

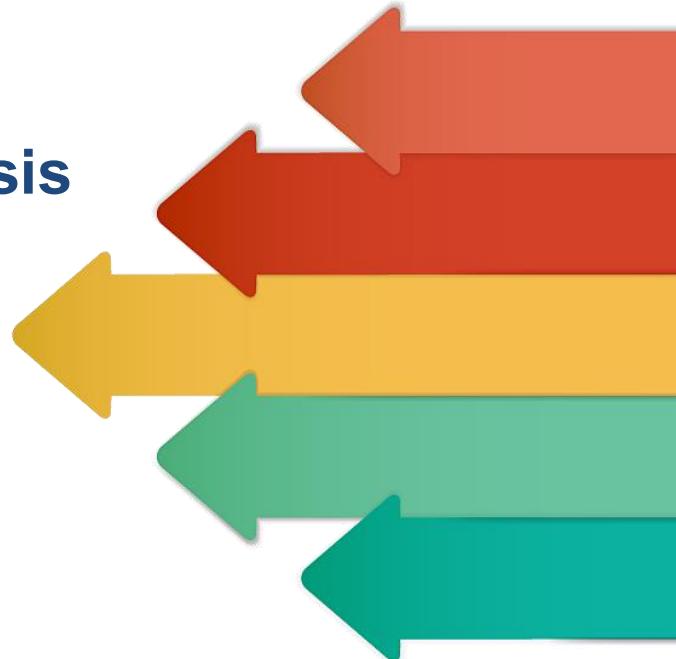
Hypokalemia

Nattawit Kaewkomoot

Potassium Homeostasis

Cellular Shift

Renal excretion



Potassium Homeostasis

- The total body potassium of an adult is about 3500 mmol (50 mmol/kg body weight)
 - 1 - 1.5 mmol/kg/day
- The plasma or serum concentration of potassium is 3.4 to 5.0 mEq/l
 - 1 – 2 mEq/kg/day
- 2 mechanism to control Potassium Homeostasis.
 1. Cellular shift
 2. Renal excretion



Cellular Shift

Metabolic alkalosis

Insulin → Na-K ATPase ↑

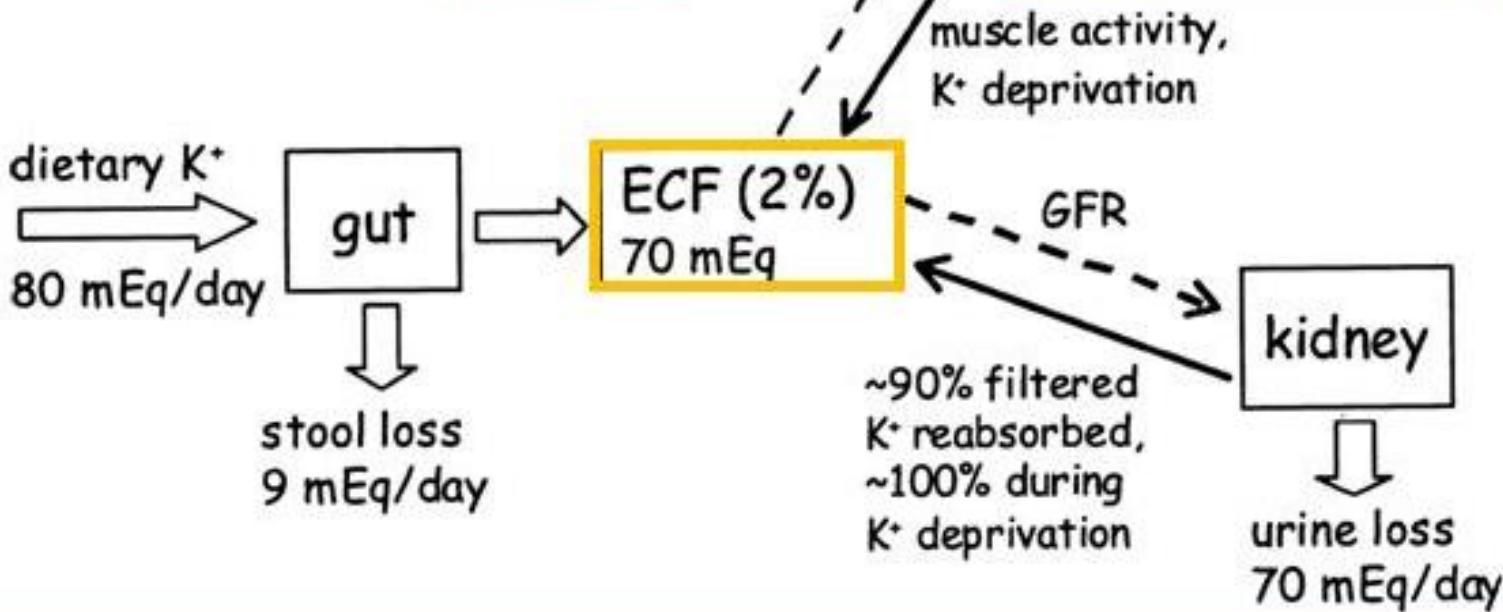
Catecholamine → Na-K ATPase ↑

Hyperthyroid → K channel ↑

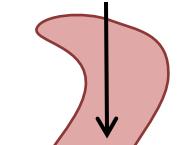
ICF (>90%)

nonmuscle 800mEq

muscle 2700 mEq



K^+ 100 mEq



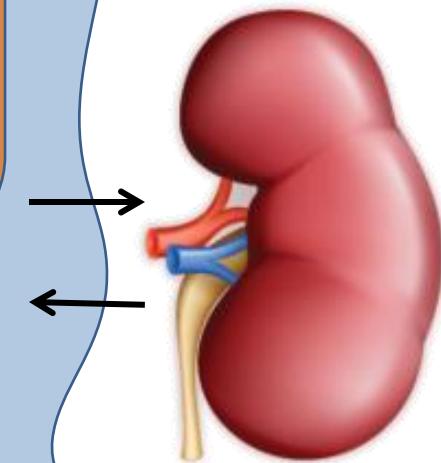
ECF (2-5 %)

Absorp (100 %)

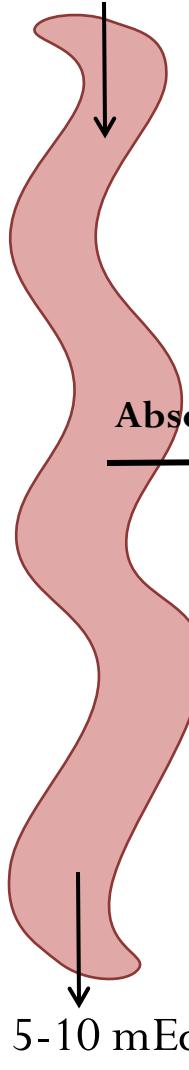
ICF (muscle) (>90%)
3000+ mEq

K^+ 5-10 mEq

Serum K⁺
3.5 - 5 mEq



K^+ 100 mEq

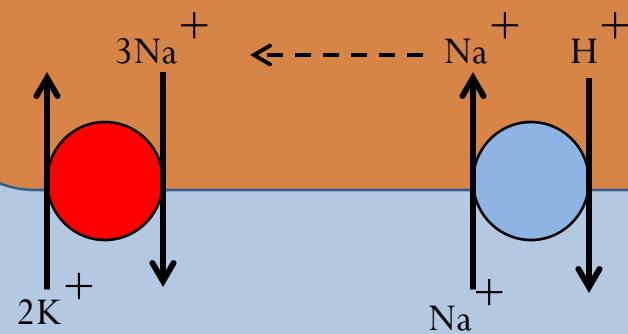


ECF (2-5 %)

ICF (muscle) (>90%)

