

On the Cover: A nodule with a centralized vascular bundle and lacking infected cells that developed on the *Medicago truncatula* *vapyrin-2* mutant 60 d post inoculation with *Sinorhizobium meliloti* 1021. The nodule was LRWhite resin embedded and longitudinally sectioned to 0.5-micron thickness using a diamond knife. The development of the central vascular bundle and the lack of infected cells is a consequence of blocked infection thread progression. See Guan et al. in this issue (pp. 107–115). Sectioning by Susan Bunnewell. Photo credit: Chengwu Liu.

ON THE INSIDE

Peter V. Minorsky

1

SCIENTIFIC CORRESPONDENCE

What Causes Opposing Actions of Brassinosteroids on Stomatal Development? *Laura Serna*

The TOO MANY MOUTHS receptor may be responsible for the organ-specific effects of brassinosteroids.

3

RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

[C][W][OA] Arabidopsis and *Brachypodium distachyon* Transgenic Plants Expressing *Aspergillus nidulans* Acetyltransferases Have Decreased Degree of Polysaccharide Acetylation and Increased Resistance to Pathogens. *Gennady Pogorelko, Vincenzo Lionetti, Oksana Fursova, Raman M. Sundaram, Mingsheng Qi, Steven A. Whitham, Adam J. Bogdanove, Daniela Bellincampi, and Olga A. Zabolina*

Acetylation of the cell wall affects plant resistance to pathogens.

9

[W][OA] Specialized Roles of the Conserved Subunit OST3/6 of the Oligosaccharyltransferase Complex in Innate Immunity and Tolerance to Abiotic Stresses. *Akhlaq Farid, Frederikke Gro Malinovsky, Christiane Veit, Jennifer Schoberer, Cyril Zipfel, and Richard Strasser*

A subunit of the oligosaccharyltransferase complex is important for efficient glycosylation of specific glycoproteins, including the receptor kinase EFR involved in innate immunity and the endo-β-1,4-glucanase KORRIGAN1 required for cellulose biosynthesis.

24

[C][W][OA] Patatin-Related Phospholipase pPLAIIIδ Increases Seed Oil Content with Long-Chain Fatty Acids in Arabidopsis. *Maoyin Li, Sung Chul Bahn, Chuchuan Fan, Jia Li, Tien Phan, Michael Ortiz, Mary R. Roth, Ruth Welti, Jan Jaworski, and Xuemin Wang*

A phospholipase promotes triacylglycerol accumulation and fatty acid composition.

39

[W][OA] Veratrole Biosynthesis in White Campion. *Tariq A. Akhtar and Eran Pichersky*

Veratrole, a scent compound in white campion flowers, is derived from L-phenylalanine via a series of reactions that lead through intermediates including a signaling compound in plant defense.

52

[W][OA] Posttranslational Influence of NADPH-Dependent Thioredoxin Reductase C on Enzymes in Tetrapyrrole Synthesis. *Andreas S. Richter, Enrico Peter, Maxi Rothbart, Hagen Schlicke, Jouni Toivola, Eevi Rintamäki, and Bernhard Grimm*

A thioredoxin reductase influences chlorophyll biosynthesis by reducing target cysteines in its biosynthesis enzymes.

63

Continued on next page

^[W] Serine Acts as a Metabolic Signal for the Transcriptional Control of Photorespiration-Related Genes in Arabidopsis. *Stefan Timm, Alexandra Florian, Maria Wittmiß, Kathrin Jahnke, Martin Hagemann, Alisdair R. Fernie, and Hermann Bauwe*

Photorespiratory metabolites contribute to the transcriptional regulation of photorespiration.

379

CELL BIOLOGY

^{[W][OA]} The *anisotropy1* D604N Mutation in the Arabidopsis Cellulose Synthase1 Catalytic Domain Reduces Cell Wall Crystallinity and the Velocity of Cellulose Synthase Complexes. *Miki Fujita, Regina Himmelspach, Juliet Ward, Angela Whittington, Nortrud Hasenbein, Christine Liu, Thy T. Truong, Moira E. Galway, Shawn D. Mansfield, Charles H. Hocart, and Geoffrey O. Wasteneys*

Cellulose synthase complexes may optimize cellulose properties and wall mechanical strength by selective exclusion of faulty CesA1 subunits.

74

^{[W][OA]} A Genetic and Metabolic Analysis Revealed that Cotton Fiber Cell Development Was Retarded by Flavonoid Naringenin. *Jiafu Tan, Lili Tu, Fenglin Deng, Haiyan Hu, Yichun Nie, and Xianlong Zhang*

Flavonoids and flavenoid synthesis affect white cotton fiber development.

