Kinetic modelling: a pathway to rational design and translation of nanomedicines

*Matthew Faria**

Department of Biomedical Engineering
The University of Melbourne
Parkville, VIC, Australia
matthew.faria@unimelb.edu.au

The worldwide success story of LNP vaccines have increased interest and investment in nanoengineered drug delivery systems to a degree never before seen. Despite this, the long-expected capability of drug delivery systems to target their cargo to specific cell and tissue within the body remains elusive and rarely realized. There are no clear design rules when setting out to target a new cell or disease, and formulations that look promising in simple in vitro experiments often have disappointing results when moved to more complex settings (e.g. animal models).

In this talk I will explain the concept of 'kinetic modeling' of interactions between cells and potential nanomedicine formulations, a quantitative biology approach that uses computational models to better understand underlying in vitro data. This approach enables us to isolate and characterise the biological kinetics of a drug delivery system using a range of commonly performed experimental techniques. For example, we can measure the rate at which a targeted particle binds to its target cell and separate this from the rate of internalisation or transcytosis.

Ultimately, this lets us establish performance metrics for drug delivery systems and identify points of failure/improvement for new formulations. This enables comparison of disparate technologies and facilitates rational design of novel nanotherapeutics. I will explain recent and past successes with this approach as well as a roadmap for future clinical translation.