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## Factors Affecting Enzyme Activity

by John Eed

(Biology 1151)

### *Abstract:*

**W**e studied the effect of temperature, enzyme concentration and pH on enzyme activity. The enzyme we studied was hydrogen peroxidase from a cow. The reaction converted hydrogen peroxide to water and oxygen and oxygen production was used as a measure of enzyme activity. We studied enzyme activity at temperatures of 9° C, 37° C, 41° C. It showed that at 9° C, there was almost no activity. The activity at 41 was 1.5X the activity at 37. The enzyme was tested using ½X, 1X and 2X enzyme concentration. Significant enzyme activity was seen at 1x enzyme concentration and the ½X enzyme concentration trial showed almost the same activity. The activity at 2X enzyme concentration was approximately 2 times that at 1X enzyme concentration. Finally, we tested the effect of pH on the enzyme with pH 7, pH 1 and pH 11. The enzyme activity was highest at neutral pH (7) and showed only 1/3 enzyme activity at pH 11 while pH of 1 showed no enzyme activity.

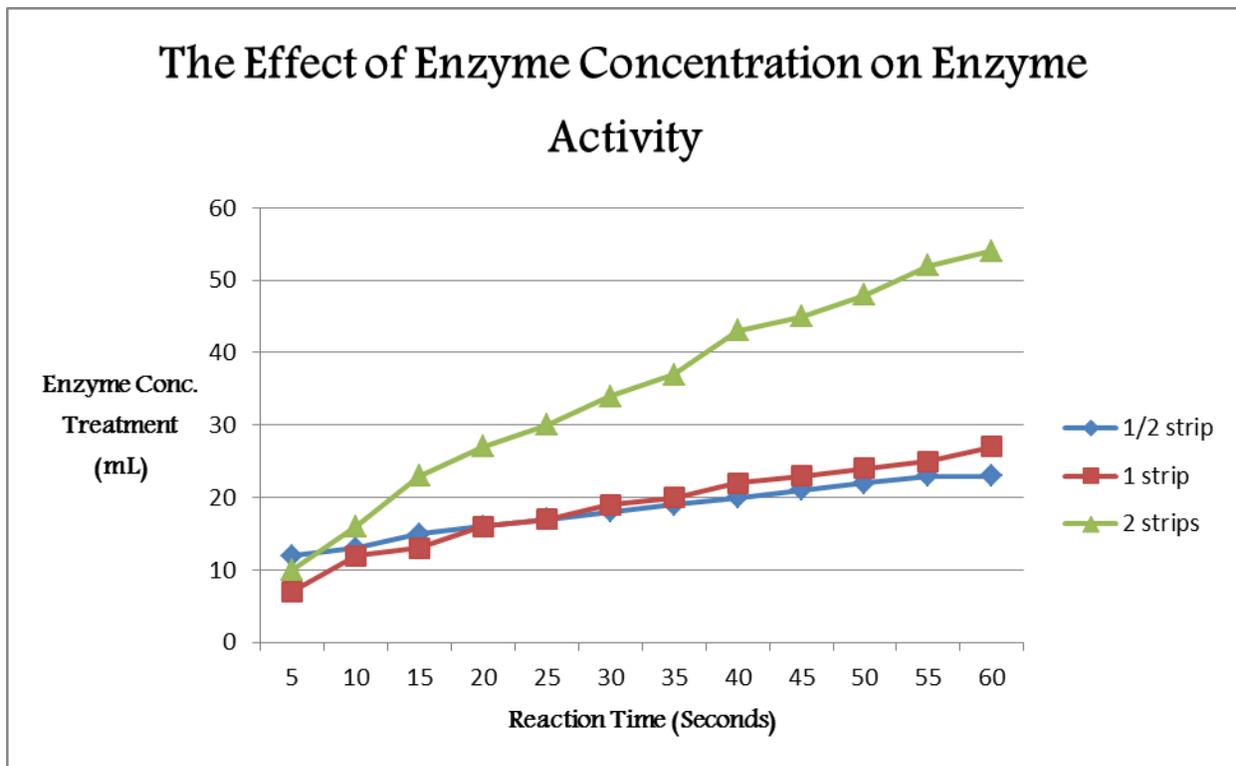
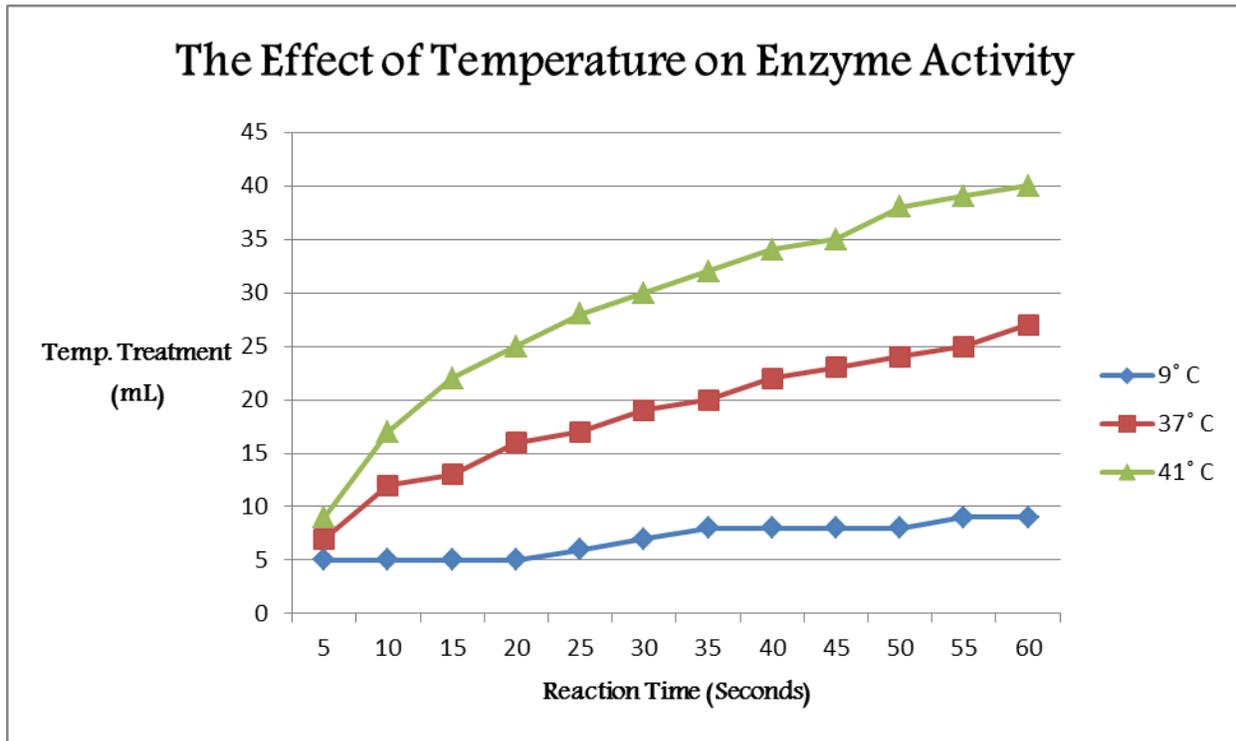
### *Introduction:*