86

^[C] Nonhomologous End Joining-Mediated Gene Replacement in Plant Cells. *Dan Michael Weinthal, Roslyn Ann Taylor, and Tzvi Tzfira*

Nonhomologous gene exchange by zinc finger nucleases is a novel method for transgene replacement and gene stacking in plants.

390

ECOPHYSIOLOGY AND SUSTAINABILITY

^[W] Arsenite Elicits Anomalous Sulfur Starvation Responses in Barley. *Rob Reid, Kate Gridley, Yuta Kawamata, and Yongguan Zhu*

The similar metabolic and morphological responses to arsenic exposure and sulfur deficiency can be explained by the binding of arsenite to key metabolites that control sulfate uptake and reduction.

401

^{[W][OA]} Global Warming Can Negate the Expected CO₂ Stimulation in Photosynthesis and Productivity for Soybean Grown in the Midwestern United States. *Ursula M. Ruiz-Vera, Matthew Siebers, Sharon B. Gray, David W. Drag, David M. Rosenthal, Bruce A. Kimball, Donald R. Ort, and Carl J. Bernacchi*

Rising carbon dioxide and rising temperature have opposing effects on yield, with variations causing slightly higher yields in one year and much lower yields in another.

410

^{[C][W]} A Transcriptomic Network Underlies Microstructural and Physiological Responses to Cadmium in *Populus × canescens*. *Jiali He, Hong Li, Jie Luo, Chaofeng Ma, Shaojun Li, Long Qu, Ying Gai, Xiangning Jiang, Dennis Janz, Andrea Polle, Melvin Tyree, and Zhi-Bin Luo*

A coexpression network plays a central role in transcriptomic regulation underlying the microstructural and physiological responses to cadmium.

424

GENES, DEVELOPMENT, AND EVOLUTION

^{[C][W][OA]} The Manipulation of Auxin in the Abscission Zone Cells of Arabidopsis Flowers Reveals That Indoleacetic Acid Signaling Is a Prerequisite for Organ Shedding. *Manojit M. Basu, Zinnia H. González-Carranza, Sayed Azam-Ali, Shouya Tang, Ahmad Ali Shahid, and Jeremy A. Roberts*

Premature loss of leaves, flowers, and fruit can reduce crop yield; manipulating the plant hormone auxin in abscission zone cells alters the timing of organ shedding.

96

- [W][OA] Rhizobial Infection Is Associated with the Development of Peripheral Vasculature in Nodules of *Medicago truncatula*. Dian Guan, Nicola Stacey, Chengwu Liu, Jiangqi Wen, Kirankumar S. Mysore, Ivone Torres-Jerez, Tatiana Vernié, Million Tadege, Chuanen Zhou, Zeng-yu Wang, Michael K. Udvardi, Giles E.D. Oldroyd, and Jeremy D. Murray
Cross talk between infection and morphogenesis is required to develop a normal nodule in the legume-rhizobia symbiosis. 107
- [W][OA] The Initiation of Epigenetic Silencing of Active Transposable Elements Is Triggered by RDR6 and 21-22 Nucleotide Small Interfering RNAs. Saivageethi Nuthikattu, Andrea D. McCue, Kaushik Panda, Dalen Fultz, Christopher DeFraia, Erica N. Thomas, and R. Keith Slotkin
An active transposable element is originally targeted for DNA methylation and epigenetic silencing. 116
- [W][OA] Rice Cytokinin GATA Transcription Factor1 Regulates Chloroplast Development and Plant Architecture. Darryl Hudson, David R. Guevara, Andrew J. Hand, Zhenhua Xu, Lixin Hao, Xi Chen, Tong Zhu, Yong-Mei Bi, and Steven J. Rothstein
Altering the expression of a rice transcription factor regulates chloroplast development and modifies plant size, tiller number, and grain production. 132
- [W][OA] An Active *Ac/Ds* Transposon System for Activation Tagging in Tomato Cultivar M82 Using Clonal Propagation. Jared D. Carter, Andy Pereira, Allan W. Dickerman, and Richard E. Veilleux
A transposon tagging system was used to develop 509 activation-tagged lines through micropropagation of derived transgenic launchpads. 145
- [C][W][OA] The Differential Transcription Network between Embryo and Endosperm in the Early Developing Maize Seed. Xiaoduo Lu, Dijun Chen, Defeng Shu, Zhao Zhang, Weixuan Wang, Christian Klukas, Ling-ling Chen, Yunliu Fan, Ming Chen, and Chunyi Zhang
Transcriptomic analysis of maize seed soon after pollination aids understanding of how maize embryo and endosperm are differentially regulated in the early development stage. 440
- [W][OA] A Common Histone Modification Code on C4 Genes in Maize and Its Conservation in Sorghum and *Setaria italica*. Louisa Heimann, Ina Horst, Renke Perduns, Björn Dreesen, Sascha Offermann, and Christoph Peterhansel
A common histone modification code is associated with light induction and cell type-specific gene expression. 456
- MEMBRANES, TRANSPORT, AND BIOENERGETICS**
- [C][W][OA] Modified Clp Protease Complex in the ClpP3 Null Mutant and Consequences for Chloroplast Development and Function in Arabidopsis. Jitae Kim, Paul Dominic Olinares, Soo-hyun Oh, Stefania Ghisaura, Anton Poliakov, Lalit Ponnala, and Klaas J. van Wijk
Chloroplast proteases are important for embryogenesis, plant growth, and development but show differential contributions. 157
- [C][W] Arabidopsis Copper Transport Protein COPT2 Participates in the Cross Talk between Iron Deficiency Responses and Low-Phosphate Signaling. Ana Perea-García, Antoni Garcia-Molina, Nuria Andrés-Colás, Francisco Vera-Sirera, Miguel A. Pérez-Amador, Sergi Puig, and Lola Peñarrubia
A copper transport protein affects copper, iron, and phosphate deficiency responses. 180
- [C][W] Tiered Regulation of Sulfur Deprivation Responses in *Chlamydomonas reinhardtii* and Identification of an Associated Regulatory Factor. Munevver Aksoy, Wirulda Pootakham, Steve V. Pollock, Jeffrey L. Moseley, David González-Ballester, and Arthur R. Grossman
Chlamydomonas reinhardtii has two-tiered gene regulation under sulfur deficiency, and ARS73a is involved in the regulation of second-tier genes. 195

