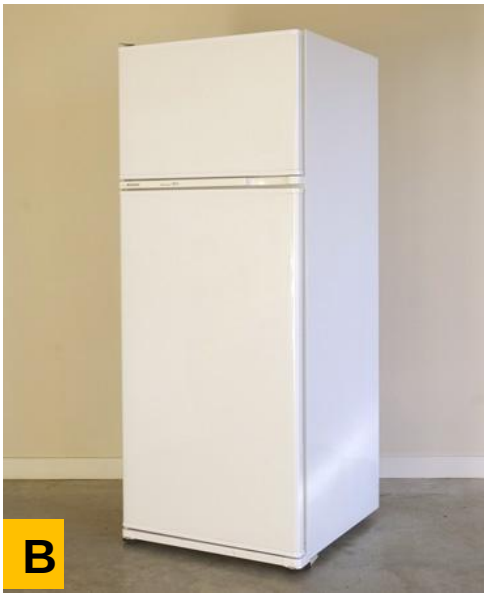
Last Modified July 11, 2012

A

What's Growing in Your Fridge?

Life on the Edge



B

C

Acknowledgements

NASA Astrobiology Institute
Georgia Institute of Technology Center for Ribosomal Origins and Evolution
Georgia Intern Fellowships for Teachers Program
National Science Foundation Research Experiences for Undergraduates Program
Georgia Institute of Technology Center for Education Integrating Science, Mathematics, and Computing

Editors
Dr. Jamila Cola, Georgia Institute of Technology
Dr. Loren Dean Williams, Georgia Institute of Technology School of Chemistry and Biochemistry
Ms. Allison Dowell, Georgia Institute of Technology, Science, Technology, and Culture Undergraduate

Authors
Ms. Aakanksha Angra, Georgia Institute of Technology, Biology Undergraduate Student
Mr. Peter Macaluso, Georgia Institute of Technology, Chemistry and Biochemistry Undergraduate Student
Ms. Jannetta Greenwod, Dunwoody High School Teacher
Ms. Deanna Boyd, McNair Middle School Teacher

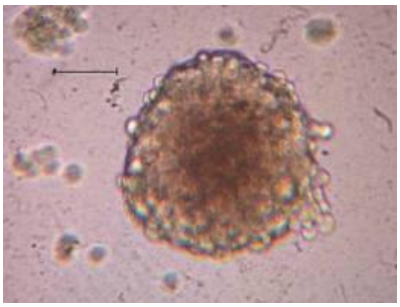
Designers
Mr. Anthony Docal, Orbit Education Inc.
Ms. Aakanksha Angra, Georgia Institute of Technology, Biology Undergraduate Student
Mr. Timothy Whelan, Georgia Institute of Technology, Distance Learning and Professional Education

Photography Credits:

A. Picture of *Psychrobacter urativorans.*
B. Picture of a fridge.
C. Picture of a tank with *Psychrobacter urativorans* bacteria.

National Standards Correlation

Life Science Content Standard C



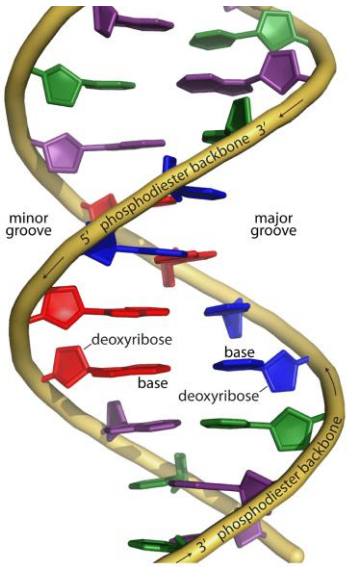
SK-N-SH cells grown in the NASA RCCS.

The Cell

Cells store and use information to guide their functions. The genetic information to guide their functions. The genetic information stored in DNA is used to direct the synthesis of the thousands of proteins that each cell requires.

The Molecular Basis of Heredity

In all organisms, the instructions for specifying the characteristics of the organism are carried in the DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular “letters”) and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome. Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells can create the variation that changes an organism’s offspring.



DNA’s double helix.

Teacher Manual

Purpose

Students will learn if Psychrophiles are found in the home fridge. Students will also practice sterile techniques.

Key Concepts

- Students will be introduced to prokaryotic extremophiles and learn their importance.
- Students will learn where prokaryotic extremophiles fit on the phylogenetic tree and what distinguishes them from other organisms.
- Students will learn and understand how prokaryotic extremophiles are able to survive extreme conditions.

