Mathematical Biology Seminar

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Ingo Brigandt
University of Alberta

Accounts of Mechanistic Explanation in Philosophy: The Challenge from Systems Biology

The received philosophical account of explanation is that an explanation is a derivation from laws and quantitative principles. This account faces notorious problems, and in the context of molecular biology has been replaced with the notion of mechanistic explanation, i.e., the analysis of a whole in terms of its structural parts and their qualitative interactions. However, systems biology shows that there is no dichotomy between mechanistic explanation and mathematical modeling, and so I argue that a broader philosophical vision of mechanistic explanation is needed. Based on several cases, I point to questions about qualitative phenomena (rather than the explanation of quantitative details), where quantitative models are still indispensable to the explanation, e.g., bistability, spontaneous symmetry breaking in pattern formation, synchronized oscillations, and robustness. Systems biology shows that a broader philosophical conception of mechanisms is needed, which takes into account functional-dynamical aspects, interaction in complex networks with feedback, system-wide functional properties such as distributed functionality and robustness, and a mechanism’s ability to respond to perturbations (beyond its actual operation). Beyond a narrow philosophical focus on explanation, I conclude with several issues about modeling in systems biology that philosophers yet have to fully investigate.