Homogenization Results for the Calcium Dynamics in Living Cells

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Via the periodic unfolding method, the macroscopic behavior of a nonlinear system of coupled reaction-diffusion equations appearing in the modeling of calcium dynamics in living cells is rigorously analyzed.

We consider, at the microscale, two reaction-diffusion equations for the concentration of calcium ions in the cytosol and, respectively, in the endoplasmic reticulum, coupled through a nonlinear interfacial exchange term. Depending on the scaling of this exchange term, various models arise at the limit. In particular, we obtain, at the macroscale, a calcium bidomain model. Such a model is extensively used for describing the dynamics of the calcium ions, which are important intracellular messengers between the cytosol and the endoplasmic reticulum inside the biological cells.

The case in which the calcium reacts with the buffering proteins from the cytosol and the endoplasmic reticulum is also addressed.

Our results constitute a generalization of those contained in [1] and [2].

References

[1] P. Goel, J. Sneyd and A. Friedman, *Homogenization of the cell cytoplasm: the calcium bidomain equations*, Multiscale Model. Simul., **5** (4), 1045-1062, 2006.

[2] I. Graf, M. Peter and J. Sneyd, *Homogenization of a Nonlinear Multiscale Model of Calcium Dynamics in Biological Cells*, Preprint Nr. 11/2013, www.math.uni-augsburg.de/de/forschung/- preprints.html.