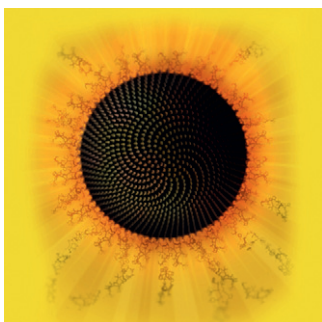


T H E
PLANT
C E L L

Volume 26 Number 3 March 2014

The electronic form of this issue, available at www.plantcell.org, is the journal of record.

ON THE COVER



Common sunflower (*Helianthus annuus*) contains the unusual gene *PawS1* (*Preproalbumin with SFTI-1*) that encodes both a precursor for seed storage albumin and the protease-inhibiting peptide SFTI-1. Elliott et al. (pages 981–995) show that this dual biosynthesis process is of ancient evolutionary origin and propose the biochemical sequence of events that allowed the peptide to arise de novo. On the cover, a stylized sunflower floret is ringed by structural models of the various peptides, solved by nuclear magnetic resonance spectroscopy. Artwork by Scot Nicholls, Domokun Design.

IN BRIEF

- A Useful Model of Auxin Transport in the Root Apex** 843
Nancy A. Eckardt
- N*-Glycosylation of a Chitin Binding Effector Allows a Fungal Pathogen to Evade the Plant Immune Response** 844
Jennifer Mach
- Getting to the Root of Regeneration: Adventitious Rooting and Callus Formation** 845
Nancy Hofmann
- Cryptochromes and Seed Dormancy: The Molecular Mechanism of Blue Light Inhibition of Grain Germination** 846
Nancy Hofmann

COMMENTARIES

- Chloroplast DNA in Mature and Senescing Leaves: A Reappraisal** [W|OPEN](#) 847
Hieronim Golczyk, Stephan Greiner, Gerhard Wanner, Andreas Weihe, Ralph Bock, Thomas Börner, and Reinhold G. Herrmann
- On the Fate of Plastid DNA Molecules during Leaf Development: Response to the Golczyk et al. Commentary** [W](#) 855
Delene J. Oldenburg, Beth A. Rowan, Rachana A. Kumar, and Arnold J. Bendich

LARGE-SCALE BIOLOGY ARTICLES

- Systems Analysis of Auxin Transport in the *Arabidopsis* Root Apex** [W|OPEN](#) 862
Leah R. Band, Darren M. Wells, John A. Fozard, Teodor Ghetiu, Andrew P. French, Michael P. Pound, Michael H. Wilson, Lei Yu, Wenda Li, Hussein I. Hijazi, Jaesung Oh, Simon P. Pearce, Miguel A. Perez-Amador, Jeonga Yun, Eric Kramer, Jose M. Alonso, Christophe Godin, Teva Vernoux, T. Charlie Hodgman, Tony P. Pridmore, Ranjan Swarup, John R. King, and Malcolm J. Bennett
- Systems Biology of Lignin Biosynthesis in *Populus trichocarpa*: Heteromeric 4-Coumaric Acid:Coenzyme A Ligase Protein Complex Formation, Regulation, and Numerical Modeling** [W](#) 876
Hsi-Chuan Chen, Jina Song, Jack P. Wang, Ying-Chung Lin, Joel Ducoste, Christopher M. Shuford, Jie Liu, Quanzi Li, Rui Shi, Angelito Nepomuceno, Fikret Isik, David C. Muddiman, Cranos Williams, Ronald R. Sederoff, and Vincent L. Chiang

