KEY POINTS Rose. p.399 -406

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**Homeostatic response to acid and base loads occurs in 3 stages**

1. Chemical buffering by extracellular and intracellular buffers
2. Changes in alveolar ventilation to control $PCO_2$
3. Alterations in renal $H^+$ excretion to regulate plasma $HCO_3^-$ concentration

**Proximal acidification**

- **In the proximal tubule** the $H^+$ is secreted into the lumen by the $Na^+$-$H^+$ exchanger (or antiporter), whereas $HCO^-_3$ is returned to systemic circulation primarily by Na-3$HCO^-_3$ cotransporter
- **In the collecting tubule** the $H^+$ is secreted into the lumen by the active $H^+$-ATPase pump in the luminal membrane, whereas $HCO^-_3$ is returned to systemic circulation primarily by Cl- $HCO^-_3$ exchanger in the basolateral membrane

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REGULATION OF ACID BASE BALANCE

$HCO_3^-/CO_2$ buffering system important for acid-base homeostasis:

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

- $[HCO_3^-]$ and $PCO_2$ can be regulated independently
- $[HCO_3^-]$ by changes in renal H+ excretion
- PCO2 by changes in the rate of alveolar ventilation

**Homeostatic response to acid and base loads occurs in 3 stages**

4. Chemical buffering by extracellular and intracellular buffers
5. Changes in alveolar ventilation to control $PCO_2$
6. Alterations in renal $H^+$ excretion to regulate plasma $HCO_3^-$ concentration

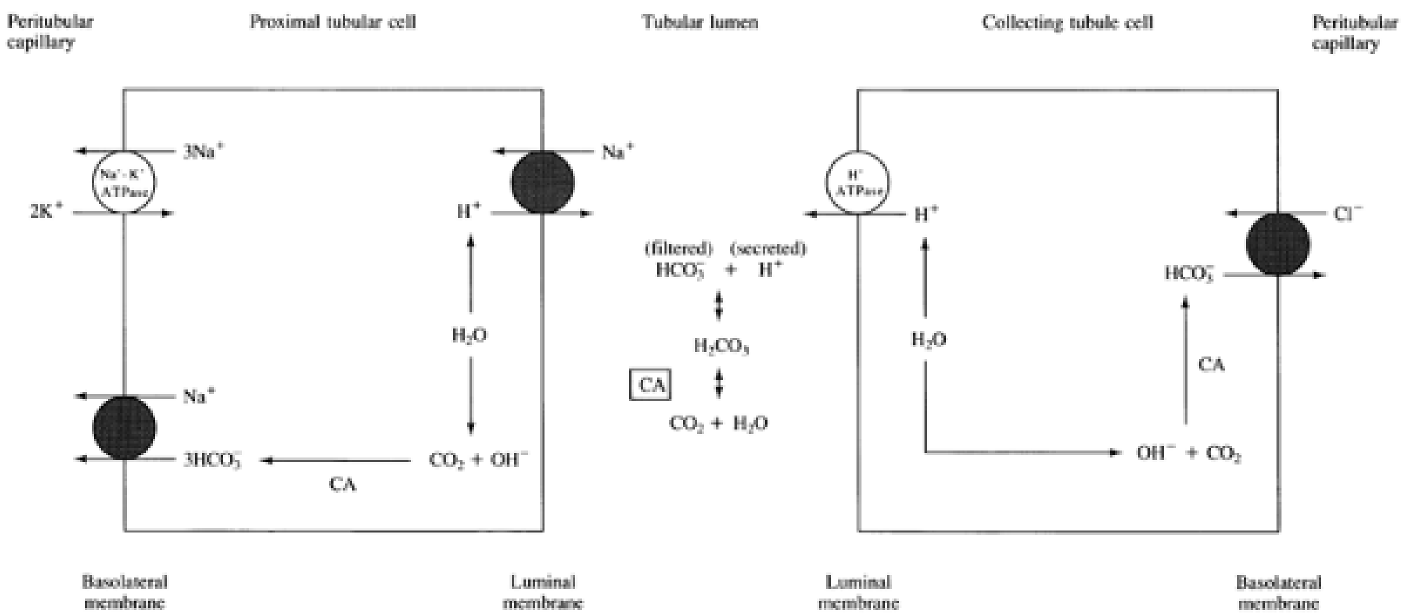
<u>RENAL HYDROGEN EXCRETION</u>

- Renal $H^+$ excretion varies directly with rate of $H^+$ production

- Kidneys contribute to acid base balance by regulating $H^+$ excretion so that plasma $HCO3^-$ concentration remains within appropriate limits.
  - Step 1: reabsorption of filtered HCO3-
  - Step 2: excretion of H+ (of 50-100 mEq H+ produced per day)

- Loss of filtered $HCO_3^-$ in urine is equivalent to addition of $H^+$ to the body, since both are derived from dissociation of $H_2CO_3$

## Proximal Acidification




a. Primary step is secretion of $H^+$ by $Na^+$-$H^+$ exchanger (or antiporter) in the luminal membrane
b. Intracellular water breaks down into $H^+$ ion and $OH^-$ ion
c. $OH^-$ combines with $CO_2$ to form $HCO_3^-$ (reaction catalyzed by carbonic anhydrase)
d. **In the proximal tubule** the $H^+$ is secreted into the lumen by the $Na^+$-$H^+$ exchanger (or antiporter), whereas $HCO^-_3$ is returned to systemic circulation primarily by Na-3$HCO^-_3$ cotransporter
e. **In the collecting tubule** the $H^+$ is secreted into the lumen by the active $H^+$-ATPase pump in the luminal membrane, whereas $HCO^-_3$ is returned to systemic circulation primarily by Cl- $HCO^-_3$ exchanger in the basolateral membrane
f. The secreted $H^+$ ions combine with filtered $HCO^-_3$ to form carbonic acid, then $CO_2$+$H_2O$ can be passively reabsorbed

- This maintains plasma $HCO^-_3$ concentration by preventing $HCO^-_3$ loss in the urine
- Na+-H+ exchanger (or antiporter) is responsible for 2/3 of proximal H+ excretion
- H+-ATPase pump is responsible for 1/3 of proximal H+ excretion

## Questions

Primary step in proximal acidification is secretion of H+ by which of the following

a. Na+-H+ exchanger in the luminal membrane
b. Na+-H+ exchanger in the basolateral membrane
c. Active H+-ATPase pump in the luminal membrane
d. Active H+-ATPase pump in the basolateral membrane

**Fill in the blanks.** In the collecting tubule H+ is secreted into the lumen by the __________________ in the luminal membrane, whereas HCO3- is returned to systemic circulation primarily by ________________ in the basolateral membrane

Answers

Primary step in proximal acidification is secretion of H+ by which of the following

- **e. Na+-H+ exchanger in the luminal membrane**
- f. Na+-H+ exchanger in the basolateral membrane
- g. Active H+-ATPase pump in the luminal membrane
- h. Active H+-ATPase pump in the basolateral membrane

In the collecting tubule H+ is secreted into the lumen by the active H+-ATPase pump in the luminal membrane, whereas HCO3- is returned to systemic circulation primarily by Cl-HCO3- exchanger in the basolateral membrane