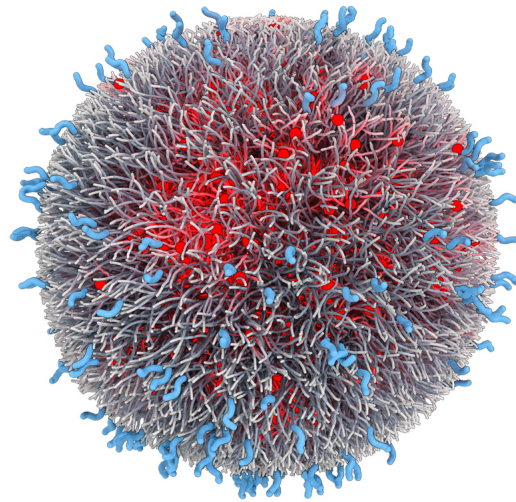


NANOTECHNOLOGY

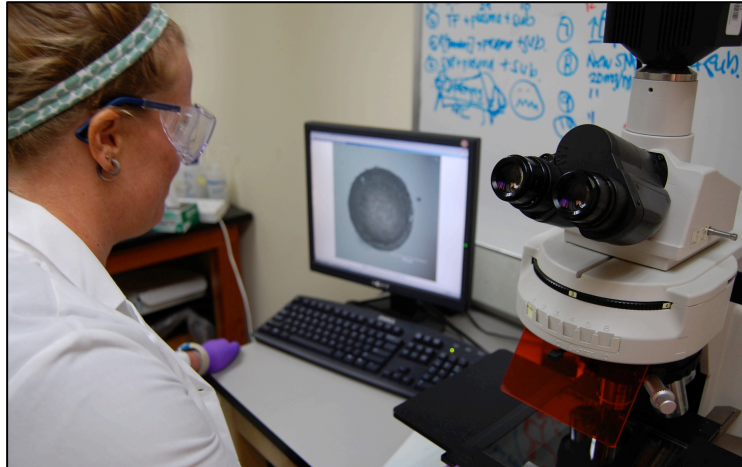
What's the **BIG** Deal with
the World's smallest Technology?



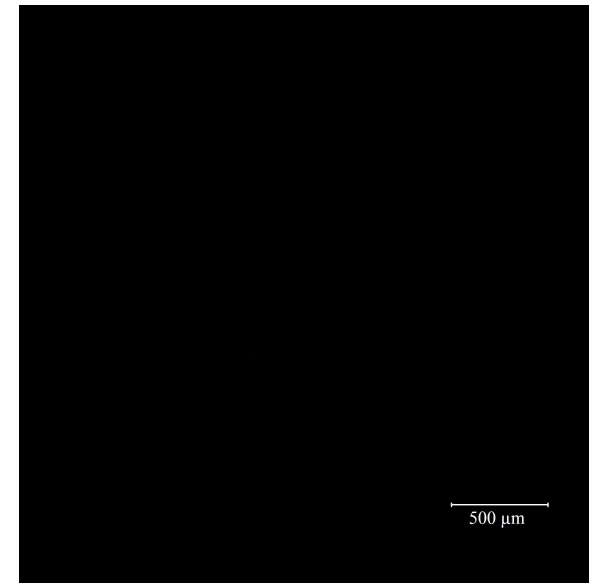
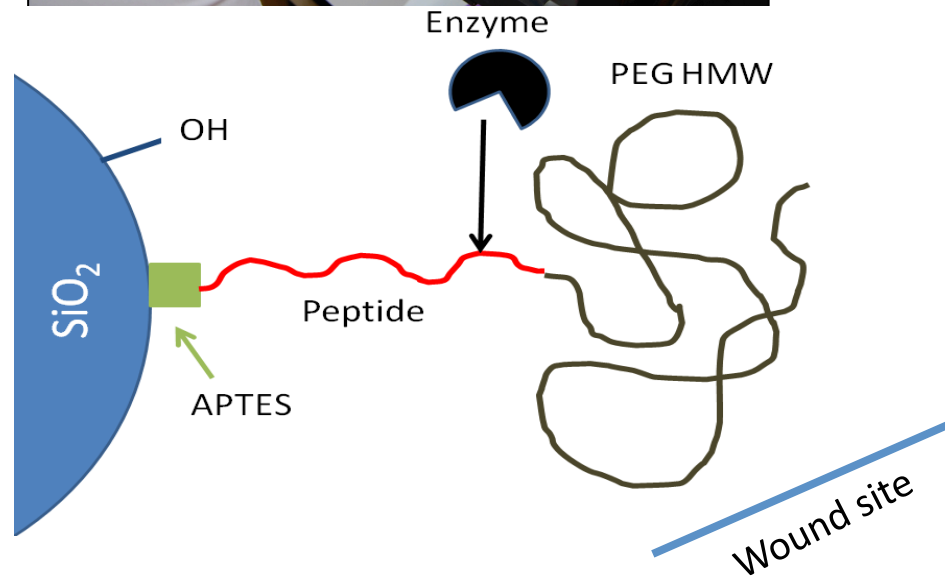
Megan Nesland
Anacapa School, Grades 7-12
Santa Barbara CA

