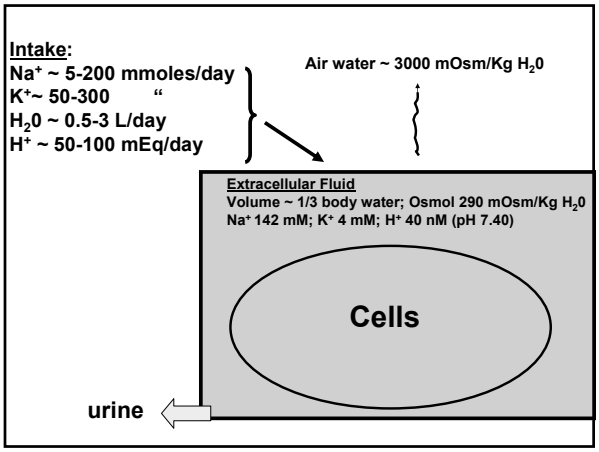
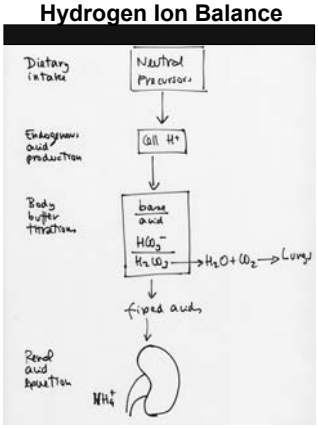


Hydrogen Ion Balance



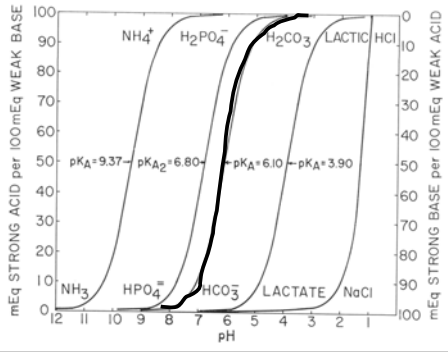
The task of the kidney in acid-base balance is excretion of the daily acid load

- Oxidation of amino acids, fats and carbohydrates often leads to acid production

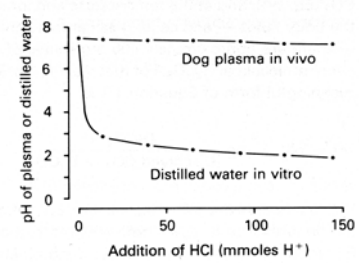
- On an average American diet we produce about 1 of H^+mEq / kg /day

Buffers

$$A^- + H^+ \rightleftharpoons HA$$



Buffering of an acid load



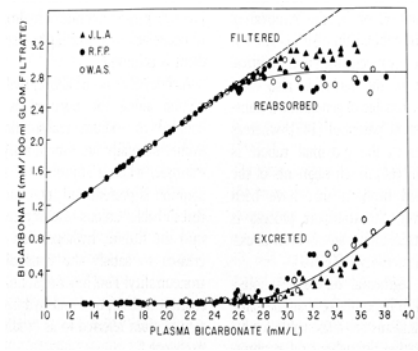
Pitts. *Harvey Lect*. 48:172. 1953

The Henderson Hasselbalch Equation

$$pH = pK + \log \frac{[HCO_3]}{\alpha pCO_2}$$

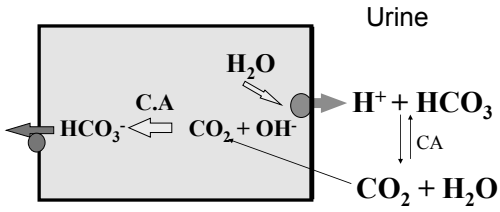
pK = 6.1 at 37°C and 0.15 M salt
" = 0.03

Filtered Bicarbonate

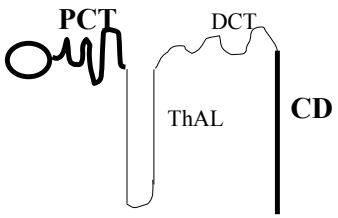


Pitts *JCI* 28:35. 1949

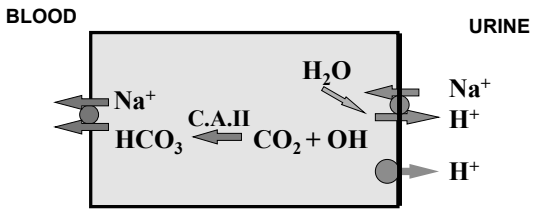
HCO_3 Reabsorption by H^+ secretion



HCO_3 reabsorption / H^+ secretion occurs in the Proximal and Collecting tubules

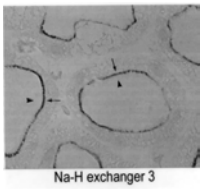


H^+ Secretion in the Proximal Tubule

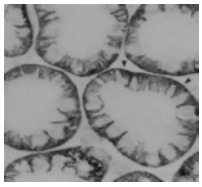


NHE_3 Na:H Exchanger
H^+ translocating ATPase
NBC Na:HCO_3 cotransporter

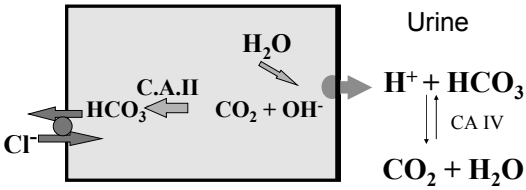
Proximal Tubule


Na-H exchanger 3


Na-K-ATPase


NBC1

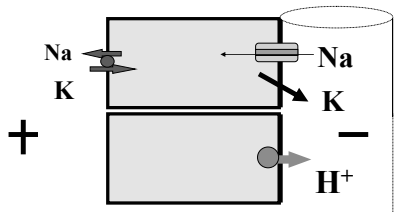
H^+ secretion in the Collecting Tubule



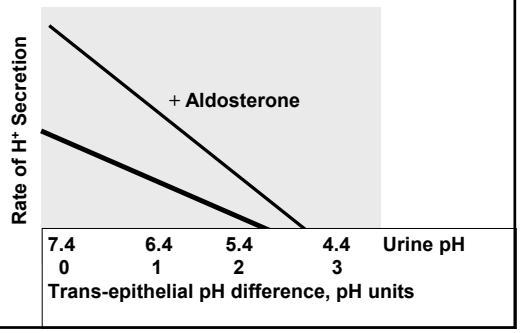
H^+ translocating ATPase

AE1 Cl:HCO_3 exchanger

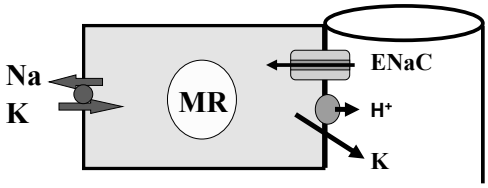
The Membrane Potential Generated by Na Absorption Regulates H^+ and K^+ Secretion in Collecting Tubules



Regulation of H^+ Secretion in the Collecting Tubule by Aldosterone

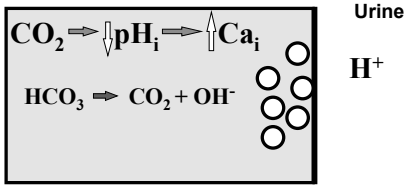


Aldosterone Action in Collecting Duct



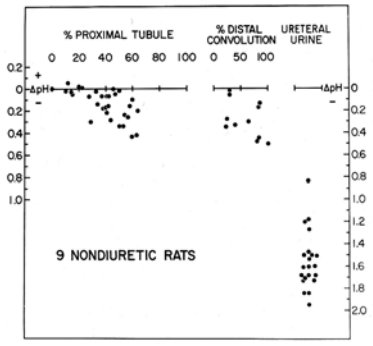
Binds to Mineralocorticoid Receptor MR
Increases opening of Na Channel ENaC and K channel
Increases activity of H^+ ATPase

