

Physio Renal Dr. Khaled

1. Regarding physiologic anatomy of the kidneys which of the following is incorrect:

- a) The kidneys are posterior abdominal wall structure, an extraperitoneal structure.
- b) The ureters and renal veins pass to the kidney at the hilum.
- c) The renal pelvis is a globular structure from which rises the major calyces
- d) The pyramids are parts of the medulla have apices open to the papillae.
- e) Bowman's capsules for all nephrons lie in the cortex

2. About the filtration barrier:

- a) The pores of the filtration membrane are about 8 nanometers still does not allow passage of albumin (6 nanometer)
- b) It consists from 4 different specialized layers.
- c) All the layers contain special fixed negative charges that prevent passage of large negatively charged molecule.
- d) The foot processes are specialized projection arise from capillary endothelial cells to form the slit pores.
- e) The filterability of the molecule is directly proportional to its diameter.

3. Concerning the Juxtamedullary nephrons

- a) lie superficially in the renal cortex
- b) Its loop of Henle are surrounded by extensive network of peritubular capillaries
- c) Have shorter loop of Henle
- d) Plays a minor role in urine concentration.
- e) 20% to 30% of the nephrons

4. Use the values below to answer the following question.

Glomerular capillary hydrostatic pressure = 47 mm Hg

Bowman space hydrostatic pressure = 10 mm Hg Bowman space oncotic pressure = 0 mm Hg

At what value of glomerular capillary oncotic pressure would glomerular filtration stop?

- a) 57 mm Hg
- b) 47 mm Hg
- c) 37 mm Hg
- d) 10 mm Hg
- e) 0 mm Hg

5. By which of the following angiotensin II would produce an increase in the reabsorption through tubule?

- a) Increased filtration fraction
- b) Extracellular fluid (ECF) volume expansion
- c) Decreased peritubular capillary protein concentration
- d) Increased peritubular capillary hydrostatic pressure
- e) Oxygen deprivation

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6. Which of the following would cause an increase in both glomerular filtration rate (GFR) and renal plasma flow (RPF)?

- a) Hyperproteinemia
- b) A ureteral stone
- c) Dilation of the afferent arteriole
- d) Constriction of the efferent arteriole
- e) C and D are correct

7. If a drug totally blocked glucose reabsorption, then its clearance:

- a) Is not affected.
- b) Equals inulin clearance
- c) The same as transport maximum
- d) Can be used to measure renal plasma flow
- e) All of above are true

8. To maintain normal H^+ balance, total daily excretion of H^+ should equal the daily

- a) CO_2 produced through oxidative phosphorylation
- b) HCO_3^- -excretion
- c) HCO_3^- -filtered load
- d) fixed acid production plus fixed acid ingestion
- e) filtered load of H^+

9. regarding the clearance of a substance:

- a) it equals the amount of substance removed from the plasma as it passes the kidneys per unit of time.
- b) It can be used to estimate substance filtration and reabsorption not secretion
- c) The clearance of inulin is used to measure GFR and renal plasma flow
- d) The clearance of creatinine can be used to estimate GFR
- e) The clearance of PAH exactly equals renal plasma flow.

10. The reabsorption of filtered HCO_3^-

- a) results in reabsorption of less than 50% of the filtered load when the plasma concentration of HCO_3^- is 24 mEq/L
- b) acidifies tubular fluid to a pH of 4.4
- c) is directly linked to excretion of H^+ as NH_4^+
- d) is inhibited by decreases in arterial PCO_2
- e) can proceed normally in the presence of a renal carbonic anhydrase inhibitor

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11. which of the following substance is associated with increase in renal plasma flow and GFR:

- a) Nitric oxide
- b) Angiotensin II
- c) Norepinephrine
- d) Endothelin
- e) None of the above

12. Regarding signals from macula densa which is true:

- a) Will increase the renal blood flow through efferent arteriole feedback.
- b) Will increase the Glomerular hydrostatic pressure through feedback to both afferent and efferent arterioles.
- c) is directly proportional to amount of Na delivered to juxtaglomerular cells
- d) Will result in angiotensin release from granular cells
- e) Does not play role in renal autoregulation

13. Which of the following substances will lead to enhanced Na reabsorption through kidneys:

- a) Proteins in high protein diet.
- b) Systemic stimulation by aldosterone
- c) Systemic stimulation by ANP
- d) A and B
- e) A and B and C

14. Incorrect

- a) Aquaporin 3 and 4 expression is dependent on ADH stimulation.
- b) Its effect can result indirectly in net increase in Na excretion.
- c) Stimulation through osmotic changes is more durable than through blood pressure changes.
- d) Volume overload will not cause any further secretion of ADH.
- e) All of above are incorrect.

15. All of the following conditions will evoke increase in plasma ADH except:

- a) Dehydration
- b) Trauma
- c) Pain
- d) Hyponatremia
- e) Hemorrhage

16. Which of the following substances has the lowest renal clearance:

- a) Glucose
- b) Urea
- c) Inulin
- d) Creatinine
- e) PAH

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17. Which of the following substances has the highest renal clearance:

- a) Glucose
- b) urea
- c) inulin
- d) creatinine
- e) PAH

18. A patient with uncontrolled hypertension is placed on a new diuretic targeted to the Na⁺ reabsorption site from the basolateral surface of the renal epithelial cells. Which of the following transport processes is the new drug affecting?

- a) Na⁺/H⁺ exchange
- b) Na⁺-glucose cotransport
- c) Na⁺-K⁺ pump.
- d) Facilitated diffusion
- e) Solvent drag

1. Secretion of K^+ by the distal tubule will be decreased by

- (A) metabolic alkalosis
- (B) a high- K^+ diet
- (C) hyperaldosteronism
- (D) spironolactone administration
- (E) thiazide diuretic administration

2. Jared and Adam both weigh 70 kg. Jared drinks 2 L of distilled water, and Adam drinks 2 L of isotonic NaCl. As a result of these ingestions, Adam will have a

- (A) greater change in intracellular fluid (ICF) volume
- (B) higher positive free-water clearance ($-C_{H_2O}$)
- (C) greater change in plasma osmolarity
- (D) higher urine osmolarity
- (E) higher urine flow rate

Questions 3 and 4

A 45-year-old woman develops severe diarrhea while on vacation. She has the following arterial blood values:

pH = 7.25

P_{CO_2} = 24 mm Hg

$[HCO_3^-]$ = 10 mEq/L

Venous blood samples show decreased blood $[K^+]$ and a normal anion gap.

