بِسۡمِ ٱللَّهِ ٱلرَّحۡمَٰنِ ٱلرَّحِيمِ

Physiology Team 436

Renal Block

MCQs File 1

(from books)

(وقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ) صدق الله العظيم

Done by: Laila Mathkour

Reviewed by: Lulwah Alshiha

دعواتكم لنا بالتوفيق

MCQ'S for renal block (include all lecture)

Questions 1 and 2

Use the following clinical laboratory test results for questions 1 and 2:

Urine flow rate = 1 ml/min

Urine inulin concentration = 100 mg/ml

Plasma inulin concentration = 2 mg/ml

Urine urea concentration = 50 mg/ml

Plasma urea concentration = 2.5 mg/ml

1. What is the glomerular filtration rate (GFR)?

A. 25ml/min
B. 50 ml/min
C. 100 ml/min
D. 125ml/min
E. None of the above

2. What is the net urea reabsorption rate?

A. 0 mg/min
B. 25 mg/min
C. 50 mg/min
D. 75 mg/min
E. 100 mg/min

3. Which of the following solutions when infused intravenously would result in an increase in extracellular fluid volume, a decrease in intracellular fluid volume, and an increase in total body water after osmotic equilibrium?

A. 1 L of 0.9% sodium chloride solution
B. 1 L of 0.45% sodium chloride solution
C. 1 L of 3% sodium chloride solution
D. 1 L of 5% dextrose solution
E. 1 L of pure water

Answer:
1=B
2=D
3=C

The Explanation of the answers will be in slide 19

Cont.

4. A 65-year-old man has a heart attack and experiences cardiopulmonary arrest while being transported to the emergency room. The following laboratory values are obtained from arterial blood:

A. plasma pH = 7.12,
B. plasma PCO_2 = 60mm Hg, and
C. plasma HCO_3
D. concentration = 19 mEq/L.

Which of the following best describes his acid-base disorder?

A. Respiratory acidosis with partial renal compensation
B. Metabolic acidosis with partial respiratory compensation
C. Mixed acidosis: combined metabolic and respiratory acidosis
D. Mixed alkalosis: combined respiratory and metabolic alkalosis

5. In the patient described in question 4, which of the following laboratory results would be expected, compared with normal?

A. Increased renal excretion of HCO_3
B. Decreased urinary titratable acid
C. Increased urine pH
D. Increased renal excretion of NH_4

Answer:
4=C
5=D

The Explanation of the answers will be in slide 19

Cont.

6. In normal kidneys, which of the following is true of the osmolarity of renal tubular fluid that flows
through the early distal tubule in the region of the macula densa?

A. Usually isotonic compared with plasma
B. Usually hypotonic compared with plasma
C. Usually hypertonic compared with plasma
D. Hypertonic, compared with plasma, in antidiuresis

7. After receiving a renal transplant, a patient develops severe hypertension (170/110 mm Hg). A renal arteriogram indicates severe renal artery stenosis in his single remaining kidney, with a reduction in GFR to 25% of normal. Which of the following changes, compared with normal, would be expected in this patient, assuming steady-state conditions?

A. Large increase in plasma sodium concentration
B. Reduction in urinary sodium excretion to 25% of normal
C. Reduction in urinary creatinine excretion to 25% of normal
D. Increase in serum creatinine to about four times normal
E. Normal renal blood flow in the stenotic kidney due to autoregulation

8. Which of the following tends to decrease potassium secretion by the cortical collecting tubule?

A. Increased plasma potassium concentration
B. A diuretic that decreases proximal tubule sodium reabsorption
C. A diuretic that inhibits the action of aldosterone (e.g., spironolactone)
D. Acute alkalosis
E. High sodium intake

Answer:
6=B
7=D
8=C

The Explanation of the answers will be in slide 20

Cont.

9. If a patient has a creatinine clearance of 90 ml/min, a urine flow rate of 1 ml/min, a plasma K+ concentration of 4 mEq/L, and a urine K+ concentration of 60 mEq/L, what is the approximate rate of K+ excretion?

A. 0.06 mEq/min
B. 0.30 mEq/min
C. 0.36 mEq/min
D. 3.6 mEq/min
E. 60 mEq/min

10. Which of the following changes would be expected in a patient with diabetes insipidus due to a lack of antidiuretic hormone (ADH) secretion?

	Plasma osmolarity concentration	Plasma sodium concentration	Plasma renin	Urine volume
A)	↔	↔	↓	↑
B)	↔	↔	↑	↑
C)	↑	↑	↑	↑
D)	↑	↑	↔	↔
E)	↓	↓	↓	↔

11. A patient with severe hypertension (blood pressure 185/110 mm Hg) is referred to you. A renal magnetic resonance imaging scan shows a tumor in the kidney, and laboratory findings include a very high plasma renin activity of 12 ng angiotensin I/ml/hr (normal = 1). The diagnosis is a renin-secreting tumor. Which of the following changes would you expect to find in this patient, under steady-state conditions, compared with normal?

	Plasma aldosterone concentration	Sodium excretion rate	Plasma potassium concentration	Renal blood flow
A)	↔	↓	↓	↑
B)	↔	↔	↓	↑
C)	↑	↔	↓	↓
D)	↑	↓	↔	↓
E)	↑	↓	↓	↔

Answer:
9=A
10=C
11=C

The Explanation of the answers will be in slide 20,21

Cont.

12. Which of the following changes, compared with normal, would you expect to find 3 weeks after a patient ingested a toxin that caused sustained impairment of proximal tubular sodium chloride (NaCl) reabsorption? Assume that there has been no change in diet or ingestion of electrolytes.

	Glomerular filtration rate	Afferent arteriolar resistance	Sodium excretion
A)	↔	↔	↑
B)	↔	↔	↑
C)	↓	↑	↑
D)	↓	↑	↔
E)	↑	↓	↔

13. A 26-year-old woman recently decided to adopt a healthier diet and eat more fruits and vegetables. As a result, her potassium intake increased from 80 to 160 mmol/day. Which of the following conditions would you expect to find 2 weeks after she increased her potassium intake, compared with before the increase?

