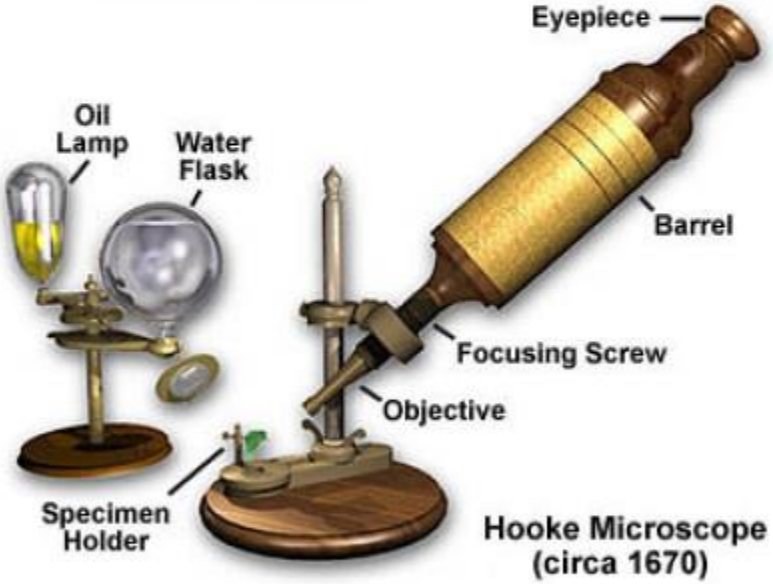
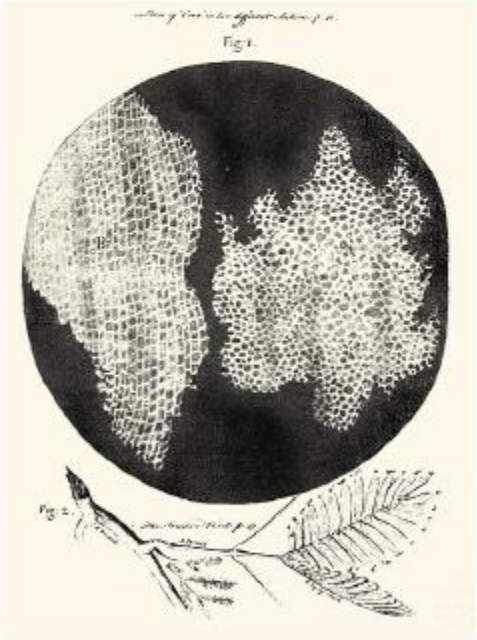
# I. Studying Cells

**a.** Robert Hooke coined the term "cell" in 1665 when he used a primitive microscope (30x magnification) to look at a piece of cork. He noticed tiny boxes, much like the rooms (called cells) that the monks lived in.

**b.** In 1675, Anton von Leeuwenhoek used an improved version of the microscope (could magnify 300x) to discover single-celled organisms in pond water, which he called *animalcules*. (Today they are classified as protists, since all animals are multicellular.)

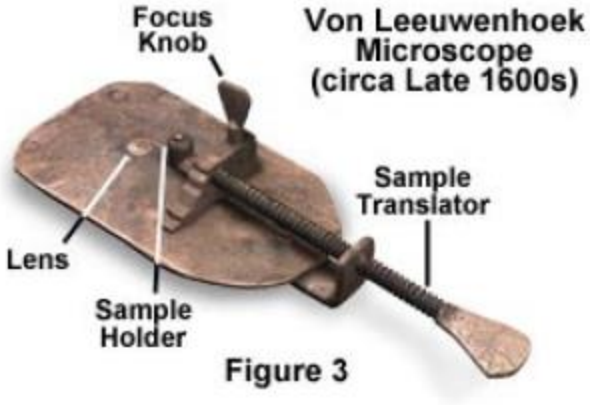
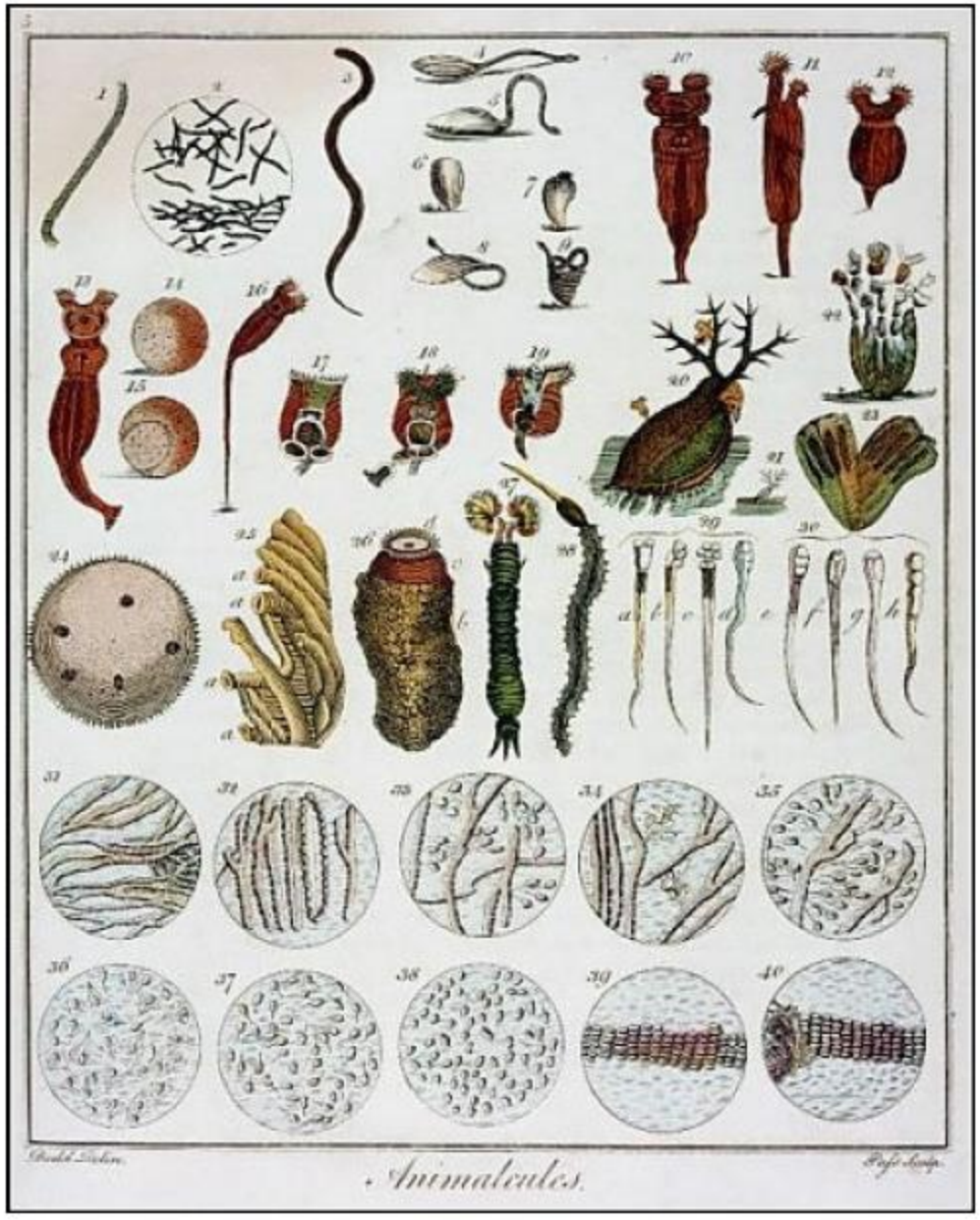
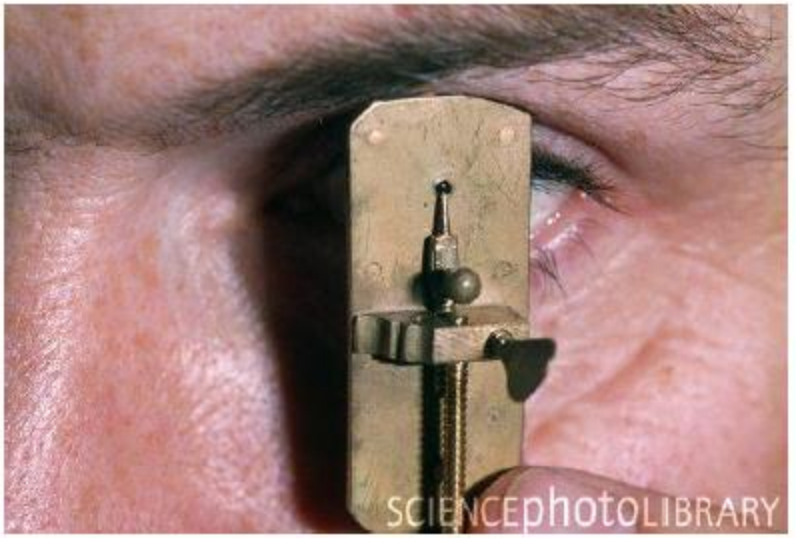



Figure 3


Animalcules.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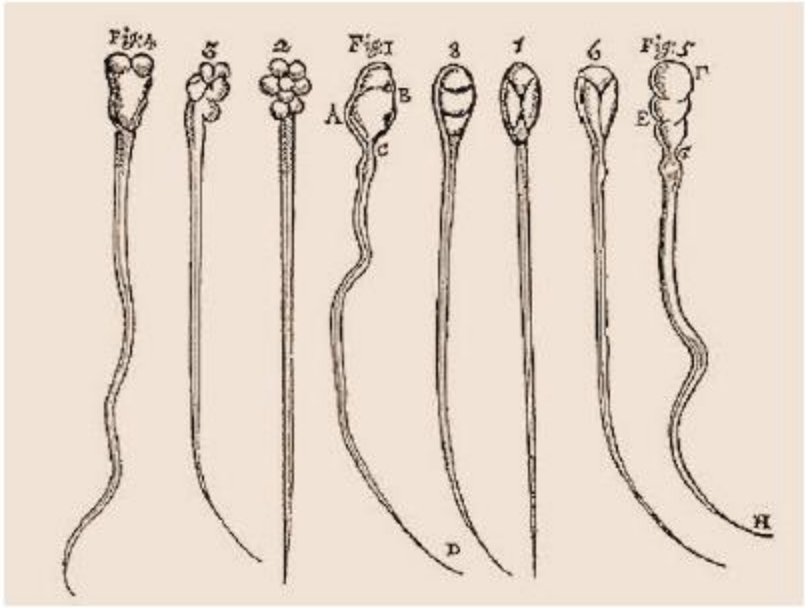


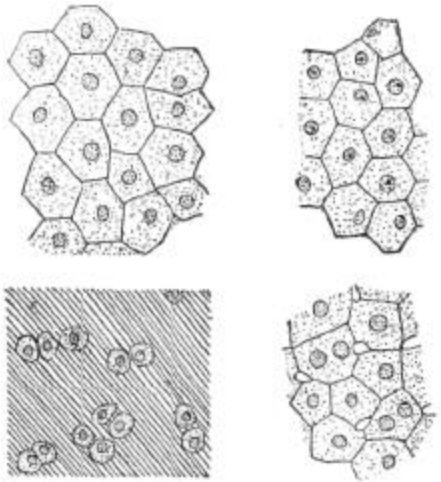
Fig. A
Fig. I
Fig. 5

**c.** Cell Theory: the research of biologists over the next 150 years eventually led to what is known today as the **cell theory**, which consists of three parts:

**i.** All living things are made of one or more cells.

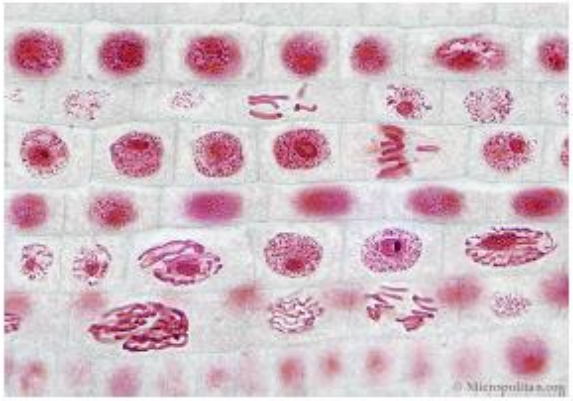
**ii.** Cells are the basic unit of structure and function in a living organism. (In other words, the cell is the smallest part of an organism that still shows all characteristics of life.)

