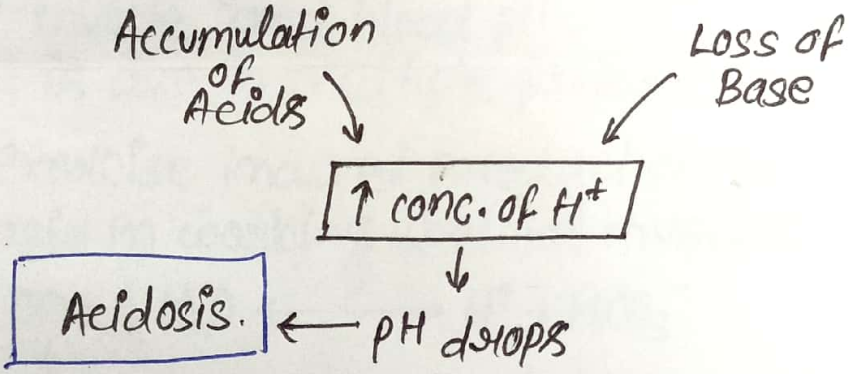
Unit → Exercise and Acid Base Balance

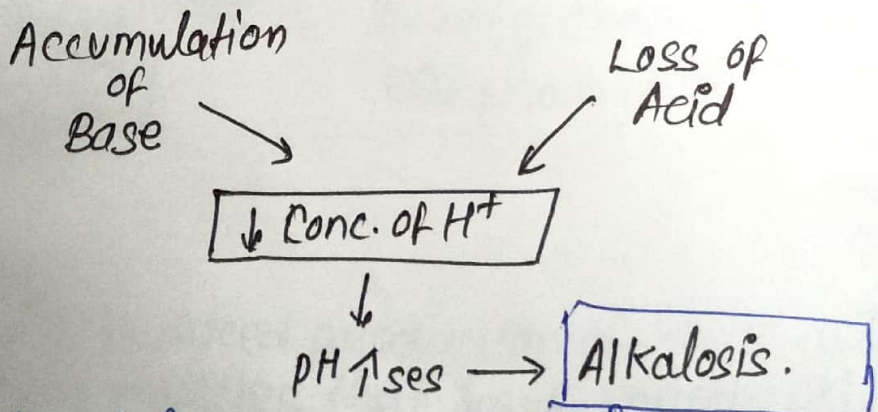
Acids Acids are defined as molecules that release H^+ ions which increases H^+ ion concentration of an aqueous solution.
eg.– Body fluids.

Bases Bases are molecules that are capable of combining H^+ ion, this results in a lower H^+ ion concentration and ↑ in pH.

pH pH of a solution is the negative logarithm of H^+ ion concentration.

$$pH = -\log_{10}[H^+]$$





▷ Acid-Base Balance during exercise.
– Lactic acid production depends on:–
- exercise intensity
- Amount of muscle involved
- Duration of exercise.

Acid-Base Balance during exercise

Lactic acid production depends on :-

① Exercise intensity
② Amount of muscle involved
③ Duration of exercise.

Blood pH

Decrease with increased intensity of exercise.

Muscle pH

Decrease more dramatically than Blood pH.
Muscle has lower buffer capacity.

H^+ ion production during exercise

High intensity exercise results in decrease in both muscle and blood pH.
It is due to multiple factors.

① Exercise induced production of CO_2 and carbonic acid in working skeletal muscles.

$$CO_2 + H_2O \longleftrightarrow H^+ + HCO_3^-$$

CO_2 ↓ Gas
Eliminated by lungs so it is called **Volatile Acid.**

During day, body produces CO_2.
During exercise, metabolic CO_2 production ↑ – volatile load ↑ses on Body.

② Exercise induced production of lactic acid in working muscles that ↓ses muscle pH.

