

Center for the Environmental Implications of NanoTechnology



www.ceint.duke.edu

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Mark R. Wiesner

Director

Duke University

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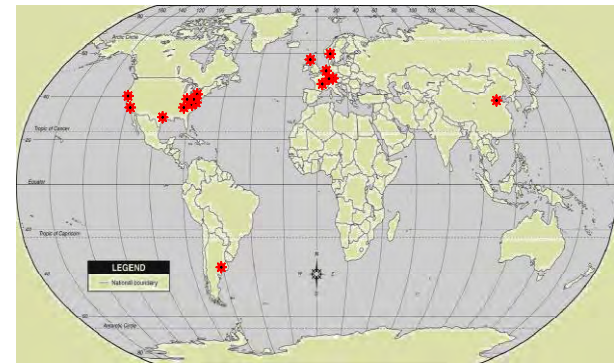
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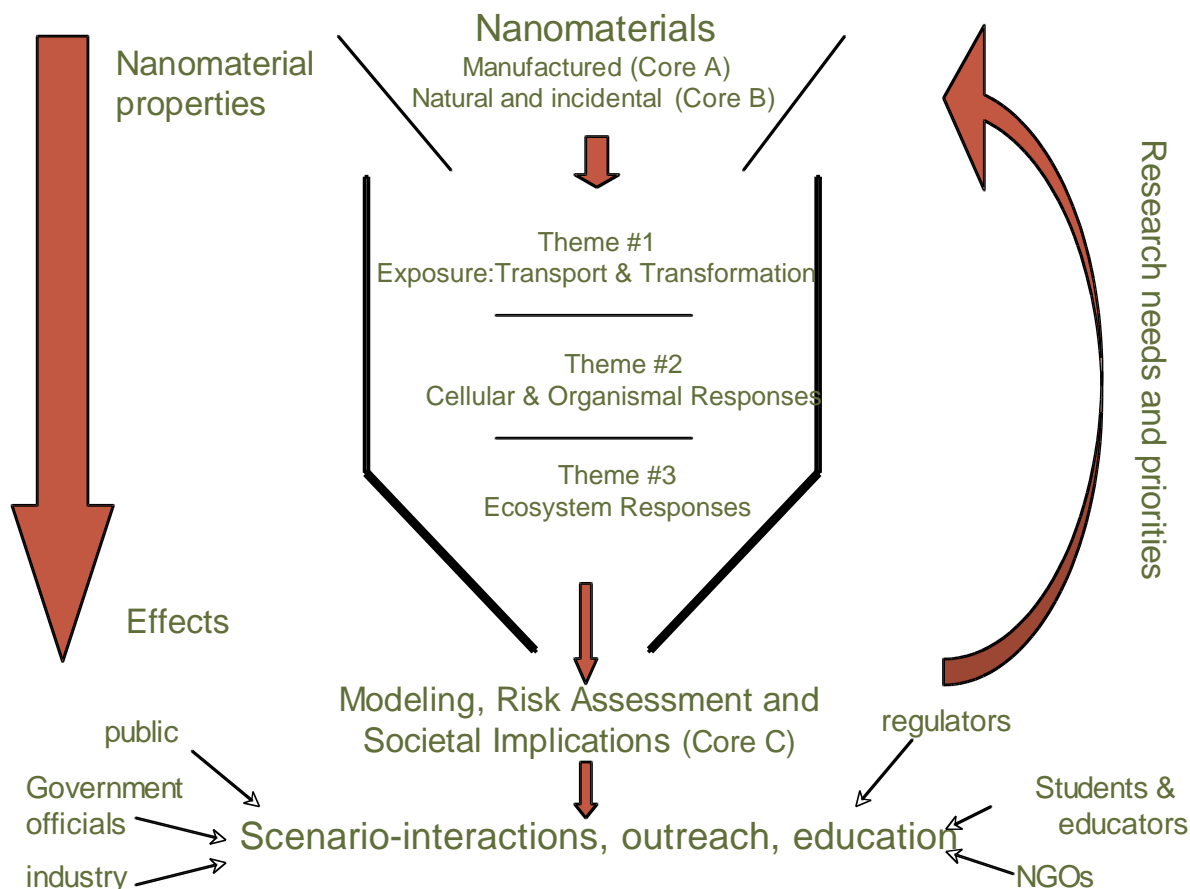
Center for the Environmental Implications of NanoTechnology (CEINT)

1. *Elucidate general principles that determine environmental behavior of nanomaterials*
2. *Provide guidance in assessing existing and future concerns*
3. *Educate students and the general public regarding nanotechnology, nanoscale science, and the environment*

- ◎ **4 Core Institutions: Duke (headquarters), CMU, Howard, Virginia Tech + U Kentucky, Stanford**
- ◎ **Collaborating US universities & government entities**
- ◎ **ICEINT- International partners (France) supported by CNRS and CEA**
- ◎ **10 additional international partners**



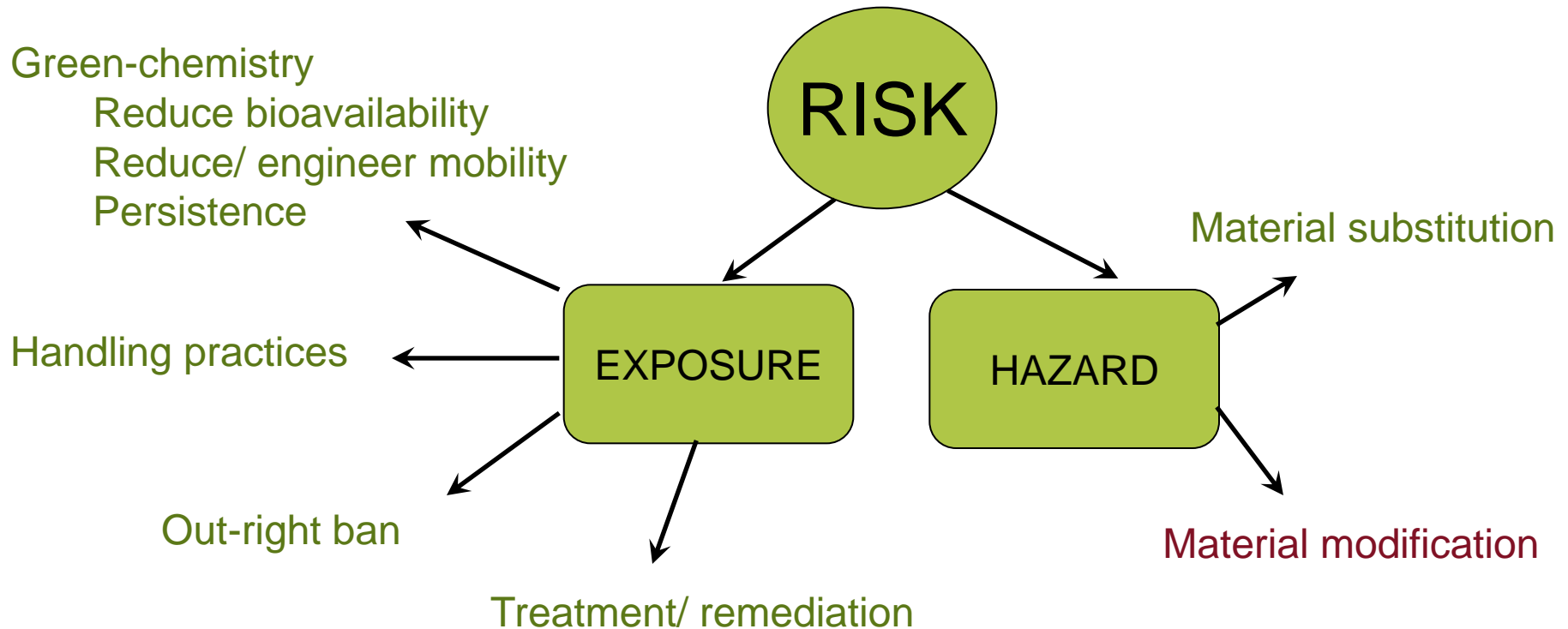
Research Thrusts



Key Areas of Expertise

- Environmental biology
- Ecotoxicology
- Nanomaterial transport & transformation
- Nano-Biogeochemistry
- Nanochemistry
- Risk assessment and societal impact
- Atmospheric particles

