University of Nottingham
Nanoscale and Microscale Research Centre

Nanoscale and Microscale Research Centre (nmRC)

Undergraduate Summer Research Projects 2022

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UNDERGRADUATE SUMMER RESEARCH PROJECTS 2022

The Nanoscale & Microscale Research Centre (nmRC) is delighted to announce three funded summer research projects are now available to current University of Nottingham Undergraduate students. These studentships will last for six to eight weeks between June and September 2022 and are open to second and third year students (from any discipline) interested in developing a career in research and keen for experience in a world leading analytical facility.

Selected students will get hands-on experience in an acclaimed research environment using a range of cutting edge experimental techniques, academic methods and fundamental laboratory skillsets to contribute to real and current scientific investigations. The research projects available are designed to offer an opportunity to view, experience and contribute to the University 's research activities. Guided learning will be blended with both general and technically specific training in laboratory practice in addition to opportunities to engage with our research community and visit a broad range of our facilities.

Please read the introductory details to the projects on offer provided below for more specific details.

Funding:

The studentships will be undertaken for between six to eight weeks with £285.00 being paid to each student per week (£1,710-£2,280 in total). Adjustment to project length may be considered on a case by case basis as appropriate. Projects will also possess an experimental budget to enable use of relevant facilities.

Eligibility and Timing:

This opportunity is open to second and third year University of Nottingham Undergraduate students who are interested in developing a career in research. Candidates must be averaging a 2.1 or above. The placements will take place between June and September 2022. Initial applications will be reviewed on closing, with shortlisted candidates invited to interview.

How to apply:

1. **Please complete the application form via the following link:**

   https://forms.office.com/r/L2b0bGjDh2

2. **Please e-mail a copy of your CV to isac@nottingham.ac.uk**

Closing Date:

Friday 10th June.

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PROJECT 1:

WORKFLOW DEVELOPMENT FOR ELECTRON MICROSCOPY IMAGING OF NANOPARTICULATE SOLUTIONS / SUSPENSIONS

Dr Chris Parmenter, Dr Julie Watts, Dr Jacqueline Hicks




Pharmaceutical preparations, soft matter or nanoparticle suspensions are usually formulated in the presence of water or a buffer to maintain the hydro-phillic/-phobic interactions that sustain sample structure. Characterising the particle size and consistency of such formulations is a critical research step to determine if what has been made is as designed.

Indirect approaches such as light-scattering, laser diffraction give large volume approximations based on data modelling. However it is observation via microscopy that allows a direct assessment of sample structure, morphology and consistency. Where samples have nanoscale components of interest it is electron microscopy specifically that is necessary to resolve them. But this is not always straight forward, particularly if features are expected to fall in the 100-500nm size range because:

⇒ **There is a cross-over between the use of either Transmission or Scanning Electron Microscopy (TEM / SEM) techniques at this scale.**

⇒ **TEM / SEM take place under vacuum so soft matter or 'wet' samples require either the removal of water or stabilisation of the sample by cryogenic preparation.**

⇒ **Dehydration can be done via several controlled or uncontrolled methods but these can lead to aggregation, rearrangement and collapse of self-assembled structure.**

⇒ **Cryogenic sample preparation typically retains the water during freezing but is much more complex to run, requires expensive hardware and can still suffer from some freezing artefacts.**

This project will therefore look to compare and contrast several of the available preparation and imaging methods as a means to develop a workflow selection tool that can be used to inform future nmRC users of the best approach to take for their samples. Variations on preparation approaches, instrument types and analysis techniques will include the use of TEM and SEM imaging, negative staining of dried samples, and variants of cryogenic freezing.

The student undertaking the work will receive:

* **An introduction to electron microscopy, including training on (or of elements) of a TEM and a SEM.**
* **Training on use of sample preparation techniques for electron microscopy.**
* **An opportunity to work within a world leading, cross faculty research facility.**
* **The opportunity to contribute to/author a reference document for future students.**
* **The opportunity to prepare a conference submission on this topic.**
* **Research collaboration with nmRC staff and postgraduate researchers.**

