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Renal Physiology: Kidney & Nephron

Printable Flashcards — Pre-Med Biology

Nephron anatomy, glomerular filtration, reabsorption and secretion, loop of Henle, ADH, aldosterone, RAAS, acid-base regulation, and urinalysis.

212 cards — Print double-sided, flip on long edge, then cut along dashed lines.

212 cards — Printable Flashcards

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1

Kidneys do way more than 'make pee'. Their core jobs are...

2

Main waste products the kidneys remove (basic):

3

Kidneys help control blood pressure mainly by...

4

Kidneys help control pH by...

5

Hormones made/activated by kidneys (pre-med level):

6

Trap: kidneys are only excretory organs. True or false?

7

Basic kidney anatomy: the outer part is the... and the inner part is the...

8

Nephron is...



2

Urea, creatinine, and excess ions/drugs.

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1

Control water + salts, remove wastes, regulate pH, and help control blood pressure.

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4

Reabsorbing bicarbonate (HCO_3^-) and secreting H^+ into urine.

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3

Controlling blood volume (water/salt) and using the RAAS system.

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6

False.

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5

EPO (red blood cells) + active vitamin D (calcitriol).

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8

The functional unit of the kidney that makes urine.

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7

Cortex (outer) and medulla (inner).

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9

Roughly, one kidney has about... nephrons.

10

The nephron has 2 big parts:

11

The glomerulus is...

12

Bowman's capsule is...

13

The 'filtrate' in Bowman's capsule
is NOT urine yet because...

14

Trap: urine is made in the
glomerulus. True or false?

15

Kidney regions: outer `{{c1::cortex}}`,
inner `{{c2::medulla}}`.

16

Functional unit of the kidney:



10

Renal corpuscle (glomerulus + Bowman's capsule)
+ renal tubule (PCT, loop, DCT, collecting duct).

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9

About a million.

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12

The cup that collects the filtrate
coming out of the glomerulus.

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11

A ball of capillaries where filtration happens.

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14

False.

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13

Most useful stuff (water, glucose,
ions) still gets reabsorbed later.

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16

Nephron

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15

Kidney regions: outer cortex, inner medulla.

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17

Renal blood flow path (simplified):

18

Afferent arteriole does what?

19

Efferent arteriole does what?

20

Why is it arteriole -> capillaries
-> arteriole in the nephron?

21

Glomerular filtration is driven mainly by...

22

Filtration barrier has 3 main layers (concept):

23

Podocytes are...

24

Trap: red blood cells normally
pass into filtrate. True or false?



18

Brings blood INTO the glomerulus.

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17

Renal artery -> afferent arteriole -> glomerulus -> efferent arteriole -> peritubular capillaries/vasa recta -> renal vein.

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20

To keep glomerular pressure high for filtration and then allow reabsorption later.

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19

Takes blood OUT of the glomerulus.

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22

Fenestrated endothelium + basement membrane + podocyte slits.

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21

High hydrostatic pressure in glomerular capillaries.

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24

False.

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23

Special cells that wrap glomerular capillaries and create filtration slits.

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25

Trap: plasma proteins normally appear in urine. True or false?

26

Proteinuria suggests the filtration barrier is letting through...

27

Peritubular capillaries are important because they...

28

Vasa recta are...

29

Cortex vs medulla: where are most glomeruli?

30

Trap: loop of Henle is mainly in cortex. True or false?

31

GFR stands for...

32

If GFR drops too low, the immediate problem is...



26

Proteins that are normally too big/charged to pass.

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25

False (normally).

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28

Special capillaries around loops of Henle that help maintain the medullary gradient.

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27

Pick up reabsorbed water/solutes from the tubules.

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30

False.

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29

Cortex.

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32

Wastes build up and fluid/electrolyte balance gets harder.

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31

Glomerular filtration rate.

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33

Kidneys filter a LOT, then reabsorb a LOT. Why?

34

Afferent arteriole brings blood
{{c1::into}} the glomerulus; efferent
arteriole takes blood {{c2::out}}.

35

High-pressure capillary bed
where filtration happens:

36

Nephron segment order (from Bowman's capsule):

37

PCT (proximal convoluted tubule) is the...

