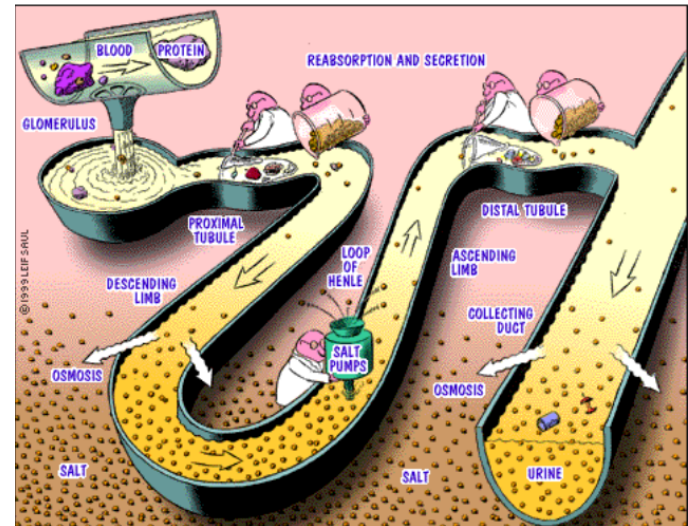


Renal Transport Process 2

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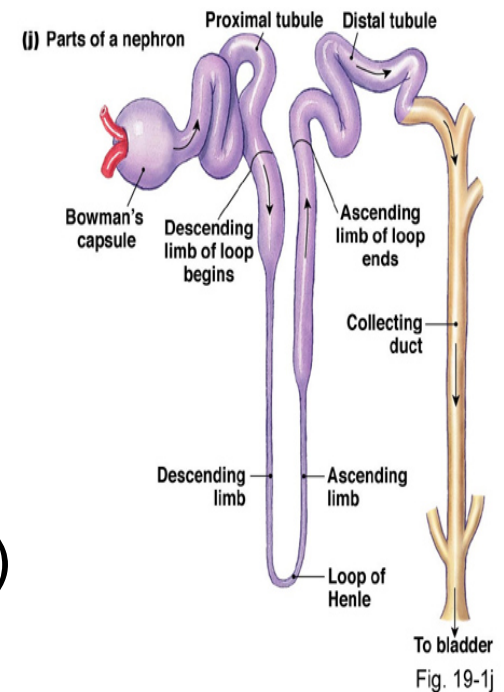


Learning Objectives:

- Describe tubular secretion with PAH transport and K^+
- Identify and describe the characteristic of loop of Henle, distal convoluted tubule and collecting ducts for reabsorption and secretion
- Identify the site and describe the influence of aldosterone on reabsorption of Na^+ in the late distal tubules.

Loop of Henle

- **Thin descending limb**
 - 15% water reabsorbed
 - permeable to water (filtrate hyperosmotic)
- **Thick ascending limb (TAL)**
 - Impermeable to water (isosmotic)
 - Important in concentrating urine
 - 25% NaCl, K⁺ reabsorbed as well as Ca₂⁺, HCO₃⁻ occurs in



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Loop of Henle

- Solute absorption (TAL):

1) **Transcellular**
(50%)

