2015 YCCSA SUMMER SCHOLARSHIP PROJECT SUBMISSION

Date	*2015-01-08*
Main Supervisor's	*Dr. Laurence Wilson*
Department	*Department of Physics*
Co-supervisors' names and Departments	*Prof. Seth Davis (Department of Biology)* *Prof. Martin Bees (Department of Mathematics)*
Project Title	*Quantitative biology squared: quantitative genetics applied to quantitative, high-speed imaging of swimming behaviour*
Project Description	*Swimming behaviour in single-celled eukaryotes is a complex process that shows relevance in diverse contexts. This includes sperm swimming, pathogen movement in blood and the deterministic movement of algal cells in response to environmental stimuli. Eukaryotic swimmers often use flagella for rapid propulsion. Flagella are multi-purpose organelles; many single-celled organisms beat their flagella in a whip-like fashion, allowing them to move or pump fluid. The mechanical structures within flagella are highly conserved, and are found across all major kingdoms of the eukaryotic domain. Chlamydomonas reinhardtii is a model organism used to study flagella: excellent genetic resources on flagellar components exist to associate genotype to behavioural consequence, and the relatively simple flagellar configuration make it a good system to study the fluid dynamics of flagella beating. Notably, the two approaches of physics and genetics are rarely, if ever, combined. Mathematics can be a bridge.* *This project will use a new development in quantitative genetics now available in C. reinhardtii (Davis lab) to "map" those regions of a genome associated with swimming behaviour. Visualising flagella has been a challenge in optical microscopy due to their small size and rapid movement. To overcome these past obstacles, the student will use various contrast-generation methods (e.g. phase contrast, DIC, dark field) coupled with high-speed imaging to quantify swimming behaviour (Wilson and Bees labs). This application of quantitative genetics to quantitative imaging is novel and the analyses of flagellar-beating patterns can be performed under an array of physiological and genetic contexts. By correlating genomic variation with swimming behaviour – swimming speeds and flagellar beat frequency, for example – the student will provide novel insight into the structure/function relationships of the flagellum's mechanics. The student will culture and image cells, before performing customised quantitative assays based on the integrated use of image analysis with statistical genetics. The project will suit students with multi-disciplinary interests, as research time will be split roughly 50:50 between computational and lab-based work to bridge biology, physics and mathematics.*
Required skills	*Data analysis with Excel or a comparable package; basic programming (any language) would be helpful. A general level of statistical understanding is highly desirable.*
Project dates	*Monday, 13 July 2015 - Friday, 11 September 2015.*
Other information	*The student will engage with multiple investigators to drive forward an interdisciplinary approach that intersects physics, mathematics and biology.*
References	*(1) Polin et al., "Chlamydomonas Swims with Two "Gears" in a Eukaryotic Version*

	of Run-and-Tumble Locomotion", Science ***325*** *p.487 (2009).* *(2) Anwer et al. " Natural variation reveals that intracellular distribution of ELF3 protein is associated with function in the circadian clock", eLife e02206 (2014)*