

DISEASES OF THE

Kidney & Urinary Tract

Eighth Edition

Volume II

Robert W. Schrier

DISEASES OF THE

Kidney & Urinary Tract

Eighth Edition

Volume II

Edited by

Robert W. Schrier, MD

Professor of Medicine

Department of Medicine

University of Colorado School of Medicine

Denver, Colorado



Wolters Kluwer | Lippincott Williams & Wilkins
Health

Philadelphia • Baltimore • New York • London
Buenos Aires • Hong Kong • Sydney • Tokyo

Acquisitions Editor: Lisa McAllister
Developmental Editor: Louise Bierig
Managing Editor: Kerry Barrett
Production Editor: Fran Gunning
Marketing Manager: Kimberly Schonberger
Manufacturing Manager: Kathleen Brown
Design Coordinator: Risa Clow
Compositor: Techbooks
Printer: RR Donnelley-Willard

© 2007 by LIPPINCOTT WILLIAMS & WILKINS
530 Walnut Street
Philadelphia, PA 19106 USA
LWW.com

All rights reserved. This book is protected by copyright. No part of this book may be reproduced in any form by any means, including photocopying, or utilized by any information storage and retrieval system without written permission from the copyright owner, except for brief quotations embodied in critical articles and reviews. Materials appearing in this book prepared by individuals as part of their official duties as U.S. government employees are not covered by the above-mentioned copyright.

Printed in the USA

Library of Congress Cataloging-in-Publication Data

Diseases of the kidney & urinary tract.—8th ed. / edited by Robert W. Schrier.

p. ; cm.

Includes bibliographical references and index.

ISBN 13: 978-0-7817-9307-0

ISBN 10: 0-7817-9307-6 (alk. paper)

1. Urinary organs—Diseases. 2. Kidneys—Diseases. I. Schrier, Robert W. II. Title:

Diseases of the kidney and urinary tract.

[DNLM: 1. Kidney Diseases. 2. Urologic Diseases. WJ 300 D6115 2007]

RC900.D56 2007

616.6'1—dc22

2006028279

Care has been taken to confirm the accuracy of the information presented and to describe generally accepted practices. However, the authors, editors, and publisher are not responsible for errors or omissions or for any consequences from application of the information in this book and make no warranty, expressed or implied, with respect to the currency, completeness, or accuracy of the contents of the publication. Application of the information in a particular situation remains the professional responsibility of the practitioner.

The authors, editors, and publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accordance with current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new or infrequently employed drug.

Some drugs and medical devices presented in the publication have Food and Drug Administration (FDA) clearance for limited use in restricted research settings. It is the responsibility of the health care provider to ascertain the FDA status of each drug or device planned for use in their clinical practice.

To purchase additional copies of this book, call our customer service department at (800) 638-3030 or fax orders to (301) 223-2320. International customers should call (301) 223-2300.

Visit Lippincott Williams & Wilkins on the Internet: at LWW.com. Lippincott Williams & Wilkins. Customer service representatives are available from 8:30 am to 6 pm, EST.

10 9 8 7 6 5 4 3 2 1

■ DEDICATION



Carl William Gottschalk, MD was a man for all seasons—brilliant scholar, committed mentor of students, dedicated citizen of the University of North Carolina and the broader academic community, and a gentleman in every sense of the word. Carl was a native Virginian whose southern manners and warm demeanor emanated a personal charm to his friends, colleagues, and students. He graduated Phi Beta Kappa from Roanoke College in 1942 and received an Honorary Doctor of Science from that institution in 1966. An Alpha Omega Alpha graduate from the University of Virginia School of Medicine, Carl received his training in internal medicine at the Massachusetts General Hospital and his fellowship in Cardiology at the University of North Carolina. For the next 40 years (1952–1992), his loyalty and many talents were an integral part of the University of North Carolina, which accounted for the respect and affection that he received from his many colleagues and friends. He was the Kenan Professor of Medicine and Physiology from 1969 until his untimely death on October 15, 1997, in Chapel Hill, North Carolina.

Carl's scientific contributions were recognized by his election to the National Academy of Science. He was president of the American Society of Nephrology from 1976 until 1977 and was a Councilor of the International Society of Nephrology (ISN). Carl founded the History of Medicine Commission of the ISN and the ISN Archives in Amsterdam, *The Netherlands*, which are appropriately named the Carl W. Gottschalk Archives of the ISN. Among many honors, awards, and distinguished named lectureships, Carl received the Homer W. Smith Award from

the New York Heart Association and the David H. Hume Award from the National Kidney Foundation. The American Physiological Society has established the Carl W. Gottschalk Distinguished Lectureship in Renal Physiology, and the University of North Carolina has inaugurated the Carl W. Gottschalk Lectureship in the Basic Sciences.

The written persona of Carl W. Gottschalk—scientist, medical historian, lepidopterist who has a butterfly (*Strymon cecrops Gottshalki*) named after him, recipient of many honors and awards—can only project a very modest picture of this Renaissance man. His kindness and consideration for others was unparalleled. It was my honor to have worked with him on three editions of *Diseases of the Kidney* and to dedicate this current edition to his memory.

Robert W. Schrier, MD

■ P R E F A C E

The recent advances in all aspects of our knowledge of the kidney and its diseases mandate a new edition of *Diseases of the Kidney & Urinary Tract*. As in previous editions, a group of international experts was assembled to present this information in a comprehensive, authoritative, concise, and readily accessible fashion. The chapters have been extensively revised and updated.

Nephrology is a discipline that combines the basic and clinical sciences. Successful integration of this knowledge is the goal of this eighth edition. The 14 sections of the three volume book are actually individual texts which can stand on their own. Moreover, a unique feature of the book is a comprehensive inclusion of diseases of the urinary tract as well as the kidney.

