Soft Living Active and Adaptive Matter

Driven protein fluxes control the number, size, and position of an essential phase-separated organelle in algae

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Abstract:

Phase separation of biological molecules has emerged as a key mechanism by which cells organize their components. Investigating the physical principles by which these biomolecular condensates facilitate cellular functions, which are generically out-of-equilibrium, remains a grand challenge at the intersection of statistical physics and cell biology. The inherent complexity of biological systems has posed a significant obstacle to conceptual progress in this field. We leverage the algal pyrenoid—an experimentally tractable condensate responsible for 30% of global CO2 fixation—as a powerful model system. Notably, during cell division, the pyrenoid, consisting of the CO2 -fixing enzyme Rubisco and the linker protein EPYC1, undergoes rapid dissolution and recondensation. We identify a kinase, KEY1, that regulates pyrenoid dissolution and proves to be essential for maintaining pyrenoid number, size, and function. We develop a minimal mathematical model of kinase activity that recapitulates the dynamic behaviors seen in vivo and suggests how molecular fluxes driven by kinase activity can robustly control condensate formation and localization.

Date:
05/20/2024

Time:
9:00 AM-10:15 AM (PT)

About the speaker:

Linnea Lemma is an experimental physicist who seeks to uncover the physical principles governing intracellular organization. She is particularly interested in the out-of-equilibrium processes that underlie biological functions.

Linnea is currently a HHMI Hanna H. Gray Fellow working at Princeton University with Ned Wingreen, Martin Jonikas and Clifford Brangwynne. She obtained her PhD in active matter physics from Brandeis University.

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