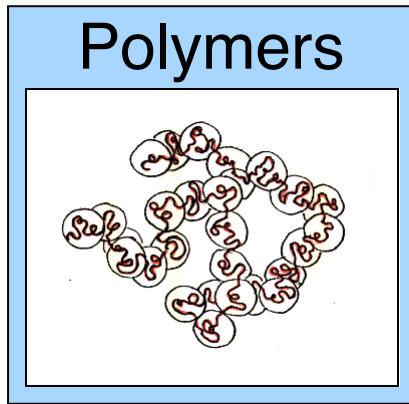


# Nanotechnologie in der Lebensmittelindustrie

Peter Schurtenberger

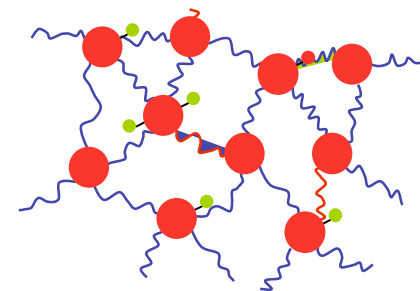
Department of Physics and Fribourg Center for Nanomaterials (FriMat)  
University of Fribourg  
1700 Fribourg, Switzerland  
[www.unifr.ch/physics/mm/](http://www.unifr.ch/physics/mm/)

# Soft Condensed Matter

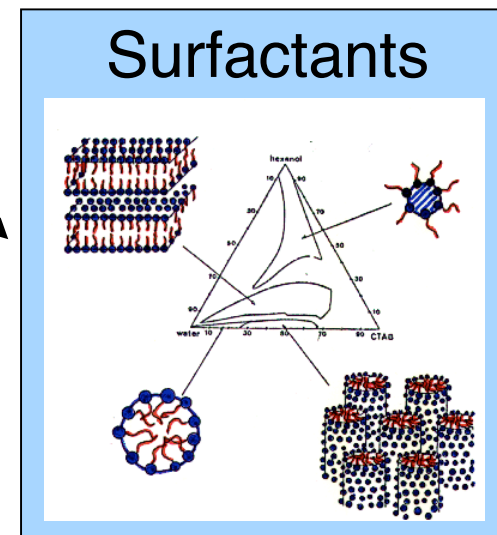
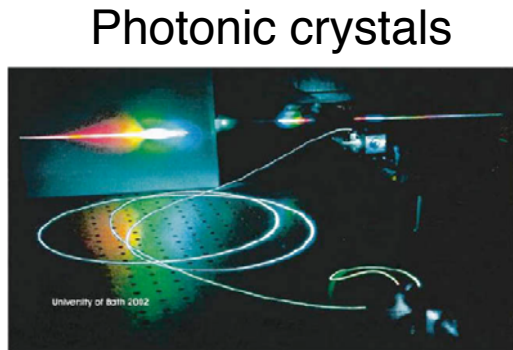
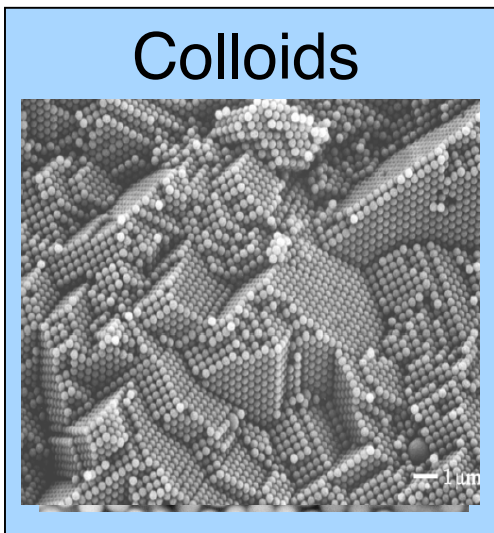
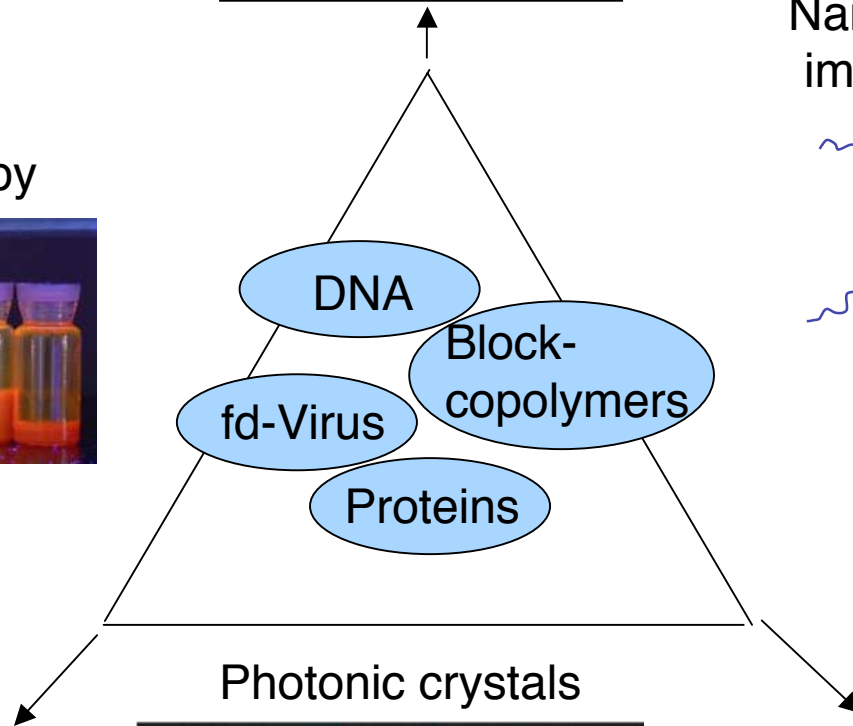


