"We easily forget how astonishing it is to watch a cell replicate itself. Kaneko reminds us that scientists still lack a fundamental molecular understanding of this most basic feature of life. Readers with backgrounds in physics and complex systems will be rewarded with a refreshing view of biology, grounded in experimental data and mathematical analysis."

MUKUND THATTAI, National Centre for Biological Sciences, India

"Living matter is a cascade of molecular and organizational machines, stretching from the scale of atoms to the expanse of the biosphere. For centuries we have sought the logic that binds this tower together. Kaneko joins this quest with an original physicist's eye, proposing universal principles that entwine the micro and the macro into a single, living cascade."

TSVI TLUSTY, Ulsan National Institute of Science and Technology, South Korea

Living systems consist of diverse components and form a hierarchy, from molecules to cells to organisms, which adapt to external perturbations and reproduce stably. This book describes the statistical and physical principles governing cell growth and reproduction, as well as the mechanisms of adaptation through noise, kinetic memory, and robust cell differentiation via cell-to-cell interaction and epigenetics. The laws governing the rates, directions, and constraints of phenotypic evolution are derived through dimensional reduction. Throughout the book, the perspective of consistency is emphasized - between microscopic units (e.g., molecules) and macroscopic states (e.g., cells), and between distinct spatial and temporal scales. By integrating theoretical, computational, and experimental approaches, this book offers novel insights into biology from a physicist's perspective and provides a detailed picture of the universal characteristics of living systems. It is indispensable for students and researchers in physics, biology, and mathematics who are interested in understanding the nature of life and the physical principles on which it is based.

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CAMBRIDGE UNIVERSITY PRESS

ISBN 978-1-009-57566-9