Urinary System

Chapter 26
Components of the Urinary System

**Kidney**
- Produces urine

**Ureter**
- Transports urine toward the urinary bladder

**Urinary Bladder**
- Temporarily stores urine prior to elimination

**Urethra**
- Conducts urine to exterior; in males, transports semen as well
Components of the Urinary System
Diaphragm
Celiac trunk
Left suprarenal gland
Left kidney
Left renal artery
Left renal vein
Superior mesenteric artery
Left ureter

Iliacus muscle
Psoas major muscle
Rectum (cut)

Figure 26.3a The Urinary System in Gross Dissection

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Function
Figure 26.2b
Figure 26.4b
Structure of the Kidney
Figure 26.4a Structure of the Kidney
Typical kidney

- Size: 10 cm long, 5.5 cm wide, 3 cm thick, 150g

- Sectional view:
  - Medial indentation is the __________
  - Renal __________ enter at the hilum
  - Renal __________ and ___________ exit at the hilum
Figure 26.5a Blood Supply to the Kidneys
Blood supply to kidneys

1. Beginning with blood in the _________, blood flows to:

2. ___________ arteries
3. ___________ arteries
4. ___________ arteries
5. ___________ ___________ arteries
6. ___________ arterioles
7. ___________ capillaries
Figure 26.5b Blood Supply to the Kidneys
The Blood Supply to the Kidneys (continued)

- After waste is filtered at the nephrons, blood leaves the kidneys via the following vessels:
  1. _________ capillaries
  2. _________ arteriole
  3. Peritubular capillaries or vasa recta capillaries
  4. _________ veins
  5. _________ veins
  6. _________ veins
  7. _______ vein
  8. Inferior vena cava
The Kidneys

- Innervation of the Kidneys
  - Urine production is regulated by **autoregulation**
    - Involves reflexive changes in the diameter of nephron arterioles
  - Receives sympathetic nerve fibers from the celiac and inferior mesenteric ganglia
  - Nerve innervation serves to:
    - Regulate renal blood flow and pressure
    - Stimulate renin release
    - Stimulate water and sodium ion reabsorption
Structure and Function of the Nephron

- Waste (glomerular filtrate) material leaves the glomerular capillaries and enters:

1. Glomerular capsule
2. __________________________(PCT)
3. Nephron loop
4. __________________________(DCT)
5. Collecting Duct
Figure 26.8a
Histology of the Nephron

- 2. Proximal convoluted tubule
- 1. Renal corpuscle
- 4. Distal convoluted tubule
- 5. Connecting tubules
- 3. Nephron loop
- 5. Collecting duct
- Thin descending limb
- Thick ascending limb
- Papillary duct
- Renal papilla
- Minor calyx

Orientation of cortical and juxtamedullary nephrons.
The filtrate that enters the DCT of various nephrons empties into a common tube called the ________ duct.

- The collecting duct passes through the renal pyramids.
- Filtrate then enters the:
  - Papillary duct »»» Minor calyx »» Major calyx
  - Filtrate leaves the kidneys:
  - Ureter »»» Urinary bladder »»» Urethra.
Figure 26.7 A Typical Nephron
Structure and Function of the Nephron

- Two main types of nephrons
  - __________ nephrons
    - 85 percent of the nephrons are cortical
    - Most of the nephron is located in the cortex
    - Have a relatively short nephron loop
  - __________ nephrons
    - 15 percent of the nephrons are juxtamedullary
    - Capsule is located near the border of the cortex and the medulla
    - Have a long nephron loop
Structure and Function of the Nephron

- Main functions of the nephron
  - ________________________________
    - Urine processing
  - ________________________________
    - Prevents dehydration
  - ________________________________
    - Urine processing
The Kidneys

- The Renal Corpuscle
  - Consists of:
    - Glomerular capsule
    - Glomerular capillaries (glomerulus)
  - Glomerular capsule consists of:
    - Parietal layer
      - Made of squamous cells
    - Visceral layer
      - Makes up the epithelial lining of the capillaries
Figure 26.9 The Renal Corpuscle (1 of 4) © 2015 Pearson Education, Inc.
The Kidneys

- The Renal Corpuscle
  - Filtration within the renal corpuscle involves three layers
    - ________________________________
    - Fenestration (.06-.1 µ)
    - ________________________________
    - Surrounds capillary endothelium (large proteins can’t pass)
    - ________________________________
    - Consists of specialized cells called podocytes
Filtration Apparatus

Plasma is filtered across the walls of the glomerulus and into the capsular space. The solution produced by this filtration process is called **glomerular filtrate**. This filtration process involves three barriers, which collectively form the filtration membrane.