38

If the kidney wants to save glucose,
where is it mostly reabsorbed?

39

Glucose in urine usually means...

40

PCT also reabsorbs a lot of... (acid-base clue)



34

Afferent arteriole brings blood into the glomerulus; efferent arteriole takes blood out.

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33

It's easier to filter everything small, then selectively take back what you want.

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36

PCT -> loop of Henle (descending then ascending) -> DCT -> collecting duct.

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35

Glomerulus

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38

PCT.

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37

Major reabsorption zone (bulk reabsorption).

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40

Bicarbonate (HCO_3^-).

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39

Blood glucose is too high and PCT transporters got saturated (like diabetes).

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41

Loop of Henle's big job is...

42

Descending limb: permeable to water or salts?

43

Ascending limb: permeable to water or salts?

44

Why is ascending limb called the 'diluting segment'?

45

Thick ascending limb uses active transport to...

46

DCT (distal convoluted tubule) is more about...

47

Collecting duct is where the kidney decides...

48

ADH mainly acts on the...



42

Water yes, salts not much.

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41

Build the medullary osmotic gradient
(set up concentrating power).

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44

It removes salt without removing
water, so filtrate becomes more dilute.

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43

Salts yes (reabsorbs NaCl), water no.

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46

Fine-tuning ions (Na^+ , K^+ , H^+)
rather than bulk reabsorption.

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45

Pump NaCl out of the tubule into the medulla.

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48

Collecting duct (and late DCT)
to increase water reabsorption.

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47

How much water to keep or lose (ADH-dependent).

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49

Trap: ADH makes you pee more. True or false?

50

Aldosterone mainly acts on...

51

Trap: aldosterone directly opens water channels (aquaporins). True or false?

52

If aldosterone increases Na^+ reabsorption, water usually...

53

What is the 'collecting duct' collecting?

54

Most reabsorption happens in the...

55

Most water reabsorption (by amount) happens in the...

56

If you drink a lot of water, ADH goes... and urine becomes...



50

Late DCT and collecting duct to increase Na^+ reabsorption and K^+ secretion.

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49

False.

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52

Follows (if ADH allows), increasing blood volume.

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51

False.

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54

PCT.

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53

Filtrate from many nephrons, then adjusting water/urea based on hormones.

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56

Down; large volume and dilute.

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55

PCT (and then collecting duct is the adjustable part).

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57

If you're dehydrated, ADH goes... and urine becomes...

58

Descending limb: water . Ascending limb: salt , water .

59

ADH increases water reabsorption mainly in the by inserting .

60

Segment where most glucose is reabsorbed:

61

Urine formation has 3 processes:

62

Filtration happens at the...

63

Reabsorption means...

64

Secretion means...



58

Descending limb: water out.
Ascending limb: salt out, water no.

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57

Up; small volume and concentrated.

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60

PCT (proximal convoluted tubule)

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59

ADH increases water reabsorption mainly in the collecting duct by inserting aquaporins.

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62

Glomerulus (into Bowman's capsule).

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61

Filtration, reabsorption, secretion.

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64

Moving stuff from blood into tubule to be excreted.

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63

Moving useful stuff from tubule back into blood.

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65

The master equation: Excretion =

66

Quick trap: If something is 100% filtered and 100% reabsorbed, it is...

67

Glucose in urine means the reabsorption step for glucose is...

68

If something is filtered and NOT reabsorbed, its excretion equals...

69

If something is filtered AND secreted, then its excretion is...

70

If something is filtered AND reabsorbed a lot, then its excretion is...

71

Clearance is basically...

72

Creatinine is often used clinically to estimate...



66

Not excreted (excretion ~ 0).

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65

Filtration - Reabsorption + Secretion.

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68

Its filtration (all filtered amount leaves).

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67

Maxed out/saturated.

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70

Less than filtration.

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69

Greater than filtration.

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72

GFR (roughly).

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71

How effectively the kidney removes a substance from the blood.

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73

Trap: high blood creatinine usually means high GFR. True or false?

