Chloroplast

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Outlines

- Type of the plastids
- Historical
- Distribution
- Chloroplast as semiautonomous organelle
- Chemical composition
- Ultrastructure
- Biogenesis
- The symbiotic origin of chloroplast
- Function of the chloroplast-Photosynthesis

Types of the plastids

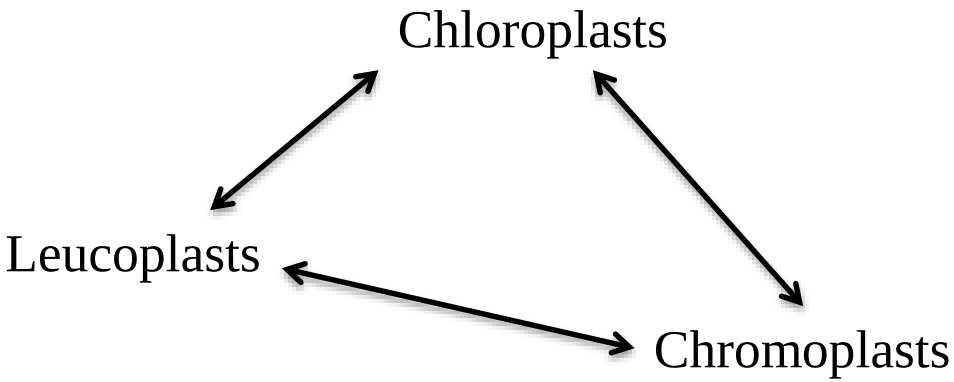
- The term plastid was used by Schimper in 1885 and he classified plastids as following

1. **Leucoplasts**-(Gr., leuco=white; plast=living) are the colourless plastids are found in embryonic and germ cells. Found in those regions of the plant which are not receiving light. They store carbohydrates, lipids and protein and accordingly are of following types i) Amyloplast ii) Elaioplast iii) Proteinoplast

2. **Chromoplast**-(Gr., chroma=colour; plast=living) are the coloured plastids containing carotenoids and other pigments. They impart colour (yellow, orange and red) to certain portion of plants such as flower petals (rose), fruits (tomato), roots (carrot). Two types i) Phaeoplast ii) Rhodoplast

3. **Chloroplast-** (Gr., chloro=green plast=living)- occurs mostly in the green algae and plants and contain pigments like chlorophyll-a and chlorophyll-b and DNA and RNA

- According to Schimper different kinds of plastids can transform into one another



Historical

- Chloroplast were described as early as seventeenth century by Nehemiah Grew and Antonie van Leeuwenhoek
- The term Plastid was used by Schimper in 1885 he also classified the plastids of plant
- A Meyer, F. Schmitz and A.F.W. Schimper showed that chloroplasts always arise from pre-existing chloroplast.
- Wilstatter and Stoll isolated and characterized green pigments- Chlorophyll *a* and *b*
- Julius Sachs showed that chlorophyll is confined to chloroplast not distributed throughout the plant cell

Distribution

- The chloroplasts remain distributed homogeneously in the cytoplasm of plant cell.
- The algae usually have a single huge chloroplast the cells of higher plants have 20-40 chloroplast.
- When the number of chloroplast is inadequate, it is increased by division when excessive, it is reduced by degeneration.

Chloroplast as semiautonomous organelle

- Like the mitochondria the chloroplast have their own DNA, RNA and protein synthetic machinery.

a. **DNA of chloroplast**- Ris and plant (1962) reported DNA in chloroplast. Chloroplast DNA is double helical circle with an average length of 45µm (about 135,000bp)

b. **Ribosomes**- ribosomes of chloroplast are smaller than cytoplasmic ribosome and are of 70S type and resemble with the bacterial ribosomes. Contain t-RNA

c. **Protein synthesis**-DNA of chloroplast codes for chloroplast mRNA, rRNA, tRNA and ribosomal proteins.

Chemical composition

Chemical Constituents	Percent dry weight	Components (Per cent)
1.Protein	35-55	Insoluble 80%
2.Lipids	20-30	Fats 50% Sterols 20% Wax 16% Phosphatides 2-7%
3.Carbohydrates	Variable	Starch, Sugar Phosphates 3-7%
4. Chlorophyll	9.0	Chlorophyll a 75% Chlorophyll b 25%
5.Carotenoids	4.5	Xanthophyll 75% Carotene 25%
6. Nucleic acid RNA DNA	 3-4 <0.02-0.1	

Cont …

- Chloroplast also contains some metallic ions like Fe, Cu, Mn and Zn

Ultrastructure

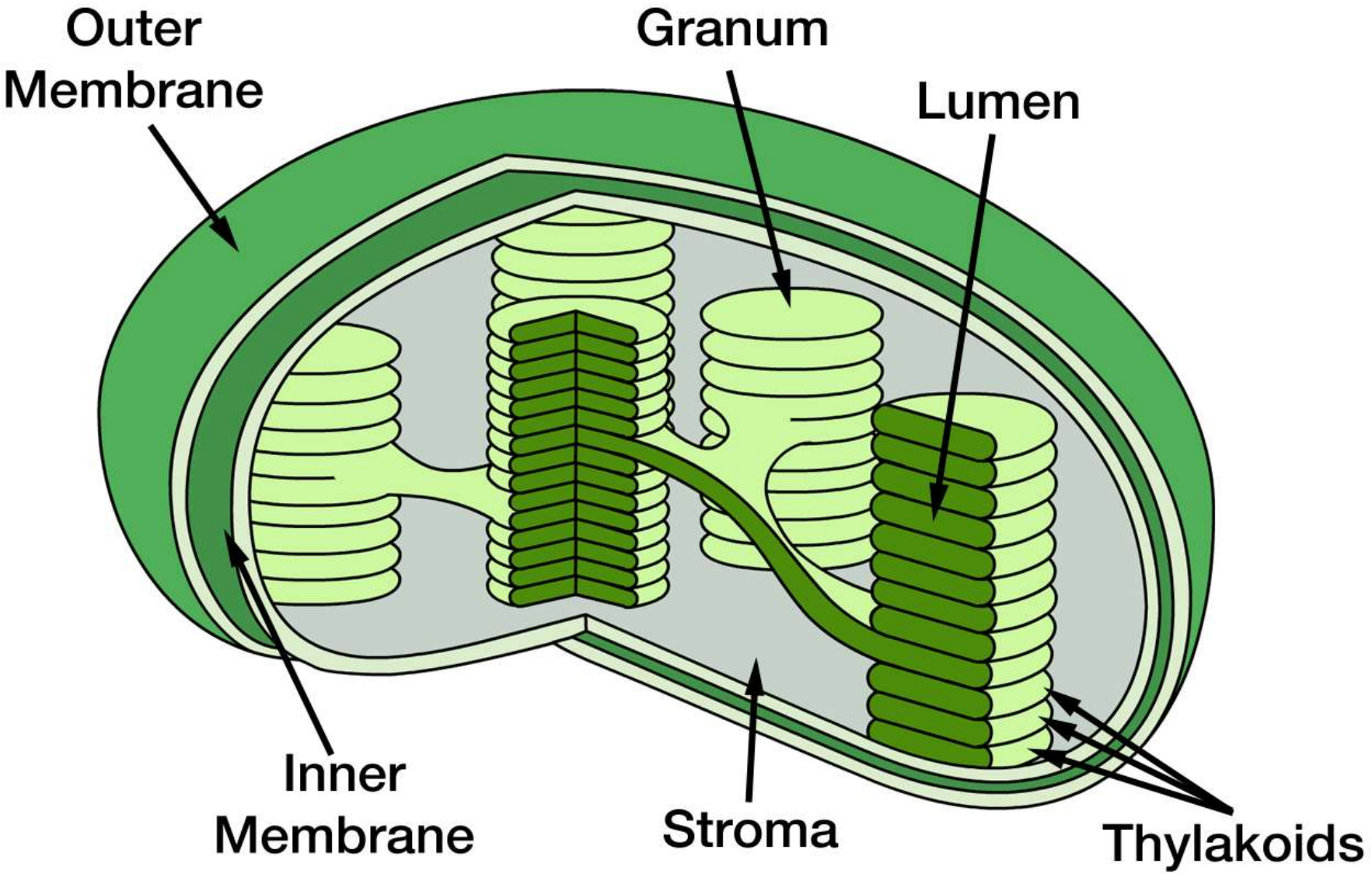
- A chloroplast comprises the following three main components

1. **Envelope-** The entire chloroplast is bounded by an envelope which is made of a double unit membranes. Across this double membrane envelope exchange of molecules between chloroplast and cytosol occurs.

2. **Stroma-** The matrix or stroma fills most of the volume of the chloroplast and is a kind of gel-fluid phase that surrounds the thylakoids (grana). It contains proteins, ribosomes and DNA. *The stroma is the site of CO2 fixation* and where the synthesis of sugar, starch, fatty acids and some proteins occurs

3. **Thylakoids-** The thylakoids consists of flattened and closed vesicles arranged as a membrane network, Thylakoids may be stacked like a neat pile of coins forming grana. There may be 40-60 grana in the matrix of a chloroplast. *Light reactions occurs in thylakoids membrane*

Chloroplast



Biogenesis of chloroplast

- The chloroplasts never originates *de novo.*
- Chloroplast multiply by fission a process that implies growth of daughter organelles
- During the development of the chloroplast the first structure to appear is the so-called proplastid.
- Proplastid is then develops into chloroplast

The symbiotic origin of chloroplast

- Chloroplast divide, grow and differentiate; they contain circular DNA, ribosomal RNA, messenger RNA and are able to conduct protein synthesis

- By visualizing these similarities between micro-organisms and chloroplast it has been suggested that *chloroplast might have relationship between autotrophic micro-organism*

- But some of the enzymes of chloroplast are coded by nuclear genes so there still exist certain doubt about the symbiotic origin of chloroplast

  (kirk ,1966)

Function of the chloroplast : PHOTOSYNTHESIS

- Process of photosynthesis consists of the following two steps

1) **Light reaction**- also known as Hill reaction, photosynthetic electron transfer reaction or photochemical reaction. In light reaction solar energy is trapped in the form of chemical energy of ATP and NADPH. During it oxygen is evolved by photolysis.

2) **Dark reaction**- also known as Calvin reaction, photosynthetic carbon reduction cycle (PCR cycle), carbon fixation reaction or thermo chemical reaction. Reducing capacity of NADPH and energy of ATP is utilized for the conversion of carbon dioxide to carbohydrate. *Occurs in the stroma*

Reference book

Cell Biology,

Genetics,

Molecular Biology,

Evolution and Ecology

P.S. VERMA
V.K.AGARWAL

S.CHAND

Which of the following is not a double membrane organelle

a) Cell
b) Chloroplast
c) Mitochondria
d) Nucleus
e) All of above

Plastids are absent in

a) Animals and plants

b) Fungi, animals and plants

c)Animals, bacterium and fungi

d) None of these

All are leucoplasts except

a) Elaioplast
b) Amyloplast
c) Rhodoplast
d) Proteinoplast

The site of light reaction is

a) Stroma
b) Grana
c) Thylakoid lumen
d) Outer membrane

State true or false

Chloroplast is autonomous organelle

a) True
b) False

- **Ratio of chlorophyll a to chlorophyll b in chloroplast is**

a. 1:1
b. 2:1
c. 3:1
d. 4:1

Percentage of chlorophyll in chloroplast is

a. 5
b. 9
c. 15
d. 3

- **Cells of higher plants generally have ……number chloroplast.**

a. 1
b. 100
c. 30
d. 200

- **The site of dark reaction is**

a) Stroma
b) Grana
c) Thylakoid lumen
d) Outer membrane

MITOCHONDRIA

CELL BIOLOGY PRESENTATION

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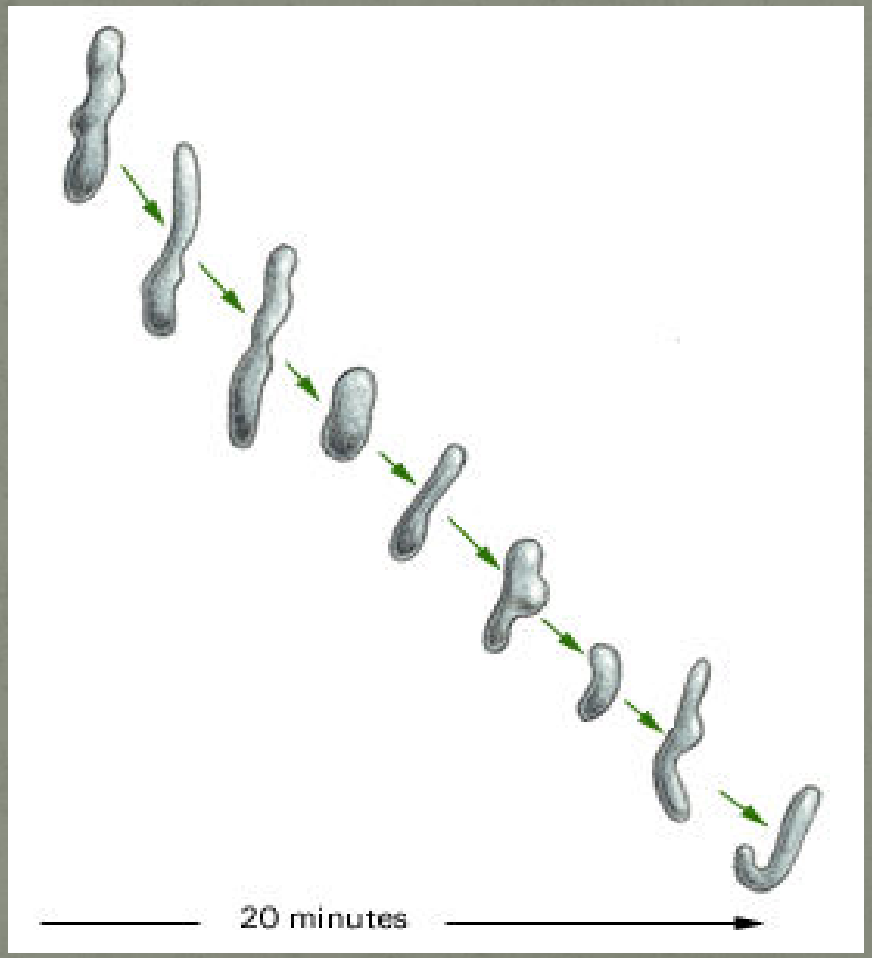
CONTENT

- Introduction
- Electron micrograph
- Brief history
- Origin
- Structure
- Function
- Disease

Introduction

- The term 'mitochondrion' is derived from a Greek word 'mitos' which means 'thread' and 'chondrion' which means 'granule'.
- Mitochondria are double membrane bound, energy converting organelles, which are present in all eukaryotic cells.
- “Power house of the cell”.
- Plastic organelle.
- Semi-autonomous organelle.
- No. Vary in different types of cells.

