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

ECOS Inquiry Template

1. Contributor's Name: NATHAN GORDON

2. Name of Inquiry: Hamburger Habitat - Microbiology of Foods

3. Goals and Objectives: To teach students about environmental requirements of microorganisms. Parts of this exercise are similar to Carl Rosier's ECOS inquiry "Isolation of Microbes from the Environment", but this inquiry explores common foods as habitats for bacteria.

a. Inquiry Questions: What are bacteria? Where do bacteria grow? Do you think there are bacteria in food? Why do we cook our food? What type of food do you think has the most bacteria? Why…what would cause that?

b. Ecological Theme(s): Bacteria are everywhere but they require a specific set of environmental conditions to grow.

c. General Goal: Demonstrate how different food storage temperatures support different amounts of bacteria.

d. Specific Objectives:

***Academic*: Students learn about temperature and nutrient requirements of bacteria**

***Experimental*: Students learn how to grow and count bacteria in a Petri dish**

***Procedural/technical*: Students learn the basics of aseptic technique, dilution of bacteria in liquid, and plating microbial samples.**

***Social*: Students work in teams to assess the bacterial counts of their food**

***Communication*: Student teams present their findings to the class so that the different food types and growth temperatures can be compared**

e. Grade Level: 5 (but easily scaled up or down)

f. Duration/Time Required:

→ Prep time: 3-4 hours to collect and sterilize the materials needed, as well as pouring agar plates. However 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: 1 hour

→ Assessment: 30-60 minutes

4. Ecological and Science Context:

a. Background (for Teachers):

Food provides and excellent growth media for bacteria when the proper temperatures exist. If a pathogenic bacterium is in our food and that food is exposed to the optimal growth temperatures, it can increase in number quickly and potentially cause illness if eaten. Human pathogens won't always be in our food, but there are still plenty of other bacteria living there. This lesson demonstrates to students how different food storage (frozen vs. warm) and food types (meat vs. vegetable) support different numbers of bacteria. The inquiry can teach food safety, basic microbiology, and microbial ecology. Bacterial communities anywhere in nature are controlled by the abiotic factors (temperature, pH, salinity, water & nutrient availability) of their environments.

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. We also need to eat and drink every day or we will be very weak. Bacteria are similar. They grow really well if they have a good food source and the proper temperature in their environment. That is why we have to be careful how we handle and prepare our food. In this inquiry we will blend up some meat, fruit, and vegetables and see which one contains more bacteria. Which food type do you think might have 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 and count the growing bacterial colonies that come from different food types. Most of us eat these foods on a regular basis. So students can relate this interesting science to their daily lives. They 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) Raw foods should not be consumed by the students. They do contain bacteria and may make a student ill.

2) Foods are chopped up in blenders for this exercise. Caution must be used when handling or operating a blender.

3) 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 with tape or parafilm.

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

A general microbiology laboratory may be necessary for materials preparation, plate incubation, and proper disposal of materials. I plan to use an autoclave at the university to sterilize the media, pipette tips, blenders, dilution bottles, weighing paper and liquids. Conventional ovens can also 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:

3 - Petri plates of Nutrient Agar
1 - Dilution bottle with 99 milliliters (ml) of sterile water
1 - Pipette with 1.0 and 0.1 ml tips (sterile)
1 – hockey stick style plate spreader
1 – container ethanol for sterilizing the plate spreader

per class:

- scale for weighing 20 grams of food
- food blender
- sterile blender jars (one per food type)
- sterile weighing paper
- 180 ml sterile water (one per food type)
- food samples (at least 20 grams) of ground meat, dried fruit, and frozen vegetables (thawed 2 hours)

9. Methods/Procedure for students:

Depending on the grade level, instructors may need to help the student teams with each step of the diluting and plating process

a. Pre-investigation work: Prior to the investigation, students should think about the food types to be tested for bacterial growth. They should answer the Pre-investigation questions on their worksheets.

b. Investigation work:

1) What evidence (data, samples) do students collect? The students work in teams. Each team has one food type. They follow the methods on the worksheet to dilute and spread the food-water mixture on the Petri plates. Once bacterial growth has occurred, the students count and record the total number and different types of bacteria they can see. Bacteria can usually be seen growing as round blobs on the surface of the plate (Figure 1). Some will have different shapes, sizes, and colors.

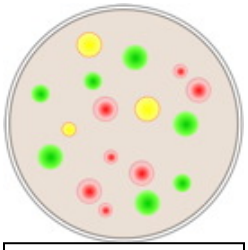


Figure 1. Bacterial colonies on a plate.

2) How do students present the evidence (data)? Students record their data on their worksheets and then each team can post their data on the chalkboard.

3) What conclusions are drawn from the evidence students collect? The students will be able to see which food type had the most bacteria growing in it. The instructor can then reinforce the reasons for the differences.

