SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME: Introduction to Surgery

TOPIC : Acid Base Balance

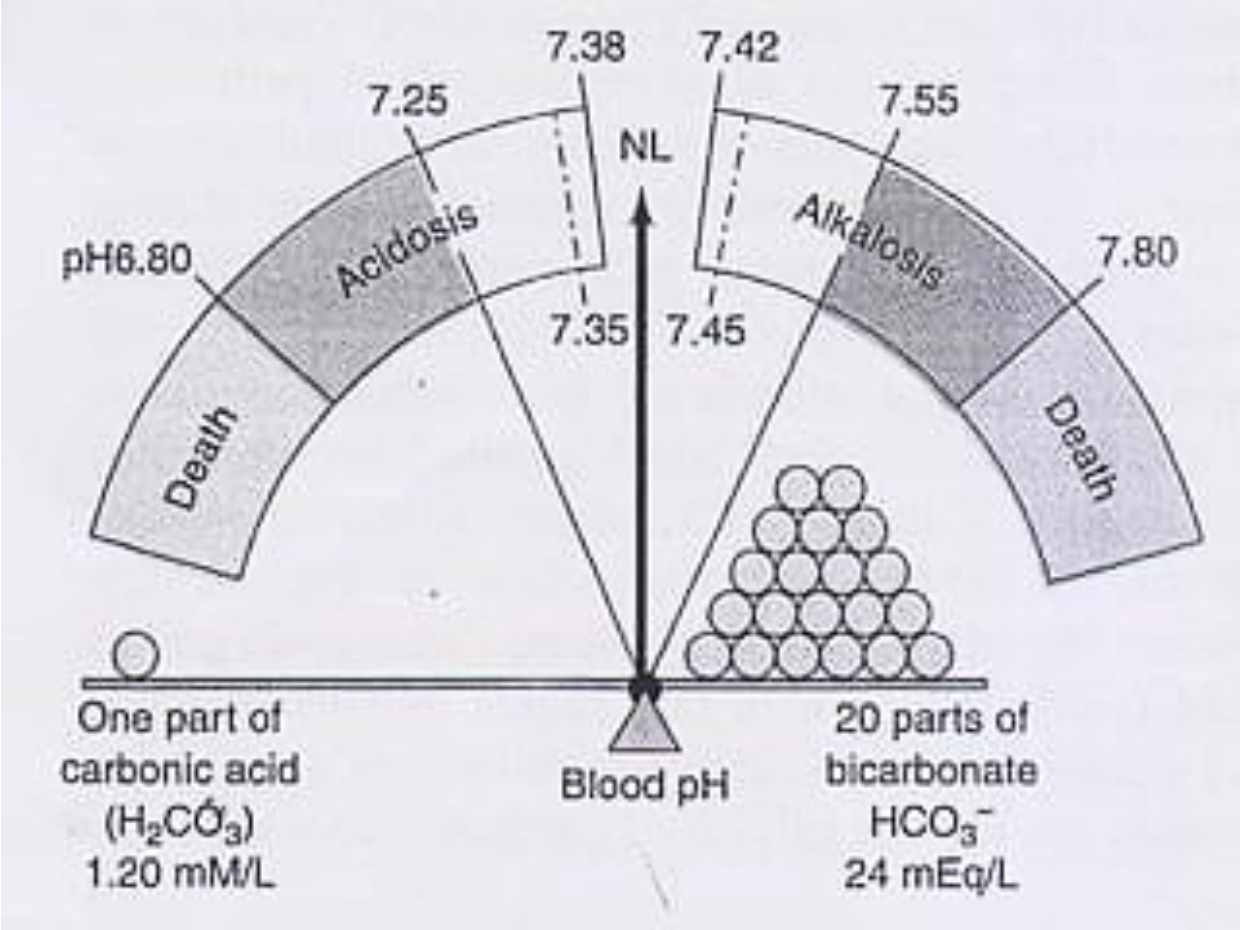
Case Study

- A 50 year Male patient was admitted to ER with the complaints of Vomiting, Dizziness and Fainting for the past one day. He has a history of smoking and had the shortness of breath.
- Upon examination, he has respiratory acidosis.
- Enumerate what is acid base balance and how its mechanism takes place and determination method for acid base balance

Definitions

- **Acids:-**are substances that dissociate or lose ions.
- **Bases:**-are substances capable of accepting ions.
- **Buffer :-**is substance that reacts with acids and bases to maintain neutral environment of stable PH.
- **PH:-**represent the free hydrogen ions concentration.

