

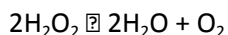
I. Question – Does changing an enzymes conditions change its effectiveness

II. Background

An enzyme is a protein that acts as a catalyst in a chemical reaction, that is, it speeds up or slows down a specific chemical reaction in an organism, builds and breaks things down. A good rule of thumb is to remember that enzyme names end in “-ase”. This will help in identifying enzymes in further readings. Generally, enzymes are catalysts.

Hydrogen peroxide (H_2O_2) is a toxic chemical that is produced in many organisms during metabolism and infection. Metabolism is the set of chemical reactions that happen in the cells of living organisms to sustain life. These processes allow organisms to grow and reproduce, maintain their structures, and respond to their environments. The word metabolism can also refer to all chemical reactions that occur in living organisms, including digestion and the transport of substances into and between different cells. Hydrogen peroxide is also produced by some specific cells to battle infection. Organisms must get rid of hydrogen peroxide, it is a toxin, to survive. Consequently, nearly all living things possess enzymes known as catalase peroxidases, which harmlessly and catalytically decompose low concentrations of hydrogen peroxide. One chemical reaction turns the hydrogen peroxide into water and oxygen. This is found in both plants and animals. In this lab we will use potatoes as our catalase peroxidase source. The reaction equation is:

Catalase



Hydrogen peroxide bubbles when it comes into contact with an enzyme called catalase. Most cells in the body contain catalase, so when the tissue is damaged the enzyme is released and becomes available to react with the peroxide. Catalase allows hydrogen peroxide (H_2O_2) to be broken down into water (H_2O) and oxygen (O_2). The bubbles you see when you pour hydrogen peroxide on a cut are bubbles of oxygen gas. Blood, cells, and some bacteria (e.g., staphylococcus) contain catalase, but it is not found on the surface of your skin so pouring peroxide on unbroken skin will not cause bubbles to form. Also, because it is so reactive, hydrogen peroxide has a shelf life once it has been opened, so if you don't see bubbles form when peroxide is applied to an infected wound or bloody cut, there is a chance your peroxide is no longer active.

The problem is researchers have found that hydrogen peroxide has little ability to reduce bacteria in wounds and can actually inflame healthy skin cells that surround a cut or a scrape, increasing the amount of time wounds take to heal.

In a study published in The Journal of Family Practice in 1987, scientists compared the effects of various topical treatments by taking a group of volunteers, administering several small blister wounds on each of their forearms, and then infecting their wounds with bacteria. After applying a different treatment to each wound, they measured bacterial amounts and rates of healing. They found that hydrogen peroxide did not inhibit bacterial growth and that wounds treated with the antibiotic bacitracin healed far more quickly.

Another study, in The American Journal of Surgery, looked at more than 200 people who had appendectomies and found that hydrogen peroxide did not reduce the risk of infection at the site of their incisions. But according to the American Medical Association, hydrogen peroxide does have at least one benefit: it can help dislodge dirt, debris and dead tissue in some wounds.

However enzymes do have limits. Under certain conditions enzymes can become denatured.

Before you begin the questions, read these directions — they will help you earn full credit.

On a separate sheet of paper answer each question in complete sentences and staple to the end. For each response include:

- A clear direct answer to the question.
- An explanation of your thinking that shows how you arrived at the answer. Use evidence from the passage when possible.
- Any calculations, diagrams, or labeled variables if the question asks for them or if they help your explanation.
- Connections to vocabulary from the reading (underline or bold any key terms you use, e.g., *enzyme*, *denature*).
- A short conclusion sentence summarizing your main point.

Do not give one-word answers or just repeat the question. Aim for 3–6 sentences for most answers unless the question specifically asks for a short response.

Example Model Answer

Question: What gas makes the bubbles produced during the catalase reaction?

Answer: The bubbles are made of oxygen gas (O_2).

Explanation: Catalase breaks hydrogen peroxide (H_2O_2) into water (H_2O) and oxygen (O_2), so the gas released is oxygen. This is shown by the reaction: $2 H_2O_2 \rightarrow 2 H_2O + O_2$. Observing bubbling indicates oxygen production.

Conclusion: Therefore, the bubbles are oxygen produced by the catalytic action of catalase.

