Anatomy and Physiology-Urinary System Cheat Sheet

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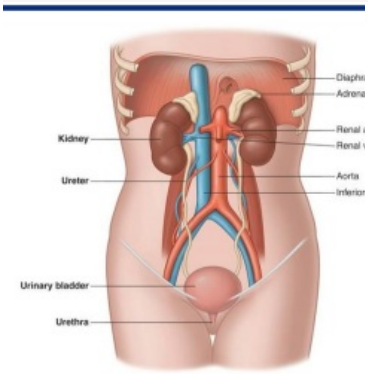
Urinary System

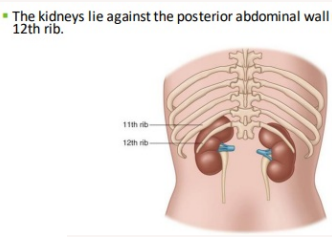


Functions of the Urinary System

Kidneys dispose of waste products in urine	Kidneys' regulatory functions include:
Nitrog-enous wastes	Production of renin to maintain blood pressure
Toxins	Production of erythropoietin to stimulate red blood cell production
Drugs	Conversion of vitamin D to its active form
Excess ions	

The urinary system consists of kidneys, ureters, urinary bladder, and urethra.

Kidneys

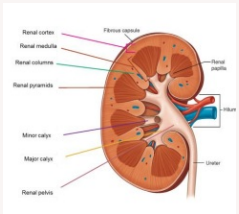


The kidneys lie against the posterior abdominal wall, underneath the 12th rib. They are retroperitoneal (posterior to the parietal perito-neum).

• The ribs help protect the kidneys, as does a heavy cushion of fat encasing each organ.

• Structures (such as blood vessels, the ureters, and nerves) enter and leave the kidney through a slit called the hilum—located in a concave notch on the medial side.

Interior of the Kidney



Interior of the Kidney

Blood Flow Through Kidneys

Aorta → Renal Artery → Afferent Arterioles → Glomerulus → Efferent Arterioles → Pelvic Capillaries → Renal Vein → Inferior Venal Cava → Right Atrium

Kidney Protection

Three protective layers enclose the kidney

Fibrous capsule encloses each kidney

Perirenal fat capsule surrounds the kidney and cushions against blows

Renal fascia is the most superf-icial layer that anchors the kidney and adrenal gland to surrounding structures

Renal Tubule

Arising from Bowman's capsule is the proximal convoluted tubule.

The renal tubule straig-htens out and dips into the medulla before turning sharply and returning to the cortex.

The collecting duct receives drainage from the distal convoluted tubules of several different nephrons.

Renal Tubule (cont)

Thousands of microvilli that allow absorption line the inside of the proximal convoluted tubule

his entire segment—which consists of a descending limb and an ascending limb—is called the loop of Henle

The collect duct passes throug the medull and merge with other collect ducts before drainir into a minor calyx.

After returning to the cortex, the ascending limb coils again, forming the distal convoluted tubule.

Renal Circulation – Blood Supply

One-quarter of the total blood supply of the body passes through the kidneys each minute

Renal artery provides each kidney with arterial blood supply

Renal artery divides into segmental arteries → interlobar arteries → arcuate arteries → cortical radiate arteries

A tough, fibrous capsule surrounds each kidney. The interior consists of the renal cortex and renal medulla; the renal cortex forms the outer region and the renal medulla forms the inner region.	Rrenal columns extened from the renal cortex,and divide the interior into cone-shaped sections, renal pyramids. The base of each pyramid faces outward toward the cortex; the point of the pyramid, renal papill-a,faces the hilum. The renal papilla extends into a cup called a minor calyx.	The calyx collectsV urine leaving the papilla. Two or three minor calyces join together to form a major calyx The major calyces converge to form the renal pelvis, which receives urine from the major calyces. The renal pelvis continues as the ureter, which channels urine to the urinary bladder

Renal Circulation – Blood Supply (cont)

As it enters the kidney, it divides into smaller and smaller arteries. The arteries pass through the renal columns and into the renal cortex.

Blood leaves the kidney through the renal vein, which empties into the inferior vena cava.

Renal Circulation – Blood Supply (cont)

Nephrons—the filtration units of the kidney—primarily lie in the kidney's outer region (the cortex). Loops from the nephron dip into the inner region (the medulla).

