JAMES RENNIE BEQUEST

REPORT ON EXPEDITION / PROJECT / CONFERENCE

Expedition/Project/ Conference Title: Motile Active Matter international conference

Travel Dates: 16/11/2024-24/11/2024

Location: Bonn, Germany

Group member(s): Diana Coroiu

Aims: Present my PhD research and meet people in fields that are closely related to mine

Photography consent form attached: *(please refer to your award letter)*

☐ Yes
☒ No

OUTCOME (a minimum of 500 words):-

The Motile Active Matter conference brought together researchers from physics, biology, and engineering to explore active matter systems, from bacteria to synthetic microswimmers. The conference focused on understanding, modelling, and exploiting motility across scales, which directly relates to my PhD project on using the bacterial flagellar motor (BFM) as a readout to obtain whole-cell biosensors.

In my work, I engineered and characterised *E. coli* strains that respond to environmental analytes through a change in the direction of the BFM rotation. In wild type *E. coli*, the BFM direction is tightly controlled by the chemotactic pathway through the phosphorylation and dephosphorylation events of the cytoplasmic protein CheY. When phosphorylated, CheY interacts with the BFM and switches its direction from counterclockwise to clockwise. BFM-based sensors work by having the so-called *cheY*** gene (encoding a mutant form of CheY which is always active) controlled by an inducible promoter. Thus, in the presence of the analyte of interest, the cells will synthesise CheY** and their motors will rotate clockwise more often.

At the conference, I presented my findings on the response dynamics and sensitivity range of this system, from both a theoretical and experimental perspective. My talk was well received, sparking engaging discussions with other researchers interested in biosensing or bacterial motility. Several attendees approached me afterwards, raising insightful questions about the potential of this new way of sensing. The poster session also allowed for deeper conversations, where I exchanged ideas with scientists working on motility in different contexts.

A series of talks at the conference were particularly interesting to me, as they were looking into *E. coli*'s flagellar motor biophysical and biochemical control. For example, Navish Wadhwa had a very exciting talk where he showed how different mutations in stator proteins affect swimming dynamics and efficiency. Another highlight of the conference was Victor Sourjik's talk on exploiting the regulation mechanisms of motility machinery expression in *E. coli* to obtain chemotactic minibots (minicell-based biohybrids) for cargo delivery. I also learnt about many other aspects of bacterial motility such as the physics of swimming close to surfaces, and the mechanisms of viscotaxis (movement in response to viscosity changes) and rheotaxis (movement in response to fluid flow). Not only did I find all this new knowledge

and discussions exciting, but I also believe they will be useful as I am embarking on a new project on the effect of flow on the bacterial flagellar motor.

I also found several other talks, which were more distant from my area of expertise, very interesting. For example, I learnt about synthetic microswimmers, from how they can be synthesised and engineered to very interesting biological knowledge that we can gain from their behaviour. Another example is Antoine Deblais' talk, whose work recently received an Ig Nobel prize. He showed how they modelled worms as active polymers and, through a combination of theory and experiments, they show that differences in activity of these polymers will affect the time taken by the worm to exit a porous material. Another exciting talk was the one given by Manu Prakash, who walked us through his expeditions around the world, where he came across numerous different ways that motility has evolved in microorganisms.

Beyond the formal sessions, I had the chance to reconnect with colleagues from past conferences and meet new researchers. Due to the small nature of the conference, there were countless opportunities to discuss exciting science in an informal setting, as well as gain insight and advice from senior academics. I particularly enjoyed conversations about careers in science and reasons why to pursue such careers from the perspective of accomplished researchers.

Overall, attending the Motile Active Matter conference was an enriching experience that deepened my understanding of bacterial motility, and introduced me to new physical concepts and mathematical models and tools that I would like to explore in the future. I left with new ideas, friends, and a renewed enthusiasm for my next research phase. I would like to thank the James Rennie Bequest for making travelling to this conference possible.