CHAPTER

20 Kidney

PBD9 Chapter 20 and PBD8 Chapter 20: The Kidney

BP9 Chapter 13 and BP8 Chapter 14: The Kidney and Its Collecting System

1 A 71-year-old man has had decreased urine output <500 mL per day for the past 3 days. Physical examination shows vital signs with temperature 37° C, pulse 88/min, respiratory rate 18/min, and blood pressure 85/60 mm Hg. He has peripheral edema and diffuse rales on auscultation of the chest. Urinalysis shows specific gravity 1.019 and no protein, blood, glucose, ketones, WBCs, RBCs, or casts. His serum creatinine is 3.3 mg/dL, and urea nitrogen is 62 mg/dL. The fractional excretion of sodium (FE_{Na}) is <1%. Which of the following underlying conditions is he most likely to have?

A Dilated cardiomyopathy
B Membranous nephropathy
C Prostatic hyperplasia
D Systemic lupus erythematosus
E Urothelial carcinoma

2 A 36-year-old woman has had increased malaise for 3 weeks and urine output <500 mL/day for the past 4 days. On examination, she has blood pressure 170/112 mm Hg and peripheral edema. Urinalysis shows protein 1+ and blood 3+, but no glucose or ketones. Urine microscopic analysis shows RBCs and RBC casts. Her serum urea nitrogen is 39 mg/dL, and creatinine is 4.3 mg/dL. Her serum complement C1q, C3, and C4 are decreased. A renal biopsy is performed, and immunofluorescence microscopy shows a granular pattern of staining with antibody to C3. Which of the following types of hypersensitivity reactions is most likely causing her renal disease?

A I (IgE-mediated systemic anaphylaxis)
B II (Antibody-dependent cell-mediated cytotoxicity)
C III (Immune complex formation)
D IV (Delayed-type hypersensitivity)

3 A 29-year-old man with chronic hepatitis C virus infection has noted dark urine for the past 2 weeks. On examination he is hypertensive but afebrile. Laboratory studies show serum creatinine of 3.8 mg/dL and urea nitrogen of 35 mg/dL. Cryoglobulins are detected. Urinalysis shows RBCs and RBC casts. A renal biopsy is performed and microscopically shows hypercellular glomeruli with lobulation and a double-contour appearance to split basement membranes adjacent to subendothelial immune complexes. Which of the following cell types has most likely proliferated in his glomeruli?

A Juxtaglomerular cells
B Mesangial cells
C Parietal epithelial cells
D Podocytes
E Endothelial cells

4 A study of renal disease identifies patients with greater than 3.5 g of protein in a 24-hour urine collection, but no RBCs or WBCs. Dysfunction involving which of the following cells is most likely to be responsible for proteinuria?

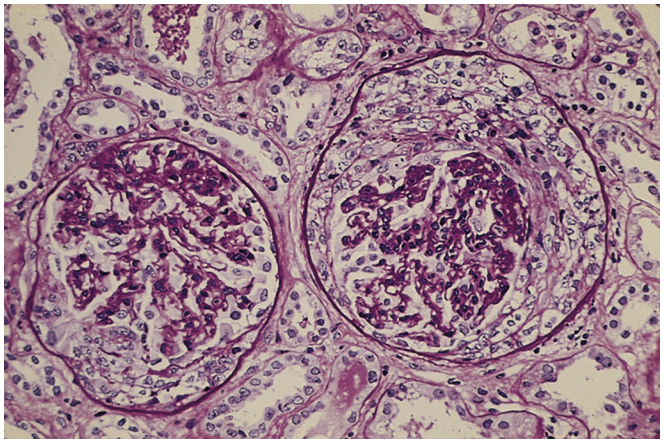
A Endothelium
B Macula densa
C Mesangium
D Parietal epithelium
E Podocytes

5 A 7-year-old boy is recovering from impetigo. Physical examination shows five honey-colored crusts on his face. The crusts are removed, and a culture of the lesions grows *Streptococcus pyogenes*. He is treated with antibiotics. One week later, he develops malaise with nausea and a slight fever and passes dark brown urine. Laboratory studies show a serum anti–streptolysin O titer of 1:1024. Which of the following is the most likely outcome of his renal disease?

A Chronic renal failure
B Complete recovery
C Crescentic glomerulonephritis
D Rheumatic heart disease
E Streptococcal urinary tract infection

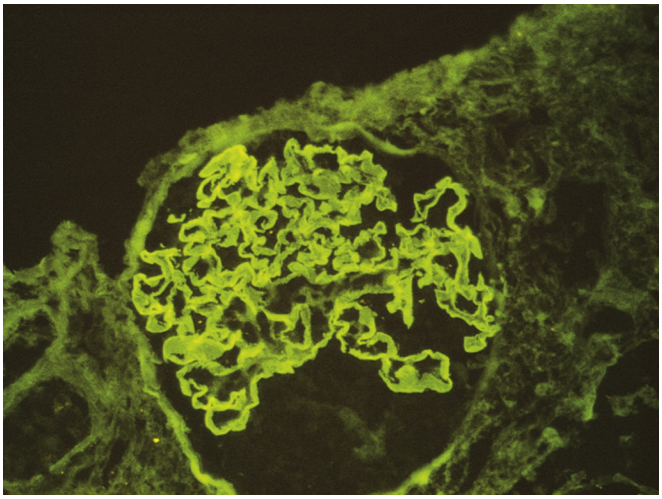
6 A 17-year-old girl living in the Congo has had a chronic febrile illness for 2 years. In the past 2 days she notes her urine is smoky brown. On physical examination her blood pressure is 145/95 mm Hg. Laboratory studies show her serum creatinine is 3.7 mg/dL, and urea nitrogen is 35 mg/dL. Urinalysis shows 4+ blood with 1+ protein, but no glucose, ketones, or leukocytes. The serum haptoglobin is decreased and Coombs test is negative. Her Hgb is 8.5 g/dL. A peripheral blood smear shows rare ring stage trophozoites. Immunofluorescence microscopy performed on renal biopsy shows granular deposition of IgG and C3 in glomerular capillary basement membranes. Electron microscopy shows electron-dense subepithelial "humps." Which of the following renal diseases is she most likely to have?

- **A** Focal segmental glomerulosclerosis
- **B** Hereditary nephritis
- **C** IgA nephropathy
- **D** Lupus nephritis
- **E** Membranous nephropathy
- **F** Acute proliferative glomerulonephritis



7 A 45-year-old man has experienced increasing malaise, nausea, and reduced urine output for the past 3 days. On physical examination, he is afebrile and normotensive. Laboratory findings show a serum creatinine level of 7.5 mg/dL. Urinalysis shows hematuria, but no pyuria or glucosuria. A renal biopsy is done; the light microscopic picture is shown in the figure. Which of the following additional studies is most useful for classification and treatment of this disease?

- **A** Antinuclear antibody
- **B** Anti–glomerular basement membrane antibody
- **C** HIV-1 RNA copy level
- **D** Quantitative serum immunoglobulins
- **E** Rheumatoid factor
- **F** Urine immunoelectrophoresis



8 A 21-year-old previously healthy man has noticed blood in his urine for the past 2 days. He reports no dysuria, frequency, or hesitancy of urination. On physical examination, there are no abnormal findings. Laboratory findings show a serum urea nitrogen level of 39 mg/dL and creatinine level of 4.1 mg/dL. A renal biopsy specimen is obtained; the immunofluorescence pattern of staining with antibody against human IgG is shown in the figure. Which of the following serologic findings is most likely to be present in this patient?

- **A** Anti–glomerular basement membrane antibody
- **B** Anti–streptolysin O antibody
- **C** C3 nephritic factor
- **D** Hepatitis B surface antibody
- **E** HIV antibody

9 A 46-year-old woman has had worsening malaise for the past 36 hours. Her urine output is markedly diminished, and it has a cloudy brown appearance. On examination she has periorbital edema. Laboratory findings include serum creatinine of 2.8 mg/dL and urea nitrogen of 30 mg/dL. A renal biopsy is performed and on microscopic examination shows focal necrosis in glomeruli with glomerular basement membrane breaks and crescent formation. No immune deposits are identified with immunofluorescence. Which of the following autoantibodies is most likely detectable in her serum?

- **A** Anti–DNA topoisomerase antibody
- **B** Anti–glomerular basement membrane antibody
- **C** Anti–neutrophil cytoplasmic autoantibody
- **D** Antinuclear antibody
- **E** Anti-HBs Ag

10 A 44-year-old woman has developed a fever, nonproductive cough, and decreased urine output over the past 3 days. On physical examination, her temperature is 37.7° C, and blood pressure is 145/95 mm Hg. She has sinusitis. On auscultation, crackles are heard over all lung fields. A chest radiograph shows bilateral patchy infiltrates and nodules. The serum creatinine level is 4.1 mg/dL, and the urea nitrogen level is 43 mg/dL. The results of serologic testing are negative for ANA, but positive for C-ANCA. A renal biopsy specimen shows glomerular crescents and damage to small arteries. The result of immunofluorescence staining with anti-IgG and anti-C3 antibodies is negative. Which of the following additional microscopic findings is most likely to be seen in this biopsy?

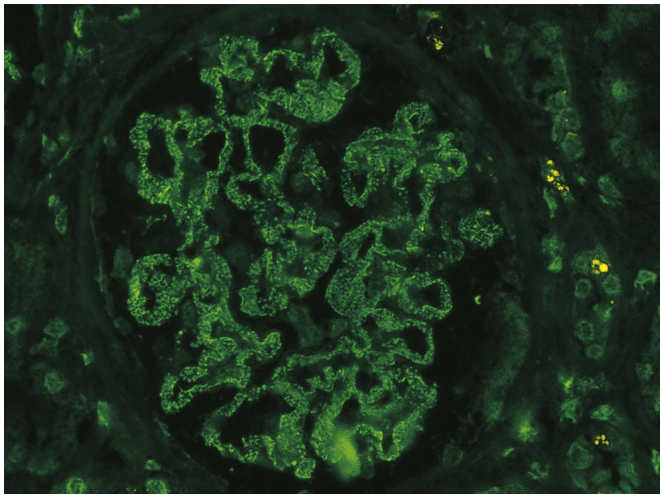
- **A** Focal segmental glomerulosclerosis
- **B** Glomerular basement membrane thickening
- **C** Hyperplastic arteriolosclerosis
- **D** Infiltrations by neutrophils
- **E** Mesangial proliferation
- **F** Necrotizing granulomatous vasculitis

11 A 48-year-old man has had increased swelling in the extremities for 2 months. Physical examination showed generalized edema. A 24-hour urine collection yielded 4.1 g of protein (albumin and globulins). He did not respond to a course of corticosteroid therapy. A renal biopsy was done, and microscopic examination showed diffuse thickening of the basement membrane. Immunofluorescence staining with antibody to the C3 component of complement was positive in a granular pattern in the glomerular capillary loops. Two years later, he experiences increasing malaise. Laboratory studies now show serum creatinine level of 4.5 mg/dL and urea nitrogen level of 44 mg/dL. Which of the following immunologic mechanisms was most likely responsible for the glomerular changes observed in the biopsy specimen?

- **A** Antibodies that react with basement membrane collagen
- **B** Antibodies against streptococci that cross-react with the basement membrane
- **C** Cytotoxic T cells directed against renal antigens
- **D** Deposition of immune complexes on the basement membrane
- **E** Release of cytokines by inflammatory cells

12 A 7-year-old boy has become less active over the past 10 days. On physical examination, the boy has facial puffiness. Urinalysis shows no blood, glucose, or ketones, and microscopic examination shows no casts or crystals. The serum creatinine level is normal. A 24-hour urine collection yields 3.8 g of protein. He improves after corticosteroid therapy. He has two more episodes of proteinuria over the next 4 years, both of which respond to corticosteroid therapy. What is the most likely mechanism causing his disease?

- **A** Cytokine-mediated visceral epithelial cell injury
- **B** Cytotoxic T cell–mediated tubular epithelial cell injury
- **C** IgA-mediated mesangial cell injury
- **D** Immune complex–mediated glomerular injury
- **E** Verocytotoxin-induced endothelial cell injury

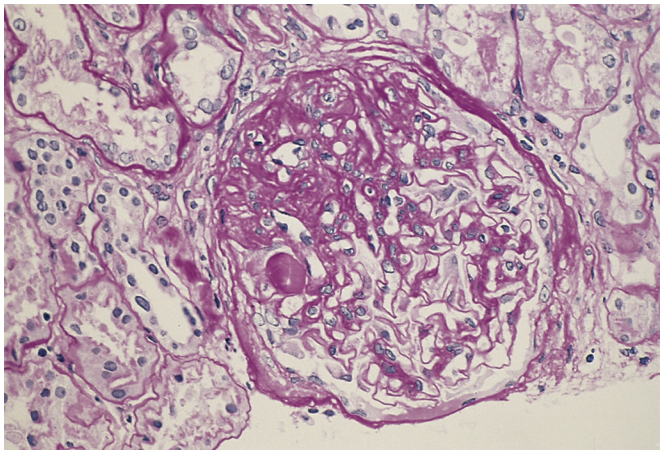


13 A 44-year-old man with increasing malaise for the past month now is bothered by increasing swelling in the hands and legs. On physical examination, there is generalized edema. He is afebrile, and his blood pressure is 140/90 mm Hg. Urinalysis shows a pH of 6.5; specific gravity 1.017; 4+ proteinuria; and no blood, glucose, or ketones. Microscopic examination of the urine shows no casts or RBCs and 2 WBCs per high-power field. The 24-hour urine protein level is 4.2 g. A renal biopsy specimen is obtained, and immunofluorescence staining with antibody to the C3 component of complement produces the pattern shown in the figure. Which of the following underlying disease processes is most likely to be present in this man?

