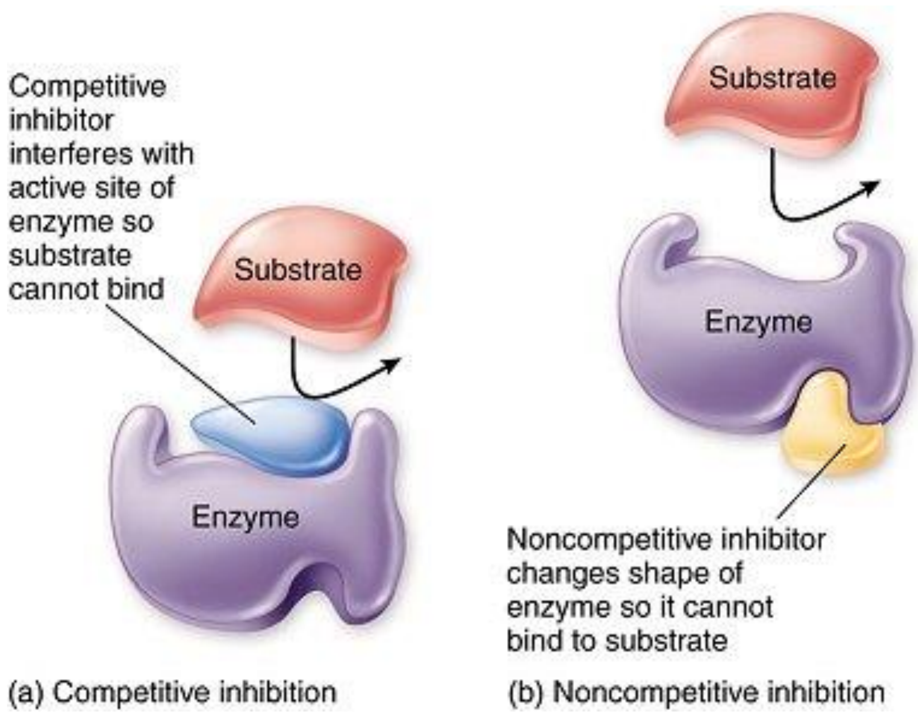
Name ____________________________ Date _______
Reaction Rate of Toothpickase AP Biology

The Reaction Rate of Toothpickase

Background Information:

Enzymes are proteins that help speed up (*catalyze*) chemical reactions without being used up or changed by the reactions. Enzymes are able to increase the rate of chemical reactions by *lowering the activation energy* to start the reaction. Each enzyme is specifically designed to fit with a specific substrate and the enzyme and substrate bind at the active site. Various factors impact enzyme activity including pH, temperature, salinity and concentration of the enzyme and/or substrate.

In this activity, your hands will represent "toothpickase", an enzyme that aids in breaking apart toothpicks (*the substrate*). Your tip of thumb and forefinger represent the active site where the toothpick binds and is broken. Enzymes work randomly and rely on the kinetic energy of the system, so to model this you will complete all tasks **with your eyes closed**. During this activity, you will examine "normal" toothpickase activity along with the impact competitive and noncompetitive inhibition has on enzyme activity.



Ground Rules:

- Only **ONE** toothpick may be broken at a time just like only one key can fit into a lock at one time.
- The toothpick must be broken **COMPLETELY** in half, or it does not count as a product.
- Each broken toothpick must go back into the original pile (*simulating that products and reactants continue mixing during the reaction - entropy*).
- Complete all rounds with your eyes **CLOSED** (*simulating the randomness of enzymes*)
- Record all data in Table 1.

Table 1. Reaction Rate of Toothpickase

	[Broken Toothpicks]				
Time (seconds)	**Control**	**Competitive Inhibition (10mg)**	**(20mg)**	**(40mg)**	**Noncompetitive Inhibition**
0					
30					
60					
90					
120					
150					
180					
210					
240					
Overall Reaction Rate					

Overall Reaction Rate Calculations:

$$\text{Slope} = \frac{\Delta y}{\Delta x} = \frac{\text{Total \# of Toothpicks Broken}}{\text{Change in Time}}$$

Graph & Calculations:

1. Create one graph displaying the data from Table 1. Graph the total number of toothpicks broken over the cumulative time. Appropriately label each axis, and create a legend to distinguish between each set of data.

Questions/Analysis:

1. Draw a picture of a hand and a toothpick. Label the parts that represent the enzyme, substrate, and active site in this simulation.
2. What would happen to the reaction rate if the toothpicks were spread out so that the breaker had to reach for them? Explain.
3. What should happen to the reaction rate if more toothpicks (*substrate/reactant*) were added? Explain.
4. What should happen to the reaction rate if more broken toothpicks (*product*) were added? Explain.
5. What if the enzyme was put into boiling water for one minute? Would the reaction rate return to normal after the active site cooled down? Why is this different than putting the enzyme in ice water? (Hint: think about the bonds)
6. Which causes a more permanent change in the enzyme, cooling or heating?
7. **Calculate the reaction rates for 0-30 seconds and 210-240. Explain your results.**