EDITORIAL BOARD

Editor in Chief

Cathie Martin

Coeeditors

Sarah M. Assmann

Jody Banks

Alice Barkan

Sebastian Bednarek

James Birchler

Ulla Bonas

Christopher Bowler

Judy Callis

XiaoFeng Cao

Vincenzo De Luca

Xing Wang Deng

Xinnian Dong

Allan Downie

Alisdair Fernie

Pascal Genschik

Jean T. Greenberg

Thomas Guilfoyle

Herman R. Höfte

David Jackson

Regine Kahmann

Martin Kater

Daniel J. Kliebenstein

William Lucas

Blake Meyers

Ortrun Mittelsten Scheid

Giles Oldroyd

Michael Palmgren

Markus Pauly

Scott C. Peck

Barry Pogson

Zhaohui Qin

Karin Schumacher

David Smyth

Chris J. Staiger

Keiko Sugimoto

Managing Editor

Patti Lockhart

Senior Features Editor

Nancy A. Eckardt

Features Editor

Mary Williams

Science Editors

Greg Bertoni

Kathleen L. Farquharson

Nancy R. Hofmann

Jennifer Lockhart

Jennifer M. Mach

Production Manager

Susan L. Entwistle

Manuscript Manager

Annette Kessler

Publications Director

Nancy A. Winchester

Publisher

American Society of

Plant Biologists

Executive Director,

Crispin Taylor

Editorial Office

15501 Monona Drive

Rockville, Maryland 20855-2768

Telephone: 301/296-0908

Fax: 301/279-2996

http://www.aspb.org

Online at www.plantcell.org

Complete Proteomic-Based Enzyme Reaction and Inhibition Kinetics Reveal How Monolignol Biosynthetic Enzyme Families Affect Metabolic Flux and Lignin in *Populus trichocarpa* [W](#) 894

Jack P. Wang, Punith P. Naik, Hsi-Chuan Chen, Rui Shi, Chien-Yuan Lin, Jie Liu, Christopher M. Shuford, Quanzi Li, Ying-Hsuan Sun, Sermsawat Tunlaya-Anukit, Cranos M. Williams, David C. Muddiman, Joel J. Ducoste, Ronald R. Sederoff, and Vincent L. Chiang

Linking Gene Expression and Membrane Lipid Composition of *Arabidopsis* [W](#)[OPEN](#) 915

Jedrzej Szymanski, Yariv Brotman, Lothar Willmitzer, and Álvaro Cuadros-Inostroza

Systematic Structural Characterization of Metabolites in *Arabidopsis* via Candidate Substrate-Product Pair Networks [C](#)[W](#) 929

Kris Morreel, Yvan Saeys, Oana Dima, Fachuang Lu, Yves Van de Peer, Ruben Vanholme, John Ralph, Bartel Vanholme, and Wout Boerjan

RESEARCH ARTICLES

The Most Deeply Conserved Noncoding Sequences in Plants Serve Similar Functions to Those in Vertebrates Despite Large Differences in Evolutionary Rates [W](#) 946

Diane Burgess and Michael Freeling

A Conserved Network of Transcriptional Activators and Repressors Regulates Anthocyanin Pigmentation in Eudicots [C](#)[W](#)[OPEN](#) 962

Nick W. Albert, Kevin M. Davies, David H. Lewis, Huaibi Zhang, Mirco Montefiori, Cyril Brendolise, Murray R. Boase, Hanh Ngo, Paula E. Jameson, and Kathy E. Schwinn

Evolutionary Origins of a Bioactive Peptide Buried within Preproalbumin [C](#)[W](#) 981

Alysha G. Elliott, Christina Delay, Huanle Liu, Zaiyang Phua, K. Johan Rosengren, Aurélie H. Benfield, Jose L. Panero, Michelle L. Colgrave, Achala S. Jayasena, Kerry M. Dunse, Marilyn A. Anderson, Edward E. Schilling, Daniel Ortiz-Barrientos, David J. Craik, and Joshua S. Mylne

Global Dissection of Alternative Splicing in Paleopolyploid Soybean [W](#) 996

Yanting Shen, Zhengkui Zhou, Zheng Wang, Weiyu Li, Chao Fang, Mian Wu, Yanming Ma, Tengfei Liu, Ling-An Kong, De-Liang Peng, and Zhixi Tian

A Distal CCAAT/NUCLEAR FACTOR Y Complex Promotes Chromatin Looping at the *FLOWERING LOCUS T* Promoter and Regulates the Timing of Flowering in *Arabidopsis* [W](#)[OPEN](#) 1009

Shuanghe Cao, Roderick W. Kumimoto, Nerina Gnesutta, Alessandra M. Calogero, Roberto Mantovani, and Ben F. Holt III

