

The Urinary System

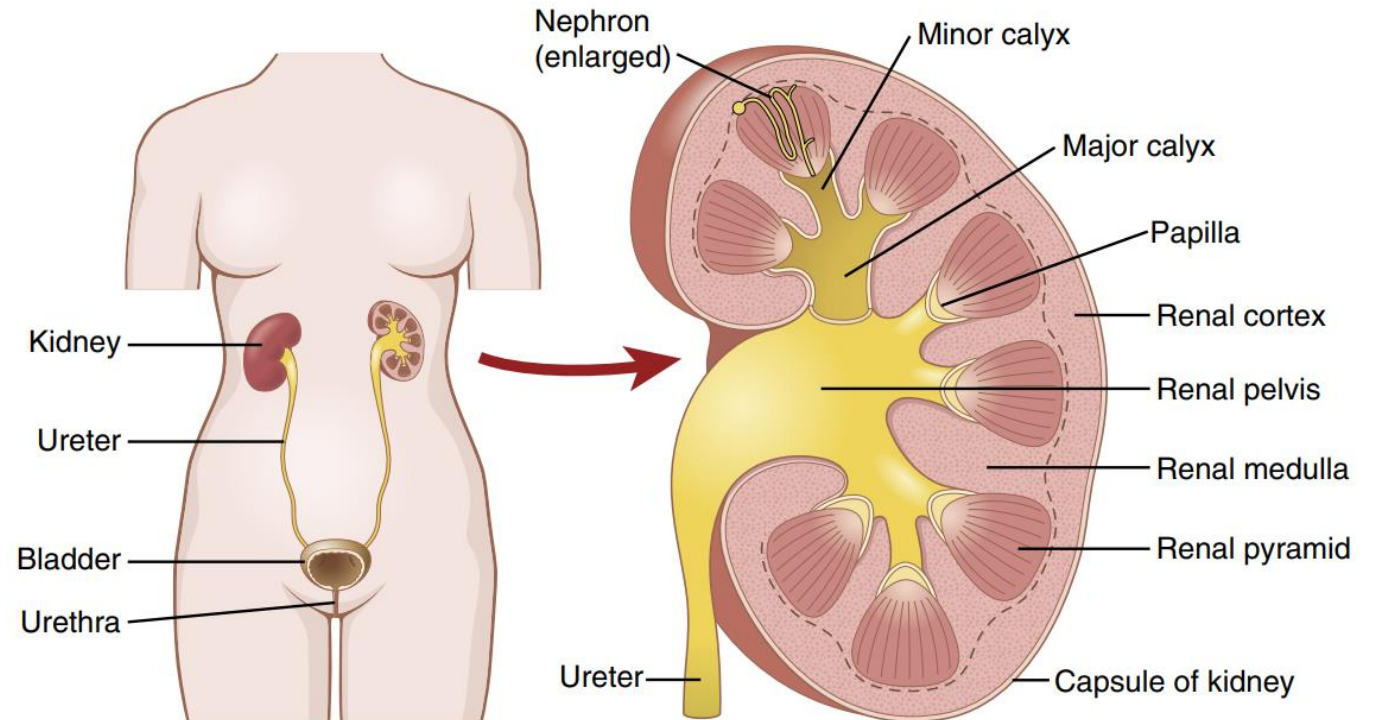
By Khushal Khan

Urinary System

- Also called **Renal system** or **Urinary tract**.
- The urinary system is **the organ system responsible for the production and excretion of urine.**

Parts:

1. **Kidneys (2 in number)**
2. **Ureters (1 from each kidney)**
3. **Urinary bladder**
4. **Urethra**



Kidneys

Location:

- Lie on posterior abdominal wall
- On either side of vertebral column
- Below the diaphragm
- Retroperitoneal

Colour:

- Reddish brown

Shape:

- Bean shaped

Dimensions:

- 11 cm (L) x 6cm (W) x 3cm (thickness)

Weight:

- 150 grams

Perirenal Fat:

- Structural fat
- Provide protection and anchoring functions

Renal Capsule:

- Tough fibrous outer covering
- Protect internal delicate structures

Borders:

- Concave (inner)
- Convex (outer)

Hilum:

- Indented region on medial side
- Entry and exit point of renal artery, renal vein, lymphatics, nerve supply, and ureter

Blood Supply:

- Arterial – Renal artery
- Venous – Renal vein

Gross Structure of Kidney

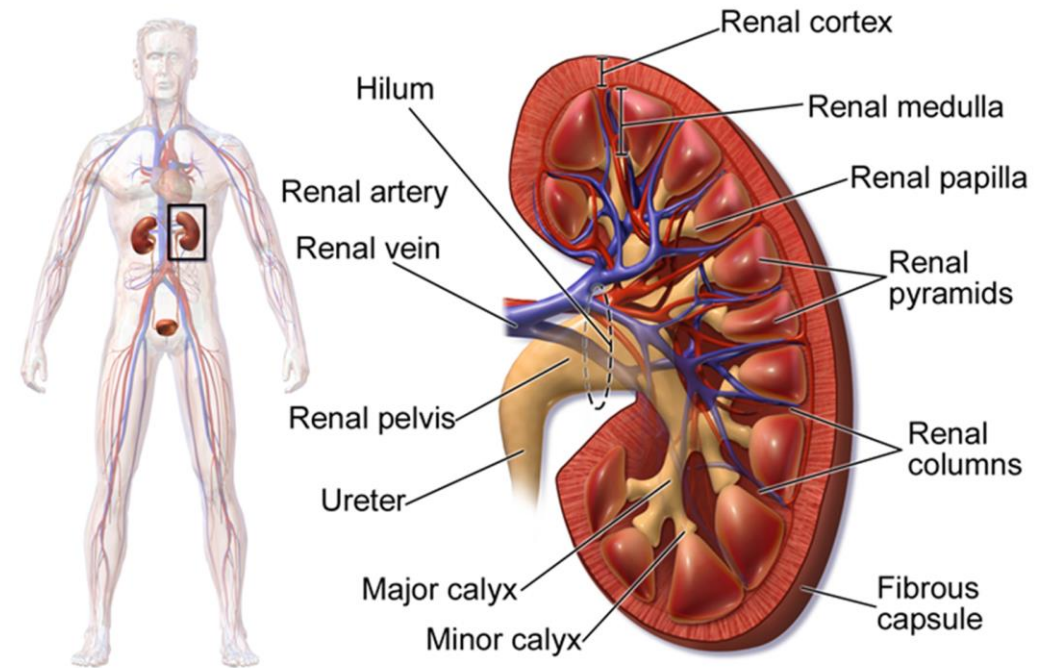
Regions (Layers):

1) Renal Cortex

- Outer layer, lies below the capsule
- **Reddish – brown** in colour

2) Renal Medulla

- Innermost layer
- Divided into **8 - 10 cone-shaped masses of tissue – renal pyramid**



Renal Pyramids

- Base – originates at border b/w cortex and medulla, terminates at papilla
- **Papilla** → projects into the space of **renal pelvis**

Gross Structure of Kidney

Renal Columns

- Projections (extensions) of renal cortex b/w the pyramids.

Renal Pelvis

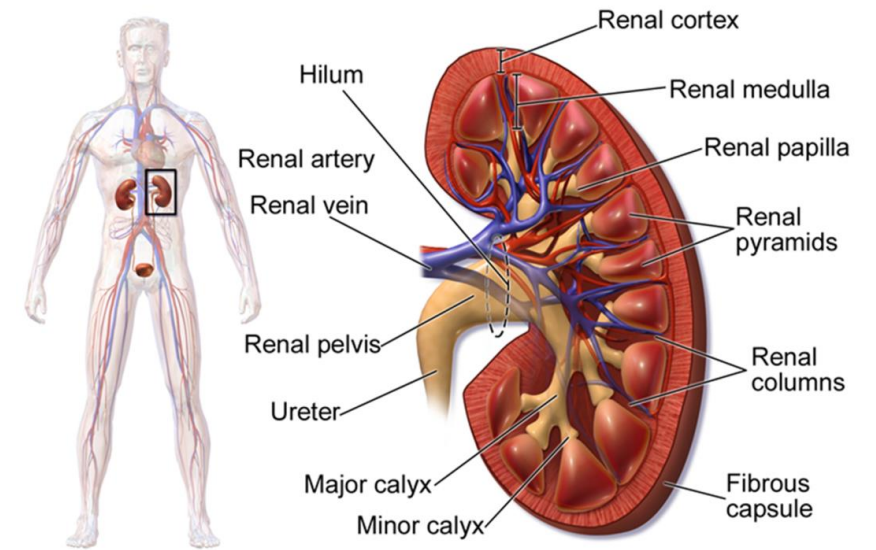
- A funnel-shaped continuation of the upper end of the ureter.
- It **collects urine formed** by the kidney.

Major calyces

- Outer border of the pelvis is divided into open-ended **pouches** - major calyces.
- They extend downward and divide into **minor calyces**.

