

On the Cover: Plant cell growth is constrained by cell walls that glue neighboring cells together, yet the growth of these cells within a tissue can be highly variable. To understand this, Tauriello et al. (pp. 2342–2358) observed and analyzed dividing cells in live *Arabidopsis* (*Arabidopsis thaliana*) sepals. They tracked cell lineages at 6-hour intervals to extract growth curves for all lineages. These growth curves showed varying growth rates in space and time. The constant property was that all cell lineages reached the same maximum growth rate relative to their size. Thus, despite the observed variability, individual cell lineages follow similarly shaped growth curves. The cover image shows cell lineages on the abaxial epidermis of an *Arabidopsis* sepal grown for 66 h. Cell outlines are marked with blue dots. Each cell and all of its daughters in a single lineage have the same color. Cell lineages are superimposed on plasma membranes and nuclei (in gray). Cover image credits: Gerardo Tauriello (ETH Zürich), Heather M. Meyer (Cornell University), and Adrienne H.K. Roeder (Cornell University).

ON THE INSIDE

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COMMENTARY

A View to a Kill: Markers for Developmentally Regulated Cell Death in Plants. Alexis Maizel 2341

BREAKTHROUGH TECHNOLOGIES

^[OPEN]Variability and Constancy in Cellular Growth of *Arabidopsis* Sepals. Gerardo Tauriello, Heather M. Meyer, Richard S. Smith, Petros Koumoutsakos, and Adrienne H.K. Roeder

The growth of cells in the developing sepal is highly variable, but all cells exhibit a surprisingly common, asynchronous maximum growth rate relative to their size. 2342

^[OPEN]phenoVein—A Tool for Leaf Vein Segmentation and Analysis. Jonas Bühler, Louai Rishmawi, Daniel Pflugfelder, Gregor Huber, Hanno Scharr, Martin Hülskamp, Maarten Koornneef, Ulrich Schurr, and Siegfried Jahnke

phenoVein is a user-friendly software tool designed for automated leaf vein segmentation and analysis of leaf vein traits, including a model-based vein width determination. 2359

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Ethylene: Traffic Controller on Hormonal Crossroads to Defense. Colette Broekgaarden, Lotte Caarls, Irene A. Vos, Corné M.J. Pieterse, and Saskia C.M. Van Wees

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Ethylene Control of Fruit Ripening: Revisiting the Complex Network of Transcriptional Regulation. Mingchun Liu, Julien Pirrello, Christian Chervin, Jean-Paul Roustan, and Mondher Bouzayen

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RESEARCH ARTICLES

BIOCHEMISTRY AND METABOLISM

[OPEN] An Intracellular Laccase Is Responsible for Epicatechin-Mediated Anthocyanin Degradation in Litchi Fruit Pericarp. Fang Fang, Xue-lian Zhang, Hong-hui Luo, Jia-jian Zhou, Yi-hui Gong, Wen-jun Li, Zhao-wan Shi, Quan He, Qing Wu, Lu Li, Lin-lin Jiang, Zhi-gao Cai, Michal Oren-Shamir, Zhao-qi Zhang, and Xue-qun Pang

Anthocyanin degradation by an intracellular laccase, mediated by epicatechin oxidation, causes the loss of red color in Litchi fruit peel. 2391

[OPEN] Four Isoforms of Arabidopsis 4-Coumarate:CoA Ligase Have Overlapping yet Distinct Roles in Phenylpropanoid Metabolism. Yi Li, Jeong Im Kim, Len Pysh, and Clint Chapple

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[OPEN] Developmental and Metabolic Plasticity of White-Skinned Grape Berries in Response to *Botrytis cinerea* during Noble Rot. Barbara Blanco-Ulate, Katherine C.H. Amrine, Thomas S. Collins, Rosa M. Rivero, Ariel R. Vicente, Abraham Morales-Cruz, Carolyn L. Doyle, Zirou Ye, Greg Allen, Hildegard Heymann, Susan E. Ebeler, and Dario Cantu

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Comparative Transcriptomics Unravel Biochemical Specialization of Leaf Tissues of Stevia for Diterpenoid Production. Mi Jung Kim, Jingjing Jin, Junshi Zheng, Limsoon Wong, Nam-Hai Chua, and In-Cheol Jang

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[OPEN] Highly Branched Xylan Made by IRREGULAR XYLEM14 and MUCILAGE-RELATED21 Links Mucilage to Arabidopsis Seeds. Cătălin Voiniciuc, Markus Günl, Maximilian Heinrich-Wilhelm Schmidt, and Björn Usadel

