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THEMATIC ARTICLES

The Cytoskeleton: Problems, Paradigms, and Prospects

Karl H. Hasenstein*

Department of Biology, University of Louisiana, Lafayette, Louisiana 70504-2451, USA

Proteins that polymerize into cell-specific and dynamic scaffolding make up the cytoskeleton. This ubiquitous cellular structure is a core element of cellular development and function and is involved in cellular mechanics, signal transduction, and numerous biochemical processes. Molecular studies on structure and the associated mechanisms of proteins are rapidly developing. However, understanding function will be incomplete without adequate comprehension of the spatial and temporal distribution and function of cytoskeletal proteins. Therefore, unraveling the processes controlled by the cytoskeleton is far from complete.

Problems associated with cytoskeletal function include the translation of external factors such as temperature, light, gravity, and pressure, and responses to ions, stress, and strain during cell development. Although we know that these and other parameters affect the cytoskeleton, the underlying mechanisms are unknown. Nor do we understand whether the cytoskeleton functions as a transducer for other structures, or is itself the target of physiologic signals. The variability, resilience, organization, and response of the cytoskeleton make it difficult to determine the function of its elements. Can cell elongation depend on the cytoskeleton if it proceeds even after severely impeding either or both F-actin and microtubules? Are the perceived alterations in the structure of the cytoskeleton the result of reduced affinity for antibody or drugs that are used for its visualization rather than genuine changes in its structure?

The cytoskeleton controls numerous events, including cell division, wall formation, spermatid development, pollen tube growth, signal transduction, and gravisensing. For each of these functions, there are exceptions that refute the accepted paradigm. For example, the involvement of microtubules in microfibril deposition in root hairs is questionable, because no apparent correlation exists between microtubule and microfibril orientation. Drugs presumed to target specific components of the cytoskeleton often affect other cytoskeletal elements as well. Therefore, understanding functions of the diverse cytoskeletal elements may be impossible unless we determine the interactions between them.

The articles included in this special issue represent diverse yet complementary approaches to understanding the cytoskeleton. Klink and Wolniak describe the gene-specific block of translation by double-stranded RNA, a novel approach that can explain the role of regulatory components of the cytoskeleton and other proteins. Gloria Muday studies interactions between cytoskeletal proteins and the auxin transport pathway, one of the most intensely researched signaling mechanisms in plants. Her article exemplifies biochemical studies integrating nature, structure, distribution, and function of the putative auxin transport carrier. Zhang and Hasenstein

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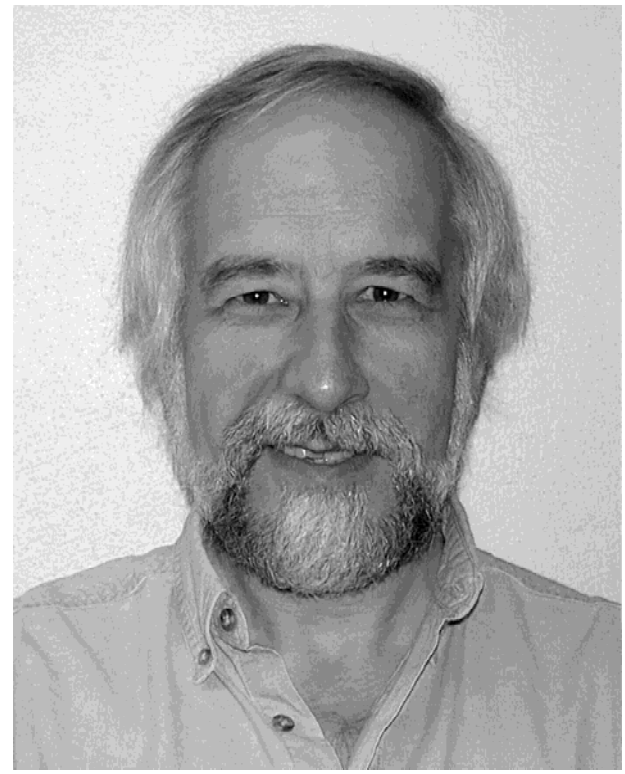
Corresponding author; e-mail: hasenstein@louisiana.edu

investigate the role of microtubule structure and behavior on the direction and rate of root elongation and postulate effects of an elusive root growth promoter on the cytoskeleton. Blancaflor's article addresses the unresolved and increasing complexity of cytoskeletal interactions. The long-standing paradigm that microtubules are the primary regulators of cell wall formation was formulated before we learned that F-actin is part of the cortical array. The interaction between F-actin and microtubules in the cortical array demonstrates the importance of visualization for accurate assessment of cytoskeletal function. The combination of the approaches described in these articles is applicable for a variety of tasks, such as identification of cytoskeletal mutants, effect of growth regulators, and cytoskeletal interactions.

The articles included in this special issue exemplify significant prospects for investigating the physiology of the cytoskeleton. The long-dominant and extremely successful control of plant growth through biochemical agents will have to be supplemented by a thorough understanding of cytoskeletal function and organization
if we are to understand
the multiple and fascinating aspects of plant growth and development.



Karl H. Hasenstein
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