

ABNORMALITIES IN ACID-BASE BALANCE

Objectives

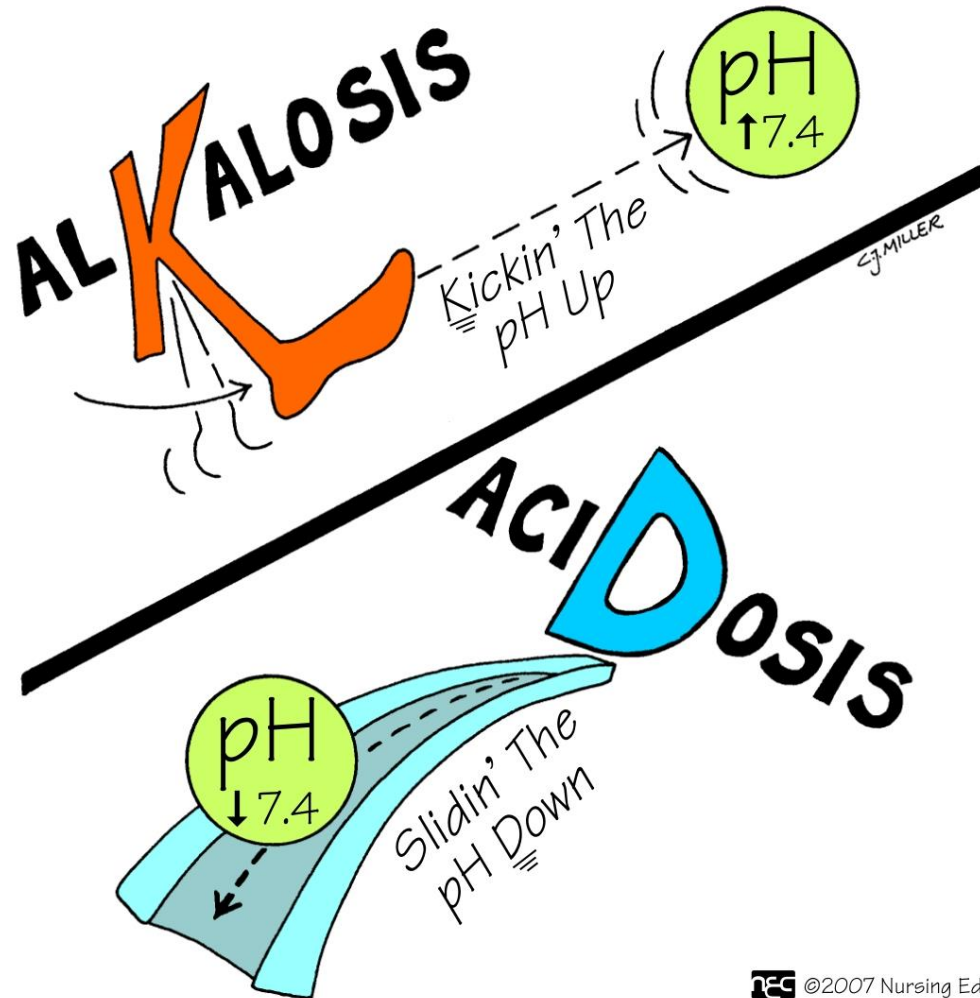
- To explain the principles of blood gas and acid-base analysis
- To interpret blood gas analysis and diagnose various acid base disorders
- Describe causes of acid base disorders
- Understand use of acid base nomograms

