

General microbiology

Lecture-7

Microbial cell structure Eukaryotes

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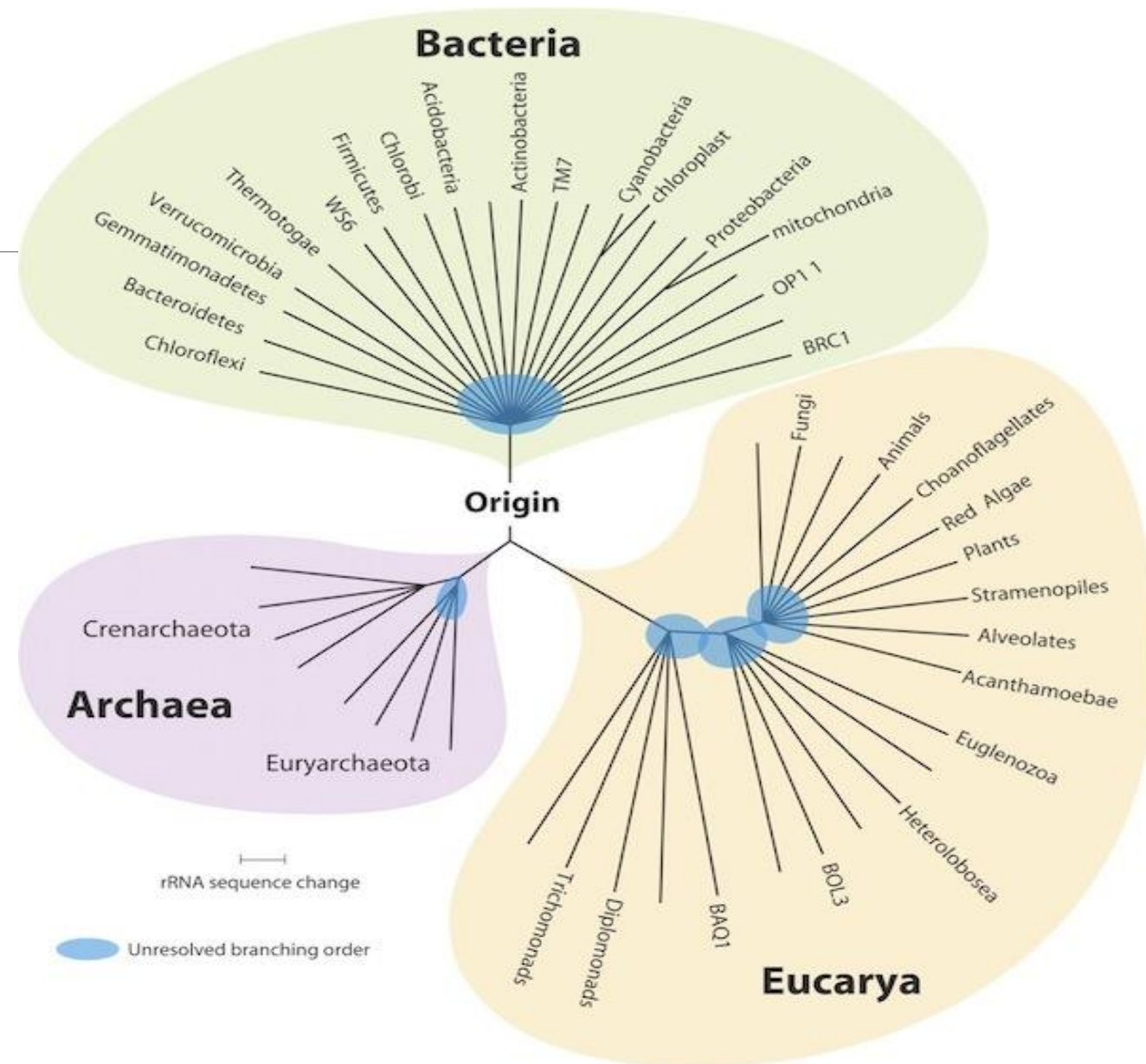
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Domains of living cells

Phylogeny of living cells

- All living cells can be divided into two groups: **Eukaryotic** and **Prokaryotic**
- **A domain is:** a classification unit larger than kingdom.
- **Three domains exists:**
 - **Archaea (Archaeobacteria)**
 - **Bacteria (Eubacteria)**
 - **Eukarya (Eucaryotes).**

Both Archaea and Bacteria are prokaryotes.



Domains of living cells

Phylogeny of living cells

Eukaryotic vs. Prokaryotic Cells

Eukaryotes

- DNA enclosed in a membrane-bound nucleus
- Cells are generally larger and more complex
- Contain organelles

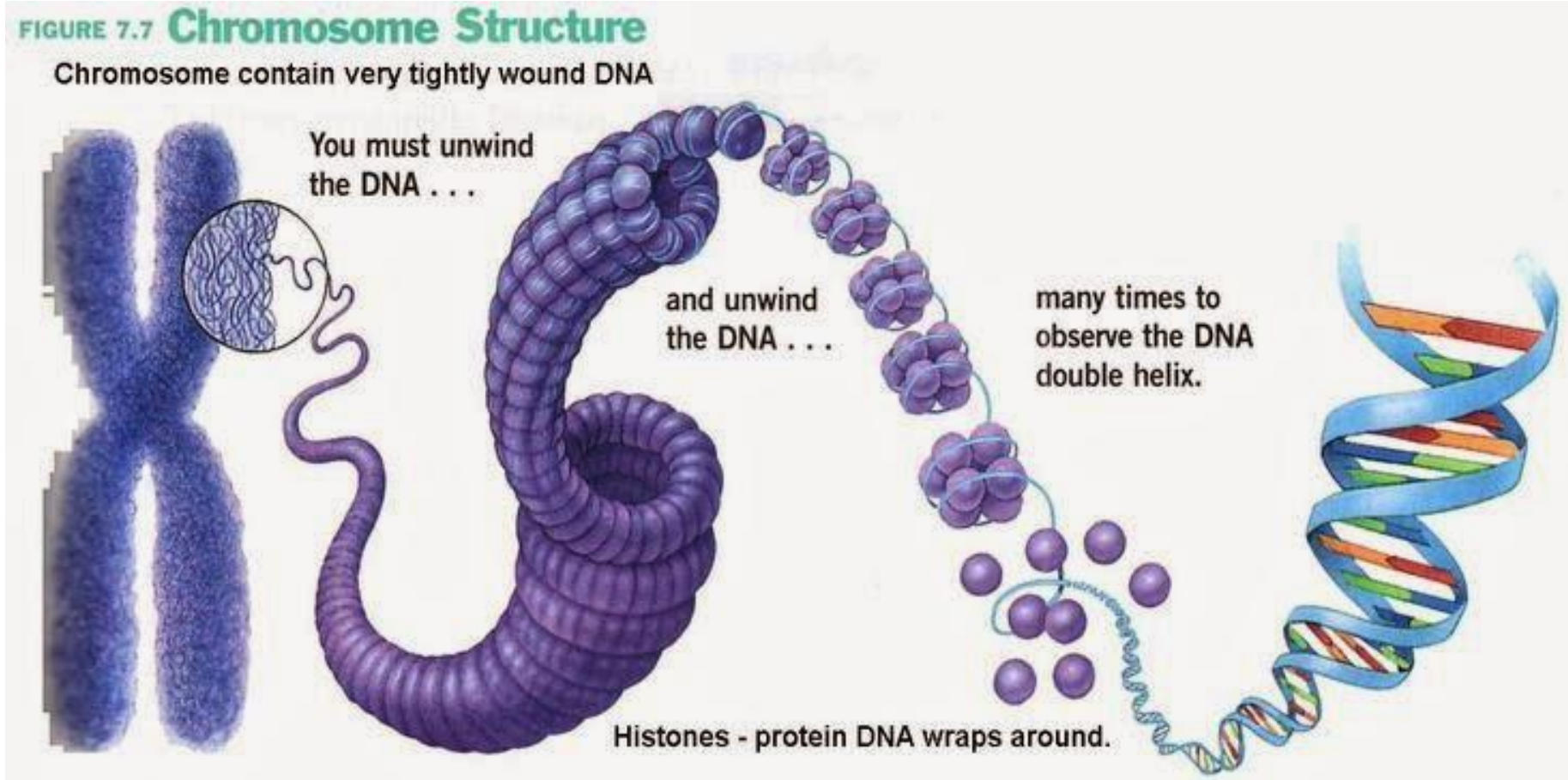
Prokaryotes

- No membrane-enclosed organelles (no nucleus)
- Generally smaller than eukaryotic cells

Eukaryotic Cells: an over view

- The DNA is found in the cell's nucleus, which is separated from the cytoplasm by a nuclear membrane, and DNA is found in multiple chromosomes.
- The DNA is consistently associated with chromosomal proteins called histones and with non-histone proteins.
- They have a number of membrane-enclosed organelles
- If cell walls are present, they are chemically simple
- Cell division usually involves mitosis.

