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Have plant cells been forgotten?

Eugenia Russinova (Guest Editor)[1,2,*]

I am delighted to introduce this Journal of Cell Science Special Issue on plant cell biology. Plants are the basis of our life and well-being, because they are an essential resource for food, water, medicine, air, habitat and climate. Still, they can do much more than satisfy our hunger, warm our bodies and help us quickly move from one place to another. For example, plants have contributed a great deal to the investigation of many problems in science and, in fact, historically, they have given rise to cell biology. Early advances in cell biology benefited from the ability to visualize predominantly different plant tissues by means of light microscopy. In 1665, when Robert Hooke cut thin slices of cork and examined them under his own crude microscope, he found that the cork cutting was made up of small chambers that reminded him of the cells or compartments of honeycombs. So he designated them with the same name, that is, cells. Later, in 1672, the plant anatomist Nehemiah Grew and the biologist Marcello Malpighi presented in their plant microanatomy description that plant tissues comprise a huge mass of rigid bubbles or cells. In 1839, these discoveries led the botanist-turned-lawyer Matthias Jakob Schleiden and the zoologist Theodor Schwann to establish the well-known cell theory that “the cell is a structural and functional unit of all plants and animals”. Again owing to plants, many important findings have been made in cell biology, including the discovery of the nucleus by Robert Brown in 1831, the first careful description of cell division by the botanists Barthélemy Charles Dumortier and Hugo von Mohl in 1835, and the detection of chromosomes by Anton Schneider in 1873, which were subsequently described by the botanist Eduard Strasburger in 1875.

Whereas in the past, cell biologists sampled a diverse selection of plant species in order to obtain numerous fundamental outcomes, cell biology research has recently been narrowed down to only a few model systems. As a consequence, plant cells have been relatively neglected. Although developmental biology journals often publish papers on plant research, plant manuscripts are less frequently published in general cell biology journals. Although this discrepancy can be attributed, in part, to the increasing number of journals that specialize in plant research, this does not tell the whole story. Can plants deliver ground-breaking cell biology research or are plant cell biologists simply discouraged from submitting their work to general cell biology journals?

As my own studies address how endocytosis regulates receptor-mediated signalling in plants, I attended an EMBO conference on endocytosis in 2013. To my great surprise, I found that I was one of only two plant researchers present. Furthermore, by examining this conference program and other past cell biology meetings, I realized that plants were either totally absent or only occasionally represented, usually by one talk placed at the end of the meeting. So why are plants seemingly not so exciting for present-day cell biology? Is it because plant cells are considered too different from mammalian cells to be useful biological models because they are enclosed by a cell wall that influences many, if not all, of their features? Here, I present one remarkable example to illustrate how plant research can impact our understanding regarding cell biology across many species. While in 2014 the animal and yeast fields celebrated 50 years since the discovery of clathrin-coated pits, in the plant field the prevailing opinion, until the 1980s, was that turgor pressure would prevent plasma membrane invagination in the plant cell, thus precluding endocytic internalization. Only in 1986 was endocytosis demonstrated to function in plant cells, resulting in a 20-year lag in plant research. Another factor that contributed to the delayed interest in plant endocytosis was the belief that the process would simply be evolutionarily conserved and, hence, that no additional insight would be generated from unravelling the endocytic machinery in plants. Notwithstanding these shortcomings, the recent identification of the evolutionarily ancient TPLATE/TSET complex-dependent mechanism of endocytosis in plants (Gadeyne et al., 2014; Hirst et al., 2014) illustrates that plants can still deliver exciting cell biology and that, despite the fundamental differences with mammalian cells, plant cells remain an excellent multicellular model system for addressing basic cell biology questions.

For this special issue, a broad call for papers was made. Although the accepted papers encompass diverse aspects of plant cell biology, some of the articles are synergistic and/or complementary. As you will see, the papers can be divided into several groups, primarily based on their focus, but most articles could fit into several categories. With one exception, the plant *Arabidopsis thaliana* was used as model. One group of research papers deals with the molecular function and biogenesis of a number of plant organelles, including mitochondria, peroxisomes and chloroplasts. A second group of studies centred on the endoplasmic reticulum–Golgi anterograde transport provides a functional characterization of the conserved family of small integral membrane p24 proteins, the description of the plant-specific COPII-independent Golgi entry core compartment (GECCO), and the targeting mechanisms of the Qc-SNARE, BET12. Another group of articles focuses on the control of cell polarity in plants in relation to the directional distribution of the plant hormone auxin and to the root hair specification through studies of the family of phosphatidylinositol transfer proteins, the PATELLINs, and the plant ACAP-type ADP-ribosylation factor-GTPase-activating protein AGD1. Through the use of a fluorescence-activated cell sorter for nuclei at different cell cycle stages, super-resolution imaging with three-dimensionally structured illumination and image analysis, a very thorough study reports on the replication timing and location of the ribosomal DNA. Several papers present findings on the mechanisms that regulate photomorphogenesis, brassinosteroid signalling and defence responses. Understanding the cell wall evolution in land plants and the transition from water to land in addition to cell wall functions is at the centre of a study on the distribution of major hemicelluloses and cell wall-modifying enzymes in the green algae.

[1]Department of Plant Biotechnology and Bioinformatics, Ghent University, 9052 Ghent, Belgium. [2]VIB-UGent Center for Plant Systems Biology, 9052 Ghent, Belgium.

*E-mail: eurus@psb.vib-ugent.be

E.R., 0000-0002-0569-1977

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These research articles are complemented by two short reports dealing with the dynamics of the γ-tubulin-containing ring complex and cell fusion during fertilization in *Arabidopsis*. Ten review-type publications covering a very broad selection of plant cell biology topics were also commissioned, and you are warmly encouraged to read them. These papers provide an overview of the current progress in plant cell biology research, including studies on cell wall, cytoskeleton, endomembrane trafficking, signalling, pollen tube guidance and current challenges in live-cell imaging in plants. Finally, I would like to thank and express my gratitude to the many authors, reviewers and the editorial staff of Journal of Cell Science, who made this issue possible and provided me with a most unforgettable experience as a guest editor.

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