

Plant Physiology[®]

November 2016 • Volume 172 • Number 3

www.plantphysiol.org

Metabolic Organization during Secondary Cell Wall Synthesis

Downloaded from on March 12, 2018 - Published by www.plantphysiol.org
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On the Cover: Secondary cell walls are of immense importance to our society as they provide raw material for the paper, textile, biomaterial, and fuel sectors. Secondary cell walls also sustain plant growth and the water-transporting capacity of the vasculature that support water and nutrient transport from the root to the aerial parts of a plant. A better understanding of how secondary walls are made is therefore of utmost importance. Li et al. (Vol. 172, pp. 1334–1351) and Ohtani et al. (this issue, pp. 1612–1624) used inducible secondary wall systems to explore metabolite and transcript changes after the onset of secondary wall production. They found dynamic changes associated with many different classes of metabolites, in particular amino acid biosynthesis and hormone signaling. These changes were put in context to transcript changes during the induction to generate a comprehensive map of how cells re-program to change their developmental fates. These data will lay a foundation for a better understanding of how secondary walls are synthesized in plants. The cover image shows an induced seedling that was torn to expose a secondary wall structure of a proto-xylem converted cell. The image was captured using a Olympus BX-51 epi-fluorescence microscope using a 20× lens and was generated by Dr. Rene Schneider at the University of Melbourne.

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Peter V. Minorsky

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[OPEN]Primary Metabolism during Biosynthesis of Secondary Wall Polymers of Protoxylem Vessel Elements. Misato Ohtani, Keiko Morisaki, Yuji Sawada, Ryosuke Sano, Abigail Loren Tung Uy, Atsushi Yamamoto, Tetsuya Kurata, Yoshimi Nakano, Shiro Suzuki, Mami Matsuda, Tomohisa Hasunuma, Masami Yokota Hirai, and Taku Demura

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[OPEN] Mechanical Failure of Fine Root Cortical Cells Initiates Plant Hydraulic Decline during Drought. Italo F. Cuneo, Thorsten Knipfer, Craig R. Brodersen, and Andrew J. McElrone

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GENES, DEVELOPMENT, AND EVOLUTION

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[OPEN]TWS1, a Novel Small Protein, Regulates Various Aspects of Seed and Plant Development. *Elisa Fiume, Virginie Guyon, Carine Remoué, Enrico Magnani, Martine Miquel, Damaris Grain, and Loïc Lepiniec*

TWISTED SEED1 is a novel small protein located in the endomembrane system of Arabidopsis that regulates various aspects of seed and plant development.

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[OPEN]ZRF1 Chromatin Regulators Have Polycomb Silencing and Independent Roles in Development. *Jing Feng, Donghong Chen, Alexandre Berr, and Wen-Hui Shen*

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Comparative analysis of immunostained metaphase chromosomes at the single cell level with ChIP-seq of individual genes reveals a chromatin basis for biased homoeolog gene expression in polyploids.

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[OPEN]A Rice Ca²⁺ Binding Protein Is Required for Tapetum Function and Pollen Formation. *Jing Yu, Zhaolu Meng, Wanqi Liang, Smrutisanjita Behera, Jörg Kudla, Matthew R. Tucker, Zhijing Luo, Mingjiao Chen, Dawei Xu, Guochao Zhao, Jie Wang, Siyi Zhang, Yu-Jin Kim, and Dabing Zhang*

OsDEX1 binds Ca²⁺ and plays a conserved role in the development of tapetal cells and pollen formation in rice.

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[OPEN]The Genetics of Leaf Flecking in Maize and Its Relationship to Plant Defense and Disease Resistance. *Bode A. Olukolu, Yang Bian, Brian De Vries, William F. Tracy, Randall J. Wisser, James B. Holland, and Peter J. Balint-Kurti*

Leaf flecking in maize may be related to disease resistance and to a diverse set of metabolic pathways.

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Multiple levels of functional divergence contributed to gene retention after whole-genome duplication in the soybean membrane-bound NAC transcription factors gene family.

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Transcriptomic and metabolomic profiling of grapevine berries after harvest in different Vitis vinifera genotypes reveals the molecular basis of cluster detachment, senescence and dehydration stress.

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DWARF 14 protein, a strigolactone receptor, is transported through phloem to axillary buds and the transport is required for full function of strigolactones to suppress shoot branching.

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[OPEN] Developmental Defects Mediated by the P1/HC-Pro Potyviral Silencing Suppressor Are Not Due to Misregulation of *AUXIN RESPONSE FACTOR 8*. *Sizolwenkosi Mlotshwa, Gail J. Pruss, John L. MacArthur, Jason W. Reed, and Vicki Vance*

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[OPEN] Analysis of Arabidopsis Accessions Hypersensitive to a Loss of Chloroplast Translation. *Nicole Parker, Yixing Wang, and David Meinke*

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MEMBRANES, TRANSPORT, AND BIOENERGETICS

[OPEN] Sucrose Transporter *ZmSut1* Expression and Localization Uncover New Insights into Sucrose Phloem Loading. *R. Frank Baker, Kristen A. Leach, Nathaniel R. Boyer, Michael J. Swyers, Yoselin Benitez-Alfonso, Tara Skopelitis, Anding Luo, Anne Sylvestre, David Jackson, and David M. Braun*

Maize SUCROSE TRANSPORTER1 functions to load sucrose into phloem companion cells, restrict its accumulation in the apoplast, and prevent its loss during long-distance transport. 1876

[OPEN] The HvNramp5 Transporter Mediates Uptake of Cadmium and Manganese, But Not Iron. *Dezhi Wu, Naoki Yamaji, Miki Yamane, Miho Kashino-Fujii, Kazuhiro Sato, and Jian Feng Ma*

