MCR/SCR RESEARCH DAY

Robinson College

Thank you for attending!

What could we do better?

We would love to hear from you! How did you find our Research Day?

Please do let us know if there's anything that we could do to make our next Research Day even more successful.

Sat 31st January 2026

Crausaz Wordsworth Building

Table of Contents

Programme Schedule

9:30 – 10:00	**Arrival and refreshment**
10:00	Welcome (Julia Stachyra, MCR President)
10:00 – 10:30	Dr Andrew Sharkey
10:30 – 10:50	Oliver Basquette
10:50 – 11:10	Julia Stachyra
11:10 – 11:40	**Break with refreshments**
11:40 – 12:00	Adam Pullin
12:00 – 12:30	Dr Matthew Simpson
12:30 – 12:50	Shreya Kaul
12:50 – 13:50	**Lunch**

SCR Speakers

Dr Andrew Sharkey (Pathology)

How do our Mothers' Immune Cells Control Development of our Placenta?

The placenta is the critical interface between the mother and her fetus. Early in pregnancy, specialised fetal trophoblast cells (EVT) from the placenta invade into the lining of the uterus to remodel maternal arteries. This allows a good blood supply to the developing baby. The invading fetal EVT cells come into direct contact with maternal immune cells. These interactions play a role in how well the placenta develops. Reduced EVT invasion alters allocation of resources between the mother and fetus and is associated with common diseases of pregnancy, including pre-eclampsia, stillbirth and fetal growth restriction (FGR). These disorders are major worldwide causes of maternal and fetal mortality.

I will outline our work showing how specific receptors (KIR) on maternal uterine NK cells (uNK) recognise fetal HLA-C class I molecules on invading fetal trophoblast. Of all human gene families, HLA and KIR exhibit extreme polymorphism so every pregnancy will be different. Our genetic studies have established that that certain maternal KIR/fetal HLA-C combinations increase the risk of disorders of placentation such as pre-eclampsia. The key question now is to understand the biological mechanisms underlying these genetic results. We are working to identify what functional responses are triggered in uNK by high and low-risk KIR/HLA combinations and how these regulate trophoblast function and placental development. By understanding underlying mechanisms, we aim to improve prediction and management of these diseases.

Shreya Kaul

MPhil Student, Development Studies

Intimacy on Trial: Sexual Jurisprudence of 'Transgressing' in India

This research explores how the Indian state and courts regulate personal relationships that cross socially accepted boundaries, such as inter-faith marriages, inter-caste unions, and live-in relationships. It examines how laws meant to prevent "forced" religious conversion and protect family "honour" are increasingly used to monitor, question, and sometimes criminalise consensual relationships—especially those involving women and religious or caste minorities.

Focusing on legal terms like "coercion," "fraud," and "allurement," the research shows how courts interpret these ideas in ways that often undermine adult choice and intimate autonomy. Through an analysis of major court judgments, including cases related to the controversial idea of "love jihad," the paper highlights how families and the state are given legal power to intervene in private relationships.

The research argues that these legal practices reflect deeper anxieties about caste purity, religious identity, and social order, and that the law plays an uneven role—sometimes protecting individual freedom, but often reinforcing social control. By examining how intimacy becomes a matter of public scrutiny and legal regulation, the research invites a broader conversation about freedom, consent, and state power in contemporary India.

Adam Pullin

2nd Year PhD student, Astronomy

Ear-ECG Denoising Using Heart Sounds and the Extended Kalman Filter

Electrocardiogram (ECG) recording systems are increasingly being integrated into consumer wearable systems such as smartwatches, providing users with access to clinically-relevant information about their heart activity anytime, anywhere. The increasing adoption of in-ear wearables, known as earables, as well as their stable position on the body, makes them an attractive prospect for ECG integration. However, this comes with several challenges. Other biosignals, including those from the brain and surrounding muscles, are detectable at the ear in the same frequency bands with much higher amplitudes. This means that the ECG signal-to-noise ratio (SNR) can be extremely low at this location. The few existing denoising approaches mostly rely on autoencoders. In some cases they fail to recover the ECG morphology, and their black-box nature does not allow for explainability or understanding of limitations.

