Book Review

Basic Transport Phenomena in Biomedical Engineering, 2nd Edition, by Ronald L. Fournier, Taylor & Francis, New York, 2006

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In the words of the author, the second edition of this text "brings together fundamental engineering and life science principles to provide a focused coverage of key transport concepts in biomedical engineering." The book is focused toward the beginning student of biomedical engineering as well as its already-established engineers and scientists. The second edition has been substantially augmented and reorganized over the first edition.

The new text starts with an introductory chapter covering units, dimensions, and several basic approaches and principles applied to solving biomedical transport problems. Before delving into transport processes, the revised text also includes, as Chapter 2, a useful summary on the thermodynamic principles of chemical systems. This chapter will be especially useful for students of biomedical engineering, who sometimes begin the study of transport processes without having had sufficient background in principles of chemical equilibrium. After all, a "transport process" describes a system disrupted from equilibrium that is attempting to regain equilibrium. More practically, the conditions that apply at the boundary of biomedical transport systems stem from various principles of chemical equilibrium at interfaces between various subcellular, cellular, tissue, or organ components (or "compartments").

The remaining chapters in the book appeared in the first edition but have been reorganized, augmented, and reordered. As in other texts on biomedical transport phenomena, momentum transport is addressed before mass transport. Chapter 4 covers the flow dynamics of blood flow with emphasis given to paradigmatic relationships such as the Hagen-Poiseuille equation, as well as the non-Newtonian characteristics of blood rheology and blood rheological models. The chapter also provides coverage and analysis relative to the "particulate effects" of blood flow in the microcirculation, the Fahraeus and Fahraeus-Lindqvist effects describing hematocrit and viscosity reductions in microvessels. Chapters 5 and 6 cover solute and oxygen transport in blood and tissue as well as transcapillary exchange. The breadth of coverage in these chapters is extensive, with many important paradigms covered, including convective mass transport, capillary filtration, membrane transport, transcapillary solute exchange, oxygen carriage in blood, oxygen transport within tissue (Krogh model), and characteristics of artificial blood.

A strong point of the original text and revised text is coverage of several areas of interest in applied biomedical transport phenomena, which will garner significant interest from beginning students in biomedical engineering. Chapters 7 through 10 cover pharmacokinetics, extracorporeal medical devices, tissue engineering, and biohybrid artificial organs. These are some of the more interesting applications in the biomedical area for implementing transport design principles. The presentation of extracorporeal devices focuses mainly on membrane-based devices such as hemodialyzers and blood oxygenators. The tissue engineering chapter focuses mainly on general principles related to extracellular matrix, cellular receptors, and transport within polymeric matrices. The coverage of biohybrid artificial organs reviews basic principles of immunology and immunological isolation and describes encapsulated cellular systems such as the artificial pancreas. Recent advances in the biohybrid liver and kidney systems are also briefly described. Consistent with the philosophy put forward for this book, the text does not pursue a comprehensive review of contemporary developments in all these areas but instead intends to teach and illustrate principles and applications of biomedical transport phenomena within the context of important technologies currently in clinical use or close to clinical reality.

The suitability of this book as a text for an undergraduate or graduate course in biomedical transport phenomena will largely depend on the style of the instructor. This is not necessarily a textbook that derives important relationships from first principles, nor does it follow a Bird, Stewart, and Lightfoot approach to the development of transport principles. Important concepts in biomedical transport phenomena are introduced, but the pace may seem too rapid for a beginning engineering student. However, the student or practitioner who has already been exposed to some of the engineering principles covered in this text will appreciate the efficiency and breadth with which biomedical applications of classic transport principles are presented. Transport or mechanics faculty working in the bioengineering area will find this book an excellent addition to their bookshelves.

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