After studying this chapter, you will be able to:

9.1 Name the parts of the urinary system and discuss the function of each part
9.2 Define combining forms used in building words that relate to the urinary system
9.3 Identify the meaning of related abbreviations
9.4 Name the common diagnoses, clinical procedures, and laboratory tests used in treating disorders of the urinary system
9.5 List and define the major pathological conditions of the urinary system
9.6 Explain the meaning of surgical terms related to the urinary system
9.7 Recognize common pharmacological agents used in treating disorders of the urinary system

Structure and Function

The urinary system (also called the renal system or excretory system) maintains the proper amount of water in the body and removes waste products from the blood by excreting them in the urine. The urinary system consists of:

- Two kidneys, organs that remove dissolved waste and other substances from the blood and urine
- Two ureters, tubes that transport urine from the kidneys to the bladder
- The bladder, the organ that stores urine
- The urethra, a tubular structure that transports urine through the meatus, the external opening of a canal, to the outside of the body

Figure 9-1a shows the urinary system, and Figure 9-1b diagrams the path of urine through the system.

Kidneys

Each kidney is a bean-shaped organ about the size of a human fist, weighs about 4 to 6 ounces, and is about 12 centimeters long, 6 centimeters wide, and 3 centimeters thick. The kidneys are located in the retroperitoneal (posterior to the peritoneum) space behind the abdominal cavity on either side of the vertebral column. The kidneys sit against the deep muscles of the back surrounded by fatty and connective tissue. The left kidney is usually slightly higher than the right one.

The kidneys serve two functions—to form urine for excretion and to retain essential substances the body needs in the process called reabsorption.
Urine is produced by filtration of water, salts, sugar, urea, and other nitrogenous waste materials such as creatine (and its component creatinine) and uric acid. The excretion rate of creatinine is measured in urinary tests because it is an indicator of how the kidney is functioning. Kidneys, in the average adult, will filter about 1700 liters of blood per day. Urine output is the only means for the body to remove toxic nitrogenous wastes from the body.

The kidneys have an outer protective portion, the cortex, and an inner soft portion, the medulla, which is a term used for the inner, soft portion of any organ. In the middle of the concave side of the kidney is a depression, the hilum, through which the blood vessels, the nerves, and the ureters enter and exit the kidney.

The functional unit of the kidney is the nephron (Figure 9-2). The nephron removes waste products from the blood and produces urine. Each kidney contains about one million nephrons, more nephrons than one person needs. That is why people can live a normal life with only one kidney.

Blood enters each kidney through the renal artery and leaves through the renal vein. Once inside the kidney, the renal artery branches into smaller arteries called arterioles. Each arteriole leads into a nephron. Each nephron contains a renal corpuscle made up of a group of capillaries called a glomerulus (pl., glomeruli) (Figure 9-3). The glomerulus filters fluid from the blood and is the first place where urine is formed in the kidney. Each nephron also contains a renal tubule, which carries urine to ducts in the kidney’s cortex. Blood flows through the kidneys at a constant rate. If the blood flow is decreased, the kidney automatically produces renin, a substance that causes an increase in the blood pressure in order to maintain the filtration rate of blood. The wall of each glomerulus is thin enough to allow water, salts, sugars, urea, and certain wastes to pass through. Each glomerulus is surrounded by a capsule, Bowman’s capsule, where this fluid collects. The filtered substances that are removed from the blood then pass into the renal tubules.
Substances held in the renal tubule that can be used by the body are reabsorbed back to the bloodstream. During this reabsorption, most of the water, nutrients including glucose, and selected electrolytes move back to the blood. Any substance not reabsorbed will become urine. Urine travels to the renal pelvis, a collecting area in the center of the kidney. Pelvis is a general term for the collecting area of an organ or system. The renal pelvis

**FIGURE 9-3** Blood flows into the glomeruli where urine is excreted and moved to the kidney’s cortex.

**FIGURE 9-4** The kidneys form urine for excretion and retain essential substances for reabsorption.

---

**MORE ABOUT . . .**

**Blood Pressure and the Kidneys**

The kidneys have mechanisms to maintain *homeostasis* (equilibrium) in the filtration rate of the glomeruli. The constant flow of water and its substances back into the bloodstream and the flow of water and waste substances into the renal tubule maintain the body’s balance of water, salts (the most common salt in the body is sodium chloride), sugars (the most common sugar in the body is glucose), and other substances. To do this, the kidneys have two lines of defense. The first is the automatic dilating and constricting of the arterioles as needed to increase or decrease the flow of blood into the glomeruli. The second is to release renin to increase the blood pressure and thus the filtration rate of blood to maintain a constant supply. Maintaining homeostasis affects blood pressure either by lowering it when blood is flowing too quickly or by increasing it when blood is flowing too slowly. Some forms of high blood pressure are caused by the effort of poorly functioning kidneys to maintain homeostasis.

Substances held in the renal tubule that can be used by the body are reabsorbed back to the bloodstream. During this reabsorption, most of the water, nutrients including glucose, and selected electrolytes move back to the blood. Any substance not reabsorbed will become urine. Urine travels to the **renal pelvis**, a collecting area in the center of the kidney. Pelvis is a general term for the collecting area of an organ or system. The renal pelvis
contains small cuplike structures called **calices** (also spelled **calyces**; singular **calyx**) that collect urine. Figure 9-4 shows the parts of a kidney involved in urine flow.

**Ureters**

Attached to each kidney is a **ureter**, a tube (usually 16 to 18 centimeters long) that transports urine from the renal pelvis to the urinary bladder. The two ureters are made up of three layers of tissue—smooth muscle, fibrous tissue, and a mucous layer. **Peristalsis**, a rhythmic contraction of the smooth muscle, helps to move urine into the urinary bladder.

**Bladder**

The **urinary bladder** is a hollow, muscular organ that stores urine until it is ready to be excreted from the body. **Bladder** is a general term meaning a receptacle. Urine is pumped into the bladder every few seconds. The **sphincter muscles**, muscles that encircle a duct to contract or expand the duct, hold the urine in place. Control of urination has to be taught to young children (usually between the ages of one and three), while in adults it is usually easily controlled. The bladder can hold from 300 to 400 milliliters of urine before emptying. The bladder’s walls contain epithelial tissue that can stretch and allow the bladder to hold twice as much as it does when normally full. The walls also contain three layers of muscle that help in the emptying process. The base of the bladder (Figure 9-5) contains a triangular area, the **trigone**, where the ureters enter the bladder and the urethra exits it.

**Urethra**

Urine is excreted outside the body through the urethra, a tube of smooth muscle with a mucous lining. The female urethra is only about 4 centimeters [1.5 inches] long. It opens through the meatus, which is located at the distal end of the urethra between the clitoris and the vagina. The male urethra is about 20 centimeters [8 inches] long and passes through three different regions. The first region is the **prostate**, a gland where the urethra and the ejaculatory duct meet. Thus, the urethra in the male is part of the urinary system as well as part of the reproductive system. The second region is a membranous portion, after which urine passes into the third part, the penis, and is excreted through the meatus at the distal end of the penis. Excreting urine is called **voiding** or **micturition**.

**Vocabulary Review**

In the previous section, you learned terms relating to the urinary system. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
</table>
| bladder [BLÄD-ēr]  
Old English blaedre | Organ where urine collects before being excreted from the body. |
| Bowman’s [BÖ-māns] capsule  
After Sir William Bowman (1816–1892), English anatomist | Capsule surrounding a glomerulus and serving as a collection site for urine. |
| calices, calyces (sing., calix, calyx) [KĀL-ī-sēz  
(KĀ-likes)]  
From Greek kalyx, cup of a flower | Cup-shaped structures in the renal pelvis for the collection of urine. |
| cortex [KÖR-tëks] Latin, bark | Outer portion of the kidney. |
| creatine [KRÉ-a-tēn]  
From Greek kreas, flesh | Substance found in urine; elevated levels may indicate muscular dystrophy. |
| filtration [fīl-TRĀ-shūn] | Process of separating solids from a liquid by passing it through a porous substance. |
| glomerulus (pl., glomeruli) [glō-MAR-yū-lōs  
(glō-MAR-yū-li)]  
From Latin glomus, ball of yarn | Group of capillaries in a nephron. |
| hilum [HĪ-lūm]  
Latin, a small bit | Portion of the kidney where blood vessels and nerves enter and exit. |
| kidney [KĪD-nē]  
Middle English, kidenei | Organ that forms urine and reabsorbs essential substances back into the bloodstream. |
| meatus [mē-Ā-tūs]  
Latin, passage | External opening of a canal, such as the urethra. |
| medulla [mē-DUL-ā]  
Latin, marrow | Soft, central portion of the kidney. |
| nephron [NĒF-rōn]  
From Greek nephros, kidney | Functional unit of a kidney. |
| prostate [PRŌS-tāt]  
Greek prostās, one that protects | Gland surrounding the urethra in the male; active in ejaculation of semen. |
| reabsorption [rē-āb-SÖRP-shūn]  
re + absorption | Process of returning essential elements to the bloodstream after filtration. |
| renal pelvis | Collecting area for urine in the center of the kidney. |
| renin [RĒ-nīn]  
Latin ren, kidney | Enzyme produced in the kidneys to regulate the filtration rate of blood by increasing blood pressure as necessary. |
| retroperitoneal [RĒ-trō-PĒR-ī-tō-nē-āl]  
retro-, behind + peritoneal | Posterior to the peritoneum. |
| trigone [TRĪ-gōn]  
Latin trigonum, triangle | Triangular area at the base of the bladder through which the ureters enter and the urethra exits the bladder. |
### Term Definition

