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Book Reviews

Biological Data Analysis: A Practical Approach (Practical Approach Series 115) by J. C. Fry

IRL Press at Oxford University Press, Oxford New York and Tokyo, 1992. 418 pages.

Reviewed by Michael L. Johnson, Departments of Pharmacology and Internal Medicine, Box 448, University of Virginia Health Sciences Center, Charlottesville, VA

"This volume aims to allow biologists to carry out accurate statistical analysis and modelling with the minimum chance of making mistakes." (Preface) An error-free statistical analysis is obviously a requirement for all scientific endeavors. However, too few graduate students in biological disciplines are well versed in the application of statistical methodologies. Thus books such as the present example play an important role in the education of students. They are also important for the continuing education of established researchers, many of whom were also not well educated in statistics.

This book, like many other books, describes several classical statistical methods such as analysis of variance, bivariate regression, multiple regression, ordination, classification, and time series analysis. The distinguishing feature of this work is that it describes these from the perspective of biologists with examples that are of some interest to biologists. Many specific examples in the book use, and describe in some detail, commonly available software such as Minitab. The book is "aimed at final-year undergraduate students, masters degree students, postgraduate and professional biologists in industry, research and education." (Preface) It assumes that the reader already has some understanding of descriptive statistics (e.g., means and variance) and elementary distributions (e.g., Gaussian and Poisson).

Also included is a brief introduction to dynamic and compartmental models. However, as the preface notes, "readers with special interest in this subject would need to read other books."

The usefulness of this book will depend upon the reader's application and interests. If the reader is interested in the latest nonlinear dynamic and chaos theory methods for the analysis of time series data then this is not the book. If the reader is interested in fitting time domain fluorescence lifetime data to mechanistic models that include terms for collisional quenching and diffusion then this is not the book. If the reader wishes to distinguish between different statistical thermodynamic mechanistic models of cooperativity in human hemoglobin then, again, this is not the book. However, an understanding of the techniques required for these complex statistical analyses is based on the elementary statistical methods outlined in this book. The scope of this book is by necessity limited, but the included topics are covered clearly and in sufficient detail to be useful to biological researchers. Therefore, this book may be of some interest to biologists as an introductory text.

Introduction to Scanning Tunneling Microscopy by C. Julian Chen

Oxford University Press, New York, 1993. 472 pages. $65.00

Reviewed by Stuart M. Lindsay, Department of Physics and Astronomy, Arizona State University

If the last thing you heard about biological scanning tunneling microscopy was artifacts-on-graphite, it is time to look again. Even if you have no interest in the technique beyond the scanning tunneling microscope's (STM's) "simple" cousin (the atomic force microscope, AFM) you may well want this book. Proximal probe microscopes are, when used to their full potential, probes of the interatomic interactions between a probe and a sample. These interactions are not well described in classical terms. They are quantum mechanical and chemical in nature, and this is the text to read in order to grasp the fundamentals. To write the definitive book, Julian Chen has had to give coherence to a wide body of new knowledge and had to do so in a way that is accessible to an inherently interdisciplinary audience. He has succeeded brilliantly. Unfortunately, from the perspective of readers of *Biophysical Journal*. "Biological Applications" merits a scant page. Chen has rightly sought to incorporate that which is "fundamental." One suspects that the controversy that surrounded much of the early biological work has disqualified it in his eyes. That having been said, a number of papers have been published since this book was prepared that demonstrate high-resolution images of biopolymers, membranes, and organic adlayers obtained by STM. STM images of DNA in its natural, hydrated state have far higher resolution than given by most electron microscopy. Although interpretation of AFM images may be less controversial, understanding the limits of its resolution is not so simple. There is evidence that suggests that "atomic resolution" images are often moiré patterns formed as many points on the tip slide over an underlying periodic surface. There is a lot to be gained from a widespread appreciation of the atomic aspects of scanning probe microscopy.

The book is focused on the use of STM with simple surfaces. It begins with a gorgeous gallery of STM images. The first chapter is a broad overview comprehensible at an undergraduate level of physics. Theoretical aspects of STM imaging are covered in the next seven chapters of Part I. They are atomic-scale tunneling, wavefunctions at surfaces, the simple Tersoff-Hamann theory, and the author's extension of the theory to deal with atomic states beyond the *s*-wave approximation. Chapters 7 and 8 deal with interatomic forces and the role of interaction forces in imaging. Material such as this is not covered in Sarid's (1992) book on AFM. The introductory chapters of Part II (instrumentation) give a good review of the basics of piezoelectric scanners, vibration isolation, servo electronics, and mechanical design for STMs. They serve as an excellent introduction for the AFM also. A fifteenth chapter is devoted entirely to the AFM and is probably all that is needed (unless you plan to build your own instrument).

There is another level beyond the strictly practical matters of setting up servo parameters properly. I still feel a sense of wonder at using such simple equipment to sense, image, and manipulate atoms and molecules. It brings quantum mechanics to life. As a primer on the relevant quantum phenomena, Chen's book is an absolute delight. His discussion of quantum transmission is simple, yet it leads to a powerful generalization of the Bardeen theory for tunneling in condensed matter. Many simple connections with basic physics and chemistry are made. I had not realized how profound Linus Pauling's picture of "resonance energy" is: We see on page 177 how the time evolution of the charge distribution on a hydrogen molecular ion follows a simple oscillatory pattern, "tunneling" back and forth between protons at what Pauling christened the "resonance" frequency. In the same chapter, we see how to combine hydrogenic wavefunctions correctly for this problem. I gather that this beautiful piece of work had languished in Westinghouse library until Chen found it.

There has been real progress in both biological AFM and STM in the last two years. High-resolution images are being made reliably underwater (the real power of the techniques). The biology community probably needs a book that goes beyond Chen's. Personal computers and programs such as Mathmatica allow mathematical novices to appreciate quantum transmission (Walker and Gathright, 1993). There have been significant advances in understanding the imaging of molecules (Sautet and Joachim, 1992) and tunneling in water (Lindsay et al., 1994). Such a book is not yet written. When it is, Chen's work will be a required prerequisite.

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Motility Assays for Molecular Motors by Jonathan M. Scholey in Methods in Cell Biology, vol. 39

Academic Press, Inc., New York, 20 chapters, 1993. 304 pages. $45.00

Reviewed by Ewa Prochniewicz, Department of Biochemistry, University of Minnesota Medical School

Until recently, most research aimed at understanding the molecular mechanism of muscle contraction and cell motility was done using complementary methods of physiology and biochemistry. Physiological experiments dealt with the mechanics of intact muscle and cell locomotion, whereas biochemical studies utilized purified proteins in solution to characterize enzymatic properties of motor proteins and their interactions with actin and microtubules. However, the correlation of data obtained by the two methods was difficult, because the results of physiological experiments were not directly related to the actions of single-motor molecules, and purified proteins in solution generated neither force nor directional movement. The recent development of molecular motility assays fills the gap between biochemistry and physiology, permitting study of the measurement of motion and force using purified motor proteins (myosin, dynein, or kinesin) and the protein filaments with which they interact (actin or microtubules).

In "Motility Assays for Molecular Motors" Jonathan M. Scholey provides a timely summary of a wide range of these techniques and outlines the current problems in this exciting and promising field. The movements discussed range from those of single molecules to intracellular organelles. Many of the experiments using single molecules are focused on the fundamental step size, i.e., the distance (on the nanometer scale) a motor protein moves its load/molecule of ATP