- ^{[C][W]}PARAQUAT RESISTANT1, a Golgi-Localized Putative Transporter Protein, Is Involved in Intracellular Transport of Paraquat. *Jianyong Li, Jinye Mu, Jiaoteng Bai, Fuyou Fu, Tingting Zou, Fengying An, Jian Zhang, Hongwei Jing, Qing Wang, Zhen Li, Shuhua Yang, and Jianru Zuo*
- Golgi-localized putative transporter proteins are involved in the intracellular transport of paraquat.* 470
- ^{[C][W][OA]}Thylakoid Terminal Oxidases Are Essential for the Cyanobacterium *Synechocystis* sp. PCC 6803 to Survive Rapidly Changing Light Intensities. *David J. Lea-Smith, Nic Ross, Maria Zori, Derek S. Bendall, John S. Dennis, Stuart A. Scott, Alison G. Smith, and Christopher J. Howe*
- Terminal oxidases are essential for survival under high light/dark changes but not under diurnal conditions.* 484
- ^{[C][W]}Capacity and Plasticity of Potassium Channels and High-Affinity Transporters in Roots of Barley and Arabidopsis. *Devrim Coskun, Dev T. Britto, Mingyuan Li, Saehong Oh, and Herbert J. Kronzucker*
- Steady-state K⁺ uptake mechanisms differ between NH₄⁺-grown barley and Arabidopsis. Sudden NH₄⁺ withdrawal uncovers dramatic capacity and plasticity of K⁺ transport among the two model species.* 496
- SIGNALING AND RESPONSE**
- ^{[W][OA]}Functional Characterization of Type-B Response Regulators in the Arabidopsis Cytokinin Response. *Kristine Hill, Dennis E. Mathews, Hyo Jung Kim, Ian H. Street, Sarah L. Wildes, Yi-Hsuan Chiang, Michael G. Mason, Jose M. Alonso, Joseph R. Ecker, Joseph J. Kieber, and G. Eric Schaller*
- Five out of 11 related transcription factors were found to mediate the cytokinin response based on complementation analysis of a cytokinin-signaling mutant.* 212
- ^{[W][OA]}Reduced Carbohydrate Availability Enhances the Susceptibility of Arabidopsis toward *Colletotrichum higginsianum*. *Timo Engelsdorf, Robin J. Horst, Reinhard Pröls, Marlene Pröschel, Franziska Dietz, Ralph Hückelhoven, and Lars M. Voll*
- Carbon availability is crucial for defense against the hemibiotrophic fungus *Colletotrichum higginsianum* during necrotrophic fungal growth but is dispensable during biotrophic growth.* 225
- ^{[W][OA]}Transcriptomic Analysis of the Role of Carboxylic Acids in Metabolite Signaling in Arabidopsis Leaves. *Iris Finkemeier, Ann-Christine König, William Heard, Adriano Nunes-Nesi, Phuong Anh Pham, Dario Leister, Alisdair R. Fernie, and Lee J. Sweetlove*
- Perturbations in cellular concentrations of citrate, and to a lesser extent malate, have a major impact on nucleus-encoded transcript abundance, hinting at specific roles of carboxylic acids in metabolite signaling.* 239
- ^{[W][OA]}AtWRKY40 and AtWRKY63 Modulate the Expression of Stress-Responsive Nuclear Genes Encoding Mitochondrial and Chloroplast Proteins. *Olivier Van Aken, Botao Zhang, Simon Law, Reena Narsai, and James Whelan*
- WRKY transcription factors modulate the expression of nuclear genes encoding mitochondrial and chloroplast proteins via direct promoter binding and coordinate common stress responses.* 254
- ^{[C][W][OA]}Identification of Cytokinin-Responsive Genes Using Microarray Meta-Analysis and RNA-Seq in Arabidopsis. *Apurva Bhargava, Ivory Clabaugh, Jenn P. To, Bridey B. Maxwell, Yi-Hsuan Chiang, G. Eric Schaller, Ann Loraine, and Joseph J. Kieber*
- Meta-analysis of cytokinin-regulated gene expression across multiple transcriptome studies identifies the transcriptional changes occurring in response to cytokinin.* 272
- ^{[W][OA]}Mutations in the TIR1 Auxin Receptor That Increase Affinity for Auxin/Indole-3-Acetic Acid Proteins Result in Auxin Hypersensitivity. *Hong Yu, Britney L. Moss, Seunghee S. Jang, Michael Prigge, Eric Klavins, Jennifer L. Nemhauser, and Mark Estelle*
- A directed genetic screen produced auxin receptors with increased activity both in vitro and in the plant.* 295

