Book Reviews

Methods in Enzymology. Vol. 259: Energetics of Biological Macromolecules, edited by M. L. Johnson and G. K. Ackers

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Biophysics is a molecular science, and any science of molecules must consider three interrelated aspects of behavior: energetics, structure, and dynamics. Of these, it can be argued that energetics is most fundamental. Biophysics is also a biological science, so an additional consideration emerges: function. This volume of *Methods in Enzymology* brings these themes together by presenting "modern thermodynamic methods. . .for determining the 'functional energetics' of macromolecular processes, including ligand binding, conformational change, macromolecular assembly, allosteric regulation, phase transition, protein-nucleic acid recognition, and the coupling of these with the covalent chemistry of enzyme-catalyzed reactions." This is an ambitious purpose, but an essential one, and it is carried out splendidly in this book, which is an important addition to our tools for research and graduate teaching.

Traditionally, *Methods in Enzymology* volumes have been like cookbooks, with many short contributions, each giving a detailed recipe for a particular technique or system. This volume is different. There are 29 articles in 720 pages, plus indexes. A typical article is about 20 pages long, some shorter and a few significantly longer, allowing plenty of room for discussion of background, fundamentals, and implications. This makes the book useful as an introduction for researchers in biomolecular thermodynamics and as a resource for teaching.

Many of the articles are predominantly concerned with techniques for obtaining thermodynamic parameters, generally considering thermodynamic fundamentals and basic equations, methods of data analysis, and interpretation of results more than the minutiae of experimental manipulation. These include denaturant and pH probes of energy transduction in enzyme catalysis (Huang and Bolen), thermal denaturation methods for studying protein folding (Freire), volume perturbation calorimetry applied to lipid membrane phase transition kinetics (Chen et al.), calorimetric determination of binding affinities (Doyle et al., Fisher and Singh), hydrogen exchange (Englander et al.), sedimentation equilibrium (Laue), and various spectroscopic methods to monitor protein unfolding (Eftink). The uses of hydrostatic and osmotic stress and volume measurements to probe biomolecular interactions are described by Parsegian et al.; Royer; Rellick and Becktel; and Robinson and Sligar.

Other articles deal with the interpretation of thermodynamic measurements in terms of noncovalent interactions. These include proton and salt effects on protein energetics (García-Moreno E.), contributions of hydrogen bonding and hydrophobic interactions to protein folding (Pace), solvent reorganization and hydrophobicity (Lee), force field for peptide and protein conformations (Creamer and Rose), and interpretation of data from isothermal processes (Lumry).

The third major group of articles deals with the thermodynamic analysis of particular systems, with strong emphasis on the linkage concepts promulgated by Jeffreys Wyman, to whom, along with John Edsall, the book is dedicated. The proteins discussed are hemoglobin (Holt and Ackers; Perrella and Denisov), thrombin (Di Cera et al.), aspartate aminotransferase (Martinez-Carrion et al.), and aspartate transcarbamylase (Allewell and LiCata). Breslauer treats the thermodynamics of conformational transitions in DNA oligonucleotide; transitions of oligomeric and polymeric RNA are discussed by Serra and Turner and by Draper and Gluick. Thermodynamic and mutational studies of RNA-protein interactions are described by Hall and Kranz. Articles by Wong and Lohman, Jen-Jacobson, and Yang and Carey discuss various approaches to DNA-protein interactions.

All of these articles are authoritative, informative, and readable, as is to be expected from the eminent group of authors who have been persuaded to contribute. Although experimental details have in some (but not all) cases been minimized to allow broader-scale treatment, adequate references are always given to enable interested readers to find the details.

This book makes a unique contribution, serving to crystallize the emerging modern discipline of biochemical thermodynamics. It is arguably the first place to turn when thinking about how to measure, analyze, and interpret the thermodynamics of conformational change and interactions of proteins and nucleic acids. It would make a fine textbook for a graduate course, though lamentably few graduate programs will devote the time to do it justice. Instructors who teach courses in less depth will find it an important background reference. For researchers, it belongs not just in the library, but on the personal bookshelf of anyone who is serious about research in molecular biophysics.