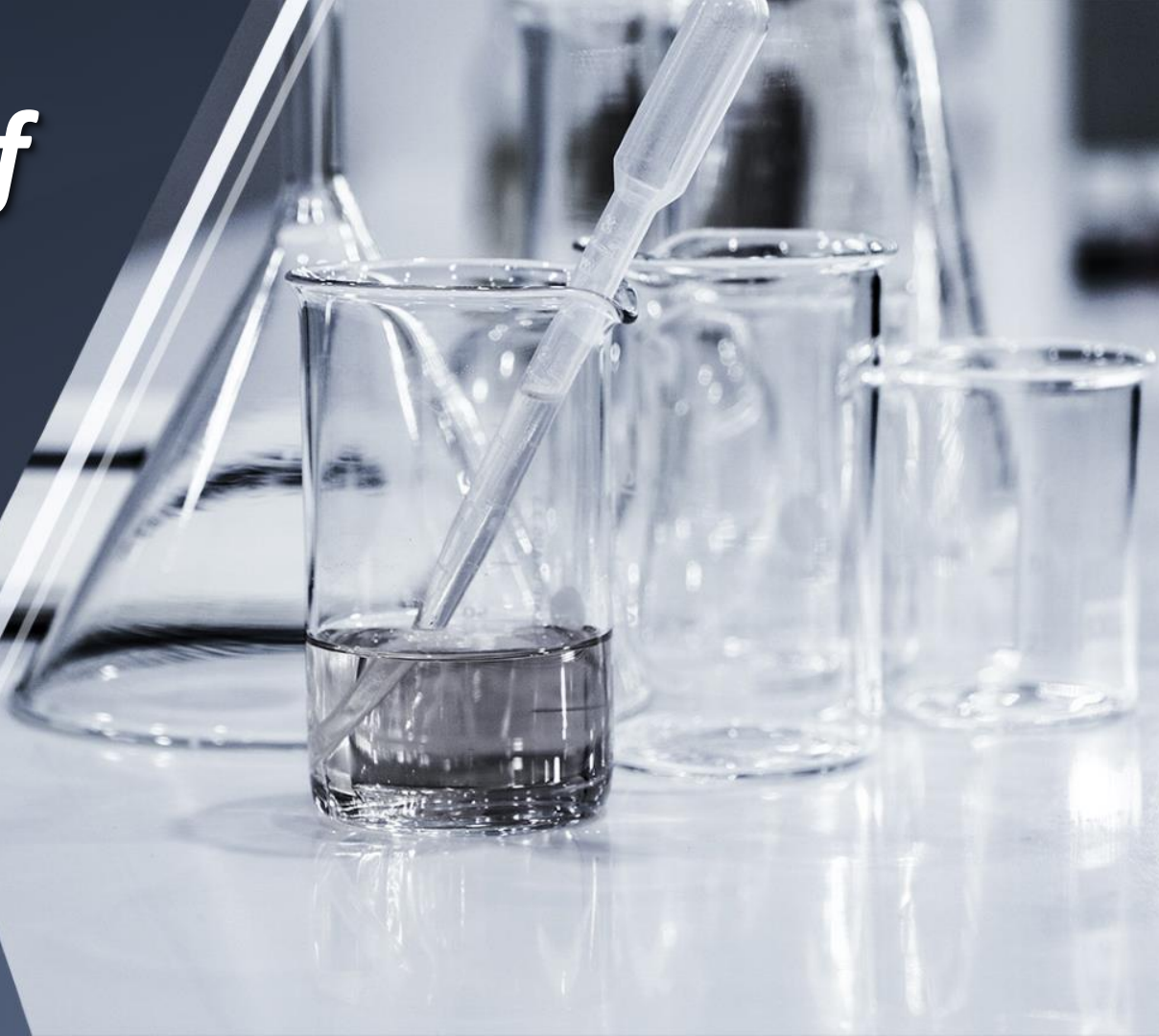


***In The Name
Of God***



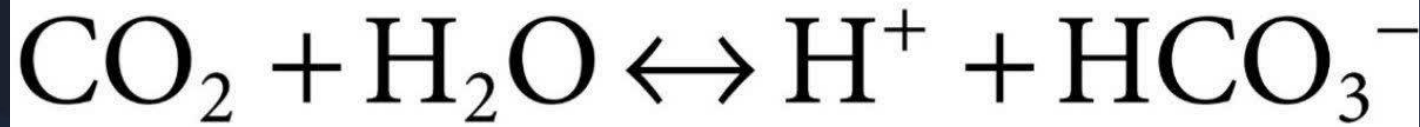
Disorders of Acid–Base Balance

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- *To maintain homeostasis, the human body employs many physiological adaptations. One of these is maintaining an acid-base balance.*
- *Control of acid-base balance depends on the kidneys, the lungs, and intracellular and extracellular buffers.*





