

**Topic:** Enzyme Lab

**Summary:** Students will determine the concentration of the enzyme catalase in different foods. Students will test if temperature affects enzyme activity.

**Goals & Objectives:** Students will be able to analyze the results of food with different concentrations of the enzyme catalase. Students will be able to analyze how temperature affects enzyme activity. Students will be able to create a bar graph of their results.

**Standards:** CA Biology *1b. Students know* that enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium. Students also know that the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.

**Time Length:** 100 minutes

**Materials:**

- Raw beef liver
- Raw ground beef
- Raw carrots
- Sugar cubes
- Hydrogen peroxide (  $H_2O_2$  )
- Goggles, gloves, and lab aprons
- Forceps
- Plates or bowls
- Graduated cylinder lab per station
- 2 thermometers per lab station
- 10 test tubes in rack per lab station
- Test tube brushes and soap at sink

**Lab Setup:**

Cut liver and Carrot into small cubes, a size small enough to fit into your test tubes. Role ground beef into small balls the same size as above. Set-up a food station with liver cubes, ground beef cubes, carrot cubes, and sugar cubes, each in a beaker. Setup a liquid station with one beaker of the chilled hydrogen peroxide and another beaker of room temperature hydrogen peroxide. Chill the hydrogen peroxide in the refrigerator and bring out right before lab starts. Setup the student stations with 10 test tubes per rack, a graduated cylinder, 2 thermometers, and forceps. Prepare the sink for disposal of waste materials and clean-up of test tubes.

**Procedures:**

1. Group students as lab partners. Each group should be assigned to a lab station. If there are more groups than stations, put two groups per station or make groups of four. Hand out lab safety equipment.
2. Students conduct the lab, start filling out the handout, and clean their lab areas once finished.
3. Students return to their desks and then finish filling out the handout and graphs.
4. Completion of the two bar graphs: one graph with the bubble activity as the DV and the other graph with the change in temperature as the DV. Both graphs have the food material as the IV.

**Accommodations:** Students who are not able to participate or are not willing to participate in the handling of food can record observations, temperature and time onto their handout. If you do not have much time, you can have students do a room temperature reading instead of both room temperature  $H_2O_2$  and cold  $H_2O_2$ . Students with an IEP can take the handout home if they need extra time, work with two other partners if not able to take measurements, and/or create one graph instead of two.

**Evaluation:**

- The hypothesis and conclusion section on the handout are worth 1 point each, for a total of 2 points.
- The two data tables are worth 2 points each, for a total of 4 points.
- The 10 questions are worth 1 point each, for a total of 10 points.
- Each graph is scored with the title worth 1 point, labels 1 point, and the correct values are worth 5 points. The graphs are worth a total of 14 points.
- This assignment is worth a total of 30 points.

# Enzyme Lab

**Purpose:**

Your cells make poisonous chemicals, but you do not die because your cells use enzymes to break down these poisonous chemicals into harmless substances. We will examine how the poison hydrogen peroxide is broken down by the enzyme catalase. We will determine which food products have the enzyme and how temperature affects the rate of decomposition.

**Hypothesis:**

If \_\_\_\_\_,  
then \_\_\_\_\_.

**Materials:**

- Raw beef liver
- Raw ground beef
- Raw carrot
- Sugar cubes
- Hydrogen peroxide
- Clock or timers
- Forceps to remove material from test tubes.
- Goggles, gloves, and lab aprons
- Graduated cylinder and 3 beakers per station
- 2 Thermometers per lab station
- 10 test tubes in rack per lab station
- Test tube brushes and soap at sink

**Procedures:**

1. There are four types of lab stations: food station, liquid station, cleaning / disposal station, and student stations. Each group will have their own lab station. Students are not to disrupt other students or other stations. Students are to wear the safety equipment at all times.
2. One lab partner goes to the food material station with 2 test tubes and forceps to put the *same* material of their choice into each test tube. The lab partner then returns to their lab station. The other lab partner goes to the liquid station with the graduated cylinder and measures 5 or 10 mL of room temperature hydrogen peroxide. That student returns to their lab station.
3. One student puts the thermometer into the graduated cylinder and records the initial temperature on their handout. The other student puts the food test tubes back into the rack. After the temperature of the graduated cylinder has been recorded, a student pours all 5 or 10 mL of H<sub>2</sub>O<sub>2</sub> into one food test tube. The second thermometer is then placed into the same test tube. Leave the thermometer in the food test tube. One student then makes observations in the handout of the chemical reaction happening in the test tube.
4. When the material stops bubbling, take a new temperature reading and record on the handout.