	Potassium excretion rate	Sodium excretion rate	Plasma aldosterone concentration	Plasma potassium concentration
A)	↔	↔	↑	Large increase (>1 mmol/L)
B)	↔	↓	↑	Small increase (<1 mmol/L)
C)	↑2×	↔	↑	Small increase (<1 mmol/L)
D)	↑2×	↑	↓	Large increase (>1 mmol/L)
E)	↑2×	↑	↔	Large increase (>1 mmol/L)

14. An 8-year-old boy is brought to your office with extreme swelling of the abdomen. His parents indicate that he had a very sore throat a "month or so" ago and that he has been "swelling up" since that time. He appears to be edematous, and when you check his urine, you find large amounts of protein being excreted. Your diagnosis is nephrotic syndrome subsequent to glomerulonephritis. Which of the following changes would you expect to find, compared with normal?

	Thoracic lymph flow	Interstitial fluid protein concentration	Interstitial fluid hydrostatic pressure	Plasma renin concentration
A)	↑	↓	↑	↑
B)	↑	↓	↑	↔
C)	↑	↓	↔	↑
D)	↓	↑	↔	↔
E)	↓	↓	↓	↓

Answer:
12=D
13=C
14=A

The Explanation of the answers will be in slide 21,22

Cont.

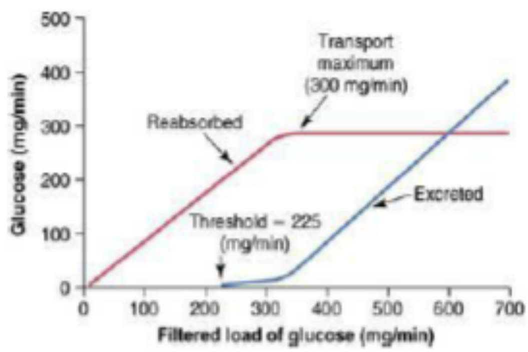
Answer:
15=C
16=C

15. Which of the following changes would you expect to find after administering a vasodilator drug that
caused a 50% decrease in afferent arteriolar resistance and no change in arterial pressure?

A. Decreased renal blood flow, decreased GFR, and decreased peritubular capillary hydrostatic pressure
B. Decreased renal blood flow, decreased GFR, and increased peritubular capillary hydrostatic pressure
C. Increased renal blood flow, increased GFR, and increased peritubular capillary hydrostatic ressure
D. Increased renal blood flow, increased GFR, and no change in peritubular capillary hydrostatic pressure
E. Increased renal blood flow, increased GFR, and decreased peritubular capillary hydrostatic pressure

16. A 32-year-old man complains of frequent urination. He is overweight (280 lb, 5 ft 10 in tall), and after measuring the 24-hr creatinine clearance, you estimate his GFR to be 150 ml/min. His plasma glucose is 300 mg/dL. Assuming that his renal transport maximum for glucose is normal, as shown in the figure, what would be this patient's approximate rate of urinary glucose excretion?

A. 0 mg/min
B. 100 mg/min
C. 150 mg/min
D. 225 mg/min
E. 300 mg/min
F. Information provided is inadequate
G. to estimate the glucose excretion rate



The Explanation of the answers will be in slide 22,23

Cont.

Answer:
17=B
18=C
19=B

17.The clinical laboratory returned the following values for arterial blood taken from a patient: plasma pH = 7.28, plasma HCO_3^- = 32 mEq/L, and plasma Pco_2 = 70 mm Hg. What is this patient's acid–base disorder?

A) Acute respiratory acidosis without renal compensation
B) Respiratory acidosis with partial renal compensation
C) Acute metabolic acidosis without respiratory compensation
D) Metabolic acidosis with partial respiratory compensation

18.Which of the following changes tends to increase peritubular capillary fluid reabsorption?

A. Increased blood pressure
B. Decreased filtration fraction
C. Increased efferent arteriolar resistance
D. Decreased angiotensin II
E. Increased renal blood flow

19.Which of the following would cause the greatest degree of hyperkalemia?

A) Increase in potassium intake from 60 to 180 mmol/day in a person with normal kidneys and a normal aldosterone system
B) B) Chronic treatment with a diuretic that inhibits the action of aldosterone
C) C) Decrease in sodium intake from 200 to 100 mmol/day
D) D) Chronic treatment with a diuretic that inhibits loop of Henle Na^+-$2Cl^-$-K^+ co-transport
E) E) Chronic treatment with a diuretic that inhibits sodium reabsorption in the collecting ducts

The Explanation of the answers will be in slide 23,24

Cont.

20.Which of the following is filtered most readily by the glomerular capillaries?

A) Albumin in plasma
B) Neutral dextran with a molecular weight of 25,000
C) Polycationic dextran with a molecular weight of 25,000
D) Polyanionic dextran with a molecular weight of 25,000
E) Red blood cells

21.Under conditions of normal renal function, which of the following is true of the concentration of urea in tubular fluid at the end of the proximal tubule?

A) It is higher than the concentration of urea in tubular fluid at the tip of the loop of Henle
B) It is higher than the concentration of urea in the plasma
C) It is higher than the concentration of urea in the final urine in antidiuresis
D) It is lower than plasma urea concentration because of active urea reabsorption along the
proximal tubule

22.Which of the following changes would be expected in a patient with Liddle's syndrome (excessive activity of amiloride-sensitive sodium channel in the collecting tubule) under steady-state conditions, assuming that intake of electrolytes remained constant?

	Plasma renin concentration	Blood pressure	Sodium excretion concentration	Plasma aldosterone
A)	↔	↑	↓	↔
B)	↑	↑	↔	↑
C)	↑	↑	↓	↓
D)	↓	↑	↔	↓
E)	↓	↑	↓	↓
F)	↓	↓	↑	↑

74

Answer:
20=C
21=B
22=D

The Explanation of the answers will be in slide 24,25

Cont.

Answer:
23=A
24=A
25=B

23. A patient's urine is collected for 2 hr, and the total volume is 600 ml during this time. Her urine osmolarity is 150 mOsm/L, and her plasma osmolarity is 300 mOsm/L. What is her "free water clearance"?

A) +5.0 ml/min
B) +2.5 ml/min
C) 0.0 ml/min
D) −2.5 ml/min
E) −5.0 ml/min21

24. A patient is referred for treatment of hypertension. After testing, you discover that he has a very high level of plasma aldosterone, and your diagnosis is Conn's syndrome. Assuming no change in electrolyte intake, which of the following changes would you expect to find, compared with normal?

