid (soda water)
	4. hydrogen peroxide
4. Observe the reactions and record the results in Data Table 1.

**Station Two Lab Procedure**

1. Label 3 test tubes A – C.
2. Put test tube A in a beaker of ice.
3. Add 3 mL of chilled liver homogenate to test tube A.
4. Put 3 mL of room temperature liver homogenate in test tube B.
5. Put 3 mL of boiled liver homogenate in test tube C. (boiled homogenates have been cooled to room temperature)
6. Add 3 mL of hydrogen peroxide to each test tube.
7. Observe reactions and record in Data Table 2.

**Station Three Lab Procedure**

1. Label 3 test tubes A – C.
2. Add 3 mL liver homogenate to each test tube.
3. Add 3 **DROPS** of each of the following substances in each tube as noted:
	1. 3 drops 1M HCl
	2. 3 drops of distilled water
	3. 3 drops of 1M NaOH
4. Measure the pH of each solution.
5. Add 3 mL of hydrogen peroxide to each test tube.
6. Observe reactions and record in Data Table 3.