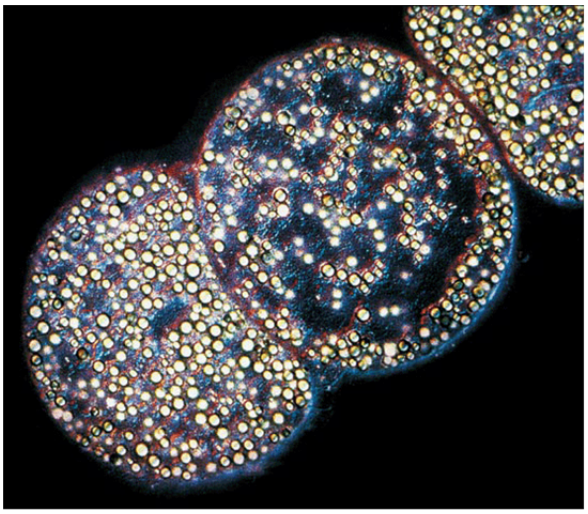
Theme 2:
Microbiology 101 – Introduction to Microbes

Overview



Activities in this theme introduce students to the concept of microbiology, the study of microscopic life. A reading and question exercise introduces characteristics of microbial life, cellular structure, and the abundance of microbes on Earth, and provides some background on the history of microbiology. Students will apply this knowledge in the virtual "adoption" of a microbe from a microbe Adoption Center, and write poems/haiku about the adopted microbes. Finally, students will participate in a hands-on activity to start the equivalent of an "ant farm" for microbes — a Winogradsky Column. The Winogradsky Column activity will introduce students to microbes that can be found in the environment, and it will also teach them about how scientists on oceanographic expeditions explore for microbes at the bottom of the ocean. Note: *In Part I students start the growth experiment in the column; Part II should follow after a few weeks during Theme 5 Environmental Microbiology, so the columns have had a chance to develop. This is when students will make observations of the different communities that grew and explain how variations in the environmental conditions impact what can grow.*

Learning Objectives

Students will be able to:

- Classify a microbe,
- Recall common features of microbes,
- Describe the habitat of a microbe,
- Describe a subseafloor microbe,
- Write a haiku,
- Assembly a Winogradsky column for growing environmental microorganisms

Science Standards:

- Next Generation Science Standards
  - Content Standards
    - Earth Science - Biogeology
    - Life Science – Interdependent relationships in ecosystems; ecosystem dynamics, functioning, and resilience
  - Science & Engineering Practices
    - Planning & Carrying Out Investigations
    - Developing and Using Models
  - Cross Cutting Concepts
    - System and System Models

- National Science Education Standards
  - Science in Personal and Social Perspectives
  - History and Nature of Science
  - Life Science – Diversity and Adaptation of Organisms
  - Earth Science – Structure of the Earth System

- OCEAN LITERACY PRINCIPLES
  - the ocean makes Earth habitable
  - the ocean supports a great diversity of life and ecosystems
  - the ocean is largely unexplored

- EARTH SCIENCE LITERACY "BIG IDEAS":
  - Big Idea #6 (life evolves on a dynamic Earth…): 6.5, 6.9

Target Ages
Grades 6-8

Time
Activity A: Adopt a Microbe - 60 minutes, which includes optional video viewing
Activity B: Microbe Haiku - 20-30 minutes
Activity C: Winogradsky column Part I - 60 minutes

Materials
- Optional: Internet access to watch some YouTube videos
- Main text for students to read with accompanying *Reflection Page*
- Activity A: Adopt A Microbe activity
  - Introduction to Microbes
  - Adoption Center handout
  - *Microbe Adoption Student Page*
- Activity B: Microbe Haiku activity:
  - *Adoption Center handout*
  - *Microbe Haiku student page* with example haiku
- Activity C: Winogradsky activity:
  - *NOTE: this activity requires going outside to collect mud. If this cannot be done during the class period, ask the students to collect some mud on their own, outside of glass, and bring it to school in a sealed jar (recycled spaghetti jars work great, or a canning jar)*
  - *Winogradsky* Column Student Page
  - Paper towels or something else to wipe dirty hands on
  - an empty 1 liter plastic bottle with a lid (like a soda bottle)
  - a hand-shovel or large spoon to scoop mud with
  - a bucket or large bowl to collect mud into
  - a box or cooler to transport the mud and water
  - a glass container, such as a Mason jar or a clean pasta sauce jar
  - plastic wrap (like you would use for wrapping up leftovers)
  - rubber band
  - the yolk of a hard boiled egg
  - a handful of shredded newspaper
  - a well-lit spot where you can leave the container for a few weeks
  - a camera, to take pictures of sample collection

