



NACK
CENTER

Nanotechnology Applications
& Career Knowledge

WWW.NANO4ME.ORG

Tech Intersection: Understanding the Bio & Nano Link

The NACK Center was established at the Pennsylvania State College of Engineering, and is funded in part by a grant from the National Science Foundation.



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Welcome to NACK's Webinar

Presenter



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Program Manager - Nanotoxicology & Nanopharmacology at RTI International
csayes@rti.org

Webinar Outline

GOAL:

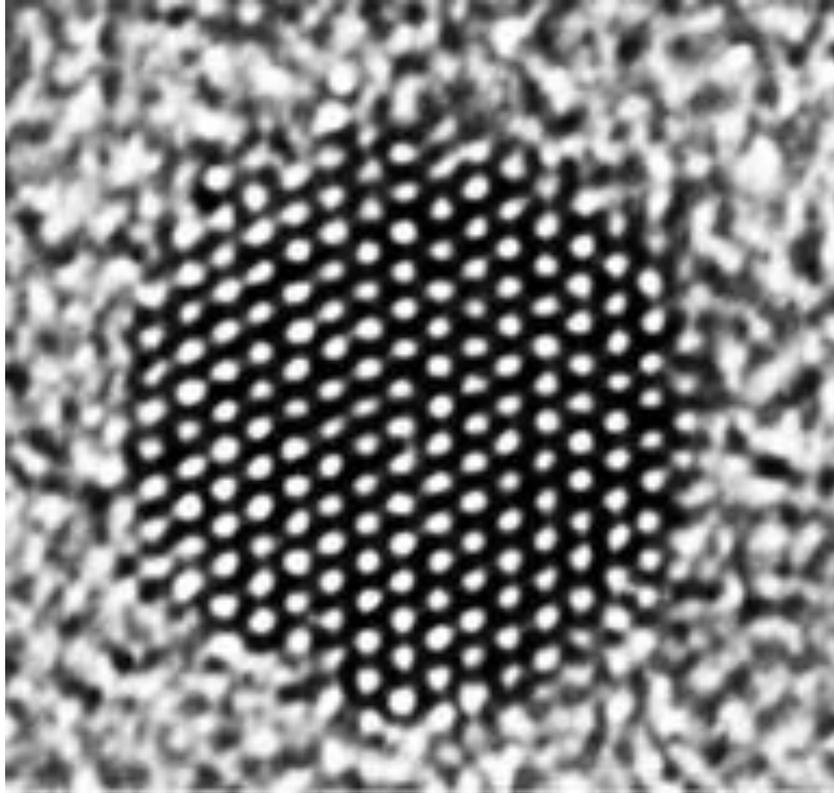
The application (medicine and engineering) and implication (human health and environmental toxicology) of the Nano-Bio Interface

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

PART 1

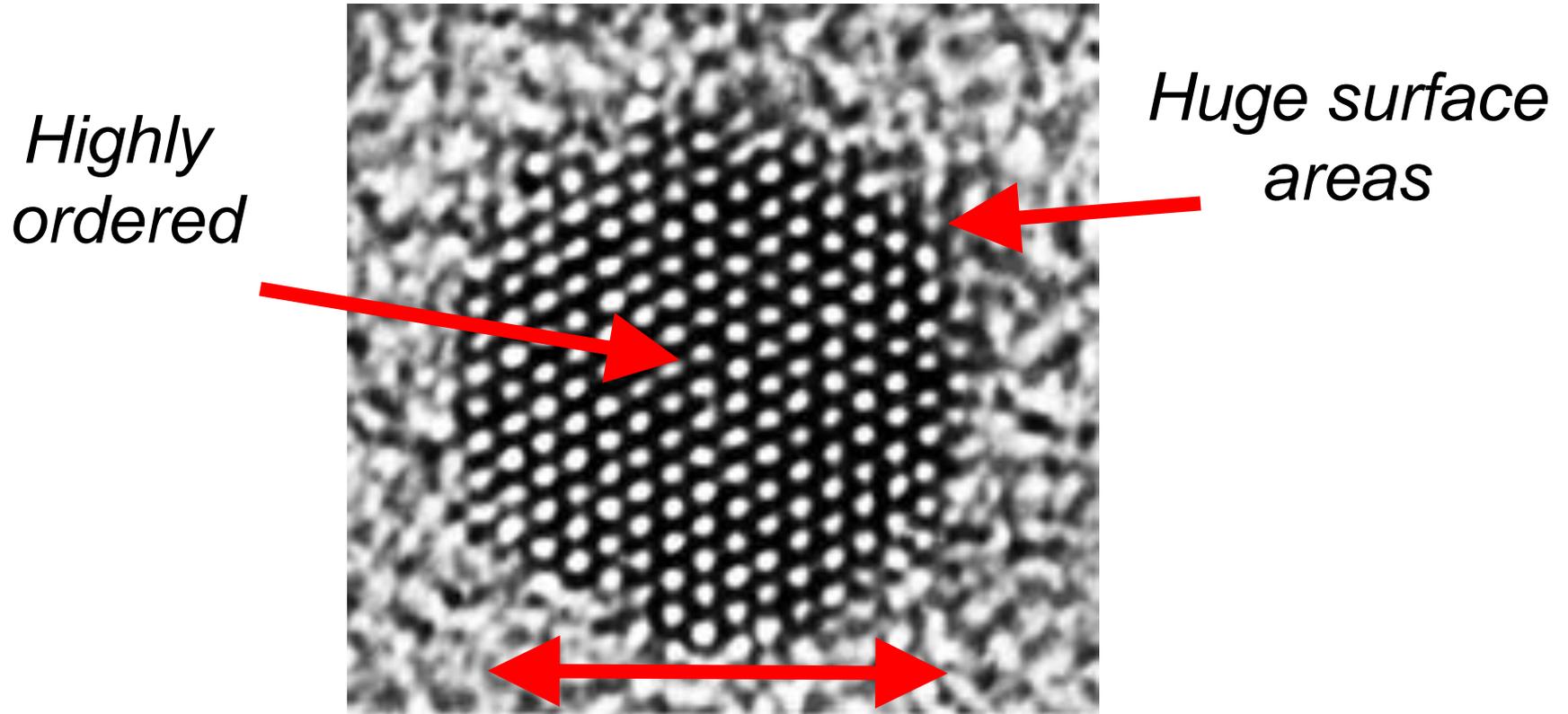
INTRODUCTION TO THE FIELDS OF NANOMEDICINE AND NANOTOXICOLOGY

Engineered “Model” Nanoparticle



*Cadmium Selenide nanocrystal
6 nm*

Engineered “Model” Nanoparticle

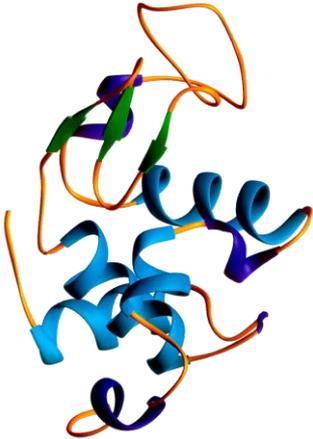
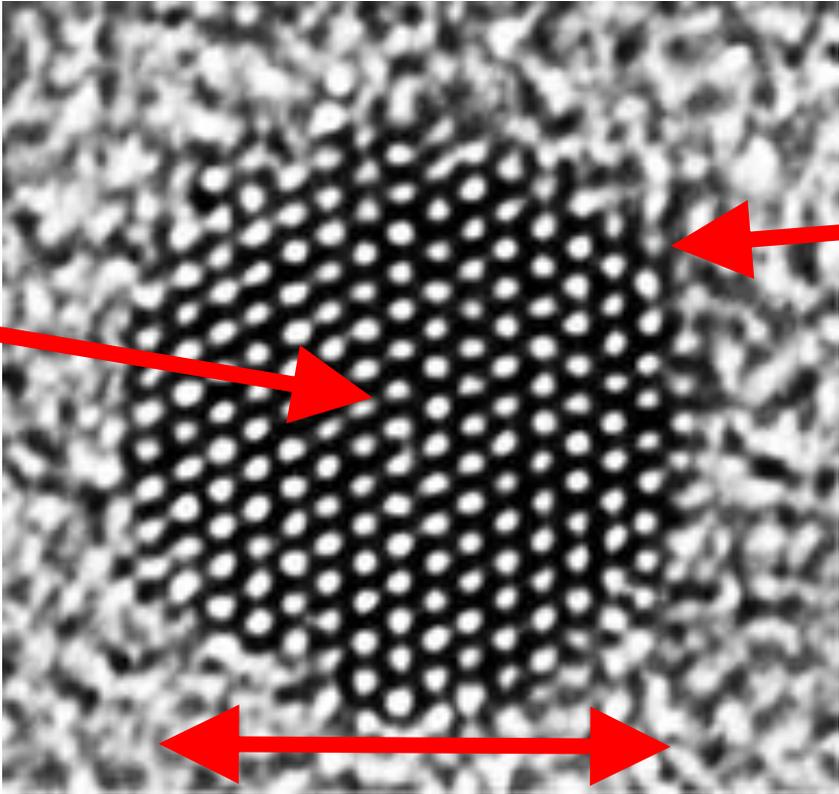


