



Building College-University
Partnerships for Nanotechnology
Workforce Development

Tech Intersection: Understanding the Bio & Nano Link

Welcome to NACK's Webinar

Presenter



Christie M. Sayes, Ph.D.

Program Manager - Nanotoxicology & Nanopharmacology at RTI International

csayes@rti.org

Webinar Outline

GOAL:

The application (medicine and engineering) and implication (human health and environmental toxicology) of the Nano- Bio Interface

- **Part 1:** Introduction to the fields of nanomedicine and nanotoxicology
- **Part 2:** Commercialization case studies

PART 1

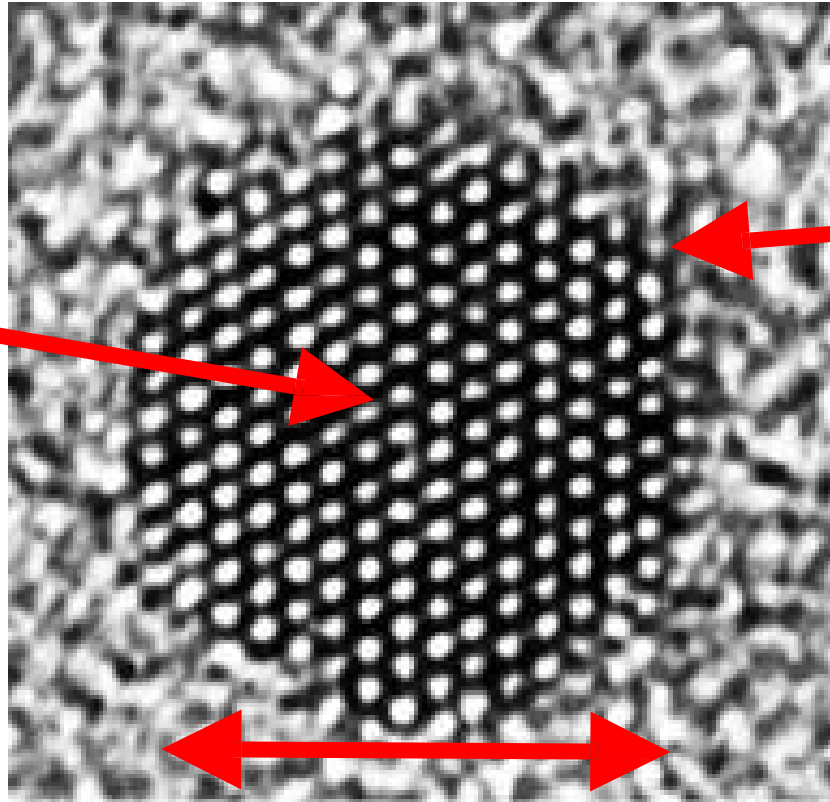
INTRODUCTION TO THE FIELDS OF NANOMEDICINE AND NANOTOXICOLOGY

Engineered “Model” Nanoparticle

*Highly
ordered*



C_{60}
1nm



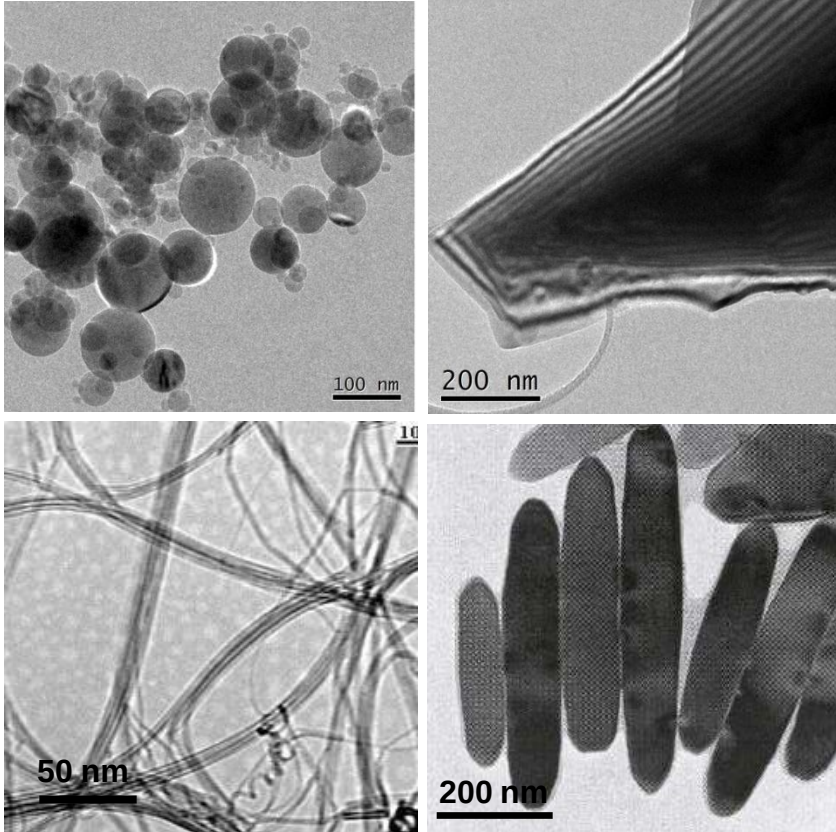
*Huge surface
areas*



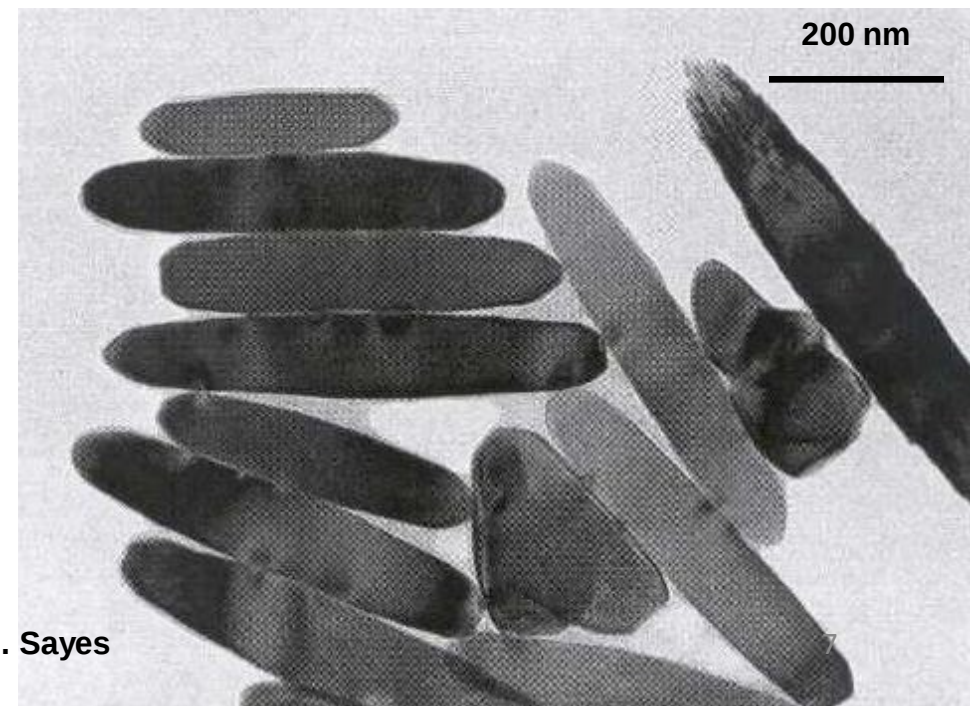
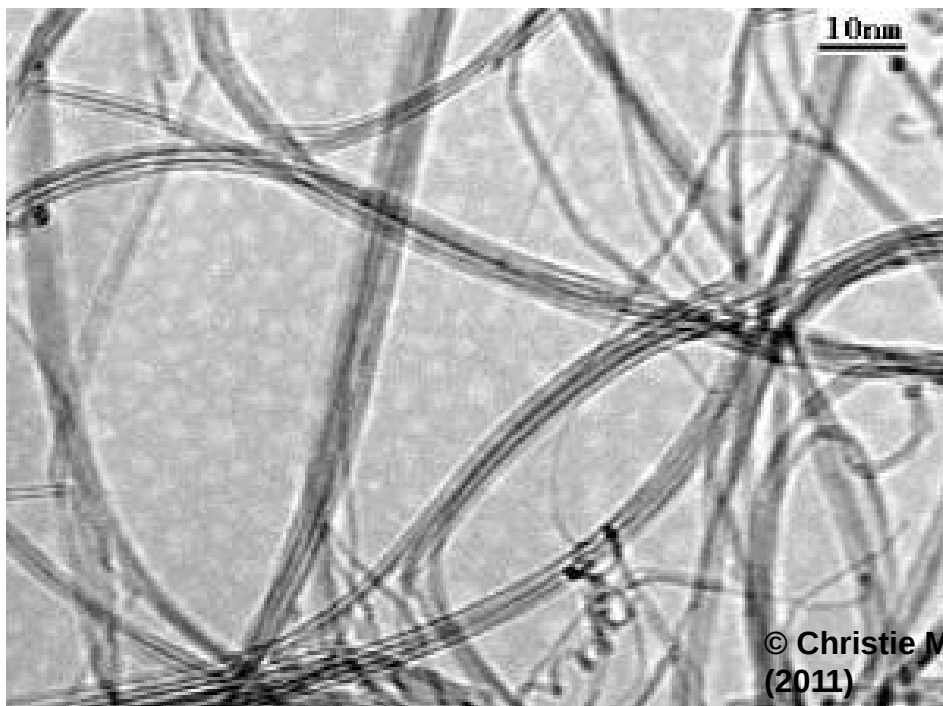
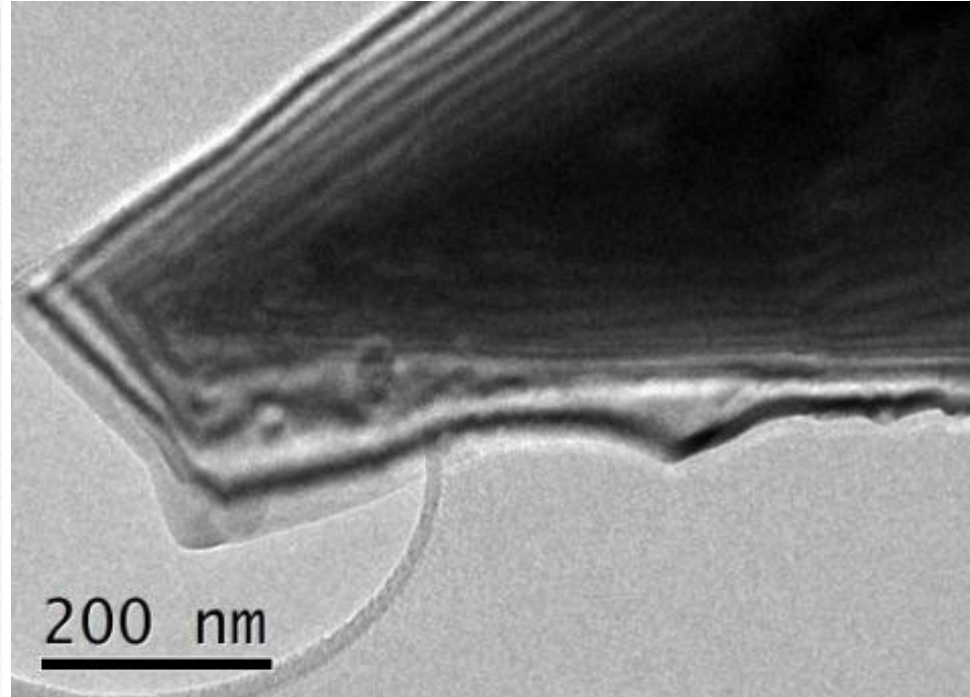
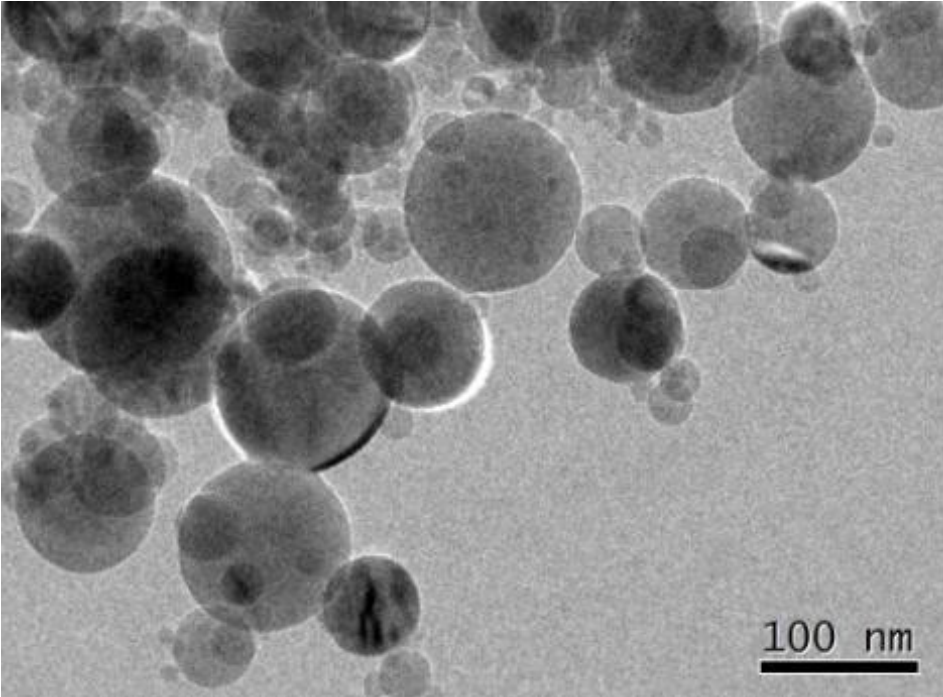
Lysozyme
3 nm