Abnormalities in Acid-Base Balance

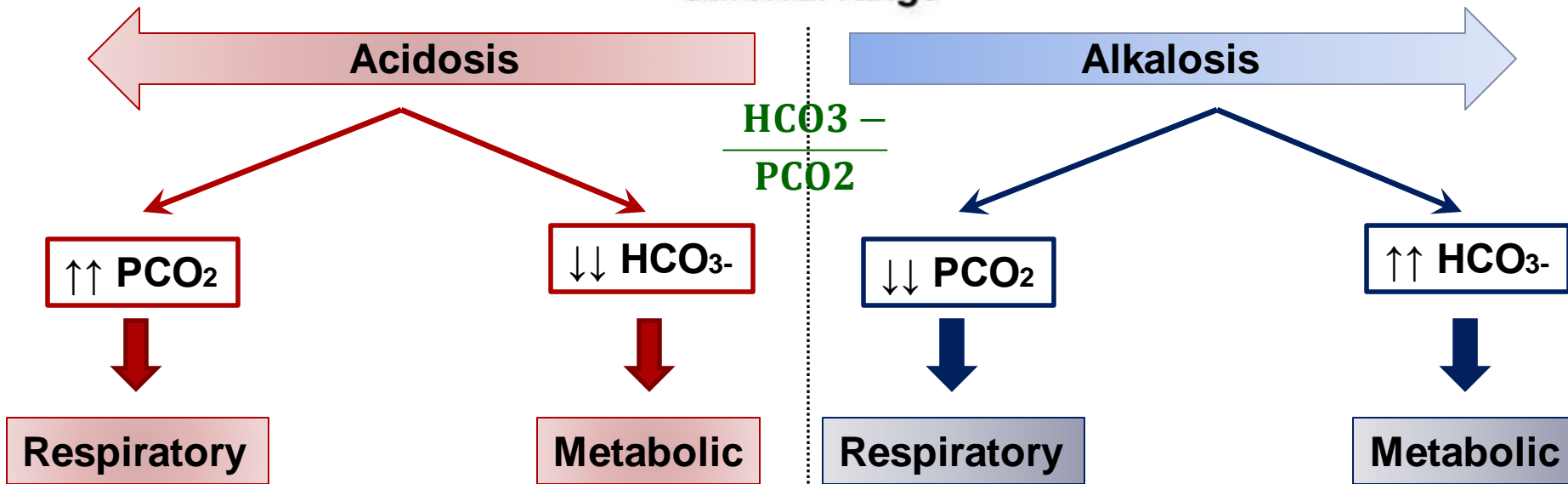
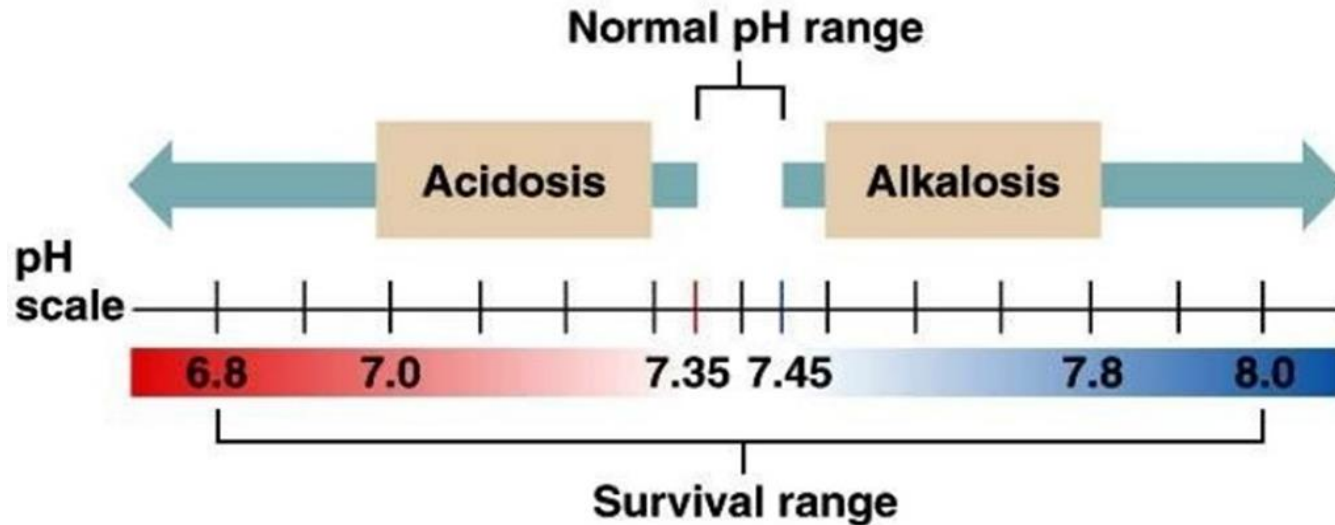
- Many critical illnesses can disturb acid-base balance.
- Acid-base disturbances may indicate an underlying disease or organ damage.
- Accurate interpretation of acid-base disturbances requires the following:
 - ✓ Arterial blood gases.
 - ✓ Plasma electrolytes.
 - ✓ Knowledge of the compensatory physiologic mechanisms.

Abnormalities in Acid-Base Balance

ACIDOSIS - ALKALOSIS



Abnormalities in Acid-Base Balance



Primary Acid-Base Disorders

There are 4 *primary* acid-base disorders

Defence mechanism of the body
Compensatory/secondary response

Respiratory acidosis

Respiratory alkalosis

The kidney compensates
“Renal compensation”

Metabolic acidosis

Metabolic alkalosis

The lung compensates
“Respiratory compensation”

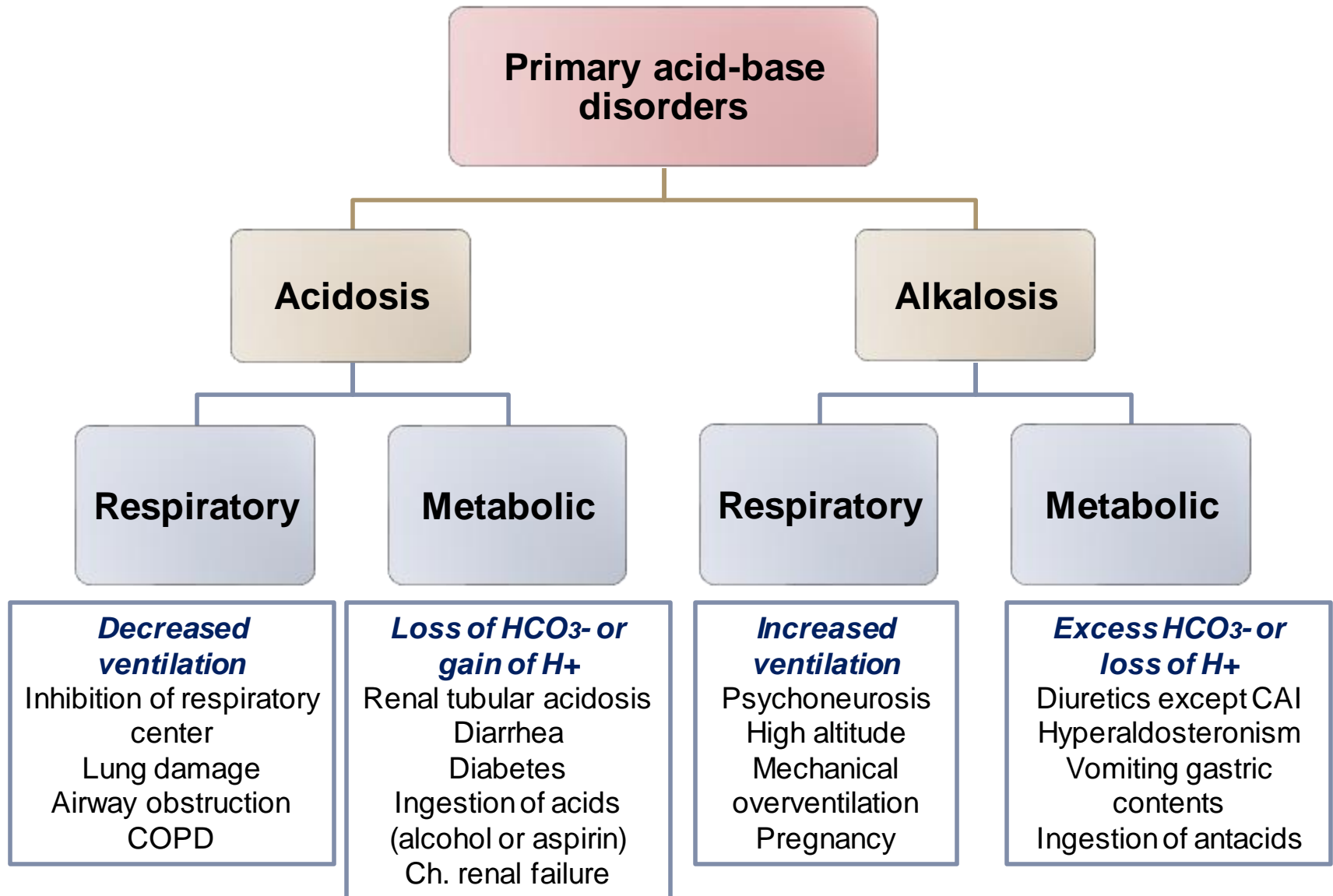
If a person develops any of these disorders,

