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UNIT-3

ACID BASE BALANCE

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Renal Control of Acid-Base Balance

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- The kidneys control acid-base balance by excreting either acidic or basic urine
- Excreting acidic urine reduces the amount of acid in extracellular fluid
- Excreting basic urine removes base from the extracellular fluid

- The kidneys regulate extracellular fluid H^+ concentration through three fundamental mechanisms:

(1) secretion of H^+

(2) reabsorption of filtered HCO3

(3) production of new HCO3

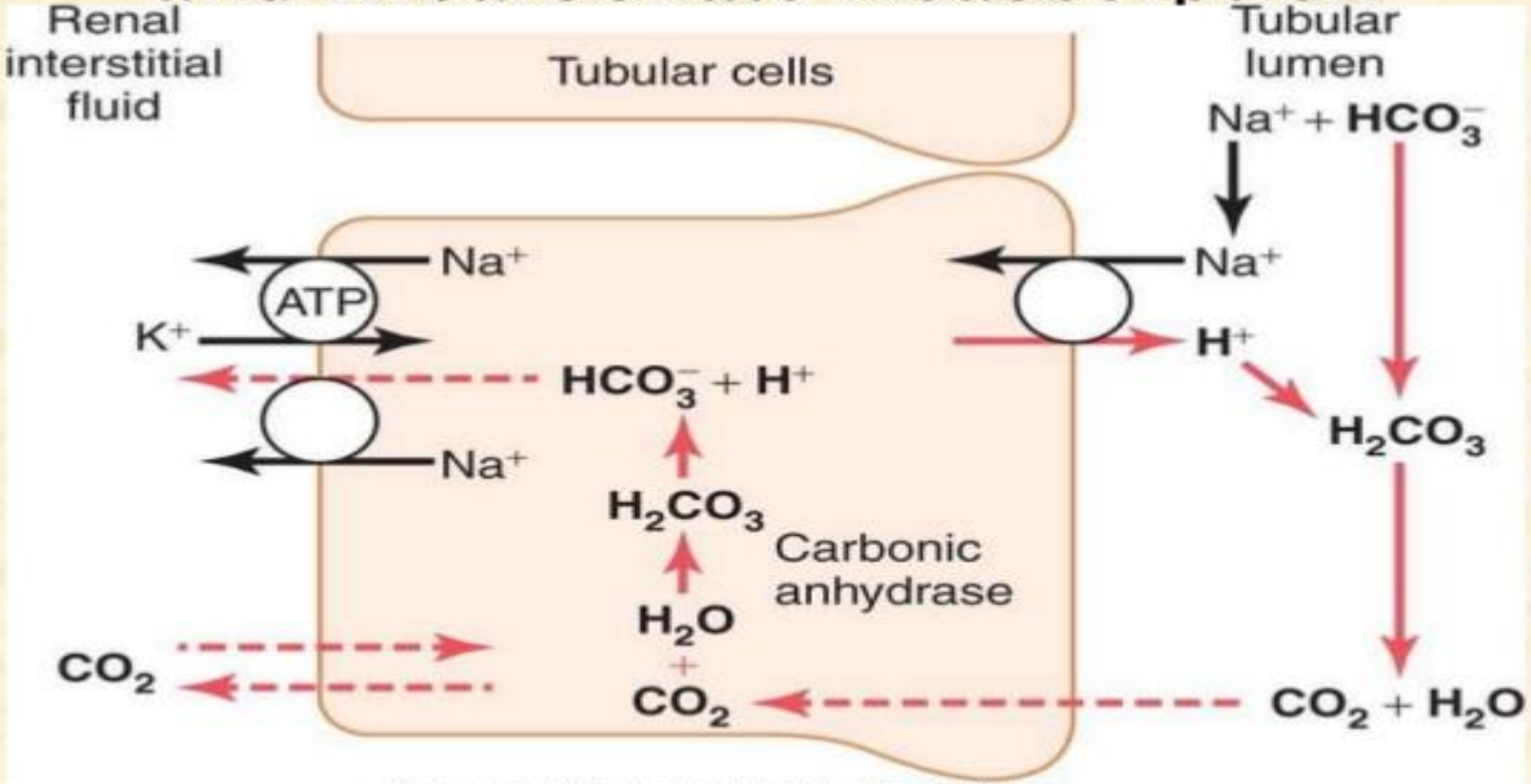
- In acidosis, the kidneys do not excrete HCO_3 into the urine but reabsorb all the filtered HCO_3 and produce new HCO_3 which is added back to the extracellular fluid
- This reduces the extracellular fluid H^+ concentration back toward normal

