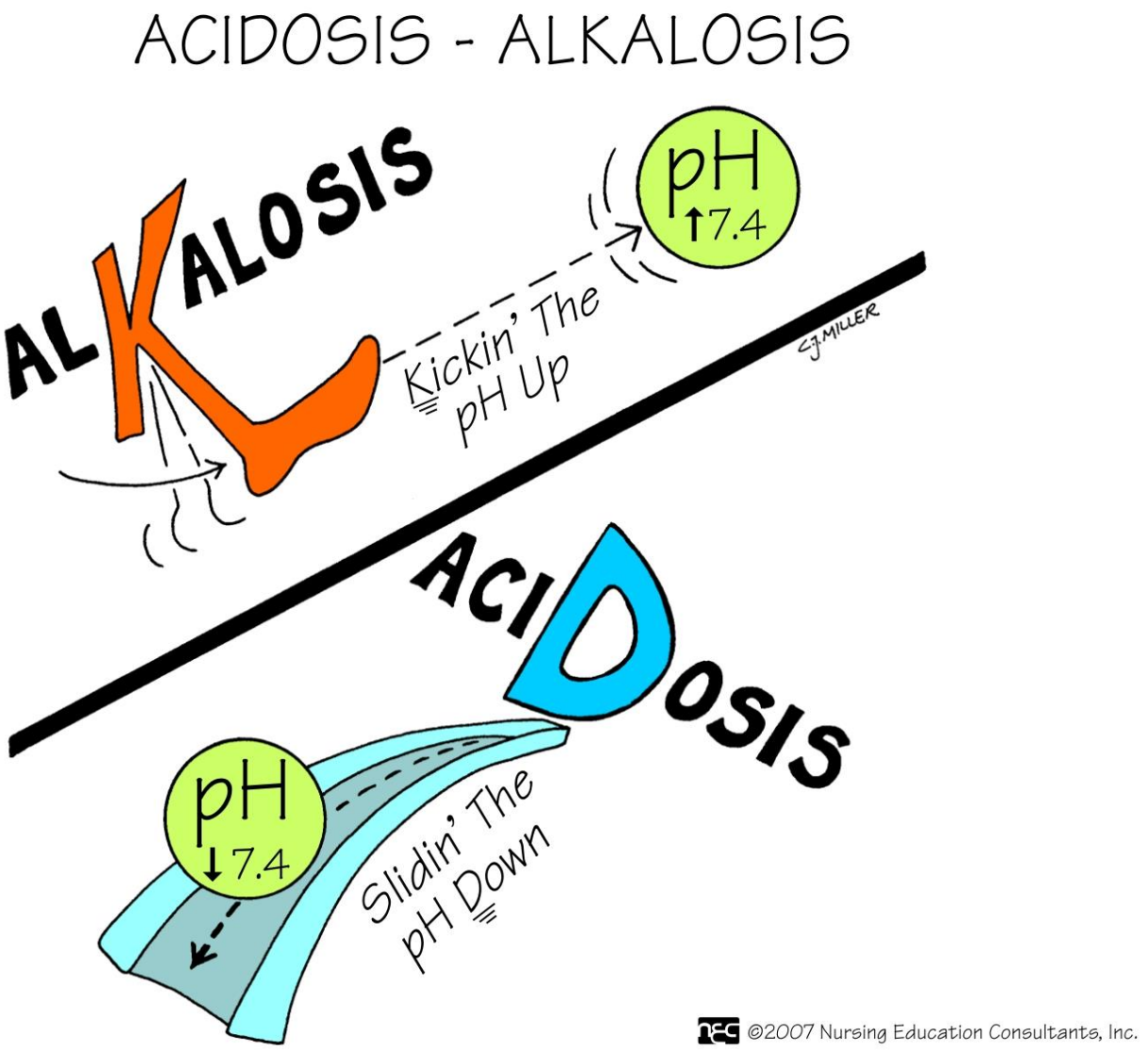
ABNORMALITIES IN ACID-BASE BALANCE

Abnormalities in Acid-Base Balance

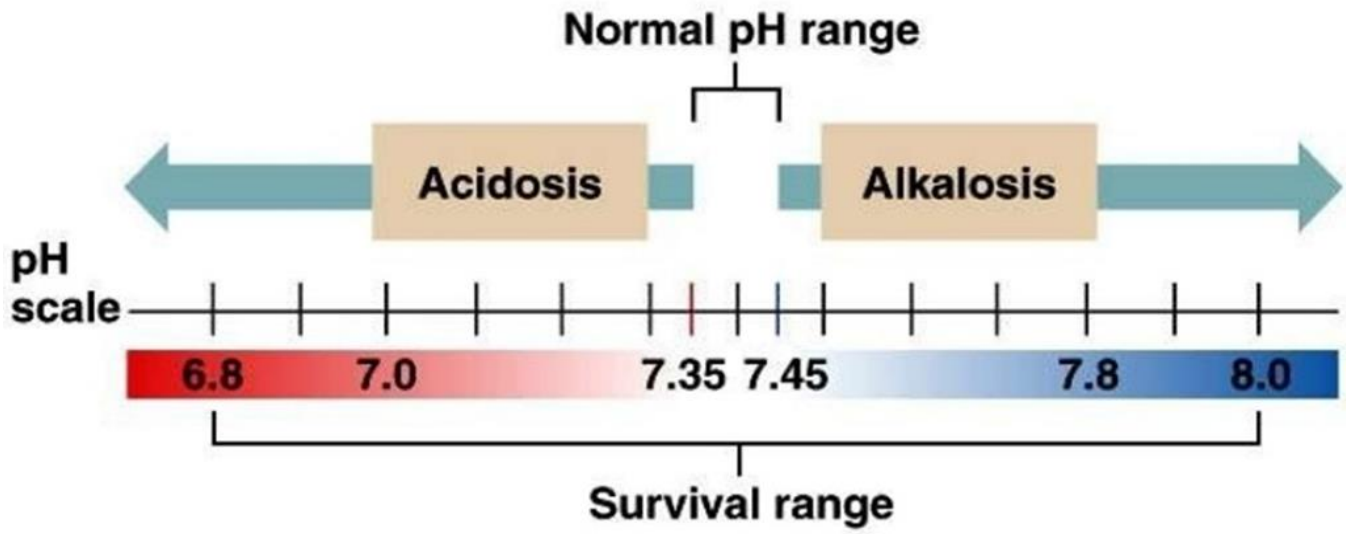
- Many critical illnesses can disturb acid-base balance.
- Acid-base disturbances may indicate an underlying disease or organ damage.
- Accurate interpretation of acid-base disturbances requires the following:
  - ✓ Arterial blood gases.
  - ✓ Plasma electrolytes.
