Photo © Susan Tenney, Wild Yeast\Flour + Water = Starter. Used with permission.

Fuel for Living Things

The Science of Global Atmospheric Change: Activity 6

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Fuel for Living Things

The objectives of this activity are aligned with the National Science Education Standards, specifically those related to Science as Inquiry and Physical Science. “Fuel for Living Things” uses guided inquiry to teach students that carbon dioxide is released when organisms use food, or when sugar is used for energy inside living things. Students will observe what happens when yeast cells are provided with a source of food (sugar). Students will make predictions and qualitative observations, and draw conclusions based on their investigation.

This activity addresses the following science concepts.

- All organisms need a source of energy.
- Plants and some other organisms (producers) take in energy from the sun.
- All other living things rely on producers for energy and raw materials.
- Carbon dioxide usually is released when living things use food.

Student Worksheets
Student pages in the teacher’s guide are provided in English and in Spanish.

Reference

Moreno N., and B. Tharp. (2011). *The Science of Global Atmospheric Change Teacher´s Guide.* Third edition. Baylor College of Medicine. ISBN: 978-1-888997-76-7.
Development of this student activity was supported, in part, by grant numbers R25 ES06932 and R2510698 from the National Institute of Environmental Health Sciences of the National Institutes of Health to Baylor College of Medicine.

Image Reference

Photo of mature starter © Susan Tenney. Wild Yeast\Flour + Water = Starter. Used with permission. http://www.wildyeastblog.com/2007/07/13/raising-a-starter/

Key Words
lessons, experiment, energy, fuel, yeast, sugar, food, living,

Materials

Have students work in groups of four.

Teacher Materials

- 1 teaspoon of baking soda
- A few drops of vinegar

Materials per Student Group

- 2 cups, 9-oz clear plastic
- 2 spoons or coffee stirrers
- 1/2 to 1 cup warm water
- Clear, re-sealable plastic bag, 4 in. x 6 in. in size
- Handful of raw, finely sliced red or purple cabbage
- 1 teaspoon of dry yeast
- 1 teaspoon of sugar

Setup

The indicator solution can be made in advance by the teacher, or by student groups during Sessions 1 or 2. Session 3 should be conducted as an investigation by student groups. Between sessions, consider having students read part of *Mr. Slaptail's Curious Contraption*.

Reference

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Image Reference:

Photo by Christopher Burnett © Baylor College of Medicine.

Key Words
materials list, materials needed,

Science Safety Considerations

Students always must think about safety when conducting science investigations. This slide may be used to review safety with your class prior to beginning the activity.

Safety first!

•Always follow school district and school science laboratory safety guidelines.

•Have a clear understanding of the investigation in advance.

•Practice any investigation with which you are not familiar before conducting it with the class.

•Make sure appropriate safety equipment and gear, such as safety goggles, etc., are available.

•Continually monitor the area where the investigation is being conducted.

References

1.Dean R., M. Dean, and L. Motz. (2003). *Safety in the Elementary Science Classroom*. National Science Teachers Association.

2.Moreno N., and B. Tharp. (2011). *The Science of Global Atmospheric Change Teacher's Guide*. Third edition. Baylor College of Medicine. ISBN: 978-1-888997-76-7.

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Key Words

science, classroom, safety, lab, laboratory, rules, safety signs,

Food for Living Organisms

- Did you know that yeast is alive?
- Living organisms need food to survive.
- Food provides energy!
- Is carbon dioxide released when living organisms use food?
- How is carbon dioxide released?

Yeasts are members of the same Kingdom as mushrooms (Fungi Kingdom)

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Food for Living Organisms

To focus student's attention, begin by asking, *Did you know that yeast is a living thing?* Remind students that food provides the energy living organisms need to grow and reproduce. Ask, *Is carbon dioxide released when living organisms use food? How is carbon dioxide released?*

Tell students that when organisms consume food, the food is broken down to release energy and produce critical building blocks for other molecules. During this process, oxygen is consumed and some carbon is given off as carbon dioxide. Inform students that they will conduct an experiment to observe how yeast cells release carbon dioxide gas.

