

Bootcamp 2021

An Integrative Approach to Understand Cell Function

29 July - 7 August



Otherwise known as **BOOTCAMP 2021**

MB5104 AN INTEGRATIVE APPROACH TO UNDERSTAND CELL FUNCTION

The Bootcamp aims to bring together new Life Sciences graduate students, regardless of their backgrounds.

Each morning, there will be lectures on topics revolving around biophysics, cell, and developmental biology. The afternoon sessions will be more focused on developing your practical skills, in particular, the use of Python and Fiji for image analysis. Interweaving the lessons from the morning and afternoon sessions, you will be solving problem sets.

A key element of the Bootcamp is teamwork. To begin, you will be assigned to groups of around four students. These groups have been put together to include students from mixed academic backgrounds, such as materials engineering to genetics. You will work in these groups to produce a report and talk on a "hot topic" in cell biology. To encourage teamwork, groups will be graded as one, based on the performance of all the members. During the practical sessions and problem solving, teamwork is also strongly encouraged; learning is achieved through active participation, including the teaching of others.

Each group will write a report and present its key conclusions at the end of the Bootcamp. The topics focus on areas where there is often uncertainty or misunderstanding. It is important to be critical and provide a balanced summary. All group members must contribute to the writing and presentation of the report.

In the space of such a short course, it is difficult for us to cover all relevant topics for the start of your graduate studies. Therefore, we choose to focus on developing your critical skills and collaborative tools – both of which will serve you well for your graduate research. We describe the cell from a mechanistic perspective, and discuss different model systems and genomic techniques that allow you to gain insight into biological curiosities. We complement this with microscopy and quantitative techniques that enable the cell to be probed and seen in detail. Alongside all these, we will develop your computational techniques which will enable you to perform the quantitative analysis that is essential in modern biological research.

This course provides you with a strong breadth of knowledge before you begin your research rotations. You will also gain insight into techniques that are available in Singapore that may assist you in your studies. As you progress in your graduate studies, you will have the opportunity to add greater depth to this knowledge.

Yusuke TOYAMA Andrew HOLLE Jennifer YOUNG Thuan Beng SAW Samuel BARNETT Chii Jou CHAN, Joe LONG Yuchen LIEU Zi Zhao, Robert Elizabeth LEE Mei Yin Richard DE METS



Department of Biological Sciences Faculty of Science



National University of Singapore

TIMETABLE -

MB5104: An Integrative Approach to Understand Cell Function (For registered students, leading to 4MC) 29th July to 7th August 2021

VENUES —

MR	Level 5 Meeting Rooms @ T-Lab Building (5A Engineering Drive 1, Level 5, S117411) Directions: <u>http://www.temasek-labs.nus.edu.sg/about/about_visitor.php</u>
SPS	SPS Teaching Labs @ Block S16 (6 Science Drive 2, Level 3, S117546) Directions: <u>http://sps.nus.edu.sg/about-us/contact-us/</u>
CBIS	NUS Centre for Bioimaging Sciences @ Block S1A (14 Science Drive 4, Level 2, S117557) Directions: <u>https://www.dbs.nus.edu.sg/cbis/about-cbis/contact-cbis/</u>

DAY 1

Date	Time	Content	Speaker	Venue
Thursday	10:30 am - 11:00 am	Registration (Please register at the front)		MR
29th July 2021	11:00 am - 11:30 am	Introduction to the Bootcamp	Assoc. Prof. Yusuke Toyama	MR
	11:30 am - 12:00 pm	Safety briefing	Tan Bee Leng	MR
	12:00 pm - 1:00 pm	Lunch		
	1:00 pm - 4:00 pm	Introduction to Python (Coffee at 2:30 pm)	Dr. Samuel Barnett Dr. Richard De Mets	MR
	4:00 pm - 4:30 pm	Group assignments	Assoc. Prof. Yusuke Toyama	MR
	4:30 pm - 6.30 pm	Mechanopathology of Diseases from Bench to Bedside	Prof. Lim Chwee Teck	MR

