STEM ACTIVITY OF THE WEEK

HUDSON RIVER PK

Monitor Bacteria in Your Environment

Theme: Research, Bacteria, Water Quality, Combined Sewer Overflows
Ages: 10-14
Prep Time: 10 min
Activity Time: 30 min, then 10 min/day for up to 7 days
Note: Adult supervision is required for this activity

Activity Summary:
This lesson teaches students about bacteria using an experiment to detect bacteria in their environment. Students model methods that scientists use in this experiment that can be monitored for up to one week. During this experiment, students will learn to prepare a bacterial culture and learn compare presence of potentially harmful bacteria before and after washing hands. The lesson also showcases how proper handwashing removes the presence of potentially harmful bacteria.

Lesson Materials:
- Monitor Bacteria in Your Environment Lesson
- Draw Your Results Worksheet
- Experiment Materials (suggested alternatives for materials also provided below): beef stock powder; gelatin powder; sugar; boiling water; spoon; foil cupcake cups; cotton swabs; re-sealable sandwich bags

BACKGROUND:

Have you ever wondered about the bacteria in your own environment?

You might be surprised to learn that bacteria are *everywhere*: on your skin, in your body, on furniture, in the ocean, on plants--everywhere! But that's not something that should scare you. Although you might think of being sick when you think about bacteria, most kinds of bacteria are harmless and some can even help people.

For example, yogurt is made by adding certain types of bacteria to milk. It's actually the activities of those bacteria that turn the milk into yogurt. You may have heard that yogurt is good for your health, especially yogurt with "live and active cultures." "Live cultures" means live bacteria! The bacteria in yogurt are some of the same bacteria that live in your gut and help you digest food. When you eat yogurt, it adds more helpful bacteria to your body.

Of course, some bacteria, such as sewage bacteria sometimes found in the Hudson River, can make people sick. Because so many people use our waterways for boating and fishing, scientists monitor bacteria to inform people about safe water use. To learn more about bacteria in NYC's waters, view the section "Understanding NYC's Sewer System" at the end of this lesson.

How do scientists monitor bacteria in the environment? Can you monitor bacteria in your environment?

Even though bacteria are everywhere, because they are so tiny, you usually can't see them without a microscope. Bacteria are single-celled organisms (living things). The average bacteria cell is about 1/100 as wide as a human hair and many are even smaller than that!

Since bacteria are really tiny, we can't just look for individual bacteria with our eyes. One way scientists study bacteria without using a microscope is by growing bacteria in an environment where they will multiply hundreds of times. Clusters of thousands of bacteria, called **colonies**, are visible to the human eye.

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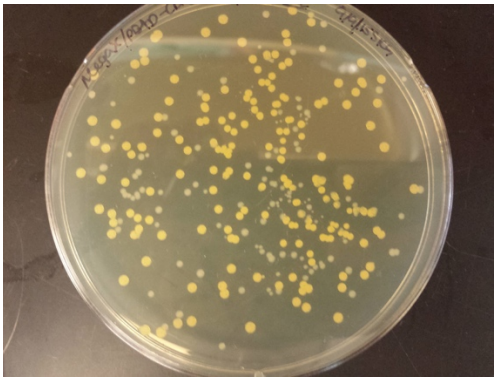
To help bacteria multiply quickly, scientists create an environment that has good conditions for bacteria to grow in. Often, scientists grow bacteria in a petri dish on a gel-like material called **agar** that has bacteria food mixed into it. The pictures below show petri dishes with and without bacteria growing in them.

A petri dish filled with agar gel.



A petri dish with agar gel that bacteria are growing on. Each dot on the agar is a colony of thousands of bacteria.

In our experiment, we're going to create an environment in a cupcake cup that bacteria will grow and multiply in. You will monitor bacteria by collecting samples from your hands with a cotton swab and growing those samples in the cupcake cups. This experiment will teach us how scientists sample for and grow bacteria to find out if bacteria are present in an environment that they're studying.

A Note on Germs & Viruses

You may have heard people use the word *germ* to describe bacteria. Germ is a word used to describe many living things or agents that can make people sick, including bacteria, viruses, fungi, and protozoa.

Scientists usually avoid using the word germ because it can mean so many different things, which can be confusing. For example, bacteria are living cells, while viruses are technically not even alive! Viruses need to be grown in living cells and can't be grown on agar, like bacteria can.

Meaning, with this experiment, students are only able to culture, or grow, colonies of bacteria. We want to take this opportunity to emphasize that **it is not possible to culture a virus using these methods.**

One thing all germs have in common though: if you wash your hands well with soap and water for at least 20 seconds, almost any kind of germ will be washed away! You can read more about different kinds of germs here or you can always reach out to education@hrpt.ny.gov if you have any questions about this experiment.

EXPERIMENT: Caution: This experiment requires adult supervision.

