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**On the Cover:** Flooding events affect plant distribution and abundance as well as crop yield and have become increasingly frequent. Plants growing in flood-prone habitats have evolved adaptive strategies to cope with this stress. In this issue, Sasidharan et al. (pp. 1277–1292) study the flooding response of two such plant species: *Rorippa sylvestris* and *Rorippa amphibia*. These extremely flood-tolerant wild relatives of *Arabidopsis* (*Arabidopsis thaliana*), belong to the same lineage in the Brassicaceae family and survive flooding using distinct survival strategies. The relatedness to *Arabidopsis* facilitated the use of *Arabidopsis* gene chips to characterize the molecular adjustments of *Rorippa* spp. roots to flooding stress. Furthermore, a comparison with the transcriptome reconfiguration of the flooding-intolerant *Arabidopsis* in response to this stress identified gene clusters potentially associated with tolerance. Cover image: *R. sylvestris* flowers. Cover image credits: Melis Akman and Onur Kutluoglu.

## ON THE INSIDE

Peter V. Minorsky

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## COMMENTARIES

Going Green: Phytohormone Mimetics for Drought Rescue. Kenichi Hitomi, Elizabeth D. Getzoff, and Julian I. Schroeder

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## BREAKTHROUGH TECHNOLOGIES

A Method for the Rapid Generation of Nonsequential Light-Response Curves of Chlorophyll Fluorescence. João Serôdio, João Ezequiel, Jörg Frommlet, Martin Laviale, and Johann Lavaud

*Light-response curves of chlorophyll fluorescence are rapidly generated from independent, nonsequential measurements through the combined use of spatially separated beams of actinic light and fluorescence imaging.*

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## SCIENTIFIC CORRESPONDENCE

A Reevaluation of the Role of *Arabidopsis* NRT1.1 in High-Affinity Nitrate Transport. Anthony D.M. Glass and Zorica Kotur

*A reevaluation of flux data for Arabidopsis mutants reveals that nitrate uptake through AtNRT1.1 conforms to a single low-affinity transport system that makes virtually no contribution to high-affinity nitrate uptake.*

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## RESEARCH ARTICLES

### BIOCHEMISTRY AND METABOLISM

<sup>[C][W][OPEN]</sup>Reduced Wall Acetylation Proteins Play Vital and Distinct Roles in Cell Wall O-Acetylation in *Arabidopsis*. Yuzuki Manabe, Yves Verhertbruggen, Sascha Gille, Jesper Harholt, Sun-Li Chong, Prashant Mohan-Anupama Pawar, Ewa J. Mellerowicz, Maija Tenkanen, Kun Cheng, Markus Pauly, and Henrik Vibe Scheller

*Four proteins in Arabidopsis are essential for plant development and play overlapping but different roles in acetylation of cell wall polysaccharides.*

1107

<sup>[W]</sup>Suberin-Associated Fatty Alcohols in *Arabidopsis*: Distributions in Roots and Contributions to Seed Coat Barrier Properties. Sollapura J. Vishwanath, Dylan K. Kosma, Ian P. Pulsifer, Sabine Scandola, Stéphanie Pascal, Jérôme Joubès, Franziska Dittrich-Domergue, René Lessire, Owen Rowland, and Frédéric Domergue

*Reduced levels of fatty alcohols in seed coat suberin increase permeability to tetrazolium salts and sensitivity to abscisic acid.*

1118

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[W]Natural Variation in the ATP5I Isoform of ATP Sulfurylase Contributes to the Control of Sulfate Levels in Arabidopsis. Anna Koprivova, Marco Giovannetti, Patrycja Baraniecka, Bok-Rye Lee, Cécile Grondin, Olivier Loudet, and Stanislav Kopriva

Variation in mRNA levels for a single isoform of ATP sulfurylase in Arabidopsis affects the total enzyme activity and sulfate assimilation and causes a variation in foliar sulfate levels.

1133

[W][OPEN]Feedback Inhibition of Starch Degradation in Arabidopsis Leaves Mediated by Trehalose 6-Phosphate. Marina Camara Mattos Martins, Mahdi Hejazi, Joerg Fettke, Martin Steup, Regina Feil, Ursula Krause, Stéphanie Arrivault, Daniel Vosloh, Carlos María Figueroa, Alexander Ivakov, Umesh Prasad Yadav, Maria Piques, Daniela Metzner, Mark Stitt, and John Edward Lunn

Trehalose 6-phosphate inhibits the nighttime breakdown of transitory starch in leaves, potentially linking starch remobilization to sucrose demand for respiration and growth at night.

