NAME: OLAKADA FAVOUR ADAMBA

MATRIC NO: 17/MHS01/254

COLLEGE: MEDICINE AND HEALTH SCIENCES

DEPARTMENT: MEDICINE AND SURGERY

COURSE: RENAL PHYSIOLOGY, BODY FLUID AND TEMPERATURE REG.

COURSE CODE: PHS 303

ASSIGNMENT TITLE: RENAL PHYSIOLOGY

LEVEL: 300

QUESTION

1. Discuss the role of kidney in glucose homeostasis
2. Discuss the process of micturition
3. Explain juxtaglomerular apparatus
4. Discuss the role of kidney in regulation of blood pressure
5. Discuss the role of kidney in calcium homeostasis

ANSWERS

1. ROLE OF KIDNEY IN GLUCOSE HOMEOSTASIS

All the filtered glucose is completely reabsorbed into the proximal tubule by an active transport mechanism:

Carrier mediated Na^+-glucose co-transport: Carrier protein located at the apical membrane in the proximal tubule reabsorbs glucose from tubular fluid into the blood. The carrier protein for glucose in early and late proximal tubule is called SGLT-2 and SGLT-1, respectively (SGLT – sodium-dependent glucose transporter). The carrier is driven by the Na^+ concentration gradient which exists between the high tubular (Na^+) concentration and the low intracellular (Na^+) gradient produced by the pumping out of Na^+ through the basolateral surface.

Facilitated Diffusion: moves the glucose out of the cell through the basolateral membrane. The carrier for facilitated diffusion across the basolateral membrane in early and late proximal tubule is called GLUT-2 and GLUT-1, respectively. (GLUT- glucose transporter).\

2. THE PROCESS OF MICTURITION

Micturition is the process by which urinary bladder empties when filled. It is a reflex process. However, in grown up children and adults, it can be controlled voluntarily to some extent. The main physiological events in the process of micturition are:

a. Filling of the urinary bladder and
b. Emptying of urinary bladder.

Filling of the Urinary Bladder

As urine constantly formed in the nephrons collects in the renal pelvis, the pressure in the pelvis increases and initiates a peristaltic contraction beginning in the pelvis and spreading along the ureter to force urine towards the bladder.

Physiological capacity of the bladder varies with age, being 20-50mL, about 200mL at 1 year, and can be as high as 600mL in young adult males. In all cases, the physiological capacity is about twice at which the first desire to void is felt.

The normal bladder is completely empty at the end of micturition and the intravesical pressure is equal to the intraabdominal pressure. As the bladder is filled up, it adjusts its tone and a fairly large volume of urine can be accommodated with minimal alterations in the intravesical pressure. This possible because of the phenomenon of adaptation. The adaptation occurs because of the inherent property of plasticity, the smooth muscles of detrusor and because of law of Laplace.

Emptying of the Bladder

Emptying of the bladder is basically a reflex action called the micturition reflex, which is controlled by supraspinal centres and is assisted by contraction of perineal and abdominal muscles.

Micturition reflex is initiated by the stimulation of the stretch receptors located in the wall of the urinary bladder. Filling the bladder by 300-400mL of urine in adults constitutes the adequate stimulus for the micturition reflex to occur. The sensory (afferent) impulses from the stretch receptors in the detrusor muscle and urethra travel along the pelvic splanchnic nerves and enter the spinal cord through dorsal roots to S_2, S_3, S_4 segments to reach the sacral micturition centre (the sacral micturition centre is formed by the detrusor nucleus and sacral pudendal nucleus). Motor (efferent) impulses produced in spinal cord, travel through motor fibres of pelvic nerve towards bladder and internal sphincter. Motor impulses cause contraction of detrusor muscle and relaxation of internal sphincter so that, urine enters the urethra from the bladder.

Once micturition reflex is initiated, it is self-regenerative, i.e. initial contraction of the bladder wall further activates the receptors to increase the sensory impulses (afferents) from the bladder and urethra which cause further increase in the reflex contraction of detrusor muscle of the bladder. The cycle continues repeatedly until the force of contraction of bladder reaches the maximum and urine is voided out completely. Once the micturition reflex becomes powerful enough, this causes another reflex which passes through pudendal nerves to external sphincter to cause its inhibition. If this inhibition is more potent than the voluntary constrictor signals from brain, then urination will not occur. If not so, urination will occur unless the bladder fills stills more and micturition reflex becomes more powerful.

