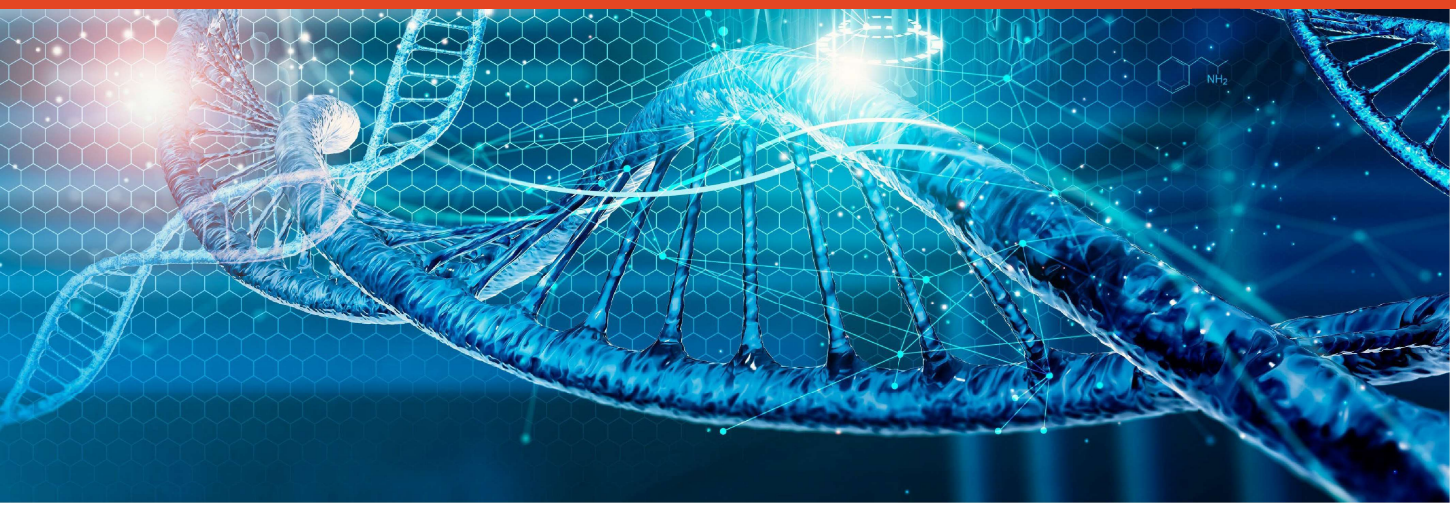
Nano Health Symposium 2024

Thursday 31 October

THE UNIVERSITY OF SYDNEY
Nano Institute



Plenary speakers

Prof Robert Langer

Institute Professor MIT, co-founder of Moderna

Prof Frank Caruso

University of Melbourne

Prof Wei Tao

Harvard Medical School

Organising committee

Dr Chun Xu, Dr Ann Na Cho, A/Prof Khoon Lim, Dr Chang Lei, Dr Jonathan Danon

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Program

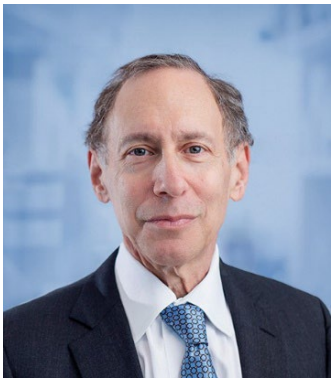
Thursday 31 October (ABS Lecture Theatre 1110**)**

8:30 – 9:00	**Registrations, welcome and coffee**
9:00 – 9:15	**Opening remarks – Prof Benjamin Eggleton, Pro-Vice-Chancellor (Research)**
9:15 – 10:00	**Plenary: Prof Robert Langer, Massachusetts Institute of Technology** Title: From nanotechnology to mRNA vaccines: How overcoming scepticism and barriers led to new cancer treatments and ways to tackle a global health challenge Chair: Dr Chun Xu
10:00 – 10:45	**Plenary: Prof Wei Tao, Harvard Medical School** Nano- & Microscale Materials-enabled Drug Delivery Technologies Chair: Dr Chun Xu
10:45 – 11:10	**Morning tea**

11:10 – 12:40	**Session 1** Chair: Dr Chang Lei
11:10 Keynote	**Prof Wei Chen** Title: Sensor Systems and Health Informatics
11:25 Keynote	**Prof Jeremy Crook** Title: Electroceuticals for Nanomedicine: Disruptive HealthTec Innovation for Regenerative Medicine and Cancer Therapy
11:40 Keynote	**Prof Kristopher Kilian** Title: Hierarchically Assembled Hydrogels for Tissue Engineering and Regenerative Medicine
11:55 Keynote	**Prof Wenlong Cheng** Title: Intelligent Wearable Skins for Soft Biodiagnostics
12:10 Invited	**Dr Shelley Wickham** Title: Towards Bio-nanorobotics: Sensors and Responsive Devices Assembled from DNA
12:25 – 13:10	**Lunch + Poster**

13:10 – 13:55	**Plenary: Prof Frank Caruso FRS FAA, The University of Melbourne** Title: Nanoparticle Platforms for Therapeutic Applications Chair: Prof Ali Abbas
13:55 – 15:25	**Session 2** Chair: Dr Jonathan Danon
13:55 Keynote	**Prof Rachel Codd** Title: An Antibody-compatible Cancer-targeting Theranostic Agent for Precision Oncology
14:10 Keynote	**Prof Steven Wise** Title: On-Demand Bioactivation of Inert Materials With Plasma-Polymerized Nanoparticles
14:25 Keynote	**A/Prof Arnold Ju** Title: Personalized 3D Vessel-on-chip: Towards 'Sherlock Holmes' approach to detecting blood clots
14:40 Invited	**Dr Hien Duong** Title: Bacteriophage-Antimicrobial Conjugates: A Targeted Approach to Overcome Antimicrobial Resistance
14:55 Invited	**Dr Peter Wich** Title: Polysaccharides and Proteins as Biopolymer Nanomaterials in Drug Delivery and Biocatalysis
15:10 Invited	**Dr Hao Song** Title: Nature-Inspired Therapeutics and Vaccine Delivery Systems
15:25 – 15:50	**Afternoon tea + Poster**

15:50– 17:50	**Session 3** Chair: Dr Ann-Na Cho
15:50 Keynote	**Prof Ashish Diwan** Title: Back Pain Arising from the Disc can be Regenerated and Pain Resolved using Novel Intradiscal Therapy
16:05 Keynote	**A/Prof Zi (Sophia) Gu** Title: Bioresponsive Nanoparticles Enabled Catalytic Therapy
16:20 Keynote	**Prof Yuling Wang** Title: Extracellular Vesicles: the Emerging Biomarkers and Therapies for Cancer Diagnosis/Prognosis and Treatment
16:35 Invited	**Dr Yannan Yang** Title: Nanotechnology-based In situ Cancer Vaccines
16:50 Invited	**Dr Ruirui Qiao** Title: Polymer Engineered Nanoparticles for Molecular Imaging and Gene Therapy
17:05 Invited	**Dr Jie Tang** Title: Oral Delivery of Biomolecules: From Nanocarriers to Biomodulators
17:20 Invited	**Dr Nicholas Hunt** Title: Development of Oral Nanotherapeutic Formulation of Insulin with Reduced Episodes of Hypoglycaemia
17:35 – 17:50	**Closing with prize announcement -- Prof Ali Abbas** Chair: Dr Ann-Na Cho
17:50 – 19:00	**Cocktail event**



