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Hierarchical structure and function of cartilage matrix

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This work focuses on developing a quantitative understanding of how the main polymeric components (aggrecan, hyaluronic acid, collagen) of extracellular matrix determine the biological functions of cartilage. In particular, we investigate the structure and dynamic properties of model systems using osmotic pressure measurements and scattering measurements (SANS, SAXS, DLS, etc.). We identify important physical properties that distinguish these stiff polymers from other highly charged polyelectrolytes. These differences are important because such rigid structures are typical in living systems. Osmotic pressure measurements made on aggrecan solutions bring evidence of self-assembly of the bottlebrush shaped aggrecan molecules into microgel-like assemblies. It is demonstrated that in near-physiological salt solutions aggrecan assemblies display remarkable insensitivity to changes in the ionic environment, notably to multivalent cations. This insensitivity of the structure of aggrecan assemblies to calcium ions contrasts with the behavior of linear polyelectrolytes. The results are consistent with the role of aggrecan as an essential structural component in the load bearing function of cartilage and as an ion-exchange matrix in bone metabolism.

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