uBEATS Teacher's Guide:

Introduction to Nanotechnology

(Grades 6-12)

This teacher guide is a supplementary text to support the use of the uBEATS Introduction to Nanotechnology module for grades 6-12.

To help students develop the knowledge necessary for an incredible future in health care, we created UNMC Building Excellence in Academics Through STEM (uBEATS), an online health science resource for Nebraska students.

UNMC uBEATS modules are short (15 minutes or less), interactive online health science modules to supplement curriculum taught in grades 6–12. These do not replace curriculum, but are a supplement for teachers and students incorporating evidence-based information and UNMC expert guided material. Each module is chunked into sections with formative and summative assessments with immediate feedback provided.

Tips on how to utilize uBEATS modules:

- Internet access is required to view uBEATS modules.
- For those who have access to one-to-one technology, modules can be used in or outside of the classroom as a topic introduction, extension, or review.
- For classrooms without individual student devices modules can be used in whole group instruction. Formative assessment questions can use the teacher's preferred call and response method and summative assessment questions can be displayed on the board and answered individually by students or printed and distributed to students after viewing the module.

Objectives

- Become familiar with the basic Nanotechnology terminology.
- Identify properties of Nanomaterials.
- Describe the various application of Nanotechnology and Nanoscience.

ubeats@unmc.edu

Introduction

For centuries humans have been amazed by the sky: galaxies, stars, planets, satellites, comets. The large universe: its organization, shape, size, and colors have triggered the imagination of adults and children for generations. Astonishingly, there is another universe as fascinating and intriguing as the large universe. It is a microscopic universe, the "Nano" universe. Although we cannot see it, the Nano-world also possesses a complex organization and is full of shapes, sizes and colors. The minuscule universe is found in plants, food, cars, telephones, computers, and us. Yes, humans are also part of the fascinating Nano world.

Prior Knowledge

Before beginning this module, the student should understand the Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning.

Core Idea ETS2.B: Influence of Engineering, Technology, and Science on Society and the World.

- The fields of science and engineering are mutually supportive. New technologies expand the reach of science, allowing the study of realms previously inaccessible to investigation; scientists depend on the work of engineers to produce the instruments and computational tools they need to conduct research. Engineers in turn depend on the work of scientists to understand how different technologies work so they can be improved; scientific discoveries are exploited to create new technologies in the first place. A Framework for K-12 Science Education.

- Scientists and engineers often work together in teams, especially in new fields, such as nanotechnology or synthetic biology that blur the lines between science and engineering. Students should come to understand these interactions and at increasing levels of sophistication as they mature. Their appreciation of the interface of science, engineering, and society should give them deeper insights into local, national, and global issues.

Science and Engineering Practices NGSS

- Constructing explanations and designing solutions.

Crosscutting Concepts NGSS

- Influence of Science, Engineering, and Technology on Society of Applications of Science: New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.

Key Terms/Vocabulary

Nanotechnology, nanomaterials, nanoscience, nanodimensions, nanometer, nanostructure, nanofibers, nanoparticles, atomic force microscopy, nanoscale, melting point, electric conductivity, magnetism, catalyzing reactions, surface/volume ratio, molecules, chitosan, chitin, keratin, nanopillars, gyroids, virus, virion, capsid, amino acid, protein, nucleic acid, envelope, van der Waals forces, adhesion, capillary forces, surface tension, sea urchin, nacre, mollusk, abalone, calcium carbonate, magnetotactic, magnetosome, nanocrystal.

Science Standards

Nebraska's College and Career Ready Standards for Science 2024 Nebraska Science Standards

Energy: SC.HS.4.4.D
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Chemical Reactions: SC.HS.5.5.E
- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Structure and Properties of Matter: SC.HSP.3.1.C
- Develop and use models to predict and explain forces that are in and between molecules.

Extensions of the lesson

- To help students become more familiar with the Key Terms of this module, the teacher can use the vocabulary list for a classroom Word Wall, or integrate the vocabulary into classroom word games during review sessions.
- Encourage students to check current events for the latest news involving nanotechnology.
- As student misconceptions become apparent, the teacher may need to reinforce these important concepts:
    - The nano-universe is too small for us to see.
    - The difference between science and technology is that science studies the natural world, while technology applies the scientific knowledge for practical purposes. For example, nanoscience studies the structure and properties of molecules in abalone shells, whereas nanotechnology puts that scientific knowledge to use in the design of bullet-proof vests.

- The pronunciation of “chitin” varies, but the word comes from a French version of the Greek word *chiton*, meaning “a covering.” Therefore the traditional pronunciation is “KAI-tn”. Likewise, the pronunciation of “chitosan” has many versions: “KAI-tuh-sn”, “CHIT-uh-sn”, “chai-TO-sn”, “CHEE-to-sn”, and others.

Enrichment

- For information about Healthcare Career Opportunities, see UNMC’s **Careers in Healthcare**.
- To make connections in your community, contact local universities.
- For a lab activity, see **Fun with Nanotechnology**.
- Watch a short video (1:42) about **Natural Nanotech: How Geckos Climb Walls**.
- Follow the research of the National Nanotechnology Initiative at **Nano.gov** .
- To study the correlation between the Nebraska Science Standards and the Next Generation Science Standards (NGSS) see the Crosswalk.