AUSTRALIA-JAPAN SCIENCE AND INNOVATION

Fifth JSPSAAA Annual Symposium

Information and Abstract Booklet

UNIVERSITY OF CANBERRA

JSPS ALUMNI ASSOCIATION IN AUSTRALIA

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Prof Ashraf Ghanem (FRACI, CChem, FHEA)

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UNIVERSITY OF CANBERRA

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Secretary of the Japan Society for the Promotion of Science Alumni Association in Australia (JSPSAAA)

ANSTO

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PROGRAM DAY 1 — 22 NOV 2023

TIME	PRESENTER	TITLE	AFFLIATION
Introductory Session			
8:00-8:30am	Registrations		
8:30-8:35am	Janine Deakin	Country acknowldgement and welcoming message	University of Canberra
8:35-8:40am	Ashraf Ghanem	Introduction of JSPSAAA	JSPSAAA
8:40-8:45am	Yashuara Koji	Message from JSPS Tokyo	JSPS-Tokyo
8:45-8:50am	Miyano Michiko	Message from the Embassy of Japan in Canberra	Embassy of Japan in Canberra
8:50-8:55am	Caroline McMillen AO FAHMS	Message from AJF	Australia-Japan Foundation
8:55-9:00am	Maxwell J. Crossley	Message from AAS	Australian Academy of Science
9:00-9:10am	Break		
Session 1 Chair: Tamim Darwish			
9:10-9:35 (25 min)	Andrzej Kilian	Two into one: bringing ecological principles into agricultural practice for sustainable future	Diversity Arrays Technology Pty Ltd
9:35-9:55 (20 min)	Pat Wongpan	Helicopter-Based Ocean Observations Capture Broad Ocean Heat Intrusions Toward the Totten Ice Shelf	University of Tasmania
9:55-10:15 (20 min)	Pierluigi Cesana	Fully automatization of ring-opening reactions in lactone derivatives via 2-step machine learning	Kyushu University
10:15-10:35 (20 min)	Amani Batarseh	Advancements in the detection of localised breast cancer by a lipidomic signature directly from plasma	BCAL Diagnostics
10:35-11:00 (25 min)	Morning Tea		
11:00-11:25 (25 min)	Chiharu Tokoro	Creation of a New Resource Circulation Loop by Electrical Pulsed Dismantling	Waseda University and The University of Tokyo
11:25-11:45 (20 min)	Cris dos Remedios	Collaboration between Australian human heart tissue biobanks and Japanese heart researchers	Victor Chang Cardiac Research Institute
11:45-12:05 (20 min)	Scott G Stewart	Dirthodium Catalyzed Reactions for the Preparation of Natural Products and Valuable Materials	University of Western Australia
12:05-12:25 (20 min)	Cheng Jiang	3D RBSM: A new Mesoscale DISCRETE approach for FRP-CONCRETE INTERFACIAL SIMULATION	Western Sydney University
12:25-12:45pm (20 min)	Shaneel Chandra	From Measurement to Monitoring: Why pollution research needs a rethink and reboot	Central Queensland University
12:45-13.10pm (20 min)	Iwao Hosako	How to use terahertz wireless communications at 6G	National Institute of Information and Communications Technology (NICT)
13:10-14:00	Lunch		
Session 2 Chair: Ashraf Ghanem			
14:00-14:25 (25 min)	Paul Harris	Recent developments in Australian Government policy and what they mean for Australia-Japan collaboration	Innovative Research Universities (IRU)
14:25-14:45 (20 min)	Jonathan C. Aitchison	Accreted REY-rich OPS in Gondwana margin subduction complexes: A new target for critical mineral resources	The University of Queensland
14:45-15:10 (25 min)	Faisal Hai	Generation of microplastics from the current plastic recycling process – an unintentional consequence of concern	University of Wollongong
15:10-15:35 (25 min)	Mitra Safavi-Naeini	Advancements and Translational Potential of Neutron Capture Enhanced Particle Therapy	ANSTO
15:35-16:00 (25 min)	Kei Murayama	Clinical and molecular basis of mitochondrial disease and medicine in Japan	Faculty of Medicine, Juntendo University
16:00-16:15 (15 min)	Afternoon tea		
Session 3 Chair: Mitra Safavi-Naeini			
16:15-16:30 (15 min)	Holly Tootell	From Play to Progress: Co-Designing Technology for Early Learners	The University of Canberra
16:30-16:45 (15 min)	Kenji Kajiwara	Development of Mathematics for Industry in Asia Pacific Area: New Research Area, Education and Platform	Kyushu University
16:45-17:00 (15 min)	Chamari Jayarathna	Japan- Australia Collaboration: Systems approach for transitioning to a decarbonized circular economy	The University of Queensland
17:30	Depart for the reception at the Embassy of Japan		

PROGRAM DAY 2 — 23 NOV 2023

TIME	PRESENTER	TITLE	AFFLIATION
8:30-8:40	Ashraf Ghanem and Tamim Darwish	Housekeeping	JSPSAAA
Session 1 Chair: Mitra Safavi-Naeini			
9:00-9:25 (25 min)	Masanori Tachikawa	H/D isotope effect in protonated/deuterated aqueous solution	Yokohama City University
9:25-9:45 (20 min)	Bobby Cerini	Looking Back, Facing Forward: Celebrating 35 Years of Australia-Japan Science Communication Collaboration	QUESTACON
9:45-10:05 (20 min)	Ernest Koh	The Art and Science of grant-writing: Japan-Australia collaborations in undergraduate research training	University of Canberra
10:05-10:25 (20 min)	Peter Bridgewater	The International Whaling Commission-Transformative, Regressive or Pathway to Future	University of Canberra
10:25-10:45 (20 min)	Morning Tea		
Session 2 Chair: TBC			
10:45-11:05 (20 min)	Nenad Naumovski	The role of food science and human nutrition on the development of functional foods for the management of stress, anxiety and sleep	University of Canberra
11:05-11:25 (20 min)	Withawat Withayachumnankul	Japan-Australia Joint Corporation of Advanced Terahertz Technology	University of Adelaide
11:25-11:40 (15 min)	Matthew McKenzie	Reversing Pathogenic Defects that Disrupt Mitochondrial Fat and Sugar Metabolism with Mitochondrial Biogenesis Stimulation	Deakin University
11:40-11:55 (15 min)	Sohel M. Julovi	Disease modifying interactions between chronic kidney disease and osteoarthritis: a new co-morbid mouse model	Westmead Institute for Medical Research
11:55-12:15 (20 min)	David Collings	Phi Thickenings Form a Three-Dimensional Scaffold That May Mechanically Stiffen Roots	The Australian National University
12:15-12:30 (15 min)	Kosuke Ishii	Neutron reflectometry analysis of ion compositions and protein monolayers at electrochemical liquid/liquid interfaces and Single-step deuteration of quaternary phosphonium-based ionic liquids	Kyoto University
12:30-12:45 (15 min)	Izuhara Takero	Artificial Intelligence and Robotics in Australia	Softbank Australia
12:45-13:00 (15 min)	Patrick Askew	Therapeutic Uses of 1,8-cineol, an extract from Eucalyptus globulus	University of Canberra
13:10-14:00	Lunch		

WELCOME

In this year's symposium, JSPSAAA would like to celebrate the collaborative links between Australia and Japan and to provide a networking event to foster further interactions between the two countries in the field of science. Speakers from both countries will showcase their research, promoting collaboration and networking. The event aims to give researchers the opportunity to present the collaborative work between Australia and Japan and explore the possibilities that can benefit their research through this bilateral collaboration. We are bringing researchers together from diverse backgrounds and fields of research to catalyze the collaborations needed to enrich the strong bilateral science and research relationship between Australia and Japan in areas of research priorities of both countries.

We would like to thank Australia-Japan Foundation, Australian Academy of Science and JSPS-Tokyo for their generous support. We hope you enjoy our fourth annual symposium and benefit from this networking event.

HEALTH

ENVIRONMENT

ENERGY

FOOD

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LARGE RESEARCH INFRASTRUCTURES

RELATIONSHIPS, INSTITUTIONS AND SOCIETY

CODE OF CONDUCT

Recording and taking photos of the presentations without the explicit permission from the individual delivering them is not permitted.

