# NUS Synthetic Biology for Clinical and Technological Innovation

# SynCTI

# Opening Ceremony & Symposium

SynCTI
Synthetic Biology *for* Clinical & Technological Innovation

**30 September 2015 – 01 October 2015**
**NUS, Centre for Life Sciences (CeLS) Auditorium**
**http://tinyurl.com/nkp4qzd**

NUS National University of Singapore

National University of Singapore, Centre for Life Sciences, Level 2, 28 Medical Drive, Singapore 117456 | syncti@nus.edu.sg | www.syncti.org | +65 6601 2449

SynCTI

## PROGRAM OVERVIEW

### DAY 1 - Wednesday 30th September 2015

| Time | Activity / Title | Presenter |
|---|---|---|
| 8.00 - 8.45 | Registration | |
| 8.45 - 9.00 | Participants to be seated | |
| 9.00 - 9.15 | Welcome Address and Opening Ceremony | Barry Halliwell<br>Tan Chin Tuan Centennial Professor,<br>Senior Advisor to the President, NUS |
| 9.15 - 9.30 | NUS SynCTI Corporate Video, and address by BD and Singer (Corporate Labs) | |
| **Theme 1: Solving Challenges in Society. Session Chair: Sanjay Swarup** | | |
| 9.30 - 10.15 | Engineering microbes for production of chemicals and fuels | Jay Keasling<br>UC Berkeley, US Joint Bioenergy Institute, SynBERC |
| 10.15 - 10.45 | Developing programmable biological functionalities for autonomous microbial therapeutics | Matthew Chang<br>NUS SynCTI |
| 10.45 - 11.15 | Refreshments | |
| 11.15 - 11.45 | Engineering peptides for antimicrobial functionalization of biomedical devices | Susanna Leong<br>Singapore Institute of Technology |
| 11.45 - 12.15 | Broadband DNA synthesis | Emily Leproust<br>TWIST Biosciences |
| 12.15 - 13.30 | Lunch | |
| **Theme 2: Rewiring Biological Communities. Session Chair: Wen Shan Yew** | | |
| 13.30 - 14.15 | Engineering cells and cell networks for 'executive' function and discovery | William Bentley<br>University of Maryland |
| 14.15 - 14.45 | Integrating ecological frameworks to enhance outcomes of synthetic biology applications | Sanjay Swarup<br>NUS SynCTI, NERI, SCELSE |
| 14.45 15.15 | Decoding cancer-immune dynamics: from analytic to synthetic approaches | Paul Choi<br>Genome Institute of Singapore |
| 15.15 - 15.45 | Refreshments | |
| **Time** | **Activity / Title** | **Presenter** |
| **Theme 3: Therapeutics and Biomimetics. Session Chair: Zhi Li** | | |
| 15.45 - 16.30 | Unlocking the potential of synthetic biology for the development of healthcare diagnostics | Paul Freemont<br>Imperial College London |
| 16.30 - 17.00 | Stearoyl-CoA desaturase inhibition blocks formation of hepatitis C virus-induced specialized membranes | Anthony Patridge<br>Merck |
| 17.00 - 17.30 | Biomimetic production of customizable bacterial cellulose through synthetic biology approach | Sierin Lim<br>Nanyang Technological University |
| 17.30 - 18.00 | CRISPR design tools for translational synthetic biology | Kevin Clancy<br>Thermo Fisher Scientific |
| 18.00 - 18.10 | Summation | Adison Wong<br>NUS SynCTI |

SynCTI

# PROGRAM OVERVIEW

## DAY 2 - Thursday 1st October 2015

| Time | Activity / Title | Presenter |
|---|---|---|
| 8.00 - 8.45 | Registration | |
| 8.45 - 9.00 | Participants to be seated | |
| **Theme 4: Fundamental Tools and Design Principles. Session Chair: Ee Sin Chen** | | |
| 9.00 - 9.15 | Corporate Lab Launch with BD Biosciences and Singer Instruments | Matthew Chang |
| 9.15 - 10.00 | Design and characterization in synthetic biology | Richard Kitney<br>Imperial College London |
| 10.00 - 10.30 | Systems and synthetic biotechnology for characterizing and designing plant and mammalian cells | Dong-Yup Lee<br>NUS SynCTI, Bioprocessing Technology Insitute |
| 10.30 - 11.00 | Engineering genetic circuits | Chueh Loo Poh<br>Nanyang Technological University |
| 11.00 - 11.30 | Refreshments | |
| 11.30 - 12.00 | Synthetic biology and metabolic engineering in unconventional yeasts: peculiarities, challenges and opportunities | Andrea Camattari<br>Bioprocessing Technology Institute |
| 12.00 - 12.30 | More than just a tool for immunology: Flow cytometry applications beyond the mammalian cell | Darren Ellemor<br>BD Biosciences |
| 12.30 - 13.30 | Lunch | |
| **Theme 5: Synthetic Biology and Enzymology. Session Chair: Dong-Yup Lee** | | |
| 13.30 - 14.15 | Tools and strategies for discovering novel enzymes and metabolic pathways | John Gerlt<br>University of Illinois |
| 14.15 - 14.45 | Actin filament systems in health and disease | Robert Robinson<br>Institute of Molecular and Cell Biology |
| 14.45 - 15.15 | Computation-guided ligand discovery: virtual screening against protein structures | Fan Hao<br>Bioinformatics Institute |
| 15.15 - 15.45 | Engineering enzyme substrate specificity by combinatorial selection | Dr. Farid Ghadessy<br>p53 Laboratory |
| 15.45 - 16.15 | Refreshments | |
| **Time** | **Activity / Title** | **Presenter** |
| **Theme 6: Metabolic and Biomolecular Engineering. Session Chair: Chu-Young Kim** | | |
| 16.15 - 17.00 | Building a biological foundry for next-generation synthetic biology | Huimin Zhao<br>University of Illinois |
| 17.00 - 17.30 | Challenges for commercialization in bio-based chemicals | Won Jae Choi<br>Institute of Chemical and Engineering Sciences |
| 17.30 - 18.00 | Developing of microbial cell factories for bio-based chemicals | Ee Lui Ang<br>Metabolic Engineering Research Lab |
| 18.00 - 18.15 | Closing Remarks | Matthew Chang<br>NUS SynCTI |

