1. All of the following are considered normal functions of the kidney *except:*
A) regulating body hydration
B) elimination of nitrogenous wastes
C) regulating electrolyte balance
D) elimination of serum proteins

2. The approximate number of nephrons contained in each kidney is:
A) 100,000
B) 500,000
C) 1,000,000
D) 5,000,000

3. The order of blood flow through the nephron is:
A) afferent arteriole, peritubular capillaries, vasa recta, efferent arteriole
B) efferent arteriole, peritubular capillaries, vasa recta, afferent arteriole
C) peritubular capillaries, vasa recta, afferent arteriole, efferent arteriole
D) afferent arteriole, efferent arteriole, peritubular capillaries, vasa recta

4. The total renal blood flow is approximately:
A) 40 mL/min
B) 120 mL/min
C) 600 mL/min
D) 1200 mL/min

5. The total renal plasma flow is approximately:
A) 60 mL/min
B) 120 mL/min
C) 600 mL/min
D) 1200 mL/min

6. The glomerular filtrate is described as a:
A) plasma filtrate containing glucose and protein
B) protein-free ultrafiltrate of plasma
C) selective filtrate of plasma containing urea
D) plasma filtrate without glucose and protein

7. Increased production of aldosterone causes:
A) decreased plasma sodium levels
B) decreased glomerular blood pressure
C) increased plasma sodium levels
D) increased urine volume

8. The primary chemical affected by the renin-angiotensin-aldosterone system is:
A) glucose
B) potassium
C) chloride
D) sodium

9. The specific gravity of the glomerular ultrafiltrate is:
A) 1.002
B) 1.010
C) 1.020
D) 1.030

10. All of the following are reabsorbed from the glomerular filtrate by active transport *except:*
A) glucose
B) water
C) sodium
D) amino acids

11. For active transport to occur, a chemical:
A) must combine with a carrier protein to create electrochemical energy
B) must be filtered through the proximal convoluted tubule
C) must be in higher concentration in the filtrate than in the blood
D) must be in higher concentration in the blood than in the filtrate

12. Water is passively reabsorbed in all parts of the nephron *except* the:
A) proximal convoluted tubule
B) descending loop of Henle
C) ascending loop of Henle
D) collecting duct

13. Most of the sodium filtered by the glomerulus is reabsorbed in the:
A) proximal convoluted tubule
B) descending loop of Henle
C) distal convoluted tubule
D) collecting duct

14. The enzyme renin is produced by the kidney:
A) to activate antidiuretic hormone
B) in response to low plasma sodium levels
C) when too much sodium is being reabsorbed
D) to regulate secretion of hydrogen ions

15. Concentration of the tubular filtrate by the countercurrent mechanism is dependent on all of the following *except:*
A) high salt concentration in the medulla
B) water-impermeable walls of the ascending loop of Henle
C) reabsorption of sodium and chloride from the ascending loop of Henle
D) active transport reabsorption of sodium and glucose in the proximal convoluted tubule

16. The osmotic gradient of the medulla:
A) controls the permeability of the walls of the collecting duct
B) affects passive reabsorption of water in the descending loop of Henle
C) affects sodium reabsorption in the proximal convoluted tubule
D) controls ammonia production by the distal convoluted tubule

17. Aldosterone regulates sodium reabsorption in the:
A) proximal convoluted tubule
B) descending loop of Henle
C) ascending loop of Henle
D) distal convoluted tubule

18. Decreased production of vasopressin:
A) produces a low urine volume
B) produces a high urine volume
C) increases ammonia excretion
D) affects active transport of sodium

19. Production of antidiuretic hormone is controlled by the:
A) osmotic gradient of the medulla
B) renin-angiotensin-aldosterone system
C) state of body hydration
D) cells of the renal cortex

20. Substances removed from the blood by tubular secretion include primarily:
A) protein, hydrogen, and ammonia
B) protein, hydrogen, and potassium
C) amino acids, urea, and glucose
D) protein-bound substances, hydrogen, and potassium