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[OPEN] The Arabidopsis Class III Peroxidase AtPRX71 Negatively Regulates Growth under Physiological Conditions and in Response to Cell Wall Damage. Sara Raggi, Alberto Ferrarini, Massimo Delledonne, Christophe Dunand, Philippe Ranocha, Giulia De Lorenzo, Felice Cervone, and Simone Ferrari

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[OPEN] RNA Silencing of Exocyst Genes in the Stigma Impairs the Acceptance of Compatible Pollen in Arabidopsis. Darya Safavian, Yara Zayed, Emily Indriolo, Laura Chapman, Abdalla Ahmed, and Daphne R. Goring

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MicroRNA857 Is Involved in the Regulation of Secondary Growth of Vascular Tissues in Arabidopsis. Yuanyuan Zhao, Sen Lin, Zongbo Qiu, Dechang Cao, Jialong Wen, Xin Deng, Xiaohua Wang, Jinxing Lin, and Xiaojuan Li

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An ABA-dependent increase of root hydraulic conductivity and aquaporin expression mediates the plant shoot enhancement caused by dissolved sedimentary humic acids. 2587

[OPEN] Stem Hydraulic Conductivity depends on the Pressure at Which It Is Measured and How This Dependence Can Be Used to Assess the Tempo of Bubble Pressurization in Recently Cavitated Vessels. Yujie Wang, Jinyu Liu, and Melvin T. Tyree

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[^{OPEN}] Auxin Resistant1 and PIN-FORMED2 Protect Lateral Root Formation in Arabidopsis under Iron Stress. *Guangjie Li, Haiyan Song, Baohai Li, Herbert J. Kronzucker, and Weiming Shi*

Iron stress modulates auxin and ethylene pathways to regulate lateral root formation in Arabidopsis. 2608

[^{OPEN}] The Interplay between Sulfur and Iron Nutrition in Tomato. *Sabrina Zuchi, Mutsumi Watanabe, Hans-Michael Hubberten, Mariusz Bromke, Sonia Osorio, Alisdair R. Fernie, Silvia Celletti, Anna Rita Paolacci, Giulio Catarcione, Mario Ciaffi, Rainer Hoefgen, and Stefania Astolfi*

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[^{OPEN}] GmEXPB2, a Cell Wall β -Expansin, Affects Soybean Nodulation through Modifying Root Architecture and Promoting Nodule Formation and Development. *Xinxin Li, Jing Zhao, Zhiyuan Tan, Rensen Zeng, and Hong Liao*

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[^{OPEN}] Metabolite Profiles of Maize Leaves in Drought, Heat, and Combined Stress Field Trials Reveal the Relationship between Metabolism and Grain Yield. *Toshihiro Obata, Sandra Witt, Jan Liseč, Natalia Palacios-Rojas, Igor Florez-Sarasa, Salima Yousfi, Jose Luis Araus, Jill E. Cairns, and Alisdair R. Fernie*

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GENES, DEVELOPMENT, AND EVOLUTION

[^{OPEN}] A Conserved Core of Programmed Cell Death Indicator Genes Discriminates Developmentally and Environmentally Induced Programmed Cell Death in Plants. *Yadira Olvera-Carrillo, Michiel Van Bel, Tom Van Hautegeem, Matyáš Fendrych, Marlies Huysmans, Maria Simaskova, Matthias van Durme, Pierre Buscaill, Susana Rivas, Nuria S. Coll, Frederik Coppens, Steven Maere, and Moritz K. Nowack*

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[^{OPEN}] Polyploidy Enhances F₁ Pollen Sterility Loci Interactions That Increase Meiosis Abnormalities and Pollen Sterility in Autotetraploid Rice. *Jinwen Wu, Muhammad Qasim Shahid, Lin Chen, Zhixiong Chen, Lan Wang, Xiangdong Liu, and Yonggen Lu*

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Dynamic Changes in the Transcriptome and Methylome of *Chlamydomonas reinhardtii* throughout Its Life Cycle. *David Lopez, Takashi Hamaji, Janette Kropat, Peter De Hoff, Marco Morselli, Liudmilla Rubbi, Sorel Fitz-Gibbon, Sean D. Gallaher, Sabeeha S. Merchant, James Umen, and Matteo Pellegrini*

Secretory and alga-specific genes are induced during gamete and zygote development in Chlamydomonas reinhardtii, concurrent with a dramatic increase in chloroplast cytosine methylation.

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BnaC9.SMG7b Functions as a Positive Regulator of the Number of Seeds per Silique in *Brassica napus* by Regulating the Formation of Functional Female Gametophytes. *Shipeng Li, Lei Chen, Liwu Zhang, Xi Li, Ying Liu, Zhikun Wu, Faming Dong, Lili Wan, Kede Liu, Dengfeng Hong, and Guangsheng Yang*

A major QTL encodes a small protein with an Arabidopsis homolog and promotes the formation of functional ovules, thus yielding more seeds per silique in Brassica napus.