	Plasma pH	Plasma K^+ concentration	Urine K^+ excretion	Urine Na^+ excretion	Plasma renin concentration
A)	↑	↓	↔	↔	↓
B)	↓	↓	↔	↔	↓
C)	↑	↓	↑	↓	↓
D)	↑	↑	↔	↓	↑
E)	↑	↑	↑	↑	↑

25. A patient with renal disease had a plasma creatinine of 2 mg/dL during an examination 6 months ago. You note that his blood pressure has increased about 30 mm Hg since his previous visit, and the lab tests indicate that his plasma creatinine is now 4 mg/dL. Which of the following changes, compared with his previous visit, would you expect to find, assuming steady-state conditions and no changes in electrolyte intake or metabolism?

	Sodium excretion rate	Creatinine excretion rate	Creatinine clearance	Filtered load of creatinine
A)	↔	↔	↓ by 50%	↓
B)	↔	↔	↓ by 50%	↔
C)	↔	↔	↓ by 75%	↓
D)	↓	↓	↔	↔
E)	↓	↓	↓ by 50%	↓

The Explanation of the answers will be in slide 25,26

Cont.

26. Which of the following changes tends to increase GFR?

A) Increased afferent arteriolar resistance
B) Decreased efferent arteriolar resistance
C) Increased glomerular capillary filtration coefficient
D) Increased Bowman's capsule hydrostatic pressure
E) Decreased glomerular capillary hydrostatic pressure

27. The maximum clearance rate possible for a substance that is totally cleared from the plasma is equal to which of the following?

A) GFR
B) Filtered load of that substance
C) Urinary excretion rate of that substance
D) Renal plasma flow
E) Filtration fraction

28. A patient has the following laboratory values: arterial pH = 7.13, plasma HCO_3^- = 15 mEq/L, plasma chloride concentration = 118 mEq/L, arterial Pco_2 = 28 mm Hg, and plasma Na^+ concentration = 141 mEq/L. What is the most likely cause of his acidosis?

A) Salicylic acid poisoning
B) Diabetes mellitus
C) Diarrhea
D) Emphysema

29. A 26-year-old man develops glomerulonephritis, and his GFR decreases by 50% and remains at that level. For which of the following substances would you expect to find the greatest increase in plasma concentration?

A) Creatinine
B) K^+
C) Glucose
D) Na^+
E) Phosphate
F) H^+

Answer:
26=C
27=D
28=C
29=A

The Explanation of the answers will be in slide 26,27

Cont.

30. A patient with a history of frequent and severe migraine headaches arrives at your office complaining of stomach pain and breathing rapidly. She informs you that she has had a severe migraine for the past 2 days and has taken eight times the recommended dose of aspirin to relieve her headache during that time. Which of the following changes would you expect to find, compared with normal?

	Plasma HCO_3^- concentration	Plasma P_{CO_2}	Urine HCO_3^- excretion	Urine NH_4^+ excretion	Plasma anion gap
A)	↑	↓	↑	↑	↑
B)	↑	↑	↑	↓	↑
C)	↓	↓	↓	↓	↓
D)	↓	↓	↓	↑	↑
E)	↓	↓	↓	↑	↓

Questions 31 and 32

Assume the following initial conditions: intracellular fluid volume = 40% of body weight before fluid administration, extracellular fluid volume = 20% of body weight before fluid administration, molecular weight of NaCl = 58.5g/mol, and no excretion of water or electrolytes.

31. A male patient appears to be dehydrated, and after obtaining a plasma sample, you find that he has hyponatremia, with a plasma sodium concentration of 130 mmol/L and a plasma osmolarity of 260 mOsm/L. You decide to administer 2 L of 3% sodium chloride (NaCl). His body weight was 60 kilograms before giving the fluid. What is his approximate plasma osmolarity after administration of the NaCl solution and after osmotic equilibrium? Assume the initial conditions described above.

A) 273 mOsm/L
B) 286 mOsm/L
C) 300 mOsm/L
D) 310 mOsm/L
E) 326 mOsm/L

Answer:
30=D
31=C

The Explanation of the answers will be in slide 27,28

Cont.

Answer:
32=B
33=C
34=A
35=D

32. What is the approximate extracellular fluid volume in this patient after administration of the NaCl solution and after osmotic equilibrium?
A) 15.1 L
B) 17.2 L
C) 19.1 L
D) 19.8 L
E) 21.2 L

33. The most serious hypokalemia would occur in which of the following conditions?
A) Decrease in potassium intake from 150 to 60 mEq/day
B) Increase in sodium intake from 100 to 200 mEq/day
C) Fourfold increase in aldosterone secretion plus high sodium intake
D) Fourfold increase in aldosterone secretion plus low sodium intake
E) Addison's disease

34. If the average hydrostatic pressure in the glomerular capillaries is 50 mm Hg, the hydrostatic pressure in the Bowman's space is 12 mm Hg, the average colloid osmotic pressure in the glomerular capillaries is 30 mm Hg, and there is no protein in the glomerular ultrafiltrate, what is the net pressure driving glomerular filtration?
A) 8 mm Hg
B) 32 mm Hg
C) 48 mm Hg
D) 60 mm Hg
E) 92 mm Hg

35. In a patient who has chronic, uncontrolled diabetes mellitus, which of the following sets ofconditions would you expect to find, compared with normal?

	Titratable acid excretion	NH^+ excretion	HCO_3^- excretion	Plasma P_{CO_2}
A)	↔	↑	↓	↔
B)	↓	↑	↔	↓
C)	↑	↑	↔	↑
D)	↑	↑	↓	↓
E)	↓	↓	↓	↓
F)	↔	↑	↓	↔

The Explanation of the answers will be in slide 28,29

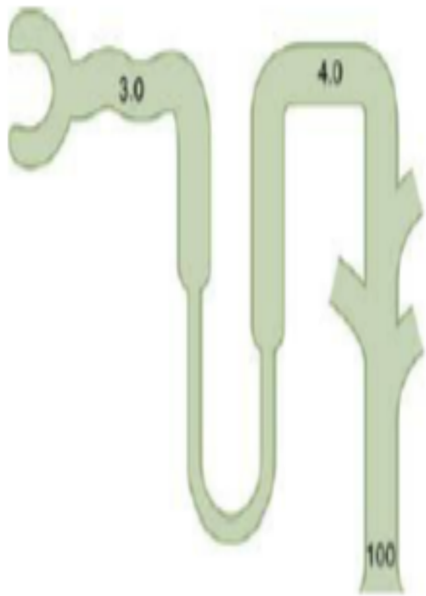
Cont.

