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On the Cover: Aquaporins are essential molecular players in plant water relations, nutrition, and signaling processes. Plant genomes encode multiple aquaporin isoforms, which display a large variety of subcellular localization patterns. In particular, maize (*Zea mays*) aquaporins belonging to the plasma membrane intrinsic protein (PIP) ZmPIP1 and ZmPIP2 groups are respectively located in the endoplasmic reticulum (ER) and the plasma membrane (PM) when they are expressed alone in maize cells. In this issue, Chevalier et al. (pp. 125–138) undertook a systematic protein domain-exchange approach, which revealed a critical role of the third transmembrane helix in the trafficking of ZmPIP2s to the PM, in both maize mesophyll protoplasts and leaf epidermal cells transformed by biolistic DNA delivery. Single-transmembrane domain proteins confirmed the ability of the third transmembrane helix of ZmPIP1s and ZmPIP2s to discriminate between ER and PM localization. More specifically, the conserved L127 and A131 residues of ZmPIP2;5 are required for ER export. The cover image shows confocal microscopy images of maize mesophyll protoplasts expressing wild-type and mutated ZmPIPs tagged with the monomeric yellow fluorescent protein, or incubated with the steryl dye FM4-64 to label the plasma membrane. Cover image credits: Adrien S. Chevalier.

ON THE INSIDE

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Targeting of Polytopic Proteins to the Plasma Membrane. *Andreas Nebenführ*

New research reveals unexpected targeting signals in a transmembrane domain of plasma membrane water channels.

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TOPICAL REVIEW

The Art of Being Flexible: How to Escape from Shade, Salt, and Drought. *Ronald Pierik and Christa Testerink*

Plants escape from stressful conditions through the plasticity of root and shoot development.

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BREAKTHROUGH TECHNOLOGIES

^[W]Activity-Based Profiling of a Physiologic Aglycone Library Reveals Sugar Acceptor Promiscuity of Family 1 UDP-Glucosyltransferases from Grape. *Friedericke Bönisch, Johanna Frotscher, Sarah Stanitzek, Ernst Rühl, Matthias Wüst, Oliver Bitz, and Wilfried Schwab*

A method based on an aglycone library was developed for the targeted analysis of acceptor molecules of UDP-glycosyltransferases.

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SCIENTIFIC CORRESPONDENCE

Differential Accumulation of ELONGATED HYPOCOTYL5 Correlates with Hypocotyl Bending to Ultraviolet-B Light. *Filip Vandenbussche and Dominique Van Der Straeten*

During UV-B-specific induction of bending to the light in Arabidopsis etiolated seedlings, the transcription factor HY5 accumulates on the illuminated side and orchestrates the response.

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RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

[W][OPEN] Different Mechanisms Are Responsible for Chlorophyll Dephytylation during Fruit Ripening and Leaf Senescence in Tomato. *Luzia Guyer, Silvia Schelbert Hofstetter, Bastien Christ, Bruno Silvestre Lira, Magdalena Rossi, and Stefan Hörtensteiner*

Phytol hydrolysis during chlorophyll breakdown in tomato leaves is specifically catalyzed by pheophytinase, while during fruit ripening other, so far unknown, hydrolases are active.

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[W][OPEN] Functional Evidence for the Critical Amino-Terminal Conserved Domain and Key Amino Acids of Arabidopsis 4-HYDROXY-3-METHYLBUT-2-ENYL DIPHOSPHATE REDUCTASE. *Wei-Yu Hsieh, Tzu-Ying Sung, Hsin-Tzu Wang, and Ming-Hsiun Hsieh*

Key residues near the N-terminus and around the central active site are critical for the function of Arabidopsis 4-hydroxy-3-methylbut-2-enyl diphosphate reductase.

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[C][W][OPEN] Chlorophyll Degradation: The Tocopherol Biosynthesis-Related Phytol Hydrolase in Arabidopsis Seeds Is Still Missing. *Wei Zhang, Tianqi Liu, Guodong Ren, Stefan Hörtensteiner, Yongming Zhou, Edgar B. Cahoon, and Chunyu Zhang*

Two known chlorophyll-related types of phytol hydrolases may only play limited roles in tocopherol biosynthesis in Arabidopsis seeds, implicating another unknown dephytylase that may exist.

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[W] Molecular Cloning and Characterization of a Geranyl Diphosphate-Specific Aromatic Prenyltransferase from Lemon. *Ryosuke Munakata, Tsuyoshi Inoue, Takao Koeduka, Fazeelat Karamat, Alexandre Olry, Akifumi Sugiyama, Kojiro Takanashi, Audrey Dugrand, Yann Froelicher, Ryo Tanaka, Yoshihiro Uto, Hitoshi Hori, Jun-Ichi Azuma, Alain Hehn, Frédéric Bourgaud, and Kazufumi Yazaki*

A prenyltransferase gene from lemon encodes a membrane-bound geranyl diphosphate-specific prenyltransferase for coumarin, which produces a novel compound, 8-geranyllumbelliferone, in citrus species.