Monodisperse
Cadmium Selenide nanocrystal
6 nm

Engineered “Model” Nanoparticle

Highly ordered

Huge surface areas

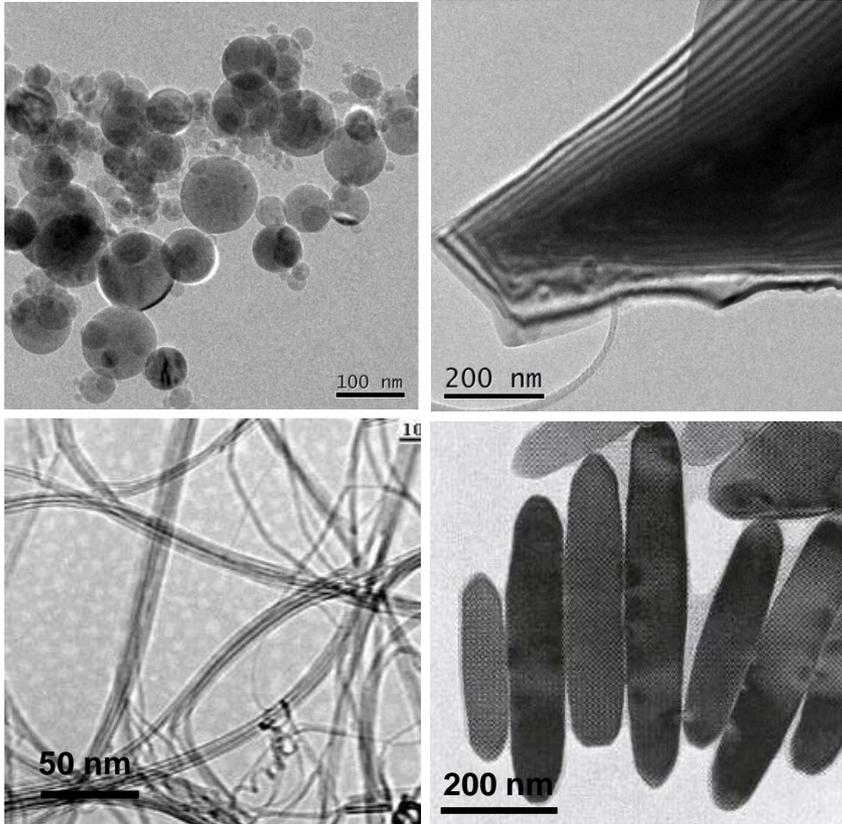


C_{60}
1nm

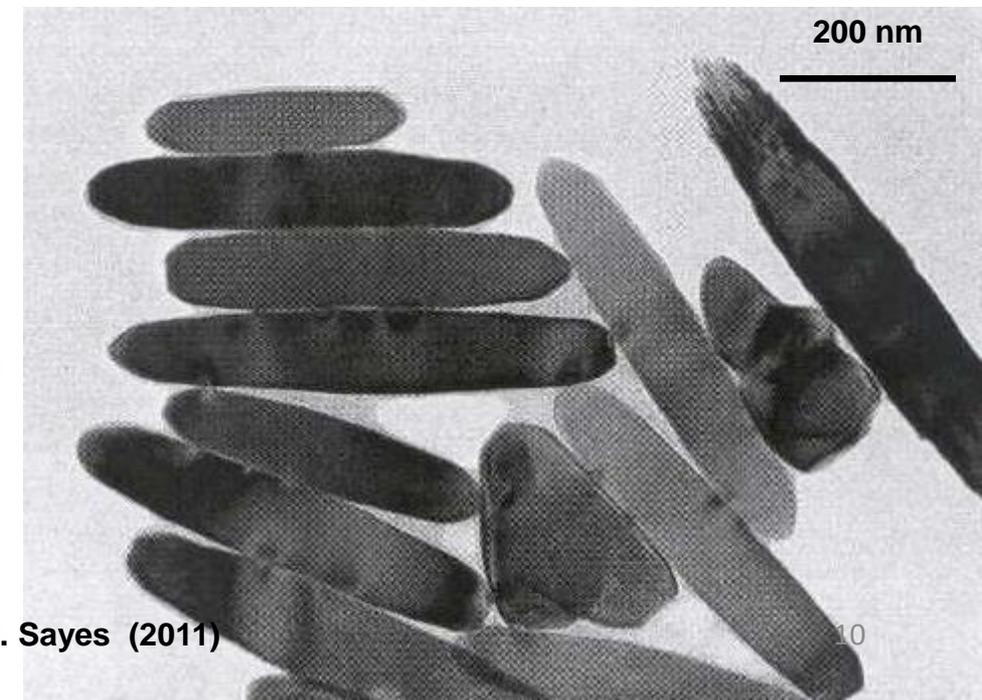
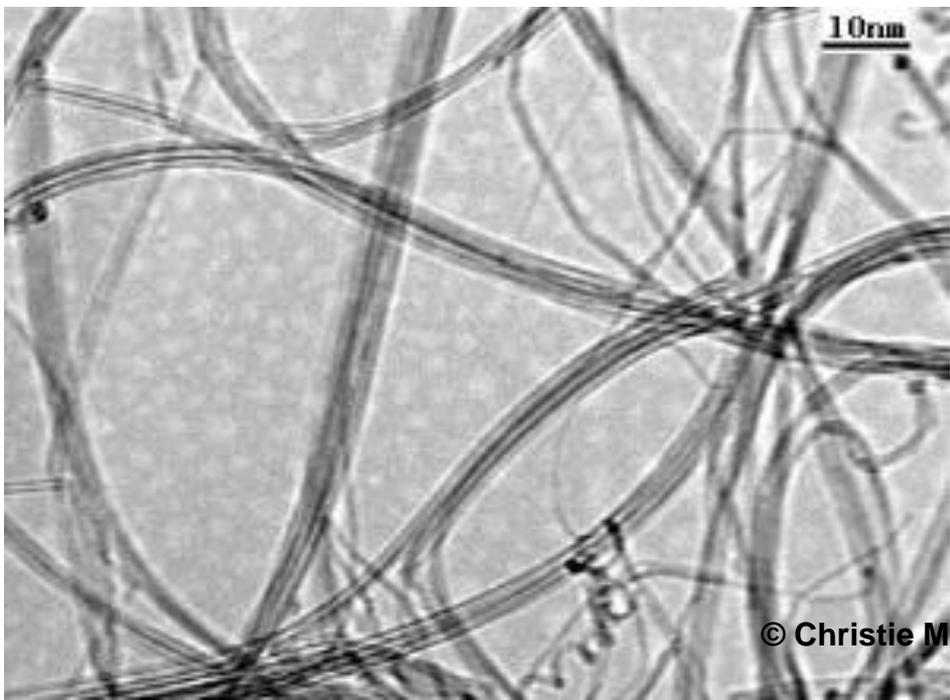
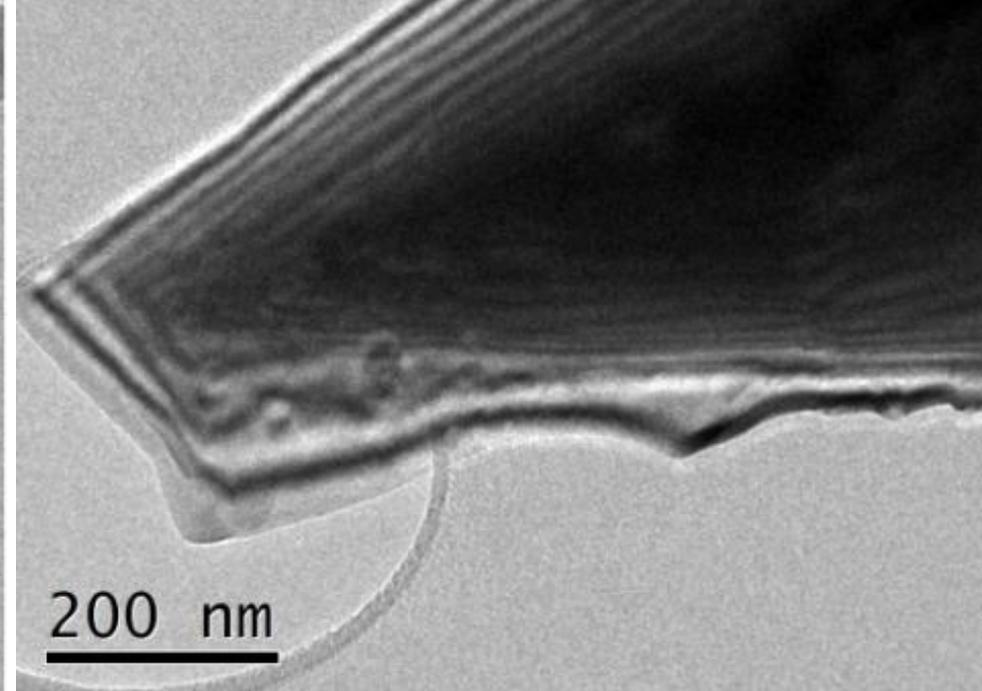
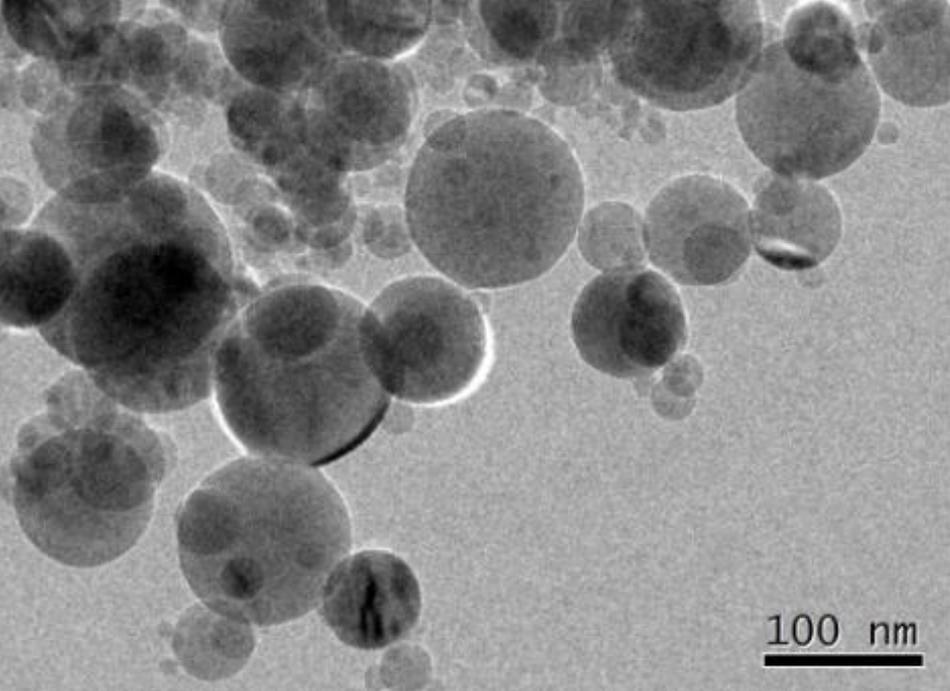
Monodisperse
Cadmium Selenide nanocrystal
6 nm

Lysozyme
3 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

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- 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