*Monodisperse
Cadmium Selenide nanocrystal
6 nm*

Nanomaterial Variety



- Size
- Shape
 - Fibers vs. particles
 - Tubes, rods, spheres, wires
- Composites & clays
- Classes
 - Carbon-based
 - Inorganic
 - » Metals
 - » Metal oxides
 - Organic
 - » dendrimers
- Crystalline vs. amorphous
 - Crystal phase



For nanomaterials, here are some of the properties you can characterize...

- Chemical composition
- Solubility
- Size, size distribution, surface area
- Surface charge
- Surface chemistry
 - Oxidation state
 - REDOX potential
- Crystallinity/purity
- Agglomeration, aggregation, coagulation
- pH
- Method preparation
- Exposure vs. intended use
- Morphology
- Rheological measurements
- Mechanical properties
- Thermal properties
- Spectroscopic properties
- Optical properties
- Magnetism

Poll Question:

What is the single most important property of a nanomaterial?

- A. Size
- B. Shape
- C. Chemical Composition
- D. Surface Charge
- E. All of the Above

Key Challenges in Medicine

- Translating breakthroughs in:
 - understanding of disease into preventive medicine
- How to increase productivity, DRAMATICALLY
- How to align care with better outcomes and efficiencies
- How to design affordable healthcare for the bottom-of-the-pyramid
- How to reap the benefits of healthcare while reducing the inefficiencies
 - This is the largest factor of a country's economic growth