SynCTI

## ABOUT US

Established in 2014, NUS Synthetic Biology for Clinical and Technological Innovation (SynCTI) is the focal research program for Synthetic Biology at the National University of Singapore.

SynCTI amalgamates researchers from multiple disciplinary fields, and closely interacts with other research programs within NUS, leveraging on existing research capabilities in synthetic biology that have been developed through funding from local and international organizations.

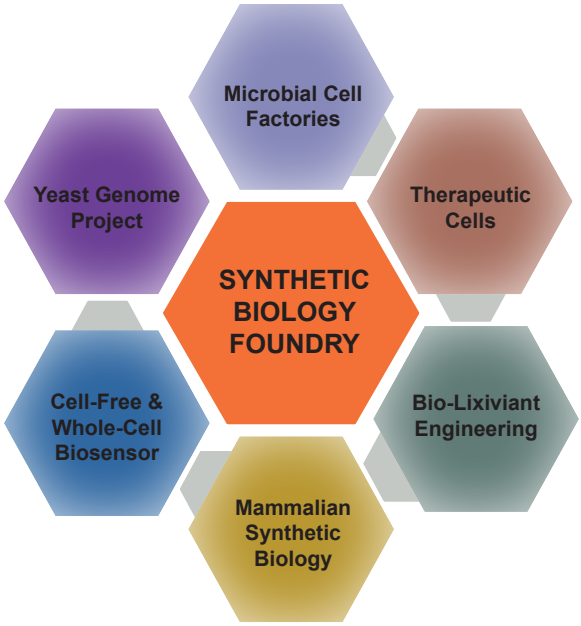
## MISSION

To create new knowledge and foundational technologies in synthetic biology, with the overall aim of solving grand challenges in society and developing a world-class research program in synthetic biology.

## VISION

To anchor Singapore as one of the leading Synthetic Biology research hubs in the world through research excellence, technology invention and training of next-generation synthetic biologists.

RESEARCH FOCI



# SynCTI

World-Class Principal Investigators from the Faculty of Engineering, the Yong Loo Lin School of Medicine and the Faculty of Science.

Host of the NUS Global Synthetic Biology Laboratory, a research partnership with UC Berkeley and Imperial College London.

Host of the Singapore Synthetic Biology Foundry.

More than 60 research staff (> 30 post-doctoral research fellows).

More than S$25 Million in research funding, including industry-aligned funding.

Societal engagement and pedagogy in synthetic biology.

PARTNERS

ThermoFisher SCIENTIFIC

BD

U.S. AIR FORCE

illumina®

Agilent Technologies

Gimelia 希世环保

MERCK

gsk GlaxoSmithKline


## Jay KEASLING

Hubbard Howle Jr Distinguished Professor of Biochemical Engineering and
Sydney Brenner Distinguished Academic Visitor,
University of California


### Title:

Engineering Microbes for Production of Chemicals and Fuels

### Abstract:


Microbial metabolism can be harnessed to convert sugars and other carbonaceous feedstocks into a variety of chemicals (commodity and specialty), fuels, and drugs. We have engineered the industrial workhorse microorganisms *Escherichia coli* and *Saccharomyces cerevisiae* to produce a variety of molecules, including the antimalarial drug artemisinin and advanced biofuels and chemicals that might otherwise be produced from petroleum. Unlike ethanol, the advanced biofuels have the full fuel value of petroleum-based biofuels, will be transportable using existing infrastructure, and can be used in existing automobiles and airplanes. Similarly, the microbially sourced chemicals can be dropped into existing processes used to produce existing materials. These chemicals will be produced from natural biosynthetic pathways that exist in plants and a variety of microorganisms as well as from pathways that have no representation in the natural world. Large-scale production of these chemicals and fuels will reduce our dependence on petroleum and reduce the amount of carbon dioxide released into the atmosphere, while allowing us to take advantage of our current transportation infrastructure and products supply chains.


### Biography:

Jay Keasling received his B.S. in Chemistry and Biology from the University of Nebraska in 1986; his Ph. D. in Chemical Engineering from the University of Michigan in 1991; and did post-doctoral work in Biochemistry at Stanford University from 1991-1992. Keasling joined the Department of Chemical Engineering at the University of California, Berkeley as an assistant professor in 1992, where he is currently the Hubbard Howe Distinguished Professor of Biochemical Engineering. Keasling is also a professor in the Department of Bioengineering at Berkeley, a Sr. Faculty Scientist and Associate Laboratory Director of the Lawrence Berkeley National Laboratory and Chief Executive Officer of the Joint BioEnergy Institute. Dr. Keasling's research focuses on engineering microorganisms for environmentally friendly synthesis of small molecules or degradation of environmental contaminants. Keasling's laboratory has engineered bacteria and yeast to produce polymers, a precursor to the anti-malarial drug artemisinin, and advanced biofuels and soil microorganisms to accumulate uranium and to degrade nerve agents.

