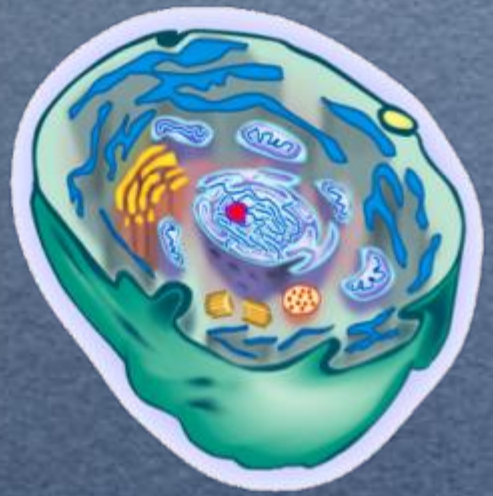
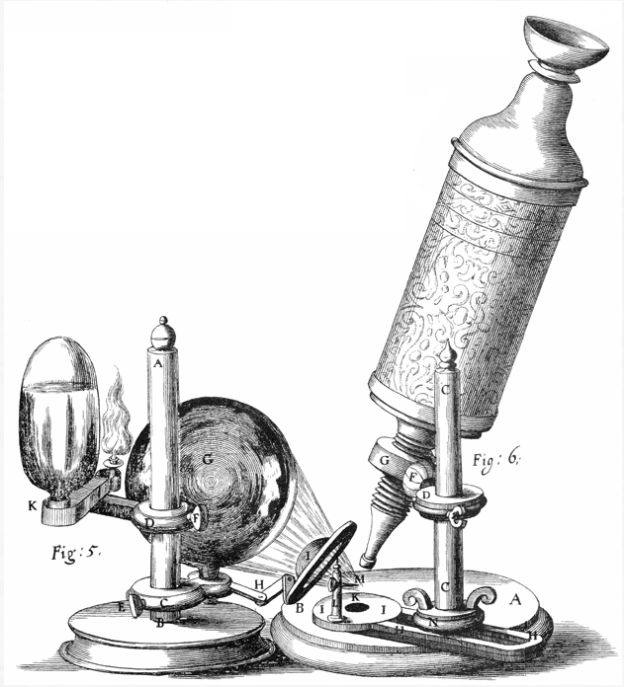
Cells and Cell Components

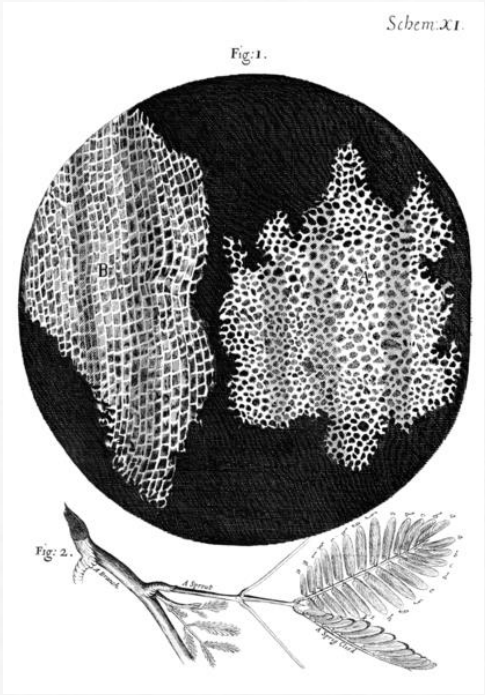


Assoc. Prof. Bengi ÇINAR KUL

Robert Hooke (mid-1600s)

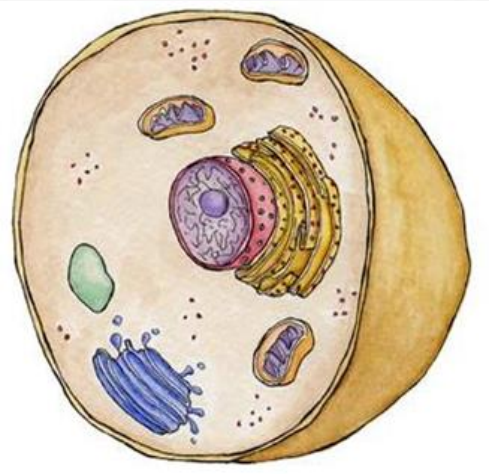
- Observed the cork
- Saw “row of empty boxes”
- Coined the term cell



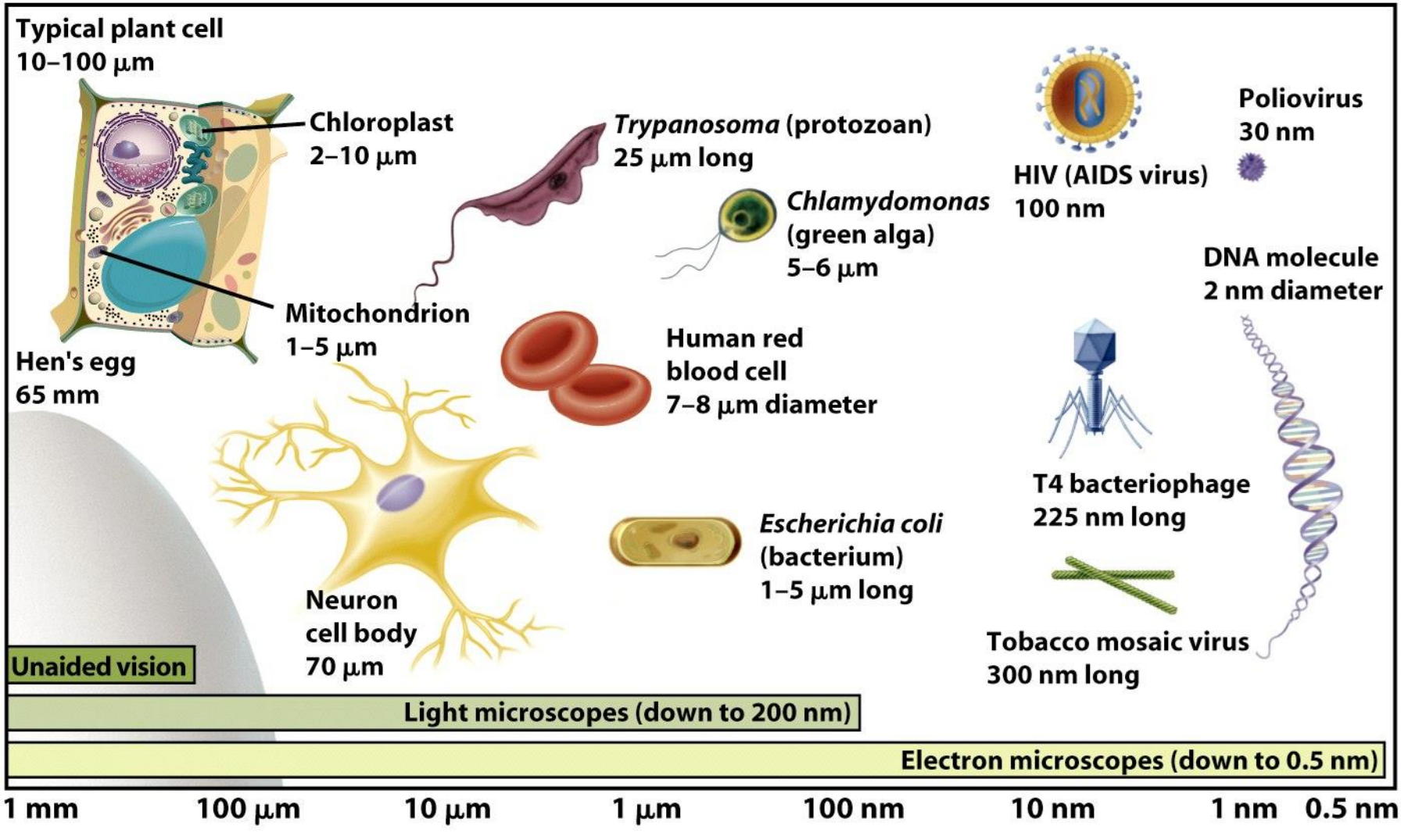


Definition of Cell

- **A cell is the smallest unit that is capable of performing life functions.**
- **Most are microscopic**



Cell Size


Typical plant cell
10–100 μm
Chloroplast
2–10 μm
Mitochondrion
1–5 μm
Hen's egg
65 mm
Trypanosoma (protozoan)
25 μm long
Chlamydomonas
(green alga)
5–6 μm
Human red
blood cell
7–8 μm diameter
Neuron
cell body
70 μm
Escherichia coli
(bacterium)
1–5 μm long
HIV (AIDS virus)
100 nm
Poliovirus
30 nm
DNA molecule
2 nm diameter
T4 bacteriophage
225 nm long
Tobacco mosaic virus
300 nm long
Unaided vision
Light microscopes (down to 200 nm)
Electron microscopes (down to 0.5 nm)
1 mm
100 μm
10 μm
1 μm
100 nm
10 nm
1 nm
0.5 nm

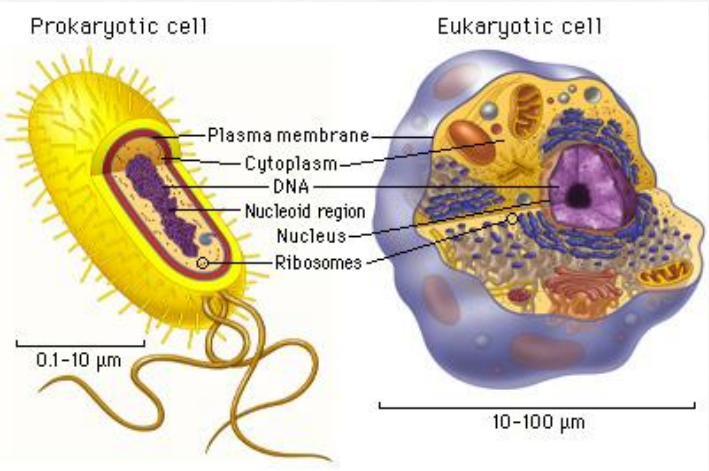
Cell theory was put forward in the early 19th century ....

Matthias Schleiden, Theodor Schwann, and Rudolf Virchow. Together, these scientists put forth the three basic rules:

- **All living things are made up of cells.**
- **Cells are the basic units of structure and function in living things.**
- **Living cells come only from other living cells.**

Characteristics of all cells

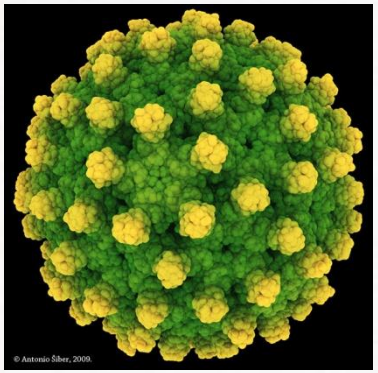
- **A surrounding membrane**
- **Protoplasm – cell contents in thick fluid**
- **Organelles – structures for cell function**
- **Control center with DNA**

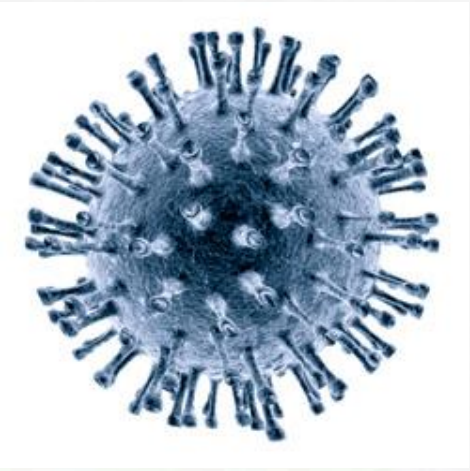


- **Cells are alive**

Have independent metabolic activities
can be replicated
can produce and use energy

Viruses?...





Viruses are non-cellular organisms that can only grow in a host cell.

