Catalase Reactions: Measuring Enzymatic Rates

INTRODUCTION:

What would happen to your cells if they made a poisonous chemical? You might think that they would die. Interestingly enough, your cells are always making poisonous chemicals, and not dying. This is because your cells use proteins known as enzymes to speed up the conversion of these poisonous chemicals into harmless ones that are useful.

All of the enzymes in your body are responsible for one specific chemical reaction. The chemical reaction of this lab is the breakdown of hydrogen peroxide (H_2O_2) by an enzyme known as catalase (KAT-uhLAYSS). When hydrogen peroxide accumulates inside cells, it becomes extremely poisonous and could result in cell death. Therefore, cells rely on catalase to convert hydrogen peroxide into nontoxic molecules of water and oxygen. Below is the chemical reaction of catalase breaking down hydrogen peroxide:

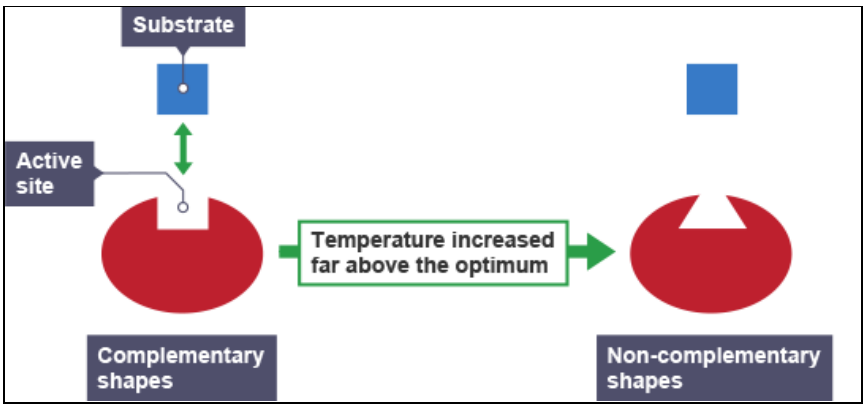
$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

hydrogen peroxide → water + oxygen

In this lab, you will compare catalase's rate of reactions in three different living things. A rate of reaction is how fast a chemical reaction occurs. When there is more enzyme present, the rate of reaction will be much faster. This is because enzymes speed up chemical reactions. Likewise, when there is less enzyme present or the enzyme no longer works, the rate of reaction will be much slower or close to zero. Use the table below as a scale to measure the reaction rates:

Reaction Rate	Description of Reaction Rate
0	No reaction, no bubbles
1	Very slow reaction, very few bubbles/foam
2	Slow reaction, some bubbles/foam
3	Fast reaction, more bubbles/foam than 2
4	Very fast reaction, lots of bubbles/foam

Enzymes can stop working when they are placed in extreme conditions (heat) outside of their optimum range. This is known as denaturation. Denaturation changes the shape of the enzyme's active site, meaning the enzyme and substrate no longer complement one another. As a result, binding does not occur and the chemical reaction will not take place. Hence, a reaction rate of 0.



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PURPOSE:
To determine the amount of catalase present in different organisms and to visualize the effects of heat on enzymes.

PROCEDURE:
1. Pour ~150mL of water into a beaker and place it on the hot plate to boil.
2. Using the scalpel and scale, weigh out 0.5g of each sample. Weigh out TWO samples of chicken liver, ONE sample of apple, and ONE sample of potato.
3. Using the tweezers, place ONE sample of chicken liver in a test tube. Be sure to get the sample to the bottom. Place the test tube in the boiling beaker and let it boil while completing steps 4-10.
4. Using the tweezers, place the APPLE sample in a test tube on the test tube holder. Be sure to get the sample to the bottom.
5. Pour one pipet full of hydrogen peroxide solution into the apple's test tube.
6. Observe the reaction as it occurs. Record any observations you can see, and prescribe a reaction rate number using the rate table.
7. Set aside the apple's test tube by standing it up on the wooden test tube rack.
8. Secure a clean test tube on the test tube holder.
9. Repeat steps 4-8 using the POTATO sample.
10. Repeat steps 4-8 using the SECOND raw chicken liver sample.
11. Repeat steps 4-7 using the newly boiled chicken liver sample.

DATA/OBSERVATIONS:

Record the reaction rates of each sample. **Record** any visual observations of each sample.

Sample	Reaction Rate (0-4)	Observations
Apple		
Potato		
Raw Liver		
Boiled Liver		

CONCLUSION:

1. Which sample contained the MOST amount of catalase? Use evidence from the data table to **justify** your reasoning.

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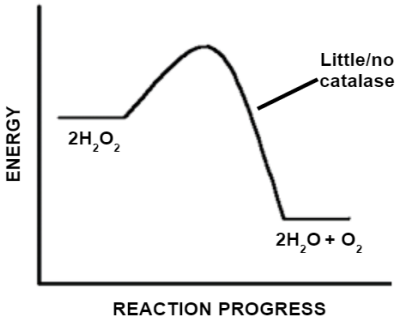
2. Which sample contained the LEAST amount of catalase? Use evidence from the data table to **justify** your reasoning.

3. The graph shows the energy of a chemical reaction with little to no catalase present. On the same graph, **sketch** & **label** what the graph would look like with a lot of catalase present. Then, answer questions a-d:



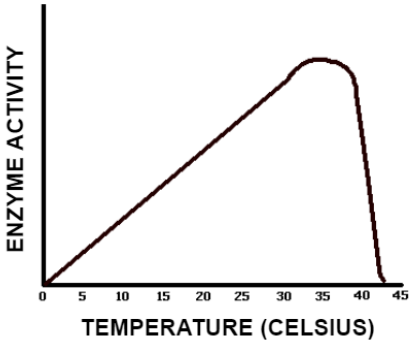
   a. Which graph has a HIGHER activation energy?
   _____

   b. Which graph has a LOWER activation energy?
   _____

   c. Which sample represents the graph with HIGHER activation energy? Use evidence from the data table to **justify**.

   d. Which sample represents the graph with LOWER activation energy? Use evidence from the data table to **justify**.

4. The graph shows the enzymatic activity of catalase at different temperatures. **Label** the optimum temperature of catalase. Then, answer questions a-d:



   a. What is the optimum temperature of catalase? _____

   b. Besides 0, what temperature is catalase completely denatured? _____

   c. Which sample represents catalase working at or near its optimum temperature? Use evidence from the data table to **justify**.

   d. Which sample represents when catalase is completely denatured? Use evidence from the data table to **justify**.