Food Safety
AUTHORITY OF IRELAND

# Nanotechnology and Food

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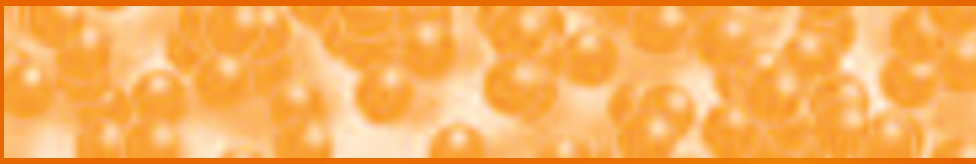
**Nanotechnology involves the use of very small particles (nanoparticles) that have an average size, in at least one dimension, of one hundred nanometres (nm) or less. A nanometre is one billionth of a metre.**

**The chemical and physical characteristics of nanomaterials can vary considerably from those of their larger counterparts, often turning an ordinary unreactive material into a highly reactive substance.**

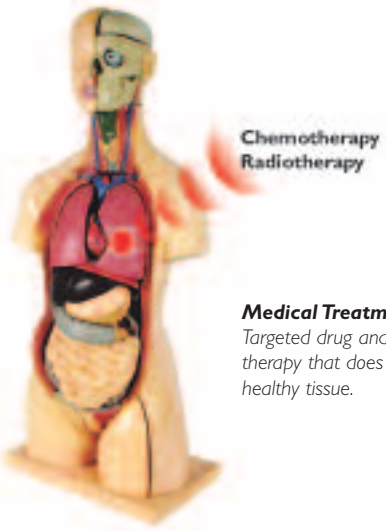


Though still an emerging science, nanotechnology has been used for some time in the production of goods such as cosmetics, and holds significant promise as a tool in the diagnosis and treatment of certain human illnesses. Despite the numerous benefits associated with nanotechnology, the interaction of nanoparticles with humans, animals and the environment has yet to be fully explored.

Nanotechnology is viewed by the food industry as a means of enhancing food safety and nutrient bioavailability, with some examples already on the market in certain parts of the world.

***Cosmetics***
*Sunscreens containing nanoparticles of zinc and titanium oxide are translucent.*

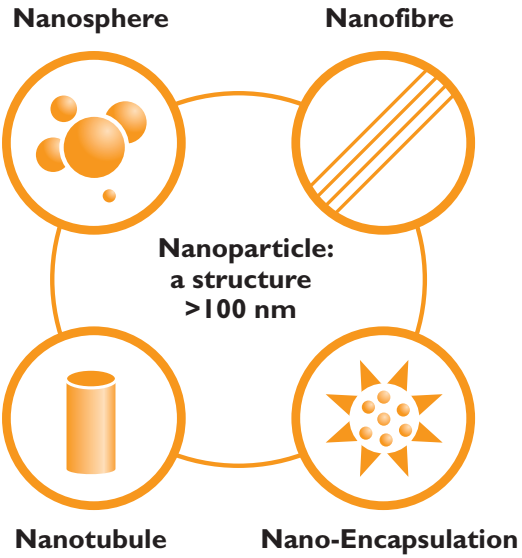
This information leaflet is designed to provide a brief and objective overview to inform stakeholders about nanotechnology and how it relates to our food in terms of its potential uses, safety and regulation.




***Medical Treatments***
*Targeted drug and radiation therapy that does not injure healthy tissue.*

## Nanoparticle Size

Nanoparticles are invisible to the human eye. At 100 nm or less, in at least one dimension, they are one thousand times smaller than the thickness of an average book page (approximately 100,000 nm), or one hundred times smaller than the diameter of a relatively fine human hair (approximately 10,000 nm).