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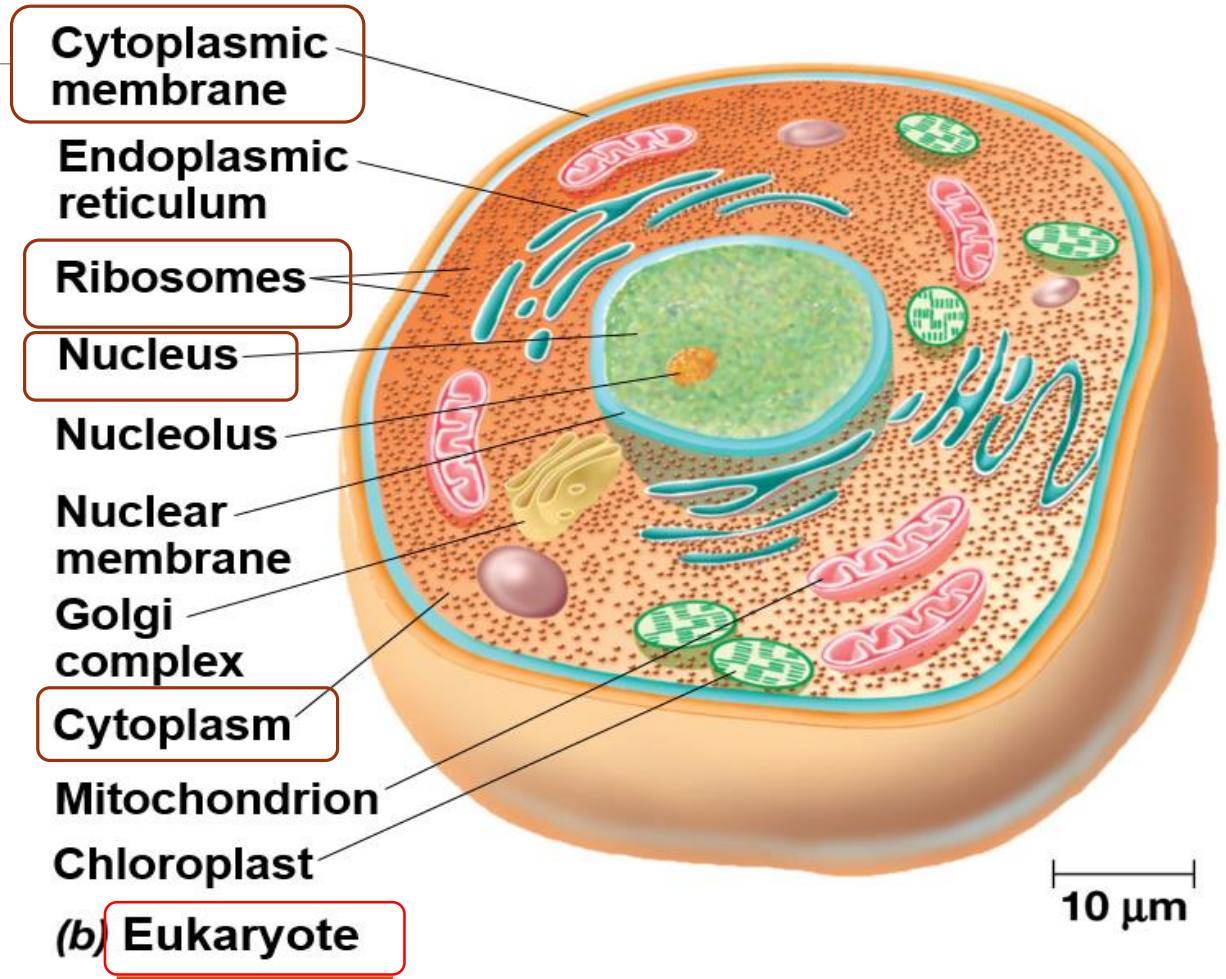
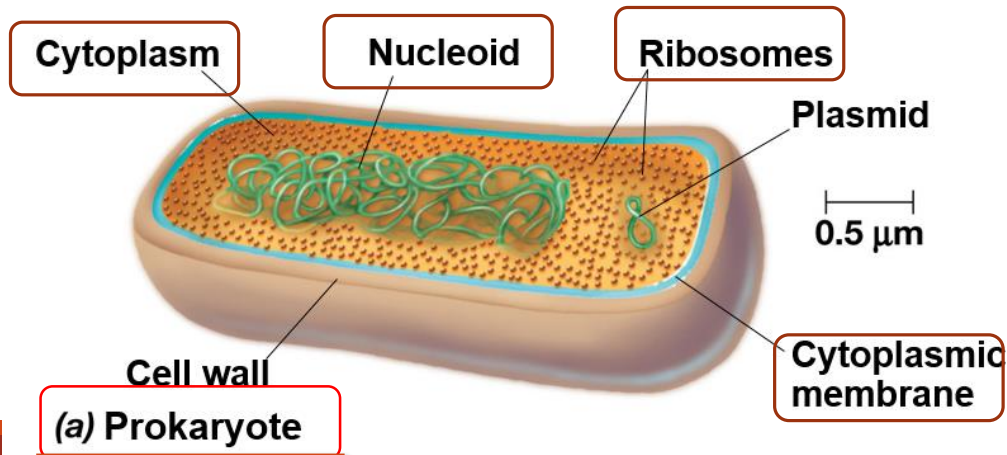


Principles of microbial cell structure

Elements of Microbial Structure

All cells (Eukaryote and Prokaryote) have the following in common:

1. Cytoplasmic membrane
2. Cytoplasm
3. Ribosomes
4. Genetic materials



Eukaryotic Cell Structure

Cytoplasmic membrane and Cytoplasm

1. Cytoplasmic membrane:

separates the inside of the cell (cytoplasm) from the outside.

2. Cytoplasm:

is an aqueous mixture of macromolecules – proteins, lipids, nucleus acids and polysaccharides- and small organic molecules.

The Eukaryotic cytoplasm is a complex internal structure.