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[OPEN] A Phylogenetically Conserved Group of Nuclear Factor-Y Transcription Factors Interact to Control Nodulation in Legumes. *Maël Baudin, Tom Laloum, Agnès Lepage, Carolina Rípodas, Federico Ariel, Lisa Frances, Martin Crespi, Pascal Gamas, Flavio Antonio Blanco, Maria Eugenia Zanetti, Fernanda de Carvalho-Niebel, and Andreas Niebel*

A phylogenetically conserved group of transcription factors form trimers to regulate root nodule development and early gene expression during the legume-Rhizobium symbiosis.

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[OPEN] Hyphal Branching during Arbuscule Development Requires Reduced Arbuscular Mycorrhiza1. *Hee-Jin Park, Daniela S. Floss, Veronique Levesque-Tremblay, Armando Bravo, and Maria J. Harrison*

A plant transcription factor regulates the expression of genes necessary to enable arbuscular mycorrhizal fungi to develop branched hyphae in root cortical cells.

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[OPEN] SUPPRESSOR OF APICAL DOMINANCE1 of *Sporisorium reilianum* Modulates Inflorescence Branching Architecture in Maize and Arabidopsis. *Hassan Ghareeb, Frank Drechsler, Christian Löffke, Thomas Teichmann, and Jan Schirawski*

A fungal protein increases plant inflorescence branching when both delivered by the fungus in maize and stably expressed in Arabidopsis, suggesting a conserved pathway for function.

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[OPEN] LEAFY COTYLEDON1-CASEIN KINASE I-TCP15-PHYTOCHROME INTERACTING FACTOR4 Network Regulates Somatic Embryogenesis by Regulating Auxin Homeostasis. *Ling Min, Qin Hu, Yaoyao Li, Jiao Xu, Yizan Ma, Longfu Zhu, Xiyang Yang, and Xianlong Zhang*

A gene network regulates auxin homeostasis, thereby affecting cell proliferation and the transition from nonembryogenic callus to somatic embryos during somatic embryogenesis.

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MEMBRANES, TRANSPORT, AND BIOENERGETICS

[^{OPEN}]Rice SPX-Major Facility Superfamily3, a Vacuolar Phosphate Efflux Transporter, Is Involved in Maintaining Phosphate Homeostasis in Rice. *Chuang Wang, Wenhao Yue, Yinghui Ying, Shoudong Wang, David Secco, Yu Liu, James Whelan, Stephen D. Tyerman, and Huixia Shou*

A transporter orthologous to a yeast vacuole phosphate transporter mediates phosphate efflux from the vacuole into the cytosol. 2822

[^{OPEN}]Nitrate-Dependent Control of Shoot K Homeostasis by the Nitrate Transporter1/Peptide Transporter Family Member NPF7.3/NRT1.5 and the Stelar K⁺ Outward Rectifier SKOR in Arabidopsis. *Navina Drechsler, Yue Zheng, Anne Bohner, Barbara Nobmann, Nicolaus von Wirén, Reinhard Kunze, and Christine Rausch*

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[^{OPEN}]Enhanced Sucrose Loading Improves Rice Yield by Increasing Grain Size. *Liang Wang, Qingtao Lu, Xiaogang Wen, and Congming Lu*

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[^{OPEN}]The CBL-Interacting Protein Kinase CIPK23 Regulates HAK5-Mediated High-Affinity K⁺ Uptake in Arabidopsis Roots. *Paula Ragel, Reyes Ródenas, Elena García-Martín, Zaida Andrés, Irene Villalta, Manuel Nieves-Cordones, Rosa M. Rivero, Vicente Martínez, Jose M. Pardo, Francisco J. Quintero, and Francisco Rubio*

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[^{OPEN}]Phosphorylation of the Light-Harvesting Complex II Isoform Lhcb2 Is Central to State Transitions. *Paolo Longoni, Damien Douchi, Federica Cariti, Geoffrey Fucile, and Michel Goldschmidt-Clermont*

Differential phosphorylation of the Lhcb1 and Lhcb2 subunits of Light Harvesting Complex II plays contrasting roles in photosynthetic light acclimation and supercomplex assembly. 2874

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Leaf herbivore attack changes free and conjugated phenolic acids in maize roots and thereby triggers an avoidance response in a specialist root herbivore. 2884

[^{OPEN}]TaFROG Encodes a Pooideae Orphan Protein That Interacts with SnRK1 and Enhances Resistance to the Mycotoxigenic Fungus *Fusarium graminearum*. *Alexandre Perochon, Jia Jianguang, Amal Kahla, Chanemougasoundharam Arunachalam, Steven R. Scofield, Sarah Bowden, Emma Wallington, and Fiona M. Doohan*

A Pooideae orphan protein that enhances plant resistance against a toxigenic fungus physically interacts with a key signaling protein. 2895

The Rice Transcription Factor WRKY53 Suppresses Herbivore-Induced Defenses by Acting as a Negative Feedback Modulator of Mitogen-Activated Protein Kinase Activity. *Lingfei Hu, Meng Ye, Ran Li, Tongfang Zhang, Guoxin Zhou, Qi Wang, Jing Lu, and Yonggen Lou*

A transcription factor functions as a negative feedback modulator of two mitogen-activated protein kinases and thereby acts as an early suppressor of herbivore-induced defenses in rice.

