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TEMASEK LIFESCIENCES LABORATORY

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Seminar Room 05-41 (Level 5)
Hosted by: Dr Gregory Jedd

Measuring the Intracellular Dew Point: Phase Transitions in Cells

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Cliff Brangwynne obtained B.S. in Materials Science from Carnegie Mellon University in 2001, and his PhD in Applied Physics in 2007 from Harvard University, working in the group of David Weitz. He was a visiting fellow at the Max Planck Institute for the Physics of Complex Systems in Dresden, and was a Helen Hay Whitney Postdoctoral Fellow in the group of Tony Hyman at the Max Planck Institute for Molecular Cell Biology and Genetics in Dresden. He is currently an Assistant Professor in the Department of Chemical and Biological Engineering at Princeton University. His primary research interests are in biological self-assembly, particularly intracellular organelles. Dr. Brangwynne is the recipient of a National Science Foundation Career Award, a National Institutes of Health New Innovator Award, a Searle Scholar Award, a Sloan Research Fellow Award, and the Howard Wentz Jr. Junior Faculty Award.

Increasing evidence suggests that phase transitions play an important role in the internal organization of living cells. We have shown that a number of membrane-less RNA and protein rich organelles, known as RNP bodies, represent condensed liquid phase droplets, which assemble by liquid-liquid phase separation. The nucleolus is a liquid-like nuclear body, which plays an important role in cell growth and size homeostasis. Using the reductive cell divisions of early C.elegans embryos, we show that a simple phase threshold model explains striking features of the intrinsic coupling of nucleolar assembly to cell size. Building on these findings, we develop a Cahn-Hilliard model for nucleolar liquid-liquid phase separation, which can quantitatively account for the dynamics of nucleolar assembly, for both an in vitro reconstituted system, and within living cells. We use a custom microfluidics platform to test these models in growing C.elegans worms, where we find that the nucleolus grows proportional to cell and organism growth. Concentration-dependent phase transitions allow the cell to read-out its size, and could provide a novel biophysical feedback mechanism for cell growth control.

Recent Publications:

1. The disordered P granule protein LAF-1 drives phase separation into droplets with tunable viscosity and dynamics. *Proceedings of the National Academy of Sciences USA*, 2015 [PDF] [F1000] Elbaum-Garfinkle S, Kim Y, Szczepaniak C, Eckmann C, Myong S, Brangwynne CP*
2. Berry J§, Weber SC §, Vaidya N, Haataja M†, **Brangwynne CP**†. RNA transcription modulates phase transition-driven nuclear body assembly. Proceedings of the National Academy of Sciences USA, 2015
3. Weber SC, **Brangwynne CP**†. Inverse Size Scaling of the Nucleolus by a Concentration-Dependent Phase Transition. Current Biology, 2015 25(5):641.