nanoassemblies

imaging

Cell
tracking

Neuro
degenerative

nanotemplates

delivery

drugs

infectious

DNA-
adducts

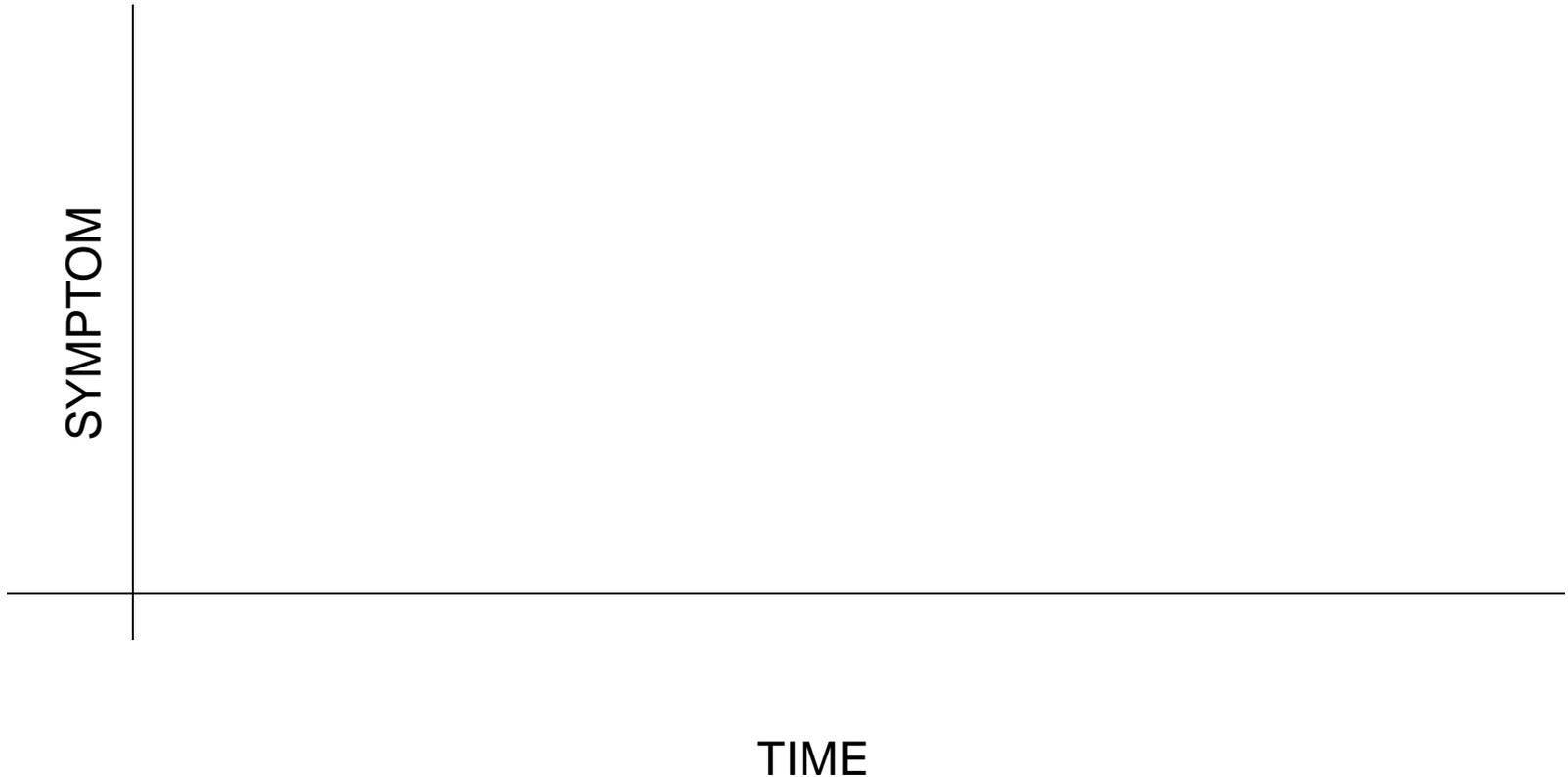
mental

MRI

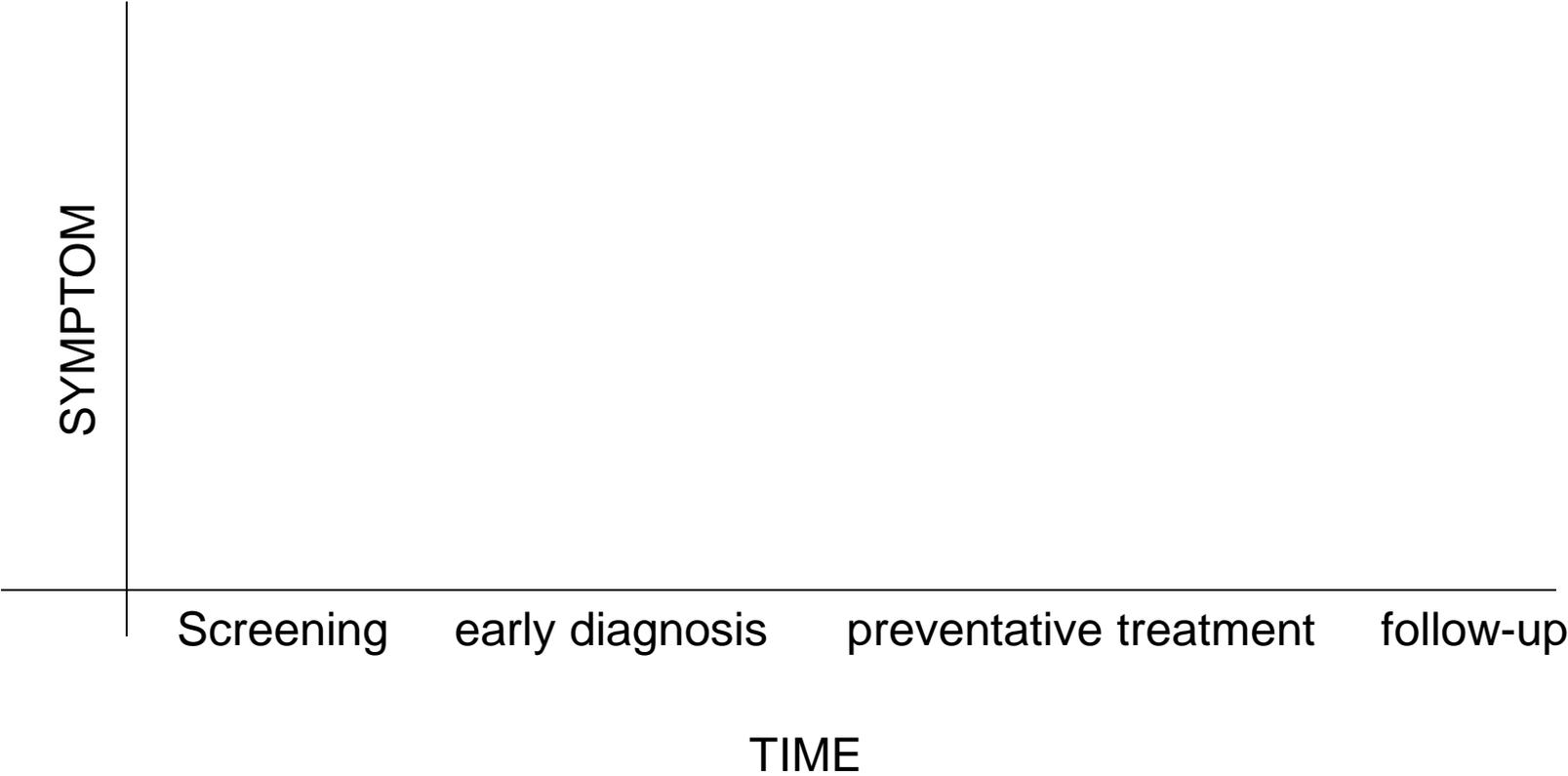
blood

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

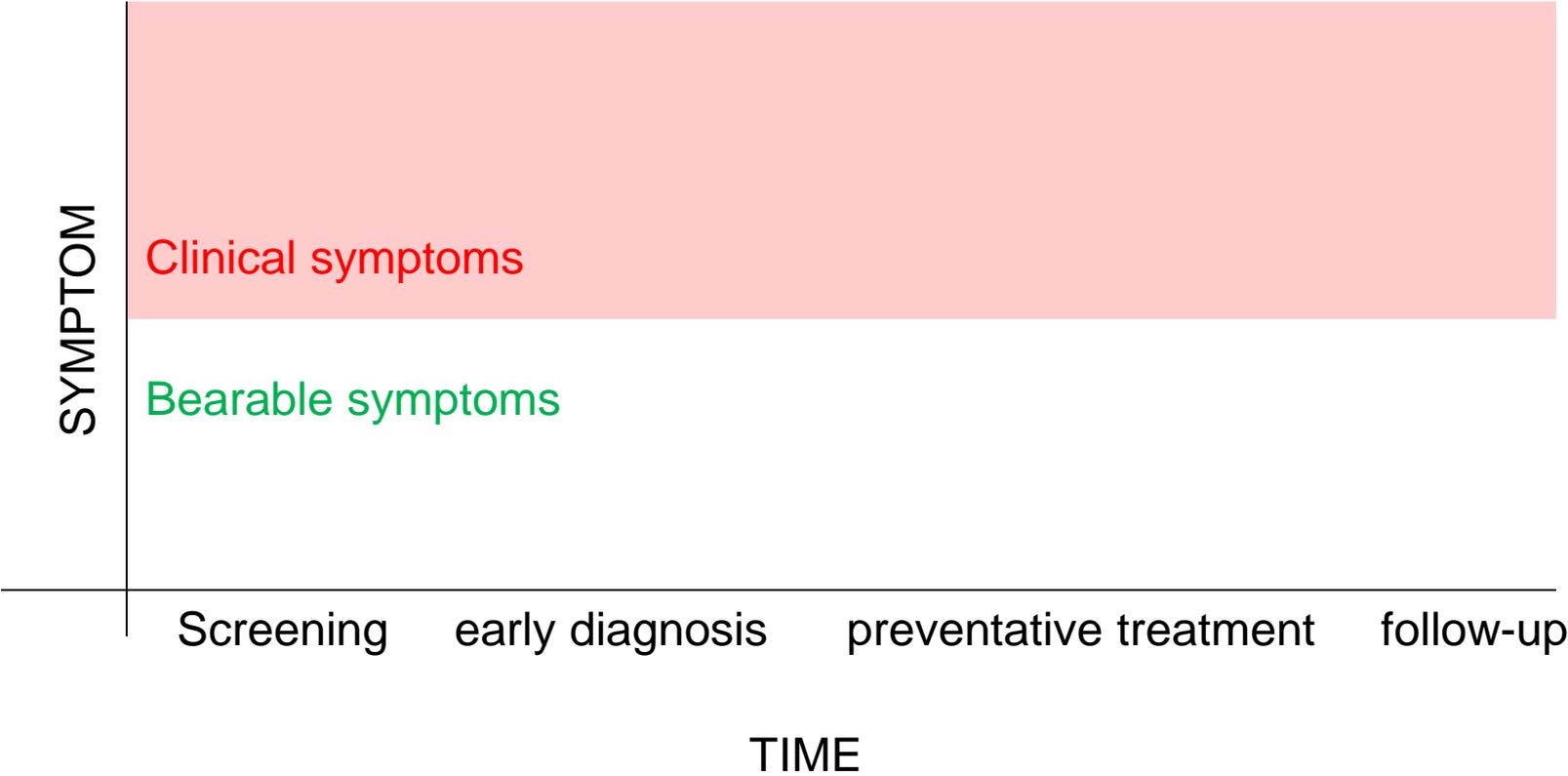
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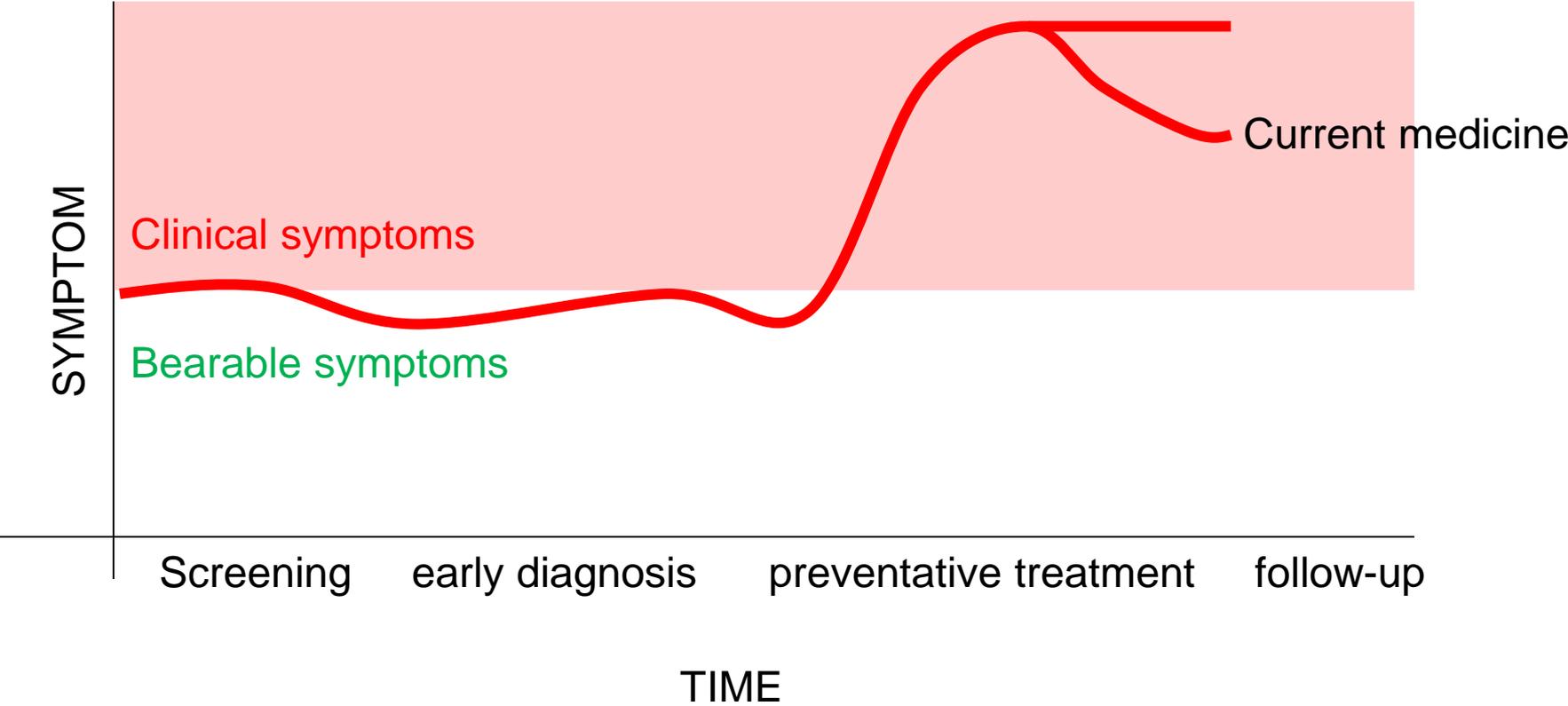
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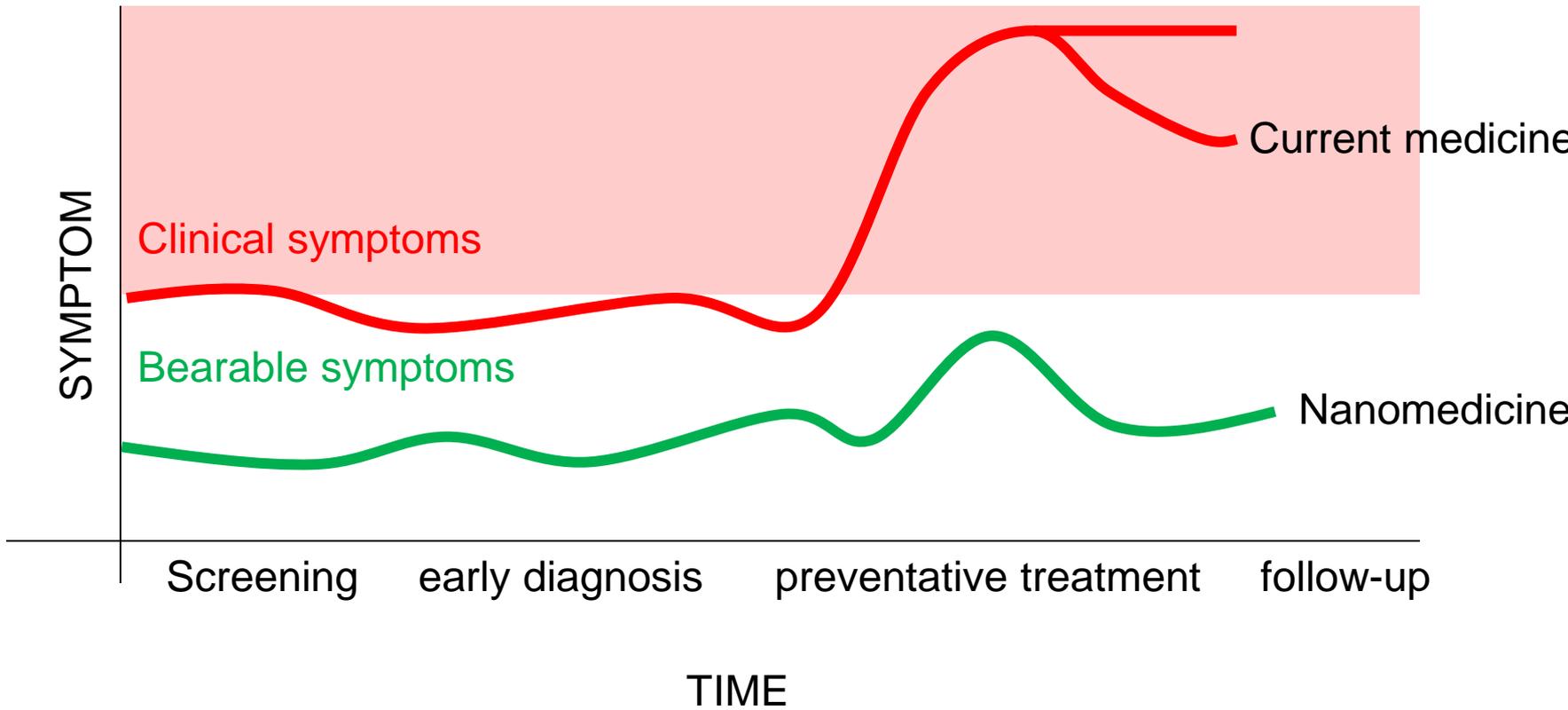
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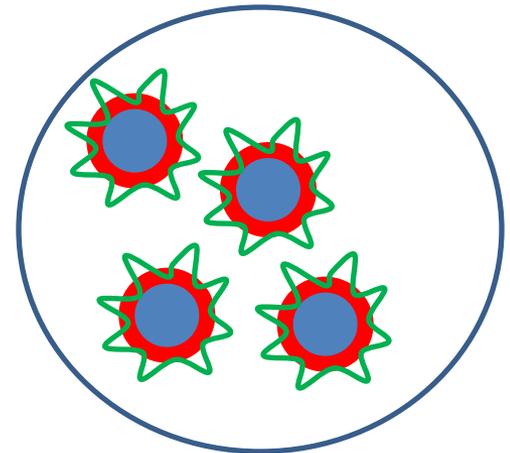
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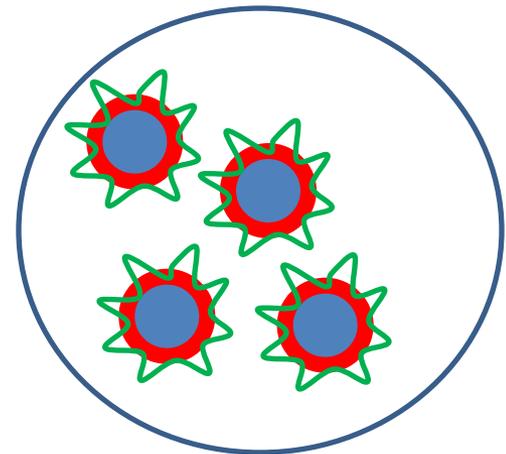


