ACTIVITY

INVESTIGATING THE ROLE OF BACTERIA IN SUSTAINABLE AGRICULTURE

Time: 480-600 minutes (may vary depending on the experiment's duration)
Days of Implementation: Four weeks (for plant growth observations)

Grade Level: Lower Secondary
Designed by: Catarina Suzzi

Alignment with STEAM subjects

Science: Investigating the role of bacteria in sustainable agriculture and its impact on soil health and plant growth.
Technology: Using various digital tools to support the collection and analysis of data.
Engineering: Designing and implementing experiments with different soil conditions.
Arts: Designing infographics or posters that communicate scientific findings creatively and clearly to a public audience.
Mathematics: Analyzing data to compare growth outcomes and performing calculations for statistical analysis.

Related or achieved SDGs

- SDG 2: Zero Hunger: Promotes awareness on how agricultural practices, such as enhancing soil fertility, can lead to sustainable food production and improve food security.
- SDG 3: Good Health and Well-being: Discusses how the presence of microorganisms contribute to soil health; soil health is linked to food quality, and therefore to human well-being and nutrition.
- SDG 15: Life on Land: Asserts that ecosystem health is crucial to ensuring clean air, water, and fertile soil; healthy ecosystems sustain life on earth.

Objectives

By the end of the class, students will be able to:

- Understand how bacteria can be beneficial and how it contributes to sustainable agriculture.
- Design and conduct experiments to test the effect of bacteria on plant growth.
- Analyze and interpret data to conclude the benefits of biological alternatives to chemical fertilizers.

Materials Needed

- Seedlings (e.g., legumes, herbs)
- Sterile soil, regular garden soil, nitrogen-fixing bacteria (Rhizobium from legume roots or inoculant), chemical fertilizer (e.g., nitrogen-based fertilizer like ammonium nitrate), organic compost (nutrient-rich but without added microbes)
- Measuring tools (e.g., ruler, soil pH test strips, thermometer)
- Growth containers (e.g., pots or trays
- Data recording sheets and digital tools for observation

Lesson Plan

Introduction

Beneficial bacteria are the best allies in sustainable agriculture. Unlike chemical fertilizers, which damage the environment, these bacteria help plants grow naturally by improving soil structure, strengthening nutrient availability, and protecting plants from harmful pathogens. These bacteria work together with plant roots to decompose organic matter, ensuring that vital nutrients like nitrogen are more accessible to plants.

1. Inquiry & Exploration
Discussion Questions:
First, ask the students the following questions:

- Why are bacteria important?
- Does bacteria play a role in agriculture? What type of role?
- How do you think microbes affect soil health and plant growth?

2. Investigation & Research
Introduce nitrogen-fixing bacteria (Rhizobium) and compost microbes to students. Students conduct research on the impact of these bacteria on soil and plants. Some ideas include:

- Nitrogen Fixing Plants and Microbes, Permaculture Magazine

- Who feeds the plants?, Frontiers for Young Minds
- Plant-microbe interactions!, Science IRL

3. Implementation & Design

- In collaboration with students, set-up five soil conditions with different treatments: control, regular soil, bacteria-inoculated soil, chemical fertilizer, and organic compost.
- Have the students measure the following variables in each of the five soil conditions:
    - plant height
    - number of leaves
    - root development
    - soil structure in each condition
    - optional: root nodules in legumes as evidence of Rhizobium

4. Testing & Reflection

Reflection Questions:

- How did each treatment affect plant growth?
- What were the visible differences between soil types?
- How did bacteria influence soil health?

5. Presentation & Action

- Students present their findings through charts, graphs, or digital presentations.
- They discuss how their results can contribute to sustainable agricultural practices.
- Part of the presentation should include a slide on concrete actions related to sustainable agriculture and SDG 2 that the students could take. This could include: improving the school garden, starting a composting system, or reducing the use of synthetic fertilizers. Each group should propose at least one action or suggestion.
- Students could also present their findings to the school community through an exhibition or assembly. They can create infographics or posters to share their data and conclusions.

Criteria

- Accurate analysis of data found in case studies.
- Quality of presentation, including clarity of visual aids that show trends and relationships.
- Effectiveness of group work and shared responsibilities.
- Depth of reflection in addressing exit card questions and linking findings to SDGs.

Reflection

- Did students fully understand the role of bacteria in sustainable agriculture?
- What should be improved for next time (e.g., more detailed instructions, additional resources)?
- Was the lesson engaging and relevant to students' interests?