TRANSLATIONAL MOLECULAR IMAGING (TMI)

The Translational Molecular Imaging facility collaborates and drives in vivo imaging research projects from the state-of-the-art preclinical models at the Beatson Institute through to clinical implantation at the West of Scotland PET Centre. Investment from the Beatson Cancer Charity of £240k/year has purchased critical radiochemistry infrastructure and funded a Medical Physicist to develop and translate quantitative PET imaging biomarkers.

In 2018, we have upgraded the radiochemistry laboratory in the Radiopharmaceutical Unit at the West of Scotland PET Centre to develop new carbon-11 and fluorine-11 labelled PET probes. Due to recent engineering works in the cyclotron and radiochemistry laboratory, we can now produce high-level carbon-11 labelled gaseous products. The safety and robustness of large-scale carbon-11 tracer productions has now been thoroughly demonstrated. Carbon-11 is a versatile radiolabel, tracing many endogenous metabolic pathways. These engineering works therefore enable flexible development of metabolic PET imaging probes for cancer imaging.

We have installed two identical universal automatic 11C/18F synthesizers (Syntha GmbH, Germany) in the R&D and GMP radionuclide labelling suites. Installation of the two synthesizers finished successfully in June 2018 and the first new tracers, [11C]acetate, [18F]fluoro-ethyl-tyroasine (FET), [11C]methionine, [18F]fluorothyymidine (FLT) and [18F]tetrafluoroborate (TFB), were made available for preclinical studies this year. Preparatory work to expand the list of available radiotracers has started with plans to produce (4S)-4-(3-[18F]fluoropropyl)-L-glutamate (FSPG), [18F]palmitate and [11C]eucine for research use in 2019. Any radiotracer developed for preclinical research will be available for rapid translation to human studies at the PET Radiopharmaceutical Unit in Gartnavel Royal Hospital.

Collaboration with the group of Dr Andrew Sansom, School of Chemistry at the University of Glasgow, has provided two novel tracers, a carbon-11 labelled S1P receptor and a fluorine-18–labelled TSPO tracer which, in collaboration with Hing Leung, will be piloted for imaging castrate-resistant prostate cancer.

Precinical and Translational Imaging

Together with MRI, which provides functional and high-contrast soft tissue imaging, PET non-invasively assesses specific biological processes such as glycolysis, fatty acid synthesis, proliferation, redox, hypoxia, amino acid uptake, and protein and nucleotide synthesis.

In 2018, we started exploring the role of PET/MRI in phenotyping subtypes of colon cancer. Colon cancer has recently been stratisfied into four major subtypes, and Glasgow is leading a European-wide consortium, ACRCerate: Colorectal Cancer Stratified Medicine Network, to enable better matching of colon cancer subtypes to therapeutic trials. In collaboration with Owen Sansom and using the collection of state-of-the-art models at the institute, we aim to develop non-invasive imaging for spatial and temporal stratification of colon cancer. Initial multiplexed PET imaging, probing glucose, nucleotide, amino acid and fatty acid metabolism (Fig. 2), has revealed subtype-specific differences in imaging phenotype. We aim to further validate this work to identify co-existing subtypes and to image subtype plasticity.

In collaboration with Karen Blyth and Jim Norman, we are exploring metabolic imaging in the PyMT breast cancer model to image tumour evolution from normal breast epithelium through invasive ductal carcinoma and metastasis. This project aims to find specific imaging biomarkers of aggressive and metastatic breast cancer which could guide patient management.

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Figure 1
Radioactive hot-cells at the PET Radiopharmaceutical Production Unit at Gartnavel Royal Hospital containing one of the new state-of-the-art Syntha Wolfpertinger modules (top left and right) and the refurbished GE Tracerlab (bottom left) with Dr Dmitry Soloviev, Senior PET Chemist. The Syntha Wolfpertinger can make any 11C- or 18F-labelled metabolite, and the GE Tracerlab is used for research fusions. These different modules can be run in quick succession for near simultaneous production of 11C and 18F products for research use.

Figure 2
Sequential PET/MRI scans of metabolic radiotracer uptake in the same implanted colorectal cancer organoid. FDG, 18F fluoro-deoxyglucose; FET, 18F fluoroethyl tyrosine; FLT, 3-deoxy-3-[18F] fluoro-thymidine; ACE, 11C acetate.