**Toothpickase Lab**: Enzymes are proteins used in metabolic chemical reactions to speed up those chemical reactions. Enzymes will decrease the energy that is needed to start these reactions. Enzymes are specific to the chemical reaction and are reusable. However, there are a number of factors that can affect the rate of an enzyme-facilitated reaction. We will investigate two of those factors today (substrate concentration and temperature)

**Hypothesis:** a) I think that as an enzyme reaction proceeds, the rate of reaction will {**increase** or **decrease**} because:

b) If the temperature decreases, then the rate of the enzyme reaction will…

**Part 1: Do enzymes speed up or slow down as substrate concentration changes?**

1. Count out 40 unbroken toothpicks and 20 straws into a bowl on your desk.
2. **ROLES**:
   1. **Toothpick-ase Enzyme**: break substrates (toothpicks ONLY) without looking at the bowl and all of its products (broken toothpicks).
   2. **Timer**: call out “start” and then every 10-second interval until 90 seconds are over.
   3. **Recorder #1**: count and write down the # of toothpicks broken during each 10-second interval
   4. **Recorder #2**: tally the **cumulative** # of toothpicks broken in each interval. This data is written in the data table.

**All broken toothpicks must remain in the bowl along with**

**the unbroken toothpicks and you cannot re-break a broken toothpick!**

1. The experiment is conducted in 10 second intervals.
2. Hey Enzyme, **WITHOUT LOOKING AT THE BOWL**, break as many toothpicks as you can in 10 second intervals. Broken toothpicks should be kept in the bowl with unbroken toothpicks because products and reactants mix in metabolic reactions.

**DO NO RE-BREAK A BROKEN TOOTHPICK!**

1. Do another 10 seconds of breaking **(cumulative total of 20 seconds now)**, and then count & record the number of toothpicks broken.
2. Do another 10 seconds **(cumulative total of 30 seconds now)** more of breaking and count and record the number of toothpicks broken.
3. Continue breaking toothpicks for these total cumulative time intervals (40, 50, 60 seconds).

**REMEMBER TO ALWAYS THROW BROKEN TOOTHPICKS BACK INTO THE PILE**

(because products and reactants stay mixed in reactions)**,**

**BUT DO NOT RE-BREAK THEM**

(because the enzyme has already acted on that substrate and broken it down into the 2-piece reactants)!

1. Graph the number of toothpicks broken as a function of time (x-axis = 10, 20, 30, 40, 50, 60, 70, 80, 90 seconds). Be sure to title your graph and to label the x and y-axis.

|  |  |  |
| --- | --- | --- |
| **Total Time**  **(seconds)** | **CUMULATIVE #**  **of Substrates Broken by Toothpickase** | **Rate of Enzyme Action**  **(toothpicks/seconds)** |
| 10 |  |  |
| 20 |  |  |
| 30 |  |  |
| 40 |  |  |
| 50 |  |  |
| 60 |  |  |

****

**Part 2: Does temperature affect the rate of enzyme-facilitated reactions?**

1. Select 15 toothpicks and place them in the bowl with 15 straws. Time how long it takes the enzyme to break the 15 toothpicks as fast as possible.
2. Place your hands in the pail of iced water for 10 or so minutes. Repeat step 1.
3. Calculate the rate of enzyme action in toothpicks per second. Compare the two rates.

|  |  |  |
| --- | --- | --- |
|  | **Time it takes to break**  **15 toothpicks (seconds)** | **Rate of Reaction**  **(toothpicks/second)** |
| **Regular Enzyme** |  |  |
| **Iced Enzyme** |  |  |

**Analysis:**

1. How does the rate of the chemical reaction change as time goes on?
2. How does the **slope of your graph** change and what is it showing you?
3. How does temperature affect enzymes? Why?
4. What would happen if the “enzyme” wore big, bulky gloves when picking up toothpicks (active site inhibitor)?
5. Were your hypotheses correct?