Bioelectrical signatures of environmental sensing by microbial populations

Supervisory team:
Main supervisor: Dr Kirsty Y. Wan (University of Exeter)
Second supervisor: Dr Nuno Reis (University of Bath)
Dr Remy Chait (University of Exeter), Prof Gaspar Jekely (University of Exeter)

Collaborator: Dr Paulo Rocha (Coimbra, Portugal)

Host institution: University of Exeter (Streatham)

Project description:

Despite their small size and apparent simplicity, microorganisms are remarkable sensors. They are able to detect minute changes in their local environment and respond accordingly. This feat is critical to their survival in a turbulent and constantly changing habitat. Photosynthetic algae - a widely distributed group of organisms that are critical to the health of marine and freshwater ecosystems, have evolved acute sensitivity and finely-tuned responses to photic stimuli in particular. Many species are motile, and are able to control their own movement and navigate toward favourable conditions have a distinct advantage, as efficient photosynthesis is predicated upon exposure to the correct wavelength, intensity, and type of photostimulus. But how is this light-dependent movement regulated at the single-cell level, and how can we measure and control it at the population level? In many species, the sensory-motor transduction pathway is complex and not well understood, but is known to be dependent on transmembrane ion fluxes. We propose a unique interdisciplinary programme with both experimental and theoretical components, to shed light on this important cellular phenomenon.

The aim of the phd project is to devise new lab- on-a-chip technology to manipulate microbial population responses to patterned light stimulation, and to detect cellular responses using extracellular electrical recordings. Different patterns of movement will be recorded as changes in electrical activity. These bioelectrical signatures contain rich spectral information and dynamical features, which will be used to understand and model the spatiotemporal dynamics of population responses to environmental stimuli. You will undertake interdisciplinary training in a number of areas of frontier biosciences research, including fabrication of microfluidic and microelectronic devices, live-cell imaging and optics, microbiology, and biophysical modelling. These are highly-transferrable skills that will likely have broad appeal, value, and applicability beyond the lifetime of the PhD project.