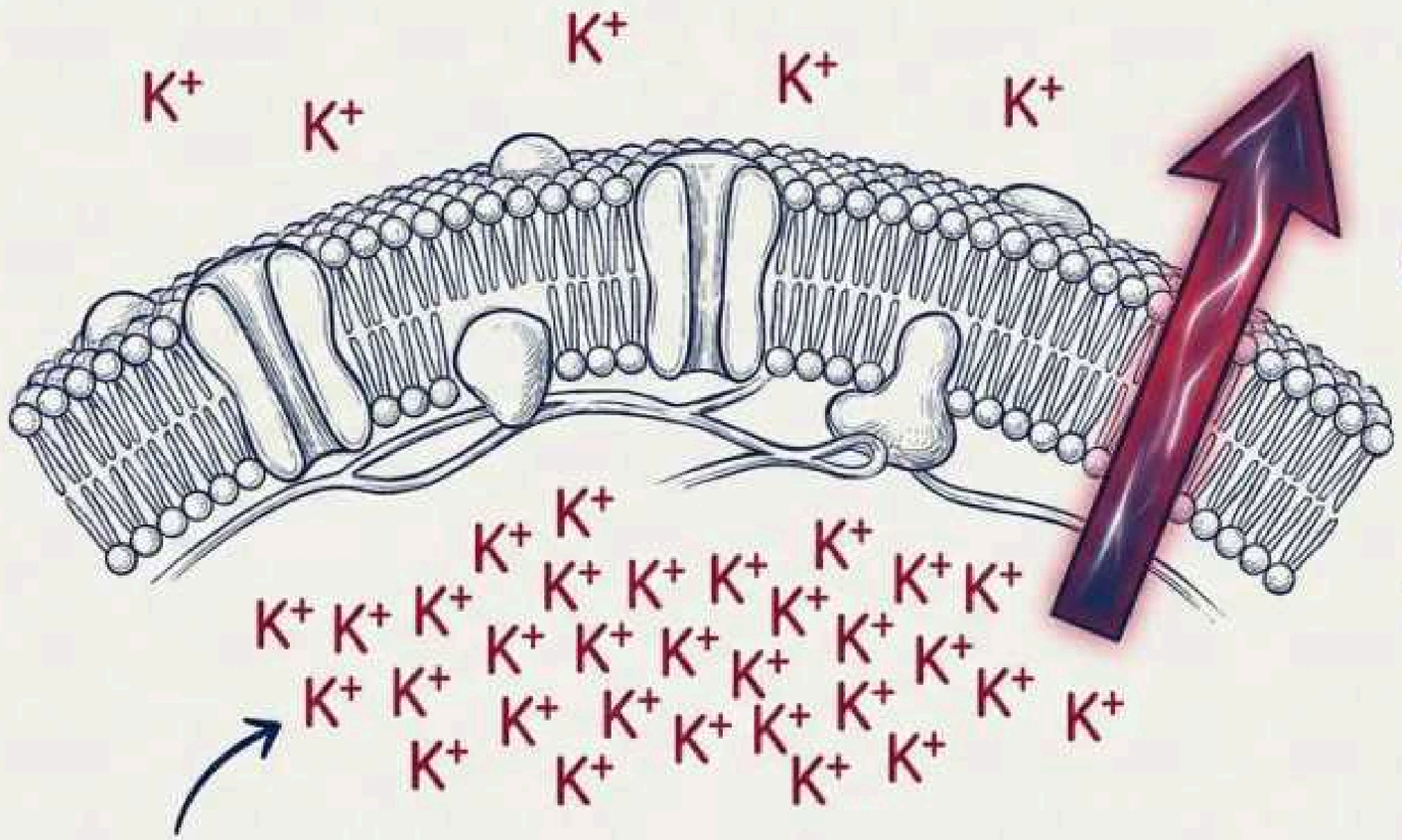
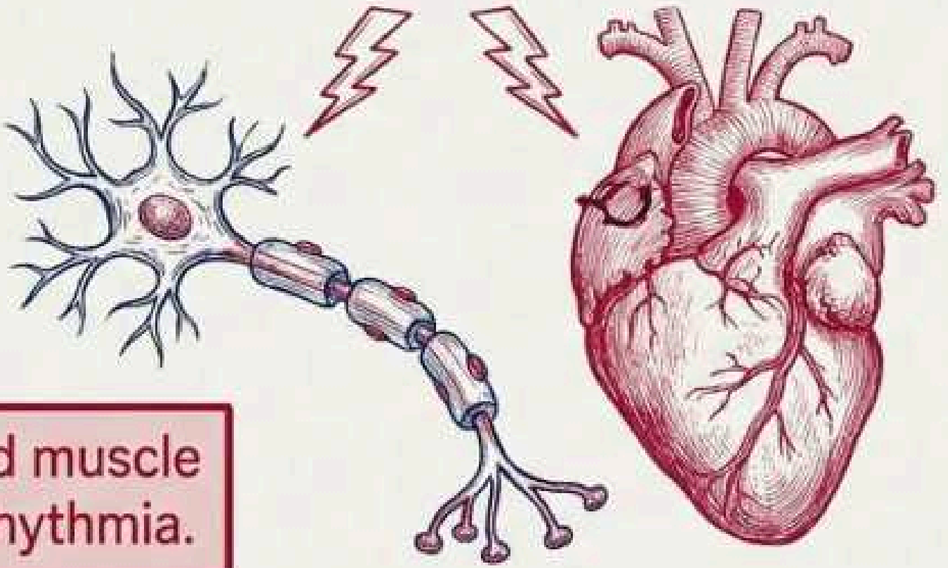
Cellular Potassium & The Resting Potential



$$E_K = \frac{RT}{zF} \ln\left(\frac{[K^+]_{out}}{[K^+]_{in}}\right)$$



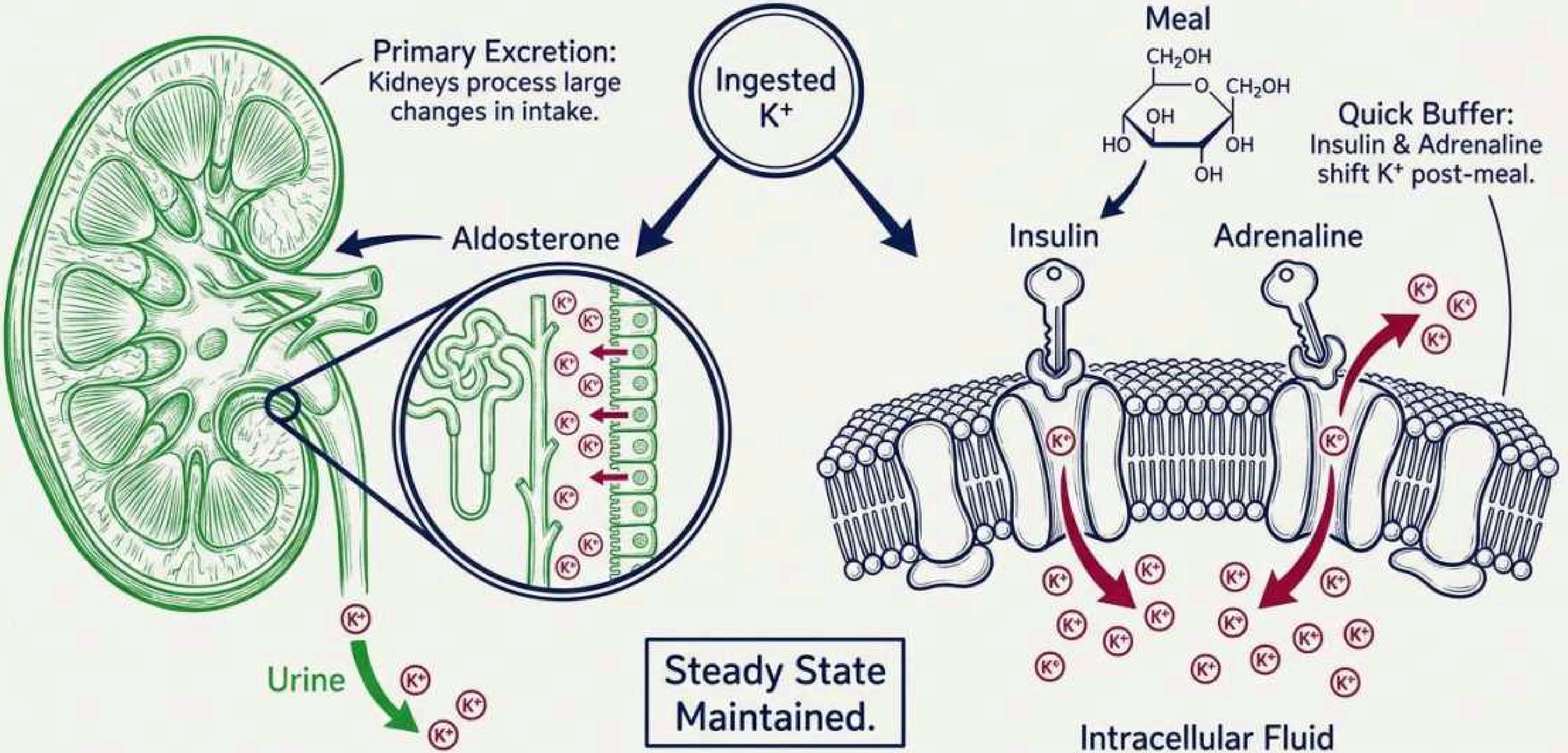
Potassium (K+):
The primary intracellular positively charged ion.

Gradient difference sets nerve and muscle resting potential. Imbalance = Arrhythmia.

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Regulating Potassium Levels

¶ 3.2

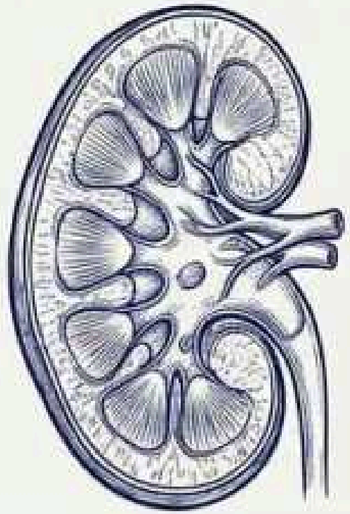


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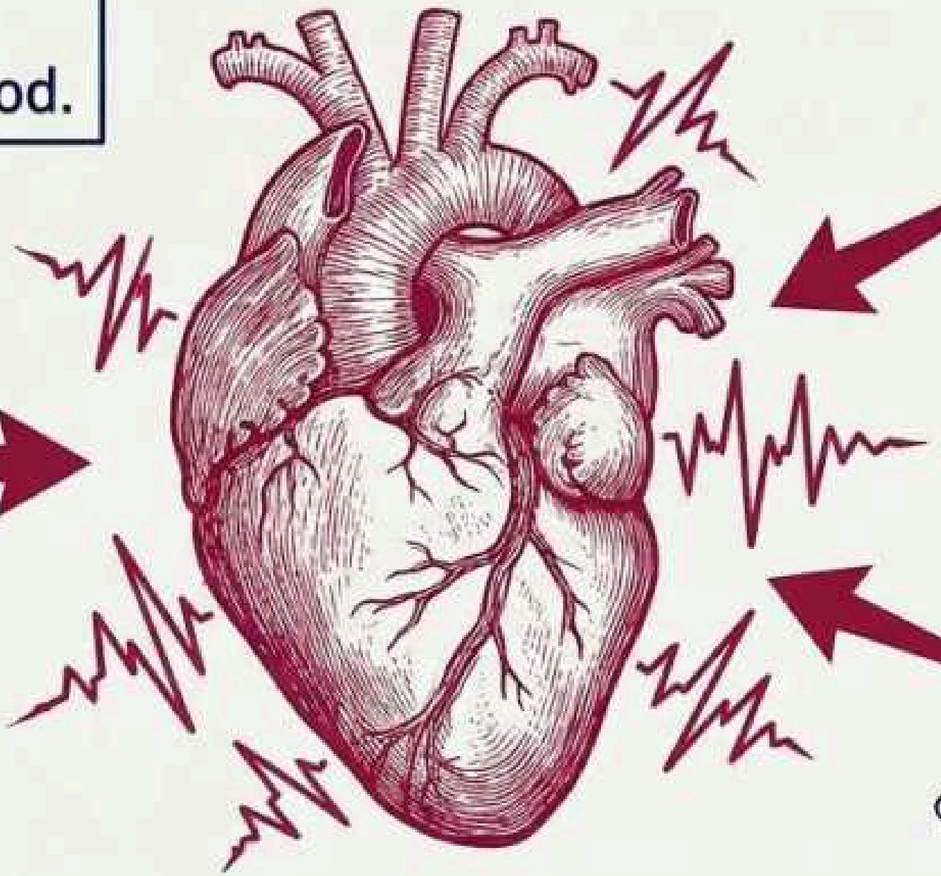
Hyperkalaemia (High Potassium)

¶ 3.3

Hyperkalaemia:
Excess potassium in the blood.

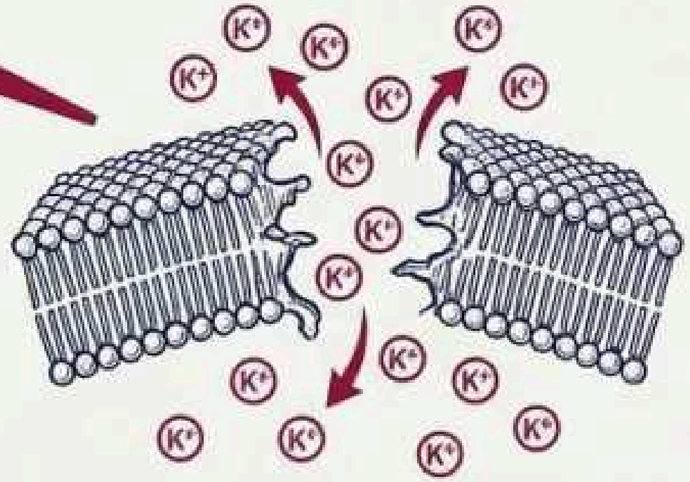


Kidney Failure





RAAS blockers &
K+-sparing drugs



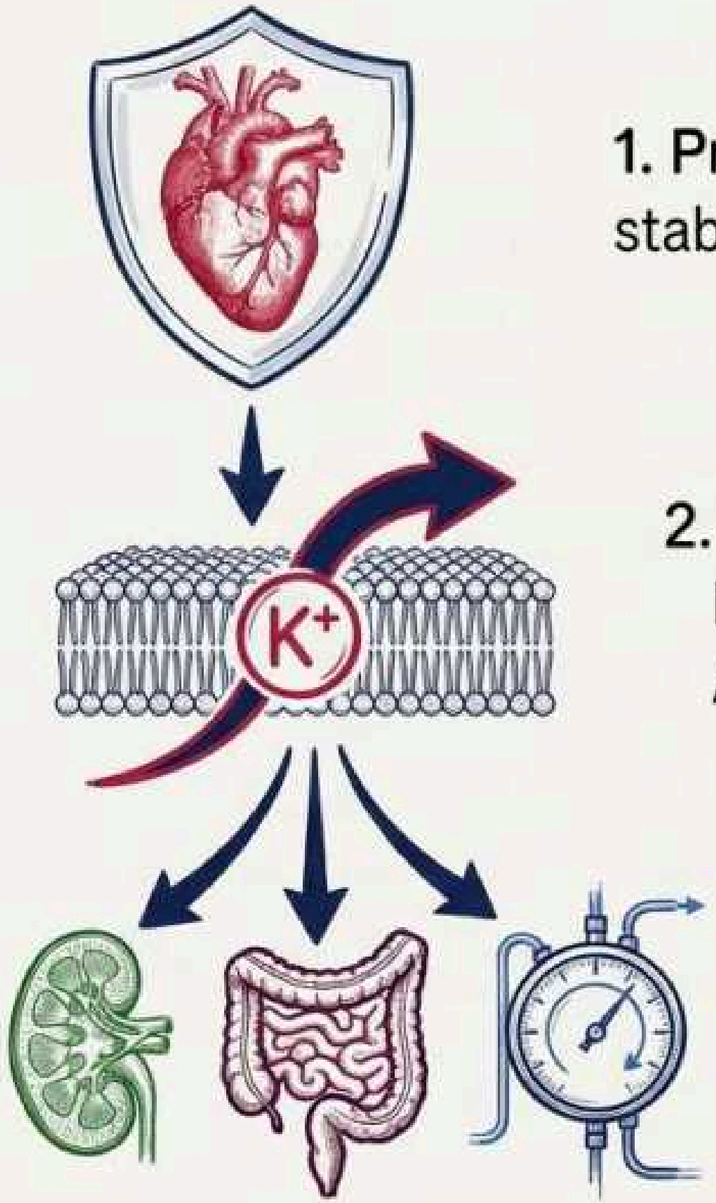
Tissue Damage

Danger: Sudden, life-threatening rhythm disturbances often present with minimal warning.

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Emergency Treatment of Severe Hyperkalaemia

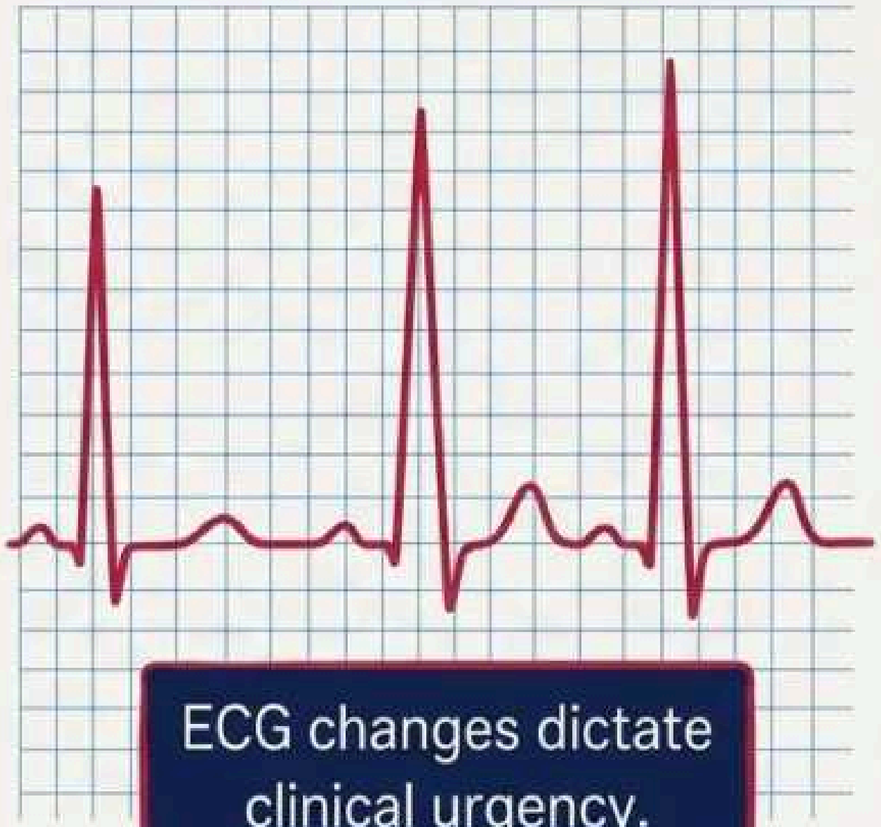
¶ 3.4



1. Protect: Administer Ca^{2+} to stabilize cardiac electrical pathways.

2. Shift: Drive K^+ into cells using Insulin + Glucose and inhaled Adrenaline-like drugs.

3. Remove: Eliminate K^+ from the body.



ECG changes dictate clinical urgency.

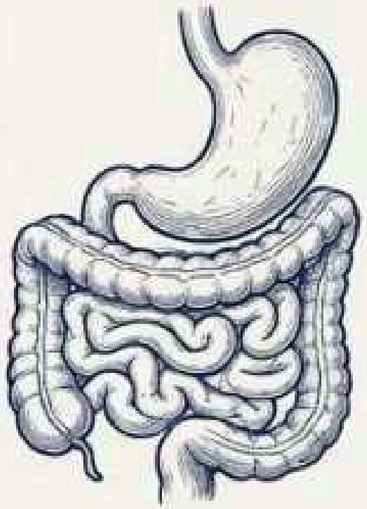
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Hypokalaemia (Low Potassium)

¶ 3.5

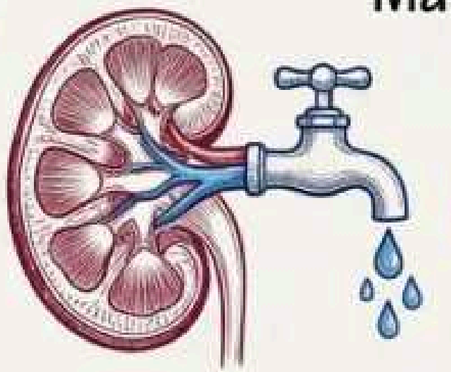
Hypokalaemia: Depleted blood potassium.

Causes



Vomiting / Diarrhoea

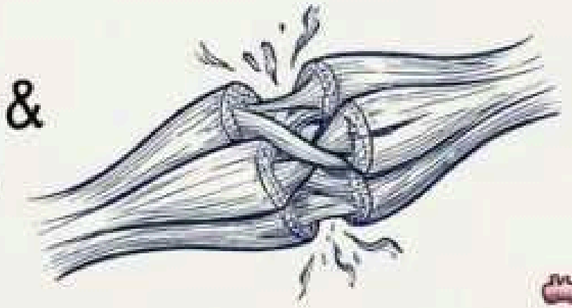
Diuretics



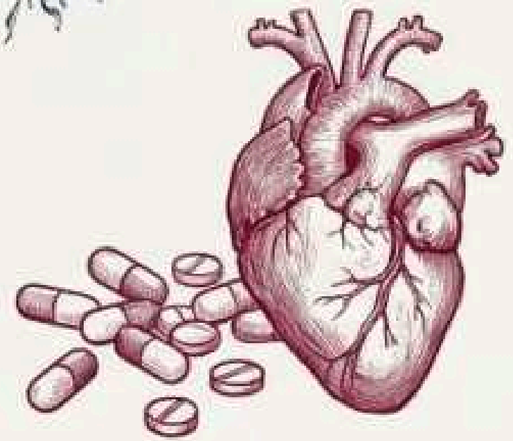
Massive K^+ loss

Effects

Weakness & Cramps



Rhythm disturbances, amplified by cardiac medications

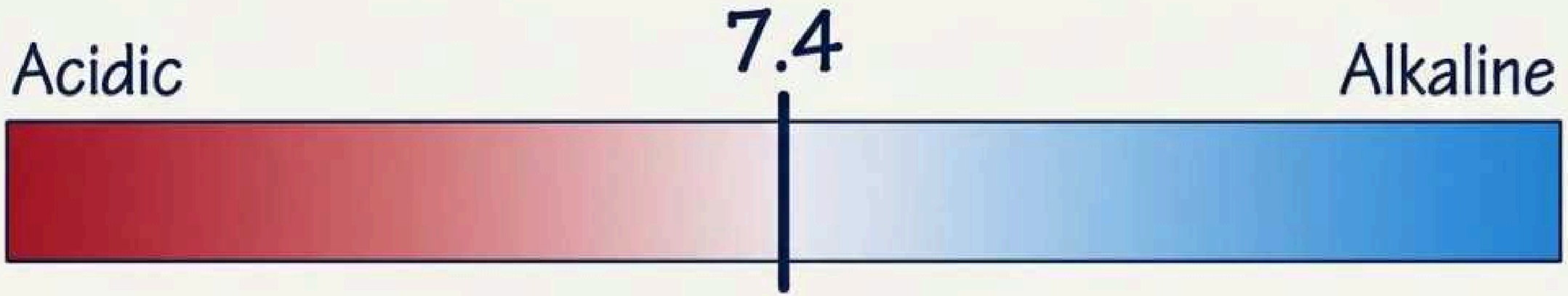


Treatment Strategy: Replace K+ AND systematically address the underlying cause.

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¶ 3.6

The Body's Acidity Limits



Metabolism constantly produces acid.

Bicarbonate System: The immediate blood buffer.

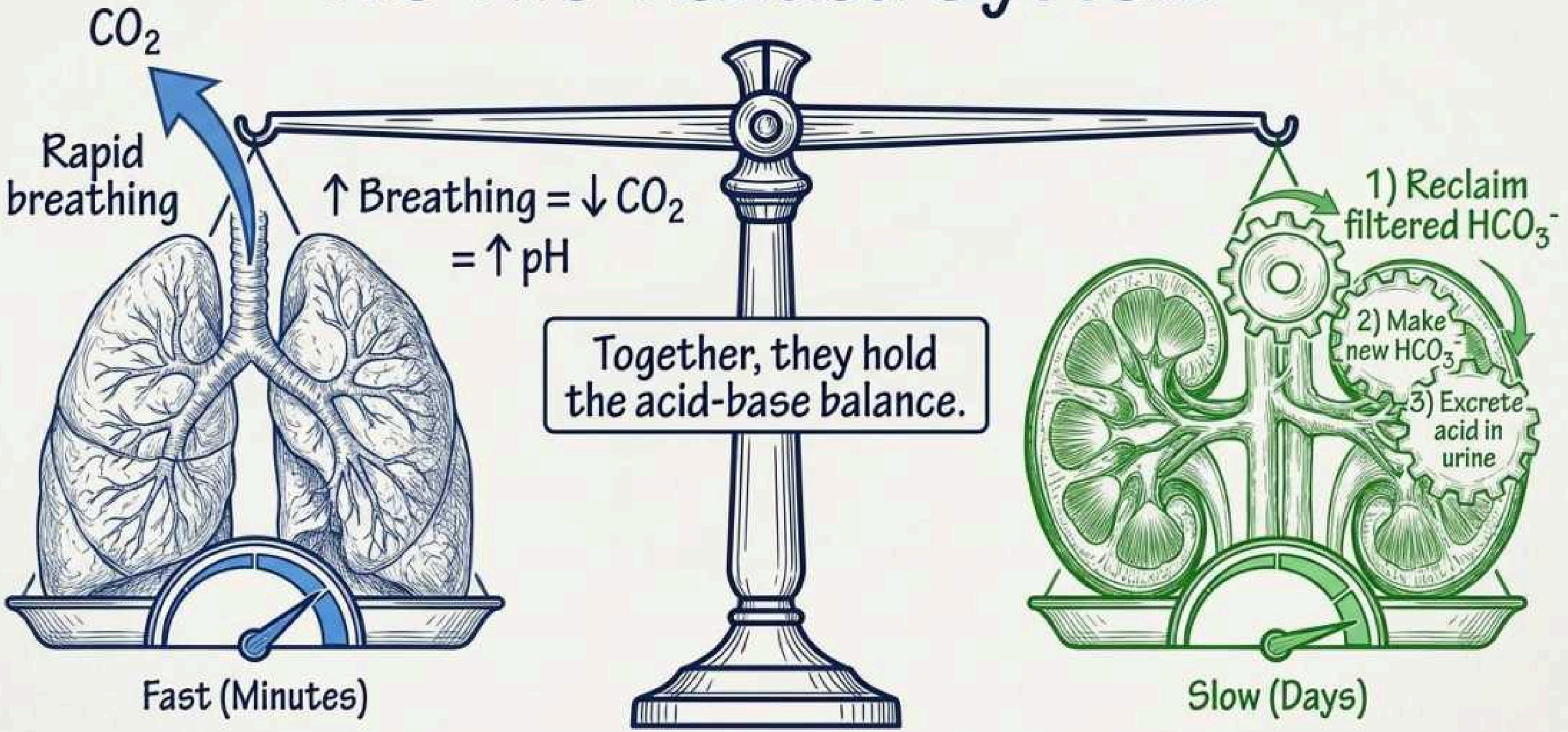
$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$$

Lungs & Kidneys perform long-term correction (minutes to days).

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¶ 3.7

The Two-Handed System



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Acid-Base Disorders Matrix

¶ 3.8

	Acidosis (pH < 7.4)	Alkalosis (pH > 7.4)
Metabolic (Kidney/Bicarb driven)	1 HCO_3^- ↓ (Acid builds up or Bicarb is lost)	2 HCO_3^- ↑ (Bicarb rises abnormally)
Respiratory (Lung/CO_2 driven)	3 CO_2 ↑ (Inadequate breathing retains acid)	4 CO_2 ↓ (Over-breathing blows off too much acid)

Compensation: The body uses the opposing system to partially balance the primary disorder.

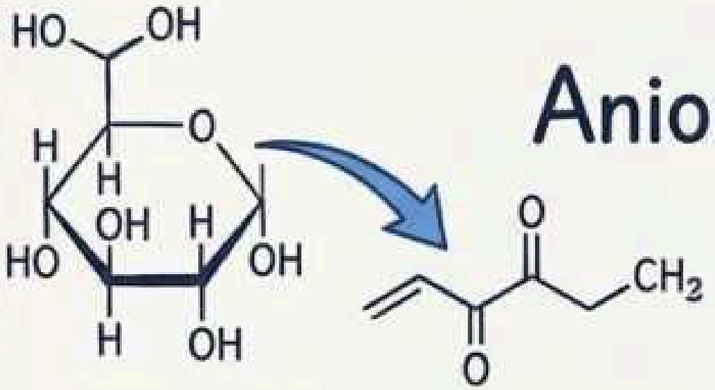
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Metabolic Acidosis & The Anion Gap

¶ 3.9

$$\text{Anion Gap} = Na^+ - (Cl^- + HCO_3^-)$$

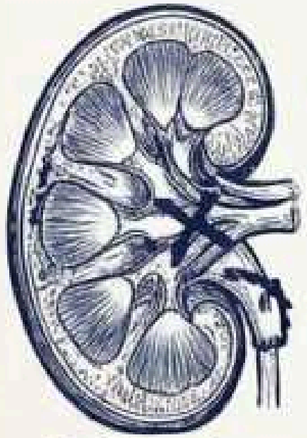
Calculated from routine blood tests.



Diabetic Ketoacidosis



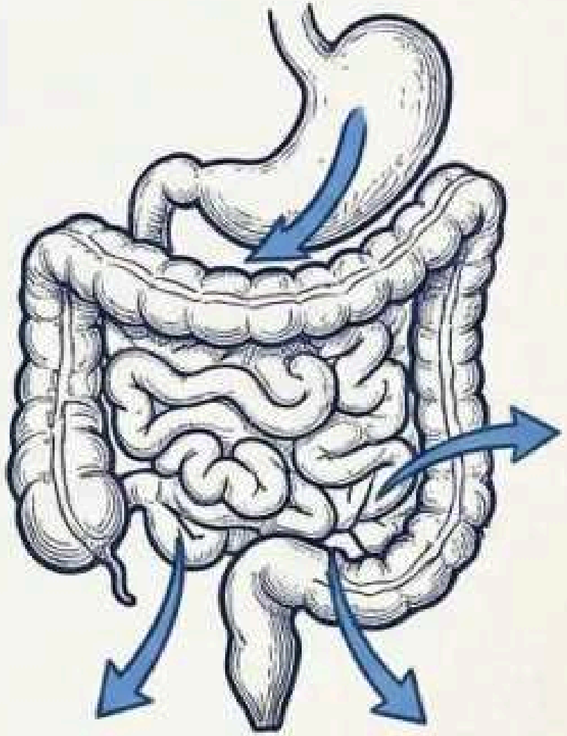
Lactic Acidosis from poor circulation



Failure to excrete acid

Adding Acid

Removing Bicarbonate

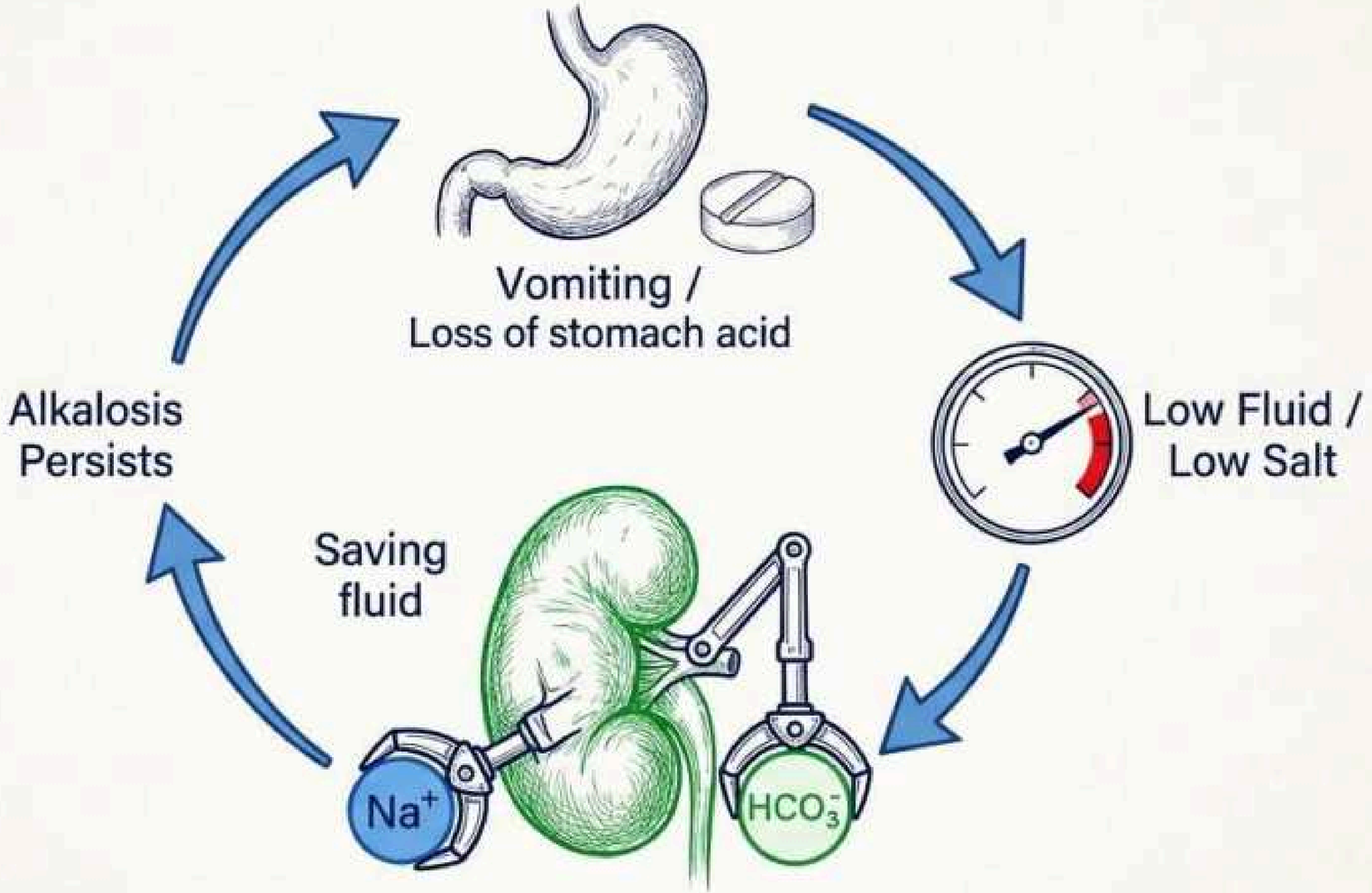


Severe Diarrhoea

The Anion Gap allows clinicians to instantly differentiate whether the acidosis is caused by gaining acid or losing bicarbonate.

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Metabolic Alkalosis & The Fluid Trap



The Kidney's Dilemma: The survival drive to retain Sodium overrides the excretion of Bicarbonate. Alkalosis cannot resolve until salt and fluid are replaced.

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Reading an Arterial Blood Gas (ABG)

Step 1: The Anchor
Look at pH.

< 7.4 (Acidic)

> 7.4 (Alkaline)

Step 2: The Source
Look at CO_2 & HCO_3^-.



Match the direction of the shift to the pH to determine if the primary driver is Respiratory or Metabolic.

Step 3: The Response
Check Compensation.



Is the other, non-primary value shifting in the expected direction to help balance the pH?

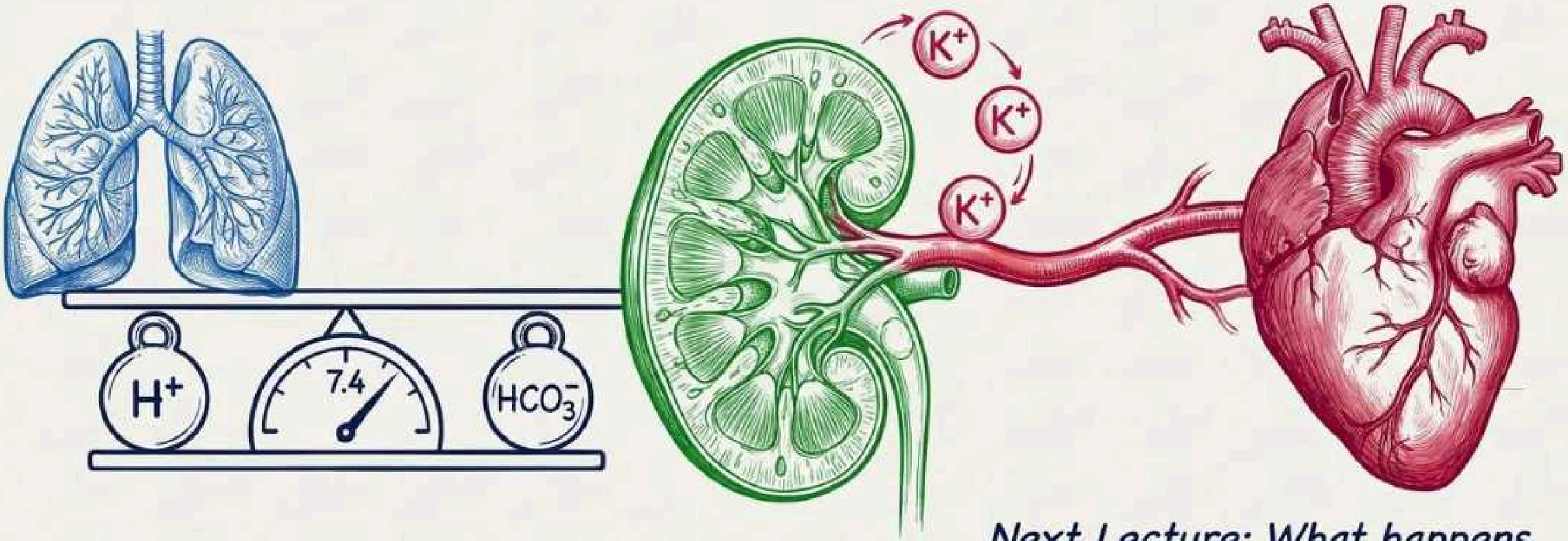
Warning: Mixed disorders (multiple primary problems occurring at once) are common in critically ill patients.

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Synthesis: The Master Balancer

¶ 3.12

Summary: The kidney maintains potassium in the tight range essential for cardiac stability, while partnering with the lungs to anchor blood acidity.



Next Lecture: What happens when the kidneys fail suddenly?

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