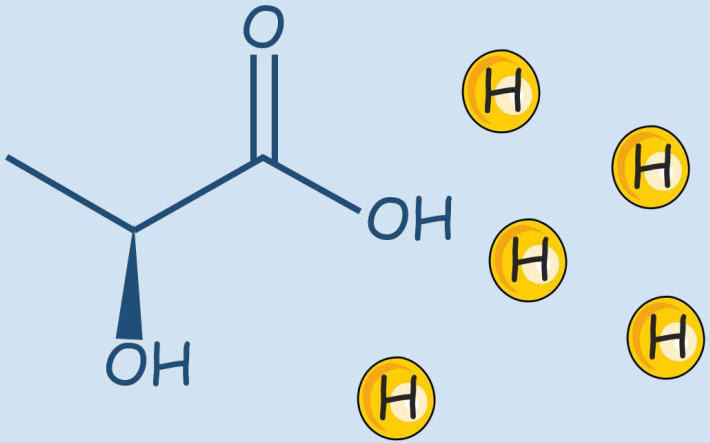
Revised & Reviewed by Abdulaziz & Bahammam Faye Wael Sendi

MED441
KING SAUD UNIVERSITY

1

Cardiovascular Block - KSU

Lactic Acidosis



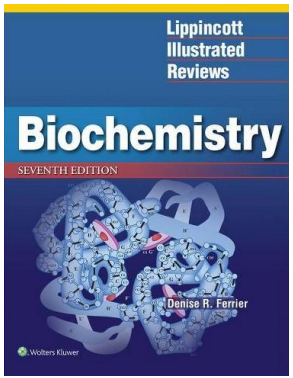
Main text
Important
Notes
Extra

Editing File

We recommend that to watch this video below to get general idea about this lecture & we suggest this book for you if you want more details