  - ✓ Knowledge of the compensatory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

(Appel & Downs. 2008. Understanding acid-base balance)

Abnormalities in Acid-Base Balance



Abnormalities in Acid-Base Balance



Acidosis

Alkalosis

$\frac{HCO3-}{PCO2}$

↑↑ PCO_2

↓↓ HCO_3^-

↓↓ PCO_2

↑↑ HCO_3^-

Respiratory

Metabolic

Respiratory

Metabolic

Fundamentals in Acid-Base Disorders

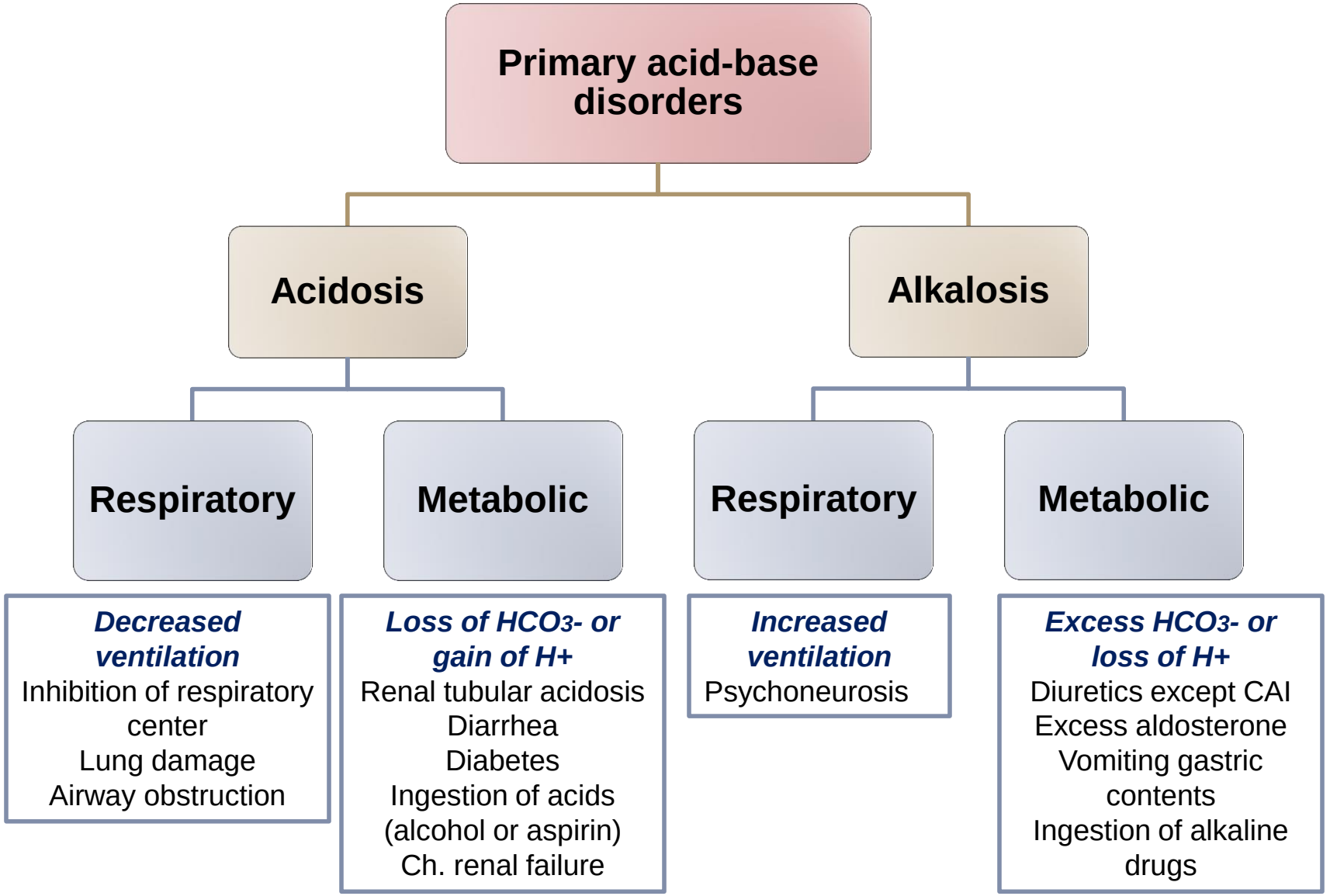
- Acid-base disorders are classified by changes in pH, PCO_2 and HCO_3^-