**Matthew CHANG**
Associate Professor
NUS SynCTI, Program Leader, YLL School of Medicine,
National University of Singapore

## Title:

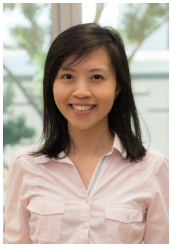
Developing programmable biological functionalities for autonomous microbial therapeutics

## Abstract:

Synthetic biology aims to engineer genetically modified biological systems that perform novel functions that do not exist in nature, with reusable, standard interchangeable biological parts. The use of these standard biological parts enables the exploitation of common engineering principles such as standardization, decoupling, and abstraction for synthetic biology. With this framework in place, synthetic biology has the potential to make the construction of novel biological systems a predictable, reliable, systematic process. Recent efforts to implement a highly systematic framework in biological engineering have provided long-awaited evidence that engineering principles can facilitate the construction of novel biological systems. Synthetic biology has so far demonstrated that its framework can be applied to a wide range of areas such as energy, environment, and health care. In this talk, our recent efforts to develop recombinant microbial cells with programmable biological functionalities will be presented. In particular, an emphasis will be placed on our development of auto-regulatory genetic circuits that transformed microbes into cell factories that autonomously monitor biosynthetic activities, and into therapeutic units that exert antimicrobial and anticancer functionalities.

## Biography:

Matthew Chang is Associate Professor at the National University of Singapore and Program Leader of NUS Synthetic Biology for Clinical and Technological Innovation (SynCTI). His research interests lie in synthetic biology of microbial systems, with particular emphasis on development of synthetic microbes that perform programmable functions for engineering applications. In particular, he has pioneered the development of synthetic microbes that show novel programmable therapeutic behaviors. His work has received international recognition and is featured in leading media agencies worldwide. He has been honored with the Scientific and Technological Achievement Award from U.S. Environmental Protection Agency, and serves as an editorial board member for ACS Synthetic Biology and Biotechnology Journal, and as an associate editor for Biotechnology for Biofuels.



**Susanna LEONG**
Program Director and Adjunct Associate Professor,
NUS SynCTI and Singapore Institute of Technology

## Title:

Engineering peptides for antimicrobial functionalization of biomedical devices

## Abstract:

Urinary catheters, which has a global market share of US$2 Bil, are widely employed in patient management in hospitals and medical centres worldwide. Although the urological catheters market is expected to expand with an aging population, long-term catheterization has been reported to frequently lead to infections, which is a major cause of patient morbidity and mortality, and constitutes one of the largest institutional reservoirs of hospital-acquired antibiotic-resistant pathogens, thereby increasing treatment costs substantially.

To address this problem, we engineered antimicrobial peptides (AMPs) that can be used to antimicrobially functionalize catheters, without eliciting cytotoxicity or antibiotic resistance problems associated with existing antimicrobial devices. A new class of short tryptophan- and arginine-rich AMPs was successfully developed, which showed superior potency to conventional antibiotics. A biocompatible 'plug-and-play' platform to stably functionalize and systematically modulate the release of the peptides on silicone catheter surfaces was established. Building off the design-build-test framework, a functional antimicrobial catheter prototype was successfully created, which demonstrated superior anti-biofilm and antimicrobial performance to commercially available antimicrobial catheters. The successful scale-up of this catheter prototype will provide an immediate, practical and cost-effective solution to minimize catheter associated urinary tract infection incidences, which will benefit patients, care-givers, and physicians alike.

## Biography:

Susanna Leong is Associate Professor and Cluster Director at Singapore Institute of Technology. She also holds an Adjunct Associate Professor appointment at NUS Department of Biochemistry. She is a chemical engineer by training, having obtained her PhD in Chemical Engineering from Cambridge University, UK. She was awarded the Danckwerts-Pergamon Prize for her research contributions in protein refolding and bioprocess development. Susanna's current research interests lie in peptide and microbial engineering using biochemical engineering tools.

**Emily LEPROUST**
Chief Executive Officer, Twist Bioscience

## Title:

Broadband DNA synthesis

## Abstract:

We have developed a proprietary semiconductor-based synthetic DNA manufacturing process featuring a 10,000-well silicon platform capable of producing synthetic biology tools, such as oligonucleotides, genes, pathways, chassis and genomes. By synthesizing DNA on silicon instead of on traditional 96-well plastic plates, our platform overcomes the current inefficiencies of synthetic DNA production, and enables cost-effective, rapid, high-quality and high throughput synthetic gene production. The Twist Bioscience platform has the potential to greatly accelerate the development of personalized medicine, sustainable chemical production, improved agriculture production as well as new applications such as in vivo diagnostics, biodetection and data storage.

## Biography:

Emily LeProust earned her PhD in organic chemistry from University of Houston and received her MS in industrial chemistry from Lyon School of Industrial Chemistry in France. She has authored some 30 publications in top scientific journals and holds more than 20 patents, mostly related to DNA synthesis. Formerly a director of genomics applications and chemistry R&D in the diagnostic and genomics Group at Agilent Technologies, she cofounded Twist Bioscience in 2013 and serves as CEO and President.


