Yeast and Cellular Respiration

Grade Level: 5

http://outreach.chem.ucsb.edu/

Standards:
2g. Students know plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO$_2$) and water. Students know that this process is called respiration.

Review the following standard:
1g. Students know properties of solid, liquid, and gaseous substances, such as sugar (C$_6$H$_{12}$O$_6$), water (H$_2$O), helium (He), oxygen (O$_2$), nitrogen (N$_2$), and carbon dioxide (CO$_2$).

Description:
Students will learn that the process of respiration produces CO$_2$ and water.

Objectives: Students will be able to:
1. use touch, smell, and sight, to understand respiration in yeast.
2. work as a team to gather and record information.
3. complete the experiment in a safe and responsible manner.
4. explain the basic process of respiration.
5. develop a testable question to identify the gas produced by the yeast.

Materials for Students:
- 5 – 7 Narrow necked 500-mL or less glass or plastic bottles (Number of bottles depends on number of groups)
- 5 – 7 Funnels (Number of funnels depends on number of groups)
- 5 – 7 high quality helium grade balloons
- Active dry yeast
- Sugar
- Plastic cups
- Plastic spoons
- Bread and cookies

Materials for Teacher:
- 500-mL Erlenmeyer flask
- 400-mL beaker
- A votive candle
- Matches

Background:
Students should know about:
- Decomposers, consumers and producers
- Photosynthesis
- Molecular formulas: sugar, C$_6$H$_{12}$O$_6$, water, H$_2$O, and carbon dioxide, CO$_2$. 
Circulatory System, Video, and Quiz: Cover the circulatory system and take a pre-video test on Bill Nye – Blood and Circulation. Students take the quiz answering with a light pencil mark. Language learners are given extra time to look up all the vocabulary needed to understand all the questions on the quiz while other students complete a math worksheet or some other assignment that language learners can complete at home. As they watch the video, they are required to correct their answers before turning in the quiz for a final grade.

Vocabulary: Review the list of vocabulary words to see what you need to do to help students learn these words:

- Do an activity or demonstration
- Visual aids – do a search for diagrams or applications on Google or Wikipedia
- Word Analysis
- Academic Vocabulary Organizer
- Identify the Root Meaning
- Multiple Meaning words
- Definition of Concept

Give the list of Life Science Definitions to students and write vocabulary words out of order on the board. Have students look words up in a dictionary or the glossary of science textbook. Once they have finished writing the vocabulary words next to the definition show students how to memorize the words and definitions using the worksheet.

Play Bingo with this word list.
Do Lung Model activity before doing this lesson. Alternatively, this lesson can be done without doing the Lung Model activity. You just need to do the CO₂ and O₂ demonstrations that are described in the Lung Model Lesson.

Vocabulary: See attached word list for technical vocabulary. For English Learners go over these descriptive words:

- **fluffy**- made of or covered with something soft and light (show objects that are fluffy)
- **flat**- smooth and level (show objects that are flat)
- **hard** – the opposite of soft (show objects that are hard)
- **soft** – the opposite of hard (show objects that are soft)
- **full of uneven holes** – define each word using objects (pumice will work well for this)
- **inflated** – full of gas (show objects that are inflated and deflated)
- **grow (grew)** – to develop or become bigger over time
- **dehydrated** – the water has been removed

Procedure:
Give students a small piece of bread and a cookie. Have students compare and contrast the physical differences between bread and cookies.

Venn diagram: Ask students if they know what bread and cookies are made of. Have students write flour and sugar in the overlapping section of the Venn diagram.
Ask students if they think that there must be an ingredient that bread and cookies don’t share. Have students read about yeast and the uses for yeast and then place yeast in the Venn diagram. A good article can be found on this site:
http://www.microbeworld.org/resources/experiment/experiment_yeast_on_the_rise.aspx

Have students write the following standard on their worksheet:

2g. Plant and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide (CO₂) and water. This process is called cellular respiration.

Review the characteristics of yeast and dehydrated yeast. Emphasize the fact that yeast is not a plant and therefore cannot make its own food like plants.

