Manipulation and Motion of Organelles and Single Molecules in Living Cells

The biomolecule is among the most important building blocks of biological systems, and a full understanding of its function forms the scaffold for describing the mechanisms of higher order structures as organelles and cells. Force is a fundamental regulatory mechanism of biomolecular interactions driving many cellular processes. The forces on a molecular scale are exactly in the range that can be manipulated and probed with single molecule force spectroscopy. The natural environment of a biomolecule is inside a living cell, hence, this is the most relevant environment for probing their function. In vivo studies are, however, challenged by the complexity of the cell. In this review, we start with presenting relevant theoretical tools for analyzing single molecule data obtained in intracellular environments followed by a description of state-of-the-art visualization techniques. The most commonly used force spectroscopy techniques, namely optical tweezers, magnetic tweezers, and atomic force microscopy, are described in detail, and their strength and limitations related to in vivo experiments are discussed. Finally, recent exciting discoveries within the field of in vivo manipulation and dynamics of single molecule and organelles are reviewed.

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