

## New Opportunities for the Development of Education at the Technical University of Liberec

Specific objective A2: Development in the field of distance learning, online learning and blended learning

**NPO\_TUL\_MSMT-16598/2022**



## **KNT\_TNA\_Risks of nanomaterials**

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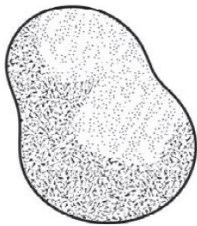


**CZECH  
RECOVERY  
PLAN**

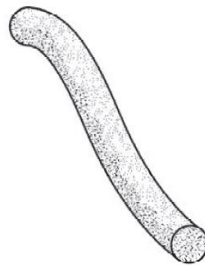
**MSMT**  
MINISTRY OF EDUCATION,  
YOUTH AND SPORTS

# Nanomaterials

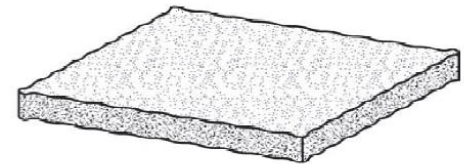
- Nanomaterials are relatively new, not yet fully explored materials that are used in many industries
- In general, nanomaterials are those materials that have at least one dimension at the nanoscale



Nanoparticles  
Three dimensions at the  
nanoscale



Nanofiber  
Two dimensions at the  
nanoscale

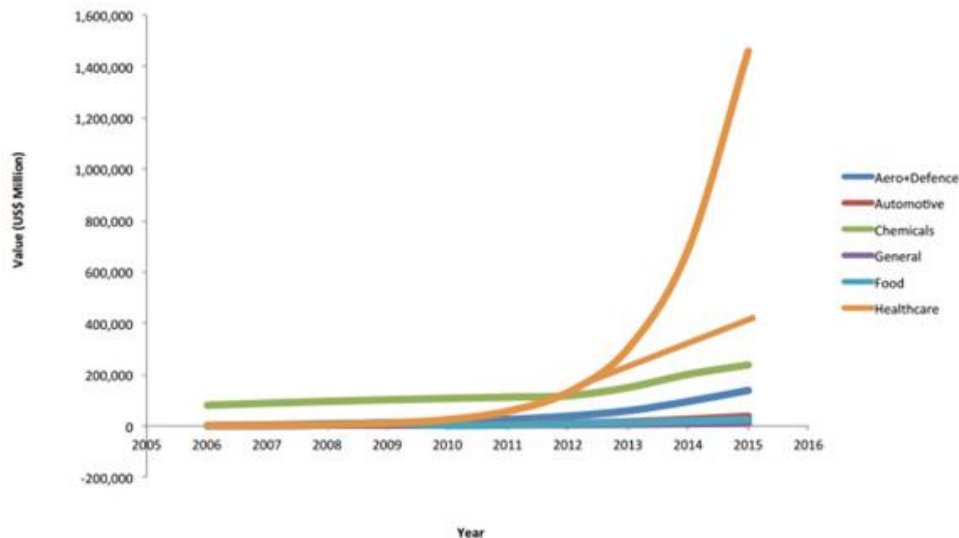


Nanoplate  
One dimension at the  
nanoscale

# Production of nanomaterials

- The global nanotechnology market is growing every year
- Nanotechnologies are used mainly in medicine, but they are also beginning to be used in the automotive industry, food industry,...

