BL/CH401 Lecture 2 -- Cell Structure and Biochemistry

Cell Structure of Prokaryotes (Bacteria) and Eukaryotes (Higher Organisms)

Prokaryotes - Single cells without nucleus or other organelles
Eukaryotes - Multicellular- Nucleus, mitochondria, etc.

Bacteria - Single Chromosome - Sometimes Plasmid or Episomal DNA
Animals - Chromosomes in nucleus - Cytoplasmic DNA in mitochondria
Plants - Chromosomes in nucleus - Cytoplasmic DNA in mitochondria and chloroplasts

Before looking into the components of these cellular types, a foundation in some generally important concepts applying to all cells must be established.

The "BASICS" of DNA (DeoxyriboNucleic Acid) and RNA (RiboNucleic Acid)

DNA is genetic material of most living systems, including eukaryotes and prokaryotes

Double Stranded DNA - Only Natural Form

Chromosomes of Eukaroytes and Prokaroytes are double stranded DNA

RNA is Single Stranded

RNA is Genetic Material in Some Viruses

RNA comes in 3 basic forms:

tRNA (transfer RNA) = adapter in protein synthesis - matches codon to amino acid

rRNA (ribosomal RNA) = structural RNA in ribosomes

mRNA (messenger RNA) = contains information for protein synthesis

---

Basics of the Relationship between Proteins and DNA:

Basics of the relationship between proteins and DNA:

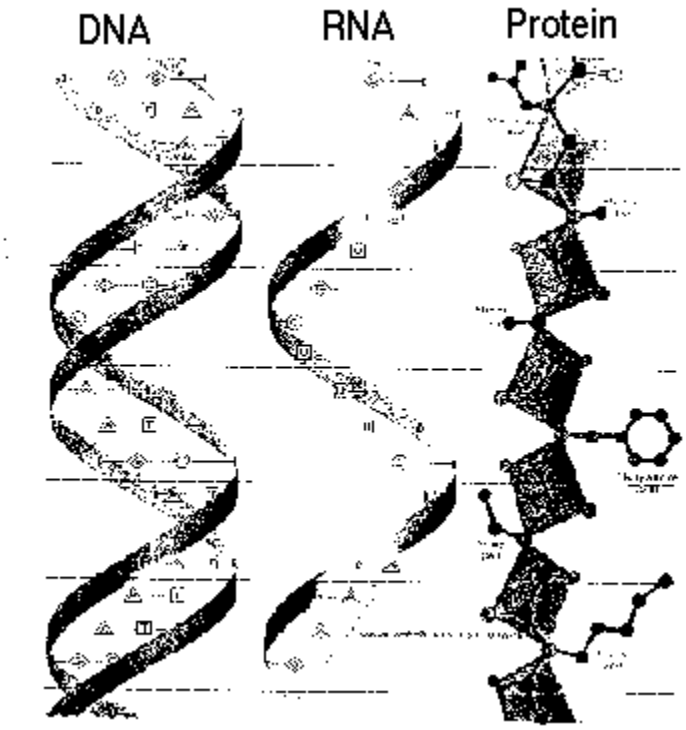


Figure 1. Linear relationship between DNA, RNA and Protein Sequence
(This Figure from unknown source, ©19?? Geis)

DNA encodes amino acids of a protein using 3 letter codons.
DNA is transcribed to make mRNA.
mRNA is translated by ribosomes to make the protein.

