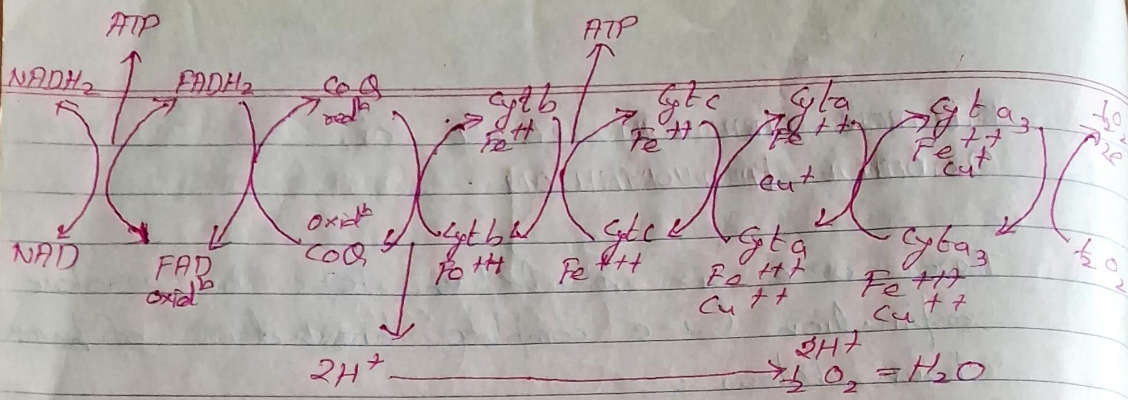
ELECTRON TRANSPORT SYSTEM OR, OXIDATIVE PHOSPHORYLATION

There are six oxidation steps in aerobic respiration (i-e complete breakdown of hexose shown below :—

SUBSTRATES	H-ACCEPTORS	PRODUCTS
① 3-phosphoglyceraldehyde	$NADPH_2$	1,3 diphosphoglyceric acid
② Pyruvic acid.	$NADPH_2$	Acetyl co A.
③ Isocitric acid	$NADH_2$	Oxalo succinic acid
④ α-ketoglutaric acid	$NADH_2$	Succinyl CoA.
⑤ Succinic acid	$FADH_2$	Fumaric acid.
⑥ Malic acid	$NADH_2$	Oxalo acetic acid

- 2H in $NADPH_2$, $NADH_2$ & $FADH_2$ is at -ve redox potential and at high energy level. These 2H cannot combine directly with oxygen to form water (H_2O) (TERMINAL OXIDATION) because oxygen is at +ve redox potential and low energy level.
- These 2H electrons has to pass through a series of intermediate compounds to bring hydrogen at the same redox potential level as that of oxygen, then these two combine together forming water (H_2O).
- The intermediate compounds are shown in the figure. The are arranged on increasing order of their redox potential i-e from more negative to positive value.



These compounds consitute "Electron Transport System" of respiratory chain. The compounds of respiratory chain can be classified into three classes :—

1. Flavo Protein – 2 types, FMN & FAD, NAD
2. Electron carriers – 2 types, CoQ & UQ.
3. Cytochromes – 4 or 5 types, Cyt b, cyt c, cyt c1, cyt a & cyt a_3.

The arrangement of these compounds has been shown in fig :— ②

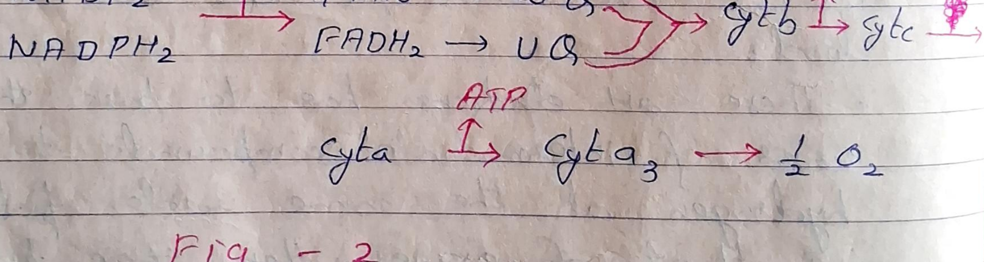


Fig – 2

• Each member of the E.T.S is alternately oxidised and reduced. It is reduced after accepting the electrons and oxidised after passing the electrons to its next member having higher redox potential.

