Fruit Motion Demo

Materials:

- At least one fruit or vegetable from the following list:
    - Potatoes
    - Red peppers
    - Bananas
    - Cucumbers
    - Apples
- At least one fruit or vegetable from the following list:
    - Lime
    - Lemon
    - Orange
    - Grapes
- Hydrogen peroxide
- Water
- Food coloring
- Clear drinking glasses (at least 2)
- Optional: Vinegar or baking soda
- Optional: Microwave or freezer

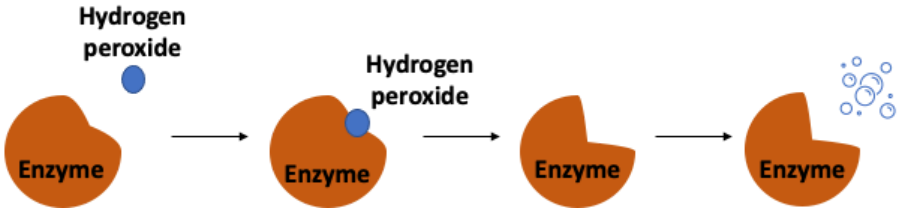
Instructions:

1. Cut a slice from one of your fruits and vegetables in the first list (potato, red pepper, banana, cucumber, apple). Drop a little bit of hydrogen peroxide on one spot. Drop a little bit of water in a different spot.
    a. What happens? Do you notice a difference between the peroxide spot and the water spot?
2. Cut a slice from one of your fruits or vegetables in the second list (lime, lemon, orange, grape). Drop a little bit of hydrogen peroxide on one spot. Drop a little bit of water in a different spot.
    a. What happens? Do you notice a difference between the produce in this list and the produce in the first list?
3. Cut two wedges from one of the fruits and vegetables in the first list.
    a. Note: We've found that potatoes work well since they stay at the bottom of the glass!
4. Place one wedge in one of the clear drinking glasses and the other wedge in the other clear drinking glass.
5. Pour water over the one wedge and pour hydrogen peroxide over the other wedge.
6. Add one drop of food coloring to each glass.
    a. What happens? Do you notice a difference between the peroxide glass and the water glass?
7. Cut one wedge from one of the fruits and vegetables in the first list and cut another wedge from one of the fruits in the second list.
8. Place one wedge in one of the clear drinking glasses and the other wedge in the other clear drinking glass.
9. Pour hydrogen peroxide over both wedges.

10. Add a drop of food coloring to each glass.
    a. What happens? Do you notice a difference between the produce from the first list and the produce from the second list?

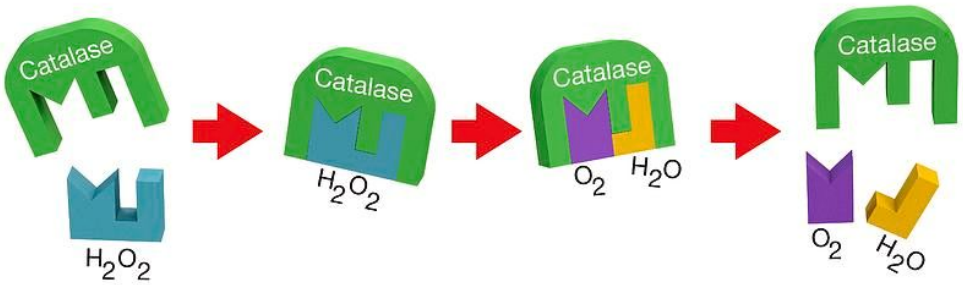
What's happening?

Why do we see bubbles when we add hydrogen peroxide? The bubbles are a sign of enzymes in action! Enzymes play a very important role in our lives. They are proteins that allow us to breathe, grow, move our muscles and digest our foods, just to name a few. But we're not the only organisms with enzymes. They are ubiquitous in nature and are in all living organisms, including animals, plants and the fruits and vegetables in this demo.



Why are enzymes so important? Enzymes speed up the chemical reactions that happen in our bodies. Usually those reactions involve breaking something down or building something up. For example, we need enzymes to break down all the food we eat into something that we can digest or use as an energy source. Our bodily processes and reactions would still occur without enzymes, but it would happen so slowly that the process would take too long for it to be useful to us. Basically without enzymes, we wouldn't be alive!

