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**300level medicine**

**RENAL PHYSIOLOGY ASSIGNMENT**

1. Discuss the role of kidney in glucose homeostasis

The kidneys play an important role in glucose homeostasis. It helps to maintain glucose homeostasis by at least two mechanisms.

* Under normal circumstances, the kidney filters and reabsorbs 100% of glucose, approximately 180 g (1 mole) of glucose, each day. The glucose transporters expressed in the renal proximal tubule ensure that less than 0.5 g/day (range 0.03-0.3 g/d) is excreted in the urine of healthy adults. More water than glucose is reabsorbed resulting in an increase in the glucose concentration in the urine along the tubule. Consequently the affinity of the transporters for glucose along the tubule increases to allow for complete reabsorption of glucose from the urine.
* It produces glucose by gluconeogenesis. The key enzymes of gluconeogenesis are phosphoenolpyruvate carboxykinase (PEPCK) and glucose 6-phosphatase (G6Pase). These are expressed in the renal proximal tubule only and not the renal medulla. The kidneys produce between 2.0-2.5umol of glucose/kg/min thereby contributing about 20-25% of circulating glucose.
1. Discuss the process of micturition

Micturition or urination is the process of expelling urine from the bladder. This act is also known as voiding of the bladder.

Stages of Micturition

The urinary bladder has two distinct stages or phases:

Resting or filling stage

Voiding stage

Resting or Filling Stage

It is in this phase of the bladder that the urine is transported from the kidneys via the ureters into the bladder. The ureters are thin muscular tubes that arise from each of the kidneys and extend downwards where they enter the bladder obliquely.

The oblique placement of the ureters in the bladder wall serves a very important function. The opening of the ureter into the urinary bladder is not guarded by any sphincter or muscle. Therefore, this oblique nature of opening prevents the urine from re-entering the ureters. At the same time, the main muscle of the urinary bladder, the detrusor muscle, is relaxing allowing the bladder to distend and accommodate more urine.

Voiding Stage

During this stage, both the urinary bladder and the urethra come into play together. The detrusor muscle of the urinary bladder which was relaxing so far starts to contract once the bladder’s storage capacity is reached.

The urethra is controlled by two sets of muscles: The internal and external urethral sphincters. The internal sphincter is a smooth muscle whereas the external one is skeletal. Both these sphincters are in a contracted state during the filling stage.

 The process of micturition is governed by both the nervous and muscular systems. Within the nervous system, the process is governed by the autonomous nervous system and the somatic system. 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.

1. Explain juxtaglomerular apparatus

The juxtaglomerular apparatus (also known as the juxtaglomerular complex) is a structure in the kidney that regulates the function of each nephron, the functional units of the kidney.

The juxtaglomerular apparatus consists of three types of cells:

-the macula densa, a part of the distal convoluted tubule of the same nephron

-juxtaglomerular cells, (also known as granular cells) which secrete renin

-extraglomerular mesangial cells

The juxtaglomerular apparatus is part of the kidney nephron, next to the glomerulus. It is found between afferent arteriole and the distal convoluted tubule of the same nephron.

Function

Renin is produced by juxtaglomerular cells.

The juxtaglomerular cells secrete renin in response to:

-Stimulation of the beta-1 adrenergic receptor

-Decrease in renal perfusion pressure (detected directly by the granular cells)

-Decrease in NaCl concentration at the macula densa, often due to a decrease in glomerular filtration rate.

Extraglomerular mesangial cells

Extraglomerular mesangial cells are located in the junction between the afferent and efferent arterioles. These cells have a contractile property similar to vascular smooth muscles and thus play a role in “regulating GFR” by altering the vessel diameter. Renin is also found in these cells.

 Clinical significance

Excess secretion of renin by the juxtaglomerular cells can lead to excess activity of the renin–angiotensin system, hypertension and an increase in blood volume.

1. Discuss the role of kidney in regulating blood pressure

The renin-angiotensin system or RAS regulates blood pressure and fluid balance in the body. When blood volume or sodium levels in the body are low, or blood potassium is high, cells in the kidney release the enzyme, renin. Renin converts angiotensinogen, which is produced in the liver, to the hormone angiotensin I. An enzyme known as ACE or angiotensin-converting enzyme found in the lungs metabolizes angiotensin I into angiotensin II. Angiotensin II causes blood vessels to constrict and blood pressure to increase. Angiotensin II stimulates the release of the hormone aldosterone in the adrenal glands, which causes the renal tubules to retain sodium and water and excrete potassium. Together, angiotensin II and aldosterone work to raise blood volume, blood pressure and sodium levels in the blood to restore the balance of sodium, potassium, and fluids. If the renin-angiotensin system becomes overactive, consistently high blood pressure results.

1. Discuss the role of kidney in calcium homeostasis.

Vitamin D and parathyroid hormone (PTH) help regulate how much calcium is absorbed and how much calcium the kidneys eliminate. Healthy kidneys turn vitamin D into an active hormone (calcitriol), which helps increase calcium absorption from the intestines into the blood.

 The principal function of vitamin D in calcium homeostasis is to increase calcium absorption from the intestine. Calcium is absorbed by both an active transcellular pathway, which is energy dependent, and by a passive paracellular pathway through tight junctions. 1,25Dihydroxyvitamin D3 (1,25(OH)2D3) the hormonally active form of vitamin D, through its genomic actions, is the major stimulator of active intestinal calcium absorption which involves calcium influx, translocation of calcium through the interior of the enterocyte and basolateral extrusion of calcium by the intestinal plasma membrane pump.

The kidney excretes calcium by:

Nearly 98 percent of filtered calcium (i.e., glomerular filtrate) is reabsorbed by either passive or active processes occurring at four sites in the kidney, each contributing to maintaining neutral calcium balance. Seventy percent of the filtered calcium is reabsorbed passively in the proximal tubule. Active calcium transport is regulated by the calcium sensing receptor located in the ascending loop of Henle, where, in response to high calcium levels in the extracellular fluid, active reabsorption in the loop is blocked through actions of the calcium sensing receptor. In contrast, when the filtered calcium load is low, the calcium sensing receptor is activated, and a greater fraction of the filtered calcium is reabsorbed.