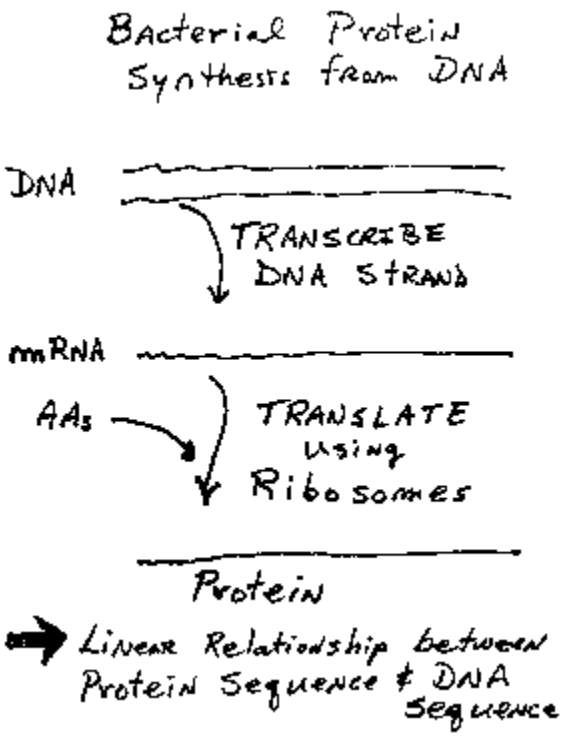
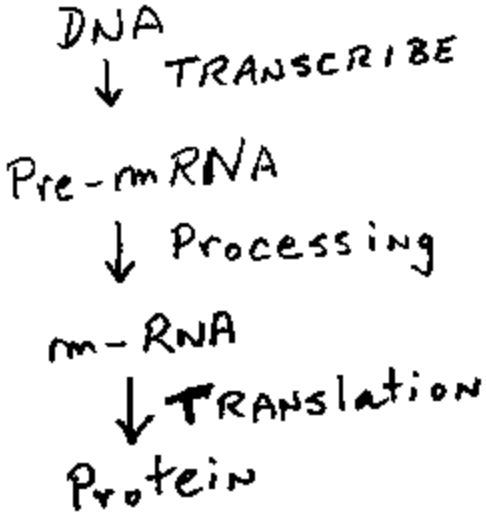


Figure 2. Bacterial Protein Synthesis.

Eukaryotic protein synthesis is more complex than prokaryotic!!



Eukaryotic DNA is transcribed to make a pre-mRNA, then the pre-mRNA is processed. Processing removes the intervening sequences found in eukaryotic DNA, which are called Introns.
During Processing, the Exons containing the coding region for the protein are joined. Also some modifications of the ends of the mRNA are made and it goes into the cytosol. In the cytosol, ribosomes translate the mRNA to make protein in manner very similar to prokaryotes.

Prokaryotic Cell Structure:

Prokaryotic example organism- *Escherichia Coli* (*E. Coli*)

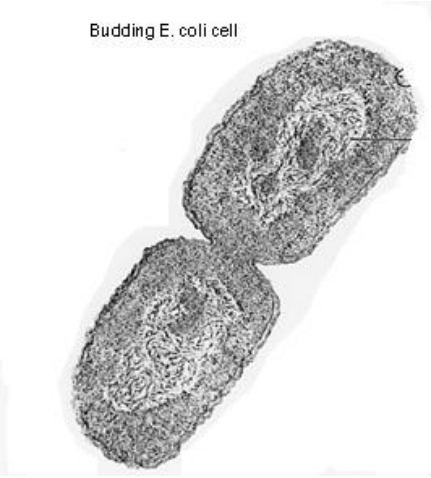


Figure 3. E. coli cell dividing.

E. Coli Grows in human intestine; Has a single, circular chromosome
Also contains DNA as plasmids - Plasmids are extra-chromosomal DNA

Details of Prokaryotic Cellular Components:

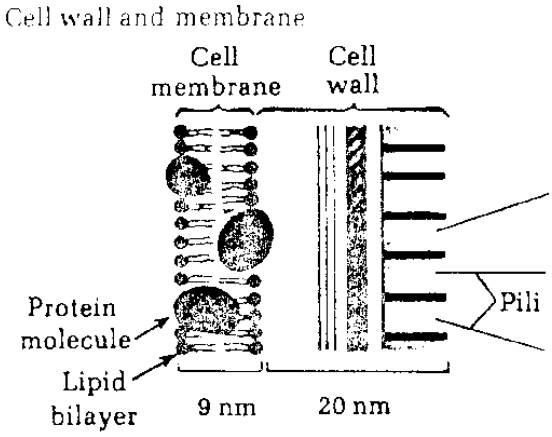


Figure 4. Prokaryotic Cell Wall.