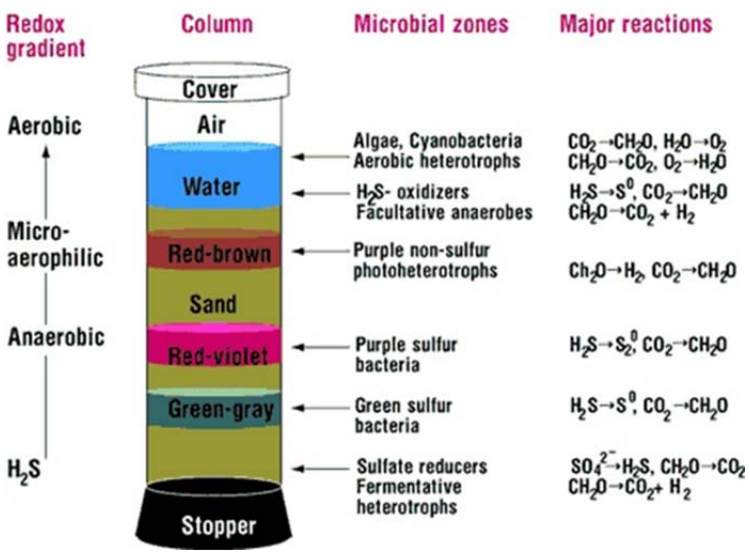
Background

Activity A: Adopt a Microbe - See Student Pages

Activity B: Microbe Hiku – See Student Pages

Activity C: Winogradsky Column

Marine scientists collect long cores of sediment from beneath the seafloor and sample them in different ways to figure out if there is microbial life in the deep sediment (the students will learn more about this a later theme). The students will set up similar experiments using mud found in the environment around them, with the aim of enriching for environmental microbes by adding a little bit of "food" to the mud to encourage the microbes to grow. The plan for this activity is to get the students to collect a short core of sediment from a stream, river, lake, or ocean (or even drainage ditch) nearby, and then they will try to 'grow' their own microbes in a Winogradsky Column. We recommend watching this video made by NASA Quest about building a Winogradsky column, to give yourself some more background - http://quest.arc.nasa.gov/projects/astrobiology/fieldwork/lessons/demo.html.



What is a Winogradsky Column, you wonder? Well, it is an experiment named after a clever guy – Mr. Sergei Winogradsky – who was interested in studying soil microbes about a century ago. He came up with the slick idea of incubating soil and mud with some yummy carbon and sulfur sources to see how the microbes would respond. What results after a few weeks of incubation is a beautiful mixed community of microbes living together, including pretty purple, green, and white bacteria. Using this type of experiment, Winogradsky developed the concept of microbial chemoautotrophy: the ability to synthesize organic compounds from carbon dioxide, like plants do using energy from sunlight, but using energy derived from inorganic chemical oxidation reactions instead.

To set up a column, mud from the banks of a stream, river or lake is mixed with some shredded newspaper (the carbon source, in the form of cellulose) and the yolks of hard-boiled and then placed in a tall and skinny container with a little bit of water on top. Over time (several weeks), the microbes will eat up a lot of the oxygen in the mud, and the bottom of the container will become "anoxic" or oxygen free. Since the top of the container is open, oxygen can still seep into the upper parts of the container. Depending on their need for oxygen and the other food in the mud, different microbes will begin to dominate different depths in the container. You will be able to see this separation over time (3-6 weeks) as the microbes start to grow really thick into bands of different colors.