- **Genetic material is single or double-stranded**

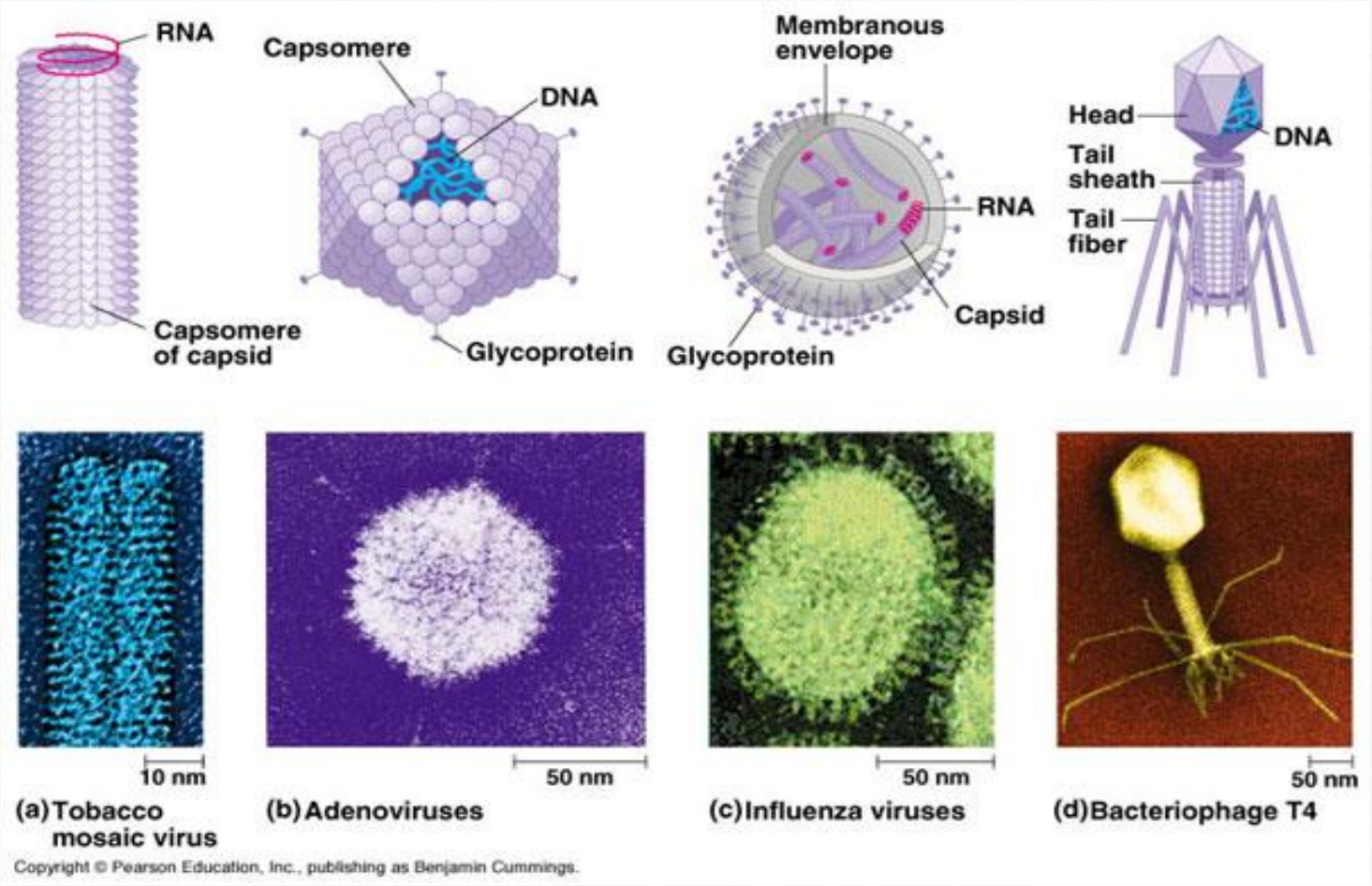
DNA or RNA in a protein sheath.

- **shapes and compositions show diversity**
- **They developed special mechanisms for infecting host cells.**

However;

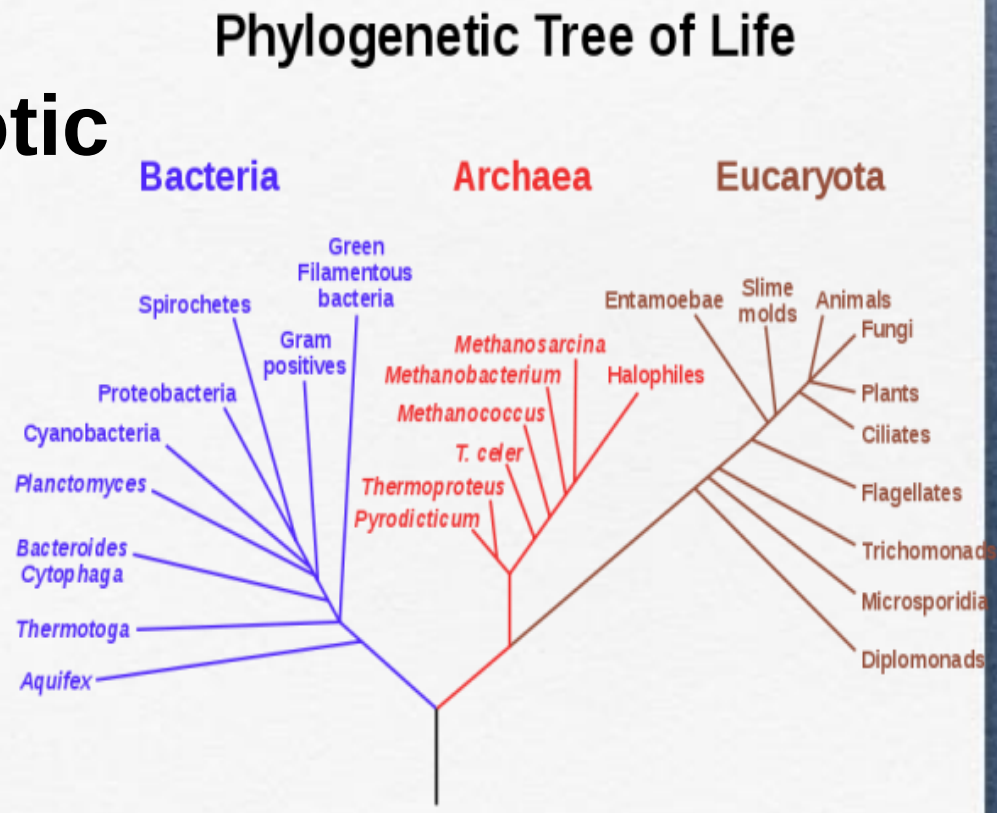
- **Viruses don't exist as cells and are not made up of cells (Cell theory, Rule 3).**
- **the viruses are alive, in that they have DNA and can infect other living things, but they have to use a hosts cells to replicate (Cell theory, Rule 1)**

Plant viruses
Animal viruses
Bacterial viruses (bacteriophage)