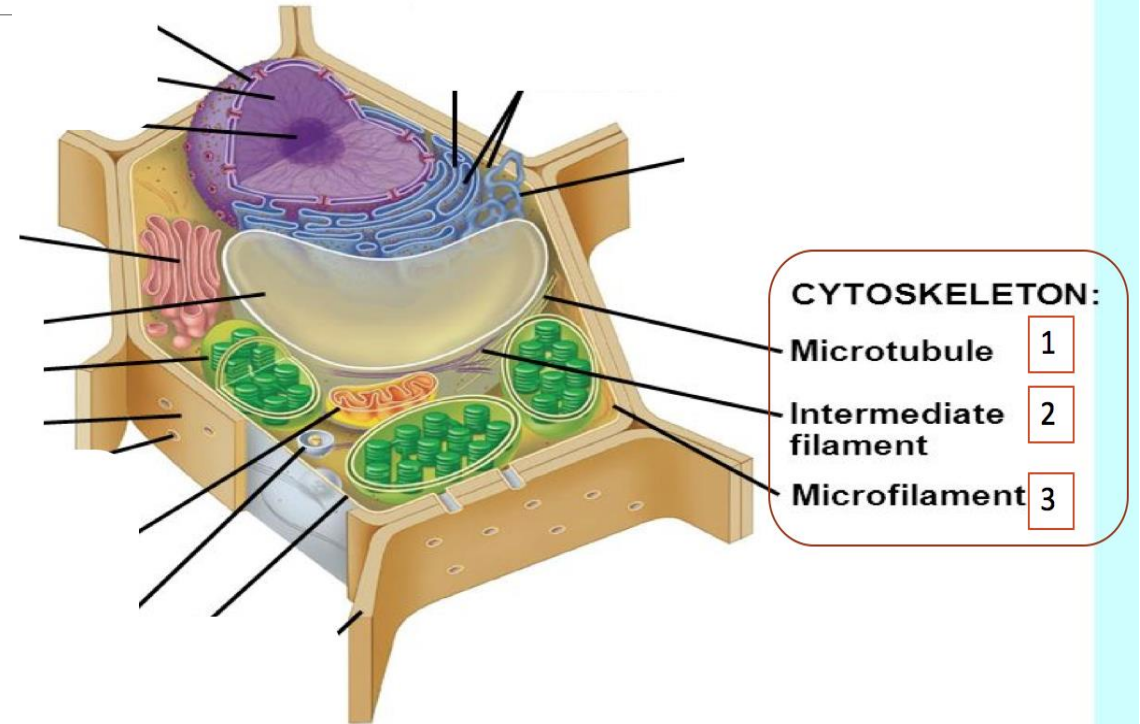
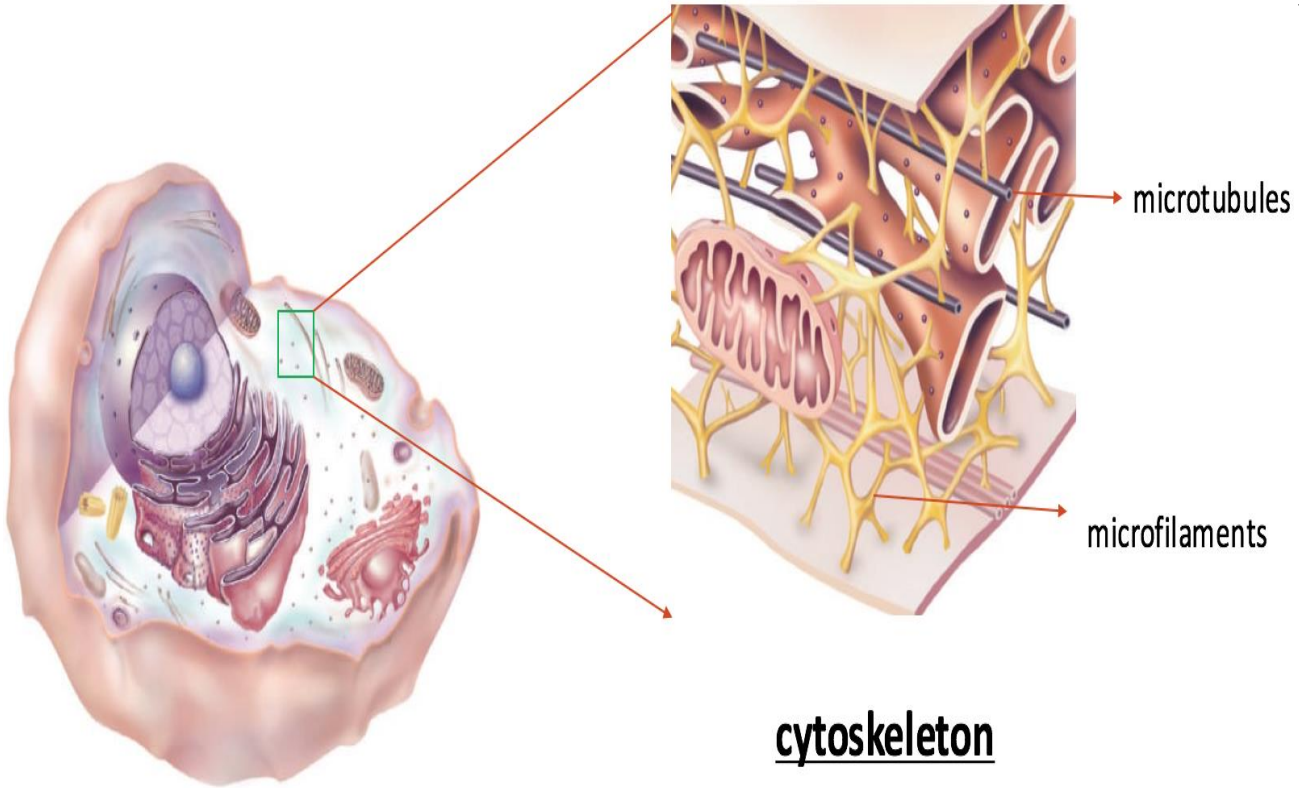
- **Cytosol** is the fluid portion of cytoplasm .
- **Cell cytoskeleton**

Eukaryotic Cell Structure

Cell Cytoskeleton

- The internal structural network comes from proteins that formed filamentous structures called *microtubules* , *microfilaments* and *intermediate filaments*
- Together, these structures form the *cell cytoskeleton* .
- The term cytoskeleton is a collective term for a series of fibers (small roads and cylinders) in the cytoplasm. Not long ago, it was believed that the absence of a cytoskeleton was a distinguishing feature of prokaryotes. However, biologists recently discovered that prokaryotic cells have a cytoskeleton similar to eukaryotes. Components include MreB and ParM, crescentin, and FtsZ, which correspond to the microfilaments, intermediate filaments, and microtubules of the eukaryotic cytoskeleton, respectively. The prokaryotic cytoskeleton assumes roles in cell division, maintaining cell shape, growth, DNA movement, protein targeting, and alignment of organelles. The cytoplasm of prokaryotes is not capable of cytoplasmic streaming.

Cell Cytoskeleton



Eukaryotic Cell Structure

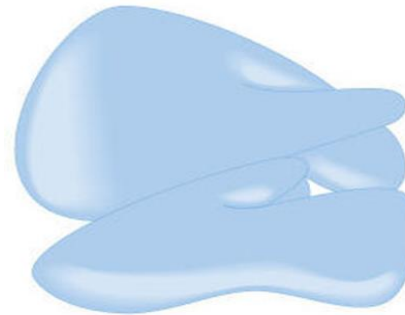
Ribosomes

3. Ribosomes

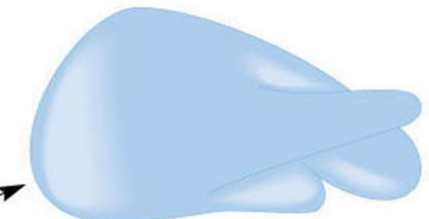
is the cell's protein –synthesizing structure.

- Ribosomes are attached to the rough endoplasmic reticulum or can be found free in the cytoplasm.
- The Eukaryotic ribosomes are **80S ribosomes**, each of which consists of **large subunit 60S** and **small subunit 40S**.

Mammalian
ribosome (80S)
(4.2×10^6 daltons)



nt = nucleotides



60S subunit



40S subunit

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Eukaryotic ribosomes
80S

Eukaryotic Cell Structure

Genetic materials(Nucleus)

4-Nucleus:

- **DNA** is the molecule that carries the genetic information in the cell.
- **DNA** molecules are tightly packed around proteins called **histones** to make structures called **chromosomes**.
- **Histones** are positively charged (+ve) proteins which help tightly pack the negatively charged DNA (-ve)
- Contain two copies of each chromosome (genes) (**Diploid** organisms)
- Visible under light microscope without staining.
- Enclosed by **nuclear membrane** which has two layer (inner nuclear membrane and outer nuclear membrane), the nuclear membranes contain pores .
- Within the nucleus is the **nucleolus** the site of ribosomal RNA (rRNA) synthesis.

