Designing Phase Separation in Complex Systems

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Electrostatic interactions have been implicated in a wide range of biological materials, including between proteins, polysaccharides, and polynucleotides. In particular, associations involving intrinsically disordered proteins have been implicated in the formation of an increasing number of liquid phase separated granules, or ‘membraneless organelles’ in cells. Here, we will discuss the potential for using and/or modulating the chemical sequence of polyelectrolytes to affect the potential for liquid-liquid phase separation via complex coacervation. In addition to controlling the propensity for phase separation, the chemical identity of the polyelectrolytes can also be used to selectively control the uptake of molecules ranging from ions to globular proteins and RNA. These features hold tremendous potential for designing synthetic reaction networks for the development of and study of systems chemistry.