Title of the Lesson Plan:

- **Survival in a Microbial Mansion**____

BIORETS Teacher's Name: Maggie Sims

Intended School Year and Marking Period: 2025-2026, first trimester

Subject and Grade Level: 8th Grade Natural Selection

Overview:

Students will learn about different microorganism traits and adaptations related to what they might find in a Winogradsky column. Students will research why these adaptations would benefit the microbes. On day two, students will create their own Winogradsky column, using mud and water from the pond behind the school. Over the following weeks, students will make observations on the changes they see in their columns and why it might be changing.

Essential Standards:

LS4.C: Adaptation
Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.

Learning Objectives:

Students will be able to describe what traits are.
Students will be able to describe how adaptations help organisms to survive.
Students will build a model to show microbial diversity and adaptations.

Length of Lesson: Two class periods (55 minutes each)

Introduction/Background:

Bacteria are among the most adaptable organisms on Earth, capable of surviving and thriving in a wide range of environmental conditions. Through millions of years of evolution, they have developed specialized strategies that allow them to utilize diverse energy sources, tolerate extreme conditions, and occupy nearly every ecological niche.
One way to observe these adaptations in action is through the use of a Winogradsky column—a self-contained ecosystem that simulates the complex interactions of microbial communities found in natural sediments. By analyzing the distinct layers that form within the column, we can explore how different bacterial species respond to levels of light, oxygen, and chemical compounds.
In this lesson, we will examine how the structure and function of bacterial populations within the Winogradsky column reflect their unique physiological adaptations.

Key Concepts and Terms Covered:

Adaptation
Aerobic
Anaerobic
Bacteria
Carbon
Cyanobacteria
Ecosystem
Microorganism
Oxygen
Photosynthesis
Sulfur
Trait
Winogradsky Column

Materials:

Gloves
Goggles
Sharpie
1 L graduated beaker
Mixing spoons or rods
250 mL tissue culture flask or similar type of container.
300 mL diatomaceous earth (DE)
300 mL freshwater inoculum from sediment
0.5 g shredded paper towel
0.5 g Na_2SO_4
0.5 g $CaCO_3$
0.5 g NH_4Cl
0.5 g K_2PO_4
**Could also use egg yolk or raw eggs.

Activities of the Session:

Day 1:
Students will participate in a round-the-room station activity where they will learn about the different bacteria that they might see in a Winogradsky column, as well as what a Winogradsky column is.
After students complete every station, we will regroup and have a classroom discussion about what they found, and how it relates to the term 'adaptation.'

Discussion Questions:
How can a bacterium's color be an adaptation?
Do all the bacteria live where there is oxygen readily available? How do they survive if there is no oxygen?
In a Winogradsky column, do you think all the bacteria will want to live at the top where there is air, water, and lots of light? Why or why not?

After the discussion, students will complete the last page of the activity and draw their prediction of what a Winogradsky column will look like. They should use what they've learned about bacteria to fill in where the bacteria will be and why.

Day 2:
Students will build their Winogradsky columns using the directions. Mud and water will be collected from the pond prior to class by the teacher. Students will measure the needed materials (water, DE, Na2SO4, CaCO3, NH4Cl, and K2PO4) and carefully pour them into their bottles. The bottles will be placed in a window sill to be observed on a weekly basis in the following weeks.

Engagement:

Each student will get to make their own Winogradsky column. Students will record their observations and take a photo to upload into their digital journals. They will also be able to look at their peers' columns to compare differences and similarities to.

Evaluation:

Students will be formatively evaluated in their answers in class discussions and in their Winogradsky column prediction. Students should be able to explain in their drawing why they think each bacterium will be located where they drew it using the traits and adaptations they had learned about earlier in the lesson.
Students will also be evaluated in their journal entries for their descriptions of why they think certain changes are happening.

Extensions and Modifications:

Students who may not have great bacteria turn out may use photos captured by a classmate of a different column to describe why certain changes occurred.
Students may also experiment with different environmental factors in their columns, like changing the amount of a chemical, cellulose, light, etc. and compare it to their classmates.

