On the Cover: Cell walls constitute complex composites of macromolecules that are of profound importance to the life of plant cells. Synthesized and secreted by highly dynamic biosynthetic machinery, the polymeric constituents must be accurately deposited into the microarchitecture of the wall in order for it to function competently. Presently, these structural and developmental properties, especially as they contribute to interactive polymeric networks in the wall, are poorly resolved. In this issue, Domozych et al. (pp. 105–118) employ the unicellular charophyte green alga, *Penium margaritaceum*, to investigate pectin architecture and dynamics in the cell wall. The outer layer of the wall is comprised of homogalacturonan fibrils that form dense aggregates that organize into a distinct outer lattice. Changes to lattice architecture may be directly monitored in live cells grown under different experimental conditions. This includes variations in levels of cations (e.g. calcium), exogenous pectin, pectin methylesterase, and pectate lyase. Pectin deposition is focused at a thin band at the cell isthmus and is part of a wall expansion mechanism that occurs in a distinct bidirectional fashion. These results highlight the efficiency of *P. margaritaceum* as a unicellular model organism for cell wall studies and provide new insight into pectin-based functions, including adhesion and cell shape maintenance. The cover shows the outer pectin lattice of the cell wall labeled with the anti-homogalacturonan monoclonal antibody, LM18. Cover image credits: David Domozych.

**ON THE INSIDE**

Peter V. Minorsky

**BREAKTHROUGH TECHNOLOGIES**

High-Efficiency Stable Transformation of the Model Fern Species *Ceratopteris richardii* via Microparticle Bombardment. Andrew R.G. Plackett, Liandong Huang, Heather L. Sanders, and Jane A. Langdale

A highly efficient method transforms fern callus tissue, with rapid and simple selection for stable transgenic lines through antibiotic selection.


Artificial microRNAs and synthetic trans-acting small interfering RNAs produced from new, high-efficiency expression vectors induce reliable gene silencing in Arabidopsis.

**RESEARCH REPORTS**

Multigene Engineering of Triacylglycerol Metabolism Boosts Seed Oil Content in Arabidopsis. Harrie van Erp, Amélie A. Kelly, Guillaume Menard, and Peter J. Eastmond

Transgenes specifically targeting fatty acid synthesis, triacylglycerol synthesis, and triacylglycerol breakdown lead to an additive effect on seed oil content in Arabidopsis.

**RESEARCH ARTICLES**

**BIOCHEMISTRY AND METABOLISM**

Metabolic Flux Analysis of Plastidic Isoprenoid Biosynthesis in Poplar Leaves Emitting and Nonemitting Isoprene. Andrea Ghirardo, Louavance Peter Wright, Zhen Bi, Maaria Rosenkranz, Pablo Pulido, Manuel Rodríguez-Concepción, Úlo Niinemets, Nicolas Brüggemann, Jonathan Gershenzon, and Jörg-Peter Schnitzler

Isoprene biosynthesis demands a huge carbon flux through the plastidic isoprenoid pathway, and the concentration of its immediate precursor modulates this flux.
Plants Utilize a Highly Conserved System for Repair of NADH and NADPH Hydrates. Tom D. Niehaus, Lynn G. L. Richardson, Satinder K. Gidda, Mona ElBadawi-Sidhu, John K. Meissen, Robert T. Mullen, Oliver Fiehn, and Andrew D. Hanson

The hydrates formed from NADH and NADPH by chemical or enzymatic damage are repaired in plants by highly conserved enzymes that are targeted to multiple compartments.

Evolutionary Convergence of Cell-Specific Gene Expression in Independent Lineages of C4 Grasses. Christopher R. John, Richard D. Smith-Unna, Helen Woodfield, Sarah Covshoff, and Julian M. Hibberd

Maize and Setaria viridis have independently recruited syntenic orthologs into the C4 pathway, and transcript abundance in the mesophyll and bundle sheath cells of these species is highly convergent.

Pepper Suppressor of the G2 Allele of skp1 Interacts with the Receptor-Like Cytoplasmic Kinase1 and Type III Effector AvrBsT and Promotes the Hypersensitive Cell Death Response in a Phosphorylation-Dependent Manner. Nak Hyun Kim, Dae Sung Kim, Eui Hwan Chung, and Byung Kook Huang

A pepper receptor-like cytoplasmic kinase and Xanthomonas effector complex promote cell death in a phosphorylation-dependent manner.


A mitochondrial pathway oxidizes hydrogen sulfide or persulfides derived from amino acid catabolism to thiosulfate and affects alternative respiration during carbohydrate starvation.

Expression of Dunaliella bardawil ω-carotene desaturase is attributed to a hypoosmolarity-responsive element different from other key carotenogenic genes. Yong-Min Lao, Lan Xiao, Li-Xin Luo, and Jian-Guo Jiang

Coenzyme A reductases contribute to the production of triterpene saponin in ginseng. Yu-Jin Kim, Ok Ran Lee, Ji Yeon Oh, Moon-Gi Jang, and Deok-Chun Yang

Characteristics of vitamin B12-mediated gene regulation in algae provide insight into the evolution of vitamin B12 auxotrophy. Katherine E. Helliwell, Mark A. Scaife, Severin Sasso, Ana Paula Ulian Araujo, Saul Purton, and Alison G. Smith

Despite evolutionary and structural differences between carboxysomes, Rubisco kinetics and in vivo performance are similar.
CELL BIOLOGY


The charophyte green alga Penium margaritaceum possesses an experimentally tractable pectin domain in its cell wall that offers insight into wall assembly and polar growth in plants.


