

CHAPTER TWENTY - SEVEN

Content Review

1. The urinary system filters water and waste from the blood plasma; stores some water and waste products as urine until the body is ready to expel the urine; excretes the urine from the bladder to outside the body; helps maintain blood volume by preventing excess water loss; and regulates erythrocyte production.
2. An external, fibrous capsule covers the outer surface of the kidney. It maintains kidney shape, protects the kidney from trauma, and helps prevent the spread of infectious pathogens. The perinephric fat (adipose capsule) is external to the fibrous capsule and completely surrounds the kidney to offer cushioning and insulation. The renal fascia is external to the perinephric fat. It anchors the kidney to the posterior abdominal wall and the peritoneum. The paranephric fat is the outermost layer that surrounds the kidney. It is composed of adipose connective tissue and lies between the renal fascia and the peritoneum.
3. Blood is carried to a kidney in a renal artery. Up to five segmental (lobar) arteries branch from the renal artery within the renal sinus. Thereafter, the branching of arteries leads to the interlobar arteries, the arcuate arteries, the interlobular arteries, the afferent arterioles, the glomerulus, the efferent arteriole, the peritubular capillaries, and the vasa recta, which drain into the interlobular veins, the arcuate veins, the interlobar veins, and the renal vein. Note that the efferent arteriole is still carrying oxygenated blood because gas and nutrient exchange for the tissues in the kidney has not yet occurred. The blood in all arteries, the arterioles, the glomerulus, the peritubular capillaries, and the vasa recta is high in oxygen. The blood in all veins is low in oxygen. The peritubular and vasa recta capillary networks are where actual gas and nutrient exchange occurs and where materials are reabsorbed.
4. The thick tangle of capillaries called the glomerulus and the epithelial capsule surrounding it, called the glomerular capsule, make up the renal corpuscle. The glomerular capsule has a visceral layer directly overlying the glomerulus and a parietal layer formed from simple squamous epithelium. Between these layers is a capsular space. As blood passes through the glomerulus, waste products and water are pushed from the glomerulus into the capsular space.
5. The proximal convoluted tubule is lined by a simple cuboidal epithelium with tall microvilli that markedly increase its reabsorption capacity. Most of the reabsorption occurs in the proximal convoluted tubules, and thus microvilli are not required elsewhere in the nephron.
6. The macula densa cells of the juxtaglomerular apparatus continuously monitor electrolyte concentration in tubular fluid. If either blood volume or solute concentration is reduced, the macula densa cells detect this change and stimulate the juxtaglomerular cells to release renin. The renin activates the renin-angiotensin pathway, resulting in the production of aldosterone, which causes electrolyte concentrations and blood volume to increase. The structures of the juxtaglomerular apparatus work together to help regulate blood pressure.
7. The ureters project through the bladder wall obliquely, and so the ureteral walls are compressed as the bladder distends. This decreases the likelihood of urine refluxing

into the ureters from the bladder.

8. The ureters are innervated by the autonomic nervous system. Sympathetic fibers come from the T11–L2 segments of the spinal cord. Pain from the ureter (such as from a kidney stone) is referred to the T11–L2 dermatomes. These dermatomes are along a “loin-to-groin” region, so “loin-to-groin” pain typically indicates ureter and/or kidney involvement. Parasympathetic fiber innervation has an unknown effect. The bladder is supplied by both sympathetic and parasympathetic nerve fibers of the autonomic nervous system. The sympathetic fibers are from the T11–L2 segments of the spinal cord. These fibers contract the internal urethral sphincter and inhibit contraction of the detrusor muscle. Thus, sympathetic fibers inhibit micturition (urination). The parasympathetic fibers come from the pelvic splanchnic nerves (S2–S4). They relax the internal urethral sphincter (so urine can pass through) and stimulate contraction of the detrusor muscle. Thus, the parasympathetic fibers stimulate micturition.
9. Water and waste products are pushed from the glomerulus into the capsular space of the glomerular capsule. This fluid is called filtrate. Filtrate enters the proximal convoluted tubule and is then called tubular fluid. Tubular fluid flows through the proximal convoluted tubule, nephron loop, distal convoluted tubule, and collecting duct, where reabsorption and secretion occur. The tubular fluid leaving the renal papilla is called urine. Urine passes from the renal papilla into and then through the minor calyx, major calyx, renal pelvis, ureter, urinary bladder, and finally through the urethra as it is voided from the body.
10. A urinary tract infection (UTI) occurs when bacteria (usually *E. coli*) or fungi enter the urinary tract and multiply. Females are more prone to UTIs because their urethra is short and close to the anus, which facilitates bacterial entry into the urethra from the GI tract. Sexual intercourse also increases the risk of UTIs. In addition, UTIs are associated with the use of a urinary catheter.