BIONANOINTERACTIONS-A RATIONAL APPROACH TO THE INTERACTION BETWEEN NANOSCALE MATERIALS AND LIVING MATTER?

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The importance of understanding the interactions between nanoscale materials and living matter has now been appreciated by an extraordinarily range of stakeholders. It is certainly understood by researchers that as the potential to manipulate materials at nanometer scale grows this leads to the opportunity to stipulate and study specific interactions with cells, tissue, organs and whole organisms. The pace of advance is extraordinary. However industry, governments and society at large also now appreciate the opportunity and requirement for this arena of research. Not only does it open up new direction in nanomedicine and nanodiagnostics, but offers the chance to implement nanotechnology across all industry in a safe and responsible manner.

The underlying reasons are real and durable. Less than 100nm nanoparticles can enter cells, less that 40 nm they can enter cell nucleus, and less that 35 nm they can pass the blood brain barrier. These are fundamental length scales of biological relevance that will ensure that engineered nanoscience will impinge on biology and medicine for many decades.

Our core idea is that nanoparticles in a biologically relevant environment (cell media, plasma etc) draw to themselves a number of proteins and lipids that form a sort of dynamical 'corona' in slow exchange with the environment. The exchange times (of the 'hard corona') can be so slow that many early biological responses are already defined by these associated biomolecules. [1-4] It is therefore these that define the biological identity of the nanoparticle, and it is important to learn their identity and more broadly to develop methods to assess them. Significant progress is being made in this arena, beyond the recent publications. [4]

Having understood the nature of the expressed biomolecule the challenge is to study where the particles go (using imaging techniques) and assess their biological impact when they reach there. We present our recent studies of this type. We also comment on the possibility to apply novel techniques. [5]

A key achievement of the field would then be to connect this biological identity (corona) to the observed biological impact. This has not been achieved yet, but progress is being made. An update is given.

We also note the surprising feature that nanoparticles are sometimes able to induce dramatic effects on protein interactions, such as the case for protein fibrillation, and of course this observation, when combined with the potential for nanoparticles to transport to the brain implies the need to study this whole arena in more depth in future. [6]

References

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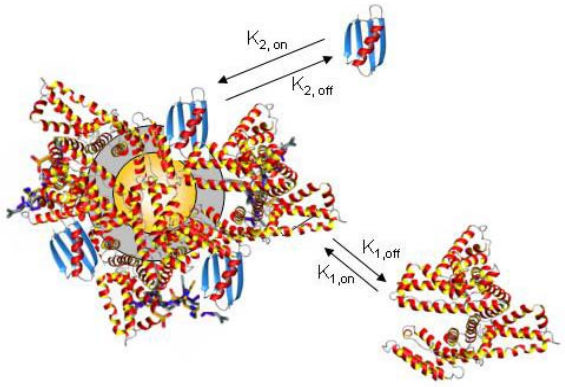

Figure 1 Schematic representation of the protein corona on a nanoparticle, illustrating the exchange processes and equilibrium constants.

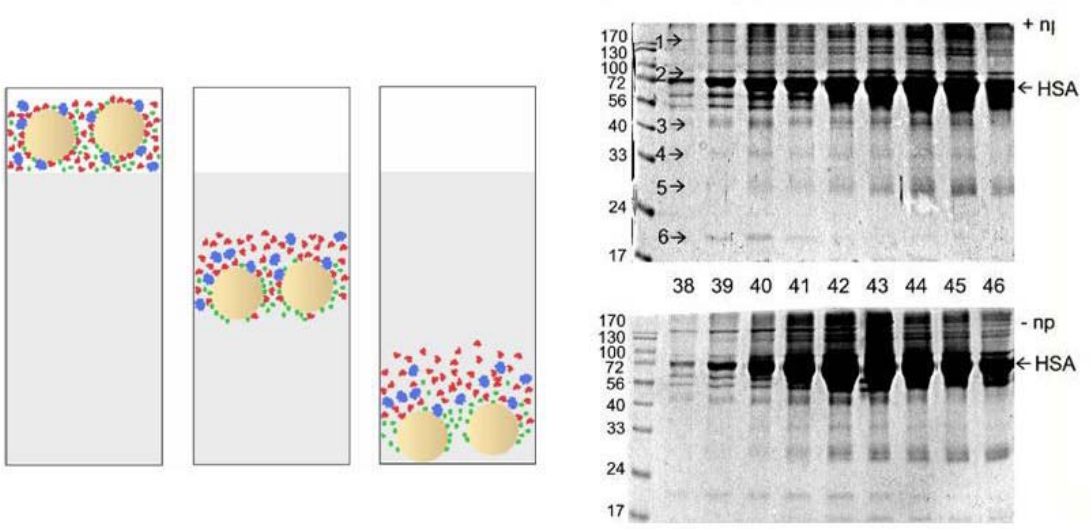

Figure 2 Size-exclusion chromatography study of nanoparticle-protein interactions: the elution time of proteins is shifted depending on their affinity for the nanoparticle surface, and the longer the protein is associated with the nanoparticle the earlier the protein elutes from the column. Proteins that have sufficiently long residence times elute in the void volume with the nanoparticles. Proteins in each fraction can be separated by gel electrophoresis and identified by mass spectrometry.