**Breaking Bricks Activity Handout**

This activity is intended to simulate enzyme kinetics using 2x2 LEGO bricks. Your job will be to separate pairs of 2x2 LEGO bricks as fast as you can under varying conditions. We suggest that you spend 30-45 minutes on this activity.

**After completing this activity, you will be able to:**

* Describe the effect of increasing substrate concentration on the velocity of an enzyme-catalyzed reaction
* Define and estimate the maximum velocity of the reaction (Vmax) and the Michaelis-Menten constant (Km) for a given enzyme
* Predict the effect of a noncompetitive inhibitor and a competitive inhibitor on the Vmax and the Km for a given enzyme

Step 1 - General concepts in enzyme kinetics (15 mins)

1. Define the following terms in the context of this activity:

* Enzyme
* Substrate
* Product
* Saturation

1. Now you will model an enzyme-catalyzed reaction at varying substrate concentrations. You will conduct the reaction at 5 different substrate conditions (5, 12, 20, 40, 60 LEGO pairs in bag at start of reaction). For each condition, add the number of substrate pairs to your bag, place the bag upright on your lab bench, then record how many LEGO pairs your “enzyme” is able to pull and separate in 30 seconds (with their eyes closed). Enter rate data (LEGO pairs separated/seconds) into a spreadsheet. If you are working in pairs, one partner should be timekeeper and recorder, and one should be enzyme for all concentrations - switch roles after you collect one set of data to have at least 2 points .

Step 2: Data analysis (5-10 mins)

1. Create a scatterplot of the data. Note down any observations you have about the shape of your curve. Does it look like what you expected? How similar are your two different “enzymes”?
2. Examine your scatterplot and estimate:
   1. the maximum velocity of the reaction (Vmax).
   2. the Michaelis-Menten constant (Km).
3. Do the values make sense given what you know about enzymes and how you felt when you were catalyzing the reaction?

Step 3: (10 mins) Introducing inhibitors to an enzymatic reaction

*Competitive inhibition*:

Competitive inhibitors bind to the active site of enzymes like the substrate does. We thought that adding LEGO pairs that have been glued together might be a good model of inhibition.

1. With your partner(s) briefly discuss whether glued LEGOs are an appropriate model of a competitive inhibitor.
2. Repeat the experiment using the 5 concentrations of LEGO shown in the table above with 15 inhibitor “molecules” added to each reaction condition (keeping the inhibitor concentration constant while the substrate concentration changes). Record your data in the greyed column. Note that for ease of cleanup, the inhibitors are a different color – if you are the “enzyme”, conduct your experiment with your eyes closed so that you are not affected by color when you are picking/separating your LEGOs.
3. Add these data to your spreadsheet and graph - how are the curves similar to part 1? How are they different? Is this what you would expect for a competitive inhibitor?

*Noncompetitive inhibition:*

Noncompetitive inhibitors do not bind in the active site, but rather bind elsewhere on the enzyme, causing a conformational change that affects catalysis within the active site.

1. Brainstorm how you might extend this simulation to model noncompetitive inhibition.

Step 4: Wrapup/followup questions (15-20 minutes)

1. What does this activity model well? What are some caveats to this activity?
2. What other experiments could you use this simulation for? How could you expand or extend the activity?
3. What unanswered questions do you have about enzyme kinetics and competitive inhibition?