Answer:
36=B
37=D
38=B

36. Intravenous infusion of 1 L of 0.45% sodium chloride (NaCl) solution (molecular weight of NaCl = 58.5) would cause which of the following changes, after osmotic equilibrium?

	Intracellular fluid volume	Intracellular fluid osmolarity	Extracellular fluid volume	Extracellular fluid osmolarity
A)	↑	↑	↑	↑
B)	↑	↓	↑	↓
C)	↔	↑	↑	↑
D)	↓	↑	↑	↑
E)	↓	↓	↓	↓

37. The figure shows the concentration of inulin at different points along the renal tubule, expressed as the tubular fluid/plasma ratio of inulin concentration. If inulin is not reabsorbed, what is the approximate percentage of the filtered water that has been reabsorbed prior to the distal convoluted tubule?



A) 25%
B) 33%
C) 66%
D) 75%
E) 99%
F) 100%

38. Which of the following tends to increase potassium secretion by the cortical collecting tubule?
A) A diuretic that inhibits the action of aldosterone (e.g., spironolactone)
B) A diuretic that decreases loop of Henle sodium reabsorption (e.g., furosemide)
C) Decreased plasma potassium concentration
D) Acute metabolic acidosis
E) Low sodium intake

The Explanation of the answers will be in slide 29,30

Cont.

Answer:
39=B
40=B
41=C

39. Which of the following changes would you expect to find in a patient with primary aldosteronism (Conn's syndrome) under steady-state conditions, assuming that electrolyte intake remained constant?

	Sodium excretion rate	Potassium excretion rate	Plasma renin concentration	Plasma potassium concentration	Blood pressure
A)	↔	↔	↔	↓	↑
B)	↔	↔	↓	↓	↑
C)	↔	↑	↓	↓	↑
D)	↓	↑	↓	↔	↑
E)	↑	↓	↑	↑	↔

40. A diabetic patient has developed chronic renal disease and is referred to your nephrology clinic. According to his family physician, his creatinine clearance has decreased from 100 ml/min to 40 ml/min over the past 4 years. His glucose has not been well controlled, and his plasma pH is 7.14. Which of the following changes, compared with before the development of renal disease, would you expect to find, assuming steady-state conditions and no change in electrolyte intake?

	Sodium excretion rate	Creatinine excretion rate	Plasma creatinine concentration	Plasma HCO_3^- concentration	NH_4^+ excretion rate
A)	↓	↓	↑	↑	↑
B)	↔	↔	↑	↓	↑
C)	↔	↔	↑	↓	↔
D)	↔	↓	↑	↓	↔
E)	↓	↓	↓	↓	↑
F)	↓	↓	↓	↓	↓

41. A 20-year-old woman arrives at your office complaining of rapid weight gain and marked fluid retention. Her blood pressure is 105/65 mm Hg, her plasma protein concentration is 3.6g/dL (normal = 7.0), and she has no detectable protein in her urine. Which of the following changes would you expect to find, compared with normal?

	Thoracic lymph flow	Interstitial fluid protein concentration	Capillary filtration	Interstitial fluid pressure
A)	↓	↓	↓	↓
B)	↓	↑	↔	↔
C)	↑	↓	↑	↑
D)	↑	↓	↑	↔
E)	↑	↑	↑	↑

The Explanation of the answers will be in slide 30,31

Cont.

Answer:
42=B
43=D
44=A

42. A 48-year-old woman complains of severe polyuria (producing about 0.5 L of urine each hour) and polydipsia (drinking two to three glasses of water every hour). Her urine contains no glucose, and she is placed on overnight water restriction for further evaluation. The next morning, she is weak and confused, her sodium concentration is 160 mEq/L, and her urine osmolarity is 80 mOsm/L. Which of the following is the most likely diagnosis?

A) Diabetes mellitus
B) Diabetes insipidus
C) Primary aldosteronism
D) Renin-secreting tumor
E) Syndrome of inappropriate antidiuretic hormone

43. Furosemide (Lasix) is a diuretic that also produces natriuresis. Which of the following is an undesirable side effect of furosemide due to its site of action on the renal tubule?

A) Edema
B) Hyperkalemia
C) Hypercalcemia
D) Decreased ability to concentrate the urine
E) Heart failure

44. 47. A patient complains of headaches, and an examination reveals that her blood pressure is 175/112 mm Hg. Laboratory tests give the following results: plasma renin activity = 11.5 ng angiotensin I/ml/hr (normal = 1), plasma Na^+ = 144 mmol/L, and plasma K^+ = 3.4 mmol/L. A magnetic resonance imaging procedure suggests that she has a renin-secreting tumor. Which of the following changes would you expect, compared with normal?

	Renal blood flow	Filtration fraction	Glomerular capillary hydrostatic pressure	Peritubular capillary hydrostatic pressure
A)	↓	↑	↑	↓
B)	↓	↑	↑	↑
C)	↓	↓	↑	↓
D)	↓	↑	↓	↑
E)	↓	↓	↓	↓

The Explanation of the answers will be in slide 31,32

Cont.

45. When the dietary intake of K+ increases, body K+ balance is maintained by an increase in K+ excretion primarily by which of the following?

A) Decreased glomerular filtration of K+

B) Decreased reabsorption of K+ by the proximal tubule

C) Decreased reabsorption of K+ by the thick ascending limb of the loop of Henle

D) Increased K+ secretion by the late distal and collecting tubules

E) Shift of K+ into the intracellular compartment

46. A female patient has unexplained severe hypernatremia (plasma Na+ = 167 mmol/L) and complains of frequent urination and large urine volumes. A urine specimen reveals that the Na+ concentration is 15 mmol/L (very low) and the osmolarity is 155 mOsm/L (very low). Laboratory tests reveal: plasma renin activity = 3 ng angiotensin I/ml/hr (normal = 1.0), plasma antidiuretic hormone (ADH) = 30 pg/ml (normal = 3 pg/ml), and plasma aldosterone = 20 ng/dL (normal = 6 ng/dL). Which of the following is the most likely reason for her hypernatremia?