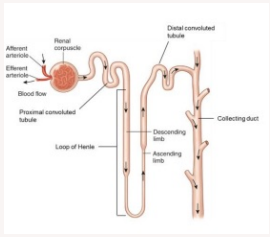
Filtrate from Glomerulus to Urine Excretion

1. Glomerulus --->
2. Bowman's capsule --->
3. Proximal Convoluted Tubule --->
4. Loop of Henle --->
5. Distal Convoluted Tubule --->
6. Collecting Duct --->
7. Renal Pelvic (minor and major calyxes) --->
8. Ureters --->

Filtrate from Glomerulus to Urine Excretion (cont)

9. Urinary Bladder --->
10. Urethra

Renal Tubule



Extends from glomerular capsule and ends when it empties into the collecting duct

- Subdivisions
- Proximal convoluted tubule (PCT)
- Nephron loop (loop of Henle)
- Distal convoluted tubule (DCT)

Renal Corpuscle

Bowman's capsule (or glomerular capsule) consists of two layers of epithelial cells surrounding the glomerulus in an open-ended covering. (

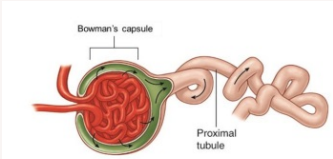
Fluid filters out of the glomerulus and collects in the space between the two layers of Bowman's capsule.

Renal Corpuscle (cont)

From there, it flows into the renal tubule on the other side of the capsule.

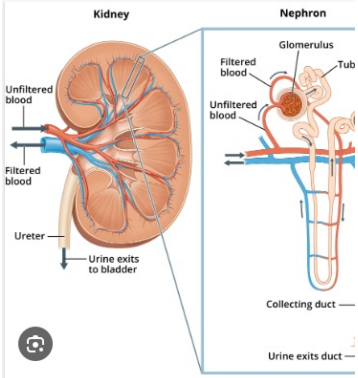
The renal corpuscle consists of a glomerulus and Bowman's capsule.

Renal Corpuscle



The renal corpuscle is the beginning of the nephron. (The two main components of a nephron are a renal corpuscle [which filters blood plasma] and a renal tubule [where urine is formed])

Nephron



Nephron

Nephrons are the filtration units of the kidney

Afferent Arterioles - arise from smaller arteries in the cortex; each afferent arteriole supplies blood to one nephron

Blood leaves the glomerulus through an efferent arteriole

Nephrons need a constant flow of blood. (More than 20% of the blood pumped by the heart each minute goes to the kidneys.)

Earise from smaller arteries in the cortex; each afferent arteriole supplies blood to one nephron, glomerulus

The efferent arteriole leads to a network of capillaries around the renal tubules, peritubular capillaries

Nephron (cont)

These capillaries pick up water and solutes reabsorbed by the renal tubules.

Blood flows from the peritu-bular capillaries into larger and larger veins that eventually feed into the renal vein

- Structural and functional units of the kidneys
- Each kidney contains over a million nephrons
- Each nephron consists of two main structures
• Renal corpuscle
• Renal tubule

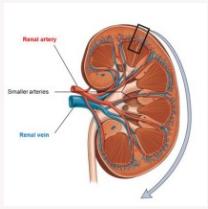
Renal Circulation – Venous

Venous blood flow

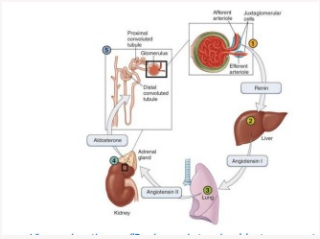
Cortical radiate veins → arcuate veins → interlobar veins → renal vein

Renal vein returns blood to the inferior vena cava

Renal Circulation – Blood Supply



Renin-Angiotensin-Aldosterone System



Urine Formation

Glomerular filtration

Tubular reabso rption

Tubular secretion

Urine Formation (cont)

Blood flows into the glomerulus through the afferent arteriole and leaves through the efferent arterioles

After filtrate leaves the glomer-ulus, it enters the renal tubules, where additional chemicals are removed from the filtrate and returned to the blood

Chemica are adde to the filtrate

Urine Formation (cont)

The walls of glomerular capillaries are dotted with pores; water and small solutes (such as electr-olytes, glucose, amino acids, vitamins, and nitrog-enous wastes) filter out of the blood and into Bowman's capsule.

Sodium, water, glucose, amino acids, chloride, potassium, and bicarb-onate moves by active transport out of the proximal convoluted tubule and into the bloods-tream of the peritu-bular capillaries

Wastes such as ammonia (NH_3) and uric acid, as well as drugs (such as aspirin and penici-llin), are secreted out of the blood and into the tubules.

Urine Formation (cont)

. Blood cells and most plasma proteins are too large to pass through the pores. The fluid that filters into Bowman's capsule flows into the renal tubules.

About half of the nitrog-enous waste urea is also reabso-rbed.

Tubular secretion of hydrogen ions also occurs, helping to regulate the body's pH.

Sodium and chloride are actively pumped out of the ascending limb of the loop of Henle into interstitial fluid.

Water diffuses out of the descending limb of the loop of Henle, further concen-trating the filtrate

Urine Formation (cont)

The distal convoluted tubule and collecting ducts reabsorb variable amounts of water and salts.

The distal convoluted tubule and collecting ducts reabsorb variable amounts of water and salts.

Urine Formation (cont)

Specialized cells play a role in acid-base balance, reabsorbing potassium and secreting hydrogen into the tubule.