**iii.** All cells come from existing cells.

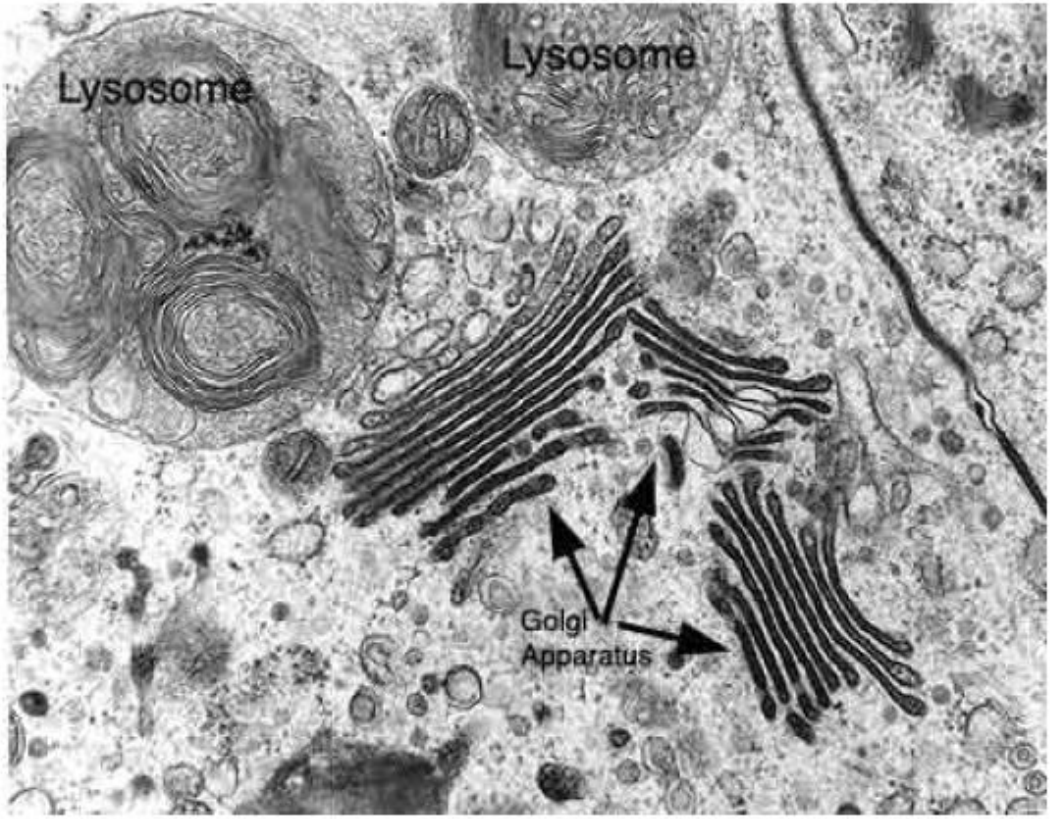
**d.** Types of microscopes

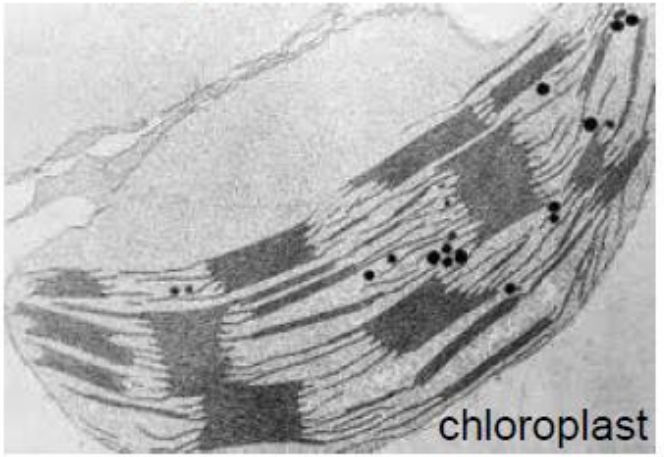
**i.** Light microscope: uses a beam of light to create an image (this is what we use in lab)



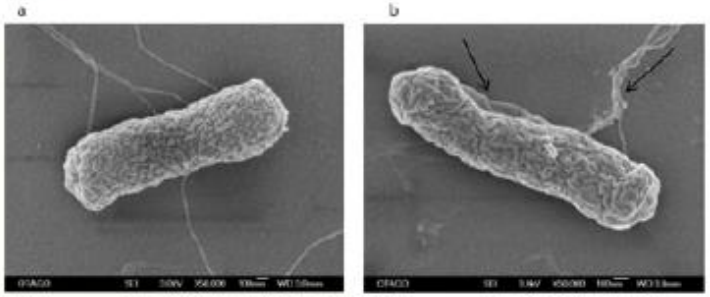

**ii.** Electron microscope: uses a beam of electrons to create an image, allows for much smaller details to be seen, but can't observe living cells

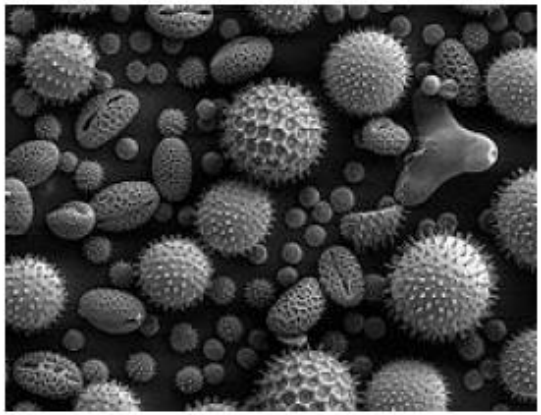
1. Transmission electron microscope: electrons pass through a thinly-sliced specimen so you can see interior details.

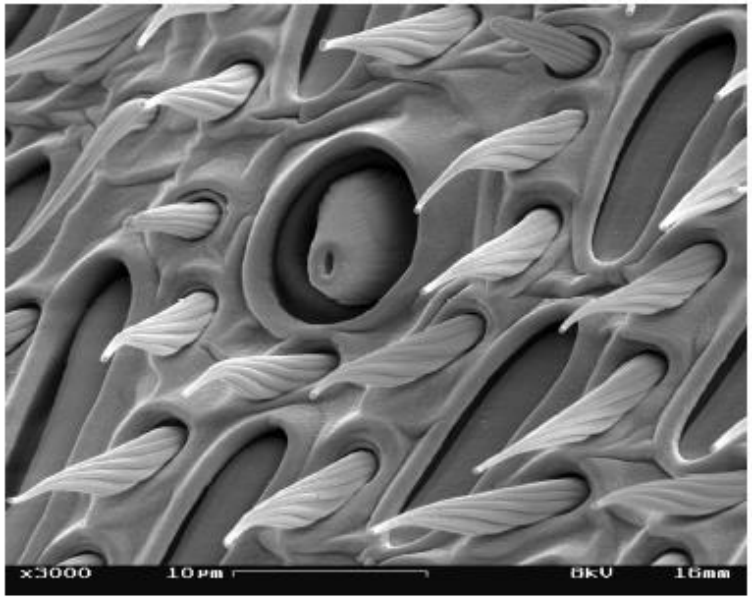



**2.** Scanning electron microscope: highly focused beams of electrons scan the surface of an object and produce an image based on the scatter



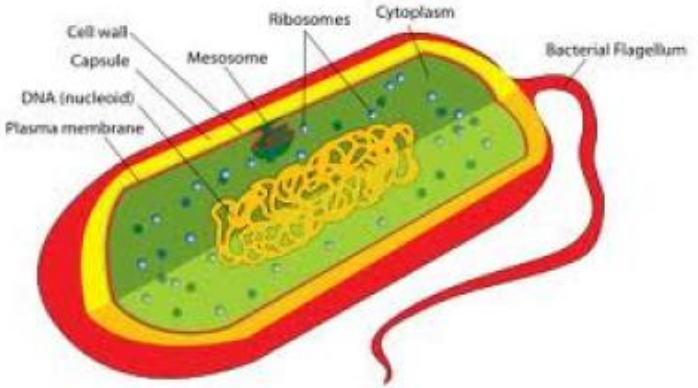



Seeing
the
Invisible

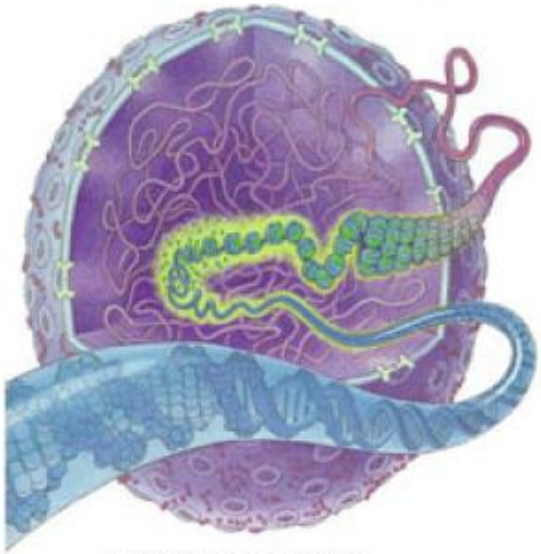
## II. Features common to all cells

### a. DNA

**i.** All cells need to store genetic information and pass it on to future generations




**ii.** In prokaryotic cells, the DNA is found as a tangled loop floating in the cytoplasm

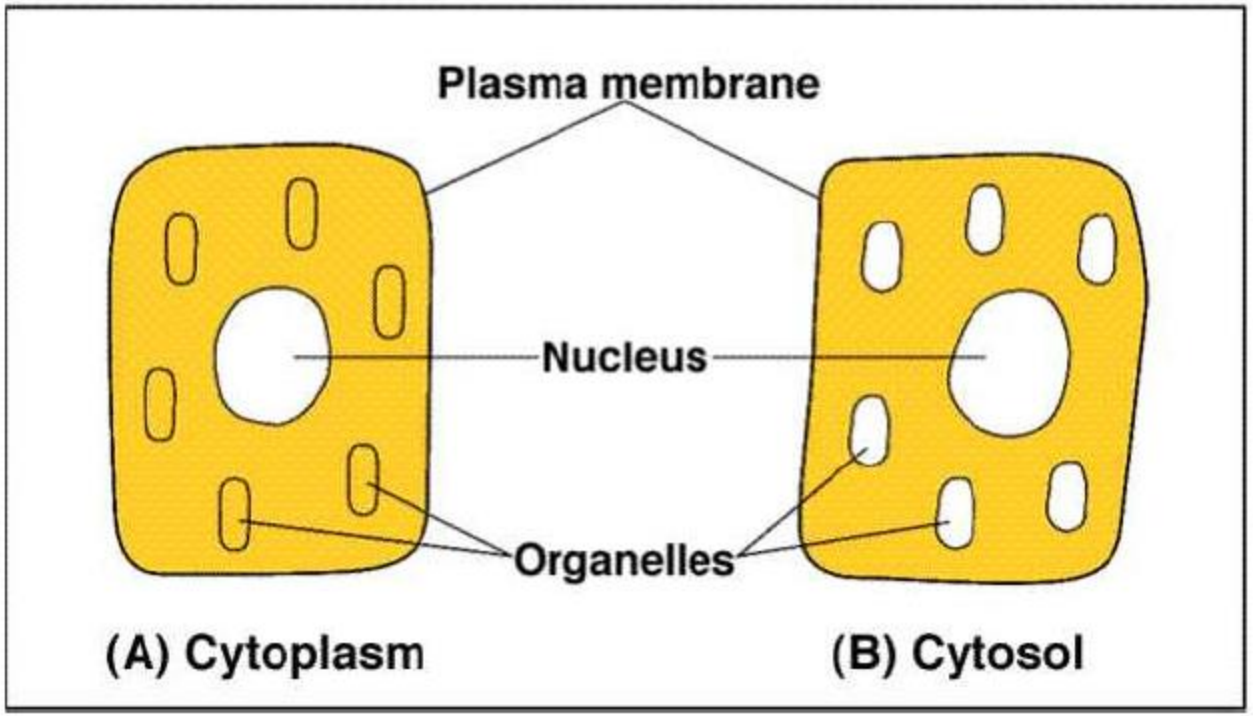



**iii.** In eukaryotic cells, the DNA is located in a membrane-bound nucleus

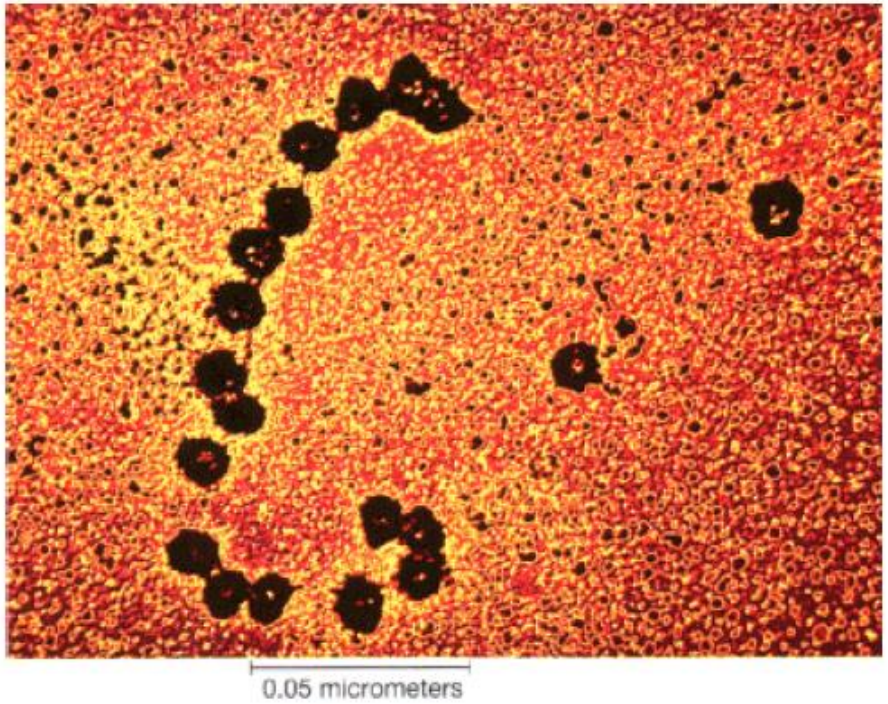
b. **Cytoplasm**: all of the jelly-like fluid inside the cell (called **cytosol**) as well as the organelles found suspended within it, excluding the nucleus (if present)