1142

[W]Functional Characterization of the Plastidial 3-Phosphoglycerate Dehydrogenase Family in Arabidopsis. Walid Toujani, Jesús Muñoz-Bertomeu, María Flores-Tornero, Sara Rosa-Téllez, Armand Djoro Anoman, Saleh Alseekh, Alisdair R. Fernie, and Roc Ros

One of the genes coding for the first enzyme of the phosphorylated pathway of serine biosynthesis is essential for embryo and pollen development, suggesting that this pathway is an important link connecting primary metabolism with development.

1164

[W][OPEN]The Nodulation Factor Hydrolase of *Medicago truncatula*: Characterization of an Enzyme Specifically Cleaving Rhizobial Nodulation Signals. Ye Tian, Wei Liu, Jie Cai, Lan-Yue Zhang, Kam-Bo Wong, Nadja Feddermann, Thomas Boller, Zhi-Ping Xie, and Christian Staehelin

An enzyme of the host legume *Medicago truncatula* exclusively cleaves nodulation signals (Nod factors) from the microsymbiont *Sinorhizobium meliloti* but lacks activity toward chitin or nonmodified chitin oligosaccharides.

1179

[W]The Gene *sml0013* of *Synechocystis* Species Strain PCC 6803 Encodes for a Novel Subunit of the NAD(P)H Oxidoreductase or Complex I That Is Ubiquitously Distributed among Cyanobacteria. Doreen Schwarz, Hendrik Schubert, Jens Georg, Wolfgang R. Hess, and Martin Hagemann

A novel subunit of the cyanobacterial NDH1 complex may mediate its coupling either to the respiratory or the photosynthetic electron flow.

1191

[W][OPEN]GALACTURONOSYLTRANSFERASE-LIKE5 Is Involved in the Production of Arabidopsis Seed Coat Mucilage. Yingzhen Kong, Gongke Zhou, Ashraf A. Abdeen, James Schafhauser, Beth Richardson, Melani A. Atmodjo, Jiyoun Jung, Louise Wicker, Debra Mohnen, Tamara Western, and Michael G. Hahn

An Arabidopsis gene product affects the size of the pectic polysaccharide, rhamnogalacturonan I, in seed coat mucilage.

1203

[C][W][OPEN]Distinct Functional Properties of Isoamylase-Type Starch Debranching Enzymes in Monocot and Dicot Leaves. Maud Facon, Qiaohui Lin, Abdelhamid M. Azzaz, Tracie A. Hennen-Bierwagen, Alan M. Myers, Jean-Luc Putaux, Xavier Roussel, Christophe D'Hulst, and Fabrice Wattebled

Maize and Arabidopsis starch debranching enzymes have evolved separately so that the monocot protein possesses enzymatic activity by itself whereas the dicot protein requires a partner for activity.

1363

[C][W]The Importance of Size and Disorder in the Cryoprotective Effects of Dehydrins. Stephanie L. Hughes, Verena Schart, Janet Malcolmson, Kaley A. Hogarth, David M. Martynowicz, Erik Tralman-Baker, Shruti N. Patel, and Steffen P. Graether

The ability of dehydrins to efficiently protect enzymes from freeze-thaw damage is determined by their length and flexibility.

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## CELL BIOLOGY

[W][OPEN] Abundant Type III Lipid Transfer Proteins in Arabidopsis Tapetum Are Secreted to the Locule and Become a Constituent of the Pollen Exine. *Ming-Der Huang, Tung-Ling L. Chen, and Anthony H.C. Huang*

*A novel lipid transfer pathway from anther to the microspore explains the need for plentiful lipid transfer proteins for the abundant exine.*

1218

[C][W] Analyses of Ca<sup>2+</sup> Accumulation and Dynamics in the Endoplasmic Reticulum of Arabidopsis Root Cells Using a Genetically Encoded Cameleon Sensor. *Maria Cristina Bonza, Giovanna Loro, Smrutisanjita Behera, Andrea Wong, Jörg Kudla, and Alex Costa*

*Generation of an ER-targeted Cameleon reporter protein enables the analysis of Ca<sup>2+</sup> accumulation and dynamics in the lumen of the ER in plant cells.*

1230

[W][OPEN] In Planta Assessment of the Role of Thioredoxin *h* Proteins in the Regulation of S-Locus Receptor Kinase Signaling in Transgenic Arabidopsis. *Masaya Yamamoto and June B. Nasrallah*

