

T H E
PLANT
C E L L

Volume 24 Number 2 February 2012

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

ON THE COVER



Plants resist pathogen infection with a multilayered defense strategy. Lectins are believed to serve as defensive molecules, but their precise roles have remained unclear. Yamaji et al. (pages 778–793) cloned the novel virus-resistance gene *JAX1* from *Arabidopsis thaliana*, which encodes a lectin-like protein with similarity to another virus-resistance protein, RTM1. However, *JAX1*-mediated resistance differs from other well-characterized virus-resistance machineries such as *R* gene-mediated resistance involving hypersensitive responses or RNA silencing. Whereas RTM1 functions to inhibit viral long-distance movement, *JAX1* inhibits viral proliferation at the cellular level. The characterization of *JAX1*-mediated resistance demonstrates the generality and significance of lectin-mediated resistance to plant viruses. The cover displays the systemic spread of green fluorescent protein fluorescence monitoring virus infection in a wild-type plant (bottom) and strict inhibition of virus infection in a *JAX1*-expressing transgenic plant (top).

IN BRIEF

- Mass Spectrometry Imaging with Single-Cell Resolution: Spatial Distribution of Lipids in Cotton Seeds** 371
Jennifer Mach
- A New Tool for Investigating Small RNA Function** 372
Nancy A. Eckardt
- Nicotianamine in Zinc and Iron Homeostasis** 373
Nancy R. Hofmann





PERSPECTIVE

- New Technologies for 21st Century Plant Science** 374
David W. Ehrhardt and Wolf B. Frommer

REVIEW

- Vitamin Deficiencies in Humans: Can Plant Science Help?**  395
Teresa B. Fitzpatrick, Gilles J.C. Basset, Patrick Borel, Fernando Carrari, Dean DellaPenna, Paul D. Fraser, Hanjo Hellmann, Sonia Osorio, Christophe Rothan, Victoriano Valpuesta, Catherine Caris-Veyrat, and Alisdair R. Fernie

RESEARCH ARTICLES

- Effective Small RNA Destruction by the Expression of a Short Tandem Target Mimic in *Arabidopsis***   415
Jun Yan, Yiyu Gu, Xiaoyun Jia, Wenjun Kang, Shangjin Pan, Xiaoqing Tang, Xuemei Chen, and Guiliang Tang
- EARLY FLOWERING4 Recruitment of EARLY FLOWERING3 in the Nucleus Sustains the *Arabidopsis* Circadian Clock**   428
Eva Herrero, Elsebeth Kolmos, Nora Bujdoso, Ye Yuan, Mengmeng Wang, Markus C. Berns, Heike Uhlworm, George Coupland, Reena Saini, Mariusz Jaskolski, Alex Webb, Jorge Gonçalves, and Seth J. Davis
- Analysis of the *Arabidopsis* Shoot Meristem Transcriptome during Floral Transition Identifies Distinct Regulatory Patterns and a Leucine-Rich Repeat Protein That Promotes Flowering**   444
Stefano Torti, Fabio Fornara, Coral Vincent, Fernando Andrés, Karl Nordström, Ulrike Göbel, Daniela Knoll, Heiko Schoof, and George Coupland

