Welcome to NACK's Webinar

Applications in Nanotechnology: Nanoscale Science & Technology for Food

NACK is an NSF-funded ATE Resource Center supporting faculty in Nanotechnology Education

Hosted by MATEC Networks

www.matecnetworks.org

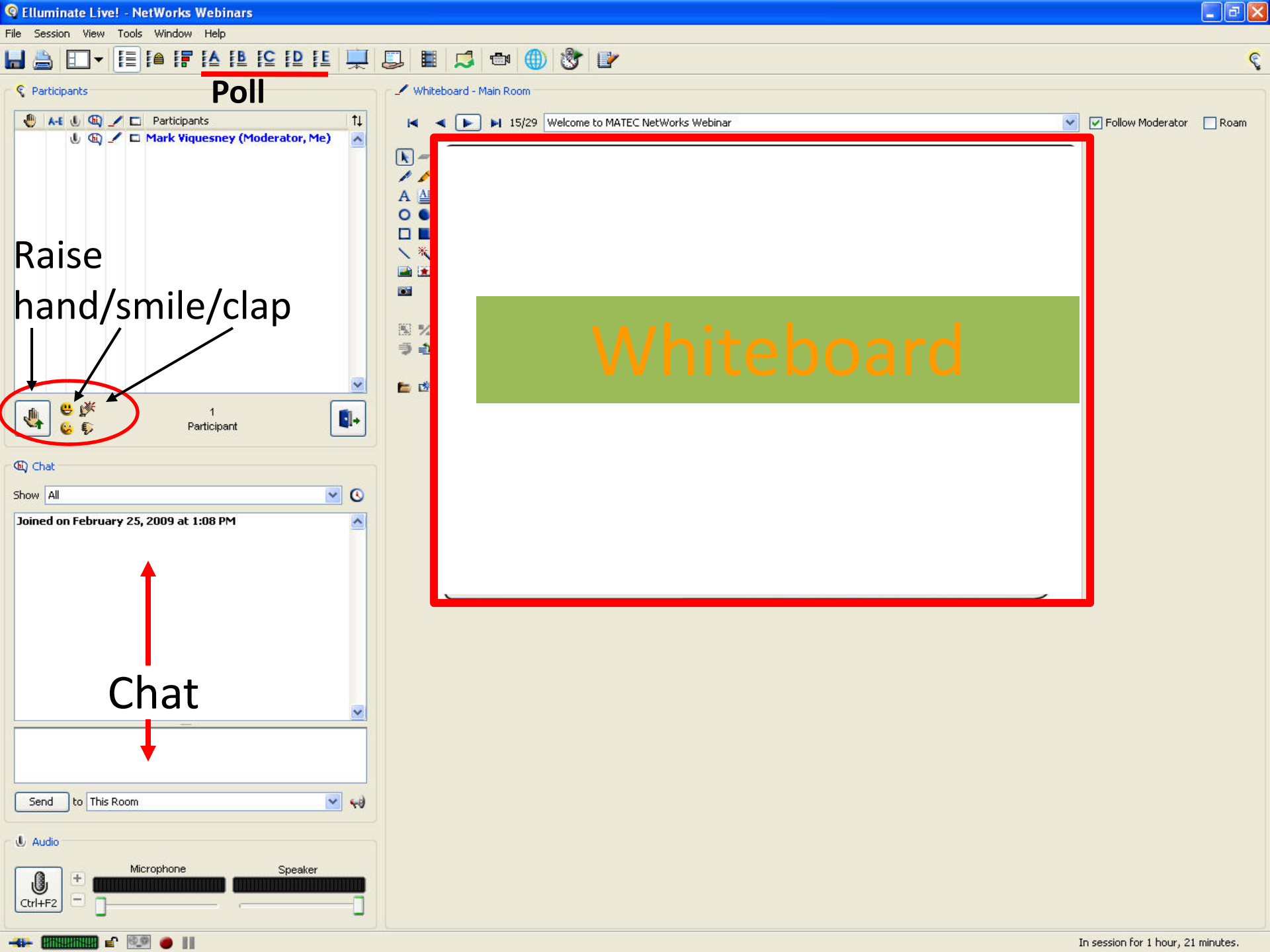
NACK CENTER

NACK is the NSF ATE National Center for Nanotechnology Applications and Career Knowledge

The NACK National Center is located at Penn State University

Funded, in part, by a grant from the National Science Foundation.
DUE-08020498

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1 Participant
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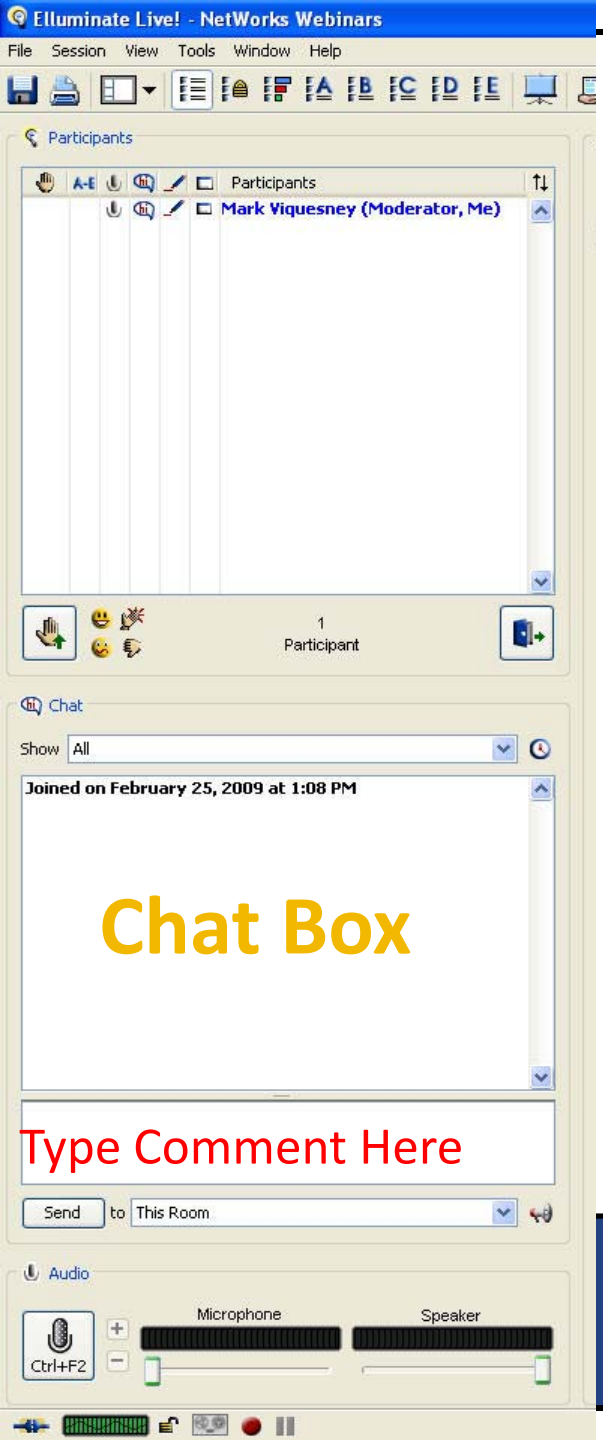


Chat Box

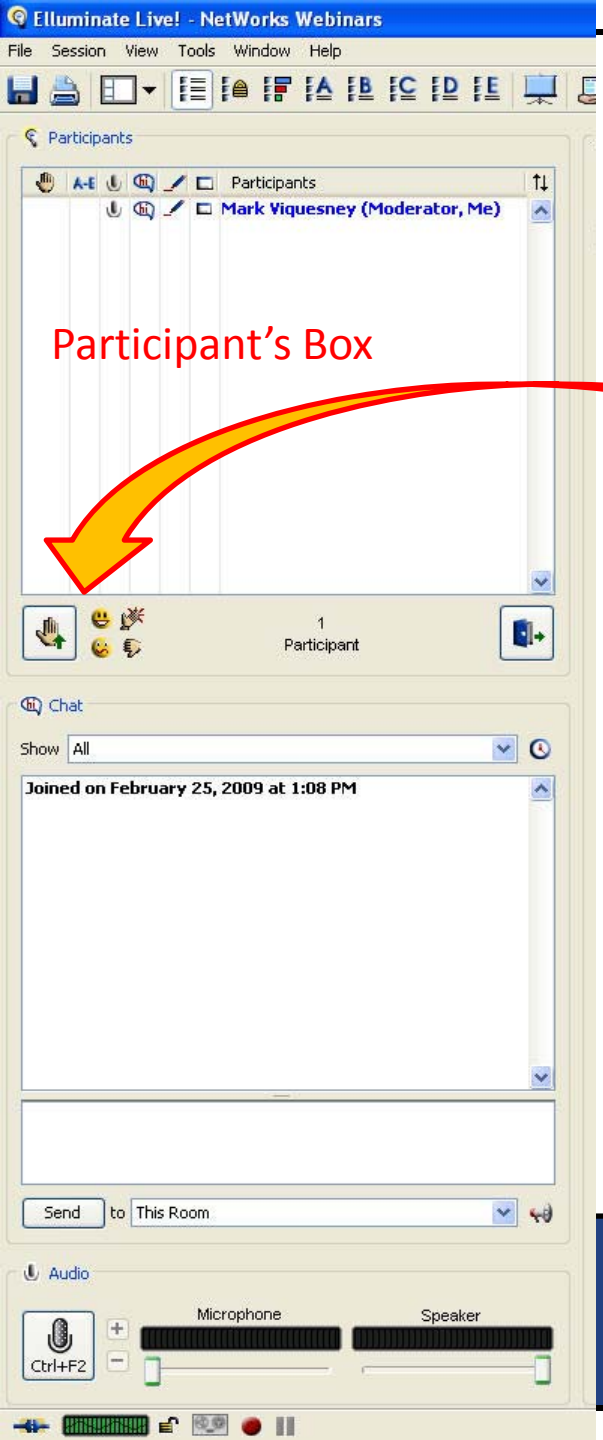
In the **Chat Box**,
please type the name of your school or organization, your location,
and how many people are attending with you today.



