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Tunable cell-surface mimetics as engineered cell substrates

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Summary:

Most recent breakthroughs in understanding cell adhesion, cell migration, and cellular mechanosensitivity have been made possible by the development of engineered cell substrates of well-defined surface properties. Traditionally, these substrates mimic the extracellular matrix (ECM) environment by the use of ligand-functionalized polymeric gels of adjustable stiffness. However, such ECM mimetics are limited in their ability to replicate the rich dynamics found at cell-cell contacts. This review focuses on the application of cell surface mimetics, which are better suited for the analysis of cell adhesion, cell migration, and cellular mechanosensitivity across cell-cell interfaces. Functionalized supported lipid bilayer systems were first introduced as biomembrane-mimicking substrates to study processes of adhesion maturation during adhesion of functionalized vesicles (cell-free assay) and plated cells. However, while able to capture adhesion processes, the fluid lipid bilayer of such a relatively simple planar model membrane prevents adhering cells from transducing contractile forces to the underlying solid, making studies of cell migration and cellular mechanosensitivity largely impractical. Therefore, the main focus of this review is on polymer-tethered lipid bilayer architectures as biomembrane-mimicking cell substrate. Unlike supported lipid bilayers, these polymer-lipid composite materials enable the free assembly of linkers into linker clusters at cellular contacts without hindering cell spreading and migration and allow the controlled regulation of mechanical properties, enabling studies of cellular mechanosensitivity. The various polymer-tethered lipid bilayer architectures and their complementary properties as cell substrates are discussed.

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