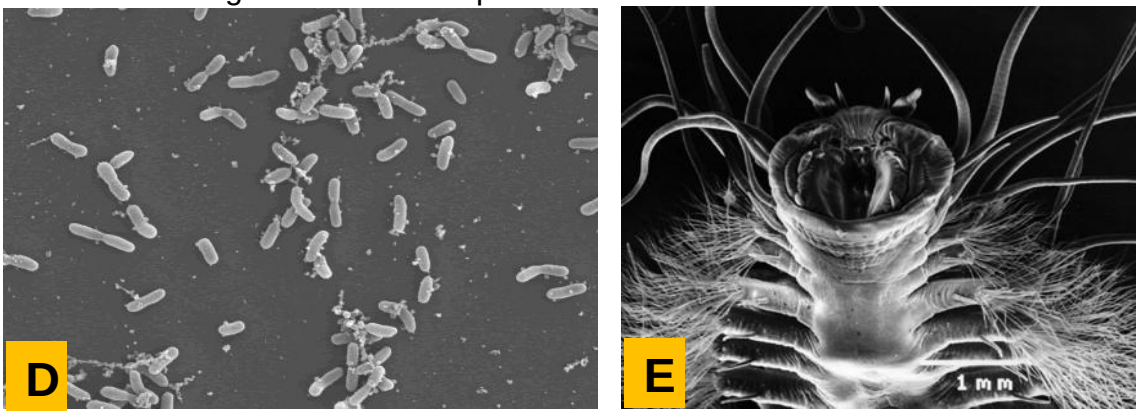
Common Misconceptions

- Bacteria does not grow in the fridge.

Overview

Astrobiology is the study of whether life might exist elsewhere in the universe. Most other planets and moons have conditions that are harsher than the conditions on Earth. Therefore, to get clues about what kind of life might be able to survive on other planets, astrobiologists study organisms that survive in harsh conditions on Earth. Organisms like this are called extremophiles, meaning *extreme loving*.

One category of extremophile is called psychrophiles, which means *cold loving*. Psychrophiles can be found in extremely cold environments all over the Earth. *Psychrobacter urativorans* is a member of the gamma Proteobacteria family[1]. This genera is commonly isolated from cold environments, including soil, sea-ice, and the skin and gills of fish[1]. It has also been associated with food spoilage and is often resistant to irradiation used for food preservation[1]. Another class of psychrophiles is ice worms, which can be found in glaciers and in deposits of frozen methane on the ocean floor.[2]



Left: *Psychrobacter urativorans*, Right: methane ice worm

In this experiment, you will attempt to find psychrophiles in a low temperature environment within your own home: Your refrigerator and freezer. Often, these contain a variety of bacteria and fungi. Organisms such as these are what cause food to spoil. We keep food at low temperatures for two reasons: First, fewer microorganisms can survive at low temperatures (remember, not all organisms are psychrophiles). Second, lower temperatures slow down the growth of most organisms.

Prep Time for teachers: 30 minutes
Class Time: 30 minutes

Skills
1. *Predicting* the outcome of an experiment
2. *Controlling* variables
3. *Conducting* an experiment
4. *Collecting, recording,* and *graphing* data
5. *Drawing* conclusions and *communicating* them to others

Objectives

Themes
- Heredity
- Diversity

Materials
1. Psychrophile sampling kit
2. Sharpie permanent marker
3. Petri dishes with agar

Teacher's Note: Procedure to make the sampling kits:
Step1- Take two15 mL centrifuge tubes with screw caps for each student.
Step 2- Put a few drops of distilled water into each tube.
Step 3- Place a sterile cotton swab into each tube.
-If agar is too expensive, beef broth with sugar and gelatin can be used instead. Visit the following website for a recipe: http://www.umsl.edu/~microbes/pdf/homemademedia.pdf
-**If materials allow, you can give each student 4 tubes and 2 Petri dishes. The instructions for this version are given under the *procedure for teachers* section.**

