

Teacher Name: <i>Jessica Kohout</i>	
Target Grade: <i>9-11</i>	Lesson Title: (Working titles) <ul style="list-style-type: none"> ● A Small Solution to a Big Problem ● Using Nanotechnology to Treat Cancer ● Gold Rush - Into Cancer Treatment
Topic: <i>Diffusion, cancer, nanoparticles</i>	
NGSS Standard – NGSS Performance Expectation HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.]	
Lesson Objectives <ul style="list-style-type: none"> ● Explore the movement of molecules through a membrane via diffusion. ● Explore the effects of concentration gradient on diffusion rate. ● Create a model to explain how nanoparticles travel through the bloodstream to interact with tumor cells and how they would be destroyed. 	
Lesson Body: Gold Nanoparticles (AuNP) are being used as a possible cancer therapy. These small particles can accumulate in tumor cells and are reactive to light. The light heats up the gold nanoparticles and this increase in temperature destroys the cancer cells. This biomedical phenomena can be used to make connections with cell structure, cell growth, and transport through body systems. Using the Science Nspired Diffusion Data Collection Lab, students will model how nanoparticles could accumulate in cancer cells. Students can continue the explanation of this phenomena as they make a diagram of the nanoparticles traveling through the circulatory system to enter tumor cells to be destroyed using UV sensitive beads to represent the AuNPs.	
Phenomena Nanotechnology is being used to target and destroy cancer cells. Nature Video - Tiny Treasure: The Future of Nano Gold: https://youtu.be/QorK2X7GsVU	
Driving Question: How can nanotechnology be used to help treat cancer?	

What Is the Teacher Doing?

Gathering:

Ts will monitor students development of questions and lead a discussion on what the students observed in the video. Gather the list of questions from students.

Potential Questions to promote discussion:

- What are nanoparticles?
- What are Gold Nanoparticles (AuNP)?
- How are they used in biomedical applications?
- How would the AuNPs get to the tumor cells?
- How does light interact with the AuNPs?
- Why would increase heat kill the cancer cells?
- How would AuNPs be able to identify cancer cells?

Ts pose the question: **How would molecules move through a selectively permeable membrane of a cell?**

Connections that can be made:

- Structure and function of cell membrane
- Cause and effect of concentration gradients on either side of the membrane, including rates of change of molecule movement across the membranes resulting in active or passive transport.

Reasoning:

Teachers will be monitoring students to find evidence of using mathematical thinking and analyzing the model to determine flaws in the system.

Potential Questions to promote discussion:

- How did the concentration of salt affect the diffusion rate?
- How is the dialysis tubing a model for the cell membrane? What are the limitations of this model?
- How would we need to adjust this model to show how nanoparticles enter the cell?
- What additional questions do we need to ask in order to understand how AuNPs function?

What Is the Student Doing?

Gathering:

- Ss watch a video “Tiny Treasure: The Future of Nano Gold”
- As they watch the video, Ss make observations on what they notice and wonder?
- Ss. ask questions about gold nanoparticles and how they can be used as a cancer treatment.

- Ss use the Science Nspired Simulation - [Exploring Diffusion](#) to define osmosis and diffusion and to describe how particles move through different substances.
- In groups of 3 or 4, students will conduct an investigation on how molecule would move across the membrane by following the procedure for Science Nspired - [Diffusion Data Collection Lab](#)

Reasoning:

- Ss will calculate the rate of change of the diffusion of different salt concentrations within the beakers movement into the cell. Ss will collaborate and share class data on the results of the diffusion lab
- Students will discuss how this is a model of gold nanoparticles movement into cells. They will share how it is representative of the process and its limitations.

Communicating:

Teachers will look for evidence of developing and using models; interaction between systems; identification of how structure and function; and cause and effect.

Potential Questions to promote discussion:

- How are the different rates of diffusion calculated in the lab?
- How does this model increase vascularization of the tumor cells?
- How does your model show how nanoparticles enter tumor cells?
- As more studies have been done on the effectiveness of nanotechnology in biomedical applications, what additional questions should be asked about the long-term effects of this treatment on individuals or the environment?
- What could be some unintended consequences of this type of therapy?

Communicating:

- Students will individually develop their own model showing how AuNP would travel through the circulatory system to accumulate in cancer tumors.
- Students will develop an explanation from evidence to show how AuNP would enter the cell using UV sensitive beads as analogs to AuNPs and UV light to show a change in structure of the AuNPs.
- Their models should include:
 - The path the AuNPs (UV beads) travel through the circulatory system to get to the tumor cells
 - The mechanisms that allow the AuNPs to enter the cell.
 - Use of light to increase heat of cell to show destruction of tumor cells.

Assessment of Student Learning

Students will develop a model to illustrate how AuNPs use the circulatory system to accumulate in cancerous tissues. The AuNPs will bind to surface receptors on the cell membrane and through receptor-mediated endocytosis, enter the cell. Using infrared light, the AuNPs will heat up and destroy the cancer cells. Students model should include descriptions of cellular structure and functions as well as the cause and effect of the accumulation of AuNPs in the tumor cells.

Idea:

Using Nanoparticles to treat cancer cells.

<http://theconversation.com/destroying-tumors-with-gold-nanoparticles-98422>

Video: <https://youtu.be/Q1y1uO6Hvk0>

Nature Video: <https://youtu.be/QorK2X7GsVU>

Research:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3473940/>

<http://www.physicscentral.com/explore/action/pnb-nanotherapy.cfm>

<https://www.nature.com/articles/aps201182>

https://www.researchgate.net/publication/258104358_Applications_of_Gold_Nanoparticles_in_Cancer_Nanotechnology