Participant's Box

Allows you to non-verbally respond to the presenter's comments.

Participant's Box



Let the presenter know if you like what they say with a smile or clap. Raise a hand if you have a question – and then type it into the chat box.

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Click A-E to take the Poll

This webinar will have a Poll. Please answer: I heard about this webinar through:

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B. Email from ETD list serv
C. Email from NACK
D. Friend or colleague
E. Other (please type where in chat box)



NACK's Webinar Presenter

J Lynne Brown

Professor

Department of Food Science

Pennsylvania State University

www.foodscience.psu.edu

FOOD SCIENCE @ PENN STATE

Disciplines

- Chemistry
- Microbiology
- Engineering
- Nutrition

www.foodscience.psu.edu

Discussion Topics

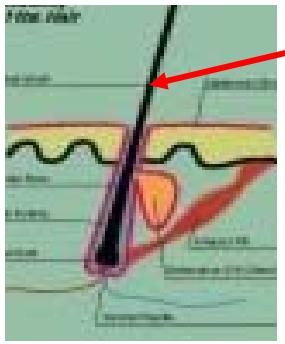
- Food Safety and Quality
- Food Ingredient Technologies
- Food Processing
- Food Packaging
- Benefits and Risks
- FDA Regulatory Approach

Information Sources

- **Pennsylvania State University**
- **Institute of Food Technologists (USA)**
- **Institute of Food Science and Technology (UK)**
- **Nanotechnology Working Group**
- **FDA Nanotechnology Task Force**

Nanoscale Science and Engineering
What is Nanotechnology?

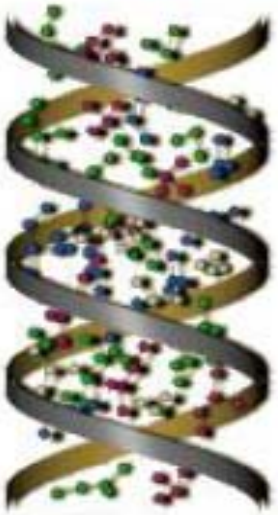
- **Generally, Nanotechnology is defined as the science and engineering of materials on the scale of 100 nm and below**
- **Defined by the size range**
- **It focuses on materials between the atomic level and the micro/macro range**

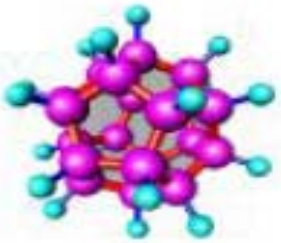


Hair
50000 nm



Scale in relation to food structure

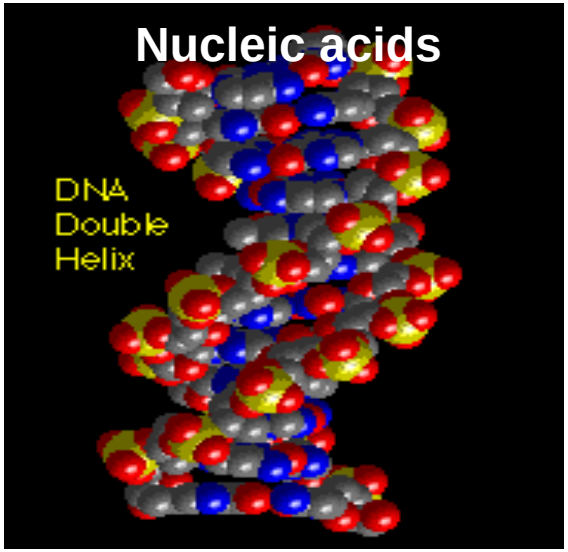




Dimensions
100 µm
Plant, Animal Cell
10 µm
Bacteria
1 µm
100 nm
Virus
Protein
10 nm
DNA "turn"
Simple Molecules
1 nm
DNA "base"
Atoms
0.1 nm