*In planta, thioredoxin h proteins do not function as negative regulators of S-locus receptor kinase activity and self-incompatibility signaling as had been proposed.*

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## ECOPHYSIOLOGY AND SUSTAINABILITY

Disarming the Jasmonate-Dependent Plant Defense Makes Nonhost Arabidopsis Plants Accessible to the American Serpentine Leafminer. *Hiroshi Abe, Ken Tateishi, Shigemi Seo, Soichi Kugimiya, Masami Yokota Hirai, Yuji Sawada, Yoshiyuki Murata, Kaori Yara, Takeshi Shimoda, and Masatomo Kobayashi*

*Loss of jasmonate-dependent plant defense converts nonhost plants to host plants that are accessible to leafminers, and demonstrates a role for jasmonate in regulating host plant suitability of herbivores.*

1242

[W][OPEN] Water Uptake along the Length of Grapevine Fine Roots: Developmental Anatomy, Tissue-Specific Aquaporin Expression, and Pathways of Water Transport. *Gregory A. Gambetta, Jiong Fei, Thomas L. Rost, Thorsten Knipfer, Mark A. Matthews, Ken A. Shackel, M. Andrew Walker, and Andrew J. McElrone*

*Peak aquaporin expression/activity and hydraulic conductivity occurred in root tips and interior tissues; contrary to theoretical predictions, low aquaporin expression and activity in suberized secondary growth portions of fine roots suggests a limited role in controlling water uptake in this region of the root.*

1254

[W][OPEN] Initial Events during the Evolution of C<sub>4</sub> Photosynthesis in C<sub>3</sub> Species of *Flaveria*. *Tammy L. Sage, Florian A. Busch, Daniel C. Johnson, Patrick C. Friesen, Corey R. Stinson, Matt Stata, Stefanie Sultmanis, Beshar A. Rahman, Stephen Rawsthorne, and Rowan F. Sage*

*The initial stages of C<sub>4</sub> photosynthetic evolution in Flaveria species is apparent in the C<sub>3</sub> species Flaveria pringlei and Flaveria robusta, which show increases in organelle number and size in bundle sheath cells and a redistribution of mitochondria to the inner region of the bundle sheath.*

1266

[C][W][OPEN] Root Transcript Profiling of Two *Rorippa* Species Reveals Gene Clusters Associated with Extreme Submergence Tolerance. *Rashmi Sasidharan, Angelika Muströph, Alex Boonman, Melis Akman, Ankie M.H. Ammerlaan, Timo Breit, M. Eric Schranz, Laurentius A.C.J. Voeselek, and Peter H. van Tienderen*

*A comparison of submergence-induced transcriptomes of two flooding-tolerant Rorippa species with the relatively flooding-sensitive Arabidopsis identifies gene clusters potentially associated with tolerance.*

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[C][W] Speciation and Distribution of Arsenic in the Nonhyperaccumulator Macrophyte *Ceratophyllum demersum*.  
*Seema Mishra, Gerd Wellenreuther, Jürgen Mattusch, Hans-Joachim Stärk, and Hendrik Küpper*

*X-ray absorption and fluorescence spectroscopy uncover previously unknown differences in As speciation and distribution between lethal and sublethal As toxicity as well as As-induced changes in zinc distribution in plant tissues.* 1396

[C][W][OPEN] Phloem Transport Velocity Varies over Time and among Vascular Bundles during Early Cucumber Seedling Development. *Jessica A. Savage, Maciej A. Zwieniecki, and N. Michele Holbrook*

*In cucumber seedlings, phloem transport velocity fluctuates in response to developmental changes and varies among discrete vascular bundles.* 1409

## GENES, DEVELOPMENT, AND EVOLUTION

[W][OPEN] Distinct Roles of LAFL Network Genes in Promoting the Embryonic Seedling Fate in the Absence of VAL Repression. *Haiyan Jia, Donald R. McCarty, and Masaharu Suzuki*

*The B3-type transcription factor genes, LEC1, ABI3, FUS3, and LEC2, that regulate seed maturation, comprise a self-activated network.* 1293

[C][W] Maize LAZY1 Mediates Shoot Gravitropism and Inflorescence Development through Regulating Auxin Transport, Auxin Signaling, and Light Response. *Zhaobin Dong, Chuan Jiang, Xiaoyang Chen, Tao Zhang, Lian Ding, Weibin Song, Hongbing Luo, Jinsheng Lai, Huabang Chen, Renyi Liu, Xiaolan Zhang, and Weiwei Jin*