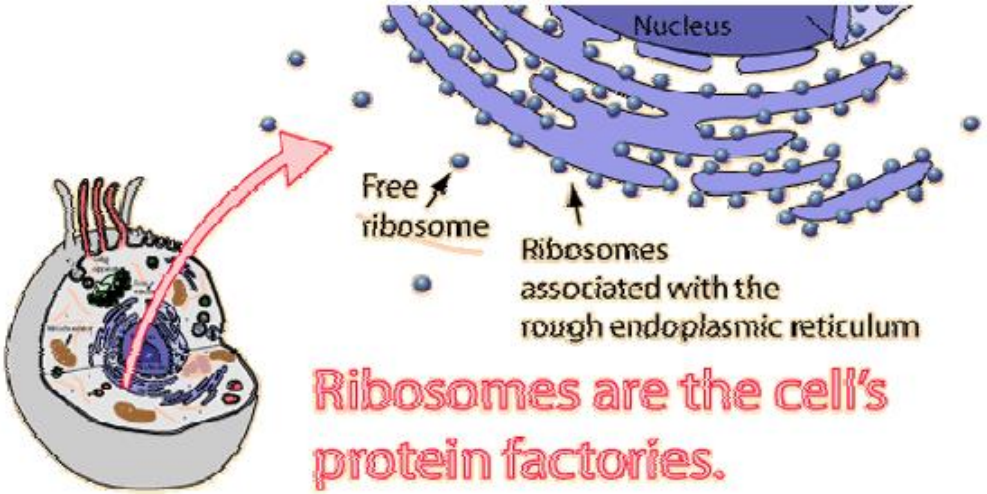
c. **Cell Membrane**: made of phospholipids and controls what can enter/leave the cell (also called plasma membr

**Comparison of Cytoplasm and Cytosol**

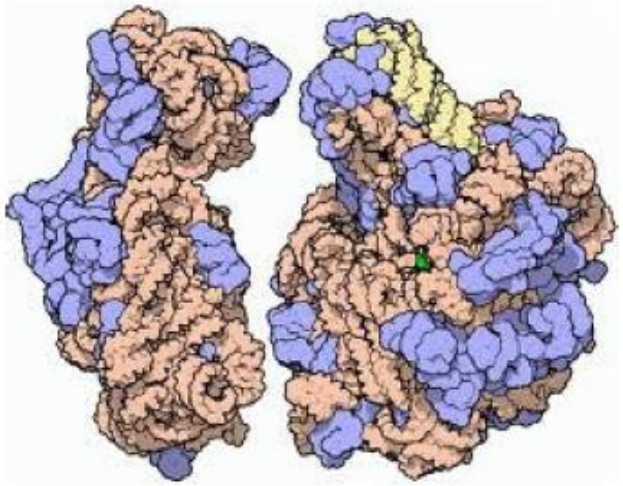


**d. Ribosomes**: made of RNA, ribosomes are tiny structures that are not even considered true organelles by many biologists because they lack a membrane; their function is to produce proteins




Ribosomes are the cell's protein factories.



# III. Prokaryotic Cells

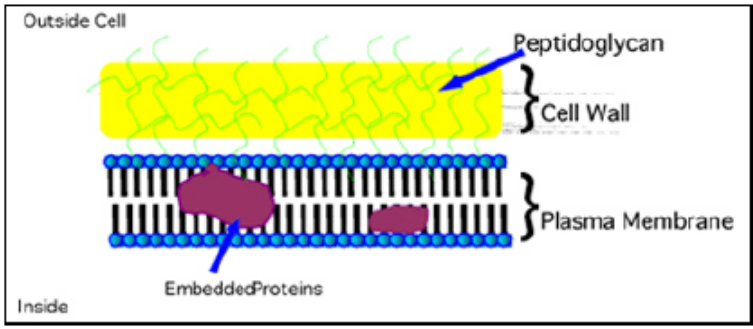
## a. Characteristics:

### i. No nucleus

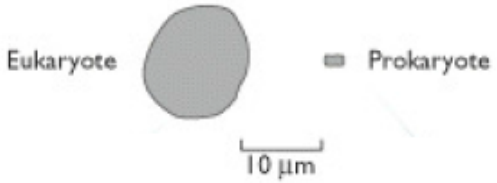
### ii. No membrane-bound organelles

### iii. Have a cell wall

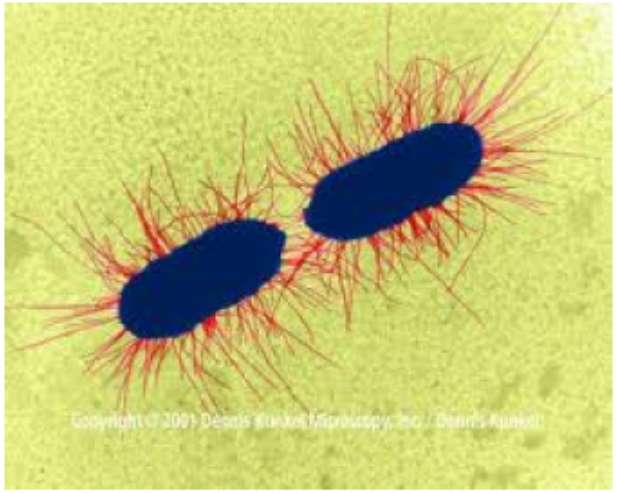
(made of **peptidoglycan**, a substance made of protein and carbohydrates)

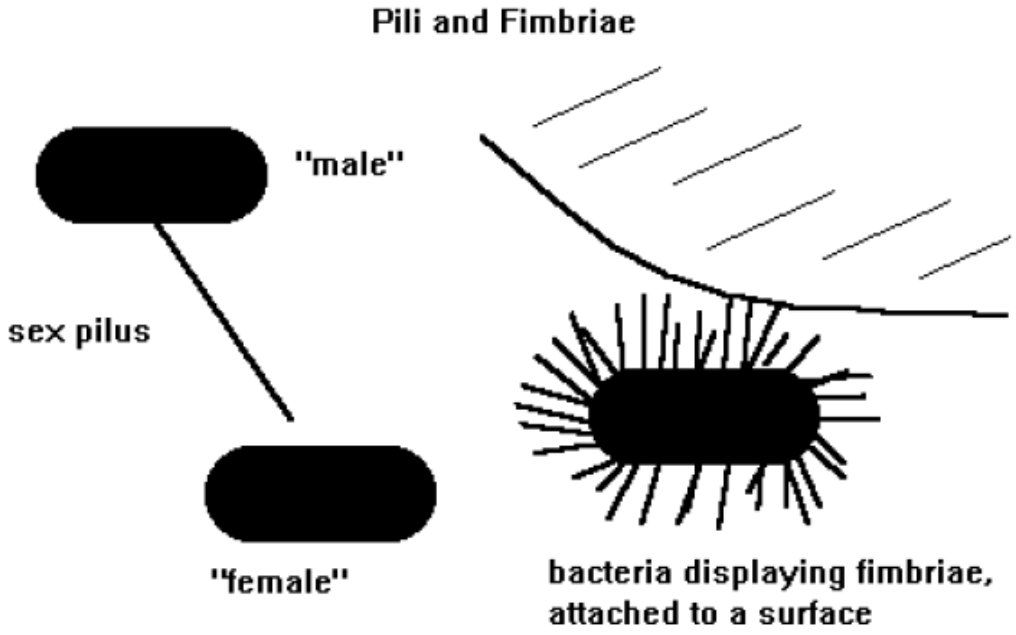



### iv. Very small (most are between 1µm – 10 µm; 1 µm = 0.000 001 m)

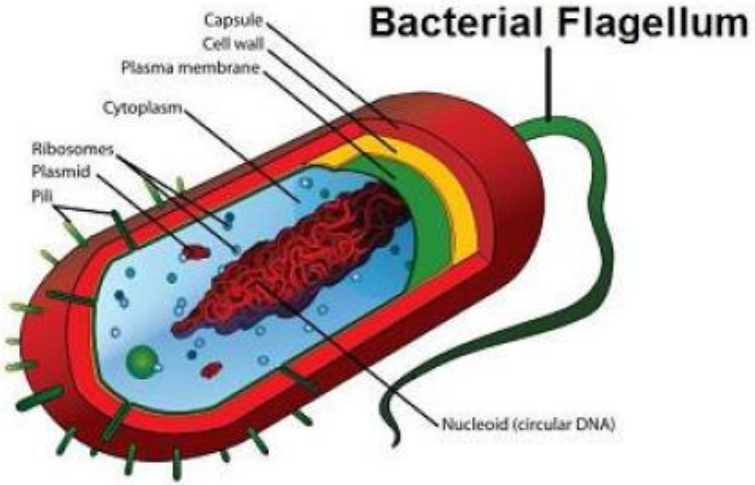


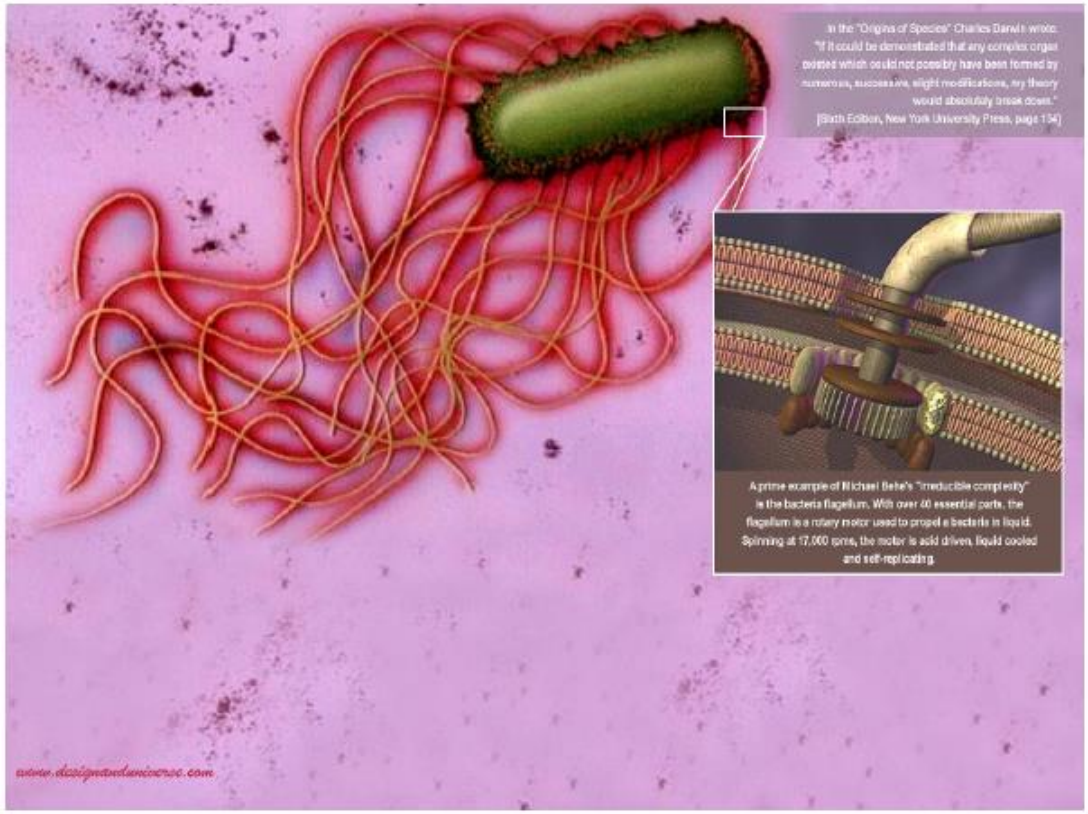
v. Pili: structures extending from the cell surface that are used for attachment to surfaces or exchange of genetic material





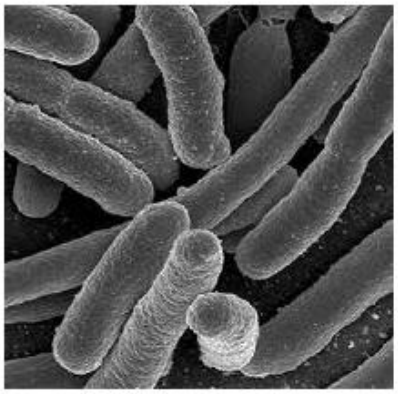
**vi.** Flagella: some prokaryotes (not all) move by using flagella, whip-like structures that look like tails



