Special Section on Nanoparticles and QDs in Nanobiomedicine

NANOTECHNOLOGY is a rising science combining the knowledge of physics, chemistry, biology, material science, and electronics to create new materials, devices, and systems. Apart from playing a critical role in major advances such as electronics and robotics, nanotechnology provides the tool for investigation and improvement in biomedical and diagnostic applications such as gene therapy, gene targeting, and cell tracking, none more so than the use of nanoparticles.

The potential of functionalized nanoparticles in both biomedical research and clinical use is without doubt promising, due to a number of beneficial factors including a large surface area to volume ratio and the possibility of ubiquitous tissue accessibility. Recent advances in synthesis can now produce particles, such as gold, magnetic and quantum dot, down to sizes of below 10 nm, thus opening up more specific avenues in nanobioscience. Due to their rapidly expanding use and promising future potential, this special issue of IEEE TRANSACTIONS ON NANOBIOSCIENCE is focused on the recent and future applications of nanoparticles and quantum dots in bioscience, with both reviews and original research papers from a range of researchers currently working in the field.

One of the more referenced uses for nanoparticles in the literature to date is that of magnetic nanoparticles. Magnetic nanoparticles were widely used in research, with cell labeling becoming an increasingly common method for cell separation, and the emergence of magnetic resonance imaging (MRI) as a potentially powerful tool for cell imaging both *in vitro* and *in vivo*. To reflect this, the issue has two dedicated reviews on the uses of magnetic nanoparticles in biomedicine, each highlighting different aspects. Petri-Fink and Hofmann detail more specific areas of synthesis and characterization with successes in *in vivo* trials; while Quarta *et al.* focus on the recent combinational use of magnetic nanoparticles with fluorescent properties. As methods of particle synthesis and functionalization improve, it is envisaged that steps can be taken towards using particles as a tool to controlling cell–nanomaterial interaction, as highlighted by de la Fuente *et al.* Here the authors have synthesized magnetic nanoparticles with various biologically relevant saccharides, which are shown to confer specific cell responses.

Gold nanoparticles make an excellent intracellular targeting vector for several reasons, including the fact that nanoparticles can be synthesized in sizes from 1 to 200 nm and that they can be easily functionalized. This ease of modification has lead to research on the application of gold nanoparticles as nonviral gene delivery vectors. A comprehensive review by Ragusa *et al.* describes the potential of various nanoparticles as nonviral gene delivery vectors, with original papers by Eaton *et al.*, who describe gold particle synthesis and subsequent DNA interaction. Gold nanoparticle functionalization with cell penetrating peptides, such as the HIV-1 tat peptide, appear to further support the use of nanoparticles as delivery vectors, as reported by Berry *et al.*, who demonstrate intracellular and intranuclear targeting *in vitro* using such a system. Finally, Blum *et al.* report on a more novel application of gold nanoparticles is their engineered bottom up self-assembly to create switchable molecular networks that may be used in nanoscale memory circuits.

When considering nanoparticle applications in biomedicine, quantum dots are also at the forefront. Quantum dots have two main advantages over organic dye molecules, namely that different sized particles are capable of emitting fluorescence at particular wavelength, and that they are robust and stable light emitters due to their inorganic makeup and are less susceptible to photo bleaching than organic dye molecules. This photostability makes them extremely useful in cell imaging and tracking. For example, Hoshino *et al.* describe a potential *in vitro* diagnostic use for quantum dots conjugated to specific antibodies that recognize activated neutrophils, thus enabling their detection via flow cytometry and immunostaining.

However, while the above papers all highlight the potential uses and applications for nanoparticles in nanobioscience, it is well accepted that when taking bulk materials down to the nanoscale, alterations in the chemical and physical properties are apparent. While many of these changes are of benefit to potential applications, it must also be noted that ordinarily innocuous materials can suddenly elicit a toxicological response when reduced to the nanosize. Stone *et al.* have produced a comprehensive review that describes cellular and molecular interactions that may lead to and cause such a response.

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