5 E Lesson Plan

Title: Cellular Respiration: Factors Influencing the Rate of Yeast Fermentation

Grade Level and Course:
7th grade, Life Science
10th grade, Biology

Materials:
- 6 balloons
- 14 grams raw yeast
- 14 grams table sugar
- String
- Aluminum foil
- 50 mL graduated cylinder (2)
- 600 mL beaker or bowl
- Overflow pan
- Funnel
- Permanent marker
- Electronic balance
- Paper towel
- Ice Water bath
- Warm Water bath

Instructional Resources Used: (concept maps, websites, think-pair-share, video clips, random selection of students etc.)
- Show students two short video clips: one on aerobic respiration and the other on fermentation.
  - Aerobic respiration: [http://www.youtube.com/watch?v=DyrUbsyBjfq](http://www.youtube.com/watch?v=DyrUbsyBjfq)
  - Fermentation: [http://www.youtube.com/watch?v=-nIDGG0sYcg](http://www.youtube.com/watch?v=-nIDGG0sYcg)

Using a Venn diagram, ask students to compare aerobic respiration to fermentation. The Venn diagram will be used again at the end of the class to add any additional information the students learned after doing the lab.

California State Standards: (written out)
7th grade, Life Science:
1d: Students know mitochondria liberate energy for the work that cells do, and chloroplasts capture sunlight for photosynthesis.

10th grade, Biology:
1g: Students the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.

Lesson Objectives:
Students will be able to explain how the process of fermentation produces carbon dioxide gas and compare fermentation to aerobic respiration.

Differentiation Strategies to meet the needs of diverse learners:
- English Learners: Students will brainstorm to create a cluster diagram about what they know about fermentation.
• Special Education: Students will use a two column graphic organizer to organize the main points about the process of cellular respiration and fermentation.
• GATE: Students will compare and contrast aerobic respiration and anaerobic respiration (fermentation).

ENGAGE
• Describe how the teacher will capture the students’ interest.
• What kind of questions should the students ask themselves after the engagement?
  Teacher shows students a YouTube video clip to capture their interest:
  http://www.youtube.com/watch?v=vlZZUtpyCgQ

• Questions students should ask themselves:
  1. What is the function of cellular respiration in organisms?
  2. During what conditions do organisms switch from aerobic respiration to fermentation?
  3. How are the processes of cellular respiration and fermentation similar? Different?

EXPLORE
• Describe the hands-on laboratory activity that the students will be doing.
• List the “big idea” conceptual questions that the teacher will ask to focus the student exploration.
  Students will create a closed environment using balloons, yeast and varying amounts of sugar to model the process of fermentation. They will find the initial mass and volume of each balloon, and measure the final mass and volume of each balloon. Students will then analyze their data to determine the optimal conditions necessary for fermentation.
• “Big Idea” Conceptual Questions:
  1. Why is glycolysis necessary for fermentation to proceed?
  2. What factors affect the rate of fermentation in yeast?

EXPLAIN
• What is the “big idea” concept that students should have internalized from doing the exploration?
• List the higher order questions that the teacher will ask to solicit student explanations for their laboratory outcomes, and justify their explanations.
  “Big Idea Concept:
  1. Fermentation allows the production of small amounts of ATP without oxygen.
  2. Fermentation allows the process of glycolysis to continue when oxygen is unavailable.
  3. Lactic acid fermentation occurs in many cells including human muscle cells while alcoholic fermentation is used in industries such as breweries.
  Higher order Questions:
  1. What environment is created by tying the balloons shut after squeezing the air out? Why is this significant?
  2. What is occurring in the balloons as they sit in the warm water bath? How do you know?
  3. Which balloon showed the greatest change in mass and volume? Explain.
  4. Which balloon showed the least change in mass and volume? Explain.

EVALUATE
• How will the student demonstrate their new understanding and/or skill?
Students will create a science fiction story that tells what would happen if all the green plants on earth were to die. Use information you have learned about aerobic respiration and fermentation. You may include pictures to illustrate your story.

- What is the learning product for the lesson?
  Student science fiction stories.

**EXTEND**

- Explain how students will develop a more sophisticated understanding of the concept.
- How is this knowledge applied in our daily lives?
  1. Students should create a children’s book to explain the process of fermentation and its uses/applications in industry.
     (Students should pull recipes for making yogurt from the internet and use the process of fermentation to make homemade yogurt.)

**Background Knowledge for the Teacher:**

Fermentation is a process that is important in anaerobic conditions when there is insufficient oxygen to maintain the production of ATP. For fermentation to proceed there has to be an initial breakdown of glucose (glycolysis) to produce pyruvates. Fermentation then follows in one of two ways: homolactic fermentation produces lactic acid from pyruvate while alcoholic fermentation converts pyruvate into ethanol and carbon dioxide.

Sources: http://www.bioresearchonline.com/article.mvc/What-Is-Fermentation-Biochemistry-0001

Student pages are attached.
**Cellular Respiration:**

**Factors Influencing the Rate of Yeast Fermentation**

Objective: Students will be able to explain how the process of fermentation allows glycolysis to continue when oxygen is not present.

**Materials:**
- 6 balloons
- 14 grams raw yeast
- 14 grams table sugar
- String
- Aluminum foil
- 50 mL graduated cylinder (2)
- 600 mL beaker or bowl
- Overflow pan
- Funnel
- Permanent marker
- Electronic balance
- Paper towel
- Ice Water bath
- Warm water bath

**Procedures:**

1. Label six balloons A-F with a permanent marker.
2. Add 2 grams of yeast to each balloon.
3. Add sugar to the balloons in the following manner: 2 grams to balloon A, 3 grams to balloon B, 4 grams to balloon C, 5 grams to Balloon D, 6 grams to balloon E, and 7 grams to balloon F.
4. Add 50 mL of water to each balloon tie securely shut with string, squeezing as much air from the balloons as possible. Work quickly, and as soon as each balloon is secure, add to an ice water bath to prevent the start of fermentation.
5. Once all balloons are prepared, determine the mass of each balloon (using an electronic balance) and the volume of each balloon (using the bucket and overflow pan by volume displacement).
6. Place all balloons into a 37-degree warm water bath for 30 minutes.
7. After 30 minutes, remove each balloon, towel dry, and record mass and volume. Record results of mass and volume changes on the data table.
8. Graph the result.
Data Table:

<table>
<thead>
<tr>
<th>Balloons</th>
<th>Initial mass (g)</th>
<th>Initial volume (cm³)</th>
<th>Mass after 30 mins. (g)</th>
<th>Volume after 30 mins. (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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<td>B</td>
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<tr>
<td>F</td>
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</tr>
</tbody>
</table>

Analysis Questions:

1. Why is glycolysis necessary for fermentation to proceed?

2. What factors affect the rate of fermentation in yeast?

3. What environment is created by tying the balloons shut after squeezing the air out? Why is this significant?

4. What is occurring in the balloons as they sit in the warm water bath? How do you know?

5. Which balloon showed the greatest change in mass and volume? Why?

6. Which balloon showed the least change in mass and volume? Why?

7. Compare and contrast aerobic respiration and anaerobic respiration (fermentation) using the information you learned from this lesson.