Synopsis of Original Research Paper

Studies on Structure, Mechanism, and Function of Self-Assemblies of Elastomeric Protein

Kozue Kaibara

Department of Chemistry, Faculty of Science, Kyushu University

Extracellular self-assembly process of tropoelastin, as a key step of the elastogenesis, can be mimicked by the temperature-dependent coacervation of elastin-related polypeptides such as tropoelatin, a-elastin, and block copolymeric model peptide,$(Val\text{-}Pro\text{-}Gly\text{-}Val\text{-}Gly)_n$. Homogeneous aqueous solutions of these polypeptides in low temperature become turbid with elevating temperature by the formations of coacervate droplets. Critical behaviors of the liquidliquid phase separation of bovine neck ligamental a-elastin-water system were observed by the laser light scattering photometry. The critical point was determined to be near 0.11mg/ml and 21.5ºC. In the critical region, the estimated hydrodynamic radius was decreased gradually with elevating temperature probably due to the hydrophobic interactions excluding water molecules from the polypeptide assemblies. Then, the hydrodynamic radius increased sharply to induce liquid-liquid phase separation. On the contrary at the region far from the critical point, gradual decrease in hydrodynamic radius followed by the additional decrease to induce the phase separation. The temperature-dependent coacervation of elastin-related polypeptides are characterized by these two types of dynamic behaviors. The same modes of molecular assembly process were also observed by the rotary viscometric measurements for the critical and offcritical regions. The reduced viscosity of bovine neck ligamental crelastin solution was increased with elevating temperature in the region near critical point until the liquid-liquid phase separation was induced. While in the region far from the critical point, the reduced viscosity of aqueous α-elastin solution was suppressed to constant levels with elevating temperature. Selective and specific interactions of calcium ions and copper ions were employed as a tool to survey structure and function of the elastin coacervate. Low diffusion coefficient and high concentration of calcium ions, seven times higher than that of magnesium ions, within coacervate phase were based on the selective binding to the electrically neutral backbone Val carbonyl groups. These selective interactions of calcium ions are tightly correlated with arteriosclerosis induced by the calcium deposition on the arterial wall elastm. Novel interactions of copper ions with elastm coacervate stabilized the microcoacervate droplet and the macroscopic phase separation to form coacervate layer and upper layered equilibrium solution phase. Unique effects of copper ions seem to present a key to clarify the molecular structural bases of elastomeric mechanisms.