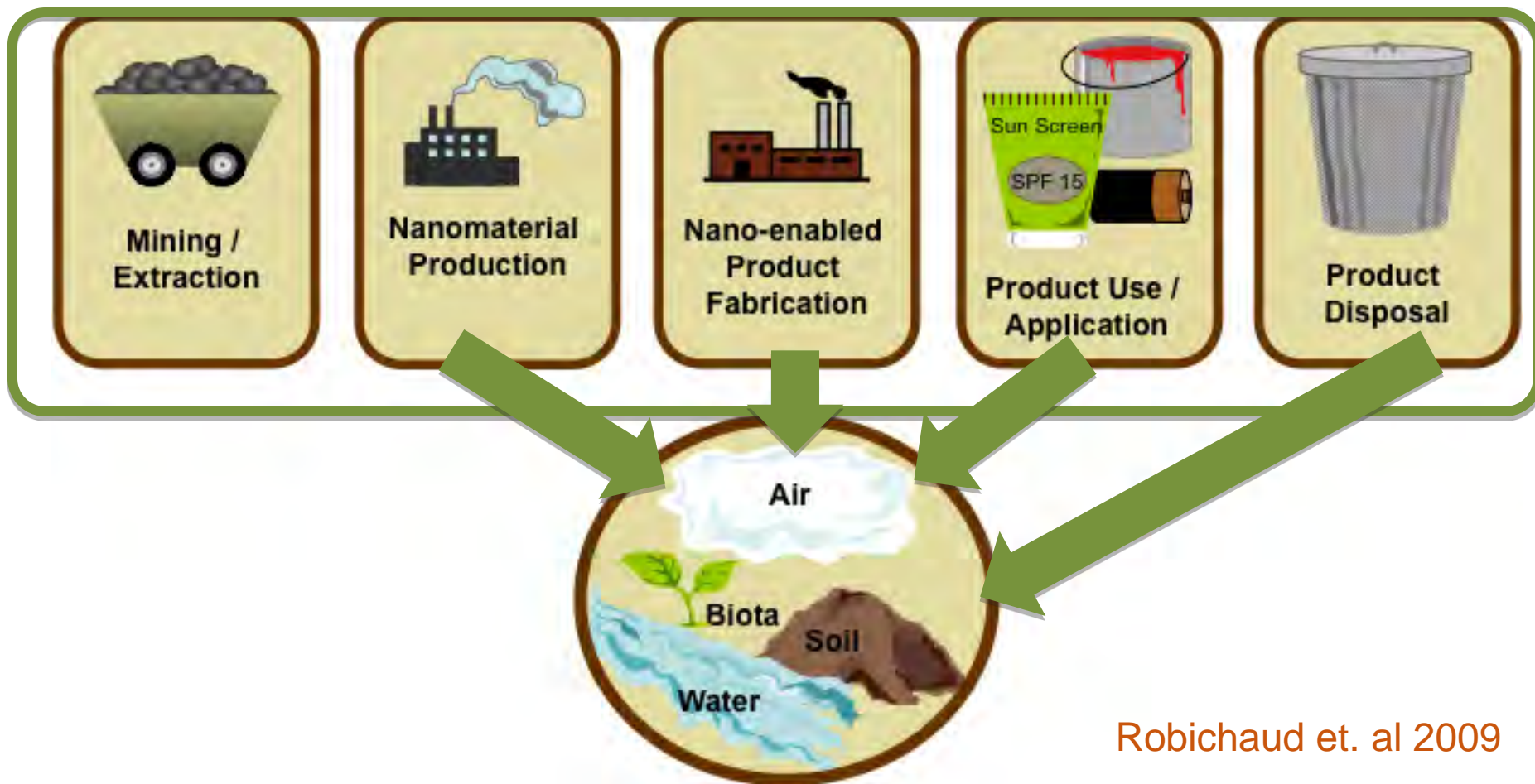
IF NANOMATERIALS POSE A RISK WHAT ARE THE OPTIONS FOR MANAGING RISK?



