Aquarium Simulator Activity: Microbial Mediation of the Nitrogen Cycle

High School (NGSS Aligned) Teacher Guide

Overview

This guide supports implementation of the Aquarium Simulator Activity: Microbial Mediation of the Nitrogen Cycle using the 5E instructional model.

Learning Objectives

- Students will develop and use a model to illustrate nitrogen cycling through biotic and abiotic components
- Students will analyze the role of bacteria in biogeochemical transformations
- Students will observe patterns in nitrogen transformations over time

Standards Alignment

- **HS-LS2-5:** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere (adapted for nitrogen cycle)
- **HS-LS1-7:** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed
- **HS-PS1-7:** Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

Prerequisites

- Understanding of chemical equations and molecular formulas

- Knowledge of oxidation-reduction reactions
- Basic understanding of microbial metabolism

Time Estimate

50-55 minutes (or 90-minute block for extended investigation)

Materials Needed

- Computer/tablet with internet access
- Student Activity Sheet
- Graph paper or digital graphing tool

Teaching Tips by Phase

Phase 1: ENGAGE (5-10 minutes)

- Start with the phenomenon or problem presented
- Elicit student predictions and prior knowledge
- Create cognitive dissonance if possible
- Build excitement for investigation

Phase 2: EXPLORE (15-20 minutes)

- Allow students to investigate with minimal guidance
- Circulate and ask probing questions
- Encourage systematic data collection
- Note common discoveries and difficulties

Phase 3: EXPLAIN (10-15 minutes)

- Have students share their findings first
- Build on their observations to introduce concepts
- Address misconceptions directly
- Connect to broader biological principles

Phase 4: ELABORATE (10 minutes)

- Apply knowledge to new scenarios
- Make real-world connections
- Encourage deeper investigation
- Support transfer of learning

Phase 5: EVALUATE (5-10 minutes)

- Use varied assessment strategies
- Focus on conceptual understanding
- Provide immediate feedback
- Plan follow-up based on results

NGSS Three-Dimensional Learning

- **Science Practices:** Developing and using models, analyzing data, constructing explanations
- **Crosscutting Concepts:** Patterns, cause and effect, systems thinking
- **Disciplinary Core Ideas:** See standards alignment above

> **Remember:**
>
> The goal is student discovery through guided inquiry. Resist the urge to explain concepts before students have explored them!