A) Simple dehydration due to decreased water intake

B) Nephrogenic diabetes insipidus

C) Central diabetes insipidus

D) Syndrome of inappropriate ADH

E) Primary aldosteronism

F) Renin-secreting tumor

Answer:
45=D
46=B

The Explanation of the answers will be in slide 32

Cont.

47. Juvenile (type I) diabetes mellitus is often diagnosed because of polyuria (high urine flow) and polydipsia (frequent drinking) that occur because of which of the following?

A) Increased delivery of glucose to the collecting duct interferes with the action of antidiuretic hormone

B) Increased glomerular filtration of glucose increases Na+ reabsorption via the sodium-glucose co-transporter

C) When the filtered load of glucose exceeds the renal threshold, a rising glucose concentration in the proximal tubule decreases the osmotic driving force for water reabsorption

D) High plasma glucose concentration decreases thirst

E) High plasma glucose concentration stimulates antidiuretic hormone release from the posterior pituitary

48. You begin treating a hypertensive patient with a powerful loop diuretic (e.g., furosemide). Which of the following changes would you expect to find, compared with pretreatment values, when he returns for a follow-up examination 2 weeks later?

	Urine sodium excretion	Extracellular fluid volume	Blood pressure	Plasma potassium concentration
A)	↑	↓	↓	↓
B)	↑	↓	↔	↔
C)	↔	↓	↓	↓
D)	↔	↓	↔	↔
E)	↑	↔	↓	↑

49. In acidosis, most of the hydrogen ions secreted by the proximal tubule are associated with which of the following processes?

A) Excretion of hydrogen ions

B) Excretion of NH4+

C) Reabsorption of bicarbonate ions

D) Reabsorption of phosphate ions

E) Reabsorption of potassium ions

Answer:
47=C
48=C
49=C

The Explanation of the answers will be in slide 33

Explanation of answers

1.B) GFR is equal to inulin clearance, which is calculated as the urine inulin concentration (100 mg/ml)× urine flow rate (1 ml/min) ÷ plasma inulin concentration (2 mg/ml), which is equal to 50 ml/min.

2.D) The net urea reabsorption rate is equal to the filtered load of urea (GFR [50 ml/min] × plasma urea concentration [2.5 mg/ml]) − urinary excretion rate of urea (urine urea concentration [50 mg/ml] × urine flow rate [1 ml/min]). Therefore, net urea reabsorption = (50 ml/min × 2.5 mg/ml) − (50 mg/ml × 1ml/min) = 75 mg/min.

3.C) A 3% sodium chloride (NaCl) solution is hypertonic and when infused intravenously would increase extracellular fluid volume and osmolarity, thereby causing water to flow out of the cell. This would decrease intracellular fluid volume and further increase extracellular fluid volume. The 0.9% NaCl solution and 5% dextrose solution are isotonic, and therefore would not reduce intracellular fluid volume. Pure water and the 0.45% NaCl solution are hypotonic, and when infused would increase both intracellular and extracellular fluid volumes.

4.C) Because the patient has a low plasma pH (normal = 7.4), he has acidosis. The fact that his plasma bicarbonate concentration is also low (normal = 24 mEq/L) indicates that he has metabolic acidosis. However, he also appears to have respiratory acidosis because his plasma Pco2 is high (normal = 40 mm Hg). The rise in Pco2 is due to his impaired breathing as a result of cardiopulmonary arrest. Therefore, the patient has a mixed acidosis with combined metabolic and respiratory acidosis.

5.D) An important compensation for respiratory acidosis is increased renal production of ammonia(NH4+) and increased NH4+ excretion. In acidosis, urinary excretion of HCO3− would be reduced, as would urine pH, and urinary titratable acid would be slightly increased as a compensatory response to the acidosis.

Explanation of answers

6.B) As water flows up the ascending limb of the loop of Henle, solutes are reabsorbed, but this segment is relatively impermeable to water; progressive dilution of the tubular fluid occurs so that the osmolarity decreases to approximately 100 mOsm/L by the time the fluid reaches the early distal tubule. Even during maximal antidiuresis, this portion of the renal tubule is relatively impermeable to water and is therefore called the diluting segment of the renal tubule.

7.D) A severe renal artery stenosis that reduces GFR to 25% of normal would also decrease renal blood flow but would cause only a transient decrease in urinary creatinine excretion. The transient decrease in creatinine excretion would increase serum creatinine (to about four times normal), which would restore the filtered creatinine load to normal and therefore return urinary creatinine excretion to normal levels under steady-state conditions. Urinary sodium secretion would also decrease transiently but would be restored to normal so that intake and excretion of sodium are balanced. Plasma sodium concentration would not change significantly because it is carefully regulated by the antidiuretic hormone–thirst mechanism.

8. C) Aldosterone stimulates potassium secretion by the principal cells of the collecting tubules. Therefore, blockade of the action of aldosterone with spironolactone would inhibit potassium secretion. Other factors that stimulate potassium secretion by the cortical collecting tubule include increased potassium concentration, increased cortical collecting tubule flow rate (as would occur with high sodium intake or a diuretic that reduces proximal tubular sodium reabsorption), and acute alkalosis.

9. A) K+ excretion rate = urine K+ concentration (60 mEq/L) × urine flow rate (0.001 L/min) = 0.06 mEq/min

Explanation of answers

10. C) In the absence of ADH secretion, there is a marked increase in urine volume because the late distal and collecting tubules are relatively impermeable to water. As a result of increased urine volume, there is dehydration and increased plasma osmolarity and high plasma sodium concentration. The resulting decrease in extracellular fluid volume stimulates renin secretion, resulting in an increase in plasma renin concentration.

11..C) In a patient with a very high rate of renin secretion, there would also be increased formation of angiotensin II, which in turn would stimulate aldosterone secretion. The increased levels of angiotensin II and aldosterone would cause a transient decrease in sodium excretion, which would cause expansion of the extracellular fluid volume and increased arterial pressure. The increased arterial pressure as well as other compensations would return sodium excretion to normal so that intake and output are balanced. Therefore, under steady-state conditions, sodium excretion would be normal and equal to sodium intake. The increased aldosterone concentration would cause hypokalemia (decreased plasma potassium concentration), whereas the high level of angiotensin II would cause renal vasoconstriction and decreased renal blood flow.

