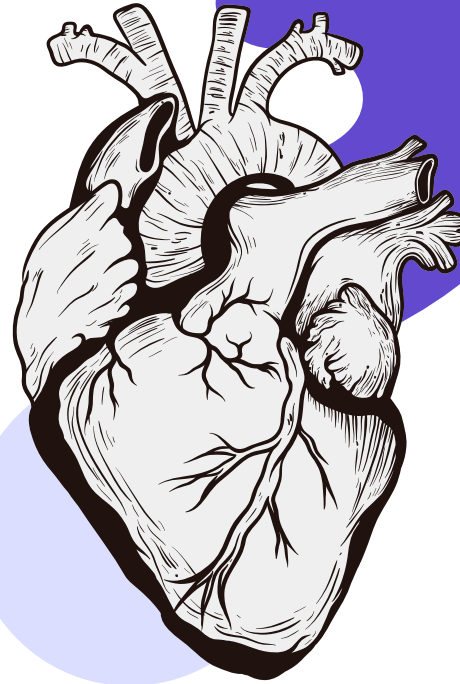




Lactic acidosis



Editing File

COLOR INDEX:

MAIN TEXT (BLACK)

FEMALE SLIDES (PINK)

MALE SLIDES (BLUE)

IMPORTANT (RED)

DR'S NOTE (GREEN)

EXTRA INFO (GREY)

Objective

01

Define metabolic acid-base disorders including lactic acidosis.

02

Understand the causes and clinical effects of metabolic acidosis and alkalosis.

03

Recall the lactate metabolism in the body.

04

Differentiate between the types of lactic acidosis.

05

Understand the clinical significance of measuring anion gap.

06

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.

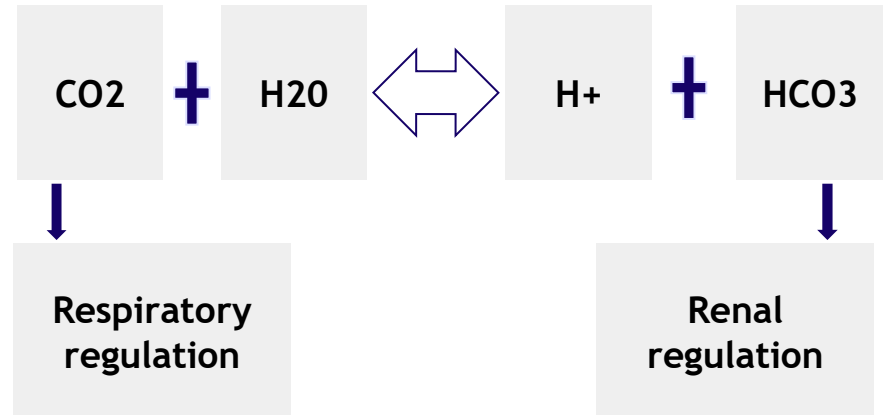
Occur due to high concentration or loss of H⁺ ions.
Metabolic acid-base disorders

Can lead to:

- Metabolic acidosis.
- Metabolic alkalosis.

In both, the function of the body will be affected because of the change in PH

Carbonic acid-Bicarbonate buffering system



Blood Gas results

It is a test that help us to know if it is metabolic acidosis or alkalosis by inspecting the HCO_3 concentration