Prof Robert Langer, Massachusetts Institute of Technology

Title: From nanotechnology to mRNA vaccines: How overcoming skepticism and barriers led to new cancer treatments and ways to tackle a global health challenge

Abstract: Advanced drug delivery systems are having an enormous impact on human health. We start by discussing our early research on developing the first controlled release systems for macromolecules and the isolation of angiogenesis inhibitors and how these led to numerous new therapies. This early research then led to new drug delivery technologies including nanoparticles and nanotechnology that are now being studied for use treating cancer, other illnesses and in vaccine delivery (including the Covid-19 vaccine). Finally, by combining mammalian cells, including stem cells, with synthetic polymers, new approaches for engineering tissues are being developed that may someday help in various diseases. These can also serve as a basis for tissues on a chip which can potentially reduce animal and human testing. Examples in the areas of cartilage, skin, blood vessels, GI tract and heart tissue are discussed.

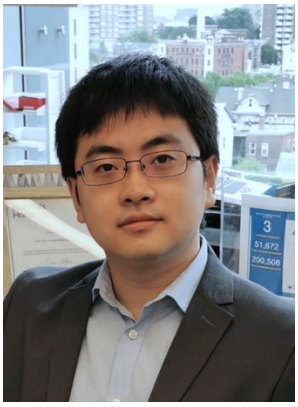
Biography: Robert S. Langer is one of nine Institute Professors at MIT and cofounder of Moderna, which developed the first COVID-19 vaccine. Dr Langer has written more than 1,600 articles and holds over 1,495 issued and pending patents worldwide. His patents have been licensed or sublicensed to over 400 pharmaceutical, chemical, biotechnology, and medical device companies. He is the most cited engineer in history (h-index 324 with more than 427,700 citations according to Google Scholar).

Prof Frank Caruso FRS FAA, The University of Melbourne

Title: Nanoparticle Platforms for Therapeutic Applications

Abstract: Advances in nanoparticle-mediated therapeutic delivery are poised to revolutionize disease treatment and prevention. In particular, the formulation of mRNA into lipid nanoparticles to combat COVID-19 has highlighted the transformative potential of nanoparticle platforms in the pharmaceutical industry and clinical practice. However, distinct types of therapeutics are required to meet specific therapeutic purposes and their encapsulation is typically tailored on a case-by-case basis. This presentation will present a versatile and biocompatible nanoparticle platform, whereby diverse therapeutics, including functional small molecules, siRNA, mRNA, and proteins, can be readily assembled into nanoparticles. The encapsulated therapeutics maintain their intrinsic activity and can be released upon exposure to the biological milieu. This nanoparticle platform has potential for usage in a range of applications.

Biography: Frank Caruso is a Melbourne Laureate Professor and an NHMRC Leadership Fellow at The University of Melbourne. During his appointment at The University of Melbourne, he held ARC Federation Fellowships (2002–2012) and an ARC Australian Laureate Fellowship (2012–2017). His research focuses on developing materials for biomedical applications. He has published over 550 peer-reviewed papers and is a highly cited researcher. He is an Executive Editor of the ACS journal Chemistry of Materials and serves on the Editorial Advisory Board of 11 other scientific journals. He was elected a Fellow of the Australian Academy of Science in 2009 and of the Royal Society of London in 2018. He is the co-inventor of 38 patents. He is co-founder of Messenger Bio Pty Ltd (2021), a company that focuses on mRNA technologies.

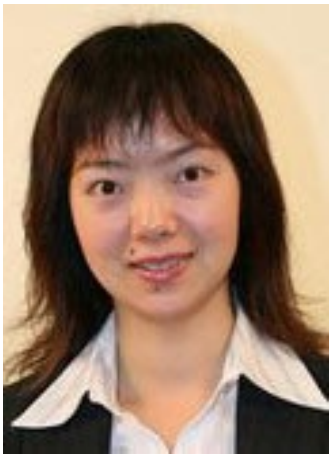


Prof Wei Tao, Harvard Medical School

Title: Nano- & Microscale Materials-enabled Drug Delivery Technologies

Abstract: Despite all of the coverage of new drugs, it is not enough to just have an effective drug. To enhance therapeutic efficacy and reduce the side effects, the drugs must be protected and transported to the right location to get an effect at the right time. Over the past few decades, nano-/microscale materials-enabled drug delivery platforms have made tremendous advancement in preventing and treating human diseases. Especially, the recent great success achieved by the two highly effective mRNA nanoparticle vaccines during the COVID-19 pandemic has further highlighted the great potential of drug delivery technologies. During the evolution of these drug delivery technologies, materials science innovation has played an important role from drug modification to the synthesis of different drug delivery platforms, which fulfill effective medical applications in various diseases including cancers, cardiovascular diseases, diabetes, infectious diseases, and many others. In this talk, I will introduce our current studies on nano-/microscale materials-enabled drug delivery technologies with the promise to improve health care, as well as our effort in accelerating their translation into the drug development pipeline.

Biography: Prof Wei Tao is the Farokhzad Family Distinguished Chair for Innovation, Co-Director of Nano Immune-Imaging Core, Principal Investigator in the Center for Nanomedicine, and Faculty Member in the Department of Anesthesiology, Perioperative and Pain Medicine at Brigham and Women's Hospital, Harvard Medical School. He is also the first Distinguished Chair Professor as an assistant professor at his institution. His research focuses on biomaterials, nanotechnology and drug delivery, as well as their various applications in translational medicine. Prof. Tao is ranked as a Clarivate's Global Highly Cited Researcher, World's Top 2% Scientist (Career-List, Mendeley Data from Elsevier), and an elected fellow of IAAM. MIT Technology Review previously listed him as one of the top Chinese innovators. Microsoft Academic also listed him as one of the *Global Top 5 Trending Authors in Nanotechnology*, and *Top Authors in Nanomedicine*. He serves as an invited reviewer for the European Research Council, NIH (US), DoD (US), Deutsche Forschungsgemeinschaft (German), Swiss National Science Foundation (Switzerland), Dutch Research Council (Netherlands), Israel Science Foundation (Israel), Canadian Institutes of Health Research (Canada), etc. He also serves on numerous editorial boards including as Founding Editor-in-Chief of *Biomedical Technology*, Deputy Editor of *Exploration*, Associate Editor of *Aggregate*, and *Journal of Nanobiotechnology*; Editor of *PNAS*; Guest Editor of *eLife*, etc.; Senior Editorial Board Member of *Materials Today*, etc.; and Advisory Board Member of *Matter* (Cell Press).