21. Kidneys with impaired production of ammonia will consistently produce urine with a:
A) high pH
B) high volume
C) low pH
D) low volume

22. To enhance the excretion of hydrogen ions, ammonia is produced by the cells of the:
A) proximal convoluted tubule
B) loop of Henle
C) distal convoluted tubule
D) collecting duct

23. To maintain the buffering capacity of the blood, hydrogen ions combine with:
A) filtered phosphate ions
B) filtered bicarbonate ions
C) secreted ammonia
D) secreted ammonium ions

24. Clearance tests used to determine the glomerular filtration rate must measure substances that are:
A) not filtered by the glomerulus
B) completely reabsorbed by the proximal convoluted tubule
C) secreted in the distal convoluted tubule
D) neither reabsorbed or secreted by the tubules

25. Results for glomerular filtration tests are reported in:
A) milliliters per minute
B) milliliters per 24 hours
C) milligrams per deciliter
D) milliequivalents per liter

26. All of the following are endogenous clearance test substances *except:*
A) urea
B) creatinine
C) inulin
D) $beta_2$ microglobulin

27. Performing a clearance test using radionucleotides:
A) eliminates the need to collect urine
B) does not require an infusion
C) provides visualization of the filtration
D) both A and C

28. If a substance is completely filtered by the glomerulus and then completely reabsorbed by the tubules, the clearance of that substance will be:
A) falsely decreased
B) falsely increased
C) normal
D) zero

29. The most routinely used laboratory method for measuring the glomerular filtration rate is the:
A) inulin clearance
B) urea clearance
C) creatinine clearance
D) $beta_2$ microglobulin clearance

30. The most common error in measuring the glomerular filtration rate using the creatinine clearance is:
A) diurnal variations in creatinine production
B) inaccurate timing of urine collection
C) calculation errors
D) errors in the chemical analysis

31. All of the following could cause falsely decreased creatinine clearance results *except:*
A) consumption of a heavy meat during urine collection
B) noncreatinine plasma substances reacting in the chemical test
C) secretion of creatinine by the tubules
D) maintaining urine specimens at room temperature

32. The body surface of the average person in square meters is:
A) 0.60
B) 1.73
C) 2.10
D) 3.50

33. An additional calculation that may be required in the creatinine clearance is a correction for:
A) body size
B) age
C) fasting status
D) basal metabolism rate

34. Calculate the creatinine clearance for a patient of average size from the following data:
Urine volume: 720 mL for 12 hours
Urine creatinine: 120 mg/dL
Serum creatinine: 1.5 mg/dL
A) 60 mL/min
B) 80 mL/min
C) 100 mL/min
D) 120 mL/min

35. Performing a creatinine clearance is helpful for determining:
A) renal concentrating ability
B) the feasibility of administering medications
C) early renal disease
D) renal blood flow

36. John White donates one of his two healthy kidneys to his twin brother. His glomerular filtration rate can be expected to:
A) decrease by 50%
B) increase by 50%
C) decrease gradually over 1 year
D) remain within a normal range

37. The renal function that is most frequently the first affected by early renal disease is:
A) renal blood flow
B) glomerular filtration
C) tubular reabsorption
D) tubular secretion

38. For accurate evaluation of renal tubular concentrating ability, patient preparation should include:
A) fasting
B) fluid deprivation
C) increased hydration
D) abstaining from all medications

39. Measurement of urine osmolarity is a more accurate measure of renal concentrating ability than specific gravity because:
A) osmolarity is measured by instrumentation
B) specific gravity is not influenced by urea and glucose molecules
C) osmolarity is influenced equally by small and large molecules
D) specific gravity measures only urea and glucose molecules

40. Solute dissolved in solvent will:
A) decrease the boiling point
B) decrease the freezing point
C) raise the vapor pressure
D) raise the dew point

