

# Lecture Notes in Biomathematics

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Eckart Frehland

Stochastic  
Transport Processes in  
Discrete Biological Systems



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# Stochastic Transport Processes In Discrete Biological Systems

**Rosina Ehmman**



## **Stochastic Transport Processes In Discrete Biological Systems:**

Stochastic Transport Processes in Discrete Biological Systems Eckart Frehland, 2013-03-13 These notes are in part based on a course for advanced students in the applications of stochastic processes held in 1978 at the University of Konstanz These notes contain the results of recent studies on the stochastic description of ion transport through biological membranes In particular they serve as an introduction to an unified theory of fluctuations in complex biological transport systems We emphasize that the subject of this volume is not to introduce the mathematics of stochastic processes but to present a field of theoretical biophysics in which stochastic methods are important In the last years the study of membrane noise has become an important method in biophysics Valuable information on the ion transport mechanisms in membranes can be obtained from noise analysis A number of different processes such as the opening and closing of ion channels have been shown to be sources of the measured current or voltage fluctuations Biological transport systems can be complex For example the transport process can be coupled to other processes such as chemical reactions and take place in discontinuous structures of molecular dimensions Furthermore since there are strong electric fields or high concentration gradients across biological membranes ion transport processes of biological relevance are mostly processes far from equilibrium For these reasons the development of new theoretical concepts has been necessary The concept of transport in discrete systems has turned out to be more appropriate than continuum models

*Voltage-Sensitive Ion Channels* H. Richard Leuchtag, 2008-12-21 The goal of this book is to explore the complexity of a microscopic bit of matter that exists in a myriad of copies within our bodies the voltage sensitive ion channel We seek to investigate the way in which these macromolecules make it possible for the long fibers of our nerve and muscle cells to conduct impulses These integral components of cell membranes are marvels of nature's evolutionary adaptation To understand them we must probe the boundaries of physics and chemistry Since function is intimately related to structure we examine the molecular structure of channels focusing on physical principles that govern all matter With the application of genetic methods our knowledge of ion channels has broadened and deepened In the hope that research can help ameliorate suffering we discuss the diseases that arise from channel malfunctions due to genetic mutations This book is intended for students and scientists who are willing to travel into uncharted waters of an interdisciplinary science We approach the subject of voltage sensitive ion channels from various points of view This book seeks to give voice to the viewpoints of the physical and the biological scientist and to bridge gaps in terminology and background Readers may find this book to have both elementary and advanced aspects For the reader trained in the biological sciences it reviews background in physics and chemistry for the reader trained in the physical sciences it reviews background in physiology and biochemistry

*Biological Motion* Wolfgang Alt, Gerhard Hoffmann, 2013-11-11 behavior is not what an organism does itself but to what we point Therefore whether a type of behavior of an organism is adequate as a certain configuration of movements will depend on the environment in which we describe it Humberto Maturana Francisco Varela *El árbol del*

conocimiento 1984 A thorough analysis of behavior must result in a scheme that shows all regularities that are to be found between the sensorial input and the motorical output of an animal This scheme is an abstract representation of the brain

Valentin Braitenberg *Gehirngespinnste* 1973 During the 70ies when Biomathematics beyond Biomedical Statistics and Computing became more popular at universities and research institutes the problems dealt with came mainly from the general fields of Population Biology and Complex Systems Analysis such as epidemics ecosystems analysis morphogenesis genetics immunology and neurology see the first series of Springer Lecture Notes in Biomathematics Since then the picture has not considerably changed and it seems that a thorough analysis of behavior of single organisms and moreover of their mutual interactions is far from being understood On the contrary mathematical modellers and analysts have been well advised to restrict their investigations to specific aspects of biological behavior one of which is biological motion Until now only a few Conference Proceedings or Lecture Notes have paid attention to this important aspect some of the earlier examples being Vol 24 The measurement of biological shape and shape changes 1978 or Vol [Transient Processes in Cell Proliferation Kinetics](#)

Andrej Yu. Yakovlev, Nikolaj M. Yanev, 2013-03-08 A mathematician who has taken the romantic decision to devote himself to biology will doubtlessly look upon cell kinetics as the most simple and natural field of application for his knowledge and skills Indeed the thesaurus he is to master is not so complicated as say in molecular biology the structural elements of the system i e cells have been segregated by Nature itself simple considerations of balance may be used for deducing basic equations and numerous analogies in other areas of science also superficial add to ones confidence Generally speaking this number of impression is correct as evidenced by the very great theoretical studies on population kinetics unmatched in other branches of mathematical biology This however does not mean that mathematical theory of cell systems has traversed in its development a pathway free of difficulties or errors The seeming ease of formalizing the phenomena of cell kinetics not infrequently led to the appearance of mathematical models lacking in adequacy or effectiveness from the viewpoint of applications As in any other domain of science mathematical theory of cell systems has its own intrinsic logic of development which however depends in large measure on the progress in experimental biology Thus during a fairly long period running into decades activities in that sphere were centered on devising its own specific approaches necessitated by new objectives in the experimental in vivo and in vitro investigation of cell population kinetics in different tissues *Lindenmayer Systems, Fractals, and Plants* Przemyslaw Prusinkiewicz, James Hanan, 2013-11-11 1 systems are a mathematical formalism which was proposed by Aristid Lindenmayer in 1968 as a foundation for an axiomatic theory of development The notion promptly attracted the attention of computer scientists who investigated 1 systems from the viewpoint of formal language theory This theoretical line of research was pursued very actively in the seventies resulting in over one thousand publications A different research direction was taken in 1984 by Alvy Ray Smith who proposed 1 systems as a tool for synthesizing realistic images of plants and pointed out the relationship between 1 systems and the concept of fractals introduced by Benoit Mandelbrot The

