

英文原版

骨及骨关节疾病诊断学

RESNICK

Diagnosis of

Bone *and* Joint Disorders

Fourth
Edition

volume **2**

Articular Diseases



人民卫生出版社

Health Science Asia,
Elsevier Science

Diagnosis *of* Bone *and* Joint Disorders



VOLUME 2

Fourth Edition

Diagnosis of Bone *and* Joint Disorders

DONALD RESNICK, M.D.

Chief, Musculoskeletal Imaging

Professor of Radiology

University of California, San Diego

Veteran Affairs San Diego Healthcare System

San Diego, California

*With the Editorial Assistance of Lee Ann Draud
and Catherine F. Fix*

With the Technical Assistance of Debra J. Trudell

With the Administrative Assistance of Michael R. Holbrook

With the Secretarial Assistance of Joyce Velligan

人民卫生出版社

Health Science Asia, Elsevier Science

人民卫生出版社

Health Science Asia, Elsevier Science

Original English Language Edition

Copyright© 2002,1995,1988,1981 by W.B. Saunders Company

All Rights Reserved.

Authorized English Reprints

Copyrights© 2002 by Health Sciences Asia, Elsevier Science.

图书在版编目 (CIP) 数据

骨及骨关节疾病诊断学. 第2卷/(美)雷斯尼克(Resnick)著.
—影印本. —北京:人民卫生出版社,2002
ISBN 7-117-04886-7

I. 骨… II. 雷… III. ①骨疾病—诊断学—英文
②关节疾病—诊断学—英文 IV. R680.4

中国版本图书馆 CIP 数据核字 (2002) 第 022160 号

图字: 01-2002-1962

骨及骨关节疾病诊断学(英文版)

(第2卷)

编 著: DONALD RESNICK, M. D.

出版发行: 人民卫生出版社(中继线 67616688)

地 址: (100078)北京市丰台区方庄芳群园3区3号楼

网 址: [http://www. pmph. com](http://www.pmph.com)

E - mail: [pmph @ pmph. com](mailto:pmph@pmph.com)

印 刷: 北京市安泰印刷厂

经 销: 新华书店

开 本: 889×1230 1/16 印张: 65.5

字 数: 2744 千字

版 次: 2002 年 8 月第 1 版 2002 年 8 月第 1 版第 1 次印刷

标准书号: ISBN 7-117-04886-7/R·4887

定 价: 236.00 元

著作权所有, 请勿擅自用本书制作各类出版物, 违者必究

(凡属质量问题请与本社发行部联系退换)

CONTRIBUTORS

RONALD S. ADLER, PH.D., M.D.

Professor of Radiology, Cornell University Joan and Sanford I. Weill Medical College and Graduate School of Medical Sciences; Attending Radiologist, Hospital for Special Surgery, New York, New York

Diagnostic Ultrasonography**WAYNE H. AKESON, M.D.**

Emeritus Professor of Orthopaedics, University of California, San Diego, School of Medicine, La Jolla; Chief of Orthopaedics, Veterans Affairs San Diego Healthcare System, San Diego, California

Articular Cartilage: Morphology, Physiology, and Function**MICHAEL ANDRÉ, Ph.D.**

Associate Professor of Radiology and Chief, Physics and Engineering Division, University of California, San Diego, School of Medicine, La Jolla; Medical Physicist, Veterans Affairs San Diego Healthcare System, San Diego, California

Computed Tomography**ROBERT DOWNEY BOUTIN, M.D.**

Executive Musculoskeletal Radiologist, Med-Tel International, McClean, Virginia

Muscle Disorders**WILLIAM BUGBEE, M.D.**

Assistant Professor In Residence, Department of Orthopaedics, University of California, San Diego, School of Medicine, La Jolla, California

Articular Cartilage: Morphology, Physiology, and Function**CONSTANCE R. CHU, M.D.**

Assistant Professor, University of Pittsburgh School of Medicine; Director, Cartilage Restoration, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Articular Cartilage: Morphology, Physiology, and Function**CHRISTINE B. CHUNG, M.D.**

Assistant Professor of Radiology, University of California, San Diego, School of Medicine, La Jolla; Department of Radiology, Veterans Affairs San Diego Healthcare System, San Diego, California

Developmental Dysplasia of the Hip**JAMES M. COUMAS, M.D.**

Musculoskeletal Radiologist, Carolina Hospital Authority, Charlotte, North Carolina