What will the body try to do?

Fundamentals in Acid-Base Disorders

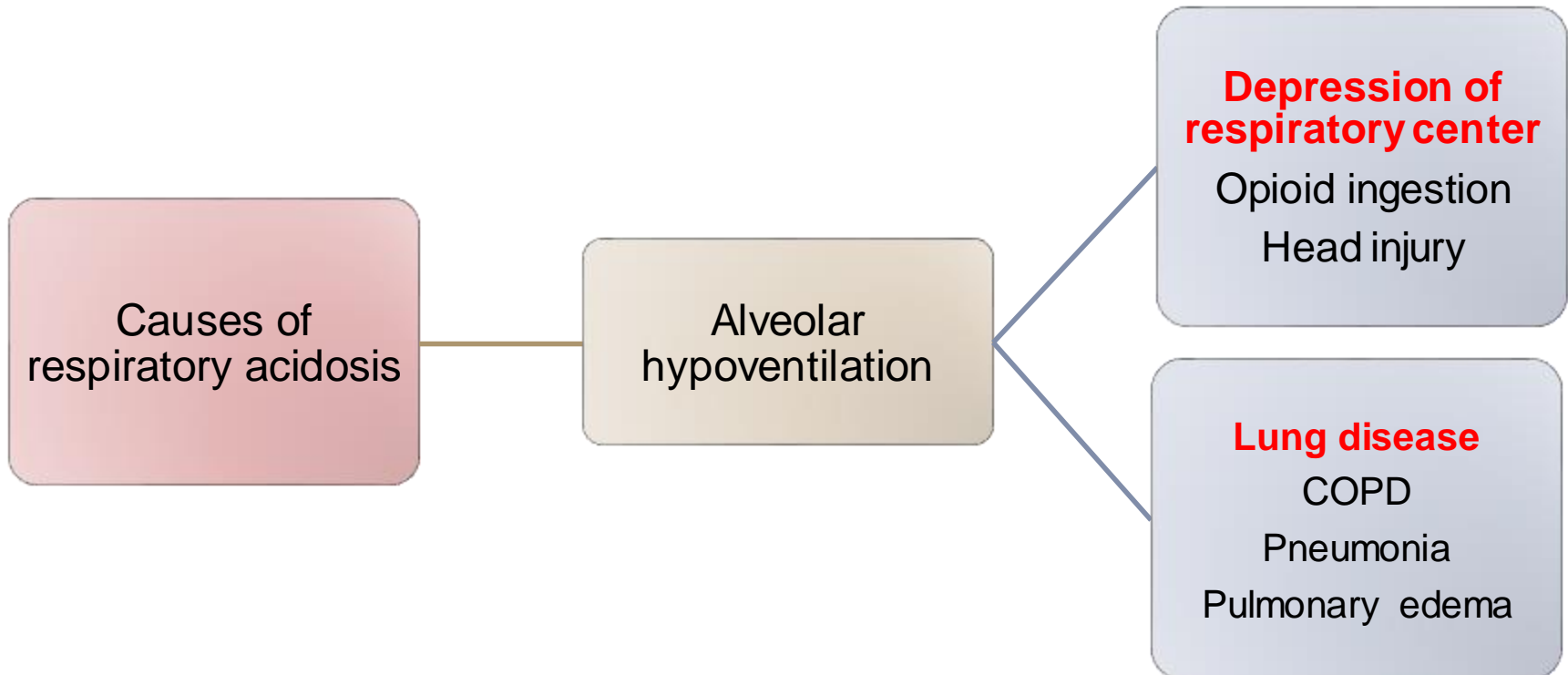
- Acid-base disorders are classified by changes in pH, PCO_2 and HCO_3^-
- There are 4 **primary** acid-base disorders:
 - **Respiratory acidosis:** $\uparrow \text{PCO}_2$
 - **Respiratory alkalosis:** $\downarrow \text{PCO}_2$
 - **Metabolic acidosis:** $\downarrow [\text{HCO}_3^-]$
 - **Metabolic alkalosis:** $\uparrow [\text{HCO}_3^-]$
- The body normally attempts to correct the primary acid-base disturbances by a **secondary** or **compensatory** response trying to restore pH towards normal.
 - The **kidneys** compensate for primary **respiratory disorders**.
 - The **lungs** compensate for primary **metabolic disorders**.