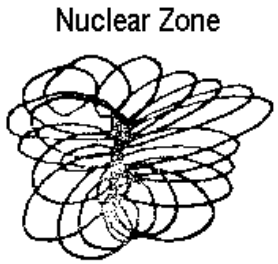


Figure 5. Prokaryotic Nuclear Zone - 1 circular chromosome

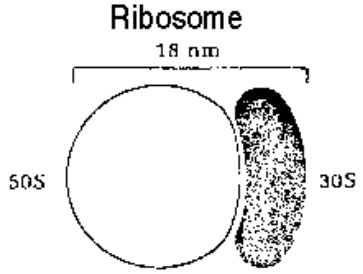


Figure 6. Prokaryotic Ribosomes

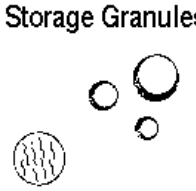


Figure 7. Prokaryotic Storage Granules

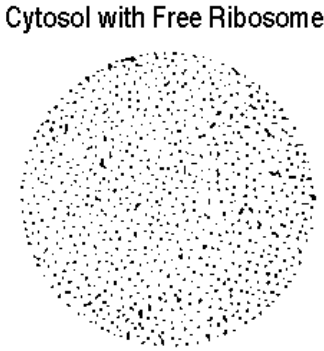
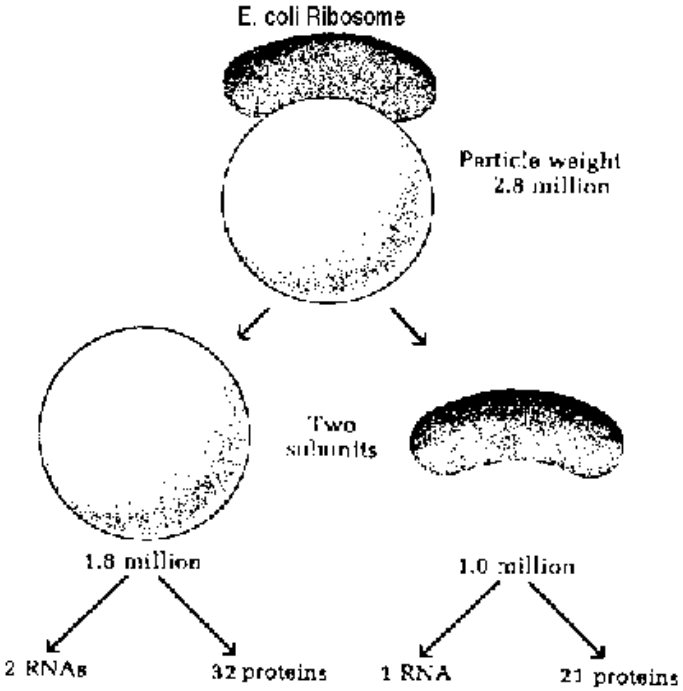


Figure 8. Prokaryotic Cytosol



Ribosome Structure:

Figure 10. Two Dimensional (2-D) Model of E. coli Ribosomes

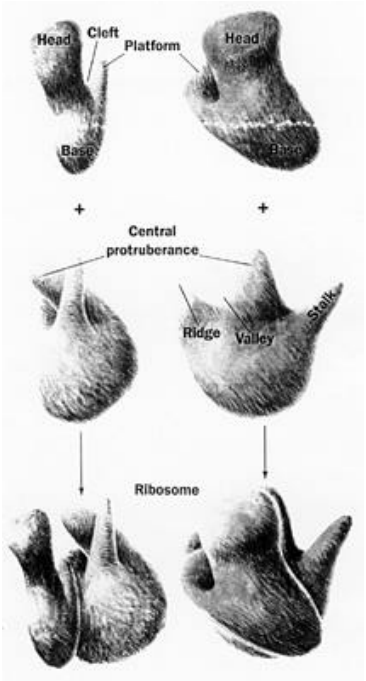


Figure 11. 3-D Model of E. coli Ribosomes

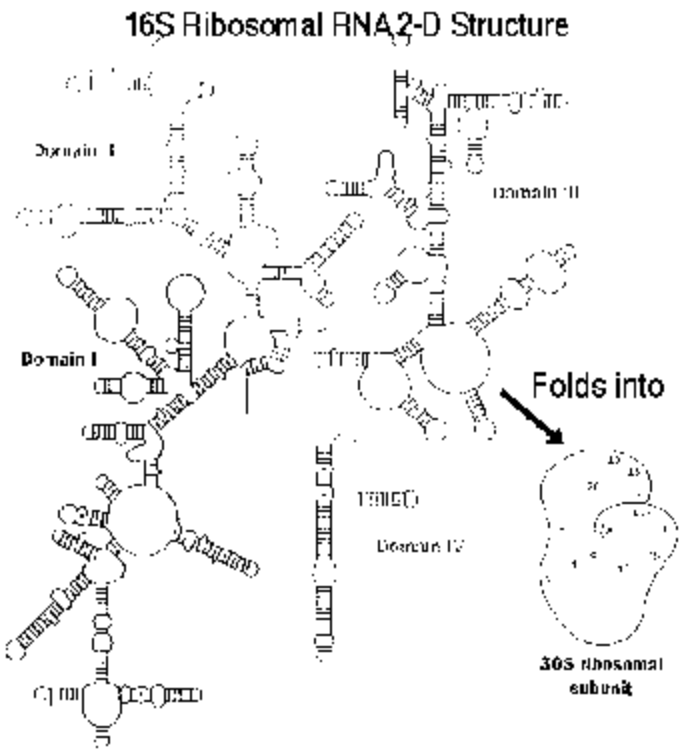


Figure 12. 2-D Structure of 16S rRNA of 30S Subunit of E. coli Ribosome

Typical Animal Cell:

Figure 13. Liver Cell.

Eukaryotic Animal Cell Components:

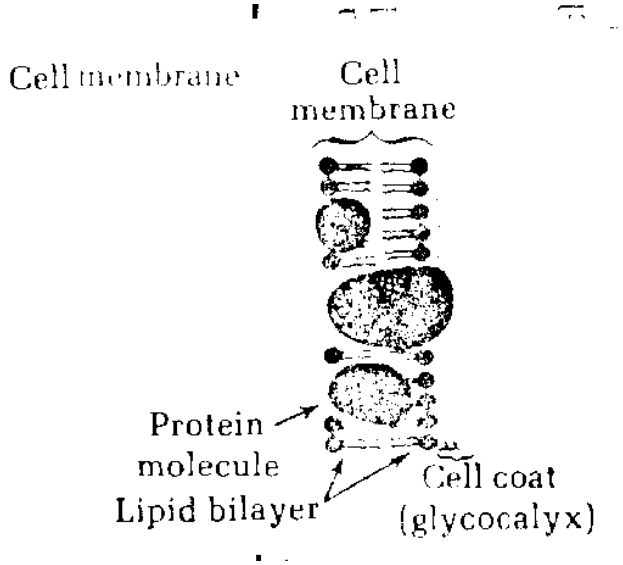


Figure 14. Eukaryotic Cell Membrane or Plasma Membrane

Cell or plasma membrane contains equal amounts of lipids and proteins, which are arranged in a bilayer. Plasma membrane is semi-permeable and contains transport systems for ions, sugars, and amino acids.

