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Correlative Microscopy of the Biology-Materials Interface for Development of Nanomedicines

Multimodal materials combine materials with complementary imaging and therapeutic capabilities into one platform and are receiving increasing interest in the field of cancer theranostics. These surface modified nanomaterials carriers offer several advantages, such as high drug loading capacity, ability to evade efflux pump action at the brain microvessels, and size-tunability. By integrating different component modules into these platforms, it should be possible to combine the qualities of each module to modulate their properties for flexible treatment of a range of diseases. We are developing multifunctional luminescent nanomaterials for delivery of chemotherapeutic drugs to treat breast cancers and for delivery of therapeutics across biological barriers, such as the lung epithelium and blood brain barrier. Before these materials can be used commercially, it is vital to assess their safety to human health and the environment. Thus, we are also adapting these materials to assess the potential health and ecological consequences of the increasing prevalence of new classes of nanoparticulate material in the environment.

The talk will describe our understanding of the fundamental properties of current and new generation multimodal bionanomaterials and how their physicochemical properties might relate to their bioreactivity, translocation and ultimate fate, weighed against the advantages such materials offer in nanomedicines. In this paper, I will discuss our work on application correlative, multiscale spectro microscopy techniques to characterise the nanomaterials-biology interface. Key challenges include the need for high spatial and energy resolution allowing discrimination of subtle chemical signatures. Information about dynamic processes is also required to track how these nanomaterials degrade and transform in different environments in situ, since alterations to their physicochemistry will alter their

ultimate bioreactivity. The talk will highlight new insights that are gained by using advanced characterisation techniques, and discuss the benefits of correlative approaches between in situ X-ray and electron spectroscopies.