Book Review

Biomedical Engineering Principles: An Introduction to Fluid, Heat, and Mass Transport Processes (Biomedical Engineering and Instrumentation, Volume 2), Marcel Dekker, Inc. New York, 1976, 448 pages, illus., $36.50

DAVID O. COONEY

In his preface, Dr. Cooney describes this book as a "quantitative physiology" text, meant for use in introductory biomedical engineering courses at the junior and senior level. He states that certain chapters may also provide an introductory overview for applied physiologists. The first chapter presents a brief history of biomedicine, which, while interesting, has little relation to the remainder of the book. The second chapter contains anatomical charts for various systems and a discussion of body fluid composition, including a number of tables which would serve as convenient reference sources on this topic. This brief survey would probably not be sufficient for a student with no previous coursework in anatomy and physiology, and would be superfluous for one who had these courses. The remaining nine chapters are detailed reviews of some of the transport systems of the body, including blood and the circulatory system, heat transfer within the body and heat exchange with the environment, compartmental analysis, cell membrane transport, and renal and pulmonary mass transfer. There are separate chapters on applications of mass transfer theory to artificial kidney and blood oxygenator design. While some basic physiological background is given, the emphasis is on the development of mathematical representations for the various transport processes. The derivations and methods of solution of the equations are quite clear, and in most cases require only a knowledge of linear ordinary differential equations. There are many figures showing results of simulations, with well-chosen comments about their physical or physiological implications.

The depth of treatment varies considerably among chapters. The section on applications of compartmental analysis (the book's longest chapter) is a compendium of mathematical solutions for one and two compartment systems with consideration of almost every type of input and constraint that may be utilized. Although most of this information is available in standard texts on compartmental analysis or pharmacokinetics, the presentation here provides a convenient summary. The chapter on the human thermal system is probably the most extensive coverage of the analytical aspects of this topic outside of specialized texts.

In contrast, the shortest chapter is that on the circulatory system, in which the analysis is limited to the Bernoulli equation. This is somewhat surprising, since circulatory dynamics have been a major area for engineers interested in biological systems. In particular, Dr. Cooney has chosen to omit discussion of transcapillary exchange, except for the special case of the renal glomerulus. This is a topic which would seem to merit inclusion, both because of its physiological relevance and the extensive amount of mass transfer analysis that has been applied to transcapillary exchange.

The book's numerous illustrations, while mostly not original, are used quite effectively to clarify the text. Problems at the end of each chapter are also useful in this respect. The text contains remarkably few typographical errors. Production from camera ready typed copy, as was apparently done here, should enable publication of a fairly up to date book. Unfortunately, that is not the case in some chapters. For example, the drawing and text for the renal countercurrent multiplier system show the single effect generated by active sodium transport, while evidence obtained several years ago indicates it should be chloride transport. The discussion of cell membrane pores is limited to the Danielli membrane model, whereas Singer's more recent globular protein model provides a better explanation of the observed permeability characteristics. In some of the chapters, almost all of the references are from before 1970, and important recent work is neglected.

The text also contains inaccuracies and errors in concept. The discussion of osmotic pressure seems to imply that the term isotonic is equivalent to isoosmotic, and the important concept of effective osmotic pressure is not mentioned. In discussing pressures in the respiratory system and volume balances on inspired and expired gas, the intrapleural pressure during expiration is taken to be 780 mmHg, a value that would not be achieved during normal breathing.

After reading this book, I find that I agree with the author's preface that "a significant number of biomedical engineers will find that the present text clashes with their own views and/or needs". For an introductory text, I would prefer a book that had a somewhat broader scope and more balance. On the other hand, I think that this book would be an excellent starting point for engineers or physiologists embarking upon modeling or analysis of the specific systems that Cooney discusses.

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