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ureter</strong> [yū-RĒ-tēr] Greek oureter, urinary canal</td>
<td>One of two tubes that conduct urine from the kidney to the bladder.</td>
</tr>
<tr>
<td><strong>urethra</strong> [yū-RĒ-thrā] Greek ourethra</td>
<td>Tube through which urine is transported from the bladder to the exterior of the body.</td>
</tr>
<tr>
<td><strong>uric</strong> [YŪR-īk] acid ur-, urine + -ic, pertaining to</td>
<td>Nitrogenous waste excreted in the urine.</td>
</tr>
<tr>
<td><strong>urinary</strong> [YŪR-i-när-ē] bladder</td>
<td>See bladder.</td>
</tr>
<tr>
<td><strong>urinary system</strong></td>
<td>Body system that forms and excretes urine and helps in the reabsorption of essential substances.</td>
</tr>
<tr>
<td><strong>urine</strong> [YŪR-in] Greek ouroν, urine</td>
<td>Fluid excreted by the urinary system.</td>
</tr>
</tbody>
</table>

### CASE STUDY

**Visiting a Clinic**

Central Valley HMO is located in a large medical office building next to a hospital complex. The first floor is a large clinic where patients are evaluated first. Later, they may be referred to specialists located in the same building.

Three of the morning patients complained of problems relating to the urinary system. The first, Mr. Delgado, was having difficulty urinating. The second, Ms. Margolis, showed blood in her urine, and the third, Ms. Jones, complained of frequent, painful, and scanty urination. All three were seen by Dr. Chorzik, a family practitioner employed by the HMO.

**Critical Thinking**

1. Is blood normally seen in the urine? Why or why not?
2. Does the fact that Mr. Delgado and Ms. Jones are of different sexes make the diagnosis of their urinary problems different?

### Structure and Function Exercises

**Check Your Knowledge**

Fill in the blanks.

3. Urine is transported within the urinary system via the _____________.
4. Urine is transported to the outside of the body via the _____________.
5. Each kidney has about one million _____________.
6. The renal corpuscle contains a mass of capillaries termed a _____________.
7. The collecting area in the center of the kidney is called the _____________.
8. The return of essential substances to the bloodstream is called _____________.
9. The urethra draws urine from the _____________.
10. Two words meaning excreting urine are _____________ and _____________.
11. A fluid collection site in a nephron is called a _____________.
12. A triangular area at the base of the bladder is called a _____________.

**Check Your Accuracy**

Circle T for true or F for false.

13. The loss of one kidney is fatal. T F
14. The urethra transports urine from the kidney to the bladder. T F
15. Most of the water and sugar filtered in the kidney are reabsorbed. T F
16. Renin increases blood flow through the kidneys. T F
17. Two fluid collection sites within the kidney are the calices and the Bowman’s capsule. T F
18. The female urethra is longer than the male urethra. T F
19. The female urethra opens into the vagina. T F
20. The prostate gland ejects semen into the male urethra. T F
21. The left kidney is usually slightly higher than the right one. T F
22. Blood flows through the kidney at varying intervals. T F

**Go with the Flow**

Put the following steps, which describe the flow of urine, in order by placing the letters a through g in the space provided.

23. Urine flows from the ureters into the bladder. _____________
24. Fluid collects in the Bowman’s capsule. _____________
25. Urine flows through the renal tubules to ducts in the kidney. _____________
26. Urine exits the body. _____________
27. Urine flows from the bladder to the urethra. _____________
28. Urine flows from the kidneys into the ureter. _____________
29. Fluid flows from the Bowman’s capsule to the renal tubule. _____________

**Combining Forms and Abbreviations**

The lists below include combining forms and abbreviations that relate specifically to the urinary system. Pronunciations are provided for the examples.

<table>
<thead>
<tr>
<th>Combining Form</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>cali(o), calic(o)</td>
<td>calix</td>
<td>calioplasty [KĀ-lē-ō-plās-tē], surgical reconstruction of a calix</td>
</tr>
<tr>
<td>cyst(o)</td>
<td>bladder, especially the urinary bladder</td>
<td>cystitis [sīs-TĪ-tīs], bladder inflammation</td>
</tr>
<tr>
<td>glomerul(o)</td>
<td>glomerulus</td>
<td>glomerulitis [glō-MĀR-yū-LĪ-tīs], inflammation of the glomeruli</td>
</tr>
<tr>
<td>meat(o)</td>
<td>meatus</td>
<td>meatotomy [mē-ā-TŌT-o-mē], surgical enlargement of the meatus</td>
</tr>
<tr>
<td><strong>COMBINING FORM</strong></td>
<td><strong>MEANING</strong></td>
<td><strong>EXAMPLE</strong></td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>nephr(o)</td>
<td>kidney</td>
<td>nephrītis [nē-FRĪ-tĭs], kidney inflammation</td>
</tr>
<tr>
<td>pyel(o)</td>
<td>renal pelvis</td>
<td>pyelo[plas-]plasty [pī-lō-plās-tē], surgical repair of the renal pelvis</td>
</tr>
<tr>
<td>ren(o)</td>
<td>kidney</td>
<td>renomegaly [RĒ-nō-MĒG-ā-lē], enlargement of the kidney</td>
</tr>
<tr>
<td>trigon(o)</td>
<td>trigone</td>
<td>trigonitis [TRĪ-gō-NĪ-tĭs], inflammation of the trigone of the bladder</td>
</tr>
<tr>
<td>ur(o), urin(o)</td>
<td>urine</td>
<td>uremia [yū-RĒ-mē-ā], excess of urea and other nitrogenous wastes in the blood</td>
</tr>
<tr>
<td>ureter(o)</td>
<td>ureter</td>
<td>ureterostenosis [yū-RĒ-tēr-ō-stē-NŌ-sĭs], narrowing of a ureter</td>
</tr>
<tr>
<td>urethr(o)</td>
<td>urethra</td>
<td>urethrorrhrea [yū-thrō-RĒ-ā], abnormal discharge from the urethra</td>
</tr>
<tr>
<td>-uria</td>
<td>of urine</td>
<td>anuria [ān-yū-RĒ-ā], lack of urine formation</td>
</tr>
<tr>
<td>vesic(o)</td>
<td>bladder, generally used when describing something in relation to a bladder</td>
<td>vesicoabdominal [VĒS-ē-kō-āb-DŌM-ĭ-nāl], relating to the urinary bladder and the abdominal wall</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ABBREVIATION</strong></th>
<th><strong>MEANING</strong></th>
<th><strong>ABBREVIATION</strong></th>
<th><strong>MEANING</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ADH</td>
<td>antidiuretic hormone</td>
<td>IVP</td>
<td>intravenous pyelogram</td>
</tr>
<tr>
<td>A/G</td>
<td>albumin/globulin</td>
<td>K+</td>
<td>potassium</td>
</tr>
<tr>
<td>AGN</td>
<td>acute glomerulonephritis</td>
<td>KUB</td>
<td>kidney, ureter, bladder</td>
</tr>
<tr>
<td>ARF</td>
<td>acute renal failure</td>
<td>Na+</td>
<td>sodium</td>
</tr>
<tr>
<td>BNO</td>
<td>bladder neck obstruction</td>
<td>pH</td>
<td>power of hydrogen concentration</td>
</tr>
<tr>
<td>BUN</td>
<td>blood urea nitrogen</td>
<td>PKU</td>
<td>phenylketonuria</td>
</tr>
<tr>
<td>CAPD</td>
<td>continuous ambulatory peritoneal dialysis</td>
<td>RP</td>
<td>retrograde pyelogram</td>
</tr>
<tr>
<td>Cath</td>
<td>catheter</td>
<td>SG</td>
<td>specific gravity</td>
</tr>
<tr>
<td>CRF</td>
<td>chronic renal failure</td>
<td>UA</td>
<td>urinalysis</td>
</tr>
<tr>
<td>ESRD</td>
<td>end-stage renal disease</td>
<td>UTI</td>
<td>urinary tract infection</td>
</tr>
<tr>
<td>ESWL</td>
<td>extracorporeal shock wave lithotripsy</td>
<td>VCU, VCUG</td>
<td>voiding cystourethrogram</td>
</tr>
<tr>
<td>HD</td>
<td>hemodialysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Chapter 9  The Urinary System 297
CASE STUDY

Using Tests for Diagnosis

Dr. Chorzik ordered a urinalysis for two of his patients. The results give some clues to a possible diagnosis (see chart below and on p. 299). Note that the column marked Flag indicates when something is out of the range of normal. The reference column gives the normal ranges, and the results column gives the actual readings for the patients’ tests. A clean catch urine test is one in which the urine is collected once the area has been cleaned and some urine has been excreted first.