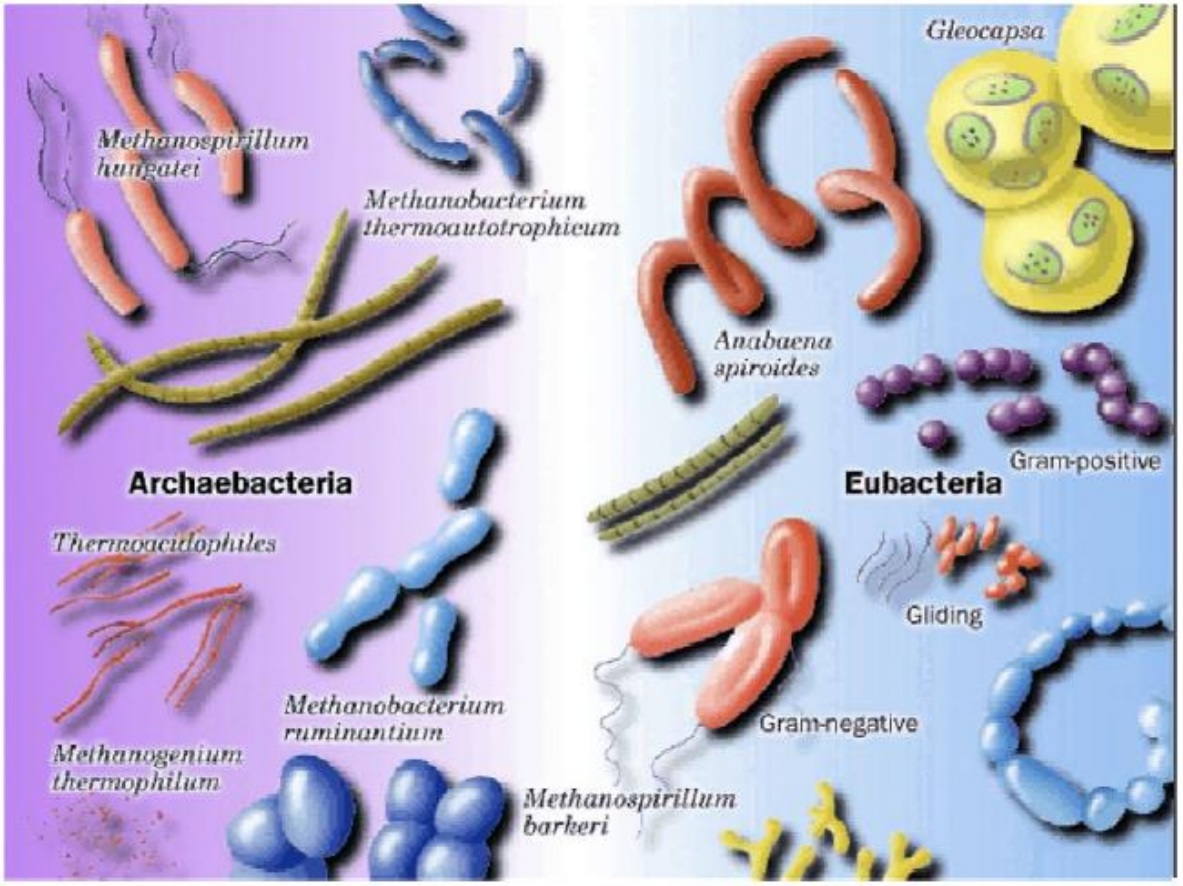



**b.** Examples:

**i.** Bacteria



**ii.** Archaea

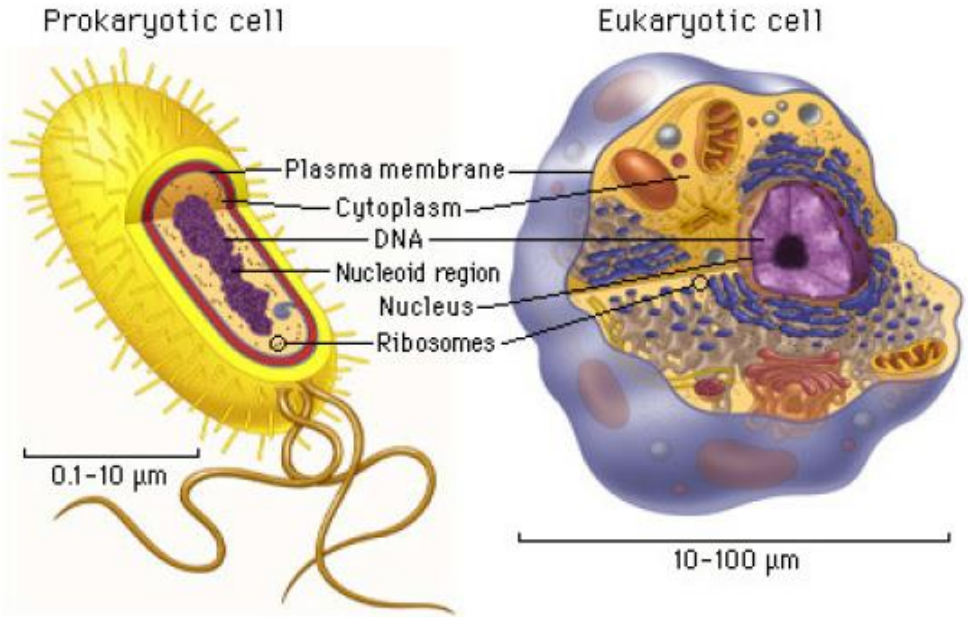


# IV. Eukaryotic Cells

## a. Characteristics:

### i. DNA is contained in a membrane-bound nucleus

### ii. Larger and more structurally complex than prokaryotes

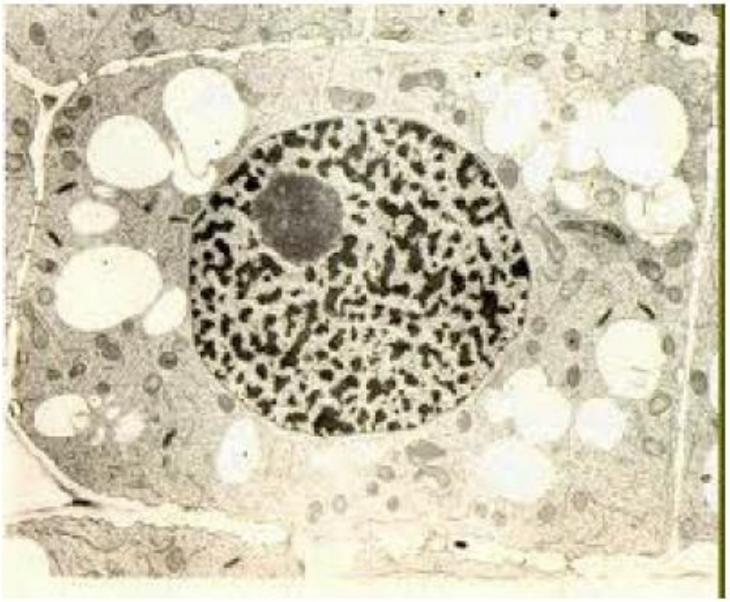


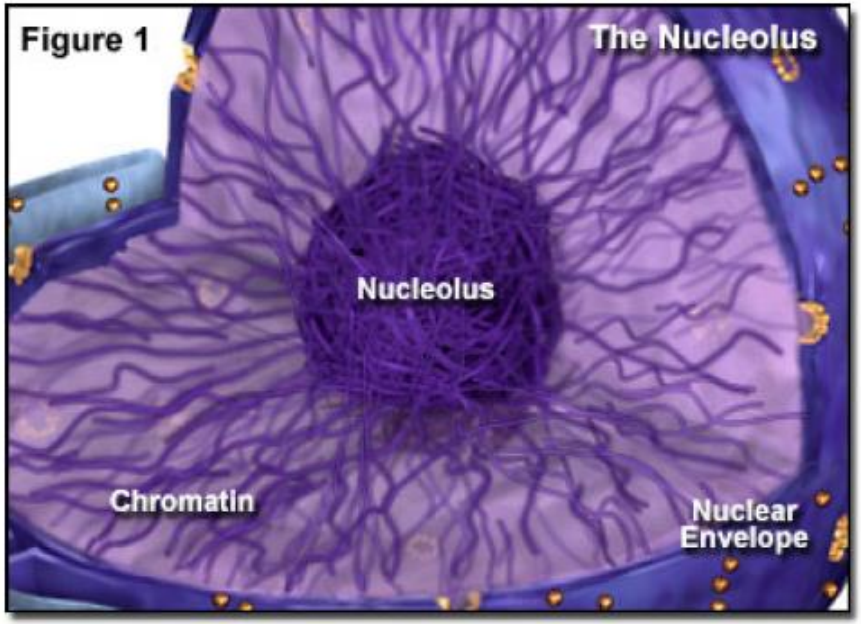
**iii.** Structures common to all eukaryotes:

**1.** Nucleus

**a.** Surrounded by a **nuclear envelope**, a membrane with many pores that allow RNA to pass out of the nucleus into the cytoplasm

**b.** Inside the nucleus is a structure called the **nucleolus**, which is where ribosomes are made





**2.** Mitochondria

**a.** Break down food (glucose) to make energy (ATP)

**b.** Surrounded by a double membrane

**i.** Outer membrane surrounds a folded inner membrane

**ii.** Folds in the inner membrane are called **cristae**

**iii.** The **matrix**, or area inside the inner membrane, contains many enzymes necessary for ATP production

**c.** Contains its own DNA (different from the nucleus)

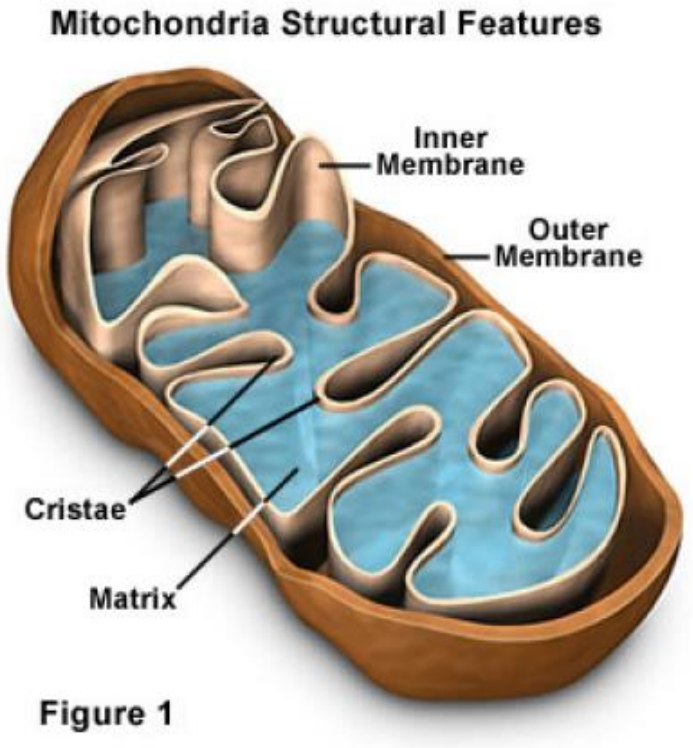
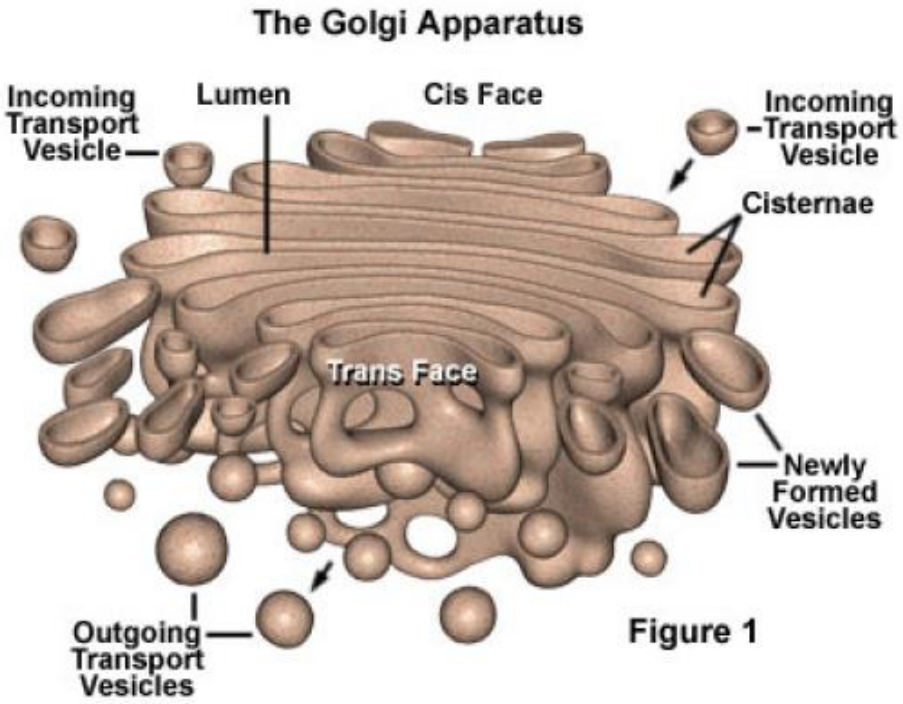
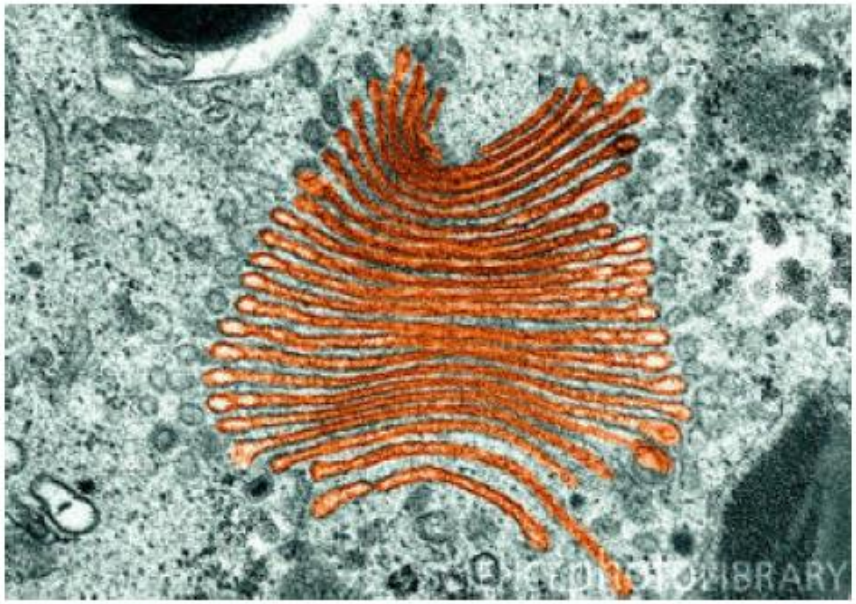