# The Magic Triangle in Soft Nanotechnology

Nanocomposites with improved properties

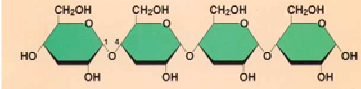


Quantum dots for diagnostics and therapy

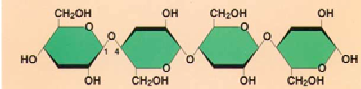


# Soft Condensed Matter

## Polymers

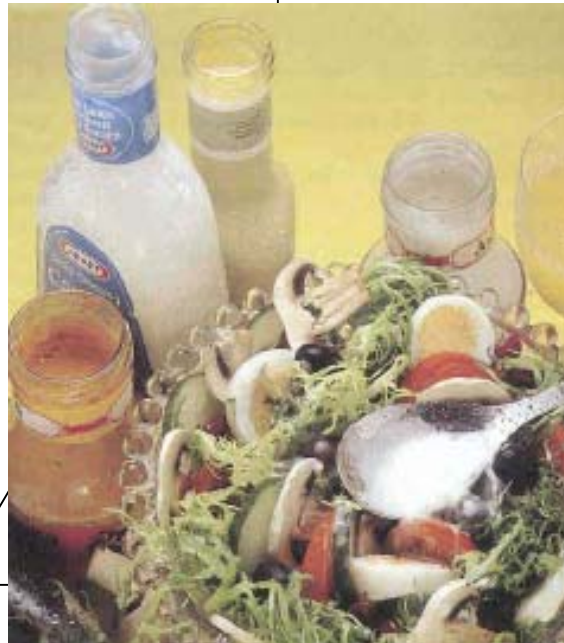


(b) Starch: 1-4 linkage of  $\alpha$  glucose



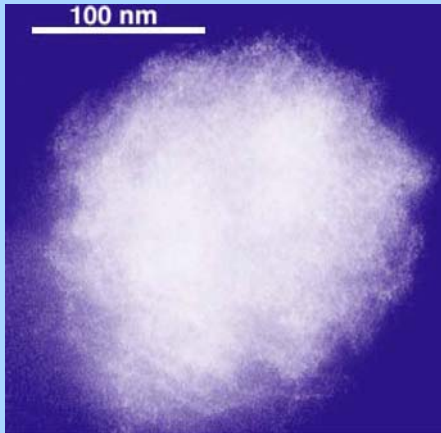
(c) Cellulose: 1-4 linkage of  $\beta$  glucose

# The Magic Triangle in Soft Nanotechnology



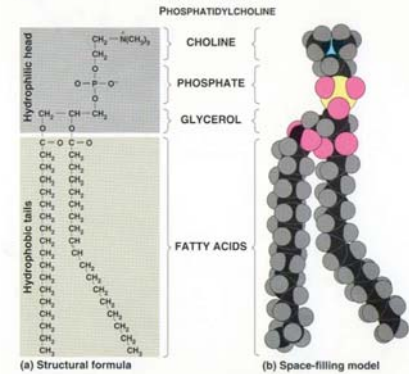
## Colloids

100 nm



## Surfactants

Figure 5.12 The structure of a phospholipid



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# Nanotechnology and Food ?

