25/Aug/17.

Cellular Respiration

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(1) Aerobic (O_2 ✓)

(2) Anaerobic (O_2 ××)

Anaerobic Res :-

glucose —glycolysis (cytoplasm) (anaerobic)→ 2 PA —

- yeast → $2C_2H_5OH + 2CO_2$ } formentation
- 2 ATP
- muscle cells → 2 lactic Acid (3C)

Aerobic Res :-

(a) Glycolysis (cytoplasm)

(b) Kreb's cycle (Mitochondria)

(c) Electron Transport chain (ETC) [inner memb of mitochondria]

(d) Oxidative Phosphorylation ($F_0 - F_1$ particle).

Glycolysis :-

→ Carried in cytoplasm

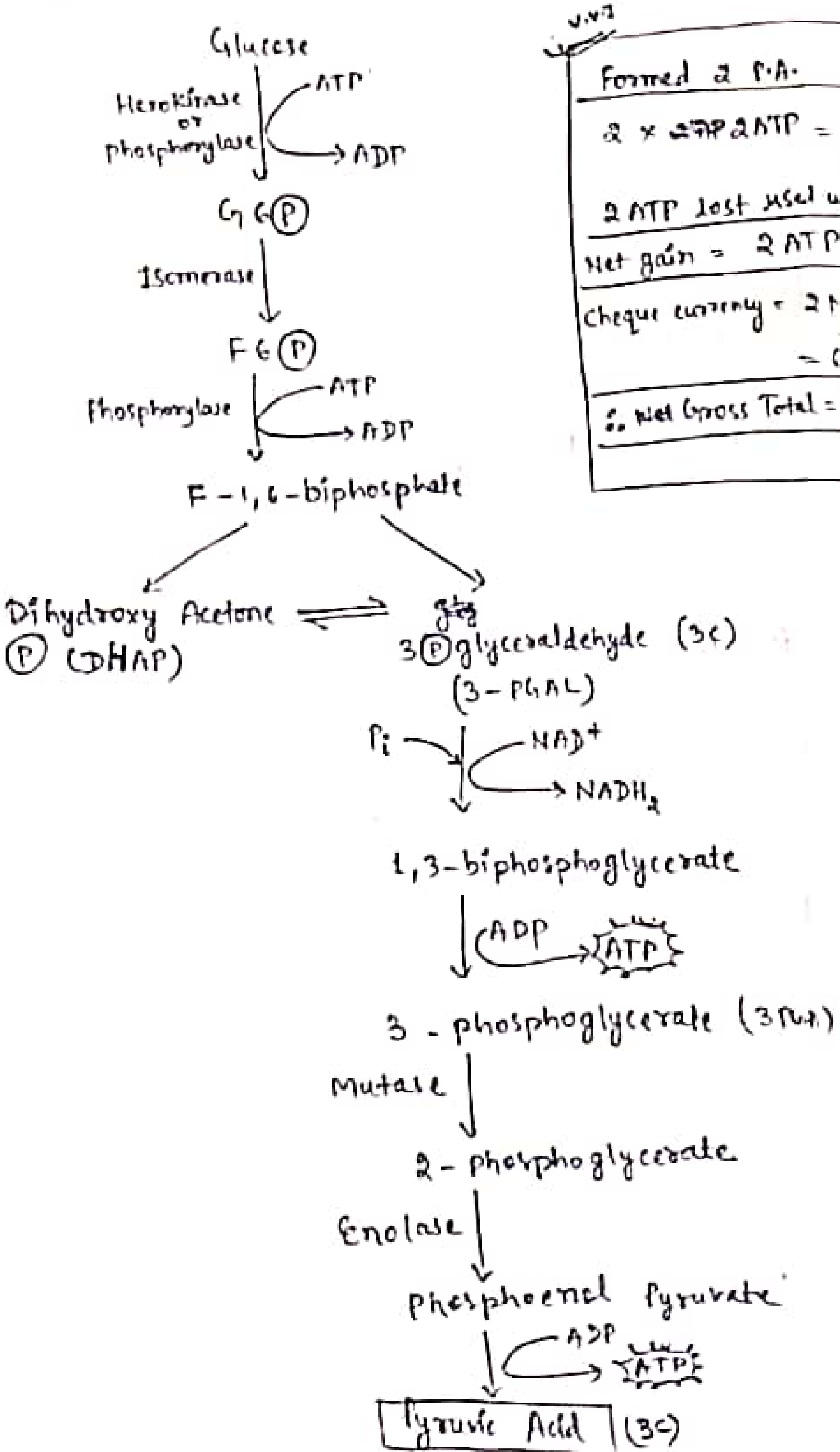
→ Anaerobically

→ EMP Pathway (another name).

[Embden E
