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Global properties of virus dynamics models with multi-target cells and delays

In this paper, we propose a class of virus dynamics models with multi-target cells and intracellular delays and study their global properties. We first study the global properties of a virus dynamics model with two target cells and delays. Then we introduce two new virus dynamics models with multi-target cells and delays. The first model is a $(2n+1)$-dimensional nonlinear delay ODEs that describes the dynamics of the virus, n class of target cells (uninfected cells) and n class of infected target cells. The second model generalizes the first one by assuming that the infection rate is given by saturation functional response. Two classes of time delays are incorporated into these models, (i) the times needed for newly infected cells to start to produce viruses, (ii) the time for newly produced virus to become infectious (matures). Lyapunov functionals are constructed to establish the global asymptotic stability of the uninfected and infected steady states of these models. We have proven that if the basic reproduction number R_0 is less than unity then the uninfected steady state is globally asymptotically stable, and if $R_0 > 1$ (or if the infected steady state exists) then the infected steady state is globally asymptotically stable.
Keywords: Global stability; viral infection; intracellular delays; direct Lyapunov method.