- **A** Chronic hepatitis B virus infection
- **B** HIV infection
- **C** Multiple myeloma
- **D** Recurrent urinary tract infection
- **E** Nephrolithiasis

14 A 6-year-old girl has become increasingly lethargic over the past 2 weeks. On examination she has puffiness around the eyes. Her temperature is 36.9° C, and blood pressure is 100/60 mm Hg. Laboratory findings show serum creatinine, 0.7 mg/dL; urea nitrogen, 12 mg/dL; and cholesterol, 217 mg/dL. Urinalysis shows pH, 6.5; specific gravity, 1.011; 4+ proteinuria; lipiduria; and no blood or glucose. The 24-hour urine protein level is 3.8 g. The child's condition improves after glucocorticoid therapy. Which of the following findings by electron microscopy is most likely to characterize this disease process?

- **A** Areas of thickened and thinned basement membrane
- **B** Effacement of podocyte foot processes
- **C** Increased mesangial matrix
- **D** Reduplication of glomerular basement membrane
- **E** Subepithelial electron-dense humps



15 A 12-year-old girl has experienced increasing malaise for the past 2 weeks. On physical examination, she has periorbital edema. The child is afebrile. Laboratory findings show proteinuria on dipstick urinalysis, but no hematuria or glucosuria. Microscopic examination of the urine shows numerous oval fat bodies. The serum creatinine level is 2.3 mg/dL. She receives a course of corticosteroid therapy, but does not improve. A renal biopsy is performed and microscopic examination shows that approximately 50% of the glomeruli in the specimen are affected by the lesion shown in the figure. What is the most likely diagnosis?

- **A** Dense deposit disease
- **B** Focal segmental glomerulosclerosis
- **C** Minimal change disease
- **D** Nodular glomerulosclerosis
- **E** Postinfectious glomerulonephritis
- **F** Rapidly progressive glomerulonephritis

16 A 46-year-old Hispanic man has had increasing malaise with headaches and easy fatigability for the past 3 months. Physical examination reveals his blood pressure is 200/100 mm Hg. There are no palpable abdominal masses and no costovertebral tenderness. Laboratory studies show hemoglobin, 9.5 g/dL; hematocrit, 28.3%; MCV, 92 μm^3; creatinine, 4.5 mg/dL; and urea nitrogen, 42 mg/dL. Urinalysis reveals 3+ hematuria and 3+ proteinuria, but no glucose or leukocytes. A renal biopsy is done; light microscopic examination of the biopsy specimen shows that approximately 50% of the glomeruli appear normal, but the rest show that a portion of the capillary tuft is sclerotic. Immunofluorescence staining shows IgM and C3 deposition in these sclerotic areas. His history is significant for repeated episodes of passing dark brown urine, which failed to respond to corticosteroid therapy. Which of the following mechanisms is most likely responsible for his disease?

- **A** Attachment of anti–glomerular basement membrane antibodies
- **B** Deposition of immune complexes containing microbial antigens
- **C** Deposition of C3 nephritic factor (C3NeF)
- **D** Dysfunction of the podocyte slit diaphragm apparatus
- **E** Inherited defect in the basement membrane collagen

17 A 38-year-old woman has been feeling lethargic for 4 months. On physical examination, she is afebrile, and her blood pressure is 140/90 mm Hg. Laboratory findings show the serum creatinine level is 5.8 mg/dL. C3 nephritic factor is present in serum, resulting in hypocomplementemia, and the ANA test result is negative. Urinalysis shows 2+ blood and 1+ protein. A renal biopsy is done; microscopic examination shows hypercellular glomeruli and prominent ribbonlike deposits along the lamina densa of the glomerular basement membrane. Which of the following forms of glomerulonephritis is most likely to be present in this patient?

- **A** Chronic glomerulonephritis
- **B** Dense deposit disease
- **C** Membranous nephropathy
- **D** Postinfectious glomerulonephritis
- **E** Rapidly progressive glomerulonephritis

18 A 25-year-old man has a 5-year history of celiac sprue. Four days after a mild upper respiratory infection, he begins passing dark red-brown urine. The dark urine persists for the next 3 days and then becomes clear and yellow, only to become red-brown again 1 month later. There are no remarkable findings on physical examination. Urinalysis shows a pH of 6.5; specific gravity, 1.018; 3+ hematuria; 1+ proteinuria; and no glucose or ketones. Microscopic examination of the urine shows RBCs, but no WBCs, casts, or crystals. A 24-hour urine protein level is 200 mg. A renal biopsy specimen from the glomeruli of this patient is most likely to show which of the following alterations?

- **A** Diffuse cellular proliferation and basement membrane thickening
- **B** Granular staining of the basement membrane by anti-IgG antibodies
- **C** Mesangial IgA staining by immunofluorescence
- **D** Subepithelial electron-dense deposits
- **E** Thrombosis within the glomerular capillaries

19 One week after a mild flulike illness, a 9-year-old boy has an episode of hematuria that subsides within 2 days. One month later, he tells his parents that his urine is red again. On physical examination, there are no significant findings. Urinalysis shows a pH of 7; specific gravity, 1.015; 1+ proteinuria; 1+ hematuria; and no ketones, glucose, or urobilinogen. The serum urea nitrogen level is 36 mg/dL, and the creatinine level is 3.2 mg/dL. Serum electrophoresis shows increased IgA1. Which of the following glomerular structures is most likely to show structural alterations in this boy?

- **A** Basement membranes
- **B** Capillaries
- **C** Mesangium
- **D** Parietal epithelium
- **E** Podocytes

20 A 15-year-old boy has been passing dark-colored urine for the past month. On physical examination, he has bilateral sensorineural hearing loss and corneal erosions. Urinalysis shows a pH of 6.5; specific gravity, 1.015; 1+ hematuria; 1+ proteinuria; and no ketones, glucose, or leukocytes. The serum creatinine level is 2.5 mg/dL, and the urea nitrogen level is 24 mg/dL. A renal biopsy specimen shows tubular epithelial foam cells by light microscopy. By electron microscopy, the glomerular basement membrane shows areas of attenuation, with splitting and lamination of lamina densa in other thickened areas. What is the most likely diagnosis?

- **A** Mutation in a gene encoding type IV collagen
- **B** Increased synthesis of abnormal IgA
- **C** Autoimmune destruction of pancreatic beta cells
- **D** Acquired deficiency of ADAMTS13 metalloprotease
- **E** Toxic injury to slit diaphragm proteins

21 A 56-year-old woman is found on health screening to have a blood pressure of 168/109 mm Hg. No other physical examination findings are noted. Urinalysis shows a pH of 7.0; specific gravity, 1.020; 1+ proteinuria; and no blood, glucose, or ketones. The ANA and ANCA test results are negative. The serum urea nitrogen level is 51 mg/dL, and the creatinine level is 4.7 mg/dL. The hemoglobin A_{1c} concentration is within the reference range. An abdominal ultrasound scan shows bilaterally and symmetrically small kidneys with no masses. What is her most likely diagnosis?

- **A** Amyloidosis
- **B** Autosomal dominant polycystic kidney disease
- **C** Chronic glomerulonephritis
- **D** Microscopic polyangiitis
- **E** Nodular glomerulosclerosis

22 An autopsy study is performed involving persons with gross pathologic findings of bilaterally small kidneys (<100 g) that have a coarsely granular surface appearance. Microscopic examination shows sclerotic glomeruli, a fibrotic interstitium, tubular atrophy, arterial thickening, and scattered lymphocytic infiltrates. Which of the following clinical findings was most likely reported in these patients' medical histories?

- **A** Hemoptysis
- **B** Hypertension
- **C** Lens dislocation
- **D** Pharyngitis
- **E** Skin rash

23 A 33-year-old woman has had fever and increasing fatigue for the past 2 months. Over the past year, she has noticed soreness of her muscles and joints and has had a 4-kg weight loss. On physical examination, her temperature is 37.5° C, pulse is 80/min, respirations are 15/min, and blood pressure is 145/95 mm Hg. She has pain on deep inspiration, and a friction rub is heard on auscultation of the chest. Laboratory findings show glucose, 73 mg/dL; total protein, 5.2 g/dL; albumin, 2.9 g/dL; and creatinine, 2.4 mg/dL. Serum complement levels are decreased. CBC shows hemoglobin of 9.7 g /dL, platelet count of 85,000/mm^3, and WBC count of 3560/mm^3. A renal biopsy specimen shows a diffuse proliferative glomerulonephritis with extensive granular immune deposits of IgG and C1q in capillary loops and mesangium. After being treated with immunosuppressive therapy consisting of prednisone and cyclophosphamide, her condition improves. Which of the following serologic studies is most likely to be positive in this patient?

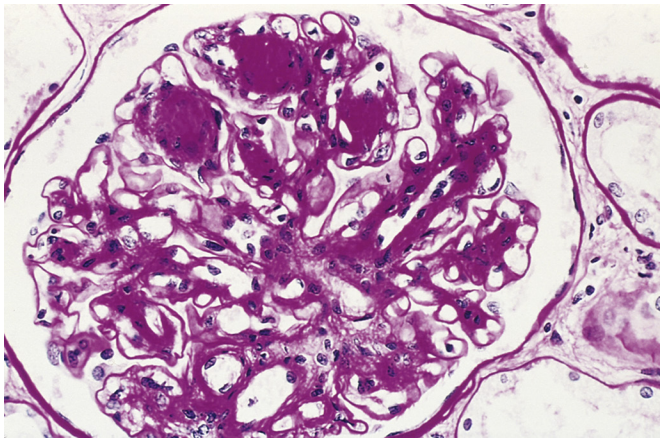
- **A** Anticentromere antibody
- **B** Anti–DNA topoisomerase I antibody
- **C** Anti–double-stranded DNA antibody
- **D** Anti–glomerular basement membrane antibody
- **E** Antihistone antibody
- **F** Antineutrophil cytoplasmic autoantibody
- **G** Antiribonucleoprotein

24 A 33-year-old woman with a history of intravenous drug use comes to the emergency department because she has had a high fever for the past 2 days. On physical examination, her temperature is 38.4° C. She has a palpable spleen tip, bilateral costovertebral angle tenderness, and diastolic cardiac murmur. Laboratory findings show a serum urea nitrogen level of 15 mg/dL. Urinalysis shows 2+ hematuria, and no glucose, protein, or ketones. A blood culture is positive for *Staphylococcus aureus.* Which of the following best describes the likely gross appearance of the kidneys in this patient?

- **A** Enlarged, and replaced by 1- to 4-cm, fluid-filled cysts
- **B** Marked pelvic and calyceal dilation with thinning of the cortices
- **C** Normal size, with smooth cortical surfaces
- **D** Shrunken, with uniformly finely granular cortical surfaces
- **E** Slightly swollen, with scattered petechial hemorrhages
- **F** Small and asymmetric, with irregular cortical scars and marked calyceal dilation
- **G** Wedge-shaped regions of yellow-white cortical necrosis

25 A 55-year-old woman with poorly controlled hyperglycemia for many years now has had burning pain on urination for the past 3 days. Physical examination shows a 2-cm ulceration on the skin of the heel and reduced sensation in the lower extremities. Her visual acuity is 20/100 bilaterally. Urinalysis shows 1+ proteinuria; 2+ glucosuria; and no blood, ketones, or urobilinogen. A urine culture contains more than 100,000 colony-forming units/mL of *Klebsiella pneumoniae.* Which of the following pathologic findings is most likely to be present in both her kidneys?

- **A** Deposits of IgG and C3 in the glomerular basement membrane
- **B** Effacement of podocyte foot processes
- **C** Formation of glomerular crescents
- **D** Mesangial deposits of IgA
- **E** Necrotizing granulomatous vasculitis
- **F** Nodular hyaline mesangial deposits



26 A 58-year-old man is found to have mild hypertension. Laboratory findings show a serum creatinine level of 2.2 mg/dL and urea nitrogen level of 25 mg/dL. Microalbuminuria is present, with excretion of 250 mg/day of albumin. Two years later, he remains hypertensive and has a serum creatinine level of 3.8 mg/dL, urea nitrogen level of 38 mg/dL, and 24-hour urine protein level of 2.8 g. A renal biopsy is done; the light microscopic appearance of a PAS-stained specimen is shown in the figure. Blood/serum test for which of the following is most likely to be abnormal in this patient?

