

“Cutting-Edge Methods in Physics for Studying Intracellular Bacterial Pathogen Interactions with Host Cells and Small Molecules”

Workshop Report
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Background to the event

“Cutting-Edge Methods in Physics for Studying Intracellular Bacterial Pathogen Interactions with Host Cells and Small Molecules” is indispensable to advance our fundamental understanding of how host cells interact with intracellular bacterial pathogens, which leads for effective development of diagnostic tools as well as preventive and treatment approaches against critical global infectious diseases caused by intracellular pathogens.

Important global diseases caused by intracellular bacteria include brucellosis, listeriosis, chlamydia, salmonellosis and tuberculosis. According to the World Health Organisation (WHO), tuberculosis alone is responsible for around 10 million new cases and 1.4 million deaths worldwide each year. Drug resistance now occurs in around 0.5 million cases of tuberculosis each year and this reduces the rate of successful treatment from 85% to 57%. Tuberculosis imposes an immense burden of human suffering, specifically for poor and vulnerable people living in low- and middle-income countries. Thus, the World Health Organisation (WHO) has identified the importance of “Intensified Research and Innovation” as one of the three critical pillars for a global action framework for the end of the tuberculosis epidemic. For these reasons, tuberculosis was the primary infectious disease focus of this workshop.

Throughout the workshop, challenging biological problems that seek to understand underpinning physical processes associated with the spatiotemporal dynamics in antibiotic transport and pathogenesis of infectious diseases were discussed. This interdisciplinary workshop provided an opportunity to experts in different fields to discuss cutting-edge methods for studying intracellular bacterial pathogens and the transport of antibiotics inside a living cell.



Event themes

To address both the challenging biological problems and the cutting-edge methods in physics as potential solutions, the participants were first introduced to the overview of the topics about intracellular bacterial pathogens, followed by the technical sessions for 'Optical Spectroscopy and Imaging I/II', 'Mass Spectrometry', and 'Mathematical and Computational Analysis'. The talks sparked a productive debate on what we need to measure to understand these pathogens well enough to rationally develop treatments. For example, measuring how drugs cross a pathogen's outer membrane is technically very challenging and this is proving to be a bottleneck in rational drug design. Additionally, the following key questions were addressed in the workshop.

- How to understand the transport of small molecules (i.e., antibiotics) inside a living cell?
- How to characterise heterogeneity in host-intracellular pathogen interactions?
- Define unmet challenges in understanding and monitoring host-intracellular pathogen interactions such as control of pathogen uptake, nutrient exchange between host and pathogen, intracellular trafficking, phagosome escape, cell death, antigen presentation and cell-to-cell spread of bacteria.
- What are the most appropriate physical methods to address the questions above and where do physical methods need further development for their study?

The workshop also featured a showcase exhibition of new BioArt works by internationally renowned British artist Anna Dumitriu stemming from her artist residency at the University of Surrey. Dumitriu explored cutting edge scientific research being undertaken at the University, including quantum biology, carbon capture, vaccine research and tuberculosis. This residency was funded through an Institute of Advanced Studies Fellowship awarded to Professor Mark Chambers, who is one of the event organising committee members.



Feedback among the event participants

“Overall really fantastic event!!! People were so welcoming and really lovely, great networking opportunity..., it was really fantastic to have a meeting focused towards the overlap of chemistry physics and biology. ... I have only been to a couple of in person conferences but this has by far been the best, specifically in terms of networking and sparking dialogue because different disciplines. Networking dinner was really fantastic and I was very thankful that vegan options were available.”

“Great event, I really enjoyed it and gave me a lot of food for thought for future grant/studentship proposals.”

Next steps – Outcomes

The workshop provided opportunities to engage the participants with the speakers and to stimulate interactions for developing potential collaborative projects at the intersection of physics and life sciences, specifically in the field of host-intracellular bacterial pathogen interactions. The main outcome is to create an international interdisciplinary collaborative network with workshop

participants that aims at encouraging cross-disciplinary collaborations not only to study the pathogenesis and treatment of global diseases, such as tuberculosis, but also to ultimately influence future related policy.

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