

On the Cover: During development, many plant cell types replicate their DNA several times without cell division in a process known as endoreplication, resulting in a polyploid nucleus. Wild-type *Arabidopsis* trichomes are unicellular and endoreplicated, and the cyclin-dependent kinase inhibitor SIM plays a central role in inhibiting mitosis during trichome development. This scanning electron microscope image shows a multicellular trichome on a leaf of a *sim* mutant plant. Credit: Narender Kumar, Louisiana State University.

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BREAKTHROUGH TECHNOLOGIES

^[CC-BY]Foxtail mosaic virus: A Viral Vector for Protein Expression in Cereals. Clément Bouton,
Robert C. King, Hongxin Chen, Kasi Azhakanandam, Stéphane Bieri, Kim E. Hammond-Kosack,
and Kostya Kanyuka
*A foxtail mosaic virus vector allows the rapid expression of heterologous proteins of up to 600 amino acids
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^[CC-BY]EZ-Root-VIS: A Software Pipeline for the Rapid Analysis and Visual Reconstruction of
Root System Architecture. Zaigham Shahzad, Fabian Kellermeier, Emily M. Armstrong, Simon Rogers,
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*EZ-Root-VIS is a free software package that enables the rapid quantification and visual reconstruction
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^[OPEN]The Persistent Homology Mathematical Framework Provides Enhanced Genotype-to-Phenotype
Associations for Plant Morphology. Mao Li, Margaret H. Frank, Viktoriya Coneva, Washington Mio,
Daniel H. Chitwood, and Christopher N. Topp
*Persistent homology offers a mathematical framework to quantify diverse plant morphologies and significantly
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RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

^[OPEN]Heterologous Expression of Key C and N Metabolic Enzymes Improves Re-assimilation of
Photorespired CO₂ and NH₃, and Growth. Anish Kaachra, Surender Kumar Vats, and Sanjay Kumar
*Heterologous coexpression of phosphoenolpyruvate carboxylase (ZmPepcase), aspartate aminotransferase
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NH₃ with concomitant gains in shoot biomass and seed yield in transgenic Arabidopsis.* 1396

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- [OPEN] **DIACYLGLYCEROL ACYLTRANSFERASE1** Contributes to Freezing Tolerance. Steven A. Arisz, Jae-Yun Heo, Iko T. Koevoets, Tao Zhao, Pieter van Egmond, A. Jessica Meyer, Weiqing Zeng, Xiaomu Niu, Baosheng Wang, Thomas Mitchell-Olds, M. Eric Schranz, and Christa Testerink
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- [OPEN] **Editing of an Alpha-Kafirin Gene Family Increases, Digestibility and Protein Quality in Sorghum.** Aixia Li, Shangang Jia, Abou Yobi, Zhengxiang Ge, Shirley J. Sato, Chi Zhang, Ruthie Angelovici, Thomas E. Clemente, and David R. Holding
Single-consensus guide RNA partially reduces kafirin levels in Sorghum bicolor grain, leading to an increased proportion of non-kafirins and improved digestibility and protein quality. 1425
- [OPEN] **An Assembly Factor Promotes Assembly of Flavinated SDH1 into the Succinate Dehydrogenase Complex.** Katharina Belt, Olivier Van Aken, Monika Murcha, A. Harvey Millar, and Shaobai Huang
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- [OPEN] **ONE-HELIX PROTEIN2 (OHP2) Is Required for the Stability of OHP1 and Assembly Factor HCF244 and Is Functionally Linked to PSII Biogenesis.** Daniel Hey and Bernhard Grimm
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- Two Tabersonine 6,7-Epoxidases Initiate Lochnericine-Derived Alkaloid Biosynthesis in Catharanthus roseus.** Inês Carqueijeiro, Stephanie Brown, Khoa Chung, Thu-Thuy Dang, Manish Walia, Sébastien Besseau, Thomas Dugé de Bernonville, Audrey Oudin, Arnaud Lanoue, Kevin Billet, Thibaut Munsch, Konstantinos Koudounas, Céline Melin, Charlotte Godon, Bienvenue Razafimandimby, Johan-Owen de Craene, Gaëlle Glévarec, Jillian Marc, Nathalie Giglioli-Guivarc'h, Marc Clastre, Benoît St-Pierre, Nicolas Papon, Rodrigo B. Andrade, Sarah E. O'Connor, and Vincent Courdavault
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- Digalactosyldiacylglycerol Is Essential for Organization of the Membrane Structure in Etioplasts.** Sho Fujii, Koichi Kobayashi, Noriko Nagata, Tatsuru Masuda, and Hajime Wada
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- [OPEN] **Jasmonate Hydroxylase, a Key Enzyme in the Synthesis of the Alcohol Moiety of Pyrethrin Insecticides.** Wei Li, Fei Zhou, and Eran Pichersky
A Tanacetum cinerariifolium CYP71 cytochrome P450 enzyme catalyzes the hydroxylation of jasmonate to jasmolone, an alcohol moiety of pyrethrin insecticides. 1498
- Protein Carbonylation and Glycation in Legume Nodules.** Manuel A. Matamoros, Ahyoung Kim, María Peñuelas, Christian Ihling, Eva Griesser, Ralf Hoffmann, Maria Fedorova, Andrej Frolov, and Manuel Becana
In legume nodules, selective carbonylation and glycation of proteins occurs during nodule development and may have a role in the regulation of metabolism and senescence. 1510