Cell Types

- **Eukaryotic**
- **Prokaryotic**

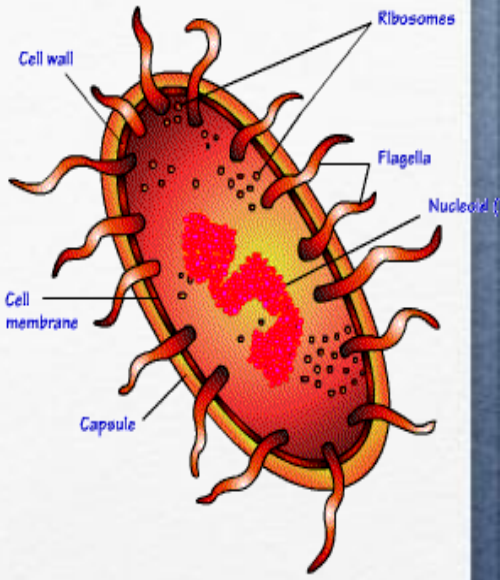


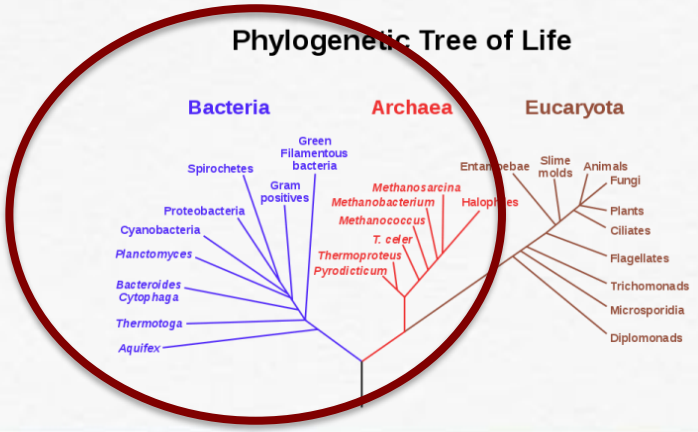
Prokaryotic Cells

First cell type on earth

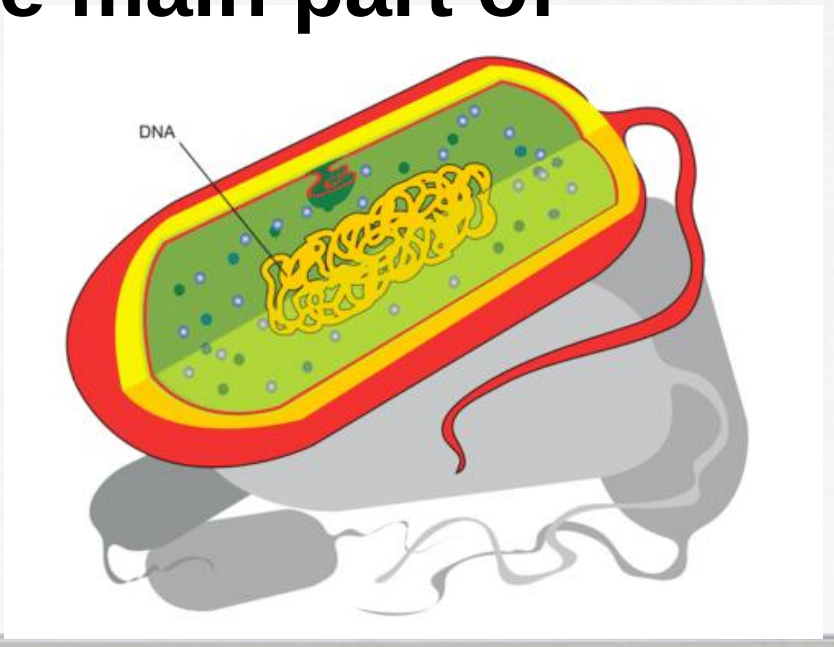
Cell type of Bacteria and Archaea

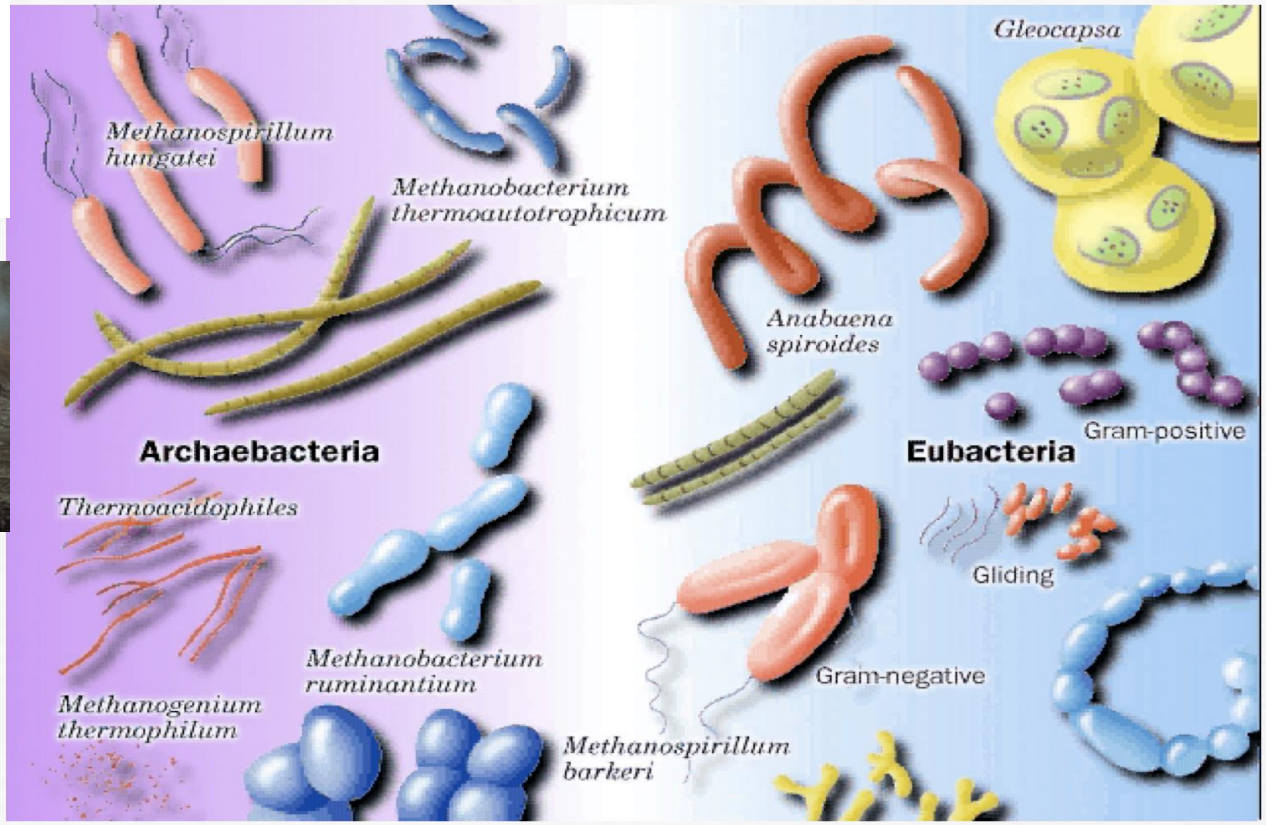
- **No membrane bound nucleus**
- **Nucleoid = region of DNA concentration**
- **Organelles not bound by membranes**

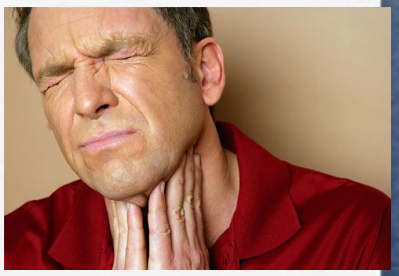




- They do not have membrane-bound organelles.
- In prokaryotic cells, the DNA, or genetic material, forms a single large circle that coils up on itself.
- The DNA is located in the main part of the cell.

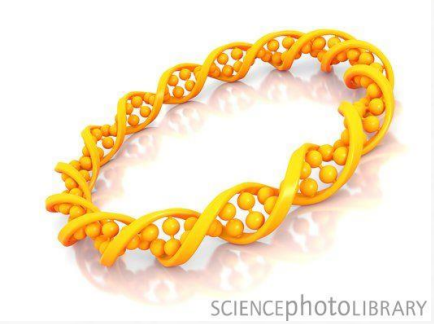




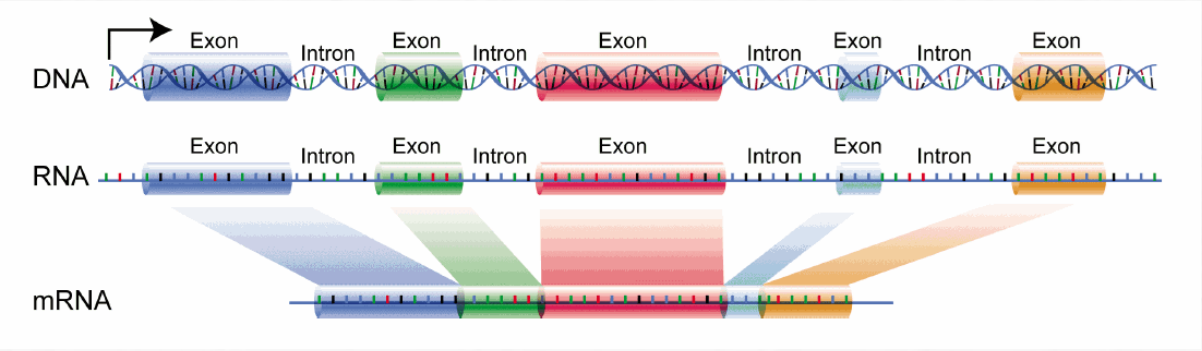


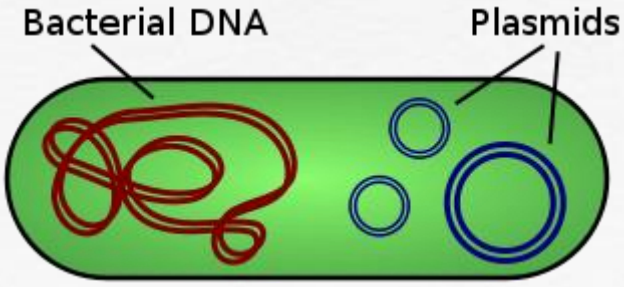
Some bacteria cause inf. disease,
but most are beneficial.

Genetic material in prokaryotic cells

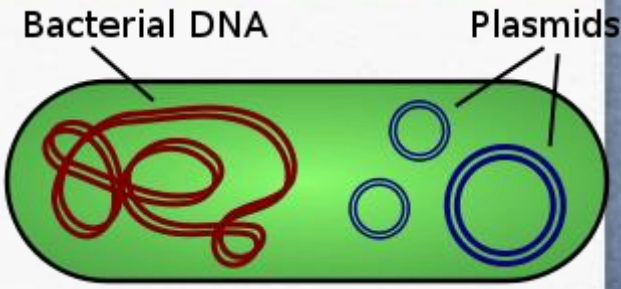


- **Single**
- **Circular**
- **Associated with a small number of proteins**
- **It does not include nuclear membrane**
- **There are many ribosomes in the cytoplasm.**
- **No introns in the DNA. Just exon !!!**





Plasmids

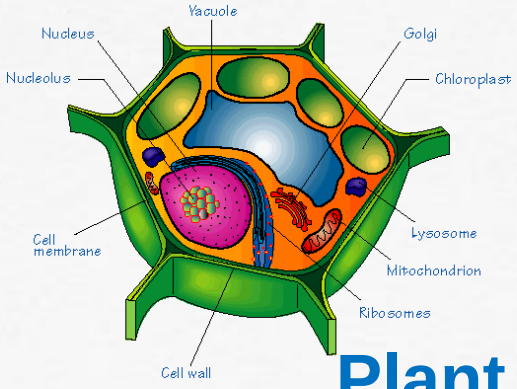


Plasmids are extrachromosomal DNA segments found in the cytoplasm of bacteria and can replicate their own DNA independently. They carry genes that may benefit the survival of the organism;

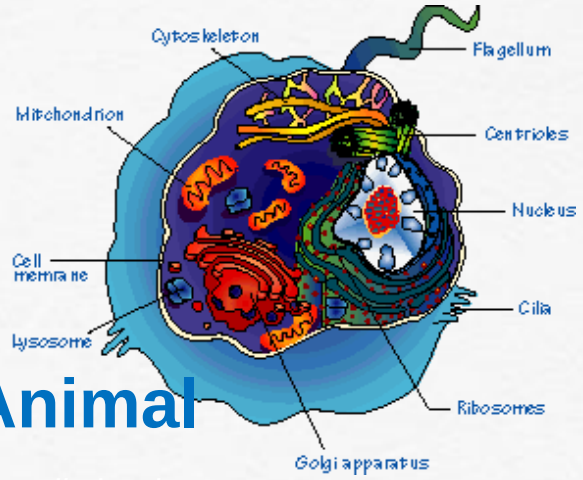
- **Resistance to antibiotics**
- **Resistance to heavy metal ions**
- **Resistance to UV rays**
- **Creating various enzymes and toxins**
- **Colonization**
- **Fermentation of various carbohydrates**

Eukaryotic Cells

- **Contain *organelles* surrounded by membranes**
- **Contain chromosomes**
- **Most living organisms, include fungi, protists, plant, and animal cells**



