

See link to ATP synthase movie in this file

## Electron Transport Chain and Phosphorylation

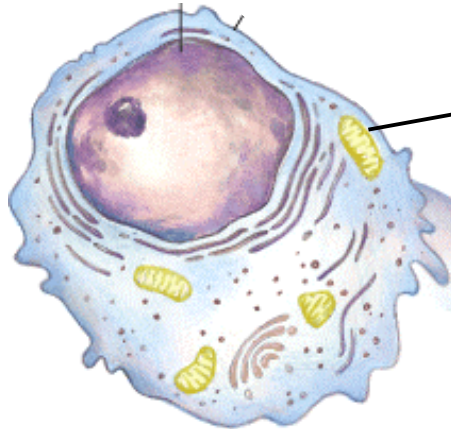


Diagram of a typical cell

Fig 02-01.GIF

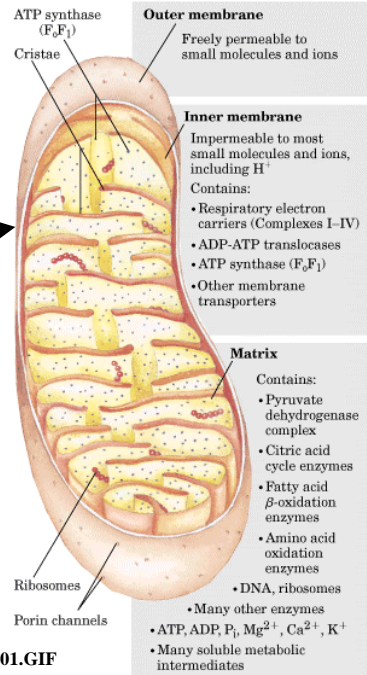


Fig 19-01.GIF

## Introduction to Membranes - Functions

### MEMBRANES

#### FUNCTIONS:

- selective, semipermeable barrier
- provides a nonpolar environment for special processes (photosynthesis, electron transport,
- provides outside surface for cell recognition, receptors

#### FEATURES:

- contains phosphoglycerides as main building blocks (sphingomyelins in nerve tissue)
- contains proteins that carry out wide variety of different functions of membrane

On the average: 40 % by weight lipid  
60 % by weight protein

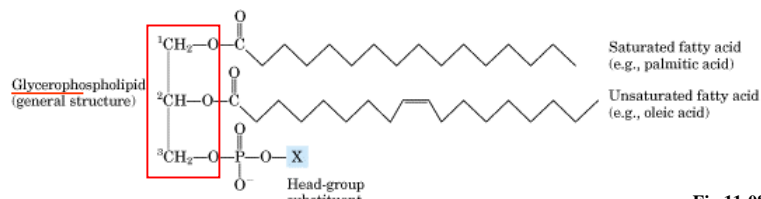
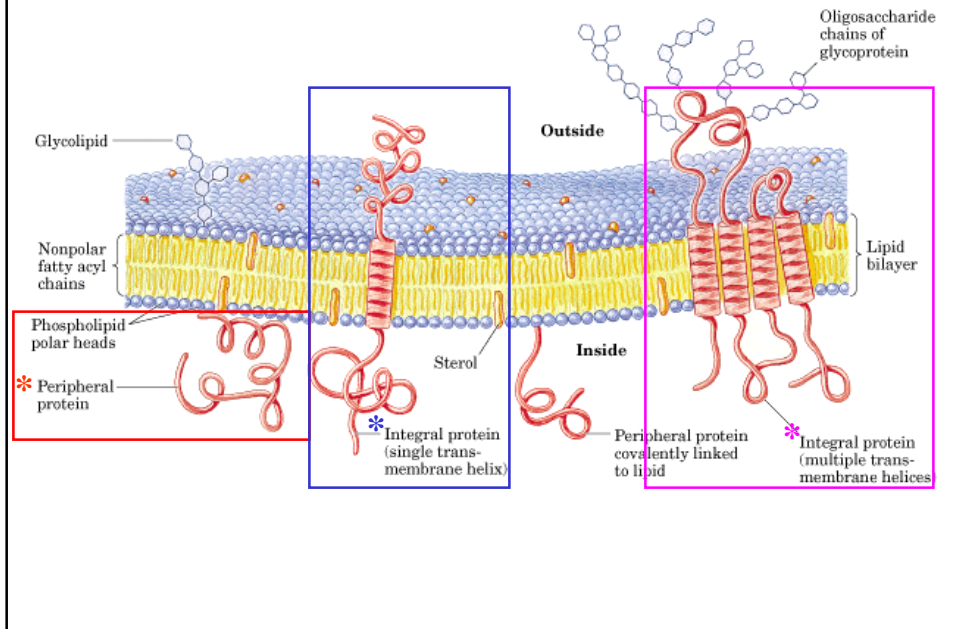


