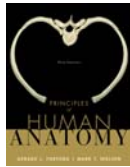


## Chapter 26

# The Urinary System



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## Introduction

- The urinary system consists of two kidneys, two ureters, one urinary bladder, and one urethra.
- The kidneys filter blood plasma, they return most of the water and solutes to the bloodstream.
- The remaining water and solutes constitute **urine**, which passes through the ureters and is stored in the urinary bladder until it is excreted from the body through the urethra.

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## Organs of the Urinary System (Fig. 26.1)

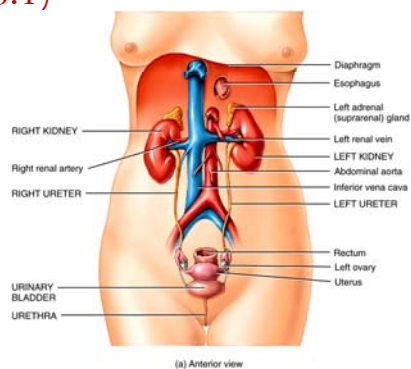


Figure 26.1a, Tubules, 19th Ed.  
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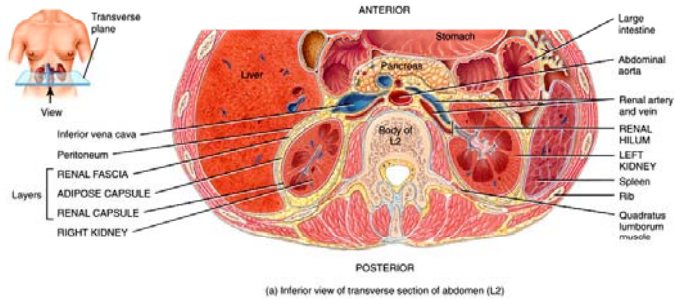
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## Kidneys

- Located in the **retroperitoneum** and the posterior wall of the abdomen, between the levels of the last thoracic and third lumbar vertebrae, where they are partially protected by the ribs.
- The Functions of the kidneys:
  - Regulation of blood ionic composition.
  - Regulation of blood pH.
  - Regulation of blood volume.
  - Enzymatic regulation of blood pressure.
  - Maintenance of blood osmolarity
  - Production of hormones
  - Regulation of blood glucose level.
  - Excretion of wastes and foreign substance

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## Position of Kidneys (Figure 26.2)



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## External Anatomy of Kidneys

- A typical kidney in an adult is 10–12 cm (4–5 in.) long, 5–7 cm (2–3 in.) wide, and 3 cm (1 in.) thick, has a mass of 125–170 g (4.5–5 oz).
- The concave medial border of each kidney faces the vertebral column.
- The **renal hilum**: ureter emerges from the kidney along with blood vessels, lymphatic vessels, and nerves.

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## Internal Anatomy of Kidneys (Fig. 26.3)

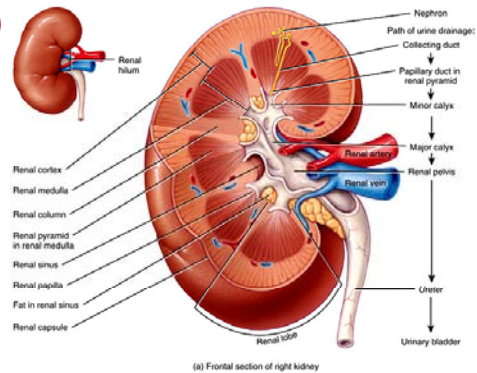
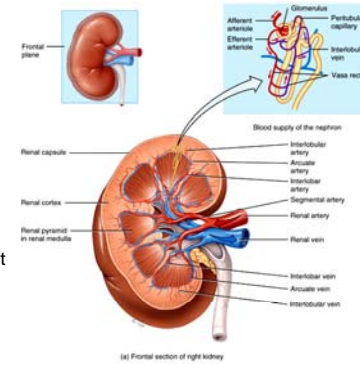


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## Blood and Nerve Supply of the Kidney (Fig. 26.4)

- The kidneys remove wastes from the blood and regulate its volume and ionic composition, there are abundantly supplied with blood vessels.
- The kidneys constitute less than 0.5% of total body mass, they receive 20–25% of the resting cardiac output via the right and left **renal arteries**.
- In adults, renal blood flow, the blood flow through the kidneys, is about 1200 mL per minute.



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## Kidneys

- Within the kidney, the renal artery divides into several **segmental arteries**.
- **Interlobar arteries** pass through the renal columns between the lobes.
- At the bases of the renal pyramids, the interlobar arteries arch between the renal medulla and cortex; the **arcuate arteries** arch over the bases of the renal pyramids.
- Divisions of the arcuate arteries produce a series of **interlobular arteries**.
- Interlobular arteries enter the renal cortex and give off branches called **afferent arterioles**.
- The afferent arteriole, enter the capillary network the **glomerulus**.
- The glomerular capillaries then reunite to form an **efferent arteriole**.