Acidosis and Alkalosis MADE EASY

BY Dr Matt & Dr Mike



Biochemistry Lippincott Illustrated Reviews 7th Edition

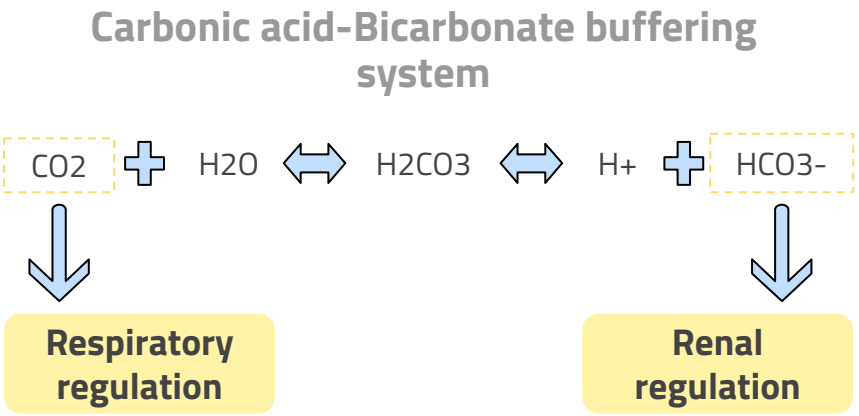
BY Denise R. Ferrier

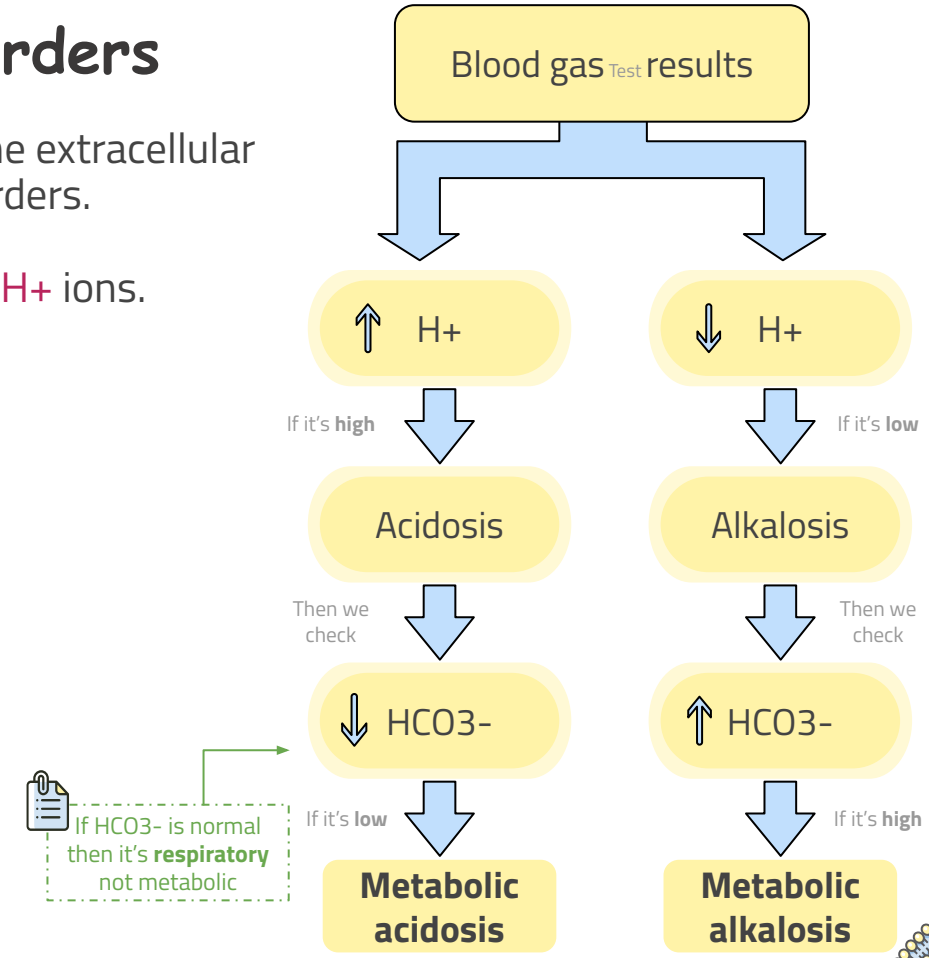
Objectives

- Define metabolic acid-base disorders including lactic acidosis.
- Understand the causes and clinical effects of metabolic acidosis and alkalosis.
- Recall the lactate metabolism in the body.
- Differentiate between the types of lactic acidosis.
- Understand the clinical significance of measuring anion gap.
- Discuss the causes and diagnosis of lactic acidosis in conditions such as myocardial infarction.

Metabolic acid-base disorders

- Changes in bicarbonate concentration in the extracellular fluid (ECF) cause metabolic acid-base disorders.
- Occur due to **high** concentration or **loss** of H+ ions.
- Can lead to:
  - Metabolic acidosis.
  - Metabolic alkalosis.



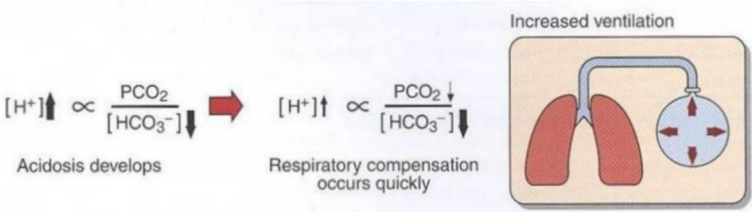


Metabolic acidosis

Reduction in bicarbonate concentration of ECF.

Causes:

- Increased production of H+ ions.
- Ingestion of H+ or drugs metabolized to acids.
- Impaired excretion of H+ By kidney
- Loss of HCO_3^- E.g chronic diarrhea

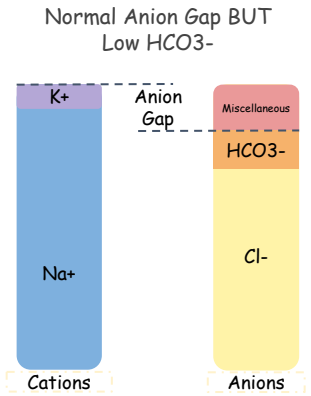


Anion gap

- It is the difference between:
  - The sum of **Na+** and **K+** (cations).
  - The sum of **Cl–** and **HCO3–** (anions).
- Helps in assessing acid-base problems.