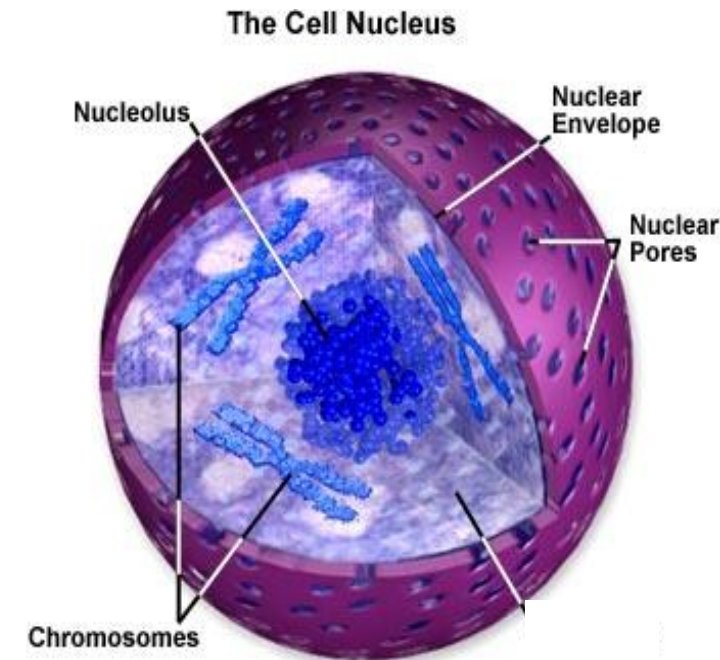
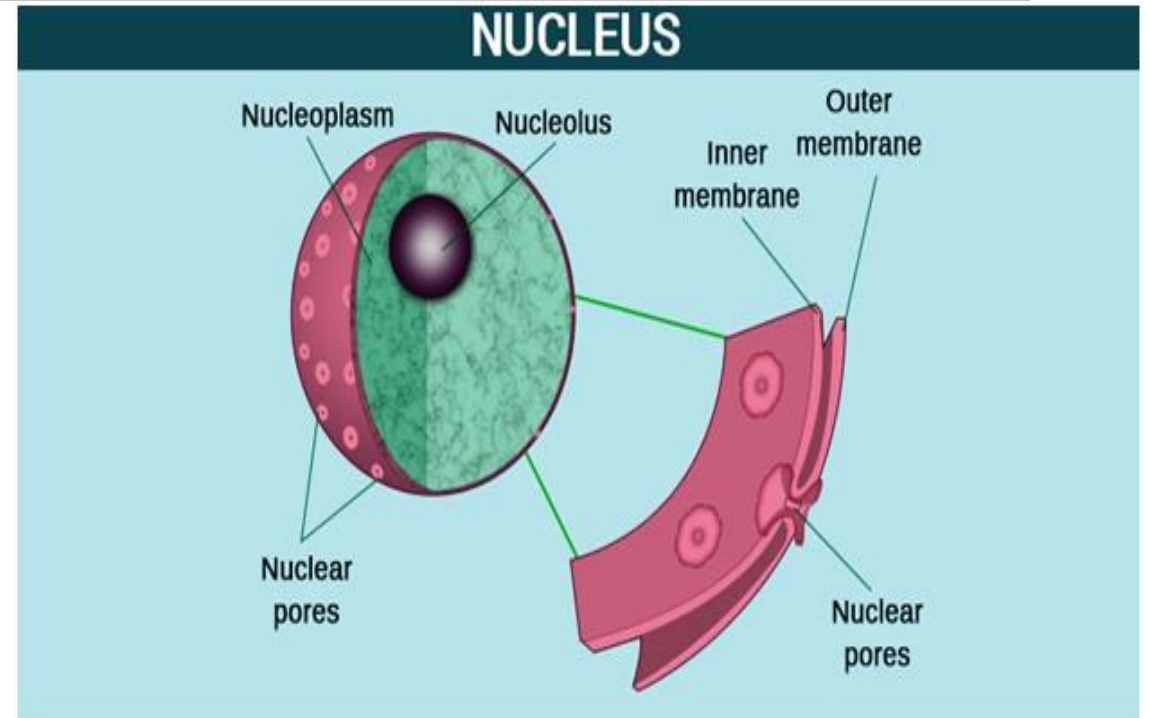
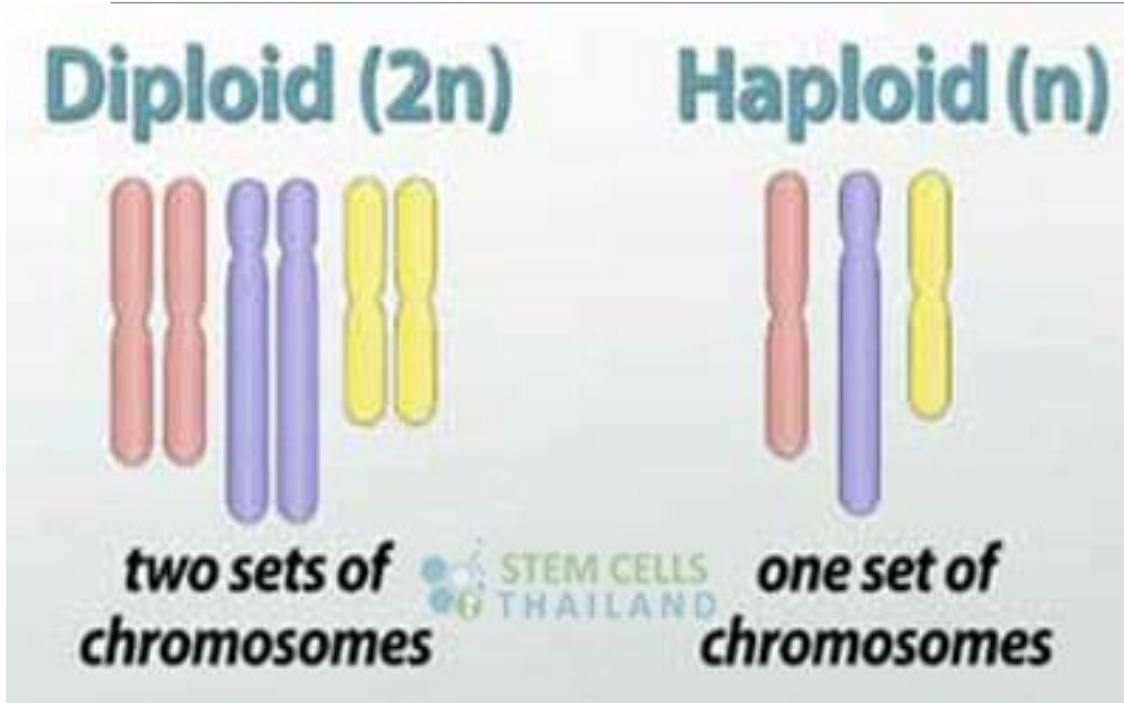


