Concept of an Agent-stress Model of a Tissue

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The mechanical environment is important to the cells' behavior. It changes the cell performance. The very extreme case is the statement: "Change the mechanical stresses experienced by cancer cells and they may start to behave more like healthy ones" [1]. However, the observation of stress development in a single cell and in particular, in a growing tissue is still rare. The same concerns the numerical simulations. The growing epithelial tissue while treating each cell as an agent is modeled in [2].
We use a tensegrity model for a single cell [3]. This model serves for stress evaluation in growing tissue. This is formulated as a mechanical problem. The mechanical problem is coupled with the agent model. The agent model determines the positions of the cells, their division and differentiation. This is done using the FLAME [4] (Flexible Large-scale Agent Modeling Environment). The rules implemented into the agent model, can be identified in the following categories; Signal rules (used to communicate cell location and internal state), Cell Cycle rules, Cell Division rules, Differentiation rules, Migration rules and Location Resolution rules. In previous work [4] on epithelial tissue the keratinocyte colony formation model contains four types of cells, namely, Stem cells, Transit Amplifying cells, Committed cells and Corneocytes. The tissue evolution is steered by this model and the stress evolution is followed employing tensegrity model of the tissue.

References

[1] Ainsworth, C., Stretching the imagination, Nature, 456, 696, 2008.

[2] Adra, S., Sun, T., McNeil, S., Holcombe, M., Smallwood, R., Development of a three dimensional multiscale computational model of the human epidermis, PLoS ONE, 5, 1, 2010.

[3] Postek, E., Smallwood, R., Nodal positions displacement sensitivity of an elementary icosahedral tensegrity structure, Computational Plasticity X Fundamentals and Applications, CD publication, 2009.

[4] Sun, T., McMinn, P., Coakley S., Holcombe, M., Smallwood, R., MacNeil, S., An integrated systems biology approach to understanding the rules of keratinocyte colony formation, J Roy Soc Interface, 4, 1077, 2007.