Interventional Spinal Procedures**MURRAY K. DALINKA, M.D.**

Professor of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania

Radiation Changes**DAVID G. DISLER, M.D.**

Staff Radiologist, Commonwealth Radiology, Richmond, Virginia

Articular Cartilage: Magnetic Resonance Imaging**JERRY R. DWEK, M.D.**

Adjunct Assistant Professor of Radiology, Medical College of Ohio, Toledo; Clinical Assistant Professor of Radiology, Ohio State University College of Medicine and Public Health, Columbus; Staff Attending Physician, Children's Hospital, Columbus, Ohio

Developmental Dysplasia of the Hip**MICHAEL D. FALLON, M.D.***

Former Assistant Professor of Pathology, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania
*deceased

Histogenesis, Anatomy, and Physiology of Bone**FRIEDA FELDMAN, M.D.**

Professor of Radiology, Columbia College of Physicians and Surgeons; Attending Radiologist, New York Presbyterian Hospital, New York, New York

Tuberous Sclerosis, Neurofibromatosis, and Fibrous Dysplasia**LAWRENCE R. FRANK, Ph.D.**

Associate Professor of Radiology and Associate Director for Biomedical Applications for the fMRI Center, University of California, San Diego, La Jolla; Staff Physicist, Department of Radiology, Veterans Affairs San Diego Healthcare System, San Diego, California

Magnetic Resonance Imaging: Basic Principles**STEVEN R. GARFIN, M.D.**

Chairman, Department of Orthopaedic Surgery, University of California, San Diego, University of California, San Diego, Medical Center, San Diego, California

Imaging after Spine Surgery

HARRY K. GENANT, M.D.

Professor of Radiology, Medicine, and Orthopaedic Surgery; Director, Osteoporosis Research Group, Department of Radiology, University of California, San Francisco, School of Medicine, San Francisco, California

Quantitative Bone Mineral Analysis

THOMAS G. GOERGEN, M.D.

Associate Clinical Professor, University of California, San Diego, School of Medicine, La Jolla; Palomar Medical Center, Escondido, California

Physical Injury: Concepts and Terminology

AMY BETH GOLDMAN, M.D.

Radiologist, Dosbi Diagnostic Imaging Services, New York, New York

Heritable Diseases of Connective Tissue, Epiphyseal Dysplasias, and Related Conditions

GUERDON D. GREENWAY, M.D.

Associate Clinical Professor, Department of Radiology, University of California, San Diego, School of Medicine, La Jolla, California; Clinical Associate Professor, Department of Orthopaedic Surgery, University of Texas Southwestern Medical Center, Dallas; Attending Physician, Department of Radiology, Baylor University Medical Center, Dallas, Texas

Tumors and Tumor-like Lesions of Bone: Imaging and Pathology of Specific Lesions

PAUL N. GROOFF, M.D.

Staff Physician, Cleveland Clinic Foundation, Cleveland, Ohio

Digital Imaging

W. BONNER GUILFORD, M.D.

Musculoskeletal Radiologist, Charlotte Radiology, Carolina Healthcare System, Charlotte, North Carolina

Interventional Spinal Procedures

PARVIZ HAGHIGHI, M.D., F.R.C.P.A.

Professor of Clinical Pathology, University of California, San Diego; Staff Pathologist, Veterans Affairs Medical Center, San Diego, California

Lymphoproliferative and Myeloproliferative Disorders

TAMARA MINER HAYGOOD, Ph.D., M.D.

Radiology Associates, Corpus Christi, Texas

Radiation Changes

THOMAS E. HERMAN, M.D.

Assistant Professor, Mallinckrodt Institute of Radiology, Washington University School of Medicine; Radiologist, St. Louis Children's Hospital, St. Louis, Missouri

Osteochondrodysplasias, Dysostoses, Chromosomal Aberrations, Mucopolysaccharidoses, and Mucopolipidoses

BRIAN A. HOWARD, M.D., M.B.C.H.B.

Musculoskeletal Radiologist, Charlotte Radiology, Carolina Healthcare System, Charlotte, North Carolina

Interventional Spinal Procedures

MICHAEL JERGAS, M.D.

Visiting Researcher, Department of Radiology, Musculoskeletal Section, and Osteoporosis Research Group, University of California, San Francisco, School of Medicine, San Francisco, California

Quantitative Bone Mineral Analysis

PHOEBE A. KAPLAN, M.D.

Professor of Radiology, Massachusetts General Hospital, Boston, Massachusetts

Temporomandibular Joint

MICHAEL KYRIAKOS, M.D.

