NMR Study of Kinetics of Protein / Cellulose Interactions

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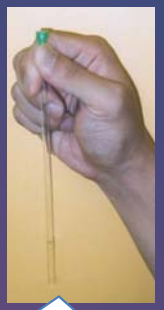
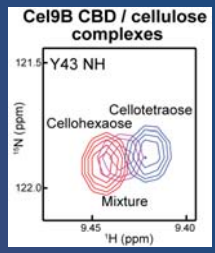
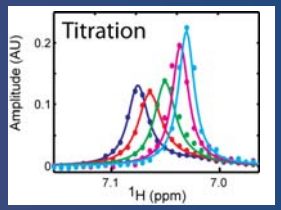
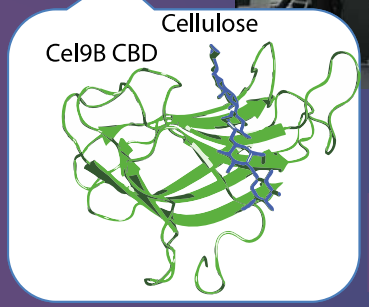
As society's demand for sustainable energy is increasing, efficient production of biofuels from biomass is becoming an important issue. In order to increase the efficiency via engineering of cellulase enzymes that digest cellulose, it is crucial to understand the kinetics and mechanisms of the protein / cellulose interactions. The goal of this project was to understand how the enzyme moves from one substrate to another.









Kinetics & Dynamics

Translocation mechanisms

1) Dissociation & re-association

k_{on} = 6.7 x 10^{7} M^{-1} s^{-1}

Cellulose

Protein

Cellulose

k_{off} = 590 s^{-1}

Rate-limitting

2) Direct transfer

Cellulose k_{DT} = 2.9 x 10^{6} M^{-1} s^{-1}

Protein

Collision

cellulose

A major mechanism

Using the cellulose-binding domain (CBD) of the cellulase enzyme Cel9B from *Cellulomonas fimi* as a model system, we have successfully studied the kinetic mechanisms of protein translocation on cellulose. Our data suggest that the protein can efficiently transfer from one cellulose chain to another via the direct transfer mechanism (left), which had been found only for protein/DNA interactions. Since the Cel9B CBD is homologous to many other CBDs of other cellulase enzymes, direct transfer is likely a general mechanism that enhances translocation of the enzyme on noncrystalline cellulose. Modulations of this mechanism by engineering may lead to improved activities of the enzymes.