



# **ACID-BASE BALANCE & DISTURBANCES**

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Advance Clinical Biochemistry I (MA 407)

Summer Semester

Lecture Four

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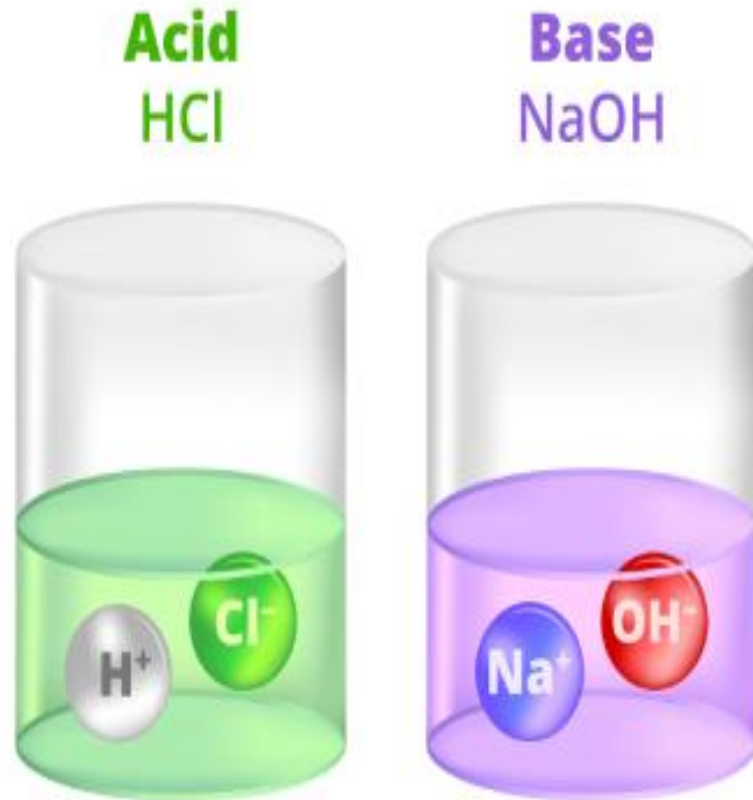
# Outlines

- Objectives
- Introduction
- Acid-base balance
- pH scale and its important
- Maintenance of acid-base balance
- Buffering system in human body
- Acid-base disturbances
- Summary

# Objectives

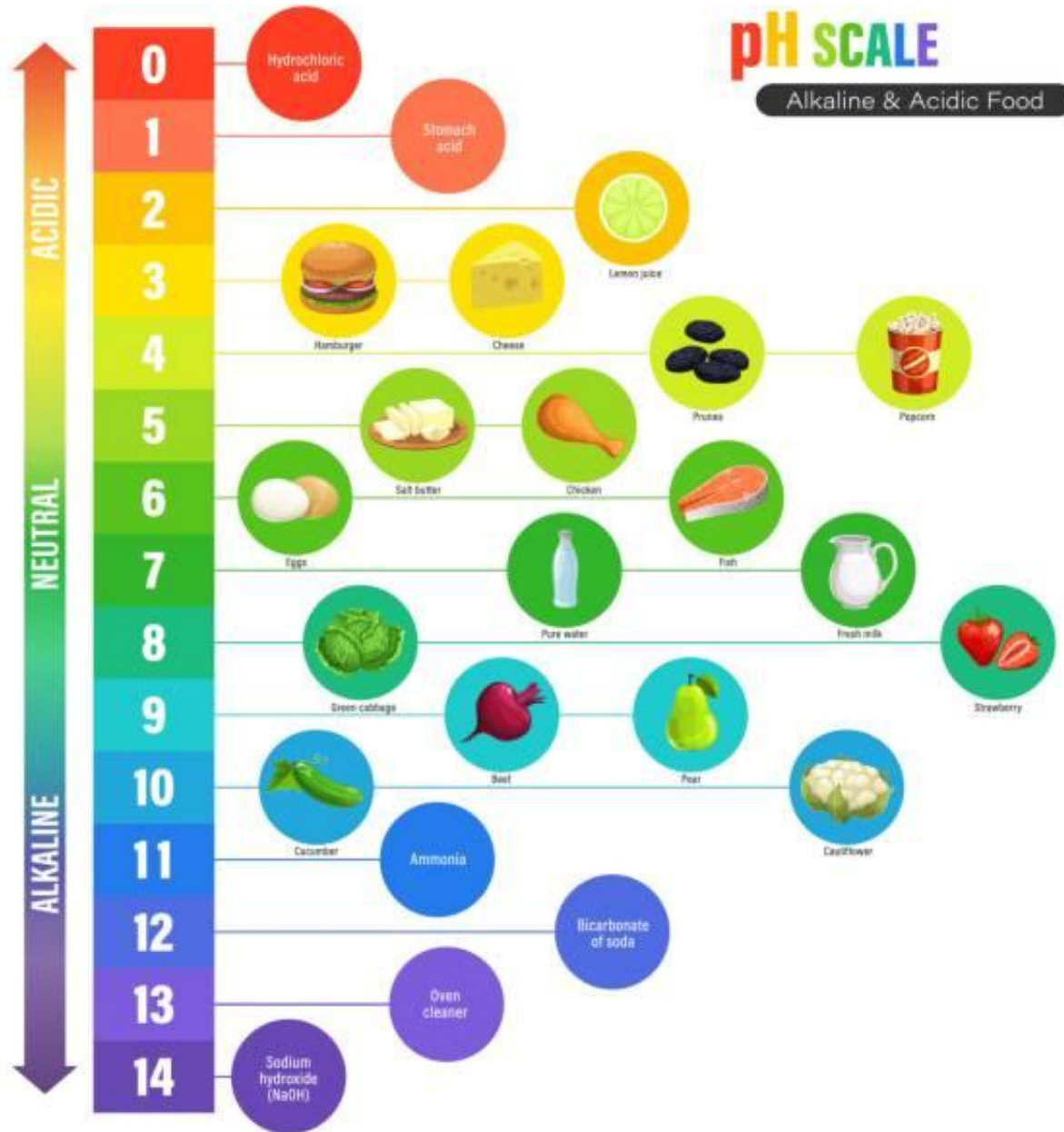
- At the end of the lesson, the students should be able to understand:
  - ✓ The importance of acid-base balance in the body
  - 
  - ✓ The pH scale, pH values, and its Physiology significance.
  - ✓ The human body buffering system and its importance.
  - ✓ The conditions associated with acid-base imbalance (disturbances) and their implications.