Primary Acid-Base Disturbances



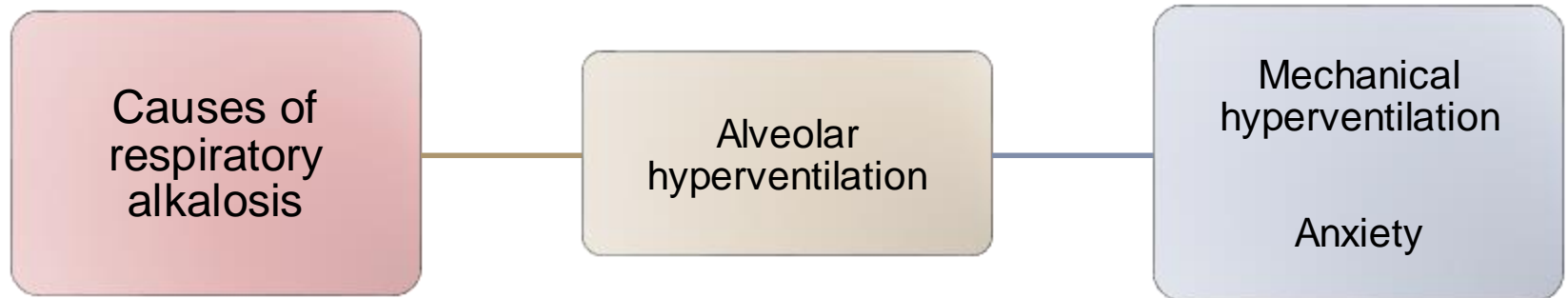
Respiratory Acidosis

- Respiratory acidosis = \downarrow pH + \uparrow PCO₂
 - Due to alveolar hypoventilation.



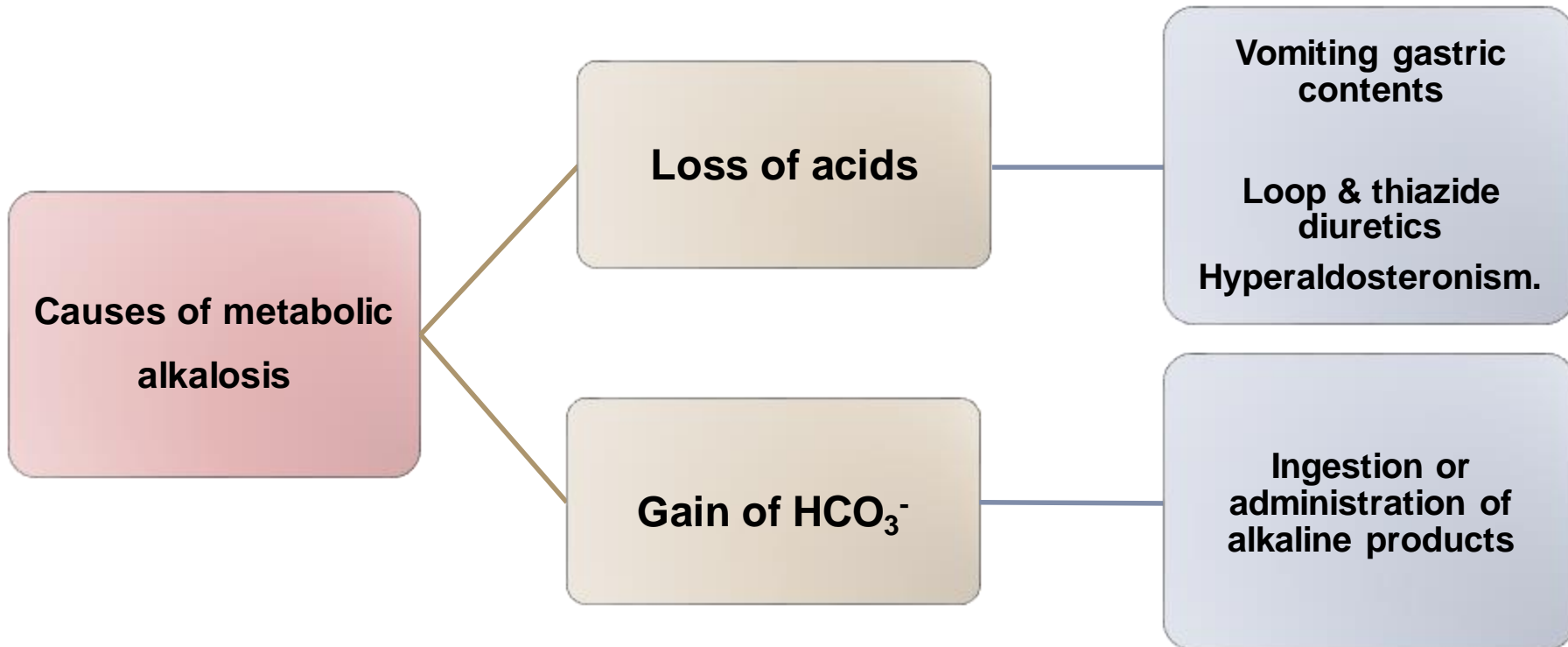
Respiratory Alkalosis

- Respiratory alkalosis = \uparrow pH + \downarrow PCO₂
 - Due to alveolar hyperventilation.