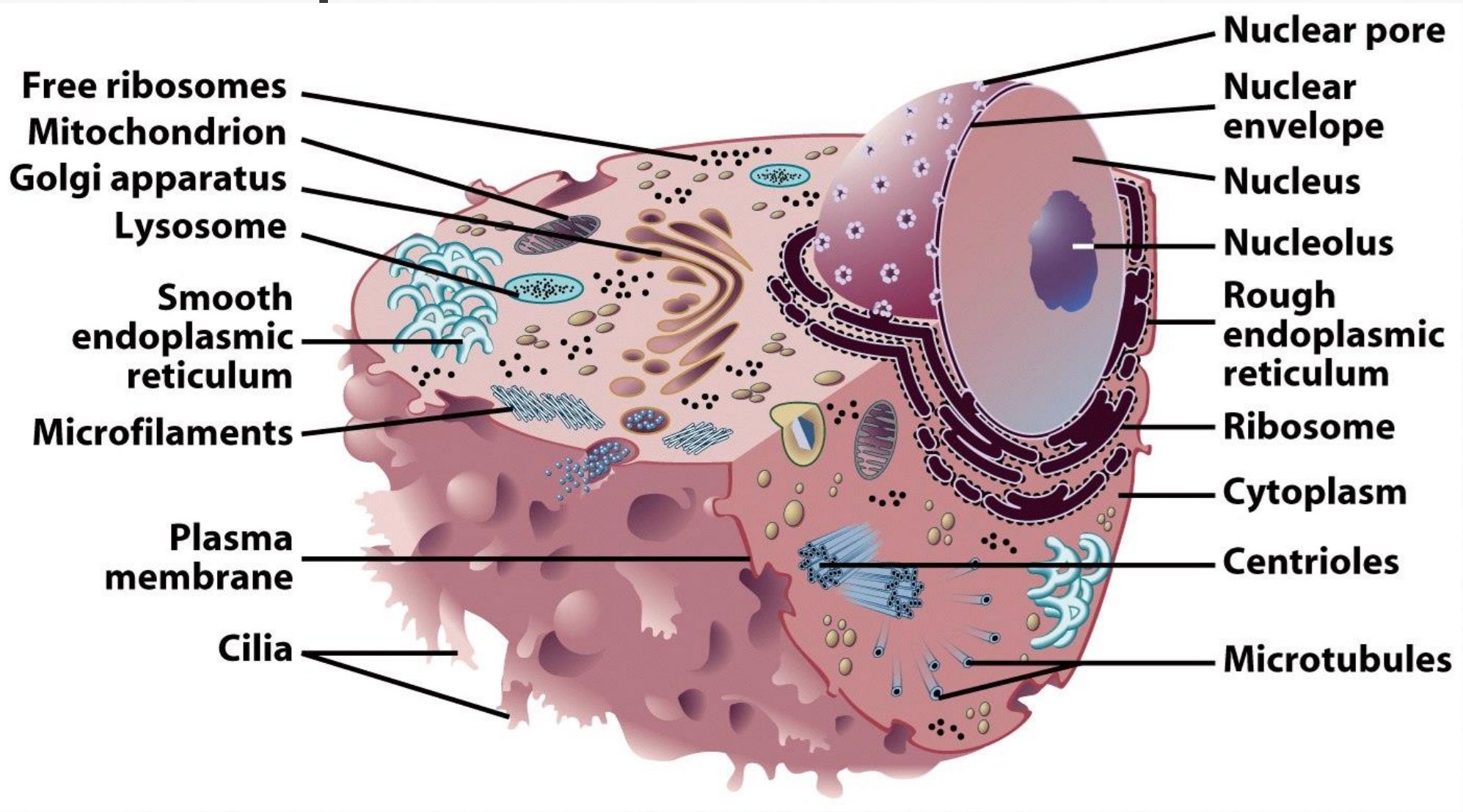
Plant



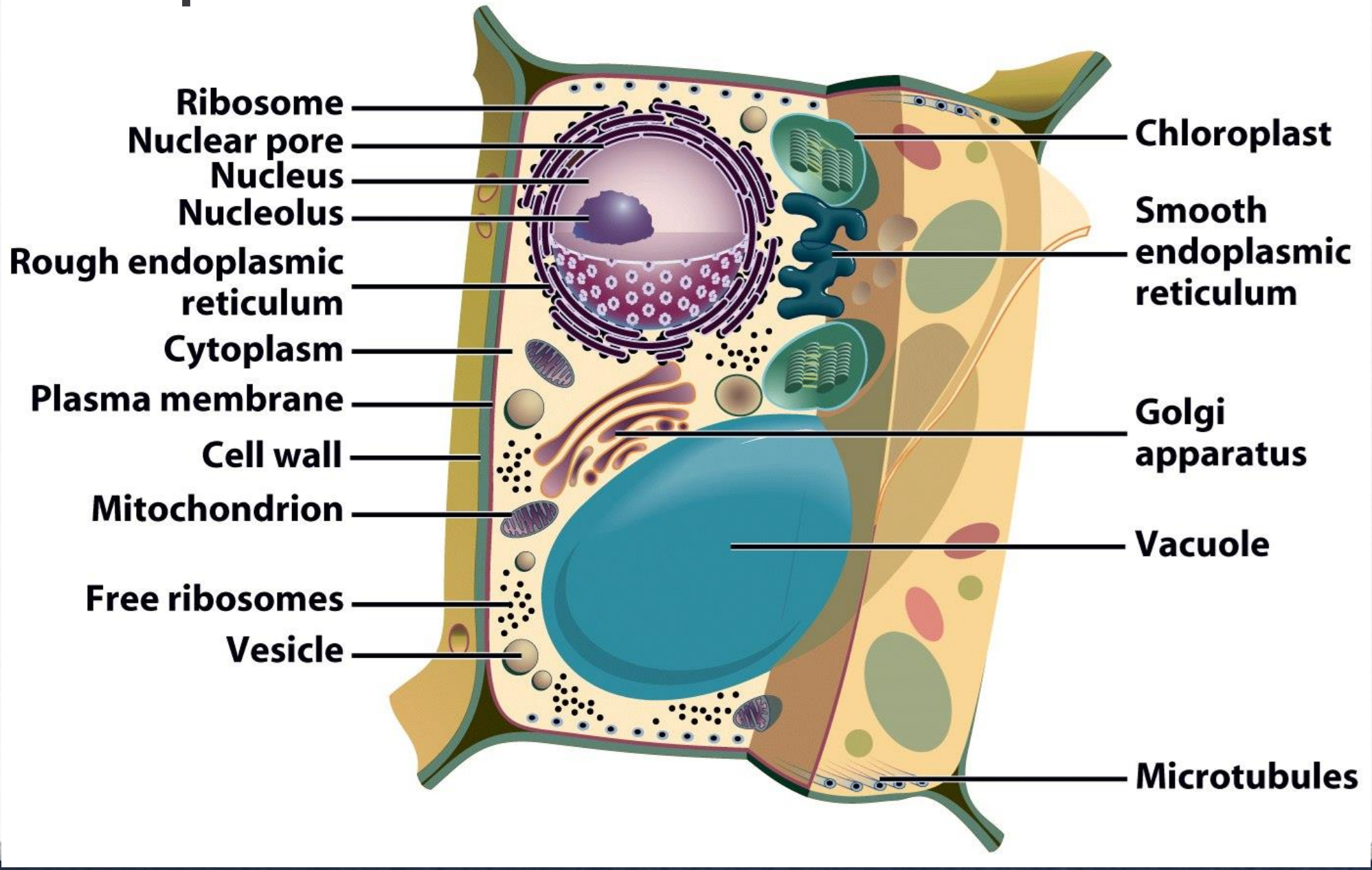
Animal

http://library.thinkquest.org/C004535/eukaryotic_cells.html

Representative Animal Cell

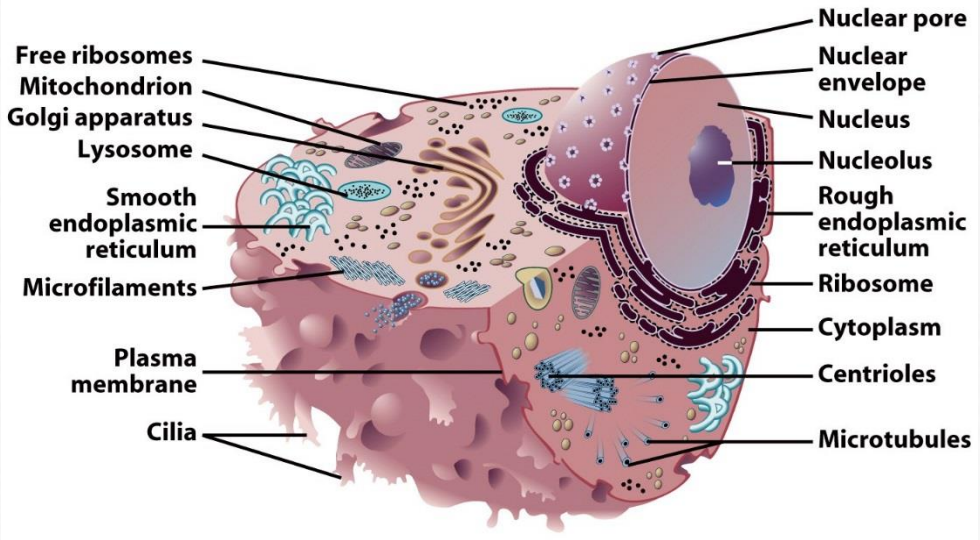


Representative Plant Cell

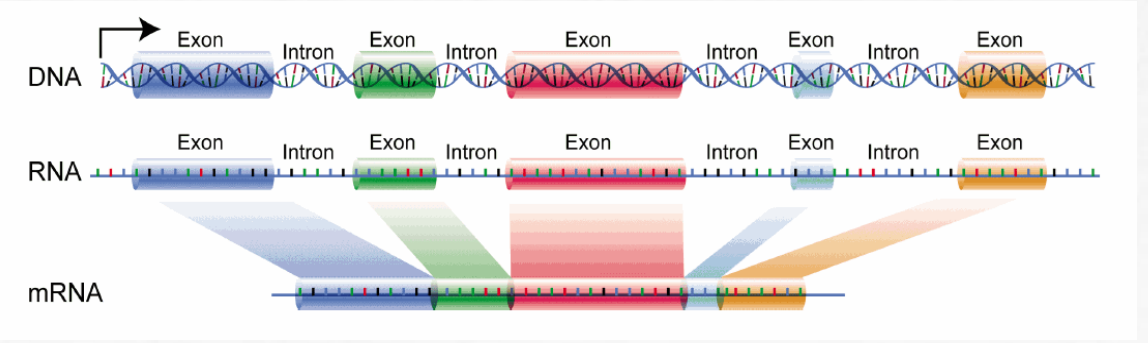


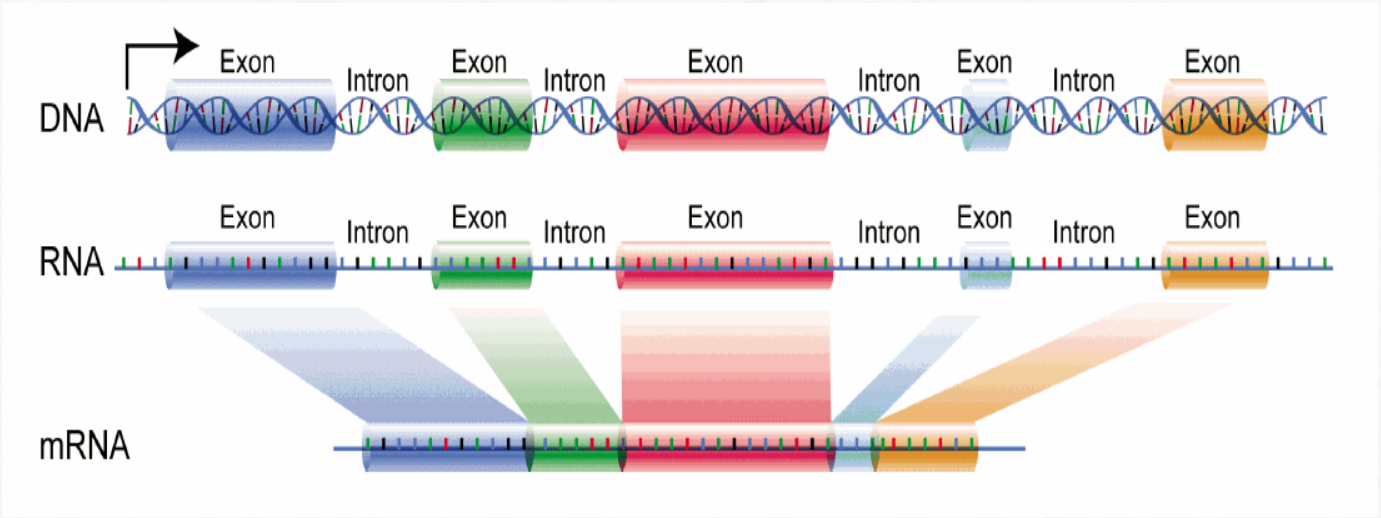
Organelles

- **Cellular machinery**
- **Two general kinds**
  1. **Derived from membranes**
  2. **Bacteria-like organelles (mitoch, chloropl)**



- Genetic material is DNA
- The main difference between eukaryotic and prokaryotic cells is that eukaryotic cells have a nucleus
- Genomic DNA enclosed within the nucleus which is located in the cytoplasm
- Nucleus has a membrane and tiny pores, selectively permit certain macromolecules to enter and leave the nucleus
- DNA has exons and introns.





They are parts of genes.

Exons code for proteins, whereas introns do not.

Exons are parts of DNA that are converted into mature messenger RNA (mRNA)

Introns are the intervening sequences that are removed from a gene before the RNA product is made.

Introns are usually considered non-coding regions because they don't seem to code for any enzymes or structural proteins.

Question:

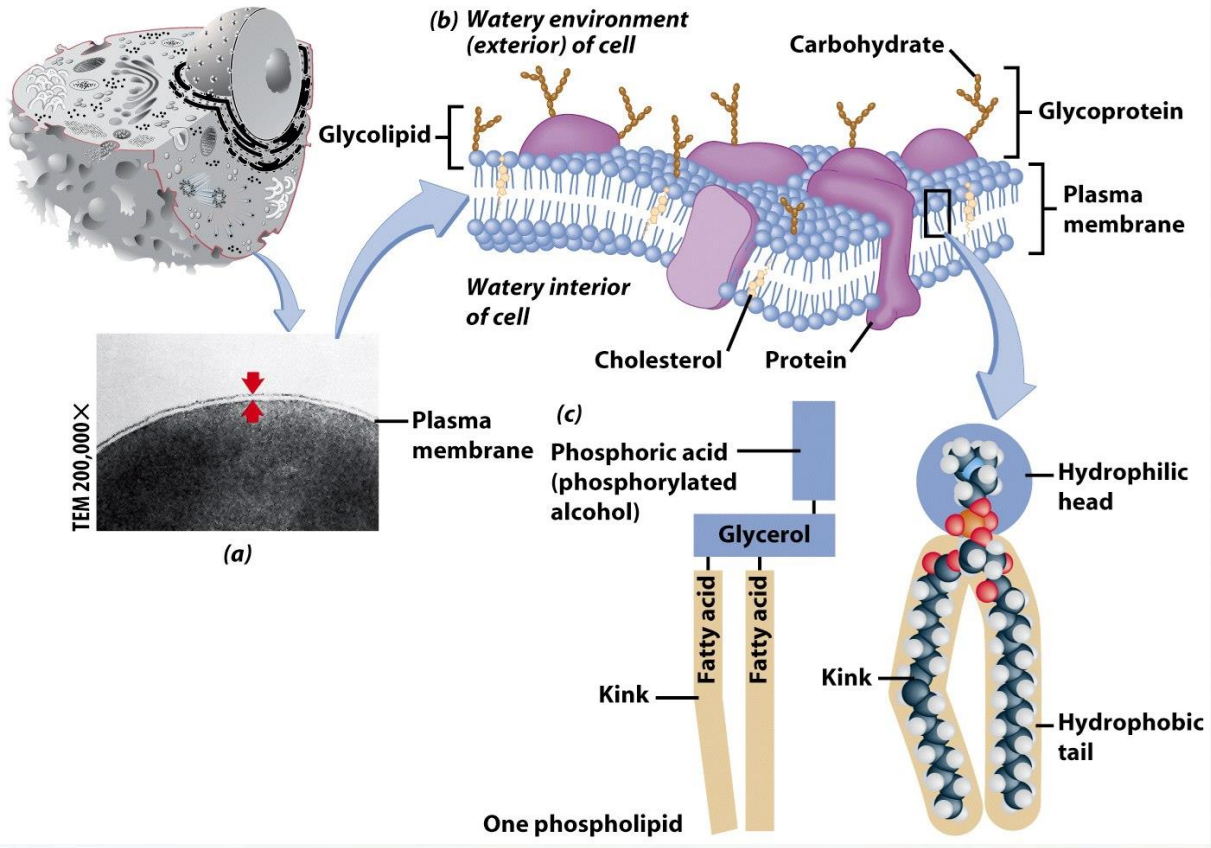
How is the distribution of intron/exon in genomes?

What is the main and most important function of introns?

Why the prokaryotes doesn't have it?

Plasma Membrane

- **Contains cell contents**
- **Double layer of phospholipids & proteins**



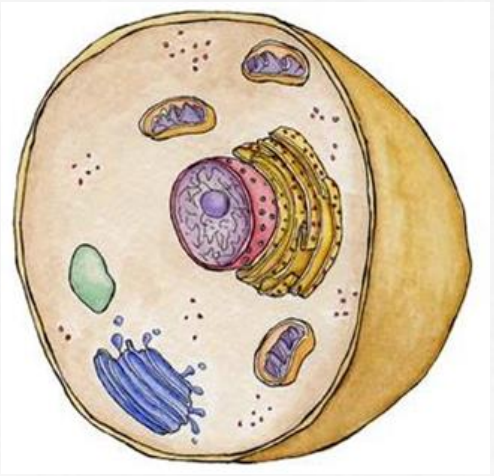
Carrier proteins
Receptors

Cell Walls

- **Found in plants, fungi, & many protists**
- **Surrounds plasma membrane**

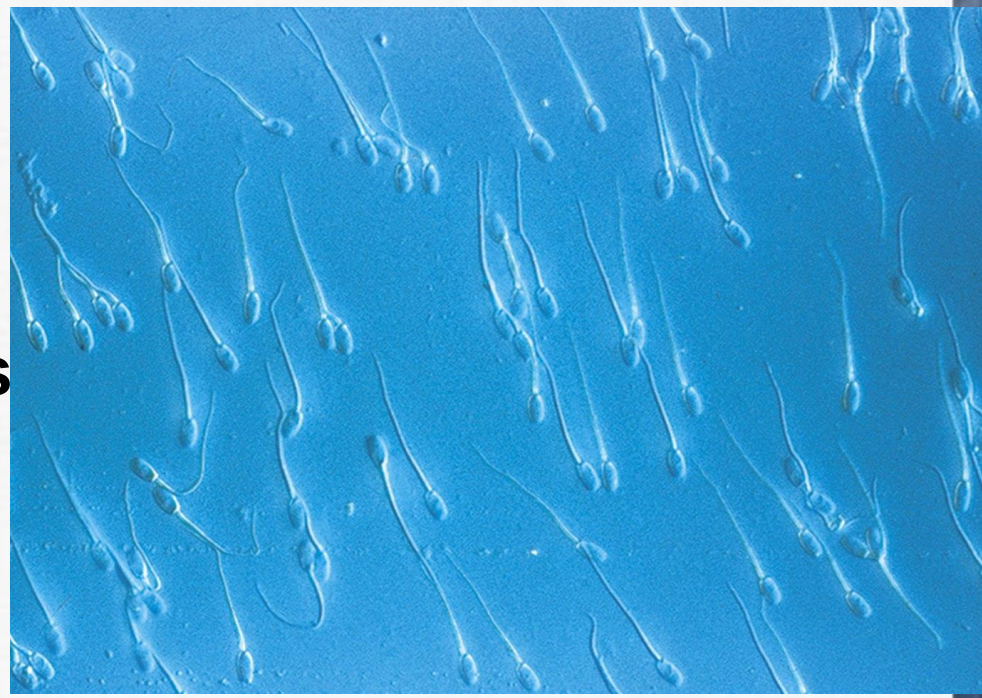
Cytoplasm

- **Viscous fluid containing organelles**
- **components of cytoplasm**
  - **Interconnected filaments & fibers**
  - **Fluid = cytosol**
  - **Organelles (not nucleus)**
  - **storage substances**



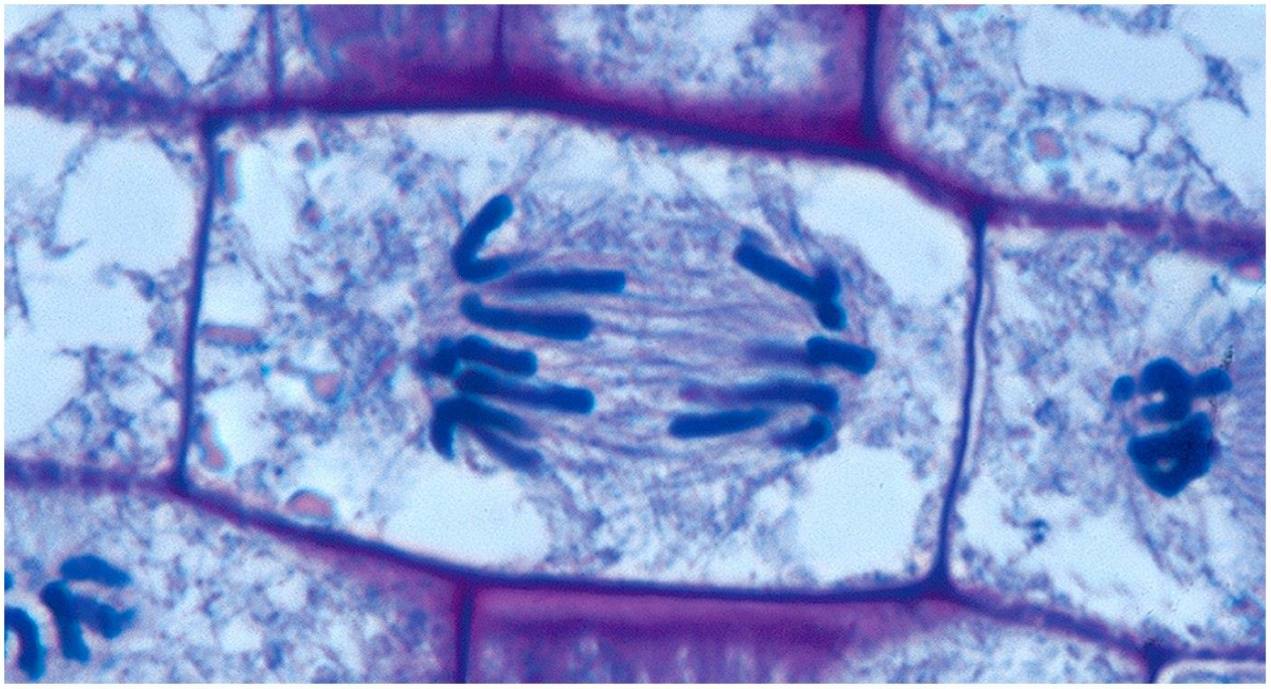
Cilia & Flagella

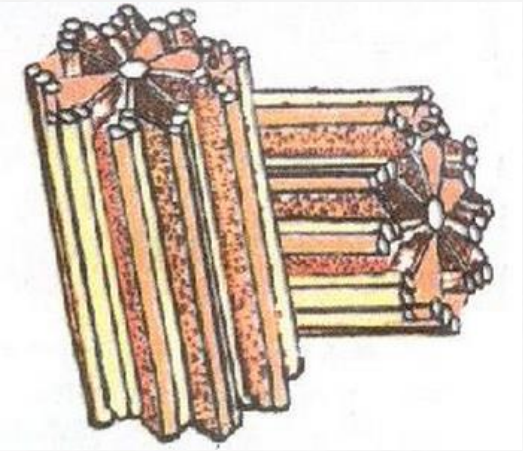
- **Provide motility**
- **Cilia**
  - **Short**
  - **Used to move substances**
- **Flagella**
  - **Whip-like extensions**
  - **Found on sperm cells**



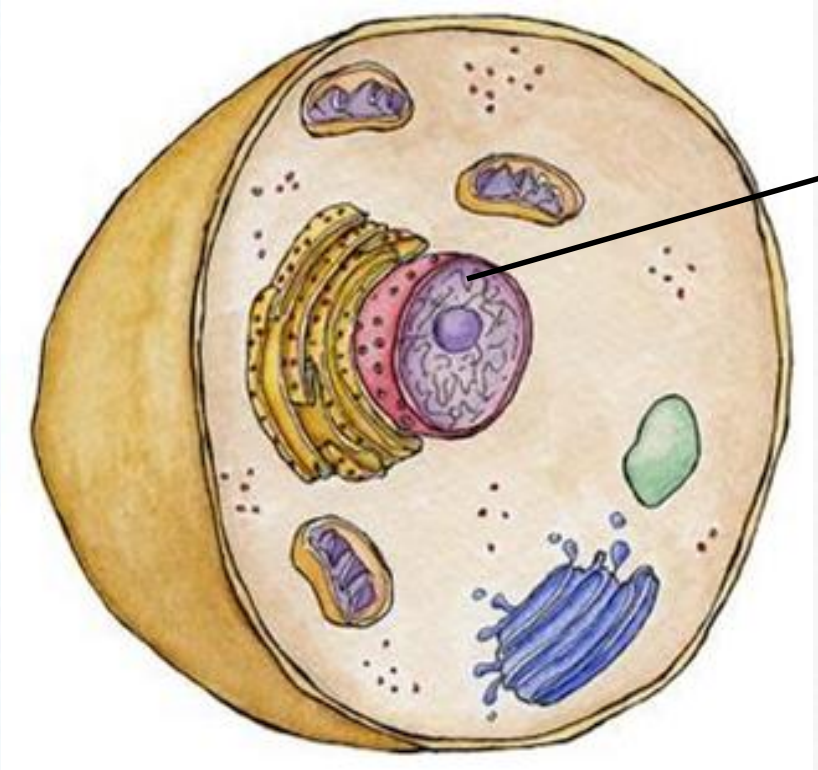
Centrioles

- **Pairs of microtubular structures**
- **Play a role in cell division**
- **Absent in neuron and mature egg cell**





Question:if they don’t have centrioles, does it mean that they do not divide?