Acidosis

H^+ elevated

HCO_3 decreased

Metabolic acidosis

Alkalosis

H^+ decreased

HCO_3 increased

Metabolic alkalosis

- Impaired H^+ excretion
- Increased H^+ production or ingestion
- Loss of HCO_3

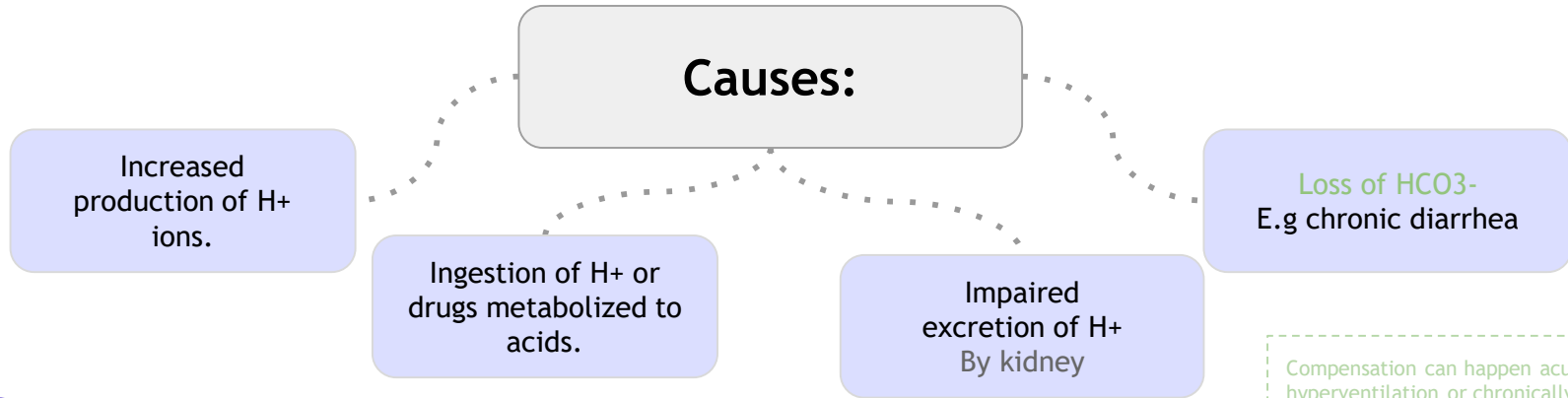
Reasons for metabolic
Acidosis

Reasons for metabolic
Alkalosis

- Loss of H^+ in vomit
- Alkali ingestion
- K^+ deficiency

Metabolic acidosis

Reduction in bicarbonate concentration of ECF.

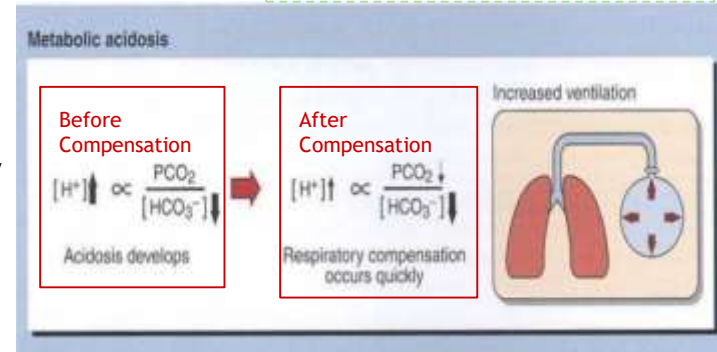


Compensation can happen acutely by hyperventilation or chronically by kidneys (we won't go into it)



Clinical effects of acidosis

- Hyperventilation: is the compensatory physiological response to acidosis to remove CO₂.
- Increased H⁺ conc. stimulates respiratory response.
- Hyperventilation: deep, rapid, and gasping respiratory pattern
- Arrhythmia, cardiac arrest.
- Loss of consciousness, coma, death.



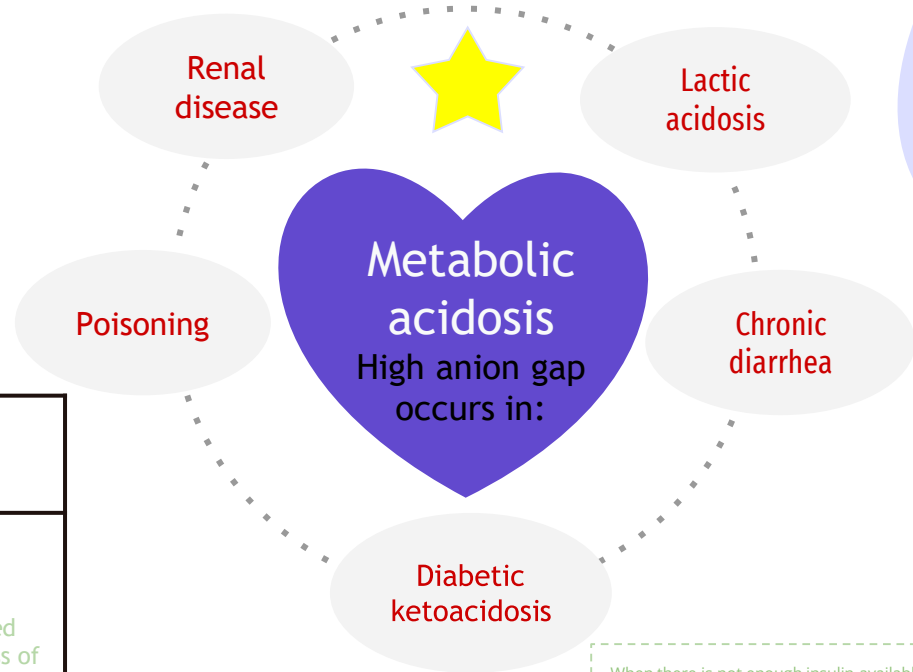
Anion Gap

It is the difference between:

- The sum of Na^+ and K^+ (cations).
- The sum of Cl^- and HCO_3^- (anions).