Figure 1

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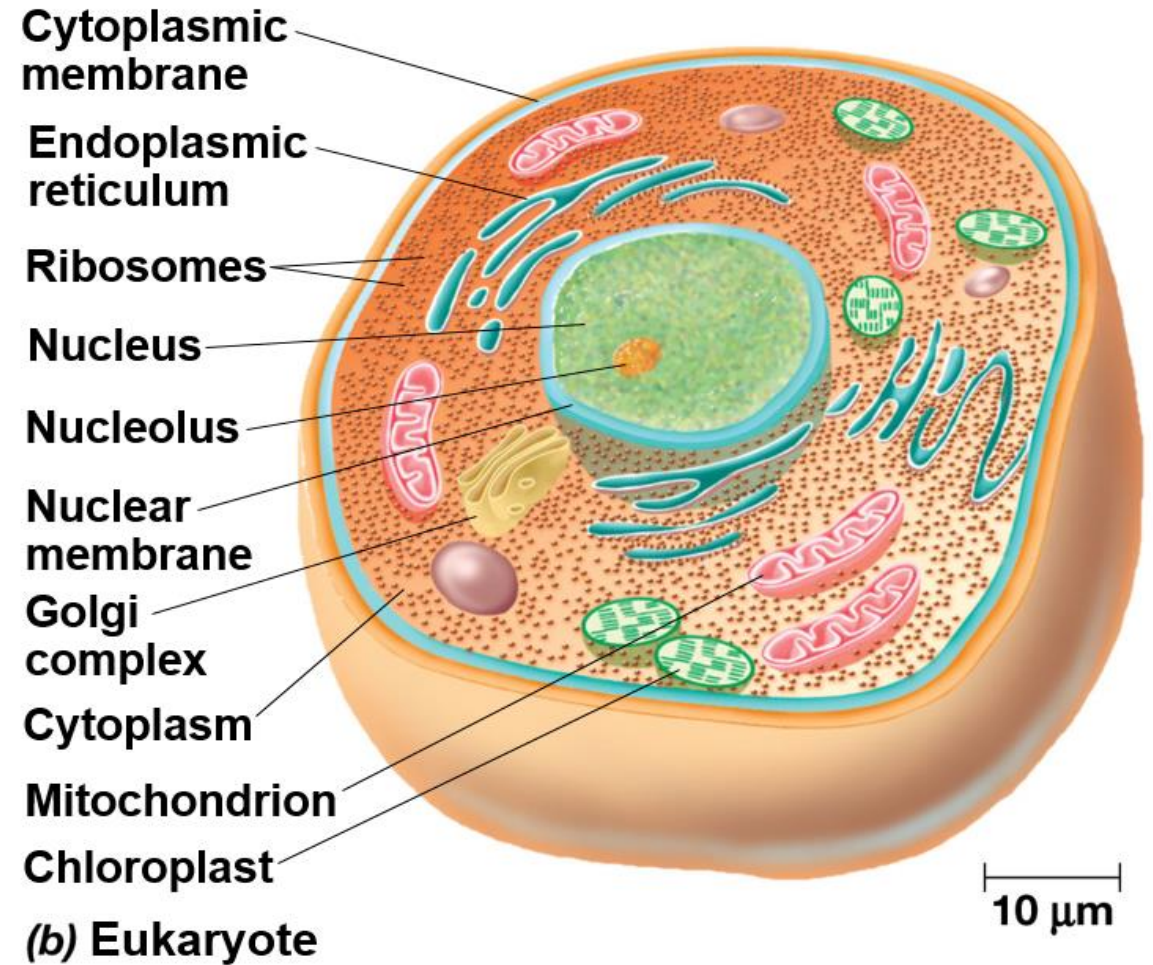


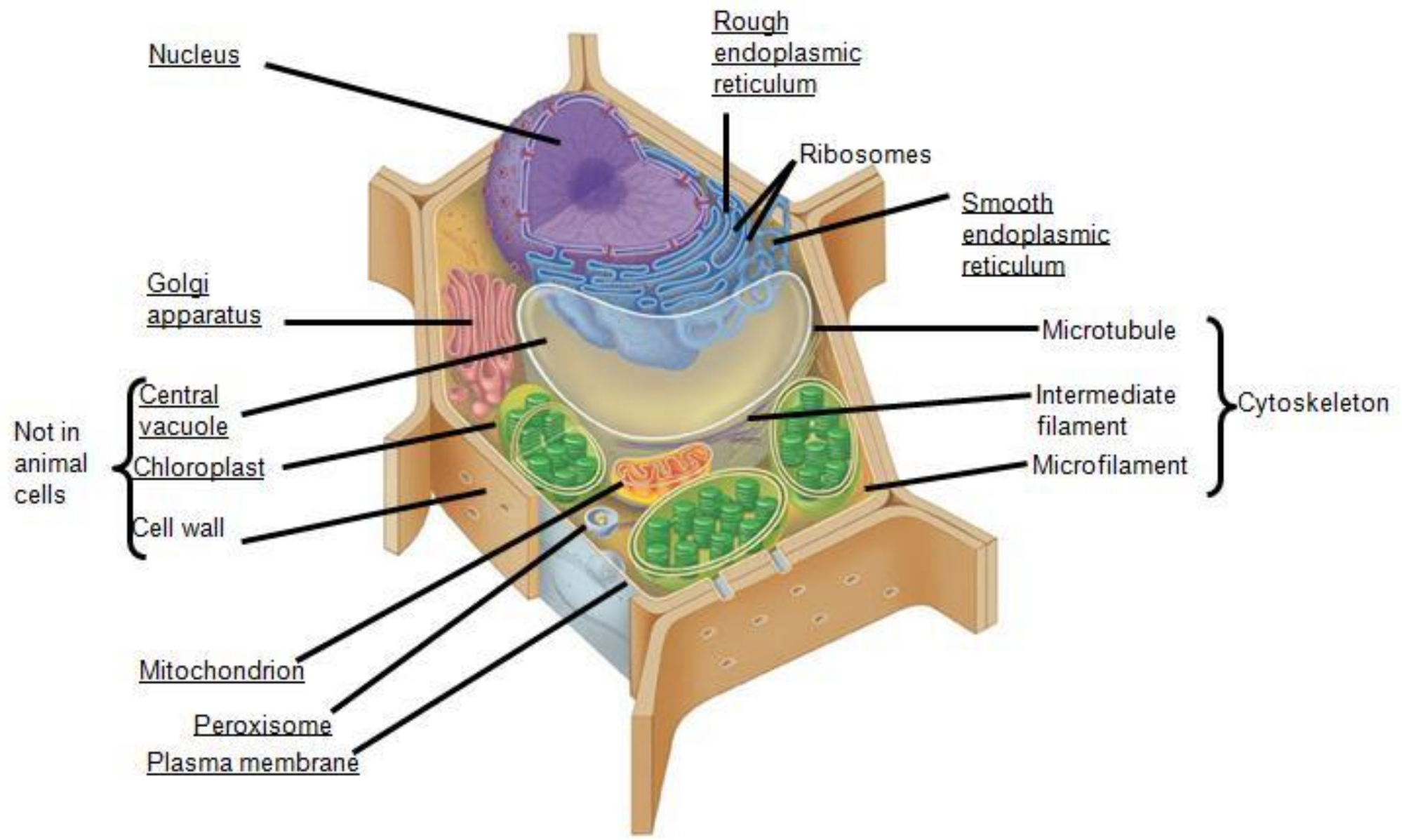
Eukaryotic Cell Structure

Eukaryotes cell:

Contain a membrane-enclosed organelles e.g.:

- 1.mitochondria
2. Chloroplast
- 3.endoplasmic reticula (endoplasmic reticulum)
4. Golgi complex
5. peroxisomes
6. cytoskeleton (microtubules, microfilaments and intermediate filaments)