To address these issues, we introduce a novel system to record and denoise ear-ECG signals, leveraging open-source hardware and the Extended Kalman Filter. In-ear audio recording of heart sounds is used to accurately determine timings of cardiac cycles. From these timings, a short-term ensemble average ECG signal is calculated, which is used to fit the parameters of a dynamical ECG model to an individual user. The Kalman filter is then applied to the full time series ECG for denoising, using the dynamical model for its state prediction steps, and heart sounds as phase measurements. We have evaluated the system with data collected from 18 participants. The results report a mean SNR of 6.4 dB, mean absolute QT interval error of 54 ms, and heart rate error of 3 BPM, demonstrating the system’s potential for continuous, non-invasive, user-friendly ECG monitoring.

Dr Matthew Simpson (Philosophy)

Logic, Inference, and Lewis Carroll's Tortoise

Not everyone knows that Lewis Carroll, the author of Alice's Adventures in Wonderland, was also a logician and philosopher. In his 1895 paper 'What the Tortoise said to Achilles', Carroll presents the story of the thoughtful but stubborn Tortoise, who refuses to reason to the end of a very simple logical argument, no matter how much his friend Achilles tries to persuade him. Carroll's story has troubled philosophers of logic greatly, though they disagree on why the story is troubling. In my view, Carroll's story challenges us to show why ordinary thinkers are not like the Tortoise - why we do in fact reason through simple arguments, as we so often do. In this talk, I will set out Carroll's story and the two different ways we can avoid being like the Tortoise. I will then explain why I prefer one of those ways, and why Carroll's story matters both for the study of logic and for theories of how we think and talk about the world around us.

MCR Speakers

Oliver Basquette

1st Year PhD Student, Astronomy

Probing the adolescent Universe with the Cosmic Microwave Background

The Cosmic Microwave Background (CMB) is the oldest light we can observe, carrying primordial information about its origins across the infant Universe. Throughout its nearly 14-billion-year journey to our modern telescopes, this relic radiation has traversed the expanding cosmos, gathering a wealth of data about the density, temperature, and composition of the aging Universe at each successive cosmic epoch. This information is encoded in the CMB's amplitude and frequency via several subtle distortions, whose faint signatures are difficult but possible to detect with today's high-precision instruments. In this talk, I introduce three of these primary distortions: the Sunyaev-Zel'dovich effect, which probes the hot gas within massive galaxy clusters; gravitational lensing, which reveals the large-scale distribution of dark matter; and the 21-cm signal, a unique window into the era of the first stars and galaxies. I explore how astronomers can unwind this intricate cosmic tapestry to extract precise information about the origins and evolution of the Universe.

Julia Stachyra

3rd Year PhD student, Chemical Engineering

Identification of Strategic Molecules in Complex Reaction Networks

The rapid growth of chemical reaction databases has enabled researchers to view synthetic chemistry from a different perspective: not as separate reactions or pathways, but as a single interconnected network. In this representation, molecules are connected by the reactions that transform them, forming a complex system similar to transportation, social, or information networks. Research on complex networks has shown that in many such systems, a small number of entities play disproportionately important roles. Motivated by this idea, my work focuses on identifying *strategic molecules*—compounds whose position in the global reaction network gives them an outsized influence over the chemical supply chain. Researchers studying graph theory have developed a range of measures, called centrality metrics, that quantify a node's importance within a network. These measures have different mathematical definitions, which can be connected to different structural roles within the network and thus different strategic functions. By combining network analysis with machine learning, I create molecule representations that reflect their structural role within the network. This role-based perspective provides a flexible framework for understanding the strategic value of chemical compounds and offers a data-driven way to support decisions in synthesis planning, green chemistry, and supply-chain design.