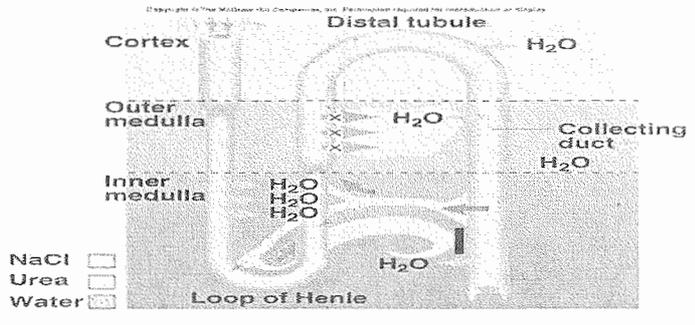


CONCENTRATION OF URINE AND COUNTER CURRENT MECHANISM



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ROLE OF THE DIFFERENT PARTS OF THE NEPHRON

PROXIMAL CONVOLUTED TUBULE
Reabsorption (over 60% of filtered)
 Water: 60% reabsorbed
 Na⁺: 60% reabsorbed
 Cl⁻: 60% reabsorbed
 Glucose: 100% reabsorbed
 Amino acids: 100% reabsorbed
 H₂O: 60% reabsorbed
 Urea: 50% reabsorbed
 Ca²⁺, Mg²⁺: variable reabsorption
Secretion (into tubule lumen)
 H⁺: variable, increases in metabolic acidosis
 Urea: variable reabsorption
 Creatinine: secreted
 At end of PCT, tubular fluid is isotonic to blood (300 mOsm/L).

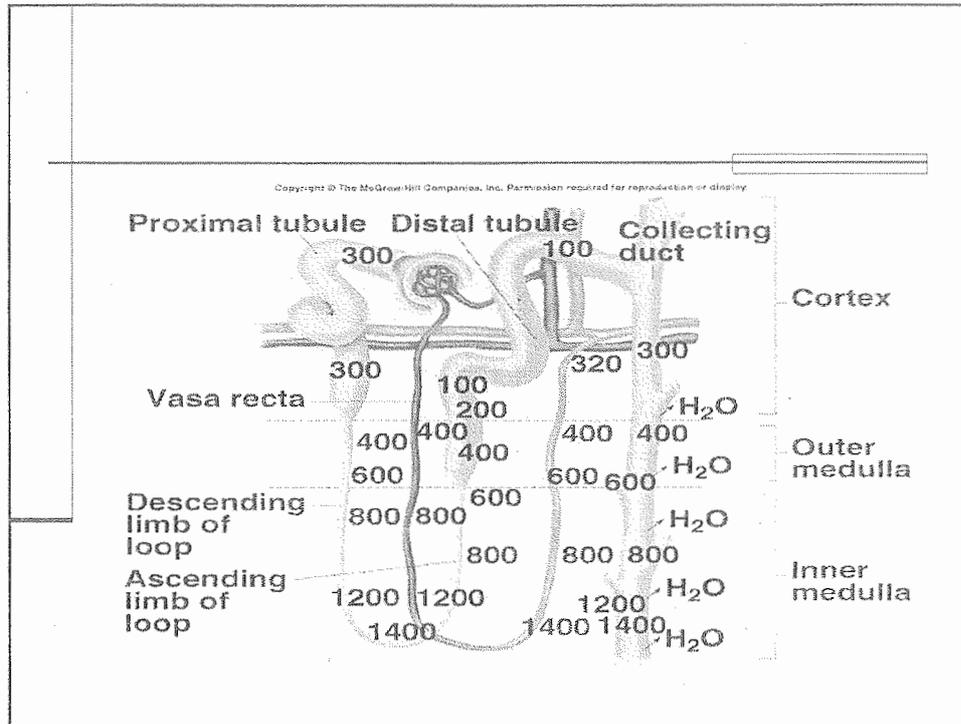
LOOP OF HENLE
Reabsorption (over 20% of filtered)
 Water: 15% reabsorbed
 Na⁺: 20% reabsorbed
 K⁺: 20-25% reabsorbed
 Cl⁻: 20% reabsorbed
 H₂O: 15% reabsorbed
 Ca²⁺, Mg²⁺: variable reabsorption
Secretion (into tubule lumen)
 Urea: variable reabsorption
 At end of loop of Henle, tubular fluid is hypertonic (1200-1250 mOsm/L).