3. The correct diagnosis for this patient is

- (A) metabolic acidosis
- (B) metabolic alkalosis
- (C) respiratory acidosis
- (D) respiratory alkalosis
- (E) normal acid–base status

4. Which of the following statements about this patient is correct?

- (A) She is hypoventilating
- (B) The decreased arterial $[HCO_3^-]$ is a result of buffering of excess H^+ by HCO_3^-
- (C) The decreased blood $[K^+]$ is a result of exchange of intracellular H^+ for extracellular K^+
- (D) The decreased blood $[K^+]$ is a result of increased circulating levels of

aldosterone

(E) The decreased blood $[K^+]$ is a result of decreased circulating levels of antidiuretic hormone (ADH)

5. Use the values below to answer the following question.

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6. The reabsorption of filtered HCO_3^-

(A) results in reabsorption of less than 50% of the filtered load when the plasma concentration of HCO_3^- is 24 mEq/L

(B) acidifies tubular fluid to a pH of 4.4

(C) is directly linked to excretion of H^+ as NH_4^+

(D) is inhibited by decreases in arterial P_{CO_2}

(E) can proceed normally in the presence of a renal carbonic anhydrase inhibitor

7. The following information was obtained in a 20-year-old college student who was participating in a research study in the Clinical Research Unit:

Plasma

[Inulin] = 1 mg/mL

[X] = 2 mg/mL

Urine

[Inulin] = 150 mg/mL

[X] = 100 mg/mL

Urine flow rate = 1 mL/min

Assuming that X is freely filtered, which of the following statements is most

correct?

- (A) There is net secretion of X
- (B) There is net reabsorption of X
- (C) There is both reabsorption and secretion of X
- (D) The clearance of X could be used to measure the glomerular filtration rate (GFR)
- (E) The clearance of X is greater than the clearance of inulin

8. To maintain normal H^+ balance, total daily excretion of H^+ should equal the daily

- (A) fixed acid production plus fixed acid ingestion
- (B) HCO_3^- excretion
- (C) HCO_3^- filtered load
- (D) titratable acid excretion
- (E) filtered load of H^+

9. One gram of mannitol was injected into a woman. After equilibration, a plasma sample had a mannitol concentration of 0.08 g/L. During the equilibration period, 20% of the injected mannitol was excreted in the urine. The woman's

- (A) extracellular fluid (ECF) volume is 1 L
- (B) intracellular fluid (ICF) volume is 1 L
- (C) ECF volume is 10 L
- (D) ICF volume is 10 L
- (E) interstitial volume is 12.5 L

10. A 58-year-old man is given a glucose tolerance test. In the test, the plasma glucose concentration is increased and glucose reabsorption and excretion are measured. When the plasma glucose concentration is higher than occurs at transport maximum (T_m), the

- (A) clearance of glucose is zero
- (B) excretion rate of glucose equals the filtration rate of glucose
- (C) reabsorption rate of glucose equals the filtration rate of glucose
- (D) excretion rate of glucose increases with increasing plasma glucose concentrations
- (E) renal vein glucose concentration equals the renal artery glucose concentration

11. A negative free-water clearance ($-C_{H_2O}$) will occur in a person who
- (A) drinks 2 L of distilled water in 30 minutes
 - (B) begins excreting large volumes of urine with an osmolarity of 100 mOsm/L after a severe head injury
 - (C) is receiving lithium treatment for depression and has polyuria that is unresponsive to the administration of antidiuretic hormone (ADH)
 - (D) has an oat cell carcinoma of the lung, and excretes urine with an osmolarity of 1000 mOsm/L
12. A buffer pair (HA/A^-) has a pK of 5.4. At a blood pH of 7.4, the concentration of HA is
- (A) 1/100 that of A^-
 - (B) 1/10 that of A^-
 - (C) equal to that of A^-
 - (D) 10 times that of A^-
 - (E) 100 times that of A^-
13. Which of the following would produce an increase in the reabsorption of isosmotic fluid in the proximal tubule?
- (A) Increased filtration fraction
 - (B) Extracellular fluid (ECF) volume expansion
 - (C) Decreased peritubular capillary protein concentration
 - (D) Increased peritubular capillary hydrostatic pressure
 - (E) Oxygen deprivation
14. Which of the following substances or combinations of substances could be used to measure interstitial fluid volume?
- (A) Mannitol
 - (B) D_2O alone
 - (C) Evans blue
 - (D) Inulin and D_2O
 - (E) Inulin and radioactive albumin
15. At plasma para-aminohippuric acid (PAH) concentrations below the transport maximum (T_m), PAH
- (A) reabsorption is not saturated
 - (B) clearance equals inulin clearance
 - (C) secretion rate equals PAH excretion rate

(D) concentration in the renal vein is close to zero

(E) concentration in the renal vein equals PAH concentration in the renal artery

16. Compared with a person who ingests 2 L of distilled water, a person with water deprivation will have a

(A) higher free-water clearance (C_{H_2O})

(B) lower plasma osmolarity

(C) lower circulating level of antidiuretic hormone (ADH)

(D) higher tubular fluid/plasma (TF/P) osmolarity in the proximal tubule

(E) higher rate of H_2O reabsorption in the collecting ducts

17. Which of the following would cause an increase in both glomerular filtration rate (GFR) and renal plasma flow (RPF)?

(A) Hyperproteinemia

(B) A ureteral stone

(C) Dilation of the afferent arteriole

(D) Dilation of the efferent arteriole

(E) Constriction of the efferent arteriole

18. A patient has the following arterial blood values:

pH = 7.52

P_{CO_2} = 20 mm Hg

$[HCO_3^-]$ = 16 mEq/L

Which of the following statements about this patient is most likely to be correct?

(A) He is hypoventilating

(B) He has decreased ionized $[Ca^{2+}]$ in blood

(C) He has almost complete respiratory compensation

(D) He has an acid–base disorder caused by overproduction of fixed acid

(E) Appropriate renal compensation would cause his arterial $[HCO_3^-]$ to increase

19. Which of the following would best distinguish an otherwise healthy person with severe water deprivation from a person with the syndrome of inappropriate antidiuretic hormone (SIADH)?

(A) Free-water clearance (C_{H_2O})

- (B) Urine osmolarity
- (C) Plasma osmolarity
- (D) Circulating levels of antidiuretic hormone (ADH)
- (E) Corticopapillary osmotic gradient

20. Which of the following causes a decrease in renal Ca^{2+} clearance?

- (A) Hypoparathyroidism
- (B) Treatment with chlorothiazide
- (C) Treatment with furosemide
- (D) Extracellular fluid (ECF) volume expansion
- (E) Hypermagnesemia

21. A patient arrives at the emergency room with low arterial pressure, reduced tissue turgor, and the following arterial blood values:

$$\text{pH} = 7.69$$

$$[\text{HCO}_3^-] = 57 \text{ mEq/L}$$

$$\text{Pco}_2 = 48 \text{ mm Hg}$$

Which of the following responses would also be expected to occur in this patient?

