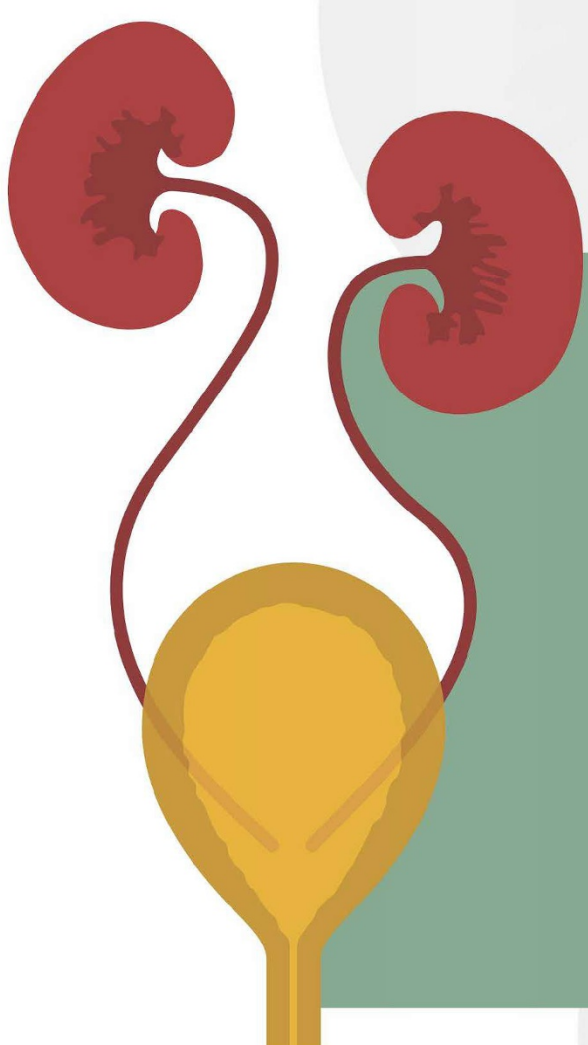
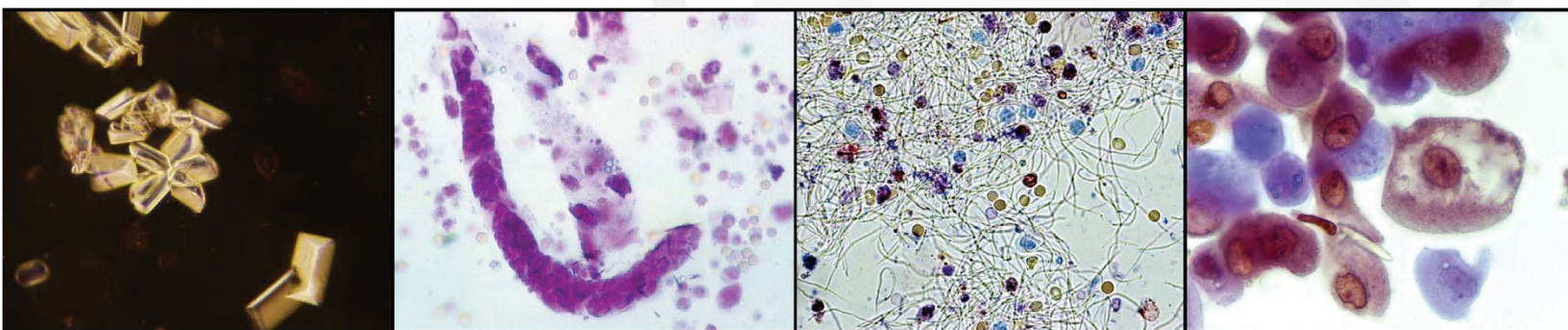


A stylized illustration of a kidney and bladder. The kidney is shown in a dark red color with a lighter red outline, and the bladder is shown in a yellow color with a darker yellow outline. The kidney is connected to the bladder by a thin red line representing the ureter. The background is a light green color with a faint, stylized outline of a dog's head.

