Larval Zebrafish Development in 4D: 
Zebrafish Pharyngeal Cartilage Morphogenesis is regulated by Proteoglycans

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The present study addresses the roles of heparan sulfate (HS) proteoglycans and chondroitin sulfate (CS) proteoglycans in the development of zebrafish pharyngeal cartilage structures. A transgenic fli1:EGFP zebrafish line was used to image the cartilage structures in early zebrafish development in 4D under the confocal microscope.

Four zebrafish mutant strains for defined proteoglycans (uxs1, b3gat3, ext2 and extl3 mutants) were crossed into the fli1:EGFP transgenic background and the abnormalities in chondrocyte formation was imaged over time. In addition, electron microscopy was used to reach higher cellular resolution and describe details of cellular arrangement.

The morphologies in the single mutant strains as well as in ext2:uxs1 double mutants could be characterized and linked to their biochemical profiles. A correlation between HS and CS production and phenotypes was found, such that impaired HS biosynthesis was shown to affect chondrocyte intercalation, whereas impaired CS biosynthesis inhibited formation of the extracellular matrix surrounding chondrocytes.

Figure 1: The image shows a ventral view of a 5-day-old Tg(fli1:EGFP) zebrafish larvae. Chondrocytes within the pharyngeal arches intercalate and elongate to form ordered parallel stacks, similar to a stack of coins, resulting in slender cartilage elements.