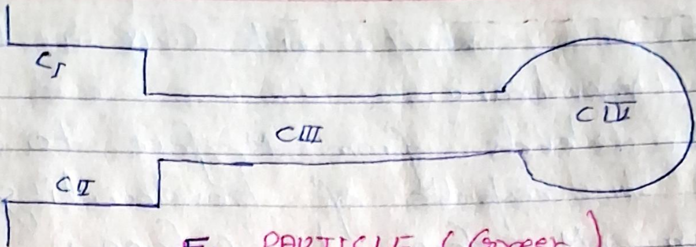
The released energy is utilised in the formation of one ATP (ADP + ip = ATP) at each of the above three steps. This ATP formation is termed as OXIDATIVE PHOSPHORYLATION.

SITE OF SITUATION OF MEMBERS OF E.T.S.

- Green and his associated grouped the members of E.T.S into four complexes and named them complex I, Complex II, Complex III & Complex IV. According to him these complexes occupy positions in the foot, stalk & head of F_1 - particles as shown in the figure. According to recent views the members of E.T.S are situated in the inner membrane of Mitochondria.
- The inner membrane is a unite membrane having peripheral protein layers and a central bilipid layer, where members of E.T.S are situated togather known as "RESPIRATORY ASSEMBLAGE".
- According to Papa 1976, Depierre and Ernster 1977, the main characteristics and topology of the four complexes are as follows :-

COMPLEX - I

- This is the largest complex.
- It has FMN.
- It has Iron, sulpher centre as prosthetic group.
- Its NADH reaction site is at the M-face.



F1 PARTICLE (Green)

