

Nano-functionalized biomaterials for disease diagnosis and therapy

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The application of nano- and micro-technology for healthcare has been of great interest due to its unique features as biomedical materials for therapy and diagnostics. Nanoparticle systems based on magnetic or fluorescence detection can be engineered to achieve excellent sensitivity and specificity by maximizing signal-to-noise ratios and reducing off-target binding. We introduce the application of nanoparticle systems as a rapid and simple diagnostic platform for detecting bacterial pathogens and multidrug-resistance. We have investigated various molecular labeling approaches using multifunctional nanomaterials, small molecule antibiotic ligands, and rapid linking chemistries, for rapid and sensitive detection of bacterial pathogens. We also introduce the development of simple visualization methods based on nanoparticle-mediated nucleic acid or bacterial aggregation. Secondly, we also developed a nonviral genome editing therapeutic based on nano-delivery of the CRISPR/Cas9 system. Nano-sized complexes were prepared by direct covalent modification of Cas9 and single-guide RNA, and applied for therapeutic genome editing in bacteria and cancer. These approaches can be potentially applied in the clinic either as a rapid diagnostic platform in the bedside, or as a therapeutic that can overcome safety issues of conventional virus-based strategies.