

# Quantitative cell biology: transforming the conceptual, theoretical, instrumental, and methodological approaches to cell biology

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New technological innovations in multiscale microscopy, image analysis, cell-focused physics, bioinformatics, and computational modeling are enabling fundamental principles of cell activity to be studied in ways previously deemed impossible. These innovations make it now possible to distinguish individual molecules as they diffuse across membranes; count subunits comprising receptor or structural scaffolds; measure cellular forces; and model complex cell behaviors. The remarkable information so obtained is profoundly transforming the world within which cell biology is conceived and done, drawing in physicists, chemists, theoreticians,



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and engineers and causing the convergence cell biology with traditional disciplines of physics, mathematical modeling, and bioinformatics.

This special issue of *Molecular Biology of the Cell* recognizes this transformation in cell biology's methodologies and conceptual foundations and signals a broadening of the scope of MBoC to include papers that employ quantitative approaches to address cell biology problems. The issue includes a broad collection of research articles and Perspectives that all apply or discuss physical and quantitative approaches to cell biology problems. The articles range from those focused on new quantitative imaging approaches to ones devoted to computational modeling of complex physical processes. The Perspectives focus on how to bridge the wide gulf between collection

of quantitative data and the use of physics, mathematics, and computers in providing causal relationships in cell biology. This is important, because intuition about how objects behave generally fails at the scale of cells and molecules. Computational approaches and mathematical modeling can help overcome this by excluding alternative explanations, putting competing hypotheses into a rigorous framework, explaining paradoxical data, and constraining possible outcomes.

Together the reviews and studies demonstrate how the combination of mathematical modeling with quantitative experimental studies can be a powerful and compelling approach to understanding cell biology. We expect that more and more researchers will adopt this approach for

addressing their specific cell biological problems in innovative ways, making quantitative and computational approaches part of the standard tool kit of cell biologists. Recognizing this, we have expanded MBoC's ability to handle quantitative biology manuscripts by adding seven editors with expertise in diverse quantitative approaches: Patricia Bassereau, Margaret Gardel, Diane Lidke, Wallace Marshall, Samara Reck-Peterson, Thomas Surrey, and Valerie Weaver.