Urinalysis in the Dog and Cat



Dennis J. Chew ■ Patricia A. Schenck

WILEY Blackwell

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This book is dedicated TO Dr. Richard C. Scott and Dr. Carl A. Osborne for their untiring efforts to promote the value of the complete urinalysis, encouraging all veterinarians to both perform and interpret the urinalysis with accuracy.

Dr. Scott (“Scotty”) emphasized the need to perform urine microscopy within 15 minutes of urine collection. That was the practice of the day at the Animal Medical Center, New York, NY during the evaluation of sick dogs and cats being seen by the Medicine Service and on all consults for other hospital services. The so-called rare urinary elements were found with surprising frequency (e.g. WBC casts, RBC casts, and renal tubular epithelium) when fresh warm urine was examined. Dr. Scott’s influence in this arena cannot be overstated, due to the large numbers of interns and residents that were engaged in the routine viewing of urine microscopy and integration of those findings into the two other components of the complete urinalysis (physical properties and urine chemistry) as part of daily rounds. Dr. Scott routinely acquired photomicrographs of urine sediment to assist in his teaching, some of which are in this book. I continue to admire Scotty for all of his contributions to nephrology, but I believe his biggest contribution was sharing his expertise and philosophy regarding the value of urine microscopy.



Dr. Osborne’s influence in urology and nephrology was extensive and also pioneering in so many instances.

Dr. Osborne believed in the need for the profession to reconfigure its thinking, to understand that it was ESSENTIAL to get a urine sample on all patients and then integrate the results of the complete urinalysis with the blood work from those patients. He detailed how to interpret results from urinalysis during his many extensive continuing education lectures, which influenced generations of graduate veterinarians and students. His mantra that using the results of a partial urinalysis was analogous to doing a CBC without a differential cell count is legendary. Dr. Osborne enthusiastically promoted the use of routine urinalysis and emphasized that a medical

workup was incomplete without it. His numerous publications usually referenced the value that results of a complete urinalysis brought to case management and to understanding the pathophysiology of a particular disease.

“Just get the urine sample and submit the urinalysis, you will be glad that you did.”



A shout-out to the fathers of modern veterinary nephrology in addition to Dr. Carl Osborne; Drs. Del Finco, Don Low, Ken Bovee, and Jerry Ling. It is necessary to acknowledge the foundation laid for all of the advances in veterinary urology and nephrology that were to follow. There were many veterinarians, too numerous to list, trained or heavily influenced by these pioneers, that contributed to the growth and advancement of the field of urology and nephrology.

Further thanks to the many students, interns, residents, and graduate veterinarians who asked those basic and clinically relevant questions, that were at times difficult to answer with certainty, for spurring me on to try to find answers. And I must especially thank my patients, the animals for which we were privileged to study their urine and their diseases in our attempts to help them and to the many cats and dogs in my home that taught me way more than I thought possible about urinary diseases and life in general.

To the performance of a complete urinalysis along with every CBC and biochemistry submitted.

To the collection of fresh warm urine for immediate urinalysis – make it so!

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How to Read and Use this Book

This book largely reflects how I think findings from the components of the complete urinalysis (urine physical properties, urine chemistry, and urine microscopy) can best be clinically integrated and interpreted. My clinical experience combined with an extensive review of the literature informs much of this interpretation, but high-quality evidence may not be available to support some of my opinions, conclusions, and recommendations. I have tried to be clear where my experience and opinion are the primary support for a conclusion. Basic to advanced information is provided in most chapters. References are extensive by design, as many of the references are old and difficult to find. This book has been written largely from a urine-centric view, meaning that findings from urine are featured first and then other data from cytology or histopathology, hematology, serum biochemistry, and imaging are integrated afterward.

