Simulink model for the Ca^{2+} as Seccond Messenger in the Neuronal Cell

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Abstract—**The concentration of K^+ at the equilibrium level when the neuronal cell is fired is maintained principaly by the Ca^{2+} as seccond messenger through different categories of cellular responses like the Ca^{2+}-activated K^+ channels opening or closing.**

In the systemic approach, the neuronal cell is an open system with distinct input and output ports and specific response mechanisms. The final effect of the signals received by a cell can be translated in the regulation of the neuronal cell metabolism, in the alteration or maintenance of its differentiation state, and in its death. Once the extracellular signals bind to the receptors, different process of signalling are activated, which generate complex networks of intracellular signalling [1].

MatLab and Simulink offer adequate tools and algorithms for modeling these kind of processes

Keywords— **Ca^{2+}regulation, dynamical model, algorithms, Simulink**

I. Introduction

One of the most important role of the Ca^{2+} in the neuronal cell is to maintain the concentration of K^+ at the equilibrium level when the neuronal cell is fired.

In conditions of cellular rest the Ca^{2+} concentration is maintained at values below 10^{-7} mol/l, due to the existing equilibrium between the Ca^{2+} flux and influx. Ca^{2+} influxes could come from outside the cell, through IL, ISA channels, through messengers I, or through G proteins from the receptor complex, or through other secondary messengers (cAMP, cGMP, IP4). Another source for the Ca^{2+} influx is the deposits of bond Ca^{2+} within the cell, represented by mitochondria or by the endo(sarco)plasmatic reticulum [2].

The increase of the concentration of free cytoplasmatic Ca^{2+} is compensated (during cellular rest) by equivalent fluxes either towards outside (Ca^{2+} ATPasic pump, operated by other messengers II and the 1/3 Na+/Ca2+ antiport system), either towards deposits (recapture through Ca^{2+} ATPases). When the concentration of free Ca^{2+} from the cytoplasm goes beyond the limit value of 10^{-5} mol/l, the cellular response occurs, triggered by Ca^{2+} as messenger II.

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II. Systemic modeling

For developing the model in SIMULINK,in order to describe the behavior of intracellular Ca^{2+} as messenger II, the following things were considered:

-description of the biological process

-analysis of great number of lab tests regarding the behavior of Ca^{2+} , including:

1. substances and equipment used
2. experimental methods
3. data acquisition protocols
4. tables and charts containing results of the analyzed tests [3,4].

The models that were built are characterized by the fact that, for input data that is similar to measurable input data for the real system in laboratory conditions, the output data, from point of view of values and evolution in time, was very close to the experimental data obtained from the lab tests.

Also, the obtained models have been verified, to establish their validity and adjustments were made where it was required, for a higher fidelity of the models.

The models were developed with MATLAB 4.2 for Windows and SIMULINK 1.3.

References

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