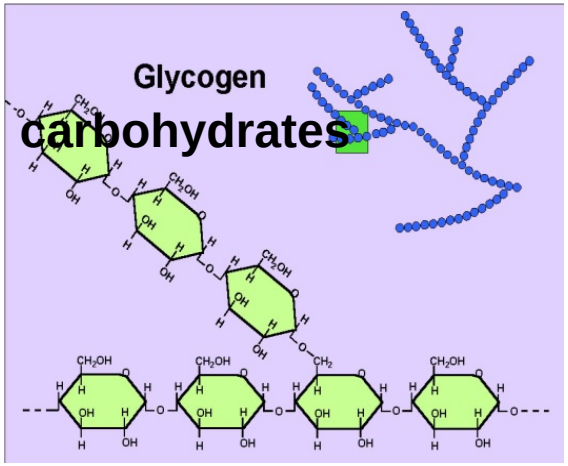
Warad and Dutta, 2005

Biomolecules



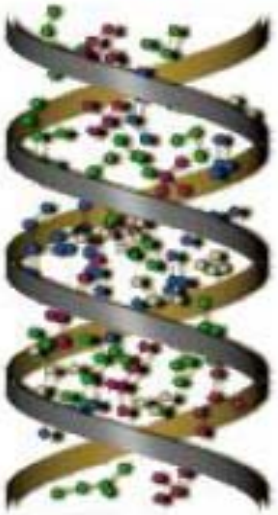
Proteins

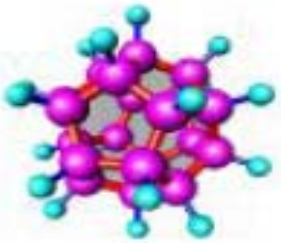
lipids



Small molecules e.g., vitamins, phenolics…

Scale in relation to food structure





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Atoms
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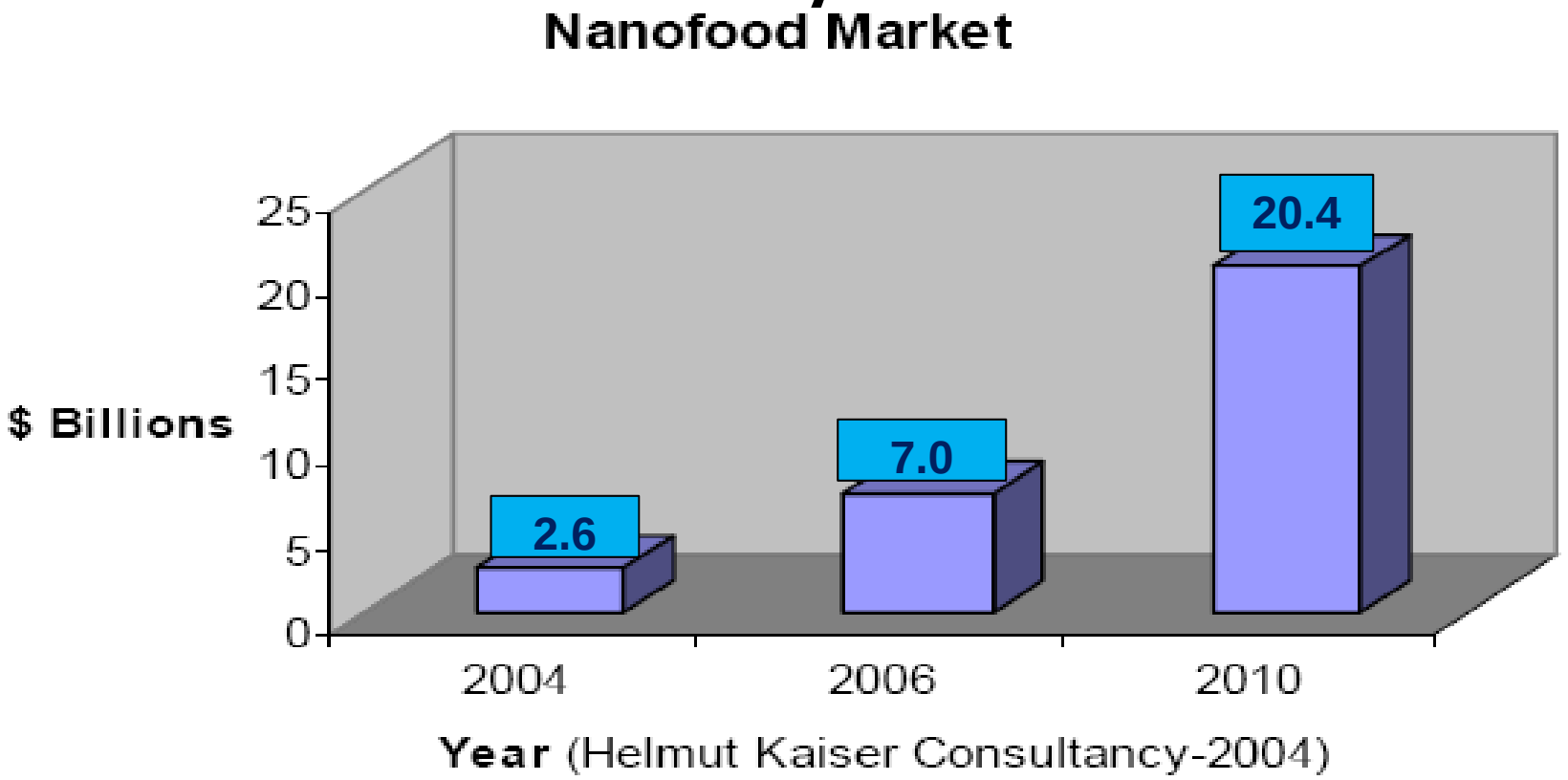
Warad and Dutta, 2005

Impact of nanotechnology in the food system



www.nanoforum.com



Questions?

Type them in your chat window

Nanotechnology Research & Applications in Food

- **Food Safety and Quality**
  - **Nano-structures interacting with microbial cells**
  - **Tracking and tracing systems**
- **Ingredient Technologies & Systems**
  - **Nanoparticle utilization for delivery of ingredients**
  - **Flavors, Antioxidants, Antimicrobials, Bioactives etc.**

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Nanotechnology Research & Applications in Food

- **Food Processing**
  - **New membrane separation systems**
  - **Catalysis immobilization**
- **Food Packaging**
  - **Low permeability, high-strength plastics**
  - **Intelligent packaging**

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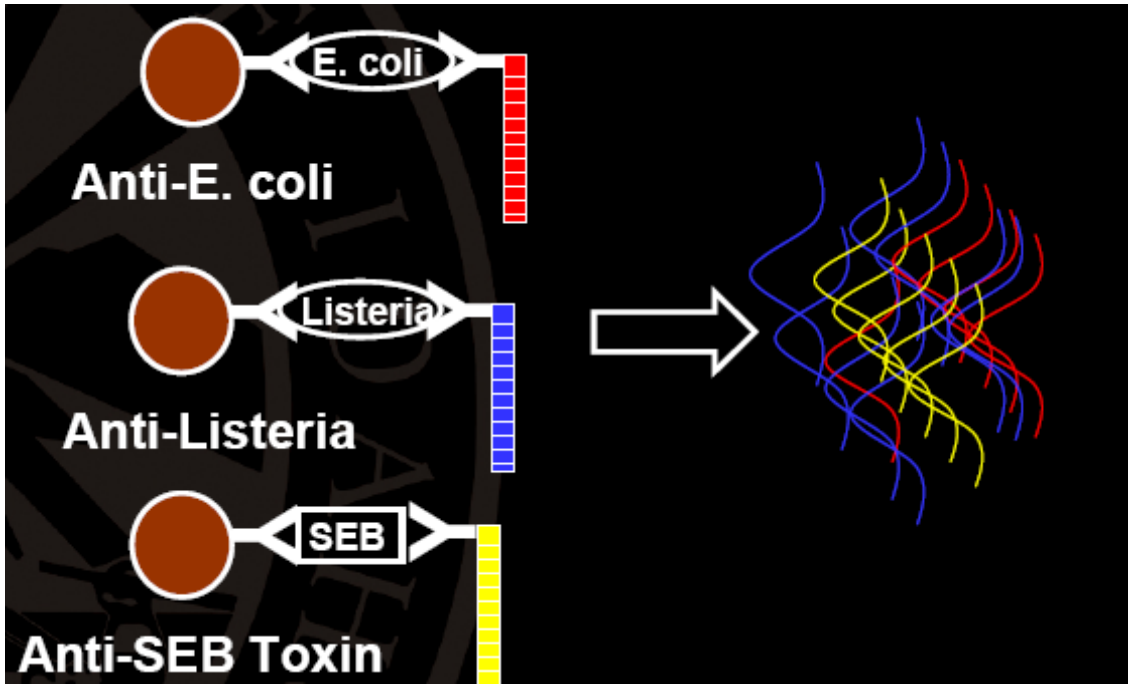
Sensors

- **Environmental conditions**
  - **temperature**
  - **Humidity**
  - **Oxygen**
  - **Chemical contaminants**
  - **Microbial contaminants**



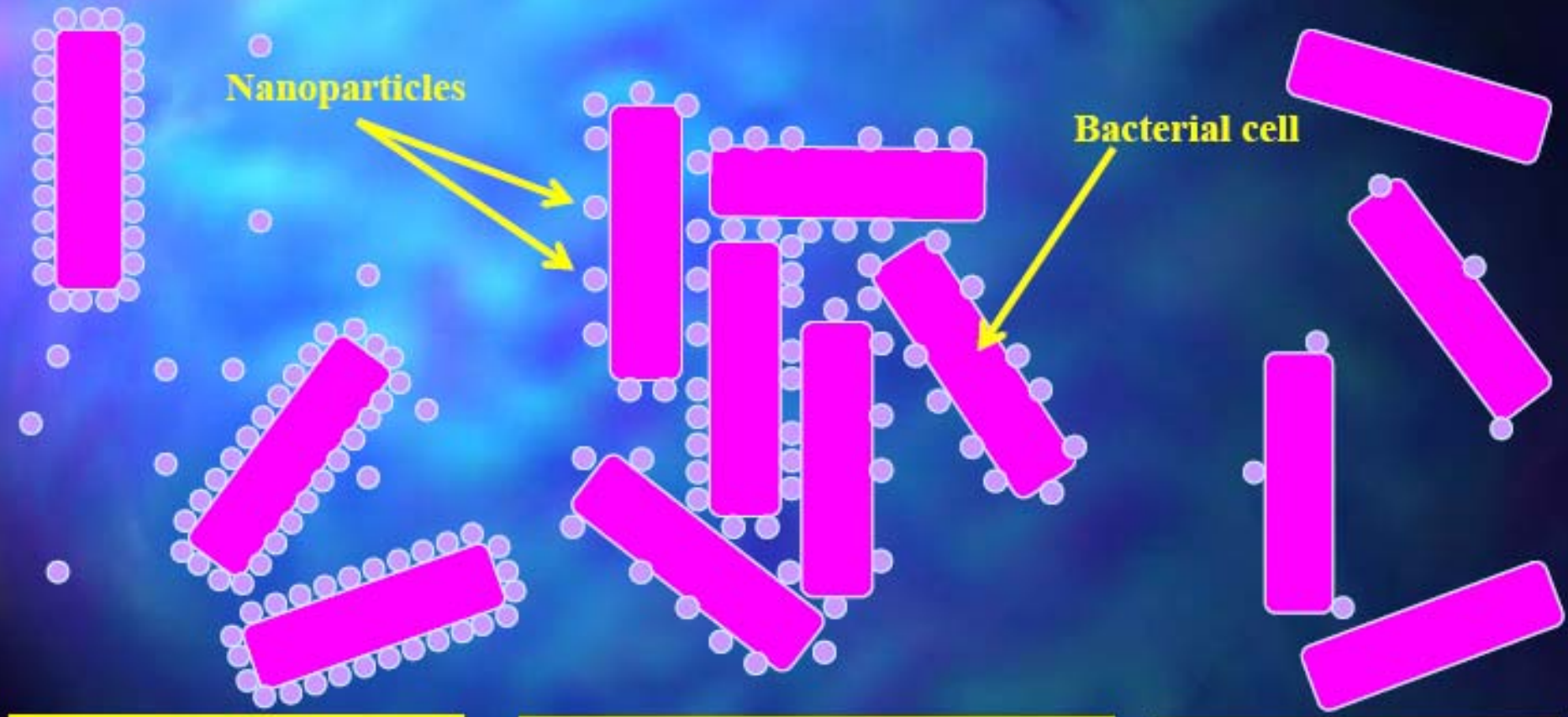
Detection of Microorganisms/toxins

Magnetic nanoparticles attached antibody



X Huang, University of Toledo, OH

Nanoparticle-Bacterial Bindings



Jeremy Tzeng, 2007

Campylobacter jejuni-Specific Nanoparticles

Jeremy Tzeng, ASM 2007

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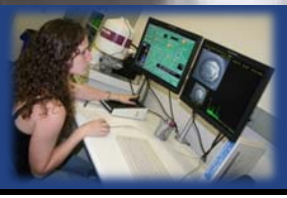


