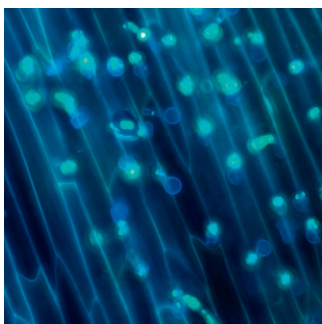


T H E  
**PLANT**  
C E L L

Volume 23 Number 6 June 2011

The electronic form of this issue, available at [www.plantcell.org](http://www.plantcell.org), is the journal of record.

**ON THE COVER**



Wang et al. (pages 2064–2086) present a broad functional survey of a large sample of candidate RXLR effectors in *Phytophthora sojae*, an oomycete pathogen of soybean. The pathogen releases zoospores (swimming spores) that swim towards the soybean surface and form cysts (non-swimming zoospores), which germinate and form appressorium to penetrate into the soybean surface. The cover image shows a fluorescent microscope image of cysts (dark-blue ring) germinating on the soybean root surface, inducing early plant defense response (callulose deposition, visible as high-light spots) around infection sites.

**IN BRIEF**

- A New Role for ROP GTPases in the Polarization of Cell Division** 2007  
Nancy R. Hofmann
- De Novo Telomere Formation in *Arabidopsis* Tetraploids** 2008  
Nancy A. Eckardt
- How to Make a C<sub>4</sub> Plant: Insight from Comparative Transcriptome Analysis** 2009  
Nancy A. Eckardt

**REVIEWS**

- Coping with Stresses: Roles of Calcium- and Calcium/Calmodulin-Regulated Gene Expression** [W](#) [O](#) [A](#) 2010  
Anireddy S.N. Reddy, Gul S. Ali, Helena Celesnik, and Irene S. Day
- AUXIN BINDING PROTEIN1: The Outsider** 2033  
Michael Sauer and Jürgen Kleine-Vehn

**LARGE-SCALE BIOLOGY ARTICLES**

- A Guideline to Family-Wide Comparative State-of-the-Art Quantitative RT-PCR Analysis Exemplified with a Brassicaceae Cross-Species Seed Germination Case Study** [W](#) [O](#) [A](#) 2045  
Kai Graeber, Ada Linkies, Andrew T.A. Wood, and Gerhard Leubner-Metzger
- Transcriptional Programming and Functional Interactions within the *Phytophthora sojae* RXLR Effector Repertoire** [C](#) [W](#) [O](#) [A](#) 2064  
Qunqing Wang, Changzhi Han, Adriana O. Ferreira, Xiaoli Yu, Wenwu Ye, Sucheta Tripathy, Shiv D. Kale, Biao Gu, Yuting Sheng, Yangyang Sui, Xiaoli Wang, Zhengguang Zhang, Baoping Cheng, Suomeng Dong, Weixing Shan, Xiaobo Zheng, Daolong Dou, Brett M. Tyler, and Yuanchao Wang

**RESEARCH ARTICLES**

- Evolution of C<sub>4</sub> Photosynthesis in the Genus *Flaveria*: How Many and Which Genes Does It Take to Make C<sub>4</sub>?** [W](#) 2087  
Udo Gowik, Andrea Bräutigam, Katrin L. Weber, Andreas P.M. Weber, and Peter Westhoff

## EDITORIAL BOARD

### Editor in Chief

Cathie Martin

### Coeditors

Sarah M. Assmann

Jody Banks

David Baum

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

Patricia Leon

Clive Lloyd

William Lucas

Blake Meyers

Ortrun Mittelsten-Scheid

Joseph Noel

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 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](http://www.plantcell.org)

