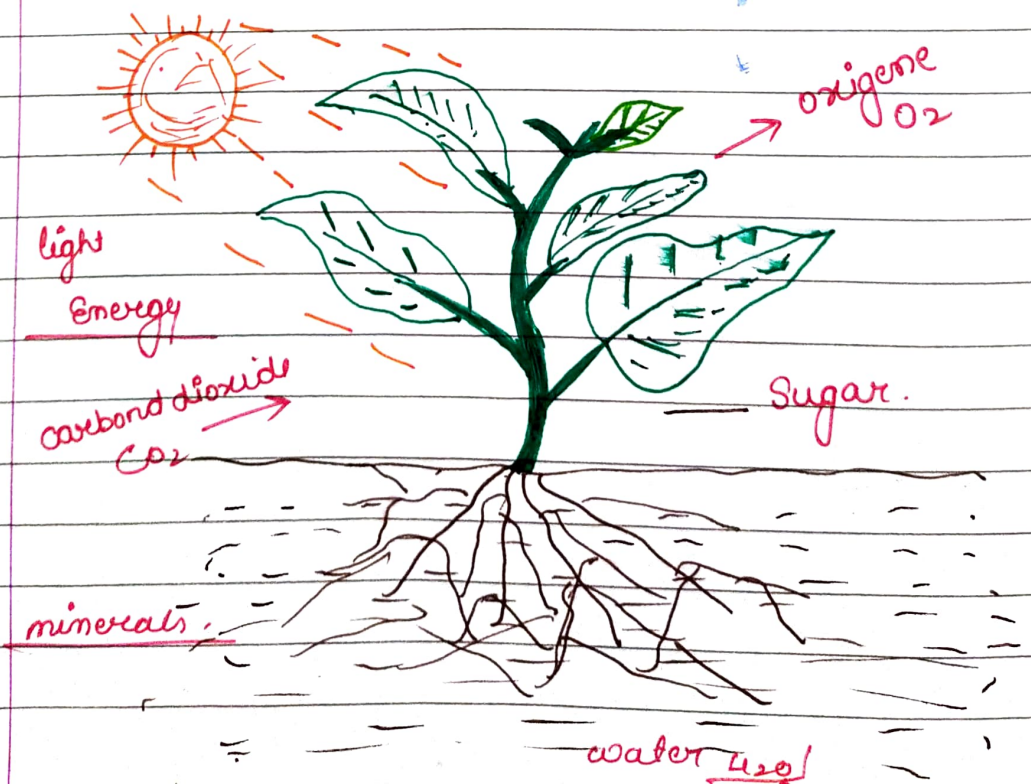
@ UNIT-4 – PLANT PHYSIOLOGY.

Respiration in Plants

RESPIRATION IN PLANTS

PHOTOSYNTHESIS.



Respiration in Plants.

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→ **Respiration in plants.**

- Respiration is a Biological process
  - Amphibolic [catabolic + Anabolic]
  - Exergenic [Energy releasing]
  - Vital
  - Downhill Process.

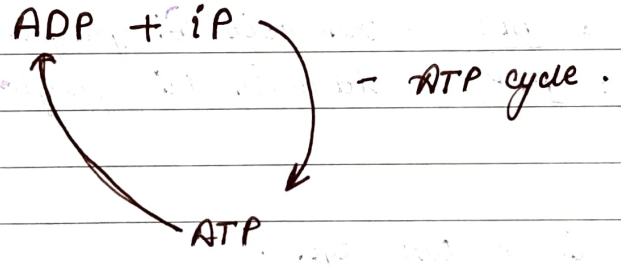
- Downhill process that involves in production of cellular energy (i.e ATP).

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + 38/36\ ATP$$

* **ATP**

→ ATP discovered by Lohmann.

→ ATP cycle was proposed by Lipmann.



- ATP cycle.

- ATP = Adenosin tri phosphate

Adenin + Sugar (Pentose Sugar)

Adenosin.

- ATP = A ~ P ~ P ~ P

6.5 K cal

3.5 K cal

7.3 K cal / 7.9 K cal.

= 17.3.

- To form ATP we use 12 K cal.
- Adenosin is a type of Nucleotype.

Nitrogenous Base is of two type.

Purin	Pyrimidine
- Adenin	- Thymine.
- Guanine	- cytosin.
	- uracil.

* **ATP formation Process.**

- Adenin + Sugar (pentose) = Adenosin.

Adenosin + ip = AMP - Adenosin mono phosphate.
AMP + ip = ADP - Adenosin Di-phosphate.
ADP + ip = ATP - Adenosin tri Phosphate.

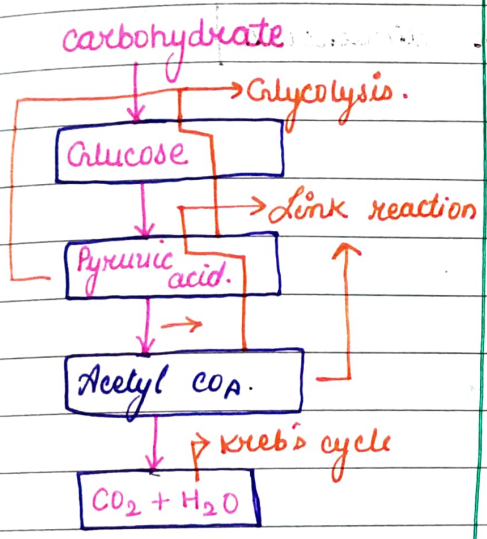
* **Respiration is of two type.**

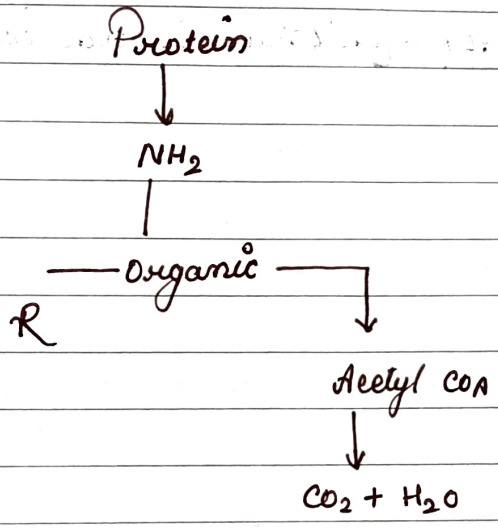
1) Aerobic respiration - in the presence of oxygen is called aerobic
2) Anaerobic respiration - in the absence of oxygen is called anaerobic respiration.