All participants should treat each other with respect and consideration. Personal attacks directed toward other participants, harassment, intimidation, or discrimination in any form will not be tolerated. Disruption of talks at oral or poster sessions will also not be tolerated.

Examples of unacceptable conduct include, but are not limited to, verbal comments related to gender, sexual orientation, disability, physical appearance, body size, race, religion, national origin, inappropriate use of nudity and/or sexual images in Zoom meetings or in presentations or threatening or stalking any participant.

Consequences for Violating the Code of Conduct: Anyone requested to cease unacceptable behavior will be expected to comply immediately. The event organizers may take any action deemed necessary and appropriate, including immediate removal from the event. JSPSAAA organizers may also prohibit attendance for anyone violating this code of conduct at any future meetings.

Reporting Violations of the Code of Conduct: If you are the subject of unacceptable behavior or have witnessed such behavior, please immediately notify the organizer at JSPSAAA@Canberra.edu.au.

VENUE DETAILS

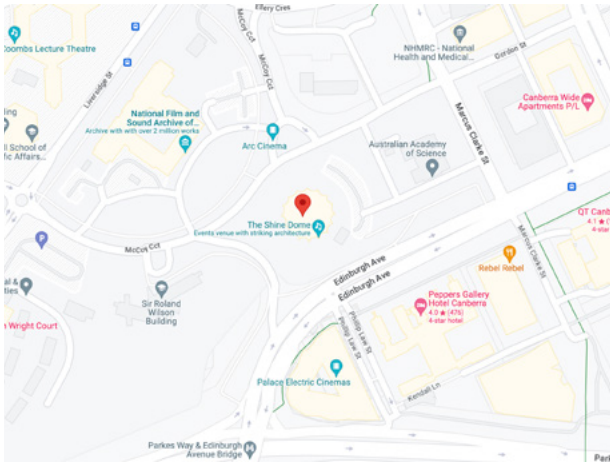
The Shine Dome, Australian Academy of Science

15 Gordon St, Acton ACT 2601.

Parking

Paid parking is available in the Nishi Building, on New Acton Precinct, and on London Circuit.

Three-hour parking is also available out the front of The Shine Dome and across the road at the National Film & Sound Archive.



PRESENTERS INFO

Presenters

We ask all presenters to visit the registration table with their talks on USB only at least one session prior to their scheduled talk.

Computer

Computers and slide changes will be supplied for all presentations; the use of personal computers will not be permitted for talks due to the tight schedule.

Please ensure that all videos are embedded. You are welcome to view your presentation at the break prior with one of our tech supports people

MAC Users

There is no facility to accommodate MAC all presentations will need to save as a ppt or pptx file.

Select File > Export to > PowerPoint.

INVITED SPEAKERS

Prof Andrzej Kilian

Director at Diversity Arrays Technology Pty Ltd

Two into one: bringing ecological principles into agricultural practice for sustainable future

Prof Chiharu Tokoro

Professor at the University of Tokyo

Creation of a New Resource Circulation Loop by Electrical Pulsed Dismantling

Prof Iwao Hosako

Director of Terahertz Research Center at NICT

How to use terahertz wireless communications at 6G

INVITED SPEAKERS

Prof Kei Murayama

Diagnosis and Therapeutics of Intractable Disease

Clinical and molecular basis of mitochondrial disease and medicine in Japan

Prof Kenji Kajiwara

Director of the Institute of Mathematics for Industry

Development of Mathematics for Industry in Asia Pacific Area: New Research Area, Education and Platform

Prof Masanori Tachikawa

Computational Chemistry

H/D isotope effect in protonated/deuterated aqueous solution

INVITED SPEAKERS

Prof Nenad Naumovski

Nutrition Science

The role of food science and human nutrition on development of functional foods for the management of stress, anxiety and sleep

UNIVERSITY OF CANBERRA

Paul Harris

Executive Director, Innovative Research Universities

Recent developments in Australian Government policy and what they mean for Australia-Japan collaboration

Innovative Research Universities

Prof Peter Bridgewater

Chairs Wildlife Health Australia

The International Whaling Commission – Transformative, Regressive, or pathway to the future.

Wildlife Health AUSTRALIA

INVITED SPEAKERS

Prof Withawat Withayachumnankul

Electronic Engineering

Japan-Australia Joint Corporation of Advanced Terahertz Technology

THE UNIVERSITY of ADELAIDE

Dr Amani Batarseh

Chief Scientific Officer, BCAL Diagnostics

Advancements in the detection of localised breast cancer by a lipidomic signature directly from plasma

BCAL diagnostics

Dr Bobby Cerini

General Manager of Science and Learning and Deputy Director, Questacon

Looking Back, Facing Forward: Celebrating 35 Years of Australia-Japan Science Communication Collaboration

Questacon The National Science and Technology Centre

Izuhara Takero

Director of Softbank Australia

Artificial Intelligence and Robotics in Australia

SoftBank Group

Two into one: bringing ecological principles into agricultural practice for sustainable future

Authors: Andrzej Kilian
DArT (Diversity Arrays Technology Pty Ltd)

Presenter: Andrzej Kilian

The last century has seen quite dramatic gains in the productivity of industrial agriculture, through advances in mechanisation and heavy use of chemicals. Modern breeding techniques, including genetics, have been used to produce new cultivars with increased yield potential. This has played a significant role in averting hunger and malnutrition for millions of people. "Green evolution" became the poster child of this change.

However, there is a downside. Chemicals degrade the land, and a reliance on just a few crops brings about a loss of biodiversity. The result is that while the world produces more than enough food to feed the global population, as many as 800 million people still go hungry - and this number continues to grow.

This, and climate change, are key factors behind a search for new solutions to achieve not only more productive, but also more sustainable agriculture. These new strategies need to design and achieve ecologically sound agroecosystems. This can be achieved, with ecological knowledge, and a high level of integration with the local environmental, social and commercial reality.

While DArT was founded on the strength of developing and delivering innovative DNA analysis technologies, a decade ago the company complemented this work with significant improvements in data analysis and management. At first this was aimed at the agricultural sector. It has now been extended to include ecological data.

The strength of this has been that while the initial beneficiaries of DArT technologies and services were predominantly researchers and breeding/seed organisations, in recent years DArT has been able to steadily increase its support for primary producers and ecologists globally.

Our longer-term vision is to use available genetic and environmental data to take a broader view - redesigning cropping systems at country, continent and global levels. A new data management system currently in development, and cooperation with a range of strategic partners, are stepping stones towards this ambitious goal.

Rapid changes in climate and environmental conditions across the world, including in our own backyards, are putting additional pressures on food production. The need for changing the way we grow food, and where we grow it, is clear.

Furthermore, the current pandemic has exposed the vulnerability of the supply system, even in our most developed cities and countries. This has heightened consumer awareness of the issues surrounding food security.

The opportunity is here to design food production systems at various scales in order to arrive at more ecologically and economically sound land uses. As a part of DArT's vision towards biodiversity and food security - especially in the most disadvantaged regions - for the sake of humanity this must be achieved.

Helicopter-Based Ocean Observations Capture Broad Ocean Heat Intrusions Toward the Totten Ice Shelf

Authors: Yoshihiro Nakayama, Pat Wongpan, Jamin S. Greenbaum, Kaihe Yamazaki, Tomohide Noguchi, Daisuke Simizu, Haruhiko Kashiwase, Donald D. Blankenship, Takeshi Tamura, Shigeru Aoki

Presenter: Pat Wongpan

The recent discovery of warm ocean water near the Totten Ice Shelf (TIS) has increased attention to the Sabrina Coast in East Antarctica. We report the result of 6-day helicopter-based observations conducted during the 61st Japanese Antarctic Research Expedition (JARE61), revealing warm ocean water (0.5–1°C) occupying a large previously unsampled area of the Sabrina Coast (116.5°E–120°E) below 550–600 m. Along the TIS front, we observe modified Circumpolar Deep Water (mCDW) well above freezing (−0.7°C), consistent with previous work. We identify glacial meltwater outflow from the TIS cavity west of 116°E. No signs of mCDW intrusions toward the Moscow University Ice Shelf cavity are observed; however, those observations were limited to only two shallow (330 m) profiles. We also highlight the advantages of helicopter-based observations for accessibility, speed, maneuverability, and cost-efficiency. The combination of ship- and helicopter-based observations using the JARE61 approach will increase the potential of future polar oceanographic observations.