- In alkalosis the kidneys fail to reabsorb all the filtered HCO_3 thus increasing the excretion of HCO_3
- Because HCO_3 normally buffers H^+ in the extracellular fluid, this loss of HCO_3 is the same as adding H^+ to the extracellular fluid.
- In alkalosis the removal of HCO_3 raises the extracellular fluid H^+ concentration back towards normal

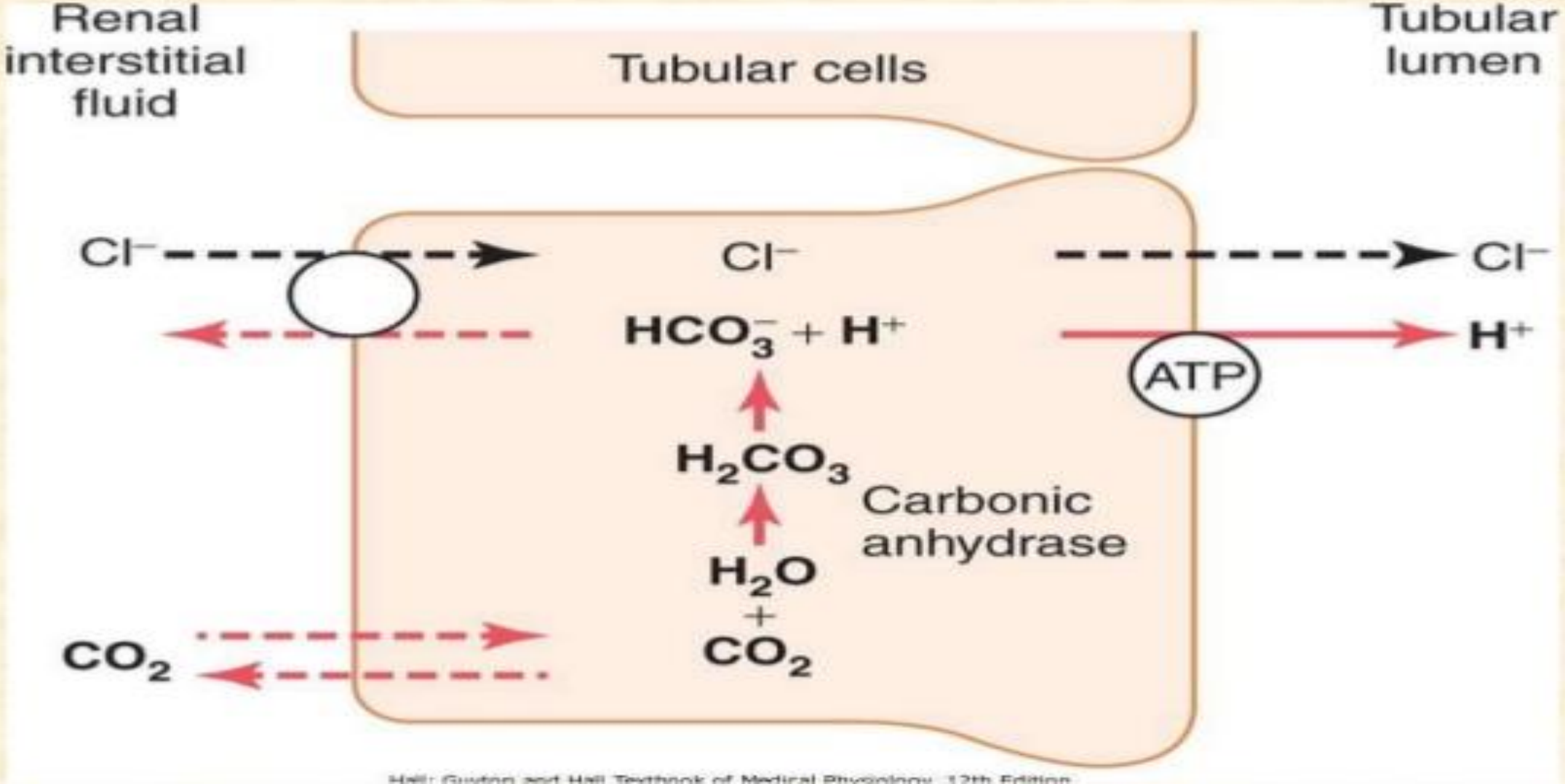
Secretion of H^+ and Reabsorption of Bicarbonate by the Renal Tubules

