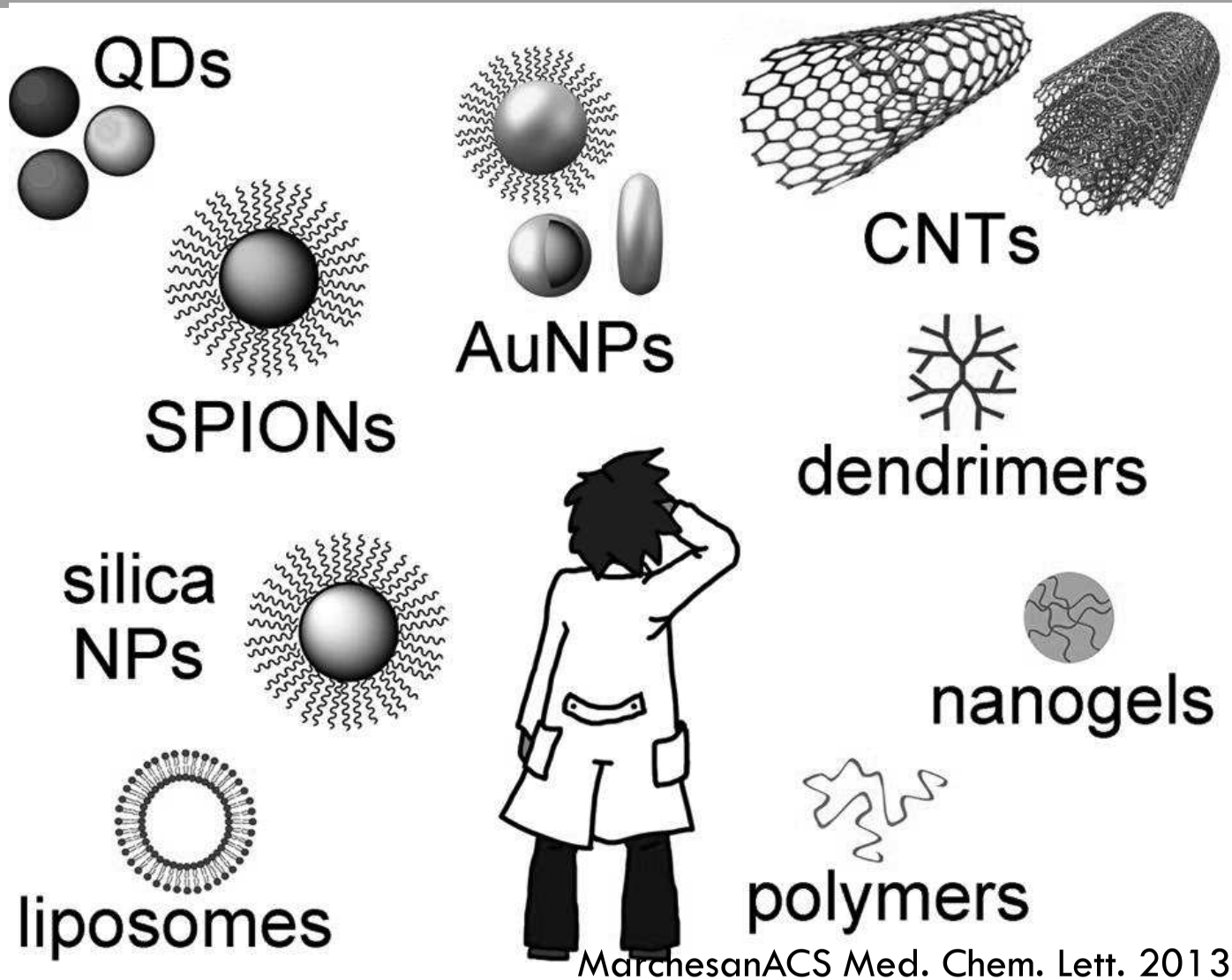
Inorganic Nanoparticles for medical applications

H. Hofman Powder Technology Laboratory

Outline

- Overview
- Why inorganic Nanoparticles for medical applications?
  - Needs from the medical side
  - Potential from the material side
- Examples:
  - Silica
  - QD
  - SPION
- Interaction of nanoparticles with tissue, cells, proteins

The medicinal chemist looks at the vast landscape of nanomaterials.



