

Acid base buffer and its disorder

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Remix education

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FOR OPTIMAL FUNCTIONING OF CELLS..

- Acids and bases in the body must be in balance.
- We all consume every day food and drinks which contain acids, metabolism produces also acids...

BODY PH BALANCE

- Chemical blood buffers:
 - Lungs,
 - Cells,
 - Kidneys
- Defences against changes in hydrogen concentration (getting acidotic..)

YOU GET ACIDOTIC EVERY DAY.....

- While living, eating and drinking...there is-
Production of 1 mmol of fixed acid/kg body weight per day (60 kg=60 mmol/day)

BUFFERS

- **Extracellular....**
- **Hemoglobin**
(‘Chloride shift’-for each chloride leaving the cell-one bicarbonate ion enters)
- **Plasma protein**
(with the liver, varying the amount of H-ions in the protein structure)
- **Bicarbonate system:**
Normal acid to base ratio is 20:1
20 parts bicarbonate to 1 part carbonic acid ($\text{H}_2\text{CO}_3=\text{CO}_2$),
Neutralizing a strong acid bicarb. will be lost

Human Acid-base Homeostasis

- **Tight regulation:**
- **CO₂ tension**
by respiratory excretion (of volatile acids)
- **Plasma bicarbonate [HCO₃⁻]**
By renal HCO₃⁻ reabsorption and
Elimination of protons produced by metabolism
- pH is determined by **CO₂ tension** and **[HCO₃⁻]**
- Human Acid-base Homeostasis

PHYSIOLOGY OF BUFFERING

- Ability of a solution containing a weak or poorly dissociated acid and its anion (a base) to resist change in pH when strong acid or alkali is added
- 1 ml of 0.1 M HCl to 9 ml distilled water =
- $[H^+]$ from 10^{-7} M to 10^{-2} M = pH from 7 to 2
- 1 ml of 0.1 M HCl to 9 ml of phosphate buffer: dissoc.
 H^+ combines with $[HPO_4^{2-}] = (H_2PO_4^-)$
- pH fall of only 0.1 = to 6.9

BICARBONATE BUFFER

- **Extracellular** most important buffer
- Proteins and phosphate buffer less important
- **Intracellular** phosphate- most important b.
- Equilibrium conditions because abundant carbonic anhydrase in blood
- $\text{H}^+ + \text{HCO}_3^- \rightleftharpoons \text{H}_2\text{CO}_3 \rightleftharpoons \text{H}_2\text{O} + \text{CO}_2$
- $[\text{H}^+] = K_{eq} \times [\text{H}_2\text{CO}_3] / [\text{HCO}_3^-]$

ACIDOSIS

- **Clinical effects of severe acidosis: pH <7.2**
- Cardiovascular system effects:
- Decreased myocardial contractility
- Decreased cardiac output
- Cardiac failure
- Hypotension
- Decreased hepatic and renal blood flow
- Centralization of effective blood volume
- Tissue hypoxia
- Pulmonary edema

METABOLIC ACIDOSIS

- Hallmark is $\downarrow\downarrow[\text{HCO}_3^-]$
- Acid production \uparrow net acid intake \uparrow
above net renal excretion
 - (ketoacidosis, lactic acidosis, ammonium chloride loading)
- failure of renal net excretion
(chronic renal failure, renal tubular acidosis)
- Bicarbonate loss via the gastrointestinal tract
(diarrhea, gastrointestinal fistula)
- Nonbicarbonate solutions added to ECF (dilutional acidosis)

RESPIRATORY ACIDOSIS

- Acute increase in $p\text{CO}_2$
- Buffered primarily by intracellular buffers
- Chronic state:
 - Kidneys compensation:
 - Increase net acid excretion,
 - (48 hours for fully development)
 - Underlying cause:
 - Central nervous system disease,
 - lung (COPD) and heart disease,
- **sedatives and opiates depressing the respiratory center**
- **Hypercapnic encephalopathy can develop**

METABOLIC ALKALOSIS

- Plasma bicarbonate $[\text{HCO}_3^-]$ $\uparrow\uparrow = \text{pH } \uparrow\uparrow$
- H^+ GI loss or shift into cells
- Excess HCO_3^-
 - Administration of $\uparrow\uparrow$ bicarbonate, or precursors: $\uparrow\uparrow$ lactate, acetate, citrate or Failure to excrete: mineralocorticoid effect
- Loss of fluid with
 - Diuretic therapy
 - $[\text{Cl}^-]$, $[\text{K}^+]$ and $[\text{H}^+]$ loss from plasma-extracellular volume contraction

ALKALOSIS

Table 11.11 Major adverse consequences of severe alkalemia

Cardiovascular

- Arteriolar constriction
- Reduction in coronary blood flow
- Reduction in angina threshold
- Predisposition to refractory arrhythmias

Respiratory

- Hypoventilation with attendant hypercapnia and hypoxemia

Metabolic

- Stimulation of anaerobic glycolysis and lactic acid production
- Hypokalemia, hypomagnesemia, and hypophosphatemia
- Decreased plasma ionized calcium concentration

Cerebral

- Reduction of cerebral blood flow
- Tetany, seizures, lethargy, delirium, and stupor

RESPIRATORY ALKALOSIS

pCO₂ ↓, pH ↑ due to:

Hypoxia (compensatory hyperventilation)

- **Acute:** pulmonary edema or emboli, pneumonia,
- **Chronic:** severe anemia, high altitude, hypotension

Respiratory center stimulation

- Pregnancy, Anxiety, Fever, heat stroke, sepsis, salicylate intox., cerebral disease, hepatic cirrhosis,

Increased mechanical ventilation

RESPIRATORY ALKALOSIS

- Most common acid-base disorder
Physiologic in pregnancy and high altitude
- **Bad prognosis in critically ill** patients
(the higher hypocapnia, the higher mortality)
- Hyperventilation,
- Perioral and extremity paresthesias,
- Light-headedness,
- Muscle cramps,
- Hyperreflexia, seizures, ↓ ionized Ca \Rightarrow tetany

Thank you

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