To my loving wife, Yvonne, my wonderful daughters, Jennifer and Caroline, and my amazing granddaughters, Olivia and Augusta.

— J. Charles Jennette

In loving memory of my parents, Caroline and Arthur Olson.

— Jean L. Olson

To my lovely wife, Jean, and our wonderful daughter, Lindsay.

— Fred G. Silva

To my loving and supportive husband, Edward Imperatore, my sons, Edward and Paul, and my grandson, Edward James.

— Vivette D. D’Agati
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This seventh edition of *Heptinstall’s Pathology of the Kidney* has the greatest increase in new knowledge and new insights into kidney diseases of any prior new edition. This comprehensive text maintains the excellence established by Robert H. Heptinstall, who edited and to a considerable degree authored the first four editions of this classic text first published in 1966. Since the publication of the sixth edition in 2007, there have been extraordinary advances in the understanding of the cellular, molecular, and genetic basis for kidney diseases; in the knowledge of pathologic and clinical manifestations of kidney diseases; and in the utilization of pathologic findings for directing new and more precise treatment of kidney diseases. This seventh edition has been thoroughly updated to include in-depth reviews of these important new advances that have clarified our understanding of kidney diseases, redirected research on the mechanisms of kidney diseases, modified the pathologic diagnostic evaluation of kidney diseases, and improved the treatment and prevention of kidney diseases.

The authors who contributed to the seventh edition are among the most capable and accomplished renal pathologists in the world. All of these authors have extensive hands-on experience with diagnostic renal pathology, teaching renal pathology at major medical centers, and advancing the field through clinical and translational research. They have contributed thousands of articles to the literature on renal pathology. In fact, many of the major advances in our current understanding of renal pathology have been made by authors of chapters in this book. The editors thank all of the authors of the seventh edition for their truly outstanding contributions.

We are saddened by the recent passing of two extraordinary real pathologists, Kendrick A. Porter and Gary S. Hill, who authored stellar chapters in earlier editions and were dear friends of Dr. Heptinstall. We are thankful for their many personal and professional contributions to our field of renal pathology.

All of the editors and authors are honored by the opportunity and challenge afforded us by Dr. Heptinstall to sustain his preeminent book on renal pathology. We and all others who are interested in the study of kidney diseases are forever indebted to him for establishing this classic text. We are convinced that the seventh edition of *Heptinstall’s Pathology of the Kidney* is the most comprehensive, most authoritative, most thoroughly referenced, and best illustrated book on renal pathology ever produced.

*J. Charles Jennette, MD, Jean L. Olson, MD, Fred G. Silva, MD, Vivette D. D’Agati, MD*
The first edition of *Pathology of the Kidney* by Robert H. Heptinstall marked the watershed between autopsy- and biopsy-based studies of renal disease in human beings. Before the *Pathology of the Kidney*, renal pathology textbooks related the clinical evolution of “renal syndromes” and the associated autopsy findings. The percutaneous renal biopsy initially described by Iversen and Brun only 15 years prior to the publication of *Pathology of the Kidney* allowed a more dynamic view of kidney disease, and the text drew heavily on renal biopsy studies and immunofluorescence and electron microscopic findings in renal tissue. This new information had to be integrated with the autopsy-based renal literature for, as “Heppy” wrote in the preface to the first edition, “we are almost completely ignorant of the sequence of events that takes place during the evolution of a given disease, and … the nomenclature in use at the moment is most unsatisfactory. Most of our concepts and nomenclature of renal disease have been based on kidneys studied at autopsy, which except in rare instances represent the end stage of a process that has been going on for years. The renal biopsy has presented us with histological pictures that in the light of our present concepts are not only difficult to interpret but defy satisfactory labeling.” The enduring contribution of *Pathology of the Kidney* is that it brought order out of chaos and in doing so defined the central issues of modern renal pathology. Over the years, this classic textbook and its subsequent editions have provided guidance and insight not only to nephropathologists but also to nephrologists, renal physiologists, and the entire renal community.

The first edition of *Pathology of the Kidney* is also an outstanding example of medical authorship. The book was written with wit and style, and it is scholarly, authoritative, and comprehensive. This monumental achievement is even more remarkable when one considers that the first four editions were essentially monographs.