How do enzymes work? There are thousands of different kinds of enzymes and each one plays a very important role. All enzymes interact with something called a substrate. A substrate is just the term for the molecule that the enzyme reacts with. Enzymes are very specific so each enzyme will only work with a select few substrates or molecules. In the demo, we are interested in the enzyme catalase. This is an enzyme that breaks substances down. However, because enzymes are so specific, it can only break down one molecule: hydrogen peroxide. This means that hydrogen peroxide is the substrate for catalase. In the reaction between catalase and hydrogen peroxide, catalase breaks down hydrogen peroxide to water and oxygen.



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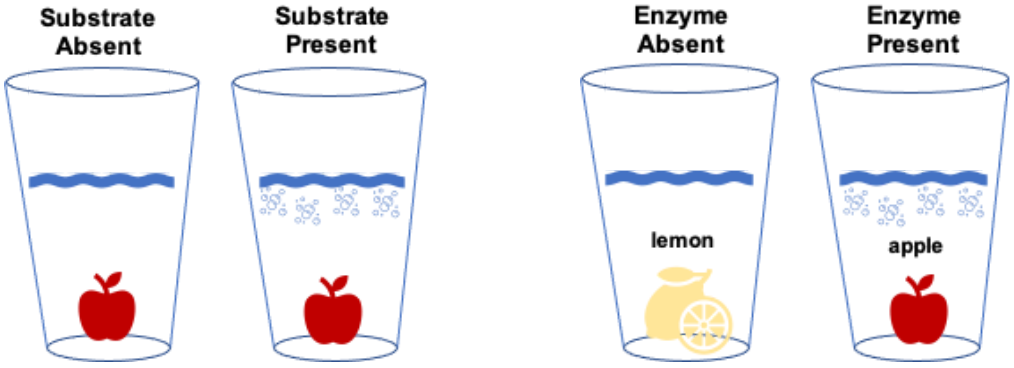
In the first part of our demo, we put drops of hydrogen peroxide or water on different fruits and vegetables. We gave you two lists of fruits and veggies. The produce on the first list all contain catalase while the produce from the second list do not contain catalase. Therefore, when the fruits or vegetables that do contain catalase come in contact with hydrogen peroxide, we are seeing peroxide break down to water and oxygen bubbles, hence the significant bubbling you see! But we will not see bubbles if we add peroxide to any of the fruits in the second list. Even though there are plenty of enzymes in limes or lemons or oranges, none of those enzymes are catalase and so none of them react with hydrogen peroxide and we do not see any bubbles. This is also the case when we add water, nothing happens because water is not the substrate for catalase.

In the second part of our demo, we put a vegetable or fruit at the bottom of a glass. In one glass, we added hydrogen peroxide and in the other glass, we added water. We see the food coloring mix much better in the hydrogen peroxide glass than the water glass. This is because in the hydrogen peroxide glass, catalase breaks down the peroxide to water and oxygen. The result is lots of bubbles and because the bubbles are light and want to be at the top of the liquid, we see lots of mixing. When we added produce from the second list to the hydrogen peroxide, we didn't see any mixing. Again, this is because there is no catalase present and therefore, hydrogen peroxide is not broken down so there isn't any bubbling.



This is a great way to see the effect of something that is too small to see by eye, or sometimes even with a microscope! Enzymes have lots of really important applications, not only in our body, but also in the world around us. We use enzymes in the paper industry to make paper, in the brewing industry to make beer and wine, in cooking and food processing and even to make new sources of fuel. We hope you learned more about enzymes and have a new appreciation for the tiny proteins that keep us alive!

Activity Extension Questions:
See Experimental Extension worksheets to keep engaging with your children.

1. What happens if you change the temperature of one of your fruits or vegetables?
   Feel free to change the temperature of one of the fruits or vegetables from the first list by either microwaving or freezing it. Now add a drop of hydrogen peroxide to a fruit or vegetable that changed temperature versus a fruit or vegetable at room temperature. Changing the temperature should affect the amount or presence of bubbles you see on your fruit or vegetable. This is because enzymes are very sensitive. They do not like

drastic changes in temperature and extreme heat will cause them to die and therefore not function correctly. This means that you should not see bubbles on your microwaved fruit or vegetable even though there were plenty of bubbles on the fruit or vegetable at room temperature.

