directional motion. The high sensitivity of cells to the slightest asymmetry points toward an inherent instability of the motile cell, which, due to its highly nonlinear character, can be driven by very small perturbations.[42]

Conclusion and Outlook

We presented different aspects of fibroblast mechanics, probed with modern micromanipulation tools, and we discussed the orders of magnitude of the physical characteristics that describe the mechanical phenomena. Besides a purely passive viscoelastic description, experiments suggest a well-regulated active response of the cell, powered by chemical energy and molecular motors, and reacting precisely to external mechanical stimulation.

Adhesion and force-generation involve a cascade of biochemical reactions that may alter the cytoskeleton,[43] and at present, this has only poorly been taken into account. These reactions should lead, however, to different overall mechanical properties, which in turn influence the biochemical functions of the cell. Therefore, understanding the synergy of the aspects discussed here should be emphasized during future work. This may not only be interesting for academia, but also should be important for any biological or medical research where putting the cell in a well-defined state is essential for reproducible and meaningful results. Without control of the mechanical state, the overall function of a cell, including its biochemistry, remains underdetermined.

To the materials scientist, the state of the art in cell mechanics may seem a collection of bits and pieces lacking a general analytical picture. Yet one has to be aware that work on cells is complex, with each subcomponent having its own set of problems and requiring specialized knowledge, skills, and study. Linking these local experiments to a global understanding is a challenge for future research and should greatly add to our understanding of the biological organism.

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