Critical Thinking
30. Whose tests had the most abnormal readings?
31. Spell out at least three of the items being tested for.

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Flag</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLOR</td>
<td>YELLOW</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>APPEARANCE</td>
<td>HAZY</td>
<td>**</td>
<td>1.001-1.030</td>
</tr>
<tr>
<td>SP GRAVITY</td>
<td>1.018</td>
<td></td>
<td>1.001-1.030</td>
</tr>
<tr>
<td>GLUCOSE</td>
<td>NORMAL</td>
<td>NEG</td>
<td>NEG mg/dl</td>
</tr>
<tr>
<td>BILIRUBIN</td>
<td>NEGATIVE</td>
<td>NEG</td>
<td>NEG mg/dl</td>
</tr>
<tr>
<td>KETONE</td>
<td>2+</td>
<td>**</td>
<td>4.5-8.0</td>
</tr>
<tr>
<td>BLOOD</td>
<td>5.0</td>
<td>**</td>
<td>NEG</td>
</tr>
<tr>
<td>PH</td>
<td>TRACE</td>
<td>**</td>
<td>NEG mg/dl</td>
</tr>
<tr>
<td>PROTEIN</td>
<td>NORMAL</td>
<td>NEG</td>
<td>NORMAL-1.0 mg/dl</td>
</tr>
<tr>
<td>UROBILINOGEN</td>
<td>NEGATIVE</td>
<td>NEG</td>
<td>NEG</td>
</tr>
<tr>
<td>NITRITES</td>
<td>2+</td>
<td>**</td>
<td>0-5 /HPF</td>
</tr>
<tr>
<td>LEUKOCYTES</td>
<td>20-50</td>
<td>**</td>
<td>0-5 /HPF</td>
</tr>
<tr>
<td>WBC</td>
<td>2-5</td>
<td></td>
<td>0-5 /HPF</td>
</tr>
<tr>
<td>RBC</td>
<td>20-50</td>
<td></td>
<td>HPF</td>
</tr>
<tr>
<td>EPI CELLS</td>
<td>2+</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>BACTERIA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MUCUS</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patient 1

COMBINING FORMS AND ABBREVIATIONS EXERCISES

Build Your Medical Vocabulary

Complete the words by adding combining forms, suffixes, or prefixes you have learned in this chapter and in Chapters 1, 2, and 3.

32. Lack of urination: ___________urea.
33. Inflammation of the renal pelvis: ___________itis
**CASE STUDY**

Dr. Joel Chorzik  
1420 Glen Road  
Meadowvale, OK 44444  
111-222-3333

**Specimen Report**

**Patient:** Sarah Margolis  
**Acct #:** E005792849  
**Loc: **U  
**#:**

**Reg Dr:** S. Anders, M.D.  
**Age/Sx:** 45/F  
**Status: **Reg ER

**Run Date:** 09/22/XX  
**Run Time:** 1507  
**Reg ER Bed:** Des:  
**Status:** Reg ER

**Spec #:** 0922: U00010R  
**Coll:** 09/22/XX  
**Status Comp:** Req #: 00704181  
**Recl:** 09/22/XX  
**Subm Dr:**

**Ordered:** UA with micro  
**Comments:** Urine Description: Clean catch urine

### Urinalysis

**Test** | **Result** | **Flag** | **Reference**
--- | --- | --- | ---
COLOR | BROWNISH | *** |  
APPEARANCE | HAZY | *** |  
SP GRAVITY | 1.017 | 1.001-1.030 |  
GLUCOSE | NORMAL |  
BILIRUBIN | NEGATIVE |  
KETONE | NEGATIVE |  
BLOOD | TRACE | ** |  
PH | 5.0 | 4.5-8.0 |  
PROTEIN | NEGATIVE |  
UROBILINOGEN | NORMAL |  
NITRITES | NEGATIVE |  
LEUKOCYTES | NEGATIVE |  
WBC | NO CELLS |  
RBC | 2-5 | 0-5 /HPF |  
EPI CELLS | 0-2 | /HPF |  
MUCUS | 1+ |  

**Test Result Flag Reference**

- **COLOR:** BROWNISH  
- **APPEARANCE:** HAZY  
- **SP GRAVITY:** 1.017  
- **GLUCOSE:** NORMAL  
- **BILIRUBIN:** NEGATIVE  
- **KETONE:** NEGATIVE  
- **BLOOD:** TRACE  
- **PH:** 5.0  
- **PROTEIN:** NEGATIVE  
- **UROBILINOGEN:** NORMAL  
- **NITRITES:** NEGATIVE  
- **LEUKOCYTES:** NEGATIVE  
- **WBC:** NO CELLS  
- **RBC:** 2-5  
- **EPI CELLS:** 0-2  
- **MUCUS:** 1+

Patient 2

34. Excessive urination: _____________ uria
35. Kidney disease: _____________ pathy
36. Scanty urination: _____________
37. Bladder paralysis: olig___________ plegia
38. Lipids in the urine: lip___________
39. Abnormally large bladder: mega___________
40. Relating to the bladder and the urethra: vesico___________ al
41. Kidney enlargement: reno___________
42. Inflammation of the tissues surrounding the bladder: _____________ cystitis
43. Medical specialty concerned with kidney disease: _____________ logy
44. Inflammation of the renal pelvis and other kidney parts: pyelo___________ itis
45. Suturing of a calix: calio___________
46. Between the two kidneys: inter___________
47. Abnormal urethral discharge: urethro___________
48. Hemorrhage from a ureter: _____________ rrhagia
49. Softening of the kidneys: nephro_____________
50. Within the urinary bladder: ______________cystic
51. Removal of a kidney stone: ______________litho____________
52. Imaging of the kidney: ______________graphy
53. Kidney-shaped: reni_____________

Root Out the Meaning
Divide the following words into parts. Write the urinary combining forms in the space at the right and define the word shown.

54. glomuleronephritis
55. nephrocystosis
56. urethrosthenosis
57. ureterovesicostomy
58. urocyanosis
59. urolithology
60. pyeloureterectasis

61. calicotomy
62. cystolithotomy
63. nephroma
64. meatorrhaphy
65. nephrosclerosis
66. renopulmonary
67. trigonitis

Find the Right Words
Define the following abbreviations.

68. ADH
69. pH
70. CAPD
71. VCU
72. HD
73. PKU
74. BUN
75. KUB
76. ESWL
77. UTI
78. RP

Reviewing Word Parts
Write the letter of the correct definition in the space provided. Letters may be used more than once or not at all.

79. ____ ur(o)____________
a. many
70. ____ ureter
b. flowing
81. ____–uria
c. urine
82. ____ ren(o)
d. bladder
83. ____ meat(o)
e. enlargement
84. ____ nephr(o)
f. bladder
85. ____ pyel(o)____________
g. renal pelvis
86. ____ cyst(o)
h. kidney
87. ____ urin(o)
i. opening
88. ____ vesic(o)
j. tube from kidney to bladder
89. ___ -megaly
90. ___ -rrhea
91. ___ oligo-
92. ___ poly-
93. ___ -itis

Building Words
Complete each of the following urinary terms by putting a word part in the blank.

94. bladder inflammation: cyst__________
95. removal of a kidney: ____________ectomy.
96. hernia in the bladder: ____________cele.
97. blood in the urine: hemat__________
98. common urinary test: ____________alysis.
99. bladder tumor: cyst__________
100. enlargement of the kidneys: nephro__________

Diagnostic, Procedural, and Laboratory Terms

Specialists in the urinary system are urologists, who treat disorders of the male and female urinary tracts and the male reproductive system, and nephrologists, who treat disorders of the kidneys. Urinalysis is the most common diagnostic and laboratory test of the urinary system. It involves the examination of urine for the presence of normal or abnormal amounts of various elements. Substances in the urine are a prime factor in the diagnosis of diseases of the urinary system as well as of other body systems. In addition, various imaging and blood tests help diagnose conditions or diseases.

