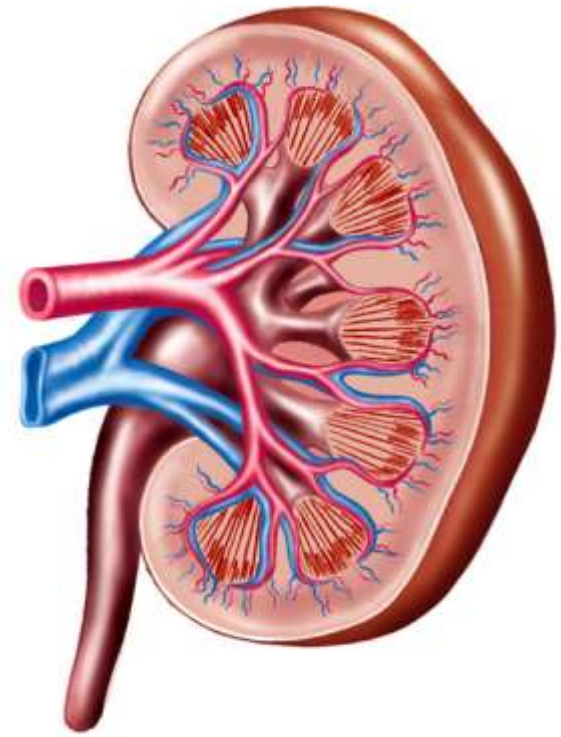


THE URINARY SYSTEM

What type of waste does the kidney eliminate and how does it use osmosis to do it?

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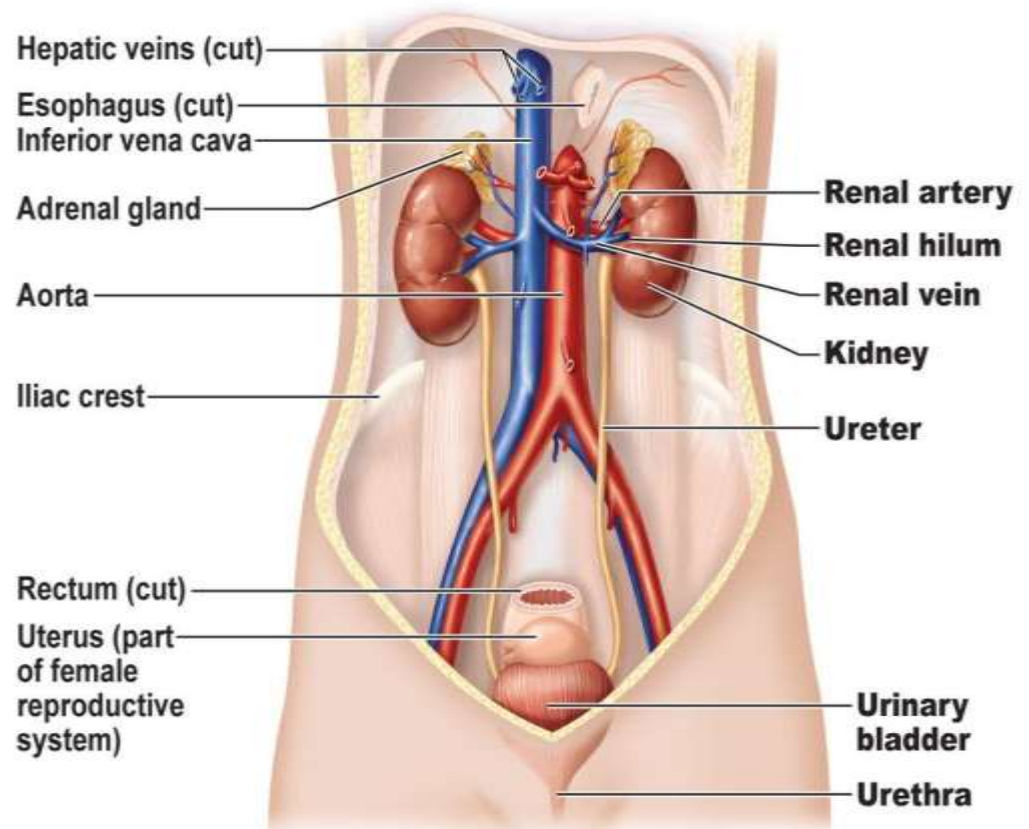


Functions of the Urinary System

- Elimination of waste products
 - Nitrogenous wastes
 - Toxins
 - Drugs
- Regulate aspects of homeostasis
 - Water balance
 - Electrolytes
 - pH balance
 - Blood pressure
 - RBC production
 - Activation of vit.D