UCSB, RET II

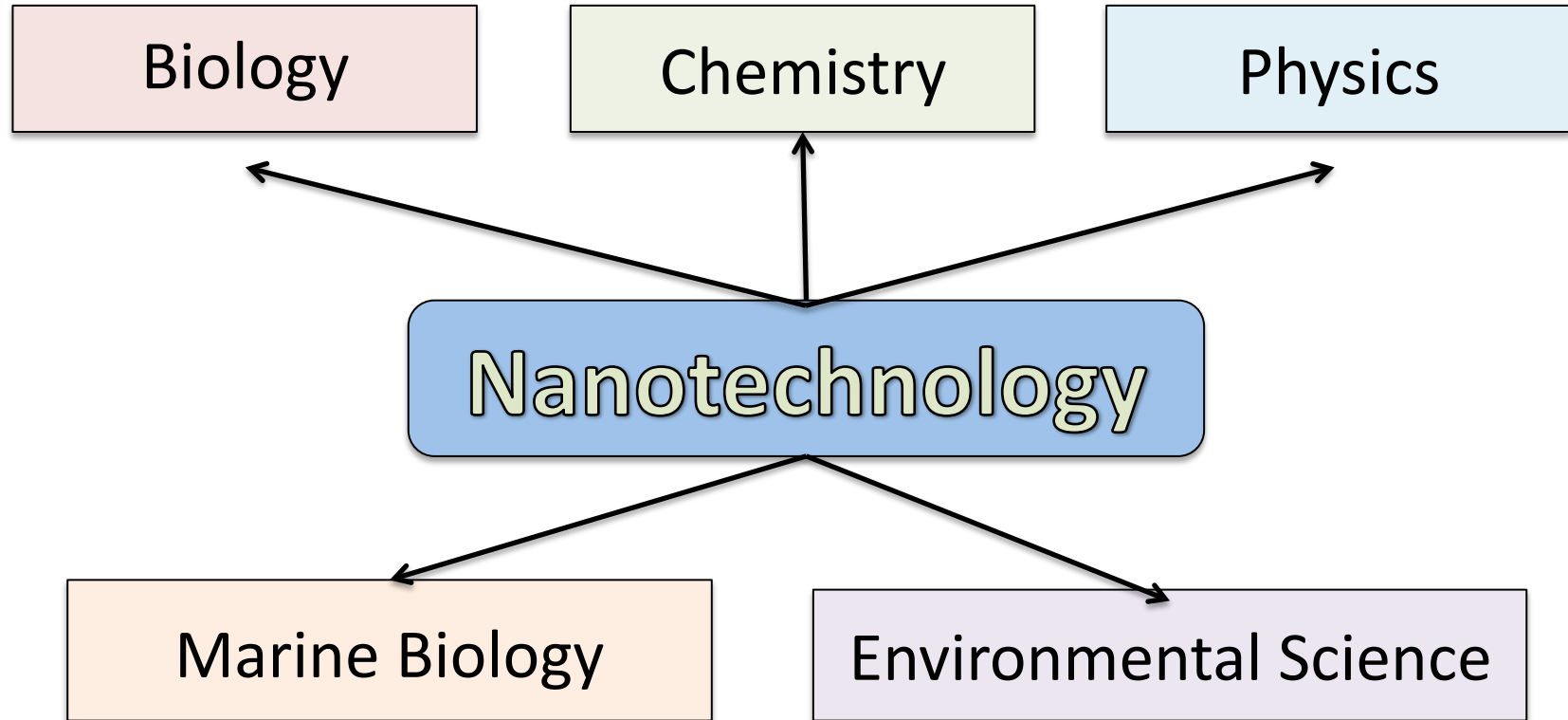
The Inspiration: RET I



*Nanoparticles and Blood
Coagulation:
Measuring the Effect of Silica
Nanoparticles on Clot Time of
Human Plasma*



The Rationale: Why Teach Nanotechnology?



Nanotechnology is an opportunity to incorporate emerging technologies seamlessly into established content areas at many grade levels.

The Rationale: Why Teach Nanotechnology?

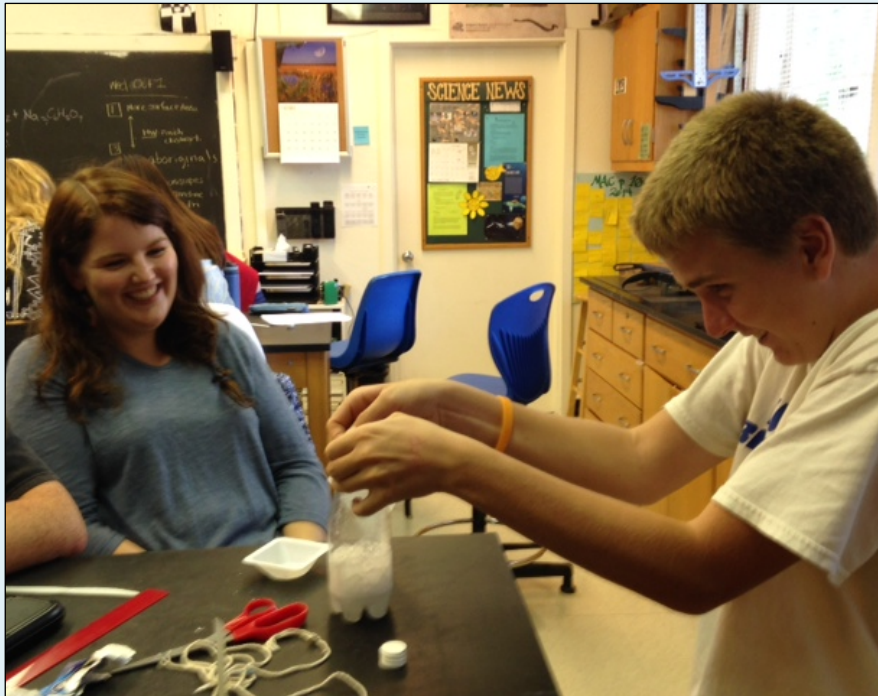
“Scale, Proportion and Quantity-

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.”

- NGSS Cross Cutting Concepts

Nanotechnology is an opportunity to incorporate emerging technologies seamlessly into established content areas at many grade levels.

The Rationale: Why Teach Nanotechnology?



100 % of students discussed the unit in their semester reflection

93% of students could accurately explain the meaning of “nano”

65% of students could explain the role of surface area in nano-phenomena

Students reacted extremely positively to the subject, both in terms of intellectual growth and overall experience of the unit.

The Curriculum: RET II

What is Nanotechnology?



- Why do we care about Nanoparticles?
- What are nanoparticles?
- How small is nano?

