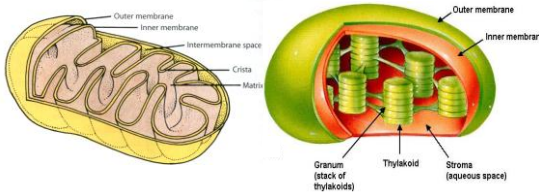







Chapter 4

The Cell's Energy System(s): Mitochondria & Chloroplasts



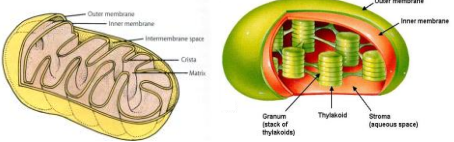
Overview

- Mitochondria & chloroplasts are the organelles that convert energy to forms that cells can use for work
 - ♦ **mitochondria:**
from glucose to ATP  → 
 - ♦ **chloroplasts:**
from sunlight to ATP & carbohydrates
 - ATP = active energy
 - carbohydrates = stored energy

 →  + 


Mitochondria & Chloroplasts

- Important to see the similarities
 - ♦ transform energy
 - generate ATP
 - ♦ double membranes = 2 membranes
 - ♦ **semi-autonomous** organelles
 - move, change shape, divide
 - ♦ internal ribosomes, DNA & enzymes



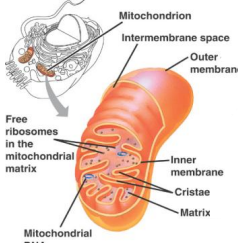
Mitochondria

- Function
 - ♦ **cellular respiration**
 - ♦ generate ATP
 - from breakdown of sugars, fuels
 - in the presence of **oxygen**
 - ♦ break down larger molecules into smaller to generate energy = **catabolism**
 - ♦ generate energy in presence of O₂ = **aerobic respiration**

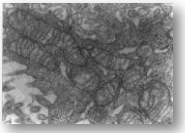
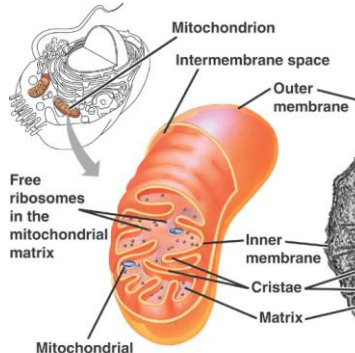


Mitochondria

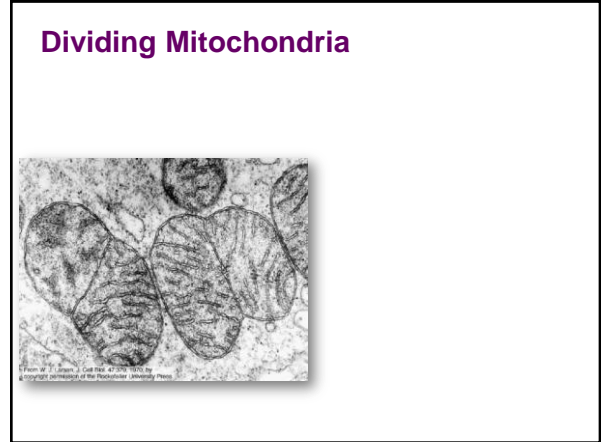
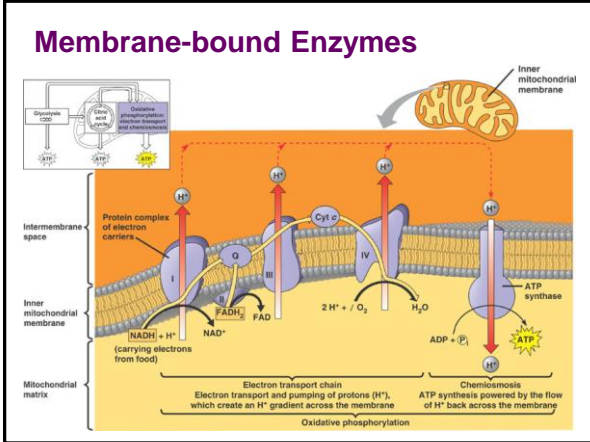
- Structure
 - ♦ 2 membranes
 - smooth outer membrane
 - highly folded inner membrane
 - ♦ the **cristae**
 - ♦ fluid-filled space between 2 membranes
 - ♦ internal fluid-filled space
 - **mitochondrial matrix**
 - DNA, ribosomes & enzymes