HvNramp5 is a plasma membrane-localized transporter, which is responsible for Mn and Cd uptake in barley. 1899

[OPEN] The Nonspecific Lipid Transfer Protein AtLtpI-4 Is Involved in Suberin Formation of *Arabidopsis thaliana* Crown Galls. *Rosalia Deeken, Stefanie Saupe, Joern Klinkenberg, Michael Riedel, Jana Leide, Rainer Hedrich, and Thomas D. Mueller*

AtLtpI-4 involvement in suberin formation is essential for crown gall growth, while ectopic expression in epidermal cells provides evidence for AtLpI-4 functioning in extracellular lipid deposition. 1911

[OPEN] Hydrocarbons Are Essential for Optimal Cell Size, Division, and Growth of Cyanobacteria. *David J. Lea-Smith, Maite L. Ortiz-Suarez, Tchern Lenn, Dennis J. Nürnberg, Laura L. Baers, Matthew P. Davey, Lucia Parolini, Roland G. Huber, Charles A. R. Cotton, Giulia Mastroianni, Paolo Bombelli, Petra Ungerer, Tim J. Stevens, Alison G. Smith, Peter J. Bond, Conrad W. Mullineaux, and Christopher J. Howe*

Optimal growth and division of cyanobacteria depends upon hydrocarbon induced flexibility in the thylakoid membranes of cyanobacteria, via accumulation of these compounds within the lipid bilayer. 1928

SIGNALING AND RESPONSE

[OPEN] The Proteasome Acts as a Hub for Plant Immunity and Is Targeted by *Pseudomonas* Type III Effectors. *Suayib Üstün, Arsheed Sheikh, Selena Gimenez-Ibanez, Alexandra Jones, Vardis Ntoukakis, and Frederik Börnke*

The proteasome is required for local and systemic immune responses and is targeted by Pseudomonas type III effectors. 1941

[OPEN] Two Different Transcripts of a LAMMER Kinase Gene Play Opposite Roles in Disease Resistance. *Liu Duan, Wenfei Xiao, Fan Xia, Hongbo Liu, Jinghua Xiao, Xianghua Li, and Shiping Wang*

A LAMMER kinase gene generates two types of transcripts, the long OsDR11L and the short OsDR11S, which have opposite functions in rice resistance to a bacterial pathogen. 1959

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[OPEN] Ubiquitination-Related MdbT Scaffold Proteins Target a bHLH Transcription Factor for Iron Homeostasis. Qiang Zhao, Yi-Ran Ren, Qing-Jie Wang, Xiao-Fei Wang, Chun-Xiang You, and Yu-Jin Hao

BTB-TAZ proteins bridge and scaffold the CRL3 complex to modulate iron homeostasis by ubiquitinating and degrading MdbHLH104 proteins in response to Fe status in apple.

1973

[OPEN] Arabidopsis Responds to *Alternaria alternata* Volatiles by Triggering Plastid Phosphoglucose Isomerase-Independent Mechanisms. Ángela María Sánchez-López, Abdellatif Bahaji, Nuria De Diego, Marouane Baslam, Jun Li, Francisco José Muñoz, Goizeder Almagro, Pablo García-Gómez, Kinia Ameztoy, Adriana Ricarte-Bermejo, Ondřej Novák, Jan F. Humplík, Lukáš Spíchal, Karel Doležal, Sergio Ciordia, María Carmen Mena, Rosana Navajas, Edurne Baroja-Fernández, and Javier Pozueta-Romero

Cytokinin-mediated responses of Arabidopsis to volatile compounds emitted by pathogenic microorganisms involve the activation of plastidic phosphoglucose isomerase-independent mechanisms.

1989

[OPEN] A Legume TOR Protein Kinase Regulates *Rhizobium* Symbiosis and Is Essential for Infection and Nodule Development. Kalpana Nanjareddy, Lourdes Blanco, Manoj-Kumar Arthikala, Xóchitl Alvarado-Affantranger, Carmen Quinto, Federico Sánchez, and Miguel Lara

Target of rapamycin regulates infection and nodule development during rhizobial symbiosis in Phaseolus vulgaris.

2002

[OPEN] Regulation of Stomatal Defense by Air Relative Humidity. Shweta Panchal, Reejana Chitrakar, Blaine K. Thompson, Nisita Obulareddy, Debanjana Roy, W. Sealy Hambright, and Maeli Melotto

High relative humidity suppresses Pseudomonas syringae-triggered stomatal closure by regulating hormone signaling in guard cells.

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The Thiamine Biosynthesis Gene *THI1* Promotes Nodule Growth and Seed Maturation. Miwa Nagae, Martin Parniske, Masayoshi Kawaguchi, and Naoya Takeda

A mutant in the thiamine biosynthesis gene THI1 reduces the size of root nodules and leads to high frequency of immature seeds in Lotus japonicus.

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[OPEN] Phytoglobins Improve Hypoxic Root Growth by Alleviating Apical Meristem Cell Death. Mohamed M. Mira, Robert D. Hill, and Claudio Stasolla

Phytoglobin expression in hypoxic root apical meristems alleviates programmed cell death by removing NO and moderating ethylene and ROS in the maize meristematic cells.

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SYSTEMS AND SYNTHETIC BIOLOGY

[OPEN] Central Metabolic Responses to Ozone and Herbivory Affect Photosynthesis and Stomatal Closure. Stefano Papazian, Eliezer Khaling, Christelle Bonnet, Steve Lassueur, Philippe Reymond, Thomas Moritz, James D. Blande, and Benedicte R. Albrechtsen

When confronted with sequential abiotic and biotic stress, black mustard regulates glycerol and central energy metabolism to prioritize processes of photosynthesis and stomatal osmoregulation.

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