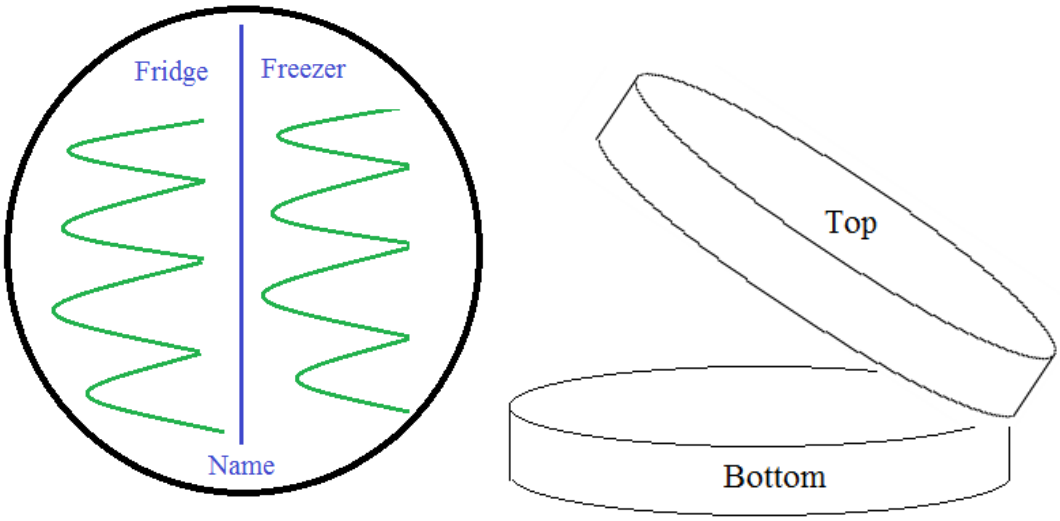
Procedure for Teachers
Teacher's Note: If you are using 4 tubes per student, they will collect two samples from the fridge and two from the freezer. Then, they will store one of each sample in the fridge and one of each sample in the freezer. **You may want to label the tubes yourself ahead of time and hand out the labeled tubes to studends.**
Tube 1-Swab fridge, store in fridge

Tube 2- Swab fridge, store in freezer
Tube 3- Swab freezer, store in freezer
Tube 4- Swab fridge, store in fridge
If you are using 2 tubes per student, the labels will simply be “fridge” and “freezer.”

Demonstrate proper technique for collecting samples:
Step1- Open the tube.
Step 2- Make sure the swab is moistened
Step 3- Wipe it along the inside surface of the fridge or freezer (Designate location of the fridge and freezer to your students so that location does not vary. (Ex. The back wall of the fridge/freezer, etc.)
Step 4- Put the swab back in the tube and close it.

Safety
The organisms in your fridge or freezer are what cause food to spoil, so they can be harmful if they get inside your body. Make sure to keep your samples away from your skin, eyes, and mouth.

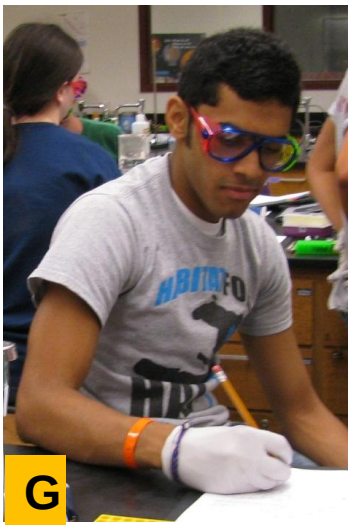
Procedure for Students
Step 1- Obtain a psychrophile sampling kit from your teacher.
Your teacher will explain how to collect your samples.
Step 2- Take your sampling kit home and collect samples. Store them in the appropriate place overnight.
Step 3- Bring your samples to class the next day to plate them on agar plates.
Step 4- Flip your petri dish over so that the agar side is facing towards you. Using a permanent marker, draw a line down the middle of the dish. Along the edge of the plate, write the label from each tube on each half. Write your name along the edge of the plate. See the picture below for an example.



Left: how to divide your plates in half, label them, and streak them. Right: open your plates at an angle to help prevent contamination.

Step 5- Flip your petri dish so the top of the petri dish with no agar is on top.
Step 6- Open one of your sample collecting tubes and take out the swab. Drag it in a zig-zag pattern on the appropriate half of your plate. Only open the lid of the plate about 45^{o} to prevent contamination.
Step 7- Repeat with the other sample tubes on the appropriate plates.
Step 8-Leave the plates out at room temperature. Wait two days to see if anything grows on your plates. Record your observations in your *Data and Observations* sheet.

F


G

Student Observations with Suggested Answers

1. Why do you think we store our food in a cold environment?
   To slow the growth of microorganisms that cause spoiling.

2. What do you think will be the effect of leaving the plates at room temperature? What do you think would happen if we put them back into the fridge?
   The microorganisms will grow faster; they would slow down their growth again.

3. Formulate your hypothesis: Which plates do you think will show the most growth? The least?
   Answers may vary

4. After two days, observe your plates for growth. You can make sketches of your plates here.

5. Define quantitative data. What can you quantify in your data collection?
   Quantitative data is data that can be measured and quantified on a numeric scale. For your experiment, the quantitative data is counting the number of colonies and measuring their size(diameter).

6. Define qualitative data. Give examples from your data collection.
   Quantitative data is describing the data, example, color, size, texture, etc. Examples from your experiment will be the shape and color of your colonies.

