Division of Forest and Biomaterials Science, Graduate School of Agriculture, Kyoto University (2012.6.21)

FROM MOLECULES TO TREES - How do trees grow so huge?

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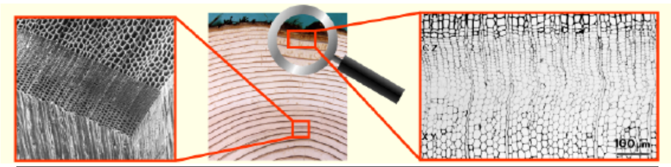
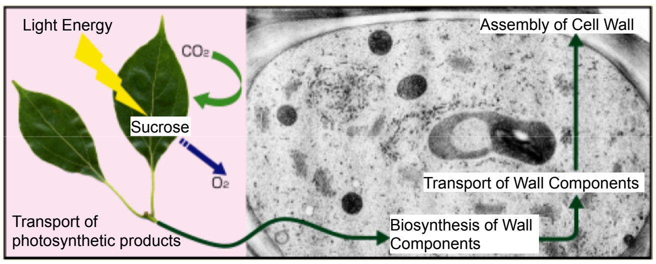
Mechanism of Wood Formation



Xylem cells are produced from spring to autumn in the vascular cambium, which is a layer of active dividing cells on the tree trunk underneath the bark. Fully developed xylem cells lose their cell contents and form hollow tubes of lignified cell wall 1 to 6 µm thick. The wood of a tree trunk is built mostly of dead xylem cells. This structure is responsible for the lightness and strong qualities of wood, and enables the trees to support their huge weight.

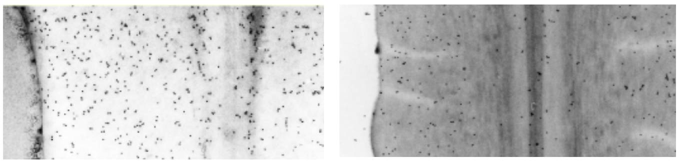
Biosynthesis of the Cell Wall

We have been examining many organelles such as plastids, mitochondria, rough endoplasmic reticula, and the Golgi apparatus by electron microscopy during cell wall formation. Photosynthetic products made from CO_2, water and light energy are delivered to these cells. Then the cells synthesize cell wall components and deliver them to their cell wall.

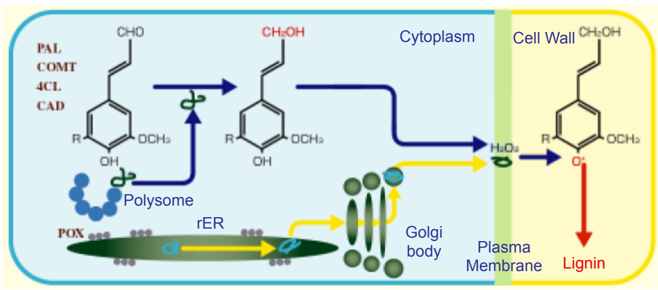


Cell Wall Components

The cell wall of xylem cells is composed of 50% cellulose, 20-30% hemicelluloses and 20-30% lignins. Cellulose is responsible for the strength and flexibility of the cell wall, and lignins fot the water resistance as well as strength of the cell wall. Hemicelluloses are closely linked to cellulose and lignin.
We have revealed the distribution of lignins and hemicelluloses in the cell wall by immuno-electron microscopy.



The distribution of hemicelluloses and lignins
Small black dots show the presence of hemicelluloses (left) and lignins (right).



By the study of localization of enzymes involved in the biosynthesis, we have found where the biosynthesis of the cell wall components takes place. Lignin precursors, for instance, polymerize to form 3-D macromolecules in the cell wall but not in the cytoplasm.

Keywords

Wood, Xylem formation, Cell Wall, Lignin, Lignification, Electron Microscopy, Immuno cytochemistry

Recent Publications

Ultrastructure of the innermost surface of differentiating normal and compression wood tracheids as revealed by field emission scanning electron microscopy
Kim JS, Awano T, Yoshinaga A, Takabe K (2012)
Planta, 235:1209-1219

Occurrence of xylan and mannan polysaccharides and their spatial relationship with other cell wall components in differentiating compression wood tracheids of *Cryptomeria japonica*
Kim JS, Awano T, Yoshinaga A, Takabe K (2011)
Planta, 233:721–735

Temporal and spatial diversities of the immunolabeling of mannan and xylan polysaccharides in differentiating earlywood ray cells and pits of *Cryptomeria japonica*
Kim JS, Awano T, Yoshinaga A, Takabe K (2011)
Planta, 233:109–122

Immunolocalization and structural variations of xylan in differentiating earlywood tracheid cell walls of *Cryptomeria japonica*
Kim JS, Awano T, Yoshinaga A, Takabe K (2010)
Planta, 232:817-824

Temporal and spatial immunolocalization of glucomannans in differentiating earlywood tracheid cell walls of *Cryptomeria japonica*
Kim JS, Awano T, Yoshinaga A, Takabe K (2010)
Planta, 232: 545-554

Immunolocalization of β-1-4-galactan and its relationship with lignin distribution in developing compression wood of *Cryptomeria japonica*
Kim JS, Awano T, Yoshinaga A, Takabe K (2010)
Planta, 232:109-119

Cellular distribution of coniferin in differentiating xylem of *Chamaecyparis obtusa* as revealed by Raman microscopy
Morikawa Y, Yoshinaga A, Kamitakahara H, Wada M, Takabe K (2010)
Holzforschung, 64:61-67

Enzymatic saccharification of Eucalyptus bark using hydrothermal pre-treatment with carbon dioxide
Matsushita Y, Yamauchi K, Takabe K, Awano T, Yoshinaga A, Kato M, Kobayashi T, Asada T, Furujyo A, Fukushima K (2010)
Bioresource Technology, 101:4936-4939