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Cellular Particle Dynamics simulation of biomechanical relaxation processes of multi-cellular systems[1] MATTHEW MCCUNE, IOAN KOSZTIN, Department of Physics and Astronomy, University of Missouri, Columbia, Missouri 65211, USA — Cellular Particle Dynamics (CPD) is a theoretical-computational-experimental framework for describing and predicting the time evolution of biomechanical relaxation processes of multi-cellular systems, such as fusion, sorting and compression. In CPD, cells are modeled as an ensemble of cellular particles (CPs) that interact via short range contact interactions, characterized by an attractive (adhesive interaction) and a repulsive (excluded volume interaction) component. The time evolution of the spatial conformation of the multicellular system is determined by following the trajectories of all CPs through numerical integration of their equations of motion. Here we present CPD simulation results for the fusion of both spherical and cylindrical multi-cellular aggregates. First, we calibrate the relevant CPD model parameters for a given cell type by comparing the CPD simulation results for the fusion of two spherical aggregates to the corresponding experimental results. Next, CPD simulations are used to predict the time evolution of the fusion of cylindrical aggregates. The latter is relevant for the formation of tubular multi-cellular structures (i.e., primitive blood vessels) created by the novel bioprinting technology.

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