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## Kidneys

- The efferent arterioles divide to form the **peritubular capillaries**.
- Extending from the efferent arterioles are capillaries called **vasa recta** that supply tubular portions of the nephron in the renal medulla.
- The peritubular capillaries eventually reunite to form **peritubular venules and then interlobular veins, which also receive blood from the vasa recta**.
- The **arcuate veins drain to the interlobar veins running between the renal pyramids**.
- Blood leaves the kidney through a single **renal vein** that exits at the renal hilum and carries venous blood to the inferior vena cava.

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## The Nephron

- Each Nephron consists of 2 parts:
  - **renal corpuscle**, where blood plasma is filtered
  - **renal tubule into which the filtered fluid passes**.
- The 2 components of a **renal corpuscle**
- **glomerulus (capillary network)**.
- **glomerular (Bowman's) capsule**, the glomerular capillaries.
- The fluid (filtrate) passes through the renal tubule consists of a
  - (1) proximal convoluted tubule,
  - (2) loop of Henle (nephron loop), and
  - (3) distal convoluted tubule.

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## The Structure of Nephrons (Fig. 26.5)

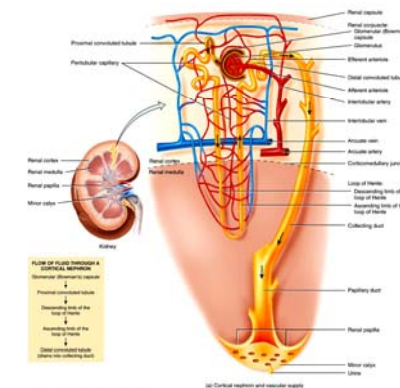


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## Renal Corpuscles

- The short loops of Henle receive their blood supply from peritubular capillaries that arise from efferent arterioles. The other 15–20% of the nephrons are **juxtamedullary nephrons**.
- Their **renal corpuscles** lie deep in the cortex, close to the medulla, and they have long loops of Henle that extend into the deepest region of the medulla.
- Long loops of Henle receive their blood supply from peritubular capillaries and from the vasa recta that arise from efferent arterioles.
- The juxtamedullary nephrons the ascending limb of the loop of Henle consists of two portions: a **thin ascending limb followed by a thick ascending limb**.
- The lumen of the thin ascending limb is the same as in other areas of the renal tubule; it is only the epithelium that is thinner. Nephrons with long loops of Henle enable the kidneys to excrete very dilute or very concentrated urine.

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## Renal Corpuscle (Fig. 26.6)

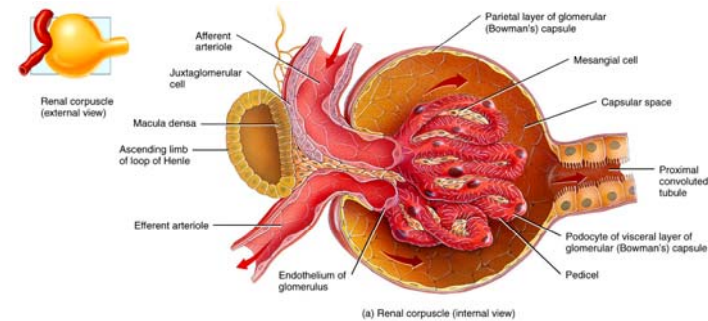


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## Nephron and Collecting Duct

- A single layer of epithelial cells forms the entire wall of the glomerular capsule, renal tubule, and ducts.
- The **glomerular (Bowman's) capsule** consists of visceral and parietal layers. The visceral layer consists of modified simple squamous epithelial cells called **podocytes**.
- The many footlike projections of these cells (pedicels) wrap around the single layer of endothelial cells of the glomerular capillaries and glomerular capsule consists of simple squamous epithelium and forms the outer wall of the capsule.
- Fluid filtered from the glomerular capillaries enters the **capsular (Bowman's) space**, the space between the two layers of the glomerular capsule, is the lumen of the urinary tube.

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## Renal Tubule and Collecting Duct

- The distal convoluted tubule (DCT) begins a short distance past the macula densa. In the last part of the DCT and continuing into the collecting ducts, two different types of cells are present.
- Most are **principal cells, which have receptors for both antidiuretic hormone (ADH) and aldosterone**, two hormones that regulate their functions. A smaller number are **intercalated cells, which play a role in the homeostasis of blood pH**.
- The collecting ducts drain into large papillary ducts, which are lined by simple columnar epithelium. The number of nephrons is constant from birth. Any increase in kidney size is due solely to the growth of individual
- Signs of kidney dysfunction usually do not become apparent until function declines to less than 25% of normal because the remaining functional nephrons adapt to handle

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## Nephron's Structure and Functions (Fig. 26.7)

