



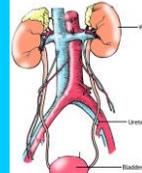
Urinary System

Urine

- 0.05% Ammonia
- 0.18% Sulphate
- 0.25% Phosphate
- 0.8% Chloride
- 0.01% Magnesium
- 0.015% Calcium
- 0.07% Potassium
- 0.1% Sodium
- 0.1% Creatinine
- 0.03% Uric acid
- 2% Urea

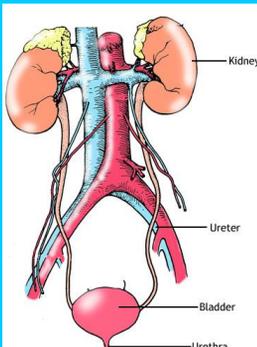
95% Water





I. Structures

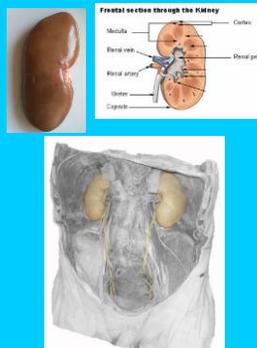
- A. Two kidneys that filter the blood.
- B. Two **ureters**
- C. A **urinary bladder**.
- D. A **urethra** to convey waste substances to the outside.



II. Kidneys

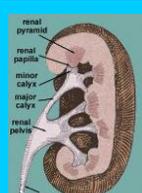
A. Kidney Structure

1. Reddish brown, bean-shaped organ 12 centimeters long.
2. Enclosed in a tough, fibrous capsule.
3. **Retroperitoneally**: Behind parietal peritoneum on either side of the vertebral column.
4. Left kidney slightly higher than the right.
5. Blood vessels, nerves, lymphatic vessels, and the **ureter** enter into a hollow **renal sinus**.



II. Kidneys

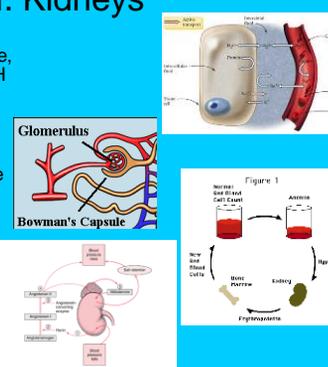
6. Inside the renal sinus lies a **renal pelvis**
 - a) Pelvis is subdivided into **major and minor calyces**.
 - b) Small **renal papillae** project into each minor calyx.
7. Two distinct regions are found within the kidney:
 - a) The **renal medulla** houses tubes leading to the papillae.
 - b) The **renal cortex** contains the **nephrons** (the functional units of the kidney).




II. Kidneys

B. Kidney Functions

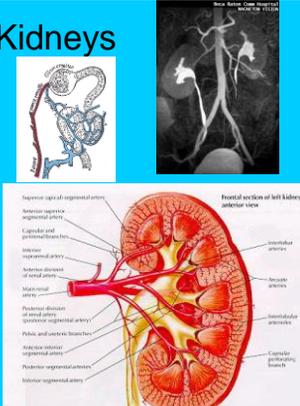
1. Regulate the volume, composition, and pH of **body fluids**.
2. Remove metabolic wastes from the **blood**.
3. Help control the rate of red blood cell formation by secreting hormone **erythropoietin**.
4. Regulate blood pressure by secreting enzyme **renin**.



II. Kidneys

C. Renal Blood Vessels

1. The abdominal aorta gives rise to **renal arteries** leading to the kidneys.
2. Interlobar arteries → **arcuate arteries** → interlobular arteries → afferent arterioles → **nephrons**.
3. Venous vessels generally correspond to the arterial pathways.

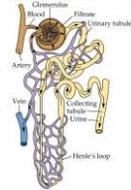
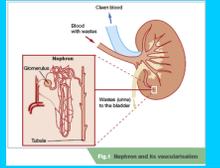


II. Kidneys

D. Nephrons

1. Nephron Structure

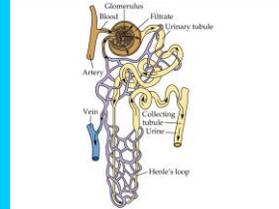
- a) A kidney contains about one million **nephrons**.
- b) Each of which consists of a **renal corpuscle** and a **renal tubule**.
 - 1) The renal corpuscle
 - a) Filtering portion of the **nephron**.
 - b) Made up of a ball of capillaries called the **glomerulus** and a **glomerular capsule** (receives the **filtrate**).



II. Kidneys

2) The renal tubule

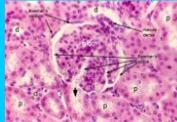
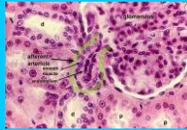
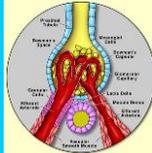
- a) Leads away from the glomerular capsule and first becomes a highly coiled **proximal convoluted tubule**.
- b) Then leads to the **nephron loop**, and finally to the **distal convoluted tubule**.
- c) Several **distal convoluted tubules** join to become a **collecting duct**.



II. Kidneys

2. Juxtaglomerular Apparatus

- a. **Macula densa** - Formed by the distal convoluted tubule at the point of contact between the **afferent** and **efferent arterioles**.
- b. Near the macula densa on the afferent arteriole are smooth muscle cells called **juxtaglomerular cells**.
- c. The macula densa together with the juxtaglomerular cells make up the **juxtaglomerular apparatus**.

