Electron Transport System // Respiratory chain

There are four types of oxidations —

(i) By gain of molecular oxygen.
(ii) By removal of hydrogen (Dehydrogenation).
(iii) By change in valency.
(iv) By hydration followed by dehydrogenation.

→ The most common one type in respiration as a whole is removal of a pair of hydrogen from the oxidising substrate.

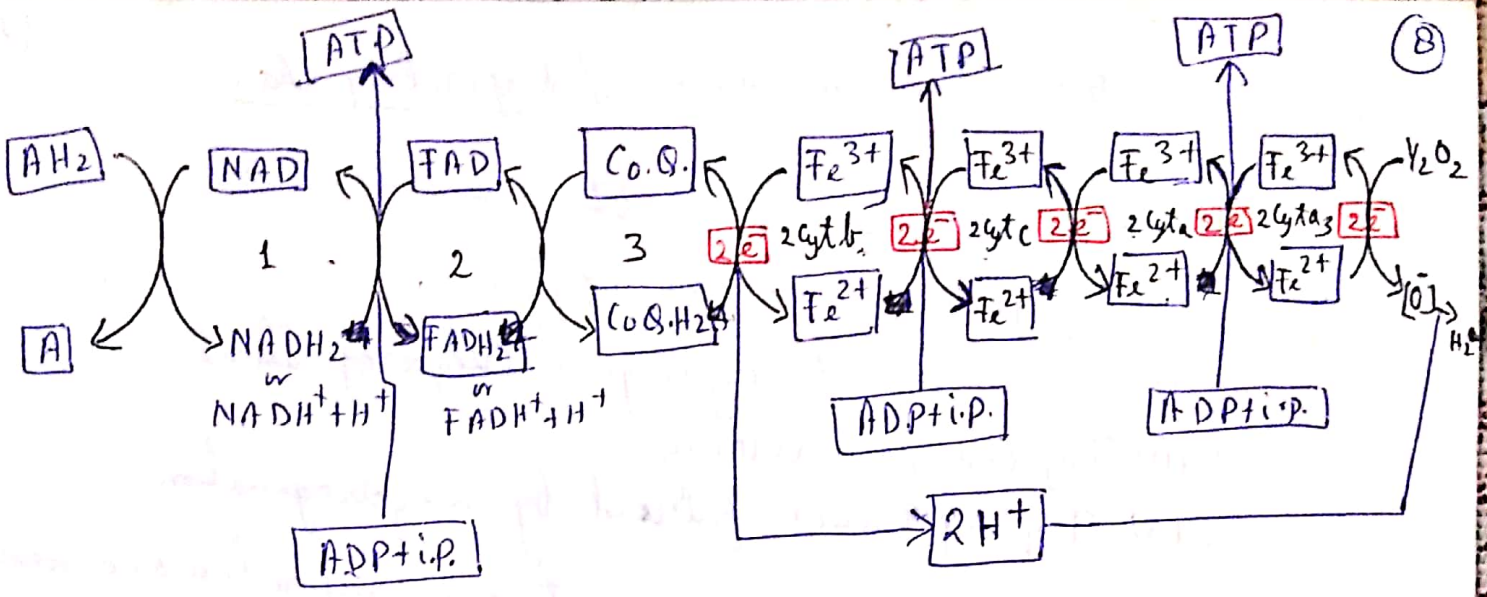
→ The pairs of hydrogen ($2H^+ + 2e$) removed in oxidation steps are transported to oxygen molecules through an assembly of enzymes lined up one after the other in sequence of their relative electropotential, which is known as Respiratory chain (oxidation-reduction chain).

→ The enzymes of this chain mediate the transport of hydrogen by help of their prosthetic or enzyme groups.

→ The prosthetic group subsequently undergoes reduction and oxidation by accepting hydrogen or electrons from the prosthetic group of the preceding member of the chain and passing them on the next member of the chain.

→ Most of the enzymes catalysing actual removal of hydrogen from the substrate are thought to be more or less loosely bound to the inner membrane, where as rest of the enzymes are incorporated as integral components of the lipoprotein matrix of the inner membrane.