Show students how to make a yeast solution with warm water. Ask students what they believe will happen if they add sugar to the yeast solution. Have students reread the standard. Ask students, “Do yeast cells also need sugar to obtain energy?” Have students write a hypothesis. “If __________ break down __________ to obtain energy, then they will ______________ and ______________.”

Only write this sentence frame down if students cannot come up with a hypothesis after consulting with each other and after they have analyzed the meaning of the standard either by looking up any unknown words or researching in their textbook.

After everyone has written a hypothesis, students will do the following in groups of 4-5:
- Mix one teaspoon of yeast and one cup of warm water, keep stirring until all the yeast is dissolved.
- After all the yeast is dissolved, add one teaspoon sugar.
- Pour the solution into a glass bottle.
- Hand out balloons and have students attach the opening of the balloon over the mouth of the bottle.
- Have students fill out the chart with information about what the balloon looks like and what is in the bottle.
- Students should touch the bottle and feel the temperature.
- Bottles should be placed under a lamp, in the sun or in a warm area.
- Every half hour write down observations on student worksheet.

If students do not question what kind of gas has inflated the balloons ask the following questions:
1. How do you know a gas was produced?
2. What kind of gas is in the balloons?
3. Is there a way we can test the gas?
4. Do you remember the two types of gases we tested when doing the lung model?
5. How did we test for CO₂ and O₂?

Have students write a hypothesis before you perform the test. Keep questioning until a student comes up with “If yeast cells break down sugar for energy, then CO₂ will be produced.” “If yeast breaks down sugar for energy, then it will produce CO₂.”

Gather all the bottles. Light a candle and place it in 400-mL beaker. Ask for a student volunteer. Then carefully remove each balloon and squeeze the balloon to force the CO₂ gas into the Erlenmeyer flask and have the student quickly cover the flask with a cardboard or a note pad until you are ready with the next balloon full of gas. Continue emptying all the gas from the balloons and then pour the gas over the lit candle. Make sure to point out that the reason the flame went out is because the CO₂ replaced the O₂ in the beaker and that fire needs oxygen in order to burn.
**Assessment:**
Students will be evaluated on how well they fill in the table and answer the questions on the worksheet.

**Journal prompts:**

1. **Is yeast a producer, consumer or decomposer? How do you know?**

Since the yeast ___________ and ____________, I can infer that yeast is ________________ or ________________.

2. **What would have happened if you would have added twice as much sugar?** Look for an answer that includes: would have + past participle

**Extension:**
Write the following chemical reactions and ask students if they can figure out which one is the basic equation for respiration and which one is for photosynthesis.

$$6 \text{ CO}_2 + 12 \text{ H}_2\text{O} + \text{ Solar Energy} \rightarrow C_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2 + 6 \text{ H}_2\text{O}$$

$$C_6\text{H}_{12}\text{O}_6 + 6 \text{ O}_2 \rightarrow 6 \text{ CO}_2 + 6 \text{ H}_2\text{O} + \text{ Energy for cells}$$

Have students defend their reasons why one is for respiration while the other, which is the exact opposite, is photosynthesis.

Do the experiment again and have different groups put in different amounts of sugar. Make sure that all the other variables are the same. The bottles you use should be exactly the same, measure the warm water carefully and place the bottles near the same heat source. Help them write the following hypothesis.

**The more sugar is mixed in with yeast and water, the more CO}_2 will be produced. The more sugar is added to the yeast solution, the more it will produce CO}_2.**

Graph your answers with the number of teaspoons of sugar on the x–axis and the amount of gas that was produced on the y–axis.

The amount of gas can be measured by the amount of displacement of water when the inflated balloon is placed in a small tub of water.

Nancy Escamilla – 8/07

**Resources:**
South Coast Science Project – 2006
What is Yeast?

Yeasts are single-celled fungi. As fungi, they are related to the other fungi that people are more familiar with. These include edible mushrooms available at the supermarket, common baker’s yeast used to leaven bread, molds that ripen blue cheese and the molds that produce antibiotics for medical and veterinary use. Many consider edible yeast and fungi to be as natural as fruits and vegetables.

Yeast Cells

Over 600 different species of yeast are known and they are widely distributed in nature. They are found in association with other microorganisms as part of the normal inhabitants of soil, vegetation, marine and other aqueous environments. Some yeast species are also natural inhabitants of man and animals. While some species are highly specialized and found only in certain habitats at certain times of the year, other species are generalists and can be isolated from many different sources.