41. Vapor pressure osmometers are based on the principle that:
A) increased solute raises the vapor pressure of a solution
B) increased solute lowers the vapor pressure of a solution
C) increased solute raises the dew point of a solution
D) A and C, but not B, are correct

42. Clinical osmometers use NaCl as a reference solution because:
A) 1 g molecular weight of NaCl will lower the freezing point 1.86^{o}C
B) NaCl is readily frozen and vaporized
C) NaCl is partially ionized similar to the composition of urine
D) 1 g equivalent weight of NaCl will lower the freezing point 1.86^{o}C

43. Substances that can interfere with serum osmolarity readings include all of the following *except:*
A) lipids
B) lactic acid
C) ethanol
D) sodium

44. The results of a serum osmolarity performed by both freezing-point and vapor-pressure osmometry do not agree. A possible cause of this discrepancy would be:
A) increased ethanol
B) increased lipids
C) decreased lactic acid
D) decreased potassium

45. A technical error that could cause a discrepancy between freezing-point and vapor-pressure osmometry readings is:
A) failure to refrigerate the sample
B) evaporation of the sample
C) failure to separate cells and serum
D) fluid deprivation of the patient

46. The normal serum osmolarity is:
A) 50 to 100 mOsm
B) 275 to 300 mOsm
C) 400 to 500 mOsm
D) Three times urine osmolarity

47. The extent to which the kidney concentrates the glomerular filtrate can be determined by measuring:
A) serum creatinine
B) urine creatinine
C) serum osmolarity
D) urine and serum osmolarity

48. Following fluid deprivation, a patient has a serum osmolarity of 276 mOsm and a urine osmolarity of 1000 mOsm. This patient:
A) has normal concentration ability
B) may have defective ADH production
C) may have insufficient tubular ADH response
D) has a high serum lipid concentration

49. The test that provides information similar to specific gravity is the:
A) total colloid content
B) protein concentration
C) absorbance
D) osmolarity

50. The serum osmolarity of a patient with hyponatremia:
A) will be similar to the urine osmolarity
B) should be greater than 300 mOsm
C) should be lower than 275 mOsm
D) will be falsely increased

51. Following injection of ADH, a patient has a serum osmolarity of 290 mOsm and a urine osmolarity of 450 mOsm. The patient:
A) continued to observe water deprivation
B) lacks tubular response to ADH
C) may have ingested excess alcohol
D) should be evaluated with a creatinine clearance

52. To determine the amount of water that must be cleared to produce urine with the same osmolarity as the ultrafiltrate, one should perform:
A) a free water clearance
B) a Mosenthal test
C) an osmolar clearance
D) a urine-to-plasma ratio

53. To determine the ability of the kidneys to respond to filtrate osmolarity, one should perform a:
A) free water clearance
B) Fishberg test
C) urine-to-plasma osmolarity
D) PAH test

54. A free water clearance of -2.5 could be indicative of:
A) lack of renal concentration and dilution
B) decreased ADH production
C) hyponatremia
D) dehydration

55. A patient with insufficient production of ADH would have which of the following results?
A) Urine volume—2 mL/min; osmolar clearance—2 mL/min
B) Urine volume—5 mL/min; osmolar clearance—2 mL/min
C) Urine volume—3 mL/min; osmolar clearance—4 mL/min
D) Urine volume—1 mL/min; osmolar clearance—3 mL/min

56. The PAH test is used to measure:
A) glomerular filtration
B) tubular reabsorption
C) albumin excretion
D) renal blood flow

57. To provide an accurate measure of renal blood flow, a test substance should be:
A) filtered by the glomerulus
B) reabsorbed by the tubules
C) secreted by the distal convoluted tubule
D) cleared on each contact with functional renal tissues

58. PAH is secreted by the:
A) proximal convoluted tubule
B) descending loop of Henle
C) distal convoluted tubule
D) collecting duct