- About 80 to 90 percent of the bicarbonate reabsorption and H^+ secretion occurs in the proximal tubule

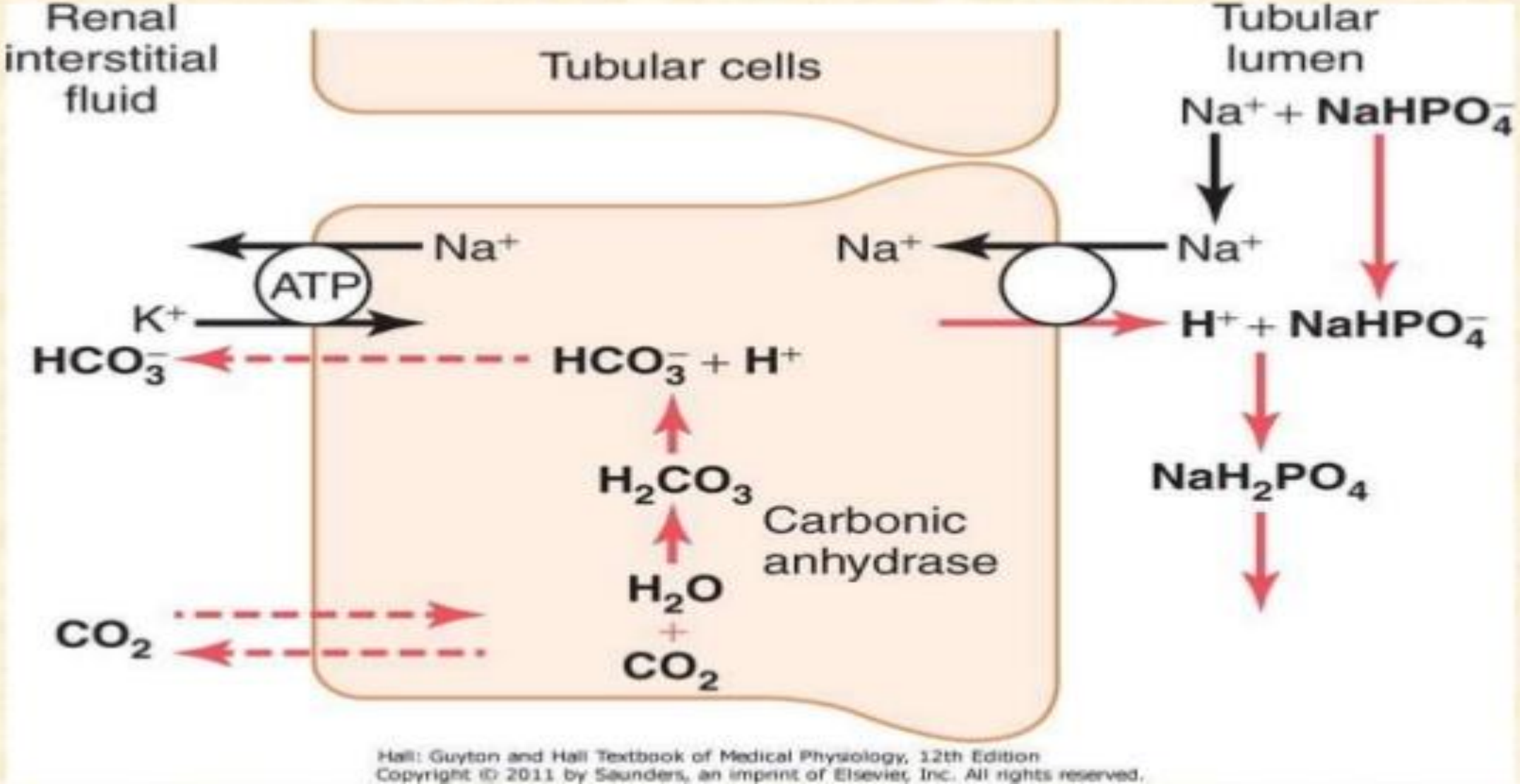
Mechanism of Hydrogen ion secretion and Bicarbonate Reabsorption