[C][W][OA] Unraveling Root Developmental Programs Initiated by Beneficial *Pseudomonas* spp. Bacteria. Christos Zamioudis, Parthena Mastranesti, Pankaj Dhonukshe, Ikram Blilou, and Corné M.J. Pieterse

Beneficial soil-borne Pseudomonas rhizobacteria influence root development and promote growth, independent of their ability to stimulate systemic immunity.

304

[C][W][OA] ETHYLENE RESPONSE FACTOR6 Acts as a Central Regulator of Leaf Growth under Water-Limiting Conditions in Arabidopsis. Marieke Dubois, Aleksandra Skiryecz, Hannes Claeys, Katrien Maleux, Stijn Dhondt, Stefanie De Bodt, Robin Vanden Bossche, Liesbeth De Milde, Takeshi Yoshizumi, Minami Matsui, and Dirk Inzé

ETHYLENE RESPONSE FACTOR6 is a central regulator of both leaf growth inhibition and stress tolerance under osmotic stress conditions.

319

[C][W] Nuclear Accumulation of Cytosolic Glyceraldehyde-3-Phosphate Dehydrogenase in Cadmium-Stressed Arabidopsis Roots. Marco Vescovi, Mirko Zaffagnini, Margherita Festa, Paolo Trost, Fiorella Lo Schiavo, and Alex Costa

Cadmium-induced oxidative stress leads to nuclear relocation of glyceraldehyde-3-phosphate dehydrogenase.

333

[C] An Autoregulatory Loop Controlling Arabidopsis HsfA2 Expression: Role of Heat Shock-Induced Alternative Splicing. Jinjie Liu, Na Sun, Meng Liu, Jiancheng Liu, Bojing Du, Xinjing Wang, and Xiaoting Qi

A new heat stress-induced splice variant is involved in the self-regulation of HsfA2 transcription in Arabidopsis.

512

[W][OA] Specific Subunits of Heterotrimeric G Proteins Play Important Roles during Nodulation in Soybean. Swarup Roy Choudhury and Sona Pandey

Subunits of heterotrimeric G proteins are positive regulators of nodule formation in soybean. Interactions with nod factor receptor NFR1 implicates plant G proteins in a yet unexplored signaling network.

522

SYSTEMS AND SYNTHETIC BIOLOGY

[W][OA] Impact of the Carbon and Nitrogen Supply on Relationships and Connectivity between Metabolism and Biomass in a Broad Panel of Arabidopsis Accessions. Ronan Sulpice, Zoran Nikoloski, Hendrik Tschoep, Carla Antonio, Sabrina Kleessen, Abdelhalim Larhlimi, Joachim Selbig, Hirofumi Ishihara, Yves Gibon, Alisdair R. Fernie, and Mark Stitt

Metabolite profiles support a robust prediction of biomass across a range of conditions and accounts for environmental influences on metabolic networks.

347

[W] Reduction of Oxalate Levels in Tomato Fruit and Consequent Metabolic Remodeling Following Overexpression of a Fungal Oxalate Decarboxylase. Niranjana Chakraborty, Rajgourab Ghosh, Sudip Ghosh, Kanika Narula, Rajul Tayal, Asis Datta, and Subhra Chakraborty

Oxalate decarboxylase-regulated metabolic networks may provide a widely applicable strategy for enhancing crop nutritional value.

364

[C] 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.