Baker’s yeast is used to leaven bread throughout the world and it is the type of yeast that people are most familiar with. Baker’s yeast is produced from the genus and species of yeast called Saccharomyces cerevisiae. The scientific name of the genus of baker’s yeast, Saccharomyces, refers to “saccharo” meaning sugar and “myces” meaning fungus. The species name, cerevisiae, is derived from the name Ceres, the Roman goddess of agriculture. Baker’s yeast products are made from strains of this yeast selected for their special qualities relating to the needs of the baking industry.

The typical yeast cell is approximately equal in size to a human red blood cell and is spherical to ellipsoidal in shape. Because of its small size, it takes about 30 billion yeast cells to make up to one gram of compressed baker’s yeast. Yeast reproduce vegetatively by budding, a process during which a new bud grows from the side of the existing cell wall. This bud eventually breaks away from the mother cell to form a separate daughter cell. Each yeast cell, on average, undergoes this budding process 12 to 15 times before it is no longer capable of reproducing. During commercial production, yeast is grown under carefully controlled conditions on a sugar containing media typically composed of beet and cane molasses. Under ideal growth conditions a yeast cell reproduces every two to three hours.

Yeast is the essential ingredient in many bakery products. It is responsible for leavening the dough and imparting a delicious yeast fermentation flavor to the product. It is used in rather small amounts in most bakery products, but having good yeast and using the yeast properly often makes the difference between success and something less than success in a bakery operation.

http://www.dakotayeast.com/yeast_what.html
<table>
<thead>
<tr>
<th><strong>Vocabulary</strong></th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>– blood vessels that carry blood away from the heart</td>
<td></td>
</tr>
<tr>
<td>– the basic unit of life</td>
<td></td>
</tr>
<tr>
<td>– what cells need to do work</td>
<td></td>
</tr>
<tr>
<td>– a gas that living organisms exhale</td>
<td></td>
</tr>
<tr>
<td>– microscopic blood vessels that exchange nutrients and waste</td>
<td></td>
</tr>
<tr>
<td>– the movement of blood around the body</td>
<td></td>
</tr>
<tr>
<td>– organism that feeds on other organisms for food</td>
<td></td>
</tr>
<tr>
<td>– the process by which many materials go in and out of cells</td>
<td></td>
</tr>
<tr>
<td>– the tube from your mouth to your stomach</td>
<td></td>
</tr>
<tr>
<td>– enclosed space in the heart</td>
<td></td>
</tr>
<tr>
<td>– organism that feeds or obtains nutrients by breaking down organic matter</td>
<td></td>
</tr>
<tr>
<td>– the gas we breathe in</td>
<td></td>
</tr>
<tr>
<td>– organism that makes its own food from the environment; usually a green plant</td>
<td></td>
</tr>
<tr>
<td>– plants and animal cells break down sugar to obtain energy, a process that produces carbon dioxide and water</td>
<td></td>
</tr>
<tr>
<td>– a type of solid, liquid or gas that has particular qualities</td>
<td></td>
</tr>
<tr>
<td>– organs that work together</td>
<td></td>
</tr>
<tr>
<td>– the tube that takes air from your throat to your lungs</td>
<td></td>
</tr>
<tr>
<td>– to carry or move from one place to another</td>
<td></td>
</tr>
<tr>
<td>– blood vessels that carry blood to the heart</td>
<td></td>
</tr>
<tr>
<td>– the nutrient that cells use for energy</td>
<td></td>
</tr>
</tbody>
</table>
# Life Science - Bingo Checklist