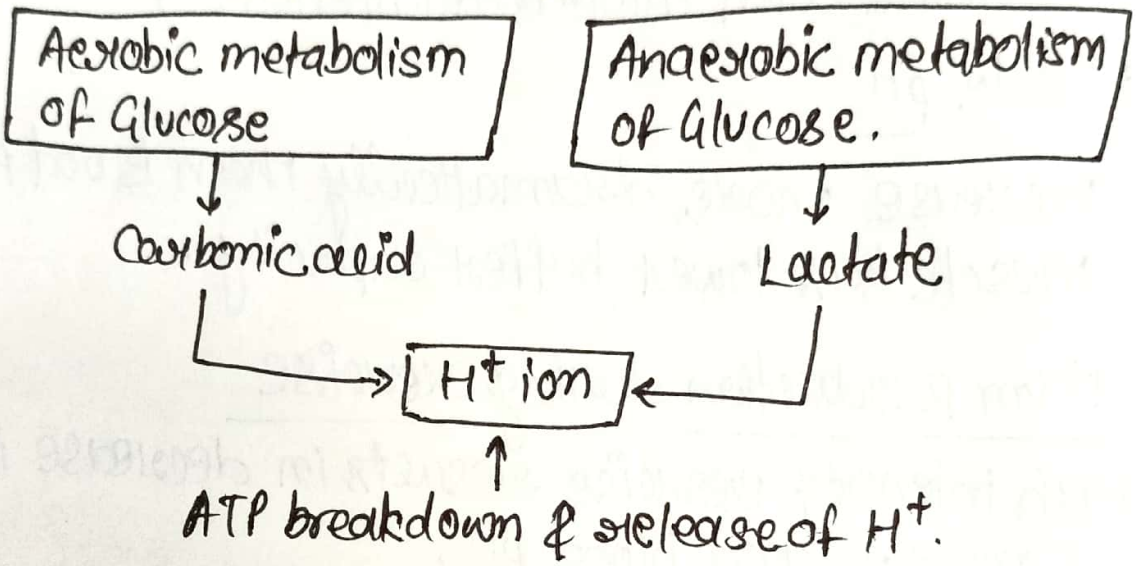
(3)

③ Exercise induced ATP breakdown in working muscles.

$$ATP + H_2O \longrightarrow ADP + HPO_4 + H^+$$

i.e. ATP breakdown produce H^+ ion in working muscle.

Primary sources of H^+ ion in contracting skeletal muscles.



H^+ ion exert a powerful effect on other molecule & alter their original size and fuction.

(eg:- Decrease function of enzyme by ↓ their activity.)

As the-

① Concentration of H^+ ↑ses, Decrease in muscle cells ability to produce ATP by inhibiting key enzymes involved in both anaerobic and aerobic production of ATP.

② H^+ ion compete with Ca^{2+} ion for binding sites on troponin thereby hindering contractile properties.

Acid-Base Buffer System

one of the important means of regulating H^+ concentration in body fluids is by aid of buffers.

A Buffer resists pH change by removing H^+ when H^+ concentrations ↑ses, and releasing H^+ when H^+ concentration falls.

Buffer often consist of a weak-acid and its associated base (conjugate base).

Intracellular buffers - Proteins, phosphates, bicarbonates and dipeptides (i.e carnosine).

Muscle fibers possess two important H^+ transporters that carry H^+ from inside the muscle fibre into the interstitial space (1) Na/H^+ Exchange.

(2) Monocarboxlate transporters.

Primary extracellular buffers include - Bicarbonates, ↓ Most important Buffer system of Body.

Haemoglobin.

Respiratory influence on acid-base balance.
(Rapid means of regulating pH).

It involves regulation of blood PCO_2.

Increase in blood PCO_2 lowers pH whereas ↓es in blood PCO_2 increases pH.

Increase in pulmonary ventilation can remove CO_2 from body thus eliminate H^+ and ↑ pH.

$$CO_2 + H_2O \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO_3^-$$

(5)

Regulation of Acid-Base Balance via Kidneys.

Kidneys do not play important part in Acid-Base regulation during short term exercise.

Kidneys regulate H^+ concentration by increasing or decreasing bicarbonate concentration.

The kidney mechanism involved in regulating the bicarbonate concentration is located in a portion of kidney called tubule through a series of complicated reactions and active transport across tubular wall.

