

# WORKBOOK

# ELECTROLYTE AND ACID-BASE MASTERY CERTIFICATION COURSE



**FIRST EDITION**

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**VETEMCRIT**  
CRITICAL THINKING IN VETERINARY CRITICAL CARE

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WORKBOOK

**ELECTROLYTE AND ACID-BASE  
MASTERY CERTIFICATION  
COURSE**

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# **Part 1. Potassium derangements**

## CHAPTER 1:

# Potassium homeostasis

Potassium functions as the primary cation inside cells. More than 95% of the total body potassium resides within the cells. While the typical concentration of extracellular potassium is approximately 4-5 mEq/L, the concentration inside the cells reaches about 140mEq/L.

It is important to recognize that serum potassium levels may not accurately represent the overall potassium content of the body in specific situations.

To maintain a potassium concentration gradient between the inside and outside of cells, an active pump called Na<sup>+</sup>-K<sup>+</sup>-ATPase is responsible for transporting potassium ions into the cell while expelling sodium ions out of the cell in a 3:2 ratio.

The regulation of potassium must be able to adjust to changes in potassium intake from the diet and intravenous fluids administered to hospitalized patients.

**Distribution of potassium in intracellular vs. extracellular space (note: extracellular space includes both interstitial and intravascular compartments)**