Metabolic Alkalosis

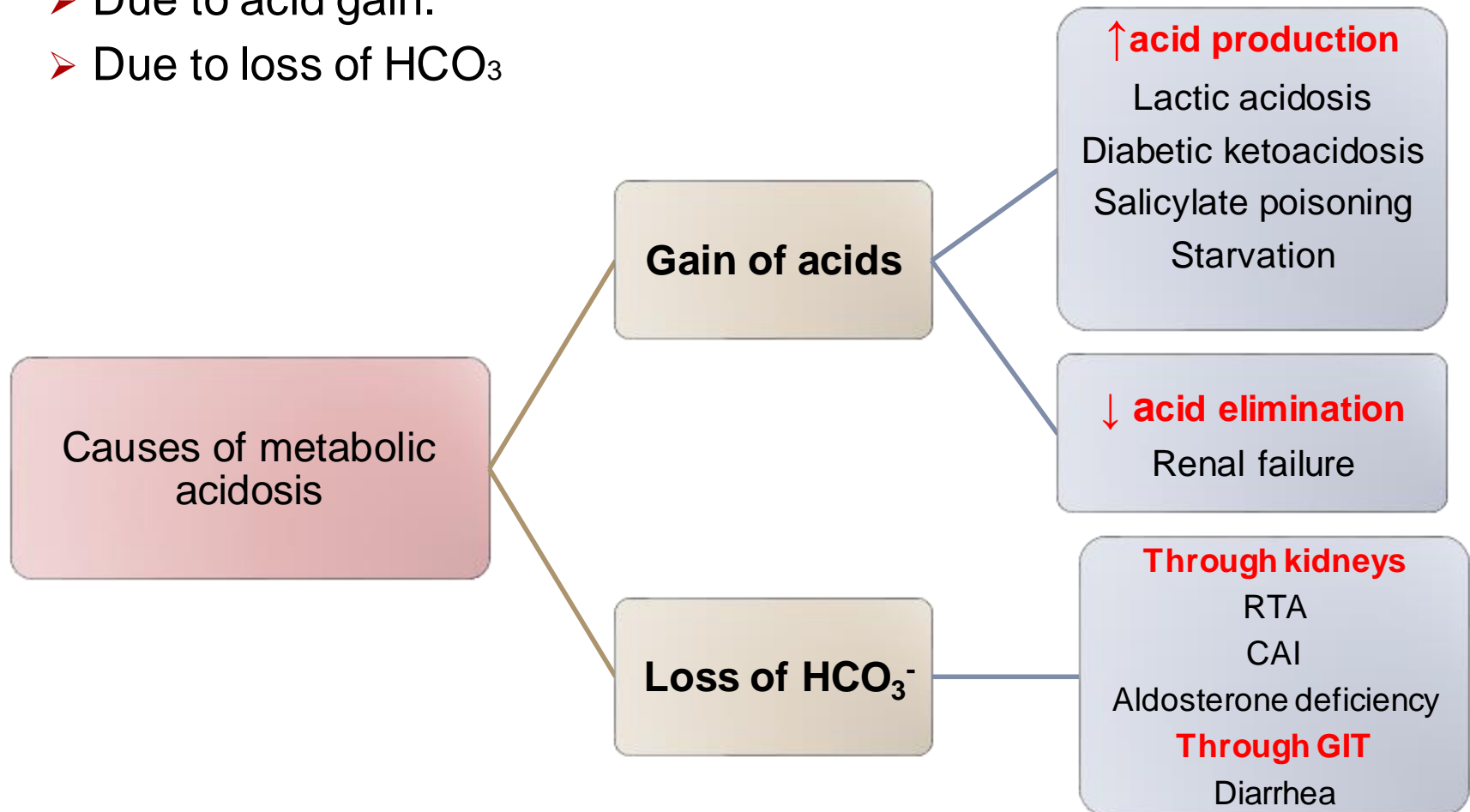
- Metabolic alkalosis = \uparrow pH + \uparrow $[\text{HCO}_3^-]$
 - Due to loss of acids.
 - Due to gain of HCO_3^-



