GROW YOUR OWN BACTERIA

GRADES 6-12

BACKGROUND

It's a fact of life. Everybody poops! Kids, parents, teachers, firefighters, scientists, dogs, kangaroos, and cows – everybody poops. It's the way our bodies get rid of waste. It's natural. But poop is full of bacteria, and that can lead to all sorts of problems.

Bacteria are microorganisms found everywhere in our environment. They are vital to our existence and perform many important functions, such as digesting our food and keeping our ecosystem in balance. There are thousands of bacteria living in waterways such as streams, rivers, and lakes. We need bacteria to survive and most are harmless, but there are some bacteria that can cause diseases and make us sick. Many of these harmful bacteria are found in poop, especially fecal coliform bacteria, which can make us sick if we swim in or drink bacteria-contaminated water.

MATERIALS

- Plastic or glass bottles (4 oz or larger to collect environmental water samples)
- Beef broth (1 oz pack)
- Gelatin (1 packet)
- Boiling water
- Glass or plastic petri dishes
- Wire, glass rod, or spatula
- Isopropyl (rubbing) alcohol
- Cotton swabs
- Sterile disposable droppers

DEFINITIONS

Bacterium (plural bacteria): A unicellular (one-celled) microscopic organism that lacks a distinct cellular membrane.
Binary fission: The process of one bacterium multiplying by dividing into two daughter cells.
Culture media: A substance used to grow bacteria, consisting of various nutrients that are specific to certain types of bacteria.
Doubling time: The period of time required for a population to double in size.
Exponential growth: When the growth rate of the value of a mathematical function is proportional to the function's current value (bacterial growth and human population growth have been shown to follow exponential growth curves).
Fecal coliform bacteria: A group of bacteria found in feces, or human and animal waste, and used as an indicator for feces contamination in water.
Habitat: A living environment for organisms that fits each species' life necessities.
Incubation period: The time it takes bacteria to grow.
Nutrients: Essential elements that are needed by all living organisms. Examples include (but are not limited to) nitrogen, phosphorus, potassium, and calcium.

TEACHER PREPARATION

- Collect various environmental water samples such as tap, river, lake, wetland, swimming pool, etc. Label each bottle with the source and date. Keep samples in a cool place out of the sun.
- To sanitize petri dishes (if they are not packaged sterile), use isopropyl (rubbing) alcohol and cotton swabs to clean them.
- For the culture media, dissolve 1 packet of gelatin in 60 mL of boiling water and add 1 oz of beef broth.
- Pour the culture media into the petri dishes to a depth of ¼ inch. Put the covers on the petri dishes and allow them to cool to room temperature.

INSTRUCTIONS

1. Explain to students that different bodies of water are home to different types and quantities of bacteria. Bacteria get their food from the surrounding environment. We can also grow bacteria in the lab by providing appropriate food and habitat for the microorganisms.

2. Share with students the different water samples that were collected.

3. Set aside one petri dish as a control in which no environmental water sample is added.

4. In the other petri dishes, place 3 drops of sample water onto each of the cooled plates using sterile disposable droppers. Smear the water carefully by using a glass rod, bent wire, or spatula that has been sterilized.

5. Prompt students to come up with hypotheses as to which petri dish will have the greatest number of bacterial colonies and why.

6. Incubate the petri dishes at room temperature for 4-6 days.

7. After the incubation period is complete, visually analyze the petri dishes for dots. These dots are colonies of bacteria. The more dots, the more colonies of bacteria, which means there was a higher concentration of bacteria present in the source water at the time of sampling.

8. Prompt students to discuss their findings:
   - Why did you observe more bacteria in some petri dishes than others? (Some water is cleaned by humans for drinking like tap water; other water is from nature where animals and humans affect the bacteria count.)
   - What are some sources of the bacteria? (There are many sources of bacteria in water but some major ones include feces, terrestrial and aquatic animal waste, and other animal/human byproducts.)
   - What conditions allowed the bacteria to grow? (The media we made with beef broth and gelatin contained nutrients for the bacteria. We also let the bacteria grow by allowing time to pass.)
   - Did you see the bacteria in the water samples before incubation? (Think about how small bacteria are and how we cannot see them, yet bacteria are everywhere!)

- How do you expect the results of this experiment to change if the environmental water samples were collected during different seasons of the year? (Bacterial metabolism is temperature dependent; thus, we would likely see the lowest bacteria concentrations in water bodies during the winter months. We would likely see the highest bacteria counts during the summer months; students may recall beach closings or news stories about high bacteria concentrations in nearby water bodies occurring during the summer season.)
- What are some potential sources for error or reasons that bacteria could have grown in the petri dishes even if they were not present in the water? (There could have been bacteria on the wire or rod or we could have contaminated the petri dishes with other bacteria from our bodies or the air.)

9. Ask students to research aerobic and anaerobic metabolisms and decide which bacteria they found on their petri dishes. (These bacteria are aerobic because they are all living in the presence of oxygen.)

10. Next, prompt students to determine whether the bacteria are autotrophs or heterotrophs. (These bacteria need organic carbon from the beef broth to survive; therefore they are heterotrophic. Most bacteria in our environment are heterotrophic, especially ones found in water systems. Autotrophic organisms, on the other hand, use carbon dioxide as their carbon source.)

Adapted from Clean Water Education Partnership (http://www.nccwep.org/pdf/activity12.pdf)

MATHEMATICS CHALLENGE EXERCISE

1. Discuss with students that bacteria reproduce in a very different way than humans do:
   - Bacteria are unicellular organisms that reproduce by a process called binary fission, meaning that each singular bacterium splits into two after its genetic material is duplicated. (This method of replication is asexual, since the bacterium does not need a partner's genetic material to be able to reproduce.) Under ideal growth conditions, the doubling time (amount of time required for one cell to become two) for *E. coli* is 20 minutes.
   - If you begin at time t=0 with 1 *E. coli* cell, how many cells will be present after 4 hours under optimal growth conditions?
   - If you begin at time t=0 with 1 *E.coli* cell, how many cells will be present after 24 hours under optimal growth conditions?
   - Using graph paper, create a graph of bacterial growth over time under optimal growth conditions. Plot time on the x-axis (range of 0 to 24 hours) and number of bacterial cells on the y-axis… this is exponential growth in action!

2. For another perspective on bacterial growth rates and human population growth, read the interactive tutorial "Understanding Exponential Growth" produced by World Population Balance (http://www.worldpopulationbalance.org/exponential-growth-tutorial/bacteria-exponential-growth.html).

ADDITIONAL RESOURCES

- http://www.nccwep.org/involvement/kids/dogdoo.php (Bacteria from poop)
- http://www.nccwep.org/stormwater/sources/bacteria.php (Bacteria and stormwater)
- http://water.epa.gov/type/rsl/monitoring/vms511.cfm (United States Environmental Protection Agency - Information about fecal coliform bacteria)
- http://textbookofbacteriology.net/nutgro.html (Nutrients and bacteria)
- http://www.encyclopedia.com/topic/bacteria.aspx (Encyclopedia.com of bacteria)