

# A Course In Mathematical Biology Quantitative Modeling With Mathematical And Computational Monographs On Mathematical Modeling And Computation

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*Essential Mathematical Biology* - Nicholas F. Britton 2012-12-06

This self-contained introduction to the fast-growing field of Mathematical Biology is written for students with a mathematical background. It sets the subject in a historical context and guides the reader towards questions of current research interest. A broad range of topics is covered including: Population dynamics, Infectious diseases, Population genetics and evolution, Dispersal, Molecular and cellular biology, Pattern formation, and Cancer modelling. Particular attention is paid to situations where the simple assumptions of homogeneity made in early models break down and the process of mathematical modelling is seen in action.

**Model Emergent Dynamics in Complex Systems** - A. J. Roberts

2014-12-18

Arising out of the growing interest in and applications of modern dynamical systems theory, this book explores how to derive relatively simple dynamical equations that model complex physical interactions.? The author?s objectives are to use sound theory to explore algebraic techniques, develop interesting applications, and discover general modeling principles.?

Applied and Computational Measurable Dynamics - Erik M. Bollt

2013-12-03

Until recently, measurable dynamics has been held as a highly theoretical mathematical topic with few generally known obvious links for practitioners in areas of applied mathematics. However, the advent of high-speed computers, rapidly developing algorithms, and new numerical methods has allowed for a tremendous amount of progress and

sophistication in efforts to represent the notion of a transfer operator discretely but to high resolution. This book connects many concepts in dynamical systems with mathematical tools from areas such as graph theory and ergodic theory. The authors introduce practical tools for applications related to measurable dynamical systems, coherent structures, and transport problems. The new and fast-developing computational tools discussed throughout the book allow for detailed analysis of real-world problems that are simply beyond the reach of traditional methods.

**Solutions Manual to Accompany Models for Life** - Jeffrey T. Barton  
2016-03-07

A solutions manual to accompany *An Introduction to Discrete Mathematical Modeling with Microsoft® Office Excel®*. With a focus on mathematical models based on real and current data, *Models for Life: An Introduction to Discrete Mathematical Modeling with Microsoft® Office Excel®* guides readers in the solution of relevant, practical problems by introducing both mathematical and Excel techniques. The book begins with a step-by-step introduction to discrete dynamical systems, which are mathematical models that describe how a quantity changes from one point in time to the next. Readers are taken through the process, language, and notation required for the construction of such models as well as their implementation in Excel. The book examines single-compartment models in contexts such as population growth, personal finance, and body weight and provides an introduction to more advanced, multi-compartment models via applications in many areas, including military combat, infectious disease epidemics, and ranking methods. *Models for Life: An Introduction to Discrete Mathematical Modeling with Microsoft® Office Excel®* also features: A modular organization that, after the first chapter, allows readers to explore chapters in any order Numerous practical examples and exercises that enable readers to personalize the presented models by using their own data Carefully selected real-world applications that motivate the mathematical material such as predicting blood alcohol concentration, ranking sports teams, and tracking credit card debt References throughout the book to

disciplinary research on which the presented models and model parameters are based in order to provide authenticity and resources for further study Relevant Excel concepts with step-by-step guidance, including screenshots to help readers better understand the presented material Both mathematical and graphical techniques for understanding concepts such as equilibrium values, fixed points, disease endemicity, maximum sustainable yield, and a drug's therapeutic window A companion website that includes the referenced Excel spreadsheets, select solutions to homework problems, and an instructor's manual with solutions to all homework problems, project ideas, and a test bank *Mathematical Models in Biology* - Leah Edelstein-Keshet 1988-01-01 *Mathematical Models in Biology* is an introductory book for readers interested in biological applications of mathematics and modeling in biology. A favorite in the mathematical biology community, it shows how relatively simple mathematics can be applied to a variety of models to draw interesting conclusions. Connections are made between diverse biological examples linked by common mathematical themes. A variety of discrete and continuous ordinary and partial differential equation models are explored. Although great advances have taken place in many of the topics covered, the simple lessons contained in this book are still important and informative. Audience: the book does not assume too much background knowledge--essentially some calculus and high-school algebra. It was originally written with third- and fourth-year undergraduate mathematical-biology majors in mind; however, it was picked up by beginning graduate students as well as researchers in math (and some in biology) who wanted to learn about this field.

