

The electronic form of this issue, available as of September 11, 2008, at www.plantphysiol.org, is considered the journal of record.

On the Cover: The bioenergy feedstock grass *Miscanthus × giganteus* is exceptional among C₄ species for its high productivity in cold climates. It can maintain photosynthetically active leaves at temperatures 6°C below the minimum for maize (*Zea mays*), which allows it to have a longer growing season in cool climates. Understanding the basis for this difference between these two closely related plants is critical in adapting other C₄ crops like maize to colder weather. In this issue, Wang et al. (pp. 557–567) establish a link between cold tolerance and increased expression and activity of a C₄ enzyme: pyruvate P_i dikinase (PPDK). Their data indicate that of the two enzymes known to limit C₄ photosynthesis, increase of PPDK, not Rubisco, content corresponds to the recovery and maintenance of photosynthetic capacity in *M. × giganteus*, by increasing the stability of the active form of PPDK at low temperature. The finding may indicate how other related C₄ crops, such as sorghum (*Sorghum bicolor*) and maize, might be adapted for improved production in cool climates. The cover image is created and provided by Patrick Schmitz, Rachel Knepp, and Dafu Wang of the University of Illinois.

ON THE INSIDE

Peter V. Minorsky 1

HIGH IMPACT

Phosphate Accumulation in Plants: Signaling. Aleel K. Grennan 3

UPDATES

^[W]The Enigmatic LEA Proteins and Other Hydrophilins. Marina Battaglia, Yadira Olvera-Carrillo, Alejandro Garcarrubio, Francisco Campos, and Alejandra A. Covarrubias 6

GENOME ANALYSIS

^[W]^[OA]Genome-Wide Analysis of Transposon Insertion Polymorphisms Reveals Intraspecific Variation in Cultivated Rice. Xuehui Huang, Guojun Lu, Qiang Zhao, Xiaohui Liu, and Bin Han 25

BREAKTHROUGH TECHNOLOGIES

^[C]^[OA]Geminivirus-Mediated Gene Silencing from Cotton Leaf Crumple Virus Is Enhanced by Low Temperature in Cotton. John R. Tuttle, A.M. Idris, Judith K. Brown, Candace H. Haigler, and Dominique Robertson 41

^[W]Combination of Novel Green Fluorescent Protein Mutant TSapphire and DsRed Variant mOrange to Set Up a Versatile in Planta FRET-FLIM Assay. Vincent Bayle, Laurent Nussaume, and Riyaz A. Bhat 51

SCIENTIFIC CORRESPONDENCE

^[W]Revisiting the Involvement of *SELF-PRUNING* in the Sympodial Growth of Tomato. Johanna Thouet, Muriel Quinet, Sandra Ormenese, Jean-Marie Kinet, and Claire Périlleux 61

RESEARCH ARTICLES

BIOCHEMICAL PROCESSES AND MACROMOLECULAR STRUCTURES

Two Arabidopsis ADP-Glucose Pyrophosphorylase Large Subunits (APL1 and APL2) Are Catalytic. Tiziana Ventriglia, Misty L. Kuhn, M^a Teresa Ruiz, Marina Ribeiro-Pedro, Federico Valverde, Miguel A. Ballicora, Jack Preiss, and José M. Romero 65