Figure 1

**3.** Golgi Apparatus: repackages proteins and other cell materials to be sent out of the cell

(also Golgi Body or Golgi Complex)

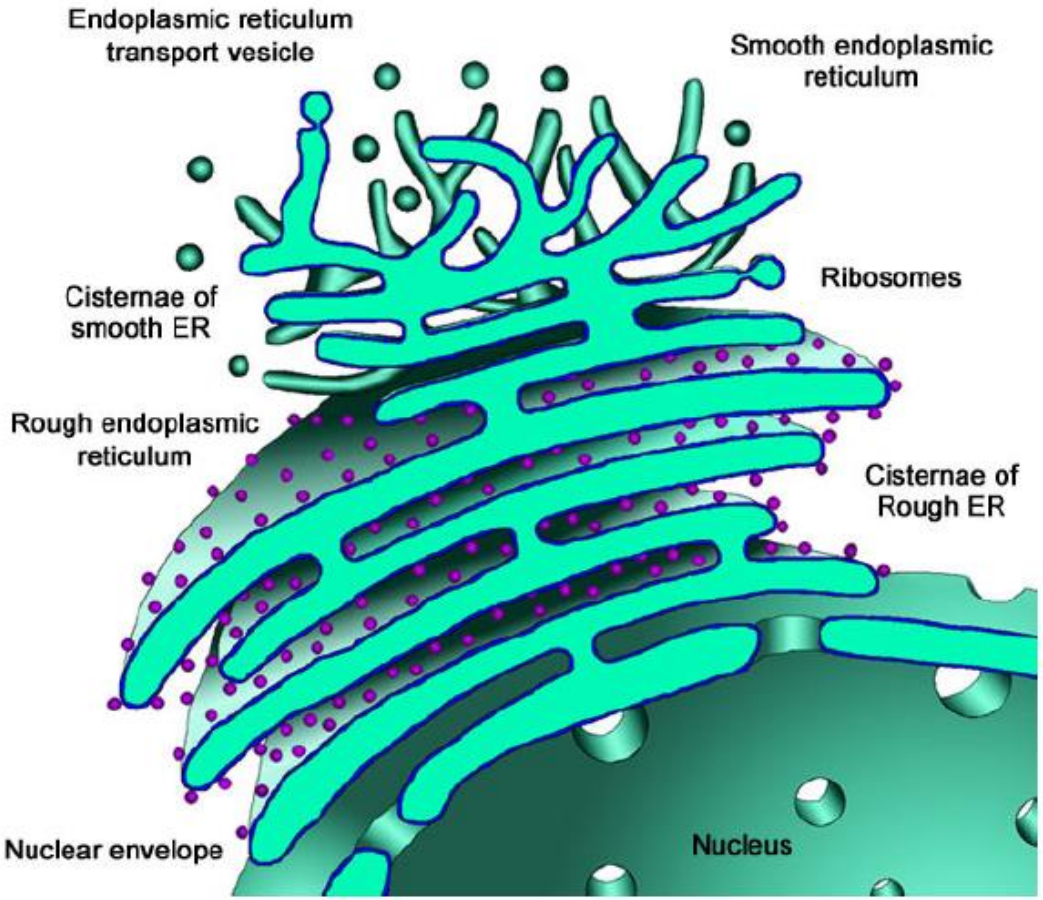


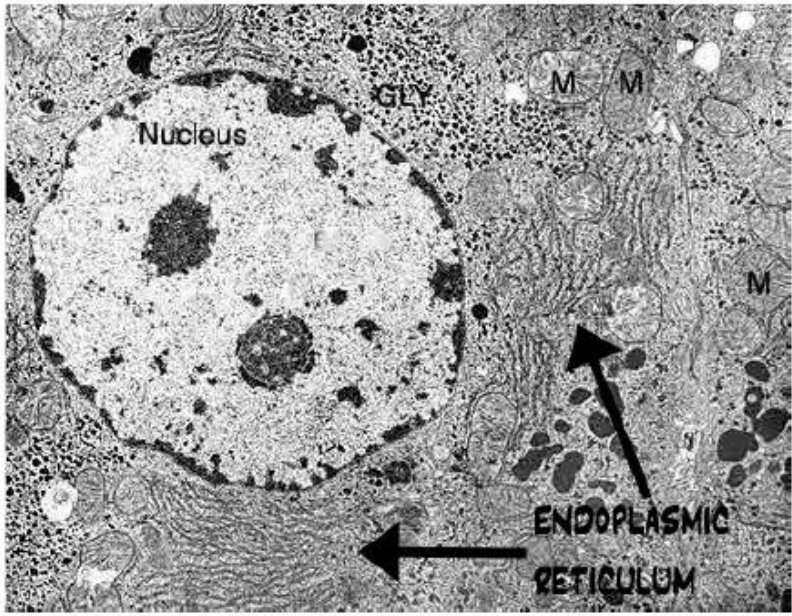



**4.** Endoplasmic Reticulum: transports proteins throughout the cell

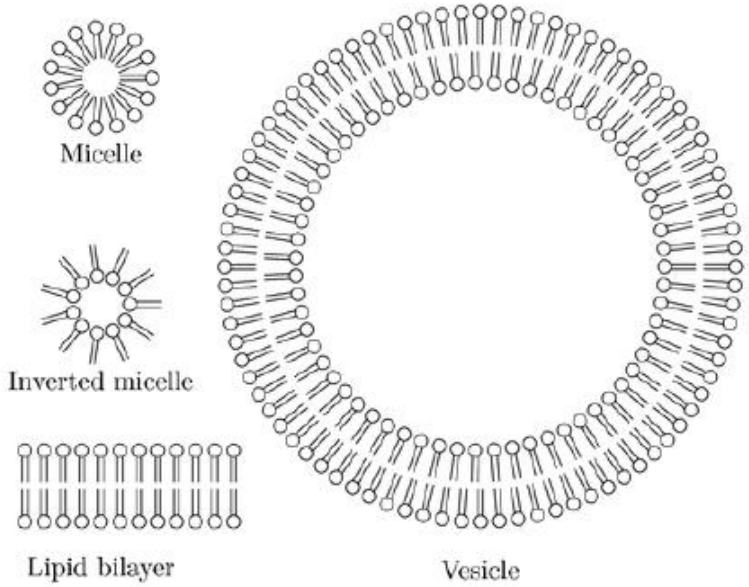
**a.** Rough ER: has many attached ribosomes

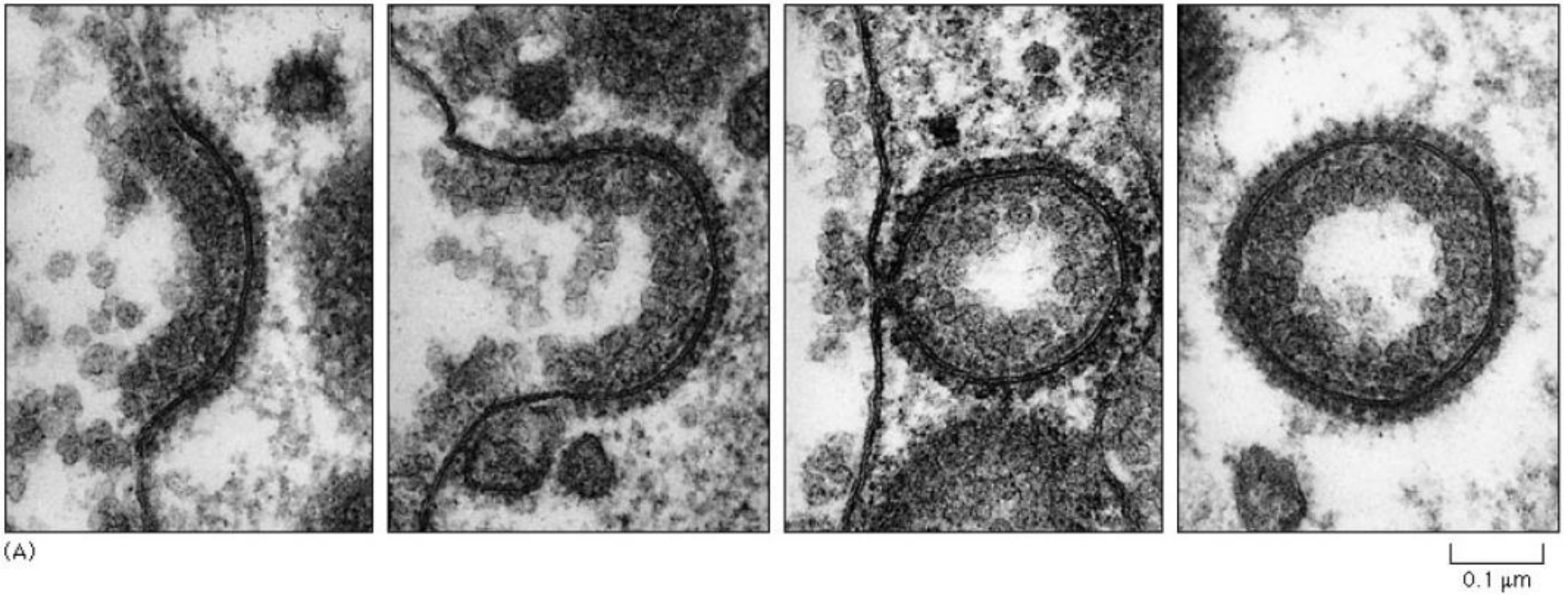
**b.** Smooth ER: does not have attached ribosomes



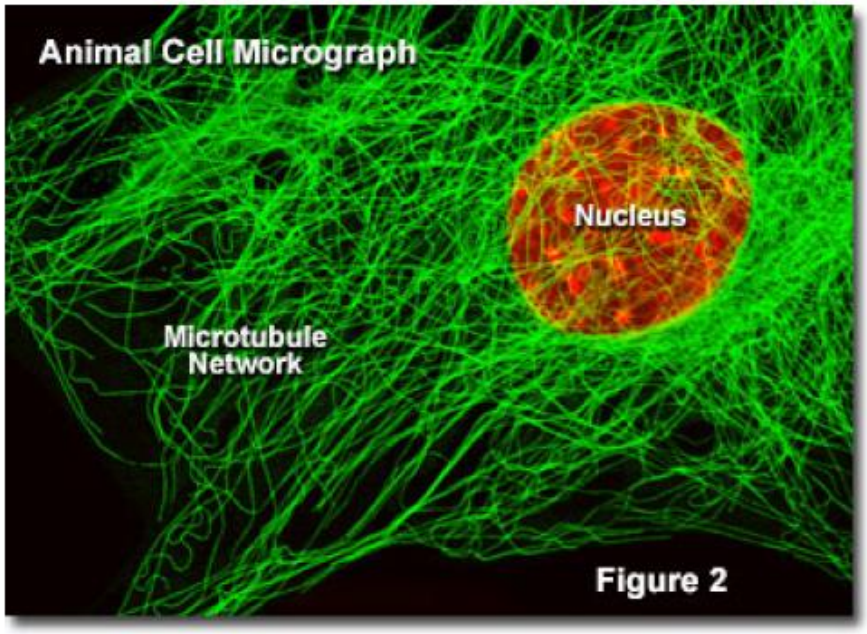



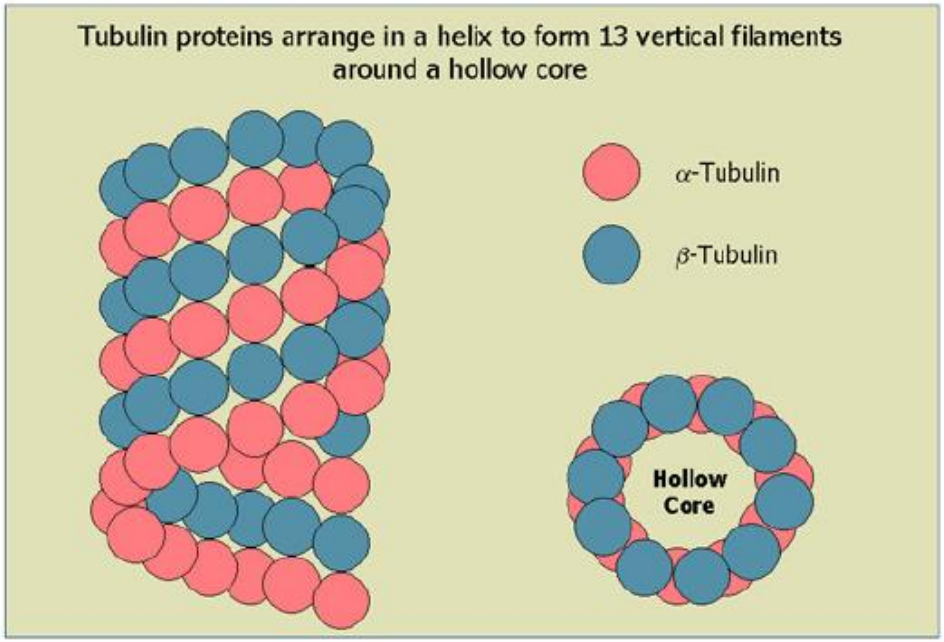
**5.** Vesicles: membrane-bound sacs that contain proteins and other cell materials