Professor of Surgical Pathology, Washington University School of Medicine; Senior Pathologist, Barnes Hospital, St. Louis, Missouri

Tumors and Tumor-like Lesions of Bone: Imaging and Pathology of Specific Lesions

LAURENCE A. MACK, M.D.*

Former Professor of Radiology, Adjunct Professor of Orthopedics, and Director of Ultrasound, University of Washington, Seattle, Washington

**deceased*

Diagnostic Ultrasonography

JOHN E. MADEWELL, M.D.

Professor of Radiology and Director of Clinical Radiology Operations, University of Texas M. D. Anderson Cancer Center, Houston, Texas

Osteonecrosis: Pathogenesis, Diagnostic Techniques, Specific Situations, and Complications

STAVROS C. MANOLAGAS, M.D., Ph.D.

Professor of Medicine and Director, Division of Endocrinology and Metabolism, University of Arkansas for Medical Sciences, Little Rock, Arkansas

Histogenesis, Anatomy, and Physiology of Bone

WILLIAM H. MCALISTER, M.D.

Professor of Radiology and Pediatrics, Washington University School of Medicine and Mallinckrodt Institute of Radiology; Radiologist-in-Chief, St. Louis Children's Hospital, St. Louis, Missouri

Osteochondrodysplasias, Dysostoses, Chromosomal Aberrations, Mucopolysaccharidoses, and Mucopolipidoses

WILLIAM A. MURPHY, JR., M.D.

John S. Dunn, Sr., Distinguished Chair and Professor of Radiology, University of Texas M. D. Anderson Cancer Center, Houston, Texas

Temporomandibular Joint**M. B. OZONOFF, M.D.**

Salt Lake City, Utah

Spinal Anomalies and Curvatures**MINI N. PATHRIA, M.D.**

Professor of Clinical Radiology, University of California, San Diego, School of Medicine, La Jolla, California

Imaging after Spine Surgery; Physical Injury: Spine**DAVID W. PIRAINO, M.D.**

Staff Physician, Cleveland Clinic Foundation, Cleveland, Ohio

Digital Imaging**MICHAEL J. PITT, M.D.**

Professor of Radiology, University of Alabama School of Medicine; Staff, University Hospital, UAB Children's Hospital of Alabama, Birmingham, Alabama

Rickets and Osteomalacia**MICHAEL P. RECHT, M.D.**

Assistant Professor of Clinical Radiology, Ohio State University College of Medicine and Public Health, Columbus; Section Head, e-Radiology, and Staff Radiologist, Cleveland Clinic Foundation, Cleveland, Ohio

Articular Cartilage: Magnetic Resonance Imaging**JEFFREY S. ROSS, M.D.**

Head, Radiology Research, and Staff Neuroradiologist, Cleveland Clinic Foundation, Cleveland, Ohio

Spinal Imaging**DAVID A. RUBIN, M.D.**

Assistant Professor of Radiology, Washington University School of Medicine; Director, Musculoskeletal Section, Mallinckrodt Institute of Radiology, St. Louis, Missouri

Magnetic Resonance Imaging: Practical Considerations**DAVID J. SARTORIS, M.D.***

Formerly Professor of Radiology, University of California, San Diego; Chief, Quantitative Bone Densitometry, UCSD Medical Center; Professor of Radiology, Veterans Affairs Medical Center and Scripps Clinic, Green Hospital, La Jolla, California

**deceased*

Developmental Dysplasia of the Hip; Plain Film Radiography: Routine and Specialized Techniques and Projections**WILLIAM SCHEIBLE, M.D.**

Radiology Consultants of Iowa, Cedar Rapids, Iowa

Diagnostic Ultrasonography**ROBERT SCHNEIDER, M.D.**

Associate Professor of Radiology, Cornell University Joan and Sanford I. Weill Medical College and Graduate School of Medical Sciences; Attending Radiologist, Hospital for Special Surgery, New York, New York

Radionuclide Techniques**CAROLYN M. SOFKA, M.D.**

Assistant Professor of Radiology, Cornell University Joan and Sanford I. Weill Medical College and Graduate School of Medical Sciences; Assistant Attending Radiologist, Hospital for Special Surgery, New York, New York

Diagnostic Ultrasonography**DONALD E. SWEET, M.D.**

Clinical Professor of Pathology, Georgetown University School of Medicine, Washington, D.C.; Clinical Professor of Pathology, Uniformed Services University of Health Sciences, Bethesda, Maryland; Chairman, Department of Orthopedic Pathology, Armed Forces Institute of Pathology, Washington, D.C.

