CONCEPT: ATP SYNTHESIS DRIVE FROM PROTON GRADIENTS

● An *electrochemical proton gradient* drives ATP _____

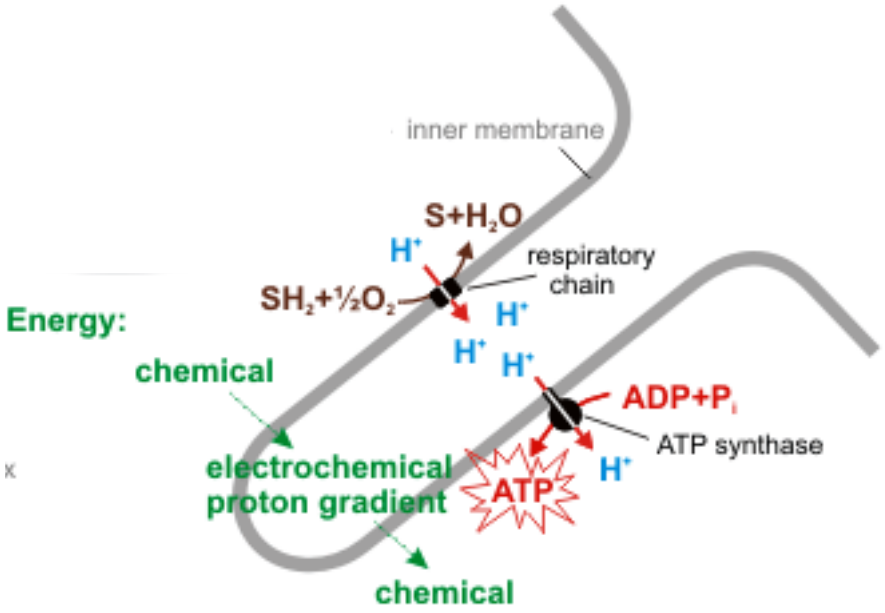
□ The **electrochemical proton gradient** is created by an H^+ gradient and a voltage (charge) gradient

- Occurs across the inner mitochondrial membrane

- Driven by the electron transport chain

□ **Chemiosmotic coupling**: Electron transport chain and H^+ pumping across a membrane drives ATP synthesis

EXAMPLE: Chemiosmotic coupling across the inner mitochondrial membrane



● **ATP synthase** is the transmembrane _____ that drives ATP synthesis

□ In cell respiration the F_1F_0 ATP synthase drives ATP

- Uses energy from the electrochemical proton gradient to create ATP

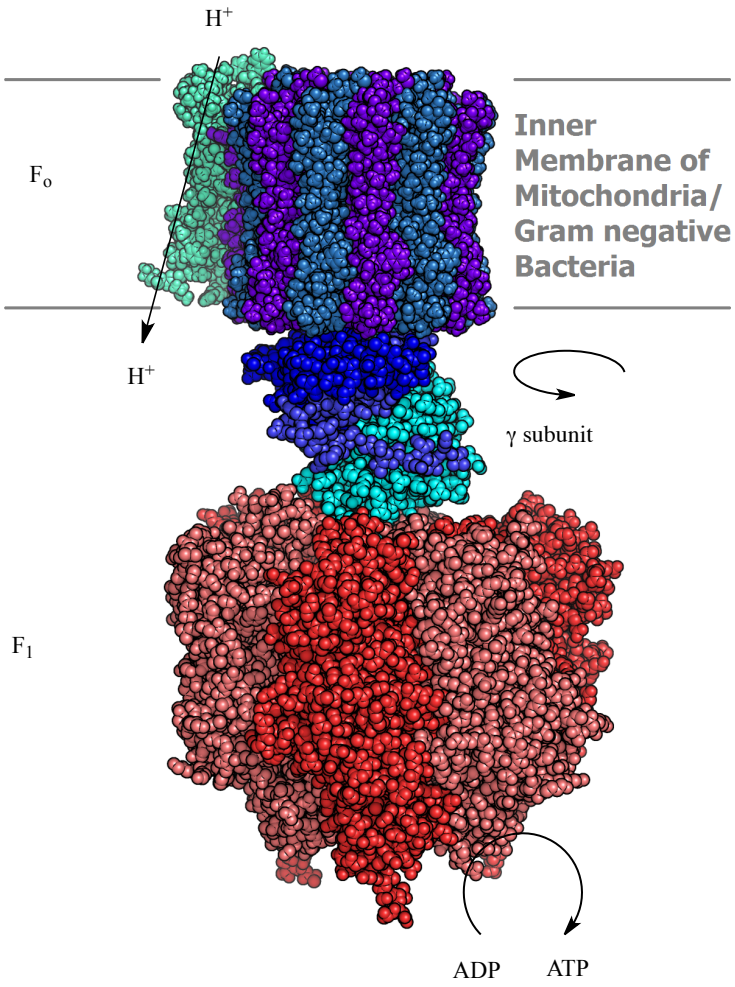
- F_0: The "stationary head" is responsible for catalyzing ATP synthesis (cytosolic side)

