ENERGETIC ENZYMES

Reading:

Enzymes Science Literacy

Key Questions:

What are enzymes?
How do enzymes function within the human body?
Which organ has the greatest catalase per unit of volume, liver or skeletal muscle? Why?

SAFETY:

Wear appropriate safety gear (goggles, gloves, apron, etc.).
Use caution when working with chemicals.

MATERIALS AND EQUIPMENT:

For the classroom:
3% Hydrogen Peroxide
Chicken Breast and Chicken Liver*
Or Beef Chuck Roast and Beef Liver*
*See teachers notes.

For each group:
3 Conical Vials or Skirted Test Tubes
Scalpel (or other cutting utensil)
Cheesecloth or gauze
3 Disposable Pipettes
Pan (or paper towels)
Plastic Bag (for disposal)
Forceps
Plastic Ruler
Timing Device
Permanent Marker
150 mL Beaker

PREDICTIONS:

In this activity, you will explore how the enzyme catalase reacts with hydrogen peroxide by testing different types of tissues. Based on your reading, predict the outcome of this experiment. Explain your predictions.

→Liver added to hydrogen peroxide:

I think _____

because_____

_____

→Skeletal muscle added to hydrogen peroxide:

I think _____

because_____

_____

PROCEDURE:

Read each set of directions before proceeding. Answer the comprehension questions as you go.

Part 1- Catalase Inside Your Cells

Skeletal muscle

1. Label the three vials as 1, 2, and 3.
2. Use a pipette to measure 5 mL of 3% hydrogen peroxide (H_2O_2) into vial 1.
3. Using forceps, transfer one section of muscle tissue into the vial.
4. Notice what is happening in the solution. Is a chemical reaction taking place? How do you know?

5. Describe what is taking place in the vial. Include visual observations and the chemical equation for the reaction.

6. What gas do you think is being produced? Why?

7. A reaction that absorbs heat is endothermic and results in a cold temperature. A reaction that gives off heat is exothermic and results in a warm temperature. Feel the temperature of the vial with your hand. Is the reaction endothermic or exothermic? How do you know?

8. After two minutes, use a ruler to measure the height of the foam produced by the reaction. Measure from the bottom of the foam to the top of the foam inside the vial. Make sure to measure from the "0" on your ruler! The "0" should be level with the bottom of the foam before you read the height of the foam. Record your findings.

   Height of Foam: _____ cm

9. Place the cap on your vial and set it to the side.

Liver

1. Use a pipette to measure 5 mL of 3% hydrogen peroxide (H_2O_2) into vial 2.
2. Using forceps, transfer one section of liver into the vial.
3. Notice what is happening in the solution. Is a chemical reaction taking place? How do you know?

4. Describe what is taking place in the vial.

5. After two minutes, use a ruler to measure the height of the foam produced by the reaction. Measure from the bottom of the foam to the top of the foam inside the vial, as described above. Record your findings.

Height of Foam: _____ cm

6. Place the cap on your vial and set it to the side.

DATA ANALYSIS

1. According to your results, which body tissue contained the most catalase?

2. How do you know which organ had the most catalase? Cite specific evidence from the activity to support your answer.

3. Did you support or not support your hypothesis? Cite specific evidence from the activity.

Part 2- Has the Reaction Gone to Completion?

Consider the Following

Now that the reaction has run its course, the liquid in the two vials on your table is no longer entirely hydrogen peroxide. But is it all water? Or is there hydrogen peroxide left over? Let's find out!

1. What is the liquid in the vials?

2. What do you think will happen if you add more enzyme (from liver) to this liquid?

3. Place the gauze or cheese cloth (double thickness) over vial 3. This will prevent contamination of the solution with foam.
4. Use a pipette or just pour the liquid from the vial 2 to vial 3.
5. Using forceps, transfer one section of new liver into vial 3.
6. Observe what is happening in the solution. Is a chemical reaction taking place? How do you know?

7. Explain your results.

Part 3- Can Enzymes be Re-used?

Can Catalase be Re-used?

1. Take the original vial containing the liver (vial 2). (You just drained the liquid off.)
2. Use a pipette to measure 5 mL of fresh 3% hydrogen peroxide (H_2O_2) into the vial.
3. Using a scale of 0-5 with 0= no reaction, 1= very slow, 2= slow, 3= medium speed, 4= fast, and 5= very fast, estimate the rate of the reaction currently taking place in the vial.

Rate of Reaction: _____

4. Describe what is taking place in the vial.

5. According to your observations, is catalase re-useable?

6. Based on these results, what can you infer about other enzymes found inside your body?

7. Clean up according to your teacher's directions. Then complete the data analysis and conclusions sheet for this lab activity.

8. Record data from all groups in the class on the next page.

DATA ANALYSIS – PART 1

1. Obtain data #1 (muscle height of foam) from all groups in the class. Calculate the mean and standard deviation for data #1.

   Mean height of foam generated by skeletal muscle catalase: _____

   Standard deviation of the height of foam generated by skeletal muscle catalase: _____

2. Obtain data #2 (liver height of foam) from all groups in the class. Calculate the mean and standard deviation for data #2.

   Mean height of foam generated by liver catalase: _____

   Standard deviation of the height of foam generated by liver catalase: _____

Data Tables:

Muscle

group	x (cm)	$(x - \underline{x})$	$(x - \underline{x})^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	$(\sum x)$**=**		$\sum(x - \underline{x})^2 =$
	$(\sum x)$**/n=**		$n - 1$**=**
			$\frac{\sum (x-\underline{x})^2}{n-1}$ **=**
			$\sqrt{\frac{\sum (x-\underline{x})^2}{n-1}}$ **=**

Liver

group	x (mm)	$(x - \underline{x})$	$(x - \underline{x})^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
	$(\sum x)$**=**		$\sum(x - \underline{x})^2 =$
	$(\sum x)$**/n=**		$n - 1$**=**
			$\frac{\sum (x-\underline{x})^2}{n-1}$ **=**
			$\sqrt{\frac{\sum (x-\underline{x})^2}{n-1}}$ **=**

Equations: Mean: $\underline{x} = (\sum x) / n$ Standard deviation: $s = \sqrt{\frac{\sum (x - \underline{x})^2}{n-1}}$

3. Create a bar graph using the average foam height data collected in Part 1 of the activity. Title the graph and label the x-axis as "Tissue" and the y-axis as "Average Height of Foam." Label the bar for each tissue that was used and add error bars. Your graph should include units for the y-axis and error bars that represent the standard deviation.

CONCLUSIONS:

1. What is the function of catalase?

2. What were the dependent and independent variables in this experiment?

3. Every experiment has the potential for error. List three things from this experiment that could have biased your data.

4. Write a paragraph stating the results of each part of your experiment. Make sure to include data that you have collected from the lab to support your findings.