Urinalysis

Urinalysis is the examination of urine for its physical and chemical and microscopic properties (Figure 9-6). Urine is gathered from clients who fill a specimen bottle by themselves or whose urine is obtained by urinary catheterization, the insertion of a flexible tube through the meatus and into the urinary bladder. Some patients do not have bladder control or may have certain conditions that require catheters to aid in urination. A Foley catheter (Figure 9-7) is indwelling (left in the bladder) and is held in place by a balloon inflated in the bladder. Foley catheters are also known as retention catheters. Other types of catheters may be disposable units. Condom catheters (also called Texas catheters, external urinary drainage [EUD] catheters, or latex catheters) are changed at least once a day (Figure 9-8). A condom catheter consists of a rubber sheath placed over the penis with tubing connected to a drainage or leg bag where the urine collects.
There are three phases of a complete urinalysis:

1. The first phase is the macroscopic or physical phase. During this phase, the color, turbidity (cloudiness caused by suspended sediment), and specific gravity (ratio of density of a substance) of urine give certain diagnostic clues. Normal urine is straw-colored and clear. Blood in the urine may darken it, or show up clearly as blood. Pus or infection may make the urine cloudy. Low specific gravity may indicate kidney disease, and high specific gravity may indicate diabetes.

2. The second phase is the chemical phase, which determines what chemicals are present in the urine. It also determines the pH range of urine. The normal pH range is from 5 to 7. A reading above 7 indicates alkaline urine; a reading below 7 indicates acid urine. Alkaline urine may indicate the presence of an infection. Acidic urine controls the bacteria.
entering the urethra. High uric acid may indicate gout, a metabolic disorder.

3. The third phase is the microscopic phase during which urine sediment is examined for solids (including cellular material) or casts, which are formed when protein accumulates in the urine. This may indicate the presence of kidney disease. The casts are often composed of pus or fats. The amount of wastes, minerals, and solids in urine is measured as the specific gravity.

Appendix E gives the chemical analyses and ranges commonly used in urinalysis.

In addition, tests of urine are designed to detect various substances indicative of specific conditions. The presence of high quantities of acetones usually occurs in diabetes. Ketones in the urine may indicate starvation or diabetes. Ketones in the urine can lead to dangerously high levels of acid in the blood, a potential cause of coma and/or death. The presence of the serum protein albumin in urine may indicate a leakage of blood proteins through the renal tubules, an indicator of nephron disease. Glucose in the urine usually indicates diabetes. Pus in the urine makes the urine cloudy and indicates an infection or inflammation in the urinary system. Bacteria in the urine elevates the nitrite result on the urinalysis. This indicates a urinary tract infection. Blood in the urine usually indicates bleeding in the urinary tract. Calcium in the urine is abnormal and indicates one of several conditions, such as rickets. Bilirubin in the urine indicates liver disease, such as obstructive disease of the biliary tract and liver cancer.

Blood Tests

Two important blood tests of kidney function are the blood urea nitrogen (BUN) and the creatinine clearance test. The presence of high amounts of urea or creatinine in the kidney shows that the kidney is not filtering and removing these toxic substances from the blood. If this is not treated and kidney failure persists, death may result.

Phenylketones in the blood show a lack of an important enzyme that can lead to mental retardation in infants unless a strict diet is followed into adulthood. Infants are routinely tested for this deficiency at birth by taking a blood sample (using a heel stick), which is analyzed for presence of the enzyme.
Imaging Tests

Various tests are used to visually diagnose stones, growths, obstructions, or abnormalities in the urinary system. A **cystoscopy** is the insertion of a tubular instrument (a **cystoscope**) to examine the bladder with a light (Figure 9-9). An **intravenous pyelogram** (**IVP**) and an **intravenous urogram** are x-rays of the urinary tract after a contrast medium is injected into the bloodstream. A **kidney, ureter, bladder** (**KUB**) is an x-ray of three parts of the urinary tract. A **renal angiogram** is an x-ray of the renal artery after a contrast medium is injected into the artery. A **retrograde pyelogram** (**RP**) is an x-ray of the kidney, bladder, and ureters taken after a cystoscope is used to introduce a contrast medium. A **voiding (urinating) cystourethrogram** (**VCU, VCUG**) is an x-ray taken during urination to examine the flow of urine through the system. An **abdominal sonogram** is the production of an image of the urinary tract using sound waves.

Radioactive imaging is also used to diagnose kidney disorders via a renal scan. A **renogram** is used to study kidney function.

Urinary Tract Procedures

Certain procedures, particularly **dialysis**, can mechanically maintain kidney or renal function when kidney failure occurs. **Hemodialysis** is the process of filtering blood outside the body in an artificial kidney machine and returning it to the body after filtering (Figure 9-10). **Peritoneal dialysis** is the insertion and removal of a dialysis solution into the peritoneal cavity (Figure 9-11). The action of this type of dialysis causes the wastes in the capillaries of the peritoneum to be released and drained out of the body. Peritoneal dialysis is used for patients who are able to have dialysis while ambulatory. The patient attaches a bag containing the dialysis solution to an opening in the peritoneum and fills the peritoneal cavity. The fluid is retained for several hours. During that time, waste products will move from the blood into the fluid through osmosis. Once empty, the bag is removed and replaced by a drainage bag into which the solution flows gradually.
Extracorporeal shock wave lithotripsy (ESWL) is the breaking up of urinary stones by using shock waves from outside the body. Figure 9-12 shows a patient undergoing this procedure. The stones are broken into fragments that can then pass through the urine. This procedure is often used for kidney stones. There are other methods for treating stones or calculi. Some involve surgery; others involve medication and/or waiting for smaller stones to pass through the urinary tract.

**Vocabulary Review**

In the previous section, you learned terms relating to diagnosis, clinical procedures, and laboratory tests. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetone [ĂS-ě-tŏn]</td>
<td>Type of ketone normally found in urine in small quantities; found in larger quantities in diabetic urine.</td>
</tr>
<tr>
<td>albumin [āl-BYÚ-mĭn]</td>
<td>Simple protein; when leaked into urine, may indicate a kidney problem.</td>
</tr>
<tr>
<td>bilirubin [bil-ĭ-RŬ-hĭn]</td>
<td>Substance produced in the liver; elevated levels may indicate liver disease or hepatitis when found in urine.</td>
</tr>
<tr>
<td>casts</td>
<td>Materials formed in urine when protein accumulates; may indicate renal disease.</td>
</tr>
<tr>
<td>condom catheter [KŎN-dŏm KĀTH-ĕ-tĕr]</td>
<td>Disposable catheter for urinary sample collection or incontinence.</td>
</tr>
<tr>
<td>cystoscope [SĬS-tō-skŏp]</td>
<td>Tubular instrument for examining the interior of the bladder.</td>
</tr>
<tr>
<td>cystoscopy [sĬs-TŎS-kŏ-pĕ]</td>
<td>The insertion of a cystoscope to examine the bladder with light.</td>
</tr>
<tr>
<td>Foley [FŎ-lĕ] catheter</td>
<td>Indwelling catheter held in place by a balloon that inflates inside the bladder.</td>
</tr>
<tr>
<td>glucose [GLŬ-kŏs]</td>
<td>Form of sugar found in the blood; may indicate diabetes when found in the urine.</td>
</tr>
<tr>
<td>hemodialysis [HĔ-mŏ-dĭ-ĂL-ĭ-sĭs]</td>
<td>Dialysis performed by passing blood through a filter outside the body and returning filtered blood to the body.</td>
</tr>
<tr>
<td>indwelling [ĬN-dwĕ-ling]</td>
<td>Of a type of catheter inserted into the body.</td>
</tr>
<tr>
<td>ketone [KĔ-tŏn]</td>
<td>Substance that results from the breakdown of fat; indicates diabetes or starvation when present in the urine.</td>
</tr>
<tr>
<td>kidney, ureter, bladder (KUB)</td>
<td>X-ray of three parts of the urinary system.</td>
</tr>
<tr>
<td>peritoneal [PĔR-ĭ-tŏ-NĔ-ăl] dialysis</td>
<td>Type of dialysis in which liquid that extracts substances from blood is inserted into the peritoneal cavity and later emptied outside the body.</td>
</tr>
<tr>
<td>pH</td>
<td>Measurement of the acidity or alkalinity of a solution such as urine.</td>
</tr>
<tr>
<td>phenylketones [FĔN-ĭl-KĔ-tŏns]</td>
<td>Substances that, if accumulated in the urine of infants, indicate phenylketonuria (PKU), a disease treated by diet.</td>
</tr>
</tbody>
</table>
**Term** | **Definition**
---|---
renogram [RĒ-nō-grām]  
reno-, kidney + -gram, a recording |  
Radioactive imaging of kidney function after introduction of a substance that is filtered through the kidney while it is observed.

retrograde pyelogram  
[RĒT-rō-grād Pi-ēl-ō-grām] (RP) |  
X-ray of the bladder and ureters after a contrast medium is injected into the bladder.

specific gravity |  
Measurement of the concentration of wastes, minerals, and solids in urine.

urinalysis [yū-ri-NĀL-i-sēs]  
urin-, urine + (an)alysis |  
Examination of the properties of urine.

voiding (urinating) cystourethrogram  
[sīs-tō-yū-RĒ-thrō-grām] (VCU, VCUG) |  
X-ray image made after introduction of a contrast medium and while urination is taking place.