- (A) Hyperventilation
- (B) Decreased K^+ secretion by the distal tubules
- (C) Increased ratio of H_2PO_4^- to HPO_4^{2-} in urine
- (D) Exchange of intracellular H^+ for extracellular K^+

22. A woman has a plasma osmolarity of 300 mOsm/L and a urine osmolarity of 1200 mOsm/L. The correct diagnosis is

- (A) syndrome of inappropriate antidiuretic hormone (SIADH)
- (B) water deprivation
- (C) central diabetes insipidus
- (D) nephrogenic diabetes insipidus
- (E) drinking large volumes of distilled water

23. A patient is infused with para-aminohippuric acid (PAH) to measure renal blood flow (RBF). She has a urine flow rate of 1 mL/min, a plasma [PAH] of 1 mg/mL, a urine [PAH] of 600 mg/mL, and a hematocrit of 45%. What is her “effective” RBF?

- (A) 600 mL/min
- (B) 660 mL/min
- (C) 1091 mL/min
- (D) 1333 mL/min

24. Which of the following substances has the highest renal clearance?

- (A) Para-aminohippuric acid (PAH)
- (B) Inulin
- (C) Glucose
- (D) Na^+
- (E) Cl^-

25. A woman runs a marathon in 90°F weather and replaces all volume lost in sweat by drinking distilled water. After the marathon, she will have

- (A) decreased total body water (TBW)
- (B) decreased hematocrit
- (C) decreased intracellular fluid (ICF) volume
- (D) decreased plasma osmolarity
- (E) increased intracellular osmolarity

26. Which of the following causes hyperkalemia?

- (A) Exercise
- (B) Alkalosis
- (C) Insulin injection
- (D) Decreased serum osmolarity
- (E) Treatment with β -agonists

27. Which of the following is a cause of metabolic alkalosis?

- (A) Diarrhea
- (B) Chronic renal failure
- (C) Ethylene glycol ingestion
- (D) Treatment with acetazolamide
- (E) Hyperaldosteronism
- (F) Salicylate poisoning

28. Which of the following is an action of parathyroid hormone (PTH) on the renal tubule?

- (A) Stimulation of adenylate cyclase
- (B) Inhibition of distal tubule K^+ secretion

- (C) Inhibition of distal tubule Ca^{2+} reabsorption
- (D) Stimulation of proximal tubule phosphate reabsorption
- (E) Inhibition of production of 1,25-dihydroxycholecalciferol

29. A man presents with hypertension and hypokalemia. Measurement of his arterial blood gases reveals a pH of 7.5 and a calculated HCO_3^- of 32 mEq/L. His serum cortisol and urinary vanillylmandelic acid (VMA) are normal, his serum aldosterone is increased, and his plasma renin activity is decreased. Which of the following is the most likely cause of his hypertension?

- (A) Cushing syndrome
- (B) Cushing disease
- (C) Conn syndrome
- (D) Renal artery stenosis
- (E) Pheochromocytoma

30. Which set of arterial blood values describes a heavy smoker with a history of emphysema and chronic bronchitis who is becoming increasingly somnolent?

	pH	HCO_3^- (mEq/L)	Pco_2 (mm Hg)
(A)	7.65	48	45
(B)	7.50	15	20
(C)	7.40	24	40
(D)	7.32	30	60
(E)	7.31	16	33

31. Which set of arterial blood values describes a patient with partially compensated respiratory alkalosis after 1 month on a mechanical ventilator?

	pH	HCO₃⁻ (mEq/L)	Pco₂ (mm Hg)
(A)	7.65	48	45
(B)	7.50	15	20
(C)	7.40	24	40
(D)	7.32	30	60
(E)	7.31	16	33

32. Which set of arterial blood values describes a patient with chronic renal failure (eating a normal protein diet) and decreased urinary excretion of NH₄⁺?

	pH	HCO₃⁻ (mEq/L)	Pco₂ (mm Hg)
(A)	7.65	48	45
(B)	7.50	15	20
(C)	7.40	24	40
(D)	7.32	30	60
(E)	7.31	16	33

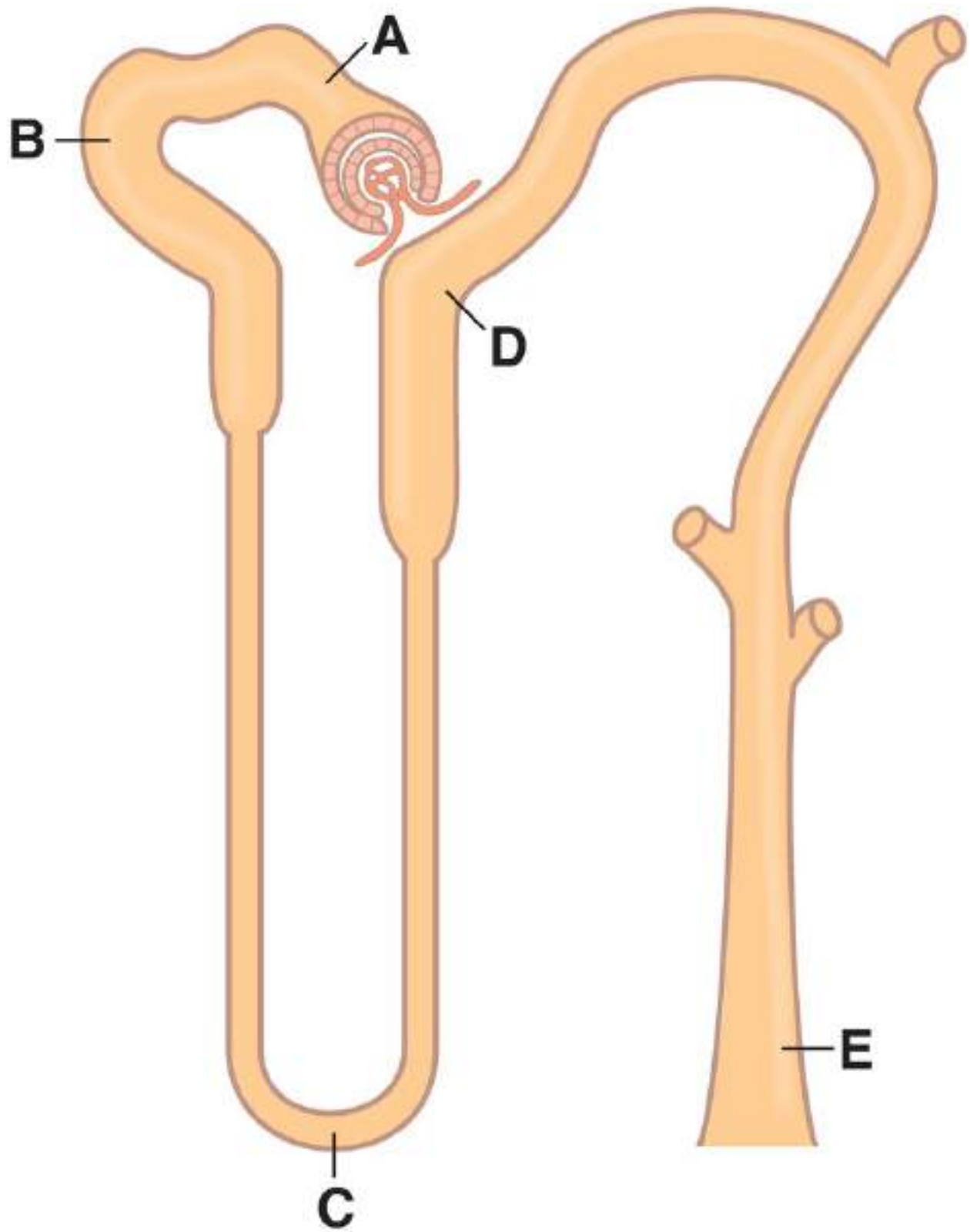
33. Which set of arterial blood values describes a patient with untreated diabetes mellitus and increased urinary excretion of NH₄⁺?

