Electrochemical gradients as regulators of cytoskeletal patterns during oogenesis of *Drosophila melanogaster*

**Isabel Weiß and Johannes Bohrmann**

RWTH Aachen University, Institute for Biology II, Dept. of Zoology and Human Biology, D-52074 Aachen, weiss@bi2.rwth-aachen.de

**Introduction**

*Drosophila melanogaster* provides an excellent model system for studying the potential role of electrochemical signals during development. Intercellular gradients of intracellular pH (pH*) and membrane potential (*V* mem) establish patterns that depend on the asymmetrical distribution and/or activity of various ion transport mechanisms. Since alterations of electrochemical properties of cells and tissues are known to function as fast and stable signaling during development in several systems, we investigated whether pH* and *V* mem gradients correlate with the organization of the basal microfilament pattern (bMF) and the microtubule pattern (MT) in the follicle-cell epithelium of *Drosophila* during the course of oogenesis.

**Materials and methods**

For studying the properties of pH* and *V* mem in living follicles, we used the fluorescent pH indicator *S*-FM4-64 and the potentiometric dye DIONIC(R). The bMF and MT patterns were analyzed in fixed follicles using labelled phalloidin and an antibody against tubulin. In addition, we used the Cell-Cell system for the follicle-cell specific expression of GFP (Bcell89F) and GFP-tubulin (pGTPA3), respectively, to investigate bMF and MT patterns in living follicles.

**Results**

Stage-specific pH* and *V* mem gradients correlate spatially and temporally with structural modifications of bMF and MT in the follicle-cell epithelium.

**The basal microfilament (bMF) and microtubule (MT) pattern is affected by pH* and *V* mem changes.**

Using inhibitors of several ion transport mechanisms we modified pH* and *V* mem gradients. The bMF pattern as well as the MT organization were affected in a way similar to changes occurring naturally in parallel with pH* and *V* mem alterations during oogenesis. The results obtained with *S*-FM4-64 and a DIONIC(R)-expressing follicles were similar to those obtained with fixed wild-type follicles using phalloidin and an antibody against tubulin.

(A) Alkalization prevented contractions of bMF and stabilized their parallel alignment. The bMF bundles also became thinner in contrast to the conditions leading to contraction of bMF. No further effect of *V* mem changes on bMF was observed.

(B) Alkalization led to diffuse cell in all follicle cells, loss of haphazard alignment, while abolition together with hyperpolarization maintained the pattern. This was complemented by a thinning of MT.

**Conclusion**

Correlations between bioelectrical properties and cytoskeletal patterns in the follicle-cell epithelium of *Drosophila* were confirmed using inhibitors of several ion transport mechanisms. Our results support the hypothesis that electrochemical signals like pH* and *V* mem can play an important role in the regulation of cell and tissue architecture by organizing elements of the cytoskeleton.