Antimicrobial Nanomedicine informing Cancer Nanomedicine and *vice versa*

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Anti-microbial resistance (AMR) with associated recalcitrant life-threatening infections, and difficult to treat cancers with poor prognoses are two of the major health and medical challenges facing humankind. Though there are many effective cancer and antimicrobial drugs that kill cancer cells and microbial pathogens, there are many biological and physicochemical barriers and challenges that limit optimal medicines development. Key examples include cellular barriers, resistance mechanisms of cancer cells and microbes, complex and heterogenous pathophysiology, solubility/permeability balance and poorly controlled biomolecular interactions (coronas), all which limit effective biodistribution of drugs.

Drug nanocarriers can be optimally synthesized from lipids or polymers or porous silica that offer significant opportunities in overcoming these biological and physicochemical challenges for improved delivery of anti-microbials, chemo agents and photodynamic therapy (PDT) sensitizers. Here we describe and discuss case studies which demonstrate how such nanocarriers can be engineered to facilitate high drug loading, triggered and targeted release for both water soluble and insoluble agents, overcoming cellular, biofilm and other bio-barriers and enhancing the efficacy/toxicity balance. We demonstrate that there are equivalent challenges in the delivery of either cancer or antimicrobial agents and that knowledge in either of these two fields can cross fertilize each other. Examples include: (i) the use of lipid liquid crystal nanoparticles (LCNP) to maximise the generation of reactive oxygen species from photosensitizers resulting in improved photodynamic therapy (PDT); (ii) functionalizing lipid and silica nanocarriers for controlling uptake by specific cell types with relevance to pulmonary delivery and (iii) engineering specific chemistry and nanostructure of lipid and polymer nanocarriers to facilitate triggered drug release within specific biological and intracellular environments (e.g. low pH and enzyme rich).

Insight into the optimal design and mechanisms of action of smart nanocarriers will be presented and opportunities for clinical application discussed.

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