Osteonecrosis: Pathogenesis, Diagnostic Techniques, Specific Situations, and Complications**BARBARA N. WEISSMAN, M.D.**

Professor of Radiology, Harvard Medical School; Vice Chair for Ambulatory Services, Brigham and Women's Hospital, Boston, Massachusetts

Imaging after Surgery in Extraplural Sites; Imaging of Joint Replacement

PREFACE

The new millennium and right on schedule comes the fourth edition of *Diagnosis of Bone and Joint Disorders*. This, then, is the third time I have revised this text since its initial publication in 1981, more than 2 decades ago. Each time I have begun work on a new edition, I believed incorrectly that my job would be easier because, I thought, how much information could possibly have been introduced in the 5 or 6 years that had elapsed since the previous edition? And each time, without exception, I have been surprised by the progress that has occurred with regard to the further understanding and improved diagnostic assessment of the many diseases that affect the musculoskeletal system. So now, 7 years after the publication of the third edition, the fourth edition is offered as clear evidence that much has been learned, new concepts have emerged, and “old facts” have been modified or eliminated altogether.

I am often asked at the time of publication of a new edition precisely how much of the material is appearing for the first time. This is a difficult question to answer quantitatively. My educated guess is that 30 per cent of the information is new or has been modified significantly from that contained in the third edition, that the number of references has been expanded by 25 to 35 per cent (with emphasis given to pertinent recent publications), and that new illustrations represent 25 to 30 per cent of the total number appearing in this edition. With regard to the illustrative material, the new figures underscore the increasing importance of MR imaging as a vehicle for investigation of these diseases.

The size of the fourth edition does not differ significantly from that of the last edition, although the number of volumes has been decreased by one. (You will note that each is somewhat heavier than in the past!) To be certain that this multivolume book did not become too large, I consulted extensively with the experts at W.B. Saunders. You will note the following changes:

- Several previous chapters have been eliminated completely. These chapters either focused primarily on older imaging methods whose importance has decreased in recent years or contained material that was also detailed in other sections of the book.
- Several previous chapters have been combined to consolidate material and avoid redundancy.
- As the index for such a large text must be comprehensive (and, therefore, quite long), the complete index now appears only at the end of the fifth volume. To compensate for this change, a more abbreviated (but still useful) index appears in each of the other four volumes.

Certain topics have been addressed in detail for the first time in this fourth edition. These include digital imaging (Chapter 2), spinal interventional procedures (Chapter 11), cartilage imaging (Chapter 19), and disorders of muscle (Chapter 85). Furthermore, new authors have been recruited for many other chapters to offer a perspective different from that contained in the previous edition.

As I write this, with the fourth edition completed and ready for press, I am once again satisfied with the final product. I believe that the considerable efforts of the many persons responsible for this text will be evident to the readers. For my part, there were times during the process that the enthusiasm may have wavered a bit, but conversations with colleagues and timely phone calls to the publishers corrected this. In truth, writing my chapters and reading those provided by others contributed significantly to my own education. Further, I believe that the result will be similar for those who consult this book or, better still, read it in its entirety.

Donald Resnick, M.D.

PREFACE TO THE FIRST EDITION

I profess both to learn and to teach anatomy, not from books but from dissection; not from positions of philosophers but from the fabric of nature.

William Harvey (1578–1657)
De Motu Cordis et Sanguinis (1628)
An Anatomical Disquisition of the
Motion of the Heart and Blood in
Animals, translated from the Latin
by Robert Willis (1847)

The roentgenographic features of many common and some not so common musculoskeletal disorders, particularly those that affect articulations, can be explained by closely correlating the radiographic, gross pathologic, and histologic abnormalities. Although this technique is not new, it is seldom applied to the evaluation of skeletal diseases. When radiographic and pathologic correlation was utilized in the past to analyze these diseases, the discussion generally centered upon primary bone neoplasms, which, although important, are rare occurrences indeed. The common “everyday” disorders have, in large part, been neglected, requiring the student of radiology to memorize lists of roentgenographic signs and differential diagnoses without regard to disease mechanisms and pathogeneses. Yet, the radiograph is but a mirror, and its image a reflection of the underlying anatomy and pathology. When the student is armed with an understanding of the basic pathologic aberrations of disease, perception of the “image” takes on new meaning.

