

**Lesson Title:** Pickling with Bacteria: Fermentation and Food Preservation**Time:** 40 minutes**Materials:**

Foods to taste

Computers

Recipe sheet

Mason jars (2 per class x 5 classes= 10)

Cucumbers

Other ingredients

**Standards:**

**S7.B.1.1.2:** Describe how specific structures in living things (from cell to organism) help them function effectively in specific ways (e.g., chlorophyll in plant cells— photosynthesis; root hairs—increase surface area; beak structures in birds— food gathering; cacti spines—protection from predators). \*Lactic acid bacteria force out bad bacteria

**S7.A.3.1.1:** Describe a system (e.g., ecosystem, circulatory system, agricultural system) as a group of related parts with specific roles that work together to achieve an observed result.

**Objectives:**

Students will understand the role that bacteria can play in food preservation and learn the procedure for making “quick” refrigerator pickles. They will also learn that there are “good” and “bad” bacteria.

**Opening/Overview:**

- “You guys have learned a lot of ways bacteria work in our lives. Can you tell me a few of them? (role of bacteria in nature: oxygen production, food production, decomposers, nitrogen-fixing bacteria, how bacteria work in their bodies, and how they can make medicines, antibiotics and vaccines). One other great function of bacteria is preserving (or keeping food) fresh.
- Most bacteria helps us be healthy, but a few kinds can make us very sick like Salmonella and E-coli
- Pickling is one way we can try to keep food safe, the seal prevents bad bacteria from getting into the jar, and the vinegar helps healthy bacteria grow instead of dangerous bacteria.
- Other ways of keeping food safe include: salting, cooking, and freezing. Some foods, like potatoes, just need to be kept in a cool, dark place.

**More Explanation (if needed)**

All foods are continually assaulted by many kinds of microorganisms, racing to eat as much as possible. When you pickle vegetables by fermentation, you help one type of microbe win this “race.”

*Although this project is funded in part by the Environmental Protection Agency, it does not necessarily reflect the opinion or position of the EPA*

More specifically, you create special conditions in your pickle crock that keep away "bad" spoilage-causing microorganisms, and that allow a unique class of "good" bacteria, called lactic acid bacteria, to colonize your cucumbers.

Why are lactic acid bacteria good?

As lactic acid bacteria grow in your pickle crock, they digest sugars in the cucumbers and produce lactic acid. Not only does this acid give the pickles their characteristic sour tang, it controls the spread of spoilage microbes. Also, by gobbling up the sugars, *lactic acid bacteria* remove a potential food source for bad bacteria. Salt gives the good guys an edge.

Adding salt to your pickling brine is one important way to help lactic acid bacteria win the microbial race. At a certain salt concentration, lactic acid bacteria grow more quickly than other microbes, and have a competitive advantage.

### Activity 1: Food Production (10 minutes)

- **Further Resources:** <http://resources.schoolscience.co.uk/SGM/sgmfoods5.html>
- **Hand out** different foods for everyone to try that were made with fungi or bacteria (don't tell them that bacteria and fungi were used in making their food).
  - Bread, yogurt, mushrooms, pickles, olives, chocolate, and cheese (especially blue-cheese).
  - **Ask** students if they know what some of the foods are and how those foods are made.
  - **Explain** that bacteria or fungi are involved in making each food. And in the case of mushrooms, the mushrooms themselves are fungi!
- **Bread:** Yeast is added to dough to allow it to rise. The yeast digests sugars in the starch in the dough and produces the product of carbon dioxide (through fermentation) that causes the dough to rise.
- **Cheese:** A starter culture of bacteria is added to milk and as the bacteria culture grows in the milk, it converts the milk sugar (lactose) into lactic acid. The lactic acid gives the cheese the correct level of acidity and gives the cheese its moisture. As the cheese ripens, the culture gives it a balanced aroma, taste, and texture.
- **Yogurt:** Milk is fermented with lactic acid producing bacteria. As the bacteria culture grows in the milk, it converts the milk sugar (lactose) into lactic acid. The milk thickens, creating yogurt!
- **Pickles:** Pickles are fermented cucumbers. The cucumbers are put into containers filled with salty water. The salt helps to remove the sugars from the cucumbers and bacteria living on the cucumbers consume these sugars and turn them into lactic and acetic acid. Many different bacteria cultures are involved in the process, creating a lot of acid. Carbon dioxide is also a product of fermentation, but is removed from the containers. Fermentation takes several weeks and the combination of the bacteria products (lactic and acetic acid) and salt, preserves the food and prevents the food from being broken down by other microbes that would cause it to otherwise rot.
- **Olives:** Olives are inedible until fermented.
  - The green olives are picked unripe and treated with a sodium hydroxide solution (lye) to break down a compound called oleuropein which has a very bitter taste

