

# Bay Area Scientists in Schools Presentation Plan

**Lesson Name:** Microbes in Action

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**Grade Level:** 4<sup>th</sup>

**Standards Connection(s):** Life Sciences (microorganisms)

## Teaser:

Microbes are everywhere; they are in our bodies, our food, and outside in the environment. We all know about the “bad” microbes – the germs that make us and other plants and animals sick. But what about the “good” microbes? There are many more good microbes than bad microbes! How do microbes benefit people and shape the world around us? Over the course of this lesson, we will learn how microbes help other organisms, even you and I!

Yeast are a type of microorganism involved in the production of many foods. We will be exploring how yeast make gas that is used for food production. Plants also benefit from microbes that grow on their roots and give them nitrogen. We will look at where these tiny organisms live and how they interact with, and benefit, plants. Other bacteria are important in cloud and ice formation; we will demonstrate how fast and astonishing their role really is!

**Over the course of these hands-on activities and demonstrations, we hope to emphasize the substantial contribution of microbes to the planet we know and love. Where would we be without microbes?!**

## Vocabulary/Definitions:

*Microscopic:* visible only with a microscope (not with the naked eye)

*Microbe:* a microscopic organism (bacteria and yeast are two examples of microbes)

*Fermentation:* a process by which organisms can convert “food” molecules to acids, gasses and/or alcohols in order to gain energy.

*Ice nucleation:* the process of cold water droplets beginning to form ice crystals beginning to form.

*Ice nucleating bacteria:* bacteria that produce special molecules that make it easier for water to freeze around them, creating ice crystals (like snowflakes in clouds).

*Nitrogen-fixing bacteria:* bacteria that take nitrogen gas from the air and make it into a form that plants and bacteria can use

*Root nodules:* a place on the root of certain plants where nitrogen-fixing bacteria live.

*Symbiosis:* two organisms living together and helping each other out

## Materials:

*Activity 1: Yeast Fermentations*

- Warm water
- Rapid rise yeast
- Sugar
- Splenda
- Cocoa
- 4 small bottles
- 4 balloons



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- Sharpies
- A clothing tape measure to measure the balloons'

### *Activity 2: Nitrogen-fixing Bacteria*

- clover plants
- Hand lenses
- Laminated board games (with plant outline on them)
  - \*see end of lesson plan
- Nitrogen and carbon tokens
- Green dry-erase markers

### *Activity 3: Ice formation*

- Test tube
- Distilled or deionized water
- Crushed ice
- Small cooler/container for ice
- Alcohol
- Disposable pipette or syringe
- A couple drops of *Pseudomonas syringae* culture (less than one milliliter, completely harmless to humans, not genetically modified)

## **Classroom Set-up:**

### *Activity 1:*

For this activity students will be placed in 4 groups and each group will be responsible for 1 experiment (sugar, cookie, Splenda, water).

#### Before experiment:

- Prepare warm water, bottles and balloons
- Have correct amount of sugar/Splenda/cookie ready
- Have correct amount of yeast ready

### *Activity 2:*

For this activity students will stay in their groups (4 groups) and each group will examine one plant.

#### Before experiment:

- Prepare clover plants (dig up and wash roots)
- Prepare magnifying glasses
- Prepare game set up (give each student a board, place 1 green marker and tokens at each table)

### *Activity 3:*

For this activity students will come together as a class.

#### Before experiment:

- Fill cooler with crushed ice
- Fill test tube with distilled/deionized water
- Pour alcohol into cooler with ice (if necessary)
- Cool test tube in ice/alcohol mix

- Prepare *Pseudomonas syringae* culture by scraping colonies from a plate into a little bit of liquid media, keep on ice until activity

### Classroom Visit

#### 1. **Personal Introduction:** 2 **Minutes**

*Who are you? What do you want to share with students and why? How will you connect this with students' interests and experiences?*

#### 2. **Topic Introduction:** 10 **Minutes**

*Defining microscopic—what exists that you cannot see with the naked eye? How can we see these things?*

*What are microbes? Where do they live? What do they do?*

*How do microbes help us?*

#### **Microscopic:**

Many things exist in the world around us that cannot be seen with the naked eye (microbes, viruses, sound waves, air). There are different ways (different technologies we can use) to be able to see them! One such technology is a microscope.