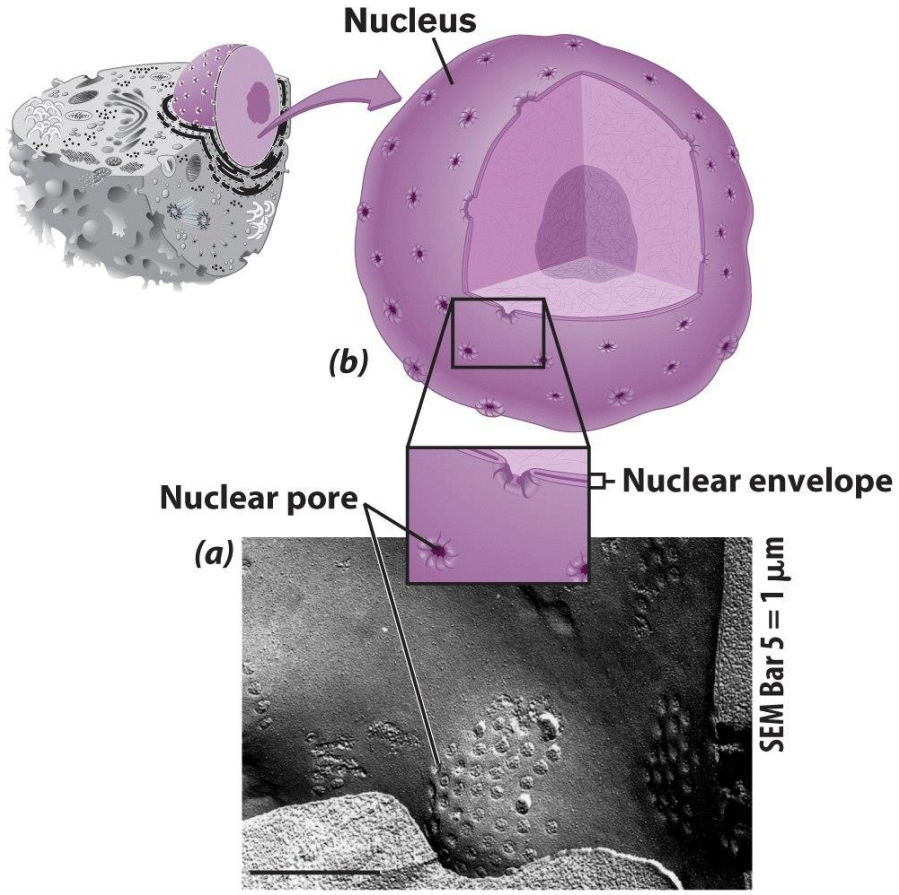


Nucleus

- **Control center of cell**
- **Double membrane**
- **Contains**
  - **Chromosomes**
  - **Nucleolus**

Nuclear Envelope

- **Separates nucleus from rest of cell**
- **Double membrane**
- **Has pores**

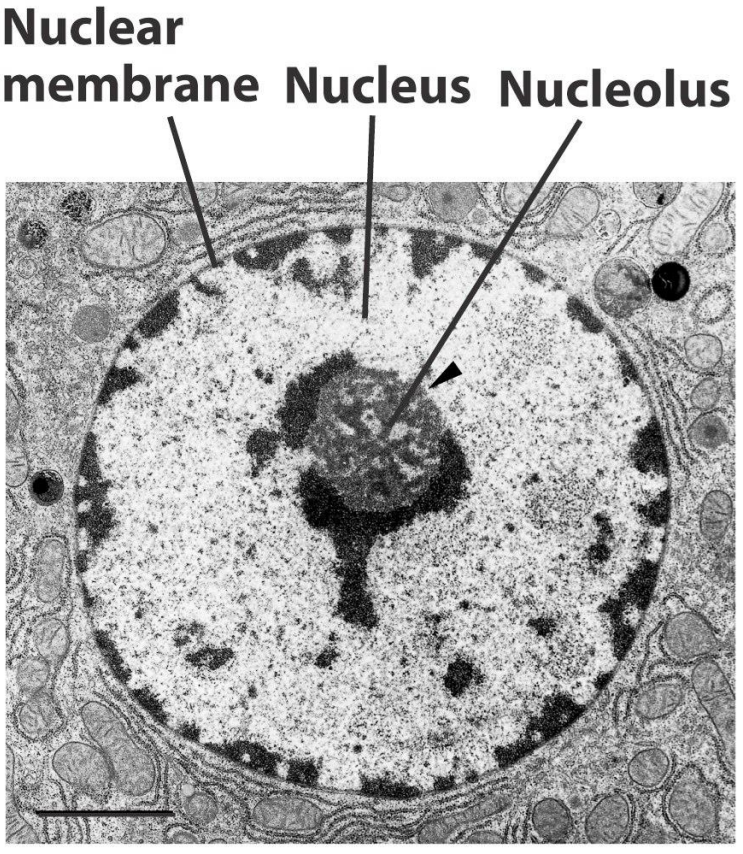


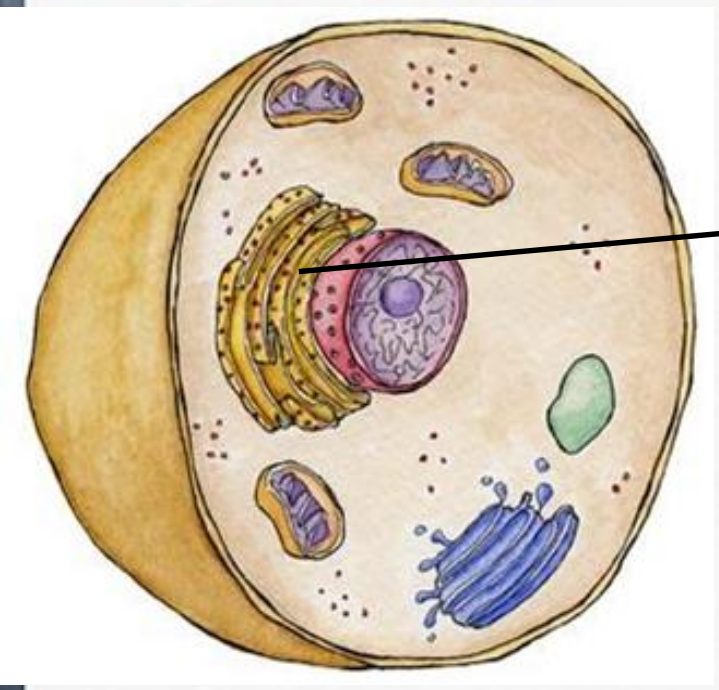
DNA

- **Hereditary material**
- **Chromosomes**
  - **DNA**
  - **Protiens**
  - **Form for cell division**
- **Chromatin**

Nucleolus

- **Most cells have 2 or more**
- **Directs synthesis of RNA**
- **Forms ribosomes**





Endoplasmic Reticulum

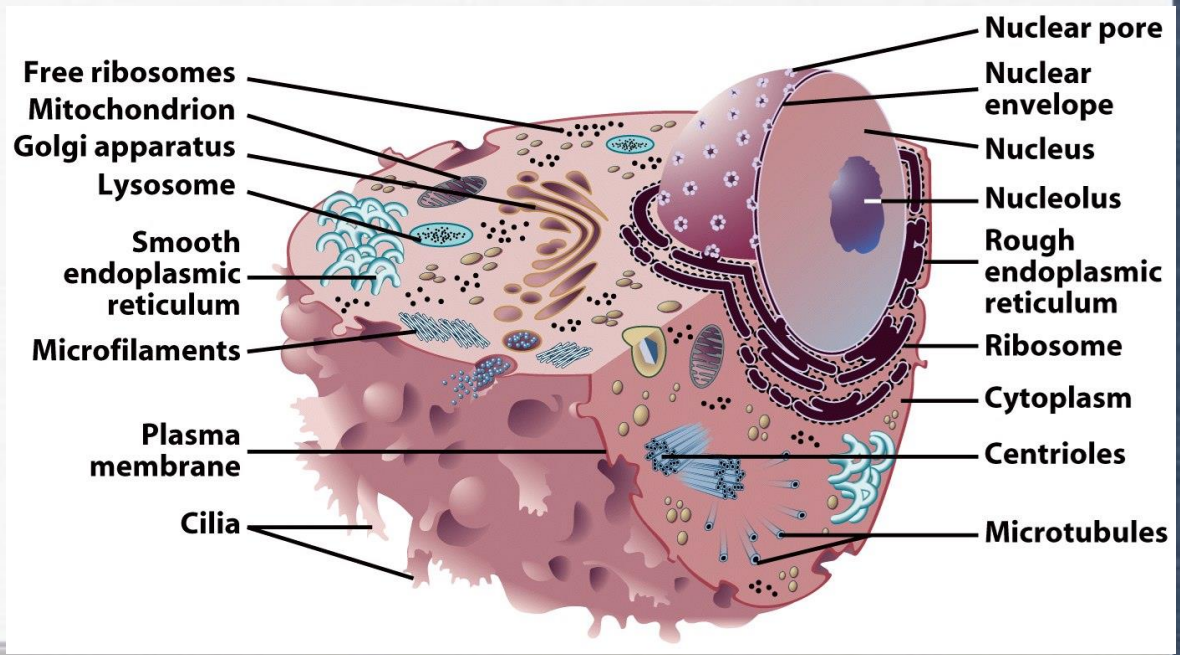
- **Helps move substances within cells**
- **Network of interconnected membranes**
- **Two types**
  1. **Rough endoplasmic reticulum**
  2. **Smooth endoplasmic reticulum**

Rough Endoplasmic Reticulum

- **Ribosomes attached to surface**
  - **Manufacture protiens**
  - **Not all ribosomes attached to rough ER**
- **May modify proteins from ribosomes**