- **There are 4 *primary* acid-base disorders:**
  - **Respiratory acidosis**: ↑ PCO_2
  - **Respiratory alkalosis**: ↓ PCO_2
  - **Metabolic acidosis**: ↓ [HCO_3^-]
  - **Metabolic alkalosis**: ↑ [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*.**

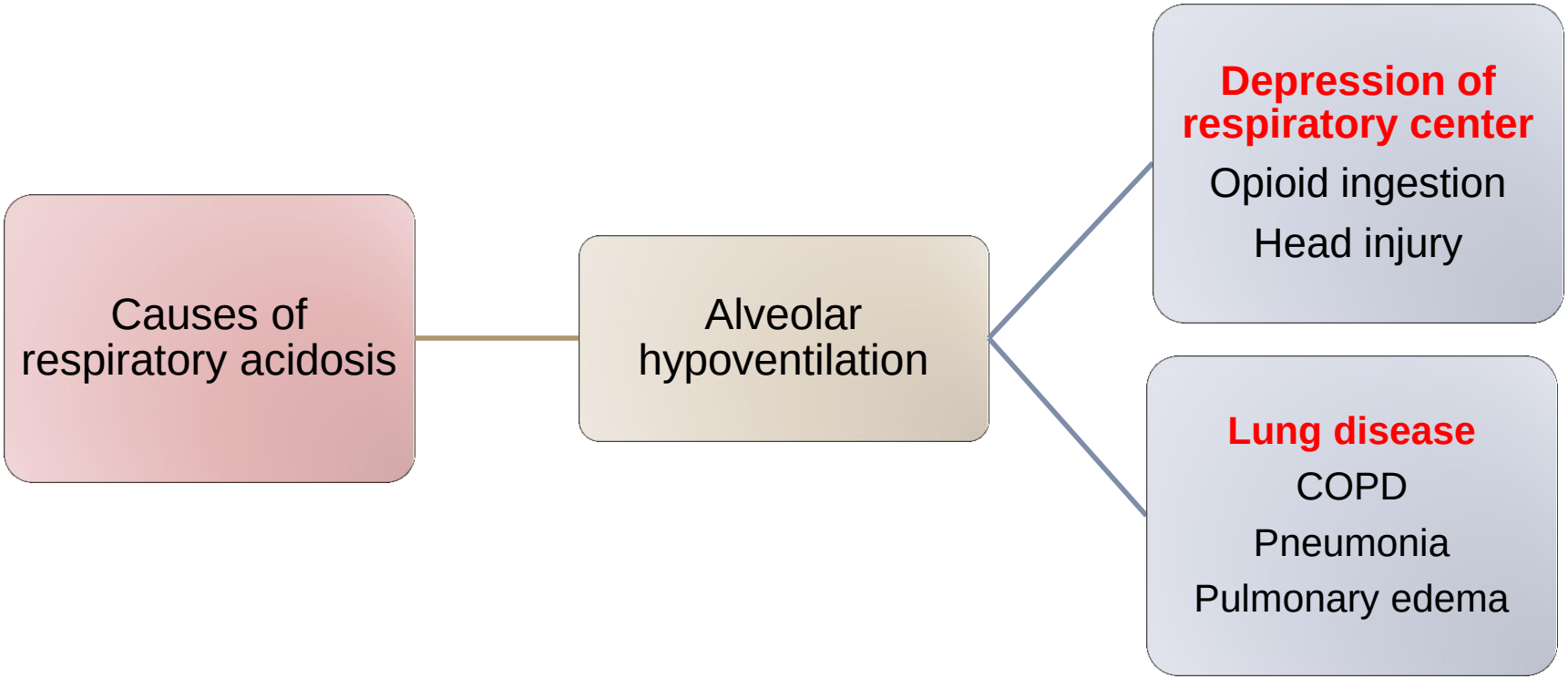
(Dooley & Sisson. Acid-base disorders)

