PART III: MAINTENANCE OF THE HUMAN BODY
CHAPTER 16: URINARY SYSTEM AND EXCRETION

LEARNING OUTCOMES

16.1 Urinary System
1. List four major functions of the urinary system.
2. Trace the path of urine from its formation to its exit from the body.
3. Compare and contrast the structure and functions of the male versus female urethra.

16.2 Anatomy of the Kidney and Excretion
1. Illustrate and label the structure of a nephron.
2. Distinguish between glomerular filtration, tubular reabsorption, and tubular secretion.

16.3 Regulatory Functions of the Kidneys
1. Discuss where the reabsorption of salt occurs and how it is hormonally controlled.
2. Explain how a solute gradient is established in the renal medulla.
3. Describe two ways that the kidneys regulate blood pH.

16.4 Disorders of the Urinary System
1. Indicate how damage to the glomeruli/nephrons can lead to uremia and edema.
2. List one advantage and one disadvantage of hemodialysis, continuous ambulatory peritoneal dialysis, and transplantation for kidney failure patients.
3. Describe three common disorders of the bladder and urethra.

LECTURE OUTLINE

16.1 Urinary System
Excretion is the removal of metabolic wastes from the body.

Functions of the Urinary System
The urinary system produces urine and conducts it to outside the body. As the kidneys produce urine they excrete metabolic wastes, maintain water-salt balance, maintain acid-base balance, and secrete hormones.

Organs of the Urinary System
The urinary system consists of the kidneys, ureters, urinary bladder, and urethra.

Kidneys
The kidneys are paired organs located near the small of the back.

Ureters
The ureters conduct urine from the kidneys to the bladder.

Urinary Bladder
The urinary bladder stores urine until it is expelled form the body.

Urethra
The urethra is a small tube that extends from the urinary bladder to an external opening. In males, the urethra carries urine during urination and semen during ejaculation.

Urination
When the urinary bladder fills to about 250 ml with urine, stretch receptors send sensory nerve impulses to the spinal cord.

16.2 Anatomy of the Kidney and Excretion
The renal cortex is an outer, granulated layer. The renal medulla is the inner layer. The renal pelvis is a central space continuous with the ureter.

Anatomy of a Nephron
The kidney is composed of over one million nephrons. Each nephron has its own blood supply including two capillary regions.

Parts of a Nephron
Each nephron is composed of a glomerular capsule, a proximal convoluted tubule, the loop of the nephron, the distal convoluted tubule, and the collecting duct.

**Urine Formation**
Urine formation is divided into glomerular filtration, tubular reabsorption, and tubular secretion.

**Glomerular Filtration**
The glomerular filtrate contains small dissolved molecules in approximately the same concentration as plasma. Formed elements and plasma proteins are not filterable.

**Tubular Reabsorption**
Tubular reabsorption occurs as molecules and ions are passively and actively reabsorbed from the nephron into the blood. Most water, nutrients, and required salts are reabsorbed.

**Tubular Secretion**
Tubular secretion removes substances from the blood and adds them to the tubular fluid.

### 16.3 Regulatory Functions of the Kidneys
The kidneys maintain the water-salt balance of the blood within normal limits. In this way, they also maintain the blood volume and blood pressure.

**Process of Water Reabsorption**
The excretion of hypertonic urine is dependent upon the reabsorption of water from the loop of the nephron and the collecting duct.

**Reabsorption of Salt**
The kidneys regulate the salt balance in blood by controlling the excretion and reabsorption of various ions. Hormones regulate the reabsorption of sodium.

**Establishment of a Solute Gradient**
The long loop of a nephron is situated within an osmotic gradient in the tissues of the renal medulla.

**Reabsorption of Water**
Water is reabsorbed at the loop of the nephron and the collecting duct. Hormones control the amount of water that is reabsorbed.

**Diuretics**
Diuretics are chemicals that increase the flow of urine.

### Acid-Base Balance
The pH scale can be used to indicate the basicity or the acidity of body fluids. The normal pH for body fluids is about 7.4.

**Acid-Base Buffer Systems**
A buffer is a chemical or a combination of chemicals that can take up excess hydrogen ions or excess hydroxide ions. These reactions temporarily prevent any significant change in blood pH.

**Respiratory Center**
The respiratory center in the medulla oblongata increases the breathing rate if the hydrogen ion concentration of the blood rises.

**The Kidneys**
Only the kidneys can rid the body of a wide range of acidic and basic substances and otherwise adjust the pH. The kidneys are slower acting than the other two mechanisms, but they have a more powerful effect on pH.

### 16.4 Disorders of the Urinary System
**Disorders of the Kidneys**

Infection of the kidneys is called pyelonephritis. Kidney stones are hard granules that can form in the renal pelvis. One of the first signs of kidney damage is the presence of albumin, white blood cells, and/or red blood cells in the urine.

**Treatment Options for Kidney Failure**

Patients with renal failure can undergo hemodialysis, utilizing either an artificial kidney machine or continuous ambulatory peritoneal dialysis (CAPD). A kidney transplant is the surgical replacement of a defective kidney with a functioning kidney from a donor.

**Disorders of the Urinary Bladder and Urethra**

Infections are probably the most common cause of problems in the urinary bladder and urethra. Inflammation of the bladder is cystitis while infection of the urethra is urethritis. Stones and cancer are also disorders of the bladder.