

## SNC2D/2P Tissues, Organs, and Systems of Living Things/Tissues, Organs, and Systems

### Teacher Demonstration: Liver Enzyme Action

Topics	Timing
organ systems	preparation: 5 min demonstration: 10–15 min

### Specific Expectations

#### SNC2D

**A1.1** formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

**A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions

**B3.4** explain the primary functions of a variety of systems in animals (e.g., the circulatory system transports materials through the organism; the respiratory system supplies oxygen to and removes carbon dioxide from the body)

**B3.5** explain the interaction of different systems within an organism (e.g., the respiratory system brings oxygen into the body, and the circulatory system transports the oxygen to cells) and why such interactions are necessary for the organism's survival

#### SNC2P

**A1.1** formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

**A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions

**B3.4** explain the general function of some of the systems in the human body (e.g., the function through the body; the function of the digestive system is to absorb nutrients; the function of the respiratory system is to bring oxygen into and remove carbon dioxide from the body)

**B3.5** describe the interaction of systems in the human body (e.g., the respiratory system brings oxygen into the body, and the circulatory system transports the oxygen to cells), and explain why these interactions are necessary for survival

### Introduction

This demonstration illustrates the importance of enzymes in the human body. Enzymes catalyze many important chemical reactions in the body. This demonstration is a visual example of how the enzyme catalase, which is present in all cells, but in highest concentrations in the liver, breaks down hydrogen peroxide into water and oxygen gas. Hydrogen peroxide, which is a potentially damaging oxidizing agent, is a by-product of certain cellular reactions. It must be broken down quickly because it could damage and destroy cells.

## Materials

chemical safety goggles	wooden splint
lab coat or apron	3 test tubes
protective gloves	test-tube rack
chicken liver (ground or cut into 1 cm cubes)	marker for labelling test tubes
tweezers	10 mL graduated cylinder
3% hydrogen peroxide solution, H <sub>2</sub> O <sub>2</sub> (aq)	matches or lighter

## Safety Considerations

- Provide MSDS sheets for all chemicals used.
- Hydrogen peroxide is an oxidizing agent and body tissue irritant. Avoid skin or eye contact. Safety goggles and gloves should be worn when handling hydrogen peroxide. Flush eyes and skin with water immediately and for 15 minutes if you come into contact with hydrogen peroxide. If ingested, do not induce vomiting and call poison control immediately.
- A flame is used to determine the presence of oxygen. Tie back long hair and secure loose clothing. Ensure that the flame is extinguished before disposal of splint. Also, remind students of emergency procedures related to fire (extinguishers, exits, etc.).

## Hazardous Materials Identification System Rating

(0-minimal 1-slight 2-moderate 3-serious 4-severe)

3% hydrogen peroxide, H<sub>2</sub>O<sub>2</sub>(aq)

### HMIS (0 to 4)

Health	1
Fire Hazard	0
Reactivity	1

## Procedure

Wear appropriate PPE: chemical safety goggles, lab coat or apron, and protective gloves.

Prepare the following immediately prior to performing the demonstration.

1. Place three test tubes in the test-tube rack and label them 1 through 3.
2. Cut three 1 cm<sup>3</sup> pieces of fresh liver and, using tweezers, place one piece in test tubes #1 and #3. (Alternatively, place 1 small spoonful of fresh ground liver in test tubes #1 and #3.)
3. Use the graduated cylinder to measure 2–4 mL of hydrogen peroxide into test tube #2. Test tubes #1 and #2 are controls and will be used to show that oxygen is not produced by either the liver or the hydrogen peroxide on its own in an amount that is detectable by the glowing splint test.
4. **Predict/Explain**  
Show test tubes #1 and #2 to the students, describing what each contains. Ask students to predict what will happen
  - a. when the hydrogen peroxide is added to the liver in test tube #3,
  - b. when each test tube is tested for oxygen using the glowing splint.Students should also attempt to come up with rationales for their predictions.

- Observe**  
Pour 2–4 mL of hydrogen peroxide into test tube #3 and provide time for students to record their observations.
- Test for the presence of oxygen by lighting the end of a wooden splint and then shaking or blowing it until the flame is extinguished but the splint glows. Lower the glowing splint into test tube #1. Do not let the splint touch the side or the contents of the test tube.
- Repeat Step 6, relighting the splint each time, with the other two test tubes.
- Explain**  
Ask the students try to explain their observations.

## Disposal

The product mixture contains only water and liver. The liver can be disposed of in regular solid waste, and the liquid can be flushed down the sink with running water. Always follow disposal procedures that are consistent with school board protocol and appropriate for your municipality.

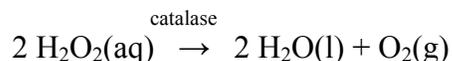
## What happens?

When the hydrogen peroxide is added to the liver (test tube #3) bubbles of oxygen gas quickly begin to form. Only the glowing splint inserted into test tube #3 should reignite due to the presence of oxygen.

## How does it work?

Enzymes are biological catalysts that increase the rate of chemical reactions in the body by lowering the activation energy required for reactions to proceed. As a result, more reactant molecules collide with the energy required to result in a successful reaction. Enzymes achieve this by binding the reactants (sometimes called substrates) to their active sites. An enzyme's shape is so specific that it can normally only catalyze one specific reaction.

The enzyme catalase is present in all cells, but found in the highest concentrations in liver cells. This is because one of the functions of the liver is to break down toxins found in the blood. Catalase is a catalyst for the decomposition of hydrogen peroxide which is formed as a by-product of many essential chemical reactions in cells. Hydrogen peroxide is toxic and, if not broken down, will damage and destroy cells. The chemical equation for the decomposition of hydrogen peroxide is



Like all enzymes, catalase functions within a certain temperature and pH range. At low temperatures, the reaction occurs very slowly. At high temperatures and/or extreme pH levels, the three-dimensional structure of the enzyme protein is altered. As a result, the enzyme no longer works properly and it is described as being denatured.

## Teaching Suggestions/Hints

- This demonstration can be modified into a student inquiry lab in which students investigate factors that affect the enzyme action (i.e., temperature, concentration, and pH). In this case, students should wear safety goggles, lab coats or aprons, and protective gloves.

2. Chicken and beef liver work equally well, so use whatever is more readily available.

### **Next Steps**

This demonstration could be used to extend and introduce concepts that will be learned in senior level biology (biochemical processes) and chemistry (rates of reaction) courses.

### **Additional Resources**

1. Video of demonstration with explanation:  
<http://www.schooltube.com/video/0f9b17a9d14e4b93af83/Liver-Enzyme-Lab>
2. Further information about enzymes:  
<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/E/Enzymes.html>