Impact of Intracellular Delay, Immune Activation Delay and Nonlinear Incidence on Viral Dynamics

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In this talk, we investigate a class of viral infection models with a nonlinear infection rate and two discrete delays, one of which represents an intracellular latent period for the contacted target cell with virus to begin producing virions, the other of which represents the time needed in cytotoxic T cells (CTLs) response before immune becomes effective after a novel pathogen invades. Since immune system is a complex network of cells and signals that have evolved to respond to the presence of pathogens, we further assume two situations for immune activation delay. When both delays are ignored, the global stability for the ordinary differential equations model are established. While both delays are included, the positivity and boundedness of all solutions of the delay differential equations model are proved. Utilizing Lyapunov functionals and LaSalle invariance principle, the global dynamical properties are also studied. In particular, stability switch is shown to occur as immune delay increasing by bifurcation theory. Our results exhibit that the intracellular delay does not affect the stability of equilibria. However, the immune activation delay is able to destabilize the interior equilibrium and brings periodic solutions. Numerical simulations are performed to verify the theoretical results and display the different impacts of two type delays in two cases. Those analysis give us some useful suggestions on new drugs to fight against viral infection such that it is effective for the drugs to prolong the latent period, and/or to reduce the activation delay of CTLs immune response and/or to inhibit infection.