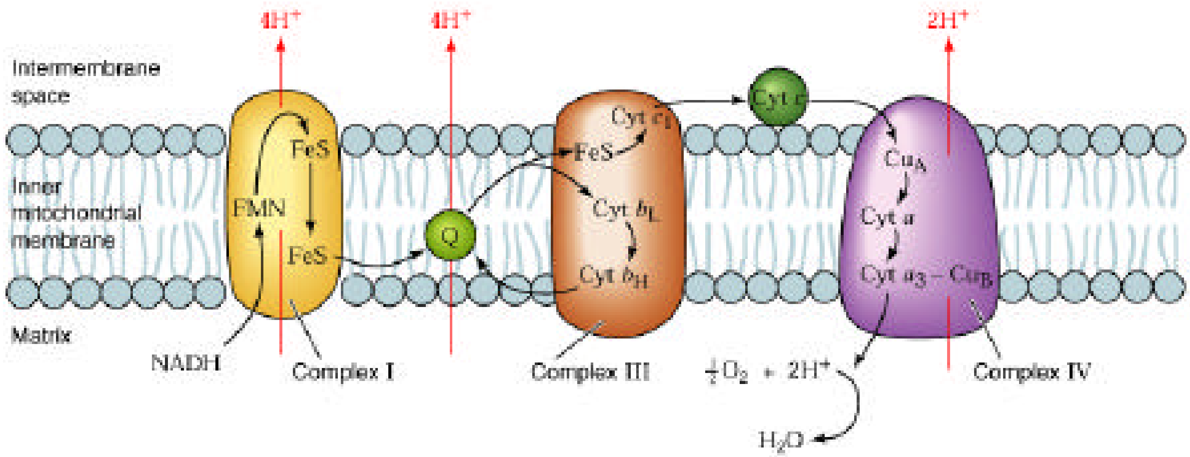
Electron Transport Chain II

The ETS is composed of four large protein complexes in the inner mitochndrial membrane and are involved in transferring electrons from reduced carriers (coenzymes) to to O2. Complexes I and II transfer electrons to the lipid-soluble electron carrier coenzyme Q, which transfers electrons to complex III. From there, electrons pass to cytochrome c, a peripheral membrane protein with a heme prosthetic group, which then transfers electrons to complex IV.

Cytochromes - There are 7 cytochromes (heme proteins; heme = iron + porphyrin) in the ETS. All have a reddish-brown tint caused by the presence of iron. Each cytochrome has a distinct absorbance spectra which represent a structural feature of the cytochrome and is designated as a member of a, b, or c family. Why hemes? You must recognize the differences with the function of hemes in myoglobin and hemoglobin and the cytochromes. The metals (iron for most copper of a and a3) are used for there ability to accept and donate electrons easily. Differences in the redox state is due to the total environment of the heme/cytochrome complex.

Iron-sulfur centers – A characteristic of the ETS is to have components with different oxidative potential placed strategically along the chain. The proteins with iron-sulfur centers are needed to provide a low oxidation potential. Thus they are present in complexes I, II and III but not in IV.



Complex I

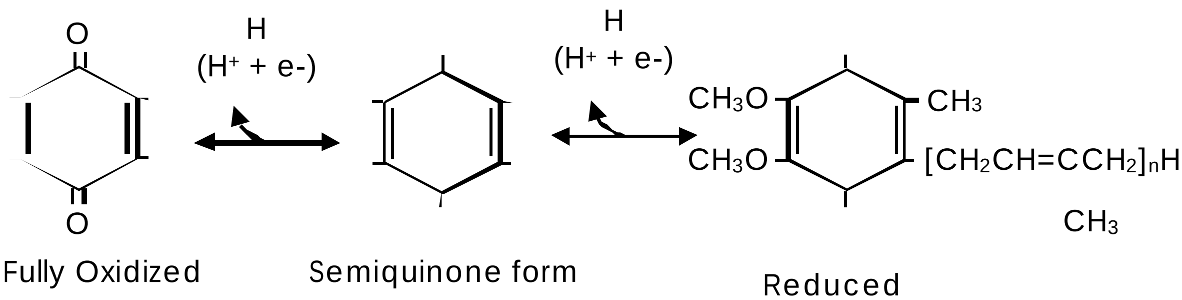
- large complex (850 kDa) with over 30 subunits some from mitochondrial DNA.
- mediates transfer of e- from NADH to ubiquinone
- NADH is oxidized and in doing so transfer of e- to FMN
- There are several Fe-S centers held in place by cys residues (2Fe-2S, or 4Fe-4S)
- Coenzyme Q is ultimate acceptor of electrons in this complex
- Q and FMN can adopt 3 oxidation states
- protein changes conformation redox state - most likely leads to proton pumping - resulting pKa changes in aas in complex I probably leads to loss and gain of protons
- 2 e- are transferred from NADH and 4 H+ are pumped