CO_2 stimulates Exocytosis of H^+ATPase Vesicles

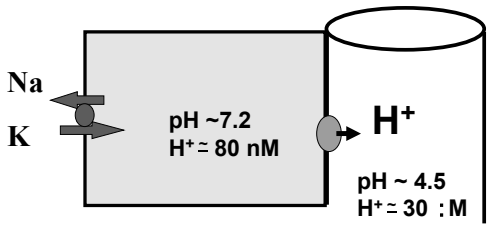


Proximal and collecting Tubules

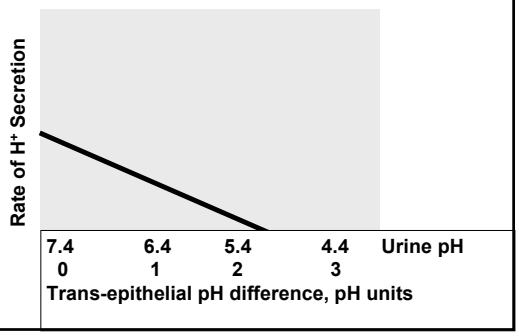
pH of Tubular Urine



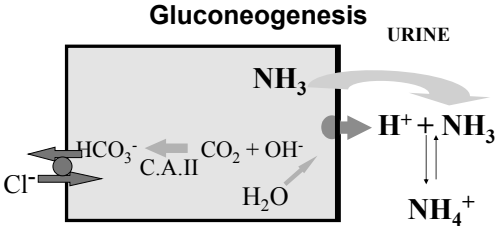
Collecting Tubule Urine pH



H^+ Secretion in the Collecting Tubule



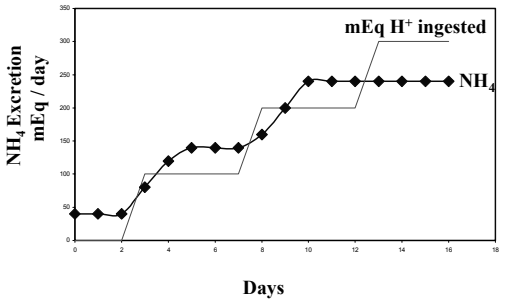
Gluconeogenesis



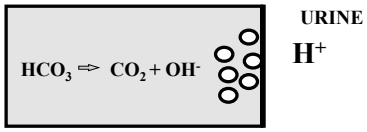
NH_3 NH_3

Glutamine ⇦ Glutamate ⇦ αketo-glutarate ⇨ PEP ⇨ ⇨Glucose

Acid Ingestion increases Ammonia Synthesis and Excretion



Regulation of H^+ Transport

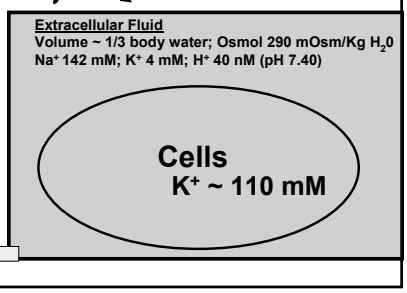


pCO_2	Aldosterone
K	Acid-Base status
NH_3	pH Gradient
Membrane Potential	

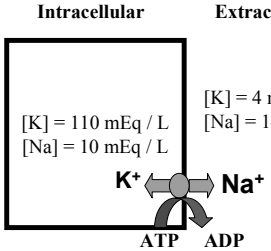
Intake:

Na^+ ~ 5-200 mmoles/day
K^+~ 50-300 "
H_20 ~ 0.5-3 L/day
H^+ ~ 50-100 mEq/day

Air water ~ 3000 mOsm/Kg H_20

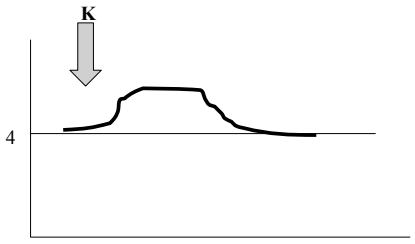


Potassium Distribution



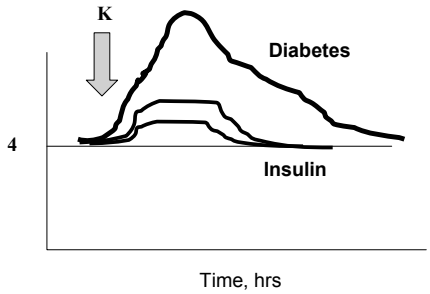
Total Body K 4400 mEq 50 mEq

Plasma Potassium Concentration

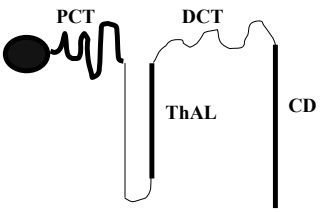


Disposal of an ingested K Load occurs by re-distribution and by urinary excretion

Insulin Increases K^+ Uptake by Cells



Renal Potassium Handling

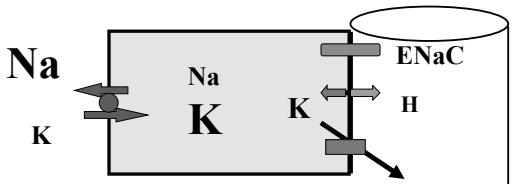


K is Freely Filtered

> 95% of Filtered K is reabsorbed in the Proximal Tubule and Thick Ascending Limb

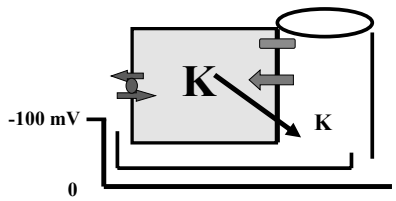
What appears in the Urine is secreted by the Distal Tubule and Collecting Duct

K Secretion in Collecting Duct



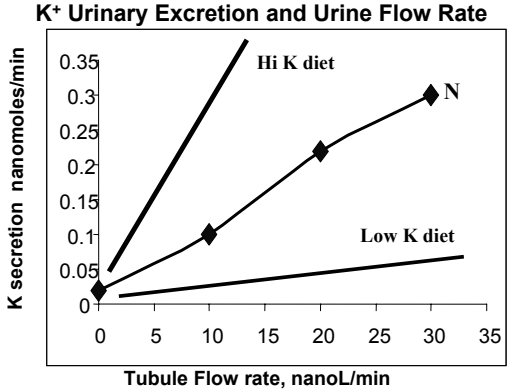
ENaC	Epithelial Na Channel
K	K channel
	H,K ATPase

Driving Forces for K Secretion in Collecting Duct

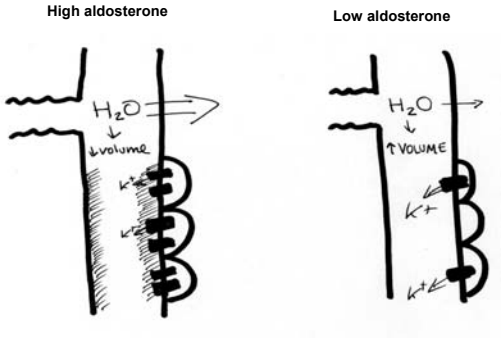


Concentration Gradient
Trans-epithelial Membrane Potential

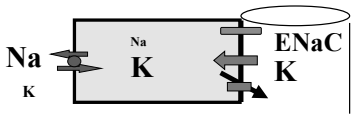
K^+ Urinary Excretion and Urine Flow Rate



Interaction Between Aldosterone and Urine Flow in K^+ Excretion



Regulation of K Secretion



Aldosterone

increases activity of K channel
increases activity of Na channel
increases Na,K ATPase

Urine Flow Rate

brings in low K tubular fluid