**NANOTECH
PLATFORMS**

FUNCTIONS

METHODS

DISEASE

nanoparticles

sensing

proteomics

cancer

**Cell
tracking**

**Neuro
degenerative**

nanoassemblies

imaging

drugs

infectious

**DNA-
adducts**

mental

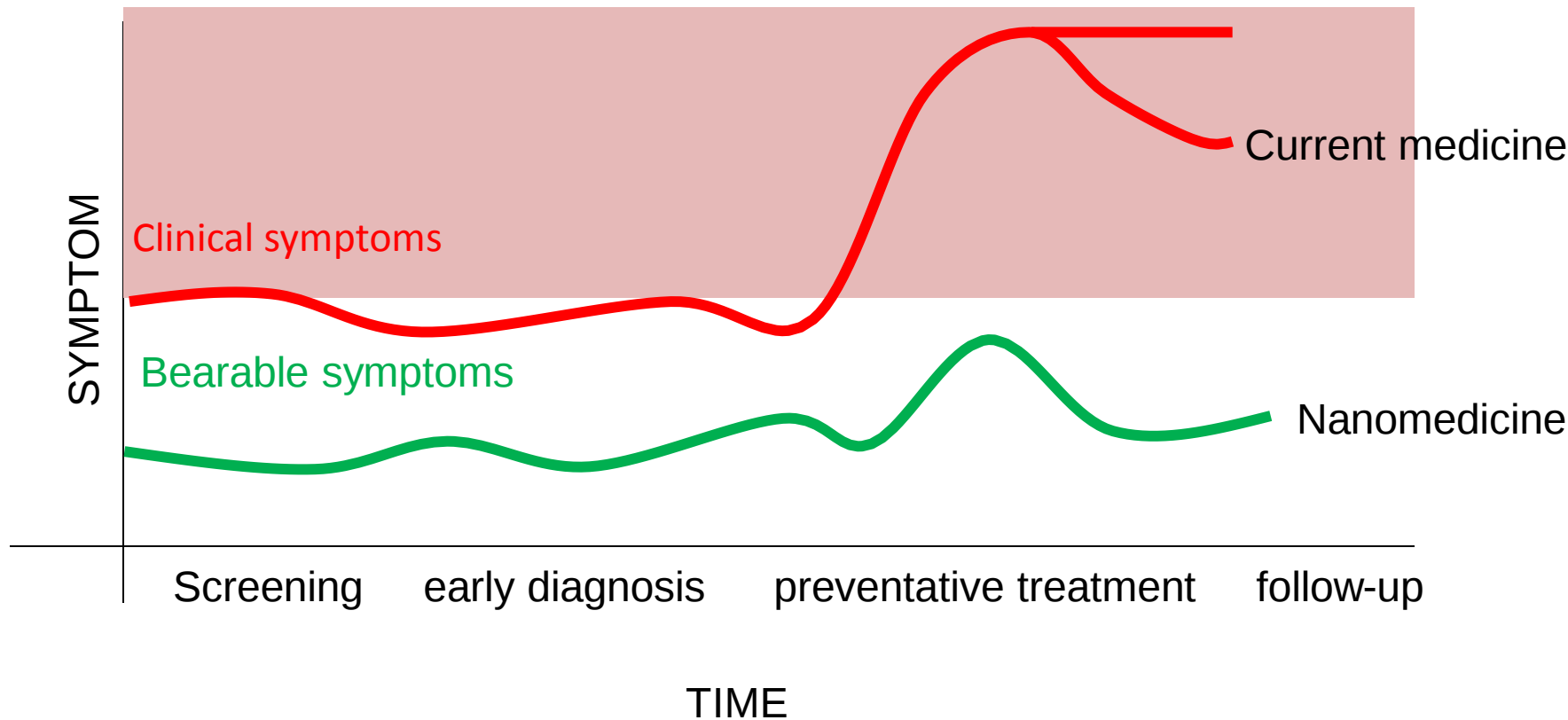
nanotemplates

delivery

MRI

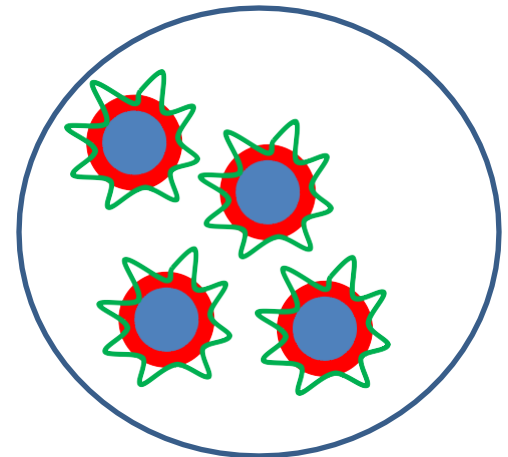
blood

Nanomedicine can also be about early diagnosis, early and regenerative treatment



What are the most important characteristics of nanoparticles for medicine?

- Surface coating to allow for target specificity
- Extreme small size
- Can be encapsulated
- Can carry highly concentrated amount of drug
- Tunable surface charge
- Drug release

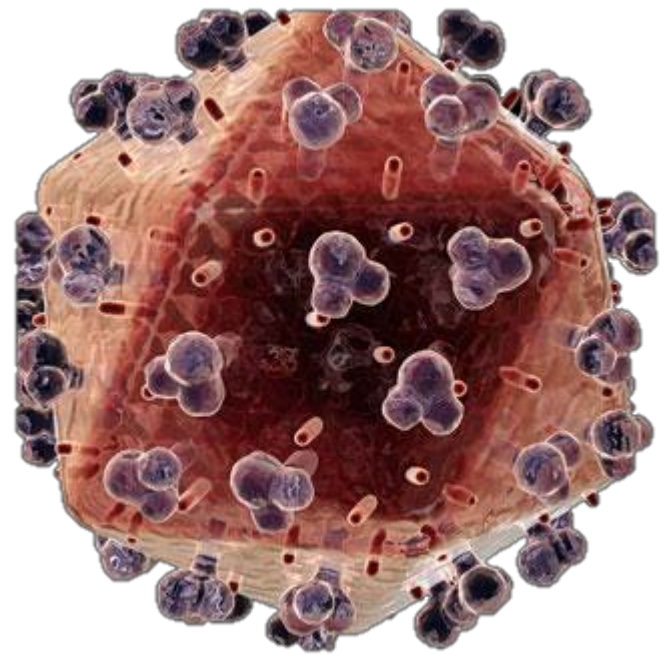


Governing Principles for Nanoparticles in Medicine

1. Particles must be on the same size scale as other biological entities



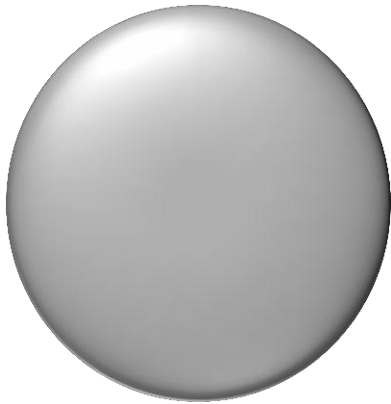
DNA



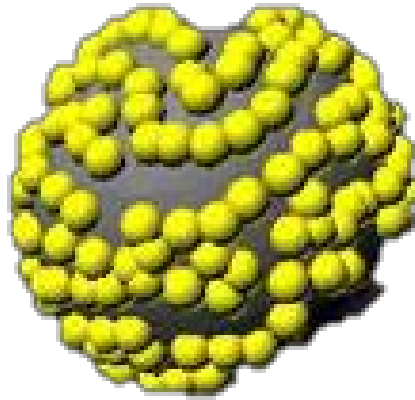
Virus

Governing Principles for Nanoparticles in Medicine

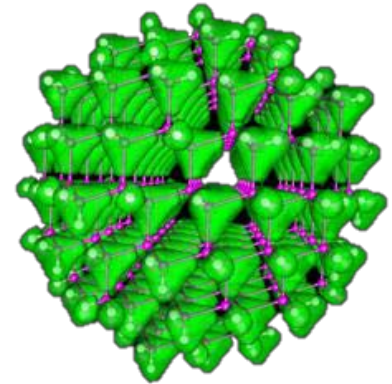
2. Particles must be robust and stable (most are metallic)