Primary Acid-Base Disturbances



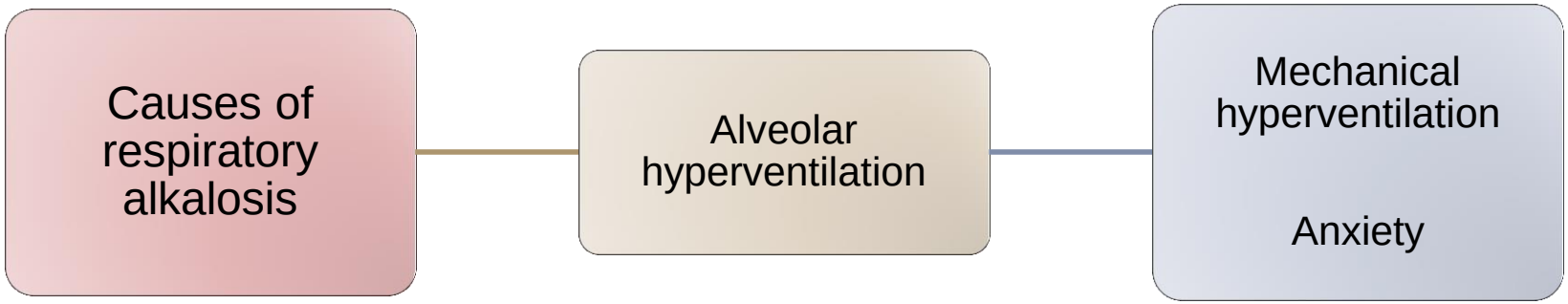
Respiratory Acidosis

- Respiratory acidosis = ↓ pH + ↑ PCO2
  - Due to alveolar hypoventilation.



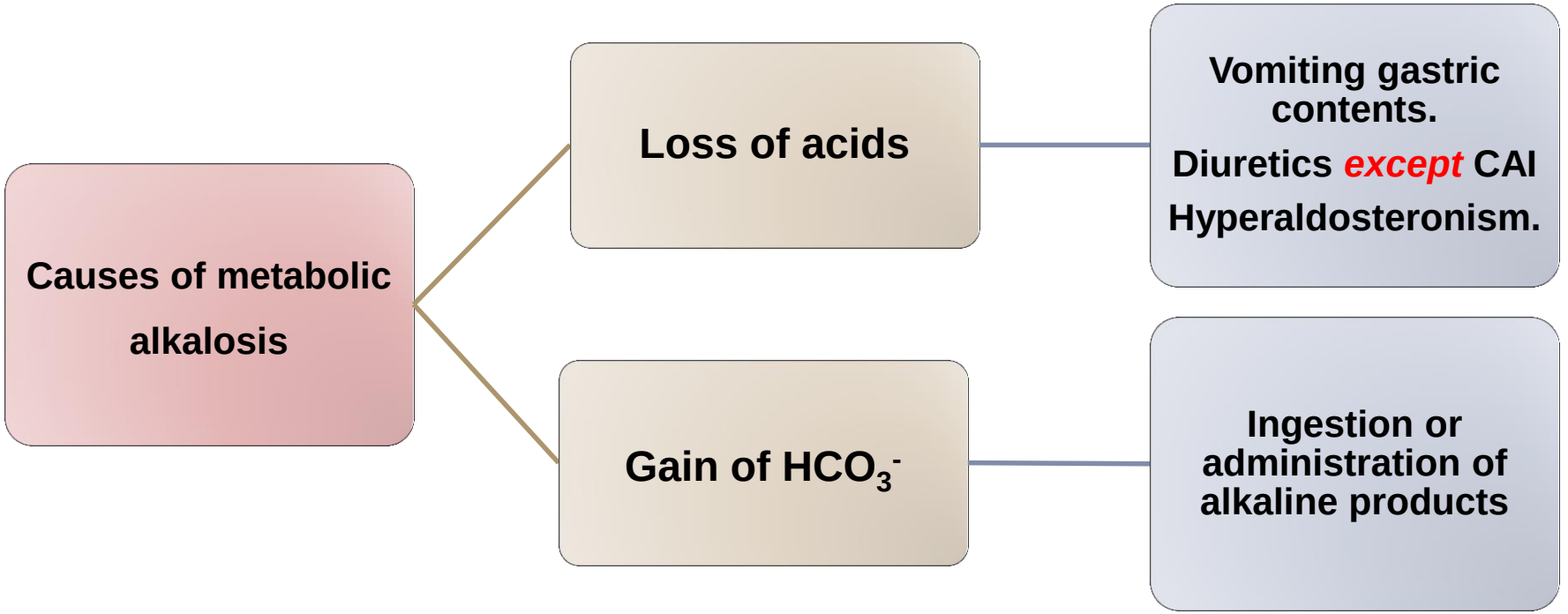
Respiratory Alkalosis

- Respiratory alkalosis = ↑ pH + ↓ PCO2
  - Due to alveolar hyperventilation.