## Introduction

- An acid is any hydrogen-containing substance that is capable of donating a proton (hydrogen ion) to another substance.
- A base is a molecule or ion able to accept a hydrogen ion from an acid.



## Acid-base balance

- Acid-base balance is the physiological process by which the body **maintains a stable pH** essential for **normal cellular function**.
- Blood needs the right balance of **acidic and basic compounds** to function properly.
- **Kidneys and lungs** work to maintain the acid-base balance.

# Alkaline Diet: ALkaline Foods



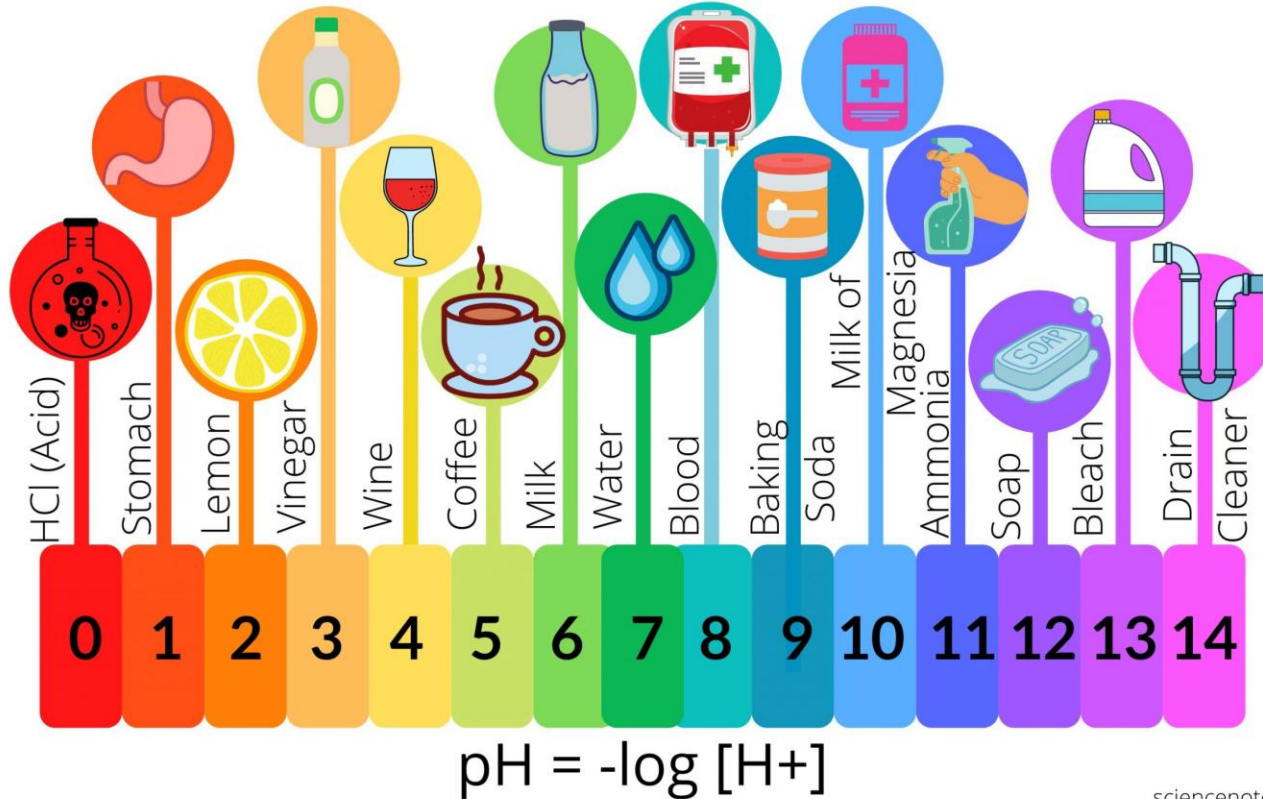
"Create an alkaline body with potassium and sodium rich foods."

