Osvaldo Chara
Zentrum für Informationsdienste und Hochleistungsrechnen (ZIH), Technische Universität Dresden, Germany
e-mail: osvaldo.chara@tu-dresden.de
Lutz Brusch
Zentrum für Informationsdienste und Hochleistungsrechnen (ZIH), Technische Universität Dresden, Germany
Brigitte Galliot
Department of Zoology and Animal Biology, Faculty of Sciences, University of Geneva, Switzerland
Andreas Deutsch
Zentrum für Informationsdienste und Hochleistungsrechnen (ZIH), Technische Universität Dresden, Germany

The role of Wnt3 in early Hydra head regeneration

Several organisms including planaria, fish, insects and salamanders respond to injury and amputation by regenerating the lost body part. A general open question is: How does the remaining tissue 'measure' the degree of injury and mount a regeneration response of adequate magnitude? This question is studied in the fresh water polyp Hydra. The Hydra body column can be viewed as a hollow bilayered tissue cylinder with head and foot on opposite ends referred to as apical and basal, respectively. The tissue consists of the following cell types: ectodermal and endodermal cells (in the epithelial lineage), interstitial stem cells, progenitors, neurons, nematocytes and gland cells (in the interstitial lineage). Previous experiments of cutting Hydra into two halves showed secretion of Wnt3 molecules by cells undergoing apoptosis near the amputation plane of the basal half [1].

We model this immediate Wnt3 response and the following response of the different cell types by a system of coupled partial differential equations. We assume that Wnt3 is produced by apoptotic cells near the amputation plane, diffuses deeper into the tissue and subsequently undergoes a lytic degradation. We model the cell dynamics considering cell differentiation, self-renewal, apoptosis (triggered by amputation), basal loss of cells due to migration toward the extremities along with increases in cell proliferation and cell migration in response to the concentration and spatial gradient of Wnt3, respectively.

We implemented the model in a simulation program coded in C++. Model-dependent fitting simulations to the experimental data [1] demonstrated that these mechanisms could be responsible for the measured cell dynamics, corroborating an important role of Wnt3 within the injury response that ultimately determines the fate of the regeneration process in Hydra.

References

[1] Chera S, Ghila L, Dobretz K, Wenger Y, Bauer C, Buzgariu W, Martinou JC, Galliot B. 2009. Apoptotic cells provide an unexpected source of Wnt3 signaling to drive hydra head regeneration. Dev Cell. 17(2):279-89.