## William E. BENTLEY

Robert E. Fischell Distinguished Professor and Chair
Fischell Department of Bioengineering, University of Maryland


### Title:

Engineering Cells and Cell Networks for 'Executive' Function and Discovery


### Abstract:

Synthetic biology provides a means for articulating concepts into new products. With pathway analysis and optimization, cells are now engineered to produce large quantities of economically important molecules. Largely untapped within synthetic biology are the signaling motifs that guide cell processes and interactions among communicating populations. That is, signal molecules guide many cellular processes and these can be exploited to endow cells with "executive" function, where decision events are programmed and cells carry out tasks in addition to making products. These functions include engineering bacteria to fight cancer, cure diabetes, or to "tune" the microbiome in our GI tracts. Biofabrication, the use of biological components and biological processes for assembly, can provide a means for tailoring hierarchical order in biological systems. We exploit the principles of biofabrication to create 3D "test tracks" where chemical cues can be spatiotemporally controlled and task-accomplishing bacteria can be appropriately designed.


### Biography:

William E. Bentley is the Robert E. Fischell Distinguished Professor of Engineering and founding Chair of the Fischell Department of Bioengineering. He is also appointed in the Department of Chemical and Biomolecular Engineering at the University of Maryland, College Park and the Institute for Bioscience and Biotechnology Research. At Maryland since 1989, he has authored over 270 related archival publications, while also served on advisory committees for the NIH, NSF, DOD, DOE, FDA, USDA, and several state agencies. He is also a fellow of the ACS, AAAS, and AIMBE and an elected member of the American Academy of Microbiology. Through the creation and facile assembly of biologically functional interfaces, his lab has pioneered strategies for "biofabrication' and enabling 'communication' between devices and biological systems.

**Sanjay SWARUP**
NUS SynCTI
NERI
SCELSE

## Title:

Integrating Ecological Frameworks to Enhance Outcomes of Synthetic Biology Applications

## Abstract:

Developments in engineering microbes and other organisms using synthetic biology framework have led to diverse applications. In many of these applications, redesigned organisms are expected to function either in open systems or in well-controlled closed systems that have mixed communities of microbes. In such scenarios, it is becoming clear that integrating design principles of engineered organisms within an ecological framework will be key to achieve sustained benefits. It will allow engineered microbes to be successfully integrated within larger communities of microbes or interact more favourably with the surrounding environment. This talk will cover selected ecological frameworks for integration with synthetic biology. More specifically, case studies will be discussed from microbial ecology and chemical ecology fields to illustrate how knowledge can be extracted for engineering microbial systems and their interactions with hosts. Examples will be drawn from studies on microbiome successions in surface water systems, recruitment strategies in aquatic plant rhizosphere and from chemical signalling in plant-pathogen interactions. The talk will end with some perspectives on how synergy between ecology and synthetic biology can be used in improving our design principles of organisms.

## Biography:

Sanjay Swarup's research combines multidisciplinary approaches to understand the biological roles of metabolites in cellular networks and in signalling between environmental microbes and their hosts. Swarup has contributed towards bringing multi-'omics approaches, especially developing metabolomics tools, to better understand microbial processes in two environmental contexts; in tropical urban freshwater systems and in carbon emissions from tropical peat microbes. He holds PhD degrees in Genetics and in Plant Pathology from India and USA, respectively. Swarup is currently Deputy Director, NUS Environmental Research Institute (NERI) at the National Universtiy of Singapore, SCELSE Graduate Programme Director and Deputy Research Director (Environmental Engineering), and principal investigator in NUS SynCTI.

**Paul Jongjoon CHOI**
Senior Research Scientist, Genome Institute of Singapore

## Title:

Decoding cancer-immune dynamics: from analytic to synthetic approaches

## Abstract:

Abstract: Mechanistic and therapeutic advances recognize that cancer is not an isolated system, but rather engaged in a dynamic interaction with immunity. Our knowledge of how to engineer this interaction for improved health is, however, still in a nascent stage. Thus, I am developing methods to monitor and manipulate cancer-immune interactions.

## Biography:

Paul Choi received his B.S. in Chemistry from the California Institute of Technology in 2003 and his Ph.D. in Chemical Physics from Harvard University in 2009. After a postdoctoral position at Harvard Medical School's Department of Systems Biology, he moved to Singapore at the end of 2014. He is currently a Senior Research Scientist in Synthetic Biology at the Genome Institute of Singapore and Adjunct Assistant Professor in the Department of Biological Sciences at the National University of Singapore.


## Paul FREEMONT

Co-Director of ICL Synthetic Biology Hub, Imperial College London


### Title:

Unlocking the potential of synthetic biology for the development of healthcare diagnostics


### Abstract:

Synthetic Biology aims to establish a systematic framework for the design and/or redesign of living biological systems based on modular parts for useful purposes. However, biological systems are complex, non-linear, functionally context-dependent and stochastic in nature and are therefore intrinsically difficult to forward engineer. To address these fundamental challenges, there is a rapidly developing and expanded repertoire of approaches and tools, which are being applied either at the whole genome level or pathways/circuit design level. One exciting application area for synthetic biology design is in point-of-care diagnostics for disease monitoring or detection. In particular, cell-free biosensor has the advantage of being non-GMO and can be implemented in a freeze-dried paper form or incorporated in other materials. In this presentation I will describe two biosensor devices, one aimed at detecting pseudomonas infections in cystic fibrosis patients and the other infective schistosoma worms in watercourses that give rise to schistosomiasis infections in humans.


