Engineering Imaging Probes and Molecular Machines for Nanomedicine

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The integration of biomolecular engineering, nanotechnology and biology is expected to produce major breakthroughs in medical diagnostics and therapeutics. Due to the size-compatibility of nano-scale structures with proteins and nucleic acids, the design, synthesis and application of nanoprobes, nanocarriers and nanomachines provide unprecedented opportunities for achieving a better control of biological processes, and drastic improvements in disease detection, therapy, and prevention. Recent advances include the development of multi-functional nanoparticles, nano-structured materials and devices, and engineered nucleases for biological and medical applications. In this talk I will present the development and application of molecular imaging probes and engineered nucleases in my lab, including molecular beacon enabled purification of living cells by targeting cell-type specific mRNAs, nanocrystal–based signal amplification for biomolecule detection, and the new tools and methods for the design and optimization of zinc finger nuclease (ZFN), TAL effector nuclease (TALEN) and CRISPR/Cas9 systems for treating single-gene disorders. The opportunities and challenges in genome editing based treatment for human diseases are also discussed.