Poster III-68

A Two-Delay Differential Equation System for Innate and Adaptive Immunity
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The immune system is a complex network of cells and signals that has evolved to respond to the presence of pathogens (bacteria, virus, fungi). The two basic types of immunity are innate and adaptive. There is a natural temporal kinetic that arises as part of these immune responses. The innate immune response is the first line of defense occurring on the order of minutes and hours. Adaptive immunity follows innate and occurs on the order of days or weeks. Each has an inherent delay in their development and this timing may be crucial in determining success or failure in clearing the pathogen.

Little research in the experimental setting addresses the timing of these kinetics. To begin to study these questions, we first developed a general model of the two-fold immune response, specifically to intracellular bacterial pathogens, incorporating mathematical delays for both innate and adaptive immunity.

We study how different kernels (i.e., uniform and exponential growth) and forms of the delay) might affect the outcomes of the infection. For each of these different types of delay cases we derive a boundary (uninfected state) and a positive equilibrium (infected state), we analyze both local and global stability and we define conditions for transcritical and Hopf bifurcations (only for the baseline model).

Our baseline model suggests a key role for innate immunity in establishing a protective response and describes how different delays shape the pattern of bacterial growth and its impact on the host. Our study indicates how a delayed innate response (larger than three days) results in an oscillatory behavior of the system, suggesting how trade offs for initial conditions of both the host (for example the baseline level of innate immunity cells or the host capability of containing the early stages of infection) and the pathogen (its proliferation rate) determine the final outcome of the disease.