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[W][OPEN] Proteins with High Turnover Rate in Barley Leaves Estimated by Proteome Analysis Combined with in Planta Isotope Labeling. *Clark J. Nelson, Ralitzia Alexova, Richard P. Jacoby, and A. Harvey Millar*

Proteins turn over at different rates in plant tissues, and these have been quantified using stable isotope labeling of nitrogen and peptide mass spectrometry of leaf tissue from hydroponically grown barley.

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[W] The Reductase Activity of the Arabidopsis Caleosin RESPONSIVE TO DESSICATION20 Mediates Gibberellin-Dependent Flowering Time, Abscisic Acid Sensitivity, and Tolerance to Oxidative Stress. *Elizabeth Blée, Benoît Boachon, Michel Burcklen, Marina Le Guédard, Abdulsamie Hanano, Dimitri Heintz, Jürgen Ehrling, Cornelia Herrfurth, Ivo Feussner, and Jean-Jacques Bessoule*

A peroxxygenase controls floral transition and tolerance to oxidative stress.

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[C][W][OPEN] Geranyllinalool Synthases in Solanaceae and Other Angiosperms Constitute an Ancient Branch of Diterpene Synthases Involved in the Synthesis of Defensive Compounds. *Vasiliki Falara, Juan M. Alba, Merijn R. Kant, Robert C. Schuurink, and Eran Pichersky*

The genes encoding geranyllinalool synthases in Solanaceae represent an ancient branch of the terpene synthase gene family that likely diverged from the rest of the family prior to the split between the gymnosperm and angiosperm lineages.

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CELL BIOLOGY

[W][OPEN] A New LxxxA Motif in the Transmembrane Helix3 of Maize Aquaporins Belonging to the Plasma Membrane Intrinsic Protein PIP2 Group Is Required for Their Trafficking to the Plasma Membrane. *Adrien S. Chevalier, Gerd Patrick Bienert, and François Chaumont*

Two amino acids located in a transmembrane helix regulate the trafficking of endoplasmic reticulum- and plasma membrane-localized aquaporins along the secretory pathway.

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[W][OPEN] The Apical Actin Fringe Contributes to Localized Cell Wall Deposition and Polarized Growth in the Lily Pollen Tube. *Caleb M. Rounds, Peter K. Hepler, and Lawrence J. Winship*

Inhibition of lily pollen tube growth with three different agents, brefeldin A, latrunculin B, and potassium cyanide, provides evidence that the apical actin fringe contributes to localized pectin deposition and polarized cell growth.

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[C][W] Chloroplast Dysfunction Causes Multiple Defects in Cell Cycle Progression in the Arabidopsis *crumpled leaf* Mutant. *Elodie Hudik, Yasushi Yoshioka, Séverine Domenichini, Mickaël Bourge, Ludivine Soubigout-Taconnat, Christelle Mazubert, Dalong Yi, Sandrine Bujaldon, Hiroyuki Hayashi, Lieven De Veylder, Catherine Bergounioux, Moussa Benhamed, and Cécile Raynaud*

The constitutive stress response induced by chloroplast dysfunction causes early differentiation via the activation of cell cycle inhibitors.

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ECOPHYSIOLOGY AND SUSTAINABILITY

[OPEN] Wettability, Polarity, and Water Absorption of Holm Oak Leaves: Effect of Leaf Side and Age. *Victoria Fernández, Domingo Sancho-Knapik, Paula Guzmán, José Javier Peguero-Pina, Luis Gil, George Karabourniotis, Mohamed Khayet, Costas Fasseas, José Alejandro Heredia-Guerrero, Antonio Heredia, and Eustaquio Gil-Pelegrín*

The highly pubescent abaxial side of holm oak leaves is unwettable and water repellent, while the adaxial side is wettable and can take up water, which may be an adaptation to growing under Mediterranean conditions.

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[W][OPEN] TRICHOME BIREFRINGENCE-LIKE27 Affects Aluminum Sensitivity by Modulating the O-Acetylation of Xyloglucan and Aluminum-Binding Capacity in Arabidopsis. *Xiao Fang Zhu, Ying Sun, Bao Cai Zhang, Nasim Mansoori, Jiang Xue Wan, Yu Liu, Zhi Wei Wang, Yuan Zhi Shi, Yi Hua Zhou, and Shao Jian Zheng*

O-acetylation of xyloglucan affects aluminum sensitivity in Arabidopsis by modifying the aluminum-binding capacity of xyloglucan in the cell wall.

