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MEDICINE AND SURGERY

300L

RENAL PHYSIOLOGY

1. ***ROLE OF KIDNEY IN GLUCOSE HOMEOSTASIS***

The primary role of kidney is homeostasis. It is accomplished by the formation of urine. It is involved in the regulation of glucose homeostasis and in abnormalities found in diabetes mellitus via

1. Release of glucose into the circulation via gluconeogenesis
2. Uptake of glucose from the circulation to satisfy its energy needs
3. Reabsorption into the circulation of glucose from the glomerular filtrate to conserve glucose carbon.

It helps to maintain glucose homeostasis by: under normal circumstances the kidney filters and reabsorbs 100% of glucose, approximately 180g (1 mole) of glucose each day. The glucose transporters expressed in the renal proximal tubule ensures that less than 0.5g/day (range 0.03-0.2g/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.

1. ***THE PROCESS OF MICTURITION.***

Micturition is the process by which urine is voided from the urinary bladder. It is brought about by the reflex contraction of the DETRUSOR muscle after voluntary relaxation of the sphincter muscle. The human excretory system consists of a pair of kidneys and ureters, a urinary bladder and a urethra. The kidneys play a major role in urine formation and its stored in the urinary bladder.

Micturition process consist of two phases

***.*** *storage phase*

***.*** *Voiding phase*

***i.) STORAGE PHASE:*** the urinary bladder in a healthy urinary system can store up to 16 ounces of urine for 2 to 5 hours easily. The circular sphincter muscles prevent leakage of urine. They close tightly around the opening of the opening of the bladder into the urethra that allows the passage of urine outside the body.

***ii.) VOIDING PHASE:*** When the bladder is filled with urine, the nerves in it are triggered, which in turn stimulates the need to urinate. The brain signals urinary bladder to contract. The receptors of the urinary bladder send a signal to the central nervous system, the nervous system then sends a signal that incites the contraction of the urinary bladder. Through the urinary opening at the urethra, the urine is eliminated and the process is called MICTURITION and the neural mechanism involved is MICTURITION REFLEX.

1. ***JUXTAGLOMERULAR APPARATUS***

Juxtaglomerular apparatus is a specialized organ situated near the glomerulus of each nephron.

STRUCTURE: It’s formed by three structures

1. Macula densa
2. Extraglomerular mesangial cells
3. Juxtaglomerular cells

MACULA DENSA: Is the end portion of thick ascending segment before it opens into the distal convoluted tubule. It is situated between afferent and efferent arterioles of the nephron. It is formed by tightly packed cuboidal epithelial cells

EXTRAGLOMERULAR MESANGIAL CELLS: they are situated in triangular region bound by afferent arteriole, efferent arteriole and macula densa. The cells are also called agranular cells, lacis cells or goormaghtigh cells

JUXTAGLOMERULAR CELLS: They are specialized smooth muscle cells situated in the wall of afferent arteriole just before it enter the bowman capsule. The smooth muscle cells are mostly present in tunica media and tunica adventitia of the wall of the afferent arteriole. They are also called granular cells because of the presence of secretory granules in their cytoplasm.

Functions: The primary function is the secretion of hormones. It also regulates the glomerular blood flow and glomerular filtration rate.

MACULA DENSA: Cells in the macula densa respond to changes in the sodium chloride levels in the distal tubule of the nephron via the tubuloglomerula feedback loop (TGF). An increase in the salt concentration causes several cell signals to eventually cause the adjacent afferent arteriole to constrict, this decreases the amount of blood coming from the afferent arterioles to the glomerular capillaries and therefore decreases the amount of fluid that goes from the glomerular capillaries into the Bowman`s space. When there is decrease in the sodium concentration, less sodium is reabsorbed in the Macula densa cells. The cells increase the production of nitric oxide and prostaglandins to vasolidate the afferent arteriole to increase renin release.

EXTRAGLOMERULAR MESANGIAL CELLS: 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.

JUXTAGLOMERULAR CELLS: These cells produce renin. They 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

ROLE OF KIDNEY IN REGULATION OF BLOOD PRESSURE

The kidneys play a central role in the regulation of arterial blood pressure. A key modulator of blood viscosity is the renin-angiotensin system (RAS) or the renin-angiotensin-aldosterone system (RAAS), a hormone system that regulates blood pressure and water balance. The blood pressure in the body depends upon

. The force by which the heart pumps out blood from the ventricles of the heart.

. The degree to which the arteries and arterioles constrict.

. The volume of blood circulating round the body.

The kidney influences blood pressure by

. causing the arteries and veins to constrict

. increasing the circulating blood volume.

The macula densa cells sense Na in the filtrate, while the arterial cells (juxtaglomerular cells) sense the blood pressure. When the blood pressure drops, the amount of filtered Na also drops. The arterial cells sense the drop in blood pressure, and the decrease in Na concentration is relayed to them by the macula densa cells. The juxtaglomerular cells then release an enzyme called renin. Renin converts angiotensinogen into angiotensin-1. Angiotensin-1 is thereafter converted to angiotensin-2 by an angiotensin-converting enzyme found in the lungs. Angiotensin-2 causes blood vessels to contract- the increased blood vessel constrictions elevate the blood pressure. When the volume of blood is low, arterial cells in the kidneys secrete renin into the circulation. Plasma renin then carries out the conversion of angiotensinogen released by the liver to angiotensin-1. Angiotensin-1 is subsequently converted to angiotensin-2 by the enzyme angiotensin converting enzyme found in the lungs. Angiotensin-2 a potent vasoactive peptide causes blood vessels to constrict, resulting in increased blood pressure. Angiotensin-2 also stimulates the secretion of the hormone aldosterone aldosterone from the adrenal cortex.

ROLE OF KIDNEY IN CALCIUM HOMEOSTASIS

Kidneys play a role in regulation of blood calcium level by activating 1,25 dihydroxycholecalciferol into vitamin-D. Vitamin is necessary for the absorption of calcium from the intestine.