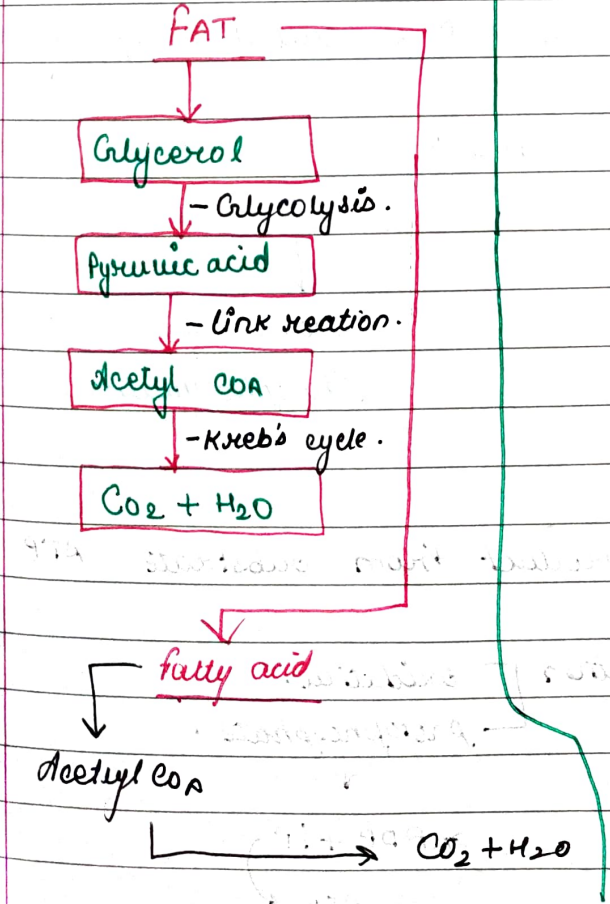
– on the basis of Substrate respiration is of two type :

① floating respiration.
② protoplasmic respiration.

1) | Floating respiration | Protoplasmic respiration |







* NAD - Nicotinamide Adenosine dinucleotide

- Co enzyme - I
- catabolic process.
- Reduce - at → 3ATP.

- co enzyme can't work without Enzyme.

② NADP - Nicotinamide Adenosine dinucleotide

- Co enzyme - II
- Anabolic process.
- Reduction - 3ATP
-
- co enzyme can't work without enzyme.

- phosphorylation

- The process of formation of ATP is called phosphorylation.

it is of two type :-

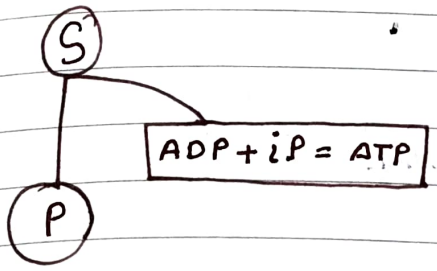
Substrate level phosphorylation.

Chain level Phosphorylation.

- During formation of product from Substrate ATP Synthesis

② Chain level phosphorylation [oxidative.
photophosphate.

ADP + iP
ATP



- Synthesis of ATP is due to circulatory movement of electron through which ATP synthesized.

- Chain lebael phosphorylation is of two type :—

① Oxidative phosphorylation — Energy form ATP Synthesis comes from oxidation food particle.

② Phosphorylation — Energy for ATP Synthesis comes from light energy in which electron moves.

Glucose respiration can be facilitated into 4 steps.

1) Glycolysis. | Link reaction | Kreb's cycle | Electron transport System ETS

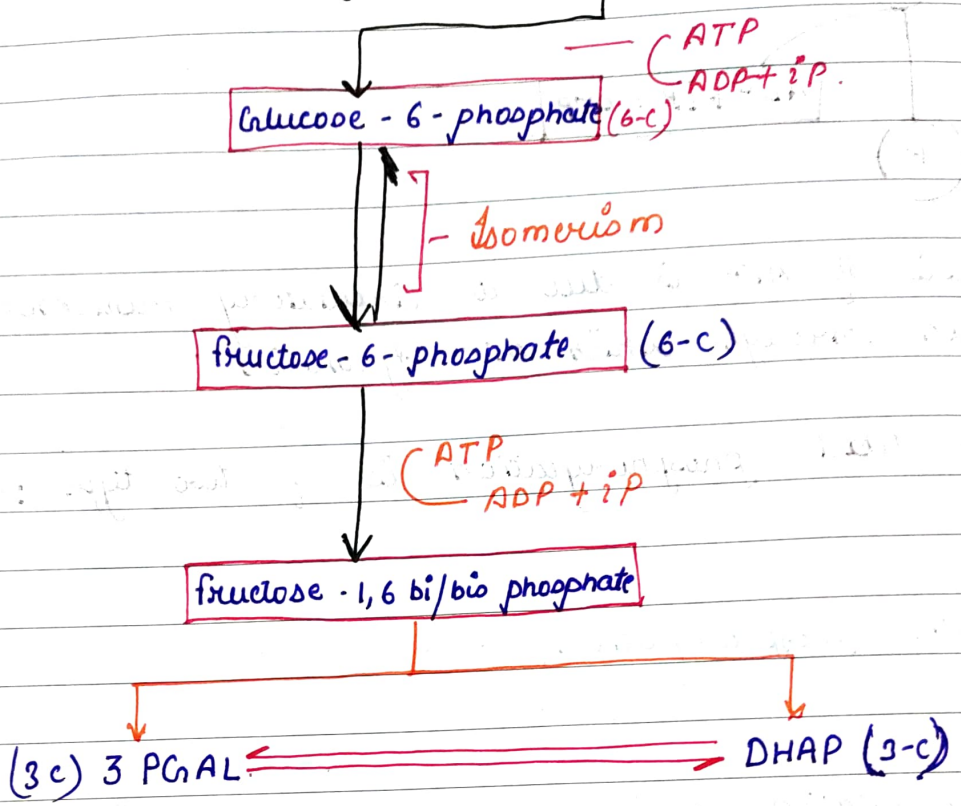
Site - cytoplasm.
Nucleoplasm.