Plasticity:



Ref: molecular biology of cell 5th edition

Electron micrograph

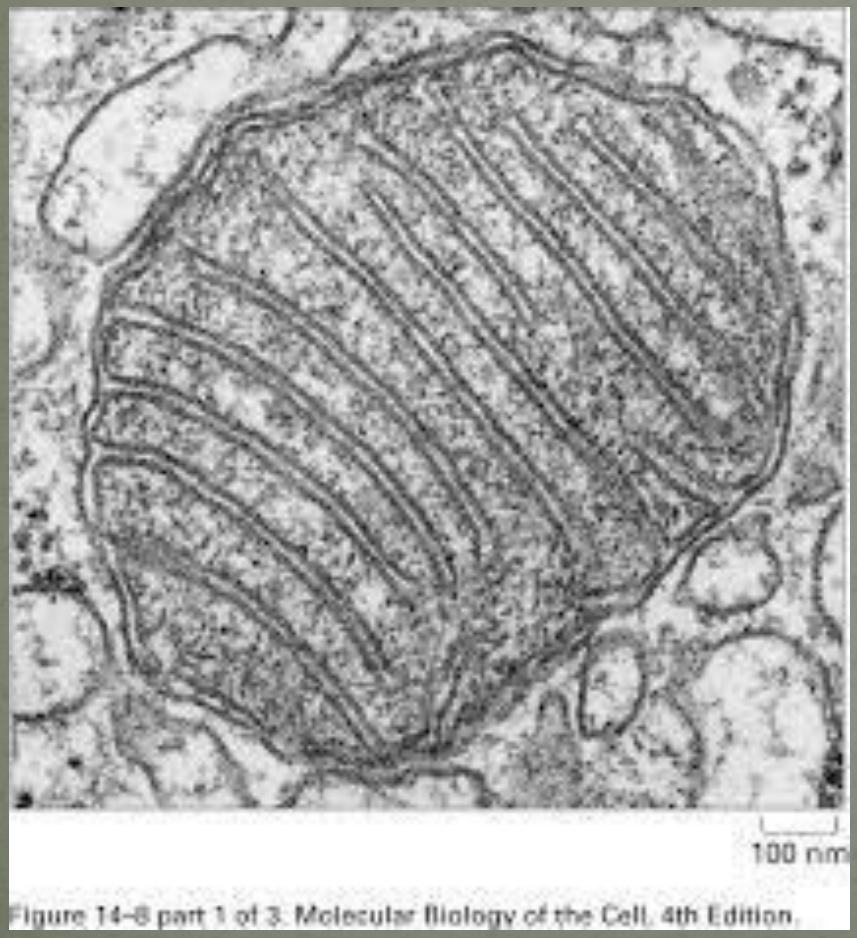


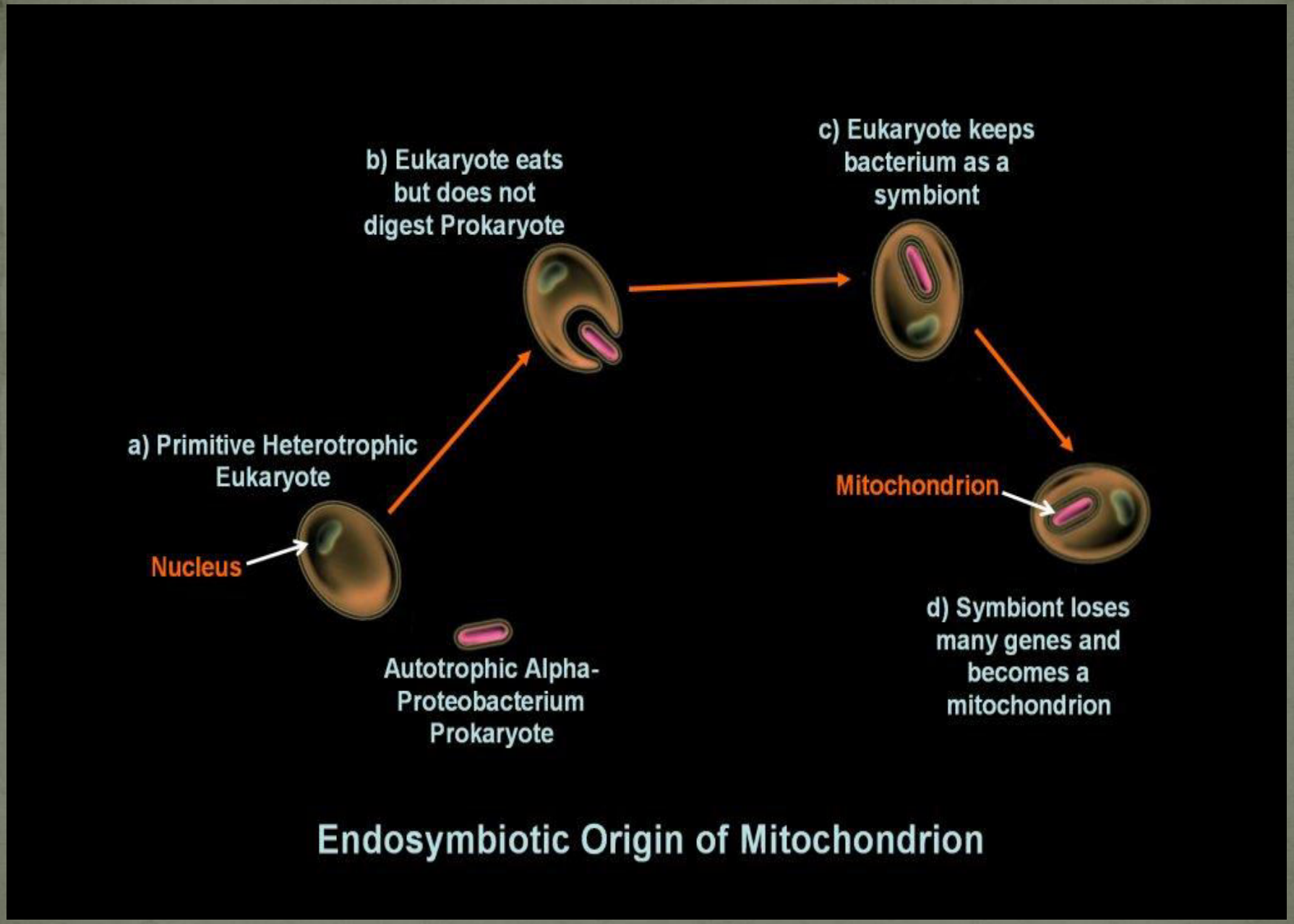
Figure 14–8 part 1 of 3. Molecular Biology of the Cell, 4th Edition.

Brief History

- Scientists known to identify the existence of mitochondria were working during the mid-1800s.
- In 1857, Albert von Kölliker described & called "granules" in the cells of muscles.
- The discovery of mitochondria in general came in 1886 when Richard Altman, a cytologist, identified the organelles using a dye technique, called "bioblasts".
- He postulated that the structures were the basic units of cellular activity.
- Carl Benda, in 1898, coined the term *mitochondria*.

Origin of mitochondria: Endosymbiotic theory

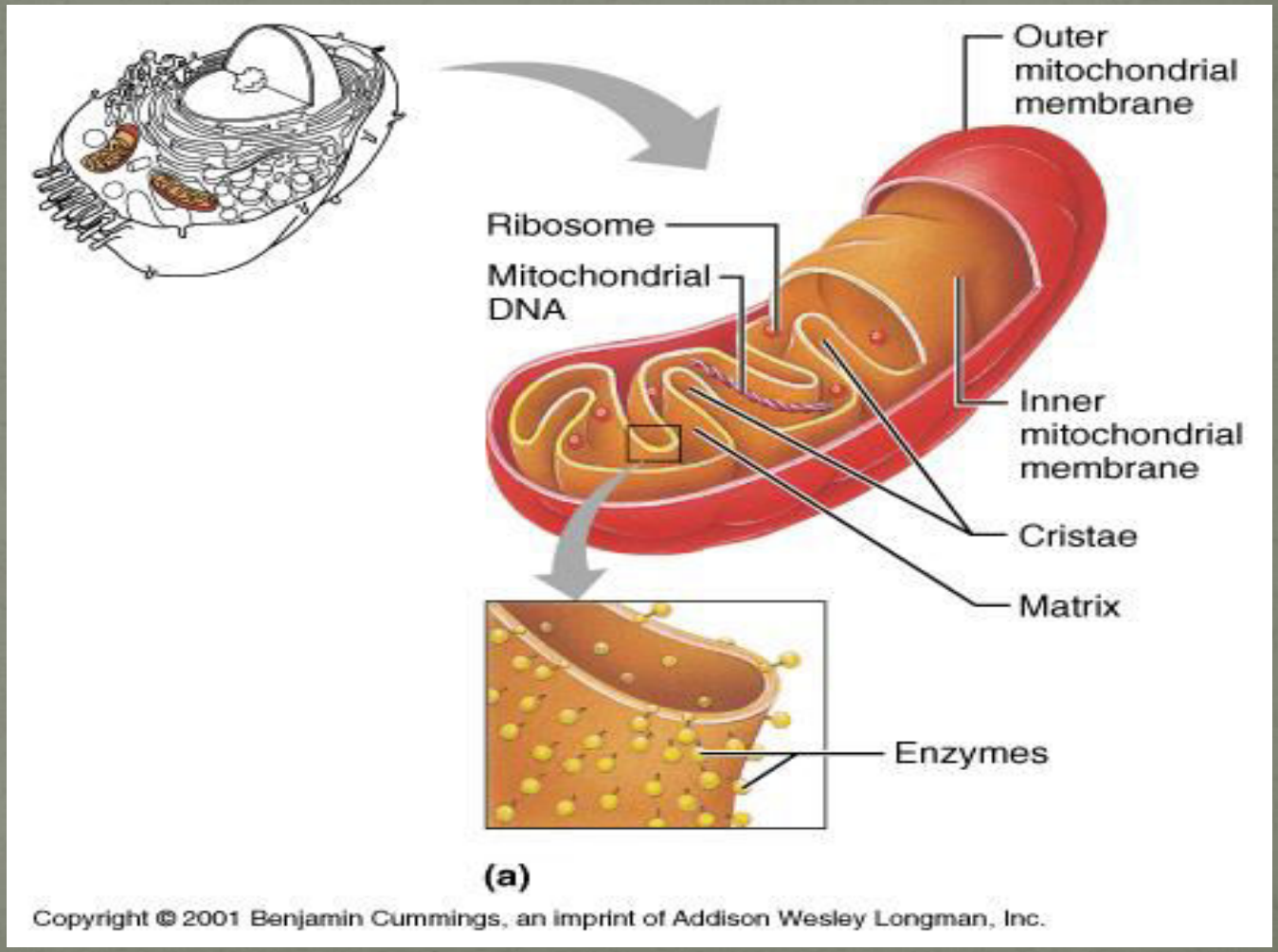
- Unlike any other organelle, except for chloroplasts, mitochondria appear to originate only from other mitochondria.
- They contain their own DNA, which is circular as is true with bacteria, along with their own transcriptional and translational machinery.
- These and related observations led Dr. Lynn Margulis, in the 1970s, to propose an extracellular origin for mitochondria.


b) Eukaryote eats but does not digest Prokaryote
c) Eukaryote keeps bacterium as a symbiont
a) Primitive Heterotrophic Eukaryote
Nucleus
Mitochondrion
Autotrophic Alpha-Proteobacterium Prokaryote
d) Symbiont loses many genes and becomes a mitochondrion
Endosymbiotic Origin of Mitochondrion

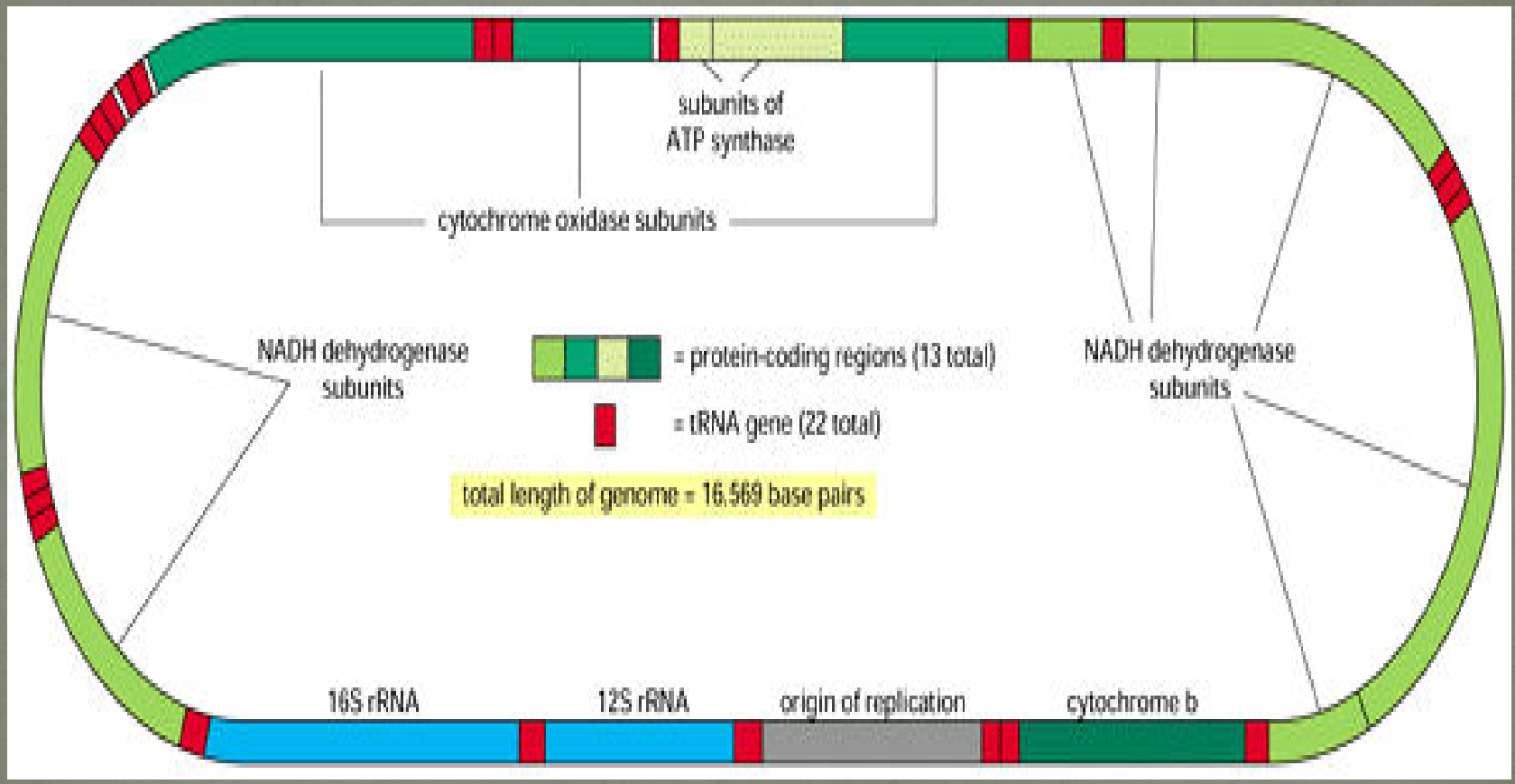
Similarity of Mitochondria with Bacteria:

Characteristics	Mammalian mitochondria	Bacteria
Size width and length	0.2-1.0 and 1.0-4μm	0.2-2.0 and 0.3-10μm
Lipoprotein membrane	6-7nm	7-8 nm
Invagination of membrane	Cristae	Mesosomes
DNA shape	Closed circle	Closed circle
Ribosomes	70S	70S

Structure:



Mitochondrial Genome:



Ref : google

Functions of mitochondria:

- Mitochondrial ribosomes and transfer RNA molecules are similar to those of bacteria, as are components of their membrane.
- Produce energy by oxidative phosphorylation.
- The liver cells mitochondria have enzymes that detoxify ammonia.
- The mitochondria also play important role in the process of apoptosis or programmed cell death.

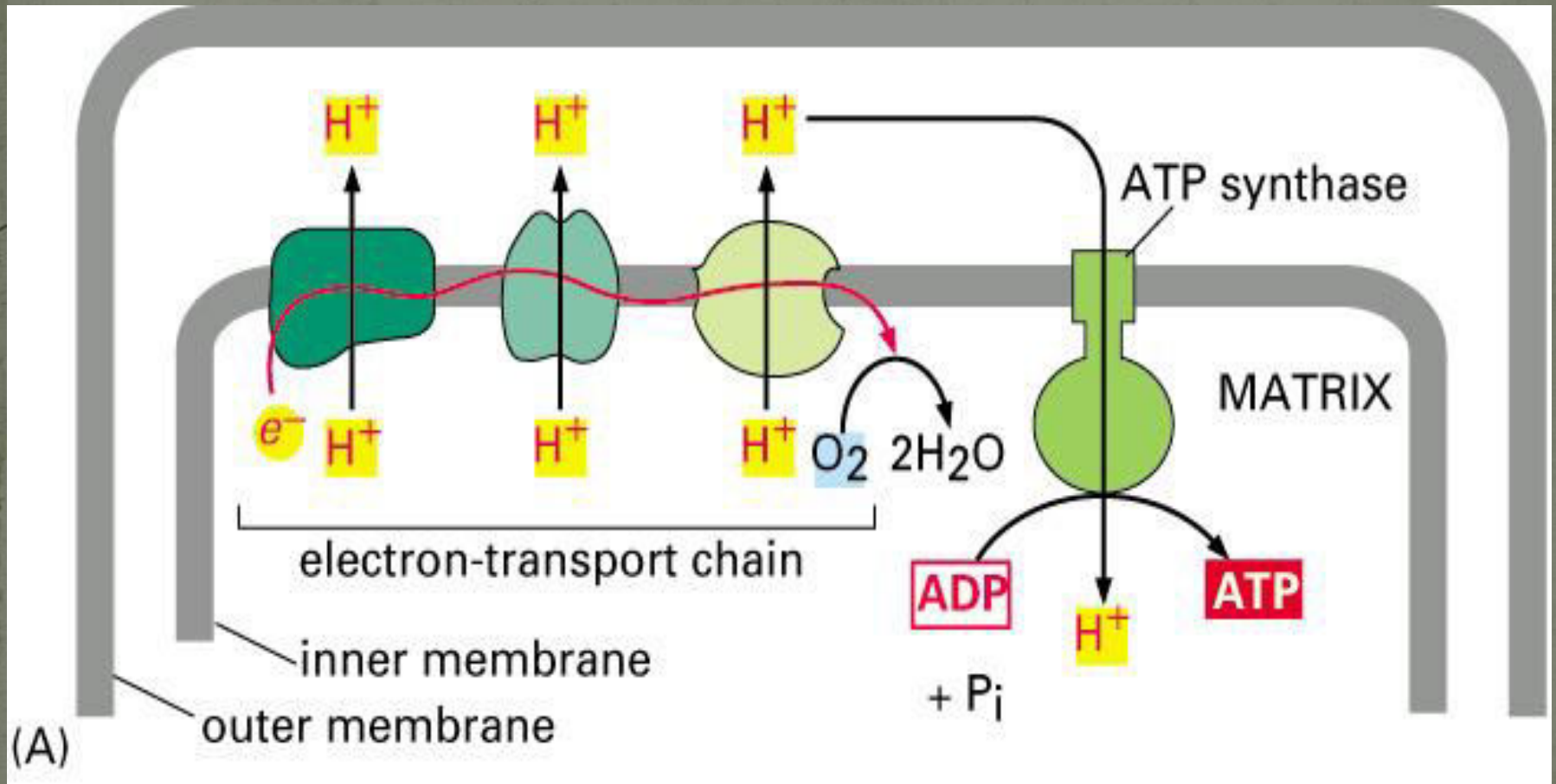
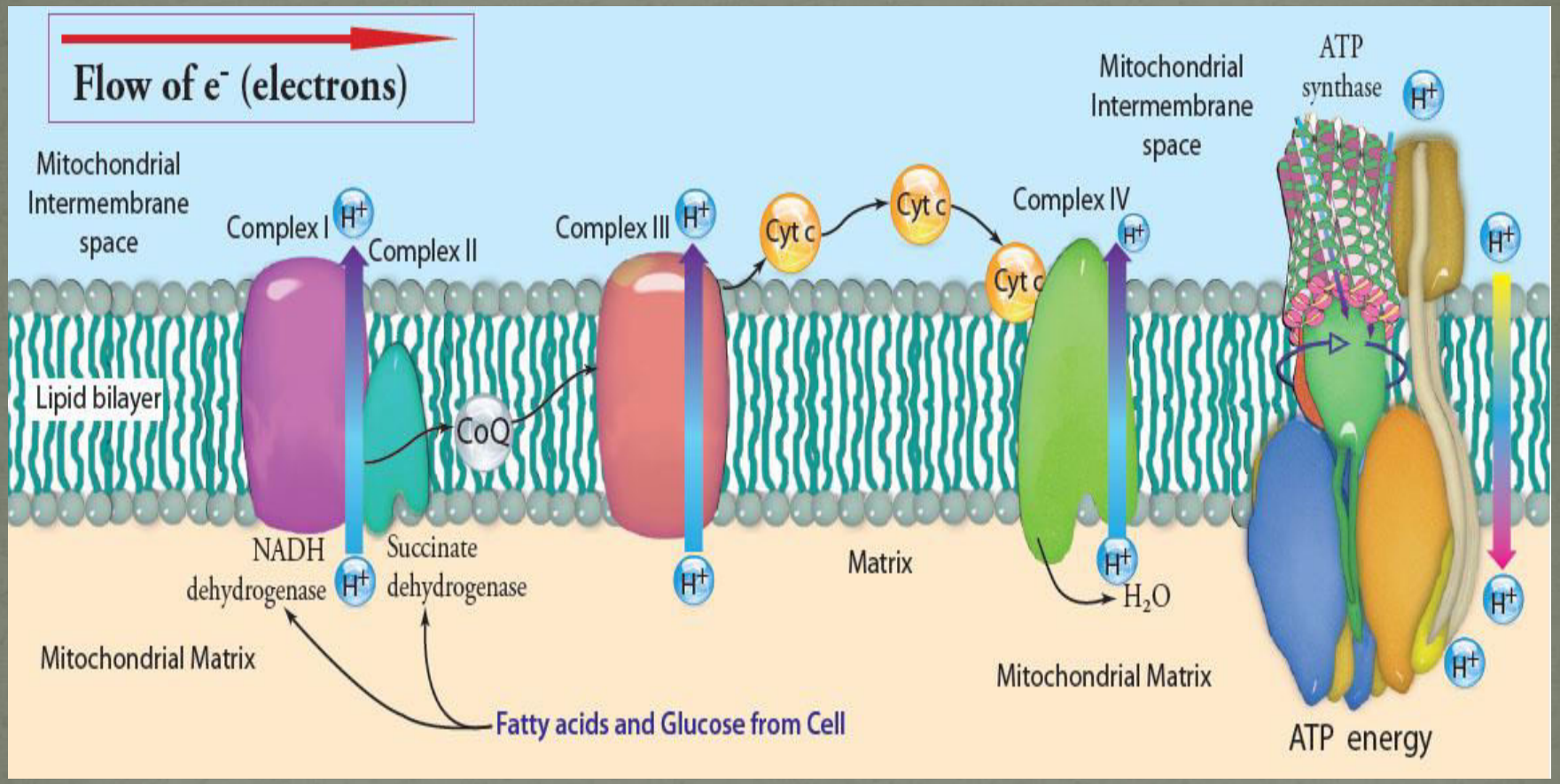
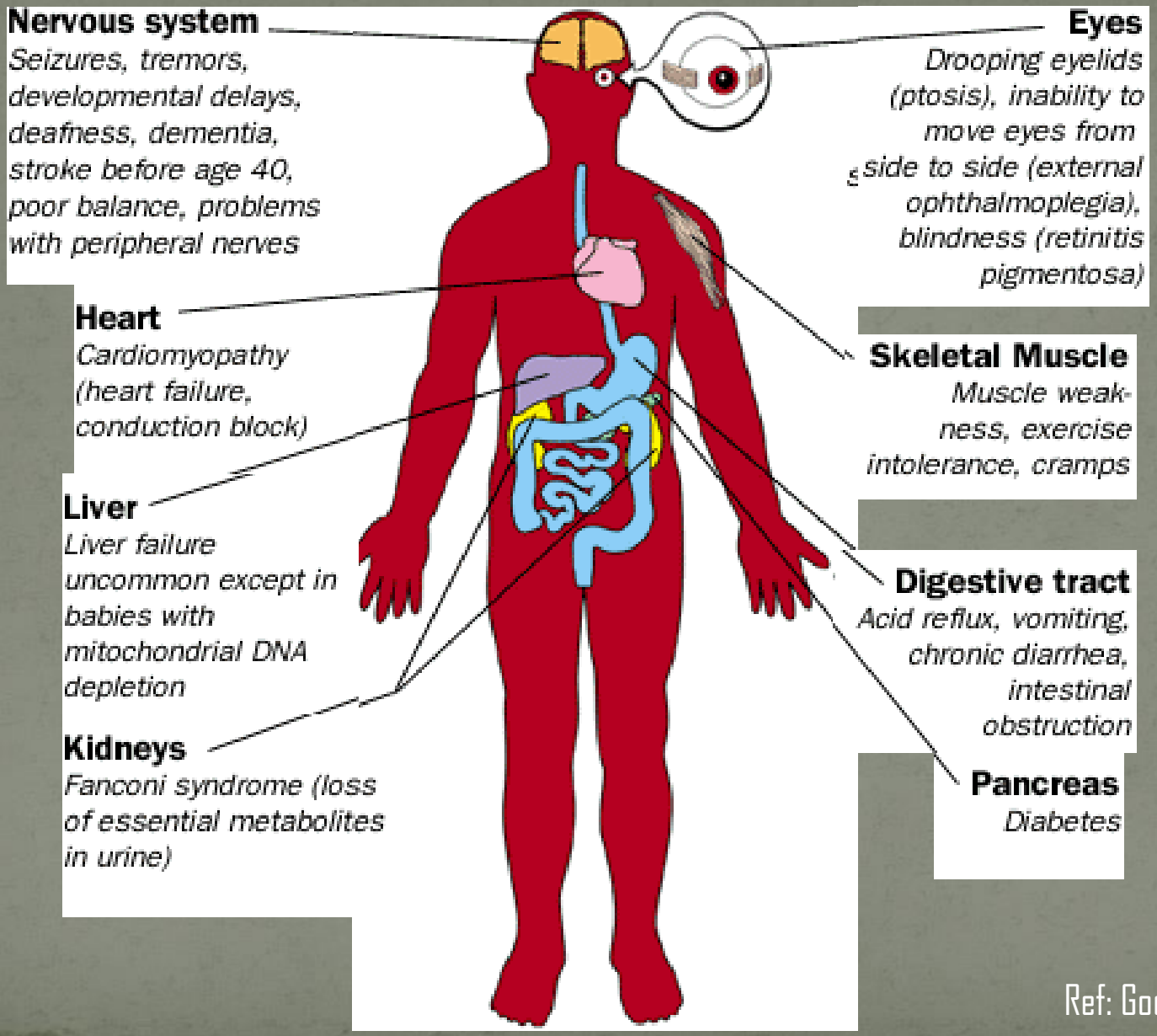


Figure 14–14 part 1 of 2. Molecular Biology of the Cell, 4th Edition.