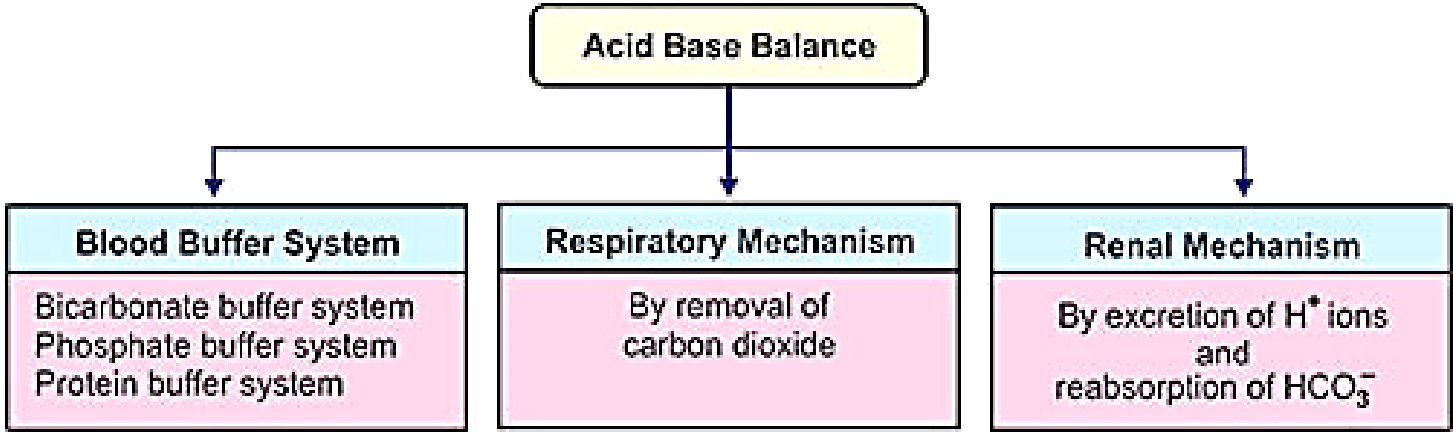
- If [H+] is high, the solution is acidic pH < 7 If [H+] is low, the solution is basic or alkaline pH > 7



Regulations of Acid Base Balance

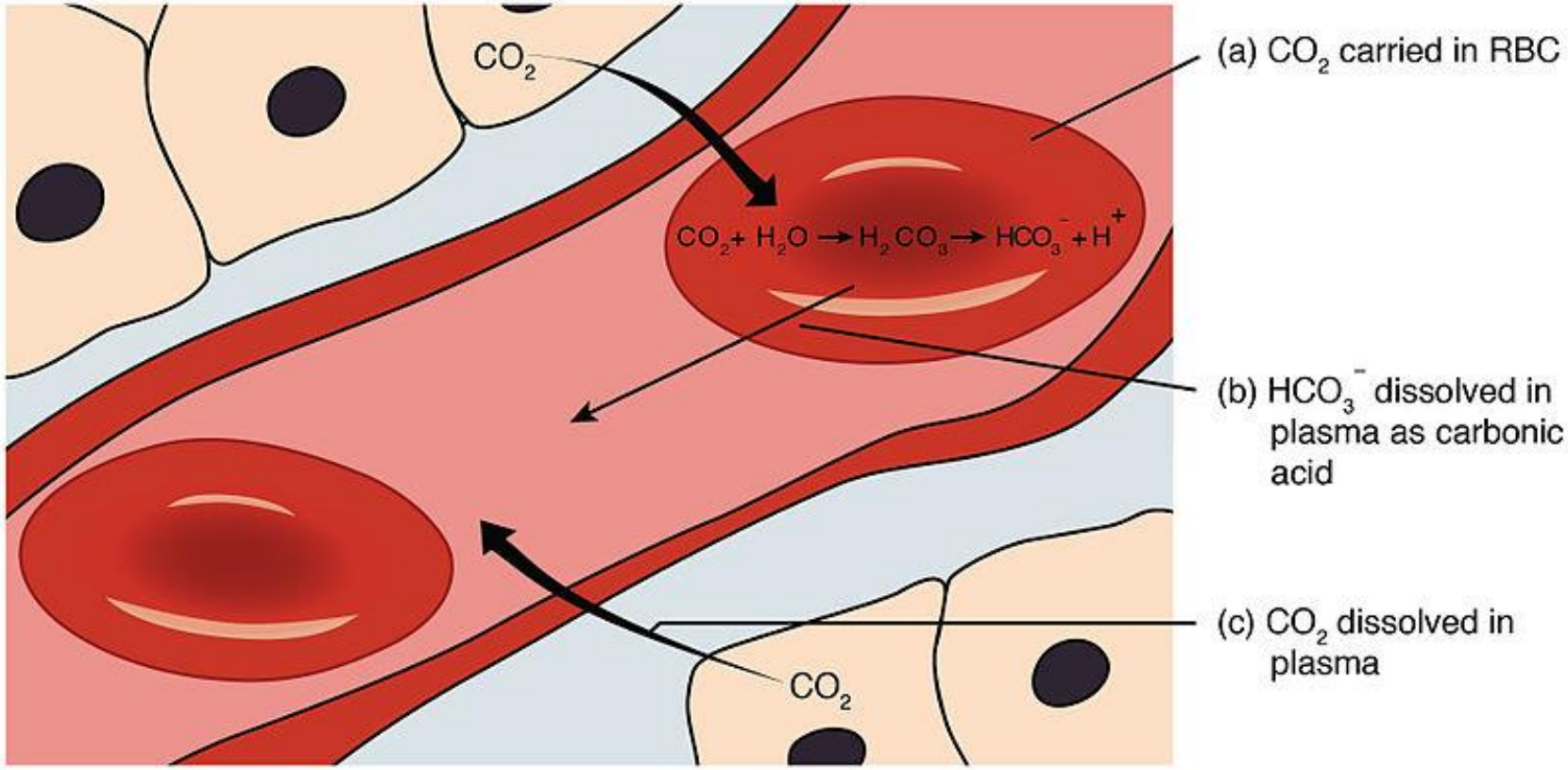
The body has three mechanisms to maintain acid-base balance:

- Buffering mechanism.
- The respiratory compensation mechanism.
- The metabolic or renal compensation mechanism.