*Barriers and Transport in Unsteady Flows* - Sanjeeva Balasuriya  
2016-12-08

?Fluids that mix at geophysical or microscales tend to form well-mixed areas and regions of coherent blobs. The Antarctic circumpolar vortex, which mostly retains its structure while moving unsteadily in the atmosphere, is an example of a coherent structure. How do such structures exchange fluid with their surroundings? What is the impact on global mixing? What is the "boundary" of the structure, and how does it

move? Can these questions be answered from time-varying observational data?? This book addresses these issues from the perspective of the differential equations that must be obeyed by fluid particles. In these terms, identification of the boundaries of coherent structures (i.e., "flow barriers"), quantification of transport across them, control of the locations of these barriers, and optimization of transport across them are developed using a rigorous mathematical framework. The concepts are illustrated with an array of theoretical and applied examples that arise from oceanography and microfluidics. Barriers and Transport in Unsteady Flows: A Melnikov Approach provides an extensive introduction and bibliography, specifically elucidating the difficulties arising when flows are unsteady and highlighting relevance in geophysics and microfluidics; careful and rigorous development of the mathematical theory of unsteady flow barriers within the context of nonautonomous stable and unstable manifolds, richly complemented with examples; and chapters on exciting new research in the control of flow barriers and the optimization of transport across them.

*An Introduction to Mathematical Modeling* - Edward A. Bender  
2012-05-23

Accessible text features over 100 reality-based examples pulled from the science, engineering, and operations research fields. Prerequisites: ordinary differential equations, continuous probability. Numerous references. Includes 27 black-and-white figures. 1978 edition.

**PDE Dynamics** - Christian Kuehn 2019-04-10

This book provides an overview of the myriad methods for applying dynamical systems techniques to PDEs and highlights the impact of PDE methods on dynamical systems. Also included are many nonlinear evolution equations, which have been benchmark models across the sciences, and examples and techniques to strengthen preparation for research. PDE Dynamics: An Introduction is intended for senior undergraduate students, beginning graduate students, and researchers in applied mathematics, theoretical physics, and adjacent disciplines. Structured as a textbook or seminar reference, it can be used in courses titled Dynamics of PDEs, PDEs 2, Dynamical Systems 2, Evolution

Equations, or Infinite-Dimensional Dynamics.

**A Primer in Mathematical Models in Biology** - Lee A. Segel  
2013-05-09

A textbook on mathematical modelling techniques with powerful applications to biology, combining theoretical exposition with exercises and examples.

*The Theoretical Biologist's Toolbox* - Marc Mangel 2006-07-27

Mathematical modelling is widely used in ecology and evolutionary biology and it is a topic that many biologists find difficult to grasp. In this new textbook Marc Mangel provides a no-nonsense introduction to the skills needed to understand the principles of theoretical and mathematical biology. Fundamental theories and applications are introduced using numerous examples from current biological research, complete with illustrations to highlight key points. Exercises are also included throughout the text to show how theory can be applied and to test knowledge gained so far. Suitable for advanced undergraduate courses in theoretical and mathematical biology, this book forms an essential resource for anyone wanting to gain an understanding of theoretical ecology and evolution.

*Mathematics in Population Biology* - Horst R. Thieme 2018-06-05

*Modeling and Dynamics of Infectious Diseases* - Zhien Ma 2009

This book provides a systematic introduction to the fundamental methods and techniques and the frontiers of OCo along with many new ideas and results on OCo infectious disease modeling, parameter estimation and transmission dynamics. It provides complementary approaches, from deterministic to statistical to network modeling; and it seeks viewpoints of the same issues from different angles, from mathematical modeling to statistical analysis to computer simulations and finally to concrete applications.

