

On the Cover: Gibberellins (GAs) are plant hormones that regulate most plant life cycle aspects, including flowering and fruit development. In this issue, Gomez et al. (pp. 2403–2415) demonstrate that GAs are involved in ovule development. DELLA proteins, negative GA response regulators, act as positive factors for ovule integument development in a mechanism that involves the transcription factor ATS. The seeds of the *della global* mutant, a complete loss of function of DELLA, and the *ats-1* mutant are remarkably similar, with a round shape, a disorganized testa, and viviparism. These defects are the result of an alteration in integuments that fail to fully develop and are shorter than in wild-type plants. DELLAs and ATS proteins interact, which suggests the formation of a transcriptional complex that regulates the expression of genes involved in integument growth. The requirement of both activities to coordinate proper ovule development argues that the ATS-DELLA complex acts as a key molecular factor. This work provides the key evidence for a role of GAs in ovule and seed development. The cover shows expression of the DELLA GAI in developing ovule primordia. Expression is visualized by GUS assay coupled with mPS-PI staining, using the transcription line pGAI:GUS constructed in collaboration with J. Hu and T.-p. Sun and originally described by Gallego-Giraldo et al. (2014). Cover image credits: M.D. Gomez and M.A. Perez-Amador.

ON THE INSIDE

Peter V. Minorsky 2079

COMMENTARY

Getting to the Right Side *Markus Geisler* 2081

TOPICAL REVIEW

^[OPEN]Does Abiotic Stress Cause Functional B Vitamin Deficiency in Plants?

Andrew D. Hanson, Guillaume A. Beaudoin, Donald R. McCarty, and Jesse F. Gregory III

Unlike animals, plants produce their own B vitamins but may nonetheless suffer vitamin deficiencies under stress conditions, with wide-ranging metabolic consequences. 2082

UPDATE

^[OPEN]Role of Reactive Oxygen Species during Cell Expansion in Leaves.

Romy Schmidt, Alicja B. Kunkowska, and Jos H.M. Schippers

Reactive oxygen species as potent regulators of leaf development poses special interest for cell expansion. 2098

RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

^[OPEN]The Target of β -Expansin EXPB1 in Maize Cell Walls from Binding and Solid-State NMR Studies.

Tuo Wang, Yuning Chen, Akira Tabuchi, Daniel J. Cosgrove, and Mei Hong

Results from binding assays and paramagnetic relaxation enhancement ssNMR demonstrate that β -expansin EXPB1 binds matrix polysaccharides, predominantly glucuronarabinoxylan, rather than cellulose. 2107

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The α -Terpineol to 1,8-Cineole Cyclization Reaction of Tobacco Terpene Synthases.

Birgit Piechulla, Richard Bartelt, Anne Brosemann, Uta Effmert, Harro Bouwmeester, Frank Hippauf, and Wolfgang Brandt

The conversion of α -terpineol to 1,8-cineole by monoterpene synthases is initiated by a catalytic dyad, followed by a reaction via (S)-(-)- α -terpineol, and influenced by amino acids more than 10 Å away from the active site.

2120

Dissecting the Metabolic Role of Mitochondria during Developmental Leaf Senescence.

Daria Chrobok, Simon R. Law, Bastiaan Brouwer, Pernilla Lindén, Agnieszka Ziolkowska, Daniela Liebsch, Reena Narsai, Bozena Szal, Thomas Moritz, Nicolas Rouhier, James Whelan, Per Gardeström, and Olivier Keech

During developmental leaf senescence in Arabidopsis, mitochondria simultaneously maintain primary energy processes and are the site of a number of catabolic processes, thus ensuring effective nutrient reallocation.

2132

Endogenous Bioactive Jasmonate Is Composed of a Set of (+)-7-iso-JA-Amino Acid Conjugates.

Jianbin Yan, Suhua Li, Min Gu, Ruifeng Yao, Yuwen Li, Juan Chen, Mai Yang, Jianhua Tong, Langtao Xiao, Fajun Nan, and Daoxin Xie

Four jasmonate conjugates are perceived by receptor COI1 and function as new endogenous bioactive JA molecules.