### Biography:

Paul Freemont is co-director and co-founder of the EPSRC Centre for Synthetic Biology and Innovation and the National UK Innovation and Knowledge Centre for Synthetic Biology at Imperial College London. He is also currently Head of the new Section of Structural Biology in the Department of Medicine at Imperial. He was previously the Head of the Division of Molecular Biosciences (2005-2012), Head of the Imperial College Centre for Structural Biology (2000-2005). His research interests span from understanding the molecular mechanisms of human diseases to the development of synthetic biology platform technologies and biosensors and is the author of over 170 scientific publications. He was elected an EMBO member in 2009 and is also a fellow of the Royal Society of Biology and the Royal Society of Medicine.

**Anthony PARTRIDGE**
Principal Scientist, Merck

## Title:

Stearoyl-CoA desaturase inhibition blocks formation of hepatitis C virus-induced specialized membranes

## Abstract:

Hepatitis C virus (HCV) replication is dependent on the formation of specialized membrane structures; however, the host factor requirements for the formation of these HCV complexes remain unclear. Herein, we demonstrate that inhibition of stearoyl-CoA desaturase 1 (SCD-1) halts the biosynthesis of unsaturated fatty acids, such as oleic acid, and negatively modulates HCV replication. Unsaturated fatty acids play key roles in membrane curvature and fluidity. Mechanistically, we demonstrate that SCD-1 inhibition disrupts the integrity of membranous HCV replication complexes and renders HCV RNA susceptible to nuclease-mediated degradation. Our work establishes a novel function for unsaturated fatty acids in HCV replication.

## Biography:

Anthony Partridge is an industrial pharmacologist with over ten years of experience. Since July 2015, he has served as Principal Scientist at MSD's drug discovery unit (TMRC) in Singapore where he works on a variety of programs in the early discovery space. As an In Vitro Pharmacology Capability Lead in the xDPS group at Merck & Co., he helped pioneer collaborative efforts with CRO partners in China focusing on assay development and screening for SAR campaigns. Dr. Partridge has authored twenty peer-reviewed scientific publications in top journals such as Cell, Journal of Clinical Investigation and Journal of Biological Chemistry. He received his B.Sc. from the University of Guelph in 1998, his Ph.D. from the University of Toronto in 2003 and completed post-doctoral training at Scripps/UCSD (2003-2006).

**Sierin LIM**
Assistant Professor
School of Chemical and Biomedical Engineering,
Nanyang Technological University

## Title:

Biomimetic Production of Customizable Bacterial Cellulose through Synthetic Biology Approach

## Abstract:

Bacterial cellulose (BC) has found applications in the biomedical, food, and cosmetics industries. *Gluconacetobacter xylinus* has been the model organism for BC biosynthesis. The cellulose produced is of high purity and crystallinity compared to those isolated from wood pulp due to the absence of lignin and hemicellulose. Despite the natural production capacity and the biogenesis knowledge, BC is produced in relatively low quantity and there has been no reported systematic engineering of cellulose production by *G. xylinus*. We hypothesize that through rational engineering of regulatory network of G. xylinus, properties associated with the secretion and self-assembly of cellulose can be controlled. In this project, our goal is to systematically rewire the natural production cascade to enhance BC production capacity and the self-assembly of microfibrils/nanofibers for the synthesis of tailor-made and customizable cellulose.

## Biography:

Sierin Lim's Bioengineered and Applied Nanomaterials Laboratory (BeANs Lab) at Nanyang Technological University (NTU) Singapore focuses on the design and engineering of hybrid nano/microscale devices from biological parts by utilizing protein engineering as a tool for applications in medicine, energy, cosmetics, and food. She received both her B.S. and Ph.D. degrees from University of California at Los Angeles (UCLA) in Chemical Engineering and Biomedical Engineering, respectively, and did a postdoc at UC Irvine. She is the founder of the Biomedical Engineering Society (Singapore) Student Chapter (BES-SC) and the 2013 recipient of the L'Oréal-UNESCO Singapore for Women in Science National Fellowship.

**Richard I KITNEY**
Co-Director of ICL Synthetic Biology Hub, Imperial College London

## Title:
Design and characterisation in Synthetic Biology

## Abstract:
Synthetic biology provides a framework for the systematic design of biological devices, systems and cells. This is achieved by the application of the engineering principles of modularity, standardisation and characterisation. In our case, this has led to a strategy which comprises the development of platform technology which can be applied across a range of applications. The development of a web-based information system (SynBIS) will be described. This is used in systematic workflow related to device design. Another aspect of this work is how laboratory robots can be used for automatic characterisation of BioParts, so that the same BioPart can be characterised independently at multiple locations with high reproducibility. One of the keys to this approach is the development of a standard which is capable of capturing the characterisation experiments in detail. We will describe how DICOM-SB is capable of capturing the data and metadata associated with a characterisation experiment, as well as other tacit information. Importantly, this work enables the integration of the characterisation workflow into a DNA synthesis foundry.

## Biography:
Richard I Kitney is Professor of Biomedical Systems Engineering; Chairman of the Institute of Systems and Synthetic Biology; and Co-Director of the EPSRC National Centre for Synthetic Biology and Innovation. He chaired The Royal Academy of Engineering Inquiry into Synthetic Biology and is a member of the Ministerial Leadership Council for Synthetic Biology. Kitney has published over 300 papers in the fields of synthetic biology, mathematical modelling, biomedical information systems, and medical imaging. He was awarded The Order of the British Empire (OBE) for services to Information Technology in Healthcare and honoured as an Academician of the International Academy of BioMedical Engineering.


