

Renal Anatomy

Major Organs:

[\[Section 25.2: Gross Anatomy of Urine Transport\]](#)

- kidneys
- ureters
- urinary bladder
- urethra

Functions:

[\[Section: Introduction \(chapter 25\)\]](#)

- filters dissolved material from the blood
- regulates electrolytes
- regulates fluid volume
- concentrates and stores waste products
- reabsorbs metabolically important substances back into the circulatory system

Urethra

[\[Section 25.2.1: Urethra\]](#)

[\[Figure 25.3: Female and Male Urethras\]](#)

- carries urine from the internal urethral orifice to the external urethral orifice and exits the body
- Note the basic differences in length between male and female ureters. What additional risk does this cause for females?
- Notice that the male urethra is a common exit for both the urinary and reproductive systems.

Urinary Bladder

[\[Section 25.2.2: Bladder\]](#)

[\[Figure 25.4: Bladder\]](#)

- trigone – triangular region on the posterior wall of the urinary bladder – contains the ureteral openings, the entrance of the ureters to the urinary bladder – inferiorly the urethra exits
- inner surface lined with transitional epithelium (allows for expansion)
- detrusor muscles – in the wall of the bladder (expels urine from bladder)
- rugae – folds formed from epithelial lining

Ureters

[\[Section 25.2.3: Ureters\]](#)

[\[Figure 25.6: Ureter\]](#)

- narrow, long, muscular tubes
- urine is moved by peristalsis from the kidney to the urinary bladder

Kidneys:

[\[Section 25.3: Gross Anatomy of the Kidney \(all subsections\)\]](#)

[\[Figure 25.7: Kidneys\]](#)

[\[Figure 25.8: Left Kidney\]](#)

- located posterior to the parietal peritoneum
- basic anatomy:
 - renal capsule
 - renal cortex
 - renal medulla
 - renal pyramid
 - renal column
 - renal papilla
 - calyces (major and minor)
 - renal pelvis
 - renal hilum

Blood Flow through the Kidney

[\[Throughout Section 25.3\]](#)

[\[Figure 25.9: Blood Flow in the Kidney\]](#)

Since the primary function of the kidneys is to filter waste materials from the blood, it is important for you to understand the complexities of the flow of blood into and out of the kidneys.

- Blood is delivered via the renal artery, which branches from the abdominal aorta
- Then it branches into segmental arteries then into interlobar arteries, which pass through renal columns
- Interlobar a. then divide into arcuate arteries, which cross the base of pyramids and enter the renal cortex as interlobular arteries
- These branch into afferent arterioles which are what forms the glomerulus
- At the end of the glomerulus, opposite the afferent arteriole, an efferent arteriole exits the glomerulus
- The efferent arteriole forms a bed of peritubular capillaries around the entire tubular portion of cortical nephrons
- But only around the proximal and distal convoluted tubules in juxtamedullary nephrons
- In juxtamedullary, the loop of henle is surrounded by vasa recta capillaries
- Both networks drain into interlobular veins, which drain into arcuate veins, to interlobar veins and finally the renal vein

Specific Kidney Functions

1. Remove waste: The kidneys filter waste products and excess fluid out of the blood and remove them from the body in the form of urine. (nitrogenous wastes such as urea and ammonium)
2. Maintain the right balance of chemicals in the body: The kidneys keep the right balance of chemicals, such as sodium, potassium, calcium, magnesium, and other substances your body needs to function properly. They filter excess amounts of these chemicals from the blood and get rid of them in the urine.
3. Synthesize several regulatory chemicals: The kidneys produce and secrete three important chemicals: renin, erythropoietin, and the active form of vitamin D (Calcitriol).

Production of Urine: An Overview

- The kidneys maintain the chemical balance of body fluids by removing metabolic wastes, excess water and electrolytes
- Three physiological process occur in nephrons to produce urine:
 1. Filtration
 - Blood is initially filtered in the glomerulus
 2. Reabsorption
 - as the filtrate moves through the PCT, 60-70% of water and 100% of the organic nutrients (glucose, amino acids) are reabsorbed into the blood
 - The loop of Henle conserves water and salt while concentrating the filtrate for modification by the DCT
 - Reabsorption in the DCT is controlled by two hormones, aldosterone and antidiuretic hormone (ADH)
 3. Secretion
 - Most secretion takes place in the DCT

The Nephron

[*\[Section 25.4: Microscopic Anatomy of the Kidney\]*](#)

[*\[Figure 25.10: Blood Flow in the Nephron\]*](#)

- The basic functional unit of the kidney is the nephron
- Here, water, ions and other waste material are removed from the blood to produce filtrate
- The filtrate then circulates through tubules and anything still needed is absorbed back into the blood
- The remaining filtrate is excreted as urine
- *2 types of nephrons*:
 - Cortical make up about 85% of all nephrons in a kidney
 - Juxtamedullary make up the other 15%

Nephron Anatomy

Each nephron consists of 2 distinct regions:

1. renal corpuscle – filters blood
2. renal tubule – modifies the filtrate through reabsorption and secretion to form urine

Nephron Part 1: The Renal Corpuscle

[*\[Section 25.4.1.1: Renal Corpuscle\]*](#)

[*\[Figure 25.11: Podocytes\]*](#)

[*\[Figure 25.12: Fenestrated Capillary\]*](#)

- initial filtration of blood
- Consists of two components: the glomerulus and Bowman's capsule
- Filterable blood components such as water, nitrogenous waste, and nutrients form the glomerular filtrate.
- Non-filterable blood components such as blood cells and platelets remain in the blood and exit the glomerulus via the efferent arteriole.

