Intercellular communication in plants. Annual Plant Reviews Vol 16

Volume 16 of the Annual Plant Reviews series, compiled by Andrew J. Fleming, focuses on intercellular communication in plants. This is an extremely interesting book that extensively covers ten topics related to cell–cell or long-distance communication in plants. The chapters are written in a clear style and they compile the most relevant and up-to-date information in a manner understandable for anybody seriously interested in short- and long-distance intercellular communication. Moreover, besides black-and-white illustrations and photographs found in all chapters, there are also six separate colour plates. I highly recommend this book to the wide audience of plant cell biologists, but especially to researchers and postgraduates.

The book starts with a chapter devoted to auxin, currently the most ‘popular’ plant molecule, which is known to affect almost all processes in plants. Besides its well-known hormonal status, auxin emerges also as plant morphogen. The authors of this chapter start with Charles and Francis Darwin as their studies with grass coleoptiles, accomplishing phototropic growth responses, lead to the discovery of auxin. Auxin is transported from cell-to-cell via still-elusive mechanisms. The last 6–8 years have witnessed an explosion of new data identifying mutants and proteins relevant for the polar transport of auxin along and across plant organs. However, the exact roles of these proteins, as well as the nature of underlying cellular processes driving the transcellular transport of auxin, still remain unknown. The classical chemiosmotic theory faces difficulties in explaining the inability of auxin molecules, despite their small size (approx. 175 Da), to traverse plasmodesmata that allow free passage for large molecules up to 1000 Da (see chapter 5). Moreover, there are also new data that are at variance with the current version of chemiosmotic theory, including the rapid inhibition of auxin transport with brefeldin A, inhibitor of vesicular secretion, and findings that the inhibitors of auxin transport act rather as general inhibitors of plant endocytosis. To account for all of this, the authors mention as the most exciting possibility a scenario according to which auxin would be exported from cells via secretory processes analogous to vesicular neurotransmitters released at neuronal synapses.

The next chapter deals with emerging roles of peptides in regulation of divisions, growth and wound responses of plant cells. Although peptide-based intercellular signalling is popular in animal/human biology, it was not considered to be relevant for sessile plants lacking mobile cells. As this chapter concludes, we will soon be forced to abandon this popular view as there are striking similarities between animal and plant peptide signalling. The following chapter deals with the emerging roles of RNAs in short- and long-distance cell–cell communication. As this topic is closely related to RNAi technology, this technique is briefly introduced too. Systemic transport of RNP complexes integrates the whole plant body and orchestrates the biological functions of plants. Interestingly, cell–cell transport of RNA molecules is also closely related to viral resistance.

Continuous cell walls provide the plant body with a superstructure interconnecting all cells into a structurally coherent medium, allowing supracellular transport of molecules small enough to penetrate cell-wall pores. In addition to this, fragments of cell wall molecules, especially of pectins and hemicelluloses, serve as paracrine-like intercellular signalling molecules. This provides the focus of chapter 4, written by the editor of the book, Andrew Fleming. The following chapter deals with another supracellular structure of plants, plasmodesmata—representing stable cell–cell channels of plants. It might serve as an introduction to Volume 18 of the same Annual Plant Reviews series, edited by the co-author of this chapter, Karl Oparka. Here it is important to mention that although plasmodesmata are well accepted now, it took more than 80 years to get them accepted by the wide scientific community (Carr, 1976) as they were often regarded as fixation artefacts. Interestingly in this respect, animal cells can also be interconnected via similar, but more delicate and often only temporary, cell–cell channels termed nanotubules (Baluska et al., 2004, Rustom et al., 2004). Hopefully, rapidly developing technologies, especially in respect of in vivo microscopy, will allow reliable assessment of their importance for animal tissues more quickly than was the case with plasmodesmata.

Chapter 6, similar to the subsequent chapters 8 and 9, deals with impacts of intercellular communication on morphogenesis of shoot and root apices (chapters 6, 8), as well as in the leaf epidermis with a particular focus on trichomes (chapter 9). Clavata-based peptide signalling and auxin signalling dominate these chapters. But plant morphogenesis and tissue patterning also rely heavily on cell–cell communication via plasmodesmata and this is highlighted in chapter 7, which discusses the long-distance...
signalling and mobile molecules underlying floral initiation and development. Recent advances in this field clearly reveal that intercellular communication is of prime importance for transmission of floral stimuli from young leaves to the shoot apical meristem.