## Cont.

- Even slight variations from the normal range can have significant effects on the vital organs.
- Acid and alkaline levels are measured on a **pH scale which is the degree of acidity and alkalinity in the body.**



## The pH Scale



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## pH scale and important values

- Blood in the human body is typically slightly more alkaline than acidic.
- Normal body pH: 7.35 - 7.45
- Acidemia: the actual condition of the blood having a pH below the normal range (less than 7.35).
- Alkalemia: the actual condition of the blood having a pH above the normal range (greater than 7.45).

# Interaction

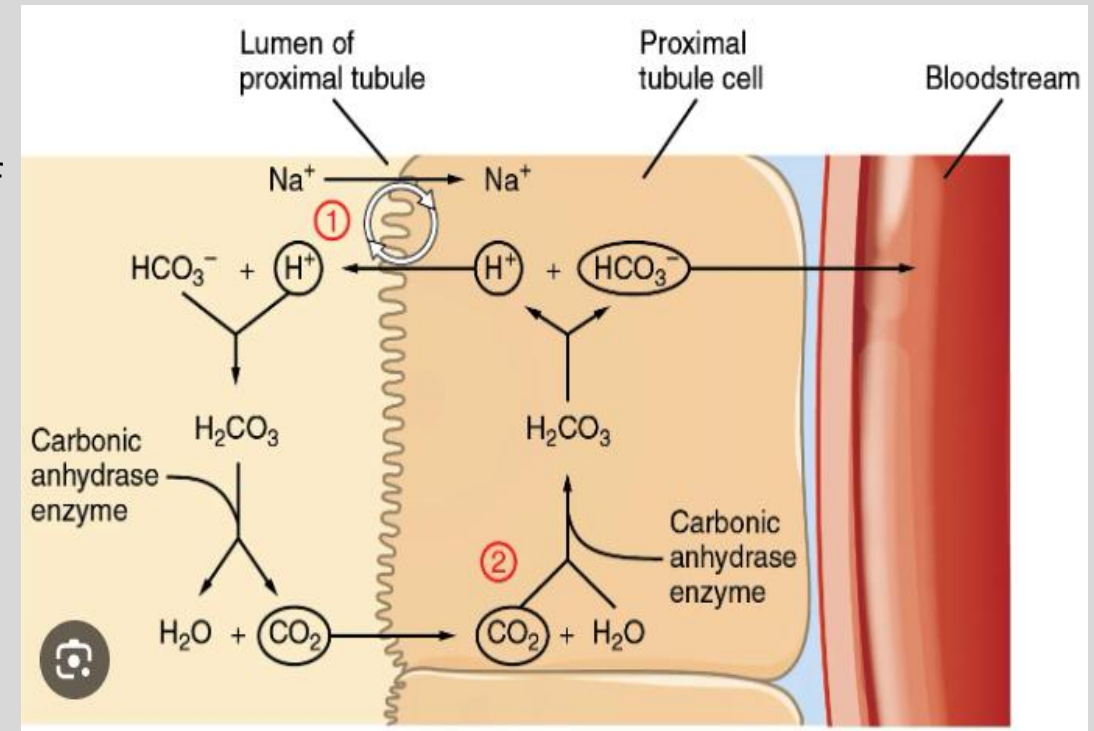
- What is the normal pH range of human blood?
- Name two major organs responsible for maintaining acid-base balance.
- The pH scale measures only alkalinity. T/F?
- A pH of 7.0 is considered neutral. T/F?





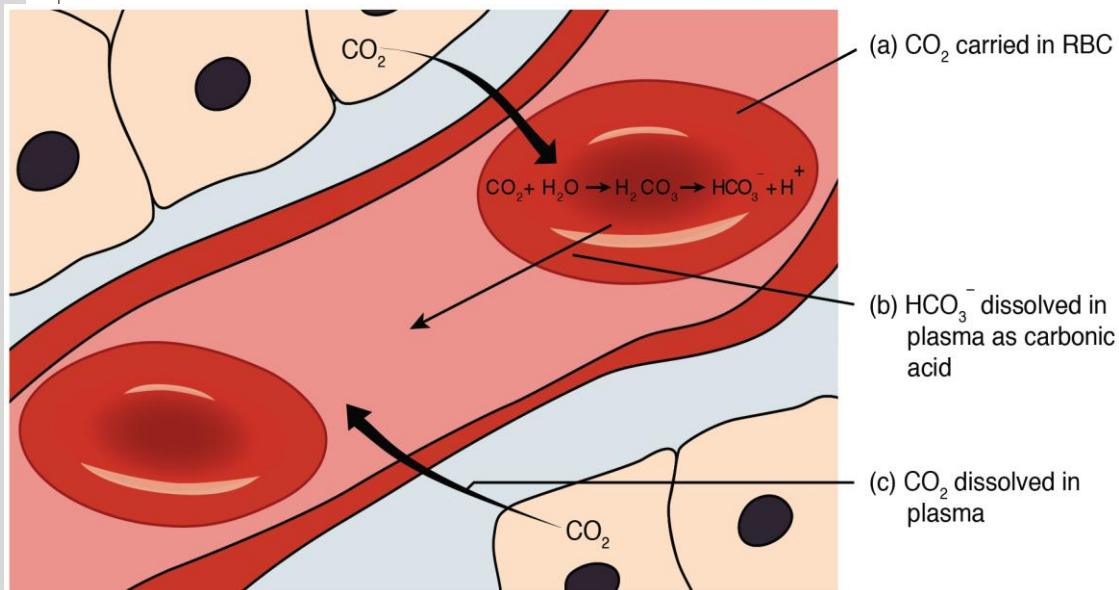
# Maintenance of Acid-Base Balance by the Body