**Modeling Life** - Alan Garfinkel 2017-09-06

This book develops the mathematical tools essential for students in the life sciences to describe interacting systems and predict their behavior. From predator-prey populations in an ecosystem, to hormone regulation

within the body, the natural world abounds in dynamical systems that affect us profoundly. Complex feedback relations and counter-intuitive responses are common in nature; this book develops the quantitative skills needed to explore these interactions. Differential equations are the natural mathematical tool for quantifying change, and are the driving force throughout this book. The use of Euler's method makes nonlinear examples tractable and accessible to a broad spectrum of early-stage undergraduates, thus providing a practical alternative to the procedural approach of a traditional Calculus curriculum. Tools are developed within numerous, relevant examples, with an emphasis on the construction, evaluation, and interpretation of mathematical models throughout. Encountering these concepts in context, students learn not only quantitative techniques, but how to bridge between biological and mathematical ways of thinking. Examples range broadly, exploring the dynamics of neurons and the immune system, through to population dynamics and the Google PageRank algorithm. Each scenario relies only on an interest in the natural world; no biological expertise is assumed of student or instructor. Building on a single prerequisite of Precalculus, the book suits a two-quarter sequence for first or second year undergraduates, and meets the mathematical requirements of medical school entry. The later material provides opportunities for more advanced students in both mathematics and life sciences to revisit theoretical knowledge in a rich, real-world framework. In all cases, the focus is clear: how does the math help us understand the science?

[Introduction to Mathematical Biology](#) - S. I. Rubinow 2002

Designed to explore the applications of mathematical techniques and methods related to biology, this text explores five areas: cell growth, enzymatic reactions, physiological tracers, biological fluid dynamics and diffusion. Topics essentially follow a course in elementary differential equations — some linear algebra and graph theory; requires only a knowledge of elementary calculus.

**Climate Modeling for Scientists and Engineers** - John B. Drake  
2014-01-01

Climate modeling and simulation teach us about past, present, and future

conditions of life on earth and help us understand observations about the changing atmosphere and ocean and terrestrial ecology. Focusing on high-end modeling and simulation of earth's climate, *Climate Modeling for Scientists and Engineers* presents observations about the general circulations of the earth and the partial differential equations used to model the dynamics of weather and climate, covers numerical methods for geophysical flows in more detail than many other texts, discusses parallel algorithms and the role of high-performance computing used in the simulation of weather and climate, and provides supplemental lectures and MATLAB® exercises on an associated Web page.

*Elements of Mathematical Ecology* - Mark Kot 2001-07-19

*Elements of Mathematical Ecology* provides an introduction to classical and modern mathematical models, methods, and issues in population ecology. The first part of the book is devoted to simple, unstructured population models that ignore much of the variability found in natural populations for the sake of tractability. Topics covered include density dependence, bifurcations, demographic stochasticity, time delays, population interactions (predation, competition, and mutualism), and the application of optimal control theory to the management of renewable resources. The second part of this book is devoted to structured population models, covering spatially-structured population models (with a focus on reaction-diffusion models), age-structured models, and two-sex models. Suitable for upper level students and beginning researchers in ecology, mathematical biology and applied mathematics, the volume includes numerous clear line diagrams that clarify the mathematics, relevant problems throughout the text that aid understanding, and supplementary mathematical and historical material that enrich the main text.

[Physical Models of Living Systems](#) - Philip Nelson 2015-03-06

Written for intermediate-level undergraduates pursuing any science or engineering major, *Physical Models of Living Systems* helps students develop many of the competencies that form the basis of the new MCAT2015. The only prerequisite is first-year physics. With the more advanced "Track-2" sections at the end of each chapter, the book can be

used in graduate-level courses as well.

**A Course in Mathematical Biology** - Gerda de Vries 2006-07-01

This is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology. Included is an integrated package of theoretical modeling and analysis tools, computational modeling techniques, and parameter estimation and model validation methods, with a focus on integrating analytical and computational tools in the modeling of biological processes. Divided into three parts, it covers basic analytical modeling techniques; introduces computational tools used in the modeling of biological problems; and includes various problems from epidemiology, ecology, and physiology. All chapters include realistic biological examples, including many exercises related to biological questions. In addition, 25 open-ended research projects are provided, suitable for students. An accompanying Web site contains solutions and a tutorial for the implementation of the computational modeling techniques. Calculations can be done in modern computing languages such as Maple, Mathematica, and MATLAB?

