ARC Training Centre for
Innovative
BioEngineering

Postgraduate Study at the Centre for Innovative Bioengineering

Who are we?

The ARCTCIBE is a research centre for the discovery, development and manufacture of biomedical technologies. We are a research collaborative based out of The University of Sydney, UTS, UNSW, ANU, RMIT and Swinburne University of Technology. We are working in collaboration with leading industry partners including Allegra Orthopaedics, Osseointegration International Pty Ltd, Peter Brehm GmbH, Ti2Medical, and the Royal Prince Alfred Hospital.

What is the Scholarship?

We are supporting **Bioengineering Innovation Scholarships** available to outstanding domestic and international applicants to pursue projects in development of biomedical technologies. The Scholarship will provide an annual stipend allowance of **$31,828 pa**.

Applicants who hold a Research Training Program (RTP) Scholarship or equivalent are eligible to apply and may be considered for a supplementary top-up scholarship of up to **$10,000 pa**.

When is it due?

Applications will be accepted on an ongoing basis

How can I find out more information?

Download and review the information package available at:
https://arctcibe.org/wp-content/uploads/2018/09/infomation_scholarships.pdf

Or contact 'arc.tcibe@sydney.edu.au'

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Required documentation to make and application

The following documents should all be prepared and submitted to 'arc.tcibe@sydney.edu.au' to be eligible for Bioengineering Innovation Scholarships, or top-up awards.

- 2-page CV

Your CV should not exceed 2 pages. Expand on all quantifiable reasons for us to discriminate between applications. Your grades, # of publications, # of citations, years of experience, and techniques that you know are some examples of measurable characteristics that we can use to find the best students.

- Evidence of supervisor support and project selection

Provide evidence that you have established communication with one of the 12 research leaders at the ARCTCIBE (https://arctcibe.org/chief-researchers/). This can be in the form of a .pdf copy of communications between yourself and the supervisor. You should explicitly demonstrate your commitment to one of the 8 available projects at the Centre (see project descriptions below)

- Academic transcripts including the testamur of a recognised Honours or Master's program in science or engineering field

All applications must have successfully completed a honours or master's course in field related to their chosen project within the Centre. Applicants must provide a certified copy of previous academic awards, including their academic transcript and testamur.

- Personal statement and research proposal document

Applications will provide up to 500 word statement outlining their interest and motivations to complete this research degree.

- 2 academic reference letters

All applicants will provide 2 academic reference letters, who have worked with and are familiar with the applicant.

Additional information

We encourage all applicant to apply for RTP/UPA/APS/Endeavour or EITRS scholarships.

If applicants are yet to confirm the award of a RTP/UPA or equivalent, and qualify for the top-up award, we will provide a conditional offer for the top-up award to be paid following the applicants successful receipt of the scholarship award.

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Application process overview

1. Find a project of interest to you and make contact with a project supervisor (see **Project Description** documentation)

In your initial email include why you are interested in this project, any research experience you have and how you meet the initial eligibility requirements – i.e. indicate you have or will soon obtain an Honours degree (First Class or Second Class upper) or a Master's degree in an Engineering field with a substantial research component.

If this is the first time you're are contacting a prospective supervisor, please include (CC) 'arc.tcibe@sydney.edu.au'

2. Work with your supervisor to develop your personal statement and research proposal document

3. Complete and compile the above documentation

We encourage all applicants to make a parallel application for RTP/UPA/APS/Endeavour or EITRS scholarships. More information on these scholarships can be found at: http://sydney.edu.au/scholarships/research/

4. Email your application package to 'arc.tcibe@sydney.edu.au'

Applicants should be contacted within 2 weeks of application submission.

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Project descriptions

PROJECT 1: Deep neural networks for omni-modality musculoskeletal (MSK) image analysis

The discovery of biomarkers requires accurate delineation of bone and tissues surrounding a MSK defect, but this is difficult because different types of images (x-ray, PET, CT, MRI) depict different characteristics. We will derive a computerised image segmentation algorithm to automatically delineate bones and musculature surrounding the defect, using state-of-the-art convolutional neural networks (CNNs) – a data-driven approach to identify the quantifiable image characteristics that are most relevant for a particular task – in this case, segmentation. The key challenge will be to train the CNNs across all image types (both functional and anatomical) to identify the correlations between them so that bones and muscles can be optimally delineated regardless of the image type. The outcomes will be techniques to improve diagnostic processes by allowing automated localisation and biomarker analysis of the anatomical defect sites.