Continued on next page

[W]Molecular and Functional Analyses Support a Role of Ornithine- δ -Aminotransferase in the Provision of Glutamate for Glutamine Biosynthesis during Pine Germination. <i>Rafael A. Cañas, David P. Villalobos, Sara M. Díaz-Moreno, Francisco M. Cánovas, and Francisco R. Cantón</i>	97
[OA]Expression of <i>Umbelopsis ramanniana</i> DGAT2A in Seed Increases Oil in Soybean. <i>Kathryn Lardizabal, Roger Effertz, Charlene Levering, Jennifer Mai, M.C. Pedroso, Tom Jury, Eric Aasen, Ken Gruys, and Kristen Bennett</i>	89
[W][OA]Identification of the Wax Ester Synthase/Acyl-Coenzyme A:Diacylglycerol Acyltransferase WSD1 Required for Stem Wax Ester Biosynthesis in Arabidopsis. <i>Fengling Li, Xuemin Wu, Patricia Lam, David Bird, Huanquan Zheng, Lacey Samuels, Reinhard Jetter, and Ljerka Kunst</i>	97
[OA]Citrus Chlorophyllase Dynamics at Ethylene-Induced Fruit Color-Break: A Study of Chlorophyllase Expression, Posttranslational Processing Kinetics, and in Situ Intracellular Localization. <i>Tamar Azoulay Shemer, Smadar Harpaz-Saad, Eduard Belausov, Nicole Lovat, Oleg Krokhin, Victor Spicer, Kenneth G. Standing, Eliezer E. Goldschmidt, and Yoram Eyal</i>	108
[C][W][OA]Functional Analysis of Arabidopsis Postprenylation CaaX Processing Enzymes and Their Function in Subcellular Protein Targeting. <i>Keren Bracha-Drori, Keren Shichrur, Tsofnat Cohen Lubetzky, and Shaul Yalovsky</i>	119
[C][OA]Novel Rhamnogalacturonan I and Arabinoxylan Polysaccharides of Flax Seed Mucilage. <i>Radnaa Naran, Guibing Chen, and Nicholas C. Carpita</i>	132
[W][OA]In-Depth Investigation of the Soybean Seed-Filling Proteome and Comparison with a Parallel Study of Rapeseed. <i>Ganesh Kumar Agrawal, Martin Hajduch, Katherine Graham, and Jay J. Thelen</i>	504
[C]SUGAR-DEPENDENT6 Encodes a Mitochondrial Flavin Adenine Dinucleotide-Dependent Glycerol-3-P Dehydrogenase, Which Is Required for Glycerol Catabolism and Postgerminative Seedling Growth in Arabidopsis. <i>Anne-Laure Quettier, Eve Shaw, and Peter J. Eastmond</i>	519
[OA]The Binding of Auxin to the Arabidopsis Auxin Influx Transporter AUX1. <i>David J. Carrier, Norliza Tendot Abu Bakar, Ranjan Swarup, Richard Callaghan, Richard M. Napier, Malcolm J. Bennett, and Ian D. Kerr</i>	529
[W][OA]Functional Characterization of an Unusual Phytochelatin Synthase, LjPCS3, of <i>Lotus japonicus</i> . <i>Javier Ramos, Loreto Naya, Marina Gay, Joaquín Abián, and Manuel Becana</i>	536
[W]The Coenzyme A Biosynthetic Enzyme Phosphopantetheine Adenylyltransferase Plays a Crucial Role in Plant Growth, Salt/Osmotic Stress Resistance, and Seed Lipid Storage. <i>Silvia Rubio, Lynne Whitehead, Tony R. Larson, Ian A. Graham, and Pedro L. Rodriguez</i>	546
BIOENERGETICS AND PHOTOSYNTHESIS	
[W][OA]Mobilization of Rubisco and Stroma-Localized Fluorescent Proteins of Chloroplasts to the Vacuole by an ATG Gene-Dependent Autophagic Process. <i>Hiroyuki Ishida, Kohki Yoshimoto, Masanori Izumi, Daniel Reisen, Yuichi Yano, Amane Makino, Yoshinori Ohsumi, Maureen R. Hanson, and Tadahiko Mae</i>	142
[C][W][OA]Quantitative Proteomics of a Chloroplast SRP54 Sorting Mutant and Its Genetic Interactions with CLP1 in Arabidopsis. <i>Heidi Rutschow, A. Jimmy Ytterberg, Giulia Friso, Robert Nilsson, and Klaas J. van Wijk</i>	156
[W][OA]Cool C ₄ Photosynthesis: Pyruvate P ₁ Dikinase Expression and Activity Corresponds to the Exceptional Cold Tolerance of Carbon Assimilation in <i>Miscanthus × giganteus</i> . <i>Dafu Wang, Archie R. Portis Jr., Stephen P. Moose, and Stephen P. Long</i>	557
[W][OA]Comparative Proteomics of Chloroplast Envelopes from C ₃ and C ₄ Plants Reveals Specific Adaptations of the Plastid Envelope to C ₄ Photosynthesis and Candidate Proteins Required for Maintaining C ₄ Metabolite Fluxes. <i>Andrea Bräutigam, Susanne Hoffmann-Benning, and Andreas P.M. Weber</i>	568
[W][OA]Monogalactosyldiacylglycerol Deficiency in Arabidopsis Affects Pigment Composition in the Prolamellar Body and Impairs Thylakoid Membrane Energization and Photoprotection in Leaves. <i>Henrik Aronsson, Mark A. Schöttler, Amélie A. Kelly, Christer Sundqvist, Peter Dörmann, Sazzad Karim, and Paul Jarvis</i>	580
[OA]Leaf Development in the Single-Cell C ₄ System in <i>Bienertia sinuspersici</i> : Expression of Genes and Peptide Levels for C ₄ Metabolism in Relation to Chlorenchyma Structure under Different Light Conditions. <i>María Valeria Lara, Sascha Offermann, Monica Smith, Thomas W. Okita, Carlos Santiago Andreo, and Gerald E. Edwards</i>	593

