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

-Ionic Selectivity and Self-Assembly of Primeval Proteins-

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Summary

"Coacervation", liquid -liquid phase separation, has already been recognized at an early stage of the movement to establish the chemical and physical science of colloidal substances. The term "coacervation" has become vastly popular by Oparin's scientific insight and literary talent developed in his famous work on the origin of life. But phenomenological complexities of coacervation process inhibit the scientific progress both in the theoretical and experimental points of view. Recently, reevaluations of coacervation are carried out in basic science and applications. Coacervate formation of elastin as a primitive protein with simple amino acid composition is a useful model for primeval cell system. On the other hand, self-assembly of elastin precursor protein is a key step of the elastogenesis and can be mimicked by the temperature-dependent coacervation of elastomeric protein-water system.

In a variety of experiments employing bovine neck ligamental α-elastin and polypentapeptides based on the repeating sequenc, -Val-Pro-Gly-Val-Gly-, specific in elastin, calcium selective interactions of elastin coacervate were widely observed. Under the conditions where coacervation is accelerated based on the general salting-in-and-out mechanisms, calcium ions only decelerated the phase process. NMR measurements using C-13 labelled polypentapeptide showed that only calcium ions affect the chemical shifts of ^{3}Gly and ^{5}Gly groups. Ion transport experiment across coacervated layer indicated that calcium ions are more concentrated and immobilized than magnesium ions in coacervate phase. These results suggest the existence of the two types of metal cation binding sites on elastomeric protein, side chain carboxy oxygen and β-spiral peptide backbone carbonyl oxygen specific to pentapeptide sequence. CD measurements were performed to survey cations capable to bind peptide backbone. Lanthanum ions only can bind to the β-spiral carbonyl oxygen, but not modify global self-assembly process, since the critical concentration of LCST-type phase separation profiles of the elastomeric protein-water system stayed unchanged. Calcium ions are significantly active both to destroy the β-spiral structure and to modify the phase separation profiles with the increasing critical concentration. These results correlate well to the fact where lanthanum can relief experimental atherosclerosis with calcium deposition. Ion selective characteristics of elastin as a primitive protein are important for primeval cell model and elastomeric functions of elastin as an extracellular matrix.