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**CASE STUDY**

**Examining the Symptoms**
Ms. Jones is a 77-year-old female who complained to Dr. Chorzik of painful, scanty, and frequent urination for the past two days. She says that she normally drinks 7 to 8 glasses of water a day, but lately has cut down because of the frequent urination. Her urine was cloudy with a strong odor.

**Critical Thinking**

101. What did the cloudy urine most likely indicate?
102. What might be present in cloudy urine to indicate infection?

**DIAGNOSTIC, PROCEDURAL, AND LABORATORY TERMS EXERCISES**

**Find the Test**
In the space provided, put Y for those properties or substances tested for in urinalysis and N for those substances that are not tested for in urinalysis.

103. glucose _____________  
104. sodium _____________  
105. albumin _____________  
106. cholesterol _____________  
107. protein _____________  
108. lipids _____________  
109. specific gravity _____________  
110. pH _____________  
111. bilirubin _____________  
112. acetone _____________  

---

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Finish the Thought

Fill in the blanks.

116. Removing wastes from the blood outside the body is called _____________.
117. Removing wastes from the peritoneal cavity using a portable apparatus is called _____________ _____________.
118. A type of indwelling catheter is a(n) _____________ catheter.
119. A catheter changed at least once a day is called a(n) _____________ _____________ catheter.
120. Two substances found in the urine that may indicate diabetes are _____________ and _____________.
121. Lithotripsy is used to break up _____________ that have formed.
122. Solids found in urine are called _____________.
123. Dialysis is a method of _____________ used in _____________ failure.
124. Kidney disorders may be diagnosed by blood tests such as the _____________ _____________ _____________ or _____________ _____________ _____________.
125. An x-ray image taken during urination is a(n) _____________ _____________.

Pathological Terms

Infections can occur anywhere in the urinary tract. A urinary tract infection (UTI) commonly refers to a bladder or urethra infection. Symptoms include painful and frequent urination and a general feeling of malaise (general discomfort). Treatment generally includes antibiotics. Fully emptying the bladder during urination, emptying the bladder after intercourse, adequate water intake, and careful maintenance of cleanliness around the urethra can help in preventing UTIs.

Hardened lumps of matter (calculi or stones) tend to form in the kidneys and other parts of the urinary system. The stone may cause bleeding that shows up as blood in the urine. Stones can be extremely painful. If possible, the stones are allowed to pass into the urine; otherwise, lithotripsy (the use of sound waves aimed at the stone to break it up) or surgery may be required. The patient’s urine is then filtered through something (such as gauze) that retains the solid material. The solid material is analyzed for content, and a diet or medication is prescribed to prevent the occurrence of further stones. Kidney stones are also known as nephrolithiasis.

A number of infections and inflammations affect the urinary system. Nephritis is the general term for inflammation of the kidney. Glomerulonephritis refers to a kidney inflammation located in the glomeruli. This inflammation, known as Bright’s disease, can be acute, as after a systemic infection, or may become chronic. When chronic, high blood pressure, kidney failure, and other conditions can result. Interstitial nephritis is an inflammation of the
connective tissue between the renal tubules. **Pyelitis** is an inflammation of the renal pelvis. **Pyelonephritis** is a bacterial infection in the renal pelvis with abscesses.

**Nephrosis** or **nephrotic syndrome** is a group of symptoms usually following or related to another illness that causes protein loss in the urine (**proteinuria**). **Edema** (swelling) may result from this syndrome. Such swelling may adversely affect blood pressure. **Hydronephrosis** is the collection of urine in the kidneys without release due to a blockage. **Polycystic kidney disease** is a progressive, hereditary condition in which numerous kidney cysts form that can cause other conditions in adults, such as high blood pressure and excess blood and waste in the urine.

**Renal hypertension** may result from other kidney or systemic diseases. **Kidney (renal) failure**, the loss of kidney function, may result from other conditions—some chronic, such as diabetes, and some acute, such as a kidney infection. Kidney failure can be treated with dialysis and medications. **Uremia** and **azotemia**, excesses of urea and other nitrogenous wastes in the blood, may result from kidney failure. **End-stage renal disease (ESRD)** is severe, and fatal if not treated. **Renal cell carcinoma** or kidney cancer is usually treated by surgery. **Wilms’ tumor** or a **nephroblastoma** is a malignant tumor of the kidneys found primarily in children. It is usually treated with surgery, radiation, and chemotherapy. A **nephroma** is any renal tumor.

**Cystitis** is an inflammation of the bladder. Aside from urinary tract infections, the bladder may be the site of **bladder cancer**. Various tumors can be removed or treated. In cases of extensive malignancy, the bladder may need to be surgically removed. Other bladder problems include a **cystocele**, a hernia of the bladder, and a **cystolith**, a stone in the bladder.

Inflammations can also occur in the urethra (**urethritis**), the urethra and bladder together (**urethrocystitis**), or the ureters (**ureteritis**). **Urethral stenosis** is a narrowing of the urethra that causes voiding difficulties.

Difficulties in urination are often a symptom of another systemic disease, such as diabetes, or a localized infection (UTI). Such difficulties can include no urine output (**anuria**), painful urination (**dysuria**), lack of bladder control (**enuresis**, including **nocturnal enuresis**, nighttime bed-wetting), frequent nighttime urination (**nocturia**), scanty urination (**oliguria**), excessive urination (**polyuria**), or urination during sneezing or coughing (**stress incontinence**). The general term **incontinence** refers to the involuntary discharge of urine or feces.

Abnormal substances or specific levels of substances in the urine indicate either urinary tract disorders or systemic disorders. Some can be minor infections or major problems. **Albuminuria** or **proteinuria** indicates the presence of albumin in the urine; **hematuria** indicates the presence of blood in the urine. **Ketonuria** indicates the presence of ketone bodies in the urine. **Pyuria** indicates the presence of pus and white blood cells in the urine.

Diabetes is a name for several metabolic diseases that both affect, and are diagnosed, in part, through observation of, the urinary system. Diabetes is covered in detail in Chapter 15.

Many congenital problems can occur in the urinary system. Surgery can correct many of these. **Hypospadias** is a congenital problem and is discussed in Chapters 10 and 11. It is a defect in which the urinary meatus opens at a place other than the distal end of the penis in males or between the clitoris and vagina in females. **Atresia** (narrowing) of the ureters or urethra may also be present at birth.
In the previous section, you learned terms relating to pathology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>atresia [ā-TRĒ-zē-ā] a-, without + Greek tresis, hole</td>
<td>Abnormal narrowing, as of the ureters or urethra.</td>
</tr>
<tr>
<td>bladder cancer</td>
<td>Malignancy of the bladder.</td>
</tr>
<tr>
<td>Bright’s disease</td>
<td>Inflammation of the glomeruli that can result in kidney failure.</td>
</tr>
<tr>
<td>cystitis [sīs-TĪ-tīs] cyst-, bladder + -itis, inflammation</td>
<td>Inflammation of the bladder.</td>
</tr>
<tr>
<td>cystolith [SĪS-tō-līth] cysto- + -lith, stone</td>
<td>Bladder stone.</td>
</tr>
<tr>
<td>edema [ē-DĒ-mā] Greek oidema, a swelling</td>
<td>Retention of water in cells, tissues, and cavities, sometimes due to kidney disease.</td>
</tr>
<tr>
<td>end-stage renal disease (ESRD)</td>
<td>The last stages of kidney failure.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>glomerulonephritis</td>
<td>Inflammation of the glomeruli of the kidneys.</td>
</tr>
<tr>
<td>hematuria</td>
<td>Blood in the urine.</td>
</tr>
<tr>
<td>hydrenephrosis</td>
<td>Abnormal collection of urine in the kidneys due to a blockage.</td>
</tr>
<tr>
<td>incontinence</td>
<td>Inability to prevent excretion of urine or feces.</td>
</tr>
<tr>
<td>ketonuria</td>
<td>Increased urinary excretion of ketones, usually indicative of diabetes or starvation.</td>
</tr>
<tr>
<td>kidney failure</td>
<td>Loss of kidney function.</td>
</tr>
<tr>
<td>nephritis</td>
<td>Inflammation of the kidneys.</td>
</tr>
<tr>
<td>nephroblastoma</td>
<td>See Wilms’ tumor.</td>
</tr>
<tr>
<td>nephroma</td>
<td>Any renal tumor.</td>
</tr>
<tr>
<td>nephrosis</td>
<td>Disorder caused by loss of protein in the urine.</td>
</tr>
<tr>
<td>nocturia</td>
<td>Frequent nighttime urination.</td>
</tr>
<tr>
<td>oliguria</td>
<td>Scanty urine production.</td>
</tr>
<tr>
<td>polycystic</td>
<td>Condition with many cysts on and within the kidneys.</td>
</tr>
<tr>
<td>polyuria</td>
<td>Excessive urination.</td>
</tr>
<tr>
<td>proteinuria</td>
<td>Abnormal presence of protein in the urine.</td>
</tr>
<tr>
<td>pyelitis</td>
<td>Inflammation of the renal pelvis.</td>
</tr>
<tr>
<td>pyuria</td>
<td>Pu in the urine.</td>
</tr>
<tr>
<td>uremia</td>
<td>Excess of urea and other nitrogenous wastes in the blood.</td>
</tr>
<tr>
<td>urinary tract infection (UTI)</td>
<td>Infection of the urinary tract.</td>
</tr>
<tr>
<td>Wilms’ tumor</td>
<td>Malignant kidney tumor found primarily in young children; nephroblastoma.</td>
</tr>
</tbody>
</table>

**PATHOLOGICAL TERMS EXERCISES**

**Build Your Medical Vocabulary**

Using the combining forms in this chapter, complete the names of the disorders.