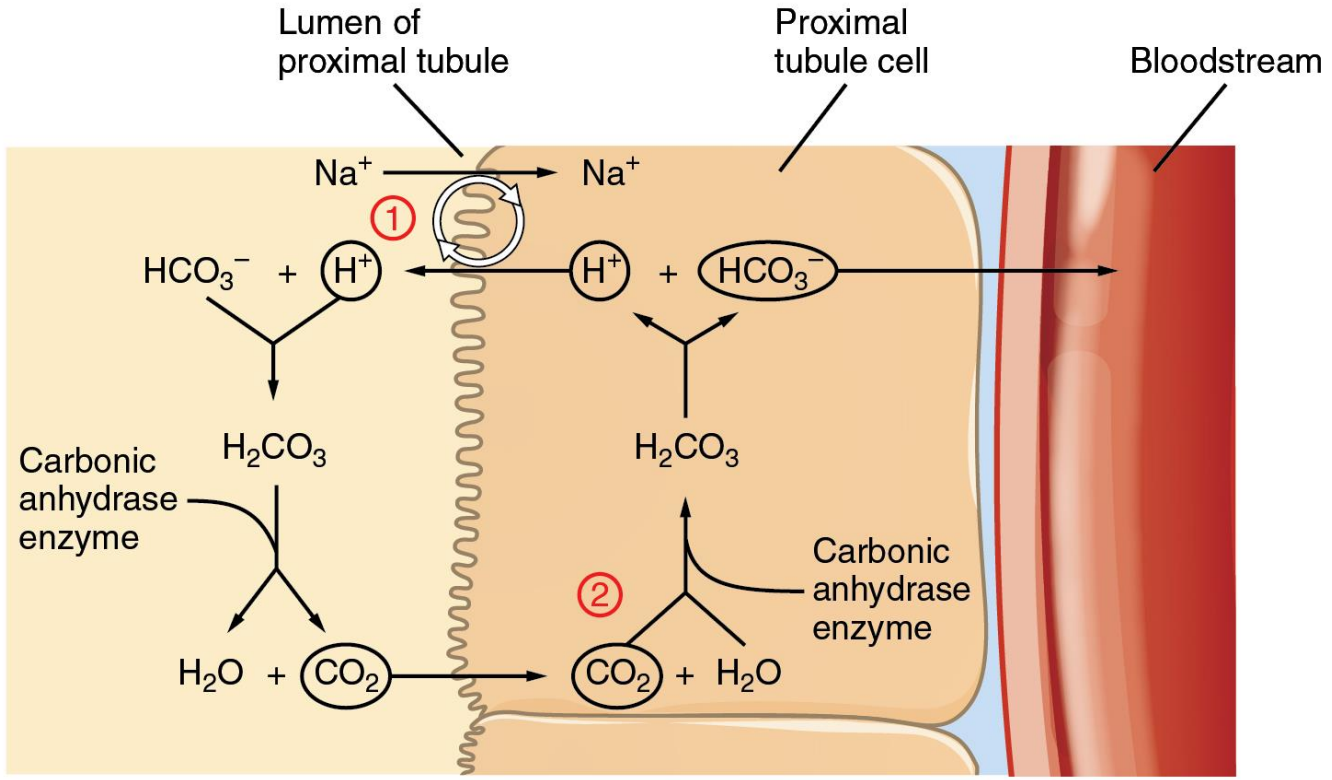
Acid base buffer

- **Acid-base buffer** is defined as a solution containing two or more chemical compounds that prevent marked change in hydrogen ions



Bicarbonate Buffer System

- It is the most abundant and acts both extracellular and intracellular
- **The two elements are regulated as:** CO2 by the lungs,
- HCO3- by the kidney.
- Its concentration in blood = 27mEq/L and is called Alkali Reserve



Phosphate Buffer System

- Phosphate are more abundant within the cell and rivaled as a buffer in the Intracellular Fluid.

