Amerman Active-Learning Workbook: Chapter 24 Answers

What do you already know?: What are the main functions of the urinary system?
In addition to its main job of removing metabolic wastes, the Urinary System regulates fluid and electrolyte balance, acid-base balance, and erythrocyte production. It also influences aspects of physiology such as blood pressure and vitamin D production.

Key Concept: How is blood flow through the kidney different from other organs?
The kidneys contain an unusual capillary bed called the glomerulus that is both fed and drained by arterioles (afferent arterioles and efferent arterioles) instead of an arteriole and a venule.

Key Concept: What is a nephron?
The nephron is the microscopic functional unit of the kidney, which filters the blood and produces urine. It is composed of a renal corpuscle, which filters the blood, and a renal tubule that modifies the composition of urine.

Key Concept: How does the filtration membrane determine the composition of the filtrate?
The filtration membrane (made up of the glomerular capillary endothelial cells, a basal lamina, and podocytes), forms a filter that allows filtrate to pass through, but leaves relatively large substances behind in the blood.

Key Concept: How do the three pressures in the renal corpuscle interact to determine the glomerular filtration rate?
Glomerular hydrostatic pressure (essentially the blood pressure in the glomerulus) *promotes* filtration, **glomerular colloid osmotic pressure** (solutes like albumin in the plasma) *opposes* filtration, and **capsular hydrostatic pressure** (due to fluid pressure in the capsule) *opposes* filtration. The latter two forces are subtracted from the first one to obtain net filtration pressure.

Key Concept: How does the renin-angiotensin-aldosterone system affect systemic blood pressure and the GFR? What are other mechanisms that regulate the GFR?
Angiotensin-II increases the GFR to maintain nephron function, stimulates retention of sodium ions (both directly and through stimulation of aldosterone release), and is a strong systemic vasoconstrictor (which increases blood pressure). Atrial natriuretic peptide, the myogenic mechanism, and tubuloglomerular feedback can also regulate GFR by vasoconstriction/vasodilation of the afferent and efferent arterioles.

Key Concept: What role do sodium ions play in the reabsorption of water and other solutes?
Reabsorption of sodium ions also pulls water with it through osmosis (obligatory water reabsorption); sodium is also important in co-transport of other substances such as glucose and hydrogen ions.

Key Concept: How does reabsorption differ in the proximal and distal tubules?
Most activity in the proximal tubule occurs without outside control, and large amounts of solutes and water are reabsorbed automatically.

Processes in the distal tubule are controlled by hormones such as aldosterone, antidiuretic hormone, and atrial natriuretic peptide.

Key Concept: What hormone must be secreted in lower amounts to produce dilute urine? Why?
Reduction of ADH release allows the excess water in the filtrate of the distal and collecting system to remain trapped inside.

This filtrate already has less solute (and more water) than interstitial fluids, and produces a dilute urine.

Key Concept: Why is the medullary osmotic gradient important to the production of concentrated urine?
Water reabsorption happens only by osmosis, a passive process that only occurs only if a concentration gradient is present.

To accomplish this, the nephrons work to create a concentration gradient within the renal medulla called the medullary osmotic gradient.

Key Concept: How do the vasa recta and countercurrent exchange maintain the medullary osmotic gradient?
The countercurrent multiplier in the nephron loops pump NaCl out of the thick ascending limb into the interstitial fluid and water moves out of the thin descending limb. The countercurrent exchanger of the vasa recta removes NaCl from the interstitial fluid as they descend into the renal medulla and then redeposit the NaCl and absorb water as they ascend into the renal cortex. This maintains higher solute concentrations in the deeper renal medulla.

Key Concept: How can renal clearance be used to estimate the glomerular filtration rate?
The rate at which substances like creatinine and inulin are removed from the blood by the kidney (renal clearance) is a way to estimate GFR by comparing its excretion in the urine to its plasma concentration.

Key Concept: How do the male and female urinary tracts differ?
The urethra of the female is much shorter than that of the male, and is exclusively a passageway for urine. The male urethra is much longer, as it passes through the penis as a common tube of the urinary and reproductive systems. The space of the urinary bladder is more restricted in the female, as it is anterior to the vagina and inferior to the uterus.

Key Concept: What part of the nervous system mediates the micturition reflex? How does the central nervous system exert voluntary control over micturition?
The micturition reflex is controlled by the parasympathetic nervous system, stimulating the detrusor muscle to contract and the internal urethral sphincter to relax. The cerebral cortex may allow the external urethral sphincter to relax, but if the reflex is stopped, the detrusor muscle relaxes and the sphincters remain closed.