There are several reasons why correlation of radiology and pathology is infrequently encountered in descriptions of many musculoskeletal diseases. Such studies require the close cooperation of two interested parties, a radiologist and a pathologist. For the radiologist, the development and the refinement of newer and more sophisticated diagnostic modalities, such as ultrasonography and computed tomography, have led to some degree of complacency and disinterest in the older and more established techniques of plain film radiography and standard tomography. The radiographic information presented by routine examination of the skeleton no longer evokes the excitement it once did, particularly when compared to the enthusiasm that accompanies an unusual sectional display on ultrasound or computed tomographic examination. For the pathologist, skillful and meticulous postmortem and surgical pathologic examinations have been neglected, in many institutions, in favor of histologic studies and complicated chemical analyses. Some regard anatomic pathology as “descriptive” in nature, static, and of little importance. Nothing is farther from the truth.

The difficulty in obtaining adequate pathologic mate-

rial is another reason for the infrequency of close radiographic and pathologic correlation in musculoskeletal disorders. The energetic investigator, however, can find several sources of such material. First, tissues can be obtained at postmortem examination. Although there is a general reluctance to remove large samples of bones and joints during autopsy, portions of the spine, sacroiliac articulations, symphysis pubis, sternum, sternoclavicular and acromioclavicular joints, and ribs can be examined in detail without deforming the body in any fashion. In certain situations, special permission to allow more extensive skeletal examination can be obtained, although this may require knowledge of the presence in a hospital of patients who are seriously ill and personal interviews with these individuals or their immediate family members. A second source of material is derived from surgical specimens. In many institutions, osseous and articular specimens are examined superficially, yet material obtained from total joint replacements, biopsy procedures, and amputations can shed light on many common and important disorders. A third source of pathologic material is the anatomy departments of nearby medical centers. Body donation programs exist in many such departments, and careful analysis of donated cadavers can uncover various musculoskeletal diseases. Body donation programs may also be associated with local chapters of organizations such as the Arthritis Foundation.

Once the material has been collected, meticulous radiographic and pathologic study is mandatory. We have routinely obtained radiographs and photographs of all intact specimens. Subsequently, tissue freezing with sectioning followed by radiographic and pathologic evaluation, or tissue maceration followed by similar evaluation, is useful. Histologic material can then be obtained from appropriate tissue sections.

This textbook utilizes such radiographic and pathologic correlation, wherever possible, in a variety of musculoskeletal disorders. Although the original intent of the authors was to discuss only “articular” problems, it soon became apparent that any discussion of joint diseases that did not encompass alterations of neighboring bones and soft tissue was incomplete. Thus, the scope of the textbook has been expanded to cover additional local and systemic disease processes, although in all cases articular findings are emphasized. The major portion of the discussion is directed toward radiographic and pathologic features that aid in accurate diagnosis, although some attention is focused upon major clinical and laboratory alterations. The methods and goals of therapy of the various diseases are not included as these are given in other available sources.

The organization of the material appears quite logical. Initially, developmental and comparative anatomy,

physiology, biochemistry, and biomechanics of articulations are studied. This discussion of the basic sciences is followed by an evaluation of the role of available radiographic and related modalities in the diagnosis of musculoskeletal diseases, of normal anatomic variants and artifacts that simulate disease, and of methods of classification of articular disorders. Subsequently, four chapters summarize the principles of medical and surgical examination in patients with articular diseases and of radiographic evaluation of the postoperative patient. In the remaining portions of the text, individual musculoskeletal disorders are evaluated. These are grouped into specific categories, although we recognize that some disagreement might exist regarding the manner in which the diseases are divided. In the final chapters, additional sites of abnormality are discussed, including the temporomandibular joint, soft tissues, and other organ systems. A summary of the patterns of distribution of articular abnormalities is included. Four appendixes consider additional diagnostic and investigative modalities. By design, some degree of overlap in discussion appears in certain segments of the book to provide emphasis.

The choice of contributing authors was made carefully and deliberately. Each is a recognized authority in the field of musculoskeletal disease and most are well known for their interest in the area of radiographic-

pathologic correlation. Although the writing style of one author might differ from that of another, these differences are minimal, and the terminology that is utilized is remarkably consistent throughout the textbook. Furthermore, great care has been exercised in the choice and in the preparation of the illustrations. When necessary, color photographs are used, and the orientation of the radiographic and pathologic material is such to facilitate correlation of the findings. A conscious effort has also been made to arrange many of the radiographs and photographs throughout the textbook in such a fashion that it appears that the same side of the body has been examined. This technique will enable comparison of disease processes discussed in different sections of the book. An extensive and up-to-date bibliography is included for those who might wish to consult pertinent references for additional information. Each reference has been carefully verified in the final stages of preparation to assure accuracy.

In conclusion, creation of this text has indeed been a labor of love. We sincerely hope that it will bring an equal amount of enjoyment to those who read it.

