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On modeling biosensor devices based on predator-prey cellular automaton

Vasyl MARTSENYUK[1], Aleksandra KLOS-WITKOWSKA[1], Andriy SVERSTIUK[2], Oksana BAGRII-ZAYATS[2]

[1] *University of Bielsko-Biala, Poland, vmartsenyuk@ath.bielsko.pl, awitkowska@ath.bielsko.pl,*

[2] *Ternopil State Medical University, Ukraine sverstyuk@tdmu.edu.ua, bagrijzayats@tdmu.edu.ua*

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With the growing pace of life and the need for more and more accurate detection methods, interest in biosensors is rising among science and industry as well. Biosensors are an alternative to commonly used measurement methods, which are characterized by: poor selectivity, high cost, poor stability, slow response and often can be performed only by highly trained personnel [1].

In the work we propose the model of cellular automaton for predator-prey system, which is based on the system of lattice differential equations with delay. The model is based on biological assumptions for arbitrary cell. Each cell can assume a value of state in some discrete scales, which mean density of predator or prey population that the cell contain, respectively. We have some constant birthrate for prey population. Preys are neutralized by predators with some probability rate. Prey population tends to some carrying capacity. We have some diffusion of preys from neighboring cells with the given diffusion rate. We have some constant death rate of predators. As a result of immune response we observe increase of density of predators in the cell with the given probability rate. Predator population tends to some carrying capacity. Immune response appears with some constant time delay. For the reasonings given we consider lattice of the delayed antibody-antigen competition models for cells two-dimensional array which is based on well-known Marchuk model and using spatial operator. Numerical examples come from the design of biosensors and are implemented in R environment.

Applications of nanomaterials in biosensors provide opportunities for building up a new generation of biosensor technologies. Nanomaterials improve mechanical, electrochemical, optical and magnetic properties of biosensors [2].

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