

## Bacterial Terrarium

### Lesson Overview:

In the 1880's, a Russian microbiologist named Sergei Winogradsky discovered that water mud poured into a tall bottle and placed in the sun turned many different colors. He found that by adding a few simple things, such as cheese or paper, he could control which colors appeared. Here's a recipe for making your own Winogradsky column.

**CTE Standards:** Energy and Environmental Technology Pathway  
Standards 11 B1.1-1.3; B2.1-2.2, 2.6; 3.1-3.3

### Materials required:

- mud from a bay shore of the edge of a shallow pond (the smellier the better)
- water
- a clear tennis-ball container or plastic soda bottle with the top cut off
- container top or plastic wrap and a rubber band
- 1/4 newspaper page shredded
- 1 raw egg (without shell)
- bowl
- spoon
- lamp with a 40-watt incandescent bulb

### Main objective:

- Students will be able to build a model biological digester to show the recycling of nutrients

### Learning outcomes:

- Students will be able to describe the role that bacteria play as a decomposer in a model ecosystem

### Student Deliverables:

- Students will produce a model of a digester using their bacterial terrarium

### The Lesson:

1. Remove any rocks or sticks from the mud, and put the mud in the bowl. Mix it with water until it's the consistency of heavy cream.
2. Remove the label from you container. Put in the shredded paper and egg, add an inch of mud, and mix well. Then, fill the container with mud up to an inch from the top and cover it. Wash your hands after you complete the setup.
3. Put the container about a foot from a 40-watt bulb that you can leave on all the time. Every few days, briefly remove the container's top to vent off the biogases (if too much gas is allowed to build up, it can blow the top off). If the mud at the top is drying out, add a little water. In a few weeks, you'll see auras of brilliantly colored bacteria. Keep watching, and you'll see the colors develop and change during the next several months.

### Explanation:

- Many kinds of bacteria live in mud. Some are decomposers that get nutrients by breaking down organic materials and things like the egg and paper. During the process of decomposition, all the oxygen near the bottom of the container is used up.
- Other bacteria are photosynthetic. Blue-green bacteria near the top of the mud column use light, carbon from carbon dioxide, and hydrogen from water to make carbohydrates

and give off oxygen just like plants. The carbon dioxide they need is released when the decomposers break down the paper and egg.

**Lesson Extensions:**

1. The students or teacher can collect expelled gases and test for volatility with a glowing splint test (1<sup>st</sup>) and a flaming splint test (2<sup>nd</sup>)
2. Students can discuss the changes in atmosphere on the Earth during evolutionary time. Our current atmosphere is a secondary atmosphere that is primarily nitrogen ( $\approx 78\%$ ) and oxygen ( $\approx 21\%$ ) gas. The primary atmosphere contained gases similar to those produced in this activity. Have students research the difference in the two atmospheres and list the gases produced and then have them describe the differences in the properties of the gases.

**Further Reading:**

Microbiology of atmospheric trace gases: sources, sinks and global change processes by J C Murrell; Publisher: Springer

**Web resources:**

<http://www.thegateway.org/browse/16442>

<http://abyss.uoregon.edu/~js/ast221/lectures/lec14.html>

<http://www.physicalgeography.net/fundamentals/7a.html>

**Teacher resources:**

<http://www.exploratorium.edu/theworld/glow/grow.html>

**Student Activity:**

Student additional reading sheet

**Lesson Plan Relevance to Externship:**

- As part of the Energy and Technology Center of SMUD, I was given the task of researching and visiting a Dairy Digester to assist with their presentation to science teachers during the annual convention this fall

## Rubric for the Bacterial Terrarium Project

Student Deliverables	4 Exceeds Expectations	3 Meets Expectations	2 Approaches Expectations	1 Fails to meet Expectations
Content Knowledge	Student demonstrates full knowledge (more than required) with explanations and elaboration	Student is at ease with content, but fails to elaborate.	Student is uncomfortable with information and is able to answer only rudimentary questions.	Student does not have the grasp of information; student cannot answer questions about subject.
Format followed	All elements followed	Format followed, but no bacteria is grown	Student layers incorrectly	Format ignored
Maintenance	All gases produced are expelled in a safe manner	Maintenance is consistent; some gas build-up is observed	Some maintenance is performed	Student does not maintain terrarium
Documentation	Photos are included and model is submitted	Some photos are included	Model completed and submitted	No documentation