BDR SEMINAR via Zoom

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10:00-11:00

Meeting URL will be announced on the event day by e-mail.

Nucleation landscape of biomolecular condensates

This seminar is a part of the IPB seminar series.

Summary

Forming at the right place and time is important for all structures within living cells. This includes condensates such as the nucleolus and stress granules, which form via liquid-liquid phase separation (LLPS) of biomolecules, particularly proteins enriched in intrinsically-disordered regions (IDRs). In non-living systems, the initial stages of nucleated phase separation arise when thermal fluctuations overcome an energy barrier due to surface tension. This phenomenon can be modeled by classical nucleation theory (CNT), which describes how the rate of droplet nucleation depends on the degree of supersaturation, while the location at which droplets appear is controlled by interfacial heterogeneities. In living cells, however, it is unknown whether this framework applies, due to the multicomponent and highly complex nature of the intracellular environment, including the presence of diverse IDRs, whose specificity of biomolecular interactions is unclear. Here we show that despite this complexity, nucleation within living cells occurs through a physical process not unlike that within inanimate materials, but where the efficacy of nucleation sites can be tuned by their biomolecular features. By quantitatively characterizing the nucleation kinetics of endogenous and biomimetic condensates within living cells, we found that key features of condensate nucleation can be quantitatively understood through a CNT-like theoretical framework. Nucleation rates can be significantly enhanced by compatible biomolecular (IDR) seeds, while the kinetics of cellular processes can impact condensate nucleation rates and location specificity. This quantitative framework sheds light on the intracellular nucleation landscape, and paves the way for engineering synthetic condensates precisely positioned in space and time.

Reference

[1] Shunsuke F. Shimobayashi, Pierre Ronceray, David W. Sanders, Mikko P. Haataja, and Clifford P. Brangwynne, Nature, in press.

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