Living produces wastes. Wherever people live or work or play, wastes accumulate. To keep these areas healthy, there must be a method of disposing of these wastes such as a sanitation department. Wastes also accumulate in your body. The conversion of food and gases into substances and energy necessary for survival results in waste products. A large percentage of these wastes is removed by the urinary system.

Two vital organs, the kidneys, cleanse the blood of the many waste products that are continually produced as a result of the metabolism of food in the body cells. They eliminate these wastes in the form of urine.

Urine formation is the result of three processes: filtration, reabsorption, and secretion. These processes occur in successive portions of the microscopic units of the kidneys known as nephrons. The amount of urine produced by the nephrons is controlled primarily by the hormones ADH and aldosterone. After the urine is produced, it is drained from the renal pelvis by the ureters to flow into the bladder. The bladder then stores the urine until it is voided through the urethra.

If waste products are allowed to accumulate in the body, they soon become poisonous, a condition called uremia. A knowledge of the urinary system is necessary to understand how the body rids itself of waste and avoids toxicity.

1 ANATOMY OF THE URINARY SYSTEM

Multiple Choice - select the best answer.

1. Which of the following is regulated by the kidneys?
   a. water content of the blood
   b. blood pH level
   c. blood ion concentration
   d. all of the above

2. The medial surface of each kidney has a notch called the:
   a. medulla. c. hilum.
   b. cortex. d. pelvis.

3. At the beginning of the "plumbing system" of the urinary system, urine leaving the renal papilla is collected in the cuplike structures called:
   a. renal columns, c. calyces.
   b. renal pyramids, d. ureters.

4. The functional unit of the kidney is the:
   a. renal corpuscle.
   b. nephron.
   c. juxtaglomerular apparatus.
   d. Bowman's capsule.

5. Which of the following is a component of the renal corpuscle?
   a. glomerulus
   b. Bowman's capsule
   c. afferent arteriole
   d. both a and b

6. Which of the following structures secretes renin when blood pressure in the afferent arteriole drops?
   a. renal tubule
   b. proximal convoluted tubule
   c. juxtaglomerular apparatus
   d. both a and b
7. Substances pass from the glomerulus and into the Bowman's capsule by:
   a. diffusion.  c. filtration.
   b. active transport.  d. osmosis.

8. The juxtaglomerular cells reside in the:
   a. afferent arteriole.
   b. efferent arteriole.
   c. proximal convoluted tubule.
   d. distal convoluted tubule.

**True or false**

9. ______ The left kidney is often slightly larger and positioned slightly lower than the right kidney.

10. ______ Blood is brought to the kidneys by the renal vein.

11. ______ 
    **Micturition and urination** are synonymous terms.

12. ______ The glomerulus is one of the most important capillary networks for survival.

13. ______ Once urine enters the renal pelvis, it then travels to the renal calyces.

14. ______ As the basic functional unit of the kidney, the nephron’s function is blood processing and urine formation.

15. ______ The kidneys are covered with visceral peritoneum.

**Labeling—using the terms provided, label the following illustration of the kidney.**

renal pelvis
renal papilla of pyramid
minor calyces
renal column
cortex

hilum
ureter
renal sinus
interlobular arteries

capsule (fibrous)
medulla
major calyces
medullary pyramid
Labeling—using the terms provided, label the following illustration of the nephron.

- vasa recta
- glomerulus
- afferent arteriole
- arcuate artery and vein
- descending limb of Henle's loop
- pyramid (medulla)
- proximal tubule
- efferent arteriole
- interlobular vein and artery
- ascending limb of Henle's loop
- Henle's loop
- collecting tubule
- distal convoluted tubule
- juxtamedullary nephron
- cortical nephron
Labeling—label the following structure of the male urinary bladder.

16. Which of the following is NOT one of the processes of urine formation?
   a. filtration  c. reabsorption
   b. diffusion   d. secretion

17. The movement of water and solutes from the plasma in the glomerulus, across the glomerular-capsular membrane, and into the capsular space of the Bowman's capsule, is termed:
   a. filtration  c. reabsorption.
   b. diffusion   d. secretion.

