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SINGAPORE • 6-8 October 2026

24th International Conference on Mechanics in Medicine and Biology (ICMMB 2026)

6 to 8 October 2026

Academia, SGH Campus, Singapore

ABSTRACTS

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PROGRAM OVERVIEW

Tuesday, 6 October 2026			
Time	**NAK Auditorium**	**L1-S1**	**L1-S2**
08:30-16:30	Registration		
09:00-09:30	**Opening Ceremony**		
09:30-10:15	**Plenary Lecture 1: Advances in Medical Bionics and Brain-computer Interfaces** **David B. Grayden** Session Chair: Rosa So, A*STAR		
10:15-10:45	**Break**		
10:45-12:45	**Oral Health ACP Special Session (TuA2NAK)** Session Chair: Bee Tin Goh, National Dental Centre Singapore; Christina Sim, National Dental Centre Singapore	**Cell Mechanics, Confinement & Mechanotransduction (TuA2L1S1)** Session Chair: Andrew Holle, NUS	**Neuroengineering & BCI I: Control, Detection & Neural Interfaces (TuA2L1S2)** Session Chair: Brian Premchand, A*STAR
Keynote	**Smart Piezoelectric 3D-printed Bioresorbable Scaffolds for Bone Tissue Engineering** Swee Hin Teoh **Low Frequency Ultrasound Treatment of Age-related Maladies** Linda J Kenney	**Compression-induced Mechanical Memory in Progression of Breast Cancer** Sarah Boyle	
12:45-14:00	**Lunch**		
14:00-14:45	**Plenary Lecture 2: Eavesdropping on Human Behaviors: From Electrophysiology to Motion and Interaction** **Rosa Chan** Session Chair: Swee Lan See, IEEE EMBS SG		
14:45-16:00	**Tissue Mechanics & Cardiac Aging (TuP1NAK)** Session Chair: Zhong Liang, SingHealth Duke-NUS AMC	**Engineered Tissue Microenvironments & Mechanobiology (TuP1L1S1)** **Andrew Holle, NUS** Session Chair: Andrew Holle, NUS	**Sports, Gait & Musculoskeletal Biomechanics (TuP1L1S2)** Session Chair: Rosa So, A*STAR
Keynote	**Imaging for Ageing So That Future Tools Make Sense: The Cardiovascular Perspective** Angela Koh	**Mechanics and Materials: Integrated Roles in Metastatic Cancer** Shreya Raghavan	
16:00-16:30	**Break**		
16:30-17:15	**Plenary Lecture 3: MitoCharge Magnetic Muscle – Mitochondria Activation and Healthy Longevity** **Ivan Goh** Session Chair: Benjamin Lee, Singapore Polytechnic		
17:15-18:15	**Poster Session 1**		

Wednesday, 7 October 2026			
Time	**NAK Auditorium**	**L1-S1**	**L1-S2**
08:30-16:15	Registration		
09:00–10:30	**Assistive Robotics & Neurorehabilitation (WeA1NAK)** Session Chair: Jaichandar Kulandaidaasan Sheba, Singapore Polytechnic	**Computational Tools, AI/ML & Biomedical Data (WeA1L1S1)** Session Chair: Liu Nan, SingHealth Duke-NUS AMC	**Neuroengineering & BCI II: Cognitive, Psychiatric & Developmental Signals (WeA1L1S2)** Session Chair: Mengjiao Hu, A*STAR
Keynote	**Soft Robotics Meets Human Biomechanics** Raye Yeow		
10:30–11:00	**Break**		
11:00-11:45	**Plenary Lecture 4: Brain Cancer Chip for Precision Medicine** **Metin Akay** Session Chair: Rosa So, A*STAR		
11:45-13:00	**Bone & Musculoskeletal Mechanobiology (WeA2NAK)** Session Chair: Benjamin Lee, Singapore Polytechnic	**Cardiovascular Modeling & Mechanics (WeA2L1S1)** Session Chair: Mengjiao Hu, A*STAR	
Keynote	**Carpal Tunnel Mechanics and Clinical Applications** Zong-Ming Li	**AI-Enhanced Cardiac Digital Twins: From Mechanistic Modeling to Personalized Healthcare** Lei Li	
13:00-14:00	**Lunch**		
14:00-14:45	**Plenary Lecture 5: Advancing Neuroengineering with Electroceuticals and Neuromorphic Twins** **Michela Chiappalone** Session Chair: Brian Premchand, A*STAR		
14:45-15:45	**Developmental & Reproductive Tissue Microenvironments (WeP1NAK)** Session Chair: Swee Lan See, IEEE EMBS SG	**Translational Clinical Engineering & Rehabilitation (WeP1L1S1)** Session Chair: Jaichandar Kulandaidaasan Sheba, Singapore Polytechnic	**Disease & Immune Mechanobiology (WeP1L1S2)** Session Chair: Kenneth Cheong, H&H Group
Keynote	**Living Under Pressure: From Force Sensing to Force Survival** Yao Wang	**Engineering Living Muscles for Biohybrid Robots: From Tissue Training to High-Performance Locomotion** Yu Jun Tan	
15:45-16:15	**Break**		
16:15-17:00	**Plenary Lecture 6: Mechanobiology of Apoptosis and Tissue Turnover in Aging** **Yusuke Toyama** Session Chair: Andrew Holle, NUS		
17:00-18:00	**Poster Session 2**		

18:30-21:00	**Banquet @** Chui Huay Lin Club, Level 2

Thursday, 8 October 2026			
Time	**NAK Auditorium**	**L1-S1**	**L1-S2**
08:30-11:00	Registration		
09:00-11:00	**Musculoskeletal Sciences ACP Session (ThA1NAK)** Moderators: Joyce Koh, Singapore General Hospital; Andy Yew, Singapore General Hospital	**Clinical Devices & Mechanobiological Tools (ThA1L1S1)** Session Chair: Benjamin Lee, Singapore Polytechnic	**Physiological Signals, Speech & Respiratory Modeling (ThA1L1S2)** Session Chair: Liu Nan, SingHealth Duke-NUS AMC
Keynote		**Soft Robotic Technologies for Safe Interaction with Human Tissue** Amy Kyungwon Han	
11:00-11:30	Break		
11:30-12:15	**Plenary Lecture 7: Probing Subnuclear Deformation in Cancer Cells** **Wenting Zhao** Session Chair: Andrew Holle, NUS		
12:15-12:30	**Closing & Award Presentation Ceremony**		
12:30-13:30	**Lunch**		
13:30	**Social Program** Free and Easy to Gardens by the Bay		

Tuesday, 6 October 2026

Plenary Lecture 1

Date: Tuesday, 6 October 2026

Venue: NAK Auditorium

Time: 09:30 - 10:15

Chair: Rosa So



David B. GRAYDEN

Professor and Clifford Chair in Neural Engineering;
Department of Biomedical Engineering
The University of Melbourne

Professor David B. Grayden is Clifford Chair of Neural Engineering in the Department of Biomedical Engineering, Faculty of Engineering & Information Technology and the Graeme Clark Institute for Biomedical Engineering. He is Co-Director of the Victorian Medtech Skills and Devices Hub and Director of the ARC Training Centre in Cognitive Computing for Medical Technologies. Prof Grayden's main research interests are in understanding how the brain processes information, how best to present information to the brain using medical bionics, such as the bionic ear and bionic eye, and how to record information from the brain, such as brain-machine interfaces. He is also conducting research in epileptic seizure prediction and electrical stimulation to prevent or stop epileptic seizures. Prof Grayden teaches BioDesign Innovation in collaboration with the Melbourne Business School, and he is Co-Director of Biodesign Australia.

Title

Advances in Medical Bionics and Brain-computer Interfaces at The University of Melbourne

Abstract:

Medical bionics and brain-computer interfaces (BCIs) are reshaping how we understand, restore, and augment human function. At the University of Melbourne, interdisciplinary teams spanning engineering, neuroscience, medicine, rehabilitation, and industry are developing technologies that translate signals from the nervous system into meaningful therapeutic and functional outcomes. This plenary presentation will highlight recent advances across the medical bionics innovation pipeline. Particular emphasis is placed on minimally invasive technologies designed to support people living with neurological disease, sensory impairment, and movement disorders. It will also consider the importance of co-design, clinical partnerships, responsible innovation, and commercial pathways in moving promising devices from proof-of-concept research to real-world impact.

Special Session: Oral Health ACP Special Session (TuA2NAK)

Date: Tuesday, 6 October 2026 **Time:** 10:45–12:45 **Venue:** NAK Auditorium

Chairs



GOH Bee Tin

Chief Executive Officer
National Dental Centre Singapore;
Academic Chair
SingHealth Duke-NUS Oral Health Academic Clinical Program



Christina SIM

Senior Consultant and Director of Research
National Dental Centre Singapore;

Keynote Speaker



Swee Hin TEOH

Distinguished Changjiang Chair Professor and Director
Centre for Advanced Medical Engineering
Hunan University;
Emeritus Professor
Nanyang Technological University

Prof Teoh is the Director and Distinguished Senior Yelu/Changjiang Chair Professor, Center for Advanced Medical Engineering (CAME) at the College of Materials Science and Engineering, Hunan University, People's Republic of China. He majored in Materials Engineering (B Eng with First Class Honors and PhD at Monash University in 1978 and 1982 respectively). He is a Fellow of the Institution of Engineers, Singapore.

Prof Teoh spent 30 yrs (1982-2012) at the National University of Singapore (NUS) and Co-Chaired the Graduate Program in BioEngineering (GPBE). He also Chaired the school of Chemical and Biomedical Engineering (SCBE) with a joint Professorship at the Lee Kong Chian School of Medicine (LKC Med) at Nanyang Technological University (NTU), from 2012-2021. He was awarded the prestigious NTU President's Chair Award for Educational Leadership and for his outstanding research and entrepreneurship. He is also the Senior Mentor to the clinical scientists at the National Dental Centre of Singapore for the last 10 years. Prof Teoh is a pioneer in 3D printing for implants. To date, his spin-off company, Osteopore International (IPO Australia ASX), has implanted more than 150,000 scaffolds worldwide. His pioneering work has earned him the prestigious "Golden Innovation Award" from the Far Eastern Economic Review (2004) and the "Notable Engineering Achievement Award" from the Institute of Engineers, Singapore. His team also received the "2018 Patent Excellence Award" from the Intellectual Property Office of Singapore. Currently, he is focusing on biomaterials, piezoelectric bone tissue engineering and regenerative medicine with research ranging from synthetic bones, blood vessels and skin, bioreactors, fish collagen, decellularized organs.

Title

Smart Piezoelectric 3D-printed Bioresorbable Scaffolds for Bone Tissue Engineering

Keynote Speaker



Linda J KENNEY

President
Mechanobiologics, Inc.

Professor Linda J. Kenney is the President of Mechanobiologics, Inc., Santa Fe, New Mexico, USA. She is also an Adjunct Professor at the National Dental Centre Singapore. She is a global scientific leader in Microbiology, Biophysics and Mechanobiology with over 150 publications & multiple patents. A proven mentor and leader, she has trained 45+ PhDs and post-doctoral fellows now in global academic, government, and industry leadership. She was previously the Tom and Kaye Arnold Professor of Gastroenterology at the University of Texas and is an AAAS Fellow and a member of the American Academy of Microbiology.

Title

Low Frequency Ultrasound Treatment of Age-related Maladies

Invited Speaker



Hemant Vijaykumar UNADKAT

Principal Investigator
National Dental Research Institute Singapore
National Dental Centre Singapore;
Assistant Professor
Academic Clinical Program in Oral Health
Duke-NUS Medical School

Title

From Surface Topography to Regenerative Devices: AI-Guided Bioengineering for Oral Tissue Regeneration



Zayim RAZINA

Senior Research Fellow
National Dental Research Institute Singapore
National Dental Centre Singapore

Title

D-IONIC (Dental-IONIC) – A Novel Conductive Microneedle Patch for Modulating the Oral Tissue Mirconenvironment for Accelerated Drug Diffusion across Oral Mucosa and Bone

Invited Speaker



LIM Yujing

Chief Executive Officer & Chief Technology Officer
Osteopore International;
Adjunct Assistant Professor
NUS Biomedical Engineering Convenor
National Mirror;
Working Group TC194
Biocompatibility and Clinical Evaluation

Title

Application of Tissue Engineering Concepts in Medical Devices: A Decade of Experience



SONG Juha

Associate Professor
School of Chemistry, Chemical Engineering and Biotechnology
Nanyang Technological University

Title

Digital Dentures: From Design to Future



YEONG Wai Yee

Chair
School of Mechanical & Aerospace Engineering
Nanyang Technological University;
Professor
School of Mechanical & Aerospace Engineering
Nanyang Technological University

Title

Bioelectronics Interface for Tissue Engineering

Keynote: Cell Mechanics, Confinement & Mechanotransduction (TuA2L1S1)

Date: Tuesday, 6 October 2026

Venue: L1-S1

Time: 10:45 - 12:45

Chair: Andrew Holle



Sarah BOYLE

Research Fellow, Centre for Cancer Biology
Adelaide University

Dr. Sarah Boyle is an Australian Research Council DECRA Research Fellow at the Centre for Cancer Biology, Adelaide University, South Australia. Leading the Cancer Matrix and Mechanics Group in the Tumour Microenvironment Laboratory, Sarah's research focusses on the mechanisms and interplay between mechanical force, mechanotransduction, and various aspects of the tumour microenvironment in progression and metastasis of breast and other cancers. She has established an emerging leadership profile in the fields of cell, cancer, and mechano biology, evidenced by publications in multi-disciplinary journals including Nature Cell Biology, Science Advances, Journal of Cell Science, Advanced Science, and Oncogene, and has previously held fellowships from the Royal Adelaide Hospital Research Committee and Australian Breast Cancer Research through The Hospital Research Foundation Group.

Title

Compression-induced Mechanical Memory in Progression of Breast Cancer

Abstract:

External mechanical force is exerted upon tissues and cells throughout development and homeostasis. These tissue-level forces transduced by the extracellular matrix initiate mechanotransduction signalling pathways that generate dynamic intracellular forces via enhancing actin polymerisation and myosin contractility. This reciprocity is fundamental to the maintenance of tissue integrity. However, in disease states such as cancer, enhanced extracellular matrix density coupled with rapid growth within a constricted space aberrantly activates mechanotransduction pathways that promote tumour progression.

Cytoskeletal tension is exerted by myosin II, and its regulatory subunit myosin regulatory light chain-2 (Mlc2) can be directly activated by the Ser/Thr kinase ROCK. We have found that acute compressive force applied to early-stage mammary cancer cells and tissue can activate the Rho-ROCK signalling pathway, elevating RhoA-GTP levels and increasing actomyosin contractility and tension. We have further discovered that activation of Rho requires the mechanosensitive ion channel Piezo1 and downstream calcium signalling. Compression induces calcium ion influx and activation of calmodulin-dependent protein kinase II (CaMKII), leading to Rho-ROCK pathway activation, and this is suppressed by silencing Piezo1, depleting available calcium, or inhibiting CaMKII.

Our findings suggest that acute compressive forces engender mechanical memory to promote tumour progression via the induction of a Piezo1-CaMKII-Rho-ROCK cascade, evidenced by histone modifications associated with open chromatin that regulate the expression of key cancer-related genes across cell, explant, and in vivo tumour models. Our results therefore strongly suggest that Rho-ROCK-mediated mechanotransduction in cancer, induced by compressive stress from mammary tumour growth within a constricted space, may play a role in cancer progression via establishing persistent tumour-promoting epigenetic changes.

Cell Mechanics, Confinement & Mechanotransduction (TuA2L1S1)

Date: Tuesday, 6 October 2026 **Venue:** L1-S1

Time: 11:15 – 12:00 **Chair:** Andrew Holle

11:15-11:30

Submission ID: 43 - Confined migration drives fibroblast state transition

Yeji Chang, Nicole Jia Wen Lee, Jin Zhu, Matthew Ackers-Johnson and Andrew Holle

Abstract: Fibroblasts play essential roles in tissue homeostasis, fibrosis, cancer, and wound healing. Their function is driven by their ability to activate, transitioning from a quiescent to an activated state. Activated fibroblasts produce extracellular matrix (ECM) proteins, remodel the ECM, and exhibit enhanced contractility. While biochemical factors are well-known drivers of fibroblast activation, the role of mechanical forces remains less explored. Various mechanical stresses experienced by fibroblasts, including stiffness, compression, stretching, topology, and ECM anisotropy, have been shown to influence fibroblast activation. However, these systems do not recapitulate the active migratory journey through confining interstitial spaces that fibroblasts experience in vivo. During this process, fibroblasts are subjected to compressive and spatial confinement that induce nuclear deformation. As the nucleus serves as a central mechanosensor that translates external mechanical stimuli into intracellular signaling, we hypothesize that confined migration could serve as a mechanical cue driving fibroblast activation. To test this, we developed a physiologically relevant, flow-free microchannel system using photolithography and polydimethylsiloxane (PDMS)-based replica molding, allowing precise control over the degree of confinement. By observing fibroblast migration and subsequent exit from confinement, we identified novel signatures of confinement-based fibroblast migration. Additionally, immunofluorescent labeling of α-SMA, a cytoskeletal protein and a hallmark of TGF-β-induced activation, revealed that fibroblast activation increases with confinement. Transcriptomic profiling revealed that confinement induces a graded transcriptional shift that is distinct from TGF-β-induced activation. Pharmacological inhibition experiments further revealed that confinement-induced activation is dependent on actomyosin contractility but independent of YAP signaling. Additionally, using curved microchannels that decouple confinement from alignment, we further established that physical confinement is the dominant mechanical driver in confinement-induced activation. These findings identify confined migration as a mechanical regulator of fibroblast activation and provide mechanistic insight into how the microenvironment shapes fibroblast fate.

11:30-11:45

Submission ID: 48 - The role of spatial confinement in primordial germ cell migration and fate specification.

Malhar Sojwal Chitnis, Jia Wen Nicole Lee, Yeji Chang, Harini Rajendiran, Hui Ting Ong, Sudipto Roy and Andrew William Holle

Abstract: Primordial germ cells (PGCs) are the earliest progenitors of male and female gametes in higher animals. In vertebrates, they are initially specified at gastrulation, after which they migrate as single cells across diverse tissue contexts towards a group of mesodermal cells, associating with these cells to form sex-specific reproductive organs. During their migration, PGCs undergo epigenetic remodeling and differentiate from an immature pluripotent identity to a mature germline fate. However, current understanding of the mechanochemical cues driving PGC migration and maturation is limited. We propose that the physical architecture of embryonic tissue creates a highly confining environment during PGC migration, requiring germ cells to undergo drastic nuclear deformations to reach their destination effectively. Using zebrafish embryos, we show that PGCs migrate through narrow gaps between tissues and intercellular spaces significantly smaller than their size. We show that PGCs exhibit highly wrinkled nuclei, indicating that these cells may be uniquely adapted for confined migration. In actively migrating germ cells, we observed rapid changes in nuclear shape as cells moved across regions of variable dimensions, showing a confinement-dependent deformation of the nucleus.

To understand the role of this deformation in germ cell fate determination of human PGCs, we recapitulated migration of embryonic stem cell-derived PGC-like cells using a PDMS-based microchannel device. Using this in vitro model, we observed that PGCs migrate through highly confining (30 μm2) as well as non-confining (100 μm2) microchannels without chemotactic cues. We also showed a dramatic downregulation of the pluripotency factor NANOG after confined migration, indicating that nuclear deformation alone is sufficient to alter germ cell fate. Going forward, we aim to utilize in vitro confinement tools, combined with in vivo studies in zebrafish, to gain a comprehensive understanding of the dynamics of PGC confined migration and the role it plays in the maturation of the germline.

11:45-12:00

Submission ID: 14 - Sonomechanobiology: A New Field of High Frequency Cell Mechanostimulation

Lizebona August Ambattu and Leslie Yeo

Abstract: Cells are known to respond to diverse forms of mechanical cues, yet most dynamic mechanostimulation studies have been conducted at low frequencies—typically several Hz, characteristic of the physiological frequencies experienced by cells in their local environment. Contrary to that expected, it has nevertheless been recently observed that 10 MHz order nanoscale vibrational stimulation is capable of eliciting unique cellular responses. These include modulation of mechanosensitive ion channels (Biophys J 124, 25, 2025), and, transient and reversible permeabilisation of the cell membrane, which has implications for efficient intracellular cytosol delivery (Nanoscale 10, 13165, 2018; ACS Appl Bio Mater 4, 2781, 2021), exosome biogenesis (Commun Biol 3, 553, 2020), immune cell activation (Adv Sci 9, 2105809, 2022), stem cell differentiation (Small 18, 2106823, 2022), cytoskeletal reorganisation and endothelial barrier modulation (Biomaterials 292, 121866, 2023)—all while maintaining very high cell viabilities (>95%).

As an example, we demonstrate, in particular, the possibility for early induction of mesenchymal stem cells toward an osteogenic lineage in as little as three days—without requiring osteogenic factors. This is shown to stem from a ‘mechanopriming' effect as a consequence of epigenetic modifications induced by the high frequency mechanostimulation: chromatin fluctuations driven by the spatiotemporal dynamics associated with the bidirectional crosstalk between two key second messengers, namely calcium and cyclic adenosine monophosphate (cAMP) (Adv Sci 12, e09860, 2025).

Altogether, these findings highlight the potential of high-frequency mechanostimulation as a powerful and underexplored paradigm for mechanobiology and cell engineering.

Neuroengineering & BCI I: Control, Detection & Neural Interfaces (TuA2L1-S2)

Date: Tuesday, 6 October 2026 **Venue:** L1-S2

Time: 10:45 – 12:45 **Chair:** Brian Premchand

10:45-11:00

Submission ID: 24 - Stimulation Parameters and Computational Volume Estimates Correlate with Motor Outcomes in Deep Brain Stimulation for Parkinson's Disease

Kezia Tanesha Susanto, Brian Premchand, Fatimah Misbaah, Kai Rui Wan and Rosa So

Abstract: Deep brain stimulation (DBS) is an established neuromodulation therapy for Parkinson's disease (PD), yet the relationship between programmable stimulation parameters and motor improvement remains incompletely characterised at the individual hemisphere level. This study investigates how stimulation voltage, volume of tissue activated (VTA), and electric field (EF) volume correlate with clinical motor outcomes across 24 stimulated hemispheres in 12 PD patients who underwent subthalamic nucleus (STN) DBS.

Post-operative VTA and EF volumes were computed using LeadDBS with the FieldTrip/SimBio finite element method, based on lead localisation from post-operative CT co-registered to pre-operative MRI. Stimulation voltage was recorded at one month post-operatively during clinical assessment in the medication-off condition. Motor outcomes were quantified as absolute UPDRS-III score reduction between stimulation-off and stimulation-on states, with specific focus on total score, rigidity, and bradykinesia subscores.

Pearson correlation analyses revealed significant negative correlations between stimulation voltage and total UPDRS-III improvement ($r = -0.48$, $p = 0.018$), rigidity ($r = -0.44$, $p = 0.033$), and bradykinesia ($r = -0.42$, $p = 0.041$). Similarly, EF volume correlated negatively with rigidity improvement ($r = -0.42$, $p = 0.040$), and VTA with rigidity ($r = -0.41$, $p = 0.048$). These negative associations indicate that patients requiring larger stimulation voltages and volumes achieved comparatively less motor improvement, potentially reflecting greater baseline disease severity or reduced stimulation sensitivity driving the need for escalated parameters.

These findings demonstrate that both programmable and computationally derived stimulation metrics meaningfully relate to motor outcomes one month post-operatively. The associations between volume-based estimates and specific motor subscores suggest that spatial characteristics of the stimulation field may differentially influence symptom-specific DBS response. Future work will incorporate DTI-based fibre tract engagement metrics to further elucidate the structural substrates of differential motor improvement and support patient-specific programming optimisation.

11:00-11:15

Submission ID: 85 - Comparison of Motor Execution and Motor Imagery Brain Activation Patterns Using Functional Near-Infrared Spectroscopy for Potential BCI applications

Janani A and Sasikala M

Abstract: The present study investigates the cerebral haemodynamic responses associated with motor execution (ME) and motor imagery (MI) tasks using functional Near-Infrared Spectroscopy (fNIRS) for potential Brain–Computer Interface (BCI) applications. The primary objective was to evaluate whether MI tasks evoke activation patterns comparable to ME tasks and to analyze the discriminability of upper- and lower-limb motor activities using fNIRS signals. Ten healthy right-handed female participants performed right- and left-fist clenching as well as right- and left-foot tapping tasks under both ME and MI conditions. fNIRS data were acquired using a 20-channel NIRScout system positioned over the motor cortex regions corresponding to Brodmann areas associated with motor planning, control, and execution.

The recorded oxyhaemoglobin (HbO) and deoxyhaemoglobin (HbR) signals were preprocessed that involved baseline correction, band-pass filtering, and wavelet-based motion artefact removal. Haemodynamic responses were analyzed using time-series plots, topographic activation maps, and statistical evaluation of channel-wise activation differences. Results demonstrated that both ME and MI tasks activated regions within the precentral and postcentral gyri associated with voluntary motor control. Upper-limb tasks, particularly right- and left-fist clenching, elicited strong contralateral activation patterns with clear differentiation between tasks. MI responses showed activation trends similar to ME, although with lower magnitude and delayed peak activation.

In contrast, foot-tapping tasks exhibited less distinguishable activation patterns, with overlapping ipsilateral and contralateral responses, making discrimination between right- and left-foot tasks comparatively difficult. Statistical analysis revealed significant task-related activation differences across several motor cortex channels during both ME and MI conditions ($p < 0.05$). The findings confirm that fNIRS can reliably capture distinguishable haemodynamic patterns associated with upper-limb motor imagery and execution, supporting its applicability in non-invasive BCI systems. Furthermore, the study highlights the potential inclusion of both foot tapping tasks in future fNIRS-based BCI paradigms and contributes toward improving multi-class motor intention decoding frameworks.