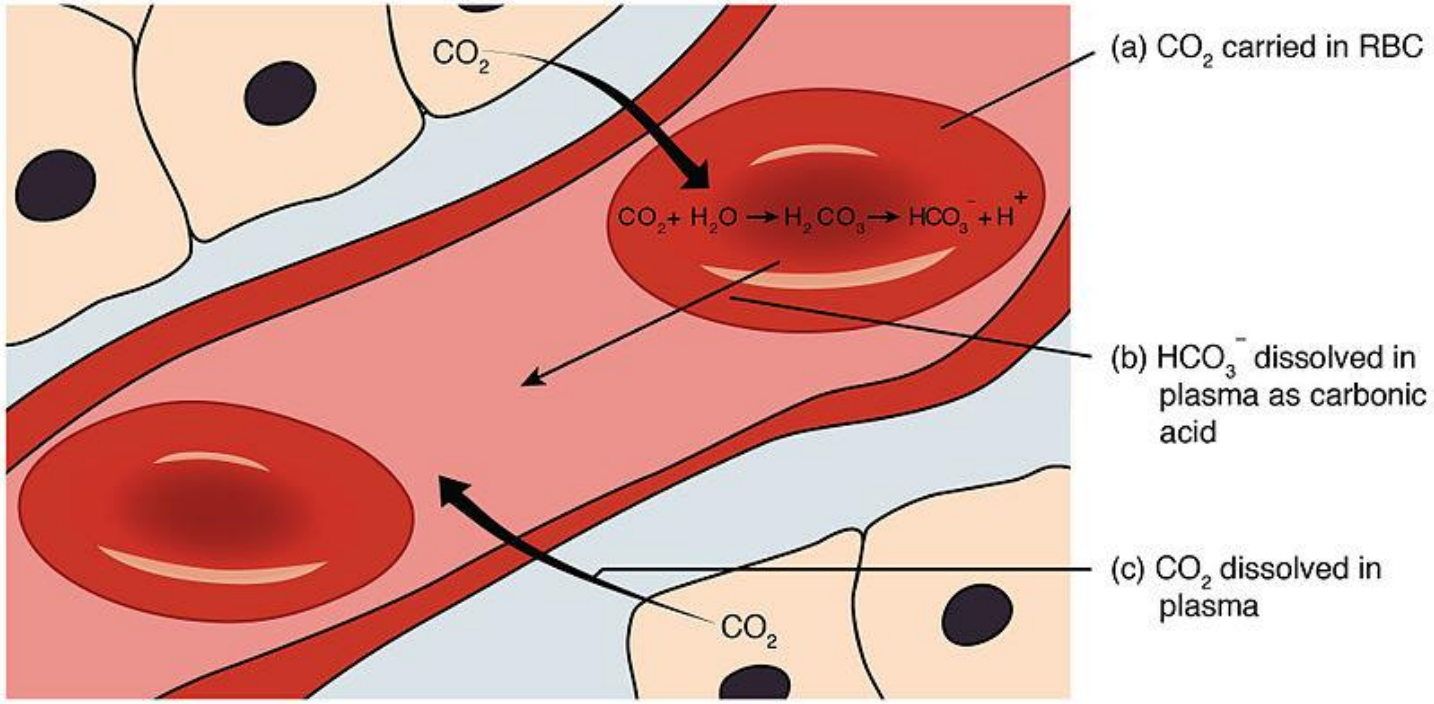
- $H_2PO_4^-$ dihydrogen phosphate is an acid
- HPO_4^{2-} hydrogen phosphate is a base

- $H^+ + HPO_4^{2-}$ (base) ↔ $H_2PO_4^-$ (Monohydrogen phosphate = BASE “hydrogen acceptor”)

- $OH^- + H_2PO_4^-$ (acid) ↔ $H_2O + HPO_4^{2-}$ (Dihydrogen phosphate = ACID “Donner”)