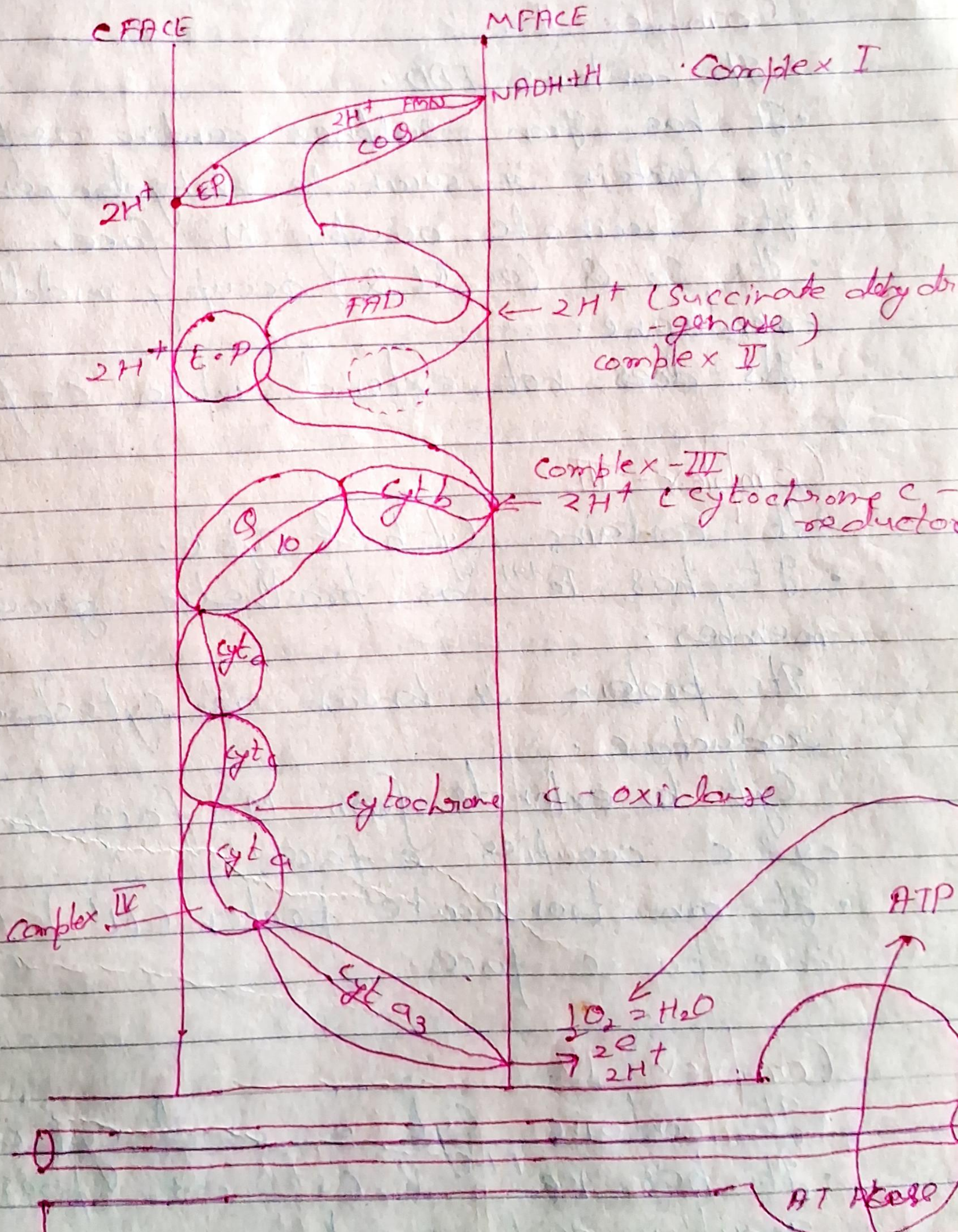


Fig - Topology of complex in inner membrane

- Movement of electrons & protons across the inner memb

of E.T.S & Oxi-phosph

- It is contact with CoQ in the middle of the membrane.
- It extends from M-face to C-face.
- It is capable of translocating protons (H^+) from M-face to C-face.

Complex-II

- It contains FAD.
- It has Iron-sulphes centre as prosthetic group
- Its protein is succinate dehydrogenase.
- Its succinate occupy M-face.
- Its Co Q (or U Q) occupy middle of the membrane.
- Its does not extend upto C-face.

Complex-III

- It contains Cyt b & Cyt c.
- It has Fe^{+++} as prosthetic group in each member.
- Its protein is known as cytochrome c-reductase.
- Cyt b extends from M-face to C face, cyt c occupies C-face.
- It can translocate proton (H^+) from M-face to C-face.

Complex IV

- It contains Cyt a and cyt a_3.
- It has Fe^{+++} & Cu^{++} as prosthetic group in each member.
- Its protein is known as cytochrome c oxidase.

- It extends from C-face to M-face.
- It supplies (transfer) electrons to oxygen at the M-face.

MODERN CONCEPT OF OXIDATIVE PHOSPHORYLATION

- The protons (H^+) originating from electrons transfer are translocated by the respiratory chain across the inner membrane of mitochondria from M-face to C-face at three points of the E.T.S as shown in the figure.

- This translocation creates a PH gradiant and potential difference across the membrane which constitute "PROTON MOTIVE FORCE."

- The proton motive force tends to move the protons (H^+) from C-face to M-face since the inner membrane is highly impermeable for such movement of protons, these can only reach the M-face through the "PROTON CHANELS" in F_1 particle having ATP-ase.

When protons (H^+) move from C-face to M-face, the F_1 ATPase catalyses ATP synthesis. Figure indicates that for each NADH + H^+ that is oxidised six protons are translocated through the inner membrane. These six protons when reaching to the M-face through F_1 ATP ase give rise three molecules of ATP. Where as for each

$FADH_2$ two ATP molecules are produced.

CONCLUSION → The Electron Transport system of mitochondria is coupled at three po[ints] with phosphorylating system.