**Station 1-Catalyst**

[**https://www.youtube.com/watch?v=9KQdF1bnXHE**](https://www.youtube.com/watch?v=9KQdF1bnXHE)

**Watch the video and in your notebook, answer the following questions.**

1. **What is a Catalyst (more importantly what to Catalyst do)?**
2. **What is the biological Catalyst that we have in our bodies that help with our everyday reactions?**
3. **Why would Catalyst be important for industry use?**
4. **How does a well designed Catalyst work? You may sketch this, but be able to explain it too.**
5. **What are the three most important points of a Catalyst?**

**Station 2: The lock and key theory of Enzymes**

**Watch the video and answer the following questions.**

[**https://www.youtube.com/watch?v=E-\_r3omrnxw**](https://www.youtube.com/watch?v=E-_r3omrnxw)

**You can use the pieces on the table to explain each process and help you visualize it.**

1. **Based off the video, how do enzymes work? Use the analogy of a lock and key to explain. Sketch the example.**
2. **What does the word inhibit mean? Use the dictionary provided.**
3. **How is the activation energy affected with the use of a catalyst like an enzyme?**
4. **What condition in our body do enzymes work best in?**
5. **How do enzymes help in reactions that occur in our body?**
6. **What is a Competitive Inhibitor and how does it affect the enzyme reaction? Use what you saw to answer the question. Sketch the Competitive Inhibitor and explain what it is doing to Inhibit the enzyme from working on the substrate.**
7. **What is a Competitive Inhibitor and how does it affect the enzyme reaction? Use what you saw to answer the question. Sketch the Competitive Inhibitor and explain what it is doing to Inhibit the enzyme from working on the substrate.**

**Enzyme and Denature**

**Watch the video and answer the following questions.**

[**https://www.youtube.com/watch?v=KIeq7lQnxLs**](https://www.youtube.com/watch?v=KIeq7lQnxLs)

1. **What is the activation site?**
2. **How does the enzyme activity work?**
3. **Explain why they say enzymes are recyclable?**
4. **Why do enzymes have optimal conditions in which to work in?**
5. **What is denature and how does it affect the enzyme and enzyme activity**

**Factors that affect Enzyme rate of reaction**

[**https://www.youtube.com/watch?v=2Old2ODOpDc**](https://www.youtube.com/watch?v=2Old2ODOpDc)

**Watch the video and answer the following questions.**

1. **What are the factors that affect how enzymes work?**
2. **What is the ideal temperature for enzymes? What happens if the temperature is too high or too low?**
3. **What is the ideal pH for enzymes? Why is this?**
4. **What happens to the enzyme reaction if they is too much substrate or not enough substrate?**
5. **Summarize ideal conditions for enzymes**

***Toothpick-ase: Introduction to Enzymes***



**Enzymes are used in all metabolic reactions 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. Enzymes are proteins that are used as catalysts in biochemical reactions. A catalyst is a factor that controls the rate of a reaction without itself being used up. In biological systems, enzymes are used to speed up the rate of a reaction. However, there are a number of factors that can affect the rate of an enzyme-facilitated reaction, in addition to the presence of the enzyme, amongst them are:**

1. **Substrate concentration**
2. **Temperature**

***Materials:*100 toothpicks per team  
bowl  
clock/watch with a second hand  
Pencil**

***Procedure:***

***Part A - rate of Product Formation in an Enzyme-Facilitated reaction*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 toothpick-*ase*.**

**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!**

**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*!***

**Answer the following questions:**

**1. What happens to the reaction rate as the supply of toothpicks runs out?**

**2. What would happen to the reaction rate if the toothpicks were spread out so that the "breaker" has to reach for them?**

**3. What would happen to the reaction rate if more toothpicks (substrate) were added?**

**4. What would happen to the reaction rate if there were two "breakers" (more enzymes)?**

**Graph the number of toothpicks broken as a function of time (10, 20, 30, 60, 120, & 180 seconds.) Be sure to title your graph and to label the x and y-axis.**

***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)** |  |

**Graph Title**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



***Materials:*1 box toothpicks per team  
100 paper clips  
clock/watch with a second hand  
Pencil**

***PART B: EFFECT OF SUBSTRATE CONCENTRATION ON REACTION RATE***

1. **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. **Graph the results.**
5. **Discuss your results and explain why the rates were different at different concentrations. Summarize the effect of substrate concentration on enzyme action.**

**Discussion & summary:**

***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** |  |

**Graph Title**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



***Materials:*10 toothpicks per team  
ice & ice bucket  
clock/watch with a second hand  
Pencil**

***PART C: EFFECT OF TEMPERATURE SUBSTRATE CONCENTRATION ON REACTION RATE***

1. **Select 10 toothpicks. Time how long it takes to break the 10 toothpicks as fast as you can.**
2. **Place your hands in the pail of iced water for 3 minutes. Repeat step 1.**
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.**

**Discussion & summary:**

**5. Explain what would happen to an enzyme-facilitated reaction if temperature were** **increased. Be sure to include the effect if temperature were increased to 100°C.**

**6. What is the optimal temperature (°C) for enzymes functioning in the human body?**

**7. What happens if the breaker wears bulky gloves (active site affected) when picking up toothpicks?**