

Trends in

BIOPHYSICS

From Cell Dynamics Toward Multicellular Growth Phenomena



Pavel Kratochvíl, PhD
Editor

Apple Academic Press



CRC Press
Taylor & Francis Group

Trends In Biophysics From Cell Dynamics Toward Multicellular Growth Phenomena

Krastan B. Blagoev, Herbert Levine



Trends In Biophysics From Cell Dynamics Toward Multicellular Growth Phenomena:

Trends in Biophysics Pavel Kraikivski, 2013-04-12 This title includes a number of Open Access chapters This book covers a wide scope of biological approaches to such biological phenomena as cell division motility collective cell behavior multicellular structures morphogenesis and tumor development Over the past two decades biologists have generated large sets of experimental data and discovered a lot of facts that need explanation This biological boom attracts physicists who believe they can help to develop a theoretical framework in biology and explain complete biological phenomena using basic principles This is the first book to present recent advances in biophysical studies of the different aspects of cell life This book presents recent advances in biophysical studies of living cells and gives the impression that a combination of quantitative live cell observations detailed biochemical and biophysical data and mathematical modeling are capable to answer many important biological questions and to achieve a more complete understanding of such complex phenomena

Growth Vaclav Smil, 2020-12-08 A systematic investigation of growth in nature and society from tiny organisms to the trajectories of empires and civilizations Growth has been both an unspoken and an explicit aim of our individual and collective striving It governs the lives of microorganisms and galaxies it shapes the capabilities of our extraordinarily large brains and the fortunes of our economies Growth is manifested in annual increments of continental crust a rising gross domestic product a child's growth chart the spread of cancerous cells In this magisterial book Vaclav Smil offers systematic investigation of growth in nature and society from tiny organisms to the trajectories of empires and civilizations Smil takes readers from bacterial invasions through animal metabolisms to megacities and the global economy He begins with organisms whose mature sizes range from microscopic to enormous looking at disease causing microbes the cultivation of staple crops and human growth from infancy to adulthood He examines the growth of energy conversions and man made objects that enable economic activities developments that have been essential to civilization Finally he looks at growth in complex systems beginning with the growth of human populations and proceeding to the growth of cities He considers the challenges of tracing the growth of empires and civilizations explaining that we can chart the growth of organisms across individual and evolutionary time but that the progress of societies and economies not so linear encompasses both decline and renewal The trajectory of modern civilization driven by competing imperatives of material growth and biospheric limits Smil tells us remains uncertain

Scientific Interfaces and Technological Applications, 1986-01-01

Biophysics in the cell Thomas Bornschlöggl, Hendrik Dietz, 2025-02-10 This textbook is for all students of the natural sciences interested in the physical concepts describing fundamental cellular processes For example the phenomena of diffusion and the mechanics of macromolecules and the cell membrane are treated

and illustrated with many examples Furthermore the formation of the fibrous proteins of the cytoskeleton as well as enzyme kinetics and the functioning of molecular motors are discussed This compact book builds on a two semester lecture entitled Biophysics in the Cell given at the Technical University of Munich To emphasize different approaches and thus make them more comprehensible important formulas are often derived in different ways By the way sections highlighting historical or current backgrounds and the scientific zeitgeist of the respective research enrich the material in an entertaining way Attractive clear and modern illustrations give the book a special charm in addition to the technically up to date andcomprehensibly presented content From the contents Origin and structure of cells basic concepts of biophysics and important basics of thermodynamics and statistical mechanics Passive motion by diffusion physical description of diffusion lattice models diffusion in a potential biochemical reactions Mechanics of beams polymers and membranes elastic properties of biological components forces bending stretching stretching and rupture of the cell membrane and cytoskeleton Active movement and enzyme kinetics functioning of enzymes molecular motors and the dynamics of fibre proteins in the cytoskeleton

Phase Transitions in Cell Biology Gerald H. Pollack, Wei-Chun Chin, 2008-08-15 Phase transitions occur throughout nature The most familiar example is the one that occurs in water the abrupt discontinuous transition from a liquid to a gas or a solid induced by a subtle environmental change Practically magical the ever so slight shift of temperature or pressure can induce an astonishing transition from one entity to another entity that bears little resemblance to the first So convenient a feature is seen throughout the domains of physics and chemistry and one is therefore led to wonder whether it might also be common to biology Indeed many of the most fundamental cellular processes are arguably attributable to radical structural shifts triggered by subtle changes that cross a critical threshold These processes include transport motion signaling division and other fundamental aspects of cellular function Largely on the basis of this radical concept a symposium was organized in Poitiers France to bring together people who have additional evidence for the role of phase transitions in biology and this book is a compendium of some of the more far reaching of those presentations as well as several others that seemed to the editors to be compelling The book should be suitable for anyone interested in the nature of biological function particularly those who tire of lumbering along well trodden pathways of pursuit and are eager to hear something fresh The book is replete with fresh interpretations of familiar phenomena and should serve as an excellent gateway to deeper understanding