Explorations of Mathematical Models in Biology with MATLAB - Mazen Shahin 2013-12-24

Explore and analyze the solutions of mathematical models from diverse disciplines As biology increasingly depends on data, algorithms, and models, it has become necessary to use a computing language, such as the user-friendly MATLAB, to focus more on building and analyzing models as opposed to configuring tedious calculations. Explorations of Mathematical Models in Biology with MATLAB provides an introduction to model creation using MATLAB, followed by the translation, analysis, interpretation, and observation of the models. With an integrated and interdisciplinary approach that embeds mathematical modeling into biological applications, the book illustrates numerous applications of mathematical techniques within biology, ecology, and environmental sciences. Featuring a quantitative, computational, and mathematical approach, the book includes: Examples of real-world applications, such as population dynamics, genetics, drug administration, interacting

species, and the spread of contagious diseases, to showcase the relevancy and wide applicability of abstract mathematical techniques Discussion of various mathematical concepts, such as Markov chains, matrix algebra, eigenvalues, eigenvectors, first-order linear difference equations, and nonlinear first-order difference equations Coverage of difference equations to model a wide range of real-life discrete time situations in diverse areas as well as discussions on matrices to model linear problems Solutions to selected exercises and additional MATLAB codes Explorations of Mathematical Models in Biology with MATLAB is an ideal textbook for upper-undergraduate courses in mathematical models in biology, theoretical ecology, bioeconomics, forensic science, applied mathematics, and environmental science. The book is also an excellent reference for biologists, ecologists, mathematicians, biomathematicians, and environmental and resource economists.

**Methods and Models in Mathematical Biology** - Johannes Müller 2015-08-13

This book developed from classes in mathematical biology taught by the authors over several years at the Technische Universität München. The main themes are modeling principles, mathematical principles for the analysis of these models and model-based analysis of data. The key topics of modern biomathematics are covered: ecology, epidemiology, biochemistry, regulatory networks, neuronal networks and population genetics. A variety of mathematical methods are introduced, ranging from ordinary and partial differential equations to stochastic graph theory and branching processes. A special emphasis is placed on the interplay between stochastic and deterministic models.

**Mathematical Biology II** - James D. Murray 2011-02-15

This richly illustrated third edition provides a thorough training in practical mathematical biology and shows how exciting mathematical challenges can arise from a genuinely interdisciplinary involvement with the biosciences. It has been extensively updated and extended to cover much of the growth of mathematical biology. From the reviews: ""This book, a classical text in mathematical biology, cleverly combines mathematical tools with subject area sciences."--SHORT BOOK REVIEWS

Elementary Calculus of Financial Mathematics - A. J. Roberts 2009-03-12  
Financial mathematics and its calculus introduced in an accessible manner for undergraduate students.

**Differential Dynamical Systems, Revised Edition** - James D. Meiss 2017-01-24

Differential equations are the basis for models of any physical systems that exhibit smooth change. This book combines much of the material found in a traditional course on ordinary differential equations with an introduction to the more modern theory of dynamical systems. Applications of this theory to physics, biology, chemistry, and engineering are shown through examples in such areas as population modeling, fluid dynamics, electronics, and mechanics. Differential Dynamical Systems begins with coverage of linear systems, including matrix algebra; the focus then shifts to foundational material on nonlinear differential equations, making heavy use of the contraction-mapping theorem. Subsequent chapters deal specifically with dynamical systems concepts: flow, stability, invariant manifolds, the phase plane, bifurcation, chaos, and Hamiltonian dynamics. This new edition contains several important updates and revisions throughout the book. Throughout the book, the author includes exercises to help students develop an analytical and geometrical understanding of dynamics. Many of the exercises and examples are based on applications and some involve computation; an appendix offers simple codes written in Maple, Mathematica, and MATLAB software to give students practice with computation applied to dynamical systems problems.

**Mathematical Models in Biology** - Elizabeth S. Allman 2004

Linear and non-linear models of populations, molecular evolution, phylogenetic tree construction, genetics, and infectious diseases are presented with minimal prerequisites.

*Biology in Time and Space: A Partial Differential Equation Modeling Approach* - James P. Keener 2021-06-02

How do biological objects communicate, make structures, make measurements and decisions, search for food, i.e., do all the things necessary for survival? Designed for an advanced undergraduate

audience, this book uses mathematics to begin to tell that story. It builds on a background in multivariable calculus, ordinary differential equations, and basic stochastic processes and uses partial differential equations as the framework within which to explore these questions.