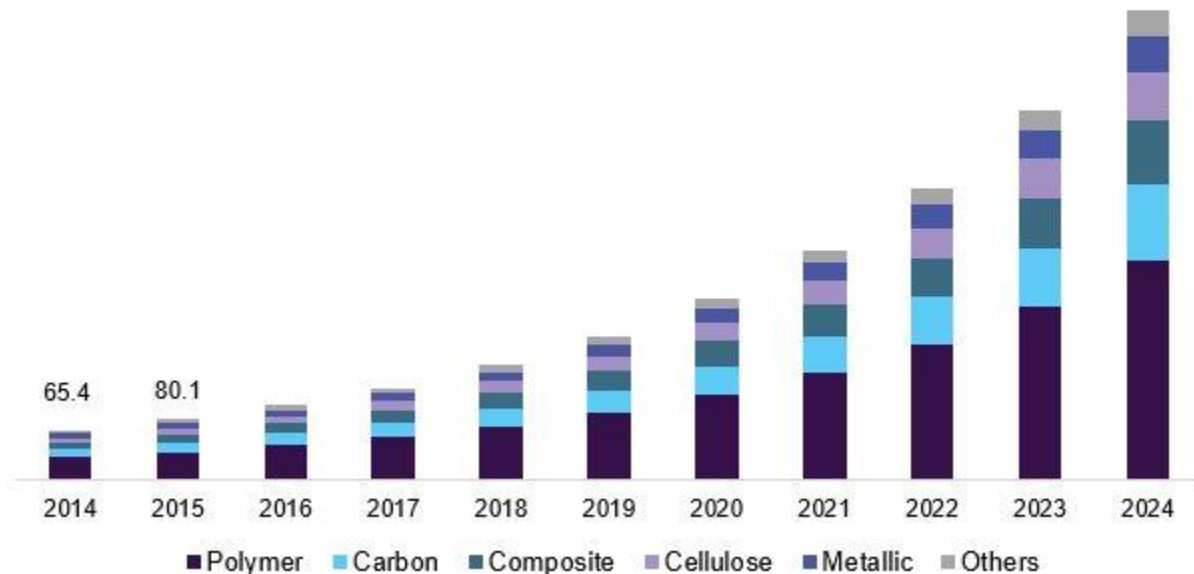
Nanotechnology Market Evolution 2006-15



# Production of nanomaterials

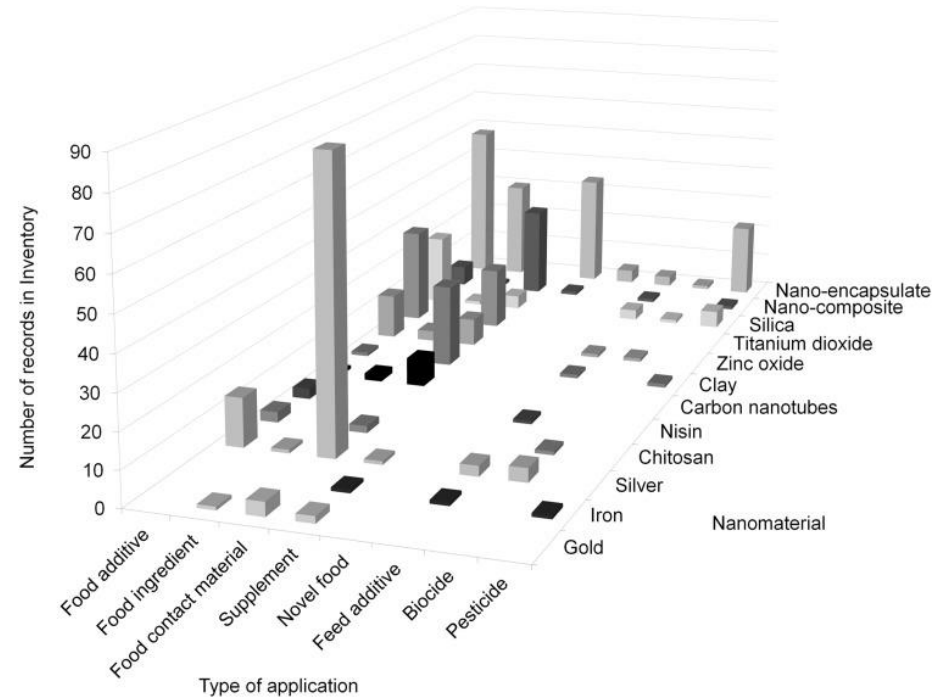
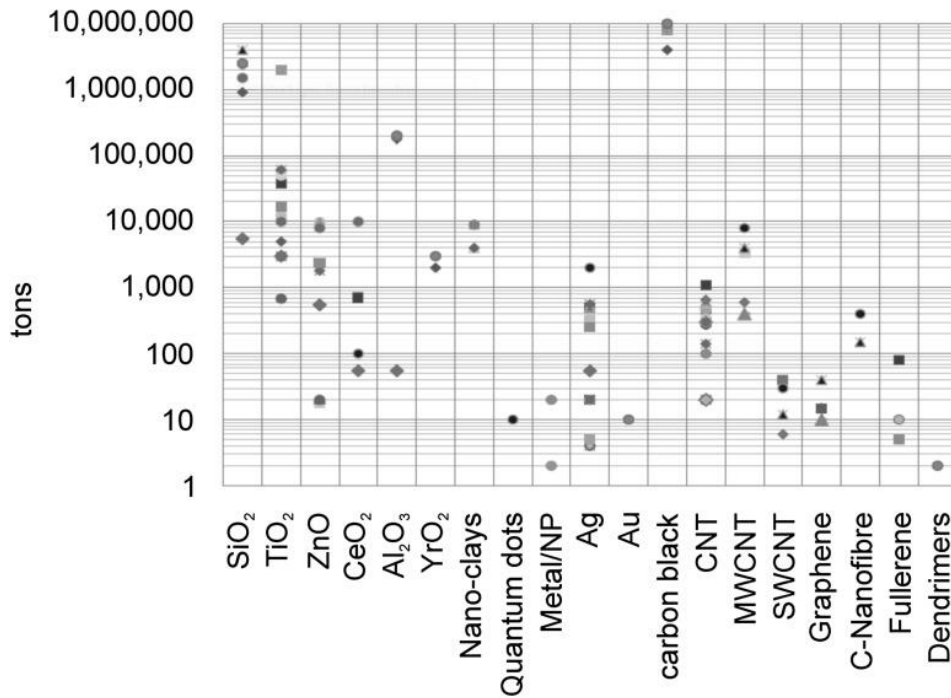
- The world market for nanotechnology is growing every year

