held at the American Enterprise Institute. Jon Entine, the editor, is an adjunct fellow at the institute and a scholar in residence at Miami University in Ohio.

The book is divided into three major sections. The first, entitled "Ideological Gridlock," contains three chapters. Results from attitude surveys of worldwide opinion leaders are presented by Thomas Jefferson Hoban in chapter 1. Biotechnology firms and farmers tend to favor the technology. Some consumers, regulatory agencies, government leaders (especially in the European Union), and food industry officials are less favorable in their perceptions of the health, economic, and environmental benefits of the genetically modified (GM) crops currently in the marketplace. While the transatlantic controversy rages, according to Robert L. Paarlberg in chapter 5, African and other developing countries struggle to gain access to, or benefits from, the promise of these technologies that might increase the productivity of their low-income farmers and provide more nutritious food for millions of undernourished children. Paarlberg further states that the European emphasis on the precautionary principle is creating a regulatory and trade gridlock. Although rich OECD (Organisation for Economic Co-operation and Development) nations may be able to opt against GM foods with minimal adverse economic impacts, the economic and human costs in developing countries can be huge. Hence, the intense political and ethical controversy has substantial international consequences.

The second section, entitled "Consequences," explores the implications of placing restrictions on the adoption and availability of GM foods from US, European, and developing country perspectives. The three chapters in "Solutions," the final section, examine possible ways to address the agricultural biotechnology controversy. Issues discussed include the organization and financing of anti-biotechnology groups, the prospects for transgenic crops with enhanced nutritional or pharmaceutical attributes, and the role of the media in the debate.

This well-organized book offers insights into the sources and consequences of the still-unresolved debate on agricultural biotechnology that has been raging for over a decade. This is not intended to be a technical treatise on biotechnology, but rather a compilation of ideas on why a technology that has so much promise to enhance the well-being of agriculture, the environment, and consumers has not been adopted as rapidly as many initially anticipated.

All 10 authors are leading scholars on the topics addressed. The general tone of the book is favorable toward agricultural biotechnology, yet efforts are made to present different views and perspectives on the topic. For example, Hoban, the author of chapter 1, has conducted extensive domestic and international surveys on consumer attitudes toward agricultural biotechnology. C. S. Prakash (chapter 2) and Carol Tucker Foreman (chapter 6) both served on the US Department of Agriculture Advisory Committee on Agricultural Biotechnology during the Clinton administration. Patrick Moore (chapter 9), a founder of Greenpeace, has in recent years altered some of his views about the impact of the adoption of agricultural biotechnology, and now accepts it as potentially environmentally friendly.

All the authors suggest that effective communication focused on the current and potential benefits of agricultural biotechnology is essential if society is to benefit from these scientific advances. Sound science and regulatory review are only part of the process. Policymakers must also consider the political, social, ethical, and economic dimensions of the debate on agricultural biotechnology. Clearly, the degree of people's understanding of scientific discoveries is quite diverse: There are wide differences in their willingness to accept perceived risk, and their perspectives on the benefits depend, in part, on whether they represent a farmer, an agribusiness firm, a policymaker, or a consumer.

Resolution of this controversy has enormous consequences for the future of world agriculture as the global population continues to grow, and as we seek to offer a more nutritious food supply in an economically and environmentally sustainable fashion. The book provides thoughtful insights into the arguments about—and potential solutions to—the current agricultural biotechnology debate.

The book would be appropriate for a college-level course in science communication or in agricultural or science policy. Scientists involved in molecular biology and related research might find the book helps them better understand how something that they may think is a safe and exciting scientific discovery is not readily accepted by others in society.

MARSHALL A. MARTIN
Marshall A. Martin (e-mail: marshallmartin@purdue.edu) is a professor of agricultural economics and associate director of agricultural research programs at Purdue University, West Lafayette, IN 47907.

doi:10.1641/B570317
Include this information when citing this material.

MODELING BIOLOGY

Dynamic Models in Biology. Stephen P. Ellner and John Guckenheimer. Princeton University Press, Princeton, NJ, 2006. 330 pp. $99.50 (ISBN 0691118434 paper).

Why should biologists be interested in mathematical modeling? Never at a loss for an anecdote, the late eminent biomathematician Lee Segel loved to quote Picasso: "Art is the lie that helps us see the truth," and, Lee quipped, "the same can be said for mathematical modelling." His assessment certainly proved true. Over the last 10 years we have witnessed dramatic changes in biological research in terms of its dependence on the quantitative sciences. In some university corridors, it is even possible to hear whispers of "the New Biology," which, according to one informed view, is made up of approximately one-third statistics, mathematics, and computer science; one-third physics, chemistry, and engineering; and one-third traditional biological sciences. The impact of the New Biology may be gauged by the recent estimate that 30

percent of *all* high-performance computing worldwide is now dedicated to biological analyses. The new experimental setups, huge data sets, statistical analyses, and modeling approaches are having their effect. Many of the brightest young scientists are following the excitement and moving into the areas of biophysics, nanotechnology, bioinformatics, and biomathematics.