2154

^[OPEN]Dirigent Protein Mode of Action Revealed by the Crystal Structure of AtDIR6. Raphael Gasper, Isabelle Effenberger, Piotr Kolesinski, Barbara Terlecka, Eckhard Hofmann, and Andreas Schaller

Crystal structure analysis reveals the mode of substrate radical binding and indicates a previously unrecognized catalytic function for dirigent proteins during enantioselective pinoselin formation.

2165

Impaired Cyclic Electron Flow around Photosystem I Disturbs High-Light Respiratory Metabolism.

Igor Florez-Sarasa, Ko Noguchi, Wagner L. Araújo, Ana Garcia-Nogales, Alisdair R. Fernie, Jaume Flexas, and Miquel Ribas-Carbo

The cytochrome oxidase pathway mediates photorespiratory glycine oxidation and amino acid synthesis under severe light stress, thus reducing photoinhibition when alternative oxidase is not induced.

2176

Methyl Transfer in Glucosinolate Biosynthesis Mediated by Indole Glucosinolate

O-Methyltransferase 5. Marina Pfalz, Maisara Mukhaimar, François Perreau, Jayne Kirk, Cecilie Ida Cetti Hansen, Carl Erik Olsen, Niels Agerbirk, and Juergen Kroymann

Indole glucosinolate O-methyltransferase 5 catalyzes the methyl transfer reaction in the biosynthesis of Trp-derived glucosinolates that are modified at position 1 of the indole ring.

2190

CELL BIOLOGY

DEFECTIVE KERNEL1 (DEK1) Regulates Cell Walls in the Leaf Epidermis.

Dhika Amanda, Monika S. Doblin, Roberta Galletti, Antony Bacic, Gwyneth C. Ingram, and Kim L. Johnson

The phytoalexin DEFECTIVE KERNEL1 effects physical changes in the cell wall and expression of cell wall-related genes in Arabidopsis thaliana.

2204

Control of Autophagy in Chlamydomonas Is Mediated through Redox-Dependent Inactivation of the ATG4 Protease.

María Esther Pérez-Pérez, Stéphane D. Lemaire, and José L. Crespo

The activity of the Chlamydomonas ATG4 protease is regulated by the intracellular redox state and it is inhibited under stress conditions to ensure lipidation of ATG8 and thus autophagosome formation.

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[^{OPEN}] Low-Phosphate Induction of Plastidal Stromules Is Dependent on Strigolactones But Not on the Canonical Strigolactone Signaling Component MAX2. Gilles Vismans, Tom van der Meer, Olivier Langevoort, Marielle Schreuder, Harro Bouwmeester, Helga Peisker, Peter Dörman, Tijs Ketelaar, and Alexander van der Krol

Induction of stromule formation in plastids is dependent on strigolactones, but not on the strigolactone signaling component MAX2. 2235

[^{CC-BY}] A Framework for Lateral Membrane Trafficking and Polar Tethering of the PEN3 ATP-Binding Cassette Transporter. Hailiang Mao, Moritaka Nakamura, Corrado Viotti, and Markus Grebe

ACTIN7 is required for trans-Golgi network trafficking of outer lateral membrane cargo and for polarity of its EXOCYST84b tethering factor. 2245

ECOPHYSIOLOGY AND SUSTAINABILITY

[^{OPEN}] Reversible Leaf Xylem Collapse: A Potential “Circuit Breaker” against Cavitation. Yong-Jiang Zhang, Fulton E. Rockwell, Adam C. Graham, Teresa Alexander, and N. Michele Holbrook

Reversible collapse of the xylem in the smallest vein orders of red oak leaves buffers major veins from cavitation over time scales relevant to stomatal responses. 2261

Spectacular Oscillations in Plant Isoprene Emission under Transient Conditions Explain the Enigmatic CO₂ Response. Bahtijor Rasulov, Eero Talts, and Ülo Niinemets

Oscillations in isoprene emission demonstrate that the emission is controlled by chloroplast reductant status. 2275

[^{OPEN}] Apparent Overinvestment in Leaf Venation Relaxes Leaf Morphological Constraints on Photosynthesis in Arid Habitats. Hugo J. de Boer, Paul L. Drake, Erin Wendt, Charles A. Price, Ernst-Detlef Schulze, Neil C. Turner, Dean Nicolle, and Erik J. Veneklaas