Prof Wei Chen, The University of Sydney

Title: Sensor Systems and Health Informatics

Abstract: Many challenges exist in health monitoring and management, such as continuous, accurate, and comfortable monitoring of multi-parameters, early detection and warning of diseases, as well as the interaction with environments. The challenges in healthcare raise health risks and imposes significant economic and social burden. The development of modern sensors, Internet of Things, advanced materials, machine learning and AI technology has inspired the innovation on intelligent designs for healthcare. The novel intelligent wellness sensing platforms seamlessly integrate smart sensing technologies, data fusion techniques, advanced materials, and clinical knowledge. Physiological signs, behaviours and environmental information can be obtained effectively. By jointly analysing physiological and behavioural parameters with environmental interaction information and using data fusion technology, the health-related activities can be identified, predicted and evaluated. With intelligent wellness sensing platform, personal health monitoring and forecasting will be provided assisting to develop personalised healthcare and health management plan, guiding people towards a healthier lifestyle. The multidisciplinary research on wearable and ambient sensor systems, machine learning, and biomedical signal processing will bring new development for improving the quality of life for people ranging from babies to aging population during their everyday life, and have significant social impact.

Biography: Prof Wei Chen is Head of School of Biomedical Engineering and Professor at the University of Sydney, Australia. She obtained her Ph.D. degree in 2007 from the University of Melbourne in Australia and her bachelor's and master's degrees from Xi'an Jiaotong University in China. She worked at Bell Laboratories Germany, Alcatel-Lucent, Stuttgart, Germany as an intern in 2005. From 2007 to 2015, she was an Assistant Professor at Eindhoven University of Technology in the Netherlands. From 2015 to 2023, she worked as a full Professor and Director of Center of Intelligent Medical Electronics at School of Information Science and Technology and Director of the Physiological Signal and Sleep platform in the Human Phenome Institute at Fudan University in Shanghai. She serves as the IEEE EMBS (Engineering Medicine and Biology Society) AdCom Asia/Pacific representative, Associate Editor of IEEE Transactions on Biomedical Engineering, IEEE Journal on Biomedical Health Informatics, IEEE Transactions on Neural Systems and Rehabilitation Engineering and IEEE Journal of Translational Engineering in Health and Medicine. From 2020 to 2022, She was the Chair of IEEE Sensor and Systems Council China Chapter and Managing Editor of IEEE Reviews in Biomedical Engineering. She has published 2 books, 200+ scientific papers, holds 20+ granted patents, and successfully led 10+ important R&D projects. Her research focuses on biomedical unobtrusive sensor systems and health informatics, including wearable and ambient sensor systems, physiological and behavioral data sensing and analysis, multimodal approaches for health regulation, artificial intelligence for biomedical engineering, neonatal monitoring, brain activity monitoring, smart rehabilitation and sleep monitoring.

Prof Jeremy Crook, Chris O` Brien Lifehouse, The University of Sydney

Title: Electroceuticals for Nanomedicine: Disruptive HealthTec Innovation for Regenerative Medicine and Cancer Therapy

Biography: Jeremy Crook is Director and conjoint Arto Hardy Family Chair and Professor of Biomedical Innovation at the Chris O` Brien Lifehouse and School of Medical Sciences, University of Sydney, respectively, and Professorial Fellow of Biomedical Engineering, University of Wollongong. Jeremy completed his PhD at the University of Melbourne (UoM; 1998) followed by a US National Institutes of Health (NIH) Fogarty International Centre Medical Research Fellowship (received NIH Fellows Award for Research Excellence). Jeremy's discoveries from his PhD opened up new treatment possibilities for people with schizophrenia, leading to the recent (September 2024) approval by the US Food and Drug Administration of the first antipsychotic drug that targets cholinergic receptor defects. Since 2002, Jeremy has held the positions of Program Manager in the stem cell biotech ES Cell International (2002-2007), Group Leader in Singapore's A*STAR Institute of Medical Biology (2007-2009), Head of the Stem Cells and Disease Modelling Laboratory in the UOM Centre for Neural Engineering (2011-2014), and Chief Investigator and Deputy Theme Leader (Synthetic Biosystems) in the ARC Centre of Excellence for Electromaterials Science (2014-2021). At ESI Jeremy oversaw the development of the world's first clinically compliant pluripotent stem cell lines (Cell Stem Cell 2007), selected by the Californian Institute of Regenerative Medicine and the University of California system institutions to translate stem cells to human therapies. Jeremy's award-winning research (Research Australia 2019 Health and Medical Research Frontiers Research Award) focuses on next-generation tissue building for drug discovery, medical device development, and regenerative and cancer medicine. Jeremy is an inventor on several patents and authored more than 110 publications in top ranked journals, including Advanced Science, Advanced Healthcare Materials, Cell Stem Cell, Nature (Biotech, Cell Biology, Genetics, Molec Psychiatry), Proc Natl Acad Sci, Biol Psych, and the Am J Psychiatry, with over 7975 citations.

Prof Kristopher A. Kilian, The University of New South Wales

Title: Hierarchically assembled hydrogels for tissue engineering and regenerative medicine

Abstract: Soft structures in nature reversibly assemble into hierarchical networks with non-linear viscoelastic properties that are central to directing cell activity and tissue assembly. Supramolecular assembly has been used to create hydrogels that mimic the structural aspects of natural materials. However, synthetic approaches generally fall short in replicating the dynamic behaviour of native tissue. Here I will present our work designing supramolecular materials to serve as scaffolding for 3D cell culture and biofabrication. Using coarse grain molecular dynamics, we discovered a novel short peptide based on the "tryptophan zipper" (Trpzip) motif that self-assembles into a hierarchically ordered nanofibrous hydrogel. Trpzip gels display tunable modulus, self-healing characteristics, stress-relaxation behavior, with inherent bioactivity that promotes matrix deposition and cell proliferation. The low yield point and self-healing properties facilitate syringe extrusion with cytoprotection, while also providing scope for use as a support matrix for suspension bioprinting. Integrating complementary polymer networks can expand the range of mechanical properties, allowing increased strength and toughness, while maintaining desirable viscous characteristics. Overall, harnessing supramolecular assembly with careful design of network architecture holds promise for advancing our goal of mimicking the complex attributes of natures soft materials.

Biography: Professor Kris Kilian leads the Laboratory for Advanced Biomaterials and Microphysiological Engineering (LAB&ME) at the University of New South Wales (UNSW) in Sydney Australia. He is co-Director of the Australian Centre or NanoMedicine and has affiliations in the School of Materials Science and Engineering, School of Chemistry, and the Adult Cancer Program in the Prince of Wales Clinical School. Kris received B.S. and M.S. degrees in Chemistry from the University of Washington in 1999 and 2003 respectively, and his PhD in Chemistry at UNSW Sydney in 2007. Kris was a NIH postdoctoral fellow at the University of Chicago (2008-2010), Assistant Professor (2011-2017) and Associate Professor (2017-2018) at the University of Illinois at Urbana-Champaign, before returning to UNSW Sydney in 2018. Kris is a recipient of the Cornforth Medal from the Royal Australian Chemical Institute for "The Best PhD thesis submitted in a branch of chemistry, chemical science or chemical technology in Australia" (2008), the NIH Ruth L. Kirschstein National Research Service Award (2008), the National Science Foundation's CAREER award (2015), a Young Innovator of Cellular and Molecular Bioengineering (2017), the Australian Research Council Future Fellowship (2018), the Deans award for Excellence in Research (2020), and a Eureka Prize Finalist from the Australian National Museum for "Innovative Use of Technology" (2023). His research interests include the design and development of model extracellular matrices and dynamic hydrogels for cell and tissue engineering.