EDITORIAL BOARD

Editor in Chief

Cathie Martin

Coeeditors

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


- Mutations in the *Arabidopsis* Homolog of LST8/GβL, a Partner of the Target of Rapamycin Kinase, Impair Plant Growth, Flowering, and Metabolic Adaptation to Long Days**   463
Manon Moreau, Marianne Azzopardi, Gilles Clément, Thomas Dobrenel, Chloé Marchive, Charlotte Renne, Marie-Laure Martin-Magniette, Ludivine Taconnat, Jean-Pierre Renou, Christophe Robaglia, and Christian Meyer
- JUNGBRUNNEN1, a Reactive Oxygen Species-Responsive NAC Transcription Factor, Regulates Longevity in *Arabidopsis***   482
Anhui Wu, Annapurna Devi Allu, Prashanth Garapati, Hamad Siddiqui, Hakan Dortay, Maria-Inés Zanor, Maria Amparo Asensi-Fabado, Sergi Munné-Bosch, Carla Antonio, Takayuki Tohge, Alisdair R. Fernie, Kerstin Kaufmann, Gang-Ping Xue, Bernd Mueller-Roeber, and Salma Balazadeh
- STAY-GREEN and Chlorophyll Catabolic Enzymes Interact at Light-Harvesting Complex II for Chlorophyll Detoxification during Leaf Senescence in *Arabidopsis***   507
Yasuhiro Sakuraba, Silvia Schelbert, So-Yon Park, Su-Hyun Han, Byoung-Doo Lee, Céline Besagni Andrés, Felix Kessler, Stefan Hörtensteiner, and Nam-Chon Paek
- Roles of the Middle Domain-Specific *WUSCHEL-RELATED HOMEBOX* Genes in Early Development of Leaves in *Arabidopsis***   519
Miyuki Nakata, Noritaka Matsumoto, Ryuji Tsugeki, Enno Rikirsch, Thomas Laux, and Kiyotaka Okada
- JAZ8 Lacks a Canonical Degron and Has an EAR Motif That Mediates Transcriptional Repression of Jasmonate Responses in *Arabidopsis***   536
Christine Shyu, Pablo Figueroa, Cody L. DePew, Thomas F. Cooke, Laura B. Sheard, Javier E. Moreno, Leron Katsir, Ning Zheng, John Browse, and Gregg A. Howe
- The Signal Transducer NPH3 Integrates the Phototropin1 Photosensor with PIN2-Based Polar Auxin Transport in *Arabidopsis* Root Phototropism**   551
Yinglang Wan, Jan Jasik, Li Wang, Huaqing Hao, Dieter Volkmann, Diedrik Menzel, Stefano Mancuso, František Baluška, and Jinxing Lin
- Nuclear Phytochrome A Signaling Promotes Phototropism in *Arabidopsis***   566
Chitose Kami, Micha Hersch, Martine Trevisan, Thierry Genoud, Andreas Hiltbrunner, Sven Bergmann, and Christian Fankhauser
- Somatic and Reproductive Cell Development in Rice Anther Is Regulated by a Putative Glutaredoxin**   577
Lilan Hong, Ding Tang, Keming Zhu, Kejian Wang, Ming Li, and Zhukuan Cheng
- CHITINASE-LIKE1/POM-POM1 and Its Homolog CTL2 Are Glucan-Interacting Proteins Important for Cellulose Biosynthesis in *Arabidopsis***   589
Clara Sánchez-Rodríguez, Stefan Bauer, Kian Hématy, Friederike Saxe, Ana Belén Ibáñez, Vera Vodermaier, Cornelia Konlechner, Arun Sampathkumar, Markus Rüggeberg, Ernst Aichinger, Lutz Neumetzler, Ingo Burgert, Chris Somerville, Marie-Theres Hauser, and Staffan Persson
- The *Arabidopsis* Cell Cycle Checkpoint Regulators TANME1/ALT2 and ATR Mediate the Active Process of Aluminum-Dependent Root Growth Inhibition**   608
Cynthia D. Nezames, Caroline A. Sjogren, Jesus F. Barajas, and Paul B. Larsen

