

### Electron transport Chain inhibitor

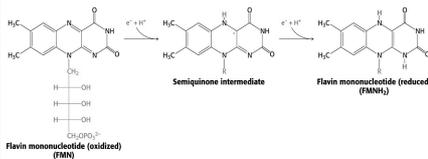
pump1	Rotenone
pump3	Antimycin
pump4	Cyanide
ATP synthase	Oligomycin
protons	uncoupling agent

### Generated

Glycolysis	ATP	2
	NADH	3-5
Pyruvate metabolism	NADH	5
TCA cycle	ATP	2
	NADH	6
	FADH <sub>2</sub>	2

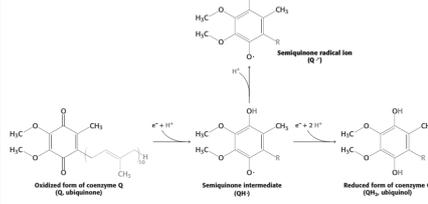
### FMN/FMNH/FMNH<sub>2</sub>

#### Flavin Mononucleotide (FMN): 1 or 2 e-carrier



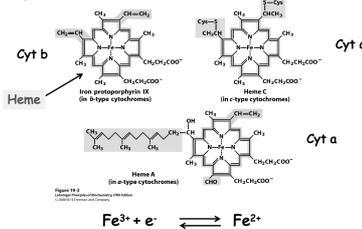
### Coenzyme Q

**Coenzyme Q**  
also called CoQ, Q or ubiquinone, is very hydrophobic



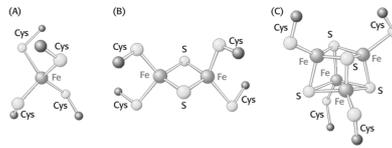
### Prosthetic groups of cytochromes

Cytochromes are subdivided into three classes depending on what wavelengths of light they absorb



### Iron-sulfur protein (Fe-S)

Iron-sulfur protein contains iron-sulfur clusters comprising sulfide-linked mono-, di-, or tetra iron centers in variable oxidation states.



**Figure 18.9 Iron-Sulfur Clusters.** (A) A single iron ion bound by four cysteine residues. (B) 2Fe-2S cluster with iron ions bridged by sulfide ions. (C) 4Fe-4S cluster. Each of these clusters can undergo oxidation-reduction reactions.

### Complex 1

#### NADH-Q Oxidoreductase

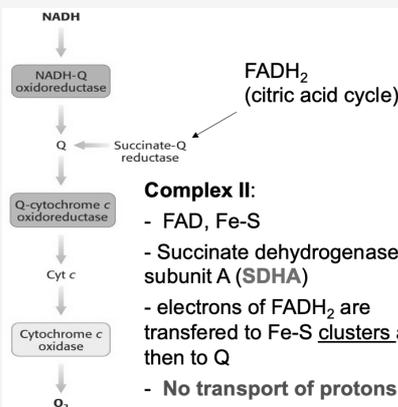
Enormous enzyme (>900 kDa), 46 polypeptides

FMN, Fe-S clusters

Steps of Electron-Transfer:

1. Binding of NADH and transfer of its electrons to FMN (prosthetic group of complex)
  2. Electrons are transferred from FMNH<sub>2</sub> to a series of iron-sulfur clusters (prosthetic group of complex)  $\rightarrow 2Fe-2S + 4Fe-4S$  clusters
  3. Electrons are shuttled to coenzyme Q (ubiquinone)
- 2 Electrons from NADH to Coenzyme Q  $\rightarrow$  pumping 4 H<sup>+</sup> from matrix to intermembrane space

### Complex 2 & CoQ (entry point for electrons from FADH<sub>2</sub>)



### Complex 3

#### Electrons Flow from Ubiquinol (QH<sub>2</sub>) to Cytochrome c Through Q-Cytochrome c Oxidoreductase

Cytochrome b: heme bL and heme bH

Cytochrome c1: heme c1

iron-sulfur protein: 2Fe-2S center

Function: catalyse transfer of electrons from QH<sub>2</sub>  $\rightarrow$  oxidized cyt c

pumps 4 H<sup>+</sup> out of matrix  $\rightarrow$  intermembrane space

Coupling of electron transport from Q  $\rightarrow$  cyt c and transmembrane proton transport: Q cycle

### Complex 4

#### Cytochrome c oxidase catalyzes the reduction of molecular oxygen to water

CuA/CuB, heme a, heme a<sub>3</sub>, CuB

heme a<sub>3</sub>-CuB is responsible for reduction of O<sub>2</sub>

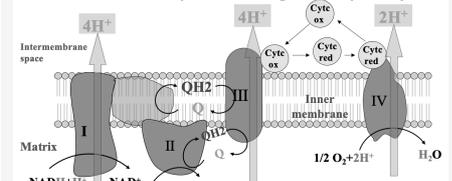
Oxidation of cyt c coupled to reduction of O<sub>2</sub>  $\rightarrow$  H<sub>2</sub>O

Electron transfer coupled to proton pump

pumps 2 H<sup>+</sup> from the matrix to intermembrane space

### Flow

#### Flow of electrons and protons through the respiratory chain



1. NADH  $\rightarrow$  Complex I  $\rightarrow$  Q  $\rightarrow$  Complex III  $\rightarrow$  cytochrome c  $\rightarrow$  Complex IV  $\rightarrow$  O<sub>2</sub>
2. FADH<sub>2</sub>  $\rightarrow$  Complex II  $\rightarrow$  Q  $\rightarrow$  Complex III  $\rightarrow$  cytochrome c  $\rightarrow$  Complex IV  $\rightarrow$  O<sub>2</sub>