The first section presents an overall view of the structural, physiologic, and biochemical aspects of the kidney. This section incorporates the latest developments in cellular and molecular biology, emphasizing the most current information and concepts on cell signaling, receptors, and ion channels. The subsequent 13 sections are disease-oriented, with each section beginning with a pathophysiology chapter. The goal of *Diseases of the Kidney & Urinary Tract* is to publish the most comprehensive material for practicing and academic physicians caring for patients with renal, hypertension, and urological diseases. The 14 sections of the book cover 104 chapters and are summarized as follows:

- I. **Biochemical, Structural, and Functional Correlations in the Kidney** includes structural, hemodynamic, hormonal, ion transport and metabolic functions in nine chapters.
- II. **Clinical Evaluation** is covered in six chapters on urinalysis, laboratory evaluation, urography, tomography, and angiography, with indications and interpretations for renal biopsy.
- III. **Hereditary Diseases**, in five chapters, covers genetic mechanisms, medullary cystic and sponge disorders, polycystic kidney disease, Alport syndrome, Fabry disease, and nail-patella syndrome, as well as isolated renal tubular disorders.
- IV. **Urological Diseases of the Genitourinary Tract** are described in six chapters, including congenital abnormalities, urinary tract obstruction, renal calculi, reflux nephropathy, and prostatic and micturition disorders.

- V. **Neoplasms of the Genitourinary Tract** are addressed in five chapters covering molecular mechanisms in malignancy, testicular carcinoma, prostate and bladder cancer, and primary neoplasms of the kidney and renal pelvis.
- VI. **Infections of the Urinary Tract and the Kidney** are contained in seven chapters, including host defense mechanisms; urinary bacterial infections, including tuberculosis and fungal infections; renal abscesses; and cystitis.
- VII. **Acute Renal Failure** is described in 11 chapters, including the pathophysiology of renal cell ischemia and nephrotoxic injury, acute tubular necrosis, acute interstitial nephritis, and acute nephrotoxic renal disease.
- VIII. **Hypertension** and its renal manifestations are covered in seven chapters, which include pathophysiology, renal vascular and endocrine-related hypertension, as well as hypertension in pregnancy and in diabetes.
- IX. **Glomerular, Interstitial, and Vascular Renal Diseases** are discussed in 16 chapters, including collagen vascular diseases, chronic interstitial nephritis, primary glomerulonephritides, and vasculitides.
- X. **Systemic Diseases of the Kidney** are covered in eight chapters, including diabetes, hepatorenal syndrome, sickle cell disease, gout, myeloma/amyloidosis, and tropical diseases.
- XI. **Disorders of Electrolyte, Water, and Acid-Base** are covered in ten chapters, including SIADH, central and nephrogenic diabetes insipidus, cardiac failure, cirrhosis, and the nephrotic syndrome.
- XII. **Uremic Syndrome** covers pathophysiology, anemia, osteodystrophy, the nervous system, cardiovascular complications and metabolic and endocrine dysfunctions in six chapters.
- XIII. **Management of End-Stage Renal Disease** by transplantation, peritoneal dialysis and hemodialysis, including complications outcomes, and is discussed in four chapters.
- XIV. **Nutrition, Drugs, and the Kidney** are covered in four chapters, including protein and caloric dietary issues, as well as drug dosing recommendations in renal failure.

I would like to thank our authoritative and remarkably talented contributing authors whose dedication to nephrology is unmatched.

Robert W. Schrier, MD

■ CONTRIBUTING AUTHORS

William T. Abraham, MD, FACP, FACC, FAHA

Professor of Internal Medicine
Director, Division of Cardiovascular Medicine
The Ohio State University
Columbus, Ohio

Gregory A. Achenbach, MD

Assistant Clinical Professor
Department of Pathology
University of Colorado School of Medicine
Chairman
Department of Pathology
Rose Medical Center
Denver, Colorado

Marcin Adamczak, MD

Department of Nephrology
Endocrinology and Metabolic Diseases
Medical University of Silesia
Katowice, Poland

Horacio J. Adrogué, MD

Professor
Department of Medicine
Baylor College of Medicine
Chief, Renal Service
Department of Medicine
The Methodist Hospital
Houston, Texas

Robert J. Alpern, MD

Dean, School of Medicine
Departments of Internal Medicine
and Nephrology
Yale University School of Medicine
New Haven, Connecticut

Jamshid Amanzadeh, MD

Assistant Professor
Department of Medicine
University of Texas Southwestern
Medical School
Staff Physician
Department of Medicine
VA North Texas Health Care System
Dallas, Texas

Robert J. Anderson, MD

Meiklejohn Professor
Chair, Department of Medicine
University of Colorado Health Sciences Center
Chief, Department of Medicine
University of Colorado Hospital
Denver, Colorado

Sharon Anderson, MD

Professor and Vice Chair
Department of Medicine, Division of Nephrology
Oregon Health and Science University
Portland, Oregon

Thomas E. Andreoli, MD, MACP

Distinguished Professor
Department of Internal Medicine
Department of Physiology and Biophysics
University of Arkansas College of Medicine
Little Rock, Arkansas

Dennis L. Andress, MD

Professor of Medicine
Department of Medicine
University of Washington
Seattle, Washington

Vincent T. Andriole, MD

Professor of Medicine
Department of Internal Medicine
Yale School of Medicine
Attending Physician
Department of Internal Medicine
Yale-New Haven Hospital
New Haven, Connecticut

William P. Arend, MD

Professor
Department of Medicine
University of Colorado Health Sciences Center
Denver, Colorado

William J. Arendshorst, PhD

Professor
Department of Cell and Molecular Physiology
University of North Carolina at Chapel Hill
Chapel Hill, North Carolina

Allen I. Arieff, MD

Professor Emeritus
Department of Medicine
University of California
San Francisco, California
Attending Physician
Department of Medicine
Cedars-Sinai Medical Center
Los Angeles, California

Anthony Atala, MD

Professor and Chair
Department of Urology
Wake Forest University School of Medicine
Chief, Department of Urology
North Carolina Baptist Hospital
Winston-Salem, North Carolina

Robert C. Atkins, MB, BS, DSc, FRACP

Professor of Medicine
Department of Epidemiology and
Preventive Medicine
Monash University
Melbourne, Australia
Director Emeritus
Department of Nephrology
Monash Medical Centre
Victoria, Australia

Pierre Aucouturier, PhD

Professor
Department of Immunology
Université Pierre et Marie Curie
PU-PH
Department of Immunology
Hôpital Tenon
Paris, France