DAY 2

Date	Time	Content	Speaker	Venue
Friday	9:00 am - 9:45 am	The Cell Cytoskeleton	Prof. Hanry Yu	MR
30th July 2021	9:45 am - 10:30 am	Cell Compartments	Assoc. Prof. Gregory Jedd	MR
	10:30 am - 11:00 am	Break		
	11:00 am - 11:45 am	Endomembrane System	Asst. Prof. Zhang Dan	MR
	11:45 am - 12.30 pm	Cell Migration	Asst. Prof. Andrew Holle	MR
	12:30 pm - 1:30 pm	Lunch		
	1:30 pm - 5:00 pm	Introduction to Image Analysis on Python (Coffee at 3:00 pm)	Dr. Elizabeth Lee Dr. Samuel Barnett	MR
	5:00 pm - 5:45 pm	How to Write Well	Prof. Antonia Monteiro	MR
	5:45 pm - 6:30 pm	How to Present Well	Prof. Antonia Monteiro	MR

4

DAY 3

Date	Time	Content	Speaker	Venue
Saturday 31st July 2021	9:30 am - 10:30 am	How Fluorescents Work; History of GFP	Assoc. Prof. Yusuke Toyama	MR
	10:30 am - 11:00 am	Break		
	11:00 am - 12:00 pm	Introduction to Microscopy	Assoc. Prof. Yusuke Toyama	MR
	12:00 pm - 1:00 pm	Lunch		
	1:00 pm - 4:00 pm	Optics tutorial (Coffee at 3:30 pm)	Asst. Prof. Duane Loh	MR
	4:00pm - 6:00pm	Introduction to Image Analysis in Fiji	Dr. Richard De Mets Dr. Saw Thuan Beng	MR

DAY 4

Date	Time	Content	Speaker	Venue
Sunday 1st August 2021	9:00am - 1:00pm	Image Analysis in Fiji and Python (Coffee at 10:30 am)	Dr. Richard De Mets Dr. Saw Thuan Beng	MR

DAY 5

Date	Time	Content	Speaker	Venue
Monday	8:30 am - 10:00 am	Gene Editing	Dr. Robert Lieu Zi Zhao	MR
2nd August	10:00 am - 10:30 am	Break		
2021	10:30 am - 11:30 am	Genomes	Dr. Robert Lieu Zi Zhao	MR
	11:30 am - 12:30 pm	Genomics worksheet (BLAST and more)	Dr. Robert Lieu Zi Zhao	MR
	12:30 pm - 1:30 pm	Lunch		
	1:30 pm - 6:30 pm	Wet Lab and Sample Preparation (Group A) / Illustration (Group B)	Dr. Robert Lieu Zi Zhao / Dr. Diego Pitta de Araujo	SPS / MR

DAY 6

Date	Time	Content	Speaker	Venue
Wednesday 4th August	9:00 am - 9:30 am	Introduction to Yeast	Assoc. Prof. Yeong Foong May	MR
2021*	9:30 am - 10:00 am	Introduction to Drosophila	Asst. Prof. Wang Hongyan	MR
	10:00 am - 10:30 am	Introduction to Fish	Asst. Prof. Ajay Sriram Mathuru	MR
	10:30 am - 11:00 am	Break		
	11:00 am - 11:30 am	Introduction to Plants	Asst. Prof. Lau On Sun	MR
	11:30 am - 12:00 pm	Introduction to Mouse	Asst. Prof. Chii Jou Chan	MR
	12:00 pm - 1:00 pm	Lunch	-	
	1:00 pm - 5:30 pm	Microscopy (Group A) / Wet Lab and Sample Preparation (Group B)	Assoc. Prof. Yusuke Toyama / Dr. Robert Lieu Zi Zhao	MBI CBIS / SPS