	pH	HCO₃⁻ (mEq/L)	Pco₂ (mm Hg)
(A)	7.65	48	45
(B)	7.50	15	20
(C)	7.40	24	40
(D)	7.32	30	60
(E)	7.31	16	33

34. Which set of arterial blood values describes a patient with a 5-day history of vomiting?

	pH	HCO_3^- (mEq/L)	Pco_2 (mm Hg)
(A)	7.65	48	45
(B)	7.50	15	20
(C)	7.40	24	40
(D)	7.32	30	60
(E)	7.31	16	33

The following figure applies to Questions 35–39.



35. At which nephron site does the amount of K^+ in tubular fluid exceed the

amount of filtered K^+ in a person on a high- K^+ diet?

- (A) Site A
- (B) Site B
- (C) Site C
- (D) Site D
- (E) Site E

36. At which nephron site is the tubular fluid/plasma (TF/P) osmolarity lowest in a person who has been deprived of water?

- (A) Site A
- (B) Site B
- (C) Site C
- (D) Site D
- (E) Site E

37. At which nephron site is the tubular fluid inulin concentration highest during antidiuresis?

- (A) Site A
- (B) Site B
- (C) Site C
- (D) Site D
- (E) Site E

38. At which nephron site is the tubular fluid inulin concentration lowest?

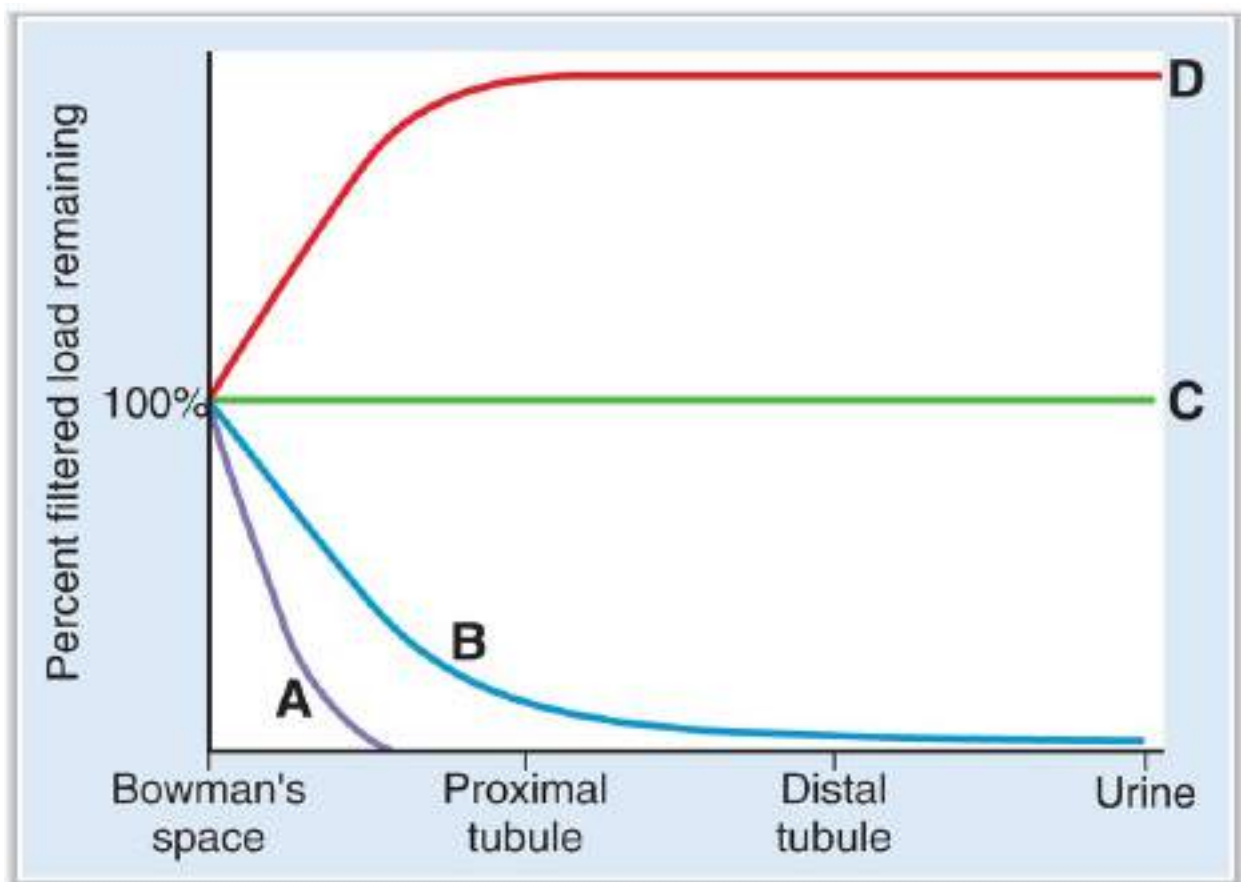
- (A) Site A
- (B) Site B
- (C) Site C
- (D) Site D
- (E) Site E

39. At which nephron site is the tubular fluid glucose concentration highest?

- (A) Site A
- (B) Site B
- (C) Site C
- (D) Site D
- (E) Site E

The following graph applies to Questions 40–42. The curves show the percentage of the filtered load remaining in the tubular fluid at various sites

along the nephron.



40. Which curve describes the inulin profile along the nephron?
- (A) Curve A
 - (B) Curve B
 - (C) Curve C
 - (D) Curve D

41. Which curve describes the alanine profile along the nephron?
- (A) Curve A
 - (B) Curve B
 - (C) Curve C
 - (D) Curve D

42. Which curve describes the para-aminohippuric acid (PAH) profile along the nephron?

- (A) Curve A
- (B) Curve B
- (C) Curve C
- (D) Curve D

43. A 5-year-old boy swallows a bottle of aspirin (salicylic acid) and is treated in the emergency room. The treatment produces a change in urine pH that increases the excretion of salicylic acid. What was the change in urine pH, and what is the mechanism of increased salicylic acid excretion?

