ECOS
Ecologists Educators and Schools: Partners in GK-12 Education

ECOS Inquiry Template

1. Contributor's Name: NATHAN GORDON

2. Name of Inquiry: NOT TOO HOT, NOT TOO COLD: THE EFFECTS OF TEMPERATURE ON SOIL BACTERIA

3. Goals and Objectives:

a. Inquiry Questions:

1. How does temperatures affect bacterial growth?
2. Do different bacteria grow at different temperatures?
3. Is there a temperature where nothing grows?

b. Ecological Theme(s): Bacteria (like all living things) are heavily influenced by the conditions of their environment.

c. General Goal: To demonstrate that temperature affects biological growth and stimulate thought and questions about other environmental factors that may also be important.

d. Specific Objectives:

Academic: Students think about abiotic (non-living) factors that affect living creatures.

Experimental: Students learn to grow bacteria from soil under varying environmental conditions and record the effects of temperature on growth.

Procedural/Technical: Sampling from the environment. Executing a dynamic experiment.

e. Grade Level: 4-5

f. Duration/Time Required:

→ Prep time: 3-4 hours to collect and sterilize the materials needed, as well as pouring agar plates. This media is available through Carolina Biological Supply (Listed as Nutrient Agar Media Kit (Long-life) cost is about $25.00 for 20 plates).

→ Implementing Exercise During Class: 30-60 minutes

→ Assessment: 15 minutes

4. Ecological and Science Context:

a. Background (for Teachers):

Bacteria live in nearly every environment that exists on earth. Whether home is Antarctic ice or Yellowstone's hot springs, some bacterium is well-suited to live there. These environments represent a broad range of temperatures from nearly 0°C to over 90°C. Obviously, all bacteria can't grow at these extremes, but it's a good example of just how tough these little organisms can be. Lots of bacteria grow in soil and their growth rates are controlled by several conditions around them. One condition that can greatly affect bacterial growth is temperature. The enzymes in bacteria that control their growth are directly affected by the temperatures around them. Each enzyme has a minimum and maximum temperature range within which it can function. If conditions are outside this range, then the enzymes become inactive. There is also an optimum temperature for each enzyme, where it functions best. This inquiry should demonstrate for students that

different environmental conditions (temperatures) support different organisms or numbers of organisms.

b. Background (to present to Students):

Bacteria can be found everywhere. Some conditions are better for bacterial growth than others. Humans have to stay at a certain body temperature or else we become ill. Bacteria are similar. They grow really well if they have the proper temperature in their environment. In this inquiry we will grow bacteria from soil at different temperatures. Which temperature do you think might support the most bacteria?

5. Motivation and Incentive for Learning:

This inquiry is an opportunity for students to work in teams and learn some simple techniques that should be fun. They will get to see bacterial colonies that come from the soil in the schoolyard and how temperature affects them. Students may see different shapes and colors of bacteria, and this should be a unique experience for most students.

6. Vocabulary:

1) Microorganism: An organism that is too small to be seen with the naked eye. Examples are bacteria, very small fungi, protozoans, and viruses.

2) Bacteria: Single-celled organisms that exist almost everywhere on earth (even in our food). They break down organic matter and recycle nutrients in the environment. Some can cause disease in humans and animals, but they also help us make great things like yogurt and antibiotics.

3) Petri Dish: A shallow, circular, glass or plastic dish with a loose-fitting cover over the top and sides, typically used for growing microorganisms.

4) Agar: A gelatinous solidifying agent used as a culturing medium for microbial analysis or isolation.

5) Abiotic: Nonliving, inanimate (relating to characteristics of an environment)

7. Safety Information:

1) When bacterial colonies have grown on the Petri plates, they should not be touched directly by the students. It is possible that some pathogen may be present. Keep Petri plates sealed parafilm or tape.

8. Materials List (including any handouts or transparency masters):

Conventional ovens can be used to sterilize glass bottles (1-2 hours at 350 degrees F). Additionally, a microwave oven can be used to boil and sterilize liquids (at least a 15 minute boil). All supplies can be ordered from Carolina Biological Supply.

Per Team or Student Supplies:

1 - Petri plate of Nutrient Agar (sterile)

1 - Cotton swab (sterile)

Per Class Supplies:

1 - Glass bottle with about 90 milliliters (ml) of sterile water

1 - Scale for weighing about 10 grams of soil

2 or 3 - Incubation areas with different temperatures (ie - box at room temp, box in refrigerator and box in freezer) OR (inside temp vs. outside temp)

9. Methods/Procedure for students:

a. Pre-investigation work:

Prior to the investigation, students should think about the environment the bacteria come from (soil) and the environments we will try to grow them in. They should answer the Pre-investigation questions on their worksheets.

b. Investigation work:

1) What evidence (data, samples) do students collect?