126. Inflammation of the urethra: _____________ itis
127. Inflammation of the ureter: _____________ itis
128. Inflammation of the bladder and urethra: _____________ itis
129. Inflammation of the kidneys: ___________ itis
130. Tumor in the kidneys: ___________ oma

Spell It Correctly
Check the spelling of the following words. Write C if the spelling is correct. If it is incorrect, write the correct spelling in the space provided.

131. ureteritis ___________
132. cystitis___________
133. dysuria___________
134. uretheritis___________
135. cytorrhaphy___________

Check Your Knowledge
Circle T for true or F for false.

136. Wilms' tumor is found only in middle-aged adults. T F
137. Urine collects in the renal pelvis. T F
138. Edema is swelling that may be due to kidney disease. T F
139. Oliguria is abnormally high production of urine. T F
140. Anuresis means the same as enuresis. T F

CASE STUDY

Seeing a Specialist
Mr. Delgado had a fairly normal urinalysis, but restricted urination indicated some other urinary tract problem. Dr. Chorzik referred Mr. Delgado to a urologist. Ms. Margolis had blood in her urine and some signs of infection. Ms. Jones had pus in her urine, and it was cloudy. She had complained about painful, scanty, and excessive urination at various times. Dr. Chorzik concluded that she had a urinary tract infection.

Critical Thinking
141. What are the medical terms for the symptoms Ms. Jones experienced?
142. What course of treatment will likely be prescribed for Ms. Jones?

Surgical Terms

Urology is the practice of medicine specializing in the urinary tract. The practitioner is called a urologist. Urologists diagnose, treat, and perform surgery on the urinary system in the female and on the urinary and reproductive system in the male.

Parts of the urinary system may be surgically removed. A person can live with only one kidney, so a diseased kidney may be removed in a nephrectomy. Diseased kidneys are removed before a kidney or renal transplant. Other
surgical procedures on the kidney include **nephrolisis**, the removal of adhesions in the kidney; **nephrostomy**, the creation of an opening in the kidney leading to the outside of the body; **nephrolithotomy**, surgical removal of a kidney stone; **nephropexy**, surgical affixing in place of a floating kidney; and **nephrorrhaphy**, suturing of a damaged kidney.

An incision into the renal pelvis is called a **pyelotomy**. A **pyeloplasty** is the surgical repair of the renal pelvis. Surgical repair of a ureter is **ureteroplasty**. **Ureterorrhaphy** is the suture of a damaged ureter. **Ureterectomy** is the surgical removal of a diseased ureter.

The urinary bladder can be the site of stones, which are removed during a **lithotomy**. A **cystectomy** is the removal of the bladder (usually when cancer is present). Surgical fixing of the bladder to the abdominal wall is **cystopexy**, an operation to help correct urinary incontinence. **Cystoplasty** is the surgical repair of a bladder, and **cystorrhaphy** is the suturing of a damaged bladder.

The urethra may also need surgical repair (**urethroplasty**), surgical fixation (**urethropexy**), or suturing (**urethrorrhaphy**). A **urethrostomy** is the surgical creation of an opening between the urethra and the skin, while a **meatotomy** is the surgical enlargement of the opening of the meatus. Either of these operations may be necessary when certain birth defects are present. A narrowing in the urethra may require a **urethrotomy**, a surgical incision to enlarge the narrowed area.

Sometimes an opening is made to bypass diseased parts of the urinary tract. A **urostomy** is the creation of an artificial opening in the abdomen through which urine exits the body. **Intracorporeal electrohydraulic lithotripsy** is the use of an endoscope, an instrument for examining an interior canal or cavity, to break up stones in the urinary tract. A **resectoscope** is an endoscope used to cut and remove lesions in parts of the urinary system. An instrument called a **stone basket** may be attached to an endoscope and used for retrieving stones through a body cavity.

**VOCABULARY REVIEW**

In the previous section, you learned terms relating to surgery. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

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<tr>
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<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>cystectomy</td>
<td>Surgical removal of the bladder.</td>
</tr>
<tr>
<td>cystopexy</td>
<td>Surgical fixing of the bladder to the abdominal wall.</td>
</tr>
<tr>
<td>cystoplasty</td>
<td>Surgical repair of the bladder.</td>
</tr>
<tr>
<td>cystorrhaphy</td>
<td>Suturing of a damaged bladder.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>litho-, stone + -tomy</td>
<td>Surgical enlargement of the meatus.</td>
</tr>
<tr>
<td>nephro-, stone + -tomy</td>
<td>Surgical fixing of a kidney to the abdominal wall.</td>
</tr>
<tr>
<td>nephro-, nephro-, -tomy</td>
<td>Suturing of a damaged kidney.</td>
</tr>
<tr>
<td>nephrostomy [nē-FRÔS-tō-mê] nephro- + -stomy, opening</td>
<td>Establishment of an opening from the renal pelvis to the outside of the body.</td>
</tr>
<tr>
<td>pyelotomy [pī-ē-LÔT-ō-mê] pyelo- + -tomy</td>
<td>Incision into the renal pelvis.</td>
</tr>
<tr>
<td>resectoscope [rē-SÈK-tō-skōp] Latin reseco, to cut off + scope, instrument for viewing</td>
<td>Type of endoscope for removal of lesions.</td>
</tr>
<tr>
<td>ureterectomy [yū-rē-tēr-ĒK-tō-mê] ureter + -ectomy</td>
<td>Surgical removal of all or some of a ureter.</td>
</tr>
<tr>
<td>uretero-, ureter + -plasty</td>
<td>Surgical repair of a ureter.</td>
</tr>
<tr>
<td>urethrostomy [yū-rē-THRÔS-tō-mê] urethro- + -stomy</td>
<td>Establishment of an opening between the urethra and the exterior of the body.</td>
</tr>
<tr>
<td>urethrotomy [yū-rē-THRÔT-ō-mê] urethro- + -tomy</td>
<td>Surgical incision of a narrowing in the urethra.</td>
</tr>
<tr>
<td>urology [yū-RÔL-ō-jê] uro-, urine + -logy, study of</td>
<td>Medical specialty that diagnoses and treats the urinary system and the male reproductive system.</td>
</tr>
<tr>
<td>urostomy [yū-RÔS-tō-mê] uro- + -stomy</td>
<td>Establishment of an opening in the abdomen to the exterior of the body for the release of urine.</td>
</tr>
</tbody>
</table>
### CASE STUDY

**Getting the Diagnosis**

*Patient #1:* Mr. Delgado’s appointment with the urologist was scheduled for the next day. During a physical examination, the urologist noticed some swelling in the prostate gland, but did not think this was enough to cause Mr. Delgado’s difficulties. The urologist ordered a blood test (PSA) to determine if there were another possible cause. The PSA results were normal. The urologist then ordered imaging tests. One test showed a narrowing of the urethra.

*Patient #2:* Ms. Margolis, a 69-year-old female, had additional tests and was found to have serious kidney disease in one kidney. A nephrectomy was performed, and eventually her symptoms subsided.

### Critical Thinking

143. What procedure might relieve Mr. Delgado’s symptoms?

144. Ms. Margolis had one kidney removed. The other one is healthy. Does she need dialysis?

### SURGICAL TERMS EXERCISES

**Build Your Medical Vocabulary**

Complete the name of the operation by adding one or more combining forms.

145. Removal of kidney stones: _____________ tomy
146. Removal of kidney adhesions: _____________ lysis
147. Removal of a kidney: _____________ ectomy
148. Removal of a ureter: _____________ ectomy
149. Creation of an artificial opening in the urinary tract: _____________ stomy

**Check Your Knowledge**

Circle T for true or F for false.