Helps in assessing acid-base problems.

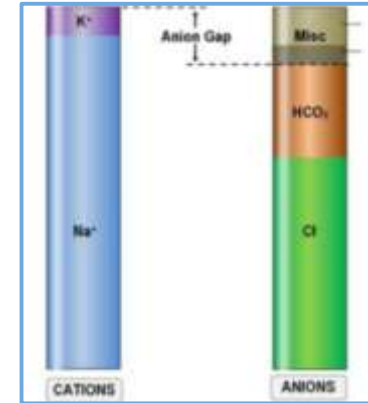
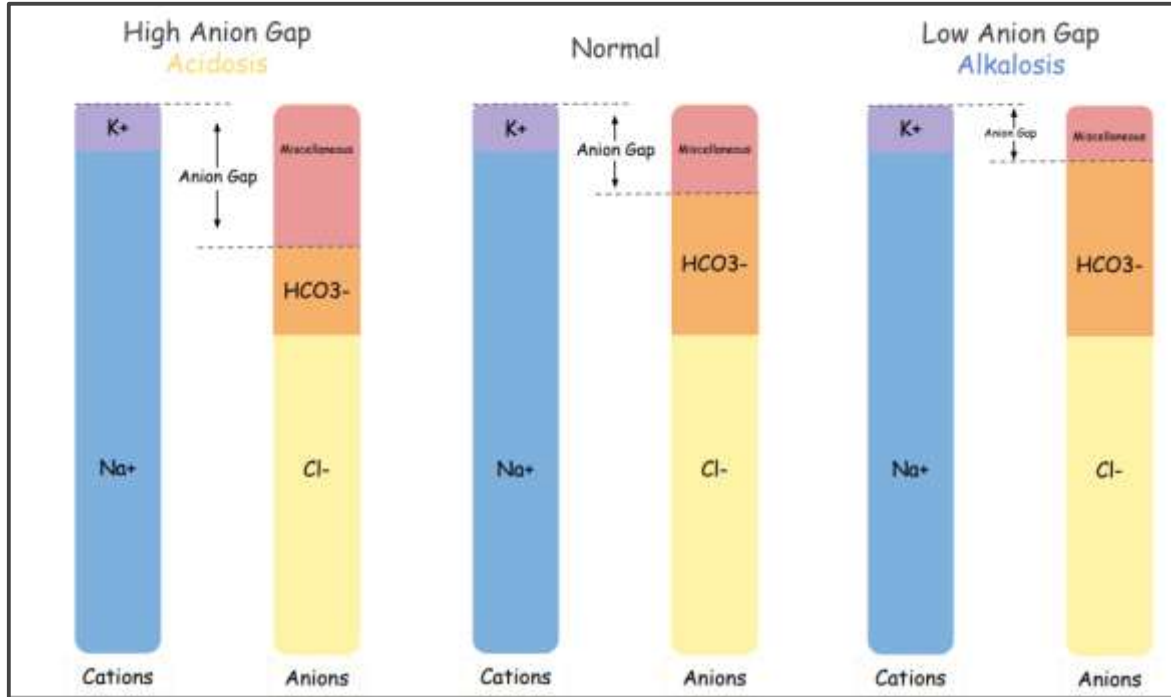
Normal anion group	3-11 mEq/L
High anion group	>11 mEq/L (acidosis) (Can happen due to increase in unmeasured ions: po_4 /lactate/protein/ketos or due to loss of HCO_3)
Low anion group	<3 mEq/L (alkalosis)



Can happen due to drug intoxication

Metabolic acidosis can be accompanied by a normal anion gap like in the case of (Chronic Diarrhea) because you will lose HCO_3^- and the Cl^- will be high due to compensation of HCO_3^- . This is known as hyperchloremic metabolic acidosis.

