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RENAL PHYSIOLOGY

Explain urine formation and concentration.

URINE FORMATION

Urine formation is a blood cleansing function, about 1,300 ml of blood enters the kidney. Kidney excrete unwanted substances along with water from the blood as urine. Urine formation includes 3 processes;

Glomerular filtration

When blood passes through glomerular capillaries, the plasma is filtered into the bowman capsule. Glomerular filtration is called ultrafiltration. When blood passes through glomerula capillaries, the plasma is filtered into the bowman capsule. All the substances of the plasma are filtered except the plasma proteins.

Tubular reabsorbtion

Filtrate from the bowman capsule passes through the tubular portion of nephron, while passing the tubule, the filtrate undergoes different changes. Many wanted substances are reabsorbed from the tubules. It involves two techniques; **micropuncture** technique and **stop-flow method**.

Tubular secretion

Some unwanted substances are secreted into the tubule from peritubular blood vessels. It is also known as selective reabsorption because the tubular cells reabsorb only the substances necessary for the body. Essential nutrients such as amino acids, glucose and vitamins are completely reabsorbed from the renal tubule, unwanted substances like metabolic waste are not reabsorbed, and hence, they are excreted as urine

URINE CONCENTRATION

Urine concentration test measures the ability of the kidney to conserve or excrete water. Everyday 180L of glomerular filtrate is formed with large quantity of water. If much water is excreted, the body will face serious threats, hence the concentration of water is important. Osmolarity of glomerular filtrate is same as that of plasma and it is 300 mOsm/L. Osmolarity of urine depends on 2 factors;

1. Water content in the body
2. Antidiuretic hormone (ADH)

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 achieve in the loop by a process known as countercurrent exchange multiplication. 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 it's 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. This contraction process continues until the osmotic pressure of the fluid is sufficient to balance the reabsorptive power of the collecting ducts in the medulla, through which all off the final urine must pass. This reabsorptive capacity in the ducts is regulate by ADH, in the presence of ADH, the medullary collecting tubules become freely permeable to solute and water. As a consequence, the urine becomes concenteaed . in the absence of ADH, the collecting ducts are impermeable to solute and water.

At normal blood tonicity there's a steady receptor discharge and a steady secretion of ADH. If the plasma becomes hypertonic, either from the ingestion of crystalloids or from shortage of water, receptor discharge increases, triggering the increased ADH output, and more water leaves the collecting ducts to be absorbed into the blood. Water ingestation dilutes body fluids and reduces ADH secretion; the urine becomes hypotonic and extra water is secreted in the urine.

ADH secretion is inhibited by the drinking of excess water, or by disease, or by presence of tumour affecting the base of the brain, water diuresis results; and the rate of urine formation will approach the rate of 16mL/min filtrate at the glomeruli.

A urine concentration test can be used to evaluate:

- Dehydration
- Kidney failure
- Heart failure
- Complications of the urine tract infection
- To indicate central diabetes insipidus