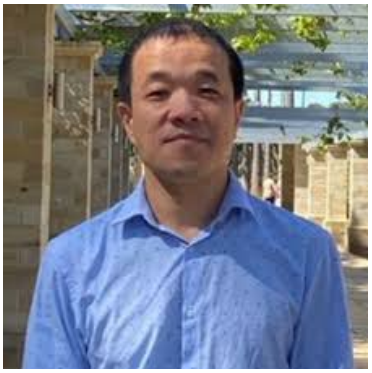
Dr Shelley Wickham, The University of Sydney

Title: Reconfigurable 3D DNA Origami nanostructures, programmable lipid-interactions and microdroplets

Abstract: DNA nanotechnology has emerged over the past decades as a powerful strategy to build self-assembling nanostructures, with applications as tools for single molecule biophysics, platforms for diagnostics and therapeutics, and templates for nanofabrication. For example, we recently demonstrated DNA origami barrels as versatile nanoscale pegboards with up to 2000 uniquely addressable pixels, spaced 9 nm, as a 3D template for proteins, polymer nanowires, metallic nanoparticles, and lipid tubes. In parallel, the field of DNA computing has implemented complex logical operations in molecular reaction networks, such as synthetic molecular motors. Current key limitations are the size and complexity of DNA nanostructures, and the integration of structural DNA nanotechnology with DNA computing circuits to build reconfigurable and responsive nanostructures.

Here I will describe some recent strategies towards hierarchical assembly of DNA origami building blocks into arbitrary 3D shapes. I will discuss how reconfiguration by DNA circuits can be used to guide nanostructure assembly pathways to increase yield and structural diversity. Reconfiguration can also achieve functional diversity, for example we are developing programmable lipid-interacting nanostructures for cell-cell communication in synthetic droplet networks. Finally, future directions in using DNA interactions to drive liquid-liquid phase separation will be discussed for building artificial cells.

Biography: Dr Shelley Wickham is a Senior Lecturer and group leader in the Schools of Chemistry and Physics at the University of Sydney. She received her PhD in Condensed Matter Physics from the University of Oxford, UK, working on building synthetic molecular motors out of DNA. She then moved to a postdoctoral fellow position at Harvard Medical School, USA, based in the Department of Cancer Biology, Dana-Farber Cancer Institute, and the Wyss Institute for Biologically Inspired Engineering, where she worked on designing 3-dimensional DNA origami nanostructures, and using them to study biological systems. At the University of Sydney Dr Wickham is group leader of the DNA nanotechnology group, with research interests in self-assembling nanotechnology and molecular robotics.



Prof Wenlong Cheng, The University of Sydney

Title: Intelligent Wearable Skins for Soft Biodiagnostics

Abstract: In the context of telehealth and internet of things (IOT), there are unprecedented needs for developing remote diagnostic tools that can monitor chemical and biological markers remotely anytime anywhere, such as via a smart phone. Such sensing devices are ideally soft and thin so that they can "bio-friendly" interface with soft biological systems. However, traditional biosensing devices are typically constructed by bulk electrodes which are rigid and planar limited electroactive surface areas.

Here, I will present our skin-like sensing devices that can remotely monitor human's health and cardiac organoids.

Biography: Wenlong Cheng is a professor in the School of Biomedical Engineering at the University of Sydney. He was a director of research in the Department of Chemical&Biological Engineering at Monash University, Australia. He is currently NHMRC Investigator Leadership Fellow and a fellow of Royal Society of Chemistry and was an Ambassador Tech Fellow in Melbourne Centre for Nanofabrication. He earned his PhD from Chinese Academy of Sciences in 2005 and his BS from Jilin University, China in 1999. He was Alexander von Humboldt fellow in the Max Planck Institute of Microstructure Physics and a research associate in the Department of Biological and Environmental Engineering of Cornell University. He founded Monash NanoBionics lab at the Monash University in 2010. His research interest lies at the Nano-Bio Interface, particularly self-assembly of 2D plasmonic nanomaterials, DNA nanotechnology, electronic skins and stretchable energy devices. He has published >220 papers. He is currently the scientific editor for Nanoscale Horizon (Royal Society of Chemistry) and the editorial board members for a few journals including Nanoscale, Nanoscale Horizons, Nanoscale Advances, Advanced Sensor Research, Advanced Electronic Materials, ChemNanomat, Advanced Sensors and Energy Materials, iScience, Chemosensors, and Austin Journal of Biomedical Engineering, FlexTech and Wearable Electronics.

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1. Hierarchically resistive skins as specific and multimetric on-throat wearable biosensors. Shu Gong, Xin Zhang, Xuan Anh Nguyen, Qianqian Shi, Fenge Lin, Sunita Chauhan, Zongyuan Ge, Wenlong Cheng*. *Nature Nanotechnology*, 2023, 18, 889–897.
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3. Soft wearable healthcare materials and devices. Quanxia Lyu, Shu Gong, Jialiang Yin, Jennifer M Dyson, Wenlong Cheng*. *Advanced Healthcare Materials* 2021, 2100577.
4. Real-Time and In-Situ Monitoring of H2O2 Release from Living Cells by a Stretchable Electrochemical Biosensor Based on Vertically Aligned Gold Nanowires. Quanxia Lyu, Qingfeng Zhai, Jennifer Dyson, Shu Gong, Yunmeng Zhao, Yunzhi Ling, Ramya Chandrasekaran, Dashen Dong, Wenlong Cheng*. *Analytical Chemistry* 2019, 91 (21), 13521-13527
5. A soft and ultrasensitive force sensing diaphragm for probing cardiac organoids instantaneously and wirelessly. Quanxia Lyu, Shu Gong, Jarmon G Lees, Jialiang Yin, Lim Wei Yap, Anne M Kong, Qianqian Shi, Runfang Fu, Qiang Zhu, Ash Dyer, Jennifer M Dyson, Shiang Y Lim, Wenlong Cheng*. *Nature Communications* 2022, 13, 7259.

Prof Rachel Codd, University of Sydney

Title: An antibody-compatible cancer-targeting theranostic agent for precision oncology

Abstract: Targeted ligand therapy (TRT) is a new treatment modality approved by the FDA in 2022 for eligible patients with metastatic castration-resistant prostate cancer (mCRPC). This TRT agent – marketed as Pluvicto – has significantly improved outcomes for these patients in the USA, and in August 2024, was approved by the TGA for use in Australia. Pluvicto (and a second clinical TRT agent Lutathera used for a different type of cancer) contains the metal radioisotope lutetium-177 which emits DNA damaging beta-radiation. To control the distribution of radiation for patient safety, the Lu-177 isotope is tightly encapsulated in a small-molecule organic housing known as a 'chelator' which itself is covalently attached to a peptide that recognises the prostate specific membrane antigen (PSMA) upregulated at the tumour cell surface. This peptide-PSMA attractant mechanism enables the TRT assembly is ferried selectively to the tumour to deliver local radiation benefit, and that damage to surrounding healthy cells is reduced. We conceived an approach to expand the scope of TRT by designing a molecular scaffold compatible with using a wider range of radioisotopes with useful decay properties. The molecular design aligned with the goal to open opportunities to use avid antibody-antigen recognition partners for targeting and to develop a single theranostic agent with switchable use for imaging or therapy to offer potential to improve the precision of dosing calculations.