#### **Microbes:**

Microbes are microscopic organisms. They live EVERYWHERE (in your tummy and mouth, in the food that you eat, in the air, in the water, in the soil). They have many different roles. Some of them can make you and other plants and animals sick, but the majority of microbes are actually beneficial!

→Food production: Many of our favorite foods are made by microbes (yogurt, cheese, bread). Microbes can take sugar and convert it to acids and gasses (and alcohol). Microbes give yogurt its unique flavor. Microbes (yeast) make bread fluffy by producing gasses.

→Symbiosis with plants: Microbes also help plants (and us because we eat plants!). They grow in and the roots and leaves of plants and help them take up the food that plants need to grow.

→Microbes and the weather: microbes can be responsible for the formation of ice! They contain molecules that make ice crystals grow. They are also found in the sky, where they help little droplets of water come together to form clouds.

#### **Experiments:**

Doing an experiment is one way to answer a question. You need to carefully think out your experiment so that it can answer your question, and you need to start by forming a hypothesis (educated guess) as to what the answer to your experiment will be! Today we are talking about the different roles of microbes. First, we're going to be talking about yeast, a microbe that helps make some foods. We know yeast sometimes produces gas (like in bread) during a process called fermentation. We can ask the question of what do yeast like to ferment? In other words, what do yeast like to eat to produce gas... what "food" makes yeast produce the most gas! We will look at 4



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different “foods”: water, sugar, “fake sugar” and cocoa! We will feed yeast all of these things. We will measure the amount of gas produced in each case. By comparing the amount of gas produced, we can see what yeast like to eat most!

### 3. Learning Experience(s): Minutes

**40**

#### *Activity 1:*

Divide the class into 4 groups. Each group will set up one fermentation (sugar, fake sugar, water or cookie).

- Add warm water to the bottle
- Add sugar/fake sugar/cocoa/nothing
- Add teaspoons of yeast
- Mix well
- Place balloon over bottle mouth (make sure it is air tight!)

Explain the experiment as performing it, and what outcome you can expect given what we know about yeast fermentation (that it is the conversion of SUGAR to other things). Have each group write down its hypothesis on the board. Explain that now we need to wait a little for the microbes to eat and produce gas, and that after that we will come back and compare the results.

After activity 3, bring the class together and compare the size of each balloon. Ask the class to evaluate their hypotheses.

Talk about why yeast is used in bread formation (because of its ability to make bread rise). Mention other foods that are made using microbes (e.g. yogurt and cheese).

#### *Activity 2:*

Next move on to talking about other roles of microbes. They live in the soil and sometimes they live in plant roots. Give each group one clover plant on a moist paper towel. Pass around a hand lens and the plant, and have students scan the roots of the plant. Show them the root nodules and explain that bacteria live there (to make sure they know what they see, you can ask them to draw it on the board; the nodules should look like little black circles on the roots). Have a discussion on what these bacteria could be doing. Explain that plants need nitrogen (just like we need food) but that they can't get nitrogen on their own. The bacteria living in the root nodules take nitrogen gas from the air and give it to the plant in a form it can use (just like when your mom makes you dinner from a box of uncooked pasta and some vegetables you refuse to eat). The plant is happy! The bacteria are also happy because the plant shares some of its food with the bacteria as well. This is called a symbiosis: 2 organisms living together, both benefiting.

The concept of symbiosis between plants and nitrogen-fixing bacteria will be further emphasized over the course of a game. Students will play the game in their groups; each student will have a board and will be able to trade two sugar (carbon) tokens and two nitrogen tokens for a leaf. The goal of the game is to grow the most leaves on your plant! There is a twist, however! Some students will have a board with a microbe drawn on it; these students have plants with nitrogen-fixing bacteria on them! Thus, they will be able to trade some sugar for some nitrogen, which may end up being beneficial to them! The rest of the students will have plants without nitrogen-fixing bacteria on them; they will get only the sugar and nitrogen given to them at each turn and will need to use this wisely in order to grow their plants.



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### Activity 3:

As a class, we will do the ice nucleation demo. Explain that bacteria are also found in water and air. We all know that when it is cold, ice forms. But actually bacteria help! It would need to be a LOT colder without bacteria for ice to form. They have a molecule that starts the formation of ice crystals, causing rapid freezing! These bacteria are used in snow machines (machines that make snow for you to be able to ski on!). In the same way, bacteria in the air help form clouds – water vapor in the atmosphere freezes around bacteria. When enough water vapor has frozen around the bacteria, they become too heavy for wind to keep them afloat and they fall down. If it is cold near the ground, this makes snow. If it is warm near the ground, this makes rain. That's right, when it rains, it's raining bacteria!