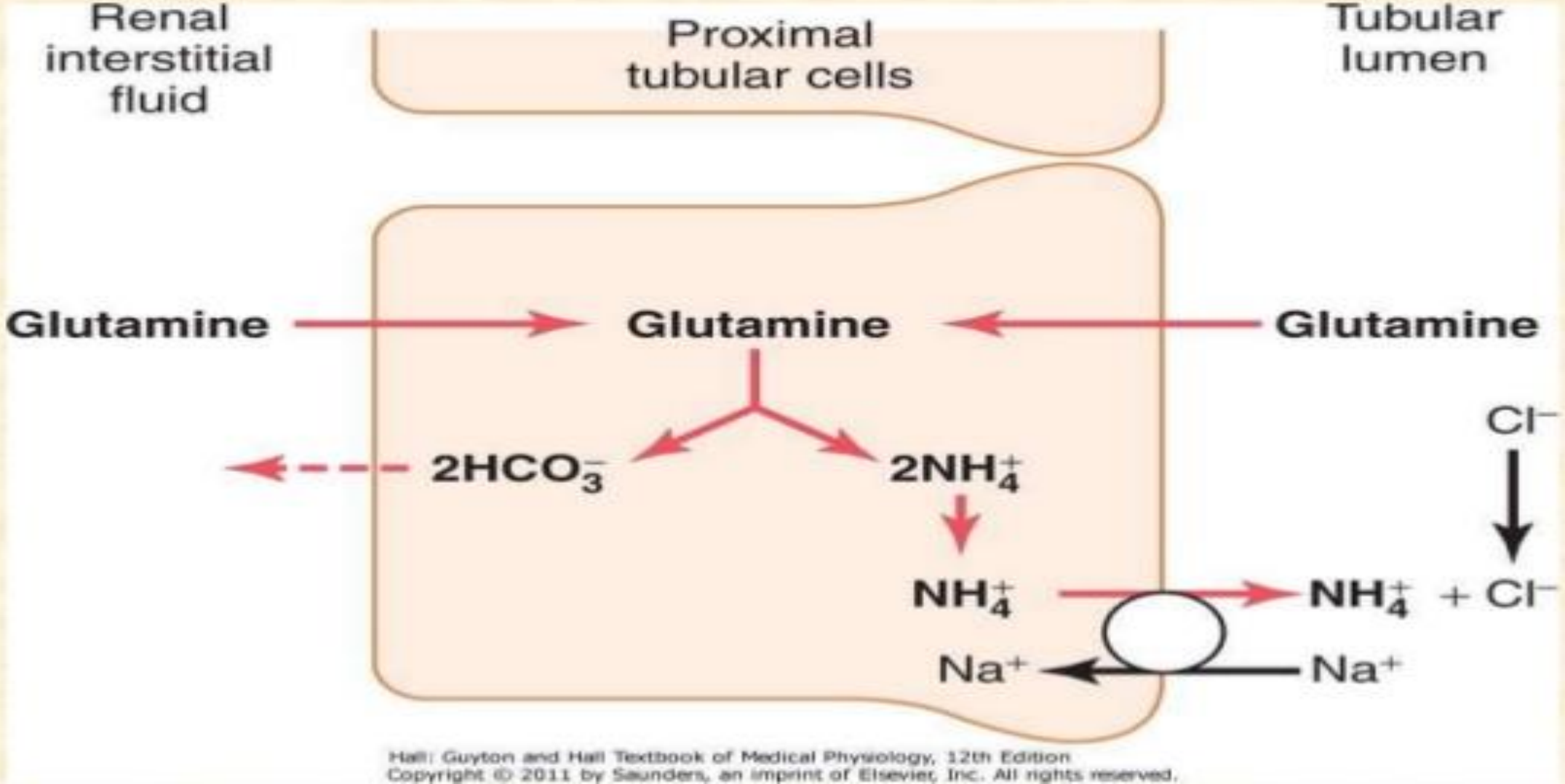
Primary Active Secretion of H^+ in the Intercalated Cells of Late Distal and Collecting Tubules