Eukaryotic Cell Organelles (Fig. 15 to 18)

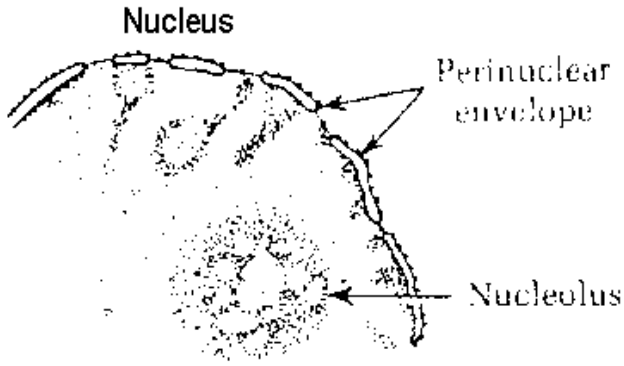
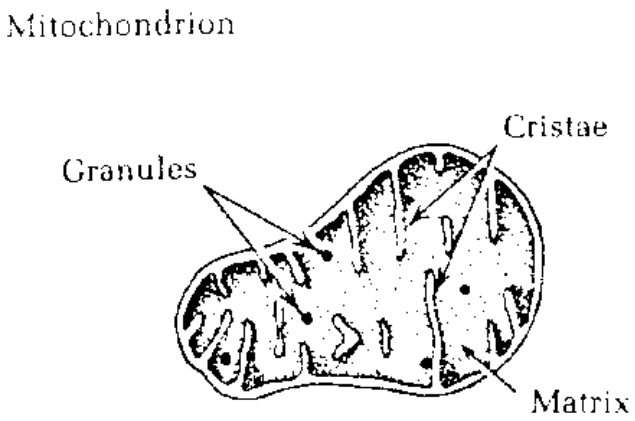
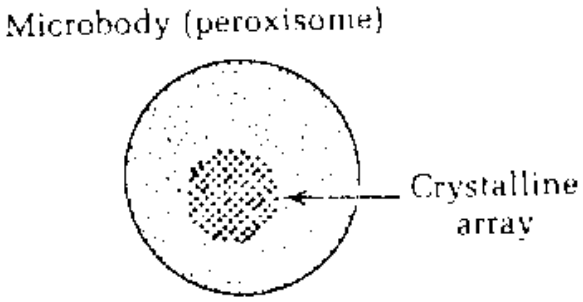


Figure 15. Eukaryotic Cell - Nucleus
Nucleus contains DNA molecules, nucleolus, and RNA molecules. Histones (Proteins) bind to DNA to organize the chromosomes and chromosomal replication or mitosis. Nucleolus processes RNA for export, perinuclear membrane controls export of RNA and import of cytoplasmic proteins. Proteins from cytoplasm regulate the genes to be expressed as messenger RNA.

Figure 16. Eukaryotic Cell - Mitochondria



Mitochondria are cellular energy producers. They have two membranes and entrap an aqueous phase separated from the cytoplasm. They also contain DNA and synthesize their own proteins for insertion into their inner membrane. Their outer membrane controls access to the matrix and allows in only proteins with special target sequences.



Eukaryotic Cell - Microbodies: **Figure 17. Eukaryotic Cell - Peroxisome**

Microbodies (Peroxisomes) and lysozomes both have single membrane and no DNA. Peroxisomes oxidize amino acids and generate hydrogen peroxide, which is broken down by catalase. Catalase sometimes forms a crystal within the peroxisome.

