Winogradsky Column

Grade: 5-6

Time: 2hrs

Activity Overview :

Today you are going to be a microbiologist! You will culture some colourful microorganisms and learn what they need to thrive. Microorganisms are very small organisms (living beings) that are essential to ecosystems and life. Just like us, microorganisms need specific nutrients to survive and grow. We will get a firsthand look at this through making a Winogradsky column. A Winogradsky column is a long sealed tube of muddy soil. This column leads to a colourful gradient of different microorganism growth due to the varying levels of oxygen and sulphur inside. It will also change in appearance with time!

Before we begin think about the following questions:

- Why are microorganisms important?
- What do microbiologists do?
- How is the Winogradsky column able to cultivate different types of microorganisms and be self-sustaining?

Materials:

- Mud (preferably nearby a lake or body of water)
- 3 Bottles
- Carbon source (shredded newspaper, sawdust, grass clippings, or oatmeal)
- Sulfur source (egg yolk, hard boiled eggs, raw eggs, or cheese)
- Saran wrap
- Bucket
- Scoop or Shovel
- Mixing bowl
- Spoon
- Rubber Band

Activity:

1. Head over to a stream or nearby body of water with gloves, a bucket, and a shovel/scoop. Wear the gloves and use the shovel/scoop to scoop in some mud into the bucket. Collect enough to fill 2 bottles of your choice. The bigger the bottles, the easier it will be to see the layers of microorganisms. Make sure the mud is wet and try to keep the rocks out if possible.

2. Go back home and cut off the top of one bottle. The top of the bottle will act as your funnel later on, and the other part will be your column. Remove the bottle cap, flip the cut out top, and place it on top of your column. It should now look like there is a funnel on top of the column.

3. Transfer your mud into a mixing bowl.

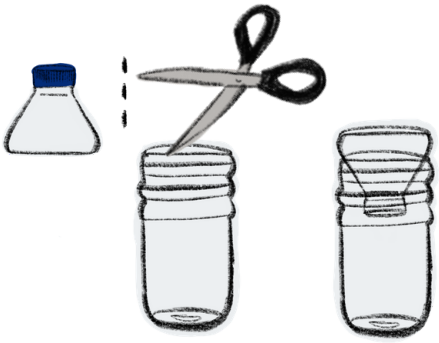
4. Make sure your mud has the consistency of a milkshake. If it does not have this consistency, add the necessary amount of water. Use the scoop to mix.

5. Add a handful of your carbon source to your mud. This could be shredded newspaper, sawdust, grass clippings, or oatmeal. Mix this into the mud.

6. Add a spoonful of your sulphur source. This could be egg yolk, hard boiled eggs, raw eggs, or cheese. Stir this into the mud, adding more water if needed.

Step 1

Step 2



Step 3 - 6

7. Using your scoop, transfer the mixture into your column through the funnel. Every time you add some mixture into the column, make sure to gently tap the column against a surface. This is to avoid trapped air at the bottom of the column.

8. Once the column is filled, add a centimetre of tap water to the top. Then cover the column with saran wrap and secure with a rubber band.

9. Repeat steps 3-9 with the other bottle.

10. And you're done making the Winogradsky columns! Place one column in a well lit room, away from direct sunlight. Place another column in a fridge with a light source. If it is around 0-15 °C outside, you can leave the column outside instead. The different temperatures will select for different kinds of microorganisms. Wait a few weeks to start seeing colourful microorganism layers! If you keep it around even longer, you will start to see shifts in colour and appearance as the microorganisms change.

    - If you are curious, the kind of microorganisms that can grow in a Winogradsky column are Clostridium, Desulfovibrio, Chlorobium, Chromatium, Rhodomicrobium, and Beggiatoa, as well as many other species of bacteria, cyanobacteria, and algae!

Step 6

Step 7

Step 8

Engineering and Science Connections

Why are microorganisms important?

Microorganisms help us develop life-saving medicine, metabolize, and digest food. On a more global scale, microorganisms help plants fix nitrogen (which is needed for animals to create proteins), produce vast amounts of oxygen, break down waste, keep the global biogeochemical cycles running, and many more! Even though we cannot see microorganisms, the world would be very different without them.

What do microbiologists do?

Microbiologists study the growth and interactions of microorganisms like bacteria, fungus, viruses, and protozoa. They often are hired to investigate contamination sites, medicine and pharmaceuticals, food production, agriculture, and how to use bacteria to our advantage.

How is the Winogradsky column able to cultivate different types of microbes and be self-sustaining?

Different species of microorganisms have different needs to survive and grow. Many need sugars, nutrients, vitamins, and respiratory gases like oxygen. In the Winogradsky column, a certain type of microorganism may use up a specific resource it needs to grow. However, that allows another type of microorganism, which has different needs, to take over. For example, one microorganism can live in the bottom layers of the column and deplete it of oxygen. But there are microorganisms which do not need oxygen to survive, and then it is their turn to shine. This dynamic repeats itself, allowing the column to be self-sustaining. In general, the column always has differing amounts of oxygen and sulphur in its various layers, and the microorganisms will grow in the layer which best suits its needs.

We as humans prefer certain temperatures over others. Just like us, microorganisms have temperatures they grow best in. When a column is placed in a fridge, the cold-loving microbes will grow. These cold-loving microorganisms are known as psychrophiles. To be more specific, psychrophiles grow best in the temperature range of 0–15 °C, in other words, below room temperature. Contrastingly, the column that is placed in a well-lit room will grow moderate-loving microorganisms known as mesophiles. These microorganisms grow optimally in a temperature range of 20 to 45 °C.

Take a look at the table below to see what colour is associated with what microorganism! Note that this table is referring to the typical microbes you would see growing when you have the column at room temperature.

Position in the column	Possible main microorganism	Colour
Top (oxygen loving)	Cyanobacteria	Green or reddish-brown layer. Sometimes bubbles of oxygen
	Beggiatoa, Thiobacilus	White layer
	Rhodomicrobium, Rhodospirilum, Rhodopseuodmonas	Red, purple, orange, or brown layer.
	Chromatium	Purple, or purple-red layer.
	Chlorobium	Green layer
	Desulfovibrio, Desulfotomaculum, Desulfobacter, Desulfuromonas	Black layer
Bottom (sulfur loving)	Methanococcus, Methanobactin	Sometimes bubbles of methane

Extensions

- Create more Winogradsky columns with different types of materials. For example, if you used mud from a pond before, try using mud from a lake!
- Keep a logbook of the changes that happen to the column. Did one layer change colour? Do you see bubbles somewhere? The column is very dynamic (it is a bunch of living organisms after all!), and the appearance changes with time.
- Redo the experiment but add 25-50g of salt per 1L Winogradsky column to the collected mud before adding water and stirring. By adding salt, you are ensuring that the only microorganisms that grow in your column are halophiles. Halophiles are salt-loving bacteria, allowing them to grow in salty conditions.

3, 2, 1 Done!

3 - Write or draw 3 things you learned from this activity

2 - Write or draw 2 things you found super interesting or cool and want to learn more about

1 - Do you have any questions about the activity? Did something make you wonder...what if? how? or why?