Reference

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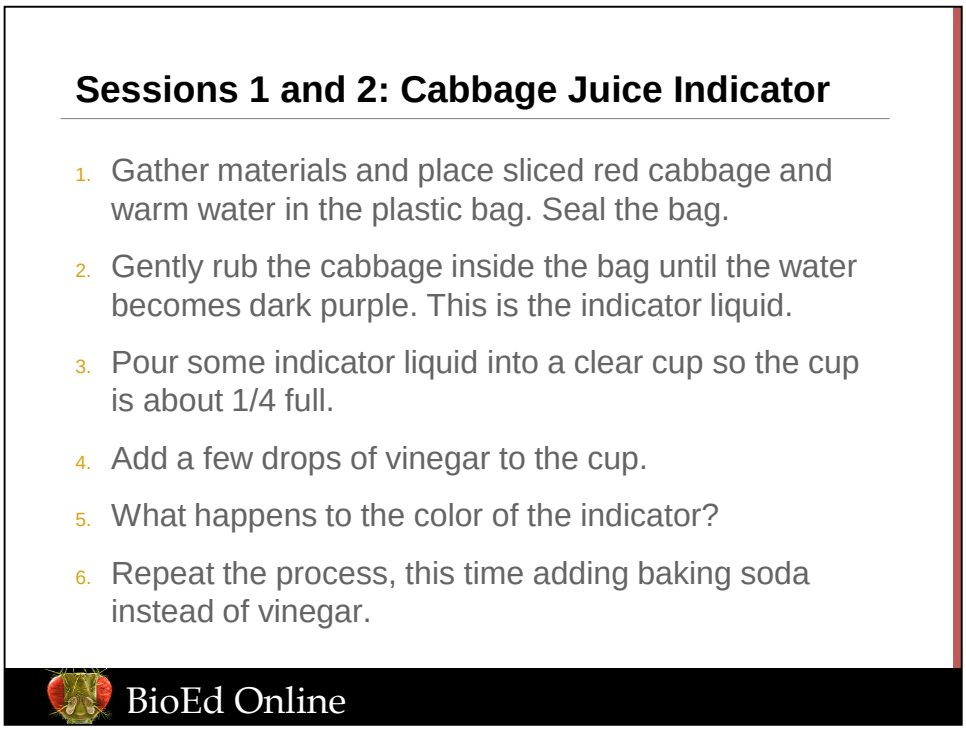
Image Reference

Photo of Am*anita muscaria* © Michael Maggs CC-BY-SA 2.5.

http://commons.wikimedia.org/wiki/File:Amanita_muscaria_%28fly_agaric%29.JPG

Key Words
lesson, experiment, yeast, energy, fuel, sugar, organism, microorganism, alive, living,



Sessions 1 and 2: Cabbage Juice Indicator

In this activity, students will learn that most organisms release carbon dioxide when they use food. Students will make predictions and qualitative observations, and draw conclusions based on their investigation. They will discover that yeast consumes sugar and produces carbon dioxide as a by-product. In session 1, students will observe that cabbage juice (the indicator liquid) will turn pink in the presence of carbon dioxide, which acts as an acid.

1.Have the Materials Managers collect the materials for their groups. Students should place the sliced red cabbage in the plastic bags, along with 1/2 to 1 cup of warm water, and seal the bags tightly. Direct students to take turns gently rubbing the cabbage inside the bags until the water becomes dark purple (usually about 10–15 minutes). This is the indicator solution.

2.Explain that the indicator liquid will be used to test for the presence of carbon dioxide, which becomes a weak acid in water. If necessary, identify some common examples of acidic items, such as lemon juice and vinegar.

3.Pour some indicator liquid into a clear cup. Ask students, *What color is the liquid? What do you think will happen if I put something acidic into this water?*

4.Add a few drops of vinegar to the solution, until it turns pink (this indicates an acid). You also may show how the indicator reacts to baking soda (the solution will turn pale blue or green indicating a base). Explain to students that they will use the indicator to test for the presence of carbon dioxide, a gas that is given off when living things use food for energy. This gas when dissolved in water turns it more acidic.