Normal anion gap	3-11 mEq/L
High anion gap	>11 mEq/L (acidosis)
Low anion gap	<3 mEq/L (alkalosis)

Metabolic acidosis can also occur in normal anion gap in (Chronic Diarrhea) because you will loss HCO3- and the Cl- will be high due to compensation of HCO3-

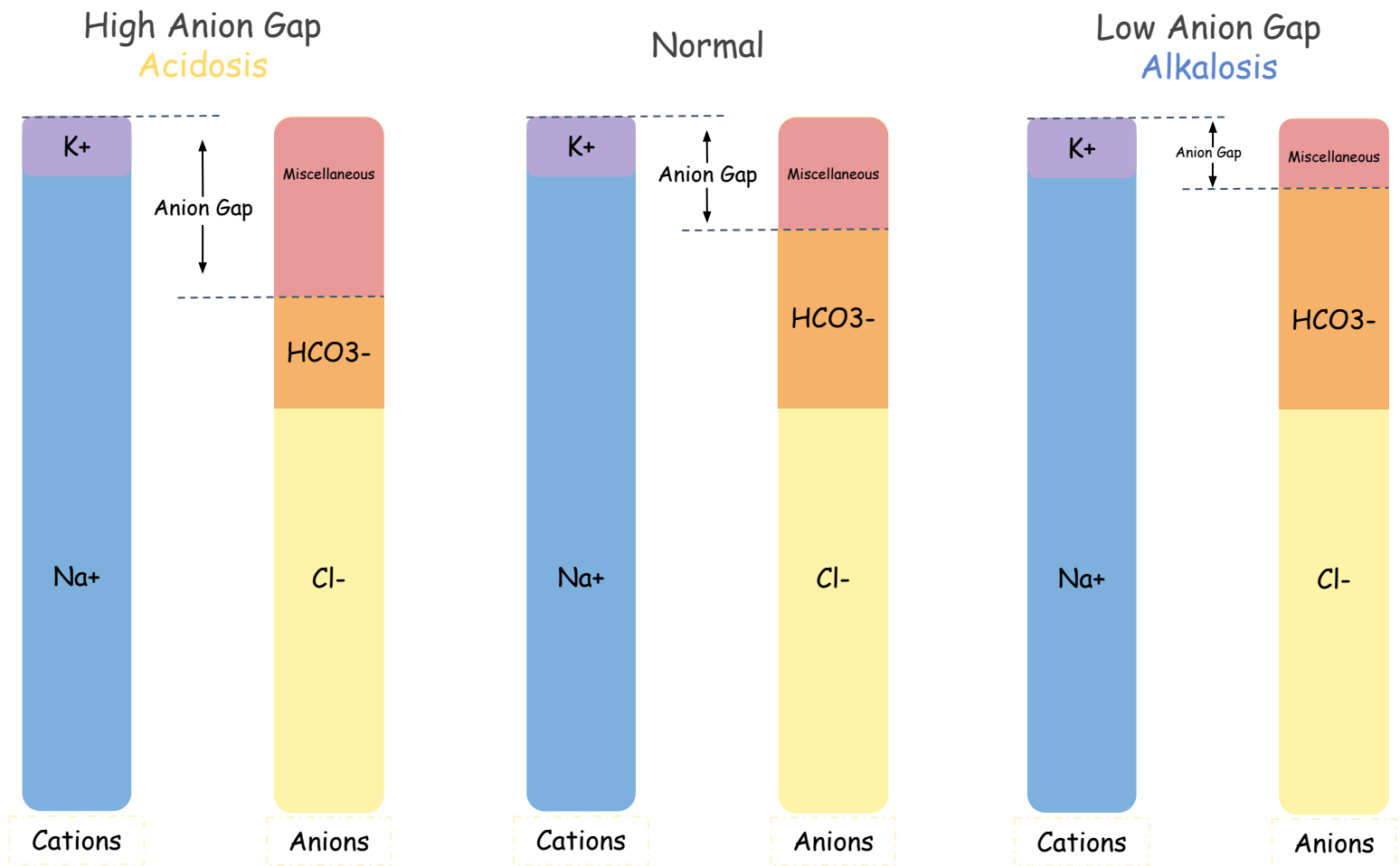


High anion gap occurs in:

- Renal disease.
- Diabetic ketoacidosis.
- Lactic acidosis. (most common cause of metabolic acidosis)
- Poisoning.

Anion gap

Extra slide for illustration



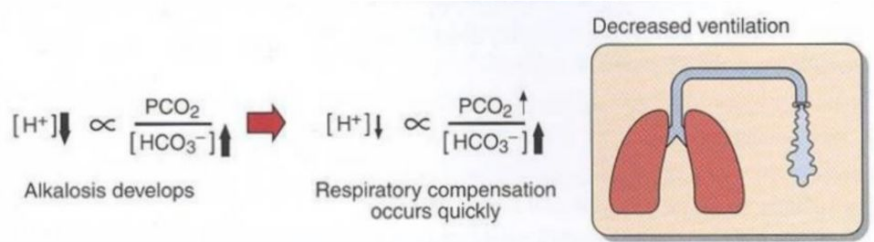
Metabolic alkalosis

Increase in bicarbonate concentration in ECF.

Causes:

- Loss of H+ ions in gastric fluid due to vomiting.
- Ingestion of sodium bicarbonate.
- Potassium deficiency as a result of diuretic therapy.

In hypokalemia cells will take H+ from ECF to inside the cell to become neutralied because K+ & H+ have the same charge thus alkalosis



Clinical effects

6.9		7.35	7.45		8
Death	**Acidosis**		**Normal PH**	**Alkalosis**	**Death**

- Hyperventilation: deep, rapid, and gasping respiratory pattern (Kussmaul breathing).
- Increased H+ conc. stimulates respiratory response.
- Increase in neuromuscular irritability.
- Arrhythmia, cardiac arrest.
- Loss of consciousness, coma, death.

← The compensatory physiological response →

- Hypoventilation (depressed breathing) : Increases PCO2 to compensate alkalosis.
- Respiratory arrest. (If it continues)
- Confusion, coma, death.

Lactic acidosis

- Elevated concentration of plasma lactate is called lactic acidosis.

- Occurs either due to:
  - Failure of circulatory system (hypoxia) Type A.
  - Disorders of carbohydrate metabolism Type B.

    E.g. pyruvate dehydrogenase deficiency.

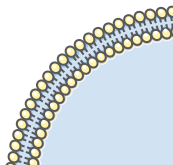
Any cause of acidosis NOT from O2 reduction it will be consider as type B

Mechanisms involved in lactic acidosis:

- Lactic acidosis can occur due to:
  - Excessive tissue lactate production.
  - Impaired hepatic metabolism of lactate.

Types and Causes of Lactic Acidosis

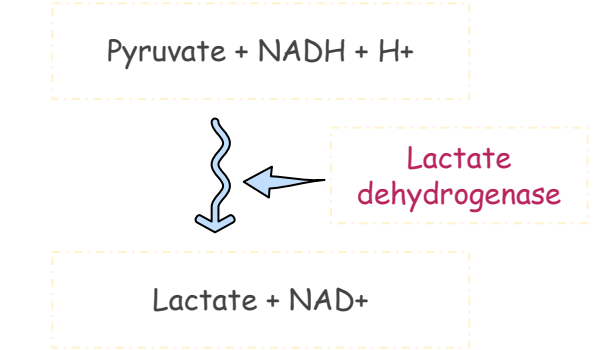
	Type A	Type B
Due to:	Inadequate supply of oxygen (hypoxia) to tissues (most common) in : • Myocardial infarction. • Pulmonary embolism. • Uncontrolled hemorrhage. (bleeding) • Tissue hypoperfusion (shock, cardiac arrest, acute heart failure, etc.). • Anaerobic muscular strong exercise.	Disorders in carbohydrate metabolism. - Congenital lactic acidosis is due to deficiency of pyruvate dehydrogenase enzyme • Chronic hepatic disease accompanied by shock or bleeding. • Liver failure. • Drug intoxication. (poisoning)
Hypoxia causes:	Impaired oxidative phosphorylation and decreased ATP synthesis.	
To survive:	The cells switch to anaerobic glycolysis for ATP synthesis This produces lactate as a final product.	
Adaptive response:	The amount of oxygen required to recover from oxygen deficiency is called oxygen debt. (definition)	