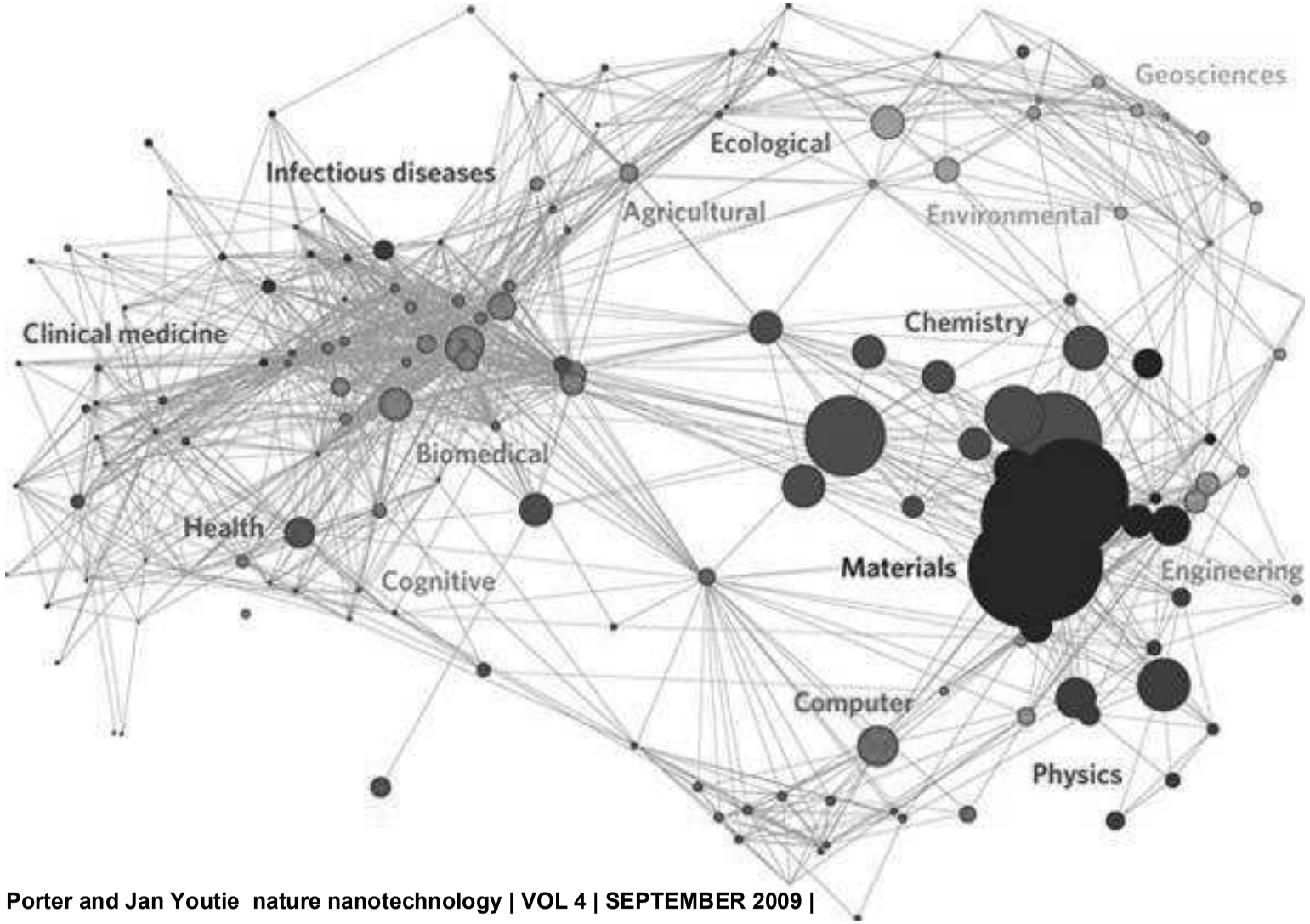
Marchesan ACS Med. Chem. Lett. 2013, 4, 147−149

Preliminary statements

- The landscape of nanomaterials for medicines is rich with options, and innovative solutions will likely be found in the wise combination of different components.
- The researchers who venture into this field should reach out to and partner with physicists, biologists, and clinicians to find creative solutions to these complex, multidisciplinary problems.

