

ELASTIC INTERACTIONS OF BIOLOGICAL CELLS

S. A. Safran^{*}, A. Nicolas^{**}, U. Schwarz^{***}

^{*} *Dept. Materials and Interfaces, Weizmann Institute of Science, Rehovot, Israel 76100*

^{**} *CRPP, Centre Recherche Paul Pascale, F-33600 Pessac, France*

^{***} *Max Planck Institute for Colloids and Interfaces, 14424 Potsdam, Germany*

This talk reviews recent theoretical developments that focus on the physics of cell adhesion and its implications for cell-cell interactions. Biological cells contain a gel-like cytoskeleton that gives the cell a weak, but measurable elastic response. Modifications of the elasticity of the cytoskeleton of biological cells are responsible for dramatic changes in cell shape. Adhering cells exert forces on their environment; experiments on micropatterned elastomer substrates showed that these forces are correlated with the size and orientation of adhesion regions. The adhesions act as mechanosensors that convert the mechanical forces within the cytoskeleton into biochemical signals that cause these adhesions to grow in response to external stress. Averaging the forces due to the adhesions shows that each cell can be modeled as a pair of oppositely directed elastic forces. We predict theoretically that the cells deform the medium (e.g., an elastic substrate or a three-dimensional gel) and this gives rise to an effective interaction among the cells that can be either attractive or repulsive, depending on their orientations and the boundary conditions. These interactions can have important implications for wound healing and tissue formation and engineering. Our theory for the physical origin of the mechanosensor action of focal adhesions, models the adhesion molecules as a grafted layer whose effective elastic modulus determines its response to cytoskeletal forces. The model may explain the observed force dependent anisotropy of the focal adhesions and its kinetics.

[Experimental collaborators: B. Geiger, A. Bershadsky, N. Balaban]

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