iCase Project / AY 2023 -2024

How do soluble enzymes from microbes degrade insoluble plant cell walls?

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Department/Institute: Biochemistry

Industrial Partner: Novozymes

Project outline:

Plant cell walls are assembled with cellulose fibrils coated with hemicelluloses. The hemicellulose xylan is the most important and abundant hemicellulose in woody biomass and in grasses. Recent studies have shown that xylan changes its conformation into a flat two-fold screw ribbon to bind to the surface of cellulose. This functional form of xylan is inaccessible to conventional xylanases, since they require a soluble three-fold screw form for binding to the active site and hydrolysis. Current xylanase assays use extracted xylan or pretreated biomass that has altered the natural xylan conformations. In nature, microbes encounter xylan attached in the two-fold screw conformation, suggesting the natural degradation process might be somewhat different to measured assays.

In this project we aim to understand how enzymes can effectively degrade the solid natural substrate. We will use holocellulose nanofibrils, which are cellulose coated with xylan in the natural conformation. These have been isolated recently in the Dupree lab. We will study the ability of different xylan-active enzymes to degrade the xylan coatings in the solid state. Such enzyme could include xylanases and also appendage-releasing enzymes such as acetyl esterases. We will study the activity using biochemical assays of released sugars, and also droplet-based assays that are coupled to degradation of the entire holocellulose.

The project could involve some enzyme discovery, investigation of xylan degradation pathways, and also some enzyme characterisation.

BBSRC DTP main strategic theme: Bioscience for renewable resources and clean growth

BBSRC DTP secondary strategic theme: Bioscience for sustainable agriculture and food