During micturition, the flow of urine is facilitated by the increase in the abdominal pressure due to the voluntary contraction of abdominal muscles.

Voluntary Control of Micturition

Spinal centers for micturition are present in sacral and lumbar segments. But these spinal centers are regulated by higher centers. The higher centers, which control micturition are two types, inhibitory centers and facilitatory centers.

- Inhibitory Centers for Micturition

Centers in midbrain and cerebral cortex inhibit the micturition by suppressing spinal micturition centers.

- Facilitatory Centers for Micturition

  Centers in pons facilitate micturition via spinal centers. Some centers in cerebral cortex also facilitate micturition.

3. JUXTAGLOMERULAR APPARATUS

Juxtaglomerular apparatus refers to the collection of specialized cells located vey near to the glomerulus. It forms the major component of renin-angiotensin-aldosterone system. The juxtaglomerular apparatus compromises three types of cells:

a. Macula densa cells

b. Extraglomerular mesangial cells

c. Juxtaglomerular cells

Macula Densa

Macula densa is the end portion of thick ascending segment of loop of Henle before it opens into distal convoluted tubule. It is situated between afferent and efferent arterioles of the same nephron. It is very close to afferent arteriole. Macula densa is formed by tightly packed cuboidal epithelial cells. It secretes thromboxane A_2.

Extraglomerular Mesangial Cells

Extraglomerular mesangial cells are situated in the triangular region bound by afferent arteriole, efferent arteriole and macula densa. These cells are also called agranular cells, lacis cells or Goormaghtigh cells. They are the interstitial cells of the juxtaglomerular apparatus. They secrete cytokines like interleukin-2 and tumor necrosis factor.

Juxtaglomerular Cells

Juxtaglomerular cells are specialized myoepithelial (modified vascular smooth muscle) cells located in the wall (tunica media and tunica adventitia) of the afferent arteriole in the region of juxtaglomerular apparatus. Juxta glomerular cells are also called granular cells because of the presence of secretary granules in their cytoplasm. Juxtaglomerular cells form a thick cuff called polar cushion or polkissen around the afferent arteriole before it enters the Bowman capsule. The functions of the juxtaglomerular cells are:

- They synthesize, store and release an enzyme called renin. Renin is stored in the secretory granules of juxtaglomerular cells and, therefore, these are also called granular cells.
- They act as baroreceptors (tension receptors) and respond to changes in the transmural pressure gradient between the afferent arteriole and the interstitium.
- They are densely innervated by the sympathetic nerve fibres and release their renin content in response to the sympathetic discharge.
- As these cells act as vascular volume receptors, they monitor rnal perfusion pressure and are stimulated by hypovolaemia or decreased renal perfusion pressure.

4. ROLE OF KIDNEY IN THE REGULATION OF BLOOD PRESSURE

Kidneys play an important role in the long-term regulation of arterial blood pressure by two ways:

i. By regulating the volume of extracellular fluid

ii. Through renin-angiotensin mechanism

5. ROLE OF KIDNEY IN CALCIUM HOMEOSTASIS

The kidney is critically important in calcium homeostasis. Under normal blood calcium concentrations, 95% of the calcium that enters glomerular filtrate is reabsorbed from the tubular system back into blood, which preserves blood calcium levels. In the proximal tubules, 60% of filtered calcium is reabsorbed by passive mechanisms. In the thick ascending limb, 15% of calcium is reabsorbed by paracellular diffusion. The fine regulation of calcium excretion occurs in the distal convoluted tubules despite the fact that only 10-15% of filtered calcium is reabsorbed there. Kidneys play a role in the regulation of blood calcium level by activating 1,25-dihydroxycholecalciferol into vitamin D. By alpha one hydroxylase enzyme in cells of PCT under effect of PTH. Vitamin D is necessary for the absorption of calcium from intestines into the blood.