Metabolic Alkalosis

- Metabolic alkalosis = ↑ pH +↑ [HCO_3^-]
  - Due to loss of acids.
  - Due to gain of HCO_3^-

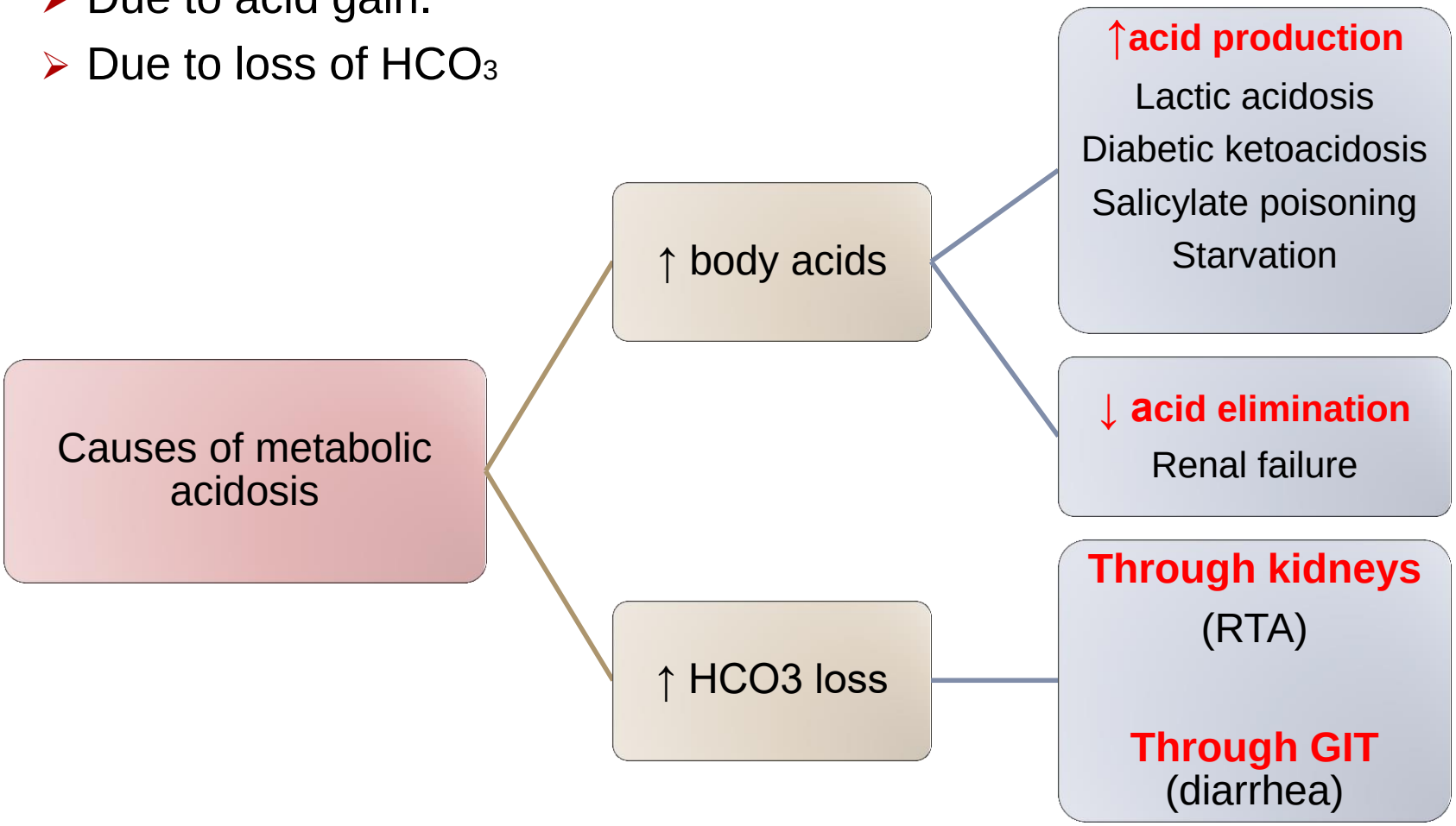


(Appel & Downs. 2008. Understanding acid-base balance; Dooley & Sisson. Acid-base disorders)

