Enzymes in Context: The Toothpickase

This activity was adapted from "Finding the Perfect Fit: An Introduction to Enzymes" designed by Bay Area Scientists in Schools.

Directions: Split up into groups of two. Decide who will act as the toothpickase and who will keep track of time and record data. The objective for this exercise is to understand how enzymes act as catalysts to convert substrate to product, and how molecules such as *inhibitors* may impact an enzyme's ability to function properly.

The toothpickase is a poorly understood macro-enzyme. It catalyzes the breaking of toothpicks into smaller toothpicks through a multi-step reaction. The first step of the enzyme's mechanism involves picking up a single toothpick in the right-hand domain of the enzyme. The right-hand domain moves close to the left-hand domain, bringing the toothpick substrate into close proximity. Then, spontaneously, half of the toothpick substrate moves into the left-hand domain triggering the breaking reaction and the subsequent release of product.

For this activity one student will be the toothpickase. During the activity their eyes are to remain closed. The recorder will be responsible for setting up the arena. While the toothpickase student's eyes are closed the recorder will put either 40, 20, 10, 5, or 2 toothpicks into the designated arena. Then, the recorder will signal to the toothpickase to begin breaking toothpicks for 10 seconds. After 10 seconds the recorder will announce to stop, and the amount of toothpicks broken within those 10 seconds will be recorder. If the toothpickase breaks all the toothpicks inside the arena before the time is up, pause the timer and record the number of toothpicks broken in the time period.

Pre-experimental Questions:

1) Why do you think it is important for the toothpickase student to keep their eyes closed during the exercise?

2) How do you think the amount of toothpicks broken per second will change as the number of toothpicks in the arena decreases?

3) How do you think the presence of *inhibitors* will impact the rate of toothpick breaking?

Scenario 1: Starting with 40 toothpicks in the arena, record how many toothpicks the toothpickase is able to break in 10 seconds. After this is completed repeat the scenario using 20, 10, 5, and 2 toothpicks.

# of toothpicks	40	20	10	5	2
toothpicks/second					

Scenario 2: Repeat the same exercise as scenario 1. However, this time introduce the *inhibitors* into the arena alongside the toothpicks.

# of Inhibitors in arena: _____

# of toothpicks	40	20	10	5	2
toothpicks/second					

Post-experiment questions:

1) What happened as the number of toothpicks in the arena decreased? Why do you think this happened? The toothpickase may have personal insight into this question.

2) What did the *inhibitors* do when they were in the arena? How did this impact the rate of toothpick breaking? How may this relate to a real inhibitor's effect on an enzyme?