

## BOOK REVIEWS

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**Gas Mixing and Distribution in the Lung.** (Lung Biology in Health and Disease Volume 25.), Edited by Ludwig A. Engel and Manuel Paiva, Marcel Dekker Inc., New York, NY, 1985, 416 pp. \$75 (U.S. and Canada); \$90.00 (all other countries).

Recent interest in high frequency ventilation has created a growing need for detailed understanding of the mass transfer processes involved in ventilation of the lung. More generally, ventilation distribution and gas mixing are important in various aspects of both health and disease. This book presents the subject from an interdisciplinary viewpoint blending the current theoretical understanding with the most recent experimental findings. The book is organized into eight chapters authored by some of the leading researchers in the field who are drawn from a variety of disciplines.

The basic concepts of molecular diffusion are discussed first. This book contains a wealth of quantitative anatomical data that is particularly useful for theoretical and physical modeling. Detailed data on the dimensions of airways, bifurcations, bifurcation angles, and the number of acinar structures are well presented. Physiological implications are explained and functional anatomy including asymmetry, collateral ventilation and shape changes in the vicinity of bronchial bifurcations are well discussed. Also, anatomical considerations of the diseased lungs are beautifully illustrated.

Mass transfer of gas and aerosol in the conducting airways (dead space) is discussed

in detail. For instance, the velocity profiles downstream of a single bifurcation are presented for inspiration and expiration. The mixing mechanisms are reviewed in detail and the results of mixing experiments with physical models and human subjects are analyzed.

The chapter on low tidal volume high frequency ventilation is of particular interest to the readers of this journal. The mechanisms of high frequency ventilation are analyzed well. Physical experiments with hardware and mathematical models, and physiological studies with animal and human subjects are all examined.

Also of particular interest is the chapter on regional ventilation. Experimental results on the effects of posture, regional lung expansion, and voluntary muscle contraction are well presented. Spatial distribution of ventilation of various lung diseases and muscle paralysis is also discussed.

Theoretical (mathematical) models of gas mixing are reviewed in a separate chapter. Both continuous and discrete deterministic models as well as stochastic models are discussed, and the assumptions and limitations of these models are well explained.

Single and multi-breath washout experiments with human subjects are discussed with reference to inhomogeneity, regional differences in pulmonary compliance, and airway resistance. Further comparison between experiments and theory could have been made, yet this chapter appears to be long, relative to its contents. The last chapter on distribution and mixing in lungs of non-mammalian vertebrates appears to be out of place.

The writing style is uniform and easy to follow. The mathematics are kept to a minimum and used only where necessary. While this book presents the current state of our understanding of the fundamental gas transfer and mixing processes in the lung, clinical outlook is very much lacking. Clinical applications or diagnostic procedures based on the understanding of these processes are not developed. For instance, the effect of mucus secretions on gas distribution and gas mixing in the lung is completely neglected. The effects of aerosols and particle inhalation are not considered, and the alterations in gas mixing that occur in various lung diseases should have been included. Nevertheless, this book would be a useful reference for the readers of this journal. In addition, this is a must for researchers, pulmonary physiologists, exercise physiologists, bioengineers, medical students, other pulmonary health professionals, and others involved in gas transport. The book is reasonably priced. On the whole, it is a welcome addition to the expanding biomedical engineering literature.

The contents are: Chang, H.K. "General concepts of molecular diffusion"; Horsfield, K. "Anatomical factors influencing gas mixing and distribution"; Ultman, J.S. "Gas transport in the conducting airways"; Slutsky, A.S., Kamm, R.D. and Drazen, J.M., "Alveolar ventilation at high frequencies using tidal volumes smaller than the dead space"; Hughes, J.M.B., and Amis, T.C. "Regional ventilation distribution"; Paiva, M. "Theoretical studies of gas mixing in the lung"; and Scheild, P. and Piiper, J. "Distribution and mixing in gas-exchange organs of non-mammalian vertebrates."

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**Three Dimensional Biomedical Imaging, Volumes I and II.** Edited by R. A. Robb, CRC Press, Inc. Boca Raton, FL 1985. \$55 each. Vol. I, 169 pp., and Vol. II, 149 pp.

This two volume set contains 11 chapters from 11 different authors aimed at describing and illustrating the methods and capabilities of currently available three dimensional biomedical imaging systems. Each chapter is written by an expert in the field, a synopsis and prediction of advancements deemed possible is presented at the end of the text by the editor. The aim of the text is tutorial, and is to provide a comparison by experienced authors of the capabilities and limitations of their particular imaging system(s).

After a brief introductory chapter, digital radiography is the first topic covered. An outline is followed by a well written, and well illustrated chapter covering an introduction to the field, a good technical discussion of the constraints involved (low photon flux, for example), equipment design, image subtraction techniques (with examples), and conclusions. The chapter is well referenced with 109 citations.

The following three chapters, completing volume one, cover X-ray Computed Tomography—Basic Principles (3), Implementation and Applications (4), and Advanced Systems and Applications in Biomedical Research (5). Again, in each case, a chapter outline is followed by text relevant to the title, a summary, and references. Some overlap is evident in these chapters (two authors, three chapters) and could have been avoided by writing a single chapter jointly, or by more editing. These chapters, taken together, succinctly cover the field of X-ray CT, and will serve as a good reference (and well referenced) source. Two or more page distances between text and illustrations being described by the text make this a somewhat difficult section to follow at times.

Volume two begins with a review article on single photon emission-computed-tomography (SPECT), covering the basic terminology relevant to the field, a very light description of the types of collimators used, and techniques, display, and applications. For the novice, this would be a difficult chapter, the collimators used are mentioned with no schematics, the reconstruction methods (and reasons for them) are very lightly treated. With 147 citations, however, this is a good starting point for those interested in specific areas of this field.

A short introduction to Positron Emission Tomography serves only to acknowledge that the field exists, and briefly describes what it is. The four references would presumably assist in the reader's enlightenment.

A brief discussion of Computed Ultrasound Tomography serves also to give an overview of the field, giving the reader the ability to expand on an area of interest from some 105 references.

The techniques involved in Nuclear Magnetic Resonance imaging are adequately covered in the next chapter, with several illustrations of images obtained from a normal volunteer. Again, a reference list allows one to attempt to obtain specialized knowledge about the field.

A brief chapter, Display of Multidimensional Biomedical Image Information, affords one a succinct introduction to both direct and surface display methods. This chapter is well referenced, and thus, would afford one the opportunity to pursue any of several display methods. The editors did well to include this chapter since the topic is seldom treated separately in other texts. The topic is increasingly becoming important as the use of three dimensional imaging modalities increases.

The concluding chapter, written by the editor, serves to briefly summarize, and compare in tabular form, the various imaging modalities discussed in the text. This table should become handout and study material in biomedical instrumentation courses, and should be of use when interviewing graduate students interested in projects in medical imaging.

To summarize, this text, composed of several chapters by several authors, generally succeeds in giving one an overview of an area in medical imaging and allows, through generally adequate referencing, the pursuit of knowledge in a given subset of the area. Due to the multiple authorship approach, the text is somewhat uneven in readability and content. Questions such as how often a CAT (or other) scan is done, reasons for using one or a combination of scan modalities, specific areas of strength of a modality, and the interweaving of clinical information into the text is generally missing.

This text will serve as a good reference in the department of radiology, it should be found in the medical library, and should be accessible to researchers, teachers and advisors in the area of medical imaging.

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