CELL BIOLOGY AND SIGNAL TRANSDUCTION

- [W][OA] Interactions of Two Transcriptional Repressors and Two Transcriptional Activators in Modulating Gibberellin Signaling in Aleurone Cells. *Xiaolu Zou, Dawn Neuman, and Qingxi J. Shen* 176
- [W][OA] Immunolocalization of Solanaceous SUT1 Proteins in Companion Cells and Xylem Parenchyma: New Perspectives for Phloem Loading and Transport. *Bianca Schmitt, Ruth Stadler, and Norbert Sauer* 187
- [OA] Functional Characterization of the Arabidopsis AtSUC2 Sucrose/H⁺ Symporter by Tissue-Specific Complementation Reveals an Essential Role in Phloem Loading But Not in Long-Distance Transport. *Avinash C. Srivastava, Savita Ganesan, Ihab O. Ismail, and Brian G. Ayre* 200
- [W] Arabidopsis Mitogen-Activated Protein Kinase Kinases MKK1 and MKK2 Have Overlapping Functions in Defense Signaling Mediated by MEKK1, MPK4, and MKS1. *Jin-Long Qiu, Lu Zhou, Byung-Wook Yun, Henrik Bjørn Nielsen, Berthe Katrine Fiil, Klaus Petersen, Jim MacKinlay, Gary J. Loake, John Mundy, and Peter C. Morris* 212
- [C][W][OA] A Novel RNA-Binding Protein Associated with Cell Plate Formation. *Lian Ma, Bo Xie, Zonglie Hong, Desh Pal S. Verma, and Zhongming Zhang* 223
- [W][OA] The Omp85-Related Chloroplast Outer Envelope Protein OEP80 Is Essential for Viability in Arabidopsis. *Ramesh Patel, Shih-Chi Hsu, Jocelyn Bédard, Kentaro Inoue, and Paul Jarvis* 235
- [W][OA] In Planta Analysis of the Cell Cycle-Dependent Localization of AtCDC48A and Its Critical Roles in Cell Division, Expansion, and Differentiation. *Sookhee Park, David Michael Rancour, and Sebastian York Bednarek* 246
- [C][W] Arabidopsis SOMATIC EMBRYOGENESIS RECEPTOR KINASE Proteins Serve Brassinosteroid-Dependent and -Independent Signaling Pathways. *Catherine Albrecht, Eugenia Russinova, Birgit Kemmerling, Mark Kwakaitaal, and Sacco C. de Vries* 611