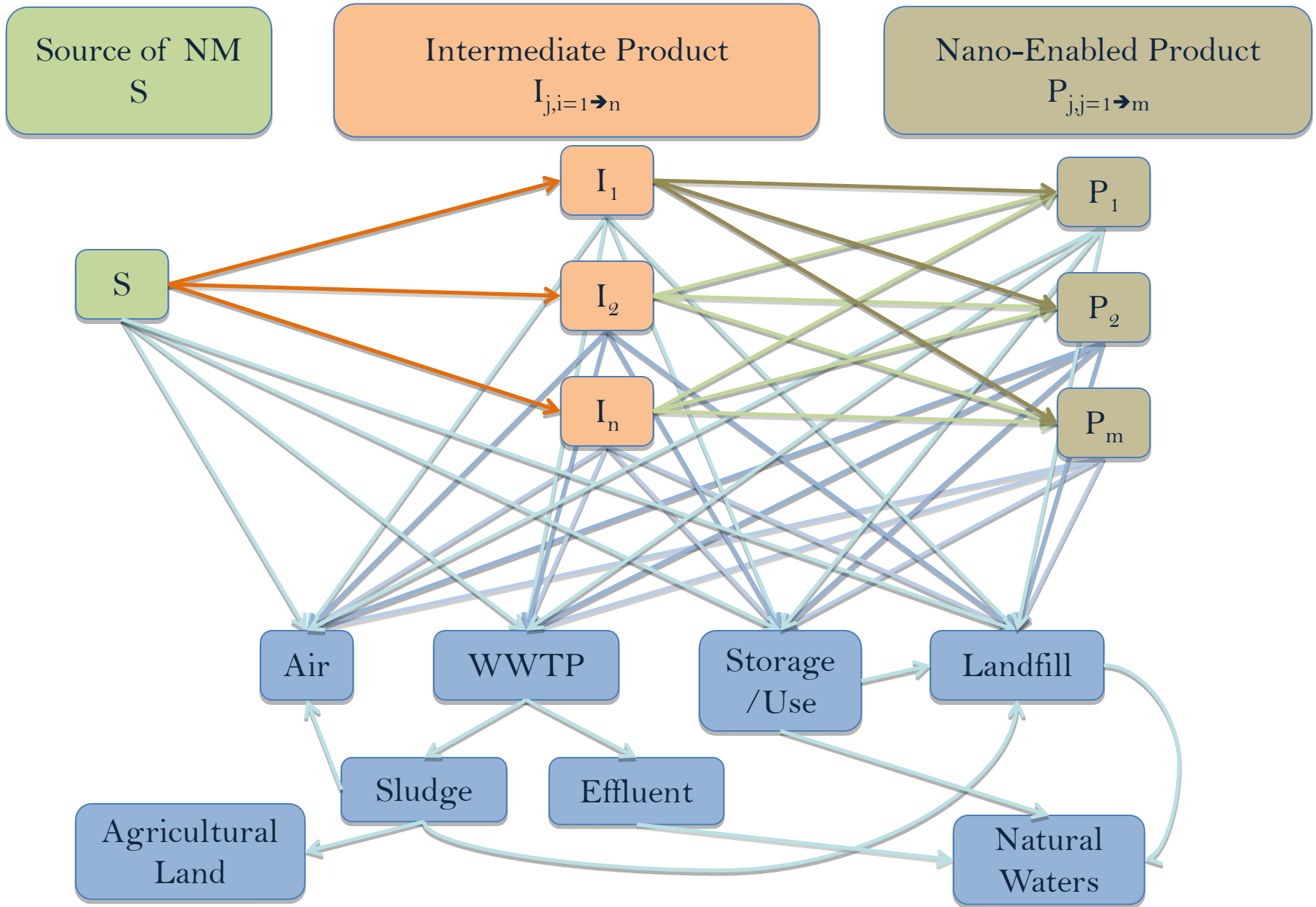
Core C: Risk Assessment & Modeling

Sources

A lifecycle perspective of nano risk



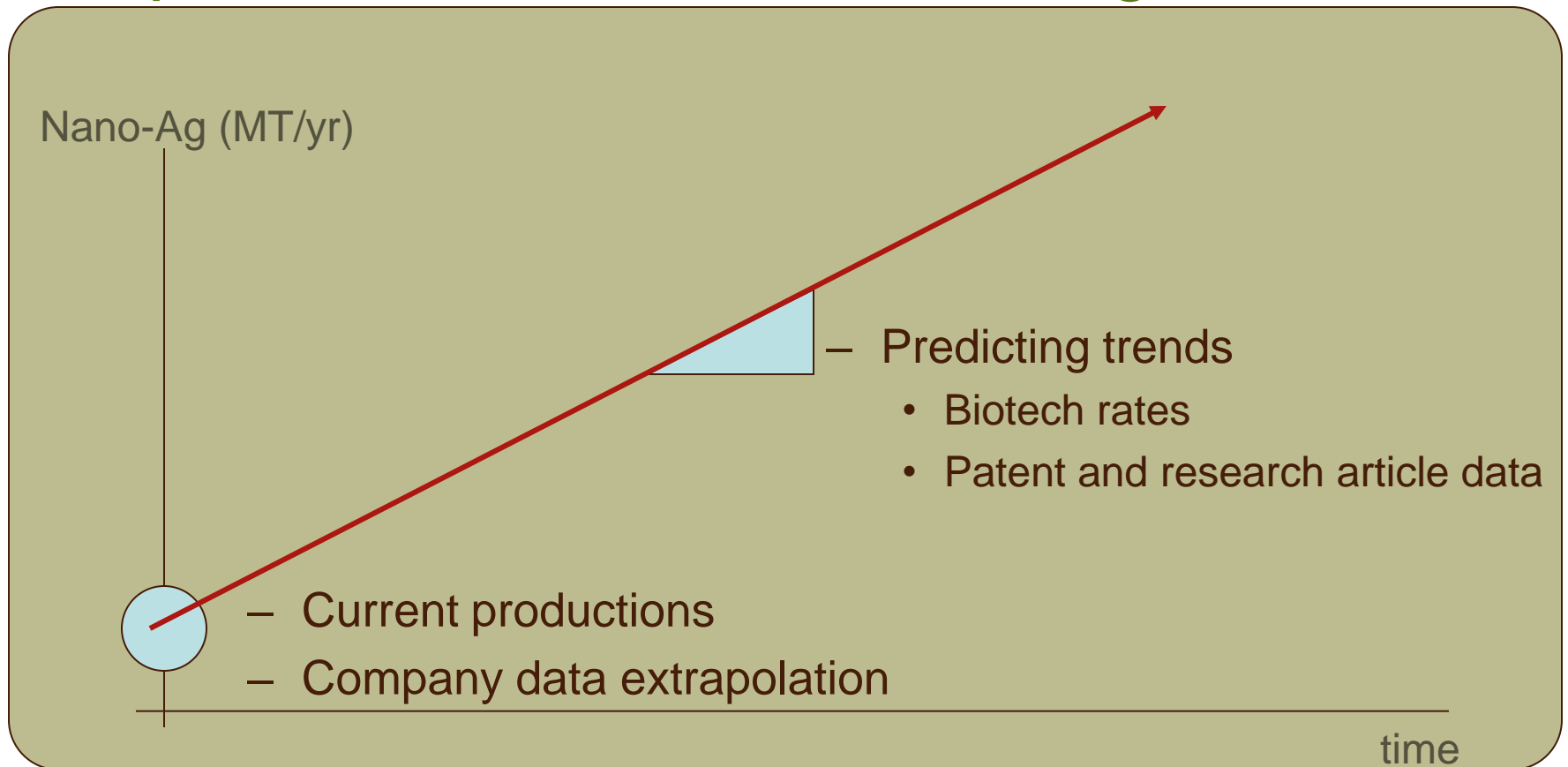
Robichaud et. al 2009



Upper bound production estimation

Intercept: how much is out there now?

Slope: how fast will this amount grow?



Cores A & B: Manufactured, Natural and Incidental Nanoparticles

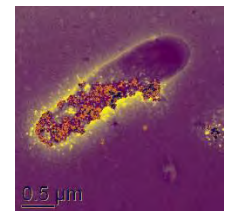
Manufactured

Incidental



Environmental Transformations

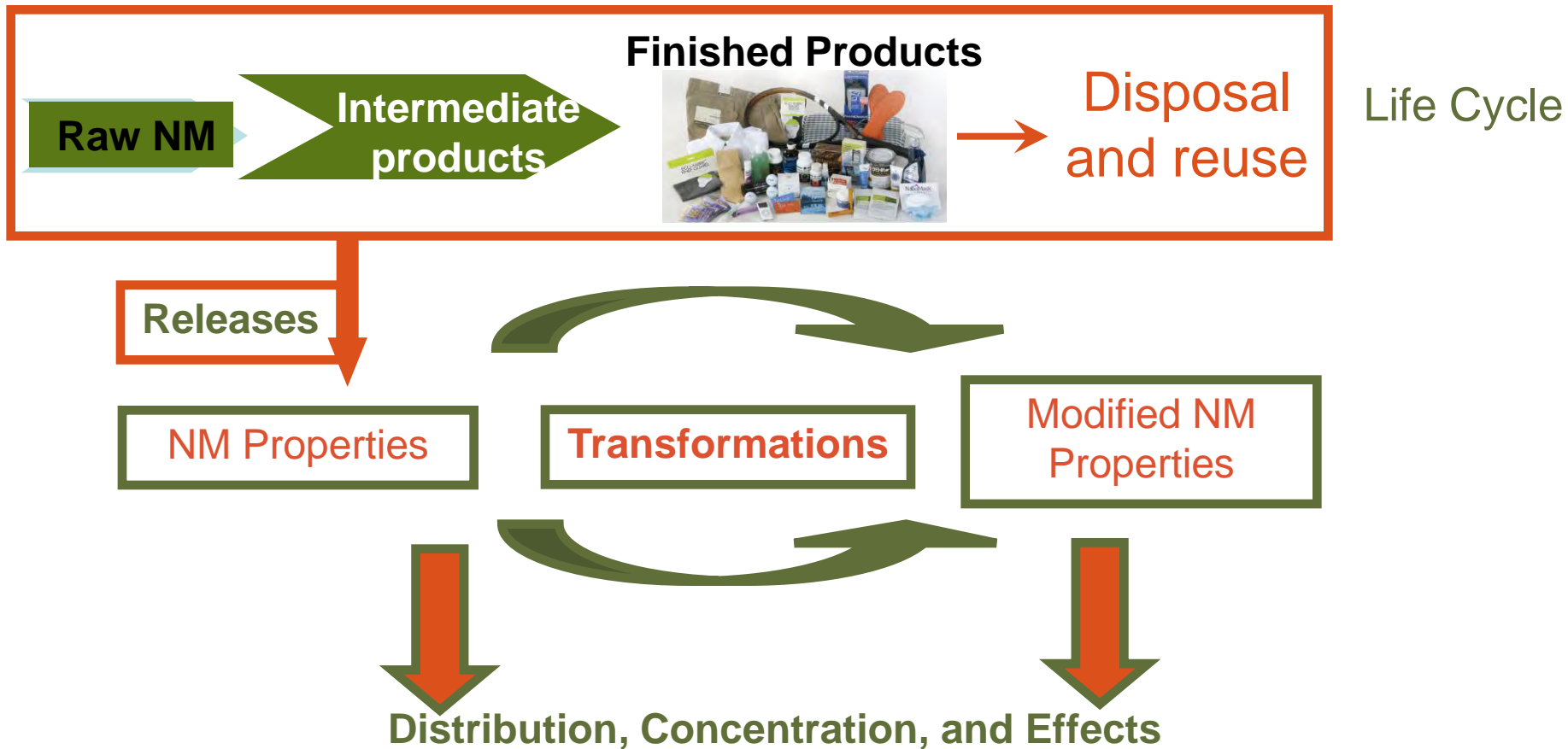
Natural



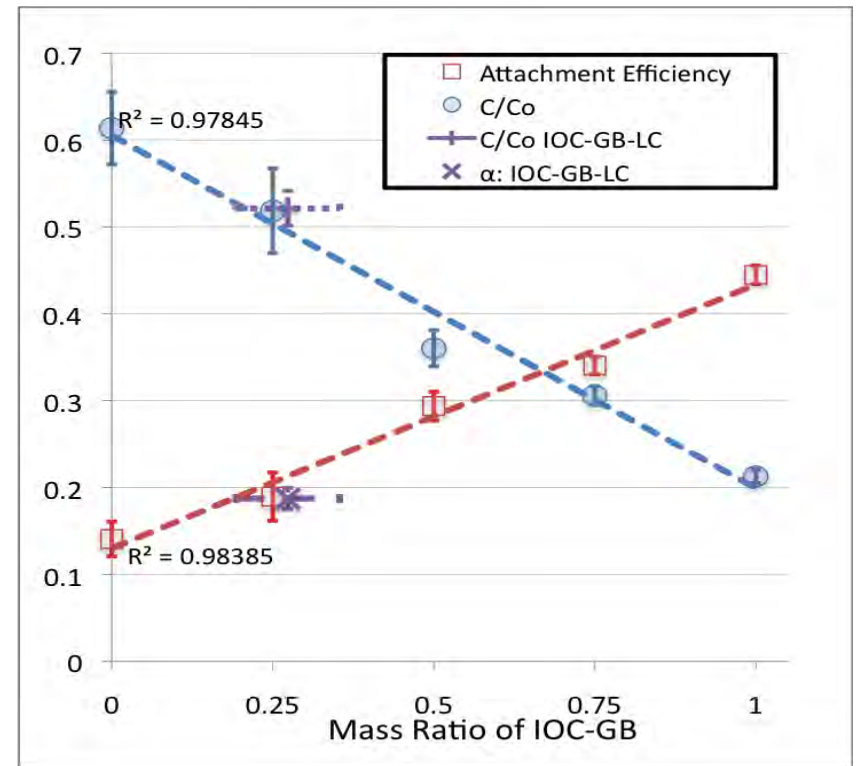
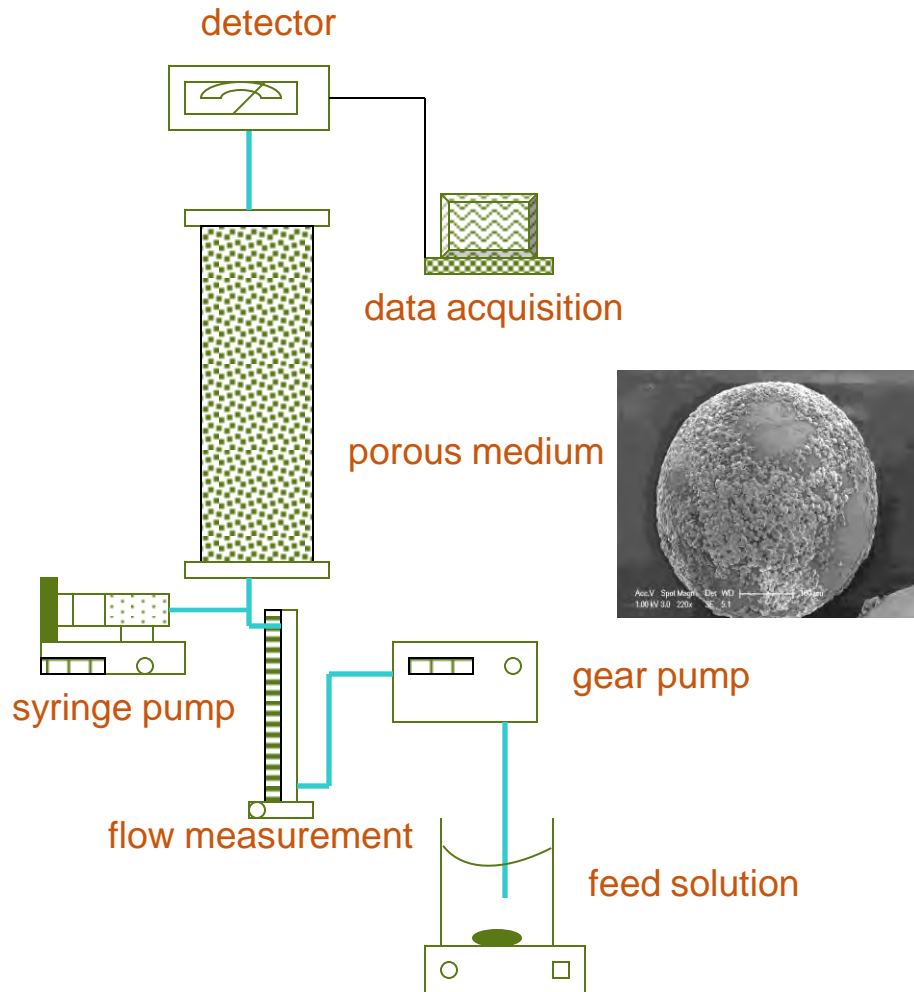
QuickTime™ and a
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Theme 1: Exposure: Transport and Transformation