Anaerobic
- O_2

found in ~~Mitochondria~~ Mitosis.
Site - Mitochondria.
+ O_2 - Aerobic.

Glycolysis. - (Breaking down)

- Glycolysis · — Glucose ·



GLYCOLYSIS PROCESS

ENZYMES

GLYCOLYSIS

HEXOSE / HEXOKINASE ← → ADP + iP, ATP ⊖

GLUCOSE - 6- PHOSPHATE

PHOSPHO GLUCOSE ISOMERE / ISOMERASE ← → - ISOMERISM

FRUCTOSE 6- PHOSPHATE - (6-C)

PHOSPHO FRUCTO KINASE ← → ADP + iP, ATP ⊖

ALDOSE ← FRUCTOSE - 1,6 bi / bis PHOSPHATE - Cleavage formation

3PGAL ⇄ DHAP

→ H_3PO_4 - metaphoophoric acid.

1,3 bi PGAL

NAD - oxidation.
$NADH_2$

1,3 bi PGA

ADP + iP
ATP ⊕

3PGA

2 PGA

ENOLASE ←

PEP

PHOSPHO KINASE ← → ADP + iP, ATP ⊕

pyruvic acid

NON ENZYMATIC PROCESS.

PGAL – phospho glyceral aldehyde.
PGA – phospho glyceric acid.
DHAP – Dihydroxy Acetone phosphate.
PEP – phospho enol Pyruvate.

Process – Glycolysis.
Site – cytoplasm/Nucleoplasm.
Substrate – Glucose.

Other name – fundamental respiration, core respiration, Primary respiration.

EMP pathway
Embden | Meyerhof | Parnas.

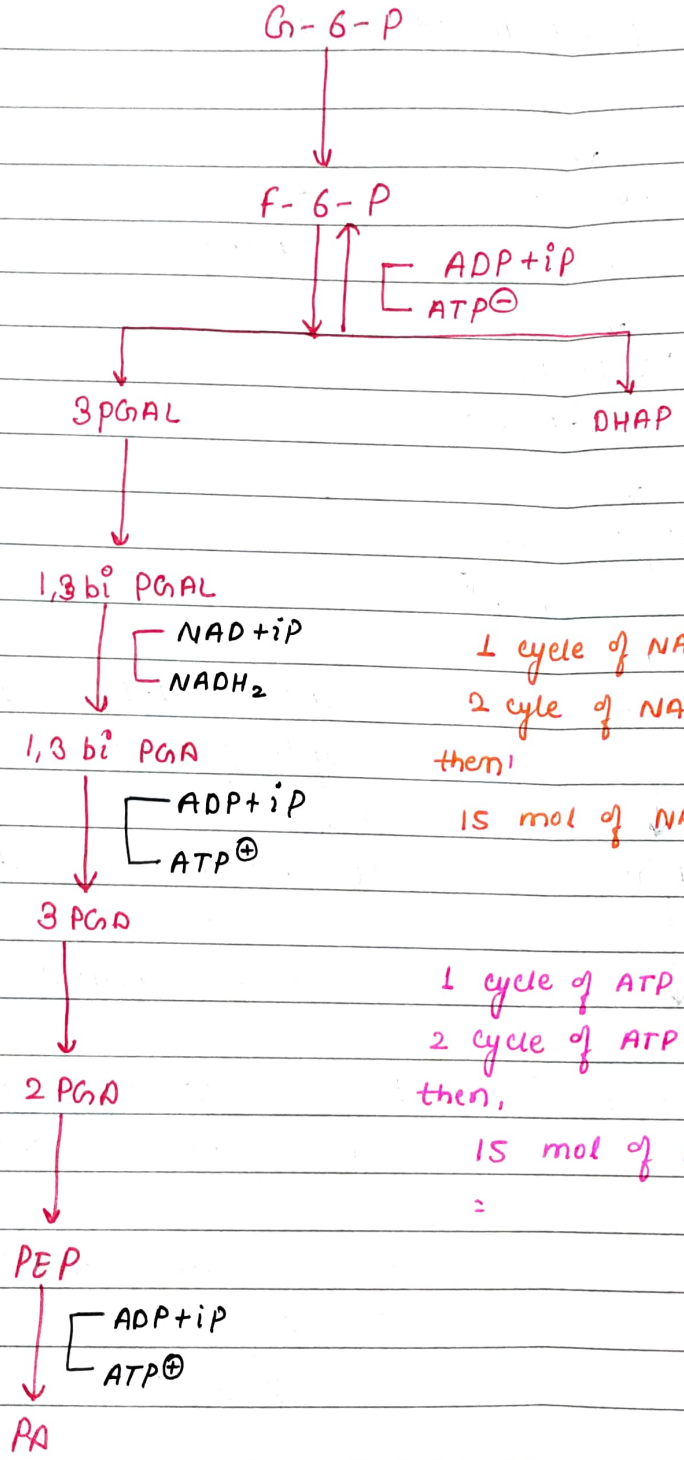
Note :→ if 1 $NADH_2$ is reduced it releases 3 ATP Equivalent energy. i.e – 1 $NADH_2$ = 3 ATP

Q] if 12 mole of 1,3 bi PGAL is used as respiratory substrate then net gain of ATP & $NADH_2$ would be?

1,3 bi PGAL
↓ (NAD + iP → $NADH_2$)
1,3 bi PGA
↓ (ADP + iP → ATP) ⊕
3 PGA
↓
2 PGA
ATP ⊕ ← ↓ PEP → PA

So one cycle of $NADH_2$ = 1
~~the two cycle of $NADH_2$ = 1 × 2 = 2~~
then 12 mole of $NADH_2$
= 12 × 1
= 12 $NADH_2$

Q2| if 15 mol of Glucose-6 phoophate is used as respiratory substrate then net gain of ATP & $NADH_2$ would be?



1 cycle of $NADH_2$ is 1 $NADH_2$.

