

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

Volume 22 Number 4 April 2010

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

**ON THE COVER**



Grain morphology has been an important agronomic trait even in very early farming societies. Gegas et al. (pages 1046–1056) identified the genetic components that underlie the variation in grain size and shape in modern elite wheat. A comprehensive survey of the variation in grain morphology in modern and ancestral wheat indicates the occurrence of significant, and surprisingly recent, bottlenecks in the evolution of modern hexaploid wheat. This work provides an important advance in understanding the genetic and historical basis of natural diversity of grain traits in domesticated wheat. The cover image shows the diversity in grain morphology in the genus *Triticeae* with an illustration of a modern hexaploid wheat spike in the background.

**IN BRIEF**

- Evolution of Domesticated Bread Wheat** 993  
Nancy A. Eckardt
- MicroRNA Evolution in the Genus *Arabidopsis*** 994  
Nancy R. Hofmann
- A Shot in the Dark: How Parasitic Plants Find Host Roots** 995  
Jennifer Mach
- Blast Effector Proteins May Pave the Way for Hyphal Invasion** 996  
Kathleen L. Farquharson

**PERSPECTIVE: SPECIAL SERIES ON LARGE-SCALE BIOLOGY**

- Mapping Plant Interactomes Using Literature Curated and Predicted Protein–Protein Interaction Data Sets** 997  
KiYoung Lee, David Thorneycroft, Premanand Achuthan, Henning Hermjakob, and Trey Ideker

**REVIEWS**

- How a Plant Builds Leaves** 1006  
Siobhan A. Braybrook and Cris Kuhlemeier
- Morphogenesis of Simple and Compound Leaves: A Critical Review** 1019  
Idan Efroni, Yuval Eshed, and Eliezer Lifschitz

**RESEARCH ARTICLES**

- Convergent Evolution of Syringyl Lignin Biosynthesis via Distinct Pathways in the Lycophyte *Selaginella* and Flowering Plants** 1033  
Jing-Ke Weng, Takuya Akiyama, Nicholas D. Bonawitz, Xu Li, John Ralph, and Clint Chapple
- A Genetic Framework for Grain Size and Shape Variation in Wheat** 1046  
Vasilis C. Gegas, Aida Nazari, Simon Griffiths, James Simmonds, Lesley Fish, Simon Orford, Liz Sayers, John H. Doonan, and John W. Snape
- Cell Number Regulator1 Affects Plant and Organ Size in Maize: Implications for Crop Yield Enhancement and Heterosis** 1057  
Mei Guo, Mary A. Rupe, Jo Ann Dieter, Jijun Zou, Daniel Spielbauer, Keith E. Duncan, Richard J. Howard, Zhenglin Hou, and Carl R. Simmons
- MicroRNA Gene Evolution in *Arabidopsis lyrata* and *Arabidopsis thaliana*** 1074  
Noah Fahlgren, Sanjuro Jogdeo, Kristin D. Kasschau, Christopher M. Sullivan, Elisabeth J. Chapman, Sascha Laubinger, Lisa M. Smith, Mark Dasenko, Scott A. Givan, Detlef Weigel, and James C. Carrington

## EDITORIAL BOARD

### Editor in Chief

Cathie Martin

### Coeditors

Sarah M. Assmann  
Jody Banks  
Alice Barkan  
Kathy Barton  
David Baum  
Sebastian Bednarek  
James Birchler  
Ulla Bonas  
Christopher Bowler  
Judy Callis  
XiaoFeng Cao  
Nigel Crawford  
Vincenzo De Luca  
Xing Wang Deng  
Xinnian Dong  
Allan Downie  
Alisdair Fernie  
Pascal Genschik  
Jean T. Greenberg  
Thomas Guilfoyle  
David Jackson  
Martin Kater  
Patricia Leon  
Clive Lloyd  
William Lucas  
Blake Meyers  
Joseph Noel  
Michael Palmgren  
Markus Pauly  
Scott C. Peck  
Barry Pogson  
David Smyth  
Chris J. Staiger  
Keiko Sugimoto  
Nicholas J. Talbot

### Managing Editor

John Long

### 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)

- Arabidopsis lyrata* Small RNAs: Transient *MIRNA* and Small Interfering RNA Loci within the *Arabidopsis* Genus** [W](#)[OA](#) 1090  
Zhaorong Ma, Ceyda Coruh, and Michael J. Axtell
- miR390, *Arabidopsis TAS3* tasiRNAs, and Their *AUXIN RESPONSE FACTOR* Targets Define an Autoregulatory Network Quantitatively Regulating Lateral Root Growth** [W](#) 1104  
Elena Marin, Virginie Jouannet, Aurélie Herz, Annemarie S. Lokerse, Dolf Weijers, Herve Vaucheret, Laurent Nussaume, Martin D. Crespi, and Alexis Maizel
- DAY NEUTRAL FLOWERING* Represses *CONSTANS* to Prevent *Arabidopsis* Flowering Early in Short Days** [W](#)[OA](#) 1118  
Karl Morris, Sarah Thornber, Lesley Codrai, Christine Richardson, Adam Craig, Ari Sadanandom, Brian Thomas, and Stephen Jackson
- Phosphorylation of Conserved PIN Motifs Directs *Arabidopsis* PIN1 Polarity and Auxin Transport** [W](#)[OA](#) 1129  
Fang Huang, Marcelo Kemel Zago, Lindy Abas, Arnoud van Marion, Carlos Samuel Galván-Ampudia, and Remko Offringa
- Jasmonate and Phytochrome A Signaling in *Arabidopsis* Wound and Shade Responses Are Integrated through *JAZ1* Stability** [C](#)[W](#) 1143  
Frances Robson, Haruko Okamoto, Elaine Patrick, Sue-Ré Harris, Claus Wasternack, Charles Brearley, and John G. Turner
- TCP1 Modulates Brassinosteroid Biosynthesis by Regulating the Expression of the Key Biosynthetic Gene *DWARF4* in *Arabidopsis thaliana*** [C](#)[W](#) 1161  
Zhongxin Guo, Shozo Fujioka, Elison B. Blancaflor, Sen Miao, Xiaoping Gou, and Jia Li
- Identification of Specific DNA Binding Residues in the TCP Family of Transcription Factors in *Arabidopsis*** [W](#) 1174  
Pooja Aggarwal, Mainak DasGupta, Agnel Praveen Joseph, Nirmalya Chatterjee, N. Srinivasan, and Utpal Nath
- Integrative Transcript and Metabolite Analysis of Nutritionally Enhanced *DE-ETIOLATED1* Downregulated Tomato Fruit** [W](#) 1190  
Eugenia M.A. Enfissi, Fredy Barneche, Ikhlak Ahmed, Christiane Lichtlé, Christopher Gerrish, Ryan P. McQuinn, James J. Giovannoni, Enrique Lopez-Juez, Chris Bowler, Peter M. Bramley, and Paul D. Fraser
- Sulfite Reductase Defines a Newly Discovered Bottleneck for Assimilatory Sulfate Reduction and Is Essential for Growth and Development in *Arabidopsis thaliana*** [C](#)[W](#) 1216  
Muhammad Sayyar Khan, Florian Heinrich Haas, Arman Allboje Samami, Amin Moghaddas Gholami, Andrea Bauer, Kurt Fellenberg, Michael Reichelt, Robert Hänsch, Ralf R. Mendel, Andreas J. Meyer, Markus Wirtz, and Rüdiger Hell
- Arabidopsis* Histidine Kinase CKI1 Acts Upstream of HISTIDINE PHOSPHOTRANSFER PROTEINS to Regulate Female Gametophyte Development and Vegetative Growth** [C](#)[W](#) 1232  
Yan Deng, Haili Dong, Jinye Mu, Bo Ren, Binglian Zheng, Zhendong Ji, Wei-Cai Yang, Yan Liang, and Jianru Zuo
- VND-INTERACTING2, a NAC Domain Transcription Factor, Negatively Regulates Xylem Vessel Formation in *Arabidopsis*** [W](#)[OA](#) 1249  
Masatoshi Yamaguchi, Misato Ohtani, Nobutaka Mitsuda, Minoru Kubo, Masaru Ohme-Takagi, Hiroo Fukuda, and Taku Demura
- Functional Modules in the *Arabidopsis* Core Cell Cycle Binary Protein–Protein Interaction Network** [W](#) 1264  
Joanna Boruc, Hilde Van den Daele, Jens Hollunder, Stephane Rombauts, Evelien Mylle, Pierre Hilson, Dirk Inzé, Lieven De Veylder, and Eugenia Russinova
- The Activity of a Wall-Bound Cellulase Is Required for and Is Coupled to Cell Cycle Progression in the Dinoflagellate *Cryptothecodinium cohnii*** [C](#)[W](#)[OA](#) 1281  
Alvin C.M. Kwok and Joseph T.Y. Wong
- Arrangement of Photosystem II and ATP Synthase in Chloroplast Membranes of Spinach and Pea** [W](#)[OA](#) 1299  
Bertram Daum, Daniela Nicastro, Jotham Austin II, J. Richard McIntosh, and Werner Kühlbrandt