RENAL CORPUSCLE
Glomerular filtration rate
 120-130 mL/min
 Filtered substances: water, electrolytes, glucose, amino acids, urea, creatinine, urea, and

DISTAL CONVOLUTED TUBULE
Reabsorption (over 20% of filtered)
 Water: 10-15% reabsorbed
 Na⁺: 5% reabsorbed
 Cl⁻: 5% reabsorbed
 Ca²⁺: variable reabsorption

PRINCIPAL CELLS IN THE LATE DISTAL TUBULE AND COLLECTING DUCT
Reabsorption (over 20% of filtered)
 Water: 20% reabsorption
 Na⁺: 20% reabsorption
 Urea: variable reabsorption
Secretion (into tubule lumen)
 H⁺: variable reabsorption
 Urea: variable reabsorption

INTERSTITIAL CELLS IN THE LATE DISTAL TUBULE AND COLLECTING DUCT
Reabsorption (over 20% of filtered)
 Water: 20% reabsorption
 Na⁺: 20% reabsorption
 Urea: variable reabsorption
Secretion (into tubule lumen)
 H⁺: variable reabsorption
 Urea: variable reabsorption



ROLE OF KIDNEYS AS BODY NEEDS

- Kidneys alter the composition of urine in response to the body's daily requirements / needs.
- Kidneys maintain the osmolality of the body fluids.
- If necessary, kidneys conserve body water, excrete urine with a high solute concentration.
- When it is necessary to rid the body of excess water, the kidneys excrete urine with a dilute solute concentration.

REQUIREMENTS FOR EXCRETING CONCENTRATED URINE:

Requirements for Excreting a Concentrated Urine:

The basic requirements for forming a concentrated urine are:

[1] *High level of ADH, which increases the permeability of the distal tubules and collecting ducts to water, thereby allowing these tubular segments to keenly reabsorb water*

[2] *High osmolarity of the renal medullary interstitial fluid, which provides the osmotic gradient necessary for water reabsorption to occur in the presence of high levels of ADH*

COUNTER CURRENT MULTIPLIER AND EXCHANGERS

Tubular re-absorption of water

- Tubular re-absorption of water determines the urine flow rate and osmolality of urine
- Countercurrent multipliers: Loops of Henle act as countercurrent multipliers [countercurrent theory]

Countercurrent exchanger: The vasa recta

Factors that influence the ability to form an osmotically concentrated urine

Delivery of NaCl to ascending limb of LOH

ADH

COUNTER CURRENT MULTIPLIER AND EXCHANGERS

A COUNTERCURRENT EXCHANGE SYSTEM: This mechanism works to keep the concentration of solutes in the medullary part of the kidney, by the two mechanisms. It absorbs water like any capillary and take it to the cortical vascular system while small amount of solute is allowed to go out of the vasa recta. Hence it this mechanism maintain the osmotic concentration in the medulla at higher level [hyperosmolality] more than 500 mosmol / lit and can go up to 1200 mosmol / l

MECHANISM OF EXCRETING DILUTE URINE

When the osmolality of the extracellular fluid is decreased, the secretion of (ADH) by the hypothalamus / posterior pituitary gland is also decreased.

Due to decreased ADH, the reabsorption of water is decreased in the distal tubule, cortical collecting tubule and collecting ducts. Thus, more water is excreted in urine [dilute urine].