150. Surgical repair of the urethra is ureteroplasty. T F
151. Several organs and structures in the urinary system may need surgical attaching to be held in position. T F
152. A resectoscope is an instrument used to remove lesions. T F
153. A urethrostomy and a urostomy serve the same function. T F
154. A cystopexy can help urinary incontinence. T F

**Pharmacological Terms**

Medications for the urinary tract can relieve pain (analgesics), relieve spasms (antispasmodics), or inhibit the growth of microorganisms (antibiotics). They may also increase (diuretics) or decrease (antidiuretics) the secretion of urine. Table 9-1 shows some common medications prescribed for urinary tract disorders.
### TABLE 9-1  Some Common Medications Used to Treat the Urinary System

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Purpose</th>
<th>Generic</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>analgesic</td>
<td>to relieve pain</td>
<td>phenazopyridine</td>
<td>Pyridium, Urogesic</td>
</tr>
<tr>
<td>antibiotic</td>
<td>to treat infections (especially UTIs) including ones with a fungal cause</td>
<td>trimethoprim amoxicillin tetracycline ciprofloxacin levofloxacin</td>
<td>Trimpex Amoxil, Wymox Sumycin Cipro Levaquin</td>
</tr>
<tr>
<td>antidiuretic</td>
<td>to control secretion of urine</td>
<td>vasopressin</td>
<td>Pitressin</td>
</tr>
<tr>
<td>antispasmodic</td>
<td>to relax muscles so as to relieve pain and decrease urgency to urinate</td>
<td>oxybutynin tolteridine</td>
<td>Ditropan Detrol</td>
</tr>
<tr>
<td>diuretic</td>
<td>to increase urination</td>
<td>bethanecol</td>
<td>Duvoid, Urecholine</td>
</tr>
</tbody>
</table>

### VOCABULARY REVIEW

In the previous section, you learned terms relating to pharmacology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>antispasmodic</td>
<td>[ĀN-tē-spāz-MÔD-îk] Pharmacological agent that relieves spasms; also decreases frequency of urination.</td>
</tr>
<tr>
<td>anti-, against + spasmodic</td>
<td></td>
</tr>
<tr>
<td>diuretic</td>
<td>[dī-yū-RĒT-îk] Pharmacological agent that increases urination.</td>
</tr>
<tr>
<td>From Greek dia-, through + ouresis, urine</td>
<td></td>
</tr>
</tbody>
</table>

### CASE STUDY

**Receiving Treatment**

Ms. Jones recovered from her urinary tract infection but came in a few months later with swollen feet and high blood pressure. She was given a prescription, a list of dietary changes she should observe, and a course of mild, daily exercise to follow.

**Critical Thinking**

155. What type of medication do you think was prescribed for Ms. Jones?

156. How might diet help reduce swelling?
PHARMACOLOGICAL TERMS EXERCISES

Know the Right Medication

Fill in the blanks.

157. To help relieve edema, a(n) _____________ may be prescribed.
158. For dysuria, a(n) _____________ may be prescribed.
159. For cystitis a(n) _____________ may be prescribed.
160. Sudden contractions may lead to urinary incontinence and, therefore, a(n) _____________ may be prescribed.

CHALLENGE SECTION

Review the following doctor’s notes and test results for a patient hospitalized with an unusually high fever, dysuria, and general malaise.

Critical Thinking

What do the abnormal results of the urinalysis indicate?
What other tests might be necessary to reach a diagnosis?

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Flag</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinalysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UA with micro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLOR</td>
<td>YELLOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPEARANCE</td>
<td>CLEAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP GRAVITY</td>
<td>1.017</td>
<td>**</td>
<td>1.001-1.030</td>
</tr>
<tr>
<td>GLUCOSE</td>
<td>4.7</td>
<td></td>
<td>NEG</td>
</tr>
<tr>
<td>BILIRUBIN</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG</td>
</tr>
<tr>
<td>KETONE</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG mg/dl</td>
</tr>
<tr>
<td>BLOOD</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG</td>
</tr>
<tr>
<td>PH</td>
<td>5.0</td>
<td></td>
<td>4.5-8.0</td>
</tr>
<tr>
<td>PROTEIN</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG mg/dl</td>
</tr>
<tr>
<td>UROBILINOGEN</td>
<td>NORMAL</td>
<td></td>
<td>NORMAL-1.0 mg/dl</td>
</tr>
<tr>
<td>NITRITES</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG</td>
</tr>
<tr>
<td>LEUKOCYTES</td>
<td>NEGATIVE</td>
<td></td>
<td>NEG</td>
</tr>
<tr>
<td>WBC</td>
<td>8-10</td>
<td>**</td>
<td>0-5 /HPF</td>
</tr>
<tr>
<td>RBC</td>
<td>2-5</td>
<td></td>
<td>0-5 /HPF</td>
</tr>
<tr>
<td>EPI CELLS</td>
<td>0-2</td>
<td></td>
<td>/HPF</td>
</tr>
<tr>
<td>MUCUS</td>
<td>1+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patient 4
Terminology in Action

Below is a urinalysis for a 55-year-old woman. Write a short paragraph explaining what pathology the abnormal readings might indicate.

```
Patient 5
```

Using the Internet

Go to the National Kidney Foundation’s Web site (http://www.kidney.org) and enter the cyberNephrology site by typing cybernephrology in the search window. Write a short paragraph on what’s new in transplantation or dialysis.
CHAPTER REVIEW

The material that follows is to help you review all the material in this chapter.

Using Your Allied Health Dictionary

Build a urinary term using each of the following word parts; define the word part and the term.

161. –ectomy: _____________
162. –emia: _____________
163. dips/o: _____________
164. glycos/o: _____________
165. –lithiasis: _____________
166. –lith: _____________
167. cyst/o: _____________
168. nephr/o: _____________
169. olig/o: _____________
170. py/o: _____________
171. ren/o: _____________
172. –rrhaphy: _____________
173. ur/o: _____________
174. –plasty: _____________
175. –scope: _____________
176. –stenosis: _____________
177. urethr/o: _____________
178. ureter/o: _____________
179. noct(o): _____________
180. –megaly: _____________
181. dys-: _____________
182. anti-: _____________
183. poly-: _____________
184. retro-: _____________
185. a-, an-: _____________
186. –lysis: _____________
187. urin/o: _____________

Spelling Correctly

Circle the correct spelling.

188. polydipsia  pollydipsia
189. urethra  uretha
190. urination  urinetion
191. abscess  abscess
192. catheter  catheter
193. bacteriuria  bacteruria
194. nephrolithisis  nephrolithiasis

Definitions

Define the following terms and combining forms. Review the chapter before starting. Make sure you know how to pronounce each term as you define it. The blue words in brackets are references to the Spanish glossary available online at www.mhhe.com/medterm3e.
215. acetone [ÅS-ē-tōēn] (acetona)
216. albumin [āl-BYŪ-mín] (albúmina)
217. albuminuria [āl-byū-mī-NŪ-rē-ā] (albuminuria)
218. antispasmodic [ĀN-tē-spāz-MÕD-īk]
219. anuria [än-YÜ-rē-ā] (anuria)
220. azotemia [āz-ō-TĒ-mē-ā] (azoemia)
221. bilirubin [bēl-ēRū-bin] (bilirrubina)
222. bladder [BLĀD-ēr] (vejiga)
223. bladder cancer
224. Bowman’s capsule
225. Bright’s disease
226. cali(o), calic(o)
227. calices, calyces (sīng. calix, calyx) [KAL-ī-sēz (KĀ-liks)] (calices)
228. casts
229. cyst(o)
230. cystectomy [sīs-TĒK-tō-mē] (cistectomía)
231. cystitis [sīs-TĪ-tīs] (cistitis)
232. cystocele [SĪS-tō-sēl] (cistocèle)
233. cystolith [SĪS-to-līth] (cistolito)
234. cystopexy [SĪS-tō-pēk-sē] (cistopexia)
235. cystoplasty [SĪS-tō-plās-te] (cistoplastía)
236. cystorrhaphy [sīs-TŌR-ā-fē] (cistorrhafía)
237. cystoscope [SĪS-tō-skōp] (cistoscopio)
238. cystoscopy [sīs-TŌS-kō-pē] (cistoscopia)
239. dialysis [dí-ĀL-ī-sīs] (dialysis)
240. diuretic [dí-yū-RĒT-īk]
241. dysuria [dīs-YŪ-rē-ā] (disuria)
242. end-stage renal disease (ESRD)
243. filtration [fil-TRĀ-shūn] (filtración)
244. Foley [FŌ-lē] catheter
245. glomerul(o)
246. glomerulonephritis [glō-MĀR-yū-lō-nēf-RĪ-tīs]
247. glomerulus (pl., glomeruli) [glō-MĀR-yū-lōs (glō-MĀR-yū-lī)] (glomerulo)
248. glucose [GLŪ-kōs] (glucose)
249. hematuria [hē-mā-TŪ-rē-ā] (hematuria)
250. hemodialysis [HĒ-mō-dī-ĀL-ī-sīs] (hemodiálisis)
251. hilum [HI-lūm] (hilio)
252. hydro nephrosis [HI-drō-nē-FRŌ-sīs]
253. incontinence [in-KŌN-tī-nēns] (incontinencia)
254. indwelling [IN-dwē-līng] (indwelling)
255. introcorporeal shock wave lithotripsy [ÉKS-trā-kōr-PŌR-e-āl shōk wāv LĪTh-ō-trīp-sē] (ESWL)
256. ketone [KĒ-tōn] (ketona)
257. ketonuria [kē-tō-NŪ-rē-ā] (ketonuria)
258. kidney [KĪD-ne] (riñón)
259. kidney failure
260. kidney, ureter, bladder (KUB)
261. kidney, urethra
262. lithotomy [lī-THÔT-ō-mē]
263. meat(o)
264. meatotomy [mē-ē-TŌT-ō-mē]
265. meatus [mē-Ā-tūs] (meato)
266. medulla [mē-DŪL-ā] (médula)
267. nephrectomy [nē-FRĒK-tō-mē]
268. nephritis [nē-FRĪ-tīs] (nefritis)
269. nephroblastoma [NĒF-rō-blās-TŌ-mā]
270. nephrolithotomy [NĒF-rō-li-THÔT-ō-mē]
271. nephrology [nē-FRŌL-ī-sīs] (nefrólisis)
272. nephroma [nē-FRŌ-mā] (nefrona)
273. nephron [NĒF-rōn] (nefrona)
274. nephropexy [NĒF-rō-pēk-sē]
275. nephroprophaphy [nēf-RŌR-ā-fē]
276. nephrosis [nē-FRŌ-sīs] (nefrosis)
277. nephrostomy [nē-FRŌS-tō-mē]
278. nocturia [nōk-TŪ-rē-ā] (nocturia)
279. oliguria [ōl-ē-GŪ-rē-ā] (oliguria)
280. peritoneal [PĒR-ī-tō-NĒ-āl] (peritoneal)
281. pH [pH]
282. phenylketones [FĒN-ēl-KĒ-tōns] (PKU)
Abbreviations
Write the full meaning of each abbreviation.