Biography: Rachel Codd (FRACI) is the Professor of Bioinorganic and Medicinal Chemistry at The University of Sydney and leads the Chemical Biology in Drug Discovery group. Codd applies her cross-discipline career training and expertise in chemistry, microbiology, and chemical biology, to innovate in methodological approaches to deliver new chelator chemotypes with expanded applications in biomedical metal sequestration and/or delivery. Impact is demonstrated by her listing on the Stanford University World's Top 2% Scientists Most-Cited List in 2022 in two fields (inorganic and nuclear chemistry; organic chemistry).

Prof Steven Wise, The University of Sydney

Title: On-Demand Bioactivation of Inert Materials With Plasma-Polymerized Nanoparticles

Abstract: Introduction: The performance of materials employed in biomedical applications is profoundly influenced by their interactions with proteins, cells, and tissues at the implantation site. Our study sought to employ a novel nanocarrier platform as a new way to functionalise inert polymeric materials including hydrogels and porous constructs.

Approach: We were the first to collect and characterize the 'plasma dust', which has long been known to form in particulate-rich 'dusty' plasmas, for biological applications1. Plasma dust nanoparticles (called plasma polymerized nanoparticles or PPN) retain many of the favourable physical and chemical properties known for plasma thin films, including hydrophilicity and linker-free biomolecule binding. Here we propose to use PPN as a fundamentally new plasma-derived surface modification approach for functionalizing materials, available as an off-the-shelf and on-demand surface functionalization tool in vials.

Results: We show that adsorption of PPN leads to an activation of a range of material surfaces, prompted by changes in surface chemistry and enhanced hydrophilicity. We further demonstrate that PPN can be robustly immobilized onto inert substrates (e.g. PCL, polypropylene, silk and cellulose), resisting washing and desorption. Materials functionalization with arginylglycylaspartic acid (RGD)-loaded PPN significantly enhanced cell attachment, spreading, and substrate coverage on inert scaffolds compared to passive RGD coatings. Improved adhesion to complex geometries and subsequent differentiation following growth factor exposure is also demonstrated2.

Conclusion: This research introduces a novel substrate functionalization approach that mimics the outcomes of plasma coating technology but vastly expands its applicability, promising advancements in biomedical materials and devices.

Biography: Prof Steven Wise is Professor of Cardiovascular Bioengineering at the School of Medical Sciences, University of Sydney, a Heart Foundation Future Leader Fellow and recently elected Fellow of Biomaterials Science and Engineering (FBSE). Working in multi-disciplinary research teams he specialises in engineering new biocompatible materials and devices, particularly for vascular applications. He leads large competitive grant programs developing new stents, valves, grafts and nanotherapies to better treat cardiovascular disease. He is co-founder and CSO at Nanomedx, a start-up developing next generation vascular therapies.

References:

1 Santos, M. et al. *ACS Applied Nano Materials* 1, 580-594 (2018).
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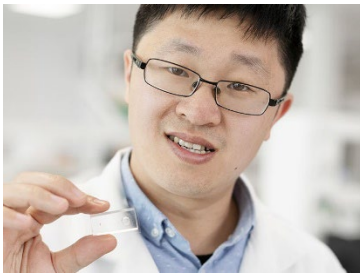

A/Prof Arnold Ju, The University of Sydney

Title: Personalized 3D Vessel-on-chip: Towards 'Sherlock Holmes' approach to detecting blood clots

Abstract: We present a groundbreaking approach to personalized thrombosis detection and stroke prevention. Our innovative 'Sherlock Holmes' methodology combines advanced microprecision 3D printing techniques with microfluidic technologies to create patient-specific vessel-on-chip models. These miniaturized vascular systems, derived from individual patient CT scans, serve as precise replicas of carotid arteries, allowing for detailed investigation of thrombotic events at a microscale level.

Utilizing carbon-reinforced photopolymer resins, we achieve unprecedented resolution in 3D printing, enabling the fabrication of intricate vascular geometries with micron-level accuracy. The integration of carbon nanotubes enhances the mechanical properties and biocompatibility of these models, mimicking the elasticity of natural blood vessels.

Our vessel-on-chip platform incorporates real-time imaging capabilities and advanced sensors, leveraging volumetric confocal microscopy for ultra-sensitive detection of platelet aggregation and fibrin formation. This setup allows for the observation and quantification of thrombotic events under patient-specific flow conditions, providing a level of detail previously unattainable in conventional diagnostic methods.

By applying this 'Sherlock Holmes' approach, we can deduce the likelihood of blood clot formation in individual patients, identify high-risk areas within the vascular system, and test the efficacy of various antithrombotic therapies in a personalized manner. This carbon-enabled technology represents a significant leap towards precision medicine in stroke prevention, offering a powerful tool for clinicians to make informed decisions and tailor treatments to individual patient needs.

Biography: Snow Fellow, Australian Heart Foundation Future Leader Fellow and Australian Academy of Science John Booker Medal, The University of Sydney, School of Biomedical Engineering.

A/Prof Ju received his PhD in Biomedical Engineering at Georgia Institute of Technology and Emory University, USA. In 2014, he joined the Australian Centre for Blood Diseases, Monash University, Melbourne as a junior postdoc; and relocated in 2015 to Sydney, to join the Heart Research Institute. In early 2020, Dr Ju joined the University of Sydney (USYD)'s new School of Biomedical Engineering as a senior lecturer and started up the Mechanobiology and Biomechanics Laboratory (MBL).

A/Prof Ju works at the biomedical engineering and mechanobiology. His team has pioneered multiple biomechanical nanotools, including blood-clot-on-a-chip microfluidic devices (Nature Materials 2019), single-cell biomembrane force probes (Nature Communications 2018), 4D hemodynamic modeling (Nature 2021) and fluorescent micropipette aspiration assays (Nature Communications 2024). His novel understanding of the mechanics behind blood clot formation has profound implications for diagnosing and preventing heart attacks and strokes. His vision is to build novel platforms that integrate advanced biomanufacturing, high-throughput biomechanical manipulation, and artificial intelligence for biobank data processing. Recently, he was awarded the prestigious $8 million Snow Fellowship. This acknowledgment fuels his mission to create microdevices that monitor and alert individuals at risk of life-threatening conditions for his father and broader community worldwide.

Dr Hien Duong, The University of Sydney

Title: Bacteriophage-Antimicrobial Conjugates: A Targeted Approach to Overcome Antimicrobial Resistance

Abstract: This talk will explore the innovative use of bacteriophage-antimicrobial conjugates to combat antimicrobial resistance. By coupling bacteriophages with active agents, these conjugates provide targeted, site-specific delivery of therapeutics, minimising off-target toxicity while concentrating treatment at the infection site. This adaptable platform allows for the customisation of active agents and phages, enabling precision treatment for a range of bacterial infections.

Biography: Hien Duong has over a decade of expertise in nanotechnology, reflected in her 47 publications and 4 patents, which have earned 3,824 citations and an H-index of 33 (Scopus). Her research is highly interdisciplinary, focused on nanoscale materials and devices to improve health outcomes. Her primary goals are to utilise nanotechnology for early detection of life-threatening diseases and to enhance existing therapies. With a background in polymer synthesis and nanomaterial fabrication, her work spans organic, inorganic, and biocompatible nanomaterials for biomedical applications, particularly in treating infectious diseases and cancer. This unique combination of skills gives her a deep understanding of the interface between polymer science and biomedical applications.

