Nanotechnology:

What’s the ***Big*** Deal with the World’s *Smallest* Technology?

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**Abstract**

*This curriculum introduces students to the field of nanotechnology, a growing field in science with a wide array of potential applications. It supplements the high school science curriculum and can be adapted into a variety of classrooms, including biology or chemistry, while developing inquiry skills and the ability of students to produce and support claims. The curriculum guides students through three essential questions: What is nanotechnology, how does it work and for what is it used? Students investigate concepts of scale, derive the importance of surface area in nanotechnology through various engaging activities and demos, and explore a variety of applications of nanomaterials. Culminating lessons include investigations of medical applications of nanoparticles including a mini-activity based on a research project on internal blood clotting and a “Build a Particle” activity in which students design their own nanoparticle to solve a specific problem such as cancer, multiple sclerosis, arthritis, asthma or antimicrobial resistance.*

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**Curriculum Overview:**

**Rationale and Standards**

**RET I Research:**

During my RET I experience, I investigated the effectiveness of a variety of silica-based nanoparticles as blood coagulants using real-time fluorescence microscopy, along with mentor, Tracy Chuong in the Stucky Lab at UCSB. These nanoparticles are currently being developed for use in humans as an injectable blood coagulant for internal wounds. I gained practice with a variety of new lab techniques and experienced the added challenge of working with biohazard materials, including human plasma. RET I also impressed upon me the importance of innovative and systematic problem solving throughout any experiment. Perhaps most importantly, my time spent in the lab introduced me to the exciting field of nanotechnology and its wide range of potential applications. I found it exhilarating as a scientist and knew that my students would as well, thus inspiring this curriculum unit.

**RET II: Rationale for Teaching:**

Nanotechnology is a rapidly emerging field in which students may find themselves employed in the future. Early exposure to this topic puts students at the forefront of science, exploring a current topic in which research in currently being conducted. Because of its plethora of applications, nanotechnology seamlessly ties into several concepts area, including reaction kinetics in chemistry, surface area-volume ratios in math and several biochemical processes in human biology. In addition, nanotechnology has the potential to effectively incorporate several of the Next Generation Science Standards (NGSS) “Crosscutting Concepts”, as well as “Science and Engineering Practices.”

**Learning Objectives:**

Through the course of this curriculum, students will utilize many important skills of successful scientists, including inquiry, collaboration and data analysis, while simultaneously exploring the world of nanotechnology. By the end of the unit, students will be more practiced scientists and answer the three essential questions about nanotechnology: what is it, how does it work and how do we use it?

**Standards:**

Next Generation Science Standards (NGSS) Crosscutting Concepts:

1. ***Scale, proportion, and quantity****.* In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system’s structure or performance.
   * ***In grades 9-12,*** students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly.
2. ***Structure and function.***The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
   * ***In grades 9-12,*** students investigate systems by examining the properties of different materials, the structures of different components, and their interconnections to reveal the system’s function and/or solve a problem. They infer the functions and properties of natural and designed objects and systems from their overall structure, the way their components are shaped and used, and the molecular substructures of their various materials.

NGSS- Science and Engineering Practices

1. Planning and Carrying out Investigations
2. Analyzing and Interpreting Data
3. Constructing explanations and designing solutions

Common Core Reading Standards for Literacy in Science and Technical Subjects 6-12

1. Key Ideas and Details:
   * Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
2. Integration of Knowledge and Ideas
   * 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.
   * Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Common Core Reading Standards for Writing Subjects 6-12

1. Text types and purposes

* Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.