What are the most important characteristics of nanoparticles for medicine?



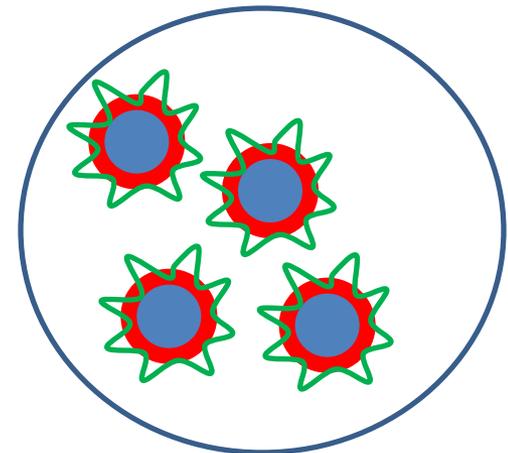
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- Surface coating to allow for target specificity



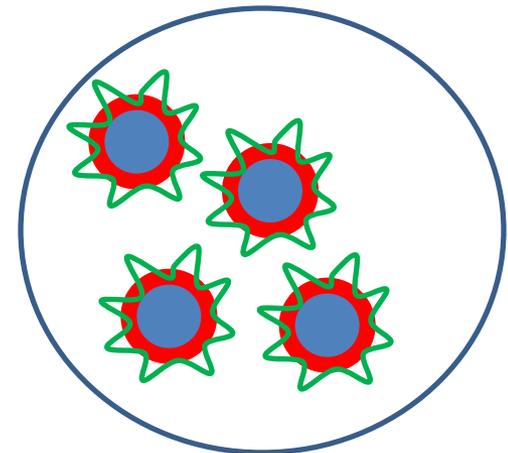
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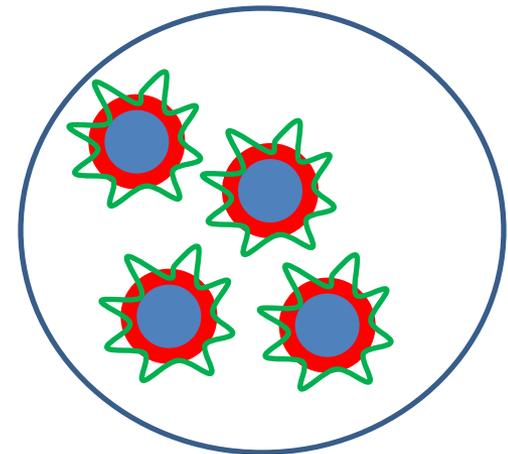
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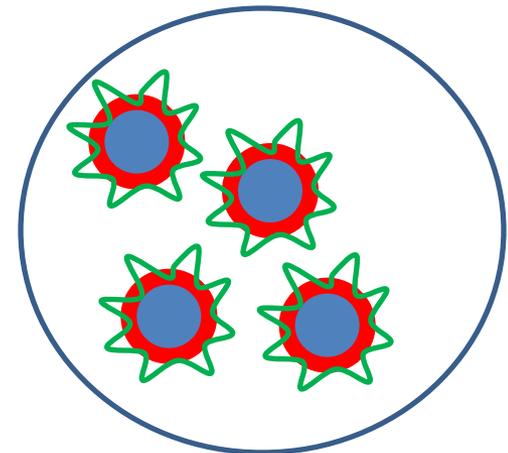
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- Can carry highly concentrated amount of drug



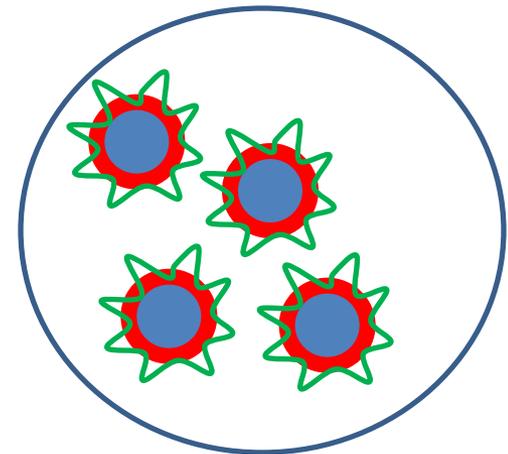
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What are the most important characteristics of nanoparticles for medicine?