Published article:

Nakayama, Y., Wongpan, P., Greenbaum, J. S., Yamazaki, K., Noguchi, T., Simizu, D., et al. (2023). Helicopter-based ocean observations capture broad ocean heat intrusions toward the Totten Ice Shelf. Geophysical Research Letters, 50, e2022GL097864. https://doi.org/10.1029/2022GL097864

Media coverage:

Joint press release by the Australian Antarctic Program Partnership (AAPP), National Institute of Polar Research, and Hokkaido University: Helicopter-based observations uncover warm ocean flows toward Totten Ice Shelf in Southeast Antarctica: https://www.global.hokudai.ac.jp/blog/category/research-news/research-press-release/

abc News: Antarctic helicopter mission helps confirm Totten Glacier melting from below due to warm water: https://www.abc.net.au/news/2023-09-13/antarctic-sea-ice-probes-dropped-from-helicopter-totten-glacier/102844512

abc News: VIDEO: Antarctic mission confirms glacier melting from below: https://www.abc.net.au/news/2023-09-14/antarctic-mission-confirms-glacier-melting-from-below/102854492

Mercury: How Antarctic scientists used helicopters for melting ice research
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abc Radio: Hobart Drive with David Reilly: https://www.abc.net.au/listen/programs/hobart-drive/hobart-drive/102836942

AAPP: Helicopters track warm ocean water melting Totten Glacier ice shelf
https://aappartnership.org.au/helicopters-track-warm-ocean-water-melting-totten-glacier-ice-shelf/

The Daily Telegraph: IMAS Scientists deploying a probe from a helicopter in Antarctica: https://www.dailytelegraph.com.au/news/northern-territory/imas-scientists-deploying-a-probe-from-a-helicopter-in-antarctica/video/be99a6bcb29348db5f91f1df6d1741b0

Also featured on MSN, EurekAlert!, ScienceDaily etc.

Fully automatized optimization of ring-opening reactions in lactone derivatives via 2-step machine learning

Authors: Linh Thi Hoai Nguyen[1] (Dr.), Yasuhide Fukumoto[1] (Prof.), Pierluigi Cesana[1] (Prof.) & Aleksandar Staykov[2] (Prof.),

Presenter: Pierluigi Cesana

Cyclization and cycloreversion of organic compounds are fundamental kinetic processes in the design of functional molecules, molecular machines, nanoscale sensors and switches in the field of molecular and nano electronics. We present a fully automatic computational platform for the design of a class of 5- and 6- membered ring lactones by optimizing the ring-opening reaction rate. Starting from a minimal initial parent set, our program generates iteratively cascades of pools of candidate lactone derivatives where optimization and down-selection are performed not requiring human supervision at any stage. We use Density Functional Theory combined with transition state theory to elucidate the exact mechanism leading to lactone ring opening reaction. Based on the analysis of the reaction pathway and the frontier molecular orbitals, we identify a simple descriptor which can easily correlate with the reaction rate. Consequently, we can omit computationally expensive transition state calculations and deduce the reaction rate from simple ground state and ionic calculations. To accelerate the platform, we use a dataset of the order of 800 molecules to train machine learning models for the prediction of targeted chemical properties reducing the computational time by a 90% factor. We develop an evolutionary algorithm capable of generating datasets three orders of magnitude larger than the initial parent set. Thus, we can explore a large domain of the chemical space using minimal computational effort. Our entire platform is modular and our current implementation for lactone can be further generalized to more complex systems via substitution of the quantum chemical and fingerprinting modules.

Keywords: Lactone, Cyclization, Machine Learning, Random Forest, Evolutionary Algorithm, Fingerprint, Density Functional Theory

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2 International Institute for Carbon-neutral Energy Research (WPI-I2CNER), Kyushu University, 744 Motooka, Nishi-ku, Fukuoka, 819-0395, Japan.

Advancements in the detection of localised breast cancer by a lipidomic signature directly from plasma

Authors: XY Lim,[1,2] C Kehelpannala,[1,2] D Pascovici,[3] D Li,[1,2] KJ Heffernan,[1,2] M David,[1,2] K Huynh,[4] G Lamoury,[5] K Ekroos,[6] PJ Meikle,[4] F Vafaee,[7] F Koch,[7] AM Batarseh,[1,2]

Presenter: Amani Batarseh

Introduction

One in seven Australian women are at risk of a breast cancer diagnosis in their lifetime. Early detection is key for survival. Mammography, used for over three decades, is the current diagnostic standard. An effective and accurate blood test may increase the detection rate and improve patient outcomes. We have derived a lipid signature from plasma-enriched extracellular vesicles (EVs) that effectively distinguishes localised breast cancer from cancer-free controls. Significant refinements have allowed assessment of the lipid signature directly from plasma samples, advancing the commercial viability towards clinical application.

Methods

Over 400 manually curated lipids were quantified from donated fasted plasma samples, localised breast cancer and controls (n=793). Lipids extracted from enriched EVs were analysed by liquid chromatography-high resolution mass spectrometry (LC-HRAM-MS). An independent review and retrospective analysis of the data established a lipid signature, modelled on each of the four cohorts using leave-one-out internal cross-validation. Following variable selection, a lipid signature capable of distinguishing breast cancer samples from controls was derived. We then applied the lipid signature derived using EVs directly on plasma lipidomic data (n=256) to investigate if the lipid signature can be assessed directly from plasma. NIST Standard Reference Material (SRM) 1950–Metabolites in Frozen Human Plasma used for inter-laboratory quality control.

Results

An EV lipid signature differentiated breast cancer subjects from controls with an area under the curve (AUC) of 0.77-0.89 across four cohorts. A comparable AUC of 0.84 was achieved by assessing the signature directly from plasma, with additional benefits of improved scalability, throughput, ease of use and clinical viability.

Conclusions

A lipid signature, which shows high potential for distinguishing breast cancer samples from controls, can be derived directly from plasma, reducing the test complexity. Ongoing studies will optimize the plasma lipidomic signature and prospectively compare the test against mammographic and pathological diagnoses.

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Creation of a New Resource Circulation Loop by Electrical Pulsed Dismantling

Authors: Chiharu Tokoro
Waseda University, The University of Tokyo

Presenter: Chiharu Tokoro

The compatibility of resource circulation with the reduction of environmental burdens, such as carbon neutrality, is one of the major challenges facing us. Many reports have expressed concern that the use of certain mineral resources will increase more rapidly than at present due to the promotion of the use of renewable energy and lithium-ion battery. The circular economy is one solution to this problem, but energy-saving separation technologies and product design for easy disassembly are indispensable for its realization.

In this presentation, I will introduce an example of our attempt to develop a new separation technology and resource recycling loop for lithium-ion batteries and PV panels as an example. In the lithium-ion batteries, it was possible to separate the aluminum foil, which is the current collector foil of the cathode material, and the black mass, which is the cathode active material, with high accuracy using an electrical pulsed discharge. Since the separated cathode active material has not undergone any chemical transformation, it is expected to be regenerated as oxide by post-treatment and used as cathode active material again. In PV panels, when electric pulses are applied to silver wires in the cell sheet after the glass has been separated, the silver wires become plasma and can be separated from the resin as particles with high precision. The shock waves generated during this process can also separate copper wires and some silicon from the resin. We have confirmed that these methods can separate materials without heating or chemicals and are also advantageous from the perspective of LCA.

Collaboration between Australian human heart tissue biobanks and Japanese heart researchers.

Authors: Professor Cris dos Remedios (Victor Chang Cardiac Research Institute), Associate Professor Amy Li (La Trobe University) and Associate Professor Sean Lal (University of Sydney).