Meyerholf M
Parnes P]

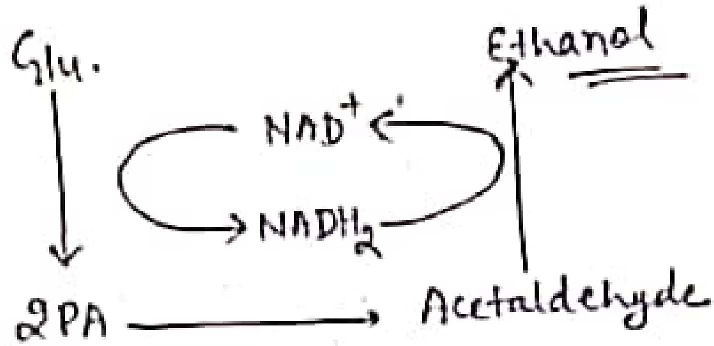
V.V.I

Formed 2 P.A.
2 × 2ATP = 4ATP formed
2 ATP lost used up earlier
Net gain = 2 ATP
Cheque currency = 2 $NADH_2$ ↓ = 6 ATP.
∴ Net Gross Total = 8 ATP



Note:- Glycolysis also occurs in Anaerobic respiration but the gross total ATP we get is only 2 (unlike 8 ATP in aerobic).

Reason is, 2 $NADH_2$ produced during glycolysis is after then used up to form ethanol in case of Anaerobic respiration.



Kreb's cycle :-

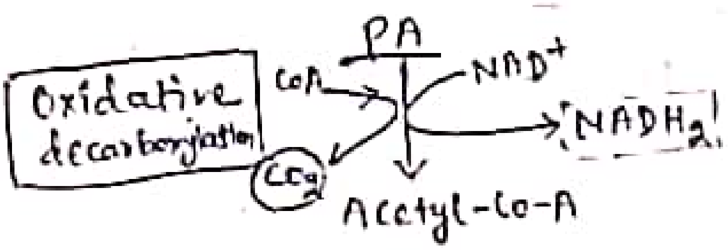
Remember:-

→ Kreb's cycle always starts with a 2 carbon containing compound called "ACETYL-CO-A".

