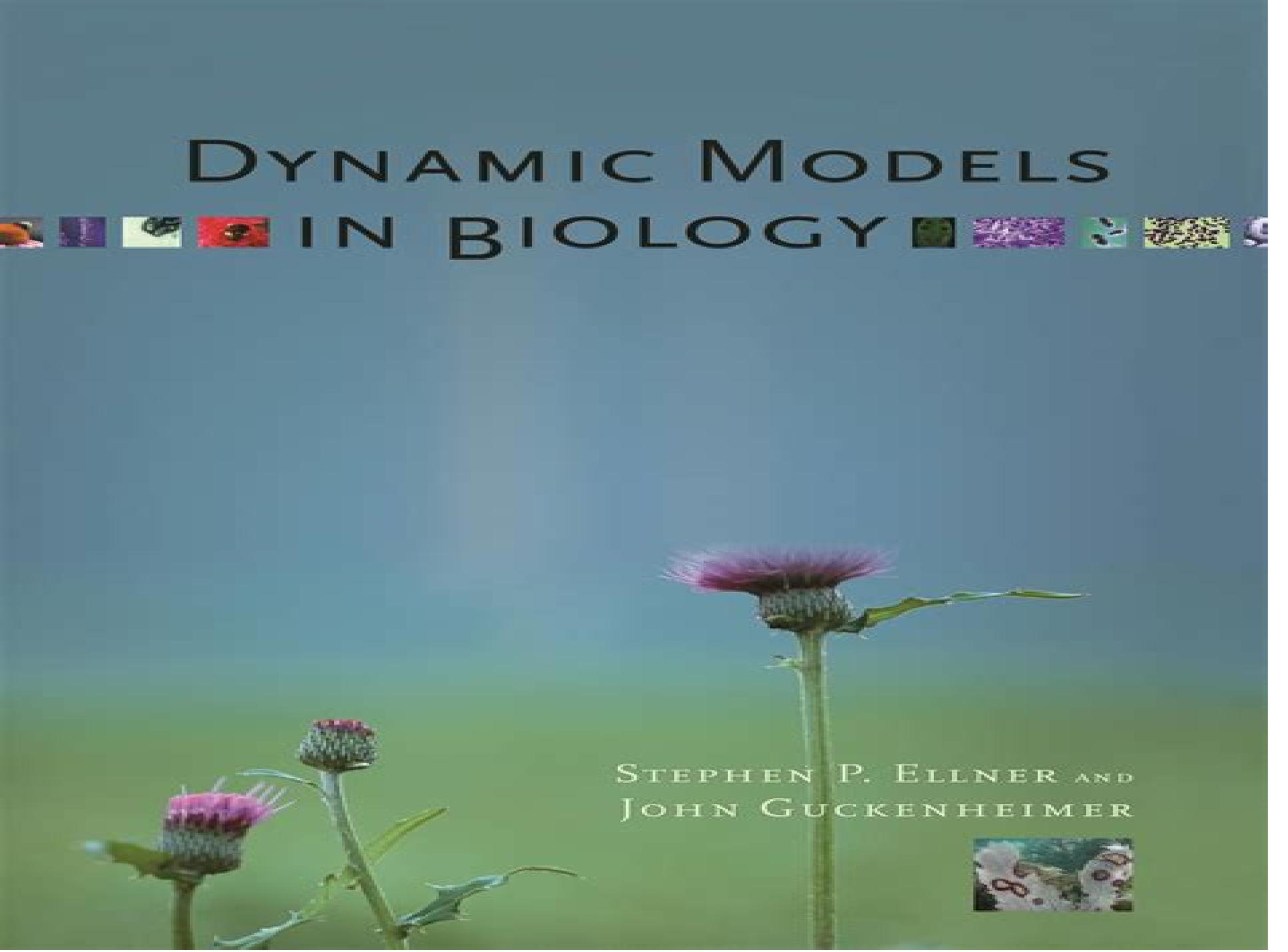# Dynamic Models in Biology

Stephen P. Ellner and

John Guckenheimer

Dynamic Models In Biology

Thomas Griffiths

Dynamic Models In Biology:

    Dynamic Models in Biology Stephen P. Ellner,John Guckenheimer,2011-09-19 From controlling disease outbreaks to predicting heart attacks dynamic models are increasingly crucial for understanding biological processes Many universities are starting undergraduate programs in computational biology to introduce students to this rapidly growing field In Dynamic Models in Biology the first text on dynamic models specifically written for undergraduate students in the biological sciences ecologist Stephen Ellner and mathematician John Guckenheimer teach students how to understand build and use dynamic models in biology Developed from a course taught by Ellner and Guckenheimer at Cornell University the book is organized around biological applications with mathematics and computing developed through case studies at the molecular cellular and population levels The authors cover both simple analytic models the sort usually found in mathematical biology texts and the complex computational models now used by both biologists and mathematicians Linked to a Web site with computer lab materials and exercises Dynamic Models in Biology is a major new introduction to dynamic models for students in the biological sciences mathematics and engineering *Dynamical Models in Biology* Miklós Farkas,2001-06-15 Dynamic Models in Biology offers an introduction to modern mathematical biology This book provides a short introduction to modern mathematical methods in modeling dynamical phenomena and treats the broad topics of population dynamics epidemiology evolution immunology morphogenesis and pattern formation Primarily employing differential equations the author presents accessible descriptions of difficult mathematical models Recent mathematical results are included but the author s presentation gives intuitive meaning to all the main formulae Besides mathematicians who want to get acquainted with this relatively new field of applications this book is useful for physicians biologists agricultural engineers and environmentalists Key Topics Include Chaotic dynamics of populations The spread of sexually transmitted diseases Problems of the origin of life Models of immunology Formation of animal hide patterns The intuitive meaning of mathematical formulae explained with many figures Applying new mathematical results in modeling biological phenomena Miklos Farkas is a professor at Budapest University of Technology where he has researched and instructed mathematics for over thirty years He has taught at universities in the former Soviet Union Canada Australia Venezuela Nigeria India and Columbia Prof Farkas received the 1999 Bolyai Award of the Hungarian Academy of Science and the 2001 Albert Szentgyorgyi Award of the Hungarian Ministry of Education A down to earth introduction to the growing field of modern mathematical biology Also includes appendices which provide background material that goes beyond advanced calculus and linear algebra Dynamical Models in Biology Miklós Farkas,2001-06-06 Dynamic Models in Biology offers an introduction to modern mathematical biology This book provides a short introduction to modern mathematical methods in modeling dynamical phenomena and treats the broad topics of population dynamics epidemiology evolution immunology morphogenesis and pattern formation Primarily employing differential equations the author presents accessible descriptions of difficult mathematical models Recent mathematical

results are included but the author s presentation gives intuitive meaning to all the main formulae Besides mathematicians who want to get acquainted with this relatively new field of applications this book is useful for physicians biologists agricultural engineers and environmentalists Key Topics Include Chaotic dynamics of populations The spread of sexually transmitted diseases Problems of the origin of life Models of immunology Formation of animal hide patterns The intuitive meaning of mathematical formulae explained with many figures Applying new mathematical results in modeling biological phenomena Miklos Farkas is a professor at Budapest University of Technology where he has researched and instructed mathematics for over thirty years He has taught at universities in the former Soviet Union Canada Australia Venezuela Nigeria India and Columbia Prof Farkas received the 1999 Bolyai Award of the Hungarian Academy of Science and the 2001 Albert Szentgyorgyi Award of the Hungarian Ministry of Education A down to earth introduction to the growing field of modern mathematical biology Also includes appendices which provide background material that goes beyond advanced calculus and linear algebra **Dynamical Models of Biology and Medicine** Yang Kuang,Meng Fan,Shengqiang Liu,2019-09-25 Mathematical and computational modeling approaches in biological and medical research are experiencing rapid growth globally This Special Issue Book intends to scratch the surface of this exciting phenomenon The subject areas covered involve general mathematical methods and their applications in biology and medicine with an emphasis on work related to mathematical and computational modeling of the complex dynamics observed in biological and medical research Fourteen rigorously reviewed papers were included in this Special Issue These papers cover several timely topics relating to classical population biology fundamental biology and modern medicine While the authors of these papers dealt with very different modeling questions they were all motivated by specific applications in biology and medicine and employed innovative mathematical and computational methods to study the complex dynamics of their models We hope that these papers detail case studies that will inspire many additional mathematical modeling efforts in biology and medicine **Dynamic Models and Control of Biological Systems** Vadrevu Sree Hari Rao,Ponnada Raja Sekhara Rao,2009-07-30 Mathematical Biology has grown at an astonishing rate and has established itself as a distinct discipline Mathematical modeling is now being applied in every major discipline in the biological sciences Though the field has become increasingly large and specialized this book remains important as a text that introduces some of the exciting problems which arise in the biological sciences and gives some indication of the wide spectrum of questions that modeling can address **Modeling Dynamic Phenomena in Molecular and Cellular Biology** Lee A. Segel,1984-03-30 The dynamic development of various processes is a central problem of biology and indeed of all the sciences The mathematics describing that development is in general complicated because the models that are realistic are usually nonlinear Consequently many biologists may not notice a possible application of theory They may be unable to decide whether a particular model captures the essence of a system or to appreciate that analysis of a model can reveal important aspects of biological problems and may even describe in detail