11:15-11:30

Submission ID: 98 - Development of an EEG Framework for Parkinson's Disease Detection Using Grey Wolf-Optimized Random Forest Classification

Renu Deepthi A and Kavitha G

Abstract: Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects motor function due to abnormalities in the basal ganglia and cortical motor networks. Electroencephalography (EEG) provides a non-invasive approach for analysing these abnormalities by capturing alterations in brain oscillations, cortical synchronization, and nonlinear neural dynamics associated with PD. This research proposes an optimized EEG framework for discriminating PD patients from healthy controls using resting-state EEG recordings from the University of New Mexico (UNM) dataset. The methodology comprises wavelet-based EEG preprocessing, signal segmentation, feature extraction, feature optimization, and machine learning classification. Nonlinear features, including the Hurst exponent, Higuchi Fractal Dimension (HFD), and Lyapunov exponent, were extracted along with spectral band-power features from the C3, C4, Cz, CP3, and CP4 channels. These channels represent sensorimotor and centro-parietal regions associated with PD-related motor dysfunction. Feature optimization was performed using Mutual Information (MI), Particle Swarm Optimization (PSO), and Grey Wolf Optimization (GWO), followed by Random Forest (RF) and Extreme Gradient Boosting (XGBoost) classification. Experimental results demonstrated that the GWO-RF framework achieved the best performance while reducing the feature space. The proposed model attained 87% accuracy, 88.53% precision, and 87% recall using a compact set of discriminative EEG biomarkers. GWO identified an optimal subset of ten biomarkers (C3_hurst, C4_hfd, C4_lyapunov, C4_delta_power, Cz_hurst, Cz_hfd, Cz_alpha_power, CP3_hfd, CP3_theta_power, and CP3_alpha_power), reflecting PD-related alterations in nonlinear neural dynamics and spectral oscillations. Leave-One-Subject-Out (LOSO) validation achieved approximately 83% accuracy, demonstrating robust generalization. Furthermore, SHAP analysis identified HFD and Hurst-based nonlinear EEG biomarkers as the most influential features for PD detection. In contrast, statistical analysis confirmed significant differences between PD and healthy control groups ($p < 0.001$). The framework removed redundant EEG information while preserving physiologically meaningful biomarkers, improving interpretability, computational efficiency, and classification performance. These findings highlight the potential of optimized EEG biomarkers for reliable, explainable Parkinson's disease detection.

11:30-11:45

Submission ID: 69 - EEG-Based Grip Type and Motor Phase Classification Using a Hybrid Stacking Ensemble of Machine Learning and Deep Learning Models

S.Pravin Kumar, Saranya S, Kavitha A, Harshadha V K and Ananya Sriram

Abstract: Electroencephalography (EEG)-based brain–computer interface (BCI) systems have emerged as promising solutions for neuroprosthetic control by enabling direct interpretation of motor intentions from neural activity. This study presents a hybrid machine learning–deep learning framework for the simultaneous classification of hand grip type and motor execution phase using EEG signals. The proposed system utilizes EEG data from the publicly available BNCI Horizon 2020 dataset, focusing on motor cortex channels C3, CZ, and C4, with band-power features extracted from Mu (8–13 Hz) and Beta (13–30 Hz) frequency bands associated with motor planning and execution.A hierarchical stacking ensemble architecture was developed by integrating four heterogeneous base learners, namely Random Forest, XGBoost, LightGBM, and CatBoost, followed by a deep neural network meta-learner trained using out-of-fold stacking features. A soft-voting ensemble strategy was employed to enhance prediction reliability and classification robustness. The proposed framework performs dual-task classification, simultaneously identifying grip type (power and precision grip) and motor execution phase (pre-movement, movement, and post-movement).Experimental evaluation demonstrated excellent classification performance, achieving 98.40% accuracy, 97.79% precision, and 99.00% recall for grip classification, and 99.14% accuracy, 99.13% precision, and 99.12% recall for motor phase classification. The framework also achieved near-perfect discrimination with AUC values exceeding 0.999. These results indicate that the proposed hybrid ensemble framework significantly enhances EEG-based classification performance and demonstrates strong potential for real-time neuro-prosthetic control and intelligent assistive rehabilitation systems.

11:45-12:00

Submission ID: 116 - Cross-Session EEG Biometric Identification Using Mel-Spectrograms and Hybrid CNN-Transformer Architectures

Chetan Tanaji Rakshe and Jac Fredo Agastinose Ronickom

Abstract: Electroencephalography (EEG) has emerged as a robust modality for cognitive biometrics due to the uniqueness and consistency of brain activity patterns across individuals. This study investigates the effect of Mel-spectrogram time-frequency representation (TFR) and multiple deep learning architectures on EEG-based biometric identification. EEG signals were recorded from 25 subjects under resting-state conditions and preprocessed using a standard pipeline including bandpass filtering and notch filtering. Mel spectrograms were extracted from the preprocessed signals and used as input to five architectures: Vanilla Transformer, Convolutional Neural Network-Transformer (CNN-Transformer), EfficientNetV2-S, ConvNeXt-Tiny, and Swin Transformer. To adapt pretrained vision models to 32-channel EEG input, a novel Topological Stem based on depth-wise separable convolutions was proposed. Cross-session evaluation was performed using a Leave-One-Run-Out (LORO) protocol to assess generalisation to unseen data. The CNN-Transformer achieved the highest identification accuracy of 88.19% with an Equal Error Rate (EER) of 3.28%. The proposed Topological Stem improved EfficientNetV2-S accuracy from 73.24% to 83.84%, validating the significance of EEG-specific spatial preprocessing for pretrained vision architectures. These results demonstrate that Mel-spectrogram features combined with hybrid attention-based models provide strong cross-session generalisation for EEG biometric identification.

Plenary Lecture 2

Date: Tuesday, 6 October 2026

Time: 14:00 - 14:45

Venue: NAK Auditorium

Chair: Swee Lan See



Rosa CHAN

Professor, Department of Electrical Engineering
City University of Hong Kong

Dr. Rosa H. M. Chan is a Professor in the Department of Electrical Engineering at City University of Hong Kong and Associate Director of the Hong Kong Center for Cerebro-Cardiovascular Health Engineering. Her research interests include brain-computer interface, wearable computing, and human-computer interaction. She received a B. Eng. (1st Hon.) degree in Automation and Computer-Aided Engineering from The Chinese University of Hong Kong in 2003. Dr. Chan received her Ph.D. degree in Biomedical Engineering in 2011 from the University of Southern California, where she also earned her M.S. degrees in Biomedical Engineering, Electrical Engineering, and Aerospace Engineering. She was co-received the Outstanding Paper Award of IEEE Transactions on Neural Systems and Rehabilitation Engineering in 2013. Dr. Chan is Co-Chair of IEEE BHI 2026 and served as VP-Finance of IEEE EMBS (2024–2025). Currently, she is an associate editor for IEEE Transactions on Neural Systems and Rehabilitation Engineering and IEEE Reviews in Biomedical Engineering.

Title

Eavesdropping on Human Behaviors: From Electrophysiology to Motion and Interaction

Abstract:

Artificial intelligence of things (AIoT) is advancing health and performance assessment by offering accessible, low-cost solutions for continuous and portable physiological monitoring. By integrating AI with IoT sensing, AIoT enables the seamless collection and analysis of physiological and behavioural metrics, including electroencephalogram (EEG), electrocardiogram (ECG), electromyogram (EMG), and movement patterns. Together, these metrics offer a comprehensive view of the biological neural system, reflecting brain activity, cerebro-cardiovascular health, and neuromuscular coordination. Leveraging common sensors such as electrodes and inertial measurement units, AIoT systems can operate across clinical settings, daily living, and athletic training.

Translating these multimodal biosignals into actionable insights, however, requires overcoming substantial real-world variability across individuals, demographics, and temporal states. This talk highlights our group's recent efforts across these modalities, including neural decoding, fairness-aware diagnostics, and motor function tracking. Together, these methodologies illustrate how designing models that embrace individual variability enables robust and equitable health technologies across clinical neurorehabilitation, sports performance, and daily well-being.

Keynote: Tissue Mechanics & Cardiac Aging (TuP1NAK)

Date: Tuesday, 6 October 2026

Venue: NAK Auditorium

Time: 14:45 - 16:00

Chair: Zhong Liang



Angela KOH

Director, Cardiovascular Ageing and Longevity
National Heart Centre Singapore

Director of the Cardiovascular Ageing and Longevity program at National Heart Centre Singapore; Clinician Scientist and Senior Consultant at NHCS. Leadership Council member at the American College of Cardiology (ACC) for Geriatric Cardiology; Past recipient of the emerging leader program and current Advisor at World Heart Federation.

Title

Imaging for Ageing So That Future Tools Make Sense: The Cardiovascular Perspective

Abstract:

As populations age, cardiovascular imaging is increasingly used to do more than detect disease. It helps clinicians understand why people of the same chronological age have markedly different cardiovascular health, functional capacity, and responses to treatment. The challenge is to distinguish changes associated with ageing from early disease, and to identify findings that can meaningfully guide care.

This keynote will examine cardiovascular ageing through a clinical imaging lens. Echocardiography, cardiac magnetic resonance, computed tomography, and vascular imaging offer complementary views of changes in cardiac structure, tissue, function, and the circulation. Together, they can reveal patterns of ventricular and atrial remodeling, vascular stiffness, myocardial disease, and impaired reserve. Yet read-outs from these advanced multimodality techniques are of unknown significance, without corroborative and human-guided insights on the patient's clinical history, cardiometabolic risk, frailty, symptoms, and goals of care.

The talk will consider how imaging can move from describing ageing to identifying clinically useful phenotypes: who is at risk of heart failure, which changes may be reversible, and where an intervention is most likely to help.

New AI and multimodal tools may detect patterns that clinicians cannot readily see. For these tools to make sense in practice, they must be grounded in cardiovascular biology, validated in diverse older populations, and shown to improve decisions rather than simply generate more precise measurements. From the perspective of cardiovascular ageing, the goal is an imaging approach that supports earlier recognition, more appropriate treatment, and better health and function in later life.

Tissue Mechanics & Cardiac Aging (TuP1NAK)

Date: Tuesday, 6 October 2026 **Venue:** NAK Auditorium

Time: 14:45 –16:00 **Chair:** Zhong Liang

15:15-15:30

Submission ID: 87 - Beyond Passive Mechanics: The Poynting Effect, Cell Viability, and Bioelectricity in Brain and Aortic Tissue

Mina Khalaj, Gerhard Sommer, Gerhard. A. Holzapfel and Christian Baumgartner

Abstract: The Poynting effect (PE) describes the occurrence of normal stresses under shear loading. The sign of these normal stresses – positive (dilatational) or negative (contractile) – is critical for validating constitutive models for soft tissue. Although factors such as fibrous networks and sample geometry are known to influence this effect, their interactions and underlying mechanisms remain unclear, particularly for brain tissue, where a positive PE is often assumed.

This study presents an experimental investigation of the PE in two and distinct biological materials: brain tissue and aorta. Stepwise, strain-controlled cyclic simple shear tests were performed and induced normal forces measured. To assess the validity and generalizability of the experimental setup, a well-characterized rubber was first tested under conditions and demonstrated the expected positive PE, confirming the reliability of the methodology.

Aortic samples were tested in axial and circumferential orientations to investigate anisotropy, while brain samples with two height-to-width ratios were tested to evaluate geometric effects. Critically, all biological samples were tested at cell viabilities exceeding 70%, confirmed through viability assays, ensuring that the measured mechanical responses reflect living tissue behavior. Given that cells are bioelectrically active, this opens the possibility that bioelectric signaling contributes to the observed mechanical response under shear — a dimension not previously considered in PE studies.

In all configurations, a strong negative PE was consistently observed, challenging the prevailing assumption for brain tissue. Despite its fibrous structure, the aorta showed low sensitivity to loading orientation. Similarly, reducing the sample aspect ratio caused proportional stress reduction without sign reversal. Cyclic analysis revealed that material softening was governed primarily by shear stress, while normal stress remained insensitive to damage.

These findings establish the contractile response to shear as an intrinsic property of both tissues, with implications for constitutive modeling and the role of bioelectricity in soft tissue mechanics.

15:30-15:45

Submission ID: 92 - Extracellular matrix structure-stiffness relationships in cardiac aging

Md Faris H. Ramli, Ranmadusha M. Hengst, Huan Ting Ong, Avery R. Sun, Shen Xingyu, Kevin Nicholas, Gianluca Grenci and Jennifer Young

Abstract: Cardiac extracellular matrix (ECM) remodeling occurs progressively with age and contributes to impaired cardiac function. Increased tissue stiffness and ECM alterations are recognized features of cardiac aging; however, how localized ECM architecture associates with regional mechanical heterogeneity remains poorly understood. Here, we developed a correlative structure-mechanics workflow integrating spatial stiffness mapping with quantitative ECM architectural analysis to investigate localized matrix remodeling during cardiac aging.

Fresh vibratome-sectioned cardiac tissues from young (~1-2 months) and aged (~18-24 months) mice were subjected to high-resolution nanoindentation mapping using a customized correlative setup that enabled direct correlation of stiffness measurements with ECM imaging. Distinct ECM compartments, including fibrillar collagen, fibronectin, collagen VI, laminin, and collagen IV, were analyzed to assess remodeling across interstitial, pericellular, and basement membrane-associated matrix networks. Quantitative image analysis was performed using geometric descriptors, including high-density matrix, fractal dimension, hyphal growth unit, lacunarity, fiber deviation, and fiber width, to characterize ECM organization across the distinct matrix compartments. These architectural parameters were integrated into an Architecture Index derived from principal component analysis (PCA) to quantitatively define localized ECM remodeling states.

Distinct ECM components displayed unique remodeling signatures during aging, demonstrating that ECM remodeling was not uniform across matrix compartments. Regions exhibiting elevated stiffness spatially corresponded with areas of disrupted ECM organization and higher Architecture Index values. Aged tissues further displayed greater spatial variability in ECM architecture and tissue mechanics, indicating localized and heterogeneous matrix remodeling during cardiac aging. Overall, this work establishes a spatially resolved framework linking ECM architecture to localized tissue mechanics during cardiac aging. By directly correlating multidimensional ECM organization with microscale stiffness heterogeneity, this approach advances understanding of age-associated myocardial remodeling and provides a quantitative platform for investigating structure-mechanics relationships within the aging cardiac microenvironment.

Keynote: Engineered Tissue Microenvironments & Mechanobiology (TuP1L1S1)

Date: Tuesday, 6 October 2026

Venue: L1-S1

Time: 14:45-16:00

Chair: Andrew Holle



Shreya RAGHAVAN

Associate Professor and Holder of the Cain Faculty Fellowship
Department of Biomedical Engineering
Texas A&M University

Dr. Shreya Raghavan is an Associate Professor in the Department of Biomedical Engineering at Texas A&M University. She is also a Fellow of the American Institute for Medical and Biological Engineering. Dr. Raghavan earned her PhD in Biomedical Engineering from Wake Forest University/Virginia Tech and was an NIH Postdoctoral Fellow at the University of Michigan. The Raghavan lab engineers mechanically competent microenvironments to advance our understanding of cancer and women's health. Her approaches integrate mechanobiology, biomaterials and microenvironment engineering. Her work is funded by the NIH/NCI through an R37 MERIT award, the NSF CAREER Award, the Department of Defense, and the Cancer Prevention and Research Institute of Texas. She is an award winning scientist, recognized by the Rita Schaffer Young Investigator Award, CMBE Young Innovator Award and CMBE Rising Star Award from the Biomedical Engineering Society.

In the biomedical engineering classroom, Dr. Raghavan is recognized for her excellence in teaching by the Montague Scholars Award and the Provost's Innovative Teaching Fellowship from Texas A&M University. Dedicated to broadening participation in STEM, Dr. Raghavan serves the Society for Biomaterials and Biomedical Engineering Society in several roles.

Title

Mechanics and Materials: Integrated Roles in Metastatic Cancer

Abstract:

Mechanics is widely prevalent in our body at many scales, starting from subcellular forces all the way up to tissue scales. Every cell in the colon, including a cancer cell, experiences the near constant tissue-scale mechanics of peristalsis, transducing these signals for its own malignant gain. First, using a bioreactor device invented in our lab, our work demonstrates that peristalsis mechanics drive a physical, transcriptomic, and molecular program that primes for metastasis in colorectal cancer cells. Our work shows that malignant mechanoresponse and metastatic priming is confined to cells with oncogenic mutations in the KRAS oncogene, establishing the first oncogene-mechanics axis as a driver of metastatic colorectal cancer. Next, we will discuss how we engineer the material microenvironment of metastasis, using natural materials. Using engineered scaffolds, our work examines the functional implications of mechanics-induced metastatic priming. We show that encounters with the 3D scaffolding and architectures of distant organs like the liver induce metastatic outgrowth at increased rates when primed mechanically. Together, these intersection stories speak to how engineering variables in the cellular microenvironment acutely impact and drive metastatic cancer.

Engineered Tissue Microenvironments & Mechanobiology (TuP1L1S1)

Date: Tuesday, 6 October 2026 **Venue:** L1-S1

Time: 14:45 – 16:00 **Chair:** Andrew Holle

15:15-15:30

Submission ID: 26 - A deep learning and biophysical approach to study impaired ovulation during ageing.

Jake Turley, Tobias Kiehntopf, Ling Wang, Ranmadusha Merengha Hengst, Yuting Lou, Apoorva Shivankar, Jennifer Lauren Young, Robert Prevedel, Alexander Mietke and Chii Jou Chan

Abstract: The release of oocytes from inside an ovarian follicle is a critical biological process required for reproduction. While the hormonal signals regulating ovulation are well studied, less is known about the role of tissue mechanics in follicle rupture. Ovulation is fundamentally a mechanical event, where increases in follicle volume, degradation of the follicle wall, and internal pressure contribute to rupture and oocyte release. Anovulation is associated with ageing and disorders such as polycystic ovary syndrome, while aged ovaries are stiffer and exhibit dysregulated hyaluronic acid synthesis that impair follicle rupture efficiency. We combine ex vivo mouse follicle cultures with advanced microscopy and deep learning to investigate how ageing alters the biomechanics of follicle rupture during ovulation. Label-free optical coherence microscopy is used to capture ovulation dynamics at high temporal resolution, while a deep learning-based segmentation approach enables quantitative analysis of follicle structure. We further apply biophysical measurements, including nano-indentation and pipette aspiration, to quantify tissue stiffness. Using this framework, we quantify the temporal sequence of mechanical changes during ovulation. In young follicles, ovulation stimulation triggers an initial relaxation phase characterised by softening of the theca layer, followed by a progressive increase in volume and rounding as the theca layer contracts several hours before rupture, with highly consistent progression across follicles. Our theoretical model demonstrates that this rounding behaviour reflects a build-up of internal pressure. In contrast, aged follicles exhibit reduced rupture rates and highly heterogeneous responses, with diminished and less consistent softening, volume expansion, and rounding. Together, these results identify a breakdown of coordinated follicle mechanics with ageing and highlight a framework for quantifying dynamic 3D tissue processes using label-free imaging and machine learning.

15:30-15:45

Submission ID: 53 - Microfluidic platform reveals the novel role of mechanical confinement in tendon homeostasis and disease

Sriram Muthukumar

Abstract: Tenocytes, the primary resident cells of tendon tissue, are mechanosensitive and play an essential role in maintaining tendon homeostasis. Within the tendon, tenocytes are confined to narrow spaces between aligned collagen fibers that impose mechanical confinement. Notably, in tendinopathy, tendon tissue exhibits spatial remodelling characterized by fiber disorganization and increased interfibrillar spacing which coincide with aberrant tenocyte phenotypes. This correlation suggests that a loss of mechanical confinement may disrupt tenocyte behaviour, contributing to the pathogenesis of tendinopathy. Although mechanical confinement is known to influence various mechanosensitive processes, its specific role in regulating tenocyte function and tendon pathology remains poorly understood. Bridging this knowledge gap could yield critical insights into tendon biology and disease mechanisms. One of the main challenges is creating a physiologically relevant in vitro system to study tenocytes under controlled confinement. In our work, by combining soft lithography and photopatterning, we engineered a PDMS-based microfluidic platform that enables long-term culture of tenocytes within microchannels of physiologically relevant dimensions. The in vitro microfluidic platform mimics the confining microarchitecture of tendon tissue and allows us to investigate how spatial confinement influences tenocyte morphology, the expression of key tendon biomarkers and the transition towards tendinopathic phenotype. These findings offer a novel perspective on how tendon microstructure regulates tenocyte behaviour and may inform future therapeutic approaches for tendinopathy.

15:45-16:00

Submission ID: 97 - Actin-dependent mechanotransduction controls nucleocytoplasmic partitioning of DNMT3a through ERK1/2 signaling during cutaneous wound healing

Johan Ajnabi, Binita Dam, Ekta Gupta, Tirthankar Saha, Abhik Dutta, Saurav Kumar, Ashish Gupta, Dasaradhi Palakodeti and Colin Jamora

Abstract: Cutaneous wound healing is a multifaceted physiological process that requires a dynamic shift in cellular state from homeostasis to tissue repair. Wound-induced mechanical cues perceived by the keratinocytes in the epidermis, allow them to undergo rapid remodelling to initiate wound response. However, the exact mechanism by which these mechanical cues are sensed and transduced by the keratinocytes to enable this cell state change remain largely elusive. We found that sheets of differentiated keratinocytes with interconnected actin cables undergo rapid actin remodelling upon wounding. Cellular tension release associated with this actin remodelling signals Extracellular Signal-Related Kinase 1/2 (ERK1/2) inactivation mediated by an ERK-targeting Dual Specificity Phosphatase 6 (DUSP6). Mechanoregulation of the ERK signaling pathway, in turn, dictates the subcellular localization of de novo DNA methyltransferase 3 alpha (DNMT3a), a key regulator involved in the initiation of wound healing processes. Overall, these findings illuminate the early wound response by an important yet underappreciated pool of differentiated keratinocytes in the skin epidermis upon mechanical cues.

Sports, Gait & Musculoskeletal Biomechanics (TuP1L1S2)

Date: Tuesday, 6 October 2026 **Venue:** L1-S2

Time: 14:45 – 16:00 **Chair:** Rosa So

14:45-15:00

Submission ID: 10 - Relationship Between Inter-Segmental Coordination of the Instep Kick and General Coordination Abilities in Experienced Soccer Athletes

Liwen Zhang, Meizhen Zhang and Hui Liu

Abstract: Inter-segmental coordination of the kicking leg plays a critical role in determining soccer instep kicking performance. Our previous research found that athletes achieving greater maximum ball speed exhibited more knee flexion dominant coordination patterns during the backswing and leg-cocking phases, and more knee extension dominant coordination patterns during the leg acceleration phase. The present study aimed to investigate the relationship between these inter-segmental coordination features and general coordination abilities in experienced soccer players. Fourteen collegiate soccer players performed instep kicking trials, with three-dimensional kinematics collected to quantify hip–knee and knee–ankle coordination patterns using vector coding. General coordination was assessed using two tasks: (1) a hand–foot flexion–extension synchronization test at 80, 120, and 180 bpm under same- and opposite-direction conditions, and (2) the Harrer Circuit Test (HCT), where shorter times indicate better coordination. Correlation analyses revealed that better performance in the opposite-direction condition at 180 bpm was negatively correlated with hip–knee thigh dominance during the backswing ($p=0.003$, $r=-0.567$), hip–knee thigh dominance during leg acceleration ($p=0.020$, $r=-0.61$), and knee–ankle foot dominance during the backswing ($p=0.00$, $r=-0.682$). Faster HCT times were significantly associated with less hip–knee in-phase during the backswing ($p=0.389$, $r=-0.55$), less hip–knee thigh dominance during the backswing and leg-cocking phases ($p=0.02$, $r=0.588$), less knee–ankle foot dominance during the backswing ($p=0.005$, $r=0.70$), less knee–ankle shank dominance during the leg-cocking phase ($p=0.022$, $r=-0.60$), and less knee–ankle foot dominance during the leg-cocking phase ($p=0.02$, $r=-0.610$). Collectively, these findings indicate that both the high-frequency opposite-direction hand–foot coordination task and the HCT effectively capture general coordination attributes that relate to key inter-segmental coordination features of the kicking leg in skilled soccer players. Therefore, incorporating these general coordination assessments may offer valuable insights for talent

15:00-15:15

Submission ID: 21 - Effects of External Load and Different Slopes on Hamstring muscle function during the Nordic Hamstring Exercise

Samatchai Chamnongkich, Aatit Paungmali, Cheng-Feng Lin and Amornthep Jankaew

Abstract: Background: The Nordic Hamstring Exercise (NHE) is widely used to enhance eccentric hamstring strength and reduce injury risk. Modifications such as increasing external load or altering slope angle are commonly applied to adjust exercise intensity. However, evidence regarding how these factors influence hamstring muscle activation and breaking point angle (BPA) remains limited. This study aimed to compare hamstring muscle activity and BPA during the NHE under different external load and slope conditions.

Methods: Twenty healthy male athletes (20.8 ± 0.83 years) participated in this repeated-measures study. Participants performed the NHE under nine conditions combining three external loads (0%, 4%, and 8% body weight) and three slope angles (0°, +20°, −20°). Electromyographic activity of the biceps femoris long head (BFLH) and semitendinosus (ST) was recorded, and BPA was defined as the point of loss of controlled forward descent. A 3x3 repeated-measures ANOVA was used for analysis.

Results: For the BFLH, significant main effects were observed for slope ($p = 0.004$) and load ($p < 0.001$), with significant interaction ($p < 0.001$). EMG activity increased with higher loads across slope conditions. For the ST, no significant main effects were found; however, a significant interaction was observed ($p = 0.037$), indicating load-dependent responses across slopes. BPA showed significant main effects of slope ($p < 0.001$) and load ($p < 0.001$), with no interaction.

Conclusion: Both slope and external load influence hamstring activation and the mechanical demands of NHE. The BFLH appeared more sensitive to changes in exercise conditions than the ST. Clinically, upslope NHE without added load may be appropriate as an early stage of rehabilitation, whereas adding external load, particularly in the downslope condition, may be useful for increasing neuromuscular demand. Adjusting slope and load may therefore help optimize NHE progression for injury prevention and rehabilitation.

15:15-15:30

Submission ID: 23 - Influence of EMG-Informed Muscle Activation on Medial–Lateral Knee Contact Force Distribution During Walking in Patients with Knee Osteoarthritis

Momoko Yamagata, Masashi Taniguchi, Masahide Yagi, Shogo Okada, Sayaka Okada, Yoshiki Motomura, Masashi Kobayashi and Noriaki Ichihashi

Abstract: In knee osteoarthritis (KOA), increased co-contraction of knee-spanning muscles during walking has been reported and may contribute to elevated knee contact force. Such co-contraction, particularly involving the lateral knee muscles, may also serve as a compensatory strategy to enhance joint stability. However, its influence on medial-lateral load distribution remains unclear. Sixty-five female patients (mean age: 71 years; Kellgren–Lawrence grades 1, 2, 3, and 4: n = 15, 22, 15, and 13, respectively) with symptomatic medial KOA walked at a self-selected comfortable speed. A motion capture system, force plates, and surface electromyography (EMG) were used to record kinematics, kinetics, and muscle activity. EMG signals were obtained from the rectus femoris (RF), vastus lateralis (VL), biceps femoris (BF), and lateral gastrocnemius (LG). Processed EMG signals were incorporated into an AnyBody musculoskeletal model using an EMG-informed scaling procedure, in which the EMG envelopes were scaled according to the modeled muscle activity profile. Medial and lateral knee contact forces (KCFmed and KCFlat) estimated by the EMG-informed model were compared with those estimated by the default model. To explore the potential role of co-contraction, co-contraction indices were calculated for VL–BF, VL–LG, RF–BF, and RF–LG. Compared with the default model, the first peak of total KCF during stance was significantly greater in the EMG-informed model. Both KCFmed and KCFlat increased; however, the increase was greater for KCFlat than for KCFmed, resulting in a significantly lower medial load ratio and redistribution toward the lateral compartment. In addition, VL–LG co-contraction was significantly associated with the increase in KCFlat, and this association remained significant after adjustment for walking speed. These findings suggest that lateral muscle co-contraction, particularly VL–LG co-contraction, may be associated with increased overall compressive loading during gait and with a relative redistribution of knee loading toward the lateral compartment in patients with KOA.

15:30-15:45

Submission ID: 34 - Computational study on the evolution of cross-shear ratio as function of flexion angle and total knee arthroplasty size

Gusztav Dr. Fekete

Abstract: Abstract:

Osteolysis, triggered by wear debris, still poses a credible threat as a long-term failure mode for total knee arthroplasties (TKAs), therefore deeper understanding of wear mechanism is indispensable. Wear is fundamentally characterized by load, sliding length and wear factor, which considerably depends on the cross-shear ratio (CSR or CS) in case of ultra-high-molecular-weight polyethylene-based (UHMWPE) tibial inserts. Although an accepted, approximate relationship has been established between wear factor and cross shear ratio, it is not analytically or numerically described how cross-shear ratio changes between the contact surfaces during daily movements, such as gait or squat, as a function of flexion angle or time. Only a limited number of studies dealt with quantitative determination of cross-shear ratio in case of different daily- or sport motions, and those studies provided solely averaged results, not flexion or time dependent functions, accordingly the applicability of these results are rather limited. In consequence, the aim of this study is to determine the cross-shear ratio as a function of flexion angle by multibody dynamics (MBD) simulations involving six commercially available, cruciate retained TKAs under standardized gait (following ISO 14243-3 2014) and deep squat motion. As for the results, study numerically demonstrates that cross-shear ratio falls in the range of 0.02-0.08 during gait and squat motion, moreover, the study provides the first time a flexion dependent CRS description, which enables us to use wear factor in a way that CRS is take into account as a flexion-dependent parameter. In summary, the obtained result offer more reliable and punctual way to model wear propagation, while they also reveal that TKA size has considerable effect on CRS, consequently on wear as well.

15:45-16:00

Submission ID: 33 - Cane-handling strategy alters hip loading and gait performance in preoperative hip osteoarthritis

Yuta Chujo, Ryo Kubota, Kimihiko Mori, Shunsuke Kimura, Sota Takehara, Ryota Egashira, Kimitaka Hase and Hirokazu Iida

Abstract: Introduction: Cane use can reduce hip joint loading in hip osteoarthritis (HOA), yet the biomechanical and functional consequences of different cane-handling strategies remain unclear. This study aimed to evaluate how instructed cane strategies affect gait speed and external hip moments in patients with moderate-to-severe HOA (Kellgren–Lawrence grade 3–4).

Methods: Fifty-four patients with HOA (median age 65.5 years; 87% female; KL grade 4: 91%) participated. Participants performed gait trials under four conditions: cane-vertical (CV), cane-propulsive (CP), cane-braking (CB), and no-cane walking (NC). External hip moments were quantified as peak moments and cadence-adjusted cumulative metrics (moment integral × cadence) as a proxy of repeated loading. Condition effects were estimated using linear mixed models with Holm-adjusted pairwise comparisons to accommodate missing values across conditions/outcomes.

Results: CP produced a propulsive cane impulse, whereas CB produced a braking cane impulse. Vertical cane support was comparable across cane strategies. Gait speed was higher in CP than CV (CV–CP: −0.082 m/s; 95% CI −0.119 to −0.044; $p<0.001$) and higher in CP than CB (CP–CB: 0.045 m/s; 0.008 to 0.083; $p=0.005$). Peak hip flexion and adduction moment did not differ among cane strategies; however, all cane conditions showed lower peaks than NC. For cadence-adjusted cumulative loading (moment integral × cadence), cadence-adjusted cumulative hip flexion-moment loading did not differ among cane strategies, whereas cadence-adjusted cumulative hip adduction-moment loading was lower in CP than CV (CV–CP: 21.262, 4.544 to 37.980; $p=0.003$) and lower in CB than CV (CV–CB: 14.751, −1.925 to 31.427; $p=0.039$), and was lower in all cane conditions than in NC.

Conclusion: In KL grade 3–4 HOA, a propulsive cane strategy improves gait speed relative to vertical and braking strategies while maintaining comparable peak frontal-plane hip loading; cadence-adjusted cumulative hip adduction-moment loading was lower in propulsive and braking than vertical cane walking.

Plenary Lecture 3

Date: Tuesday, 6 October 2026

Venue: NAK Auditorium

Time: 16:30 - 17:15

Chair: Benjamin Lee



Ivan GOH

CEO

QuantumTX Pte Ltd

Ivan Goh is the CEO of NUS Medtech spin-off QuantumTX. Driven by the ethos that "Good Business Drives Good Impact from Good Tech", he has spent his career partnering Scientist and Clinicians to bring their life-changing technologies to market. Leveraging experiences in product development, manufacturing, regulatory / clinical affairs, investment / fundraising, business development and building teams, he leads the QuantumTX team towards their mission of creating a World with Zero Muscle Weakness!

Title

MitoCharge Magnetic Muscle – Mitochondria Activation and Healthy Longevity

Abstract:

Healthy longevity depends not only on how long we live, but also on our capacity to remain healthy, active and independent throughout those years. Healthy skeletal muscle and mitochondria are central to this capacity, supporting physical function, energy production and metabolic health. Yet ageing, illness and inactivity can compromise these systems, while pain and frailty may limit participation in the exercise needed to maintain them.

Can magnetic stimulation reproduce some of the biological adaptations associated with physical exercise? Can low-intensity pulsed magnetic fields stimulate mitochondrial signalling and trigger adaptive responses in muscle? These questions underpin the science behind MitoCharge and its potential as a non-strenuous complement to exercise and rehabilitation, particularly when physical activity is constrained.

This session traces the scientific journey behind MitoCharge, from the early observations that sparked the research, through investigations of cellular mechanisms and exposure parameters, to the engineering of a technology for clinical use. It examines current human evidence across older-adult mobility, muscle recovery and musculoskeletal rehabilitation, alongside emerging questions in sports performance, metabolic health and healthy longevity.

Poster Session 1

Date: Tuesday, 6 October 2026 **Venue:** Outside NAK Auditorium

Time: 17:15 – 18:15

17:15-18:15

Submission ID: 112 - Investigating the Effects of IL-11 Neutralising Antibody on Attenuating Smooth Muscle Cell Activation for Potential Stent Eluting against In-Stent Restenosis

Ethen Seah, Yan Jie Yang, Nathanael Yj Koh, Wei Wen Lim and Sheng Jie Lu

Abstract: Background

In-stent restenosis (ISR) following percutaneous coronary intervention is driven by pathological vascular smooth muscle cell (VSMC) phenotypic switching from a quiescent contractile state to a migratory, synthetic phenotype, compounded by endothelial dysfunction that impairs vascular healing. Interleukin-11 (IL-11) has emerged as a convergent downstream effector in fibrotic vascular remodelling, and this study evaluated whether IL-11 neutralisation could simultaneously suppress pathological activation of VSMCs and restore their healthy contractile phenotypic state.

Methods

Human VSMCs were stimulated with PDGF-BB, TGF-β1, and Angiotensin II to model pathological activation. The effect of IL-11 neutralisation was assessed using the anti-IL-11 antibody X203 (2–10 μg/mL) compared to IgG isotype controls. Scratch-wound migration assay, a CCK-8 viability assay, quantitative PCR, Western blotting, immunofluorescence, and ELISA were applied for VSMC function evaluation. Statistical significance was determined by one-way ANOVA (*$p < 0.05$).

Results

X203 dose-dependently attenuated PDGF-BB-induced VSMC migration (wound confluence reduced from ~90% to ~40% at 90 hours, *$p < 0.05$), while promoting recovery of contractile markers (α-SMA/ACTA2, MYH11) and suppressing synthetic markers (COL1A1) at both transcriptional and translational levels.

Conclusion

These findings identify IL-11 as a functionally important mediator of VSMC pathological remodelling in ISR. They support the further development of localised anti-IL-11 delivery via drug-eluting stent coatings as a potential dual-acting therapeutic strategy that targets both restenosis arrest and re-endothelialisation promotion.

17:15-18:15

Submission ID: 64 - Post-Exercise Blood Lactate Recovery Profiles are Independent of Skeletal Muscle Oxygenation Kinetics

Violet Man-Chi Ko, Pui Wah Kong, Chor Hiong Tee, Alfredo Franco-Obregón, Jing Rong Tay, Xin Yue Chong and Stephen Francis Burns

Abstract: Introduction: Skeletal muscle oxygenation (SmO2) and post-exercise blood lactate are key markers for monitoring recovery in sport. This study examined the correlation between Half Time of Recovery (HTR) of SmO2 and blood lactate concentrations after a 30-second maximal cycling (Wingate) test.

Methods: This study was approved by the Nanyang Technological University Institutional Review Board (IRB-2025-575). Thirty young adults (14 males, 16 females) aged 18-30 years who regularly trained at least twice per week were recruited for this study. The data were collected as baseline data for a randomised controlled trial. Participants performed a standard maximal effort 30-second Wingate cycling test, followed by 4 minutes of active recovery. Blood lactate concentrations were measured at four time points: before the Wingate test and at 5, 15, and 30 minutes post-test. Changes in blood lactate concentrations were computed from 5 minutes to 15 minutes post-test (ΔL1) and from 5 minutes to 30 minutes post-test (ΔL2). SmO2 of the right vastus lateralis was monitored using near-infrared spectroscopy to calculate the HTR. HTR was defined as the time from the completion of the Wingate test to the point at which SmO2 reached 50% of its maximum during active recovery. Pearson correlation coefficients were used to assess relationships between changes in blood lactate concentrations (ΔL1, ΔL2) and HTR.

Results: The mean (SD) of ΔL1, ΔL2 and HTR after the Wingate test were -1.13 (2.68) mmol/L, -5.08 (2.40) mmol/L, and 51.0 (46.2) seconds, respectively. There was no statistically significant correlation between ΔL1 and HTR ($r = .351$, $p = .062$) or between ΔL2 and HTR ($r = .248$, $p = .195$).

Conclusions: The absence of any significant correlation between blood lactate concentrations and HTR indicates that post-exercise blood lactate recovery profiles and skeletal muscle oxygenation kinetics are independent in young adults following maximal sprint cycling.

17:15-18:15

Submission ID: 41 - Mechanical Interactions of Granulosa Cells and Their Role in Follicle Growth

Yiwen Tang, Jue Yu Kelly Tan, Kim Whye Leong, Yuting Lou and Chii Jou Chan

Abstract: The growth of mammalian ovarian follicles is essential for successful reproduction and hormone regulation in females. Within the follicle, granulosa cells (GCs) constitute the major cell population, and their microenvironment plays a critical role in determining oocyte quality. As follicles develop from secondary to tertiary stages, they undergo accelerated growth accompanied by pronounced and spatially organized transitions in GC morphology. Recent experiments further demonstrate that modest external compression enhances GC mitosis, reduces apoptosis, and promotes follicle growth, highlighting the importance of mechanical forces in folliculogenesis. However, how mechanical interactions shape the GC morphology and regulate cell-cycle activity remains unclear. Using quantitative 3D imaging and advanced segmentation pipelines, we found that GCs surrounding the oocyte (oocyte-GCs) and those contacting the basement membrane (basal-GCs) in small follicles display strong radial elongation, whereas GCs located between these layers (mid-GCs) remain tangentially elongated. As follicles develop, GCs undergo volume expansion, while both basal- and mid-GCs progressively adopt more isotropic shapes. To understand the underlying mechanics, we developed a 3D Voronoi model that recapitulates GC morphology and infers intrafollicular stress patterns. Our simulations reveal that layer-specific shape indices govern GC elongation, whereas interfacial tension drives the radial elongation of oocyte-GCs and basal-GCs. In addition, by correlating mechanical stress with cell-cycle activity maps, we investigate what and how distinct mechanical factors regulate GC proliferation. Overall, our study provides a simple theoretical framework to investigate the emergence of intrafollicular mechanical stress and the potential feedback between tissue mechanics and cell proliferation in driving robust follicle growth that is essential for ovarian functions.

17:15-18:15

Submission ID: 73 - A bioengineering approach to investigate age-associated mechanical reprogramming of ovarian macrophages during follicular atresia

Neha Paddillaya, Apoorva Shivankar and Chii Jou Chan

Abstract: In mammalian ovaries, follicular atresia is a physiological process involving degenerative loss of follicles throughout development. Efficient clearance and remodeling of apoptotic tissues by immune cells, such as macrophages, is needed to maintain ovarian homeostasis. With aging, the ovary becomes inflamed and undergoes mechanical remodeling. Here, we compare ovarian macrophages from young and aged mice to test whether aging-associated mechanical reprogramming impairs macrophage atretic clearance function using bioengineered ex vivo approaches. Using adhesion-based enrichment verified by fluorescence-activated cell sorting (FACS), we achieved nearly 80% purity in macrophages isolated from ovarian stromal cells (~5000 ovarian macrophages/ovary). We found that aged macrophages showed a larger cell spread area, reduced phagocytosis, increased traction stress, higher cortical tension, and reduced migration compared to young macrophages. These findings suggest that aged macrophages become hyperactivated but are less efficient at reaching and clearing apoptotic targets. We next test the hypothesis that aging-associated macrophage mechanical reprogramming impairs clearance of atretic follicles, and that this dysfunction is further regulated by matrix stiffness. To this end, we will establish a 3D GelMA hydrogel co-culture system combining TNF-α-induced atretic follicles with young or aged macrophages in soft and stiff matrices of 1 kPa and 5 kPa, which mimic changing ovarian stiffness during aging. We will then assess follicle-macrophage contact, macrophage localization, apoptotic cell clearance, and inflammatory remodeling. This work will define how immune cell mechanics regulate follicular atresia and reveal potential misregulation of age-associated immune-ECM crosstalk that contributes to unresolved inflammation and to follicle atresia clearance during reproductive aging.

17:15-18:15

Submission ID: 62 - Uncertainty-Aware Machine Learning for ADMET Prediction to Accelerate Clinically-Relevant Drug Development

Shamieraah Jamal, Tingyang Wei, Paul Ongkowidjaja, Angela Huiyun Moh, Janice Jia Ni Goh, Zhao Wei and James Lu

Abstract: Early-stage drug attrition due to poor pharmacokinetic and toxicity profiles remains a central challenge in drug development, with failures in absorption, distribution, metabolism, excretion, and toxicity (ADMET) accounting for a significant proportion of costly late-stage clinical withdrawals. Computational models that accurately predict these properties from molecular structure which can assess their own uncertainty offer a principled route to integrate biochemical assay data into actionable decisions. We present a suite of machine learning models for ADMET endpoint prediction, encompassing both classification and regression tasks. Quantitative structure-activity relationship (QSAR) analysis forms the methodological backbone, enabling systematic mapping of molecular features to biological activity. To mitigate data leakage and ensure realistic generalisability, we employ molecule-aware splitting strategies that respect chemical similarity boundaries during train-test partitioning. Our models leverage pretrained molecular representations, subsequently fine-tuned on task-specific assay data, capturing both broad chemical space priors and endpoint-specific patterns. Critically, each model is equipped with calibrated uncertainty quantification (UQ), enabling reliable confidence estimates across both classification endpoints (e.g. cytotoxicity prediction) and regression endpoints (e.g. microsomal clearance, a key determinant of hepatic drug metabolism). These calibrated uncertainty estimates directly enable active learning loops, whereby the model identifies high-uncertainty, high-value compounds for experimental prioritisation, creating an efficient feedback cycle between computational prediction and wet-lab assay. For medicinal chemists and drug developers alike, this framework provides a transparent, trustworthy decision-support layer: one that not only predicts whether a candidate molecule is likely safe and metabolically stable, but quantifies how confident that prediction is, enabling more informed, risk-stratified progression decisions throughout the drug discovery pipeline.

17:15-18:15

Submission ID: 42 - Application of Patient Journey Prediction Using an Object Tracking System Based on Transformer

Yuya Gushiken, Reiya Shimura, Takenobu Ike, Ryogo Suzuki, Koya Takahashi and Noriko F. Hiroi

Abstract: In this study, we applied a transformer-based object tracking system to predict medical history by training the system using health information obtained from blood tests and other sources as non-linguistic time-series vectors. The training dataset comprised 37,800 points spanning approximately 60 years for 1,000 individuals across 4 variables. After training, 10-year predictions were made based on 11 years of new data, estimating 21-year trajectories indicating the patient group to which the prediction results belonged. For the classification of patients, we applied UMAP. Furthermore, a function was implemented to provide health advice via LLM based on the predicted data.

We aimed to build a system that can be trained with healthcare data, predict long term futures for unknown data, and provide a set of healthcare advice based on the predictions. Our developed system could achieve those objectives.

Such platforms can be the foundation for tools that will aid AI-powered, individualized pre-disease management in the future.

17:15-18:15

Submission ID: 40 - Characterisation of metal-oxidisation bacterial cytochrome for the search of new candidates of conductive materials

Masato Kanzaki, Soya Kakizaki, Sora Endo, Katsunmasa Kamiya and Noriko F. Hiroi

Abstract: Biogenic conductive materials and magnetic sensors, which are expected to become available through the application of functional proteins, are attracting attention in the fields of economy, environmental conservation and the development of new technologies because of their potential for domestic production of new resources to replace mineral resources, their compatibility with the natural environment and their high functionality, which cannot be expected when elements are used as they are. It is attracting attention in economic, environmental protection, and new technology development for these reasons. Metal-reduction bacteria possess multi-heme cytochromes in their outer membrane, which are functional proteins capable of transporting electrons to external electron acceptors. It has been suggested that these proteins increase the efficiency of electron transfer through the control of electron spin orientation, which could lead to their application as novel conductive materials.

This study aims to identify novel proteins sharing structural features within the homol- ogous gene family of polyhem cytochromes found in metal-respiring bacteria, specifically focusing on those with high electron spin orientation capability.

Molecular dynamics analysis based on the three-dimensional structure has been con- ducted for one of the polyhem cytochromes of Schwannella oneidenensis. The same anal- ysis was performed on a polyhem cytochrome from a closely related species identified through primary sequence search and found to share high overall homology. A com- parison of the three-dimensional structural features between the two proteins was then conducted.

17:15-18:15

Submission ID: 106 - Provisional Stenting: Side Branch Ostia Opening or Not?

Shaoliang Shawn Lian, Pawel Gasior, Jaryl Ng, Wojciech Wojakowski, Nicholas Fion, Hui Ying Ang and Shengjie Lu

Abstract: BACKGROUND: Percutaneous Coronary Intervention (PCI) for bifurcation lesions remains challenging. Overhanging struts in front of the side branch ostium (SBO) are thought to act as a focal point for thrombi formation and consequently possible stent thrombosis. However, SBO opening has failed to show a benefit in some clinical trials when comparing patients with KBI vs those without KBI. Recent technological advances make it possible to achieve almost-zero floating struts by provisional stenting a dedicated bifurcation stent without SB dilation.

METHODS: Bifurcation dedicated DES (n=5, Bioss LIM C, Balton) and three conventional DES (Ultimaster, Terumo; Xience Sierra, Abbott; Biomime, Meril; n=5 for each) were chosen and deployed in bifurcation silicone vessel models. Xience Sierra were used to compare different stenting techniques, KBI and KIO approaches. All the devices were implanted with proximal optimisation using a 5.5 semi-compliant balloon at 14atm, ensuring expansion (confirmed by OCT), and then perfused with porcine blood in a flow loop for up to 60 minutes. Subsequently, strut apposition and thrombus formation at the SBO were analysed using OCT pullback and immunofluorescence.

RESULTS: OCT strut analysis demonstrated that the Bioss stent has a significantly lower percentage of floating struts than other DESs (0.0 (0.0-0.7) vs 12.7 (12.0-13.6) Ultimaster vs 14.5 (11.6-16.4) Xience vs 17.2 (15.3-18.5) Biomime, P <0.05, Table 1) and when comparing between 0.0 (0.0-2.7) Bioss vs 3.8 (3.5 – 5.1) KBI vs 15.9 (13.0 -17.7)_ KIO (Table 2).Correspondingly, a trend toward reduced SBO thrombus formation with the Bioss stent compared to other DESs (Figure 1) and in other stenting techniques (Figure 2).

CONCLUSIONS: In vitro perfusion models demonstrated that reducing floating struts like in Bioss may attenuate acute thrombogenicity at SBO.

CLINICAL IMPLICATIONS: The study will help cardiovascular clinicians better understand the performance of the dedicated stent and the provisional stenting technique.

17:15-18:15

Submission ID: 61 - Peak Power Output During a 30-second Wingate Cycling Sprint is Correlated with the Change in Skeletal Muscle Oxygen Saturation

Pui Wah Kong, Violet Man-Chi Ko, Chor Hiong Tee, Alfredo Franco-Obregón, Jing Rong Tay, Xin Yue Chong and Stephen Francis Burns

Abstract: Introduction: Anaerobic capacity and localised muscle haemodynamics are essential to high-intensity athletic performance. This study investigated the correlation between 30-second maximal sprint cycling (Wingate) performance outcomes and skeletal muscle oxygenation (SmO2) kinetics.

Methods: Approved by the Nanyang Technological University Institutional Review Board (IRB-2025-575), this study recruited 30 participants (14 Males, 16 Females) aged 18 to 30 years who exercised at least twice per week as part of a randomised controlled trial. Participants completed a standard 30-second Wingate test. Anaerobic performance outcomes analysed were relative peak and mean power output, and rate of fatigue. Simultaneously, muscle oxygenation of the right vastus lateralis was monitored using near-infrared spectroscopy to extract two kinetic variables: the change in muscle oxygenation from baseline to the lowest SmO2 (ΔSmO2), and the Half Time of Recovery (HTR). Pearson correlation analyses were conducted to assess the relationships between Wingate performance and muscle oxygenation variables.

Results: Relative peak and mean power output and rate of fatigue over the 30 seconds were: [mean (SD)] 9.23 (2.55) W/kg, 6.99 (1.38) W/kg and 40.6 (12.2)%. The analysis revealed statistically significant correlation between peak power output and ΔSmO2 ($r = .369$, $p = .049$) but not HTR ($r = -.078$, $p = .687$). There was no significant correlation between mean power output and HTR ($r = -.058$, $p = .766$), or between mean power output and ΔSmO2 ($r = .348$, $p = .065$). Rate of fatigue did not significantly correlate with ΔSmO2 ($r = .222$, $p = .246$) or HTR ($r = .143$, $p = .459$).

Conclusions: The positive correlation between peak power output and changes in muscle oxygen saturation suggests that an individual's capacity to generate maximal anaerobic power is linked to localised muscle oxygen extraction and depletion.

17:15-18:15

Submission ID: 20 - Associations between hamstring mechanical properties and muscle recruitment during jumping in male athletes

Amornthep Jankaew, Yih-Kuen Jan and Cheng-Feng Lin

Abstract: Introduction: It is unclear whether the mechanical properties of the hamstring have a relationship with hamstring recruitment during jump-landing, a common task in sports activities. Thus, this study aimed to investigate the correlations between hamstring properties and recruitment during jumping in healthy male athletes.

Methods: 38 athletes from various sports (age: 22.4±2.8 years) were recruited. Hamstring mechanical properties (tone, stiffness, elasticity, relaxation, and creep) were assessed by the Myoton Pro Device at the hamstrings of the dominant leg. EMG electrodes, attached to the lateral hamstring (LH) and medial hamstring (MH) of the dominant leg, were recorded during squat jump (SJ) and countermovement jump (CMJ). Hamstring recruitments were analyzed using wavelet analysis methods during takeoff, flight, and landing phases, and the mean frequency of the wavelet was reported to indicate recruitment levels.

Results: There was a correlation between tone and LH recruitment in both SJ (r=0.329) and CMJ (r=0.413), and between creep and LH recruitment in both jumps (SJ: r=-0.415, CMJ: r=-0.339) during takeoff. Similarly, these patterns persisted in the flight phase (r=0.435 and -0.329 for the SJ, and r=0.437 and -0.348 for the CMJ). Negative correlations were observed between relaxation and LH recruitment (SJ: r=-0.327, CMJ: r=-0.374), and between creep and LH recruitment in both jumps (SJ: r=-0.355, CMJ: r=-0.411) during the landing phase.

Discussion: Hamstring mechanical properties are associated with hamstring recruitment during jumping. Positive correlations suggest that higher muscle tone and stiffness may facilitate increased LH activation during takeoff and flight, potentially supporting force transmission and jump performance. In contrast, consistent negative correlations between muscle recruitment and both relaxation time and creep indicate that lower recruitment is associated with reduced viscoelastic resistance, particularly during landing tasks requiring rapid force modulation. Thus, hamstring mechanical behavior should be considered in training, as it contributes to neuromuscular strategies during jumping.

17:15-18:15

Submission ID: 36 - Evaluating the effect of varying pinhole configuration in unicompartmental knee arthroplasty: A finite element study

Hongxuan Lyu, Pivatidevi Pareatumbee, Andy Yew, Siaw Meng Chou, Sheng Xu, Hee Nee Pang, Lincoln Liow, Seng Jin Yeo and Eric Liu

Abstract: Despite unicompartmental knee arthroplasty (UKA) high success rate, complications such as tibial plateau fractures continue to be seen clinically. We hypothesize that pin holes from the cutting jig may play a part in such fractures. We aimed to investigate the effect of varying pinhole configuration on the bone stresses in the knee joint following UKA, and to identify the optimal pinhole configuration.

CT and MRI scanning of a cadaveric knee specimen and image segmentation were performed to create three-dimensional (3D) models of the cortical and cancellous bone and soft tissue models. Digital models of a UKA implant were obtained via laser scanning. Linear isotropic material properties were applied to the bone and implant. Virtual implantation of the UKA implant was performed to create the bone-implant assembly. Using the surgical jig as reference, the control pinhole configuration was created and varied with an angular rotation of 45 degrees in the clockwise direction to create two other variations. An axial compressive force, 2000 N, was applied to the proximal femur with the distal tibia fixed and static FE analysis was conducted. Intact model validation was performed by comparing the experimental and computational strains.

Peak stress on the intact tibia is 15.8 MPa. For variations 1, 2 and 3, maximum von Mises stress of 81.6 MPa, 58.9 MPa and 50.3 MPa occurring on the inner surface of the medial pinhole were predicted. Despite similar location of stress concentration in implanted models, a noticeable reduction in the peak stress change of 38.4% relative to control was observed in variation 3.

In conclusion, the inner surface of the medial pinhole remains the most critical region for stress concentration with variation 3 being the optimal configuration. This suggests that lowering the medial pinhole position reduces tibial stresses, and can potentially decrease risk of failure post-operatively.

17:15-18:15

Submission ID: 44 - Establishment of Maxillary Basal Arch Three-Dimensional Norms in Taiwanese Young Adults: A Cone-Beam Computed Tomography Study

Chih-Yu Chang, Jian-Hong Yu and Jui-Ting Hsu

Abstract: Orthodontic diagnosis and treatment planning rely heavily on the morphology of the maxillary basal arch; however, in Taiwan, there is a lack of localized anatomical norms for the basal arch, and traditional measurements are often confounded by dentoalveolar compensation. This study aimed to establish a three-dimensional (3D) database of the maxillary basal arch for the Taiwanese young adult population using cone-beam computed tomography (CBCT) and to investigate its sexual dimorphism. CBCT images of 60 Taiwanese subjects (30 males and 30 females, aged 18–30 years) were collected at the Department of Dentistry, China Medical University Hospital. Using Mimics software, the center of resistance was identified at the level of the root furcations for the first and second molars, and at 61.5% of the total tooth length for the canines, to determine the maxillary basal arch width. Additionally, palatal height was measured from the plane defined by the cemento-enamel junction line. Data normality was confirmed using the Kolmogorov-Smirnov test, and sex-related differences were analyzed using the independent Student's t-test. Results showed that the 3D anatomical norms for the Taiwanese population were successfully established, and significant sexual dimorphism was observed across all dimensions ($p < 0.05$). Males exhibited significantly larger basal arch widths at the canines, first molars (49.72 ± 2.73 mm vs. 46.87 ± 3.10 mm), and second molars, as well as a significantly greater palatal height at the first molar region (13.00 ± 2.71 mm vs. 11.22 ± 2.23 mm) and second molar region compared to females. In conclusion, this study establishes 3D anatomical norms for the maxillary basal arch in Taiwanese young adults. The significant gender differences suggest that clinicians should consider sex-specific benchmarks and biomechanical limits, particularly in females with narrower basal dimensions, to optimize orthodontic treatment outcomes.

17:15-18:15

Submission ID: 54 - Investigating the Effect of Confinement on Cell Cycle

Hannah A. Yuson and Andrew Holle

Abstract: The physical microenvironment of cells plays a crucial role in regulating cellular behaviour, including proliferation, differentiation, and genome stability. In physiological and pathological contexts such as cancer invasion, immune cell trafficking, and tissue regeneration, cells frequently experience spatial confinement that imposes mechanical stress on intracellular structures, particularly the nucleus. While prior work has established that bi-axial physical confinement reduces division frequency and arrests cells in S/G2/M, and that confinement-induced mitotic perturbation causes heritable chromosome loss, these studies examined cells within confining spaces or under uniform compression. It remains unknown whether cells spatially modulate their division decisions in response to impending confinement, that is, whether a cell, when approaching a channel whose width limits mitotic rounding, will preferentially divide before entry rather than inside it.

Using live cell imaging of confined migration, we observed that cells migrating in a PDMS microchannel device with varying widths show a striking spatial bias: in 3 micron channels, cells divide significantly more often before entering the constriction, whereas no spatial bias was observed in the 20 micron channels. This suggests a threshold-dependent spatial decision mechanism that is absent in wider, non-constrictive geometries.

Understanding how cells spatially navigate division decisions under confinement is important because metastatic tumor cells encounter narrow interstitial tracks and pores during dissemination. Where a cell chooses (or is forced) to divide could influence where secondary tumors seed, and identifying the width threshold that triggers this spatial bias may reveal targetable mechanosensing pathways that control proliferation during invasion.

Wednesday, 7 October 2026

Keynote: Assistive Robotics & Neurorehabilitation (WeA1NAK)

Date: Wednesday, 7 October 2026

Venue: NAK Auditorium

Time: 09:00 - 10:30

Chair: Jaichandar Kulandaidaasan Sheba



Raye YEOW

Dean's Chair Professor
National University of Singapore

Raye Yeow received his PhD in Bioengineering (NUS) in 2010, and his post-doctoral training in BioRobotics (Harvard University) from 2010-2012. He is a Dean's Chair Professor and Deputy Head (Outreach & Industry) with the Department of Biomedical Engineering and Advanced Robotics Center, NUS, and the President of the Biomedical Engineering Society (Singapore). He was the Program Lead for the Soft and Hybrid Robotics Program under the National Robotics Programme Office in Singapore. He was a Visiting Professor at Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology in 2023. His research group specializes in soft robotics, with focus on fundamental mechanisms and building market-ready systems. He has published >200 journal and conference papers, with >40 research and innovation awards, and co-founded 6 soft robotics/AI startups that are translating his technologies into the healthcare, food assembly, logistics and maritime sectors.

Title

Soft Robotics Meets Human Biomechanics

Abstract:

The human body achieves remarkable movement through the coordinated interaction of muscles, joints, soft tissues, and sensory feedback, yet conventional robots remain fundamentally different in how they generate and interact with motion. Soft robotics offers an opportunity to bridge this gap by designing machines that conform to the body, accommodate its natural biomechanics, and deliver assistance through safe and compliant physical interaction. In this keynote, I will discuss how principles of human biomechanics can inform the design, sensing, control, and evaluation of soft robotic systems for healthcare and human augmentation. Drawing on our work in wearable robotics, I will illustrate how biomechanical understanding of the hand and upper limb can guide the development of soft robotic devices for rehabilitation and movement assistance, and how sensing and human–robot interaction can enable assistance to become increasingly responsive to individual movement and functional needs. I will also discuss the emerging convergence of biomechanics, wearable sensing, and artificial intelligence, where multimodal information about human movement can enable robots to better understand the person they are assisting and adapt their behaviour accordingly. Ultimately, bringing soft robotics and human biomechanics together provides a pathway toward a new generation of human-centered machines that do not simply move the body, but work with its mechanics to restore, augment, and better understand human movement.

Assistive Robotics & Neurorehabilitation (WeA1NAK)

Date: Wednesday, 7 October 2026 **Venue:** NAK Auditorium

Time: 09:30 – 10:30 **Chair:** Jaichandar Kulandaidaasan Sheba

09:30-09:45

Submission ID: 75 - Effect of Hip Abduction Assistance on Hip Joint Contact Force During Walking: A Pilot Study

Linghui Xu and Elena Gutierrez Farewik

Abstract: Hip abductor muscles stabilize the pelvis and maintain balance during the single-limb support phase of gait. In individuals with mild-to-moderate hip osteoarthritis, pain often leads to compensatory strategies that reduce the mechanical burden on the joint by decreasing the demand on the hip abductors. This results in functional muscle weakness and further deterioration of hip strength. While exoskeletons are emerging as a tool to support walking, their influence on internal hip loading remains poorly understood. This pilot study aimed to quantify the effects of hip abduction assistance on hip contact force in a healthy group. Participants walked on an instrument treadmill at a constant speed under two conditions: with shod-only and with active hip abduction assistance. A customized soft hip exosuit was used during the test that provided bilateral hip abduction assistance during walking via Bowden cables driven by remote motors. Kinematics were recorded by a motion capture system at 100 Hz, and ground reaction forces were collected using force plates at 1000 Hz. A full-body musculoskeletal model was scaled to represent participant's anthropometry, and the measured bilateral cable forces were modeled as external forces applied to the device contact locations on the thigh and pelvis. Muscle forces and compressive hip contact force were estimated by solving the muscle redundancy problem. Preliminary results from an initial participant suggest that hip abduction assistance, equivalent to 10% of the peak biological torque, reduced peak and average stance-phase hip contact forces by approximately 15% and 10%, respectively. Data collection and process are ongoing. Our initial results demonstrate the potential for hip abduction assistance to offload the hip joint by reducing stabilizing muscle demand. These preliminary data provide a foundation for further exploring hip abduction assistance as a non-invasive strategy to manage hip joint loading.

09:45-10:00

Submission ID: 78 - Ankle Exoskeleton Assistance for Walking Economy and Knee Joint Load Reduction

Yuanyang Zhang, Israel Luis Pena and Elena Gutierrez Farewik

Abstract: Ankle exoskeletons can reduce the metabolic cost of walking by assisting plantarflexion during push-off, but their effects on knee joint loading remain insufficiently understood. This study investigates how ankle assistance designed for different biomechanical objectives affects walking economy and knee joint loading. Specifically, we compare ankle exoskeleton torque profiles optimized to minimize whole-body metabolic cost with profiles optimized to minimize knee contact force.

A simulation-informed experimental framework was used. First, a bilevel optimization approach was applied to predict objective-specific ankle assistance profiles across walking speeds. The outer loop optimized the timing and magnitude of an idealized ankle torque profile, while the inner loop solved the muscle redundancy problem using inverse simulation. Metabolic cost was estimated using a muscle energetics model, and knee contact force was estimated through musculoskeletal joint reaction analysis. This process generated assistance profiles corresponding to distinct objectives and walking speeds.

These simulation-derived profiles were then implemented on an ankle exoskeleton and tested in healthy adults. Participants completed familiarization sessions followed by an experimental evaluation including no-exoskeleton, zero-torque, metabolic-minimization, and knee-load-minimization conditions at selected walking speeds. During walking, motion capture, ground reaction forces, electromyography, and metabolic data were collected.

The ongoing analysis will quantify how objective-specific ankle assistance influences net metabolic cost, lower-limb muscle activity, joint mechanics, and estimated knee contact forces. By combining predictive musculoskeletal simulation with human-exoskeleton experiments, this study provides a framework for evaluating whether ankle assistance can be designed to address both energetic demand and knee joint loading. This approach may inform future multi-objective exoskeleton control strategies for individuals with knee osteoarthritis and other populations where both mobility and joint health are clinically relevant.

10:00-10:15

Submission ID: 102 - Toward Closed-Loop VR Neuro-Rehabilitation: A Pace-Adaptive Mirror Therapy System with EEG-Based Engagement Monitoring

Tharun R. Ragav, Che-Wei Lin and Kavitha Anandan

Abstract: Conventional mirror therapy is widely used for upper-limb rehabilitation in hemiplegic patients, but it offers limited feedback, low task adaptability, and little objective monitoring of patient engagement. To address these limitations, we present a Virtual Reality Mirror Therapy (VRMT) system that combines immersive interaction with neurofeedback-informed adaptation. The system is built in the Unity game engine, using animation, text, and audio to render a virtual coach that demonstrates exercises for the patient to imitate. To improve task adherence, the coach is pace-adaptive: it monitors the user's real-time hand velocity and replays each demonstration faster or slower to match the patient's movement speed. To extend the system toward cognitive-state monitoring, we additionally classify electroencephalography (EEG) signals from the PhysioNet Motor Movement/Imagery dataset. Raw EEG is preprocessed to remove artefacts through filtering and feature extraction, then classified with a Support Vector Machine (SVM), achieving 72% accuracy for engagement-state detection and 78.1% for movement laterality. These results indicate that EEG-derived indicators of engagement and fatigue can, in principle, drive more responsive pacing and neurofeedback visualisation. By integrating motor-performance tracking with offline EEG-based cognitive-state classification, this work establishes a foundation for closed-loop VR neuro-rehabilitation. Future work will integrate a real-time EEG headset, a therapist analytics dashboard, and a home-based rehabilitation platform for hemiplegic patients.

10:15-10:30

Submission ID: 82 - TremorSense: An Intelligent and Adaptive Glove for Speech-Guided Tremor Suppression in Parkinson's Disease

Hareesh Karthikeyan G, Nitiswaar S, Shanmuga Priya J, Dr. Kavitha G and Renu Deepthi A

Abstract: Parkinson's disease tremors (3–7 Hz) severely impair activities of daily living (ADL) like eating and drinking. TREMORSENSE is presented as an embedded AI-driven wearable integrating inertial sensing, speech-guided task selection, multimodal biofeedback, and proportional vibrotactile control for real-time tremor stabilization.

An ESP32-S3 microcontroller fuses continuous MPU6050 IMU and MAX9814 microphone data. A dataset comprising 1,361 segmented IMU samples was collected from normal and simulated Parkinsonian activities to construct the physical motion profiles. Tremor dynamics are processed via a rolling-window architecture (256 samples, 50-sample overlap) to extract 50 time-domain and 3 frequency-domain features. To enable hands-free control, a 16 kHz speech recognition subsystem uses vowel-triggered commands to activate specific ADL modes. This audio classifier was trained on 1,080 augmented samples using 80 cepstral, 28 spectral, 24 chroma, and 3 temporal features.

Embedded classification utilizes a Random Forest model, selected specifically for its superior real-time robustness. Tremor detection is fortified via hybrid confidence, persistence, and frequency-band filtering. Actuation relies on adaptive proportional PWM control, dynamically modulating vibrotactile intensity up to 160 levels based on tremor severity and the speech-selected task. Localized LEDs and micro-speakers provide real-time multimodal state confirmation for elderly users.

The deployed Random Forest model achieved a 97% validation accuracy, outperforming both the SVM (93%) and XGBoost (90%) classifiers. Experimental testing confirmed stable detection within the 4–6 Hz range, smooth actuator transitions without oscillations, and effective false-positive reduction.

The integration of edge-AI, task-specific vibrotherapy, and multimodal biofeedback allows TREMORSENSE to offer a scalable, low-cost framework for intelligent wearable tremor assistance. Furthermore, this architecture establishes a reliable foundation for future closed-loop neurorehabilitation applications.

Computational Tools, AI/ML & Biomedical Data (WeA1L1S1)

Date: Wednesday, 7 October 2026 **Venue:** L1-S1

Time: 09:00 – 10:30 **Chair:** Liu Nan

09:00-09:15

Submission ID: 31 - A Modular Audio Forensic Pipeline for Deepfake Detection, Speaker Impersonation, and Tampering Localisation

Ebenezer Priya, Aditi Sagesh, Harees Raja M B and Harini Sri R

Abstract: The rapid development in neural text-to-speech and voice cloning technologies has far exceeded the forensic capability of reliably detecting synthetic versus natural speech. Although state-of-the-art anti-spoofing solutions are robust, they lack an important aspect since their operation is within a binary classification paradigm that does not localise the tampering nor provide reasons for classification. This work develops a multi-expert forensic system in which the process is decomposed into three streams: speech recognition, transcription veracity, and spectral forgery, followed by a stacking ensemble. The forensic usability of the system has also been discussed in this paper, which provides three independent forensic evidence streams and the explicit boundary estimates of the tampering segment. Under constrained conditions, the system reports 89.3% accuracy and an AUC of 0.912; under real audio conditions, the system achieves 82.1% accuracy and an AUC of 0.871 on the VCTK, LibriSpeech, and ASVspoof 2019/2021 datasets.

09:15-09:30

Submission ID: 46 - Domain-Aware Deepfake Detection: A Lightweight Heterogeneous Ensemble Approach for Generative Artifacts

Priya E, Praveen V, Muthu Selvan V and Vijay Srinivas R V

Abstract: The rapid proliferation of high-fidelity generative AI models has rendered traditional image forensics increasingly inadequate, creating an urgent need for detection mechanisms that balance accuracy with computational efficiency. To address this challenge, a Lightweight Heterogeneous Ensemble System is proposed, decomposing the detection task into three domain-specific experts: a MobileNetV2-based object specialist and two EfficientNetB0-based experts dedicated to scene context and generative art analysis. The outputs of these experts are fused through a weighted soft-voting strategy enhanced with Test-Time Augmentation (TTA). Experimental evaluation across heterogeneous datasets demonstrates that the proposed system achieves an Area Under the Curve (AUC) of 0.866. Notably, the Scene Expert independently attains approximately 92% accuracy in detecting environmental inconsistencies while maintaining a parameter count nearly 60% lower than conventional monolithic baselines. These results indicate that domain-aware, lightweight ensemble architectures offer a scalable and computationally efficient solution for modern media forensics, supporting the feasibility of deepfake detection in resource-constrained edge environments.

09:30-09:45

Submission ID: 7 - MatRad-OIDS: an open-source tool for segmenting microscopy 3D images and extracting IBSI-compliant radiomic features

Mariachiara Stellato, Giovanni Pasini, Elisa Missori, Daniel Remondini, Marco Calvaruso, Jae-Chul Pyun, Gastone Castellani, Alessandro Stefano and Filippo Piccinini

Abstract: Radiomic analysis of 3D multicellular cultures is emerging as a powerful tool for quantitative characterization of complex cellular models. The list of features that can be extracted from 3D images, alongside their specific mathematical equations, has been validated since 2016 by the International Image Biomarker Standardisation Initiative (IBSI) to ensure comparability between different analysis. The aim of this work is to create user friendly, open-source software for radiomic analysis of 3D cell culture images tailored to support both experts and non-experts' users in the whole analysis framework, from segmentation to classification models following the IBSI standard. MatRad-OIDS is a MATLAB-based, open-source tool created to analyse z-stack images of 3D cell cultures acquired with a confocal or light-sheet fluorescence microscope. The software allows to visualize TIF/TIFF multilayer images, segment them with manual, semi-automatic and automatic methods, extract and reduce IBSI compliant features and train classification models based on the features extracted. MatRad-OIDS has been validated on two different datasets of microscopy images composed, respectively, of 3D spheroids and mesenchymal single cells z-stacks. Both the segmentation performances and the extracted features compliance with the IBSI initiative have been tested. The results showed high goodness in the segmentation (with an average JI of 0.8 ± 01) and complete conformity with the IBSI standard. The output of the analysis is automatically saved in a designated folder where the segmentation masks, the reduced and extracted features, the classification models and the user parameters are stored to guarantee complete repeatability of the radiomic workflows. MatRad-OIDS offers a comprehensive and easily accessible platform for radiomic analysis of 3D multicellular cultures of different types, improving the integration between acquisition, segmentation, feature extraction and classification. MatRad-OIDS MATLAB source code, standalone Windows, MacOS and Linux applications, video tutorial, user documentation, and sample datasets are publicly available at: https://github.com/research-giovap/MatRad-OIDS/.

09:45-10:00

Submission ID: 90 - An Optimized Hybrid Deep Learning Framework for Automated Acute Lymphocytic Leukemia Detection with Twin-SVM Classification

Alagu S and Thamil Selvi J

Abstract: Acute lymphocytic leukemia (ALL) is a life-threatening hematological malignancy that requires early and accurate diagnosis for effective treatment and improved patient survival. In this work, a modified multi-branch deep learning framework is proposed for the automated identification of ALL using microscopic blood smear images. The input images are collected from four publicly available benchmark datasets to enhance the diversity and robustness of the proposed model. To overcome the issue of class imbalance, the Synthetic Minority Over-sampling Technique (SMOTE) and image augmentation methods are employed. Initially, the nucleus region of white blood cells is segmented using the ResU-Net architecture, as significant morphological variations in the nucleus are commonly observed in ALL patients. Subsequently, multiple deep learning models are utilized to extract discriminative deep features from the segmented images. The extracted features are concatenated to form a comprehensive feature vector for classification. To reduce redundancy and improve feature relevance, feature selection is performed using Maximum Relevance Minimum Redundancy (mRMR) and Least Absolute Shrinkage and Selection Operator (LASSO) techniques. Further optimization of the selected features is carried out using the Moth-Flame Optimization (MFO) and Whale Optimization Algorithm (WOA). Statistical significance analysis of the extracted features is evaluated using the ANOVA test. Experimental results indicate that WOA provides superior optimization performance compared to MFO. The optimized features are then classified using K-Nearest Neighbor (KNN), Support Vector Machine (SVM), and Twin Support Vector Machine (Twin-SVM) classifiers. Among these, the Twin-SVM classifier achieves the highest classification accuracy of 98.28%. The proposed system can assist pathologists in the efficient detection of leukemia cells and support accurate clinical decision-making.

10:00-10:15

Submission ID: 104 - Automated Multi-Contrast Thigh MRI Phenotyping with IMAT and IMF Quantification Using 2.5D Deep Learning

Arvind Channarayapatna Srinivasa, Erwan Lecesne, Choo Yu Liang, Sai Sriya Poluri, Jia Qian Chia, Jordan Sim Zheng Ting, Wee Shiong Lim and Justin Chew Linghui

Abstract: Purpose: To develop and evaluate a fat-fraction-guided 2.5D deep learning framework for fine-grained multi-contrast thigh MRI segmentation and automated quantification of intermuscular adipose tissue (IMAT) and intramuscular adipose tissue (IntraMAT).

Materials and Methods: The dataset comprised 80 community-dwelling older adults with a mean age of 67.2 ± 5.8 years, of whom 705% were female. Participants underwent thigh MRI using 3D modified Dixon T1-weighted gradient-echo and axial HASTE sequences on a 3T Siemens MAGNETOM Vida scanner. Fifty expert-annotated studies were used for model development and evaluation. Multi-contrast inputs included fat, water, in-phase, and fat-fraction images. The segmentation task comprised 50 anatomical and tissue classes, including bilateral pelvic and thigh muscles, subcutaneous adipose tissue (SAT), IMAT, IntraMAT, and bone. A 2.5D DeepLabV3+-HRNet model incorporated adjacent axial slices to provide through-plane contextual information while preserving slice-wise computational efficiency. The fat-fraction channel provided quantitative lipid-distribution information, supporting separation of adipose tissue between muscle groups from adipose tissue within muscle compartments. Performance was assessed using Dice similarity coefficient (DSC), 95th percentile Hausdorff distance (HD95), and average symmetric surface distance, and compared with 3D SwinUNETR and 3D full-resolution U-Net baselines.

Results: The proposed model achieved DSCs of 0.934 for IMAT, 0.895 for IntraMAT, and 0.990 for SAT. Corresponding HD95 values were 1.36 mm, 1.49 mm, and 1.26 mm, respectively. Compared with 3D baselines, the 2.5D model showed improved accuracy for adipose-tissue targets while maintaining efficient inference.

Conclusion: Fat-fraction-guided 2.5D multi-contrast thigh MRI segmentation enables accurate muscle-adipose phenotyping and automated IMAT/IntraMAT quantification for musculoskeletal and cardiometabolic imaging.

10:15-10:30

Submission ID: 121 - Analysis of morphological changes in precancerous cervical cells using Segment Anything Model approaches

Praveen Kumar Govarthan, Deeksha Sivakumar, Saiyugan Jegan, Nithiyasri Chakravarthy, Keerthana Kumar, Sakthi Pugazhendhi, Gunasekaran Kamalakaran, Arun Vishal Prabakaran and Ramakrishnan Swaminathan

Abstract: This study investigates the morphological and biomechanical effects of perinuclear halo formation in cervical precancerous cells using semi-automated image analysis. For this, Pap smear images of superficial squamous epithelial and precancerous koilocytotic cells are used, and image features are extracted. Pap smear images preserve individual cell morphology, enabling direct quantitative analysis. A quantitative set of exclusion criteria is established to ensure unbiased and representative sampling. The selected images are then converted to grayscale. The Segment Anything Model 3 (SAM3) is explored for semi-automated segmentation of the perinuclear halo region using point prompts selected for prompt-guided segmentation capability, adaptability to diverse cellular morphologies, reduced annotation requirements, and the ability to delineate irregular boundaries. However, challenges such as prompt sensitivity and dependence on image quality are observed. Following segmentation, area-based ratiometric parameters such as halo/nuclear ratio (H/N), halo/cell ratio (H/Cell), and halo/cytoplasm ratio (H/C) are extracted and analyzed. Results show that the SAM-based image processing pipeline demonstrated the ability to differentiate koilocytotic cells from superficial squamous cells. The H/C ratio is found to be the most significant discriminating parameter, with koilocytotic cells showing markedly larger size than superficial cells ($p < 0.05$). Nuclear enlargements are confirmed by a tenfold increase in the nucleus-to-cytoplasm ratio ($p<0.05$). These findings indicate the presence of nuclear enlargement accompanied by perinuclear clearing, which suggests structural decoupling and mechanical remodeling of the cytoplasmic architecture. The observed morphological trends reflect progressive deterioration in cytoskeletal integrity, intracellular force transmission, and cell mechanical stability. As the perinuclear halo formation is associated with a reduction in cellular mechanical stiffness, the proposed pipeline appears to be clinically useful for automated diagnosis of precancerous conditions in cellular images.

Neuroengineering & BCI II: Cognitive, Psychiatric & Developmental Signals (WeA1L1S2)

Date: Wednesday, 7 October 2026 **Venue:** L1-S2

Time: 09:00 – 10:30 **Chair:** Mengjiao Hu

09:00-09:15

Submission ID: 9 - Multidomain EEG Biomarker Analysis for Major Depressive Disorder Detection

Ahana Priyanka, Sneka Nandhini Ramesh, Neeraja R and Kavitha Ganesan

Abstract: Major Depressive Disorder (MDD) is a prevalent global health condition, and symptom-based clinical assessments are subjective and diagnostically limited. Electroencephalogram (EEG) signals provide information on cortical activity but are nonlinear and non-stationary. Thus, clinical interpretation is difficult and time-consuming. Therefore, effective computational approaches are needed to identify reliable biomarkers for accurate MDD detection and differentiation. This study aims to identify robust electrophysiological biomarkers of MDD by examining group-level discrimination, asymmetry patterns, and individual-level anomaly detection using multidomain EEG features. This work utilizes the MODMA dataset containing 53 subjects with 258-channel EEG. They are preprocessed and features were extracted from time, frequency, and nonlinear domains. Totally, 52 channel-averaged features were used to understand global brain measures of MDD and control. Z-score standardization and feature selection were applied. Asymmetry was quantified using a ratio-based method, and anomaly detection was performed within each feature domain to recognize deviant patterns. The result shows that MDD and control groups have similar EEG characteristics across all domains in asymmetry scores such as time=0.0826, frequency=0.0705, nonlinear=0.0031. However, delta relative power, Zero-crossing rate and peak fequency shows significant discrimination with $p<0.005$, indicating cortical hypoactivation, diminished brain signal and poor cognitive performance. In nonlinear features, MDD patients exhibit irregular patterns. Conversely, frequency-domain anomalies were more prevalent in controls than MDD. This suggests that EEG biomarkers are domain dependent. Among them, frequency features provide optimal discrimination for clinical support.

09:15-09:30

Submission ID: 118 - Characterization of Autism Spectrum Disorder with Graph-Theoretical Metrics from Positive Sparsified DTI Networks

Ravi Ratnaik, Lavanya Selvaganesh and Jac Fredo Agastinose Ronickom

Abstract: Autism spectrum disorder (ASD) is a neurodevelopmental condition chacterized by impairments in social interaction, communication, and behavior. Conventional diagnostic tools, such as the Autism Diagnostic Observation Schedule and Autism Diagnostic Interview-Revised, are time-consuming, subjective, and limited in accuracy. Diffusion tensor imaging (DTI) enables assessment of white matter (WM) microstructural alterations using fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD). Most studies focus on localized tract-level abnormalities rather than system-level network disruptions. This study integrates graph-theoretical metrics with machine learning (ML) to develop an objective framework for ASD diagnosis. DTI data from the ABIDE-II database, comprising 154 individuals with ASD and 129 typically developing (TD), were preprocessed using a standard pipeline. FA, AD, MD, and RD were extracted from 50 WM regions based on the Johns Hopkins University (JHU) atlas. Inter-regional correlations were constructed using the biweight midcorrelation coefficient (BMCC), and positive and negative correlations were separated and sparsified at thresholds from 0.1 to 0.9 with an increment of 0.1. Nine graph-theoretical measures, including betweenness centrality, closeness centrality, clustering coefficient, degree centrality, participation coefficient, strength, average shortest path length, PageRank centrality, and eigenvector centrality, were computed across 50 regions, yielding 450 features per participant. Recursive feature elimination with nested cross-validation was applied for feature selection, and logistic regression, support vector machine (SVM), random forest, and extreme gradient boosting classifiers were trained on the selected features. Positive BMCC-based graph-metric features achieved the highest accuracy of 90.12% with SVM, using 275 and 425 features at full and 0.3 thresholding, respectively, and consistently outperformed negative configurations across all classifiers. The most discriminative features included eigenvector centrality of the right inferior cerebellar peduncle and right uncinate fasciculus, and PageRank centrality of the left cingulum (cingulate gyrus), highlighting disruptions in limbic and cerebellar WM pathways as key network-level indicators of ASD.

09:45-10:00

Submission ID: 70 - VR Buddy - Virtual Reality for Enhancing Learning in Specially Abled Children

Kavitha A, Pravin Kumar S, Divya B and Dyanesh Kannan N

Abstract: Approximately 15–20% of school age children are affected by learning disorders such as ADHD, Autism, and Dyslexia, yet most educational tools are not designed with their needs in mind. This study presents VR Buddy, a customized VR based learning platform built to enhance accessibility and engagement through immersive environments, real-time interaction tracking, and continuous improvement based on expert and user feedback. Six customized VR modules were developed using Unity, targeting ADHD, Autism, and Dyslexia through scenarios including Photosynthesis exploration, Supermarket Simulation, Communication practice, and Literacy tasks. Field testing was conducted at a School where participant interactions were captured through hand and head tracking. Quizzes and feedback questionnaires were collected from students and teachers to measure learning effectiveness and usability. Phase 1 testing involved 15 students across three VR modules. Head tracking from 8 participants showed a mean gaze value of 62.37 ± 13.32 over 285.8 seconds, with 7 out of 8 reaching maximum gaze. An upward gaze trend of 48.7% ± 31.3% was noted. Hand tracking revealed mean left and right hand movements of 66.06 ± 107.03 and 31.17 ± 20.81, with bilateral symmetry of 82.3% ± 24.9%. Student feedback yielded a mean User Experience score of 4.67 ± 0.40 and Engagement score of 4.62 ± 0.36 out of 5. Teachers rated overall performance at 4.77 ± 0.25 out of 5, with 13 out of 15 students awarded an A+ grade. Among the 5 students who attended the VR Photosynthesis module, a post session knowledge quiz yielded a mean score of 2.00 ± 0.89 out of 4. Future work will include quantitative EEG analysis to measure neural engagement during VR learning sessions. VR Buddy demonstrates that immersive Virtual Reality can meaningfully support learning for children with ADHD, Autism, and Dyslexia.

10:00-10:15

Submission ID: 77 - Electroencephalographic Comparison of Fatigue-Induced Cognitive Effects Across Age Groups

Kavitha A, S. Pravin Kumar, Shravan Kumar Subbaraman and Sujay Arjunan

Abstract: Muscle fatigue is known to affect not only physical performance but also higher cognitive functions such as attention, executive control, and decision-making. These effects become more pronounced with aging due to structural and functional changes in the brain. This study investigates and compares the cognitive effects of upper-limb muscle fatigue in young adults (20–30 years) and middle-aged individuals (>50 years) using electroencephalography (EEG). EEG signals were acquired from 54 healthy participants, including 30 young adults and 24 middle-aged adults, using a 16-channel wireless EEG system. Electrodes were positioned according to the international 10–20 system to cover Brodmann Areas 4, 5, 6, and 9, which are associated with motor execution, sensory integration, motor planning, and executive functioning.

Participants completed a standardized protocol consisting of pre and post fatigue Box and Blocks Test, and fatigue-inducing tasks including shoulder abduction hold and repetitive bicep curls. The recorded EEG signals were preprocessed before the features were extracted. Time-domain features such as peak amplitude and root mean square (RMS), frequency-domain features including relative band power in theta, alpha, and beta bands, and time-frequency measures such as event-related desynchronization/synchronization (ERD/ERS) were extracted and analyzed.

Statistical tests revealed that the relative theta band powers of middle aged individuals differed significantly in all regions of interest indicating increased cognitive effort to sustain the exerted force during the tasks (lowest p value of 0.0013 in BA 4). Tests assessing the pre and post fatigue differences in activation revealed decreased motor output in the motor cortex and compensatory cognitive activations in the prefrontal cortex in both the age groups ($p=0.0019$ corresponding to alpha and beta bands in BA 9). ERD/ERS plots further revealed increased cortical activity in the middle aged individuals post activity. These findings suggest that aging alters cortical strategies used to maintain motor and cognitive performance under fatigue.

10:15-10:30

Submission ID: 2 - Teal-time Implementation of an EEG-based MI BCI System for Wheelchair Control for People with Physical Challenges

Mahmud Khalil Rabby, Nazmus Sakib and Md Kafiul Islam

Abstract: Individuals with severe physical challenges such as quadriplegia, muscular dystrophy, or locked-in syndrome often lack reliable means of independent mobility due to the absence of voluntary muscular control. Conventional wheelchair control methods based on eye movements, voice commands, touch interfaces, or tongue-drive mechanisms are frequently unsuitable, fatiguing, or impractical for these populations. This study presents a real-time Electroencephalogram (EEG)-based Motor Imagery Brain–Computer Interface (MI-BCI) system designed for intuitive and practical wheelchair control using purely cognitive commands.

The proposed system employs a wearable 14-channel Emotiv EPOC EEG headset, enabling low-cost and user-friendly deployment. EEG signals corresponding to motor imagery tasks—left movement, right movement, and braking—are acquired in real time using the Lab Streaming Layer (LSL). The signals undergo preprocessing that includes segmentation, Butterworth low-pass filtering, and notch filtering to remove artifacts. Feature extraction is performed using Hjorth parameters (activity, mobility, and complexity) along with gamma band power, capturing both temporal and spectral characteristics of brain activity.

An ensemble machine learning classifier is trained and evaluated using multiple segment lengths to analyze the trade-off between accuracy and responsiveness. Experimental results demonstrate that 5-second segments yield higher classification accuracy of around 96%, while 1-second segments provide faster response times with accuracy of approx. 94%, making them more suitable for real-time navigation. The ensemble model consistently outperforms individual classifiers across accuracy, ROC-AUC, recall, and F1-score metrics.

The system successfully validates real-time EEG-based wheelchair control with reduced hardware complexity and improved usability. This work contributes toward practical, assistive mobility solutions for individuals with severe motor impairments and highlights the feasibility of real-time MI-BCI deployment in rehabilitation engineering.

Plenary Lecture 4

Date: Wednesday, 7 October 2026
Time: 11:00 - 11:45

Venue: NAK Auditorium
Chair: Rosa So



Metin AKAY

John S Dunn Endowed Professor, Biomedical Engineering
University of Houston

Dr. Akay is the John S Dunn Endowed Professor of the Biomedical Engineering Department at the University of Houston. His vision focused on integrating basic and translational research to address the rapidly evolving global healthcare landscape. He received honorary doctorates from Aalborg Silesian and Pécs Universities and professorship from the Technical University of Crete. He has authored more than 20 books and 170 journal papers, along with 200 conference papers and abstracts and delivered over 200 keynote, plenary and invited talks at highly respected international conferences, including IEEE ICASSP twice. He is a recipient of the IEEE EMBS Academic Career, Early Career and Service Awards, an IEEE Third Millennium Medal, and the prestigious Zworykin Award from the International Federation for Medical and Biological Engineering (IFMBE). He is a life fellow of IEEE, fellow of the Institute of Physics (IOP), the International Academy of Medical and Biological Engineering (IAMBE), the American Institute for Medical and Biological Engineering (AIMBE), and the American Association for the Advancement of Science (AAAS). His research focuses on neurotechnology for addiction and pain, novel therapeutics for treatment of cancer, and platform for the detection and treatment of coronary occlusions.

Title

Brain Cancer Chip for Precision Medicine

Abstract:

Glioblastoma multiforma (GBM) is the most common and malignant primary brain tumor in adults because of its highly invasive behavior. The best existing treatment for GBM involves a combination of resection, chemotherapy and radiotherapy, and has a very limited success rate with a median survival rate of less than 1 year. Therefore, there is an urgent need to reduce the time of the preclinical brain tumor growth studies by developing large-scale in vitro cancer platforms for cost-effective high-throughput screening of novel cancer drugs and therapeutics and assessment of treatment responses.

The aim of our project is to develop a novel 3D brain cancer chip as a tool for high-throughput drug screening in order to determine personalized treatment plans for individual brain cancer patients in a matter of weeks. The brain cancer chip we have developed is composed of photopolymerizable poly(ethylene) glycol diacrylate (PEGDA) hydrogel, and integrates a microwell array with microfluidic channels. This chip allows for the simultaneous administration of up to three drugs while establishing a concentration gradient that supplies a unique mixture of drugs to each microwell. Therefore, our brain cancer chip provides a sustainable, high-throughput 3D tissue formation platform for multi-drug testing. Our preliminary studies strongly encourage us to utilize the brain cancer chip to determine the optimal combination of anticancer drugs, using only a tiny tissue sample collected from a patient by biopsy, to most effectively treat GBM in patients in a shorter period of time.

We believe that the chip will also be useful and cost-effective for high-throughput screening of cancer drugs and assessment of treatment responses, and could pave the way for precision medicine in cancer treatment.

In collaboration with Drs. H Xia, N Avci, YM Akay

Keynote: Bone & Musculoskeletal Mechanobiology (WeA2NAK)

Date: Wednesday, 7 October 2026

Venue: NAK Auditorium

Time: 11:45 - 13:00

Chair: Benjamin Lee



Zong-Ming LI

William and Sylvia Rubin Chair of Orthopaedic Research
Professor, Orthopaedic Surgery and Biomedical Engineering
University of Arizona

Zong-Ming Li, PhD, is currently the William and Sylvia Rubin Chair of Orthopedic Research and Professor of Orthopedic Surgery and Biomedical Engineering at the University of Arizona. With more than 35 years of research in musculoskeletal biomechanics, Dr. Li's work has advanced scientific understanding and informed clinical applications that improve patient outcomes. Dr. Li is recognized as a Fellow of several science/engineering and medical organizations, including American Institute for Medical and Biological Engineering (AIMBE), American Society of Biomechanics (ASB), American Society of Mechanical Engineers (ASME), International Academy of Artificial Intelligence Sciences (AAIS), International Academy of Medical and Biological Engineering (IAMBE), International Combined Orthopaedic Research Societies (ICORS), International Society of Biomechanics (ISB), Institute of Electrical and Electronics Engineers (IEEE), and Orthopaedic Research Society (ORS). Dr. Li is the recipient of the ASME Savio L-Y. Woo Translational Biomechanics Medal.

Title

Carpal Tunnel Mechanics and Clinical Applications

Abstract:

The median nerve is prone to compression neuropathy at the wrist, leading to carpal tunnel syndrome. Our work related to carpal tunnel mechanics has investigated the mechanical properties of the transverse carpal ligament and structural properties of the carpal tunnel in an effort to develop innovative, non-surgical treatment for carpal tunnel syndrome. Our goal is to biomechanically treat carpal tunnel syndrome by manipulating carpal tunnel geometry and mechanics to increase its volume and decompress the median nerve without severing the transverse carpal ligament. Concurrent research related to hand sensorimotor function has examined the pathokinetics and pathophysiology manifestations due to carpal tunnel syndrome. Our research findings have revealed biomechanical and neurophysiological mechanisms of sensorimotor functional deficits associated with carpal tunnel syndrome, identified biomechanical and neural markers, and provided non-surgical intervention strategies.

Bone & Musculoskeletal Mechanobiology (WeA2NAK)

Date: Wednesday, 7 October 2026 **Venue:** NAK Auditorium

Time: 11:45 – 13:00 **Chair:** Benjamin Lee

12:15-12:30

Submission ID: 25 - Bone mineral density prediction in transfemoral amputee using different type of prosthetic interfaces

Isna Riski Safira, Spyros Masouros and Anthony Mj Bull

Abstract: Bone mineral density (BMD) adaptation in transfemoral amputees (TFA) remains insufficiently understood, particularly during the early years following amputation when altered mechanical loading may drive long-term skeletal degeneration. While previous studies have identified localized osteopenia in combat-related traumatic injury (CRTI) TFA, the mechanobiological relationship between prosthetic interface design and bone remodelling has not been comprehensively quantified.

This study presents a patient-specific adaptive finite element framework coupled with a bone remodelling algorithm to investigate how different prosthetic interfaces influence femoral BMD distribution in TFA. MRI-derived anatomy from a CRTI TFA (male, 32 years, 185 cm, 86 kg) was combined with subject-specific musculoskeletal loading obtained from cohort-based gait simulations. Multi-loadcase boundary conditions representing the stance phase of gait were applied to four models: healthy femur, end-bearing (EB) socket, ischial containment (IC) socket, and osseointegrated (OI) prosthesis. Model predictions were validated against the ADVANCE study, comprising 1,144 participants including both socket and OI prosthesis users.

Long-term simulations predicted up to 20-30% lower BMD at proximal femur in TFA compared with the healthy limb, with the most pronounced reduction occurring in the trochanteric region. Distinct spatial patterns of bone loss were observed across prosthetic interfaces: the IC socket demonstrated the lowest proximal femoral BMD, whereas the OI model showed the greatest reduction in the periprosthetic region. These changes were associated with reduced mediolateral knee joint reaction forces in TFA and diminished superior loading in both IC and OI configurations. Furthermore, the simulations revealed two distinct stress-shielding mechanisms: femoral offloading caused by ischial load transfer in IC sockets, and stiffness-driven material mismatch in OI implants.

These findings provide new mechanistic insight into interface-dependent bone adaptation in TFA and establish a computational platform for optimizing prosthetic design to mitigate osteopenia and improve long-term skeletal health.

12:30-12:45

Submission ID: 94 - Osteoporotic deterioration induces mechanical transition of the trabecular bone microenvironment under physiological gait loading

Yan Wang and Qiang Chen

Abstract: Osteoporosis-induced microstructural deterioration of trabecular bone destroys both its structural integrity and its internal mechanical microenvironment, thereby impairing bone remodeling; but how these biomechanical signals change during disease progression remains unclear. The objective of this study is to reveal how bone structural deterioration alters the mechanical microenvironment within trabecular bone under physiological loading conditions. In this study, 16 human femoral heads were classified into osteoporotic ($T < -2.5$, $n = 6$), osteopenic ($-2.5 \leq T \leq -1$, $n = 6$), and normal ($T > -1$, $n = 4$) groups according to T-scores. A total of 268 trabecular bone cubes (6× 6× 6 mm) were extracted from micro-CT images, and fluid–structure interaction (FSI) models were established. Subsequently, a body weight-related gait loading forces was applied on the reconstructed trabecular bones immersed in a bone marrow domain. The results show that the apparent elastic modulus in the osteoporotic group decreased by more than 51% compared with the normal group. More importantly, obvious nonlinear relationships were observed between trabecular structure and the mechanical environment. In specimens with higher bone volume fraction (BV/TV), the wall shear stress (WSS), marrow fluid velocity, stress, and strain exhibited stable and gradual variations with tightly clustered distributions. However, below a BV/TV threshold of approximately 22%, both fluid and solid mechanical signals exhibited abrupt increases accompanied by dispersed distributions. Within this low-BV/TV regime, even minute variations in bone volume fraction could trigger nonlinear surges in the mechanical environment of trabecular bone. Notably, only 15% of normal specimens fell within this mechanically unstable region, 32% in the osteopenic group, and contrasted with 58% in the osteoporotic group. These findings indicate that osteoporosis progression involves a mechanical transition; once trabecular microarchitecture deteriorates beyond a threshold, the internal mechanical microenvironment rapidly evolves from stable state into mechanically unstable regime.

12:45-13:00

Submission ID: 95 - Prediction of Pivot Shift Grade Using In-Vivo Ultrasound Bone Tracking During Sit-Stand-Sit

Jiya Dutta, Isaac Tay, Kah Weng Lai, Jeremy Lim and Zi Yang Chia

Abstract: Background: The pivot shift (PS) test is the gold standard for assessing anterolateral rotational instability in ACL-deficient knees, but grading remains subjective with poor inter-observer reliability, especially for Grade 2. Since distinguishing low-grade (Grade 1) from high-grade (Grades 2/3) PS guides decisions on lateral extra-articular augmentation, inconsistent grading in awake clinic patients introduces surgical variability. Current quantification methods require examiner-performed testing under general anaesthesia, and no prior approach has predicted PS grade from a patient-performed functional movement.

Purpose: To evaluate the feasibility of a machine learning (ML) classifier, which was trained on kinematic ultrasound bone-tracking signals from a patient-performed sit-stand-sit (SSS) movement, to predict PS grade and differentiate low versus high-grade PS.

Methods: Ultrasound bone-tracking data were collected during SSS manoeuvres in 23 ACL-injured patients using the GATOR device. Ground truth PS grades (0–3) were assigned under general anaesthesia by fellowship-trained orthopaedic surgeons. Leave-one-out cross-validation (LOOCV) was used for classifier training, with independent held-out validation in 6 additional patients for binary low- vs high-grade PS classification. Multiple deep learning architectures and training strategies were evaluated.

Results: The classifier achieved a maximum one-versus-rest AUC of 0.928 ± 0.084 under LOOCV. Grade 3 was identified most reliably (AUC ~0.81; sensitivity 0.70–0.80), while Grade 2 remained most challenging (sensitivity 0.20–0.75). For the clinically relevant binary classification, the model generalised well to unseen patients (AUC 0.889; accuracy 0.860; sensitivity 0.850; minimum-class sensitivity 0.767).

Conclusion: This is the first reported approach to predict PS grade from a patient-performed functional movement using kinematic ultrasound bone-tracking. Strong cross-validation performance confirms meaningful grade-discriminative signal, though larger datasets (50–100 sessions per grade) will be needed to achieve patient-level generalisation and support clinical adoption.

Keynote: Cardiovascular Modeling & Mechanics (WeA2L1S1)

Date: Wednesday, 7 October 2026

Venue: L1-S1

Time: 11:45-13:00

Chair: Mengjiao Hu



Lei LI

Assistant Professor
National University of Singapore

Dr. Lei Li is an Assistant Professor of National University of Singapore (NUS). Previously, she was a Lecturer at University of Southampton and a Postdoc at University of Oxford. She serves as President of Women in MICCAI (WiM) and Area Chair of MICCAI 2024-2026. She is also the Guest Associate Editor of IEEE Transactions on Medical Imaging (TMI) and Editorial Board Member of Information Fusion. Her research interest is AI for healthcare, specifically focusing on cardiac digital twins, medical imaging, and multi-modal AI.

Title

AI-Enhanced Cardiac Digital Twins: From Mechanistic Modeling to Personalized Healthcare

Abstract:

Cardiac digital twins (CDTs) are emerging as a powerful framework for integrating multimodal patient data with mechanistic models to support personalized cardiovascular care. In this talk, I will discuss how artificial intelligence can enhance cardiac digital twins by bridging data-driven learning with physiological modeling. I will introduce our recent work on AI-enabled cardiac anatomy and function modeling, electrophysiological simulation, and multimodal integration of medical imaging and wearable data. Particular emphasis will be placed on how AI can accelerate computationally intensive simulations, learn personalized physiological parameters, and enable continuously updated digital representations of individual patients. I will also discuss applications of these technologies in personalized risk assessment, arrhythmia management, and post-myocardial infarction care. Finally, I will highlight current challenges, including data integration, model validation, interpretability, and clinical translation, and discuss future opportunities for building scalable and clinically useful cardiac digital twins.

Cardiovascular Modeling & Mechanics (WeA2L1S1)

Date: Wednesday, 7 October 2026 **Venue:** L1-S1

Time: 11:45 – 13:00 **Chair:** Mengjiao Hu

12:15-12:30

Submission ID: 13 - Subrenal abdominal aortic aneurysms: a new approach, beyond old beliefs

Ivan Corazza, Tania Menghi, Pier Luca Rossi, Laura Bondioli and Romano Zannoli

Abstract: An aneurysm is one of the most common vascular diseases and consists of a local, abnormal, and progressive dilatation of a blood vessel that may lead to rupture and hemorrhage. Aortic aneurysms can occur in the thoracic or abdominal region, but infrarenal aneurysms are more prevalent with aging.

Their formation is a long, multifactorial process involving structural weakening of the arterial wall, degradation of elastic fibers, chronic inflammation, neovascularization, activation of proteolytic processes, and altered blood flow dynamics, including changes in shear stress.

We hypothesize that the first important step for a subrenal aneurysm formation is the progressive deformation of the subrenal aorta with age, due to compression of intervertebral discs and spinal shortening: as a consequence, aortic curvature changes, blood flow and shear stress change, and the artery accordingly remodels, triggering a self-sustaining vicious cycle leading to progressive artery dilatation.

To demonstrate our hypothesis, a deformed glass model of the abdominal aorta was placed in a mechanical cardiovascular system with physiological pressure and flow conditions. Data were collected and analyzed using the ANScovery System. The flow patterns have been visualized by injecting ink.

Observations show that high-velocity flow in the vessel center shifts toward the inner curvature and away from the outer side, increasing shear stress on one side and decreasing it on the other. Increased shear stress may activate the endothelium, promoting nitric oxide production and causing vasodilation. This dilatation can create conditions conducive to turbulence, generating vortices that affect the entire vessel cross-section and abnormally stimulate the vessel walls, leading to aortic dilatation. This slow process is difficult to observe in vivo or simulate numerically. Direct visualization, although qualitative, provides more reliable insight, especially for complex vortical flows.

12:30-12:45

Submission ID: 100 - Continuous Hemodynamic Risk Stratification in Cardiogenic Shock Using a Latent ODE Competing-Risks Model: A Multi-Center Validation Study

Min Wan, Liang Zhong and Hao Xu

Abstract: Background: Cardiogenic shock (CS) carries 40–50% in-hospital mortality. Existing risk scores rely on static admission features and ignore competing clinical outcomes. This study evaluates a deep learning framework designed to model continuous hemodynamic trajectories and competing risks for real-time risk stratification.

Methods: We developed the Latent ODE Competing-Risks (LODE-CR) model to process irregularly sampled intensive care unit (ICU) data. The architecture couples a gated recurrent unit (GRU) sequence encoder with a neural ordinary differential equation (ODE) module to output cause-specific hazards for two competing events: in-hospital death and hemodynamic recovery. The model was trained on 1,767 CS patients from the MIMIC-IV database and externally validated on 829 patients from the eICU Collaborative Research Database.

Results: On internal testing (n = 266), LODE-CR achieved a concordance index (C-index) of 0.922 for death and 0.780 for recovery, outperforming static 24-hour Cox proportional hazards models by +19.9% and +11.4%, respectively. At 48 hours, the area under the receiver operating characteristic curve (AUROC) for mortality was 0.997. On multi-center external validation, discriminative performance was maintained (C-index of 0.908 for death, 0.746 for recovery) despite missing 6 of 15 input variables. Permutation analysis revealed that respiratory parameters strongly predicted death, whereas mean arterial pressure, vasopressor dose, and lactate drove recovery prediction.

Conclusions: Continuous trajectory modeling utilizing neural ODEs and competing risks provides accurate, real-time risk stratification that substantially outperforms static clinical scores in cardiogenic shock. The framework demonstrates robust generalizability across institutions and resistance to missing data, showing potential to guide ICU treatment escalation and weaning decisions.

12:45-13:00

Submission ID: 56 - Patient-Specific Digital Twin Modeling of Wall Stress Superior Biomechanical Stratification of Dilated Cardiomyopathy

Daniel Zong, Yiyuan Gao, Wenqi Liu, Shuang Leng, Chengbin He, Jingjing Shi, Wanzhen Li, Siying Ma, Xi Hu, Zhan Feng, Youfan Zhao, Angela Koh, Xiaodan Zhao, Ru-San Tan, Yunjun Yang, Wenbo Xiao, Hongjie Hu, Maosheng Xu and Liang Zhong

Abstract: Background Risk stratification in dilated cardiomyopathy (DCM) is limited by conventional volumetric markers, like left ventricular ejection fraction (LVEF), which fail to characterize the multiscale biomechanical environment driving remodeling. While myocardial wall stress is a fundamental biophysical stimulus for disease progression, its quantification is hindered by the complexity of measuring forces non-invasively within heterogeneous, patient-specific topologies.

Purpose This study aimed to characterize the mechanostructural signature of DCM using a digital twin-derived wall stress index (WSI). By integrating patient-specific geometry, wall thickness, and local curvature, we evaluated WSI as a primary biomechanical driver of adverse clinical outcomes.

Methods A cohort of 379 DCM patients (mean LVEF 22±11%) was retrospectively analyzed. We utilized a high-fidelity digital twin pipeline, based on a pressure-normalized 3D thick-walled model, to generate biventricular models, enabling the computation of global end-systolic WSI. Prognostic performance was validated against a composite endpoint of sudden cardiac death or heart transplantation and compared with conventional anatomical indices.

Results The computational pipeline successfully reconstructed patient-specific topologies across all cases. Over a median 31-month follow-up, global WSI demonstrated superior mechanical-to-clinical discrimination (C-index: 0.74) compared to LVEF (0.60). A one-standard deviation increase in WSI was associated with a more than twofold event risk (HR: 2.06; 95% CI: 1.48–2.87; $p<0.001$). Even after adjusting for Late Gadolinium Enhancement (LGE) and ventricular volumes, WSI remained a significant independent biomechanical predictor (adjusted HR: 1.65, $p=0.02$). Kaplan-Meier analysis confirmed that elevated wall stress significantly compromises event-free survival (log-rank $p<0.001$).

Conclusion Digital twin-derived wall stress resolves the complex mechanical-structural coupling that anatomical markers overlook, providing incremental prognostic value in DCM. Incorporating these biomechanical digital twins into clinical workflows offers a robust framework for precise risk stratification in heart failure.

Plenary Lecture 5

Date: Wednesday, 7 October 2026

Venue: NAK Auditorium

Time: 14:00 - 14:45

Chair: Brian Premchand



Michela CHIAPPALONE

Associate Professor of Bioengineering
University of Genova; Head of LisTechLab
IRCCS Azienda Ospedaliera Metropolitana;
Researcher, Istituto Italiano Di Technologia

M. Chiappalone graduated summa cum laude in Electronic Engineering from the University of Genova (UNIGE) and obtained her PhD in Electronic Engineering and Computer Science from the same University in 2003. In 2002 she was a visiting scholar at Northwestern University (Chicago, USA). After a postdoctoral period at UNIGE, she joined the Istituto Italiano di Tecnologia (IIT) in 2007, where she became Researcher in 2013. She served as Visiting Professor at the University of Kansas in 2015. From 2012 to 2015 she coordinated the European FET Open project BrainBow, evaluated as excellent. In 2018 she joined the Rehab Technologies Lab at IIT, and in 2021 she became Associate Professor of Bioengineering at UNIGE. She has held several leadership roles within IEEE EMBS, including Distinguished Lecturer (2021–2022), AdCom member (2024), and currently she is VP for Technical Activities. She has authored 108 journal publications, over 80 conference papers and gave > 110 scientific talks.

Title

Advancing Neuroengineering with Electroceuticals and Neuromorphic Twins

Abstract:

In recent years, biomedical devices have been developed to treat different neurological disorders. To reach useful therapeutic results, these tools need a multidisciplinary approach and a continuous dialogue between neuroscience and engineering, a field named Neuroengineering. In her talk, M. Chiappalone will highlight the importance of the symbiosis between biological and artificial systems, which makes it possible to answer increasingly stimulating scientific questions and developing incredible new technologies for the ultimate benefit of patients affected by neurological disorders. She will introduce novel electroceutical-based therapies to be used for brain rewiring in case of focal ischemic damage in vivo, also exploiting sleep-related plasticity. She will continue by introducing the concept of Neuromorphic Twin, to be used in the above context for brain repair. Major achievements on the aforementioned topics and the challenges expected for the next years in the field of Neuroengineering will be also introduced and discussed.

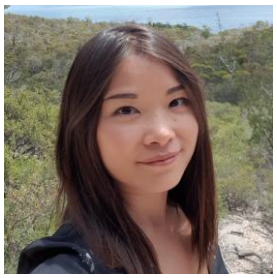
Main references:

1. Chiappalone M and Levi T. Advancing neuroengineering with Neuromorphic Twins. Nature Communications, 17. Article number: 1938. 2026.
2. Cota VR, Del Corso S, Barban F, Carè M, and Chiappalone M. Multi-scale disruption of sleep-related cortical activity following ischemic lesions. https://www.biorxiv.org/content/10.64898/2025.12.19.695488v1 (under review)
3. Beaubois R, Cheslet J, Duenki T, De Venuto G, Carè M, Khoyratee F, Chiappalone M, Branchereau P, Ikeuchi Y, and Levi T. BioemuS: A new tool for neurological disorders studies through real-time emulation and hybridization using biomimetic Spiking Neural Network. Nature Communications, 2024.
4. Carè M, Averna A, Barban F, Semprini M, De Michieli L, Nudo RJ, Guggenmos DJ, and Chiappalone M. The impact of closed-loop intracortical stimulation on neural activity in brain-injured, anesthetized animals. Bioelectronic Medicine. 8 (1): 1-14, 2022.

Keynote: Developmental & Reproductive Tissue Microenvironments (WeP1NAK)

Date: Wednesday, 7 October 2026 **Venue:** NAK Auditorium

Time: 14:45-15:45 **Chair:** Swee Lan See



Yao WANG

Snow Medical Postdoctoral
Research Fellow
The University of Sydney

Dr Yao Wang is a Snow Medical Postdoctoral Research Fellow in the School of Biomedical Engineering at the University of Sydney, where she co-leads the Mechanobiology and Biomechanics Laboratory with Prof. Arnold Ju. Her work lies at the intersection of mechanobiology and biomedical engineering, with a focus on cancer-associated thrombosis, blood cell biomechanics, and microvascular haemostasis. She develops advanced microfluidic vascular models and quantitative biophysical technologies to uncover how mechanical forces regulate cellular behaviour in health and disease. Her studies have revealed new principles of mechanosensing, membrane tension regulation, calcium signalling, and cytoskeletal–membrane interactions, leading to publications in leading journals including Nature Communications, Current Biology, Advanced Materials, and Advanced Functional Materials. Dr Wang has played a key role in establishing nationally unique mechanobiology and single-molecule biophysics infrastructure in Australia and has contributed to collaborative research programs that have attracted more than $7 million in funding. By integrating engineering innovation with fundamental biology, her work aims to translate mechanobiological discoveries into next-generation diagnostics and therapeutics for cardiovascular disease and cancer.

Title

Living Under Pressure: From Force Sensing to Force Survival

Abstract:

The plasma membrane is continuously exposed to mechanical forces, yet how cells protect themselves from force-induced membrane damage remains poorly understood. Here, we identify a previously unrecognized role for the mechanosensitive ion channel PIEZO1 as an adaptive mechanoprotective element.

We show that PIEZO1 protects cells through two complementary mechanisms operating across distinct timescales. During the early response to mechanical stress, PIEZO1's unique triskelion architecture redistributes membrane tension independently of ion permeation. This structural protection is further enhanced by rapid, calcium-independent local enrichment of PIEZO1 at regions of high mechanical stress. Under sustained mechanical challenge, PIEZO1-mediated calcium signalling drives remodeling of the actin cytoskeleton through calmodulin, VASP, and filamin A, providing additional cortical reinforcement. Consistent with a structural role, an ion-permeation-impaired PIEZO1 mutant that retains the triskelion architecture preserves mechanoprotective capacity, whereas structurally unrelated ion channels do not. Importantly, PIEZO1-deficient erythrocytes exhibit increased hemolysis during ischemia-reperfusion injury in mice.

Together, these findings reveal that PIEZO1 functions not only as a sensor of mechanical force, but also as an adaptive protector that couples rapid membrane-level structural adaptation with calcium-dependent cytoskeletal reinforcement to preserve cellular integrity under mechanical stress. Understanding this biphasic mechanism of cellular mechanoprotection may provide new insights into mechanically driven pathologies and inform future therapeutic strategies for conditions including hemolytic disorders, ischemia-reperfusion injury, and mechanical trauma.

Developmental & Reproductive Tissue Microenvironments (WeP1NAK)

Date: Wednesday, 7 October 2026 **Venue:** NAK Auditorium

Time: 14:45 – 15:45 **Chair:** Swee Lan See

15:15-15:30

Submission ID: 55 - Critical phenomenon underlies de novo luminogenesis and control of mammalian follicle development

Kim Whye Leong, Yuting Lou, Jue Yu Kelly Tan, Arikta Biswas, Boon Heng Ng, Zixuan Zhao, Xixun Lu, Xin Ping Joan Teo, Thong Beng Lu, Ling Wang, Carlo Bevilacqua, Isabelle Bonne, Robert Prevedel, Tetsuya Hiraiwa and Chii Jou Chan

Abstract: The formation of a fluid-filled antrum in ovarian follicles is critical for mammalian reproduction, yet the mechanism of luminogenesis and its biological functions remain poorly understood. Here, we showed that in secondary follicles, the interstitial gaps exist in a near-critical regime, forming dynamic and interconnected fluid network near the oocyte, with gap size obeying a power-law distribution. Developing into tertiary follicles, we observed the emergence of cell death and stably growing fluid cavities, resembling phase separation. A simple binary fluid model recapitulated the two regimes and predicted that a spatial gradient of cell-fluid interfacial tension, as observed experimentally, is sufficient to maintain the near-critical state. Conversely, reducing the interfacial tension leads to fluid fragmentation, attenuated metabolic cooperativity between the granulosa cells and oocytes, and impaired oocyte growth. Altogether, our study demonstrates that the collective spatiotemporal regulation of cell junction mechanics drives the fluid transition crucial for the maturation of follicles.

15:30-15:45

Submission ID: 93 - Mechano-chemical feedback regulates mammalian ovarian follicle growth competition

Kosei Tomida, Yuting Lou, Sukhada Darpe, Hugo Raveton, Apoorva Shivanker, Arikta Biswas, Xiang Teng, Yusuke Toyama and Chii Jou Chan

Abstract: During mammalian ovarian development, only a limited number of follicles are selected for preferential growth and ovulation, while the remaining cohort of follicles remain dormant or undergo degeneration. While inter-follicle paracrine signalling has long been considered the primary determinant of follicle selection, its precise mechanism remains unknown. Here, using an in vitro model of follicle doublets, we demonstrate that physical contact between similar-sized follicles leads to growth asymmetry, which is absent in follicles that preserve paracrine communication but do not establish contact. Physical contact between follicles rapidly deformed the follicles through the formation of an interface and a continuous contractile belt covering the doublet. Intriguingly, stress inference and laser ablation revealed a higher mechanical stress in growth-suppressed follicles compared to that of the growing ones. Finally, experiments on isolated follicles demonstrated that both mechanical deformation and inhibitory paracrine signals are required for growth suppression. Based on these experimental data, we constructed a biophysical model which shows that differential deformation enables one follicle to outgrow the other through a positive feedback loop linking deformation and growth. Consistent with model predictions, molecular perturbations of contact mechanics disturb differential deformation, thereby abolishing growth asymmetry in the doublets. Together, our findings provide evidence that coupled inter-follicle mechano-chemical feedback interaction is an essential component driving differential growth, and provides a novel framework to understand collective dynamics of follicles in ovarian development and physiology.

Keynote: Translational Clinical Engineering & Rehabilitation (WeP1L1S1)

Date: Wednesday, 7 October 2026

Venue: L1-S1

Time: 14:45-15:45

Chair: Jaichandar Kulandaidaasan Sheba



Yu Jun TAN

Assistant Professor
National University of Singapore

Yu Jun Tan (National University of Singapore, NUS) is an Assistant Professor in the Department of Mechanical Engineering, where she is a PI at both the NUS Centre for Additive Manufacturing (AM.NUS) and the Advanced Robotics Centre (ARC). Dr. Tan's research integrates materials science, mechanics, and bioengineering to develop next-generation bio-derived, bioinspired and biohybrid materials for soft robotics and biomedical devices. Her group investigates the processing, deformation, and functional behaviors of soft materials (such as bio-based polymers, gels, and living tissues) with particular emphasis on self-healing, electro-mechanical behaviours, and large-deformation mechanics. By linking fundamental mechanics with sustainable design, her work advances the creation of adaptive, self-powered, and eco-responsible soft machines. She has published over 40 peer-reviewed papers in top-tier journals, including Nature Materials, Nature Electronics, Nature Communications, Science Robotics, Science Advances, and Advanced Materials. Her publications have been featured on journal covers and highlighted in scientific media and documentaries.

Title

Engineering Living Muscles for Biohybrid Robots: From Tissue Training to High-Performance Locomotion

Abstract:

Living muscle offers a compelling route to robots powered by biological actuators that are compliant, adaptable, and capable of converting chemical energy into motion. However, translating muscle contraction into reliable, high-performance locomotion requires coordinated advances in tissue engineering, training, and robot design. This talk explores how engineered skeletal muscle can be developed and integrated into biohybrid robots, tracing the path from tissue formation and functional maturation to controlled movement. It examines how self-training can guide muscle development and improve contractile performance. At the device level, the discussion considers force transmission and locomotion. Connecting tissue-scale performance to system-level behavior highlights the importance of designing the living actuator and robotic structure together. By linking muscle training and mechanical integration, this talk outlines an engineering framework for advancing biohybrid locomotion. It offers a perspective on how living tissues can become functional components of robotic systems and what is needed to move toward more robust, adaptable, and capable machines.

Translational Clinical Engineering & Rehabilitation (WeP1L1S1)

Date: Wednesday, 7 October 2026 **Venue:** L1-S1

Time: 14:45 – 15:45 **Chair:** Jaichandar Kulandaidaasan Sheba

15:15-15:30

Submission ID: 50 - A Multimodal Framework Combining MFCC and Articulatory Dynamics for Disordered Speech Analysis

Sunantha Sri B, Dhanalakshmi Munirathnam and Anitha G

Abstract: Background: Automatic speech recognition (ASR) systems perform well for healthy speech but often struggle with dysarthric speech because acoustic cues alone cannot capture articulatory variability. Traditional approaches primarily rely on Mel Frequency Cepstral Coefficients (MFCCs), which capture spectral characteristics while neglecting articulatory dynamics. To address this gap, we investigate a multimodal framework that fuses MFCCs with articulatory features derived from positional data (.pos files) in the TORGO corpus that consists of 7 healthy and 8 dysarthric speakers' data around 13,000 utterances, including three-dimensional positional data of tongue tip, tongue dorsum, lips, jaw, and velum.

Methods: Speech audio was processed into MFCCs using a 25 ms frame length and 10 ms frame shift. Articulatory trajectories from positional data were interpolated and aligned to match MFCC frame rates, ensuring temporal correspondence. The fused feature vectors were constructed by concatenating MFCCs with articulatory coordinates. A deep learning model with a shared encoder was trained on these multimodal inputs, with evaluation against an MFCC only baseline.

Results: The multimodal framework consistently outperformed the MFCC-only baseline. Baseline accuracy was 68.5%, while fusion with tongue tip, tongue dorsum, lips, jaw, and velum features achieved 72.1%, 72.8%, 73.4%, 74.0%, and 74.5%, respectively. Combining all articulators produced the highest accuracy of 76.2%, corresponding to a relative improvement of 13.7%. The findings show that articulatory information complements degraded acoustic cues and enables clinically interpretable analysis of impaired articulation.

Conclusions: This study demonstrates the feasibility of integrating MFCCs with positional articulatory features for disordered speech recognition. The proposed framework improves recognition accuracy while providing clinically meaningful articulatory analysis. Future work will explore attention based fusion and multimodal expansion with video or EMG signals, advancing accessibility technologies and therapeutic applications.

15:30-15:45

Submission ID: 117 - Effect of Guolin Qigong on Quality of Life in Rehabilitative Breast Cancer Survivors: A Longitudinal Study

Bing Wang, Xuetong Wang, Hao Yuan, Xuan Wang, Shuai Chang and Xinbo Qi

Abstract: Abstract

Objective: Breast cancer ranks as the most common malignancy among women globally, posing a severe public health burden. Post-treatment quality of life impairment remains a major clinical challenge, and standardized non-pharmacological interventions are urgently needed. This study investigates the longitudinal association between Guolin Qigong practice and quality of life in rehabilitative breast cancer survivors, to provide evidence-based support for integrating traditional exercise into population-level breast cancer rehabilitation programs.

Methods: First, a systematic review and meta-analysis were conducted to synthesize existing evidence on Qigong's efficacy in breast cancer rehabilitation. Second, a comparative cohort study was performed, administering validated quality of life questionnaires to patients in the Guolin Qigong group and conventional exercise groups to compare quality of life improvements. Third, cross-lagged panel analysis was applied to 12-month longitudinal follow-up data to examine the bidirectional dynamic relationship between Qigong practice and health outcomes.

Results: Rehabilitative breast cancer survivors generally exhibited poor baseline quality of life. Regular Guolin Qigong practice significantly improved physical and mental well-being, and effects increasing progressively over 12 months. Notably, a stable bidirectional relationship was observed: better baseline quality of life predicted greater intervention benefits. The optimal population-adaptable regimen was moderate-intensity practice (3–4 hours/session, 7 sessions/week).

Conclusion: Guolin Qigong is an effective, accessible non-pharmacological intervention for breast cancer rehabilitation. Its bidirectional beneficial effect forms a sustainable health-promoting cycle. These findings provide strong evidence for including Guolin Qigong in clinical rehabilitation guidelines and public health initiatives to improve long-term outcomes for breast cancer survivors globally.

Keywords: Guolin Qigong; Breast cancer survivors; Rehabilitation; Quality of life; Longitudinal study; Public health

Disease & Immune Mechanobiology (WeP1L1S2)

Date: Wednesday, 7 October 2026 **Venue:** L1-S2

Time: 14:45 – 15:45 **Chair:** Kenneth Cheong

14:45-15:00

Submission ID: 57 - Sustained confinement modulates macrophage ability to clear cellular corpses during aging

Jessica Evangeline T. Kabigting, Mei Shan Cheam, Yuan Bin Lim, Tetsuya Hiraiwa, Daan Vorselen, Andrew William Holle and Yusuke Toyama

Abstract: During aging, adipocytes become hypertrophic due to lipid accumulation, with some eventually undergoing cell death. The clearance of these large adipocyte corpses (more than 100μm in diameter) necessitates the formation of crown-like structures (CLS). Fixed histological studies have shown that the CLS features many macrophages recruited around a single corpse. However, the spatiotemporal dynamics of adipocyte death, macrophage infiltration into the CLS, and macrophage interaction with the corpse remain poorly characterized. Here, we show that adipocyte death results in cytoskeletal network disassembly and plasma membrane degradation within several hours. Surprisingly, however, the death process does not disrupt the local extracellular matrix (ECM) surrounding the corpse. Imaging of whole-mount adipose explants revealed that throughout clearance, macrophages are compressed between the intact ECM shell and the adipocyte corpse for several days. To interrogate the functional consequences of this compression, we subjected macrophages to compressive forces using microfabricated confinement channels. Strikingly, CD36 scavenger receptor expression was found to be mechanosensitive in an aging-dependent manner. Confinement elevated CD36 levels in young macrophages while suppressing them in aged macrophages, with corresponding effects on phagocytic capacity. Collectively, these findings advance our understanding of CLS biology in the aging adipose tissue and identify mechanical compression as a key determinant of macrophage phagocytic function during corpse clearance.

15:00-15:15

Submission ID: 15 - Mechanical Signaling Protects Astroglia from Toxic α-Synuclein Aggregates and Facilitates Formation of Tunneling Nanotubes

Sangeeta Nath, Suchana Chatterjee, Ashok Ravula, Anirudh Sreenivas Bk, Abinaya Raghavan, Sivaraman Padavattan and Sreenath Balakrishnan

Abstract: Astroglia can counteract the harmful effects of α-synuclein protofibrils (α-SYN) and reverse premature cellular senescence-like toxicities by promoting the formation of tunneling nanotubes (TNTs). TNTs are nano-sized, open-ended, actin-rich membrane channels connecting neighboring cells, enabling transfer of organelles and cytoplasmic materials. Cytoskeletal remodeling, especially via actin signaling, is key to TNT formation. However, the mechanism behind this recovery is unknown. We demonstrate that disruption of Lamin A/C in α-SYN-treated senescent cells reduces actin-cytoskeleton stress, as measured by nucleus flatness index and isometric scale factor from quantitative microscopy. ROCK (Rho-associated kinase) inhibition, which is crucial for reducing actin-cytoskeleton tension, facilitates the formation of TNTs. Small molecules like Cytochalasin-D, Nocodazole, and Jasplakinolide, which inhibit TNTs by altering actin tension other than ROCK-pathway, cannot reverse senescence. RNA-seq pathway and STRING analyses indicate upregulation of the mechanical signaling via the Hippo pathway. Experiments show that cytosolic YAP translocation, a key regulator of the Hippo pathway, is vital for TNT formation and actin-based stability in astrocytoma cell lines and primary astrocytes. Interestingly, we observe many instances in which TNTs form between cells with low actin tension and Hippo-signaling on and those with relatively higher actin tension and Hippo-signaling off. The most notable observation is the high abundance of YAP inside the TNTs, which seems to colocalize with actin, as shown by the surface plot image of α-SYN-treated TNTs. The study reveals that TNTs maintain mechanical stability through Lamin A/C integrity and actin tension in α-SYN-treated astroglia, and protect against α-SYN toxicity, reversing premature senescence.