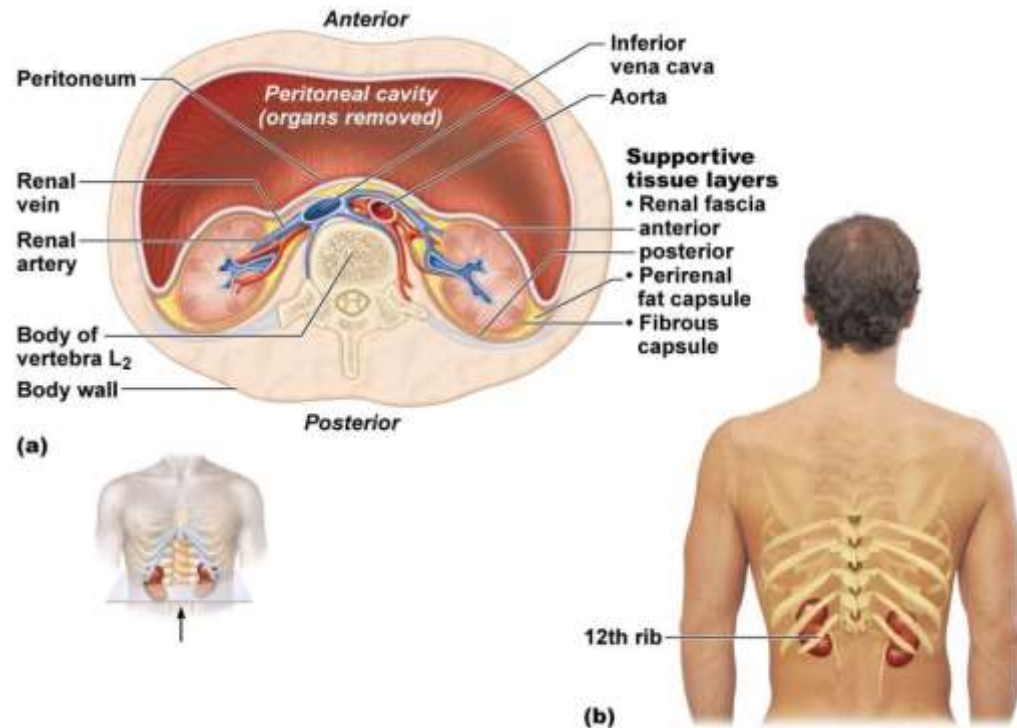
Basic Gross Anatomy

- Two kidneys
- Two ureters
- Urinary bladder
- Urethra



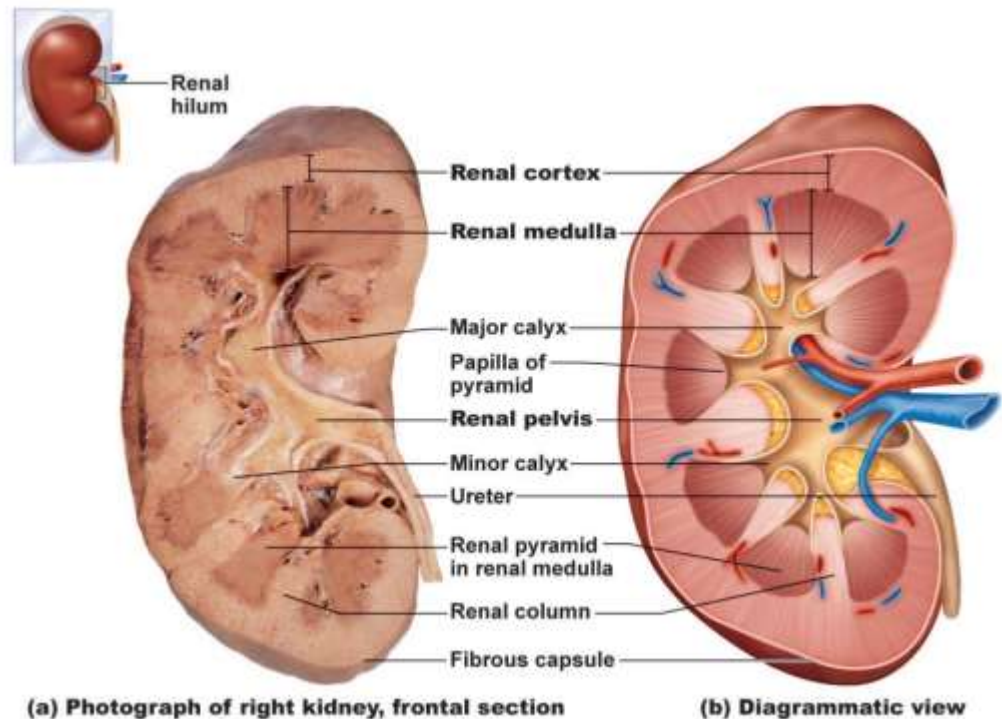
External Anatomy of the Kidneys

- Within the muscular wall of the back between T12-L3.
- Connective tissue layers:
 - Renal capsule
 - Adipose capsule
 - Renal fascia



Internal Anatomy of the Kidneys

- Renal Cortex
- Renal Medulla
 - Renal pyramids
 - Renal papillae
 - Renal columns
- Renal Pelvis
 - With major calyces and minor calyces



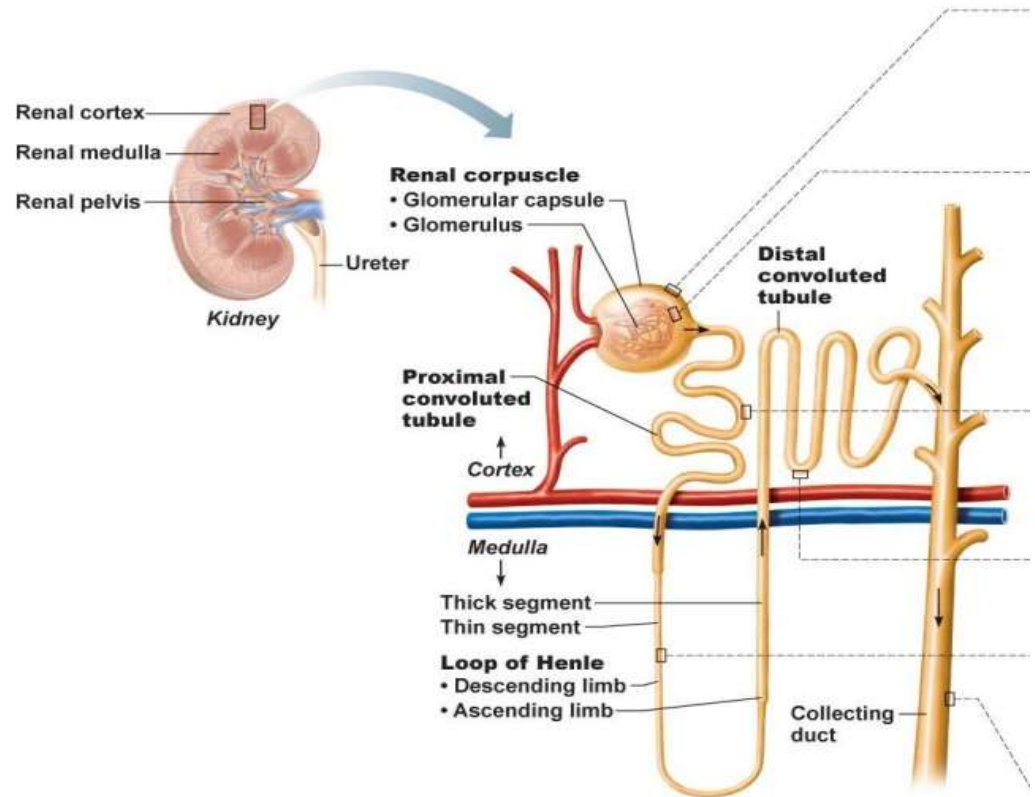
Nephron Anatomy

■ Renal Corpuscle

- Glomerulus
- Bowman's capsule

■ Renal Tubules

- Proximal convoluted tubule (PCT)
- Loop of Henle
- Distal convoluted tubule (DCT)



