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Zbigniew Peradzyński

MODELOWANIE FAL KONCENTRACJI WAPNIA W KOMÓRKACH

MODELING CALCIUM CONCENTRATION WAVES IN BIOLOGICAL CELLS

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slowa kluczowe: fale wapniowe

We discuss the coupling between chemical and mechanical processes which are accompanying and influencing the diffusion of calcium in biological tissues. The increase of calcium concentration in the cell results in the appearance of mechanical forces – so called traction forces due to sol gel transition of the citosol. The tissue as a whole, similarly as a single cell, can be treated as a visco-elastic medium. The diffusion of calcium is enhanced by the autocatalytic release of calcium, and modified by reaction with diffusing buffers. This sort of behavior makes possible that the diffusion of calcium can have a form of a travelling wave, described by reaction diffusion equation. In addition, as it follows from experiments, the mechanical strain can also influence the release of the cytosolic calcium. Therefore the whole process is governed by a system of reaction diffusion equations coupled with the mechanical equations of the viscoelastic medium. Different boundary conditions can be considered at the lateral boundary of the long cylindrical cell (e.g. myocytes). The simplest is to assume no mechanical load and zero flux of calcium at this boundary.
There is however some evidence that in a variety of cells, the progressing wave in the cell can excite the calcium channels located at the membrane (due to the rearrangement of actomyosin filaments), causing an influx of calcium from outside of the cell. This may significantly accelerate the propagation of calcium wave. It seems that this rearrangement occurs mainly in the region where the concentration of calcium increases.
Developing certain asymptotic procedures with respect to the viscosity of the medium as well as with respect to its size (a thin cylinder as a model of a cell and a thin layer of tissue), and finally assuming the fast reaction terms in equations for buffers, we reduce the full system of equations (also in the case of nonzero flux at the boundary) to a single nonlinear reaction diffusion equation. The dimensionality of this equation corresponds to the dimensionality of the problem (a single space variable for the cell, two space variables for a thin layer of tissue, and three space variables in case of a bulk medium).

LITERATURA:

[1] B. Kaźmierczak. Z. Peradzyński, Calcium waves with fast buffers and mechanical effects, J. Math. Biol. (2011) 62: 1-38
[2] Z. Peradzyński, Diffusion of calcium in biological tissues and accompanying mechanochemical effects, Arch. Mech.,62, 6 pp. 423-440, 2010.