how a system works The aim of this textbook is to remedy the situation by adopting a general approach to model analysis and applying it several times to problems drawn primarily from molecular and cellular biology of gradually increasing biological and mathematical complexity Although material of considerable sophistication is included little mathematical background is required only some exposure to elementary calculus appendixes supply the necessary mathematics and the author concentrates on concepts rather than techniques He also emphasizes the role of computers in giving a full picture of model behavior and complementing more qualitative analysis Some problems suitable for computer analysis are also included This is a class tested textbook suitable for a one semester course for advanced undergraduate and beginning graduate students in biology or applied mathematics It can also be used as a source book for teachers and a reference for specialists

Dynamical System Models in the Life Sciences and Their Underlying Scientific Issues Frederic Y. M. Wan,2018 Broadly speaking there are two general approaches to teaching mathematical modeling 1 The case study approach focusing on different specific modeling problems familiar to the particular author and 2 The methods approach teaching some useful mathematical techniques accessible to the targeted student cohort with different models introduced to illustrate the application of the methods taught The goal and approach of this new text differ from these two conventional approaches in that its emphasis is on the scientific issues that prompt the mathematical modeling and analysis of a particular phenomenon For example in the study of a fish population we may be interested in the growth and evolution of the population whether the natural growth or harvested population reaches a steady state equilibrium or periodically changing population in a particular environment is a steady state stable or unstable with respect to a small perturbation from the equilibrium state whether a small change in the environment would lead to a catastrophic change etc Each of these scientific issues requires the introduction of a different kind of model and a different set of mathematical tools to extract information about the same biological organisms or phenomena Volume I of this three volume set limits its scope to phenomena and scientific issues that can be modeled by ordinary differential equations ODE that govern the evolution of the phenomena with time The scientific issues involved include evolution equilibrium stability bifurcation feedback optimization and control Scientific issues such as signal and wave propagation diffusion and shock formation pertaining to phenomena involving spatial dynamics are to be modeled by partial differential equations PDE and will be treated in Volume II Scientific issues involving randomness and uncertainty are deferred to Volume III   Dynamic Systems Biology Modeling and Simulation Joseph DiStefano III,2015-01-10 Dynamic Systems Biology Modeling and Simuation consolidates and unifies classical and contemporary multiscale methodologies for mathematical modeling and computer simulation of dynamic biological systems from molecular cellular organ system on up to population levels The book pedagogy is developed as a well annotated systematic tutorial with clearly spelled out and unified nomenclature derived from the author s own modeling efforts publications and teaching over half a century Ambiguities in some concepts and tools are clarified and others are rendered more accessible and practical

