Teacher’s Notes: Looking for Life in the Solar System Mini-Lab

Typically, living organisms are viewed as forms of life that use respiration and are often not thought of as organisms that do not require oxygen to thrive. However, many living organisms use another chemical process known as fermentation to produce energy. Even though these organisms do not use respiration, they are considered living because they fulfill many aspects of the fundamental criteria for life. These organisms react to stimuli, grow, have a form of locomotion, use some type of cellular division or reproduction to replicate themselves and show signs of metabolic reactions.

In this lab, students will develop ideas as to what dictates whether an organism is living or not. They will incorporate the fundamental criteria for life in their ideas and make observations utilizing this information. As students observe live yeast cultures reacting with sugar (sucrose) and water, they will also be observing chemical reactions between Alka-Seltzer, sugar (sucrose) and water. They will compare their findings and infer if it is possible for life to thrive beyond our planet.

Objective
To use visual observations to view reactions between sugar-water and both living organisms (yeast) and non-living substances. Students will verify if a living organism or a non-living substance causes the reaction they view. They will use the information they obtain to infer if life is possible beyond our planet.

Learning Outcomes
Enable students to:
- Form an operational definition of life
- State relationships between the water samples using their operational definition of life
- Learn to take observational data
- Make inferences about the possibility of life in our/other solar system(s)

Duration of Lesson 1-2 hours

Preparation
Teachers should precut pieces of wax paper to be used when measuring the sugar on the scale. See student handout for materials needed.

Procedure
Give students the handout below. Discuss what characteristics make something alive or not. For example: a bear and a chair both have legs, but one cannot move on its; therefore, independent movement might be one characteristic that indicates life. Not every living organism needs legs or roots, but all need a mode of locomotion or a way to get nutrients. Ask what other criteria does a bear have to indicate it is alive compared to a chair (i.e. it breathes).
Mini-Lab: Looking for Life in the Solar System

Keywords to Know
- **Anaerobic** – occurring in the absence of oxygen or not requiring oxygen to live
- **Aerobic** – living or occurring in the presence of oxygen
- **Respiration** – the end result of the physical and chemical processes an organism uses to convey oxygen to tissues and cells; oxidation products, CO\(_2\) and H\(_2\)O are given off as a by-product.
- **Fermentation** – the process of deriving energy from the oxidation of organic compounds, such as carbohydrates; anaerobic reaction used to produce energy; can be used in the presence of oxygen, but does not utilize the oxygen
- **Organism** – a form of life composed of mutually interdependent parts that maintain various vital processes.
- **Replication** – The process by which genetic material, a single-celled organism or a virus reproduces or copies itself; cellular replication
- **Metabolism** – chemical processes by which cells produce the substances and energy needed to sustain

Materials Needed
- Dictionaries and Encyclopedias
- Examples of living organisms (both aerobic and anaerobic) and non-living objects
- Table sugar (sucrose)
- Active Dry Yeast packets
- Alka-Seltzer tablets
- Warm water
- (3) 500mL beakers
- Paper and writing utensils to write/draw observations
- Scale able to measure in grams
- Small pieces of wax paper to measure sugar on

Procedure: **work in groups to determine the fundamental criteria for life**
- Use dictionaries and encyclopedias to research what criteria is necessary for life forms to thrive. Write your criteria in a table on a separate paper with your group’s names on it.
- Show you understand what aerobic and anaerobic life forms are, and incorporate these terms in your fundamental criteria for life.
- Each group will gather: (3) 500mL beakers; (1) packet of Active Dry Yeast; (1) Alka-Seltzer tablet; water; (15g) of sugar (sucrose); (1) piece of wax paper; and paper/writing utensils.
- Mix yeast and sugar, place on wax paper, and add a small amount of warm water. Observe and record the reaction. Wait 15 minutes and observe again. Wait another 15 minutes and observe again.
- Crush Alka-Seltzer and mix with sugar, place on wax paper, and add a small amount of warm water. Observe and record the reaction several times as above.
- Try other mixes of these substances, if time. Which mixtures meet your criteria for life and which don’t? Why? Do you think you should revise your criteria? Write a paragraph explaining your answers.