Presenter: Cris dos Remedios

Japan differs from the Western world by having the highest proportion of old people (25.9% of the population) and a relatively low level of ischemic heart disease (IHD) (47%) compared to for the Western world (54-57%). The number of Japanese outpatients with left ventricular dysfunction in 2014 was 979,000 (0.8% of the population this number is predicted to reach pandemic proportions (1.3 million) by 2030. However, while the rate of IHD was relatively low, the rate left ventricular heart failure with preserved ejection fraction (HFrEF) (aka Dilated Cardiomyopathy) is comparable to Western countries. Patients in end-stage heart failure in Australia can be successfully treated by Orthotopic Heart Transplantation (OHT), a procedure pioneered by Dr Victor Chang who was awarded an Order of Australia in 2000. However, in Japan there was considerable reluctance to OHT. In part this was due to widely held religious beliefs (Buddhism and Shinto) but was also due to notion of "brain death" which was accepted in 1971 by Finland but it took until 1997 before it was accepted in Japan. It was not until 2018 that five strategies were developed for dealing with the impending pandemic (Komuro et al. 2019) including accelerated clinical and basic research. There was a gradual decline in scientific research (fewer research papers in cardiovascular medicine) which fell by about half over the previous decade compared to the number of published papers in cancer research. As a result, in 2018 the Japanese Circulation Society (JCS) launched a forum for heart failure which is expected to help Japan's progress in basic research including genomic science, transcriptomics, proteomics. How can the JSPS-AAA can contribute to these aims? In 1989 we initiated the Sydney Heart Bank at the University of Sydney which began biobanking human heart tissue from a wide range of failing as well as healthy donor hearts. We minimised the ischemic time by snap-freezing samples in liquid nitrogen in the transplant theaters. We harvested tissue sampled from all chambers of the heart. This produced extremely good preservation of sensitive biomolecules. We then undertook extensive collaborations around the world, which to date have produced over 160 quality research papers in highly ranked journals. We have published with the Late Professor Koscak Maruyama (Chiba University), Professor Shin'ich Ishiwata (Waseda University) and Professor Norio Fukuda (Jikei University School of Medicine, Tokyo). And one of us (CdR) was awarded a JSPS fellowship to work with the Tokyo Medical and Dental University. Therefore, the stage is set for us to make closer links in basic research.in cardiovascular medicine.

References:

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Komuro I, et al. Circulation J 2019 83: 1819-1821. Doi: 10.1253/circj.CJ-19-0562.

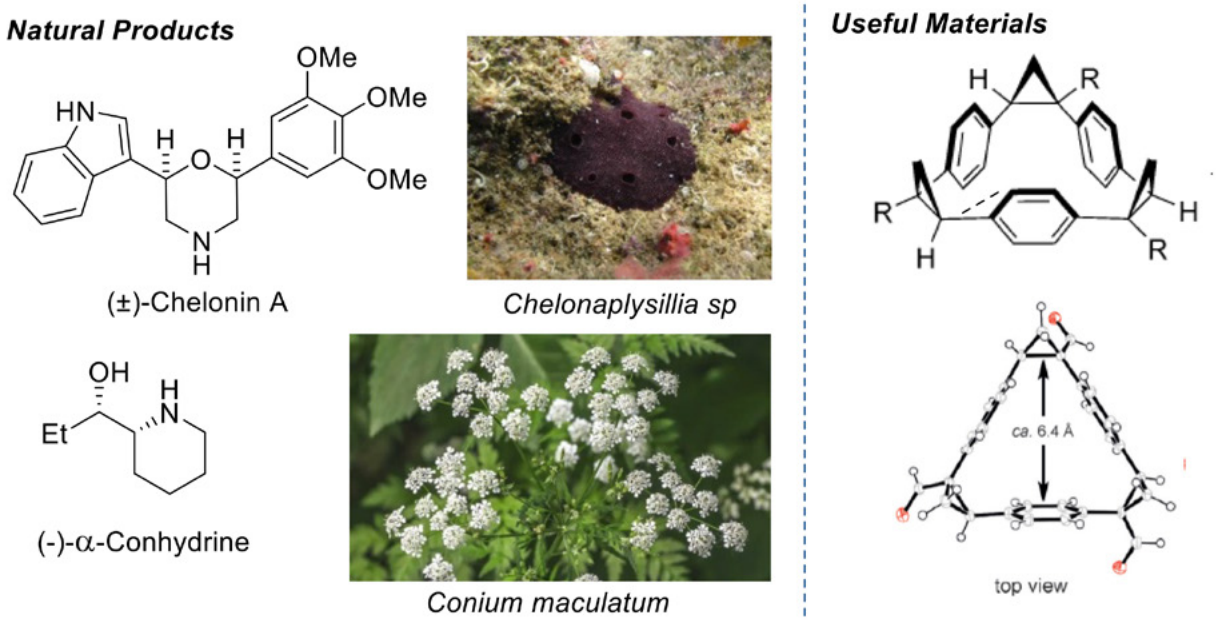
Konishi M, et al. ESC Heart Failure 2016, 3: 145-151. Doi: 10.1002/ehf2.12103

Dirhodium Catalyzed Reactions for the Preparation of Natural Products and Valuable Materials

Authors: Scott G Stewart[a]

Presenter: Scott Stewart

Analyzing the bond behavior between fiber reinforced polymer (FRP) sheets/laminates and concrete poses a significant challenge in numerical simulation. This paper introduces a recently developed rational simulation method in this area by the authors that utilizes the 3D rigid body spring model (RBSM). The developed mesoscale simulation method proposes all parameters with clear and precise physical meanings and straightforward calculation methods. The simulation produces reasonable and accurate results that agree well with both experimental results and finite element (FE) outputs. The proposed method offers a superior and effective alternative to conventional FE approaches for analyzing FRP-strengthened concrete structures.



a School of Molecular Sciences, The University of Western Australia (M310), 35 Stirling Highway, Crawley, WA, 6009, Australia.

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3D RBSM: A new Mesoscale DISCRETE approach for FRP-CONCRETE INTERFACIAL SIMULATION

Authors: Cheng Jiang1*

Presenter: Cheng Jiang

Analyzing the bond behavior between fiber reinforced polymer (FRP) sheets/laminates and concrete poses a significant challenge in numerical simulation. This paper introduces a recently developed rational simulation method in this area by the authors that utilizes the 3D rigid body spring model (RBSM). The developed mesoscale simulation method proposes all parameters with clear and precise physical meanings and straightforward calculation methods. The simulation produces reasonable and accurate results that agree well with both experimental results and finite element (FE) outputs. The proposed method offers a superior and effective alternative to conventional FE approaches for analyzing FRP-strengthened concrete structures.

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From Measurement to Monitoring: Why pollution research needs a rethink and reboot.

Authors: Shaneel Chandra, Fiona Tan and Amie Anastasi

Presenter: Shaneel Chandra

Some of the most beautiful locations in the world naturally coincide with tourism hotspots like Fiji and the Great Barrier Reef and on the opposite end, the relatively undisturbed Solomon Islands. Unfortunately, these contrasting regions still share a common link – aquatic pollution.

There is considerable research effort devoted to methods that are more accurate, fast, inexpensive, and sensitive. Yet are we devoting enough time and energies towards a smarter, more interventive approach? If we could monitor pristine and fragile environments like that of the Great Barrier Reef in real time and detect pollution as it starts to occur rather than after the fact, then it would represent a more effective resource rationalisation and help prevent large-scale pollution events from developing.

This talk will share our experiences in developing a world-first, self-powered sensor for inorganic nitrogen monitoring in the rivers of the Great Barrier Reef catchment in North Queensland. These sensors can send a text when nitrogen levels reach a nominated value, which can then pinpoint pollution as it occurs and help in arresting high discharge from otherwise large, non-point sources.

The talk will conclude with an outlook for these environmentally sensitive areas amidst the current state of play of the detection technologies and discuss any mitigation measures against pollution. The audience will also be welcome to contribute to the discussion.

How to use terahertz wireless communications at 6G

Authors: Iwao Hosako
Terahertz Research Center at the National Institute of Information and Communications Technology (NICT), Japan

Presenter: Iwao Hosako

In the next generation of mobile communication systems (beyond 5G or 6G), terahertz radio communication is expected to be introduced, enabling ultra-high speed of over 100 Gbps using the frequency band above 100 GHz. The attractiveness of terahertz radio, the use cases, the current status of R&D, etc. will be discussed.

