香港中文大學 The Chinese University of Hong Kong

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

UQ-CUHK Health Engineering Virtual Symposium

The University of Queensland (UQ) and The Chinese University of Hong Kong (CUHK) share a strong track record and vision for success. The two institutions have identified strong potential for future collaboration in numerous areas including engineering, health sciences, medicine, and social sciences to share expertise, leverage opportunities and address global challenges. To build a strong research network and engagement across UQ and CUHK, a series of research symposiums are planned to guide future research collaborations.

The inaugural **UQ-CUHK Health Engineering Virtual Symposium** will be held on **Wednesday 19 August 2020** (11.00am-4.00pm AEST / 9.00am-2.00pm HKT). The Symposium will focus on two key areas **Tissue Engineering** and **Healthcare Technology**, which represent synergistic research and teaching strengths at both institutions.

VIRTUAL SYMPOSIUM OVERVIEW

Wednesday 19 August – Zoom	
11.00 – 11.30am AEST 09.00 – 09.30am HKT	**Opening and Welcome:** **Welcome address:** Professor Deborah Terry AO, Vice-Chancellor and President, The University of Queensland (5 mins) **Welcome address:** Professor Rocky S. Tuan, Vice-Chancellor and President, The Chinese University of Hong Kong (5 mins) **Overview of Tissue Engineering session:** Professor Alan Rowan, Director, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland (5 mins) **Overview of Tissue Engineering and Regenerative Medicine research:** Professor Wai-yee Chan, Pro-Vice-Chancellor (Strategic Developments) and Li Ka Shing Professor of Biomedical Sciences, The Chinese University of Hong Kong (5 mins) **Overview of Healthcare Technology session:** Professor Raymond Kai-yu Tong, Chairman, Department of Biomedical Engineering, The Chinese University of Hong Kong (5 mins)
11.30 – 1.30pm AEST 09.30 – 11.30am HKT Each speaker will have 10-min presentation, followed by 5-min Q&A/discussion	**Session One – Tissue Engineering** **Moderator:** Professor Alan Rowan, Director, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland ***Mechanotransduction a key tool for Cellular Control*** Professor Alan Rowan, Director, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland ***Engineering 3D Cell-Cell and Cell-Extracellular Matrix Interactions for Tissue Engineering*** Professor Hon Fai (Vivas) Chan, Assistant Professor, Institute for Tissue Engineering and Regenerative Medicine (iTERM), The Chinese University of Hong Kong ***Multivariate patterning of human pluripotent cells under perfusion reveals critical roles of induced paracrine factors in kidney organoid development: Implications for Tissue Engineering and Regenerative Medicine Applications*** Professor Justin Cooper-White, Head of School, School of Chemical Engineering, Faculty of Engineering, Architecture and Information Technology, Affiliate Professor, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland ***Engineering Microenvironments for Regenerative Medicine*** Professor Anna Blocki, Assistant Professor, iTERM, The Chinese University of Hong Kong ***Tissue Engineering of Orofacial Structures*** Professor Saso Ivanovski, Professor, School of Dentistry, Director of Research and Professor of Periodontology**,** The University of Queensland ***Nano-cell Interactions of Non-Cationic Bionanomaterials*** Professor Jonathan Choi, Associate Professor, Department of Biomedical Engineering, The Chinese University of Hong Kong

	Functionalisation of polyester-based biomaterials **Professor Lisbeth Grondahl**, Professor, School of Chemistry and Molecular Biosciences, Faculty of Science, Affiliate Principal Research Fellow, Australian Institute for Bioengineering and Nanotechnology**,** The University of Queensland **Discussion** 1.15 – 1.30pm AEST / 11.15 – 11.30am HKT (15 minutes) **Break** 1.30 – 2.00pm AEST / 11.30 – 12.00pm HKT (30 minutes)
2.00 – 3.45pm AEST 12.00 – 1.45pm HKT Each speaker will have 10-min presentation, followed by 5-min Q&A/discussion	**Session Two – Healthcare Technology** **Moderator:** **Professor Raymond Kai-yu Tong**, Chairman, Department of Biomedical Engineering, The Chinese University of Hong Kong ***Advanced Manufacturing Case Studies from The ARC Research Hub for Advanced Manufacturing of Medical Devices*** **Professor Matthew Dargusch**, Professor, School of Mechanical and Mining Engineering Faculty of Engineering, Architecture and Information Technology, The University of Queensland ***Neuroplastic Changes in Brain using Intention-driven Robotic Training in Stroke Rehabilitation*** **Professor Raymond Kai-yu Tong**, Chairman, Department of Biomedical Engineering, The Chinese University of Hong Kong ***From Advanced Imaging to Healthcare Innovation: A New Frontier for Brain Injury*** **Professor Michael O'Sullivan**, Professor, UQ Centre for Clinical Research, Faculty of Medicine, Affiliate Professor, Institute for Molecular Bioscience, The University of Queensland ***Computational Neuroradiology and its Clinical Applications*** **Professor Lin Shi**, Associate Professor, Department of Imaging and Interventional Radiology, The Chinese University of Hong Kong ***Biomedical engineering solutions for management of osteoarthritis*** **Professor Juha Toyras**, Professor in Biomedical Engineering, School of Information Technology and Electrical Engineering, Faculty of Engineering, Architecture and Information Technology, The University of Queensland ***Detection and Identification of New Biomarkers for Disease Diagnostics*** **Professor Megan Yi-Ping Ho**, Assistant Professor, Department of Biomedical Engineering, The Chinese University of Hong Kong **Discussion** 3.30 – 3.45pm AEST / 1.30 – 1.45pm HKT (15 minutes)
3.45 – 4.00pm AEST 1.45 – 2.00pm HKT	**Closing and Next Steps:** **Dr Jessica Gallagher**, Pro-Vice-Chancellor (Global Engagement and Entrepreneurship), The University of Queensland (15 mins)