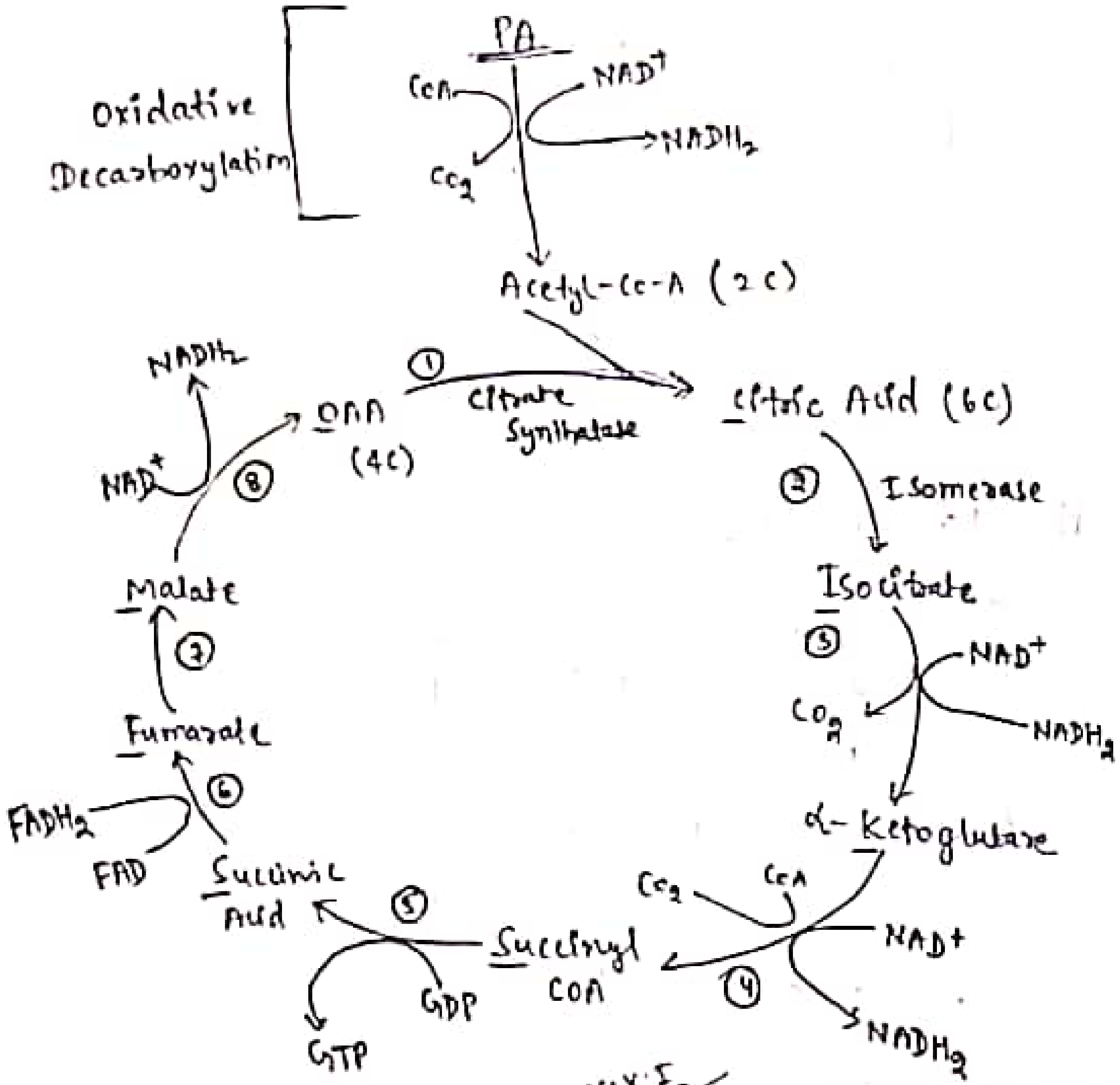
→ Also called as 'TCA Cycle'.
TCA → Tri Carboxylic Acid

→ Also named as Citric Acid cycle. because first stable intermediated formed during Kreb's cycle is citric Acid (6C).

→ Before Kreb's cycle to start, oxidative decarboxylation process is carried out with PA.



→ The first acceptor of Acety-Co-A is OAA oxalo Acetic Acid (OAA) which combines to form citric acid.



v.v.I

→ Trick to Remember Comp.

C I Know Some Simple Formula Making options.

Kreb cycle	
$3\ NADH_2$	= 9 ATP
$1\ FADH_2$	= 2 ATP
1 GTP	= 1 ATP
For 1 Kreb cycle	→ 12 ATP × 2
For 1 Glu molecule	→ 24 ATP

Electron Transport System :-

→ The energy cheques in the forms of $NADH_2$ & $FADH_2$ that we got through glycolysis + oxi. decarboxylat. & Kreb's cycle is now passed through a series of e^- acceptor proteins to release energy.

→ E.T.C. occurs in the inner membrane of mitochondria.

→ ETC comprises of series of intrinsic proteins which are completly embedded in inner membrane of mitochondria.