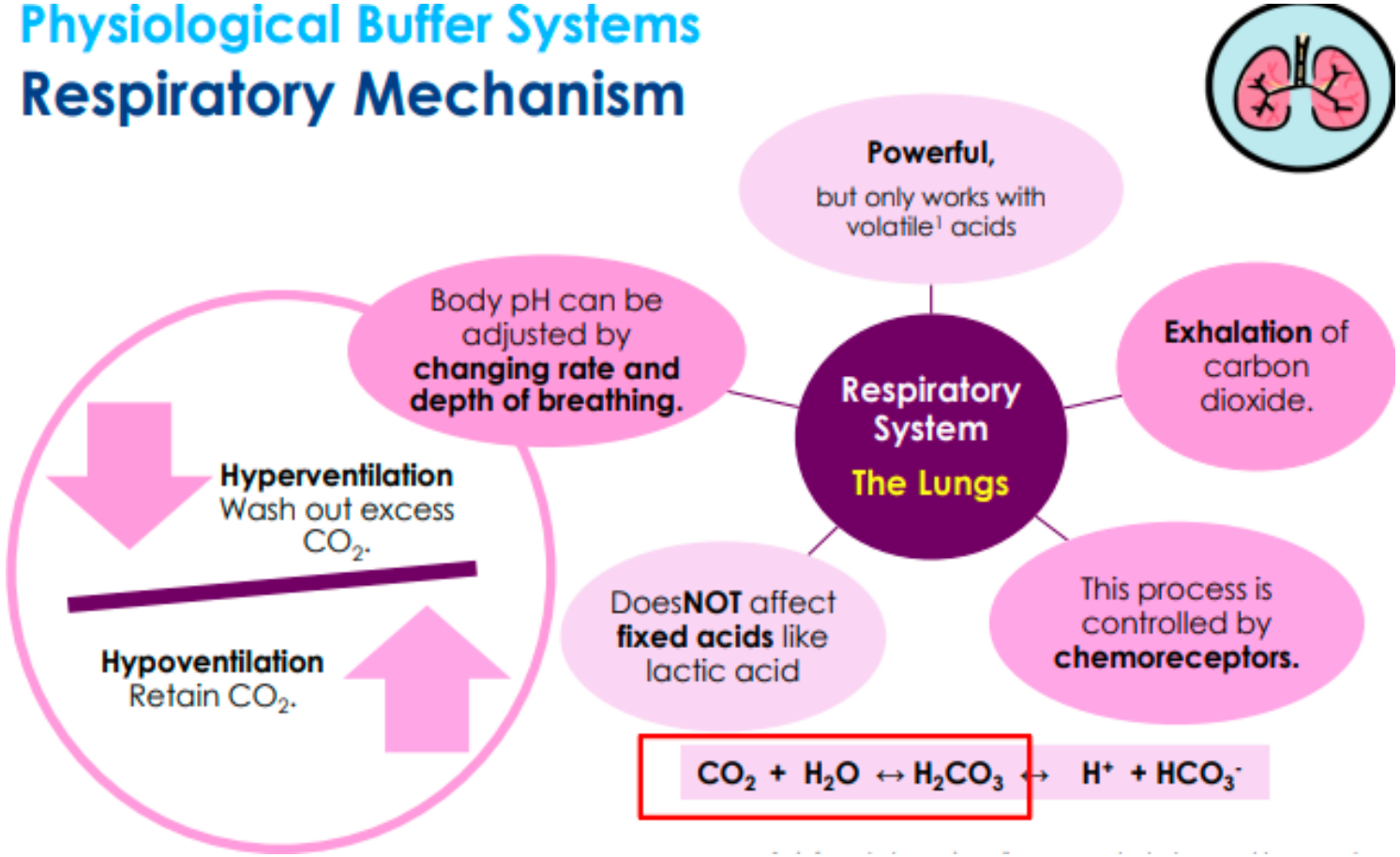
Protein Buffer System

- The plasma proteins in general and **hemoglobin** in particular constitute an important buffer system.
- It plays an important role in buffering co2
- There are about **700gm** of hemoglobin in the blood of an adult person.
- Deoxy hemoglobin is better buffer than oxy hemoglobin.