The latter include novel qualitative theory and methodologies for recognizing dynamical signatures in data using structural multicompartmental and network models and graph theory and analyzing structural and measurement data models for quantification feasibility The level is basic to intermediate with much emphasis on biomodeling from real biodata for use in real applications Introductory coverage of core mathematical concepts such as linear and nonlinear differential and difference equations Laplace transforms linear algebra probability statistics and stochastics topics The pertinent biology biochemistry biophysics or pharmacology for modeling are provided to support understanding the amalgam of math modeling with life sciences Strong emphasis on quantifying as well as building and analyzing biomodels includes methodology and computational tools for parameter identifiability and sensitivity analysis parameter estimation from real data model distinguishability and simplification and practical bioexperiment design and optimization Companion website provides solutions and program code for examples and exercises using Matlab Simulink VisSim SimBiology SAAMII AMIGO Copasi and SBML coded models A full set of PowerPoint slides are available from the author for teaching from his textbook He uses them to teach a 10 week quarter upper division course at UCLA which meets twice a week so there are 20 lectures They can easily be augmented or stretched for a 15 week semester course Importantly the slides are editable so they can be readily adapted to a lecturer s personal style and course content needs The lectures are based on excerpts from 12 of the first 13 chapters of DSBMS They are designed to highlight the key course material as a study guide and structure for students following the full text content The complete PowerPoint slide package 25 MB can be obtained by instructors or prospective instructors by emailing the author directly at joed cs ucla edu **Modeling Dynamic Biological Systems** Bruce Hannon,Matthias Ruth,2014-07-05 Many biologists and ecologists have developed models that find widespread use in theoretical investigations and in applications to organism behavior disease control population and metapopulation theory ecosystem dynamics and environmental management This book captures and extends the process of model development by concentrating on the dynamic aspects of these processes and by providing the tools such that virtually anyone with basic knowledge in the Life Sciences can develop meaningful dynamic models Examples of the systems modeled in the book range from models of cell development the beating heart the growth and spread of insects spatial competition and extinction to the spread and control of epidemics including the conditions for the development of chaos Key features easy to learn and easy to use software examples from many subdisciplines of biology covering models of cells organisms populations and metapopulations no prior computer or programming experience required Key benefits learn how to develop modeling skills and system thinking on your own rather than use models developed by others be able to easily run models under alternative assumptions and investigate the implications of these assumptions for the dynamics of the biological system being modeled develop skills to assess the dynamics of biological systems *Dynamical Modeling of Biological Systems* Stilianos Louca,2023-06-07 This book introduces concepts and practical tools for dynamical mathematical modeling of biological

systems Dynamical models describe the behavior of a system over time as a result of internal feedback loops and external forcing based on mathematically formulated dynamical laws similarly to how Newton s laws describe the movement of celestial bodies Dynamical models are increasingly popular in biology as they tend to be more powerful than static regression models This book is meant for undergraduate and graduate students in physics applied mathematics and data science with an interest in biology as well as students in biology with a strong interest in mathematical methods The book covers deterministic models for example differential equations stochastic models for example Markov chains and autoregressive models and model independent aspects of time series analysis Plenty of examples and exercises are included often taken or inspired from the scientific literature and covering a broad range of topics such as neuroscience cell biology genetics evolution ecology microbiology physiology epidemiology and conservation The book delivers generic modeling techniques used across a wide range of situations in biology and hence readers from other scientific disciplines will find that much of the material is also applicable in their own field Proofs of most mathematical statements are included for the interested reader but are not essential for a practical understanding of the material The book introduces the popular scientific programming language MATLAB as a tool for simulating models fitting models to data and visualizing data and model predictions The material taught is current as of MATLAB version 2022b The material is taught in a sufficiently general way that also permits the use of alternative programming languages   <u>Dynamical models in biology</u> ,1990   *Dynamical Models in Biology* Nicolas Farkas,2001   **Cornell University Courses of Study** Cornell University,2007   *A Mathematical Treatment of Dynamical Models in Biological Science* Kristína Smítalová,Štefan Šujan,1991 Providing a comprehensive introduction to mathematical modelling in biology and ecology this book presents numerous results and developments The basic mathematical facts on the theory of the dynamics of biological communities are presented with emphasis placed on the quantitive aspects   **Stochastic Chemical Reaction Systems in Biology** Hong Qian,Hao Ge,2021-10-19 This book provides an introduction to the analysis of stochastic dynamic models in biology and medicine The main aim is to offer a coherent set of probabilistic techniques and mathematical tools which can be used for the simulation and analysis of various biological phenomena These tools are illustrated on a number of examples For each example the biological background is described and mathematical models are developed following a unified set of principles These models are then analyzed and finally the biological implications of the mathematical results are interpreted The biological topics covered include gene expression biochemistry cellular regulation and cancer biology The book will be accessible to graduate students who have a strong background in differential equations the theory of nonlinear dynamical systems Markovian stochastic processes and both discrete and continuous state spaces and who are familiar with the basic concepts of probability theory   *Modeling Biological Systems* James W. Haefner,2012-12-06 This book is intended as a text for a first course on creating and analyzing computer simulation models of biological systems The expected audience for this book are students wishing to use dynamic

