**RENAL FUNCTION – SUMMARY**

On the medial surface of each Kidney is a bean-like indentation called the **Renal Hilum** (Hilus). The Renal Artery and nerves enter in at this location, while the Renal Vein and **Ureter** exit the kidney at this point. The Ureter is a muscular tube that carries urine from the kidney to the **Urinary Bladder**. Urine can move into the bladder by gravity or by peristaltic contractions of the Ureter. They Urinary Bladder muscle can stretch considerably and can also forcefully contract to push urine out of the body through the **Urethra.**

The kidney has three major regions. The outermost peripheral area which tends to look darker, is called the Renal Cortex. The striated (lined) middle region is called the Renal Medulla and it consists of several triangular shaped Renal Pyramids. The innermost kidney region is called the Renal Pelvis. The renal pelvis is continuous with the ureters and forms a cavity within the kidney that collects urine from the multitude of collecting ducts.

Each kidney contains approximately 1-2 million microscopic filtering tubules called **Nephrons.** These nephrons and their associated blood vessels form the majority to the tissue found in the renal cortex and renal medulla. Each Nephron is composed of several specialized regions listed in order here: **Glomerular (Bowman's) Capsule 🡪 Proximal Convoluted Tubule 🡪 Loop of Henle 🡪Distal Convoluted Tubule 🡪 Collecting Duct.** Blood plasma is filtered across a very permeable (leaky) capillary bed called a Glomerulus. This **"Pressure/Glomerular Filtration"** process is size selective, so all small substances dissolved in the blood plasma move out of the glomerulus and enter the Glomerular Capsule. While all large substances, such as leukocytes, erythrocytes, thrombocytes, and plasma proteins stay behind in the blood.

As the filtrate moves into the Proximal Convoluted Tubule **"Tubular Reabsorption"** takes place. Normally all of the Glucose and Amino Acids will be reabsorbed back into the blood. During this process vast amount of Sodium ions are also reabsorbed, along with all of these solutes, water is reabsorbed through osmosis. The cells lining the Proximal Convoluted Tubule are specially designed with lots of Microvilli to increase surface area for reabsorption. These cells also possess numerous Mitochondria to generate plenty of ATP to sustain adequate levels of active transport.

Next the filtrate will move through the Loop of Henle. As the filtrate moves down the descending limb, water is continuously reabsorbed back into the blood. This reabsorption of water helps concentrate the filtrate (soon to be urine). As the filtrate moves up the ascending limb Na + ions move out passively at the bottom of the ascending limb. Then as the filtrate move higher up the ascending limb, sodium pumps are turned on to actively transport more Na+ ions out of the filtrate. The tissues around the Loop of Henle and Collecting duct become increasingly hypertonic as one moved from the Renal Cortex down toward the Renal Medulla.

Then the filtrate moves on toward the Distal Convoluted Tubule to undergo **"Tubular Excretion/Secretion".** During this process, certain substances are grabbed from the blood and added to the filtrate. These substances include molecules such as Penicillin, Histamines, H+ ions, and Creatinine.

Then the final filtrate moves down the Collecting Duct where even more water is reabsorbed to concentrate the urine. This urine will then gather in the Renal Pelvis and move into a Ureter.

The body produces many types of metabolic wastes that must be removed from the body to maintain homeostasis. The bodily tissues and blood may have an excess of sodium and phosphate ions on occasion that must be excreted from the body. The catabolism of proteins/amino acids produces toxic nitrogenous wastes such as ammonia. This ammonia is converted to a less toxic substance called urea by the liver. Other metabolic reactions along with the variety of foods eaten in the diet may produce an excess of acids that lower the general pH in the blood and tissues. The kidneys along with the respiratory system, play a major role in maintaining blood pH at about 7.35 🡨🡪 7.45, by removing these substances from the blood. Most of this buffering effect takes place at the distal convoluted tubule during tubular secretion.

Another major function of the kidney is to help regulate salt & water concentrations in the body/blood. In doing so, this helps regulate blood volume (4-5 liters) and in turn your blood pressure (~120/80 mm Hg). Dehydration can cause several problems in the body, including: loss of appetite, dry skin, low blood pressure, faster heart rate, headaches, nausea, impaired thermoregulation (can't sweat); and ultimately, impaired nervous and muscular function. One hormone that counteracts dehydration is **Antidiuretic Hormone (ADH**). This hormone is produced in the Hypothalamus and sent down to the posterior lobe of the Pituitary Gland for storage and release. It works by increasing the permeability of cells lining the nephron (especially those of the collecting duct) making them more able to allow water to leak out to get reabsorbed into the blood. In effect, this will cause blood volume to increase which raises blood pressure. Urine becomes more concentrated and the individual will urinate less frequently, allowing the body to increase its level of hydration.

Another key hormone that helps monitor salt and water concentrations is **Aldosterone.** When body senses that blood pressure is low and blood is not salty enough, the body will trigger the Adrenal Glands to release higher levels of Aldosterone. This Aldosterone primarily targets the cells of the Distal Convoluted Tubule to pump more Na+ ions back into the body from the filtrate. As more Na+ returns to the blood from the filtrate, more water will follow. This will also increase blood volume and therefore blood pressure.

The kidney itself can monitor blood pressure near the Glomerulus. When blood pressure is too low, receptors in a patch of tissue called the Juxtaglomerular Apparatus will start to secrete **RENIN** hormone into the blood. This hormone will trigger the adrenal gland to release more Aldosterone to stimulate increased salt/water reabsorption. Renin also indirectly causes arteries to constrict which will further increase blood pressure.

The last key hormone that plays a role with kidney function is **Atrial Natriuretic Hormone (ANH).** This hormone is produced by the Atria of the heart. When blood pressure is too high it can cause damage to small and large blood vessels. In an effort to reduce blood pressure, the atria release ANH, this ANH targets the cells of the distal convoluted tubule to block their Aldosterone receptors. Aldosterone can no longer stimulate these cells to pump Na+ ions back into the blood. As a result more Na+ ions stay in the filtrate which in turn keep more water in the filtrate. This increases the amount of urine you will excrete and reduces blood volume which in turn decreases your blood pressure.

**REVIEW TABLES**

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| **PROCESS** | **Description** | **Location(s)** |
| **Pressure (Glomerular) Filtration** |  |  |
| **Tubular Secretion/**  **Excretion** |  |  |
| **Water Reabsorption**  **(3 key locations)** |  |  |
| **Tubular Reabsorption** |  |  |

**KEY HORMONES**

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| --- | --- | --- | --- |
| **HORMONE** | **Role (Action)** | **Site of Action** | **Source of Hormone** |
| **ANH** | **Inhibits the effect of Aldosterone. Nephrons reabsorb less Na+ ions, so more Na+ ions stay in the urine. So we pee more. Blood pressure drops** | **Distal Convoluted Tubule** | **Atria of the Heart** |
| **ADH** |  |  |  |
| **RENIN** |  |  |  |
| **Aldosterone** |  |  |  |