D. Resnick, M.D.

G. Niwayama, M.D.

ACKNOWLEDGMENTS

As always, I am indebted to many others who provided significant help during the preparation of this textbook. First, I would like to thank the many contributors who approached their task with a great sense of commitment. The quality of their chapters speaks for itself.

Long ago, I made the wise choice to establish a professional relationship with W.B. Saunders, an Elsevier Science Company. As was the case in previous editions, this latest edition, in large part, reflects the dedication of the many professionals at W.B. Saunders. Lisette Bralow, Executive Editor, Medical Books, has always served as my advisor and friend. I would like to thank her for her efforts and those of her able associates: Lee Ann Draud, Project Manager and Copy Editing Supervisor; Natalie Ware, Production Manager; Karen O'Keefe Owens, Designer; Walt Verbitski, Illustration Coordinator; and Sally Grande, Marketing Manager.

A radiology text requires the very best of illustrations.

As the legends indicate throughout this work, many of the illustrations were kindly donated by associates and friends, and I thank them all. I would like to mention one person, Doug Goodwin, who, almost monthly since his fellowship in 1993–1994, has been kind enough to send me his interesting cases, illustrations of which are scattered throughout the pages of this text. Doug, my thanks hardly seem sufficient.

Several other persons clearly deserve thanks as well. Susan Brown coordinated the illustrative material. Catherine Fix served as a copy editor in the early stages of the process. I am indebted to Joyce Velligan for her attention to detail during the typing of numerous passages in this text. Finally, Michael Holbrook and Debra Trudell, two of my most loyal associates, were again at my side during the whole process. To them, I express my sincere appreciation.

CONTENTS

VOLUME 1

SECTION I

Radiography and Related Diagnostic Techniques in the Evaluation of Bone, Joint, and Soft Tissue Diseases..... 1

- 1 *Plain Film Radiography: Routine and Specialized Techniques and Projections*3
David J. Sartoris, M.D., and Donald Resnick, M.D.
- 2 *Digital Imaging*36
David W. Piraino, M.D., and Paul N. Grooff, M.D.
- 3 *Computed Tomography*.....45
Michael André, Ph.D., and Donald Resnick, M.D.
- 4 *Magnetic Resonance Imaging: Basic Principles*72
Lawrence R. Frank, Ph.D.
- 5 *Magnetic Resonance Imaging: Practical Considerations*.....111
David A. Rubin, M.D.
- 6 *Diagnostic Ultrasonography*167
Ronald S. Adler, Ph.D., M.D., Laurence A. Mack, M.D., William Scheible, M.D., Carolyn M. Sofka, M.D., and Donald Resnick, M.D.
- 7 *Arthrography, Tenography, and Bursography*193
Donald Resnick, M.D.
- 8 *Radionuclide Techniques*.....319
Robert Schneider, M.D.
- 9 *Needle Biopsy of Bone and Soft Tissue*425
Donald Resnick, M.D.

SECTION II

Imaging and Interventional Procedures of the Spine 439

- 10 *Spinal Imaging*.....441
Jeffrey S. Ross, M.D.
- 11 *Interventional Spinal Procedures*.....499
Brian A. Howard, M.D., W. Bonner Guilford, M.D., and James M. Coumas, M.D.

- 12 *Imaging after Spine Surgery*521
Mini N. Pathria, M.D., and Steven R. Garfin, M.D.

SECTION III

Imaging of the Postoperative Patient. . 557

- 13 *Imaging after Surgery in Extraplural Sites*559
Barbara N. Weissman, M.D.
- 14 *Imaging of Joint Replacement*.....595
Barbara N. Weissman, M.D.

SECTION IV

Basic Sciences of Musculoskeletal Diseases 645

- 15 *Histogenesis, Anatomy, and Physiology of Bone*647
Donald Resnick, M.D., Stavros C. Manolagas, M.D., Ph.D., and Michael D. Fallon, M.D.
- 16 *Articular Anatomy and Histology*688
Donald Resnick, M.D.
- 17 *Anatomy of Individual Joints*708
Donald Resnick, M.D.
- 18 *Articular Cartilage: Morphology, Physiology, and Function*.....793
Wayne H. Akeson, M.D., Constance R. Chu, M.D., and William Bugbee, M.D.
- 19 *Articular Cartilage: Magnetic Resonance Imaging*817
Michael P. Recht, M.D., and David G. Disler, M.D.

VOLUME 2

SECTION V

Rheumatoid Arthritis and Related Diseases 835

- 20 *Rheumatoid Arthritis and the Seronegative Spondyloarthropathies: Radiographic and Pathologic Concepts*837
Donald Resnick, M.D.