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[OPEN] Short Hypocotyl in White Light1 Interacts with Elongated Hypocotyl5 (HY5) and Constitutive Photomorphogenic1 (COP1) and Promotes COP1-Mediated Degradation of HY5 during Arabidopsis Seedling Development. *Anjil Kumar Srivastava, Dhirodatta Senapati, Archana Srivastava, Moumita Chakraborty, Sreeramaiah N. Gangappa, and Sudip Chattopadhyay*

A unique regulator of proteasome-mediated degradation of photomorphogenesis-promoting factors affects Arabidopsis seedling development.

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[OPEN] OsMADS26 Negatively Regulates Resistance to Pathogens and Drought Tolerance in Rice. *Giang Ngan Khong, Pratap Kumar Pati, Frédérique Richaud, Boris Parizot, Przemyslaw Bidzinski, Chung Duc Mai, Martine Bès, Isabelle Bourrié, Donald Meynard, Tom Beeckman, Michael Gomez Selvaraj, Ishitani Manabu, Anna-Maria Genga, Christophe Brugidou, Vinh Nang Do, Emmanuel Guiderdoni, Jean-Benoit Morel, and Pascal Gantet*

A MADS-box transcription factor represses resistance to pathogenic microorganisms and water deficit, and its down-regulation results in improved biotic and abiotic stress tolerance of rice.

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[OPEN] PBL13 Is a Serine/Threonine Protein Kinase That Negatively Regulates Arabidopsis Immune Responses. *Zuh-Jyh Daniel Lin, Thomas W.H. Liebrand, Koste A. Yadeta, and Gitta Coaker*

An Arabidopsis kinase possesses a unique repeat motif and suppresses resistance to the bacterial pathogen Pseudomonas syringae.

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[OPEN] Glutathione Regulates 1-Aminocyclopropane-1-Carboxylate Synthase Transcription via WRKY33 and 1-Aminocyclopropane-1-Carboxylate Oxidase by Modulating Messenger RNA Stability to Induce Ethylene Synthesis during Stress. *Riddhi Datta, Deepak Kumar, Asma Sultana, Saptarshi Hazra, Dipto Bhattacharyya, and Sharmila Chattopadhyay*

Glutathione induces ethylene biosynthesis by enhancing ACC synthase transcription and increasing the mRNA stability of ACC oxidase during stress.

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SYSTEMS AND SYNTHETIC BIOLOGY

[OPEN] Evolution of Cis-Regulatory Elements and Regulatory Networks in Duplicated Genes of Arabidopsis. *Andrej A. Arsoovski, Julian Pradinuk, Xu Qiu Guo, Sishuo Wang, and Keith L. Adams*

Cis-regulatory elements and regulatory networks have diverged considerably in duplicated genes.

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Engineering Monolignol *p*-Coumarate Conjugates into Poplar and Arabidopsis Lignins. *Rebecca A. Smith, Eliana Gonzales-Vigil, Steven D. Karlen, Ji-Young Park, Fachuang Lu, Curtis G. Wilkerson, Lacey Samuels, John Ralph, and Shawn D. Mansfield*

Novel monolignol p-coumarate conjugates in eudicot lignin result from the introduction of a monocot acyltransferase.

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[OPEN] Unraveling the Light-Specific Metabolic and Regulatory Signatures of Rice through Combined *in Silico* Modeling and Multiomics Analysis. *Meiyappan Lakshmanan, Sun-Hyung Lim, Bijayalaxmi Mohanty, Jae Kwang Kim, Sun-Hwa Ha, and Dong-Yup Lee*

Combined in silico modeling and multiomics data analysis elucidate the transcriptional control of rice cellular metabolism upon light signaling.

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Changes in the Phosphoproteome and Metabolome Link Early Signaling Events to Rearrangement of Photosynthesis and Central Metabolism in Salinity and Oxidative Stress Response in *Arabidopsis*. *Yanmei Chen and Wolfgang Hoehenwarter*

Rearrangement of central metabolism and photosynthesis is linked to the dynamic phosphoproteome in abiotic stress signaling in Arabidopsis.

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