Application:

Knowledge gained in this lesson can be applied to how waste is broken down, as the bacteria break down paper towels as their carbon source. It can also be applied to gardening, as some of the bacteria use nutrients like sulfur and can improve the health of soils for crops.
Students are also able to practice many valuable skills during this lesson. They are able to practice their observational and modeling skills, as well as to think critically about how bacterial adaptations affect what they see happening in their microbial communities. Students also practice their measuring skills when making their Winogradsky column.

Resources:

Benoit, T.G. 2015. Increase the visibility of microbial growth in a Winogradsky column by substituting diatomaceous earth for sediment. J. Microbiol. and Biol. Ed. 16:85-86.

Survival in a Microbial Mansion

Please go around the room to each station and answer each of the following questions based on the information given. Please do not use outside sources to answer the questions.

Station 1: Cyanobacteria

Where are cyanobacteria found?

What color is cyanobacteria?

What does it have in common with algae?

What makes it different from algae?

Station 2: Iron-oxidizing bacteria

How do iron bacteria get their food?

What color are iron bacteria?

Where are iron bacteria found?

What do iron bacteria need in order to survive?

Station 3: Purple non-sulfur bacteria

What does PNSB eat?

What does it look like?

What is it used for? How is it used?

Station 4: Purple sulfur bacteria

How does this bacterium get food?

Where are they found?

What do they look like?

Station 5: Green sulfur bacteria

How do they get food?

Why do they need sulfur?

Where do they live?

