

INTERDISCIPLINARY APPLIED MATHEMATICS

MATHEMATICAL BIOLOGY

From cell division to heartbeat, clocklike rhythms pervade the activities of every living organism. The cycles of life are ultimately biochemical in mechanism, but many of the principles that dominate their orchestration are essentially mathematical.

The Geometry of Biological Time describes periodic processes in living systems and their nonliving analogues in the abstract terms of nonlinear dynamics. Emphasis is given to phase singularities, waves, and mutual synchronization in tissues composed of many clocklike units. Also provided are descriptions of the best-studied experimental systems such as chemical oscillators, pacemaker neurons, circadian clocks, and excitable media organized into biochemical and bioelectrical wave patterns in two and three dimensions.

No theoretical background is assumed: the required notions are introduced through an extensive collection of pictures and easily understood examples.

This extensively updated new edition incorporates the fruits of two decades' further exploration guided by the same principles. Limit cycle theories of circadian clocks are now applied to human jet lag and are understood in terms of the molecular genetics of their recently discovered mechanisms. Supercomputers reveal the unforeseen architecture and dynamics of three-dimensional scroll waves in excitable media. Their role in life-threatening electrical aberrations of the heartbeat is exposed by laboratory experiments and corroborated in the clinic. These developments trace back to three basic mathematical ideas discussed in this volume.

Arthur T. Winfree, the John D. and Catherine T. MacArthur Fellow for 1984-1989 in theoretical biology and Einthoven award winner of 1989-1991 in cardiology, was recently honored with the Norbert Wiener Prize of AMS and SIAM for 2000-2004 and the Aisenstadt Award/Chair of the CRM for 2000, both in applied mathematics. He is a Regents Professor at the University of Arizona.

"Few people equal Arthur Winfree in contributions to our understanding of biological rhythms. *The Geometry of Biological Time* was magisterial in its first edition. The publication of this second edition updated with more years of Winfree's brilliance is a major boon to the biological community."

—Stuart Kauffman

External Professor of Santa Fe Institute and

Founder, Chairman, and Chief Scientific Officer of Bios Group