The Penny-Picker Enzyme

**Objectives**

1. To study reaction rates of an enzyme-mediated reaction.
2. To study the effects of environmental variables on enzyme function.
3. To collect, graph, and analyze data relating to the reaction.

**Materials:**

* 1 roll of pennies
* 1 roll of masking tape
* 1 crumpled piece of paper
* 1 stopwatch

**Introduction** – The very rare penny-picker *enzyme* has been harnessed by humans and can now be used by your hand! The function of penny-picker is to pick up pennies and flip them over. The *active site* of penny-picker can only hold ONE penny at a time. Penny-picker cannot work on any other *substrates* besides pennies. Just like all enzymes, penny-picker can be *denatured* and *inhibited*. In this lab you will explore penny-picker and what factors influence its ability to facilitate the reaction of turning over pennies. You will analyze the effects of three factors on the *reaction rate* compared to a baseline trial.

**Procedure**

**TRIAL I - BASELINE**

Students should work in groups of 4. Pennies will be distributed to each group. The pennies should be spread on a desk tails side up. One member of each team will attempt to pick up as many pennies as possible turning each one so that the head side is facing up. This process will be done four times for a period of 10 seconds each time. A second member of the group will be responsible for timing. Do not replace the pennies between time periods. The number of pennies recovered in each trial period will be counted and recorded. Place this data into Table I - Team Data. The third member of the group will record data.

**TRIAL II - DENATURATION**

Redistribute the pennies on the desk, heads-up. Group members will switch roles of the enzyme, timer, and data recorder. In this trial the hand used to select the pennies will be taped around all four fingers to represent the partial *denaturation* of the enzyme. Enzymes, like all proteins, tend to change shape at high temperatures, when in contact with strong acids or bases, or when exposed to heavy metal ions. Repeat the procedure for picking up and turning over pennies in four 10 second periods. Record the data into Table I - Team Data.

1. *How well do you expect to do in picking up pennies compared to Trial I? Why?*

**TRIAL III - COMPETITIVE INHIBITORS**

In this last trial, group members should switch tasks and tape a crumpled paper ball to the palm of the hand to be used. The ball or object represents an *inhibitor* which is competing with the place on your hand where you pick up the pennies. Try it for four time periods and record data as in the previous trials.

1. *How well do you expect to do in picking up pennies compared to Trials I and II? Why?*

**TABLE I - TEAM DATA**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time (sec)** | **Trial I** | | **Trial II** | | **Trial III** | |
|  | **# Pennies** | **Total** | **# Pennies** | **Total** | **# Pennies** | **Total** |
| 0-10 |  |  |  |  |  |  |
| 10-20 |  |  |  |  |  |  |
| 20-30 |  |  |  |  |  |  |
| 30-40 |  |  |  |  |  |  |
| Average |  | ---------- |  | ---------- |  | ---------- |

Record the data from each time period in the “# Pennies” column. Next, calculate the average number of pennies turned over for each trial. Total the number of pennies turned over, cumulatively, at each time step and record in the “Total” column. For example, at Time 10-20 sec, the total = (# pennies turned over in 0-10 sec) + (# pennies turned over in 10-20 sec).

**TABLE II - CLASS DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| **Group #** | **Trial I Baseline** | **Trial II Denatured** | **Trial III Competitor** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| Average |  |  |  |

Record the average number of pennies turned over by each group for each trial. Calculate the average number of pennies turned over for each trial across the whole class. Record these values in Table II.

**Data Analysis**

1. Make a graph from your groups’ data (whatever type you thinks best displays the data).

**Analysis Questions:**

1. In this activity, what were the enzyme, substrate, and competitive inhibitor represented by?
2. Across the class, in which trial was the enzyme most successful? Explain.
3. In Trial I, was there a change in the rate of reaction? Why did this happen? How could this have been avoided?
4. If more substrate (pennies) were present in Trial I at the beginning, would the initial rate have been higher? Why or why not?
5. What happened to the active site of the enzyme during Trial II? How did this affect its functioning?
6. What effect did inhibition have upon the reaction rate?
7. How might chemicals affect your body if they acted like the paper ball in Trial III?