Biochemistry
Team 434

Respiratory Chain

Respiratory Block

COLOR INDEX: Red= Important Purple= Addition Orange= Explanation

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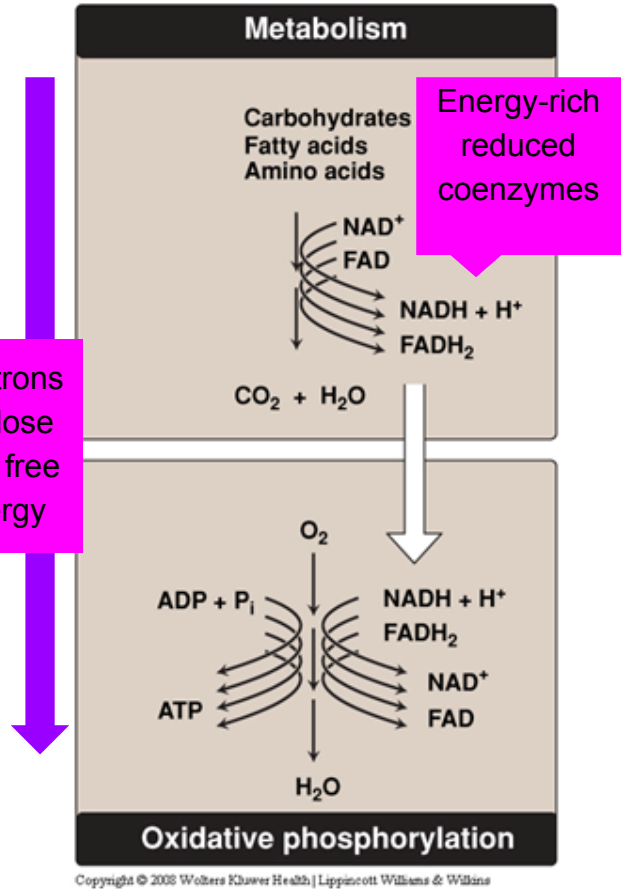
Electron Transport Chain (ETC)

- Use respiratory O_2 to finally produce ATP (energy)
- Located in the inner mitochondrial membrane
- Final common pathway of metabolism
- Electrons from food metabolism are transported to O_2
- Uses maximum amount of body's oxygen

Metabolic breakdown of energy-yielding molecules



Components of ETC

- All members/components are located in the inner mitochondrial membrane (IMM)
- **IMM contains 5 complexes:**

-Complex I, II, III, IV (part of ETC)

-Complex V (ATP synthase: catalyzes ATP synthesis)

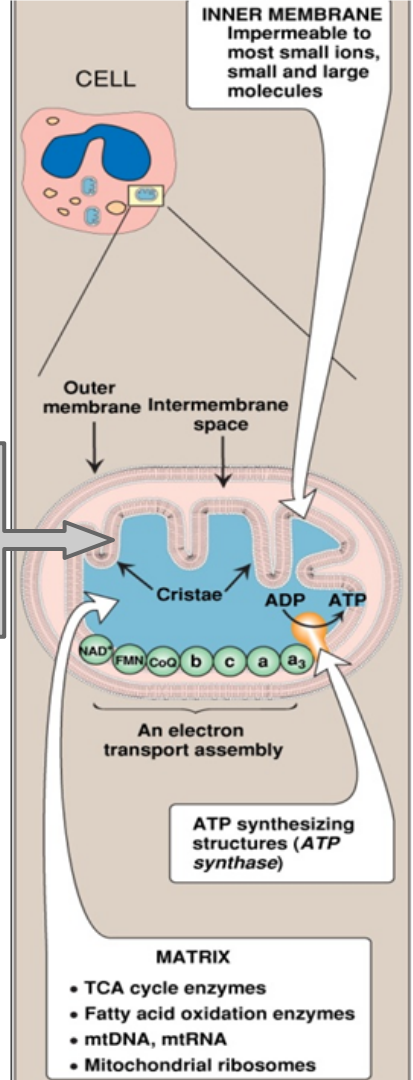
-Mobile electron carriers :

- CoQ (coenzyme Q)
- Cytochrome c (cytochrome complex)

