Developmental biology seminar series

Join us to hear from five exciting, external scientists about their research in the field of developmental biology.

Tuesday,
5 February 2019,
12:30pm – 5:00pm

Theatre M2,
37 Rainforest Walk,
Monash University, Clayton

Melanie White

Institute of Molecular and Cell Biology, Agency for Science, Technology & Research, Singapore.

Melanie is Senior Research Fellow in the Plachta Lab at IMCB, A*STAR where she is an expert in the use of quantitative biological imaging. Melanie was a Research Fellow at EMBL Australia, Monash University and a Senior Research Officer at the Melbourne Brain Centre, The University of Melbourne. She completed her PhD in Neurological Studies at the Institute of Neurology, University College, London.

12:45 - 1:30pm: 'Morphogenesis revealed: imaging how cells organise to form an embryo'

Understanding how an initially homogenous population of cells organises into tissues and forms an embryo is a fundamental problem in developmental biology. Processes occurring across multiple scales must be precisely coordinated: from the expression of individual genes, to the behaviour of single cells, to the forces driving the simultaneous movement of thousands of cells. I use quantitative live imaging technologies to visualise and understand how these dynamic mechanisms control tissue formation and cell fate *in vivo*.

I will present my research using live imaging to reveal key morphogenetic events directing the divergence of the earliest cell lineages and formation of the first epithelium in the preimplantation mouse embryo. I will demonstrate how changes in transcription factor dynamics predict embryonic cell fate, describe the discovery of a new class of filopodia required for embryo compaction, show how the pluripotent inner cell mass of the embryo is formed by apical constriction, and explain how expanding actin rings seal the embryo for blastocyst formation. Together, my work has revealed how a complex interplay between epigenetic determinants, cellular properties and mechanical forces directs the earliest morphogenetic processes during mammalian development.

My next challenge is to apply quantitative biological imaging approaches to study the formation of more complex tissues *in vivo*. I will focus on development of the neural tube which is the embryonic precursor to the brain and spinal cord. My research will investigate how molecular, cellular and mechanical processes are dynamically integrated across multiple scales, and how these mechanisms summate over time to pattern tissues.

Senthil Arumugam

Single Molecule Science, University of New South Wales

Senthil is currently investigating endosomal dynamics in the context of intracellular trafficking of signaling receptors using Lattice light-sheet microscopy (LLSM). His training as an under-graduate student was at the Tata Institute of Fundamental Research, Mumbai. He completed his Ph.D. training in the lab of Prof. Petra Schwille at the Max Planck Institute for Cell Biology and Genetics in Dresden, Germany, and his post-doctoral training in the labs of Prof. Patricia Bassereau and Prof. Ludger Johannes at the Curie Institute, Paris, France. He was also a visiting researcher in the labs of Prof. Tomas Kirchhausen, Harvard Medical School, USA, and Prof. Satyajit Mayor, National Centre for Biological Sciences, Bangalore, India.

1:30 - 2:15pm: 'Understanding living systems by imaging across scales'

Living systems are complex and difficult to understand. While they obey the basic laws of physics and chemistry, we do not understand how each component that participates in many different interactions, integrate to generate emergent properties.

For instance, interactions between non-living molecules and molecular assemblies, at a larger scale result in a living cell. Imaging and measuring processes that build up this complexity is a direct way to observe, analyze and understand living systems. In this talk, I will discuss particular examples of self-organization in bacterial proteins, phase separation and clustering in membranes, and organization of endosomal trafficking, demonstrating the use of single molecule techniques to large-volume imaging in understanding biology. I will allude to the next generation imaging techniques that will enable single molecule level imaging in multi-cellular systems and my future research goals on the organization of multi-cellularity.

Samantha Stehbens

Diamantina Institute, The University of Queensland.

Dr Samantha Stehbens is a cell biologist with a long-standing interest in understanding the fundamental mechanisms that regulate cell adhesion and the cytoskeleton. She investigates how changes in cytoskeletal dynamics drive cell migration and invasion using high-resolution, spinning disc confocal microscopy. She completed her PhD at UQ in the lab of Prof. Alpha Yap and went on to train as a post-doctoral researcher at UCSF in California and QUT.