**U.S nanofibers market size, by product, 2014 - 2024 (USD Million)**



# Production of nanomaterials

production of nanomaterials (up to 2010)



# Risks

- Why is the potential risk of nanomaterials being addressed?
- All materials, including water, can be toxic to the human body
- It depends on the amount and circumstances of the exposure
- The risk of nanomaterials lies primarily in their size and large specific surface area
- Thus, nano-sized materials can be toxic, even if the same micro-dimensional materials are not toxic

# Risks

- However, in addition to size, other properties of nanomaterials also affect toxicity, they are:
  - Chemical composition
  - Shape
  - Surface structure
  - Surface charge
  - Aggregation
  - Solubility
  - Functional groups



# Risks

- The large number of variables affecting toxicity means that it is difficult to generalize the health risks associated with exposure to nanomaterials.
- Each new nanomaterial must be assessed individually and all material properties must be taken into account
- The field examining the health risks of the production and use of nanomaterials is called nanotoxicology



# Exposure

- A phenomenon in which an organism is exposed to a given substance
- The following factors play a role in exposure:
  - Exposure medium
  - Particle shape
  - Batch of particles
  - Exposure time
- These factors determine whether and where a given particle penetrates

# Sources of nanoparticles

- We distinguish two types of nanoparticle sources
  - Particles produced in a targeted manner
  - Particles produced inadvertently
- Nanoparticles produced inadvertently are a by-product of a process, such as emissions from engines



# Penetration into the body

- Nanoparticles can enter to the body in several ways:
  - By inhalation
  - Swallowing
  - Skin absorption
  - Injection
- However, nanomaterials can also be released from pre-implanted materials into living tissue

# Filtration of nanoparticles

- If nanoparticles enter to the body, they can pass through biological barriers
- The cell membrane is able to capture particles up to 6 nm
- The blood-brain barrier filters particles up to 35 nm
- The renal system of the kidneys is able to capture particles in the range of 8-12 nm
- The dermal barrier of the skin captures particles measuring 20-30 nm
- The gastric mucosa traps particles larger than 500 nm

# Effect on health

- Health and environmental risks have been demonstrated for a number of manufactured nanomaterials

