

# Issues and challenges for nanoscale science in food applications

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# Issues

- Are nanomaterials safe for food applications?
- Will the use of nanomaterials be accepted by the public?
- What are the potential environmental and society impacts of nanomaterials in foods?



What is the safety of food applications of nanomaterials?



*“It is a mistake for someone to say nanoparticles are safe, and it is a mistake to say nanoparticles are dangerous. They are probably going to be somewhere in the middle, and it will depend very much on the specifics.”*

Vicki Colvin, Director of Center for Biological and Environmental Nanotechnology at Rice University (quoted in *Technology Review*, 2003)



# Safety

- *“free from danger or the risk of harm”*
- *To assess whether something is “safe”, we assess the risk of harm*
- *Risk = hazard X exposure*
  - *Low hazard X exposure = Low Risk*
  - *Hazard X low exposure = Low Risk*

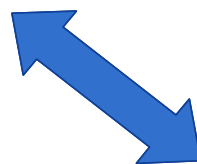


## Hazard Characterization and Dose-Response Assessment

- *In vitro* tests
- Animal studies
- Structure-activity relationships

## Exposure Assessment

- Amount present in food
- Consumption of foods
- Estimation of degree of exposure



## Risk Characterization

- Estimation of potential for adverse health effects to occur
- Evaluation of uncertainty
- Summary of risk information

\*Adapted from Derelanko, 1995



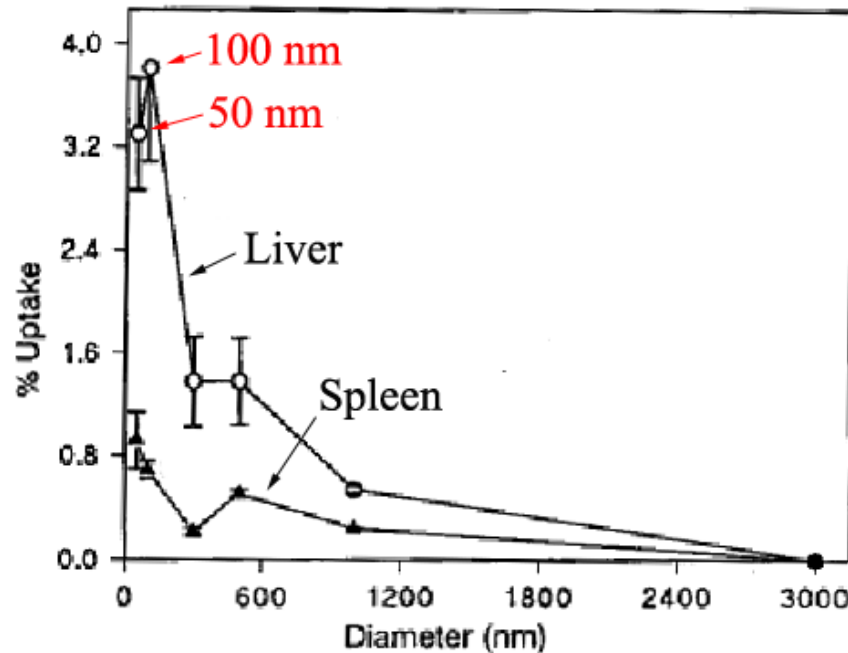
# General concerns of nanoscale *versus* microscale materials

- Higher exposure per unit mass
  - Small size, large surface area, may result in increased ability to generate Reactive Oxygen Species (ROS)
- Routes of exposure may differ due to smaller size.
  - E.g. olfactory transport, dermal penetration
- Different distribution to tissues by virtue of their different size or surface coating/chemistry.
  - E.g. ability to move within the body
- “Novel property” of nanoscale material may translate into a new mode of action.



# Effect of particle size on uptake uptake

- 50 nm - 3  $\mu\text{m}$  polystyrene beads, gavage in rats
  - 50 nm beads - 34% total uptake,
  - 100 nm beads - 26% total uptake



Jani *et al.*, 1990



## Characterization of Nanomaterials

Size and shape,  
uniformity of  
size/shape

Composition  
and purity

Form of material  
(particle, laminate,  
composite, etc)

## Testing guidelines

*In vitro* assays

- Gastrointestinal absorption
- Digestion models

*In vitro* assays

- Cytotoxicity
- Oxidative stress



Determines need  
for *in vivo* testing



*In vivo* assays

- Challenges in dose metrics, need for large amounts of materials for oral dosing, role of food matrix must be considered, end-points need to be established.