Instructions for the Educator:

Activity A: Adopt A Microbe

1. Optional: Introduce students to the concepts of studying life below the seafloor using:

Looking for Life Below the Seafloor - http://youtu.be/yOgZy9TfSFo If there is time to show two videos, you might also consider showing this TED Talk about the "secret social lives of bacteria", which gives a broader overview about what microbes are, how abundant they are, and why they are important to human health - http://youtu.be/TVfmUfr8VPA

2. Hand out the Microbe Basics Student Pages. Ask the students to read the main text and then answer the questions. This main text provides a background to microbiology, the study of microbes, and gives classification information about microbes.

3. Hand out the Adoption Center Guide, along with the Adopt A Microbe Student Page

4. Give students a little time to select a microbe from the Adoption Center and fill out the Microbe Adoption Student Page. They should discuss their selection.

Activity B: Microbe Haiku

1. Pass out the Microbe Haiku student page to each student.
2. The "Microbe Haiku" activity is inspired, in part, by the multi-cultural, international experience of scientists participating in research on the RV JOIDES Resolution, the scientific ocean drilling vessel from the USA. Talk with the students about the international nature of oceanographic research. The scientists and crew for the ship come from many different nations and cultures. Part of the excitement on these cruises is getting to know new people and learning about their lives. On one expedition, four of the scientists were Japanese. To reflect this multicultural experience, the students will compose a haiku about their adopted microbe, to reflect learning about basic traits of their microbes. Haiku is a Japanese form of poetry. In western cultures, haiku has been translated into poems that contain three lines, where the first and last lines have five syllables, and the middle line has seven. As a way to get a bit of international flavor and to better get to know their microbe, students will write their own haiku.

3. Explain to students that they will write a haiku to summarize interesting or common features about their adopted microbe. They can use information in the Adoption Center handout or the Internet. The haiku can be about any topic related to the adopted microbe, for example what the microbe eats, where it lives, what it looks like, etc. Silly or serious would be fine.
4. Show the students some example haiku from the Microbe Haiku Student Page
5. Give students 5-10 minutes to write their haiku, then have them share their haiku aloud with each other.

Activity C: Make a Winogradsky Column

1. Handout the Winogradsky Column Student Page and explain to the students that they are going to set up a Winogradsky column of their own using nearby mud. Remind students to not put any mud or dirt or water into their mouth while doing this, and to wash their hands when they are finished. While mud and water is not necessarily harmful, it is always good to be safe.

2. Take the bucket/bowl and spoon/shovel to the bank of a nearby stream, river or lake. Taking care not to fall into the water or get stuck in the mud, scoop up a few handfuls of mud into your bucket. Try to avoid mud with lots of roots or rocks. Take a picture of the sampling location, and fill out the relevant questions on the Student Page.
3. Fill up one of the plastic bottles with water from the stream, river or lake. Close up the bottle.
4. Transport the mud and water back to the classroom, trying to keep the samples from getting too hot or exposed to sunlight.
5. In the glass jar, add a handful or so of the shredded newspaper and the yolk of a hard-boiled egg to some mud and mix it up with the spoon. You want the mud to have the consistency of a milkshake, so if you need more water, use the water you collected (but don't use it all, you will need a little bit for the end). You want to fill the jar about three-quarters of the way with mud. Gently tap the jar on a table to squish out any air bubbles.
6. Pour a little bit of the water on top of the mud in the container, leaving about half an inch of space between the water and the top of the container.
7. Place a piece of plastic wrap over the container and hold it in place with a rubber band. The plastic allows air to get through but reduces the amount of water that escapes.
8. Now the Winogradsky column is ready to start incubating - take a picture of it! Store it somewhere in a well-lit room but not in direct sunlight (to prevent it from overheating). Over a few weeks time, you should hopefully start to see development of thick colored bands with a slimy texture – these are different types of enriched microbes. In a few weeks, we will revisit your Winogradsky columns to use them for another activity.
9. Have students finish answering questions on the Student Pages.

Acknowledgements

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