*Although this project is funded in part by the Environmental Protection Agency, it does not necessarily reflect the opinion or position of the EPA*

and also inhibits lactic acid producing bacteria. It also softens the olive skins. This takes several hours, after which the caustic solution is washed off thoroughly. The olives are placed in brine (salt water) and the natural fermentation sequence begins. Sometimes sugar is added to the brine to help start the microbial growth. Due to the low pH and salt, lactic acid bacteria and some yeasts replace the natural flora of the fruits. Air is kept out of the vat so that spoilage molds and yeasts cannot grow. The process takes some weeks.

- o The black olives are ripe and are not treated with lye. The fermentation is slower because it takes time for nutrients to diffuse through the olive skins into the brine for the microbes to grow on. A variety of yeasts are responsible for the fermentation process, with significant numbers of lactic bacteria present only if the salt content is less than 6-7%. The final product is much less acidic than green olives (pH 4.5-4.8) and so more salt is usually added to prevent the growth of spoilage microbes in storage.
- **Chocolate:** After harvesting the cacao pods by cutting them down from a tree, the beans are removed from the pods and placed in bins or piles. Fermentation begins through the products of ethanol (produced by yeast), lactic acid (produced by lactic acid bacteria), and acetic acid (produced by acetic acid bacteria). The fermentation process produces the chocolate taste we all know and love. The beans are then dried after about 7 days of fermentation and then shipped to a chocolate manufacturer and processed and eventually made into what we know as chocolate.
- **Mushrooms:** Mushrooms are fungi!

### Activity 2: Researching Good Bacteria and Fungi (20 minutes)

- Have students break into groups of 2-4 and use a computer to research (for 5-7 minutes) how bacteria and fungi help us in other ways, besides in food production. Have each group answer one of the following questions, and then create a short 2-minute presentation on their findings.
  - o What are microbes?
  - o How are animals dependent on microbes?
  - o What are probiotics?
  - o How are microbes used in medicine?
  - o How are microbes used to clean up the environment?
  - o How does sterilization cause resistant bacteria?

### Activity 3: Garden Refrigerator Pickles

#### Ingredients:

½ cup vinegar	6 black peppercorns
2 cups water	4 pinches mustard seed
8 teaspoons salt	5 to 6 medium cucumbers
1 cup dill	

#### Steps:

*Although this project is funded in part by the Environmental Protection Agency, it does not necessarily reflect the opinion or position of the EPA*

Harvest, wash and slice the cucumbers into wedges. Place them in a bowl with the dill and salt, and mix them by hand or with a mixing spoon. Using two mason jars, add to each 2 pinches of mustard seed, 3 peppercorns,  $\frac{1}{4}$  cup vinegar, and one cup of water. Add half of the dill/salt/cucumber mixture to each jar. Seal the lid and mix the pickles until you're ready to eat them!

Generate discussion with students using some or all of the following questions:

1. Why do you use refrigerators?
2. What happens to food that is left out?
3. Does the same thing happen to every type of food? Milk, bread, vs. apples?
4. What did people eat before there were grocery stores, restaurants, and refrigerators?
5. What could they eat when the garden/farm wasn't growing anything?
6. What foods do we not keep in refrigerators?
7. How would you keep food safely, if your power went out or your fridge broke?
8. Why can we leave foods in sealed cans or jars out for a long time, but have to put open cans or jars in the fridge?