How do substrate concentration and pH affect the rate of an enzyme-controlled reaction?

To sustain the processes of life, a typical cell carries out thousands of biochemical reactions each second. Many of these reactions require the help of enzymes. Enzymes are proteins that speed up the rate of chemical reactions. Many important processes in the body involve the work of enzymes, including the digestion of nutrients such as carbohydrates, proteins and fats.

Enzymes are organic catalysts. A catalyst is a chemical that controls the rate of a reaction, but is itself not used up in the process. Reactions that are accelerated due to the presence of enzymes are known as enzyme-catalyzed reactions.

Enzymes are proteins that accelerate chemical reactions but do not change themselves in the reaction. Enzymes enable molecules to undergo chemical changes, forming new substances called products. Substrates are molecules that are acted upon by enzymes. For instance, amylase, an enzyme found in saliva, helps break down complex starch molecules (substrates) into smaller sugar molecules (products). In other biochemical reactions, substrates require assistance of specific enzymes to form new products.

Each substrate fits into an area of the enzyme called the active site. This fitting together is often compared to a lock-and-key mechanism. However, researchers believe that the fit between enzyme and substrate need not be exact. Enzymes are viewed as flexible keys that can shape and conform to the shape of the substrate.

**Objectives:**

* + Determine the effect of substrate concentration on the initial rate of an enzyme-catalyzed reaction
  + Determine the effect pH can have on the rate of an enzyme-catalyzed reaction

**Procedures:** In this investigation you will determine the effects of substrate concentration and pH on the initial rate of an enzyme-catalyzed reaction.

1. Click the TV/VCR.
2. Click the play button on the video controller.
3. Watch an animation about enzyme action.
4. Click More Information to read about enzymes and substrates.
5. To conduct the experiment, adjust the pH level of the test tube by clicking the up and down arrows, then add substrate to each of the test tubes that already contain an enzyme solution.
6. Click and drag a piece of weighing paper with the powdered substrate to a test tube. \*(NOTE. Assume that the enzyme concentration is each test tube is constant.)
7. Click the computer monitor to see the digital counter table that displays the number of product molecules formed during the first minute in each of the five test tubes. This is the initial reaction rate of this enzyme-catalyzed reaction.
8. Record the data in the table.
9. Click the Reset button.
10. Repeat the experiment using one substrate at five different pH levels.
11. Record your results in the Table.
12. When all the data have been collected and recorded, complete the Graph.

**Data Collection**: Complete the Data Table

**Data Analysis**: Complete the Graph

**Conclusions**: Answer all questions

1. 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?
2. What kind of catalysts are enzymes?
3. What is the maximum initial reaction rate for this enzyme at pH 7?
4. What are enzyme-catalyzed reactions?
5. Explain why the maximum initial reaction rate cannot be reached at low substrate concentrations.
6. Where could you find the enzyme amylase?
7. What does your data indicate about the optimum pH level for this enzyme-catalyzed reaction?
8. Into what part of an enzyme does the substrate fit?
9. 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.