263rd American Chemical Society National Meeting
Division of Biological Chemistry
March 20-24, 2022, San Diego, CA
Abstracts

Composition and Function of Cartilage Extracellular Matrix

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Articular cartilage is a gel-like material that caps the ends of bones at the joints. Cartilage provides a smooth, lubricated slippery surface that allows bones to glide over each other with low friction. Diseases, in which cartilage wears away, can cause serious movement problems. For example in osteoarthritis, the mechanical properties of cartilage (e.g., its load-bearing ability) are reduced due to changes in both the chemical composition and the organization of its macromolecular constituents.

The hydration of cartilage defines its swelling and load bearing ability. To quantify the effect of hydration on cartilage properties we developed a tissue micro-osmometer to perform experiments in a practical and rapid manner. This instrument is capable to measure very small changes in the amount of water absorbed by small tissue samples (less than 1 microgram tissue) as a function of the equilibrium activity (vapor pressure) of the surrounding tissue water. We have also developed a method for mapping the local elastic and osmotic properties of cartilage using the Atomic Force Microscope (AFM) together with the tissue micro-osmometer. Many of the impediments that previously hindered the use of AFM to probe soft inhomogeneous samples, particularly biological tissues, were addressed by our new approach that utilizes the precise scanning capabilities of the AFM to generate large volumes of compliance data from which the relevant elastic properties can be extracted. In conjunction with results obtained from scattering measurements (small angle neutron scattering, small angle x-ray scattering, static and dynamic light scattering, etc.) probing the structure at higher resolution, tissue micro-osmometry, and biochemical analysis, we determined the map of the osmotic modulus of tissue specimens. This knowledge is particularly important, given that the osmotic modulus determines the compressive resistance of the tissue to external load.