- Developmental Analysis of a *Medicago truncatula* smooth leaf margin1 Mutant Reveals Context-Dependent Effects on Compound Leaf Development** [W](#)[I](#)[O](#)[A](#) 2106  
Chuanen Zhou, Lu Han, Chunyan Hou, Alessandra Metelli, Liying Qi, Million Tadege, Kirankumar S. Mysore, and Zeng-Yu Wang
- STENOFOLIA Regulates Blade Outgrowth and Leaf Vascular Patterning in *Medicago truncatula* and *Nicotiana sylvestris*** [C](#)[W](#)[I](#)[O](#)[A](#) 2125  
Million Tadege, Hao Lin, Mohamed Bedair, Ana Berbel, Jiangqi Wen, Clemencia M. Rojas, Lifang Niu, Yuhong Tang, Lloyd Sumner, Pascal Ratet, Neil A. McHale, Francisco Madueño, and Kirankumar S. Mysore
- The *COP1* Ortholog *PPS* Regulates the Juvenile–Adult and Vegetative–Reproductive Phase Changes in Rice** [C](#)[W](#) 2143  
Nobuhiro Tanaka, Hironori Itoh, Naoki Sentoku, Mikiko Kojima, Hitoshi Sakakibara, Takeshi Izawa, Jun-Ichi Itoh, and Yasuo Nagato
- The *Arabidopsis* NAC Transcription Factor VNI2 Integrates Abscisic Acid Signals into Leaf Senescence via the *COR/RD* Genes** [W](#) 2155  
So-Dam Yang, Pil Joon Seo, Hye-Kyung Yoon, and Chung-Mo Park
- Analysis of Cytokinin Mutants and Regulation of Cytokinin Metabolic Genes Reveals Important Regulatory Roles of Cytokinins in Drought, Salt and Abscisic Acid Responses, and Abscisic Acid Biosynthesis** [C](#)[W](#) 2169  
Rie Nishiyama, Yasuko Watanabe, Yasunari Fujita, Dung Tien Le, Mikiko Kojima, Tomás Werner, Radomira Vankova, Kazuko Yamaguchi-Shinozaki, Kazuo Shinozaki, Tatsuo Kakimoto, Hitoshi Sakakibara, Thomas Schmölling, and Lam-Son Phan Tran
- Gibberellin Regulates PIN-FORMED Abundance and Is Required for Auxin Transport–Dependent Growth and Development in *Arabidopsis thaliana*** [C](#)[W](#)[I](#)[O](#)[A](#) 2184  
Björn C. Willige, Erika Isono, René Richter, Melina Zourelidou, and Claus Schwechheimer
- Targeted mRNA Oxidation Regulates Sunflower Seed Dormancy Alleviation during Dry After-Ripening** [C](#)[W](#)[I](#)[O](#)[A](#) 2196  
Jérémie Bazin, Nicolas Langlade, Patrick Vincourt, Sandrine Arribat, Sandrine Balzergue, Hayat El-Maarouf-Bouteau, and Christophe Bailly
- The MYB80 Transcription Factor Is Required for Pollen Development and the Regulation of Tapetal Programmed Cell Death in *Arabidopsis thaliana*** [W](#)[I](#)[O](#)[A](#) 2209  
Huy Anh Phan, Sylvana Iacuone, Song F. Li, and Roger W. Parish
- Defective Pollen Wall Is Required for Anther and Microspore Development in Rice and Encodes a Fatty Acyl Carrier Protein Reductase** [C](#)[W](#)[I](#)[O](#)[A](#) 2225  
Jing Shi, Hexin Tan, Xiao-Hong Yu, Yuanyun Liu, Wanqi Liang, Kosala Ranathunge, Rochus Benni Franke, Lukas Schreiber, Yujiong Wang, Guoying Kai, John Shanklin, Hong Ma, and Dabing Zhang
- Malonyl-CoA Synthetase, Encoded by *ACYL ACTIVATING ENZYME13*, Is Essential for Growth and Development of *Arabidopsis*** [C](#)[W](#)[I](#)[O](#)[A](#) 2247  
Hui Chen, Hyun Uk Kim, Hua Weng, and John Browse
- Parameters Affecting Telomere-Mediated Chromosomal Truncation in *Arabidopsis*** [W](#) 2263  
Andrew D. Nelson, Jonathan C. Lamb, Pierre S. Kobrossly, and Dorothy E. Shippen