Recent developments in Australian Government policy and what they mean for Australia-Japan collaboration

Authors:: Paul Harris
Executive Director, Innovative Research Universities (IRU)

Presenter: Paul Harris

Over the last year, the Australian Government has undertaken a number of major policy reviews that will have significant impacts on higher education, research and innovation. These include the Australian Universities Accord process, the review of the Australian Research Council and the review of the National Science and Research Priorities. This presentation will highlight future directions for Australian research and innovation policy and opportunities for closer Australia-Japan cooperation into the future.

Accreted REY-rich OPS in Gondwana margin subduction complexes: A new target for critical mineral resources

Authors: Jonathan C. Aitchison[a], Kentaro Nakamura[b], Kazutaka Yasukawa[b,c] and Renjie Zhou[a]

Presenter: Jonathan C. Aitchison

Global transition to a new green economy is contingent on the availability of critical minerals that include Rare Earth Elements and Yttrium (REY), which are essential to new and developing renewable industries. The discovery of high-concentrations of REY in deep sea muds on the Eastern South and central North Pacific sea floor (Kato et al., 2011) was a huge step towards finding resources of strategic importance. However, major technological hurdles and uncertain environmental issues surround any development of such resources.

Fortunately, plate tectonics and subduction along convergent plate boundaries brings ancient examples of ocean plate stratigraphy (OPS) onshore through accretion into subduction complexes (Matsuda and Isozaki, 1991). Examination of umbers and deep marine cherts in well-studied OPS successions such as the Shimanto Complex (Aitchison, 1986) in Japan has revealed their potential for further exploration (Fujinaga et al., 2022; Kato et al., 2005).

During much of Paleozoic time eastern Australia was a convergent plate margin that developed along the eastern margin of Gondwana as part of the Terra Australis orogen (Cawood, 2005). Numerous well-preserved OPS are known from The New England Orogen in northern NSW and SE Queensland (Aitchison and Flood, 1990; Andjić et al., 2022) as well as the Broken River and Hodgkinson Provinces in far north Queensland. Preliminary investigation shows that when compared against the North American shale composite (NASC) the abundance of REY in some of these sections is above average. Given the demonstrated relative ease with which REY can be recovered from such rocks (Yasukawa et al., 2020) further research is clearly warranted.

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Generation of microplastics from the current plastic recycling process – an unintentional consequence of concern

Authors:: Michael J. Stapleton and Faisal I. Hai

Presenter: Faisal Hai

This study casts light on the potential of microplastic generation during plastic recycling - an unintended consequence of the process. To date, microplastics have been detected in the wastewater and sludge from plastic recycling facilities; however, generation pathways, factors and minimization strategies are understudied. The purpose of this study is to identify the factors affecting microplastic generation, namely, plastic type and weathering conditions. The size reduction phase, which involved the mechanical shredding of the plastic waste material, was identified to be the predominate source of microplastic generation. Material type was found to significantly affect microplastic generation rates. Focusing on the microplastic particles in the size range of 0.212-1.18 mm, polycarbonate (PC), polyethylene terephthalate (PET), polypropylene (PP), and high-density polyethylene (HDPE) generated 28,600 ± 3961, 21,093 ± 2211, 18,987 ± 752 and 6807 ± 393 particles/kg of plastic material shredded, respectively. The significant variations between different plastic types were correlated (R^2 = 0.88) to the hardness of the plastic. Environmental weathering was observed to significantly affect microplastic generation rates. Generation rates increased for PC, PET, PP, and HDPE by 185.05 %, 159.80 %, 123.70 % and 121.74 %, respectively, over a six-month environmental exposure period. The results in this study confirm production of large amounts of microplastics from the plastic recycling industry through its operational processes, which may be a significant source for microplastic pollution if measures to reduce their production and removal from wastewater and sludge are not considered.

Disclaimer: This presentation is based on a recent peer reviewed publication by the authors.

Advancements and Translational Potential of Neutron Capture Enhanced Particle Therapy

Authors: Mitra Safavi-Naeini
ANSTO

Presenter: Mitra Safavi-Naeini

Introduction: This talk will delve into the research and development of Neutron Capture Enhanced Particle Therapy (NCEPT). NCEPT capitalises on thermal neutrons generated intrinsically during particle therapy via nuclear inelastic collisions within the patient. The thermal neutron field extend beyond the treatment volume, allowing for enhancing the radiation dose directly to tumour cells inside, or adjacent to the tumour volume. Dose enhancement is achieved through the capture of these thermal neutrons by non-toxic, 10B or 157Gd-based Neutron Capture Agents (NCAs), localising the radiation boost at the micron or nanometer scales. Drawing from Neutron Capture Therapy (NCT) methodologies and approved or in-development agents, NCEPT integrates NCT into existing proton or heavy-ion therapies. The talk will summarize five years of work aimed at evaluating and establishing NCEPT's translational potential through computational modelling and biological assays, both in vitro and in vivo.

Materials and Methods: The initial discovery of the thermal neutron field that laid the groundwork for NCEPT was accomplished through Monte Carlo simulations. These simulations were instrumental in quantifying the extent and characteristics of the neutron field, as well as identifying the interactive properties between the primary radiation field and dose enhancement via neutron capture. As our research evolved, we shifted to test our hypotheses using biological platforms, necessitating access to particle therapy facilities abroad. We secured access through collaborative partnerships with institutions in Japan, including Japan's Quantum Science and Technologies' Heavy Ion Medical Accelerator Facility in Chiba (HIMAC, QST), Sumitomo Heavy Industries (SHI) and Japan's Proton Accelerator's Research Complex (J-PARC). We assessed the efficacy of NCEPT for targeting gross tumour volume, as well as the tumour microenvironment and micro-metastasis via conducting cell viability assays under varying radiation dose and NCA concentrations. The in vivo component involved treating tumour-bearing, xenograft animal models with ion beams in conjunction with a clinically approved NCA.

Key Findings: In silico models initially indicated the feasibility of enhancing the therapeutic ratio via NCEPT. Subsequent in vitro tests demonstrated a 50% to 60% reduction in cell viability when glioblastoma cells were treated with helium and carbon ions in the presence of NCAs, compared to the ion beam alone. The in vivo mouse model results have been particularly encouraging: 5 Gy carbon ion dose coupled with our clinically approved NCA surpasses the tumour control rates achieved by 10 Gy of carbon ion treatment alone.

Translational Opportunities: Collectively, these findings emphasize the compelling translational potential of NCEPT. By optimizing dose delivery and reducing collateral damage to surrounding tissues, NCEPT offers a promising avenue for the treatment of complex and deep-seated tumors.

Conclusion: This talk encapsulates the multi-disciplinary journey of NCEPT, emphasizing its scientific credibility and translational prospects in the realm of particle therapy.

Acknowledgements: We would like to thank the Japan Society for the Promotion of Science Alumni Association in Australia (JSPSAAA), the Australian Government through the Supporting Australian Innovation in Asia grant, and the Australian Nuclear Science and Technology Organisation (ANSTO) for their foundational and translational research support.

Clinical and molecular basis of mitochondrial disease and medicine in Japan

Authors:: Kei Murayama
Diagnosis and Therapeutics of Intractable Disease, Intractable Disease Research Center and Department of Pediatrics, Juntendo University Faculty of Medicine

Presenter: Kei Murayama

"Mitochondrial disease" is a collective term for various clinical disorders characterized by a failure of mitochondrial function and energy production. Mitochondria are intracellular organelles with a double membrane. Mitochondria play an essential role in cells in the biosynthesis of adenosine triphosphate (ATP) via oxidative phosphorylation (OXPHOS). ATP is produced by the ATP-synthase complex, which is driven by the proton-motive force created by the respiratory chain complexes (complexes I, III, and IV). Impairment of OXPHOS leads to organ damage. This is referred to as mitochondrial respiratory chain disorder, which is considered to occur at a frequency of 1 in 5000 births in Japan and Western countries.

Leigh syndrome is a major phenotype of mitochondrial encephalopathy in children. It is known as a 'subacute necrotizing encephalopathy' and is a genetically heterogeneous disease that primarily affects the central nervous system. With new therapeutic options being proposed, assessing the mortality and clinical condition of Leigh syndrome patients is crucial for evaluating therapeutics. We have published the data on mortality in Leigh syndrome patients concerning effects of age at onset and genetic diagnosis in 2020 (Ogawa E et al. J Inherit Metab Dis. 2020).

Mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episodes (MELAS) is also a phenotype with encephalopathy in childhood. m.3243A>G is the most common mtDNA mutation that can cause MELAS. The administration of oral and intravenous L-arginine, a precursor of nitric oxide, has improved the clinical symptoms of stroke-like episodes in MELAS and decreased the frequency and severity of stroke. Taurine supplementation is also a specific treatment for MELAS with m.3243A>G, which has been covered by medical insurance in Japan since 2019. Taurine can restore the taurine modification in MELAS patients with m.3243A>G mutation and promote the maturation of tRNALeu (UUR).

In this lecture, the clinical and genetic features, including novel treatment, of mitochondrial disease in children are focused.

From Play to Progress: Co-Designing Technology for Early Learners

Authors:: Holly Tootell, Grant Ellmers & Mark Freeman

Presenter: Holly Tootell

In the last decade, the pervasive integration of computers, tablets, and mobile devices has transformed how both children and adults engage with technology. While the potential for digital tools to reshape education is widely recognized, their practical implementation in classrooms, especially for pre-schoolers, remains limited (Blackwell et al., 2014). This discrepancy between available technology and its meaningful use underscores the importance of designing developmentally appropriate applications that cater to preschool children's cognitive abilities and motor skills. To this end, the concept of co-design, involving children as active contributors to the design process, has gained traction.

Incorporating technology into preschool education requires a nuanced understanding of young children's communication abilities and cognitive development (Ertmer et al., 2011). Traditional design methodologies often fail to elicit valuable input from pre-schoolers due to challenges in articulating thoughts and preferences (Druin, 2002). Thus, the methods must be adapted to accommodate how children express themselves and respond to stimuli (Berggren & Hedler, 2014). Engaging other influential figures in pre-schoolers' lives, such as educators and parents, can further enrich the design process.

Co-design empowers children by granting them a platform to influence technological development. Unlike previous methods that relied heavily on adult perspectives, co-design shifts the power dynamic, letting children's insights and ideas take centre stage (Sanders & Stappers, 2008). This methodology has yielded innovative and impactful results, particularly in technologies designed for primary school children and adolescents. However, its application in the context of preschool children has been limited due to their different comprehension levels and shorter attention spans.

This research explores existing technology and design environments aimed at pre-schoolers, emphasizing co-design and participatory design practices. By assessing the methodologies and techniques used in designing and evaluating technology for young children, this research uncovers the extent of the application of co-design in preschool-aged contexts. The article underscores the significance of addressing the unique challenges posed by preschool-aged children's cognitive development and communication skills.

In summary, as digital devices become increasingly integrated into modern life, their potential to revolutionize preschool education is clear. However, harnessing this potential requires overcoming the barriers inherent in designing for young children. Co-design presents as a promising solution, bridging the gap between technology and meaningful educational experiences for pre-schoolers.

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Development of Mathematics for Industry in Asia Pacific Area: New Research Area, Education and Platform

Authors:: Kenji Kajiwara
Director, Institute of Mathematics for Industry, Kyushu University

Presenter: Kenji Kajiwara

In this talk, we exhibit activities of "Mathematics for Industry" (MfI) in Japan, initiated by the Institute of Mathematics for Industry (IMI), Kyushu University founded in 2011. MfI intends to develop a new research area of mathematics formed by responding to the needs of industries associated with various relevant activities, one of which is the international activities. The IMIf has been trying to establish strategic international relationships putting a particular emphasis on the Asia Pacific area. To this end, we established the IMI Australia Branch jointly with La Trobe University in 2015 as a base in this area. We will explain the various challenges made at the IMI Australia Branch, and how we overcome the difficulties in management arising from the difference of two countries.

Japan- Australia Collaboration: Systems approach for transitioning to a decarbonized circular economy

Authors:: Chamari Jayarathna
The University of Queensland

Presenter: Chamari Jayarathna

The urgent need to address climate change and resource depletion has prompted a paradigm shift towards decarbonized circular economy, combining the principles of circularity with ambitious carbon reduction goals. Japan and Australia are both keen to achieve their climate mitigation targets while reducing their waste. We present a comprehensive system approach aimed at facilitating the transition to a decarbonized circular economy, where carbon neutrality and sustainable resource management are integrated. Drawing on principles from systems science, industrial ecology, and sustainable development, we provide suggestions for analysing the carbon emissions, resource use, and economic activities. We also highlight the role of stakeholder engagement in shaping policies that incentivize decarbonization, and successful strategies and best practices from diverse sectors in decarbonizing circular economies. By adopting the systems approach that integrates carbon neutrality goals with circular principles, societies can achieve the objectives of mitigating climate change and sustainable resource consumption.

H/D isotope effect in protonated/deuterated aqueous solution

Authors:: Masanori Tachikawa
Yokohama City University

Presenter: Masanori Tachikawa

Water dissolves various substances, and many essential chemical reactions occur in aqueous solution. The proton (H+) behavior in an aqueous solution is also crucial in biochemical reactions and proton transfer in living organisms. On the other hand, the behavior of deuteron (D+) in heavy water (D2O), an isotope of water, is still unclear. In this study, thus, we have applied the on-the-fly path integral molecular dynamics simulation, which can include both the nuclear quantum effect and thermal effect. To elucidate the isotope effects of H+/D+ behavior in an aqueous solution, we calculated the systems of H+ in light water solvent and D+ in heavy water. We found a significant isotope effect around the Eigen H3O+/D3O+ region. First, the structures with Zundel H5O2+, H7O3+, and H9O4+ were confirmed at the system of H+ in a light water solvent, while such structures are less at that of D+ in heavy water. We also found the H/D isotope effect at the radial distribution function of O-O distances.

Looking Back, Facing Forward: Celebrating 35 Years of Australia-Japan Science Communication Collaboration

Authors: Dr Bobby Cerini

Presenter: Bobby Cerini

Australia and Japan have a long history of collaboration on shared issues of science communication. A significant shared investment was the establishment of Questacon as Australia's National Science and Technology Centre in 1988, enabled through support from the Japanese government and business community. Over 35 years, Questacon has been a hub for strong engagement between Australian and Japanese science communicators, connecting to universities, science agencies, museums and community organisations. Together we have hosted many bilateral visits and discussions, developed programs for the exchange of skills and knowledge, and worked in collaboration and co-design on projects of shared interest. This talk will share case studies and stories from this rich past and outline some key challenges for future science communication cooperation, from emergent technologies to changing audiences and more.

The Art and Science of grant-writing: Japan-Australia collaborations in undergraduate research training

Authors: Dr Ernest Koh, Jesse Blakers *(University of Canberra)*, and Prof Jan Lauwereyns *(Kyushu University)*

Presenter: Ernest Koh

This paper outlines a new teaching collaboration between the University of Canberra and Kyushu University. At the heart of this capacity-building program is a single assessment task: working in joint Japan-Australia teams, students learn how to put together an international and interdisciplinary research grant application. In doing so, it seeks to unpack this complicated genre of writing for students and build students' skills in transforming their individual research interests into a coherent, consistent, cohesive, team-based funding application. Just as importantly, it fosters close working relationships across borders and disciplines, creating new networks for the researchers of the future.

The International Whaling Commission – Transformative, Regressive, or pathway to the future.

Authors: Peter Bridgewater
Institute for Applied Ecology, University of Canberra

Presenter: Peter Bridgewater

So long, and thanks for all the fish – the title of a humorous book (Adams, 1984) about dolphins (Cetacea) leaving the earth before it is destroyed by an alien race to make way for a hyperspace by-pass, nicely illustrates people's relationships with Cetacea. That relationship has been expressed in many ways over centuries, from hunting Whales and dolphins for meat, blubber, and oil, to a status of protectionism based on welfare concerns. The latter welfare concerns became blended and blurred, in the second half of the C20th century, with conservation. The major global tool for people's interactions with Cetacea is the International Whaling Commission (IWC) – the operational vehicle for the International Convention for the Regulation of Whaling. However, both the Convention on Migratory Species and the Convention on International Trade in Endangered Species of wild Flora and Fauna (CITES) have legitimate interests in matters cetacean in their own domains.

A particular issue is how the IWC should evolve over the coming decades – either rewriting the convention text to become a conservation convention, or to lose its doors and pass the baton to CMS and CITES. The arguments for this latter course of action are now very strong. Through the lens of time, the IWC is an excellent example of transformative change – a change that will continue.