18. The movement of molecules out of the peritubular blood and into the tubule for excretion is:
   a. filtration  c. reabsorption.
   b. diffusion   d. secretion.

19. Under normal conditions most water, electrolytes, and nutrients are reabsorbed in the:
   a. proximal convoluted tubule.
   b. distal convoluted tubule.
   c. loop of Henle.
   d. collecting duct.
20. Which of the following is considered a countercurrent structure?
   a. glomerulus
   b. proximal convoluted tubule
   c. loop of Henle
   d. distal convoluted tubule

21. Water loss from the blood is reduced by:
   a. ADH.
   b. ANH.
   c. aldosterone.
   d. both a and c.

22. *Dysuria* is a term describing:
   a. blood in the urine.
   b. pus in the urine.
   c. painful urination.
   d. absence of urine.

23. All of the following are normal contents of urine *EXCEPT*:
   a. nitrogenous wastes.
   b. hormones.
   c. pigments.
   d. plasma proteins.

24. Which of the following is *NOT* symptomatic of diabetes mellitus?
   a. copious urination
   b. glycosuria
   c. anuria
   d. diuresis

**True or false**

25. _________ Kidney failure means homeostatic failure, and if not relieved, inevitable death.

26. _________ Post exercise proteinuria is considered serious and often indicative of kidney disease.

27. _________ Fluid exiting the loop of Henle becomes less concentrated with Na\(^+\) and Cl\(^-\) ions.

28. _________ A hydrostatic pressure gradient drives the filtration out of the plasma and into the nephron.

29. _________ The efferent arteriole has a larger diameter than the afferent arteriole.

30. _________ Stress causes an increase in glomerular hydrostatic pressure.

31. _________ In the renal tubule, Na\(^+\) is reabsorbed via active transport.

32. _________ Glomerular filtration separates only harmful substances from the blood.

33. _________ Urine consists of approximately 75% water.

34. _________ Urine has a pH of 4.6 to 8.0 and is generally alkaline.

35. _________ Gout is a condition characterized by excessive levels of uric acid in the blood

*****If you had difficulty with this section, review pages 838-850

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### Matching—select the correct disorder from the choices provided.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.</td>
<td>urine backs up into the kidneys causing swelling of the renal pelvis and calyces</td>
<td>a. pyelonephritis</td>
</tr>
<tr>
<td>37.</td>
<td>kidney stones</td>
<td>b. renal colic</td>
</tr>
<tr>
<td>38.</td>
<td>final stage of chronic renal failure</td>
<td>c. renal calculi</td>
</tr>
<tr>
<td>39.</td>
<td>involuntary retention of urine with subsequent distention of the bladder</td>
<td>d. acute glomerulonephritis</td>
</tr>
<tr>
<td>40.</td>
<td>inflammation of the bladder</td>
<td>e. proteinuria</td>
</tr>
<tr>
<td>41.</td>
<td>inflammation of the renal pelvis and connective tissues of the kidney</td>
<td>f. uremia</td>
</tr>
<tr>
<td>42.</td>
<td>an abrupt reduction in kidney function characterized by oliguria and a sharp rise in nitrogenous compounds in the blood</td>
<td>g. neurogenic bladder</td>
</tr>
<tr>
<td>43.</td>
<td>progressive condition resulting from gradual loss of nephrons</td>
<td>h. acute renal failure</td>
</tr>
<tr>
<td>44.</td>
<td>intense kidney pain caused by destruction of the ureters by large kidney stones</td>
<td>i. hydronephrosis</td>
</tr>
<tr>
<td>45.</td>
<td>most common form of kidney disease caused by a delayed immune response to streptococcal infection</td>
<td>j. chronic renal failure</td>
</tr>
<tr>
<td>46.</td>
<td>albumin in the urine</td>
<td>k. cystitis</td>
</tr>
<tr>
<td>47.</td>
<td>inflammation of the urethra that commonly results from bacterial infection</td>
<td>l. urethritis</td>
</tr>
</tbody>
</table>

*****If you had difficulty with this section, review pages 850-853
Crossword Puzzle

Across
1. Capillary network in renal corpuscles
4. Movement of molecules back into the blood
8. Tube from kidney to bladder
9. Mouth of nephron (two words)
10. Outer region of kidney (two words)

Down
2. Inner region of kidney (two words)
3. Opening from bladder to exterior
5. Osmotic concentration of a solution
6. Functional unit of kidney
7. Amount of substance removed from blood by kidneys per minute

APPLYING WHAT YOU KNOW

48. Mr. Dietz, an accident victim, was admitted to the hospital several hours ago. His chart indicates that he had been hemorrhaging at the scene of the accident. Nurse Petersen has been closely monitoring his urinary output and has noted that it has dropped to 10 ml/hr (the normal urine output for a healthy adult is approximately 30 to 60 ml/hr). What might explain this drop in urine output?