- ROP GTPases Act with the Receptor-Like Protein PAN1 to Polarize Asymmetric Cell Division in Maize** [W](#) [O](#) [A](#) 2273  
John A. Humphries, Zuzana Vejlupkova, Anding Luo, Robert B. Meeley, Anne W. Sylvester, John E. Fowler, and Laurie G. Smith
- Transcription Factor–Dependent Chromatin Remodeling at Heat Shock and Copper-Responsive Promoters in *Chlamydomonas reinhardtii*** [W](#) [O](#) [A](#) 2285  
Daniela Strenkert, Stefan Schmollinger, Frederik Sommer, Miriam Schulz-Raffelt, and Michael Schroda
- Live Cell Imaging Reveals Structural Associations between the Actin and Microtubule Cytoskeleton in *Arabidopsis*** [W](#) [O](#) [A](#) 2302  
Arun Sampathkumar, Jelmer J. Lindeboom, Seth Debolt, Ryan Gutierrez, David W. Ehrhardt, Tijs Ketelaar, and Staffan Persson
- The Plant-Specific Actin Binding Protein SCAB1 Stabilizes Actin Filaments and Regulates Stomatal Movement in *Arabidopsis*** [C](#) [W](#) 2314  
Yang Zhao, Shuangshuang Zhao, Tonglin Mao, Xiaolu Qu, Wanhong Cao, Li Zhang, Wei Zhang, Liu He, Sidi Li, Sulin Ren, Jinfeng Zhao, Guoli Zhu, Shanjin Huang, Keqiong Ye, Ming Yuan, and Yan Guo
- Maize *opaque5* Encodes Monogalactosyldiacylglycerol Synthase and Specifically Affects Galactolipids Necessary for Amyloplast and Chloroplast Function** [C](#) [W](#) [O](#) [A](#) 2331  
Alan M. Myers, Martha G. James, Qiaohui Lin, Gibum Yi, Philip S. Stinard, Tracie A. Hennen-Bierwagen, and Philip W. Beecraft
- Subunit Stoichiometry, Evolution, and Functional Implications of an Asymmetric Plant Plastid ClpP/R Protease Complex in *Arabidopsis*** [C](#) [W](#) 2348  
Paul Dominic B. Olinares, Jitae Kim, Jerrold I. Davis, and Klaas J. van Wijk
- Sphingolipids Containing Very-Long-Chain Fatty Acids Define a Secretory Pathway for Specific Polar Plasma Membrane Protein Targeting in *Arabidopsis*** [W](#) 2362  
Jonathan E. Markham, Diana Molino, Lionel Gissot, Yannick Bellec, Kian Hématy, Jessica Marion, Katia Belcram, Jean-Christophe Palauqui, Béatrice Satiat-JeuneMaître, and Jean-Denis Faure
- The Plasma Membrane of the Cyanobacterium *Gloeobacter violaceus* Contains Segregated Bioenergetic Domains** [C](#) [W](#) 2379  
Sascha Rexroth, Conrad W. Mullineaux, Dorothea Ellinger, Esther Sendtko, Matthias Rögner, and Friederike Koenig
- Tunable Membrane Binding of the Intrinsically Disordered Dehydrin LtI30, a Cold-Induced Plant Stress Protein** [W](#) 2391  
Sylvia K. Eriksson, Michael Kutzer, Jan Procek, Gerhard Gröbner, and Pia Harryson
- Botrytis cinerea* Manipulates the Antagonistic Effects between Immune Pathways to Promote Disease Development in Tomato** [C](#) [W](#) [O](#) [A](#) 2405  
Mohamed El Oirdi, Taha Abd El Rahman, Luciano Rigano, Abdelbasset El Hadrami, María Cecilia Rodriguez, Fouad Daayf, Adrian Vojnov, and Kamal Bouarab
- A Barley ROP GTPase ACTIVATING PROTEIN Associates with Microtubules and Regulates Entry of the Barley Powdery Mildew Fungus into Leaf Epidermal Cells** [C](#) [W](#) 2422  
Caroline Hoeffle, Christina Huesmann, Holger Schultheiss, Frederik Börnke, Götz Hensel, Jochen Kumlehn, and Ralph Hüchelhoven

**The *Arabidopsis* Leucine-Rich Repeat Receptor–Like Kinases BAK1/SERK3 and BKK1/SERK4 Are Required for Innate Immunity to Hemibiotrophic and Biotrophic Pathogens** 


2440

Milena Roux, Benjamin Schwessinger, Catherine Albrecht, Delphine Chinchilla, Alexandra Jones, Nick Holton, Frederikke Gro Malinovskiy, Mahmut Tör, Sacco de Vries, and Cyril Zipfel

**Cytosolic  $\gamma$ -Glutamyl Peptidases Process Glutathione Conjugates in the Biosynthesis of Glucosinolates and Camalexin in *Arabidopsis***  

2456

Fernando Geu-Flores, Morten Emil Møldrup, Christoph Böttcher, Carl Erik Olsen, Dierk Scheel, and Barbara Ann Halkier

 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.

 Open Access articles can be viewed online without a subscription.



© 2011 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 1531-298X) 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](mailto:institution@aspb.org). A subscription includes both *The Plant Cell* and *Plant Physiology*; single copies may be purchased for \$95 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 \$185. Nonmember individuals may subscribe for \$375. 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](mailto: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](mailto: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](http://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 October 29, 2020

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