Dr Peter Wich, The University of New South Wales

Title: Polysaccharides and Proteins as Biopolymer Nanomaterials in Drug Delivery and Biocatalysis

Abstract: Nature's polymers, such as polysaccharides and proteins, show remarkable versatility as multifunctional materials. They can be easily modified with the toolkit of bioorganic chemistry and are attractive because of their degradability and biocompatibility.

The presentation will feature our latest results on different nanoparticle systems that contain modified polysaccharides and enzymes. Examples will include dextrans as versatile biopolymer starting materials. Conjugation with synthetic and bio-derived polymers results in biohybrid materials that are responsive and show triggered disassembly and payload release. Similarly, we explore proteins and enzyme conjugates as materials for nanoparticles in order to obtain active materials that show high efficiencies in biotransformations and catalytic applications.

The presented multifunctional biopolymer nanosystems exemplify that the function and structure of the particle material itself are as important as the transported payloads.

Biography: Peter Wich is Senior Lecturer and Junior Professor for Bioorganic and Macromolecular Chemistry in the School of Chemical Engineering at the University of New South Wales in Sydney (Australia). He is a member of the Centre for Advanced Macromolecular Design (CAMD) and the Australian Center for Nanomedicine (ACN). Previously, Peter worked as Assistant Professor at the University of Mainz (Germany) and as Alexander von Humboldt Fellow at the University of California Berkeley (USA).

Peter has been awarded more than 20 prizes and scholarships for his research, including the Innovation Prize in Medicinal/Pharmaceutical Chemistry for his work on bioinspired nanomaterials and the Galenus Technology Prize. He is a "Young Member" of the Academy of Sciences and Literature in Mainz (Germany). In 2019, he was named Emerging Investigator of the Journal "Soft Matter", and in 2020, he was selected as Polymer Chemistry Emerging Investigator. In 2022, he received the David Sangster Polymer Science and Technology Achievement Award.

Peter leads the UNSW Research Lab for Functional Biopolymers. His primary research interests are in the fields of macromolecular chemistry at the interface between nanotechnology and bioorganic chemistry. His lab focuses on the chemical modification of natural biopolymers with the aim of engineering new multifunctional and biocompatible materials for applications in drug delivery, nanomedicine, bio-catalysis, and 3D printing.

(For more information visit: www.wichlab.com or follow him on X/Instagram @peterwich

Dr Hao Song, The University of Queensland

Title: Nature-Inspired Therapeutics and Vaccine Delivery Systems

Abstract: The intriguing nature systems have inspired remarkable advances in the development of functional materials towards versatile applications. Pollen grains with distinct spiky surfaces are extraordinary delivery vectors in nature, where the rough surface enables strong adhesion towards the hairy legs of honeybees for pollination. The nano-sized viruses also show spiky features, where the protein spikes form multiple 'entry claws' promoting their cellular invasion. Spiky structures create fascinating properties at the bio-interfaces, while it is challenging to engineer spiky textures onto a single nanoparticle in a controllable manner for drug delivery applications. Here, we showcase our recent progress in the development of spiky nanoparticle-based gene and vaccine delivery platform. Through a simple sol-gel synthesis approach, colloidal nanoparticles with an intrinsic spiky surface are fabricated[JACS 2016, JACS 2017, Sci Adv 2023] and characterized by the advanced microscopy techniques of electron tomography.[Adv Mater 2019] We demonstrated the precise control over delicate nanotopography of spiky nanoparticles [ACS Appl Mater Interfaces 2021], tailored the surface chemistry,[JCIS 2022] size,[J Mater Sci 2021] and asymmetry of the particles[JMCB 2022] for enhanced plasmid DNA delivery at both in vitro and in vivo levels,[Adv Therapeutics 2020] gaining in-depth understandings at the bio-nano-interfaces. Based on the biomimetic strategies, we have developed a series of pathogen-mimetic delivery systems for vaccine development and cancer immunotherapy, where the rational engineering of nano-micro particulates showed bioactive and bio-responsive therapeutic effect.

Biography: Dr. Hao Song obtained his PhD in biomedical engineering in 2018 from the University of Queensland (UQ), had his postdoc training at UQ then moved to MIT Koch Institute for Integrative Cancer Research working with Prof. Robert Langer. From 2021, he took the role of ARC DECRA & NHMRC Emerging Leadership Fellow at the Australian Institute for Bioengineering and Nanotechnology (AIBN), leading a team working on functional nanoparticles for gene and vaccine delivery. He published over 85 paper in Sci Adv, JACS, Adv Mater, Adv Sci, etc., with citations over 5000 times and an H-index of 38. As a chief investigator, he has attracted ~ $4.5 millions of funding from ARC, NHMRC, and industry, and promoted translations of his 'Spiky Nanoparticle Technology' in collaboration with industrial partners launched a product of NUVEC®.

Prof Ashish Diwan, The University of Adelaide and Royal Adelaide Hospital

Title: Back Pain arising from the Disc can be regenerated and Pain resolved using novel intradiscal therapy

Abstract: Recalcitrant back pain, arising from the intervertebral disc injury or degeneration may end up after prolonged non operative care with a spinal fusion operation. While on one hand these operations are risky and do not allow full return to good quality of life, on the other hand they lead to significant revision spinal surgeries. The gap between non-operative treatments, like physiotherapy and drugs, to that major surgical intervention for discogenic pain continues to the chagrin of governments and payors all over the world.

In 1995 I and colleagues from genetics department embarked on investigating the genetic basis of Klippel Feil Syndrome (agenesis of disc also known as spinal fusion in cervical spine) amongst some family members. Collaborative effort led the discovery by 2008 that a point mutation in the pro-domain of GDF6 (Also known as BMP13 or CDMP2) is a cause for the heterogenic condition[2]. We localized GDF6 to regions where disc's form in the human embryo[3].

Since then four animal models (from 2008 to 2022) including Kawakami's composite rabbit-rat model[4], a 12-month sheep model[5], multi-level disc injury model[6] and a rat tail disc-compression model[7] have demonstrated GDF6's efficacy to not only regenerate the disc, but also ameliorate pain.

In an attempt to understand the mechanisms by which GDF6 may bring about its effect, it has been demonstrated that when compared to the bone forming BMP7, GDF6 is non-osteogenic and pro-chondrogenic to human stem cells[8], That GDF6 is superior to GDF5 in converting stem cells of various origin from humans to disc cells[9], that GDF6 is an attractant and displays chemotactic behavior to cells that mobilises stem cells from niches or adjacent bone marrow[10]. The intracellular signaling pathway involves SMAD's; however such pathways are independent of MAPK[11, 12].

As GDF6 brings about its effect via receptors, we then wished to understand whether GDF6 and their receptors are expressed in the aging or degenerating human disc, demonstrating that indeed they are[11, 12]. This allows for using a recombinant protein therapeutic to be used in a range of patients across the age and degeneration spectrum.

Human clinical trials are being initiated by after GMP protein manufacturing and intricate clinical study designs. Trial designs have failed in the past to address early disc disease, hence adaptive designs that address a select population are being considered.

