NanoEngineering gone viral: plant virus-based therapeutics

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Nanoscale engineering is revolutionizing the way we detect, prevent and treat diseases. Viruses are playing a special role in these developments because they can function as prefabricated nanoparticles naturally evolved to deliver cargos to cells and tissues. We have developed a library of plant virus-based nanoparticles and through structure-function studies we are beginning to understand how to tailor these materials appropriately for biomedical applications. Through chemical biology, we have developed virus-based delivery systems carrying medically-relevant cargo. Application areas lie in molecular imaging applications aiding risk stratification and prognosis as well as tissue-specific drug delivery; we target cancer and cardiovascular disease. Another exciting avenue is the development of plant virus-like particle platforms for cancer immunotherapy. The idea pursued is an 'in situ vaccination' to stimulate local and systemic anti-tumor immune responses to treat established disease, and most importantly to induce immune memory to protect patients from outgrowth of metastasis and recurrence of the disease. Beyond applications targeting human health, we begun to repurpose plant viruses to enable plant health; we employ principles of nanomedicine to target pesticides residing deep in the soil therefore challenging to reach using contemporary pesticides. I will highlight engineering design principles employed to synthesize the next-generation nanotherapeutics using plant virus-based platform technologies, and I will discuss the evaluation of such in preclinical mouse models and canine patients as well as in the agricultural arena.