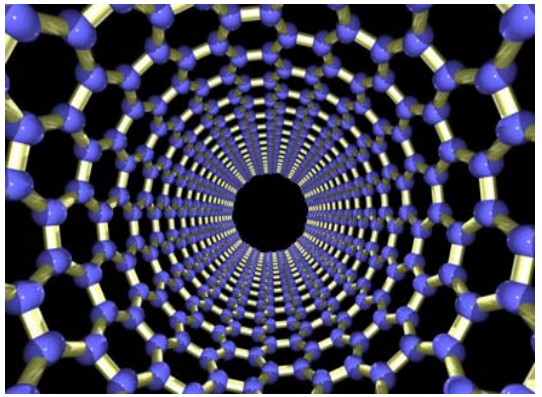
Properties of CNT

- **SWCNT**

  Variable conductivity from semi-conductor to metallic

  Good electrical conduction

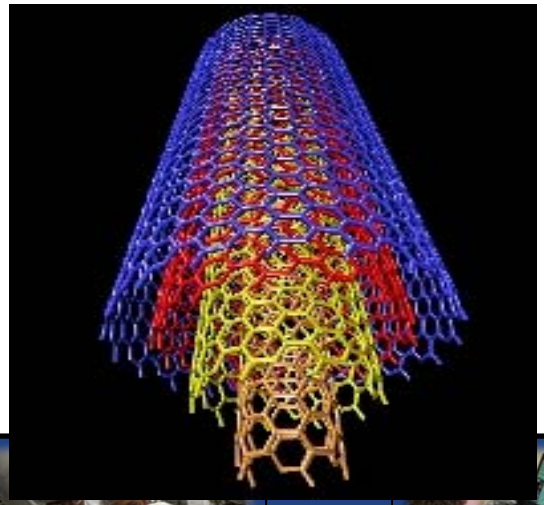
  High electronic conductivity



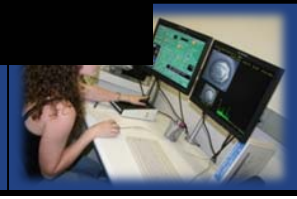
SWCNTs

- **MWCNT**
- **Nanowires**
- **Nanorods**

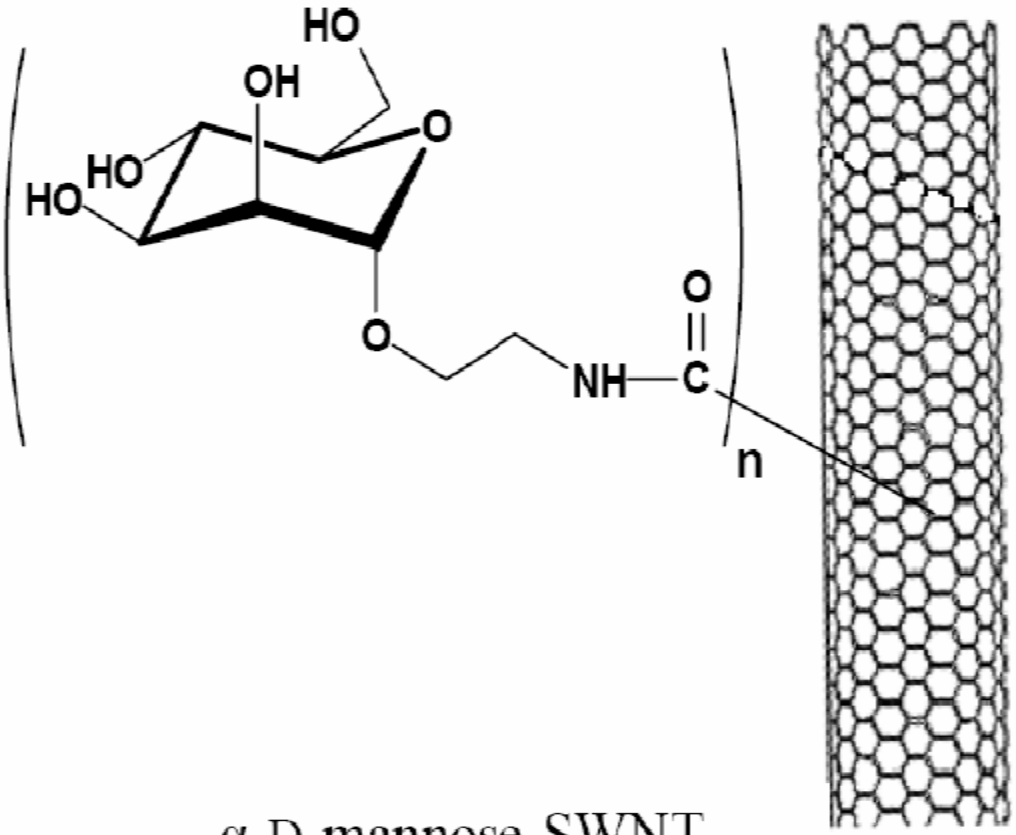
  Most possess a remarkable tensile strength



MWCNTs



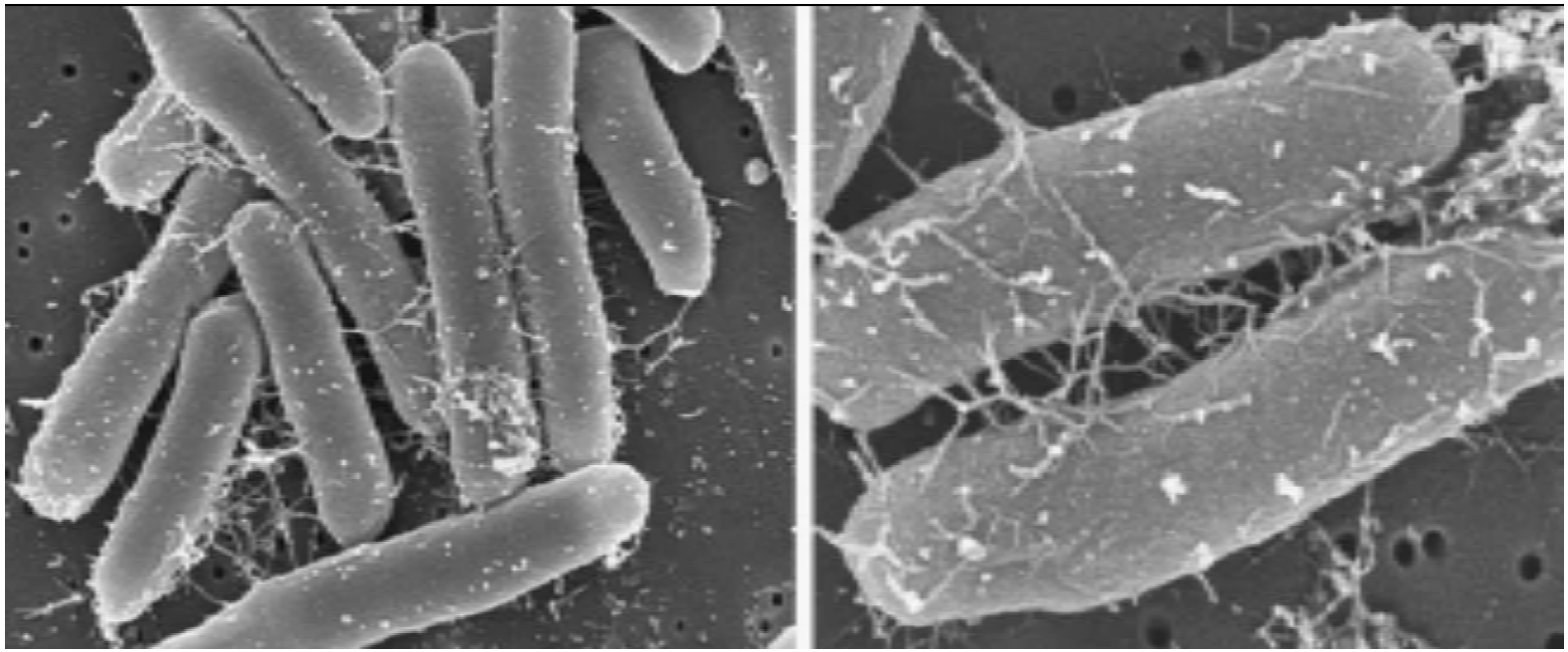
Single-Walled Nanotube (SWNT)



α-D-mannose-SWNT

Nanotubes & *E. Coli*

Binding of SWNT to Targeted *E. coli* O157: H7 Strain C7927



Chem. Commun., 2005:874-876

Questions?