#### 4. **Wrap-up: Sharing Experiences** **Minutes**

**5**

What did we learn today? What are some of the roles that microbes play in shaping the world around us?

#### 5. **Connections & Close:**

**3 Minutes**

Possible homework: what would the world look like without microbes? You have the choice of destroying all the microbes on the planet – would you do it? What would be the consequences?

**Total 50 – 60 Minutes**

#### **Follow-up – After Presentation**

*Suggest students write a letter explaining "How we learned about good microbes"*

*Suggest students complete the homework outlined above.*

#### **Microbes in our food:**

- Students can extend their knowledge of yeast and the gas they produce by actually making bread!  
<http://www.education.com/science-fair/article/fungus-among-us/>
- A great way to appreciate the role of microbes in our everyday lives is to enumerate all the microbe-containing foods we eat on an everyday basis! Students can go through grocery advertisements and circle microbe-containing foods! Don't forget the mushrooms in the pasta sauce! (Activity B from here: <http://www.uen.org/Lessonplan/preview.cgi?LPid=2517>)

**The Nitrogen Cycle Game:** Students can appreciate the complexities of the nitrogen cycle, its importance, and the role bacteria play in it, with this interactive game!

<http://scied.ucar.edu/activity/nitrogen-cycle-game>

**Setting up a compost:** Students can learn how bacteria are critical for decomposition and returning nutrients to the soil, completing the cycle of life. Some good composting activities can be found here

[http://www.epa.gov/osw/education/quest/pdfs/sections/u2\\_chap3.pdf](http://www.epa.gov/osw/education/quest/pdfs/sections/u2_chap3.pdf)

A more simple composting activity can be found in Part A, here:

<http://www.uen.org/Lessonplan/preview.cgi?LPid=2517>

#### **Readings:**



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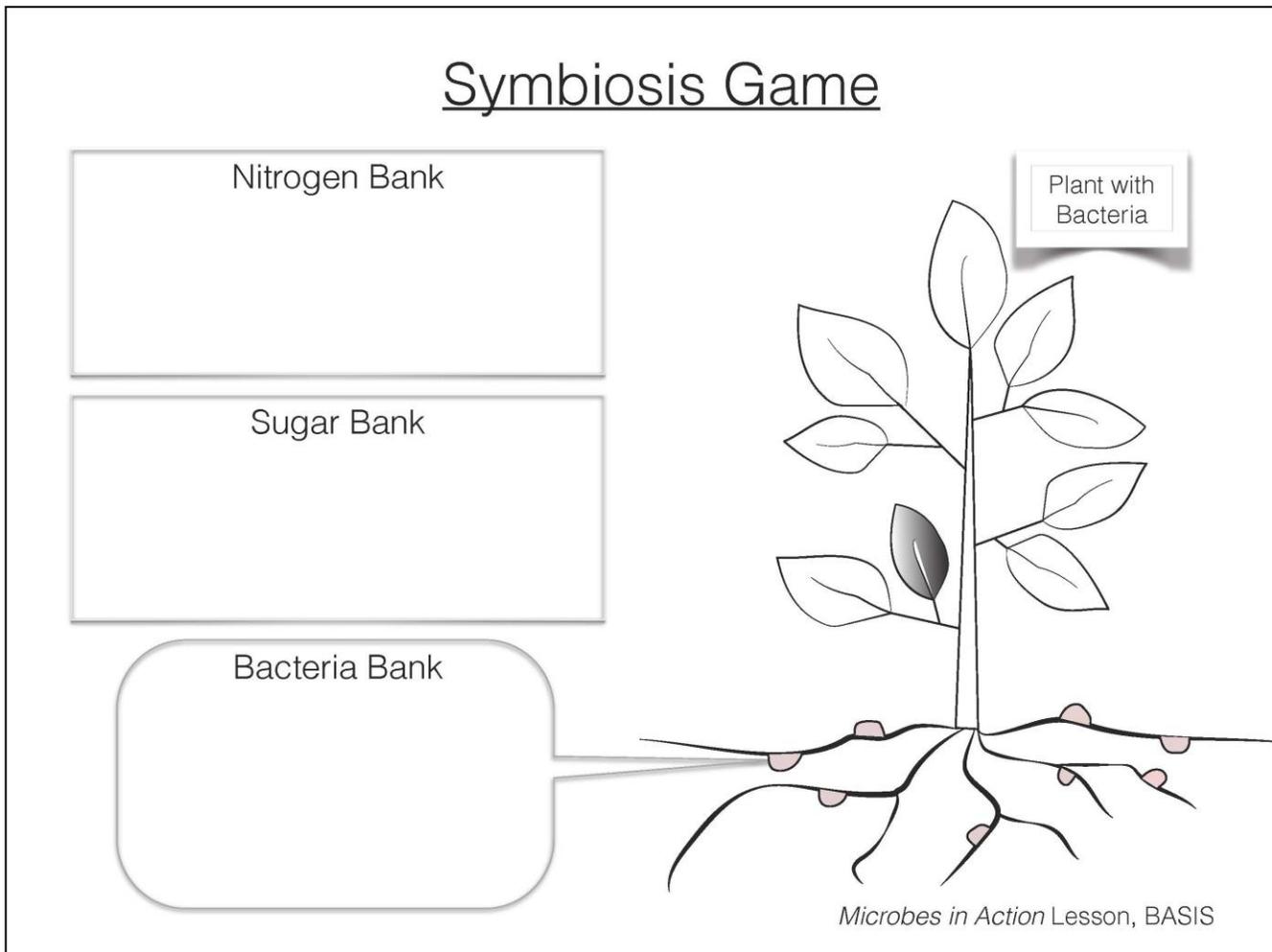
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- Bacteria – Fun facts booklet! Learn about different types of microbes, where they live, and what they do! <http://www.loveyourgut.com/wp-content/uploads/2076-facteria-booklet.pdf>
- The Surprising World of Bacteria With Max Axiom, Super Scientist : Learn about microbes alongside a superhero! This is a great series that explains science in an easy, fun way. [http://www.bookworm.com/p/the-surprising-world-of-bacteria-with-max-axiom-super-scientist-697055?site=CA&utm\\_source=Google&utm\\_medium=cpc\\_bw&utm\\_term=FPS-123755&utm\\_campaign=GoogleAW&CAWELAID=1611571596&utm\\_content=pla&adtype=pla&cagpspn=pla](http://www.bookworm.com/p/the-surprising-world-of-bacteria-with-max-axiom-super-scientist-697055?site=CA&utm_source=Google&utm_medium=cpc_bw&utm_term=FPS-123755&utm_campaign=GoogleAW&CAWELAID=1611571596&utm_content=pla&adtype=pla&cagpspn=pla)

## **Board Game Sheets:**

Plant with Bacteria:



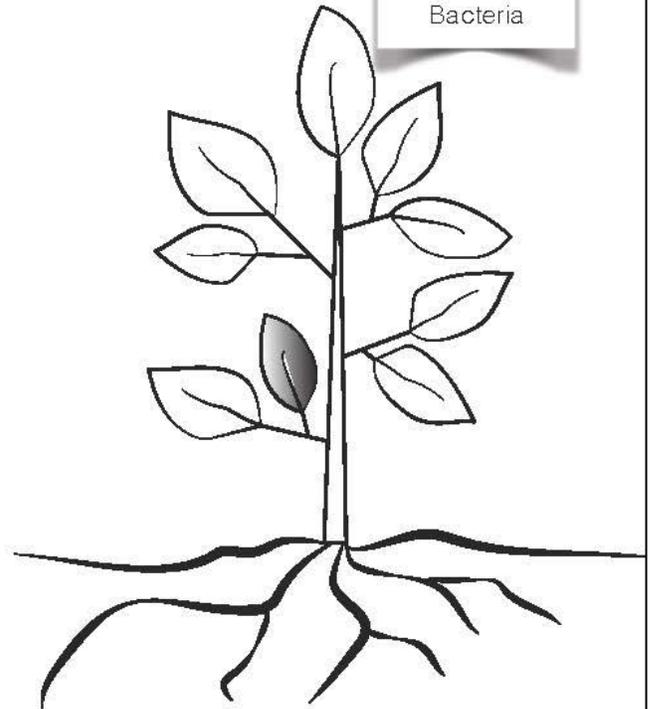
Plant without bacteria:

## Symbiosis Game

Nitrogen Bank

Sugar Bank

Plant without  
Bacteria.



*Microbes in Action Lesson, BASIS*



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