## Dong-Yup LEE

Assistant Professor and Principal Investigator
Department of Chemical and Biomolecular Engineering, NUS SynCTI,
National University of Singapore and Bioprocessing Technology Institute


### Title:

Systems and synthetic biotechnology for characterizing and designing plant and mammalian cells

### Abstract:


We have recently established knowledge-based “Systems and synthetic biotechnology” platform where multi-omics data-driven and hypothetical model-driven approaches can be integrated to study the cell growth characteristics under various conditions, enhance the cellular performance/ properties and design novel biological products or functions. In this talk, several applications of the framework to plant and mammalian systems will be presented and current challenges and issues will be discussed.


### Biography:

Dong-Yup Lee is an assistant professor of the Department of Chemical and Biomolecular Engineering at the National University of Singapore, and leads the Bioinformatics group as a senior scientist at the Bioprocessing Technology Institute, A*STAR. His research interests include Systems Biology/Biotechnology/Bioinformatics, Synthetic and Engineering Biology, and Drug and Disease Modelling.

**Chueh Loo POH**
Assistant Professor
School of Chemical and Biomedical Engineering,
Nanyang Technological University

## Title:
Engineering Synthetic Gene Circuits

## Abstract:
Synthetic biology involves designing and building complex biological systems for various applications including health, energy and environment. Synthetic genetic circuits are designed and built to “re-program” the biological systems. It has been challenging, largely due to the complexity of biological systems and contextual issues. To engineer biological systems with new functions, synthetic genetic circuits are often designed and introduced into microorganism (which serves as host) to achieve the desired functions. In this talk, I will present our recent work in the development of modeling tools/framework that could aid in the design of genetic circuits and our effort on creating a set of engineering solutions for overcoming failure modes during the development of the synthetic genetic circuits.

## Biography:
Chueh Loo Poh is an Assistant Professor with School of Chemical and Biomedical Engineering at Nanyang Technological University (NTU), Singapore since 2007. He obtained his PhD in Bioengineering from Imperial College London and B.Eng. in Electrical and Electronic Engineering from NTU Singapore. His current research interests in Synthetic Biology include development of biological parts/devices, development of modeling techniques and computer aided system to aid the design of complex biological system, and engineering of beneficial microbes with novel functions for human health. He has been actively involved in international synthetic biology competition (iGEM) since 2006. He was part of the program organizing committee for SB6.0 2013 and SynbioBETA Singapore in June 2014. He was awarded NTU Excellence in Teaching award in 2010, and Tan Chin Tuan Fellowship in 2012.

**Andrea CAMATTARI**
Staff Scientist
Bioprocessing Technology Institute (BTI)

## Title:

Synthetic biology and metabolic engineering in unconventional yeasts: peculiarities, challenges and opportunities

## Abstract:

The concept of cell factory, introduced in the last decade to describe an extensive exploitation of cellular machineries to produce a wide range of products, has been recently extended, due to the wide application and development of multidisciplinary approaches generally referred as metabolic engineering and synthetic biology: the possibility to rewire metabolic pathways allows scientists to direct metabolic fluxes more or less at will towards the desired products.
The full understanding of host metabolism represents, by definition, the starting point from which all manipulation can be conceived: not surprisingly, then, the vast majority of metabolic engineering attempts are based on the two most exploited and studied microorganisms, the bacteria *Escherichia coli* and the yeast *Saccharomyces cerevisiae*. Although rational or semi-rational metabolic modification allows to effectively manipulating these hosts, many other hosts represent a valid alternative, due to specific pathways leading either more efficiently to products of interest, or to entirely new products.
A serious hindrance to the development of such hosts for metabolic engineering is represented by the scarcity of tools for molecular biology, and a lack of knowledge – at the molecular level – on specific pathways. In our lab we are actively focusing on fulfilling such gaps, introducing novel expression vectors, universally applicable to various yeasts, and novel expression strategies for key genes in cell metabolism. Moreover, as bioproducts are not only the result of a genetic program, we are developing culturing conditions to maximise the impact of genetic manipulations in unconventional yeasts.

## Biography:

Andrea Camattari obtained his graduation working on the yeast *Kluyveromyces lactis* at University of Milan, where he obtained his PhD in industrial biotechnology in 2006. Soon after his PhD defence, he moved to the Bioprocessing Technology Institute (BTI) in Singapore, where he deepened some aspects related to microbial – and yeast, in particular – physiology. He then moved to Anton Glieder's group at Graz University of Technology in Graz, Austria, where he co-managed the research on the methylotrophic yeast *Pichia pastoris* from 2010 to 2015. Since March 2015, he re-joined BTI, where, as staff scientist, he manages the *Pichia pastoris* and unconventional yeasts unit within the Microbial Cells group.

**Darren ELLEMOR**
Marketing Manager
BD Biosciences

## Title:

More than Just a Tool for Immunology: Flow Cytometry Applications Beyond the Mammalian Cell

## Abstract:

For decades Flow Cytometry has been an indispensable tool for unravelling the complexities of haematological systems. However the utility of this technology is far from limited to the mammalian cell. Join us as we explore some of the exciting applications that can be unlocked through the rapid analysis – and purification – of samples at the single cell level.

## Biography:

Darren Ellemor has over 15 years of experience in flow cytometry, starting as a post-graduate researcher in 1996 and including 3 years as Assistant Manager of the flow cytometry core facility at Monash University in Melbourne. He now supports the BD Biosciences range of research instruments and reagents as Product Manager for the Asia Pacific region.