Lactic metabolism in tissue

All organs **produce** lactate but during exercise MAINLY muscles

- The body tissues produce ~ 1500 mmoles of lactate each day.
- The lactate enters blood stream and metabolized mainly by the liver (Cori cycle).
- All tissues can produce lactate under **anaerobic** conditions.
- **Pyruvate** is converted to **lactate** by lactate dehydrogenase enzyme.
- The skeletal muscles produce high amounts of lactate during vigorous(strong) exercise.
- Lactate is metabolized in **liver** (60%) and **kidney** (30%) to glucose.
- Some lactate is metabolized to **CO2** and **water** (Krebs cycle).

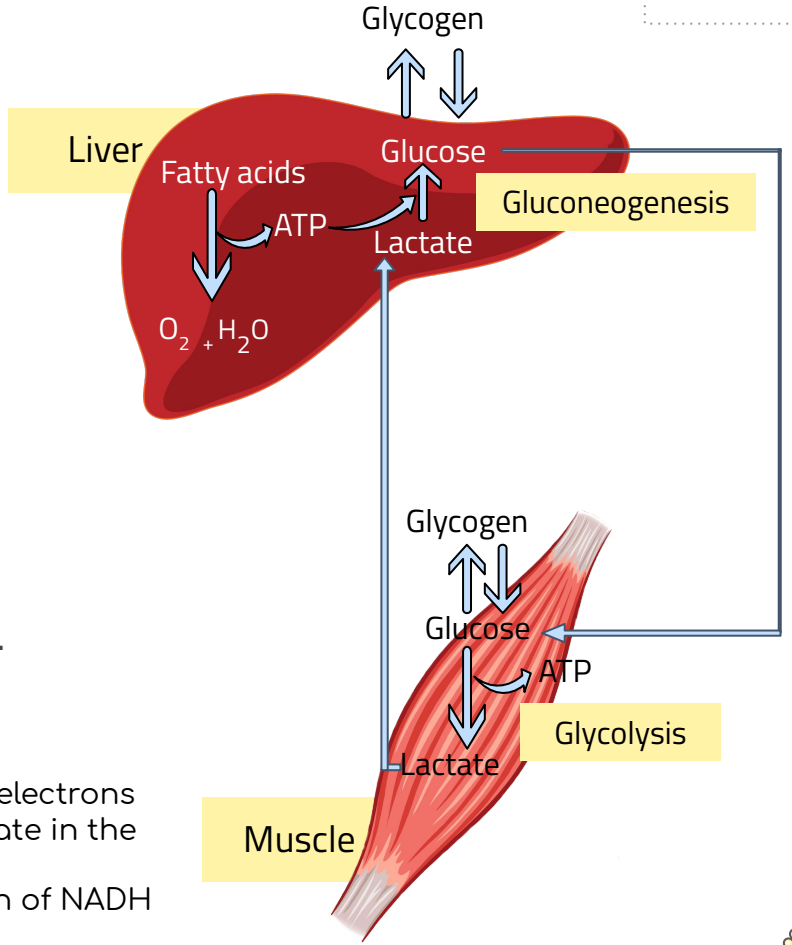


Extra slide

The Cori Cycle

- In anaerobic glycolysis

1. **In the muscle:**
   Glucose is converted into lactate by anaerobic glycolysis.
2. Lactate is released into the blood and is transported to the liver.
3. **In the liver:**
   Lactate → glucose (gluconeogenesis).
4. Glucose is transported to the muscles (for energy again).



