NINTH EDITION

RADIOLOGIC SCIENCE for TECHNOLOGISTS

PHYSICS, BIOLOGY, AND PROTECTION

Stewart Carlyle Bushong

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Bushong

RADIOLOGIC SCIENCE for TECHNOLOGISTS

PHYSICS, BIOLOGY, AND PROTECTION, NINTH EDITION

Ensure the highest-quality images and the safest, most effective practice!

Develop the skills and knowledge to make informed decisions regarding technical factors and diagnostic imaging quality with this highly detailed, vibrantly illustrated, full-color resource! Updated with the latest advances in radiologic science, the ninth edition of this trusted text addresses a broad range of radiologic disciplines, providing a strong foundation in the study and practice of radiologic physics, imaging, radiobiology, radiation protection, and more. Unique learning tools strengthen your understanding of key concepts, and challenging review exercises help you prepare for certification and professional success!

Build a working knowledge of radiologic science with...

- **Two NEW chapters** that guide you through the benefits and challenges of working with **digital imaging.**
- **Expanded chapters** bringing you the latest developments in mammography, interventional radiology, multislice spiral computed tomography, and radiation protection.
- **Quick, easy access** to frequently used formulas, conversion tables, abbreviations, and more.
- **Special *Math Formulas* boxes and *Important Concepts* boxes** that emphasize key chapter content.
- ***Challenge Questions*** at the end of each chapter that test your understanding of terms, concepts, and formulas with a variety of definition exercises, short answer questions, and calculations.

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Preface

PURPOSE AND CONTENT

The purpose of ***Radiologic Science for Technologists: Physics, Biology, and Protection*** is threefold: to convey a working knowledge of radiologic physics, to prepare radiography students for the certification examination by the ARRT, and to provide a base of knowledge from which practicing radiographers can make informed decisions about technical factors, diagnostic image quality, and radiation management for both patients and personnel.

This textbook provides a solid presentation of radiologic science, including the fundamentals of radiologic physics, diagnostic imaging, radiobiology, and radiation management. Special topics include mammography, fluoroscopy, interventional procedures, multislice spiral computed tomography, and the various emerging modes of digital imaging.

The fundamentals of radiologic science cannot be removed from mathematics, but this textbook does not assume a mathematics background for the readers. The few mathematical equations presented are always followed by sample problems with direct clinical application. As a further aid to learning, all mathematical formulas are highlighted with their own icon.

Likewise, the most important ideas under discussion are presented with their own colorful penguin icon and box:

The use of the penguin icon is described early in Chapter 1.

This ninth edition improves this popular feature of information bullets by including even more key concepts and definitions in each chapter. This edition also presents learning objectives, chapter overviews, and chapter summaries that encourage students and make the text user friendly for all. Challenge Questions at the end of each chapter include definition exercises, short-answer questions, and a few calculations. These questions can be used for homework assignments, review sessions, or self-directed testing and practice. Answers to all questions are provided on the Evolve site at http://evolve.elsevier.com.

HISTORICAL PERSPECTIVE

For seven decades after Roentgen's discovery of x-rays in 1895, diagnostic radiology remained a relatively stable field of study and practice. Truly great changes during that time can be counted on one hand: the Crookes tube, the radiographic grid, radiographic intensifying screens, and image intensification.

Since the publication of the first edition of this textbook in 1975, however, newer systems for diagnostic imaging have come into routine use: multislice spiral computed tomography, computed radiography, digital radiography, and digital fluoroscopy. Truly spectacular advances in computer technology and x-ray tube and image receptor design have made these innovations possible, and they continue to transform the diagnostic imaging sciences.

NEW TO THIS EDITION

Currently we are accelerating to all-digital imaging. Digital radiography is replacing screen-film radiography rapidly and this requires that radiologic technologists acquire a new and different fund of knowledge in addition to what has been required previously—and in the same length of training time!

This ninth edition includes eight new chapters on digital imaging. Much of the material in the other 32 chapters has been reprocessed for brevity so that the size of this edition remains essentially the same as the previous edition. Another recent innovation described in this textbook is the imaging characteristics associated with the use of amorphous silicon and amorphous selenium. There is a new discussion of charge-coupled devices and the advantages for interventional radiology procedures.

Also presented are many updates in the areas of special imaging, in which the greatest advances in radiologic technology have occurred. There is a new chapter on multislice spiral computed tomography. Also discussed are advances in target composition, compression, and digital imaging for mammography. Pay particular attention to Chapter 30, Digital Display Quality

Control, a field that requires new skills on the part of the radiographic technologist. The AAPM TG-18 recommendations will become as standard as processor quality control.

The ninth edition also includes more in-text definitions and chapter cross-references. All boldface terms are defined when first introduced and are collected in an expanded glossary. New radiographs and line drawings keep this text fresh and fun.

ANCILLARIES

Student Workbook and Laboratory Manual

This three-part resource has been updated to reflect the changes in the text and the rapid advancements in the field of radiologic science. Part I offers a complete selection of worksheets organized by textbook chapter. Part II, the Math Tutor, provides an outstanding refresher for any student. Part III, Laboratory Experiments, collects experiments designed to demonstrate important concepts in radiologic science.

Evolve Resources

Instructor ancillaries, including an ExamView Test Bank of over 900 questions, an image collection of all of the images in the text, and a PowerPoint lecture presentation are all available at http://evolve.elsevier.com.

Mosby's Radiography Online

Instructional materials to support teaching and learning online, radiologic physics, radiographic imaging, radiobiology, and radiation protection have been developed by Elsevier and may be obtained by contacting the publisher directly.

A NOTE ON THE TEXT

Although the ARRT has not formally adopted the International System of Units (SI units), they are presented in this textbook. With this system come the corresponding units of radiation and radioactivity. The roentgen, the rad, and the rem are being replaced the gray (Gy), and the sievert (Sv), respectively. A summary of special quantities and units in radiologic science can be found on the inside front cover of the text.

Radiation exposure is measured in SI units of C/kg, or in terms of air kerma, measured in mGy. Because mGy is also a unit of dose, a measurement of air kerma is distinguished from tissue dose by applying a subscript *a* or *t* to mGy, according to the recommendations of Archer and Wagner (***Minimizing Risk From Fluoroscopic X-rays*, PRM, 2007**). Therefore, when the SI is used, air kerma is measured in mGy_a and tissue dose in mGy_t.

ACKNOWLEDGMENTS

For the preparation of the ninth edition, I am indebted to the many readers of the eighth edition who submitted suggestions, criticisms, corrections, and compliments. I am particularly indebted to the following radiologic science educators and students for their suggestions for change and clarification. Many supplied radiographic illustrations, and they are additionally acknowledged with the illustration.

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My colleague, Ben Archer, is the author of the Penguin Tale (Chapter 1), which for me has become a particularly effective teaching tool. Special thanks to **Linda Rarey**, MA, CNMT, ARRT at St. Joseph Health System for her excellent and conscientious work on the accompanying Test Bank and PowerPoint presentation.

As you, student or educator, use this text and have questions or comments, I hope you will email me at *sbushong@bcm.edu* so that together we can strive to make this very difficult material easier to learn.

"Physics is fun" is the motto of my radiologic science courses, and I believe this text will help make physics enjoyable for the student radiologic technologist.

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