Short Visit Report

Title: Theoretical Model of Ventral Furrow Formation in *Drosophila*

The purpose of my short visit to Leptin's lab in EMBL, Heidelberg (7.-13. September 2014) was to continue our successful collaboration with the Maria Leptin group and to work on our current project of cell mechanics during ventral furrow formation in *Drosophila*. The goal of my visit was to finalize a theoretical model that describes the actual cell movements and deformations during this stage of *Drosophila* embryonic development.

Our collaboration with Leptin's group already produced a theoretical analysis of the collective mechanics of non-differentiated cells during ventral furrow formation [Hočevar Brezavšček et al., *Biophys. J.* **103**(5), 1069 (2012)]. This model considers cross sections of incompressible epithelial cells enclosed in a semi-hard circular confinement imposed by the vitelline membrane. The cell energy is associated with surface tension in actomyosin cortical network and cell-cell adhesion. In this model cell shape depends on surface tensions of apical and basal cell sides relative to the surface tension of lateral cell sides. Ventral furrow formation can be described by using different scenarios: i) a decrease of basal tension combined with a moderate increase of apical tension; ii) a decrease of apical tension combined with a moderate increase of basal tension; iii) an increase of lateral tension. However in all cases ventral furrow internalization can be understood as buckling instability which occurs due to the increase of epithelial perimeter. Since the tissue is confined by vitelline membrane, this leads to internal stresses which are then released by buckling.

Also published in collaboration was a review of theoretical models for the description of furrow formation [Rauzi et al., *Biophys. J.* **105**(1), 3 (2013)] showing different approaches for the description of this fundamental process during embryonic development. The review also implies that even though ventral furrow internalization has been studied in details both experimentally and theoretically it is far from being understood completely.

Very recent and detailed experimental results of the Leptin group show that ventral furrow internalization is indeed the collective process where all embryonic cells play their part. Cell displacement and deformation pattern has been monitored using sophisticated methods of observation and manipulation of both wildtype embryos and mutants. Based on these experimental results we developed an improved theoretical model which accurately describes collective cell movements and deformations during ventral furrow formation.

During the visit, I discussed the details of the model with the members of the Leptin group so as to fine-tune the model parameters. We managed to achieve a very good agreement of the experimental results and the theoretical predictions while I was at EMBL. Although some more work is needed to complete the theory, the preliminary results are very encouraging and we intend to publish our findings in a joint publications.

The goal of my short but fruitful visit at EMBL Heidelberg was realized. In addition, I learned about the ongoing projects at EMBL and visited several laboratories. I talked to many researchers about their work, and their feedback will be very helpful. The visit will contribute towards a successful and fast completion of our joint work, and it also paved the way to new projects.

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