Universal Molecular Tension-based Fluorescence Microscopy Probe to Visualize Receptor Forces in Living Cells

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Proper cell function relies heavily on the interactions between the cell and its environment. Mechanosensitive proteins, for example, sense external mechanical forces to initiate signaling pathways within the cell. Muscle, bone, and other mechanically strained tissue also depend on mechanostransduction-- the process of biochemical action being triggered by cells in response to mechanical forces. Studies on this crucial relationship between cells and external mechanical forces have been limited by a lack of a means to image real-time interactions between biological systems. A force probe was designed as a novel mechanism to map forces between cellular cytoskeleton and the extracellular matrix to better understand the transduction of mechanical to chemical signals. The organic probe was synthesized with a polyethylene glycol body and is recognized by transmembrane proteins through peptides attached to the probe through biotin-streptavidin bonding. The probe attaches to these proteins by elongating its flexible spring-like structure. The amount of deformation the sensor experiences is marked through fluorescence resonance energy transfer, and the change in distance can be used to calculate the pulling force exerted by the proteins This will ultimately enable high-resolution mapping of the forces exerted by cells onto its environment. Application of this sensor extends to studies based on cancer. It is understood that the mechanical forces of the extracellular matrix are connected to the signal transduction networks relevant to tumor transformations and metastasis. Mapping and comparing the behavior of healthy and cancer cells through their interactions with external forces may lead to a better understanding of the mutation of cells and the development of cancerous tumors.