Type them in your chat window

Tracking – Tracing – Monitoring

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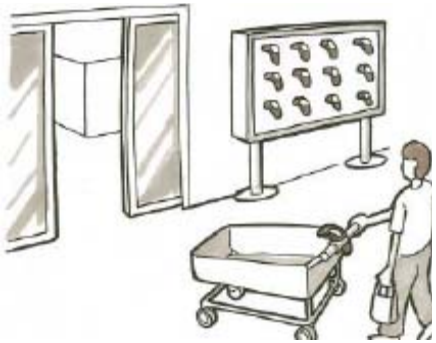
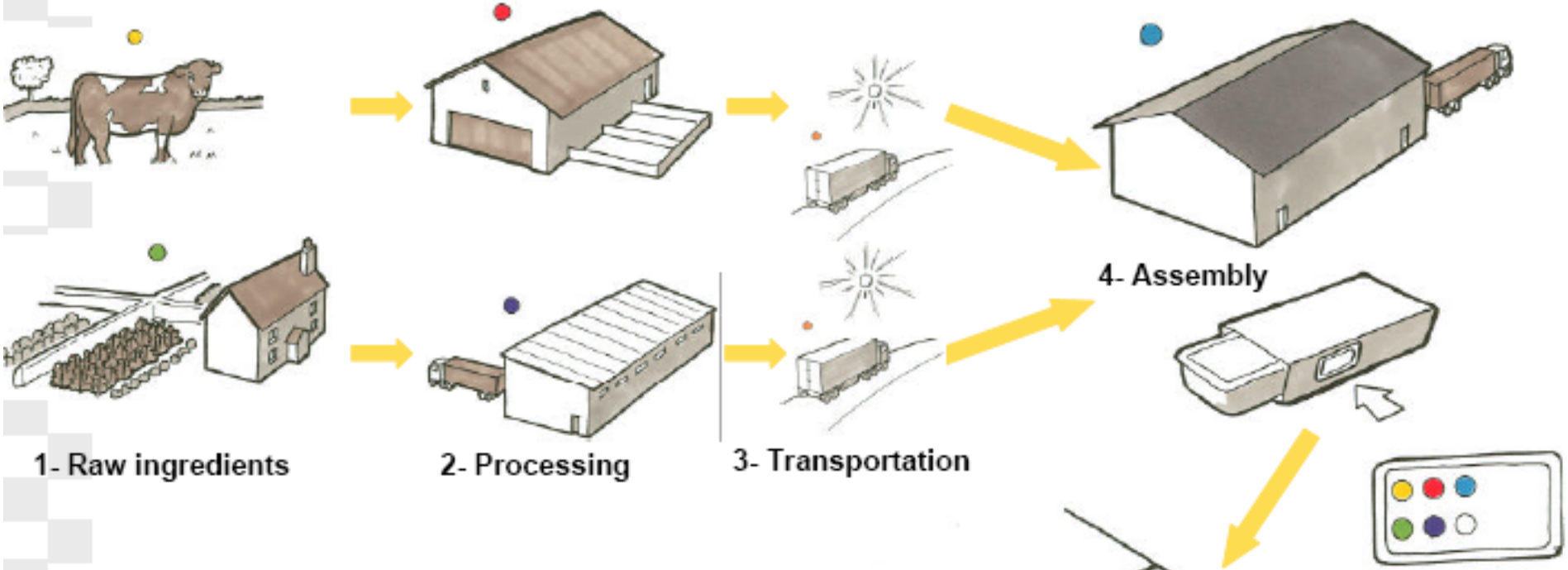
Improving Food Labeling



Improving label readability in the supermarket to suit costumers diet in nutritional requirements

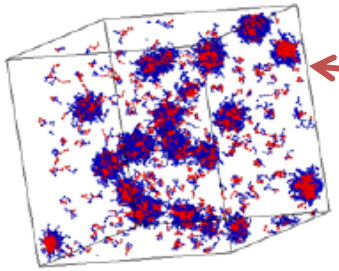
www.cambridge consultants.com

Food Traceability



Enhanced control and monitoring of the food chain and easier product recalls

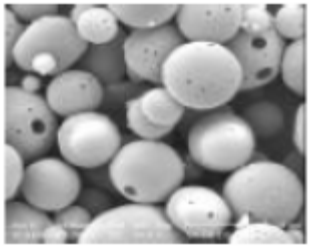
Nanotechnology for Ingredients and Materials



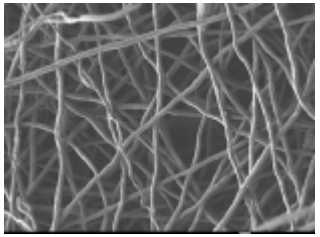
- **Microemulsions**

- **Liposomes**

- **Nanoemulsions**

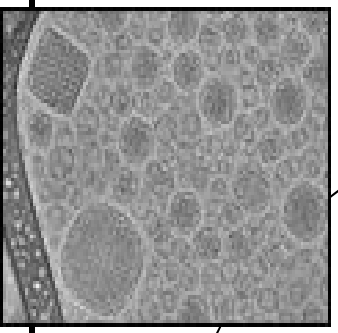


- **Particles**



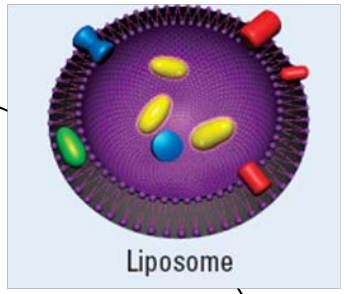
- **Fibers**

Encapsulation Materials



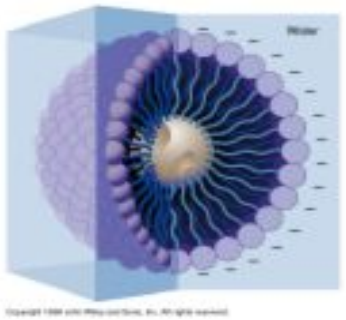
Cubosomes
5-10 nm

Liposomes
20nm



Flavors
Antioxidants
Vitamins
Nutrients
Nutraceuticals
Antimicrobials

Micelles
5-500nm



- **Starch**
- **Chitosan**
- **Starch**
- **Polylactic acid**
- **Gum arabic**
- **Carrageenan**
- **Alginate**

Biopolymeric nanoparticles

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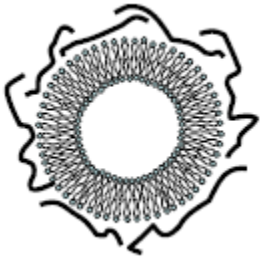
Encapsulation Impacts

- **Bioavailability**
  - **How much is absorbed based on digestion and transport across intestinal cell wall?**
  - **How is it transported to target site?**
  - **Does it need to be activated, altered by body enzymes once absorbed?**
  - **How long does it stay in the body?**

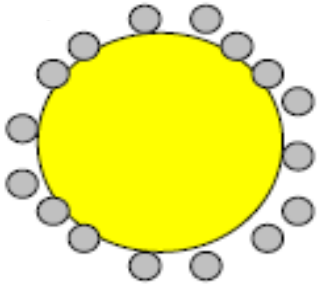


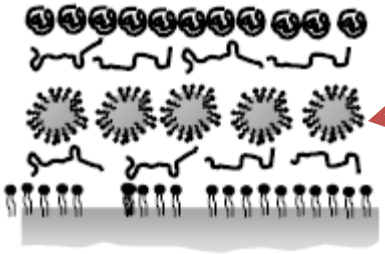
Next Generation Nano-Encapsulation Systems

- **Double Layered Liposomes**



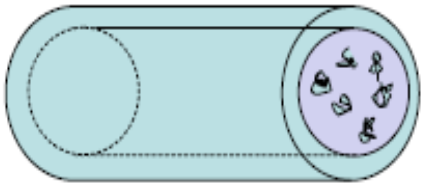
- **Solid-Lipid Nanoparticles**
- **Colloidosomes**