Flow of e⁻ (electrons)
Mitochondrial Intermembrane space
Complex I
Complex II
Complex III
Complex IV
Cyt c
Cyt c
Cyt c
H+
Lipid bilayer
CoQ
NADH dehydrogenase
Succinate dehydrogenase
Mitochondrial Matrix
Matrix
H2O
Mitochondrial Intermembrane space
ATP synthase
Mitochondrial Matrix
Fatty acids and Glucose from Cell
ATP energy

Disease :

- Results due to the failure of mitochondria
- Dysfunction in the mitochondria fails to produce energy that is needed for the sustainment of life and growth of an organism.
- The mitochondrial disease causes most of the damage to the cells of brain, heart, liver, muscles.
- Symptoms…


Nervous system
Seizures, tremors, developmental delays, deafness, dementia, stroke before age 40, poor balance, problems with peripheral nerves
Eyes
Drooping eyelids (ptosis), inability to move eyes from side to side (external ophthalmoplegia), blindness (retinitis pigmentosa)
Heart
Cardiomyopathy (heart failure, conduction block)
Skeletal Muscle
Muscle weakness, exercise intolerance, cramps
Liver
Liver failure uncommon except in babies with mitochondrial DNA depletion
Digestive tract
Acid reflux, vomiting, chronic diarrhea, intestinal obstruction
Kidneys
Fanconi syndrome (loss of essential metabolites in urine)
Pancreas
Diabetes

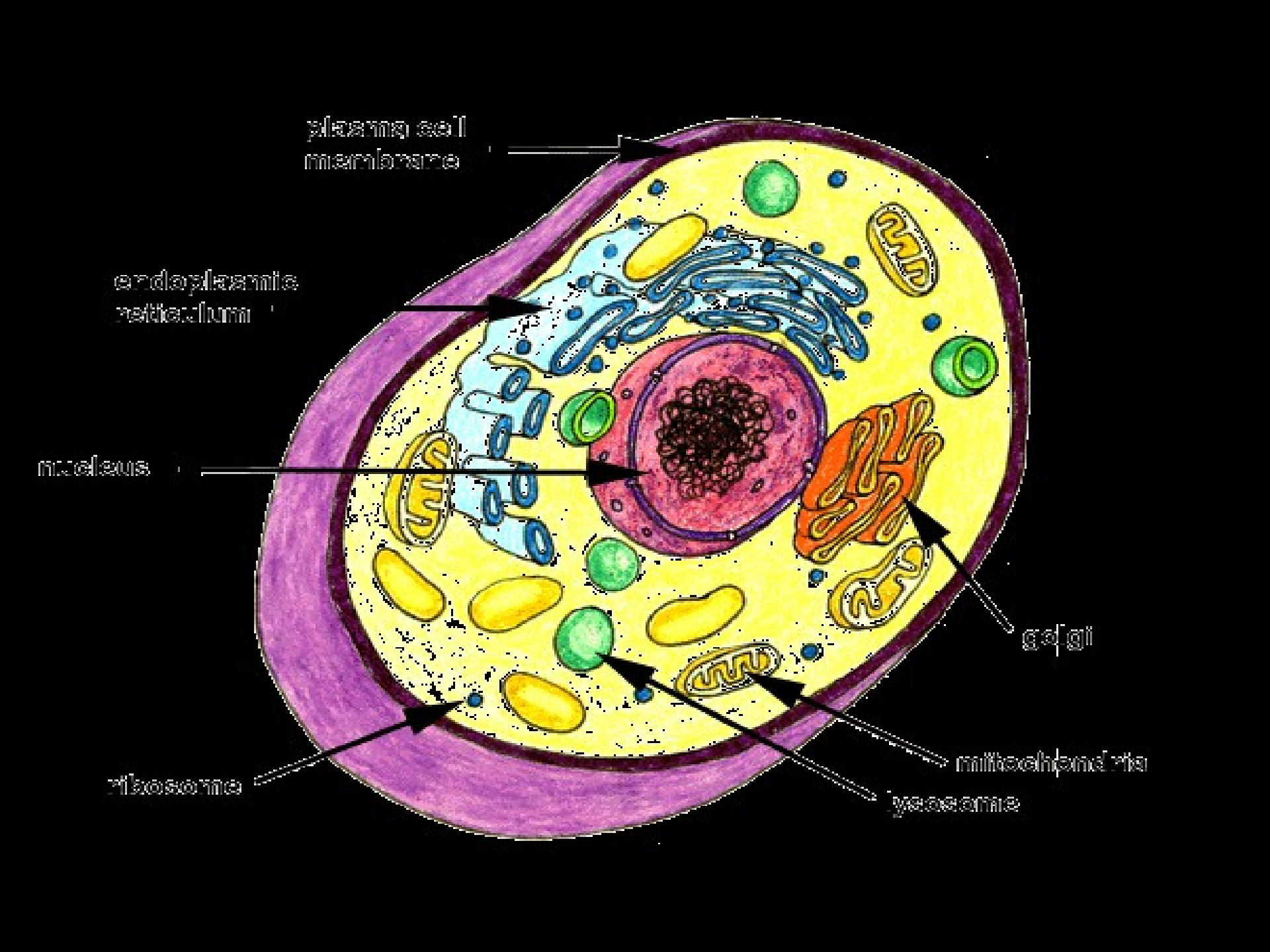
Ref: Google

THANKS

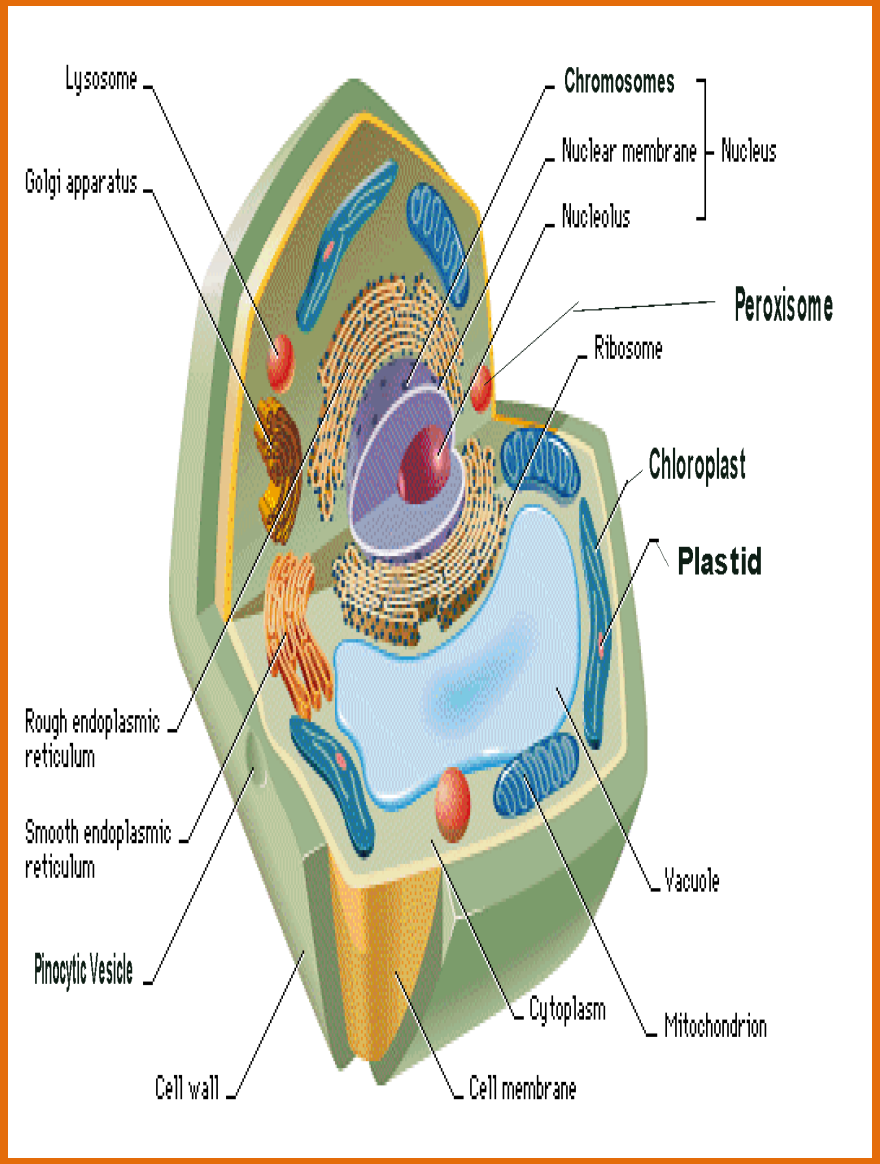
CELL

-The cell is the structural and functional unit of all known living organisms. It is the smallest unit of an organism that is classified as living, and is often called the building block of life. Some organisms, such as most **bacteria**, are **unicellular** (consist of a single cell). Other organisms, such as **humans**, are **multicellular**.

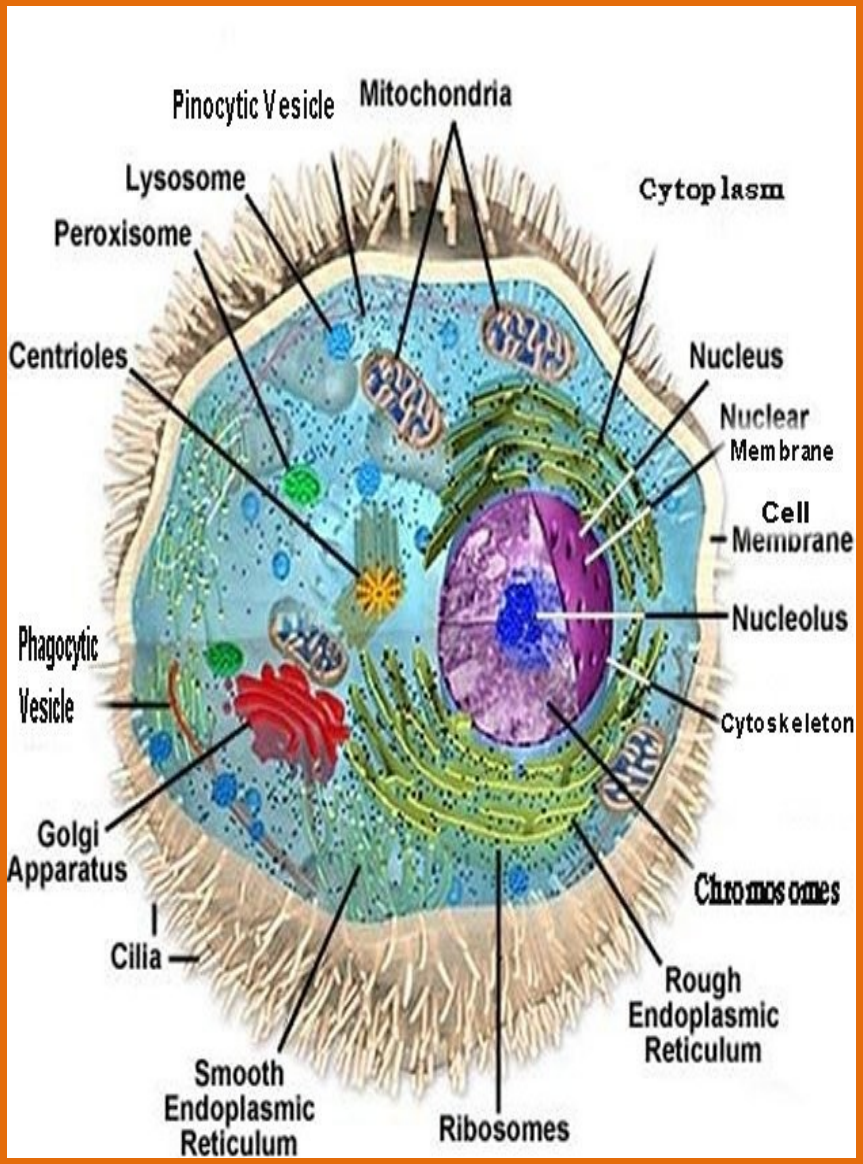
-Eukaryotic cells are about 10 times the size of a typical prokaryote and can be as much as 1000 times greater in volume. The major difference between prokaryotes and eukaryotes is that eukaryotic cells contain membrane-bound compartments in which specific metabolic activities take place. Most important among these is the presence of a **cell nucleus**, a membrane-delineated compartment that houses the eukaryotic cell's DNA. It is this nucleus that gives the eukaryote its name, which means "true nucleus." Other differences include


plasma cell membrane
endoplasmic reticulum
nucleus
golgi
ribosome
mitochondria
lysosome

