Urinary System

- The urinary system consists of the organs
- Which sharing the path of urine. and
- This section discusses the organs of the urinarsystemy, urination, and the functions of the urinary system.

Urinary Organs

- **The kidneys:- are found on either side of the vertebral column, just below the diaphragm. They lie in depressions against the deep muscles of the back beneath the peritoneum,**
- **the lining of the abdominal cavity. Although they are somewhat protected by these muscles and by the lower rib cage,**

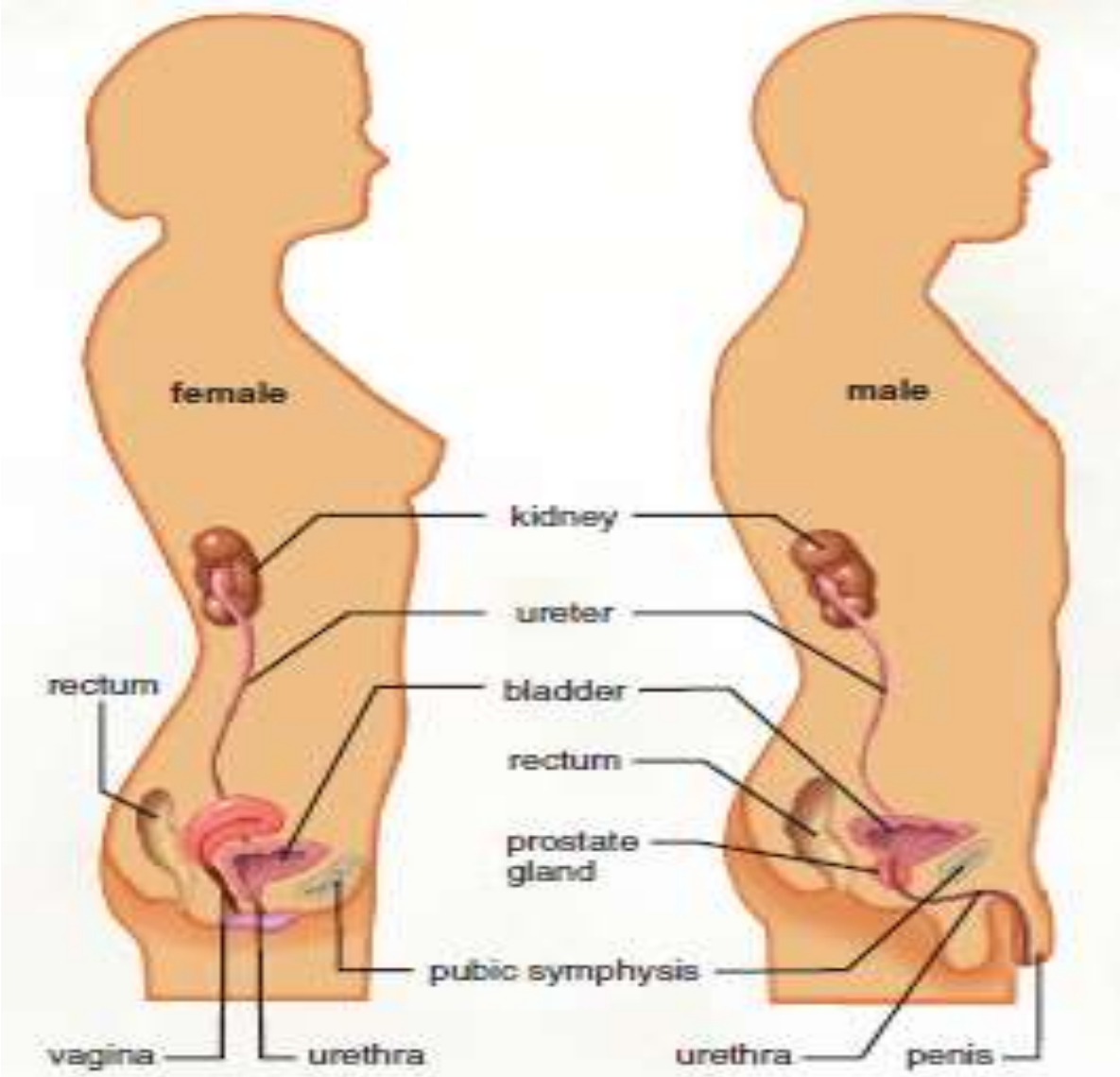


Figure 10A **Female versus male urinary tract.**
Females have a short urinary tract compared to that of males. This means that it is easier for bacteria to invade the urethra and helps explain why females are 50 times more likely than males to get a urinary tract infection.

- **The kidneys are bean-shaped and reddish-brown in color. The fist-sized organs are covered by a tough capsule of fibrous connective tissue overlaid by adipose tissue. The concave side of a kidney has a depression called the hilum. The renal artery enters and the renal vein and ureters exit a kidney at the hilum.**

