

16 The Urinary System

The Urinary System

OUTLINE:

- Eliminating Waste
- Components of the Urinary System
- Kidneys and Homeostasis
- Dialysis and Transplant Surgery
- Urination
- Urinary Tract Infections

Eliminating Waste

- Excretion
 - Elimination of wastes and excess substances from the body
 - Metabolic wastes include carbon dioxide, water, heat, salts, and nitrogen-containing wastes (ammonia, urea, uric acid, creatinine)

Eliminating Waste

- Several organs eliminate wastes and excess essential ions
 - Lungs
 - Heat, water, and carbon dioxide
 - Skin
 - Heat, water, bicarbonate ions, salts, urea, uric acid
 - Organs of the GI tract
 - Solid wastes and some metabolic wastes
 - Kidneys
 - Form urine (mix of water and solutes): water, bicarbonate ions, inorganic salts, hydrogen ions, urea, uric acid, and creatinine

Components of the Urinary System

- The urinary system consists of two kidneys, two ureters, one urinary bladder, and one urethra
 - Functions
 - Regulates the volume, pH, pressure, and composition of the blood
 - Organs
 - Kidneys
 - Regulate the amount of water and dissolved substances that are removed from and returned to the blood
 - Substances not returned to the blood form urine

Components of the Urinary System

- Organs (cont'd)
 - Ureters
 - Transport urine from kidneys to bladder
 - Urinary bladder
 - Stores urine
 - Urethra
 - Transports urine from urinary bladder to outside the body

Kidneys and Homeostasis

- Kidneys are reddish brown in color and shaped like beans
- Each one is about the size of a fist
- Three regions
 1. Renal cortex
 2. Renal medulla
 3. Renal pelvis

Kidneys and Homeostasis

- Nephrons
 - Microscopic functional units of the kidneys
 - Responsible for formation of urine
 - Each nephron consists of
 - Renal corpuscle
 - Renal tubule

Structure of the Kidneys

- Renal corpuscle
 - Site of filtration
 - Consists of
 - Glomerulus: tuft of capillaries
 - Glomerular capsule: surrounds glomerulus

Structure of the Kidneys

- Renal tubule
 - Site of reabsorption and secretion
 - Consists of three sections
 - Proximal convoluted tubule
 - Loop of the nephron
 - Distal convoluted tubule

Nephrons

- Nephrons perform three functions
 - Glomerular filtration
 - Tubular reabsorption
 - Tubular secretion

Nephrons

- Glomerular filtration
 - Occurs as blood pressure forces water, ions, and other small molecules from the blood in the glomerulus to the space inside the glomerular capsule
 - The concentration of the filtrate within the glomerular capsule is close to that of blood

Nephrons

- Tubular reabsorption
 - Removes useful materials from the filtrate as it passes through proximal convoluted tubule
 - About 99% of filtrate is returned to the blood
 - Reabsorbed substances include water, essential ions, and glucose

- Tubular secretion
 - Occurs along the proximal and distal convoluted tubules and collecting ducts
 - Removes wastes and excess ions from blood

Acid–Base Balance

- Kidneys help regulate blood pH by
 - Returning bicarbonate ions to the blood during tubular reabsorption
 - Removing excess hydrogen ions from the blood during tubular secretion

Water Conservation

- Nephrons with long loops that extend into the renal medulla are responsible for conserving water
 - Maintenance of high solute concentrations in the interstitial fluid within renal medulla is key
 - Leads to water moving out of collecting ducts for conservation by the body
 - Leads to production of concentrated urine

Hormones and Kidney Function

- Our health depends on our keeping the salt and water levels in our body near certain optimum values
- Three hormones play important roles in adjusting kidney function
 1. Aldosterone
 2. Antidiuretic hormone (ADH)
 3. Atrial natriuretic peptide (ANP)

Hormones and Kidney Function

- Aldosterone
 - Released by the adrenal cortex
 - Increases reabsorption of sodium by the distal convoluted tubules and collecting ducts, resulting in more water following sodium as it moves from filtrate to blood
 - Increases blood volume and pressure
 - Production of concentrated urine
 - Released in response to blood pressure monitored by juxtaglomerular apparatus

Hormones and Kidney Function

- Antidiuretic hormone (ADH)
 - Produced by the hypothalamus and released by the posterior pituitary gland
 - Increases permeability to water of collecting ducts, resulting in more water moving from filtrate to blood
 - Increases blood volume and pressure
 - Production of concentrated urine

Hormones and Kidney Function

- Atrial natriuretic peptide (ANP)

- Released from the right atrium of the heart in response to increased blood volume and pressure
- Decreases reabsorption of sodium by the distal convoluted tubules and collecting ducts, resulting in more sodium and water remaining in the filtrate
 - Decreases blood volume and pressure
 - Production of dilute urine

Red Blood Cells and Vitamin D

- Kidneys have two homeostatic functions unrelated to the urinary system
 - Release erythropoietin
 - Hormone that stimulates the production of red blood cells in red bone marrow
 - Transform vitamin D into its active form
 - Promotes the absorption and use of calcium and phosphorus by the body

Dialysis and Transplant Surgery

- Renal failure
 - Decrease or complete cessation of glomerular filtration
 - Can be acute or chronic
 - Consequences
 - Acidosis
 - Anemia
 - Edema
 - Hypertension
 - Accumulation of nitrogen-containing wastes in the blood

Dialysis and Transplant Surgery

- Treatments for renal failure
 - Hemodialysis
 - Using artificial devices (e.g., artificial kidney machine) to cleanse the blood
 - Continuous ambulatory peritoneal dialysis
 - Using patient's own peritoneum as the dialyzing membrane
 - Kidney transplantation
 - The ultimate hope for many people whose kidneys fail is to receive a healthy kidney from another person

Dialysis and Transplant Surgery

Urination

- Process by which the urinary bladder is emptied
 - Includes both involuntary and voluntary components
 - Internal urethral sphincter
 - Smooth muscle; involuntary
 - External urethral sphincter
 - Skeletal muscle; voluntary

Urination

- Urinary incontinence
 - Lack of voluntary control over urination

- Norm for infants and toddlers
- Stress incontinence is more common in women
- Urinary retention
 - Failure to expel urine from the bladder to a normal degree

Urinary Tract Infections (UTIs)

- Caused by presence of microorganisms in organs of the urinary system
 - Bacteria can enter the urethra from the rectum or as STDs
- More common in women than men
- Symptoms include fever, blood in urine, painful and frequent urination
- Treated with antibiotics
 - Important to treat infection of lower urinary tract to prevent spread to the kidneys

You Should Now Be Able To:

- Understand how waste is eliminated
- Know the components of the urinary system
- Know the functions of the nephrons
- Understand kidneys and hormones
- Understand kidneys and homeostasis
- Explain dialysis and transplant surgery
- Know the process of urination
- Understand urination conditions and urinary tract infections