A Anti–glomerular basement membrane antibody
B Antinuclear antibody
C Anti–neutrophil cytoplasmic autoantibody
D Anti–streptolysin O
E C3 nephritic factor
F Hemoglobin A_{1c}
G Hepatitis B surface antigen

27 A 17-year-old boy is involved in a motor vehicle accident in which he sustains severe blunt trauma to the extremities and abdomen. Over the next 3 days, he develops oliguria and dark brown urine. The urine dipstick analysis is positive for myoglobin and for blood, but microscopic examination of the urine shows no RBCs. His serum urea nitrogen level increases to 38 mg/dL, and he undergoes hemodialysis for 3 weeks. His condition improves, but the urine output remains greater than 3 L/day for 1 week before the urea nitrogen returns to normal. Which of the following renal lesions was most likely present in this patient?

A Acute pyelonephritis
B Acute tubular injury
C Malignant nephrosclerosis
D Membranous nephropathy
E Renal vein thrombosis

28 A 63-year-old man is in stable condition after an acute myocardial infarction when he became hypotensive for 3 hours before paramedical personnel arrived. Over the next week, the serum urea nitrogen level increases to 48 mg/dL, the serum creatinine level increases to 5 mg/dL, and the urine output decreases. He undergoes hemodialysis for the next 2 weeks and then develops marked polyuria, with urine output of 2 to 3 L/day. His renal function gradually returns to normal. Release of which of the following substances most likely participated in the elevation of BUN, creatinine, and reduced urinary output?

A Aldosterone
B Endothelin
C Erythropoietin
D Natriuretic peptide
E Vasopressin

29 A 19-year-old woman has had a fever and chills accompanied by right flank pain for the past 3 days. She has had two similar episodes during the past year. On physical examination, her temperature is 38.3° C, her blood pressure is 152/94 mm Hg, and there is right costovertebral angle tenderness. Laboratory findings show a serum glucose level of 77 mg/dL and creatinine level of 1 mg/dL. Urinalysis shows a pH of 6.5; specific gravity, 1.018; and no protein, blood, glucose, or ketones. Microscopic examination of the urine shows many WBCs and WBC casts. Which of the following is the most useful test to obtain on this patient?

A Antinuclear antibody
B Plasma renin
C Renal biopsy
D Urine culture
E Abdominal CT scan

30 A 51-year-old woman has had dysuria and urinary frequency for the past week. On physical examination, her temperature is 38° C, and she has pain on palpation over the left costovertebral angle. Laboratory findings show glucose, 177 mg/dL; hemoglobin A_{1c}, 9.8%; hemoglobin, 13.1 g/dL; platelet count, 232,200/mm^3; and WBC count, 11,320/mm^3. Urinalysis shows a pH of 6.5; specific gravity, 1.016; 2+ glucosuria; and no blood, protein, or ketones. Microscopic examination of the urine shows numerous neutrophils, and a urine culture is positive for *Escherichia coli*. Which of the following complications is most likely to develop in this patient?

A Acute tubular necrosis
B Crescentic glomerulonephritis
C Hydronephrosis
D Necrotizing papillitis
E Renal calculi

31 A 53-year-old woman has had fever and flank pain for the past 2 days. On physical examination, her temperature is 38.2° C, pulse is 81/min, respirations are 16/min, and blood pressure is 130/80 mm Hg. Urinalysis shows no protein, glucose, or ketones. The leukocyte esterase test is positive. Microscopic examination of the urine shows numerous polymorphonuclear leukocytes and occasional WBC casts. Which of the following organisms is most likely to be found in the urine culture?

A *Cryptococcus neoformans*
B *Escherichia coli*
C Group A streptococcus
D *Mycobacterium tuberculosis*
E *Mycoplasma hominis*

32 A 30-year-old woman has had increasing malaise with nocturia and polyuria for the past year. She has had a high fever for the past 3 days. On physical examination, her blood pressure is 170/95 mm Hg. Urinalysis shows a pH of 7.5; specific gravity, 1.010; 1+ proteinuria; positive leukocyte esterase and nitrite; and no glucose, blood, or ketones. A renal ultrasound scan shows an enlarged right kidney with pelvic and calyceal enlargement and cortical thinning; the left kidney appears normal. A right-sided nephrectomy is performed, and grossly there are large U-shaped scars at the poles with underlying blunted calyces. Microscopic examination shows inflammatory infiltrates extending from the medulla to the cortex, with tubular destruction and extensive interstitial fibrosis. Lymphocytes, plasma cells, and neutrophils are abundant. Which of the following underlying conditions is most likely to produce these findings?

A Polycystic kidney disease
B Essential hypertension
C Congestive heart failure
D Systemic lupus erythematosus
E Systemic amyloidosis
F Vesicoureteral reflux

33 A 29-year-old woman has had a fever and sore throat for the past 3 days. On physical examination, her temperature is 38° C. The pharynx is erythematous, with yellowish tonsillar exudate. She is treated with ampicillin and recovers fully in 7 days. Two weeks later, she develops fever and a rash, and notices a slight decrease in urinary output. Her temperature is 37.7° C, and there is a diffuse erythematous rash on the trunk and extremities. Urinalysis shows a pH of 6; specific gravity, 1.022; 1+ proteinuria; 1+ hematuria; and no glucose or ketones. Microscopic examination of the urine shows RBCs and WBCs, including eosinophils, but no casts or crystals. What is the most likely cause of her disease?

A Deposition of immune complexes with streptococcal antigens
B Formation of antibodies against glomerular basement membrane
C Hematogenous dissemination of septic emboli
D Hypersensitivity reaction to ampicillin
E Renal tubular cell necrosis caused by bacterial toxins

34 A 32-year-old man developed a fever and rash over 3 days. Five days later, he has increasing malaise. On physical examination, the maculopapular erythematous rash on his trunk has nearly faded away. His temperature is 37.1° C, and blood pressure is 135/85 mm Hg. Laboratory studies show a serum creatinine level of 2.8 mg/dL and blood urea nitrogen level of 29 mg/dL. Urinalysis shows 2+ proteinuria; 1+ hematuria; and no glucose, ketones, or nitrite. The leukocyte esterase result is positive. Microscopic examination of urine shows RBCs and WBCs, some of which are eosinophils. Which of the following most likely precipitated his renal disease?

A Antibiotic ingestion
B Congestive heart failure
C Eating poorly cooked ground beef
D Streptococcal pharyngitis
E Urinary tract infection

35 A 72-year-old man with chronic arthritis has taken more than 3 g of analgesics per day, including phenacetin, aspirin, and acetaminophen, for the past 20 years. He now has increasing malaise, nausea, and diminished mentation. On physical examination, his blood pressure is 156/92 mm Hg. Laboratory findings show serum urea nitrogen level of 68 mg/dL and creatinine level of 7.1 mg/dL. Which of the following renal diseases is he most likely to develop?

A Acute tubular injury
B Chronic glomerulonephritis
C Hydronephrosis
D Renal cell carcinoma
E Renal papillary necrosis

36 A 49-year-old man is found on physical examination to have a blood pressure of 160/110 mm Hg, but no other abnormalities. Laboratory studies show serum glucose of 75 mg/dL, creatinine of 1.3 mg/dL, and urea nitrogen of 20 mg/dL. His plasma renin is elevated. CT angiography shows marked stenosis of his renal arteries. He is treated with an angiotensin-converting enzyme inhibitor. A week later, he has a headache for which he takes ibuprofen. Over the next day, his urine output decreases. This effect on urinary output is most likely mediated by the unopposed action of which of the following chemicals?

A Aldosterone
B Histamine
C Nitric oxide
D Prostaglandin
E Tumor necrosis factor

37 A 28-year-old man is diagnosed with acute myelogenous leukemia (M2), with a total leukocyte count of 45,000/mm^3, including 60% blasts. After induction with a multiagent chemotherapy protocol, he has an episode of lower abdominal pain accompanied by passage of red urine. He has no fever, dysuria, or urinary frequency. On physical examination, there are no remarkable findings. Urinalysis shows a pH of 5.5; specific gravity, 1.021; 2+ hematuria; and no protein, ketones, or glucose. There are no remarkable findings on an abdominal radiograph. Which of the following additional urinalysis findings is most likely to be reported for this patient?

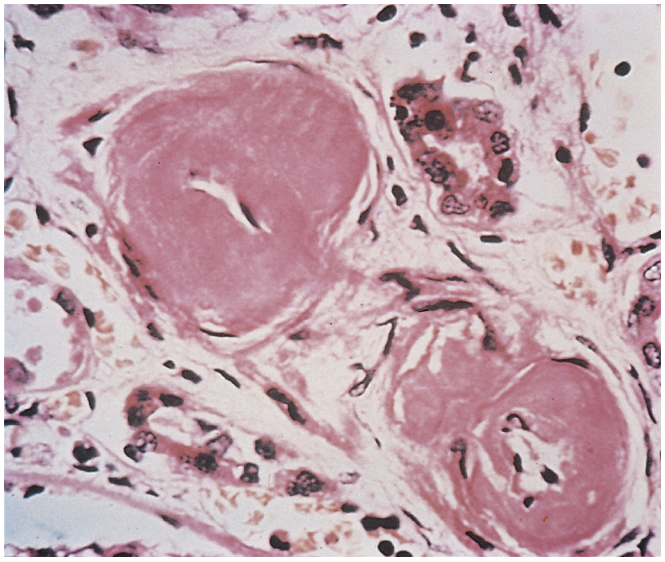
A Bence Jones protein
B Eosinophils
C Myoglobin
D Oval fat bodies
E RBC casts
F Uric acid crystals

38 A 49-year-old woman had a mastectomy of the right breast 2 years ago to remove a carcinoma. She now has bone pain, and a radionuclide scan shows multiple areas of increased uptake in the vertebrae, ribs, pelvis, and right femur. Urinalysis shows a specific gravity of 1.010, which remains unchanged after water deprivation for 12 hours. She undergoes multiple courses of chemotherapy over the next year. During this time, the serum urea nitrogen level progressively increases. Which of the following abnormal laboratory findings is most likely to be reported for this patient?

A Hypercalcemia
B Hypercholesterolemia
C Hypergammaglobulinemia
D Hyperglycemia
E Hyperuricemia

39 A 63-year-old man has noted increasing back pain for 7 months. He has had three respiratory tract infections with *Streptococcus pneumoniae* during the past year. On examination, he has pitting edema to his thighs. Laboratory studies show total serum protein, 9.6 g/dL; albumin, 3.5 g/dL; creatinine, 3 mg/dL; urea nitrogen, 28 mg/dL; and glucose, 79 mg/dL. Urinalysis shows proteinuria of 4 g/24 hr, but no glucosuria or hematuria. Abdominal CT scan shows enlarged kidneys without cysts or masses. A renal biopsy specimen stained with H&E shows deposits of amorphous pink material within glomeruli, interstitium, and arteries. Which of the following diseases is he most likely to have?

- **A** Analgesic nephropathy
- **B** ANCA-associated granulomatous vasculitis
- **C** Type 2 diabetes mellitus
- **D** Membranous nephropathy
- **E** Multiple myeloma
- **F** Systemic lupus erythematosus



40 A 66-year-old woman has experienced five transient ischemic attacks within a week. On physical examination, the only abnormal finding is a blood pressure of 150/95 mm Hg. Urinalysis shows 1+ proteinuria, and no glucose, blood, or ketones. Microscopic examination of the urine shows no RBCs or WBCs and few oxalate crystals. On abdominal ultrasound, the kidneys are slightly decreased in size. The representative high magnification microscopic appearance of the kidneys is shown in the figure. Which of the following renal lesions is most likely to be present in this patient?

- **A** Acute tubular necrosis
- **B** Fibromuscular dysplasia
- **C** Hyaline arteriolosclerosis
- **D** Interstitial nephritis
- **E** Necrotizing vasculitis

41 A 45-year-old man has had headaches, nausea, and vomiting that have worsened over the past 5 days. He has started "seeing spots" before his eyes and experienced periods of mental confusion. On physical examination, his blood pressure is 270/150 mm Hg. Urinalysis shows 1+ proteinuria; 2+ hematuria; and no glucose, ketones, or leukocytes. The serum urea nitrogen and creatinine levels are elevated. He dies 2 weeks later from a cerebral bleed. Which of the following histologic findings is most likely to be seen in this patient's kidneys at autopsy?