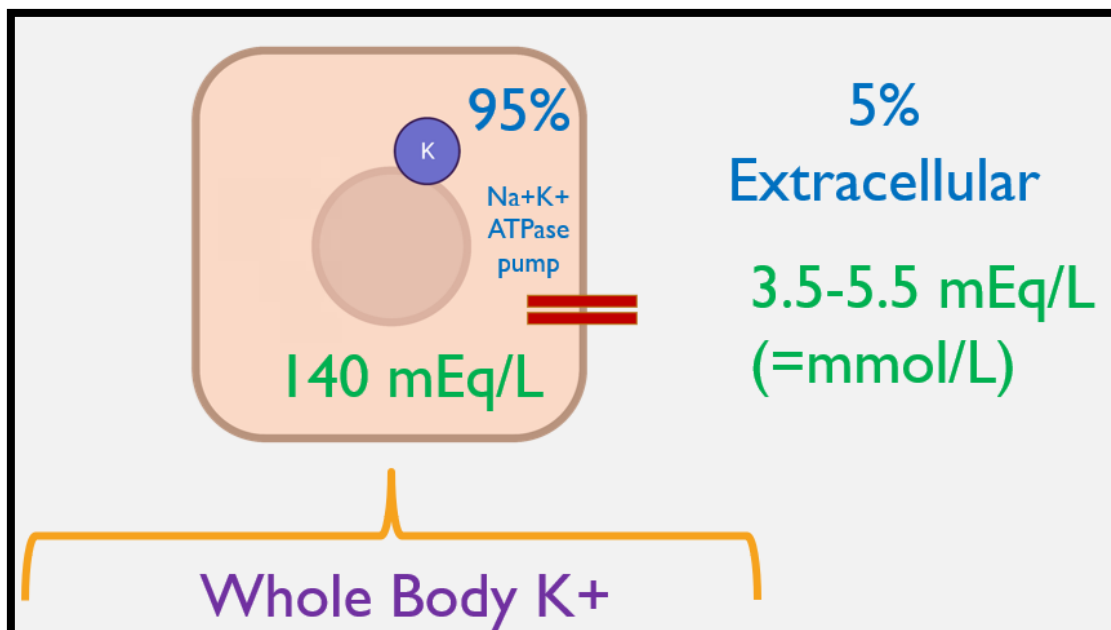


FIGURE 1

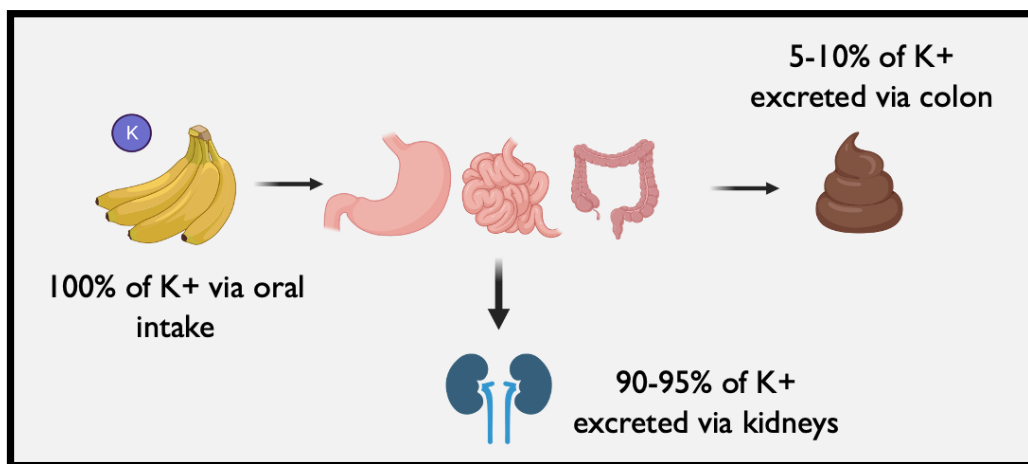


There are two vital mechanisms that work to keep the serum potassium concentration within a normal range:

- internal potassium balance, which involves the distribution of potassium between the intracellular and extracellular fluid compartments
- external potassium balance, which entails the kidney's excretion of excess potassium

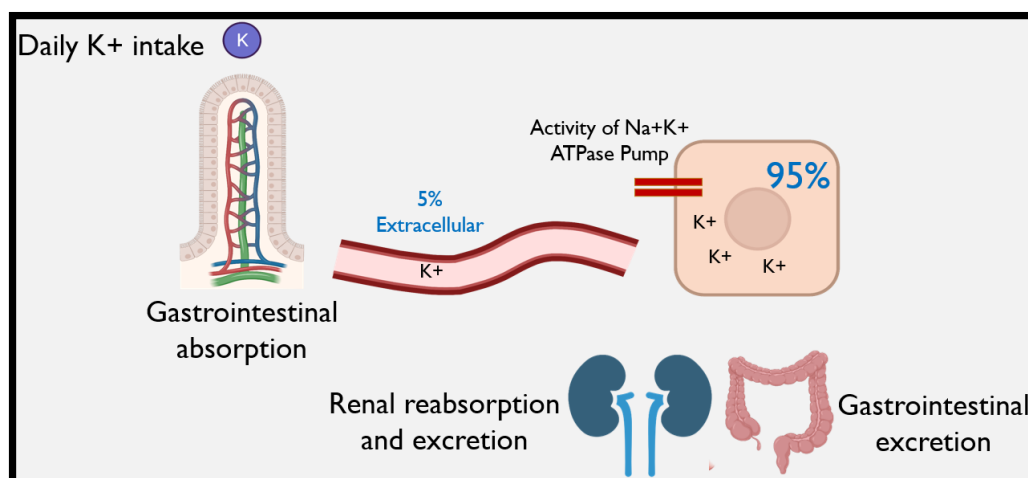
Abnormal serum potassium levels may arise due to disturbances in potassium intake, imbalances in internal potassium distribution, or issues with external potassium excretion.

## External potassium balance



**FIGURE 2**

## Internal potassium balance



**FIGURE 3**

### Potassium translocation

Potassium may shift in and out of cells secondary to different physiologic and pathologic conditions.

