This article is published as part of the *Dalton Transactions* themed issue entitled:

Radiopharmaceuticals for Imaging and Therapy

Guest Editors Stephen Faulkner (Oxford University) and Nick Long (Imperial College)

Published in issue 23, 2011 of *Dalton Transactions*

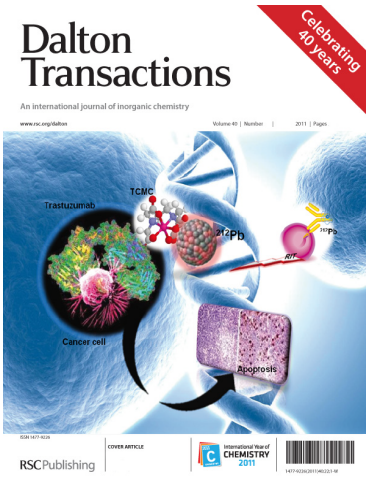

Image reproduced with permission of Martin W. Brechbiel

Articles in the issue include:

PERSPECTIVES:

ARTICLES:

Dalton Transactions

Dynamic Article Links

Cite this: *Dalton Trans.*, 2011, **40**, 6067

www.rsc.org/dalton

EDITORIAL

Radiopharmaceuticals for imaging and therapy

DOI: 10.1039/c1dt90067f

Stephen Faulkner[a] and Nicholas J. Long[b]

Radiopharmaceuticals have already made an enormous contribution to the diagnosis and therapy of disease. Rapid development of the field continues, with important new approaches to targeting, bioconjugation and control of biological kinetics as well as through the application and purification of new radioisotopes, the development of new experimental techniques and the application of radioisotopes in multimodal imaging. The time seems right to highlight and review these developments, and to present them in a single issue to the wider community of inorganic chemists. With this themed issue on radiopharmaceutical chemistry, we are aiming to highlight contributions from leading experts in the field, illustrating the scope of these new developments and analysing their potential in detail. This issue contains a mix of perspective articles and papers, which outline and expand upon some of the key themes in the current development of the field.

The development of imaging modalities that make use of radioisotopes has allowed clinical scientists to understand and diagnose the progress of disease. Early tomographic probes focused upon imaging blood flow and blood pool, but their scope has been extended to truly functional imaging. In the clinic, the use of 18-FDG is now widespread, while metallic complexes with bifunctional chelating agents have been shown to target cell receptors and uptake pathways.

Positron and γ-ray tomography remain unique in combining the potential for whole body imaging with the low detection limits that are required for observing receptors at low local concentrations. They also pose important challenges to chemists. Some of these challenges are presented by the short half-lives associated with radioisotopes used in imaging, and require the development of new synthetic methodologies that can accommodate these short half-lives *via* new preparative techniques and efficient and fast methods for compound purification, such as microfluidic devices. Furthermore, as the range of clinically useful radioisotopes is expanded, it becomes important that generator systems are identified and engineered to permit ready access to new radionuclides. Obviously, a complex used in imaging must be kinetically stable over the course of the imaging experiment, and an understanding of the physical inorganic chemistry of metal binding and release is vital if we are to avoid the problem of dissociation *in vivo* (and the consequent problem of uncertainty in imaging). Equally, it is important to understand the pathways for uptake and localisation of imaging agents.

Considerable recent interest has focused on the development of multi-modal imaging agents, which can be addressed by more than one technique. Once again, the low detection limits associated with radioisotope tomography are ripe for exploitation. Multi-modal probes which combine optical and tomographic imaging have the potential to provide images extending from the sub-cellular detail that can be obtained by microscopy to the whole organism. This permits us to consider the prospect of imaging agents that can be used as optical agents in screening assays, then applied directly to tomographic whole body imaging and conceivably also used as an aid to surgery, using their optical properties to identify the nature of exposed tissue.

The use of radioisotopes in therapy has been established even longer than in imaging. However, much that is new and important has only emerged in the last few years, including the demonstration of cellular targeting, and the use of alpha particles and Auger electrons in inflicting highly selective tissue damage upon diseased cells. While the isotopes may differ, the approach has much in common with that used for imaging. Indeed, there is currently great excitement about the prospects for theranostic compounds (*i.e.* compounds which combine the potential for imaging and therapy).

Much still remains to be done, and a supra-disciplinary approach is essential if a new generation of effective and useful imaging tools is to be developed. Some of these will involve new approaches to instrument development, where (i) techniques such as time-of-flight positron emission tomography have the potential to lower detection limits (and radiation dose to patients) considerably, and (ii) combined PET/MRI scanners are now a reality. New methods for the analysis of data, for example through multiplexing of targeted probes, have the potential to speed up the diagnosis of disease and the personalisation of medical care. Effective chemistry is the key to all of this: there remains a need for bioconjugates and probes with high specificity for a range of receptors, and for a versatile chemical tool-kit that can be applied to the vast range of clinical problems which present themselves.

[a]*University of Oxford, Chemistry Research Laboratory, Mansfield Road, Oxford, UK, OX1 3TA. E-mail: stephen.faulkner@keble.ox.ac.uk*

[b]*Department of Chemistry, Imperial College London, South Kensington, London, UK, SW7 2AY. E-mail: n.long@imperial.ac.uk*