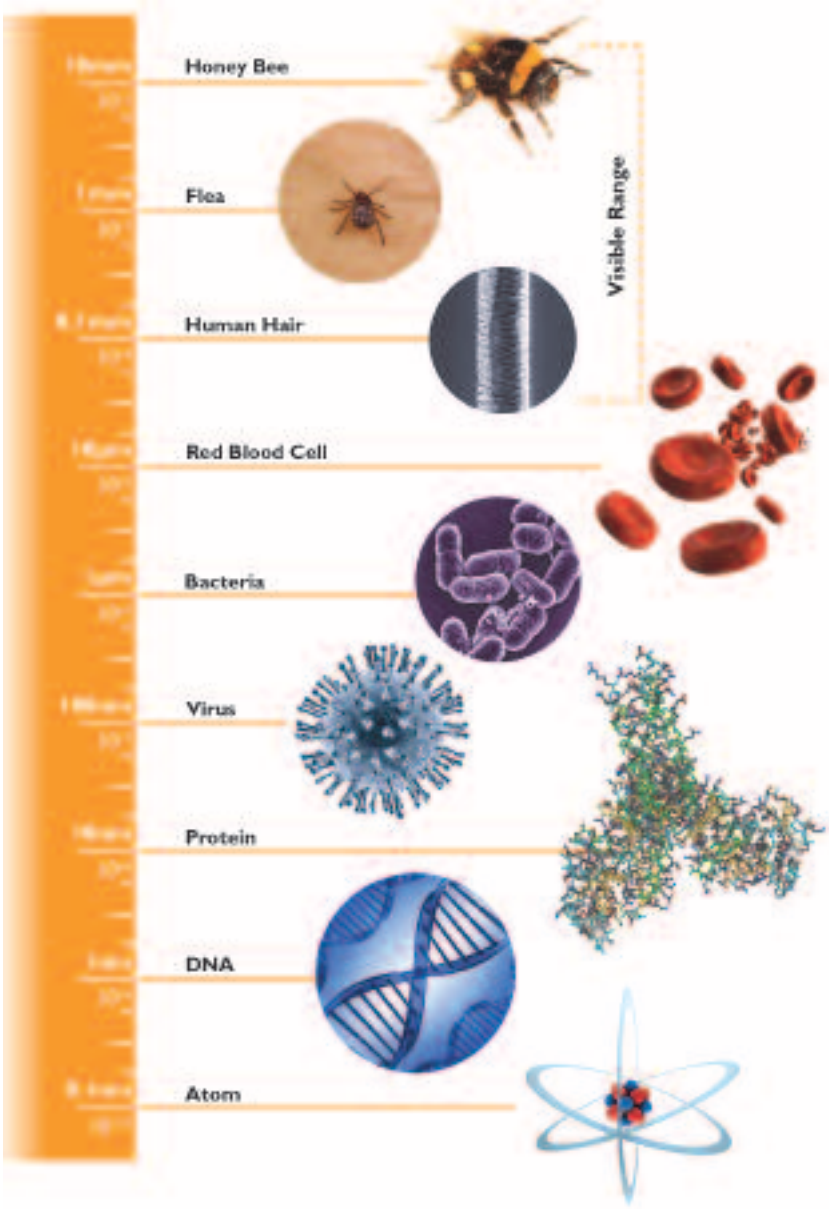



## Characteristics of Nanoparticles

Nanoparticles have a considerably greater surface area to mass ratio than their larger counterparts which can alter physical and chemical properties such as reactivity and surface charge, e.g. gold at the macro scale conducts electricity, is chemically unreactive and yellow in colour. In contrast, gold at the nanoscale is a semiconductor, highly reactive and varies in colour from pink to red or orange, depending on how small the particles are. The small dimensions of nanoparticles also means they can reach locations in the human body not normally accessible to larger counterparts. However, the full impact of nanoparticles and their novel properties on the health of humans, animals and the environment is not fully understood at this time.

