The Drive to Master the Foundation Principles of Nanoscale interactions with living Organisms

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The nanoscale is unique in biology, and our capacity to engineer on that scale will be transformative. Thus, the endogenous (intrinsic) machinery of biology is defined and operates on the nanoscale. Typical biomolecules and assemblies that are actively transported around organisms by specific motors and drivers are between 5-80nm. This means that nanoparticles are also actively (using the energy of the cell) transported around cells and biological barriers all unlike small molecules which passively partition into biological compartments (cells, organs etc). Secondly, the power of being able to communicate with, and use those endogenous mechanisms of biology is potentially transformative in practical terms. That is an enduring fact that renders our effort to draw the power of nano to the challenge of medicine.

However, these could remain only words, or broad ideas in our generation, if we do not learn how to engage this enormous potential to interact with the machinery of organisms. There are deep challenges. First of all, the complexity of the interaction is remarkable, much more so than for small cell and molecules, or large particles. Capturing this new capacity for benefit of human society will require dedication and commitment, indeed an exceptional generational effort, rather than peripheral or aspirational research. Both the potential, and the challenge, of this field may have been underestimated, but now now we have faced the need to invest in guiding principles and laws governing the whole arena, the true picture is unfolding quickly. We are optimistic.

We discuss progress being made in understanding how interactions between nanoscale objects and living organisms occur, and their governing principles. [2,3] We argue that the future lies in pressing forward to develop a truly microscopic (molecular scale) understanding between the nanoscale and living organisms. [4]

References

1. Proceedings of the National Academy of Sciences 104 (7), 2050-2055 **(2007).**

2. Nature nanotechnology 7 (12), 779-786 (**2012**)

3. Nature nanotechnology 7 (1), 62-68 (**2012**)

4. Nature nanotechnology 10 (5), 472-479 **(2015)**