

What Affects the Function of an Enzyme?

Explanation Activity

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

Analysis:

1. Enzymes are reaction specific. That is, they catalyze a specific chemical reaction. Which lab observations permit you to infer that catalase acted on the hydrogen peroxide and not on the other solutions that were used in the lab?
2. The shape of a protein can be changed by environmental factors such as pH and temperature. Which laboratory observation permits you to infer that catalase contains a protein?

Application of principles

1. Placing 3% hydrogen peroxide on a cut produces bubbles. What causes the bubbles to form in the wound, but not on the surrounding skin?
2. Hydrogen peroxide is an effective antiseptic on inanimate objects but is less effective on a skin wound. Account for this difference.
3. When an apple is cut and left out for awhile, the wound turns brown because of the action of an enzyme found in the apple cells. Applying lemon juice (pH = 3) prevents the apple from turning brown. Use the results of your laboratory investigation and your knowledge of enzymes to account for this.
4. Dr. T.H. Oliver reported the first intravenous use of hydrogen peroxide in 1920. Influenza patients were given hydrogen peroxide treatments with good results. What was accomplished by injecting the patients with hydrogen peroxide?

Conclusions:

1. State the pH range in which catalase can decompose hydrogen peroxide.
2. What environmental factors affect the rate at which an enzyme functions?
3. How does the protein portion of an enzyme affect the behavior of the enzyme?

The Effects of pH on the Function of Catalase - Answer Key

Observations:

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

Test performed	pH	Test result (+/-)	Additional observations
Water	7	+	Bubbles form around the potato. The slices float to the surface.
Vinegar	2- 3	-	No reaction occurs.
0.1 M NaOH	13	-	No reaction occurs.
Detergent	10 – 11	+	The reaction that occurs is not as vigorous as it is with water.

Analysis:

1. Enzymes are reaction specific. That is, they catalyze a specific chemical reaction. Which lab observations permit you to infer that catalase acted on the hydrogen peroxide and not on the other solutions that were used in the lab?

Bubbles did not form when the solutions were added. Bubbles formed only after the hydrogen peroxide was added.

2. The shape of a protein and its ability to function can be changed by environmental factors such as pH and temperature. Which laboratory observation permits you to infer that catalase contains a protein?

The tests at the extreme pH values (acetic acid and sodium hydroxide) produced negative results while the other tests were positive.

Application of principles

1. Placing 3% hydrogen peroxide on a cut produces bubbles. What causes the bubbles to form in the wound, but not on the surrounding skin?

The damaged cells around the wound release catalase (or some similar enzyme). The unbroken skin around the wound does not release catalase.

2. Hydrogen peroxide is an effective antiseptic on surfaces but is less effective on a skin wound. Account for this difference.

Since catalase is present at the site of a skin wound, hydrogen peroxide is being decomposed rapidly. Surfaces do not have enzymes and so the hydrogen peroxide lasts longer and can more effectively kill any bacteria in the area.

3. When an apple is cut and left out for awhile, the wound turns brown because of the action of an enzyme found in the apple cells. Applying lemon juice (pH = 3) prevents the apple from turning brown. Use the results of your laboratory investigation and your knowledge of enzymes to account for this.

Enzyme action is affected by the pH of the environment. The result of the acetic acid test shows that a low pH prevents an enzyme from functioning.

4. Dr. T.H. Oliver reported the first intravenous use of hydrogen peroxide in 1920. Influenza patients were given hydrogen peroxide treatments with good results. What was accomplished by injecting the patients with hydrogen peroxide?

Hydrogen peroxide, in the presence of catalase, was rapidly converted to water and oxygen. The oxygen level of the blood increased. Note: the answers to problems 1 and 2 provide evidence for inferring that catalase is present in the blood.

Conclusions:

1. State the pH range in which catalase can decompose hydrogen peroxide.

Catalase decomposes hydrogen peroxide when the pH is between 3 and 13.

2. What environmental factors affect the rate at which an enzyme functions?

Temperature, pH, and salinity affect the rate at which an enzyme functions. The results of this lab demonstrate the effects of pH on the enzyme rate.

3. How does the protein portion of an enzyme affect the behavior of the enzyme?

Proteins have specific shapes that can be altered by environmental factors such as pH and temperature. Altering the shape of the protein also alters the shape of the enzyme, affecting its behavior.