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Polymer Theranostics: Imaging a Treatment *in vivo*

Molecular imaging has had a profound influence on modern diagnostics and has helped drive the evolving field of nanomedicine. "Theranostics", the portmanteau of therapy and diagnostics, is one sub-section of nanomedicine and offers the opportunity to monitor the effectiveness of a therapy using molecular imaging techniques - this may be achieved by monitoring drug release from a polymeric carrier, defining tumour boundaries or quantifying necrosis. In this project we will develop biocompatible polymeric devices that target a specific disease state in vivo, and subsequently deliver a therapy to treat that disease using various biological stimuli. The effectiveness of treatment will then be monitored using molecular imaging. This will involve utilising advanced chemistries for both the synthesis of the polymer-drug composites, and subsequent ligation of cell-targeting and imaging moieties. The polymeric architecture will be investigated by techniques such as NMR, GPC-MALLS, DLS, HPLC, UV-VIS etc. The polymeric device will incorporate imaging components for modalities such as magnetic resonance imaging (MRI), positron emission tomography (PET), computed tomography (CT) and optical imaging to definitively locate and monitor tumour regression.

Enrolling School: School of Chemistry & Molecular Biosciences (SCMB)

Suitable academic background: BSc Chemistry or Biotechnology

Skills obtained in project: Advanced materials science, polymer science, biomaterials science

Publication & postgraduate career potentials: All of our projects will lead to refereed publications and prepare the student for postgraduate studies.

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Polymeric vectors for gene delivery

One of the most promising routes for cancer therapy that has evolved in the last decade is the use of small-interfering RNA (siRNA) and gene therapy as a means of switching off genes that are responsible for tumour development. However, while siRNA and gene/antisense therapies provide alternatives to conventional chemotherapies, significant hurdles related to the delivery and efficacy of treatment must still be overcome before this technology can be used as a universal treatment of cancer and other diseases. These problems include the instability of RNA/DNA in serum due to the presence of degrading enzymes, poor cellular uptake, limited endosomal escape (following uptake) and in the case of gene therapy, nuclear trafficking in cells. This project involves the development of biocompatible polymeric carriers that act as carriers for the RNA/DNA. Such a carrier must incorporate a mechanism for binding the therapy, directing the therapy to the site of interest in the body, and a means of releasing the therapy when it is in the correct region of action. Thus, the project will involve synthetic polymer chemistry (for development of the carrier vehicle) as well as development of a series of ligation strategies for attachment of cell-targeting ligands and nuclear-penetrating peptides as well as the RNA/DNA gene of interest. Advanced characterisation techniques such

as GPC, NMR, PAGE, HPCL and UV-VIS will be used.

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