Faten Ayyoub, MD

Staff Nephrologist
Department of Medicine
Harper University Hospital
Detroit, Michigan

Kamal F. Badr, MD

Professor and Chair
Department of Internal Medicine
American University of Beirut
American University of Beirut Medical Center
Beirut, Lebanon

Ross R. Bailey, MD, FRACP, FRCP (deceased)

Clinical Lecturer, Department of Medicine,
Christchurch School of Medicine
Head, Department of Nephrology
Christchurch Hospital
Christchurch, New Zealand

Dean F. Bajorin, MD, FACP

Professor
Department of Medicine
Weill Medical College of Cornell University
Attending Physician
Department of Medicine
Memorial Sloan-Kettering Cancer Center
New York, New York

David S. Baldwin, MD

Professor Emeritus
Department of Medicine
New York University School of Medicine
Honorary Attending
Department of Medicine
New York University Medical Center
New York, New York

Rashad S. Barsoum, MD, FRCP, FRCPE

Professor of Medicine
Department of Internal Medicine
Cairo University
Chairman
Cairo Kidney Center
Cairo, Egypt

Anne M. Beck, MD

Associate Professor
Department of Pediatrics
Washington University School of Medicine
Medical Director of Pediatric Dialysis
Department of Pediatrics
Division of Nephrology
St. Louis Children's Hospital
St. Louis, Missouri

Darren T. Beiko, MD, FRCSC

Assistant Professor
Department of Urology
Queen's University
Urologist
Department of Urology
Kingston General Hospital
Kingston, Ontario, Canada

Mir Reza Bekheirnia, MD

Department of Medicine
Division of Renal Diseases and Hypertension
University of Colorado School of Medicine
Denver, Colorado

William M. Bennett, MD

Northwest Renal Clinic
Medical Director
Transplant Services
Legacy Good Samaritan Hospital
Portland, Oregon

Anatole Besarab, MD

Adjunct Professor
Department of Medicine
Wayne State University
Senior Staff
Department of Medicine
Henry Ford Health System
Detroit, Michigan

Daniel G. Bichet, MD, MSc

Professor
Departments of Medicine and Physiology
Canada Research Chair, Genetics of Renal Disease
University of Montreal
Nephrologist
Hôpital du Sacré-Coeur de Montréal
Montréal, Québec, Canada

Warren Kline Bolton, MD

Professor of Internal Medicine
Division of Nephrology
University of Virginia
Chief
Division of Nephrology
University of Virginia Health Systems
Charlottesville, Virginia

George J. Bosl, MD

Professor of Medicine
Department of Medicine
Joan and Sanford I. Weill Medical College
Chairman
Department of Medicine
Memorial Sloan-Kettering Cancer Center
New York, New York

Jean-Louis Bosmans, MD, PhD

Associate Professor
Department of Medicine
University of Antwerp
Section Director
Department of Nephrology
University Hospital of Antwerp
Antwerp, Belgium

Mayer Brezis, MD, MPH

Professor of Medicine
Braun School of Public Health
Hebrew University of Jerusalem
Director, Center for Quality and Safety
Hadassah Medical Center
Jerusalem, Israel

Verena A. Briner, MD

Professor
Department of Medicine
University of Basel
Basel, Switzerland
Head, Department of Medicine
Kantonsspital Luzern
Luzern, Switzerland

Keith E. Britton, MD, MSc, FRCR, FRCP

Emeritus Professor
University of London
Chairman of the Board
Cromwell Hospital
London, United Kingdom

Ruth Ellen Bulger, PhD

Professor
Department of Anatomy, Physiology, and Genetics
F. Edward Hebert School of Medicine
Uniformed Services University of the Health Sciences
Bethesda, Maryland

John M. Burkart, MD

Professor
Corporate Director, Dialysis Program
Department of Nephrology
Wake Forest University Medical Center
Winston-Salem, North Carolina

Melissa A. Cadnapaphornchai, MD

Associate Professor
Departments of Pediatrics and Medicine
University of Colorado Health Sciences Center
Attending Nephrologist
Department of Pediatrics
The Children's Hospital
Denver, Colorado

Andrés Cárdenas, MD

Associate Investigator
Faculty of Medicine
University of Barcelona
Associate Investigator
Liver Unit 7-3
Hospital Clinic
Barcelona, Spain

Michele Ceruti, MD

Mario Negri Institute for Pharmacological Research
Division of Nephrology and Dialysis
Azienda Ospedal, Ospedali Riuniti
Bergamo, Italy

Joumana Chaiban, MD

Endocrinology Fellow
Department of Internal Medicine
American University of Beirut
American University of Beirut Medical Center
Beirut, Lebanon

Laurence Chan, MD, PhD, FRCP, FACP

Professor of Medicine
Department of Medicine
Division of Renal Diseases and Hypertension
University of Colorado School of Medicine
Denver, Colorado

Silvia D. Chang, MD

Assistant Professor
Department of Radiology
University of British Columbia
Head of Abdominal MRI
Department of Radiology
Vancouver General Hospital
Vancouver, British Columbia, Canada

Cyril Chantler, MD, FRCP

GKT Department of Pediatric Nephrology
Guy's Tower
Guy's Hospital
Vice Principal
King's College
London, United Kingdom

Devasmita Choudhury, MD

Associate Professor of Medicine
University of Texas Southwestern Medical Center at Dallas
Director of Dialysis
Department of Medicine
Dallas Veterans Affairs Medical Center
Dallas, Texas

Godfrey Clark, MD

GKT Department of Pediatric Nephrology
Guy's Tower
Guy's Hospital
London, United Kingdom

Anthony R. Clarkson, MD, MBBS, FRACP

Associate Professor
Department of Medicine
University of Adelaide
Emeritus Consultant Nephrologist
Department of Renal Medicine
Royal Adelaide Hospital
Adelaide, South Australia

Kirk P. Conrad, MD

Professor
Department of Physiology and Functional Genomics
University of Florida College of Medicine
Gainesville, Florida