Minor calyces

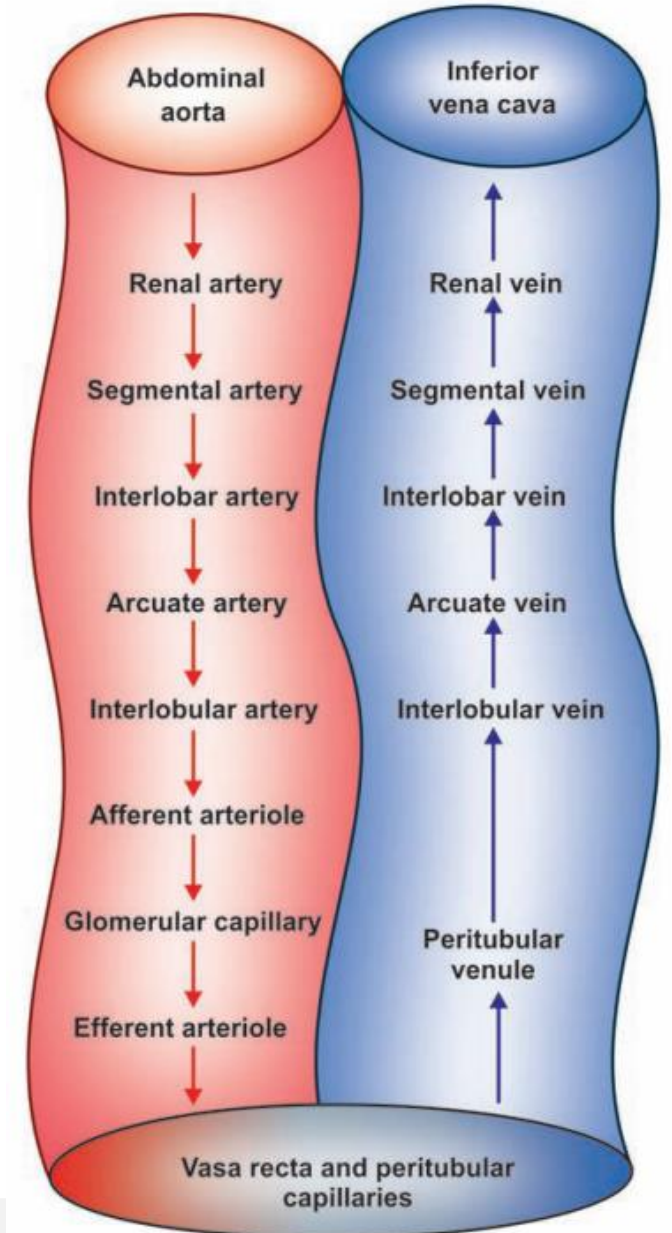
- Collect urine from the tubules of each papilla.



Renal Blood Flow

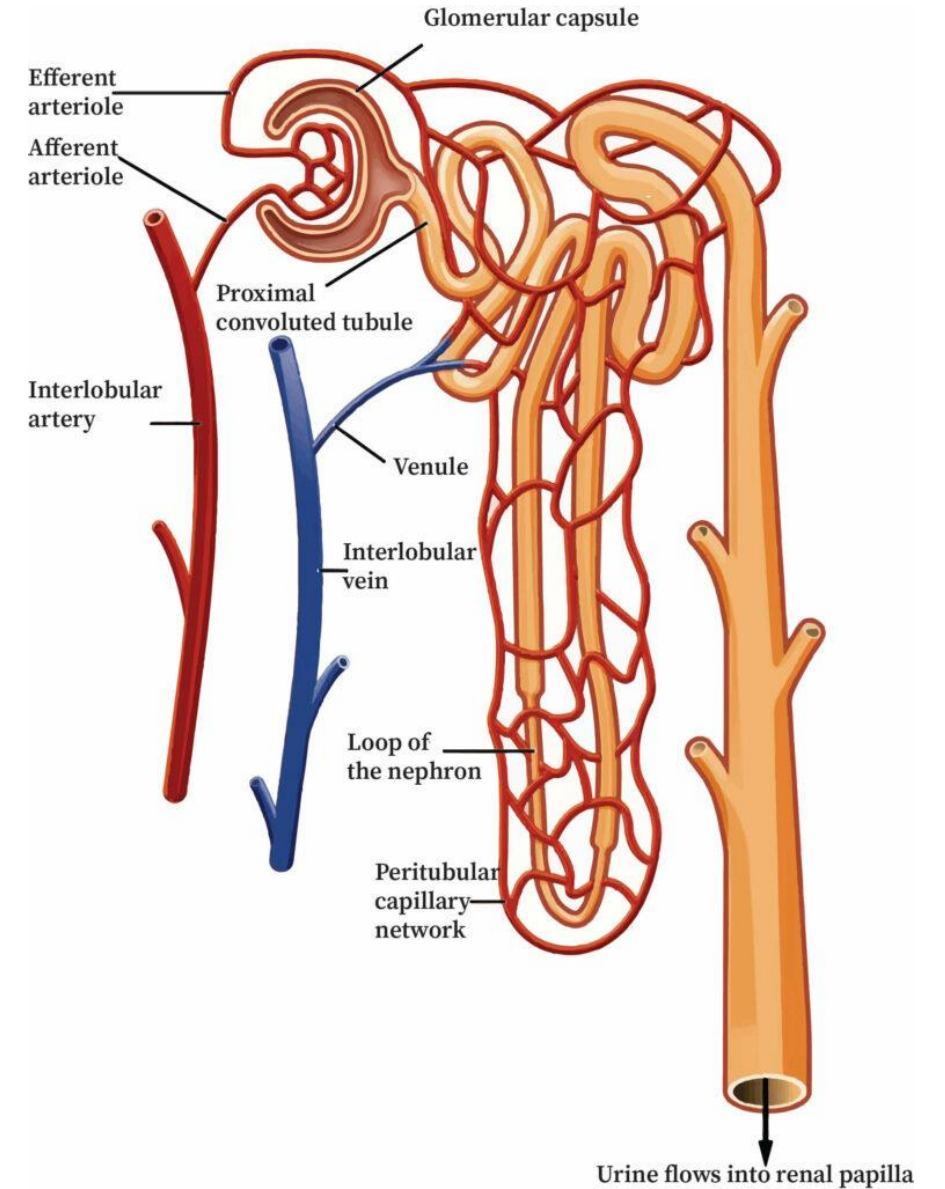
Renal Blood Flow Rate

- Approximately 22% of cardiac output – Equivalent to 1100 ml/min



Microscopic Structure of Kidney

- A kidney is composed of;
 1. Nephrons
 2. Collecting Ducts



Nephron

- The **nephron** is the microscopic **structural and functional unit of the kidney**.
- A healthy adult have **1-1.2 million nephron** each kidney.
- A nephron is composed of:

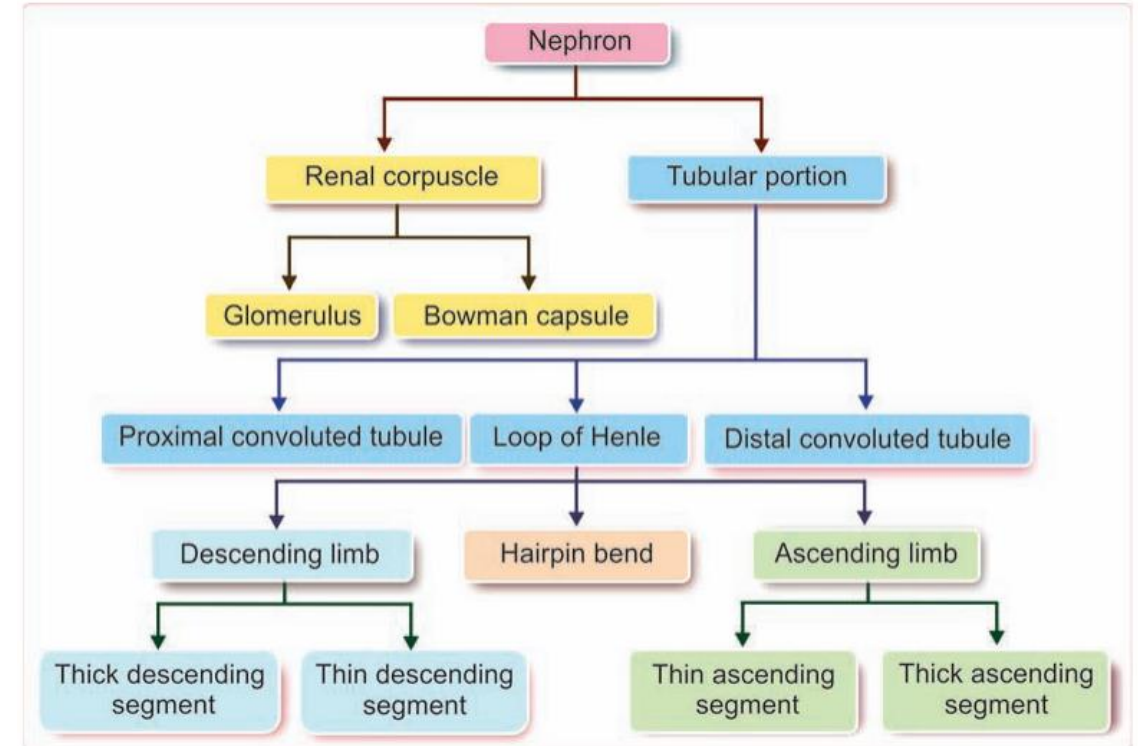
1. **Renal Corpuscle**
2. **Renal Tubule**

1. Renal Corpuscle

- The renal corpuscle consists of;
- **Glomerulus** - a tuft of capillaries
- **Bowman's capsule** - a cup-shaped structure

2. Renal Tubule

- It extends from the **Bowman's capsule**.
- The **capsule and tubule are connected** and are **composed of epithelial cells**.



Nephron

- Components of renal tubules:

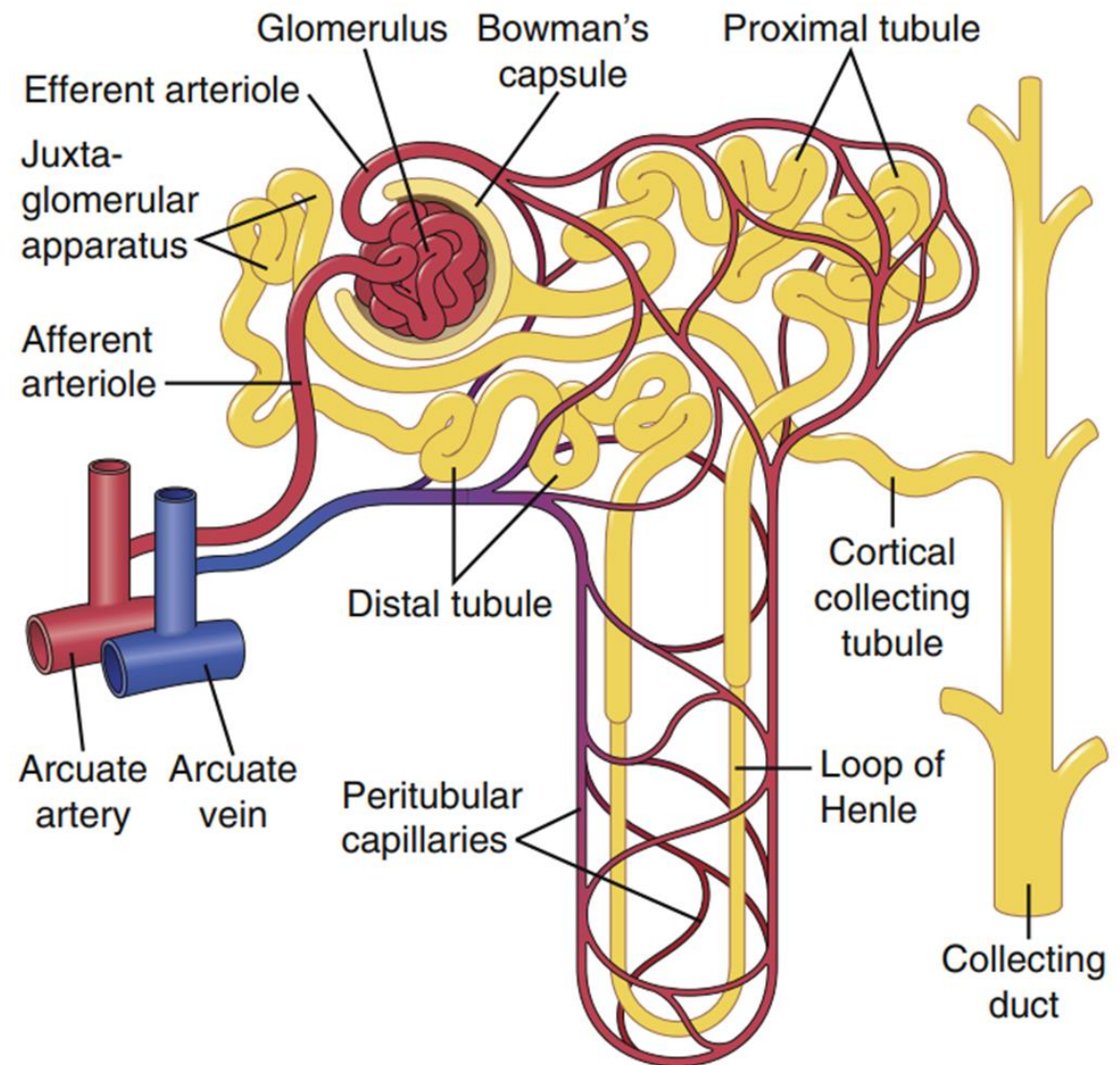
1. Proximal Convoluted Tubule

- Location: Renal cortex
- Epithelium: Simple cuboidal with brush borders
- Function: Increased absorption area

2. Loop of Henle

- Location: Renal medulla
- Structure: U-shaped, hair-pin like
- Limbs:
 - Thin (Descending limb)
 - Thick (Ascending limb)

3. Distal convoluted tubule



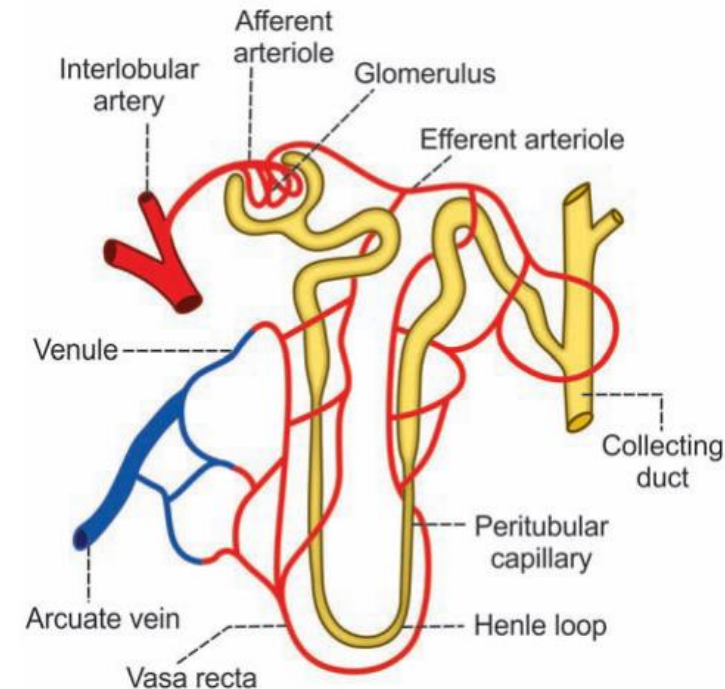
Renal Capillaries

1. Peritubular Capillaries

- **Location:** Around tubular portion of cortical nephrons
- **Function:** Facilitate reabsorption and secretion between blood and nephron lumen

2. Vasa Recta

- **Location:** Supply tubular portion of juxtamedullary nephrons
- **Type:** Specialized capillaries
- **Structure:** Straight blood vessels
- **Origin:** Arise directly from efferent arteriole of juxtamedullary nephrons
- **Path:** Run parallel to renal tubule into medulla, ascend towards cortex