2 cycle of $NADH_2$ is $2 \times 1 = 2$ $NADH_2$

then,

15 mol of $NADH_2$ = 15×2

= **30 $NADH_2$**

1 cycle of ATP = 2 ATP.

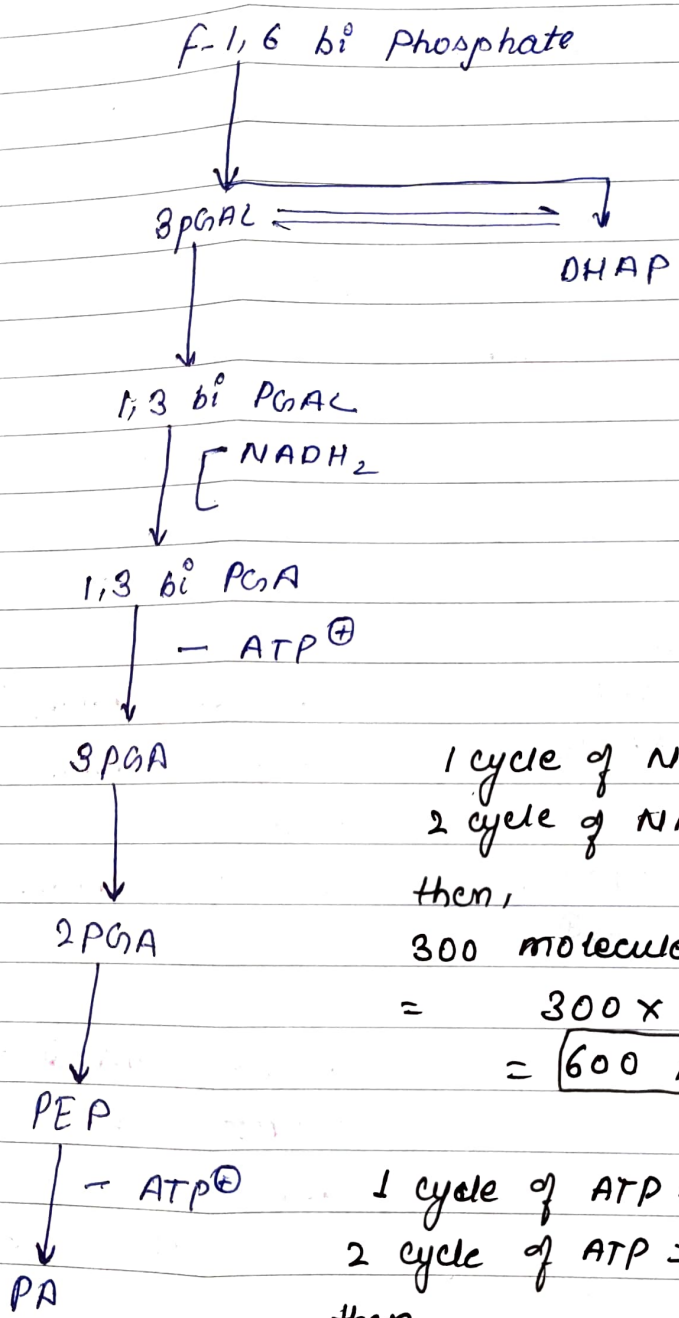
2 cycle of ATP = $2 \times 2 = 4$ ATP.

then,

15 mol of ATP = 15×4

= **90 ATP**

③ If 300 molecules f-1,6 bi phosphate is used as respiratory substrate then net gain of ATP & $NADH_2$ would be.



1 cycle of $NADH_2$ = 1

2 cycle of $NADH_2$ = 2 × 1 = 2.

then,

300 molecules of $NADH_2$

= 300 × 2

= **600 $NADH_2$**

1 cycle of ATP = 2 ATP

2 cycle of ATP = 2 × 2 = 4

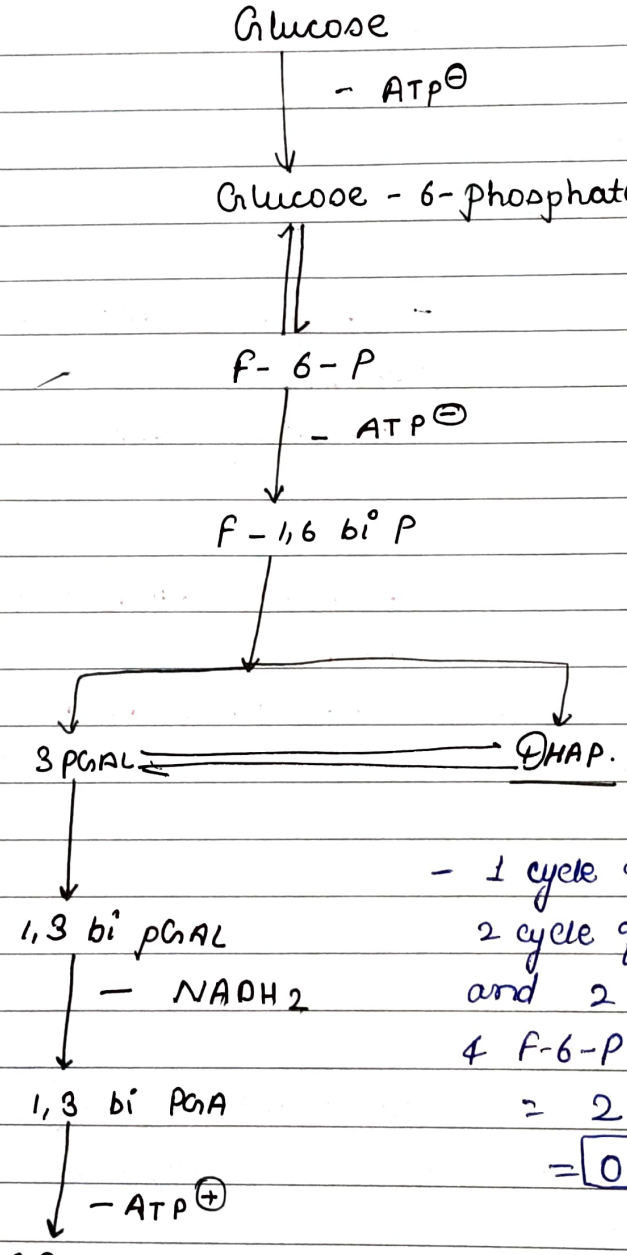
then,

300 molecule of ATP.