Dynamics of Cell and Tissue Motion Wolfgang Alt, 1997 Understanding the dynamics of cell and tissue motion forms an essential step in understanding the dynamics of life and biological self organization Biological motion is one of the most obvious expressions of self organization as it requires autonomous creation and regulated action of forces leading to shape formation and translocation of cells and tissues The topics of the book include intracellular motility and cytoplasmic dynamics e g cell division single cell movement in varying extracellular media e g chemotaxis or contact guidance cell aggregation and cooperative motion e g cellular swarms or slugs and finally cell cell interactions in developing tissues e g

embryogenesis or plant movement The dynamics underlying biological motion are explained on the one hand by various methods of image processing and correlation analysis and on the other hand by using physico chemical theories developing corresponding mathematical models and performing continuum field or stochastic simulations Thus the study is of an interdisciplinary character typically found in theoretical and mathematical biology Its presentation is intended to reach a broad audience from theoretically interested bioscientists physicians and biophysicists to applied mathematicians interested in the application of nonlinear dynamical systems and simulation algorithms The most important feature of the book is that it considers possible synergetic mechanisms of interaction and cooperation on different microscopic levels on the molecular level of cytoskeletal polymers membrane proteins and extracellular matrix filaments as well as on the level of cells and cellular tissues New results concern the aspects of filament or cell alignment various modes of force transduction and the formation of global stress fields The latter aspect of mechanical cell cell communication is emphasized in order to complement the much more well studied phenomena of chemical genetical or electrophysical communication

Integrated Molecular and Cellular Biophysics Valerica Raicu,Aurel Popescu,2010-10-19 Biophysics represents perhaps one of the best examples of interdisciplinary research areas where concepts and methods from disciplines such as physics biology chemistry colloid chemistry and physiology are integrated It is by no means a new eld of study and has actually been around initially as quantitative physiology and partly as colloid science for over a hundred years For a long time biophysics has been taught and practiced as a research discipline mostly in medical schools and life sciences departments and excellent biophysics textbooks have been published that are targeted at a biologically literate audience With a few exceptions it is only relatively recently that biophysics has started to be recognized as a physical science and integrated into physics departments curricula sometimes under the new name of biological physics In this period of crystallization and possible redefinition of biophysics there still exists some uncertainty as to what biophysics might actually represent A particular tendency among physicists is to associate biophysics research with the development of powerful new techniques that should eventually be used not by physicists to study physical processes in living matter but by biologists in their biological investigations There is value in that judgment and excellent books have been published that introduce the interested reader to the use of physical principles for the development of new methods of investigation in life sciences

Cell Dynamics M. Tazawa,2012-01-07 *Physics of Molecular and Cellular Processes* Krastan B. Blagoev,Herbert Levine,2022-10-08 This is a graduate level introduction to quantitative concepts and methods in the science of living systems It relies on a systems approach for understanding the physical principles operating in biology Physical phenomena are treated at the appropriate spatio temporal scale and phenomenological equations are used in order to reflect the system of interest Biological details enter to the degree necessary for understanding specific processes but in many cases the approach is not reductionist This is in line with the approach taken by physics to many other complex systems The book bridges the gap between graduate students general

physics courses and research papers published in professional journals. It gives students the foundations needed for independent research in biological physics and for working in collaborations aimed at quantitative biology and biomedical research. Also included are modern mathematical and theoretical physics methods giving the student a broad knowledge of tools that can shed light on the sophisticated mechanisms brought forth by evolution in biological systems. The content covers many aspects that have been the focus of active research over the past twenty years, reflecting the authors' experience as leading researchers and teachers in this field. *Molecular Biophysics for the Life Sciences* Norma Allewell, Linda O.