DEVELOPMENT AND HORMONE ACTION

- [W][OA] AGL61 Interacts with AGL80 and Is Required for Central Cell Development in Arabidopsis. *Joshua G. Steffen, Il-Ho Kang, Michael F. Portereiko, Alan Lloyd, and Gary N. Drews* 259
- [C][OA] Regulation of CONSTANS and FLOWERING LOCUS T Expression in Response to Changing Light Quality. *Sang Yeol Kim, Xuhong Yu, and Scott D. Michaels* 269
- [W][OA] Proteome-Wide Characterization of Seed Aging in Arabidopsis: A Comparison between Artificial and Natural Aging Protocols. *Loïc Rajjou, Yoann Lovigny, Steven P.C. Groot, Maya Belghazi, Claudette Job, and Dominique Job* 620

ENVIRONMENTAL STRESS AND ADAPTATION TO STRESS

- [C][W][OA] Enhanced Tolerance to Oxidative Stress in Transgenic Arabidopsis Plants Expressing Proteins of Unknown Function. *Song Luhua, Sultan Ciftci-Yilmaz, Jeffery Harper, John Cushman, and Ron Mittler* 280
- [W][OA] SENSITIVE TO FREEZING6 Integrates Cellular and Environmental Inputs to the Plant Circadian Clock. *Heather Knight, Adrian J.W. Thomson, and Harriet G. McWatters* 293
- [OA] Overexpression of the Arabidopsis 10-Kilodalton Acyl-Coenzyme A-Binding Protein ACBP6 Enhances Freezing Tolerance. *Qin-Fang Chen, Shi Xiao, and Mee-Len Chye* 304
- [W][OA] Regulation of Respiration and the Oxygen Diffusion Barrier in Soybean Protect Symbiotic Nitrogen Fixation from Chilling-Induced Inhibition and Shoots from Premature Senescence. *Philippus D.R. van Heerden, Guy Kiddle, Till K. Pellny, Phatlane W. Mokwala, Anine Jordaan, Abram J. Strauss, Misha de Beer, Urte Schlüter, Karl J. Kunert, and Christine H. Foyer* 316

GENETICS, GENOMICS, AND MOLECULAR EVOLUTION

- [OA] Transfer of Plastid DNA to the Nucleus Is Elevated during Male Gametogenesis in Tobacco. *Anna E. Sheppard, Michael A. Ayliffe, Laura Blatch, Anil Day, Sven K. Delaney, Norfarhana Khairul-Fahmy, Yuan Li, Panagiotis Madesis, Anthony J. Pryor, and Jeremy N. Timmis* 328

PLANTS INTERACTING WITH OTHER ORGANISMS

- [C][W][OA] A Novel ARID DNA-Binding Protein Interacts with SymRK and Is Expressed during Early Nodule Development in *Lotus japonicus*. *Hui Zhu, Tao Chen, Maosheng Zhu, Qing Fang, Heng Kang, Zonglie Hong, and Zhongming Zhang* 337