= 300 × 4

= **1200 ATP**

- if 30 mol of glucose is used as respiratory substrate then net gain of ATP & $NADH_2$ would be if an inhibitor inhibit the enzyme mutes.



- 1 cycle of ATP = 1 ATP
2 cycle of ATP : 2 × 1 = 2 ATP
and 2 ATP are used in Glucose & F-6-P are reduced then
= 2 − 2
= 0 ATP

- ~~NAD~~ 1 cycle of $NADH_2$ = 1 $NADH_2$
2 cycle of $NADH_2$ = 2 $NADH_2$

then, 30 mol of ~~glucose~~ $NADH_2$:
= 2 × 30
= 60 $NADH_2$

- If 12 mol of 1,3 bi PGAL is used as respiratory substrate. then net gain given of ATP & $NADH_2$ would be

1,3 bi PGL
- $NADH_2$
1,3 bi PGA
- ATP (+)
3PA
2PGA
PEP
- ATP (+)
PA

- 1 cycle of ATP = 2 ATP.
then,
12 mol of ATP = 12 x 2
= 24 ATP

1 cycle of $NADH_2$ = 1 $NADH_2$
then,
12 mol of $NADH_2$ = 12 x 1
= 12

- Pyruvic Acid

- Substrate - Pyruvic Acid.
Enzyme - PDC (Pyruvate dehydrogenate complex / Pyruvate decarboxylate complex)

- Site :- Mitochondria.

- Co Enzyme - TPP, Lipoic acid, NAD, COA, Mg^{+2}
  - TPP → Thymine Pyro Phosphate
  - Lipoic acid → Intake of PA.

2 pyruvic acid + 2 CO-A + 2 NAD $\xrightarrow{PDC}$ 2 Acetyl-CoA + $2NADH_2 + 2CO_2$

Q) If 18 molecules fructose 1,6 bis phosphate is used as respiratory substrate then net gain of ATP & $NADH_2$ in link reaction.

Fructose - 1,6 bis phosphate

↓

3 PGAL ⇌ DHAP

↓

1,3 bi PGAL

↓ - $NADH_2$

1,3 bi PGA

↓ $ATP^{\oplus}$

3 PGA

↓

2 PGA

↓

PEP

↓ $ATP^{\oplus}$

PA

↓ - $NADH_2$

A-CoA

if one cycle of $NADH_2$ = 1 $NADH_2$ formed in glycolysis and one formed in link reaction.

then two cycle of $NADH_2$

= 4 $NADH_2$

then 18 molecules of $NADH_2$

= 4 × 18

= 72 $NADH_2$

1 cycle of ATP = 2 ATP formed

~~then, 18~~

2 cycle of ATP = 2 × 2 = 4 ATP.

then, 18 molecules of ATP

= 18 × 4

= 72 ATP

- one cycle of ATP = 2 ATP formed.

then 9 molecules of ATP =

9×2

= 18 ~~FAD~~ ATP

= 18 $NADH_2$.

- 18 ATP.

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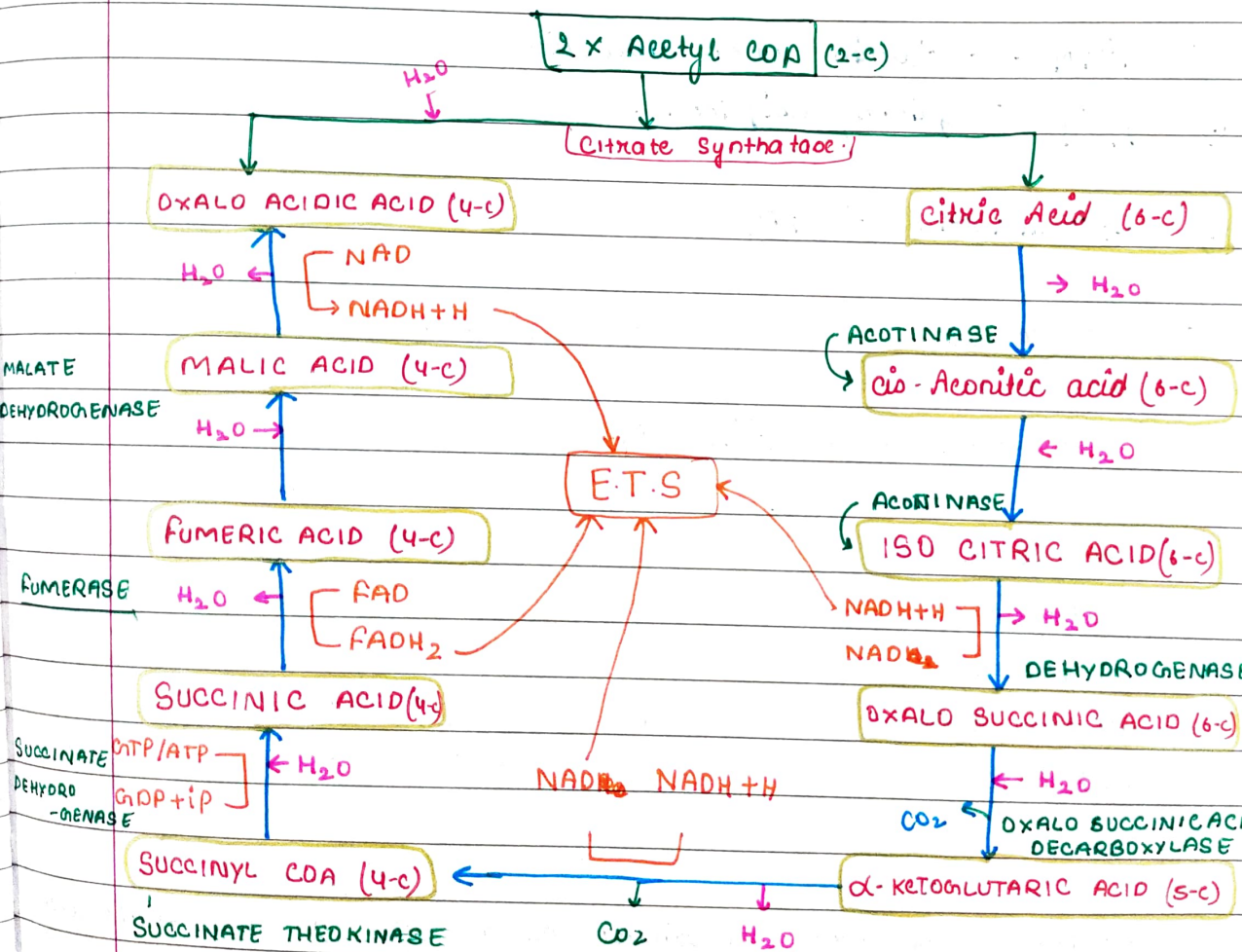
* Kreb's cycle / Citric acid cycle.