Professor Alan Rowan, Director, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland

Mechanotransduction a key tool for Cellular Control

Fibrous networks of biopolymers are found in both the intracellular and extracellular matrix. From the microscopic scale of a single cell to the macroscopic scale of fibrous tissues, biopolymers with different stiffness control cellular processes such as cell differentiation, proliferation, transportation and communication. In recent years, a large number of different hydrogels has been developed, often with the goal to create an artificial extracellular matrix for biomedical applications. The mechanics of natural biopolymer gels however, are very different from most synthetic hydrogels because they show strain stiffening behaviour. Reconstituted networks of cytoskeletal polymers such as actin or intermediate filaments or extracellular biopolymers such as collagen or fibrin show a large increase in stiffness upon an applied stress or deformation. The stiffening response prevents these networks from breaking under external stresses and also enables communication between cells growing in these materials. Recently a new biomimetic polymer hydrogel was developed with unique cytomimetic properties, based upon oligo(ethylene glycol) grafted polyisocyanopeptides. These extremely stiff helical polymers form gels upon *warming* at concentrations as low as 0.005 %-wt polymer, with materials properties almost identical to these of intermediate filaments and extracellular matrices.[3,4] The unique ability of these materials and their application in cell growth, organoid development and drug therapeutics revealed the importance of polymer stiffness and material non-linear mechanics.[5] How to control these nonlinear mechanical properties by tailoring the composite nature and architecture of the extracellular matrix and its influence on cellular activity will be discussed.

Professor Justin Cooper-White, Head of School, School of Chemical Engineering, Faculty of Engineering, Architecture and Information Technology, Affiliate Professor, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland

Multivariate patterning of human pluripotent cells under perfusion reveals critical roles of induced paracrine factors in kidney organoid development: Implications for Tissue Engineering and Regenerative Medicine Applications

Nick R. Glass[1,2] , Minoru Takasako[3,4] , Pei Xuan Er[3,4] , Drew M. Titmarsh[1,2] , Alejandro Hidalgo[1,2], Ernst J. Wolvetang[2] , Melissa H. Little[3,4,5] , Justin J. Cooper-White[1,2]

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Creating complex multicellular kidney organoids from pluripotent stem cells (derived from individual patient somatic cells) shows great promise in application areas such as drug screening and discovery, tissue engineering and regenerative medicine. Further improvements in differentiation outcomes, patterning and maturation of specific cell types are however intrinsically limited by standard tissue culture approaches. To address this limit, and expose new factor combinations and factor interplay, we recapitulated early kidney tissue patterning events within a full factorial microbioreactor array (MBA), exploring over 1000 unique conditions in an unbiased and quantitative manner. Single cell resolution identification of distinct renal cell types, coupled with multivariate analysis, defined the roles and interplay of Wnt, FGF and BMP signalling in their specification, while exposing retinoic acid as a minimal effector of nephron patterning. We reveal critical contributions of induced paracrine factors on cell specification and patterning into multilayered kidney organoids, along with media combinations that achieve near pure renal cell types. This study, in probing the relevance and interplay between the pathways stimulated by staged soluble factor-based protocols provides the necessary insight for the development of improved protocols for directed differentiation of kidney lineage cells for use in drug screening, regenerative medicine and tissue engineering. Whilst this sophisticated but facile MBA-based methodology can be used for tuning nephron segmentation, it will prove useful for interrogating other complex multicellular differentiation processes and organoid development and maturation.

