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DEPARTMENT: NURSING SCIENCE

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**Urine formation and concentration.**

Urine formation- by filtering the blood the nephrons perform the following functions

1. Regulate concentration of solutes in blood plasma; this also regulates pH

2. Regulate water concentrations; this helps regulate blood pressure

3. Removes metabolic wastes and excess substances

• Urine formation:

1. Glomerular filtration- water and solutes are forced through the capillary walls of the glomerulus into the bowman’s capsule (glomerular capsule)

• Filtrate- the fluid that is filtered out into bowman’s capsule

Glomerular filtration rate is regulated by mechanisms:

1. Autoregulation- the smooth muscle in the afferent arteriole responds to blood pressure changes by constricting and dilating to regulate filtration rate.

2. Sympathetic control- causes afferent arterioles to constrict or dilate when activated by a nerve impulse (fight of flight response to keep blood pressure up)

Renin-angiotensin mechanism- triggered by the juxtaglomerular apparatus; when filtration rate decreases, the enzyme renin is released. Renin converts a plasma protein called angiotensinogen into angiotensin I. angiotensin I is quickly converted into angiotensin II by another enzyme. Angiotensin II causes 3 changes:

• (1) constriction of the arterioles- decreases urine formation and water loss

• (2) stimulates the adrenal cortex to release aldosterone- promotes water reabsorption by causing the absorption of salt

• (3) stimulates the posterior pituitary to release ADH- antidiuretic hormone- promotes water reabsorption

• (4) stimulates the thirst and water intake (hypothalamus says we’re thirsty so we get a drink)

Tubular reabsorption- occurs both passive and actively; glucose, amino acids, and other needed ions (Na, K, Cl, Ca, HCO3) are transported out of the filtrate into the peritubular capillaries (they are reabsorbed back into the blood); about 65% of the filtrate is reabsorbed in the proximal convoluted tubule.

• As these substances are reabsorbed, the blood becomes hypertonic so water easily follows by osmosis

• Reabsorption in the distal convoluted tubule is under hormonal control- aldosterone causes more salt to be absorbed, ADH causes more salt to be absorbed, ADH causes more water to be absorbed

Secretion- waste products such as urea and uric acid, drugs and hydrogen and bicarbonate ions are move out of the peritubular capillaries into the filtrate; this removes unwanted wastes and helps regulate pH

• Urine- filtrate after it has passed through the nephron and undergone filtration, reabsorption, and secretion. The urine passes into the collecting duct, which joins with the minor calyx, and eventually the renal pelvis. The renal pelvis joins with the ureter.

• Color- yellow color is due to urochrome- a pigment produced form the breakdown of bile pigments in the intestine

i. Deep yellow to orange- more concentrated, less water

ii. Light yellow to clear- less concentrated, more water

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| substances secreted or reabsorbed in the nephron and their location   |  |  |  |  |  | | --- | --- | --- | --- | --- | | substance | PCT | Loop of Henle | DCT | Collecting ducts | | glucose | Almost 100% reabsorbed; secondary active transport with Na+ |  |  |  | | Oligopeptides, proteins, amino acids | Almost 100% reabsorbed symport with Na+ |  |  |  | | Vitamins | Reabsorbed |  |  |  | | Lactate | reabsorbed |  |  |  | | Creatinine | secreted |  |  |  | | Urea | 50% reabsorbed by diffusion; also secreted | Secretion diffusion in descending limb |  | Reabsorption in medullary collecting ducts; diffusion | | sodium | 65% actively reabsorbed | 25% reabsorbed in thick ascending limb; active transport | 5% reabsorbed active | 5% reabsorbed stimulated by aldosterone active | | Chloride | Reabsorbed symport with Na+, diffusion | Reabsorbed in thin and thick ascending limb; diffusion in ascending limb | Reabsorbed; diffusion | Reabsorbed; symport | | Water | 67% reabsorbed osmotically with solutes | 15% reabsorbed in descending limb; osmosis | 8% reabsorbed if ADH; osmosis | Variable amounts reabsorbed, controlled by ADH, osmosis | | Bicarbonate | 80-90% symport reabsorption with Na+ | Reabsorbed symport with Na+ and antiport with Cl-; in ascending limb |  | Reabsorbed antiport with Cl- | | H+ | Secreted; diffusion |  | Secreted; active | Secreted; active | | NH4+ | Secreted; diffusion |  | Secreted; diffusion | Secreted; diffusion | | HCO3- | Reabsorbed; diffusion | Reabsorbed; diffusion in ascending limb | Reabsorbed; diffusion | Reabsorbed; antiport with Na+ | | Some drugs | Secreted |  | Secreted; active | Secreted; active | | Potassium | 65% reabsorbed; diffusion | 20% reabsorbed in thick ascending limb; symport | Secreted; active | Secretion controlled by aldosterone; active | | Calcium | Reabsorbed; diffusion | Reabsorbed in thick ascending limb; diffusion |  | Reabsorbed if parathyroid hormone present; active | | Magnesium | Reabsorbed; diffusion | Reabsorbed in thick ascending limb; diffusion | Reabsorbed |  | | Phosphate | 85% reabsorbed, inhibited by parathyroid hormone, diffusion |  | Reabsorbed; diffusion |  | |