Toothpick-ASE Lab: Introduction to Enzymes (SB1b, SB1c)

Enzymes are used in all metabolic reactions (catabolic and anabolic) to control the rate of reactions and decrease the amount of 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. The purpose of this lab is to simulate the reaction of an enzyme with its substrate in both catabolic and anabolic reactions. In this activity, the toothpicks and beads represent a substrate and your thumbs and index fingers represent the enzyme, *toothpick-ASE*. When you break a toothpick or connect two beads, the place where the toothpick or bead fits between your fingers represents the active site of the enzyme. *Your eyes must be closed for each trial.*

Read through entire lab first and create a data table that is suitable for the data set you will be collecting.

PART 1: A Catalyzed Catabolic Reaction (Please complete steps 1 and 2 twice. The first time will be a practice trial and will not count, so you do not need to record the data for your trial attempt.

1. Count out 20 toothpicks on your desk.

2. Break all 20 toothpicks as FAST as you can and record the amount of time (in seconds) it takes. Broken toothpicks should be thrown into the pile of unbroken toothpicks because products & reactants mix in metabolic reactions. DO NOT BREAK TOOTHPICKS ALREADY BROKEN!

3. Count out another 20 toothpicks on your desk. Also count out 20 paper clips. Mix the toothpicks and paperclips together.

4. Break all 20 toothpicks as fast as you can and record the amount of time (in seconds) it takes. Broken toothpicks should be thrown into the pile of unbroken toothpicks and paper clips because products & reactants mix in metabolic reactions. DO NOT BREAK TOOTHPICKS ALREADY BROKEN!

5. Count out 20 toothpicks on your desk (return the paper clips). Soak your hands in the ice bath for as longs as you can tolerate, but keep track of the amount of time your hands were in the ice water. Immediately return to your station and proceed to step 6 below.

6. Break all 20 toothpicks as fast as you can and record the amount of time (in seconds) it takes. Again, broken toothpicks should be thrown into the pile of unbroken toothpicks because products & reactants mix in metabolic reactions. DO NOT BREAK TOOTHPICKS ALREADY BROKEN!

7. Count out another 20 toothpicks on your desk. Pretend that you have submerged your hands (the enzymes) into an acidic solution with a pH of 3.2. The toothpick-breaker will need to see Mr. Pedersen to find out what will happen to their hands (the enzyme's active site). Return to your station and break all 20 toothpicks as fast as you can and record the amount of time (in seconds) it takes. Again, broken toothpicks should be thrown into the pile of unbroken toothpicks because products & reactants mix in metabolic reactions.

PART 2: A Catalyzed Anabolic Reaction

1. Obtain a bag of snap beads and connect two beads repeatedly as FAST as you can and record the amount of time (in seconds) it takes (color does not matter). DISCONNECT ALL BEADS when you are done.

2. Now obtain a bag of square cubes and mix them in with the snap beads. Connect two beads repeatedly as FAST as you can and record the amount of time (in seconds) it takes (color does not matter). Do not connect square cubes, as they will not fit. DISCONNECT ALL BEADS when you are done!

3. Soak your hands in the ice bath for as longs as you can tolerate, but keep track of the amount of time your hands were in the ice water. Connect two beads repeatedly as FAST as you can and record the amount of time (in seconds) it takes (color does not matter). DISCONNECT ALL BEADS when you are done!

4. Lastly, soak your hands in the solution labeled "Simulated pH 12.5". Connect two beads repeatedly as FAST as you can and record the amount of time (in seconds) it takes (color does not matter). DISCONNECT ALL BEADS when you are done. Thoroughly RINSE all beads and leave them out to dry on top of their plastic baggy bag under the drying fan.

Analysis & conclusions:

1. Identify the dependent and independent variables in both parts of this experiment?

2. Explain the difference in time between each trial's results. How is this a realistic simulation of enzyme efficacy?

3. Explain what would happen to the reaction rate if the toothpicks or beads were spread out and were further apart?

4. Explain what the paperclips and square cubes represented in the reaction. How could these items affect enzyme reactivity rates?

5. Explain what would happen to the reaction rate if there were two "breakers" (more enzymes)?

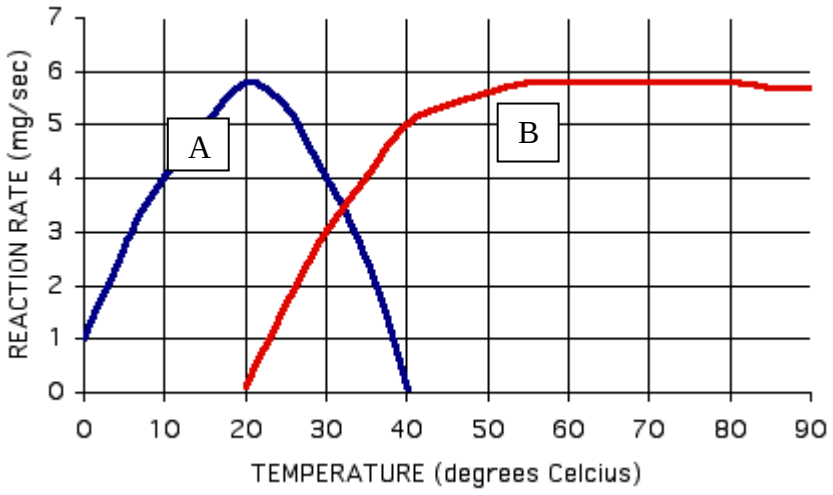
6. Identify which steps in the lab represented enzymatic denaturation. Please explain your answers.

7. Create a graph for the amount of time it took for each toothpick trial and snap bead trial. Be sure to title your graph and to label the x and y-axis with units.

8. Explain the role of activation energy in a reaction. How does an enyme affect the activation energy?

9. Transcribe and complete the concept map on page 106 in your textbook.

10. *SB2B Connection:* The *G6PD* gene provides instructions for making an enzyme called glucose-6-phosphate dehydrogenase. This enzyme is involved in the normal processing of carbohydrates. It also protects red blood cells from the effects of potentially harmful molecules called reactive oxygen species. Reactive oxygen species are byproducts of normal cellular functions. Chemical reactions involving glucose-6-phosphate dehydrogenase produce compounds that prevent reactive oxygen species from building up to toxic levels within red blood cells**.** Hypothesize what deleterious effects an individual might exhibit if they lacked Glucose-6-phosphate dehydrogenase. Is this enzymatic pathway catabolic or anabolic and why?



11. Examine the graph to the left. Describe the differences between the reactivity rates of enzyme A and B. Hypothesize what abiotic conditions could have influenced enzyme A. Describe what is occurring for both enzymes at 20 degrees Celsius.

Georgia Performance Standard SB1 b, c