GLOBAL STABILITY ANALYSIS OF A DELAYED SPATIOTEMPORAL MODEL OF HBV INFECTION WITH BEDDINGTON-DEANGELIS INCIDENCE FUNCTION AND HUMORAL IMMUNE RESPONSE

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Abstract

In this talk, we propose and investigate a mathematical model of hepatitis B virus (HBV) infection. We assume spatial diffusion of free HBV particles, and use Beddington-DeAngelis incidence function to describe viral infection. The model takes into account the exposed hepatocytes and the usually neglected humoral immune response. Moreover, a time delay is introduced to account for the transformation processes necessary for actual HBV production. Using the techniques of lower and upper solutions, combined with parabolic maximum principle, we show that the obtained model has a unique global positive bounded solution. We naturally find two threshold parameters, namely the basic reproduction number R_0 and the humoral immune response activation number R_1 which completely determine the global properties of the obtained model. By constructing suitable Lyapunov functionals and applying LaSalle's invariance principle we show that, if $R_0 \leq 1$, the HBV-free equilibrium is globally asymptotically stable. If $R_1 \leq 1 < R_0$, the HBV-infected equilibrium without humoral immune response is globally asymptotically stable. If $R_1 > 1$, the HBV-infected equilibrium with humoral immune response is globally asymptotically stable. Finally, we perform some numerical simulations to illustrate the obtained theoretical results.

Keywords: HBV infection; Diffusion; Humoral immune response; Time delay; Lyapunov functional; Global stability.

Oberseminar Analysis

Donnerstag 24. Oktober, 14.15 Uhr, Raum 04-522

Alle Interessenten sind herzlich eingeladen