See also MarchesanACS Med. Chem. Lett. 2013, 4, 147−149

Interactions in Nanoscience and Nanotechnology



Alan L. Porter and Jan Youtie nature nanotechnology | VOL 4 | SEPTEMBER 2009 |

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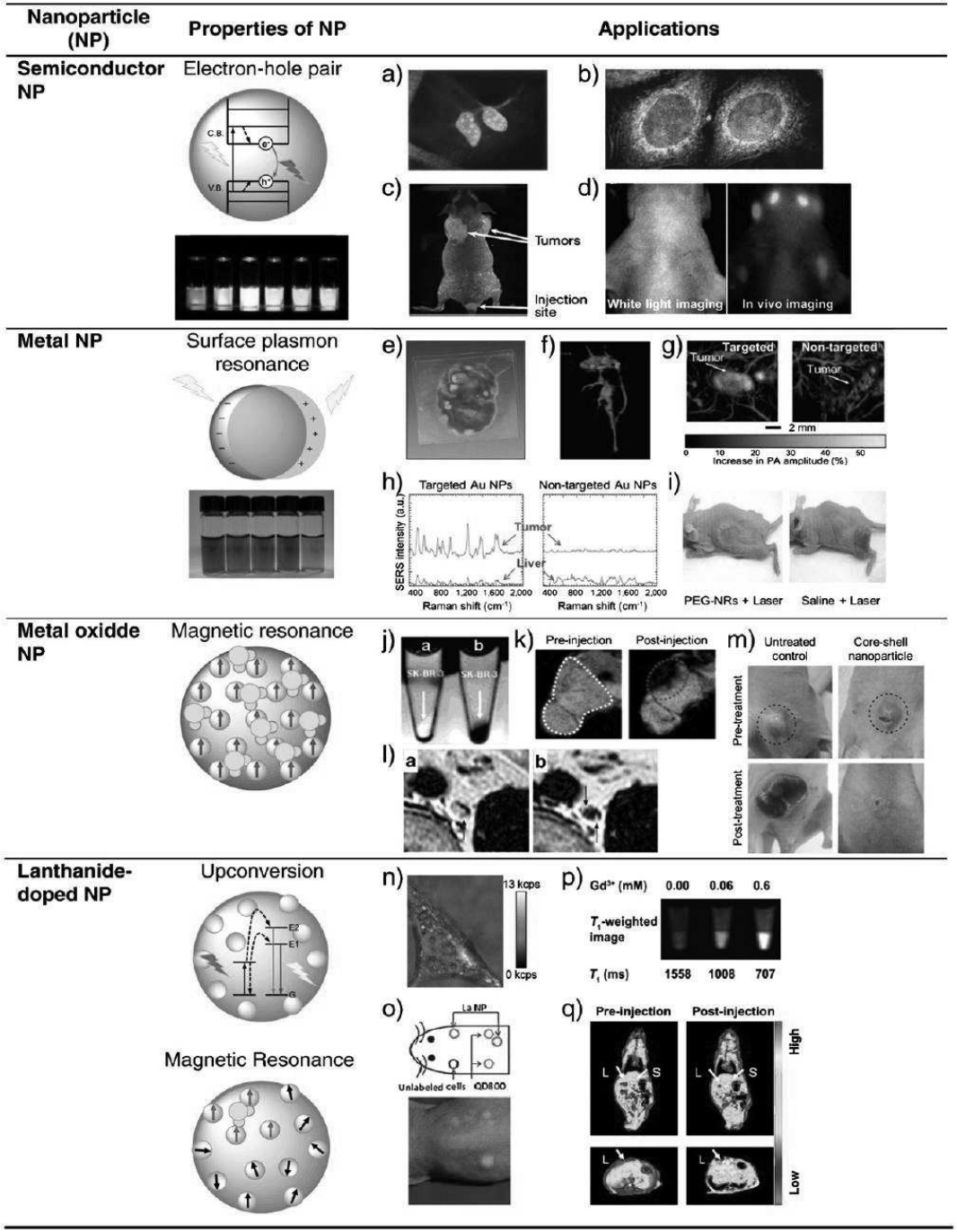
Bioanalysis and Diagnostics :