Nanolaminates

Composite Nanofibers



Nanotechnology in Food Processing

Frans Kampers, 2007

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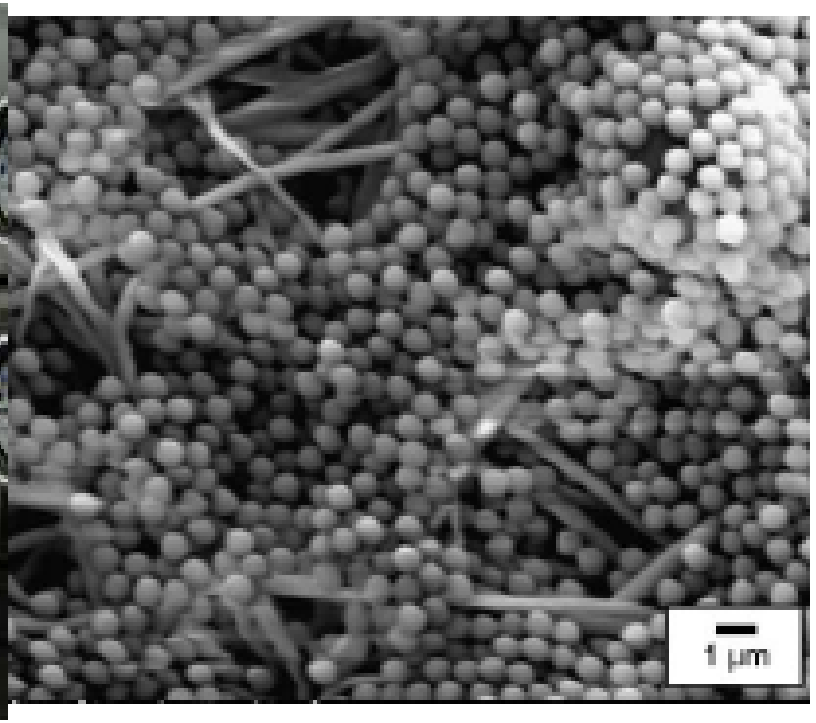
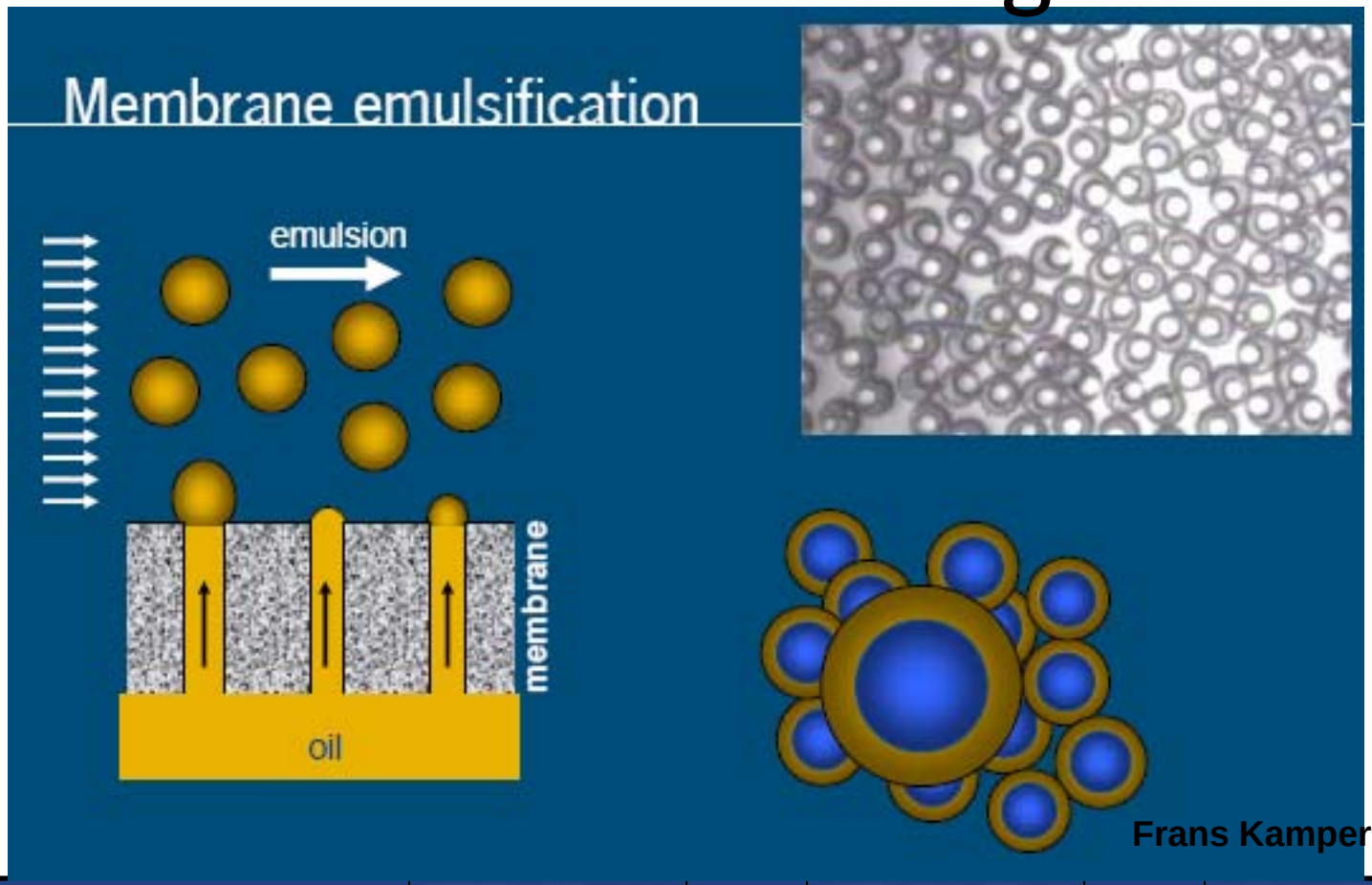
Nanotechnology in Food Processing

Nanofiltration – Molecular Separation Technologies



Jochen Weiss, 2007

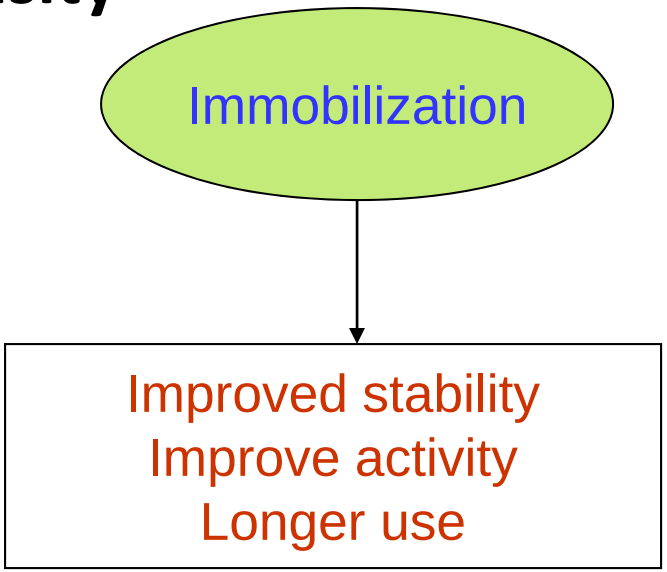
Nanotechnology in Food Processing



Frans Kampers, 2007

Enzymes in Food Processing

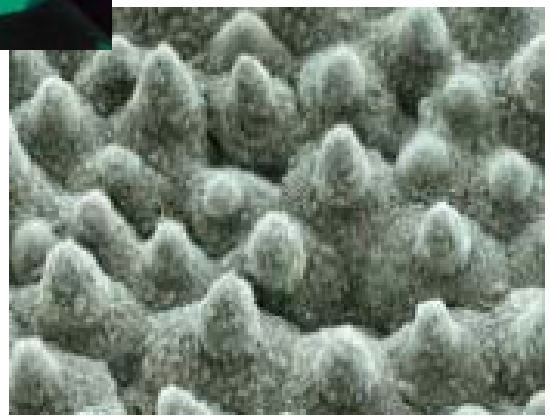
- **Biopolymers breakdown (starch hydrolysis)**
- **Reduce haziness and density**
- **Improve flavor**
- **Add nutritional value**
- **Product development**
- **Texture control**



Questions?

Type them in your chat window

Nanotechnology in Food Packaging



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Nanotechnology in Food Packaging

Protect food from contamination to preserve its quality and shelf-life

- Microbial contamination
- Chemical contamination
- Oxygen
- Water vapor
- Light



Molding better plastics with clay

Super plastics:
Plastic polymers are combined with clay nanoparticles to create a stronger, cleaner, more flame-resistant material.

