NanoEngineering gone viral: plant virus-based therapeutics

Nanoscale engineering is revolutionizing the way we prevent, detect 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 system carrying medically-relevant cargo enabling tissue-specific imaging and treatment. A particular exciting avenue is the development of virus-like particle platforms for cancer immunotherapy. The idea pursued is an ‘in situ vaccination’ to stimulate local and systemic anti-tumor immune response to treat established disease, and most importantly to induce immune memory to protect patients from outgrowth of metastasis and recurrence of the disease. Another avenue is the repurposing of plant viruses to target 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 virus-based platform technology, and I will discuss the evaluation of such in preclinical mouse models and canine patients as well as in the agricultural setting.