Urine Formation (cont)

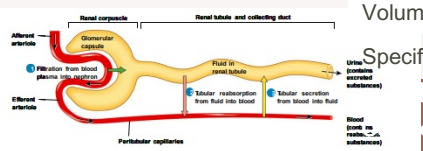
Several different hormones 23 Tubular Reabsorption and Secretion View animation on “Urine formation” Copyright ©2020 F.A. Davis Company Chapter 19: Urinary System 23 help regulate reabsorption by the cells in the distal convoluted tubule.

Urine Formation (cont)

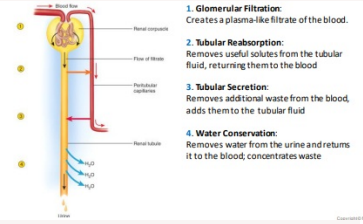
The collecting duct reabsorbs water and concentrates the filtrate, resulting in urine.

Urine formation involves three processes:
1. Glomerular filtration
2. Tubular reabsorption
3. Tubular secretion

Formation of Urine



Basic Stages of Urine Formation



1. Glomerular Filtration:
Creates a plasma-like filtrate of the blood.
2. Tubular Reabsorption:
Removes useful solutes from the tubular
fluid, returning them to the blood
3. Tubular Secretion:
Removes additional waste from the blood,
adds them to the tubular fluid
4. Water Conservation:
Removes water from the urine and returns
it to the blood; concentrates waste

Urine Composition

Color – the color is generally yellow but varies in degree and clarity

Odor – freshly voided urine should have no particular order unless affected by certain ingredients. Urine that has sat smells of ammonia

pH – pH is generally acidic but can range from 4.5-8.0

Volume – 0.75L – 2L/24 hours

Specific Gravity – 1.003 – 1.032

osition of Urine

Consists of 95% water; 5% dissolved substances	Reveals information about health of kidneys and other organs

The dissolved substances include nitrogenous wastes—such as urea, uric acid, ammonia, and creatinine—as well as other solutes, such as sodium, potassium, and sulfates.

Solutes in Urine

Solutes normally found in urine	Solutes NOT normally found in urine
Sodium and potassium ions	Glucose

Solutes in Urine (cont)

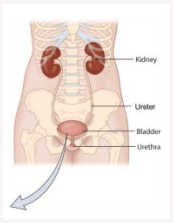
Urea, uric acid, creatinine	Blood proteins
Ammonia	Red blood cells
Bicarbonate ions	Hemoglobin
	WBCs (pus)
	Bile

Hormones That Affect the Urinary System

HORMONE	EFFECT ON KIDNEYS
Aldosterone	Reabsorbs: NaCl; H_2O Excretes: K^+
Atrial natriuretic peptide (ANP)	Excretes: NaCl; H_2O
Antidiuretic hormone (ADH)	Reabsorbs: H_2O
Parathyroid hormone (PTH)	Reabsorbs: Calcium Excretes: Phosphate

• Aldosterone, ANP, and PTH all act on the renal tubules; ADH acts primarily on the collecting duct.
• The adrenal cortex secretes aldosterone when blood levels of Na+ decline or concentration of K+ increases.
• The atria of the heart secretes ANP when blood pressure rises; this inhibits the secretion of aldosterone and ADH.
• The posterior pituitary gland secretes ADH.
• The parathyroid glands secrete PTH in response to low calcium levels.

Urinary System



The ureters and urethra serve as passageways for conducting urine away from the kidneys and out of the body while the bladder stores urine until it can be eliminated.
The ureters connect the renal pelvis of each kidney with the bladder

Ureters

Attaching the kidney to the urinary bladder	Peristalsis aids gravity in urine transport

Continuous with the renal pelvis

Enter the posterior aspect of the urinary bladder

Run behind the peritoneum

Urinary Bladder

Smooth, collapsible, muscular sac situated posterior to the pubic symphysis	Trigone—triangular region of the urinary bladder base based on three openings

Urinary Bladder (cont)

Mucous transitional epithelium lines the bladder. When the bladder relaxes, this layer forms folds, rugae. As urine fills the bladder, the rugae flatten and the epithelium thins, allowing the bladder to expand.	Two openings from the ureters (ureteral orifices)
	One opening to the urethra (internal urethral orifice)

At the point where the urethra leaves the bladder is a ring of smooth muscle that forms the internal urethral sphincter. This sphincter contracts involuntarily to retain urine in the bladder.

Urinary Bladder (cont)

External urinary sphincter exists where the urethra passes through the pelvic floor; this sphincter consists of skeletal muscle and is, therefore, under voluntary control.

The urethra is a small tube that conveys urine away from the bladder and out of the body; it opens to the outside of the body at the external urinary meatus.

- In males, the prostate surrounds the neck of the urinary bladder

Urinary Bladder

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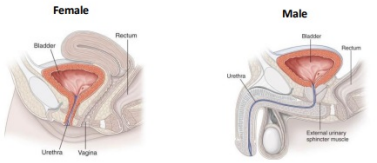
Urethra



Thin-walled tube that carries urine from the urinary bladder to the outside of the body by perist-alsis