Unfortunately, these changes have hardly filtered into the undergraduate curriculum at most universities, yet there is an obvious need to train and prepare the next generation's young scientists. To help fill this growing gap, Stephen P. Ellner (Department of Ecology) and John Guckenheimer (Department of Mathematics), both highly respected mathematical biologists at Cornell University, have published their new book *Dynamic Models in Biology.*

The book is based on an interdisciplinary course given by the authors to a heterogeneous group of undergraduate students majoring in the biological and exact sciences, including medicine, computer sciences, mathematics, and engineering. Anyone wanting to bring together students from such wide-ranging backgrounds will find this no easy feat. It is in fact a major teaching challenge. The authors' strategy is to maintain a careful balance between the mathematics and biology presented, while following a "business school" model that gives an in-depth treatment of a selective set of case studies. Working through particular case studies allows students to come to grips with nitty-gritty aspects of biology that might push math students to their limits, while exposing biology students to areas of mathematics they may not otherwise have encountered, and possibly inspiring them to learn more in the process. The case studies chosen span major areas in biology, with chapter topics that include structured population models, membrane channels and action potentials, cellular dynamics and simple gene networks, infectious diseases, spatial patterns in biology, and agent-based models of digital evolution. In addition, there are several technical chapters conveying important background material on dynamical systems and the art of building biological models.

As part of their strategy, the authors pair up very different biological case studies that are amenable to analysis with similar mathematical frameworks. For example, chapter 2 introduces matrix models of structured populations, a good home base for ecologists or biologists who are likely to have encountered parts of this material previously. The chapter walks the reader through essential mathematical concepts that include projection matrices, eigenvalues, left and right eigenvectors, the Perron–Frobenius theorem, stable age distributions, and eigenvalue sensitivity (elasticity). These same concepts are heavily drawn on in the paired chapter 3, which moves on to the study of gating in membrane channels via Markov chain matrix models. Now, however, the probabilistic transition matrix replaces the projection matrix, and the right eigenvector and Perron–Frobenius theorem are used to calculate residence times rather than stable age population distributions. The pairing of chapters can be exploited by the course instructor to reinforce learning, or, alternatively, the instructor has the freedom to skip one of the pairs without loss of material required later in the book.

It becomes clear that the chapters are written by true specialists who have a deep knowledge of the subject matter and an extensive and up-to-date awareness of the literature. A good example is the chapter dealing with modeling infectious diseases, which gives a wonderful overview of the field. The first 17 pages deal with the basic textbook theory covering the classical SIR (susceptible, infectious, recovered) epidemic model (with and without the birth/death process), model scaling and dimensionless variables, the reproductive rate R_0, force of infection, and the model's natural oscillations, plus a little bit of history. These topics are dealt with in a linear and very readable fashion, and followed by a set of challenging computer exercises.

The remaining 15 pages move into some lesser-known terrain, where simple models lay bare (a) the role of core groups in sexually transmitted diseases (STDs) and methods for controlling disease spread; (b) the dynamics of drug resistance of infectious diseases such as tuberculosis and HIV; and (c) within-host dynamics of HIV and its T-cell targets. Each section is conveyed cleverly and compellingly. The section on STDs, for example, brings to light a paradox introduced by Hethcote and Yorke, namely, why does gonorrhea demonstrate long-term persistence when it shows all the signs of being on the brink of extinction? The reader learns that this can be resolved by introducing the concept of a core group, and it takes the authors a matter of seconds to set up a simple, elegant model that manages to illuminate exactly how this is done. The deep insights gained make the power of dynamic modeling directly evident.

The book's business school approach to modeling comes at a price, in that a large amount of course material accumulates as unrelated and weighty case studies are introduced and dealt with in succession. As a result, the material outlined in the book is more than can be covered in a one-semester course. The authors suggest guidelines for different course variants based on subsets of chapter combinations that should be realistic over a semester. Because of the amount of material covered in the book, the pace is sometimes uneven. Certain concepts are dwelt on at length, while others are necessarily covered too briefly and will need more careful preparation by any instructor planning to lecture on the material in class. However, overall, the book is well organized and well written, and the authors have a captivating style that keeps the reader interested and tuned in. This is facilitated by the witticisms scattered through the book, with the authors admonishing the reader with such warnings as "Thou Shalt Not Extrapolate Beyond the Range of Thy Data" or invoking fear of "the Curse of Dimensionality."