The role of food science and human nutrition on development of functional foods for the management of stress, anxiety and sleep

Authors:: Nenad Naumovski[1-4]
Professor in Food Science and Human Nutrition

Presenter: Nenad Naumovski

There is strong evidence that supports the importance of adhering to adequate dietary patterns in the overall human health. The rise in technological advancements, convenience of quick and easy meals to prepare, accessibility and overindulgence in ultra-processed foods were seen as the hallmarks for majority of the health issues currently seen in the world. With the global population on increase and consequences of recent pandemic (economical, physical and psychosocial) it is a no surprise that the levels of stress and anxiety in the population are also on the rise. Furthermore, poor dietary choices and some aspects of mental health are directly related, allowing for the continuation of vicious cycle of this two-way relationship.

This presentation will include the findings from current studies relating to some of the functional foods and nutraceuticals as well as adhering to different dietary approaches that may be used in coping with stress, management of anxiety and improvements in the quality of sleep. Some of the most common functional foods and beverages of animal and plant origin including their active functional groups will also be presented.

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Japan-Australia Joint Corporation of Advanced Terahertz Technology

Authors: Withawat Withayachumnankul

Presenter: Withawat Withayachumnankul

Terahertz technology explores the electromagnetic spectrum, encompassing frequencies from 100 GHz up to 10 THz, which situates it between the microwave and infrared domains. In the past, this spectral range was known as the terahertz gap due to difficulties in wave generation, detection, and manipulation. However, recent advancements have dismantled these barriers, unveiling new opportunities for harnessing terahertz waves in a wide range of applications from communications to sensing. I have led my Terahertz Engineering Laboratory in collaboration with esteemed terahertz research groups at institutions such as the Tokyo Institute of Technology, Osaka University, Kyushu University, and Keio University. In this presentation, I will delve into our latest achievements in terahertz source development, platform innovations, detector technologies, and their diverse applications. Attendees can look forward to gaining insights into the groundbreaking work at the forefront of terahertz technology.

Reversing Pathogenic Defects that Disrupt Mitochondrial Fat and Sugar Metabolism with Mitochondrial Biogenesis Stimulation

Authors: Harrison Burgin[1], Alice J. Sharpe[2], Shuai Nie[3], Mark Ziemann[1], Jordan J. Crameri[4], Diana Stojanovski[4], James Pitt[5], Akira Ohtake[6,7], Kei Murayama[8] and Matthew McKenzie[1]

Presenter: Matthew McKenzie

Short chain enoyl-CoA hydratase 1 (ECHS1) is involved in the second step of mitochondrial fat metabolism. Genetic defects in ECHS1 are associated with Leigh Syndrome, a severe disease associated with brain white matter degeneration and heart dysfunction that is often fatal in early childhood. Here, we examined the molecular pathogenesis of ECHS1 deficiency using a CRISPR/Cas9 edited human cell 'knockout' model and skin fibroblasts from ECHS1 deficient patients. Transcriptome analysis of ECHS1 'knockout' cells showed reductions in not just mitochondrial fat metabolism but also other key pathways, including the TCA cycle and nucleotide biosynthesis. Functional analysis of mitochondrial activity revealed a reduced ability to metabolize fat as expected, as well as an additional defect in glucose oxidation. These findings suggest ECHS1 deficiency also causes a secondary defect in sugar metabolism via disruption of oxidative phosphorylation (OXHPOS). Indeed, the steady-state levels of various OXPHOS protein complex enzymes were reduced in ECHS1 'knockout' cell mitochondria.

To reverse these mitochondrial defects caused by a lack of ECHS1 expression, we investigated the possibility of stimulating mitochondrial biogenesis to increase mitochondrial mass and boost total ATP generation above the critical disease threshold. Following this principle, we tested the ability of deoxyribonucleosides (dNs) to stimulate mitochondrial biogenesis and improve overall mitochondrial function.

DNs treatment of ECHS1 'knockout' cells increased the expression of mitochondrial DNA (mtDNA)-encoded transcripts, as well as key nuclear-encoded mitochondrial gene sets, including 'respiratory electron transport', 'formation of ATP by chemiosmotic coupling' and 'OXPHOS complex I biogenesis'. This was associated with an increase in OXPHOS complex I assembly and steady-state levels. Importantly, dNs treatment boosted mitochondrial oxygen consumption rates in the presence of either sugar (glucose) or fat (palmitoyl-L-carnitine).

Overall, we found that the combined defects in mitochondrial sugar and fat metabolism in ECHS1 deficient cells could be improved by exogenous stimulation of mitochondrial biogenesis with dNs, with the possibility of developing this approach into novel therapies for mitochondrial disease.

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Disease modifying interactions between chronic kidney disease and osteoarthritis: a new co-morbid mouse model

Authors: Sohel M Julovi[1, 2], Aiken Dao[2, 3], Katie Trinh [1, 2], 'Alexandra K O'Donohue'[2, 3], Cindy Shu[4], Susan Smith[4], Meena Shingde[5], Aaron Schindel [2, 3], Natasha M Rogers[1, 2], Christopher B Little[2, 4].

Presenter: Sohel M Julovi

Aim of the study

The prevalence of co-morbid chronic kidney disease (CKD) and osteoarthritis (OA) are increasing globally. While sharing common risk factors, the mechanism and consequences of concurrent CKD-OA are unclear. The aims of the study were to develop a preclinical co-morbid model, and to investigate the disease-modifying interactions.

Methods

Seventy (70) male 8-10 week-old C57BL/6 mice were subjected to 5/6 nephrectomy (5/6Nx) ± destabilisation of medial meniscus (DMM) or sham surgery. OA pathology and CKD were assessed 12 weeks post-induction by blinded histology scoring, micro-computed tomography (μCT), immuno-histochemistry for osteoclast and matrix metalloproteinase (MMP)-13 activity, and serum analysis of bone metabolic markers.

Results

The 5/6Nx model recapitulated characteristic features of CKD, with renal fibrosis and deranged serum alkaline phosphatase, calcium and phosphate. There was no histological evidence of cartilage pathology induced by 5/6Nx alone, however synovial MMP-13 expression and subchondral bone osteoclastic activity was increased ($P<0.05$), with accompanying reductions ($P<0.05$) in subchondral trabecular bone, bone volume and mineral density. DMM significantly ($P<0.05$) increased tibio-femoral cartilage damage, subchondral bone sclerosis, marginal osteophytes, and synovitis, in association with increased cartilage and synovial MMP-13. DMM alone induced ($P<0.05$) renal fibrosis, proteinuria and increased ($P<0.05$) 5/6Nx-induced serum urea. However, DMM in 5/6Nx-mice resulted in significantly reduced ($P<0.05$) cartilage pathology and marginal osteophyte development, in association with reduced subchondral bone volume and density, and inhibition of 5/6Nx-induced subchondral bone osteoclast activation.

Discussion

This study assessed a world-first preclinical co-morbid CKD-OA model. Our findings demonstrate significant bi-directional disease modifying interaction between CKD and OA.

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Phi Thickenings Form a Three-Dimensional Scaffold That May Mechanically Stiffen Roots

Authors: David Collings [1,2], David McCurdy[2] and Maketalena Aleamotu'a [2,3].

Presenter: David Collings

Towards the end of the nineteenth century, a novel type of plant cell wall was observed in the roots of a range of different plant species, with these structures becoming known as phi thickenings because of their similarity in cross section to the Greek letter phi. These enigmatic thickenings are rings of secondary cell wall that loop around the cortical cells in the root in locations where only a thin, primary cell wall would normally be found. Moreover, because these secondary wall bands are aligned between adjacent cells, the phi thickenings form a complex scaffold that wraps around the central vasculature of the root. Phi thickenings are present in multiple gymnosperm and angiosperm (nonflowering and flowering) plant families, including several that are agriculturally important, but no systematic investigation has been made of their structures and their function(s) have not been demonstrated. However, because of the thickness of the cell walls that form the phi thickenings, often being considerably thicker than the walls of the conducting tissue at the centre of the root, along with the fact that the phi thickenings form an integrated network towards the root's periphery, the phi thickenings are thought to mechanically strengthen the growing root.

