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## Research on the Plant Cell Wall Polysaccharide Pectin Leads to the Identification of a Gene Family that Impacts Plant Biomass and Plant-Based Products

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This research may result in improved biomass for agriculture and energy, improved gelling and stabilizing agents in the food and cosmetic industries, and in new value-added products such as pectin-based nutraceuticals and pharmaceuticals.

**P**lants account for a large percentage of the biomass on earth. Once water is removed, plant cell walls are the most abundant component of that biomass, which is evident in wood, leaf litter, and the fruits and vegetables that we eat. The plant cell wall, which consists largely of a mixture of complex polysaccharides, provides the raw material for many economically important natural products,

including wood, paper, textiles, gels, stabilizing agents, adhesives, food additives, and diverse fine chemicals, including cellulose derivatives. In addition, the plant wall has multiple essential roles for plant growth and development, such as providing structural support for the plant, serving as a major first line of defense against pathogenic organisms, and providing a complex reservoir of signals for the plant to use as it grows and responds

to its environment. More than 50 years of research by carbohydrate chemists provides a reasonably detailed description of the major carbohydrate structures in plant walls. However, the finer level details of how the wall is synthesized and how the diverse polysaccharides are connected to each other and to proteins and lignin structures in the wall remain elusive. This information is essential to meet future agricultural and energy needs

Figure 1. (A) Partial representative structure of a trimeric region of the pectic polysaccharide homogalacturonan (HG). (B) Reaction catalyzed by the pectin biosynthetic galacturonosyltransferase (GalAT) encoded by GAUT1.

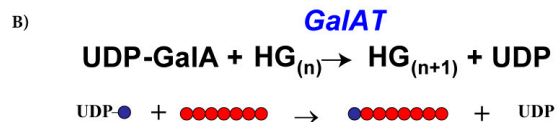
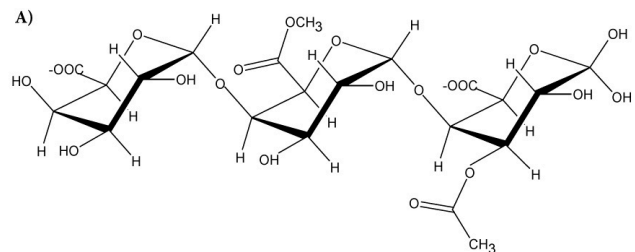


Figure credit: Debra Mohnen

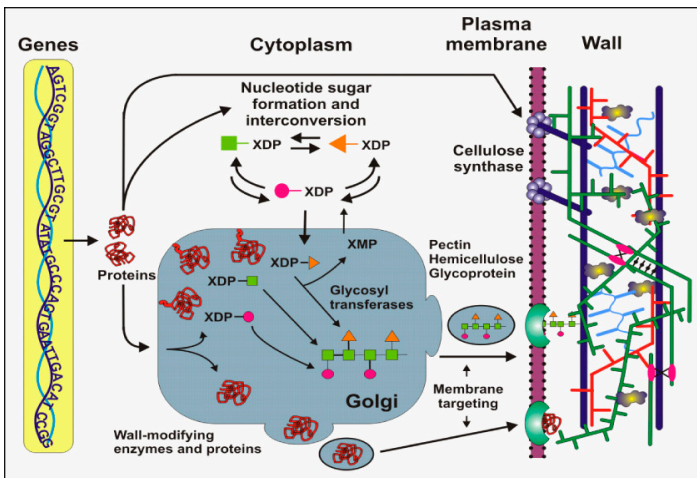


Figure credit: Malcolm O'Neill

Figure 2. Schematic showing the process of primary cell wall formation: from genes, to biosynthetic enzymes, to wall polysaccharides cellulose, hemicellulose and pectin.

as plants become an increasingly integral source of raw materials for a growing variety of essential products.

Pectin is a complex family of polysaccharides that are major components in primary plant cell walls. Primary walls are the first walls laid down by all growing and dividing plant cells. These structures also surround cells in the edible soft parts of plants and are the predominant wall type in fruits and vegetables. Pectin synthesis studies resulted in the identification of the first functionally proven pectin biosynthetic enzyme, galacturonosyltransferase 1 (GAUT1).

GAUT1 was discovered in the model plant *Arabidopsis thaliana*. However, comparative sequence and phylogenetic analyses of

*Arabidopsis* and other plants demonstrate the importance of these studies across the plant kingdom. Also, diverse plants contain Golgi-localized galacturonosyltransferase activity with similar enzymatic properties to the GAUT1 protein.

GAUT1 synthesizes the most abundant pectic polysaccharide, homogalacturonan (HG), which is a major component in pectins used in the food industry and a major component of the matrix that holds plant cells together. GAUT1 is part of a family of GAUT1-related genes, which the researchers propose encode galacturonosyltransferases involved in the synthesis of pectin and other cell wall polysaccharides and proteoglycans. The GAUT1-related gene family appears to be ubiquitous among higher plants, being present in rice, maize,

switchgrass, Medicago, soybean, chickpea, and *Populus*. Pectin biosynthesis appears to occur in protein complexes, at least some of which contain multiple members of the GAUT1-related protein family. These results suggest that the final structure of a pectin will depend on the composition of such biosynthetic enzyme complexes.

Recent work supports the involvement of some GAUT1-related gene family members in the synthesis of another class of wall polysaccharides, the xylans. Xylans are important components of plant secondary walls which represent a major source of biomass for biofuel production. Research on the GAUT1-related gene family comes at a critical point with regard to the modification of plant walls for the generation of improved biomass for fuel production.



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