Citric Acid - Citrate.

Fumeric acid - Fumerase.

Malic acid - Malate.
Succinic acid - Succinate.

1 $NADH_2$	= 3 ATP.
1 $FADH_2$	= 2 ATP.
GTP	= 1 ATP.

- ETS - Electron transport System.

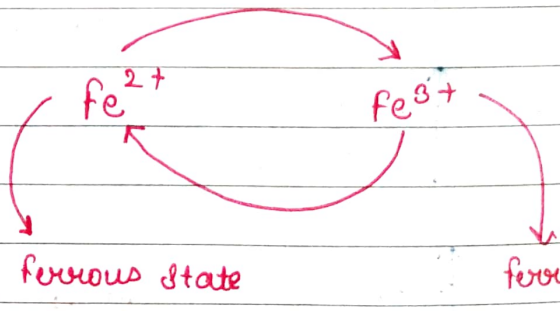
- In Electron transport System we require a reciever for electron and proton these are

① FMN - - Flemin mono Nucleotide.
ii) Q/UQ - Quinon / ubiquinon.
iii) CYTOCHROME - (CYT).

- cytochrome is a iron containing protein.

cytochrome is of five type.

- cytochrome b
- cytochrome c_1
- cytochrome C
- cytochrome a_1
- cytochrome a_3



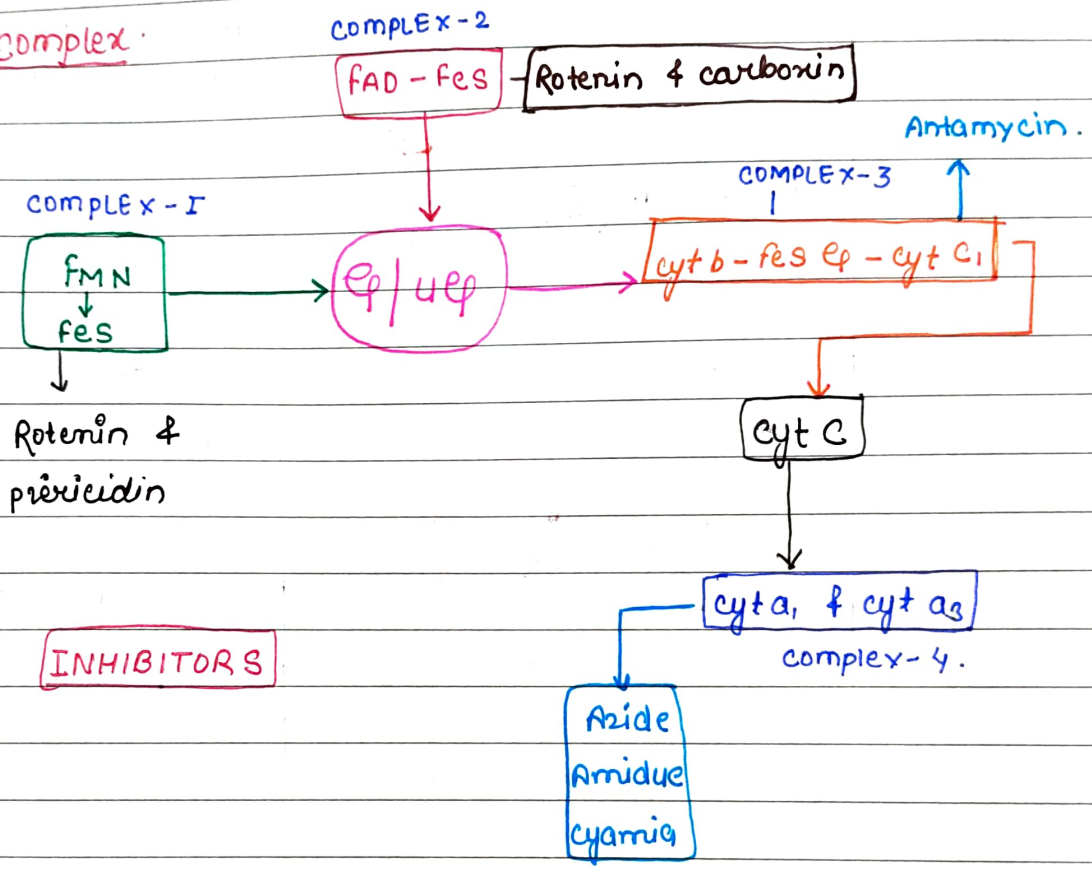
- cytochrome a_3 have containing Cu as well as Fe thats why it is called cytochrome oxidase.