- **The whole class can collect a soil sample from the schoolyard. Take a sample from about 10cm (4 inches) below the surface and place in a clean bag or container. Weigh about 10 grams of the soil and add it to the 90ml of sterile water. Cap and shake the bottle of water and soil for 3 minutes. Now let the bottle settle for about 10 minutes while the students prepare their Petri plates for swabbing.**

- **The students should label their nutrient agar plates with a marker. They should write their name, the date and the temp at which their plate will be incubated.**

- **Now the students dip their cotton swabs into the water and swab the liquid evenly over the surface of the agar in the plate. (Be careful not to push too hard on the agar surface, it is a soft gel.)**

- **Incubate plates at the appropriate temperatures for a week and then observe.**

2) How do students present the evidence (data)? Students record their observations on the worksheet and answer the questions. This can also be done in a class discussion.

3) What conclusions are drawn from the evidence students collect? Which temperature allowed for the most growth? Did one temperature allow no growth? Now incubate all the plates at the optimal temperature for another week and see what happens. Do all the plates now have the same amount of growth? If so, how is this possible? If not, what happened?

4) Include examples of data sheets.

10. Assessment: Post-investigation questions on the worksheet will help assess whether or not students learned the key concepts.

11. Extension Ideas: This same experiment could be conducted using different amounts of light, pH, salinity or other environmental factors that the students think may have an effect on bacteria.

Art extension: Have students draw and color the bacterial colonies growing on their plate. This will aid in the observation process and give students something to refer to once the plate is gone.

12. Scalability: The concepts presented in this inquiry could be scaled to any grade level.

13. Science Standards Accomplished:

1) Life Science Standard

- The Characteristics of Organisms

- Organisms and their Environments

2) Science in Personal and Social Perspectives

- Changes in Environments

14. References:

1) The Microbe Zoo has lots of fun information about microbial ecology.
http://commtechlab.msu.edu/sites/dlc-me/zoo/index.html

2) Microbe World has lots of microbiology experiments that kids can do!
http://www.microbeworld.org/resources/experiment.aspx

15. List of Experts and Consultants:

1) Nathan Gordon will be able to provide technical assistance with the preparation of materials.

2) There are many sources of reliable information on the internet about basic microbiology for students:
http://www.microbes.info/resources/Education_and_Learning/
http://www.microbeworld.org/resources/

16. Evaluation/Reflection by Fellows and Teachers of how it went:

Not Too Hot, Not Too Cold:
The Effect of Temperature on Soil Bacteria
Worksheet (page 1)

PRE-INVESTIGATION QUESTIONS:

1) Where do you think soil bacteria will grow the best? (circle one)

   a) At human body temperature (37°C)
   b) At room temperature (25°C)
   c) In the refrigerator (4°C)
   d) In the freezer (-20°C)

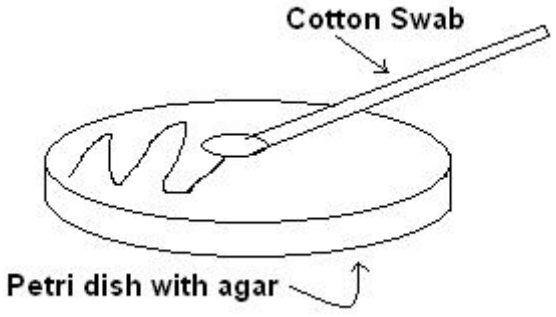
2) Do you think some temperatures might kill all the bacteria? YES / NO

3) Which temperatures do you think might kill them?_____Why?_____

INVESTIGATION:

As a class:
- Add 10 grams of soil (not rocks) to the 90ml of sterile water.
- Cap and shake the bottle of water and soil for 3 minutes.
- Let the bottle settle for about 10 minutes.

Student:
- Label your nutrient agar plates with a marker.
- Include your **name**, the **date** and the **temperature** your plate will be stored at.
- Now dip the cotton swab into the water and swab the liquid evenly over the entire surface of the agar. **(Be careful not to push too hard on the agar surface, it is a soft gel.)**
- Put your Petri plate in the box with the appropriate temperature marked



- Incubate plates at the appropriate temperatures for a week and then observe.

Not Too Hot, Not Too Cold:
The Effect of Temperature on Soil Bacteria
Worksheet (page 2)

OBSERVATIONS OF PLATES AFTER ONE WEEK:

1) Which temperature allowed for the most bacterial growth?_____

This is the **OPTIMAL TEMPERATURE**.

2) Did any temperature(s) allow no growth?_____Why?_____

Now incubate all the plates at the **optimal** temperature for another week and see what happens.

OBSERVATIONS OF PLATES AFTER TWO WEEKS:

1) Do all the plates now have the same amount of growth?_____

2) If so, how is this possible?_____

3) If not, what happened?_____