15:15-15:30

Submission ID: 47 - Mechanical confinement programs cytotoxic T cell adaptation for enhanced anti-tumor activity

Fang Zhou and Andrew Holle

Abstract: T cells frequently encounter severe mechanical confinement during migration through dense tissues and solid tumors in vivo. Recent studies suggest that confinement is not merely a physical barrier but an active regulator of T cell behaviors. When forced through constrictions smaller than their nuclear diameter, T cells rapidly reorganize their actin cytoskeleton and activate mechanosensitive signaling pathways. However, whether sustained or repeated confinement induces long-term adaptive programs relevant to immune function of T cells remains poorly understood.

Here, we hypothesize that mechanical confinement acts as a programmable biophysical cue capable of priming T cell mechano-adaptation and modulating anti-tumor efficiency. Using microfabricated microchannel platforms, we established reproducible confinement conditions for primary human CD8+ T cells at subnuclear length scales. Live-cell imaging revealed that T cells actively migrate through confined microchannels while undergoing pronounced yet reversible nuclear deformation. Notably, T cells migrated significantly faster in highly confined microchannels (2 × 5 μm) than in larger channels (10 × 5 μm), indicating that confinement geometry directly regulates T cell migratory behavior. To investigate confinement-induced transcriptional remodeling, we further developed a multilayer microchannel platform capable of imposing uniform confinement on large T cell populations while enabling efficient retrieve of post-confinement cells for RNAseq analysis.

Together, our work identifies mechanical confinement as a programmable biophysical cue that drives cytotoxic T cell mechano-adaptation and may enhance anti-tumor immunity.

15:30-15:45

Submission ID: 101 - Age-related cardiac stiffness regulates tissue resident macrophage phenotype

Kottpalli Vidhipriya, Lim Yuan Bin, Jin Zhu, Yusuke Toyama and Jennifer L. Young

Abstract: Cardiac aging involves extracellular matrix (ECM) remodeling, increased myocardial stiffness, and chronic inflammation, which together drive adverse tissue remodeling and susceptibility to heart failure. Tissue-resident macrophages (TRMs) are long-lived, self-renewing immune cells that support cardiac homeostasis, regulate inflammation, and promote repair. Because they persist within the cardiac microenvironment, they may be particularly sensitive to age-dependent mechanical changes, unlike monocyte-derived macrophages (M-dMs) recruited during inflammation. Although macrophages are mechanosensitive, it remains unclear whether progressive age-related myocardial stiffening (~4-fold) directly regulates TRM phenotype, or whether these responses differ from M-dMs. Here, we combine transcriptomic reanalysis of young and aged cardiac macrophages with tunable hydrogels to test whether age-associated cardiac stiffness promotes inflammatory activation of tissue-resident macrophages through lineage-specific mechanosensitive pathways. Reanalysis of a public SMART-Seq dataset of young and aged murine cardiac macrophages (Xia et al., 2024) revealed that TRMs are transcriptionally distinct, with ~87% of age-associated differentially expressed genes (DEGs) showing lineage specificity. In aged TRMs, ECM organization and actomyosin genes were downregulated, while innate immune genes were upregulated, and mechanosensitive candidates, including Ttn, Ddr2, and Ctnnb1, were altered, suggesting aging may rewire mechanosensitive signaling. To test this experimentally, we isolated primary cardiac macrophages from young (~3 weeks) hearts using CD45+ microbeads; FACS yielded ~80% CCR2- cells, with CD68 and LYVE-1 immunofluorescence confirming TRM identity. When seeded onto fibronectin-functionalized polyacrylamide hydrogels, cells on 40 kPa (aged) substrates showed increased iNOS/CD206 compared to 10 kPa (young), suggesting stiffness-dependent inflammatory responses. Building on this, we fabricated a continuous gradient hydrogel, confirmed by nanoindentation, spanning ~12 to 60 kPa over 10 mm. Together, these findings suggest age-associated stiffening drives inflammatory remodeling by modulating tissue-resident macrophage phenotype. Future work will add functional assays (cytokine profiling, efferocytosis), dynamic materials, and young and aged decellularized ECM to decouple mechanical and biochemical regulators of activation.

Plenary Lecture 6

Date: Wednesday, 7 October 2026

Venue: NAK Auditorium

Time: 16:15 - 17:00

Chair: Andrew Holle



Yusuke TOYAMA

Principal Investigator, Mechanobiology Institute;
Associate Professor, Department of Biological Sciences
National University of Singapore

Dr. Yusuke Toyama received his foundational engineering and physics training at Hokkaido University and Osaka University, earning his Ph.D. in Engineering from Osaka University in 2003 with a focus on plasma physics and laser-driven nuclear fusion. He subsequently transitioned into biophysics and mechanobiology during his postdoctoral training at Duke University. In 2010, Dr. Toyama joined the Department of Biological Sciences at the National University of Singapore as an Assistant Professor and was promoted to tenured Associate Professor in 2018. Concurrently, he was appointed as a Principal Investigator at the Mechanobiology Institute (MBI), where he has also served as Deputy Director since 2019. His interdisciplinary research seamlessly bridges engineering principles with biological systems to uncover how mechanical forces shape and regulate tissue turnover, immunology, and aging.

Title

Mechanobiology of Apoptosis and Tissue Turnover in Aging

Abstract:

Each day, billions of cells in the human body undergo apoptosis, a tightly regulated form of programmed cell death. The efficient removal of these dying cells, carried out predominantly by macrophages, is critical to maintaining tissue homeostasis. It is well established that apoptotic cells are recognized through surface "eat-me" signals that trigger their engulfment by macrophages. However, how macrophages clear dead cells that greatly exceed their own size remains an open question.

Adipocytes (fat cells) present a unique case of this challenge. During aging and obesity, adipocytes undergo substantial hypertrophy through lipid accumulation, and a subset eventually die. These enlarged dead adipocytes can be more than 1,000 times larger in volume than the macrophages responsible for their removal. The mechanisms by which macrophages accomplish this clearance remain poorly understood.

To address this question, we combine in vitro microfluidic platforms, which enable precise control over the mechanical environment experienced by macrophages, with ex vivo mouse adipose tissue explants. In this presentation, I will discuss our current understanding of the mechanisms underlying dead adipocyte clearance and how these processes may be altered with aging. I will further examine how the mechanical compression macrophages experience during clearance regulates their phagocytic capacity. Together, these findings offer new insight into the mechanical regulation of tissue turnover in aging.

Poster Session 2

Date: Wednesday, 7 October 2026

Venue: Outside NAK Auditorium

Time: 17:00 – 18:00

17:00-18:00

Submission ID: 38 - Theca cell mechanosensing and regulation of follicular extracellular matrix during ovarian follicle development

Arikta Biswas, Boon Heng Ng, Kosei Tomida, Kim Whye Leong, Yuting Lou, Chin Hao Lee, Rothswell Lanting, Thong Beng Lu, Ranmadusha Merengha Hengst, Mui Hoon Nai, Isabelle Bonne, Jennifer Lauren Young, Chwee Teck Lim and Chii Jou Chan

Abstract: Mammalian folliculogenesis is essential for female hormonal regulation and successful reproduction. While the steroidogenic functions of theca cells (TCs) have been implicated in ovarian diseases and infertility, the physico-structural properties of TCs and their associated extracellular matrix (ECM), or theca matrix, remain poorly understood. Using murine ovaries, we show that a stiff basement membrane (BM) and theca matrix constitute a mechanically instructive niche that modulates TC proliferation and Yes-associated protein (YAP) signalling in secondary follicles. We identify hyaluronic acid (HA) as a key matrix component that is actively secreted by contractile TCs. The HA scaffold, in turn, regulates TC proliferation, YAP signalling and motility, and is required for overall follicle growth. We showed that stiffer substrates enhance YAP nuclear transport in TCs, while mechanical stretch, cell packing, and curvature affect TC proliferation. In addition, TCs exhibit directed migration towards regions of positive curvature. Together, this study reveals a mechanochemical feedback mechanism that establishes TC mechanics and HA as key regulators of theca matrix formation that is essential for mammalian folliculogenesis.

17:00-18:00

Submission ID: 65 - Mechanical cues orchestrate granulosa cell dynamics in mammalian folliculogenesis

Kelly Tan, Kim Whye Leong, Arikta Biswas, Xixun Lu, Yuting Lou and Chii Jou Chan

Abstract: Female fertility depends on the proper growth of ovarian follicles, multicellular structures in the ovary that nurture and support oocyte maturation. Granulosa cells (GCs), which make up majority of the follicle, perform distinct functions depending on their location: GCs surrounding the oocyte provide metabolic support, while basal GCs adjacent to the basement membrane regulate hormonal homeostasis. Although their biochemical roles are well-characterised, how mechanical cues influence GC behaviour during follicle growth remains unexplored. Here, we investigated how GCs in different follicular regions respond to changes in their physical microenvironment during development. We show that basal GCs transition from a columnar to more rounded morphology, exhibit reduced packing density and weaker cell-cell adhesion as follicles grow. Live imaging further revealed increased basal GC motility and more frequent cellular rearrangements in larger follicles, suggesting a transition towards a more fluid-like tissue state. Weakening cell-cell junctional strength also increased cellular rearrangements, supporting a role for cell-cell adhesion in regulating tissue fluidity. In addition, analysis of division dynamics revealed a shift in basal and oocyte GC division orientation from being predominantly perpendicular to the oocyte surface in small follicles, to more parallel in the large follicles, possibly highlighting changes in intrafollicular stress patterns during growth. Together, our results demonstrate that GCs undergo coordinated morphological and mechanical transitions during follicle maturation. These findings contribute to a fundamental understanding of ovarian follicle mechanobiology, and may support future advances in fertility preservation and reproductive medicine.

17:00-18:00

Submission ID: 67 - De-risking Drug Development with AI Target Funnel

Isaac Yeoh and James Lu

Abstract: Therapeutic target evaluation remains a major bottleneck in drug discovery. Currently, this task requires expert knowledge of the therapeutic area, disease pathways and manual synthesis of fragmented evidence across molecular biology, disease mechanism, human genetics, structural biology, safety pharmacology, chemical tractability, competitive intelligence and so on. This process is time-intensive and gaps in the analysis can contribute to costly preclinical attrition, when mechanistic liabilities are identified only after experimental validation. We present the AI Target Funnel, an autonomous target de-risking infrastructure powered by large language model–based evidence reasoning modules, that integrates heterogeneous biomedical evidence from scientific literature, molecular databases, population genetics resources, and structural repositories to generate evidence-based assessments for wet-lab target prioritization. The infrastructure performs modular evidence acquisition, cross-source evidence reconciliation, and narrative synthesis across target biology, genetic causality, safety liabilities, structural tractability, and competitive landscape. Compared with conventional manual literature review, the infrastructure reduced target assessment time from days or weeks to minutes, while preserving mechanistic interpretability and evidence provenance. These results demonstrate the potential of autonomous target de-risking systems to improve target prioritization, reduce translational risk, and accelerate therapeutic development from discovery to clinical application.

17:00-18:00

Submission ID: 22 - Multiview Clustering and Biomarker Analysis for Differentiating Alzheimer's Disease from Mild Cognitive Impairment

Ahana Priyanka, Latha Manohar, Muthulakshmi M and Kavitha Ganesan

Abstract: This study explores the effectiveness of Multiview feature integration for distinguishing between Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD) using radiomic features, cerebrospinal fluid (CSF) markers, and gene expression biomarkers in the corpus callosum and lateral ventricle regions of MR brain images. Data were obtained from the ADNI database. Segmentation of the ventricle and corpus callosum regions was performed using the Multiplicative Intrinsic Component Optimization algorithm. Texture analysis of these regions was conducted to examine atrophy patterns. Multi-view Low-Rank Sparse Subspace Clustering (MLRSSC) was employed for classification. The analysis revealed distinct atrophy patterns, with AD patients showing lower texture values compared to MCI subjects, consistent with Alzheimer's pathology. CSF markers and gene expression features provided additional insights into neurodegeneration, synaptic dysfunction, and inflammation. The integration of radiomic, CSF, and gene expression markers using MLRSSC significantly improved classification accuracy, achieving 98.75% for the corpus callosum and 96.25% for the lateral ventricle, outperforming single-modality models. These findings suggest that integrating multiview features enhances the ability to distinguish between MCI and AD, providing a comprehensive approach for identifying neurodegenerative patterns and disease progression. The corpus callosum exhibited more distinct multiview differences than the lateral ventricle, making it a stronger biomarker for differentiation.

17:00-18:00

Submission ID: 8 - ViFoSe, a user-friendly open-source post-processing tool for foreground segmentation in time-lapse videos

Filippo Piccinini, Michele Sarneri, Luca Rinaldi, Abdelrahman Abdelaziz Mohamed, Mariachiara Stellato, Jae-Chul Pyun, Misu Lee, Bongseop Kwak, Bosung Ku, Emanuele Domenico Giordano and Gastone Castellani

Abstract: Time-lapse videos are commonly acquired in microscopy and outdoor imaging to study the behaviour of objects of interest (OOIs) under different stimuli. However, in most cases, the relevant information pertains only to the OOIs, considered as the foreground (FG, e.g. moving cells), while the background (BG, e.g. an inorganic scaffold) is often irrelevant. Today, a wide range of algorithms to segment the FG is available, spanning from post-processing to real-time solutions, accommodating dynamic/static cameras and/or BG, and catering to both general and case-specific scenarios. However, no freely available tool allows users to test different automatic solutions while also providing manual corrections for missed detections or false inclusions. In this work, we propose Video Foreground Segmentation (ViFoSe), a user-friendly, open-source, post-processing tool for FG segmentation in time-lapse videos. ViFoSe includes several automatic algorithms, but its key feature is the set of options provided for easily correcting missed or incorrect detections. To validate the tool, videos under controlled conditions were acquired. Specifically, we began by considering common real-world scenarios with a static camera and static BK. Then, the analysis has been extended to all possible variations involving a dynamic camera and/or dynamic BK. The experiments conducted demonstrate ViFoSe's ability to correctly segment OOIs, even when they cross each other or are partially hidden behind BG elements, in cases with a static camera and static BK. However, poor results were obtained when analysing videos with a dynamic BG (e.g., moving cells in hydrogels with debris or outdoor videos recorded in windy conditions). The ViFoSe source code, standalone applications for Windows, macOS, and Linux, user documentation, video tutorial, and the extensive testbed dataset are publicly available at: https://github.com/UniBoDS4H/ViFoSe/

17:00-18:00

Submission ID: 76 - Deep Learning Architectures and Use of Explainable AI in Interpreting Model Predictions for Classifying Ear Disorders

Kavitha A, S. Pravin Kumar, Sujay Arjunan and Shravan Kumar Subbaraman

Abstract: Ear related disorders, particularly the ones affecting the middle ear, are a major global health concern and can lead to significant hearing impairment if left undiagnosed. While existing methods such as otoscopic examination remains the standard diagnostic approach, interpretation of otoscopic images is often subjective and largely dependent on clinical expertise. Recent advancements in deep learning have shown promising results and potential in automated medical image analysis. This study presents a comparative evaluation of three DL architectures DenseNet-121, EfficientNet-B2, and ConvNeXt-Tiny for binary classification of otoscopic images into normal and abnormal categories.

A publicly available otoscopic image dataset containing 956 tympanic membrane images belonging to both normal and abnormal classes was used for model training and evaluation. All models were trained under identical conditions and evaluated using metrics such as accuracy, precision, recall, specificity, F1-score, ROC-AUC, and confusion matrix analysis. Additionally, Explainable Artificial Intelligence (XAI) using occlusion sensitivity maps was employed to interpret model predictions.

Among the evaluated architectures, ConvNeXt-Tiny achieved the best overall performance with an accuracy of 90.57%, and ROC-AUC of 0.9625. EfficientNet-B2 demonstrated the highest abnormal-class recall, while DenseNet-121 showed comparatively lower performance across most metrics. Occlusion heatmaps revealed that the models mainly focused on clinically relevant regions of the tympanic membrane during classification.

The findings of the study showed that ConvNeXt-Tiny provides the most balanced performance for automated otoscopic image classification while being reliable at the same time, thus making it a promising candidate for clinical decision-support and large-scale screening applications.

17:00-18:00

Submission ID: 99 - Synthesis of Contrast-Enhanced CT Pulmonary Angiograms from Spectral Virtual Non-Contrast CT with Vessel-Aware Evaluation

Hao Xu, Zihao Li, Wenjun Zhang, Yunxin Liu, Min Wan, Liang Zhong and Liang-Geng Gong

Abstract: CT pulmonary angiography (CTPA) is the reference standard for diagnosing pulmonary embolism but requires intravenous iodinated contrast, which is contraindicated in patients with renal impairment, prior contrast reactions, or a need for repeated imaging. We investigate whether a contrast-enhanced pulmonary angiogram can be synthesized from a virtual non-contrast (VNC) image reconstructed by a spectral CT scanner, thereby eliminating the need for additional contrast administration. Spectral CT offers a methodological advantage for this task: VNC and contrast-enhanced angiographic images are derived from the same acquisition and are therefore inherently co-registered, removing the inter-scan alignment error that otherwise confounds supervised contrast-synthesis training.

We trained a conditional generative adversarial network, ContrastCTGAN, to map windowed VNC axial slices to their corresponding angiographic slices. The generator is a 2D U-Net with six encoder and five decoder stages, skip connections, and a sigmoid output. The model was trained and evaluated on a cohort of 57 patients imaged on a Philips IQon Spectral CT, partitioned 70/10/20 into training, validation, and reserved test subsets.

Because global image-quality metrics are dominated by background and parenchyma, we additionally propose a vessel-aware evaluation framework. Pulmonary-artery masks were automatically generated using a self-configuring nnU-Net v2 model trained on the PARSE 2022 public dataset, achieving a validation pseudo-Dice of 0.894. Structural similarity (SSIM) and peak signal-to-noise ratio (PSNR) were then computed both globally and within the pulmonary-artery region.

On the validation subset, ContrastCTGAN achieved a global SSIM of 0.970 and PSNR of 27.74 dB, but vessel-region SSIM of 0.884 and PSNR of 23.30 dB (a gap of 4.44 dB) demonstrating that global metrics substantially overstate vascular fidelity. These results confirm the feasibility of spectral VNC-to-CTPA synthesis while identifying the central pulmonary arteries as the primary challenge, motivating vessel-conditioned synthesis as future work.

17:00-18:00

Submission ID: 109 - Sequence-Based Deep Learning Framework for Automated Obstructive Sleep Apnea Detection from Multimodal Sleep Signals

Febryan Setiawan and Che-Wei Lin

Abstract: Background: Obstructive sleep apnea (OSA) is a prevalent sleep disorder characterized by recurrent episodes of upper airway obstruction during sleep, resulting in intermittent hypoxia, sleep fragmentation, and increased risks of cardiovascular and metabolic diseases. Automated OSA detection using physiological signals has gained significant attention as a means of reducing the burden of manual polysomnography analysis. This study proposed a sequence-based multimodal deep learning framework for OSA detection using physiological signals from the Multi-Ethnic Study of Atherosclerosis (MESA) database.

Methods: The proposed framework integrated oxygen saturation (SpO_2), thoracic effort, abdominal effort, and electrocardiogram (ECG)-derived heart rate variability (HRV) features to capture complementary respiratory and cardiovascular characteristics associated with OSA events. To incorporate temporal context, five consecutive 30-second epochs were grouped into a sequence centered on the target epoch. Modality-specific one-dimensional convolutional neural networks (1D-CNNs) were employed to extract representative features from each physiological signal, while a bidirectional long short-term memory (BiLSTM) network modeled temporal dependencies across neighboring epochs. To address class imbalance, weighted random sampling and class-weighted loss functions were applied during training. Model performance was evaluated using subject-wise five-fold cross-validation to ensure robust and subject-independent assessment.

Results: Experimental results demonstrated that the proposed framework achieved a balanced accuracy of 75.6 ± 0.04%, sensitivity of 82.0 ± 0.03%, and an area under the receiver operating characteristic curve (AUC) of 0.815 ± 0.06 for overall binary OSA classification. Furthermore, sleep-stage-specific analysis revealed enhanced detection performance during non-rapid eye movement (NREM) sleep, achieving a sensitivity of 83.63 ± 4.85%, whereas a sensitivity of 73.99 ± 11.83% was obtained during rapid eye movement (REM) sleep.

Conclusion: These findings suggest that the integration of multimodal physiological signals with temporal sequence modeling effectively captures OSA-related physiological patterns across different sleep stages, highlighting its potential for automated sleep-disordered breathing detection and computer-aided sleep monitoring applications.

17:00-18:00

Submission ID: 32 - Development of custom indentation and uniaxial traction frameworks for the mechanical characterization of low-density anisotropic collagen hydrogels

Mariana Otoya, Chloé Techens and Jean-Marc Allain

Abstract: Collagen hydrogels are essential tissue-mimicking scaffolds, yet optimizing them for cell survival often results in soft, low-density matrices that complicate standardized mechanical characterization. While macro-rheology is the current gold standard, a significant scale gap remains between micro and bulk properties. Bridging this gap is critical to understand the mechanical link between cellular-level events and macroscopic tissue behavior. This study establishes a foundational framework using custom-built experimental setups to quantify the properties of isotropic and anisotropic hydrogels across complementary scales.

Isotropic and fiber-oriented collagen hydrogels were synthesized at collagen concentrations ranging from 2 to 6.2 mg/mL. Bead-drop indentation tests were conducted, putting 500 µm-diameter glass beads on the gel surface under an Optical Coherence Tomograph. The steady-state indentation depth was measured to dissipate poro-viscoelastic effects, enabling the use of models to compute a localized Young's modulus. Macroscopically, tensile stiffness was measured using a custom horizontal machine for uniaxial traction, taking into account the direction of the oriented fibers in anisotropic gels. Hydrogel fiber orientation was assessed by second harmonic generation microscopy.

Preliminary results from the indentation tests yielded Young's modulus values of 15.84 ± 3.51 Pa for 2 mg/mL to 88.70 ± 19.08 Pa for 6.2 mg/mL, capturing the characteristic low-Pascal stiffness of these matrices, with an almost linear increase with their collagen concentration. These measurements establish a baseline for isotropic scaffolds. The first traction tests were successfully conducted by reinforcing the bone-shaped hydrogels with polycaprolactone scaffolds. The sample could be stretched up to 61% before the hydrogel failure near the grips.

The ongoing development of anisotropic hydrogels will allow the comparison of their multiscale mechanical properties with their isotropic counterparts. It will open the door to future studies on how cellular-level mechanical modifications relate to tissue structural failures observed in some vascular pathologies.

17:00-18:00

Submission ID: 39 - Tailor-made Analysis of Micro-expression Using Deep Learning

Kazuho Narita, Chikara Takeda, Andre Antezana, Keito Kimura, Hidenobu Takao and Noriko F. Hiroi

Abstract: We build a CNN-based, supervised image classification model which can detect human microexpression and can connect LLM for producing advices for the observed person.

The dataset consists of image frames extracted from videos recorded simultaneously with time-series measurements of Galvanic Skin Response (GSR).

The objective to develop this model is to use it for finding a stressed person and try relaxing them with gentle words.

In our earlier research, directly training a CNN on the micro-expression dataset caused the model to attend not only to facial areas but also to unrelated high-contrast regions.

To overcome this problem, the present study adopts a transfer learning strategy. First, the CNN was pre-trained on a general facial expression dataset to learn fundamental facial features. Then, transfer learning was conducted using the micro-expression dataset.

After transfer learning, attention analysis using

Gradient-weighted Class Activation Mapping (Grad-CAM) demonstrated a general increase in the model's focus on facial regions compared to the earlier model, and this

difference was confirmed to be statistically significant ($p < 2.2e-16$). At the same time, the classification performance was maintained with the F-score exceeding 99\% on the validation dataset.

Additionally, to visualize the research outcomes and demonstrate the applicability of the proposed model, a demonstration web application and developped a tiny-physical AI as the user interface of our model.

17:00-18:00

Submission ID: 45 - Sex-Based Mandibular Morphology and BSSO Bad Split Risk in Taiwanese Patients

Meng-Jie Lin, Jui-Ting Hsu, Yuan-Chien Chen and I Chen

Abstract: This study investigates sex-based variations in mandibular bone thickness within the mandibular second molar region among Taiwanese individuals to evaluate how these anatomical differences influence the biomechanical risk of bad splits and inferior alveolar nerve (IAN) injury during bilateral sagittal split osteotomy (BSSO). A retrospective cone-beam computed tomography (CBCT) analysis was conducted on 26 Taiwanese patients (13 males, 13 females) diagnosed with Angle's Class III malocclusion. Key parameters, including cortical bone thickness, cancellous bone thickness, and the total distance from the IAN canal to the buccal surface, were measured at the distal aspect of the mandibular second molar region. The data revealed significant sexual dimorphism in mandibular architecture, wherein females exhibited a significantly greater mean cortical bone thickness (2.90 ± 0.36mm) compared to males (2.39 ± 0.35mm, $p = 0.001$). Conversely, males demonstrated a significantly wider cancellous bone width (5.15 ± 1.09mm, $p = 0.011$) and a greater total distance from the IAN to the outer cortex (7.62 ± 1.41 mm) than their female (7.28 ± 0.98 mm) counterparts. These findings suggest that the reduced mandibular dimensions in females may lead to higher mechanical stress under functional loading, potentially inducing compensatory cortical thickening via the mechanostat theory. This distinctive "thick cortex and thin cancellous" profile in females increases structural resistance while drastically reducing the surgical safety margin for osteotome advancement. Consequently, female patients may face a substantially higher risk of intraoperative bad splits and IAN injury, whereas the more expansive cancellous bone in males provides a more forgiving surgical margin, underscoring the necessity of meticulous, sex-specific preoperative assessment to mitigate these anatomical risks during BSSO.