12. D) Impairment of proximal tubular NaCl reabsorption would increase NaCl delivery to the macula densa, which in turn would cause a tubuloglomerular feedback–mediated increase in afferent arteriolar

resistance. The increased afferent arteriolar resistance would decrease the GFR. Initially there would be a transient increase in sodium excretion, but after 3 weeks, steady-state conditions would be achieved. Sodium excretion would equal sodium intake, and no significant change would occur in urinary sodium excretion.

Explanation of answers

13. C) When potassium intake is doubled (from 80 to 160 mmol/day), potassium excretion also approximately doubles within a few days, and the plasma potassium concentration increases only slightly. Increased potassium excretion is achieved largely by increased secretion of potassium in the cortical collecting tubule. Increased aldosterone concentration plays a significant role in increasing potassium secretion and in maintaining a relatively constant plasma potassium concentration during increases in potassium intake. Sodium excretion does not change markedly during chronic increases in potassium intake.

14. A) The patient described has protein in the urine (proteinuria) and reduced plasma protein concentration secondary to glomerulonephritis caused by an untreated streptococcal infection ("strep throat"). The reduced plasma protein concentration, in turn, decreased the plasma colloid osmotic pressure and resulted in leakage from the plasma to the interstitium. The extracellular fluid edema raised interstitial fluid pressure and interstitial fluid volume, causing increased lymph flow and decreased interstitial fluid protein concentration. Increasing lymph flow causes a "washout" of the interstitial fluid protein as a safety factor against edema. The decreased blood volume would tend to lower blood pressure and stimulate the secretion of renin by the kidneys, raising the plasma renin concentration.

15. C) A 50% reduction in afferent arteriolar resistance with no change in arterial pressure would increase renal blood flow and glomerular hydrostatic pressure, thereby increasing GFR. At the same time, the reduction in afferent arteriolar resistance would raise peritubular capillary hydrostatic pressure.

Explanation of answers

16. C) The filtered load of glucose in this example is determined as follows: GFR (150 ml/min) × plasma glucose (300 mg/dL) = 450 mg/min. The transport maximum for glucose in this example is 300 mg/min. Therefore, the maximum rate of glucose reabsorption is 300 mg/min. The urinary glucose excretion is equal to the filtered load (450 mg/min) minus the tubular reabsorption of glucose (300 mg/min), or 150 mg/min.

17. B) This patient has respiratory acidosis because the plasma pH is lower than the normal level of 7.4 and the plasma Pco2 is higher than the normal level of 40 mm Hg. The elevation in plasma bicarbonate concentration above normal (~24 mEq/L) is due to partial renal compensation for the respiratory acidosis. Therefore, this patient has respiratory acidosis with partial renal compensation.

18. C) Peritubular capillary fluid reabsorption is determined by the balance of hydrostatic and colloid osmotic forces in the peritubular capillaries. Increased efferent arteriolar resistance reduces peritubular

capillary hydrostatic pressure and therefore increases the net force favoring fluid reabsorption. Increased blood pressure tends to raise peritubular capillary hydrostatic pressure and reduce fluid reabsorption.

Decreased filtration fraction increases the peritubular capillary colloid osmotic pressure and tends to reduce peritubular capillary reabsorption. Decreased angiotensin II causes vasodilatation of efferent arterioles, raising peritubular capillary hydrostatic pressure, decreasing reabsorption, and decreasing tubular transport of water and electrolytes. Increased renal blood flow also tends to raise peritubular capillary hydrostatic pressure and decrease fluid reabsorption.

Explanation of answers

19. B) Inhibition of aldosterone causes hyperkalemia by two mechanisms: (1) shifting potassium out of the cells into the extracellular fluid, and (2) decreasing cortical collecting tubular secretion of potassium.

Increasing potassium intake from 60 to 180 mmol/day would cause only a very small increase in plasma potassium concentration in a person with normal kidneys and normal aldosterone feedback mechanisms. A reduction in sodium intake also has very little effect on plasma potassium concentration. Chronic treatment with a diuretic that inhibits loop of Henle Na^+-$2Cl^-$-K^+ cotransport would tend to cause potassium loss in the urine and hypokalemia. However, chronic treatment with a diuretic that inhibits sodium reabsorption in the collecting ducts, such as a

miloride, would have little effect on plasma potassium concentration.

20. C) The filterability of solutes in the plasma is inversely related to the size of the solute (molecular weight). Also, positively charged molecules are filtered more readily than are neutral molecules or negatively charged molecules of equal molecular weight. Therefore, the positively charged polycationic dextran with a molecular weight of 25,000 would be the most readily filtered substance of the choices provided. Red blood cells are not filtered at all by the glomerular capillaries under normal conditions.

21. B) Approximately 30% to 40% of the filtered urea is reabsorbed in the proximal tubule. However, the tubular fluid urea concentration increases because urea is not nearly as permeant as water in this nephron segment. Urea concentration increases further in the tip of the loop of Henle because water is reabsorbed in the descending limb of the loop of Henle. Under conditions of antidiuresis, urea is further concentrated as water is reabsorbed and as fluid flows along the collecting ducts. Therefore, the final urine concentration of urea is substantially greater than the concentration in the proximal tubule or in the

plasma.

Explanation of answers

22. D) Excessive activity of the amiloride-sensitive sodium channel in the collecting tubules would cause a transient decrease in sodium excretion and expansion of extracellular fluid volume, which in turn would increase arterial pressure and decrease renin secretion, leading to decreased aldosterone secretion. Under steady-state conditions, sodium excretion would return to normal so that intake and renal excretion of sodium are balanced. One of the mechanisms that re-establishes this balance between intake and output of sodium is the rise in arterial pressure that induces a "pressure natriuresis."

23. B) Free water clearance is calculated as urine flow rate (600 ml/2 hr, or 5 ml/min) − osmolar clearance (urine osmolarity × urine flow rate/plasma osmolarity). Therefore, free water clearance is equal to +2.5 ml/min.

24. A) Primary excessive secretion of aldosterone (Conn's syndrome) would be associated with marked hypokalemia and metabolic alkalosis (increased plasma pH). Because aldosterone stimulates sodium

reabsorption and potassium secretion by the cortical collecting tubule, there could be a transient decrease in sodium excretion and an increase in potassium excretion, but under steady-state conditions, both urinary sodium and potassium excretion would return to normal to match the intake of these electrolytes. However, the sodium retention as well as the hypertension associated with aldosterone excess would tend to reduce renin secretion.