Howard L. Corwin, MD

Professor
Department of Medicine and Anesthesiology
Dartmouth Medical School
Hanover, New Hampshire
Medical Director, Intensive Care Unit
Dartmouth-Hitchcock Medical Center
Lebanon, New Hampshire

Luciano J. Costa, MD, ScD

Clinical Fellow, Division of Medical Oncology
Department of Medicine
University of Colorado
Aurora, Colorado

E. David Crawford, MD

Professor of Medicine
University of Colorado Hospital Cancer Center
Urologic Oncology
University of Colorado Health Sciences Center
Denver, Colorado

Byron P. Croker, MD, PhD

Professor
Department of Pathology, Immunology, and
Laboratory Medicine
University of Florida
Chief
Department of Pathology and Laboratory Medicine Service
North Florida/South Georgia Veterans Health System
Gainesville, Florida

Robert E. Cronin, MD

Professor
Department of Internal Medicine
University of Texas Southwestern Medical Center
Staff Nephrologist
Medical Service
VA North Texas Health Care System
Dallas, Texas

Brian S. Cummings, PhD

Assistant Professor
Department of Pharmaceutical and Biomedical Sciences
University of Georgia
Athens, Georgia

Giuseppe D'Amico, MD, FRCP

Emeritus Director
Department of Nephrology
San Carlo Borromeo Hospital
Milan, Italy

Eugene Daphnis, MD

Assistant Professor
Department of Nephrology
Crete University
Chief
Department of Nephrology
University Hospital of Heraklion
Heraklion, Greece

Scott F. Davies, MD

Professor and Vice Chairman
Department of Medicine
University of Minnesota Medical School
Chief
Department of Medicine
Hennepin County Medical Center
Minneapolis, Minnesota

Marc E. De Broe, MD, PhD

Professor Emeritus
Faculty of Medicine
University of Antwerp
Wilrijk, Antwerp, Belgium

Paul E. de Jong, MD, PhD

Department of Internal Medicine
University Hospital Groningen
Groningen, The Netherlands

Angelo M. De Mattos, MD, MPH

University of Alabama (UAB) Birmingham
Division of Nephrology and Transplantation
Birmingham, Alabama

Louise-Marie Dembry, MD, MS

Associate Professor of Medicine and Epidemiology
Department of Internal Medicine
Yale University School of Medicine
Hospital Epidemiologist
Department of Quality Improvement and
Support Services
Yale-New Haven Hospital
New Haven, Connecticut

Gary V. Desir, MD

Professor
Department of Medicine, Section of Nephrology
Yale University School of Medicine
New Haven, Connecticut
Chief
Department of Medicine
VA Connecticut Health Care System
West Haven, Connecticut

Hugh E. de Wardener, MD, FRCP

Emeritus Professor of Medicine
Imperial College School of Medicine
Department of Clinical Chemistry
Division of Investigative Sciences
London, United Kingdom

Giovanni Barbiano di Belgiojoso, MD

Associate Professor
Department of Medicine and Nephrology
University of Milan
Chief
Nephrology Unit
Luigi Sacco Hospital
Milan, Italy

Jacques Diezi, MD

Professor
Department of Pharmacology and Toxicology
University of Lausanne
Lausanne, Switzerland

Susan R. DiGiovanni, MD

Associate Professor of Medicine
Department of Medicine
Virginia Commonwealth University
Richmond, Virginia

Burl R. Don, MD

Professor of Medicine
Division of Nephrology
University of California, Davis
Director, Clinical Nephrology
Division of Nephrology
University of California, Davis Medical Center
Sacramento, California

Michael S. Donnenberg, MD

Department of Microbiology and Immunology
 Division of Infectious Diseases
 Department of Medicine
 University of Maryland Medical System
 Baltimore, Maryland

Harry A. Drabkin, MD

Professor of Medicine
 Division of Medical Oncology
 University of Colorado School of Medicine
 Aurora, Colorado

Tevfik Ecder, MD

Professor of Medicine
 Department of Internal Medicine
 Istanbul School of Medicine
 Istanbul, Turkey

Charles L. Edelstein, MD, PhD

Professor
 Department of Medicine/Renal
 University of Colorado Health Sciences Center
 University Hospital
 Denver, Colorado

Garabed Eknayan, MD

Professor
 Department of Medicine
 Baylor College of Medicine
 Houston, Texas

David H. Ellison, MD

Professor of Medicine and Physiology and Pharmacology
 Head, Division of Nephrology and Hypertension
 Department of Medicine
 Oregon Health and Science University
 Portland, Oregon

Raymond O. Estacio, MD

Associate Professor of Medicine
 Department of Medicine
 University of Colorado Health Sciences Center
 Internal Medicine
 Department of Community Health
 Denver Health
 Denver, Colorado

Ronald J. Falk, MD

Doc J. Thurston Professor of Medicine
 Division of Nephrology and Hypertension
 The University of North Carolina at Chapel Hill
 School of Medicine
 Chief of Nephrology and Hypertension
 Director, UNC Kidney Center
 Department of Medicine
 UNC Hospitals
 Chapel Hill, North Carolina

Randall James Faull, MBBS, PhD

Associate Professor
 Department of Medicine
 University of Adelaide
 Senior Consultant Nephrologist
 Renal Unit
 Royal Adelaide Hospital
 Adelaide, South Australia

Franco Ferrario, MD

Chief
 Renal Immunopathology Center
 San Carlo Borromeo Hospital
 Milan, Italy

Godela M. Fick-Brosnahan, MD

Western Nephrology and
 Metabolic Bone Disease
 Lakewood, Colorado

Eli A. Friedman, MD

Distinguished Teaching Professor
 Chief
 Division of Renal Disease
 Department of Medicine
 SUNY, Health Science Center at Brooklyn
 University Hospital of Brooklyn
 Brooklyn, New York

Jørgen Frøkiaer, MD, DMSc

Professor of Cell Biology and Pathophysiology
 The Water and Salt Research Centre
 Institute of Experimental Clinical Research
 Aarhus University Hospital, Skejby Sygehus
 Aarhus C, Denmark