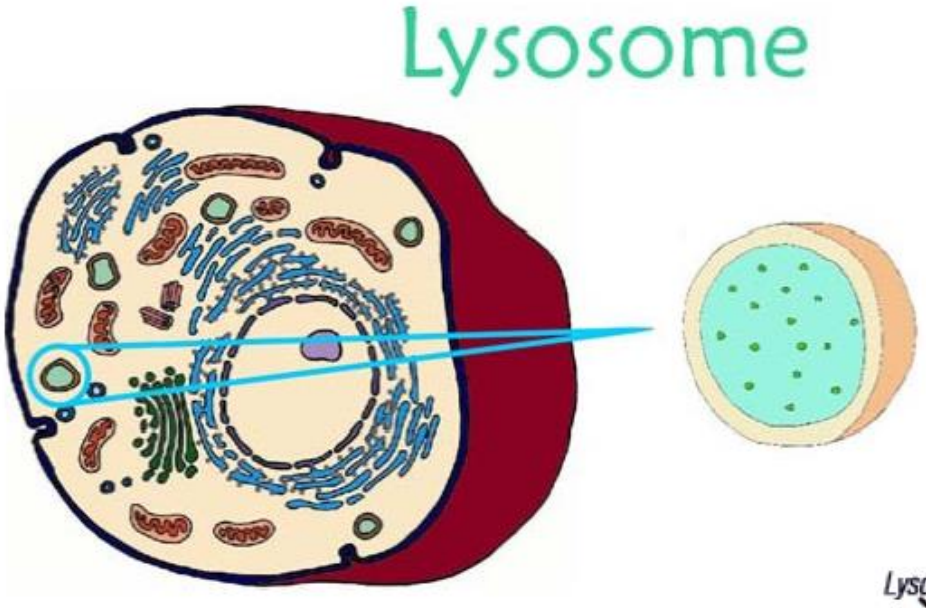
6. Microtubules: major component of the **cytoskeleton**, which provides cell structure and allows for the internal movement of organelles

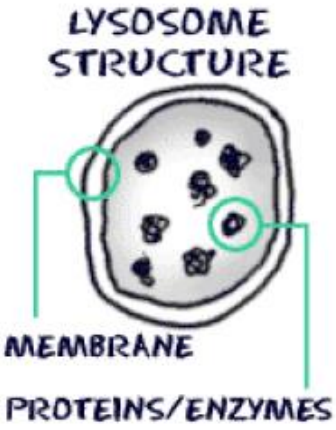


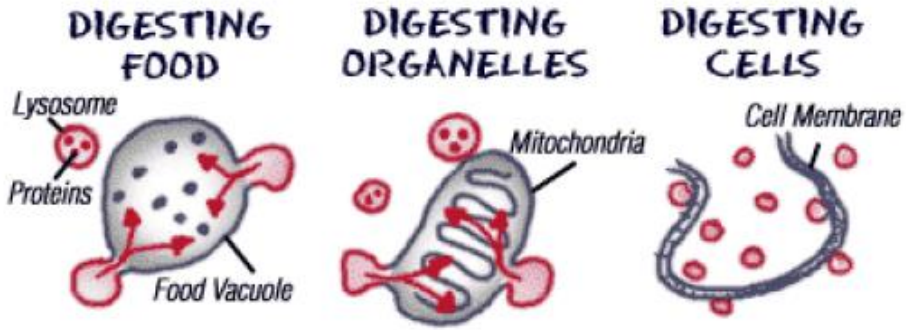



**b.** Animal Cells

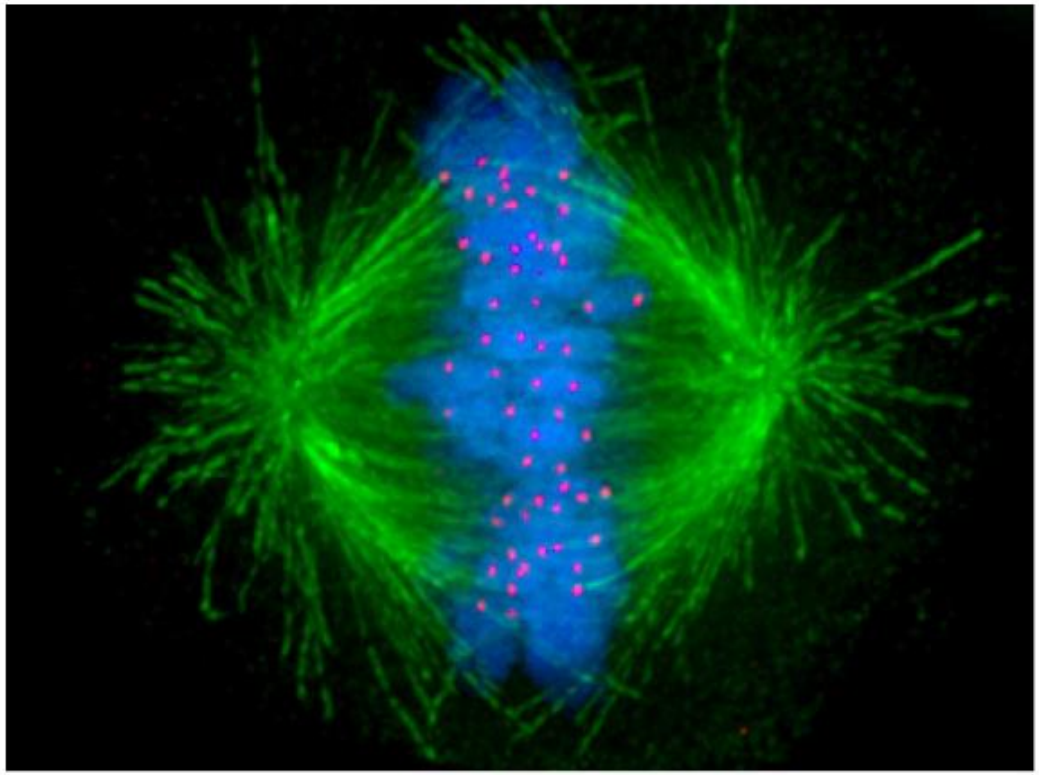
**i.** Lysosomes: contain enzymes to break down wastes and old cell parts (only very rarely found in plant cells)

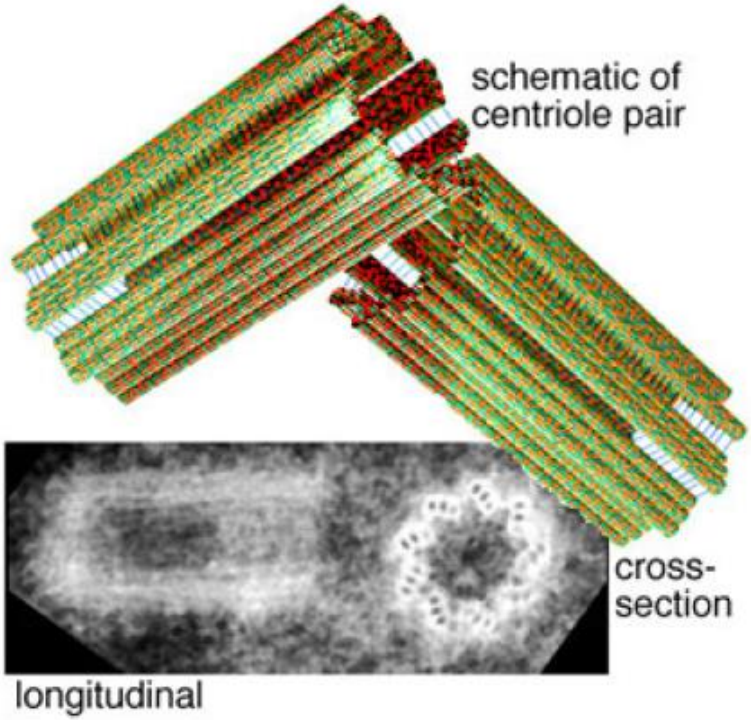


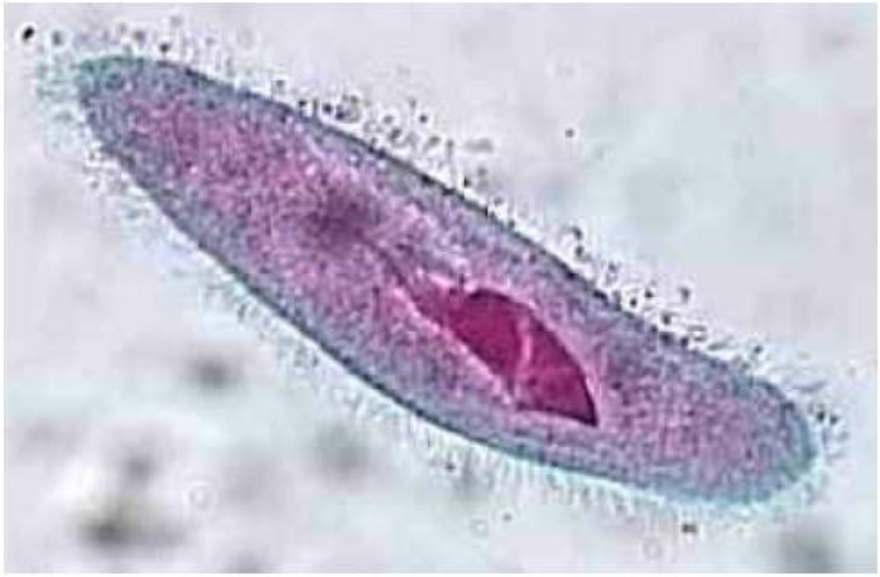
**ii.** Centrioles: arrangement of microtubules that create the "spindle fibers" the cell uses during cell division

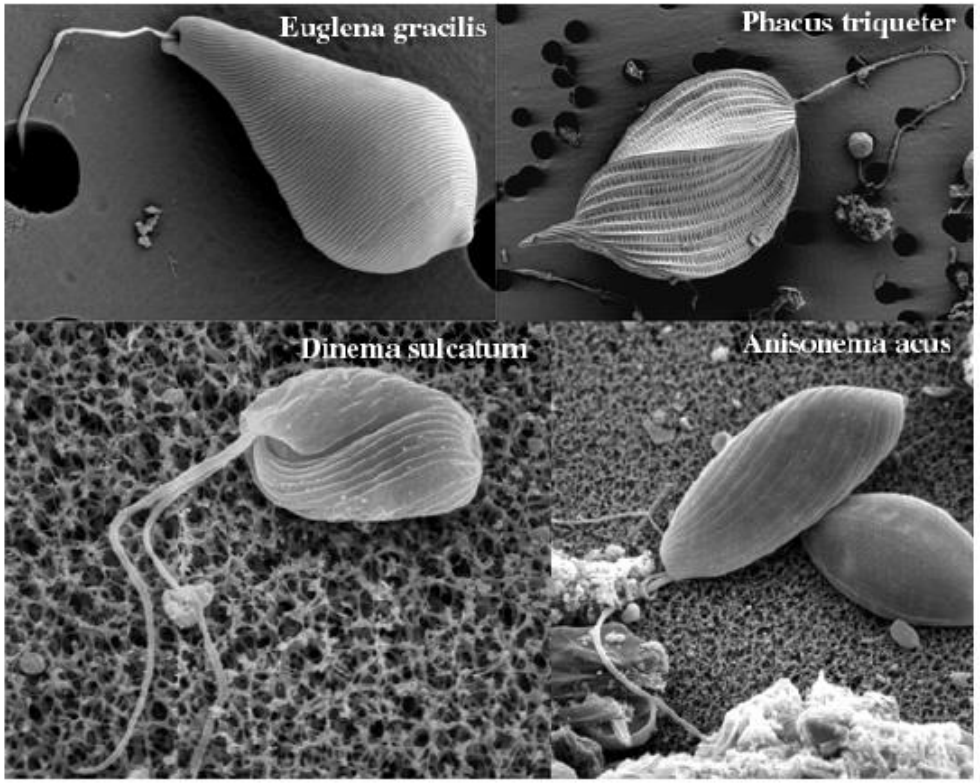




**iii.** Structures for movement

1. Cilia: short "hairs" made of microtubules
2. Flagella: long, whip-like "tails" (bacteria can have these as well)

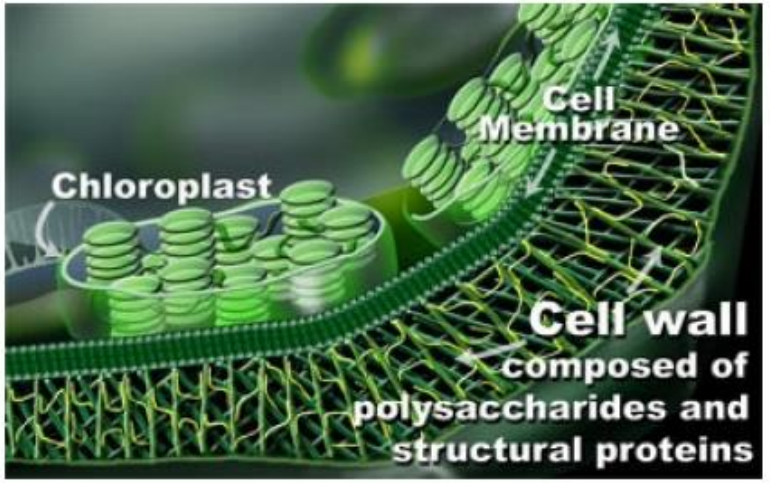





Flagellar diversity in Euglena species.