Fig 11-08.GIF

## Introduction to Membranes – Fluid Mosaic Model



## Inner Mitochondrial Membrane

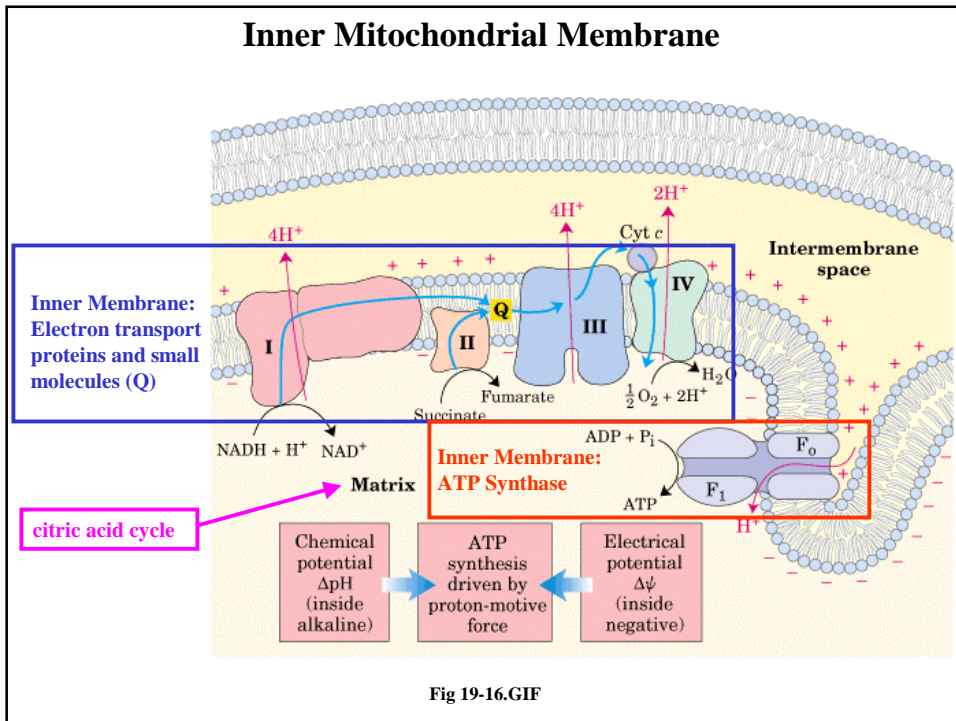


Fig 19-16.GIF

## Electron Transport Chain and Phosphorylation

### Oxidative Phosphorylation:

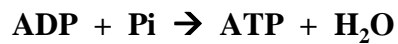
Process of oxidation of NADH and FADH<sub>2</sub> using the energy of oxidation to make ATP. Electrons from NADH and FADH<sub>2</sub> are transferred to O<sub>2</sub>.

#### Oxidation:

Process of oxidation of NADH and FADH<sub>2</sub> by carriers in the electron transport chain