Explanation of answers

25. B) A doubling of plasma creatinine implies that the creatinine clearance and GFR have been reduced by approximately 50%. Although the reduction in creatinine clearance would initially cause a transient

decrease in filtered load of creatinine, creatinine excretion rate, and sodium excretion rate, the plasma concentration of creatinine would increase until the filtered load of creatinine and the creatinine excretion rate returned to normal. However, creatinine clearance would remain reduced, because creatinine clearance is the urinary excretion rate of creatinine divided by the plasma creatinine concentration. Urinary sodium excretion would also return to normal and would equal the sodium intake, under steadystate conditions, as a result of compensatory mechanisms that reduce renal tubular reabsorption of sodium.

26. C) The glomerular capillary filtration coefficient is the product of the hydraulic conductivity and surface area of the glomerular capillaries. Therefore, increasing the glomerular capillary filtration coefficient tends to increase GFR. Increased afferent arteriolar resistance, decreased efferent arteriolar resistance, increased Bowman's capsule hydrostatic pressure, and decreased glomerular hydrostatic pressure tend to decrease GFR.

27. D) If a substance is completely cleared from the plasma, the clearance rate of that substance would equal the total renal plasma flow. In other words, the total amount of substance delivered to the kidneys in the blood (renal plasma flow × concentration of substance in the blood) would equal the amount of that substance excreted in the urine. Complete renal clearance of a substance would require both glomerular filtration and tubular secretion of that substance.

Explanation of answers

28. C) The patient has a lower than normal pH and is therefore acidotic. Because the plasma bicarbonate concentration is also lower than normal, the patient has metabolic acidosis with respiratory compensation (Pco2 is lower than normal). The plasma anion gap (Na^+-Cl^--HCO_3^- = 10 mEq/L) is in the normal range, suggesting that the metabolic acidosis is not caused by excess nonvolatile acids such as salicylic acid or ketoacids caused by diabetes mellitus. Therefore, the most likely cause of the metabolic acidosis is diarrhea, which would cause a loss of HCO_3^- in the feces and would be associated with a normal anion gap and a hyperchloremic (increased chloride concentration) metabolic acidosis.

29. A) A 50% reduction of GFR would approximately double the plasma creatinine concentration, because creatinine is not reabsorbed or secreted and its excretion depends largely on glomerular filtration. Therefore, when GFR decreases the plasma concentration of creatinine increases until the renal excretion of creatinine returns to normal. Plasma concentrations of glucose, potassium, sodium, and hydrogen ions are closely regulated by multiple mechanisms that keep them relatively constant even when GFR falls to very low levels. Plasma phosphate concentration is also maintained near normal until GFR falls to below 20% to 30% of normal.

30. D) Excessive ingestion of aspirin (salicylic acid) causes metabolic acidosis characterized by reductions in plasma HCO_3^- concentration and increased plasma anion gap. The acidosis stimulates respiration, causing a compensatory decrease in plasma Pco2. The acidosis also increases renal reabsorption of HCO_3^-, leading to decreased urine HCO_3^- excretion. Finally, the acidosis also stimulates a compensatory increase in renal tubular NH_4^+ production.

Explanation of answers

31. C) Calculation of fluid shifts and osmolarities after infusion of hypertonic saline is discussed in Chapter 25 of TMP12. The tables shown above represent the initial conditions and the final conditions

after infusion of 2 L of 3% NaCl and osmotic equilibrium. Three percent NaCl is equal to 30 g NaCl/L, or 0.513 mol/L (513 mmol/L). Because NaCl has two osmotically active particles per mole, the net effect is to add a total of 2052 millimoles in 2 L of solution. As an approximation, one can assume that cell membranes are impermeable to the NaCl and that the NaCl infused remains in the extracellular fluid

compartment.

32. B) Extracellular fluid volume is calculated by dividing the total milliosmoles in the extracellular compartment (5172 mOsm) by the concentration after osmotic equilibrium (300 mOsm/L) to give 17.2 L.

33. C) A large increase in aldosterone secretion combined with a high sodium intake would cause severe hypokalemia. Aldosterone stimulates potassium secretion and causes a shift of potassium from the extracellular fluid into the cells, and a high sodium intake increases the collecting tubular flow rate, which also enhances potassium secretion. In normal persons, potassium intake can be reduced to as low as one-fourth of normal with only a mild decrease in plasma potassium concentration .A low sodium intake would tend to oppose aldosterone's hypokalemic effect, because a low sodium intake would reduce the collecting tubular flow rate and thus tend to reduce potassium secretion. Patients with Addison's disease have a deficiency of aldosterone secretion and therefore tend to have hyperkalemia.

Explanation of answers

34. A) The net filtration pressure at the glomerular capillaries is equal to the sum of the forces favoring filtration (glomerular capillary hydrostatic pressure) minus the forces that oppose filtration (hydrostatic pressure in Bowman's space and glomerular colloid osmotic pressure). Therefore, the net pressure driving glomerular filtration is 50 − 12 − 30 = 8 mm Hg.

35. D) Uncontrolled diabetes mellitus results in increased blood acetoacetic acid levels, which in turn cause metabolic acidosis and decreased plasma HCO3 − and pH. The acidosis causes several compensatory responses, including increased respiratory rate, which reduces plasma Pco2; increased renal NH+ production, which leads to increased NH+ excretion; and increased phosphate buffering of hydrogen ions secreted by the renal tubules, which increases titratable acid excretion.

36. B) Infusion of a hypotonic solution of NaCl would initially increase extracellular fluid volume and decrease extracellular fluid osmolarity. The reduction in extracellular fluid osmolarity would cause osmotic flow of fluid into the cells, thereby increasing intracellular fluid volume and decreasing intracellular fluid osmolarity after osmotic equilibrium.

37. D) The tubular fluid–plasma ratio of inulin concentration is 4 in the early distal tubule, as shown in the question's figure. Because inulin is not reabsorbed from the tubule, this means that water reabsorption

must have concentrated the inulin to four times the level in the plasma that was filtered. Therefore, the amount of water remaining in the tubule is only one-fourth of what was filtered, indicating that 75% of the water has been reabsorbed prior to the distal convoluted tubule.

