

Learning Module

Nanomaterials: To Use or Not to Use

Nanomaterials are increasingly used in a variety of products and technologies because of their size and unique properties. However, the impact of nanomaterials on ecosystems is a new area of investigation for scientists and offers an opportunity for original and authentic investigations. This investigation will introduce students to nanomaterials, their life cycle, methods of research and the possible impacts of nanomaterials on the ecosystem. Students will also contribute their learning to the public's understanding of nanomaterials.

Target Class/Grade Level

This content can be used for a high school Living Environment class (complies with Regents exam) or as part of the curriculum for AP Environmental Science. We believe the material can also be adopted for middle school science courses. Suggestions are provided for ways to adapt and/or expand upon these lessons.

Duration

3-4 Weeks

Lesson 1: Introduction to Nanomaterials

This lesson helps students begin to understand what nanomaterials are, how small they are relative to everyday items, why they are used, and the products/technologies they are used in. The content includes a PowerPoint presentation, a nano-product poster, and activity suggestions from the NISE Network.

Questions Answered

- What is a nanomaterial?
- How big is a nanomaterial?
- What do nanomaterials do?
- What products/technologies are they used in?

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Presentation and nanoscale activities links from NISE Network

- [Exploring Size - Measure Yourself \(NanoDays 08, 09, 10, 11, 14\)](#)
- [Sizing Things Down card game](#)

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Lesson 2: An Introduction to Material Flows

Following traditional Industrial Ecology methods, this lesson guides students through a material life cycle to show where emerging pollutants such as nanomaterials come from and where they go throughout material and product manufacture, product use, and product disposal. The content includes a PowerPoint presentation, material flow visualization worksheets, and a Sankey diagram worksheet.

Questions Answered

- Where do nanomaterials come from and where do they go?
- How can you visualize material flows through earth and human systems?

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- Presentation and Sankey diagram activity
- Presentation and class discussion ideas

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Lesson 3: Determining the Effects of Emerging Pollutants on the Environment

Students will learn how pollutants can move around different compartments of the earth (air, water, land), how pollutants can disrupt ecosystems, and will be introduced to ecotoxicology methods and experimentation. Contents include PowerPoint presentations, ecotoxicology experiment worksheets, and an example rubric.

Questions Answered

- How do things move around the earth (air, water, land)?
- What is the natural world vs. human world?
- How can pollutants disrupt ecosystems?
- Introduction to ecotoxicology, lethal dose (LD₅₀)
- How to design a toxicology experiment
- How to report results

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- Presentations, class discussion ideas, and 72-hour ecotoxicology experimental design (salt, nano-TiO₂) using *Daphnia magna*

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Lesson 4: Communicating Ecotoxicology Results

After completing an ecotoxicology experiment, students will learn about the importance of communicating their results to different audiences as well as best practices for doing so. The content of this final lesson contains a PowerPoint presentation, guidelines for reporting results (e.g. posters, PowerPoint presentations, videos, blogs), and examples of scientific communication at RIT.

Process

- Identify goals, audience, format
- Identify content
- Create content (poster, video, blog, presentation, etc.)
- Deliver content

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- Presentation, guidelines, and examples

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Lesson Extensions

To alter these lessons for longer experiments or for a younger/older audience, please find suggestions for extensions of this module.

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