As with any scientific book, some information in this book may already be outdated due to current research. But core concepts for performing and interpreting the urinalysis have remained stable and are not expected to quickly or radically change over time. The chapter on proteinuria (Chapter 7) is the chapter most likely to be affected by current and ongoing research, yielding new information of clinical consequence for the diagnosis and management of renal proteinuria. It is also likely that new information will be published regarding the use of automated urinary sediment readers, as this is a recent technological advancement. Readers of this book should be aware that Internet Websites listed in this work may have changed or disappeared between when this work was published and when you read it.

The information in this book is accurate to the best of my abilities, but nearly all books have inadvertent errors or insufficient coverage of some topics. I believe that the content in this book is complete to the extent that a clinical book of this nature should be. Always question anything in this book that does not make sense to you. You should always double-check and verify drug dosages. Ultimately, it is your obligation to decide what you believe to be accurate and useful in your clinical practice. I would appreciate hearing from you (denischew@me.com) about any specific places in the book that you find to be unclear, suspect to be in error, that contains discrepancies with other places in the book, or is missing some important part of urinalysis which you expected to find.

This book is not likely to be read in its entirety from start to finish, except by the most interested readers. It is a reference – not a novel. It is expected that you will pick and choose

selected sections that have information relevant to a current need for understanding or a clinical question. There is some overlap in content and concepts between the chapters that is by design, as repetition can reinforce learning of important or complicated material. The outline at the beginning of each chapter should help you find relevant subheadings quickly and the detailed index should also help you get to the specific information you are seeking.

Each chapter has the basic information in the beginning and progresses to more advanced and detailed/technical information later. Where relevant, clinically applied sections follow discussions of diagnostics and pathophysiology. This book was primarily written to be useful to students, veterinarians in general practices, and veterinary technicians. However, residents and specialists in internal medicine, nephrology and urology, clinical pathologists, and anyone seeking more will find advanced concepts in most chapters which should be of use to them, both in teaching and in practice.

This book is visually rich with hundreds of high-quality photomicrographs, medical illustrations, tables, and algorithms. Most of the images for urinary sediment were collected during my time at The Ohio State University College of Veterinary Medicine – initially using a film photomicroscope system and later with digital capture. Other images were given to me to use by permission as noted in the legends. The legends for many of the urine microscopy images are often detailed and contain history or outcome when available.

Legends for some of the medical illustrations (those drawn by Tim Vojt) are quite detailed. The language in the legends generally parallels that in the main text but may be modified to tell the story in a slightly different way. It is best to read both the figure legend and the main text that aligns with that illustration in order to best understand the illustration. Tables that summarize important concepts are included in most chapters.

There are numerous algorithms in this book designed to capture a plausible decision-making flow after you identify a particular abnormality. Some of these algorithms are simple and some are complex. In general, readers usually either like or hate the concept of algorithms in decision-making. As almost no algorithm is perfect in all clinical situations, do not blindly follow any one of the algorithms; rather, use them for general guidance in your particular situation.

If you are perplexed about a particular finding from a urinalysis result on one of your patients and cannot find an adequate answer after searching in this book or others,

consultation with a clinical pathologist or specialist in urology and nephrology is recommended. Sending pictures from urine microscopy that contain mysterious or unidentified elements to specialists is recommended in order to gain more definitive information. These pictures can be taken using your smartphone camera during manual microscopy, or from digital images acquired during automated microscopy.

If you are weak in renal physiology, Renal Anatomy and Applied Renal Physiology (Chapter 1) offers a review of basic renal functions with extensive review of how urine is concentrated. A general understanding of this chapter is needed as background for content that follows in most of the other chapters.

