

An Indian-Australian research partnership

Project title In situ gelling nano-particulate systems for tissue engineering using stem cells

Project number: IMURA0132

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Research Academy theme/s

1. Biotechnology and stem cell research

The research problem

Tissue regeneration and stem cell therapy are at the fore front of treatment for many ailments [1]. It involves the development of scaffolds to facilitate healing within tissues e.g. skin regeneration, nervous regeneration [1-4]. The scaffold further incorporates cells like stem cells and growth factors. The proposed work will deal with nanoparticles for growth factor release within the scaffolds and both stem cells and induced pluripotent cells using nanoparticles for gene transfection. The scaffolds will be in the form of in-situ gels to provide a novel platform for minimally invasive delivery of a gel matrix to the site as has been studied in the case of the vitreous humor [5] and other applications [6]. The in-situ gels will contain nanoparticles encapsulating growth factors and/or drugs (corticosteroids, anti inflammatory agents, neuroprotective agents [2, 7], or a gene of interest [8]), which will release in a controlled manner to ensure a sustained local effect. One area of interest is the induction of neuron regeneration by such scaffolds and nanoparticle delivery systems. Spinal cord injuries, which are caused mainly due to disease or accidents[2, 9], are cases where such in situ gelling regenerative systems will be very useful. Various events mark the primary and secondary injury status to the spinal cord injuries. Primary lesions mostly include injury to surrounding tissues, injury to artery, trauma to spine etc. The secondary aspects include the degeneration of the lesional site because of the death of tissue due to excitotoxicity and further degeneration of the tissue due to inflammation [2]. To serve to protect the nervous system from damage to the sequel of events that occur after the injury, corticosteroids have been used to prevent inflammation, gangliosides to improve neurite growth and synaptic transmission and erythropoietin has been used as a neuro-protective or a glioprotective agent [2, 9]. There have been studies to develop support matrices to facilitate the regeneration of the nervous tissues, peripheral as well as the central nervous system [2, 4, 10], but there is scope for further improvement. The next step in this approach would be a consolidated approach where in cells (stem cells, Schwann cells, or somatic cells that can be induced via gene delivery to be pluripotent, can be introduced within the matrix of an in situ gel containing growth factor loaded nanoparticles [10-12]. The project would

consist of the development of scaffolds based on biological and synthetic polymers, mainly in-situ gels, embedded with stem cells or somatic cells which can be induced by gene delivery to study induced pluripotent cell responses. Nanoparticle delivery systems will also be evaluated for induction of pluripotency in somatic cells through gene delivery and for the delivery of growth factors/ drugs.

References

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Project aims

The aim of the project is to investigate approaches that use nanoparticles to deliver growth factors to cells without genetic modifications.

The project aims to investigate the use bio-scaffolds to deliver nanoparticles for induction of pluripotency to somatic cells.

Expected outcomes

The ability to generate non-genetically modified reprogrammed somatic cell via nanoparticle technology will significantly impact on the application of cell therapy.

Which of the above Theme does this project address?

1. Biotechnology and stem cell research

How will the project address the Goals of the above Themes?

The project directly applies to the theme as it utilises cutting edge biotechnology by using nanoparticles to generate induced pluripotent stem cells without genetic modifications that currently limits the use of stem cells for therapy. Further, it proposes translational studies to investigate regeneration of nervous tissue using in situ gel matrices.