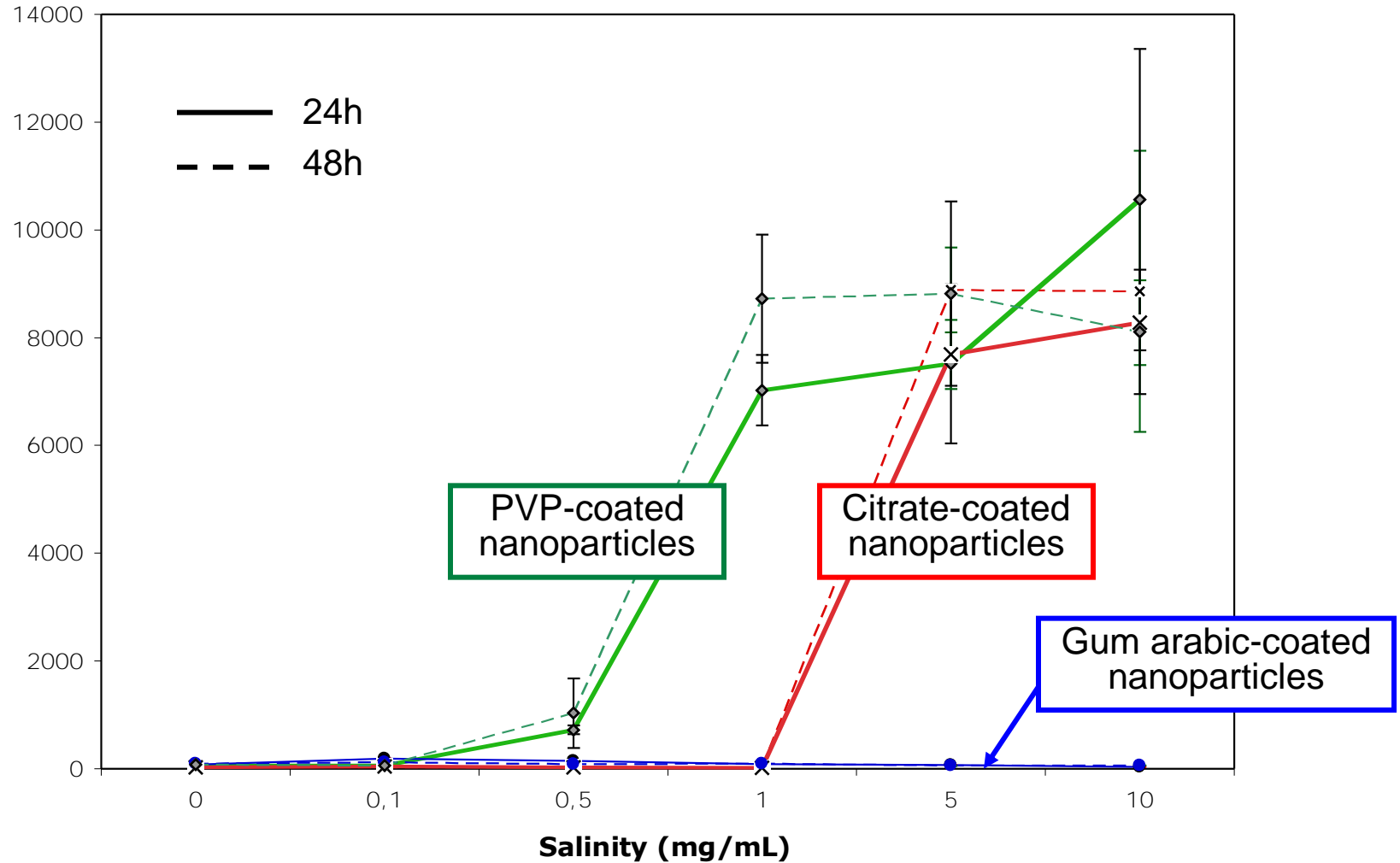
Predict NM behavior from first principles



