Multi–agent simulation for virus infector using mixed immunity model

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Abstract

In this study, we suggest a differential equation model of mixed immunity which is implemented both humoral immune and cell–mediated immune mechanisms. Also, we have investigated transmission of infection by using multi–agent based computer simulation with our mixed immunity model. We try to clarify a course of epidemic prevention from our multi–agent simulation.

Human body has natural immunity and acquired immunity mechanism. The acquired immunity, which also consists of humoral immunity and cell–mediated immunity, is acquired by contracting an infection. Immunity mechanism is described as simple differential equations by Nowak and Bangham. Many studies based on Nowak–Bangham model are proposed, but there is not immunity model in consideration of both acquired immunity mechanisms. We propose a mixed immune model included in two kinds of acquired immunity mechanisms. Furthermore, we add absorption effect to our mixed model. The absorption effect gives a reduction in number of pathogen coused by infection with uninfected cells. Numbers of cells in our mixed model are retained by the absorption effect.

In almost previous research about immunity simulation analysis, changes in infected(uninfected) population are dealt by statistically based on SIR like models or diffusion models. These models make easy to analyze by several unifomity asuumptions, such as population distribution or contact between persons. However in the real world, an infection occurs in any confined spaces, and an infected person moves a long distance with any transpotations. Therefore, we experiment on diffusion process of infection by multi–agent simulateion with our mixed immunity model. Each agent in our simulation plays as one among the three roles(worker, student or homemaker). Its behavioral space for the agents has a number of bases(office, school, home). In our experiments, the number of agents is 100,000, and the simulation period is about one month.