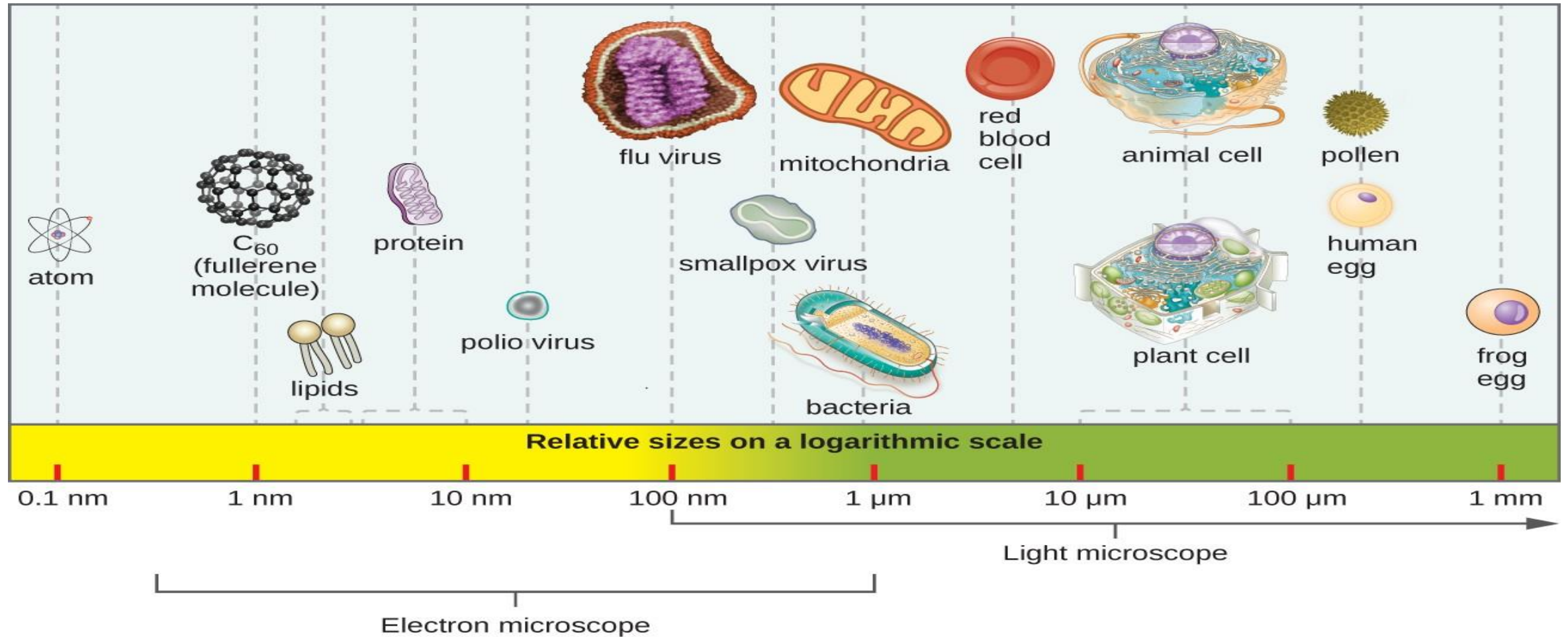
Eukaryotic Cell Structure

The Mitochondrion (Mitochondria)

Specialize in chemotrophic energy metabolism

- Respiration and oxidative phosphorylation (powerhouses of the cell)
- Mitochondrion dimensions is like bacterial dimensions (rod or spherical shaped)
- The number of mitochondria per cell varies among different types of cells. e.g. (over 1,000 per animal cell).

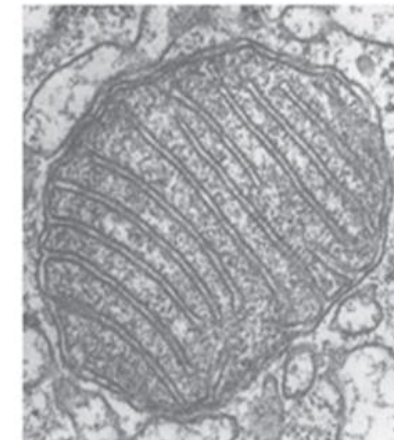
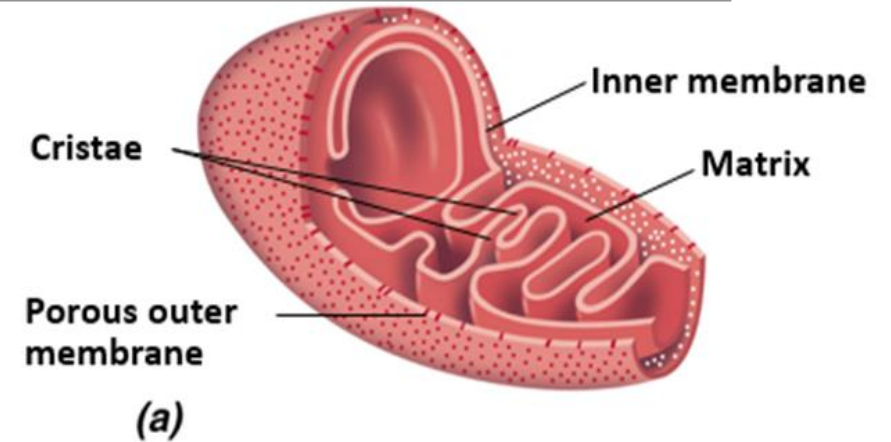
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Eukaryotic Cell Structure

The Mitochondrion (Mitochondria)

- Surrounded by two membranes
- Outer membrane is smooth, **permeable** and contains numerous channels that allow passage of ions and small organic molecules .
- Inner membrane is folded and called **cristae** which are the sites of reaction
- The center of the mitochondrion is a semifluid substance called **Matrix** .
- **Crista** contain a transport proteins that regulates the passage of ATP

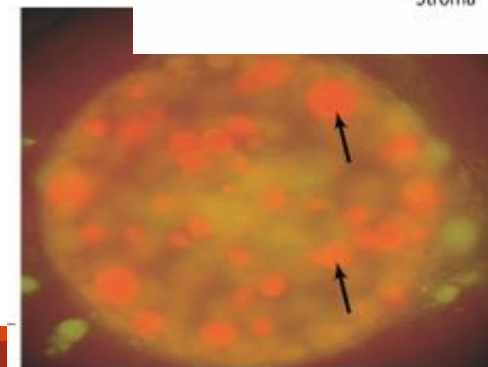
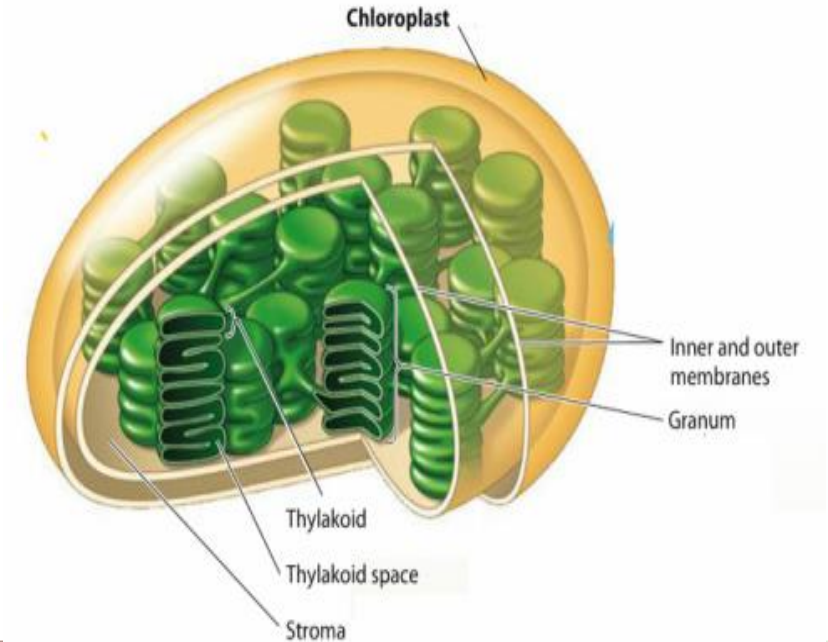


Eukaryotic Cell Structure

The Chloroplast

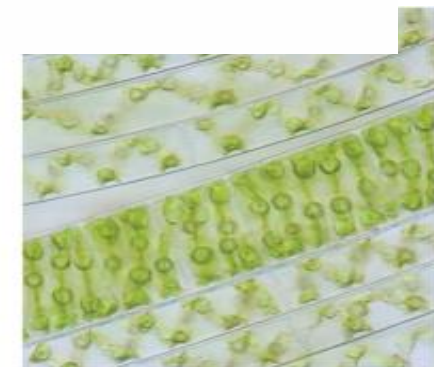
Chloroplast

- Algae and green plants contain the chloroplast.
- Chlorophyll-containing organelle found in phototrophic eukaryotes.
- Size, shape, and number of chloroplasts varies.
- The pigment is contained in flattened membrane sacs called **thylakoids**
- Stacks of thylakoids are called **grana**.
- Lumen of the chloroplast is called the **stroma**



(a)

