

Urinary system

Overview of the Urinary System

The **urinary system** (also known as the **renal system**) is responsible for:

- Removing **waste products** and **excess fluids** from the body.
- Regulating **electrolyte balance**, **blood pressure**, **pH**, and **blood volume**.
- Producing and excreting **urine**.

Major Functions

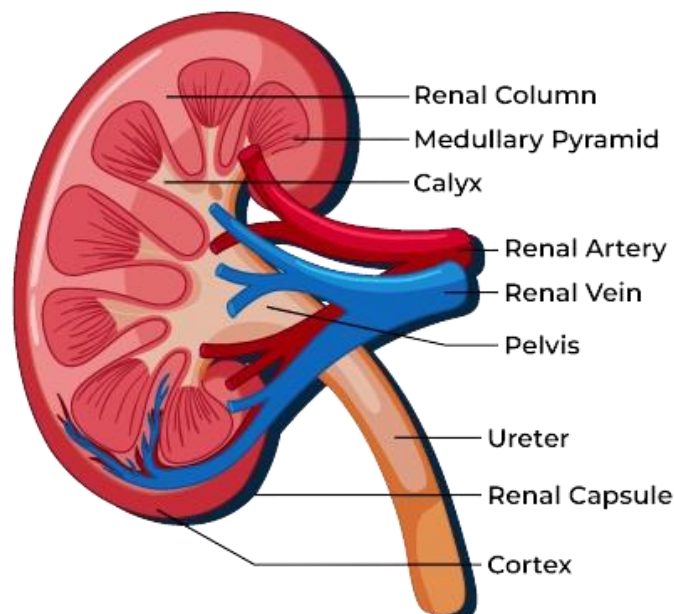
1. **Filtration of blood** to remove waste (mainly by kidneys).
2. **Reabsorption** of essential nutrients, water, and electrolytes.
3. **Secretion** of waste into forming urine.
4. **Storage** and **elimination** of urine.

Anatomy of the Urinary System

The urinary system consists of **four major components**:

1. Kidneys (Primary Organ)

- **Location:** Retroperitoneal, on either side of the spine (T12–L3).
- **Shape & Size:** Bean-shaped, approximately 10–12 cm long.
- **Protection:** Surrounded by fat (perirenal fat) and a fibrous capsule.



Internal Structure

1. Renal Cortex (outer layer):

- Contains renal corpuscles (glomeruli + Bowman's capsule).
- Site of filtration.

2. Renal Medulla (inner layer):

- Composed of renal pyramids.
- Collects urine and channels it to the renal pelvis.

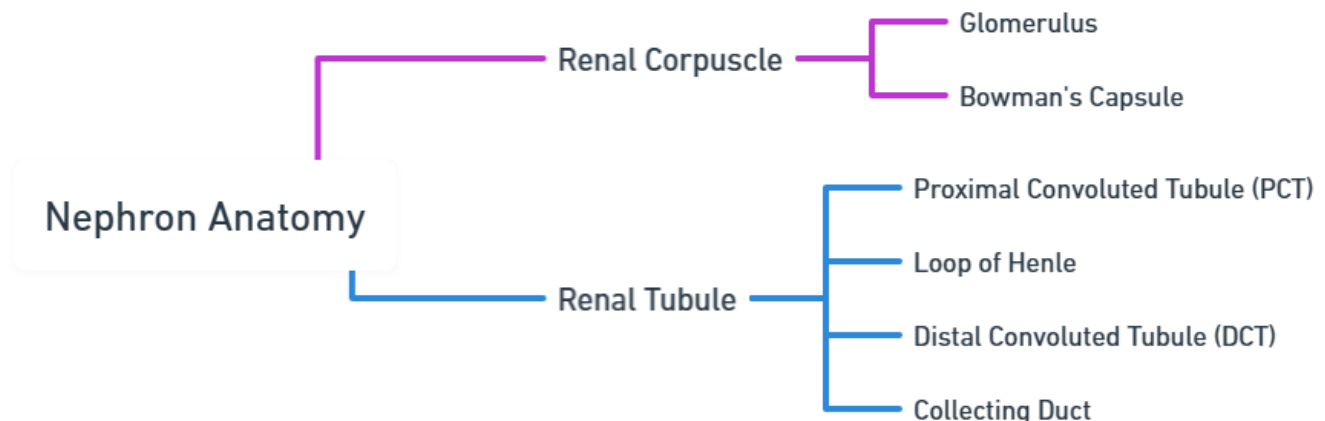
3. Renal Pelvis:

- Funnel-shaped structure that collects urine from pyramids and passes it into the ureter.

4. Nephrons (functional unit of kidney):

- Each kidney contains about 1 million nephrons.
- Nephrons are responsible for filtering blood and forming urine.

Structure of a Nephron



A. Renal Corpuscle:

- **Glomerulus:** Capillary tuft that filters plasma.
- **Bowman's Capsule:** Surrounds glomerulus; collects filtrate.

B. Renal Tubule:

1. Proximal Convoluted Tubule (PCT):

- Reabsorbs water, glucose, amino acids, and ions.