**c.** Plant Cells

**i.** Cell Wall: provides rigid structure for plants; made of cellulose, a carbohydrate



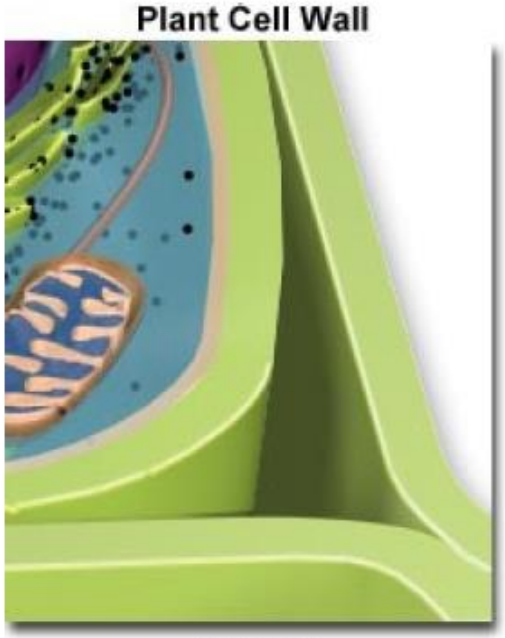




Figure 1

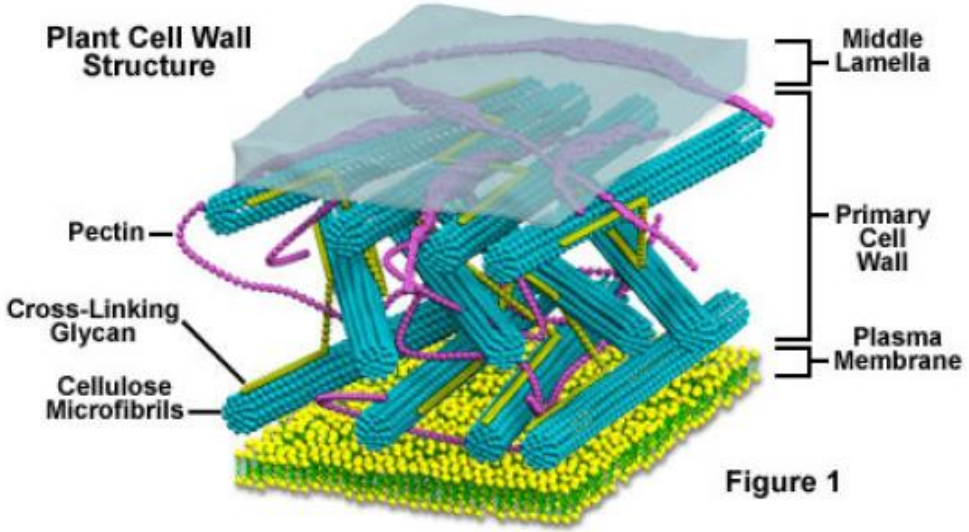
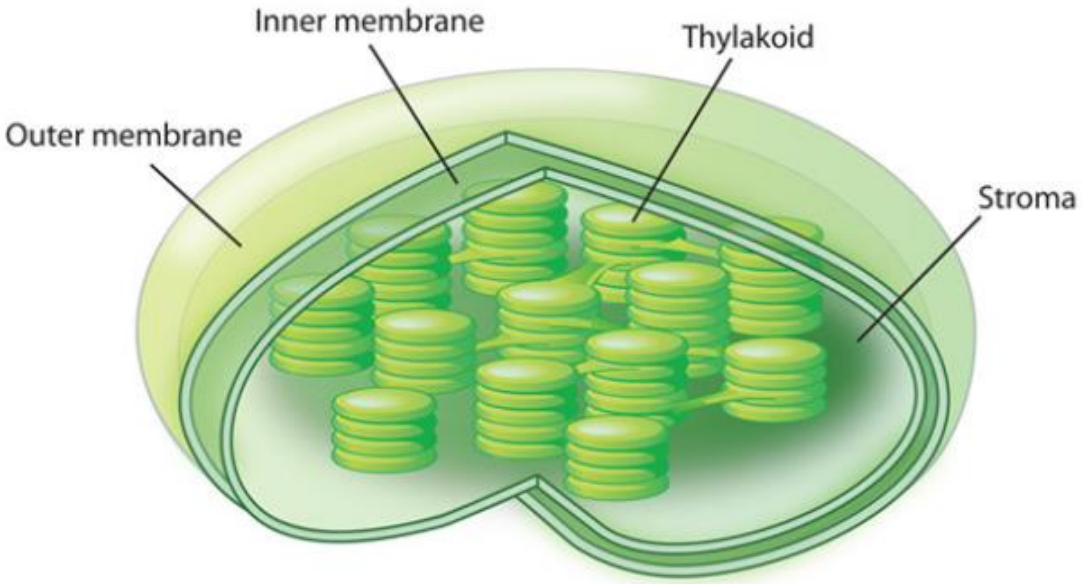
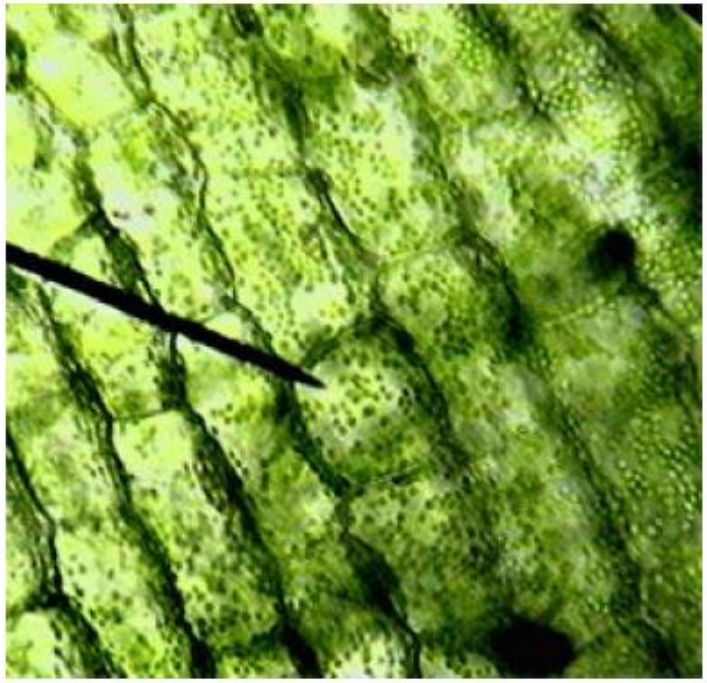



Figure 1

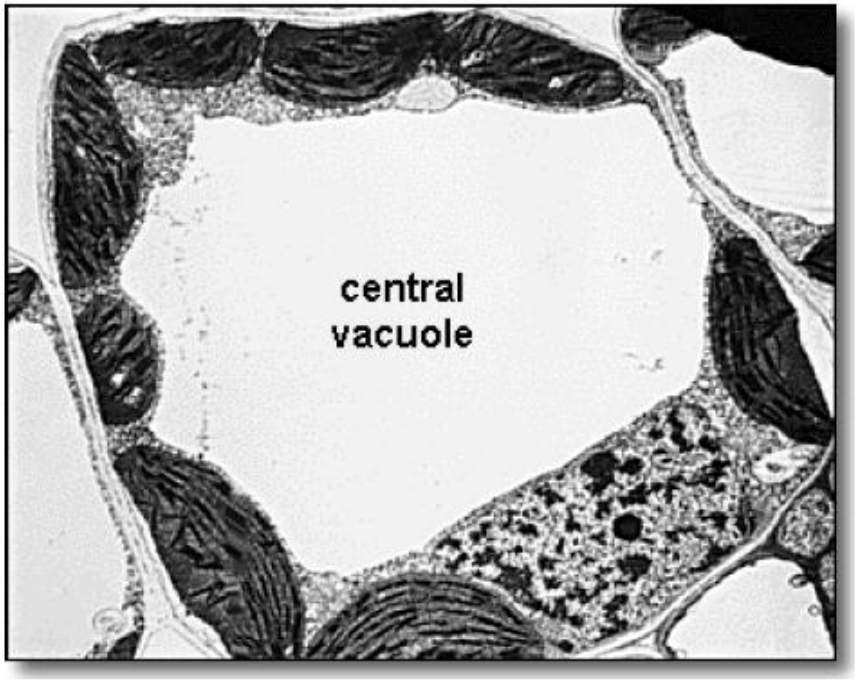
**ii.** Chloroplasts

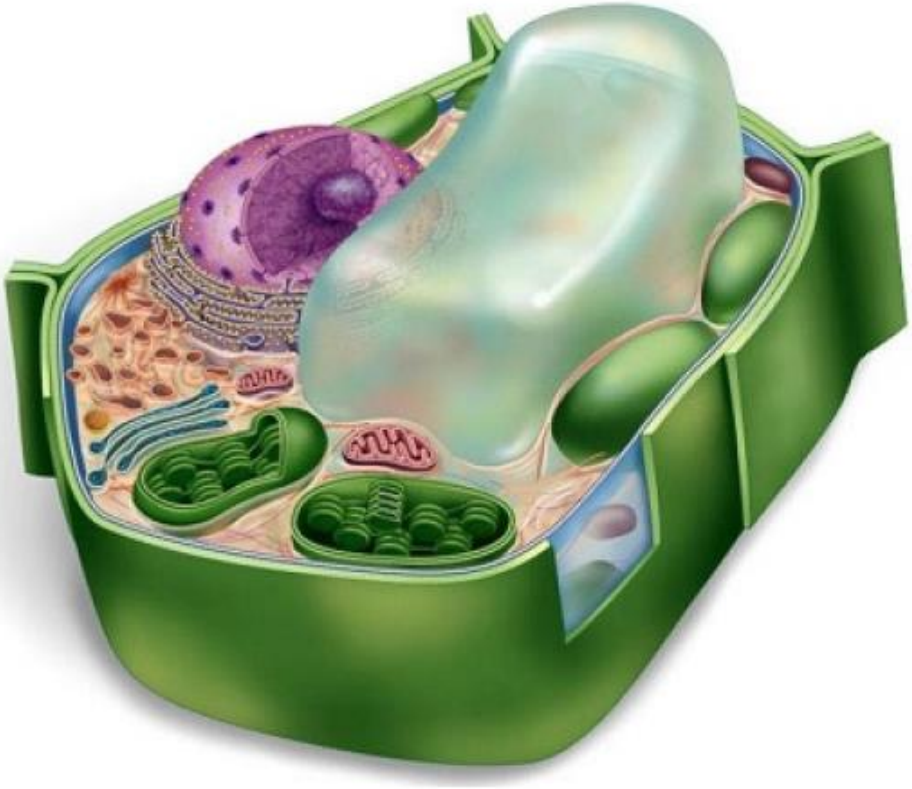
1. Site of photosynthesis, or the use of sunlight energy to produce glucose
2. Surrounded by a double membrane
3. Contains DNA different from the nucleus



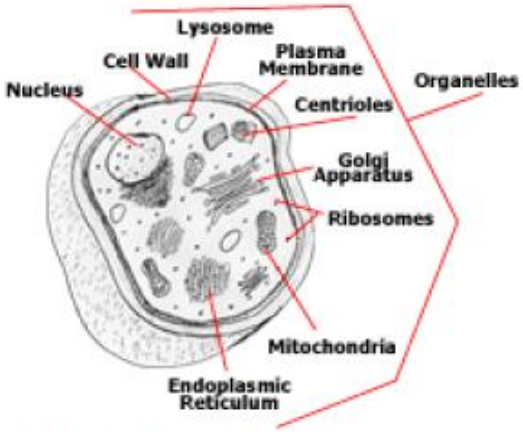
## **iii.** Central Vacuole: stores water and nutrients