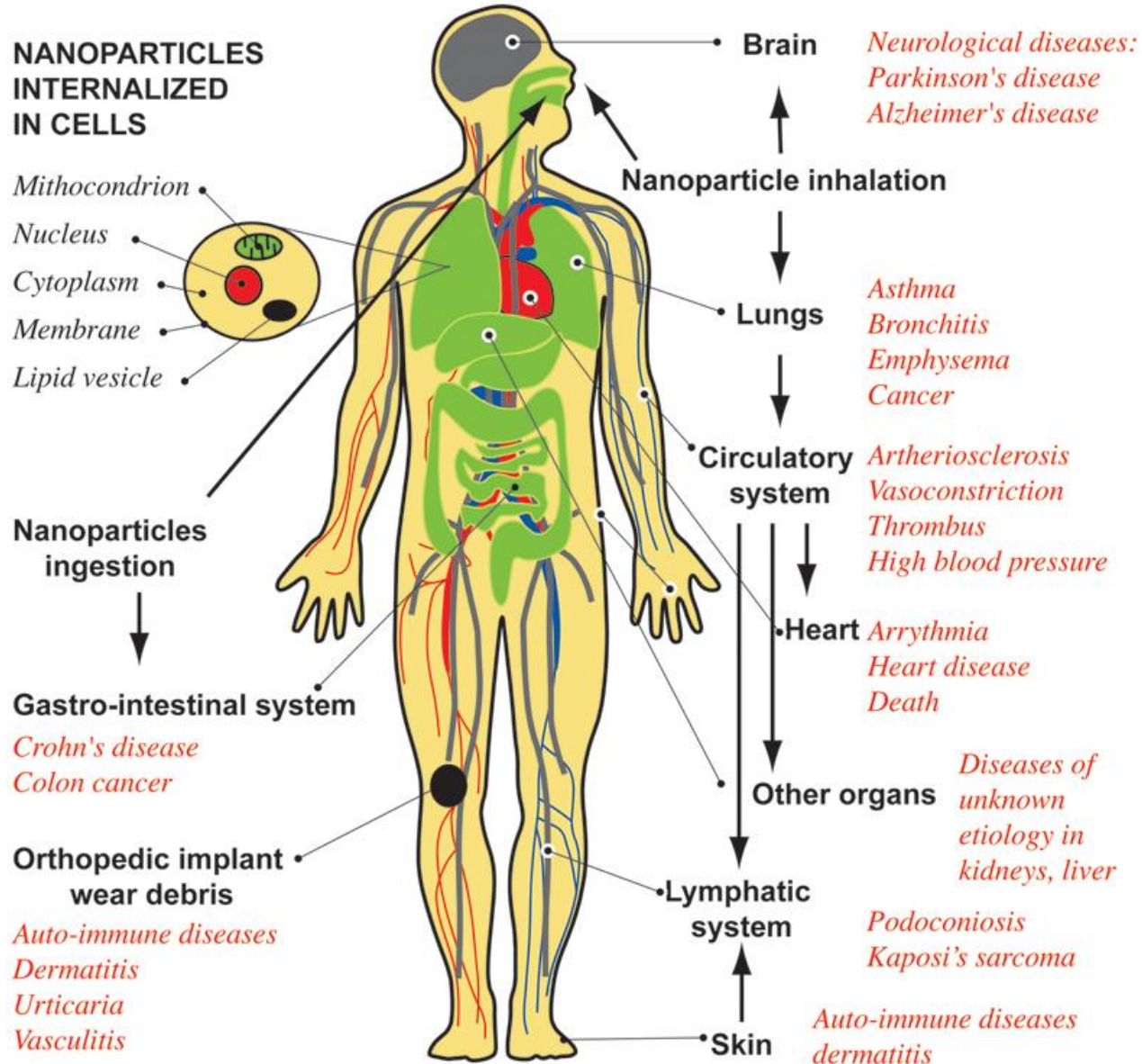
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<b>Type of nanomaterial</b>	<b>Potential risk</b>
Carbon nanomaterials	Pneumonia, fibrosis, granuloma
Carbon, silver and gold nanoparticles	Distribution to other organs, including the central nervous system
Quantum dots, carbon nanoparticles, TiO <sub>2</sub> nanoparticles	Skin penetration
MnO <sub>2</sub> , TiO <sub>2</sub> , and carbon nanoparticles	Penetration into the brain through olfactory neurons

