

Hyaluronan Glycocalyx Physically Modulates Cell Adhesion and Migration

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Polymer brushes are used to tailor and engineer fundamental surface properties in a wide range of applications. Biological organisms may leverage the same strategy at cell surfaces via the presentation of the glycocalyx, a sugar-rich cell surface bound polymer matrix. In particular, we focus on the glycocalyx associated with biological processes involving cell dynamics and rearrangements – events that require exquisite control of cell adhesion and migration. From embryogenesis to wound healing to synaptogenesis to cancer metastasis, changes in the hyaluronan-rich glycocalyx and HA milieu is connected to these processes. Hyaluronan (HA) is a linear polyelectrolyte whose gigantic size (up to 20 microns) creates significant physical effects when it is bound to the cell surface. These impacts are enhanced by its binding to and potential for dense aggregation of bottlebrush proteoglycans.

Our lab is interested in the consequences of maintaining a bulky sugar matrix on the surface of cells, whether it is neurons in the brain, cancer cells in a tumor, or fibroblasts in a wound. How does the glycocalyx interfere with or alter receptor-ligand binding and cell-cell contacts? How is it possible that integrins manage to bind to extracellular matrix (ECM) proteins? When the glycocalyx is compressed at an interface after cell-ECM binding, how do the forces alter the cell adhesion strength? Here we present quantitative measurements demonstrating that indeed, compressed HA glycocalyx reduces cell adhesion strength. Further, we show how manipulating cell adhesion strength with HA glycocalyx is an independent parameter to tune cell migration speed. Together these data suggest that HA glycocalyx works in concert with adhesion receptors to modulate the strength cell adhesion thru physical repulsion. This is an interesting outcome because it provides evidence that cell integration into tissues – a fundamental aspect of multicellular organisms – is controlled not just via adhesion, but in some cases, via an interplay of adhesive and repulsive elements.

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