MARRYING BIOMOLECULES AND NANOPARTICLES FOR DIAGNOSTICS AND NANOMEDICINE

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Noble metal nanoparticles (NPs) such as silver and gold NPs, at the size range of 1-100 nm have attracted enormous scientific and technological interest due to their unique optical, electronic and catalytic properties, which are largely determined by their size, shape and crystal structure. Inspired by the natural biomineralization process on using biomolecular templates to form a range of sophisticated inorganic nanostructures, our current research efforts focus on the development of bioinspired metal NPs with tunable physicochemical properties that incorporate the highly specific recognition function of biomolecules for a vast plethora of biomedical applications. Firstly, I will talk about the rational design of peptide and nucleic acid-based biomolecular templates for the biomimetic synthesis of multifunctional metal NPs with different optical properties (i.e., plasmon absorption and light emission) and integrated biofunctionalities for biosensing, imaging, delivery and therapy.[1-7] Recently, we have designed a unique self-assembly DNA templates to form redox-responsive photoluminescent silver nanoclusters (NCs < 2 nm in size) for two-way color change detection of free radicals (red-to-blue) and antioxidants (blue-to-red) in real time. These DNA-templated AgNCs are found to have excellent antimicrobial and toxin inhibition properties towards superbugs. Using bi-functional peptide templates, AuNCs with tunable emission color from visible to near-infrared wavelength have been successfully synthesized for targeted gene delivery and bioimaging applications. We have also employed this bioinspired approach to 'turn' the native protein into bioactive fluorescent sensors for small molecule drug screening and photodynamic therapy. The biocompatibility and adaptability of biomolecules involved in the synthesis enable an efficient control over nanostructures morphology (size and shape) with fine-tuned properties, resulting in low energy use and environmental impact. The second part of my talk will focus on the biofunctionalization strategies of nanometals for the development of ultrasensitive biosensors, to convert 'invisible' biological responses into easily measurable and observable optical outputs.[8-13] By exploiting the plasmonic coupling, fluorescence and/or light scattering properties of the nanometals, we have developed a series of label-free optical nanosensors to detect a wide range of bioanalytes (e.g., vitamins, small molecule drug, etc.) and for studying important biomolecular interactions such as gene transcription, DNA mutation and enzymatic reaction. These bioassays are versatile, efficient and low-cost with high throughput sensing capability, which could culminate into tangible products useful for biomedical research and clinical diagnostics.

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