59. A PAH test result showing a renal plasma flow of 400 mL/min:
A) is a normal result
B) may be falsely decreased from impaired tubular secretion
C) should be corrected to correspond to the patient's body size
D) indicates glomerular filtration of PAH

60. Which of the following is *not* associated with the elimination of hydrogen ions?
A) Protein
B) Phosphate
C) Ammonia
D) Bicarbonate

61. Renal tubular acidosis can be caused by the:
A) production of excessively acidic urine due to increased filtration of hydrogen ions
B) production of excessively acidic urine due to increased secretion of hydrogen ions
C) inability to produce an acid urine due to impaired production of ammonia
D) inability to produce an acid urine due to increased production of ammonia

62. Tests to measure the tubular secretion of hydrogen ions include all of the following *except:*
A) pH
B) titratable acidity
C) urinary bicarbonate
D) urinary ammonia

63. Following administration of oral ammonium chloride, a patient with renal tubular acidosis will produce:
A) highly concentrated urine
B) urine with a low pH
C) urine with a high pH
D) very dilute urine

64. Total acidity of a urine specimen is a combination of:
A) titratable acidity and pH
B) titratable acidity and ammonium ion
C) pH and total acidity
D) total acidity and ammonium ion

65. The afferent and efferent arterioles have the ability to vary in size.
A) True
B) False

66. Blood pressure within the glomerulus varies directly with systemic blood pressure.
A) True
B) False

67. A decrease in plasma sodium produces an increase in blood volume.
A) True
B) False

68. The filtrate leaving the ascending loop of Henle is highly concentrated.
A) True
B) False

69. A substance that is not filtered by the glomerulus will not be found in the urine.
A) True
B) False

70. Hydrogen ions are filtered by the glomerulus and reabsorbed and secreted by the renal tubules.
A) True
B) False

71. An increase in the plasma level of $beta_2$ microglobulin correlates with decreased glomerular filtration.
A) True
B) False

72. To calculate a creatinine clearance using the Gault formula, the patient must collect at least a 2-hour urine specimen.
A) True
B) False

73. The nephrons with the longest loops of Henle are the cortical nephrons.
A) True
B) False

74. Which of the following clearance substances does *not* require urine collection?
A) Creatinine
B) Cystatin C
C) Inulin
D) All of the above

75. A 12-hour urine specimen with a volume of 360 mL is collected for a creatinine clearance. What is the volume (V) used to calculate the clearance?
A) 0.5 mL/min
B) 1.0 mL/min
C) 1.5 mL/min
D) 2.0 mL/min

76. Using the following values, calculate the creatinine clearance: urine volume—1200 mL/12h, urine creatinine—60 mg/dL, and serum creatinine—0.8 mg/dL
A) 60 mL/min
B) 75mL/min
C) 112 mL/min
D) 128 mL/min

77. Can a patient with the following results be given a nephrotoxic medication: urine volume—720 mL/24 h, urine creatinine—100 mg/dL, and serum creatinine—2.5 mg/dL?
A) No, clearance is 20 mL/min
B) No, clearance is 40 mL/min
C) Yes, clearance is 80 mL/min
D) Yes, clearance is 120 mL/min

78. Given the following information, calculate the osmolar clearance: urine volume—720 mL in 24 hours, urine osmolarity—700 mOsm, and plasma osmolarity—300 mOsm.
A) 1.0 mL/min
B) 1.2 mL/min
C) 1.8 mL/min
D) 2.0 mL/min

79. Given the following information, calculate the patient's free water clearance: urine volume—360 mL in 12 hours, urine osmolarity—1400 mOsm, and plasma osmolarity—275 mOsm.
A) +0.5 mL/min
B) -1.5 mL/min
C) -1.0 mL/min
D) -2.0 mL/min

80. Following a 2-hour infusion of *p*-aminohippuric acid, during which 200 mL of urine is collected, the urine PAH is 260 mg/dL, and the patient's plasma PAH is 0.8 mg/dL. Calculate the renal plasma volume.
A) 525 mL/min
B) 553 mL/min
C) 614 mL/min
D) 765 mL/min