work by Smith inspired our studies of the application of 1 systems to computer graphics Originally we were interested in two problems Can 1 systems be used as a realistic model of plant species found in nature Can 1 systems be applied to generate images of a wide class of fractals It turned out that both questions had affirmative answers Subsequently we found that 1 systems could be applied to other areas such as the generation of tilings reproduction of a geometric art form from East India and synthesis of musical scores based on an interpretation of fractals This book collects our results related to the graphical applications of systems It is a corrected version of the notes which we prepared for the ACM SIGGRAPH 88 course on fractals

**Modeling and Management of Resources under Uncertainty** Thomas L. Vincent, Yosef Cohen, Walter J. Grantham, Geoffrey P. Kirkwood, Jan M. Skowronski, 2013-03-08 This volume contains the proceedings of the second U S Australia workshop on Renewable Resource Management held at the East West Center Honolulu Hawaii December 9-12 1985 The workshop was jointly sponsored by the National Science Foundation USA and the Department of Science and Technology Australia under the U S Australia Cooperative Science Program The objective of the workshop was to focus on problems associated with the management of renewable resource systems A particular emphasis was given to methods for handling uncertain elements which are present in any real system Toward this end the participants were chosen so that the collective expertise included mathematical modeling dynamical control game theory ecology and practical management of real systems Each participant was invited to give an informal presentation in his field of expertise as related to the overall theme The formal papers contained in this volume were written after the workshop so that the authors could utilize the workshop experience in relating their own work to others To further encourage this exchange each paper contained in this volume was reviewed by two other participants who then wrote formal comments These comments with author's reply in some cases are attached to the end of each paper

Mathematical Topics in Population Biology, Morphogenesis and Neurosciences Ei Teramoto, Masaya Yamaguti, 2013-03-08 This volume represents the edited proceedings of the International Symposium on Mathematical Biology held in Kyoto November 10-15 1985 The symposium was organized by an international committee whose members are Ei Teramoto M Yamaguti S Amari S A Levin H Matsuda A Okubo L M Ricciardi R Rosen and L A Segel The symposium included technical sessions with a total of 11 invited papers 49 contributed papers and a poster session where 40 papers were displayed These Proceedings consist of selected papers from this symposium This symposium was the second Kyoto meeting on mathematical topics in biology The first was held in conjunction with the Sixth International Biophysics Congress in 1978 Since then this field of science has grown enormously and the number of scientists in the field has rapidly increased This is also the case in Japan About 80 young Japanese scientists and graduate students participated this time The sessions were divided into 4 categories 1 Mathematical Ecology and Population Biology 2 Mathematical Theory of Developmental Biology and Morphogenesis 3 Theoretical Neurosciences and 4 Cell Kinetics and Other Topics In every session there were stimulating and active discussions among the participants We are convinced that

the symposium was highly successful in transmitting scientific information across disciplines and in establishing fruitful contacts among the participants We owe this success to the cooperation of all participants

Cell Kinetic Modelling and the Chemotherapy of Cancer Helmut Knolle, 2013-03-08 During the last 30 years many chemical compounds that are active against tumors have been discovered or developed At the same time new methods of testing drugs for cancer therapy have evolved before 1964 drug testing on animal tumors was directed to observation of the increase in life span of the host after a single dose A new approach in which the effects of multiple doses on the proliferation kinetics of the tumor in vivo as well as of cell lines in vitro are investigated has been outlined by Skipper and his co workers in a series of papers beginning in 1964 Skipper Schabel and Wilcox 1964 and 1965 They also investigated the influence of the time schedule in the treatment of experimental tumors Since the publication of those studies cell population kinetics cannot be left out of any discussion of the rational basis of chemotherapy When clinical oncologists began to apply cell kinetic concepts in practice about 15 years ago the theoretical basis was still very poor in spite of Skipper's progress and the lack of relevant cytokinetic and pharmacologic data was apparent Subsequently much theoretical work has been done and many cell kinetic models have been elaborated for a review see Eisen 1977

