Mechanobiological induction of long-range contractility by diffusing biomolecules and size scaling in cell assemblies

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Mechanobiological studies of cell assemblies have generally focused on cells that are, in principle, identical. Here we predict theoretically the effect on cells in culture of locally introduced biochemical signals that diffuse and locally induce cytoskeletal contractility which is initially small. In steady-state, both the concentration profile of the signaling molecule as well as the contractility profile of the cell assembly are inhomogeneous, with a characteristic length that can be of the order of the system size. The long-range nature of this state originates in the elastic interactions of contractile cells (similar to long-range ``macroscopic modes'' in non-living elastic inclusions) and the non-linear diffusion of the signaling molecules, here termed mechanogens. We suggest model experiments on cell assemblies on substrates that can test the theory as a prelude to its applicability in embryo development where spatial gradients of morphogens initiate cellular development.