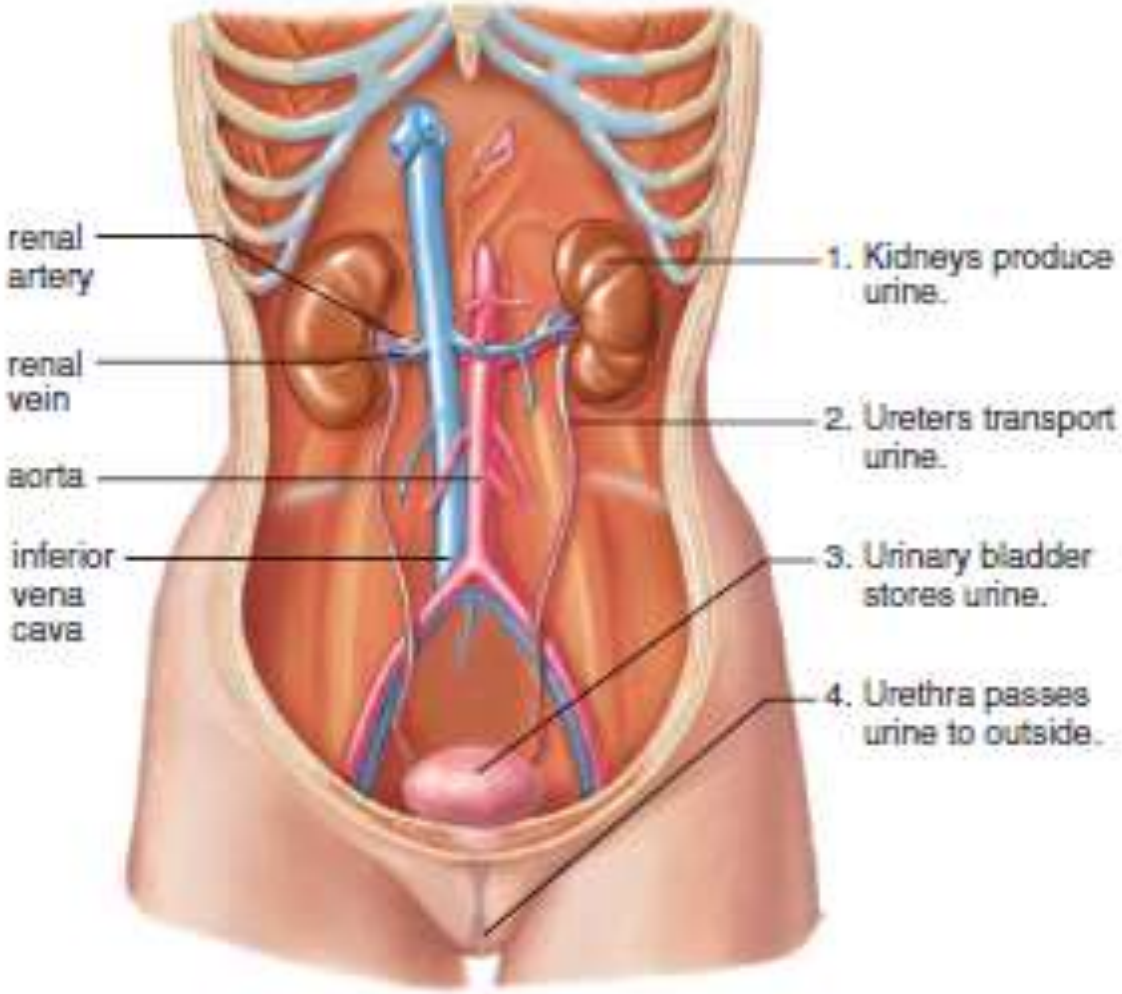


Figure 10.2 **The urinary system.**
Urine is found only within the kidneys, the ureters, the urinary bladder, and the urethra.

- **The ureters,**
- **which extend from the kidneys to the bladder, are small muscular tubes about 25 cm long in male and female .**
- **Peristalsis moves urine within the ureters, and peristaltic contractions cause urine to enter the bladder at a rate of about five jets per minute.**

- The urinary bladder,
- which can hold up to 600 ml of urine, is a hollow, muscular organ that gradually expands as urine enters.
- A sphincter is a circular muscle that encloses a tube two sphincters are found in close proximity where the urethra exits the bladder. When these sphincters are closed, urination does not take place.

- The urethra,
- which extends from the urinary bladder To an external opening,
- has a different length in females and males.
- In females, the urethra is only about 4 cm long and
- there is no connection between the reproductive and urinary systems.
- The above reasons can causes females urinary diseases more than males
- The female urethra makes bacterial invasion easier and helps explain why females are more prone to urinary tract infections than males.

- In males, the urethra averages 20 cm and
- the urethra carries urine during urination and sperm during ejaculation
- This double function of the urethra in males does not alter the path of urine. and
- the urethra is encircled by the prostate gland . which produce basic substance to neutralize the acidity of Urine before erect of penis
- In older men, enlargement of the prostate gland can restrict urination.
- A surgical procedure can usually correct the condition and restore a normal flow of urine.

- **Urination**
- **When the urinary bladder fills to about 250 ml of urine, stretch receptors send sensory nerve impulses to the spinal cord.**
- **Subsequently, motor nerve impulses from the spinal cord cause the urinary bladder to contract and the sphincters to relax so that urination is possible (Fig. 10.3).**
- **In older children and adults, the brain controls this reflex, delaying urination until a suitable time.**