Continuum Modeling in the Physical Sciences - E. van Groesen 2007-01-01

Mathematical modeling - the ability to apply mathematical concepts and techniques to real-life systems has expanded considerably over the last decades, making it impossible to cover all of its aspects in one course or textbook. Continuum Modeling in the Physical Sciences provides an extensive exposition of the general principles and methods of this growing field with a focus on applications in the natural sciences. The authors present a thorough treatment of mathematical modeling from the elementary level to more advanced concepts. Most of the chapters are devoted to a discussion of central issues such as dimensional analysis, conservation principles, balance laws, constitutive relations, stability, robustness, and variational methods, and are accompanied by numerous real-life examples. Readers will benefit from the exercises placed throughout the text and the challenging problems sections found at the ends of several chapters.

**Exploring Mathematical Modeling in Biology Through Case Studies and Experimental Activities** - Rebecca Sanft 2020-04-15

Exploring Mathematical Modeling in Biology through Case Studies and Experimental Activities provides supporting materials for courses taken by students majoring in mathematics, computer science or in the life sciences. The book's cases and lab exercises focus on hypothesis testing and model development in the context of real data. The supporting mathematical, coding and biological background permit readers to explore a problem, understand assumptions, and the meaning of their results. The experiential components provide hands-on learning both in the lab and on the computer. As a beginning text in modeling, readers will learn to value the approach and apply competencies in other settings. Included case studies focus on building a model to solve a particular biological problem from concept and translation into a

mathematical form, to validating the parameters, testing the quality of the model and finally interpreting the outcome in biological terms. The book also shows how particular mathematical approaches are adapted to a variety of problems at multiple biological scales. Finally, the labs bring the biological problems and the practical issues of collecting data to actually test the model and/or adapting the mathematics to the data that can be collected. Presents a single volume on mathematics and biological examples, with data and wet lab experiences suitable for non-experts. Contains three real-world biological case studies and one wet lab for application of the mathematical models. Includes R code templates throughout the text, which are also available through an online repository, along with the necessary data files to complete all projects and labs.

**How to Write and Illustrate a Scientific Paper** - Björn Gustavii  
2008-02-28

This second edition of *How to Write and Illustrate a Scientific Paper* will help both first-time writers and more experienced authors, in all biological and medical disciplines, to present their results effectively. Whilst retaining the easy-to-read and well-structured approach of the previous edition, it has been broadened to include comprehensive advice on writing compilation theses for doctoral degrees, and a detailed description of preparing case reports. Illustrations, particularly graphs, are discussed in detail, with poor examples redrawn for comparison. The reader is offered advice on how to present the paper, where and how to submit the manuscript, and finally, how to correct the proofs. Examples of both good and bad writing, selected from actual journal articles, illustrate the author's advice - which has been developed through his extensive teaching experience - in this accessible and informative guide.

*Quantifying Life* - Dmitry A. Kondrashov 2016-08-04

Since the time of Isaac Newton, physicists have used mathematics to describe the behavior of matter of all sizes, from subatomic particles to galaxies. In the past three decades, as advances in molecular biology have produced an avalanche of data, computational and mathematical techniques have also become necessary tools in the arsenal of biologists.

But while quantitative approaches are now providing fundamental insights into biological systems, the college curriculum for biologists has not caught up, and most biology majors are never exposed to the computational and probabilistic mathematical approaches that dominate in biological research. With *Quantifying Life*, Dmitry A. Kondrashov offers an accessible introduction to the breadth of mathematical modeling used in biology today. Assuming only a foundation in high school mathematics, *Quantifying Life* takes an innovative computational approach to developing mathematical skills and intuition. Through lessons illustrated with copious examples, mathematical and programming exercises, literature discussion questions, and computational projects of various degrees of difficulty, students build and analyze models based on current research papers and learn to implement them in the R programming language. This interplay of mathematical ideas, systematically developed programming skills, and a broad selection of biological research topics makes *Quantifying Life* an invaluable guide for seasoned life scientists and the next generation of biologists alike.