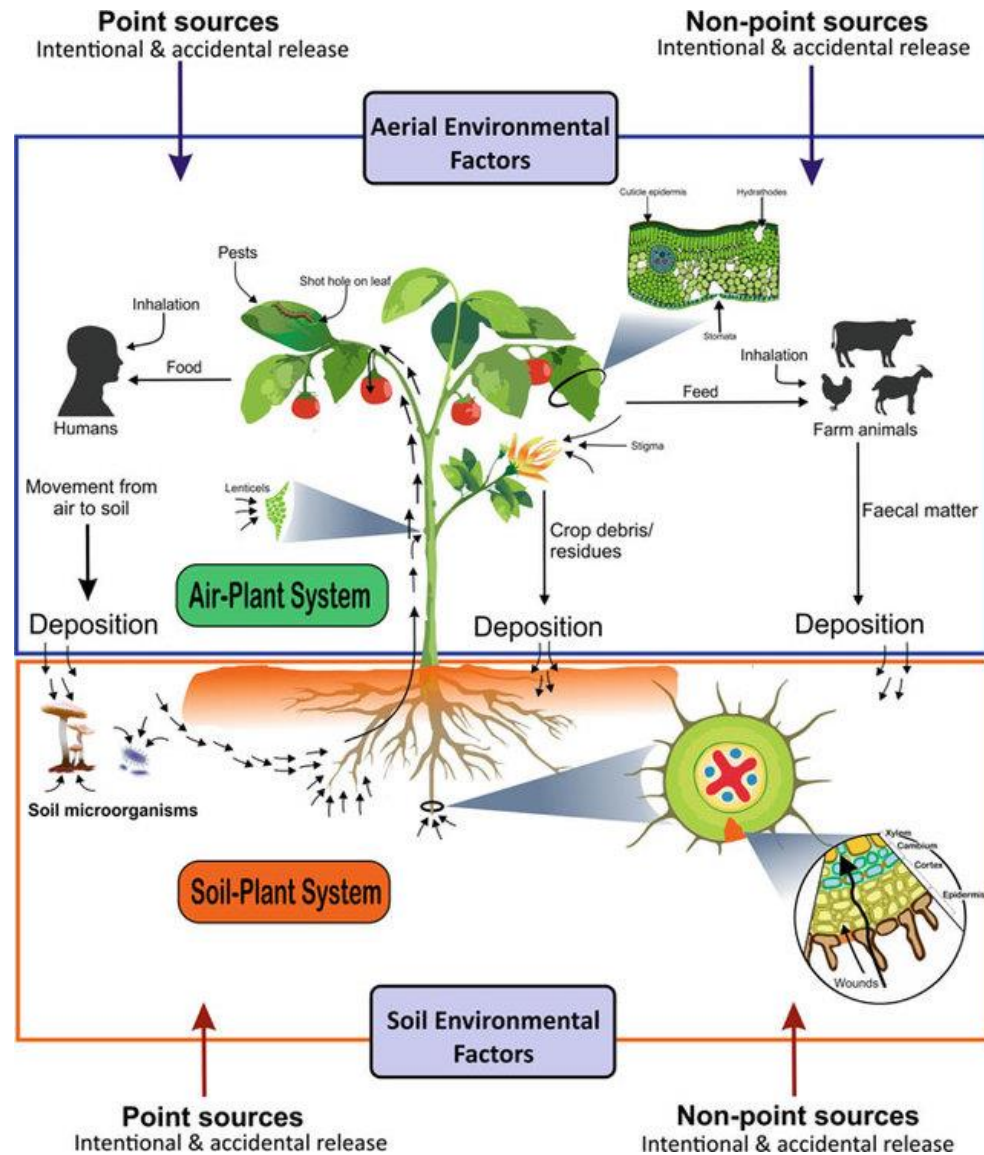
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# DISEASES ASSOCIATED TO NANOPARTICLE EXPOSURE

C. Buzea, I. Pacheco, & K. Robbie, *Nanomaterials and nanoparticles: Sources and toxicity, Biointerphases 2 (2007) MR17-MR71*



# Effect on environment



Thank you for your attention!



# TEST

- What properties affect the toxicity of nanomaterials?
- What factors determine where particles penetrate?
- What sources of nanoparticles do we distinguish?
- How can nanoparticles penetrate the body?