Microbeads, Mega-Problem

Project Overview

Your students are in charge of designing a device or technique that will prevent plastic microbeads from entering local lakes and streams. Plastic microbeads are a common additive in personal care products such as body wash and facial soaps. The microbeads make excellent exfoliants, but persist in aquatic environments, soaking up other pollutants and being consumed by wild organisms. This type of plastic pollution is not filtered out through wastewater treatment plants, and has the potential to harm wildlife and humans.

- Students will research plastic microbeads and how they are entering waterways.
- Students will research how the water in our homes is eventually discharged back into the environment.
- Students will analyze the different techniques that are used to remove pollutants and unwanted materials from wastewater.
- Students will use the engineering process to design a solution that will remove plastic microbeads from the wastewater supply.
- Students will present their design to the class, who will act as an advisory board interested in removing plastic microbeads from a city's water supply.

Objective

The goal of this project is to help students make a real-world connection to the following Life Science topic(s):

- Anthropogenic (human-induced) impacts can have effects on ecosystem functioning and biodiversity.
- Human activities and livelihoods are benefited by functional ecosystems with higher levels of biodiversity.
- Engineered solutions need to consider a range of environmental, safety, and cost-related constraints.

Before You Begin

- Based on class size and student abilities, have students work in groups of 2–4.
- Have students read about threats to biodiversity and specifically review problems associated with biomagnification. This information can be found in Chapter 5 Section 2 of *Glencoe Biology.*
- Discuss plastic pollution in general and the issues associated with its porosity (can absorb and bind to toxins) and longevity.
- Encourage students to think about where along the wastewater process their design could be used.
- Encourage students to explore real-world constraints to design concepts– cost, environmental impact, time, etc.

Suggested Pacing

Day 1	Guide the Investigation
Microbeads, Mega-Problem	• Ask students what they know about plastic pollution: where does it come from, why is it a problem? • Introduce the project with the overview of **Microbeads, Mega-Problem.** • Talk about the presence of plastics in products where we might not expect them, such as personal care products. • Review a simplified food web from a local freshwater ecosystem. • Review the concept of bioaccumulation and biomagnification with students. • Have students discuss how pollution that affects freshwater ecosystems and fish can also affect human activities.

Day 2	Guide the Investigation
Get Started!	• Introduce students to the project scenario: they are scientists and engineers who have been hired by a municipality to come up with a solution to remove plastic microbeads from wastewater. • Let students know what resources are available for research (Internet, books, etc.). • See the **Additional Resources** section to help guide student research. • Allow students to make natural connections as they search the recommended topics. • Ask guiding questions if students need help determining a plan.
Day 3	**Guide the Investigation**
Brainstorm Solutions!	• Check in with each group as they work on their project. • Remind students to reference the engineering design loop as they think about their solutions. • Encourage students to gather background information and ideas from a variety of sources • Students should begin work on their presentation after their research is complete. Suggest that students limit the time of their presentation to 5 to 10 minutes. • Presentations should include an overview of their designs, as well as why it would be the best design for the municipality to adopt.
Day 4	**Guide the Investigation**
Work Through It!	• Ask guiding questions to help students identify the strengths and weaknesses of their suggestions. • Based on the results of their analysis, have students make modifications as necessary and finish their presentations.

Day 5	Guide the Investigation
Finish Up!	• Have students give their presentations in class. • Invite class discussion based on each group's presentation and suggested solution.

Additional Resources

The following information can be used to guide student research.

Key Terms to Research

- Water pollution
- Biomagnification
- Bioaccumulation
- Wastewater treatment
- Biodiversity
- Trophic interaction

Key Web Sites

- New York Attorney General report ("Unseen Threat: How Microbeads Harm New York Waters, Wildlife, Health And Environment")
- News outlets, such as National Public Radio, Reuters, or CBS
- Research web site of Dr. Sherri Mason, associate professor at SUNY-Fredonia

Rubric

A rubric for scoring projects can be found in the **Program Resources.**

Next Generation Science Standards*

This project supports the following items in the Next Generation Science Standards:

Performance Expectation:

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.* [*Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.*]

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Disciplinary Core Ideas:

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary to HS-LS2-7)*
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)*

ETS1.B: Developing Possible Solutions

- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary to HS-LS2-7)*

Science and Engineering Practices:

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Crosscutting Concepts:

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6)(HS-LS2-7)

Common Core State Standards Connections:

ELA/Literacy

RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-LS2-6), *(HS-LS2-7), (HS-LS2-8)*

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. *(HS-LS2-6), (HS-LS2-7), (HS-LS2-8)*

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-LS2-6), (HS-LS2-7), (HS-LS2-8)

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-LS2-7)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), (HS-LS2-6), *(HS-LS2-7)*

HSN.Q.A.1 Use units as a way to understand problems and to guide the solutions of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and origin in graphs and data displays. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), *(HS-LS2-7)*

HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), *(HS-LS2-7)*

HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-LS2-1), (HS-LS2-2), (HS-LS2-4), *(HS-LS2-7)*