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“**Toothpickase” Activity as An Example of Enzyme Activity**

This is a “hands-on” lesson in enzyme action. You are to pretend that toothpicks are the substrate to be broken down and your hands are an enzyme, complete with an “active site” (between you thumb and fingers). Notice that the enzyme (your hand) is much larger than the substrate (toothpicks). As you will be performing the activity with your eyes closed, this simulates the random contact made between substrate and enzyme.

**The object of the activity is to break as many toothpicks in half as possible in two minutes to test the “enzyme’s” activity level.**

During the activity, you will also notice that the substrate will not break unless you find just the right spot (the bonding site) and that you will naturally find a maximum rate of reaction, the top speed at which your hands can find and break the enzyme. This speed may be lower during the activity as your hands become tired, the pieces are all too small to break and the substrates get more and more scattered in the “solution” (your playing field). Throughout the activity, notice that the enzyme (your hand) remains unchanged throughout the reaction.

**Materials**

Toothpicks, approximately 50 per group ice water and container

Stopwatch coffee straws

Calculator colored pencils

**Procedure:**

**The Rules:**

1. You may only break one toothpick at a time.
2. You must break each toothpick with ONE HAND ONLY.
3. You must break each toothpick completely in half.
4. You cannot begin before the time calls “Go”.
5. You must stop precisely when the timer says “Stop”.
6. You must keep your eyes closed throughout the entire activity. Enzymes don’t have eyes.

**Part 1 Enzyme**

1. Spread the toothpicks on the lab table in a random pile.
2. When the timer says “Go”, begin breaking toothpicks.
3. After **10 seconds**, the timer will say “stop”.
4. Count and record the number of toothpick broken. Record on data table 1.
5. When the timer says “Go”, begin breaking toothpicks again.
6. At the end of 20 more seconds (30 seconds all together), the timer will say “stop”.
7. Count and record the total number of toothpicks broken. Record on data table 1.
8. When the timer says “Go”, begin breaking toothpicks again.
9. At the end of 30 more seconds (60 seconds total), the timer will say “Stop”.
10. Count and record the total number of toothpicks broken. Record on data table 1.
11. When the timer says “Go”, begin breaking toothpicks again.
12. At the end of 60 more seconds, (120 seconds total), the timer will say “Stop”.
13. Count and record the total number of toothpicks broken. Record on data table 1.

**Analysis**

1. Calculate the initial rate of enzyme activity by dividing the number of toothpicks broken by the change in time (10 seconds). Record the initial rate in data table 1.

Formula: Rate = Δ # = number broken

Δt change in time Δ = change in

1. Now, calculate the rate of enzyme activity for 10, 30, 60 and 120 seconds. Remember the rate is the # broken/change in time in seconds. Record these rates in data table 1.

**Data Table 1: Reaction Rate of Enzyme**

|  |  |  |
| --- | --- | --- |
| **Time (seconds)** | **Number Broken** | **Reaction Rate** |
| 0 | 0 | 0 |
| 10 |  |  |
| 30 |  |  |
| 60 |  |  |
| 120 |  |  |

**\*\*\*\*\*Graph # 1 Draw a graph that shows number of toothpicks broken and time.**

**Part 2: Effect of Temperature on Reaction Rate**

1. Place your “enzyme hand” in an ice bath for 3-4 minutes.
2. Complete the same procedure as in part 1 and record data in data table 2.
3. Draw a different colored line on the graph from part 1 showing the number of toothpicks broken and time. Make a key to show what color was used for each activity.

**Data Table 2: Effect of Temperature on Reaction Rate**

|  |  |  |
| --- | --- | --- |
| **Time (seconds)** | **Number Broken** | **Reaction Rate** |
| 0 | 0 | 0 |
| 10 |  |  |
| 30 |  |  |
| 60 |  |  |
| 120 |  |  |

1. What effect did temperature have on the reaction rate? Why?

**Part 3: Effect of Adding an Additional Substrate to the Solution**

1. Use the same procedure as you did in part 1…except… add 20 coffee straws to your initial pile of toothpicks.
2. Record your data on data table 3.
3. Add an additional line to your graph using a different color. Add to key.

**Data Table 3: Effect of Additional Substrate to Solution**

|  |  |  |
| --- | --- | --- |
| **Time (seconds)** | **Number Broken** | **Reaction Rate** |
| 0 | 0 | 0 |
| 10 |  |  |
| 30 |  |  |
| 60 |  |  |
| 120 |  |  |

1. What was the effect of adding an additional substrate to your solution?

**Graph: your data from parts 1, 2, and 3. Use different colors for each line. Make a key to show color used for each part of lab.**

Reaction Rate/ Toothpickase Efficiency

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **Number of Toothpicks Broken** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Time (seconds)

Key: