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## Rate and Catalysis

Grade 7

### Goals:

- Learn basic function and purpose of proteins (enzyme catalysis etc.)
- Learn about different rates, and what affects rate in general and in enzymatic reactions
- Acquaint students with data acquisition, data organization and graphical analysis
- Relate nature of research by discussing inconsistency of data between groups

### Materials:

- Legos or paper clips
- Calculators
- Bandanas
- Graphing paper
- Timer

### Introduction

Ask students what is rate, provide commonly accepted definition; compare and contrast with theirs. Briefly describe importance of rate measurements in different sciences, also relating to planetary sciences (travel of light, etc.) and proteins (biological catalyst). Talk about factors affecting rates, particularly rate of chemical reaction (temperature, concentration). Make transition to proteins, introducing importance of proteins, give example of an enzyme catalyzed reaction in the body and state its importance (how much faster is enzymatic reaction ex.  $1$  vs.  $10^{14} \text{ s}^{-1}$ ). State the magnitude of the difference of uncatalyzed reaction and how it would affect the body (a good example would be, digestive enzyme, without it we would starve before we would digest). Talk about temperatures and how they affect proteins. Why high fever is dangerous, make comparison to frying the egg. Heat (and cold) can damage the enzyme and other proteins by changing their shape and function (analogy to hands covered with glue).

### Experiment

#### Part 1

Divide students in groups, provide the materials and divide the work (some students are enzymes, one records the data, one measures time). Three of the students will put lego or paper clips of the same size together simulating enzyme catalyzed reaction. Number of newly created molecules will be monitored over 10 – 20 second intervals. The data will be organized in a table. Note that there should be variety of sizes in a bunch to simulate real body environment, where enzymes must distinguish among thousands of molecules.

#### Part 2

Students will study the effect of external factors on the rate of the reaction by simulating reaction from part one in a cold temperature. Some of the students (enzymes) will be blindfolded, simulating extremely low temperature. Explain that in cold temperature their fingers would be numb and they would not be able to work as fast that will be simulated with blindfolding. Data will be collected as in part one.

#### Analysis/Discussion

Make a plot of data from part one and two. Describe the relationship between time and number of molecules formed. Is it linear? Compare rates of reaction at standard condition and the one at low

temperatures (students blindfolded). How is the reaction affected by the temperature? Do you think that all reactions overall would be affected by temperature in this way? Why or why not? Temperature is energy. Compare results among groups and discuss any differences and possible factors which could account for those inconsistencies.

Worksheet:

Name: \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_  
\_\_\_\_\_

Standard Conditions		Low temperatures	
Time (sec)	Number of molecules created (N)	Time (sec)	Number of molecules created (N)
10		10	
20		20	
40		40	
60		60	
80		80	
100		100	

Graph your results on one graph and compare the rates of reactions. Which rate is faster? \_\_\_\_\_.

Why warmer temperature enables the enzyme to work faster?

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Can the enzyme work at all temperatures? Discuss extremely cold and hot environments and how they affect enzymes and proteins in general.

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