models to interpret real data mueh as they would use standard statistical techniques It is meant to provide both the essential principles as well as the details and equa tions applicable to a few particular systems and subdisciplines Biological systems however encompass a vast diverse array of topics and problems This book discusses only a select number of these that I have found to be useful and interesting to biologists just beginning their appreciation of computer simulation The examples chosen span classical mathematical models of well studied systems to state of the art topics such as cellular automata and artificial life I have stressed the relationship between the models and the biology over mathematical analysis in order to give the reader a sense that mathematical models really are useful to biologists In this light I have sought examples that address fundamental and I think interesting biological questions Almost all of the models are directly COIIl pared to quantitative data to provide at least a partial demonstration that some biological models can accurately predict **Biological Control Systems and Climate Change** Joan van Baaren,Cécile Le Lann,Chun-Sen Ma,Gang Ma,2025-11-03 Biological control or Biocontrol is the use of natural enemies predators parasitoids or pathogens for the control of pests in crops In classical biological control a natural enemy is introduced as a new predator to a range where it is not native In augmentative biological control a large number of natural enemies are introduced either in an area with no natural enemies like glasshouses or to augment natural populations to ensure a rapid pest suppression In conservation biological control habitats surrounding and within crops are managed to favour an increase in natural enemy populations while suppressing pest populations These agroecological systems can be complex and are affected by climate change both negatively and positively The object of this book is to synthesize and summarize current knowledge of the many ways climate change can influence the effectiveness of biological control systems This is the second book in the CABI Ecostacking Series Biological control is a major component of the ecostacking approach to cropping systems It is intended for students researchers lecturers and stakeholders engaged in biological control worldwide It is also essential reading for research personnel and managers in companies that produce biological control agents for field application **Practitioner's Handbook on the Modelling of Dynamic Change in Ecosystems** John Norman Richard Jeffers,International Council of Scientific Unions. Scientific Committee on Problems of the Environment,1988 The variety of techniques available which environmental scientists and managers can use to model environmental change are described in this handbook The book begins by defining ecological systems and their dynamics before outlining modelling techniques and their inter relationships The author then looks at systems analysis and the various types of models which can be used *Biologically Inspired Robot Behavior Engineering* Richard J. Duro,Jose Santos,Manuel Grana,2013-06-05 The book presents an overview of current research on biologically inspired autonomous robotics from the perspective of some of the most relevant researchers in this area The book crosses several boundaries in the field of robotics and the closely related field of artificial life The key aim throughout the book is to obtain autonomy at different levels From the basic motor behavior in some exotic robot architectures right through to the

planning of complex behaviors or the evolution of robot control structures the book explores different degrees and definitions of autonomous behavior These behaviors are supported by a wide variety of modeling techniques structural grammars neural networks and fuzzy logic and evolution underlies many of the development processes Thus this text can be used by scientists and students interested in these areas and provides a general view of the field for a more general audience **Aerospace Medicine and Biology** ,1990 A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in Scientific and technical aerospace reports STAR and International aerospace abstracts IAA

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