Metabolic Acidosis

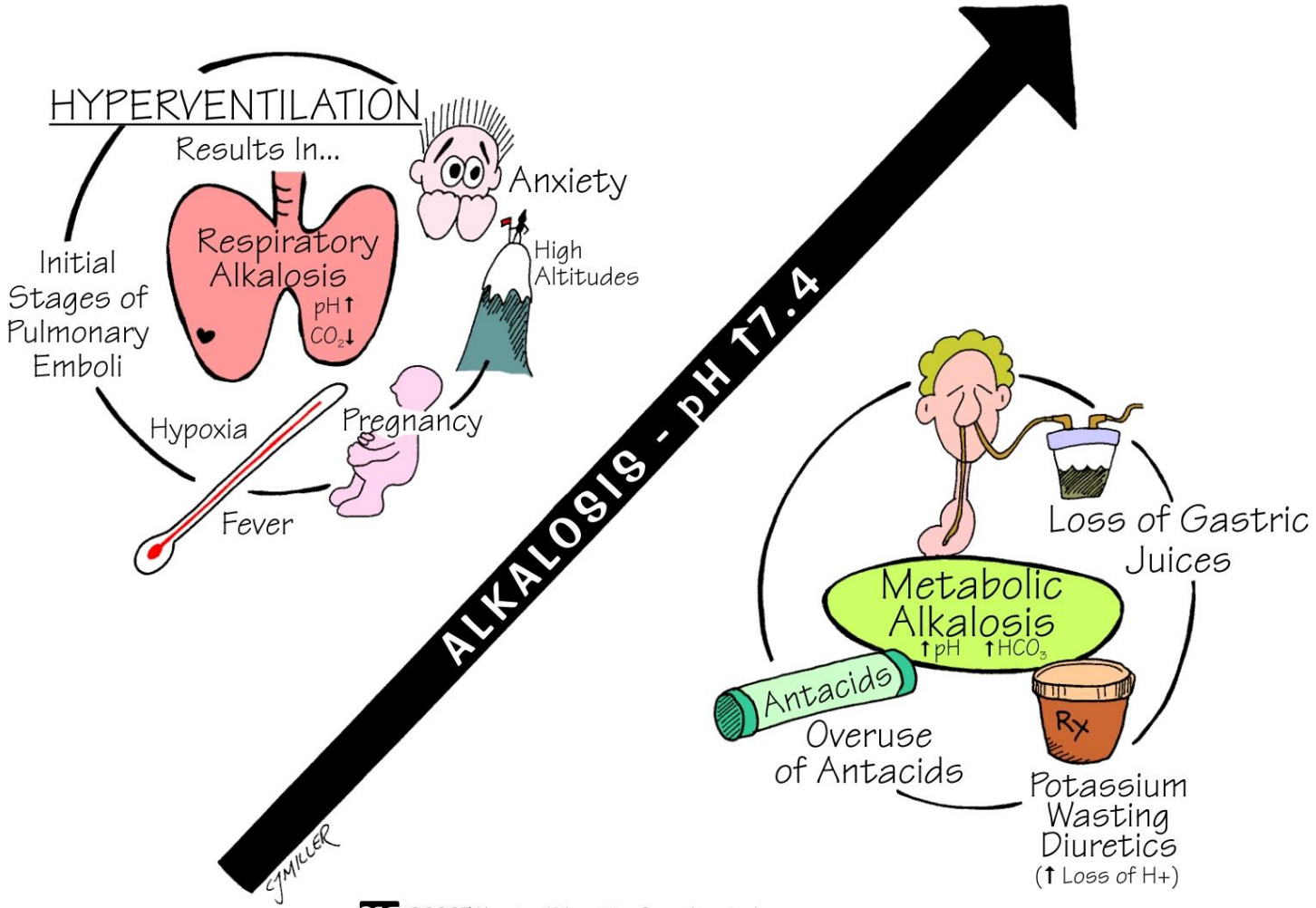
Metabolic acidosis = ↓pH due to ↓ [HCO_3^-]