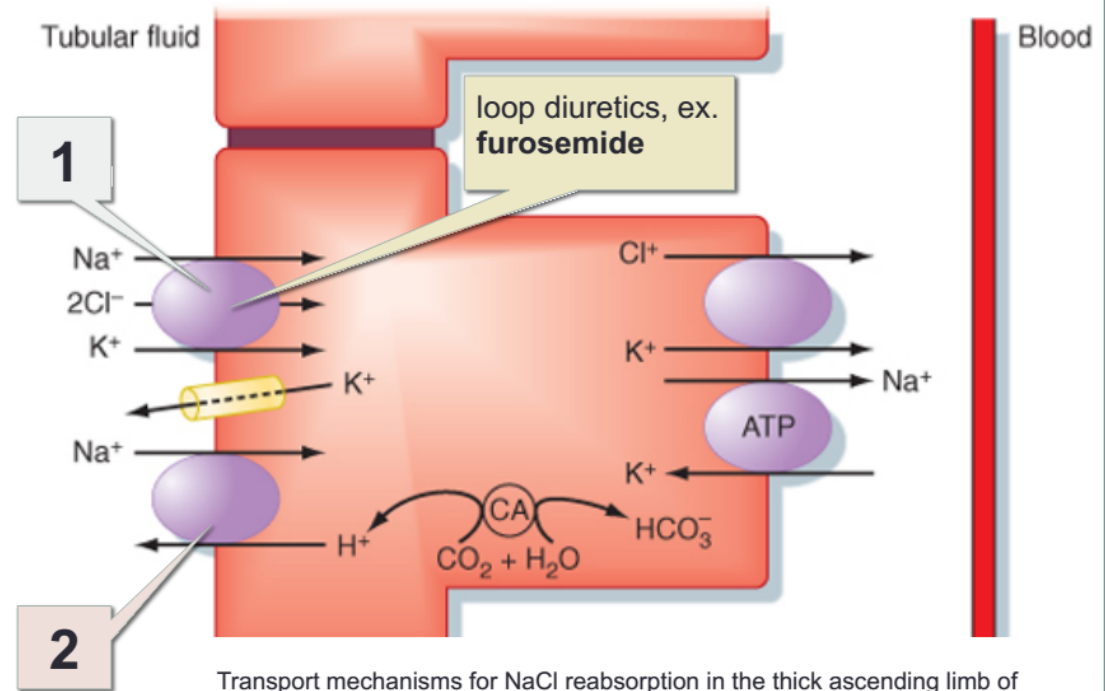
a) $\text{Na}^+ / 2\text{Cl}^- / \text{K}^+$
cotransporter/
symporter

b) NHE

i) Na^+ in

ii) H^+ out

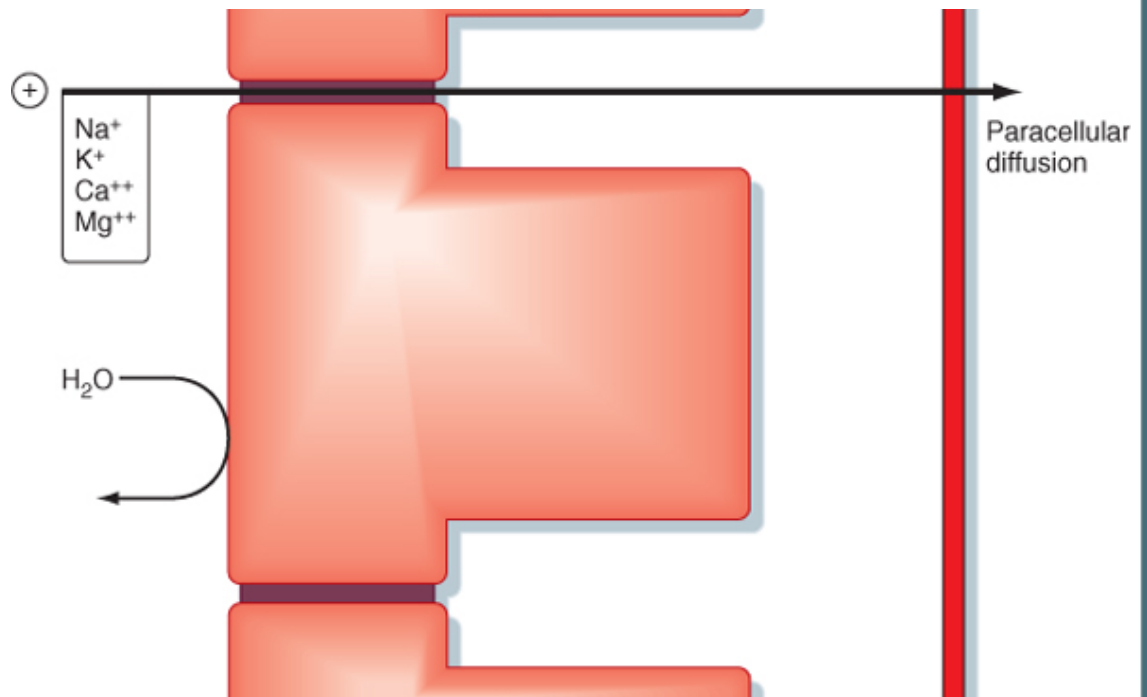
iii) HCO_3^- in



Transport mechanisms for NaCl reabsorption in the thick ascending limb of Henle's loop.