*Mathematical Methods in Biology* - J. David Logan 2009-08-17

A one-of-a-kind guide to using deterministic and probabilistic methods for solving problems in the biological sciences. Highlighting the growing relevance of quantitative techniques in scientific research, *Mathematical Methods in Biology* provides an accessible presentation of the broad range of important mathematical methods for solving problems in the biological sciences. The book reveals the growing connections between mathematics and biology through clear explanations and specific, interesting problems from areas such as population dynamics, foraging theory, and life history theory. The authors begin with an introduction and review of mathematical tools that are employed in subsequent chapters, including biological modeling, calculus, differential equations, dimensionless variables, and descriptive statistics. The following chapters examine standard discrete and continuous models using matrix algebra as well as difference and differential equations. Finally, the book outlines probability, statistics, and stochastic methods as well as material

on bootstrapping and stochastic differential equations, which is a unique approach that is not offered in other literature on the topic. In order to demonstrate the application of mathematical methods to the biological sciences, the authors provide focused examples from the field of theoretical ecology, which serve as an accessible context for study while also demonstrating mathematical skills that are applicable to many other areas in the life sciences. The book's algorithms are illustrated using MATLAB®, but can also be replicated using other software packages, including R, Mathematica®, and Maple; however, the text does not require any single computer algebra package. Each chapter contains numerous exercises and problems that range in difficulty, from the basic to more challenging, to assist readers with building their problem-solving skills. Selected solutions are included at the back of the book, and a related Web site features supplemental material for further study. Extensively class-tested to ensure an easy-to-follow format, *Mathematical Methods in Biology* is an excellent book for mathematics and biology courses at the upper-undergraduate and graduate levels. It also serves as a valuable reference for researchers and professionals working in the fields of biology, ecology, and biomathematics.

**Cellular Biophysics and Modeling** - Greg Conradi Smith 2019-03-14  
What every neuroscientist should know about the mathematical modeling of excitable cells, presented at an introductory level.

**Mathematical Methods in Image Reconstruction** - Frank Natterer 2001-01-01

This book provides readers with a superior understanding of the mathematical principles behind imaging.

*Epidemic Modelling* - D. J. Daley 2001-05-28

This is a general introduction to the mathematical modelling of diseases.

*Mathematical Modeling in Systems Biology* - Brian P. Ingalls 2013-07-05

An introduction to the mathematical concepts and techniques needed for the construction and analysis of models in molecular systems biology. Systems techniques are integral to current research in molecular cell biology, and system-level investigations are often accompanied by mathematical models. These models serve as working hypotheses: they

help us to understand and predict the behavior of complex systems. This book offers an introduction to mathematical concepts and techniques needed for the construction and interpretation of models in molecular systems biology. It is accessible to upper-level undergraduate or graduate students in life science or engineering who have some familiarity with calculus, and will be a useful reference for researchers at all levels. The first four chapters cover the basics of mathematical modeling in molecular systems biology. The last four chapters address specific biological domains, treating modeling of metabolic networks, of signal transduction pathways, of gene regulatory networks, and of electrophysiology and neuronal action potentials. Chapters 3-8 end with optional sections that address more specialized modeling topics. Exercises, solvable with pen-and-paper calculations, appear throughout the text to encourage interaction with the mathematical techniques. More involved end-of-chapter problem sets require computational software. Appendixes provide a review of basic concepts of molecular biology, additional mathematical background material, and tutorials for two computational software packages (XPPAUT and MATLAB) that can be used for model simulation and analysis.

**A Course in Mathematical Biology** - Gerda de Vries 2006-07-01

This is the only book that teaches all aspects of modern mathematical modeling and that is specifically designed to introduce undergraduate students to problem solving in the context of biology. Included is an integrated package of theoretical modeling and analysis tools, computational modeling techniques, and parameter estimation and model validation methods, with a focus on integrating analytical and computational tools in the modeling of biological processes. Divided into three parts, it covers basic analytical modeling techniques; introduces computational tools used in the modeling of biological problems; and includes various problems from epidemiology, ecology, and physiology. All chapters include realistic biological examples, including many exercises related to biological questions. In addition, 25 open-ended research projects are provided, suitable for students. An accompanying Web site contains solutions and a tutorial for the implementation of the

computational modeling techniques. Calculations can be done in modern computing languages such as Maple, Mathematica, and MATLAB?.

