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EDITORIAL

Plant development: a Special Issue

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I am very pleased to introduce this Special Issue focusing on plant developmental biology, published in honour of a founding father of the field, Ian Sussex.

At its core, developmental biology is about understanding how a single cell, the zygote, becomes a complex multicellular organism with specialised cell types organised into coherent functional patterns. Evolution has provided two particularly successful independent solutions to this problem in the form of plants and animals. In each kingdom, the problems to be solved are the same, and the solutions are derived from a common single-celled ancestor. However, the constraints of autotrophy versus heterotrophy have driven significant differences in the solutions that have survived the filter of natural selection.

For me, this has always made the comparison of developmental mechanisms between plants and animals particularly interesting. In each kingdom, the same key concepts recur: specification, determination, commitment, differentiation, dedifferentiation, transdifferentiation, positional information, planar cell polarity, pattern formation, homeosis, and so on. This has provided coherence to the field of developmental biology, and makes integrated developmental biology journals and conferences that cover both the plant and animal kingdoms valuable and illuminating.

Over the past couple of decades, both the plant and animal developmental biology fields have primarily focused on the nano scale, with the goal of identifying the molecular players underlying the core processes of development. This has been an exciting time to be a developmental biologist, but it has perhaps resulted in less emphasis on the bigger picture. As a plant biologist attending general developmental biology meetings, talks have often launched immediately into a baffling list of abbreviated protein names, with the major advances presented concerning evidence of their physical interactions. Although this has been an essential phase in the progress of the field, it is even more exciting to see the new focus emerging, zoomed back out onto the bigger picture. Now that many of the important parts are known, the field is moving on to understanding the properties of the dynamic systems driven by these molecular players.

This history is beautifully illustrated in the life, work and intellectual legacy of Ian Sussex. Ian made pioneering contributions to defining the properties of the systems that pattern the shoot apical meristem – the growing tip of plant shoots that continuously gives rise to the above-ground organs. He did his PhD in Manchester, UK, with Claude Wardlaw, who was working with Alan Turing on the application of reaction-diffusion models to the patterning processes underlying organ formation at the shoot apical meristem. Ian's early work is highlighted in the Spotlight article in this issue written by his former student Scott Poethig (Poethig, 2016). During this time, Ian used microsurgery to understand the relationship between intrinsic meristematic signals and signals emanating from its recently specified organs in patterning both the meristem and its derived organs. This type of elegant experiment, pinpointing key properties of the systems that pattern plant meristems and embryos, characterised his whole career. There are surely few contemporary plant developmental biologists who have not been influenced by the book that he wrote with Taylor Steeves, *Patterns in Plant Development*, first published in 1972, which still provides an insightful introduction to the key questions in plant development (Steeves and Sussex, 1989).

The application of molecular approaches has revealed the identity of some of the main players in these patterning systems. For example, significant progress has been made in understanding the role of meristem-derived signals in patterning developing organs, as reviewed in this issue (Kuhlemeier and Timmermans, 2016). As knowledge of the parts has grown, it has become abundantly clear that it is their dynamic interactions, characterised by interlocking feedback loops, that encode the regulatory properties of the systems. After decades in the shadows, computational modelling has re-emerged as an essential tool in understanding these processes, but now with previously theoretical parameters replaced with known players, although not always known quantities. This perhaps defines a central current bottleneck in developmental biology, namely the quantification over real time of key systems parameters.

This renewed zoomed-out focus, emphasizing the properties of dynamic systems, has reunified developmental biology. The regulatory logic of the systems is universal, even if the proteins making up the circuits are not. As the big overarching questions in development re-emerge centre stage, journals such as Development are more important than ever in providing a forum for the communication and discussion of these ideas within the field as a whole. I therefore very much hope that you will enjoy this Special Issue, which illustrates some of these points with plant examples. Development has a long and strong track record of publishing influential plant developmental studies and I encourage you to continue to submit papers in this great tradition. Our sister journal, Journal of Cell Science, is also planning a Special Issue on plant cell biology, so look out for an announcement from them in the coming weeks.

Finally, I would like to thank Jane Langdale (a member of The Company of Biologists' Board of Directors) for suggesting this initiative, and members of Development's Advisory Board (Dominique Bergmann, Enrico Coen, Ykä Helariutta, Elliot Meyerowitz, Ben Scheres, Jan Traas and Miltos Tsiantis) for assistance with handling submissions to the Special Issue.

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