CONCEPT: ELECTRON TRANSPORT CHAIN

Overview

● The electron transport chain uses energy from activated carriers to drive the creation of an H^+ gradient for ATP synthesis

□ The first stage of oxidative phosphorylation is the electron transport chain

□ The electron transport chain is embedded in the _____ mitochondrial membrane

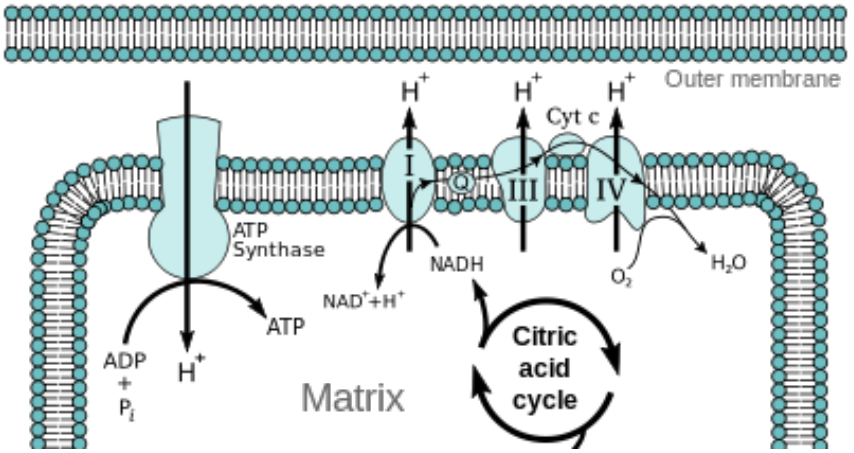
□ NADH and $FADH_2$ are the two activated carriers that donate electrons to the electron transport chain

- They are oxidized to NAD^+ and FAD

□ Stepwise movement of high energy electrons through protein complexes allows for energy capture and transfer

- The last electron acceptor is O_2 which forms _____

EXAMPLE: Overview of the electron transport chain



Steps

● _____ from NADH and $FADH_2$ are fed through the four complexes of the electron transport chain

□ **NADH dehydrogenase** transfers electrons to **ubiquinone** (coenzyme Q), a hydrophobic e^- carrier in lipid bilayer)

- Contains **iron-sulfur centers** which are iron-sulfur linkages which can accept or donate electrons

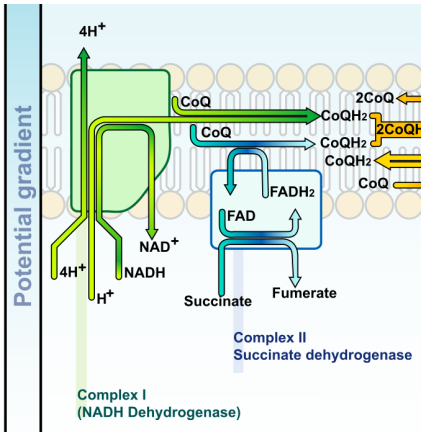
- Moves four H^+ into the intermembrane space

□ **Succinate dehydrogenase** transfers low-energy electrons from succinate to FAD then to ubiquinone

- Contains iron-sulfur centers

- Does not move H^+ across membranes

EXAMPLE: First two steps to the electron transport chain



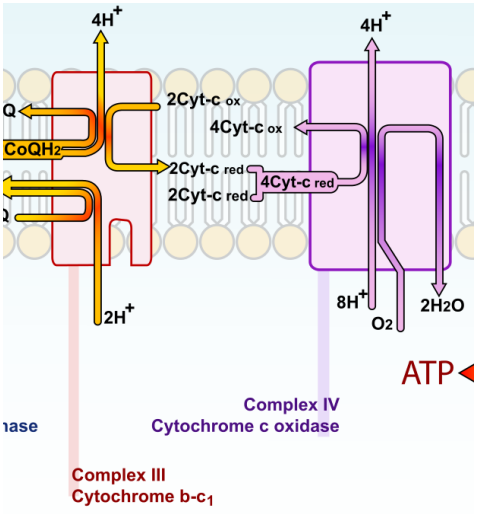
□ **Cytochrome bc_1** catalyzes the transfer of electrons from ubiquinol (reduced form of ubiquinone) to **cytochrome C** (electron carrier in the intermembrane space)

- Contains **heme** groups which bind iron and undergo iron oxidation to allow for accepting/donating e^-
- Moves four H^+ into the intermembrane space (sometimes called the **Q cycle)**
- Can also be called the $CoQH_2$ –cytochrome c reductase

