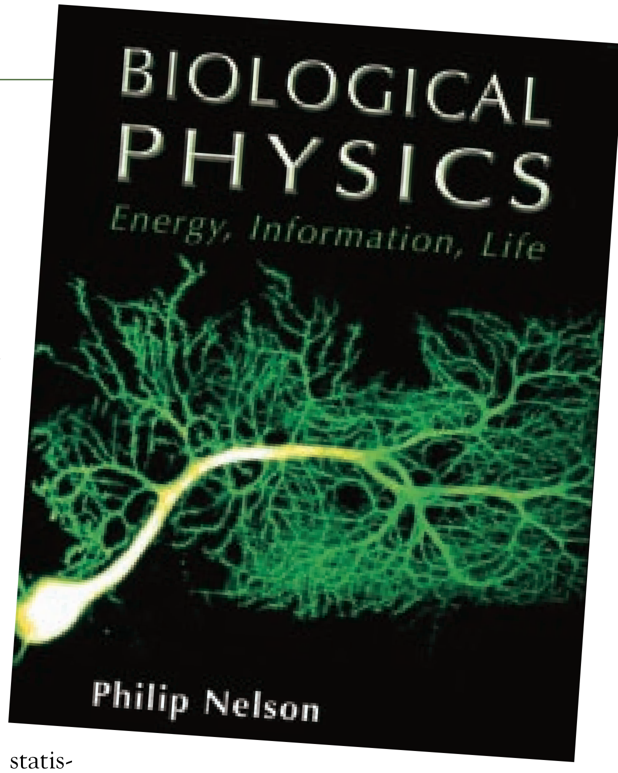
BY RUSS B. ALTMAN, MD, PhD

Teaching Biology and Physics Together



While science educators actively debate the relative merits of teaching natural science in an integrated fashion, some authors are writing texts that will make it happen. Philip Nelson's book, Biological Physics, breaks down the traditional boundaries between mathematics, physics, chemistry, and biology, and does so in a compelling fashion.

In a paper published in *Science* (2004 Feb 6;303(5659):788-90), Bialek and Botstein argue against the fragmented teaching of science, and call for "a unified introductory science curriculum that fully incorporates mathematics and quantitative thinking." As biological research becomes more quantitative—with the advent of functional genomics, molecular evolution, imaging, and systems biology—biologists must become better versed in the quantitative, theory-oriented, and computational approaches embraced by physics and chemistry.

DETAILS

Book Review:
Biological Physics: Energy, Information, Life

By Philip Nelson, PhD,
W.H. Freeman Co., 2003.

Nelson's well-written book epitomizes this approach. Aimed toward students who understand calculus and high-school biology, the book introduces physical concepts using biological examples. Nelson capitalizes on the realization that many uncomplicated biological processes (such as diffusion) are actually easier to describe using the underlying nonlinear mathematics instead of being handled in a simplified fashion for the sake of teaching students not versed in calculus.

The real strength of the book is the introduction of basic physical principles that are particularly relevant to biology (excluding all quantum mechanical ones). The examples are taken chiefly from molecular and cellular biology, with rare examples from the world larger than the cell. Thus, for example, the book provides excellent, contextualized introductions to Boltzmann statistics (and its relevance to the hypothesis that a long chain molecule must carry hereditary information), diffusion (and the derivation of the Nernst equation for membrane potential), entropy (and macromolecular folding forces), chemical potential (and the self-assembly of bilayers/micelles), cooperativity (in molecular assembly and function), and energy transduction (in the creation of molecular motors).

In order to accommodate advanced students, each chapter includes "extra" information labeled "Track 2," that goes into more challenging material. There are numerous in-line, worked-out examples, and "Your Turn" exercises. At the end of each chapter, are useful summaries: "Big Picture," "Key Formulas," and the traditional end-chapter problems.

> Nelson's text inspires students to approach biological phenomena quantitatively.

Nelson wrote the book to allow students to see "big ideas" in biology and physics early in their education as undergraduates. In this he succeeds. In the end, the student will not have an understanding of modern experimental biology, but will have seen physics applied to basic biological elements (DNA, proteins, lipids), and will have a feel for how physical forces dictate constraints on biological systems, and how biological systems use physics to get things done.

Students with a primary interest in physics will find this book a natural entry into biology. Students with a primary interest in biology will learn how biological phenomena can be approached quantitatively. By stimulating student interest, integrated science texts like this one promote a long-term future filled with important developments in quantitative, theory-based biology. □