Glomerulus

- A specialized capillary bed
- Attached to arterioles on both sides (maintains high pressure)
 - Large afferent arteriole
 - Narrow efferent arteriole
- The glomerulus sits within a glomerular capsule (the first part of the renal tubule)

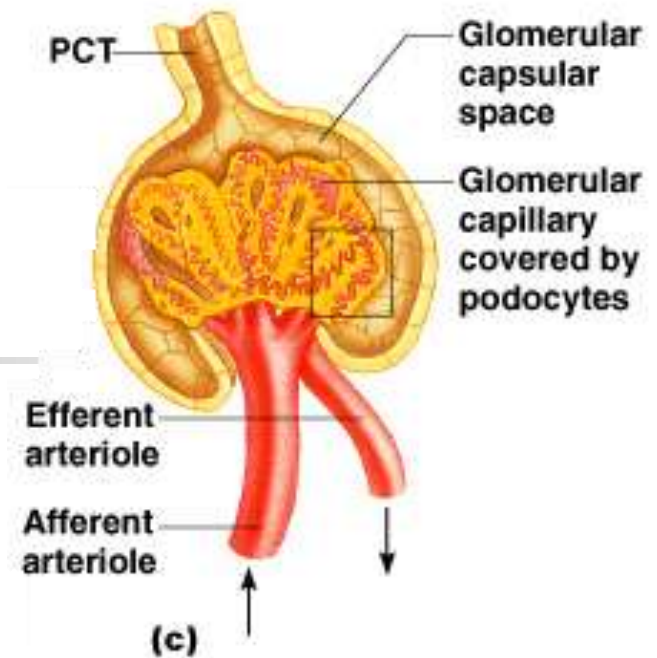
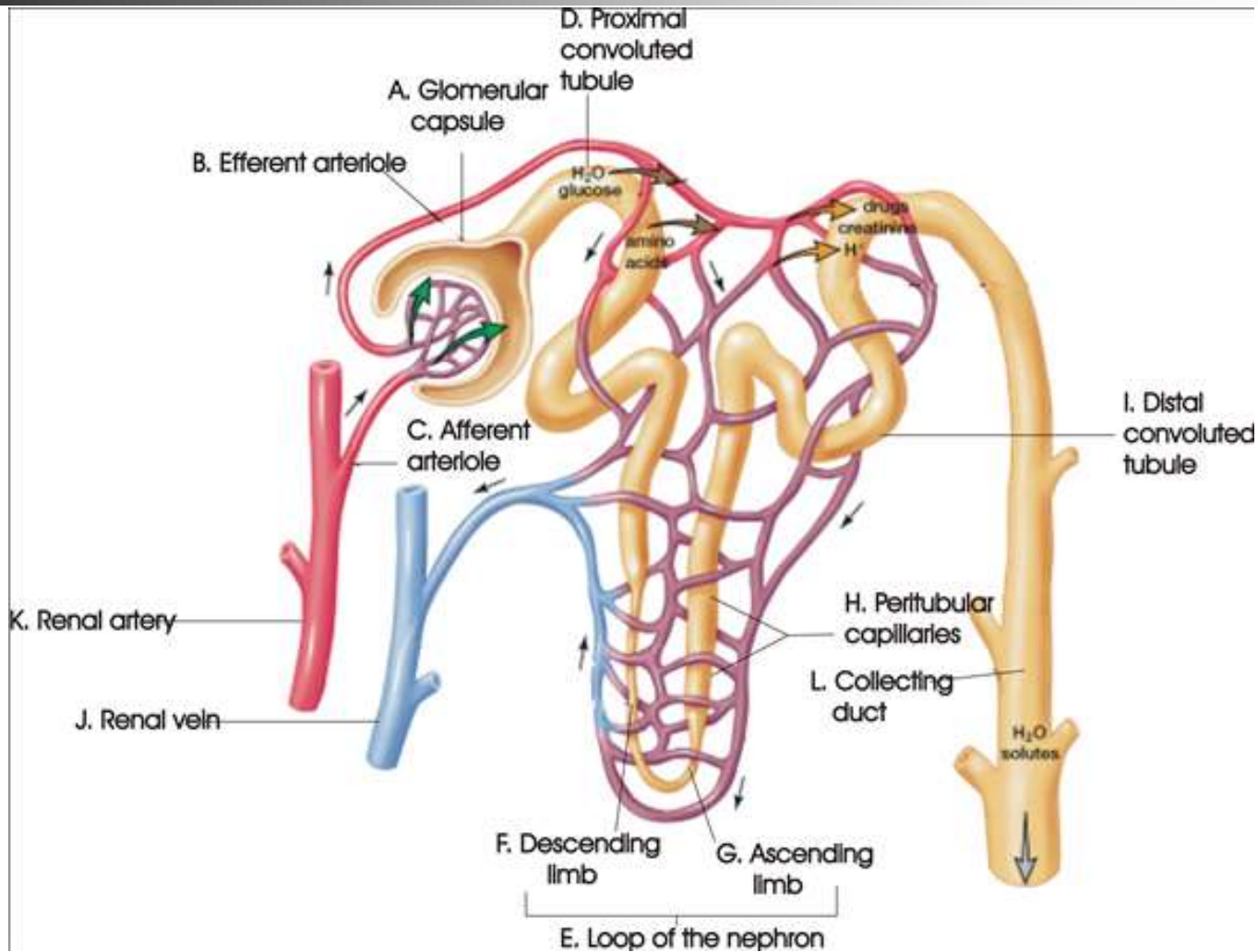
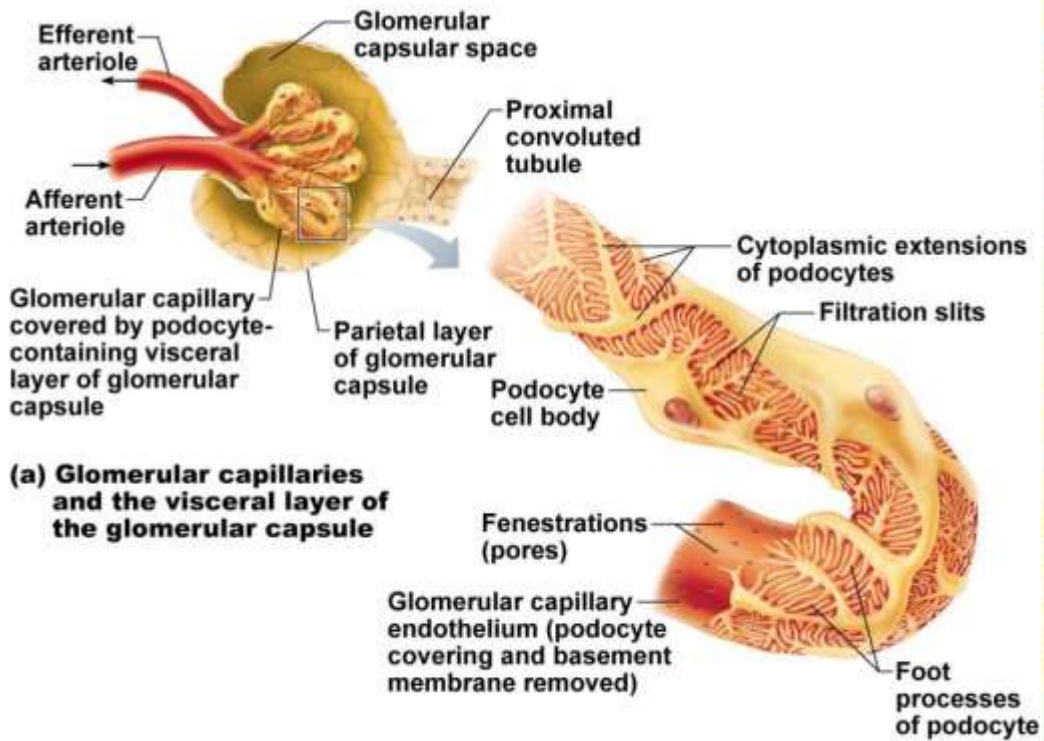


