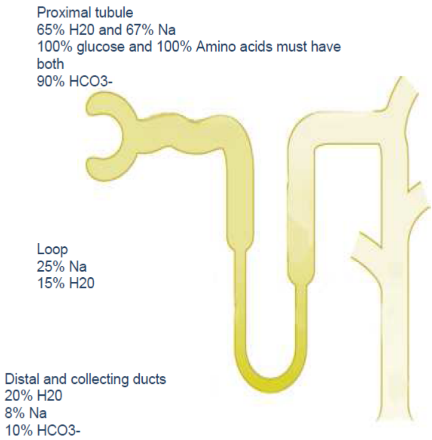
Control of Plasma Volume

Water in the body is located in either the intracellular or extracellular (composed of interstitial fluid and plasma) fluid, and the composition of the extracellular fluid affects the intracellular fluid. The kidneys control the composition of the extracellular fluid, allowing for intracellular composition to be altered.

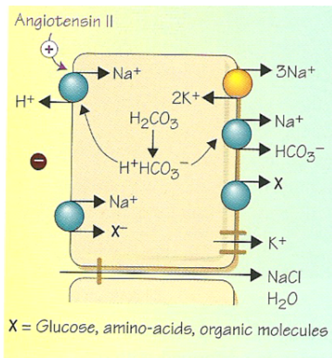
The kidneys must excrete an isotonic fluid in order for the osmotic balance of the extracellular fluid to be maintained. This means that water itself cannot simply be removed on its own, and must be excreted with other solutes to maintain this osmolarity. The water reabsorption at the kidneys is controlled by, mainly, the movement of sodium (and subsequently chloride) ions out of the nephron, such that water will follow. 67% of the reabsorption happens at the PCT and 25% at the loop of Henle. The rest is reabsorbed in a tightly regulated manner in the remaining nephron.



| Before talking about the specifics regarding sodium reabsorption, it is worth mentioning the role the GFR plays in sodium reabsorption. When the GFR changes, there will be a subsequent change in the concentration of sodium in the filtrate and the PCT will still reabsorb 67% of this. This means that the remaining sodium can be reabsorbed along the rest of the nephron. |

Proximal Convoluted Tubule

The PCT is mainly involved in the reabsorption of sodium ions, chloride ions, water, and glucose from the tubular lumen. It can be divided into early (S1) and late (S2 and S3) proximal convoluted tubule which have different apical transporters.



- The early PCT has a Na^+-K^+-ATPase on the basolateral surface, removing sodium ions from the intracellular fluid. The sodium ion electrochemical gradient produced as a consequence allows sodium to move into the cell, and is couple to H^+ ion movement via the NHE and glucose symporters. Water and chloride ions will subsequently diffuse into from the nephron lumen into the extracellular fluid at the cellular junctions (paracellular route), to maintain the electrochemical, isosmotic balance.

Na positive
Cl negative

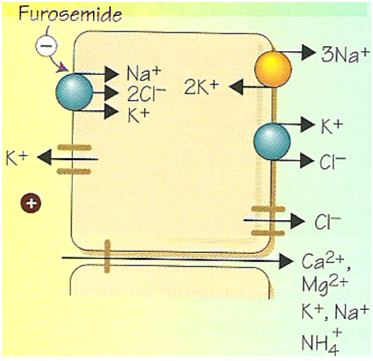
- The distal PCT most of the organic molecules and HCO_3^- ions have been removed. There is the Na^+-K^+-ATPase on the basolateral surface still and sodium reabsorption is now mainly coupled to H^+ ions via the NHE. Chloride ions move across actively now in exchange for other negatively charged compounds, maintaining electrochemical neutrality in the ECF.

The solutes in the ECF then diffuse into the peritubular capillaries and then enter the systemic circulation.

Loop of Henle = hypoosmolarity

The loop of Henle is used further for the reabsorption of water and sodium. Regarding this reabsorption, it can be divided up into descending limb and the ascending limb.

- At the descending limb, the cells are impermeable to sodium however they are very permeable to water. The surrounding tissue has a very high osmolarity such that the water moves out of the nephron. The thin ascending limb has no active transport but is permeable to sodium but not water, allowing for some diffusion of sodium out of the nephron (due to the water lost previously in the descending limb)



- At the thick ascending limb, there is active reabsorption of a sodium and two chloride ions by the NKCC2 transporter (potassium also moves in but diffuses back into lumen via ROMK channel) from the nephron lumen. The positive charge lumen as a consequence means that calcium, magnesium, and ammonium can also move out of the lumen via the paracellular route. The movement of solutes out of the lumen, effectively diluting the filtrate, means that the thick ascending limb is known as the diluting segment of the nephron.

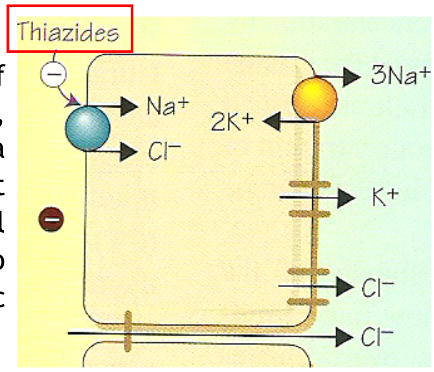
Lasics drugs , block channel , work on thick May cause hypokalamia

Aldakton oppose aldosterone May cause hyperkalmia

The fluid leaving the loop of Henle is hyposmotic fluid compared to the plasma as it enters the distal convoluted tubule.

Distal Convoluted Tubule =very hypoosmolarity Water , low ions

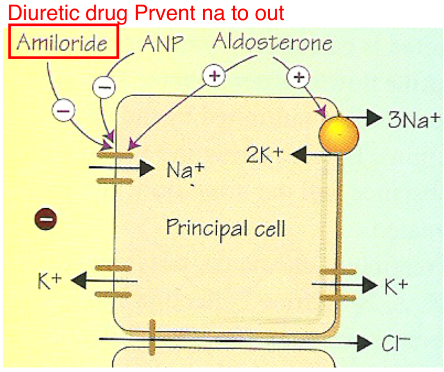
The distal convoluted tubule reabsorbs a further 5% of sodium in the nephron. This occurs via active transports, whereby sodium and chloride ions are transported via a symport (NCC symport) due to the sodium gradient produced by the Na^+-K^+-ATPase on the basolateral membrane. The water permeability at the DCT is still low so this causes further dilution, to produce a very hyposmotic fluid entering the collecting ducts.



Collecting Ducts

The collecting ducts are where 5-30% of water is reabsorbed and is the main target for water regulation by the kidney. However, there is still some sodium reabsorption at the collecting ducts by two characteristic cell types:

Diuretic drug Prvent na to out



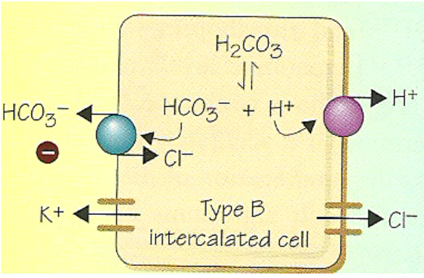
- The principal cells where there is a Na^+-K^+-ATPase on the basolateral membrane and sodium leaves the nephron lumen by the Epithelial Sodium Channel (ENaC). The creation of a negatively charged lumen

Reabsorption of Na
Another channel inter Na

allows for subsequent chloride uptake via paracellular route.

- Type B intercalated cells has no Na^+-K^+-ATPase but does have a H^+ ATPase on the basolateral membrane, producing a hydrogen ion gradient. This gradient is then used to remove chloride ions from the lumen. To out

This is the final stage before the urine passes into the renal papilla to be lost as urine.



Hyponetrimea = hypotension