- (A) Acidification, which converts salicylic acid to its HA form
- (B) Alkalinization, which converts salicylic acid to its A^- form
- (C) Acidification, which converts salicylic acid to its A^- form
- (D) Alkalinization, which converts salicylic acid to its HA form

44. A female graduate student is hyperventilating prior to her oral comprehensive examination. She is light-headed, and her feet and hands are numb and tingling. Which of the following set of blood values would be observed in the emergency room?

	pH	Pco ₂ , mm Hg	Po ₂ , mm Hg	Ionized Ca ²⁺
(A)	7.3	30	100	Decreased
(B)	7.3	50	90	Increased
(C)	7.4	40	100	Normal
(D)	7.5	30	110	Decreased
(E)	7.5	50	90	Increased

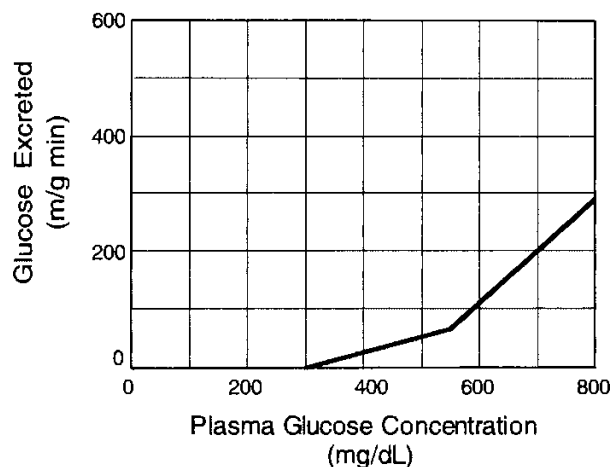
ANSWERS AND EXPLANATIONS

1. The answer is D [V B 4 b]. Distal K^+ secretion is decreased by factors that decrease the driving force for passive diffusion of K^+ across the luminal membrane. Because spironolactone is an aldosterone antagonist, it reduces K^+ secretion. Alkalosis, a diet high in K^+ , and hyperaldosteronism all increase $[K^+]$ in the distal cells and thereby increase K^+ secretion. Thiazide diuretics increase flow through the distal tubule and dilute the luminal $[K^+]$ so that the driving

Renal and Urinary Physiology

Questions

372. A 65-year-old man with uncontrolled Type II diabetes and sustained hyperglycemia (serum glucose = 550 mg/dL) and polyuria (5 L/day) is evaluated in the hospital's clinical laboratory because his urine glucose concentration (<100 mM) was much lower than expected. The graph below illustrates the relationship between plasma glucose concentration and renal glucose reabsorption for this patient. The glomerular filtration rate (GFR) is 100 mL/min. Which of the following is the $T_{\max}$ for glucose?



- a. 100 mg/min
- b. 200 mg/min
- c. 300 mg/min
- d. 400 mg/min
- e. 500 mg/min

373. A 16-year-old girl with Liddle's syndrome presents with hypertension, hypervolemia, and hypokalemia, but low levels of renin and aldosterone. Her clinical condition is reversed by administration of a diuretic, which acts by blocking epithelial sodium channels. Which of the following is the major defect in Liddle's syndrome?

- a. Increased sodium reabsorption by the proximal tubules
- b. Increased sodium reabsorption by the distal nephron**
- c. An inability of the distal nephron to secrete potassium ion
- d. An inability of the distal nephron to secrete hydrogen
- e. An inability of the distal nephron to concentrate urine

374. A previously well 12-year-old boy is brought to the Emergency Department with vomiting and severe abdominal cramps after a prolonged period of exercise. Elevated levels of serum creatinine and blood urea nitrogen suggest acute renal failure. Following treatment and recovery, his serum uric acid concentration (0.6 mg/dL) remains consistently below normal. To determine if his low serum uric acid level is related to renal dysfunction, uric acid clearance studies are conducted and the following data are obtained:

Urine volume = 1 mL/min

Urine uric acid = 36 mg/dL

Which of the following is the patient's uric acid clearance?

- a. 6 mL/min
- b. 12 mL/min
- c. 24 mL/min
- d. 48 mL/min
- e. 60 mL/min**

375. A 69-year-old male presents with symptoms of thirst and dizziness, and physical evidence of orthostatic hypotension and tachycardia, decreased skin turgor, dry mucous membranes, reduced axillary sweating, and reduced jugular venous pressure. He was recently placed on an angiotensin-converting enzyme inhibitor for his hypertension. Urinalysis reveals a reduction in the fractional excretion of sodium and the presence of acellular hyaline casts. The internist suspects acute renal failure of prerenal origin, which has increased renin secretion by the kidney. A stimulus for increasing renal renin secretion is an increase in which of the following?

- a. Mean blood pressure
- b. Glomerular filtration rate

- c. Sympathetic nerve activity
- d. Circulating angiotensin II
- e. Atrial natriuretic peptide secretion

376. A patient with uncontrolled hypertension is placed on a new diuretic targeted to the Na^+ reabsorption site from the basolateral surface of the renal epithelial cells. Which of the following transport processes is the new drug affecting?

- a. Na^+/H^+ exchange
- b. Na^+ -glucose cotransport
- c. Na^+/K^+ pump
- d. Facilitated diffusion
- e. Solvent drag

377. Which of the following is most likely to cause an increase in the glomerular filtration rate?

- a. Contraction of mesangial cells
- b. Blockage of the ureter
- c. Release of renin from the juxtaglomerular apparatus
- d. Dilation of the afferent arterioles
- e. Volume depletion

378. A 32-year-old man complaining of fatigue and muscle weakness is seen by his physician. Blood tests reveal a serum glucose level of 325 mg/dL and serum creatinine of 0.8 mg/dL. Results of a 24-hour urine analysis are as follows:

Total volume = 5 L

Total glucose = 375 g

Total creatinine = 2.4 g

The patient's glomerular filtration rate is approximately which of the following?

- a. 75 mL/min
- b. 100 mL/min
- c. 125 mL/min
- d. 200 mL/min
- e. 275 mL/min

379. A 38-year-old woman is admitted to the hospital by her physician because of decreased urine output. Prior to admission, she was rehearsing for a dance performance and had been taking Motrin for pain. Laboratory data reveal: blood urea nitrogen, 49 mg/dL; serum sodium, 135 mmol/L; serum creatinine, 7.5 mg/dL; urine sodium, 33 mmol/L, and urine creatinine, 90 mg/dL. Her fractional sodium excretion is approximately which of the following?

- a. 0.5%
- b. 1.0%
- c. 1.5%
- d. 2.0%
- e. 3.0%

380. An 85-year-old woman presents with a fever and hypovolemic hypotension. To assess her renal function, the filtration fraction is determined using a freely filterable substance that is neither reabsorbed nor secreted. The infusate yields a renal artery concentration of 12 mg/mL and a renal vein concentration of 9 mg/mL. Which of the following is the filtration fraction?

- a. 0.05
- b. 0.15
- c. 0.25
- d. 0.35
- e. 0.45

381. A 17-year-old girl went on a starvation diet for 3 days before prom so that she would look thin in her new dress. Her mother found her lethargic and hyperventilating, and took her to the Emergency Department for evaluation. Based on the following laboratory values, which of the following is her net acid excretion?