Biography: Prof Ashish Diwan (PhD, FRACS FAOrthA) is the Chair of Spinal Surgery University of Adelaide and Royal Adelaide Hospital along with Director of Spine Service at the Department of Orthopaedic Surgery, St. George Hospital, University of New South Wales. Ashish is a unique combination of global excellence in the three domains: that of surgical craft care-delivery, academic thought leadership and entrepreneurial spirit. He is positioned at the rare intersection of idea-generation-to intensive research-to-commercialization in the field of musculoskeletal health.

Whilst running a busy surgical practise, he has conducted basic science research in degeneration and regeneration of the intervertebral disc, developed numerous novel products for gap in diagnosis and treatment for back pain and conducted numerous first-in-human studies in spine. He has literally taken concepts from a piece of paper to humans. In the process he has had around two dozen patents as named inventor, understood the curious regulatory pathways involving drugs, devices and software-as-a-medical-device and led teams to clinical and commercial success. During these activities he has raised upwards of $20M in research and development activities.

His main work revolves around a single molecule's role in spinal development and repair, a work spanning more than two decades that is ready to enter clinical evaluation with the expectation of avoiding spinal fusion for disc related chronic back pain disorders.

With a team of engineers, Prof Diwan has developed a viscoelastic spinal motion segment stabiliser to partially replace the disc when disc tissue is lost, for example in lumbar disc herniations, whether chronic or recurrent.

Further, Professor Diwan and his team have also established the Australian Cervical Myelopathy Register which is a unique registry of patients suffering from chronic spinal cord dysfunction related to aging. This work will set up an adaptive platform for future discovery and management for this poorly understood condition.

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A/Prof Zi (Sophia) Gu, The University of New South Wales

Bioresponsive Nanoparticles Enabled Catalytic Therapy

Abstract: Nanoparticle-based catalysts have been developed for catalytic nanomedicine to generate therapeutic compounds locally towards safe and effective treatment of diseases. In this talk, I will present our recent work on development of bioresponsive nanoparticles for chemodynamic, photodynamic and sonodynamic therapy by leveraging the internal or external stimuli-triggered catalytic reactions. Our nanoparticle-based catalysts have demonstrated high catalytic activity to in-situ generate reactive oxygen species efficiently to induce apoptosis of tumor cells.[1] The nanoparticles exhibited highly selectivity to the tumor microenvironment. The hydroxyl radical generation-induced therapeutic effect was further enhanced by sonocatalysis and cascade catalytic reactions triggered by photocatalysis.[2-4] We have also shown that the nanoparticles generated oxygen bubbles and promoted the long-distance and directional movement, thus achieving target homing and deep penetration of the nanomedicine.[5]

Biography: Zi (Sophia) Gu is an Associate Professor at the School of Chemical Engineering, University of New South Wales (UNSW Sydney). She leads a NanoBiotechnology Research Group at UNSW and is currently a member of Australian Centre for NanoMedicine and UNSW RNA Institute. After her PhD training at the University of Queensland and Cornell University, she was awarded with Australian NHMRC Peter Doherty Biomedical Fellowship and joined UNSW in 2016. Her research focuses on developing advanced nanomaterials and delivery strategies to address critical issues in health and medicine. To date, she has published over 90 journal papers in the areas of nanomaterials and nanomedicine. Her research has been supported by ARC, NHMRC, NSW Health, National Heart Foundation, Tour de Cure etc. She serves as Editor-in-Chief of Cancer Nanotechnology and editorial member of several journals of Wiley and Springer Nature.

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Prof Yuling Wang, Macquarie University

Extracellular Vesicles: the Emerging Biomarkers and Therapies for Cancer Diagnosis/Prognosis and Treatment

Abstract: Extracellular vesicles (EVs) carry various messages and signal biomolecules to constitute key features of their parent cells, which make them as highly competitive non-invasive biomarkers for diagnosis/prognosis (*Figure 1*). Additionally, new insights on the biogenesis and molecular functions of EVs pave the way for novel EV-based therapeutic strategies as drug carriers and/or for immunotherapy.[1] In this contribution, I will discuss our recent development of biosensors for highly sensitive detection of cancer-derived small EVs (sEVs) using plasmonic nanomaterial and surface-enhanced Raman scattering (SERS).[2-4] I will also discuss our discoveries [5-6] about the involvement of key molecules in cancer-derived sEVs for cancer diagnosis/prognosis and strategies using sEVs for cancer treatment.

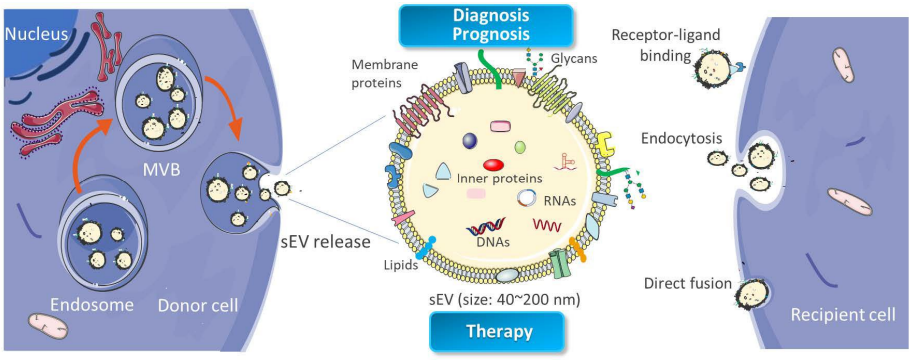

Figure 1. Biogenesis and identification of small extracellular vesicles (sEVs) for diagnosis, prognosis and therapy.[1]

Biography: Yuling completed her PhD degree at the Changchun Institute of Applied Chemistry, Chinese Academy of Sciences in 2009. After graduation, she took up a postdoctoral position at Purdue University, working in the Bindely Bioscience Center on the project of Nanobiotechnology. After working at Purdue University for 22 months, she was awarded a prestigious Alexander von Humboldt fellowship (AvH) and worked at the University of Osnabrücker in Germany for 2 years. Following her AvH fellowship, she got an individual grant supported by the German Research Foundation (DFG), working in the University of Duisburg-Essen on the topic of multiplexed cytokines detection with plasmonic nanostructures before commencing her ARC DECRA fellowship in 2014. Towards the end of her ARC DECRA Fellow, she was appointed as a Senior Lecturer at Macquarie University in 2017 and was promoted to Associate Professor in 2020. She is also a Chief Investigator within ARC Center of Excellence for Nanoscale BioPhotonics (CNBP) and leads the SERS program for in vitro diagnostics.

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Dr Yannan Yang, The University of Adelaide

Title: Nanomaterials based In Situ Vaccine against Tumours

Abstract: As a novel type of cancer vaccine, in situ vaccine utilised patient's own tumours as antigens to provoke systemic antitumour immunity through local treatment, offering a promising therapeutic paradigm for treating metastatic tumours. However, the immune response generated by in situ vaccines is usually insufficient to be therapeutically meaning and the duration is limited, posing sigfincant challenge for clinical translation. In this talk, I will discuss the most recent progress in my lab on designing nanomaterials based in situ vaccine (nano-ISV) for combating tumours. Briefly, three case studies will be introduced. Firstly, I will introduce a chemodrug-based nano-ISV that elicit potent systemic immune response by simultaneous STING activation and ROS scavenging.[1] Secondly, I will talk about a sulfide radical based nano-ISV that is capable of triggering immunogenic necroptosis and systemic antitumour immunity.[2-3] Thirdly, I will demonstrate a multiscale patterning strategy to engineer membranolytic nanoparticles that triggers immunogenic cell death by physically rupturing cell membranes.[4] We envision that these proof-of-concept studies would provide new opportunities for developing potent, safe and translational ISVs.