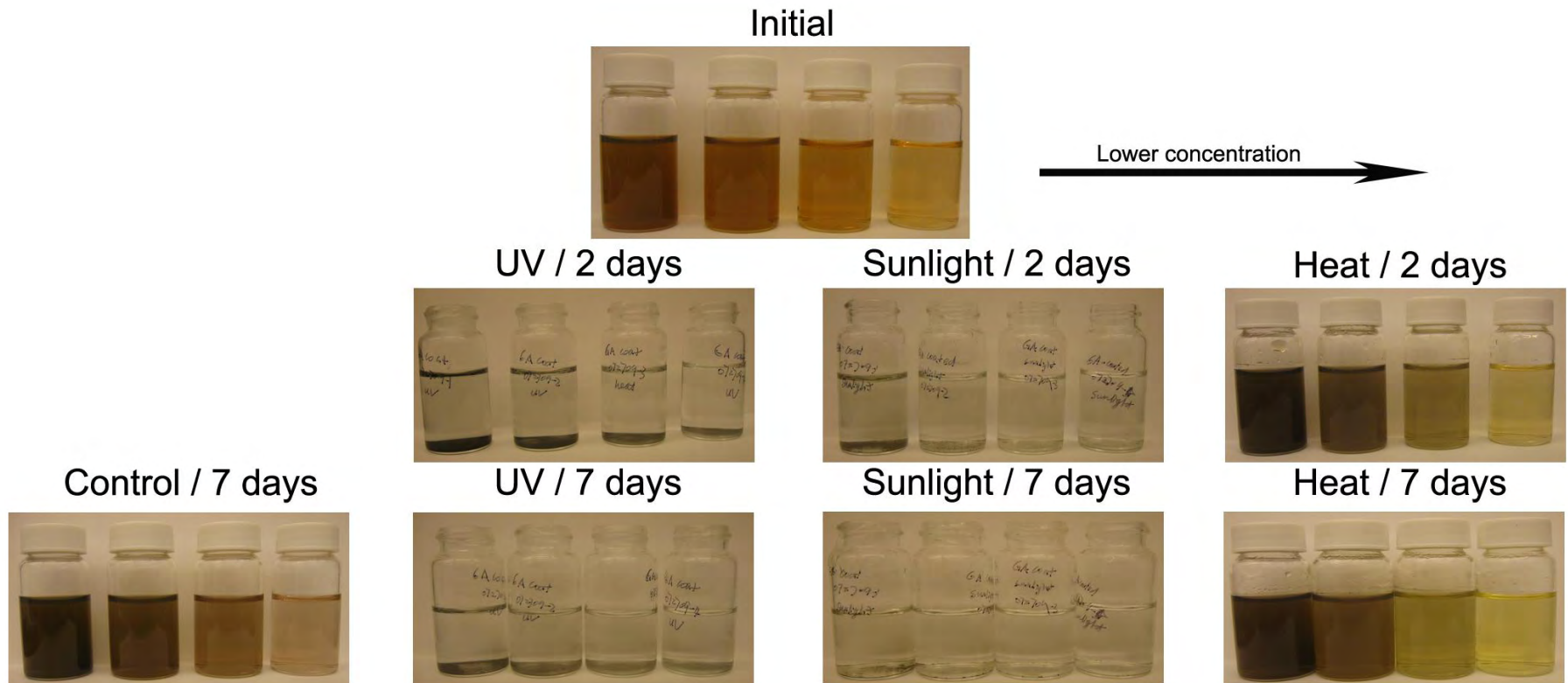
Nanoparticle aggregation and deposition



Colloidal stability of coated-Ag nanoparticles across a salinity gradient



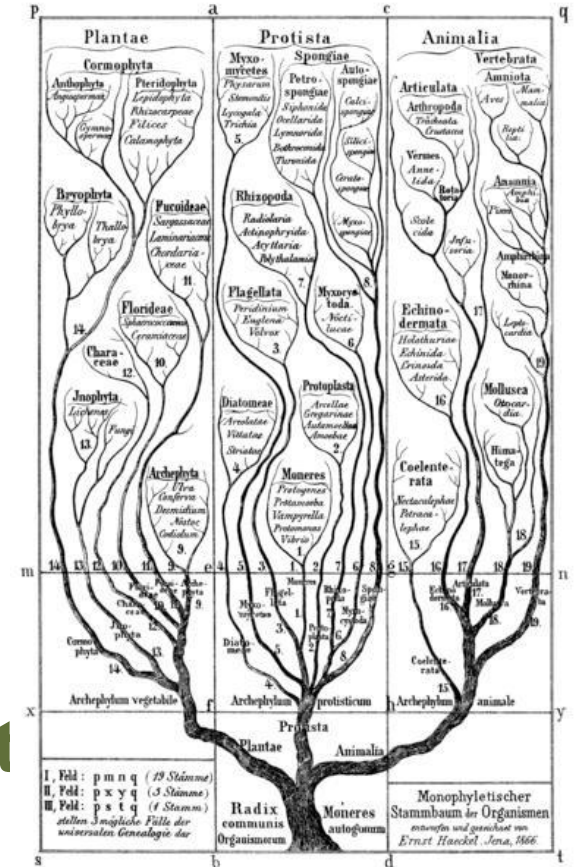
Effect of Sunlight on the Stability of Nano Ag-coated by gum arabic (GA)



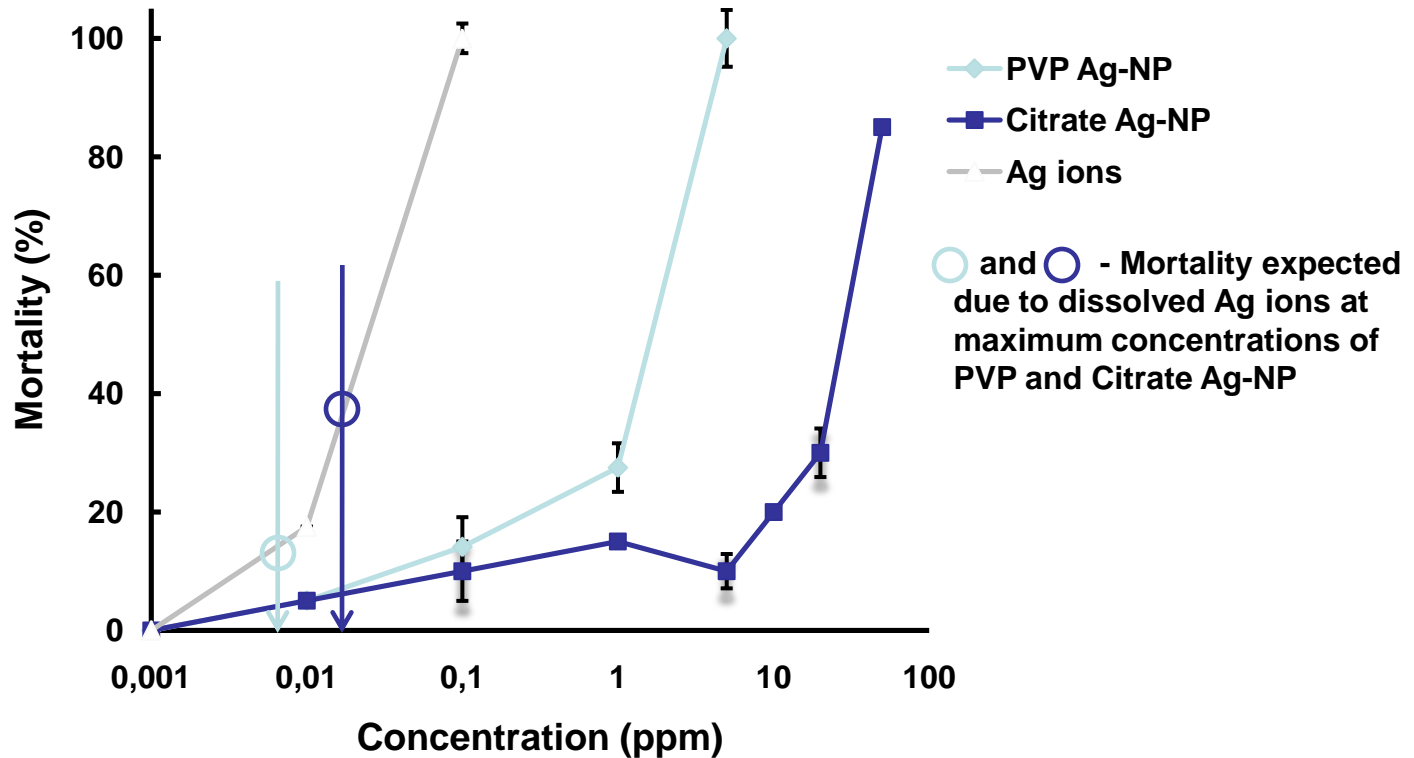
- GA coated Ag NPs were precipitated out both under UV light and sunlight
 - Stable both under heat (60 °C) and room condition (visible light)
 - No concentration dependence

Theme 2: Cellular and organismal responses

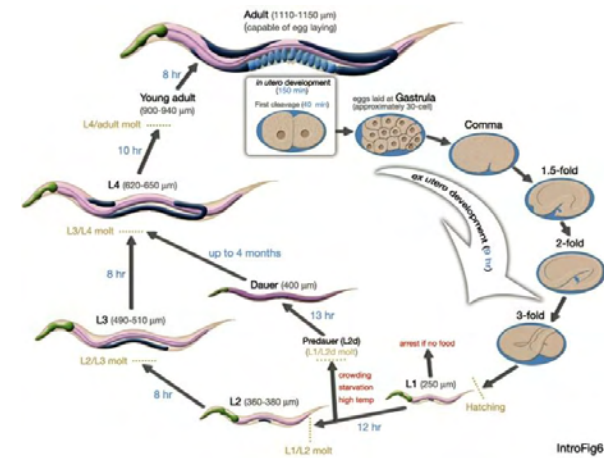
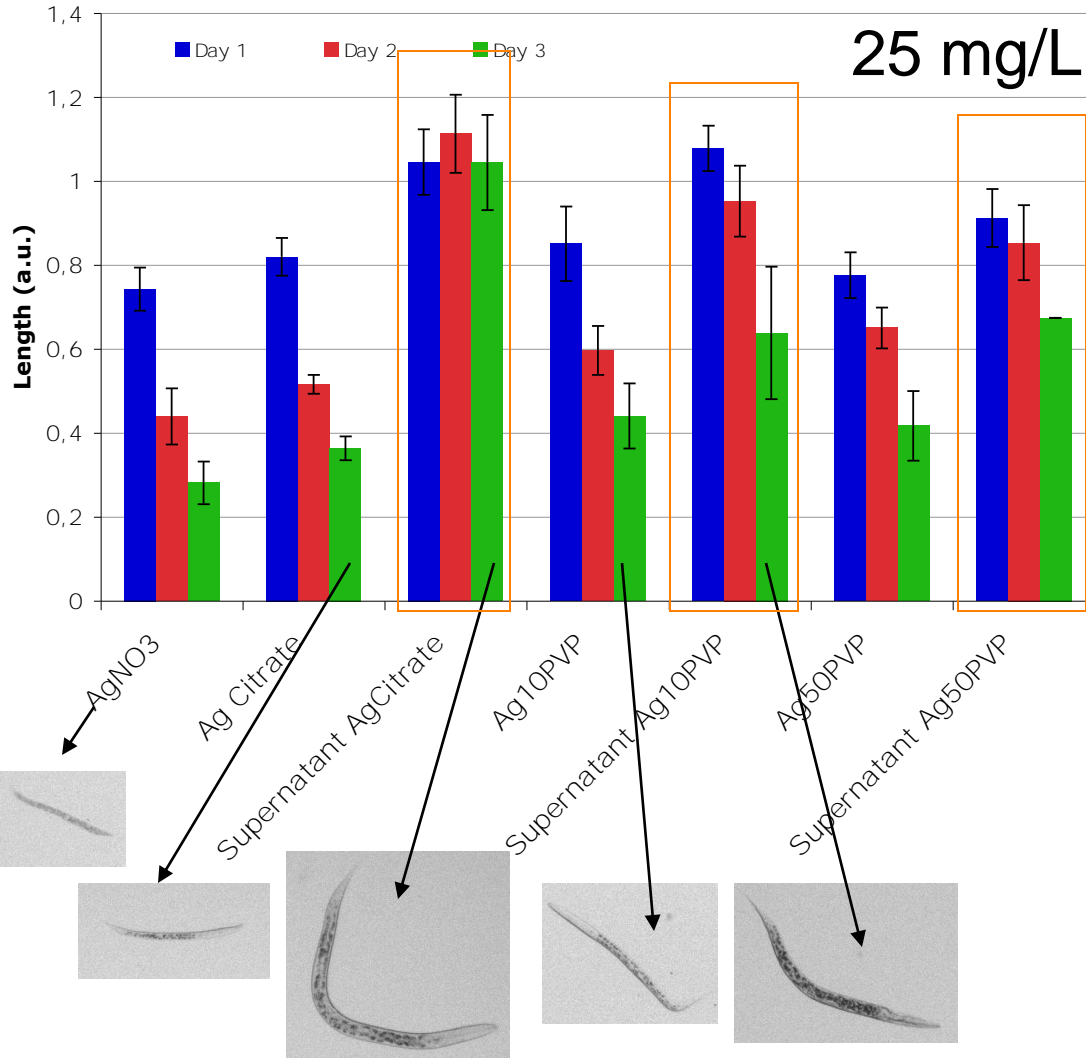
- Drivers of organismal uptake
- Impacts on organisms
- Mechanisms of toxicity
- Population-level effects
- Generational/ evolutionary impact