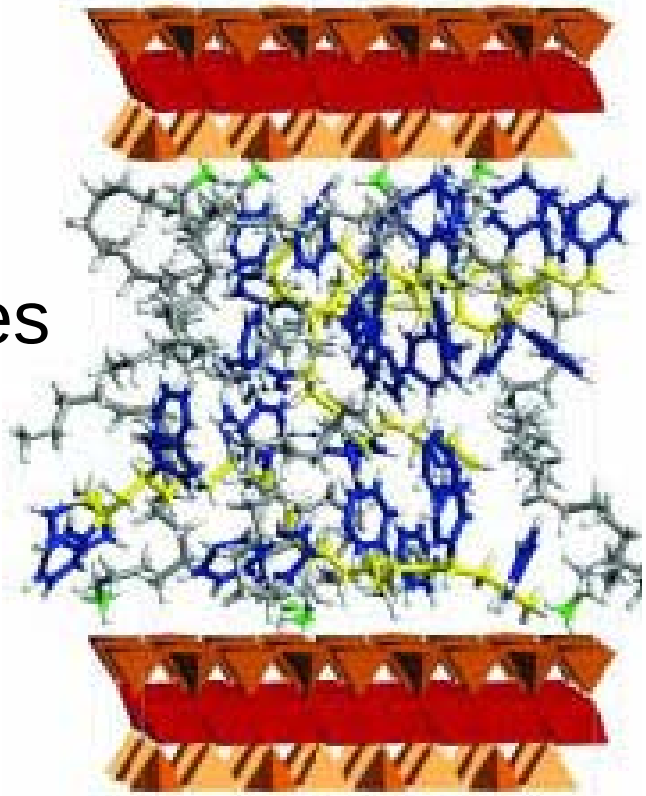


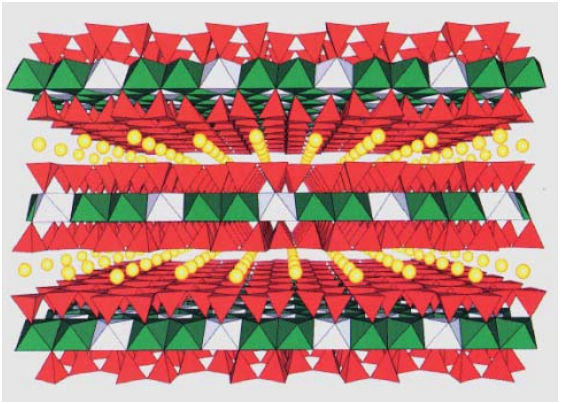
Photo credit: Evangelos Manias

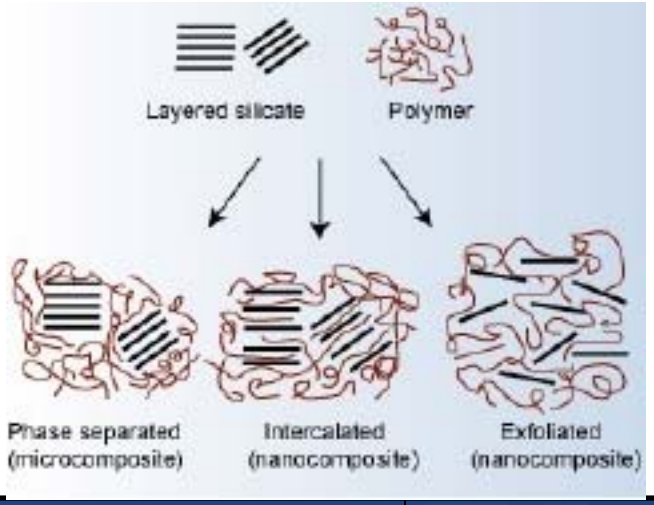
Clay Nanocomposites

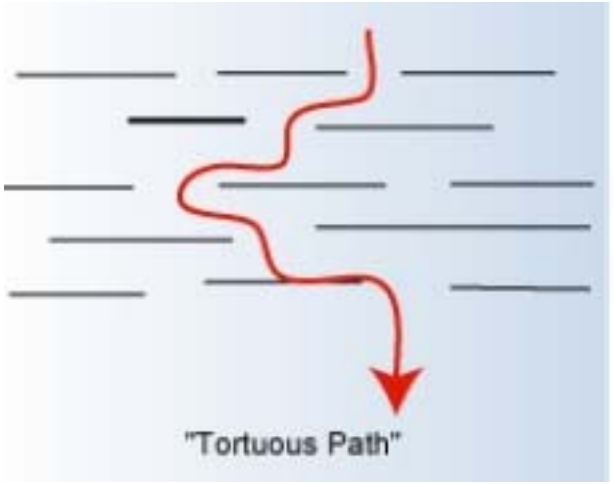
- **Based on clay-Montmorillonite**

  -Nylon

- **Improve barrier properties**







Biodegradable Nanocomposites

- **Blends of biopolymers and clay**
  - **Starch/montmorillonite**
  - **Polylactic acid/clay**
  - **Polycaprolone/nylon**

Exhibit reinforced mechanical properties, thermal, higher temperature resistance, reinforced barrier properties



Nano-Nylon (Imper)

Nanoclay with MXD6 Nylon in barrier layer in beer bottles Developed by Voridan & Nanocor

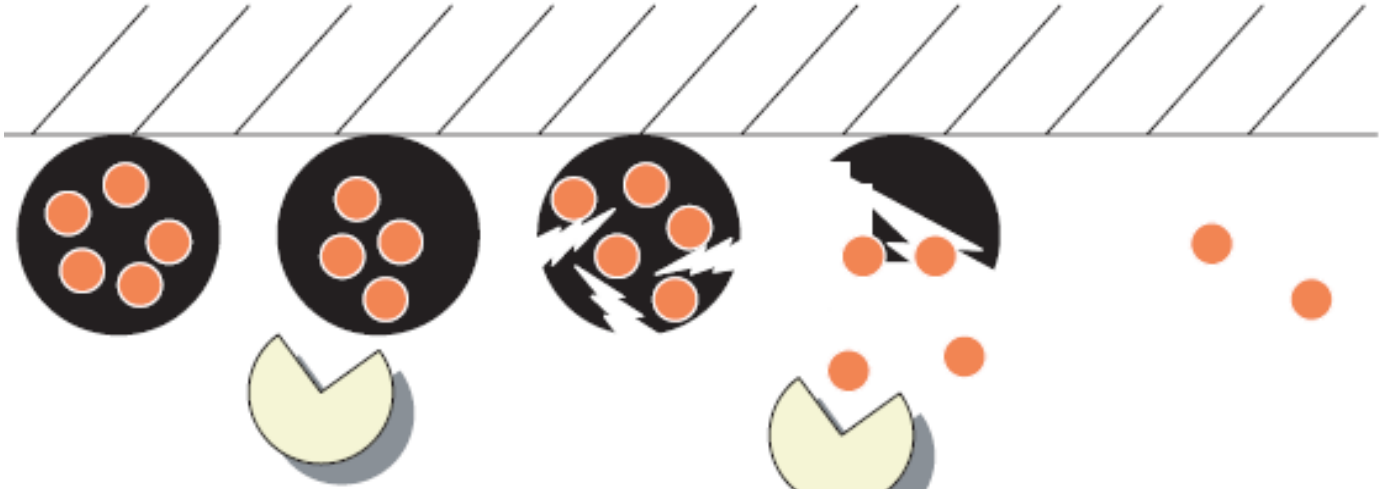
Active & Intelligent Packaging

- **Active Packaging:** **Actively changes the conditions of the packaged food to extend shelf-life or to improve food safety and quality**

- **Intelligent Packaging:** **Monitors the conditions of packaged food products and gives information about their safety and quality during transport and storage**



Schematic representation of antimicrobial active packaging



Antimicrobial active packaging. Microorganisms hydrolyze starch based particles causing release of the antimicrobial lysozyme resulting in inhibition of microbial growth

DeJong et al. 2005

Intelligent Packaging

- **Nanosensors in Packages**
  - **Detect pathogens, chemicals, toxins, etc.**

NanoSensors Inc.

Questions?

