
Enzyme Biocatalysis Outreach

5 to 30 minute demonstration about enzymes for intermediate and high school students (grades 7-12). Enzymes are the tiny machines that help the body function and are used to produce industrial products. One example is xylose isomerase for the production of fructose.

Resources Required

1. Estimated Time: 5 minutes.
2. List of Materials and Estimated Cost.
 - Paper Bags: \$1.00
 - Cloth (Tie, shirt, etc) \$1.00
 - String cheese: \$0.20
 - Soda: \$0.50
 - Laundry Detergent Container \$1.00
 - Candy Bar: \$0.50
 - Fruit Juice container \$0.25
 - Pipe cleaners: \$1.00 to >\$10.00
 - Ball and Stick Chemistry Model \$10.00
 - Enzyme Poster (Optional, available per below)

Preparation Instructions

1) Obtain the Necessary Materials

A grocery store should have most of the necessary materials. Ball and stick chemistry models can be ordered from many vendors online. A simple one is sufficient.

2) Setup for the Demonstration

Create the glucose molecule with the ball and stick model and practice transitioning to the fructose molecule (break one C-C bond and make another). Also if desired, print of ribbon diagrams of cool enzymes to be used in the enzyme model game. If possible, ask a parent or volunteer who is a biochemist or biochemical engineering come talk about their job and how students can prepare for it.

3) Determine Appropriate Length

On the following page are the demonstration instructions. It can all be presented at once, or just one of the four sections can be presented.

Section 1 = Enzyme introduction game (Instructions 1-2)

Section 2 = Enzyme activity explanation and hands-on exercise (Instructions 3-4)

Section 3 = Enzyme structure activity / game (Instruction 5)

Section 4 = Biocatalysis career opportunities (Instruction 6)

Demonstration Instructions

1. Start off with a game. Put string cheese, cloth (tie or clothing), paper, soda, candy bar, laundry detergent container, fruit juice container. Have students come up, put their hand in the bag and try to guess what it is. As a motivation you can make it a competition or just offer a small piece of candy to each person who guesses correctly.
2. Next ask what all of these items have in common (answer biocatalysis). Explain that starchases are involved in making clothing by breaking down starch used in processing, cellulases involved in breaking down fruit to get more fruit juice out, rennet enzymes are used to make cheese, proteases break down protein stains in laundry detergent, xylose isomerase is used to convert glucose to fructose. Ask students where there are thousands of different enzymes working as of this very second right here in the class room. (Answer in us. Enzymes account for 20% of the human body – Water 65%, Lipids 12%, RNA/DNA 1.1%). Enzymes are the machines of life and make reactions that happen really slowly to speed up.
3. Hang the poster where it is easy to see and use or bring up the poster as a power point slide.
4. Go over the xylose isomerase reaction. Explain that enzymes are often called biocatalysts because they catalyze reactions. To catalyze a reaction, enzymes lower the energy barrier, by stabilizing the energetically less stable chemical intermediate. Show by the ball and stick chemistry model how glucose is converted to fructose. The catalyst (glucose isomerase) recognizes glucose and interacts with it such that the intermediates that form in the process of getting to fructose are stabilized and thus less energy is needed to get the chemical to transition through these states to fructose. Depending on the class size, you can have the students practice the transition with their own ball and stick model or with a single model that you pass around.
5. Due to the many different reactions that are catalyzed, enzymes have very diverse structures. However, the structure is necessary to catalyze the reaction and even a very small perturbation can ruin the activity of the enzyme. Enzymes are made of amino acids which assemble into beta sheets and alpha helices which in turn make up the tertiary (3D structure) that you see on the poster. Pass out pipe cleaners and have students try to assemble the protein. Xylose isomerase is fairly difficult and is mainly alpha helices, so as an alternative 3D structures for a number of ribbon structures of cool enzymes could be printed off and students could pick the one they would like to make with pipe cleaners. Beta sheets can be made by folding the pipe cleaner back and forth and alpha helices can be produced by wrapping the pipe cleaner around the finger. Example cool enzymes are: firefly luciferase (makes firefly glow), cellulase (breaks down trees and plants to sugars eaten by termites and mold), chloramphenicol acetyltransferase (resistance to antibiotic protein in bacteria). There are so many, just search online for cool enzymes. This can be turned into a race and a game. Also showing the location of the active site and having students explain how the active site will catalyze the reaction and the properties of the active site.
6. Finally discuss the employment opportunities and education needed to become a biochemical engineering or biochemist. (College degree, love of science, passion for building things or discovering new concepts). For greater impact, have a parent or volunteer in this type of career come talk to the students about their job and what they do in a given day.