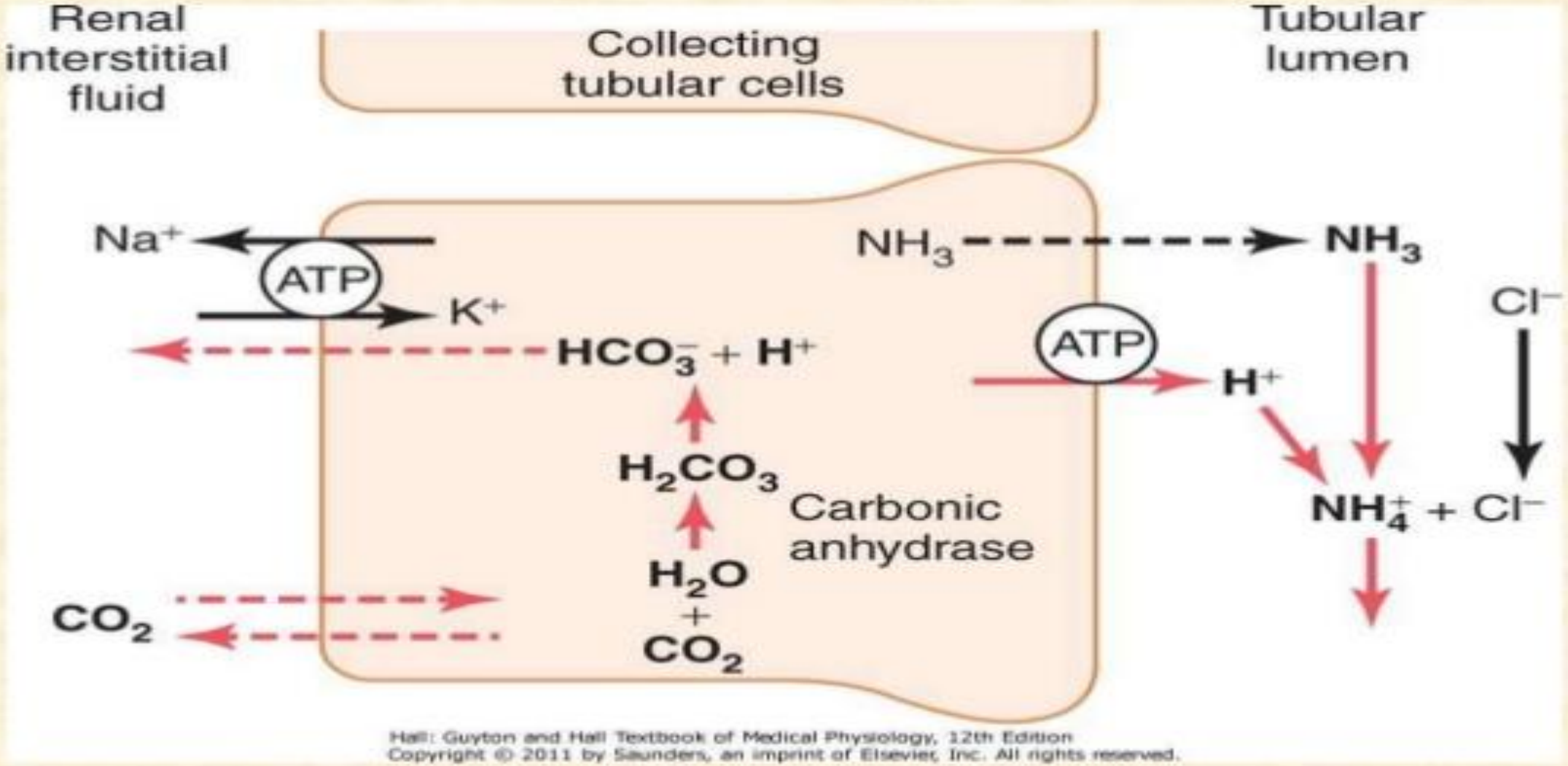
Buffering of Secreted Hydrogen Ions by Filtered Phosphate