How Heppy accomplished his goals of presenting biopsy-based pathology, relating it to the existing classifications, and identifying a pathogenetic sequence deserves exposition. Much of the text is written in the first person because it was based on his extensive experience with renal pathology in biopsy and autopsy material. When writing on disputed topics, however, he was careful to quote “widely the opinions of others.” A complete and critical reading of the literature allowed him to correlate biopsy studies of acute and evolving renal diseases with the end-stage findings and nomenclature from autopsy studies. In the few areas where he did not have personal experience, he was exact in quoting published material, and whenever possible he reviewed the pathology material obtained by others. The superb illustrations complemented the text by demonstrating the pathologic lesions in all their phases allowing a pathogenetic connection between acute and end-stage lesions. Finally, his experience as an experimental pathologist aided him in critically evaluating and identifying relevant experimental studies.

Late Ramzi S. Cotran, no mean scholar himself, acknowledged the comprehensive and scholarly nature of the *Pathology of the Kidney* by insisting that it was the place to begin not only the workup of a difficult case but also an experimental study. Thus, Heppy has provided a fair template for those who would write chapters in pathology textbooks. In so far as we succeed, the credit is his, and if we fail, the responsibility is ours.
The task of presenting a comprehensible account of the pathology of the kidney is surprisingly difficult, as I have found to my cost over the past 3 years. The main difficulties are twofold: first, we are almost completely ignorant of the sequence of events that takes place during the evolution of a given disease and, second, the nomenclature in use at the moment is most unsatisfactory. Most of our concepts and nomenclature of renal disease have been based on kidneys studied at autopsy, which except in rare instances represent the end stage of a process that has been going on for years. The renal biopsy has presented us with histologic pictures that in light of our present concepts are not only difficult to interpret but defy satisfactory labeling. Many of these pictures are doubtless early stages of a process whose end stage we already recognize, but others very likely represent processes with which we are quite unfamiliar. Only by conducting intelligently planned studies with repeat biopsies over a long period of time can we hope to resolve these problems, and a greater degree of cooperation between the various groups of investigators will be required than has been the case up to now.

Accepting the imperfect state of our knowledge, I have attempted to present an account of the more common diseases that affect the kidney. The book is mainly for the pathologist and the internist specializing in renal problems, but it is hoped that it will be of use to others, such as the urologist and the obstetrician.

The pathology of the various diseases has been presented in the light of both autopsy and biopsy experience, and although many of the views expressed are my own, this being an author’s privilege, a balanced presentation has been attempted by quoting widely the opinions of others. The clinical sections are of necessity brief, for these aspects have been authoritatively dealt with on numerous occasions by people better qualified than I am. Experimental contributions have been quoted when appropriate, and in most chapters, the role of the newer techniques such as electron and fluorescence microscopy has been described. The traditional chapter on renal physiology has been omitted, and for this, I offer no apology. This is a highly complex subject that can hardly be compressed into one chapter; it is also one that I am not competent to discuss. Renal tumors are not discussed because they are adequately considered in existing texts on surgical pathology.

I have been fortunate in persuading Dr. J.M. Kissane to write chapters on the development and congenital defects of the kidney and Dr. Kendrick A. Porter to write on renal transplantation. These two former colleagues of mine are experts in their fields, and their respective chapters amply reflect their competence.

I am very grateful to all those who supplied us with illustrations and material from which illustrations were made. Professor Paul Beeson was asked to read the two chapters on pyelonephritis and promptly replied with four single-spaced pages of comments and suggestions; I was chastened but grateful. Dr. Abou Pollack has been a constant source of pearls of wisdom and exotic material; I am much indebted to this fine pathologist. Most of the photomicrographs for my own chapters were prepared by Mr. Chester Reather, and these, as always, were of matchless quality. The wearisome job of checking the references was bravely carried out by Miss Virginia Shriver, and her efforts, and those of the staff of the William H. Welch Medical Library at Johns Hopkins, are much appreciated. The most difficult job of all was done by Miss Mary Lakin, my secretary, who, starting out with scraps of paper adorned by nearly undecipherable handwriting, restored order out of chaos and produced the final manuscript. It is impossible to thank her enough.

Lastly, it is a great pleasure to acknowledge the help and stimulus over the years of Dr. A.M. Joekes. The biopsies we saw together provided a nucleus for many of the thoughts that have been expressed in this book, and to him belongs much of the credit (or blame) for the finished product.

Robert H. Heptinstall
Dr. Jennette thanks his wife, Yvonne, daughters, Jennifer and Caroline, and granddaughters, Olivia and Augusta, for forgiving the time spent away from them pursuing his passion for renal pathology. He thanks Dr. Fred Dalldorf for sparking his interest in renal pathology, Dr. Ron Falk for his decades of stimulating professional collaboration, and the many nephropathologists and nephrologists who have shared their insights on kidney disease with him. He especially thanks the nephropathology fellows and faculty who have been his associates at UNC over the years, including current faculty Volker Nickeleit, Sharan Singh, and Adil Gasim.

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