- 21 Rheumatoid Arthritis** 891
Donald Resnick, M.D.
- 22 Juvenile Chronic Arthritis** 988
Donald Resnick, M.D.
- 23 Ankylosing Spondylitis** 1023
Donald Resnick, M.D.
- 24 Psoriatic Arthritis** 1082
Donald Resnick, M.D.
- 25 Reiter's Syndrome** 1110
Donald Resnick, M.D.
- 26 Enteropathic Arthropathies** 1127
Donald Resnick, M.D.
- 27 Periodic, Relapsing, and Recurrent Disorders** 1156
Donald Resnick, M.D.

SECTION VI

Connective Tissue Diseases 1169

- 28 Systemic Lupus Erythematosus** 1171
Donald Resnick, M.D.
- 29 Scleroderma (Progressive Systemic Sclerosis)** 1194
Donald Resnick, M.D.
- 30 Dermatomyositis, Polymyositis, and Other Inflammatory Myopathies** 1221
Donald Resnick, M.D.
- 31 Polyarteritis Nodosa and Other Vasculitides** 1238
Donald Resnick, M.D.
- 32 Mixed Connective Tissue Disease and Collagen Vascular Overlap Syndromes** 1249
Donald Resnick, M.D.
- 33 Rheumatic Fever** 1260
Donald Resnick, M.D.

SECTION VII

Degenerative Diseases 1269

- 34 Degenerative Disease of Extraspinal Locations** ... 1271
Donald Resnick, M.D.
- 35 Degenerative Disease of the Spine** 1382
Donald Resnick, M.D.

- 36 Diffuse Idiopathic Skeletal Hyperostosis** 1476
Donald Resnick, M.D.

- 37 Calcification and Ossification of the Posterior Spinal Ligaments and Tissues** 1504
Donald Resnick, M.D.

SECTION VIII

Crystal-Induced and Related Diseases 1517

- 38 Gouty Arthritis** 1519
Donald Resnick, M.D.
- 39 Calcium Pyrophosphate Dihydrate Crystal Deposition Disease** 1560
Donald Resnick, M.D.
- 40 Calcium Hydroxyapatite Crystal Deposition Disease** 1619
Donald Resnick, M.D.
- 41 Hemochromatosis and Wilson's Disease** 1658
Donald Resnick, M.D.
- 42 Alkaptonuria** 1678
Donald Resnick, M.D.
- 43 Other Crystal-Induced Diseases** 1692
Donald Resnick, M.D.

SECTION IX

Temporomandibular Manifestations of Articular Diseases 1705

- 44 Temporomandibular Joint** 1707
William A. Murphy, Jr., M.D., Phoebe A. Kaplan, M.D., and Donald Resnick, M.D.

SECTION X

Target Area Approach to Articular Diseases 1755

- 45 Target Area Approach to Articular Disorders: A Synopsis** 1757
Donald Resnick, M.D.

VOLUME 3**SECTION XI****Metabolic Diseases 1781**

- 46 Osteoporosis 1783**
Donald Resnick, M.D.

- 47 Quantitative Bone Mineral Analysis 1861**
Michael Jergas, M.D., and Harry K. Genant, M.D.

- 48 Rickets and Osteomalacia 1901**
Michael J. Pitt, M.D.

- 49 Paget's Disease 1947**
Donald Resnick, M.D.

SECTION XII**Endocrine Diseases 2001**

- 50 Pituitary Disorders 2003**
Donald Resnick, M.D.

- 51 Thyroid Disorders 2026**
Donald Resnick, M.D.

- 52 Parathyroid Disorders and Renal Osteodystrophy 2043**
Donald Resnick, M.D.

- 53 Disorders of Other Endocrine Glands and of Pregnancy 2112**
Donald Resnick, M.D.

SECTION XIII**Diseases of the Hematopoietic System 2145**

- 54 Hemoglobinopathies and Other Anemias 2147**
Donald Resnick, M.D.

- 55 Plasma Cell Dyscrasias and Dysgammaglobulinemias 2188**
Donald Resnick, M.D.

- 56 Lipidoses, Histiocytoses, and Hyperlipoproteinemias 2233**
Donald Resnick, M.D.

- 57 Lymphoproliferative and Myeloproliferative Disorders 2291**
Donald Resnick, M.D., and Parviz Haghighi, M.D.

- 58 Bleeding Disorders 2346**
Donald Resnick, M.D.