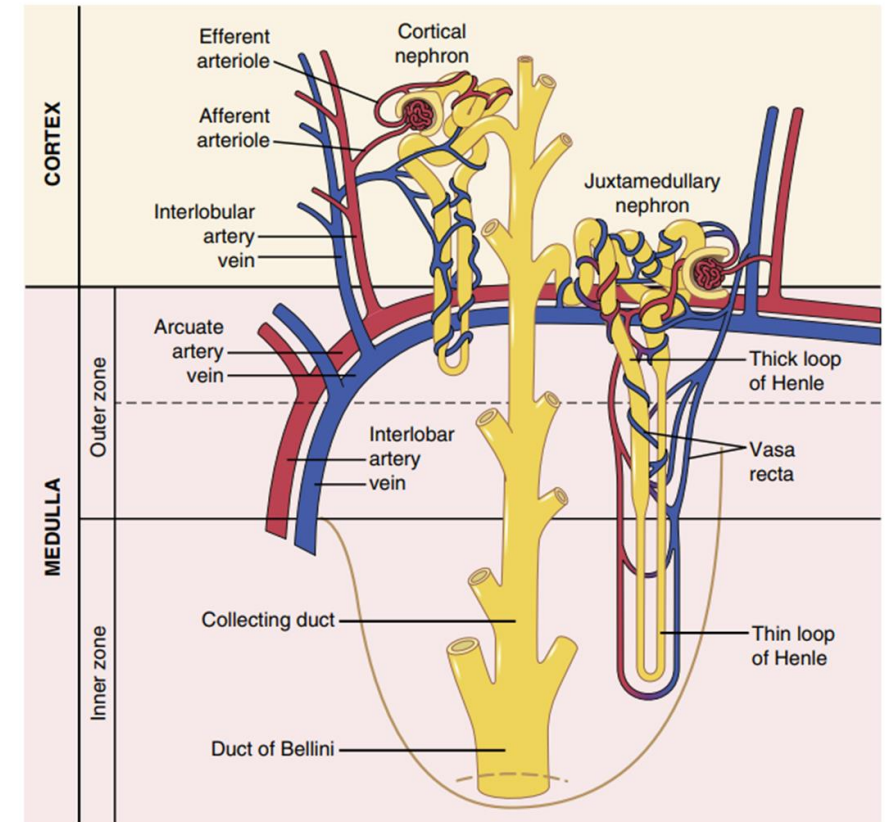
Types of Nephrons

1. Cortical Nephrons

- Glomerulus Location: Near outer cortex
- Loop of Henle: Short
- Percentage: Approximately 85% of nephrons

2. Juxtamedullary Nephrons

- Glomerulus Location: Near cortex-medulla junction
- Loop of Henle: Penetrates deep into medulla
- Percentage: Approximately 15% of nephrons



Collecting Ducts

- Collecting ducts are a **series of tubules and ducts**, that physically connect nephrons to;
 - **Minor calyx or renal pelvis**

Pathway of Urine Transport:

- Collecting ducts → Renal pyramids → Minor calyx → Major calyx → Renal pelvis → Ureter → Urinary bladder → Urethra

Support: Surrounded by **connective tissue** containing **blood vessels, nerves, and lymph vessels**

Functions of Kidneys

1. Excretion of metabolic waste products (**urea, creatinine**) & foreign materials (**drugs, toxins**)
2. Regulation of **water and electrolyte balance**
3. Regulation of concentration of electrolytes (**Na⁺, K⁺, Cl⁻, Mg⁺², H⁺, HCO₃⁻, Ca⁺²**)
4. Long term acid- base balance – **maintains pH (regulation of H⁺, HCO₃⁻ ions)**
5. **Metabolic functions:**
 - Gluconeogenesis
 - 1,25-dihydroxy vitamin D₃ production
6. **Endocrine functions:**
 - Erythropoietin – stimulates synthesis of RBC
 - Renin (enzyme) – regulation of blood pressure through RAAS system

Ureter

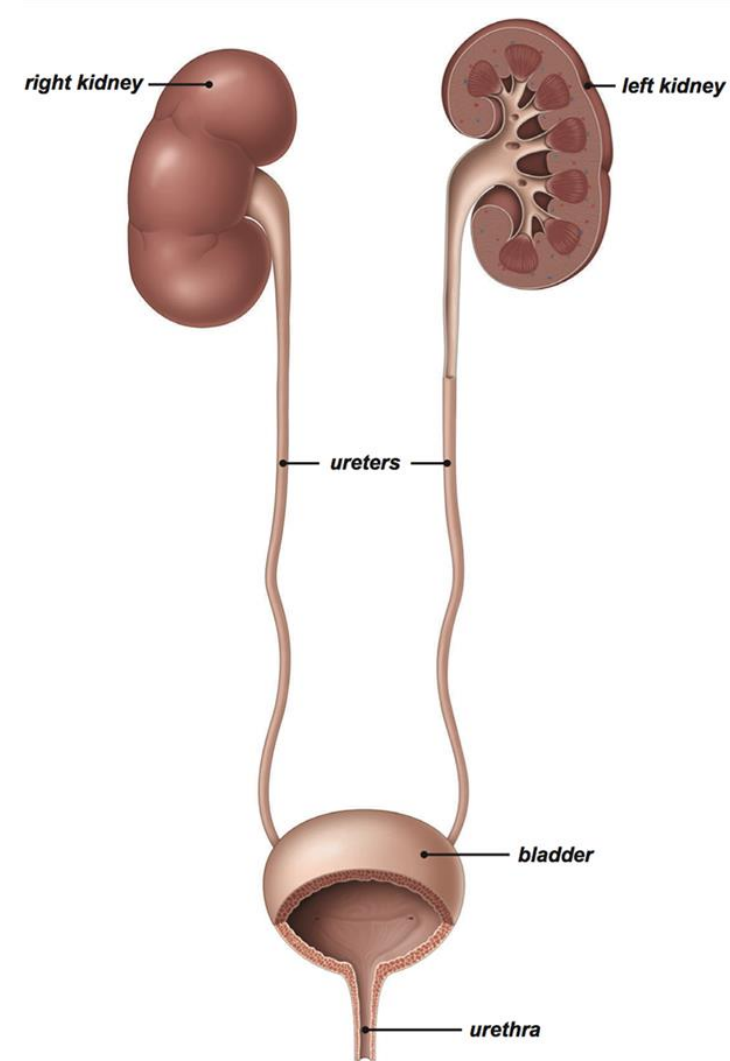
- **Function:** Carry urine from kidneys to urinary bladder
- **Length:** Approximately 25 to 30 cm
- **Diameter:** About 3 mm
- **Connection:** Continuous with renal pelvis
- **Opening:** Into posterior wall of bladder (base)