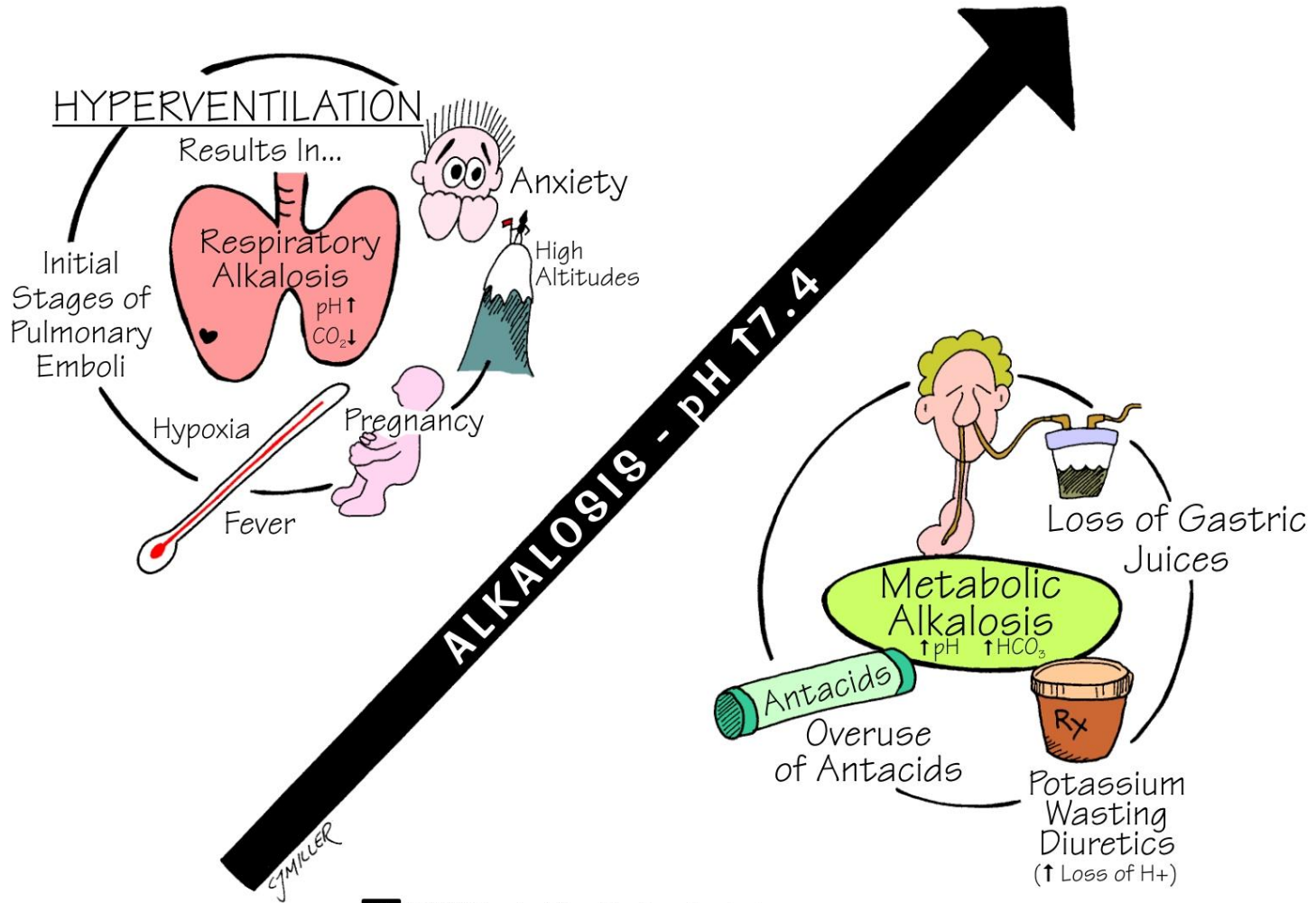
Metabolic Acidosis

Metabolic acidosis = \downarrow pH due to \downarrow $[\text{HCO}_3^-]$

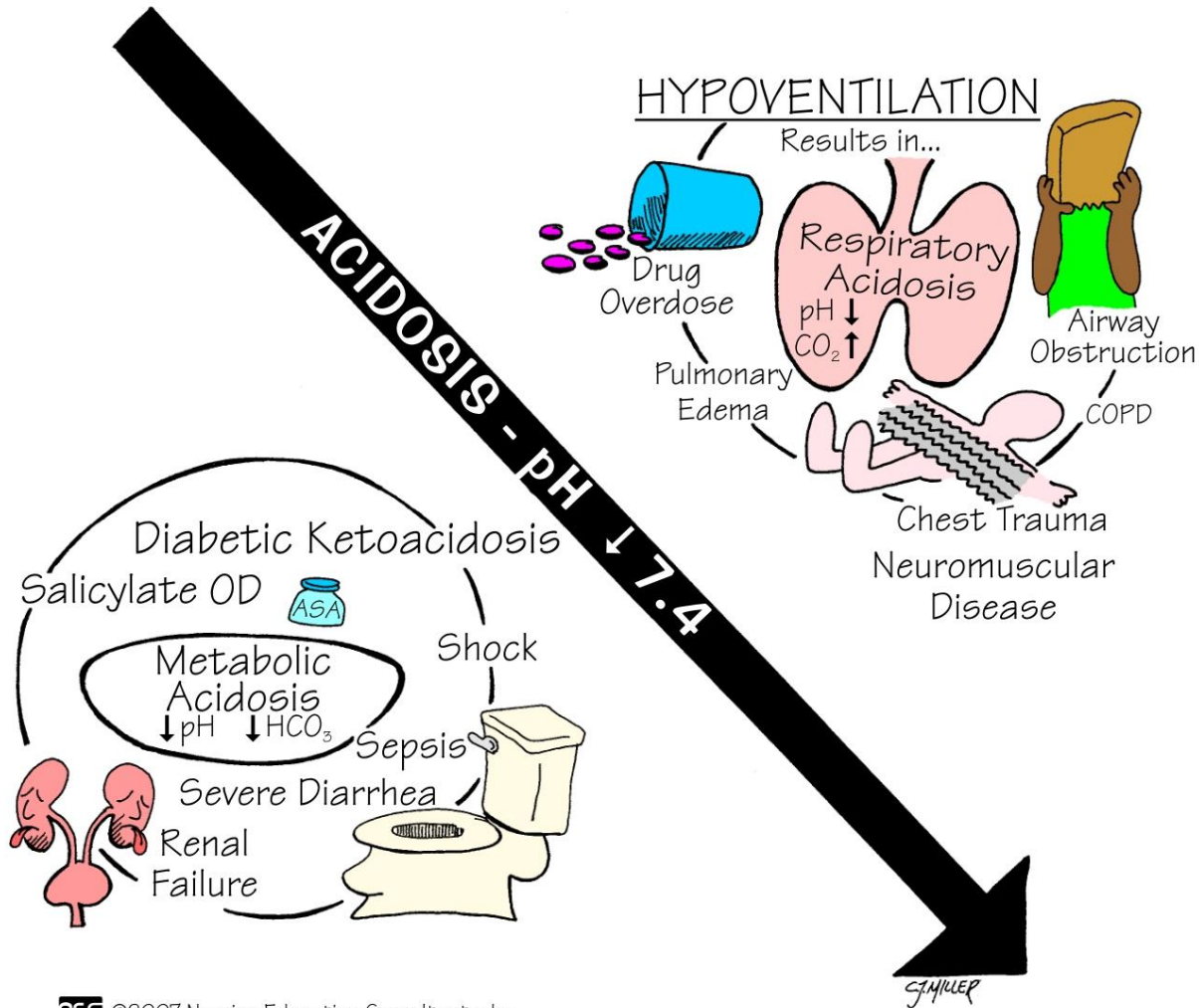
- Due to acid gain.
- Due to loss of HCO_3^-