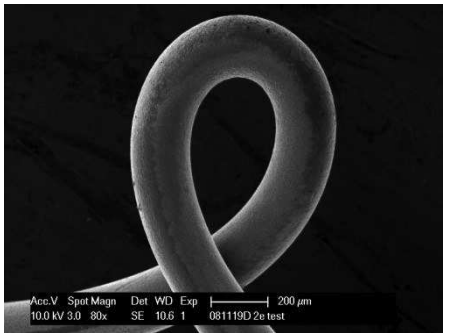
- New platforms include the use of nanoparticles (dots, bars, rods) as labels for biomolecules for separation and screening, as well as nanopore and nanoscale fluidic assay systems and self-assembling arrays of nanoparticles.
- For patient monitoring and diagnosis it needs more efficient and selective Nanoparticles for diagnostics at clinical level (MRI contrast agent).

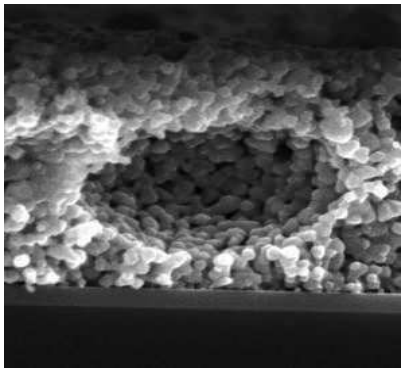
Therapeutics:

- More efficient uptake of drugs using existing drugs which are reformulated as nanocrystals or encapsulated.
- Tissue-specific delivery with a strong localized dose-control a lower overall concentration of the drug, providing lower patient toxicity and side-effects.
- Triggered drug release by a secondary mechanism such as light, pH, heat or enzyme activation.
- Diagnose and treat neurodegenerative disease with particles having the ability to cross the BBB.
- Therapeutic treatment with heat (magn. hyperthermia) light (QD)