Narhi, Ivan Rayment, 2013-09-28 This volume provides an overview of the development and scope of molecular biophysics and in-depth discussions of the major experimental methods that enable biological macromolecules to be studied at atomic resolution. It also reviews the physical chemical concepts that are needed to interpret the experimental results and to understand how the structure dynamics and physical properties of biological macromolecules enable them to perform their biological functions. Reviews of research on three disparate biomolecular machines: DNA helicases, ATP synthases, and myosin illustrate how the combination of theory and experiment leads to new insights and new questions. **Molecular and**

Cellular Biophysics Jack A. Tuszynski, 2018-10-24 From quantum theory to statistical mechanics, the methodologies of physics are often used to explain some of life's most complex biological problems. Exploring this challenging yet fascinating area of study, *Molecular and Cellular Biophysics* covers both molecular and cellular structures as well as the biophysical processes that occur in these structures. Designed for advanced undergraduate and beginning graduate students in biophysics courses, this textbook features a quantitative approach that avoids being too abstract in its presentation. Logically organized from small-scale molecular to large-scale cellular systems, the text first defines life, discussing the scientific controversies between mechanists and vitalists, the characteristics of living things, and the evolution of life. It then delves into molecular structures, including nucleic acids, DNA, RNA, interatomic interactions, and hydrogen bonds. After looking at these smaller systems, the author probes the larger cellular structures. He examines the cytoplasm, the cytoskeleton, chromosomes, mitochondria, motor proteins, and more. The book concludes with discussions on biophysical processes including oxidative phosphorylation, diffusion, bioenergetics, conformational transitions in proteins, vesicle transport, subcellular structure, formation, and cell division. **Biophysics of Tissue Self-Organization in Morphogenesis** Ivana

Pajic-Lijakovic, 2025-09-01 *Biophysics of tissue self-organization in morphogenesis* The role of dynamics along the biointerface examines interactions between tissue and the extracellular matrix. This interdisciplinary book covers the fundamentals of cell self-rearrangement and the interrelation between these biological mechanisms and physical mechanisms responsible for tissue self-organization. It provides an introduction to tissue self-organization in morphogenesis before exploring its physics from subcellular to supracellular levels. Modeling approaches to tissue self-organization are explored, followed by discussion of the application of engineering principles to solve biological and medical problems related

to the tissue self organisation A range of tools applications and medical implications are also covered including embryo development wound healing and cancerous diseases The book closes with a look to future developments in the field

Biophysics of tissue self organization in morphogenesis The role of dynamics along the biointerface provides a detailed introduction to this topic and is a valuable resource for researchers across the areas of cell biology cell physiology biophysics developmental biology tissue biomechanics and pathophysiology Describes biological mechanisms of cell self rearrangement from subcellular to supracellular levels Explores mathematical modelling approaches of tissue self organization Considers engineering principles to solve biological and medical problems related to tissue self organisation Discusses tissue self organisation within various in vivo and in vitro organoid systems

Biophysics and the Challenges of Emerging

Threats Joseph Puglisi, 2009-05-25 Single molecule techniques eliminate ensemble averaging thus revealing transient or rare species in heterogeneous systems 1 3 These approaches have been employed to probe myriad biological phenomena including protein and RNA folding 4 6 enzyme kinetics 7 8 and even protein biosynthesis 1 9 10 In particular immobilization based fluorescence techniques such as total internal reflection fluorescence microscopy TIRF M have recently allowed for the observation of multiple events on the milliseconds to seconds timescale 11 13 Single molecule fluorescence methods are challenged by the instability of single fluorophores The organic fluorophores commonly employed in single molecule studies of biological systems display fast photobleaching intensity fluctuations on the millisecond timescale blinking or both These phenomena limit observation time and complicate the interpretation of fluorescence fluctuations 14 15 Molecular oxygen O_2 modulates dye stability Triplet O_2 efficiently quenches dye triplet states responsible for blinking This results in the formation of singlet oxygen 16 18 Singlet O_2 reacts efficiently with organic dyes 2 amino acids and nucleobases 19 20 Oxidized dyes are no longer fluorescent oxidative damage impairs the folding and function of biomolecules In the presence of saturating dissolved O_2 blinking of fluorescent dyes is suppressed but oxidative damage to dyes and biomolecules is rapid Enzymatic O_2 scavenging systems are commonly employed to ameliorate dye instability 2 Small molecules are often employed to suppress blinking at low O_2 levels

Biophysics and Structure to Counter Threats and Challenges

Joseph D. Puglisi, Manolia V. Margaris, 2012-11-28 This ASI brought together a diverse group of experts who span virology biology biophysics chemistry physics and engineering Prominent lecturers representing world renowned scientists from nine 9 different countries and students from around the world representing eighteen 18 countries participated in the ASI organized by Professors Joseph Puglisi Stanford University USA and Alexander Arseniev Moscow RU The central hypothesis underlying this ASI was that interdisciplinary research merging principles of physics chemistry and biology can drive new discovery in detecting and fighting chemical and bioterrorism agents lead to cleaner environments and improved energy sources and help propel development in NATO partner countries At the end of the ASI students had an appreciation of how to apply each technique to their own particular research problem and to demonstrate that multifaceted approaches and new technologies are needed to

solve the biological challenges of our time The course succeeded in training a new generation of biologists and chemists who will probe the molecular basis for life and disease **New Techniques in Biophysics and Cell Biology**, 1973