CAUSES OF ALKALOSIS



CAUSES OF ACIDOSIS



Compensatory Mechanisms

Primary Disturbance	Compensatory Mechanism
Respiratory Acidosis	Increase HCO₃
Respiratory Alkalosis	Decrease HCO₃
Metabolic Acidosis	Decrease PCO₂
Metabolic Alkalosis	Increase PCO₂

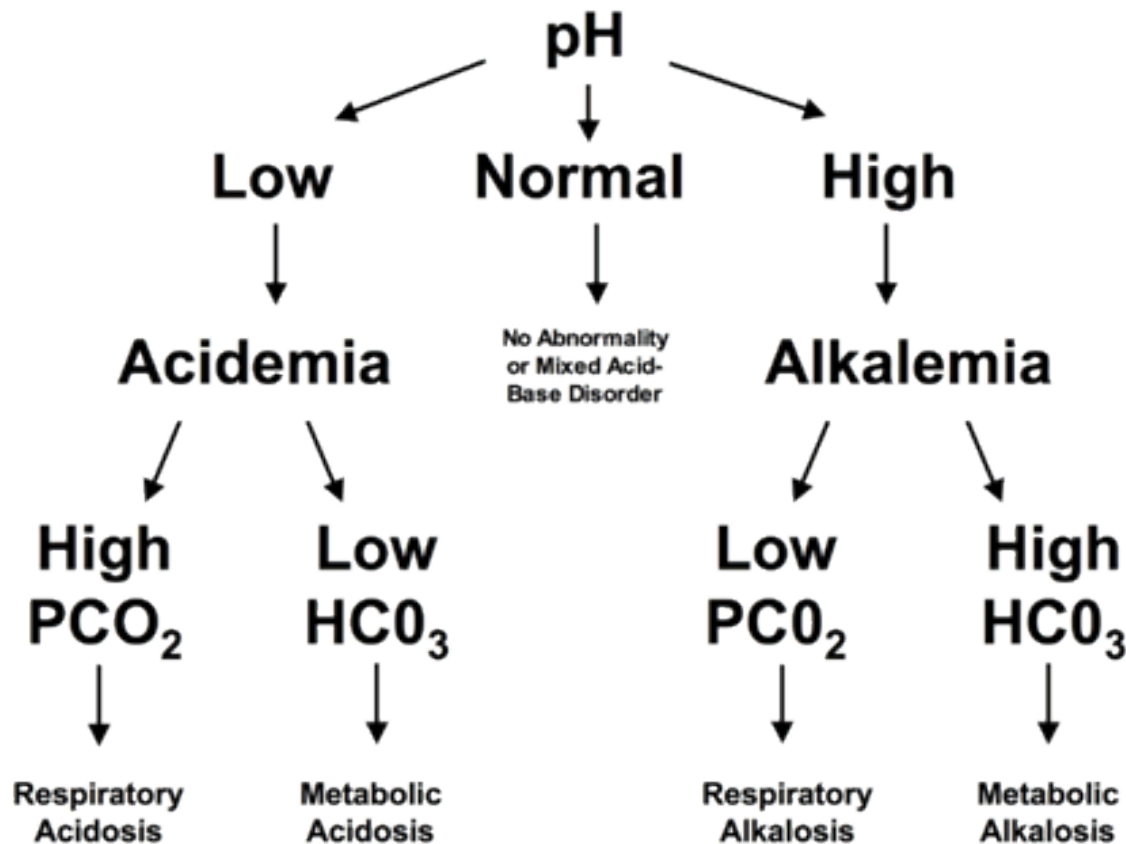
Summary of Primary Acid-Base Disorders

Acid Base Disorders

Disorder	pH	[H ⁺]	Primary disturbance	Secondary response
Metabolic acidosis	↓	↑	↓ [HCO ₃ ⁻]	↓ pCO ₂
Metabolic alkalosis	↑	↓	↑ [HCO ₃ ⁻]	↑ pCO ₂
Respiratory acidosis	↓	↑	↑ pCO ₂	↑ [HCO ₃ ⁻]
Respiratory alkalosis	↑	↓	↓ pCO ₂	↓ [HCO ₃ ⁻]

Interpretation of Acid-Base Disturbances

Figure 1: Identifying the Primary Process



Normal values;
pH = 7.35-7.45
PCO₂ = 35-45 mmHg
HCO₃⁻ = 22-28 mmol/L

Simple Acid-Base Disturbances

	pH	PCO ₂ (mmHg)	HCO ₃ (mEq/L)
Normal	7.35-7.45	35-45	22-28
Respiratory acidosis	Decrease	Increase	Increase
Respiratory alkalosis	Increase	Decrease	Decrease
Metabolic acidosis	Decrease	Decrease	Decrease
Metabolic alkalosis	Increase	Increase	Increase

Case study 1

- A patient known to have COPD presented with 3-day history of fever, SOB, and cough productive of yellowish sputum. His ABGs showed:
 - pH = 7.25
 - PCO₂ = 80 mmHg.
 - [HCO₃⁻] = 34 mEq/L.