A Biologist's Guide to Mathematical Modeling in Ecology and Evolution - Sarah P. Otto 2011-09-19

Thirty years ago, biologists could get by with a rudimentary grasp of mathematics and modeling. Not so today. In seeking to answer fundamental questions about how biological systems function and change over time, the modern biologist is as likely to rely on sophisticated mathematical and computer-based models as traditional fieldwork. In this book, Sarah Otto and Troy Day provide biology students with the tools necessary to both interpret models and to build their own. The book starts at an elementary level of mathematical modeling, assuming that the reader has had high school mathematics and first-year calculus. Otto and Day then gradually build in depth and complexity, from classic models in ecology and evolution to more intricate class-structured and probabilistic models. The authors provide primers with instructive exercises to introduce readers to the more advanced subjects of linear algebra and probability theory. Through examples, they describe how models have been used to understand such topics as the spread of HIV, chaos, the age structure of a country, speciation, and extinction.

Ecologists and evolutionary biologists today need enough mathematical training to be able to assess the power and limits of biological models and to develop theories and models themselves. This innovative book will be an indispensable guide to the world of mathematical models for the next generation of biologists. A how-to guide for developing new mathematical models in biology Provides step-by-step recipes for constructing and analyzing models Interesting biological applications Explores classical models in ecology and evolution Questions at the end of every chapter Primers cover important mathematical topics Exercises with answers Appendixes summarize useful rules Labs and advanced material available

Computational Mathematical Modeling - Daniela Calvetti 2013-03-21

Interesting real-world mathematical modelling problems are complex and can usually be studied at different scales. The scale at which the

investigation is carried out is one of the factors that determines the type of mathematics most appropriate to describe the problem. The book concentrates on two modelling paradigms: the macroscopic, in which phenomena are described in terms of time evolution via ordinary differential equations; and the microscopic, which requires knowledge of random events and probability. The exposition is based on this unorthodox combination of deterministic and probabilistic methodologies, and emphasizes the development of computational skills to construct predictive models. To elucidate the concepts, a wealth of examples, self-study problems, and portions of MATLAB code used by the authors are included. This book, which has been extensively tested by the authors for classroom use, is intended for students in mathematics and the physical sciences at the advanced undergraduate level and above.

*A Course in Mathematical Modeling* - Douglas D. Mooney 2021-11-15

The emphasis of this book lies in the teaching of mathematical modeling rather than simply presenting models. To this end the book starts with the simple discrete exponential growth model as a building block, and successively refines it. This involves adding variable growth rates, multiple variables, fitting growth rates to data, including random elements, testing exactness of fit, using computer simulations and moving to a continuous setting. No advanced knowledge is assumed of the reader, making this book suitable for elementary modeling courses. The book can also be used to supplement courses in linear algebra, differential equations, probability theory and statistics.

**Optimal Control for Mathematical Models of Cancer Therapies** - Heinz Schättler 2015-09-15

This book presents applications of geometric optimal control to real life biomedical problems with an emphasis on cancer treatments. A number of mathematical models for both classical and novel cancer treatments are presented as optimal control problems with the goal of constructing optimal protocols. The power of geometric methods is illustrated with fully worked out complete global solutions to these mathematically challenging problems. Elaborate constructions of optimal controls and

corresponding system responses provide great examples of applications of the tools of geometric optimal control and the outcomes aid the design of simpler, practically realizable suboptimal protocols. The book blends mathematical rigor with practically important topics in an easily readable tutorial style. Graduate students and researchers in science and engineering, particularly biomathematics and more mathematical aspects of biomedical engineering, would find this book particularly useful.

*Mathematical Epidemiology* - Fred Brauer 2008-04-13

Based on lecture notes of two summer schools with a mixed audience from mathematical sciences, epidemiology and public health, this volume offers a comprehensive introduction to basic ideas and techniques in modeling infectious diseases, for the comparison of strategies to plan for

an anticipated epidemic or pandemic, and to deal with a disease outbreak in real time. It covers detailed case studies for diseases including pandemic influenza, West Nile virus, and childhood diseases. Models for other diseases including Severe Acute Respiratory Syndrome, fox rabies, and sexually transmitted infections are included as applications. Its chapters are coherent and complementary independent units. In order to accustom students to look at the current literature and to experience different perspectives, no attempt has been made to achieve united writing style or unified notation. Notes on some mathematical background (calculus, matrix algebra, differential equations, and probability) have been prepared and may be downloaded at the web site of the Centre for Disease Modeling ([www.cdm.yorku.ca](http://www.cdm.yorku.ca)).