Buffers are substances that attenuate the change in pH that occurs when acids or bases are added to the body.

$$\text{pH} = 6.1 + \log[\text{HCO}_3^-]/[\text{CO}_2]$$

$$[\text{H}^+] = 24 \times \text{PCO}_2/[\text{HCO}_3^-]$$

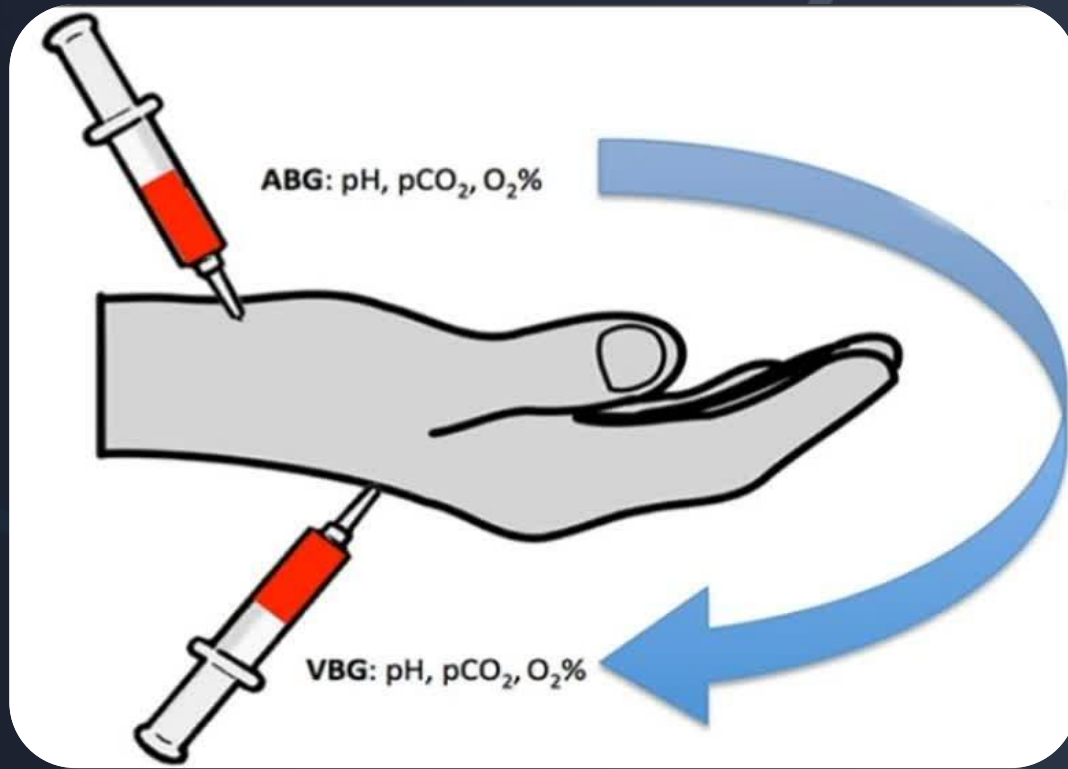
Henderson-Hasselbalch equation



ARTERIAL BLOOD GAS

- **Advantages:**
 - *gold standard test for determining : (pH, PaCO₂, HCO₃)*
 - *can determine PaO₂*
- **Disadvantages:**
 - *painful (should be performed with local anaesthetic in conscious patients)*
 - *increased risk of bleeding and hematoma*
 - *risk of pseudo aneurysm and AV fistula*
 - *infection*
 - *nerve injury*
 - *digital ischemia*
 - *clotted-blood embolism*
 - *hematoma*
 - *sympathetic dystrophy*





How to convert a VBG into an ABG?



***Adjustment formula for ABG
conversion from central VBG:***

(1) arterial pH = venous pH + 0.03

(2) arterial Pco2 = venous Pco2 - 6 mm Hg.



A background image showing laboratory glassware, including a beaker and a graduated cylinder, with a pipette dispensing liquid into the beaker. The image is slightly blurred and has a blue tint.

pH	7.35-7.45
[HCO ₃ ⁻]	20-28 mEq/L
PCO ₂	35-45 mm Hg

Normal Values of Arterial Blood Gases

Base Excess (BE) in an ABG

- *The base excess is another surrogate marker of metabolic acidosis or alkalosis.*
- *A high base excess ($> +5\text{mmol/L}$) indicates that there is a higher than normal amount of HCO_3^- in the blood.*
- *A low base excess ($< -5\text{mmol/L}$) indicates that there is a lower than normal amount of HCO_3^- in the blood.*



Terminology:

- *Acidemia is a pH below normal (<7.35).*
- *Alkalemia is a pH above normal (>7.45).*
- *Acidosis is a pathologic process that causes an increase in $[H^+]$.*
- *alkalosis is a pathologic process that causes a decrease in $[H^+]$*



A simple acid-base disorder is a single primary disturbance.

a metabolic acidosis, the decrease in the pH increases the ventilatory drive, causing a decrease in PCO_2 .