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

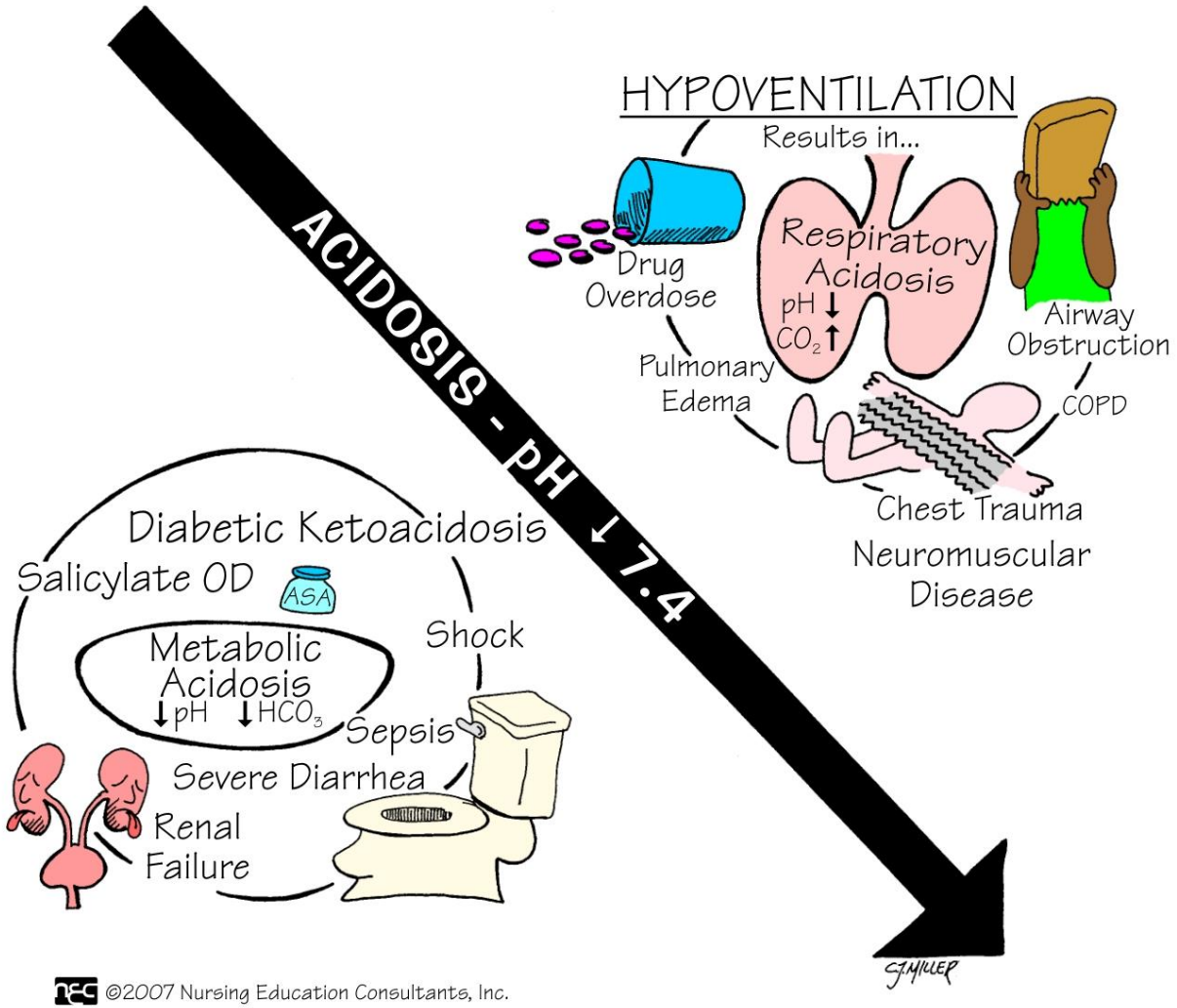


(Appel & Downs. 2008. Understanding acid-base balance; Dooley & Sisson. Acid-base disorders)

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

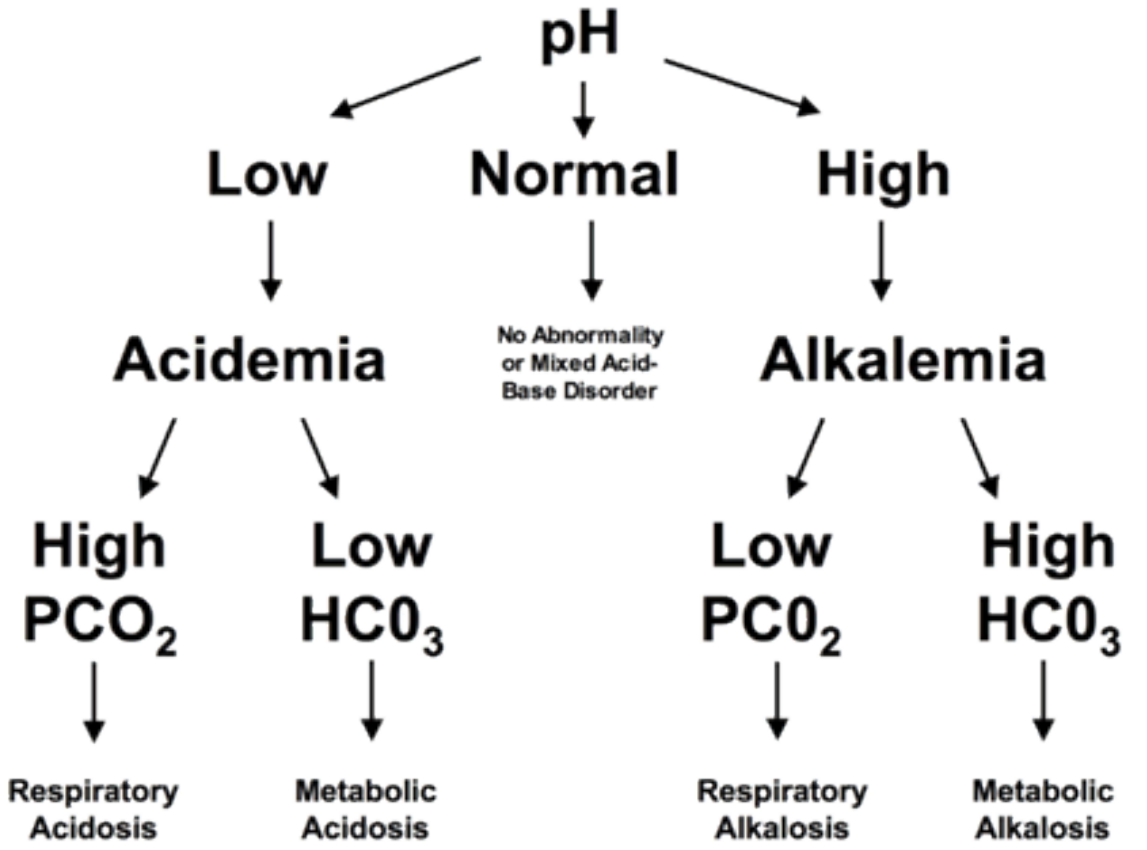
Summary of Primary Acid-Base Disorders

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	PCO2 (mmHg)	HCO3 (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

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
  - PCO2 = 24 mmHg.
  - HCO3 = 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

