Build a Microbial Townhouse (Teacher Guide)

Objective

Students will understand that micro-organisms can survive in many different environments and that micro-organisms live in places where conditions are suitable for their growth. Micro-organisms can live in the unlikeliest of places, such as the depths of the ocean or in caves where sunlight fails to penetrate or where poisonous gases exist.

What you need

Each group of students will need the following materials:

- A copy of Build a Microbial Townhouse (Student Guide) blackline master for each individual
- 1 hard-boiled egg
- 5 cups of mud
- 1 cup of de-chlorinated water
- 1 bucket
- 1 large stirring spoon
- 1 tablespoon of powdered chalk
- 2-litre clear plastic bottle with top cut off
- 1 paper cup
- Plastic wrap
- Rubber band
- Sheet of red cellophane or acetate (for one group only).

What to do

- Tell students that they will be studying how micro-organism populations grow in different mediums and how these populations change the environment in which they live. They will be creating three mud columns to study how different microbes will inhabit different environments, depending on the conditions that exist.
- Have students collect mud. The best mud comes from the margins of fresh or saltwater ponds or marshes. Moist field soils can be used, but are less likely to produce easily observed micro-organisms.
- Cut off the plastic bottle tops. Hard-boil the eggs. Organise students into three groups and give each student a copy of the Build a Microbial Townhouse (Student Guide) blackline master (downloaded from the Teacher Toolkit), then organise a set of materials for each group.
- Ask students to follow the instructions on the blackline master to create their columns. Have one group add red cellophane or acetate around its column. After the columns are made, ask students to predict what, if any, changes they think will occur over time and why.

- Students will study the columns under three variables: light, darkness, and filtered light. Have one group place its column in a well-lit place, but not in direct sunlight. Have the group making the red-acetate-wrapped column do the same. Have the final group place its column in a dark place.
- Instruct students to observe the columns daily for six weeks. They should record and describe their observations. Ask students what might have caused the layers they see. Why might the layers be different? Why might different micro-organisms grow in different places? What are the differences among the three columns? What might be responsible for those differences?
- As an extension, students could re-create the experiment using moist soils from other locations, such as their backyards, a forest area or a garden.

What Is That Smell?

The columns may smell like rotten eggs after a few weeks once microbial colonies create a sufficient amount of hydrogen sulfide. Keep the bottles in a well-ventilated space to disperse the odour. Keep the bottles sealed and prepare students for a strong smell when they are reopened.

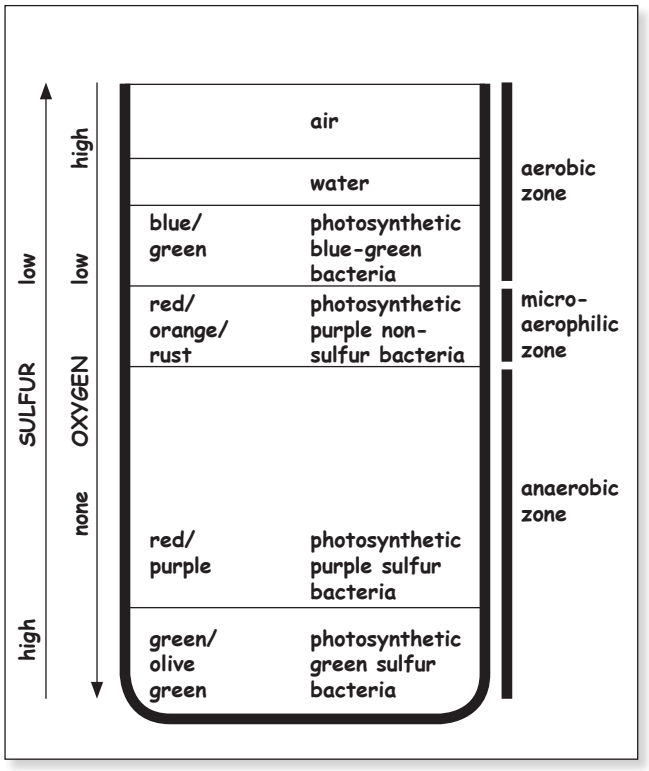
Answers

Students will have developed a mud column known as a Winogradsky column. It is named after Sergei Winogradsky, who devised it in the 1880s to study micro-organisms in the soil. Different micro-organisms will grow in each column depending upon their environmental needs.

Column in sunlight

Many of the micro-organisms that developed in the sunlight column are photosynthetic, ie they use light to give them energy to make food. However, the colonies throughout the column differ by their light, oxygen and nutrient needs. Those at the top (cyanobacteria and any green algae) use visible light wavelengths to survive while those below use sulfur from the egg yolk or carbon from the newspaper and chalk as their energy source.

After the columns are set up, the metabolic activity of the original micro-organisms in the mud soon reduces the oxygen level throughout the column. At the top, enough oxygen diffuses through the plastic wrap and water to sustain a high oxygen zone. This creates an oxygen gradient in the column: high oxygen near the top, low oxygen near the bottom. This oxygen gradient favours the growth of oxygen-dependent organisms near the top, while the growth ofbacteria that don't need oxygen is more likely near the bottom. Non-oxygen-dependent bacteria that use sulfur for energy also produce smelly and toxic hydrogen sulfide gas. These bottom bacteria createa second, opposite, gradient of hydrogen sulfide; highnear the bottom and low near the top. These gradientsproduce specific zones of opportunity for different micro-organisms. Students will observe these zones, and the growth of the micro-organisms in them, as coloured bands.



Column in sunlight with red cellophane

Students are likely to see some of the types that grow in the sunlight column because, like some of the micro-organisms that grew in the clear plastic bottle, the ones that grow in this column need red light wavelengths to survive. (The red cellophane will absorb all other light wavelengths.)

Column in dark

Students may see types of non-photosynthetic bacteria growing in this environment.

Name:

Class:

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1. Begin by ripping a newspaper square into tiny pieces.
2. Crack the hard-boiled egg and break the yolk into bits. Discard the white and the shell.
3. Combine the mud and just enough water in the bucket to make a thick mud soup. Use the spoon to mix thoroughly. When the mud and water are combined, stir in the newspaper, egg yolk, and chalk.
4. Using a paper cup, add the mixture to the bottle to 25 mm from the top. Tap the bottle on the table between additions to remove air bubbles.
5. Let stand for 30 minutes.
6. Gently add enough water so that there is a top layer of water about 13 mm deep above the mud surface.
7. Cover the top of the bottle with plastic wrap and secure with the rubber band. The gas produced by the micro-organisms is very smelly, so keep the plastic wrap on at all times.
8. Stand your bottle either in a well-lit place or in a dark place, as directed by your teacher. Do not move the bottle.
9. Do not let the bottle dry out. Add or remove water to the top to maintain the 13-mm depth.
10. Observe and record changes with sketches and descriptions each day for six weeks. After the six-week period is over, answer the questions below.

Questions

Write your answers on a separate sheet of paper.

- Did any changes occur in the bottle? If so, what is your evidence?
- How many different life forms seem to exist?
- What might explain the existence of the different things you see in the bottle?