2. What happens if you change the pH of one of your fruits and vegetables?
   Enzymes are not only sensitive to temperature, but they are also sensitive to pH. pH is just a scale that describes how acidic or basic something is. If you soak one of the fruits or vegetables from the first list in something acidic or basic, you'll change the amount of bubbles you see on the surface of the fruit or vegetable. To do this, slice three wedges from one of your fruits or vegetables in the first list. Soak one of the slices in vinegar for 10 min and soak another slice in water with some baking soda added. The vinegar is acidic while the water and baking soda is basic. You should see almost no bubbles on the slice soaked in vinegar and far less bubbles on the slice soaked in the baking soda as compared to the normal slice. Vinegar is very acidic and at that pH, catalase doesn't function so you don't see any bubbles. Baking soda is only slightly basic and so the enzyme still works, just not as well as it does at normal pH.

3. Feel free to test out different fruits and vegetables. Is there a difference between organic fruits and regular fruits? What about fruits or vegetables bought at a farmer's market? If you would like to continue exploring these trends with your children, try filling out the experimental worksheets below!

See the next page for some optional experimental extensions if you would like to keep experimenting with this system!

Experimental Extension 1:

For this experiment you will need to cut three pieces of the same fruit or vegetable that are different sizes. When doing experiments, it is important to only change one factor at a time. In this experiment we are changing the size of the fruit or vegetable, but get creative! You can also change the fruit or vegetable itself or use organic produce versus regular produce. This way you know exactly what causes the change in bubbling. Try to use the same amount of hydrogen peroxide, the same number of drops of dye, the same size glass, etc. Then while doing the experiment, look out for the intensity of bubble production and mixing. Try setting a timer as soon as you add the drop of food coloring and see if there is a difference in the amount of time it takes to mix the solutions.

Type of Produce*	Size of Piece	Intensity of Mixing	Time to Fully Mix
Potato	Small		
Potato	Medium		
Potato	Large		
Pepper	Small		
Pepper	Medium		
Pepper	Large		
	Small		
	Medium		
	Large		

*Feel free to use whatever produce you have in the house that is from the first list.

Do you notice a difference in the intensity of the mixing when you change the size of the piece of produce? Are there other things you could do to change the intensity of the reaction happening?
Record your observations here:

Experimental Extension 2:

For this experiment, cut at least six pieces of a potato (or a piece of produce from the first list) that are roughly the same size. Microwave all six pieces and take out a single piece after 5 seconds, the next piece after 10 seconds, and so on for 15 seconds, 20 seconds, 40 seconds and 60 seconds.

Piece Number	Time in the microwave	Do you still see bubbles?	How intense are the bubbles?
1	5 seconds		
2	10 seconds		
3	15 seconds		
4	20 seconds		
5	40 seconds		
6	60 seconds		

If you can still see bubbles what does that mean? Is catalase still breaking down the hydrogen peroxide? What does it mean when there are no more bubbles being produced? What does it mean when the intensity of the bubbles changes?

Record your observations here:

Once you do the experiment and record your observations, try the same reaction with a frozen piece of potato! What do you observe?

Experimental Extension 3:
This experimental variation explores the effect of changing the pH of the surroundings. Remember that pH is a scale from 0-14 that describes how acidic or basic something is; a low pH means something is acidic while a high pH means something is basic. We are going to let slices of potato (or other produce from the first list) rest in either baking soda in water (basic solution) or vinegar (acidic solution) and observe what happens when that slice is then put into hydrogen peroxide.

Slice Number	Pre-treatment Solution	Time in solution	Observations
1	No pre-treatment	0	
2	Baking soda in water	1 minute	
3	Baking soda in water	5 minutes	
4	Baking soda in water	10 minutes	
5	Vinegar	1 minute	
6	Vinegar	5 minutes	
7	Vinegar	10 minutes	

What did you observe happens when the slices are pre-treated? Was there a difference the longer you let the slices sit? Do you think we should let the slices sit longer in the pre-treatments?
Describe the trend you observed and any ideas as to what you might do differently: