Health Technology Innovations for Global Impact

SYMPOSIUM 2018

23-24 July
MD11 Auditorium
10 Medical Drive
Singapore 117597
INTRODUCTION

BIGHEART Symposium 2018 aims to explore practical technology solutions for global health, promoting interactions among researchers, clinicians, engineers, computer scientists, industry and policy makers towards effective translation.

ABOUT BIGHEART

Established in 2017, the Biomedical Institute for Global Health Research & Technology (BIGHEART) is a new institute at the National University of Singapore (NUS) that conducts interdisciplinary research to transform education and shape the future of healthcare by the creative convergence of life sciences, physical sciences, engineering, medicine, and the arts for innovative healthcare technologies.
Contents

5 Organising Committee & Sponsor Acknowledgement

6 Programme

10 Speakers – 23 July (Day 1)

25 Speakers – 24 July (Day 2)

37 Panel Discussion

38 Poster Presentations
Organising Committee

Professor Luke P. LEE
Founding Director, BIGHEART
National University of Singapore

Professor Chwee Teck LIM
Acting Director, BIGHEART
National University of Singapore

Dr Chia-Hung CHEN
Dr Tze Ping LOH
Dr Huilin SHAO
Dr John HO
Principal Investigators, BIGHEART
National University of Singapore

Sponsor Acknowledgement

Gold Sponsor

Other Acknowledgements:
Donny LIANG for operational management, ZHENG Yu for overseeing logistical and travel arrangements, and to Freddie LIM and Zac GOH for producing the programme booklet and publicity materials.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:15am</td>
<td>Registration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00am</td>
<td><strong>Session 1: Opening Session</strong> Chair: Luke P. LEE</td>
<td><strong>Opening Address</strong></td>
<td>Chwee Teck LIM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Luke P. LEE</td>
</tr>
<tr>
<td>9:10am</td>
<td></td>
<td>To See the World's Health in a Grain of SANDs*</td>
<td>Luke P. LEE</td>
</tr>
<tr>
<td>9:40am</td>
<td><strong>Plenary Talk</strong></td>
<td>Convergence: How Unexpected Partnerships in Engineering and Medicine Have Enabled the Artificial Pancreas</td>
<td>Francis J. DOYLE III</td>
</tr>
<tr>
<td>10:25am</td>
<td>Refreshment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:45am</td>
<td><strong>Session 2: Single Cell Platforms and Molecular Diagnostics</strong> Chair: Yi-Chin TOH</td>
<td>A Microfluidic Platform for Single-Cell Wound Repair Studies</td>
<td>Sindy TANG</td>
</tr>
<tr>
<td>11:15am</td>
<td></td>
<td>Nanosensor Platforms for Molecular Analyses of Circulating Biomarkers</td>
<td>Huilin SHAO</td>
</tr>
<tr>
<td>11:35am</td>
<td></td>
<td>Ultrafast Single-Cell Level Enzymatic Tumour Profiling</td>
<td>Chia-Hung CHEN</td>
</tr>
<tr>
<td>11:55am</td>
<td></td>
<td>Phenotype-Driven Precision Oncology (PDPO) – Guiding Clinical Decisions One Patient at a Time</td>
<td>Ramanuj DASGUPTA</td>
</tr>
<tr>
<td>12:15pm</td>
<td></td>
<td>Deciphering Cellular Heterogeneity with Single Cell Assays for Precision Medicine</td>
<td>Lih Feng CHEOW</td>
</tr>
<tr>
<td>12:35pm</td>
<td><strong>Poster Session &amp; Lunch Break</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Session 3: Microfluidics and Materials Chemistry for Medical Applications

**Chair: Chia-Hung CHEN**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:30pm</td>
<td>Profiling Cellular-to-Molecular Diversity Using Electrophoretic Cytometry</td>
<td>Amy E. HERR</td>
</tr>
<tr>
<td>3:00pm</td>
<td>Aggregation-Induced Emission: Materials and Biomedical Applications</td>
<td>Bin LIU</td>
</tr>
<tr>
<td>3:20pm</td>
<td>Rapid Pathogen Detection – Fantasy or Reality?</td>
<td>Catherine ONG</td>
</tr>
<tr>
<td>3:40pm</td>
<td>How Good Must a Clinical Test Be: A Perspective of Biological Variation</td>
<td>Tze Ping LOH</td>
</tr>
<tr>
<td>4:00pm</td>
<td>Refreshment</td>
<td></td>
</tr>
</tbody>
</table>

## Session 4: Wearables and Wireless Devices for Translational Medicine

**Chair: Lih Feng CHEOW**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30pm</td>
<td>From Next-Generation Phones to Wearables</td>
<td>Li Shiuan PEH</td>
</tr>
<tr>
<td>4:50pm</td>
<td>Wideband Wireless Power Transfer for Human-Involved Environment</td>
<td>Shaoying HUANG</td>
</tr>
<tr>
<td>5:10pm</td>
<td>Human-Inspired Sensory Systems</td>
<td>Benjamin TEE</td>
</tr>
<tr>
<td>5:30pm</td>
<td>Wireless Technologies for Bioelectronic Therapies</td>
<td>John HO</td>
</tr>
<tr>
<td>5.50pm</td>
<td>Group Photo Taking</td>
<td></td>
</tr>
<tr>
<td>7.00pm</td>
<td>Appreciation Dinner (by invitation only)</td>
<td></td>
</tr>
</tbody>
</table>
### DAY 2 TUESDAY, 24 JULY 2018

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 1: Biophysics and Genomics</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:55am</td>
<td>Opening</td>
</tr>
</tbody>
</table>
| 9:00am | Better Pathology Through Computational Microscopy  
Chang Huei YANG |
| 9:40am | Technologies and Strategies for Cancer: What Does the Oncologist Need?  
Boon Cher GOH |
| 10:00am | Systems Biology of Stem Cells  
Huck Hui NG |
| 10:20am | Refreshment                      |

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 2: Translational Engineering and Medicine</th>
</tr>
</thead>
</table>
| 10:40am | Title to be announced  
David WEITZ |
| 11:20am | Overcoming the Valley of Death  
Khee Chee SOO |
| 11:40am | The Future of Diagnostics and Surveillance  
Rosemary TAN |
| 12:00am | Research Translation: A Personal Journey and Some Perspectives on Improving Research Translation in NUS  
Freddy BOEY |
| 12:20pm | CURATE.AI: Optimising Clinical Combination Therapy with Artificial Intelligence and Digital Medicine  
Dean HO |
# Day 2 Continued

## Panel Discussion

**Chair:** Luke P. Lee

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:40pm</td>
<td>Clinical Applications for Global Impact</td>
<td>Luke P. Lee, David Weitz, Freddy Boey, Dean Ho, Boon Cher Goh, Khee Chee Soo, David Sun, Rosemary Tan</td>
</tr>
</tbody>
</table>

## Poster Session & Lunch Break

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:40pm</td>
<td>refreshment session</td>
</tr>
</tbody>
</table>

## Session 3: Organ-On-Chip for Precision Medicine

**Chair:** John Ho

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00pm</td>
<td>Data Analytics in Biomedical Applications</td>
<td>Hanry Yu</td>
</tr>
<tr>
<td>3:20pm</td>
<td>Engineering Heterotypic Cellular Interactions for Disease Modeling and Drug Testing</td>
<td>Yi-Chin Toh</td>
</tr>
<tr>
<td>3:40pm</td>
<td>Understanding Genetic Susceptibility Using Personalised Vascular Models</td>
<td>Christine Cheung</td>
</tr>
<tr>
<td>4:00pm</td>
<td>Future of Transfusion Medicine – Human Induced Pluripotent Stem Cells Derived Blood?</td>
<td>Jaichandran Sivalingam</td>
</tr>
<tr>
<td>4:20pm</td>
<td>Poster Award</td>
<td></td>
</tr>
<tr>
<td>4:25pm</td>
<td>Closing Remarks</td>
<td></td>
</tr>
<tr>
<td>4:40pm</td>
<td>Tour and reception at BIGHEART (by invitation only)</td>
<td></td>
</tr>
</tbody>
</table>
Luke P. LEE

Professor
Founding Director, Biomedical Institute for Global Health Research and Technology (BIGHEART)
National University of Singapore

To See the World’s Health in a Grain of SANDs*

In this talk, I will present how to gaze at the health status of humanity and the Earth in a grain of SAND* (Speedy Analytical Nano-optofluidic Diagnostic system) for predictive preventive medicine. Since the future of preventive health is in the palm of our hands, smart SANDs will be discussed along with the vision of smart digital healthcare systems for both developing and developed countries. Smart SANDs comprise three key elements of precision medicine: (1) photonic amplifications of NA biomarkers; (2) signal amplifications of protein biomarkers; (3) a self-contained sample preparation and liquid biopsy on chip, which allows a speedy sample-to-answer readout platform. Second, I will also present current progress of 3D organoids MAP (Microphysiological Analysis Platforms) that can modulate signaling pathways, and capture molecular and electrophysiological imaging. Organoid MAP provides an ideal model to address fundamental questions of molecular organogenesis as well as flow-induced epigenetic gene expressions. In addition, patient-derived organoids can recapitulate patient responses and help personalized therapy. Current development of mini-brains MAP, pancreatic islets MAP, and kidney organoids MAP will be discussed. Smart SANDs and organoids MAPs by the convergence of biology, chemistry, physics, and technology will impact on life sciences and medicine.

BIOGRAPHY
Professor Luke P. Lee received both his BA and Ph.D. from UC Berkeley. He joined the faculty at the UC Berkeley in 1999 after more than a decade of industry experience. He became the Lester John and Lynne Dewar Lloyd Distinguished Professor of Bioengineering in 2005. He also served as the Chair Professor in Systems Nanobiology at the ETH Zürich from 2006 to 2007. He became Arnold and Barbara Silverman Distinguished Professor at Berkeley in 2010 and was reappointed again 2015. From 2016 to 2017 Professor Lee was Tan Chin Tuan Centennial Professor, Director of the Biomedical Institute for Global Healthcare Research & Technology (BIGHEART), and Associate President (International Research and Innovation) at the National University of Singapore. He is a Fellow of the Royal Society of Chemistry and the American Institute of Medical and Biological Engineering. His work at the interface of biological, physical, and engineering sciences for medicine has been recognised by many honors including the IEEE William J. Morlock Award, NSF Career Award, Fulbright Scholar Award, and the HoAm Prize. Lee has over 350 peer-reviewed publications and over 60 international patents filed. His current research interests are quantum biological electron transfers in living organisms, molecular diagnostics of neurodegenerative diseases, and in vitro neurogenesis, with a focus both on studying fundamental quantum nanobiology and on solving ill-defined problems of global healthcare.
In this talk, I will make a case that world class universities have a unique opportunity to explore new pathways that result from not only the convergence of engineering and applied sciences with the life and physical sciences, but also from embedding engineering into design, business, law, medicine, and the arts and humanities. Through collaborations with other researchers, and corporate and foundation partners, engineers and applied scientists brings discovery and innovation directly to bear on improving human life and society. Such a revolution is taking root in multiple universities around the globe, and adopts the unifying principle of Convergence - the merging of distinct technologies, industries, or devices into a coherent whole. Experiences from Harvard’s multiple schools will be highlighted, illustrating the power of a convergence approach. I will highlight two examples from my own research lab - the artificial pancreas and control of the circadian clock. In the last 15 years, our research group has been working with medical doctors on clinical demonstrations of feedback control algorithms for the artificial pancreas. Such control principles are also beginning to find root in another biomedical application - the regulation of the timekeeping mechanism responsible for circadian rhythms.

BIOGRAPHY
Frank Doyle is the John A. Paulson Dean of the Paulson School of Engineering and Applied Sciences at Harvard University, where he also is the John A. & Elizabeth S. Armstrong Professor. Prior to that he was the Mellichamp Professor at UC Santa Barbara, where he was the Chair of the Department of Chemical Engineering, the Director of the UCSB/MIT/Caltech Institute for Collaborative Biotechnologies, and the Associate Dean for Research in the College of Engineering. He received a B.S.E. degree from Princeton, C.P.G.S. from Cambridge, and Ph.D. from Caltech, all in Chemical Engineering. He was the President for the IEEE Control Systems Society in 2016, and was the Vice President of the International Federation of Automatic Control from 2014-2017. In 2005, he was awarded the Computing in Chemical Engineering Award from the AIChE for his innovative work in systems biology, and in 2015 received the Control Engineering Practice Award from the American Automatic Control Council for his development of the artificial pancreas. In 2016, he was inducted as a Fellow into the National Academy of Medicine for his work on biomedical control. His research interests are in systems biology, network science, modeling and analysis of circadian rhythms, and drug delivery for diabetes.
Wound healing is an essential biological process for maintaining homeostasis and, ultimately, for survival. Cells, for example in skeletal muscles, are wounded regularly under physiological conditions. Understanding wound response at the single-cell level is critical for determining fundamental cellular functions needed for cell repair and survival, and ultimately, how wound-induced diseases such as muscular dystrophies develop. We aim to investigate the mechanisms underlying single-cell wound healing, by employing a microfluidic platform and using Stentor coeruleus as a model organism. S. coeruleus, a single cell capable of recovering from drastic wounds within 24 hours, is selected as a model because of its robust wound healing capacity, which extends to very large wounds, and the ability to perform gene knockdown experiments in a high-throughput manner compared with other cellular wound-healing models. As such, a range of new biological questions about cellular function can be answered by developing it as a model organism. Nevertheless, key barriers to answering these questions are the lack of a tool that can introduce wounds reproducibly to a large number of cells and a quantitative assay to measure healing efficiency. This talk focuses on our recent effort on developing a microfluidic platform for the manipulation of the cell and the reproducible wounding of the cell. We demonstrate a microfluidic guillotine for bisecting single cells in a continuous flow with a cutting throughput >200x faster than current methods. It enables new studies such as time-course mechanistic and RNAi measurements requiring >100 cells prepared in a synchronized stage of their repair process.

BIOGRAPHY
Dr Sindy K.Y. Tang joined the faculty of Stanford University in September 2011 as an assistant professor in the Department of Mechanical Engineering. She received her Ph.D. from Harvard University in Engineering Sciences under the supervision of Prof. George Whitesides. Her lab at Stanford works on the fundamental understanding of fluid mechanics and mass transport in microfluidic systems, and the application of this knowledge towards problems in biology, rapid diagnostics for health and environmental sustainability. The current areas of focus include the hydrodynamics of concentrated emulsions in confinements, interfacial mass transport and self-assembly, and ultrahigh throughput opto-microfluidic systems for biochemical sensing and diagnostics, water and energy sustainability, and single-cell wound healing studies. Dr Tang’s work has been recognized by multiple awards including the NSF CAREER Award, 3M Nontenured Faculty Award, and the ACS Petroleum Fund New Investigator Award.
Huilin SHAO
Assistant Professor
Biomedical Institute for Global Health Research and Technology (BIGHEART)
Department of Biomedical Engineering
National University of Singapore

Nanosensor Platforms for Molecular Analyses of Circulating Biomarkers

The growing emphasis on personalized medicine significantly increases the need to analyze key molecular markers. In comparison to tissue biopsies, circulating biomarkers (liquid biopsies) can be conveniently and repeatedly obtained from biofluids with minimal complications. In particular, exosomes have recently emerged as a promising circulating biomarker. Exosomes are nanometer-sized membrane vesicles actively shed off by cells and possess unique advantages: they abound in biofluids and harbor diverse molecular contents (e.g., proteins and nucleic acids). In this talk, I will describe various nanosensor systems that we have developed for quantitative analyses of diverse exosome targets. By enabling rapid, sensitive and cost-effective detection of circulating biomarkers, these platforms could significantly expand the reach of preclinical and clinical research, in informing therapy selection, rationally directing trials, and improving sequential monitoring to achieve better clinical outcomes.

BIOGRAPHY
Dr Huilin Shao received her BA from Cornell University, with a double major in Biological Sciences and in Physics. She completed her dual Ph.D. (Biophysics) at Harvard University and Ph.D. (Medical Engineering) from Harvard-MIT Health Sciences and Technology (HST) under the guidance of Profs. Ralph Weissleder and Robert S. Langer. After a postdoctoral fellowship with Prof. Hakho Lee at Massachusetts General Hospital, Harvard Medical School, Dr. Shao returned to Singapore and started her research group. She is currently Principal Investigator, Biomedical Institute for Global Health Research and Technology (BIGHEART), and Assistant Professor, Departments of Biomedical Engineering and Surgery, National University of Singapore. Her research focuses on developing integrated nanotechnology-based platforms for molecular analyses of novel biomarkers. Her work has been published in top journals such as Nature Biotechnology, Nature Medicine, Nature Communications and highlighted in major reviews and popular news media.
Chia-Hung CHEN
Assistant Professor
Biomedical Institute for Global Health Research and Technology (BIGHEART)
Department of Biomedical Engineering
National University of Singapore

Ultrafast Single-Cell Level Enzymatic Tumor Profiling

Precision medicine refers to giving the right therapeutics, to the right patient, at the right time. In the context of cancer, successful implementation of precision medicine, requires treatment individualization not only taking into account patient and tumor factors, but also tumor heterogeneity and tumor evolution over time. In this study, a continuous flow microfluidic device was developed as a functional flow cytometer (-FACS) to detect secreted multiplexed protease activities at single cell resolution. The individual cells from patient samples are encapsulated within water-in-oil droplets for single cell multiplexed protease assay. We modified FRET (fluorescence resonance energy transfer)-based substrates and nano sensors to accommodate different fluorescent pairs with distinct excitation and emission wavelengths to obtain multiple signals from droplets containing single cells. To infer a quantitative profile of multiple proteolytic activities from single cells, we applied the computational method Proteolytic Activity Matrix Analysis (PrAMA). The capability to determine multiple protease activities at single cell resolution has the potential to characterize tumor progress of individual patients for therapeutics.

BIOGRAPHY
Dr Chen is developing a research program focused on integrative droplet microfluidic platforms for clinical enzyme measurement and single cell phenotype characterization for biomedical applications. Compared with most current fluidic platforms using gene sequence for diagnosis, microfluidic enzyme assay offers unique advantage in rapid measurement to characterize biological fluids for on-time precision medicine. With this program, he has delivered promising research outcomes, including 40 papers in international journals including Nature Communications, PNAS, JACS, Lab on a Chip, Advanced Materials, Advanced Functional Materials, Biosensors and Bioelectronics, and Analytical Chemistry. Dr Chen has collaborated with clinicians/researchers at the National University Hospital of Singapore (NUHS) and Massachusetts General Hospital (MGH) to develop the droplet device. One of his projects is now sponsored by an industrial partner, MediaTek, in Singapore and aims to develop a wearable microfluidic sensor for personal care at home. Moreover, he has secured an external grant of ~3.5M SGD to support research activities and was nominated by the committee in Royal Society of Chemistry (RSC), as an Emerging Investigator in Lab on a Chip.
Ramanuj DASGUPTA

Group Leader
Cancer Therapeutics and Stratified Oncology
Genome Institute of Singapore

Phenotype-Driven Precision Oncology (PDPO) – Guiding Clinical Decisions One Patient at a Time

Precision medicine requires treatment individualization taking into account not only patient and tumor factors, but also intra-tumor heterogeneity and tumor evolution through time. We propose that the next generation of personalized precision drugs will come from the development of physiologically relevant "real- or accelerated-time" models of individual patient-specific tumors, that mimic tumor pathology, and progression. Importantly, such models could serve as a powerful personalized screening platform for clinical genomics-informed predictions for genetic and therapeutic vulnerabilities that can subsequently be used to provide testable therapeutic and diagnostic modalities in the clinic. With that in mind, we have developed a bank of primary patient-derived xenograft (PDx), and microtumor/primary cell line (PDmT/PDC) models of oral squamous cell carcinomas (OSCCs), and colorectal cancers (CRCs) that are amenable to high-throughput and high-content screens (HTS/HCS). Using comprehensive tumor profiling studies, and single cell transcriptomics in conjunction with image-based phenotypic screens, we are beginning to uncover novel therapeutic vulnerabilities, as well as key driver genes/pathways and their function that may regulate cancer metastasis and evolution of drug resistance, the two most common causes of cancer-related mortality.

BIOGRAPHY
Dr DasGupta received his Bachelor’s degree in Chemistry from St. Stephen’s College, Delhi, and a Tripos degree in Genetics from Cambridge University, UK. He then went on to pursue Ph.D. in Developmental and Stem cell Biology at the University of Chicago under the guidance of Dr Elaine Fuchs. Dr DasGupta conducted his postdoctoral studies at the Harvard Medical School in Dr Norbert Perrimon’s lab. He started his own laboratory at NYU School of Medicine/Cancer Institute in early 2006. Dr DasGupta is the recipient of several national and international awards such as the Harold Weintraub award, Breast Cancer Research Foundation Concept Award (USA), NYSTEM Idea Award, ACS Research Scholar Award (USA), March of Dimes Research Grant, the NYC BioAccelerate Prize, Wellcome Trust International Senior Research Fellowship, amongst others. Major focus in the DasGupta laboratory is to bring “Phenotype-driven Precision Oncology” to the clinic by actively collaborating with clinicians to build the next-generation of HTS-amenable patient personalized cancer models for the identification of novel therapeutic opportunities, and guide clinical practice in real-time. The overall goal is to define the function, and underlying mechanisms of intra-tumor heterogeneity (ITH) and tumor evolution in the acquisition of treatment resistant, and metastatic phenotypes.
Deciphering Cellular Heterogeneity with Single Cell Assays for Precision Medicine

The human body is an amazing feat where trillions of cells of different cell types work together seamlessly to enable specific functions. Understanding the molecular mechanisms of these different cells is the key to understanding the basis of human health and conditions that leads to disease. To date, however, biological measurements are largely applied to bulk cells, which mask important cell-to-cell variations in tissues that give rise to diverse phenotypes.

In this presentation, I will describe our efforts in developing single cell epigenetic and multimodal analysis to identify cellular heterogeneity in complex diseases such as cancer. These assays allow us to dissect the tumor microenvironment and recover tumor-specific epigenetic signatures. I will also present ongoing work on genome-wide profiling of genetic and epigenetic aberrations in single cells for applications in precision medicine.

BIOGRAPHY

Lih Feng Cheow is an assistant professor in the Department of Biomedical Engineering at the National University of Singapore. He received his PhD in Electrical Engineering and Computer Science from Massachusetts Institute of Technology, and was a recipient of the Helen Carr Peake Award in 2011.

His current research interest is in developing technology platforms to perform precision measurements of multiple modalities (e.g. genetic, epigenetic, transcriptomics) in individual cells, and inventing innovative technologies for bio-sample preparation and disease diagnosis to meet the evolving healthcare needs of society.
From fundamental biosciences to applied biomedicine, high dimensionality data is increasingly important. In single-cell measurement tools, microfluidic design has underpinned the throughput, multiplexing and quantitation needed for this rich data. Genomics and transcriptomics are leading examples. Yet, measurement of proteins lags. While proteins and their dynamic forms are the downstream effectors of function, the immunoassay remains the de facto standard. We posit that to realize the full potential of high-dimensionality cytometry, new approaches to protein measurement are needed. I will describe our ‘electrophoretic cytometry’ tools that increase target selectivity beyond simple immunoassays. In fundamental engineering and design, I will discuss how the physics and chemistry accessible in microsystems allow both the “scale-down” of electrophoresis to single cells and the “scale-up” to concurrent analyses of large numbers of cells, emphasizing on precision control in passive systems, with no pumps or valves. Precise reagent control allows for integration of cytometry with sophisticated sample preparation - the unsung hero of measurement science. Lastly, I will link our research to driving cytology needs, including better understanding of the development of breast cancer drug resistance and protein signaling in individual circulating tumor cells. Taken together, we view microfluidic design strategies as key to advancing protein measurement performance needed to address unmet gaps in quantitative biology and precision medicine.

BIOGRAPHY
Amy E. Herr is the Lester John & Lynne Dewar Lloyd Distinguished Professor of Bioengineering at UC Berkeley and a Chan Zuckerberg Biohub Investigator. Prior to joining UC Berkeley, she was a staff member at Sandia National Labs, earned Ph.D. and M.S. degrees in Mechanical Engineering from Stanford University, and completed her B.S. in Engineering and Applied Science with honors from the California Institute of Technology. Her research has been recognized by the NIH New Innovator Award, NSF CAREER Award, Alfred P. Sloan Fellowship (Chemistry), and DARPA Young Faculty Award, & Visionary Award from the City of Berkeley and named to the Analytical Scientist’s top 100 most influential people in analytical science. Prof. Herr has chaired the Gordon Research Conference (GRC) on the Physics & Chemistry of Microfluidics and will chair microTAS 2020. She is an elected Fellow of the American Institute of Medical and Biological Engineering (AIMBE), an entrepreneur, and was recently elected to the US National Academy of Inventors. Her research program lies at the intersection of engineering design, analytical chemistry, and targeted proteomics - with a recent focus on cytometry spanning fundamental biological to clinical questions.
Bin LIU

Professor
Head, Department of Chemical and Biomolecular Engineering
National University of Singapore

Aggregation-Induced Emission: Materials and Biomedical Applications

The recent years have witnessed the fast growth of fluorogens with aggregation-induced emission characteristics (AIEgens) in biomedical research. The weak emission of AIEgens as molecular species and their bright luminescence as nanoscopic aggregates distinguish them from conventional organic luminophores and inorganic nanoparticles, making them wonderful candidates for many high-tech applications. In this talk, we summarize our recent AIE work in the development of new fluorescent bioprobes for biosensing and imaging. The simple design and fluorescence turn-on feature of the molecular AIE bioprobes offer direct visualization of specific analytes and biological processes in aqueous media with higher sensitivity and better accuracy than traditional fluorescence turn-off probes. The AIE dot probes with different formulations and surface functionalities show advanced features over quantum dots and small molecule dyes in noninvasive cancer cell detection, long term cell tracing, and vascular imaging. In addition, our recent discovery that AIEgens with high brightness and efficient reactive oxygen species generation in aggregate state further expanded their applications to image-guided cancer surgery and therapy.

BIOGRAPHY

Prof. Bin Liu received her BS degree and Ph.D. degree from Nanjing University and National University of Singapore, respectively, before her postdoctoral training at the University of California, Santa Barbara. She joined the NUS in late 2005, where she is currently Professor and Department Head of Department of Chemical and Biomolecular Engineering. For her research focusing on organic nanomaterials for biomedical and energy applications, Prof. Liu has received many highly prestigious awards, including Singapore President’s Young Scientist Award 2008, Asia Rising Star 2013, BASF Materials Award 2014, Materials in Society Lectureship 2015, Singapore President’s Technology Award 2016, and Asian Scientist Top 100 List in 2017. Prof. Liu was named as The World’s Most Influential Minds and the Top 1% Highly Cited Researchers in Materials Science by Thomson Reuters during 2014-2017. She is the Fellow of Singapore Academy of Engineering, Asia-Pacific Academy of Materials, and the Royal Society of Chemistry.
Catherine ONG

Assistant Professor
Biomedical Institute for Global Health Research and Technology (BIGHEART)
National University of Singapore
Consultant, National University Hospital

Rapid Pathogen Detection - Fantasy or Reality?

Tuberculosis (TB) and antimicrobial resistance are key focus areas of the World Health Organisation. In bloodstream infections, turn-around time to identification and antibiotic sensitivity testing is 2 days, while the gold-standard test for TB culture and antibiotic sensitivity testing takes up to 8 weeks. Delays in diagnosis and initiation of appropriate antimicrobials contribute to morbidity and mortality in patients, and in TB perpetuates transmission of this potentially fatal infection. In this talk, I shall review the current state of TB and pathogen diagnostics and their limitations. The role of circulating cell-free *Mycobacteria tuberculosis* DNA will be discussed. Finally, the future of rapid pathogen detection both in TB and bloodstream infections will be explored.

**BIOGRAPHY**

Dr Catherine Ong is a Clinician-Scientist, Assistant Professor at NUS, Consultant in the Division of Infectious Diseases at National University Hospital and Visiting Consultant at the Singapore Tuberculosis Control Unit. She is Vice-President of Society of Infectious Disease (Singapore), Secretary of Chapter of Infectious Disease Physicians, Academy of Medicine, and serves the Ministry of Health on committees. She is Principal Investigator both in BIGHEART and Department of Medicine, Yong Loo Lin School of Medicine, with research focus in TB and rapid detection of pathogens and antimicrobial resistance.

Dr Ong was funded on the competitive NRF-MOH Healthcare Research Scholarship for her PhD in 2013 on TB host immunopathology with Professor Jon Friedland at Imperial College London. This led to 8 awards including the American Society for Leukocyte Biology Student Presidential Award, the Bill and Melinda Gates Global Health Travel Award and the Infectious Diseases Society of America International Investigator Award. She has held the 2014 Exxon-Mobil NUS Research Fellowship and the 2015 NMRC Transition Award. Her laboratory focuses on translational infectious diseases research on host-pathogen interactions, biomarker discovery and host-directed therapies with funds from the NMRC, Singapore Infectious Diseases Initiative and the National University Health System.
Biomarker discovery is the cornerstone of laboratory medicine advancement. They allow the clinical and scientific community to better understand (patho) physiology of a disease. They empower clinicians to better manage patients through more robust, precise and accurate tools to diagnose, monitor, treat and prognosticate a condition. Clinical translation of a novel biomarker is an exciting yet arduous journey. One of the uncertainties surrounding this adventure is “how good must my test be?”

In this lecture, we will initially explore a new practical framework proposed by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) for identifying unmet clinical needs for biomarkers. Following this, we will address the question of the clinical requirements of analytical performance of a biomarker using the biological variation concept.

**BIOGRAPHY**
Dr Tze Ping Loh was born in Penang, Malaysia. He obtained his undergraduate medical degree from the Royal College of Surgeons in Ireland-Penang Medical College, and undertook his fellowship (Royal College of Pathologists, UK) training in chemical pathology at the National University Hospital and Singapore General Hospital. He currently serves as Consultant, Director of Informatics and Research Director at Department of Laboratory Medicine, National University Hospital, and Director of Department of Laboratory Medicine, Alexandra Hospital, Singapore. His areas of interest include biomarker discovery and translational research (molecular diagnostics and chemical pathology), outcome research of established / novel biomarker, paediatric general biochemistry and laboratory management.
From Next-Generation Phones to Wearables

In this talk, we will discuss how mobile phones will be providing unprecedented compute power and demonstrate some applications that can be enabled by such phones in future cities. While wearables have much tighter battery and form factor constraints, next-generation wearables will similarly have substantially higher compute capabilities that can power advanced healthcare applications.

BIOGRAPHY
Dr Li Shiuan Peh joins NUS as Provost’s Chair Professor in the Department of Computer Science, with a courtesy appointment in the Department of Electrical and Computer Engineering in September 2016. Previously, she was Professor of Electrical Engineering and Computer Science at MIT and was on the faculty of MIT since 2009. Prior to MIT, she was on the faculty of Princeton University from 2002. She graduated with a Ph.D. in Computer Science from Stanford University in 2001, and a B.S. in Computer Science from the National University of Singapore in 1995. Her research focuses on networked computing, in many-core chips as well as mobile systems. She received the IEEE Fellow in 2017, NRF Returning Singaporean Scientist Award in 2016, ACM Distinguished Scientist Award in 2011, MICRO Hall of Fame in 2011, CRA Anita Borg Early Career Award in 2007, Sloan Research Fellowship in 2006, and the NSF CAREER award in 2003.
Shaoying HUANG
Assistant Professor
BioMedical-Electromagnetics Group
Singapore University of Technology and Design

Wideband Wireless Power Transfer for Human-Involved Environment

Wireless power transfer (WPT) for charging devices in a human involved environment, such as charging gadgets (with a random orientation) in a room or charging in-body medical devices (e.g. endoscopes), is challenging because human body is a lossy and highly inhomogeneous object with high dielectric constants. The challenges include to design a transmit/receive device with a wider bandwidth and a relatively high quality-factor (Q-factor) simultaneously, at a compact physical size working at a relatively low frequency, with orientation insensitivity, and guaranteeing safety. In this talk, the recent progress on the development of WPT for such an environment will be presented. It includes the approaches proposed by the BioMedical-Electromagnetics Group to address the aforementioned challenges with simulations and experimental data. Future challenges will be discussed.

BIOGRAPHY
Dr Shaoying Huang is an assistant professor at Singapore University of Technology and Design. Her expertise includes EM modeling, computational EM, magnetic resonance (MR) physics and engineering, and microwave/RF circuit designs. Her main research focus is on solving electromagnetic problems for biomedical applications.

She is leading the BioMedical-Electromagnetic Group. The research group works on a few interesting projects including research on wireless power transfer for human-involved environment, and MRI related projects, a tabletop portable MRI imager, in vivo measurement of human tissue electrical property using MRI.
Benjamin TEE

Assistant Professor
Biomedical Institute for Global Health Research and Technology (BIGHEART)
Department of Materials Science and Engineering
National University of Singapore

Human-Inspired Sensory Systems

There is a clear trend towards a living environment where humans, connected devices and robots live in synergy together. Intelligent devices and robots are augmenting human abilities and assist in a myriad of applications, such as health diagnostics, surgery and predictive analytics. Developing materials with sensitive yet robust mechanical properties is important to achieve seamless integration and digitally augmented activities. I will discuss a few key strain-engineering technologies and possible strategies to engineer damage robustness into devices, such as new self-healing materials. In addition, I will also discuss our recent progress in developing new scalable electronic skin technologies for more tactile-aware and perceptive AI robots with applications in healthcare and home settings.

BIOGRAPHY
Dr Benjamin C.K. Tee is President’s Assistant Professor in Materials Science and Engineering Department at the National University of Singapore. He obtained his PhD at Stanford University and was selected as a Singapore-Stanford Biodesign Global Innovation Fellow 2014 where he applied a needs-driven approach to innovation in healthcare technologies. He has developed and patented multiple award-winning materials and sensing technologies in electronic sensor skins. He is named one of the prestigious MIT TR35 Innovator (Global) in 2015, and is one of the 2017 National Research Foundation (NRF) Fellow. He currently leads a multi-disciplinary team to develop new materials and sensor devices technology. His current research interests are in the intersection of materials science, mechanics, electronics and biology, with a focus on sensitive electronic skins that has tremendous potential to advance global healthcare technologies in an increasingly Artificial Intelligence (AI) and Robotics future.
Wireless Technologies for Bioelectronic Therapies

Recent advances now enable electrical and optical control of biological processes with exquisite spatiotemporal resolution. Implantable bioelectronic devices could translate these sophisticated capabilities into more precise therapies, but minimally invasive insertion and long-term operation of such devices in the body remain significant challenges. In this talk, we describe wireless technologies for powering bioelectronic devices deep within the body and achieving miniaturization at the scale of a single millimeter. We demonstrate applications of these technologies for potential treatments such as cardiac stimulation, optogenetics, and phototherapy.

BIOGRAPHY
John S. Ho is an assistant professor in the Department of Electrical and Computer Engineering at the National University of Singapore. He received his PhD in electrical engineering at Stanford University where he was a National Defense Science and Engineering Graduate Fellow. He is a recipient of the NRF Fellowship and the NUS Young Investigator Award, and has appeared on the MIT TR35 Innovator Under 35 Asia and Forbes 30 Under 30 Asia lists. His current research interests are centered on the development of wireless technologies for miniaturized bioelectronic devices.
Changhuei YANG

Professor
Electrical Engineering, Bioengineering and Medical Engineering
California Institute of Technology

Better Pathology Through Computational Microscopy

Fourier ptychography has created a paradigm shift in microscopy by enabling aberration correction to be performed computationally. In addition, it has dramatically increased the spatial bandwidth product of the microscope and provided refocusing capability post-image acquisition. Fourier ptychography is currently being applied in large format digital pathology and parallel 96 well plate imaging. In addition, an off-shoot of the technology is being applied to perform high resolution retinal imaging. I will discuss our recent progress and point out some of the opportunities that Big Data can have impact on.

BIOGRAPHY
Professor Yang’s research efforts are in the areas of novel microscopy development and time-reversal based optical focusing. Prof. Yang joined the California Institute of Technology in 2003. He is the Thomas G. Myers Professor in the areas of Electrical Engineering, Bioengineering and Medical Engineering. He has received the NSF Career Award, the Coulter Foundation Early Career Phase I and II Awards, and the NIH Director’s New Innovator Award. He is a fellow of the Coulter foundation, AIMBE, OSA and SPIE.
Dr Goh was trained in Internal Medicine and Medical Oncology at the National University of Singapore, and was visiting fellow at the University of Chicago Section of Hematology-Oncology and Committee on Clinical Pharmacology. He has contributed much to the development of a clinical trial research infrastructure at the National University Health System, and chaired the Cancer Therapeutics Research Group. He has been awarded senior clinician scientist from the Biomedical Research Council and the National Medical Research Council of Singapore since 2005. His research achievements have been in investigating novel agents for treatment of cancer as well as pharmacogenomics of cancer drugs. Internationally, he has served on advisory boards on several pharmaceutical companies in early drug development, and has served on editorial boards of the Journal of Clinical Oncology and Annals of Oncology. Currently Dr Goh leads the Experimental therapeutics laboratory at the Cancer Science Institute and the phase I oncology clinical trial team at National University Cancer Institute, Singapore. As a responsible member of clinical research, he has also served for several terms as Chairman of the Domain Specific Research Board. Currently he is Director of the Investigational Medicine Unit at the NUHS, and Deputy Director of both National University Cancer Institute, Singapore and the Cancer Science Institute of Singapore.
Huck Hui NG

Professor
Executive Director
Genome Institute of Singapore
Executive Director, A*STAR Graduate Academy

Systems Biology of Stem Cells

Embryonic stem (ES) cells are characterized by their ability to self-renew and remain pluripotent. Transcription factors have critical roles in the maintenance of ES cells through specifying an ES-cell-specific gene expression program. Deciphering the transcriptional regulatory network that describes the specific interactions of these transcription factors with the genomic template is crucial for understanding the design and key components of this network. To gain insights into the transcriptional regulatory networks in ES cells, we use chromatin immunoprecipitation coupled to ultra-high-throughput DNA sequencing (ChIP-seq) to map the locations of sequence specific transcription factors. These factors are known to play different roles in ES cell biology. Our study provides new insights into the integration of these regulators to the ES cell-specific transcription circuitries. Collectively, the mapping of transcription factor binding sites identifies new features of the transcriptional regulatory networks that define ES cell identity. Using this knowledge, we investigate nodes in the network which when activated, will jump-start the ES cell-specific expression program in somatic cells.

BIOGRAPHY
Professor Ng Huck Hui was appointed Executive Director of AGA on 1 April 2017. He oversees AGA’s talent management and development strategy, and initiatives to nurture young STEM talent as well as a strong Singaporean scientific pipeline of talent. Prof. Ng is concurrently the Executive Director of GIS. He joined A*STAR as Group Leader (Biology) in GIS in 2003, before assuming the appointment as Acting ED GIS in January 2012 and ED GIS in October 2012. Under his leadership, GIS has grown to be a home for over 250 researchers working on different aspects of Human Genomics. Prior to joining A*STAR, he was a postdoctoral fellow with Harvard Medical School under the prestigious Damon Runyon-Walter Winchell Postdoctoral Fellowship. Prof. Ng is renowned in the field of stem cells, having spent more than a decade in research to understand and uncover the intricacies of gene regulation and how they relate to cell biology. He was also the President for the Stem Cell Society Singapore, which is a major platform for educating the public on stem cell research. In 2016, Prof. Ng was elected to be an Associate Member of the European Molecular Biology Organization (EMBO), making him the only associate member to be based in Singapore. In recognition of his scientific contributions, Prof. Ng has received numerous local and international honours and awards, including the Young Scientist Award in 2004, National Science Award in 2007 and President’s Science Award in 2011. Outside of A*STAR, Prof. Ng is very active in local universities and institutes, and holds adjunct positions at NUS, NTU and Singapore Eye Research Institute (SERI).
BIOGRAPHY
Prof. Weitz received his PhD in physics from Harvard University and then joined Exxon Research and Engineering Company, where he worked for nearly 18 years. He then became a professor of physics at the University of Pennsylvania and moved to Harvard at the end of the last millennium as professor of physics and applied physics. Prof. Weitz leads a group studying soft matter science with a focus on materials science, biophysics and microfluidics. He has co-founded several companies to commercialize some of the microfluidics work developed in his lab.
Khee Chee SOO

Professor
Senior Visiting Consultant
Division of Surgical Oncology
National Cancer Centre Singapore
Duke-NUS Medical School

Overcoming the Valley of Death

A pragmatic model of collaboration between clinicians, bioengineers and other basic and translational researchers is proposed. It starts not from pronouncements of interesting or ostensibly important discoveries bench discoveries - rather it starts with clinicians articulating the important medical challenges and questions in their areas of practice and then assembling various disciplinary teams in a multi-prong approach to help address the problem at hand. This approach mitigates several critical issues in clinical research including limited numbers in a clinical population, amount of tissues available, data to be analysed at various time points and importantly the time and attention span of the clinicians who are in active practice. To be presented will be our current research projects in collaboration with the various academics in our tertiary institutions.

BIOGRAPHY

Prof. Soo Khee Chee graduated from the University of Singapore’s Medical School in 1975 and moved to Australia where he specialised in Head and Neck Surgery, and Surgical Oncology. He returned to Singapore in 1988 and joined the Singapore General Hospital, becoming the Head of the Department in Surgery from 1993-2004. Prof. Soo obtained his Doctor of Medicine from the National University of Singapore in 1995. He became the Founding Director of the National Cancer Centre Singapore in 1997 and served in that position for 20 years, providing strategic leadership to over 500 staff engaged in clinical care and research. He was also the Senior Vice Dean of Duke-NUS Medical School. For his devotion to training and education, Prof. Soo was bestowed the Outstanding Teachers’ Award and Best Teacher (Undergraduate) Award in 1996 and 2001 respectively. In 2003, he was awarded the Public Administration Medal (Gold) in recognition of his outstanding efficiency, competence and industry. He was awarded the National Outstanding Clinician Mentor Award 2008, and in 2011 he was conferred the Benjamin Sheares Professorship Award for his pioneering contributions in the practice of medicine in Singapore. Prof. Soo has wide ranging research interests but has gained a reputation particularly in the conduct of clinical trials for new cancer treatments as well as in the field of biophotonics and its role as a new imaging modality for the early detection of cancer.
Rosemary TAN
Founder and Chief Executive Officer
Veredus Laboratories Pte Ltd,
Singapore

The Future of Diagnostics and Surveillance

Introduction of VerePlex, a Lab-on-Chip platform that combines MEMS and microfluidics to integrate multiplexed DNA amplification with microarray detection for rapid, cost-effective and accurate analysis of biological materials in a single test. This technology represents the future of molecular testing, bringing the benefits of miniaturization and automation to many applications including clinical, food, agriculture, bio-terror, oncology, forensic and others.

BIOGRAPHY
Dr Rosemary Tan founded Veredus Laboratories in 2004, a medical diagnostics company engaged in the development, commercialization and manufacture of innovative molecular solutions in the clinical, specialty and custom testing markets.

Dr Tan was awarded the Outstanding Science Alumni Award from the National University of Singapore in 2006. In 2017, she won The Singapore Women’s Weekly Great Women of Our Time Award for Health, Sports and Wellness. She was also honoured as one of the Top Ten innovators and disruptors in The Power List 2017 by The Peak.
Freddy BOEY

Professor
Senior Vice President (Graduate Education & Research Translation)
National University of Singapore

Research Translation: A Personal Journey and Some Perspectives on Improving Research Translation in NUS

The process and skill sets for translating research to commercial output is different from that of moving research grants into research output. Prof. Boey will share his personal experiences and lessons learnt in his several start-ups, all of which involved his research staff or students. He will also share the new exciting GRIP, a flagship innovation program specifically to help research students and staff towards starting their own spinoffs/start.

BIOGRAPHY
A pioneer in the use of functional biomaterials for medical devices, Prof. Boey has developed 100 over patents and founded several companies to commercialize his cardiovascular, ocular and surgical implants. His customizable hernia mesh is the first such surgical mesh approved for sale by the US FDA and his most recent company, Peregrine, has created a nano-based drug delivery system to treat Glaucoma which has been successfully deployed in human trials.

Prof Boey holds key appointments on the boards of the Health Science Authority Singapore, School of Science and Technology as well as several nationally-funded research centres, including the Singapore Rail Academy Board and the Government Technology Agency Planning Committee.

He has received several prestigious awards, including the Imperial College London Fellowship Award, the 2013 Singapore President’s Science and Technology Medal and he is also a recipient of two National Day Awards - the Public Administration medals (Gold and Silver) - from the Singapore government.
CURATE.AI: Optimising Clinical Combination Therapy with Artificial Intelligence and Digital Medicine

Combination therapy serves as a foundation for a broad spectrum of indications, ranging from oncology to infectious diseases, among many others. Conventional approaches to designing combination therapies include target and drug selection as well screening, validation and dose escalation/expansion. This roadmap is challenged by the existence of a virtually infinite drug-dose parameter space. As such, the primary objective of this conventional strategy is to identify synergistic drug-drug interactions. It is important to note, however, that drug synergy and global optimisation are not the same outcome. This is due to the fact that drug synergy is dose-dependent, time-dependent, and patient-specific at any given point of treatment. Therefore, even tailored treatment regimens require modulation in time in order to achieve global optimisation, as patient and disease physiology evolve. Addressing these challenges requires an actionable strategy that can deterministically pinpoint optimal drugs/dosages for the entire duration of care. This talk will highlight our recent advances in the clinical/in-human validation of CURATE.AI, an augmented artificial intelligence platform, towards applications in optimised combination therapy for oncology, post-transplant immunosuppression, and infectious diseases.

BIOGRAPHY
Dean Ho is currently Provost’s Chair Professor at the National University of Singapore in the Departments of Biomedical Engineering and Pharmacology, and a member of the Biomedical Institute for Global Health Research and Technology (BIGHEART) at the National University of Singapore. He was previously Professor of Bioengineering, Co-Director of the Weintraub Center for Reconstructive Biotechnology at the School of Dentistry at UCLA, and Associate Professor of Biomedical Engineering and Mechanical Engineering at Northwestern University. Prof. Ho is leading multiple clinical trials to prospectively optimise combination therapy using CURATE.AI. His work has been featured in The Economist, CNN, National Geographic, and other international news outlets. He previously served as the President of the Board of Directors of the Society for Laboratory Automation and Screening, a 26,000+ member global organization at the interface of drug development and diagnostics. He is a recipient of the V Foundation for Cancer Research Scholar Award, NSF CAREER Award, and Wallace H. Coulter Foundation Translational Research Award, among others. He is a Fellow of AIMBE and SLAS.
Data Analytics in Biomedical Applications

Technologies developed for biomedical applications have become more complex and they generate a large amount of data that requires sophisticated analytics to remove noise and make sense of these large datasets. I will illustrate with two examples to highlight the necessity of extracting maximal amount of information such that the applications can be more robust to tolerate the noise in these complex systems. One example is in the realm of digital pathology that sample processing and image acquisition generate high noise level. By using machine-learning based data analytics approach, we can minimise the conventional pathologist’s inter- or intra-operators variation to generate highly predictive and accurate classification of disease stages and progression for diagnostic purposes. Another example is in the development of drug testing assays to aid drug development. As the field moves away from 2D culture using cell lines into complex 3D models with primary or stem cell-derived cell models, the noise levels in these systems are increasingly frustrating to the researchers or industry. We track cell migration to model embryonic development and use it to identify teratogens (development toxins) and other forms of toxicity. With machine-learning based approach, we are capable of developing highly robust in vitro assays to aid drug development.

BIOGRAPHY

Dr Hanry Yu was trained in cell biology from Duke (US) and EMBL (Germany). He ventured into Biomaterials, Tissue Engineering, Biomedical Optics, Computation and Systems Biology, and lately Mechanobiology. He chaired three interdisciplinary graduate programs, including one jointly with MIT where he has been a visiting professor since 2008, collaborating to develop biomedical solutions using optical imaging technologies and analytics. His labs train students for both academic and industry leadership; and have students, postdocs, and mentees as professors in leading universities; founders and senior leaders in biomedical companies. Dr Yu is currently a tenured full professor of Physiology and Mechanobiology, National University of Singapore; and group leader of synthetic biosystems, Institute of Bioengineering and Nanotechnology, A*STAR. He frequently consults for government agencies in Singapore, China and Germany, and serves on boards and external examiners of international organisations and other universities. He is a founder of multiple high-tech companies, two won major awards and one became public company listed in Australia. Dr. Yu is currently a handling editor of Biomaterials.
Yi-Chin TOH

Assistant Professor
Biomedical Institute for Global Health Research and Technology (BIGHEART)
Department of Biomedical Engineering
National University of Singapore

Engineering Heterotypic Cellular Interactions for Disease Modeling and Drug Testing

Heterotypic cellular crosstalk occurs across various length scales, both within a tissue and between different tissues. Aberrations in these interactions are known to contribute to various human diseases, most notable in cancer as well as metabolic and developmental disorders. In this seminar, micro-technologies designed to control heterotypic cellular interactions and measure their manifestation in embryonic tissue patterning and drug responses will be presented. I will illustrate the use of human pluripotent stem cell micropatterning to spatially organize cells of different germ layers to direct the formation of a neuroectoderm (NE) tissue that recapitulates architectural and cellular characteristics of early neural tube development. By assessing structural dysmorphia in the micropatterned NE tissues, we can detect drugs that cause neural tube defects (NTD) in human, as well as cadherin/β-catenin dysfunctions mediated by FMR1 silencing in Fragile X Syndrome. In the context of multi-organ systemic interactions, I will be presenting a 'stick-n-play' modular approach to achieve system integration with various microfluidic components, such as micro-pumps, valves, and tissue culture chips. This allows easy and flexible configuration of multi-tissue perfusion circuits to model bioactivation of cancer prodrugs and arterio-protective nutraceuticals.

BIOGRAPHY
Yi-Chin Toh obtained her B.Eng in Chemical Engineering and PhD in Bioengineering from the National University of Singapore in 2001 and 2008 respectively. She did her post-doctoral training at the Massachusetts Institute of Technology in 2008 before joining the Institute of Bioengineering and Nanotechnology, A*STAR as a research scientist in 2010. Currently, she is an Assistant Professor with the Department of Biomedical Engineering in the National University of Singapore. Her research interest is in designing and engineering micro-systems to control and understand the spatio-temporal relationships between cellular microenvironments and stem cell fate specification during normal and pathogenic tissue patterning. These micro-engineered stem cell models will in turn be translated into scalable platforms for disease modeling and drug testing applications. Dr Toh is a recipient of the National University of Singapore Research Scholarship, A*STAR Graduate Scholarship and A*STAR International Fellowship.
Christine CHEUNG
Assistant Professor
Lee Kong Chian School of Medicine,
Nanyang Technological University

Understanding Genetic Susceptibility Using Personalised Vascular Models

Cardiovascular disease is the number one cause of mortality worldwide. Genome wide association studies (GWAS) have identified many non-coding variants that are associated with coronary artery disease (CAD). However, the difficulty of elucidating genetic aetiology of non-coding variants has often impeded clinical application of GWAS findings. Our goal is to interrogate the influence of an Asian susceptible locus 6p24.1 on vascular endothelial health. We have derived induced pluripotent stem cells (iPSCs) from CAD patients with risk genotypes, and normal individuals with non-risk genotypes. To elucidate how chromatin landscape is perturbed by the risk genotype, we performed chromatin conformation capture assay. Our finding revealed that the risk variant is a distal regulator of key genes implicated in atherosclerosis through long range chromatin interactions. In establishing the genotype-to-phenotype link, we were able to model functional differences in the iPSC-endothelial cells carrying risk versus non-risk genotypes. Taken together, our work would have broad relevance for investigating the functional genetics of other non-coding variants, holding promise for disease management guided by personal genetic risk profile.

BIOGRAPHY
Assistant Professor Christine Cheung is a Nanyang Assistant Professor in Lee Kong Chian School of Medicine, Nanyang Technological University, and an awardee of the 2016 Nanyang Assistant Professorship. She received a PhD in Cardiovascular and Stem Cell Medicine from the University of Cambridge, and a BEng (First Class) from Imperial College London. Upon securing the competitive Independent Fellowship in 2012, she started up a research group at the A*STAR Institute of Molecular and Cell Biology, where she currently holds a joint appointment. For her pioneering approach to create organ-specific blood vessels, she was recognised with the Young Investigator Prize from the British Society for Cardiovascular Research. Also, she serves as an Executive Committee member of the Stem Cell Society Singapore.
Universal red blood cells (RBCs) derived from differentiation of O-negative (neg) human induced pluripotent stem cells (hiPSCs) can potentially supplement the emergency transfusion needs of the healthcare industry. Given that each unit of blood requires 1 trillion RBCs, there is a need to develop efficient bioprocesses that could allow for large-scale differentiation and generation of very high numbers of RBCs. While many groups have described means to differentiate hiPSCs into erythroid cells, most of these have not yet been demonstrated to be amenable for scale-up.

Using process optimization, we have developed a continuous suspension agitation culture platform for differentiating hiPSCs-MC aggregates towards erythroid cells. We have efficiently scaled-up the process starting from 5 ml ultra low attachment 6 well plates to 50 ml shake-flasks and eventually demonstrating it in 125 ml spinner culture flasks. The best performing hiPSC line was efficiently differentiated in 125 ml spinner culture flasks, generating close to 1 billion erythroblasts in 100 ml culture volumes with peak cell densities of erythroblasts approaching 1.5 x 10^7 cells/ml. Our agitation suspension culture differentiation process could serve as a key platform for further developing large scale blood differentiation processes in controlled bioreactors.

**BIOGRAPHY**
Dr Sivalingam is a Research Scientist from Bioprocessing Technology Institute at A*STAR working on *in vitro* generation of functional red blood cells (RBCs) from human induced pluripotent stem cells (hiPSCs). The group leverages on the use of microcarrier platform technology to optimize and develop scalable suspension culture processes for culture and differentiation of hiPSCs to generate universal O-ve RhD-ve RBCs for cellular therapy applications.
Clinical Applications for Global Impact

An exciting wave of new scientific and technological developments amasses great potential to solve healthcare problems and alleviate human suffering at the global scale. The road to successful translation from the bench to the bedside, however, is a challenging one with many technical and societal considerations along the way, some of which may not be obvious.

The panel brings together experts from the entire spectrum of the translation process, from the initial identification of unmet clinical needs, to assessment of efficacy and safety, and then to commercialization considerations of cost and scalability. This is an excellent opportunity for audience members to actively participate in the discussion and benefit from the wealth of experience and insights of the panel members.

Panellists

1. Luke P. LEE (Chair), BIGHEART, National University of Singapore
2. David WEITZ, Harvard University
3. Freddy BOEY, National University of Singapore
4. Dean HO, National University of Singapore
5. Boon Cher GOH, National University Health System
6. Khee Chee SOO, National Cancer Centre Singapore
7. David SUN, Intelligent Sensor Research Institute
8. Rosemary TAN, Veredus Laboratories
01. In Vivo Wireless Photonic Photodynamic Therapy

Akshaya Bansal, Pui Mun Lee, Fengyuan Yang, Xi Tian, Yong Zhang, John S. Ho

Photodynamic therapy (PDT) involves selective optical illumination to activate light sensitive drugs (photosensitisers), destroying malignant cells without the side effects of systemic treatments. However, effective clinical application of PDT is hindered by light delivery challenges across optically opaque tissue. Clinical PDT uses optical fibers for light delivery, but incompatibility with chronic implantation allows only a single dose to be delivered per surgery, besides limiting treatment to catheter-accessed regions. Furthermore, for inaccessible tumors like glioblastomas (brain tumor), multiple PDT doses are even riskier. Here we report a wireless photonics approach towards PDT, using a miniaturized wirelessly powered implantable device for light delivery. The device is designed to meet the light delivery needs of the tumor based on its location and physical characteristics. Wireless powering enables non-invasive activation of the device for chronic (repeat) treatment, while multiple LEDs ensure greater illumination coverage area.

02. A Liver-immune Coculture Array for Predicting Systemic Drug-Induced Skin Sensitization

Lor Huai Chong, Huan Li, Isaac Wetzel, Hansang Cho, Yi-Chin Toh

Drug-induced skin sensitization is prevalent worldwide and can trigger life-threatening health conditions, such as Stevens-Johnson-Syndrome (SJS). We have successfully developed a novel in vitro model that can potentially predict the skin-sensitizing potential of drugs that are administered into the systemic circulation by modeling liver-mediated reactive metabolite generation and antigen presenting cells (APCs) activation. This was accomplished by designing a compartmentalized microfluidic array platform that supported HepaRG-derived hepatocytes-spheroids (HHS) with U937 immune cell coculture and maintained their respective functions, as well as promoting efficient transport and accumulation of drug reactive metabolites to trigger a robust APC activation response. We demonstrated that the microfluidic liver-immune coculture array could more consistently and reliably distinguish 3 paradigm skin sensitizing drugs from a non-skin sensitizer than a conventional bulk Transwell coculture system. This system can potentially be translated into a first-in-kind screening platform to identify compounds that can potentially cause systemic cutaneous drug reactions upon further validation studies.
Studying Defective Motor Neuron Trafficking in a Neuromuscular Junction on chip


Motoneuron-muscle communication is vital for neuromuscular junction (NMJ) formation and maintenance as well as for motoneuron survival and function. Alterations in intercellular communication can cause an onset of neurodegenerative diseases by leading to synapse disruption and axon degeneration. In vitro compartmental systems that isolate neuronal cell bodies from their axons are becoming a progressively useful tool for studying NMJs.

We have successfully differentiated human motor neurons and spontaneously contracting striated myotubes to test NMJs on a non-compartmentalised co-culture system (Ibidi Inc) and triple chamber microfluidic device (Xona Microfluidics). We aim to develop a NMJ on chip with customized fluidic architectures to mimic the physiologically relevant microenvironment and provide the flexibility of parallelization and automation for studying large-scale defective motor neuron trafficking systematically. The designed NMJ chip has a potential to overcome the shortcomings of the available systems and offers significant advantageous features such as controllability of flows, large scalability, ease-of handling and high throughput cell culture platform.

enVision: Enzyme-assisted Nanocomplexes for Visual Identification of Nucleic Acids Enabling Point-of-Care Detection of Disease

Nicholas R.Y. Ho, Geok Soon Lim, Noah R. Sundah, Diana G.Z. Lim, Tze Ping Loh, Huilin Shao

Nucleic acid testing can provide unprecedented molecular information about disease and pathology. However, such testing is commonly limited to centralized laboratories due to extensive training and equipment requirements.

Through molecular engineering, we have developed an easy-to-use method to detect nucleic acids at room temperature and with minimal equipment requirement. We termed this assay enzyme-assisted nanocomplexes for Visual identification of nucleic acids (enVision).

As a proof of concept, we designed tests for detecting different molecular subtypes of Human Papilloma Virus, the leading cause of cervical cancer. enVision showed a high detection sensitivity and accuracy when applied to cell line models and clinical samples.
A Point-of-Care Test for the Detection of Pathogens and Anti-Microbial Resistance

Jia Mei Hong, Wen Jing Sim, Bryce WQ Tan, Bumseok Namgung, Jeeyeon Lee, Kean Lee Chew, Roger Zimmermann, Win Sen Kuan, Luke Lee, Catherine WM Ong

The current standard turnaround time to detect bacteria and their antibiotic sensitivities in bloodstream infections is at least 36 hours. We aim to develop a point-of-care device using a one-step microfluidic chip for whole blood plasma separation, bacterial cell lysis and nucleic acid detection, followed by a smartphone readout of the identified pathogen and recommended antibiotics with a target turnaround time of under 1 hour. Primers targeting key pathogens causing bloodstream infections without cross-reactivity were designed. The full panel of primers and probes against bacteria and key antimicrobial resistant genes will allow concurrent detection in the microfluidic chip, with testing in live pathogen-spiked whole blood from healthy volunteers. Clinical validation on a separate large cohort of patients with bacteraemia will be performed. Our study will complement existing clinical microbiology techniques in identifying bacteria and their resistance profile in bloodstream infections and have wide application in both resource-rich and resource-limited settings.

Structural Smart Microgels - Enhancing the Sensitivity for Single Cell Secretomic Analysis

Myat Noe Hsu, Yong Zhang, and Chia-Hung Chen

High-throughput single-cell protein secretion analysis platform with a novel signal enhancement capability was established by incorporating smart hydrogels in microfluidics. Currently, fluorescence activated cell sorting (FACS) is widely employed for single-cell protein analysis. However, it lacks the ability to directly measure cellular secretions. Herein, we propose a droplet-based platform where each cell was co-encapsulated with a novel microgel immunosensor. Temperature-induced volume phase transition of the microgels allowed analyte concentration within the gel matrix, enabling rapid signal amplification of approximately 5-fold. Using this platform, single-cell secretions of the three different cytokines were analyzed using both suspended cells (HL60) and adherent cells (MCF7 and MDA-MB-231), revealing distinct single-cell secretion heterogeneity. Overall, this technology builds upon prior successes in single-cell encapsulation in droplets as well as antibody-based immunoassays while utilizing simplified schemes of sample handling and analysis, making it highly versatile for a range of biological sample profiling.
Single-CTC-Based Liquid Biopsy: Refining the Paradigm of Precision Medicine

Su Bin Lim, Trifanny Yeo, Swee Jin Tan, Daniel S. W. Tan, Weiwei Zhai, Wan-Teck Lim, and Chwee Teck Lim

Despite pronounced genomic and transcriptomic heterogeneity in non-small cell lung cancer (NSCLC) not only between tumors, but also within a tumor, validation of clinically relevant gene signatures has relied upon single-tissue samples, including two commercially available multi-gene tests. Multi-region RNA-seq of 85 spatially distinct sectors from 23 Asian EGFR-mutant lung adenocarcinomas revealed an unanticipated impact of intra-tumor heterogeneity (ITH) on risk prediction of recurrence and death, underscoring the need for a better genomic strategy to refine prognostication. To identify genetic features that distinguish metastatic from non-metastatic disease, we assessed 61 CTCs isolated from 20 NSCLC patients at the single-cell resolution. Through genomic analyses of single-CTC data, we generated a 2-gene prognostic model, which outperformed the initial 29-gene classifier in predicting recurrence-free survival in Asian NSCLC patients. Novel approaches to providing reliable risk estimates while accounting for ITH-driven variation in clinical decision-making are presented.

Digital Quantitative Polymerase Chain Reaction - A New Method for Single Molecule Measurement of Absolute Telomere Length Distributions

Yongqiang Luo, Lih Feng Cheow

There is increasing utility of telomere length as a biomarker for age-associated diseases, diabetes and cancer, however, the current measurement methods are laborious, require large amount of samples and can only measure the average telomere length. We have created the first, single molecule measurement of absolute telomere length distribution on a polymerase chain reaction (PCR) platform, with significant advantages in resolution, time and sample requirements. Our innovative platform - digital quantitative PCR (dqPCR) - for the first time combines single molecule isolation with qPCR-based DNA length measurement in a digital platform, and can be used to differentiate the telomere length distributions of different cancer cell lines and identify the telomere maintenance mechanism.
**Mycobacterium tuberculosis cell-free DNA for the diagnosis and quantification of TB burden in man**

Eddy QH Miow, Yu Wang, Jia Mei Hong, Rick TH Ong, Yik-Ying Teo, John J Totman, Catherine WM Ong

Cell-free DNA (cfDNA) are circulating DNA fragments found in body fluids. We aim to use cfDNA from *Mycobacterium tuberculosis* to diagnose pulmonary and extra-pulmonary TB patients and monitor TB treatment response. 20 active TB, 10 latent-TB and 10 non-TB controls will be recruited. cfDNA will be isolated from plasma, urine and oral secretions and mycobacterial burden will be quantitated by PET/MRI scan at Day 0, 30 and 60. The TB cfDNA signature that distinguishes active TB from latent and non-TB patients will be defined together with the correlation between cfDNA and mycobacterial burden. Results will be validated in an independent cohort of active TB patients and non-TB controls. cfDNA recovery efficiency has been optimized up to 75%. Latent-TB and non-TB patients recruitment have been completed, while active TB patient recruitment is ongoing. This project serves as a platform to develop a point-of-care test for TB diagnosis and treatment monitoring.

**TasteHealthy: AI for Explainable Food Recognition and Recommendation**

Homin Park, Homanga Bharadhwaj, Zhenkai Wang, Wendi Ren, Brian Y. Lim

There is an increasing concern for diet-related chronic diseases caused by having an unhealthy diet, such as obesity, heart diseases and cancers. Food logging with mobile phones can help users understand their food choices and encourage healthier eating habits, but manual data entry has been traditionally too tedious. We propose TasteHealthy, an AI-driven mobile app and analysis platform to tackle two major challenges for food (and drink) recognition and recommendation to monitor people's diet and promote healthy behaviors and outcomes.
A Buffer-Free Continuous-Flow Biosensor for Real-Time Monitoring of Small Biomolecules in Human Biofluids by Ion Concentration Polarization

Dinh-Tuan Phan, Lin Jin, Kerwin Kwek Zeming, Jianfeng Gao, and Chia-Hung Chen

This paper presents a novel integrated biosensor capable of continuous real-time dynamic monitoring of small biomolecules (i.e., adenosine triphosphate - ATP/cancer drug doxorubicin - DOX) in human biological samples (i.e., saliva/human serum) by integrating the electrochemical aptamer-based sensors (i.e., e-aptasensors) into an electrokinetics-based nanofluidic device. The core technology of this biosensor is buffer-free and online signal regeneration in patient samples without the use of bulky clean buffer solutions by utilizing ion concentration polarization (ICP) phenomenon in the nanofluidic component. The advantage of the current biosensor lies in its fast response time (i.e., sub-minute temporal resolutions), high sensitivity (i.e., bind to different targets ATP/DOX), and a minimal intervention. More importantly, with simple operations and all-electronic architecture, the proposed biosensor opens the possibility in transferring into a portable device for personalized health monitoring or applications in remote wireless healthcare and timely therapeutics.

A Tetris-Like (TILE) Modular Microfluidic Platform for Mimicking Multi-Organ Interactions

Louis Jun Ye Ong, Lor Huai Chong, Terry Him Ching Tsz, Seep, Yi-Chin Toh

The emergence of organs-on-a-chips, consisting of miniaturised human tissue, mimics closely human microenvironment and allows multi-organ setup showed great potential for modelling diseases and screening therapeutics. However, current multi-organ platforms are challenged with operational complexity to synchronize multiple cell culture period, expensive and time consuming product design and lack of standardizations. While modular microfluidic systems allow easy and flexible configuration of microfluidic systems, many fall short on the lack of bioimaging compatibility and backwards compatibility. Here we develop a novel backward and forward compatible Tetris-Like (TILE) modular microfluidic platform, which allows easy and flexible configuration of different biological and engineering modules into functional planar microfluidic perfusion circuits at the point-of-use. Two-organ and three-organ co-cultures on the TILE microfluidic platform further showed the robustness of the platform. The TILE microfluidic modules potentially offers a quick and cost effective way for modelling different systems for drug screening and disease modelling processes.
A Human-Specific Neuroectoderm Tissue Recapitulating Early Neural Morphogenesis and Pathogenesis

Geetika Sahni, Chang Shu-Yung, Jeremy Teo Choon Meng, Kagistia Hana Utami, Mahmoud A. Pouladi, and Toh Yi-Chin

Current neural differentiation systems can dictate neuroectoderm (NE) cell fate specification but not their morphogenesis. We report a first instance of directing the formation of a human-specific NE tissue that recapitulates architectural and cellular characteristics of early neural tube morphogenesis. These include having a continuous, polarized epithelium with laminar organization relative to the lateral mesoendoderm (ME) as well as exhibiting invagination-like folding, where the NE cells undergo E-to-N-cadherin switching and apical constriction. This is accomplished by spatio-temporal patterning of ME cells alongside the NE cells to guide their morphogenic folding. We uncovered that TGF beta signaling emanating from endodermal cells is obligatory in tissue folding. Finally, evaluating NE structural dysmorphia uniquely achievable in our model allows for early detection of pathologies mediated by FMR1 silencing in Fragile X Syndrome. This unprecedented degree of control over the NE architecture has significant impact on neurodevelopmental disease modeling and brain organoid organization.

Pulsed Electromagnetic Field (PEMF) Impairs Human Airway Smooth Muscle Cell Proliferation

Yee Kit Tai, Sheryl S.L. Tan, Rebecca H. Moon, Alfredo Franco-Obregon, Thai Tran

Asthma is a chronic lung disease that affects more than 235 million people worldwide. Asthma is caused by inflammation and contraction of the airway smooth muscle, making airway smooth muscle cells highly targeted for development of newer therapies for asthma. Here, we study the potential therapeutic effects of pulsed electromagnetic fields (PEMFs) to help inhibit or reduce airway wall remodeling associated with chronic asthma. We observed that 10 minutes of 3 mT (millitesla) of PEMF mitigates cell proliferation that is typically observed in mitogen-stimulated conditions. Transient receptor potential (TRP) channels have been suggested to be important in the regulation of proliferation in asthmatic ASM cells. Correspondingly, 3mT PEMF also reduces increase of intracellular calcium and reactive oxygen species levels associated with mitogen stimulation. The study highlights the potential application of PEMFs in suppressing ASM cell proliferation as a new non-invasive, procedure-based treatment beyond currently available asthma therapy.
15.

Single-Cell Multimodal Profiling Reveals Cellular Epigenetic Heterogeneity

Ramya Viswanathan, Elise T. Courtois, Yuliana Tan, Qiaoru Xing, Daniel Shao Weng Tan, Paul Robson, Yuin-Han Loh, Stephen R. Quake, William F. Burkholder, Lih Feng Cheow

A hallmark of multicellularism is the diversity of specialized cell types with specific gene expression patterns. Dynamic control of gene expression involves many layers of regulation including transcription factor binding and epigenetic factors such as DNA methylation. In view of the complexity of gene regulation, individual data types alone cannot fully depict the developmental stages or cellular subtypes of a sample. Integrating data of multiple "omic" dimensions, including DNA methylation, gene expression, and somatic mutation from the same biological sample can collectively provide a more comprehensive picture of genome regulation during normal development and pathogenesis.

Here, we present a method to simultaneously interrogate DNA methylation state, gene expression and gene mutation at specific loci in single cells in an automated, high throughput microfluidic platform (single-cell analysis of genotypes, expression and methylation; sc-GEM).

We applied this platform to profile cellular heterogeneity in single cells from human fibroblast cell population undergoing reprogramming to induced pluripotent stem cell, and show that we can simultaneously capture the gene expression and DNA methylation dynamics of the single cells at various stages of reprogramming. We observed that individual cells within the population reprogrammed at different rates and could be classified into early or late pluripotent cells. There was tight coupling between the timing of DNA methylation changes and activation of late pluripotency markers in individual cells. We then applied this platform to interrogate cell-to-cell variability in primary lung adenocarcinoma. We detected substantial cell type heterogeneity in the primary tumor based on the expression of marker genes and a subpopulation of epithelial cells were found to be hypermethylated in a set of tumor associated loci. This result reflects the rich microenvironment of the tumor, and also a unique epigenetic and gene expression profile of the tumor subpopulation that distinguishes them from the stromal cells. Sc-GEM can reveal subtype-specific tumor epigenetics signatures, even when these subtypes form a rare population within the tumor mass. Hence, with sc-GEM, it is possible to accurately profile epigenetic variations within and between different cell types that are identified through simultaneous transcriptional and genetic profiling of single cells in a sample.
Integrative Platform for Ultrahigh Throughput Quantitative Mechnoresponse of Adhered Single Cells

Ming Wang, Hua Liang Leo, Chwee Teck Lim, and Chia-Hung Chen

Extracellular matrix (ECM) is essential for most cell types. Mechanical properties of ECM are pivotal in cytoskeleton development and in influencing a variety of cell phenotypes. For instance, the individual responses of cancer cells to mechanical cues significantly influence cancer progression; thus it is essential to examine single cellular phenotypic mechnoresponse to provide insight in understanding disease progression. In this study, a continuous flow platform was developed to profile enzymatic secretions from single cells adhered on gelatin hydrogel particles. With the advantage of ultrahigh throughput droplet screening (~100 cells/sec), statistically relevant data (>20000 cells) of adhered single cell mechnoresponse was obtained for rapid biological sample profiling. In summary, a novel robust platform capable of detecting mechnoresponse of single adhered cells with ultrahigh throughput was developed. Its ability to precisely control individual cells' microenvironments for cellular phenotyping would be essential to unmasking various biological events influenced by ECM stiffness.

High-Throughput and Rapid Plasmonic Single Cell Immunoassay

Shih-Chung Wei, Chia-Hung Chen

Secretome has been indicated as an important biomarker source for cancer monitoring. Especially in tumor microenvironment, those secretory proteins from individual cells highly correlate to cell migration, tumor metastasis, inflammatory, and proliferation. In this study, we designed a non-wash plasmonic droplet immunoassay for detecting single-cell secretions. Antibody-conjugated nanorods were encapsulated with breast cancer or leukaemia cells in droplets. By passing those droplets through a continuous-flow microfluidic on a dark-field spectroscope, the scattering spectrum of each droplet was acquired in a rate at 20 droplets per second. leukaemia cells (HL-60) and aggressive breast cancer cells (MDA-MB-231) were analysed by this droplet plasmonic immunoassay. Different levels of interleukin secretions between leukaemia cells and breast cancer cells were observed with single cell resolution. With the advantages in high-throughput and non-wash, a simple and rapid single-cell secretomic profiling could be achieved by our single-cell plasmonic immunoassay.

Haicheng Yao, Tao Sun, Melissa Tan, Zhuangjian Liu, Benjamin C.K. Tee

Electronic-skin (e-skin) sensors enable robots and biomedical devices to acquire highly intuitive skin-like sensing abilities, spurring widespread interest in the development of e-skin sensors of excellent sensitivity. However, the quantitative relationship between applied loading and sensor response has yet to be investigated systematically. Therefore, there still exists a lack of controlled design in the sensitivity of e-skin sensors. To address this gap, we have developed a SenSEARCH engine that outputs unique sensor designs that cater to specific sensing applications, based on inputs of sensing parameters and target sensitivity. This tactile material design toolkit further provides a mathematical understanding of sensor performance under applied loading. SenSEARCH provides a platform for enhanced theoretical understanding of sensing performance and improves the effectiveness of e-skin sensor designs for the myriad applications in human-machine interfaces, robotics and healthcare.

19. Intra-Layer Bandage Pressure Monitoring for Venous Ulcer

Longteng Yu, Hong Hui Lee, Trifanny Yeo, Ren Hao Soon, Fazila Aloweni, Sivagame D/O Maniya, Shin Yuh Ang, Mei Ling Lim, Joo Chuan Yeo, Chwee Teck Lim

Compression bandaging is the gold standard for the treatment of venous ulcer, which is caused by a micro-circulatory damage triggered by chronic venous hypertension. The compressive pressure exerted by the bandages is key to the recovery of venous ulcer. However, quantifying the intra-bandage pressure throughout the treatment is an issue as the application of compression bandages is largely based on the expertise and experience of the nurse. Herein, we report a flexible, stretchable, wearable and washable piezoresistive microfibre sensor capable of continuously monitoring intra-layer bandage pressure in real time. The response of the microfiber sensor can be recorded by an integrated circuit chip and wirelessly transmitted to a smartphone. To validate the accuracy of the microfibre sensor, clinical tests on healthy volunteers were conducted in a local hospital. The results showed that the microfibre sensor embedded bandaging system can allow for a continuous monitoring for the compression therapy with high precision.
CONTACT
Biomedical Institute for Global Health Research & Technology (BIGHEART)
National University of Singapore (NUS)
MD6 Centre for Translational Medicine
14 Medical Drive
#14-01
Singapore 117599
bigheart.info@nus.edu.sg
www.bigheart.nus.edu.sg