<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>314. ADH</td>
<td>acute diuresis</td>
</tr>
<tr>
<td>315. A/G</td>
<td>acute or chronic glomerulonephritis</td>
</tr>
<tr>
<td>316. AGN</td>
<td>acute glomerulonephritis</td>
</tr>
<tr>
<td>317. ARF</td>
<td>acute renal failure</td>
</tr>
<tr>
<td>318. BNO</td>
<td>bilateral nephrectomy</td>
</tr>
<tr>
<td>319. BUN</td>
<td>blood urea nitrogen</td>
</tr>
<tr>
<td>320. CAPD</td>
<td>chronic ambulatory peritoneal dialysis</td>
</tr>
<tr>
<td>321. Cath</td>
<td>catheter</td>
</tr>
<tr>
<td>322. CRF</td>
<td>continuous renal replacement therapy</td>
</tr>
<tr>
<td>323. ESRD</td>
<td>end-stage renal disease</td>
</tr>
<tr>
<td>324. ESWL</td>
<td>extracorporeal shock wave lithotripsy</td>
</tr>
<tr>
<td>325. HD</td>
<td>hemodialysis</td>
</tr>
<tr>
<td>326. IVP</td>
<td>intravenous pyelography</td>
</tr>
<tr>
<td>327. K +</td>
<td>serum potassium level</td>
</tr>
<tr>
<td>328. KUB</td>
<td>kidney ultrasound, ultrasound of kidneys</td>
</tr>
<tr>
<td>329. Na +</td>
<td>serum sodium level</td>
</tr>
<tr>
<td>330. PH</td>
<td>peripheral hemodialysis</td>
</tr>
<tr>
<td>331. PKU</td>
<td>primary renal failure due to acute kidney injury</td>
</tr>
<tr>
<td>332. RP</td>
<td>renal replacement therapy</td>
</tr>
<tr>
<td>333. SG</td>
<td>serum glomerular filtration rate</td>
</tr>
<tr>
<td>334. UA</td>
<td>ultrafiltration</td>
</tr>
<tr>
<td>335. UTI</td>
<td>upper tract infection</td>
</tr>
<tr>
<td>336. VCU, VCUG</td>
<td>vascular access for renal replacement therapy</td>
</tr>
</tbody>
</table>

Chapter 9 The Urinary System 321
1. No, blood is normally filtered in the kidneys and returned to the bloodstream.
2. Yes, males have prostates, external urethral exits, and other anatomical features different from females, whose urethras are shorter than those of males.
3. ureters
4. urethra
5. nephrons
6. glomerulus
7. renal pelvis
8. reabsorption
9. bladder
10. voiding and micturition
11. Bowman's capsule
12. trigone
13. F
14. F
15. T
16. T
17. T
18. F
19. F
20. F
21. T
22. F
23. e
24. a
25. c
26. g
27. f
28. d
29. b
30. Patient 1
31. sample answer: white blood count, red blood count, power of hydrogen concentration
32. anurea
33. pyelitis
34. polyuria
35. nephropathy
36. oliguria
37. cystoplegia
38. lipuria
39. megacystis
40. vesicourethral
41. renomegaly
42. pericystitis
43. nephrology
44. pyelonephritis
45. caliorrhaphy
46. interrenal
47. urethrorrhrea
48. ureterorrhagia
49. nephromalacia
50. intracystic
51. nephrolithotomy
52. nephrography
53. reniform
54. glomulero-, glomulerus; nephro-, kidney; kidney disease located in the glomulerus
55. nephro-, kidney; condition with cysts in the kidneys
56. urethro-, urethra; condition with narrowing of the urethra
57. uretero-, ureter; vesico-, bladder; surgical connection of the ureter to the bladder
58. uro-, urine; condition with bluish color in the urine
59. uro-, urine; study of stones in the urinary system
60. pyelo-, renal pelvis; ureter-, ureter; dilation of the renal pelvis and ureter
61. calico-, calix; removal of a calix
62. cysto-, bladder; removal of stones in the bladder
63. nephro-, kidney; kidney tumor
64. meato-, meatus; suture of the meatus
65. nephro-, kidney; hardening of kidney tissue
66. reno-, kidney; pertaining to the kidneys and lungs
67. trigon-, trigone; inflammation of the trigone
68. antidiuretic hormone
69. power of hydrogen concentration
70. continuous ambulatory peritoneal dialysis
71. voiding cystourethrogram
72. hemodialysis
73. phenylketonuria
74. blood urea nitrogen
75. kidney, ureter, bladder
76. extracorporeal shock wave lithotripsy
77. urinary tract infection
78. retrograde pyelogram
79. c
131. C
132. C
133. C
134. urethritis
135. cystorrhaphy
136. F
137. T
138. T
139. F
140. F
141. dysuria, oliguria, polyuria
142. antibiotics
143. urethrotomy
144. No. One kidney can filter the blood for the whole body.
145. nephrolithotomy
146. nephrolysis
147. nephrectomy
148. ureterectomy
149. urostomy
150. F
151. T
152. T
153. T
154. T
155. diuretic
156. Limiting salt in the diet can relieve swelling.
157. diuretic
158. analgesic
159. antibiotic
160. antispasmodic
NOTE: These are sample answers.
162. -emia, blood condition; uremia, blood in the urine.
163. -dips/o, thirst; dipsomania, extreme thirst.
164. -glycos/o, glucose, sugar; glycosuria, glucose in the urine.
165. -lithiasis, abnormal condition of stones; nephrolithiasis, condition with kidney stones.
166. -lith, stone; cystolith, bladder stone.
167. -cyst(o), bladder; cystitis, bladder inflammation.
168. -neph/o, kidney; nephroma, kidney tumor.
169. -olig/o, scanty; oliguria, scanty urine.
170. -py/o, pus; pyuria, pus in the urine.
171. -ren/o, kidney; renogram; imaging test of the kidney.
172. -rhaphy, suture; nephrrhaphy; suture of the kidney.
173. -ur/o, urine; urology, specialist in the urinary system.
174. -plasty, surgical repair; ureteroplasty, surgical repair of a ureter.
175. -scope, tool for examining; cystoscope, instrument for examining the bladder.
176. -stenosis, narrowing; urethrostasis, narrowing of the urethra.
177. -urethr/o, urethra; urethrostomy, surgical opening into the urethra.
178. ureter/o, ureter; ureteritis, inflammation of the ureter.
179. noct(o), night; nocturia, urination during sleep.
180. -megaly, enlargement; nephromegaly, enlargement of the kidneys.
181. dys-, bad, difficult, abnormal; dysuria, difficult or painful urination.
182. anti-, against; antispasmodic, agent that prevents spasms.
183. poly-, much, many; polyuria, excessive urination.
184. retro-, back, behind; retroperitoneal, behind the peritoneum.
185. a-, an-, no, not, without; anuria, lack of urination.
186. -lysis, breakdown; nephrolysis, breaking down of kidney adhesions.
187. urin/o, urine; urinalysis, test of urine.
188. polydipsia
189. urethra
190. urination
191. abscess
192. catheter
193. bacteriuria
194. nephrolithiasis
195–336. Answers are available in the vocabulary reviews in this chapter.