Background Questions:

1. What is an enzyme, and what role does it play in chemical reactions within living organisms?
2. What does the suffix “-ase” indicate about a molecule, and why is this helpful when identifying enzymes?
3. Explain the term catalyst and describe how enzymes act as biological catalysts.
4. Define denaturing and explain how it affects enzyme activity.
5. What is a chemical reaction? Give an example from the background reading.
6. What is metabolism, and why is it essential for life?
7. Under what circumstances does the body produce hydrogen peroxide besides during normal metabolism?
8. What is hydrogen peroxide, and why is it considered toxic to cells?
9. Where in living organisms is catalase found? Provide examples.
10. When and why is catalase released from cells?
11. What do the bubbles observed when hydrogen peroxide is applied to a wound indicate?
12. What gas makes up the bubbles produced during the catalase reaction?
13. What happens to enzymes when they are exposed to non-ideal conditions such as high temperatures or extreme pH levels?
14. Explain how the catalase reaction demonstrates the role of enzymes as catalysts in living systems.
15. Based on the reaction equation ($2H_2O_2 \rightarrow 2H_2O + O_2$), identify which substances are reactants and which are products.
16. Why does hydrogen peroxide bubble when it touches damaged tissue but not unbroken skin?
17. Analyze why hydrogen peroxide is both useful and potentially harmful when used on wounds.
18. Using the research findings mentioned, evaluate whether hydrogen peroxide is an effective antibacterial treatment. Support your answer with evidence from the studies.
19. Describe how enzyme denaturation might impact the body’s ability to break down hydrogen peroxide.
20. If you were designing an experiment to measure catalase activity in potatoes, what variables would you need to control to ensure reliable results?

21. Predict how temperature or pH changes might affect the rate of the catalase reaction and explain why.
22. Hydrogen peroxide has a short shelf life once opened. Explain what might be happening at the molecular level that causes it to lose effectiveness over time.
23. Relate the concept of enzyme specificity to why catalase only acts on hydrogen peroxide and not on other substances.
24. Compare and contrast the benefits and drawbacks of using hydrogen peroxide versus antibiotics in wound care.

PURPOSE

1. Observe the breakdown of hydrogen peroxide toxin by potato's enzyme catalase.
2. Determine factors that influence how quickly the reaction takes place.
3. Determine factors that influence how well enzymes function.
4. Use graphic analysis (graphing) to analyze our results.

III. Materials: 5 test tubes, test tube rack, graduated cylinder, hydrogen peroxide, potato enzyme, timer

IV. PROCEDURE

1. Fill test tube 1-4 with 5mL room temperature hydrogen peroxide.
2. Add 1 drop of soap solution to all 5 test tubes give, a gentle shake
3. Get correct enzymes
 - a. The person assigned the HOT enzyme will go get 5mL of the HOT enzyme (test tube #1)
 - b. The person assigned the HIGH pH enzyme will use 5mL of the room temp enzyme with NaOH (sodium hydroxide) (test tube #2)
 - c. The person assigned the LOW pH enzyme will use 5mL of the room temp enzyme with HCl (Hydrochloric Acid) (test tube #3)
 - d. Test tube #4 use room temp enzyme
 - e. Test Tube #5 the person assigned the COLD enzyme will go get 5mL of COLD Hydrogen Peroxide and 5mL of the COLD enzyme Test tube give a gentle shake
4. Observe and record height of bubbles in cm for 3 minutes and any other relevant observations.
5. Clean up by washing everything well

V. HYPOTHESIS

1. Read the purpose and the procedure.
2. After having read these what is the independent and dependent variable in the experiment?
3. What test tube is the Experimental control? Why?

VI. DATA AND OBSERVATIONS

Test tube	Amount of bubbles	Observations	Time for reaction (s)
1.			
2.			
3.			
4.			
5.			

VII. a. DATA ANALYSIS

1. Graph the data. Include a title, labels, units, and a key.



**On a separate sheet of paper answer the following questions using the directions from the prelab questions
Staple to the end of the lab.**

VIIa. Questions:

1. Explain how this lab demonstrates the role of enzymes as catalysts in living systems.
2. Why does hydrogen peroxide bubble when it touches damaged tissue but not unbroken skin?
3. Analyze why hydrogen peroxide can be both useful and potentially harmful when applied to wounds.
4. Based on the research findings described in the background, evaluate whether hydrogen peroxide is an effective antibacterial treatment. Use evidence to support your answer.
5. Describe how enzyme denaturation might impact the body's ability to break down hydrogen peroxide.
6. Relate the concept of enzyme specificity to why catalase only acts on hydrogen peroxide and not other molecules.
7. If you were designing a new experiment to measure catalase activity in various organisms, what variables would you need to control to ensure reliable results?
8. Predict how catalase activity in plants (like potatoes) might compare to catalase activity in animal tissues. Provide reasoning.
9. Hydrogen peroxide loses effectiveness after a bottle has been opened. Explain what might be happening at the molecular level.
10. Compare and contrast the benefits and drawbacks of using hydrogen peroxide versus antibiotics in wound care. Which would you recommend and why?