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Special Issue – Cell and Tissue Polarity

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It is a privilege to introduce the Cell and Tissue Polarity Special Issue of Journal of Cell Science. In the broadest sense, cell polarisation is the asymmetric distribution of cellular components. This asymmetry allows for specialisation of subcellular regions in individual cells, wherein different cellular processes can occur in different regions of the cell. This seemingly simple concept can be built upon to give rise to endlessly possible form and function. For example, in single-celled organisms, polarisation of distinct regions of the cell surface enables feeding or propulsion. The co-ordination of asymmetries between interacting cells, in turn, allows cells to assemble into collectives, or into tissues, which themselves have polarised functions. Polarisation between cell couplets, such as local secretion of pore-inducing perforins from immune cells at the immune synapse, ensures that only target cells are victims of killing. Polarisation occurs across scales, such in as the collective segregation of the surface of neighbouring epithelial cells into distinct domains to form the apical domains that line an epithelial tube lumen and lateral domains that act as barriers to luminal contents. Polarisation can also vary across tissues in dynamic and wonderful ways, such the exquisite apical domain specialisation of cells in the retina to allow for light transduction and ultimately vision. These are but a few of the biological functions that are facilitated by cell and tissue polarity.

The study of cell and tissue polarity therefore sits at the interface of multiple thematic subjects. Cell polarity studies are part cell biology, part developmental biology, part anatomy, part biochemistry, part evolutionary biology and part morphogenesis, and ultimately seek to uncover a big chunk of the mechanisms that are fundamental to life itself. This can also mean that the study of cell and tissue polarisation can be equally weird, wily, wacky and particularly wonderous. It can and does lend itself to fields as diverse as comparative cell biology, by seeking to understand how basic polarisation mechanisms differ among single-celled organisms and in the formation of mammalian tissues with distinct functions, and biophysics and mathematical biology, by enticing us to delve further into the inherent properties of the molecules that promote polarity.

Journal of Cell Science has a long history of publishing original research into cell and tissue polarity, including two of my personal favourite papers from James Nelson's laboratory in 1990 (Wang et al., 1990a,b). These studies describing how the extracellular matrix controls apical–basal polarisation – some decades before the current revolution in organoid use – had a seminal impact on my career. My own research involves understanding how epithelial cells polarise into collectives, particularly in three-dimensional culture environments, and how this process goes awry during tumorigenesis and metastasis (Journal of Cell Science kindly interviewed me in 2018 in their Cell Scientist to Watch Series if you would like to know more; doi:10.1242/jcs.213181).

A large proportion of the content of this Special Issue is outstanding original research in the form of Research Articles, Short Reports and Tools and Resources articles that all ask variations of the core question of cell polarity research: what does it mean for a cell to polarise and how does this happen? Encompassing varied aspects of cell polarity and fundamental areas of cell biology, these studies address a number of questions. How does the cytoskeleton, specifically the microtubule network, organise in distinct and dynamic ways to give rise to alternative types of polarity, such as that of a stationary apical–basal polarised epithelial cell or a motile cytotoxic T cell killing its prey? Are membrane trafficking and cell polarisation arguably different names for a common process, wherein core polarity and trafficking complexes control polarisation in diverse settings? How do apical polarity complexes form modules that simultaneously regulate formation of apical–basal polarity, but also promote specialisation of the apical and basolateral domains? How does the establishment of apical–basal polarisation of epithelia allow for emergent features such as ion transport and membrane potential? How does polarity feed back on cellular mechanisms that orient and maintain asymmetric cell division? At the tissue level, other articles address the signalling pathways and machinery that allow epithelial cells to remodel into different forms through collective migration during organ morphogenesis, and a new methodology for overcoming prior limitations in organoid cultures of trophoblast cells. And last but not least, one study reports the discovery of core signalling pathways that regulate the exquisite polarisation of the unicellular eukaryote ciliate *Tetrahymena thermophila*.

