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Exact solutions to a spatially extended model of kinase-receptor interaction

B and Mast cells are activated by the aggregation of the immune receptors. Motivated by this phenomena we consider a simple spatially extended model of mutual interaction of kinases and membrane receptors. It is assumed that kinase activates membrane receptors and in turn the kinase molecules bound to the active receptors are activated by transphosphorylation. Such a type of interaction implies the positive feedback and may lead to bistability. In this study we apply the Steklov eigenproblem theory to analyze the linearised model and find exact solutions in the case of non uniformly distributed membrane receptors. This approach allows us to determine the critical value of receptor dephosphorylation rate at which cell activation (by arbitrary small perturbation of the inactive state) is possible. We found that cell sensitivity grows with decreasing kinase diffusion and increasing anisotropy of the receptor distribution. Moreover, these two effects are cooperating. We showed that the cell activity can be abruptly triggered by the formation of the receptor aggregate. Since the considered activation mechanism is not based on receptor crosslinking by polyvalent antigens, the proposed model can also explain B cell activation due receptor aggregation following binding of monovalent antigens presented on the antigen presenting cell.

References

[1] P. Szopa, T. Lipniacki, B. Kaźmierczak, *Exact solutions to a spatially extended model of kinase-receptor interaction*, Phys. Biol. (2011).