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INVITED LECTURE

Osmotic Behavior of Proteoglycan Assemblies

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Cartilage is a complex biological tissue that has many biological functions. In cartilage the largest and most abundant proteoglycan is the bottlebrush shaped aggrecan that possesses more than 100 chondroitin sulfate and keratan sulfate chains. Aggrecan interacts with hyaluronic acid (HA) to form large aggregates. Each aggregate is composed of a central filament of HA with many aggrecan molecules attached to it non-covalently. The interaction between the aggrecan core protein and the HA molecule is stabilized by the presence of a link protein that interacts with both the aggrecan and HA. In cartilage the aggrecan-HA complexes are interspersed in the network of collagen fibrils. Both the high anionic charge on the individual aggrecan molecules due to the sulfated glycosaminoglycan chains and the localization of the aggrecan-HA complexes in the collagen matrix are essential for the load bearing function of cartilage. The aggrecan-HA aggregates exhibit high osmotic swelling pressure, which gives cartilage its ability to resist compressive loading.

We made swelling pressure measurements and rheological measurements to quantify the effect of complex formation on the osmotic modulus of aggrecan-HA complexes. The changes in the supramolecular organization of aggrecan assemblies were studied by small-angle neutron scattering and small-angle X-ray scattering. These techniques probe the structure and interactions over a broad range of length scales. The dynamic response of the systems was determined by dynamic light scattering and neutron spin-echo measurements.