- **A** Glomerular crescents
- **B** Hyperplastic arteriolosclerosis
- **C** Mesangial IgA deposition
- **D** Nodular glomerulosclerosis
- **E** Segmental tubular necrosis

42 A 5-year-old girl develops cramping abdominal pain and diarrhea 4 days after eating a hamburger, chili, and ice cream at a home barbecue. The next day, she has decreased urine output. On physical examination, there are petechial hemorrhages on the skin. Her temperature is 37° C, pulse is 90/min, respirations are 18/min, and blood pressure is 90/50 mm Hg. A stool sample is positive for occult blood. Laboratory findings show a serum creatinine level of 2.2 mg/dL and urea nitrogen level of 20 mg/dL. CBC shows hemoglobin, 10.8 g/dL; hematocrit, 32.4%; platelet count, 64,300/mm^3; and WBC count, 6480/mm^3. The peripheral blood smear shows schistocytes, and the serum D-dimer level is elevated. Urinalysis shows a pH of 6; specific gravity, 1.016; 2+ hematuria; and no protein or glucose. A renal biopsy specimen shows small thrombi within glomerular capillary loops. This complication develops most commonly after infection with which of the following organisms?

- **A** *Candida albicans*
- **B** *Clostridium difficile*
- **C** *Escherichia coli*
- **D** *Proteus mirabilis*
- **E** *Staphylococcus aureus*

43 Adult patients with bilateral renal cystic disease are found to have defects in renal tubular function. Their kidneys are markedly increased in size. They have ciliopathy, with reduced mechanosensing of tubular fluid flow. Mutations are found in a gene encoding for a protein component of these cilia. What is this protein most likely to be?

- **A** Elongin
- **B** Fibrocystin
- **C** Nephrocystin
- **D** Polycystin
- **E** Tuberin

44 A 61-year-old woman has experienced increasing malaise and bouts of abdominal pain for the past 5 years. On physical examination, she has a blood pressure of 150/95 mm Hg. On auscultation, a midsystolic click is heard over the mitral area. Bilateral abdominal masses are palpable. An abdominal ultrasound shows enlarged kidneys with the representative gross appearance shown in the figure. Which of the following extrarenal conditions is she most likely to have?

A Berry aneurysm
B Coagulopathy
C Hepatic cirrhosis
D Ischemic cardiomyopathy
E Pulmonary fibrosis

45 A 20-year-old primigravid woman is in the third trimester and has felt minimal fetal movement. An ultrasound scan shows bilaterally enlarged echogenic kidneys and a markedly decreased amniotic fluid index. She gives birth to a stillborn male fetus at 33 weeks' gestation. At autopsy, there are deformations resulting from marked oligohydramnios, including flattening of the facies, varus deformities of the feet, and marked pulmonary hypoplasia. Microscopic examination of the liver shows multiple epithelium-lined cysts and a proliferation of bile ducts. Which of the following is the most likely renal disease in this fetus?

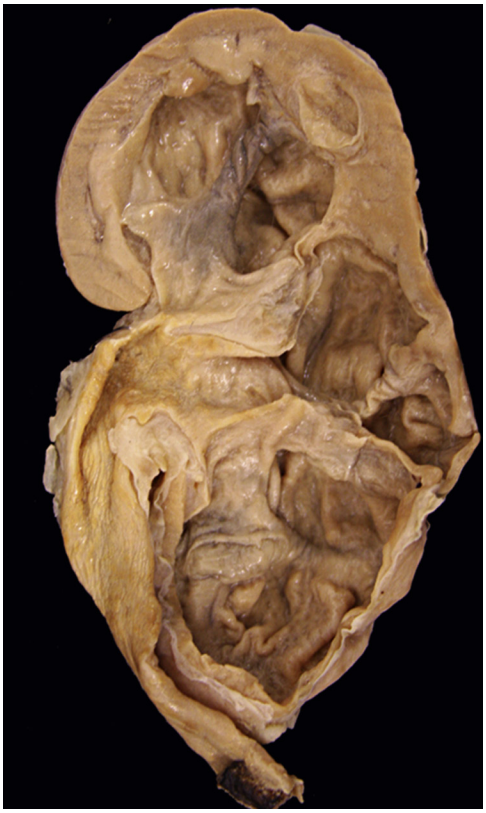
A Autosomal dominant polycystic kidney disease
B Autosomal recessive polycystic kidney disease
C Medullary sponge kidney
D Multicystic renal dysplasia
E Urethral atresia

46 A 31-year-old woman experiences abdominal pain 1 week after noticing blood in her urine. She has had three episodes of urinary tract infection during the past year. There are no remarkable findings on physical examination. Urinalysis shows 2+ hematuria, 1+ proteinuria, hypercalciuria, and no glucose or ketones. Serum creatinine is 1.0 g/dL. Microscopic examination of the urine shows numerous RBCs and oxalate crystals. An abdominal CT scan with contrast shows linear striations radiating into the renal papillae, along with small cystic collections of contrast material in dilated collecting ducts. She is advised to increase her daily intake of fluids, and her condition improves. Which of the following renal cystic diseases is most likely to be associated with these findings?

A Autosomal dominant polycystic kidney disease
B Autosomal recessive polycystic kidney disease
C Medullary sponge kidney
D Multicystic renal dysplasia

47 A 6-year-old child has been drinking more water, with more frequent urination, for the past 7 months. On physical examination dehydration is noted. Urinalysis findings include pH of 6.5; specific gravity, 1.010; and no protein, blood, glucose, or ketones. There are no WBCs, RBCs, or casts. Serum electrolytes show Na^+, 152 mmol/L; K^+, 4.6 mmol/L; Cl^-, 120 mmol/L; HCO_3^-, 21 mmol/L; urea nitrogen, 29 mg/dL; and creatinine, 3.2 mg/dL. An ultrasound scan shows bilaterally small kidneys with barely visible medullary cysts concentrated at the corticomedullary junction. Which of the following genes is most likely mutated in this child?

A *MCKD1*
B *NPHP1*
C *PKD1*
D *PKHD1*



48 An 83-year-old man has experienced difficulty with urination for the past 15 years. On physical examination, he has a 2-cm nonhealing ulceration on the ball of his right foot. He has decreased sensation to light touch over his lower extremities. The representative gross appearance of his right kidney is shown in the figure. The left kidney has a similar appearance. Which of the following conditions is he most likely to have?

A Analgesic abuse
B Benign nephrosclerosis
C Chronic pyelonephritis
D Diabetes mellitus
E Prostatic adenocarcinoma

49 A 42-year-old man has had right flank pain for the past 2 days. On physical examination, his temperature is 37.1° C, pulse is 70/min, respirations are 14/min, and blood pressure is 130/85 mm Hg. Laboratory studies show a serum creatinine level of 1.1 mg/dL. Urinalysis shows no blood, protein, or glucose, and microscopic examination of the urine shows no WBCs or RBCs. Abdominal CT scan shows a 7-cm eccentric lesion of the upper pole of the right kidney. The lesion is well circumscribed and cystic with a thin wall and focal hemorrhage. What is the most likely diagnosis?

A Acute pyelonephritis
B Acute tubular injury
C Diabetic nephropathy
D Hydronephrosis
E Simple renal cyst
F Renal cell carcinoma
G Urothelial carcinoma

50 A 24-year-old man has severe lower abdominal pain that radiates to the groin. On a scale of 1 to 10, the pain is at 10 and comes in waves. He then notes blood in his urine. He has no underlying illnesses and has been healthy all his life. On physical examination, he is afebrile and has a blood pressure of 110/70 mm Hg. Laboratory studies show serum Na^+, 142 mmol/L; K^+, 4 mmol/L; Cl^-, 96 mmol/L; CO_2, 25 mmol/L; glucose, 74 mg/dL; creatinine, 1.1 mg/dL; calcium, 9.1 mg/dL; and phosphorus, 2.9 mg/dL. Urinalysis shows a pH of 7; specific gravity of 1.020; and no protein, glucose, ketones, or nitrite. He is advised to drink more water. He likes iced tea and consumes large quantities over the course of a hot summer. He continues to have similar episodes. Which of the following substances is most likely to be increased in his urine?

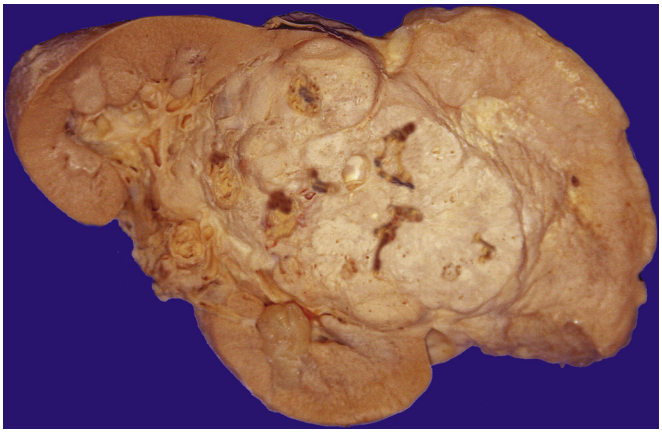
A Calcium oxalate
B Cystine
C Magnesium ammonium phosphate
D Mucoprotein
E Uric acid

51 A 28-year-old, previously healthy man suddenly develops severe abdominal pain and begins passing red urine. There are no abnormalities on physical examination. Urinalysis shows a pH of 7; specific gravity, 1.015; 1+ hematuria; and no protein, glucose, or ketones. The patient is given a device to use in straining the urine for calculi. The next day, he recovers a 0.3-cm stone that is sent for analysis. The chemical composition is found to be calcium oxalate. What underlying condition is most likely to be present in this man?

A Acute bacterial cystitis
B Diabetes mellitus
C Idiopathic hypercalciuria
D Primary hyperparathyroidism
E Secondary gout

52 A 54-year-old woman has had recurrent urinary tract infections for the past 15 years. On many of these occasions, *Proteus mirabilis* was cultured from her urine. For the past 4 days, she has had a burning pain on urination and urinary frequency. On physical examination, her temperature is 37.9° C, pulse is 70/min, respirations are 15/min, and blood pressure is 135/85 mm Hg. There is marked tenderness on deep pressure over the right costovertebral angle and on deep abdominal palpation. Urinalysis shows a pH of 7.5; specific gravity, 1.020; 1+ hematuria; and no protein, glucose, or ketones. Microscopic examination of the urine shows many RBCs, WBCs, and triple phosphate crystals. Which of the following renal lesions is most likely to be present?

A Acute tubular injury
B Malignant nephrosclerosis
C Papillary necrosis
D Renal cell carcinoma
E Staghorn calculus



53 A 55-year-old man has had back pain and has passed dark-colored urine for the past month. On physical examination, there is tenderness over the right costovertebral angle. Urinalysis shows a pH of 6; specific gravity, 1.015; 2+ hematuria; and no protein, glucose, or ketones. Microscopic examination of the urine shows numerous RBCs, few WBCs, and no casts or crystals. The figure shows the representative gross appearance of the renal lesion. Which of the following substances is most likely to be increased in the blood of this man?

A Cortisol
B Globlulins
C Erythropoeitin
D Renin
E Vasopressin

54 A 60-year-old man has a feeling of fullness in his abdomen and a 5-kg weight loss over the past 6 months. He has a 50 pack-year smoking history. Physical examination is normal. Laboratory studies show hemoglobin of 8.3 g/dL, hematocrit of 24%, and MCV of 70 μm^3. Urinalysis shows 3+ hematuria, but no protein, glucose, or leukocytes. Abdominal CT scan shows an 11-cm mass in the upper pole of the right kidney. A right-sided nephrectomy is performed, and gross examination reveals that the mass has invaded the renal vein. Microscopic examination of the mass shows cells with abundant clear cytoplasm. Which of the following molecular abnormalities is most likely to be found in tumor cell DNA?

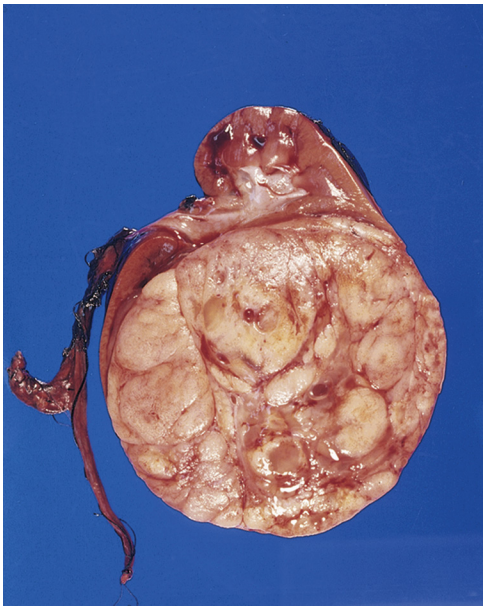
A Homozygous loss of the von Hippel–Lind (*VHL*) gene
B Integration of human papillomavirus type 16 (HPV-16)
C Microsatellite instability
D Mutational activation of the *MET* proto-oncogene
E Trisomy of genes on chromosome 7

55 Members of a family with a history of renal cancers undergo ultrasound screening. Two adults are found to have multifocal and bilateral renal mass lesions. Biopsies are obtained, and microscopic examination shows a papillary pattern. A mutation involving which of the following genes is most likely to be found in this family?