Professor Saso Ivanovski, Professor, School of Dentistry, Director of Research and Professor of Periodontology**,** The University of Queensland

Tissue Engineering of Orofacial Structures

While a variety of bioengineering approaches have been proposed for the regeneration of dental, oral and facial structures, scaffolds are of particular importance as they address the key issues of space maintenance and control over the healing events within these defect. This lecture will describe novel scaffold fabrication techniques using 3D printing and electrospinning, which can be further enhanced with cell therapy and drug delivery. The potential for clinical translation of these advanced tissue engineered constructs will be critically evaluated.

Professor Lisbeth Grondahl, Professor, School of Chemistry and Molecular Biosciences, Faculty of Science, Affiliate Principal Research Fellow, Australian Institute for Bioengineering and Nanotechnology**,** The University of Queensland

Functionalisation of polyester-based biomaterials

The surface of a material is the first contact with the cellular environment and as such these surfaces must, at minimum, possess properties amenable to cell adhesion. Polyesters lack functional moieties but functionalisation creates surface properties suited for biomaterials applications. Using graft copolymerization allows the introduction of single or multiple functional groups and creation of site-specific bi-functional scaffolds. Future challenges for the development of functionalized biodegradable materials will be discussed.

Professor Matthew Dargusch, Professor, School of Mechanical and Mining Engineering Faculty of Engineering, Architecture and Information Technology, The University of Queensland

Advanced Manufacturing Case Studies from The ARC Research Hub for Advanced Manufacturing of Medical Devices

Through industry led projects, The ARC Research Hub for Advanced Manufacturing of Medical Devices is working to concurrently develop advanced materials, methods and technologies, and more efficient design and flexible manufacturing processes, for their application and translation to the medical device industry. Current challenges to medical device manufacturing include workflow improvements, adaptive automation systems, novel biomedical materials and structures, and elevation of manufacturing to embrace Digital Transformation. In particular, the novel materials design and manufacturing considerations for biomedical metal scaffolds will be presented. Furthermore, Industry 4.0 concepts in the context of medical device manufacturing will be discussed.

Professor Michael O'Sullivan, Professor, UQ Centre for Clinical Research, Faculty of Medicine, Affiliate Professor, Institute for Molecular Bioscience, The University of Queensland

From Advanced Imaging to Healthcare Innovation: A New Frontier for Brain Injury

Brain injury is a leading cause of death, chronic disability, lost economic productivity and healthcare cost, which has a global reach. At the same time, the brain has substantial capacity to recover from injury. Innovative treatments are needed to harness this plasticity. Advanced brain imaging methods provide unprecedented insights into the processes of injury and recovery and have the potential to revolutionise the way we approach rehabilitation after brain injury from causes such as stroke and trauma. UQ's world-class infrastructure for advanced imaging extends from the development of new methods to probe structure, function and biochemical change to clinical translation through trials. Recent work shows that advanced imaging improves the prediction of recovery of language and development of depression after stroke and is beginning to reveal new mechanisms to target in the treatment of traumatic brain injury. Advances in biomedical engineering offer the potential of insight into injury in the field, before arrival at hospital. By connecting with strengths in biomedical engineering, data science and digital health, we can harness the potential of imaging technology to drive healthcare innovation and improve the outlook after brain injury.

Professor Juha Toyras, Professor in Biomedical Engineering, School of Information Technology and Electrical Engineering, Faculty of Engineering, Architecture and Information Technology, The University of Queensland

Biomedical engineering solutions for management of osteoarthritis

Osteoarthritis affects 250 million people worldwide. Currently, there is no cure for osteoarthritis and it often progresses to a stage where total knee joint replacement is the only solution. The reasons behind this unfortunate situation are related to diagnosis, prognosis and management. First, there are limited tools for early diagnosis and clinical decision-making based on personalized prediction for risk of osteoarthritis. Moreover, for acute injuries in otherwise healthy joints, there are no widely used predictive decision support tools to help selection of the optimal clinical pathway. Furthermore, the diagnostic techniques used during arthroscopic repair surgery are subjective not allowing reliable evaluation of extent and severity of the injury needed to optimise the repair operation. This seminar presentation focuses on development of quantitative techniques for arthroscopy and modelling of joint function and degeneration.

Professor Hon Fai (Vivas) Chan, Assistant Professor, iTERM/School of Biomedical Sciences, The Chinese University of Hong Kong

Engineering 3D Cell-Cell and Cell-Extracellular Matrix Interactions for Tissue Engineering

Recent advances in 3D cell culture technologies such as spheroid and organoid culture have provided a new and exciting approach to engineering functional 3D tissue/organ for applications in regenerative medicine, disease modeling, and drug discovery. Despite its promise, spheroid/organoid technology is challenged by a lack of reproducibility and scalability. In addition, according to recent studies, extracellular matrix (ECM) cues play an important role in modulating organoid function, but efforts to optimize the ECM environment for spheroid/organoid culture have been limited. In this talk, Prof. Chan will introduce the work on engineering 3D cell-cell and cell-extracellular matrix interactions via microfabrication techniques for tissue engineering.