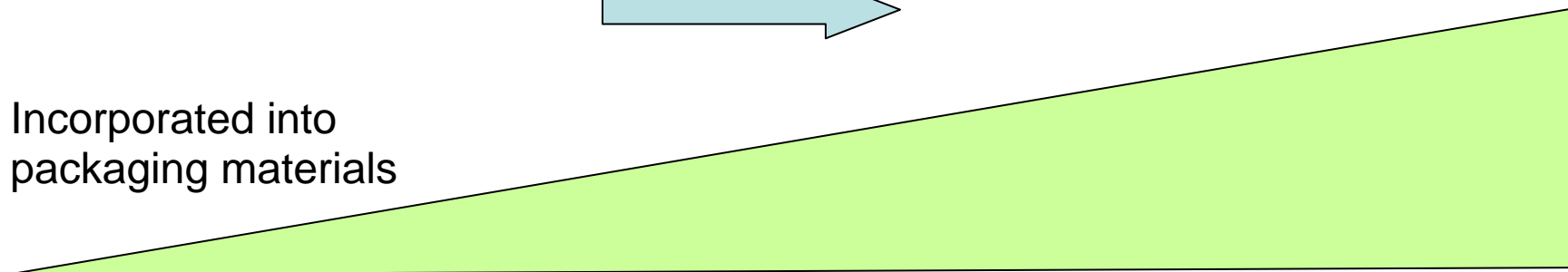


# Likelihood of Exposure

Directly added to  
widely consumed food



Incorporated into  
packaging materials





Will the use of nanomaterials  
be accepted by the public?



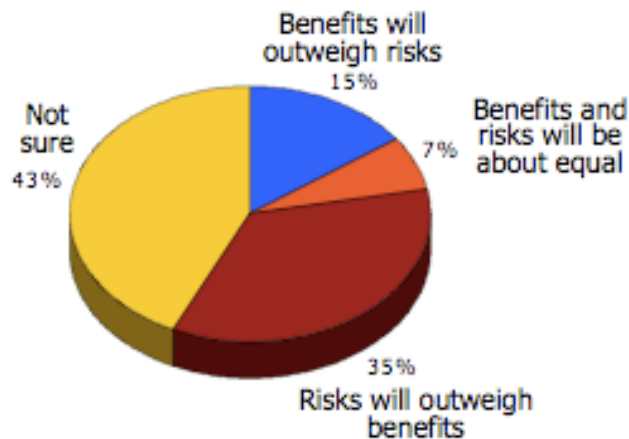
# Research on Public Perception

- Lack of information
  - products
  - health and environmental implications
  - processes designed to manage risk
- Breeds public mistrust and suspicion
- Public wants to be included
  - 76% felt call for ban was over-reaction



# Benefit versus risk

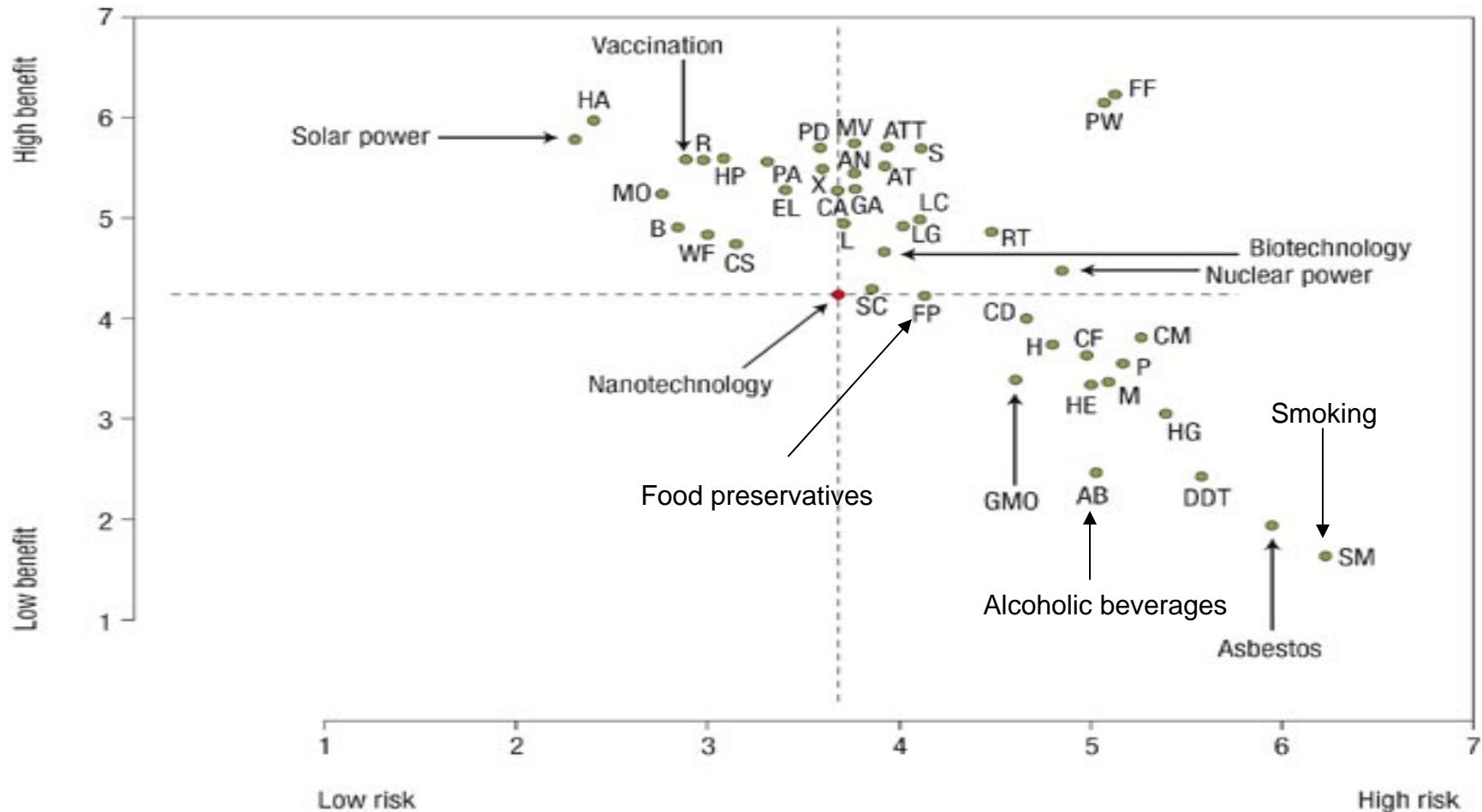
## Initial Impression Of Risks And Benefits Of Nanotechnology