Gloria R. Gallo, MD

Adjunct Professor of Pathology
 Department of Pathology
 New York University School of Medicine
 Attending Pathologist, Renal Pathology
 Department of Pathology
 New York University Medical Center
 New York, New York

Matthew D. Galsky, MD

Assistant Member
 Department of Medicine
 Memorial Sloan-Kettering Cancer Center
 New York, New York

Robert M. Gemmill, PhD

Associate Professor of Medicine
 Department of Medicine
 University of Colorado Health Sciences Center
 Aurora, Colorado

Gregory G. Germino, MD

Professor
 Department of Medicine–Renal
 Johns Hopkins University
 Active Staff Full Time
 Department of Renal Medicine
 Johns Hopkins Hospital
 Baltimore, Maryland

L. Michael Glode, MD

Professor of Medicine and Robert Rifkin Chair
 Department of Medicine
 University of Colorado Cancer Center
 Medical Oncology
 Aurora, Colorado

Eric Gibney, MD

Assistant Professor
 Virginia Commonwealth University
 Richmond, Virginia

Pere Ginès, MD

Associate Professor
Faculty of Medicine
University of Barcelona
Chairman
Liver Unit 7-3
Hospital Clinic
Barcelona, Spain

Thomas A. Golper, MD

Professor
Department of Medicine–Nephrology
Medical Director
Department of Nephrology
Medicine Specialties Patient Care Center
Vanderbilt University Medical Center
Nashville, Tennessee

Martin C. Gregory, MD

Professor
Department of Medicine
The University of Utah
Nephrologist
Department of Medicine
University of Utah Health Sciences Center
Salt Lake City, Utah

Jean-Pierre Grünfeld, MD

Professor
Department of Nephrology
Université Paris-Descartes
Consultant
Department of Nephrology
AP-HP, Hôpital Necker
Paris, France

David Harris, MD

Professor and Head, Discipline of Medicine
Department of Medicine
University of Sydney
Western Clinical School Westmead Hospital
Consultant Nephrologist and
Director of Nephrology
Western Sydney Renal Service
Department of Renal Medicine
Westmead Hospital
Westmead, NSW Australia

Choli Hartono, MD

Assistant Professor
Department of Medicine
Harvard Medical School
Assistant in Medicine
Department of Medicine
Massachusetts General Hospital
Boston, Massachusetts

Kathryn L. Hassell, MD

Associate Professor of Medicine
Division of Hematology
Director
Colorado Sickle Cell Treatment and
Research Center
University of Colorado at Denver
Health Sciences Center
Denver, Colorado

William L. Henrich, MD, MACP

Dean of the School of Medicine
VP for Medical Affairs Professor of Medicine
Department of Medicine
University of Texas Health Science Center
at San Antonio
Physician Staff
University Health System
San Antonio, Texas

Samuel N. Heyman, MD

Associate Professor
Department of Medicine
Hebrew University Faculty of Medicine
Medical School, Hadassah Medical Campus,
Ein Kerem
Senior Physician
Department of Medicine
Hadassah Hospital, Mount Scopus
Jerusalem, Israel

Friedhelm Hildebrandt, MD

Professor
Department of Pediatrics and Human Genetics
University of Michigan
Department of Diseases, Pediatric Nephrology
University of Michigan Health Systems
Ann Arbor, Michigan

Hedvig Hricak, MD, PhD

Professor
Department of Radiology
Weill Medical College of Cornell University
Chairman
Department of Radiology
Memorial Sloan-Kettering Cancer Center
New York, New York

Keith A. Hruska, MD

Professor
Department of Pediatrics, Medicine, Cell Biology
Washington University
Director
Department of Pediatric Nephrology
St. Louis Children's Hospital
St. Louis, Missouri

Michael H. Humphreys, MD

Professor of Medicine
University of California San Francisco
Division of Nephrology
San Francisco General Hospital
San Francisco, California

Alkesh Jani, MD

Assistant Professor of Medicine
Department of Medicine
Division of Renal Diseases and Hypertension
University of Colorado School of Medicine
Denver, Colorado

Robert W. Janson, MD

Associate Professor of Medicine
Division of Rheumatology
University of Colorado Health Sciences Center
Chief, Rheumatology Section
Denver VA Medical Center
Denver, Colorado

J. Charles Jennette, MD

Brinkhous Distinguished Professor and Chair
 Department of Pathology and
 Laboratory Medicine
 University of North Carolina
 Chief of Service
 Department of Pathology and
 Laboratory Medicine
 UNC Hospitals
 Chapel Hill, North Carolina

Richard J. Johnson, MD

Chief, Division of Nephrology, Hypertension
 and Transplantation
 Department of Medicine
 University of Florida
 Gainesville, Florida

Paul Jungers, MD

Emeritus Professor of Nephrology
 Faculté de Médecine Necker
 Université Paris V
 Paris, France

Igal Kam, MD

Professor
 Division Head
 Transplant Surgery
 University of Colorado
 Denver, Colorado

Mohammad Kamgar, MD

University of California–Irvine
 Irvine, California

Duk-Hee Kang, MD, PhD

Associate Professor
 Division of Nephrology, Department of
 Internal Medicine
 Ewha Woman's University College of Medicine
 Chief
 Division of Nephrology, Department of
 Internal Medicine
 Ewha Woman's University Tongdaemun Hospital
 Seoul, Korea

Peter G. Kerr, MB, BS, PhD, FRACP

Professor
 Department of Nephrology
 Monash University
 Director
 Department of Nephrology
 Monash Medical Center
 Clayton, Victoria, Australia

Walid Khairallah, MD

Endocrinology Fellow
 Department of Internal Medicine
 American University of Beirut
 American University of Beirut Medical Center
 Beirut, Lebanon

Uday Khosla, MD

Assistant Professor
 Renal Section
 Baylor College of Medicine
 Houston, Texas

Melanie S. Kim, MD

Associate Professor
 Department of Pediatrics
 Boston Medical Center
 Boston University School of Medicine
 Boston, Massachusetts

Paul L. Kimmel, MD

Professor of Medicine
 George Washington University Medical Center
 Attending Physician
 Department of Medicine
 George Washington University Hospital
 Washington, District of Columbia