74

Why is creatinine used instead of urea as the main marker (basic idea)?

75

If GFR decreases, what happens to blood levels of wastes like creatinine?

76

If a substance is too big (like albumin), its filtration is...

77

Urine excretion equation:
$$\text{Excretion} = \{\{c1::\text{Filtration}\}\} - \{\{c2::\text{Reabsorption}\}\} + \{\{c3::\text{Secretion}\}\}.$$

78

Three processes of urine formation:

79

Key concept: you can only make concentrated urine if you have...

80

Medullary osmotic gradient means...



74

Creatinine is produced more steadily and is less affected by diet than urea (concept).

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73

False.

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76

Very low (normally).

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75

They rise.

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78

Filtration, reabsorption, secretion

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77

Urine excretion equation: $\text{Excretion} = \text{Filtration} - \text{Reabsorption} + \text{Secretion}$.

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80

The deeper into the medulla you go, the saltier (higher osmolality) it gets.

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79

A salty medulla (osmotic gradient) + ADH making collecting duct water-permeable.

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81

Countercurrent multiplier is mainly created by the...

82

Countercurrent exchanger is mainly the job of the...

83

Juxtamedullary nephrons are special because they...

84

Cortical nephrons are mostly for...

85

In the collecting duct, ADH increases...

86

No ADH (or ADH not working)
means the collecting duct is...

87

The basic meaning of 'diuretic' is...

88

Why does alcohol make you pee more (basic)?



82

Vasa recta.

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81

Loop of Henle (especially the thick ascending limb).

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84

General filtration and reabsorption,
not deep concentrating power.

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83

Have long loops of Henle that go deep
into medulla, making a strong gradient.

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86

Less permeable to water ->
you lose water -> dilute urine.

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85

Water permeability -> more water
leaves -> urine gets concentrated.

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88

It reduces ADH, so less water
is reabsorbed in collecting duct.

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87

Something that makes you produce
more urine (more water excretion).

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89

Urine concentration depends on osmolality. Osmolality is basically...

90

Trap: concentrated urine means you excrete more water. True or false?

91

If you're dehydrated, your urine volume goes... and osmolality goes...

92

If you overhydrate, urine volume goes... and osmolality goes...

93

Urea recycling (basic idea) helps...

94

Trap: the loop of Henle concentrates urine directly. True or false?

95

Ascending limb is $\{\{c1::impermeable\ to\ water\}\}$ and pumps $\{\{c2::NaCl\}\}$ out -
> helps build the medullary gradient.

96

Hormone that makes collecting duct more water-permeable:



90

False.

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89

How many particles (solutes) per amount of water.

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92

Up; down.

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91

Down; up.

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94

False (not by itself).

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93

Make the medulla even saltier to support concentrating urine.

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96

ADH

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95

Ascending limb is impermeable to water and pumps NaCl out -> helps build the medullary gradient.

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97

ADH is released when the body senses...

98

ADH makes you save water by acting mainly on...

99

Aldosterone is released when... (big triggers)

100

Aldosterone's main kidney effect is:

101

ANP (atrial natriuretic peptide) is released when...

102

ANP effect in one line:

103

Trap: ANP increases aldosterone to retain sodium. True or false?

104

PTH (parathyroid hormone) in the kidney mainly helps...



98

Collecting duct (adds aquaporins).

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97

High blood osmolality (too concentrated)
or low blood volume/pressure.

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100

Increase Na^+ reabsorption and increase
 K^+ secretion in late DCT/collecting duct.

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99

RAAS is active (low BP/low
 Na^+) or potassium is high.

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102

Lose salt + water \rightarrow lower blood volume/BP.

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101

Blood volume/pressure is high (atria stretched).

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104

Increase calcium reabsorption and
increase phosphate excretion (high-level).

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103

False.

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105

Kidneys activate vitamin D into...

106

EPO (erythropoietin) is released mainly when...

107

Why can kidney disease cause anemia (low RBC)?

108

Big hormone trap: ADH vs aldosterone. Fast difference:

109

Another trap: losing sodium (Na^+) usually drags what with it?

