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BASIS Lesson Plan

Lesson Name: Microorganisms: Good or Evil?

Grade Level Connection(s)

NGSS Standards: Grade 4, Physical Science/Life Science (4-PS3, 4-LS1)
FOSS CA Edition: Grade 5, Life Science: Living Systems

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

This hands-on lesson guides students to explore microorganisms in a new light. When we think of microorganisms, we usually think of the bacteria and viruses that make us sick, but microorganisms are much more than disease-causers. One of their most important functions is digestion – they actually help keep us healthy! We will use a hands-on experiment to figure out which substances (sugars, artificial sweeteners) a particular microorganism (yeast) can digest and then discuss connections between this process and how the cells in our body convert nutrients into energy.

Lesson Objectives

- Students will conduct simple experiments, from design and hypothesis to experimentation and conclusions.
- Students will understand the similarities between the processes of yeast fermentation and cellular respiration.
- Students will measure experimental and create a graph with these data to support or reject a hypothesis.
- Students will better understand how scientists look at the world and how students can find their own answers to questions about the world around them.

Vocabulary Words

- **Microorganism**: A very tiny (*micro*!) living thing (*organism*!) that can't be seen with just your eyes

- **Yeast**: Microscopic (too small to see) fungi that are capable of converting sugar into alcohol and carbon dioxide
- **Digestion**: process of converting nutrients into energy (and waste products)
- **Hypothesis**: Educated guess in science
- **Carbon dioxide**: a colorless, odorless gas that we exhale when breathing
- **Cell**: The smallest unit of a living thing; all organisms are made up of cells
- **Cellular respiration**: process where cells in our body convert nutrients into energy (and waste products)

Materials

Scientist Volunteers will bring:

- Images of yeast
- Images of other microorganisms
- 0.5L plastic bottles
- Balloons
- Rubber bands
- Yeast (pre-measured amounts placed in Ziploc bags)
- Ziploc bags
- Sugar sources (sugar, Splenda, Stevia, Equal, etc) [Each sugar source should already be in Ziploc bags for simple materials distribution]
- Water
- Teapot
- Graduated cylinders
- Measuring tape (to measure circumference of balloons)

Materials teachers should provide:

- Pens/pencils

Classroom Set-Up

Please have students split into groups of 4 students each. Each group should have a “station” consisting of a table or couple of desks pushed together. We will need access to an outlet to plug in a kettle to make some hot water for the experiment.

Classroom Visit

1. Introduction (10 minutes)

Role Model Introduction:
Being a role model is an important part of being a BASIS volunteer! Begin your lesson by explaining who you are and what you do as a scientist. Feel free to tell your "story" as if giving an elevator pitch to elementary school students: Why did you become a scientist? What questions are you trying to figure out? What do you do in your job? Why should students relate to you? Feel free to bring in photos, specimens, and other props. Let your personality shine through!

Topic Introduction:
After you introduce yourselves as role models, take some time to introduce the topic of this lesson: the role of microorganisms in digestion. It may be helpful to keep the suggested take-away in the back of your mind throughout the lesson: **Microorganisms, such as yeast, can digest sugar and convert it into energy and waste products, which is a similar process to how cells in our body convert nutrients into energy and waste products.**

Your topic introduction should introduce students to the phenomena they will explore: microorganisms are not all harmful, some (such as yeast) are helpful and digest sugars to produce energy and waste products. As much as possible, try to frame this information as questions posed to the class, rather than as a lecture. This helps activate students' prior knowledge and facilitates student-guided conversation.

1. Introduce the phenomenon that the class will explore: the role of microorganisms in digestion.
    - What are **microorganisms**? [Write and define microorganism on board]
    - What are some common examples?
    - Hand out color photographs of microbes to each table group and have them make some observations about microbes. Ask students to discuss observations in their table groups – what are similarities? What are some differences?
    - Have groups share out and gather class thoughts on the board
    - We usually think of microbes as bad or dangerous, but they can also help us.
    - Can anyone think of examples of "good" microbes? [examples include bacteria used to make yogurt, microorganisms that live in your body and help you digest food, and, yeast used to make bread rise!]
    - So who here has eaten delicious bread before? [Should be just about everyone!]
    - How does flour, water, sugar, and yeast become delicious bread?
    - Yeast accomplishes this by doing one thing: digesting stuff. What is **digestion**?

- Digestion is the process by which yeast converts nutrients into energy. Just like how you eat foods and convert that to energy, yeast does a similar process!
- Yeast breaks down their energy sources and make carbon dioxide gas. You can measure how much yeast like a specific nutrient by measuring how much carbon dioxide gas is made. In our experiment today, we will trap all the carbon dioxide in a balloon. How big the balloon gets will tell us how much digestion is occurring.
- Ask students to turn to the person next to them and make a **hypothesis** (define): which sugar do you think the yeast will prefer, and why?