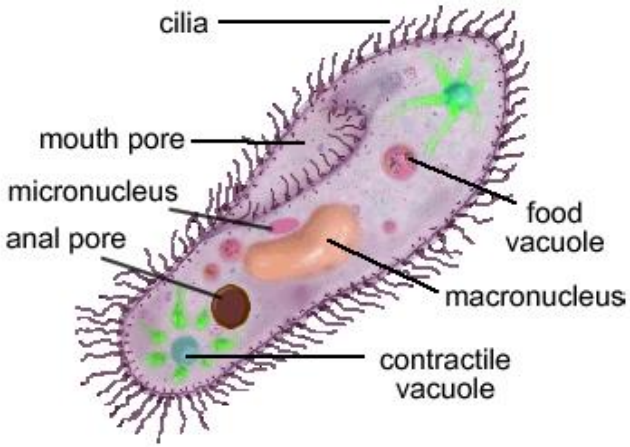



# d. Other types of eukaryotic cells:

## i. Fungi




## ii. Protists



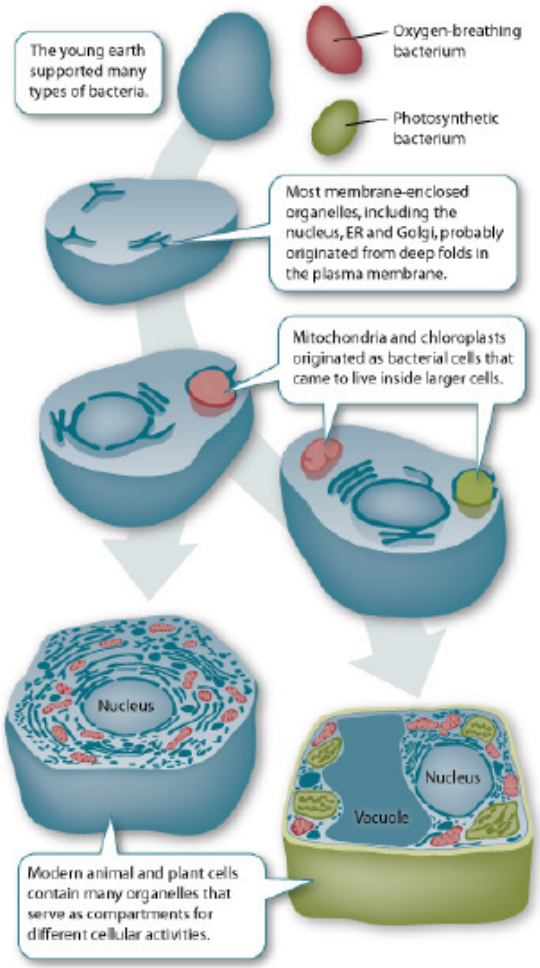

**V.** Endosymbiotic Theory

**a.** Proposed by Lynn Margulis, the endosymbiotic theory offers an explanation of how eukaryotic cells first evolved.

**b.** The theory states:

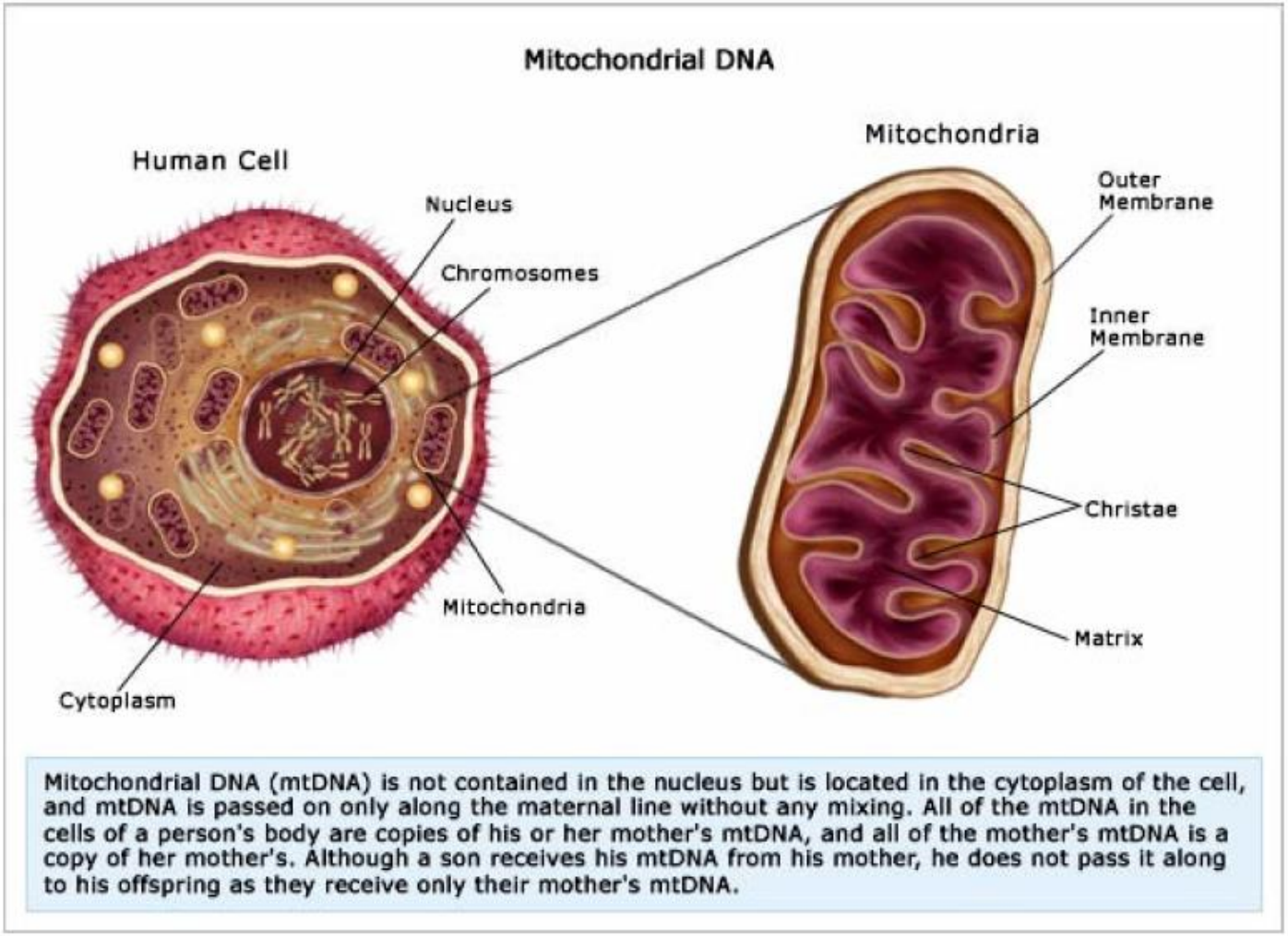
**i.** A large, ancient prokaryote engulfed a smaller, photosynthetic prokaryote and instead of digesting it, starting using the sugars being produced.

**ii.** Similarly, mitochondria were formed when a large prokaryote engulfed a smaller prokaryote that was very efficient at producing ATP and did not digest it.



**c.** Evidence to support the theory:

**i.** Both chloroplasts and mitochondria have their own DNA that is different from the cell's DNA in the nucleus.



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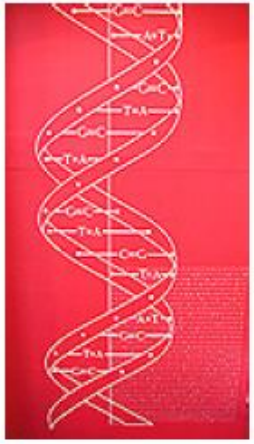
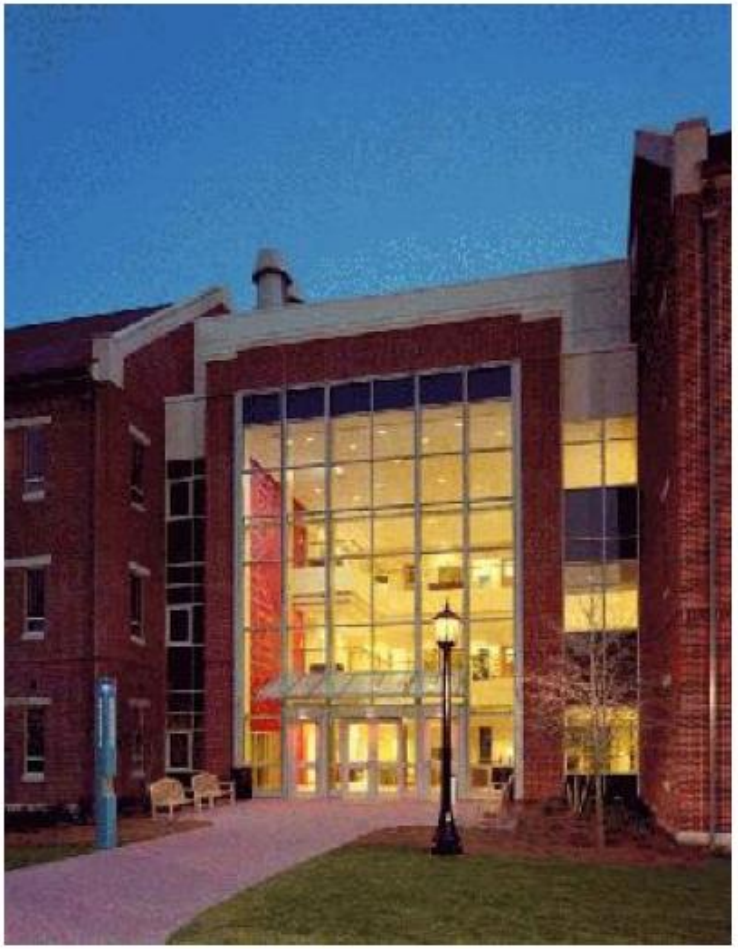
THE WORLD FOR WOMEN

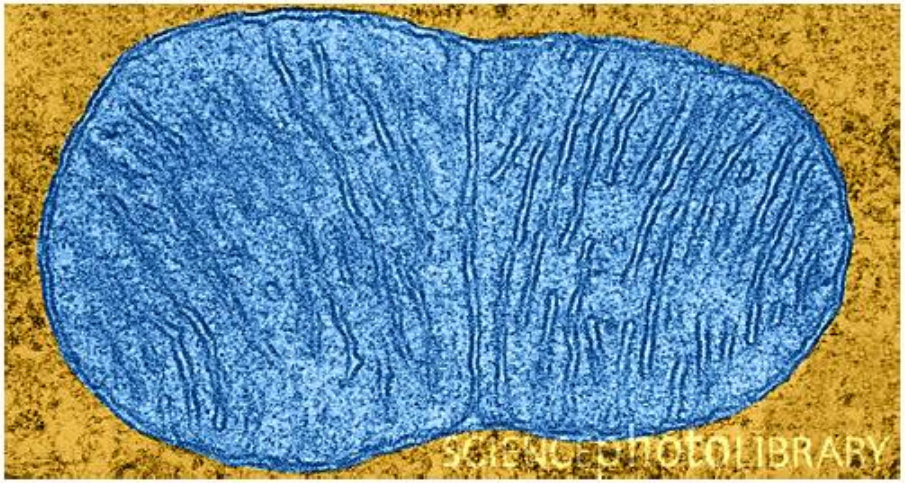
True story!

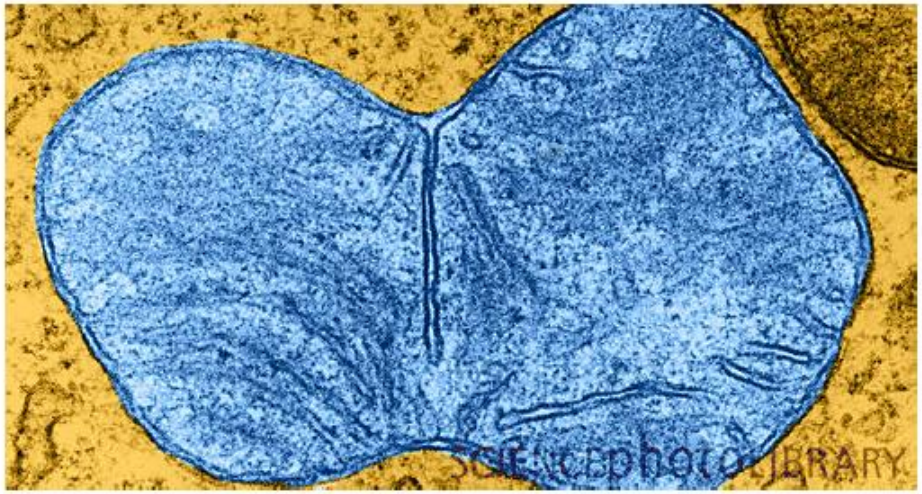
The Agnes Scott College science building has a 3 story mural of its namesake's mitochondrial DNA sequence in the atrium!

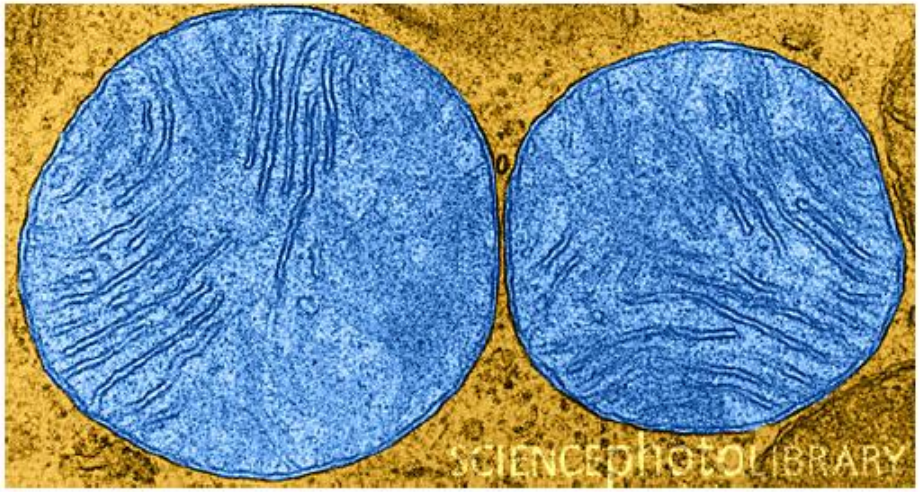




**ii.** Chloroplasts and mitochondria are able to divide on their own in a process very similar to bacterial cell division.



**iii.** The inner and outer membranes of chloroplasts and mitochondria have different compositions, suggesting that the outer membrane came from the original large prokaryote while the inner membrane belonged to the smaller prokaryote being engulfed.