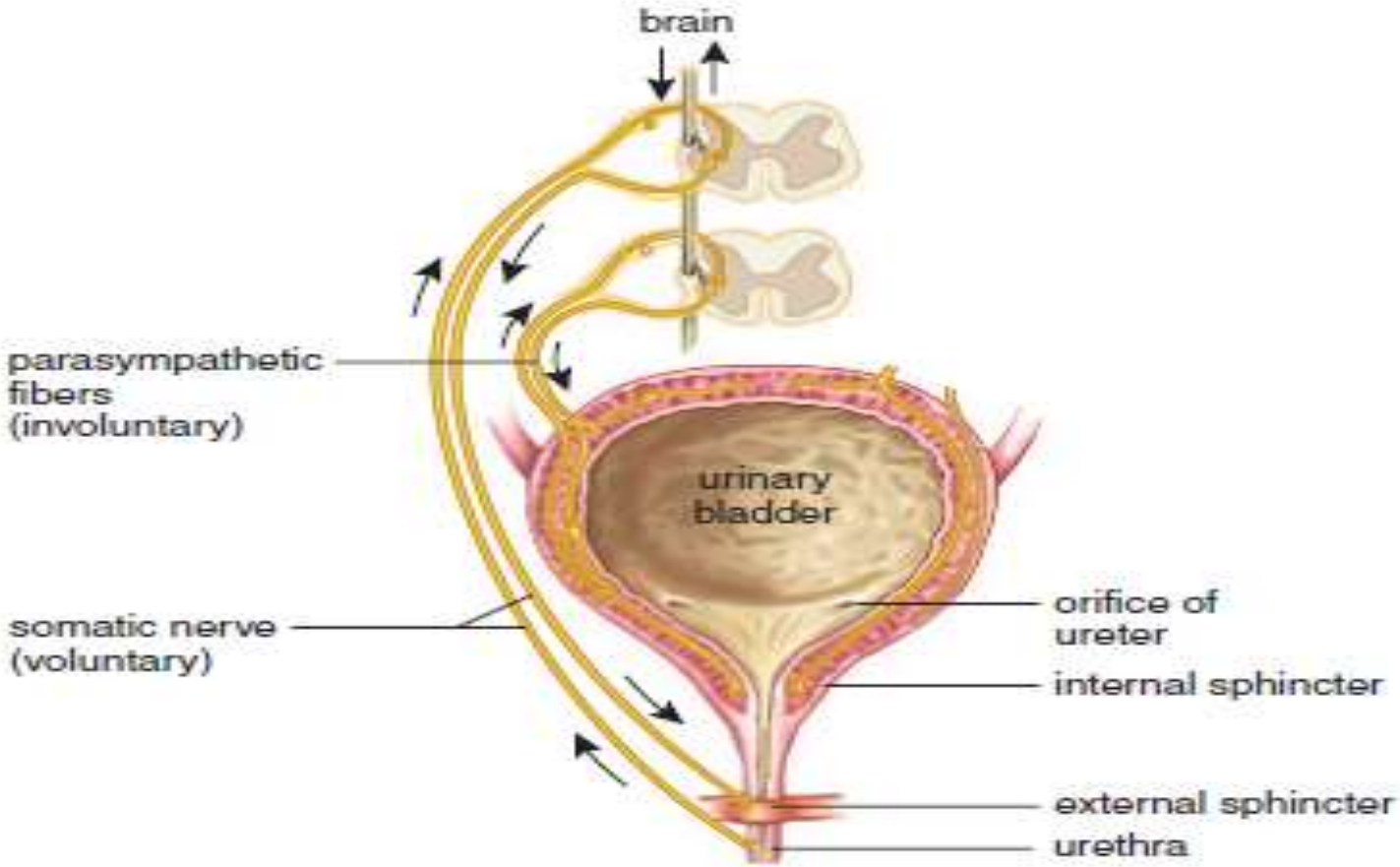


Figure 10.3 Urination.
As the bladder fills with urine, sensory impulses go to the spinal cord and then to the brain. The brain can override the urge to urinate. When urination occurs, motor nerve impulses cause the bladder to contract and an internal sphincter to open. Nerve impulses also cause an external sphincter to open.

The Function of kidney

- **The kidneys are the primary organs of the urinary system,**
- **and they play a central role in homeostasis by regulating**
- **the composition of blood, and therefore tissue fluid. As**
- **urine is being produced, the kidneys .**
- **(1) carry out the excretion of metabolic wastes, particularly nitrogenous wastes;**
- **(2) maintain the normal water-salt balance of the blood and , as a consequence, the normal blood volume and blood pressure;**
- **and (3) maintain the acid-base balance of blood.**
- **The kidneys also have a hormonal function, as discussed**
- **in the next section.**