How do Nanoparticles work?



- How does surface area relate to size and volume?
- What is the impact of surface area on reactivity?
- Why does surface area affect reactivity?

Why do Nanoparticles matter?

- How are nanoparticles used today?

Module One: What is Nanotechnology?

- NanoYou Video and Reading
- Nano Scale Walk
- “That’s Huge” Scale Activity



Module Two: How do nanoparticles work?

- Surface Area Origami
- Surface Area Reaction Series (Flour, Potato, Inquiry Alka Seltzer)
- Sticker Origami
- Nano or Normal Simulation



Module Three: Why do nanoparticles matter?

- Reading: Surface Area in Nature
- Silica Nanoparticle Presentation and Quickie Quizzes

Assessment of learning:

“Explain the term, ‘nanotechnology’ to a 3rd grader.”

Assessment of learning:

“Using specific evidence from class, explain how and why nanoparticles are useful. Include in your explanation a discussion of size and surface area.”

Assessment of learning:

“Pick 1 specific application of nanotechnology and explain, in your own words, how surface area and size enable the chosen technology.”

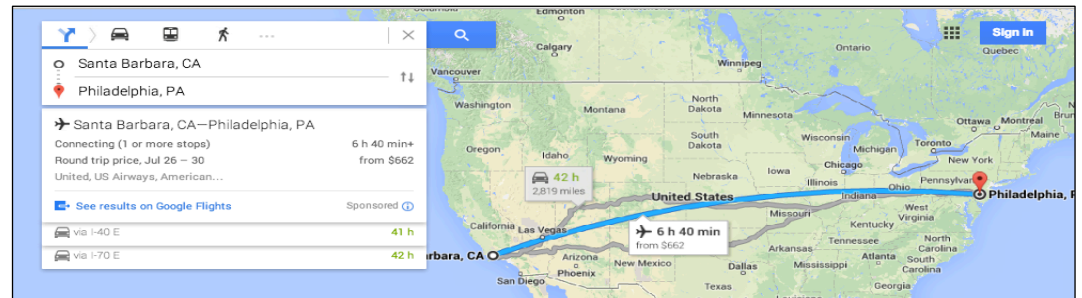
Build-A-Particle Activity

Cumulative Assessment:

Module One: What is Nanotechnology?

- NanoYou Video and Reading
- Nano Scale Walk
- “That’s Huge” Scale Activity

NANO YOU



How large of a room would you need in order to fit 1 billion sugar cubes?

Assessment of learning:

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Cumulative Assessment:

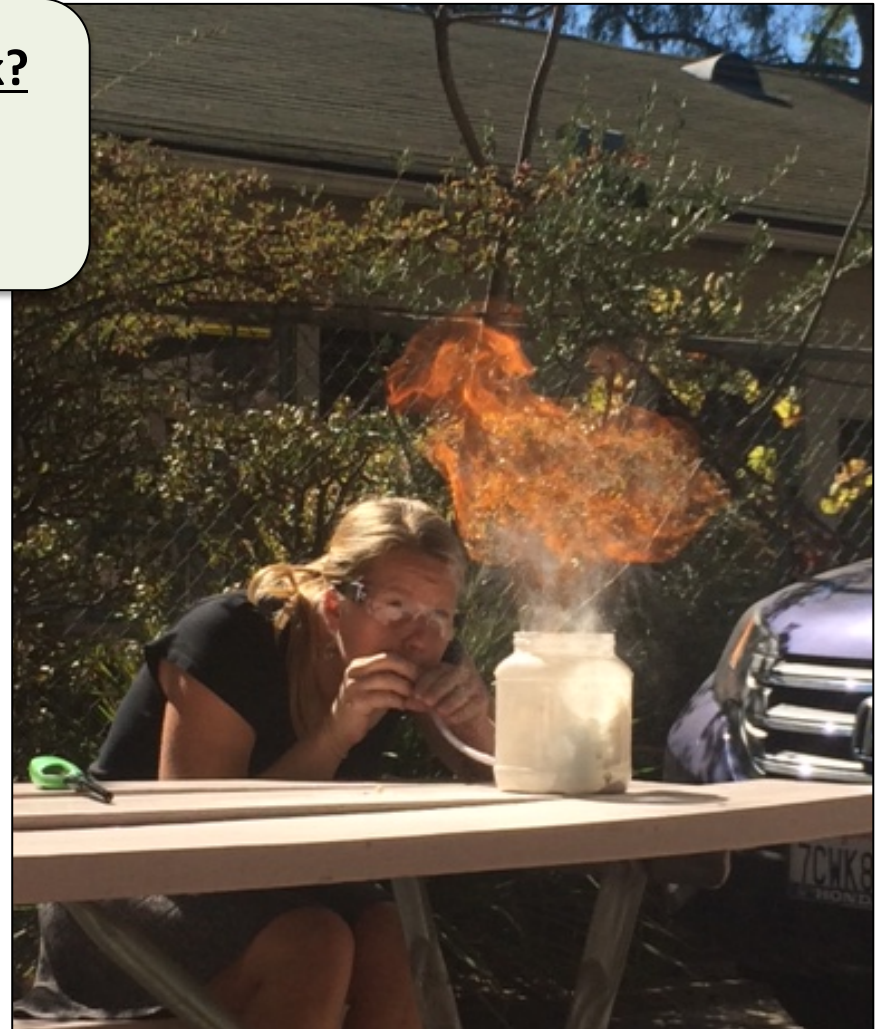
Module Two: How do nanoparticles work?

- Surface Area Origami



Module Two: How do nanoparticles work?

- Surface Area Reaction Series (Flour, Potato, Inquiry Alka Seltzer)