→ These intrinsic proteins are divided into group of four complexes namely complex I, II, III, IV

→ In case of encashment of $NADH_2$, energy is released only at complex I, II & III. That's why, 1 $NADH_2$ = 3 ATPs.

→ For $FADH_2$, energy is released at 2 places and hence, 1 $FADH_2$ = 2 ATPs.

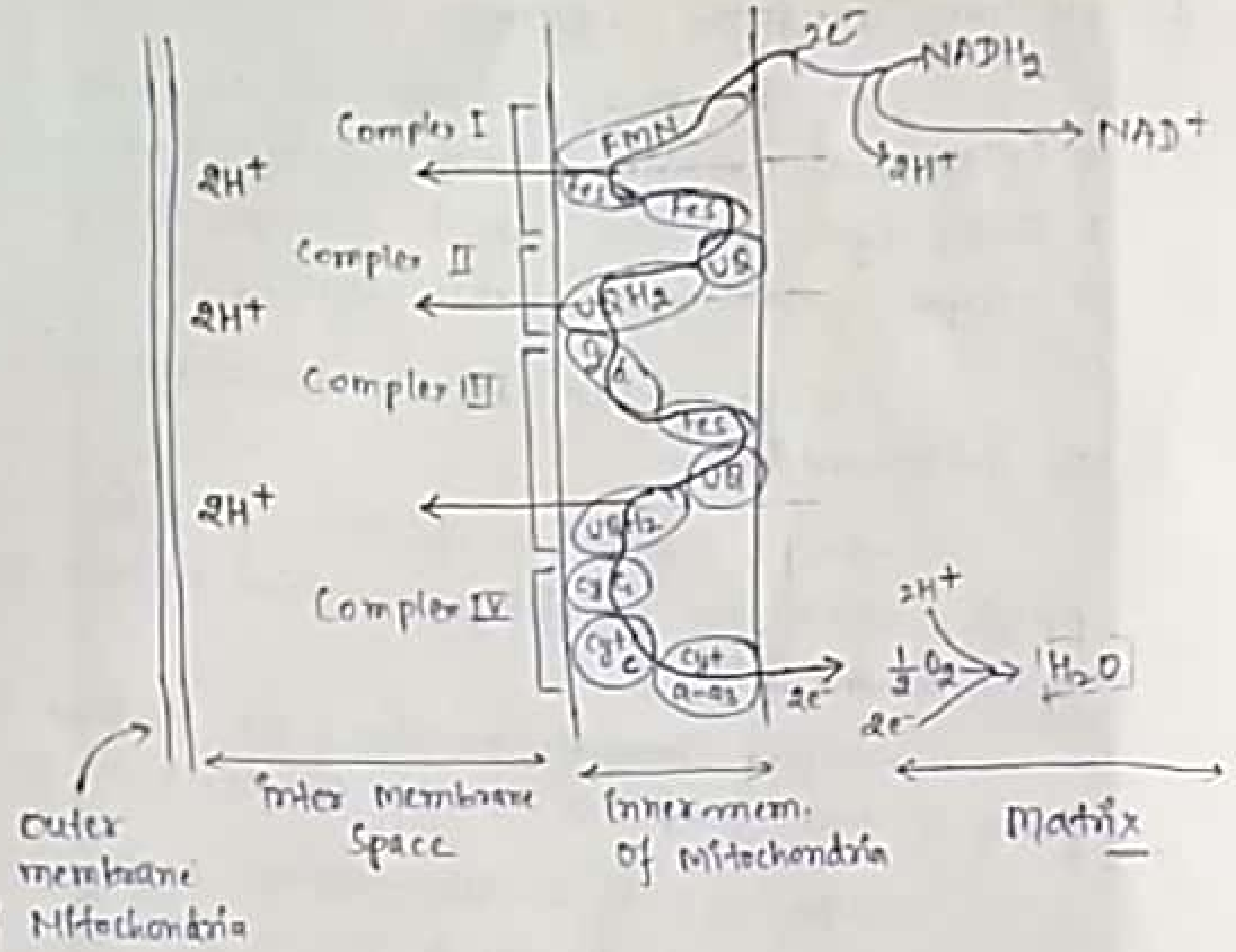
→ The energy which is released during movement of e^-s in E.T.C. are used up to pump $2H^+$ from matrix of mitochondria to inter-membrane space.

→ The 1st e^- acceptor in E.T.S is FMN.

→ The last e^- acceptor in E.T.S is Cytochrome $a-a_3$.

→ However, ultimately e^- is accepted by oxygen atom to release H_2O. (which is not a part of E.T.C.).

→ Initially, matrix has a high concentration of H+.



oxidative phosphorylation :-

↓ Aerobic process

↓ process of formation of ATP molecule by combining ADP with inorganic phosphate in presence of ATPase (F_1 - particle).

i.e) $ADP + P_i \xrightarrow[\text{or } F_1\text{-particle}]{ATPase} ATP$

→ The inner membrane of mitochondria consist of ($F_0 - F_1$) particles, cristae

→ These ($F_0 - F_1$) particle acts as a channel for the passage of 2H$^+$ back into mitochondrial matrix from inter-membrane space.

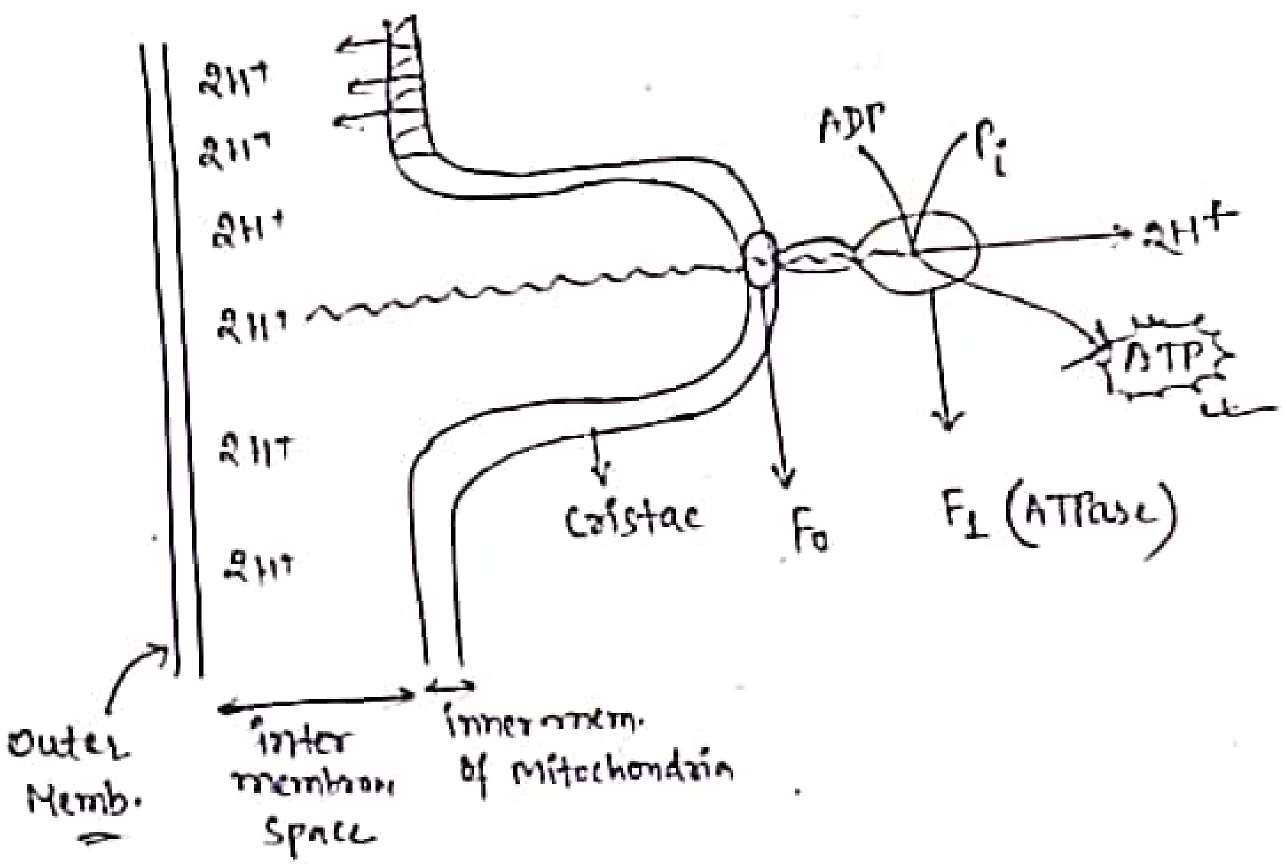
→ F_1 particle is also known as ATPases, which actually helps to combine ADP with P_i to synthesize ATP molecule.