#### Phosphorylation

Process of synthesis of ATP



## Oxidation COMPLEXES I, II, III, IV

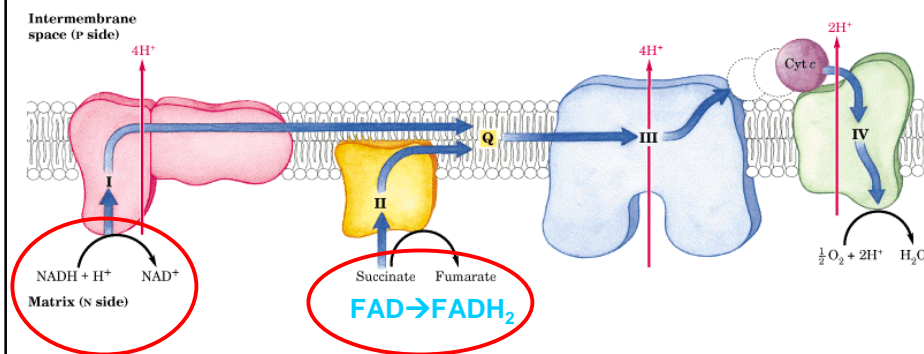
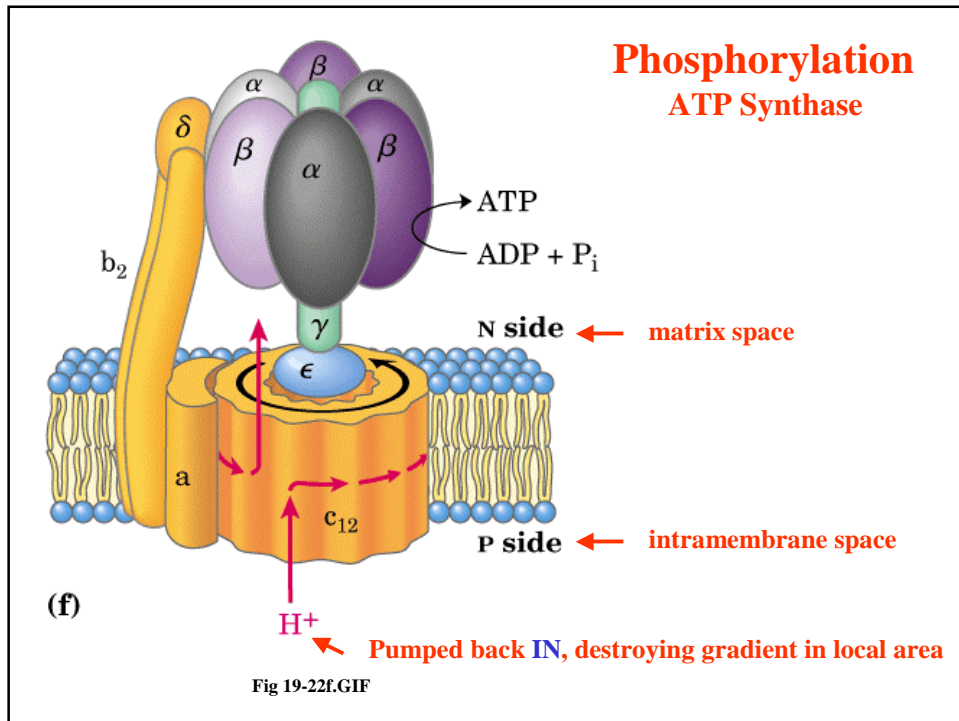
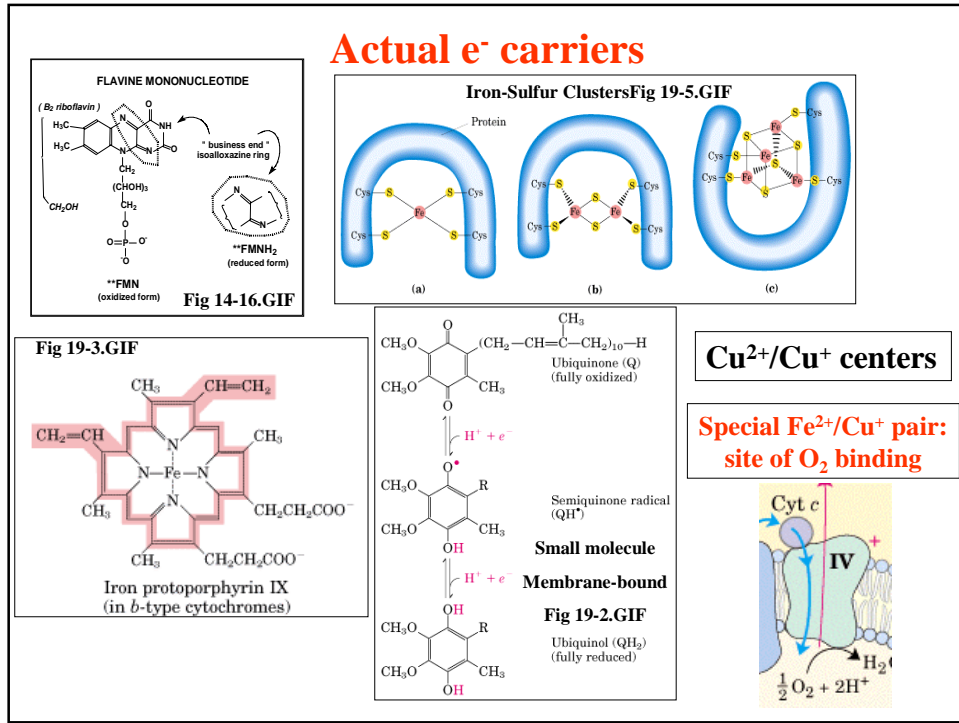
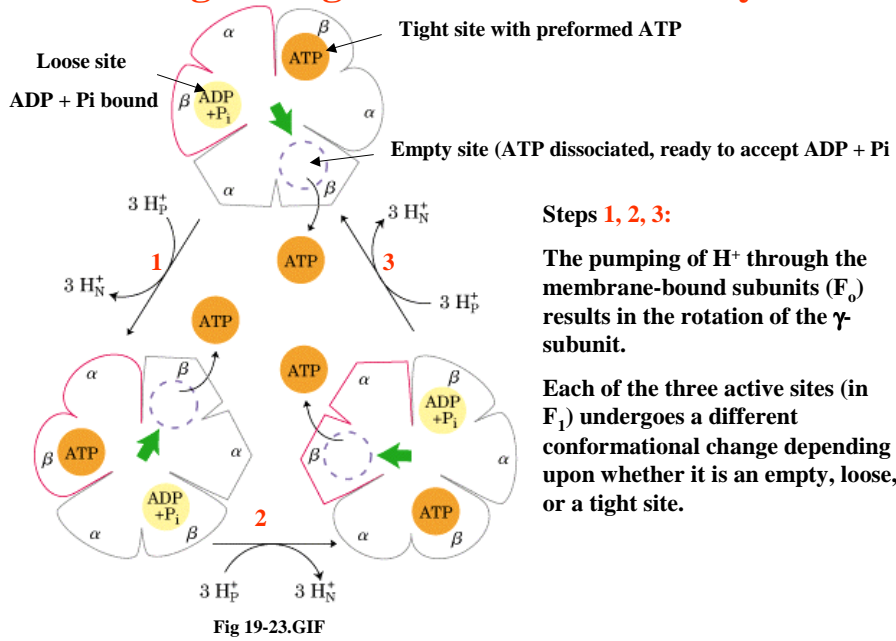