- F_1: Rotation of the γ subunit drives proton translocation across the membrane

□ ATP synthase can also run in _____

- Uses energy from ATP to pump protons uphill

EXAMPLE: ATP synthase



● Proton pumping and ATP synthesis are _____ events

□ Proton pumping occurs in 4 main steps

1. An H^+ moves into an empty binding site within the F_0 subunit causing a conformational change
2. This conformational change displaces protons further up the channel
3. Protons change place, which causes rotation of the F_1 channel
4. The rotation allows for the continual displacement and movement of protons down their gradient

□ ATP synthesis occurs in three main stages which use energy from H^+ translocation to increase affinity for ADP

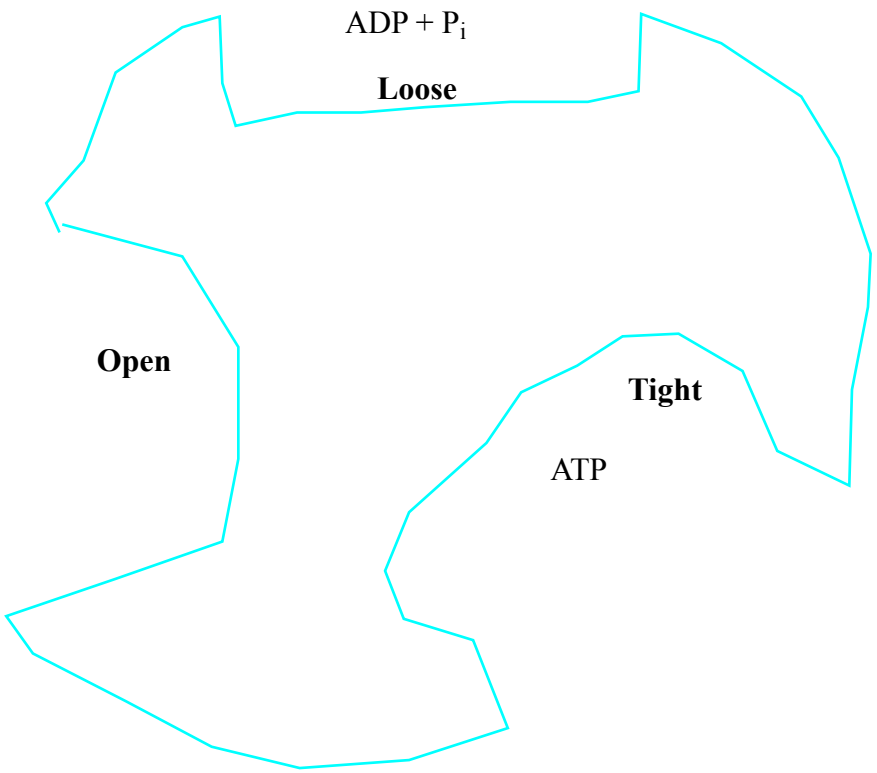
1. **O stage** (open): The F_o head binds ATP poorly and ADP weakly
2. **L stage** (loose): The F_o head cannot bind ATP but binds ADP and P_i

3. **T stage** (tight): The F_o head binds ADP and P_i so tightly they spontaneously form ATP

- The energy from two H^+ translocations triggers conformational changes and ATP synthesis

- 100 molecules of ATP are made per second (3 ATPs per revolution)

EXAMPLE: The O, L and T stages of ATP synthesis



PRACTICE

1. Which of the following is not a stage of ATP synthesis?
    a. A stage
    b. O stage
    c. T stage
    d. L stage

2. Which one of the following structures is responsible for catalyzing the ADP to ATP reaction?
    a. F_1 rotation
    b. F_0 head
    c. γ subunit

3. True or False: When ATPase is run “backwards” its purpose is to convert ATP to ADP to create a H^+ gradient.
    a. True
    b. False

4. Where does the ATPase get its energy to generate more ATP?
    a. Other ATP molecules
    b. GTP
    c. Hydrolysis of H_2O
    d. Electrochemical proton gradient