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**TOPIC: URINE FORMATION AND
CONCENTRATION**

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

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.

Urine Concentration

The nephron loop of juxtamedullary nephrons is the apparatus that allows the nephron to concentrate urine. The loop is a countercurrent multiplier system in which fluids move in opposite directions through side-by-side, semi-permeable tubes.

Substances are transported horizontally, by passive or active mechanisms, from one tube to the other. The movement of the transported substances up and down the tubes results in a higher concentration of substances at the bottom of the tubes than at the top of the tubes.

- ◆ The descending limb of the nephron loop is permeable to H₂O, so H₂O diffuses out into the surrounding fluids. Because the loop is impermeable to Na⁺ and Cl⁻ and because these ions are not pumped out by active transport, Na⁺ and Cl⁻ remain inside the loop.
- ◆ As the fluid continues to travel down the descending limb of the loop, it becomes more and more concentrated, as water

continues to diffuse out. Maximum concentration occurs at the bottom of the loop.

- ◆ The ascending limb of the nephron loop is impermeable to water, but Na^+ and Cl^- are pumped out into the surrounding fluids by active transport.
- ◆ As fluid travels up the ascending limb, it becomes less and less concentrated because Na^+ and Cl^- are pumped out. At the top of the ascending limb, the fluid is only slightly less concentrated than at the top of the descending limb. In other words, there is little change in the concentration of the fluid in the tubule as a result of traversing the nephron loop.
- ◆ In the fluid surrounding the nephron loop, however, a gradient of salt (Na^+ , Cl^-) is established, increasing in concentration from the top to the bottom of the loop.