

Virtual Lab: Enzyme-Controlled Reactions

1. Open the Virtual Lab: Enzyme Controlled Reactions
http://glencoe.mheducation.com/sites/dl/free/0078759864/383930/BL_11.html
2. Click the TV in the lab simulation to watch a video about enzyme action.
3. Click the “Information” bar at the bottom of the lab simulation and read it!
4. Complete the following guided mini “lab report”. (**This will help to ensure that your own homeostasis lab report will be formatted properly!**):

Background Information:

All (or most) reactions that happen in cells depend on enzymes. Enzymes are made up of proteins. They act as ‘catalysts’ for reactions. This means that they speed up reactions, but they are not ‘used up’ in the process. They can be used again and again. If there were no enzymes in the human body, most metabolic reactions would occur at a rate too slow to support life. Another important use of enzymes is that it allows reactions to be controlled so that just the right amount of product is made – not too much or too little.

Enzymes are used for many biological reactions. Amylase is an enzyme found in saliva that starts to break down starch into glucose, while glucose oxidase is an enzyme that helps cells to break down sugar. Glycogen synthase helps to convert glucose to glycogen. Fatty acid synthetase allows fatty acids to be created in the cytoplasm from a molecule that results from the breakdown of glucose. These fatty acids can then be used as the building blocks of more complex lipids. These are just a few examples of how enzymes enable reactions within cells.

Question: How do substrate concentration and pH affect enzyme-controlled reactions?

Hypothesis: *(If...then format)*

You may choose to write two hypotheses – one for substrate concentration, one for pH – if easier.

If pH levels are neutral, the number of molecules of product would be higher than the pH levels below 7 or higher than 7.

Variables:

For pH 5, what is the independent variable? the dependent variable? controlled variable(s)?

For 2.0g of substrate, what is the independent variable? the dependent variable? controlled variable(s)?

The independent variable: the different pH levels

Dependent variable: the number of molecules of product formed per minute ($\times 10^6$)

The controlled variable is the room temperature, the amount of substrate in each tube, enzyme concentration, the humidity

Procedure:

Include a brief description of your method. All significant details should be included, such that another scientist could repeat your experiment.

1. Get all the materials (0.5g substrate *5 , 1g substrate *5, 2 substrate *5, 4 substrate *5, 8 substrate *5/ 5 different test tubes, 5 different pH levels)
2. Make tube 1 with the pH level of 3
3. Make tube 2 with the pH level of 5
4. Make tube 3 with the pH level of 7
5. Make tube 4 with the pH level of 9
6. Make tube 5 with the pH level of 11
7. Put the same amount (0.5/1/2/4/8) of substrate into different test tubes with different pH level
8. Measure the amount of molecules of product formed per minute ($\times 10^6$)
9. Make observations
10. Make a data table
11. Repeat steps 2-10 again with a different same amount of substrate.

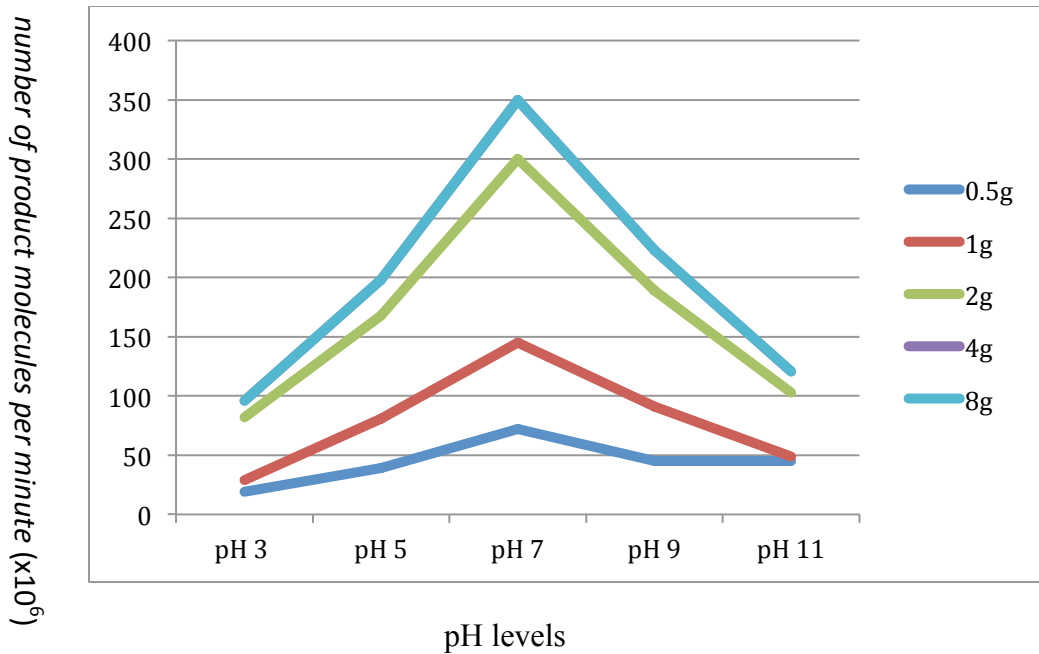
Data:

Table 1: Number of product molecules formed per minute obtained from the virtual lab.

# Product Molecules/minute at:					
Amount of Substrate (Lactose)	pH 3	pH 5	pH 7	pH 9	pH 11
0.5 g	19×10^6	39×10^6	72×10^6	45×10^6	45×10^6
1.0 g	39×10^6	81×10^6	145×10^6	91×10^6	49×10^6
2.0 g	82×10^6	168×10^6	300×10^6	189×10^6	103×10^6
4.0 g	96×10^6	198×10^6	350×10^6	223×10^6	121×10^6
8.0 g	96×10^6	198×10^6	350×10^6	223×10^6	121×10^6

Create one or more graph(s) illustrate the trends seen between amount of substrate / pH and the initial rate of reaction.

Graph 1: *The effect of pH levels to the number of product molecules per minute ($\times 10^6$)*



Analysis Questions:

- Describe the relationship between substrate concentration and the initial reaction rate of an enzyme-catalyzed reaction. Is this a linear relationship? What happens to the initial reaction rate as substrate concentration increases?
 - Yes there is a linear relationship between the substrate concentration and the initial reaction rate of an enzyme-catalyzed reaction. Substrates are molecules that are acted upon by enzymes. Hence, if the substrate concentration were different, the reaction rate of an enzyme-catalyzed reaction would change as well. The higher the substrate concentration, the rate also increases because there are more substrate molecules that fit together with the active site, which increases the rate of reaction.
- What is the maximum initial reaction rate for this enzyme at pH 7?
 - 350*10⁶ per minute
- Explain why the maximum initial reaction rate cannot be reached at low substrate concentrations.
 - If there are low substrate concentration is low, the maximum reaction rate cannot be reached because there will be less substrate molecules that will be acted upon by enzymes.
- What does your data indicate about the optimum pH level for this enzyme-catalyzed reaction?
 - The neutral pH allows the enzyme-catalyzed reaction to work more efficiently than other pH levels.
- Enzymes function most efficiently at the temperature of a typical cell, which is 37 degrees Celsius. Increases or decreases in temperature can significantly lower the reaction rate. What does this suggest about the importance of temperature-regulating mechanisms in organisms? Explain.
 - The temperature regulating mechanisms in organisms are essential because increasing or decreasing the temperature may affect the forms of substrate forms and may also cause damage on the enzymes' active site, which may alter the reaction rate. Therefore, the temperature should stay constant at 37 degrees Celsius in order to experiment the most efficient and controlled experiment.

Conclusion:

- *Summarizes data used to draw conclusions.*
- *Conclusions follow data (no wild guesses or leaps of logic).*
- *Hypothesis is rejected or accepted based on the data.*
- *Discusses possible experimental errors.*
- *Discusses applications or real world connections.*

According to the data, it clearly depicts that the neutral pH levels are the higher the number of the product molecules per minute. In pH 7, the neutral pH, the number of product molecules reached 350×10^6 in 8 grams of substrate. This was the highest number of products that was formed in 8 grams of substrate. Hence, my hypothesis was accepted by the collected data. If this experiment was not done by simulation but by our hands, I think some possible experimental errors might be keeping the controlled variables constant. For instance the room temperature may somehow change over time, and the enzyme concentration may not be completely exact. However, the ultimate understanding of this experiment was that the more neutral the pH levels are, the higher the production. This can be applied to real life because our body is filled with enzyme-catalyzed reactions. They contribute to DNA replication and to the digestive system. Thus, it is essential that we are aware of the fact that the production of enzyme-catalyzed reactions is most effective in neutral pH 7.