Date	Time	Content	Speaker	Venue
Thursday 5th August	9:00 am - 9:45 am	Perturbing The Cell	Assoc. Prof. Yusuke Toyama	MR
2021	9:45 am - 10:30 am	Super Resolution Microscopy	Assoc. Prof. Pakorn Tony Kanchanawong	MR
	10:30 am - 11:00 am	Break		
	11:00 am - 11:45 am	Extracellular Matrix and Artificial Substrate	Asst. Prof. Jennifer Young	MR
	11.45 am - 12:30 pm	Atomic Force Microscopy	Asst. Prof. Long Yuchen	MR
	12:30 pm - 1:30 pm	Lunch		
	1:30 pm - 6:00 pm	Illustration (Group A) / Microscopy (Group B)	Dr. Diego Pitta de Araujo / Assoc. Prof. Yusuke Toyama	MR / MR

DAY 8

Date	Time	Content	Speaker	Venue
Friday 6th August	9:00 am - 10:30 am	Statistical Methods for Biology	Assoc. Prof. L. Roman Carrasco	MR
2021	10:30 am - 11:00 am	Break		
	11:00 am - 1:00 pm	Hands-on Statistical Analysis	Dr. Tetsuya Hiraiwa	MR
	1:00 pm - 2:00 pm	Lunch		
	2:00 pm - 5:00 pm	Presentation workshop	Assoc. Prof. Yusuke Toyama	MR

Date	Time	Content	Speaker	Venue
Saturday 7th August 2021	9:00 am - 10:30 am	Presentations	Dr. Robert Lieu Zi Zhao Asst. Prof. Chii Jou Chan Asst. Prof. Long Yuchen Assoc. Prof. Yusuke Toyama	MR & TBD*
	10:30 am - 11:00 am	Break		
	11:00 am - 12:30 pm	Presentations	Dr. Robert Lieu Zi Zhao Asst. Prof Chii Jou Chan Asst. Prof. Long Yuchen Assoc. Prof. Yusuke Toyama	MR & TBD*
	12:30 pgn - 1:30 pm	Lunch		
	1:30 pm - 6:00 pm	Writing and Image Analysis Workshop	Assoc. Prof. Yusuke Toyama	MR

Date	Time	Content
Wednesday 11th August 2021	6:00 pm	Report submission deadline

DAY 9

SPEAKERS' BIOS

For his Bootcamp, we have engaged professors, researchers and field experts from various academic and research institutes, industries and organisations — including but not limited to faculties in the National University of Singapore (NUS), Mechanobiology Institute (MBI), Temasek Life Sciences Laboratory (TLL), Singapore-Massachusetts Institute of Technology Alliance for Research and Technology (SMART) and Agency for Science, Technology and Research (A*STAR).

Assoc. Prof. Yusuke TOYAMA -

Associate Professor, Department of Biological Sciences, NUS Principal Investigator, Mechanobiology Institute

Dr. Yusuke Toyama was classically trained in physics and engineering, and embraced biophysics and mechanobiology during his postdoctoral term at Duke University. His lab utilises multidisciplinary approaches to study cell mechanism and tissue dynamics, mainly in the context of animal development, including the mechanical role of apoptosis within a tissue and 3D cell shape change during collective cell migration. In recognition of his highimpact research on how mechanical factors couple with apoptosis, he was appointed the Dean's Chair in the NUS Faculty of Science.



Dr. Samuel Fardell Hastings BARNETT

Research Fellow, Mechanobiology Institute

Dr. Samuel Barnett is a research fellow at the Kanchanawong Lab at MBI and the Department of Biomedical Engineering, NUS, which specialises in nanoscale microbiology. His research interest lies in the molecular mechanics of mechanotransduction. He has worked on the visualisation of protein organisation at focal adhesions using super-resolution microscopy and establishing a label-free molecule useful in quantifying the interactions in chemicallyinduced dimerisation.



Dr. Richard De METS -

Research Fellow, Mechanobiology Institute Deputy Facility Manager, Singapore Microscopy and Bioimage Analysis Core at MBI

Dr. Richard De Mets is a research fellow at MBI and the deputy facility manager of the Singapore Microscopy and Bioimage Analysis Core at MBI. His research focuses on biophysics, optics, and computational image analysis.