Safety notes:

- Boiling water should only be handled by an adult.
- Although most environmental bacteria are not harmful to healthy people, you should not under any circumstance touch or open the bacteria cultures after Part 1 of the experiment. Bacteria can cause disease when in higher concentrations, so please be careful to keep your sandwich bag experiment secure.

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Experiment Materials

- 1 teaspoon beef stock powder or crushed beef bouillon cube
  - Alternatives: Chicken or vegetable stock (these may not provide as many nutrients for the bacteria, so there could be less bacterial growth than with beef stock)
- 1 teaspoon gelatin powder
  - Alternative: agar powder (vegan option)
- 1 teaspoon sugar (do not use a sugar substitute)
- 1 cup boiling water
- Spoon or other mixing utensil
- 3 foil cupcake cups (Note: cups must be foil so the hot liquid doesn't go through)
  - Alternatives:
  - Build a shallow cup with two layers of aluminum foil
  - Clean a tuna can or baby food jar really well and rinse with boiling water
  - Order disposable petri dishes
- Cupcake pan (optional if using cupcake or tin foil cups, but recommended)
- 3 cotton swabs
- 3 clear re-sealable sandwich bags

Method

Part 1: Preparing Your Samples

1. Wash your hands for at least 20 seconds before you begin. This is to make sure bacteria from your hands don't contaminate your experiment.

2. Set foil cupcake cups in a cupcake pan or onto a plate or baking pan so that the cups can be easily moved around once they are full of liquid.

3. Pour beef stock powder, gelatin powder, and sugar into a heat-proof bowl or measuring cup.

4. Add boiling water to the bowl and mix until all ingredients are dissolved.

5. Slowly pour the hot mixture into the cupcake cups until the cups are about ⅓ full.

6. Let the mixture cool in the cupcake cups until the gelatin is solid. This will happen faster if you place the cups in the refrigerator. The gelatin must be completely solid before you do the next step. **Note:** This may take up to a few hours. You can leave the gelatin cups in the refrigerator overnight and continue the experiment the next day.

7. After confirming that your gelatin cups are solid, place a cotton swab under a tap water faucet for 2 seconds to make it damp. This will help collect bacteria.

8. Without washing your hands first, rub the damp cotton swab all over your palm and fingers.

9. Rub the swab gently over the surface of one of the solid gelatin cups in a zig-zag pattern. Try to avoid breaking the surface of the gelatin.

10. Place the cup inside a sandwich bag and seal it.

11. Wash your hands for at least 20 seconds with soap and warm water. Make sure you rub the soap all over the front and back of your hands and between your fingers. After drying your hands, try not to touch anything before doing the next step.

12. Dampen a new cotton swab and rub the swab all over your palm and fingers. Repeat steps 9 and 10 using the second gelatin cup.

13. Dampen a third cotton swab and rub it directly on the third gelatin cup. This cup will be your experimental **control**. You will compare your other samples to the control.

14. **Safety Note**: Consider stapling or taping your sample bag closed to ensure that it remains shut. From this point forward, it is not safe to directly touch the sample cups.

15. Place all of the sealed cups in a warm area where they can stay for about a week. Bacteria should start growing in 3 to 7 days.
    Note: Most bacteria that live in our homes like warm temperatures, so they will grow more quickly at temperatures between 70°F and 98°F

Part 2: Recording Observations

Safety Reminder: Do not open sandwich bags when observing samples!

1. Each day, draw what you see on the gelatin on the page entitled, *Draw Your Results*. Remember to keep your samples securely sealed in the bags for safety.

2. Once you have recorded the bacteria's growth for at least 3 days, throw the cups away in the trash, being careful to make sure they remain sealed.

What happened?

Bacteria on your hands and in your environment are usually too small to see without a microscope. When you picked up bacteria from your hands on the cotton swabs and spread them on the gelatin that had bacteria food in it (the beef stock powder and sugar), the bacteria ate the food and multiplied many times over the next few days. Once thousands of bacteria were in one spot on the gelatin, the colony (group of bacteria) was big enough to be seen with your eyes.

You may have noticed colonies of different colors, shapes and sizes. Those could be different kinds of bacteria. If you were doing this experiment in a laboratory, you might do more experiments to find out exactly what kind of bacteria is in each colony.

Don't worry too much if you find lots of bacteria on your hands. Remember, bacteria are *everywhere* and most kinds of bacteria do not make people sick. Many types of bacteria even help keep people healthy! But, certain

kinds of bacteria, like bacteria that live in our toilets, could make people sick. That's why it's so important to wash your hands well with soap and warm water after you use the bathroom and before you eat.

How is monitoring bacteria in my home like monitoring bacteria in NYC waterways?

Hudson River scientists monitor our waterways to look for bacteria found in sewage (the same kind of bacteria you might find in your toilet) when they test water samples. Just like scientists monitor the water to make sure there isn't a lot of sewage bacteria in it, you tested your hands to make sure there wasn't a lot of bacteria on them after you washed them. If you did find a lot of bacteria on your hands after washing, that could tell you that you might need to work on your handwashing technique.