Common physiologic and pathologic factors resulting in potassium shifting in and out of the cells

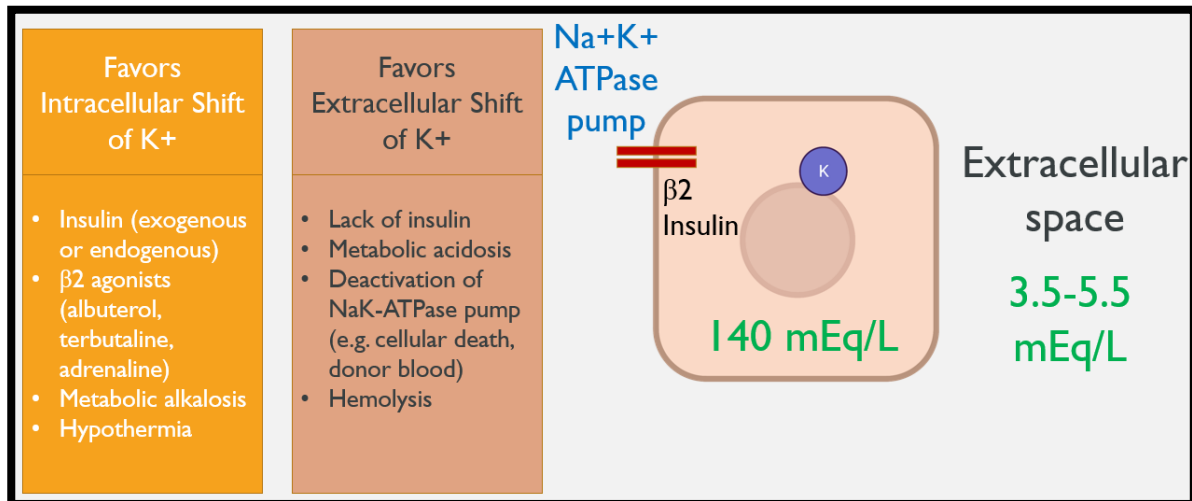


FIGURE 4

### Effect of acid-base status on potassium translocation

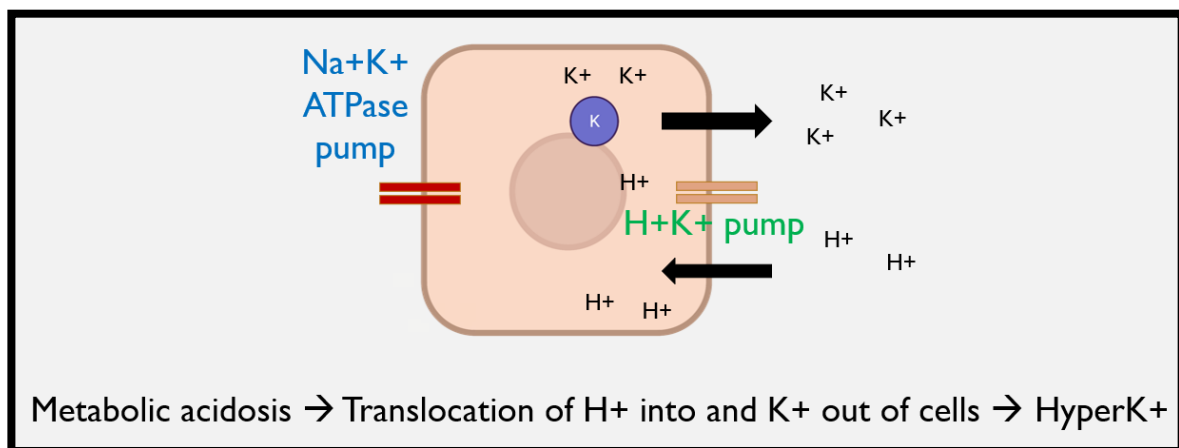
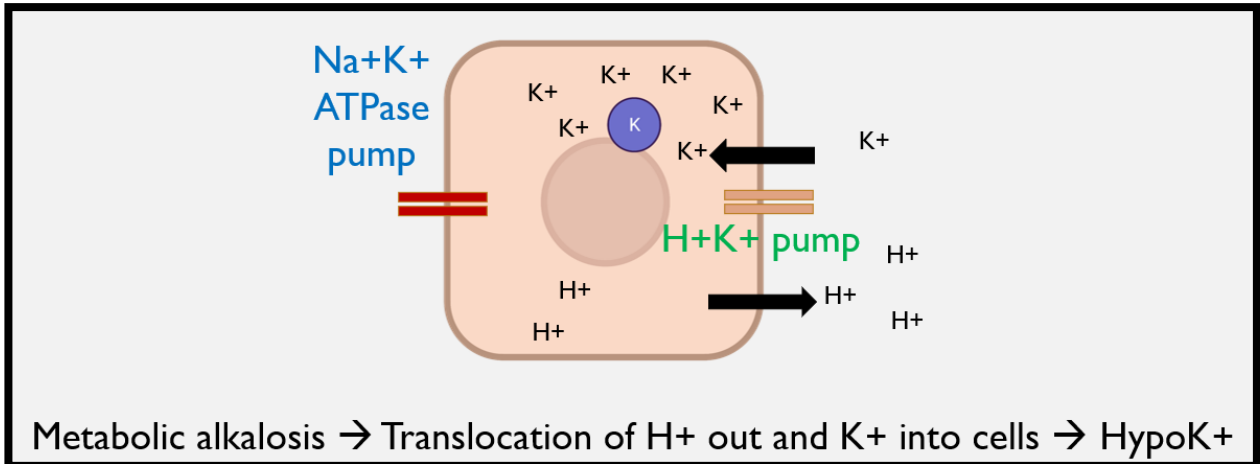