Nanoparticles







Nam et al.
Advanced Drug Delivery Reviews 65 (2013) 622–648

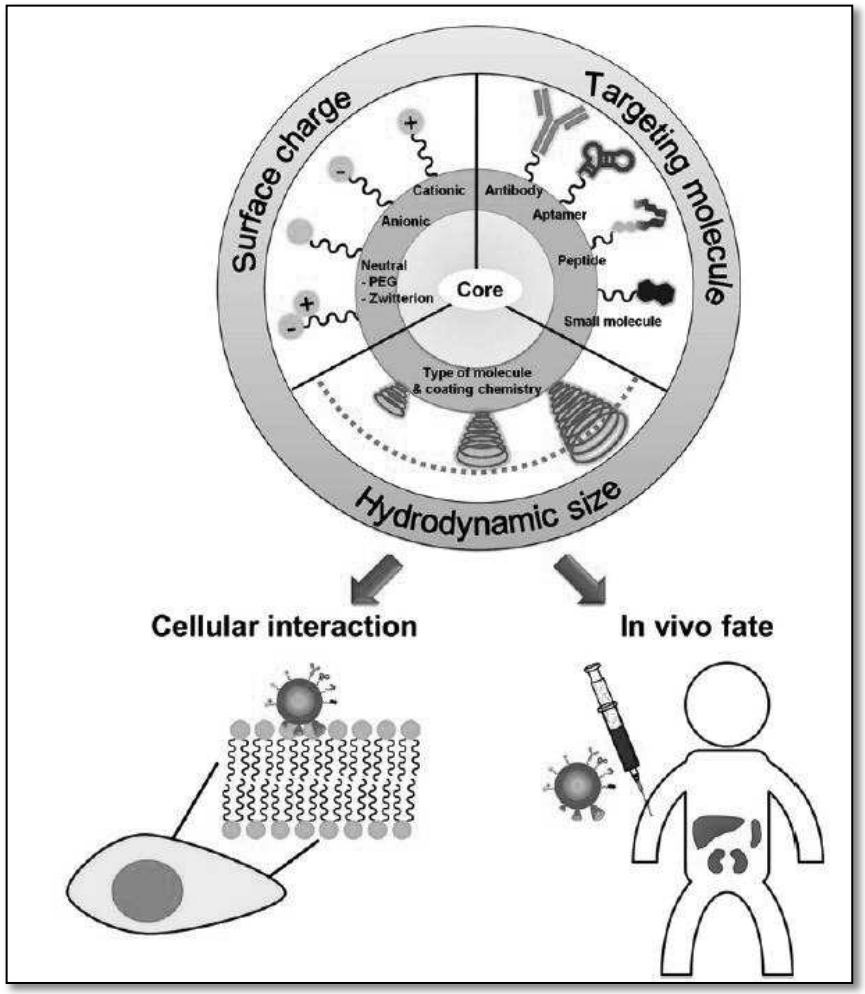
Core and Surface properties

Nanoeffects

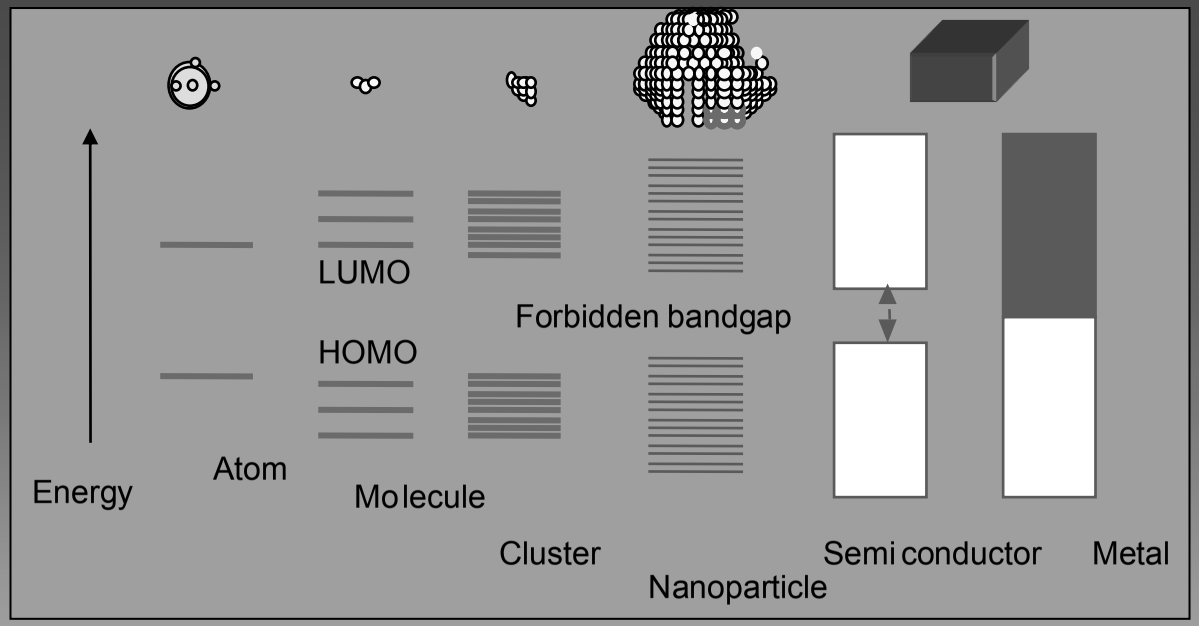
Ferro- to superparamagnetism
Band gab change (fluorescence)
Surface plasmon