## Current FDA Definition for Nanotechnology

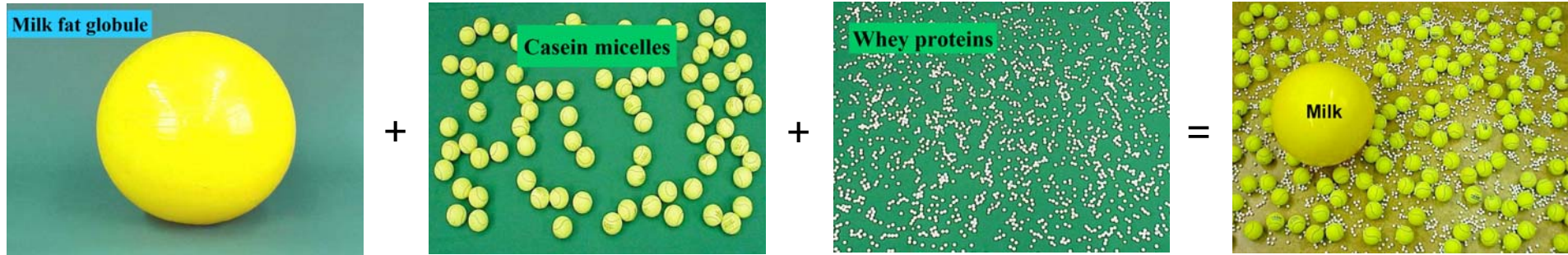
([www.FDA.GOV/NANOTECHNOLOGY](http://www.FDA.GOV/NANOTECHNOLOGY))

- FDA calls it "nanotechnology" only if it involves **all** of the following:
  - 1. Research and technology development, or products regulated by FDA, that are at the atomic, molecular or macromolecular levels, and where at least one dimension, that affects the functional behavior of the product, is in the length scale range of approximately 1-100 nanometers.
  - 2. Creating and using structures, devices and systems that have novel properties and functions because of their small and/or intermediate size.
  - 3. Ability to control or manipulate at the atomic scale.

Foods: We are already dealing with nanostructured raw materials and ingredients obtainable from biological systems

# Food - naturally occurring nanoparticles

A colloid scientist's view of milk:



## Colloids in milk



Another example: Sauce Béarnaise

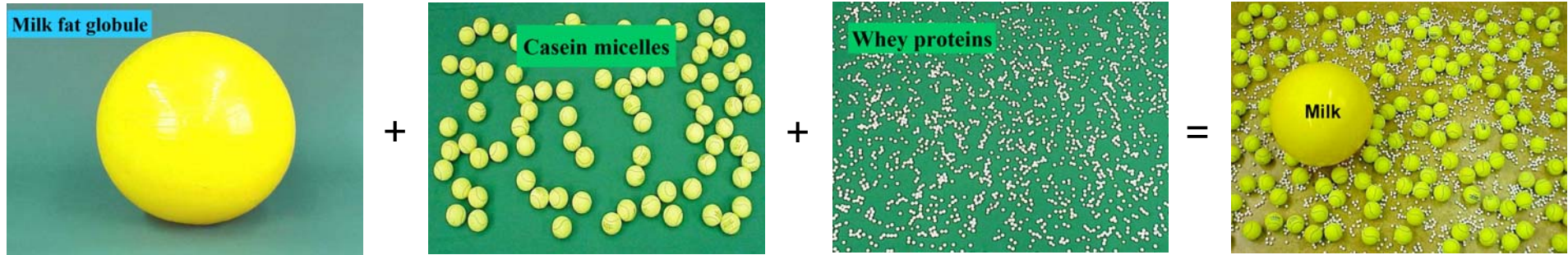


*Sol/gel for a King: Sauce Béarnaise, created in honour of Henry IV of France*

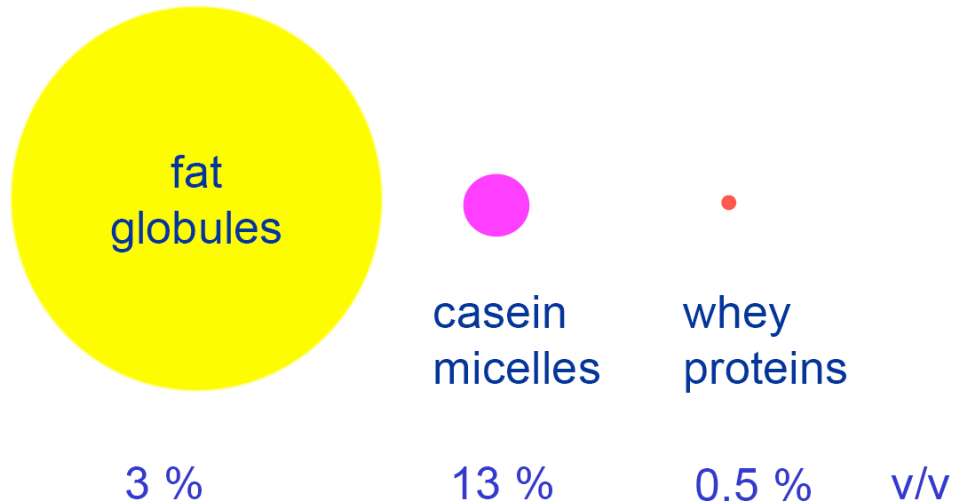


# Food - naturally occurring nanoparticles

A colloid scientist's view of milk:



## Colloids in milk

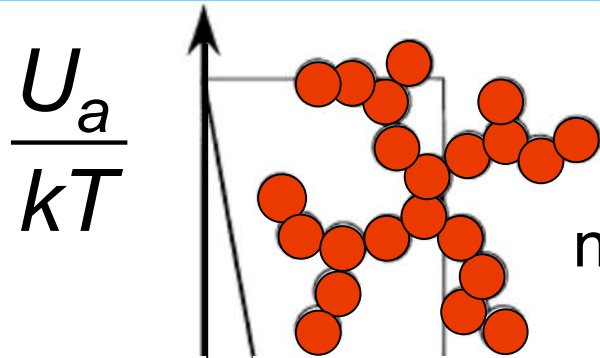


Another example: Sauce Béarnaise



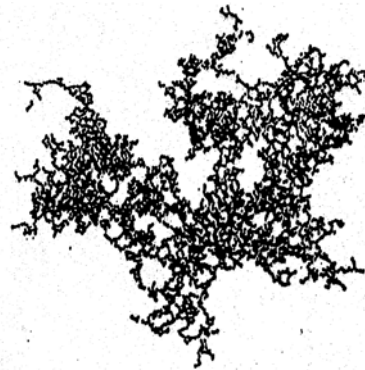
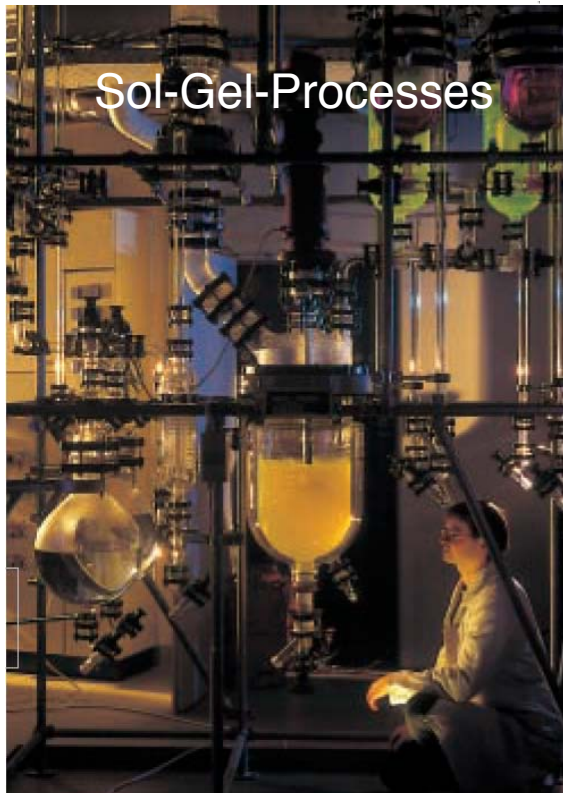
*Sol/gel for a King: Sauce Béarnaise, created in honour of Henry IV of France*