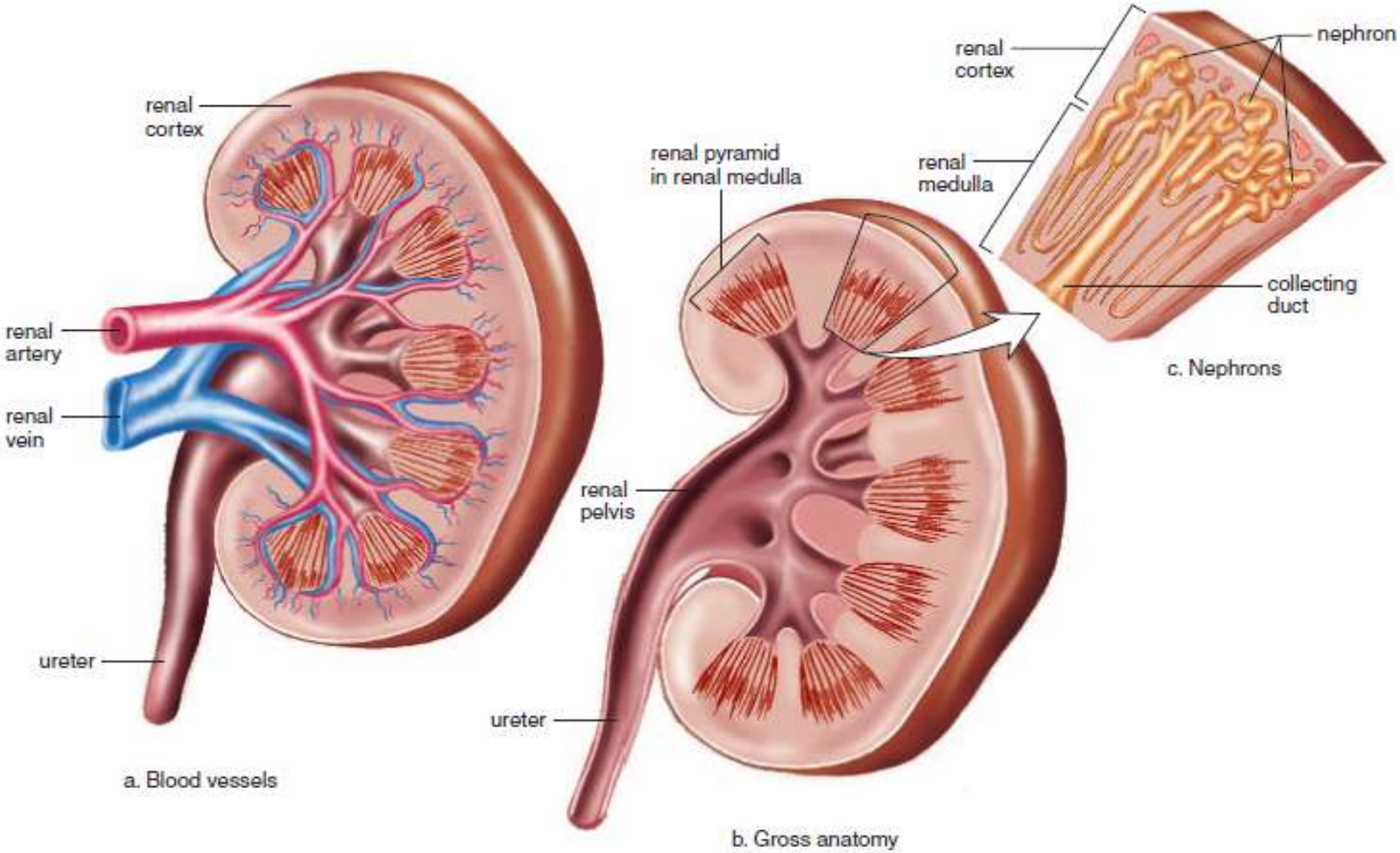
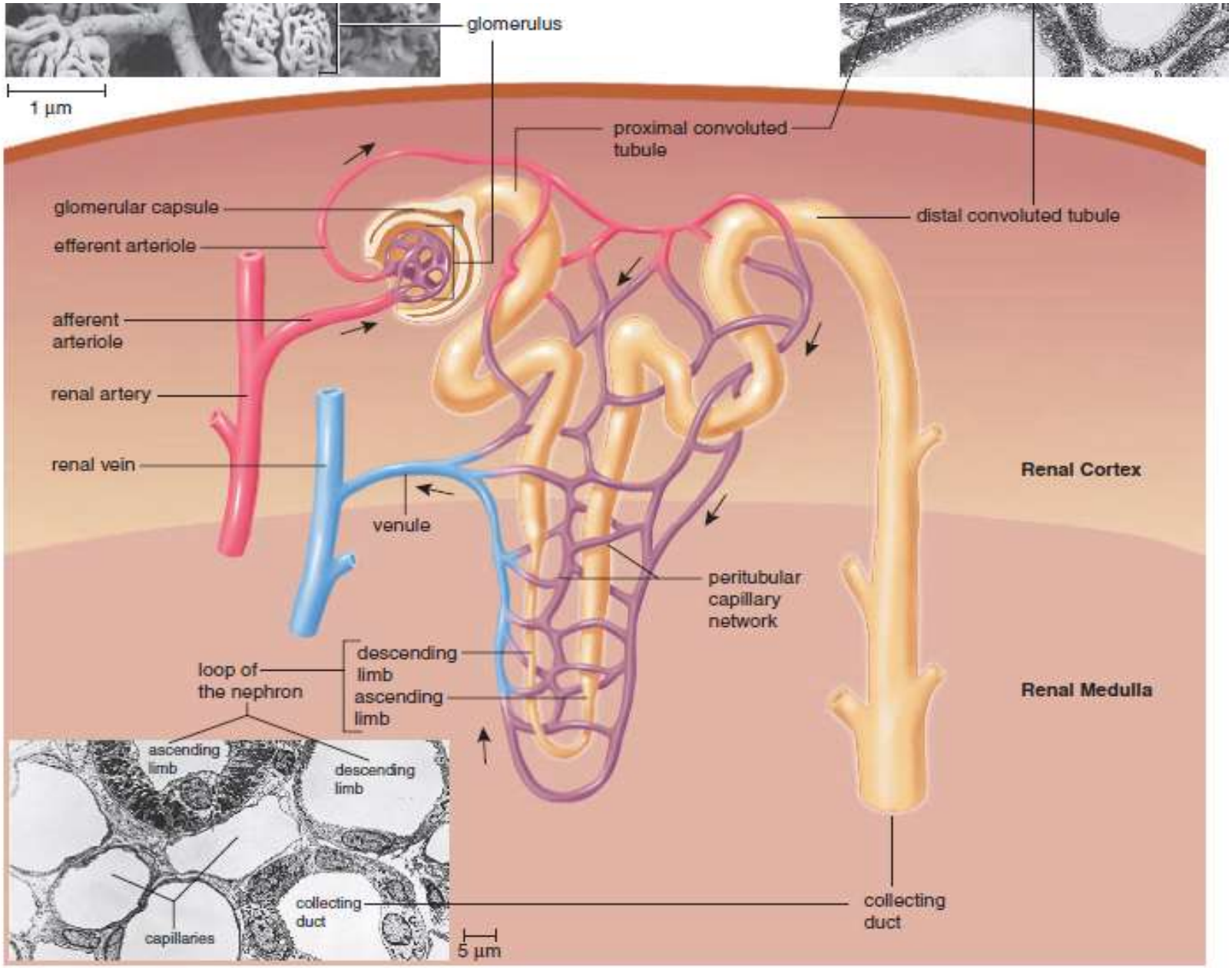


