Role of Metal Chlorides on Self-Assembly and Function Control of Proteins

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Summary

Elastin is an important and major proteinic constituent of the biological elastic fiber in tissues under sustaining strong tension, such as aortal wall, lung, and ligament. Qualitative and quantitative degradation of elastin by aging and/or physical illness is responsible to arteriosclerosis and further fatal circulatory diseases. The most important process of elastin biosynthesis is thought to be a self-assembly of precursor tropoelastin delivered from aortal smooth muscle cell and fibroblast cell by exocytosis mechanisms. The self-assembly process in extracellular space as a key step of the elastogenesis can be mimicked by the temperature-dependent coacervation of aqueous solutions containing elastin-related polypeptides. Characterizations of the phase separation process are required to visualize extracellular events in which essential molecular arrangements are established to reveal multiple function as an extracellular matrix.

Dynamic light scattering and rotary viscometric experiments were carried out to observe critical behaviors in the temperature-dependent coacervation of elastin. Binodal and spinodal lines were estimated for bovine neck ligamental α-elastin-water system. Critical concentration and temperature were estimated around 0.11 mg/ml and 21.5°C, respectively. In the light scattering experiments near the critical concentration, correlation length of fluctuations of concentration showed a divergent increment as a function of temperature. In these situations, estimated hydrodynamic sizes of scattering particles were abruptly increased. On the other hand, far from the critical concentration, temperature dependencies of these quantities were significantly depressed. These results were well correlated with viscometric measurement results. Viscosity values increased with temperature near the critical concentration, while the almost constant values were obtained in concentrations far from the critical point. The elastin coacervation was accelerated by alkali and alkali earth metals and decelerated by transition metals. Selective interactions of elastin coacervate with Ca ions were observed in many cases. Electrochemical measurements on the elastin coacervate as a protein liquid ion-exchange membrane suggested that Ca ions tend to accumulate in coacervate phase mainly due to the interactions with electrically neutral sites of elastin. These Ca specificities seem to related to the fact that Ca depositions on elastin is one of the predispositional factor to arteriosclerosis. Novel interactions of elastin coacervate with Cu ions were observed in a variety of measurements. Coacervate droplets were stabilized specifically by Cu ions and further separated layer formation was inhibited. These results suggest the possible involvement of Cu ions, enzymatic co-factor of cross-linking in elastogenesis, to the self-assembly process in extracellular space.