Biography: Dr Yannan Yang is a NHMRC Emerging Leadership Fellow and a group leader of Biomaterials and Immune Engineering Lab (BIEL) at the South Australian immunoGENomics Cancer Institute (SAiGENCI), the University of Adelaide. He has been leading a multidisciplinary research program focusing on the next-generation of nanovaccine technology that targets difficult-to-treat cancers. His research program has generated >90 publications, which led to >5500 citations and h-index of 39.

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Dr Ruirui Qiao, The University of Queensland

Title: Polymer Engineered Nanoparticles for Molecular Imaging and Gene Therapy

Abstract: Metal based inorganic nanoparticles have received great attention owing to their potential applications in biomedical field. Engineering of inorganic nanoparticles with polymer coatings lead to the reaction of polymer/inorganic nanohybrids with improved biocompatibility and functionality. The current talk focuses on the engineering of various type of inorganic nanoparticles using polymers synthesised through reversible addition-fragmentation chain transfer (RAFT) polymerisation method,[1] with a specific focus on magnetic nanoparticles[2] and liquid metal nanoparticles. These advanced polymer-coated inorganic nanoparticles can be used as imaging probes for disease diagnosis and gene delivery agents for therapeutic purposes, benefitting from the versatile designs of RAFT polymers.

Biography: Dr Ruirui Qiao is a Group Leader and NHMRC Emerging Leadership Fellow in Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland (UQ). She earned her PhD from the Chinese Academy of Sciences in 2014, along with an MSc in 2007 and a BSc in 2005 from Peking University, China. Leading a research group at AIBN, UQ, she is committed to advancing the field of functional polymer/inorganic nanohybrids for biomedical applications, including disease diagnosis, drug/gene delivery, tissue engineering, antibacterial solutions, and soft robotics. So far, she has published >110 refereed journal articles including Science, Nature Communications, ACS Nano, Advanced Materials, and JACS, with an H-index of 45 and >7800 citations. Among others, she currently serves as the associate editor for Science Advances (AAAS), Journal of Nanobiotechnology (Spring Nature) and Cancer Nanotechnology.

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Dr Jie Tang, Monash University

Title: Oral Delivery of Biomolecules: From Nanocarriers to Biomodulators

Abstract: Colorectal cancer (CRC) is one of the most common and lethal tumours worldwide. Current therapies are often unsuccessful because CRC frequently recurs with metastasis after treatment cessation. Vaccines offer great promise in preventing post-treatment recurrence, with clinical trials in progress. However, the efficacy of current (injected) vaccines remains limited due to a lack of T cell migration, which are crucial to combat CRC tumours. Oral immunisation outperforms injected immunisation (e.g. intramuscular) in generating cytotoxic T cells. While adjuvants are crucial for vaccine efficacy, currently licensed vaccine adjuvants (e.g. Alum) cannot trigger sufficient T cell immunity and are not optimal for oral delivery. In this study, we aimed to design a next-generation oral Nanoadjuvant platform technology using surface engineered silica-based nanoparticles to not only act as nanocarriers for antigen delivery but also as immunomodulators to enhance vaccine efficacy.

Our research team synthesized sodium-stabilized dendritic mesoporous aluminosilicate nanoparticles (Na-^{IV}Al-DMSN) and investigated their ability to induce dendritic cell (DC) pyroptosis-mediated protective immunity. We made two key innovations: (1) Firstly, we synthesized Na-^{IV}Al-DMSN, a new material, using a simple chemical reaction between aluminate and silicate. This material possesses framework-stabilized sodium that can exchange protons, a large mesopore of ~ 30 nm, and a uniform particle size of ~ 240 nm. (2) Second, we have elucidated the structure-function relationship of Na-^{IV}Al-DMSN, which induces H^+/Na^+ exchange in acidic lysosomes, leading to lysosome rupture and K^+ efflux. This mimics the process by which natural viral infections occur, where pyroptosis is triggered in antigen presenting cells, eliciting protective immunity.

Biography: Dr. Jie Tang is an NHMRC Emerging Leadership Fellow (EL1) and the head of the Mucosal NanoVaccine Lab at the Monash Institute of Pharmaceutical Sciences (MIPS), Monash University. With a multidisciplinary background in pharmaceutics, biomedical engineering, and nanotechnology, Dr. Tang specializes in developing nanoparticle platforms for vaccine delivery, particularly via mucosal routes like inhalation and oral administration.

Since earning her PhD from AIBN, University of Queensland, in 2018, Dr. Tang has secured over $2.3 million in competitive research funding as Chief Investigator, including grants from the ARC DP and NHMRC Investigator Grant, and has established licensing agreements with industry leaders such as AstraZeneca. Her work on inhalable mRNA delivery technology has led to collaborations with industry partners, raising €2 million to advance mRNA therapeutics and offering a promising rapid-response platform for pandemic pathogens using inhalable lipid-polymer nanoparticles.

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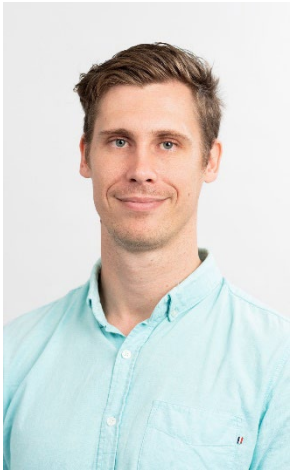

Dr Nicholas Hunt, The University of Sydney

Title: Development of Oral Nanotherapeutic Formulation of Insulin with Reduced Episodes of Hypoglycaemia

Abstract: Injectable insulin is an extensively used medication with potential life-threatening hypoglycaemic events. Here we report on insulin-conjugated silver sulfide quantum dots coated with a chitosan/glucose polymer to produce a responsive orally available and smart insulin nanoformulation. This formulation is pH responsive, being insoluble in acidic environments and shows increased absorption in human duodenum explants at neutral pH. The formulation is sensitive to glucosidase enzymes to trigger insulin release mediating insulin release based on the patients' blood glucose levels. It is found that the formulation distributes to the liver in mice and rats after oral administration and promotes a dose-dependent reduction in blood glucose without promoting hypoglycaemia or weight gain in diabetic rodents. In non-diabetic baboons also show a dose-dependent reduction in blood glucose validating the technology prior to first in humans trials. No biochemical or haematological toxicity or adverse events were observed in mice, rats and non-human primates. The formulation demonstrates the potential to orally control blood glucose with smart insulin release to reduce hypoglycaemic episodes. (Hunt, N.J., et al Nat. Nanotechnol. (2024). https://doi.org/10.1038/s41565-023-01565-2)

Biography: Nicholas Hunt is a Senior Lecturer and an NHMRC Emerging Leader Fellow at the University of Sydney. His group develops nanotechnology platforms for oral biologic delivery, and for immune tolerance promotion for the prevention of autoimmune diseases. The group is supported by the government, philanthropy and commercial sectors. He is a co-founder and CEO of Endo Axiom Pty Ltd, a clinical stage Biopharmaceutical company commercializing these technology platforms.