Metal
Nanoparticle



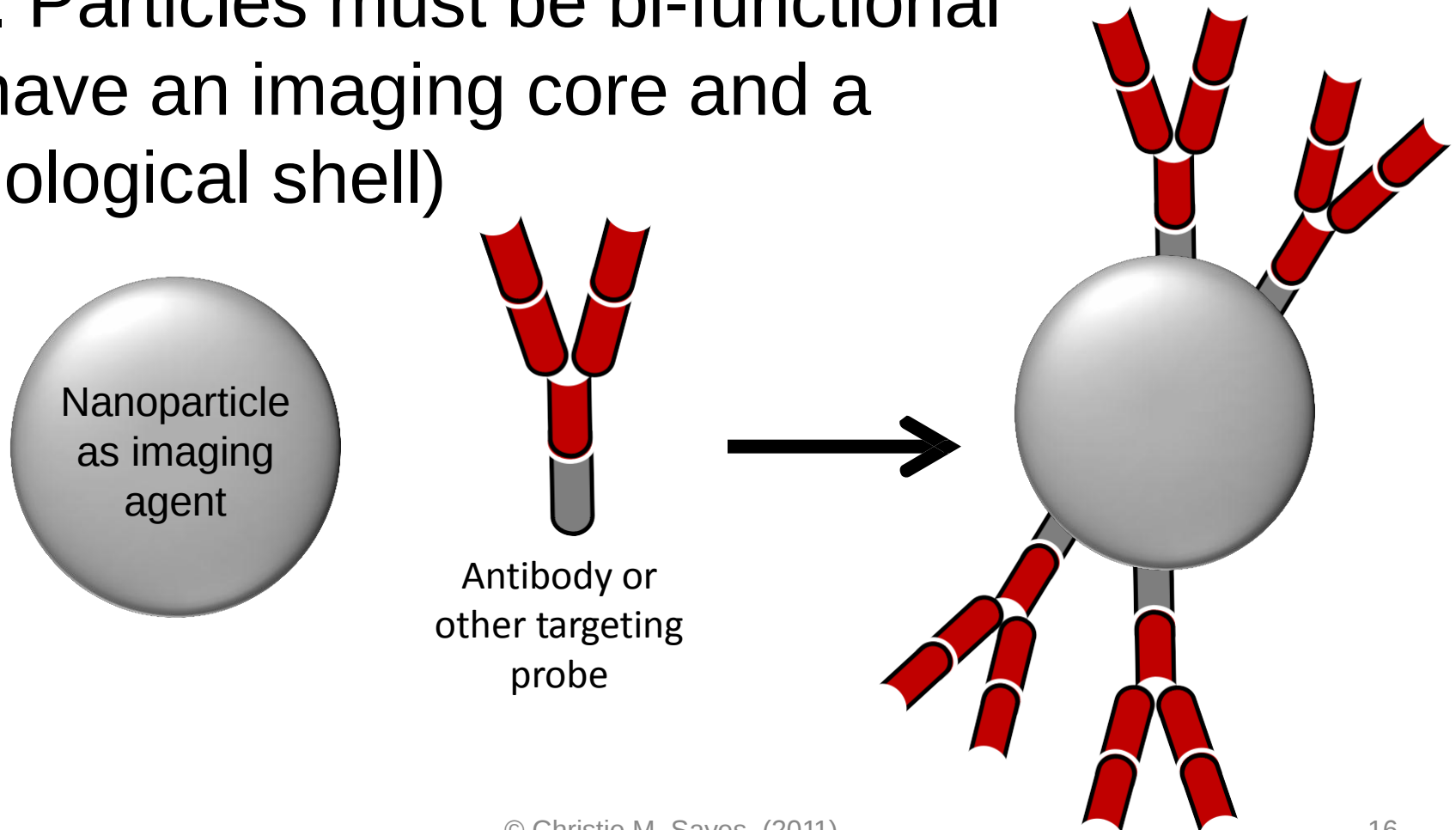
Nanoshell



Quantum
Dot

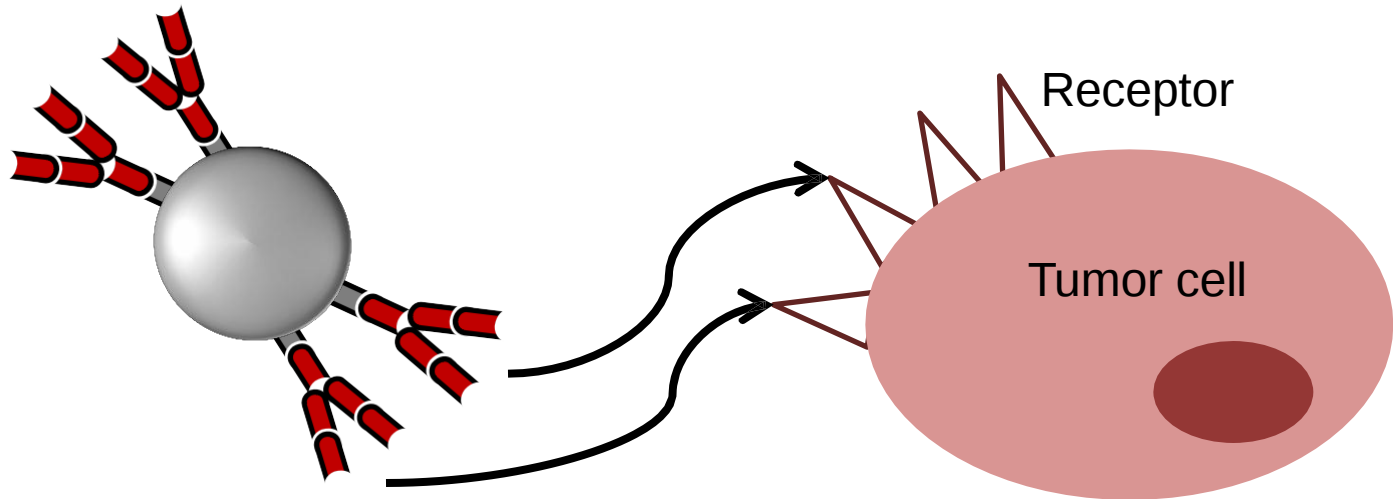
Governing Principles for Nanoparticles in Medicine