5. One student goes back to the liquid station with the graduated cylinder and refills 5 or 10 mL of cold hydrogen peroxide. That student returns to their lab station and performs the same experiment with the cold hydrogen peroxide in the second test tube.

6. Procedures 2-5 repeats until all food substances are tested and recorded.

7. One student takes the test tube rack with the test tubes to the sink and cleans them with a brush, soap and water. The other student takes a paper towel and cleans their lab station. Student returns the test tubes to their lab station once cleaned.

**Experiment:**

Material	Starting Temp ° Celsius	Highest Temp ° Celsius	Change in Temperature
Raw Beef Liver	_____	_____	_____
Raw Beef Liver – cold H <sub>2</sub> O <sub>2</sub>	_____	_____	_____
Raw Ground Beef	_____	_____	_____
Raw Ground Beef – cold H <sub>2</sub> O <sub>2</sub>	_____	_____	_____
Raw Carrot	_____	_____	_____
Raw Carrot – cold H <sub>2</sub> O <sub>2</sub>	_____	_____	_____
Sugar	_____	_____	_____

Material	Bubble Activity (Circle)	Observations
Raw Beef Liver	0 1 2 3 4 5	_____
Raw Beef Liver – cold H <sub>2</sub> O <sub>2</sub>	0 1 2 3 4 5	_____
Raw Ground Beef	0 1 2 3 4 5	_____
Raw Ground Beef – cold H <sub>2</sub> O <sub>2</sub>	0 1 2 3 4 5	_____
Raw Carrot	0 1 2 3 4 5	_____
Raw Carrot – cold H <sub>2</sub> O <sub>2</sub>	0 1 2 3 4 5	_____
Sugar	0 1 2 3 4 5	_____
	0 = no bubbles	
	5 = most bubbles	

Variables:

Independent: \_\_\_\_\_ Control Group: \_\_\_\_\_

Dependent: \_\_\_\_\_ & \_\_\_\_\_

Standardizing Variables: \_\_\_\_\_

**Analysis:**

1. Graphing:

Create two bar graphs before continuing. On one graph, use “change in temperature” as the dependent variable, and on the other graph, use “bubble activity” for dependent variable.

2. Which *food* material had the most bubble activity?

Room Temp H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_ Cold H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_

3. Which *food* material caused the largest temperature change of the hydrogen peroxide?

Room Temp H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_ Cold H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_

Which food material, besides the control group, had the smallest chemical reaction?

Room Temp H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_ Cold H<sub>2</sub>O<sub>2</sub>: \_\_\_\_\_

4. Would the enzyme catalase work on other molecules besides H<sub>2</sub>O<sub>2</sub>? \_\_\_\_\_

Explain how the shape of H<sub>2</sub>O<sub>2</sub> is important to the enzyme catalase? \_\_\_\_\_

5. What type of macromolecule are enzymes? \_\_\_\_\_

6. Did the temperature of the H<sub>2</sub>O<sub>2</sub> make a difference in the level of bubble activity? \_\_\_\_\_

7. Hydrogen peroxide is what part of the enzyme system? \_\_\_\_\_

8. What temperature was catalase most reactive? \_\_\_\_\_ Mammals internal body

temperature is close to 37 ° C. How would body temperature affect catalase activity?

9. Hydrogen peroxide is a toxic molecule that you put on cuts to kill bacteria and can be found in the cells of your body. Why would most human cells have the enzyme catalase?

10.  $2\text{H}_2\text{O}_2 (l) \rightarrow 2\text{H}_2\text{O} (l) + \text{O}_2 (g)$  is the chemical equation of the process you witnessed in this lab. What were the bubbles in this experiment made of? \_\_\_\_\_

**Conclusion:** Did the results support your hypothesis? \_\_\_\_\_