Plasma pH = 7.26

Urine flow = 1.2 L/day

Urine bicarbonate = 2 mEq/L

Urine titratable acids = 24 mEq/L

Urine ammonium = 38 mEq/L

Urine pH = 5.4

- a. 60 mEq/L
- b. 64 mEq/L
- c. 68 mEq/L
- d. 72 mEq/L
- e. 76 mEq/L

382. A 68-year-old woman presents with hypertension and oliguria. A CT of the abdomen reveals a hypoplastic left kidney. Based on the following laboratory data, which of the following is her estimated renal plasma flow?

Renal artery PAH = 6 mg/dL

Renal vein PAH = 0.6 mg/dL

Urinary PAH = 25 mg/mL

Urine flow = 1.5 mL/min

Hematocrit = 40%

- a. 475 mL/min
- b. 550 mL/min
- c. 625 mL/min
- d. 700 mL/min
- e. 775 mL/min

383. If a substance appears in the renal artery but not in the renal vein, which of the following is true?

- a. It must be filtered by the kidney
- b. It must be reabsorbed by the kidney
- c. Its clearance is equal to the glomerular filtration rate
- d. Its clearance is equal to the renal plasma flow
- e. Its urinary concentration must be higher than its plasma concentration

384. A 46-year-old man presents to his physician with a 12-week history of frontal headaches. A computed tomography (CT) of the brain shows a mass in the posterior pituitary, and the posterior pituitary “bright spot” is absent on MRI. The patient also complains of increased thirst and waking up frequently during the night. Which of the following best describes his urine?

- a. A higher-than-normal flow of hypotonic urine
- b. A higher-than-normal flow of hypertonic urine
- c. A normal flow of hypertonic urine
- d. A lower-than-normal flow of hypotonic urine
- e. A lower-than-normal flow of hypertonic urine

385. A 63-year-old woman is brought to the Emergency Department complaining of fatigue and headaches. She appears confused and apathetic. She has been taking diuretics to treat her hypertension and paroxetine for her depression. Laboratory results are as follows:

urine flow = 2 L/day
serum sodium = 125 mmol/L
serum potassium = 4 mmol/L
urine osmolality = 385 mOsm/L
urine sodium = 125 mmol/L
urine potassium = 25 mmol/L

Which of the following is this patient's approximate free water clearance?

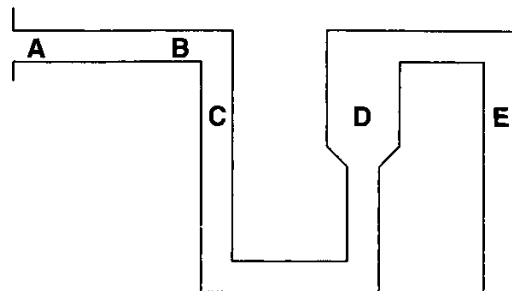
- a. -0.20 L/day
- b. -0.50 L/day
- c. -0.75 L/day
- d. +0.2 L/day
- e. +0.50 L/day

386. A 28-year-old woman with systemic lupus erythematosus (SLE) is brought to the Emergency Department after developing hypokalemic paralysis. Arterial blood-gas analysis shows a PaO_2 of 102 mmHg and a pH of 7.1. She is diagnosed with Type I renal tubular acidosis caused by an autoimmune response that damages the H^+ -ATPase on the distal nephron. Which of the following laboratory measurements will most likely be normal in this patient?

- a. Net acid excretion
- b. Aldosterone secretion
- c. Serum bicarbonate
- d. Urine ammonium
- e. Anion gap

Questions 387–389.

Use the following diagram of a nephron to answer the next three questions.



387. In the absence of ADH, the luminal Na^+ concentration is lowest at which of the following points?

- a. A
- b. B
- c. C
- d. D
- e. E

388. Parathyroid hormone increases Ca^{2+} reabsorption at which of the following points?

- a. A
- b. B
- c. C
- d. D
- e. E

389. Aldosterone increases Na^+ reabsorption at which of the following points?

- a. A
- b. B
- c. C
- d. D
- e. E

390. A 92-year-old man presents with dehydration following four days of persistent diarrhea. Under these circumstances, hypotonic fluid would be expected in which of the following?

- a. Glomerular filtrate
- b. Proximal tubule
- c. Loop of Henle
- d. Cortical collecting tubule
- e. Distal collecting duct

391. A hospitalized patient becomes oliguric with increasing BUN and creatinine. Urine specific gravity is low and the urine sediment has red cell casts with hematuria and proteinuria. Which of the following statements concerning the normal renal handling of proteins is correct?

- a. Proteins are more likely to be filtered if they are negatively charged than if they are uncharged
- b. Proteins can be filtered and secreted but not reabsorbed by the kidney
- c. Most of the protein excreted each day is derived from tubular secretion
- d. Protein excretion is directly related to plasma protein concentration
- e. Protein excretion is increased by sympathetic stimulation of the kidney

392. Which of the following best explains why the pH of the tubular fluid in the distal nephron can be lower than that in the proximal tubule?

- a. A greater sodium gradient can be established across the wall of the distal nephron than across the wall of the proximal tubule
- b. More buffer is present in the tubular fluid of the distal nephron than in the proximal tubule
- c. More hydrogen ion is secreted into the distal nephron than into the proximal tubule
- d. The brush border of the distal nephron contains more carbonic anhydrase than that of the proximal tubule
- e. The tight junctions of the distal nephron are less leaky to solute than those of the proximal tubule

393. An 18-year-old male presents with muscle weakness, cramps, and tetany. Blood pressure is normal and no edema is present. Laboratory analysis reveals hypokalemic alkalosis, hyperaldosteronism, and high plasma renin activity, diagnostic of Bartter's syndrome. Which of the following statements about renin is true?

- a. It is secreted by cells of the proximal tubule
- b. Its secretion leads to loss of sodium and water from plasma
- c. Its secretion is stimulated by increased mean renal arterial pressure
- d. It converts angiotensinogen to angiotensin I
- e. It converts angiotensin I to angiotensin II

394. The effective renal plasma flow, determined, from the clearance of *p*-aminohippuric acid (PAH), is less than the true renal plasma flow because of which of the following?

- a. The fraction of PAH filtered is less than the filtration fraction
- b. The plasma entering the renal vein contains a small amount of PAH
- c. The cortical and medullary collecting ducts are able to reabsorb some PAH

- d. The calculated clearance of PAH depends on the urinary flow rate
- e. The measured value of the plasma PAH concentration is less than the actual PAH concentration

395. A 63-year-old hospitalized woman becomes oliguric and confused. Her blood glucose is found to be only 35 mg/dL. An IV access is obtained and an ampule of 50% dextrose is given followed by a continuous infusion of 10% dextrose. Most of the glucose that is filtered through the glomerulus undergoes reabsorption in which of the following?