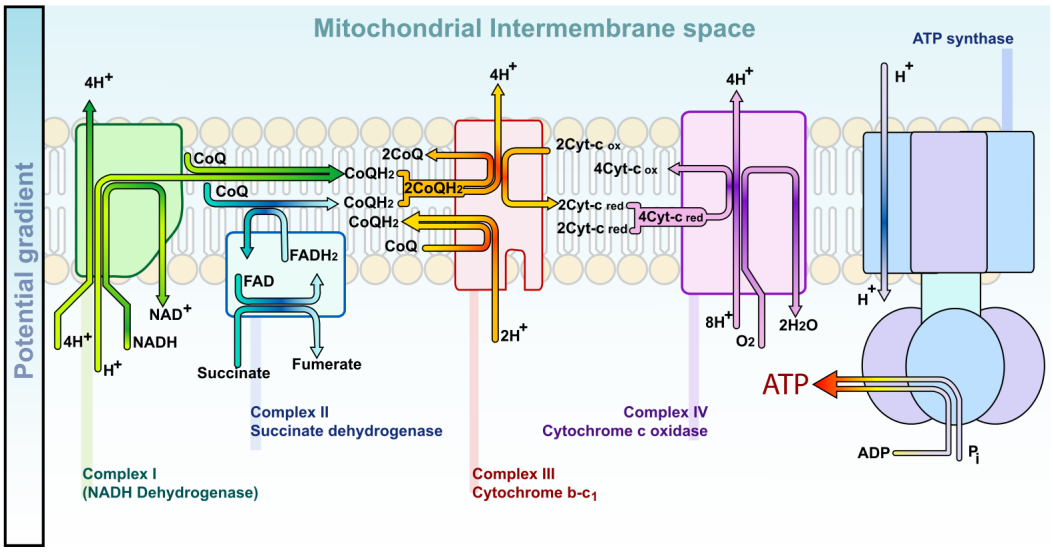
□ **Cytochrome C oxidase** transfers electrons to O_2 (Consumes the majority of the air we breathe)

- Contains a **copper center** (core of cooper atoms that accept/donate electrons) and a heme group
- After accepting two electrons, it binds O_2 tightly, breaks the double bond, and each O accepts a pair of e^-
- For each Oxygen there are 2 H^+ moved into the intermembrane space and 2 H^+ used to create H_2O

EXAMPLE: Last two steps to the electron transport chain



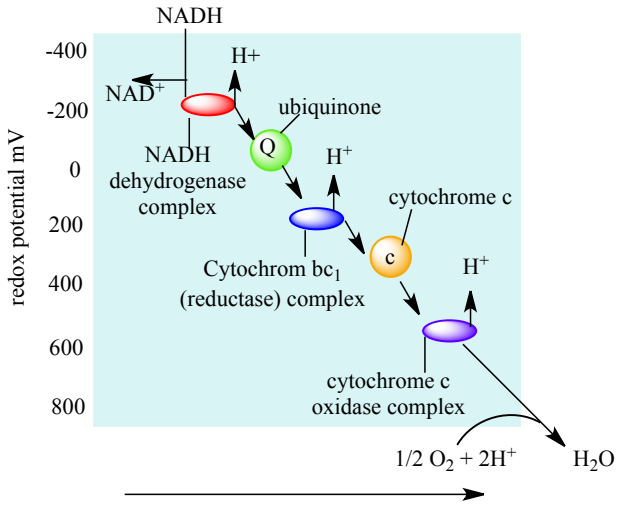
EXAMPLE: The entire electron transport chain



Reduction Potentials

- Each complex in the electron transport chain has a **redox potential (E^o)** which measures the affinity of electrons in Volts
  - □ **High electrons-transfer potential:** Strong reducing agents (V<0, ex: NADH)
  - □ **Low electron-transfer potential**: Strong oxidizing agents (V>0 ex: Oxygen)
  - □ The electron transport chain is arranged in order of _____ reduction potentials
    - $NADH \rightarrow NAD^+ + H^+ = -320mV$
    - $2\ H^+ + ½\ O_2 + 2e^- \rightarrow H_2O = 816mV$

EXAMPLE: Increase of redox potentials down the ETC



PRACTICE

1. Which of the following is not a complex of the electron transport chain?
    a. NADH dehydrogenase
    b. Succinate dehydrogenase
    c. Cytochrome C oxidase
    d. ATP dephosphorylase

2. Which of the following is the correct order of electrons through the electron chain?
    a. NADH dehydrogenase → succinate dehydrogenase → Cytochrome oxidase → Cytochrome bc_1
    b. succinate dehydrogenase → NADH dehydrogenase → Cytochrome oxidase → Cytochrome bc_1
    c. NADH dehydrogenase → succinate dehydrogenase → Cytochrome bc_1 → Cytochrome oxidase
    d. Cytochrome bc_1 → succinate dehydrogenase → Cytochrome oxidase → NADH dehydrogenase

3. Which of the following molecules is the last to accept electrons from the electron transport chain?
    a. CO_2
    b. Oxygen
    c. NAD^+
    d. FAD

4. True or False: The reduction potentials of the complexes in the electron transport chain are ordered from low to high.
    a. True
    b. False