Toxicity of Ag-NP (PVP and Citrate) and Ag ions in *C. elegans*



Growth inhibition of *C. elegans* as a sublethal toxic effect



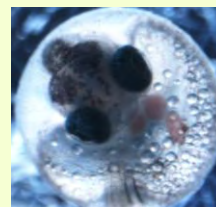
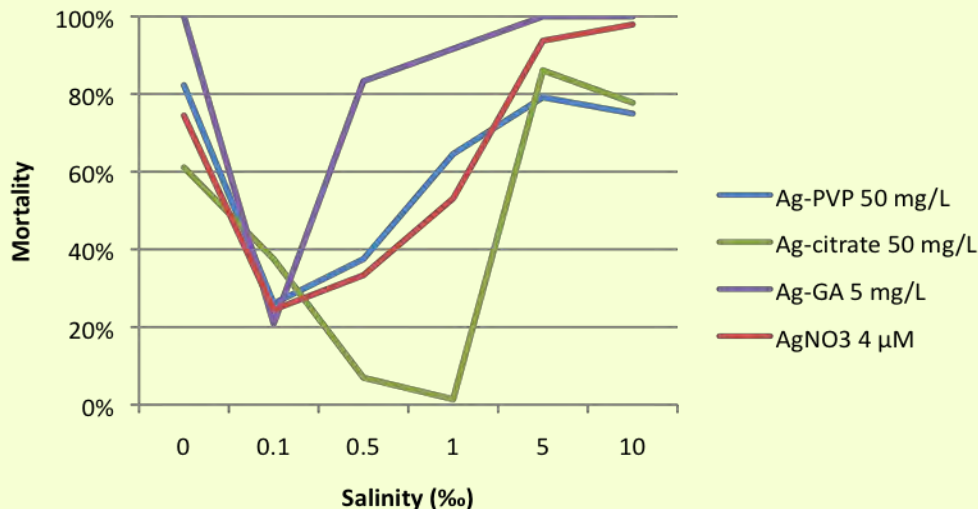
Protocol
 expose **mutans** and **wild** strains of *C. elegans* to nano Ag
 measure



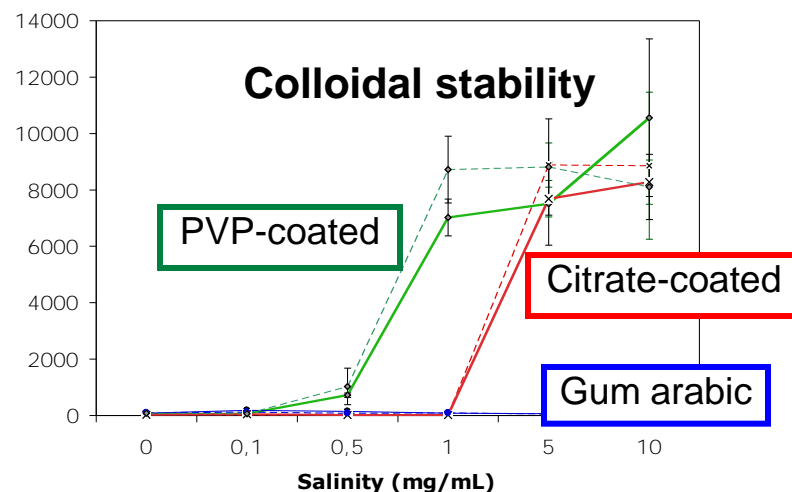
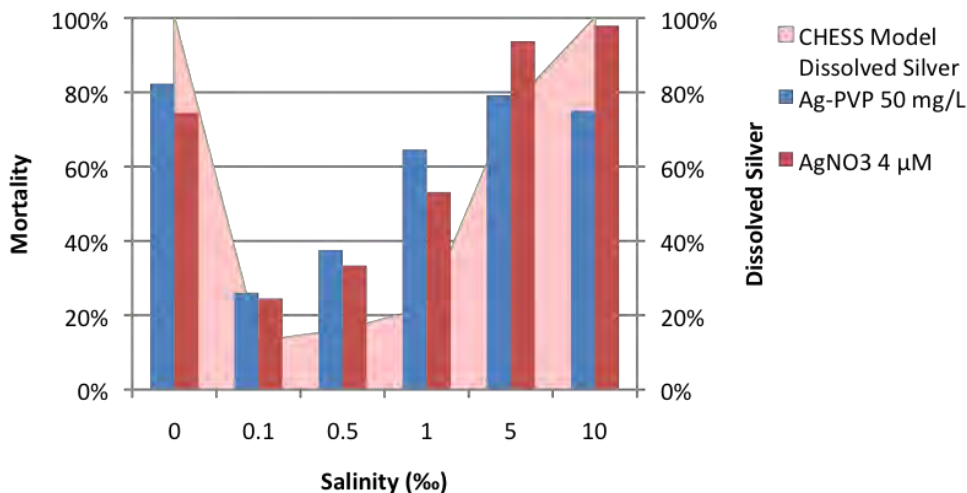
- Dose-response effects
- Different toxic mechanisms as function of the coating

Fish Embryotoxicity across a Salinity Gradient – Particle Size versus Silver Speciation

