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**Structural Basis of Stereospecificity in Enzymatic Cleavage of Lignin Bonds**

Understanding how bacteria digest plant lignin informs future engineering efforts to extract value from lignin.

**The Science**

In order to determine the structural basis for stereospecificity of bacterial enzymes involved in lignin bond cleavage, crystal structures of the enzymes involved were solved and the corresponding biochemical analyses for these proteins were performed. The detailed structural and biochemical characterization of LigE and LigF in this study,1 and the corresponding detailed structural and biochemical characterization of other members of this lignin degradation pathway (LigD, LigO, LigL, and LigG) in a second study,2 reveal important new aspects of the enzyme mechanisms and the determinants of substrate specificity.

**The Impact**

Although lignin, a combinatorial polymer comprising monoaromatic units, is a potential source of valuable aromatic chemicals, its recalcitrance to chemical or biological digestion presents major obstacles to both the production of second-generation biofuels and the generation of valuable co-products from lignin’s monoaromatic units. These collaborative studies, in which aspects of lignin degradation mechanisms have been identified, inform broader lignin valorization efforts that will ultimately enable the development of efficient pathways for the conversion of lignin into renewable aromatics with applications in advanced biofuels and chemicals.

**Summary**

The primary obstacle in the production of lignocellulosic biofuels is the release of sugars in high quantities at low cost from recalcitrant biomass feedstocks. Although lignin is a potential source of valuable aromatic chemicals, its recalcitrance to chemical or biological digestion presents major obstacles to both the production of second-generation biofuels and the generation of valuable co-products from lignin’s monoaromatic units. A catabolic pathway for the enzymatic breakdown of aromatic oligomers linked via β-aryl ether bonds typically found in lignin has been reported in the bacterium *Sphingobium* sp. SYK-6. Here are presented X-ray crystal structures and biochemical characterizations of the glutathione-dependent β-etherases, LigE and LigF from this pathway. Results from this study,1 and a second study (both of which are collaborations with GLBRC, JBEI and others),2 reveal important new aspects of the enzyme mechanisms and the determinants of substrate specificity. As β-aryl ether bonds account for 50-70% of all inter-unit linkages in lignin, understanding the mechanism of enzymatic β-aryl ether cleavage has significant potential for informing ongoing studies on the valorization of lignin.

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**Publications**

1 K. Helmich, *et al.*, “Structural basis of stereospecificity in the bacterial enzymatic cleavage of β-aryl ether bonds in lignin**.”** *The Journal of Biological Chemistry*, (2016) [DOI:10.1074/jbc.M115.694307]

2 J. H. Pereira, *et al.*, “Structural and biochemical characterization of the early and late enzymes in the lignin β-aryl ether cleavage pathway from *Sphingobium* sp SYK-6**.”** *The Journal of Biological Chemistry*, (2016) [DOI: doi:10.1074/jbc.M115.700427]

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