Question Set 5

Interactions of nanostructures with biological matter

It is necessary to read and understand the papers. The lecture handouts are also helpful to understand what is important in the course. Note that the questions may require you to go beyond the papers specified here in order to find your answers.

Basics of nanotoxicology

A nanotoxicology review paper[1] may be useful. Here is a paper on the protein corona[2].

(1) In which way can we be exposed to nanoparticles? How can nanoparticles be eliminated from the body?

(2) What are the basic factors determining the toxicity of nanoparticles?

(3) What may happen to the nanoparticles when they enter a living organism? How may it affect the toxicity of the nanoparticles?

(4) Currently in Europe, for new chemicals, the level of testing required is determined by the mass produced, with the lowest mass trigger currently set at 10kg per annum.

What is the volume of 10kg of GaP? How many nanowires (5 μm long, 50 nm in diameter) do 10 kg of GaP correspond to? How big would the surface area of the single GaP piece be (assuming a sphere)? How big would the total surface area of the nanowires be? (GaP density=4.138 g/cm^3)

Tools to study nanotoxicology

Here one paper on organ on a chip[3] and one paper on barcoded nanowires[4] are useful.

(1) What are the limitations and issues faced when using cell cultures or animal (or human) models for nanotoxicology studies?

(2) In which way would organs on a chip be useful alternative to cell cultures or animal (or human) models for nanotoxicology studies? What limitations could be imagined for organs on a chip? How can the latter problem be addressed?

(3) Why would barcoded nanoparticles be a useful tool in nanotoxicology? Explain the basic idea and give examples of uses.

Usage of nanoparticles and nanostructures

Here several papers might be useful: nanoparticles for biomedicine[5, 6], nanowires for control of cell growth[7], nanowires as nanoinjection needles[8], phage display [9].

(1) In which ways can nanoparticles be useful for treatment?

(2) What is molecular imprinting?

(3) In which ways can nanowires be useful for the development of neuroprostetics?

(4) Electroporation is a method to deliver molecules to cells. Why would hollow nanowires be better?

(5) What is phage display and how can it be used to create proteins with specific binding properties?

DNA nanotechnology

Here these two papers might be useful [10], [11] and [12].

(1) What is the basic mechanism that is used to create nanostructures using DNA?

(2) Give examples of potential uses of DNA nanostructures.

(3) Compare chemical caging / caged compounds with DNA nanostructures.

References

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9. Whaley, S.R., et al., *Selection of peptides with semiconductor binding specificity for directed nanocrystal assembly*. Nature, 2000. **405**(6787): p. 665-668.
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