MECHANISM OF EXCRETING CONCENTRATED URINE

Creating hyperosmolality in the medullary interstitial fluid:

The major cause of increasing medullary osmolality is active transport of Na^+ and Cl^- into the medullary interstitium from the thick ascending limb of the loop of Henle.

A small quantity of Na^+ and Cl^- ions are transported from the collecting duct into the medullary interstitium.

High levels of ADH, the collecting tubules become permeable to water. Water quickly moves out of the ducts by osmosis into the interstitial fluid of the inner medulla and greatly increases the concentration of urea in the collecting tubule.

MECHANISM OF EXCRETING CONCENTRATED URINE

Maintenance of hyperosmolality in the medullary interstitium:

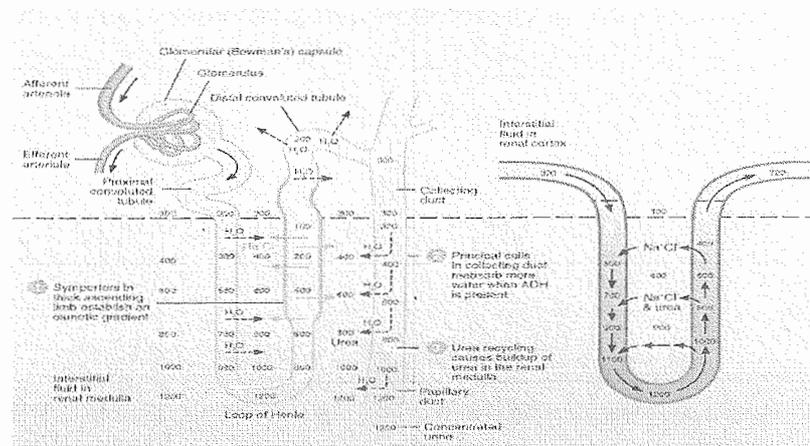
Medullary blood flow is much decreased, the removal of solutes from the medullary interstitium by the blood is also decreased.

- The vasa recta maintains the hyperosmolality of the renal medulla by means of mechanism called counter current exchange mechanism

MECHANISM OF EXCRETING CONCENTRATED URINE [Cont...]

Solutes from the medullary interstitium. As it flows up through the ascending limb of limb of the vasa recta, it gives up solutes to the medullary interstitium. Thus, the countercurrent exchange mechanism of the vasa recta maintains hyperosmolality in the medullary region.

COUNTERCURRENT MECHANISM



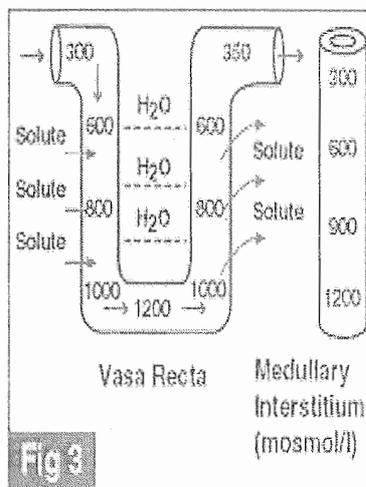
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COUNTERCURRENT EXCHANGE IN THE VASA RECTA

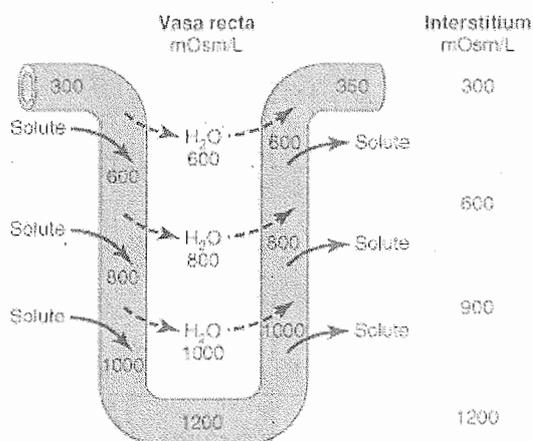
The Vasa Recta is a portion of the peritubular capillary system which enters the medulla where the solute concentration in the interstitium is high.