The research featured in this issue reinforces the idea that cell polarity is fundamental to the complexities of life. This Special Issue also asks the question of what happens when polarisation is dysregulated. Two Review articles thoughtfully consider how imbalances of symmetric and asymmetric cell division or changes in the orientation of collective epithelial apical–basal polarisation can lead to pathology. In the 'Cell Science at a Glance' section, you will find illustrated primers highlighting how dynamics of polarity underpin development in two very different settings: the prominent polarity model system of *Drosophila melanogaster* neuroblasts and the less well-studied but equally fascinating establishment of polarity in *Arabidopsis thaliana* plant zygotes. We also introduce the 'Voices' series, a collection of short perspectives exploring unique, emerging or noteworthy topics related to a central theme. In this instalment, we hear leading voices highlight what they view as important features of biological asymmetry across scales. Here, researchers working in varied disciplines of biology address open questions about cell and tissue polarity. For example, how is polarity not only conserved but also changed during evolution? How is polarity inherently connected to inheritance during cell division in different cellular systems? How do the intrinsic properties of polarity-regulating proteins – such as chirality or the ability to assemble into condensates – give rise to higher-order patterns? How can computational modelling help us understand polarity

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dynamics? What ‘weird’ and ‘extreme’ types of cell polarity exist that nevertheless fulfil vital biological functions?

As is the ethos at Journal of Cell Science, this Special Issue is also dedicated to highlighting the people behind the science. The ‘First Person’ articles accompanying a selection of the research articles in this issue allow early-career first authors to explain their original findings and implications of their work in their own words. Also included are two interviews with researchers who have embarked on their journeys as independent lab leads in the last few years – Ginny G. Farías, an Assistant Professor at Utrecht University in The Netherlands who studies polarised organelle and protein trafficking in neurons, and Dan Dickinson, an Assistant Professor at the University of Texas at Austin, USA, who investigates the single-cell biochemistry of polarity networks. These vibrant young scientists offer insights into what drives their research, personal lives and scientific citizenship efforts in the ‘Cell Scientist to Watch’ interview series.

Finally, I wanted to remark on my experience as Guest Editor for this Cell and Tissue Polarity Special Issue. I agreed to the kind invitation to be a Guest Editor for two reasons. My first goal was to assemble a series of reviews and commentaries from a wide variety of cell polarity enthusiasts discussing a breadth of models and mechanisms, and I will say that Journal of Cell Science were onboard, supportive and ready to hear diverse voices on diverse polarity-related topics. I hope that you enjoy reading these commentaries as much as we have, as the authors’ enthusiasm for their individual and wonderful model systems shines brightly through in their writing.

My second goal was to peer behind the curtain of publishing to better understand how my colleagues interact with the peer review process. By personally experiencing how the cell polarity field peer-reviews articles and interacts with each other and the editor, my prior perception of the cell polarity field as a supportive community has only itself been supported. In general, support was the key feature I encountered during my time editing this issue. I would like to thank the reviewers who wrote timely, thoughtful, helpful and concise reviews in which it was clear that they wanted to support authors towards publication. I hope that my editorial decisions similarly showed thoughtfulness and approachability, always with an undercurrent of support towards the article. In my own experience, I have benefited from the kind guidance of editors in helping me hone my lab’s efforts to integrate key experiments during paper revisions, before resubmission. Given how supportive the cell polarity field has showed itself to be, I propose that more of these opportunities for authors to speak with editors outside of the formal process of resubmission could help improve publications even further. Likewise, I was constantly impressed with the professionalism, clarity and sincerity that authors provided throughout the review process.

The end result is the outstanding collection of original research presented in this issue. With all sincerity, I hope that you enjoy this Special Issue on Cell and Tissue Polarity. We hope that you continue to send your cell and tissue polarity articles to a welcoming home at Journal of Cell Science, well beyond this special issue.

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