

Enzymes for cell wall synthesis conserved across species barriers

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Plants have neither supportive bone tissue nor muscles, and yet they can form rigid structures like stalks and even tree trunks. This is due to the fact that plant cells are enveloped by a stable cell wall. The main component of the plant cell wall is cellulose, which represents almost 50 percent of the total cell wall material and, at one billion tonnes per year, is the most frequently produced macromolecule in nature.

Very little is known about the way in which cellulose is produced, and the knowledge that is available has mainly been obtained from the [model plant](#) thale cress ([Arabidopsis thaliana](#)) which, although easy to study, is of no economic significance. Staffan Persson and his research group at the [Max Planck](#) Institute of Molecular Plant Physiology have succeeded in showing that knowledge obtained in Arabidopsis can be applied to other plant species and even advanced.

Cell walls are referred to as primary or secondary according to their materials and characteristics. While the cell is still growing it is only surrounded by the elastic and flexible primary [cell wall](#). When the cell is fully grown, certain types of cells, for example the water transporting vessels, form a rigid secondary cell wall. The most important component of both cell wall types is cellulose – a long chain-shaped molecule which consists of several thousand monosaccharides that assemble themselves to form extremely tear-resistant bundles known as microfibrils. These cellulose microfibrils surround the [plant cell](#) like steel cables and give it shape and stability. Although cellulose cannot be digested by humans and animals, and is, therefore, of no nutritional value, it is an important

industrial raw material. It is used, for example, in the paper industry, in construction and as a precursor for fuel.

Cellulose synthesis takes place in the cell membrane. The enzyme complex responsible for cellulose synthesis consists of three different CesA (cellulose synthase) proteins which supposedly link the individual sugar molecules with each other and channel them out of the cell. The CesA proteins, which are involved in the synthesis of both primary and secondary cell walls, are related to each other but also differ in certain aspects. In addition to the CesAs, many other enzymes are believed to be associated with the synthesis or export of cellulose. Up to now, the research on cellulose synthesis focused, in particular, on Arabidopsis, the model organism favoured by biologists. Due to its short lifecycle and biological simplicity, Arabidopsis is extremely useful for research, but lacks economic potential. Persson and his colleagues would therefore like to apply the knowledge gained from the research on this plant to other more economically important [plant species](#).

The aim of their research is to identify [genes](#) in important crops, such as barley, rice and wheat, and in poplar and soya beans that have the same function as already well-characterised genes found in Arabidopsis. With the help of a technique called co-expression analysis, they investigated which gene families become active at the same time and in the same place as the CesA genes and therefore are probably also involved in cellulose synthesis. "Genes that are expressed in cells at the same time probably also work in the same process," says Persson, explaining the approach adopted by his research group. In addition, this method also enables the scientists to weed out any false-positives, as genes that can only be connected with the CesA genes in Arabidopsis and not in any other species are presumably not as essential for [cellulose synthesis](#) as was previously believed.

The glycosyltransferases are a super-family of genes that can be found in

almost all co-expression networks. These are enzymes that transfer activated sugar groups to existing sugar polymers, proteins or lipids. The precise function of these enzymes in relation to [cellulose](#) is not yet known; however, their presence in a wide variety of species would suggest that they play an important role in this process. Genes that code for components of the cell cytoskeleton were more strongly associated with the primary-wall-specific Cesa genes, and this would indicate that the cell cytoskeleton plays a more important role in the synthesis of the primary cell wall. The researchers were intrigued to discover that many signalling-related genes and protein degradation genes were also persistently co-expressed with the Cesa genes.

"Our method enables the systematic analysis of entire genomes of different crops, with the aim to discover functional relationships between gene families," says Persson. Co-expression analysis is therefore a very promising tool that will enable the application of knowledge that was previously limited to Arabidopsis to other agriculturally significant plants.

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