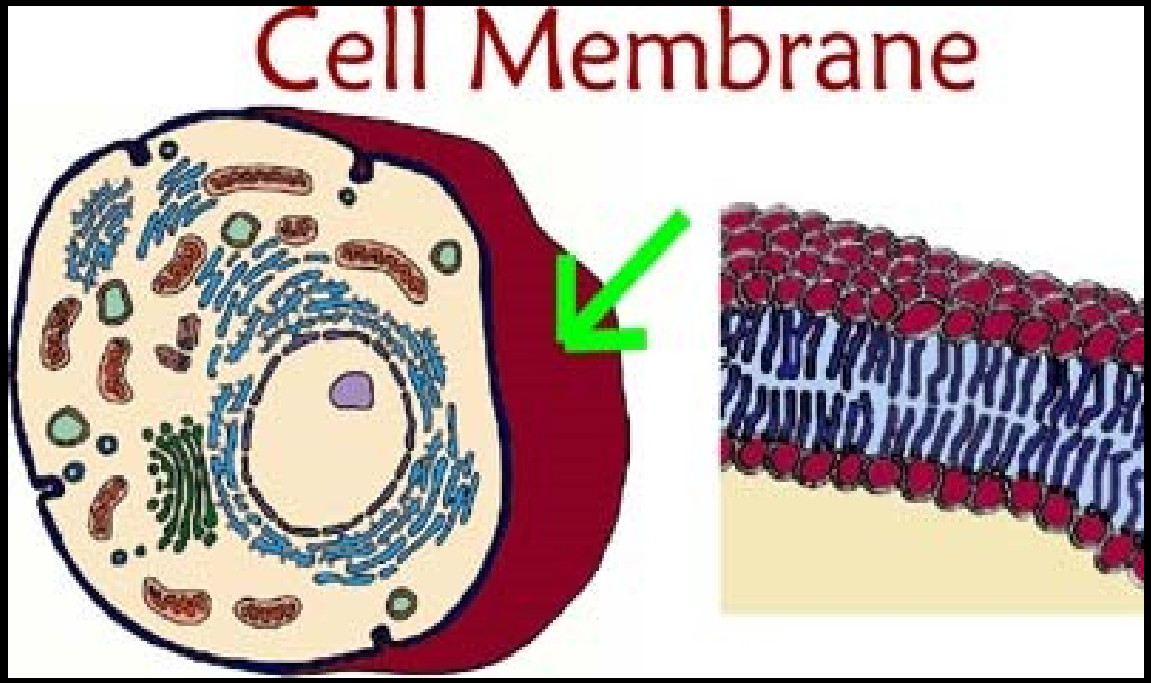
PLANT CELL



ANIMAL CELL

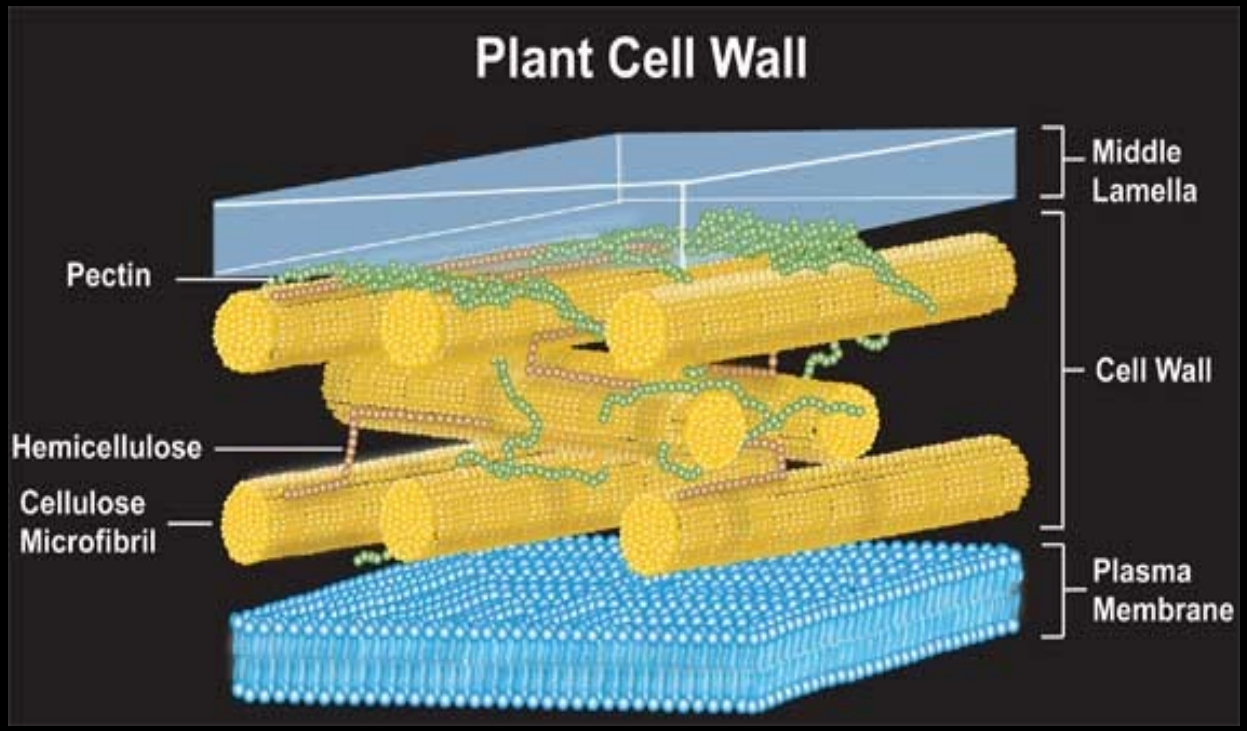


	Animal Cell	Plant Cell
Cell wall	none	yes
Plastids	no	yes
Vacuole	One or more small vacuoles	One, large central vacuole taking up 90% of cell volume
Shape	round	rectangular
Glyoxysomes	no	Some plant cells have glyoxysomes
Centrioles	Always present	Only present in lower plant forms
Lysosomes	Occur in cytoplasm	Usually not evident
Plasma Membrane	Only cell membrane	Cell membrane & cell wall
Chloroplast	Don’t have chloroplast	Have chloroplast



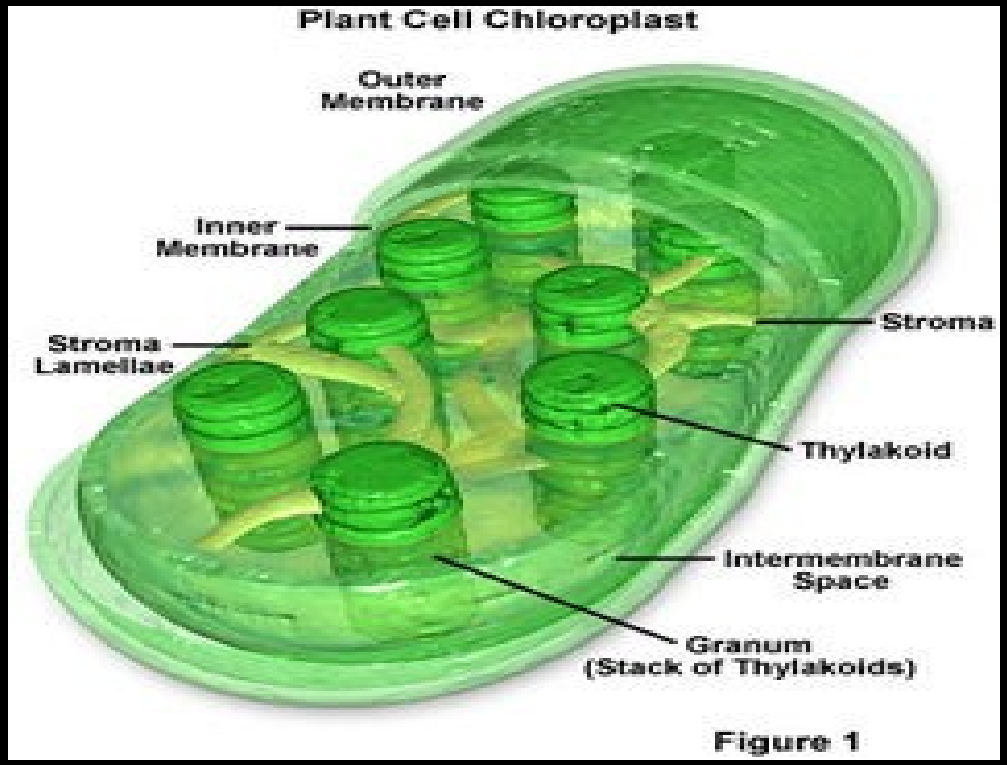
CELL MEMBRANE

Is responsible for the controlled entry and exit of molecules. **"Gate Keeper"**



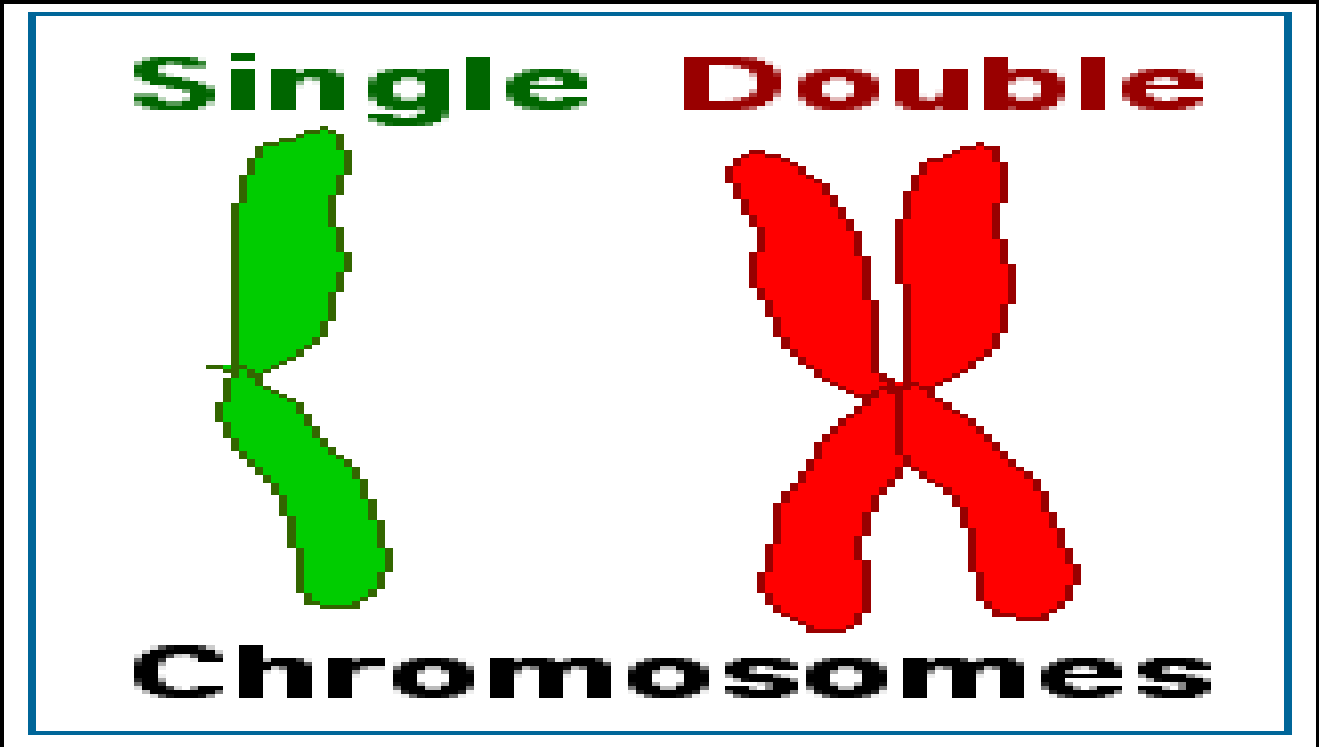
PLANT CELL

Provides and maintains the shape of cells and serves as a protective barrier.



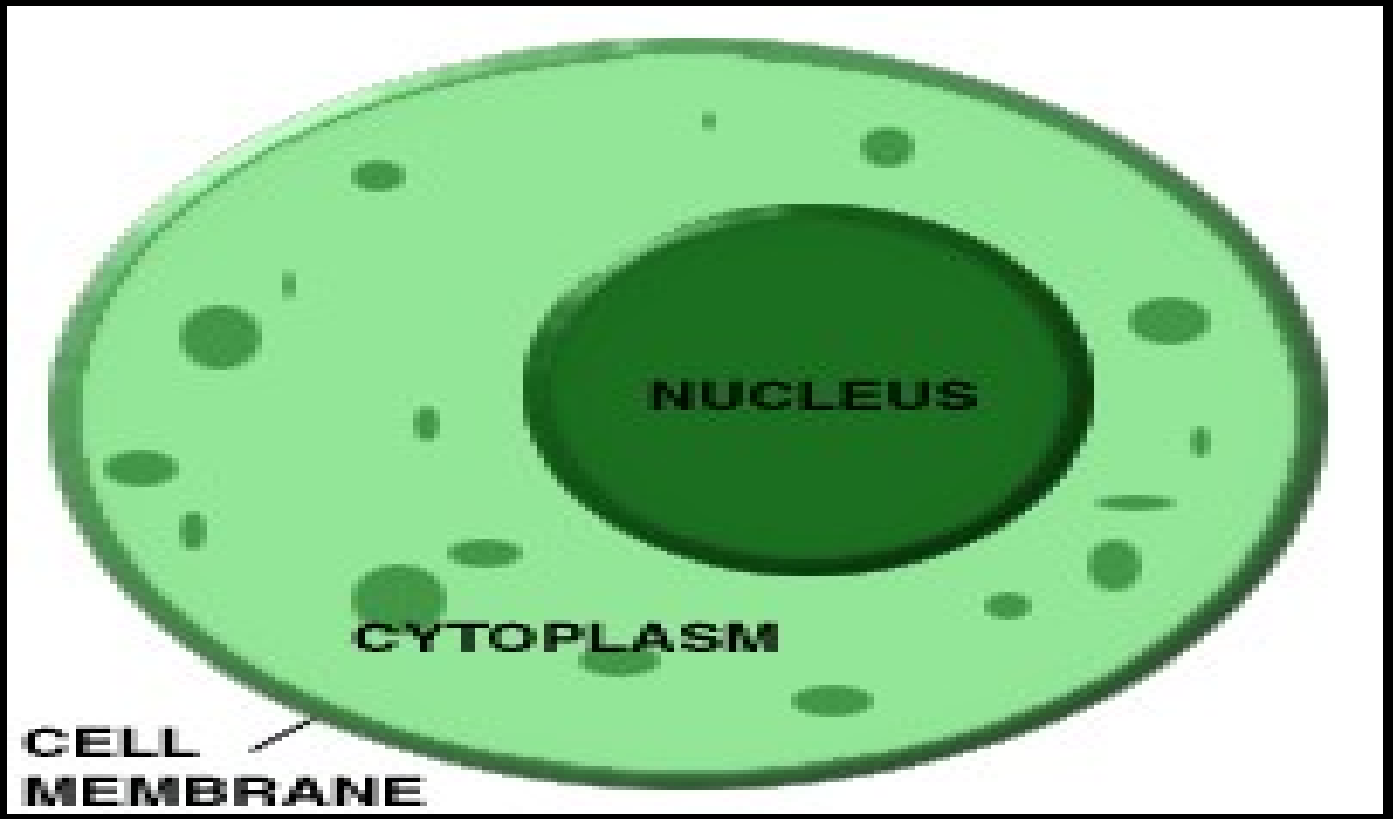
CHLOROPLAST

Contains the plant cell's chlorophyll. Produces food, turns sunlight into food. **"Food Factory"**