Introduction to Cellular Biophysics, Volume 2 Armin Kargol, 2019-12-13 All living matter is comprised of cells which are small compartments isolated from the environment by a cell membrane and filled with concentrated solutions of various organic and inorganic compounds Some organisms are single cell where all life functions are performed by that cell Others have groups of cells or organs specializing in one particular function The survival of the entire organism depends on all of its cells and organs fulfilling their roles Cells are seen differently by biologists chemists or physicists Biologists concentrate their attention on cell structure and function What the cells consist of Where are its organelles What function each organelle fulfils From a chemists point of view a cell is a complex chemical reaction chamber where various molecules are synthesized or degraded From a physics standpoint however some of the fundamental questions involve the physical movement of all these molecules between organelles within the cell their exchange with the extracellular medium as well as electrical phenomena resulting from such transport The aim of this book is to look into the basic physical phenomena occurring in cells These physical transport processes facilitate chemical reactions in the cell and various electrical effects and that in turn leads to the biological functions necessary for the cell to satisfy its role in the mother organism Ultimately the goals of every cell are to stay alive and to fulfil its function as a part of a larger organ or organism The first volume of this book is an inventory of physical transport processes occurring in cells and this volume provides a closer look at how complex biological and physiological cell phenomena result from these very basic physical processes **Nanoscale Biophysics of the Cell**

Mohammad Ashrafuzzaman, 2018 Macroscopic cellular structures and functions are generally investigated using biological and biochemical approaches But these methods are no longer adequate when one needs to penetrate deep into the small scale structures and understand their functions The cell is found to hold various physical structures molecular machines and processes that require physical and mathematical approaches to understand and indeed manipulate them Disorders in general cellular compartments perturbations in single molecular structures drug distribution therein and target specific drug binding etc are mostly physical phenomena This book will show how biophysics has revolutionized our way of addressing the science and technology of nanoscale structures of cells and also describes the potential for manipulating the events that occur in them **Multicellularity** Karl J. Niklas, Stuart A. Newman, 2022-06-07 Scholars consider the origins and consequences of the evolution of multicellularity addressing a range of organisms experimental protocols theoretical concepts and philosophical issues The evolution of multicellularity raises questions regarding genomic and developmental commonalities and discordances selective advantages and disadvantages physical determinants of development and the origins of morphological novelties It also represents a change in the definition of individuality because a new organism emerges from interactions among single cells This volume considers these and other questions with contributions that

explore the origins and consequences of the evolution of multicellularity addressing a range of topics organisms and experimental protocols Each section focuses on selected topics or particular lineages that present a significant insight or challenge The contributors consider the fossil record of the paleontological circumstances in which animal multicellularity evolved cooptation recurrent patterns modularity and plausible pathways for multicellular evolution in plants theoretical approaches to the amoebozoans and fungi cellular slime molds having long provided a robust model system for exploring the evolution of multicellularity plants and animals genomic toolkits of metazoan multicellularity and philosophical aspects of the meaning of individuality in light of multicellular evolution Contributors Maja Adamska Argyris Arnellos Juan A Arias Eugenio Azpeitia Mariana Benitez Adriano Bonforti John Tyler Bonner Peter L Conlin A Keith Dunker Salva Duran Nebreda Ana E Escalante Valeria Hernandez Hernandez Kunihiro Kaneko Andrew H Knoll Stephan G Knig Daniel J G Lahr Ottoline Leyser Alan C Love Raul Montañez Emilio Mora van Cauwelaert Alvaro Moreno Vidyanand Nanjundiah Aurora M Nedelcu Stuart A Newman Karl J Niklas William C Ratcliff Iaki Ruiz Trillo Ricard Sol Introduction to Cellular Biophysics Armin Kargol, 2019 The aim of this book is to look into the basic physical phenomena occurring in cells These physical transport processes facilitate chemical reactions in the cell and various electrical effects and that in turn leads to biological functions necessary for the cell to satisfy its role in the mother organism This volume provides a closer look at how complex biological and physiological cell phenomena result from these very basic physical processes

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