

Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

How deep cells feel: Mean-field Computations and Experiments

AMNON BUXBOIM, SHAMIK SEN, University of Philadelphia, DENNIS E. DISCHER¹ — Most cells in solid tissues exert contractile forces that mechanically couple them to elastic surroundings and that significantly influence cell adhesion, cytoskeletal organization and differentiation. However, strains within the depths of matrices are often unclear and are likely relevant to thin matrices, such as basement membranes, relative to cell size as well as to defining how far cells can “feel.” We present experimental results for cell spreading on thin, ligand-coated gels and for prestress in stem cells in relation to gel stiffness. Matrix thickness affects cell spread area, focal adhesions and cytoskeleton organization in stem cells, which we will compare to differentiated cells. We introduce a finite element computation to estimate the elastostatic deformations within the matrix on which a cell is placed. Interfacial strains between cell and matrix show large deviations only when soft matrices are a fraction of cell dimensions, proving consistent with experiments. 3-D cell morphologies that model stem cell-derived neurons, myoblasts, and osteoblasts show that a cylinder-shaped myoblast induces the highest strains, consistent with the prominent contractility of muscle. Groups of such cells show a weak crosstalk via matrix strains only when cells are much closer than a cell-width. Cells thus feel on length scales closer to that of adhesions than on cellular scales.

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Date submitted: 15 Dec 2008

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