Figure 15.3c

Renal Tubules



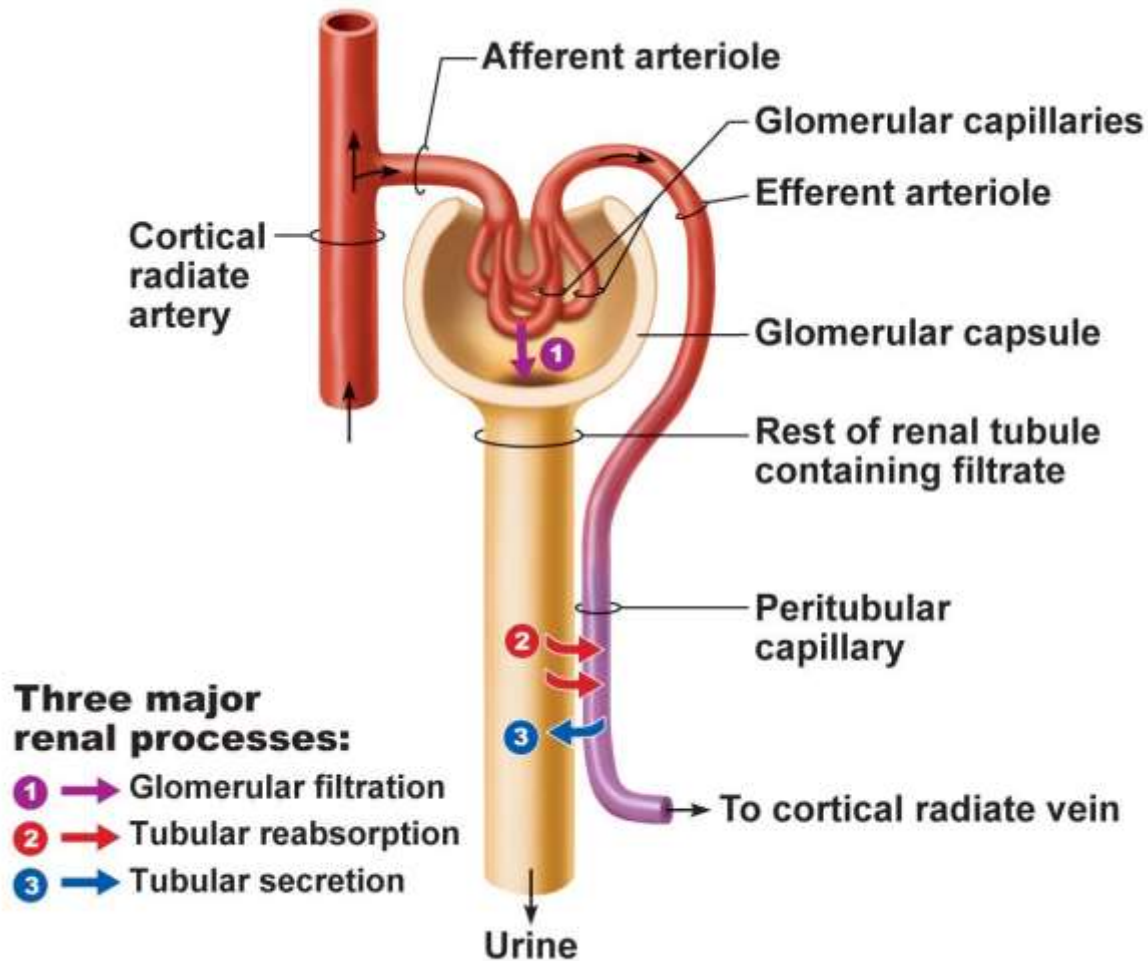
Filtration Membrane



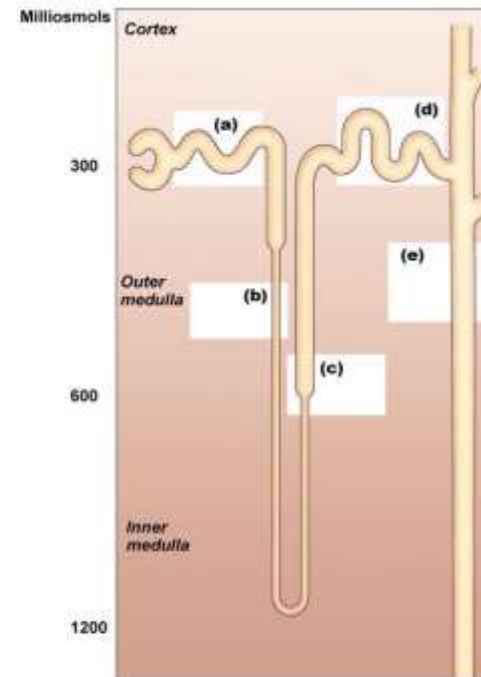
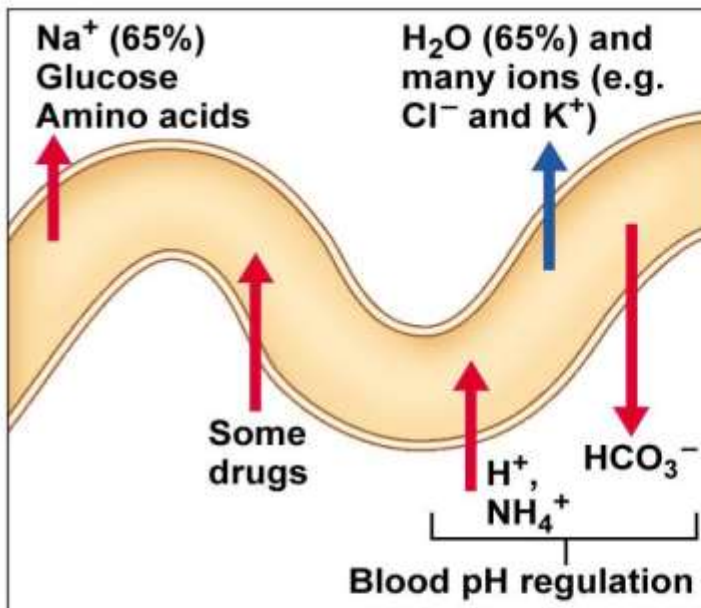
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Renal Physiology

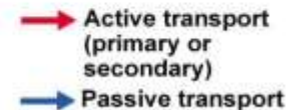


Tubular Reabsorption



(a) Proximal convoluted tubule:

- 65% of filtrate volume reabsorbed
- Na^+ , glucose, amino acids, and other nutrients actively transported; H_2O and many ions follow passively