Saulo Klahr, MD

John E. and Adaline Simon Professor of Medicine
 Department of Internal Medicine
 Washington University School of Medicine
 Physician
 Department of Internal Medicine
 Barnes-Jewish Hospital
 St. Louis, Missouri

Mark A. Knepper, MD, PhD

Chief
 Renal Mechanisms Section
 National Heart, Lung, Blood Institute
 National Institutes of Health
 Bethesda, Maryland

Sidney Kobrin, MD

Associate Professor of Medicine
 Renal, Electrolyte and Hypertension Division
 University of Pennsylvania School of Medicine
 Department of Medicine
 Hospital of the University of Pennsylvania
 Philadelphia, Pennsylvania

Radko Komers, MD, PhD

Assistant Professor
 Division of Nephrology
 Oregon Health and Science University
 Portland, Oregon
 Deputy Head
 Diabetes Center
 Institute for Clinical and Experimental Medicine
 Prague, Czech Republic

Varuni Kondagunta, MD

Instructor
 Department of Medicine
 Joan and Sanford Weill Medical College of
 Cornell University
 Assistant Attending Physician
 Solid Tumor; Department of Medicine
 Memorial Sloan-Kettering Cancer Center
 New York, New York

Jeffrey B. Kopp, MD

Staff Clinician
 National Institute of Diabetes and Digestive and
 Kidney Diseases
 National Institutes of Health
 Bethesda, Maryland

Joel D. Kopple, MD

Professor of Medicine and Public Health
The David Geffen School of Medicine at UCLA
and UCLA School of Public Health
Los Angeles, California
Chief
Division of Nephrology and Hypertension
Harbor-UCLA Medical Center
Torrance, California

Matthias Kretzler, MD

Associate Professor
Department of Internal Medicine
University of Michigan
Attending
Department of Internal Medicine
University of Michigan Medical Center
Ann Arbor, Michigan

Wilhelm Kriz, MD

Professor Emeritus
Department of Anatomy and Cell Biology
University Heidelberg
Heidelberg, Germany

Tae-Hwan Kwon, MD, PhD

University of Alabama (UAB) Birmingham
Division of Nephrology and Transplantation
Birmingham, Alabama

Richard A. Lafayette, MD

Associate Professor
Department of Medicine
Associate Chief
Department of Nephrology
Stanford University Hospital
Stanford, California

Andrew Lazar, MD

Northeast Ohio Nephrology Associates
Akron, Ohio

Vincent Weng Seng Lee, MBBS, FRACP

Renal Fellow
Department of Renal Medicine
Westmead Hospital
Westmead, NSW Australia

Andrew S. Levey, MD

Professor
Department of Medicine
Tufts University
Chief
Division of Nephrology
New England Medical Center
Boston, Massachusetts

Moshe Levi, MD

Professor and Vice Chair for Research
Departments of Medicine, Physiology, and Biophysics
University of Colorado
Denver, Colorado

Francisco Llach, MD

Newark Beth Israel Medical Center
Newark, New Jersey

Stuart L. Linas, MD

Professor of Medicine
Department of Medicine
Division of Renal Diseases and Hypertension
University of Colorado School of Medicine
Denver, Colorado

Marshall D. Lindheimer, MD

Professor Emeritus
Department of Medicine/Obstetrics and Gynecology
University of Chicago
Chicago, Illinois

**Graham A. MacGregor, MA, MB, BChir,
FRCP, FMedSci**

Professor of Cardiovascular Medicine
Blood Pressure Unit
St. George's University of London
St. George's Hospital
London, United Kingdom

Michael P. Madaio, MD

Chief of Nephrology
Department of Medicine
Temple University School of Medicine
Philadelphia, Pennsylvania

Sreedhar Mandayam, MD

Post-Doctoral Fellow
Division of Nephrology
University of Texas Medical Branch
Galveston, Texas

Bruno C. Medeiros, MD

Assistant Professor
Department of Medicine
Stanford Cancer Center
Stanford Hospital and Clinics
Stanford, California

Rajnish Mehrotra, MD, FACP, FASN

Associate Professor of Medicine
Division of Nephrology and Hypertension
Los Angeles Biomedical Research Institute at Harbor-UCLA
Medical Center and David Geffen School of Medicine
at UCLA
Torrance, California

Marie Merheb, MD

Endocrinology Fellow
Department of Internal Medicine
American University of Beirut
American University of Beirut Medical Center
Beirut, Lebanon

Timothy W. Meyer, MD

Professor of Medicine
Chief, Division of Nephrology
Stanford University of Medicine
Stanford, California
Veterans Affairs Palo Alto Health Center
Palo Alto, California

Dennis J. Mikolich, MD

Clinical Associate Professor
Department of Medicine
Brown University
Chief, Division of Infectious Diseases
Department of Medicine
Veterans Affairs Medical Center
Providence, Rhode Island

Anne Marie Miles, MD, FACP

Voluntary Assistant Professor of Medicine
and Community Preceptor
University of Miami School of Medicine
Attending Physician in Nephrology
North Shore Hospital Medical Center
Miami, Florida

William E. Mitch, MD

Gordon A. Cain Professor of Medicine
Nephrology Division, Department of Medicine
Baylor College of Medicine
Houston, Texas

Harry L. T. Mobley, PhD

Frederick G. Novy Collegiate Professor
and Chair
Department of Microbiology and Immunology
University of Michigan Medical School
Ann Arbor, Michigan

Jack Moore, Jr., MD

Associate Professor
Department of Medicine
Uniformed Services University of the
Health Sciences
Bethesda, Maryland
Director, Section of Nephrology
Department of Medicine
Washington Hospital Center
Washington, District of Columbia

Christopher S. Morris, MD

Associate Professor of Radiology
Department of Radiology
University of Vermont College of Medicine
Attending Radiologist
Radiology Health Care Service
Fletcher Allen Health Care
Burlington, Vermont

Robert J. Motzer, MD

Professor of Medicine
Weil Medical College of Cornell University
New York Presbyterian Hospital
Attending Physician
Department of Medicine
Memorial Sloan-Kettering Cancer Center
New York, New York