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[W][OPEN] Disordered COR15 Proteins Protect Chloroplast Membranes during Freezing through Binding and Folding, But Do Not Stabilize Chloroplast Enzymes in Vivo. *Anja Thalhammer, Gary Bryant, Ronan Sulpice, and Dirk K. Hincha*

Cold-induced, unstructured chloroplast proteins increase plant freezing tolerance by stabilizing membranes, but not enzymes, through folding and binding.

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[W][OPEN] Dissection of the Control of Anion Homeostasis by Associative Transcriptomics in *Brassica napus*. *Anna Koprivova, Andrea L. Harper, Martin Trick, Ian Bancroft, and Stanislav Kopriva*

Associative transcriptomics in Brassica napus identified candidate genes for the control of variation in nitrate, phosphate, and sulfate contents.

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GENES, DEVELOPMENT, AND EVOLUTION

[W][OPEN] **AtGEN1 and AtSEND1, Two Paralogs in Arabidopsis, Possess Holliday Junction Resolvase Activity.**
Markus Bauknecht and Daniela Kobbe

Arabidopsis proteins resolve intermediary structures of DNA recombination and repair by symmetrically oriented incisions and provide mechanistic insight in processing of nicked structures. 202

[C][W] **Long-Term Evolution of Nucleotide-Binding Site-Leucine-Rich Repeat Genes: Understanding Gained from and beyond the Legume Family.** *Zhu-Qing Shao, Yan-Mei Zhang, Yue-Yu Hang, Jia-Yu Xue, Guang-Can Zhou, Ping Wu, Xiao-Yi Wu, Xun-Zong Wu, Qiang Wang, Bin Wang, and Jian-Qun Chen*

During the past 54 million years of evolution, 94% of ancestral legume leucine-rich-repeat gene lineages have experienced deletions or expansions, while 6% have been maintained in a conservative manner. 217

[W][OPEN] **Evolutionary Relationship of Disease Resistance Genes in Soybean and Arabidopsis Specific for the *Pseudomonas syringae* Effectors AvrB and AvrRpm1.** *Tom Ashfield, Thomas Redditt, Andrew Russell, Ryan Kessens, Natalie Rodibaugh, Lauren Galloway, Qing Kang, Ram Podicheti, and Roger W. Innes*

Polymorphisms in the leucine-rich-repeat domains of two closely related soybean genes allow them to distinguish between two pathogen effectors detected by a single disease resistance gene in Arabidopsis. 235

[W][OPEN] **Dynamic Transcriptome Landscape of Maize Embryo and Endosperm Development.** *Jian Chen, Biao Zeng, Mei Zhang, Shaojun Xie, Gaokui Wang, Andrew Hauck, and Jinsheng Lai*

A high-resolution spatiotemporal transcriptome atlas of maize seed uncovers the genetic control of embryo and endosperm development. 252

[W][OPEN] **Intraspecific Arabidopsis Hybrids Show Different Patterns of Heterosis Despite the Close Relatedness of the Parental Genomes.** *Michael Groszmann, Rebeca Gonzalez-Bayon, Ian K. Greaves, Li Wang, Amanda K. Huen, W. James Peacock, and Elizabeth S. Dennis*

Arabidopsis hybrids show different growth patterns in outperforming parents for biomass and yield associated with differences in gene expression patterns, suggesting multiple routes for hybrid vigor. 265

[W] **Auxin Perception Is Required for Arbuscule Development in Arbuscular Mycorrhizal Symbiosis.**
Mohammad Etemadi, Caroline Gutjahr, Jean-Malo Couzigou, Mohamed Zouine, Dominique Lauressergues, Antonius Timmers, Corinne Audran, Mondher Bouzayen, Guillaume Bécard, and Jean-Philippe Combier

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[C][W][OPEN] **Functional Diversification within the Family of B-GATA Transcription Factors through the Leucine-Leucine-Methionine Domain.** *Carina Behringer, Emmanouil Bastakis, Quirin L. Ranftl, Klaus F.X. Mayer, and Claus Schwechheimer*

The family of B-GATA transcription factors is not a uniform family but can be functionally divided based on the C-terminal leucine-leucine-methionine domain. 293

MEMBRANES, TRANSPORT, AND BIOENERGETICS

[W][OPEN] **Symplastic Phloem Loading in Poplar.** *Cankui Zhang, Lu Han, Thomas L. Slewinski, Jianlei Sun, Jing Zhang, Zeng-Yu Wang, and Robert Turgeon*

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[C][W]CPK13, a Noncanonical Ca^{2+} -Dependent Protein Kinase, Specifically Inhibits KAT2 and KAT1 Shaker K^+ Channels and Reduces Stomatal Opening. *Elsa Ronzier, Claire Corratgé-Faillie, Frédéric Sanchez, Karine Prado, Christian Brière, Nathalie Leonhardt, Jean-Baptiste Thibaud, and Tou Cheu Xiong*

A Ca^{2+} -dependent kinase is identified that phosphorylates and inhibits inward potassium channels expressed in guard cells, the overexpression of which results in a reduction of stomatal aperture.