T. D. Brock



(b)

Eukaryotic Cell Structures

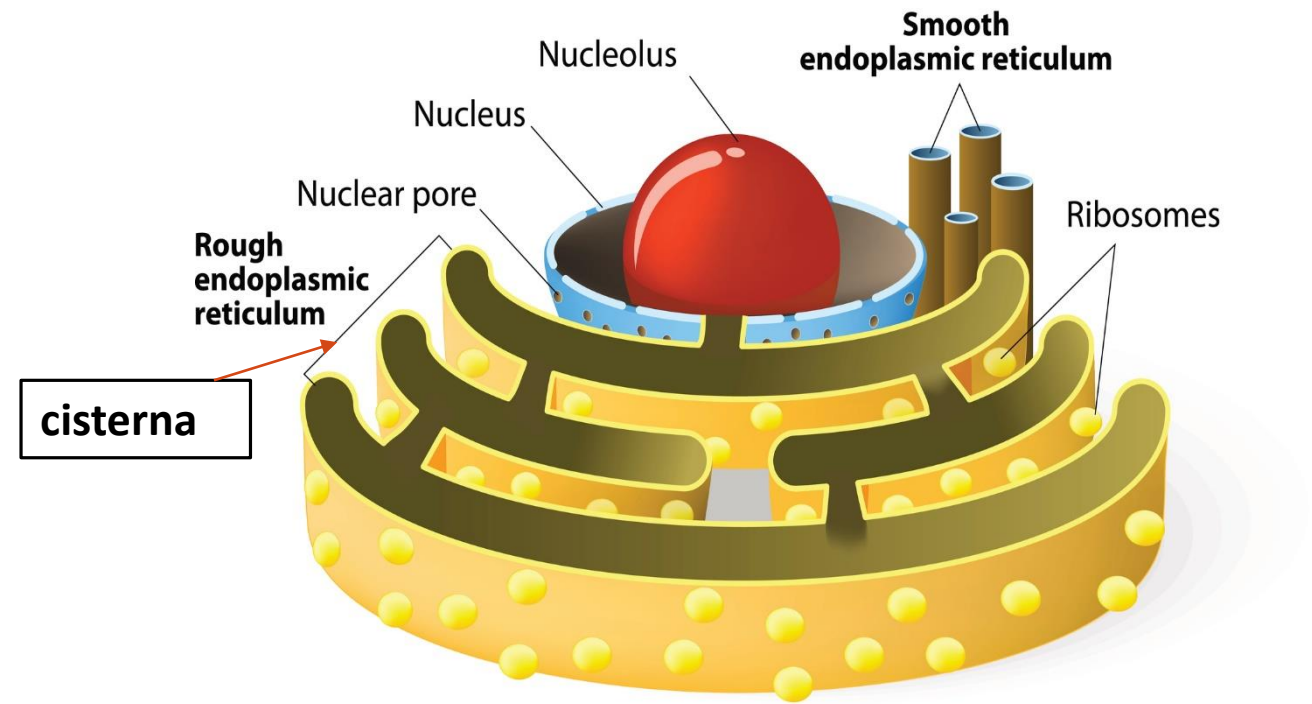
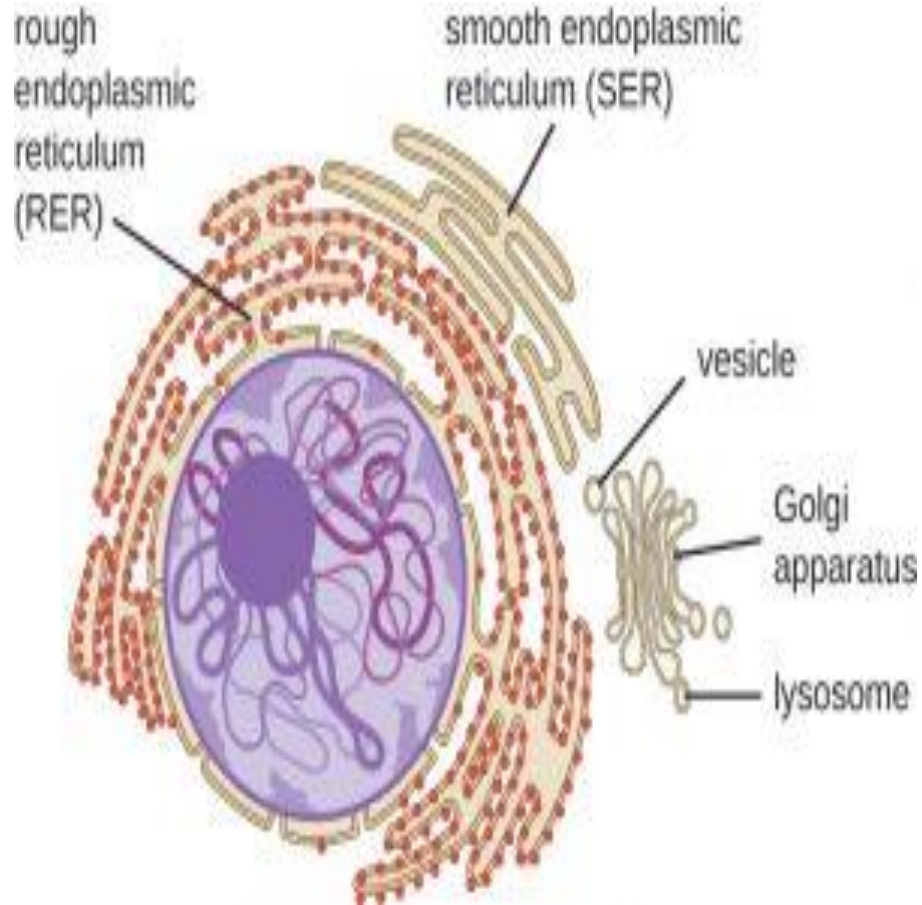
Endoplasmic reticulum

Endoplasmic reticulum (ER)

- A network of membranes continuous with the nuclear membrane .
- Flattened membranous sacs or tubules called **cisterna** (plural **cisternae**)
- Two types of ER (smooth and rough):
- **Rough endoplasmic reticulum** contains attached ribosomes, smooth does not.
 - ribosomes that attached to the rough ER do Protein synthesize.
 - Rough ER is a major producer of glycoproteins by enzymes with cisterns, this enzymes attach the protein to carbohydrate to form glycoproteins.
 - In other cases, enzymes attach the protein to phospholipids .

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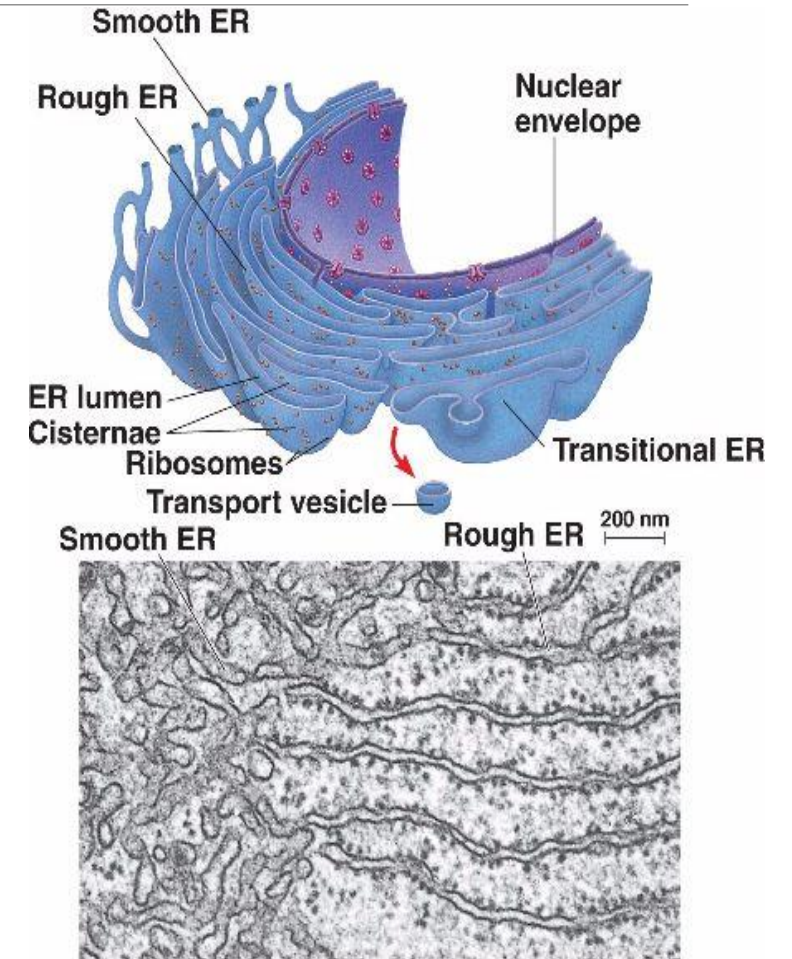
Endoplasmic reticulum