81. Can a 40-year-old male weighing 72 kg with a serum creatinine of 0.9 mg/dL be given a nephrotoxic medication?
A) No, clearance is 67 mL/min
B) No, clearance is 86 mL/min
C) Yes, clearance is 111 mL/min
D) Yes, clearance is 121 mL/min

82. What is the physical property measured by a vapor pressure osmometer?
A) Vapor temperature
B) Dew point temperature
C) Osmotic pressure
D) Oncotic pressure

Use the following to answer questions 83-88:

A patient showing symptoms of impaired renal function has a battery of tests performed. Results are:
Serum creatinine: 2.0 mg/dL
Urine creatinine: 150 mg/dL
Serum osmolarity: 270 mOsm
Urine osmolarity: 100 mOsm
24-hour urine volume: 2000 mL

83. Calculate the creatinine clearance.
A) 50 mL/min
B) 85 mL/min
C) 105 mL/min
D) 110 mL/min

84. Calculate the osmolar clearance.
A) 0.5
B) 1.0
C) 2.0
D) 2.5

85. Calculate the free water clearance.
A) -0.5
B) -1.0
C) +0.6
D) +0.9

86. Which renal function is abnormal in this patient?
A) Glomerular filtration
B) Tubular reabsorption
C) Tubular secretion
D) Renal blood flow

87. Can this patient be safely given a nephrotoxic antibiotic?
A) Yes
B) No

88. Would increasing the patients' intake of fluids alleviate this problem?
A) Yes
B) No

Use the following to answer questions 89-92:

A laboratory supervisor is authorized to purchase a new osmometer. The supervisor must decide between a freezing-point and a vapor-pressure model.

89. If this is a pediatric hospital, which model is better?
A) Freezing-point
B) Vapor-pressure

90. Which model is more likely to be affected by technical errors?
A) Freezing-point
B) Vapor-pressure

91. Which model is affected by lipemic serum but *not* elevated ethanol levels?
A) Freezing-point
B) Vapor-pressure

92. What substance is used as a reference standard in both models?
A) KCl
B) Distilled water
C) NaCl
D) Deionized water

Use the following to answer questions 93-95:

A physician is treating a patient exhibiting symptoms of impaired renal function following a massive hemorrhage. The physician orders a serum sodium and a PAH clearance test. The patient has a serum PAH of 1.0 mg/dL, urine PAH of 200 mg/dL, and a urine volume of 240 mL in 2 hours. The serum sodium is decreased.

93. Based on the tests ordered, what renal function is the physician's primary concern?
A) Glomerular filtration
B) Tubular reabsorption
C) Tubular secretion
D) Renal blood flow

94. Calculate the patient's renal blood flow.
A) 100 mL/min
B) 200 mL/min
C) 300 mL/min
D) 400 mL/min

95. Would it be better for this patient to have an increased or decreased serum renin level?
A) Increased
B) Decreased

Answer Key

1. D
2. C
3. D
4. D
5. C
6. B
7. C
8. D
9. B
10. B
11. A
12. C
13. A
14. B
15. D
16. C
17. D
18. B
19. C
20. D
21. A
22. C
23. B
24. D
25. A
26. C
27. D
28. D
29. C
30. B
31. C
32. B
33. A
34. B
35. B
36. D
37. C
38. B
39. C
40. B
41. B
42. C
43. D
44. A

45. B
46. B
47. D
48. A
49. D
50. C
51. B
52. C
53. A
54. D
55. B
56. D
57. D
58. A
59. B
60. A
61. C
62. C
63. C
64. B
65. A
66. B
67. B
68. B
69. B
70. A
71. A
72. B
73. B
74. B
75. A
76. D
77. A
78. B
79. D
80. B
81. C
82. B
83. C
84. A
85. D
86. B
87. A
88. B
89. B
90. B

91. A
92. C
93. D
94. D
95. A