

McCullagh Group Part II projects

Application of mass spectrometry and omics science to investigate chemical systems in health and disease

The McCullagh Research Group focuses on exploring chemical systems and their mechanistic function in biological and biomedical contexts. We are particularly interested in small molecule chemical systems, metabolic processes and the identification and testing of therapeutic interventions in health and disease. We use state-of-the-art mass spectrometry, spectroscopy and omics science.

Cancer metabolomics: Mutations in metabolic enzymes are found in multiple cancers leading to changes in tumours that help cancer cells survive and proliferate. If you are interested in understanding these mechanisms, and how these can provide clues to new therapeutic drug targets, we have projects that focus on identifying metabolic changes linked to specific cancer genes and new therapeutic targets.

Testing new drug treatments: We use state of the art mass spectrometry, spectroscopy and separation science to investigate the effects of novel drug treatments in cells to understand mechanisms of action. We generate molecular level knowledge of how cellular function is affected by new drugs and therapeutic processes and have projects focussing on testing how specific drugs, and their combinations, affect disease processes using cell models and 'omics' tools.

Bacterial metabolism and antimicrobial resistance (AMR): Resistance to antibiotics is an urgent global challenge and develops because bacteria evolve ways to breakdown or evade the effect of existing antibiotics. These changes may however, subsequently alter the way cells function and offer potentially new drug targets. We are interested in exploring the mechanisms underlying AMR to find new targets as well as ways to extend the effectiveness of existing antibiotics by modulating metabolic processes during treatment.

LC-MS and GC-MS methods: New analytical methods involving mass spectrometry help drive forward omics sciences, in particular, metabolomics and epigenetics. If you are interested in analytical techniques and mass spectrometry our lab collaborates with various stakeholders (including industry partners such as ThermoFisher Scientific, Waters and Immunocore currently) to develop new techniques and methods and we have projects to develop and validate lipidomics and metabolomics.

Computational biology: Omics science creates very large datasets and we rely on the development and application of statistical tools, machine-learning and AI techniques access relevant high information in our datasets. If you are interested in modelling datasets, advanced statistical analysis or coding new data analysis methods we want to develop new database matching tools, explore AI approaches to mass spectral interpretation and layer multiomics datasets together to identify regulatory mechanisms

If you are a prospective Part II or DPhil student interested in joining our group, please contact Professor James McCullagh directly and he will be happy to arrange a time to discuss further with you.
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Recent publications (2025)



<https://doi.org/10.1038/s41596-025-01222-z>

<https://doi.org/10.1016/j.cbpa.2024.102466>

<https://pubs.acs.org/doi/10.1021/acs.analchem.5c03725> <https://pubs.acs.org/doi/10.1021/jacs.5c04888>

<https://doi.org/10.1016/j.jca.2025.343979>

<https://www.amazon.co.uk/>