Inducible reorganization of the immune system

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The vertebrate immune system of consists of a great diversity of motile cells whose activities become coordinated during infection. This orchestration is mediated by signaling molecules either secreted (cytokines) or engaged by direct cell-cell contact. Pathogenic microorganism (and other stimuli) induce internal changes in the responding immune cells which, in turn, lead to spatial reorganization of these cells in a process arguably akin to a phase transition.

The models we are developing to explore these phenomena represent the cells of the immune system as individual “agents” with non-trivial internal states. The motion of these agents in a three-dimensional continuum is described by a continuous-time stochastic process, as are their internal dynamics. Soluble factors, such as cytokines, are represented as fields obeying reaction-diffusion equations on the continuum. Both the internal states of the agents and their motions are responsive to the state of the cytokine fields, which is, in turn, are influenced by the agents, which act as time-dependent sources and sinks. I will present these models and illustrate them with examples of the inflammation-mediated spatial reorganization of the immune system.