→ The linking of enzymes of the respiratory chain is in the form of a forked chain connected with a communal chain of cytochromes leading to the molecular oxygen.



Respiratory Chain / Electron Transport Chain / System.

— In respiration Hydrogen molecules are removed mostly by NAD except only one case of Succinate where FAD do it.

— The NAD ~~does~~ reduced to $NADH_2$. F

— This $NADH_2$ ~~gives~~ gives Hydrogen to FAD, get itself oxidised and reduce FAD. to $FADH_2$

— $FADH_2$ passes Hydrogen to Ubiquinone or Coenzyme Q ($CoQ.$) [Chemically related to Vitamin K and Vit E. It is similar to plastoquinone of chloroplast. Found before Cytochrome b and after FAD].

— From $CoQ.H_2$ → Electrons are separated from Protons.

$$2H \longrightarrow 2H^+ + 2e.$$

— The electrons passed through Cytochromes, b, c, a and a_3 to molecular oxygen one at a time. It is mediated by the iron (heme) prosthetic groups being reduced and oxidised ~~reversi~~ reversibly by accepting from former and donating to later

$$Fe^{3+} + e \longrightarrow Fe^{2+}$$

— At the terminal end of cytochrome chain molecular oxygen picks up electrons and $[H^+]$ from the medium and water molecule is formed

The energy released by the electrons at each step is equal to the difference in ~~the~~ the energy levels of donar and acceptor. If it is equal ~~and~~ or more than 0.28 ~~volt~~ electron volt inorganic phosphate (i.p.) binds to (ADP) and ATP is formed. It is known as oxidative phosphorylation. It occurs at three steps in this chain.

$NADH_2$ ⟶ FAD ⟶ ATP.
Cyt b ⟶ Cyt c. ⟶ ATP.
Cyt a ⟶ Cyt a_3 ⟶ ATP.

Thus from NAD — 3 ATP molecules and
from FAD — 2 ATP molecules are formed.

Hence the respiratory chain controls the gradual release of energy and functions as chemical machinery of mitochondria

E.T.S. in Glycolysis

~~1. 1. Glyceraldehyde~~
(13) 1,3 diphosphoglyceraldehyde ⟶ 1,3diphosphoglyceric Acid ⟶ (7) Step → $NADH_2$ → 3ATP

During Link Reaction

(2) Pyruvic Acid ⟶ Acetyl Co.A. → $NADH_2$ → 3ATP

During Krebs Cycle

(3) Isocitric Acid ⟶ Oxalosuccinic Acid — $NADH_2$ → 3ATP
(4) α-Ketoglutaric Acid ⟶ Succinyl Co A. → $NADH_2$ → 3ATP
(5) Succinic Acid ⟶ Fumaric Acid → $FADH_2$ → 2ATP
(6) Malic Acid ⟶ Oxalo acetic Acid → $NADH_2$ → 3ATP

⟶ 5 $NADH_2$ + 1 $FADH_2$
⟶ 5 X 3 ATP + 1 X 2 ATP.
= 15 ATP + 02 ATP = 17 ATP.

During Conversion of GDP to GTP and then GTP to ATP during ~~conv~~ at Succinyl Co A to Succinic Acid formation. direct ATP is formed ∴ via G.T.P. → one molecule.

17 ATP + 01 ATP = 18 ATP.

~~Krebs Cycle~~ For One molecule of glucose two molecules of 3 Phosphoglyceraldehyde are formed which leads to two such cycles. Form ~~for~~ → Hence 2 × 18 ATP = 36 ATP are produced

→ There is also net gain of 2 molecules of ATP during Glycolysis.

36 ATP + 02 ATP = 38 ATP ~~are produced~~ are produced.

Over all ~~resp~~ reaction of aerobic respiration is :

$C_6H_{12}O_6 + 6O_2 + 38ADP + 38H_3PO_4$ (i.P) $\longrightarrow 6CO_2 + 44H_2O + 38ATP$