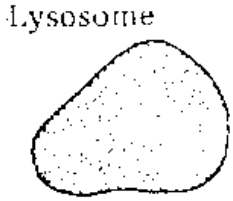
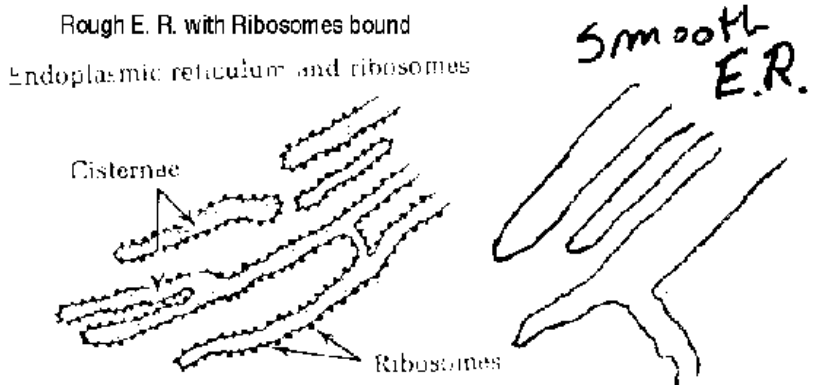


Figure 18. Eukaryotic Cell - Lysozome

Lysozomes- garbage disposal system- contain degradative enzymes and digest cell when it dies.

Figure 19. Eukaryotic cell - Endoplasmic Reticulum



Endoplasmic Reticulum is a single membrane system with an inner compartment which forms channels throughout the cytoplasm of the cell.

Smooth endoplasmic reticulum (ER) provides the cell an organic phase in its membranes and unsaturated fatty acids and cholesterol are synthesized here. Foreign organic compounds are hydroxylated here to make them easier to digest.

Rough endoplasmic reticulum is a single membrane system covered with ribosomes for the synthesis of proteins to be exported from the cell. Eukaryotic ribosomes are very similar to prokaryotic ribosomes.

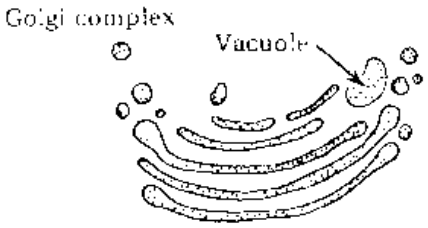
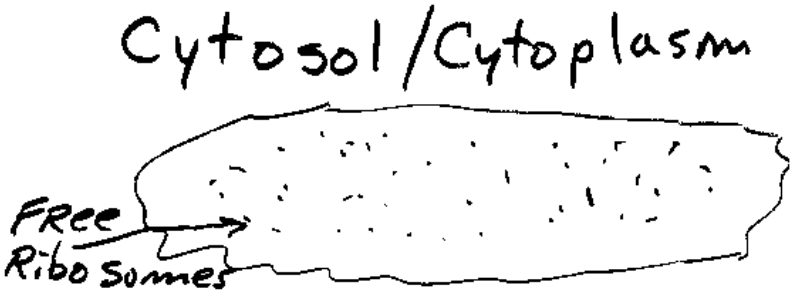


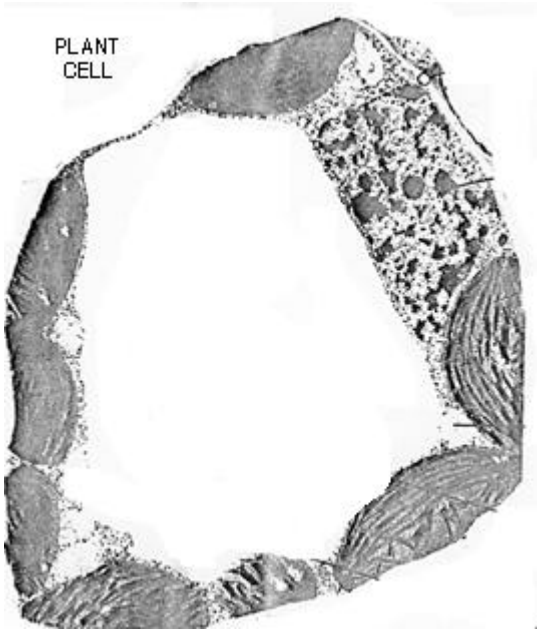
Figure 20. Eukaryotic Cell - Golgi Complex

Rough ER is connected to the golgi complex which is the system used for exporting proteins from the cell and into the plasma membrane.