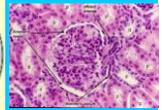
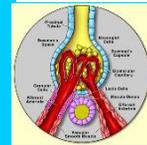
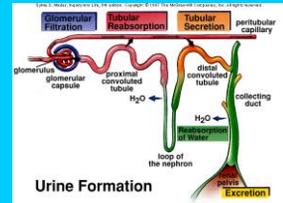


III. Urine Formation

A. Urine formation involves glomerular filtration, tubular reabsorption, and tubular secretion.

B. Glomerular Filtration

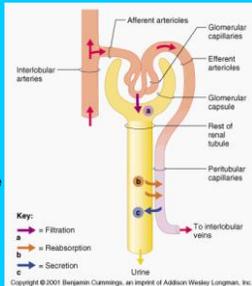
- 1. Urine formation begins when:
 - a. The fluid portion of the blood leaves the **glomerulus**.
 - b. Enters the **glomerular capsule** as **glomerular filtrate**.



III. Urine Formation

2. Filtration Rate

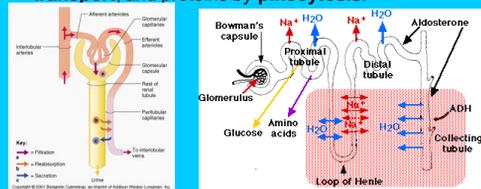
- a. When the **afferent arteriole** constricts, filtration pressure, and thus filtration rate, **declines**.
- b. When the **efferent arteriole** constricts, filtration pressure increases, **increasing** the rate of filtration.
- c. When hydrostatic pressure inside the **glomerular capsule** is high, filtration rate **declines**.
- d. Filtration rate is about 125 milliliters per minute or **180 liters** in **24 hours**, most of which is reabsorbed.



III. Urine Formation

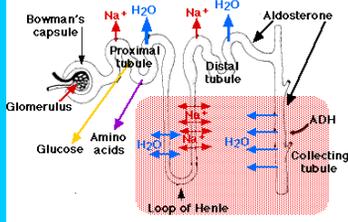
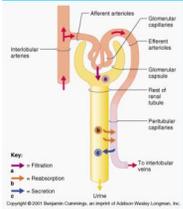
C. Tubular Reabsorption

- 1. Most reabsorption occurs in the **proximal convoluted tubule**, where cells have **microvilli** with **carrier proteins**.
- 2. Carrier proteins have a limited transport capacity, so excessive amounts of a substance will be **excreted into the urine**.
- 3. **Glucose** and **amino acids** are reabsorbed by **active transport**, and proteins by **pinocytosis**.



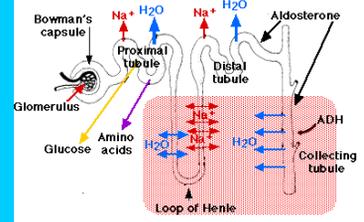
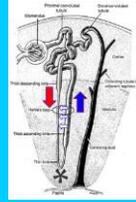
III. Urine Formation

- Sodium ions are reabsorbed by **active transport**, and negatively charged ions follow **passively**.
- As sodium is reabsorbed, water follows by **osmosis**.
- Most of the sodium ions are **reabsorbed** before the urine is excreted.



III. Urine Formation

- Sodium is concentrated in the **renal medulla** by the countercurrent mechanism.
- Normally the **distal convoluted tubule** and **collecting duct** are impermeable to water unless the hormone **ADH** is present

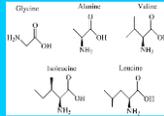


III. Urine Formation

D. Urea and Uric Acid Excretion

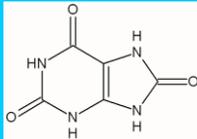
1. Urea

- A by-product of **amino acid metabolism**
- Passively reabsorbed by **diffusion** but about **50%** of urea is excreted in the urine.



2. Uric acid

- A by-product of **nucleic acid metabolism**.
- Most is reabsorbed by **active transport** and a small amount is secreted into the **renal tubule**.



III. Urine Formation

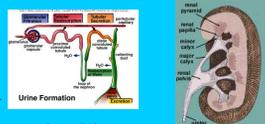
E. Urine Composition

- Varies from time to time.
- Usually **95%** water, contains urea, uric acid, a trace of amino acids, and **electrolytes**.



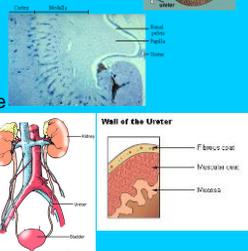
IV. Urine Elimination

- Forms in the **nephrons** → collecting ducts → renal papillae → minor and major calyces → **renal pelvis** → ureters → urinary bladder → **urethra**



B. Ureters

- Muscular tubes extending from the **kidneys** to the base of the **urinary bladder**.
- The wall is composed of three layers: **mucous coat**, muscular coat, and outer **fibrous coat**.
- Peristaltic waves** convey urine to the urinary bladder.



IV. Urine Elimination

C. Urinary Bladder

- The urinary bladder is a hollow, distensible, muscular organ lying in the **pelvic cavity**.
- The internal floor of the bladder includes the **trigone**, which is composed of the openings of the two **ureters** and the **urethra**.