Nephron Part 2: The Renal Tubule

- modifies the filtrate through reabsorption and secretion to form urine
- consists of multiple sections:
 - the proximal convoluted tubule
 - the nephron loop or loop of Henle; consists of two distinct parts:
 - descending limb
 - ascending limb
 - the distal convoluted tubule
- all tubules empty into collecting ducts which channel urine towards the center of each kidney

Proximal Convoluted Tubule

[*\[Section 25.4.1.2: Proximal Convoluted Tubule\]*](#)

- the major site for reabsorption of water and solutes from the filtrate into the interstitial fluid and then into blood capillaries
- reabsorb 100% of most organic solutes (amino acid, glucose, etc.); 65% of water, sodium ions, and potassium ions; and 50% of chloride ions

Descending Limb (of nephron loop)

[*\[Section 25.4.1.3: Loop of Henle\]*](#)

- the nephron loop is also called the loop of Henle
- 15% of the water in the filtrate is reabsorbed by osmosis into the interstitial fluid
- the descending limb is impermeable to solutes

Ascending Limb (of nephron loop)

[*\[Section 25.4.1.3: Loop of Henle\]*](#)

- reabsorbs solutes

- impermeable to water

Distal Convoluted Tubule

[Section 25.4.1.4: Distal Convoluted Tubule]

- reabsorbs a small amount of water and solutes
- mainly, secretes solutes from the blood into the filtrate
- drains into a collecting duct

Collecting Ducts

[Section 25.4.1.5: Collecting Ducts]

- reabsorbs a small amount of water and solutes
- mainly, secretes solutes from the blood into the filtrate
- merge to form larger papillary ducts

Lab Exercise - Urinary System Activities :

Kidneys;
 Blood Flow Through the Kidney
 Ultrastructure of the Kidney
 Ureters
 Urinary Bladder
 Urethra
 Microscopic Examination of the Kidney
 Dissection of the Sheep Kidney
 - See the Structures of Importance

Learning Objectives

- To describe the function of the urinary system
- To identify the organs of the urinary system on a model or a diagram, and describe the function of each
- To compare the course and length of the urethra in males and females
- To trace the blood supply of the kidney from the renal artery to the renal vein
- To describe the nephron anatomy
- To identify and describe the microanatomy features of the nephron
 - Glomerulus
 - Capsule
 - Renal tubule
- To describe the function of the nephron, and the specific functions (filtration, reabsorption, secretion) that are associated with each region

Structures of Importance

Organs of the Urinary System	Kidney anatomy
Kidney	Cortex
Ureter	Medulla
Urinary bladder	Hilus
Urethra	Pelvis
	Renal artery and vein
Urinary bladder and urethra	Major and minor calyces
Detrusor muscle	Renal pyramid and columns
Ureteric orifices	Segmental arteries
Internal and external urethral sphincters	Interlobar arteries and veins
Membranous urethra (male only)	Arcuate arteries and veins
Spongy urethra (male only)	Cortical radiate (interlobular) arteries and veins
Prostate and prostatic urethra (male only)	
Bulbourethral gland (male only)	Nephron
Crus and bulb of penis (male only)	Renal corpuscle – glomerulus and Bowman's capsule
Erectile tissue of penis (male only)	Afferent and efferent arteriole
External and urethral orifice	Renal tubule
Trigone	Loop of Henle
	Proximal and distal convoluted tubules
Bladder microanatomy	Collecting duct
Transitional epithelium	Peritubular capillaries and vasa recta
	Visceral and parietal layers of glomerular capsule
	Macula densa cells and juxtaglomerular apparatus

Structure	Location	Description/Function
Kidney		
Retroperitoneal		
Perirenal fat capsule		
Fibrous capsule		
Renal cortex		
Renal medulla		
Renal pyramids		
Hilum		
Renal papilla		
Minor calyces		
Major calyces		
Renal pelvis		
Renal sinus		
Vasculature		
Abdominal aorta		
Renal artery		
Segmental aa		
Interlobar aa		
Arcuate aa		
Interlobular aa		
Afferent arteriole		
Glomerulus		
Peritubular capillary		
Vasa recta		

Efferent arterioles		
Interlobular vv		
Arcuate vv		
Interlobar vv		
Renal v		
Inferior vena cava		
Histology		
Nephron		
Glomerular capsule		
Proximal convoluted tubule		
Nephron loop		
Distal convoluted tubule		
Renal corpuscle		
Collecting duct		
Cortical nephron		
Juxtamedullary nephron		
Ureter and Bladder		
Ureter		
Urinary bladder		
Anteperitoneal		
Trigone		
Rugae		
Detrusor muscle		
Histology of Ureter and Bladder		
Transitional epithelium		

Lamina propria		
Smooth muscle		
Urethra		
External urethral orifice		
External urethral sphincter		
Internal urethral sphincter		
Prostatic urethra		
Membranous urethra		
Penile (spongy) urethra		

This lab also includes a physiology component, *Urinalysis*.