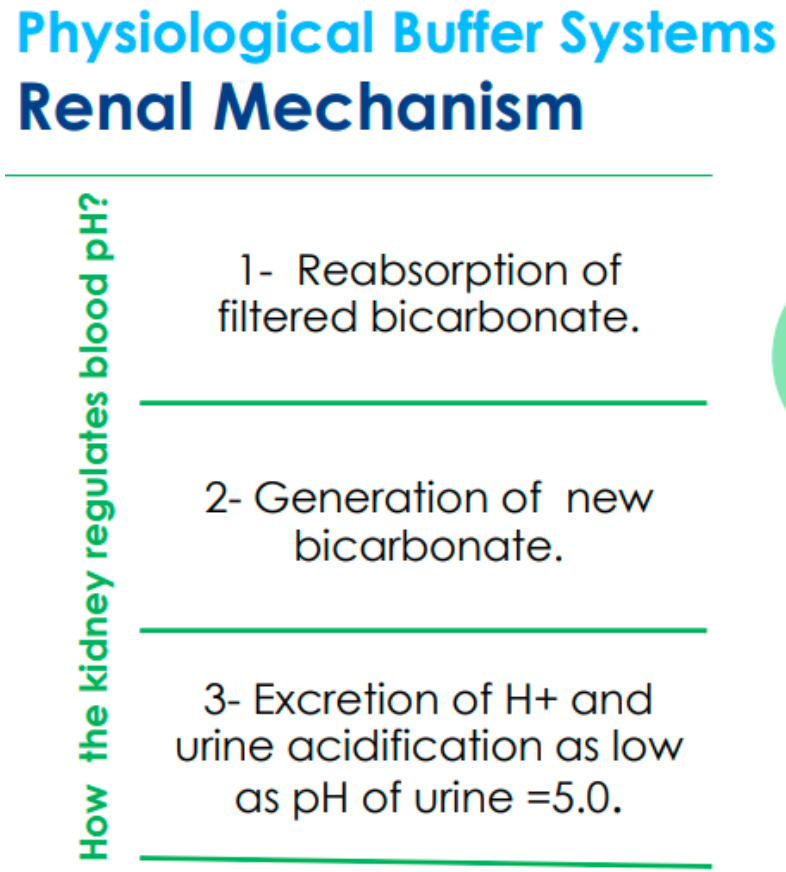
Respiratory mechanism

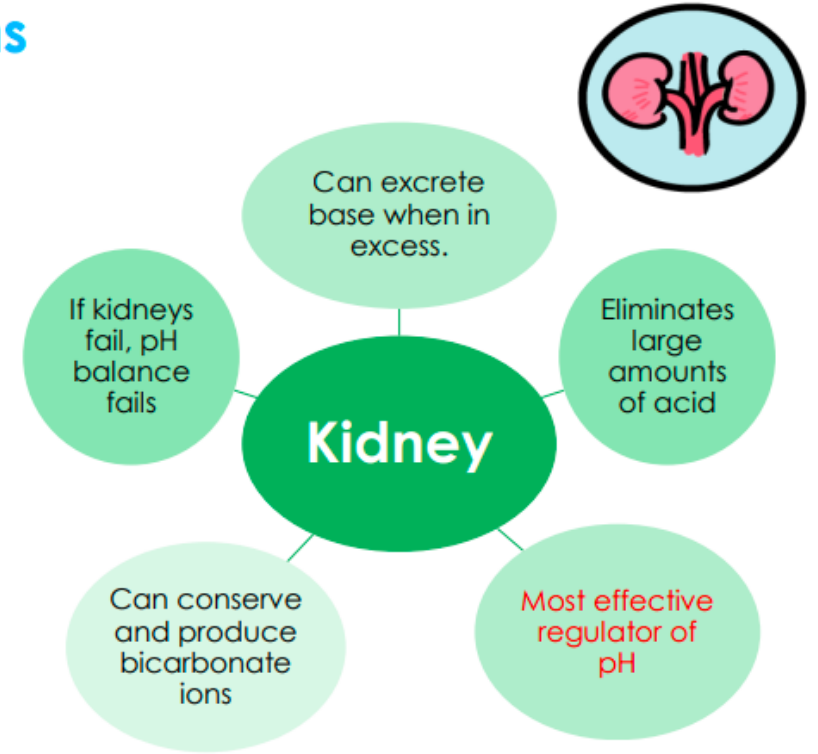
- Central chemoreceptors: Respond to changes in CO2
- Peripheral chemoreceptor: respond to changes in H+
- Hydrogen ions cant cross BBB so only the peripheral chemoreceptors will sense their change



Renal Mechanism

- Kidneys make long-term adjustment to PH.
- For the kidney to continue excretion of acidic urine, the excreted H+ has to be buffered by two buffer systems in the renal tubules: Ammonia & Phosphate Buffer
- For each HCO3- reabsorption, a H+ must be secreted in Kidney





Determination of Acid Base

- Determination of Acid Base Disorders – through **Arterial and Venous Blood Gases**

- The better choice is the Radial artery.
- Blood also can drawn from he femoral artery or brachial or indwelling arterial line
- The tests are done immediately because oxygen and carbon dioxide are unstable
- Arterial blood sample is better than venous blood.

Purpose of the Test

- This test is done on mostly hospitalized patients.
- Mostly the patients are on a ventilator or unconscious.
- It monitors critically ill non-ventilator patients.
- For patients in pulmonary distress.
- To assess the respiratory (ventilation), metabolic (renal) acid/base, and electrolyte imbalance.
- Monitor Oxygenation
- This is used as preoperative baseline parameters.

Equipment Required for ABG Analysis

- Gloves
- Heparinized syringe (3cc or 1cc)
- Dry cotton
- Alcohol wipe or gel
- Tape
- Pillow or blanket to rest wrist during sampling
- A plastic bung
- Local anaesthesia: 1% Lignocaine and syringe
- 23 G needle
- Patient label