Teaching Tip: Say, Write, Show

- Bring in photos and props to illustrate the topic intro
- Write new vocabulary words, key terms, and brainstorm lists on the board
- Help students make sense of vocab through root words, eg micro+organism
- Refer back to the board to engage visual learners and English Language Learners

2. Learning Experience (30-40 minutes)

*Students will be split into groups of 4.

1. What does our background knowledge tell us?
    - Have students fill out their worksheet, recording which sugar sources they will be testing. Have each student make a prediction or **hypothesis** about which sugar source the yeast will prefer.
    - Students record their hypothesis.
2. What does a scientific experiment tell us? (Set up yeast experiment)
    - Each table group gets one 1.5mL bottle per student, one roll of masking tape, and a marker, 150mL of each, sugar source (one for each student), and yeast, for each student.
    - Instruct students to add the yeast into the plastic bottle.
    - Then instruct students to add one sugar source to their plastic bottle – each student should be adding a different sugar source in their table groups.
    - Before passing out other supplies, instruct students to label their bottles with the name of the sugar source that is inside.
    - Instruct students that volunteers will be coming around and adding 150mL of warm water to each bottle. Once the water is added, students should gently shake the bottle and then place the balloon over the top of the bottle and secure with a rubber band. [Model how this should be done before passing out supplies.]
    - Distribute out four balloons (one for each student) and four rubber bands (one for each student) to each table group.

- Volunteers go around to each table group and add water, checking in that all students understand directions for experiment.
- Have students make observations and record these on their worksheets. [Do they see bubbles? What does the balloon look like at first?]
- Wait 5 minutes. Have students make additional observations about both the yeast and the balloons – pay attention to the amount of air in the balloon.
- Set all bottles aside while yeast eats.

3. While waiting for experiments to run (~10 minutes), have a discussion with students about cellular respiration.
    - Ask students if they have heard of **cellular respiration**; if so, guide quick discussion; if not, give a quick explanation. Focus on connecting the experiment to what actually happens inside our bodies:
    - **Cells** (define) break down the sugar that we eat.
    - The energy that is released during this process helps us do everything we do during the day, from breathing to studying to running around
    - When that sugar is broken down, carbon dioxide is released – just like in our experiment! Eventually, that carbon dioxide travels through the body to our lungs, and we breathe it out. (Ask students to breathe out onto their hand – they're breathing out carbon dioxide!) Water is another by-product.
4. Back to "What does a scientific experiment tell us?" (Return to yeast experiment)
    - Ask students to make and record observations of the balloons
    - Guide students step-by-step to measure the CO2
        i. Take the ruler and measure the circumference of the balloon in centimeters
        ii. Write down the number for each balloon
    - Collect results in a bar graph on the board

3. Wrap Up: Review and Discuss the Learning Experience (5-10 minutes)

*This is the "discussion and conclusions" part of the lesson

- Which sugars did we think yeast would prefer before we did the experiment?
- Which sugars do we think yeast prefer now, after doing the experiment and graphing our results?
- Invite observations and questions

Contextualize the conclusion:

- An experiment can test our hypothesis and an instrument can help us measure it.
- Graphs help us look at the results we get from an experiment.
- How can what we learned today help us understand microorganisms/digestion/cellular respiration? (revisit images/examples from intro)

Classroom Management Tips: Encourage Participation

- Wait 3 seconds before calling on students to answer a question. You'll be impressed with how many more (and often, more diverse) hands go up.
- It's tempting to call on eager students, but give everyone a chance!
- Be flexible in how you communicate questions and responses, reiterating information in different ways if needed.
- For more classroom management tips, visit www.crscience.org/volunteers/volunteertools

4. Connections & Close (5 minutes)

Connections to the real world around students:

Close:
Wrap up as a role model by leaving a few minutes for students to ask questions about science, about being a scientist, and about becoming a scientist. Then, thanks and goodbye!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS:

- Connections by topic
  - Life Science: 4. Structure and Function.
  - Physical Science: 4. Energy.
- Connections by disciplinary core ideas:
  - Life Science: 4-LS1 From Molecules to Organisms: Structure and Processes
  - Physical Science: 4-PS3 Energy
- Connections by scientific & engineering practices
  - 1. Asking questions and defining problems
  - 3. Planning and carrying out investigations

4. Analyzing and interpreting data

- Connections by crosscutting concepts
  2. Cause and effect: Mechanism and explanation
  5. Energy and matter: Flows, cycles, and conservation
- Connections by performance expectation:
  4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
  4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

FOSS CA Edition kit: Grade 5 Life Science: Module 3, Sugar and Cells