Organelles as intracellular osmosensors: Arabidopsis mutants unable to relieve plastid osmotic stress constitutively activate the same cellular responses as environmental osmotic stress.

[D] Dynamics and Organization of Cortical Microtubules as Revealed by Superresolution Structured Illumination Microscopy. George Komis, Martin Mistrik, Olga Šamajová, Anna Doskočilová, Miroslav Ovecka, Peter Illés, Jiří Bártek, and Jozef Šamaj

The dynamic organization of cortical microtubules in plant cells is uncovered using structured illumination superresolution microscopy.

GENES, DEVELOPMENT, AND EVOLUTION

[OPEN] A Comprehensive Analysis of MicroProteins Reveals Their Potentially Widespread Mechanism of Transcriptional Regulation. Enrico Magnani, Niek de Klein, Hye-In Nam, Jung-Gun Kim, Kimberly Pham, Elisa Fiume, Mary Beth Mudgett, and Seung Yon Rhee

Transcription factor-like proteins without a DNA binding domain, are involved in a potentially ubiquitous layer of transcriptional regulation.

[OPEN] OsmiR396d-Regulated OsGRFs Function in Floral Organogenesis in Rice through Binding to Their Targets OsJMJ706 and OsCR4. Huanhuan Liu, Siyi Guo, Yunyuan Xu, Chunhua Li, Zeyong Zhang, Dajian Zhang, Shujuan Xu, Cui Zhang, and Kang Chong

MicroRNA-regulated growth-regulating factors activate expression of specific targets to regulate floral organ development, affecting characteristics such as husk openness and sterile lemma length.


A genetic mapping population is developed and reveals female control of mating choice in plants.


The WRKY75 transcription factor is expressed in the pericycle and vascular tissues of the root and regulates root hair patterning in a non-cell-autonomous manner.


A mutated master regulator of zygotic embryogenesis is essential for creating somatic embryos and enhancing asexual propagation in Kalanchoë.

An alternative-splicing-based model explains the formation of retrogenes that retained the parental intron structure and indicates that plants have a much higher percentage of this kind of complex retrogene than animals.


Hybridization alters mutation rates in Arabidopsis.

MEMBRANES, TRANSPORT, AND BIOENERGETICS

The Arabidopsis Protein CONSERVED ONLY IN THE GREEN LINEAGE160 Promotes the Assembly of the Membranous Part of the Chloroplast ATP Synthase. Thilo Rühle, Jafar Angouri Razeghi, Evgenia Vamvakta, Stefania Viola, Chiara Gandini, Tatjana Kleine, Danja Schünemann, Roberto Barbato, Peter Jahns, and Dario Leister

A thylakoid membrane protein promotes the assembly of the protein complex that generates ATP in chloroplasts.


The Chlamydomonas reinhardtii pgr5 mutant shows photosynthetic and phenotypic traits that support the conservation of PGR5 in both redox-controlled cyclic electron flow and PSI photoprotection.

The Response of Cyclic Electron Flow around Photosystem I to Changes in Photorespiration and Nitrate Assimilation. Berkley J. Walker, Deserah D. Strand, David M. Kramer, and Asaph B. Cousins

Cyclic electron flow (CEF) contributes to balancing the photosynthetic ATP/NADPH energy budget under high but not low light according to modeled ATP and NADPH demand and does not respond to changes in nitrate availability.


The redox state of the plastoquinone pool of Synechocystis sp. strain PCC 6803 is regulated between narrow limits, in contrast to the more dynamic chlorophyll a fluorescence signal.

SIGNALING AND RESPONSE


Phylogenetic analysis of members of the two-component signaling system identifies a previously unknown subfamily of putative cytokinin receptors.
[W] Rice Fertilization-Independent Endosperm1 Regulates Seed Size under Heat Stress by Controlling Early Endosperm Development. Jing J. Folsom, Kevin Begcy, Xiaojuan Hao, Dong Wang, and Harkamal Walia

Early seed development in rice is highly sensitive to heat stress and negatively affects seed enlargement because of epigenetic misregulation of endosperm development. 238

[C] Singlet Oxygen Signatures Are Detected Independent of Light or Chloroplasts in Response to Multiple Stresses. Avishai Mor, Eugene Koh, Leo Weiner, Shilo Rosenwasser, Hadas Sibony-Benamini, and Robert Fluhr

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An Arabidopsis receptor-like kinase negatively regulates defense gene expression and resistance against microbial pathogens and is required for late responses to abscisic acid. 262

[C][W][OPEN] Abscisic Acid Uridine Diphosphate Glucosyltransferases Play a Crucial Role in Abscisic Acid Homeostasis in Arabidopsis. Ting Dong, Zheng-Yi Xu, Youngmin Park, Dae Heon Kim, Yongjik Lee, and Inhwan Huang

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[C][W][OPEN] Two Rice Authentic Histidine Phosphotransfer Proteins, OsAHP1 and OsAHP2, Mediate Cytokinin Signaling and Stress Responses in Rice. Lijing Sun, Qian Zhang, Jinxia Wu, Liqing Zhang, Xuewen Jiao, Shengwei Zhang, Zhiguo Zhang, Daye Sun, Tiegang Lu, and Ying Sun

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A lipase secreted by a pathogenic fungus during wheat head infection acts as an effector to inhibit the plant’s innate immunity-related callose biosynthesis for successful colonization.

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