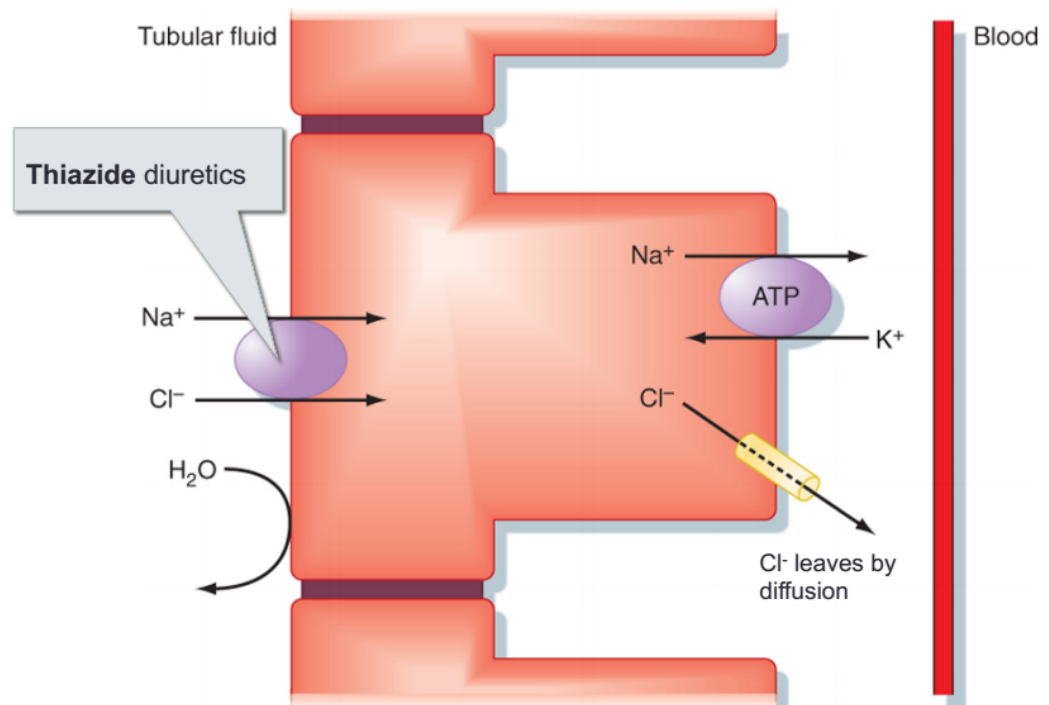
Loop of Henle

2) Paracellular (50%)



Distal convoluted tubule (DCT) & collecting duct (CD)

- 7% NaCl
- 8 – 15 % water reabsorbed (needs ADH)
- Some K^+ , H^+ secreted **into** tubule
- **Early DCT:**
- Reabsorbs Na^+ , Cl^-
- (impermeable to water)

