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Biophysical Studies of the Cell Coat

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Many mammalian cell types are enveloped by a coat of polysaccharides and proteins. This coat influences vital biological processes such as cell adhesion, proliferation, motility and embryogenesis. The constitution and thickness of this layer, referred to as the pericellular coat (PCC), pericellular matrix or glycocalyx, can vary considerably. Despite its significance, the macromolecular organization of the cell coat remains speculative. Here we focus on cell coats whose vital structural backbone is hyaluronan (HA), a highly-hydrated polysaccharide that anchors the coat to the cell membrane. The molecular interaction of HA with different HA-binding proteins determines the architecture of the PCC. The resultant mesoscopic arrangement of the different PCC components influences the cell's perception of the extracellular environment and its ability to withstand compression. The stress transduction through the PCC is especially important for chondrocytes, cells located in the load-bearing cartilage. The molecular structure of some PCC components, especially the HA-binding protein aggrecan, changes with age or osteoarthritis. These changes alter the viscoelasticity of the PCC and may also affect its molecular architecture. We employ a combination of passive microrheology and optical force probe microscopy on the PCC of living rat chondrocytes (RCJ-P) cells, which serve as a well-established model system for HA-rich coats. We establish the first micromechanical map of the PCC which reveals an increase in both the viscosity and elasticity of the PCC towards the cell surface. Further, we characterize the distribution of HA and observe a linear increase in fluorescence intensity towards the cell membrane. Comparing the results of these approaches using polymer theory sheds light on the macromolecular architecture of the PCC. Our data indicate that the structure of PCC is far more complex than expected from a pure end-grafted polymer brush.