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"Advances in biomaterial design and application for medical intervention"

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There has recently been an exponential rise in the use of biomaterials, to improve the biocompatibility and targeting of nanomedicines for diagnostic and therapeutic intervention. This has become possible through better understanding of the biochemical, cellular and tissue makeup within the diseased microenvironment. Eminent scientists, medical practitioners and international experts from over 30 countries from around the globe gathered at the 4th International Conference on Nanotechnology in Medicine (NANOMED16) http://www.nanomed.uk.com/ to discuss the latest advancements in the field of Nanomedicine. The conference was held at the Warsaw University of life sciences (WULS), Warsaw, Poland, in November 2016, marking the 200th anniversary since its inauguration (WULS-SGGW). The purpose of this special issue is to share a selection of key studies discussed at the conference, with a particular aim of highlighting some of the advances in biomaterial design and application for medical intervention, including tissue-engineering applications.

In the first manuscript, Chan and Hsiao, from the Kaohsiung Medical University in Taiwan, illustrate how understanding the tumour microenvironment, has enabled the design of innovative protease activated nanomaterials for successful theranostic targeting. In their special report, they describe the design and application of nanomaterials such as graphene oxide and gold nanoparticles labelled with matrix metalloprotein-2 sensing peptides for targeted cancer therapy. Other attractive strategies for targeted drug delivery and theranostics include the use of biomimetic peptides for the surface modification of nanomaterials. For example, by taking advantage of the overexpression of the folate receptor in many types of human cancers, Justyna Fraczyk and colleagues from Zbigniew Kaminski's group in Lodz, used a biomimetic peptide linker (that is resistant to proteolytic degradation), to modify the surface of multiwalled carbon nanotubes (MWCNTs), functionalised with folic acid, for targeted delivery to cancer cells. Ewa Dluska's group from the Warsaw University of Technology utilised a novel emulsion-based drug delivery platform and a pH-responsive biopolymer, to modulate the release of doxorubicine, a potent anticancer drug.

In imaging diagnostics, a number of research groups at the conference show-cased their work on the use of biomaterials for improving the biocompatibility and efficacy of contrast agents. In particular, Netti and Torino's group, from the Centre for Advanced Biomaterials for Healthcare, Italian Institute of technology, Napoli, presented a number of studies expected to make clinical impact in the near future. In this special issue, Ponsiglione and colleagues,

describe the effect of hydration of the hydrogel structure/biopolymer matrices, termed ‘Hydrodenticity’ to improve the relaxometric properties of Gd-DTPA contrast agents used in MRI imaging. Russo and colleagues describe the use of a one-step microfluidic flow focusing approach for the controlled synthesis and simultaneous PEGylation and loading of cross-linked hyaluronic acid nanoparticles (cHANPs) for theranostic applications. This approach is attractive because it offers a number of advantages including improved reproducibility and the boosting of MRI signal, over traditional processes. Another attractive strategy in imaging diagnostics is the combination of several imaging modalities for the simultaneous acquisition of different data to enable early and more accurate diagnosis of disease. Indeed, Vecchioni and colleagues, describe a modified coacervation and double cross-linking process for the production of hybrid core-shell polymeric nanocarrier system to improve the relaxometric properties, for simultaneous PET/MRI acquisitions, as multimodal imaging applications.

Finally, in tissue engineering, improved understanding of the cellular microenvironment and tissue topography and has allowed researchers to investigate the use of nanomaterials for improved biocompatibility and functionality of medical implants. In particular, there is increased interest in new and ‘smart materials’ which possess unique properties that resemble those of native tissues. Such materials include ‘Nitinol’, a nickel titanium alloy, which possesses a shape memory effect. This is described by Justyna Witkowska’s group, who utilised a hybrid process to enhance the surface properties NiTi shape memory alloy, thus making it suitable for cardiovascular applications. Cao and colleagues, demonstrate how the use of nitrogen ion implantation of 3D self-assembly graphene scaffolds, improves hydrophilicity, and cyto-compatibility, to support the growth of mouse fibroblast cell, thus making it attractive for tissue engineering applications. The last manuscript in this special issue is presented by Sun and colleagues, who highlight the advantages of depositing nanoscale TiN/Ag multilayers on the mechanical, cell adhesion, and antibacterial properties of medical implants. The synthesis of such multifunctional layers will undoubtedly enable the successful future use of medical devices and implants for improved medical intervention.