It acts with the loop of Henle to concentrate the urine by a counter current exchange.

If vasa recta did not exist, the high concentration of solutes in the medullary interstitium would be washed out.

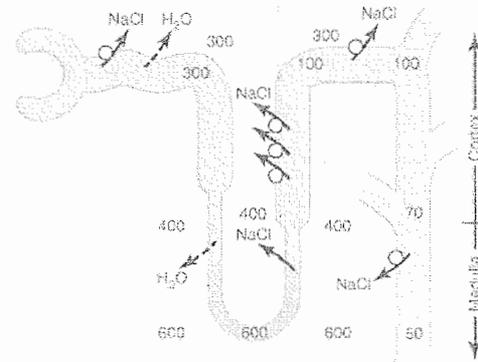


COUNTERCURRENT EXCHANGE IN THE VASA RECTA



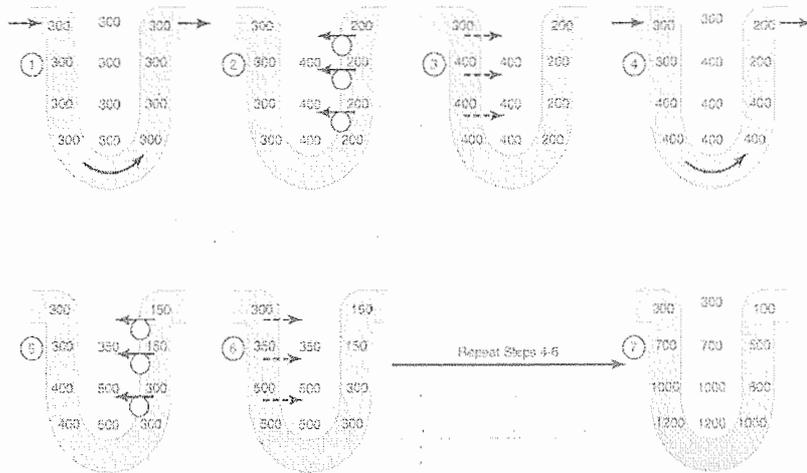
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ROLE AT MEDULLARY AND CORTICAL LEVELS

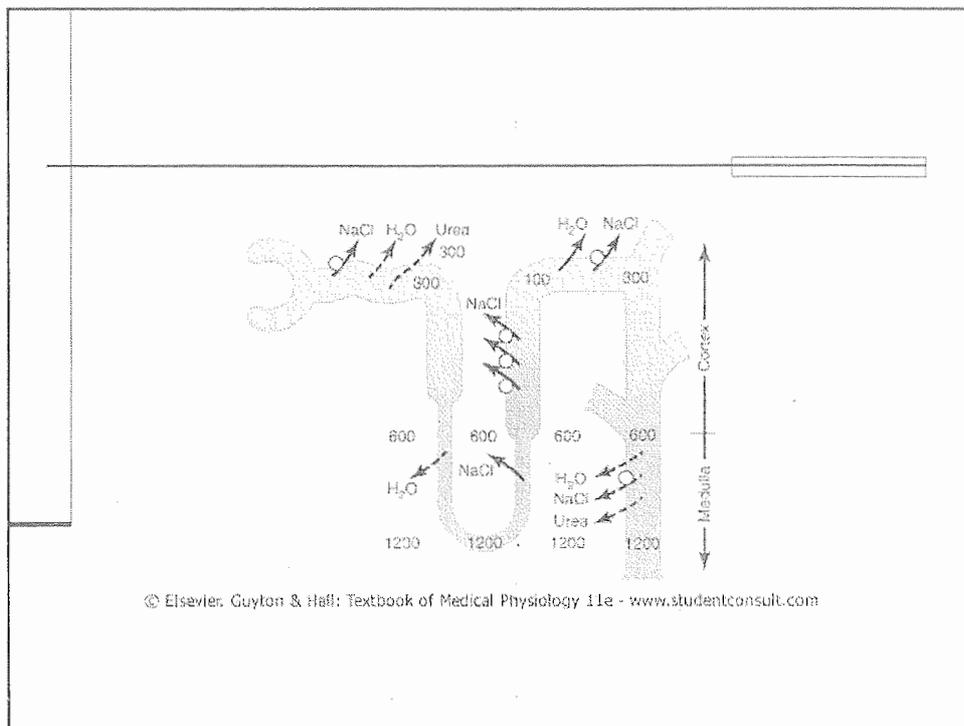


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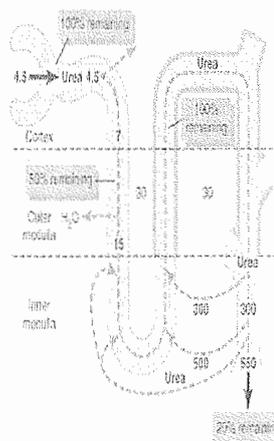
COUNTERCURRENT MULTIPLIER SYSTEM IN THE LOOP OF HENLE FOR PRODUCING A HYPEROSMOTIC RENAL MEDULLA

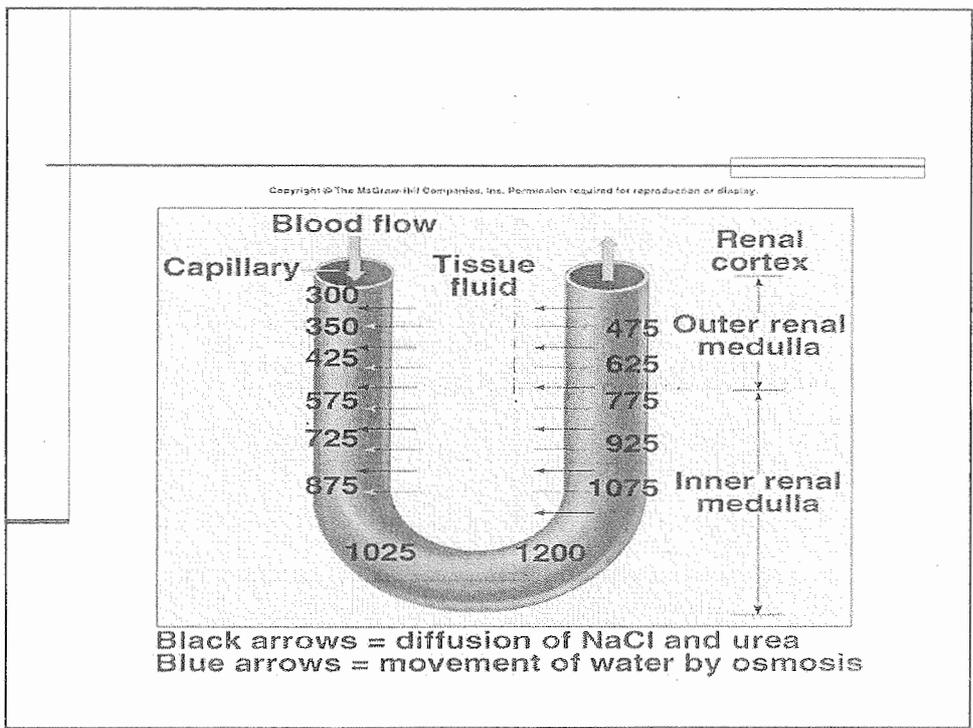
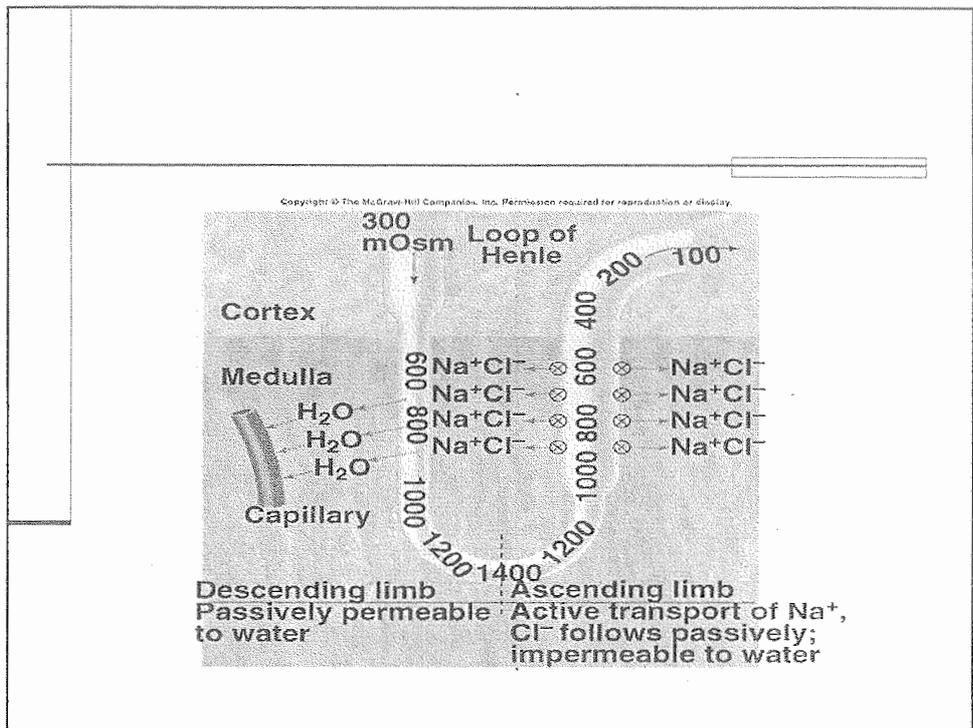


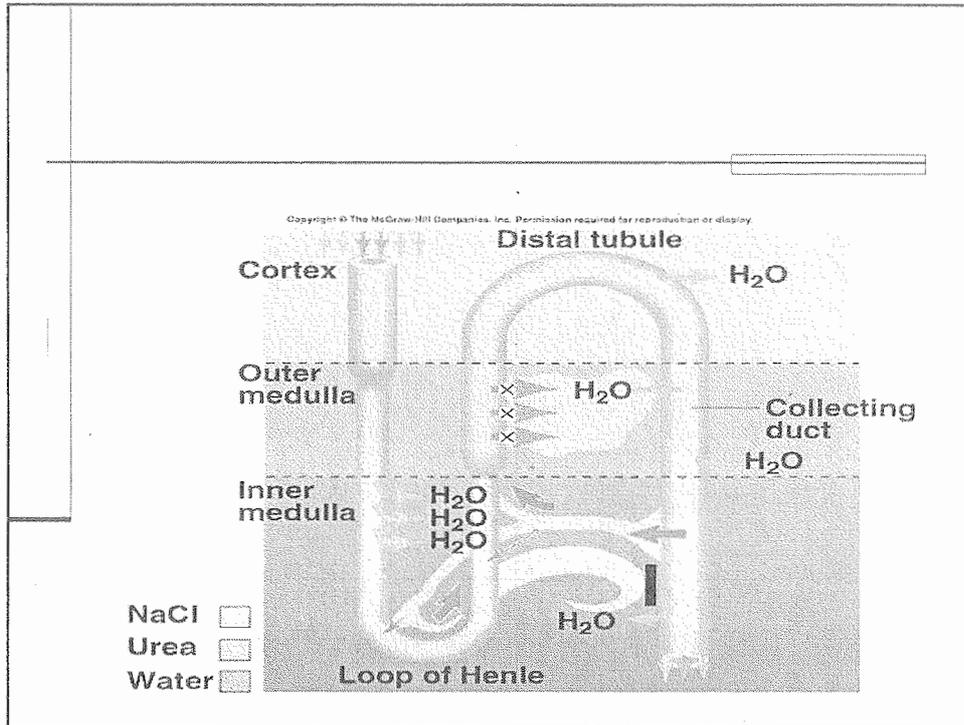
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urea absorbed from the medullary collecting duct into the interstitial fluid. Urea diffuses into the thin loop of Henle, and then passes through the distal tubules, and finally passes back into the collecting duct. The recirculation of urea helps to trap urea in the renal medulla and contributes to the hyperosmolarity of the renal medulla.



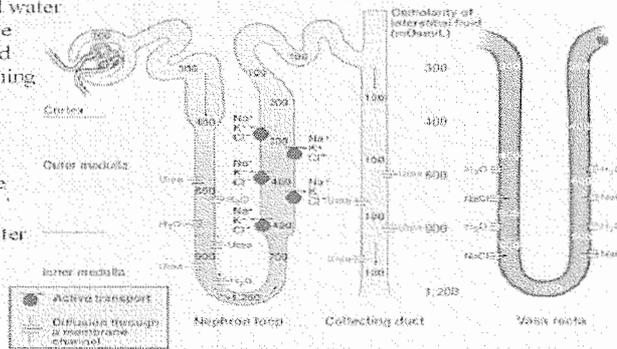




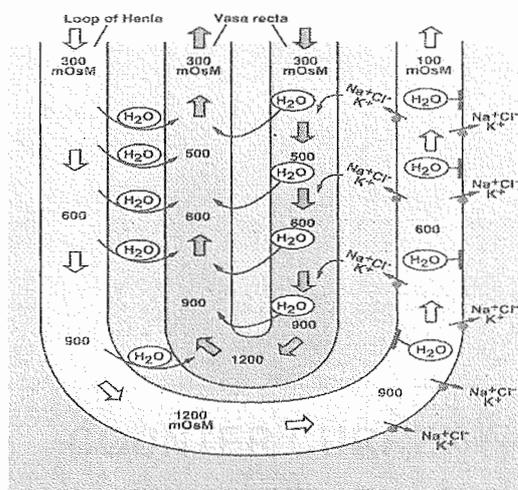
COUNTER CURRENT MULTIPLIER

The counter current multiplier

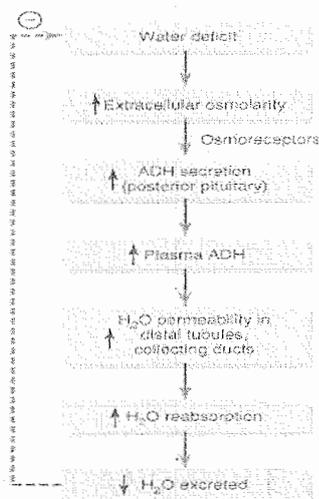
- Most of the salt and water get reabsorbed in the proximal convoluted tubule (with everything else)
 - 60% of water
 - 65% of salts
- by the bottom of the descending limb
 - only 20% of water remains
 - the 65% of salt is still there
- by the top of the ascending limb
 - only 10% of the salts remain



COUNTER CURRENT MULTIPLIER

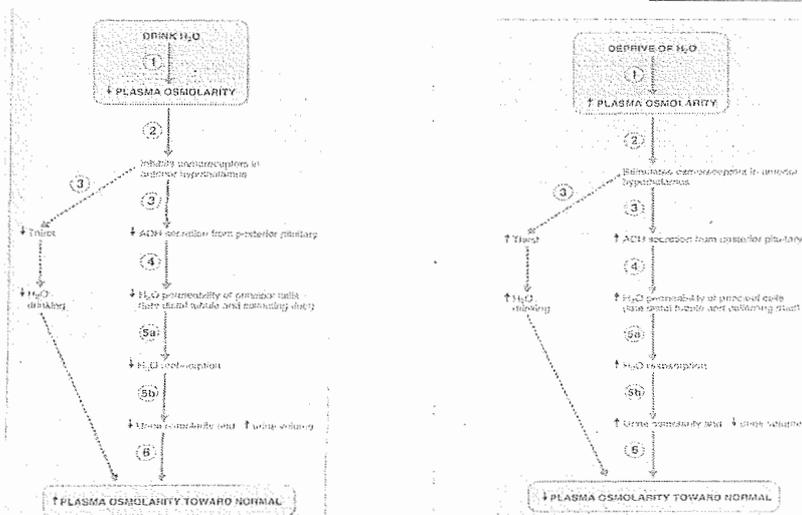


WATER DEFICIT AND ROLE OF KIDNEYS

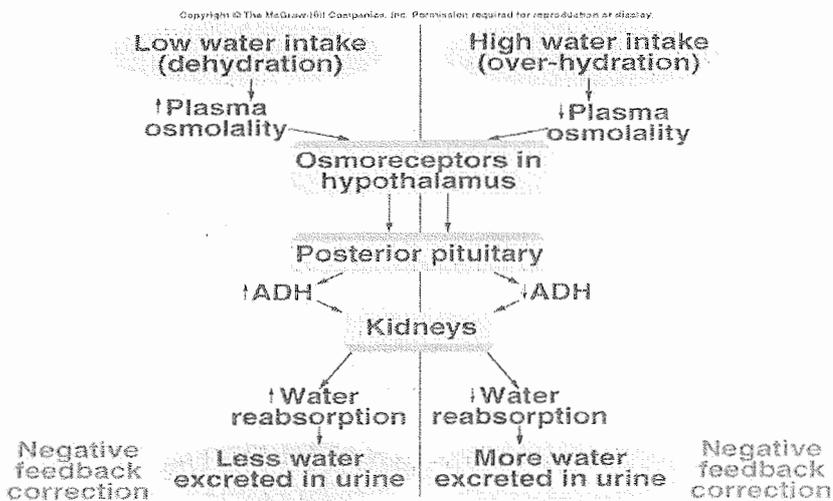


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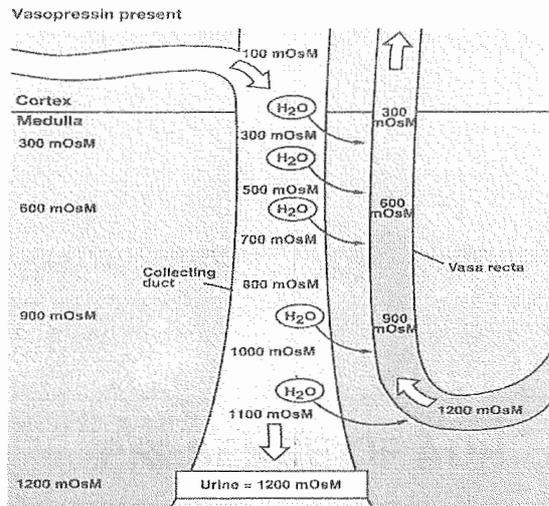
WATER INTAKE AND WATER DEFICIT AND ROLE OF ADH



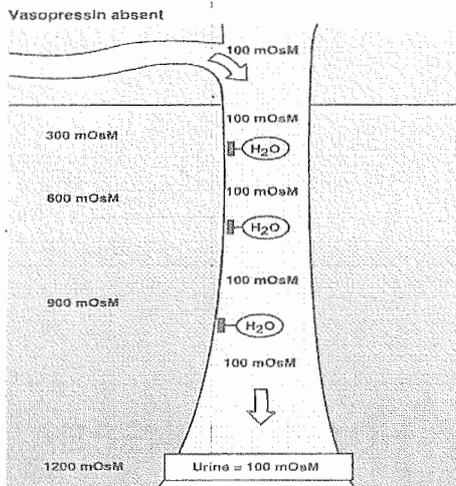
LOW WATER INTAKE AND HIGH WATER INTAKE AND ROLE OF KIDNEYS



PRESENCE OF ADH



ABSENCE OF ADH



THANK YOU