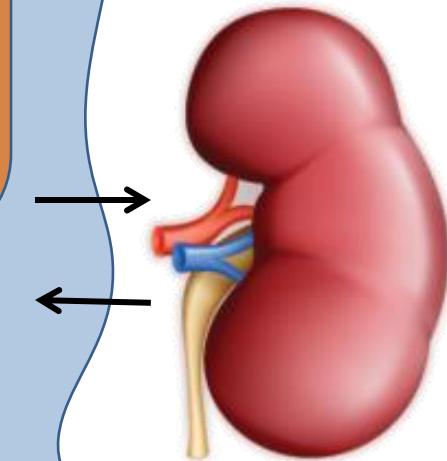
3000+ mEq

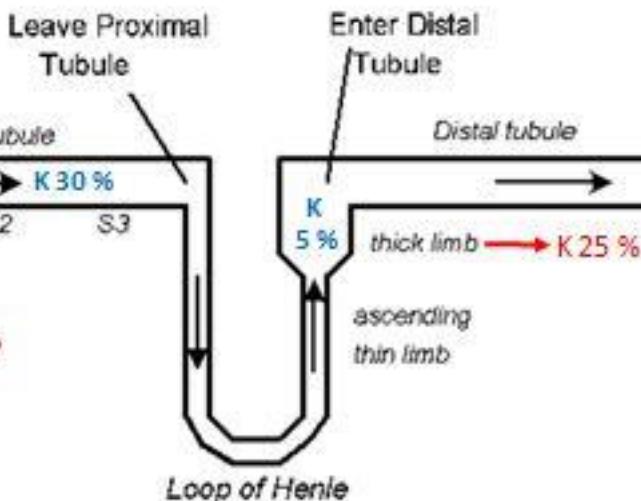
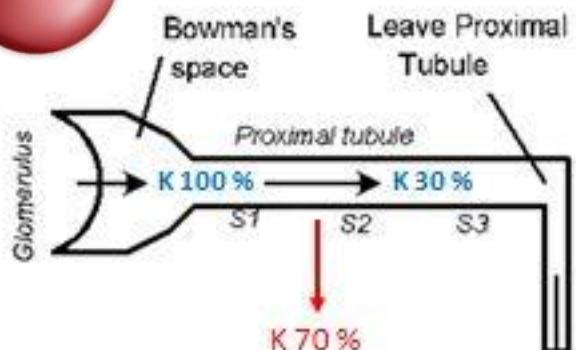
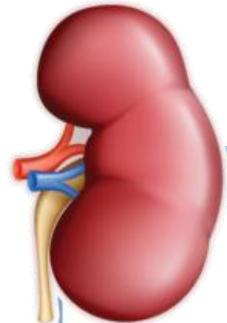
Serum K^+
3.5 - 5 mEq



-Insulin
-Thyroxine
-Cathecholamin

-Insulin
-Aldosterone

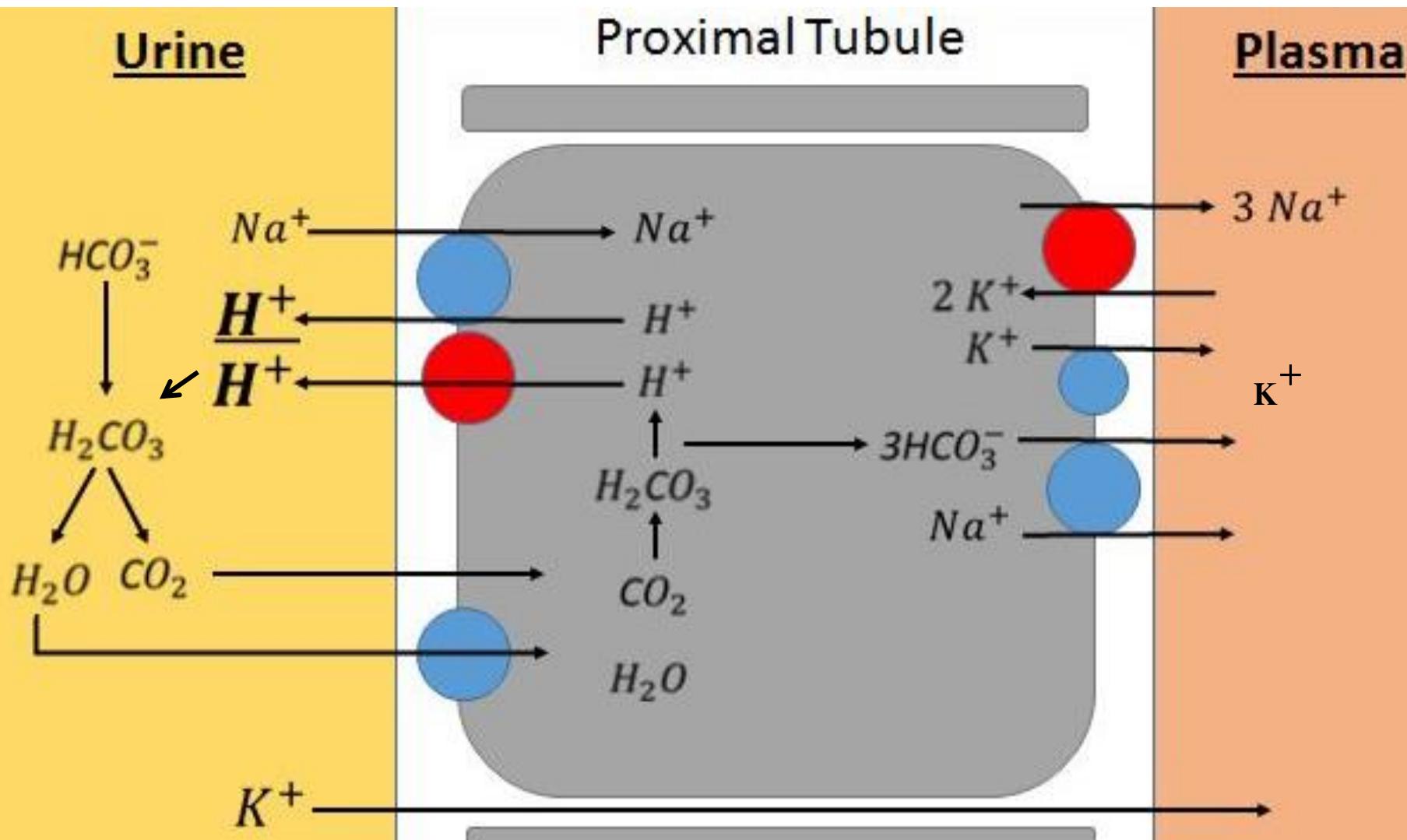




Reabsorb K

Aldosterone

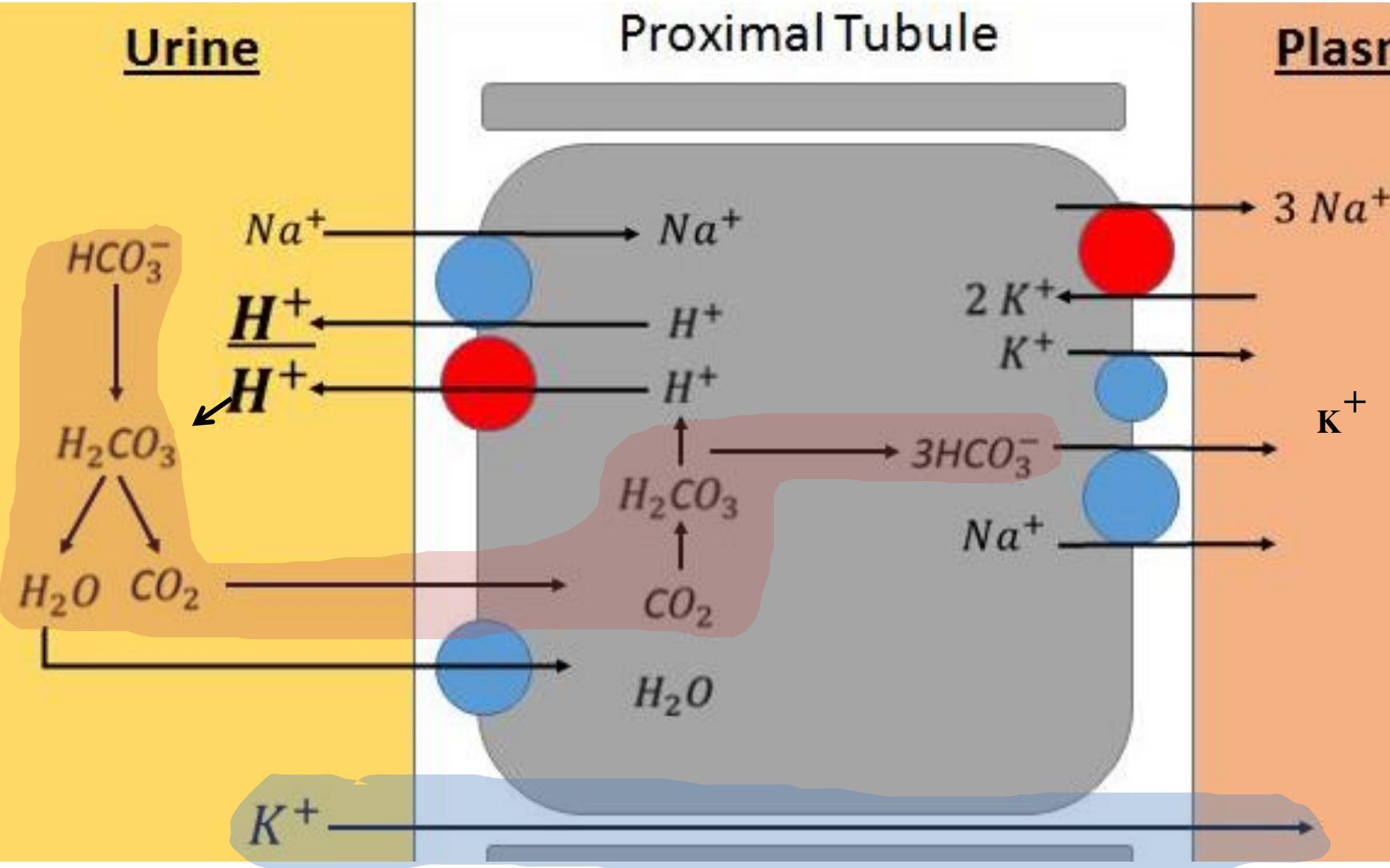
Secreted K

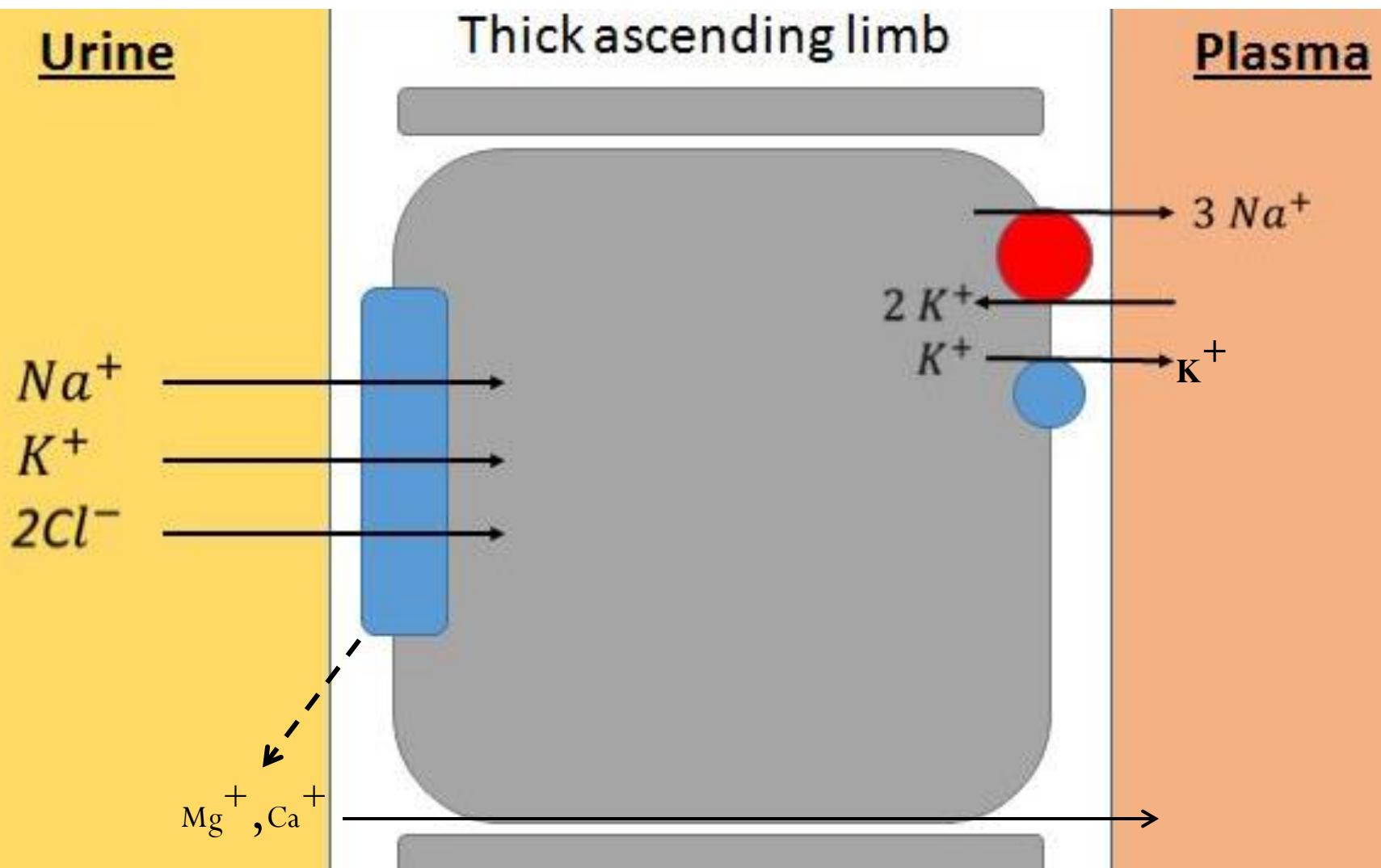


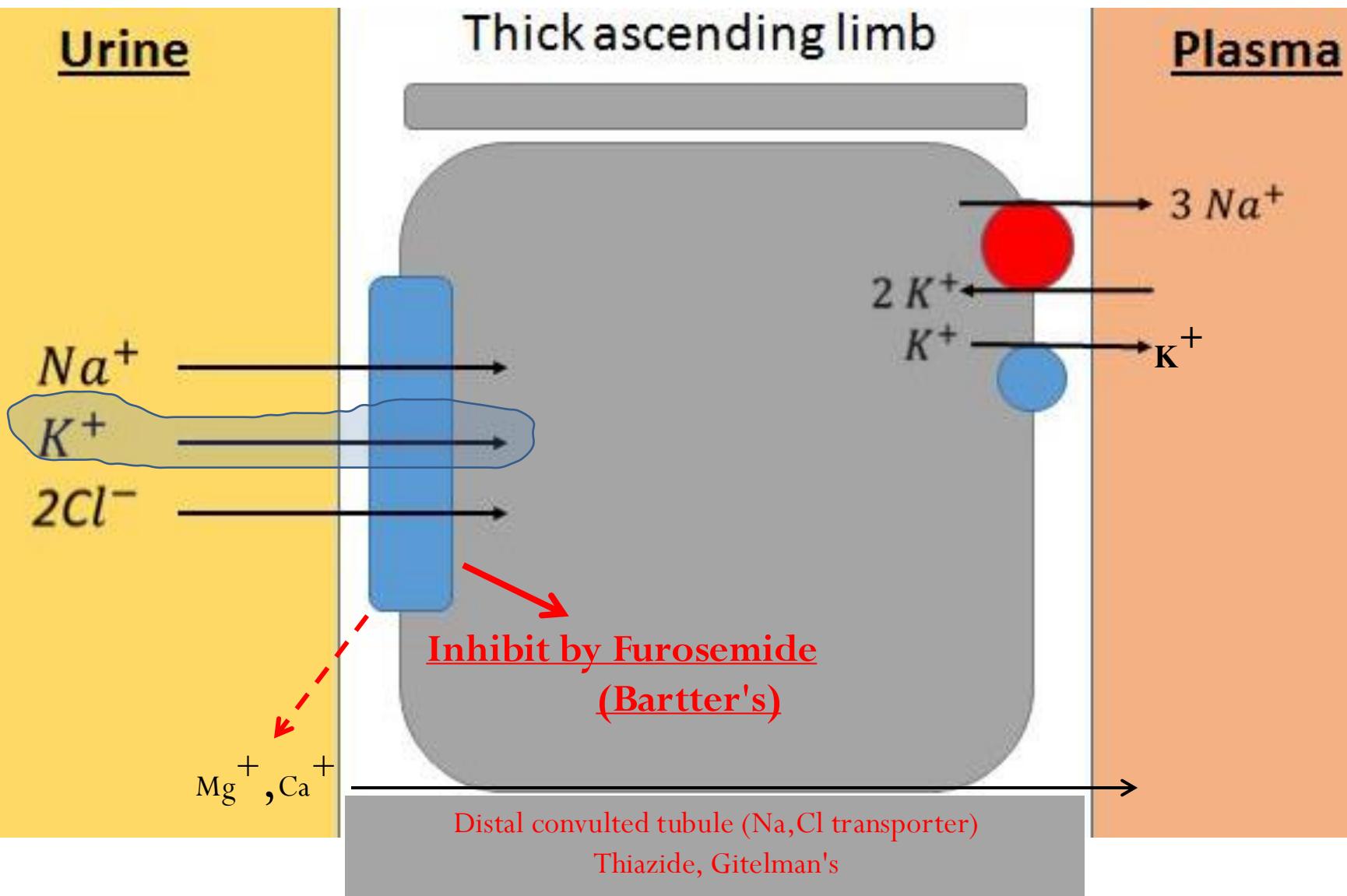
Urine

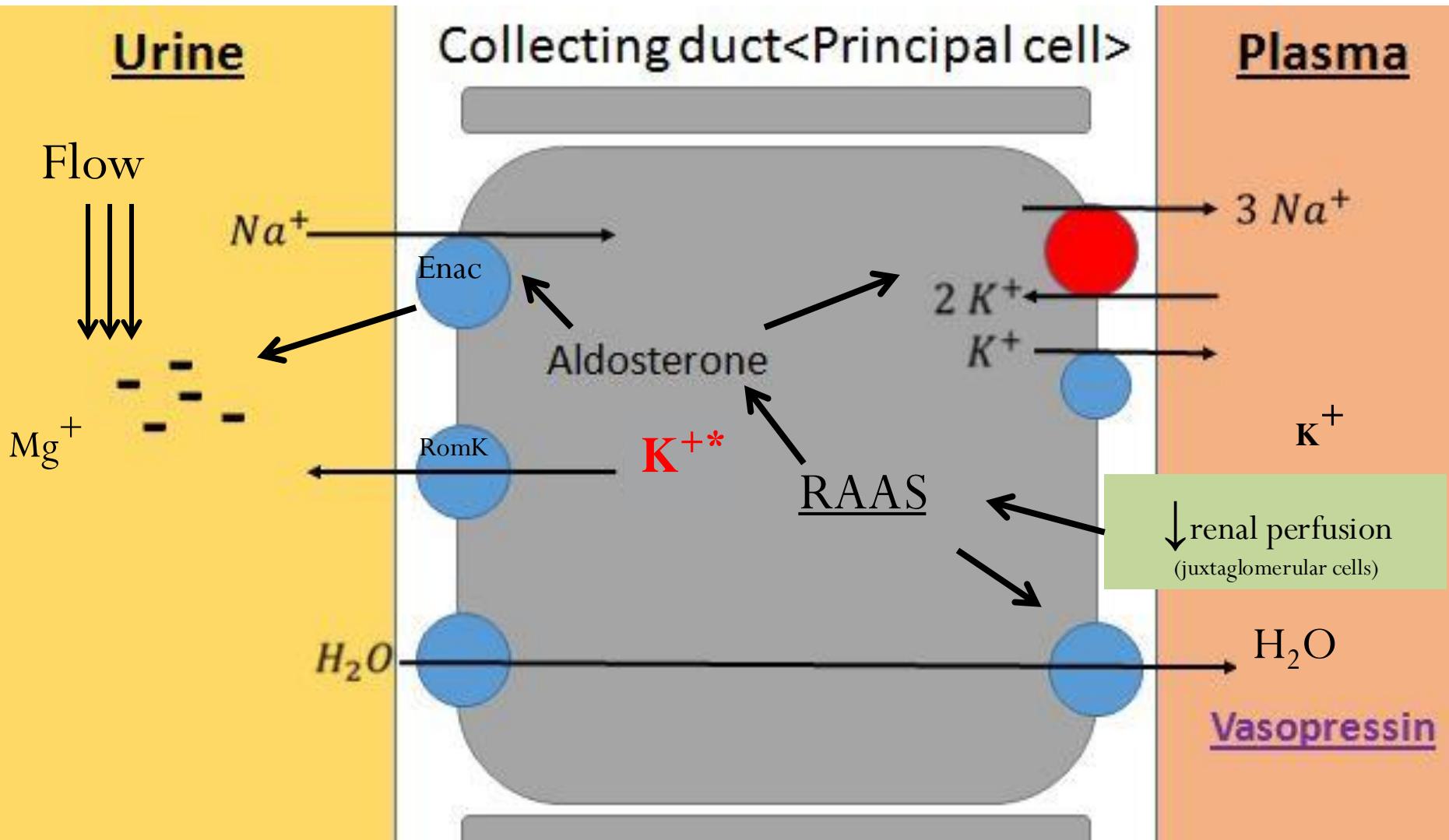
Proximal Tubule

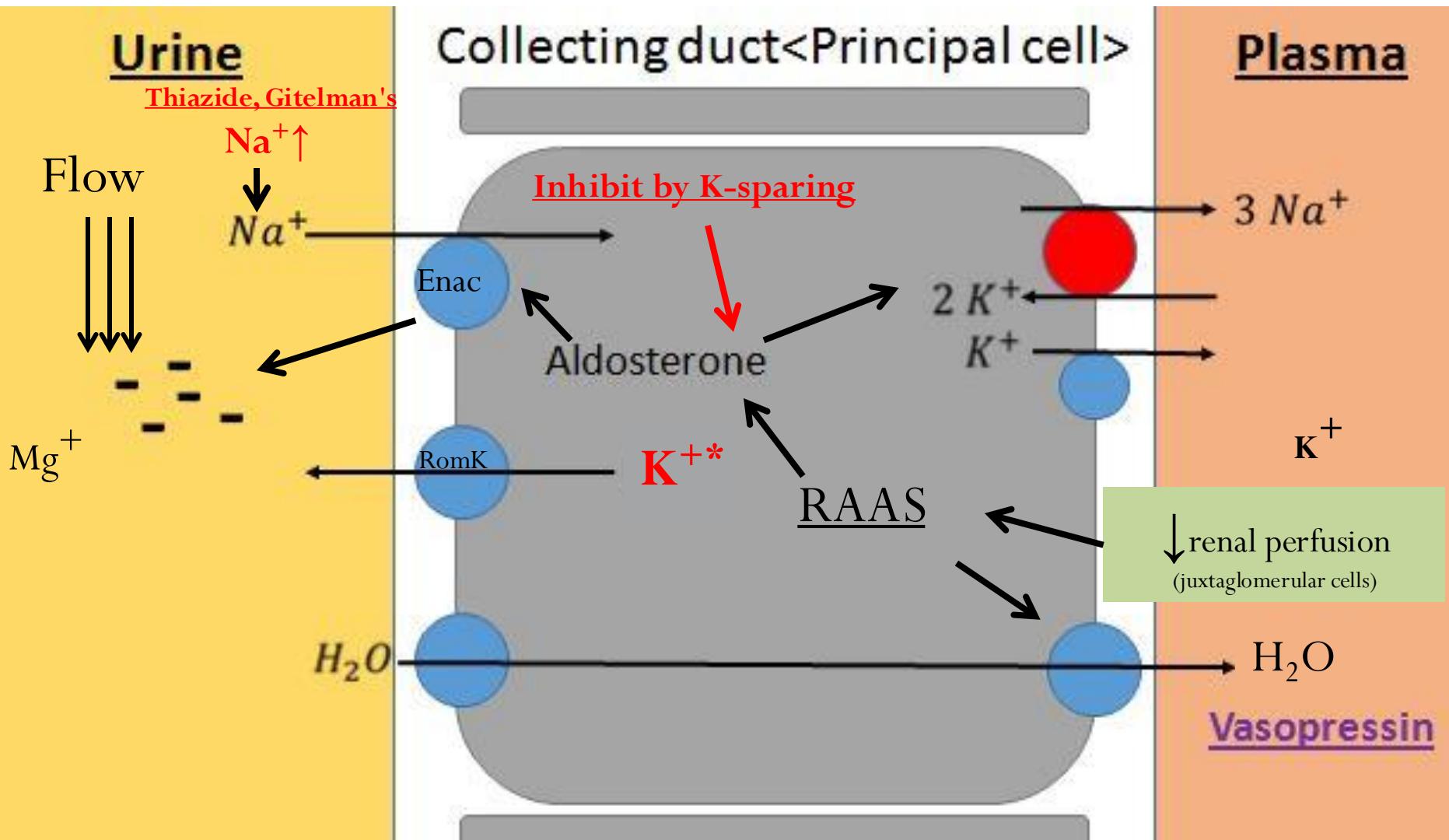
Plasma









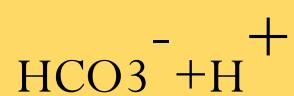


Distal

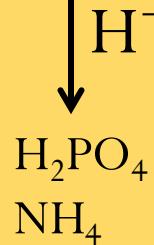
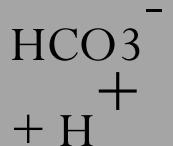
α -intercalated cell

Plasma

Urine



CA



$\text{H}^+ - \text{K}^+$
ATPase

H^+
ATPase



RTA type I (Hypo K, Non HypoK)

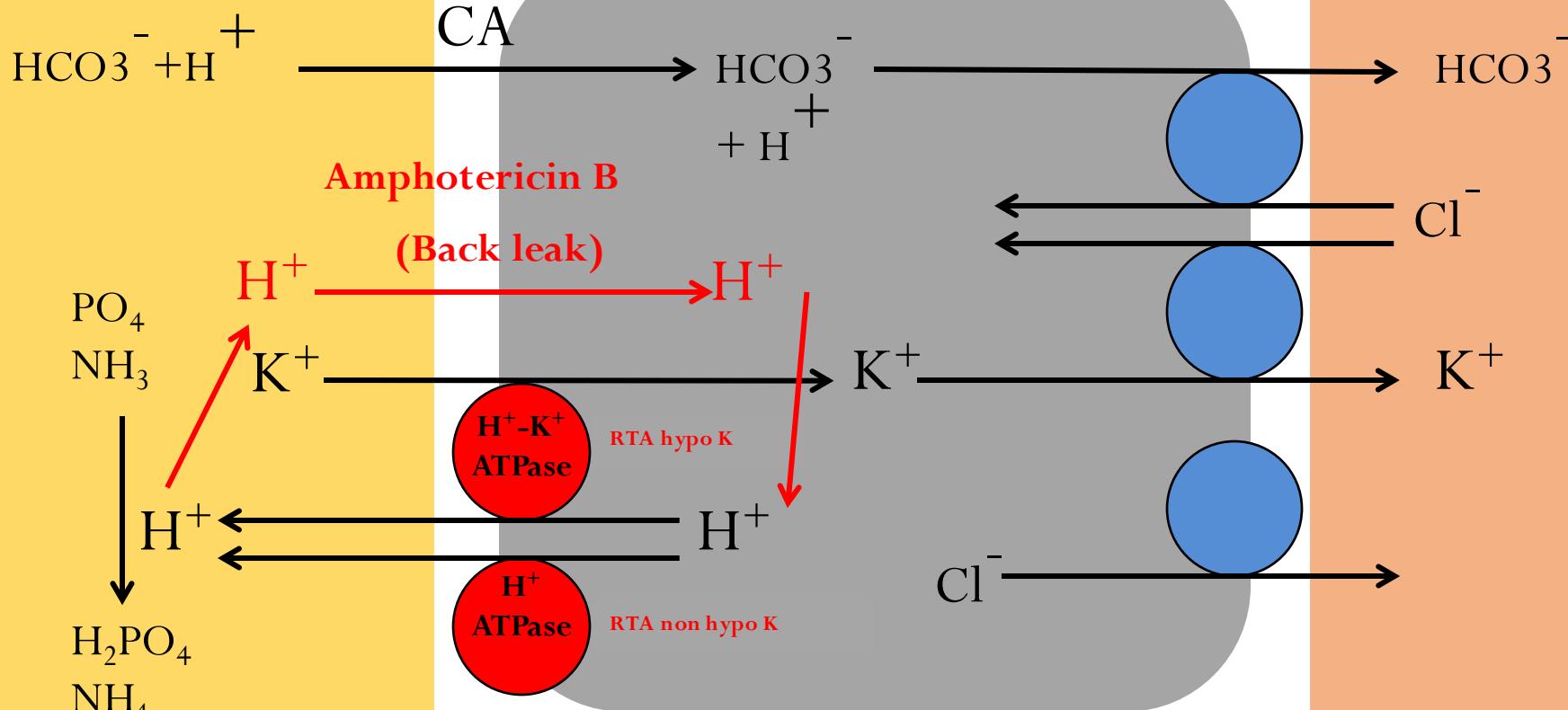
Distal

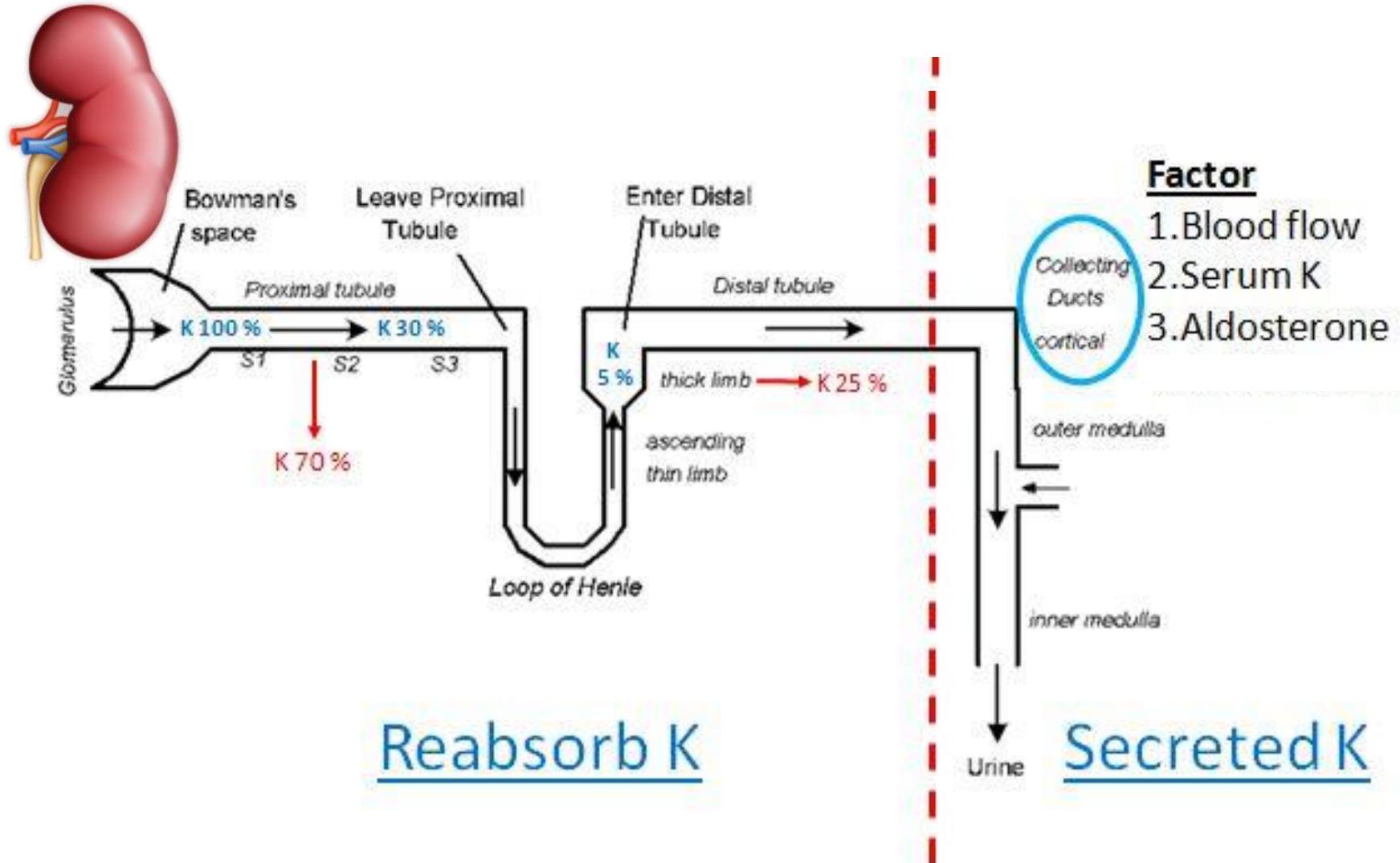
α -intercalated cell

Plasma

Urine

RTA type I (Hypo K, Non HypoK)





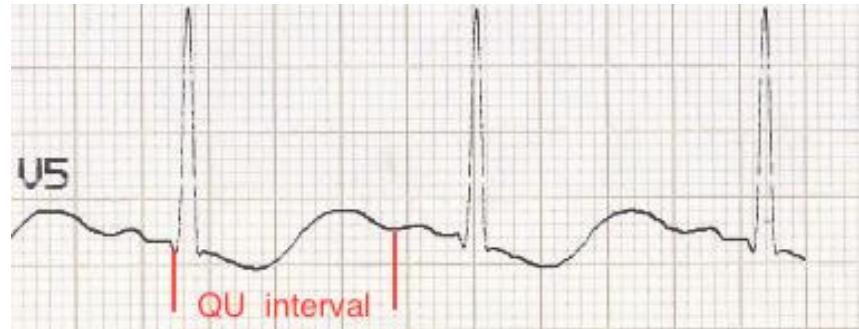
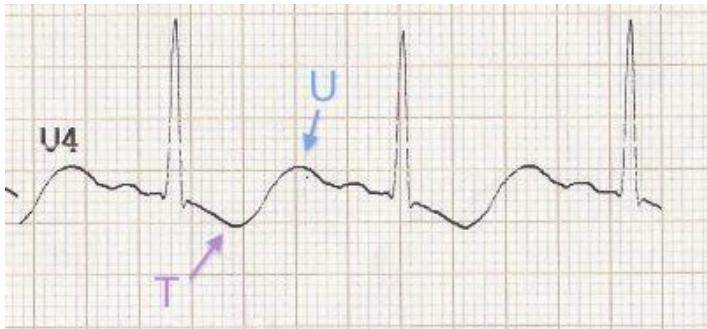
Approach

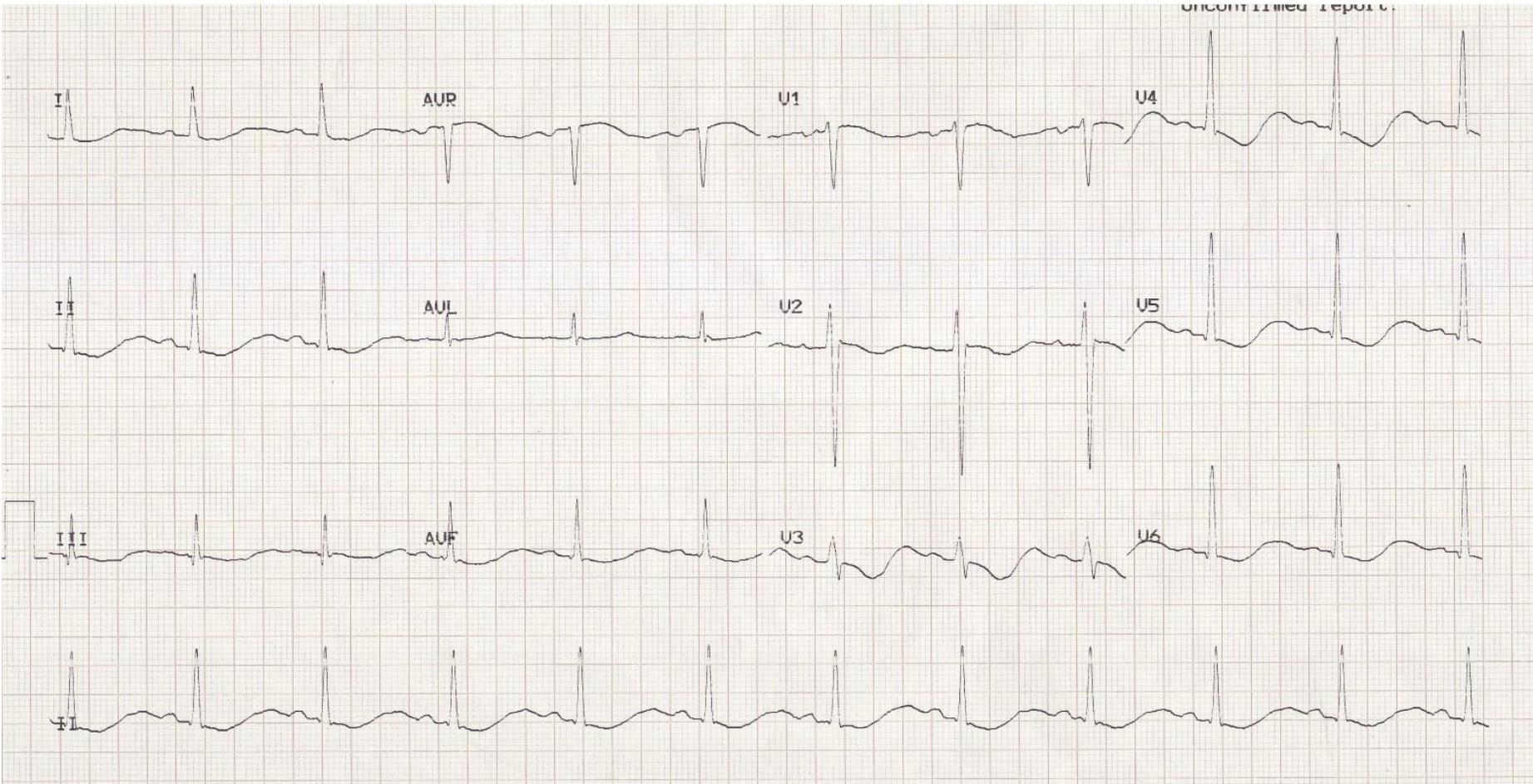
1. Emergency ?
2. Pseudo hypokalemia ?
3. K^+ Shift
4. K loss
 - Extra renal loss
 - renal loss

1.Emergency

- Severe hypokalemia $< 2.5 \text{ mEq/L}$
- ECG changes when $\text{K}^+ < 2.7 \text{ mmol/l}$
 - Increased amplitude and width of the P wave
 - Prolongation of the PR interval
 - T wave flattening and inversion
 - ST depression
 - Prominent U waves (best seen in the precordial leads)
 - Apparent long QT interval due to fusion of the T and U waves (= long QU interval)

- With worsening hypokalaemia...
 - Frequent supraventricular and ventricular ectopics
 - Supraventricular tachyarrhythmias: AF, atrial flutter, atrial tachycardia
 - Potential to develop life-threatening ventricular arrhythmias, e.g. VT, VF and Torsades de Pointe





This patient had a serum K⁺ of 1.7

- ST depression.
- T wave inversion.
- Prominent U waves.
- Long QU interval.

HR 90 PVC 9 RESP 22 T1 38.3



12-Lead ECG (EASI Derived) Bandwidth: 0.50-20.0 Hz

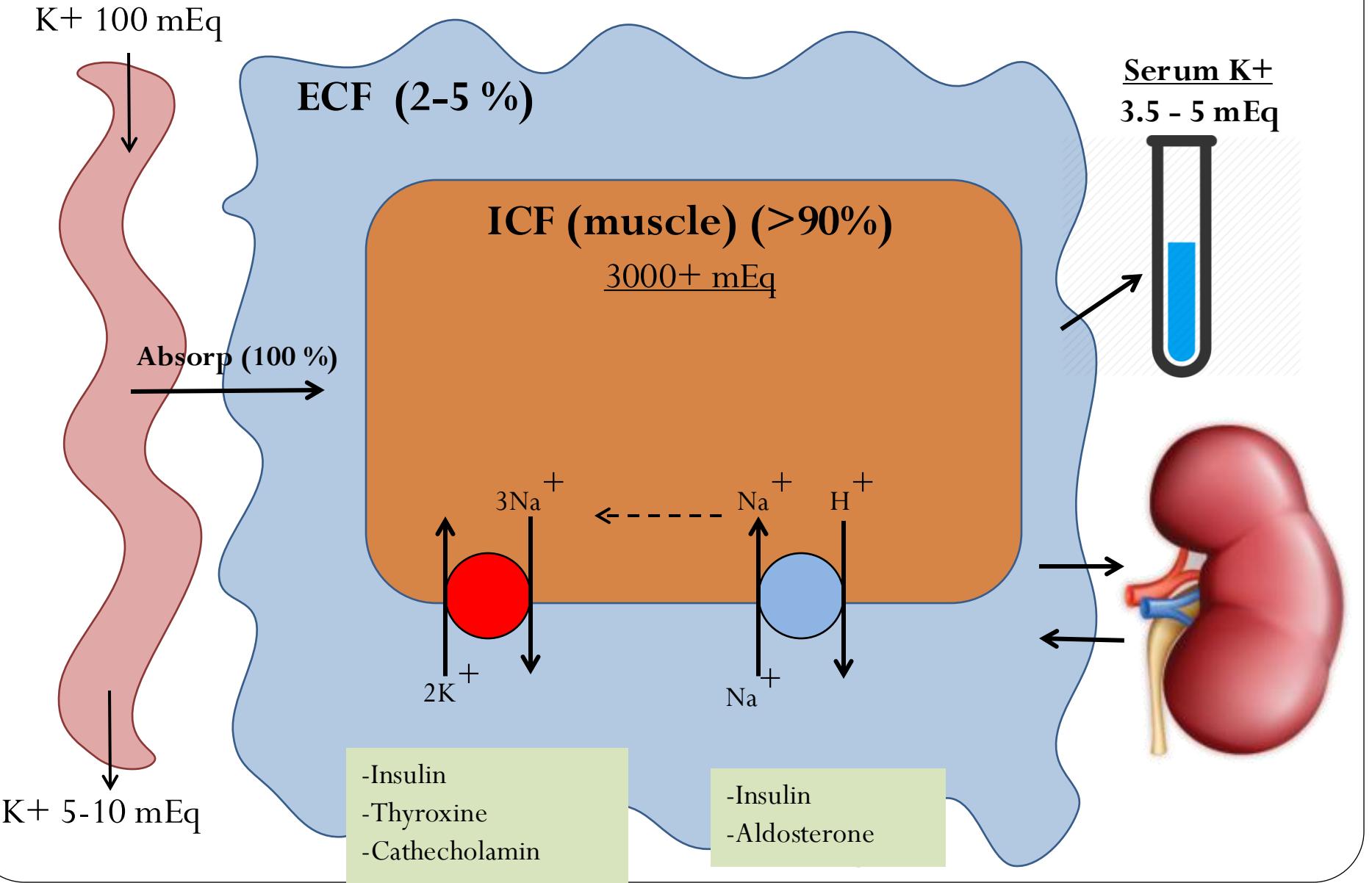
| 22/06/03 22:16:27

10 mm/mV 25.0 mm/s

2.Pseudohypokalemia

- WBC > 100,000 cells/mm³
 - Cause K⁺ shift to cell
- Leave test tube to long

3. K⁺ Shift



4. Renal or Extra renal loss

Investigation	Extra renal loss	Renal loss
Spot urine K ⁺	< 15 mEq/L	> 15 mEq/L
24 Hr urine K ⁺	< 15 mEq/day	> 15 mEq/day
Trantubular potassium concentration gradient [Urine K ⁺ /Plasma K ⁺ ÷ Urine osmol/Plasma osmol]	< 3	> 3
Urine K ⁺ / Urine Cr [mmol/mmol]	< 1.5	> 1.5

Hypokalemia

Extra-renal loss

Renal loss

GI loss
-Diarrhea
-Ostomy
Low intake
Shifting

Met alk or normal

Met a

Wide gap
-Ketoneacidosis
-Other anions

Normal gap
-RTA

Hypokalemia

Extra-renal loss

Renal loss

Met alk or normal

Met a

Normal BP

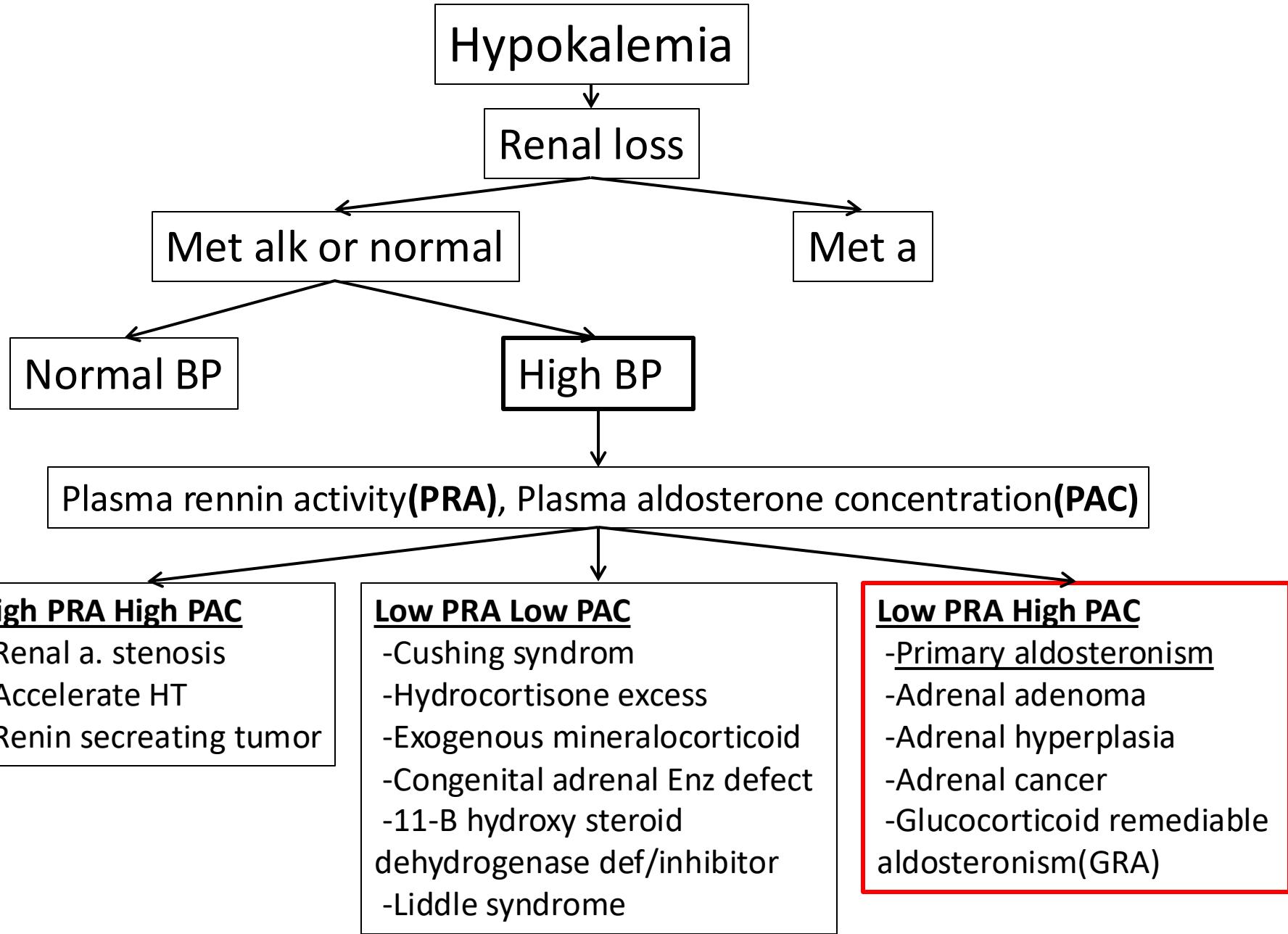
High BP

Urine Cl < 15

Urine Cl > 15

-Vomiting
-Chloride diarrhea

-Diuretic
-Gitelman/Bartter
-Hypomagnesemia
-Tuberopathy

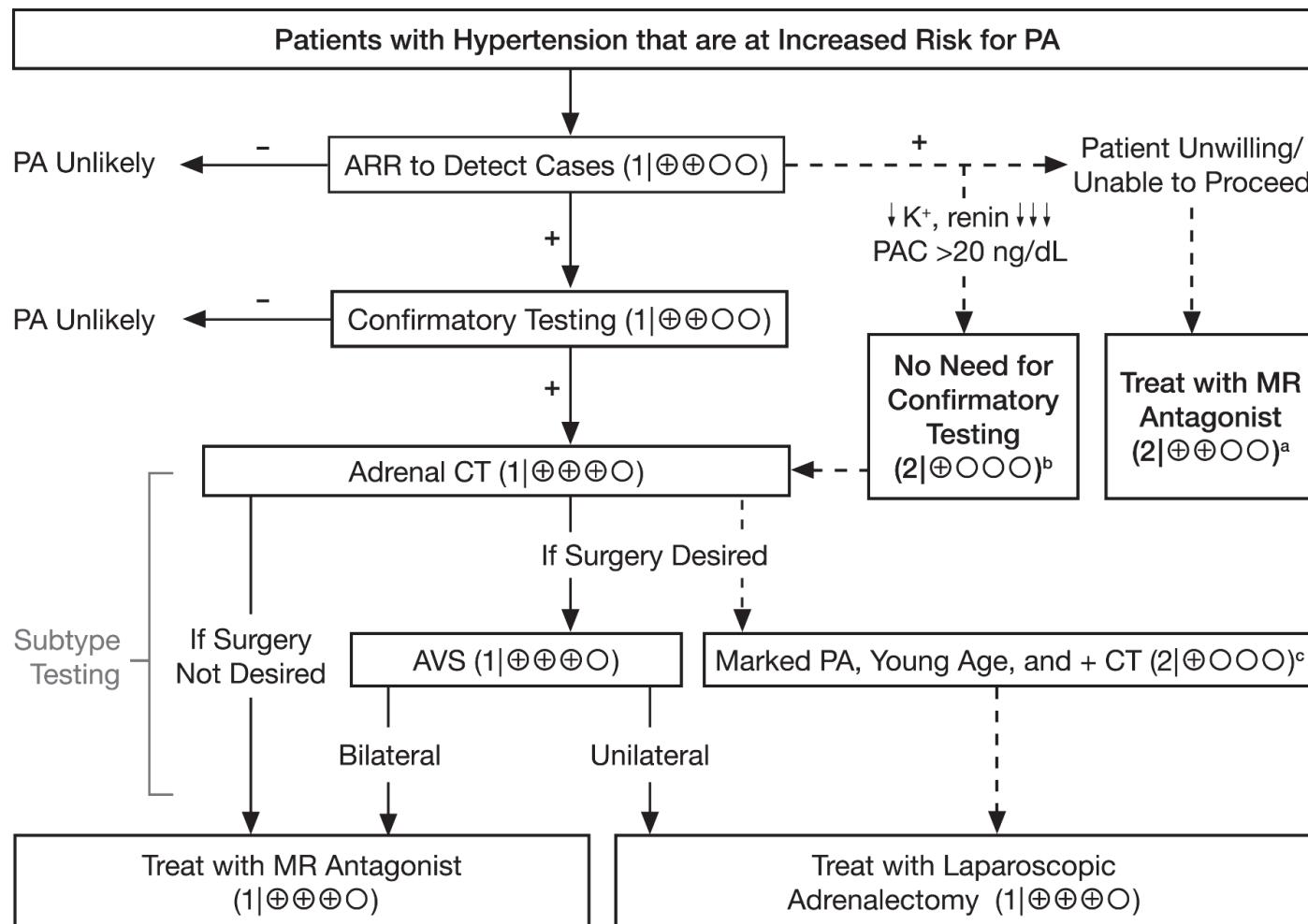


Confirmation test of Primary Aldosteronism

- **Oral sodium loading test**
 - Control BP
 - Stop spironolactone at least 6 wk before test
 - NaCl tab (1 g) 2 tab/day for 3 days
 - Collect Urine Na (24 hr) > 200 mEq (adequate NaCl intake)
 - Urine aldosterone > 12 mcg/24 hr
- **Saline infusion test**
 - Bed rest
 - NSS 2 L in 4 hr
 - PAC > 10 ng/ml (5-10 = indeterminate)

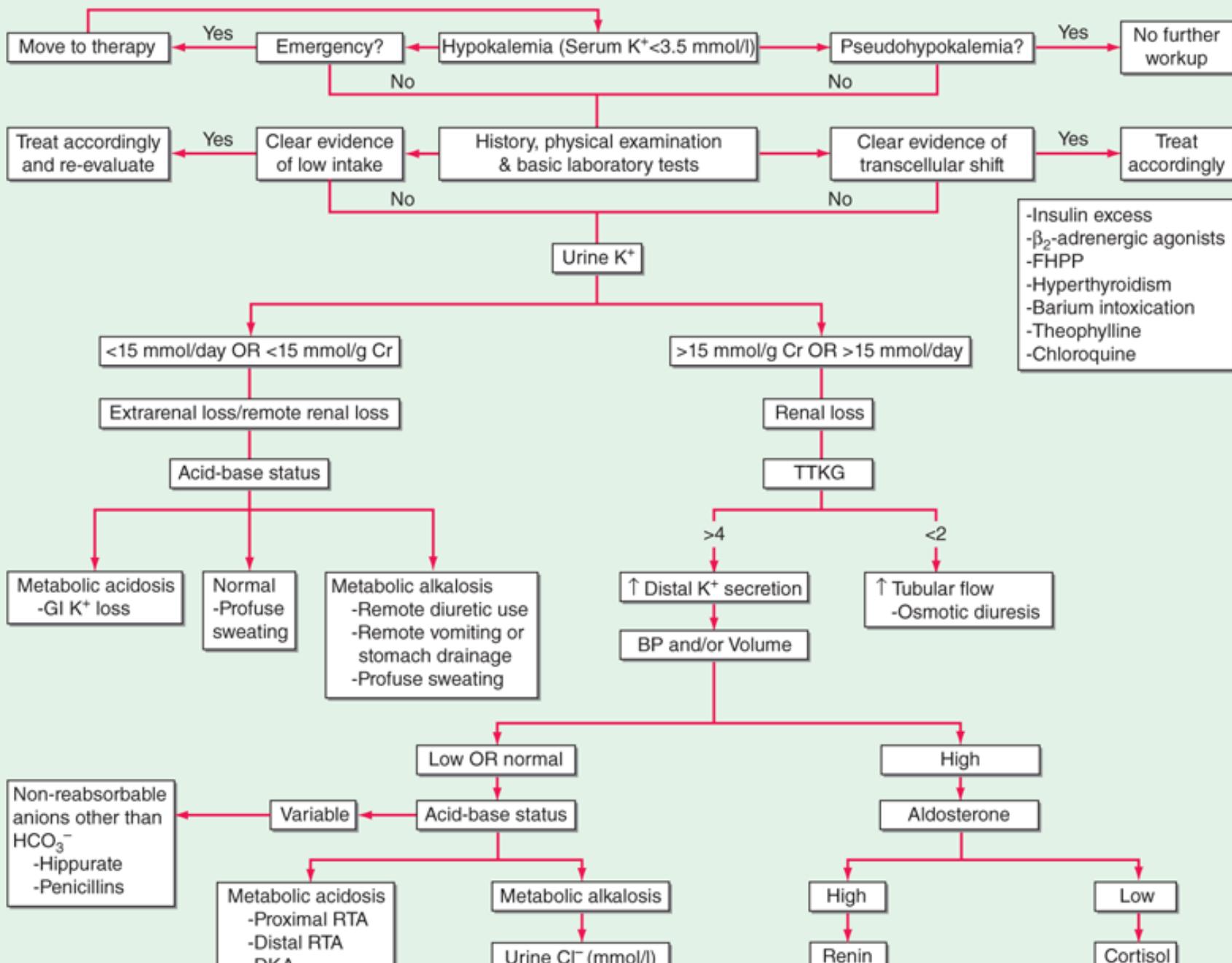
The Management of Primary Aldosteronism

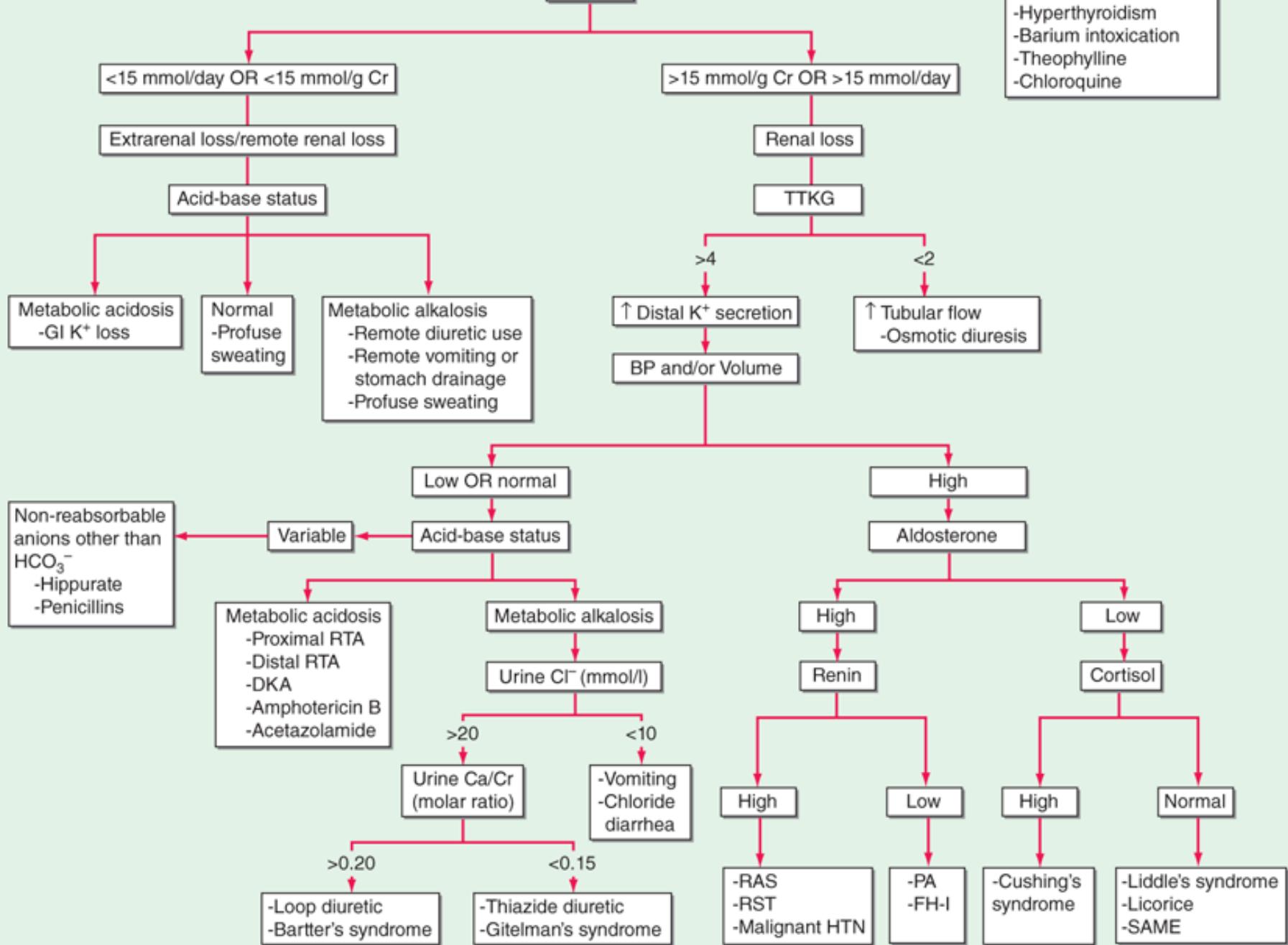
An Endocrine Society Clinical Practice Guideline



Type of potassium supplement

- Oral
 - Elixer KCL [15 ml = 20 mEq]
 - Addi K [1 tab = 10 mEq]
- IV
 - KCL [1 ml = 2 mEq]
 - K_2PO_4 [1 ml = 1 mEq]
- IV management
 - Peripheral [Conc 60 mEq/L, Rate 10 mEq/hr]
 - Central
[Conc 20-40 mEq/100 ml, Rate 10-20 mEq/hr(40 in VT VF)]





Source: D. L. Kasper, A. S. Fauci, S. L. Hauser, D. L. Longo, J. L. Jameson, J. Loscalzo: Harrison's Principles of Internal Medicine, 19th Edition

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- Hyperthyroidism
- Barium intoxication
- Theophylline
- Chloroquine