2027 Summer Research Project

Section	Description
Project title	Formulating bioactive lipid nanoparticles for mRNA immunotherapy
Hours & delivery	The project requires students to spend at both Dutton Park campus and St Lucia campus for research activities between 30-36 hours per week for a duration of 6 weeks. The main location for research is at the school of pharmacy and pharmaceutical sciences, while characterisation facilities at Frazer Institute and Australian Institute for Bioengineering and Nanotechnology will also be accessed to support the project.
About the project (150–250 words)	Lipid nanoparticles (LNPs) have become the leading delivery system for mRNA vaccines and therapeutics. Beyond delivering mRNA, there is increasing opportunity to design LNP formulations that actively modulate immune responses and enhance therapeutic outcomes. This project aims to develop bioactive LNPs by incorporating naturally derived bioactive compounds with immunomodulatory properties into mRNA-LNP formulations. A library of bioactive natural compounds will be explored and incorporated into LNP formulations to investigate how they influence nanoparticle properties, mRNA delivery and immune responses. Formulations will be screened for efficient mRNA transfection in dendritic cells, followed by analysis of dendritic cell activation and immunomodulatory effects. By integrating mRNA delivery and immune modulation within a single formulation, this project will explore new design strategies for multifunctional LNPs and establish a foundation for developing next-generation mRNA vaccines and cancer immunotherapies.
What you'll do (100-150 words)	The student will prepare mRNA-loaded LNP formulations containing selected bioactive natural compounds and systematically screen their formulation and biological performance. LNPs will be characterised for particle size, surface properties and mRNA encapsulation. Selected formulations will then be evaluated in dendritic cells to determine cellular uptake and mRNA transfection efficiency. The student will further investigate their immunomodulatory activity by measuring dendritic cell activation and relevant immune markers. The results will be compared across formulations to identify bioactive compounds and LNP compositions that provide a favourable combination of efficient mRNA delivery and immune modulation.
What you'll learn (100–150 words)	The student will gain practical experience in nanoparticle formulation, mRNA delivery and immunoengineering. Key laboratory skills will include preparation and physicochemical characterisation of LNPs, handling of mRNA formulations, mammalian cell culture and cellular transfection assays. The student will also gain experience in evaluating dendritic cell responses using techniques such as flow cytometry and other immunological assays. Through experimental design, data analysis and interpretation, the student will develop an understanding of how nanoparticle composition influences both mRNA delivery and biological responses. The project will provide multidisciplinary training across nanotechnology, pharmaceutical formulation, molecular biology and immunology.

Project outcomes (75–125 words)	The project is expected to identify bioactive natural compounds and LNP formulations that combine efficient mRNA delivery with favourable immunomodulatory activity in dendritic cells. The resulting formulation–delivery–immune response relationships will provide preliminary design principles for developing multifunctional LNPs that act as both mRNA delivery vehicles and immune modulators. Promising formulations may provide candidates for further evaluation in mRNA vaccine or cancer immunotherapy applications.
Who should apply? (75–125 words)	This project is suitable for students with an interest in nanomedicine, drug delivery, mRNA therapeutics, immunology, or pharmaceutical sciences. Applicants from pharmacy, biomedical sciences, molecular biology, biotechnology, or related disciplines are encouraged to apply. It would particularly suit students interested in hands-on laboratory research and developing deeper research capability in nanoparticle formulation and mRNA therapeutics. Students considering future research-intensive study or a research career in pharmaceutical sciences and biotechnology are especially encouraged.
Team & supervision (75–125 words)	The project will be supervised by Dr Hao Song, Group Leader at AIBN and SPPS. The group operates laboratories across AIBN and SPPS, with established capabilities in high-throughput LNP screening, nanoparticle characterisation, and mRNA vaccine and immunotherapy development. Students will work closely with experienced postdoctoral researchers and PhD students in the group, who will provide day-to-day guidance, technical training, and support throughout the project.
Additional opportunities (optional)	
Additional requirements (if applicable)	Students with prior research experience, particularly related to mRNA and nanoparticles, are desirable but not essential.
Contact	Yes, students may contact the supervisor before applying. Direct enquiries to: Dr. Hao Song **h.song6@uq.edu.au**