Type them in your chat window

Nanotechnology Research & Applications in Food

- **Food Safety and Quality**
  - Nano-structures interacting with microbial cells √
  - Tracking and tracing systems √
- **Ingredient Technologies & Systems**
  - Nanoparticle utilization for delivery of ingredients √
  - Flavors, Antioxidants, Antimicrobials, Bioactives etc.√
- **Food Processing**
  - New membrane separation systems √
  - Catalysis immobilization √
- **Food Packaging**
  - Low permeability, high-strength plastics √
  - Intelligent packaging √

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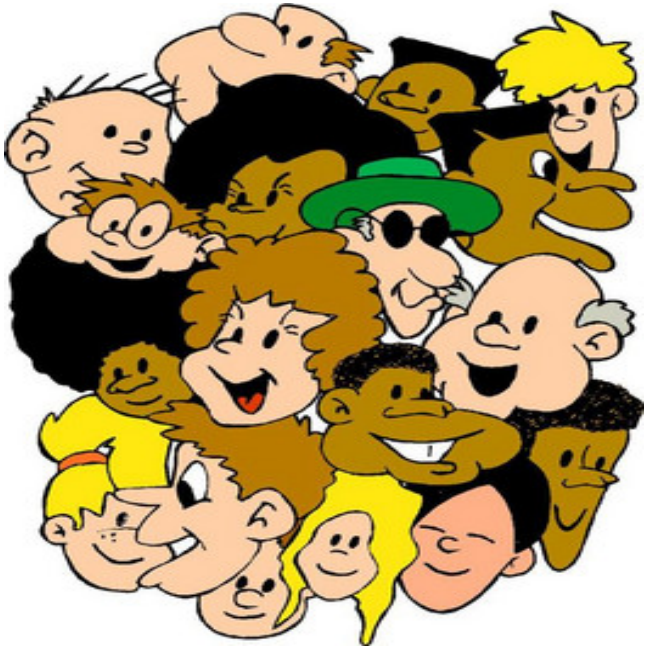
Benefits, Risk, Regulation and Consumers



Benefits vs. Risk

- **Previous information focuses on benefits seen by scientists**
- **But Nano has risks too**
- **Nano affects properties**
  - **Chemical, optical, electrical, and other physical properties change**
- **We cannot assume that 'new' nano-materials will be safe**



Food System Nanomaterials

- **Packaging, processing use will impact the environment including waste water treatment, landfill effluent and environmental life forms**
- **New food nanomaterials could affect metabolism in the body**
- ***Current concern*: effect of more effective delivery of phyto or other nutrients by encapsulation could lead to overdoses with compounds whose metabolism we do not understand well**

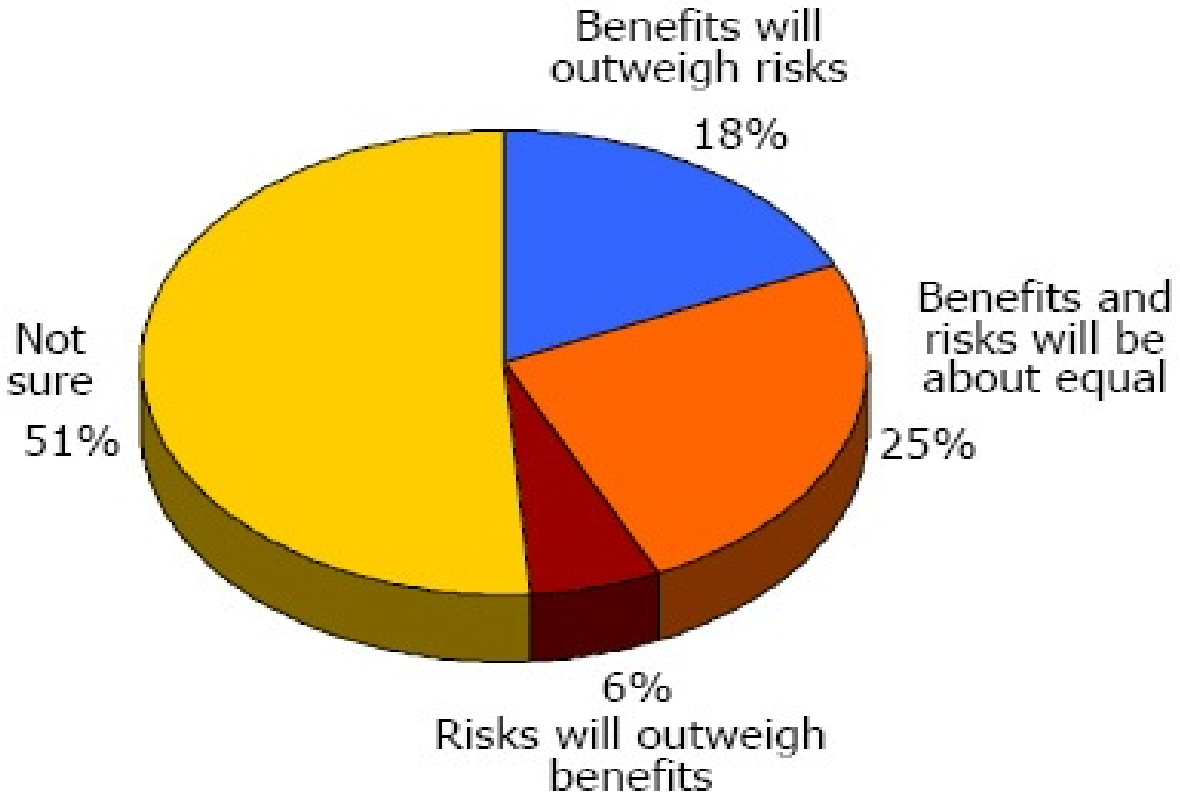


Risk Perception

- **Hazard + outrage factors = Attitudes**
- **Outrage factors reflect values and include**
  - **Voluntary or imposed**
  - **Known or unknown effects**
  - **controllable vs. uncontrollable**
  - **Immediate effect vs. delayed**
  - **Low risk to future generations vs. high risk**
  - **Scientifically understood vs. not**
  - **Ethical vs. unethical**



Initial Impression Of Risks And Benefits Of Nanotechnology



***Hart et al., 2007*: Benefits vs. Risk**

Reducing Perceived Risk

- **Technology provides a strong consumer benefit**
- **Food and regulatory system practice transparency**
- **Food companies and regulatory system offer consumers ‘choice’**



FDA Perspective

- **Does not regulate foods based on technology used**
  -Use statutory class- food additive, drug
- **Food ingredient (and hence food) has to be substantially different to receive an identifying label e.g. irradiated foods**
- **FDA has *pre-market* approval authority for food additives but only *post market* review for cosmetics and diet supplements**



FDA and Nanotechnology

- **Ability to regulate use across cosmetics, dietary supplements and GRAS ingredients is limited (nano can be used in all three)**
- **FDA has been advised to**
  - **seek pre-market approval for cosmetics and diet supplements**
  - **Increase level of risk research**
  - **Develop nanotechology labeling guidelines for voluntary and mandatory use**



Questions?

Type them in your chat window

Conclusions

- **Nanotechnology is part of our future**
- **Developments in nanotechnology have the potential to benefit society**
- **Nanotechnology use, including that in food, does entail some risk**
- **Industry and regulatory agencies need to practice transparency and offer consumers choice**



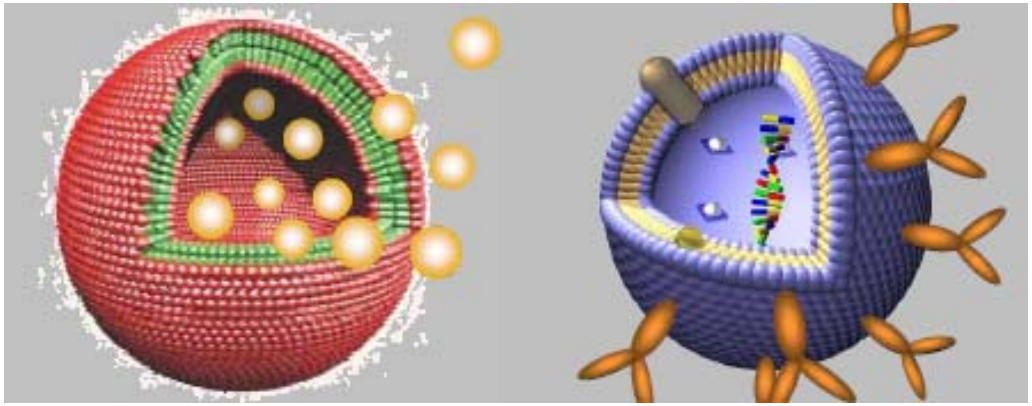
Thank You!

- **We will compile questions submitted and post answers on the NACK website**
- **Websites :**

  www.nano4me.org

  www.nanotechproject.org

  www.pewtrusts.org



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FOOD SCIENCE @ PENN STATE

Science Groups

- Chemistry
- Microbiology
- Engineering
- Nutrition

Impact Groups

- Ingredients as Materials
- Food Safety
- Food Manufacturing
- Family Food Systems

- Confectionary Products
- Dairy Products
- Plant & Fungal Products

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How Can We Better Serve You?

Whether you are joining us live or watching the recorded version of this webinar, please take 1 minute to provide your feedback and suggestions.

http://questionpro.com/t/ABkVkZHP3X



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NACK's Webinar

Applications in Nanotechnology: Nanoscale Science & Technology for Food

You may find additional resources and free curriculum for nanotechnology at www.nano4me.org and click Educators.



Upcoming NACK Workshops

Aug.	9-12	Train the Trainer (213-214)
Oct.	4-7	Train the Trainer (211-212)
Nov.	16-18	Hands on Intro to Nano Workshop



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NACK Upcoming Webinars

Sept 24: Nano Applications in Today's World

Oct 22: Building a NanoLab: Equipment and Program Overview

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Kristen Robinson at kjrobinson@engr.psu.edu



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