49. Christine developed chronic renal failure. Describe the progression of each of the three phases of chronic renal failure.

DID YOU KNOW?

- If the tubules in a kidney were stretched and untangled, there would be 70 miles of them.
- While examining urine, German chemist Hennig Brand discovered phosphorus.
ONE LAST QUICK CHECK

Multiple Choice—select the best answer.

50. Which of the following processes is used by the artificial kidney to remove waste materials from the blood?
   a. pinocytosis  
   b. dialysis  
   c. catheterization  
   d. active transport  

51. Failure of the kidneys to remove wastes from the blood will result in which of the following?
   a. retention  
   b. anuria  
   c. incontinence  
   d. uremia  

52. Hydrogen ions are transferred from blood into the urine during which of the following processes?
   a. secretion  
   b. filtration  
   c. reabsorption  
   d. all of the above  

53. Which of the following conditions would be considered normal in an infant under 2 years of age?
   a. retention  
   b. cystitis  
   c. incontinence  
   d. anuria  

54. Which of the following steps involved in urine formation allows the blood to retain most body nutrients?
   a. secretion  
   b. filtration  
   c. reabsorption  
   d. all of the above  

55. Voluntary control of micturition is achieved by the action of which of the following?
   a. internal urethral sphincter  
   b. external urethral sphincter  
   c. trigone  
   d. bladder muscles  

56. What is the structure that carries urine from the kidney to the bladder called?
   a. urethra  
   b. Bowman's capsule  
   c. ureter  
   d. renal pelvis  

57. What are the capillary loops contained within Bowman's capsule called?
   a. convoluted tubules  
   b. glomeruli  
   c. limbs of Henle  
   d. collecting ducts  

58. The triangular divisions of the medulla of the kidney are known as:
   a. pyramids  
   b. papillae  
   c. calyces  
   d. nephrons  

59. The trigone is located in the:
   a. kidney  
   b. bladder  
   c. ureter  
   d. urethra

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Matching—select the best answer from the right column to describe the terms on the left.

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<tr>
<td>60.</td>
<td>_______</td>
<td>hematuria</td>
<td>a.</td>
<td>involuntary voiding</td>
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<td>61.</td>
<td>_______</td>
<td>anuria</td>
<td>b.</td>
<td>passes through prostate gland</td>
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<td>62.</td>
<td>_______</td>
<td>nephritis</td>
<td>c.</td>
<td>absence of urine</td>
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<td>63.</td>
<td>_______</td>
<td>micturition</td>
<td>d.</td>
<td>urination</td>
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<td>64.</td>
<td>_______</td>
<td>oliguria</td>
<td>e.</td>
<td>blood in the urine</td>
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<tr>
<td>65.</td>
<td>_______</td>
<td>polyuria</td>
<td>f.</td>
<td>inflammation of the kidney</td>
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<tr>
<td>66.</td>
<td>_______</td>
<td>incontinence</td>
<td>g.</td>
<td>large amount of protein in urine</td>
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<tr>
<td>67.</td>
<td>_______</td>
<td>proteinuria</td>
<td>h.</td>
<td>large amount of urine</td>
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<tr>
<td>68.</td>
<td>_______</td>
<td>rugae</td>
<td>i.</td>
<td>folds that line the bladder</td>
<td></td>
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<tr>
<td>69.</td>
<td>_______</td>
<td>urethra</td>
<td>j.</td>
<td>scanty amount of urine</td>
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<td>70.</td>
<td>_______</td>
<td>BUN</td>
<td>k.</td>
<td>test for renal dysfunction</td>
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</table>