SECTION XIV**Infectious Diseases 2375**

- 59 Osteomyelitis, Septic Arthritis, and Soft Tissue Infection: Mechanisms and Situations 2377**
Donald Resnick, M.D.

- 60 Osteomyelitis, Septic Arthritis, and Soft Tissue Infection: Axial Skeleton 2481**
Donald Resnick, M.D.

- 61 Osteomyelitis, Septic Arthritis, and Soft Tissue Infection: Organisms 2510**
Donald Resnick, M.D.

SECTION XV**Traumatic Diseases 2625**

- 62 Physical Injury: Concepts and Terminology 2627**
Donald Resnick, M.D., and Thomas G. Goergen, M.D.

- 63 Physical Injury: Extraspinal Sites 2783**
Donald Resnick, M.D.

- 64 Physical Injury: Spine 2934**
Mini N. Pathria, M.D.

VOLUME 4**SECTION XVI****Internal Derangements of Joints 3017**

- 65 Internal Derangements of Joints 3019**
Donald Resnick, M.D.

SECTION XVII**Thermal, Iatrogenic, Nutritional, and Neurogenic Diseases 3377**

- 66 Thermal and Electrical Injuries 3379**
Donald Resnick, M.D.

- 67 Radiation Changes 3393**
Murray K. Dalinka, M.D., and Tamara Miner Haygood, Ph.D., M.D.

- 68 Disorders Due to Medications and Other Chemical Agents 3423**
Donald Resnick, M.D.

- 69 Hypervitaminosis and Hypovitaminosis 3456**
Donald Resnick, M.D.

- 70 Heavy Metal Poisoning and Deficiency** 3465
Donald Resnick, M.D.
- 71 Neuromuscular Disorders** 3479
Donald Resnick, M.D.
- 72 Neuropathic Osteoarthropathy** 3564
Donald Resnick, M.D.

SECTION XVIII

Osteonecrosis and Osteochondrosis. . 3597

- 73 Osteonecrosis: Pathogenesis, Diagnostic Techniques, Specific Situations, and Complications** 3599
Donald Resnick, M.D., Donald E. Sweet, M.D., and John E. Madewell, M.D.
- 74 Osteochondroses** 3686
Donald Resnick, M.D.

SECTION XIX

Tumors and Tumor-like Diseases. . . . 3743

- 75 Tumors and Tumor-like Lesions of Bone: Radiographic Principles** 3745
Donald Resnick, M.D.
- 76 Tumors and Tumor-like Lesions of Bone: Imaging and Pathology of Specific Lesions** 3763
Donald Resnick, M.D., Michael Kyriakos, M.D., and Guerdon D. Greenway, M.D.
- 77 Tumors and Tumor-like Lesions of Soft Tissues** . . . 4129
Donald Resnick, M.D.
- 78 Skeletal Metastases** 4274
Donald Resnick, M.D.

VOLUME 5

SECTION XX

Congenital Diseases 4353

- 79 Developmental Dysplasia of the Hip** 4355
Jerry R. Dwek, M.D., Christine B. Chung, M.D., and David J. Sartoris, M.D.

- 80 Heritable Diseases of Connective Tissue, Epiphyseal Dysplasias, and Related Conditions** 4382
Amy Beth Goldman, M.D.

- 81 Osteochondrodysplasias, Dysostoses, Chromosomal Aberrations, Mucopolysaccharidoses, and Mucopolipidoses** 4449
William H. McAlister, M.D., and Thomas E. Herman, M.D.

- 82 Spinal Anomalies and Curvatures** 4534
M. B. Ozonoff, M.D.

- 83 Additional Congenital or Heritable Anomalies and Syndromes** 4561
Donald Resnick, M.D.

SECTION XXI

Diseases of Soft Tissues and Muscles. 4633

- 84 Soft Tissue Disorders** 4635
Donald Resnick, M.D.
- 85 Muscle Disorders** 4696
Robert Downey Boutin, M.D.

SECTION XXII

Miscellaneous Diseases 4769

- 86 Sarcoidosis** 4771
Donald Resnick, M.D.
- 87 Tuberous Sclerosis, Neurofibromatosis, and Fibrous Dysplasia** 4792
Frieda Feldman, M.D.
- 88 Enostosis, Hyperostosis, and Periostitis** 4844
Donald Resnick, M.D.
- 89 Osteolysis and Chondrolysis** 4920
Donald Resnick, M.D.

Index i

SECTION V

Rheumatoid Arthritis and Related Diseases



Ankylosing spondylitis: Syndesmophytes and bone ankylosis of apophyseal joints are evident.