Organization of ETC

- Each complex accepts or donates electrons to mobile carriers
- Carriers accept electrons from donors and then donate to the next carrier in chain
- Electrons finally combine with oxygen and protons to form water
- Oxygen is required as a final acceptor (respiratory chain)

Cristae increase the surface area



Complex II
(Succinate Dehydrogenase)

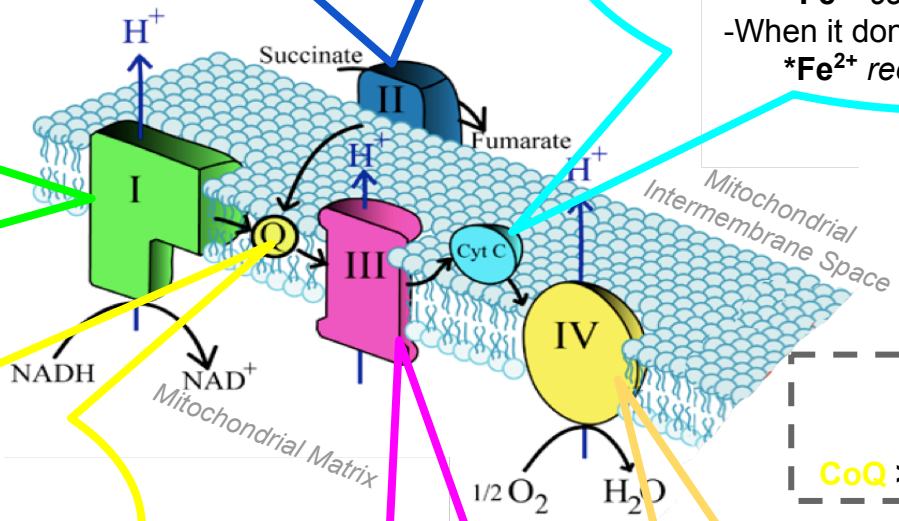
-Part of **TCA** cycle.
-Transfers electrons *to* **CoQ**.

Cytochromes

-A protein, each contains:
***Heme Group**
(*poryphyrin ring + iron in Fe^{3+} state*)
-When cytochromes accept electron:
***Fe^{3+}** *converted to* **Fe^{2+}**
-When it donates to next carrier:
***Fe^{2+}** *reoxidized to* **Fe^{3+}**

Complex I
(NADH Dehydrogenase)

-Collects pair of electrons *from* **NADH** *to* **CoQ**.



Coenzyme Q
(CoQ)

-Called **Ubiquinone.**
-In biological systems:
Ubiquitous.
-Non protein member of **ETC**.
-Lipid soluble, mobile.

Electron Flow:

CoQ > Comp III > Cyt C > Comp IV

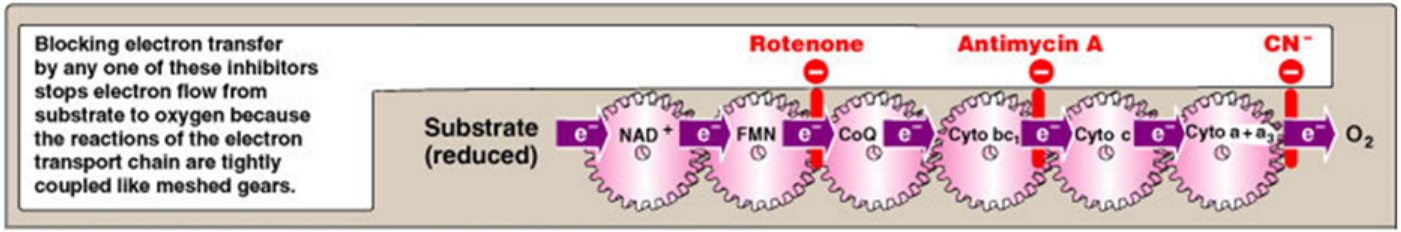
Complex III
(Cytochrome bc1)

Complex IV
(Cytochrome $a+a_3$)

Site-specific inhibitors of ETC

- Rotenone (rotates none) easier to memorize and relate :D
- Antimycin
- CN-

Those inhibitors inhibit the electron flow from substrate to oxygen by stopping one of the steps in the chain, just like stopping a gear in a chain.