CELL BIOLOGY

[OPEN] **Arabidopsis VAC14 Is Critical for Pollen Development through Mediating Vacuolar Organization.** Wei-Tong Zhang, En Li, Yan-Kui Guo, Shi-Xia Yu, Zhi-Yuan Wan, Ting Ma, Sha Li, Tomoko Hirano, Masa H. Sato, and Yan Zhang

Arabidopsis thaliana VAC14 is critical for pollen development likely by mediating the production of PI(3,5)P₂ to regulate dynamic vacuolar organization.

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[OPEN] **CHLOROPLAST RIBOSOME ASSOCIATED Supports Translation under Stress and Interacts with the Ribosomal 30S Subunit.** Pablo Pulido, Nicola Zagari, Nikolay Manavski, Piotr Gawronski, Annemarie Matthes, Lars B. Scharff, Jörg Meurer, and Dario Leister

CHLOROPLAST RIBOSOME ASSOCIATED plays a role in the biogenesis and/or stability of the chloroplast ribosome, especially under stress when ribosomal activity is compromised.

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The Microtubule-Associated Protein IQ67 DOMAIN5 Modulates Microtubule Dynamics and Pavement Cell Shape. Hong Liang, Yi Zhang, Pablo Martinez, Carolyn G. Rasmussen, Tongda Xu, and Zhenbiao Yang

The microtubule-associated protein IQD5 binds directly to microtubules to promote their stability, which affects subsequent cell shape formation in Arabidopsis.

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[OPEN] **Functional Analysis of Short Linear Motifs in the Plant Cyclin-Dependent Kinase Inhibitor SIAMESE.** Narender Kumar, Renee Dale, Daniel Kemboi, Elizabeth A. Zeringue, Naohiro Kato, and John C. Larkin

Sequences essential for the function of the CDK inhibitor SIAMESE are identified using site-directed mutagenesis.

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GENES, DEVELOPMENT, AND EVOLUTION

[OPEN] **ALTERED MERISTEM PROGRAM1 Restricts Shoot Meristem Proliferation and Regeneration by Limiting HD-ZIP III-Mediated Expression of RAP2.6L.** Saiqi Yang, Olena Poretska, and Tobias Sieberer

Hypertrophy of the shoot meristem and increased shoot regeneration capacity in the amp1 mutant depend on the enhanced expression of RAP2.6L, a direct target of miRNA-regulated HD-ZIP III transcription factors in Arabidopsis thaliana.

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[OPEN] **Evidence for Exaptation of the *Marchantia polymorpha* M20D Peptidase MpILR1 into the Tracheophyte Auxin Regulatory Pathway.** James J. Campanella, Stephanie Kurdach, Joy Bochis, and John V. Smalley

Characterization of the ancient auxin conjugate hydrolase MpILR1 from liverwort provides evidence of its exaptation in the evolution of tracheophytes.

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[OPEN] **NMT1 and NMT3 N-Methyltransferase Activity Is Critical to Lipid Homeostasis, Morphogenesis, and Reproduction.** Weihua Chen, Hooman Salari, Matthew C. Taylor, Ricarda Jost, Oliver Berkowitz, Russell Barrow, Deyun Qiu, Rémi Branco, and Josette Masle

The NMT1 and NMT3 phosphoethanolamine N-methyltransferases are required to sustain phosphatidylcholine synthesis above levels needed for growth, development, and reproduction in Arabidopsis thaliana.

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MEMBRANES, TRANSPORT, AND BIOENERGETICS

Infrared Nanospectroscopy Reveals the Chemical Nature of Pit Membranes in Water-Conducting Cells of the Plant Xylem. Luciano Pereira, Denisele N.A. Flores-Borges, Paulo R.L. Bittencourt, Juliana L.S. Mayer, Eduardo Kiyota, Pedro Araújo, Steven Jansen, Raul O. Freitas, Rafael S. Oliveira, and Paulo Mazzafera

Intervessel pit membranes have a complex chemical composition in water-conducting cells of Populus nigra xylem.

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^[OPEN]Flavodiiron-Mediated O₂ Photoreduction Links H₂ Production with CO₂ Fixation during the Anaerobic Induction of Photosynthesis. Adrien Burlacot, Anne Sawyer, Stéphan Cuiné, Pascaline Auroy-Tarrago, Stéphanie Blangy, Thomas Happe, and Gilles Peltier

Flavodiiron proteins recycle large amounts of O₂ during the anaerobic induction of photosynthesis and act as a relay of hydrogenases in priming CO₂ fixation in Chlamydomonas reinhardtii.