**Filtration Membrane**
- Capillary endothelium (blocks passage of blood cells)
- Basal lamina (blocks passage of large plasma proteins)
- Filtration slits between secondary processes of podocytes (blocks passage of almost all plasma proteins)

Capsular space containing glomerular filtrate (yellow)
- Nucleus of podocyte
- Podocyte
- Pores
- Mesangial cell
- Capillary endothelial cell
- Secondary processes
- RBC
- Parietal epithelium
Glomerular epithelium

- ____________ have long extensions that wrap around basal lamina
- Extensions have filtration slits
- Filtrate passing through consists of water, ions, small organic molecules (glucose, fatty acids, amino acids, vitamins)
- Any potential useful product will be reabsorbed in proximal convoluted tubule (PCT)
- Lined with cuboid epithelium
- Reabsorbs all:
  - Organic nutrients
  - Plasma protein
  - 60% sodium and chloride ions and water
  - Calcium, potassium, magnesium, bicarbonate, phosphate, sulfate ions
**Figure 26.7 A Typical Nephron**

- **Proximal Convoluted Tubule**
  - Nucleus
  - Microvilli
  - Mitochondria
  - Reabsorption of water, ions, and all organic nutrients

- **Distal Convoluted Tubule**
  - Secretion of ions, acids, drugs, toxins
  - Variable reabsorption of water, sodium ions, and calcium ions (under hormonal control)

- **Renal Corpuscle**
  - Parietal (capsular) epithelium
  - Capsular space
  - Visceral (glomerular) epithelium
  - Capillaries of glomerulus
  - Production of filtrate

- **Nephron Loop**
  - Thin descending limb
  - Thick ascending limb
  - Further reabsorption of water (descending limb) and both sodium and chloride ions (ascending limb)

- **Connecting Tubules and Collecting Duct**
  - Connecting tubules
  - Collecting duct
  - Variable reabsorption of water and reabsorption or secretion of sodium, potassium, hydrogen, and bicarbonate ions

- **Papillary Duct**
  - Delivery of urine to minor calyx

- **Collecting System**
  - Connecting tubules
  - Collecting duct
• Descending portion
  • Reabsorption of water into blood stream »» vasa recta

• Ascending portion
  • Pumps ions (Na and Cl ions) out of ascending loop to prevent their loss
  • Impermeable to water
(DCT)

- Active secretion of ions and acids
- Selective reabsorption of Na and Ca ions
- Very little reabsorption of water
Juxtaglomerular complex

- Located region of vascular pole. Consists of:
- Macula densa cells, juxtaglomerular cells, mesangial cells
- Produce two hormones:
  - Renin
  - Erythropoietin
Figure 26.9 The Renal Corpuscle (1 of 4)
• Ureters exit at the hilum area
• Transport urine from kidneys to urinary bladder
• Enter urinary bladder on the posterior/inferior side
• The ureteral openings enter at the ____________
• Consists of three tunic layers (mucosa, muscular, adventitia)
Figure 26.11c Organs Responsible for the Conduction and Storage of Urine

- Ureter
- Trigone
- Ureteral openings
- Membranous urethra
Figure 26.11b Organs Responsible for the Conduction and Storage of Urine
Figure 26.11a Organs Responsible for the Conduction and Storage of Urine

- Peritoneum
- Left ureter
- Pubic symphysis
- Prostate gland
- Spongy urethra
- Urogenital diaphragm

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reflex and urination

- Urge to urinate when urinary bladder fills, approx 200 ml
- Voluntary effort to relax (open) external urethral sphincter
- When urinary bladder nears capacity, both urethral sphincters will open based on pressure
- Upon “complete void,” approximately 10 ml of urine still remains