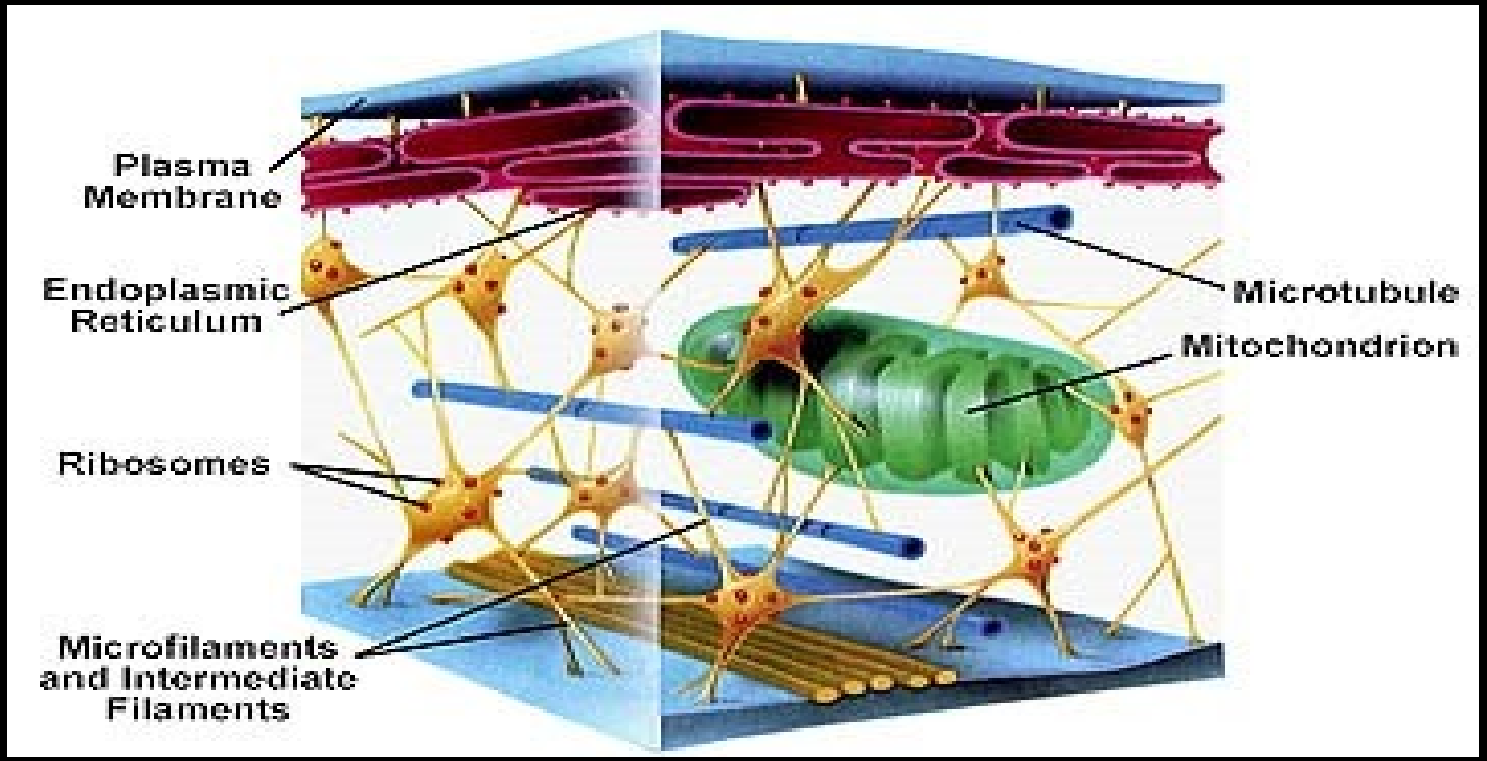
CHROMOSOMES

Is a structure of DNA that carries the genes and functions of the cell.



CYTOPLASM

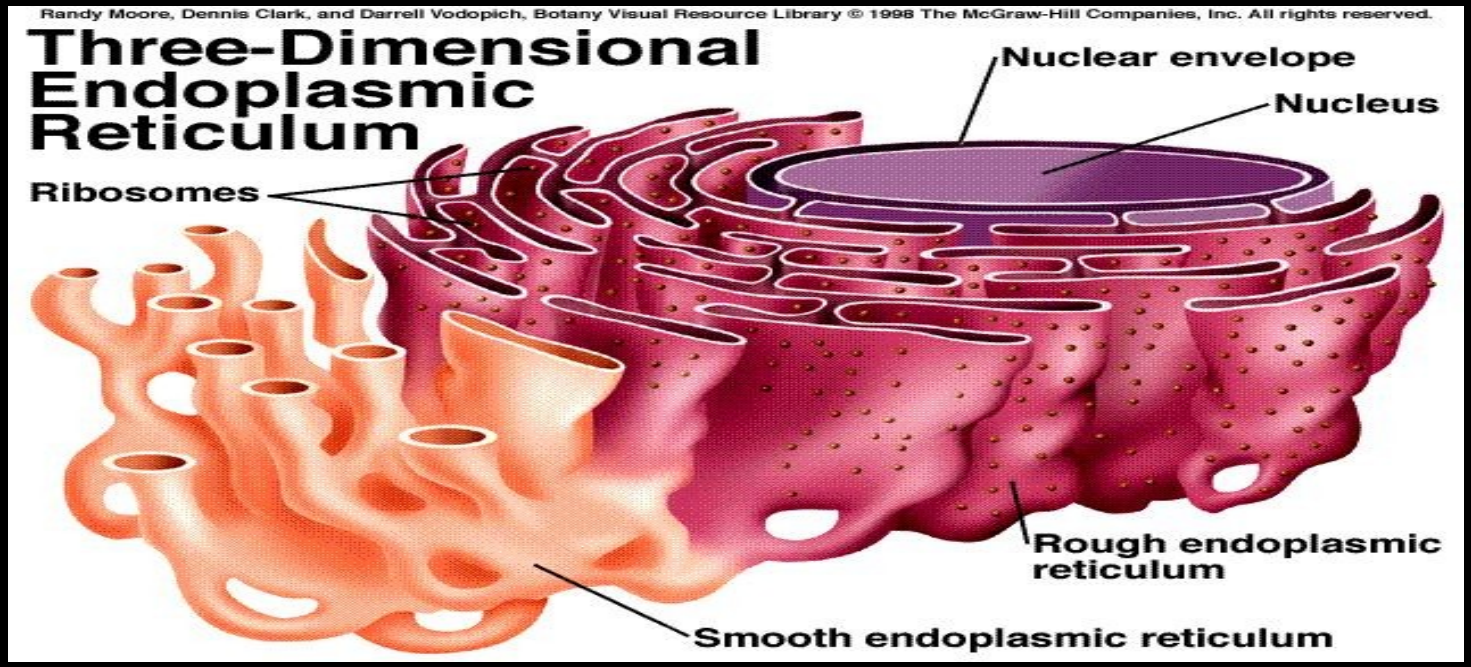
Controls cell metabolism including signal pathways, intercellular receptor. **"Cell Jello"**



CYTOSKELETON

Helps maintain the cell shape, motility and internal movement.

"Framework"

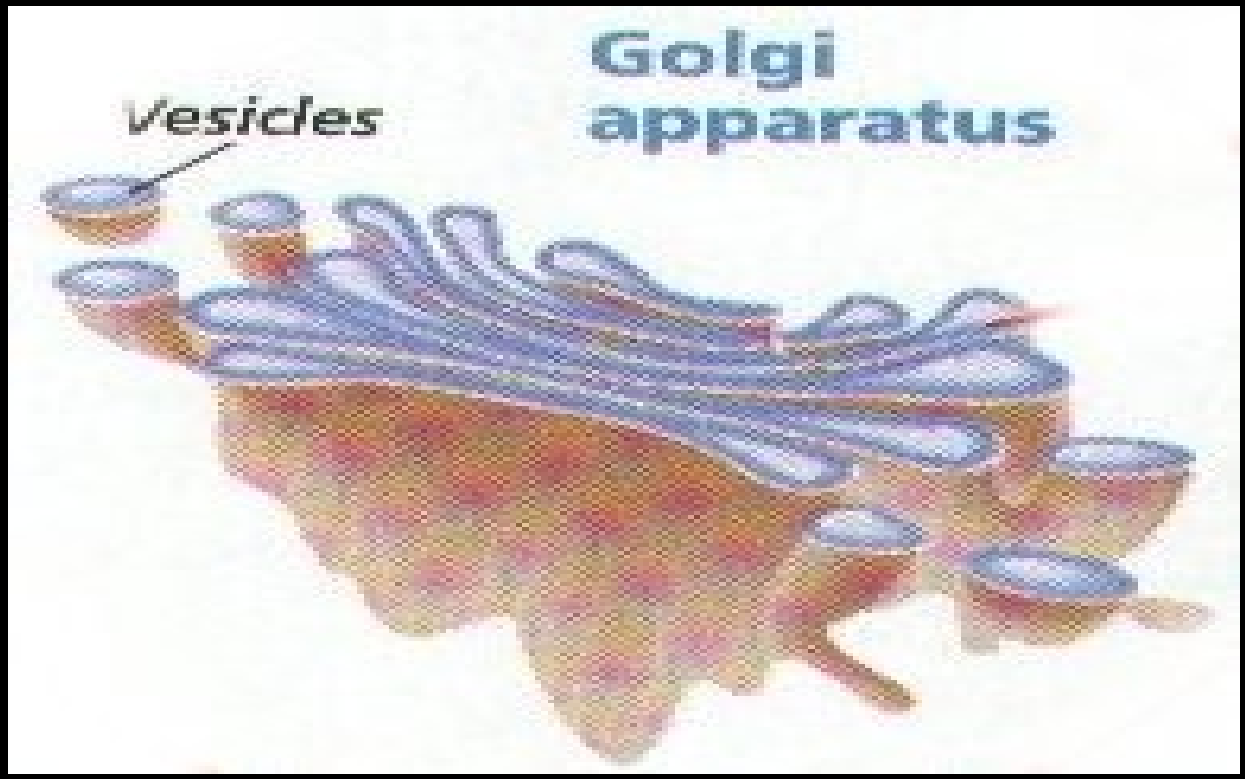


ENDOPLASMIC RETICULUM

A 3-dimensional maze of connecting and branching channels made by a continuous membrane, within the cytoplasm of cells, which classified as

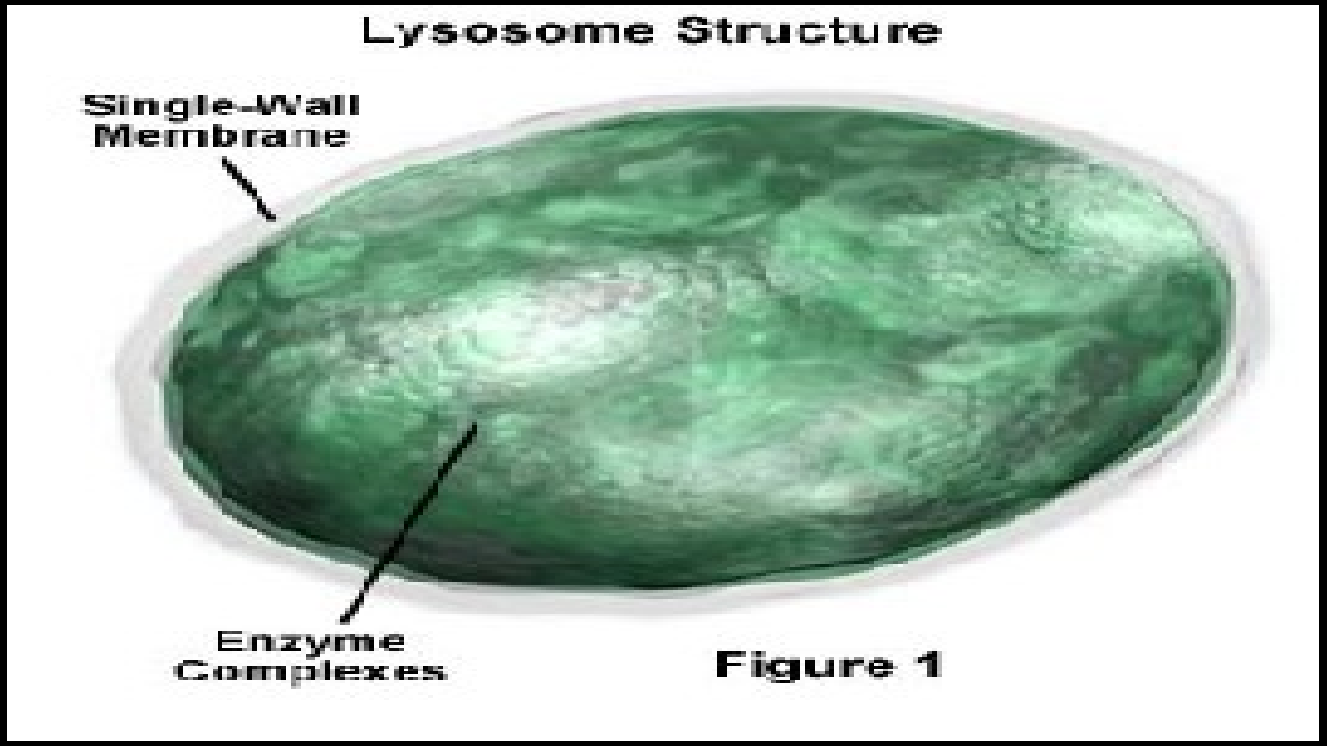
•ER (rough) - Important to synthesis of proteins with help of ribosomes.

•ER (smooth) - Important in synthesis of lipid and membrane proteins.



