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***PHARMACOLOGY***

***Filtration, Reabsorption, Secretion: The Three Steps of Urine Formation***

### *Introduction*

*Formation of urine is a process important for the whole organism. Not only****acid-base balance****is modulated by it, but also****blood osmolarity****,****plasma composition****and****fluid volume****, and thus it influences all cells in our body.*

*A healthy adult person produces****1.5-2 liters of urine per day****and this process involves****three basic mechanisms****:*

***1) Glomerular filtration***

***2) Tubular reabsorption***

***3) Tubular secretion***

#### Functional anatomy

*The basic functional unit for the urine formation is called****nephron****. Very important is the arrangement of nephron: it begins with****renal corpuscle****(Malpighi) that consists of a****glomerulus****, which is supplied by****afferent glomerular arteriole****and drained by****efferent glomerular arteriole****, and****Bowman’s capsule****(capsula glomeruli, glomerular capsule).****Renal tubules****have three segments. The****proximal tubule****, in which we distinguish pars convoluta (initial section) and pars recta,****loop of Henle****(intermediate tubule), where can be recognized the****descending limb****and****ascending limb****(its proximal part is formed by a thick segment of the ascending limb), and****distal convoluted tubule****(which has conversely first pars recta and then the pars convoluta) that subsequently joins the****collecting ducts****.*

*The kidneys filter unwanted substances from the blood and produce urine to excrete them. There are three main steps of urine formation: glomerular filtration, reabsorption, and secretion. These processes ensure that only waste and excess water are removed from the body.*

***1. The Glomerulus Filters Water and Other Substances from the Bloodstream***

*Each kidney contains over 1 million tiny structures called****nephrons****. Each nephron has a****glomerulus****, the site of blood filtration. The glomerulus is a network of capillaries surrounded by a cuplike structure, the glomerular capsule (or Bowman’s capsule). As blood flows through the glomerulus, blood pressure pushes water and solutes from the capillaries into the capsule through a filtration membrane. This glomerular filtration begins the urine formation process.*

***2. The Filtration Membrane Keeps Blood Cells and Large Proteins in the Bloodstream***

*Inside the glomerulus, blood pressure pushes fluid from capillaries into the glomerular capsule through a specialized layer of cells. This layer, the****filtration membrane****, allows water and small solutes to pass but blocks blood cells and large proteins. Those components remain in the bloodstream. The filtrate (the fluid that has passed through the membrane) flows from the glomerular capsule further into the nephron.*

***3. Reabsorption Moves Nutrients and Water Back into the Bloodstream***

*The glomerulus filters water and small solutes out of the bloodstream. The resulting filtrate contains waste, but also other substances the body needs: essential ions, glucose, amino acids, and smaller proteins. When the filtrate exits the glomerulus, it flows into a duct in the nephron called the****renal tubule****. As it moves, the needed substances and some water are reabsorbed through the tube wall into adjacent capillaries. This reabsorption of vital nutrients from the filtrate is the second step in urine creation.*

***4. Waste Ions and Hydrogen Ions Secreted from the Blood Complete the Formation of Urine***

*The filtrate absorbed in the glomerulus flows through the renal tubule, where nutrients and water are reabsorbed into capillaries. At the same time, waste ions and hydrogen ions pass from the capillaries into the renal tubule. This process is called****secretion****. The secreted ions combine with the remaining filtrate and become urine. The urine flows out of the nephron tubule into a collecting duct. It passes out of the kidney through the renal pelvis, into the ureter, and down to the bladder.*

***5. Urine Is 95% Water***

*The nephrons of the kidneys process blood and create urine through a process of filtration, reabsorption, and secretion. Urine is about 95% water and 5% waste products. Nitrogenous wastes excreted in urine include urea, creatinine, ammonia, and uric acid. Ions such as sodium, potassium, hydrogen, and calcium are also excreted.*

#### Final urine

*Final urine is characteristically malodorous, clear, golden yellow liquid. Its specific gravity  varies between****1 003-1 038 kg/m3****and its pH between****4.4-8.0****. It contains Na+ (100-250 mmol/l), K+ (25-100 mmol/l), Cl– (about 135 mmol/l), Ca2+, creatinine, vanillylmandelic acid (degradation product of catecholamines), uric acid, urea, etc. Healthy kidneys do not allow a significant amount of proteins and glucose to reach the final urine (they are almost completely reabsorbed).****Presence of high amount of proteins and glucose in the final urine is a pathological finding****.****Normal diuresis****is****1.5-2 l/day****.****Polyuria****is diuresis****higher than 2 l/day****,****oliguria******lower than 0.5 l/day****and****anuria lower than 0.1 l/day****.*