If you are intimidated by the scope and depth of this book, I suggest that you start by reading Frequently Asked Questions (Chapter 9) and Urinalysis Case Examples (Chapter 10) that are not so heavy on pathophysiology. These two chapters are filled with clinically relevant scenarios that have the potential to whet your appetite to read the more formal detailed chapters and will get you excited about going

back to the earlier chapters to better understand what you are seeing in the case examples (and your own patient's urinalyses). Reading the Glossary is also likely to be helpful. I recommend that you read the detailed chapter on Proteinuria (Chapter 7) last, since this is the most complex chapter in this book.

If you do not want to read the formal text in each chapter right now:

1. Review the figures and read their legends, realizing that the legends are a supplement to the text.
2. Review the tables and their legends in order to get a feel for the chapter detail to follow, again realizing that you will be getting an incomplete picture without referring to the text.
3. Review the algorithms and their legends as a supplement to the text.
4. For serious students of urology and nephrology, READ EVERYTHING.

Foreword

It is my honor to introduce the first edition of *Urinalysis in the Dog and Cat*. Dr. Dennis Chew is a giant among those of us who have dedicated our careers to veterinary nephrology and urology. Dr. Chew possesses a wealth of knowledge and experiences that comes only after decades of consulting with veterinarians about, and having primary case responsibility for, dogs and cats with diseases of the urinary tract. He has been able to give back so much of this expertise to our profession in the pages of this book.

The book is designed to be a comprehensive yet useful guide to understanding all aspects of urine and the urinalysis. It is rich in algorithms, tables, images, and beautiful artwork that enhance the contents of the book but also provide for quick reference as needed. The FAQ and case examples serve to consolidate the information. Although meant as a reference rather than a book to be read from cover to cover, I had trouble putting the book down because the content is so interesting and I was able to discover relevant information that could be applied to several of my current patients. *Urinalysis in the Dog and Cat* should soon find its place in the hands of anyone who wants to “go for the gold” and practice high-quality small animal medicine.

Shelly L. Vaden, DVM, PhD, DACVIM
Founder ACVNU
Professor of Nephrology and Urology
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Many years ago when I was a third-year veterinary student at The Ohio State University, a young newly minted bowtie-wearing assistant professor walked into our urinary system course and began teaching us about how the kidneys function and how urine is produced. This was our introduction to the inimitable Dr. Dennis Chew.

Dr. Chew is the consummate professor and has had a long and distinguished career teaching veterinary students, interns and residents, veterinary technicians, and legions of veterinarians all around the world. One of the things that struck me during those early lectures has remained true throughout Dr. Chew's tenure as a veterinary educator of the highest level. Dennis is as passionate today as he was then about the importance of

urinalysis and doing things right, and this is clearly evidenced through the excellence of this new book, *Urinalysis of the Dog and Cat*.

Throughout my career as a specialist and while serving as chief medical officer for VCA for many years, I have had the opportunity to work closely with over a thousand small animal hospitals of all sizes in primary care as well as specialty. Veterinary medicine has advanced leaps and bounds over the last four decades, and we have witnessed many technological advances. Today we routinely perform ultrasonography, echocardiography, endoscopy, advanced imaging using CT and MRI, and we rely on many types of antigen and PCR tests to help us diagnose our patients' illnesses with ever greater accuracy and understanding. Despite all of the high-tech options, however, urinalysis remains a critical component of the minimum database and is a must as we evaluate our patients not only when they are ill, but also every time we perform wellness screening/early detection tests. We still underutilize this important test and it is essential for us to be more thorough. We must also know how to interpret the results accurately!

Urinalysis of the Dog and Cat is a *must have* for all small animal hospital libraries. I am excited about this book because we now have an all-encompassing practical new reference work to not only instruct us on how to accurately interpret results but also correctly obtain and manage urine samples. But there is so much more at the fingertips of the reader. I enjoyed reviewing the chapters, and it was hard to stop reading as there are so many updates on patient management tips, i.e. what do we do with the results once we have them. Small animal veterinarians all see patients with some type of urinary tract disorder every month. What do we do about subtle early changes in laboratory tests? Early detection and intervention is always our goal, and it all starts with the minimum database. Chapter 1 sets the stage through a review of renal physiology and evaluation of function, Chapter 7 delves deeply into proteinuria (timely update!), and Chapter 9 presents 127 Frequently Asked Questions (FAQ) that can serve as entire “short course” on urinary tract issues. It is written in trademark Dennis Chew style: thorough, clear, and conversational. Common misconceptions and errors in interpretation are explained (e.g. overemphasis on crystals, potential for misinterpretation of “cocci” in urine sediment, and what SDMA is and isn't, among many others).