POLYGALACTURONASE INVOLVED IN EXPANSION1 Functions in Cell Elongation and Flower Development in *Arabidopsis* [C](#)[W](#) 1018

Chaowen Xiao, Chris Somerville, and Charles T. Anderson

Arabidopsis CAM7 and HY5 Physically Interact and Directly Bind to the HY5 Promoter to Regulate Its Expression and Thereby Promote Photomorphogenesis [W](#) 1036

Nazia Abbas, Jay P. Maurya, Dhiredatta Senapati, Sreeramaiah N. Gangappa, and Sudip Chattopadhyay








Abscisic Acid Regulates Early Seed Development in *Arabidopsis* by ABI5-Mediated Transcription of *SHORT HYPOCOTYL UNDER BLUE1* [C](#)[W](#)[OPEN](#) 1053

Zhi Juan Cheng, Xiang Yu Zhao, Xing Xing Shao, Fei Wang, Chao Zhou, Ying Gao Liu, Yan Zhang, and Xian Sheng Zhang

Ca²⁺-Activated Reactive Oxygen Species Production by *Arabidopsis* RbohH and RbohJ Is Essential for Proper Pollen Tube Tip Growth [W](#) 1069


Hidetaka Kaya, Ryo Nakajima, Megumi Iwano, Masahiro M. Kanaoka, Sachie Kimura, Seiji Takeda, Tomoko Kawarazaki, Eriko Senzaki, Yuki Hamamura, Tetsuya Higashiyama, Seiji Takayama, Mitsutomo Abe, and Kazuyuki Kuchitsu