Complex II

- Succinate dehydrogenase and other FADH producing enzymes are linked to the complex - direct transfer of e- from the TCA
- FADH is part of the complex and 2e- electrons are donated here
- Transfer of 1 e- to the Fe-S center to Q
- is not the second part of the chain, rather a another entry point into the chain
- no H+ pumped, so there is a reduced potential of H+ gradient formed and ATP formation potential

Coenzyme Q -

- mobile part of ETS - long hydrophobic isoprenoid chain allows movement in hydrophobic membrane core
- three different states
- transfers one or two electrons between complexes
- part of several portions of chain
- Q cycle is important in transfer single e- instead of two



Complex III

- Accepts two one e- transfers from QH2 and eventually transferred to cytochrome C
- Fe-S center and two similar hemes B and c1 involved
- reduction potential of the b hemes is different due to membrane topology
- Important that it is two individual transfers of e- to cyto C
- Two protons are pumped - partially due to lower reduction potential at this point in the chain

- Hemes

same porphyrin ring as in hemoglobin

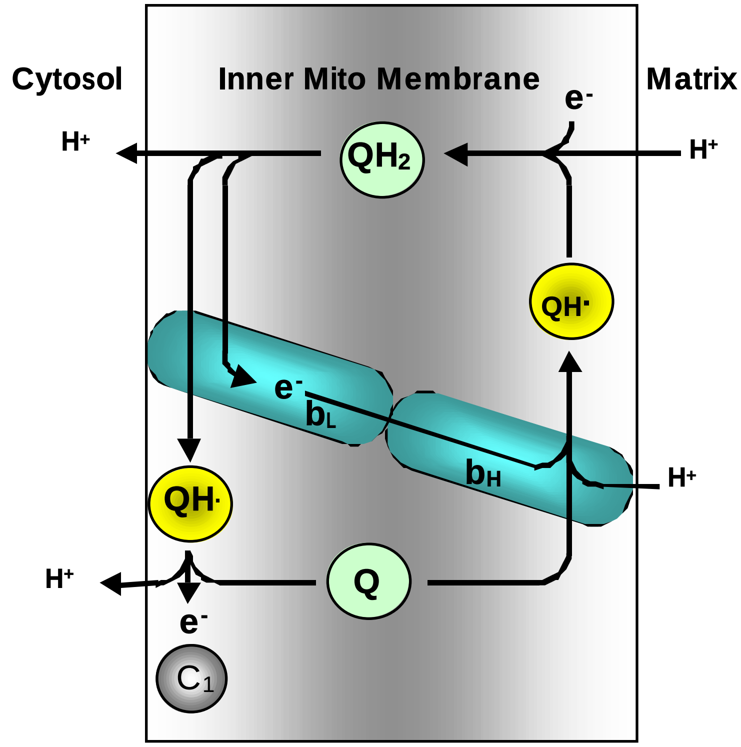
cytochromes b and c are covalently attached through cysteines via thioester linkages

Heme A has a long hydrophobic side chain

How are these held in place differently than hemoglobin heme?

Q cycle

- mobile part of ETS - long hydrophobic isoprenoid chain allows movement in hydrophobic membrane core
- three different states
- transfers one or two electrons between complexes
- part of several portions of ETS chain
- QH· Is anchored at each membrane while Q and QH_2 are mobile
- Q cycle is important in transfer single e^- instead of two



Cytochrome C

- Only water soluble cytochrome
- loosely associated with inner mitochondrial membrane (cytosolic side)
- migrates in the reduced state carrying 1e- to complex IV
- highly conserved through evolution

Complex IV

- Differs in copper ions in e- transfer not Fe-S.
- e- transferred from cytochrome C to molecular oxygen, one at a time
- one proton pumped per e- transferred - two for O_2, two cytosolic side
- Cytochrome C to Cu_A- $Heme_a$ -> $Heme_b$-Cu_B -> O_2
- This complicated system is to prevent the formation of oxygen radicals and superoxide anions
- Controlled by transfer of e- to oxygen while bound to Fe and Cu complex