110

Aldosterone \rightarrow more $\{\{c1::\text{Na}^+\}\}$ reabsorption and more $\{\{c2::\text{K}^+\}\}$ secretion (late DCT/collecting duct).

111

ANP is released when blood volume is $\{\{c1::\text{high}\}\}$ and promotes $\{\{c2::\text{Na}^+\}\}$ and water excretion.

112

Hormone made by kidneys that stimulates RBC production:



106

Kidney senses low oxygen.

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105

Calcitriol (active vitamin D).

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108

ADH controls water permeability;
aldosterone controls Na^+/K^+ handling.

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107

Less EPO production -> less RBC production.

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110

Aldosterone -> more Na^+ reabsorption and
more K^+ secretion (late DCT/collecting duct).

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109

Water.

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112

EPO (erythropoietin)

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111

ANP is released when blood volume is high
and promotes Na^+ and water excretion.

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113

RAAS is the body's 'save blood pressure' system. RAAS stands for...

114

RAAS starts when kidneys release...

115

Renin is released mainly by...

116

Juxtaglomerular apparatus (JGA) is basically...

117

Macula densa is part of JGA. It senses...

118

Three classic triggers for renin release:

119

Renin converts... into...

120

ACE converts... into...



114

Renin.

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113

Renin-Angiotensin-Aldosterone System.

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116

A sensor/control area where tubule meets arteriole to regulate GFR/BP (renin release).

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115

Juxtaglomerular (JG) cells near the afferent arteriole.

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118

Low BP in afferent arteriole, low NaCl at macula densa, sympathetic stimulation.

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117

NaCl in the tubule (early DCT).

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120

Angiotensin I into angiotensin II.

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119

Angiotensinogen into angiotensin I.

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121

Angiotensin II's main effects (basic list):

122

Why does aldosterone raise blood pressure?

123

Angiotensin II can help maintain filtration pressure by constricting the... arteriole (classic).

124

Trap: angiotensin II mainly dilates blood vessels to raise BP. True or false?

125

If RAAS is active, what happens to sodium excretion?

126

If RAAS is active, what happens to blood volume?

127

Scenario: dehydration/bleeding
-> BP low. Predict renin:

128

Scenario: high blood volume (post-salty meal + lots of water). Predict RAAS:



122

It makes kidneys keep Na^+ ; water follows \rightarrow more blood volume.

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121

Vasoconstriction + stimulates aldosterone + stimulates ADH/thirst.

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124

False.

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123

Efferent arteriole.

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126

It increases.

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125

It decreases (you retain more Na^+).

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128

Down (and ANP may go up).

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127

Up.

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129

Low BP \rightarrow $\{\{c1::renin\}\}$ \rightarrow
angiotensin II \rightarrow $\{\{c2::aldosterone\}\}$ +
 $\{\{c3::vasoconstriction\}\}$ \rightarrow BP rises.

130

Hormone released by JG cells to start RAAS:

131

The #1 ion that controls
extracellular fluid volume is...

132

So if kidneys retain more
 Na^+ , blood volume usually...

133

K^+ balance is a big deal because it affects...

134

Aldosterone's K^+ effect is to...

135

Trap: aldosterone saves potassium. True or false?

136

If blood K^+ is high, aldosterone usually goes...



130

Renin

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129

Low BP -> renin -> angiotensin II -> aldosterone + vasoconstriction -> BP rises.

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132

Increases.

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131

Sodium (Na^+).

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134

Increase K^+ secretion into urine.

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133

Heart and muscle cell electrical activity.

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136

Up.

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135

False.

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137

If aldosterone is high, you'd expect urine potassium to...

138

Calcium (Ca^{2+}) regulation: kidneys help by...

139

Phosphate balance: PTH tends to make kidneys...

140

Big exam trap: 'water follows salt' means...

141

ADH mainly changes...

142

So ADH changes blood volume by changing...

143

Aldosterone: Na^+ reabsorption up, K^+ secretion up.

144

Blood pH is tightly controlled around... (rough)



138

Reabsorbing Ca^{2+} (influenced by PTH) and activating vitamin D.

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137

Increase (more K^+ excreted).