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SIGNALING AND RESPONSE

^[OPEN]The 6xABRE Synthetic Promoter Enables the Spatiotemporal Analysis of ABA-Mediated Transcriptional Regulation. Rui Wu, Lina Duan, José L. Pruneda-Paz, Dong-ha Oh, Michael Pound, Steve Kay, and José R. Dinneny

Spatiotemporal analysis of ABA-signaling in plants reveals the dynamics of osmotic stress signaling in roots and identifies novel regulators of ABA-dependent transcriptional programs.

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A Tonoplast-Associated Calcium-Signaling Module Dampens ABA Signaling during Stomatal Movement. Shi-Jian Song, Qiang-Nan Feng, Chun-Long Li, En Li, Qi Liu, Hui Kang, Wei Zhang, Yan Zhang, and Sha Li

Arabidopsis PAT10 and its downstream tonoplast calcineurin B-like proteins (CBLs) and CBL-interacting protein kinases negatively mediate ABA signaling in guard cells by promoting vacuolar potassium influx and preventing fast vacuolar convulsion.

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Roles of Receptor-Like Cytoplasmic Kinase VII Members in Pattern-Triggered Immune Signaling. Shaofei Rao, Zhaoyang Zhou, Pei Miao, Guozhi Bi, Man Hu, Ying Wu, Feng Feng, Xiaojuan Zhang, and Jian-Min Zhou

Numerous RLCK VII members modulate plant immune signaling in overlapping and specific manners.

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MicroRNA166 Modulates Cadmium Tolerance and Accumulation in Rice. Yanfei Ding, Shaohua Gong, Yi Wang, Feijuan Wang, Hexigeduleng Bao, Junwei Sun, Chong Cai, Keke Yi, Zhixiang Chen, and Cheng Zhu

miR166-overexpressing plants show lower Cd-induced oxidative stress and Cd accumulation than in wild-type plants.

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Jasmonic Acid Inhibits Auxin-Induced Lateral Rooting Independently of the CORONATINE INSENSITIVE1 Receptor. Yasuhiro Ishimaru, Kengo Hayashi, Takeshi Suzuki, Hidehiro Fukaki, Justyna Prusinska, Christian Meester, Mussa Quareshy, Syusuke Egoshi, Hideyuki Matsuura, Kosaku Takahashi, Nobuki Kato, Erich Kombrink, Richard M. Napier, Ken-ichiro Hayashi, and Minoru Ueda

JA preferentially inhibits auxin-induced lateral rooting via stabilization of Aux/IAA repressors.

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[^{OPEN}] Singlet Oxygen Plays an Essential Role in the Root's Response to Osmotic Stress.
Tomer Chen and Robert Fluhr

Singlet oxygen generation is an essential component of root response to osmotic stress in Arabidopsis.

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The Polycomb-Group Repressor MEDEA Attenuates Pathogen Defense. *Shweta Roy, Priya Gupta, Mohit Pradip Rajabhoj, Ravi Maruthachalam, and Ashis Kumar Nandi*

Pathogen inoculation in Arabidopsis thaliana activates the expression of the imprinted gene MEDEA, a component of the PRC2 complex, which hinders defense against pathogens.

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The PILNCR1-miR399 Regulatory Module Is Important for Low Phosphate Tolerance in Maize.
Qingguo Du, Kai Wang, Cheng Zou, Cheng Xu, and Wen-Xue Li

The interaction between the long non-coding RNA PILNCR1 and the microRNA miR399 is important for low Pi tolerance in maize (Zea mays).

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SYSTEMS AND SYNTHETIC BIOLOGY

[^{OPEN}] Characterization of Imprinted Genes in Rice Reveals Conservation of Regulation and Imprinting with Other Plant Species. *Chen Chen, Tingting Li, Shan Zhu, Zehou Liu, Zhenyuan Shi, Xiaoming Zheng, Rui Chen, Jianfeng Huang, Yi Shen, Shiyu Luo, Lei Wang, Qiao-Quan Liu, and Zhiguo E*

Compared with other species, rice imprinted genes are less associated with transposable elements, and the epigenetic regulation of imprinting occurs both pre-fertilization and post-fertilization in rice.

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CORRECTION

Arabidopsis β -Amylase2 Is a K^+ -Requiring, Catalytic Tetramer with Sigmoidal Kinetics.
Monroe J.D., Breault J.S., Pope L.E., Torres C.E., Gebrejesus T.B., Berndsen C.E., and Storm A.R.

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A Cotton Annexin Affects Fiber Elongation and Secondary Cell Wall Biosynthesis Associated with Ca^{2+} Influx, ROS Homeostasis, and Actin Filament Reorganization. *Zhang F., Jin X., Wang L., Li S., Wu S., Cheng C., Zhang T., and Guo W.*

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