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[W][OPEN]Plasma Membrane Localization Is Essential for *Oryza sativa* Pto-Interacting Protein 1a-Mediated Negative Regulation of Immune Signaling in Rice. *Hidenori Matsui, Masayuki Fujiwara, Satoshi Hamada, Ko Shimamoto, Yuko Nomura, Hirofumi Nakagami, Akira Takahashi, and Hirohiko Hirochika*

Appropriate complex formation at the plasma membrane is indispensable for a negative regulator of immune signaling in rice.

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SIGNALING AND RESPONSE

[W][OPEN]Ideal Osmotic Spaces for Chlorobionts or Cyanobionts Are Differentially Realized by Lichenized Fungi. *Makiko Kosugi, Ryoko Shizuma, Yufu Moriyama, Hiroyuki Koike, Yuko Fukunaga, Akihisa Takeuchi, Kentaro Uesugi, Yoshio Suzuki, Satoshi Imura, Sakae Kudoh, Atsuo Miyazawa, Yasuhiro Kashino, and Kazuhiko Satoh*

Lichenized fungi create a suitable habitat for their photobionts to ensure desiccation tolerance by differentially adjusting their cellular osmolarity to match those of chlorobionts or cyanobionts.

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[W][OPEN]bHLH05 Is an Interaction Partner of MYB51 and a Novel Regulator of Glucosinolate Biosynthesis in Arabidopsis. *Henning Frerigmann, Bettina Berger, and Tamara Gigolashvili*

Protein-protein interaction studies of R2R3 MYB transcription factors regulating glucosinolate biosynthesis and the analysis of multiple loss-of-function mutants and gain-of-function alleles demonstrated the specific role of an associated transcription factor complex in the transcriptional regulation of glucosinolate biosynthesis.

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[C][W][OPEN]ASCORBATE PEROXIDASE6 Protects Arabidopsis Desiccating and Germinating Seeds from Stress and Mediates Cross Talk between Reactive Oxygen Species, Abscisic Acid, and Auxin. *Changming Chen, Ilya Letnik, Yael Hacham, Petre Dobrev, Bat-Hen Ben-Daniel, Radomíra Vanková, Rachel Amir, and Gad Miller*

An ascorbate peroxidase functions to protect maturing and early germinating seeds from stress and modulate the seed's cellular metabolism and signaling.

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[W][OPEN]Auxin and Strigolactone Signaling Are Required for Modulation of Arabidopsis Shoot Branching by Nitrogen Supply. *Maaïke de Jong, Gilu George, Veronica Ongaro, Lisa Williamson, Barbara Willetts, Karin Ljung, Hayley McCulloch, and Ottoline Leyser*

Limited N supply suppresses shoot branching in Arabidopsis in a process that requires auxin and strigolactone signaling and involves an increase in auxin export from active shoot apices.

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[W][OPEN]Jasmonic Acid and Its Precursor 12-Oxophytodienoic Acid Control Different Aspects of Constitutive and Induced Herbivore Defenses in Tomato. *Marko Bosch, Louwance P. Wright, Jonathan Gershenzon, Claus Wasternack, Bettina Hause, Andreas Schaller, and Annick Stintzi*

Local induction of defense gene expression on wounding is mediated by 12-oxophytodienoic acid, in contrast with constitutive herbivore defense traits that rely on the biosynthesis of jasmonic acid and its isoleucine conjugate.

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[W]Phototropin Encoded by a Single-Copy Gene Mediates Chloroplast Photorelocation Movements in the Liverwort *Marchantia polymorpha*. *Aino Komatsu, Mika Terai, Kimitsune Ishizaki, Noriyuki Suetsugu, Hidenori Tsuboi, Ryuichi Nishihama, Katsuyuki T. Yamato, Masamitsu Wada, and Takayuki Kohchi*

*Phototropin, encoded by a single-copy gene, mediates chloroplast movements in *Marchantia polymorpha*, and its expression can rescue the phot mutant defects in vascular plants.*

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CORRECTION

The Ubiquitin E3 Ligase LOSS OF GDU2 Is Required for GLUTAMINE DUMPER1-Induced Amino Acid Secretion in Arabidopsis. *Pratelli R., Guerra D.D., Yu S., Wogulis M., Kraft E., Frommer W.B., Callis J., and Pilot G.*

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