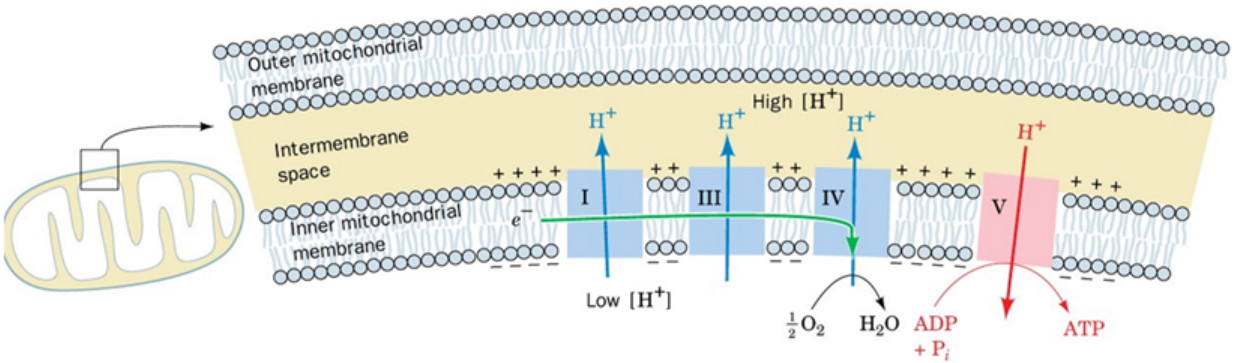


ETC is coupled to proton transport for ATP synthesis

- The energy of electron transfer is used to drive the protons out of the matrix note: H+ transfer from low concentration to high concentration.
- It is done by complexes I, III and IV (proton pumps)

complex II is probably busy in the TCA cycle :p

- This creates a proton gradient across the IMM to synthesize ATP



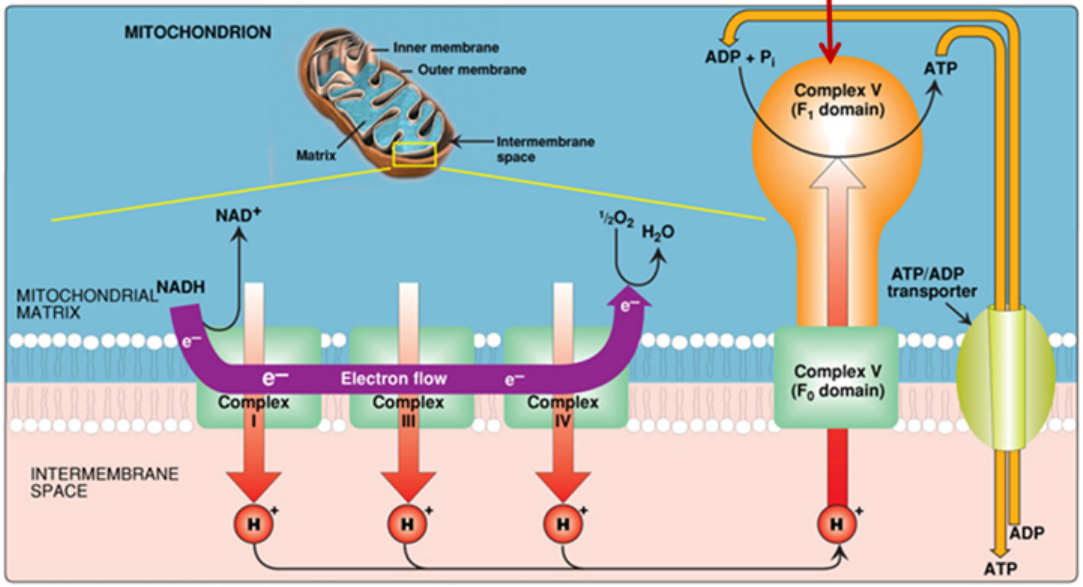
ATP synthase

ATP synthase (Complex V) synthesizes ATP

Consists of two domains:

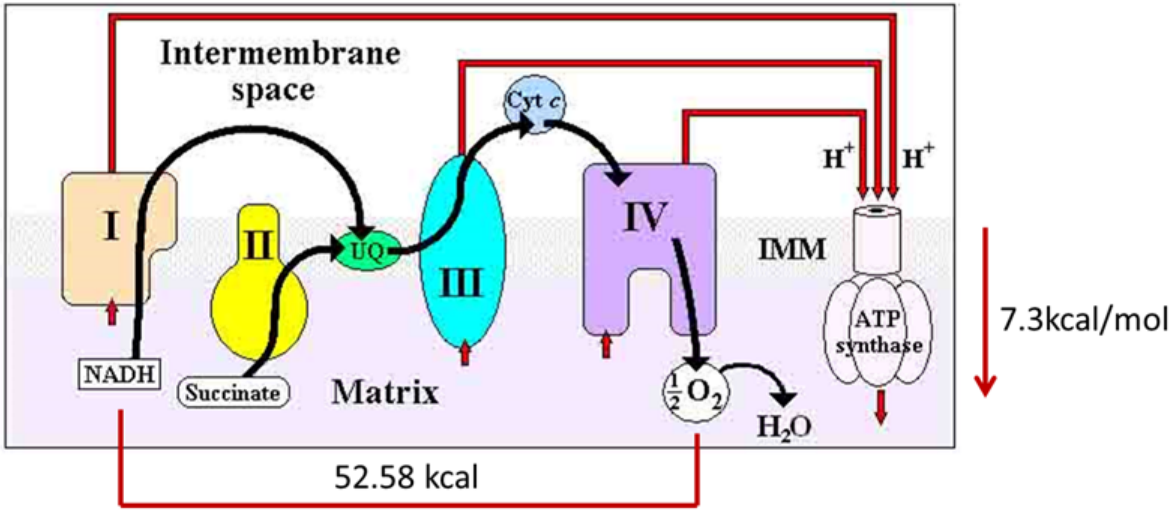
- F_0 – membrane spanning domain
- F_1 – extramembranous domain

note: H+ will move from High concentration (intermembrane space) to low concentration (mitochondrial matrix)



Energetics of ATP synthesis

- The energy required for phosphorylation of ADP to ATP = **7.3kcal/mol**
- Energy produced from the transport of a pair of electrons from NADH to O2 = **52.58 kcal**
- No. of ATP molecules produced is 3 (NADH to O2)
- Excess energy is used for other reactions or released as heat



P:O ratio

ATP made per O atom reduced

For NADH

P:O = 3:1

3 ATP molecules are made per oxygen atom reduced

For FADH2

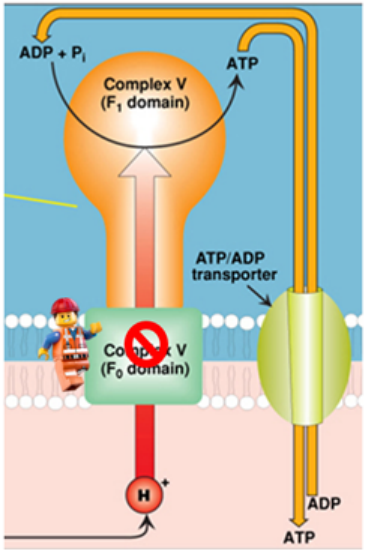
P:O = 2:1

2 ATP molecules are made per oxygen atom reduced

Inhibitors of ATP synthesis

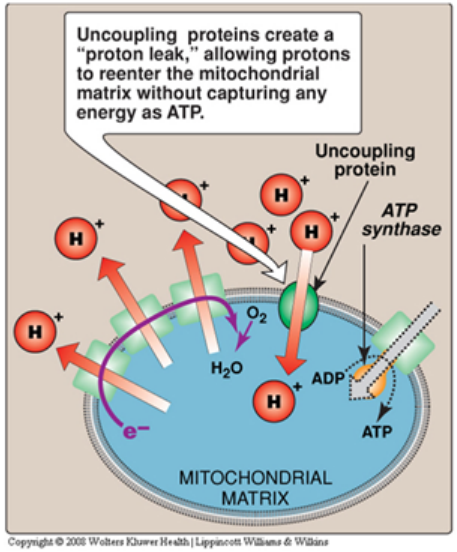
1. Oligomycin:

Binds to F0 domain of ATP synthase and closes the H+ channel



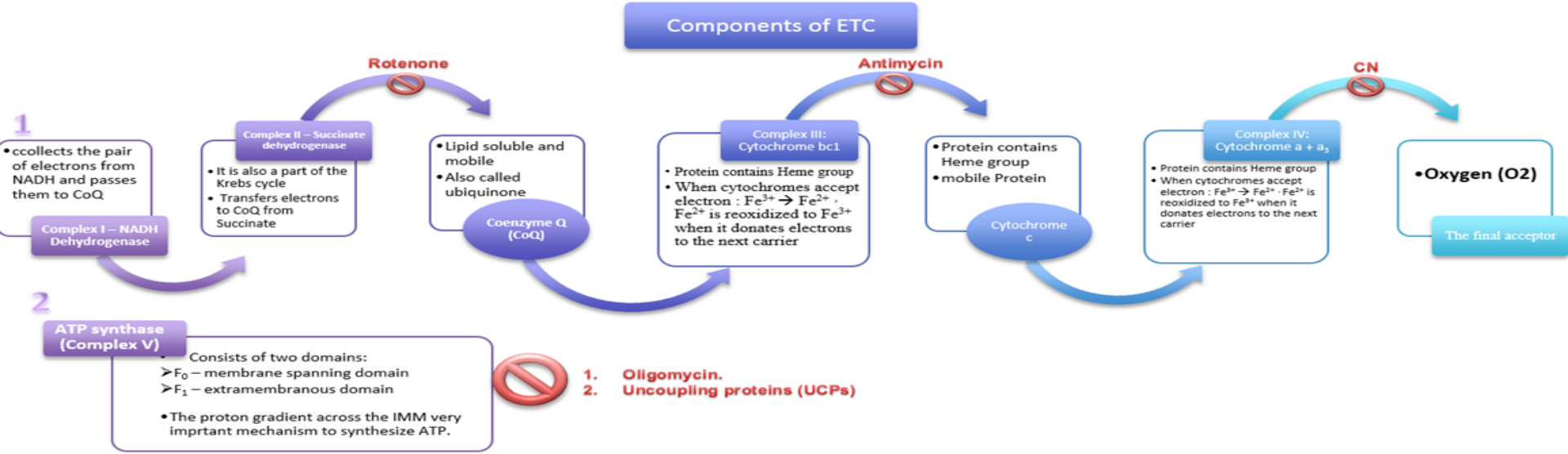
2. Uncoupling proteins (UCPs):

- Create proton leaks (allow protons to reenter the matrix without ATP synthesis)
- Energy is released as heat (nonshivering thermogenesis)



summary

- ETC is Energy extraction mechanism and it is the final common pathway of metabolism.
- The electron transport from glycolysis and crabs cycle to the respiratory Chain (ETC) and oxidative phosphlration to oxygen (the final acceptor) to produce water and ATP.
- Located in the inner mitochondrial membrane.
- Carriers accept electrons from donors and then donate to the next carrier in chain Oxygen is required as a final acceptor (respiratory chain)



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- Energy produced from the transport of a pair of electrons from NADH to O2 = 52.58 kcal
- No. of ATP molecules produced is 3 (NADH to O2)

MCQ’s

1- which one of the following is a mobile electron carrier?

A- CoQ
B- complex 1
C- oligomycin

2- ETC's components and members are located in which of the following:

A- inner mitochondrial membrane
B- outer mitochondrial membrane
C- cytoplasm

3- which of the following is NOT part of the ETC:

A- complex 1
B- complex 3
C- complex 5

4- one of the is an importance of oxygen:

A- receptor of protons
B- receptor of electrons
C- both

5- the name of the first complex in the ETC is:

A- succinate dehydrogenase
B- NADH dehydrog
C- ubiquinone

1. A
2. A
3. C
4. C
5. B

❖ Helpful Videos:

- ➢ Cellular Respiration (Electron Transport Chain)
- ➢ Gradients (ATP Synthases)

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