→ From 1 $NADH_2$, a total of 3 pairs of protons ~~H^+~~ is pumped out in intermembrane space during E.T.S.

→ The concn of H^+ rises in inter-membrane space during E.T.S. So, these H^+ have tendency to go back to matrix.

→ These pair of protons posses some energy during return, which is then utilised to combine ADP with P_i to release 1 ATP.

→ Thus, the energy released during ETS is finally encashed into ATP by oxidative phosphorylation



71 **Energy sheet of Respiration :-**

→ During anaerobic respiration, 1 Glucose molecule yield only. a total of 2 ATP.

→ But, in aerobic respiration, 1 Glucose molecule yields a total of 38 ATP in which 2 ATP is utilised to pump $2NADH_2$ in matrix which is formed during in cytoplasm during glycolysis.

Step	ATP	$FADH_2$ / $NADH_2$	Grand Total.
(1) Glycolysis	2 ATP	$2 NADH_2$ $(2 \times 3) = 6$	8 ATPs
(2) Oxidative Decarboxylation	—	$2 NADH_2$ $(2 \times 3) = 6$	6 ATPs
(3) Kreb's cycle	2ATP ↑ 2GTP	$\left.\begin{matrix} 3 NADH_2 \\ 1 FADH_2 \end{matrix}\right] \times 2$ Kreb cycle $\therefore \left.\begin{matrix} 3 \times 3 \\ 1 \times 2 \end{matrix}\right] \times 2 = \begin{matrix} 18 \\ 4 \end{matrix}$	24 ATPs

Total = 38 ATPs

Note:-

2 ATPs get used up to pump $2NADH_2$ into matrix which was synthesised during glycolysis

Hence,

$$\begin{array}{r} 38 \text{ ATPs} \\ -\ 2 \text{ ATPs} \\ \hline \end{array}$$

Net yield from 1 Glucose molecule = 36 ATPs ✓ Ans.

Shuttle System :-

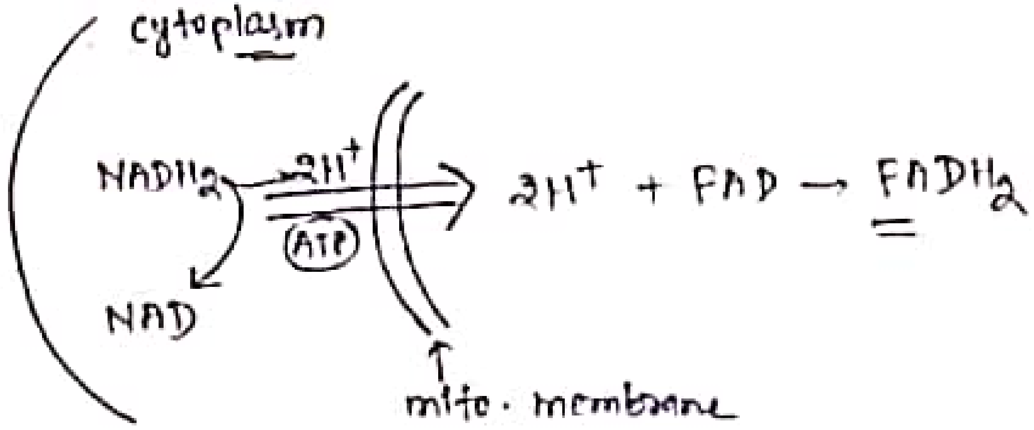
→ $2NADH_2$ systhesized during glycolysis in cytoplasm needs to pumped inside mitochondrial matrix to participate in E.T.S for excess encashment of energy

→ But the membrane of mitochondria is impermiable to $NADH_2$.