Excretion of Excess H^+ and Generation of New Bicarbonate by the Ammonia Buffer System



Buffering of hydrogen ion secretion by ammonia (NH_3) in the collecting tubules



Renal Correction of Acidosis-Increased Excretion of H^+ and Addition of Bicarbonate to the ECF

- Acidosis decreases the ratio of Bicarbonate/Hydrogen ion in Renal Tubular Fluid
- As a result, there is excess H^+ in the renal tubules, causing complete reabsorption of bicarbonate and still leaving additional H^+ available to combine with the urinary buffers (phosphate and ammonia)
- Thus, in acidosis, the kidneys reabsorb all the filtered bicarbonate and contribute new bicarbonate through the formation of ammonium ions and titratable acid

Renal Correction of Alkalosis-Decreased Tubular Secretion of H^+ and Increased Excretion of Bicarbonate

- Alkalosis increases the ratio of bicarbonate/hydrogen ion in renal tubular fluid
- The compensatory response to a primary reduction in PCO_2 in respiratory alkalosis is a reduction in plasma concentration, caused by increased renal excretion of bicarbonate

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- In metabolic alkalosis, there is also an increase in plasma pH and decrease in H^+ concentration
- The cause of metabolic alkalosis is a rise in the extracellular fluid bicarbonate concentration
- This is partly compensated for by a reduction in the respiration rate, which increases PCO_2 and helps return the extracellular fluid pH toward normal
- In addition, the increase in bicarbonate concentration in the extracellular fluid leads to an increase in the filtered load of bicarbonate which in turn causes an excess of bicarbonate over H^+ secreted in the renal tubular fluid
- The excess bicarbonate in the tubular fluid fails to be reabsorbed because there is no H^+ to react with, and it is excreted in the urine
- In metabolic alkalosis, the primary compensations are decreased ventilation, which raises PCO_2, and increased renal excretion of bicarbonate which helps to compensate for the initial rise in extracellular fluid bicarbonate concentration

	pH	H^+	PCO_2	Bicarbonate
Normal	7.4	40 mEq/L	40 mm Hg	24 mEq/L
Respiratory acidosis	↓	↑	↑↑	↑
Respiratory alkalosis	↑	↓	↓↓	↓
Metabolic acidosis	↓	↑	↓	↓↓
Metabolic alkalosis	↑	↓	↑	↑↑


THANK YOU!