- 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

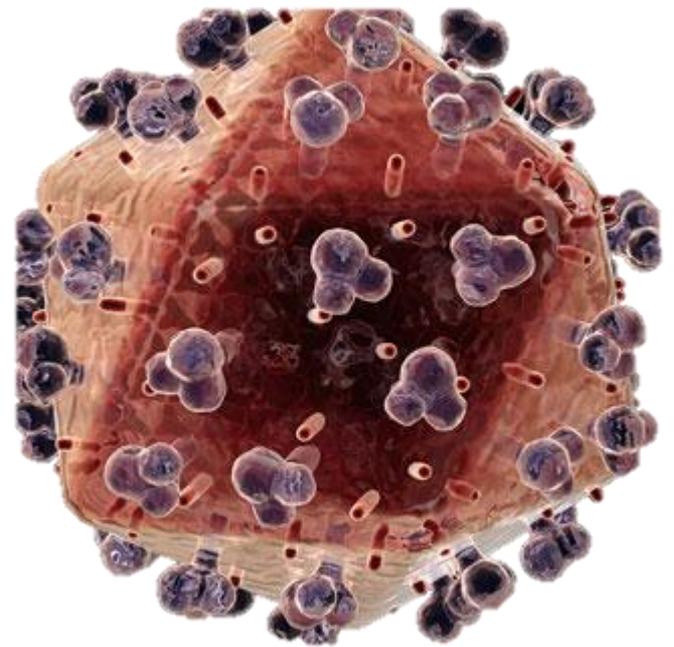


Governing Principles for Nanoparticles in Medicine

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



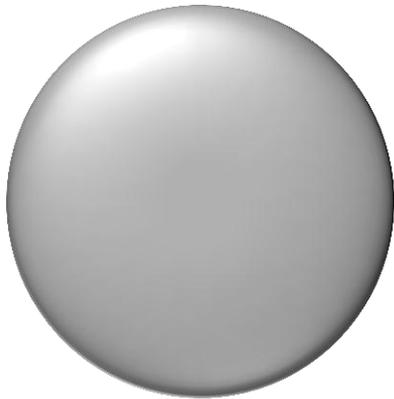
DNA



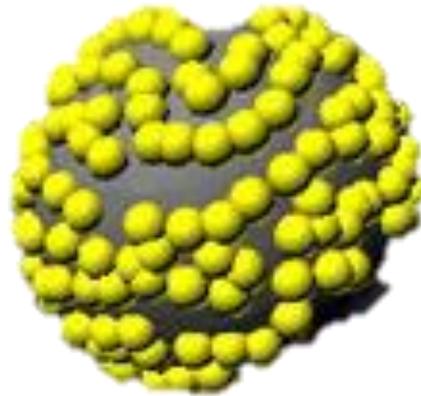
Virus

Governing Principles for Nanoparticles in Medicine

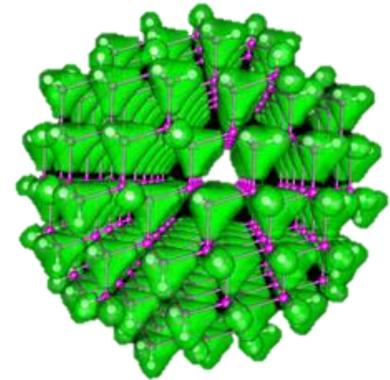
2. Particles must be robust and stable (most are metallic)



Metal
Nanoparticle



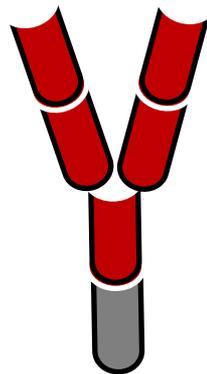
Nanoshell



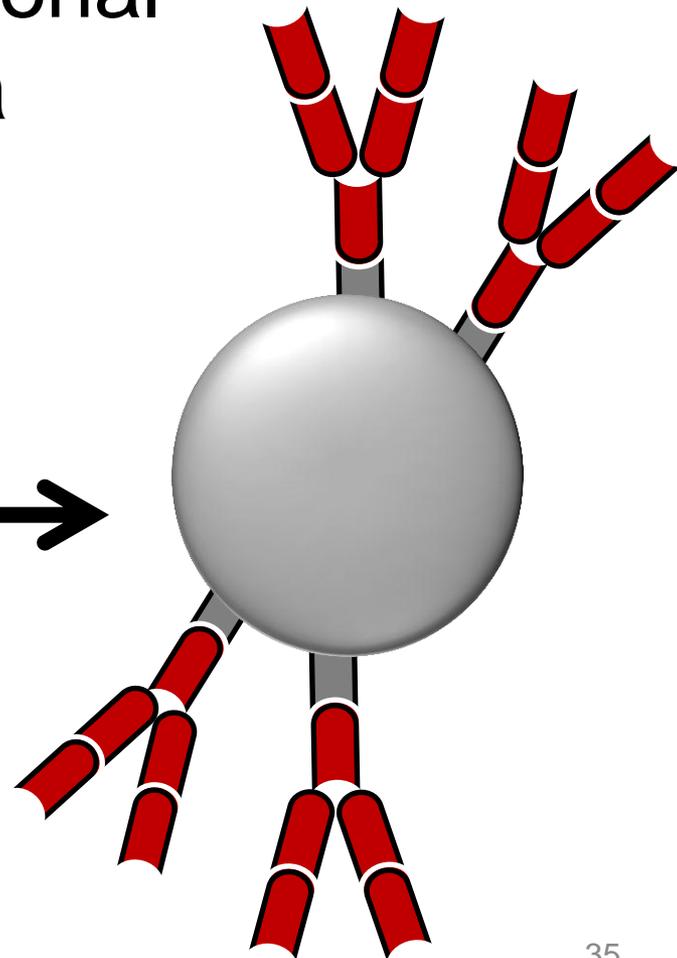
Quantum
Dot

Governing Principles for Nanoparticles in Medicine

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

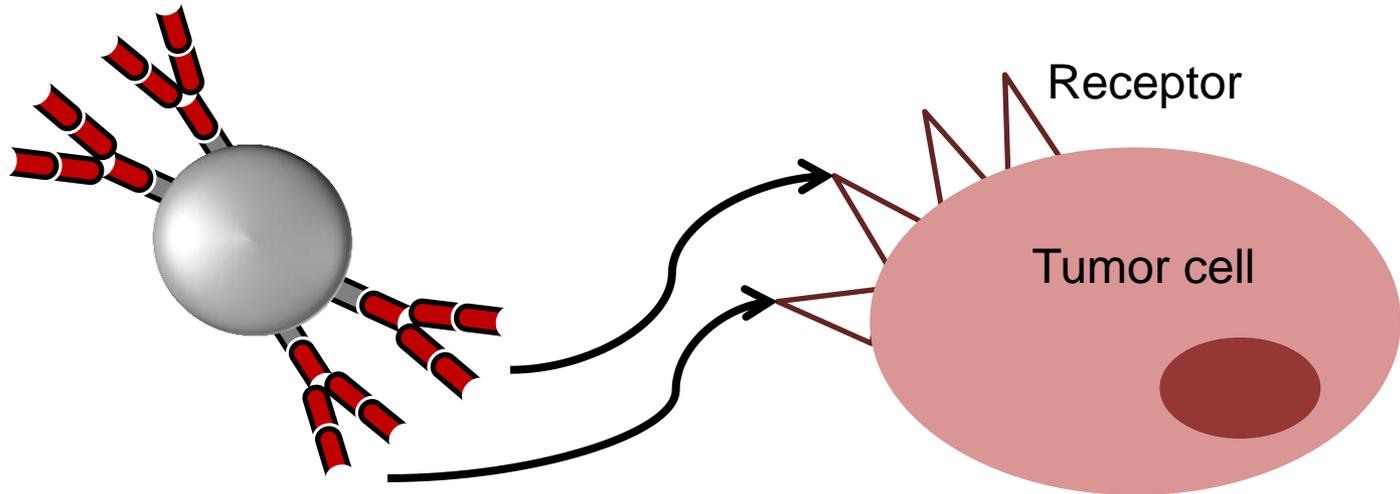


Antibody or
other targeting
probe



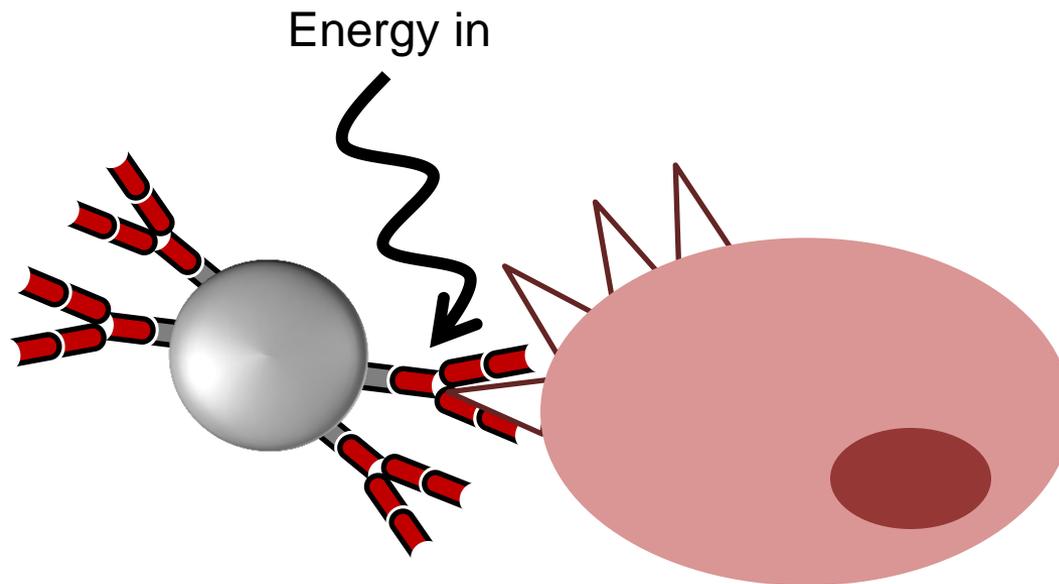
Governing Principles for Nanoparticles in Medicine