- WOX11 and 12 Are Involved in the First-Step Cell Fate Transition during de Novo Root Organogenesis in *Arabidopsis*** ^W 1081
Jingchun Liu, Lihong Sheng, Yingqiang Xu, Jiqin Li, Zhongnan Yang, Hai Huang, and Lin Xu
- A Role for Barley CRYPTOCHROME1 in Light Regulation of Grain Dormancy and Germination** ^{W|OPEN} 1094
Jose M. Barrero, A. Bruce Downie, Qian Xu, and Frank Gubler
- Jasmonate-Activated MYC2 Represses ETHYLENE INSENSITIVE3 Activity to Antagonize Ethylene-Promoted Apical Hook Formation in *Arabidopsis*** ^{C|W} 1105
Xing Zhang, Ziqiang Zhu, Fengying An, Dongdong Hao, Pengpeng Li, Jinghui Song, Chengqi Yi, and Hongwei Guo
- Arabidopsis* DELLA and JAZ Proteins Bind the WD-Repeat/bHLH/MYB Complex to Modulate Gibberellin and Jasmonate Signaling Synergy** ^{C|W} 1118
Tiancong Qi, Huang Huang, Dewei Wu, Jianbin Yan, Yijun Qi, Susheng Song, and Daoxin Xie
- Strigolactone Promotes Degradation of DWARF14, an α/β Hydrolase Essential for Strigolactone Signaling in *Arabidopsis*** ^W 1134
Florian Chevalier, Kaisa Nieminen, Juan Carlos Sánchez-Ferrero, María Luisa Rodríguez, Mónica Chagoyen, Christian S. Hardtke, and Pilar Cubas
- Fast Retrograde Signaling in Response to High Light Involves Metabolite Export, MITOGEN-ACTIVATED PROTEIN KINASE6, and AP2/ERF Transcription Factors in *Arabidopsis*** ^{C|W} 1151
Marc Oliver Vogel, Marten Moore, Katharina König, Pascal Pecher, Khalid Alsharafa, Justin Lee, and Karl-Josef Dietz
- Inhibition of the *Arabidopsis* Salt Overly Sensitive Pathway by 14-3-3 Proteins** ^{C|W} 1166
Huapeng Zhou, Huixin Lin, She Chen, Katia Becker, Yongqing Yang, Jinfeng Zhao, Jörg Kudla, Karen S. Schumaker, and Yan Guo
- PsbN Is Required for Assembly of the Photosystem II Reaction Center in *Nicotiana tabacum*** ^W 1183
Salar Torabi, Pavan Umate, Nikolay Manavski, Magdalena Plöchinger, Laura Kleinknecht, Hanumakumar Bogireddi, Reinhold G. Herrmann, Gerhard Wanner, Wolfgang P. Schröder, and Jörg Meurer
- Discovery of a Chlorophyll Binding Protein Complex Involved in the Early Steps of Photosystem II Assembly in *Synechocystis*** ^W 1200
Jana Knoppová, Roman Sobotka, Martin Tichý, Jianfeng Yu, Peter Koník, Petr Halada, Peter J. Nixon, and Josef Komenda
- HYPERSENSITIVE TO HIGH LIGHT1 Interacts with LOW QUANTUM YIELD OF PHOTOSYSTEM II1 and Functions in Protection of Photosystem II from Photodamage in *Arabidopsis*** ^{C|W|OPEN} 1213
Honglei Jin, Bing Liu, Lujun Luo, Dongru Feng, Peng Wang, Jun Liu, Qingen Da, Yanming He, Kangbiao Qi, Jinfa Wang, and Hong-Bin Wang
- Characterization and Evolution of Tetrameric Photosystem I from the Thermophilic Cyanobacterium *Chroococcidiopsis* sp TS-821** ^{C|W|OPEN} 1230
Meng Li, Dmitry A. Semchonok, Egbert J. Boekema, and Barry D. Bruce
- ATP Requirement for Chloroplast Protein Import Is Set by the K_m for ATP Hydrolysis of Stromal Hsp70 in *Physcomitrella patens*** ^W 1246
Li Liu, Robert T. McNeilage, Lan-xin Shi, and Steven M. Theg
- Kinesins Have a Dual Function in Organizing Microtubules during Both Tip Growth and Cytokinesis in *Physcomitrella patens*** ^{W|OPEN} 1256
Yuji Hiwatashi, Yoshikatsu Sato, and John H. Doonan
- A Cyanobacterial Chlorophyll Synthase-HliD Complex Associates with the Ycf39 Protein and the YidC/Alb3 Insertase** ^{W|OPEN} 1267
Jack W. Chidgey, Markéta Linhartová, Josef Komenda, Philip J. Jackson, Mark J. Dickman, Daniel P. Canniffe, Peter Koník, Jan Pilný, C. Neil Hunter, and Roman Sobotka
- Translocations of Chromosome End-Segments and Facultative Heterochromatin Promote Meiotic Ring Formation in Evening Primroses** ^{W|OPEN} 1280
Hieronim Golczyk, Amid Massouh, and Stephan Greiner


- SORTING NEXIN1 Is Required for Modulating the Trafficking and Stability of the *Arabidopsis* IRON-REGULATED TRANSPORTER1**  **1294**
Rumen Ivanov, Tzvetina Brumbarova, Ailisa Blum, Anna-Maria Jantke, Claudia Fink-Straube, and Petra Bauer
- Golgi-Dependent Transport of Vacuolar Sorting Receptors Is Regulated by COPII, AP1, and AP4 Protein Complexes in Tobacco**  **1308**
David C. Gershlick, Carine de Marcos Lousa, Ombretta Foresti, Andrew J. Lee, Estela A. Pereira, Luis L.P. daSilva, Francesca Bottanelli, and Jurgen Denecke
- A Duplicated NUCLEOLIN Gene with Antagonistic Activity Is Required for Chromatin Organization of Silent 45S rDNA in *Arabidopsis***   **1330**
Nathalie Durut, Mohamed Abou-Ellail, Frédéric Pontvianne, Sadhan Das, Hisae Kojima, Seiko Ukai, Anne de Bures, Pascale Comella, Sabine Nidelet, Stéphanie Rialle, Remy Merret, Manuel Echeverria, Philippe Bouvet, Kenzo Nakamura, and Julio Sáez-Vásquez
- Phytophthora infestans* RXLR Effector PexRD2 Interacts with Host MAPKs to Suppress Plant Immune Signaling**   **1345**
Stuart R.F. King, Hazel McLellan, Petra C. Boevink, Miles R. Armstrong, Tatyana Bukharova, Octavina Sukarta, Joe Win, Sophien Kamoun, Paul R.J. Birch, and Mark J. Banfield
- N-Glycosylation of Effector Proteins by an α -1,3-Mannosyltransferase Is Required for the Rice Blast Fungus to Evade Host Innate Immunity**   **1360**
Xiao-Lin Chen, Tao Shi, Jun Yang, Wei Shi, Xusheng Gao, Deng Chen, Xiaowen Xu, Jin-Rong Xu, Nicholas J. Talbot, and You-Liang Peng