**Nonlinear Oscillations in Biology and Chemistry** Hans G. Othmer, 1986 *The American Mathematical Monthly*, 1983 **Journal of Non-equilibrium Thermodynamics**, 1988 **Journal of Mathematical Biology**, 1983 *Mathematical Reviews*, 1994 **Rhythms in Biology and Other Fields of Application** Société mathématique de France, Société mathématique de France. Journées, 1983-06 This volume contains most of the talks presented at the Journées de la Société Mathématique de France entitled Rhythms in Biology and other fields of application Deterministic and Stochastic Approaches held in Luminy from the 14th to the 18 of September 1981 The aim of our meeting was to bring together scientists from different disciplines to discuss a common topic and to stimulate exchanges between participants We hope that this goal was reached This volume is divided into four chapters In each one the papers are arranged in alphabetical order by first author Chapters one and two contain papers devoted to description or modelling of rhythmic biological phenomena Chapters three and four deal with models for the study of rhythms involving the use of deterministic or stochastic tools capable of fruitful transfer to Biology We are pleased that these Proceedings appear in a series which constitutes an interface between Biologists and Mathematicians We are indebted to all who provided us with their help particularly the Centre International de Rencontres Mathématiques C I R M at Luminy the Société Mathématique de France S M F the Delegation aux Relations Universitaires Internationales D R U I and the Laboratoire d Informatique et de Mathématiques Appliquées de Grenoble I M A G Special thanks are due to Mrs A Litman for her dedication and her efficiency throughout the organization of this meeting Grenoble December 1982

**Mathematics in Biology and Medicine** Vincenzo Capasso, Enea Grosso, Stefano L. Paveri-Fontana, 1985-03 These Proceedings contain a large part of the papers presented at the International Conference Mathematics in Biology and Medicine organized by the Dipartimento di Matematica and the

Istituto di Igiene at the University of Bari Italy July 18 22 1983 The main objective of the Conference was to bring together scientists in pure and applied mathematics and scientists in biology and medicine The purpose was to exchange ideas and discuss the common problems encountered in the formulation analysis and numerical treatment of mathematical models in the biomedical sciences Simulation methods and problems of validation of models vs experimental data were also treated Surveys on recent mathematical results motivated by biological questions were given Altogether we think that a balance between mathematical and biomedical aspects was maintained The Scientific Committee consisted of E Biondi Milano P Colli Franzone Udine I Galligani Bologna M Iannelli Trento G Koch Roma E Marubini Milano C Matessi Pavia M Primicerio Firenze L M Ricciardi Napoli R Rinaldi Milano A Zampieri Roma and the European Liaison Committee consisted of R M Anderson United Kingdom N T J Bailey Switzerland O Diekmann The Netherlands K Dietz F R Germany K P Hadeler F R Germany J P Kernevez France

**Mathematical Ecology** S.A. Levin, T.G. Hallam, 1984-05

**Oscillations in Mathematical Biology** J.P.E. Hodgson, 1983 The papers in this volume are based on talks given at a one day conference held on the campus of Adelphi University in April 1982 The conference was organized with the title Oscillations in Mathematical Biology however the speakers were allowed considerable latitude in their choice of topics In the event the talks all concerned the dynamics of non linear systems arising in biology so that the conference achieved a good measure of cohesion Some of the speakers chose not to submit a manuscript for these proceedings feeling that their material was too conjectural to be committed to print Also the paper of Rinzel and Troy is a distillation of the two separate talks that the authors gave Otherwise the material reproduces the conference proceedings The conference was made possible by the generous support of the Office of the Dean of the College of Arts and Sciences at Adelphi The bulk of the organization of the conference was carried out by Dr Ronald Grisell whose energy was in large measure responsible for the success of the conference

**The Mathematical Gazette**, 1984

**Intrinsic Geometry of Biological Surface Growth** Philip H. Todd, 1986-05 1 1 General Introduction The work which comprises this essay formed part of a multidisciplinary project investigating the folding of the developing cerebral cortex in the ferret The project as a whole combined a study at the histological level of the cytoarchitectural development concomitant with folding and a mathematical study of folding viewed from the perspective of differential geometry We here concentrate on the differential geometry of brain folding Histological results which have some significance to the geometry of the cortex are referred to but are not discussed in any depth As with any truly multidisciplinary work this essay has objectives which lie in each of its constituent disciplines From a neuroanatomical point of view the work explores the use of the surface geometry of the developing cortex as a parameter for the underlying growth process Geometrical parameters of particular interest and theoretical importance are surface curvatures Our experimental portion reports the measurement of the surface curvature of the ferret brain during the early stages of folding The use of surface curvatures and other parameters of differential geometry in the formulation of theoretical models of cortical folding is discussed

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**Agricultural Library Catalog** National Agricultural Library (U.S.), 1983



## **Stochastic Transport Processes In Discrete Biological Systems** Book Review: Unveiling the Magic of Language

In a digital era where connections and knowledge reign supreme, the enchanting power of language has become more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Stochastic Transport Processes In Discrete Biological Systems**," compiled by a highly acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound effect on our existence. Throughout this critique, we will delve into the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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