A *MET*
B *PKD1*
C *RAS*
D *TSC1*
E *WT1*

56 A 60-year-old man has noted a nonproductive cough along with back pain for 4 months. He has passed darker urine for 1 month. He has a 50 pack/year history of smoking. On examination, his blood pressure is 175/110 mm Hg. He has tenderness to percussion of the upper back. Urinalysis shows 3+ blood but no casts or crystals. Chest CT imaging shows a 4-cm solid nodule in the right lower lobe of his lung, as well as 1- to 2-cm lytic lesions in thoracic vertebrae. A neoplasm is most likely to have arisen in which of the following urinary tract locations in this man?

A Bladder dome
B Calyx
C Penile urethra
D Renal cortex
E Urachus
F Ureter



57 A 4-year-old girl has complained of abdominal pain for the past month. On physical examination, she is febrile, and palpation of the abdomen shows a tender mass on the right side. Bowel sounds are present. Laboratory studies show hematuria without proteinuria. Abdominal CT scan shows a 12-cm, circumscribed, solid mass in the right kidney. A right-sided nephrectomy is performed; the gross appearance of the mass is shown in the figure. What is the most likely diagnosis?

A Angiomyolipoma
B Interstitial cell tumor
C Renal cell carcinoma
D Transitional cell carcinoma
E Wilms tumor

ANSWERS

1 A He has azotemia, and the BUN-to-Cr ratio is >20:1, the low FE_{Na}, high urine specific gravity, and hypotension suggest prerenal azotemia, and cardiac failure is the most likely cause. Membranous nephropathy is a renal cause with BUN-to-Cr ratio of 10:1 or less and likely proteinuria at nephrotic levels. Prostatic hyperplasia with urinary tract obstruction may produce postrenal azotemia with BUN-to-Cr ratio between 10:1 and 20:1. Systemic lupus erythematosus is likely to produce nephritic syndrome with RBCs and RBC casts, and BUN-to-Cr ratio of 10:1 or less. Urothelial carcinoma is likely to be unilateral, with sufficient reserve renal function in the remaining kidney to prevent azotemia.

PBD9 898–899 BP9 517–518 PBD8 906–907 BP8 542

2 C The findings fit with immune-mediated glomerular injury with antigen-antibody complex deposition, typical of an underlying disease such as SLE, and nephritic picture. Type I hypersensitivity may play a role in drug-induced acute interstitial nephritis. Type II hypersensitivity is present with anti–glomerular basement membrane diseases, such as Goodpasture syndrome. Type IV hypersensitivity plays a role in renal transplant rejection and some cases of drug-induced interstitial nephritis.

PBD9 904–906 BP9 519–522 BPD8 912–915 BP8 546–548

3 B The appearance of membranoproliferative glomerulonephritis, a cause for nephritic syndrome in adults, is described. Mesangial cells have a phagocytic function, but they also can elaborate inflammatory mediators, cytokines, and matrix. Proliferation of mesangial cells may be induced by injury, particularly immune complex deposition. Juxtaglomerular cells secrete renin. Parietal epithelial cells line the Bowman capsule and may proliferate with severe glomerular injury to produce crescents. Podocytes are visceral epithelial cells that form the filtration barrier. Endothelial cells are most likely to be damaged with thrombotic microangiopathies.

PBD9 900–902 BP9 527–528 PBD8 909–911 BP8 548–549

4 E The podocytes (visceral epithelial cells) of the glomerulus form a filtration barrier that depends upon both the anionic charge as well as slit diaphragms. Injuries that cause effacement, retraction, detachment, and vacuolization allow protein, principally albumin, to escape into Bowman space. Podocytes have limited capacity for regeneration and repair. The loss of 3.5 g/day of protein defines nephrotic syndrome. About a sixth of filtration occurs through the mesangium. The remaining listed options do not participate in this epithelial protein filtration barrier.

PBD9 900, 908 BP9 518, 523 BPD8 910, 915 BP8 542, 548

5 B The strains of group A streptococci that cause poststreptococcal glomerulonephritis (GN) differ from the strains that cause rheumatic fever, and most elicit an immune response via streptococcal pyogenic exotoxin B (SpeB). Most children with poststreptococcal GN recover, although 1% develop a rapidly progressive GN characterized by crescent formation. Progression to chronic renal failure occurs in 40% of affected adults. A urinary tract infection is not likely to accompany poststreptococcal GN because the organisms that caused the immunologic reaction are no longer present when symptoms of GN appear.

PBD9 910–911 BP9 529–530 PBD8 917–920 BP8 554–555

6 F She has *Plasmodium* infection with malaria and immune complex deposition with leukocytes in glomeruli that has led to a nephritic syndrome associated with her acute proliferative glomerulonephritis; many of these are postinfectious. The inciting infection depends upon the locale and frequency of occurrence. In the United States, *Staphylococcus aureus* (with IgA antibodies) is now more common than *Streptococcus pyogenes* as a cause for postinfectious GN in developed nations. Of the remaining choices, only membranous GN is likely to have an infectious cause, but this is more likely to produce a nephrotic syndrome.

PBD9 910–911 BP9 529–530 PBD8 917–918 BP8 554–555

7 B The figure shows glomeruli with epithelial crescents indicative of a rapidly progressive glomerulonephritis. Crescentic GN is divided into three groups on the basis of immunofluorescence: type I (anti–glomerular basement membrane [GBM] disease); type II (immune complex disease); and type III (characterized by the absence of anti-GBM antibodies or immune complexes). Each type has a different cause and treatment. The presence of anti-GBM antibodies suggests Goodpasture syndrome; patients with this disorder require plasmapheresis. Type II crescentic GN can occur in systemic lupus erythematosus, in Henoch-Schönlein purpura, and after infections. Causes of type III crescentic GN include granulomatosis with polyangiits (ANCA-associated vasculitis) and microscopic polyangiitis. A positive ANA test result may be reported in patients with lupus nephritis, which uncommonly manifests with glomerular crescents. HIV nephropathy has features similar to those of focal segmental glomerulosclerosis (FSGS), which is not rapidly progressive. Quantitative serum immunoglobulins are not helpful because the important consideration is the pattern of immune deposits in the kidney. Rheumatoid factor is present in rheumatoid arthritis, which is not typically associated with renal complications. Urine immunoelectrophoresis is useful in categorizing a monoclonal gammopathy.

PBD9 912–913 BP9 521–522 PBD8 920–921 BP8 557–558

8 A The linear pattern of staining shown in the figure indicates the presence of anti–glomerular basement membrane antibodies (directed against the noncollagenous domain of the α3 chain of type IV collagen). Such antibodies are typically seen in Goodpasture syndrome, a form of rapidly progressive glomerulonephritis (GN) that has a bimodal pattern of occurrence in younger and older men. The anti–streptolysin O titer is increased in poststreptococcal GN, which typically has a granular pattern of immune complex deposition. The C3 nephritic factor can be a marker for dense deposit disease. Some cases of membranous nephropathy are associated with hepatitis B virus infection, but the immune complex deposition is granular, not linear. HIV infection can lead to a nephropathy that resembles FSGS, in which IgM and C3 are deposited in the mesangial areas of affected glomeruli.

PBD9 912–913 BP9 521–522, 532 PBD8 912 BP8 557–558

9 C This is pauci-immune crescentic glomerulonephritis. The lack of immune deposits excludes anti–glomerular basement membrane disease (Goodpasture syndrome). Cases can be idiopathic, associated with ANCAs, and limited to the kidney. Rapidly progressive GN often has an abrupt onset with nephritis marked by oliguria. Anti–DNA topoisomerase antibody is seen with scleroderma, which mainly affects the vasculature. Antinuclear antibody is present with many autoimmune diseases, such as SLE, with immune complex deposition in glomeruli. Anti-HBs may occur in some cases of secondary membranous nephropathy.

PBD9 912–913 BP9 532–533 PBD8 920–921 BP8 557–558

10 F Granulomatosis with polyangiitis (ANCA-associated vasculitis) is a cause for rapidly progressive glomerulonephritis (GN) characterized by epithelial crescents in Bowman space. Several features differentiate it from other forms of crescentic GN (e.g., Goodpasture syndrome), including the presence of granulomatous vasculitis, the absence of immune complexes or anti–glomerular basement membrane (GBM) antibodies, and the presence of C-ANCA. Focal segmental glomerulosclerosis (FSGS) does not affect renal vessels and is unlikely to produce crescents with a rapidly progressive presentation. Goodpasture syndrome is a form of rapidly progressive GN with crescent formation, but a granulomatous vasculitis is not present, and there is anti-GBM antibody, not C-ANCA. Hyperplastic arteriolosclerosis can lead to focal hemorrhages and necrosis, but without a granulomatous component, and the blood pressure is usually quite high. Lupus nephritis, membranoproliferative GN, and postinfectious GN (with many neutrophils in glomeruli) occasionally can have a rapidly progressive course with crescent formation, but they do not produce granulomatous vasculitis. In patients with lupus, the ANA test result is often positive. Membranous nephropathy is most likely to produce nephrotic syndrome without crescents.

PBD9 912 BP9 520, 532 PBD8 517, 935 BP8 558

11 D Nephrotic syndrome may be produced by an idiopathic form of membranous nephropathy. Diffuse basement membrane thickening, in the absence of proliferative changes, and granular deposits of IgG and C3 are typical of this condition. It is caused by antibody targeting M-type phospholipase A_2 receptor antigen, the deposition of immune complexes on the basement membrane, and complement activation. In 75% of patients with membranous nephropathy, the cause of immune complex deposition is unknown. In the remaining cases an associated systemic disease (e.g., systemic lupus erythematosus) or some known cause of immune complex formation (e.g., drug reaction) exists. Antibodies that react with basement membrane give rise to a linear immunofluorescence pattern, as in Goodpasture syndrome. Membranous nephropathy has no association with streptococcal infections. There also is no evidence of cytokine-mediated or T cell–mediated damage in this disease.

PBD9 914–916 BP9 526–527 PBD8 922–923 BP8 551–552

12 A Steroid-responsive proteinuria in a child is typical of minimal change disease, in which the kidney looks normal by light microscopy, but fusion of foot processes is visible with electron microscopy. The most likely cause of foot process fusion is a primary injury to visceral epithelial cells caused by T cell–derived cytokines. Acute cellular renal transplant rejection is mediated by T cell injury with tubulitis. IgA nephropathy with mesangial IgA deposition and consequent glomerular injury causes recurrent gross or microscopic hematuria and, far less commonly, nephrotic syndrome. Immune complex deposition in membranous nephropathy can cause nephrotic syndrome, but is less common in children than in adults and is not steroid responsive. Certain verocytotoxin-producing *Escherichia coli* strains can cause hemolytic uremic syndrome by injury to capillary endothelium.

PBD9 917–918 BP9 524–525 PBD8 942–946 BP8 550–551

13 A One of the most common causes of nephrotic syndrome in adults is membranous nephropathy, caused by immune complex deposition, shown in the figure as extensive granular deposits with C3. About 75% of cases are idiopathic and due to autoantibodies reacting against podocyte antigens; but some cases follow infections (e.g., hepatitis, malaria), or are associated with causes such as malignancies or autoimmune diseases. In some cases of AIDS, a nephropathy resembling focal segmental glomerulosclerosis occurs. Multiple myeloma can be complicated by systemic amyloidosis, which can involve the kidney. Recurrent urinary tract infections are typically caused by bacterial organisms and can cause chronic pyelonephritis. Nephrolithiasis may lead to interstitial nephritis, but it does not cause glomerular injury.

PBD9 914–916 BP9 526–527 PBD8 922–923 BP8 551–552

14 B A child with nephrotic syndrome and no other clinical findings is most likely to have minimal change disease, a name that reflects the paucity of pathologic findings. There is fusion of podocyte foot processes, which can be seen only by electron microscopy. This fusion leads to selective proteinuria of low molecular weight proteins (albumin). Variability of basement membrane thickening may be seen in Alport syndrome. The mesangial matrix is expanded in some forms of glomerulonephritis (e.g., IgA nephropathy) and other diseases, such as diabetes mellitus, but not in minimal change disease. Reduplication of glomerular basement membrane may be seen with membranoproliferative GN. Subepithelial electron-dense humps represent immune complexes and are seen in postinfectious GN.

PBD9 917–918 BP9 524–525 PBD8 924–926 BP8 549–550

15 B Focal segmental glomerulosclerosis (FSGS) shows sclerosis of only a segment of the glomerulus (segmental lesion), and because only 50% of the glomeruli are affected, this is focal disease. FSGS manifests clinically with nephrotic syndrome that does not respond to corticosteroid therapy. FSGS can result from many forms of glomerular injury; some may be linked to *NPHS* gene mutations. In contrast, corticosteroid-responsive nephrotic syndrome in children is typically caused by minimal change disease (lipoid nephrosis) that is not associated with any glomerular change seen under the light microscope. Membranoproliferative glomerulonephritis (GN) and dense deposit disease are more likely to produce a nephritic syndrome in adults. A diabetic patient with nephrotic syndrome is likely to have nodular glomerulosclerosis or diffuse thickening of the basement membrane. An acute proliferative postinfectious GN has hypercellular glomeruli with neutrophils. A rapidly progressive GN is associated with hematuria, and glomerular crescents are present.