Aridity-adapted Eucalyptus and Corymbia species invest in high leaf vein densities to offset the negative effect of leaf thickness on photosynthesis. 2286

Calcium Deficiency Triggers Phloem Remobilization of Cadmium in a Hyperaccumulating Species. Shengke Tian, Ruohan Xie, Haixin Wang, Yan Hu, Jun Ge, Xingcheng Liao, Xiaoyu Gao, Patrick Brown, Xianyong Lin, and Lingli Lu

The hyperaccumulator Sedum alfredii under Ca deficiency accumulates a high level of Cd in young tissues by its efficient phloem remobilization of the metal. 2300

GENES, DEVELOPMENT, AND EVOLUTION

[^{OPEN}] Carotenogenesis Is Regulated by 5' UTR-Mediated Translation of Phytoene Synthase Splice Variants. Daniel Álvarez, Björn Voß, Dirk Maass, Florian Wüst, Patrick Schaub, Peter Beyer, and Ralf Welsch

A splice variant of Arabidopsis phytoene synthase is subjected to a feedback-mediated, translational control via its 5' UTR to coordinate biosynthetic pathway flux with carotenoid requirements. 2314

[^{OPEN}] Retrotransposon-Mediated Aluminum Tolerance through Enhanced Expression of the Citrate Transporter OsFRDL4. Kengo Yokosho, Naoki Yamaji, Miho Fujii-Kashino, and Jian Feng Ma

The expression of OsFRDL4 encoding an Al-induced citrate transporter is enhanced by a 1.2-kb insertion in the promoter region in rice. 2327

[^{OPEN}] Dynamic Interplay between Nucleoid Segregation and Genome Integrity in *Chlamydomonas* Chloroplasts. Masaki Odahara, Yusuke Kobayashi, Toshiharu Shikanai, and Yoshiki Nishimura

Homologs of RecA recombinase and DNA gyrase are required for the proper nucleoid segregation and maintenance of genome integrity in Chlamydomonas chloroplasts. 2337

Transcriptome and Degradome Sequencing Reveals Dormancy Mechanisms of *Cunninghamia lanceolata* Seeds. Dechang Cao, Huimin Xu, Yuanyuan Zhao, Xin Deng, Yongxiu Liu, Wim J.J. Soppe, and Jinxing Lin

Changes in cytology and gene expression are reversible during Cunninghamia lanceolata seed dormancy cycling. 2347

Transcription Factors WOX11/12 Directly Activate WOX5/7 to Promote Root Primordia Initiation and Organogenesis. Xiaomei Hu and Lin Xu

WOX11/12 directly activate WOX5/7 to induce root primordium development during de novo regeneration. 2363

[OPEN] Gene Regulation by the AGL15 Transcription Factor Reveals Hormone Interactions in Somatic Embryogenesis. Qiaolin Zheng, Yumei Zheng, Huihua Ji, Whitney Burnie, and Sharyn E. Perry

Embryo and hormonal transcription factors interact in somatic embryogenesis in Arabidopsis and soybean. 2374

[CC-BY] Starch Turnover and Metabolism during Flower and Early Embryo Development. Aff Hedhly, Hannes Vogler, Marc W. Schmid, Diana Pazmino, Valeria Gagliardini, Diana Santelia, and Ueli Grossniklaus

A systematic characterization of starch turnover in Arabidopsis during reproductive development unravels new starch deposits and sheds light on starch metabolism and transport in reproductive tissues. 2388

[OPEN] Gibberellins Regulate Ovule Integument Development by Interfering with the Transcription Factor ATS. María Dolores Gomez, Daniel Ventimilla, Raquel Sacristan, and Miguel A. Perez-Amador

Gibberellins negatively regulate integument growth in ovules through destabilization of the DELLA-ATS protein complex 2403

Regulation of Vegetative Phase Change by SWI2/SNF2 Chromatin Remodeling ATPase BRAHMA. Yunmin Xu, Changkui Guo, Bingying Zhou, Chenlong Li, Huasen Wang, Ben Zheng, Han Ding, Zhujun Zhu, Angela Peragine, Yuhai Cui, Scott Poethig, and Gang Wu