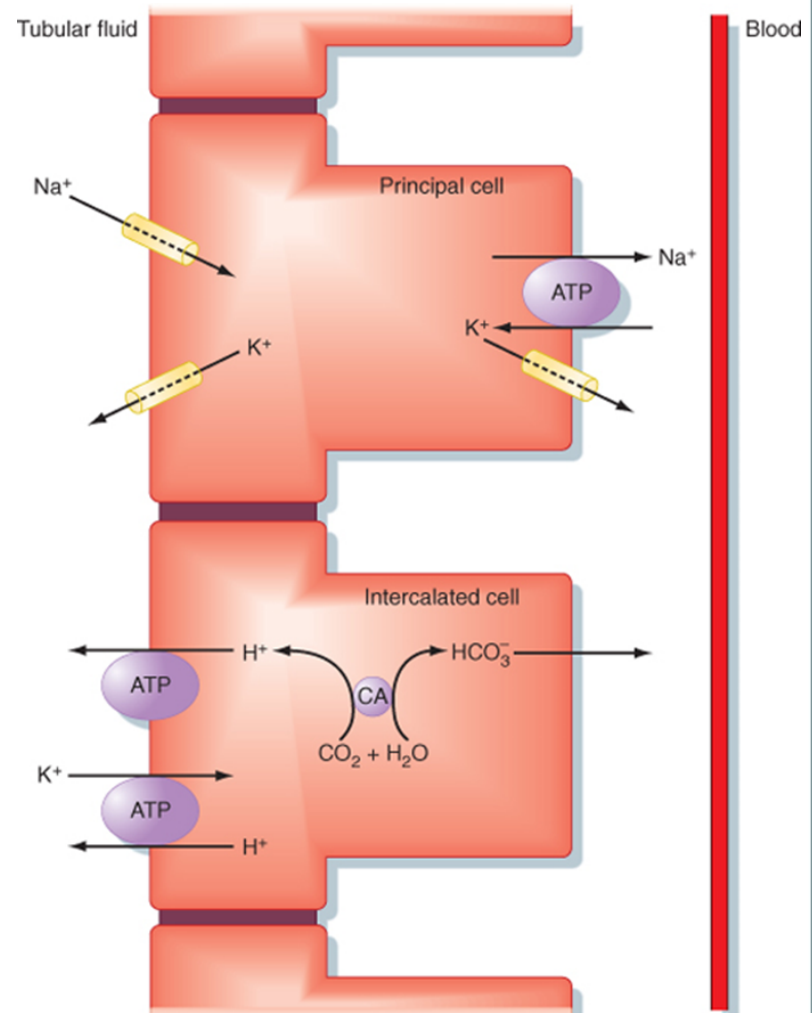


Koeppen & Stanton: Berne and Levy Physiology, 6th Edition.
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Distal convoluted tubule (DCT) & collecting duct (CD)

Late DCT:

- **Principle cells:**
 - reabsorb Na^+ , Na^+ diffuses via selective channels
 - Reabsorb water
 - secrete K^+
- **Intercalated cells:**
 - secrete H^+
 - reabsorb HCO_3^-
 - reabsorb K^+
- **Aldosterone:** \uparrow Na reabsorption by principle cells, \uparrow K⁺ secretion



Transport of potassium

- Most abundant cation in the body
- 3,5-4,0 mmol in blood.
- 98 % is intracellular, [150mM]
 - Regulates intracellular function such as Cell volume, Acid/base status, cell growth & division
- 2% K extra-cellular [3.5-5mM]
 - This regulates membrane potentials in excitable cells and diffusion potentials in transporting epithelia.