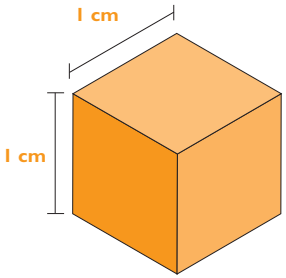
***Scratch Resistant Paint***

## Nanoparticle Scale

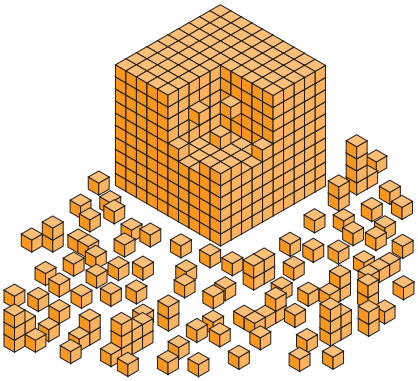


## Decreasing Particle Size Increases Surface Area

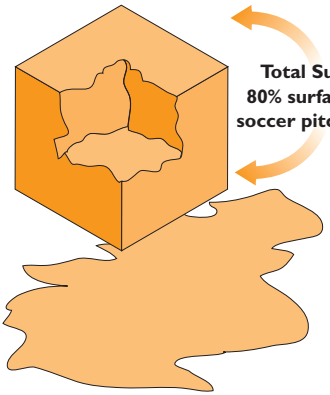
**Total Surface Area: 6 cm²**




**Total Surface Area: 60 cm²**
**(All 1mm cubes)**



**Total Surface Area: 60,000,000 cm²**
**(All 1nm cubes)**




## Nanoparticles in Food

Nanotechnology can be used in food production to enhance the taste, colour, flavour, texture and consistency of a variety of foods. Nanotechnology can also be used to improve the nutritional value of a food by boosting the bioavailability of certain nutrients.

Organic constituents such as proteins, carbohydrates and fats that are naturally present in food can vary in size from large polymers to less complex molecules in the nanoparticle range. Organic nanoparticles can also be manufactured for specific purposes such as the encapsulation of nutrients, which would improve their bioavailability, or mask an undesirable taste or odour. Some inorganic nanoparticles, including gold, silver and titanium are generally not natural constituents of food, but have a range of potential uses as additives and preservatives.

“ Nanotechnology can also be used to improve the nutritional value of a food by boosting the bioavailability of certain nutrients. ”

## Nanomaterials in Food Packaging

The packaging of the future may not just be a physical container or wrapping that protects food from the surrounding environment, but is likely to include multi-functional sensory and food safety enhancing characteristics.

Some of the potential benefits of “smart packaging” include:

- food contact materials with improved flexibility, gas barrier properties, temperature and moisture stability
- active food contact materials capable of releasing nanoscale antimicrobial compounds, antioxidants and/or flavours which would improve shelf-life or sensory characteristics such as flavour, odour etc
- intelligent food contact materials incorporating nanosensors to identify specific microbial and/or chemical contaminants and assist in product biosecurity and traceability
- biodegradable polymer-nanomaterial composites.

In November 2008, the EFSA Scientific Panel on Food Contact Materials, Enzymes, Flavourings and Processing Aids (CEF) adopted a positive safety opinion that concluded that titanium nitride nanoparticles at a level of 20 mg/kg in polyethylene terephthalate (PET) bottles, did not migrate and therefore were not a toxicological risk for food.

***Water purification***

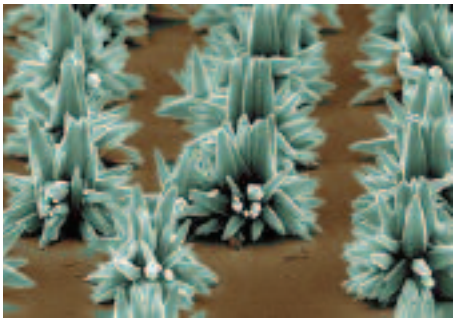
## Water Purification

Maintenance of acceptable water quality is an increasing challenge in many parts of the world with chemical and microbial pollutants from a variety of sources contaminating municipal and local water supplies alike. Aluminium oxide nanofibres are being used in some parts of the world to remove bacteria and viruses from water, while lanthanum and iron oxide nanoparticles are used to remove phosphates and arsenic, respectively.