PBD9 918–919 BP9 525–526 PBD8 916–917 BP8 550–551

16 D Corticosteroid-resistant hematuria and proteinuria leading to hypertension and renal failure is typical for focal segmental glomerulosclerosis (FSGS). FSGS is now the most common cause of nephrotic syndrome in adults in the United States. Specialized extracellular areas overlying the glomerular basement membrane between adjacent foot processes of podocytes are called *slit diaphragms,* and these exert control over glomerular permeability. Mutations in genes affecting several proteins, including nephrin and podocin, have been found in inherited cases of FSGS; podocyte dysfunction, possibly caused by cytokines or unknown toxic factors, may be responsible for acquired cases of FSGS. FSGS with collapsing glomerulopathy is seen in patients with HIV-associated nephropathy. Immune complexes containing microbial antigens cause postinfectious glomerulonephritis (GN). Anti–glomerular basement membrane antibodies are responsible for Goodpasture syndrome. C3NeF is an autoantibody directed against C3 convertase, and it is seen in membranoproliferative GN. Inherited defects in basement membrane collagen cause Alport syndrome, also characterized by hematuria, but other congenital abnormalities, such as deafness, are often present, and nephrotic syndrome is uncommon.

PBD9 918–919 BP9 525–526 PBD8 916–917 BP8 550–551

17 B Dense deposit disease (formerly membranoproliferative glomerulonephritis type II) usually leads to hematuria, and half of cases end in chronic renal failure. The term

chronic glomerulonephritis (GN) often is used when sclerosis of many glomeruli is present with no clear cause. Membranous nephropathy is often accompanied by proteinuria but less likely hematuria, and is characterized by thickening of only the basement membrane and small electron-dense deposits. Postinfectious GN is often characterized by a hypercellular glomerulus with infiltration of polymorphonuclear leukocytes, but no basement membrane thickening. A rapidly progressive GN is marked by crescents forming in the Bowman space.

PBD9 920–922 BP9 527–528 PBD8 928–929 BP8 552–554

18 C IgA nephropathy (also known as *Berger disease*) can explain this nephritic condition with the presence of recurrent hematuria in a young adult. Nephrotic syndrome is not present, and mesangial IgA deposition is characteristic. The initial episode of hematuria usually follows an upper respiratory infection. IgA nephropathy occurs with increased frequency in patients with celiac disease and liver disease. It proceeds to chronic renal failure within 20 years in up to half of cases. Diffuse proliferation and basement membrane thickening denote membranoproliferative glomerulonephritis (GN), with IgG and C3 deposited in the glomeruli. Granular staining of basement membrane with IgG antibodies denotes immune complex deposition, which may occur in postinfectious GN, along with subepithelial deposits seen on electron microscopy. Patients with these changes also have nephritic syndrome. Glomerular capillary thrombosis is typical of hemolytic uremic syndrome.

PBD9 923–924 BP9 530–531 PBD8 930–931 BP8 555–556

19 C Development of recurrent hematuria after a viral illness in a child or young adult is typically associated with IgA nephropathy. A renal biopsy specimen will show diffuse mesangial proliferation and electron-dense deposits in the mesangium. In these patients, some defect in immune regulation causes excessive mucosal IgA synthesis in response to viral or other environmental antigens. IgA complexes are deposited in the mesangium and initiate glomerular injury. Defects in the structure of glomerular basement membrane are a feature of hereditary nephritis, and antibodies against type IV collagen are formed in Goodpasture syndrome. The parietal epithelium may react with proliferation to form crescents when fibrinogen leaks into the Bowman space with severe glomerulonephritis. Podocytes may by affected by many forms of glomerular disease, but singularly malfunction in minimal change disease.

PBD9 923–924 BP9 530–531 PBD8 930–931 BP8 555–557

20 A Alport syndrome is a form of hereditary nephritis. Hematuria is the most common presenting feature, but proteinuria is often present and may be in the nephrotic range. Patients progress to chronic renal failure in adulthood. An X-linked pattern of inheritance is present in 85% of cases, but autosomal dominant and autosomal recessive pedigrees also exist. The foamy change in the tubular epithelial cells and ultrastructural alterations of the basement membrane are characteristic features. The genetic defect results from mutation in the gene for the α5 chain of type IV collagen. IgA nephropathy is a form of glomerulonephritis that does not produce tubular epithelial changes. *TTP* is often associated with inherited or acquired deficiencies of ADAMTS13, leading to thrombotic microangiopathy, similar to hemolytic uremic syndrome from *Escherichia coli* Shiga toxin damaging vascular endothelium. Nodular and diffuse glomerulosclerosis are typical changes in diabetic nephropathy that can occur following loss of pancreatic islet beta cells. Toxic injuries are most likely to damage tubular cells, leading to acute tubular necrosis.

PBD9 924 BP9 531 PBD8 931–932 BP8 556–557

21 C Chronic glomerulonephritis (GN) may follow specific forms of acute GN. In many cases, however, it develops insidiously with no known cause. With progressive glomerular injury and sclerosis, both kidneys become smaller, and their surfaces become granular. Hypertension often develops because of renal ischemia. Regardless of the initiating cause, these "end-stage" kidneys appear morphologically identical. They have sclerotic glomeruli, thickened arteries, and chronic inflammation of interstitium. Because the patient's ANA and ANCA test results are negative, vasculitis is unlikely. Polycystic kidney disease and amyloidosis would cause the kidney size to increase, not decrease. The normal hemoglobin A_{1c} concentration indicates that the patient does not have diabetes mellitus. Nodular glomerulosclerosis is typical of diabetes mellitus with an elevated hemoglobin A_{1c}.

PBD9 925 BP9 541–542 PBD8 932–933 BP8 559

22 B These findings describe end-stage renal disease, the appearance of which can be similar regardless of the cause (e.g., vascular disease or glomerular disease). The characteristics of progressive renal damage include glomerulosclerosis (starting with focal segmental glomerulosclerosis) and tubulointerstitial fibrosis. With advanced renal destruction, hypertension almost always supervenes, even if it was absent at the onset of renal disease. Many such cases are referred to as *chronic glomerulonephritis* (GN), for want of a better term. Hemoptysis occurs in Goodpasture syndrome that involves lungs as well as kidneys. Lens dislocation is a feature of Alport syndrome, from thinning of the anterior lens capsule. Pharyngitis with group A streptococcal infection may precede postinfectious GN. A skin rash might have preceded the postinfectious GN.

PBD9 925–926 BP9 541–542 PBD8 932–933 BP8 559

23 C Lupus nephritis is one manifestation of systemic problems related to immune complex deposition, including fever, arthralgias, myalgias, pancytopenia, and serositis with pericarditis and pleuritis, which are characteristic of systemic lupus erythematosus (SLE). Renal disease is common in SLE, and a renal biopsy helps to determine the severity of involvement and the appropriate therapy. Anticentromere antibody is most specific for limited scleroderma (formerly CREST syndrome), which is unlikely to have renal involvement. Anti–DNA topoisomerase I antibody is more specific for diffuse scleroderma, which does have renal involvement, although usually this

manifests as vascular disease and not as glomerulonephritis. Anti–glomerular basement membrane antibody is characteristic of Goodpasture syndrome, in which IgG antibody is deposited in a linear fashion along glomerular capillary basement membranes. Antihistone antibody may be present in drug-induced lupus. ANCAs can be seen in some forms of vasculitis, such as ANCA-associated granulomatous vasculitis or microscopic polyangiitis. Antiribonucleoprotein is present in mixed connective tissue disease, which has some features of SLE, but usually does not include severe renal involvement.

PBD9 222–224, 926 BP9 127–130 PBD8 217–219, 913–914 BP8 142–144

24 G This patient is septic, and the heart murmur strongly suggests infective endocarditis. Cardiac lesions are the source of emboli (from valvular vegetations or mural thrombi) that can lodge in renal artery branches, producing areas of coagulative necrosis. These areas of acute infarction typically are wedge-shaped on cut section because of the vascular flow pattern. In addition, these septic emboli can produce abscesses where they lodge in the vasculature. Bilaterally enlarged, cystic kidneys are typical of autosomal dominant polycystic kidney disease. This patient's kidneys may have been normal-sized and smooth-surfaced before this event. Small, shrunken kidneys represent an end stage of many chronic renal diseases. Petechiae and edema may be seen in hyperplastic arteriolosclerosis associated with malignant hypertension. Irregular cortical scars with pelvicalyceal dilation may represent hydronephrosis complicated by infection in chronic pyelonephritis, whereas dilation alone points to obstructive uropathy, such as occurs with bladder outlet obstruction.

PBD9 926 BP9 10, 393, 534 PBD8 955 BP8 560

25 F Nodular and diffuse glomerulosclerosis is a classic lesion in diabetic nephropathy. Patients with diabetes mellitus have an elevated level of glycosylated hemoglobin (HbA_{1c}) and may initially have microalbuminuria, which predicts development of future overt diabetic nephropathy. There is progressive loss of renal function. These patients are often hypertensive and have hyaline arteriolosclerosis. The presence of overt proteinuria suggests progression to end-stage renal disease within 5 years. Anti–glomerular basement membrane antibody is seen in Goodpasture syndrome, which manifests as a rapidly progressive glomerulonephritis (GN). The ANA test is positive in a variety of autoimmune diseases, most typically systemic lupus erythematosus, which can be accompanied by GN. The ANCA test is positive in some forms of vasculitis, which can involve the kidneys. The anti–streptolysin O titer is elevated after streptococcal infections, which may cause postinfectious GN. The C3 nephritic factor may be present in dense deposit disease. Some patients with membranous nephropathy have a positive serologic test result for HBsAg.

PBD9 926, 1118–1119 BP9 746–747 PBD8 934–935, 1141–1142 BP8 783–784

26 F The figure shows nodular and diffuse glomerulosclerosis that often occur in patients with long-standing diabetes mellitus, which is often complicated by urinary tract infections. Infections with bacterial organisms also occur more frequently in patients with diabetes mellitus who have an elevated Hgb A_{1c}. Deposits of IgG and C3 in the glomerular basement membrane occur with forms of glomerulonephritis (GN) caused by immune complex deposition, including lupus nephritis and membranous nephropathy. The only abnormality observed in minimal change disease is effacement of podocyte foot processes, but this change is not specific for minimal change disease and may be seen in other disorders that produce proteinuria. Crescentic GN is not typically seen in diabetes mellitus. IgA deposition in the mesangium occurs in IgA nephropathy (Berger disease). A necrotizing granulomatous vasculitis can be present in the kidneys of patients having granulomatosis with polyangiitis (ANCA-associated vasculitis).

PBD9 926, 1118–1119 BP9 746–747 PBD8 934–935, 1141–1142 BP8 783–784

27 B His severe muscle injury resulted in myoglobinemia and myoglobinuria. The large amount of excreted myoglobin produces a toxic form of acute tubular injury. With supportive care, the tubular epithelium can regenerate, and renal function can be restored. During the recovery phase of acute tubular injury, patients excrete large volumes of urine because the glomerular filtrate cannot be adequately reabsorbed by the damaged tubular epithelium. An infection with pyelonephritis is unlikely to be characterized by such a short course or such a marked loss of renal function. Trauma is not a cause of malignant hypertension. Glomerulonephritis does not occur as a result of trauma. A bilateral renal vein thrombosis is uncommon and not related to muscle trauma.

PBD9 927–929 BP9 537–538 PBD8 936–937 BP8 564–566

28 B The most common cause of acute tubular necrosis is ischemic injury. The hypotension that develops after myocardial infarction causes decreased renal blood flow, with intrarenal vasoconstriction. Sublethal endothelial injury from reduced renal blood flow leads to the increased release of the vasoconstrictor endothelin and diminished amounts of the vasodilators nitric oxide and prostaglandin. The ischemic form of acute tubular injury is often accompanied by rupture of the basement membrane (tubulorrhexis). An initiating phase that lasts approximately 1 day is followed by a maintenance phase during which progressive oliguria and increasing blood urea nitrogen levels occur, with salt and water overload. This is followed by a recovery phase, during which there is a steady increase in urinary output and hypokalemia. Eventually, tubular function is restored. Treatment of this acute renal failure results in recovery of nearly all patients. Aldosterone plays a role in sodium absorption. Erythropoietin drives RBC production. Natriuretic peptide increases when there is congestive heart failure, but does not lead to renal ischemia. Vasopressin (antidiuretic hormone) controls free water clearance.

PBD9 927–929 BP9 537–538 PBD8 936–937 BP8 564–566

29 D In younger persons presenting with recurrent acute pyelonephritis, a search for acquired or congenital conditions producing obstruction or reflux is extremely important.