SWI2/SNF2 chromatin remodeling ATPase BRAHMA controls vegetative phase change by regulation of miR156 expression at the level of nucleosome in Arabidopsis. 2416

MEMBRANES, TRANSPORT, AND BIOENERGETICS

Importance of Translocon Subunit Tic56 for rRNA Processing and Chloroplast Ribosome Assembly. Daniel Köhler, Stefan Helm, Birgit Agne, and Sacha Baginsky

A defect in Arabidopsis chloroplast translation causes an albino phenotype of the plastid protein import mutants tic56-1 and ppi2 (toc159). 2429

[OPEN] Cell-Type-Specific H⁺-ATPase Activity in Root Tissues Enables K⁺ Retention and Mediates Acclimation of Barley (*Hordeum vulgare*) to Salinity Stress. Lana Shabala, Jingyi Zhang, Igor Pottosin, Jayakumar Bose, Min Zhu, Anja Thoe Fuglsang, Ana Velarde-Buendia, Amandine Massart, Camilla Beate Hill, Ute Roessner, Antony Bacic, Honghong Wu, Elisa Azzarello, Camilla Pandolfi, Meixue Zhou, Charlotte Poschenrieder, Stefano Mancuso, and Sergey Shabala

The differential sensitivity of various root tissues to salt stress is not related to their ability to exclude or sequester sodium but rather is determined by the differences in their ability to retain potassium. 2445

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[OPEN] A Nitrogen-Fixing Subunit Essential for Accumulating 4Fe-4S-Containing Photosystem I Core Proteins. Krishna Nath, Ryan L. Wessendorf, and Yan Lu

Loss-of-function mutants of a chloroplastic nitrogen-fixation-subunit-U-type protein showed decreased accumulation of 4Fe-4S-containing photosystem I core proteins. 2459

[OPEN] Plant-Specific Preprotein and Amino Acid Transporter Proteins Are Required for tRNA Import into Mitochondria. Monika W. Murcha, Szymon Kubiszewski-Jakubiak, Pedro F. Teixeira, Irene L. Gügel, Beata Kmiec, Reena Narsai, Aneta Ivanova, Cyrille Megel, Annette Schock, Sabrina Kraus, Oliver Berkowitz, Elzbieta Glaser, Katrin Philippar, Laurence Maréchal-Drouard, Jürgen Soll, and James Whelan

tRNA import into plant mitochondria requires the outer mitochondrial membrane PRAT domain-containing proteins Tric1 and Tric2 that are orthologous to the protein import translocases of the inner membrane. 2471

SIGNALING AND RESPONSE

Two Chloroplast Proteins Suppress Drought Resistance by Affecting ROS Production in Guard Cells. Zhen Wang, Fuxing Wang, Yechun Hong, Jirong Huang, Huazhong Shi, and Jian-Kang Zhu

Suppressing chloroplastic HCF106 and THF1 expression enhances drought resistance in Arabidopsis. 2491

An E3 Ligase Affects the NLR Receptor Stability and Immunity to Powdery Mildew. Tao Wang, Cheng Chang, Cheng Gu, Sanyuan Tang, Qi Xie, and Qian-Hua Shen

The barley MIR1 E3 ubiquitin ligase interacts with MLA immune receptors to promote their ubiquitination and proteasomal degradation, thus regulating receptor stability and immunity. 2504

Transcriptional Analysis of *serk1* and *serk3* Coreceptor Mutants. G. Wilma van Esse, Colette A. ten Hove, Francesco Guzzonato, H. Peter van Esse, Mark Boekschoten, Lars Ridder, Jacques Vervoort, and Sacco C. de Vries

*Transcriptional analysis of *serk* mutants reveals a novel role of the brassinosteroid coreceptors SERK1 and SERK3 in glucosinolate biosynthesis.* 2516

CORRECTION

Evolutionary Co-Option of Floral Meristem Identity Genes for Patterning of the Flower-Like Asteraceae Inflorescence. Y. Zhao, T. Zhang, S.K. Broholm, S. Tähtiharju, K. Mouhu, V.A. Albert, T.H. Teeri, and P. Elomaa

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