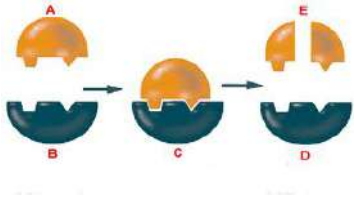
WLHS / AP Bio / Monson – UNIT 2 – Biochem

Name_____Date_____Per_____

"TOOTHPICKASE" - Enzyme Simulation



Introduction: Enzymes are proteins made by living cells. They act as catalysts and affect the rate of a chemical reaction. For example, the enzyme "amylase" in your saliva speeds up the breakdown of starch (the substrate) into simple sugars. The enzyme itself does not get used up during the chemical reaction.

This lab will serve as a pre-lab activity for AP Biology Lab #2 on enzyme catalysis. In this activity you (or rather, your hands) will become the enzyme called "toothpickase". This enzyme breaks toothpicks (the substrate) in timed intervals. Calculations will be completed to determine how many toothpicks are broken per second to determine the rate of reaction of the enzyme toothpickase.

Materials:
250 flat toothpicks
container for toothpicks
stopwatch

Pre-Lab:
The scientific vocabulary of an enzyme reaction will be modeled with your hands and toothpicks. The enzyme will be your hands with a particular shape – it demonstrates quaternary structure with the two subunits coming together to catalyze the reaction. The active site is the portion of the thumb and index finger which form a space within which the toothpick fits. The substrate is the toothpick. A toothpick can be broken into two products.

The rate of the reaction will be measured by counting the amount of product produced, or by counting the amount of substrate remaining. There are many factors that affect the rate of an enzyme reaction.

Break a toothpick!

1) Can a toothpick be broken faster?_____

2) Can it be broken infinitely faster?_____

3) Given a pile of toothpicks (substrate) and ideal conditions, it still takes some time for the enzyme to break the toothpick...that is the enzyme's **V-max**. Would it take longer to break the toothpick if it was across the room on the floor?_____

this would represent **lower substrate concentration.

4) Would it take longer to break the toothpick if it was surrounded by look-alikes?_____

this would represent **competitive inhibitors.

5) What would happen to the amount of time to break toothpicks if two people were breaking at the same time?_____

this would represent **higher enzyme concentration.

Procedure:

1) Place 40 toothpicks into the container.

2) One group member should be a timer while another does the following:

a) When the timer says "go": grab one toothpick and break it into roughly equal pieces.
*****Only break one toothpick at a time!***
b) Place the broken toothpicks **back into the container** and grab another toothpick.
c) Repeat steps a and b, as fast as you can for 10 seconds. A member of your group will be timing you for 10 seconds.

3) Empty your container and count the number of broken toothpicks. Record that number in Table 1.

4) **Place the unbroken toothpicks back into the container** and **add additional whole toothpicks** so that the number is back up to 40. You or another group member will repeat procedure steps 2a-c, but this time for **30 seconds**.

5) Repeat procedure step 4 for 60, 120, and 180 seconds. **(ALWAYS start with 40 unbroken toothpicks in the container!)**

6) Determine the rate of reaction for the following times: 0-10 seconds, 10-30 seconds, 30-60 seconds, 60-120 seconds, and 120-180 seconds. Record this information in Table 2.

EXAMPLE: for rate of reaction achieved in the 10-30 second time trial:

$$\textbf{Rate of Reaction} = \frac{\textbf{\# of toothpicks broken in 30 sec - \# of toothpicks broken in 10 sec}}{\textbf{30 sec – 10 sec}}$$

7) **Construct two line graphs**: one for the data entered in Table 1, and another for the data in Table 2.

8) Repeat the above procedure (steps 1-4) using the 30 & 60 second time intervals only, but this time **alter the conditions**. Choose from the list below. You may try as many as time allows. Compare these conditions to your first original 30 & 60-second readings.

*****Alternative Condition #1***: The toothpick-breaker should put their hands in ice water for a minute before trying to break toothpicks.
*****Alternative Condition #2***: The toothpick-breaker should tape their thumbs down to their hand before trying to break toothpicks.

9) Answer the post-lab questions.

"Toothpickase" - Data Tables

Table 1: Time Trial Results

Time (sec)	10	30	60	120	180
# of toothpicks broken					

Table 2: Rate of Reaction for Each Time Trial

Time (sec)	0-10	10-30	30-60	60-120	120-180
Rate of Reaction in "molecules" (toothpicks) per second					

Table 3: Altnernative Conditions - Time Trial Results

***which alternative did your team try?*_____

Time (sec)	30	60
# of toothpicks broken		

Post-Lab Questions: (please write or type your answers to these questions **on a separate piece of paper and attach, along with your graphs**, to this page)

1) If you were to continue this lab and break toothpicks for 240 and 300 seconds, what would happen to the rate of reaction? Why?

2) If the 40 toothpicks from each trial were dispersed around the room,
   a) Would the molecules be more or less concentrated?
   b) Would the number of reactions occurring in any given time period be more or less? Why?

3) What would happen (or did happen if you chose alternative #1) if the enzymes were submerged in ice water for a minute or longer before breaking the toothpicks? Why? And as the enzymes warmed up again would the rate eventually return to normal?

4) What if the enzymes (actual enzymes…NOT your hands!) were put into boiling water for one minute & denatured? Would the reaction rate return to normal after the active site cooled back down? Why is this a different result than putting the enzyme in ice water?

5) What would happen to the reaction rate if the toothpicks were spread out around the room so that the person acting as the enzyme had to run around the room to reach the toothpicks? What does this represent inside the cell?

6) What would happen to the reaction rate if there were 2 or 3 group members breaking toothpicks at the same time? What does this represent inside the cell?

7) What would happen to the reaction rate if the person acting as the enzyme wore bulky gloves when picking up and breaking the toothpicks? What might this represent in the cell?

8) Describe how inhibitors can inhibit enzyme action. In your answer, differentiate between a competitive and a noncompetitive inhibitor.

9) Most human enzymes work best at a neutral pH. Why do enzymes stop working if placed into a very acidic or very basic environment? (use what you know about a protein's levels of structure to answer this!) Give one exception and explain how / why it works best at a different pH.