Culture helps identify organisms resistant to antibiotic therapy. The pathogenesis of ascending urinary tract infections involves bacteria ascending from the urinary bladder into the ureter and the pelvis. Urinary tract infections generally are more common in females because of their shorter urethra, but in the absence of abnormalities of the urinary tract, the infections tend to remain localized in the urinary bladder. Older women and sexually active women are at increased risk of urinary tract infections. An ANA may be ordered in the workup of autoimmune diseases such as systemic lupus erythematosus that may involve the kidney, but are noninfectious. A renal biopsy should not be done with findings of renal infection. Measurement of renin may be part of a workup for hypertension that can cause renal vascular narrowing and ultimately impair renal function, but it does not predispose to infections. Though radiologic imaging studies may help document the extent of urinary tract abnormalities, the infection still needs to be adequately treated, hopefully before significant damage occurs.

PBD9 930–933 BP9 533–535 PBD8 940–941 BP8 560–562

30 D These laboratory findings are consistent with diabetes mellitus and clinical features of acute pyelonephritis caused by *Escherichia coli* infection. Necrotizing papillitis with papillary necrosis is a complication of acute pyelonephritis, and diabetic patients are particularly prone to this development. In the absence of diabetes mellitus, papillary necrosis develops when acute pyelonephritis occurs in combination with urinary tract obstruction. Papillary necrosis also can occur with long-term use of analgesics. Acute tubular necrosis typically occurs in acute renal failure caused by hypoxia (e.g., shock) or toxic injury (e.g., mercury). Crescentic glomerulonephritis causes rapidly progressive renal failure. Hydronephrosis occurs when urinary outflow is obstructed in the renal pelvis or in the ureter. Renal calculi can complicate conditions such as gout, but they do not complicate diabetes mellitus.

PBD9 930–933 BP9 533–535 PBD8 941–942 BP8 560–562

31 B The clinical features in this patient are typical of urinary tract infection, and *Escherichia coli* is the most common cause. The WBCs are characteristic of an acute inflammatory process. The presence of WBC casts indicates that the infection must have occurred in the kidney because casts are formed in renal tubules. Most infections of the urinary tract begin in the lower urinary tract and ascend to the kidneys. Hematogenous spread is less common. *Cryptococcus* and *Mycoplasma* are rare urinary tract pathogens. Group A streptococcus is best known as an antecedent infection to poststreptococcal glomerulonephritis, an immunologically mediated disease in which the organisms are not present at the site of glomerular injury. *Mycobacterium tuberculosis* causes the rare sterile pyuria; however, renal tuberculosis typically does not manifest as an acute febrile illness.

PBD9 930–933 BP9 533–535 PBD8 939–942 BP8 560

32 F This gross appearance of the kidney is characteristic of chronic pyelonephritis, caused most often by reflux nephropathy. Typical features include coarse and irregular scarring resulting from ascending infection, blunting and deformity of calyces, and asymmetric involvement of the kidneys. The loss of tubules from scarring gives rise to reduced renal concentrating ability; the patient had polyuria with a low specific gravity of the urine. Urinary tract obstruction favors recurrent urinary tract infection (UTI). Vesicoureteral reflux propels infected urine from the urinary bladder to the ureters and renal pelvis and predisposes to infection; it can be unilateral. Autosomal dominant polycystic kidney disease is a bilateral process; patients usually are not symptomatic until middle age; although cysts may become infected, there is unlikely to be recurrent UTI. Benign nephrosclerosis is a vascular disease that may accompany hypertension but does not carry a risk for infection. Congestive heart failure may predispose to acute tubular injury. Lupus nephritis is associated with extensive inflammatory changes of glomeruli that are noninfectious. Amyloidosis can lead to progressive renal failure as a result of amyloid deposition in the glomeruli; however, amyloid does not evoke an inflammatory response.

PBD9 933–934 BP9 535–536 PBD8 942–944 BP8 562–563

33 D An acute drug-induced interstitial nephritis can be caused by ampicillin. This is an immunologic reaction, probably caused by a drug acting as a hapten. Pharyngitis with poststreptococcal glomerulonephritis with deposition of immune complexes is unlikely to be accompanied by a rash or by eosinophils in the urine. Anti–glomerular basement membrane antibodies occur in Goodpasture syndrome, with hemorrhages in lungs as well. Acute pyelonephritis is an ascending infection; it is uncommonly caused by hematogenous spread of bacteria from other sites. Acute tubular injury can cause acute renal failure. It is caused by hypoxia resulting from shock or from toxic injury caused by chemicals such as mercury, and only rarely, if ever, by bacterial toxins.

PBD9 935–936 BP9 536 PBD8 944–945 BP8 563–564

34 A Various drugs can cause drug-induced interstitial nephritis, including sulfonamides, penicillins, cephalosporins, the fluoroquinolone antibiotics ciprofloxacin and norfloxacin, and the antituberculous drugs isoniazid and rifampin. Acute tubulointerstitial nephritis also can occur with use of thiazide and loop diuretics, cimetidine, ranitidine, omeprazole, and nonsteroidal anti-inflammatory drugs. The disease manifests about 2 weeks after the patient begins to use the drug. Elements of type I (increased IgE) and type IV (skin test positivity to drug haptens) hypersensitivity are present. Congestive heart failure can lead to acute tubular injury, but it is not associated with a rash or proteinuria. Hemolytic uremic syndrome can occur after ingestion of strains of *Escherichia coli* that may be present in ground beef. Poststreptococcal glomerulonephritis (GN) could account for the proteinuria and hematuria seen in this patient, but not for the rash, because the strains of group A β-hemolytic streptococci that cause a skin infection precede by weeks the development of GN. WBCs, but not eosinophils, may be present in the urine of a patient with a urinary tract infection.

PBD9 935–936 BP9 536 PBD8 944–945 BP8 563–564

35 E Analgesic nephropathy damages the renal interstitium and can give rise to papillary necrosis; an uncommon but feared complication is urothelial carcinoma. Hydronephrosis is unlikely to develop because there is no urinary tract obstruction in analgesic nephropathy. The sloughed papilla is likely to pass down the ureter. The toxic injury that occurs with analgesic use is slowly progressive and not acute, in contrast to the course of acute tubular injury. Glomeruli are not specifically injured with analgesic abuse.

PBD9 936 PBD8 945–946

36 D This patient's hypertension is due to renal vascular constriction, typical for renal arterial atherosclerosis. In the face of reduced renal blood flow, his glomerular filtration rate (GFR) is maintained by prostaglandin-mediated vasodilation of afferent arterioles and angiotensin II–mediated vasoconstriction of efferent arterioles. The angiotensin-converting enzyme (ACE) inhibitor decreases efferent arteriolar vasoconstriction and decreases glomerular capillary perfusion pressure. Nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen inhibit prostaglandin synthesis and lead to vasoconstriction that reduces renal blood flow and reduces GFR. Aldosterone is increased with increased renin and angiotensin production and leads to reduced sodium excretion. Histamine is a vasodilator from mast cell granules that plays a role in acute inflammatory processes, but not blood pressure regulation. Nitric oxide is a vasodilator, but does not have a significant effect on capillary blood flow. Tumor necrosis factor plays a role in many inflammatory processes, but not renal blood flow.

PBD9 936 BP9 517–518 PBD8 950–951

37 F The rapid cell turnover in acute leukemias and cell death from treatment cause the release of purines from the cellular DNA breakdown. The resulting hyperuricemia can predispose to the formation of uric acid crystal precipitation in collecting ducts. If renal calculi develop they can produce colicky pain when they pass down the ureter and through the urethra, and the local trauma to the urothelium can produce hematuria. Uric acid stones form in acidic urine. In contrast to stones containing calcium, uric acid stones are harder to visualize on a plain radiograph. The urine dipstick is sensitive to albumin, but not to globulins; a separate test for Bence Jones protein may be positive, although the dipstick protein result is negative. Bence Jones proteinuria is characteristic of multiple myeloma, however, not of leukemias or lymphomas. Eosinophils may appear in the urine in drug-induced interstitial nephritis. Myoglobin can cause the dipstick reagent for blood to become positive in the absence of RBCs or hemoglobin. Myoglobinuria results most often from rhabdomyolysis, which can occur after severe crush injuries. Oval fat bodies are sloughed tubular cells containing abundant lipid; they are characteristic of nephrotic syndromes. RBC casts appear in nephritic syndromes as a result of glomerular injury.

PBD9 936–937 BP9 545 PBD8 947 BP8 571–572

38 A These findings are characteristic of nephrocalcinosis resulting from hypercalcemia. One of the most common causes of hypercalcemia in adults is metastatic disease. The hypercalcemia produces a chronic tubulointerstitial disease of the kidneys that is initially manifested by loss of concentrating ability. With continued hypercalcemia, there is progressive loss of renal function. Urinary tract stones formed of calcium oxalate also may be present. Hypercholesterolemia may be seen in some cases of minimal change disease. Hypergammaglobulinemia with a monoclonal protein (M protein) may be present in multiple myeloma, but not in breast cancer. Hyperglycemia can occur in diabetes mellitus, but patients with cancer are not at increased risk of developing diabetes mellitus. Hyperuricemia occurs in some cases of gout. It also can occur in patients with neoplasms (particularly lymphomas and leukemias) that have a high proliferation rate and are treated with chemotherapy. In these cases, extensive cell death (lysis syndrome) causes acute elevations in uric acid levels, leading to urate nephropathy.

PBD9 937 PBD8 947

39 E There is a large amount of serum globulin, back pain from lytic lesions, immunosuppression with recurrent infections, and amyloid deposition enlarging the kidneys, all consistent with multiple myeloma. This AL amyloid deposition occurs in 6% to 24% of myeloma cases, and can involve kidneys. Patients with myeloma often have Bence Jones proteinuria (not detected by the standard dipstick urinalysis), and some have cast nephropathy, which can cause acute or, more commonly, chronic renal failure. Analgesic nephropathy (e.g., aspirin, phenacetin, acetaminophen) can lead to tubulointerstitial nephritis and papillary necrosis. There can be necrotizing vasculitis and fibrinoid necrosis of renal arteries with ANCA-associated granulomatous vasculitis, but not amyloid deposition. His serum glucose is not in the range for diabetes mellitus, and the pink deposits seen with nodular or diffuse glomerulosclerosis are not amyloid. The pink-staining, thickened capillary loops of membranous nephropathy represent immune deposits, not amyloid. Systemic lupus erythematosus can result in immune deposits to produce "wire loop" thickening of glomerular capillaries from immune deposition, not amyloid.

PBD9 937–938 BP9 439 PBD8 252, 935 BP8 167

40 C The figure shows hyaline arteriolosclerosis, which typically occurs in patients with benign hypertension, and the renal parenchymal changes may be termed *benign nephrosclerosis*. Similar changes can be seen with aging in the absence of hypertension. Vascular narrowing causes ischemic changes that are slow and progressive. There is diffuse scarring and shrinkage of the kidneys. Blood pressure screening is an important method that can identify patients with hypertension before significant organ damage has occurred. Essential (benign) hypertension may evolve to malignant hypertension that causes distinctive renal vascular lesions, including fibrinoid necrosis and hyperplastic arteriosclerosis. Chronic hypertension predisposes to cerebrovascular disease accompanied by transient ischemic attack and stroke. Acute tubular necrosis results from anoxic or toxic injury to the renal tubules. Fibromuscular dysplasia can involve one or more renal arterial layers and produce focal stenosis. In

interstitial nephritis, more cells would be seen in the urine sediment. An ANCA-associated vasculitis may have a necrotizing component, as can hyperplastic arteriolosclerosis.

PBD9 938–939 BP9 539 PBD8 949–950 BP8 566–567

41 B Malignant hypertension may follow long-standing benign hypertension. Two types of vascular lesions with accelerated nephrosclerosis are found in malignant hypertension. Fibrinoid necrosis of the arterioles may be present; in addition, there is intimal thickening in interlobular arteries and arterioles, caused by proliferation of smooth muscle cells and collagen deposition. The proliferating smooth muscle cells are concentrically arranged, and these lesions, called *hyperplastic arteriolosclerosis,* cause severe narrowing of the lumen. The resultant ischemia elevates the renin level, which further promotes vasoconstriction to potentiate the injury. Glomerular crescents are a feature of a rapidly progressive glomerulonephritis; however, the blood pressure elevation is not as marked as that seen in this patient. An IgA nephropathy involves glomeruli, but not typically the interstitium or vasculature. Nodular glomerulosclerosis is a feature of diabetes mellitus that slowly progresses over many years. Segmental tubular necrosis occurs in ischemic forms of acute tubular injury.

PBD9 939–940 BP9 539–540 PBD8 950–951 BP8 567–568

42 C Hemolytic uremic syndrome is one of the most common causes of acute renal failure in children. It most commonly occurs after ingestion of meat infected with verocytotoxin-producing *Escherichia coli,* most often serotype O157:H7. This Shiga toxin damages endothelium, reducing nitric oxide, promoting vasoconstriction and necrosis, and promoting platelet activation to form thrombi in small vessels. With supportive therapy, most patients recover in a few weeks, although perhaps one fourth progress to chronic renal failure. However, hemolytic uremic syndrome may also occur in adults from Shiga toxin and drug ingestion. Thrombotic thrombocytopenic purpura (TTP) in adults can lead to similar renal thrombotic microangiopathy, but is due to abnormal ADAMTS13 metalloproteinase clearance of von Willebrand multimers. Candidal urinary tract infections typically affect the urinary bladder. *Clostridium difficile* is best known for causing a pseudomembranous enterocolitis, not renal lesions. *Proteus* is a common cause of bacterial urinary tract infections, whereas *Staphylococcus aureus* is a less common cause.

