Experimental models for dynamic compartmentalization of biomolecules in liquid organelles: Reversible formation and partitioning in aqueous biphasic systems

William M. Aumiller Jr., Christine D. Keating

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Experimental models for dynamic compartmentalization of biomolecules in liquid organelles: Reversible formation and partitioning in aqueous biphasic systems

William M. Aumiller Jr. and Christine D. Keating*

Department of Chemistry, Pennsylvania State University, University Park, PA 16802

Abstract

Living cells contain numerous subcellular compartments, many of which lack membranous boundaries and are thought to occur due to liquid-liquid phase coexistence. This review will introduce these biological membraneless organelles and discuss simple experimental models based on liquid-liquid phase separation in polymer solutions. When more than one phase is present, solutes such as proteins or nucleic acids can be compartmentalized by partitioning into one of the phases. This could confer benefits to the cell such as enhanced reaction rates or sequestration of toxic molecules. Liquid-like compartments inside living cells are often dynamic, for example appearing and disappearing in response to stimuli and/or at different points in the cell cycle. We will discuss mechanisms by which phase transitions can be induced in the laboratory and inside living cells, with special emphasis on regulating phase formation by phosphorylation state. This work is motivated by a desire to understand the physical and chemical mechanisms that underlie biological processes and to enable new nonbiological applications.