



## Try this: Build your own Winogradsky Column

The Winogradsky Column is a simple device, invented over 100 years ago, that is still used by scientists to see if life can flourish even where there is little or no oxygen (O<sub>2</sub>) like the type we breathe in the air. In this exploration, you will build a Winogradsky Column, giving your ecosystems water and some food, in the form of carbon (C) and sulfur (S). Hopefully, it will get a pretty gradient of colors. The colors are the different bacteria that grow inside the column. Here are the type of bacteria that live in your Winogradsky Columns:

Position in Column	Type of Organism	Organism Examples	What color they look like in your column
Top	Photosynthesizers	Cyanobacteria	Green or reddish-brown layer. Sometimes bubbles of oxygen.
	Nonphotosynthetic sulfur oxidizers	<i>Beggiatoa</i> , <i>Thiobacillus</i>	White layer.
	Purple nonsulfur bacteria	<i>Rhodomicrobium</i> , <i>Rhodospirillum</i> , <i>Rhodopseudomonas</i>	Red, purple, orange, or brown layer.
	Purple sulfur bacteria	<i>Chromatium</i>	Purple, or purple-red layer.
	Green sulfur bacteria	Chlorobium	Green layer.
	Sulfate Reducing Bacteria	Desulfovibrio, Desulfotomaculum, Desulfobacter, Desulfuromonas	Black layer.
Bottom	Methanogens (archaea)	<i>Methanococcus</i> , <i>Methanosarcina</i>	Sometimes bubbles of methane.

In this exploration, you will create four (4) separate Winogradsky Columns:

- a control with no added nutrient source
- one with only a sulfur nutrient source
- one with only a carbon nutrient source
- one with both sulfur and carbon.

### Each column will create its own ecosystem.

You will need to be patient when waiting for results in your Winogradsky Columns. Typically, flourishing ecosystems and color changes require several weeks to grow. (Remember, the organisms that you are growing are very small, so small in fact that thousands could fit on the period at the end of this sentence.) Your column also demonstrates the concept of “succession” within an ecosystem. Different organisms eat and use up certain nutrients, and as those nutrients become depleted, new organisms take their place, often using the waste product of the previous organism as food.

# Exploration: Build Your Winogradsky Columns

## Purpose:

To build a model of an ecosystem that will host both bacteria and archaea organisms, understand that ecosystems thrive in a variety of harsh conditions and that living organisms can live in a variety of environments. Water is an important part of all ecosystems.

## Materials:

- 4 clear plastic water bottles (tall and narrow with a smooth inside)
- Plastic gloves
- Scissors
- Marker
- Ruler
- Trowel or shovel
- Soil from the outdoors, (quicker results would be from a ponding area, but a garden will do)
- Two buckets
- Newspaper or plain paper (shredded)
- A boiled egg
- Two smaller bowls
- Two large mixing bowls
- Measuring cup or scoop
- Wide stick
- Measuring spoon
- A warm area to place your Columns
- Plastic wrap
- Plastic trash bags or grocery bags
- Four rubber bands
- Cardboard box or brown paper bag
- Camera (optional)

## Procedure:

1. Carefully cut off the tops of your bottles using scissors. Individually label the bottles Control, Carbon, Sulfur, and Carbon + Sulfur.
2. In a bucket, collect enough mud from a ponding area to fill all four of your bottles plus a little extra. If you are using 1 liter bottles, collect 5 liters of mud. Try to avoid large pieces of material such as twigs or leaves or roots. The mud should be saturated with water. You will need enough mud to fill each of your bottles about 80% full.
3. Collect enough water from a pond to cover your mud. Water that has been left outside for a night will also work. Keep the water separate for now.
4. In the first mixing bowl, transfer enough mud to fill your bottle full twice to the mixing bowl, removing any twigs, leaves or rocks. Break apart any large clumps of dirt. Add water until the mixture is the consistency of a fruit smoothie.
5. Transfer enough mud from the bowl to fill your Control bottle 80% full. Tap the bottom of the bottle against a solid surface to remove air pockets. You may use the wide stick to push down the dirt, but do not pack it tightly.
6. Back in the first mixing bowl, repeat Step 4, but this time add a sheet of shredded newspaper or plain paper. Mix the paper into the mud until it is thoroughly mixed in.
7. Repeat step 5, but to the bottle labelled "Carbon."
8. In the second mixing bowl, repeat Step 4, but this time add your hard-boiled egg. Mix thoroughly.
9. Repeat Step 5, but to the bottle labelled "Sulfer"
10. Add the remaining Carbon and Sulfur mud together and mix.
11. Repeat Step 5, but to the remaining bottle "Carbon + Sulfur"
12. Pour the remaining water into each bottle until each bottle is about 90% full.
13. Cover each bottle tightly with plastic wrap.
14. Set each bottle in a warm environment near a lit window, but not in direct sunlight. Let the water settle.

## Observations:

1. Using your Winogradsky Worksheet, design a table to record your observations of your Winogradsky Columns. You may want to include: colored drawings or pictures of the columns, colors observed, position in the column that it was observed, guesses as to which bacteria or archaea may be growing in the column, and justifications as to why you believe that this organism may be archaea or bacteria based on the information table given on page 1.
2. Record what the Winogradsky column looks like every 4 days for 5 weeks. Record any changes in colors and mark where each different color shows up in the column. Some of the colors might be very subtle, so look closely.

\*Optional: Take a picture every 4 days for 4 weeks of your column and see how the colors change. Place the pictures in your observation journal or worksheet.

## Results

In previous explorations (Water is Life I) you looked for signs of life in your dirt sample after water was added. These signs included movement and bubbles. What signs of life did you find in your Winogradsky Column?

Did your column have the same results as others?

How did the colors change based on the nutrient type?

Did colors change over time? How?

List some of the variables you could change in this exploration.

## Extensions

- Do the same exploration, but change the source of the mud.
- Do the same experiment but change the amount of light / temperature / water.

## Design an Observation Table

Using this Winogradsky Worksheet, design a table to record your observations of your Winogradsky Columns. You may want to include: colored drawings or pictures of the columns, colors observed, position in the column that it was observed, guesses as to which bacteria or archaea may growing in the column, and justifications as to why you believe that this organism may be archaea or bacteria based on the information table given on page 1.