- H^+ and NH_4^+ secretion and HCO_3^- reabsorption to maintain blood pH (see Chapter 26)
- Some drugs are secreted

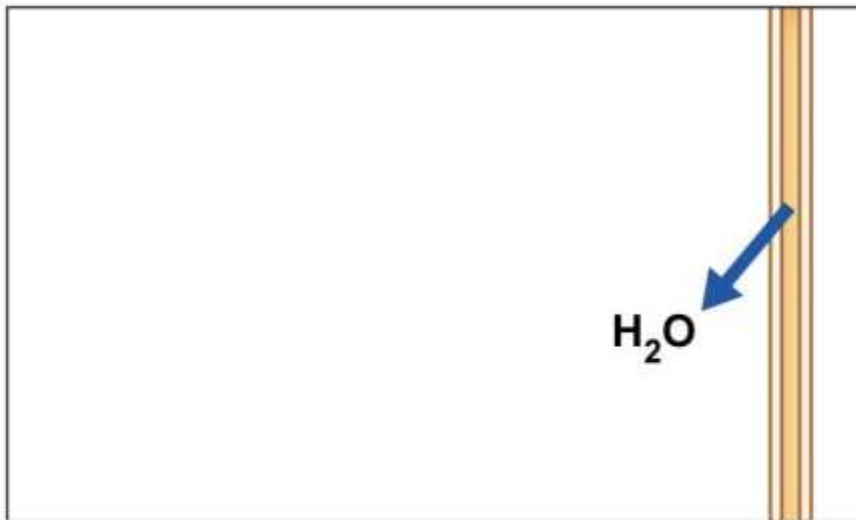




Tubular Reabsorption at the PCT

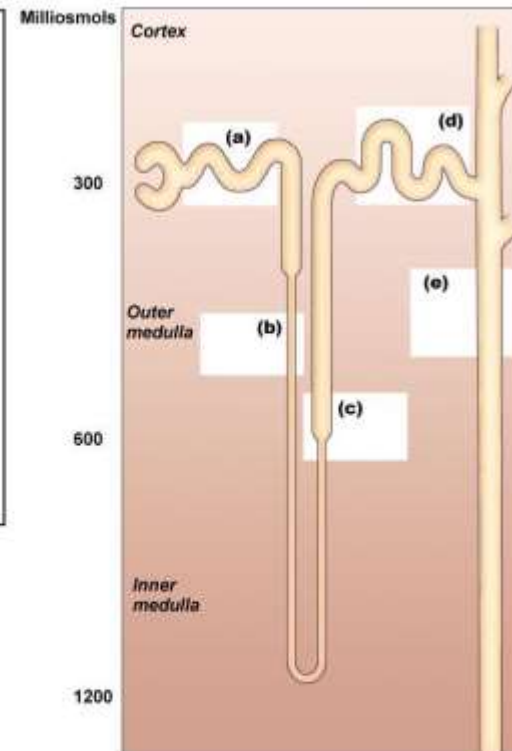
- Glucose, lactate, amino acids and vitamins – 100%
- Bicarbonate ions (HCO_3^-) – 90%
- Water and sodium ions – 65%
- Potassium ions – 55%
- Chloride ions – 50%