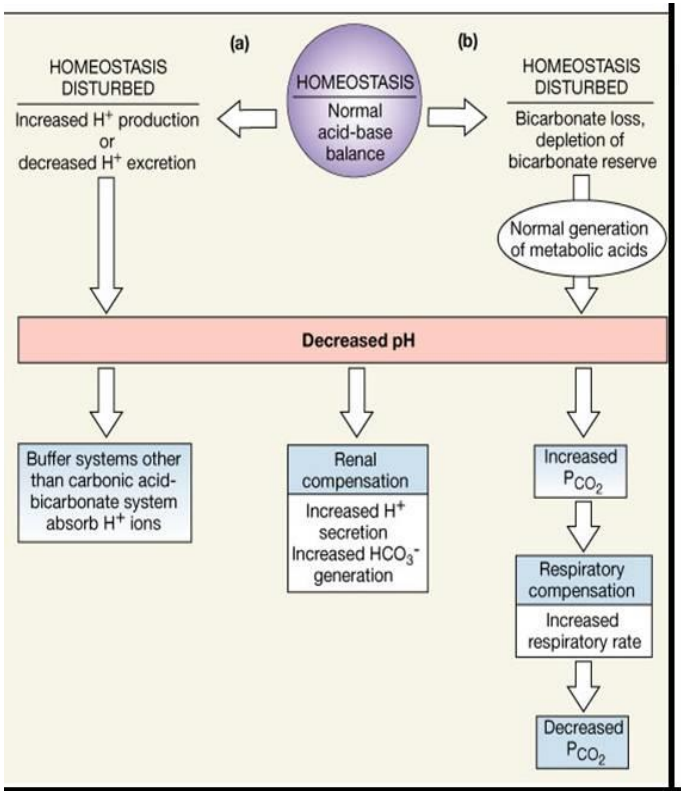
- A 69 year old patient had a cardiac arrest soon after return to the ward following an operation. Resuscitation was commenced and included intubation and ventilation. Femoral arterial blood gases were collected about five minutes after the arrest. Other results: Anion gap 24, Lactate 12 mmol/l.

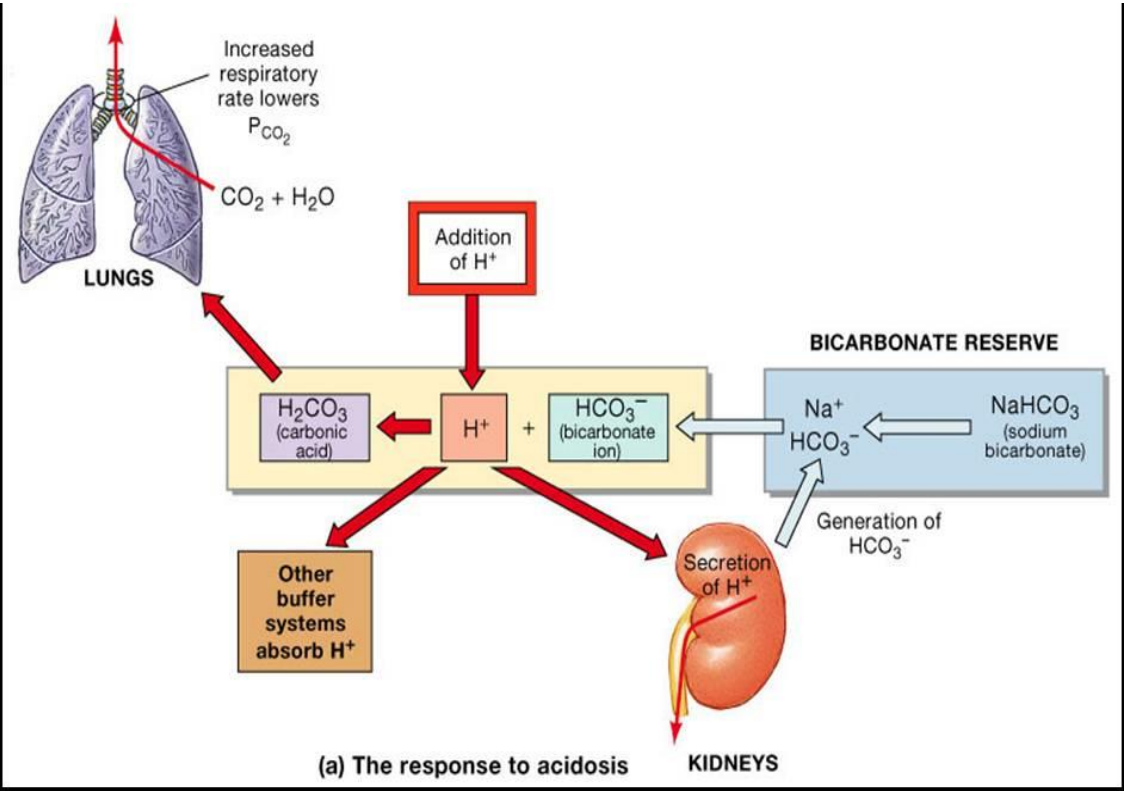
- Arterial Blood Gases
  - pH 6.85
  - pCO2 82 mmHg
  - HCO3 14 mmol/l

(http://www.anaesthesiamcq.com/AcidBaseBook/AB9_6Case9.php)

THANK YOU

Body's Response to Acidosis





Body's Response to Alkalosis