Richard Jamison

Major: Biosystem Engineering
University: Clemson University
Faculty Mentor: Dr. Gabor Forgacs
Mentor Department: Physics and Astronomy
Funded by: NSF-REU Biosystems Modeling

Cell-matrix interaction in tissue patterning

Richard Jamison, Karoly Jakab and Gabor Forgacs

In vivo pattern formation during morphogenesis is dependent upon the migration of cells. Cell movements are directed by the local structure of the surrounding extracellular matrix. It has been shown experimentally that ligament-like straps form in collagen gel due to the local tension created in the matrix by tissue explants [1]. For a comprehensive understanding of this phenomenon, the sprouting behavior of these aggregates was qualitatively studied in six different configurations embedded in a collagen gel. The biological motivation for this study was to observe how the interplay between the collagen matrix, simulating the extracellular matrix, and the cells affect pattern formation in tissues. The understanding of tissue patterning as a result of cell-matrix interaction has important implications for tissue engineering. Spherical aggregates were prepared from Chinese Hamster Ovary Cells as described previously [2]. The six configurations (triangular, square, hexagonal, bulls eye, dodecagon, and two adjacent aggregates) were built by manually placing spherical aggregates into collagen gels. Photographs of the evolving patterns were taken at regular time intervals for one hundred and eighty hours under a phase contrast microscope. Sprouting was delayed until a critical tension was reached in the collagen matrix. Once sprouting began, a clear bias was shown for migration of cells toward other aggregates creating a cellular bridge between aggregates in close proximity. Sprouting occurred toward each aggregate in a specific pattern exhibiting anisotropy due to the depletion of local collagen fibers in areas adjacent to the cellular bridges. In most aggregates, a void in cell sprouting was apparent on either side of the cellular bridge. The large-scale patterns exhibited in this experiment were found to be linked to local cell-matrix interactions. [1] Sawhney, R.K, Howard, J, Slow local movements of collagen fibers by fibroblasts drive the rapid global self-organization of collagen gels. Journal of Cell Biology. Vol 157, 6, 2002, pp. 1083-1091. [2] K. Jakab, A. Neagu, V. Mironov, R.R. Markwald and G. Forgacs. Engineering biological structures of prescribed shape using self-assembling multicellular systems. PNAS, vol. 101, 9, pp. 2864-2869, 2004.