⟹ In anaerobic metabolism there's no oxygen to accept the electrons from NADH and reoxidizing it to NAD+. So, NADH will accumulate in the cell. The reduction of pyruvate into lactate is mediated by the conversion of NADH → NAD+ and thus it prevent accumulation of NADH which is a serious problem . (439 note)

Diagnosis

- Diagnosis done by measuring blood lactate levels:
  - Hyperlactemia: 2-5 mmoles/L
  - Severe lactic acidosis: > 5 mmols/L

In hyperlactemia there will not be any lactic acidosis unless if there was a change in PH

Treatment

- Correcting the underlying conditions.
- Restoring adequate tissue oxygen.(why?)[1]
- Avoiding sodium bicarbonate. (why?)[2]

- [1] Because most of the time the cause of lactic acidosis is **hypoxia**.
- [2] In acidosis in general it's known that adding sodium bicarbonate will help to get PH back to its normal range but in lactic acidosis for unknown reasons it will make it worse by increasing lactic acidosis

Take Home Messages

- Lactic acidosis can be caused by hypoxia, excessive production and impaired clearance of lactic acid

- It carries clinical significance in the diagnosis of myocardial infarction, pulmonary embolism and other metabolic conditions

Summary

Click HERE

Or

Scan the code for the amazing summary

Quiz

Q1: Which one is seen in metabolic acidosis with normal anion gap?
A/ Chronic diarrhea
B/ Diabetic ketoacidosis
C/ Lactic acidosis
D/ Poisoning

Q2:hypoventilation is a clinical effect of?
A/ Acidosis
B/ Alkalosis
C/ Both
D/ None

Q3: Which one is a cause of alkalosis ?
A/ Ingestion of H+
B/ Impaired excretion of H+
C/ K+ deficiency
D/ Increased production of H+

Q4: The lactate is going to be metabolised MAINLY in which organ in the body?
A/ Heart
B/ Skeletal Muscle
C/ Liver
D/ Kidney

Q5: Congenital lactic acidosis happens due to deficiency in which enzyme?
A/ Lactate hydrogenase
B/ Lactate dehydrogenase
C/ Pyruvate dehydrogenase
D/ Pyruvate hydrogenase

Q6: The amount of oxygen required to recover from oxygen deficiency is called?
A/ Lactate
B/ Anion gap
C/ Oxygen peroxide
D/ Oxygen debt

Q1: Define metabolic acidosis and give 3 examples of causes?
Slide 5

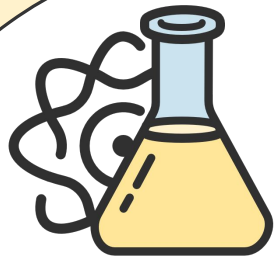
Q2: Define lactic acidosis and give 2 examples of causes ?
Slide 10

Q3: Give 3 examples of metabolic acidosis with high anion gap ?
Slide 6

Click HERE for more questions Done by Qbank team!

1)A 2)B 3)C 4)C 5)C 6)D

✦ Special Thanks to Khalid Alhamdi for his efforts



Biochemistry 441

Girls

Leader: Wareef Almousa

Fay Alluhaidan
Manal Aldhirgham
Fatimah Albenmousa
Haya Alshaloob
Maram Alenzi
Futoon Almotairi

Organizer: Aisha Alhamed

Boys

Leader: Abdulrahman Alroqi

Sub-leader: Hamad Aljubayr

Anas Alharbi
Rayan Alahmari
Mohammed Aloufi
Faisal Alazmi
Abdulrahman Badghaish
Ali Almatri

Reviser: Mohannad Mallat
Organizer: Abdullah Alqarni

Special Thanks to Arwa Almobeirek for the Great Theme!

Biochemistry441@gmail.com