Chapter 10 includes 47 cases for which the complete urinalysis is presented and then detailed interpretation, recommendations for further diagnostics, and final diagnosis are given. No doubt readers will recognize similar cases from their own practices and be able to compare notes on interpretation and diagnostic pathways as well as how to get the most out of basic testing when everything on the diagnostic menu just can't be done due to financial constraints. Test yourself!

Dr. Chew is famous for his “isms” which he has interjected in his teaching over the years, and readers will see these interspersed throughout the book. I have always enjoyed these “isms” because they continually remind us about the importance of doing things right! Among my favorites from Dr. Chew are, “JUST DO IT! (urinalysis), FAKE NEWS: USG and

urine chemistry dipstrip results are good enough without urine sediment microscopy,” and “When blood test results return without results of urinalysis at the same time, you are driving partly blind-folded.” Readers will find great value throughout this text, as I did on my first review, and their patients will be the beneficiaries of their veterinarians always striving to stay up to date and practice evidence-based medicine. The ability to help animals in need is what makes veterinary medicine such a great profession to be a part of.

It is an honor for me to write this Foreword.

Todd R. Tams, DVM, DACVIM
Vice President for External Affairs
Mars Veterinary Health
VCA Chief Medical Officer (Emeritus)
Los Angeles, California

Preface

“Superficially it might be said that the function of the kidneys is to make urine, but in a more considered view one can say that the kidneys make the stuff of philosophy itself.” Homer William Smith: *A Memoir*, New York University Press 1965; Homer Smith: *The Evolution of the Kidney, Lectures on the Kidney* 1943.

The initial impetus for writing this book was the desire to share my extensive collection of urinary sediment images, originally captured as Kodachrome slides and then with digitally acquired photomicrographs, collected over a period of nearly 40 years. These images provide multiple examples of common abnormal urinary elements, which show the many slight variations in appearance that are possible. Many of the urine microscopy images are designed to show routine abnormalities, whereas other images feature uncommonly described or rarely recognized elements. Though these images, with their legends can often stand alone, I believe there is more value when the images are combined with the fuller explanations provided in the various chapters.

Thus, the scope of this book grew and became an effort to provide a comprehensive look into the complete urinalysis, emphasizing integration of findings from physical properties (e.g. USG), urine chemistry by dipstrip, and urine microscopy (evaluation of urinary sediment). The Renal Anatomy and Applied Renal Physiology (Chapter 1) provides the backdrop showing how urine is formed by a combination of glomerular filtration and then extensive modification of that initial fluid by tubular secretion and/or reabsorption of water and small molecules. Proteinuria (Chapter 7) provides a more detailed look into the world of proteinuria than that provided in the Chemical Properties of Urine (Chapter 5) that emphasized measurement by dipstrip.

The primary intent for this book “Urinalysis in the Dog and Cat” is for it to be a useful reference which will allow practicing veterinarians to more fully recognize abnormal findings, and to understand, integrate, and interpret the results from a urinalysis to improve their understanding of their patient’s illnesses. Except for guidelines on how to mitigate renal proteinuria (Chapter 7), the treatment of specific conditions is not the goal of this book. Rather, the numerous images of urinary sediment in Urinary Microscopy (Chapter 6) and Atlas (Chapter 8) along with their detailed legends are presented to help veterinary technicians and attending veterinarians more accurately identify abnormal elements, from both manual and automated in-house urinalysis. Similarly, veterinary students should find these images useful, allowing them to more confidently identify elements during urine microscopy. There is additional value to this book when it is read by clinicians wanting a greater understanding of their patients by revealing how findings from urinalysis could help improve the diagnosis and management of cases in primary care and

specialty practices. This book should also prove useful during clinical training of residents in internal medicine and in clinical pathology.