- There are many inhibitor for cytochrome oxidase, carbon monoxide, cyanide, mustard. gas

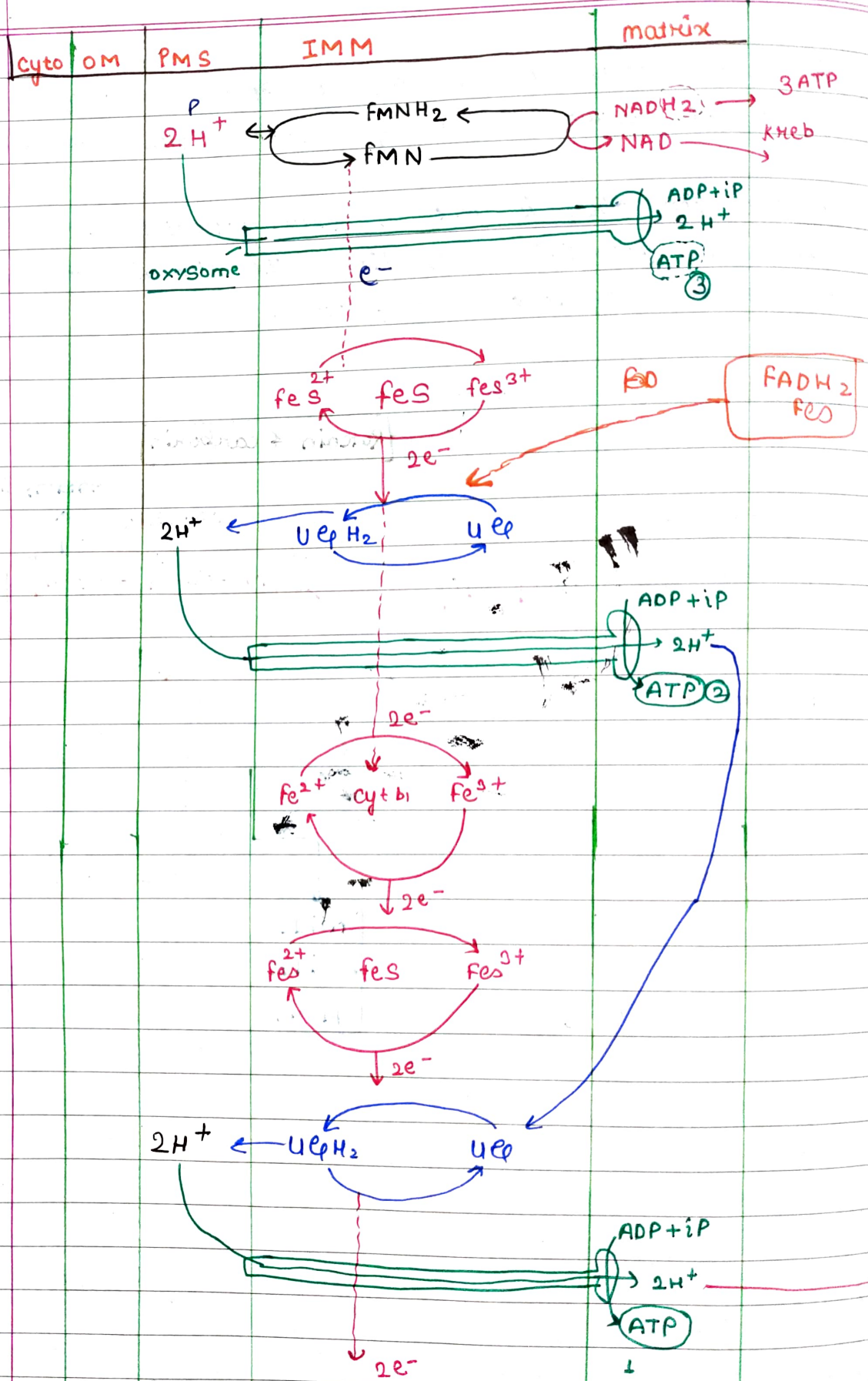
- To move electron and proton in electron transport system we require complex of electron proton reciever.

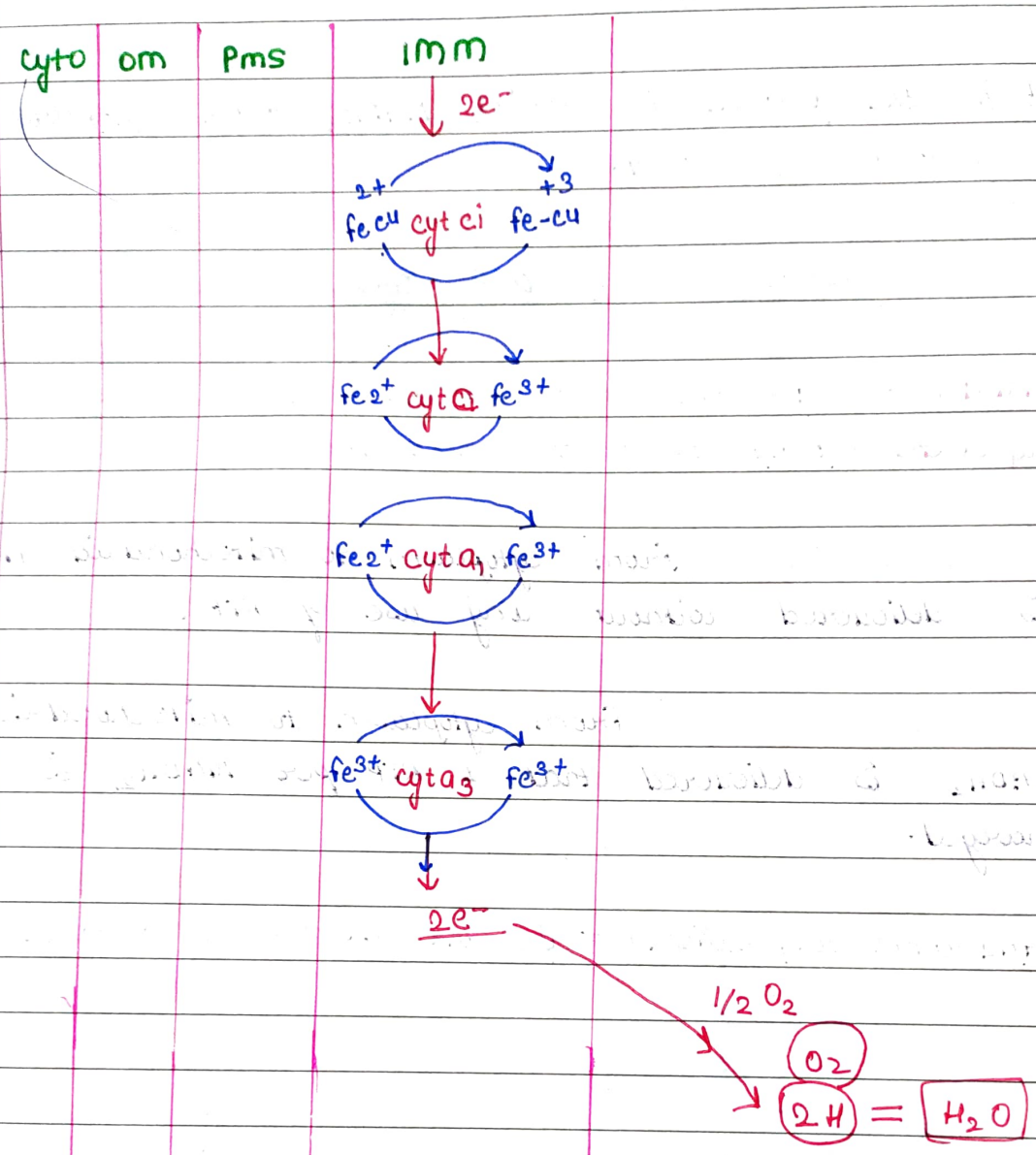
- Complex formation is best on their potential energy i.e higher the potential energy higher the strength for affinity for electron ~~transport~~ and proton.