4. Functional group on nanoparticle surface must target a receptor



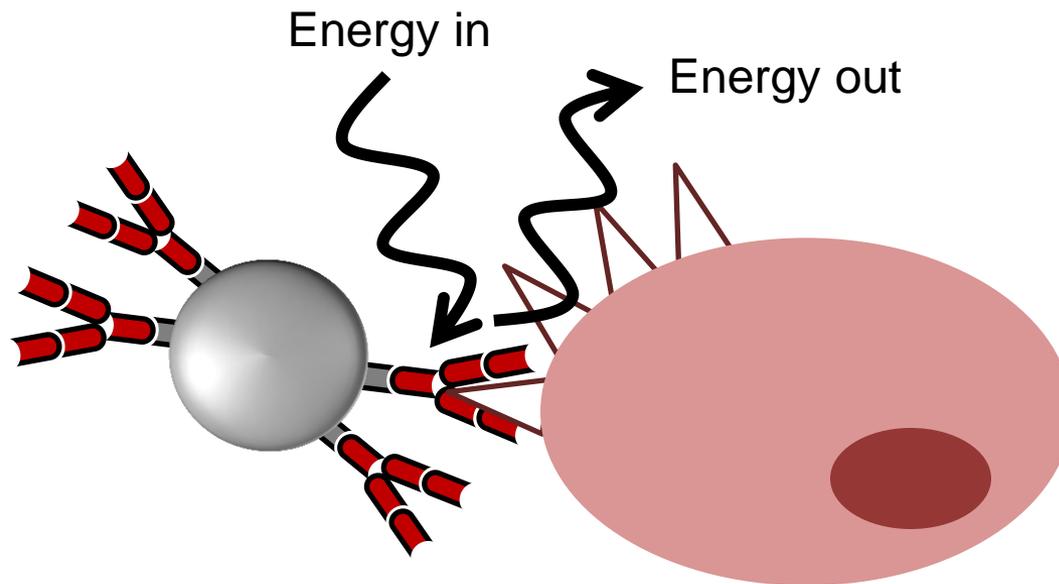
Governing Principles for Nanoparticles in Medicine

5. Energy must be applied and nanoparticle must respond



Governing Principles for Nanoparticles in Medicine

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The Global Nanomedicine Research Agenda

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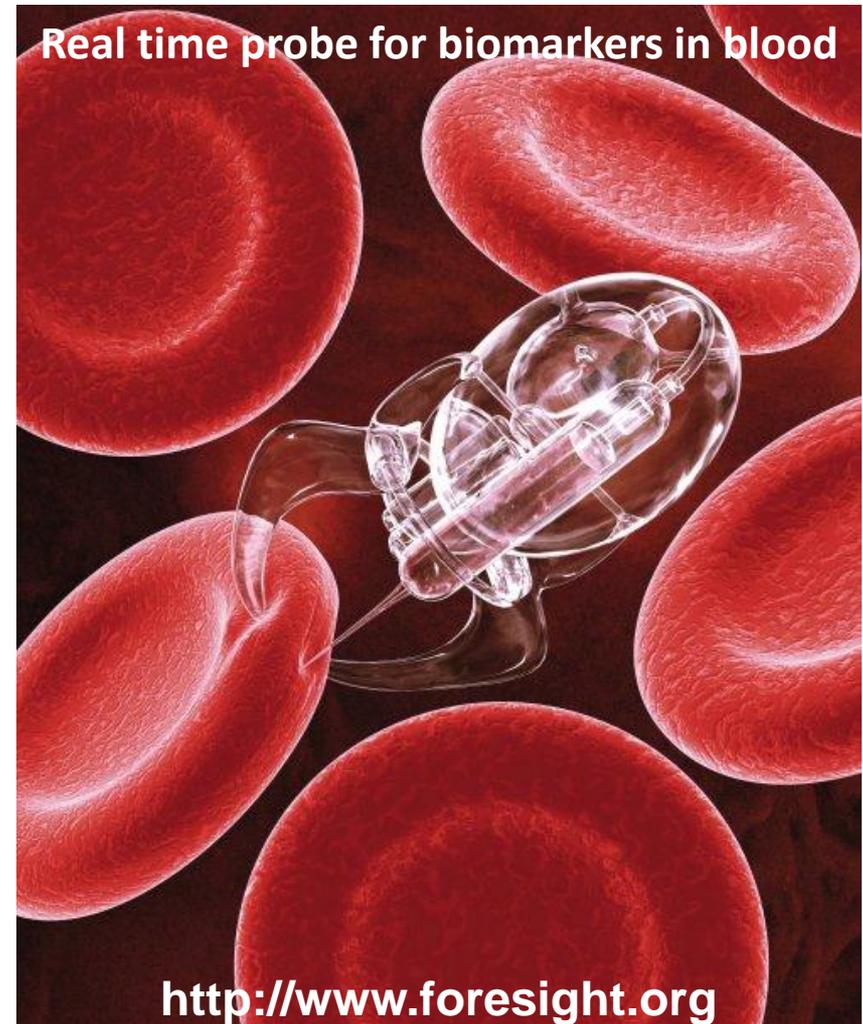
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4. Meeting ELSA challenges
 - Ethical, Legal & Social Aspects

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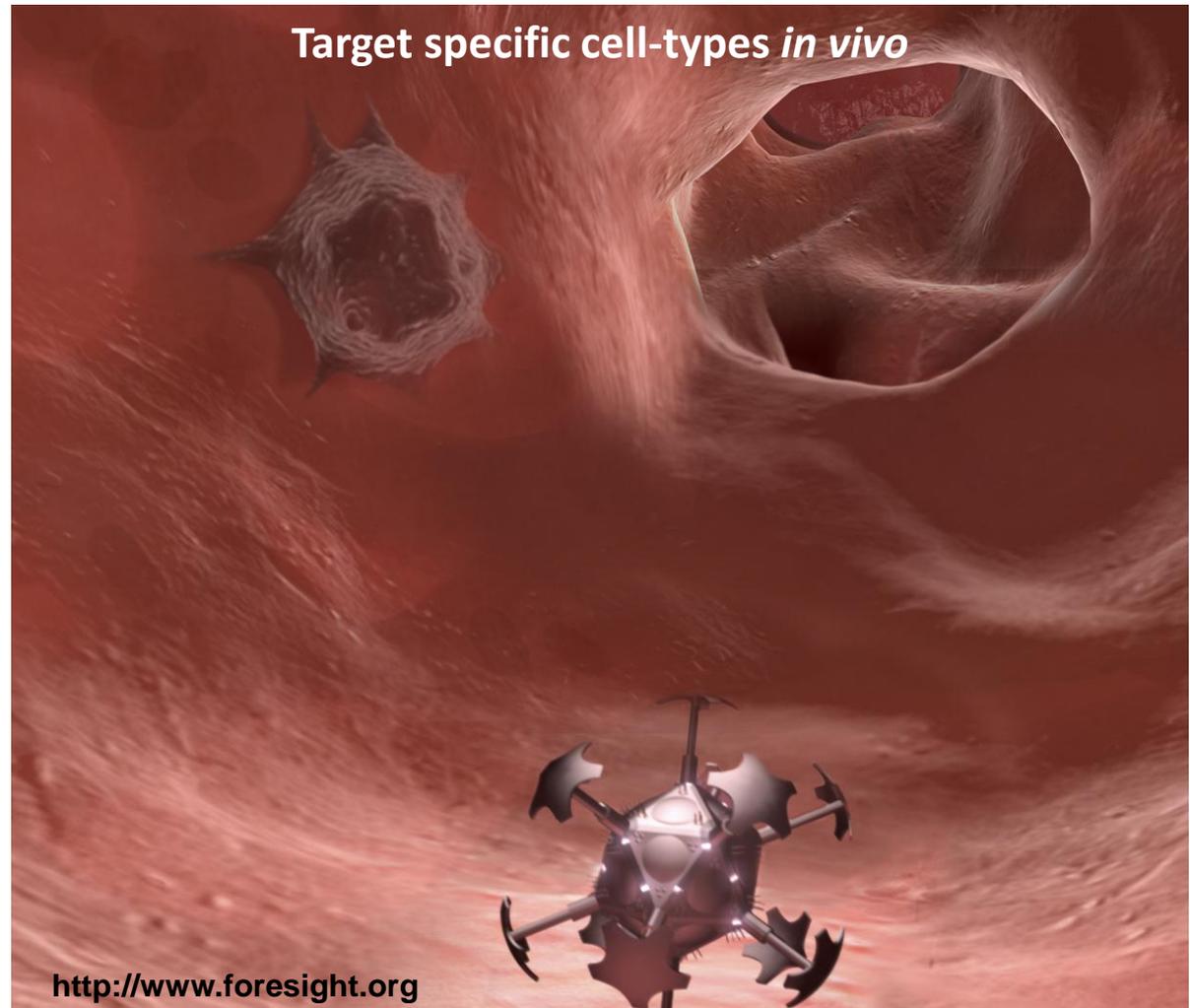
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5. For the main diseases in the world:
 - Cancer, cardiovascular disease, musculo-skeletal, mental and infectious disease, and diabetes