GOLGI APPARATUS

Important for packaging macromolecules for transport around the cell. **"Packagers"**



LYSOSOME

Intercellular digestion that also kills bacteria. **"Suicide Sacs"**

MITOCHONDRIA

Provides the energy a cell needs.
"Powerhouse

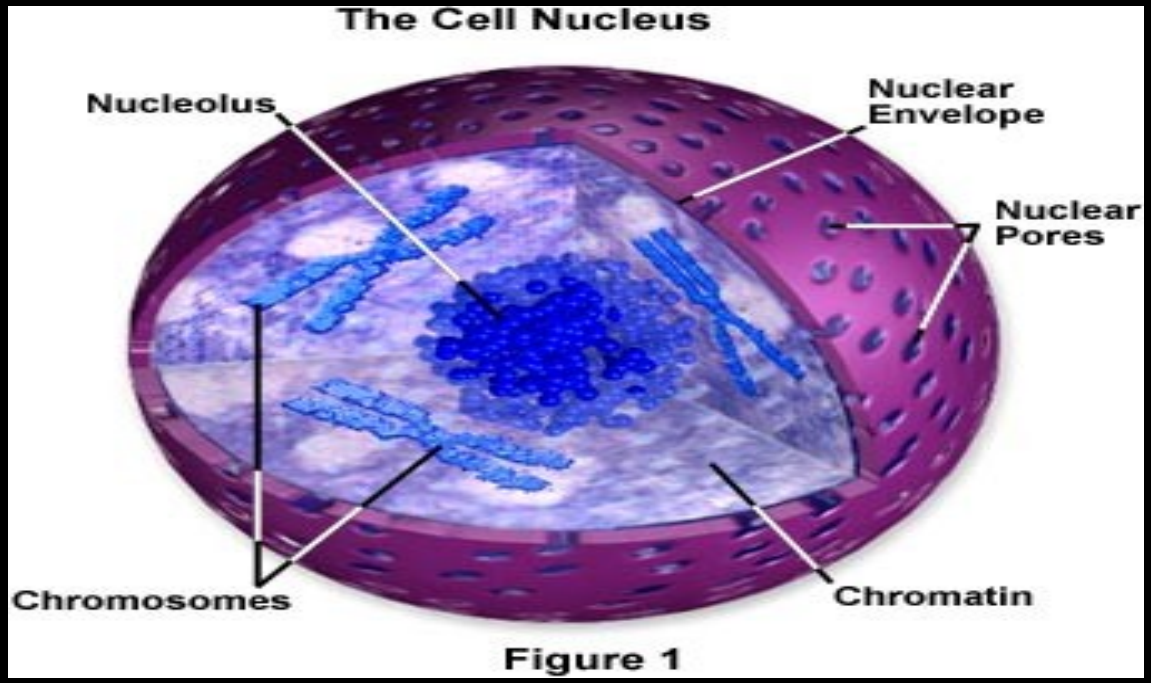
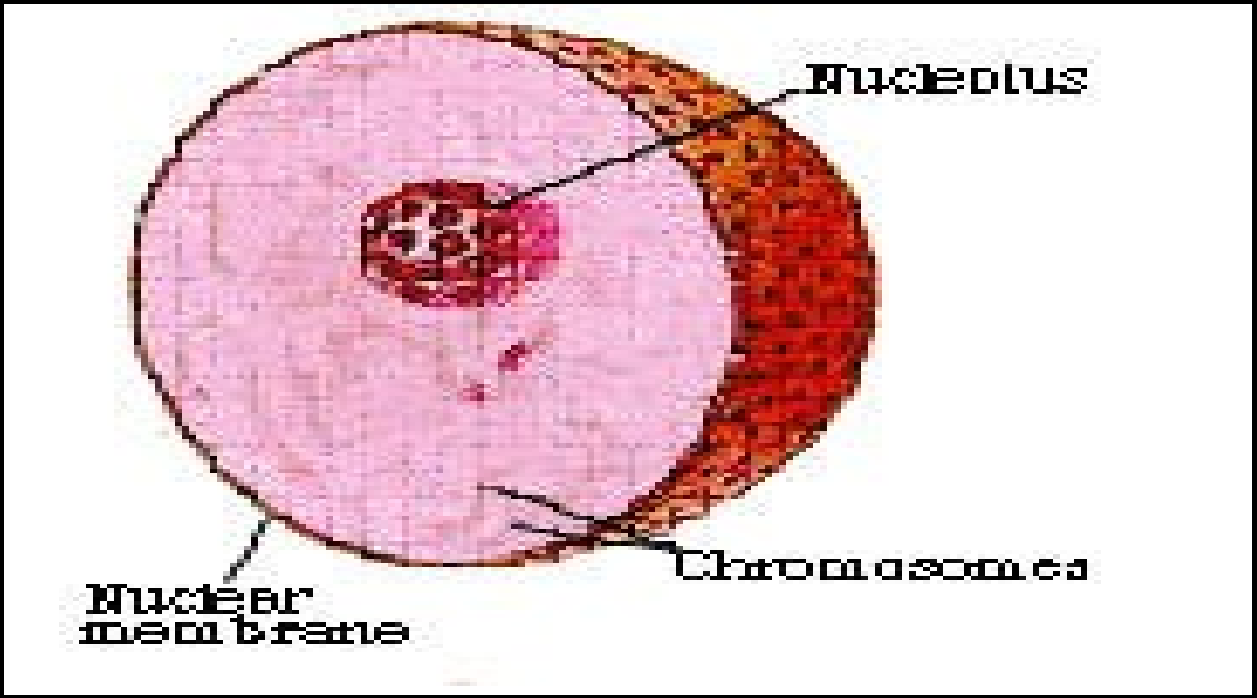


Figure 1

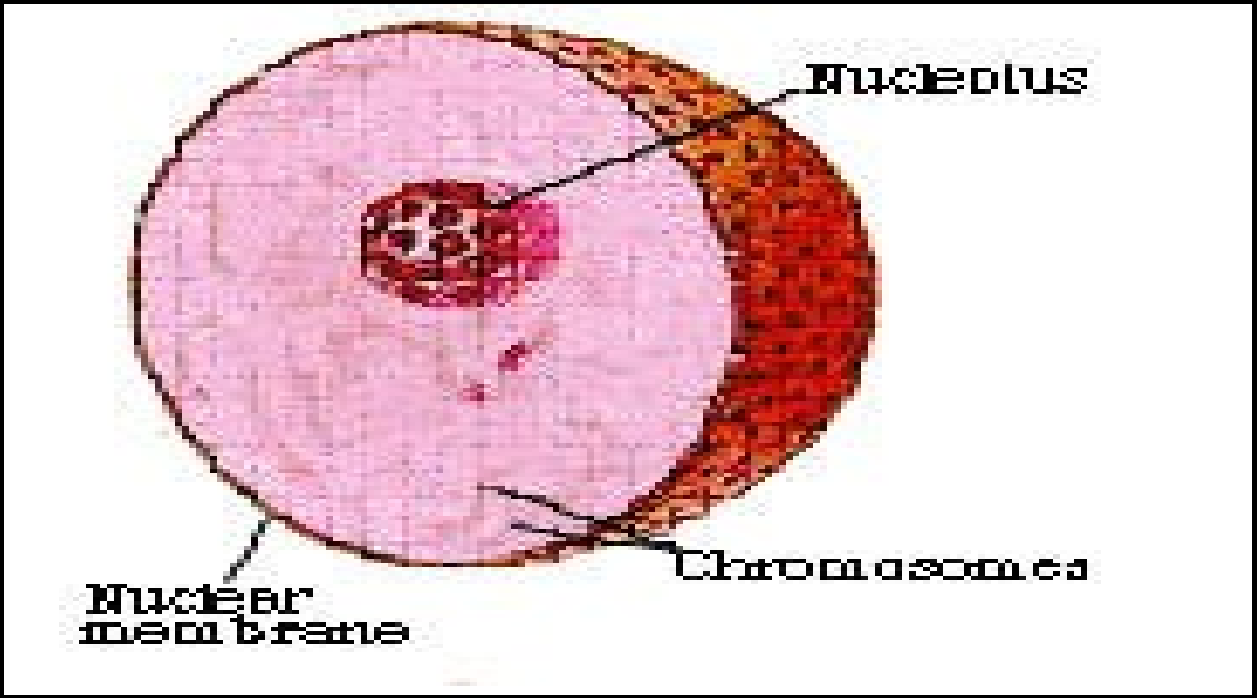
NUCLEUS

Is where DNA, which responsible for providing the cell with its unique characteristics, is located. **"Brain"**



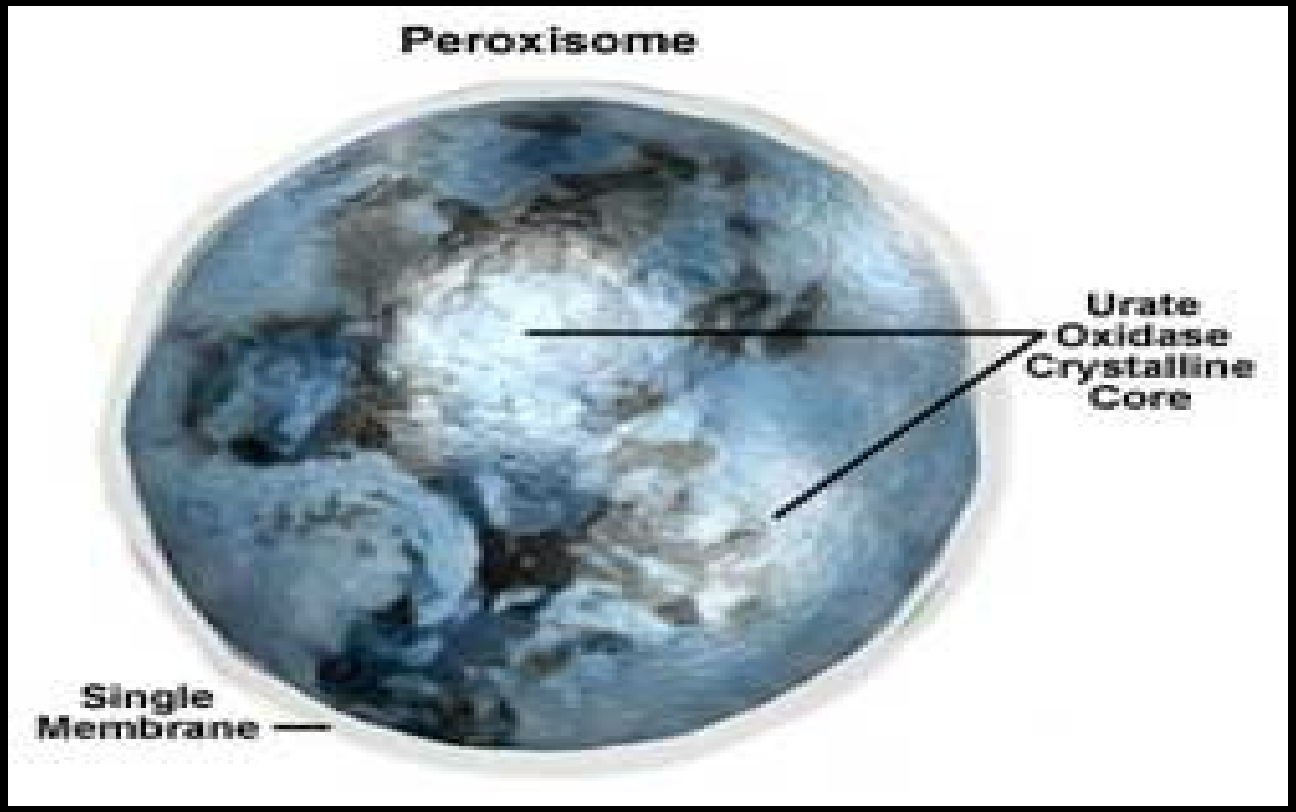
NUCLEAR MEMBRANE

A structure that binds the nucleus within the cell.



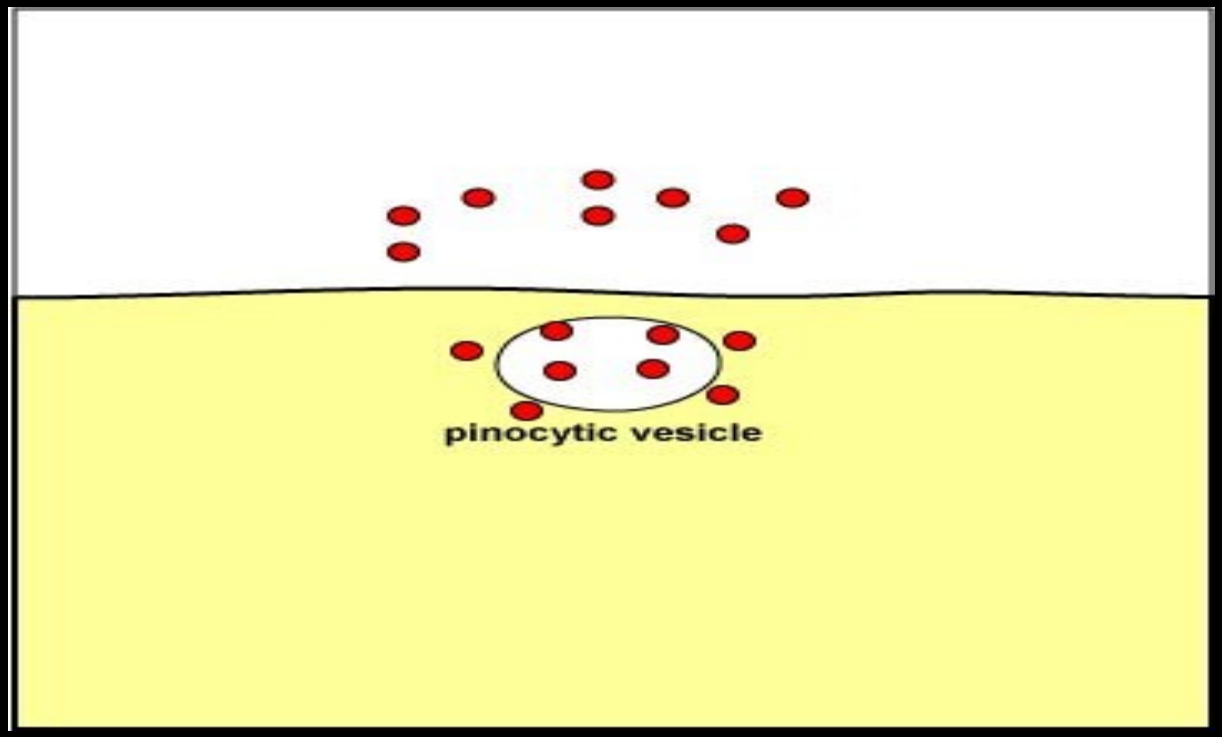
NUCLEOLUS

Produces ribosomes, moves the rough ER and is critical in protein synthesis.