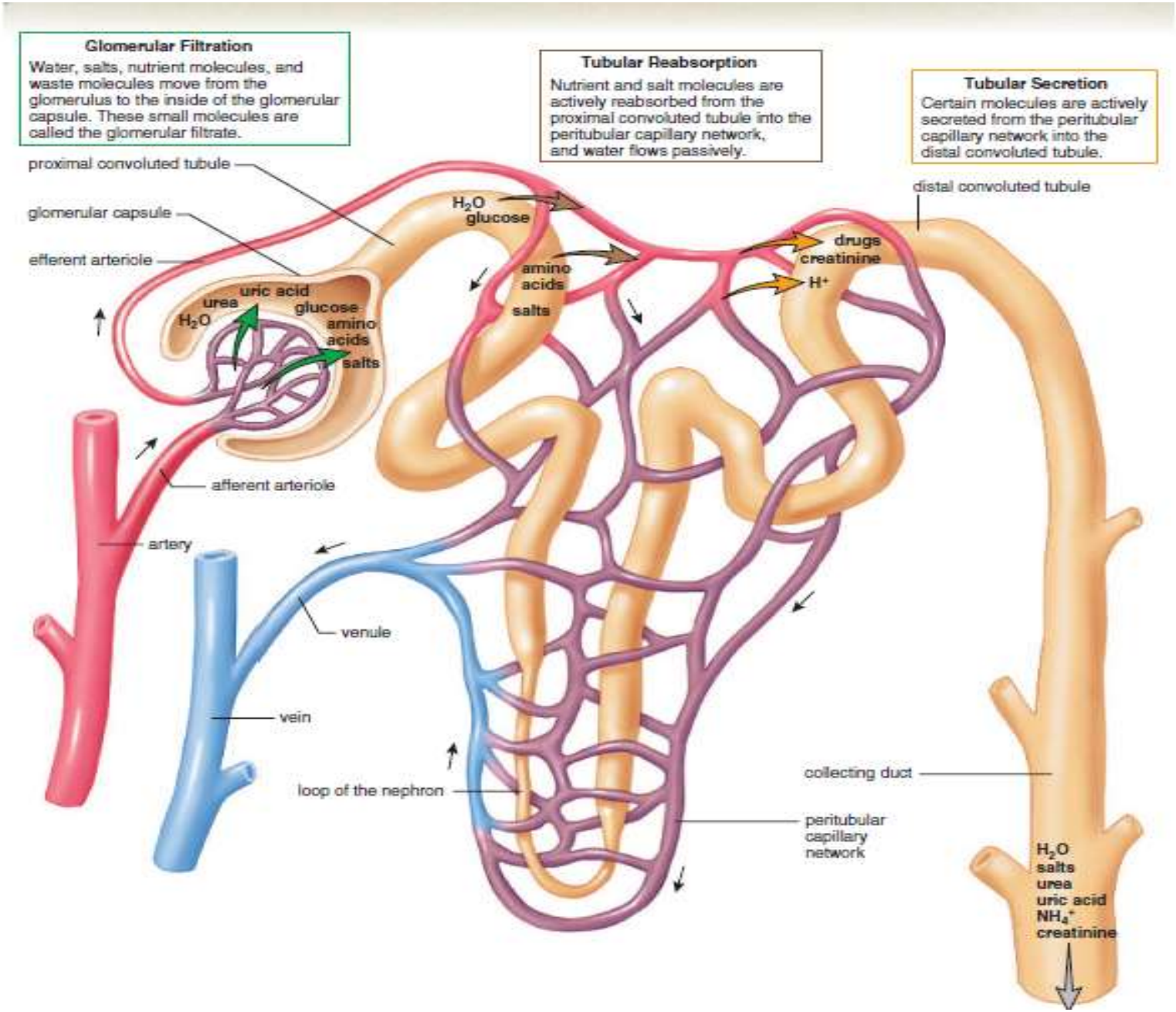
Figure 10.4 **Gross anatomy of the kidney.**
a. A longitudinal section of the kidney showing the blood supply. Note that the renal artery divides into smaller arteries, and these divide into arterioles. Venules join to form small veins, which join to form the renal vein. **b.** The same section without the blood supply. Now it is easier to distinguish the renal cortex, the renal medulla, and the renal pelvis, which connects with the ureter. The renal medulla consists of the renal pyramids. **c.** An enlargement showing the placement of nephrons.

- ***Excretion of Metabolic Wastes***
- **The kidneys excrete metabolic wastes, notably nitrogenous wastes.**
- **Urea is the primary nitrogenous end product of metabolism in human beings, but humans also excrete some ammonium, creatinine , and uric acid.**

- Urea is a by-product of amino acid metabolism. The breakdown of amino acids in the liver releases ammonia, which the liver combines with carbon dioxide to produce urea.
- Ammonia is very toxic to cells, and urea is much less toxic. Because it is less toxic, less water is required to excrete urea.
- The metabolic breakdown of creatine phosphate results

- in creatinine. Creatine phosphate is a high-energy phosphate reserve molecule in muscles.
- The breakdown of nucleotides, such as those containing
- adenine and thymine, produces uric acid. Uric acid is rather insoluble.
- If too much uric acid is present in blood, crystals form and precipitate out.
- Crystals of uric acid sometimes collect in the joints, producing a painful ailment called gout.


