SWBio DTP

Programming cyanobacterial motility and growth to engineer living materials

Supervisory team:
Main supervisor: Prof Kirsty Wan (University of Exeter)
Second supervisor: Dr Hannah Laeverenz-Schlogelhofer (University of Exeter)
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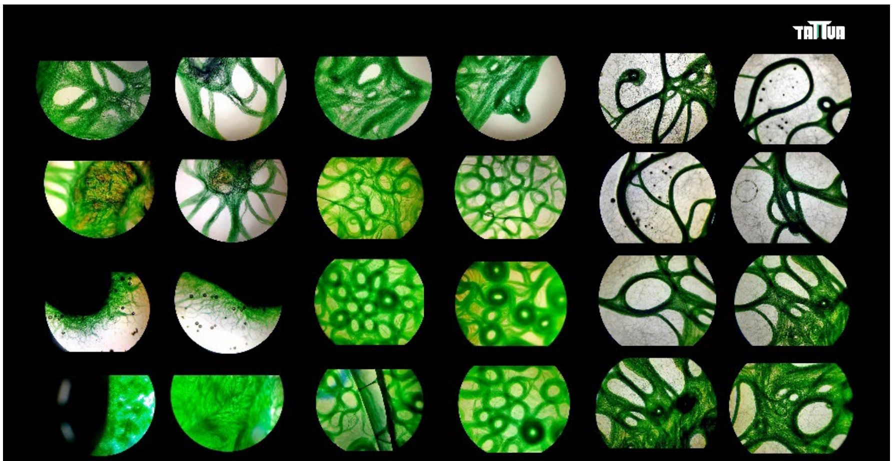
Host institution: University of Exeter (Streatham)
CASE partner: Tattva Limited

Project description:
Cyanobacteria are abundant microorganisms that play a crucial role in Earth's ecosystems, performing key processes such as photosynthesis and nitrogen fixation. Filamentous cyanobacteria exhibit an intriguing form of motility known as gliding, where they move across surfaces without the aid of flagella or cilia. Despite the biological significance and industrial potential of cyanobacterial motility, the biophysical mechanisms that underpin this process are not well-understood.



Patterns generated by filamentous cyanobacterial growth and motility under different physical conditions

Recently, cyanobacteria have emerged as promising organisms for the creation of engineered living materials (ELMs). This exciting PhD project aims to design novel methods for programming cyanobacterial growth and motility to engineer living materials. We will combine experimental and computational approaches to develop a comprehensive understanding of how these microorganisms move and interact with their environment.

This project will address three major themes:
1) how are filamentous cyanobacterial growth and motility influenced by applied external stimuli such as light, temperature, electrical fields?
2) how do substrate material properties, such as stiffness, and chemical composition, impact cyanobacteria growth and motility?
3) emergent pattern formation in motile cyanobacteria collectives within 3D environments

We will perform state-of-the-art microscopy and develop bespoke image analysis tools to track cell motility and growth. This will allow us to quantify how behaviour changes in response to controlled external stimuli, particularly their phototactic (response to light) and electrotactic (response to electric fields) behaviour. We will develop mathematical models that integrates growth and motility to predict their collective behaviour. This integrative approach will help identify new ways to control or direct cyanobacteria motility or growth patterns for bio-engineered applications. Understanding these cellular-level responses is a crucial step toward incorporating these microorganisms into functional living materials with potential applications in construction, environmental sensing, or regenerative systems.

This project includes an exciting placement opportunity with Tattva, an innovative Devon-based start-up developing novel cyanobacterial ELMs. During this placement, you will apply your findings to Tattva's bioprocess, which involves growing cyanobacteria-based materials for carbon sequestration and construction applications. Tattva's cutting-edge solid-state bioprocess, similar to tissue engineering, is being developed for use in the building industry. This partnership will offer you hands-on experience in translating academic research into practical, industrial applications, working closely with a pioneering company that aims to revolutionise sustainable construction with living materials.

In summary, this interdisciplinary project offers a unique opportunity to work at the intersection of microbiology, biophysics, and bioengineering, while collaborating with industrial partners.

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.