

Enzyme Lab Activity

Names:

Toothpickase: Introduction to Enzymes

In the activities that follow:

- One person's fingers are the enzyme TOOTHPICKASE
- The toothpicks are the SUBSTRATE
- Toothpickase is a DIGESTIVE ENZYME. It breaks down toothpicks into two units. To hydrolyze the toothpick, place a toothpick between the thumb and the first finger of each hand. Break the toothpick in two pieces.

Part A

Rate of Product Formation in an Enzyme-Facilitated reaction

Materials:

100 toothpicks per team

bowl

clock/watch with a second hand

Pencil

Procedure:

In this activity, the toothpicks represent a substrate and your thumbs and index fingers represent the enzyme, *toothpick-ase*. When you break a toothpick, the place where the toothpick fits between your fingers represents the active site of the enzyme.

1. Count out 100 unbroken toothpicks into a bowl on your desk.
2. Have one person in the group serve as the timer, have one person serve as the recorder, and have another person in your group act as the enzyme or toothpickase.
3. The person acting as the enzyme is to break toothpicks without looking at the bowl and all of its products (broken toothpicks).

All broken toothpicks must remain in the bowl along with the unbroken toothpicks, & you cannot re-break a broken toothpick!

4. The experiment is conducted in 10 second intervals.
5. WITHOUT LOOKING AT THE BOWL, break as many toothpicks as you can in 10 second intervals and record this on the data table. Broken toothpicks should be kept in the bowl with unbroken toothpicks because products & reactants mix in metabolic reactions.

DO NOT BREAK TOOTHPICKS ALREADY BROKEN!

Remember when counting, two halves equal a whole broken toothpick!

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6. Do another 10 seconds of breaking (**total of 20 seconds now**), and then count & record the number of toothpicks broken.
7. Do another 10 seconds (**thirty seconds total now**) more of breaking and count and record the number of toothpicks broken.
8. Continue breaking toothpicks for these total time intervals (60, 120, and 180 seconds). **REMEMBER TO ALWAYS THROW BROKEN TOOTHPICKS BACK IN THE PILE** (because products & reactants stay mixed in reactions), **BUT DON'T RE-BREAK THEM** (the enzyme has already acted on the substrate!)

Part A Data Table:

Total Time (seconds)	Number of toothpicks broken
10	
20 (additional 10 seconds)	
30 (additional 10 seconds)	
60 (additional 30 seconds)	
120 (additional 60 seconds)	
180 (additional 60 seconds)	

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PART B:

EFFECT OF SUBSTRATE CONCENTRATION ON REACTION RATE

Materials:

1 box toothpicks per team

100 paper clips

clock/watch with a second hand

Pencil

1. Remove the broken toothpicks from the shallow bowl. Place 100 paperclips in the empty bowl. The paper clips represent a "solvent" in which the toothpicks are "dissolved". Different concentrations are simulated by mixing different numbers of toothpicks in with the paper clips.
2. For the first trial, place 10 toothpicks in the bowl with the paper clip. Mix them up. The enzyme has 20 seconds to react (break as many toothpicks as possible). Remember the enzyme breaks the toothpicks *without* looking at the bowl and all of the products ("broken toothpicks") must remain in the bowl. Remember toothpicks can only be digested once; do not break toothpicks already broken! Record the number broken at a concentration of 10.
3. Remove the broken toothpicks and repeat with concentrations of 20, 30, 40, 50, 60, 70, 80, 90, and 100 toothpicks, each time mixing them with the 100 paper clips.
4. Discuss your results and explain why the rates were different at different concentrations. Summarize the effect of substrate concentration on enzyme action.

Part B Data Table:

Time (seconds)	Toothpick Concentration	Number of toothpicks broken
20	10	
20	20	
20	30	
20	40	
20	50	
20	60	
20	70	
20	80	
20	90	
20	100	

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PART C

EFFECT OF TEMPERATURE ON REACTION RATE

Materials:

10 toothpicks per team

ice & ice bucket

clock/watch with a second hand

Pencil

1. Select 10 toothpicks. Time how long it takes to break the 10 toothpicks as fast as you can.

TIME:

Reaction rate = # of toothpicks broken / time in seconds

Reaction rate = toothpicks/second

2. Place your hands in the pail of iced water for 5 minutes. Repeat step 1.

TIME:

Reaction rate = # of toothpicks broken / time in seconds

Reaction rate = toothpicks/second

3. Calculate the rate of enzyme action in toothpicks per second. Compare the two rates.
4. Discuss your results and explain why the rates were different at different temperatures. Summarize the effect of temperature on enzyme action.

Part C Discussion & Summary:

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PART D **EFFECT OF CHANGING THE ACTIVE SITE OF AN ENZYME ON REACTION RATE**

Materials:

40 toothpicks per team

clock/watch with a second hand

Pencil

1. Select 20 toothpicks. Time how long it takes to break the 20 toothpicks as fast as you can.

TIME:

Reaction rate = # of toothpicks broken / time in seconds

Reaction rate = toothpicks/seconds

2. Select 20 toothpicks. Cross your middle and index finger on both hands (changing the shape of the active site of toothpickase). Time how long it takes to break the 20 toothpicks as fast as you can.

TIME:

Reaction rate = # of toothpicks broken / time in seconds

Reaction rate = toothpicks/seconds

3. Calculate the rate of enzyme action in toothpicks per second. Compare the two rates.
4. Discuss your results and explain why the rates were different at different temperatures. Summarize the effect of temperature on enzyme action.

Part D Discussion & summary: