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ASSIGNMENT: EXPLAN URINE FORMATION AND CONCENTRATION

URINE FORMATION

There are two kidneys which are bean-shaped and are approximately 10cm long, 5.5cm wide and 3cm thick. Each kidney weighs about 150g and has a marked indentation medially- the hilus where the renal artery and renal nerves enter and the renal vein and ureter leave. Between them, the kidney make approximately 30ml or more urine every hour. Approximately 25percent of the cardiac output goes to the kidney where organic waste products are removed in the million nephron in each kidney. normal urine production, therefore depends on normal blood flow to the kidneys. The nephron is the functional unit of the kidney. Nephron permits the passage of some substances out the body but restrict the passage of others, for examples blood cells and large proteins.

Filtration: as blood flows through the glomerulus, much of the fluid and waste product in the blood are forced out through the walls of the capillaries, filtered and then flow into the bowman's capsule. The bowman's capsule surrounds the glomerul. This glomerular filtrate consist of water, potassium and urea. Urea is the most abundant waste product excreted by the kidney and is formed from ammonia, a highly toxic substance. Ammonia is formed in the liver from the breakdown of amino acids.

Absorption: much of the filtrate of the glomerulus includes water so it is reabsorbed into the capillaries surrounding the proximal & distal convoluted tubule, the loop of henle and the collecting tubule. All the glucose will be reabsorbed unless blood glucose levels are high, in which glucose will be excreted in the urine. Sodium is also reabsorbed but the amount varies depending on how much the body requires to maintain a

constant concentration of sodium ions in the blood.

Secretion: this is the final stage of urine formation, it occurs in the distal convoluted tubule and collecting tubules. The substances either diffuse or are actively transported out of the capillaries and into the collecting tubules to be excreted in the urine. Hydrogen ion, potassium ion, ammonia and some drugs are also secreted at this stage and the kidney plays an important role in maintaining the acid-base balance within the body.

The final composition of urine is as a result of filtration, absorption and secretion by the nephrons. The kidney produces an average of one and half liters of urine each day. The urine passes from the kidney to the bladder through the ureters where it is stored until it is eliminated via the urethra. The urine is then stored in the bladder, the bladder is a hollow, muscular sac which sits in the pelvis. In males, the base of the bladder lies between the rectum and pubic symphysis while in females the base is below the uterus and anterior to the vagina. The bladder stores approximately one liter when full. The opening described as the neck of the bladder which is between the bladder and the urethra is closed by two rings of muscles. These rings of muscles are closed by contraction, it remains contracted except during micturition when they are relax.

THE CONCENTRATON 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. The principle of the process is analogous to the physical principle applied in the conduction of hot exhaust gases past cold

incoming gas so as to warm it and conserve heat. That exchange is a passive one, but 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 the filtrate 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 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 in by antidiuretic hormone (ADH), which is secreted by the hypothalamus and stored in the posterior pituitary gland at the base of the brain. In the presence of ADH, the medullary collecting ducts become freely permeable to solute and water. As a consequence, the fluid entering the ducts acquires the concentration of the intertial fluid of the medulla. That is, the urine becomes concentrated, on the other hand, in the absence of ADH, the collecting ducts are impermeable to solute, water and the fluid in the lumen from which some solute has been removed, remains less concentrated than plasma, that is the urine is dilute. The secretion of ADH by the hypothalamus and the release by the posterior pituitary gland is part of a feedback mechanism responsive to the tonicity of plasma. This interaction between the plasma and the ADH output is mediated by specific and sensitive receptors at the base of the brain. These receptors are particularly sensitive to sodium and chloride ion. At normal blood tonicity there is a steady receptor discharge and a steady

secretion of ADH. If the plasma becomes hypertonic, either from the ingestion of crystalloids such as common salt or from the storage of water, receptor discharging increases, triggering increased ADH output and more water leaves the collecting ducts to be absorbed by the blood. If the osmotic pressure of the plasma becomes low, the reverse is the case. Thus water ingestion dilutes body fluids and reduces or stops ADH secretion, the urine becomes hypotonic and the extra water is excreted in the urine. This situation is complex because there are receptors sensitive to changes in blood volume that reflexively inhibit ADH output if there is any tendency to excessive blood volume. Exercise increases ADH output and reduces urinary flow. The same result may follow emotional disturbance, fainting, pain and injury or the use of certain drug such as a morphine or nicotine. Diuresis is the increased flow of urine produced as the result of increased fluid intake, absence of hormonal activity or the taking of certain drugs that reduce sodium and water re-absorption from the tubules, if ADH secretion is inhibited by the drinking of excess water or by the disease or the presence of tumour affecting the base of the brain, water diuresis results and the rate of urine formation will approach the rate of 16 mililitres per minute filtered at the glomeruli. In certain disorders of the pituitary in which ADH secretion is diminished or absent e.g diabetes insipidus there may be a fixed and irreversible output of a large quality of dilute urine.