3. Particles must be bi-functional
(have an imaging core and a
biological shell)



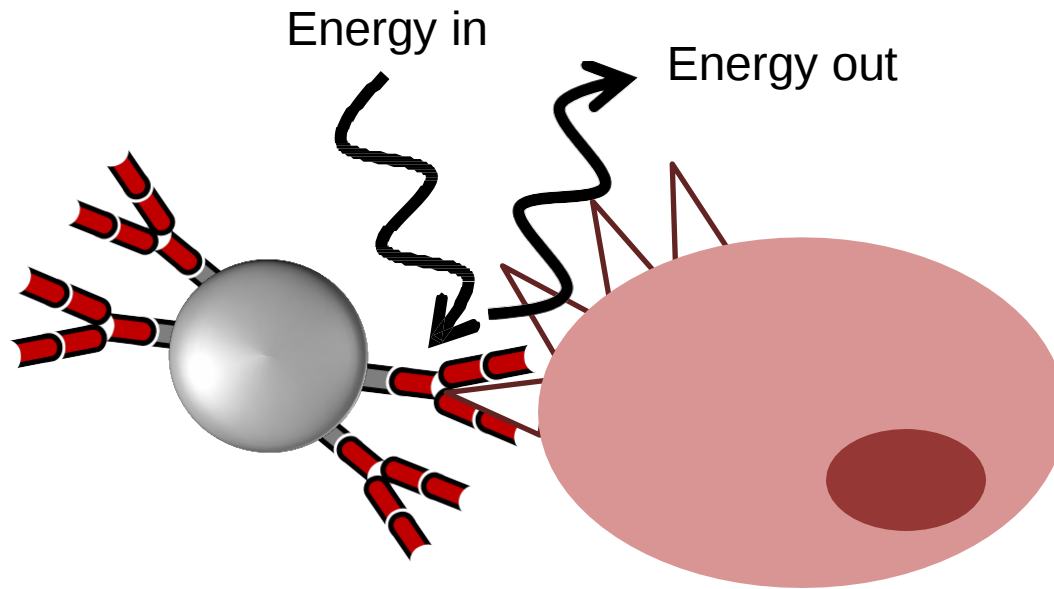
Governing Principles for Nanoparticles in Medicine

4. Functional group on nanoparticle surface must target a receptor



Governing Principles for Nanoparticles in Medicine

5. Energy must be applied and nanoparticle must respond

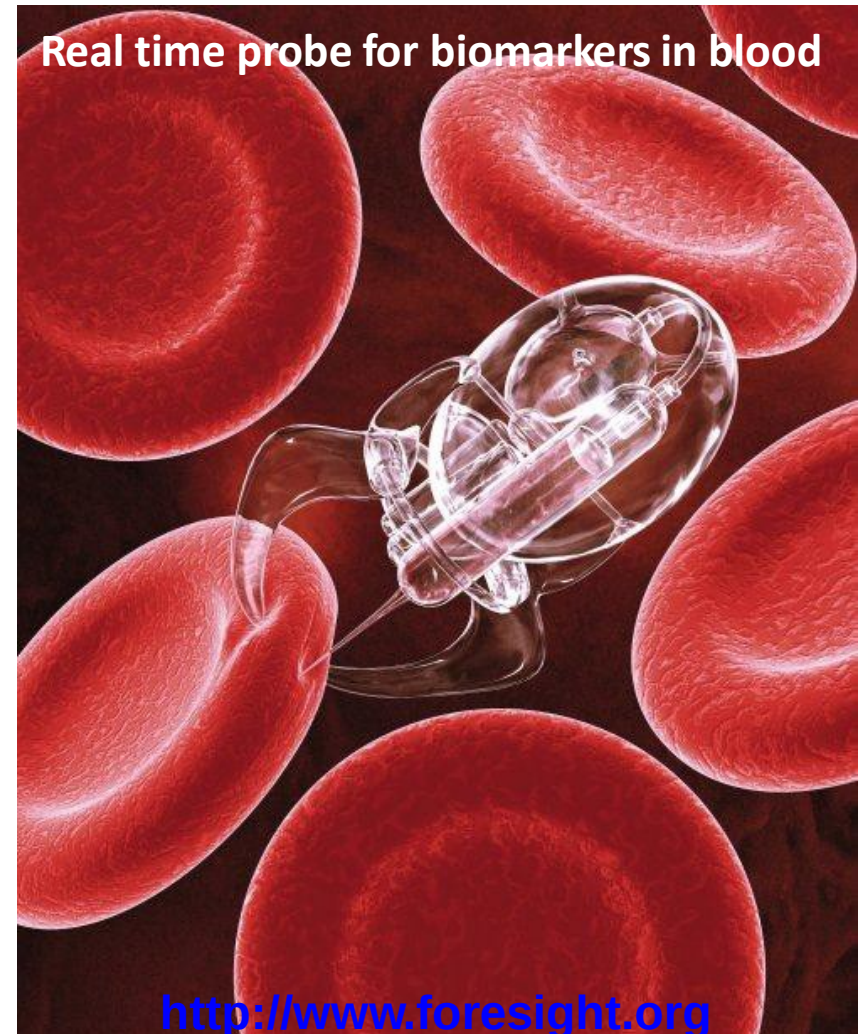


The Global Nanomedicine Research Agenda

1. Nano-Diagnostics: early and accurate diagnosis
 - Biosensors and miniaturized devices
 - Targeted imaging agents to highlight of disease
2. Targeted Drug Delivery: on the spot
 - Bring the drug to the target site and monitor its impact
3. Regenerative Medicine: stimulated repair
 - Help the body to (re)build organs or systems
4. Meeting ELSA challenges
 - Ethical, Legal & Social Aspects
5. For the main diseases in the world:
 - Cancer, cardiovascular disease, musculo-skeletal, mental and infectious disease, and diabetes