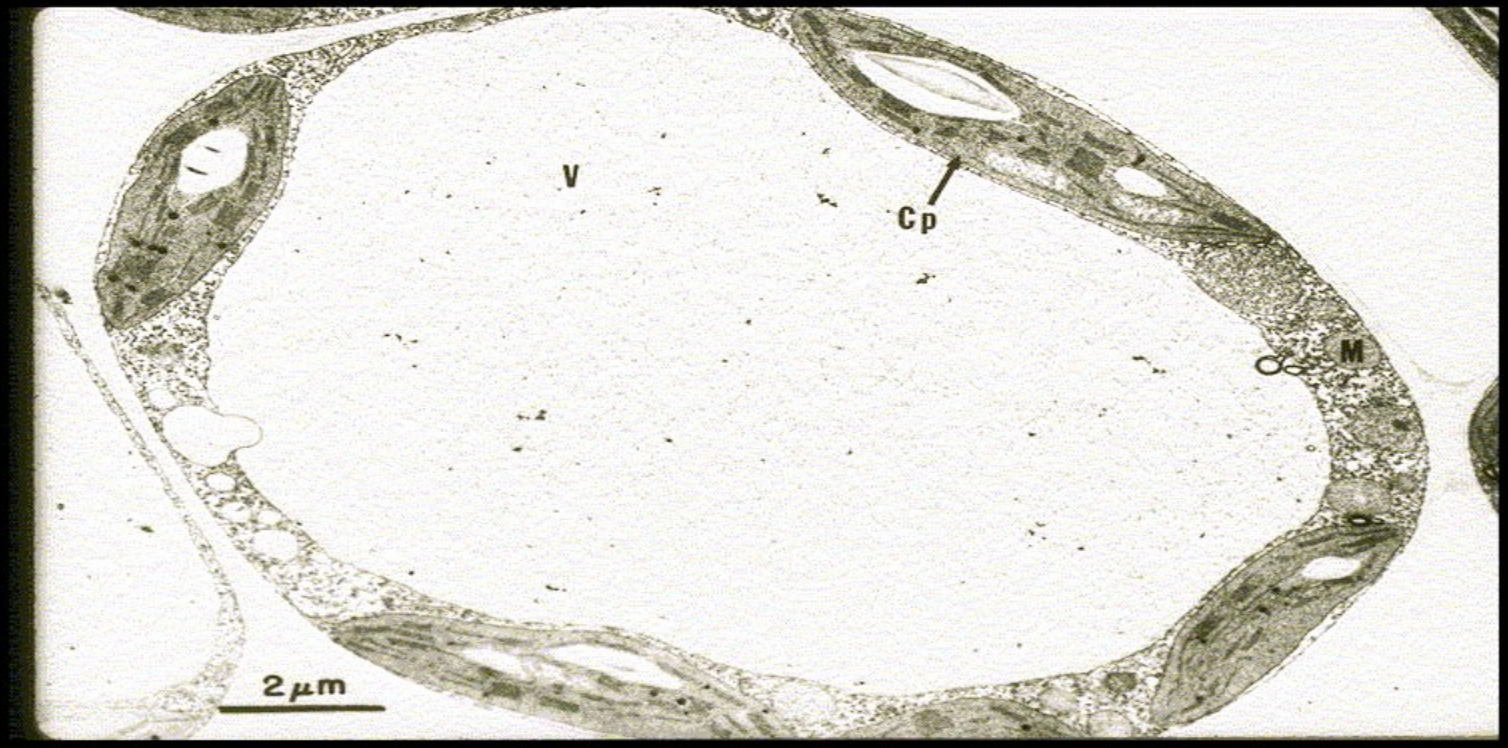
PEROXISOME

Responsible for protecting the cell from its own production of toxic peroxide.



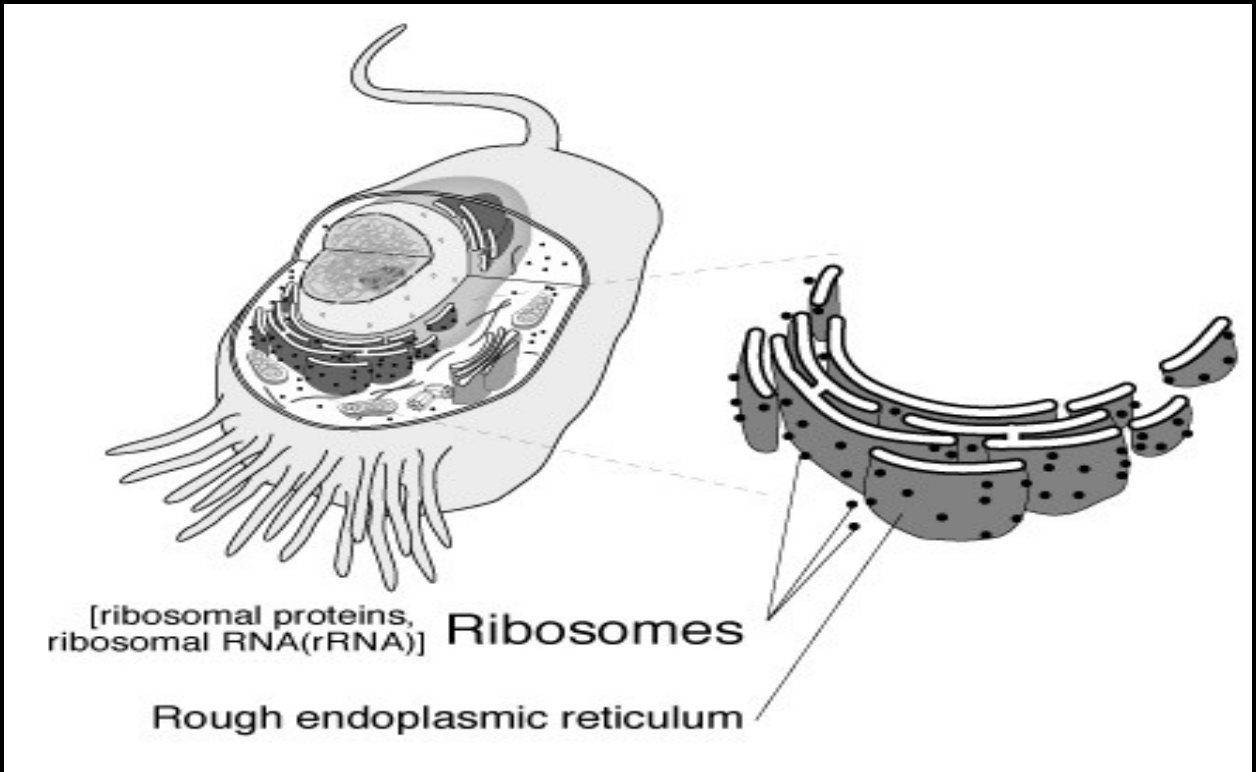
PINOCYTIC VESICLE

Stores water for the cell.



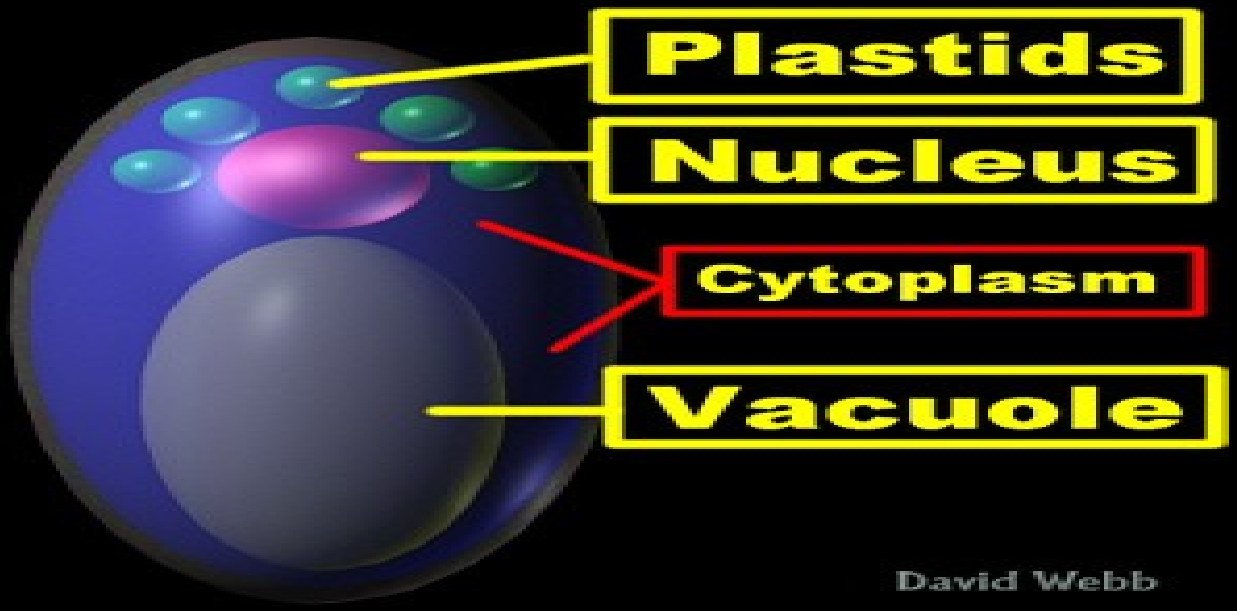
VACUOLE

Plays a role in intracellular digestion and the release of cellular waste products. **"Storage"**



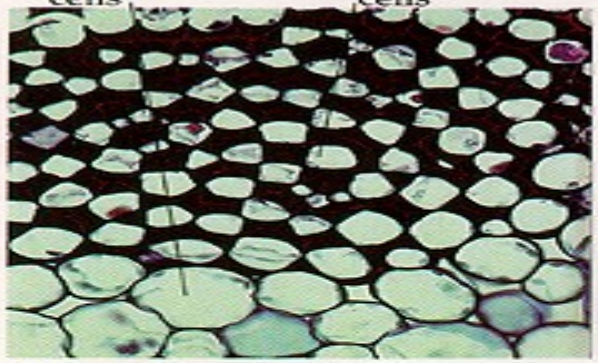
RIBOSOME

Serves as the site of assembly for polypeptides encoded by RNA. **"Protein Factory"**

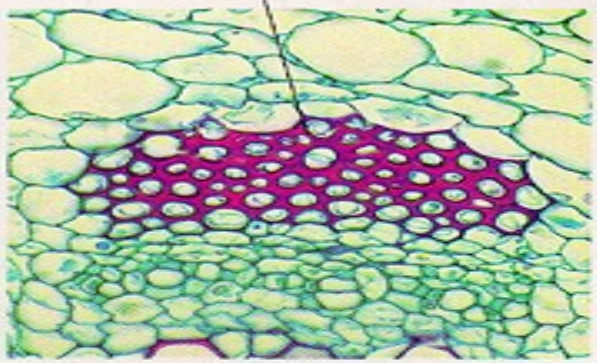


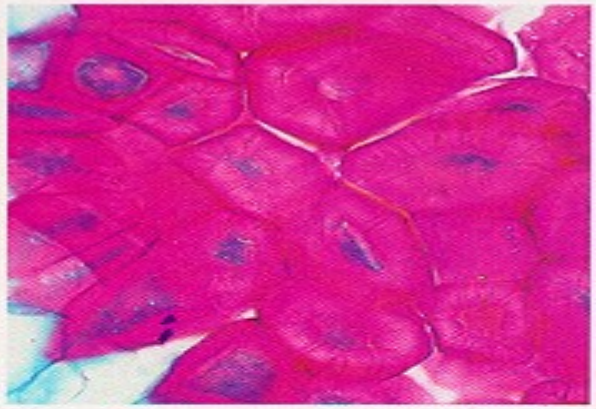
PLASTIDS

The synthesis and storage of food.

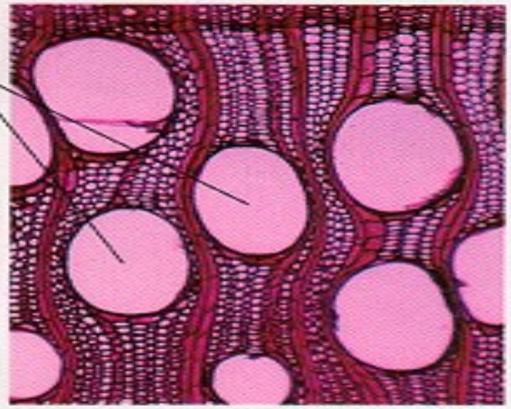


(a) Parenchyma and collenchyma

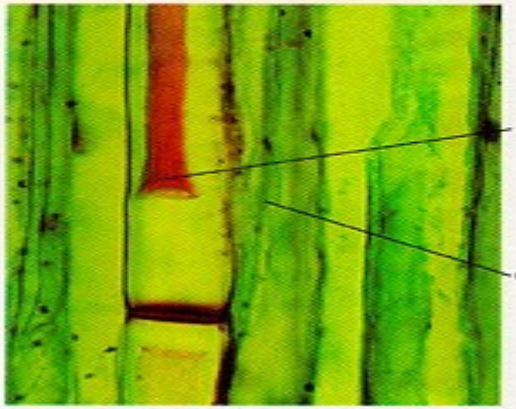


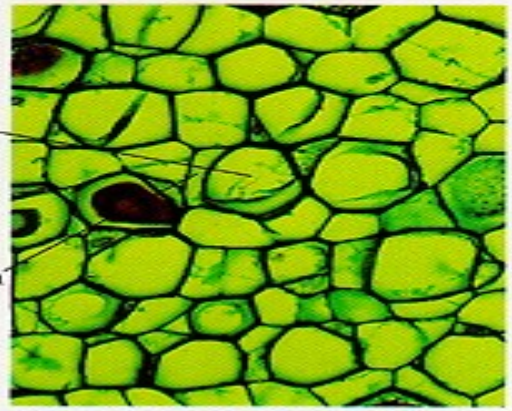


(b) Sclerenchyma: fiber cells (left) and sclereids or stone cells (right)



(c) Xylem showing vessel elements and tracheids in longitudinal (left) and transverse (right) sections





(d) Phloem showing sieve-tube members and companion cells in longitudinal (left) and transverse (right) sections