Wall Structure:

1. **Outer Layer:** Fibrous tissue covering
2. **Middle Muscular Layer:** Smooth muscle cells
3. **Inner Layer (Mucosa):** Transitional epithelium

Urine Propulsion:

- Achieved by peristaltic contraction of smooth muscle layer



Urinary Bladder

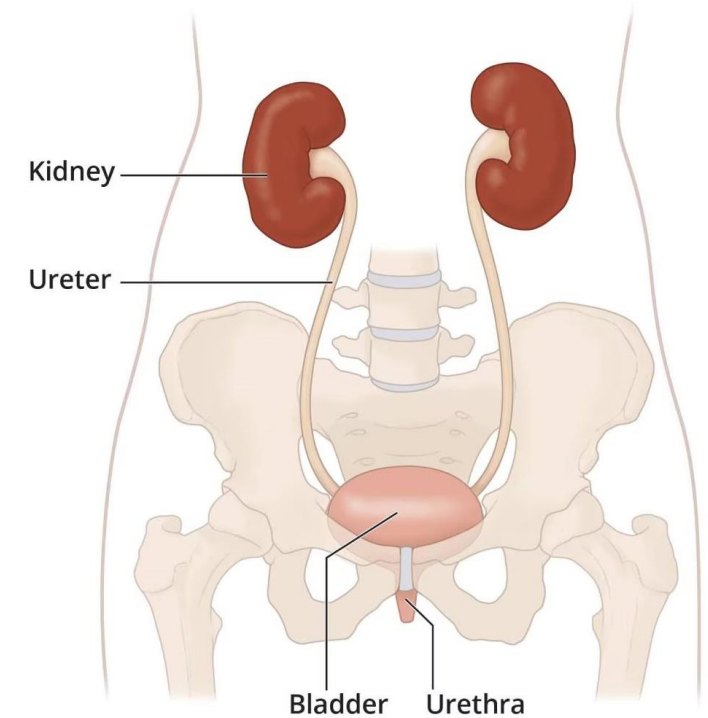
- **Function:** Reservoir for urine
- **Location:** Pelvic cavity

Size and Position

- Variable, depending on urine volume
- When distended, rises into abdominal cavity

Structure

- **Shape:** Roughly pear-shaped, becoming more oval as it fills
- **Base:** Posterior surface
- **Neck:** Opens into urethra at lowest point



Urinary Bladder

Wall Layers:

1. Outer Layer:

- Loose connective tissue containing blood vessels, lymphatics, nerves; covered by peritoneum

2. Middle Layer (Detrusor Muscle):

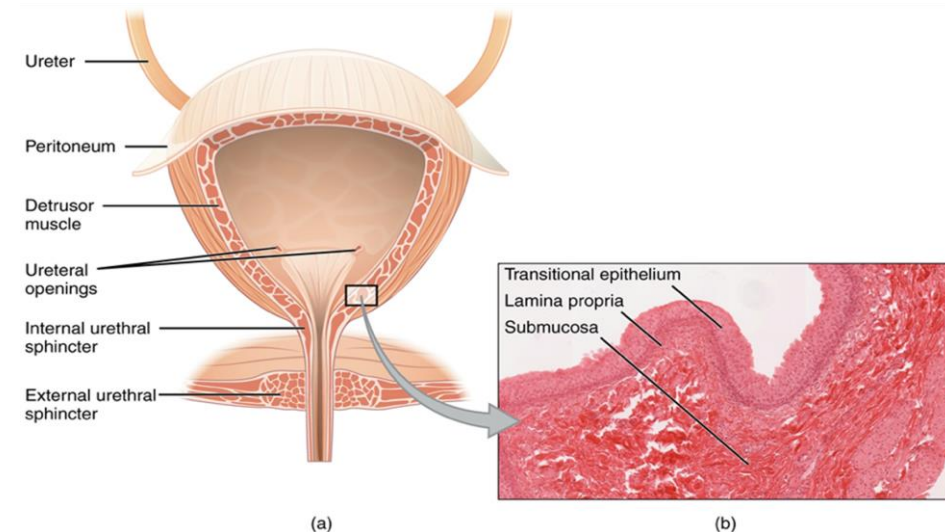
- Consists of smooth muscle fibers and elastic tissue, contracts to empty bladder