Mitochondria

100 nm



Mitochondria

- Almost all eukaryotic cells have mitochondria
 - there may be 1 very large mitochondrion or 100s to 1000s of individual mitochondria
 - number of mitochondria is correlated with aerobic metabolic activity
 - more activity = more energy needed = more mitochondria

Chloroplasts

- Chloroplasts are plant organelles
 - class of plant structures = plastids
 - amyloplasts
 - store starch in roots & tubers
 - chromoplasts
 - store pigments for fruits & flowers
 - chloroplasts
 - store chlorophyll & function in photosynthesis
 - in leaves, other green structures of plants & in eukaryotic algae

Chloroplasts

Chloroplast

Stroma

Inner and outer membranes

Granum

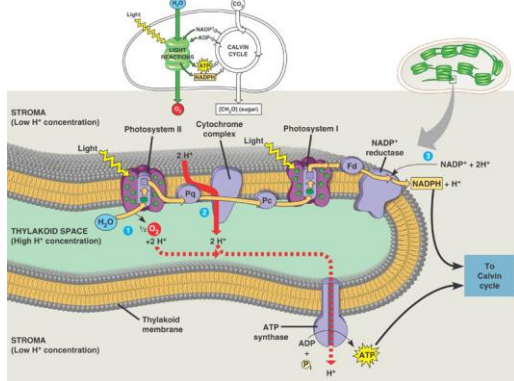
Thylakoid

1 μm

Chloroplasts

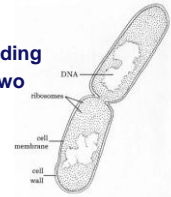
- Structure**
 - 2 membranes
 - outer membrane
 - inner membrane
 - internal fluid-filled space = stroma
 - DNA, ribosomes & enzymes
 - thylakoids = membranous sacs where ATP is made
 - grana = stacks of thylakoids

Membrane-bound Enzymes



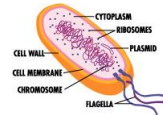
Chloroplasts

- **Function**
 - ♦ **photosynthesis**
 - ♦ generate ATP & synthesize sugars
 - transform solar energy into chemical energy
 - produce sugars from CO₂ & H₂O
- **Semi-autonomous**
 - moving, changing shape & dividing
 - can reproduce by pinching in two



Mitochondria & chloroplasts are different

- Organelles not part of endomembrane system
- Grow & reproduce
 - ♦ semi-autonomous organelles
- Proteins primarily from free ribosomes in cytosol & a few from their own ribosomes
- Own circular chromosome
 - ♦ directs synthesis of proteins produced by own internal ribosomes



Endosymbiosis theory

1981 | ??

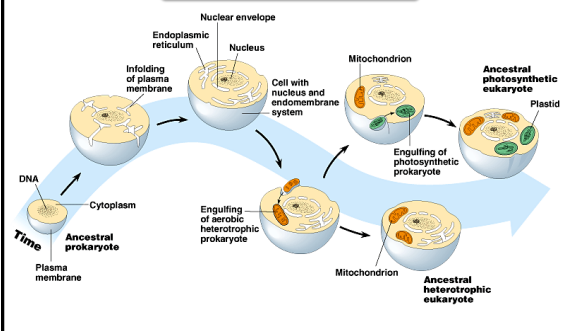
- Mitochondria & chloroplasts were once free living bacteria
 - ♦ engulfed by ancestral eukaryote
- Endosymbiont
 - ♦ cell that lives within another cell (host)
 - as a partnership
 - evolutionary advantage for both
 - ♦ one supplies energy
 - ♦ the other supplies raw materials & protection



Lynn Margulis
U of M, Amherst

Endosymbiosis theory

Evolution of eukaryotes



Any Questions??