- a. Proximal tubule
- b. Descending limb of the loop of Henle
- c. Ascending limb of the loop of Henle
- d. Distal tubule
- e. Collecting duct

396. A patient with multiple myeloma develops a defect in renal bicarbonate reabsorption, which involves the proximal tubule, that is, Type 2 renal tubular acidosis (RTA). Which of the following structural features distinguishes the epithelial cells of the proximal tubule from those of the distal tubule?

- a. The distal tubule has a thicker basement membrane
- b. The proximal tubule has a thicker basement membrane
- c. The proximal tubule has a more extensive brush border
- d. The proximal tubule forms the juxtaglomerular apparatus
- e. The distal tubule has fewer tight intercellular junctions

397. A 35-year-old male with polycystic kidney disease has a decrease in both glomerular filtration rate (GFR) and renal blood flow (RBF). The nephrologist wants to administer a drug that will increase both GFR and RBF. GFR and RBF would both increase if which of the following occurred?

- a. The efferent and afferent arterioles are both dilated
- b. The efferent and afferent arterioles are both constricted
- c. Only the afferent arteriole is constricted
- d. Only the efferent arteriole is constricted
- e. The afferent arteriole is constricted and the efferent arteriole is dilated

398. A patient with Type IV renal tubular acidosis (RTA) has a defect in aldosterone secretion and ammonium excretion. Which of the following statements about ammonia (NH_3) is correct?

- a. It is impermeable to the epithelial cells of the proximal tubule
- b. It is classified as a titratable acid
- c. It is produced by epithelial cells in the distal nephron
- d. It reduces the concentration of bicarbonate in the plasma
- e. Its synthesis is increased in respiratory acidosis

399. A patient with hypertension is given a K^+ -sparing diuretic. The amount of potassium excreted by the kidney will decrease if which of the following occurs?

- a. Distal tubular flow increases
- b. Circulating aldosterone levels increase
- c. Dietary intake of potassium increases
- d. Na^+ reabsorption by the distal nephron decreases
- e. The excretion of organic ions decreases

400. Which of the following substances will be more concentrated at the end of the proximal tubule than at the beginning of the proximal tubule?

- a. Glucose
- b. Creatinine
- c. Sodium
- d. Bicarbonate
- e. Phosphate

401. Decreasing the resistance of the afferent arteriole in the glomerulus of the kidney will decrease which of the following?

- a. Glomerular filtration rate
- b. Renal plasma flow
- c. Filtration fraction
- d. The oncotic pressure of the peritubular capillary blood
- e. Renin release from juxtaglomerular cells

402. Electrically neutral active transport of sodium and chloride from the lumen of the kidney occurs in which of the following?

- a. Proximal tubule
- b. Descending limb of the loop of Henle
- c. Thin ascending limb of the loop of Henle
- d. Cortical collecting duct
- e. Medullary collecting duct

403. A postoperative patient develops a thready pulse, tachycardia, and hypotension. A decision is made to take the patient back to surgery to check for bleeding. Laboratory analysis shows an increase in plasma angiotensin II accompanied by an increase in glomerular filtration rate (GFR). When GFR increases, proximal tubular reabsorption of salt and water increases by a process called glomerulotubular balance. Contributions to this process include which of the following?

- a. An increase in peritubular capillary hydrostatic pressure
- b. A decrease in peritubular sodium concentration
- c. An increase in peritubular oncotic pressure
- d. An increase in proximal tubular flow
- e. An increase in peritubular capillary flow

404. A 24-year-old man with a history of renal insufficiency is admitted to the hospital after taking a large amount of ibuprofen. His BUN is 150 mg/dL. This patient's high serum urea nitrogen was most likely caused by which of the following?

- a. An increased synthesis of urea by the liver
- b. An increased reabsorption of urea by the proximal tubules
- c. A decreased secretion of urea by the distal tubules
- d. A decreased glomerular filtration rate
- e. An increased renal blood flow

405. A 36-year-old African-American male presents with low renin essential hypertension. Renin release from the juxtaglomerular apparatus is normally inhibited by which of the following?

- a. β -adrenergic agonists
- b. Prostaglandins
- c. Aldosterone
- d. Stimulation of the macula densa
- e. Increased pressure within the afferent arterioles

406. A patient undergoing surgery develops an increase in the secretion and plasma levels of ACTH, cortisol, and aldosterone. Which of the following statements about aldosterone is correct?

- a. It produces its effect by activating cAMP.
- b. It produces its effect by increasing distal tubular permeability to sodium.
- c. It causes an increased reabsorption of hydrogen ion.
- d. It has its main effect on the proximal tubule.
- e. It is secreted in response to an increase in blood pressure.

407. A trauma patient with multiple rib fractures requires intubation and mechanical ventilation. Mechanical ventilation causes an increase in the patient's vasopressin secretion and plasma levels. Which of the following is the effect of vasopressin on the kidney?

- a. Increased diameter of the renal artery
- b. Increased glomerular filtration rate
- c. Increased excretion of Na^+
- d. Increased excretion of water
- e. Increased permeability of the distal nephron to water

408. The ability of the kidney to excrete concentrated urine will increase if which of the following occurs?

- a. The reabsorption of Na^+ by the proximal tubule decreases
- b. The glomerular capillary pressure increases
- c. The flow of filtrate through the loop of Henle increases
- d. The activity of the $\text{Na}^+\text{-K}^+$ pump in the loop of Henle increases
- e. The permeability of the collecting duct to water decreases

409. A 16-year-old pregnant girl is admitted to the hospital in labor. Her blood pressure is 130/85 mmHg and her plasma creatinine is 2.7 mg/dL (normal 0.6 to 1.2 mg/dL). Renal ultrasonography demonstrates severe bilateral hydronephrosis (enlarged kidney). Which of the following is the most likely cause of this patient's high creatinine levels?

- a. Increased sympathetic nerve activity
- b. Coarctation of the renal artery
- c. Hyperproteinemia
- d. Ureteral obstruction
- e. Hypovolemia

410. A 54-year-old man with small cell lung cancer presents with lethargy, confusion, and muscle cramps. Blood work shows an increase in plasma levels of antidiuretic hormone (ADH), possibly from the ectopic production of ADH. In patients with the syndrome of inappropriate antidiuretic hormone (SIADH), which of the following will increase?

- a. The concentration of plasma sodium
- b. Intracellular volume
- c. Urinary flow
- d. Plasma oncotic pressure
- e. Plasma osmolarity

411. A patient with congestive heart failure is given the loop diuretic, furosemide, along with the potassium sparing diuretic, spironolactone. Which of the following comparisons between the distal nephron and the proximal tubule is correct?

- a. The distal nephron is more permeable to hydrogen ion than the proximal tubule.
- b. The distal nephron is less responsive to aldosterone than the proximal tubule.
- c. The distal nephron has a more negative intraluminal potential than the proximal tubule.
- d. The distal nephron secretes less potassium than the proximal tubule does.
- e. The distal nephron secretes more hydrogen ion than the proximal tubule does.