glomerulus
1 µm
proximal convoluted tubule
glomerular capsule
efferent arteriole
distal convoluted tubule
afferent arteriole
renal artery
renal vein
Renal Cortex
venule
peritubular capillary network
descending limb
loop of the nephron
ascending limb
Renal Medulla
ascending limb
descending limb
collecting duct
capillaries
5 µm
collecting duct


Glomerular Filtration
Water, salts, nutrient molecules, and waste molecules move from the glomerulus to the inside of the glomerular capsule. These small molecules are called the glomerular filtrate.
Tubular Reabsorption
Nutrient and salt molecules are actively reabsorbed from the proximal convoluted tubule into the peritubular capillary network, and water flows passively.
Tubular Secretion
Certain molecules are actively secreted from the peritubular capillary network into the distal convoluted tubule.
proximal convoluted tubule
glomerular capsule
efferent arteriole
distal convoluted tubule
H_2O
glucose
amino acids
salts
drugs
creatinine
H^+
urea
uric acid
H_2O
glucose
amino acids
salts
afferent arteriole
artery
venule
vein
loop of the nephron
collecting duct
peritubular capillary network
H_2O
salts
urea
uric acid
NH_4^+
creatinine

10.3 Urine Formation

Figure 10.7 gives an overview of urine formation, which is divided into these steps: glomerular filtration, tubular reabsorption, and tubular secretion.

Glomerular Filtration

Glomerular filtration occurs when whole blood enters the afferent arteriole and the glomerulus. Due to glomerular blood pressure, water and small molecules move from the glomerulus to the inside of the glomerular capsule. This is a filtration process because large molecules and formed elements are unable to pass through the capillary wall. In effect, then, blood in the glomerulus has two portions: the filterable components and the nonfilterable components.

Table 10.1 Reabsorption from Nephrons

Substance	Amount Filtered (Per Day)	Amount Excreted (Per Day)	Reabsorption (%)
Water, L	180	1.8	99.0
Sodium, g	630	3.2	99.5
Glucose, g	180	0.0	100.0
Urea, g	54	30.0	44.0

L = liters, g = grams

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a molecule that ordinarily is completely reabsorbed because

10.4 Maintaining Water-Salt Balance

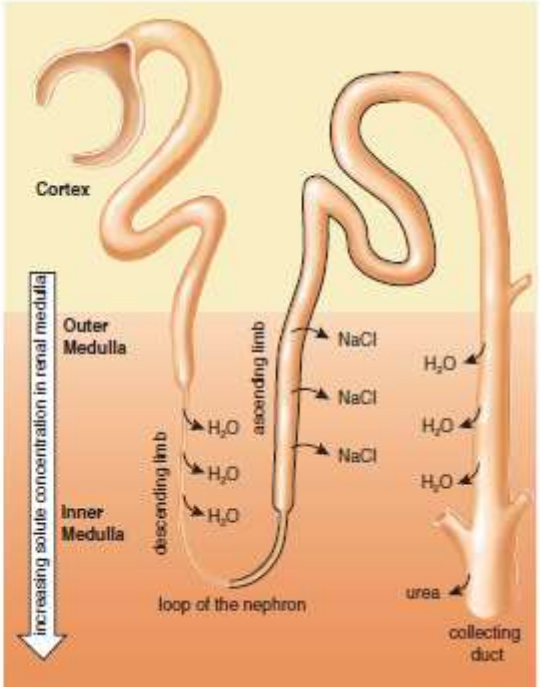
The kidneys maintain the water-salt balance of the blood within normal limits. In this way, they also maintain the blood volume and blood pressure. Most of the water and salt (NaCl) present in the filtrate is reabsorbed across the wall of the proximal convoluted tubule.

Reabsorption of Water

The excretion of a hypertonic urine (one that is more concentrated than blood) is dependent upon the reabsorption of water from the loop of the nephron and the collecting duct.

A long loop of the nephron, which typically penetrates deep into the renal medulla, is made up of a descending limb and an ascending limb. Salt (NaCl) passively diffuses out of the lower portion of the ascending limb, but the upper, thick portion of the limb actively extrudes salt out into the tissue of the outer renal medulla (Fig. 10.8). Less and less salt is available for transport as fluid moves up the thick portion of the ascending limb. Because of these circumstances, there is an osmotic gradient within the tissues of the renal medulla: the concentration of salt is greater in the direction of the inner medulla. (Note that water cannot leave the ascending limb because the limb is impermeable to water.)

The large arrow in Figure 10.8 indicates that the innermost



10.5 Maintaining Acid-Base Balance

The bicarbonate (HCO_3^-) buffer system and breathing work together to maintain the pH of the blood. Central to the mechanism is this reaction, which you have seen before:

$$H^+ + HCO_3^- \rightleftharpoons H_2CO_3 \rightleftharpoons H_2O + CO_2$$

The excretion of carbon dioxide (CO_2) by the lungs helps keep the pH within normal limits, because when carbon dioxide is exhaled, this reaction is pushed to the right and hydrogen ions are tied up in water. Indeed, when blood pH decreases, chemoreceptors in the carotid bodies (located in the carotid arteries) and in aortic bodies (located in the aorta) stimulate the respiratory center, and the rate and depth of breathing increase. On the other hand, when blood pH begins to rise, the respiratory center is depressed, and the level of bicarbonate ions increases in the blood.