Anion Gap

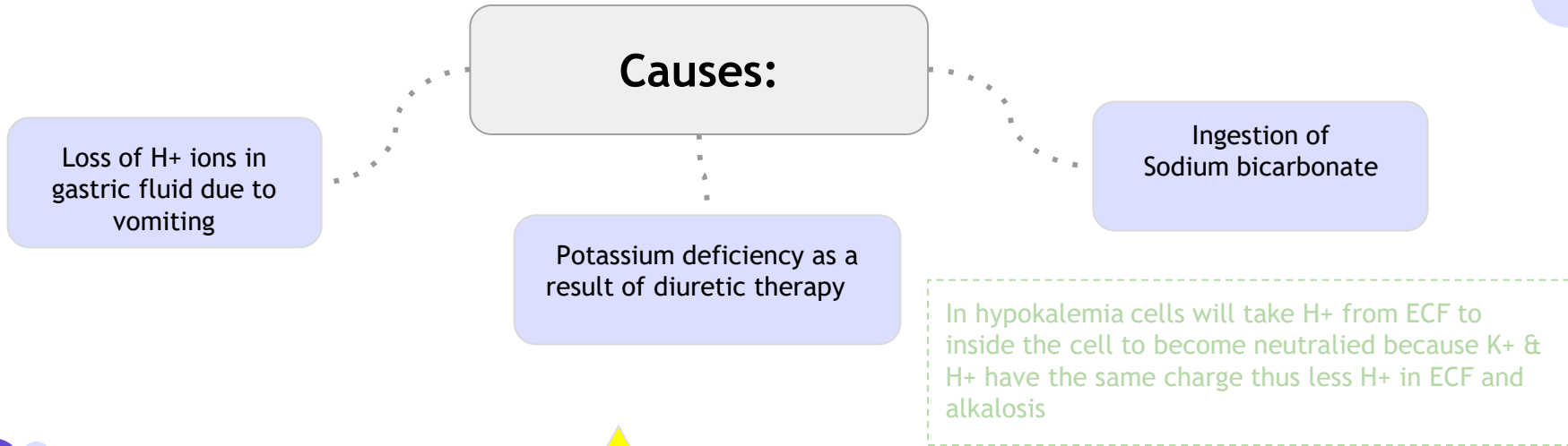


فرضا
 Cation=20 Anion= Normal con.
 Anion gap=5 (sum of their subtraction)
 في ال acidosis تنقل قيمة ال anions الى مثلاً 5ليه؟
 لأن دخلت مادة acid ونعرف ان ال acid عندهم شحنة سالبة لذلك بيروح لل anions وبيزيد ال anion gap
 ويصير ناتج الفرق يساوي 15 اذاً acidosis

In anions we only count HCO₃ and Cl

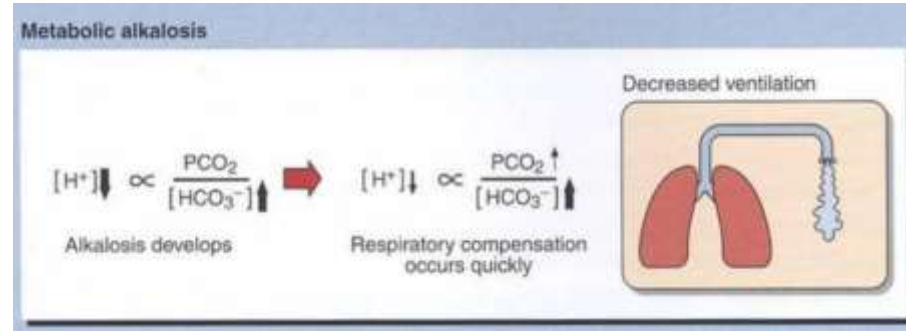
Metabolic alkalosis

Increase in bicarbonate conc. in ECF



Clinical effects of alkalosis

- Hypoventilation (depressed breathing)
- Increases PCO₂ to compensate alkalosis
- Respiratory arrest, Confusion, coma, death



Lactic Acidosis

Elevated conc. of plasma lactate is called lactic acidosis

Causes

Disorders of
carbohydrate
metabolism

Failure of
circulatory system
(hypoxia)



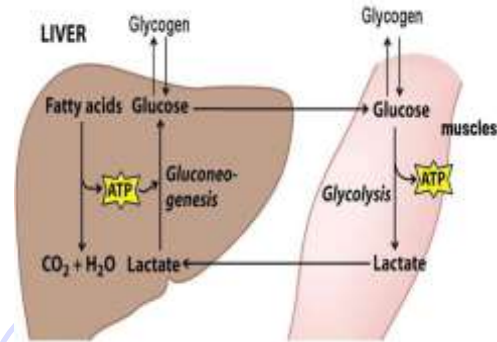
Mechanisms involved in lactic acidosis

- Excessive tissue **lactate** production
- Impaired **Hepatic** metabolism of lactate

Lactate metabolism in tissue



- The body tissues produce ~1500 moles 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 exercise
- Lactate is metabolized in Liver (60%) and Kidney (30%) to glucose
- Some lactate is metabolized to CO₂ and Water (Krebs cycle)