Tubular Reabsorption

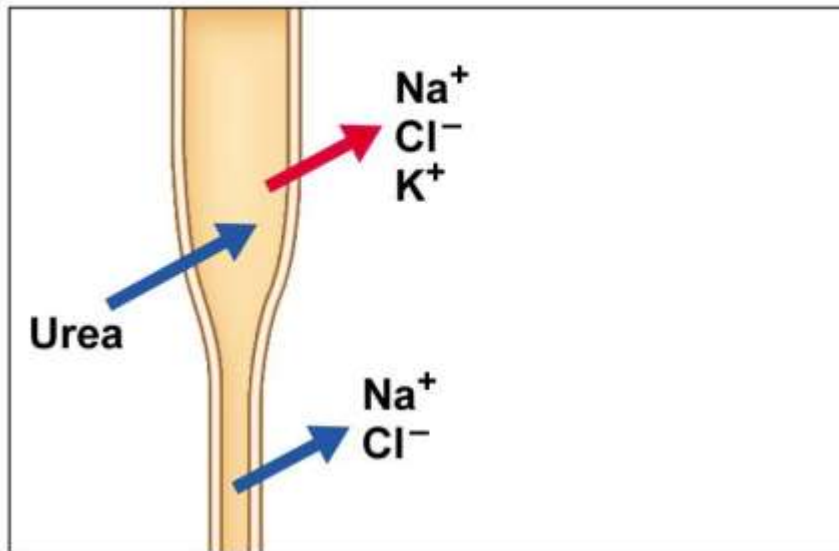


(b) Descending limb of loop of Henle

- Freely permeable to H_2O
- Not permeable to $NaCl$
- Filtrate becomes increasingly concentrated as H_2O leaves by osmosis

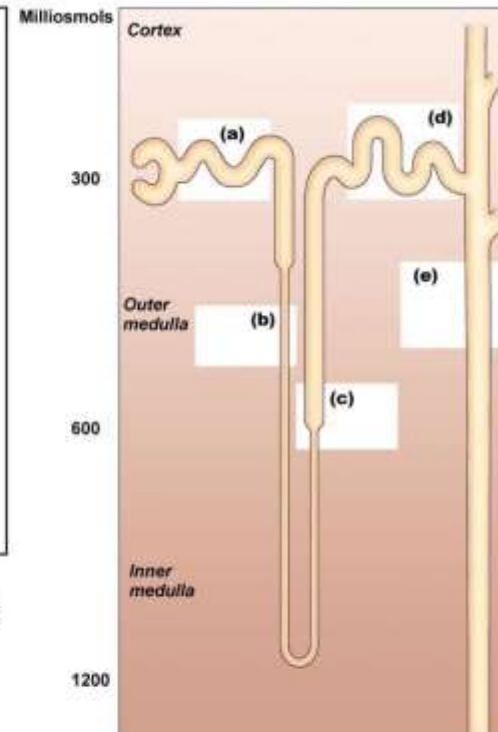


Tubular Reabsorption



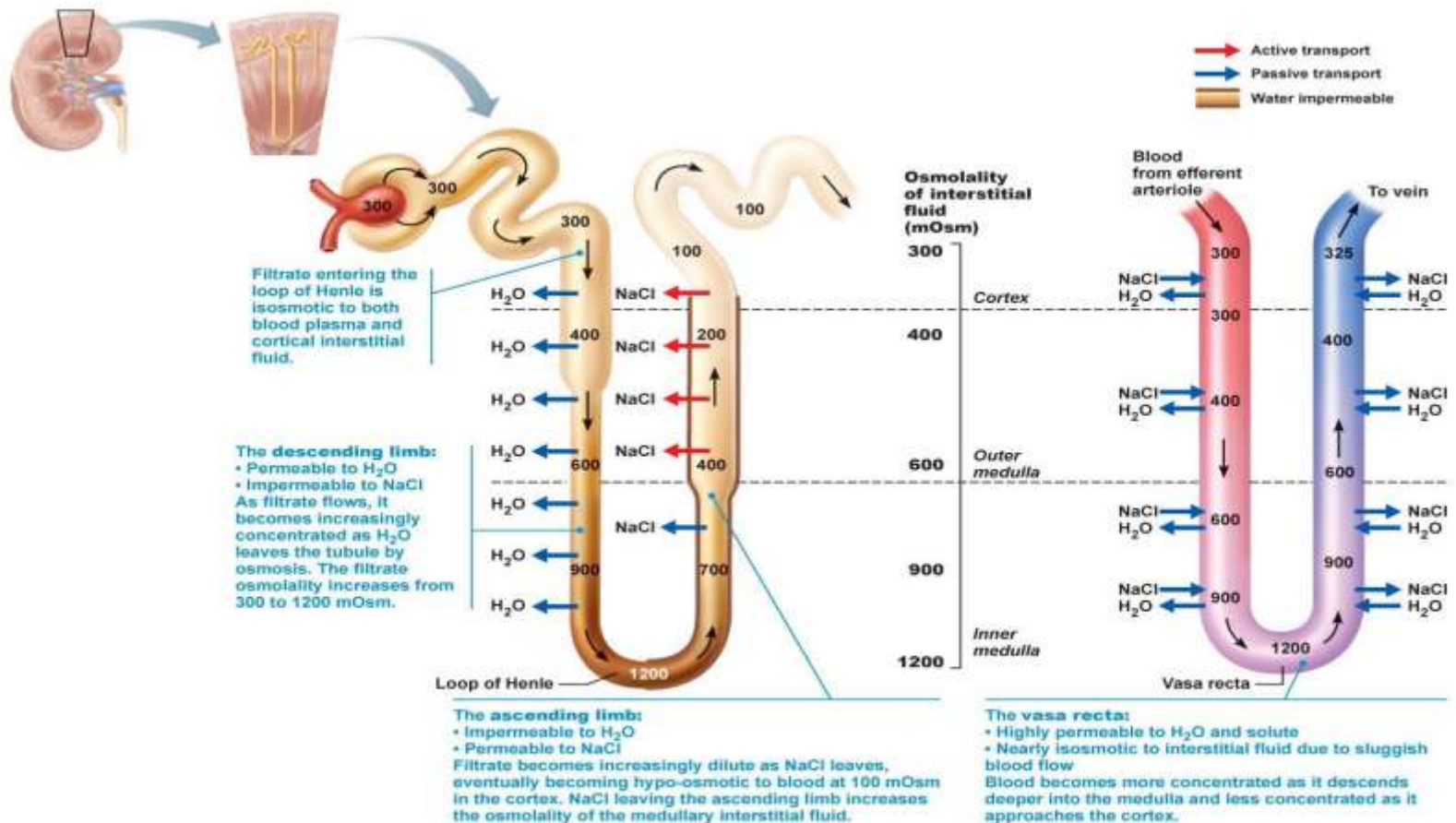
(c) Ascending limb of loop of Henle

- Impermeable to H_2O
- Permeable to NaCl
- Filtrate becomes increasingly dilute as salt is reabsorbed



- Active transport (primary or secondary)
- Passive transport

Countercurrent Mechanism



(a) Countercurrent multiplier. The long loops of Henle of the juxtamedullary nephrons create the medullary osmotic gradient.