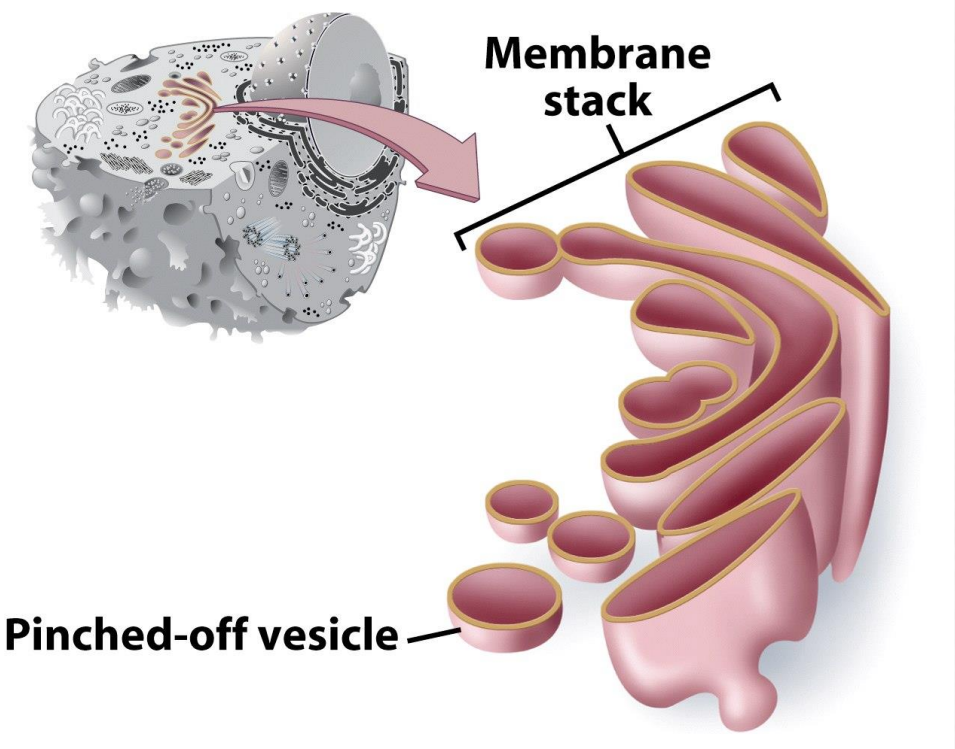
Smooth Endoplasmic Reticulum

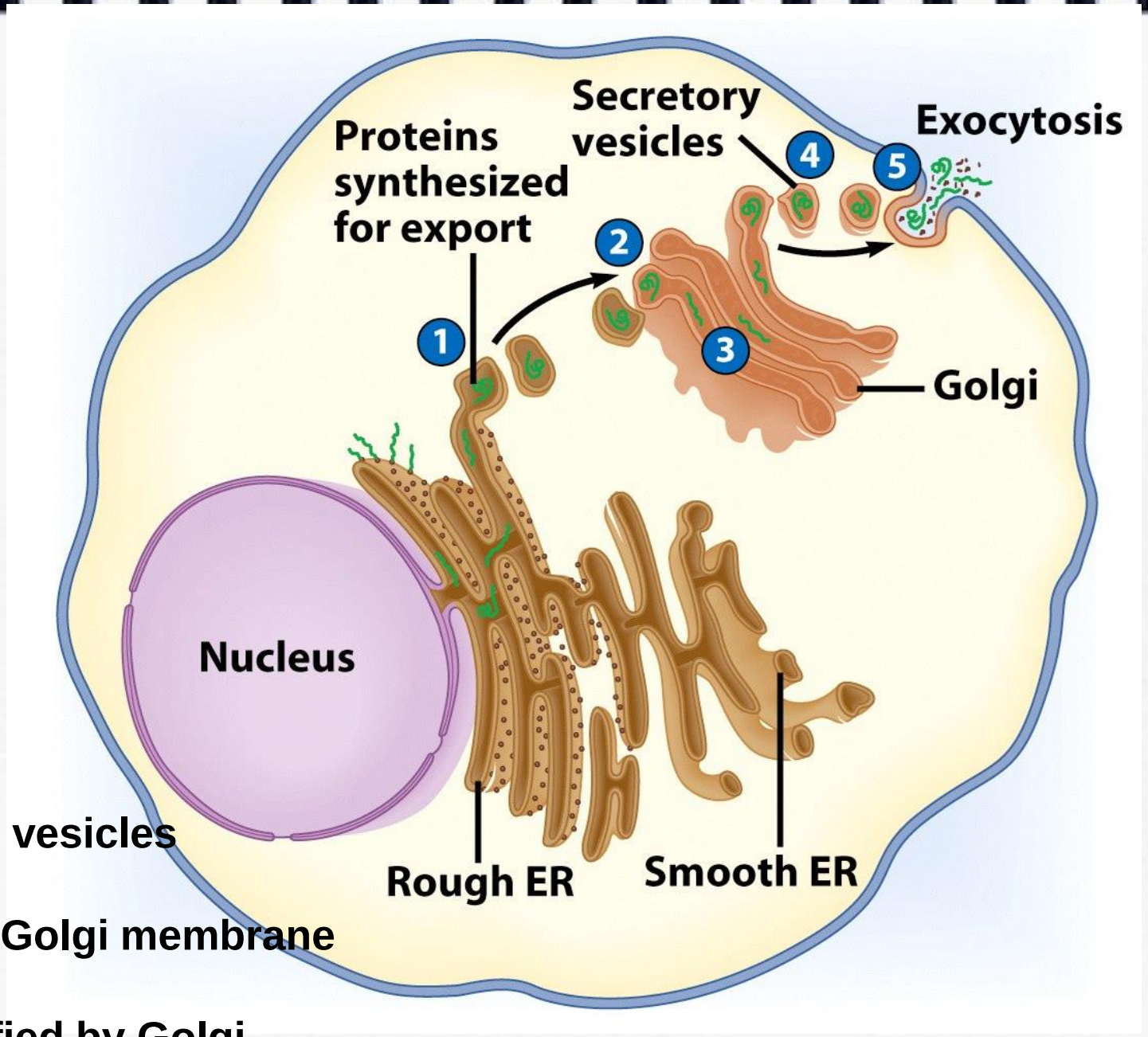
- **No attached ribosomes**
- **Has enzymes that help build molecules**
  - **Carbohydrates**
  - **Lipids**



Golgi Apparatus

- **Packaging & shipping station of cell**
- **Involved in synthesis of plant cell wall**

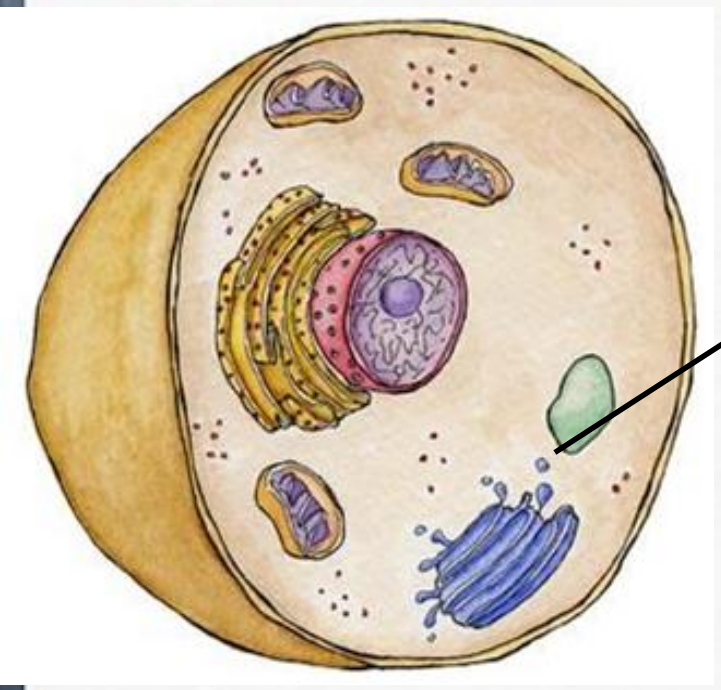




1. Molecules come in vesicles

2. Vesicles fuse with Golgi membrane

3. Molecules is modified by Golgi

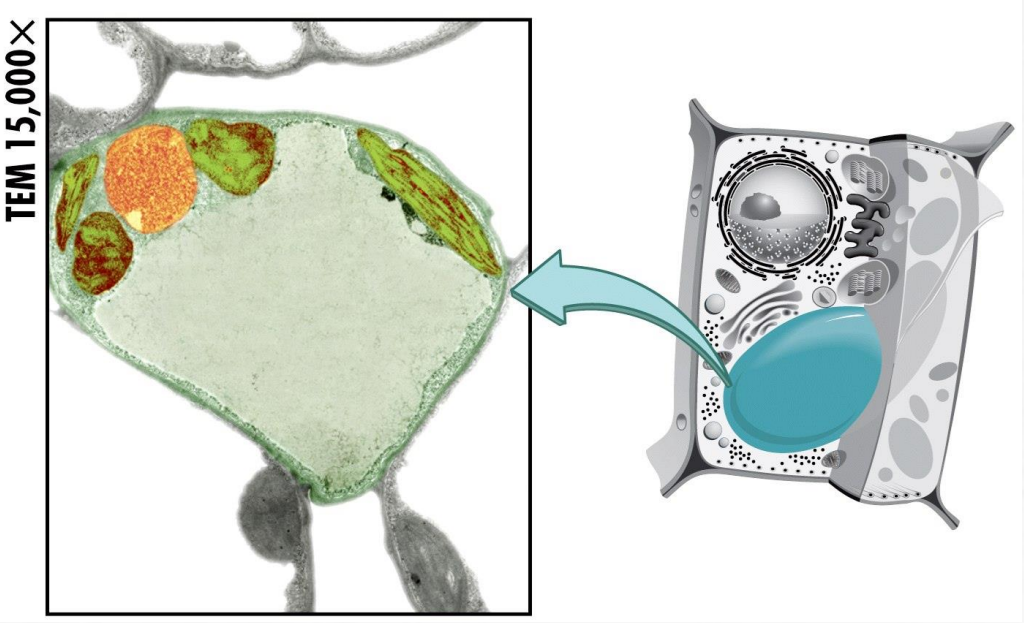


Lysosomes

- **Contain digestive enzymes**
- **Functions**
  - **Aid in cell renewal**
  - **Break down old cell parts**
  - **Digests invaders**

Vacuoles

- **Membrane bound storage sacs**
- **More common in plants than animals**
- **Contents**
  - **Water**
  - **Food**
  - **wastes**



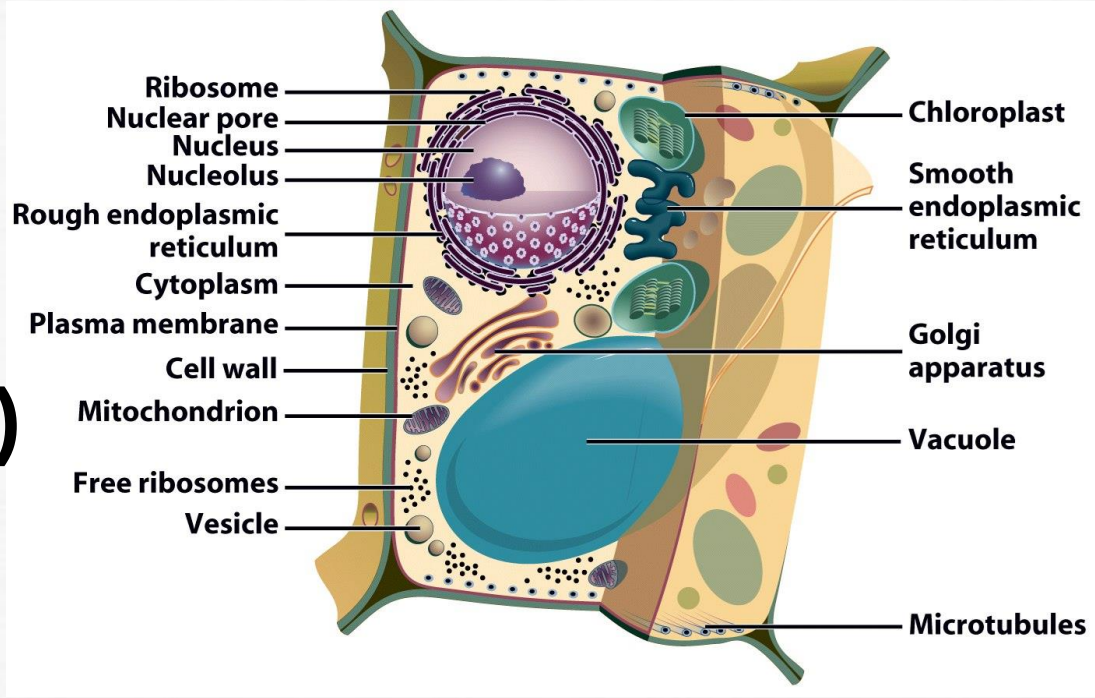
Bacteria-Like Organelles

- **Derived from symbiotic bacteria**
- **Ancient association**
- **Endosymbiotic theory based on Evolution of modern cells from cells & symbiotic bacteria**