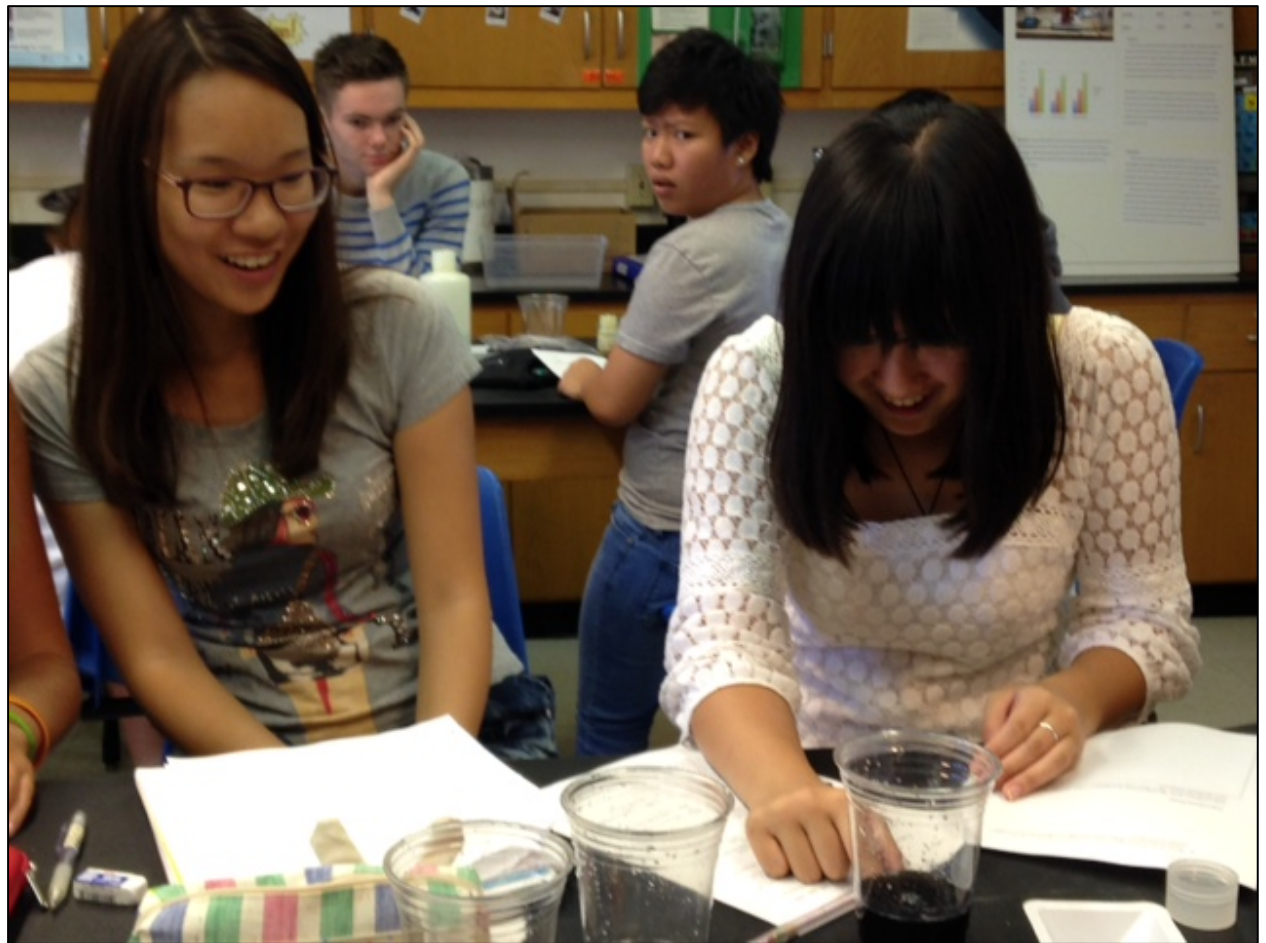


Take Home Points:

- Substances with more surface area, burn more quickly.
- Burning things is pretty fun.

Module Two: How do nanoparticles work?

- Surface Area Reaction Series (Flour, Potato, Inquiry Alka Seltzer)



Module Two: How do nanoparticles work?

- Surface Area Reaction Series (Flour, Potato, Inquiry Alka Seltzer)



Module Two: How do nanoparticles work?

- Sticker Surface Area
- Nano or Normal Simulation

Sticker Surface Area

More Stickers

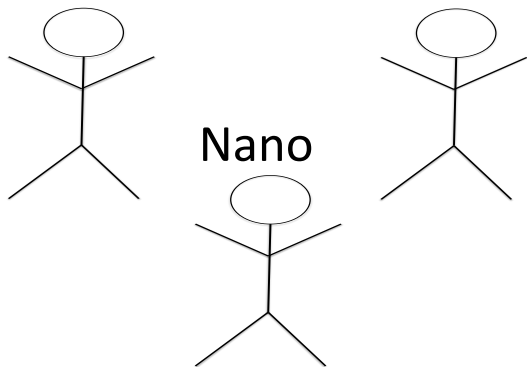


More Binding Sites →

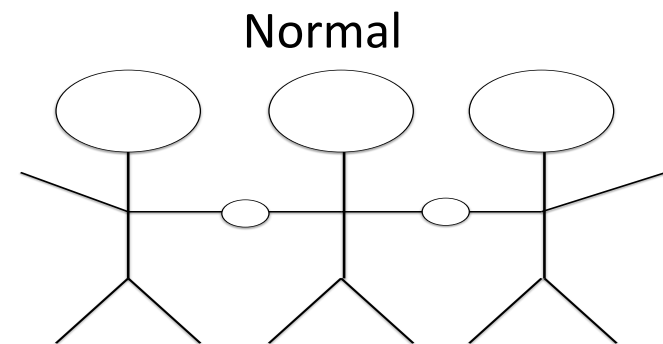
Greater Reactivity



Nano or Normal Simulation



Vs.



Module One: What is Nanotechnology?

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Build-A-Particle Activity

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QUICKIE QUIZ 3

In Solution:



In Patch:



Which delivery system of the SNP will cause clotting more quickly- Solution or Patch?