Even though we usually can't see them, bacteria play a number of big roles in the web of life. They can have positive and negative effects on our health and the health of the environment around us. By monitoring bacteria in our environment, we can help to keep people safe and learn more about the way they affect the world around us.

Reflection Questions:

1. What are some things that you need in your environment in order for you to grow? What do bacteria need in their environment?

2. Was there a difference in the amount of bacteria that grew on cups 1 and 2? Why do you think this happened?

3. Why is it important to wash your hands well with soap?

4. Are bacteria always harmful to people?

Understanding Experimental Controls

1. What did you expect to see on cup 3, the control cup?

2. If bacteria grew on cup 3, how do you think the bacteria might have gotten there?

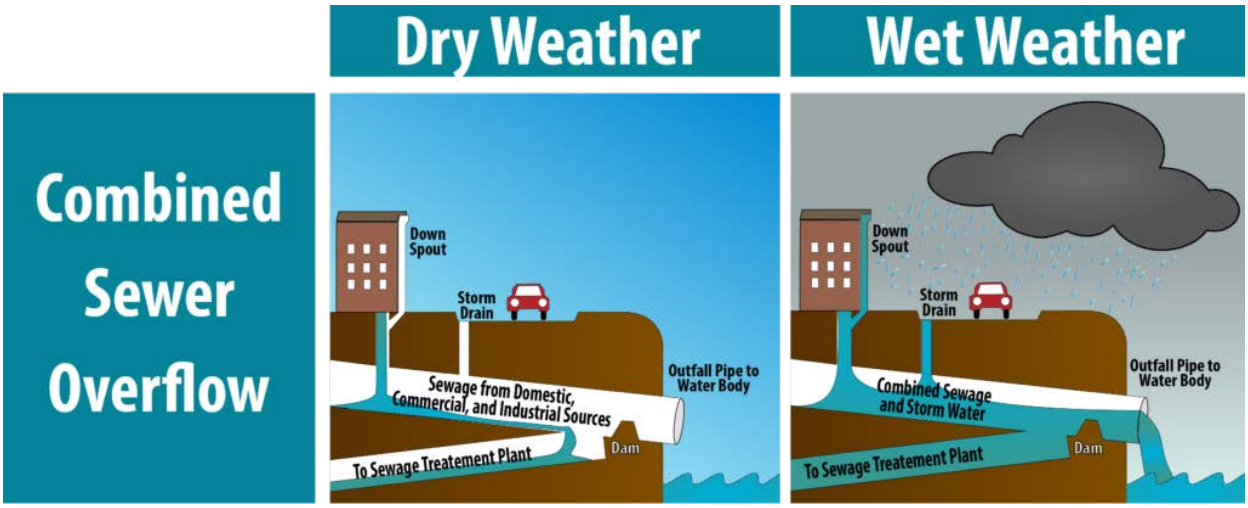
3. Why do you think we made a gelatin cup with nothing on it? How did it help you compare the other two cups?

Extension: Understanding NYC's Sewer System

New York City has a **combined sewer system**. That means, when it rains on the city streets, a lot of that rainwater runs into rain gutters and then into the same pipes as the city's sewage water. **Sewage water** is the water that goes down our drains when we flush the toilet, take a shower, do laundry, and more. Normally, the mixture of rain and sewage water goes to a place called a **wastewater treatment plant**, a facility where it is cleaned and filtered before being emptied into the ocean and rivers around NYC.

Sometimes, during heavy rain events, the sewage pipes leading to wastewater treatment plants can't hold all of this extra water. When this happens, excess rainwater and sewage water goes into the rivers without being cleaned in an event called a **combined sewer overflow** (CSO). That means that if you flush a toilet in Times Square

on a rainy day, that toilet water might flow right into the Hudson River. If someone is rowing a boat in the Hudson River later that day when the sun comes out, they unfortunately might be rowing in contact with toilet water.



Source: Sewerequipment.com

Of course, nobody wants sewage in our rivers and oceans. This is especially true for people who use NYC waterways for boating, fishing, and other activities where they might touch the water. That's because sewage has **bacteria** in it that can make people sick. People who spend time on the river want to know if sewage is present so they can make safe decisions when interacting with the water. In order to track, or *monitor*, when, where, and how much sewage bacteria is in the water, boaters and scientists teamed up to create the Citizens' Water Quality Testing Program.

Each summer, nearly 70 volunteer citizen scientists from local boathouses and community groups collect weekly water samples at boat launches and docks all around New York City. The volunteers bring their water samples to a laboratory, where scientists test the water for bacteria found in sewage. The scientists post their results online so that people know when sewage is in the areas where they boat or fish.

Results from the Citizen's Water Quality Testing Program show that bacteria levels in the river can change dramatically based on the weather. Samples taken after a big rainstorm show high levels of bacteria, while samples collected after a period of sunny weather typically show that the water is safe to interact with. This information helps community boathouses and other organizations to make safe decisions in the water.