PhD Project Advertisement

Project title: ***Genome editing enhanced myxobacterial predators for biological control of diverse crop pathogens***
Project No: FBS25-30-Whitworth-ac

Lead supervisor: Professor Dave Whitworth, Department of Life Sciences, Aberystwyth University

Email: dew@aber.ac.uk

Co-supervisors:
Dr Zoltan Kevei, Centre for Soil, Agrifood and Biosciences, Cranfield University
Dr Dylan Phillips, Dept of Life Sciences, Aberystwyth

Project description: Pathogens have a huge impact on conventional agriculture by decreasing yield and increasing spoilage. They also threaten the security of alternative agricultural systems such as hydroponics/vertical farming/insect farming/cultured meat. There is consequently an immediate need for sustainable methods to tackle pathogens of diverse crops.

Biological control (biocontrol) is an attractive method of crop protection as it avoids the need for unsustainable pesticides, which are problematic due to the emergence of resistance. Myxobacteria are extremely promising biocontrol agents, being non-pathogenic, environmental organisms. They exhibit predatory activity against an exceptionally wide range of prey (including pathogenic oomycetes, fungi and bacteria), by secreting a broad spectrum of digestive enzymes, toxins and antimicrobial peptides1.

Genome-wide association studies (GWAS) have revealed that myxobacteria carry genes whose presence correlates with poor predatory activity against prey organisms2. Deletion of such 'putative predation-inhibitory genes' (PPIGs) is expected to enhance the predatory activity of myxobacteria, making them more effective biocontrol agents.

Aims:

This studentship will identify myxobacterial PPIGs for diverse pathogens, use genome editing to remove PPIGs from myxobacterial strains and test whether genome-edited strains can better protect diverse crops from disease:

1-PPIG identification. In vitro predation assays will test how efficiently myxobacteria strains can prey upon a range of agriculturally-relevant pathogens (e.g. Pseudomonas syringae, Phytophthora infestans, Metarhizium robertsii, Bacillus thuringiensis). GWAS will then be undertaken to identify PPIGs for each pathogen (and PPIGs which inhibit predation of multiple pathogens).

2-Engineering a CRISPR-cas system. Using a range of molecular genetics methods, a CRISPR-cas9 system will be engineered for making multiple unmarked deletions in myxobacteria. Plasmids containing a cas9 gene and guide RNAs (gRNAs) will be created. gRNAs will be designed to remove multiple PPIGs (identified during aim 1) from the myxobacterial genome. Successful gene loss will be confirmed by genome sequence analysis.

3-Crop protection assays. Two alternative food production scenarios (farmed crickets and hydroponic tomatoes) will be explored. Susceptible crops will be challenged by adding pathogens with/without wild-type myxobacteria. The effect of pathogen and predator treatments will be evaluated using a variety of metrics, such as mortality, growth rate, and yield. Crop protection assays will then be repeated using genome-edited myxobacteria to test whether the loss of PPIG genes has significantly increased the efficacy of myxobacteria as a biocontrol agent. Of particular interest will be PPIGs which increase effectiveness in both crop systems.

Refs: 1-doi:10.1007/s12602-022-10036-4, 2-doi:10.3389/fmicb.2019.02650

Training opportunities: The student will learn how to cultivate and characterise a wide range of microbes, including myxobacteria and fungal/bacterial/oomycete pathogens. They will be trained how to perform predation assays, and how to enumerate microbes using molecular and traditional methods. They will also be trained in molecular genetics

methods and DNA sequence analysis, including whole genome sequencing/annotation and GWAS analysis. Training will be provided in the cultivation of crickets/tomatoes, and assessment of their health/disease status. Academic and professional development will be supported through taught modules and by conference attendance. Aberystwyth and Cranfield both offer career development programmes where students can participate in a range of interactive workshops covering the communication of postgraduate research skills to employers, effective academic applications, etc. The student will also have the opportunity to develop communication skills via conference presentations and postgraduate teaching opportunities, which can be formalised leading to AFHEA status.

Project supervision style: In addition to informal discussions, the student will meet with the primary supervisor weekly to discuss and receive feedback on progress. Depending on the phase of the project and whether the student's work requires their particular skills, weekly meetings will also be attended by DP and/or ZK (by Teams). DW's group has monthly group meetings for group discussions and to give students practice presenting their research. One Teams meeting per month will also be held with all three supervisors to monitor progress and to consider the training needs of the student. Technical supervision in the laboratory will be undertaken by the supervisors and appropriately experienced postgraduate/postdoctoral researchers. The student's progress with be evaluated in line with AU's standard practice (minuting of meetings, annual reports and annual progression interviews).

Student profile: We seek candidates with a background in biological sciences including bioinformatics, biotechnology, entomology, genetic engineering, genomics, microbiology, molecular genetics, plant biology

Stipend (Salary):
FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2024/25 this is £19,237 (£21,237 at Brunel University) and it will increase slightly each year at rate set by UKRI.

Equity Diversity and Inclusion:
The FoodBioSystems DTP is committed to equity, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the FoodBioSystems DTP website and include:

- Offering reasonable adjustments at interview for shortlisted candidates who have disclosed a disability or specific learning difference.
- Guaranteed interview and applicant mentoring schemes for applicants, with UK home fees status, from eligible under-represented ethnic groups.

These are opt-in processes**.**

Our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

For up to date information on funding eligibility, studentship rates and part time registration, please visit the FoodBioSystems website.