2:15 - 3:00pm: 'The cytoskeleton and cell motility in physiology and disease: the microscopy of movement'

Cell movement is essential for development and homeostasis. Migrating cells interact with their surroundings, translating biophysical force into biochemical signals to adapt their shape. This requires crosstalk between organelles, adhesions and the cytoskeleton, controlled in space and time. By combining cutting-edge imaging methods and fluorescent probes we track cell motility, across multiple dimensions and scales.

Using patient-derived cancer cells, coupled to genetic alteration, 3D culture and substrate microfabrication, we utilise state-of-the-art microscopy to understand the basic principles of how a cell integrates biomechanical signals to allow metastatic cells to move.

In physiologically relevant 3D environments, cells migrate in confinement, navigating through tight spaces such as pores between extracellular matrix fibres. Recent studies have uncovered that translocation of the nucleus through these confined spaces is one of the greatest obstacles for cells moving in 3D.

The molecular and mechanical principles of how cells 1) detect these physical limits, 2) deform their cortex whilst producing mechanical force for forward locomotion and 3) orient organelles to move through tissues, remains elusive. We hypothesize that targeting crosstalk between the cytoskeleton and the mechanical micro-environment, will open avenues of novel therapeutic mechanomedicines for cancer treatment.

Kate McDole

HHMI Janelia Research Campus, Ashburn, VA

Kate is a Post-doctoral Fellow/Research Scientist investigating live-imaging and analysis of early mouse development using light-sheet microscopy. She was a Pre-doctoral Fellow with Dr. Yixian Zheng, Carnegie Institution for Science, Department of Embryology, Baltimore, and completed her PhD at Johns Hopkins University, Baltimore.

3:30 - 4:15pm: 'In toto imaging and dynamic reconstruction of post-implantation mouse development at the cellular level using light-sheet microscopy'

The rapid advancement of light-sheet microscopy and computational methods for analyzing complex image data sets has provided an unprecedented opportunity to systematically study the development and morphogenesis of the mouse embryo at the single-cell level. We have developed a light-sheet system capable of continuously imaging, and adapting to, the entire mouse embryo during these stages with high spatiotemporal resolution for days at a time.

We are able to follow the dynamic behaviors of both individual cells and populations among the different germ layers, and visualize the large-scale morphodynamic events that pattern different tissues. In combination with a suite of software tools we have developed, we are able to track individual cells and build dynamic cell fate maps, describe and analyze patterns of divisions during tissue formation, such as during neural tube elongation and closure, as well as examine the formation and migration of cells through the primitive streak, and the development and formation of a number of embryonic structures such as the node and notochord.

These advances have enabled us to analyze the development of the post-implantation mouse embryo in unprecedented detail, offering new insights into this critical, yet poorly characterized area of mammalian development.

Scott Berry

Institute of Molecular Life Sciences, University of Zurich

Scott is currently a Postdoctoral Research Fellow funded by the Human Frontier Science Programme, studying the coordination of the mammalian transcriptome to cell size and shape, in the group of Lucas Pelkmans. Scott was a Post-Doctoral Fellow and completed his PhD training in the Department of Cell and Developmental Biology, John Innes Centre, Norwich, UK, in the groups of Caroline Dean and Martin Howard.

4:15 - 5:00pm: 'Understanding gene expression heterogeneity using high-throughput quantitative imaging'

Over the last several years, high-throughput microscopy in combination with automated image analysis has begun to be used to profile the phenotypes of single cells. By measuring multiple variables simultaneously, image-based approaches can harness the heterogeneity of cell populations, providing quantitative information about the relationships between measured variables (e.g. uncovering cell-cycle-dependent protein localisation or links between cell-crowding and gene expression). I will discuss recent technological developments in this area and describe how we are using these approaches to study how the transcriptome of a single cell is coordinated with its size and shape.