Bartholomew Award Lecture

Adam P. SUMMERS

Univ. of California, Irvine

From Mexico to molecules - an interdisciplinary investigation of cartilaginous skeletons.

The cartilaginous skeleton of sharks, skates, and rays provides an opportunity to explore the relationships between biochemical composition and material properties of cartilage. Cartilage is a composite material of collagen fibers in a proteoglycan rich extra-cellular matrix (ECM) which can be mineralized to varying degrees. The hygroscopic nature of the ECM provides a swelling pressure while the collagen fibers and mineralization provide structure. In tetrapods cartilage has only a few functions: as a low-friction bearing surface, contour filler, and model for developing bone. As the primary skeletal material, cartilage has wider range of functions in the cartilaginous fishes. To understand this variation we have tested tissue from a number of skeletal elements from several species of cartilaginous fishes, including very active animals (i.e mako and thresher sharks), species with average activity levels (i.e. cownose ray, smooth hammerhead, and oceanic whitetip), as well as more lethargic taxa (i.e. Pacific sleeper shark). Stiffness (0.011-9GPa) and strength (2.2-640MPa) vary over 2 orders of magnitude among taxa and skeletal elements, encompassing much of the range in properties seen in tetrapod cartilage and bone. Variation of this magnitude makes this an interesting system in which to attempt to unravel the relationship between biochemical composition and material properties. Proteoglycan content ranged from 6-34% of dry weight, with lower PG content being associated with lower stiffness and strength and higher extensibility. The PGs are similar, though not identical to PGs from mammalian cartilage. In particular there are small, decorin-rich PGs that may be novel.