Searching for Prebiotic Organizations in Primordial Sea Medium Enriched by Transition Metals

-Self-Assembly under Shear Stress and Matrix Induced Translocation-

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Summary

Elastomeric protein, elastin, is thought to be a protein having a kind of primeval characteristics, since more than 80% of amino acid contents are shared with alanine, valine, glycine, and proline, and elastin is biosynthesized and functionalized at early viviparous stages. The most important nature of the elastomeric protein-water system is a temperature-dependent coacervation process. The present investigations are carried out based on the concepts in which the structural basis of self-organized assemblies of elastomeric proteins are established during the process equivalent to the temperature-dependent coacervation. Molecular self-assembly processes in extracellular space and in simulated primordial conditions can be mimicked by the temperature-dependent coacervation of elastin-related polypeptides, such as tropoelastin, α-elastin, and model polypeptides with specific repeating amino acid sequences.

Temperature-dependent coacervation of the elastomeric protein-water system is controlled essentially by hydrophobic interactions, whereas in the coacervation of bovine serum albumin (BSA) with cationic poly(demethyl-diallylammonium chloride) (PDMDAAC), electrostatic interactions dominate the process. Key factor to discriminate these interactions is a effect of temperature. In the pH-induced coacervation in complexes of BSA and PDMDAAC, pH points at which primary complex and coacervate droplet formations initiate are clearly temperature insensitive. Shear stress is a possible important factor to control molecular self-assembly processes in a simulated primordial sea medium and in an extracellular space. Phase contrast rheomicroscope was introduced to estimate the shear stress effects on the coacervation of elastomeric protein-water system. The rheomicroscope is composed of an inverted microscope and a rotary viscometer equipped with an optically transparent cone-plate attachment. Rheoscope is able to measure viscosity simultaneously to observe phase contrast image during the temperature-dependent coacervation process. Microscopic observation under regulated shear stress is also available by means of changing rotation rate of viscometer cone. Binodal temperatures for the bovine neck ligamental α-elastin-water system increased under the effects of shear stress, however the critical concentration in a lower-critical-solution-temperature type phase diagram was unaffected with and with out shear stress. Matrix induced translocation was also examined in a elastin coacervate phase by tracing a movements of latex particles as a cell model particle.