→ So, they usese specific shuttle system to get inside into mit matrix.

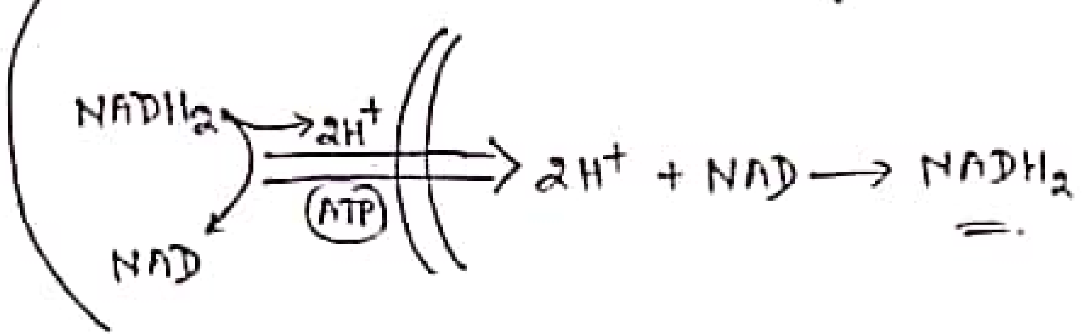
Two Types of shuttle System :-

(1) Glycerol- phosphate Shuttle System :-



(2) Malate- Aspartate Shuttle System :-

More Efficient system



Common Pathway for Protein, Fats & Carbohydrate:-

→ Respiratory rxn are AMPHIBOLIC in nature. Both, Catabolism & anabolism occurs.

→ For energy liberation, the preference order of breakdown for substrates are :-

Carbohydrates > Fats > Protein

→ Proteins first breaks into Aminoacid.

→ Fats first break into Fatty Acid and glycerol.