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140

Keeping Na^+ tends to keep water too (raising volume).

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139

Excrete more phosphate.

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142

How much water you keep.

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141

Water reabsorption (not Na^+ reabsorption).

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144

About 7.4.

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143

Aldosterone: Na^+ reabsorption up, K^+ secretion up.

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145

Two organs controlling pH:

146

Kidneys help fix acidosis (too much acid) by...

147

Kidneys help fix alkalosis (too basic) by...

148

Bicarbonate (HCO_3^-) is important because it...

149

Where is most bicarbonate reabsorbed?

150

Kidneys secrete H^+ mainly in the... (high-level)

151

Why can't kidneys just dump
free H^+ endlessly into urine?

152

Ammonia/ammonium buffer idea (basic):



146

Secreting more H^+ and reabsorbing/generating more bicarbonate.

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145

Lungs (CO_2) and kidneys (HCO_3^-/H^+).

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148

Buffers acids in the blood.

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147

Excreting more bicarbonate (and reducing H^+ secretion).

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150

Distal nephron (DCT/collecting duct) and also PCT.

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149

PCT (proximal tubule).

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152

Kidney makes NH_3 that grabs H^+ -> NH_4^+ gets excreted.

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151

Urine would become extremely acidic; buffers are needed.

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153

If urine is very acidic, the kidney is likely...

154

If urine is more basic, the kidney is likely...

155

Trap: kidneys regulate pH mainly by changing oxygen levels. True or false?

156

Lungs control CO_2 quickly; kidneys control HCO_3^- and H^+ more slowly.

157

Main blood buffer base reclaimed by kidneys:

158

Normal urine should contain lots of...

159

Normal urine should NOT contain (normally):

160

Glucose in urine points to...



154

Excreting more bicarbonate (like during alkalosis).

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153

Excreting more H^+ (like during acidosis).

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156

Lungs control CO_2 quickly; kidneys control HCO_3^- and H^+ more slowly.

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155

False.

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158

Water + urea + some ions (Na^+ , K^+ , etc.).

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157

Bicarbonate (HCO_3^-)

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160

High blood glucose (transporters saturated) or kidney reabsorption issues.

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159

Red blood cells or large amounts of protein.

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161

Protein in urine points to...

162

Blood (RBCs) in urine points to...

163

If urine is super dilute, ADH is probably...

164

If urine is very concentrated, ADH is probably...

165

Ketones in urine usually means the body is...

166

Foamy urine can be a clue for...

167

Dark urine can happen when... (basic)

168

Pale/clear urine often means...



162

Bleeding/damage in urinary tract or filtration issues.

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161

Kidney filtration barrier damage (glomerulus) or increased permeability.

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164

High (and medullary gradient is being used).

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163

Low (or not working).

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166

Protein in urine.

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165

Burning fat for energy (not enough glucose use).

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168

It's dilute (low ADH / lots of water intake).

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167

It's concentrated (dehydration) or there are pigments/blood.

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169

Trap: urea in urine means kidney disease. True or false?

170

Normal urine should not contain lots of protein or red blood cells.

171

Glucose in urine is called:

172

GFR is basically controlled by the pressure in the...

173

If the afferent arteriole constricts, glomerular pressure and GFR usually...

174

If the afferent arteriole dilates, glomerular pressure and GFR usually...

175

If the efferent arteriole constricts (a bit), glomerular pressure and GFR usually...

176

If the efferent arteriole dilates, glomerular pressure and GFR usually...



170

Normal urine should not contain lots of protein or red blood cells.

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169

False.

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172

Glomerulus.

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171

Glucosuria

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174

Increase.

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173

Decrease.

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176

Decrease.

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175

Increase (at least initially).

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177

Exam trap: RAAS (angiotensin II) helps GFR during low BP by constricting...

178

Scenario: massive dehydration -> low BP. What happens to renin and ADH?

179

Scenario: you drink 2 liters quickly. What happens to ADH and urine?

180

Scenario: low sodium diet + low BP. What hormone system turns on?

181

Scenario: high blood volume (atria stretched). What hormone helps you dump salt/water?

182

Obligatory vs adjustable water reabsorption (simple idea):

183

Why does water leave the descending limb?

184

Why doesn't water leave the ascending limb?



178

Both increase.

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177

Efferent arteriole.

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180

RAAS (renin -> angiotensin II -> aldosterone).

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179

ADH decreases; urine volume increases and becomes dilute.

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182

PCT reabsorbs lots of water automatically; collecting duct reabsorption is adjustable via ADH.

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181

ANP.

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184

Because it's impermeable to water.

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183

Because the medulla is salty, so osmosis pulls water out.

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185

Why does salt leave the ascending limb?

186

What is 'countercurrent' in one sentence?

187

Trap: the medulla is salty because the kidneys filter salt there. True or false?

188

What is 'osmotic gradient' doing for you?

189

If the medullary gradient is weak, you'd expect urine concentrating ability to be...

190

Freely filtered substances (basic examples):

191

Not freely filtered (normal):

192

Plasma proteins help oppose filtration because they...



186

Two flows in opposite directions that amplify or preserve a gradient.

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185

Transporters move NaCl out (especially in thick ascending limb).

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188

It creates a pulling force so water can be reabsorbed when needed.

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187

False.

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190

Water, Na⁺, glucose, urea.

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189

Reduced.

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192

Create oncotic (osmotic) pressure pulling water back into capillaries.

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191

Cells (RBCs) and large proteins (like albumin).

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193

So if plasma protein levels are very low, filtration might... (concept)

194

Trap: 'filtered' means the kidney removed it from the body. True or false?

195

Filtered = moved into tubule. Excreted = actually leaves body in `{{c1::urine}}`.

196

If someone pees huge volumes of very dilute urine and is always thirsty, think problem with...

197

If someone has very small volume of very concentrated urine, ADH is likely...

198

Trap: diabetes mellitus and diabetes insipidus are the same thing. True or false?

199

Simple compare: glucose in urine points to...; huge dilute urine points to...

200

Outer part of kidney (where most glomeruli are):



194

False.

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193

Increase, because there's less oncotic pull back.

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196

ADH (too low or kidneys not responding).

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195

Filtered = moved into tubule. Excreted
= actually leaves body in urine.

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198

False.

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197

High.

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200

Cortex

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199

Diabetes mellitus; ADH
problem (diabetes insipidus).

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201

Inner part of kidney with loops/collecting ducts and osmotic gradient:

202

Nephron segment doing bulk reabsorption:

203

Nephron segment that's water-permeable (descending limb):

204

Nephron segment that pumps salt out but is water-impermeable:

205

Hormone system that activates when BP/volume is low (name):

206

Hormone that promotes sodium and water excretion when volume is high:

207

Two substances that normally should NOT be in urine:

208

Most reabsorption happens in the `{{c1::PCT}}`; final water adjustment happens in the `{{c2::collecting duct}}`.



202

PCT

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201

Medulla

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204

Ascending limb of loop of Henle
(especially thick ascending limb)

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203

Descending limb of loop of Henle

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206

ANP

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205

RAAS

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208

Most reabsorption happens in the PCT; final
water adjustment happens in the collecting duct.

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207

Red blood cells and large proteins (albumin)

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209

High ADH -> urine volume $\{\{c1::down\}\}$
and urine concentration $\{\{c2::up\}\}$.

210

Low ADH -> urine volume $\{\{c1::up\}\}$
and urine concentration $\{\{c2::down\}\}$.

211

RAAS goal: raise blood $\{\{c1::pressure\}\}$ by
retaining $\{\{c2::Na^+\}\}$ and $\{\{c3::water\}\}$.

212

Aldosterone acts mainly on $\{\{c1::late\}\}$
DCT/collecting duct; ADH acts mainly on
 $\{\{c2::collecting\}\}$ duct water permeability.



210

Low ADH -> urine volume up
and urine concentration down.

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209

High ADH -> urine volume down
and urine concentration up.

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212

Aldosterone acts mainly on late
DCT/collecting duct; ADH acts mainly
on collecting duct water permeability.

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211

RAAS goal: raise blood pressure
by retaining Na^+ and water.

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