Our interests are focused on adhesion and signaling molecules involved in processes of inflammation, hemostasis, and T-cell activation. We use various combined experimental, computational, and theoretical methods to study the mechanics and kinetics of cell and molecular interactions at the level of single pair of cells and single pair/triad/group of molecules. Our research provides knowledge to understand mechanisms associated with inflammatory reaction, bleeding and thrombotic disorders, immuno-deficiencies, autoimmune diseases, cardiovascular diseases, and cancer.

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INTRODUCTION

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EXPERIMENT AND ANALYSIS

A. Atomic Force Microscopy (AFM)
AFM is used to study mechanical regulation of molecular interactions, conformational changes, and proteolysis. Using AFM, we demonstrated catch bonds selectin/ligand, GPIb/VWF, and integrin/ligand interactions. Catch bonds are counter-intuitive behaviors where force prolongs lifetimes of molecular bonds, which is opposite to the ordinary behavior of slip bonds where force shortens lifetimes.

B. Biomembrane Force Probe (BFP)
BFP uses a red blood cell as a force transducer, which can provide a much softer spring (0.3 pN/nm) to probe single molecule interactions with higher force resolution (~1 pN).

C. Micropipette Experiment
Micropipette-aspirated red cell is utilized to detect adhesion events and measure adhesion probability. The 2D binding kinetics and affinity of the specific molecular interaction are determined by comparing data to a probabilistic kinetics model:

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D. Molecular Dynamics Simulations
Molecular dynamics (MD) are used to simulate receptor-ligand interactions and to induce conformational changes. Simulations provide insights to structure-based molecular mechanisms.

E. Fluorescent Biosensor
Biosensors are used to visualize activities of kinase molecules following cell receptor engagement that triggers signaling.

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