Béatrice Mougnot, MD

Senior Pathologist
INSERM and University Pierre et Marie Curie
Senior Pathologist
Department of Pathology
Tenon Hospital (AP-HP)
Paris, France

Sean W. Murphy, MD, BSc, FRCPC

Assistant Professor of Medicine
Department of Nephrology and Clinical Epidemiology
Memorial University of Newfoundland
Health Sciences Center
St. John's, Newfoundland, Canada

Patrick H. Nachman, MD

Assistant Professor
Division of Nephrology and Hypertension
University of North Carolina
Chapel Hill, North Carolina

L. Gabriel Navar, PhD

Professor and Chair
Department of Physiology
Tulane University
New Orleans, Louisiana

Joel Neugarten, MD

Professor of Medicine
Department of Medicine
Albert Einstein College of Medicine
Site Director, Renal Division
Montefiore Medical Center
Bronx, New York

J. Curtis Nickel, MD, FRCSC

Professor
Department of Urology
Queen's University
Urologist
Department of Urology
Kingston General Hospital
Kingston, Ontario, Canada

Lindsay E. Nicolle, MO, FRCPC

Professor
Department of Internal Medicine and
Medical microbiology
University of Manitoba
Consultant, Infectious Diseases
Department of Medicine
Health Science Centre
Winnipeg, Manitoba, Canada

Søren Nielsen, MD

Professor and Director
Water and Salt Research Center
University of Aarhus
Aarhus, Denmark

David J. Nikolic-Paterson, BSc, Dphil

Senior Research Fellow
Department of Nephrology
Monash Medical Centre
Clayton, Victoria, Australia

Charles R. Nolan, MD

Professor of Medicine and Surgery
Department of Medicine
University of Texas Health Science Center
at San Antonio
Medical Director, Kidney Transplantation
Department of Organ Transplant
University Hospital
San Antonio, Texas

Mark D. Okusa, MD

John C. Buchanan Distinguished Professor of
Internal Medicine
Department of Internal Medicine
University of Virginia
Attending Physician
University of Virginia Health System
Charlottesville, Virginia

Ali J. Olyaei, PharmD, BCPS

Associate Professor of Medicine
Director of Clinical Research
Clinical Pharmacotherapist
Division of Nephrology and Hypertension
Oregon Health Sciences University
Portland, Oregon

Biff F. Palmer, MD

Professor of Internal Medicine
Nephrology Fellowship Program Director
Division of Nephrology, Department of
Internal Medicine
University of Texas Southwestern
Medical School
Dallas, Texas

Patrick S. Parfrey, MD

University Research Professor
Department of Medicine
Memorial University of Newfoundland
Staff Nephrologist
Department of Medicine, Patient Research Centre
Health Sciences Centre
St. John's, Newfoundland, Canada

Chirag R. Parikh, MD, PhD, FACP

Assistant Professor
Department of Medicine
Yale University School of Medicine
West Haven, Connecticut

Mark S. Pasternack, MD

Associate Professor
Department of Pediatrics
Harvard Medical School
Chief, Pediatric Infectious Disease Unit
Pediatrician and Physician
Infectious Disease Units
Departments of Medicine and Pediatrics
Massachusetts General Hospital
Boston, Massachusetts

Mark A. Perazella, MD, FACP

Associate Professor
Department of Medicine
Yale University
Director
Acute Dialysis Services
Yale-New Haven Hospital
New Haven, Connecticut

Ronald D. Perrone, MD

Professor
Tufts New England Medical Center
Boston, Massachusetts

Marc A. Pohl, MD

Ray W. Gifford Chair
Head, Section of Clinical Hypertension and Nephrology
Department of Nephrology and Hypertension
Cleveland Clinic
Cleveland, Ohio

Patricia A. Preisig, PhD

Professor
Departments of Internal Medicine and Cellular and
Molecular Physiology
Yale University
New Haven, Connecticut

Mahboob Rahman, MD, MS

Associate Professor
Department of Medicine
Case Western Reserve University School of Medicine
Department of Medicine
University Hospital of Cleveland
Cleveland, Ohio

Asghar Rastegar, MD

Professor of Medicine and Associate Chair for
Academic Affairs
Department of Internal Medicine
Yale University School of Medicine
Attending Physician
Department of Internal Medicine and Nephrology
Yale-New Haven Hospital
New Haven, Connecticut

W. Brian Reeves, MD

Professor of Medicine
Department of Medicine
Penn State University College of Medicine
Chief of Nephrology
Department of Medicine
Milton S. Hershey Medical Center
Hershey, Pennsylvania

Robert F. Reilly, Jr., MD

Professor of Medicine
Department of Medicine
University of Texas Southwestern at Dallas
Chief, Section of Nephrology
Department of Internal Medicine
Dallas VA
Dallas, Texas

Giuseppe Remuzzi, MD, FRCP

Research Coordinator
Negri Bergamo Laboratories
Mario Negri Institute for Pharmacological Research
Director, Division of Nephrology and Dialysis
Azienda Ospedal. Ospedali Riuniti
Bergamo, Italy

Jeffrey M. Rimmer, MD

Professor of Medicine
Department of Medicine
University of Vermont
Department of Nephrology
Fletcher Allen Health Care
Burlington, Vermont

Brian I. Rini, MD

Associate Professor
CCF/CWRU Lerner College of Medicine
Staff
Department of Solid Tumor Oncology and Urology
Cleveland Clinic Foundation
Cleveland, Ohio

Eberhard Ritz, MD

Professor Emeritus
Department of Internal Medicine (Nierenzentrum)
Ruperto Carola University Heidelberg
Heidelberg, Germany

Alan M. Robson, MD, FRCP, FRCP-CH, FAAP

Professor of Pediatrics
Department of Pediatrics
Louisiana State University School of Medicine,
Tulane University School of Medicine
Medical Director, Senior Vice President
Children's Hospital
New Orleans, Louisiana

Françoise Roch-Ramel, PhD (deceased)

Professor
Institute of Pharmacology and Toxicology
University of Lausanne
Lausanne, Switzerland