## John A. GERLT

Gutgsell Chair and Professor of Biochemistry and Chemistry
Institute for Genome Biology, University of Illinois at Urbana-Champaign


### Title:

Tools and Strategies for Discovering Novel Enzymes and Metabolic Pathways

### Abstract:


The number of sequences in protein databases continues to increase dramatically as the result of microbial sequencing projects. The UniProt database now includes >50M nonredundant sequences, with the in vitro activities and in vivo metabolic functions of ~50% of these unknown, uncertain, or incorrect. If the potential provided by sequencing projects is to be realized, strategies must be devised to facilitate the assignment of functions to uncharacterized enzymes. This lecture will provide examples of how 1) bioinformatic and computational tools can be used to predict novel enzymatic functions and pathways; and 2) enzymology, microbiology, and metabolomics can be used to verify those functions and place them in metabolic context.


### Biography:

John A. Gerlt is Gutgsell Chair and Professor of Biochemistry and Chemistry at the University of Illinois, Urbana Champaign, where he is a member of the Institute for Genomic Biology. He received his B.S. from Michigan State University in 1969, his Ph.D. from Harvard University in 1974, and was a Jane Coffin Childs Postdoctoral Fellow at the National Institutes of Health from 1974-75. Prior to his current position at the University of Illinois, Gerlt held faculty positions at Yale University and the University of Maryland, College Park. He received the Repligen Corporation Award in Chemistry of Biological Processes from the Division of Biological Chemistry, American Chemical Society in 2003, an Arthur C. Cope Scholar Award from the American Chemical Society in 2010, and the A. I. Scott Medical from Texas A&M University in 2010. Gerlt has been an Associate Editor of Biochemistry since 2004.

**Robert C. ROBINSON**
Research Director
Institute of Molecular and Cell Biology

## Title:

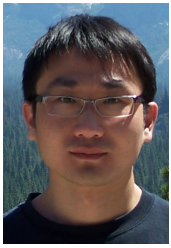
Actin Filament Systems in Health and Disease

## Abstract:

Elongating filaments systems, such as actin, are polymerizing motors that drive movement in many biological processes. My laboratory studies the structures, dynamics and evolution of actins across a wide range of species. We are particularly interested in understanding how the force generated from polymerization is integrated into different biological processes. Here I will contrast the different properties of eukaryotic and prokaryotic actin filament systems and discuss why mammalian actin is a frequent target for pathogen modulation. These structural and biochemical studies are designed to uncover mechanisms behind actin function in health and disease – very much basic research. However, given the focus of this SynCTI Synthetic Biology Symposium, I will discuss elements of these filament systems that may have relevance and uses in other areas of science.

## Biography:

Bob obtained his BSc (1987) from King's College, London University, his MSc (1990) from University of British Columbia, his DPhil (1996) from Oxford University and his postdoc was completed at the Salk Institute for Biological Studies (1996-2001). Bob was appointed as a Senior Lecturer at Uppsala University. He joined IMCB in 2005 as a Principal Investigator and became a Research Director in 2011. Bob's laboratory seeks to gain detailed knowledge of the mechanisms behind pathogenicity and disease through elucidating structures of key components involved in the progression of these disorders. The laboratory is interested in all areas of aberrant function and misregulation of proteins in conditions arising from genetic mutations or external challenges. One central, but not limiting, theme of the laboratory is the harnessing of force-generating polymerization machines in (mis) driving critical biological processes.



**Hao FAN**
Principal Investigator
Bioinformatics Institute

## Title:

Computation-guided ligand discovery: virtual screening against protein structures

## Abstract:

We are developing an integrated computational platform, combining protein structure modeling and virtual ligand screening, to facilitate ligand discovery in the pathway/superfamily/genome scale. This platform was successfully applied to ligand discovery for the protein-protein interface of PDK1 kinase, and yielded encouraging results when applied to therapeutic targets such as beta-catenin and glucose-dependent insulinotropic receptor.

## Biography:

Hao Fan was appointed Principal Investigator at the Bioinformatics Institute (BII), A*STAR in February 2014. The broad goal of his group is to develop computational techniques to facilitate ligand discovery in the pathway/superfamily/genome scale. The developed methods will be applied to families of uncharacterized enzymes and therapeutic targets such as G protein–coupled receptors (GPCRs), transporters, and downstream kinases, to contribute to a better understanding and regulation of biological processes, as well as the discovery of new drugs. The computational predictions will be tested experimentally through collaborations. Prior to joining Singapore, he worked as a postdoctoral fellow followed by a research scientist at University of California, San Francisco (UCSF). He obtained his Ph.D in Biophysical Chemistry at University of Groningen (RUG).

**Farid GHADESSY**
Group Leader
p53 Laboratory

## Title:

Engineering enzyme substrate specificity by combinatorial selection

## Abstract:

Combinatorial selection methods facilitate the rapid, high throughput interrogation of large numbers of protein variants for desired properties. Mdm2 is an E3 ubiquitin ligase and key negative regulator of the p53 tumour suppressor protein. Small molecule and peptidic antagonists of Mdm2 have been described with several in (pre) clinical trials. Using *in vitro* selection, we have shown that Mdm2 can mutate to selectively bind p53, but not a small molecule antagonist. The mutations identified represent possible routes to clinical resistance. In a further study, we have used *in vivo* selection to engineer the substrate specificity of the bacteriophage lambda integrase. The modified enzymes are useful for genome editing applications in bacteria and mammalian cells.

## Biography:

Farid Ghadessy is a group leader at the p53LAB, A*STAR (Singapore). His group focuses on the development of combinatorial methodologies for the selection of novel proteins/nucleotides. He received his PhD from the National University of Singapore, following which he carried out postdoctoral research at the National University Hospital (Singapore), Laboratory of Molecular Biology (Cambridge), University College London and Institute of Molecular and Cellular Biology (Singapore).