Professor Anna Blocki, Assistant Professor, iTERM/School of Biomedical Sciences, The Chinese University of Hong Kong

Engineering Microenvironments for Regenerative Medicine

Dysregulated microenvironment found in ischemic and chronic diseases such as non-healing wounds represent a major burden to the worldwide population. We are interested in creating novel tissue-instructive extracellular matrix (ECM)-based biomaterials with tailored bioactive properties that upon implantation will improve the hostile microenvironment in diseased tissue. For this we have developed various strategies to produce and modify ECM in vitro, including identification of key players in ECM assembly, utilization of the biophysical principle of macromolecular crowding (MMC) and co-precipitation. As a result, we are able to tailor ECMs with enhanced angiogenic and anti-inflammatory properties that can guide tissues repair and regeneration processes, such as revascularization of injured tissue.

Professor Jonathan Choi, Associate Professor, Department of Biomedical Engineering, The Chinese University of Hong Kong

Nano-cell Interactions of Non-Cationic Bionanomaterials

Advances in nanotechnology have empowered the design of Bionanomaterials y assembling different types of biomolecules as building blocks into nanoparticles (NPs). A rational approach to facilitating the delivery of NPs is to develop a comprehensive understanding in their interactions with the biological system. Cationic NPs are conventional carriers of therapeutic cargoes into cells due to their ability to penetrate the cell membrane, yet they tend to cause cytotoxicity and immune responses. Non-cationic NPs (neutral or anionic) are more biocompatible, but they generally enter cells in less copious amounts than cationic NPs. I present the cell-nano interactions of non-cationic bionanomaterials that can surprisingly and effectively enter cells in both in vitro and in vivo settings. These data guide us to explore nanomedicine applications that we did not conceive before, such as using DNA-coated NPs for targeting atherosclerotic plaques and polydopamine-coated plasmonic nanoworms for photothermal killing of cancer cells.

Professor Raymond Kai-yu Tong, Chairman, Department of Biomedical Engineering, The Chinese University of Hong Kong

Neuroplastic Changes in Brain using Intention-driven Robotic Training in Stroke Rehabilitation

Effective motor recovery after stroke depends on intensive voluntary practice of the paretic limbs. We investigate the characteristics of brain waves and muscle activities related to the paretic upper limb movements after stroke. Brain waves and muscle activities are recorded by electroencephalography (EEG) and electromyography (EMG) respectively through electrodes attached to the scalp and skin surface. Then, we developed interactive control strategies to control different rehabilitation training systems for hand training in clinical trials, such as functional electrical stimulation (FES) and rehabilitation robot. The system incorporated the EMG and EEG as the bio-parameters to indicate the voluntary effort from a subject. We applied these engineering-based technologies in the field of Neurorehabilitation, robotic system uses electric motor to provide external assistive force during the rehabilitation training. The clinical studies showed functional improvement in the clinical outcome measures on the upper limb. The EEG and MRI analysis had showed the neuroplastic changes.

Professor Lin Shi, Associate Professor, Department of Imaging and Interventional Radiology, The Chinese University of Hong Kong

Computational Neuroradiology and its Clinical Applications

Neuroimaging technology, especially magnetic resonance imaging (MRI) provides a non-invasive way to examine neurological diseases. Quantitative neuroimaging biomarkers derived from MRI can effectively assist the early detection and differential diagnosis of many neurological diseases, and computational tools to enable automated quantification are essential in various neurological researches. In this talk, the speaker will share the experience on how automated computational tools for MRI quantification can be applied to clinical researches.

Professor Megan Yi-Ping Ho, Assistant Professor, Department of Biomedical Engineering, The Chinese University of Hong Kong

Detection and Identification of New Biomarkers for Disease Diagnostics

Detection and identification of key biomarkers are of great importance in understanding the development of chronic human diseases, monitoring disease recurrence and determining the efficacy of therapeutic agents. For example, rapid and precise detection of pathogenic bacteria is critical for effective antibiotic treatment at an early stage of bacterial infections, thus preventing the spreading of bacterial disease. However, the performance of currently prevalent detection techniques hinges heavily on complex sample pre-processing or signal post-amplification thus limiting their possibilities for early diagnostics. This talk will summarize our efforts on identifying and validating new molecular biomarkers by the combination of DNA nanosensors and microfluidics. The initial development has paved the way to the diagnosis of several major infectious diseases, such as malaria, tuberculosis and HIV. This presentation will also highlight our recent initiatives in exploring the molecular activities at the single organelle and single cell level. Looking forward, we aim to understand the therapeutic variability in relation to the interplay between cell-cell interactions and microenvironments using an in vivo-mimicking in vitro platform. Our effort is envisioned to not only help interrupt disease transmission, but also enable precise predictions of treatment response or disease progression.