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NURSING DEPARTMENT

RENAL PHYSIOLOGY

URINE FORMATION

Urine is the liquid waste product of the human body. It contains urea, uric acid, salts, water and other waste products that are the result of various metabolic processes occurring in the body. It is formed in the primary excretory organs– the kidneys. The structural and functional unit of the kidneys is called the nephrons. Millions of nephrons are involved in the process of urine formation.

The formation process occurs in 3 steps or phases:

* Glomerular Filtration
* Tubular Reabsorption
* Tubular Secretion

**Glomerular Filtration**

This process occurs in the glomerular capillaries. The process of filtration leads to the formation of an ultrafiltrate. The blood gushes into these capillaries with high pressure and gets filtered across the thin capillary walls. Everything except the blood cells and proteins are pushed into the capsular space of the Bowman’s capsule to form the ultrafiltrate. The glomerular filtration rate (GFR) is 125ml/min or 180 Litres/day.

**Tubular Reabsorption**

During glomerular filtration, all substances except blood cells and proteins are pushed through the capillaries at high pressure. At the level of the Proximal Convoluted Tubule(PCT), some of the substances from the filtrate are reabsorbed. These include sodium chloride, potassium, glucose, amino acids, bicarbonate, and 75% of water.

Absorption of some substances is passive, some substances are actively transported while others are co-transported. The absorption depends upon the permeability of different parts of the nephron. The distal convoluted tubule shows selective absorption. The substances and water which is reabsorbed are taken up by the peritubular capillaries to be returned to the blood.

**Tubular Secretion**

The peritubular capillaries that help in transporting the reabsorbed substances into the bloodstream, also help in actively secreting substances like H+ ions, K+ ions. Whenever excess K+ is secreted into the filtrate, Na+ ions are actively reabsorbed to maintain the Na-K balance. Some drugs are not filtered in the glomerulus and so are actively secreted into the filtrate during the tubular secretion phase.

**THE CONCENTRATION OF URINE**

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. 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.