- Adequate level of acid and base in blood must be maintained in apparently healthy individuals.
- For the body to be in acid-base balance, the level of hydrogen ions must reach equilibrium.
- The kidneys maintain acid-base homeostasis by excreting hydrogen ions and generating bicarbonate.
- This phenomenon maintains blood plasma pH within the normal range.
- **Excretory & Buffer Systems** contribute immensely to the acid-base balance of blood?



# Buffering system in human body

- When any acidic substance enters the bloodstream, the bicarbonate ions neutralize the hydronium ions forming carbonic acid and water.
- Carbonic acid is already a component of the buffering system of blood.
- Thus, hydronium ions are removed, preventing the pH of blood from becoming acidic and vice versa.



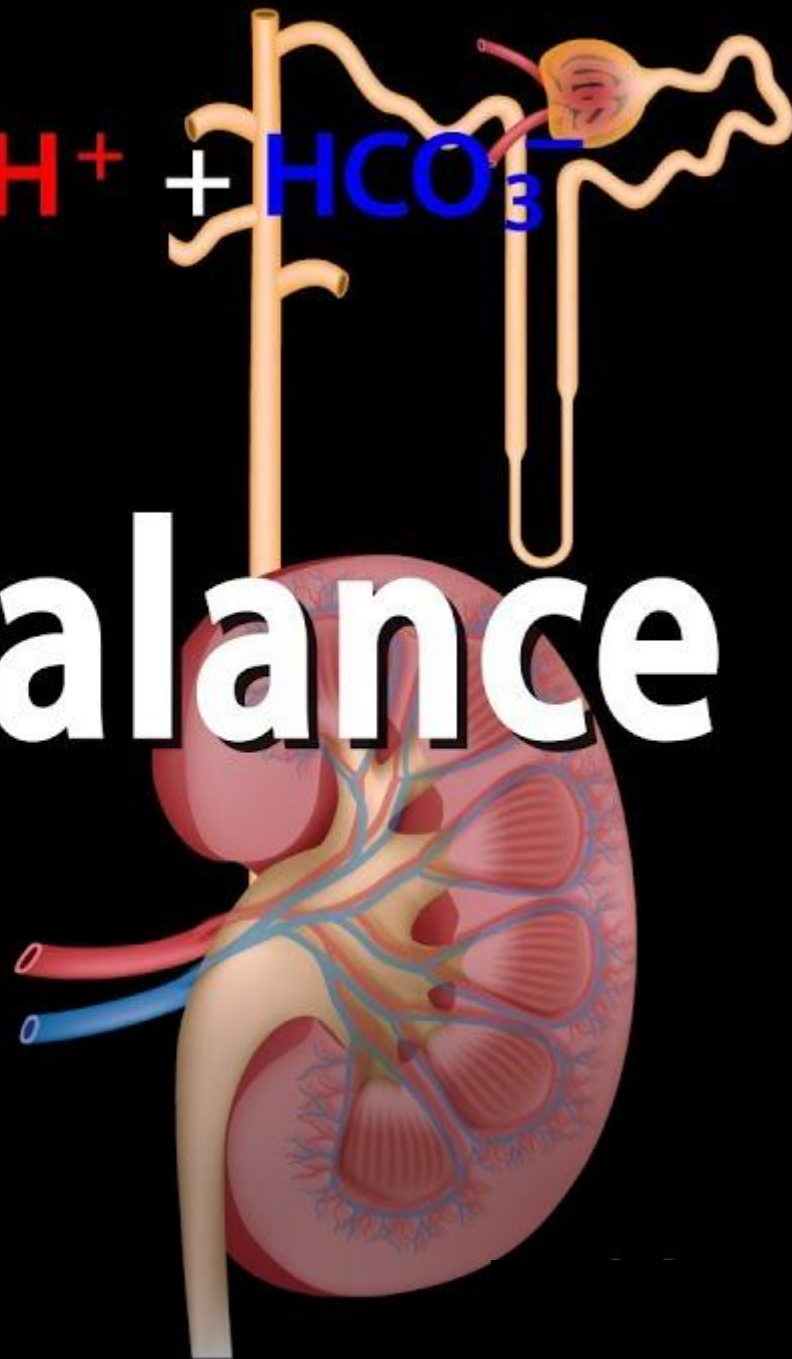
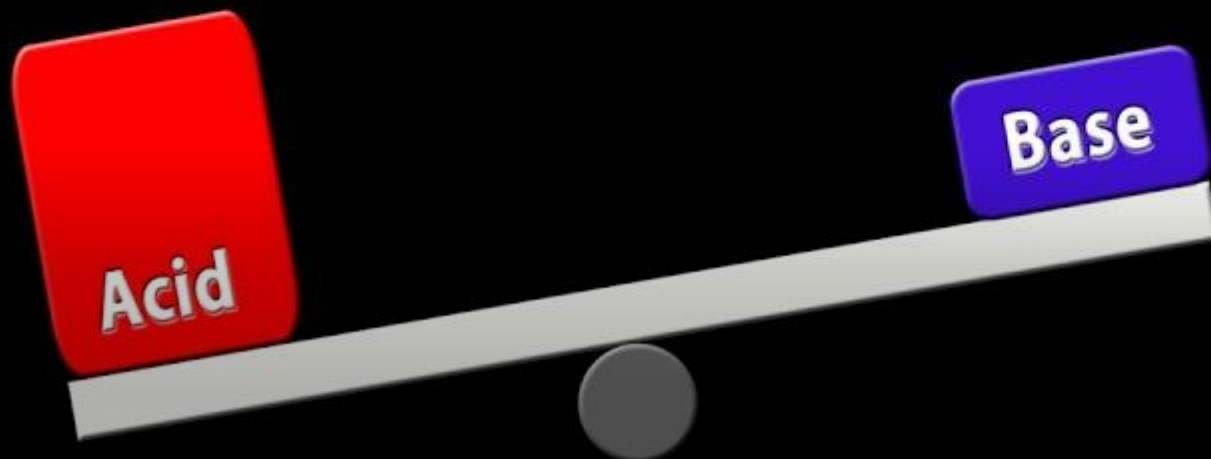