CORRECTIONS

- Shibata, M., Oikawa, K., Yoshimoto, K., Kondo, M., Mano, S., Yamada, K., Hayashi, M., Sakamoto, W., Ohsumi, Y., and Nishimura, M. (2013). Highly oxidized peroxisomes are selectively degraded via autophagy in *Arabidopsis*. *Plant Cell* 25: 4967–4983. **1377**
- Li, S., Lauri, A., Ziemann, M., Busch, A., Bhave, M., and Zachgo, S. (2009). Nuclear activity of ROXY1, a glutaredoxin interacting with TGA factors, is required for petal development in *Arabidopsis thaliana*. *Plant Cell* 21: 429–441. **1378**

 Some figures in this article are displayed in color online but in black and white in the print edition.

 Online version contains Web-only data.

 Articles can be viewed online without a subscription.



© 2014 American Society of Plant Biologists. All rights reserved. Printed on acid-free paper effective with Volume 1, Number 1, January 1989. Printed in the United States of America.

The Plant Cell (ISSN 1040-4651, online ISSN 1532-298X) is published monthly (one volume per year) by the American Society of Plant Biologists, 15501 Monona Drive, Rockville, MD 20855-2768, and is produced by Dartmouth Journal Services, Waterbury, VT. The institutional price for the print and online versions is based on type of institution; contact institution@aspb.org. Single copies may be purchased for \$40 each, plus \$10 shipping (U.S.) or \$12 (outside U.S.). Members of the American Society of Plant Biologists may subscribe to *The Plant Cell* for \$240. Nonmember individuals may subscribe for \$500. Students may subscribe for \$165. For matters regarding subscriptions, contact Suzanne Cholwek, ASPB, 15501 Monona Drive, Rockville, MD 20855-2768; telephone 301/296-0926; fax 301/251-6740; e-mail scholwek@aspb.org. Notify ASPB in writing within 3 months (domestic) or 6 months (foreign) of issue date, and defective copies or copies lost in the mail will be replaced. Send all inquiries regarding display advertising to FASEB AdNet, 9650 Rockville Pike, Bethesda, MD 20814-3998; telephone 301/634-7791; fax 301/634-7153; e-mail adnet@faseb.org. Periodicals postage paid at Rockville, MD 20850, and at additional mailing offices.

Postmaster: Send address changes to *The Plant Cell*, American Society of Plant Biologists, 15501 Monona Drive, Rockville, MD 20855-2768. The online version of *The Plant Cell* is available at www.plantcell.org.

Permission to Reprint: Permission to make digital or hard copies of part or all of a work published in *The Plant Cell* is granted without fee for personal or classroom use provided that copies are not made or distributed for profit or commercial advantage and that copies bear the full citation and the following notice on the first page: "Copyright American Society of Plant Biologists." For all other kinds of copying, request permission in writing from Nancy A. Winchester, Publications Director, ASPB headquarters.

This information is current as of July 17, 2018

Permissions	https://www.copyright.com/ccc/openurl.do?sid=pd_hw1532298X&issn=1532298X&WT.mc_id=pd_hw1532298X
eTOCs	Sign up for eTOCs at: http://www.plantcell.org/cgi/alerts/ctmain
CiteTrack Alerts	Sign up for CiteTrack Alerts at: http://www.plantcell.org/cgi/alerts/ctmain
Subscription Information	Subscription Information for <i>The Plant Cell</i> and <i>Plant Physiology</i> is available at: http://www.aspb.org/publications/subscriptions.cfm