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Explain urine formation and concentration

Answers

Urine formation begins with the delivery of blood to the glomerulus followed by its filtration past the glomerular barrier. The filtered portion of plasma continues through the nephron whereas the unfiltered portion passes into the peritubular capillaries. As the filtered portion travels through the nephron, water and certain solutes are resorbed back into the peritubular capillaries whilst other solutes are secreted from the peritubular capillaries into the nephron. Whatever fluid is remains at the end of the nephron is discarded as urine. Here we discuss the basic mechanistic that which are involved in formation of urine.

Functional organization of the glomerulonephronic unit

Blood enters the glomerulus via the afferent arteriole and leaves via the efferent arteriole to enter the peritubular capillaries that surround the nephron. The glomerular filtrate then enters the nephron and travels through it. At the different stages of the nephron the filtrate is modified by mechanisms which specifically resorb or secrete small molecules including water, into or out of the filtrate. These molecules enter the interstitial fluid where they non-specifically enter and exit the peritubular capillaries. Whatever fluid and molecules remain in the nephron at its end are excreted as urine.

The concentration of urine

As already indicated, the loop of Henle is critical to the ability of the kidney to concentrate urine. The high concentration of salt in the medullary fluid is believed to be achieved in the loop by a process known as countercurrent exchange multiplication. The principle of this process is analogous to the physical principle applied in the conduction of hot exhaust gases past cold incoming gas so as to warm it and conserve heat. That exchange is a passive one, but in the kidney the countercurrent multiplier system uses energy to “pump” sodium and chloride out of the ascending limb of the loop into the medullary fluid. From there it enters (by diffusion) the filtrate

(isotonic with plasma) that is entering the descending limb from the proximal tubule, thus raising its concentration a little above that of plasma. As this luminal fluid in turn reaches the ascending limb, and subsequently the distal tubule, it in turn provides more sodium to be pumped out into the surrounding fluid or blood, if necessary, and transported (by diffusion) back into the descending limb; this concentrating process continues until the osmotic pressure of the fluid is sufficient to balance the resorptive power of the collecting ducts in the medulla, through which all of the final urine must pass. This resorptive capacity in the ducts is regulated by antidiuretic hormone (ADH), which is secreted by the hypothalamus and stored in the posterior pituitary gland at the base of the brain. In the presence of ADH, the medullary collecting ducts become freely permeable to solute and water. As a consequence, the fluid entering the ducts (en route to the renal pelvis and subsequent elimination) acquires the concentration of the interstitial fluid of the medulla; i.e., the urine becomes concentrated. On the other hand, in the absence of ADH, the collecting ducts are impermeable to solute and water, and, thus, the fluid in the lumen, from which some solute has been removed, remains less concentrated than plasma; i.e., the urine is dilute.