Figure 21. Eukaryotic Cell - Cytosol



The cytoplasm contains many enzymes and other compounds of the major aqueous phase of the cell. There are ribosomes floating freely in the cytoplasm which are for synthesizing soluble proteins. The cytoplasm is dispersed among the organelles and also contains the cytoskeleton which helps the cell keep its shape.



Typical Cell of Plant Leaf:

Figure 22. Grass Leaf Cell containing Chloroplasts

Plant Cell Structure:

Plant cells contain all the same components as animal cells, but have three important differences.

One difference is the cell wall.

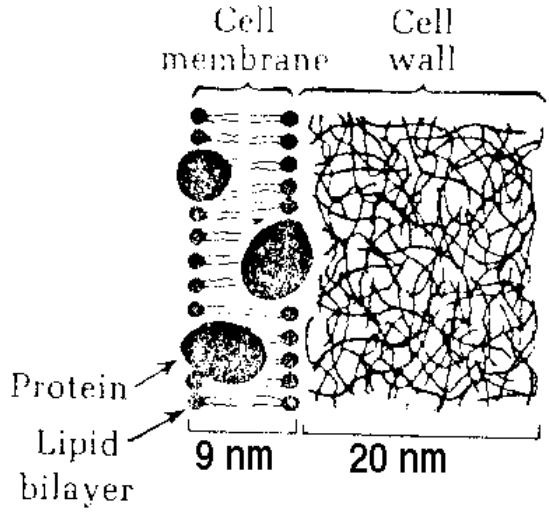


Figure 23. Plant Cell Wall
Plant cell walls are reinforces structures containing cellulose and lignin to make them rigid.

Second difference, plants are autotrophic (energetically self supporting)

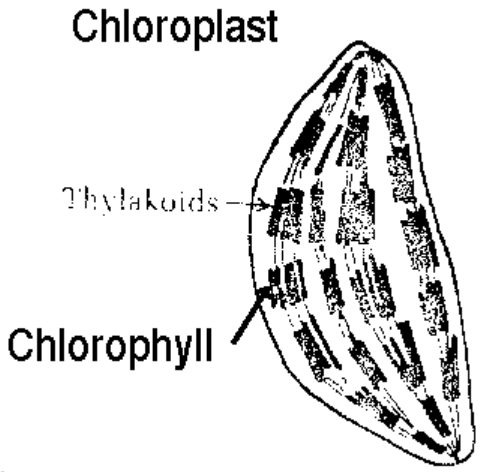


Figure 24. Chloroplasts
Plants utilize light energy and chloroplasts contain the chlorophyll and enzymes for carrying out photosynthesis.

Third difference, plant cells have a large vacuole.

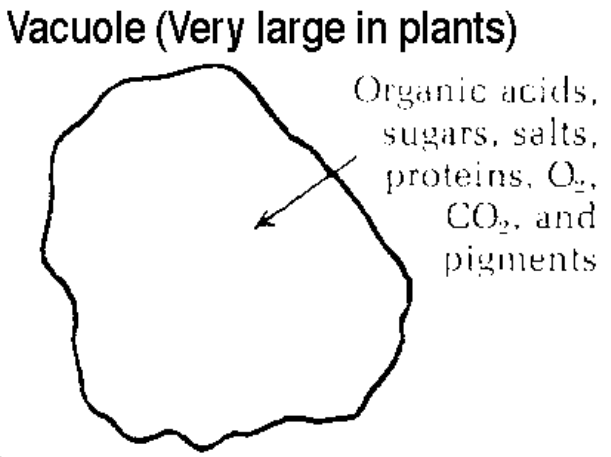


Figure 25. Plant Vacuole.
The plant vacuole is a single membrane organelle for storing organic acids, salts, etc.