412. An elderly woman presents with spiking fever, shaking chills, nausea, and costovertebral angle tenderness. Urine cultures are positive and she is hospitalized for pyelonephritis. Her glomerular filtration rate (GFR) decreases with a resultant increase in the concentration of NaCl delivered in the intraluminal fluid to the thick ascending limb of the loop of Henle. Under these conditions, the macula densa will increase the formation and release of which of the following substances?

- a. ADH
- b. Aldosterone
- c. Adenosine
- d. Renin
- e. Angiotensinogen

413. Aldosterone secretion is increased when there is a decrease in the plasma concentration of which of the following?

- a. Renin
- b. Angiotensin II
- c. ACTH
- d. Sodium
- e. Potassium

414. A patient's 24-hour urine output is lower-than-normal. Which of the following situations would reduce urinary flow?

- a. Diabetes insipidus
- b. Diabetes mellitus
- c. Sympathetic stimulation
- d. Increased renal arterial pressure
- e. Infusion of mannitol

415. A 55-year-old hypertensive patient is placed on a potassium-sparing diuretic. Potassium-sparing diuretics inhibit Na^+ reabsorption in which of the following?

- a. Proximal tubule
- b. Distal tubule
- c. Thin descending limb of Henle's loop
- d. Thick descending limb of Henle's loop
- e. Thick ascending limb of Henle's loop

416. A patient has suffered from persistent diarrhea lasting for the past seven days. Which of the following would be increased in this patient?

- a. The filtered load of HCO_3^-
- b. The production of ammonia by the proximal tubule
- c. H^+ secretion by the distal nephron
- d. The anion gap
- e. The production of new bicarbonate by the distal nephron

417. In addition to increasing the permeability of the collecting duct to water, ADH increases the permeability of the collecting duct to which of the following?

- a. Hydrogen
- b. Ammonium
- c. Potassium
- d. Sodium
- e. Urea

418. The filtration fraction is increased by which of the following?

- a. Increasing renal blood flow
- b. Increasing afferent arteriolar resistance
- c. Increasing efferent arteriolar resistance
- d. Increasing plasma oncotic pressure
- e. Increasing the pressure within Bowman's capsule

419. A 23-year-old male is given acetazolamide to take for two days prior and throughout his four-day skiing trip to Breckenridge, Colorado (elevation = 10,000 ft) for the prophylactic treatment of high altitude sickness.

- a. The proximal tubule
- b. The thick ascending limb of Henle's loop
- c. The distal convoluted tubule
- d. The cortical collecting duct
- e. The outer medullary collecting duct

420. A patient with atherosclerosis shows signs of chronic renal failure attributed to poor renal perfusion and ischemic necrosis of the nephrons. Which of the following endogenous substances causes renal blood flow to decrease?

- a. Nitric oxide
- b. Atrial natriuretic peptide
- c. Acetylcholine
- d. Angiotensin II
- e. Dopamine

421. Which of the following substances is less concentrated at the end of the proximal tubule than at the beginning of the proximal tubule?

- a. Creatinine
- b. Hydrogen
- c. Chloride
- d. Phosphate
- e. Sodium

422. A patient develops acute renal failure due to an autoimmune disorder affecting the proximal tubules. What percentage of the filtered load of sodium is reabsorbed by the proximal tubule?

- a. 15%
- b. 25%
- c. 45%
- d. 65%
- e. 95%

423. A patient with congestive heart failure presents with jugular venous distention, ascites, and peripheral edema. Blood work shows elevated levels of plasma atrial natriuretic peptide (ANP). ANP decreases Na^+ reabsorption within which of the following?

- a. The proximal tubule
- b. The thick ascending limb of Henle's loop
- c. The distal convoluted tubule
- d. The cortical collecting duct
- e. The inner medullary collecting duct

424. Free water clearance by the kidney is increased by which of the following?

- a. Heart failure
- b. Renal failure
- c. Diuretic therapy
- d. Diabetes mellitus
- e. Diabetes insipidus

425. A 39-year-old man presents with severe writhing back pain, hematuria, and nausea. An intravenous pyelogram (IVP) confirms a diagnosis of renal calculi. The presence of strongly opaque stones on the plain film is suggestive of calcium oxalate stones, which have an increased incidence with hypophosphatemia. The renal clearance of phosphate is increased by which of the following hormones?

- a. Aldosterone
- b. Parathyroid hormone
- c. Norepinephrine
- d. Vasopressin
- e. Angiotensin

426. Which of the following will produce the greatest increase in potassium secretion?

- a. A decrease in urinary flow rates
- b. An increase in distal nephron sodium concentration
- c. A decrease in circulating blood volume
- d. An increase in sympathetic nerve activity
- e. A decrease in renal blood flow

427. A decrease in the concentration of NaCl in the intraluminal fluid causes the juxtaglomerular apparatus to release which of the following hormones?

- a. ADH
- b. Aldosterone
- c. Adenosine
- d. Renin
- e. Angiotensinogen

428. A hypertensive patient develops chronic renal failure from progressive nephrosclerosis. Which of the following should you expect to occur as a result?

- a. A decrease in the fractional excretion of sodium
- b. An increase in the free water clearance

- c. A decrease in net acid excretion
- d. A decrease in the excretion of creatinine
- e. No change in the anion gap

429. A patient with renal failure develops symptoms caused by the loss of a hormone produced by the kidney. Which of the following is the most likely diagnosis?

- a. Edema
- b. Hypertension
- c. Anemia
- d. Uremia
- e. Acidosis

430. In adults, the pulmonary circulation compared to the renal circulation has a greater what?

- a. Arterial pressure
- b. Vascular resistance
- c. Blood flow
- d. Capillary hydrostatic pressure
- e. Capillary oncotic pressure

431. Which of the following is correct regarding the consumption of oxygen by the kidney?

- a. It decreases as blood flow increases
- b. It is regulated by erythropoietin
- c. It remains constant as blood flow increases
- d. It directly reflects the level of sodium transport
- e. It is greatest in the medulla

432. In the presence of antidiuretic hormone (ADH), the filtrate will be isotonic to plasma in which of the following parts of the kidney?

- a. Descending limb of the loop of Henle
- b. Ascending limb of the loop of Henle
- c. Cortical collecting tubule
- d. Medullary collecting tubule
- e. Renal pelvis

433. The secretion of H^+ in the proximal tubule is primarily associated with which of the following?

- a. Excretion of potassium ion
- b. Excretion of hydrogen ion
- c. Reabsorption of calcium ion
- d. Reabsorption of bicarbonate ion
- e. Reabsorption of phosphate ion

434. A 58-year-old male presents with hematuria, abdominal pain, and fatigue. Physical examination reveals a flank mass and an abdominal CT reveals a large solid mass on the left kidney. Laboratory studies show anemia and increased creatinine and BUN suggestive of advanced disease. A decrease in glomerular filtration rate would result from which of the following?

- a. Constriction of the efferent arteriole
- b. An increase in afferent arteriolar pressure
- c. Compression of the renal capsule
- d. A decrease in the concentration of plasma protein
- e. An increase in renal blood flow