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

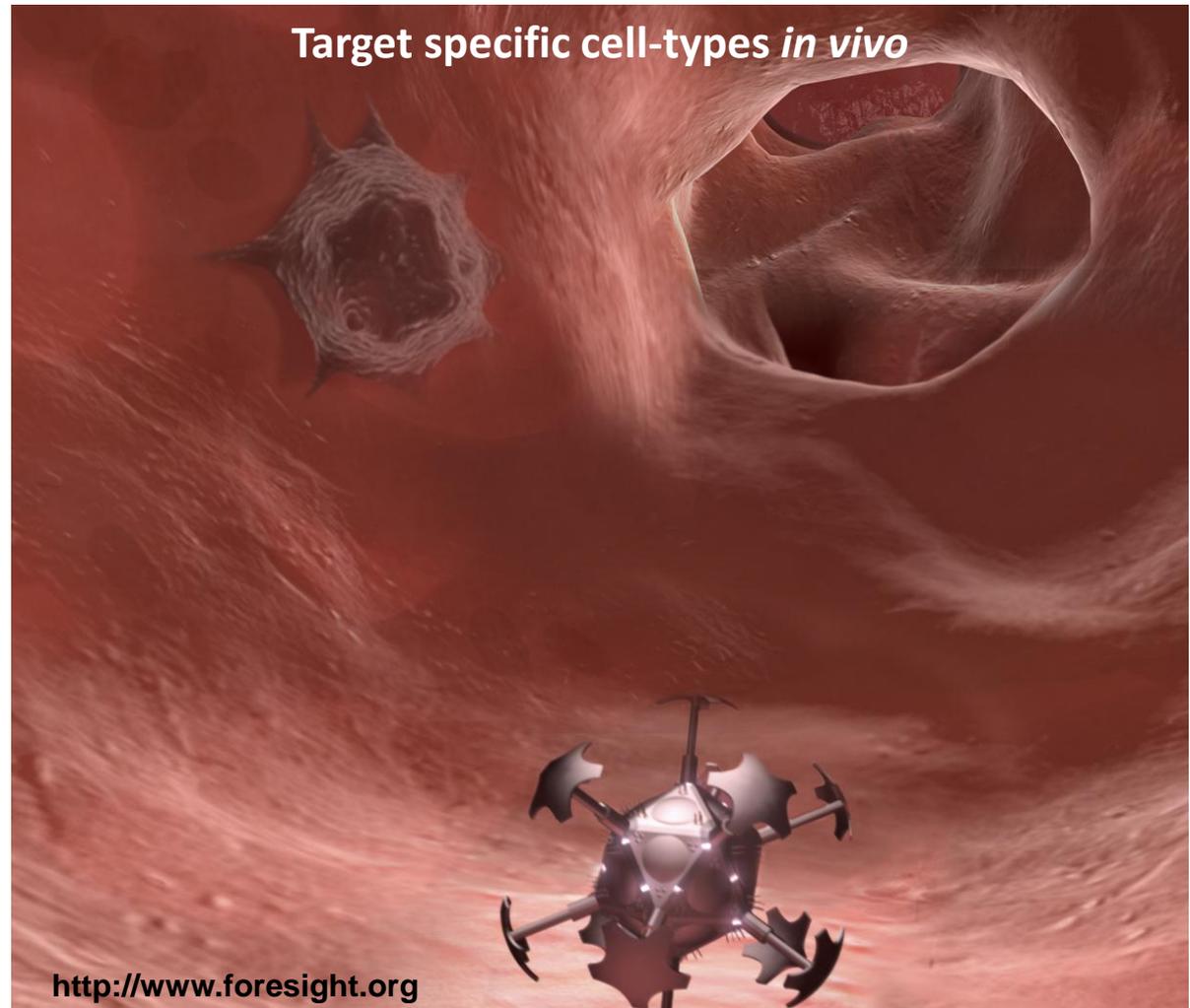


Targeted Drug Delivery



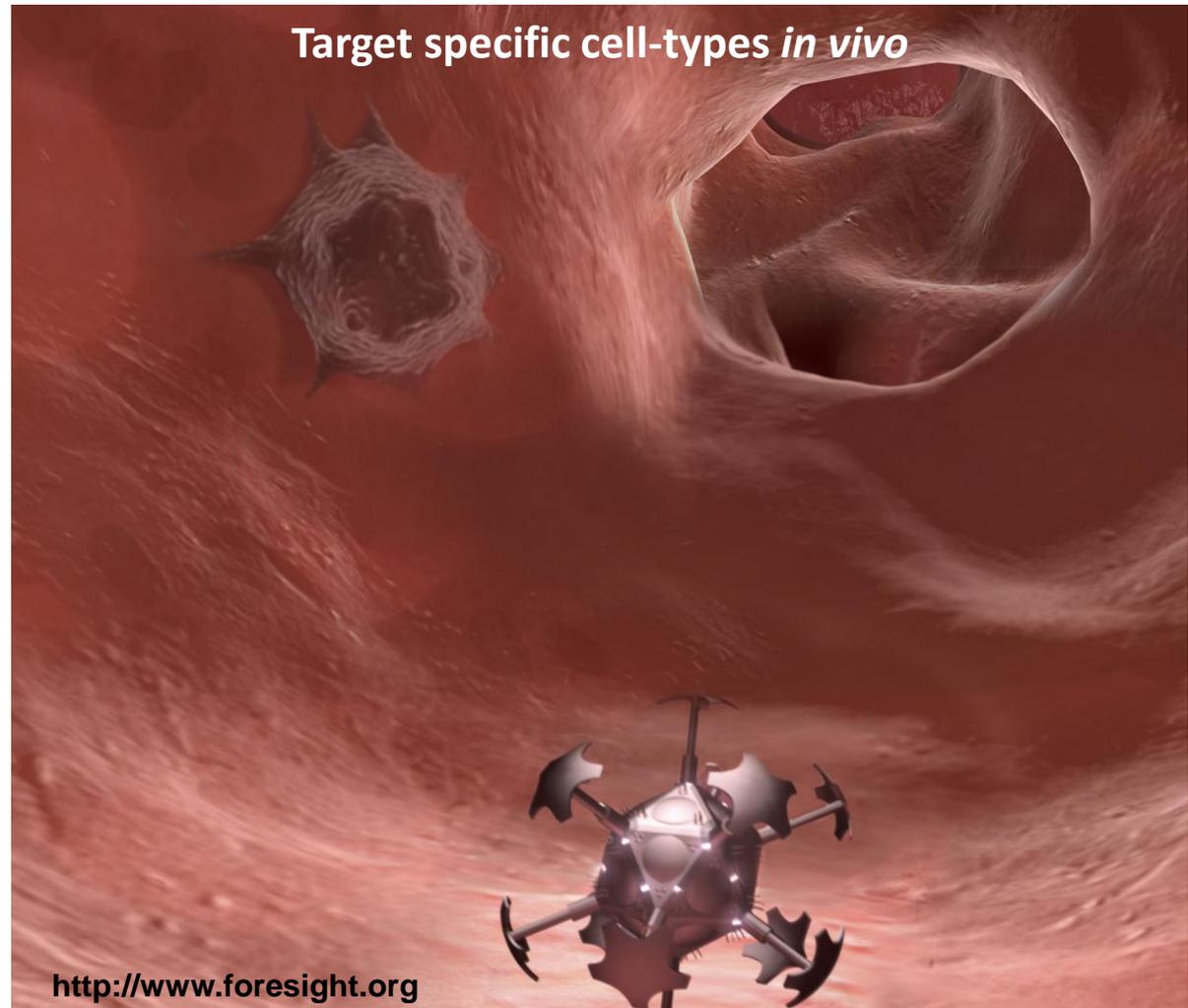
Targeted Drug Delivery

- Protected Drug delivery to target sites
 - Nanoparticles
 - Miniature devices



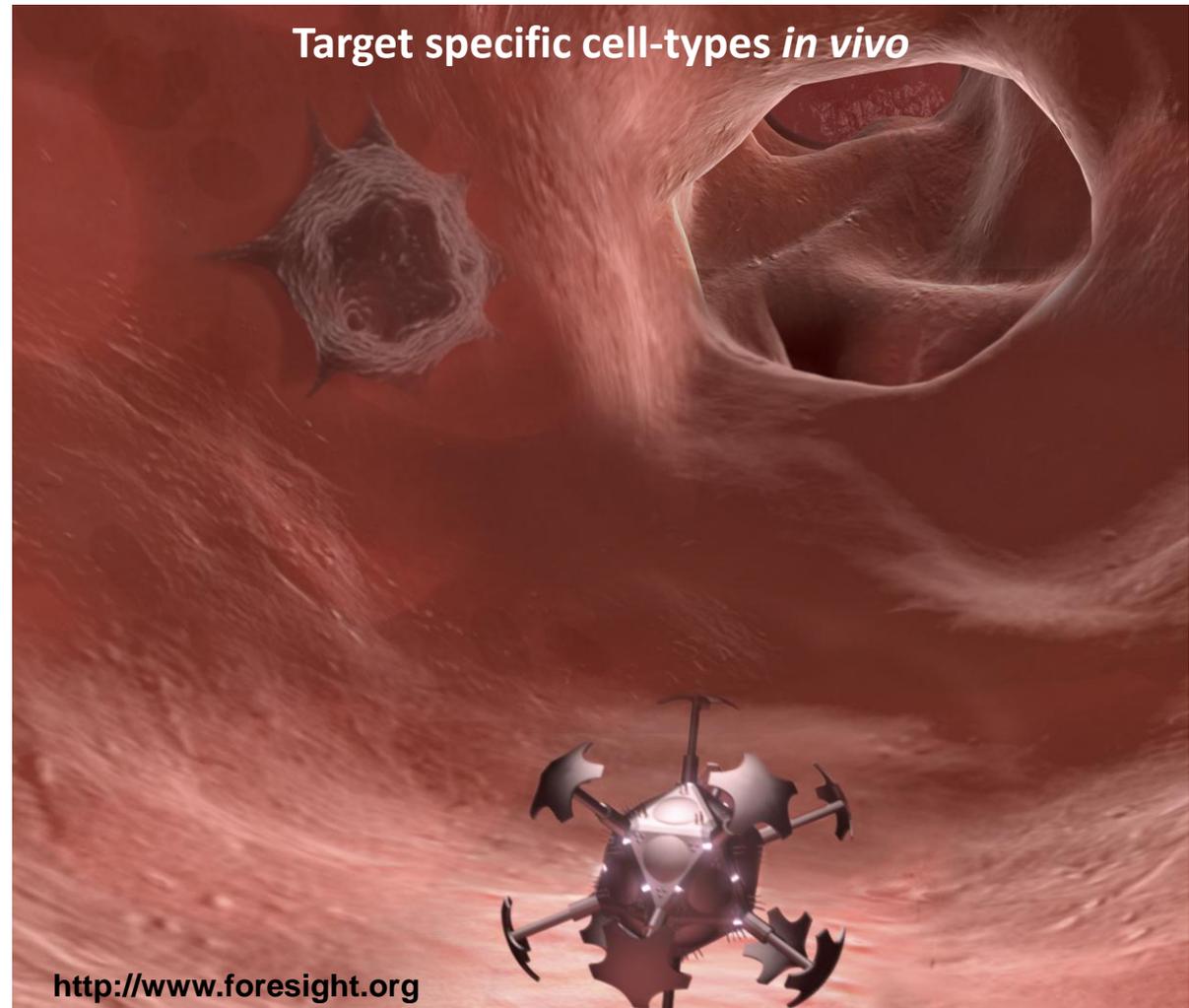
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- Higher doses?
Lower doses?