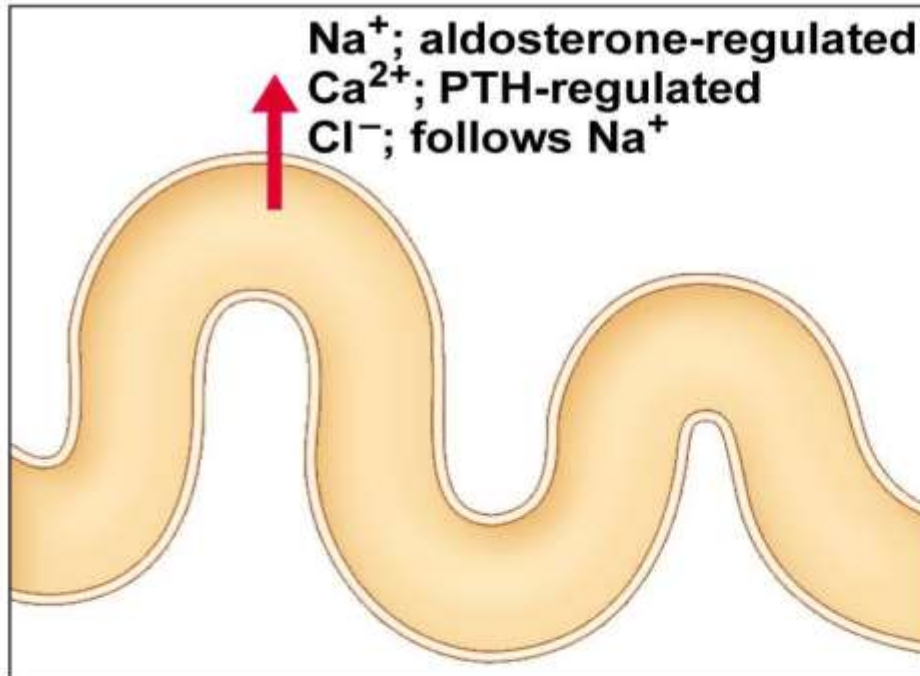
(b) Countercurrent exchanger. The vasa recta preserve the medullary gradient while removing reabsorbed water and solutes.



Tubular Reabsorption at the Loop

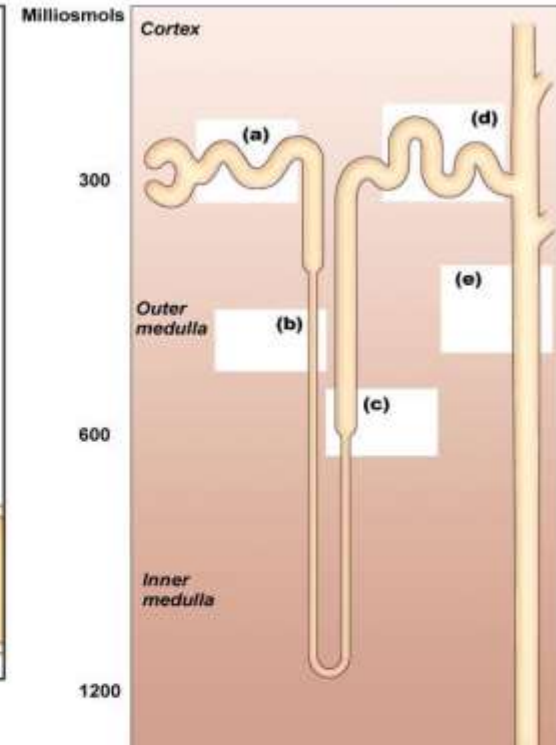
- Chloride – 35%
- Potassium – 30%
- Sodium ions – 25%
- Water – 10%

Tubular Reabsorption



(d) Distal convoluted tubule

- Na⁺ reabsorption regulated by aldosterone
- Ca²⁺ reabsorption regulated by parathyroid hormone (PTH)
- Cl⁻ cotransported with Na⁺



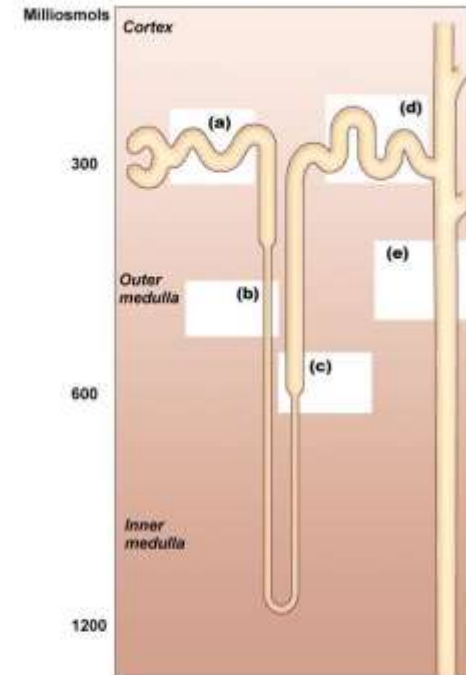
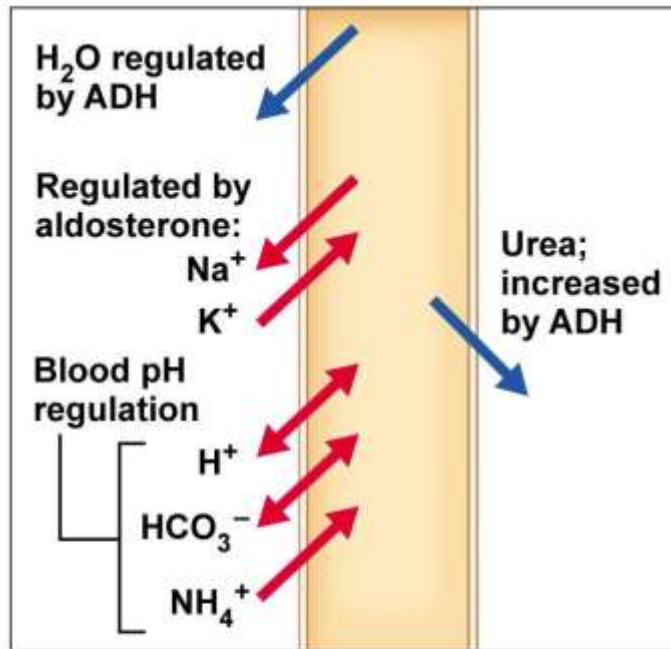
- Active transport (primary or secondary)
- Passive transport