<table>
<thead>
<tr>
<th>1st game</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arteries</strong> – blood vessels that carry blood away from the heart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capillaries</strong> – microscopic blood vessels that exchange nutrients and waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Carbon dioxide</strong> – a gas that living organisms exhale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cell</strong> – the basic unit of life</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Circulation</strong> – the movement of blood around the body</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Composer</strong> - organism that feeds on other organisms for food</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Decomposer</strong> - organism that feeds or obtains nutrients by breaking down organic matter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Diffusion</strong> – the process by which many materials go in and out of cells</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy</strong> – what cells need to do work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Esophagus</strong> – the tube from your mouth to your stomach</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Heart chamber</strong> – enclosed space in the heart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oxygen</strong> – the gas we breathe in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Producer</strong> - organism that makes its own food from the environment; usually a green plant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Respiration</strong> – plants and animal cells break down sugar to obtain energy, a process resulting in carbon dioxide and water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Substance</strong> – a type of solid, liquid or gas that has particular qualities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sugar</strong> – the nutrient that cells use for energy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System</strong> – organs that work together</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trachea</strong> – the tube that takes air from your throat to your lungs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Transport</strong> – to carry or move from one place to another</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Veins</strong> – blood vessels that carry blood to the heart</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nancy Escamilla – revised 8/07
Bill Nye – Blood and Circulation

1. Your heart is about as big as ____________.
   A. a football
   B. your shoe
   C. your fist
   D. a melon

2. Blood vessels near your heart are compared to highways because they ____________.
   A. transport blood to different parts of your body
   B. can have traffic jams
   C. are dirty
   D. transport waste

3. As the blood goes away from your heart, the blood vessels get ____________.
   A. smaller
   B. larger
   C. thicker
   D. thinner

4. A very small blood vessel is ____________.
   A. a vein
   B. an artery
   C. a capillary
   D. a cell

5. The heart can be compared to ____________.
   A. a car
   B. a highway
   C. a sponge
   D. a pump
6. The blood brings ____________________________.
   A. carbon dioxide to every cell
   B. nutrients and oxygen to every cell
   C. waste material to every cell
   D. only oxygen to every cell

7. Every cell puts ____________________ into the blood stream.
   A. nutrients
   B. oxygen and nutrients
   C. carbon dioxide and waste products
   D. carbon dioxide and nutrients

8. When the right side of your heart squeezes, it sends ________________.
   A. blood containing carbon dioxide to your lungs
   B. carbon dioxide to your body
   C. oxygen to your body

9. When the left side of your heart squeezes, it pumps blood filled with ____________.
   A. oxygen to your body
   B. oxygen to your lungs
   C. carbon dioxide to your body
   D. carbon dioxide to your lungs

10. White blood cells in your blood stream are compared to the police because they ____________________________.
    A. are better than red blood cells
    B. keep your body clean
    C. help your body fight against infection and bad germs
    D. make sure there aren’t any traffic jams in your blood stream

11. Capillaries are ____________________________.
    A. vessels that connect arteries to veins
    B. very small passageways that allow liquid to move through them
    C. vessels that transport blood cells
    D. All of the above are true about capillaries
12. The three types of blood vessels are arteries, veins, and capillaries. They do the following:

A. Arteries are connected to capillaries, which are connected to veins. Veins take blood away from the heart.
B. Arteries take blood away from your heart, while veins return the blood to your heart. Capillaries connect the arteries and the veins.
C. Capillaries take blood away from your heart through your veins and then through your arteries.

13. The stronger your heart is, the easier it is for you to exercise because it _________.

A. brings carbon dioxide to your muscles
B. is a muscle
C. brings oxygen to your muscles
D. it pumps carbon dioxide out of muscles

14. Your brain is a muscle that needs ___________ rich blood to stay alert.

A. oxygen
B. carbon dioxide
C. vitamins

15. How many chambers does your heart have?

A. Four
B. Five
C. One
D. Three
Yeast and Cellular Respiration

What will happen if we add sugar to the yeast solution?

Hypothesis:

Standard:

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Observations:

<table>
<thead>
<tr>
<th></th>
<th>Now</th>
<th>30 minutes</th>
<th>60 minutes</th>
<th>90 minutes</th>
<th>2 hours</th>
</tr>
</thead>
</table>

What evidence do you have that a chemical reaction took place? What conclusion can you make about cellular respiration?

______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________

What was the result of this chemical reaction?

______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________

How would you change this experiment to improve it or to learn something new?

______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________
______________________________________________________________________________________________

Adapted from the South Coast Science Project – 2006
Revised by Nancy Escamilla - 2007

Nancy Escamilla – revised 8/07