2. Loop of Henle:

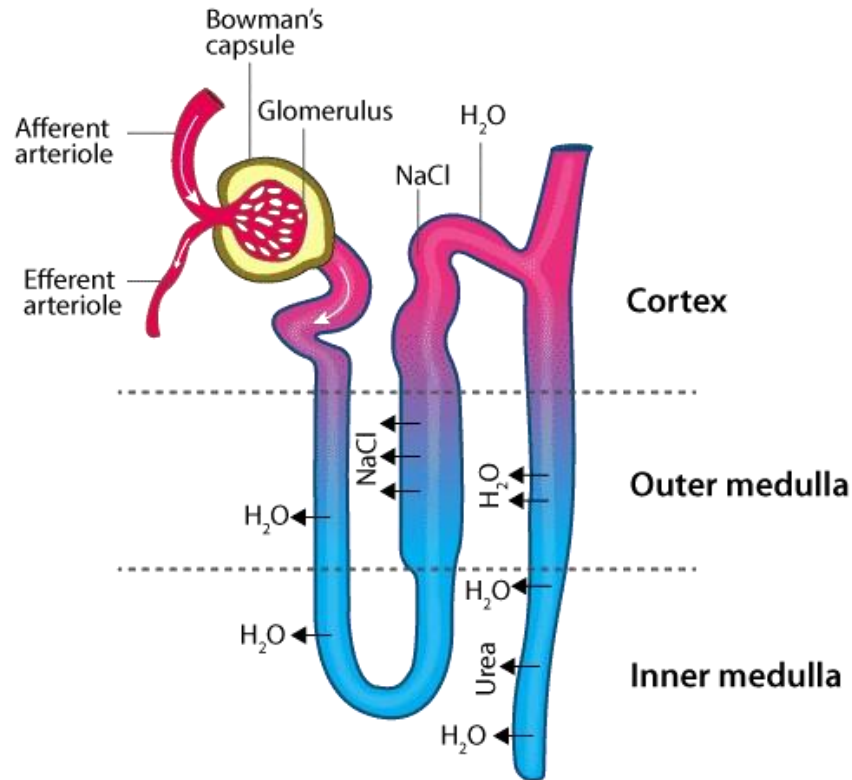
- **Descending limb:** Reabsorbs water.
- **Ascending limb:** Reabsorbs sodium and chloride.

3. Distal Convolved Tubule (DCT):

- Regulates sodium, potassium, and pH.

4. Collecting Duct:

- Final adjustment of urine concentration.
- Responds to ADH (antidiuretic hormone) for water reabsorption.



2. Ureters

- **Function:** Transport urine from kidneys to bladder.
- **Structure:** Muscular tubes (approximately 25–30 cm).
- **Movement:** Peristalsis (wave-like contractions).
- **Layers:**
 - **Mucosa:** Lined with transitional epithelium.
 - **Muscularis:** Smooth muscle.
 - **Adventitia:** Connective tissue.

3. Urinary Bladder

- **Function:** Temporary storage of urine.
- **Location:**
 - In males: in front of the rectum.

- In females: in front of the vagina and below uterus.

- **Structure:**

- **Detrusor muscle:** Smooth muscle responsible for bladder contraction.
- **Trigone:** Triangle area at the base; between ureter openings and urethra.
- **Internal urethral sphincter:** Involuntary control.
- **External urethral sphincter:** Voluntary control (skeletal muscle).

4. Urethra

- **Function:** Carries urine from bladder to exterior.
- **Length:**
 - **Males:** Approximately 20 cm (also a part of the reproductive system).
 - **Females:** Approximately 4 cm.
- **Sphincters:**
 - **Internal:** Smooth muscle (involuntary).
 - **External:** Skeletal muscle (voluntary).

Physiology of the Urinary System

1. Urine Formation

Occurs in three stages:

A. Filtration

- Occurs in the **glomerulus**.
- Blood pressure forces water and solutes out of the blood into **Bowman's capsule**.
- Filters approximately 180 liters per day, but most of it is reabsorbed.

B. Reabsorption

- Mostly in the **PCT** and **Loop of Henle**.
- Reabsorbs:
 - Water
 - Glucose
 - Sodium, potassium, calcium
 - Amino acids

C. Secretion

- Moves substances (H^+ , K^+ , drugs) from the blood into the tubule.
- Helps in pH regulation and toxin elimination.

2. Water and Electrolyte Balance

• Hormonal Control:

- **ADH (Vasopressin):** Promotes water reabsorption in collecting ducts.
- **Aldosterone:** Increases sodium reabsorption.
- **ANP (Atrial Natriuretic Peptide):** Promotes sodium excretion.
- **Renin-Angiotensin-Aldosterone System (RAAS):** Regulates blood pressure and fluid balance.

3. Acid-Base Balance

- Kidneys excrete **H^+ ions** and reabsorb **HCO_3^- (bicarbonate)**.
- Maintains blood pH around 7.35–7.45.

4. Excretion

- Final urine is composed of:
 - Approximately 95% water
 - Urea, creatinine, uric acid
 - Ions (Na^+ , Cl^- , K^+)

5. Micturition (Urination Reflex)

- **Bladder stretch receptors** signal the brain when around 200–400 mL of urine accumulates.
- The **parasympathetic** nervous system causes **detrusor muscle contraction**.
- **Voluntary relaxation** of the external sphincter allows urination.
- This is a **reflex in infants**, but **voluntary control** develops with age.

Physiology of Urine formation

- Urine formation is a complex process that involves several steps to filter blood, remove waste products, and maintain the body's fluid and electrolyte balance.
- The primary site of urine formation is the nephron, which is the functional unit of the kidney.
- There are three main steps in urine formation: glomerular filtration, tubular reabsorption, and tubular secretion.

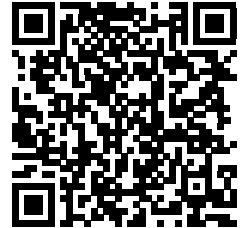


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