"Ten Equations that Changed Biology
(and that Should Change Biology Education)"
or
Interactive Mathematical Biology's Role in Curricular Reform: BioQUEST Simulations and Mathematics for Problem-Solving

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Abstract: Mathematics has played exceptionally important roles throughout the history of biology. In this century, at least five Nobel Prizes in Physiology and Medicine involve direct contributions from mathematics. These mathematical contributions include (1) reworking complete trees of life with sequence alignment and phylogenetic tree algorithms as well as the assembly of huge genomes such as we saw in the release of the human genome two weeks ago, (2) invention of three dimensional imaging that has transformed medical diagnosis through computer assisted tomography and magnetic resonance imaging, (3) development of epidemiological models of the spread of bacterial and viral infections, etc. More biology students take Calculus than any other single constituency. Too frequently, textbook authors have unappreciated mathematics in biology curricula because they assume that biology students have an inadequate mathematical preparation. This practice: (1) deskills many biology students, (2) is inconsistent with our requirements, (3) misrepresents contemporary biological research, and, (4) underprepares students to read many articles or to contribute to many areas of biology. However, the recent calculus and biology reform movements have empowered students to actively investigate the behavior of many famous mathematical models in biology. While numerous recent publications are replete with numerous models, there is a need to identify a succinct list of achievements that represent the power of mathematics in biology. Hence, "ten equations that changed biology" and a brief description of their historical importance are presented here with BioQUEST software instantiations in order to: first, draw attention to a variety of mathematical models that have been intrinsic to significant discoveries in biology and, second, to illustrate that the tools are currently available for engaging students in active investigation of biological phenomena and the development of systematic strategies for biological problem solving. These offerings will be discussed in terms of their relevance for curricular initiatives in response to the NRC Bio 2010 report and the NIH/NSF/MAA "Meeting the Challenges" conference which responded to the NRC's recommendations.