Prof. LIM Chwee Teck -

NUSS Professor, Department of Biomedical Engineering, NUS Founding Principal Investigator, Mechanobiology Institute

Dr. Lim Chwee Teck is the Director of the Institute for Health Innovation and Technology and Singapore Health Technologies Consortium, Faculty Fellow at SMART and recently appointed Fellow of the ASEAN Academy of Engineering & Technology. His areas of research are interdisciplinary and include human disease mechanobiology, microfluidic biomedical technologies for human disease diagnosis and precision medicine, and soft wearable technologies for healthcare applications. His lab also investigates how mechanical cues and constraints regulate collective cell migration.



Prof. Hanry YU

Professor, Department of Physiology, Yong Loo Lin School of Medicine, National University Health System and NUS University Scholars Program Principal Investigator, Mechanobiology Institute

Dr. Hanry Yu is a Group Leader at the A*STAR Institute of Bioengineering and Nanotechnology and Co-Lead Principal Investigator at the SMART. He trained as a cell biologist, but ventured into imaging, biomaterials, tissue engineering, drug testing and computational biology of liver fibrosis. His lab translates the latest biological and engineering knowledge into innovative medical technologies, including the study and manipulation of liver cells and tissues to advance precision engineering. He takes an interdisciplinary and team-based approach to research and graduate training, and adapts graduates to both industrial and academic settings.



Assoc. Prof. Gregory JEDD ——

Adjunct Associate Professor, Department of Biological Sciences, NUS Senior Principal Investigator, Temasek Life Sciences Laboratory

Dr. Gregory Jedd joined TLL as a Principal Investigator in 2004 and leads the Jedd Group, which explores the principles of biological organization through evolutionary cell biology. His group develops unconventional model systems to investigate the fundamental mechanisms underpinning cellular growth, development and evolution, and reveal hitherto unrecognized aspects of cellular organization. They are especially interested in adaptive cellular traits based on high-order protein assemblies and organelles.



Asst. Prof. ZHANG Dan -

Adjunct Assistant Professor, Department of Biological Sciences, NUS Principal Investigator, Temasek Life Sciences Laboratory

Dr. Zhang Dan started her independent group as a Young Investigator at TLL from 2014 and was promoted to Principal Investigator in 2019. Her research focuses on the formation and homeostasis at membrane contact sites, elucidating their nature and functions. In particular, they look at the endoplasmic reticulumplasma membrane contact sites, their mechanistic roles in calcium and lipid homeostasis, and their potential involvement in plasma membrane patterning and cell stress response.



Asst. Prof. Andrew Holle ------

Assistant Professor, Department of Biomedical Engineering, NUS Principal Investigator, Mechanobiology Institute

Dr. Andrew Holle has a joint appointment at the Department of Biomedical Engineering and MBI, where he leads the interdisciplinary Confinement Mechanobiology Lab. They use mechanobiology principles and observations of fluid-filled 'cellular highways' in the interstitial matrix to identify and leverage on the role of confinement in stem cell differentiation. His research fuses mechanobiology, tissue engineering, microfluidics, and nanotechnology, with an end goal of discovering the molecular mechanisms underlying mechanosensitive migratory stem cell differentiation.



Dr. Elizabeth LEE Mei Yin —

Postdoctoral Associate, Singapore-MIT Alliance for Research and Technology

Dr. Elizabeth Lee Mei Yin was a Ph.D. student at the 3D Optical Systems group at MIT and currently a Postdoctoral Associate at SMART. She is interested in the behaviour of light and how one can exploit the various properties of light to better understand and characterize cells and other biological materials. She is also keen in using machine learning to extract information from image and spectral datasets for analysis.



Prof. Antónia MONTEIRO ——

Professor, Department of Biological Sciences, NUS and Yale-NUS College

Dr. Antonia Monteiro is the Principal Investigator of the Monteiro Lab, which specialises in the evolution and development of butterfly wing patterns, focusing on their morphological novelties. Using tools from ethology, population genetics, phylogenetics, and developmental biology, they look at the selection factors and proximate mechanisms that generate those patterns, and how genes and the environment modify their development, as well as their impact on sex pheromones, and the process of speciation.