In addition to detailed pathophysiology, I provide nuggets of clinically useable information throughout the chapters. When appropriate, nuts and bolts technical information has been provided (e.g. how to set up for urine microscopy). Pitfalls are also identified, explaining what can go wrong when performing or evaluating the results of a urinalysis, whether considering physical, chemical, and/or microscopic properties.

Extensive referencing has been provided for those wanting to know where this content arose and for those in academia wanting to dive deeper. The Frequently Asked Questions (Chapter 9) and Urinalysis Case Examples (Chapter 10) provide clinical details appropriate for veterinary students as well as for graduate veterinarians who want a hook that will encourage them to read the more formal chapters. See “How to Read/Use This Book” (front matter below) for suggestions on how those with different learning styles might gain the information they are seeking more readily.

Ultimately, I hope this book sparks some excitement that shows the ultimate value of routinely performing urinalysis on patients that allows that component of the diagnostic testing profile to achieve the respect it deserves. If that happens, I believe our canine and feline patients, and you – my colleagues – will benefit from more accurate diagnoses and



treatment plans. You can expect to gain increasingly nuanced interpretation of urinalysis results after reading and processing the information in this book. I am also hopeful that the ability of our technicians to generate increased accuracy of their results when performing in-house urinalyses will result from the lessons presented in this book. Performing automated (microscopy, urine chemistry dipstrip) or manual urinalysis

in-house provides increased value to your practice, your patients, and your clients when the highest standards for urine handling and technical performance are in place.

“Go for THE GOLD” (Dr. Craig Greene).

“Learn to Love the Secret Language of Urine.” (Dr. Jonathan Reisman Opinions, Washington Post November 23, 2016)

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Tim Vojt is the medical illustrator at The Ohio State College of Veterinary Medicine who contributed numerous figures and drawings to this book. He is the sole survivor of that section of the biomedical media department, due to relentless budget

cuts over the years. I am thankful that recent administrations have chosen to support his work. We had several traditional medical illustrators in the past who did great work by hand. Tim took medical illustration to a whole new level with his digital drawing abilities, which I think you will appreciate throughout this book. I am amazed at Tim's ability to understand how his drawings will fit into whatever concepts I am trying to develop for a project. After each meeting with me to try to understand how best the drawing could come into being, Tim became one with his art. Tim researched just about everything related to the drawings, especially anatomy and physiology. Tim was always gentle and willing to deal with me despite my scattershot approach to ideas that were frequently emerging while he was constructing the first drafts of his images. I come close to weeping when I review the stunning quality of many of the illustrations that he developed for use in this book.