Rudolph A. Rodriguez, MD

Associate Professor of Clinical Medicine
Department of Medicine
University of California, San Francisco
Clinical Director of Nephrology
Department of Medicine, Division of Nephrology
San Francisco General Hospital
San Francisco, California

Allan R. Ronald, MD, FRCPC, FRSC, MACP

Professor Emeritus
Department of Internal Medicine
University of Manitoba
Consultant
Internal Medicine and Infectious Diseases
St. Boniface General Hospital
Winnipeg, Manitoba, Canada

Pierre M. Ronco, MD, PhD

Professor of Renal Medicine
Chief, INSERM Unit 702
Department of Nephrology
University Pierre et Marie Curie/INSERM
Chief, Division of Nephrology and Dialysis
Department of Nephrology
Hôpital Tenon/AP-HP
Paris, France

Mitchell Rosner, MD

Assistant Professor of Medicine
Division of Nephrology
University of Virginia
Charlottesville, Virginia

Robert H. Rubin, MD

Gordon and Marjorie Osborne Professor of
Health Sciences and Technology
Professor of Medicine
Harvard Medical School
Associate Director
Division of Infectious Disease
Brigham and Women's Hospital
Boston, Massachusetts

Piero Ruggenenti, MD

Assistant Professor
Division of Nephrology and Dialysis
Azienda Ospedal. Ospedali Riuniti
Head, Department of Renal Medicine
Mario Negri Institute for Pharmacological Research
Bergamo, Italy

Sandra Sabatini, PhD, MD

Professor
Departments of Internal Medicine and Physiology
Texas Tech University Health Sciences Center
Lubbock, Texas

Robert L. Safirstein, MD

Professor
Department of Internal Medicine
University of Arkansas for Medical Sciences
Chief
Department of Medicine Service
Central Arkansas Veterans Healthcare System
Little Rock, Arkansas

George A. Sarosi, MD, MACP

Professor of Medicine
Indiana University
Chief, Medical Service
Roudebush VA Medical Center
Indianapolis, Indiana

John A. Sayer, MB, ChB, PhD

Clinical Lecturer
Institute of Human Genetics
University of Newcastle upon Tyne
International Centre for Life
Clinical Lecturer
Department of Nephrology
Freeman Hospital
Newcastle Upon Tyne, United Kingdom

Laurent Schild, MD

Professor
Department of Pharmacology and Toxicology
University of Lausanne
Lausanne, Switzerland

Detlef Schlöndorff, MD

Chief
Medizinische Poliklinik-Innenstadt
Klinikum der Universität-München
Munich, Germany

H. William Schnaper, MD

Professor and Vice Chair
Department of Pediatrics
Feinberg School of Medicine of Northwestern University
Attending Physician
Division of Kidney Diseases
Children's Memorial Hospital
Chicago, Illinois

Rick G. Schnellmann, PhD

Professor and Chair
Department of Pharmaceutical Sciences
Medical University of South Carolina
Charleston, South Carolina

Anton C. Schoolwerth, MD, MSHA

Visiting Professor
Department of Medicine
Dartmouth Medical School
Senior Consultant on Chronic Kidney Disease
Center for Disease Control and Prevention
Lebanon, New Hampshire

Robert W. Schrier, MD

Professor of Medicine
Department of Medicine
University of Colorado School of Medicine
Denver, Colorado

Jörg Schübert, MD, PhD

Professor and Chief
Department of Urology
Friedrich-Schiller-University
Jena, Germany

Stephan Segerer, MD

Assistant Professor
Attending
Medizinische Poliklinik-Innenstadt
Klinikum der Universität-München
Munich, Germany

Alireza A. Shamshirsaz, MD

University of Iowa School of Medicine
Iowa City, Iowa

Donald J. Sherrard, MD

Professor
Department of Medicine
University of Washington
VA Medical Center
Seattle, Washington

Maybin Simfukwe, MD

Associate Professor
Department of Internal Medicine, Nephrology Section
Texas Tech University Health Sciences Center
Nephrologist
Department of Internal Medicine/Nephrology
Covenant Medical Center
Lubbock, Texas

**Visith Sitprija, MD, PhD, FACP, FRCP,
FRCPE, FRACP**

Professor of Medicine
King Chulalongkorn Memorial Hospital
Director
Queen Saovabha Memorial Institute
Bangkok, Thailand

Eduardo Slatopolsky, MD

Joseph Friedman Professor of Renal Diseases
in Medicine
Renal Division
Washington University
Physician
Barnes-Jewish Hospital
St. Louis, Missouri

Michael C. Smith, MD

Professor of Medicine
University Hospitals of Cleveland
Cleveland, Ohio

Walter E. Stamm, MD

Professor
Department of Medicine
University of Washington
Head, Division of Allergy and Infectious Diseases
University of Washington Medical Center
Seattle, Washington

Lodewijk W. Statius van Eps, MD

Department of History of Medicine
Free University of Amsterdam
Department of Internal Medicine
Slotervaart Hospital
Amsterdam, The Netherlands

Lesley A. Stevens, MD, FRCP

Assistant Professor
Sackler School of Graduate Biomedical Sciences
Tufts University
Boston, Massachusetts

Terry B. Strom, MD

Professor of Medicine and Surgery
Departments of Medicine and Surgery
Harvard School of Medicine
Director, Transplant Research Center
Beth Israel Deaconess Medical Center Director
Boston, Massachusetts

Frank Strutz, MD

Professor
Department of Nephrology and Rheumatology
University of Göttingen
Vice Chief
Department of Nephrology and Rheumatology
Hospital of the University of Göttingen
Göttingen, Germany

Manikkam Suthanthiran, MD

Stanton Griffis Distinguished Professor of Medicine
Department of Medicine, Division of Nephrology
Weill Medical College of Cornell University
Chief, Department of Transplantation Medicine and
Extracorporeal Therapy
New York Presbyterian Hospital
New York, New York

Charles P. Swainson, MD, FRCP

Senior Lecturer
Department of Medicine
University of Edinburgh Medical School
Consultant Renal Physician
Department of Renal Medicine
Royal Infirmary
Edinburgh, United Kingdom