The last chapter is devoted to cell–cell signalling networks underlying plant-incompatibility systems. This chapter extensively covers the current state-of-art of this intriguing topic and makes an enthusiastic finale for this ‘tour-de-force’ of intercellular communication in plants.

Overall, this volume is a valuable addition to the preceding volumes of the Annual Plant Reviews series devoted to the plant cytoskeleton (10), polarity (12) and plasmodesmata (18). Perhaps it would have been more comprehensive if it had also included chapters dealing with intercellular communication during embryogenesis and systemic signalling in plants, two fields that have also experienced dramatic developments in the last few years. Nevertheless, this volume makes it clear that intercellular communication emerges as an important topic in plant biology, which will progress rapidly in the future.

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LITERATURE CITED


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Plastids. Annual Plant Reviews Vol 13


Plastids is an advanced and authoritative multi-authored review of the more molecular and genomic aspects of the biology of chloroplasts of higher plants.

There are ten chapters. The first, by Dario Leister and Paolo Pesaresi, reviews the genomic era of chloroplast research, and the state of play largely from the perspective of proteomics and transcriptomics. The second chapter, entitled ‘Plastid development and differentiation’ is by Mark Waters and Kevin Pike. It considers the different forms of plastids within higher plants (plastids, proplastids, chromoplasts, etioplasts, amyoplast, root chloroplasts and so on) and explores the causes and mechanisms of transformation from one state to another. The third chapter, ‘Plastid metabolic pathways’, by Ian Tetlow, Stephen Rawsthorne, Christine Raines and Michael Emes, deals with recent developments in a number of aspects of primary metabolism in plastids—and again there is an emphasis on the control and regulatory interactions that manage the metabolic processes. The chapter that follows is by the editor and deals with mechanisms of plastid division within higher plants. The focus here is more on the cell biology and explores the complex interplay of proteins of both prokaryotic and eukaryotic origin. This chapter, too, is enriched by insights from the genomic era. The fifth chapter on protein import pathways into chloroplasts by Ute Vothknecht and Jürgen Soll considers the challenge faced by organelles that started life as independent endobiotic organisms needing to develop a balanced metabolic dialogue between themselves and the host around them—a process that requires over 3000 proteins encoded by the nuclear genome, which must find their way into chloroplasts. This is, interestingly, the only chapter with colour plates. The next chapter by Colin Robinson and Alexandra Mant is a follow-on, in the sense that it addresses the biogenesis of the thylakoid membrane. It not only deals with the import of proteins into the luminal space, but also with the issue of the assembly of thylakoid membranes covering, inter alia, proteins, lipids and vesicles. Zach Adam addresses the chloroplast proteolytic machinery and, in dealing with plastidic proteases and peptidases, bears on the issues of biogenesis and maintenance of chloroplasts.

This chapter has a short commentary on phylogeny. The eighth chapter, by John Gray, addresses the regulation of nuclear gene expression by plastid signals and the coordinated expression of nuclear- and plastid-encoded genes to achieve effective plastid biogenesis. There is interesting discussion of plastid signals that serve to influence expression of nuclear genes. The penultimate chapter on chloroplast avoidance movements by Masahiro Kasahara and Masamitsu Wada is the least molecular and deals much more with the cell biology of plastid movement in response to environmental stimuli. The final chapter looks at chloroplast genetic engineering in the context of agronomic, medical and industrial applications. Andrew Devine and Henry Daniell take us from the early efforts to express foreign genes in plastids in the 1980s, through the gene gun to a wide array of genetically engineered traits from herbicide resistance, to drought and salt resistance, and phytoremediation. There is also discussion of the plastids being used as bioreactors that can express foreign proteins, such as human serum albumin, insulin or vaccines.

Despite the range of contents, the final impression is of a narrowly focused book. It has missed opportunities for breadth of coverage—e.g. the diversity of plastids and other symbiotic associations between photosynthetic cyanobacteria and protists. A wealth of issues could be addressed here, from the mechanisms of establishment of symbiosis, the agreement between nucleus and plastid in the distribution of functional responsibilities and in control