17:00-18:00

Submission ID: 59 - Stair Climbing Kinematics Comparing Mechanical and Kinematic alignment in Bilateral TKA

Josephine Lam, Andy Yew, Jason Lim, Seng Jin Yeo, Lincoln Liow and Hee Nee Pang

Abstract: Total knee arthroplasty (TKA) is a widely performed surgical procedure that reduces pain in patients with end-stage osteoarthritis. However, the restoration of normal lower limb kinematics remains incomplete following traditional mechanical alignment (MA). Kinematic alignment (KA) has been proposed as an alternative that more closely replicates the native joint anatomy, but its effect on full lower limb kinematics during more demanding functional task like stair ascent remains unclear.

This study aimed to compare three-dimensional motion analysis in lower limb kinematics during stair ascent in patients that has underwent bilateral TKA, MA-TKA in one knee and KA-TKA in the other.

Sixteen participants that has underwent bilateral TKA and 7 healthy participants were recruited. All procedures were performed by the same arthroplasty surgeon, with MA TKA performed between 2007 to 2014 and KA TKA between 2015 to 2017. The mean time between MA and participant's subsequent KA TKA is 3.3 years.

Both surgical groups demonstrated lower limb kinematics that differed from the healthy population across multiple joints. Both groups exhibited greater peak knee flexion, MA by 3.8° and KA by 3.2°. Compensation in peak hip flexion was also observed in both groups, with MA showing 12.4° and KA showing 10.8° as compared to the healthy population. Notably, KA patients demonstrated substantially greater ankle plantar-flexion at the onset of swing phase with 8.73° greater than the healthy population, a pattern that was not observed in the MA group. This could indicate a distinct compensatory specific to kinematic alignment.

In conclusion, neither MA not KA fully restores the physiological lower limb kinematics during stair ascent, suggesting that regardless of TKA techniques, both imposes lasting biomechanical limitations. Future studies with larger cohorts and better aged-match healthy controls should be warranted to better determine whether these compensation patterns are repeatable.

17:00-18:00

Submission ID: 96 - Multimodal Wearable System for Objective Assessment of Dynamic Rotational Knee Biomechanics Following ACL Injury and Reconstruction

Jiya Dutta, David Tan Yuan Yu, Kah Weng Lai, Jeffrey Zhu and Zi Yang Chia

Abstract: Background: Accurate clinical assessment of knee rotational stability following ACL injury remains challenging. Existing tools, operator-dependent physical examination tests (e.g. pivot shift) and patient-reported outcomes, fail to capture subtle rotational biomechanical deficits. While laboratory motion capture provides objective data, it is impractical for clinical use. GATOR PRO is a clinic-based multimodal wearable sensor system that integrates knee-mounted Inertial Measurement Units (IMUs) with ultrasound imaging, using an ensemble deep learning model to assess in-vivo dynamic rotational knee stability.

Objective: To validate the GATOR PRO machine learning model's ability to classify knee stability in ACL-deficient and ACL-reconstructed patients using high-fidelity in-vivo biomechanical data.

Methods: This prospective clinical study (Singapore General Hospital; CIRB 2019/2766) targeted 60 patients (30 ACL-deficient, 30 ACL-reconstructed ≥6 months post-surgery). At interim analysis, 29 patients (8 ACL-deficient, 21 ACL-reconstructed) performed standardised chair-stand tests. An ensemble model combining a convolutional classifier (EfficientNet) and a time-series classifier (InceptionTime) produced binary stability classifications. Performance was evaluated using 10-fold stratified cross-validation with patient-wise splitting, repeated across 100 random seeds.

Results: The ensemble model achieved a ROC-AUC of 0.837 (SD: 0.042, $p<0.001$) and overall accuracy of 75.9% (SD: 3.2%). For ACL-reconstructed knees: precision 71.4%, recall 93.8%, F1-score 81.1%. For ACL-deficient knees: precision 87.5%, recall 53.8%, F1-score 66.7%. Notably, model sensitivity for ACL-deficient classification (53.8%) was approximately twice that of the manual pivot shift test (24–32%), with comparable specificity (93.8% vs. 90–98%).

Conclusion: The GATOR PRO ensemble model achieved clinically relevant performance in differentiating ACL-deficient from ACL-reconstructed knees, with substantially superior sensitivity to manual pivot shift testing. These findings support the feasibility of deploying ML-based rotational instability assessment in routine clinical settings.

17:00-18:00

Submission ID: 115 - Cross-Attention Fusion of Time and Frequency Domain sEMG Features for Silent Speech Recognition

Dhanalakshmi Munirathnam, Anindhitha Aravind, Faith Evangelin Joel and Durga Rajan

Abstract: Speech impairment caused by conditions such as Amyotrophic Lateral Sclerosis (ALS), stroke, and laryngectomy can severely limit an individual's ability to communicate through speech. Similarly, situations requiring discreet communication, including noisy environments, privacy-sensitive settings, and military operations, necessitate alternative speech communication methods. Silent Speech Recognition (SSR) systems address these challenges by enabling communication without audible vocalization.

This work presents the development of an end-to-end SSR system based on facial surface Electromyography (sEMG) signals acquired from two facial muscle sites: the Depressor Anguli Oris (DAO) and Zygomaticus Major (ZYM). Data were collected from twenty-five speakers who uttered five basic words and simple sentences in three speech modes: normal, whispered, and silent. Along with sEMG signals, synchronized audio and video recordings were obtained to facilitate multimodal analysis.

Several deep learning architectures were investigated for word recognition, including CNN-Bidirectional Long Short-Term Memory (CNN-BiLSTM), CNN-Bidirectional Gated Recurrent Unit (CNN-BiGRU), Wavelet-CNN for multi-scale frequency feature extraction, and a Transformer-based model utilizing self-attention for temporal sequence modeling. To exploit complementary information, time-domain and frequency-domain EMG feature streams were integrated through a cross-attention fusion mechanism. Conventional CNN and ResNet50 classifiers were also implemented as baseline models for comparison.

Experimental results demonstrate that the CNN and ResNet50 baselines achieved average accuracies of 85.94% and 87.51%, respectively, across the three speech modes. The Transformer model improved overall accuracy to 90.1%, while the Wavelet-CNN achieved the highest performance of 91.4%. The greatest improvement was observed in silent speech recognition, where the Wavelet-CNN attained 81.2% accuracy compared with 75.3% for the ResNet50 baseline. These findings indicate that advanced architectures, particularly Wavelet-CNN and Transformer models, significantly enhance silent speech recognition performance, with further improvements anticipated through larger-scale datasets.

Thursday, 8 October 2026

Special Session: Musculoskeletal Sciences ACP

Date: Thursday, 8 October 2026 **Time:** 09:00 – 11:00 **Venue:** NAK Auditorium

Moderators



Joyce KOH

Academic Vice Chair, Research
Musculoskeletal Sciences Academic Clinical Programme;
Senior Consultant
Department of Orthopaedic Surgery
Singapore General Hospital



Andy YEW

Senior Research Fellow I
Division of Musculoskeletal Sciences
Singapore General Hospital

Panelists



Denny LIE

Senior Consultant
Department of Orthopaedic Surgery
Singapore General Hospital

Title

Clinical Biomechanics & the Body's Blueprints: Engineering Better Patient Outcomes

Special Session: Musculoskeletal Sciences ACP

Date: Thursday, 8 October 2026 **Time:** 09:00 – 11:00 **Venue:** NAK Auditorium



WONG Yoke Rung

Senior Research Fellow,
Biomechanics Lab,
Singapore General Hospital

Title

Computational Modeling in Biomechanics: Applications and Current Limitations



Pivatidevi PAREATUMBEE

Principal Research Engineer
Musculoskeletal Sciences ACP
SingHealth Duke-NUS

Title

The Application of Finite Element Modelling in Orthopaedic Biomechanics



Josephine LAM Pei Wen

Senior Research Officer
Department of Orthopaedic Surgery
Singapore General Hospital

Title

The Role of Motion Capture Analysis in Research and Clinical Practice

Special Session: Musculoskeletal Sciences ACP Session

Date: Thursday, 8 October 2026 **Time:** 09:00 – 11:00 **Venue:** NAK Auditorium



Chia-Yu LIU

Medical Student
Duke-NUS Medical School

Title

Establishing a Baseline in Upper Limb Kinematics in Healthy Individuals



Ardiyansyah SYAHROM

Director,
Medical Devices Technology Centre (MEDiTEC),
Institute of Human Centred Engineering (iHumEn),
Universiti Teknologi Malaysia (UTM)

Title

A Closed-Loop System of Patient-Specific Design, Bioresorbable Materials, and Integrated Sensors for Sustainable Bone Repair

Keynote: Clinical Devices & Mechanobiological Tools (ThA1L1S1)

Date: Thursday, 8 October 2026

Venue: L1-S1

Time: 09:00 - 11:00

Chair: Benjamin Lee



Amy Kyungwon HAN

Associate Professor
Seoul National University

Amy Kyungwon Han is an Associate Professor of Mechanical Engineering at Seoul National University. She was a postdoctoral researcher at Stanford and received a Ph.D. and M.S. from Stanford and a B.S. from Georgia Tech. Her research includes soft actuators, sensors, medical robotics, haptics, and manipulation. Prof. Han's awards include the MIT Technology Review Innovators Under 35 Asia Pacific, 50 Women in Robotics, Rising Star of RoboSoft, ICRA New Generation Star, APBEC Young Scholar Award, and Best RA-L Paper Award. She serves as associate vice president of Technical Activities Board and as co-chair of Technical Committee on Haptics within IEEE Robotics and Automation Society.

Title

Soft Robotic Technologies for Safe Interaction with Human Tissue

Abstract:

Soft robotic technologies offer a promising approach for safe physical interaction with objects and the human body through compliance and adaptability. However, designing compact, lightweight, and low-power mechanisms that still deliver effective performance remains a key challenge. This talk presents a range of soft actuation technologies developed to address challenges in safe interaction across diverse domains. Examples include a low-power implantable cardiac assist device with design considerations for operating under physiological constraints, an origami-based haptic device enabling realistic tactile feedback for remote manipulation, and a slip sensor integrated surgical grasper for detecting slippage between tissue and the grasper for safe tissue handling.

Clinical Devices & Mechanobiological Tools (ThA1L1S1)

Date: Thursday, 8 October 2026 **Venue:** L1-S1

Time: 09:00 – 11:00 **Chair:** Benjamin Lee

09:30-09:45

Submission ID: 71 - Magnetically actuated hydrogels for mechanically stimulating smooth muscle cells

Guillaume Laffite and Chloe Techens

Abstract: Aortic smooth muscle cells are mechanosensitive, and mechanical stimuli from the extracellular matrix activate mechanotransduction pathways that control their differentiation. Therefore, matrix micromechanics directly affect cellular behaviour, and studying their role in pathologies such as aneurysms is crucial. However, realistic 3D in vitro models of SMC mechanical stimulation in response to local matrix loading are lacking. This study proposes using a magnetically loaded collagen-based matrix to better control the mechanical loading of the fibre network at the cellular level.

Collagen hydrogels were synthesised from bovine solutions to serve as a host matrix for the SMCs. Magnetite nanoparticles (MNPs) with a diameter of 10–20 nm were mixed into the collagen solution at various concentrations prior to gelation. The homogeneity of the nanoparticles within the hydrogels was controlled using confocal and scanning electron microscopy. The mechanical behaviour of the magnetic hydrogels was quantified using shear rheology. The mechanical deformation of the hydrogel under static and dynamic magnetic fields was recorded using optical coherence tomography. Digital volume correlation provided a volumetric strain map of the hydrogel. Finally, cell viability was tested using immunostaining.

Electron microscopy was used to establish a protocol that minimised particle aggregation in the hydrogel while ensuring homogeneous distribution. Additionally, the size of the MNPs was controlled prior to their incorporation into collagen. The stiffness of the hydrogels was not impacted by the addition of MNPs. However, above 3 mg/mL of MNPs, gelation of the hydrogel was partially prevented. The first magnetically actuated tests demonstrated that, at concentrations below 1 mg/mL, the 3 mg/mL collagen hydrogel was only subjected to microscopic deformations.

Magnetic collagen hydrogels, which are typically employed for fibre alignment, can also be effectively utilised as mechanically active matrices to stimulate SMCs. The next step will be to design a dedicated platform for automatic cell dynamic loading.

09:45-10:00

Submission ID: 19 - BALLOON CATHETER CRIMPING SLEEVE AND CRIMPING PROCESS

Alan Goh

Abstract: Percutaneous Balloon Pulmonary Valvuloplasty (BPV) is commonly used for moderate-to-severe congenital Pulmonary Valve Stenosis (PVS), a narrowing of the pulmonary valve that is often seen in newborns. Adult cardiac balloon catheters (thin, flexible tubes with inflatable balloons used to open narrowed valves) are widely available and come in many sizes, but neonatal and pediatric sizes are limited. Young patients aged 0-3 years have a wide range of heart and vestibular (valve entrance) sizes. Under- or overinflation during valvuloplasty (balloon-based surgical widening) carries distinct risks. Limited catheter sizes make it harder for pediatric cardiologists to select the correct balloon. To help solve this, the project proposes crimping (compressing and securing) a Percutaneous Transluminal Valvuloplasty (PTV) balloon catheter to its ideal diameter and reducing excess length.

Method: A proof-of-concept prototype was built and tested against criteria including length reduction and maneuverability, with verification achieved by guiding the crimped catheter through a guidewire jig (a wire simulating the route to the valve). Substitute materials were used to address resource constraints; their limitations were justified, listed, and discussed.

Results show that crimping the balloon shortens its inflation length. Maneuverability is smooth, with slight resistance, as shown in a low-fidelity guidewire jig. However, the factors affecting the accuracy of inflation length reduction remain unclear.

Overall, the proof-of-concept shows that crimping a PTV can reduce inflation length, but more work and evaluation are needed before clinical use.

10:00-10:15

Submission ID: 52 - A Lightweight GhostNet-SVM and Raspberry Pi-Based Embedded System for Real-Time MRI Diagnosis of Knee Meniscus Injuries

Priya Choudhary, Ayush Kumar Bhanja, Debadutta Dash, Ashish Verma, Shiru Sharma and Neeraj Sharma

Abstract: Meniscus injuries are common knee disorders requiring early and accurate diagnosis to prevent progressive joint degeneration. Although magnetic resonance imaging (MRI) is the gold standard for evaluating meniscal abnormalities, manual interpretation is time-consuming and subject to inter-observer variability. This research proposes a radiologist-motivated, lightweight Computer-Aided Diagnostic system that integrates GhostNet for feature extraction and SVM for classification. This study used sagittal fat-suppressed knee MRI data from the Institute of Medical Sciences at Banaras Hindu University. Empirical preprocessing was used to enhance MRI images by highlighting tears, degenerations, and superposition. A hierarchical technique was used for binary classification (normal and diseased), as well as multi-classification of tears, degeneration, and tears with degeneration. We used GhostNet to extract the feature, which was further used by an SVM classifier for classification. We used Grad-CAM for model output interpretability. The trained model was tested on a Raspberry Pi with a display and a GUI for fast meniscus disease diagnosis. The model achieved an area under the curve (AUC) of 1.0 in binary classification and above 0.98 in multi-class classification. The accuracy improved from 66.88% to 92% by pre-processing raw images. For multi-class classification, sensitivity and specificity were measured at 93.75% and 97.64%, respectively. Precision was at 92.78%, and the F1-score was 95.33%. It was evident that the neural network focused on clinically relevant areas of the meniscus. These results illustrate the feasibility of the proposed GhostNet-SVM method for automatic meniscal injury detection, providing high accuracy, transparency, and speed. The deployment on Raspberry Pi also allows for fast, inexpensive, and efficient real-time use as an effective radiologist decision support tool.

Physiological Signals, Speech & Respiratory Modeling (ThA1L1-S2)

Date: Thursday, 8 October 2026 **Venue:** L1-S2

Time: 09:00 – 11:00 **Chair:** Liu Nan

09:00-09:15

Submission ID: 74 - A Frequency-Interval and Neurophysiological Perspective on Vivādi and Non-Vivādi Melakarta Rāgas in Carnatic Music

Harikrishnan Mahesh and Vijayalakshmi P

Abstract: Carnatic music broadly classifies the 72 Melakarta rāgas as Vivādi and non-Vivādi based on the presence or absence of closely spaced swara (note) combinations which tend to be perceived as 'inimical' or 'tense' in Carnatic musicology. This study investigates whether these perceptual and structural differences produce measurable neurophysiological differences during music perception. An EEG-based framework is proposed, wherein experimental neural recordings obtained during controlled listening sessions along with theoretical analysis of interval proximity in terms of psychoacoustic parameters such as critical bandwidth and auditory roughness.

At the theoretical level, we interpret 'vivādi-ness' through principles of auditory roughness and critical bandwidth, with emphasis on the interaction of adjacent R-G and D-N swara combinations within the Melakarta system. This perspective suggests that vivādi-ness tends to be a positional property in interval space shaped by the interaction of closely spaced swaras, rather than a purely categorical musical label.

To examine corresponding neural responses, EEG recordings were obtained from listeners exposed to selected Vivādi and non-Vivādi rāgas under rest-normalized auditory conditions. Event-related potential (ERP) analysis focused on early auditory components (N1 and P2), while time-frequency analysis evaluated theta-band inter-trial phase coherence (ITPC) and spectral synchronization patterns over auditory cortical regions. Initial observations revealed subject-dependent responses. One participant demonstrated significant modulation in N1, P2, and theta-ITPC measures during Vivādi exposure, whereas another exhibited comparatively weak differentiation between conditions. These findings suggest substantial inter-individual variability in the neural perception of Vivādi interval structures.

This study establishes a framework connecting Carnatic raga structure, psychoacoustic interval tension, and neural dynamics. Beyond contributing to cultural neuroscience, the proposed approach may support future investigations into affective auditory processing and culturally grounded interventional frameworks.

09:15-09:30

Submission ID: 120 - An sEMG-Based Analysis of Malayalam Syllables using Machine Learning Methods

Alfiya Parveen P C, Remya R. Nair and Venugopal G

Abstract: Surface electromyographic (sEMG) signals are widely used for the analysis of neuromuscular activity. An sEMG-based speech syllable recognition has emerged as an efficient alternative communication approach for individuals with speech impairments. This study mainly proposes an analysis of Malayalam syllables using sEMG signals acquired from several muscles involved in speech articulation. In this work, signals corresponding to 15 Malayalam syllables are recorded using non-invasive electrodes placed around the face and neck. The collected signals are pre-processed, and then the features, including mean absolute value (MAV), root mean square (RMS), waveform length (WL), integrated EMG (IEMG), mean frequency (MNF), median frequency (MDF), variance (VE), and spectral entropy (SE), were extracted. Robust feature scaling and mutual information-based feature selection are applied to improve model performance. Further, the effectiveness of extracted features is analysed using machine learning algorithms, including random forest (RF), decision tree (DT), K-nearest neighbour (kNN), and XGBoost. Experimental results demonstrate that kNN achieves the highest test accuracy of 86.51%, outperforming RF (86.32%), XG Boost (72.83%) and DT (24.03%). Syllable o (ഒ) achieves the highest precision value of 0.97, indicating accurate prediction. Recall values of 0.94 are observed for ehh (ഹ്) and o(ഒ). Other syllables like ee (ഈ), ai (ഐ), and uu (ഊ) show low precision values around 0.76 to 0.82. The proposed research shows the feasibility of classifying 15 Malayalam syllables using sEMG signals based on time and frequency domain features. Further, such a system can support the development of assistive tools for individuals with various speech-related disorders.

09:30-09:45

Submission ID: 108 - A First Object-Detection Approach to Apnea-Hypopnea Event Estimation from Single-Lead ECG Using 1D DETR

Che-Wei Lin and Febryan Setiawan

Abstract: Background: Obstructive sleep apnea (OSA) affects 10–20% of adults yet remains largely undiagnosed due to the cost and inaccessibility of polysomnography. While prior ECG-based deep learning approaches estimate the apnea-hypopnea index (AHI) by aggregating per-epoch classifications, this discards the event-level temporal structure that defines clinical OSA severity.

Methods: We propose a novel object-detection paradigm for AHI estimation, the first to apply the Detection Transformer (DETR) architecture to single-lead ECG. From R-peak-derived features—R-R intervals, peak amplitude, and instantaneous heart rate—our 1D DETR (0.9 million parameters) predicts apnea-hypopnea events as bounding boxes over 90-second windows using 20 learnable queries. A novel post-processing pipeline maps per-night detection density to clinical AHI via leave-one-out quantile-mapped calibration, addressing systematic miscalibration on imbalanced cohorts.

Results: The model was validated across three protocols on two datasets. On NCKUHSC (N=50, 50-fold LOSO), we achieved a concordance correlation coefficient (CCC) of 0.857. On SHHS, we report results at three scales: 250-fold LOSO (CCC=0.725, matching literature protocols), 1,000-subject 10-fold cross-validation (CCC=0.505), and a 5-fold stratified evaluation on the full SHHS-1 cohort (N=5,511; CCC=0.459)—to our knowledge the largest such ECG-based validation reported. Quantile-mapped calibration provided consistent +0.05–0.10 CCC gains over linear calibration.

Conclusion: The object-detection paradigm yields competitive ECG-based AHI estimation with a transformer model compact enough for on-device deployment, paving the way toward edge-based wearable OSA screening.

09:45-10:00

Submission ID: 29 - VOF-CFD Study of Non-Newtonian Mucus Transport in a Patient-Specific Airway

Ruizhi Tao and Yan Cai

Abstract: Chronic Obstructive Pulmonary Disease (COPD) currently affects over 500 million people worldwide. As the primary active defense mechanism of the airways, the Mucociliary Clearance (MCC) system plays a pivotal role throughout the onset, progression, and prognosis of COPD. Despite its clinical significance, the intricate relationship between quantitative indicators—such as mucus physical properties and clearance efficiency—and clinico-pathological features remains poorly understood. Furthermore, existing MCC research often relies on overly idealized models.This study employs Computational Fluid Dynamics (CFD) to quantitatively elucidate the mechanisms linking abnormal MCC to disease progression. Using high-resolution CT images from a COPD patient, a three-dimensional airway model was reconstructed. We utilized the Volume of Fluid (VOF) method and CFD simulations to investigate air-mucus interactions during resting breathing, focusing on mucus plaque formation, bronchial obstruction, transport dynamics, and clearance efficiency.The results reveal significant temporal variations ($p<0.05$) in mucus thickness between inspiratory and expiratory phases, particularly at airway bifurcations. Due to shear-thinning effects, mucus plugging increases local viscosity, further impeding clearance in COPD patients. Notably, our findings indicate that under resting breathing conditions, the MCC efficiency in COPD patients is less than half that of healthy individuals, driven by pathological changes in mucus production and rheology. Additionally, impaired ciliary beat frequency exacerbates transport failure, especially at higher viscosities. This study deepens the understanding of mucus transport characteristics across different COPD stages and provides theoretical support for personalized diagnosis and treatment strategies based on MCC status.

Plenary Lecture 7

Date: Thursday, 8 October 2026

Venue: NAK Auditorium

Time: 11:30 - 12:15

Chair: Andrew Holle



Wenting ZHAO

Associate Professor, Chemical Engineering and Biotechnology;
Principal Investigator, Institute for Digital Molecular Analytics and Science (IDMxS)
Nanyang Technological University

Dr. Wenting Zhao is a faculty member in the School of Chemistry, Chemical Engineering, and Biotechnology at Nanyang Technological University (Singapore) and a Principal Investigator in the Institute of Digital Molecular Analytics and Science (IDMxS). She received her Ph.D. degree in Bioengineering from the Hong Kong University of Science and Technology and completed her postdoc training at Stanford University. Her research group aims to reveal the nanoscale interplay between membrane morphology and protein assembly using advanced nanofabrication and nanomaterials. Specific focuses of her studies include nanoscale topography-guided protein clustering and complex assembly, as well as their impacts on disease progression, such as cancer progression, viral replication, and immune activation.

Title

Probing Subnuclear Deformation in Cancer Cells

Abstract:

The nucleus actively responds to mechanical perturbation with its subnuclear architecture reflecting changes associated with malignancy, chromatin organization, and cell-to-cell heterogeneity. However, many informative nuclear features, including wrinkles, grooves, lamin reorganization, and chromatin-associated mechanical fluctuations, occur at or below optical resolution and are therefore challenging to quantify systematically. In this talk, I will introduce our efforts in developing vertically aligned nanopillar arrays as an effective tool for transforming otherwise stochastic subnuclear irregularities into spatially organized deformation patterns amenable to quantitative analysis. By imposing defined nanoscale perturbations on the nuclear envelop, nanopillars generate characteristic ring- or line-like deformation patterns, whose anisotropy reports local differences in nuclear stiffness and lamina organization. Using this platform, we found that cancer cells with different malignancy display distinct deformation responses: low-malignancy cells predominantly form isotropic rings, whereas highly malignant cells exhibit aligned, anisotropic patterns, allowing single-cell assessment of mechanical heterogeneity and drug response. In neuroblastoma, coherency analysis of nanopillar-induced deformation further identified mechanically distinct cellular subpopulations associated with lamin A variability and differential motility that are poorly resolved by whole-nucleus morphometrics. More recently, nanopillar-induced indentation measurements uncovered an unexpected transient nuclear stiffening driven by chromatin decompaction. This mechano-epigenetic coupling is weakened in aggressive cancers, implicating altered chromatin–lamina mechanics as a physical hallmark of malignancy. Overall, nanopillar arrays provide a robust platform for probing subnuclear mechanical properties, mapping cellular heterogeneity, and quantifying rapid chromatin-driven mechanical transitions.