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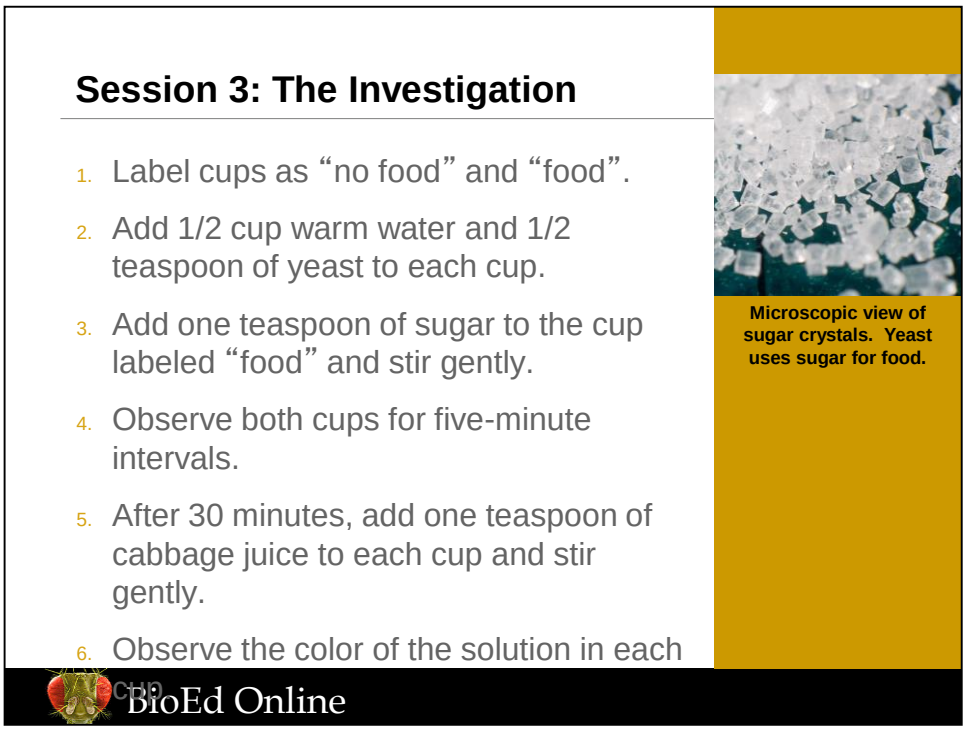
Key Words

lessons, experiment, fuel, yeast, sugar, indicator, cabbage, baking soda, vinegar, acids, bases, solutions,



Session 3: The Investigation

1.Start a brief class discussion about yeast. Remind students that yeast is a living, microscopic, single-celled organism. Given the right conditions, it will grow and multiply.

2.Direct students to label one cup as “food” and the other as “no food.” Have them add about 1/2 cup of warm water and ½ teaspoon of yeast to each cup. Ask, *Do you think the yeast cells have much to eat in the cup now?* Help students understand that all living things need food to survive and grow.

3.Ask, *What do you think would happen if we added yeast food to one of the cups?* Have students record their predictions. Then, have one person in each group add one teaspoon of sugar to the cup labeled “food,” and swirl or stir the solution gently.

4.Direct each group to set its cups side-by-side and observe both cups every 5-10 minutes. Students should stir both cups (using separate stirrers) each time they make their observations. After a short time, students will observe that the yeast in the cup with sugar has begun to produce CO_2 (turning the liquid foamy).

5.After 30-45 minutes, instruct students to pour small, equal amounts of the cabbage juice into both cups and stir the mixture. Ask them to observe the colors and record their observations. (The “FOOD” cup with yeast and sugar will be more pink than the “NO FOOD” cup without sugar.)

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Image Reference

Macro photo of sugar © Lauri Andler, CC-BY-NC 3.0.
http://commons.wikimedia.org/wiki/File:Sugar_2xmacro.jpg

Key Words
lesson, experiment, energy, fuel, yeast, cabbage juice, acids, bases, solutions,

Let's Talk About It

- What happened when you fed the yeast sugar?
- What color did the cabbage juice turn after you added it to the "FOOD" cup?
- Yeast is a microscopic living organism.
- Sugar (food) allowed the yeast to grow and release carbon dioxide (CO_2).
- How was the released CO_2 detected?
- "Why did the cabbage juice turn pink after adding it to the "FOOD" cup?"

