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**Assignment Title: Renal Physiology for pharmacology students**

**Course Title: Renal Physiology, Body fluid & Temperature Regulation and Autonomic Nervous System**

**Course Code: PHS 212**

**Questions**

Q1. Discuss renal handling of glucose and electrolytes?

Q2. Discuss the physiology of micturition?

**Answers**

**1.A.) Renal handling of glucose:** the renal handling of glucose **involves filtration and complete reabsorption.** If glucose is not reabsorbed by the kidney, it appears in the urine, in a condition known as glycosuria. This is associated with diabetes mellitus.

* Na+ -glucose symporter is the mainly involved through the sodium dependent glucose transport.
* Glucose transporter (Glut 2 and Glut 1) are involved in glucose transport through the basolateral membrane through facilitated diffusion.
* This occurs in proximal convoluted tubule.

**Glucose reabsorption in the kidney:** Glucose reabsorption happens to 100% in the proximal tubule using the sodium-glucose-cotransporter. In the case of too high glucose concentration in the serum, this mechanism is subject to saturation and glucosuria results. The threshold concentration for this saturation is 10 mmol/l (180 mg/dl) of glucose in the serum.

**1.B) Renal handling of electrolytes:** the renal handling of electrolytes **involves filtration and partial re-absorption.** Electrolyte reabsorption leads to the water reabsorption with help of the leaky intercellular spaces of the proximal tubule epithelium. The solvent drag enables the paracellular absorption of water and chloride due to electrolyte concentrations between the tubule lumen and the renal interstitium.

* Sodium is an electrolyte, it creates an osmotic cation and electrical gradient that drives the reabsorption of water and other solutes. Na+ is the most abundant cation in the filtrate, it’s reabsorbed via trans- and paracellular routes.
* 99% of the glomerular filtrate volume (primary urine, 120 ml/min), 99% of the filtrated sodium and 99% of the filtered Chloride are reabsorbed in the renal tubules of the nephron. The reabsorption is energy consuming process; the needed energy rises linearly with the NaCl-Reabsorption. The most common drive for the reabsorption is the basolateral located Na-K-ATPase (sodium-potassium pump), which transports three sodium atoms out of the cell and two potassium atoms into the cell, the energy derives from the hydrolysis of one ATP molecule.

**Renal handling of potassium:** K+ could be secreted from the principle cells, but under controlled mechanisms.

1. Plasma K+ level: hyperkalemia will increase K+ secretion.
2. Aldosterone: through 3 mechanisms; increasing Na+ -K+ pump activity (increasing the intracellular K+), increased Na+ absorption from lumen and making the lumen more negative that will favor a positive charged K+ secretion and lastly, affecting the apical membrane permeability.
3. Any substance that increase the GFR and tubular blood flow will cause K+ secretion.
4. ADH: which has 2 balanced effects:
* Decreased tubular blood flow will make decrease in K+ secretion
* Increase Na+ absorption will make the lumen negatively charged that favors K+ secretion.
1. Tubular blood flow
2. Acidity reduce K+ secretion by inhibiting Na+ -K+ pump and affecting the membrane permeability.

**Renal Phosphate Reabsorption:** Phosphate is completely filtered, 80–90% of the phosphate are reabsorbed in the proximal tubule. With high phosphate concentrations in serum, a saturation of the phosphate reabsorption is reached and phosphate is excreted till the normalization of the phosphate concentration. An increased phosphate concentration is the stimulus for the parathyroid hormone release and leads to phosphate excretion, calcium phosphate deposition into the bone and lowers the serum calcium.

**Renal Calcium Reabsorption:** 60% of the filtered calcium is reabsorbed in the proximal tubule with the paracellular absorption of water (solvent drag). Additionally, there are active transport mechanisms.

**2.) Micturition:**

Micturition or urination is the process of expelling urine from the bladder. This act is also known as voiding of the bladder. ... The process of micturition is regulated by the nervous system and the muscles of the bladder and urethra. The urinary bladder can store around 350-400ml of urine before it expels it out.

**Physiology of micturition:**

Once the urinary bladder reaches its maximum capacity, the stretch receptors in the walls of the bladder send an impulse via the pelvic nerve to the brain via the spinal cord.

The micturition reflex is ultimately generated from the level of the spinal cord after it receives reflexes from the pontine region in the brain. Once the bladder and the urethra receive the signals to empty the bladder, the two sphincters relax and the detrusor muscle causes the contractions of the bladder.

Along with these muscles, the muscles of the abdomen also play a role by putting pressure on the bladder wall. This leads to complete emptying of the bladder.

**In other words…**

1. Stretch receptors detect filling of bladder, and then transmits afferent signals to spinal cord
2. Signals return to the bladder from spinal cord segments S2 and S3 via parasympathetic fibers in pelvic nerve.
3. Efferent signals excite detrusor muscle.
4. Efferent signals relax internal urethral sphincter. Urine is involuntarily voided if not inhibited by the brain
5. For voluntary control, micturition center is pons receive signals from stretched receptors.
6. If it is timely to urinate, pons return signals to spinal inter neurons that excite detrusor and relax internal urethral sphincter. Urine is voided.
7. If it is untimely to urinate, signals from pons excite spinal inter neurons that keep external urethral sphincter contracted. Urine is retained in bladder.
8. If it is timely to urinate, signals from pons cease and external urethral sphincter relaxes. Urine is voided.

**Conclusion:**

Micturition requires the coordinated activity of sympathetic, parasympathetic and somatic nerves. It also requires normal muscle tone and freedom from physical obstruction and psychological inhibition. Control from our higher brain centers allow us to determine the right time and place to allow this important physiological function to occur.