Project eligibility:
Interest and experience in the area of image analysis algorithms.
Familiarity with image processing and/or biology would be beneficial.

For further information contact:
Associate Professor Jinman Kim in the School Information Technologies at:
jinman.kim@sydney.edu.au, or by phone +61 2 9036 9804.

PROJECT 2: Advanced 3D visualisation of musculoskeletal (MSK) imaging

Clinicians and surgeons need to interpret imaging data for diagnosis and pre-surgical planning. However, viewing the images directly is not optimal because the defect has a non-trivial risk of being obscured by noise or being occluded by other structures. The project will involve research on 3D graphics optimisations to create an algorithm that exploits graphics processing hardware to enable 3D visualisation of the anatomical defect on a computer display. The outcome will be a new 3D visualisation algorithm that enables improved diagnosis and pre-surgical planning, by allowing clinicians to view the anatomical characteristics of the MSK defect without the noise and obstruction inherent in the medical images.

Project eligibility:
Interest and experience is in the area of image visualisation algorithms. Familiarity with 3D graphics programming (CUDA) or image processing would be beneficial.

For further information contact:
Associate Professor Jinman Kim in the School Information Technologies at:
jinman.kim@sydney.edu.au, or by phone +61 2 9036 9804.

PROJECT 3: Novel 3D-printed scaffolds to promote spinal fusion

The current lack of appropriate bone substitute materials for spinal fusion applications is a major clinical problem. This project will develop a novel 3D-printed synthetic scaffold suitable for bone repair in spinal fusion, featuring both mechanical stability (for weight-bearing) and bioactivity (to regenerate the bone) – so far an extremely difficult combination to achieve. We have recently developed novel bioactive ceramics with exceptional mechanical properties and bioactivity, and suitable for use in bone repair. The aim is to produce 3D-printed bioactive ceramic scaffolds with optimised geometry, microstructure, and strength for use as bone substitutes in spinal fusion. The mechanical and biological properties of the scaffolds in spine fusion settings will be evaluated. Due to the unique characteristics of the material and ability to produce customised implants by 3D printing, the bone substitute will have potential to closely match individual patient needs and greatly improve long-term treatment efficacy.

Project eligibility:
Strong background in materials science, additive manufacturing and tissue engineering, with interest in medical product design and development.
Knowledge of 3D CAD system (preferably Solidworks and Mimic software), as well as the ability to conduct theoretical analysis and develop mechanical test protocols for different spinal implants.
Experience in spinal instrumentation product development is highly desirable but not mandatory.

For further information contact:
Professor Hala Zreiqat in the School of Aerospace, Mechanical and Mechatronic Engineering at:
hala.zreiqat@sydney.edu.au, or by phone +61 2 93512392.

PROJECT 4: Quick-release, fail-safe connector between osseointegration implants and artificial limbs

Osseointegration implants have been developed over the past two decades as a new technology for mobilising patients with lower-limb amputations, offering improved function and quality of life over traditional socket prostheses. Currently, artificial limbs for osseointegration implants are connected through traditional mechanisms used in the socket prosthesis system, which involve rigid screws and bolts that limit the versatility of the implant. As osseointegration implants become more common, there is a pressing demand for an ideal connector system designed specifically to meet the requirements of individual patients. This project aims to develop a unique and cost-effective connector system between osseointegration implant and artificial limb to allow: (1) quick and easy release for the recipient to rapidly attach and remove the artificial limb as required, and (2) a fail-safe mechanism to prevent undesirable impact and strain passing through the implant site, and to protect residual bone from breakage in the event of a fall. This project will involve medical device design, biomechanics analysis, prototype construction and testing, with ample potential for translation of the developed product.

