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From rigid structures to dynamic networks

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This issue of *Nature Cell Biology*, the first of the new millennium, includes a number of articles that focus on cytoskeletal dynamics and molecular motors. There is no doubt that cytoskeletal research is in a period of rapid growth and expansion. Although many seminal contributions to the field — such as the discovery of 'muscle proteins' in non-muscle cells and the vast variety of actin-binding proteins and their functions — have been made over the past decades, the last few years have seen an explosion of new insights, due in no small part to major technical advances. Improved microscopy techniques, in combination with the tagging of proteins with green fluorescent protein and the use of fluorescent cytoskeletal components, have allowed the imaging of cytoskeletal networks in live cells. The analysis of single molecules and the determination of the three-dimensional structures and conformational changes of motor proteins have significantly advanced our understanding of motor function. Genetic analysis of cytoskeletal components in several model organisms and the identification of protein components by mass spectrometry are just two more examples.

Small wonder, then, at the difficulty of singling out the most significant contributions in recent years. Here is just a sample of some important recent developments. The finding that small GTPases of the Rho family regulate actin reorganization has initiated a flurry of research into the signals that lead to the rapid and dynamic modification of the cytoskeleton in response to extracellular cues. The discovery of the Arp2/3 complex and its role in nucleating actin, and the reconstitution of actin-based motility using purified components *in vitro*, has galvanized the field, as have the concept of dynamic instability of microtubules and the identification of factors (including kinesins) that modulate microtubule stability. And, although our understanding of the intermediate-filament network has sometimes lagged behind, recent findings have revealed fascinating links between it and the actin and microtubule networks, and exemplify the number of physical and functional connections between the various cytoskeletal components.

The challenges ahead

With the availability of new and improved techniques, the field has progressed from looking at the cytoskeleton as a rigid scaffold to seeing it as a complex and dynamic network that influences, and is itself modulated by, most if not all cellular functions, including membrane traffic, signal transduction and cell division. Gaining a better understanding of these links is one of the major challenges ahead, and we can look forward to finding answers to the most burning questions, such as how the actin cytoskeleton participates in exocytosis and endocytosis, how specific motor proteins recognize and transport vesicles, organelles and proteins, how the machineries that drive cell division assemble and disassemble, and how environmental signals influence cell shape and migration. With this issue and by creating a website (http://cellbio.nature.com/focus/cytoskeleton/) that combines all of the material published in this field in *Nature Cell Biology*, we hope to provide some insight into the central role of the field in many aspects of cell biology that will prove interesting not only to researchers working in this area, but to all cell biologists. This website will be freely available during January and February of this year. Like our first 'focus' website on membrane traffic (http://cellbio.nature.com/focus/membrane/), we will update this site on a monthly basis and look forward to hearing your views.