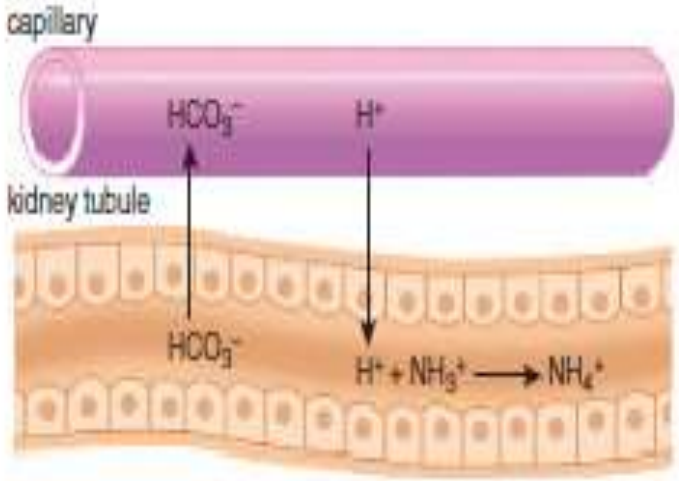


Figure 10.10 Acid-base balance.
In the kidneys, bicarbonate ions (HCO_3^-) are reabsorbed and hydrogen ions (H^+) are excreted as needed to maintain the pH o blood. Excess hydrogen ions are buffered, for example, by amm (NH_3), which is produced in tubule cells by the deamination of ar acids.

tells how the urinary system works with the other sys of the body.

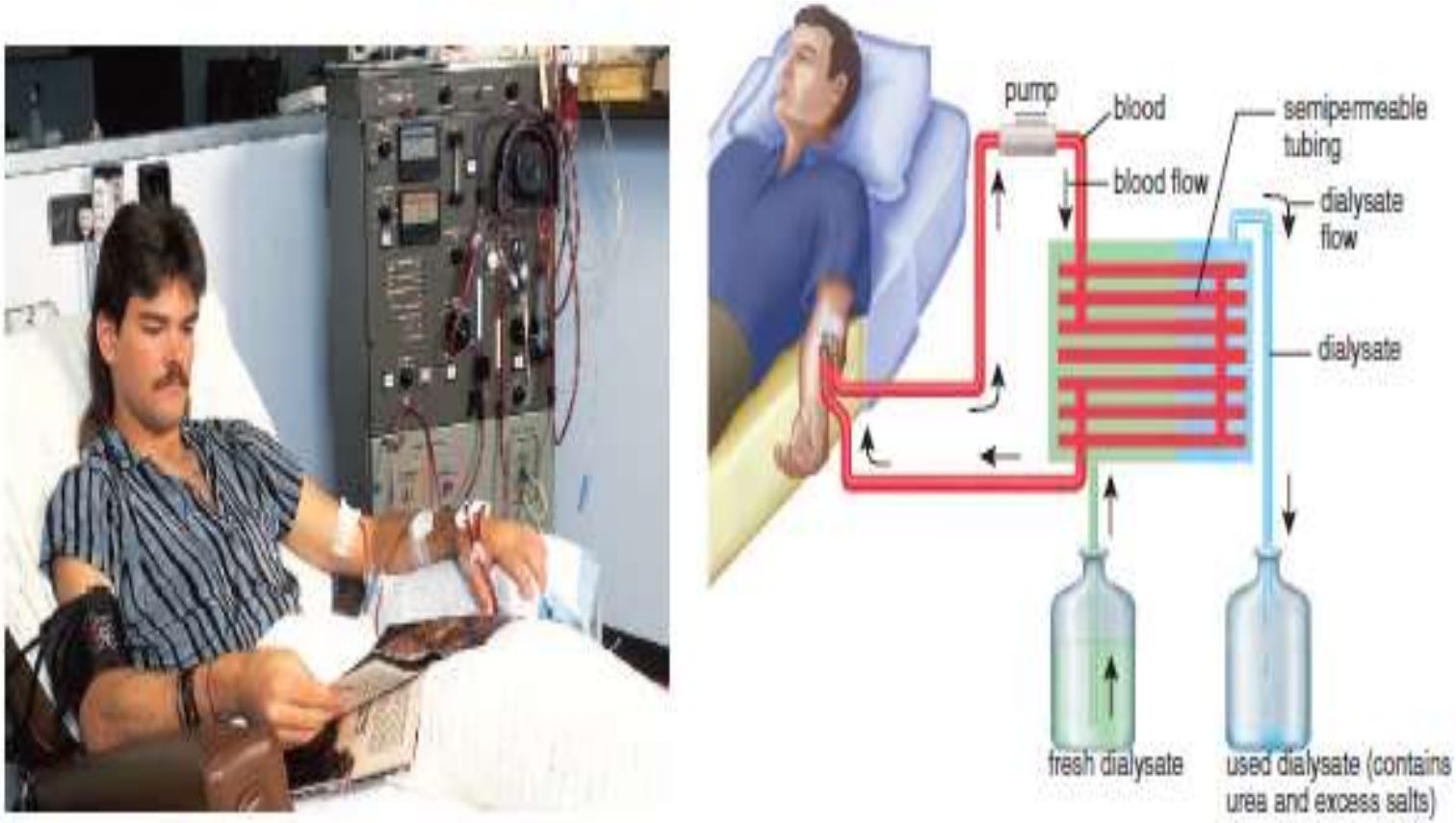
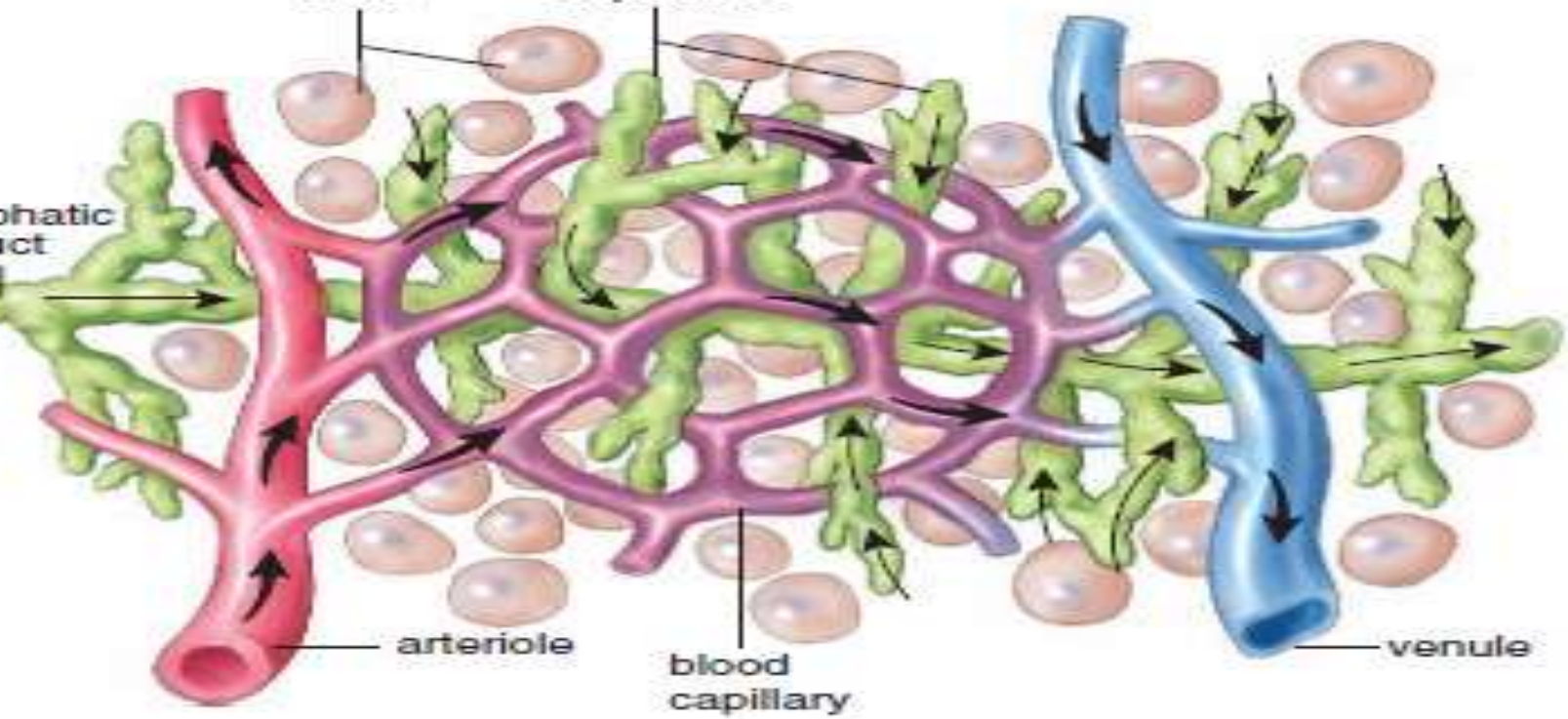