In the muscle:
Glucose is converted into lactate by anaerobic glycolysis
Lactate is released into the blood and is transported to the **Liver**
in the liver:
Lactate → Glucose (gluconeogenesis)
Glucose is transported to the muscles (for energy again)

Pyruvate + NADH + H⁺

Lactate dehydrogenase

Lactate + NAD⁺

Types and causes of lactic acidosis



Type A

Due to **hypoxia** in tissues, which is in:

- Myocardial infarction
- pulmonary embolism
- Uncontrolled hemorrhage
- Tissue hypoperfusion (shock, cardiac arrest, acute heart failure)
- Anaerobic muscular exercise

Causing

producing
lactate as a
final product.

Impaired
oxidative
phosphorylation
and decreased
ATP synthesis.

Types and causes of lactic acidosis



Type A

To survive, Cells switch to anaerobic glycolysis for ATP synthesis
And the amount of oxygen required to recover from oxygen deficiency is called **oxygen debt**



Type B

- 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)



It's important to tie between the concept of carbohydrate metabolism and Type B lactic acidosis

Diagnosis and Treatment

Diagnosis

Diagnosis done by measuring blood lactate levels:

- Hyperlactemia: 2-5 mmols/L (Risk for lactic acidosis)
- Severe lactic acidosis: > 5 mmols/L

Treatment

- Correcting the underlying conditions
- Restoring adequate tissue oxygen*
- Avoiding Sodium Bicarbonate**

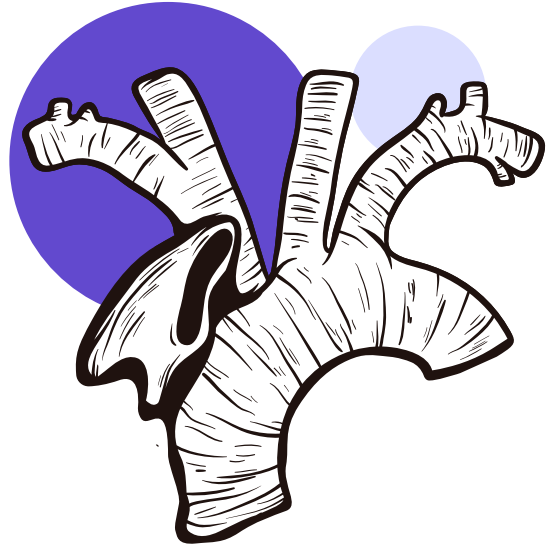
443: Dr note:

* Because most of the time the cause of lactic acidosis is hypoxia

** In Acidosis in general it's known that adding sodium bicarbonate will help to get PH back to it's normal range but in lactic acidosis for unknown reasons it will make it worse by increasing lactic acidosis

Take home Messages

- 01** Lactic acidosis can be caused by hypoxia, excessive production and impaired clearance of lactic acid.
- 02** It carries clinical significance in the diagnosis of myocardial infarction, pulmonary embolism and other metabolic conditions.



mcq

1-C 2-A 3- B

Q1: Which one is seen in metabolic acidosis with high anion gap?

A- Chronic diarrhea

B- heart failure

C- Lactic acidosis

D- vomiting

Q2: Hyperventilation is a clinical effect of?

A- Acidosis

B- Alkalosis

C- Both

D- None

Q3: Metabolic alkalosis causes which of the following ?

A- Gain of H⁺

B- hypoventilation

C- Hyperventilation

D- Both A and B

Q1: What enzyme is deficient in type B lactic acidosis

A- Pyruvate dehydrogenase

B- lactate dehydrogenase

C- succinate dehydrogenase

D- phosphofructokinase

Q2: In lactic acidosis what level of blood lactate indicate severe lactic acidosis

A- >4 mmols/L

B- <4 mmols/L

C- 2-5 mmols/L

D- >5 mmols/L

Q3: Which of the following causes doesn't cause Type A lactic acidosis

A- Uncontrolled hemorrhage

B- Myocardial infarction

C- Drug intoxication

D- Anaerobic muscular exercise

SAQ

Q1: Define the anion gap.

A1:: [The sum of Na⁺ and K⁺ (cations)]—[The sum of Cl⁻ and HCO₃⁻ (anions)]

Q2: What is the amount of oxygen required to recover from O₂ deficiency called

A2: oxygen debt

Q3: Mention two main causes of lactic acidosis

A3: failure of circulatory system, disorders of carbohydrate metabolism

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