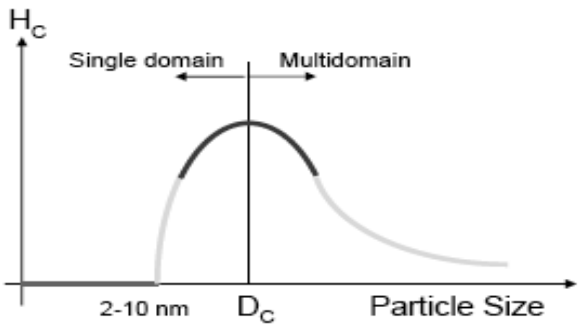
Scaling efffects

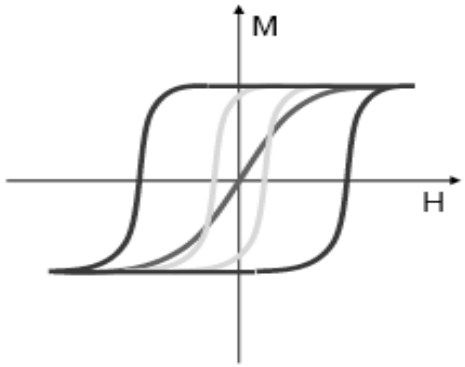
Increased reactivity per mass
Solubility
Colloidal stability
Penetration through barriers

