

Bath Monash Global PhD Programme in Sustainable & Circular Technologies

Project Title:	Peptide polymer fibres: Novel structures, syntheses and applications
Supervisors at Bath:	Dr Hannah Leese (lead)
Supervisors at Monash:	Prof Andrea Robinson
Home Institution:	Bath
Indicative period at Host Institution:	15 months

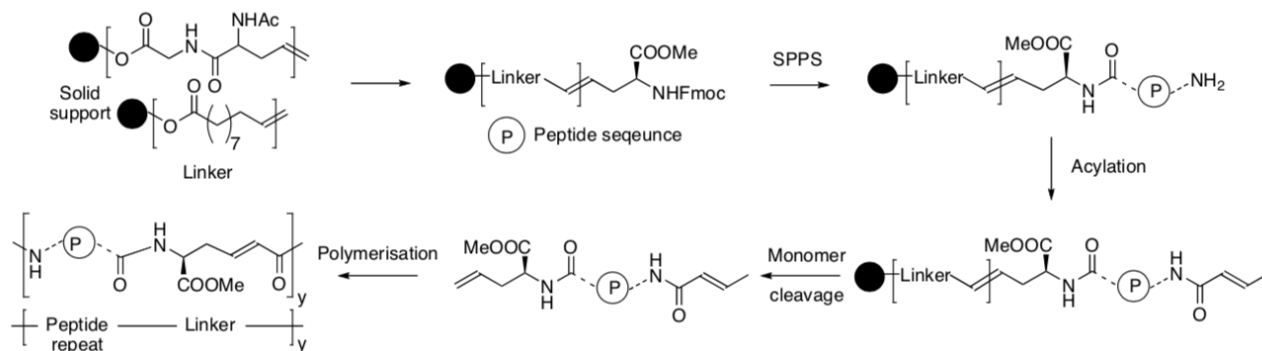
Project Summary

High performance fibres and synthetic textiles are used in large quantities in both industrial and consumer products. They are produced from petrochemical sources and are rarely biodegradable. Whilst some are in principle recyclable, laundry operations, for example, lead to uncontrolled release of microplastic pollution into the environment. Nature provides many examples of exquisite protein engineering serving a wide range of functions, including high-performance fibres i.e. spider silk. There are obvious advantages to copying these designs, however, the resultant peptide-based materials can be marred by poor *in vivo* stability and availability, challenging synthesis, upscaling and high manufacturing costs. But we can utilise chemistry to overcome these limitations to engineer enhanced chemical, physical and mechanical properties into the native, biologically active or functioning peptide. **Therefore, this project aims to combine peptide design and fibre spinning into high-performance fibre materials to drive towards circular textiles.**

The project will develop a novel catalysis-driven polymerisation strategy to generate well-defined linear peptide polymers, and exploit methods to design, synthesise and evaluate functional mimetics of resilin (and other native bioelastomers) (Scheme 1). Resilin is an elastomeric protein found in specialised regions of insect cuticles where it functions to provide low stiffness, high strain and efficient energy storage, and remarkable locomotion (i.e. the jump in fleas, acceleration of spittle bugs and hover of dragonflies). A short elastic repeat motif may be the key to resilin's extraordinary resilience (recovery after deformation) which exceeds synthetic polybutadiene, a high resilience rubber.

This project will develop, *for the first time*, a simple, catalysis-driven polymerisation method for linking multiple copies of a *peptide sequence with directional N→C ligation throughout the entire biopolymer*. Recent advances in homogeneous catalysis now provide highly efficient, *biocompatible* catalysts capable of forming new C-H (hydrogenation) and C-C bonds (metathesis) within peptides, with excellent stereo-, chemo- and regioselectivity. This control facilitates the incorporation of specially designed residues and the generation of synthetic materials with novel structures, properties and applications.

The groups of Professor Andrea Robinson (Monash) and Dr Hannah Leese (Bath) will join their expertise in peptide design and high-performance fibre materials development. Synthetic resilin polymers will facilitate structural investigations of resilin, other elastomeric proteins, such as elastin, glutin and spider silk, hybrid structures and the inclusion of additives. Post synthesis, the continuous fibre spinning production will be optimized and their physical (e.g. liquid crystalline behaviour, hygroscopicity), mechanical (e.g. resilience, durability and strength), recoverable and structural properties (*in situ* X-ray, EM, etc.) will be fully characterised.



Scheme 1

Features of the programme

- PhD researchers will be registered at both institutions and will be awarded a joint PhD degree.
- PhD researchers will be jointly supervised by academics from both Monash and Bath Universities.
- All PhD researchers in the joint programme will also undertake a bespoke advanced training plan covering a range of topics focusing on sustainability.
- Applicants can apply to either Monash University or the University of Bath as their nominated home institution.
- PhD researchers will undertake a period of no less than 12 months at the partner institution.
- Up to four scholarships/studentships will be offered. Additional and suitably qualified applicants who can access a scholarship/studentship from other sources will be also considered. Evidence of funding must be provided.
- The scholarships/studentships include:
 - a *full tuition fee sponsorship* provided by Monash or Bath for the course duration (up to a maximum 42 months). **Funding for Bath-based projects, such as the one advertised here, is available to candidates who qualify for Home fee status only.** In determining Home student status, we follow the UK government's fee regulations and [guidance from the UK Council for International Student Affairs \(UKCISA\)](#). Further information may also be found within the university's [fee status guidance](#). EU/EEA citizens who live outside the UK are unlikely to be eligible for Home fees and funding. Funding for Monash-based projects is available to candidates of any nationality.
 - a *living allowance (stipend)* provided by Monash or Bath Universities.

Note: Overseas Student Health Cover (OSHC) must be paid by the student, unless covered by the university.

How to apply

You MUST express interest for three projects in order of preference. Please submit your application at the Home institution of your preferred project ('Home' institution details can be found in the project summary). However, please note that you are applying for a joint PhD programme and applications will be processed as such.

The deadline to submit applications is **11th April 2021**

Monash University

Expressions of interest (Eoi) can be lodged through <https://www.monash.edu/science/bath-monash-program>. The Eoi should provide the following information:

CV including details of citizenship, your Official Academic Transcripts, key to grades/grading scale of your transcripts, evidence of English language proficiency (IELTS or TOEFL, for full requirements see: <https://www.monash.edu/graduate-research/faqs-and-resources/content/chapter-two/2-2>), and two referees and contact details (optional). You must provide a link to these documents in Section 8 using Google Drive (Instructions in Section 8).

University of Bath

Please submit your application through the following link: <https://www.csct.ac.uk/bath-monash-global-phd-programme/>

Please make sure to mention in the “finance” section of your application that you are applying for funding through the joint Bath/Monash PhD programme for your specified projects.

In the “research interests” section of your application, please name the three projects you are interested in and rank them in order of preference. Please also include the names of the Bath lead supervisors.