Basic

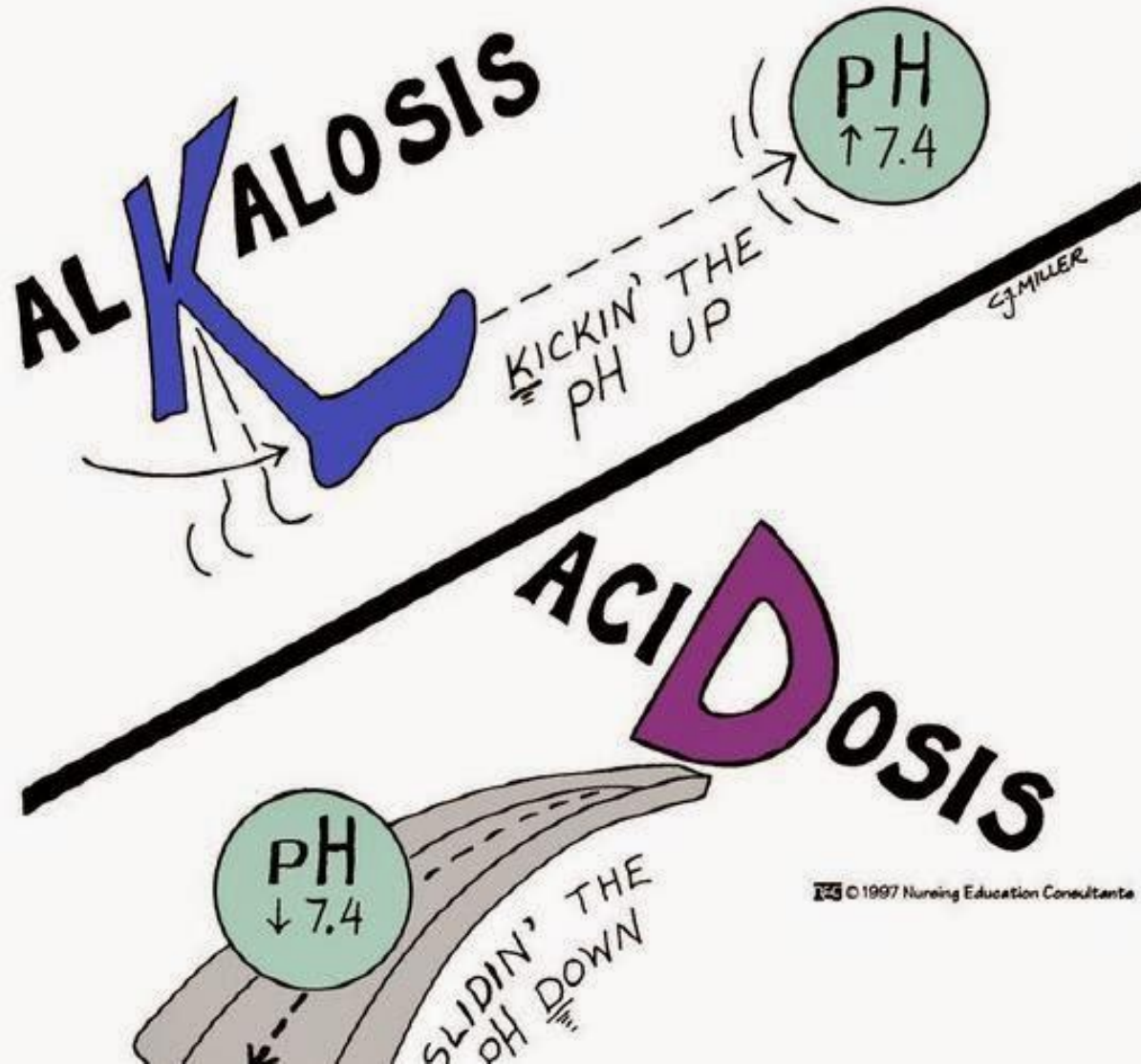
Neutral

Acidic

# Acid-Base Balance



## ACIDOSIS – ALKALOSIS



## Acid-base Disturbances

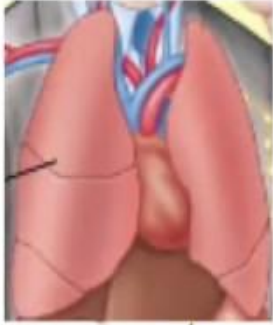
- There are two types of abnormalities I respect to acid-base balance maintenance:
- **Acidosis**
- **Alkalosis**
- **Acidosis** is referred to as a physiological or biochemical disorder that leads to a **decrease in blood pH**.
- **Alkalosis** is referred to as a physiological or biochemical disorder that leads to an **increase in blood pH**

# Acid-Base Disturbances

- **Respiratory acidosis or alkalosis** occurs when the lungs are removing **too little** CO<sub>2</sub> (acidic condition) or removing **too much** CO<sub>2</sub> (basic condition) due to a clinical situation of the lungs.
- **Metabolic acidosis or alkalosis** occurs when there is slow removal of **acidic specie (H<sup>+</sup>)** or high production of **basic specie (HCO<sub>3</sub><sup>-</sup>)** that results from kidney malfunction.