Microscopic view of yeast cells.

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Let's Talk About It

This activity allows students to observe how carbon dioxide gas is released by yeast cells when they use sugar as food. The cabbage juice turned pink when yeast was given sugar. This is because yeast produced carbon dioxide, a weak acid when it used the sugar for food.

Ask, *What happened when you fed the yeast sugar?* Students should observe foaming in the container where the sugar was present. *What color did the cabbage juice turn after you added it to the 'FOOD' cup?* Students should observe a slight color change: from a purple color to a slightly pink color.

Remind students that yeast is a microscopic living organism and that living organisms need food to grow and reproduce. They use energy and oxygen, and release carbon dioxide as a waste product. Help students understand that the yeast cells used the sugar as a source of energy.

Ask, *How did we detect if the yeast released carbon dioxide? Why did the cabbage juice turn pink after adding it to the "FOOD" cup?* Tell students that the cabbage juice was an indicator that helped up to detect the carbon dioxide produced by the yeast after it was fed sugar. The indicator solution turned pink when the presence of carbon dioxide caused the water to turn acidic. Point out that the gas given off by the yeast (carbon dioxide) is the same gas given off when wood, coal or oil is burned. Also note that the "NO FOOD" cup showed no foaming when sugar was added and no color change when the indicator was added.

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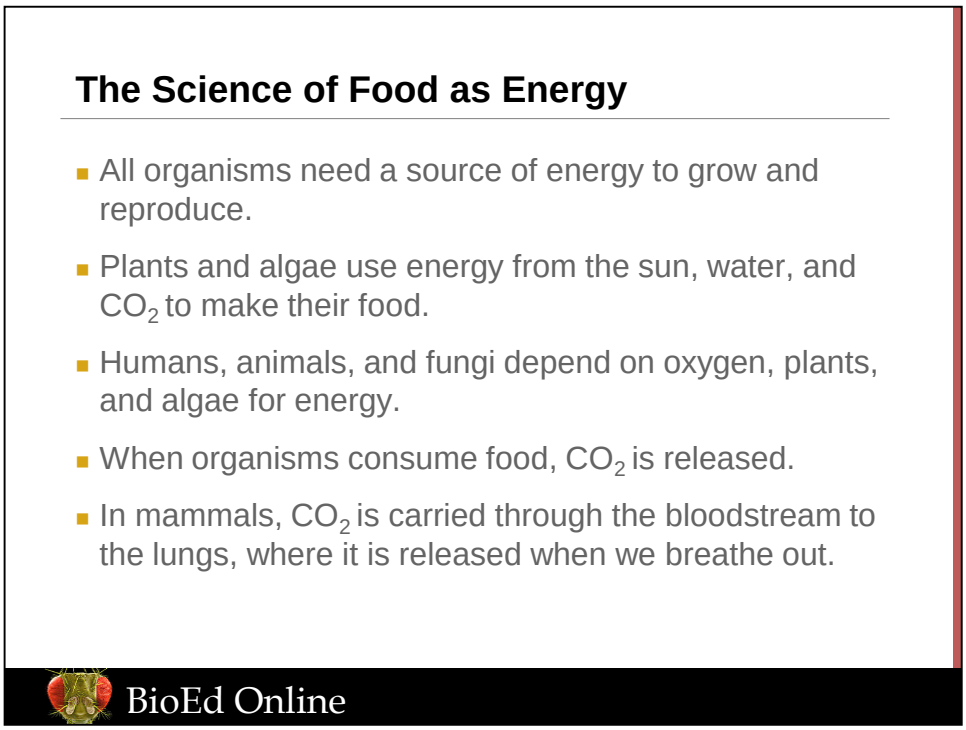
Image Reference

Photo of *Saccharomyces cerevisiae* cells courtesy of Masur, released into the public domain. http://commons.wikimedia.org/wiki/File:S_cerevisiae_under_DIC_microscopy.jpg

Key Words

lessons, food, energy, fuel, Baker's yeast, sugar, *Saccharomyces cerevisiae, S. cerevisiae,* microorganism, organism, CO_2, carbon dioxide,



The Science of Food as Energy

In this activity, students explored the following scientific concepts.