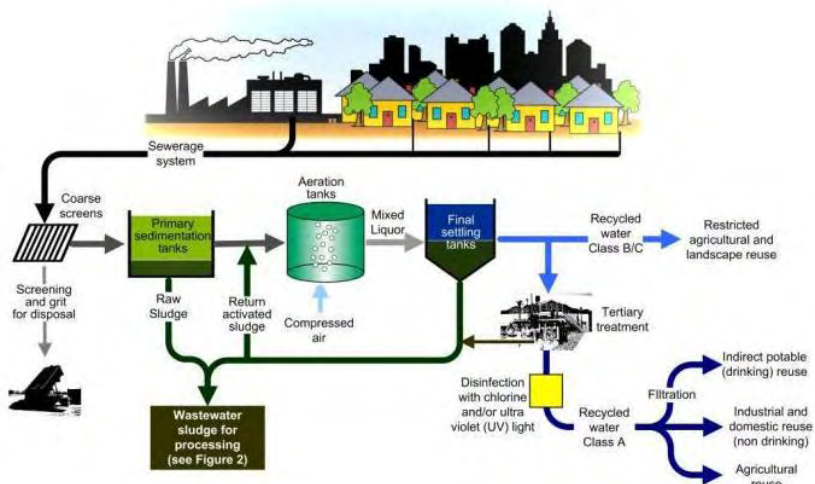
Toxicity



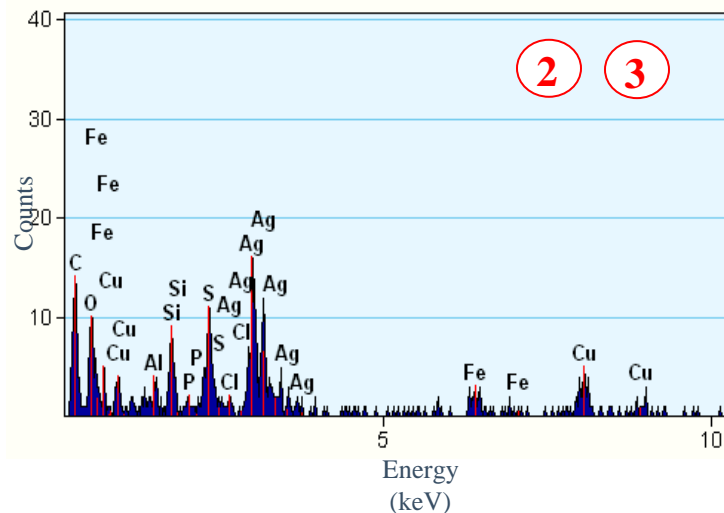
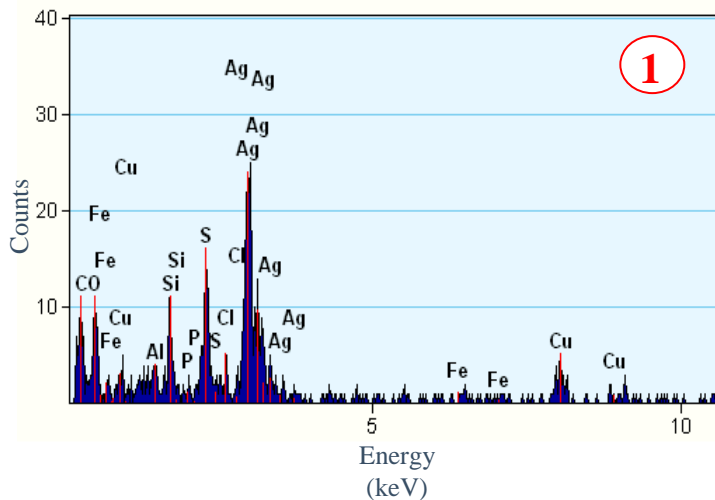
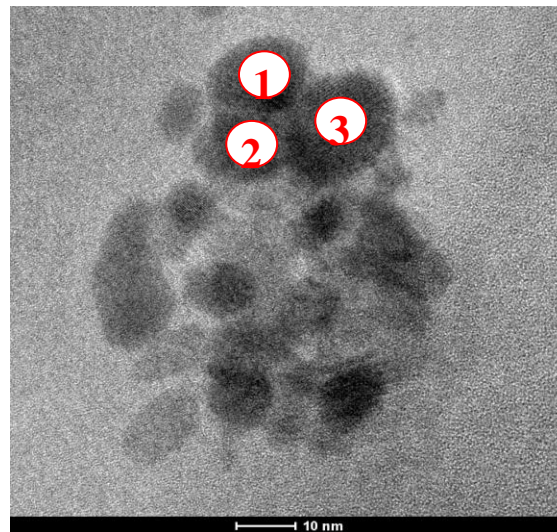
Atlantic Killifish
Fundulus heteroclitus



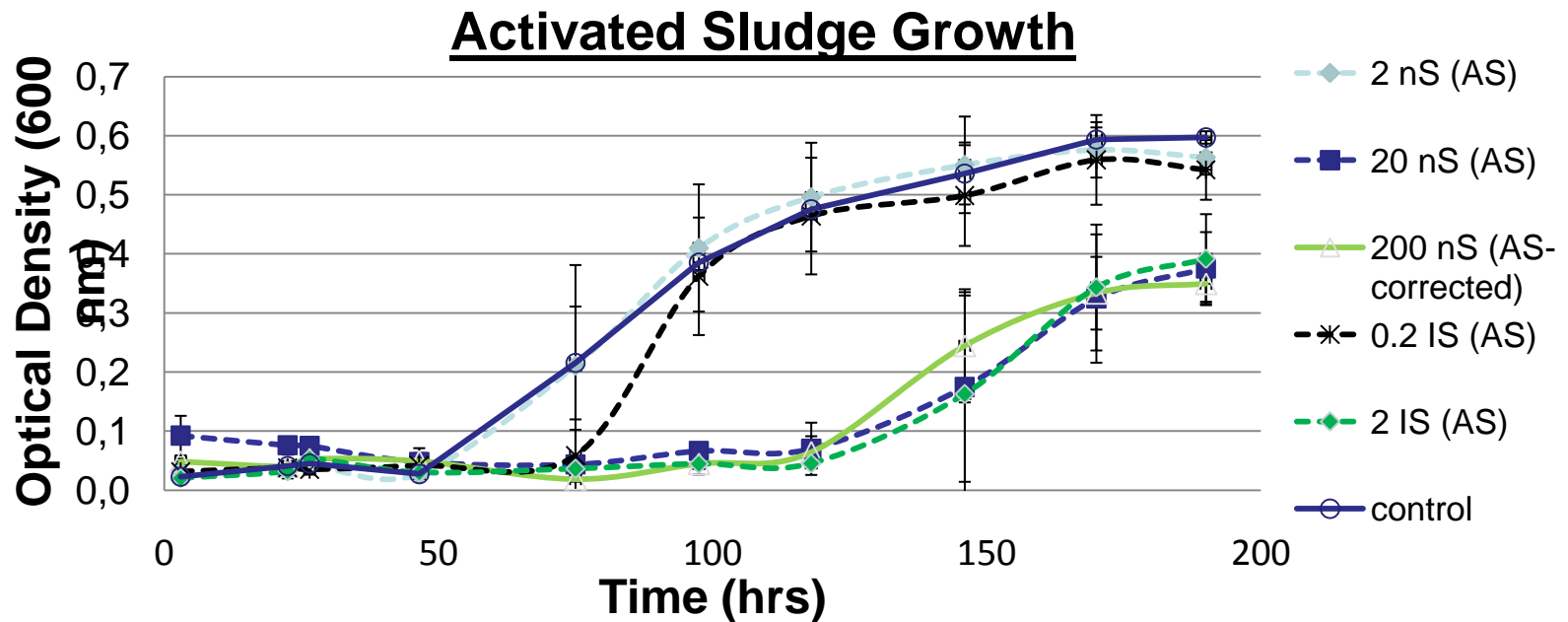
Understanding AgNPs formation/ transformation in wastewater treatment



Blaser, S. A. et al., *Science of the Total Environment* (2008).



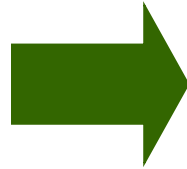
Nano-Ag inhibition of bacteria in activated sludge



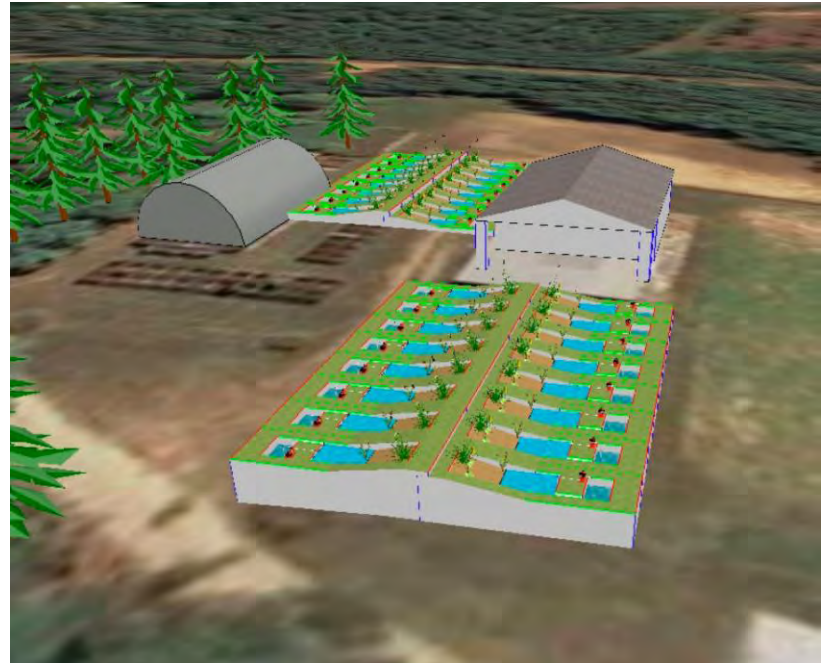
higher concentrations of silver inhibited growth by approximately 50%. Preliminary DGGE results indicate shift in 16S bacterial communities and overall decrease in the number of communities as silver concentration increased.