Renal excretion of potassium

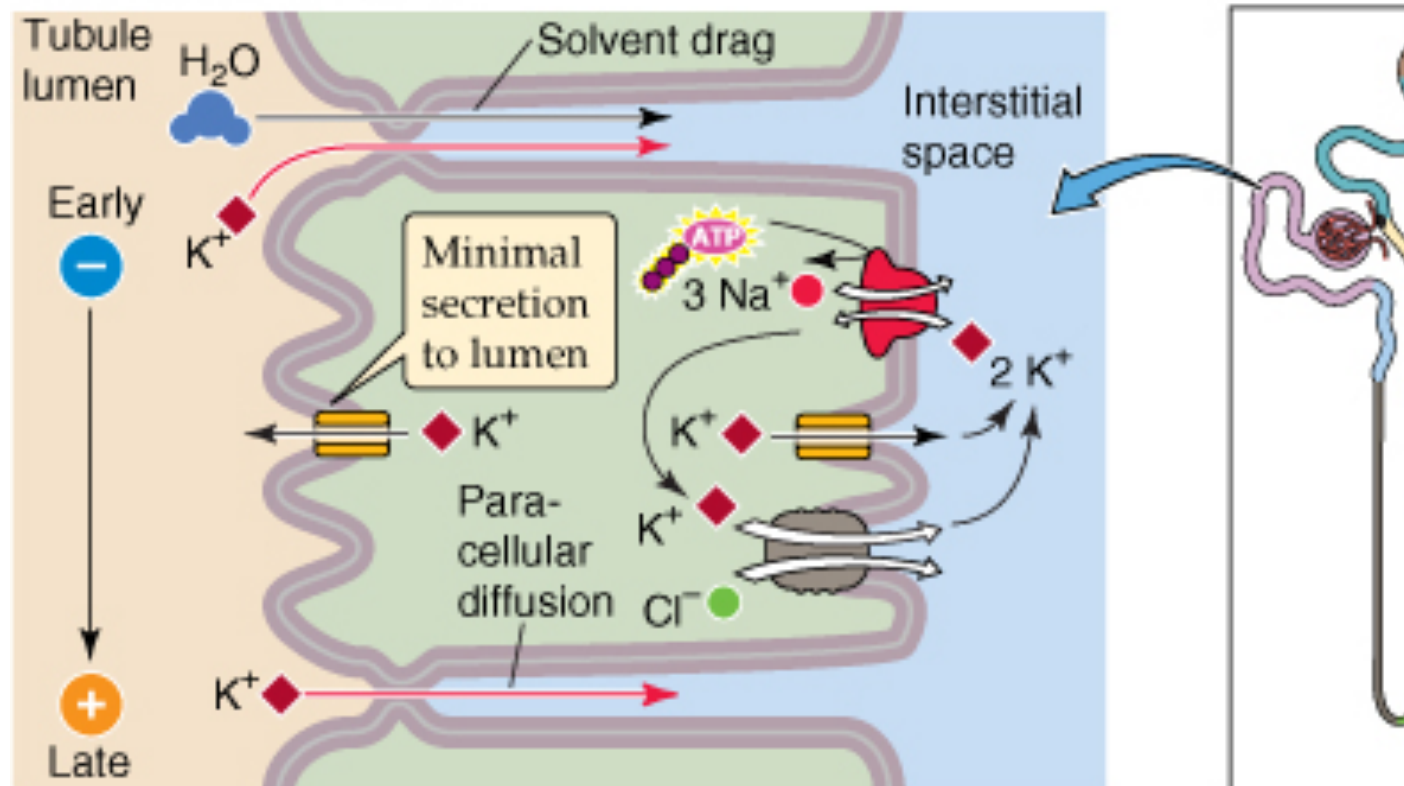
- 90-95% of Dietary K excreted via the kidneys
- 5-10% in Sweat & Feces (This is unregulated and may become significant in diarrheas)
- In normal individual intake is matched by excretion and potassium balance is maintained.
- **Bulk reabsorbed by proximal tubule and loop of Henle.**