FIGURE 5

**FIGURE 6**

## CHAPTER 2:

# Approach to a diagnosis of hypokalemia

All causes of hypokalemia can be divided into 3 big groups:

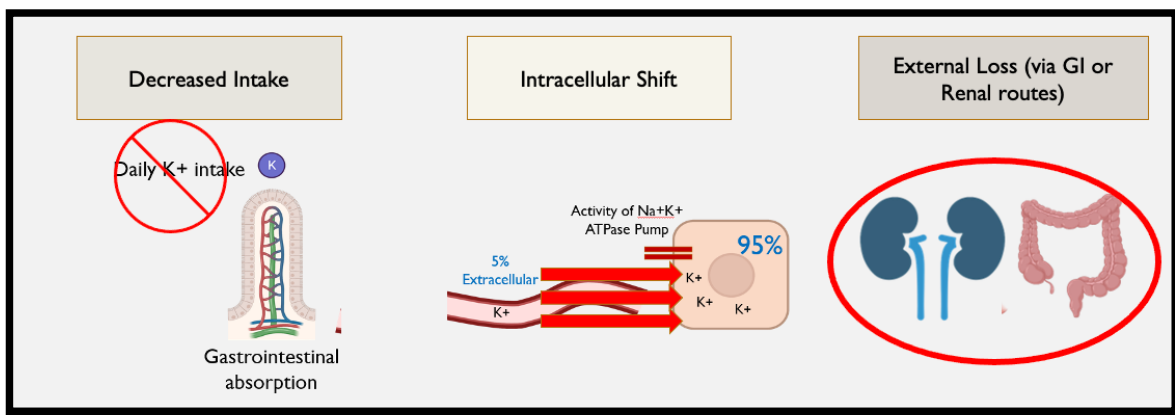


FIGURE 7

Recommended step-wise diagnostic approach to all patients with hypokalemia may include the following 6 steps:

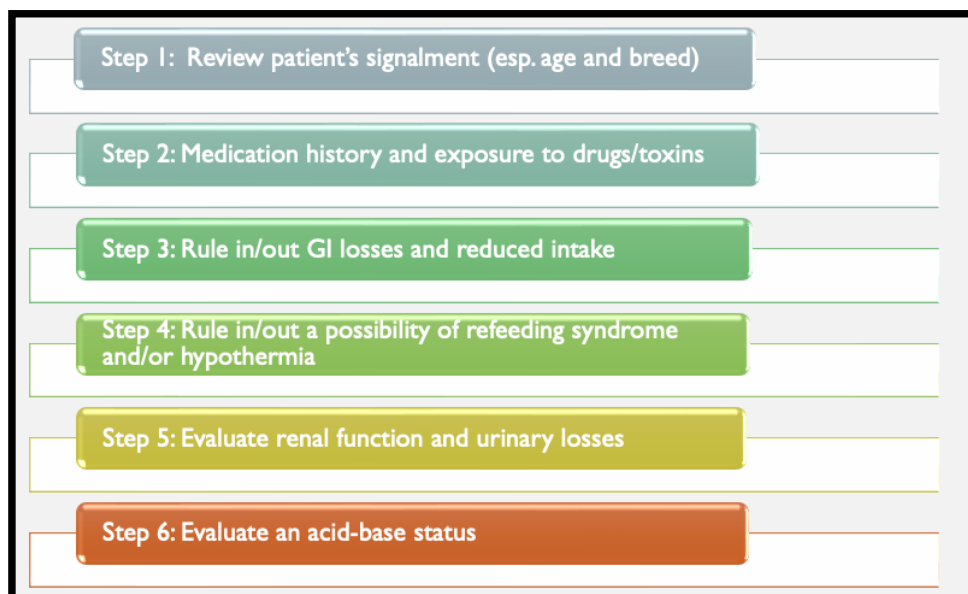


FIGURE 8

NOTE: You should complete all steps even if the cause of hypokalemia is apparent in early steps because some patients may have a multifactorial nature of hypokalemia.

## Diagnosis of hypokalemia checklist

Check off all that apply to your patient:

Step 1: Review patient's signalment

- Burmese cat?
- An old cat (a higher risk for hyperaldosteronism and chronic kidney disease)

Step 2: Medication history and exposure to drugs and toxins

- K-deficient fluids in hospitalized anorexic patients
- Loop/thiazide diuretics (as opposed to spironolactone)
- Insulin and/or dextrose administration
- Albuterol, terbutaline, epinephrine, any  $\beta_2$ -agonists
- Rattlesnake envenomation

Step 3: Rule in/out gastrointestinal losses and reduced intake

- Presence of any GI signs (vomiting/diarrhea) in a hypoK<sup>+</sup> patient will be suggestive of K<sup>+</sup> losses
- OPTIONAL
  - Calculate fractional excretion of K (Fe K) may help you to differentiate between GI losses vs. RENAL losses
  - $Fe\ K = (\text{Urine } K^+ / \text{Blood } K^+) / (\text{Urine creatine} / \text{Blood creatinine}) \times 100\%$
  - $Fe\ K > 10\text{-}12\%$  is suggestive of excessive renal losses

Step 4: Is there a possibility of a refeeding syndrome?

- Prolong starvation
- Severely malnourished patient

Step 5: Evaluate renal function and urinary losses

- Polyuria (>2 ml/kg/hr) → may cause potassium wasting
- Oligoanuria (<0.5-1 ml/kg/hr) is unlikely associated with hypokalemia
- Recent urethral obstruction → may lead to postobstructive diuresis

Step 6: What is the acid-base status?

- Metabolic or respiratory alkalosis ( $\uparrow pH$ ) → intracellular potassium shifting → Hypokalemia ( $\uparrow pH \rightarrow \downarrow K$ )
- Metabolic acidosis due to inorganic acid accumulation (uremic, HCl) ( $\downarrow pH$ ) → extracellular potassium shifting → Hyperkalemia ( $\downarrow pH \rightarrow \uparrow K$ )
- EXCEPTION: Renal Tubular Acidosis may cause potassium wasting → hypokalemia

CONCLUSION: Check off the most likely cause(s) of hypokalemia based on responses above:

- Decreased intake (anorexia, hyporexia)
- Intracellular shift
  - Congenital (e.g. Burmese cat)
  - Medication/drug/toxin/envenomation (specify \_\_\_\_\_)
  - Refeeding syndrome
  - Metabolic alkalosis
- External loss (GI or Renal)
  - Gastrointestinal losses
  - Renal losses
  - Renal tubular acidosis (type I or II)