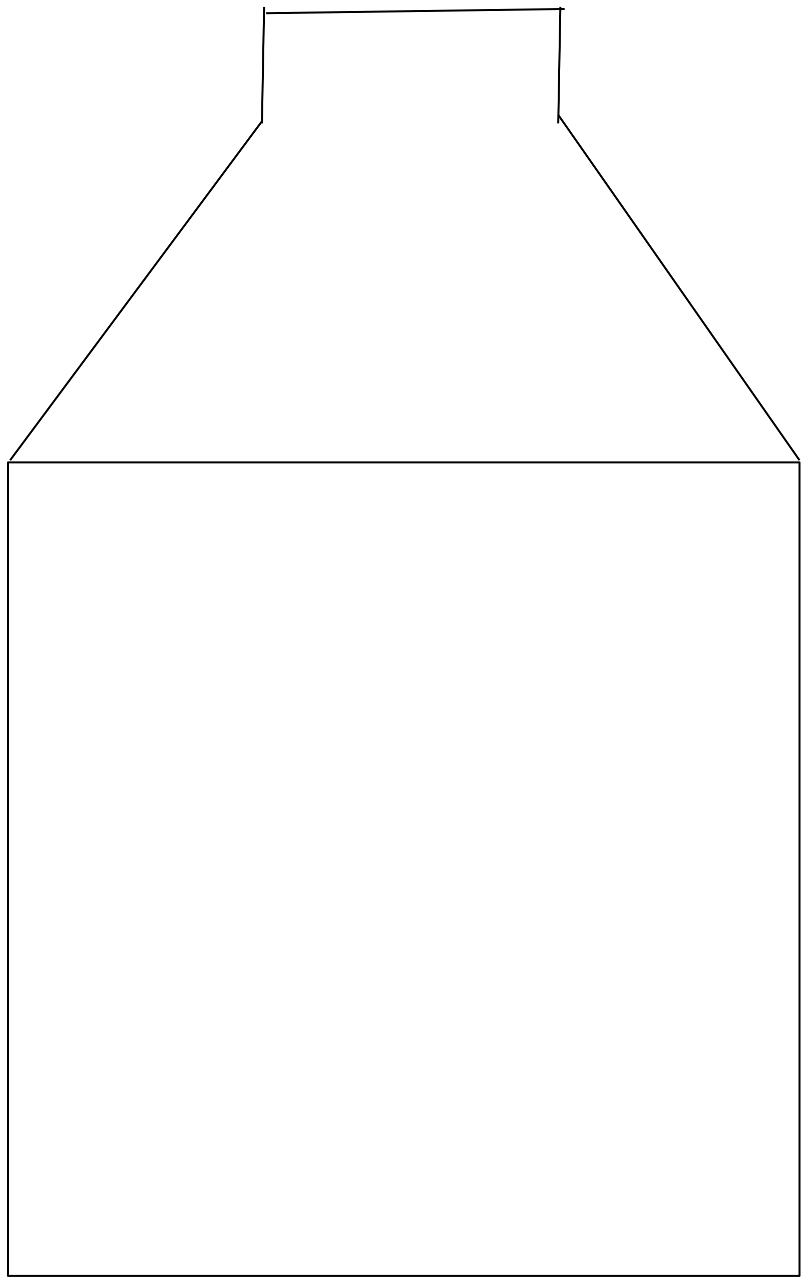
Station 6: What's a Winogradsky Column

Who is it named after? Why?

What was the Winogradsky column invented to do?

Winogradsky Predictions:

Based on what you know about the bacteria that you might see, make a prediction on what your Winogradsky column will look like after the bacteria begin to grow.



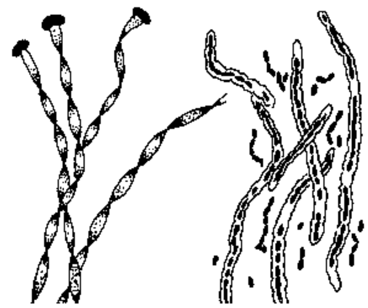
ENVIRONMENTAL Fact Sheet
NEW HAMPSHIRE DEPARTMENT OF Environmental Services
29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-BB-18 2019

Iron Bacteria in Surface Water

What are iron bacteria?

At least 18 types of bacteria are classified as iron bacteria, long thread-like bacteria that "feed" on iron and secrete slime. Unlike most bacteria, which feed on organic matter, iron bacteria fulfill their energy requirements by oxidizing ferrous iron into ferric iron. When ferrous iron is converted to ferric iron, it becomes insoluble and precipitates out of the water as a rust-colored deposit. Once the cells begin to decay, they release a reddish or brownish slime material. This process can occur simply by exposing iron-rich groundwater to the atmosphere. Slimy and clumpy deposits are likely caused by iron bacteria.



Two species of iron bacteria
http://dnr.wi.gov/org/water/dwg/images/bact.gif

Are iron bacteria harmful?

Iron bacteria are of no threat to human health. They are found naturally in soils and water in low numbers and will thrive as more iron becomes available. However, the orange slime in the water or leaching from the shore is often considered to be an aesthetic problem. The oily sheens created by the decomposing bacteria cells are often mistaken for petroleum sheens.

What causes iron bacteria?

Iron is a common element in New Hampshire soils. Consequently, iron-fixing bacteria have existed in our natural waters for over a million years. Iron-rich fill material or bedrock can create an iron bacteria problem whenever it is located near water. In general, wherever there is oxygen, water and iron there is the potential for an iron bacteria problem.

How can we identify iron bacteria?

Orange or brown slime (precipitate) and oily sheens (decomposing bacteria cells) are often the first indication that these bacteria are present. Unlike petroleum sheens the iron bacteria sheens break apart when they are disturbed. The orange or brown slime may be collected in a jar and analyzed microscopically at NHDES to identify the bacteria type.

What can we do about iron bacteria?

The best treatment for an iron bacteria problem is prevention. To thwart these obnoxious bacteria, have all fill material analyzed for iron content before using or exposing it. Unfortunately, once established, iron bacteria problems are difficult, if not impossible to correct. Sometimes iron-rich fill can be replaced by fill with lower iron content. However, this may be extremely costly and have other environmental impacts.

For more information: Please contact NHDES' Biology Section at (603) 271-3503, www.des.nh.gov.