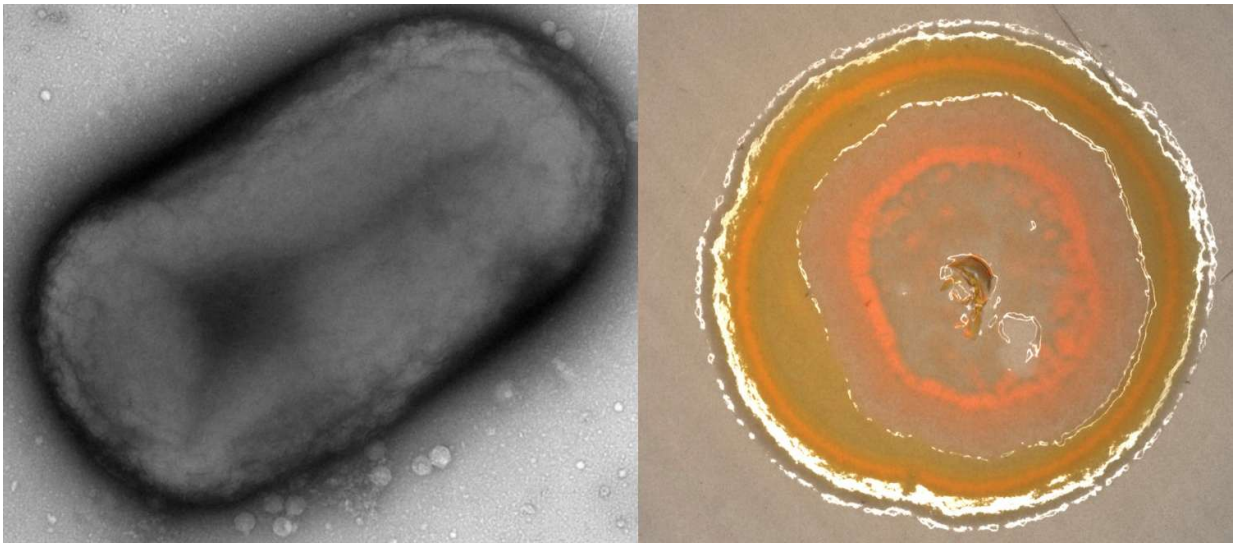
Evolvability of interactions between bacterial outer surface molecules and bacteriophages: from atoms to biofilms

Project ID: 3722

Supervisory team

Main supervisor: Dr Wolfram Moebius (University of Exeter)
Second supervisor: Dr Vicki Gold (University of Exeter)
Collaborators: Prof Phillip Stansfeld (University of Warwick) & Dr Maisem Laabei (University of Bristol)

Host institution: University of Exeter



Project description: Bacteriophages are viruses of bacteria: they infect and often kill the bacterial cell. They play a key role in microbial communities and are an alternative to chemical antibiotics for managing microbial populations, for example in infections. Phages and bacteria are not immutable; instead, they are engaged in a continuing battle between bacterial defence and phage adaptation. Bacteria evolve to escape phage predation and phage counter-adapt to overcome this. One key role in this battle is played by bacterial outer surface molecules, which serve as attachment sites for phages. Bacteria can evolve changes to these molecules and phages evolve changes to their structure to adapt, altering infection success and the range of bacteria that can be infected.The course of this battle depends on what changes are available to both bacterial cell and phage, which trade-offs these imply, and on the environmental conditions under which they interact. Building on preliminary results from the research groups you will join, you will investigate how all these factors affect coevolution across scales, from atoms to biofilms, with focus on the outer surface molecule lipopolysaccharide (LPS).You will first characterise how phages bind to bacterial surface molecules under standard lab conditions using cryo-electron microscopy, for both ancestral and experimentally evolved phage-host pairs. You will complement these experiments with coarse-grained molecular dynamics simulations to investigate how mutations alter recognition and binding between phages and bacterial cells. You will then repeat experimental evolution and atomistic characterisation under different experimental conditions, from unperturbed liquid to dense biofilms. Finally, you will investigate which factors (like excluded volume or reduced motion) are responsible for the environment-dependent evolutionary path.To undertake this research, you will join two interdisciplinary research groups at the Living Systems Institute at the University of Exeter. Both groups share a strong interest in phage–bacteria interactions: Wolfram

Moebius' group investigates phage evolution while Vicki Gold's group specialises in cryo-electron microscopy and structural biology. We will draw on our network of collaborators to provide specific expertise and enable you to investigate additional model systems. The PhD project will provide interdisciplinary training in a broad range of fields, including experimental evolution, cryo-electron microscopy, molecular simulations and quantitative analysis.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.