Precautions for the collection of blood

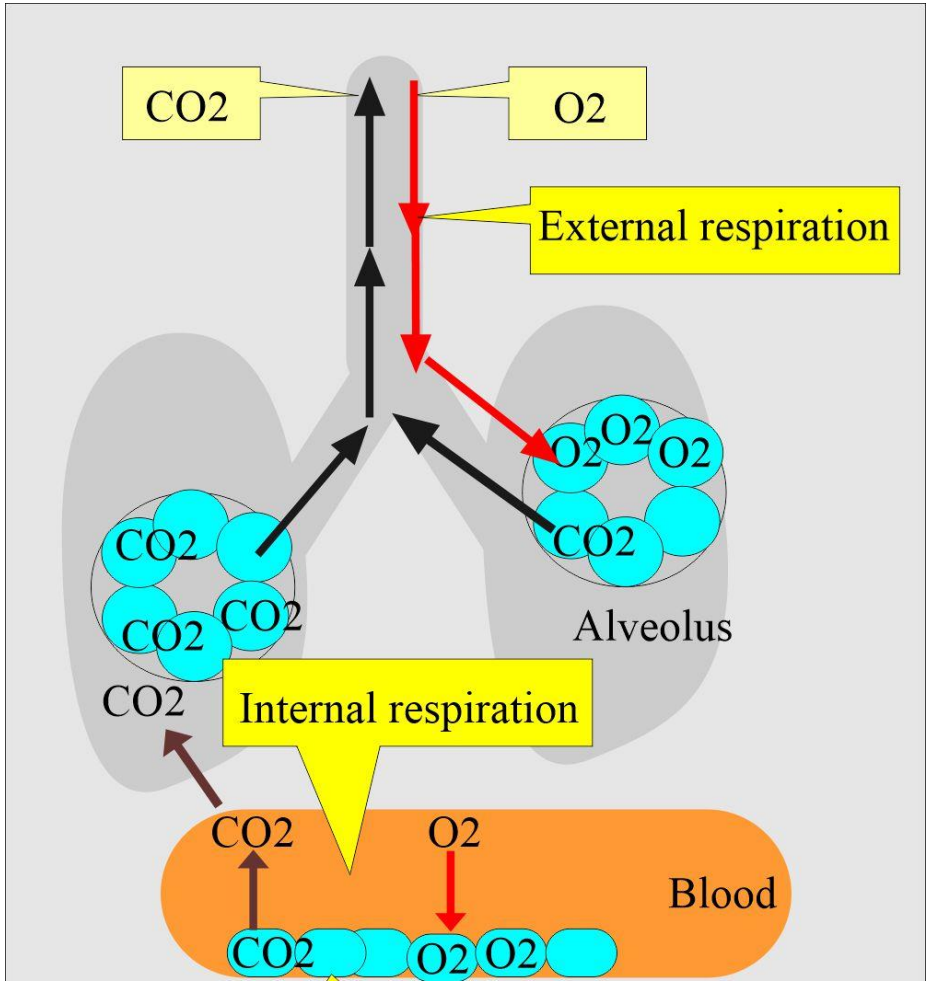
- Avoid pain and anxiety in the patient, which will lead to hyperventilation.
- Hyperventilation due to any cause leads to decreased CO2 and increased pH.
- Keep blood cool during transit.
- Don’t clench your finger or fist. This will lead to lower CO2 and increased acid metabolites.
- pCO2 values are lower in the sitting or standing position than in the supine position.
- Don’t delay the performance of the test.
- Avoid air bubbles in the syringe.
- Excess of heparin decreases the pCO2 by maybe 40% less.
- Not properly mixing the blood before running the test may give a false result.
- A prolonged tourniquet or muscular activity decreases venous pO2 and pH.

ABG

- Blood arterial gases measure the balance between Oxygen (o2) and carbon dioxide (CO2), giving information about the function of the lungs.
- It will tell the metabolic and respiratory status.
- It includes:
  - The partial pressure of oxygen (paO2).
  - Oxygen saturation
  - The partial pressure of carbon dioxide (paCO2).
  - Bicarbonate level ($HCO3^-$).
  - pH level.

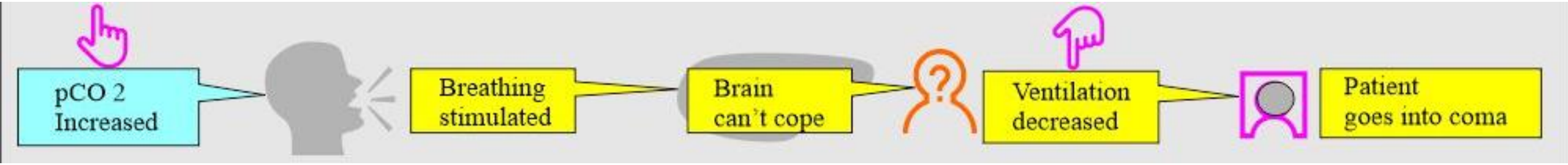
pH

- The acid-base status of the body is assessed by: pH and pCo2
- As the blood hydrogen concentration increases, the pH decreases, and if hydrogen ions decrease, the pH increases.
- The decrease of one pH unit represents a 10 times increase in H^+ activity.
- The average pH of the blood of 7.40 is equal to the H^+ ions concentration of 40 nmol/L



pCO2 (Partial pressure of the carbon dioxide CO2)

- pCO_2 measures the partial pressure of CO_2 gas in the blood (arterial blood, plasma, or serum)
- pCO_2 in the blood is 10% in the plasma and 90% carried by the red blood cells.
- With respiration, CO_2 is breathed out, and the pCO_2 level drops will depend on the breathing rate.



$HCO-_3$ or CO_2 content / O2 Content

$HCO-_3$ or CO_2 content

- Total CO_2 = HCO_3^- + Dissolved CO_2
- The most important buffer system of the plasma is HCO_3^- / $H2CO_3$.
- It is also present in the RBC but at a lower concentration.
- The ratio of base: acid = 20: 1 in plasma.

O2 Content

- About 98% of all O2 delivered to the tissue is transported in combination with the hemoglobin.
- The following formula calculates O2 contents = O_2 saturation x Hb x 1.34 + pO2 × 0.003
- Each gram of hemoglobin can maximally bind 1.34 mL of oxygen
- The solubility coefficient of oxygen in plasma is 0.003.