## Safety of Nanomaterials in Food

Human exposure to nanoparticles can occur through skin contact, inhalation or consumption of food that contains nanoparticles. Research and development into the potential benefits of nanotechnology continues at pace. However, deficiencies in our knowledge on the fate and interaction of nanoparticles within the human body means that much work remains to be done to establish the safety of this technology. In addition to addressing the information gaps that exist, the suitability of the traditional risk assessment approach in assessing the safety of foods made using nanotechnology must also be examined.

Many of the organic nanoparticles found in food are unlikely to have direct safety consequences for humans, though their role in improving nutrient bioavailability may necessitate a re-examination of safety parameters such as acceptable daily intakes (ADI) and recommended daily allowances (RDA). In contrast, the use of inorganic nanomaterials such as silver and titanium, whether directly in food or in food contact materials, will require rigorous safety assessment. Such inorganic nanoparticles are likely to be more reactive than organic counterparts while their interactions and fate within the human body are, as yet, largely unknown.



***Cluster of nano-silver on a food preparation surface***
*Nano-silver can be used as an anti-bacterial agent in food storage and on preparation surfaces.*

## EU Regulation of Nanotechnology in Food Production and Packaging

The use of nanoparticles in food production is not specifically covered in either EU or national legislation, though it is accepted that the existing regulatory framework provides sufficient safeguard. General food law (Regulation (EC) No 178/2002) stipulates that 'unsafe food' cannot be placed on the market. In accordance with the novel food (Regulation (EC) No 258/97), a food containing nano-ingredients, or produced using nanotechnology, may be considered a novel food and therefore require a safety assessment prior to marketing. Food additives must be assessed for safety by the European Food Safety Authority (EFSA), before being added to the list of permitted additives. Where an authorised additive is prepared in a different form, e.g. nano-size, the safety of that product must be re-assessed and a new authorisation may be required.

Regulatory control of food contact materials derives mainly from the EU Regulation on materials and articles in contact with food (Regulation (EC) No 1935/2004), while a Commission Regulation on recycled plastic food contact materials (Regulation (EC) No 282/2008) requires the authorisation of

***Smart Packaging***

recycling processes following a risk assessment by EFSA. The EU Commission is also developing further legislation that would require an EFSA safety assessment of active and intelligent food contact materials prior to their use.

> "a food containing nano-ingredients, or produced using nanotechnology, may be considered a novel food and therefore require a safety assessment prior to marketing"

Though current EU and national legislation is considered sufficient to regulate nanotechnology and its potential uses in food production, further legislative options are being considered at EU level with a view to closing off any possible regulatory gaps.

## Nano-foods on the Market

At least one food supplement incorporating nano-encapsulation is available on the Irish market, while EFSA recently issued a positive opinion on the safety of nanoparticulate titanium nitride for use in the making of a certain type of bottle. The customs services in Finland blocked the import of a food supplement in 2008 based on product claims of increased bioavailability of Vitamin C through nano-encapsulation. The Finnish authorities, in consultation with other Member States and the Commission deemed this product to be a novel food which requires a safety assessment and authorisation prior to marketing. However, examples of food ingredients and food supplements incorporating nanotechnology are available through internet trading which is more difficult to regulate.

***Stronger Sports Equipment***
*Tennis rackets made from carbon nanotube-infused graphite are strong but light.*

## Published Reports on Nanotechnology in Food Production

A number of published reports provide a valuable source of detailed information on nanotechnology and its use in food production:

1. **Food Safety Authority of Ireland** (2008) Relevance for Food Safety of Applications of Nanotechnology in the Food and Feed Industry
   http://www.fsai.ie/publications/reports/Nanotechnology_report.pdf
2. **US FDA Nanotechnology Task Force** (2007) Nanotechnology
   http://www.fda.gov/nanotechnology/taskforce/report2007.pdf
3. **UK Royal Society** (2004) Nanoscience and Nanotechnologies: Opportunities and Uncertainties (2004)
   http://www.nanotec.org.uk/finalReport.htm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