Nano-Diagnostics

- Screening: personal risk factors
- Identification of populations at risk
- Prediction of risk factors
 - Earlier, more sensitive, faster diagnostic
- Diagnosis of asymptomatic patients
- Higher sensitivity: detection of early biomarkers
- Non-invasive and painless diagnostic techniques
 - From a lab to physician's office and the home
 - Genetic testing for individual therapy selection
- Pharmacogenomics



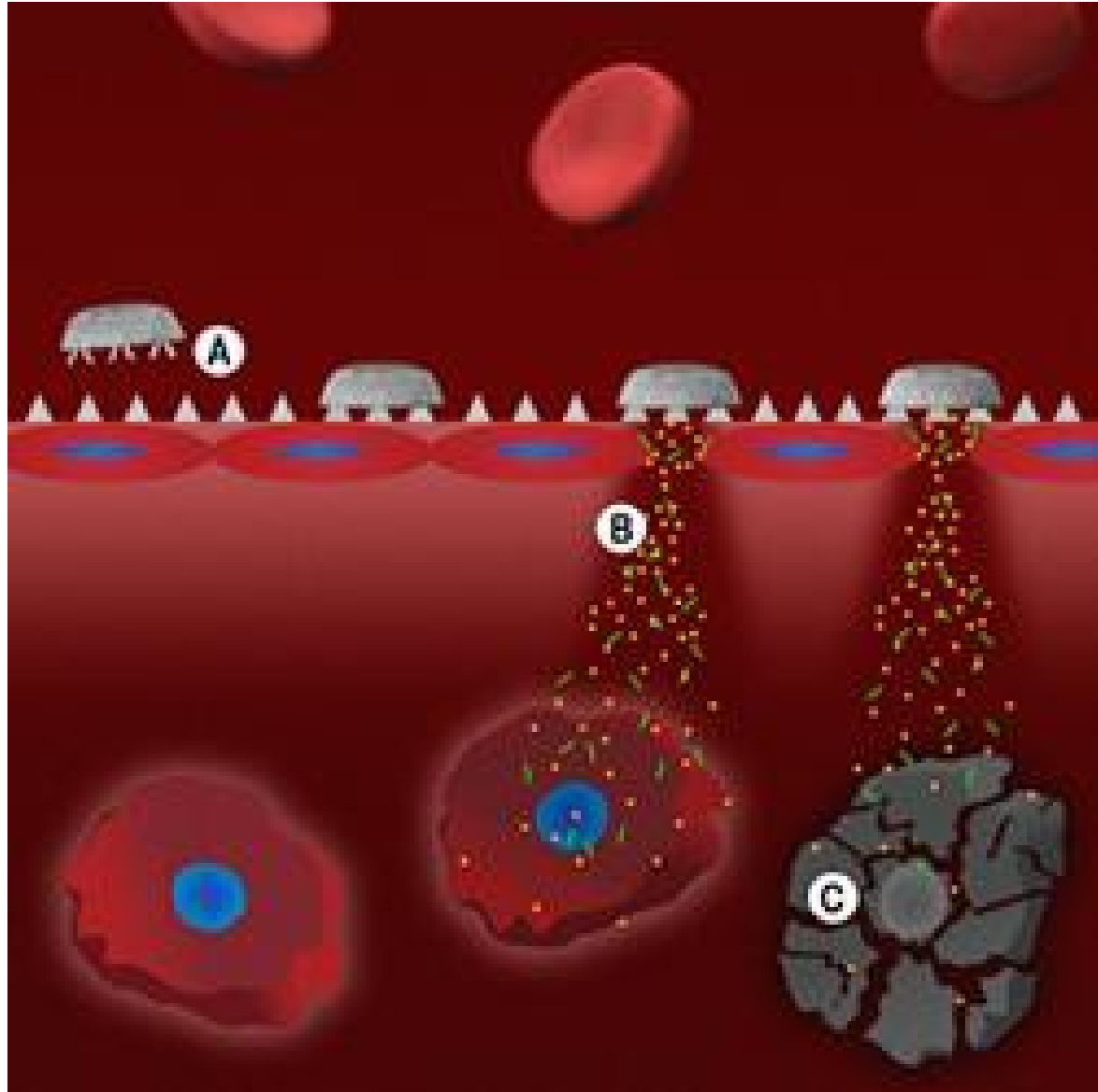
Targeted Drug Delivery

- Protected Drug delivery to target sites
 - Nanoparticles
 - Miniature devices
- Higher doses?
Lower doses?
- Healthy tissue not affected
- Theranostics