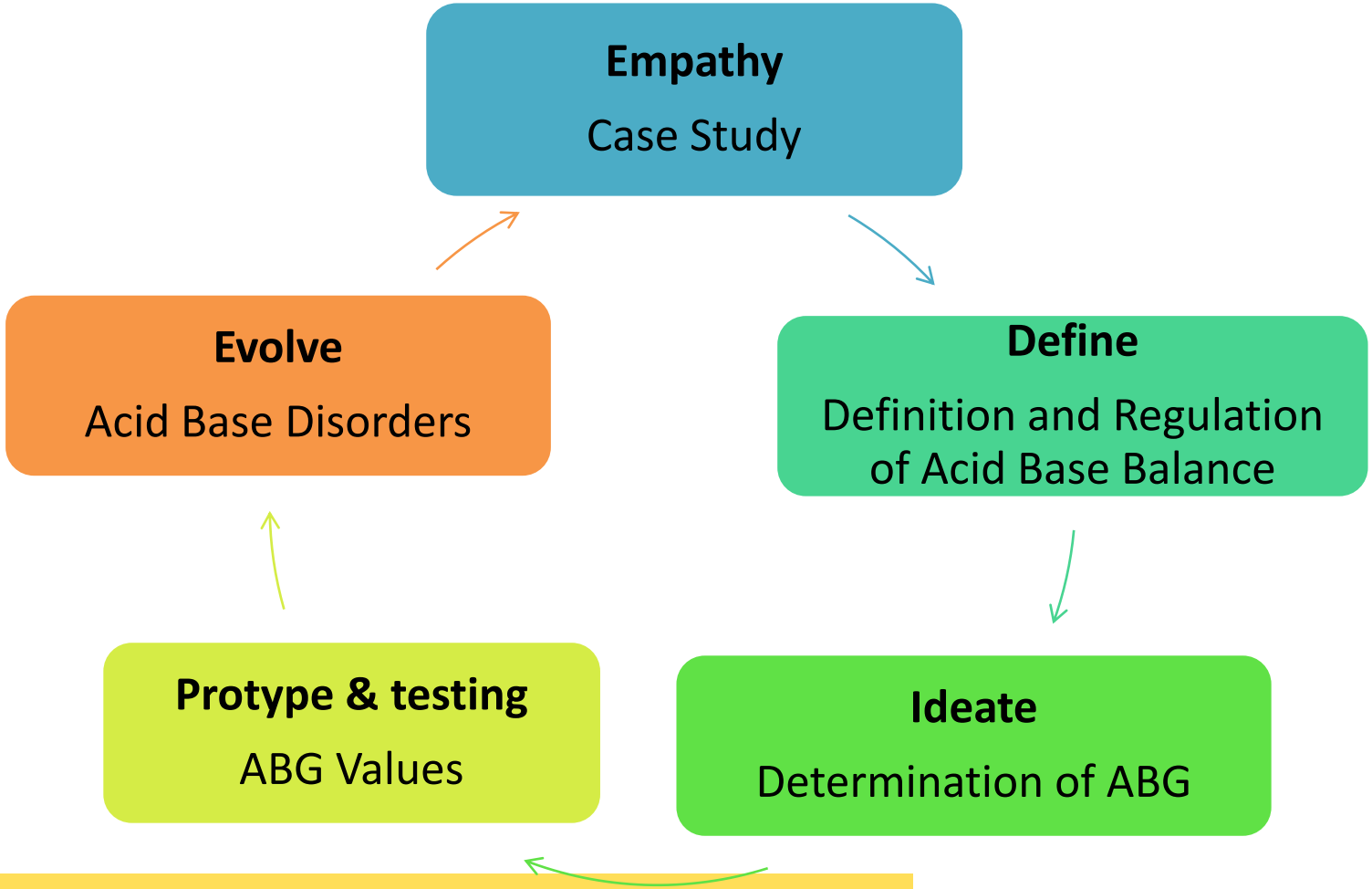
pO2 & O2 Saturation

- Oxygen in the blood is carried in two forms:
  - Dissolved in plasma = <2%.
  - Combined with hemoglobin = 98%.
- The pO2 reflects the amount of oxygen passing from the pulmonary alveoli to the blood.
- O2 saturation indicates % of hemoglobin saturated with oxygen
- When hemoglobin 92 to 100% carries O2, then perfusion or oxygen supply to the tissue is normal.
- When the O2 saturation is 70% or low, the tissues cannot get adequate oxygen.

Normal Value

	ABG	VBG
pH	7.35 – 7.45	7.35 – 7.39
Po2	75 – 100 mm Hg	38 – 42 mm Hg
Pco2	35 – 45 mm Hg	44 – 48 mm Hg
BE	0	-2.5 to + 2.5
O2 Saturation	90 to 100 %	73 – 77%
Bicarbonate	22 – 28 mEq/ L	22 – 28 mEq / L

Summary


Empathy
Case Study
Define
Definition and Regulation of Acid Base Balance
Ideate
Determination of ABG
Protype & testing
ABG Values
Evolve
Acid Base Disorders

Thank You

Reference:

https://labpedia.net/acid-base-balance-part-4-arterial-blood-gases-blood-gases/

https://slideshare.net/nahlakhalil1/acid-base-imbalances-2018

https://wecaregolp.com/abg-analysis/