Asst. Prof. Duane LOH _____

Assistant Professor, Departments of Physics and Biological Sciences, Centre for Bioimaging Sciences, Data Science Institute, NUS

Dr. Duane Loh was a former Lee Kuan Yew postdoctoral fellow at the National University of Singapore before starting his group in 2016, to develop robust computational optics techniques to recover the structure and dynamics of heterogeneous nanoscale phenomena using noisy and incomplete data from X-ray diffractive imaging and electron microscopy. He combines modeling, machine learning and optics to create computational lenses to re-invent high-resolution microscopy and uses a data-informed approach to tackle fundamental and applied problems in the field of optics and material science.



Dr. SAW Thuan Beng

Research Associate, Mechanobiology Institute

Dr. Saw Thuan Beng is an alumni and a research associate in Principal Investigators Professor Lim Chwee Teck's MechanoBioEngineering Lab and Professor Benoit Ladoux's Cell Adhesion and Mechanics Lab in MBI. His areas of research interest surround the molecular mechanisms of mechanobiology, with particular focus on bioelectric effects and tissue polarisation, growth and death. In 2018, he was awarded the prestigious Lee Kuan Yew Postdoctoral Fellowship for that year.



Dr. LIEU Zi Zhao, Robert -

Lecturer, Department of Biological Science, NUS

Dr. Robert Lieu Zi Zhao was a research fellow at MBI and is currently a lecturer in the Department of Biological Sciences. He teaches a variety of science-based and science communication modules in the Life Sciences curriculum, Special Programme in Science and NUS-Australian National University Joint Master in Science Communication programme. He is interested in researching the effects of social media on science communication, developing strategies to aid public science literacy, developing a new laboratory course for students, biotech applications and synthetic biology.



Dr. Diego Pitta de ARAUJO -

Illustrator and Animator, Mechanobiology Institute

Dr. Diego Pitta de Arajo demonstrated his affinity for science and arts through his Ph.D. research, in which he applied 3D modeling and animation software to create 3D models of flies, animate their behaviour and perform biomechanical simulations. He is interested in utilising 3D computer graphics and other creative techniques to produce interactive tools for visualization and communication of scientific data. His poster on mechanobiology also won the best scientific poster award at the Visualizing Biological Data conference.



Assoc. Prof. YEONG Foong May

Associate Professor, Department of Biochemistry, Yong Loo Lin School of Medicine, NUS

Dr. Yeong Foong May is an Associate Professor of Biochemistry and a fellow at the NUS Teaching Academy. Her research interests revolve around cell division, fungal infections and parasitology, and pedagogy. Her lab investigates regulatory networks governing mitosis and how cellular processes such as cell division play roles in yeast pathogenicity. She also actively evaluates her teaching activities and students' learning to define suitable types of framework on essential competencies for biology graduates and improving her instructional design.



Prof. WANG Hongyan -

Professor, Duke-NUS Medical School Principal Investigator, Duke-NUS Laboratory of Neural Stem Cells

Dr. Wang Hongyan is the Deputy Director of the Neuroscience and Behavioural Disorders programme at Duke-NUS Medical School and elected EMBO Associate Member. Her lab uses Drosophila and mammalian neural stem cells (NSCs) to model neurodevelopmental disorders and brain tumours. Their research extrinsic signals that "wake up" and molecular signatures of quiescent NSCs, and their intrinsic mechanisms. They have also established Drosophila larval brain neural stem cells as a model for stem cell self-renewal and tumorigenesis.



Asst. Prof. Ajay Sriram MATHURU -

Assistant Professor, Yale-NUS College

Joint Principal Investigator, Institute of Molecular and Cell Biology, A*STAR

Dr. Ajay Sriram Mathuru came to Singapore to pursue his interest and address neuroethological queries using zebrafish. In his Mechanisms Underlying Behavior Lab, he explores the neural, genetic, and molecular mechanisms underlying animal behaviour, using genetic manipulations and high resolution optical imaging of neural activity in zebrafish. His lab also develops new tools to study and analyse natural behaviours motivated by rewards and risks and strive to apply their findings to understand the neurogenetics of human disorders of the brain.



