# All Aqueous Emulsions as Model Systems for Artificial Cells

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The construction of artificial cells that mimic specific biological functions holds great promise as an innovative solution to societal issues related to health, sustainability and the environment and are useful in understanding the rules of life. All aqueous emulsions formed through the physical phenomenon of liquid-liquid phase separation (LLPS) have emerged as a strategy through which to assemble artificial cells. Common examples of LLPS include complex coacervates and aqueous two-phase systems (ATPS). Complex coacervation is a form of associative phase separation which occurs when oppositely charged polyelectrolytes associate due to ion pairing interactions giving a polymer-rich phase and a dilute phase. Conversely, ATPS represent segregative phase separation in which the components form two regions, each enriched in one component. My work focuses on the development of a new class of protein based artificial cells called 'ProteoCells'. Hierarchical construction of this cell mimic starts with the formation of cell-sized compartments with the use of complex coacervates or ATPS. Next, an engineerable membrane is formed by a special class of self-assembling proteins isolated from bacteria to stabilize the initial compartments and regulate permeability. These cell-like structures can then be customized for desired functions by specializing their internal chemistry. We exploited the encapsulation of biomolecular cargo such as enzymes and nucleic acids which can generate required products through specific chemical reactions. To increase the complexity and functionality of these primitive compartments, a multiphase system was formulated by combining complex coacervates and ATPS which consists of distinct partitions, each one encapsulating a different function of interest. Further investigation of the resulting structures paves the way for designing advanced cell mimics which could be customized as drug carriers in pharmaceutical industry as well as cell substitutes in personalized medicine. They could also be leveraged as stabilized aqueous emulsions in food, agriculture, paint, and textile industries.