Targeted Drug Delivery: CANCER

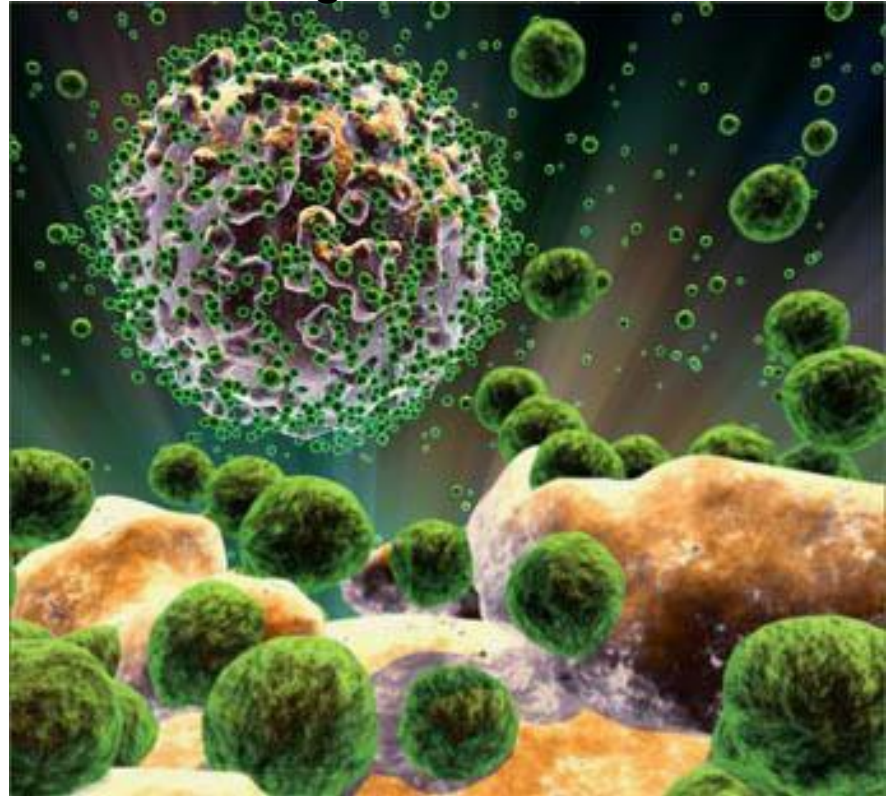
- A. Nanobot loaded with chemotherapy lands on blood vessel wall connected to vasculature
- B. One latched on, nanobot releases its drug through blood vessel wall
- C. Highly concentrated chemotherapy drug is targeted directly to cancer cell, which subsequently dies



Regenerative Medicine

- Intelligent biomaterials
 - Adjustable rate biodegradation
 - Time-programmable biomaterials for tissue growth
- Targeted cell implantation
- Biomimicking cell membranes
- Polymers & proteins with programmable conformation
- Control of implant rejections

**Destroy bacteria cell overgrowth
on regenerated tissue**



<http://www.foresight.org>

ELSA Compliance

- Nanomedicine touches familiar
Ethical, Legal, & Social Aspects (ELSA)
known from biomedical ethics such as:
 - gap between diagnostics and therapy
 - sensitivity of genetic information
- And some new ones:
 - When do we call a person “ill”?
 - Difference between medical treatment and enhancement?
 - Obtaining public acceptance
 - Differences in the role of IP between industries
- Regulatory challenges

Poll Question:

What is the single most important aspect of nanomedicine?

- A. Efficacy
- B. Toxicity
- C. Public Acceptance
- D. Cost
- E. Other (please type your response in the Chat Box)

PART 2

COMMERCIALIZATION CASE STUDIES

Examples Of Companies Commercializing Nanomaterials For Biological & Medical Applications

Company	Major area of activity	Technology
Argonide	Membrane filtration	Nanoporous ceramic materials for endotoxin filtration, orthopaedic and dental implants, DNA and protein separation
Biophan Technologies, Inc.	MRI shielding	Nanomagnetic/carbon composite materials to shield medical devices from RF fields
Capsulution NanoScience AG	Pharmaceutical coatings to improve solubility of drugs	Layer-by-layer poly-electrolyte coatings, 8–50 nm
Evident Technologies	Luminescent biomarkers	Semiconductor quantum dots with amine or carboxyl groups on the surface, emission from 350 to 2500 nm
Smith & Nephew	Coated bandages	Nanocrystal silver is highly toxic to pathogens

Waterborne pathogenic microorganisms are a major source of disease worldwide. Pathogens and water system deficiencies that are identified in outbreaks may also be important causes of endemic waterborne illness.

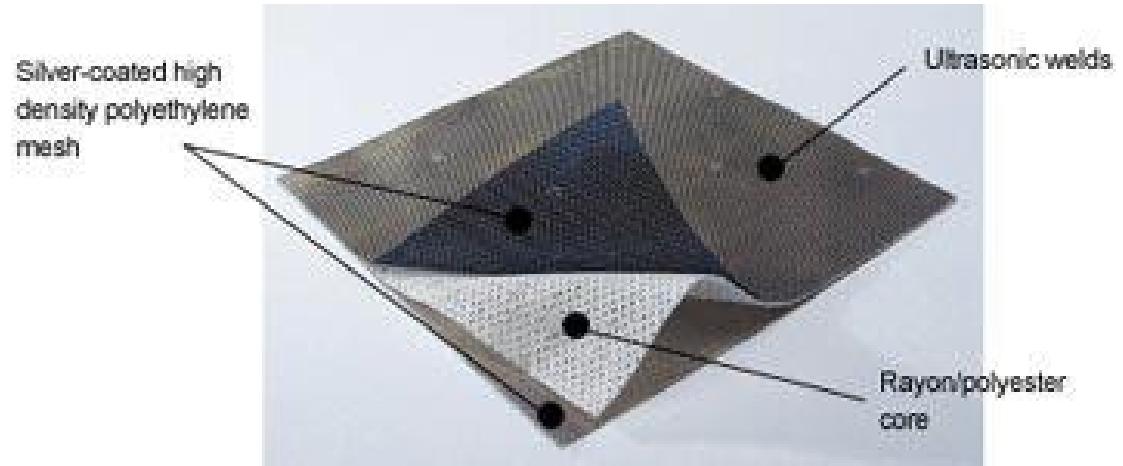


NanoCeram® filters utilize a non-woven filter media containing a thermally-bonded blend of microglass fibers and cellulose infused with nanoalumina fibers. This method makes available greater than 42,000 square meters of nanofiber surface area per square meter of filter media of loading capacity.



Smith & Nephew

<http://global.smith-nephew.com>



The ACTICOAT family are a unique range of antimicrobial barrier dressings for use over partial, full thickness and acute wounds.

- Unique Patented Silver technology: SILCRYST[†] Nanocrystalline
- Silver Antimicrobial protection
- Effective barrier to over 150 wound pathogens
- Faster kill rates, longer wear times

Questions?

Please type all questions into the
Chat Box

Tech Intersection: Understanding the Bio and Nano Link

Dr. Christie M. Sayes
Program Manager
Nanotoxicology & Nanopharmacology
RTI International

Contact Information:
csayes@rti.org

Thank you for attending the
NACK Center webinar

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