PBD9 941–943 BP9 540–541 PBD8 952–953 BP8 568

43 D Autosomal dominant polycystic kidney disease (ADPKD) is described. Most cases have mutations in the *PKD1* gene encoding polycystin-1, whereas about 15% have *PKD2* mutations encoding polycystin-2 and a more slowly progressive course. Large cysts develop over many years, culminating in renal failure in adulthood. Elongin proteins are part of a complex formed with the von Hippel–Lind (*VHL*) gene activity; cysts may be found in many organs, but *VHL* is best known as a tumor suppressor. Fibrocystin mutations are associated with autosomal recessive polycystic kidney disease (ARPKD) that manifests in utero. Mutations in *NPHP1* encoding nephrocystin are associated with nephronophthisis–medullary cystic disease complex. Tuberin encoded by *TSC2* plays a role in development of cysts associated with tuberous sclerosis.

PBD9 945–947 BP9 542–544 PBD8 956–959 BP8 569–570

44 A These findings are characteristic of autosomal dominant polycystic kidney disease (ADPKD). As seen in the figure, multiple large cysts have completely replaced the renal parenchyma; enlarging cysts and hemorrhage into cysts can cause pain. Mitral valve prolapse may be found in a fourth of patients. About 10% to 30% of affected patients with ADPKD have an intracranial berry aneurysm, and some of these can rupture without warning. Disseminated intravascular coagulation may complicate hemolytic uremic syndrome. Although ADPKD may involve liver, there are cysts, not cirrhosis. Ischemic heart disease results from atherosclerosis, which can accompany diabetes mellitus, frequently accompanied by renal disease. Pulmonary disease does not accompany ADPKD.

PBD9 945-947 BP9 542–543 PBD8 956–959 BP8 569–570

45 B Autosomal recessive polycystic kidney disease (ARPKD) most often occurs in children, and in this case with the distinctive finding of congenital hepatic fibrosis; most cases have *PKHD1* gene mutations encoding for fibrocystin expressed in kidney, liver, and pancreas. By contrast, autosomal dominant polycystic kidney disease (ADPKD) manifests with renal failure in adults and involves *PKD1* and *PKD2* gene mutations encoding for polycystin proteins found in renal tubules. Some less common forms of ARPKD are accompanied by survival beyond infancy, and these patients develop congenital hepatic fibrosis. Enlarged kidneys with 1- to 4-cm cysts are characteristic of ADPKD in adults. Perhaps the most common renal cystic disease seen in fetuses and infants is multicystic renal dysplasia (multicystic dysplastic kidney), with focal, unilateral, or bilateral from variably sized cysts, but congenital hepatic fibrosis is not present. Medullary sponge kidney is a benign condition usually found on radiologic imaging of adults. Urethral atresia would produce marked bladder dilation, hydroureter, and hydronephrosis.

PBD9 947–948 BP9 544 PBD8 959 BP8 570

46 C The congenital disorder known as *medullary sponge kidney* (MSK) is present to some degree in 1% of adults. In MSK, cystic dilation of 1 to 5 mm is present in the inner medullary and papillary collecting ducts. MSK is bilateral in 70% of cases. Not all papillae are equally affected, although calculi are often present in dilated collecting ducts. Patients usually develop kidney stones, infection, or recurrent hematuria in the third or fourth decade. More than 50% of patients have stones. Autosomal dominant polycystic kidney disease (ADPKD) produces much larger cysts that involve the entire kidney, eventually leading to massive renomegaly. Autosomal recessive polycystic kidney disease (ARPKD) is rare and leads to bilateral, symmetric renal enlargement manifested

in utero, with renal failure evident at birth. Multicystic renal dysplasia may occur sporadically or as part of various genetic syndromes, such as Meckel-Gruber syndrome, in fetuses and newborns.

PBD9 948 BP9 544 PBD8 957, 959

47 B The child has nephronophthisis, the most common genetic cause for end-stage renal disease in children and adolescents, and transmitted in autosomal recessive pattern. The *NPHP1* to *NPHP11* genes encode for proteins found in the primary cilia, attached ciliary basal bodies, or the centrosome organelle, from which the basal bodies originate. There is loss of concentrating ability and renal tubular acidosis. *MCKD1* mutations are associated with adult medullary cystic disease with autosomal dominant transmission. *PKD1* encodes for polycystin-1, associated with autosomal dominant polycystic kidney disease (ADPKD). *PKHD1* mutations encode for fibrocystin, and is associated with autosomal recessive polycystic kidney disease (ARPKD).

PBD9 948–949 BP9 544 PBD8 959–960 BP8 570–571

48 D The pelvic and calyceal dilation results from long-standing obstruction leading to hydroureter and hydronephrosis. In some patients with diabetes mellitus, neuropathy is complicated by a neurogenic bladder, and this can lead to functional obstruction. His diabetic neuropathy is also contributing to "diabetic foot" with the ulceration. There are many renal complications of diabetes mellitus, mostly from vascular, glomerular, or interstitial injury, but there is no obstruction. The scarring that accompanies analgesic nephropathy or chronic pyelonephritis can be marked; it is associated with significant loss of renal parenchyma, but not with pelvic dilation. With benign nephrosclerosis, the kidneys become smaller and develop granular surfaces, but there is no dilation. It is unlikely he would have lived 15 years with a prostatic cancer large enough to cause urinary tract obstruction.

PBD9 950–951 BP9 545–546 PBD8 960–962 BP8 571–573

49 E Simple cysts are common in adults, and multiple cysts may occur. The cysts are not as numerous as cysts occurring in autosomal dominant polycystic kidney disease (ADPKD), and there is no evidence of renal failure. Simple cysts may be as large as 10 cm, and hemorrhage sometimes occurs into a cyst. Multiple cysts sometimes develop in patients receiving long-term hemodialysis. Acute pyelonephritis is unlikely in this patient because of the absence of fever and WBCs in the urine. Acute pyelonephritis may be associated with small abscesses, but not with cysts, although in patients with ADPKD, cysts may become infected. Acute tubular necrosis follows ischemic or toxic injury, and there is evidence of renal failure. Diabetic nephropathy includes vascular and glomerular disease, but not cysts. Hydronephrosis may produce a focal obstruction of a calyx with dilation, but it does not produce an eccentric cyst. Neoplasms usually produce solid masses, although sometimes a renal cell carcinoma is cystic. The latter is much less common than a simple cyst.

PBD9 949 BP9 542–543 PBD8 960 BP8 569

50 A Ureteral colic from the passage of a stone down the ureter produces intense pain (10 out of 10). About 70% of all renal stones are composed of calcium oxalate crystals. Patients with these stones tend to have hypercalciuria without hypercalcemia. Uric acid stones and cystine stones tend to form in acidic urine. Cystine stones are rare. Triple phosphate (magnesium ammonium phosphate) stones tend to occur in association with recurrent urinary tract infections, particularly infections caused by urease-positive bacteria, such as *Proteus.* Mucoproteins may coalesce into hyaline casts, which are too small to produce signs and symptoms.

PBD9 951–952 BP9 545 PBD8 962–963 BP8 571–572

51 C Calcium oxalate stones are the most common type of urinary tract stone, and approximately 50% of patients have increased excretion of calcium without hypercalcemia. The basis of hypercalciuria is unclear. Infections can predispose to the formation of magnesium ammonium phosphate stones, particularly urea-splitting *Proteus* organisms. Diabetes mellitus is an uncommon cause of urinary tract lithiasis. Although infections are more common in diabetics, most are not caused by urea-splitting bacteria. Hyperparathyroidism predisposes affected individuals to form stones containing calcium, but few patients with urinary tract stones have this condition. Most uric acid stones are formed in acidic urine and are not related to gout. It is thought that these patients have an unexplained tendency to excrete acidic urine. At low pH, uric acid is insoluble, and stones form.

PBD9 951–952 BP9 545 PBD8 962 BP8 571

52 E Recurrent urinary tract infections with urea-splitting organisms such as *Proteus* can lead to formation of magnesium ammonium phosphate stones. These stones are large, and they fill the dilated calyceal system. Because of their large size and projections into the calyces, such stones are sometimes called *staghorn calculi.* Cases of acute tubular necrosis typically occur from toxic or ischemic renal injuries. Malignant nephrosclerosis is primarily a vascular process that is not associated with infection. Papillary necrosis can complicate diabetes mellitus. Infections are not a key feature of renal cell carcinoma.

PBD9 951–952 BP9 545 PBD8 962 BP8 571–572

53 C The figure shows a renal cell carcinoma. About 5% to 10% of these tumors secrete erythropoietin, giving rise to polycythemia. Other substances can be secreted, including corticotropin (adrenocorticotropic hormone), resulting in hypercortisolism in Cushing syndrome; but these cases are encountered less frequently than polycythemia. Renal cell carcinomas are usually unilateral, and typically they do not destroy all of a kidney, so there is no significant loss of renal function, and the serum urea nitrogen and creatinine levels are not elevated. Hypertension from hyperreninemia can occur in patients with some renal cell carcinomas, although this is uncommon. A syndrome of inappropriate antidiuretic hormone (vasopressin) is more likely a paraneoplastic syndrome associated with small cell lung carcinomas. Globulin

would be increased with multiple myeloma and lead to amyloid deposition, a diffuse process.

PBD9 953–955 BP9 547–549 PBD8 964–966 BP8 573–575

54 A The clear cell form of renal cell carcinoma, the most common form of kidney cancer, often manifests with painless hematuria, most often in individuals in the sixth or seventh decade; tobacco use is a risk factor. Most sporadic clear cell carcinomas show loss of both alleles of the *VHL* gene. Germline inheritance of the *VHL* mutation can give rise to von Hippel–Lind syndrome, with peak incidence of renal cell carcinoma in the fourth decade, and they may have other tumors, including cerebellar hemangioblastomas, retinal angiomas, and adrenal pheochromocytomas. HPV-16 infection is associated with carcinomas of the uterine cervix. Microsatellite instability is a feature of Lynch syndrome, also called *hereditary nonpolyposis colon cancer syndrome,* characterized by right-sided colon cancer and, in some cases, endometrial cancer. Mutation of the *MET* gene on chromosome 7 is associated with the papillary variant of renal cell carcinoma, but trisomies are not specific to renal cell carcinomas.

PBD9 953–955 BP9 547–549 PBD8 964–966 BP8 573–574

55 A The second most common carcinoma of the kidney in adults is papillary renal cell carcinoma, associated with *MET* gene mutations that can be familial or sporadic. *PKD1* mutations are associated with autosomal dominant polycystic kidney disease. *RAS* mutations are common in many cancers at many sites, particularly the gastrointestinal tract, but are not likely associated with familial renal cancers. *TSC1* encodes hamartin, associated with tuberous sclerosis, and angiomyolipomas of the kidney. *WT1* mutations can be found with Wilms tumors of the kidney, seen in childhood.

PBD9 953–955 BP9 547–548 PBD8 965–966 BP8 574

56 D Carry the CT imaging down to the upper abdomen and a renal mass is likely to be found, representing a renal cell carcinoma. Smoking is a risk factor. Distant metastases may be evident before the primary tumor produces symptoms. Hematuria is common, but can be microscopic. Production of hormones by a renal cell carcinoma may lead to hypertension. Removing the primary tumor may lead to regression of metastases, dependent upon elaboration of cytokines such as VEGF by the primary renal cell carcinoma. Urothelial carcinomas, also associated with smoking, are less likely to metastasize to bone and lung, and may arise in the renal calyces and pelvis, as well as in the urinary bladder and ureters. A urachal carcinoma, usually an adenocarcinoma, is a rare cause for hematuria that arises in a urachal remnant of the embryonic allantois.

PBD9 953–955 BP9 547–549 PBD8 964–966 BP8 573–575

57 E Wilms tumor is the most common renal neoplasm in children, and one of the most common childhood neoplasms. A complex staging, grading, and molecular analysis formula, and surgery, chemotherapy, and radiation result in a high cure rate. The microscopic pattern of Wilms tumor (nephroblastoma) resembles the fetal kidney nephrogenic zone. Angiomyolipomas may be sporadic or part of the genetic syndrome of tuberous sclerosis. They may be multiple and bilateral and have well-differentiated muscle, adipose tissue, and vascular components. Renomedullary interstitial cell tumors (medullary fibromas) are generally smaller than 1 cm and are incidental findings. Renal cell carcinoma is rare in children, and the most common patterns are clear cell, papillary, and chromophobe. Transitional cell carcinomas arise in the urothelium in adults and microscopically resemble urothelium.

PBD9 479–481, 952 BP9 261–263 PBD8 479–481 BP8 271–273