<p>Spatial Mapping of Lipids at Cellular Resolution in Embryos of Cotton W OA</p> <p>Patrick J. Horn, Andrew R. Korte, Purnima B. Neogi, Ebony Love, Johannes Fuchs, Kerstin Strupat, Ljudmilla Borisjuk, Vladimir Shulaev, Young-Jin Lee, and Kent D. Chapman</p>	622
<p>Evidence for a Role of VIPP1 in the Structural Organization of the Photosynthetic Apparatus in <i>Chlamydomonas</i> W OA</p> <p>André Nordhues, Mark Aurel Schöttler, Ann-Katrin Unger, Stefan Geimer, Stephanie Schönfelder, Stefan Schmollinger, Mark Rütgers, Giovanni Finazzi, Barbara Soppa, Frederik Sommer, Timo Mühlhaus, Thomas Roach, Anja Krieger-Liszkay, Heiko Lokstein, José Luis Crespo, and Michael Schroda</p>	637
<p>Initial Steps of Photosystem II de Novo Assembly and Preloading with Manganese Take Place in Biogenesis Centers in <i>Synechocystis</i> C W</p> <p>Anna Stengel, Irene L. Gügel, Daniel Hilger, Birgit Rengstl, Heinrich Jung, and Jörg Nickelsen</p>	660
<p>PPR2263, a DYW-Subgroup Pentatricopeptide Repeat Protein, Is Required for Mitochondrial <i>nad5</i> and <i>cob</i> Transcript Editing, Mitochondrion Biogenesis, and Maize Growth C W</p> <p>Davide Sosso, Sylvie Mbelo, Vanessa Vernoud, Ghislaine Gendrot, Annick Dedieu, Pierre Chambrier, Myriam Dauzat, Laure Heurtevin, Virginie Guyon, Mizuki Takenaka, and Peter M. Rogowsky</p>	676
<p>Altered Fermentative Metabolism in <i>Chlamydomonas reinhardtii</i> Mutants Lacking Pyruvate Formate Lyase and Both Pyruvate Formate Lyase and Alcohol Dehydrogenase W</p> <p>Claudia Catalanotti, Alexandra Dubini, Venkataramanan Subramanian, Wenqiang Yang, Leonardo Magneschi, Florence Mus, Michael Seibert, Matthew C. Posewitz, and Arthur R. Grossman</p>	692
<p>Elevated Nicotianamine Levels in <i>Arabidopsis halleri</i> Roots Play a Key Role in Zinc Hyperaccumulation W</p> <p>Ulrich Deinlein, Michael Weber, Holger Schmidt, Stefan Rensch, Aleksandra Trampczynska, Thomas H. Hansen, Søren Husted, Jan K. Schjoerring, Ina N. Talke, Ute Krämer, and Stephan Clemens</p>	708
<p>Vacuolar Nicotianamine Has Critical and Distinct Roles under Iron Deficiency and for Zinc Sequestration in <i>Arabidopsis</i> C W</p> <p>Michael J. Haydon, Miki Kawachi, Markus Wirtz, Stefan Hillmer, Rüdiger Hell, and Ute Krämer</p>	724
<p>Transcriptome Sequencing Identifies <i>SPL7</i>-Regulated Copper Acquisition Genes <i>FRO4/FRO5</i> and the Copper Dependence of Iron Homeostasis in <i>Arabidopsis</i> C W</p> <p>María Bernal, David Casero, Vasantika Singh, Grandon T. Wilson, Arne Grande, Huijun Yang, Sheel C. Dodani, Matteo Pellegrini, Peter Huijser, Erin L. Connolly, Sabeeha S. Merchant, and Ute Krämer</p>	738
<p>The Conjugated Auxin Indole-3-Acetic Acid–Aspartic Acid Promotes Plant Disease Development C W</p> <p>Rocío González-Lamothe, Mohamed El Oirdi, Normand Brisson, and Kamal Bouarab</p>	762
<p>Lectin-Mediated Resistance Impairs Plant Virus Infection at the Cellular Level C W OA</p> <p>Yasuyuki Yamaji, Kensaku Maejima, Ken Komatsu, Takuya Shiraishi, Yukari Okano, Misako Himeno, Kyoko Sugawara, Yutaro Neriya, Nami Minato, Chihiro Miura, Masayoshi Hashimoto, and Shigetou Namba</p>	778

The Mutualistic Fungus *Piriformospora indica* Colonizes *Arabidopsis* Roots by Inducing an Endoplasmic Reticulum Stress–Triggered Caspase-Dependent Cell Death   794
Xiaoyu Qiang, Bernd Zechmann, Marco U. Reitz, Karl-Heinz Kogel, and Patrick Schäfer

Nuclear-Localized and Deregulated Calcium- and Calmodulin-Dependent Protein Kinase Activates Rhizobial and Mycorrhizal Responses in *Lotus japonicus*  810
Naoya Takeda, Takaki Maekawa, and Makoto Hayashi

A MAP Kinase Kinase Interacts with SymRK and Regulates Nodule Organogenesis in *Lotus japonicus*   823
Tao Chen, Hui Zhu, Danxia Ke, Kai Cai, Chao Wang, Honglan Gou, Zonglie Hong, and Zhongming Zhang

 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.



© 2012 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. 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 \$240. 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. 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 September 18, 2020

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