ARC Centre of Excellence in
CONVERGENT
BIO-NANO SCIENCE
& TECHNOLOGY

www.cbns.org.au

Signature projects

Our CBNS Signature Projects draw on the capabilities of our expert researchers to solve the big questions in bio-nano research.

IMPROVED MOLECULAR IMAGING AGENTS

Leaders: Professor Andrew Whittaker, Professor Tom Davis

Co-Leaders: Dr Jeroen Goos, Dr Ruirui Qiao, Dr Cheng Zhang, Dr Changkui Fu, Dr Simon Puttick

THE PROJECT

We aim to improve the resolution and accuracy of molecular imaging at different physiological sites and to exploit nanotechnology for specific diagnosis and theranostic applications.

THE BIG QUESTIONS

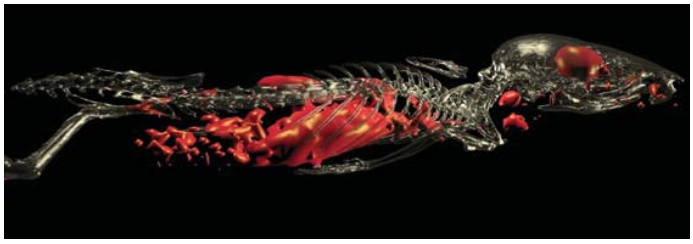
- Can we monitor pathophysiological changes non-invasively by combining molecular imaging with bio-responsive nanoparticles?
- Can we exploit nanotechnology to increase the signal-to-noise ratio of existing molecular imaging probes?
- Can we develop novel tools for multimodality imaging by combining different imaging probes in a single molecular imaging agent?

The benefits of this research

- Molecular imaging, the visualisation of the location and biochemistry of tissue in whole organisms, is revolutionising modern medicine. Imaging modalities such as MRI, CT and PET enable the clinical scientist to provide more accurate patient diagnosis and monitoring the progress of therapy. All these imaging methods require administration of a molecular imaging agent, a nanoparticle or small molecule which enhances local image intensity, or reports on the local health of tissue.
- The major challenges in the field are related to sensitivity of the imaging agents and the type of information available from the scans. High sensitivity is critical for detection of the early stages of disease and for detection of diffuse pathologies or the margins of diseased tissue. For example, contrast-enhance MRI is used to delineate the margins of tumours, including brain tumours and to guide the surgeon in the design of appropriate resection protocols. Such information is critical in determining long-term survival rates of cancer patients. Brighter imaging agents have the potential to improve discrimination between diseased and healthy tissue and to consequently improve the outcome of surgical intervention.
- The clinical scientist also will benefit from agents which report on the biology of the tissue, for example; the presence of specific surface markers indicative of particular disease types and the presence of hypoxic tissue which is more resistant to radiation therapy. Newly-developed molecular imaging agents are able to provide such information within a spatially-resolved image, opening up new possibilities for more precise therapies.

Our goals

- This signature project tackles the three big problems in this field. The initial goal is to develop brighter imaging agents through smart molecular design, to allow early and more accurate detection of disease. Secondly, the imaging agents will be designed to report to the clinical scientist on the state of the disease, by responding to changes in physiology (pH, ionic strength, temperature, etc.) and the presence of specific markers of disease. Finally each imaging modality (MRI, PET, CT), has advantages and deficiencies compared with each other. For example; PET is an extremely sensitive imaging modality, whilst MRI provides much superior spatial resolution. We are developing novel multimodal agents which can be imaged by more than one of the major imaging methods, to take advantage of the respective advantages of each modality.

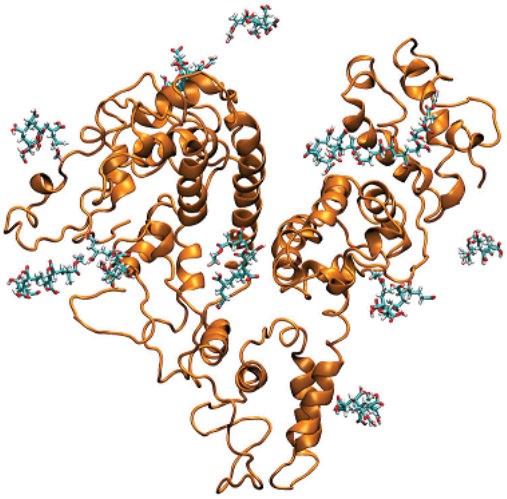


Superposition of PET/CT images of a mouse with a brain tumour xenograft, after injection with a 64Cu labelled antibody.

IMPROVED MOLECULAR IMAGING AGENTS

Recent publications

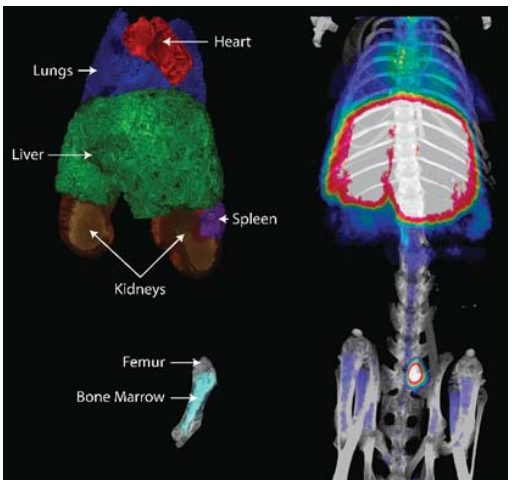
- Conformation Transitions of Thermoresponsive Dendronized Polymers across the Lower Critical Solution Temperature; Macromolecules; 49 (3), 900-908; 2016.
- Multifunctional hyperbranched polymers for CT/^{19}F MRI bimodal molecular imaging; Polymer Chemistry; 7, 1059; 2016.
- The Evolution of Gadolinium Based Contrast Agents: From Single-modality to Multi-modality; Nanoscale 8; (20), 10491-10510; 2016.
- Ion-responsive ^{19}F MRI Contrast Agents for the Detection of Cancer Cells; ACS Sensors; 1(6), 757-765; 2016.
- Fluorinated POSS-Star Polymers for ^{19}F MRI; Macromolecular Chemistry and Physics; 217 (20), 2262-2274; 2016.



Snapshots of MD simulation of bovine serum albumin interacting with oligo meric polymer acrylic acid taken at the end of 20 ns of MD simulation.

Signature Project collaborations: Improved molecular imaging agents

Institution	Collaborator
ANSTO	Dr Ivan Greguric
Memorial Sloan Kettering Cancer Centre	Professor Jason Lewis
MacDiarmid Institute	Professor Thomas Nann
University of California	Professor Craig Hawker
Université de Mons	Dr Sophie Laurent
University of Queensland	Professor Debra Bernhardt
CSIRO	Professor Stephen Rose
National Center for Nanoscience and Technology of China	Professor Guangjun Nie
Shanghai University	Professor Afang Zhang
Hubei University	Professor Zushun Xu



PET/CT showing the distribution of one of star polymers (MR Whittaker), showing uptake in the bone marrow.

MONASH University
THE UNIVERSITY OF MELBOURNE
UNSW SYDNEY
THE UNIVERSITY OF QUEENSLAND AUSTRALIA
University of South Australia

Australian Government
Australian Research Council

ARC Centre of Excellence in CONVERGENT BIO-NANO SCIENCE & TECHNOLOGY