Preparing Psychrobacter Plates

Materials

1. 1L of distilled or deionized water
2. 3g Beef Extract
3. 5g Bacto-Peptone
4. 15g Agar
5. Autoclavable bottle
6. Stir bar
7. Stir plate
8. 60 degree Celsius water bath
9. 40 Petri Dishes

Procedure

Step1- Obtain a 1L glass bottle and place a stir bar inside
Step2- Fill the bottle half-way with DI water and place it on the stir plate.
Step3- Turn on the stir plate and position the bottle until a tornado forms. This will ensure proper mixing of the ingredients.
Step4- Weigh the ingredients and add them to the bottle. *Note- The agar in the bottle will not dissolve.
Step5- Autoclave the bottle at 121 degrees Celsius for 30 minutes.
Step6- Take out the bottle from the autoclave and place it in a 60 degree water bath
Step7- Once the bottle is cool enough to handle, pour the fresh media onto the bottom half of the Petri dish. Pour just enough media so that it coats the bottom. Then quickly, place the lid on the Petri dish.
Step8- Continue pouring the plates until you run out of media.
Step 9- To get rid of any bubbles on the plates, invert a Bunsen burner or an alcohol lamp on the agar medium.
Step 10- Let the plates sit at room temperature until solidified.
Step 11- Store the Petri dishes bottom side up in the refrigerator until ready for use.

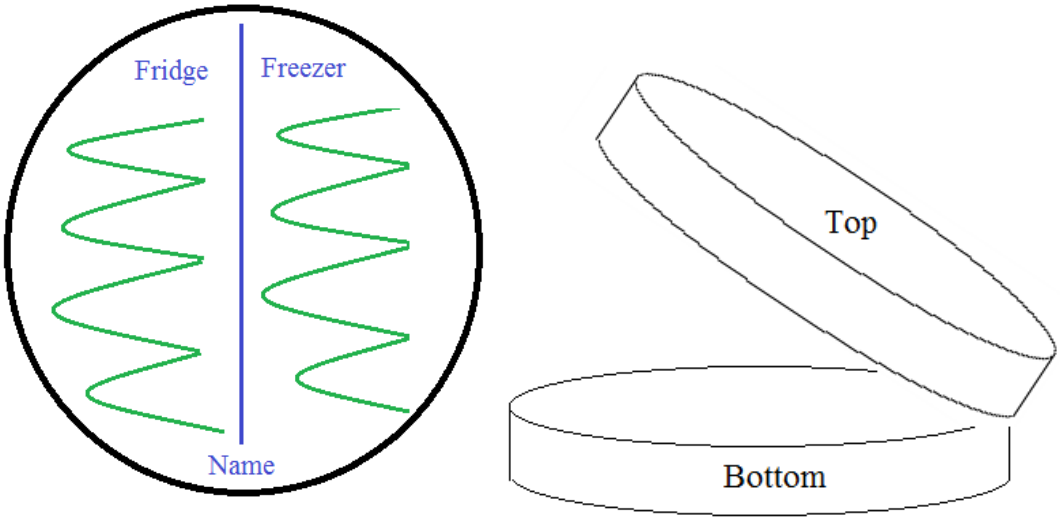
References

1. http://genome.jgi-psf.org/psy24/psy24.home.html
2. http://www.science.psu.edu/news-and-events/1997-news/iceworms.htm

Student Activity Guide

Procedure

Step 1- Obtain a psychrophile sampling kit from your teacher.
Your teacher will explain how to collect your samples.
Step 2- Take your sampling kit home and collect samples. Store them in the appropriate place overnight.
Step 3- Bring your samples to class the next day to plate them on agar plates.
Step 4- Flip your petri dish over so that the agar side is facing towards you. Using a permanent marker, draw a line down the middle of the dish. Along the edge of the plate, write the label from each tube on each half. Write your name along the edge of the plate. See the picture below for an example.



(PLACE PICS AFTER STEP 4)

Left: how to divide your plates in half, label them, and streak them. Right: open your plates at an angle to help prevent contamination.

Step 5- Flip your petri dish so the top of the petri dish with no agar is on top.
Step 6- Open one of your sample collecting tubes and take out the swab. Drag it in a zig-zag pattern on the appropriate half of your plate. Only open the lid of the plate about 45^{o} to prevent contamination.
Step 7- Repeat with the other sample tubes on the appropriate plates.
Step 8-Leave the plates out at room temperature. Wait two days to see if anything grows on your plates. Record your observations in your *Data and Observations* sheet.

Student Observation Sheet

1. Why do you think we store our food in a cold environment?

2. What do you think will be the effect of leaving the plates at room temperature? What do you think would happen if we put them back into the fridge?

3. Formulate your hypothesis: Which plates do you think will show the most growth? The least?

4. After two days, observe your plates for growth. You can make sketches of your plates here.

5. Define quantitative data. What can you quantify in your data collection?

6. Define qualitative data. Give examples from your data collection.