

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

Volume 23 Number 12 December 2011

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

**ON THE COVER**



Sieve tubes are the functional units for long-distance transport and signaling in the phloem. The tube architecture defines frictional interactions with the fluid, so sieve tube structure has a direct impact on translocation. There has been debate about the in vivo structure of sieve elements and the pressure flow hypothesis for many decades; in particular, the shape and location of P proteins remained unresolved. Froelich et al. (pages 4428–4445) present in vivo observations of transgenic *Arabidopsis thaliana* plants carrying P proteins from the Sieve-Element-Occlusion-Related (SEOR) family, tagged with yellow fluorescent protein. New protocols for transmission electron microscopy reveal the in vivo ultrastructure of sieve tubes. The authors show that massive protein agglomerations in the flow path are common but do not impede translocation, and implications for understanding phloem translocation are discussed. The cover shows an epifluorescence micrograph of an *Arabidopsis* flower. Yellow fluorescent protein-tagged SEOR proteins outline the phloem files in the petals (green/blue).

**IN BRIEF**

- Postcards from the Rice Genome: Massive Analysis of Small RNAs in Response to Environmental Stress** 4165  
Nancy A. Eckardt
- Large-Scale RNA Sequencing to Identify Maize Genes with Parent-of-Origin Expression Effects** 4166  
Jennifer Mach
- A Case for Spatial Regulation in Tetrapyrrole Biosynthesis** 4167  
Nancy R. Hofmann

**LETTERS TO THE EDITOR**

- Internal Membranes in Maize Aleurone Protein Storage Vacuoles: Beyond Autophagy** 4168  
John C. Rogers
- Reply: Internal Membranes in Maize Aleurone Protein Storage Vacuoles: Beyond Autophagy** 4171  
Francisca C. Reyes, Marisa S. Otegui, and Richard Vierstra

**PERSPECTIVE**

- Plant Oxygen Sensing Is Mediated by the N-End Rule Pathway: A Milestone in Plant Anaerobiosis** 4173  
Rashmi Sasidharan and Angelika Mustroph

**LARGE-SCALE BIOLOGY ARTICLES**

- Massive Analysis of Rice Small RNAs: Mechanistic Implications of Regulated MicroRNAs and Variants for Differential Target RNA Cleavage** 4185  
Dong-Hoon Jeong, Sunhee Park, Jixian Zhai, Sai Guna Ranjan Gurazada, Emanuele De Paoli, Blake C. Meyers, and Pamela J. Green
- Systems Analysis of a Maize Leaf Developmental Gradient Redefines the Current C<sub>4</sub> Model and Provides Candidates for Regulation** 4208  
Thea R. Pick, Andrea Bräutigam, Urte Schlüter, Alisandra K. Denton, Christian Colmsee, Uwe Scholz, Holger Fahnenstich, Roland Pieruschka, Uwe Rascher, Uwe Sonnwald, and Andreas P.M. Weber

## 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)

**Parent-of-Origin Effects on Gene Expression and DNA Methylation in the** 4221

### Maize Endosperm

Amanda J. Waters, Irina Makarevitch, Steve R. Eichten,  
Ruth A. Swanson-Wagner, Cheng-Ting Yeh, Wayne Xu, Patrick S.  
Schnable, Matthew W. Vaughn, Mary Gehring, and Nathan M. Springer

**The RootChip: An Integrated Microfluidic Chip for Plant Science** 4234

Guido Grossmann, Woei-Jiun Guo, David W. Ehrhardt, Wolf B. Frommer,  
Rene V. Sit, Stephen R. Quake, and Matthias Meier

## RESEARCH ARTICLES

**Different Gene Families in *Arabidopsis thaliana* Transposed in Different** 4241  
**Epochs and at Different Frequencies throughout the Rosids**

Margaret R. Woodhouse, Haibao Tang, and Michael Freeling

***Arabidopsis* ATM and ATR Kinases Prevent Propagation of Genome** 4254  
**Damage Caused by Telomere Dysfunction**

Simon Amiard, Annie Depeiges, Elisabeth Allain, Charles I. White,  
and Maria Eugenia Gallego

**Identification of Plant *RAD52* Homologs and Characterization of the** 4266  
***Arabidopsis thaliana* *RAD52*-Like Genes**

Aviva Samach, Cathy Melamed-Bessudo, Naomi Avivi-Ragolski,  
Shmuel Pietrokovski, and Avraham A. Levy

**Maize *Rough Endosperm3* Encodes an RNA Splicing Factor Required for** 4280  
**Endosperm Cell Differentiation and Has a Nonautonomous Effect on**  
**Embryo Development**

Romain Fouquet, Federico Martin, Diego S. Fajardo, Christine M. Gault,  
Elisa Gómez, Chi-Wah Tseung, Tyler Policht, Gregorio Hueros,  
and A. Mark Settles

**The RPT2 Subunit of the 26S Proteasome Directs Complex Assembly, Histone** 4298  
**Dynamics, and Gametophyte and Sporophyte Development in *Arabidopsis***

Kwang-Hee Lee, Atsushi Minami, Richard S. Marshall, Adam J. Book,  
Lisa M. Farmer, Joseph M. Walker, and Richard D. Vierstra

**A Data-Driven Integrative Model of Sepal Primordium Polarity** 4318  
**in *Arabidopsis***

Camilo La Rota, Jérôme Chopard, Pradeep Das, Sandrine Paindavoine,  
Frédérique Rozier, Etienne Farcot, Christophe Godin, Jan Traas,  
and Françoise Monéger