*Map-based cloning of a maize prostrate-growth mutant links gravitropism with inflorescence development through auxin transport, auxin signaling, and response to light.* 1306

[C][W] Flow Sorting and Sequencing Meadow Fescue Chromosome 4F. *David Kopecký, Mihaela Martis, Jarmila Čihalíková, Eva Hřibová, Jan Vrána, Jan Bartoš, Jitka Kopecká, Federica Cattonaro, Štěpán Stočes, Petr Novák, Pavel Neumann, Jiří Mačas, Hana Šimková, Bruno Studer, Torben Asp, James H. Baird, Petr Navrátil, Miroslava Karafiátová, Marie Kubaláková, Jan Šafář, Klaus Mayer, and Jaroslav Doležel*

*Sorting and sequencing of individual chromosomes of forage grasses facilitates the analysis of genome structure and evolution and provides a resource for the community of plant biologists and breeders.* 1323

[W][OPEN] Selective Acquisition and Retention of Genomic Sequences by Pack-Mutator-Like Elements Based on Guanine-Cytosine Content and the Breadth of Expression. *Ann A. Ferguson, Dongyan Zhao, and Ning Jiang*

*Pack-MULE transposable elements selectively duplicate bona fide genes.* 1419

[C][W][OPEN] Exogenous Gibberellins Induce Wheat Spike Development under Short Days Only in the Presence of VERNALIZATION1. *Stephen Pearce, Leonardo S. Vanzetti, and Jorge Dubcovsky*

*Long-day up-regulation of GA biosynthesis in the wheat apices is required in combination with the meristem identity gene VRN1 for normal spike development.* 1433

## MEMBRANES, TRANSPORT, AND BIOENERGETICS

[W] Overexpression of the Vacuolar Sugar Carrier *AtSWEET16* Modifies Germination, Growth, and Stress Tolerance in Arabidopsis. *Patrick A.W. Klemens, Kathrin Patzke, Joachim Deitmer, Lara Spinner, Rozenn Le Hir, Catherine Bellini, Magali Bedu, Fabien Chardon, Anne Krapp, and H. Ekkehard Neuhaus*

*Regulation of a novel vacuolar sugar carrier is important for a range of plant functions.* 1338

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[W][OPEN] A Member of the Heavy Metal P-Type ATPase OsHMA5 Is Involved in Xylem Loading of Copper in Rice. Fenglin Deng, Naoki Yamaji, Jixing Xia, and Jian Feng Ma

*A plasma membrane-localized, P-type ATPase is required for xylem loading of Cu at both vegetative and reproductive growth stages in rice.*

1353

[W][OPEN] Vacuolar Transport of Abscisic Acid Glucosyl Ester Is Mediated by ATP-Binding Cassette and Proton-Antiport Mechanisms in Arabidopsis. Bo Burla, Stefanie Pfrunder, Réka Nagy, Rita Maria Francisco, Youngsook Lee, and Enrico Martinoia

*The transport of the glucoside of the plant hormone abscisic acid (abscisic acid glucosyl ester) into Arabidopsis mesophyll vacuoles is mediated by proton gradient-dependent and by ATP-binding cassette (ABC) transport mechanisms, presumably involving ABC subfamily C transporters.*

1446

## SIGNALING AND RESPONSE

[OPEN] Molecular Steps in the Immune Signaling Pathway Evoked by Plant Elicitor Peptides: Ca<sup>2+</sup>-Dependent Protein Kinases, Nitric Oxide, and Reactive Oxygen Species Are Downstream from the Early Ca<sup>2+</sup> Signal. Yi Ma, Yichen Zhao, Robin K. Walker, and Gerald A. Berkowitz

*The immune signaling pathway evoked by endogenous plant elicitor peptides involves the brassinosteroid BAK1 coreceptor and a cGMP-dependent Ca<sup>2+</sup> signal, as well as Ca<sup>2+</sup>-dependent protein kinases, NO, and ROS-dependent gene expression.*

1459

[C][W] A Mathematical Model for the Coreceptors SOMATIC EMBRYOGENESIS RECEPTOR-LIKE KINASE1 and SOMATIC EMBRYOGENESIS RECEPTOR-LIKE KINASE3 in BRASSINOSTEROID INSENSITIVE1-Mediated Signaling. Wilma van Esse, Simon van Mourik, Catherine Albrecht, Jelle van Leeuwen, and Sacco de Vries

*Complex physiological responses of the brassinosteroid pathway can be explained by a biochemical model based on kinase loss-of-function alleles with brassinosteroid receptor complex occupancy as the central estimated parameter.*

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

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