Physics in Nuclear Medicine

S.R. Cherry, J.A. Sorenson, and M.E. Phelps

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Cherry, Sorenson, and Phelps' *Physics in Nuclear Medicine* is perhaps the best-known textbook on the subject and continues to be the text of choice for many education programs in nuclear medicine technology and nuclear medicine science and for radiology residents. This latest, 2012, edition is the fourth since the original publication in 1980 and brings up to date this now classic introductory text on physics of nuclear medicine.

The content is essentially the same as in the previous edition, except for a new chapter on hybrid scanners. This addition is warranted, given that PET/CT and SPECT/CT have become mainstream imaging devices and that PET/MR scanners were introduced commercially after the 2003 release of the third edition. Otherwise, the outline and order of the material are unchanged. An introductory chapter on what is nuclear medicine is followed by 5 chapters discussing the pertinent fundamental physics that underlies nuclear medicine (basic atomic and nuclear physics, modes of radioactive decay, radioactivity, radionuclide and radiopharmaceutical production, and interaction of radiation with matter). The next 5 chapters cover basic principles of radiation detectors and the associated electronics, nuclear counting and spectrometry, and performance issues and quality assurance related to radiation detection and measurement. The various devices applied clinically (counting systems, planar γ-cameras, and SPECT and PET scanners), their associated characteristics (performance, image quality), and the basics of filtered backprojection and iterative tomographic SPECT and PET reconstruction are presented in chapters 12 through 18. Discussions of the newer dedicated cardiac SPECT and breast (single-photon and PET) scanners, which are becoming mainstream imaging devices, have been incorporated. Chapters 20 and 21 introduce common digital image processing methods and tracer kinetic modeling and clinical applications, and the last 2 chapters discuss the radiation safety and protection aspects of nuclear medicine, namely MIRD-based internal dosimetry and health physics-related issues (radioactive material handling and disposal, radiation exposure, shielding, monitoring, and protection regulations). The example problems and solutions on various topics found in the prior edition (e.g., radioactivity, interactions, counting statistics, device performance characteristics, and internal dosimetry) are preserved. The 7 appendices contain the same content as before (unit conversions, properties of the elements, characteristics of various relevant radionuclides, relevant material mass attenuation coefficients, dose estimates for selected radiopharmaceuticals, and brief mathematic discussions of the commonly used Fourier transform and convolution techniques).

The new chapter, 19, begins with a brief discussion of the motivation for hybrid imaging. A review of the basic physics of CT is then presented as a prelude to discussions of the development and current generation of SPECT/CT and PET/CT imaging systems. Descriptions of animal hybrid scanners are included, the rationale being that preclinical combined molecular/anatomic scanning has become a valuable tool in the development and evaluation of new radiopharmaceuticals, as well as in the assessment of functional and anatomic response to new therapeutic agents before their use in humans. (Preclinical imaging is also mentioned in the chapters on SPECT and PET scanners.) A section describing CT-based attenuation and scatter corrections follows, and the chapter finishes with a brief discussion of the current state of PET/MR scanner development.

Two significant new features of the fourth edition are the transition to color and access to an online version of the book via ExpertConsult.com that comes with the purchase of a hard copy. All chapters, section headings, tables, graphs, and illustrations, as well as some of the clinical images illustrating the functional nature of nuclear medicine/PET, are now in color. The result is improved layout and readability compared with the all-black-and-white previous edition, in my opinion. Online access provides navigation through the text and figures, animated illustrations of key concepts, and interactive calculators and graphs for several equations in the text. Downloading of the figures for use in presentations is enabled.

With the release of the fourth edition, *Physics in Nuclear Medicine* continues to be a comprehensive and up-to-date nuclear medicine physics and instrumentation textbook, written in such a way as to be an appropriate introduction for both scientist and nonscientist nuclear medicine practitioners. Additional coverage of radiopharmaceutical therapy (β- and α-emitters, dosimetry, treatment planning); radioactive patient release (calculations, instructions, regulations); and PET, hybrid imaging, and therapy facility shielding would be useful extensions to the next edition.

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Combined Scintigraphic and Radiographic Diagnosis of Bone and Joint Diseases

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Bone is no longer considered a static structure. It alters as osteoblasts are mineralized and osteoclasts are resorbed. Combined

structural, biochemical, and functional imaging of bone is now among the most widely used technologies in clinical practice and research. The advent of micrometric bone scanning of the trabeculae—with its ability to provide the best possible and most meticulous naked-eye grasp of minute anatomy and fine visible chemical changes—has clearly created a royal road to bona fide molecular imaging and accurate diagnosis.

The internationally well-known author of this book has purposely established a more precise, easily practical, and better system of scintigraphic diagnostics of bone diseases based on piecemeal analysis and interpretation of signs demonstrated by bone scanning using pinhole collimators, γ-correction (an image-processing algorithm that transforms image pixel values nonlinearly to code), and electronic magnification of γ-corrected pinhole scans.

This fourth edition was intended, first, to rewrite and expand most of the existing chapters and, second, to introduce the more recently developed γ-correction pinhole scan diagnosis of several bony disorders, including occult fracture, stress reaction, bone marrow edema, neck sprains, and whiplash injury. The main features of this revision are the new insights and excellent micrometric scan images made possible by the use of pinhole collimators with novel γ-correction and electronic magnification of the corrected scans, judicious integration of the refined structural and biochemical scan findings, and close correlative analysis of the data with those of other imaging modalities for a whole range of bone and joint diseases. The author was able to specifically and differentially demonstrate pinpoint, minute rodlike, tiny speckled, and grossly mottled and geographic uptake of ^{99m}Tc-hydroxymethylene diphosphonate in various bone diseases. These micro- and macrometric scan findings permit accurate diagnoses and characterizations of bony disorders.

This revision is well written and clearly illustrated with superb images and a convenient index. I highly recommend this book to nuclear physicians, radiologists, pathologists, orthopedic specialties, and scientists, as well as to imaging technologists and medical students.

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