**Increased Leaf Angle1, a Raf-Like MAPKKK That Interacts with a Nuclear Protein** 4334  
**Family, Regulates Mechanical Tissue Formation in the Lamina Joint of Rice**

Jing Ning, Baocai Zhang, Nili Wang, Yihua Zhou, and Lizhong Xiong

***POPCORN* Functions in the Auxin Pathway to Regulate Embryonic Body** 4348  
**Plan and Meristem Organization in *Arabidopsis***

Daoquan Xiang, Hui Yang, Prakash Venglat, Yongguo Cao, Rui Wen,  
Maozhi Ren, Sandra Stone, Edwin Wang, Hong Wang, Wei Xiao, Dolf Weijers,  
Thomas Berleth, Thomas Laux, Gopalan Selvaraj, and Raju Datla

**Positive Autoregulation of a *KNOX* Gene Is Essential for Shoot Apical** 4368  
**Meristem Maintenance in Rice**

Katsutoshi Tsuda, Yukihiko Ito, Yutaka Sato, and Nori Kurata

**GIGAS CELL1, a Novel Negative Regulator of the Anaphase-Promoting** 4382  
**Complex/Cyclosome, Is Required for Proper Mitotic Progression and Cell**  
**Fate Determination in *Arabidopsis***

Eriko Iwata, Saki Ikeda, Sachihito Matsunaga, Mariko Kurata,  
Yasushi Yoshioka, Marie-Claire Criqui, Pascal Genschik, and Masaki Ito

***Arabidopsis* ULTRAVIOLET-B-INSENSITIVE4 Maintains Cell Division** 4394  
**Activity by Temporal Inhibition of the Anaphase-Promoting**  
**Complex/Cyclosome**

Jefri Heyman, Hilde Van den Daele, Kevin De Wit, Véronique Boudolf,  
Barbara Berckmans, Aurine Verkest, Claire Lessa Alvim Kamei,  
Geert De Jaeger, Csaba Koncz, and Lieven De Veylder


**MDP25, A Novel Calcium Regulatory Protein, Mediates Hypocotyl Cell** 4411  
**Elongation by Destabilizing Cortical Microtubules in *Arabidopsis***

Jiejie Li, Xianling Wang, Tao Qin, Yan Zhang, Xiaomin Liu, Jingbo Sun,  
Yuan Zhou, Lei Zhu, Ziding Zhang, Ming Yuan, and Tonglin Mao

- Phloem Ultrastructure and Pressure Flow: Sieve-Element-Occlusion-Related Agglomerations Do Not Affect Translocation**  4428  
Daniel R. Froelich, Daniel L. Mullendore, Kåre H. Jensen, Tim J. Ross-Elliott, James A. Anstead, Gary A. Thompson, H el ene C. P elissier, and Michael Knoblauch
- The *Arabidopsis* Tail-Anchored Protein PEROXISOMAL AND MITOCHONDRIAL DIVISION FACTOR1 Is Involved in the Morphogenesis and Proliferation of Peroxisomes and Mitochondria**   4446  
Kyaw Aung and Jianping Hu
- Lumen Thiol Oxidoreductase1, a Disulfide Bond-Forming Catalyst, Is Required for the Assembly of Photosystem II in *Arabidopsis***   4462  
Mohamed Karamoko, Sara Cline, Kevin Redding, Natividad Ruiz, and Patrice P. Hamel
- An *Arabidopsis* GluTR Binding Protein Mediates Spatial Separation of 5-Aminolevulinic Acid Synthesis in Chloroplasts**  4476  
Olaf Czarnecki, Boris Hedtke, Michael Melzer, Maxi Rothbart, Andreas Richter, Yvonne Schr oter, Thomas Pfannschmidt, and Bernhard Grimm
- Syringyl Lignin Is Unaltered by Severe Sinapyl Alcohol Dehydrogenase Suppression in Tobacco**  4492  
Abdellah Barakate, Jennifer Stephens, Alison Goldie, William N. Hunter, David Marshall, Robert D. Hancock, Catherine Lapierre, Kris Morreel, Wout Boerjan, and Claire Halpin
- GLYCOALKALOID METABOLISM1 Is Required for Steroidal Alkaloid Glycosylation and Prevention of Phytotoxicity in Tomato**  4507  
Maxim Itkin, Ilana Rogachev, Noam Alkan, Tally Rosenberg, Sergey Malitsky, Laura Masini, Sagit Meir, Yoko Iijima, Koh Aoki, Ric de Vos, Dov Prusky, Saul Burdman, Jules Beekwilder, and Asaph Aharoni

## CORRECTIONS

- Elias Bassil, Hiromi Tajima, Yin-Chih Liang, Masa-aki Ohto, Koichiro Ushijima, Ryohei Nakano, Tomoya Esumi, Ardian Coku, Mark Belmonte, and Eduardo Blumwald (2011) The *Arabidopsis* Na<sup>+</sup>/H<sup>+</sup> Antiporters NHX1 and NHX2 Control Vacuolar pH and K<sup>+</sup> Homeostasis to Regulate Growth, Flower Development, and Reproduction. *Plant Cell* 23: 3482–3497. 4526
- Kyoung Shin Yoo, Sung Han Ok, Byung-Cheon Jeong, Kwang Wook Jung, Mei Hua Cui, Sujin Hyoung, Myeong-Ryeol Lee, Hyun Kyu Song, and Jeong Sheop Shin (2011) Single Cystathionine β-Synthase Domain-Containing Proteins Modulate Development by Regulating the Thioredoxin System in *Arabidopsis*. *Plant Cell* 23: 3577–3594. 4527

 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](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 November 26, 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>