

What Affects the Function of an Enzyme?

Exploration Activity

The Effects of pH on the Function of Catalase - Teacher Notes

Advanced Preparation:

1. Each group of students should be instructed to bring in four small clear plastic cups and one potato for the lab. Groups may consist of 2 – 4 students.
2. To save class time, students should slice the potato at home, seal the slices in plastic wrap, and bring them in for the lab.
3. The pH paper (Hydriion or similar universal pH indicator strips) can be cut into 1 cm squares and placed in petri dishes for use by the students (one dish per lab station). The original pH paper container must be available for the students to interpret their results. Keeping empty containers around is useful for this.
4. The 0.1 M NaOH is prepared by placing some water in a 1-liter volumetric flask, adding 4 grams of NaOH, and adding water to bring the volume to 1 liter. Dispense 100 ml aliquots into labeled 250 ml beakers or Erlenmeyer flasks. Students will need 10 – 15 ml of this solution to run the test.

Hints:

1. Students can bring in supplies (vinegar, potato, detergent, and cups) for the lab. This simplifies the distribution of materials and prevents cross contamination of the stock supplies. Students need about 15 ml of vinegar and detergent to run their tests.
2. The 3% hydrogen peroxide can be diluted 1:1 with water to increase the volume with little impact on the results.
3. Liver produces more dramatic results but is messier to use and may not be readily available at home.
4. Potato, cantaloupe, and pear work well for this lab when the students wait a few minutes before they record their results. As long as the slices are small enough, all of these substances sink at first and float to the surface as the reaction develops.
5. You can use 0.1 M HCl instead of vinegar (add 8.3 ml of concentrated HCl to water and bringing the volume to 1 liter).
6. Supplemental information
 - Part of the cell damage (apoptosis) that occurs during the development of a person with Down's Syndrome is due to an elevated hydrogen peroxide level.
 - Hydrogen peroxide is used in the human defense system to kill bacteria, yeasts, and parasites and helps regulate the immune system.
 - Oxidative therapy includes treatments in which a weak hydrogen peroxide solution is injected into a person to elevate the blood oxygen level.
 - Over-the-counter products, such as Oxy-Gen Caps, advertise that they can increase the oxygen levels in the body because they contain magnesium peroxide, which is more stable and easier to use than hydrogen peroxide.
 - The USDA is working on a hydrogen peroxide test to determine if poultry are sufficiently cooked. They are developing a mathematical relationship between catalase activity and heating conditions.

7. Works cited

- Audesirk, Teresa, and Gerald Audesirk. *Biology: Life on Earth*. Upper Saddle River, N.J: Prentice-Hall, Inc, 1996.
- Edelson, Stephen B. "Down's Syndrome." 1998:3 pp. On-line Internet. 16 July 1998. Available WWW: <http://www.ephca.com/downs.htm>.
- Liu, R., et al. "Total Process Lethality as related to Residual Catalase Activity in Cooked Chicken Breast." ARS Report Number 0000069806 (16 April 1996): 2 pp. On-line. Internet. 16 July 1998. Available WWW: <http://www.nal.usda.gov/ttic/tektran/data/000006/98>.
- "Science of Oxidative Therapy." *The International Oxidative Medicine Association*. 2 pp. On-line. Internet. 16 July 1998. Available WWW: <http://www.healthy.net/othersites/farr/ioma/science.html>.
- "Life Plus – Oxy-Gen Caps." 3 pp. On-line. Internet. 15 July 1998. Available WWW: <http://www.unibio.com/spirit/biways/oxygen.html>.

Technology:

1. There are a variety of resources available on the Internet for students to research the uses and functions of enzymes.
2. The lab activities can be run using a CBL instead of pH paper. The changes in pH during the course of the experiment would allow students to quantify the rate at which catalase is working.

The Effects of pH on the Function of Catalase - Student Worksheet

Introduction: Hydrogen peroxide is a toxic compound produced by living organisms. Under normal conditions these organisms also produce an enzyme that quickly changes hydrogen peroxide into two harmless substances, oxygen and water. However, the function of the enzyme is affected by changes in the environment. Our knowledge of the decomposition of hydrogen peroxide and the function of enzymes is leading to a variety of applications, from treating influenza patients to testing for properly cooked poultry.

Purpose: What is the effect of altering the pH on the function of catalase?

Materials:

potato	pH paper	3% hydrogen peroxide (H_2O_2)
vinegar	permanent marker	0.1 M sodium hydroxide (NaOH)
scalpel	10 ml graduated cylinder	4 disposable cups (9 oz or less)
vinegar	liquid laundry or dishwashing detergent	

Procedure:

1. Cut four cubes of potato approximately 1 cm on each side. Remove the skin from each cube.
2. Cut each cube into four slices.
3. Number small plastic cups 1, 2, 3, and 4 using a permanent marker.
4. Place the four slices of potato into each of the four cups.
5. Cover the potato slices in cup 1 with water.
6. Cover the potato slices in cup 2 with vinegar.
7. Cover the potato slices in cup 3 with 0.1 M NaOH.
8. Cover the potato slices in cup 4 with detergent.
9. Determine the pH of the solution in each cup by holding a piece of pH paper with forceps and dipping it into the liquid. Use a new piece of pH paper for each solution. Record the pH in Table 1.
10. Measure exactly 5 ml of hydrogen peroxide in a graduated cylinder and add it to each container.
11. Observe each container for three minutes before you record your observations in Table 1. You are making qualitative measurements for this activity. Positive (+) indicates that a reaction is observed; negative (-) means that a reaction is not observed.

Observations:

Table 1: Results of a study of the effects of pH on enzyme behavior.

Test performed	pH	Test result (+/-)	Additional observations
Water			
Vinegar			
0.1 M NaOH			
Detergent			