The decrease in the carbon dioxide concentration CO_2 leads to an increase in the pH.

A mixed acid-base disorder is present when there is >1 primary acid-base disturbance.



Diagnosis

- 1. Acidemia or alkalemia is present?*
- 2. Determine a cause of the acidemia or alkalemia.*



METABOLIC ACIDOSIS



Etiology:

- ***Diarrhea***
- ***Renal tubular acidosis (RTA)***
- ***Lactic Acidosis***
- ***Tissue hypoxia***
- ***Shock***
- ***Hypoxemia***
- ***errors of metabolism***
- ***Diabetic ketoacidosis***
- ***Starvation***
- ***ketoacidosis Alcoholic ketoacidosis***
- ***Kidney Failure***
- ***Salicylate***



$$\text{Anion gap} = \text{Na}^+ - [\text{Cl}^- + \text{HCO}_3^-]$$



Manifestations

- *Related to the degree of acidemia:
pH <7.2*
- *Impaired cardiac contractility
increased risk of arrhythmias.*
- *Decrease in the cardiovascular
response to catecholamines.*
- *Vasoconstriction of the pulmonary
vasculature.*
- *Persistent pulmonary hypertension.*



$$P\text{CO}_2 = 1.5 \times [\text{HCO}_3^-] + 8 \pm 2$$



*5-years-old boy with a
history of DKA:*

- *PH:6.9*
- *Hco3:5*
- *Pco2:25*
- *BE:-20*
- *expected pCO2:13.5-17.5*



METABOLIC ALKALOSIS



Causes of Metabolic Alkalosis:

- **CHLORIDE-RESPONSIVE (URINARY CHLORIDE <15 mEq/L)**
- Gastric losses Emesis
- Nasogastric suction
- Diuretics (loop or thiazide)
- Chloride-losing diarrhea
- Cystic fibrosis
- Posthypercapnia
- **CHLORIDE-RESISTANT (URINARY CHLORIDE >20 mEq/L)**
- **High Blood Pressure**
- Adrenal adenoma or hyperplasia
- Renovascular disease
- Renin-secreting tumor 17α -Hydroxylase deficiency 11β -Hydroxylase deficiency
- Liddle syndrome
- **Normal Blood Pressure**
- Gitelman
- Bartter syndrome



- *Loop Diuretic :volume depletion, which increases angiotensin II.*
- *Cystic fibrosis can cause metabolic alkalosis, hypokalemia, and hyponatremia because of excessive NaCl losses in sweat .*
- *Post hypercapnic metabolic alkalosis occurs after the correction of a chronic respiratory acidosis.*



Clinical Manifestations

METABOLIC ALKALOSIS

- *Decrease in the ionized calcium concentration may cause symptoms of tetany (carpopedal spasm).*
- *Arrhythmias*
- *Hypoxia*
- *Decrease cardiac output*



METABOLIC ALKALOSIS

- *PCO₂ increases by 7 mm Hg for each 10 mEq/L increase in the serum [HCO₃]*
- *[H]=PCO₂/HCO₃*



RESPIRATORY ACIDOSIS

Causes of Respiratory Acidosis:

- ***RESPIRATORY MUSCLE WEAKNESS***
- ***PULMONARY DISEASE***
- ***CENTRAL NERVOUS SYSTEM DEPRESSION***



Hypercapnia causes :

- *Vasodilation in the cerebral vasculature.*
- *Vasoconstriction of the pulmonary circulation*
- *Increases the risk of cardiac arrhythmias*



- ***Acute respiratory acidosis:***
- *Plasma bicarbonate increases by 1 for each 10 mm Hg*
- *Increase in the PCO₂ (acute compensation).*
- ***Chronic respiratory acidosis:***
- *Plasma bicarbonate increases by 3.5 for each 10 mm Hg increase in the PCO₂ (chronic compensation).*



RESPIRATORY ALKALOSIS



- *paresthesias*
- *tetany*
- *seizures*
- *muscle cramps*
- *syncope*
- *reduction in cerebral blood flow*
- *reduction in ionized calcium (occurs because alkalemia causes more calcium to bind to albumin).*
- *mild reduction in the serum potassium level.*



- *The metabolic response to an acute respiratory alkalosis is predictable: Plasma bicarbonate falls by 2 for each 10 mm Hg decrease in the PCO₂*
- *(acute compensation).*
- *Plasma bicarbonate falls by 4 for each 10 mm Hg decrease in the PCO₂*
- *(chronic compensation).*
- ***$[H] = PCO_2 / HCO_3$***



THE END.