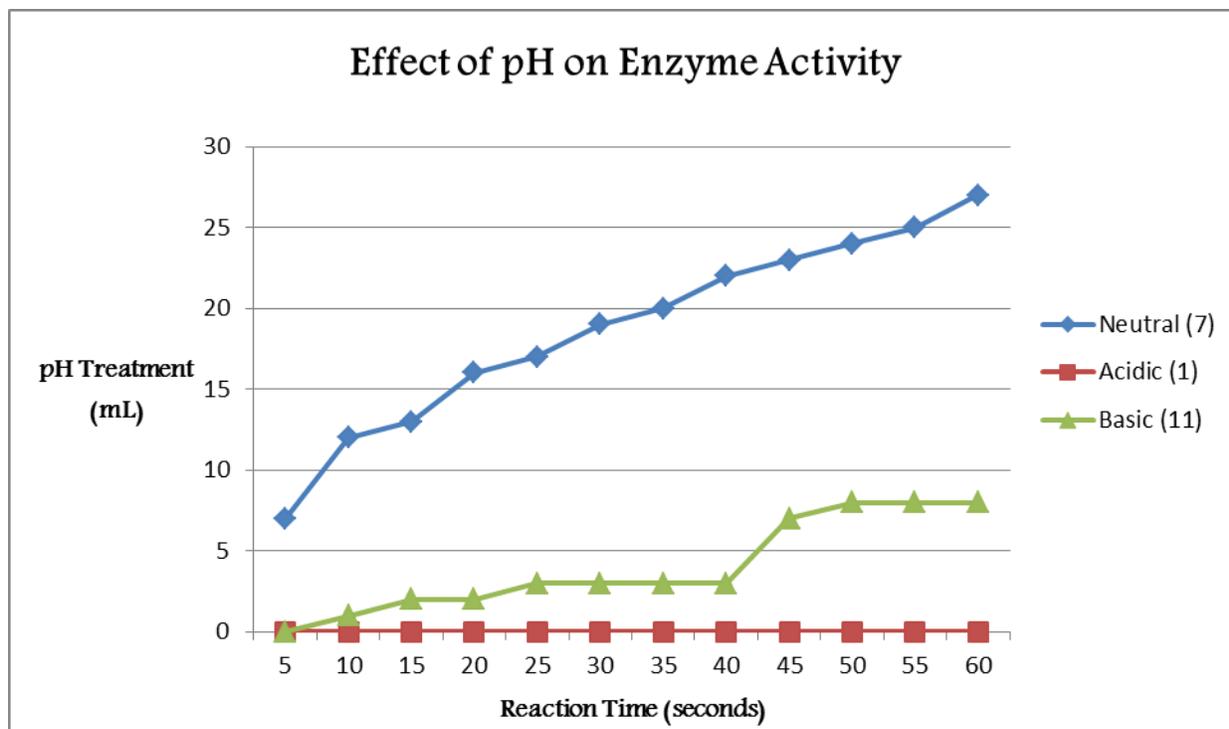
Enzymes are catalysts or chemical agents that speed up chemical reactions without being consumed by the reaction (Reece et al. 2010). Most enzymes are proteins that function to reduce activation energy in chemical reactions (Petersen and Anderson 2005). Enzymes work on reactants called substrate; the enzyme attaches to the substrate and then the enzyme converts the substrate to products while the enzyme remains unaffected (Reece et al. 2010). Enzyme activity can be affected by environmental factors (Petersen and Anderson 2005). Temperature is one environmental factor that can affect enzyme activity (Conant 2012). Another factor that affects enzymes is pH (Leake and Read 1990). In this lab, we will be studying the effects of temperature, enzyme concentration and pH on the enzyme, hydrogen peroxidase that is found in all aerobic cells and functions to decompose hydrogen peroxide (Petersen and Anderson 2005).

