

EDITORIAL

Excellence and Breadth: the Success of Cytoskeleton Research in Australia and New Zealand

The *Molecular Biology of the Cell* textbook used to include an advisory to students: "The functions of the cytoskeleton are difficult to study". For the cautious, this sounds like sage advice. When their research encounters the cytoskeleton, they will search for a detour around this difficult topic. However, for the adventurous, exploration of the cytoskeleton is the ultimate challenge – a cell biologist's ascent of Everest.

The cytoskeleton is central to cell biology. It dictates the shape of each individual cell, as well as the whole multicellular organism. It is responsible for the polarised distribution of organelles, proteins and RNA within cells. It is also responsible for the pattern by which cells proliferate to form tissues, the adherence of cells to each other and the extracellular matrix, and the chemotactic motility and polarised growth of cells. Without the cytoskeleton, cells would be an amorphous bag enclosing a random assortment of components. Cytoskeleton-dependent processes include cell differentiation, cell proliferation, synapse formation, nerve transmission, lymphocyte activation and muscle contractility. More recently, roles for the cytoskeleton have emerged in gene transcription and protein translation.

The cytoskeleton is a challenge to study for several reasons. First, the cytoskeleton contains literally hundreds of components. Many are difficult to purify and have activities that depend on other components. Cytoskeleton components also engage in complex webs of physical and genetic interactions involving functionally diverse partner proteins. Second, mutations affecting cytoskeleton components are usually pleiotropic, causing complex, multifaceted phenotypes. Finally, there is functional redundancy, such that loss of one cytoskeleton component is often compensated for by increased expression of another, thus masking the mutant phenotype.

The cytoskeleton field has recognised the extraordinary

value of diverse experimental approaches that each provide a unique insight. These include *in vitro* assays of cytoskeleton assembly/disassembly and cytoskeleton-based cargo movement, structural biology, microscopic imaging, study of inherited diseases and genetic studies employing model organisms. More recently, omic approaches have identified novel cytoskeleton genes and proteins, and have demonstrated altered expression of cytoskeleton components in both inherited and acquired diseases.

This Showcase aims to provide the broadest possible coverage of cytoskeleton research. Liz Harry and Leigh Monahan describe how a prototype cytoskeleton (only recently recognised in prokaryotes), comprising an actin and a tubulin homologue, forms intriguing spiral-shape structures that help determine where cell division initiates. Much work on the cytoskeleton traditionally has revolved around microscopic imaging. However, Alan Munn and Evelyn Sattlegger describe new roles for the actin cytoskeleton in processes that are normally the realm of classical biochemists: protein translation and protein folding. David Collings takes us on a voyage into the world of the plant cytoskeleton and explores how even a highly conserved cytoskeleton component like tubulin can assume plant-specific functions, e.g. patterning of cellulose microfibril deposition in the cell wall. To complete our evolutionary ascent, Ora Bernard, Peter Gunning and Maria Kavallaris present a beautiful overview of the actin, microtubule and intermediate filament cytoskeletons in animal cells.

I am sure you will find these Showcase articles exciting and will be impressed with the quality and breadth of cytoskeleton research in Australia and New Zealand. There are many exciting new contributions to make in this important field of research for those of you who are looking for a challenge!

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Cover Illustration

Artistic impression of the rapid movement of subcellular structures powered by explosive polymerisation of actin monomers into actin filaments. Actin has been replaced with images of the Australian (Tasmania shown separately) and New Zealand land masses polymerising into filaments. Clockwise from top left: actin cytoskeleton of bacteria, actin cytoskeleton of budding yeast, microtubule cytoskeleton of animal cells, and microtubule cytoskeleton of plant cells. Actin cytoskeleton is red and microtubule cytoskeleton is green.

Image courtesy of Evelyn Sattlegger (Institute of Natural Sciences, Massey University, Auckland, New Zealand) and Alan Munn (School of Medical Science, Griffith University Gold Coast, QLD).

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