Comprehensive Review on Plant Cell Walls – foundation for maximizing future use of biomass for production of carbohydrate-rich fuels and products

Background

- In honor of the 100-year anniversary of the founding of the American Society of Plant Biologists, Debby Delmer (discoverer of cellulose synthase) was asked to write a review of plant cell walls. She invited Rick Dixon (CBI), Ken Keegstra (GLBRC) and Debra Mohnen (CBI) to join this effort, since each had spent their careers studying one of the four types of plant cell wall polymers.

Approach

- The goal was to summarize 100 years of plant cell wall research recognizing major historical figures who shaped the field, describe our understanding of the structures of the cell wall polymers cellulose, hemicellulose, pectin, lignin and cell wall proteins, and discuss how they are synthesized, interact in the wall, and function to provide wall strength and modification in response to stresses.

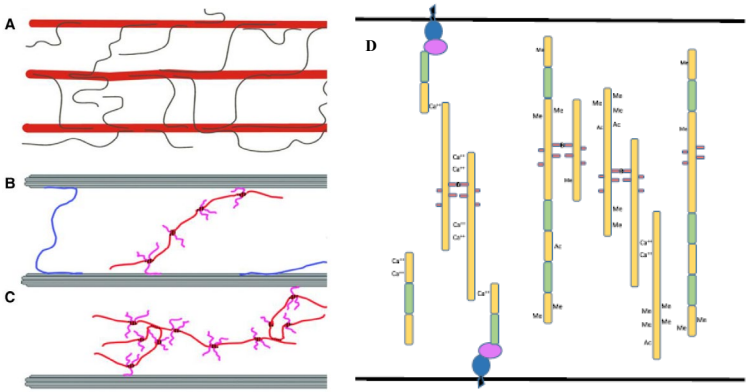
Results

- Following a description of the history of the discovery of walls and of chemical and biochemical studies that support current understanding of cell wall polymer primary, secondary, tertiary and quaternary structures, the review integrates this information into current models for how cell wall architecture is laid down to facilitate growth and yet keep plant cells, tissues and organs intact. This is followed by summaries of the actively developing field of cell wall signaling, mechanisms for surveying and maintaining cell wall integrity, and of the role of the wall in the plant's response to biotic and abiotic stress. The review ends with a summary of how cell walls develop starting with their "birth", followed by their growth and maturation and ending with carbohydrate rich cell walls that are sustainable resources for biofuels and bioproducts.

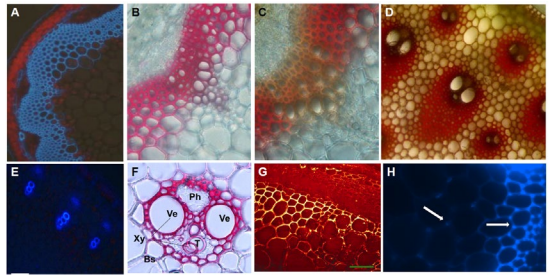
Significance

- The review provides critical reading for new and seasoned researchers in the areas of plant cell walls, biomass utilization, and sustainable agriculture. Understanding the regulation of wall polymer production, crosslinking, and architecture, and the role of cell walls in the plant's response to developmental and environmental signals, is critical for improving plants as high-yielding bioenergy feedstock resources from diverse environments.

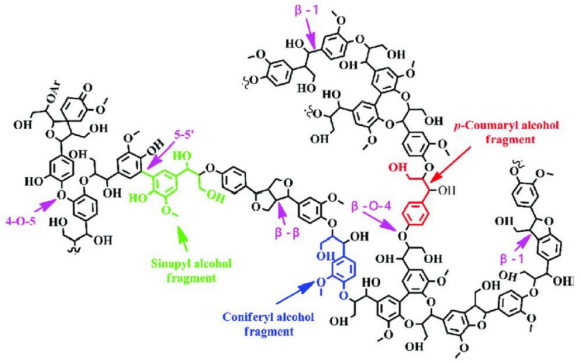
Delmer, Deborah et al. *The Plant Cell* (2024) https://doi.org/10.1093/plcell/koad325



Tethered network hypotheses with - **A** cellulose microfibrils (CMFs) connected by xyloglucan (XyG), **B** CMFs linked by both XyG and pectin, **C** CMFs linked via a network of pectic polysaccharides, heteroglycan and glycoconjugates **D**. pectic heteroglycan and glycoconjugate model of five pectin polymers.



In situ Lignin detection.



Generic lignin structure with major monomer and linkage types.