Mr. Ulrich
Regents Biology

The Toothpickase Lab

Adapted from an activity created by Peggy O'Neill Skinner

Introduction:

Organisms on every level, from elephants and blue whales down to amebas and lowly bacteria, can be described as being simply bags of chemical reactions. If left to their own, most of these reactions would either not happen at all or cause the organism to basically explode. Just as matches won't light on their own, these reactions need to be helped along so that they can be controlled.

Biologists are very interested in *enzymes* – protein catalysts that control many of the reactions that occur in living organisms. Enzymes are used in all metabolic reactions (and that's a LOT of reactions) to control the rate of reactions (so you don't burn up) and decrease the amount of activation energy necessary for the reaction to take place. Enzymes are specific for each reaction and are reusable. Enzymes have an area called the active site to which a specific substrate will bond temporarily while the reaction is taking place.

We know that conditions that change the shape of the active site (denaturation) such as heat and pH dramatically change the speed at which the enzyme can work. In this activity, you will actually become an enzyme of sorts (you're not a protein) and cause a reaction to take place. Toothpicks can't break on their own! More specifically, we will model as a class how changes in substrate concentration (number of toothpicks available) affect reaction rate (number of toothpicks broken per second).

Materials:

a pile of toothpicks per team
clock/watch with a second hand
Pencil
Your brain

Procedure:

In this activity, the toothpicks are the substrate and you are now the enzyme, *toothpickase*. When you break a toothpick, the place where the toothpick fits between your fingers is the active site of the enzyme.

1. Please, read all of the instructions first before asking for clarification. Thank you,.

2. Mr. U. will break the class into teams of 2 people. Each team will have the toothpick wand waved over them by the toothpick fairy and be transmogrified into the enzyme toothpickase. As this enzyme you have only two jobs: break toothpicks one at a time as fast as you can and keep data. You may also have to count out substrate (toothpicks) piles.

3. For each trial, each team will count out a pile of toothpicks and then be given 10 seconds to break as many toothpicks from that pile as possible.

4. In reality, the products of the reaction do not necessarily go away so we need to model this. BE SURE TO PUT BROKEN TOOTHPICK BACK INTO YOUR PILE AS YOU BREAK THEM

5. Record the data in the table on the other side of the sheet.

6. Start with a pile of 1 toothpicks and increase the starting pile each trial according to the data table.

7. Calculate the enzyme rate in toothpicks broken/second. Divide the number of toothpicks broken by the time allowed to break them – in this case 10 seconds.

Data Table:

Starting toothpick count	Number of toothpicks broken	Enzyme rate (t-pix/sec)
1		
5		
10		
20		
30		
40		

Analysis & Conclusions:

Answer the following questions **on a separate sheet of paper** using complete sentences and rephrasing the question.

1. What do you think your team's reaction rate would be if given a pile of 1000 toothpicks? 10,000? **Explain why.**

2. At what substrate concentration (starting toothpick count) did your team's reaction rate stop increasing?

3. Why is this [the answer to previous question] called the "saturation point"?

4. What happens if the enzymes wore bulky gloves when picking up toothpicks? **Explain why.** What does wearing the gloves represent?

5. What would happen to the rate of reaction if the enzymes were hosed down with ice water for one minute before breaking the toothpicks? And as the enzymes warmed up again would the rate eventually return to normal?

6. What if the enzymes were put into boiling water for one minute (denatured)? Would the reaction rate return to normal after the active site cooled down? Why is this a different result than putting the enzyme in ice water?

7. Which causes a more permanent change in the enzyme, cooling or heating?

Your completed lab report should include the following:

- ✓ This lab sheet with the data table completed.
- ✓ The graph (Starting t-pick count vs. enzyme reaction rate)
- ✓ Your conclusion questions on a separate sheet of paper.