Theme 3: Ecosystem-level impacts

laboratory



mesocosms

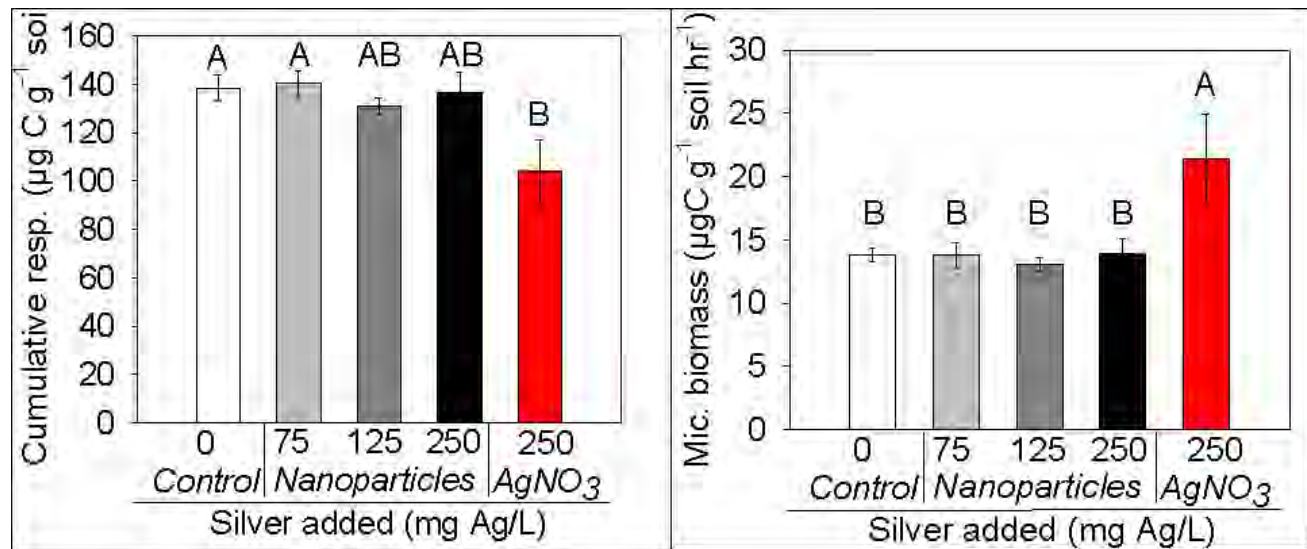
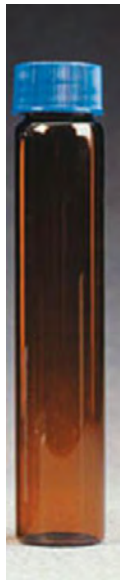
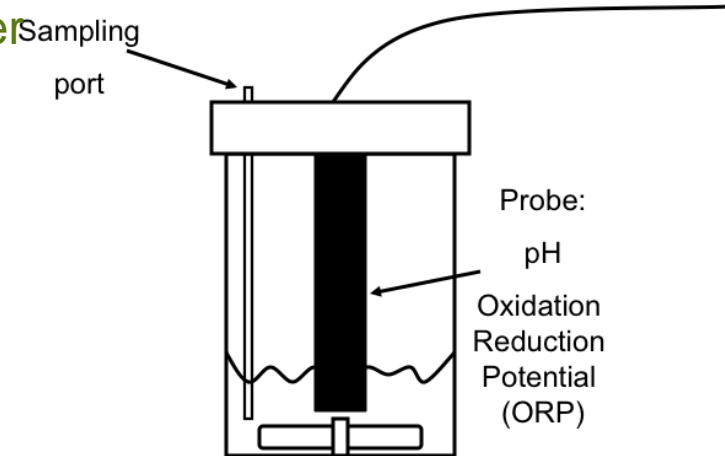


Microcosms- Sediments

More complex systems of sediment and surface water

Within 7 days – similar to controls

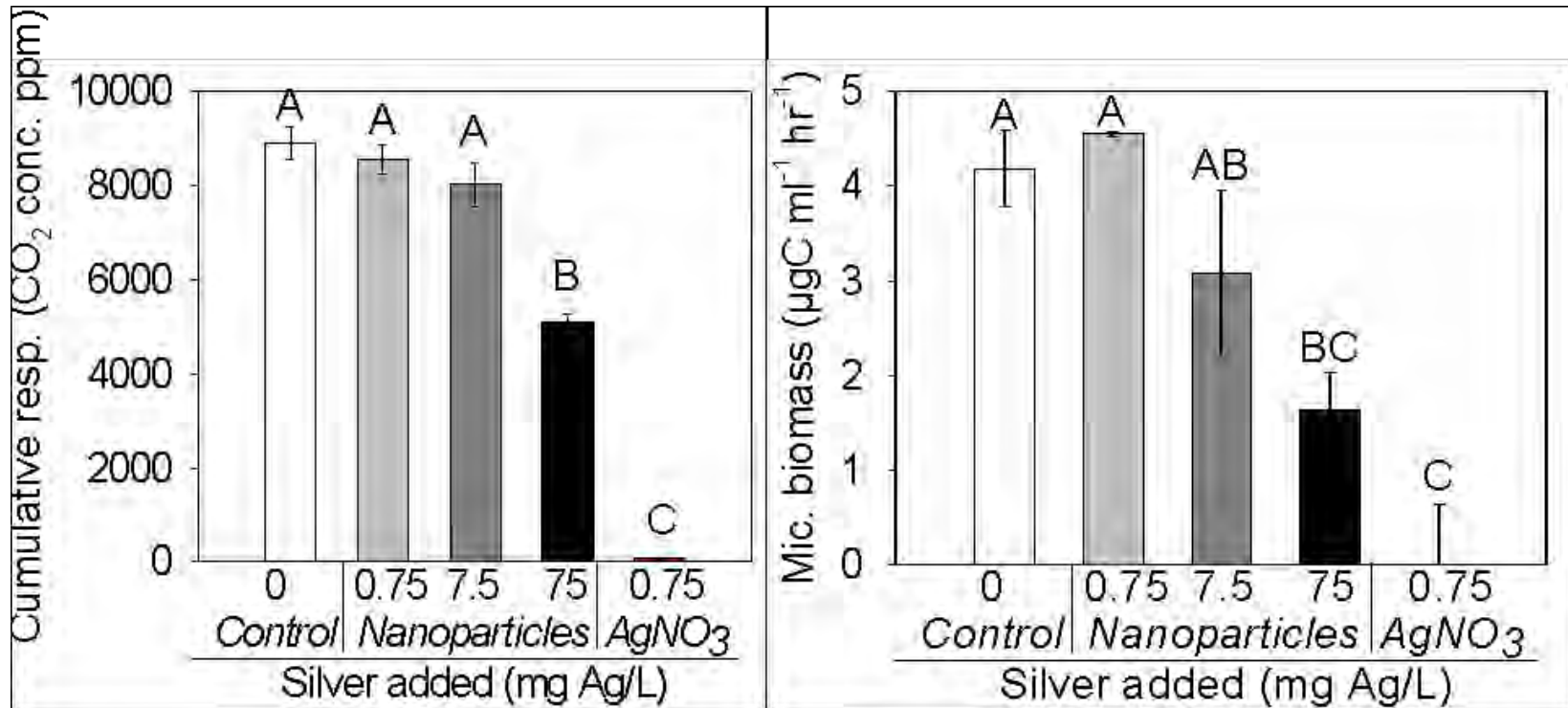
No clear effects of ionic or nanosilver on nutrient availability or enzyme activity



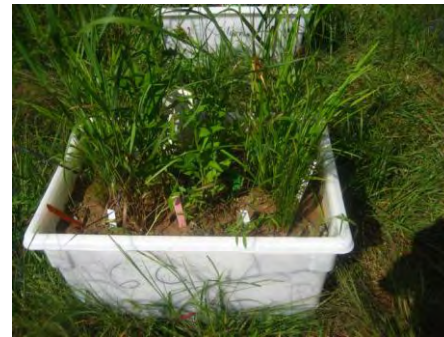
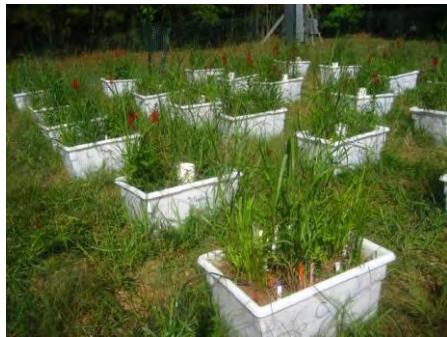
Stream water

No respiration in ionic silver
Repression of respiration at 75mg
Ag/L with AgNP

Decrease in microbial biomass with ionic
silver



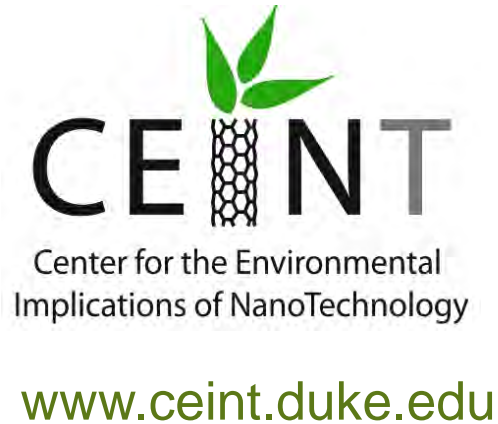
Mesocosms



Nano-Ag: Preliminary Conclusions

- Coatings can change everything:
 - transport
 - transformation
 - toxicity
- Additive affinity of nano-Ag for surfaces such as iron-oxide
- Nano-Ag toxicity: both dissolved and nanoparticle-specific effects- coating control the balance
- Complex environments contain both mitigating and exacerbating factors
- Exposure likely includes both manufactured and incidental sources

Thank You



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