Explanation of answers

38. B) Potassium secretion by the cortical collecting ducts is stimulated by (1) aldosterone, (2)increased plasma potassium concentration, (3) increased flow rate in the cortical collecting tubules, and (4) alkalosis. Therefore, a diuretic that inhibits aldosterone, decreased plasma potassium concentration, acute acidosis, and low sodium intake would all tend to decrease potassium secretion by the cortical collecting tubules. A diuretic that decreases loop of Henle sodium reabsorption, however, would tend to increase the flow rate in the cortical collecting tubule and therefore stimulate potassium secretion.

39. B) Excessive secretion of aldosterone stimulates sodium reabsorption and potassium secretion in the principal cells of the collecting tubules, causing a transient reduction in urinary sodium excretion and expansion of extracellular fluid volume, as well as a transient increase in potassium excretion rate.Sodium retention raises blood pressure and decreases renin secretion. However, under steady-state conditions, sodium and potassium excretion would return to normal, so that intake and output of these electrolytes are balanced. Excess aldosterone excretion would cause a marked reduction in plasma potassium concentration because of the transient increase in potassium excretion, as well as aldosterone's effect of shifting potassium from the extracellular fluid into the cells.

40. B) This patient with diabetes mellitus and chronic renal disease has a reduction in creatinine clearance to 40% of normal, implying a marked reduction in GFR. He also has acidosis, as evidenced by a plasma pH of 7.14. The decrease in creatinine clearance would cause only a transient reduction in sodium excretion and creatinine excretion rate. As the plasma creatinine concentration increased, the urinary creatinine excretion rate would return to normal, despite the sustained decrease in creatinine learance (creatinine excretion rate/plasma concentration of creatinine). Diabetes is associated with increased production of acetoacetic acid, which would cause metabolic acidosis and decreased plasma HCO_3^- concentration, as well as a compensatory increase in renal NH_4^+ production and increased NH_4^+excretion rate

Explanation of answers

41. C) A reduction in plasma protein concentration to 3.6 g/dL would increase the capillary filtration rate, thereby raising interstitial fluid volume and interstitial fluid hydrostatic pressure. The increased interstitial fluid pressure would, in turn, increase the lymph flow rate and reduce the interstitial fluid protein concentration ("washout" of interstitial fluid protein).

42. B) The most likely diagnosis for this patient is diabetes insipidus, which can account for the polyuria and the fact that her urine osmolarity is very low (80 mOsm/L) despite overnight water restriction. In many patients with diabetes insipidus, the plasma sodium concentration can be maintained relatively close to normal by increasing fluid intake (polydipsia). When water intake is restricted, however, the high urine flow rate leads to rapid depletion of extracellular fluid volume and severe hypernatremia, as occurred in this patient. The fact that she has no glucose in her urine rules out diabetes mellitus. Neither primary aldosteronism nor a renin-secreting tumor would lead to an inability to concentrate the urine after overnight water restriction. Syndrome of inappropriate antidiuretic hormone would cause excessive fluid retention and increased urine osmolarity.

43. D) Furosemide (Lasix) inhibits the Na^+-$2Cl^-$-K^+ co-transporter in the ascending limb of the loop of Henle. This not only causes marked natriuresis and diuresis but also reduces the urine concentrating ability. Furosemide does not cause edema; in fact, it is often used to treat severe edema and heart failure.Furosemide also increases the renal excretion of potassium and calcium and therefore tends to cause hypokalemia and hypocalcemia rather than increasing the plasma concentrations of potassium and calcium.

Explanation of answers

44. A) Excessive secretion of renin leads to the formation of large amounts of angiotensin II, which in turn causes marked constriction of efferent arterioles. This reduces renal blood flow, increases glomerular hydrostatic pressure, and decreases peritubular capillary hydrostatic pressure. Because constriction of efferent arterioles reduces renal blood flow more than GFR, the filtration fraction (ratio of GFR to renal plasma flow) increases.

45. D) Most of the daily variation in potassium excretion is caused by changes in potassium secretion in the late distal tubules and collecting tubules. Therefore, when the dietary intake of potassium increases, the total body balance of potassium is maintained primarily by an increase in potassium secretion in these tubular segments. Increased potassium intake has little effect on GFR or on reabsorption of potassium in the proximal tubule and loop of Henle. Although high potassium intake may cause a slight shift of potassium into the intracellular compartment, a balance between intake and output must be achieved by increasing the excretion of potassium during high potassium intake.

46. B) Hypernatremia can be caused by excessive sodium retention or water loss. The fact that the patient has large volumes of dilute urine suggests excessive urinary water excretion. Of the two possible disturbances listed that could cause excessive urinary water excretion (nephrogenic diabetes insipidus and central diabetes insipidus), nephrogenic diabetes insipidus is the most likely cause. Central diabetes

insipidus (decreased ADH secretion) is not the correct answer because plasma ADH levels are markedly elevated. Simple dehydration due to decreased water intake is unlikely because the patient is excreting large volumes of dilute urine.

Explanation of answers

47. C) High urine flow occurs in type I diabetes because the filtered load of glucose exceeds the renal threshold, resulting in an increase in glucose concentration in the tubule, which decreases the osmotic driving force for water reabsorption. Increased urine flow reduces extracellular fluid volume and stimulates the release of antidiuretic hormone.

48. C) Diuretics that inhibit loop of Henle sodium reabsorption are used to treat conditions associated with excessive fluid volume (e.g., hypertension and heart failure). These diuretics initially cause an

increase in sodium excretion that reduces extracellular fluid volume and blood pressure, but under steadystate conditions, the urinary sodium excretion returns to normal, due in part to the fall in blood pressure. One of the important side effects of loop diuretics is hypokalemia that is caused by the inhibition of Na^+- $2Cl^-$-K^+ co-transport in the loop of Henle and by the increased tubular flow rate in the cortical collecting tubules, which stimulates potassium secretion.

49.C) Approximately 80% to 90% of bicarbonate reabsorption occurs in the proximal tubule under normal conditions as well as in acidosis (see above). For each bicarbonate ion reabsorbed, there must also be a hydrogen ion secreted. Therefore, about 80% to 90% of the hydrogen ions secreted are normally used for bicarbonate reabsorption in the proximal tubules.

YOU ARE DONE!

إن أصبنا فهو من الله سبحانه، وإن أخطأنا فهو منا ومن الشيطان، وجل من لا يخطأ.

لا تنسون قول: اللهم إنّي استودعتك ماحفظت وماقرأت وماتعلمت فردّه لي وقت حاجتي إليه، إنك على كل شيء قدير.

Good luck our DOCTORS!

See you next year!