Renal K^+ Transport mechanisms

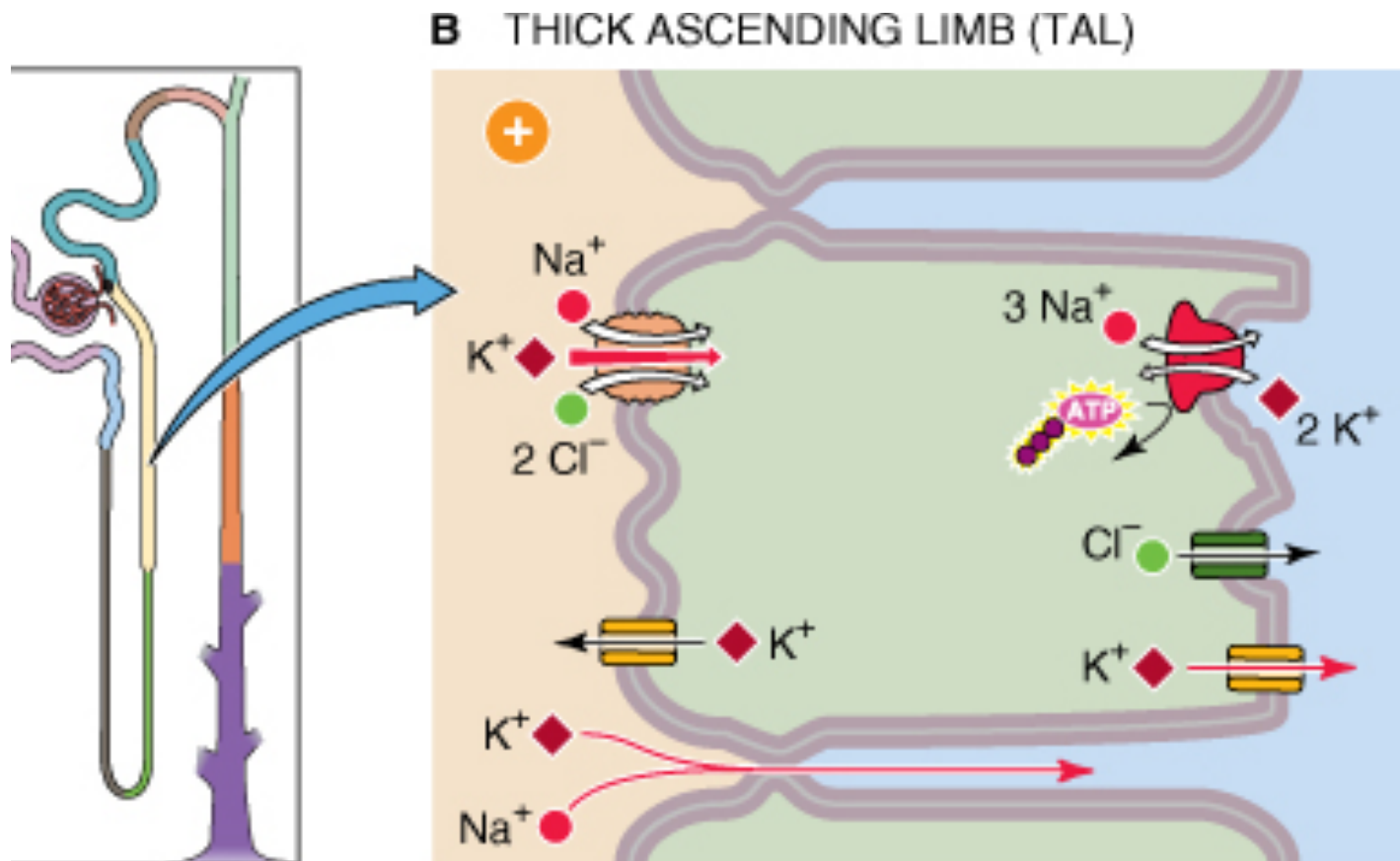
- **Cell membrane transporters**
 - Na⁺-K⁺ ATPase, H⁺-K⁺ ATPase
 - K⁺ channels, K:Cl cotransport
 - Na:K:2Cl cotransport
- **K⁺ is Reabsorbed** in PT, TAL & intercalated cell in CCD
- **K⁺ Secreted** in late distal tubule and in principal cells of late DT & CCD

- **Proximal Tubule:** K^+ is absorbed by intercellular solvent drag whereby fluid movement driven by Na^+ absorption entrains K^+ ions