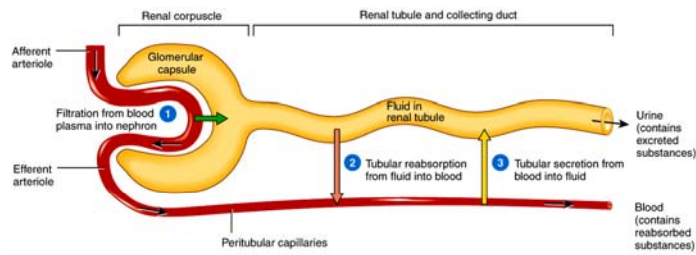


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## Ureters

- The ureters transports urine from the renal pelvis of one kidney to the urinary bladder.
- Peristaltic contractions of the muscular walls of the ureters push urine toward the urinary bladder, but hydrostatic pressure and gravity also contribute.
- The ureters are 25–30 cm (10–12 in.) long and are thick walled, narrow tubes that vary in diameter from 1 mm to 10 mm along their course between the renal pelvis and the urinary bladder. The ureters are retroperitoneal.
- At the base of the urinary bladder the ureters curve medially and pass obliquely through the wall of the posterior aspect of the urinary bladder .
- Physiological valve at the opening of each ureter into the urinary bladder, . As the urinary bladder fills with urine, pressure within it compresses the oblique openings into the ureters and prevents the backflow of urine.
- When this physiological valve is not operating properly, it is possible for microbes to travel up the ureters from the urinary bladder to infect one or both Kidneys.

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## Ureters, Urinary Bladder, and Urethra in Female (Fig. 26.9)

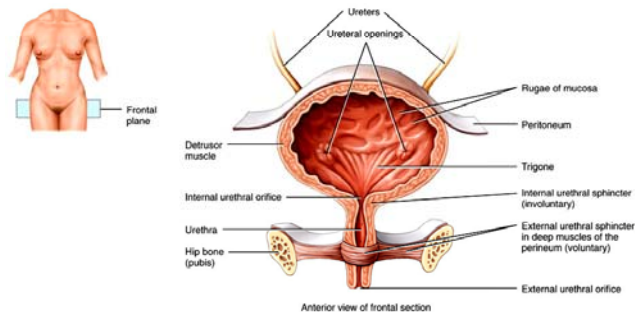


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## Anatomy of the Urinary Bladder

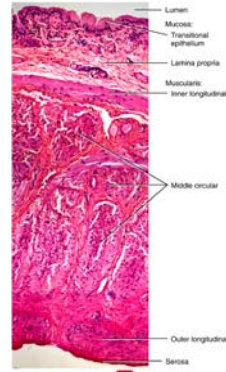
- The urinary bladder is a hollow, distensible muscular.
- In males, it is directly anterior to the rectum; in females it is anterior to the vagina and inferior to the uterus.
- Urinary bladder capacity averages 700–800 mL; it is smaller in females because the uterus occupies the space just superior to the urinary bladder.
- The floor of the urinary bladder is a small triangular area called the **trigone**. The two posterior corners of the trigone contain the 2 ureteral openings.
- The **internal urethral orifice**, lies in the anterior corner. Because its mucosa is firmly bound to the muscularis, the trigone has a smooth appearance.
- Three coats make up the wall of the urinary bladder. The deepest is the **mucosa**, a mucous membrane composed of **transitional epithelium** and an underlying lamina propria similar to that of the ureters

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## Histology of the Urinary Bladder

### (Fig. 26.11)

- Rugae (the folds in the mucosa) .
- The **intermediate muscularis, also called the detrusor muscle**, which consists of three layers of smooth muscle fibers: the inner longitudinal, middle circular, and outer longitudinal layers.
- The circular fibers form an **internal urethral sphincter**
- The **external urethral sphincter**, is composed of skeletal muscle. The most superficial coat of the urinary bladder on the posterior and inferior surfaces is the **adventitia**, a layer of areolar connective tissue that is continuous with that of the ureters.
- Over the superior surface of the urinary bladder is the **serosa, a layer of peritoneum**.



Transverse section of urinary bladder  
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## Urethra

- The **urethra is a small tube leading from the internal urethral orifice** in the floor of the urinary bladder to the exterior of the Body.
- In females, the urethra has a length of 4 cm (1.5 in.). The wall of the female urethra consists of a deep **mucosa and a superficial muscularis**. The mucosa is a mucous membrane composed of **epithelium and lamina propria (areolar connective tissue with elastic fibers and a plexus of veins)**.
- In males, the urethra first passes through the prostate, then through the deep perineal muscles, and finally through the penis, a distance of about 20 cm (8 in.). The male urethra, which also consists of a deep **mucosa and a superficial muscularis, is subdivided into three anatomical regions:**
  - (1) The **prostatic urethra** passes through the prostate;
  - (2) the membranous (intermediate) urethra,
  - (3) the **spongy urethra** pass through the penis.

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## Comparison: Female and Male Urethras (Fig. 26.12)

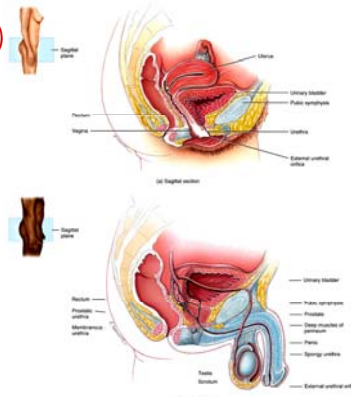


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