- Benefits
  - Environmental protection
  - Lower energy costs
  - Improved food and nutrition
  - Improved medicine
- Most concerned with food and medicine



# Public perception of risk and benefits





# Nanotechnology's Potential Threatened by Weak Public Education and Outreach

- Dr. Neal Lane, former science advisor to U.S. President Bill Clinton.
- “First ....investigate nanotechnology’s possible environmental, health, and safety risks.”
- “second step ...is to infuse nanotechnology education into the curriculum in every school and teacher education program.
- “...provide the public with balanced and easily understood information about nanotechnology’s potential benefits and its possible risks and for more public engagement”—led by government, industry and the science and engineering community working together.



# Education and Outreach

“From the beginning, an explicit aim of the U.S. National Nanotechnology Initiative (NNI)—a \$6.5 billion federal investment in nanotechnology research launched in January 2000 under President Bill Clinton—was to **excite young girls and boys about science**, particularly the physical sciences and engineering. The intent was to reach millions of children using the wonders of nanotechnology to encourage them to study science and to equip them to compete successfully at the cutting-edge of a globalized economy.”

– Dr. Lane, former science advisor to U.S. President Bill Clinton.



# Issues

- consumer perception and acceptance of the use of nanomaterials will be critical
  - Transparency
  - Education
  - Benefits to consumer
  - Safety
  - Environmental impact



What are the potential  
environmental and society  
impacts of nanomaterials in  
foods?



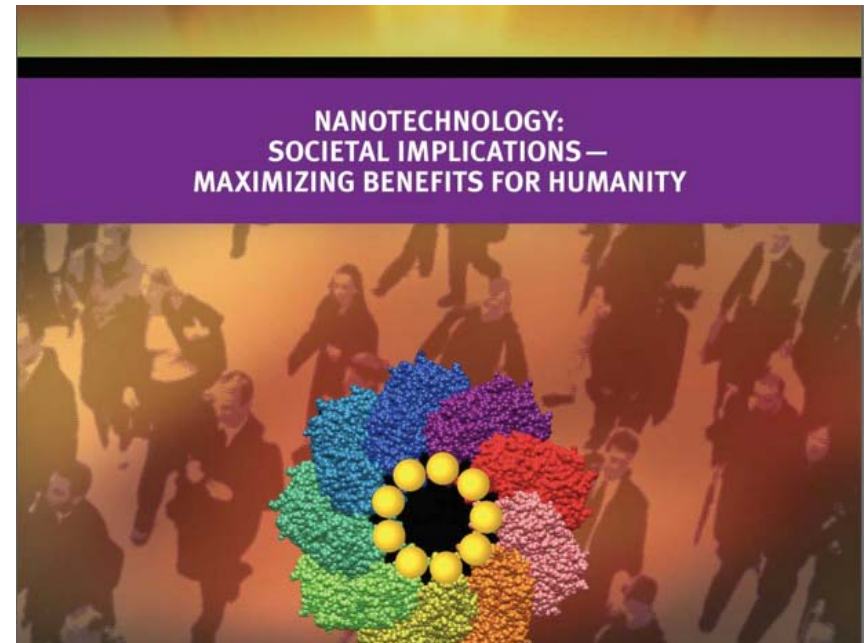
# Environmental questions

- Where will the nano go?
- Life-cycle analysis of products
  - How long do material last?
  - How do they degrade?
  - How do they move through the environment
- Impact on environment



# Societal Implications

- National Nanotechnology Initiative
- Who will benefit from nanotechnology?
- Who will pay?
- Report published by NSET, NSF
- <http://www.nano.gov/>





# ETC group

- Significant societal and environmental questions.
- believes that a moratorium should be placed on nanotechnology research
- <http://www.etcgroup.org/en/issues/nanotechnology.html>

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.



# Needs

- Demonstrate safety of food applications of nanomaterials,
- Educate industry, students and consumers to achieve acceptance of the use of nanomaterials,
- Assess and mitigate environmental and society impacts of nanomaterials in foods.



Thank you!

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