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 inquiry can be done with several food types, but additional materials will be needed. The bacterial counts can be applied to any environment of interest. For example, the students could compare the bacterial numbers of pond water with that of soil near the pond. The dilution scheme may need to be adjusted though.

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

- Personal health

- Changes in Environments

14. References:

1) Carl Rosier's ECOS inquiry "Isolation of Microbes from the Environment"
http://www.bioed.org/ecos/inquiries/Micro_Isolation_inquiry.pdf

2) Benson, H.J., (2002). *Microbiological Applications – Laboratory Manual in General Microbiology*. McGraw Hill: New York, New York.

3) Figure 1: http://www.plantsci.cam.ac.uk/Haseloff/syntheticbiology/page5/page25/page25.html

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:

MICROBIOLOGY OF FOODS WORKSHEET

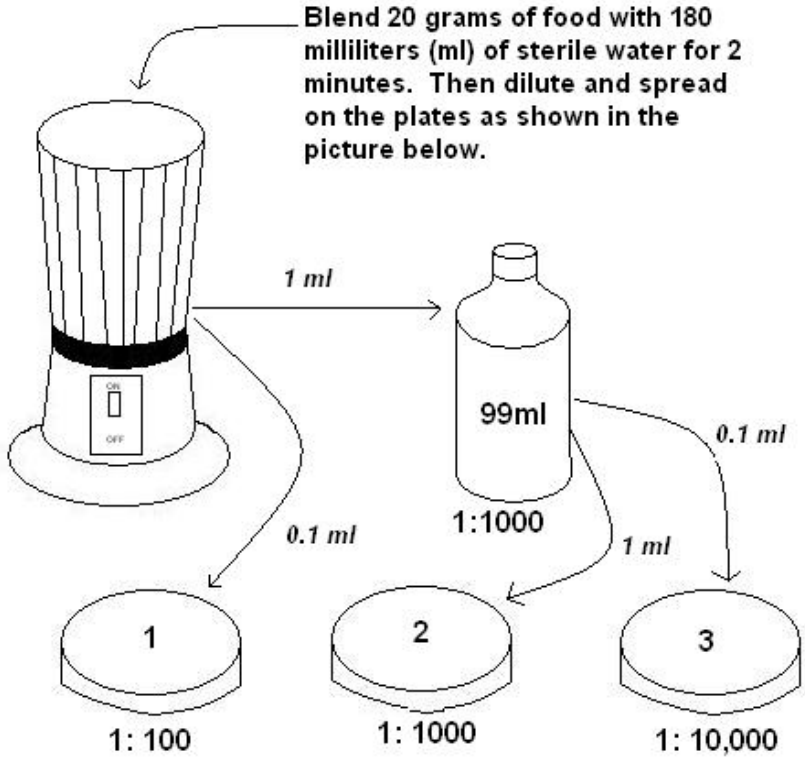
Pre-investigation questions:

1) What type of food do you think will have the most bacteria?_____
2) Why is that food likely to have more bacteria? _____

Investigation Methods: Instructors may need to assist with each step of this process.

DAY ONE:

1) Weigh out 20 grams of the food to be tested on the weigh paper.
2) Add the food and 180 ml of sterile water to a blender jar and blend for 5 minutes (this makes a 1:10 dilution)
3) Transfer 0.1 ml of this mixture to Petri plate #1 (1:100 dilution) and 1.0 ml of the mixture to the 99ml dilution bottle of water (this makes a 1:1000 dilution)
4) Sterilize the cell spreader by soaking it in ethanol and wiping it clean with a tissue
5) Spread the liquid evenly onto the plate surface with the sterile cell spreader; resterilize the spreader with ethanol and wipe clean
6) Shake the dilution bottle very well
7) Use a fresh pipette tip and transfer (from the dilution bottle) 1.0 ml onto Petri plate #2 (1:1000 dilution) and then 0.1 ml onto Petri plate #3 (1:10,000 dilution)
8) Spread the liquid evenly onto the plate surfaces with the sterile cell spreader - MAKING SURE TO RESTERILIZE THE SPREADER BETWEEN PLATES
8) Make sure the plates are labeled correctly then tape them shut
9) Now incubate (upside down) all three plates for 24-48 hours at 35°C (95°F)



DAY TWO: (when the plates all have bacterial growth)

Record data in the chart below

1) Pick the best plate to count (30-300 colonies).
2) Count total number of bacterial colony forming units.
3) Count the number of bacterial types that look different.
    -Are they different in color, shape, or size?

Food Type	**# Total Bacteria cfus**	**# Bacteria types**	**Dilution Counted** (1:100, 1:1000, or 1:10,000)	**Organisms per ml** (cfus × 100, 1000, or 10,000)

Post-investigation Questions:

1) Why are there differences in the organisms per ml between the foods? _____
_____

2) Why are high numbers of bacteria in food bad for humans? _____
_____

3) How can foods be stored so they don't grow bacteria? _____
_____