- ^{[CI][W][OA]}A Novel Role for Protein Farnesylation in Plant Innate Immunity. *Sandra Goritschnig, Tabea Weihmann, Yuelin Zhang, Pierre Fobert, Peter McCourt, and Xin Li* 348
- ^[W]A Role for AtWRKY23 in Feeding Site Establishment of Plant-Parasitic Nematodes. *Wim Grunewald, Mansour Karimi, Krzysztof Wieczorek, Elke Van de Cappelle, Elisabeth Wischnitzki, Florian Grundler, Dirk Inzé, Tom Beeckman, and Godelieve Gheysen* 358
- ^{[W][OA]}Seven in Absentia Proteins Affect Plant Growth and Nodulation in *Medicago truncatula*. *Griet Den Herder, Annick De Keyser, Riet De Rycke, Stephane Rombauts, Willem Van de Velde, María R. Clemente, Christa Verplancke, Peter Mergaert, Eva Kondorosi, Marcelle Holsters, and Sofie Goormachtig* 369
- ^{[CI][W][OA]}A Role for a Menthone Reductase in Resistance against Microbial Pathogens in Plants. *Hyong Woo Choi, Byung Gil Lee, Nak Hyun Kim, Yong Park, Chae Woo Lim, Hyun Kyu Song, and Byung Kook Hwang* 383
- ^{[CI][W]}GR24, a Synthetic Analog of Strigolactones, Stimulates the Mitosis and Growth of the Arbuscular Mycorrhizal Fungus *Gigaspora rosea* by Boosting Its Energy Metabolism. *Arnaud Besserer, Guillaume Bécard, Alain Jauneau, Christophe Roux, and Nathalie Séjalon-Delmas* 402
- ^{[CI][W]}Viroid-Induced Symptoms in *Nicotiana benthamiana* Plants Are Dependent on RDR6 Activity. *Gustavo Gómez, Germán Martínez, and Vicente Pallás* 414
- ^{[W][OA]}A Novel Type of Thioredoxin Dedicated to Symbiosis in Legumes. *Fatima Alkhalifioui, Michelle Renard, Pierre Frendo, Corinne Keichinger, Yves Meyer, Eric Gelhaye, Masakazu Hirasawa, David B. Knaff, Christophe Ritzenthaler, and Françoise Montrichard* 424
- ^{[W][OA]}Global Analysis of Arabidopsis Gene Expression Uncovers a Complex Array of Changes Impacting Pathogen Response and Cell Cycle during Geminivirus Infection. *José Trinidad Ascencio-Ibáñez, Rosangela Sozzani, Tae-Jin Lee, Tzu-Ming Chu, Russell D. Wolfinger, Rino Cella, and Linda Hanley-Bowdoin* 436

WHOLE PLANT AND ECOPHYSIOLOGY

- ^[OA]Manganese Efficiency in Barley: Identification and Characterization of the Metal Ion Transporter HvIRT1. *Pai Pedas, Cecilie K. Ytting, Anja T. Fuglsang, Thomas P. Jahn, Jan K. Schjoerring, and Søren Husted* 455
- ^{[W][OA]}Conifers, Angiosperm Trees, and Lianas: Growth, Whole-Plant Water and Nitrogen Use Efficiency, and Stable Isotope Composition ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) of Seedlings Grown in a Tropical Environment. *Lucas A. Cernusak, Klaus Winter, Jorge Aranda, and Benjamin L. Turner* 642

SYSTEMS BIOLOGY, MOLECULAR BIOLOGY, AND GENE REGULATION

- ^{[W][OA]}Integration of Carbon and Nitrogen Metabolism with Energy Production Is Crucial to Light Acclimation in the Cyanobacterium *Synechocystis*. *Abhay K. Singh, Thanura Elvitigala, Maitrayee Bhattacharyya-Pakrasi, Rajeev Aurora, Bijoy Ghosh, and Himadri B. Pakrasi* 467
- ^[OA]Eukaryotic Translation Initiation Factor 5A Is Involved in Pathogen-Induced Cell Death and Development of Disease Symptoms in Arabidopsis. *Marianne T. Hopkins, Yulia Lampi, Tzann-Wei Wang, Zhongda Liu, and John E. Thompson* 479
- ^{[CI][OA]}Redundant Requirement for a Pair of PROTEIN ARGININE METHYLTRANSFERASE4 Homologs for the Proper Regulation of Arabidopsis Flowering Time. *Lifang Niu, Yong Zhang, Yanxi Pei, Chunyan Liu, and Xiaofeng Cao* 490
- ^[W]An AbrB-Like Transcriptional Regulator, SII0822, Is Essential for the Activation of Nitrogen-Regulated Genes in *Synechocystis* sp. PCC 6803. *Ai Ishii and Yukako Hihara* 660

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

^[W] Indicates Web-only data.

^[OA] Open Access articles can be viewed online without a subscription.