3. Inner Layer (Mucosa):

- Transitional epithelium, permits bladder distension; forms folds (rugae) when empty

Capacity

- **Total:** More than 600 ml of urine
- **Sensation to urinate:** Felt when bladder fills to 300-400 ml



Urinary Bladder

Trigone

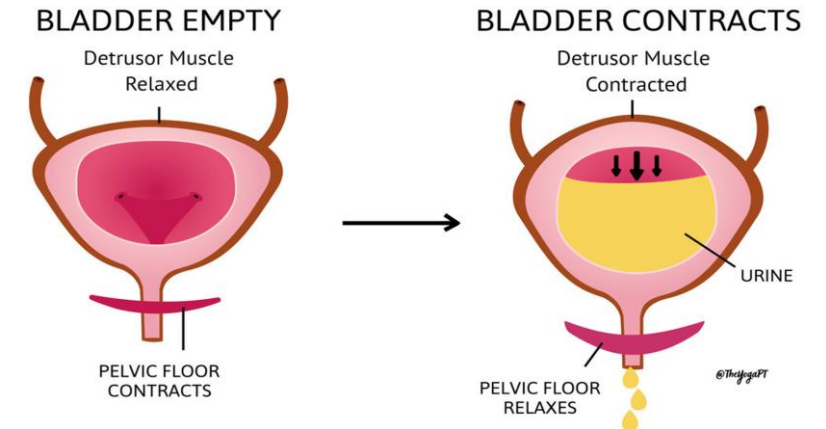
- Three orifices in bladder
- **Upper 2:** Located on posterior wall, openings of ureters
- **Lower 1:** Located anteriorly, opening of urethra

Internal Ureteral Sphincter

- Located in upper part of urethra
- Thickening of internal mucosal layer
- Controls urine outflow from bladder to urethra, not under voluntary control

Micturition

- Process of discharging urine from bladder



Urethra

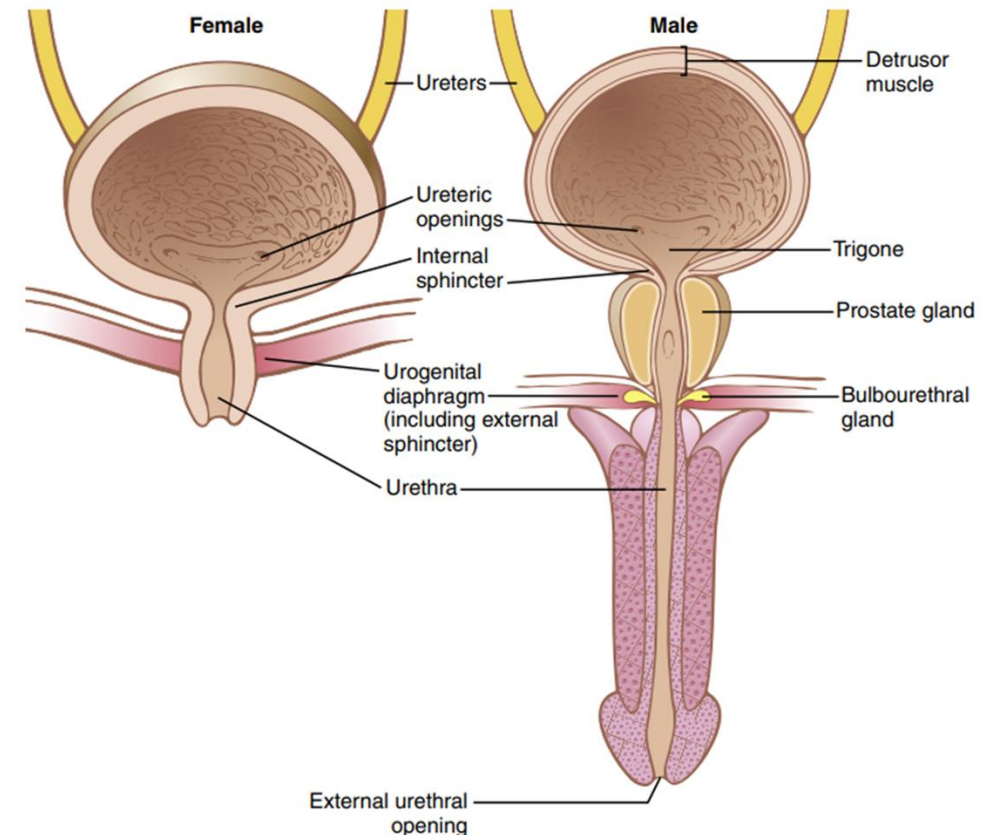
- Canal extending from **neck of bladder to exterior**
- **Opening:** External urethral orifice
- **Lining:** Stratified columnar epithelium

Sex Differences

1. **Male Urethra:**
 - **Length:** Approximately 20 cm, extends length of penis
2. **Female Urethra:**
 - **Length:** Approximately 4 cm, **Diameter:** 6 mm

External Urethral Orifice

- Guarded by: **External urethral sphincter**
- Control: **Under voluntary control**



Thank You