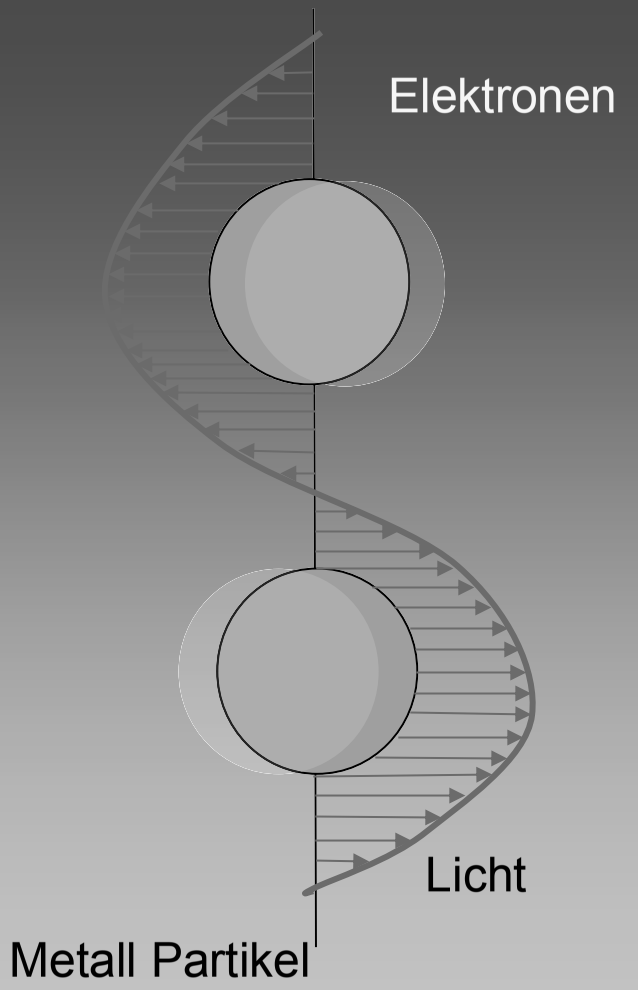


Nanoeffects









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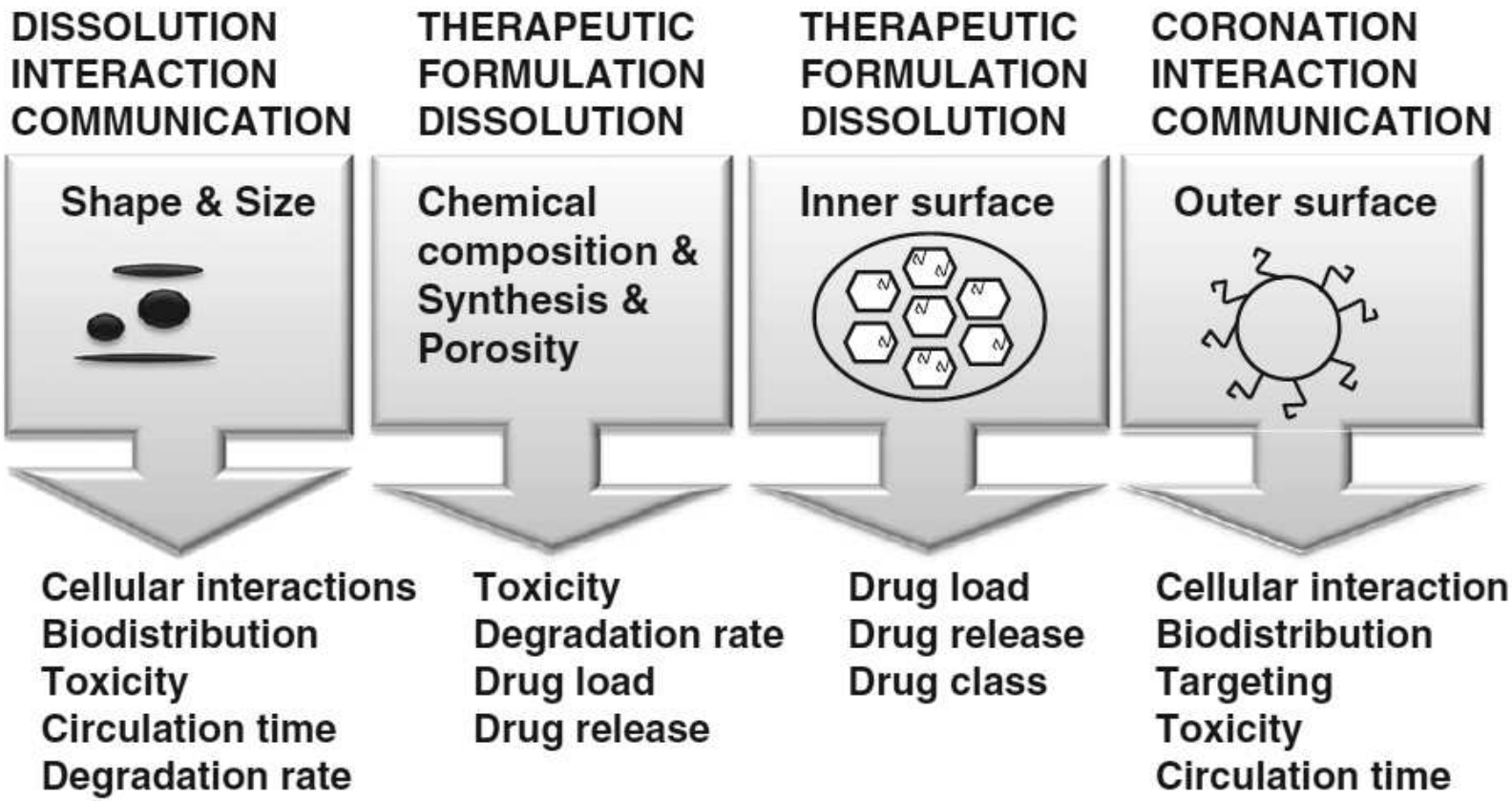
Mesoporous silica nanoparticles



Mamaeva et al. Advanced Drug Delivery Reviews 65 (2013) 689–702

SILICA nanoparticles: trend

- The in vivo studies using MSNs have to date mainly focused on the delivery of the approved cancer drug Doxorubicin using folate as the targeting ligand.
- This should be extended to include novel cancer drugs under development, in clinical trials or excluded from the market due to severe side effects.
- Generating a particle platform were the ligands and drugs are easily replaced in accordance with the patient profile could constitute a true advantage for personalized medicine.

After Mamaeva et al. Advanced Drug Delivery Reviews 65 (2013) 689–702

Superparamagnetic Iron oxide nanoparticle

Quantum Dots