Speaking from my own experience of teaching a similar course, students will especially enjoy the hands-on computer laboratories and exercises that have been prepared for the book. The authors provide a well-documented laboratory manual that comes in two versions, for Matlab or for R (freeware). The manuals have been carefully thought out and make it

possible to learn to program with these powerful software packages even if beginning from scratch. The manuals ensure that students will be able to build and test their own dynamic models in minimal time.

Dynamic Models in Biology stands apart from existing textbooks in mathematical biology largely because of its interdisciplinary approach and its hands-on, project-oriented case studies and computer laboratories. In an effort to explore biology in more detail, the authors bravely choose a style that differs from the classical biomath texts of, say, Murray and Edelstein-Keshet, whose focus is more on formal mathematics. The success of a course built around Ellner and Guckenheimer's textbook will depend on the instructor's skill in assessing the diversity of the students' backgrounds and catering to their different needs, but the task will be far easier and more enjoyable with this well-crafted book as a guide.

LEWI STONE
Lewi Stone (e-mail: lewi@post.tau.ac.il) works in the Biomathematics Unit, Department of Zoology, Tel Aviv University, Ramat Aviv, Israel.

doi:10.1641/B570318
Include this information when citing this material.

STEERING BETWEEN EXTREMES

Infinite Nature. R. Bruce Hull. University of Chicago Press, Chicago, 2006. 258 pp. $17.00 (ISBN 0226359441 cloth).

Polarized views about the relations between humans and nature, development and preservation, and economy and the environment can paralyze sustainable development initiatives and conservation projects. If these alternatives are framed as an either-or, win-lose choice, then stakeholders and policymakers are forced to choose between nature and human well-being, and little can be done to integrate environmental concerns into private and public policy or economic and development decision-making. Bruce Hull, professor of forestry at Virginia Polytechnic Institute and State University, identifies this core problem and offers a radical solution by averring that "there is not one environmentalist position, or one environment" (p. 1). Hull's book dissolves dichotomous positions by portraying a plurality of views about nature and relations between human communities and their environments.

Infinite Nature takes the reader on a kaleidoscopic journey that provides a comprehensive and evocative description of the multiple perspectives from which we observe, understand, and value nature. The journey takes place in the course of 13 chapters that illustrate its anthropogenic, evolving, ecological, finite, economic, human-health, social-justice, spiritual, human–animal, ecological- and animal-rights, aesthetic, and moral dimensions. To address each of these multifaceted dimensions, Hull adopts an effective rhetoric. Each chapter begins with two subsections that present the extreme positions. These are followed by subsections that analyze and integrate these positions into a broader variety of perspectives, and a concluding section that offers Hull's synthesis. The clear structure of the book and the dialectic tension generated by presenting opposite perspectives keep the reader enthralled. What is more, the well-documented narrative is written in a style that makes it accessible to the general public.

The tensions between the dichotomous extreme positions characterize the entire book. For example, to develop the notion of an anthropogenic nature, Hull describes and criticizes the two most radical views about aboriginal peoples. These views present such peoples, on the one hand, as primitive "subhuman savages" (with associated arguments for subjugating them) and, on the other, as environmental "noble savages" (with arguments for respecting and admiring them). For example, the value of the Amerindian environmental culture is epitomized by the accomplishments of the Aztecs, who managed to construct and administer large cities like Tenochtitlán. Built around a lake, this city was environmentally sustainable and incorporated a grid of canals connecting islands that were made of rich soil dredged from the lake bottom. This Aztec design supported a highly productive agricultural system. The city also had an aqueduct, sanitation systems, markets, arts venues, and "a zoo that exceeded any known in Europe" (p. 12).

Hull emphatically affirms that Europeans discovered in North America a nature that was cultured, not pristine. But he also criticizes the romantic view that portrays Native Americans as universally in harmony with nature. Hull points out that the widely popularized "Chief Seattle's letter" was not written by Chief Seattle but was instead derived from the script of a long-forgotten film produced by the Southern Baptist Convention (see Callicott 1989). After some debunking, Hull assesses sustainable and unsustainable human behaviors by integrating ecological notions such as resilience with lessons learned from each of the cultural perspectives.

Throughout the book, the presentation of opposing views effectively helps to locate the nuances of complex environmental issues. For example, regarding the finiteness of our planet's resources, Hull opposes "techno-optimists" who believe that human creativity is infinite against "techno-pessimists" who argue that technological solutions inevitably create more problems than they solve. The former are confident that there will always be a technological substitute for depleted nonrenewable natural resources; the latter tend to advocate for the precautionary principle. After introducing the polarized views in this contested domain, Hull analyzes appropriate technologies, emphasizing that the "real world is not nearly so black-and-white; nature is not finite or infinite and technology is not good or bad" (p. 67).

In his approach to contrasting religious perspectives, Hull finds another lucid middle ground between extreme positions. The Judeo-Christian tradition offers both a dualistic view, which emphasizes sharp differences between humans and the rest of creation, and a unifying view, supported by the idea that