Write a claim that answers this question and support it with evidence and reasoning.

Module One: What is Nanotechnology?

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- Nano Scale Walk

Assessment of learning:

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Cumulative Assessment:

Build-A-Particle

Quizzes

enable the chosen technology.”

Build-A-Particle Activity

Cumulative Assessment:

Build-A-Particle

Cumulative Assessment

Students build multi-piece, functionalized nanoparticles in response to specific medical problems currently being considered for nanoparticle-based treatments. Students provide rationales for their nanostructure design and ultimately create a class set of SuperNano Cards.



Directions:

1. In your chosen “Problem” paragraph, underline or highlight 3-5 important features of the specific problem that you may need to consider when designing a nanoparticle-based solution.

The Problem: Cancer Detection

Cancer resulted in approximately 585,000 deaths during the first half of 2014. In general, deaths from Cancer are dropping, due largely to improved treatment and earlier detection of various cancers, however technology must continue to improve to maintain this trend. Early detection of developing tumors is essential to survival rate for cancer patients, particularly in the most aggressive cancers.

Detection of cancer is often done through “tumor markers.” These are chemical substances produced in the body that are characteristic of growing tumors. These are often proteins, and are specific to different types of cancer. For example, Alpha-fetoprotein (AFP) is produced and detected in the blood of patients with developing liver cancers. In order to detect cancers in this way, however, there must be enough tumor marker in the body for current techniques to detect. The more sensitive detection methods are available, the earlier doctors could target potential cancers.

Nanoparticles have the potential to drastically reduce the amount of a particular tumor marker necessary for detection. Nanoparticles can be designed to target a specific marker, bind, and even fluoresce, or glow, with optical imaging techniques. Nanoparticles could also bind to tumor markers and cause them to appear distinct from normal tissue in Magnetic Resonance Imaging, or MRI.

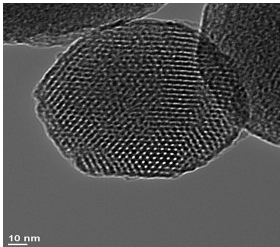
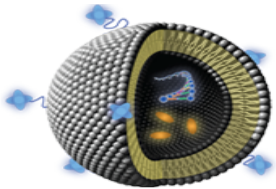
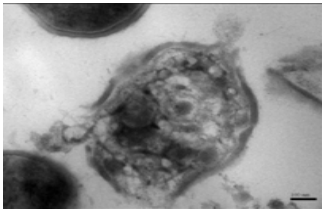
How will you design a nanoparticle to improve cancer detection?

References:

<http://www.cancer.gov/cancertopics/factsheet/detection/tumor-markers>
<http://www.cancer.org/research/cancerfactsstatistics/cancerfactsfigures2014/index>

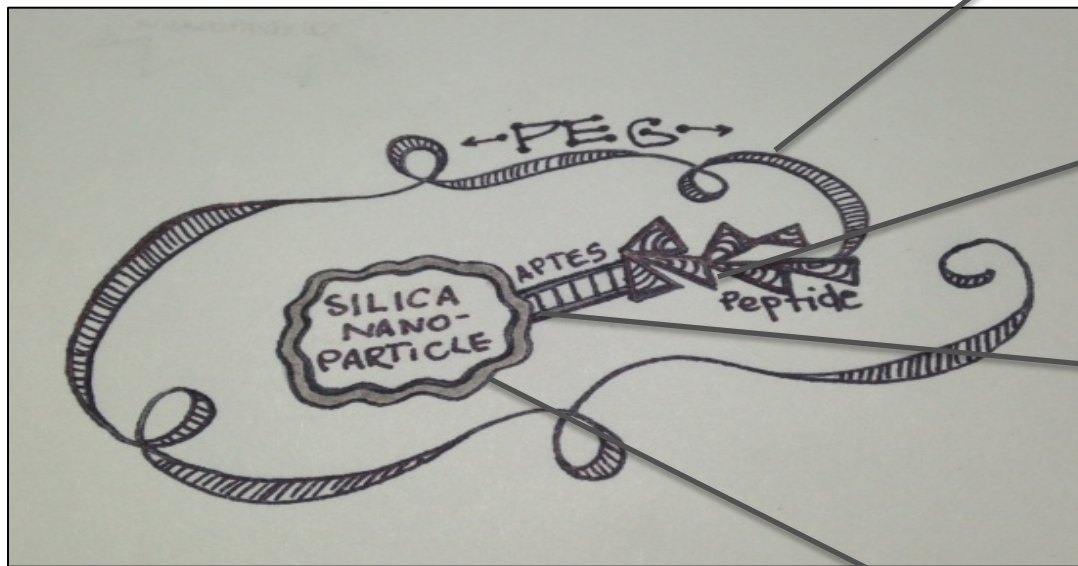
Directions:

2. Read through the “Nano-Pieces” tables and put stars next to components that may be relevant to the chosen problem.

Table 1. Base Nanoparticle	Characteristics	Image
Silica Dioxide Size: 20 nm*	<ul style="list-style-type: none">- Negatively charged surface- Stable- Low Toxicity- Used in drug delivery and plastics	 <p>10 nm</p> <p>Image: http://en.wikipedia.org/wiki/Mesoporous_silica</p>
Liposome Size: 50 nm	<ul style="list-style-type: none">- Common material for cell membranes- Form transport vesicles that can bypass biological barriers and carry substances through body- Outside can be charged- Can attach specific binding molecules when required	 <p>Image: http://mml.umd.edu/mml/projects.html</p>
Nanopolymer Size: 100 nm	<ul style="list-style-type: none">- Long chains of nanoparticles- Surface can be given positive charge- Used in many Nano-materials	 <p>Image: http://news.medill.northwestern.edu/</p>

Directions:

4. Once you have decided on the necessary pieces, draw a labeled diagram of your nanoparticle- label both the name and size of each feature. Use the provided images as a guide, but feel free to be creative as well. Keep relative sizes in mind on your diagram.



PEG- Long, stringy molecule used to mask charges

Peptide- Specific protein that is cleaved at a wound site, therefore removing PEG

APTES- Molecule used to attach peptide to nanoparticle

Silica Nanoparticle- Provides negative surface that instigates blood coagulation once exposed

The Take-Aways:

What is Nanotechnology?



Nanotechnology is an emerging field that utilizes the odd properties that materials exhibit at small scales.

How do Nanoparticles work?



Nanoparticles work in a variety of ways, including through extensive surface area. Large surface area means more reaction sites and therefore more vigorous reactions.

Why do Nanoparticles matter?

Nanoparticles have uses in a variety of fields because they can be functionalized for specific purposes.

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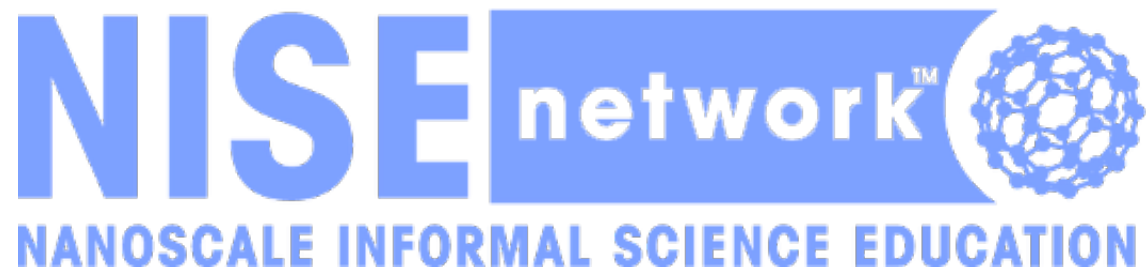
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Build-A-Particle Activity

Cumulative Assessment:

Other Resources:



Thanks to:

- Frank Kinnaman
- Marilyn Garza
- Tracy Chuong
- RET II Comrades
- MRL RET Program
- The Anacapa School