# Ceramics and yogurt formation

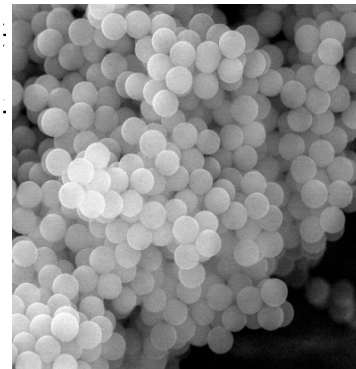


R. Mezzenga et al., Nature Materials (2005)

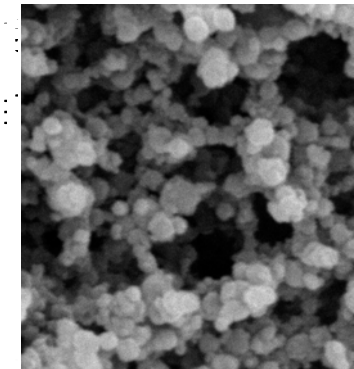
non-equilibrium solid states



fractal gels



Gel of 30% ca. 500nm  $\text{SiO}_2$  particles, H. Wyss



Yoghurt, P. Aichinger, Nestlé

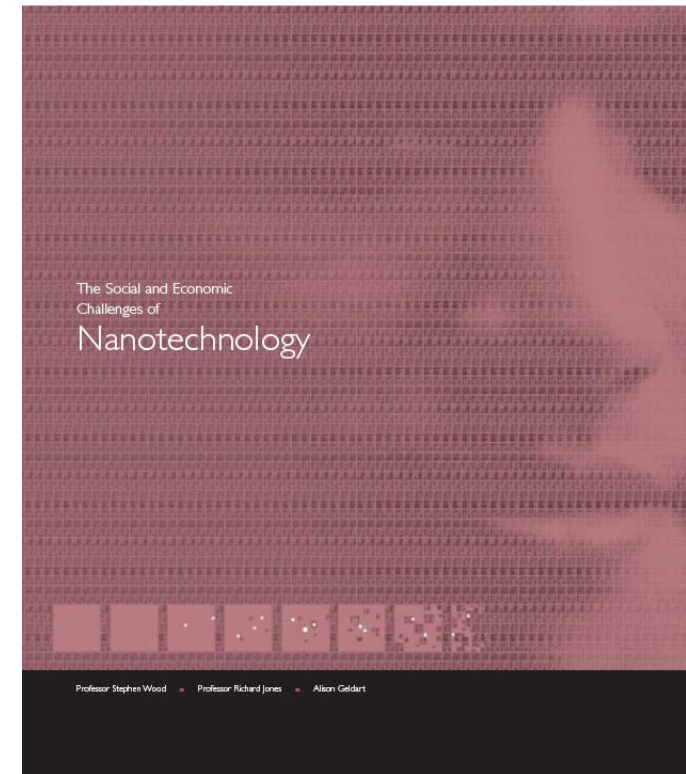
# Nanotechnology and Food - “Functional Food”



## Nanotechnology in food

Method of delivering molecules to specific targets

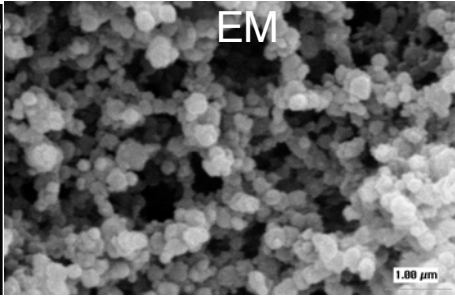
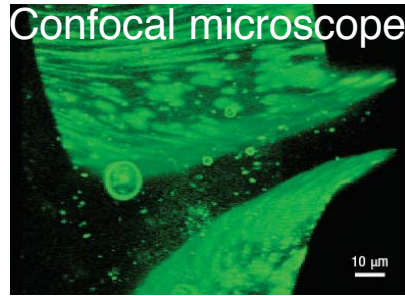
- Development of novel foods which can deliver specific nutrients or drugs to the consumer
- Nanotechnology for improved flavour delivery: encapsulating flavour particles in nanoparticles to protect them from the environment until they are released, thereby maintaining freshness.