3 Types of Fat molecules :-

(i) Monoglyceride Fat :-

↓

1 F.A + 1 glycerol

(ii) Diglyceride Fat :-

↓

2 F.A. + 1 glycerol

(iii) Triglyceride Fat :-

↓

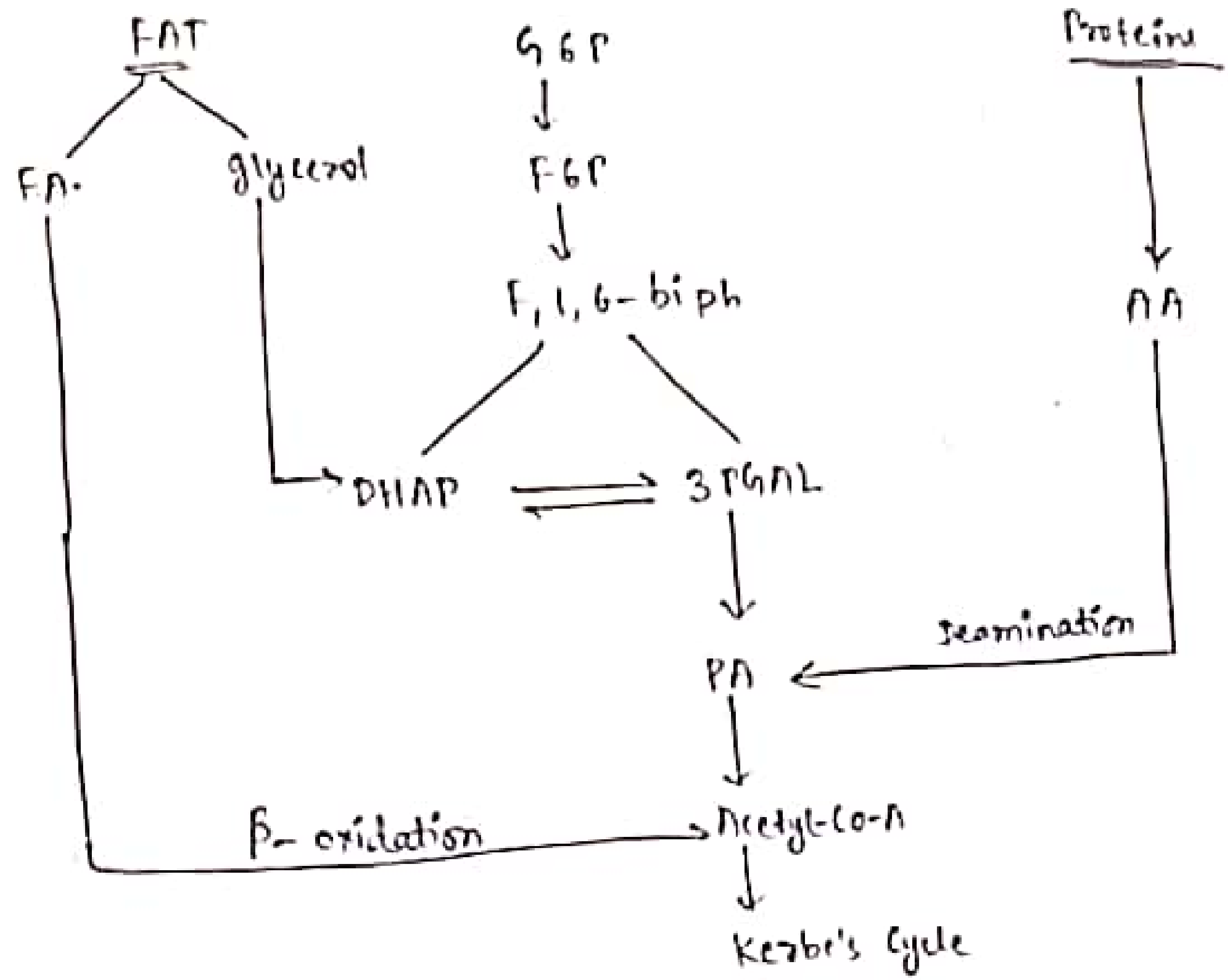
3 F.A. + 1 glycerol

Confirm it. Check it out

→ 1 A.A breaks to form 15 ATPs.

→ 1 F.A breaks to form 12 ATPs.

→ 1 glycerol breaks to forms 18 ATPs



AMPHIBOLIC PATHWAY

Respiratory Quotient :- (RQ).

$$RQ = \frac{\text{vol. of } CO_2 \text{ liberated.}}{\text{vol. of } O_2 \text{ absorbed.}}$$

(1) $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + E$

Carbohydrates

$$RQ = \frac{6CO_2}{6O_2} = 1$$

(2) Fats/Proteins

$2\,C_{51}H_{98}O_6 + 145O_2 \longrightarrow 102\,CO_2 + 98H_2O + E$

Tripalmitate

$$RQ = \frac{102\,CO_2}{145\,O_2} = 0.7$$

less than 1

(3) Organic Acids :-

$$2(COOH)_2 + O_2 \longrightarrow 4CO_2 + 2H_2O + E$$

Oxalic acid

$$RQ = \frac{4CO_2}{O_2} = 4$$

more than 1

(ii) $C_4H_6O_5 + 3O_2 \longrightarrow 4CO_2 + 3H_2O + E$

Malic Acid

$$RQ = \frac{4CO_2}{3O_2} = 1.3$$

more than 1

Imp. (4) Anaerobic Respiration :

$$C_6H_{12}O_6 \longrightarrow 2CO_2 + 2C_2H_5OH + E$$

$$RQ = \frac{2CO_2}{0} = \infty$$

Imp.

\+ (5) $2C_6H_{12}O_6 + 3O_2 \longrightarrow 3C_4H_6O_5 + 3H_2O + E$

Succulant Plant

$$RQ = \frac{0}{3O_2} = 0$$

(6) Balanced Diet :

RQ = 0.85