Our research into phi thickenings began with observations in epiphytic orchids [1] but moved to the Brassicaceae because of the agricultural importance of crops such as canola and because of the genetic resources available. We have previously demonstrated that the formation of phi thickenings in Brassica oleracea (broccoli) roots can be rapidly triggered by both osmotic and mechanical stimuli, with this development mediated by the plant stress hormone jasmonic acid [2]. We have now shown that this jasmonic acid-mediated pathway results in phi thickening formation in all tested species within the Brassicaceae, with the intriguing exception of the model plant Arabidopsis thaliana.

While phi thickenings have been described in a diverse range of gymnosperms and angiosperms, they are absent from most species. It is unclear, therefore, whether phi thickenings represent an example of convergent evolution or the retention of a conserved structure. To begin answering this question, we have systematically surveyed phi thickening morphology in 13 different plant families using confocal fluorescence microscopy and three-dimensional image reconstructions. We have found that although there are some differences in the locations and patterns in which they form, phi thickenings are similar across all the plant families in which they occur. We are now investigating whether the developmental pathway leading to phi thickening formation is conserved, and preliminary data suggests that phi thickening induction might be induced by jasmonic acid in multiple plant families. Additionally, we are developing tests to demonstrate whether or not the thickenings do contribute to mechanically strengthening the root as has been suspected. These experiments are, therefore, finally explaining one of the most enigmatic plant structures.

References

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Neutron reflectometry analysis of ion compositions and protein monolayers at electrochemical liquid/liquid interfaces and Single-step deuteration of quaternary phosphonium-based ionic liquids

Authors: Kosuke Ishii[1], Yuko Yokoyama[1], Testsuo Sakka[1], Kazuhiro Akutsu[2], and Naoya Nishi[1]

Presenter: Kosuke Ishii

Hydrophobic liquids, such as hydrophobic ionic liquids (ILs) and fluorous solvents (Fs), are immiscible with water (W) and form a two-phase system. The protein monolayer (PM) formed on the F|W interface has recently been applied as a medium for cell culture. The PM at the liquid-liquid interface has high flexibility and fluidity, which can reproduce environments similar to in vivo. The structure of PM is changed by the molecular structure of F and IL. These changes are likely due to the hydrophobic and coulombic interactions between F and IL, and proteins.

We revealed, using X-ray reflectometry and molecular dynamics simulation, that the compositions of the first layer in the IL side at the IL|W interface can be switched by controlling the interfacial potential difference. When IL is added to F, the composition of IL at the F side of the F|W interface where the PM is formed can be tuned by controlling the interfacial potential difference, E_F^W. The manipulation of ionic composition on the F side of the interface is expected to change the IL-protein coulombic interaction, inducing the structural change of PM.

In this study, the compositions of IL and PMs at the F|W interface were successfully analyzed using neutron reflectometry (NR) under the controlled condition of E_F^W. IL used was Quaternary phosphonium-based ILs which has high electrochemical stability. The NR profiles (logR vs. q) were fitted using the one-slab model, which assumes the existence of an interfacial layer (L) between F and W. As E_F^W decreased, the reflectivity increased and the scattering length density (SLD) of L decreased. These results indicate that NR quantitatively detects the segregation of IL ions at the F side of the interface triggered by externally controlled E_F^W. Moreover, the SLD of L is smaller than that of the F bulk regardless of E_F^W. This illuminates the presence of an IL-rich layer on the F side of the interface, which cannot be explained with the classical Gouy-Chapman model and therefore reflects the peculiarity of the electric double layer in F solutions.

When protein was added to W, the structures of PM were successfully measured. The NR profiles were fitted using the one-slab model, which assumes the existence of an L between F and W. When the F side of the interface was positively charged, the NR increased and the L was thicker than those on the other E_F^Wconditions. This is because the negatively charged protein at pH 7.4 was more accumulated at the interface due to the coulombic interaction between protein and IL cation which has smaller SLD than protein. The results suggest that the structures of PMs were varied by controlling E_F^W.

For further detailed analysis of the interfacial structure using contrast variation NR, we developed a single-step method to deuterate ILs. We will also report the deuteration method in the presentation.

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Advancing Energy Futures: JOGMEC and CSIRO Collaborative Research in Transition Fuels and Digital Transformation

Authors: Yusaku Konishi (JOGMEC), Yoshitake Kato (JOGMEC), Damian Barrett (CSIRO), Yevhen Kovalyshen (CSIRO) and Marina Pervukhina (CSIRO)

Presenter: Yevhen Kovalyshen

In a rapidly evolving global energy landscape, the journey toward a sustainable energy future necessitates innovation, cross-border collaboration, and the merging of traditionally siloed research areas. The collaboration between the Japan Organization for Metals and Energy Security (JOGMEC) and Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) epitomizes this convergence, setting a benchmark for international research partnerships. In this presentation, we provide an overview of our cutting-edge collaborative projects in the domains of transition fuels enhanced recovery, industry decarbonization, and digital transformation. Supported by industry partners from both Japan and Australia, as well as academic stakeholders, the outcomes of this collaboration underscore the potential for technology to drive forward-thinking solutions in the energy sector.

Project 1: Automated Lithology with AI/ML for Geological Structure Identification. Many modern techniques are heavily reliant on a comprehensive understanding of subterranean geological structures. Conventional manual lithology quantification often lacks the accuracy, speed, or scalability required to meet contemporary needs of subsurface characterisation for carbon dioxide capture and storage (CCS) and hydrogen and compressed air storage. To address this, this project sought to integrate Artificial Intelligence and Machine Learning (AI/ML) algorithms for automated lithography. This innovation streamlines the process of identifying intricate below-ground geological structures, resulting in: (1) improved accuracy in mapping and characterisation of subsurface geologies, (2) enhanced speed of data processing and interpretation, (3) reduction of human errors and biases in lithographic interpretation.

The participation of industry companies and academic institutions from Japan and Australia provided varied perspectives, enriching the development process and ensuring that the resultant AI/ML models were robust, adaptable, and applicable across diverse geological contexts.

Project 2: Enhancing Natural Gas Production with Captured CO_2. Transition fuels, such as natural gas, play a critical role in our journey toward a decarbonized future. However, their extraction and use can still contribute to greenhouse gas emissions. Addressing this dual challenge, the collaborative research developed a pioneering approach to hydraulically fracture shales using captured CO_2. This method not only enhances natural gas production but simultaneously advances emissions abatement from unconventional assets. Key outcomes include: (1) boosted natural gas yields, catering to energy demands whilst transitioning to renewable sources, (2) effective utilization of captured CO_2, reducing the environmental footprint of unconventional gas extraction, (3) demonstrable proof of the potential for industry practices to evolve in line with sustainability goals.

Both projects have been well-received by industry stakeholders, with potential applications spanning the breadth of energy exploration and production activities in both Japan and Australia. This collaboration stands as a testament to the power of cooperative research in driving the industry forward and tackling the pressing challenges of our time.

In conclusion, the JOGMEC-CSIRO partnership not only has catalyzed technological advancements but has also fostered a spirit of international cooperation and knowledge exchange. As we navigate the complexities of the energy transition, such collaborations will be indispensable in harnessing the potential of technology and innovation to create a sustainable, inclusive, and prosperous future for all.

Therapeutic Uses of 1,8-cineol, an extract from Eucalyptus globulus

Authors: Patrick E. T. Askew , João H. R. Arseniadis,
University of Canberra

Presenter: Patrick Askew

The cultural significance and connection first nations people have to traditional medicines is something that we as westerners cannot begin to understand. Inherited through song and story, these medicines were used for tens of thousands of years across the country we now call Australia.

João H. R. Arseniadis, Patrick Askew, Yuan Gao and Yiwen Zhong explore the therapeutic uses, extraction and pharmacokinetics of 1,8-cineole, a bicyclic ether extract taken from Eucalyptus globulus oil. By using a collection of novel research including but not limited to bacterial biosynthesis and self-microemulsifying drug delivery systems, our aim is to highlight the potential this extract holds in the modern market as an NSAID, bronchodilator and topical antibiotic.

This work was produced as part of the University of Canberra's therapeutic chemistry unit convened by Professor Dr. Ashraf Ghanem.