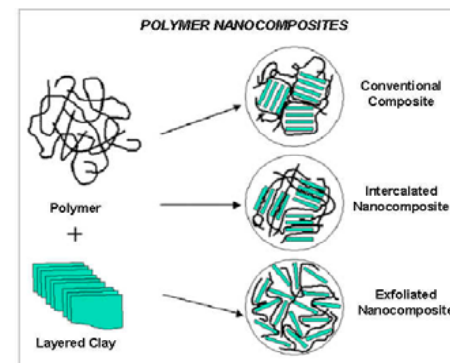
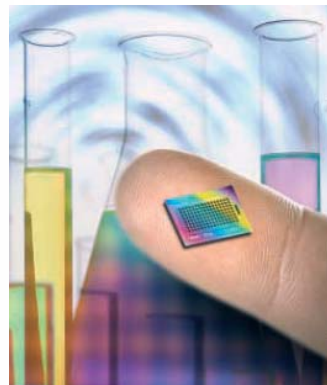
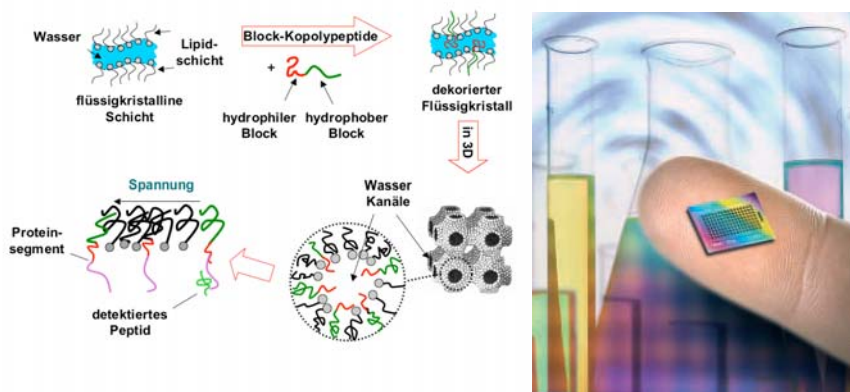


# Nanotechnology and Food - Key Areas

## Nanotools



## Nanotechnology and Food



## Nanodiagnosics

## Nanomaterials

# Nanotechnology and Food - Key Areas

Nanotechnology can be applied in: [production](#), [processing](#), [safety](#) and [packaging](#) of food.

Examples:

- A nano-composite coating process should improve food packaging by placing anti-microbial agents directly on the surface of the coated film.
- Nano-composites could increase or decrease gas permeability of different fillers as is needed for different products. They can also improve the mechanical and heat-resistance properties and lower the oxygen transmission rate.
- Research is being performed to apply nanotechnology to the detection of chemical and biological substances for sensing biochemical changes in foods.

# Nanotechnology and Food - Benefits and Risks



**NanoForum.org**

European Nanotechnology Gateway

4th  
NanoForum  
Report:

Benefits, Risks, Ethical, Legal  
and Social Aspects of  
NANOTECHNOLOGY

Part 2: Potential Benefits of  
Nanotechnology Currently  
under Debate

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2nd Edition - October 2005

[www.FDA.GOV/NANOTECHNOLOGY](http://www.FDA.GOV/NANOTECHNOLOGY)

## Historically...

- FDA has approved many products with particulate materials in the nanosize range.
- Most drugs are expected to go through a nanosize phase during the process of absorption in the body.
- There have been no safety concerns reported in the past because of particle size.



# Nanotechnology and Food - Risk Assessment

## Safety Considerations

([www.FDA.GOV/NANOTECHNOLOGY](http://www.FDA.GOV/NANOTECHNOLOGY))

As particle size gets smaller, there may be size-specific effects on activity, such as:

- Will nanoparticles gain access to tissues and cells that normally would be bypassed by larger particles?
- Once nanoparticles enter tissues, how long do they remain there?
- How are they cleared from tissues and blood?
- If nanoparticles enter cells, what effects do they have on cellular and tissue functions (transient and/or permanent)?
- Might there be different effects in different cells types?

How relevant are these for food?

# Nanotechnology and Food - Risk Assessment

Prof. R. Jones, Sheffield:



... many or even most food ingredients are naturally nanostructured or contain nanoparticles, if you don't want to ingest nanoparticles, you should stop drinking milk.

... all food is nano-scale by the time it reaches the bloodstream

Food additives: ... the usual state they arrive at the food manufacturer, and in which the consumer eats them, isn't in large lumps, but in solution - i.e. about as nanodispersed as it is possible to get.