Tubular Reabsorption at the DCT

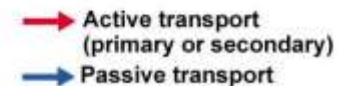
- Water – 25%
- Chloride – 10%
- Sodium ions – 10%

Tubular Reabsorption



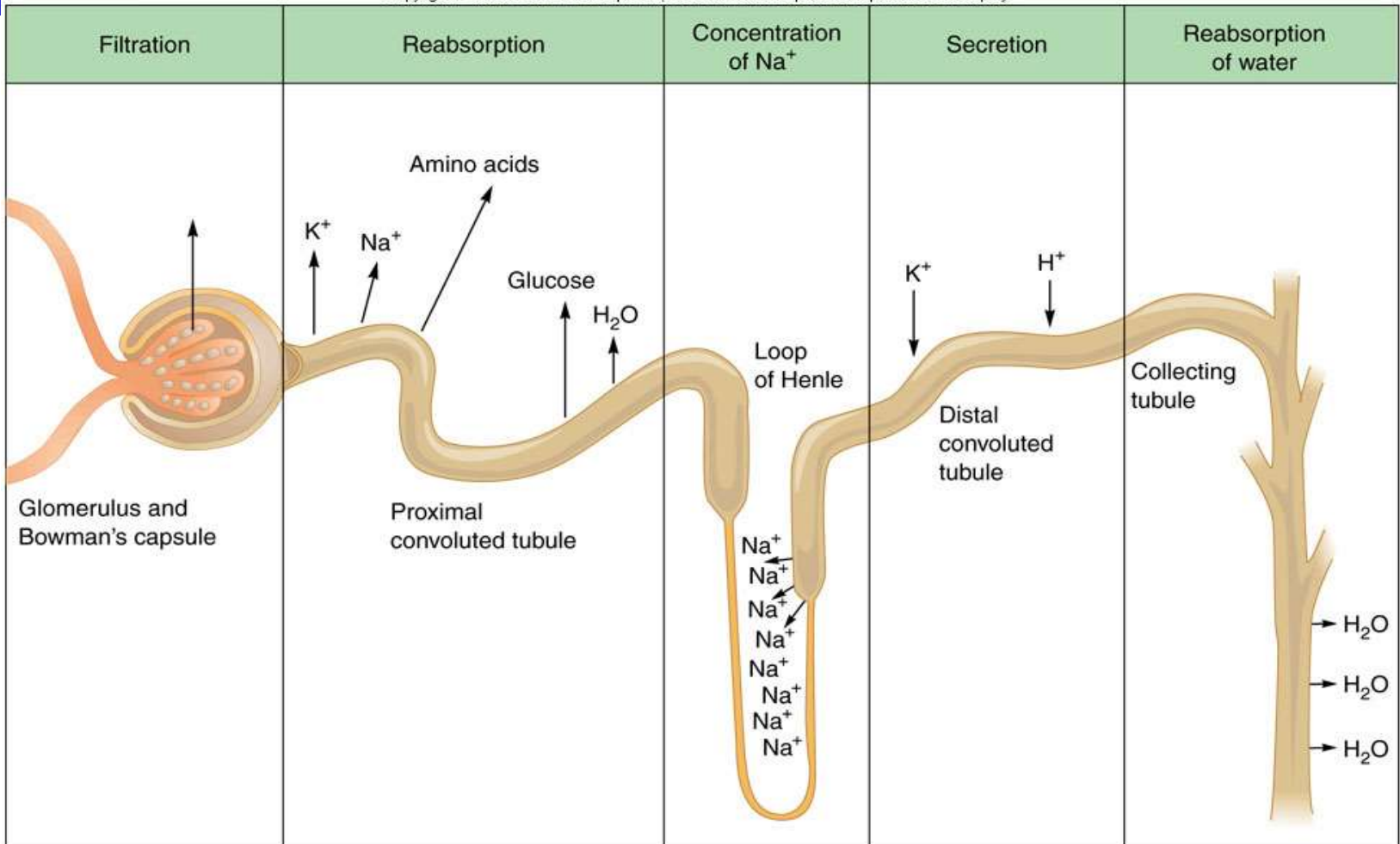
(e) Collecting duct

- H₂O reabsorption through aquaporins regulated by ADH
- Na⁺ reabsorption and K⁺ secretion regulated by aldosterone
- H⁺ and HCO₃⁻ reabsorption or secretion to maintain blood pH (see Chapter 26)
- Urea reabsorption increased by ADH



Tubular Secretion

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Urine Formation

■ Urine composition

- 90-95% water
- Solutes constitute the other 5%
 - Metabolic wastes (urea, uric acid, and creatinine)
 - Ions (Na^+ , K^+ , PO_4^{3-} , SO_4^{2-} , Ca^{2+} , Mg^{2+})
 - Toxins and pigments (urochrome)
 - Hormones

■ Urine characteristics

- Yellow in color
- Slightly aromatic or ammonia odor
- pH slightly acidic (can vary from 4.5 to 8.0)
- Specific gravity 1.001 to 1.035