- **All organisms need a source of energy. Plants and some other organisms (known as producers) take in energy from the sun.** Some living things, especially plants and algae, are able to produce all the energy they need to live using very simple substances. Using light energy, carbon dioxide, and water, these organisms, known collectively as producers, are able to make carbohydrates, which serve as fuel and raw material for the processes of life.

- **Almost all other living things rely on producers for energy and raw materials.** Humans, animals and fungi depend on (must consume) plants and algae for energy.

- **Carbon dioxide usually is given off when living things use food.** Food provides energy and raw materials needed for growth and development. When organisms consume food, it is broken down to release energy and to obtain building blocks for other molecules. During this process, oxygen is consumed and carbon dioxide is released. All organisms (with a few exceptions) release carbon dioxide when they use food. In mammals, carbon dioxide is carried through the bloodstream to the lungs, where it is released when we breathe out.

Reference

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Teacher's Guide. Third edition. Baylor College of Medicine. ISBN: 978-1-888997-76-7.
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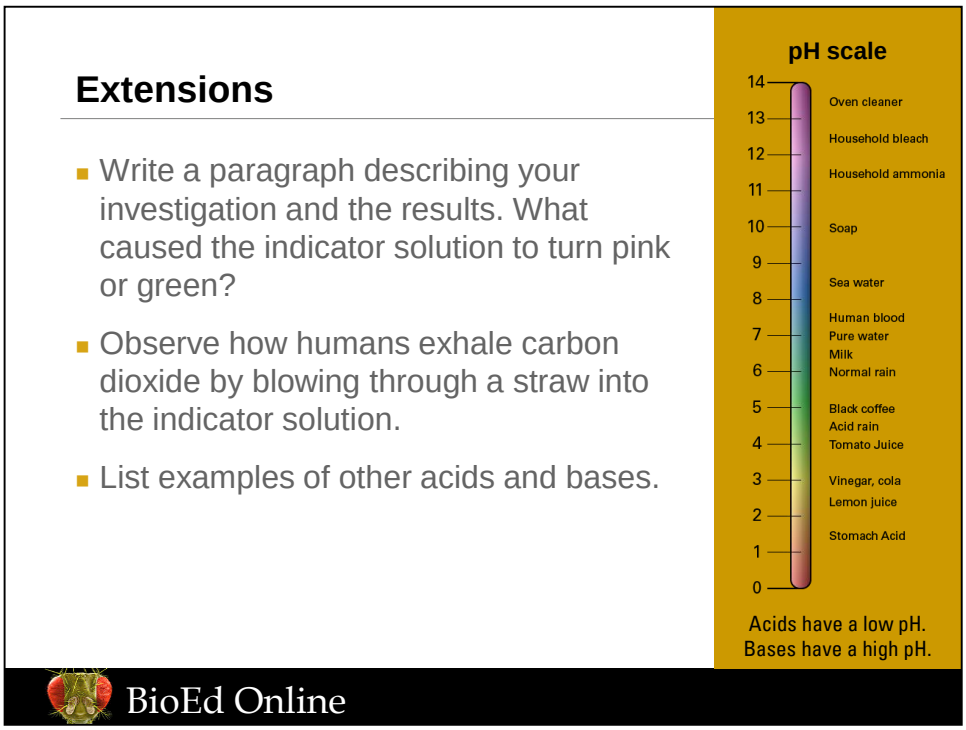
Key Words
lessons, food, energy, organism, growth, development, plant, algae, sun, water, CO_2, oxygen, carbon dioxide,



Extensions

Encourage the students to think of variations to the experiment, ask additional questions, and/or identify other examples of acids and bases.

Assess students' understanding of the experiment by having them write a paragraph describing the investigation and the results. Have them describe what caused the indicator solution to turn pink or green.

Have students observe how humans exhale carbon dioxide by blowing through a straw into the indicator solution. They will see the solution turn a pink color, due to the presence of carbon.

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Image Reference:

Graphic of pH Scale by Christopher Burnett © Baylor College of Medicine.

Key Words
lesson, experiment, investigation, indicator solution, carbon dioxide, CO_2, acids, bases, pH scale, pH,