Figure 10.11 **An artificial kidney machine.**

As the patient's blood is pumped through dialysis tubing, it is exposed to a dialysate (dialysis solution). Wastes exit from blood into the solution because of a preestablished concentration gradient. In this way, blood is not only cleansed, but its water-salt and acid-base balance can also be adjusted.

THANK YOU

Will MEET IN NEW LECTURE



gure 6.9 Lymphatic capillaries.
ows indicate that lymph is formed when lymphatic capillaries take
excess tissue fluid. Lymphatic capillaries lie near blood capillaries.

ed by the lymphatic capillaries. Edema can be due to
ny causes. One dramatic cause is a parasitic infection of
nphatic vessels by a small worm. An affected leg can be-
ne so large that the disease is called elephantiasis.

Exchange of nutrients for wastes occurs at the capillaries. Here lymphatic capillaries also collect excess tissue fluid.

1. What types of blood vessels are there? Discuss their structure and function. 126
2. Trace the path of blood through the heart, mentioning the vessels attached to, and the valves within, the heart. 129
3. Describe the cardiac cycle (using the terms systole and diastole), and explain the heart sounds. 130
4. Describe the cardiac conduction system and an ECG. Tell how an ECG is related to the cardiac cycle. 130–31
5. In what type of vessel is blood pressure highest? Lowest? Why is the slow movement of blood in capillaries beneficial?
6. What factors assist venous return of blood? 133
7. Trace the path of blood in the pulmonary circuit as it travels from and returns to the heart. 134
8. Trace the path of blood to and from the kidneys in the systemic circuit. 134–35
9. What is atherosclerosis? Name two illnesses associated with hypertension and thromboembolism. 137–38
10. Discuss the medical and surgical treatment of cardiovascular disease. 138–39

- 1. State the path of urine and the function of each organ mentioned.
- 188
- 2. Explain how urination is controlled. 188–89
- 3. List and explain four functions of the urinary system. 189
- 4. Describe the macroscopic anatomy of a kidney. 191
- 5. Trace the path of blood about a nephron. 192
- 6. Name the parts of a nephron, and tell how the structure of
- the convoluted tubules suits their respective functions. 193
- 7. State and describe the three steps of urine formation. 194–95
- 8. Where in particular are water and salt reabsorbed along the
- length of the nephron? Describe the contribution of the loop
- of the nephron. 196–97
- 9. Name and describe the action of antidiuretic hormone
- (ADH), the renin-aldosterone connection, and atrial natriuretic
- hormone (ANH). 196–97
- 10. How do the kidneys maintain the pH of the blood within
- normal limits? 199
- 11. Explain how the artificial kidney machine works. 200