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Abbreviations

1,25(OH) ₂ -vitamin D	1,25-dihydroxyvitamin D, calcitriol	Cr	creatinine
25D	25-hydroxyvitamin D	CRF	chronic renal failure
ACE2	angiotensin II converting enzyme 2	CRGV	cutaneous and renal glomerular
ACE-I	angiotensin-converting		vasculopathy
	enzyme inhibitor	CT	collecting tubule
ACTH	adrenocorticotrophic hormone	CT	computed tomography
ACVIM	American College of Veterinary	CV	coefficient of variation
	Internal Medicine	d	diameter
ADH	antidiuretic hormone	dDAVP	l-deamino-8-D-arginine vasopressin,
AG	aminoglycoside		desmopressin
AG	angiotensin	DHA	docosahexaenoic acid
AI/ML	artificial intelligence/	DIC	disseminated intravascular
	machine learning		coagulation
AIHA	autoimmune hemolytic anemia	DM	diabetes mellitus
AKI	acute kidney injury	DNA	deoxyribonucleic acid
ALP	alkaline phosphatase	DOCA	desoxycorticosterone acetate
ALT	alanine transaminase	DT	distal tubule
ANA	antinuclear antibodies	ECC	endogenous creatinine clearance
ANOVA	analysis of variance	ECF	extracellular fluid
APPD	apparent psychogenic polydipsia	ECFV	extracellular fluid volume
AQP	aquaporin	EDTA	ethylenediaminetetraacetic acid
ARB	angiotensin-II receptor blockers	EG	ethylene glycol
AST	aspartate aminotransferase	ELISA	enzyme-linked immunoassay
ATN	acute tubular necrosis	EM	electron microscopy
ATP	adenosine triphosphate	EMT	renal epithelial to mesenchymal cell
AVP	arginine vasopressin		transitioning
BHA	beta-hydroxybutyric acid	EPA	eicosapentaenoic acid
BP	blood pressure	epi	epithelial cell
BRAF	serine/threonine-protein kinase	FC	fractional clearance
	B-Raf, proto-oncogene B-Raf	FDA	Food and Drug Administration
BUN	blood urea nitrogen	FeLV	feline leukemia virus
Ca:P	calcium:phosphorus ratio	FeMV	feline morbillivirus
CAH	copper-associated hepatopathy	FGF-23	fibroblast growth factor-23
cAMP	cyclic adenosine monophosphate	FIC	feline idiopathic/interstitial cystitis
CaR	calcium receptor	FIP	feline infectious peritonitis
CAV-1	canine adenovirus	FIV	feline immunodeficiency virus
CBB	Coomassie brilliant blue	FN	field number
CBC	complete blood count	FNA	fine needle aspirate
CCB	calcium channel blockers	FOV	field of view
CDI	central diabetes insipidus	Fr	French
CFU (cfu)	colony forming unit	FSGS	focal segmental glomerulosclerosis
CHF	congestive heart failure	GAG	glycosaminoglycan
CK	creatine kinase	GBM	glomerular basement membrane
CKD	chronic kidney disease	GDI	gestational diabetes insipidus
CNN	convolutional neural network	GFR	glomerular filtration rate
CNS	central nervous system	GI	gastrointestinal