Bacteria-Like Organelles

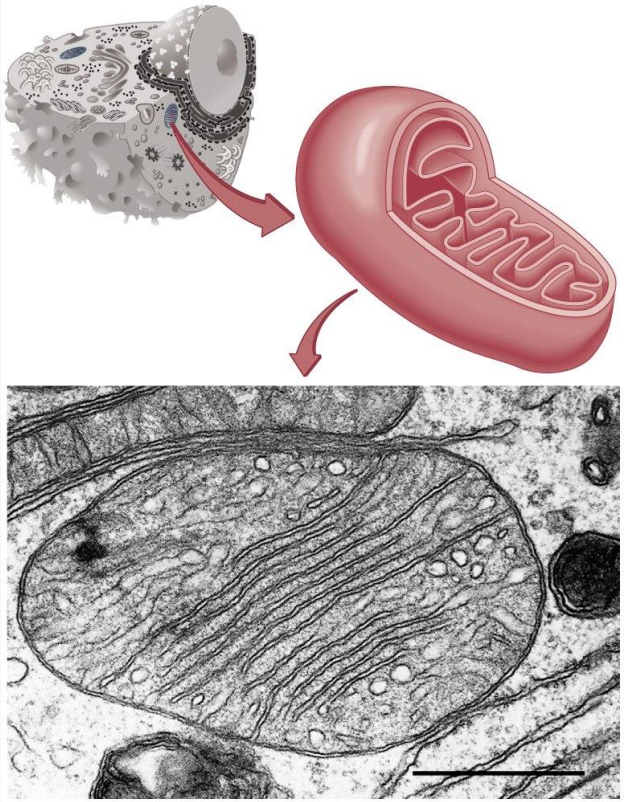
- **Release & store energy**

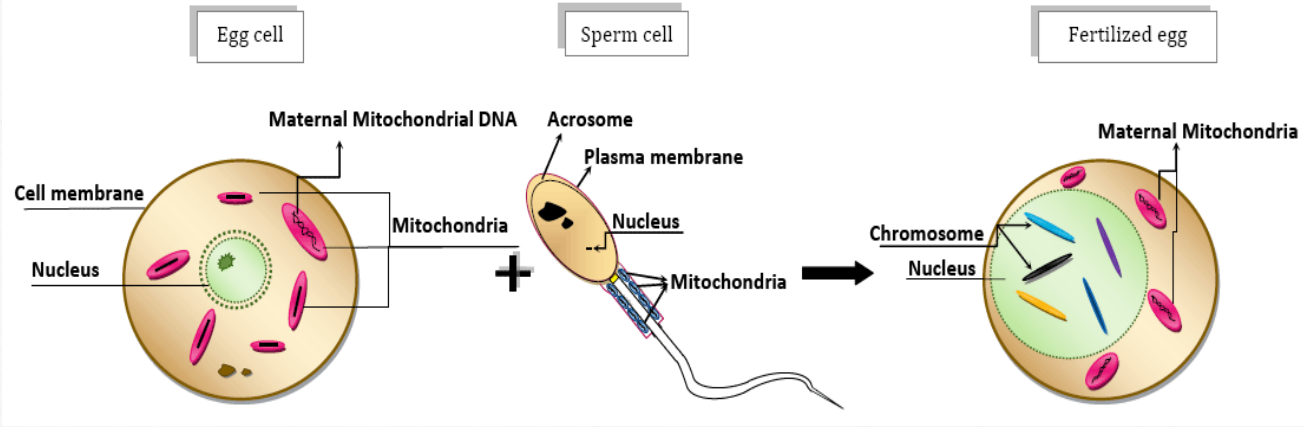
- **Types**
  - **Mitochondria (release energy)**
  - **Chloroplasts (store energy)**



Mitochondria

- **Have their own DNA!!**
- **Bound by double membrane**





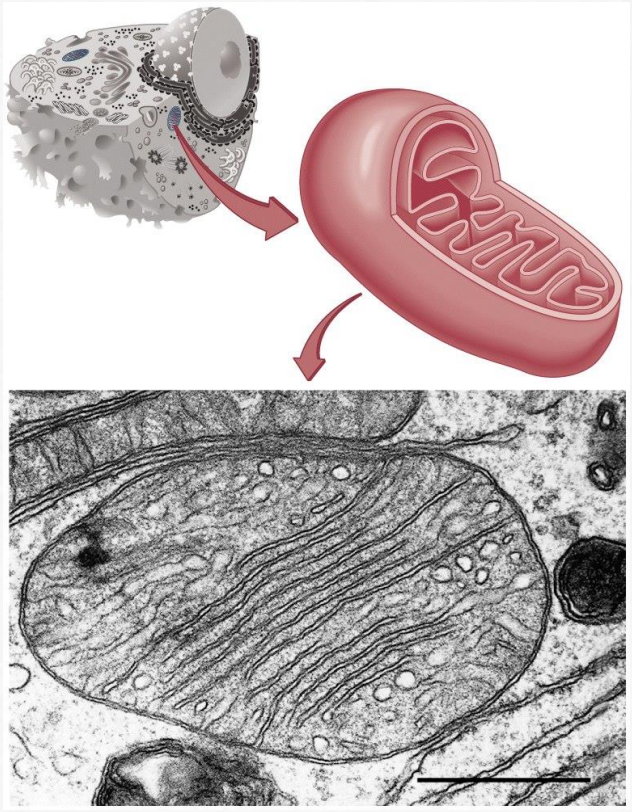
Question:

Why does mitochondria possess only maternal DNA not paternal DNA?

Are there any exceptions for this inheritance?

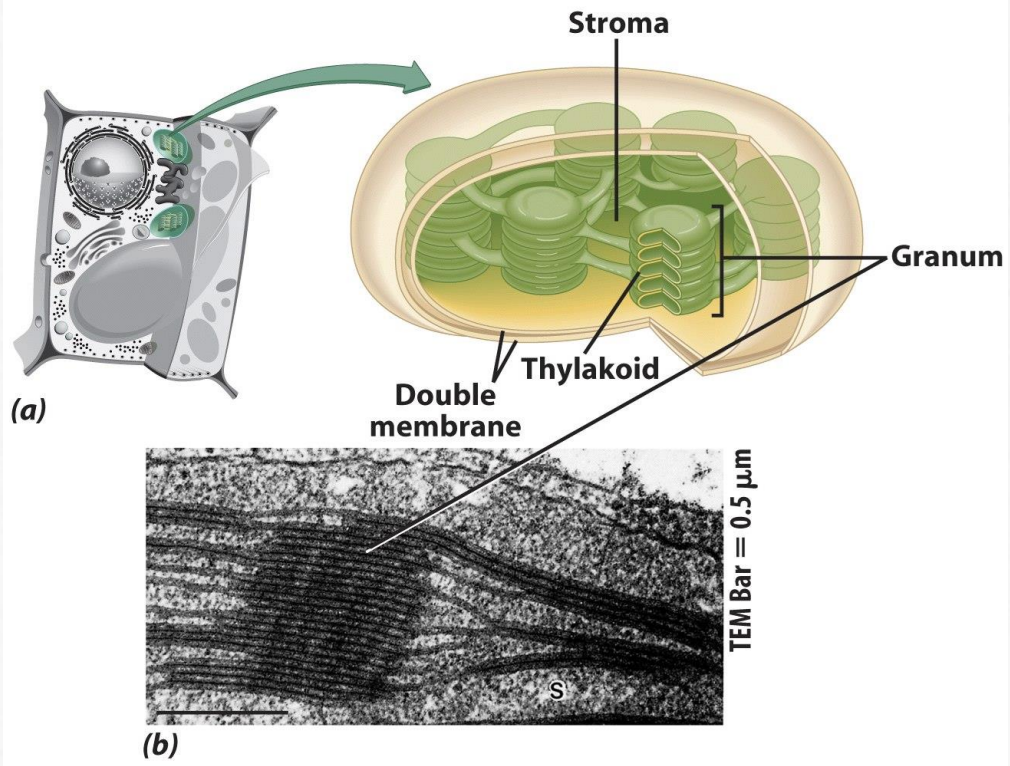
Mitochondria

- **Break down fuel molecules (cellular respiration)**
  - **Glucose**
  - **Fatty acids**
- **Release energy**
  - **ATP**



Chloroplasts

- **Derived form photosynthetic bacteria (photosyn. takes place in the chloroplast)**
- **Solar energy capturing organelle**



Photosynthesis

- **Takes place in the chloroplast**
- **Makes cellular food – glucose**

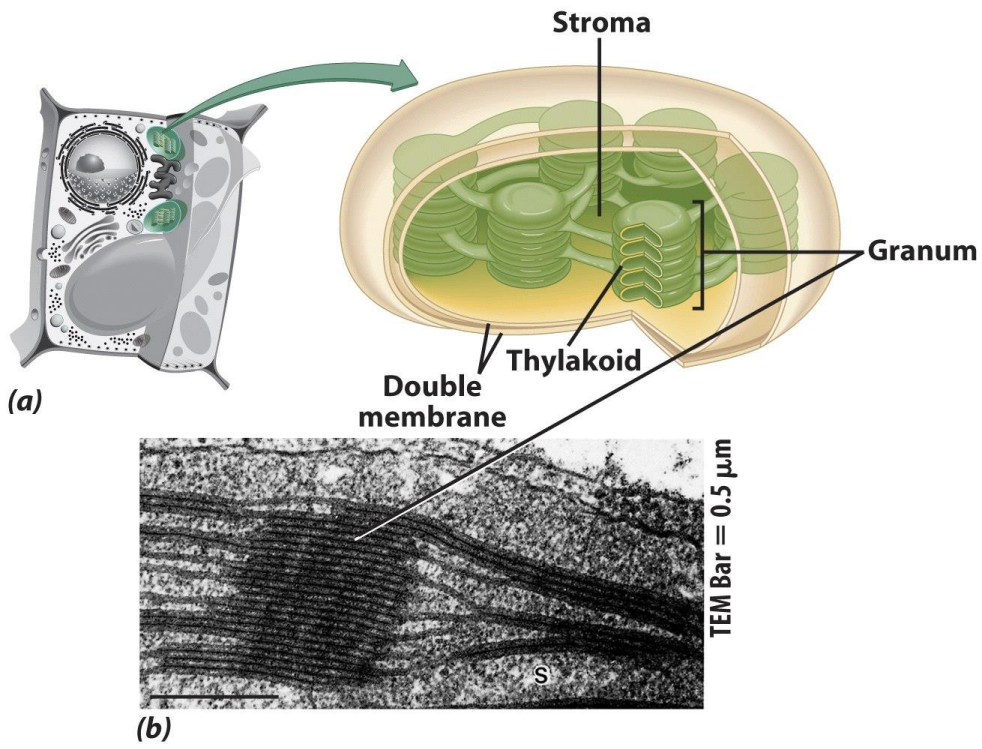


TABLE 5.2 A Comparison of Bacterial, Animal, and Plant Cells

	Bacterium	Animal	Plant
Exterior Structures			
Cell wall	Present (protein polysaccharide)	*Absent*	Present (cellulose)
Plasma membrane	Present	Present	Present
Flagella (cilia)	Sometimes present	Sometimes present	Sperm of a few species possess flagella
Interior Structures and Organelles			
Endoplasmic reticulum	*Absent*	Usually present	Usually present
Microtubules	*Absent*	Present	Present
Centrioles	*Absent*	Present	*Absent*
Golgi apparatus	*Absent*	Present	Present
Nucleus	*Absent*	Present	Present
Mitochondria	*Absent*	Present	Present
Chloroplasts	*Absent*	*Absent*	Present
Chromosomes	A single circle of naked DNA	Multiple units, DNA associated with protein	Multiple units, DNA associated with protein
Ribosomes	Present	Present	Present
Lysosomes	*Absent*	Present	Present
Vacuoles	*Absent*	*Absent* or small	Usually a large single vacuole in mature cell

Review of Eukaryotic Cells

TABLE 5.1 Eukaryotic Cell Structures and Their Functions

Structure	Description	Function
Interior Structures and Organelles		
Endoplasmic reticulum (ER)	Network of intemal membranes	Formation of compartments and vesicles; modification and transport of proteins; synthesis of carbohydrates and lipids
Ribosomes	Small, complex assemblies of protein and RNA, often bound to ER	Sites of protein synthesis
Nucleus	Spherical structure bounded by a double membrane, site of chromosomes	Control center of cell
Chromosomes	Long threads of DNA associated with protein	Sites of hereditary information
Nucleolus	Site within nucleus of rRNA synthesis	Synthesis and assembly of ribosomes
Golgi apparatus	Stacks of flattened vesicles	Packaging of proteins for export from cell
Lysosomes	Membranous sacs containing digestive enzymes found in animal cells	Digestion of various molecules
Cytoskeleton	Network of protein filaments, fibers, and tubules	Structural support, cell movement
Mitochondria	Bacteria like elements with inner membrane highly folded	"Power plant" of the cell
Chloroplasts	Bacterialike elements with inner membrane forming sacs containing chlorophyll, found in plant cells and algae	Site of photosynthesis

Review of Eukaryotic Cells

TABLE 5.1 Eukaryotic Cell Structures and Their Functions

Structure	Description	Function
Exterior Structures		
Cell wall	Outer layer of cellulose or chitin, or absent	Protection, support
Plasma membrane	Lipid bilayer in which proteins are embedded	Regulation of what passes in and out of cell, cell-to-cell recognition
Flagella (cilia)	Cellular extensions with 9 + 2 arrangement of pairs of microtubules	Motility or moving fluids over surfaces

Genetically important organelles…

- **Nucleus**
- **Mitochondri**
- **Ribosome**
- **Centrioles (animal!!!)**
- **Chloroplast (plant)**

Question: more complex organisms have bigger genetic material?

Correct

Wrong