Fig 19-14.GIF

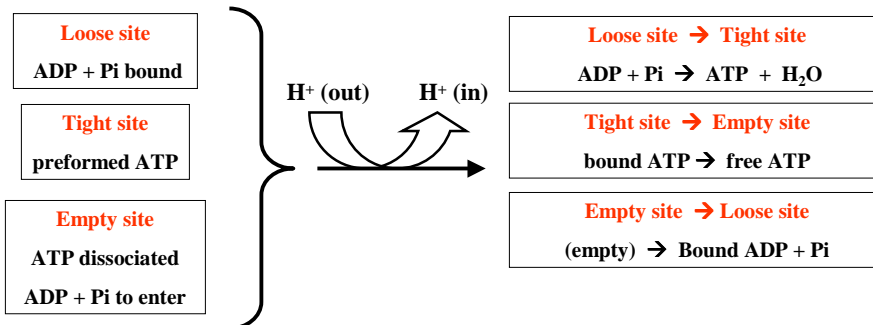


Try this link at [www.csun.edu/~hcchm001/ATP synthase](http://www.csun.edu/~hcchm001/ATP%20synthase):  
<http://www.biologie.uni-osnabrueck.de/Biophysik/Junge/pictures/Synthase.MOV>

## Binding Change Mechanism: ATP Synthase



## Binding Change Mechanism: ATP Synthase



## Oxidation and Phosphorylation are Tightly Coupled -1

Coupling "Mechanism":  $H^+$  gradient

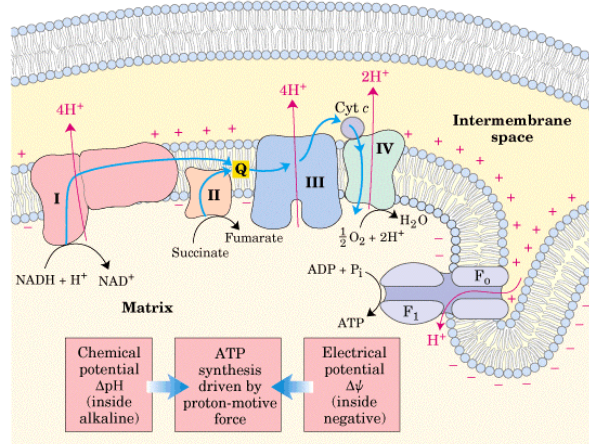


Fig 19-16.GIF

Oxidation of NADH and  $FADH_2$  is accompanied by pumping  $H^+$  **OUT** across the inner mitochondria membrane.