Project eligibility:
Strong background in computer-assisted design, finite element modelling, and biomechanics, with interest in medical device design and development.

For further information contact:
Professor Hala Zreiqat in the School of Aerospace, Mechanical and Mechatronic Engineering at:
hala.zreiqat@sydney.edu.au, or by phone +61 2 93512392.

PROJECT 5: Optimisation of bone scaffolds by design of pore geometry to modulate permeability and diffusivity

An inherent problem for bone scaffolds is the limited ability to induce tissue ingrowth and angiogenesis at the centre. Permeability and diffusivity are the main design factors which can address these limitations, in addition to conventional parameters such as pore size, porosity, and interconnectivity. Permeability quantifies the ability of a porous scaffold to transmit fluid through its interconnected pores, while diffusivity indicates the spatial gradient of oxygen concentration within a scaffold. The effect of varying permeability and diffusivity on scaffold behaviour is little explored, and their role in modulating cell behaviour is unclear. We propose a unique method to design and fabricate bone scaffolds with optimised diffusivity and permeability, by altering strut and pore geometry through the combination of computational modelling and 3D printing. Designed scaffolds will be mechanically tested and their biological performance will be evaluated using bone-related cells.

Project eligibility:
Strong background in computational modelling and design, biomechanics, solid/fluid mechanics, and additive manufacturing.

For further information contact:
Professor Hala Zreiqat in the School of Aerospace, Mechanical and Mechatronic Engineering at:
hala.zreiqat@sydney.edu.au, or by phone +61 2 93512392.

PROJECT 6: Implantable biosensors to monitor and stimulate tissue regeneration

Loss of bone density, reduced vascularisation, and muscle atrophy are limitations associated with osseointegration on large limbs in amputees. Recovery from surgery is slowed for want of a method to stimulate and monitor the regeneration of these tissues, and mechanical loading of the limb needs to be cautious due to the unknown bone porosity recovery status. This project will create new functionalised electrodes to detect changes in pH, leached materials, electrical signals, and biomechanical strain. These measurements will indicate factors that influence the healing process such as osteoporosis, implant fatigue, wear, and mechanical stimulation.

Project eligibility:
Strong background in biosensors and bioelectronics.
Familiarity with orthopaedic devices would be beneficial.

For further information contact:
Professor Alistair McEwan in the School Electrical and Information Engineering at:
alistair.mcewan@sydney.edu.au, or by phone +61 2 93517256.

PROJECT 7: Smart dressings to diagnose, stimulate and monitor musculoskeletal tissue

Current bioinstrumentation for monitoring electrical properties of tissue is bulky and requires the use of gel electrodes that cannot be worn in the long term. This project involves designing an interface between smart dressings with conductive fibres and electrical devices. This project will involve simulation and development of electrical medical devices and interfaces using electrical impedance models and 3D-printed anatomically realistic phantom model with full electrical properties.

Project eligibility:
Strong background in biosensors and bioelectronics.
Familiarity with additive manufacturing would be beneficial.
For further information:
Professor Alistair McEwan in the School Electrical and Information Engineering at:
alistair.mcewan@sydney.edu.au, or by phone +61 2 93517256.

PROJECT 8: Computational modelling and biomechanics for implant design

Additive biomanufacturing has enabled implantation in a true patient-specific basis, which has been seeing rapid growth in research and development and could potentially change prosthetic clinic in the near future. Additive biomanufacturing brings together a range of cutting-edge technologies, including medical imaging, biomaterials, biomechanics, advanced design and fabrication through computational modelling in a digitalised form. This project will work closely with clinicians and implant developers by developing novel computational modelling approaches to integrating these multidisciplinary areas for deliverable patient-specific prosthetic implants. Students will have the chance to explore high performance computing, 3D printing and bio-printing and clinical implantology.

Project eligibility:
Background and experience in some of the following areas: solid/fluid mechanics, biomechanics, biomaterials, computational methods, additive manufacturing, scientific programming and imaging processing.

For further information contact:
Professor Qing Li in the School of Aerospace, Mechanical and Mechatronic Engineering at:
qing.li@sydney.edu.au, or by phone +61 2 9351 8607.