A PROXIMAL TUBULE

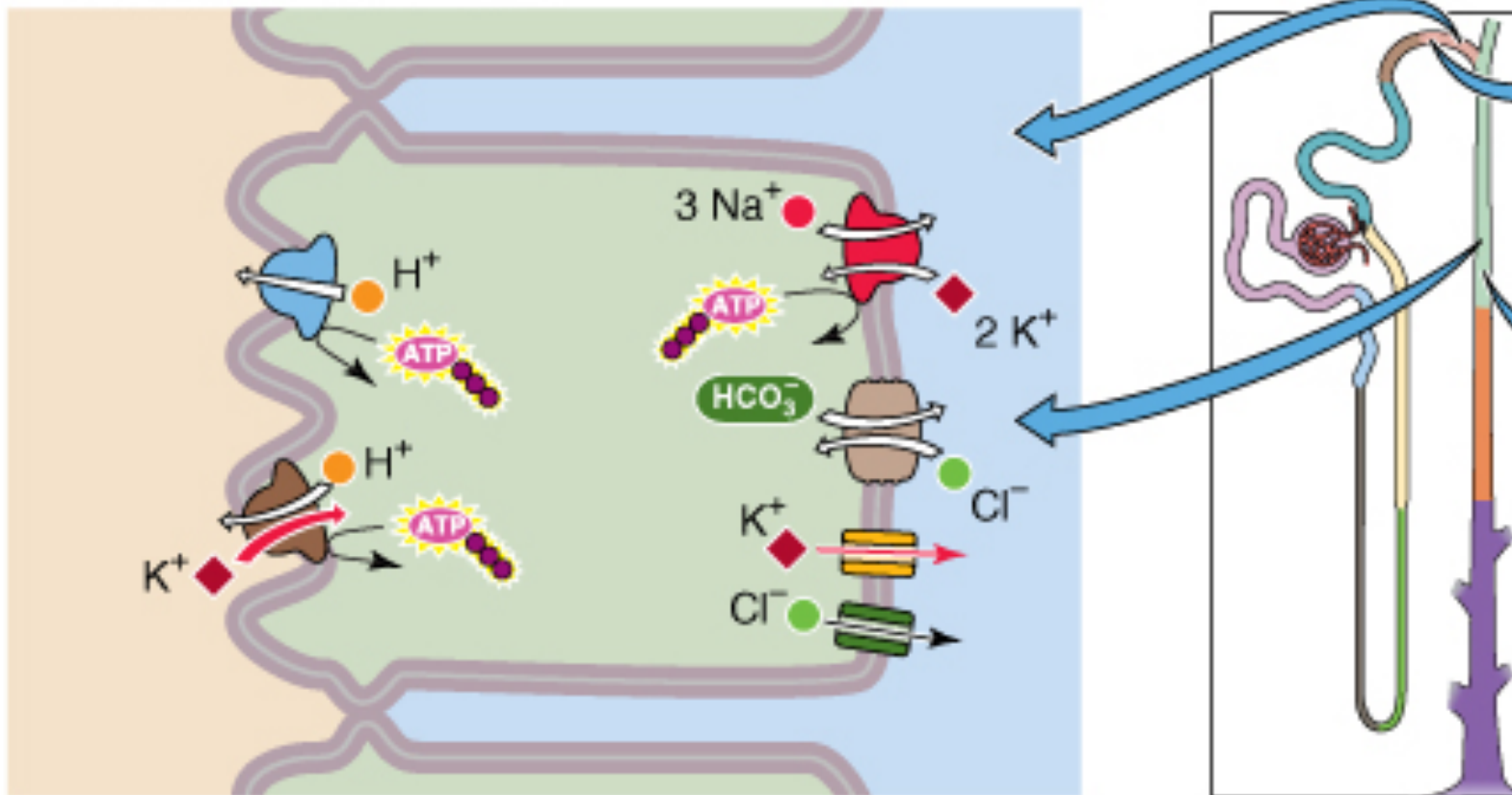


- **TAL:** Na:K:2Cl in luminal membrane
- K:Cl co-transport in baso-lateral membrane



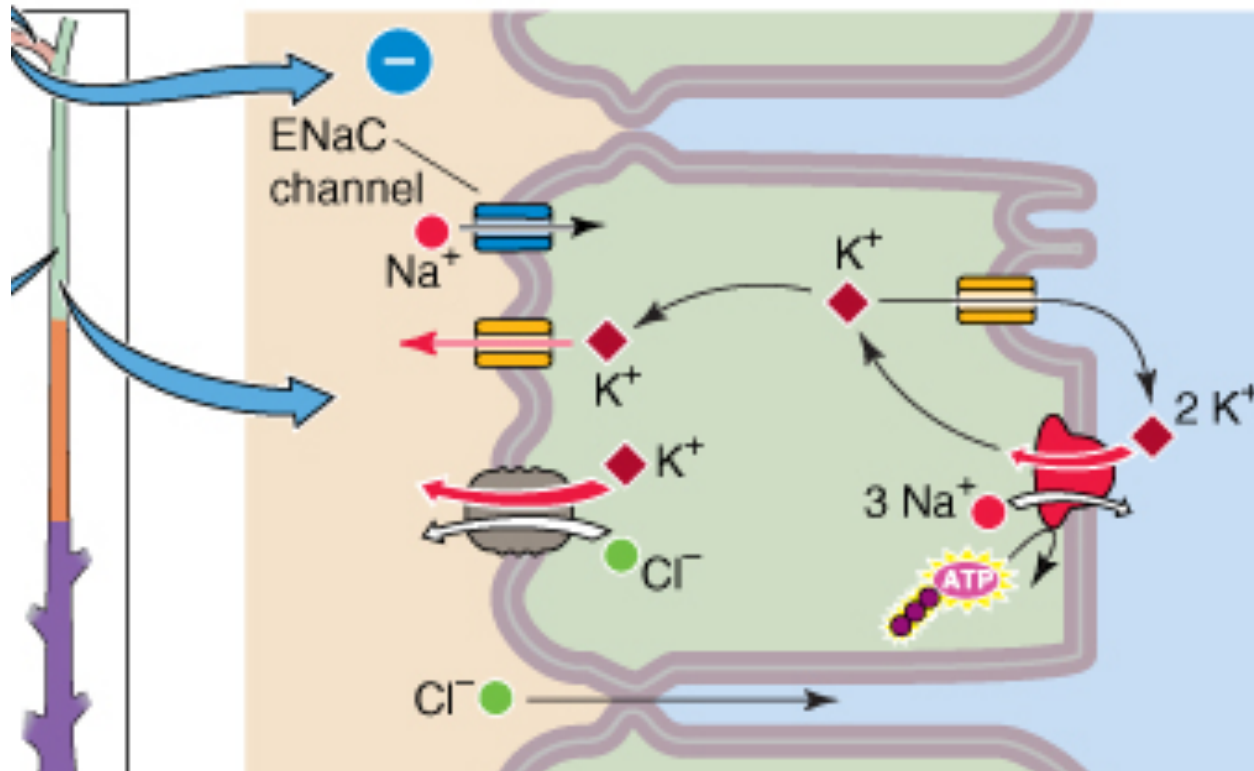
CD: K reabsorption is by the intercalated cells via a luminal H-K ATPase.

