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Bonds that strengthen under force

VIOLA VOGEL, Swiss Federal Institute of Technology, ETH

While the adhesive strength of most receptor-ligand interactions is exponentially reduced if strained, some receptor-ligand complexes exist that strengthen under force which is the hallmark of catch bonds. Although the existence of catch bonds was theoretically predicted, the first experimental demonstrations of their existence were given only recently, i.e. for the bacterial adhesin FimH that is located at the tip of type I fimbriae of *E. coli* and for p-selectin. In a major collaborative effort, we studied the structural origin by which the FimH-mannose bond is switched by force to a high binding state. Mutational studies were thereby combined with steered molecular dynamic simulations to decipher how force might affect protein conformation. Force-activation of FimH leads to a complex ‘stick-and-roll’ bacterial adhesion behavior in which *E. coli* preferentially rolls over mannosylated surfaces at low shear but increasingly sticks firmly as the shear is increased. Interesting similarities are further seen if comparing the structural mechanisms by which liganded FimH and liganded integrins are switched to a high binding state. This comparison was made possible by docking fibronectin’s 10th type III module (fnIII₁₀) to $\alpha_V\beta_3$ integrin. $\alpha_V\beta_3$ can switch from the “closed” $\alpha_V\beta_3$ integrin headpiece to the “open” conformation by opening the hinge angle between the βA domain and the hybrid domain of the β -integrin. The “open” state has been implicated by many experimental laboratories to correspond to the activated state of integrins.

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