Center for Lignocellulose Structure and Formation
An Energy Frontier Research Center supported by the US Department of Energy, Office of Basic Energy Sciences

CLSF Mission
To develop a nano- to meso-scale understanding of plant cell walls, the main structural material in plants, and the physical mechanisms of their assembly, forming the foundation for significant advances in sustainable energy and novel biomaterials.

Theme 1: How plants make cellulose:
• Structure and function of cellulose synthase (CESA)
• Regulation of CSC activity and cellulose fibril formation

Theme 2: How plants assemble multi-functional cell walls:
• Mesoscale architecture of the cell wall
• Polymer interactions and conformations
• NMR of primary and secondary walls, including grasses
• Mobility of water, polysaccharides and proteins in the wall
• Nanoscale architecture of cell wall

Cellulose synthase (CESA) model

QM/MM analysis provides the first theoretical model of the mechanism by which cellulose synthase elongates a cellulose polymer one glucosyl moiety at a time (Yang et al. 2015)

An estimated 18 CESAs are packed in the CSC that produces a cellulose microfibril. A trimer of CESAs packs each of six hexameric subunits of a CSC (predicted using computation and modern image analysis; Nixon et al. 2016, Vandavasi et al. 2016).

Cellulose structure: suNMR and density functional theory (DFT) calculations indicate cellulose polymorphism in primary cell walls (Wang et al. 2016)

Polymer interactions and conformations: Characterizing the association between glucuronarabinoxylan and cellulose in the plant cell wall (S Smith, L Petridis, D Cosgrove)

Matrix polymer delivery: Alkynyl fucose clickable probes for metabolic labeling and fluorescence imaging of polysaccharides (pectin) in cell walls (McCluskey et al. 2016)

Xyloglucan localization by FESEM with backscattered electron imaging. A, B: Xyloglucan-deficient mutant and wild type control. C: CBM3-nanogold experiments show that xyloglucan is bound to the surface of cellulose. Zheng et al. 2018

Potential arrangements of xyloglucan and pectin at different surfaces of cellulose microfibrils (Cosgrove 2018)

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