GN	glomerulonephritis	PDH	pituitary-dependent
HAC	hyperadrenocorticism		hyperadrenocorticism
HMW	high molecular weight	PGE2	prostaglandin E2 (also listed as PgE ₂)
HN	hereditary nephropathy	PgI ₂	prostaglandin I ₂
HPF	high-power field	PKD	polycystic kidney disease
HPLC	high-performance liquid chromatography	PLE	protein-losing enteropathy
		PLN	protein-losing nephropathy
HTG	hypertriglyceridemia	POC	point of care
HUS	hemolytic uremic syndrome	P _{osm}	plasma osmolality
HW	heartworm	PPD	psychogenic polydipsia, primary polydipsia
ICGN	immune-complex glomerulonephritis		pyrogallol red molybdate
ICU	intensive care unit	PRM	portosystemic shunt
IFA	Immunofluorescent antibody	PSS	parathyroid hormone
Ig	immunoglobulin	PTH	parathyroid hormone related protein
IHC	idiopathic hypercalcemia	PTHrP	polyuria/polydipsia
IRIS	International Renal Interest Society	PU/PD	purple urine bag syndrome
ISCAID	International Society for Companion Animal Infectious Diseases	PUBS	polyunsaturated fatty acids
		PUFA	renin-angiotensin-aldosterone system
IV	intravenous	RAAS	Renin-angiotensin-aldosterone system inhibition
IVRPS	International Veterinary Renal Pathology Service		red blood cell
kD (kDa)	kiloDalton	RBC	renal blood flow
LC/MS	liquid chromatography/mass spectrometry	RBF	retinol binding protein
		RBP	relative centrifugal force
L-DOPA	levodopa, L-3,4-dihydroxyphenylalanine	RCF	rapidly progressive glomerulonephritis
		RPGN	refractive index
LE	leukocyte esterase		radioimmunoassay
LMW	low molecular weight	RI	renal plasma flow
LPF	low-power field	RIA	revolutions per minute
LUT	lower urinary tract	RPF	renal tubular epithelium
MA	microalbumin	rpm	straight part of the distal proximal tubule
MA	microalbuminuria	RTE	serum amyloid A
MMB	3-mercapto-3-methylbutanol; mercaptan	S3	Soft-coated Wheaten Terrier
MR	mineralocorticoid receptor	SAA	symmetric dimethylarginine
MRA	mineralocorticoid antagonists	SCWT	sodium dodecyl sulphate-polyacrylamide gel electrophoresis
MRB	mineralocorticoid receptor blocker	SDMA	standard error of the mean
MRI	magnetic resonance imaging	SDS-PAGE	sodium-glucose cotransporter 2
mTAL	medullary thick ascending limb		serum glutamic-oxaloacetic transaminase (also known as AST)
MW	molecular weight	SEM	syndrome of inappropriate antidiuresis
MWO	medullary washout	SGLT2	syndrome of inappropriate antidiuretic hormone
NDI	nephrogenic diabetes insipidus	SGOT	severe (systemic) inflammatory response syndrome
NEW	nutrient-enriched water		systemic lupus erythematosus
NIST	National Institute of Standards and Technology	SIAD	single-nephron glomerular filtration rate
		SIADH	serum osmolality
NKCC2 transporter	sodium potassium chloride 2 cotransporter		subcutaneous
NRC	National Research Council	SIRS	
NS	nephrotic syndrome		
NSAID	nonsteroidal anti-inflammatory drug	SLE	
OHE	ovariohysterectomy	SNGFR	
PAS	Periodic-acid Schiff stain		
P _{Cr}	plasma concentration of creatinine	S _{osm}	
PCR	polymerase chain reaction	SQ	

SSA	sulfosalicylic acid	UG	urogenital
SUN	serum urea nitrogen	UGGT/U _{Cr}	urinary GGT to urinary creatinine ratio
T4	thyroxine	ULS	ultrasound
TCC	transitional cell carcinoma	UO	urethral obstruction
Tc-DTPA	technetium-labeled diethylenetriaminepentaacetic acid	U _{osm}	urine osmolality
TEM	Transmission electron microscopy	UPC	urinary protein-to-creatinine ratio
TGF-β	transforming growth factor beta	UPC	urine protein-to-creatinine ratio
THG	Tamm–Horsfall glycoprotein	USG	urine specific gravity
THP	Tamm–Horsfall protein, uromodulin	UT-A1	urea transporter-A1
T _{max}	maximal ability of proximal tubular cells to reabsorb filtered glucose	UT-A2	urea transporter-A2
TMB	3,3',5,5'-tetramethylbenzidine	UT-A3	urea transporter-A3
TNTC	too numerous to count	UT-A4	urea transporter-A4
TRPC6	transient receptor potential cation channel 6	UT-B	urea transporter-B
UA	urinalysis	UTI	urinary tract infection
UAC	urine albumin to creatinine ratio	UV	ultraviolet
UC	urothelial carcinoma	V2R	vasopressin type-2 receptor
U _{Ca}	urinary calcium concentration	VDBP	vitamin D binding protein
UCC	urothelial cell carcinoma (TCC)	VDR	vitamin D receptor
UCCR	urinary cortisol to creatinine ratio	VEGF	vascular endothelial growth factor
U _{Cr}	urinary concentration of creatinine	WBC	white blood cell
U _{creat}	urinary creatinine concentration	WDT	water deprivation testing
		XLHN	X-linked hereditary nephropathy