Case study 2

- A 21 year old man with IDDM presents to ER with mental status changes, nausea, vomiting, abdominal pain and rapid respirations. His ABGs showed:
 - pH = 7.2
 - PCO₂ = 20 mmHg
 - [HCO₃⁻] = 8 mEq/l

Check this video:

<https://www.youtube.com/watch?v=raEKXVfuWTo>

Case study 3

- A 2-year old child who is lethargic and dehydrated has a 3-day history of vomiting. His ABGs showed:
 - pH = 7.56
 - PCO₂ = 44 mmHg
 - [HCO₃⁻] = 37 mEq/l

Case study 4

- A 20-year old student suffered a panic attack while awaiting an exam. Her ABGs showed:
 - pH = 7.6
 - $\text{PCO}_2 = 24$ mmHg.
 - $[\text{HCO}_3^-] = 23$ mEq/L.

Other Acid-Base Disorders

Simple acid-base disorders

- Result from a ***single primary*** abnormality **with appropriate** physiologic compensation.

Mixed acid-base disorders

- Result from ***multiple primary*** processes.

Mixed Acid-Base Disturbances

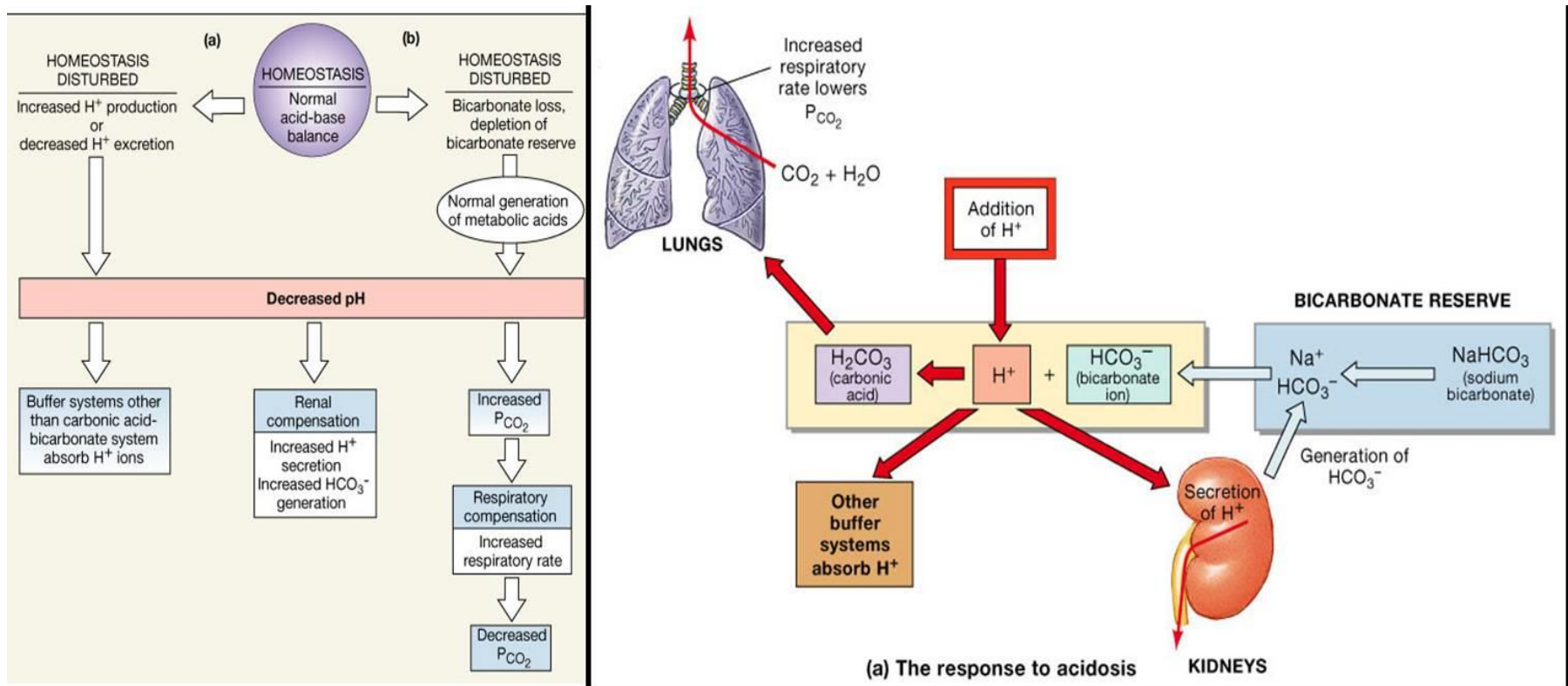
- Occurs when a patient has more than one primary acid base disorder that occur at the same time.
- Examples:
 - ✓ Respiratory alkalosis/acidosis along with a metabolic acidosis/alkalosis.
 - ✓ Two metabolic acid-base disorders occurring simultaneously.

Case study 5

- A 69 year old patient known to have COPD presented with a 3-day history of abdominal pain and diarrhea. His ABGs showed;
 - pH = 6.96
 - PCO₂ = 55mmHg
 - [HCO₃⁻] = 12 mmol/L

THANK YOU

Body's Response to Acidosis



Body's Response to Alkalosis