### *Materials and methods:*

A strip of filter paper was dipped into a cow liver homogenate for 10 seconds and then placed in a chamber. 20 mL of 1.5% H<sub>2</sub>O<sub>2</sub> was added to the chamber and the chamber was plugged with a stopper and then placed in a water bath. After 5 minutes, a 50 mL graduated cylinder filled with water was overturned over the chamber to flow the H<sub>2</sub>O<sub>2</sub>. Measurements of oxygen released were taken at 5 second intervals for one minute for each trial. This experiment was done with three different variables: Temperature, enzyme concentration and pH. The temperatures tested were: 9° C, 37° C, 41° C. The enzyme concentration was done using ½ strip, 1 strip and 2 strips of filter paper (representing ½X, 1X and 2X enzyme concentration) keeping the temperature at 37° C. The pH test was done using 1 strip with 5 drops of 50% HCl added to the H<sub>2</sub>O<sub>2</sub> to produce a pH of 1. Another pH test was performed by adding 5 drops of 50% NaOH to the H<sub>2</sub>O<sub>2</sub> to yield a pH of 11. The third trial was kept at pH 7. The temperature for the pH trials was at 37° C.

**Results:**





The activity of the enzyme at 37° C was 3 times the enzyme activity at 9° C. However, the activity of the enzyme at 41° C was about 1.5 times the activity at 37° C. All three had almost consistent slope. The activity of the enzyme with 1X enzyme concentration was a little higher than ½X but they were not significantly different. However, the enzyme activity with 2X enzyme concentration was twice the activity at 1X and followed similar kinetics. There was no enzyme activity at a pH of 1 while pH 7 showed significant activity. Further, little activity was seen at a pH of 11 until 40 seconds, at which point activity rose slightly.

#### *Discussion:*

When testing the effect of temperature on enzyme activity, the results showed that hydrogen peroxidase worked best at the temperature 41° C. When the temperature decreased to 37° C, the enzyme activity decreased. At 9° C, the activity of the enzyme decreased sharply. The flexibility of that enzyme could be affected due to the effect of temperature on covalent and hydrogen bonds. Chemical bonds make up the shape of protein and protein's function is related to its shape and therefore activity would decrease or impact the enzyme catalyzing a reaction (Reece, et al 2010). When temperature is high, the rate of the enzyme activity is high because substrates collide with active sites on the enzyme more frequently as the molecules move rapidly (Reece, et al 2010). Next, testing the effect of enzyme concentration on the enzyme activity showed some correlation between concentration of the enzyme and its activity. The enzyme activity was highest with 2X enzyme concentration. However, the experiment showed inconsistent or experimental error in ½X and 1X activity levels since there would have been a difference in enzyme activity expected and the results showed similar activities. pH also plays a role in enzyme activity. For hydrogen peroxidase, the highest activity was at pH 7. At pH 11, the activity was very low and at pH 1 there was no activity. This is likely because pH affects ionic and hydrogen bonds which are important to enzyme shape and therefore enzyme activity (Reece, et al 2010). In conclusion, enzyme activity is affected by factors such as temperatures, enzyme concentration and pH. Every enzyme has different preferences of these factors. Therefore, every organism needs to provide the appropriate conditions for all of its enzymes

to work efficiently.

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