The  $H^+$  gradient causes conformational changes in the ATP synthase ( $F_0$ ) that results in 1) the pumping of  $H^+$  back **IN** and 2) the synthesis of ATP.

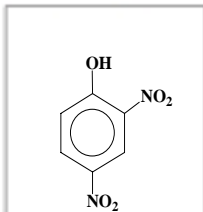
## Oxidation and Phosphorylation are Tightly Coupled- 2

Uncoupling and Inhibition of Mitochondrial Oxidative Phosphorylation

Uncouplers of Mitochondrial Oxidative Phosphorylation:

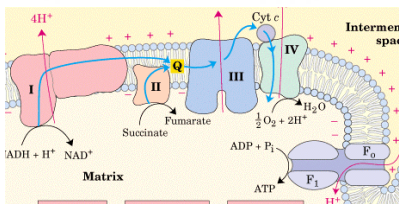
For 462: Spring 2002

Dinitrophenol carries  $H^+$



- destroy the pH gradient because they bring  $H^+$  back in by passive diffusion
- allow  $H^+$  transport out through complexes I, II, III, IV
- oxidation of NADH and  $FADH_2$  can continue
- prevent the synthesis of ATP because no pH gradient can be established
- CAC and  $\beta$ -oxidation continue
- G-2 LAC | in attempt to get needed ATP

\*\* Because these uncouplers allow  $H^+$  transport to occur within complexes I, II, III, IV, the of NADH and  $FADH_2$  can proceed as "normal". Because the gradient is destroyed, no ATP can be made.



## Oxidation and Phosphorylation are Tightly Coupled- 3

### Inhibitors of Oxidation/Reduction:

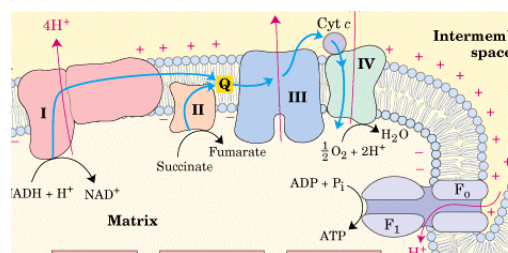
$Fe^{2+}$  -----  $Cu^{2+}$

CN

(cyanide inhibition of complex IV)

- Bind to various metal ions & other active sites, in I, II, III, IV
- Reduced forms of carriers build up on the "NADH" side of the inhibition site
- prevent  $H^+$  transport out
- pH gradient cannot be established
- ATP cannot be made
- NADH ↑, CAC ↓,  $\beta$ -oxidation ↓
- G -2 LAC ↑ in attempt to get needed ATP

\*\* Because these types of inhibitors prevent electron transport, they also prevent  $H^+$  transport out through the complex where the inhibition is occurring. The oxidation of NADH and  $FADH_2$  cannot proceed and the reduced forms of the carriers build up. Because the gradient is cannot be established, no ATP can be made.



## Oxidation and Phosphorylation are Tightly Coupled- 4

### Inhibitors of Phosphorylation:

Oligomycin  
binds to  
 $F_0$  portion  
of  
ATP synthase

- Bind to  $F_0$  or  $F_1$  portion of ATP synthase ( $F_0F_1$ -ATPase)
- Prevent  $H^+$  transport back into the mitochondria
- Gradient remains intact "locally"
- Gradient prevents further  $H^+$  transport out of mitochondria
- NADH and  $FADH_2$  oxidation inhibited
- NADH ↑, CAC ↓,  $\beta$ -oxidation ↓
- G -2 LAC ↑ in attempt to get needed ATP

\*\* Because these types of inhibitors prevent the transport of  $H^+$  back into the mitochondria, they prevent the conformational changes necessary to allow the  $F_1$  portion of the ATP synthase to make ATP. Therefore no ATP can be made even though the gradient may be present. Because the gradient is present, no further  $H^+$  transport out of mitochondria is possible. The oxidation of NADH and  $FADH_2$  cannot continue, reduced forms of carriers build up and no further ATP can be made.