- Complex.



ELECTRON TRANSPORT SYSTEM




cyto
om
Pms
IMM
2e⁻
2+
+3
fe-cu cyt ci fe-cu
fe2+ cyt c fe3+
fe2+ cyt a1 fe3+
fe3+ cyt a3 fe3+
2e⁻
1/2 O2
O2
2H = H2O
Excessive proton (2H)+

* SHUTTLE MECHANISM.

- It is the process in which $NADH_2$ from cytoplasm to mitochondria moved.

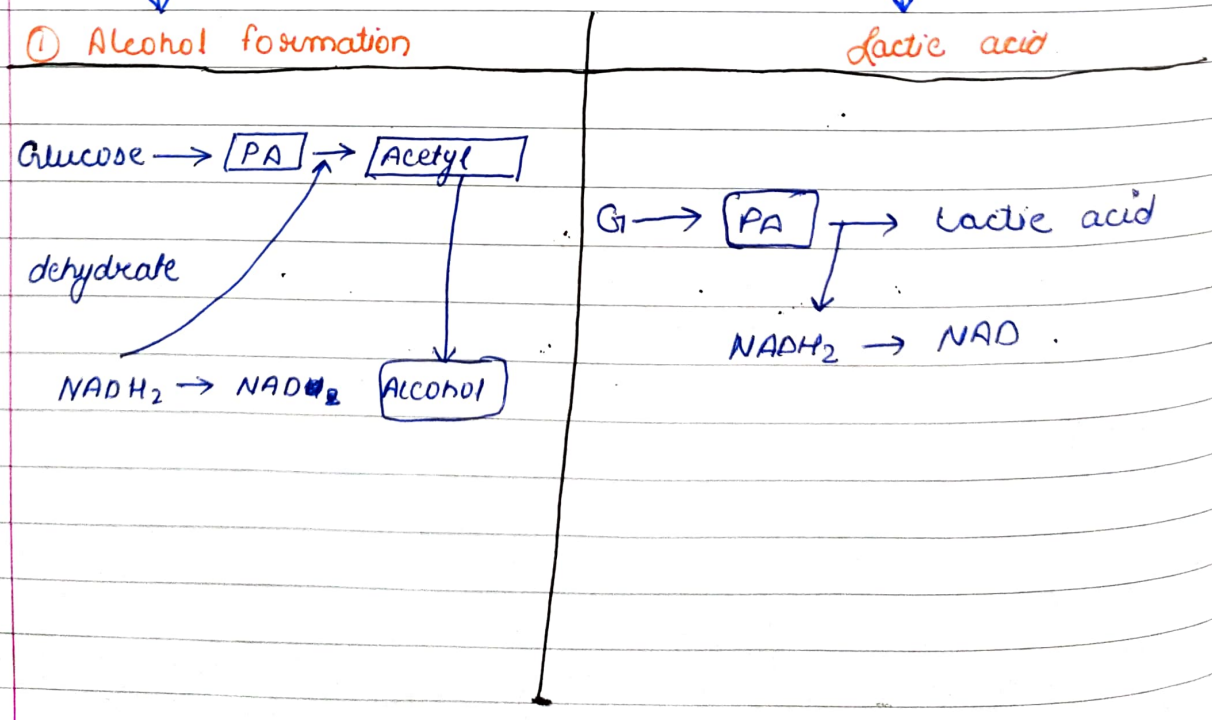
* Shutter mechanism is of two type:-

1) Malate - Aspartate Shuttle mechanism.
2) Glycerate - phosphate Shuttle mechanism.

1) Malate aspertate - from cytoplasm to mitochondria $NADH_2$ is delievered without any use of ATP.

2) Glycerate phosphate - from cytoplasm to mitochondria is $NADH_2$ is delievered that 1 ATP per $NADH_2$ is used charged.

* Anaerobic respiration - In the absence of oxygen.



At one cycle fermentation maximum 13% alcohol can produce.

If we need more than 13% Alcohol than we need to follow distillation process.

without distillation if we use 1 cycle of Alcohol as substrate that it would be poison for bacteria.

Respiratory Quotient.

Respiratory Quotient is used of substrate mechanism

Instrument → Cranags respiro meter

it is denoted by RQ.

$$RQ = \frac{\text{Total volume of } CO_2 \text{ removed}}{\text{Total volume of } O_2 \text{ consumed or used.}}$$

$$C_6H_{12}O_6 + \longrightarrow 6\,CO_2 + 6\,H_2O + ATP.$$

$$= \frac{6}{6} = 1.$$

$RQ\ (CO_2) = 1$

RQ protein = 0.9

RQ value of fat = 0.7

- RQ value of organic acid = more than 1
- factor affecting rate of respiration

① Respiratory Substrate is directly proportional to rate of respiration.

- Water is directly proportional to rate of respiration.
- Disease or wound is directly proptional to rate of respiration.
- Salt is ∝ rate of respiratory.
- Inhibitors are Cn, Azide, Amide, CO these are inhibitors for respiration.
- Age is inversaly proportional to rate of respiration.