



Internet of Things (IoT) at UCF



UNIVERSITY OF CENTRAL FLORIDA

*UCF RET Site: Collaborative Multidisciplinary
Engineering Design Experiences for Teachers*

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Biology
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RET Site: Enhancing the world with carbon nanotubes

Subject Area(s): Science

Course(s): Biology

Grade Level: 10-12

Suggested Length of Lesson: 3-4 days

Lesson Summary: Students will learn first how nanotechnology can be woven into biology. Students will then learn about carbon nanotubes and their applications in engineering. Students will next investigate how carbon nanotubes relate to biotechnology and then construct their own engineering designs.

Prerequisite Knowledge: This benchmark requires prerequisite knowledge of SC.7.L.16.4 (Recognize and explore the impact of biotechnology (cloning, genetic engineering, artificial selection) on the individual, society and the environment), SC.8.E.5.10 (Assess how technology is essential to science for such purposes as access to outer space and other remote locations, sample collection, measurement, data collection and storage, computation, and communication of information), SC.8.N.4.1 (Explain that science is one of the processes that can be used to inform decision making at the community, state, national, and international levels), and SC.8.N.4.2 (Explain how political, social, and economic concerns can affect science, and vice versa)

Materials/Technology Needed

- Laptop
- Modeling Clay
- Sketch paper
- Colored pencils

Where this Fits

- Quarter 3 Unit: "How does DNA work?"

Learning Goals

- Students will be able to connect the use of carbon nanotubes to the field of biotechnology.
- Students will be able to use modeling clay to design a product that can be wrapped in carbon nanotubes

Standard Addressed

- *Standards:* [SC.912.L.16.10 Evaluate the impact of biotechnology on the individual, society and the environment, including medical and ethical issues.](#)

Standards for Mathematical Practice

- MAFS.912.N-Q.1.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

Instructional Strategies

- The Question Is...
 - Determine a question related to the current unit of study and

Evidence of Learning (Assessment Plan)

- [Biotechnology and Carbon nanotubes Introduction](#)
- **Article summary about carbon nanotechnology and connecting it to biotechnology.**
- **Sketch Design of product**
- **Model clay design of sketch**

write only the answer to that question on the board.

- Ask students to write questions that could match the answer on sticky notes. Allow students to refer to notes or handouts, if necessary.
- Have students stick their questions to the board, surrounding the answer. Alternatively, students could write the answer in their interactive notebooks and list questions under or around it.
- allowing a teacher to see what the students understand about a given topic.
- Think-Pair-Share
 - students are given time to share their ideas with their table partners
- Relationship Building
 - teacher builds positive relationships with students to encourage learning in the classroom

Description of Lesson Activity/Experiences

Day 1: Biotechnology and Carbon nanotubes

1. Research the following question: "What are Carbon Nanotubes?"
 - a. Locate a scientific article related to the above question.
 - b. A place to start would be: <https://www.sciencedaily.com/>
 - i. Wikipedia is not a valid source
2. Write a 1 page reflection about the article
 - a. Summary about the article
 - b. Describe how the information you found relates to the topic 'Biotechnology'
 - c. The page should be in 12 pt, Times New Roman Font, Double Spaced (select format at top of page--> line spacing--> double)

Day 2: Sketch of Design

1. In your table groups, you will sketch out a design of a product that can be enhanced with Carbon nanotube technology.
 - a. the design should include an explanation of how carbon nanotubes can enhance their product

b. a description of the product use will all be included

Day 3: Modeling

1. Students will use modeling clay to sculpt out their design

Day 4: Present

1. Students will present their designs
 - a. including why their design is the best
2. Teacher will determine which design is the best based on the presentations

Recommended Assessment(s) and Steps

- Research article detailing Carbon nanotubes
- Detailed sketch of the application of Carbon Nanotubes to enhance any product
- 3D clay model of sketch design

List of Materials/Resources Used

- Laptop
- Modeling Clay
- Sketch paper
- Colored pencils

Engineering Connection (60-100 words/3 sentences)

This activity directly connects the students with the practical application of biotechnology principles. Students are able to learn about Carbon nanotubes and how they relate to different biotechnology devices. The students will work on learning about the many applications of carbon nanotubes and how everyday items can be enhanced with carbon nanotubes.

Engineering Category (choose one)

<input type="checkbox"/>	relating science and/or math concepts to engineering (primarily science & math with some engineering)
<input type="checkbox"/>	engineering analysis or partial design (primarily engineering with some science/math)
<input checked="" type="checkbox"/>	engineering design process (full engineering design)

Key Words

- Carbon nanotube
- Biotechnology
- Nanotechnology

Introduction/Motivation (written as if talking to students)

"This unit we will work on a STEM project that connects 'carbon nanotubes' to biotechnology. You will work in teams of 3-4 to design and construct a product that carbon nanotubes can be applied to. By the end of the unit we will see which group constructed the best design. The goal is for you to gain exposure to another area of biotechnology, outside the world of DNA. As well as, introduce you to an advanced engineering concept. "

Lesson Closure (written as if talking to students)

"Now that we have learned a little bit about carbon nanotubes, what are some of your biggest takeaways from this lab? What other projects could carbon nanotubes be used for? How can we promote future investment into this technology?"

Lesson Background & Concepts for Teachers

- Biotechnology
- Carbon nanotube

Important Vocabulary

Term	Definition
Biomedical	set of applied sciences applying portions of natural science or formal science, to knowledge, interventions, or technology that are of use in the healthcare or public health
Biotechnology	the exploitation of biological processes for industrial and other purposes. The types of biotechnology include: genetically modified plants and animals, cell therapies, nanotechnology, and medical.
Carbon Nanotube	tubes made of carbon with diameters typically measured in nanometers
Cloning	replicate an identical copy of
DNA ligase	an enzyme that facilitates the joining of DNA strands
Gel electrophoresis	used to separate mixtures of DNA, RNA, or proteins of different molecular sizes. Molecules pushed through a gel with pores using an electrical field.
Gene therapy	an experimental technique that uses genes to treat or prevent disease
Genetic engineering	deliberate modification of the characteristics of an organism by manipulating its genetic material. Applications include scientific research, agriculture and technology
Genome	the haploid set of chromosomes in a gamete or microorganism, or in each cell of a multicellular organism
Plasmid	a genetic structure in a cell that can replicate independently of the chromosomes, typically a small circular DNA strand in the cytoplasm of a bacterium or protozoan.
Polymerase chain reaction	used in molecular biology to make copies of a specific DNA segment. The three main stages of PCR are denaturation, annealing, and primer extension.
Recombinant DNA	DNA that has been formed artificially by combining constituents from different organisms

Restriction enzyme	an enzyme produced chiefly by certain bacteria, having the property of cleaving DNA molecules at or near a specific sequence of bases.
Nanotechnology	manipulation of matter on an atomic, molecular, and supramolecular scale
Transgenic organism	Genes of one species can be modified, or genes can be transplanted from one species to another.
Transformation	the genetic alteration of a cell by introduction of extraneous DNA, especially by a plasmid

Troubleshooting Tips

- Teacher will guide students in their research (instruction on what sites to use)
- Ensure students construct their models correctly

Other Helpful Information

- Encourage students to stretch their research skills as this topic may be difficult for them

Attachments

1. [Biotechnology and Carbon nanotubes Introduction](#)

References

Florida State University. (2019). SC.912.L.16.10. Retrieved from:
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