# Four Acid-Base Disorders:



Respiratory



**Acidosis**



**Alkalosis**



**Alkalosis**

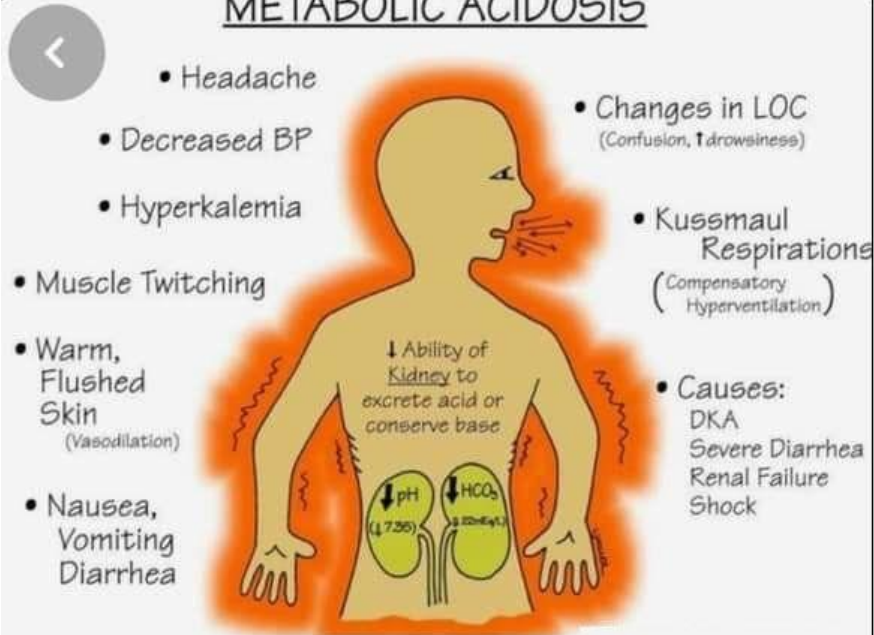


**Acidosis**

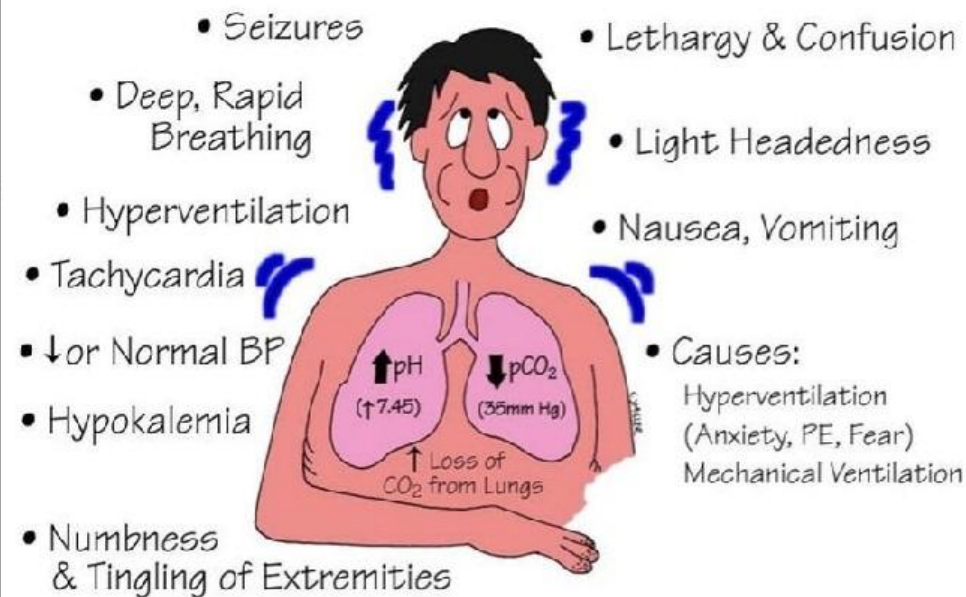


Metabolic

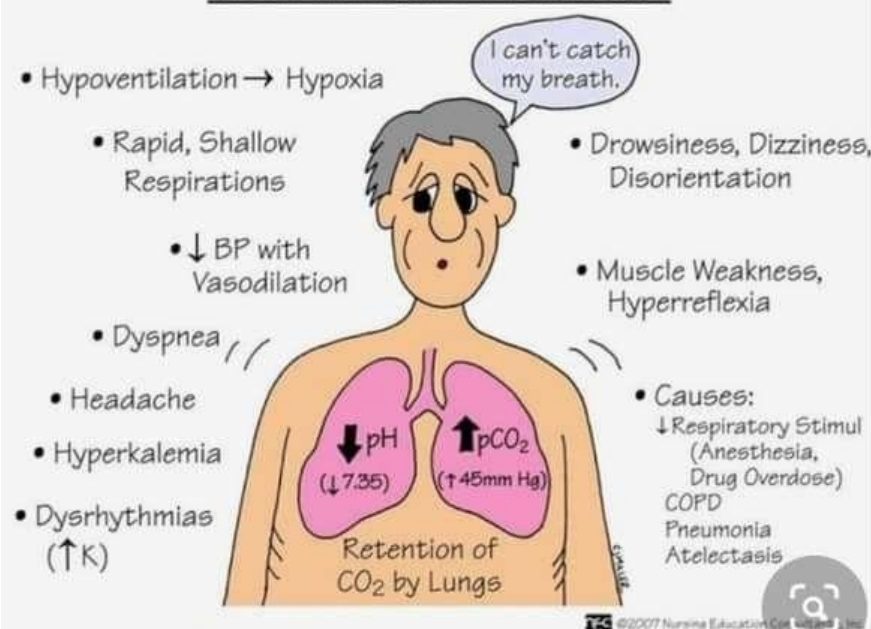
## METABOLIC ACIDOSIS



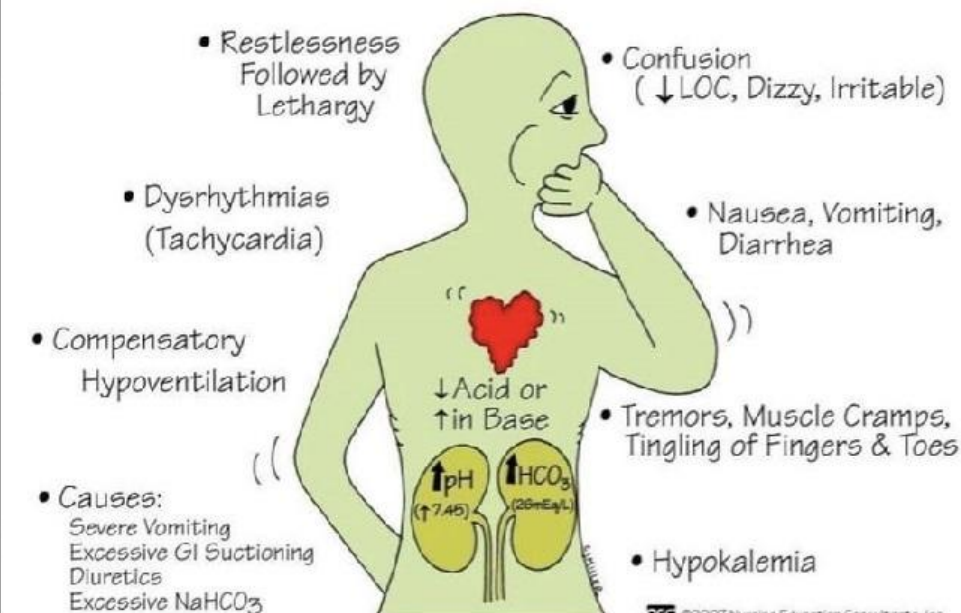
## RESPIRATORY ALKALOSIS



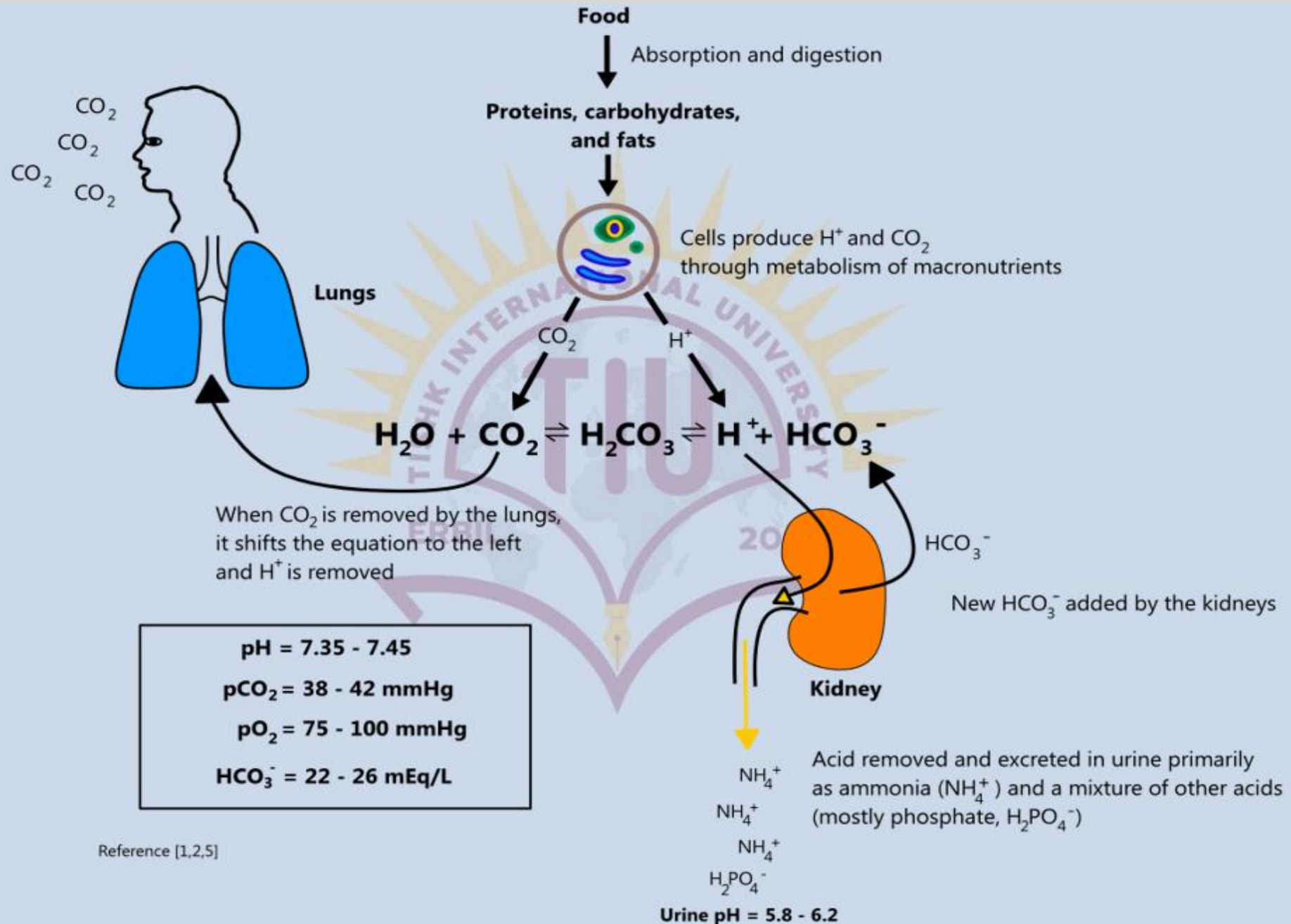
## RESPIRATORY ACIDOSIS



## METABOLIC ALKALOSIS



## Scheme



# Summary

- ✓ Acid-base balance is the physiological process by which the body maintains a stable pH (7.35–7.45) essential for normal cellular function.
- ✓ *Acid* donates hydrogen ions ( $H^+$ ) and *Base* accepts hydrogen ions.
- ✓ Lungs: Regulate  $CO_2$  (acidic component) through respiration.
