Light-driven force application on individual cell-ECM contacts

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Mechanical force is one of the most important factors that guide cell's behavior. Several approaches, including micropipettes and single-molecule techniques, magnetic actuation of nanoparticles and micropillars etc, have been developed to apply spatially confined mechanical inputs to cell. These methods, however, could be difficult to manipulate forces with molecular specificity and high spatiotemporal resolution. Photoswitches and optogenetic constructs are sharpening lengths- and timescales for activation and observation of biological phenomena. However, it is still challenging to develop molecular systems that can transfer light into mechanical force in a well-predictable way.

We present a novel approach for applying forces to cells with molecular specificity and at molecular resolution using a light-driven synthetic molecular motor. The motor is modified with two orthogonal sets of polymer chains in its upper and bottom parts. It is immobilized on a biomaterial and contains adhesive ligands at two free ends. Upon light exposure, the molecular motor rotates and twists the entangled polymer chains, thereby applying a mechanical load to receptor-ligand complexes on cell surface. Optomechanical actuation at cell-biomaterial contacts and its consequences will be demonstrated.