## Huimin ZHAO

Centennial Endowed Chair Professor of Chemical and Biomolecular Engineering and Professor of Chemistry, Biochemistry, Biophysics
University of Illinois at Urbana-Champaign


### Title:

Building a Biological Foundry for Next-generation Synthetic Biology


**Abstract:**

Inspired by the exponential growth of the microelectronic industry, synthetic biologists have been attempting to build biological foundries for rapid prototyping and manufacturing of biological systems for synthesis of bioproducts ranging from chemicals to materials to therapeutic agents. In this talk, I will briefly discuss the challenges and opportunities in synthetic biology and highlight our recent work on the development and application of novel foundational synthetic biology tools. Specifically, I will introduce the Illinois Biological Foundry for Advanced Biomanufacturing (iBioFAB) that we have been establishing to automate the design-build-test-analyze cycle and discuss its three potential biotechnological applications. The first is the rapid and high throughput synthesis of transcription activator-like effector nucleases (TALENs) for genome editing applications. The second is the discovery, characterization, and engineering of novel natural product biosynthetic pathways for drug discovery and development. The third is the design, construction and optimization of biochemical pathways and microbial factories for economic production of chemicals and fuels.


**Biography:**

Huimin Zhao is the Centennial Endowed Chair Professor of chemical and biomolecular engineering, and professor of chemistry, biochemistry, biophysics, and bioengineering at the University of Illinois at Urbana-Champaign. He has published over 220 research articles and over 20 issued and pending patent applications. He served as a consultant for over 10 companies such as Pfizer, Maxygen, BP, Gevo, and zuChem, and a Scientific Advisory Board member of Gevo, Myriant Technologies, and Toulouse White Biotechnology (TWB). He is the visiting principal investigator of the metabolic engineering research laboratory (MERL) in the Agency for Science, Technology and Research of Singapore. He is an associate editor of ACS Catalysis and an editor of ACS Synthetic Biology, Journal of Industrial Microbiology and Biotechnology, Scientific Reports, Biocatalysis, and Engineering in Life Sciences.

**Won Jae CHOI**
Senior Manager
Institute of Chemical and Engineering Sciences

## Title:

Challenges for commercialization in bio-based chemicals

## Abstract:

The fast-growing biomass conversion technology represents not only a remarkable shift from the conventional petroleum-based processes, but it also offers a valuable economic opportunity for many countries to reorganize their chemical industry. Bio-based chemicals are recognized as alternative drop-in replacements for currently available oil-based commodity chemicals. There have been extensive R&D efforts on producing them from biomass, resulting in a number of remarkable achievements, followed by successful scale-up. On the other hand, there are a number of challenges for commercialization of bio-based chemicals in terms of technical as well as business aspects. In this presentation, current status of bio-based industry is briefly summarized to identify key issues and to explore possible solutions. Examples of success and unsuccessful stories in developing target products is also described for better understanding on how to play a right role in this emerging area for future sustainable bio industry.

## Biography:

Won Jae Choi received the B.S., M.S., and Ph.D. degrees from department of Chemical Technology, Seoul National University in Korea. His research interests include synthetic biology, metabolic engineering, biocatalysis and bioprocess development for the production of pharmaceutical intermediates, therapeutic proteins, and bulk/specialty chemicals. Since obtained Ph. D. in 2001, working in industry as well as in research institute, he has been actively involved in the area of Industrial Biotechnology targeting at construction of metabolically engineered strains, fermentation process and scale-up for commercialization. In his recent career in Samsung, he was also involved in R&D management as a group leader, such as establishment of research organization, manpower building and planning R&D strategy for new business opportunity. He is currently leading “Biomass to Chemicals Program” funded by A-STAR, Singapore as a program manager and adjunct associate professor in department of biochemistry, NUS, Singapore.


## Ee Lui ANG

Principal Investigator
Metabolic Engineering Research Lab, Science and Engineering Institutes


### Title:

Developing of Microbial Cell Factories for Bio-based Chemicals


### Abstract:

The production of chemicals through biological systems offer promising solutions to global challenges presented by a carbon constrained future and an increasing global population. In the past decade, rapid advances in DNA sequencing, synthesis and editing technologies have accelerated our ability to program biological systems for the production bio-based chemicals from renewable feedstocks. However, challenges such as feedstock utilization, microbial cell factory engineering and stabilization of the production strain's genetics, still remain. This presentation will highlight our efforts in addressing these challenges through the design and engineering of recombinant microorganisms for the deconstruction of cellulose and the production of chemicals, as well as in the development of an efficient technological platform for the integration of genetic pathways and circuits into the host genomes.


### Biography:

Ee Lui received his B. Eng in Chemical Engineering from the National University of Singapore in 2002 and his Ph. D. in Chemical and Biomolecular Engineering from the University of Illinois at Urbana-Champaign & National University of Singapore Joint Ph. D. program in 2007. Subsequently, he joined Codexis Laboratories Singapore Pte Ltd, where he held the positions of Project Technical Lead, Molecular and Cellular Biology Team Leader, and Project Manager for the BioIndustrial project. He joined the Metabolic Engineering Research Lab in 2012. His current research interest is in applying metabolic engineering and synthetic biology approaches to engineer functionally improved or novel proteins, pathways, and genomes to address challenges sustainable manufacturing, nutrition and healthcare.

***NOTES***

***NOTES***

## *NOTES*

## *NOTES*

## *NOTES*

***NOTES***

## *NOTES*

## *NOTES*

## *NOTES*

***NOTES***