- ✓ Kidneys: Excrete  $H^+$  and conserve/generate  $HCO_3^-$  (base).
- ✓ Buffers: Immediate pH stabilizers—mainly the bicarbonate buffer ( $H_2CO_3/HCO_3^-$  system).
- ✓ pH Scale: Normal blood: 7.35–7.45, Acidemia:  $< 7.35$ , and Alkalemia:  $> 7.45$
- ✓ Buffering Reaction:  $H^+ + HCO_3^- \rightleftharpoons H_2CO_3 \rightleftharpoons CO_2 + H_2O$
- ✓  $CO_2$  retention (hypoventilation) - Respiratory Acidosis.
- ✓ Excess  $CO_2$  loss (hyperventilation) - Respiratory Alkalosis.
- ✓ Excess  $HCO_3^-$  loss (renal failure, diarrhea) - Metabolic Acidosis:.
- ✓ Excess base or acid loss (vomiting, diuretics) - Metabolic Alkalosis: .
- ✓ Clinical Importance: Even slight deviations from normal pH can impair vital organ functions and enzyme activity.



## Class Activities

- ✓ What are the 3 most important body systems with respect to acid-base balance?
- ✓ What condition results from excessive accumulation of  $\text{CO}_2$  in the body?
- ✓ Describe the term metabolic alkalosis
- ✓ Differentiate between acidemia and alkalosis
- ✓ What condition results from excessive accumulation of  $\text{CO}_2$  in the body?
- ✓ The main buffering system in the blood is .....
- ✓ The internal organ that maintains pH carbonic acid manipulation is known as .....
- ✓ Acid-base imbalance does not affect enzyme activity. True/False?
- ✓ Buffer systems act as the first line of promotion for pH changes. True/False?
- ✓ Respiratory acidosis is caused by excessive  $\text{CO}_2$  retention. True/False?



**Next Lecture**

# **Metabolic Diseases of GIT**

