Editorial

Special Issue: Cytoskeleton, Cell Adhesion, and Motility

This special issue on Cytoskeleton, Cell Adhesion, and Motility presents a group of papers that exemplify the diverse contributions that Bioengineering is making to the study of cytoskeletal mechanics and cell adhesion. Mechanical forces impact virtually every aspect of cell behavior, but the mechanisms by which cells sense and respond to mechanical forces are not well understood. While it is clear that the cytoskeleton and cytoskeletal motors play dominant roles in generating mechanical forces in cells, in multicellular tissue these forces must be transmitted through cell adhesion molecules. Further, mechanical perturbations of these cell adhesion proteins drive cytoskeletal rearrangement and alter cell motility. Quantitative study of these complex and integrated cellular responses is vital to our understanding of the immune system, to developing strategies for engineering functional tissue constructs, and to understanding cellular dysfunction in disease states.

This Special Issue presents a selection of some of the exciting current work in this area. These papers span the size scales from molecular investigations of single motor proteins to the mechanics of swimming of a single cell organism. One common theme woven through these papers is the development of novel strategies to extract quantitative information on the molecules and subcellular systems involved. A second common theme is the use of analytical and quantitative models that are tightly coupled to experiments.

Starting at the smallest size scale, Hariharan and Hancock use Molecular Dynamics simulations to investigate the mechanical properties of the neck linker domain in kinesin motor proteins. This domain has emerged as a key element in force generation by kinesins, and as a tether that connects the two motor domains together and hence transmits mechanical forces between them. Moving up one size scale, Shtridelman *et al.* investigate the transport of sub-micron vesicles in cells by analyzing velocity distributions to infer the number of motors transporting each cargo. This quantitative analysis helps to bridge the gap between single molecule biophysical measurements and the *in vivo* function of molecular

motors. Moving from the microtubule to the actin cytoskeleton, Dickinson investigates a different mode of intracellular transport—actin polymerization-driven transport of bacteria in cells. By developing a reaction–diffusion model of how free actin incorporates into the growing “comet tail” of actin polymer behind a bacterium, an alternative explanation is developed for the behavior of bacteria near walls *in vitro* experiments.

The other four papers investigate the behavior of cells to uncover the underlying molecular mechanics involved in diverse cellular processes. Pospieszalska and Ley develop a computational model of leukocyte rolling that investigates the interplay of cell viscoelasticity and cell adhesion kinetics, and find that bond kinetics are strongly influenced by including a viscoelastic element in describing microvilli extensions during rolling. This interplay between cytoplasmic mechanics and cell adhesion is also the subject of a paper by Sen and Kumar who investigate the kinetics of cell de-adhesion following trypsin treatment. They find that the rate that cells “ball up” following trypsinization is a function of the mechanical state of the cytoplasm and suggest this technique as a potential high throughput assay for drug discovery investigations. Microscale patterning of cell matrix proteins has proven to be a valuable tool for investigating aspects of cell adhesion and cell motility, and Lin and Helmke extend this technique to investigate cytoskeletal remodeling in vascular endothelial cells in response to fluid shear stress. By studying cellular remodeling at the edge of an adherent region, they are able to isolate the relative contributions of adhesion and cytoskeletal rearrangements in the cellular response to fluid shear stress. Finally, Holm *et al.* investigate the phototactic response of the single-cell algae *Chlamydomonas* by trapping the organisms with an optical tweezer and monitoring the beating of the two flagella during phototaxis. The results are interpreted using a three-dimensional computational model of the swimming behavior, and provide important insights into longstanding questions on this model organism.

Now in its second year of publication, Cellular and Molecular Bioengineering is filling an important niche at the interface of engineering, cell biology and biophysics. Nowhere is there a better fit for the fields of cytoskeletal mechanics and adhesion dynamics than this journal. We thank the editors Dave Odde and Ed Guo for their tireless work in putting the journal together and Springer for their commitment to this rapidly expanding field.

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