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Dynamics of Cell and Tissue Motion

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Understanding the dynamics of cell and tissue motion forms an essential step in understanding the dynamics of life and biological self-organization. Biological motion is one of the most obvious expressions of self-organization, as it requires autonomous creation and regulated action of forces leading to shape formation and translocation of cells and tissues. The topics of the book include intracellular motility and cytoplasma dynamics (e.g. cell division), single cell movement in varying extracellular media (e.g. chemotaxis or contact guidance), cell aggregation and cooperative motion (e.g. cellular swarms or slugs) and, finally, cell-cell interactions in developing tissues (e.g. embryogenesis or plant movement). The dynamics underlying biological motion are explained, on the one hand, by various methods of image processing and correlation analysis, and on the other hand by using physico-chemical theories, developing corresponding mathematical models and performing continuum field or stochastic simulations. Thus, the study is of an interdisciplinary character typically found in theoretical and mathematical biology. Its presentation is intended to reach a broad audience â€" from theoretically interested bioscientists, physicians and biophysicists to applied mathematicians interested in the application of nonlinear dynamical systems and simulation algorithms. The most important feature of the book is that it considers possible synergetic mechanisms of interaction and cooperation on different microscopic levels: on the molecular level of cytoskeletal polymers, membrane proteins and extracellular matrix filaments, as well as on the level of cells and cellular tissues. New results concern the aspects of filament or cell alignment, various modes of force transduction and the formation of global stress fields. The latter aspect of mechanical cell-cell communication is emphasized in order to complement the much more well-studied phenomena of chemical, genetical or electrophysical communication.

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