- The *Arabidopsis* Chaperone J3 Regulates the Plasma Membrane H<sup>+</sup>-ATPase through Interaction with the PKS5 Kinase**   1313  
Yongqing Yang, Yunxia Qin, Changgen Xie, Feiyi Zhao, Jinfeng Zhao, Dafa Liu, Shouyi Chen, Anja T. Fuglsang, Michael G. Palmgren, Karen S. Schumaker, Xing Wang Deng, and Yan Guo
- Five *Arabidopsis* Reticulon Isoforms Share Endoplasmic Reticulum Location, Topology, and Membrane-Shaping Properties**  1333  
Imogen Sparkes, Nicholas Tolley, Isabel Aller, Julia Svozil, Anne Osterrieder, Stanley Botchway, Christopher Mueller, Lorenzo Frigerio, and Chris Hawes
- Endocytic and Secretory Traffic in *Arabidopsis* Merge in the Trans-Golgi Network/Early Endosome, an Independent and Highly Dynamic Organelle**  1344  
Corrado Viotti, Julia Bubeck, York-Dieter Stierhof, Melanie Krebs, Markus Langhans, Willy van den Berg, Walter van Dongen, Sandra Richter, Niko Geldner, Junpei Takano, Gerd Jürgens, Sacco C. de Vries, David G. Robinson, and Karin Schumacher
- RNA-Dependent RNA Polymerase 1 from *Nicotiana tabacum* Suppresses RNA Silencing and Enhances Viral Infection in *Nicotiana benthamiana***  1358  
Xiao-Bao Ying, Li Dong, Hui Zhu, Cheng-Guo Duan, Quan-Sheng Du, Dian-Qiu Lv, Yuan-Yuan Fang, Juan Antonio Garcia, Rong-Xiang Fang, and Hui-Shan Guo
- Cucumber Mosaic Virus* Movement Protein Severs Actin Filaments to Increase the Plasmodesmal Size Exclusion Limit in Tobacco**   1373  
Shengzhong Su, Zhaohui Liu, Cheng Chen, Yan Zhang, Xu Wang, Lei Zhu, Long Miao, Xue-Chen Wang, and Ming Yuan
- Translocation of *Magnaporthe oryzae* Effectors into Rice Cells and Their Subsequent Cell-to-Cell Movement**   1388  
Chang Hyun Khang, Romain Berruyer, Martha C. Giraldo, Prasanna Kankanala, Sook-Young Park, Kirk Czymmek, Seogchan Kang, and Barbara Valent
- A Single-Electron Reducing Quinone Oxidoreductase Is Necessary to Induce Haustorium Development in the Root Parasitic Plant *Triphysaria***   1404  
Pradeepa C.G. Bandaranayake, Tatiana Filappova, Alexey Tomilov, Natalya B. Tomilova, Denneal Jamison-McClung, Quy Ngo, Kentaro Inoue, and John I. Yoder

 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.



© 2010 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 June 27, 2019

<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>