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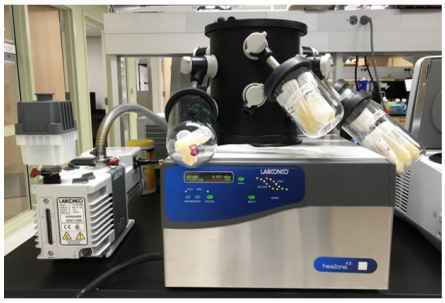
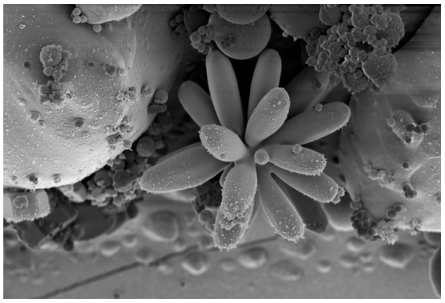
PROJECT 2:

OPTIMISING THE FORMULATION & FREEZE DRYING PROCESS FOR BIOPHARMACEUTICALS

Dr Karen Alvey[1], Dr Marion Limo[1], Prof Stephanie Allen[2]

1. The Nanoscale & Microscale Research Centre (nmRC)
2. Molecular Therapeutics & Formulation Division, School of Pharmacy





The shelf life of biopharmaceutical products, such as a therapeutic proteins, are often enhanced by manufacturing the product into a solid dosage form. Freeze drying is the most common method for drying biological medicines due to the low temperature requirements and good batch reproducibility.

The stability of the biopharmaceutical is important to its therapeutic effect and this can be influenced by the **formulation** and also the freeze drying **process**. With a wide range of biopharmaceutical products including proteins, vaccines and biomaterials, optimising both formulation and process parameters is essential for developing a stable final product.

⇒ **In an industrial freeze drying process, both the temperature and pressure can be varied.**

⇒ **As well as long term stability and therapeutic effect, key characteristics of the freeze dried product include its appearance, moisture levels, porosity, and reconstitution time.**

⇒ **The formulations of biopharmaceutical products can be complex, requiring excipients with different roles (e.g. for bulking, stability and pH).**

The aim of this project is to explore processing and formulation parameters on freeze dried biopharmaceutical product quality. The results generated from the project will be used to develop a guide for researchers on appropriate freeze drying manufacturing strategies. Depending on the results of the research, opportunities to publish will also be explored.

The student undertaking the work will receive:

* **Context on the industrial manufacture of biopharmaceutical products and the challenges associated with product quality from a clinical perspective.**
* **Training on the preparation of biopharmaceutical products (such as therapeutic proteins).**
* **Training on the use of freeze drying.**
* **Training on the use of light and electron microscopy.**
* **An opportunity to work within a world leading, cross-faculty research facility.**
* **The opportunity to contribute to /author a reference document for further students.**
* **The opportunity to prepare a conference submission on this topic.**

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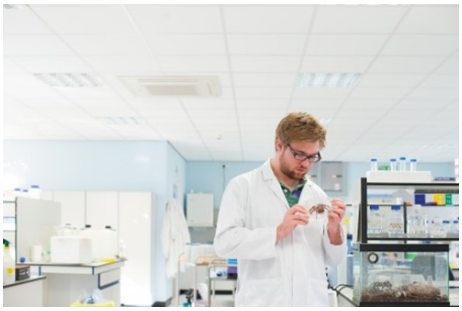
PROJECT 3:

ASSESSING THE VARIABILITY OF ARACHNID ANATOMY

Dr Tom Hartman, Mrs Nikki Weston, Mrs Denise McLean



The arachnids are a big group within the phylum Arthropoda (arthropods) with significant variability. They are broadly characterised by having eight walking legs, six or eight eyes and producing a number of different types of silks from glands in their bodies that are deposited from spinnerets at the ends of their abdomens.

Both the silks and the spinnerets are particularly variable both within a single type of spider and between different species. This project will seek to determine and capture how much variety there is between related and unrelated species. It will also look at some of the other variations in spiders such as their fangs (chelicerae), pedipalps and looking at why some spiders can walk up vertical surfaces and other cannot.

This assessment will involve a range of appropriate preparation steps and subsequent imaging by optical and scanning electron microscopy of a number of spiders.

NOTE however students will not be handling live spiders but rather a number of preserved ones and shed skins which have all the anatomical features perfectly preserved.

The student undertaking the work will receive:

* **An introduction to and training on optical and scanning electron microscopes.**
* **Training on use of sample preparation techniques for optical and electron microscopy.**
* **An introduction to and training in image analysis and manipulation.**
* **An opportunity to work within a world leading, cross faculty research facility.**
* **The opportunity to generate a research report and image bank for use in upcoming research projects.**
* **Research collaboration with nmRC staff and postgraduate researchers.**