When pH ↓ (H^+ ↑) ⟶ Kidney reduce the rate of bicarbonate excretion

↑ HCO_3^- concentration

Regulation of Acid Base Balance During Exercise

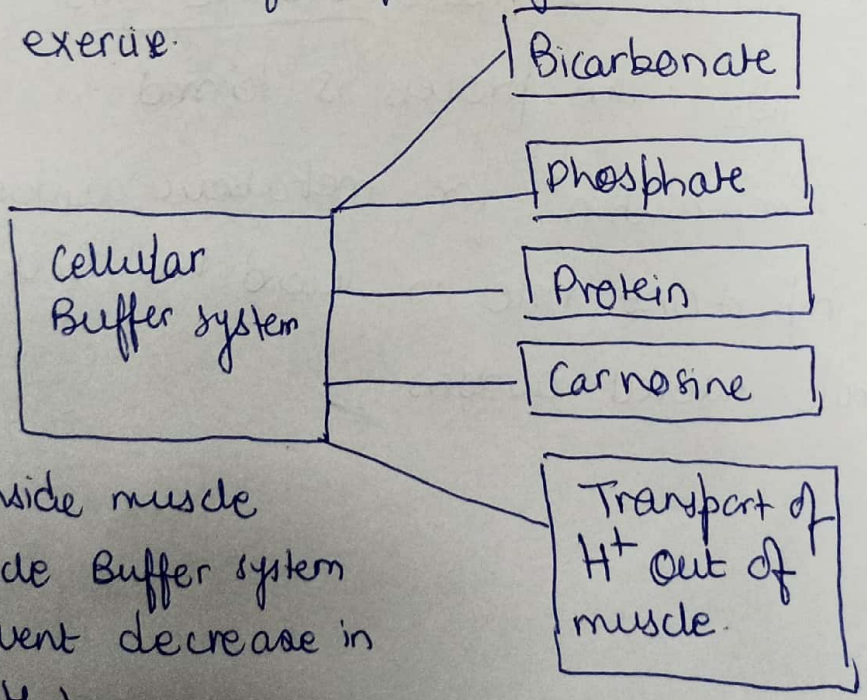
Maximal exercise ⟶ Decrease pH.

Amount of H^+ produced during exercise depends on

1. Ex intensity
2. Amount of muscle mass involved
3. Duration of exercise

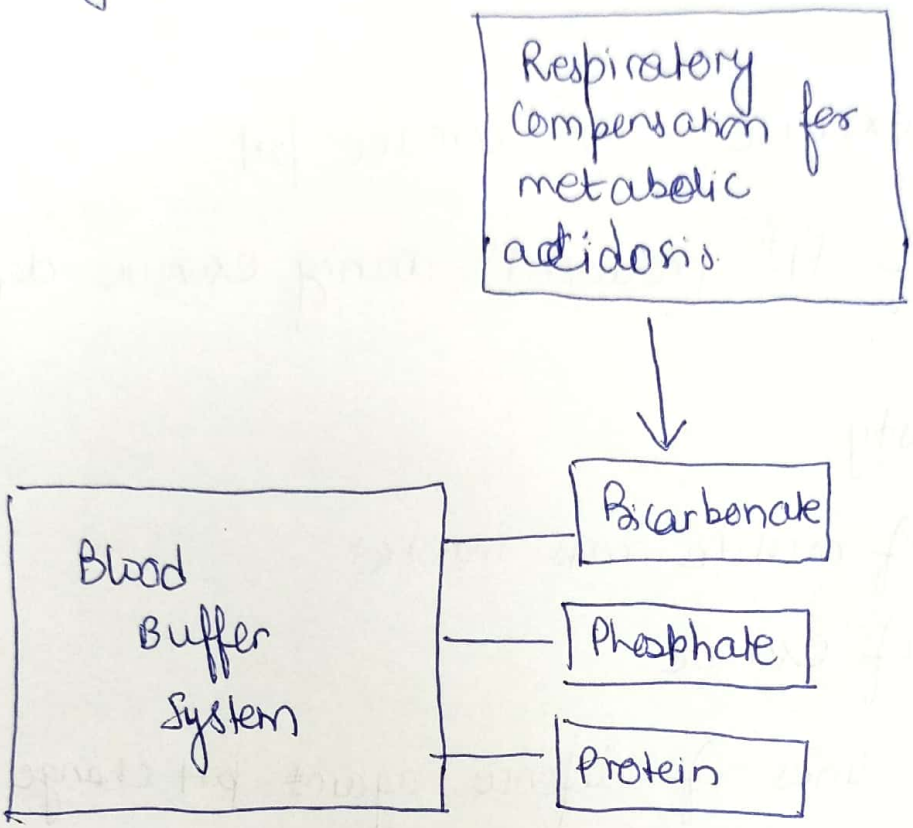
⊙ Two major lines of defence against pH change during intense exercise

* first line of Defence against muscle pH shift during exercise.



(Inside muscle Muscle Buffer system prevent decrease in pH)

* Second line of defence against blood pH shift during exercise



Importantly, increase in pulmonary ventilation during intense exercise eliminates carbonic acid by "blowing off" CO_2. This process is termed "Respiratory compensation" for metabolic acidosis" and plays important role in second line of defence against exercise induced acidosis.