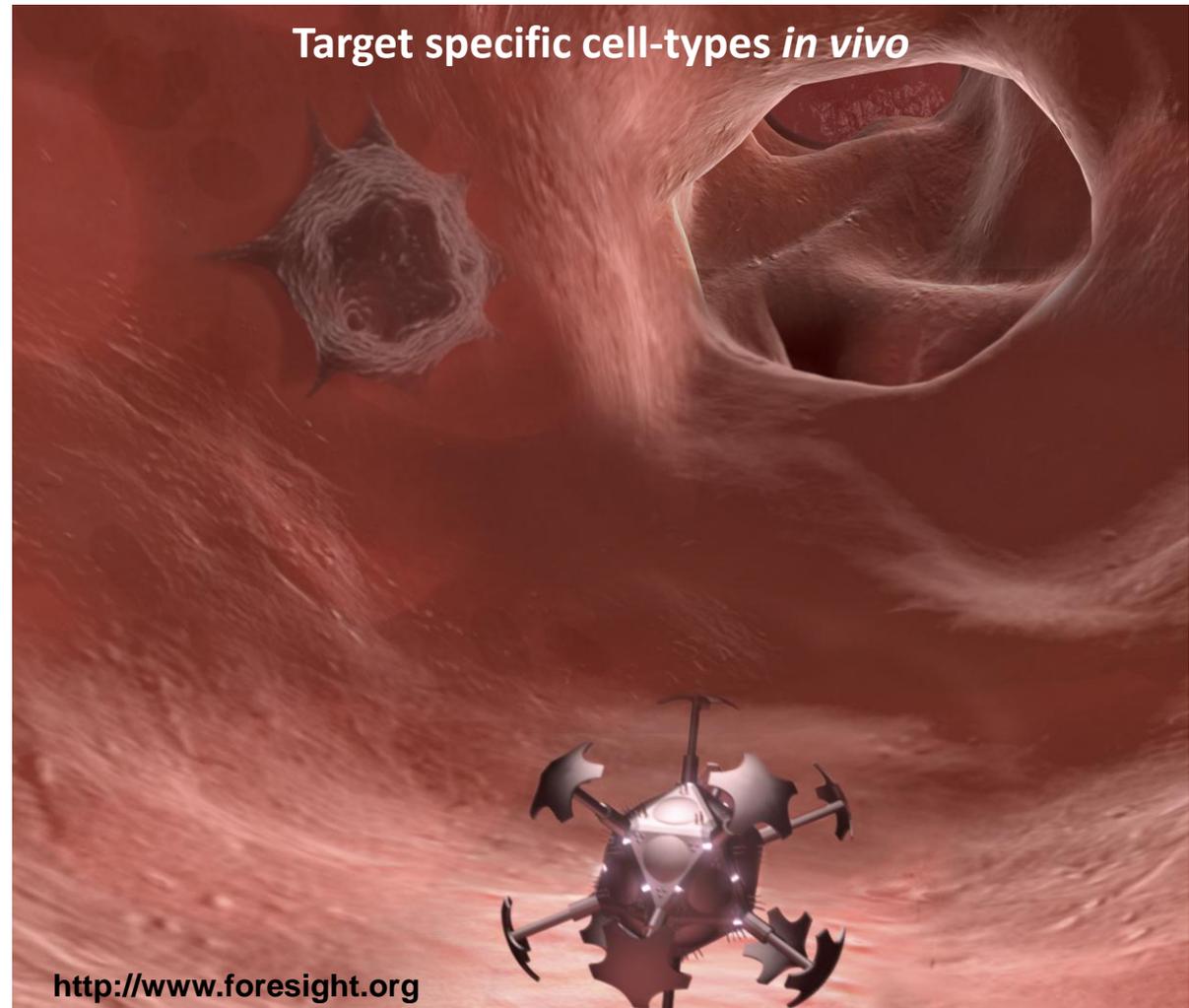
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- Higher doses?
Lower doses?
- Healthy tissue not affected



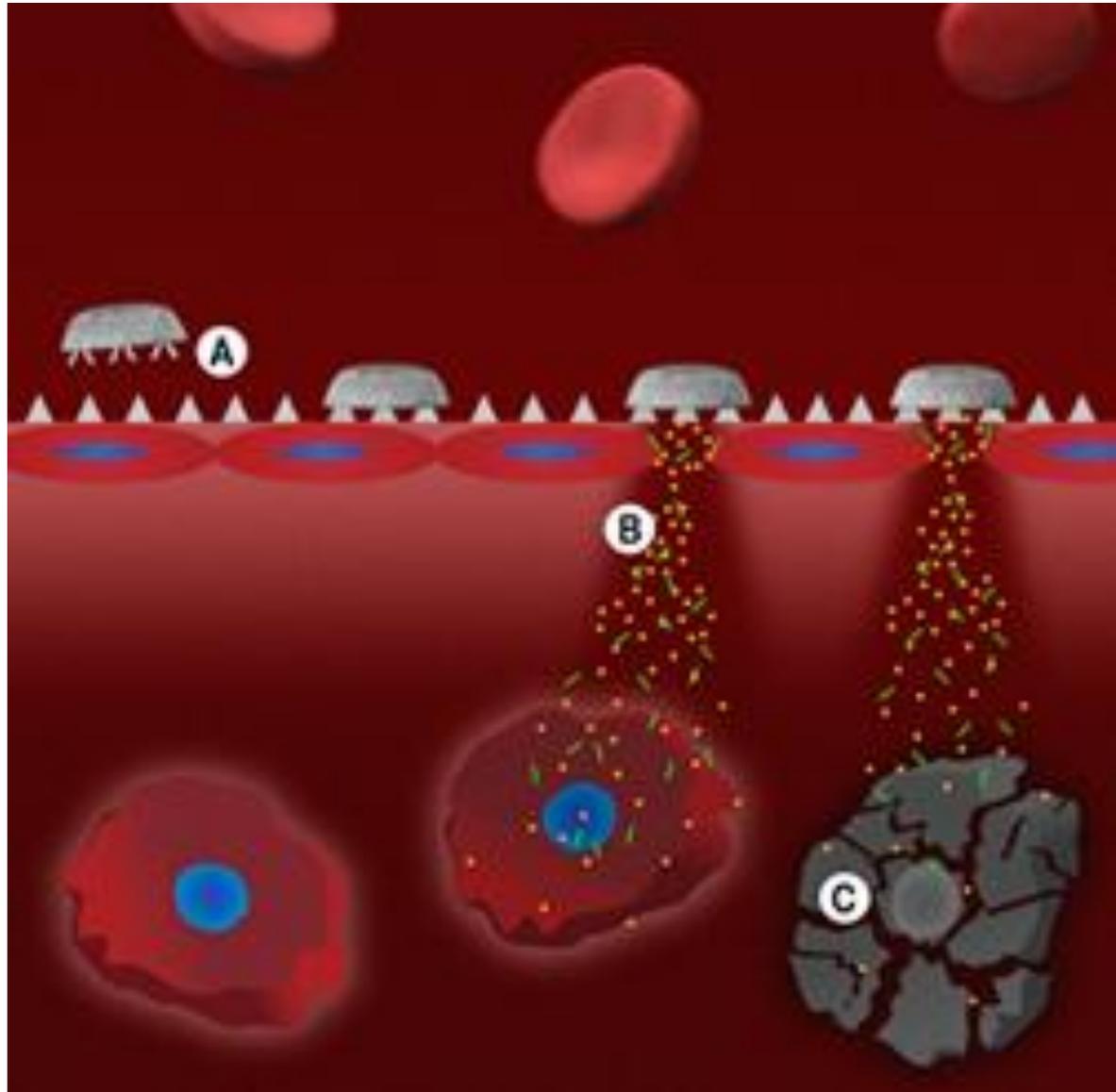
Targeted Drug Delivery

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



Targeted Drug Delivery: CANCER

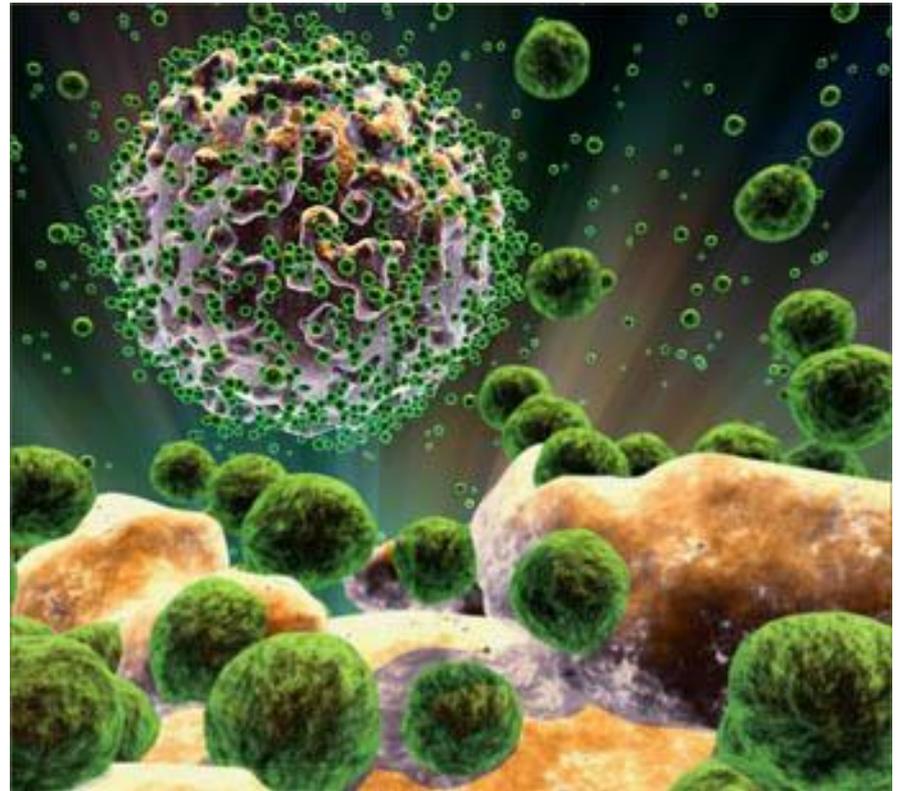
- A. Nanobot loaded with chemotherapy lands on blood vessel wall connected to vasculature
- B. One latched on, nanobot releases its drug through blood vessel wall
- C. Highly concentrated chemotherapy drug is targeted directly to cancer cell, which subsequently dies



Regenerative Medicine

Destroy bacteria cell overgrowth
on regenerated tissue

- 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



<http://www.foresight.org>

ELSA Compliance

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- Nanomedicine touches familiar

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Ethical, Legal, & Social Aspects (ELSA)

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- 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

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- And some new ones:
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 - 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 |
| Capsulation 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.

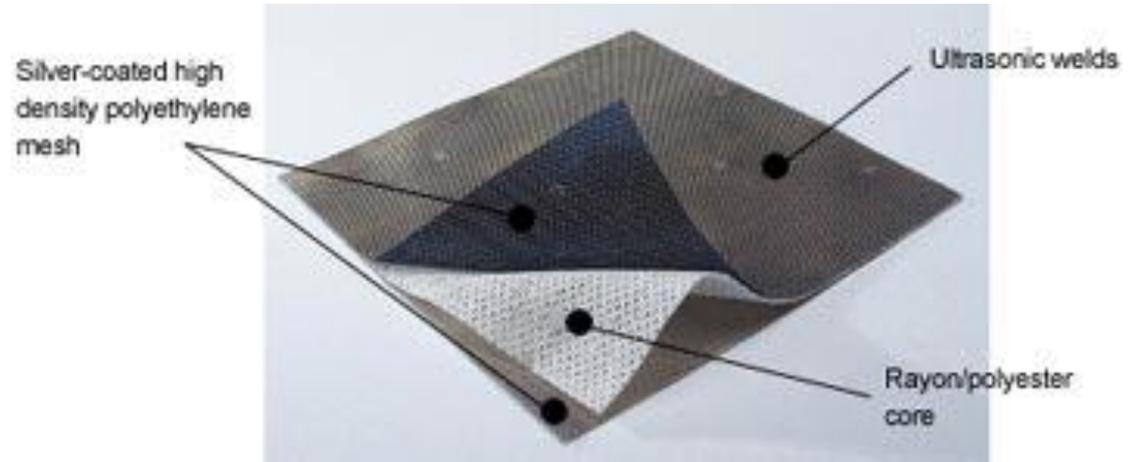


NanoCeram® filters utilize a non-woven filter media containing a thermally-bonded blend of microglass fibers and cellulose infused with nanoalumina fibers. This method makes available greater than 42,000 square meters of nanofiber surface area per square meter of filter media of loading capacity.



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

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<http://questionpro.com/t/ABkVkZLohc>

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