Asst. Prof. LAU On Sun -

Assistant Professor, Department of Biological Sciences, NUS

Dr. Lau On Sun completed his Ph.D. in Molecular, Cellular and Developmental Biology at Yale University in 2010, and received the John S. Nicholas Prize for his doctoral work. He is currently an Assistant Professor in DBS of NUS, investigating how the environment influences the growth and development of living organisms by studying the stomata. His lab aims to decipher the environmental signalling network that controls the production of stomata using a multidisciplinary approach, from cell biology, biochemistry, genetics to genomics, which may lead to implications in agriculture and food production.



Asst. Prof. CHII Jou Chan

Assistant Professor, Department of Biological Sciences, NUS Principal Investigator, Mechanobiology Institute

Dr. Chii Jou Chan was awarded the Singaporean Teaching and Academic Research Talent Inauguration Grant and launched his research group at MBI and Department of Biological Sciences, NUS in January 2021. His lab aims to understand how mechanical and biochemical signalling are integrated across multiple scales to ensure robust tissue morphogenesis and patterning in early mammalian development, especially for oogenesis. His lab also investigates how fluid pressure in tissues triggers mechanosignaling pathways to impact oocyte development and cellular functions in other developmental and physiological contexts.



Assoc. Prof. Pakorn Tony KANCHANAWONG

Associate Professor, Department of Biomedical Engineering, NUS Principal Investigator, Mechanobiology Institute

Dr. Tony Kanchanawong started his research group at MBI and the NUS Department of Biomedical Engineering in 2011 as one of the recipients of the National Research Foundation fellowship. The goal of his lab is to gain insight into the nanoscale structure-function relationship that governs the assembly, organization, dynamics, and functions of these cellular machines. Having already pioneered the use of superresolution microscopy to elucidate nanoscale cellular structures and experience developing ultra-high resolution 3D imaging techniques, iPALM, they aim to further advance the capability of super-resolution microscopy.



Asst. Prof. Jennifer YOUNG -

Assistant Professor, Department of Biomedical Engineering, NUS Principal Investigator, Mechanobiology Institute

Dr. Jennifer Young was inspired by the role of extracellular matrix (ECM) in dictating cell behavior and fate and joined the Max Planck Institute for Medical Research to study the contribution of nanoscale ECM cues to cellular function. Her work at the MBI and NUS continues to identify nanoscale ECM properties and unravel their contribution to cellular behavior in diverse biological environments. Her Soft Nano-Biomaterials Lab particularly focuses on the type and distribution of adhesive sites with which cells directly interact, using high content screening platforms.



Asst. Prof. LONG Yuchen —

Assistant Professor, Department of Biological Sciences, NUS

Dr. Yuchen Long is interested in how plant cells integrate a plethora of signals to coordinate and adapt growth and development to an ever-changing environment. His lab combines advanced quantitative imaging and biomechanical micro-measurements with traditional biological techniques to study the mechanohydraulic control of growth and development in plants.



Assoc. Prof. L. Roman CARRASCO -

Associate Professor and Assistant Head of Department, Department of Biological Sciences, NUS

Dr. Roman Carrasco is the Principal Investigator of the Bioecon Lab at the Department of Biological Sciences, NUS. They gravitate around sustainability science, identifying strategies for the reconciliation of biodiversity conservation, food security, and economic development in the tropics. They use an interdisciplinary approach where biological models are linked to economics through bioeconomic modeling, statistical and spatial analysis to study these complex interactions. Specifically, they look at tropical forests conservation and trade-offs between agriculture and ecosystem services and benefits to humans from nature.



15

Dr. Tetsuya HIRAIWA – Fellow, Mechanobiology Institute

Dr. Tetsuya Hiraiwa has a longstanding background in soft matter and out-of-equilibrium physics and is currently the group leader of Theoretical Physical Biology Group at MBI. Their research revolves around developing and applying theoretical models or frameworks to understand various biological phenomena, using mathematical modelling, theoretical model analysis, computer simulations, and quantitative data analysis. They concentrate on studying the mechanics of morphogenesis, subcellular processes and controls in cell differentiation, and collective migration of epithelial cells on a substrate.







National University of Singapore