C CORTICAL COLLECTING TUBULE (CCT):
 α INTERCALATED CELL



- **CD:** K^+ secretion in the principal cells (via luminal K channels and basolateral Na - K ATPase).

D CORTICAL COLLECTING TUBULE (CCT):
PRINCIPAL CELL



Factors affecting potassium secretion

Peritubular factors:

- 1.Hyperkalemia:** increase K in tubular cells, increase chemical gradient of K between tubular cell and tubular lumen which lead to increase in the secretion and excretion of K.
- 2.Hyper-aldosteronism:** increase aldosterone increase secretion and excretion of K.
- 3.Alkalosis:** increase H-K exchange at baso-lateral membrane then increase secretion and excretion of K.

Factors affecting potassium secretion

Luminal factors:

- 1. Diuresis:** increase volume of urine and decrease conc of K in lumen which causes secretion via chemical gradient.
(increase secretion and excretion)
- 2. Increased urinary excretion of Na:** increase in Na-K exchange at luminal membrane causes an increase in secretion and excretion of K.
- 3. Increased urinary excretion of bicarbonate, phosphate, sulphate and ketone acids:** increase negativeness of lumen then increase electrochemical gradient between cell and lumen causes secretion and excretion of K.

NaCl Transport along the Nephron

Segment	Percentage of Filtrate Reabsorbed	Mechanism of Na ⁺ Entry across the Apical Membrane	Major Regulatory Hormones
Proximal tubule	67%	Na ⁺ -H ⁺ antiporter, Na ⁺ symporter with amino acids and organic solutes, 1Na ⁺ -1H ⁺ -2Cl ⁻ -anion antiporter, paracellular	Angiotensin II Norepinephrine Epinephrine Dopamine
Loop of Henle	25%	1Na ⁺ -1K ⁺ -2Cl ⁻ symporter	Aldosterone Angiotensin II
Distal tubule	≈5%	NaCl symporter (early) Na ⁺ channels (late)	Aldosterone Angiotensin II
Collecting duct	≈3%	Na ⁺ channels	Aldosterone, ANP, BNP, urodilatin, uroguanylin, guanylin, angiotensin II

Water Transport along the Nephron

Segment	Percentage of Filtrate Reabsorbed	Mechanism of Water Reabsorption	Hormones That Regulate Water Permeability
Proximal tubule	67%	Passive	None
Loop of Henle	15%	Descending thin limb only; passive	None
Distal tubule	0%	No water reabsorption	None
Late distal tubule and collecting duct	≈8%-17%	Passive	ADH, ANP, BNP*

References

- Guyton and Hall Textbook of physiology
 - Chapter 27

Thank You