Eukaryotic Cell Structures

Endoplasmic reticulum

- **Smooth endoplasmic reticulum** extends from the rough ER to form a network of tubules.
- Does not have ribosomes so does not synthesize protein.
- Smooth ER participates in the synthesis of lipids and some aspects carbohydrates metabolism and phospholipid.

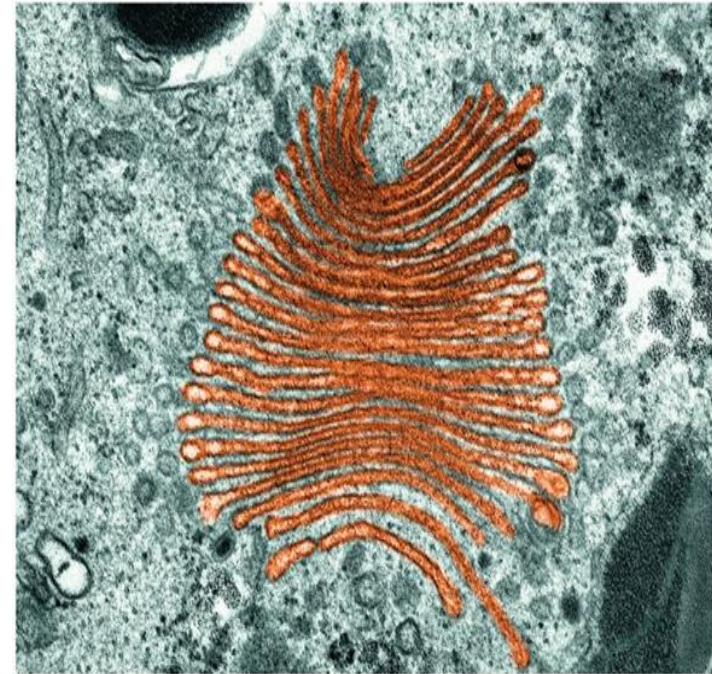


Eukaryotic Cell Structures

Golgi complex

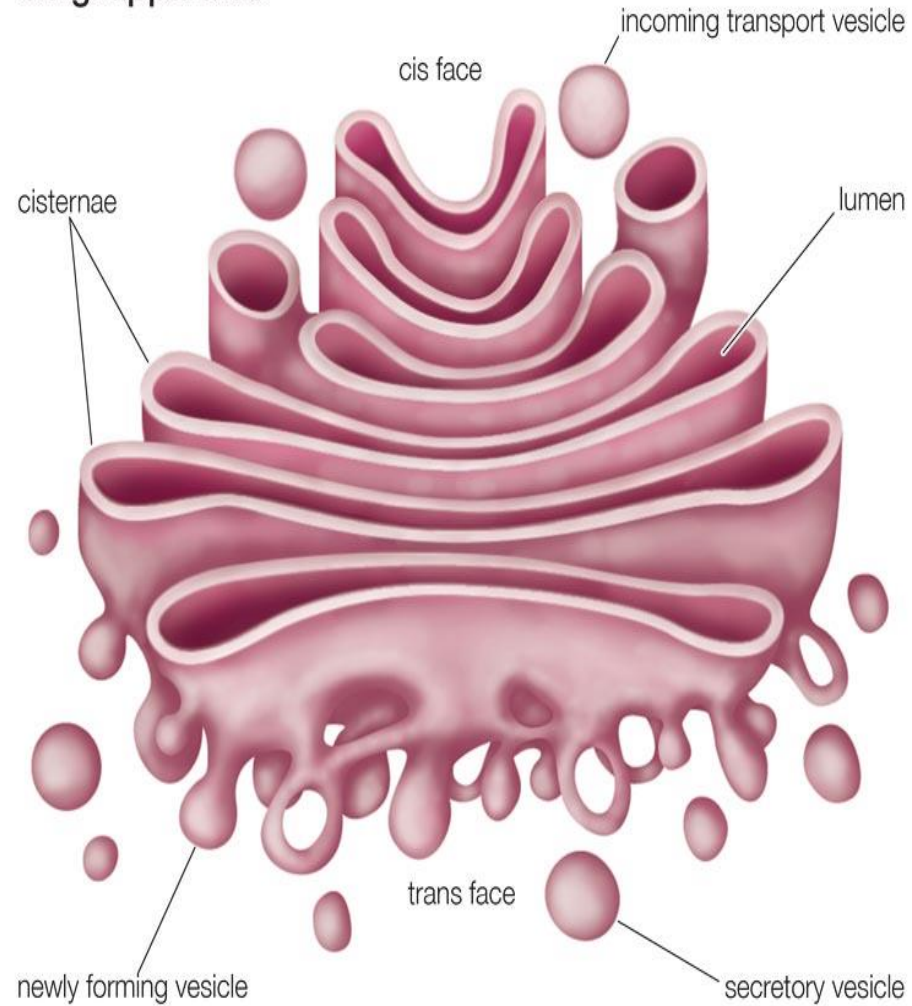
Golgi complex: (Golgi body, the Golgi apparatus)

- **Function:** the Golgi apparatus is a major collection and dispatch station of protein products received from the endoplasmic reticulum, it is also involved in lipid transport.
- **Structure:** stacks of membrane distinct from the ER, but functioning in concert the ER.
- The synthesized proteins in rough ER are transported to other region of the cells and first step through the golgi complex.
- Golgi apparatus transport the modified products of the ER destined for secretion e.g. (hormones, digestive enzyme)



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Golgi apparatus

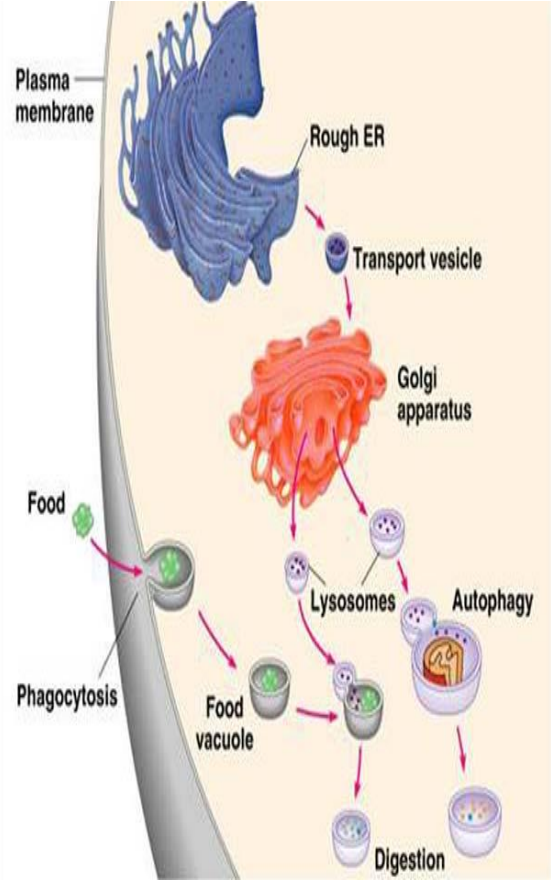
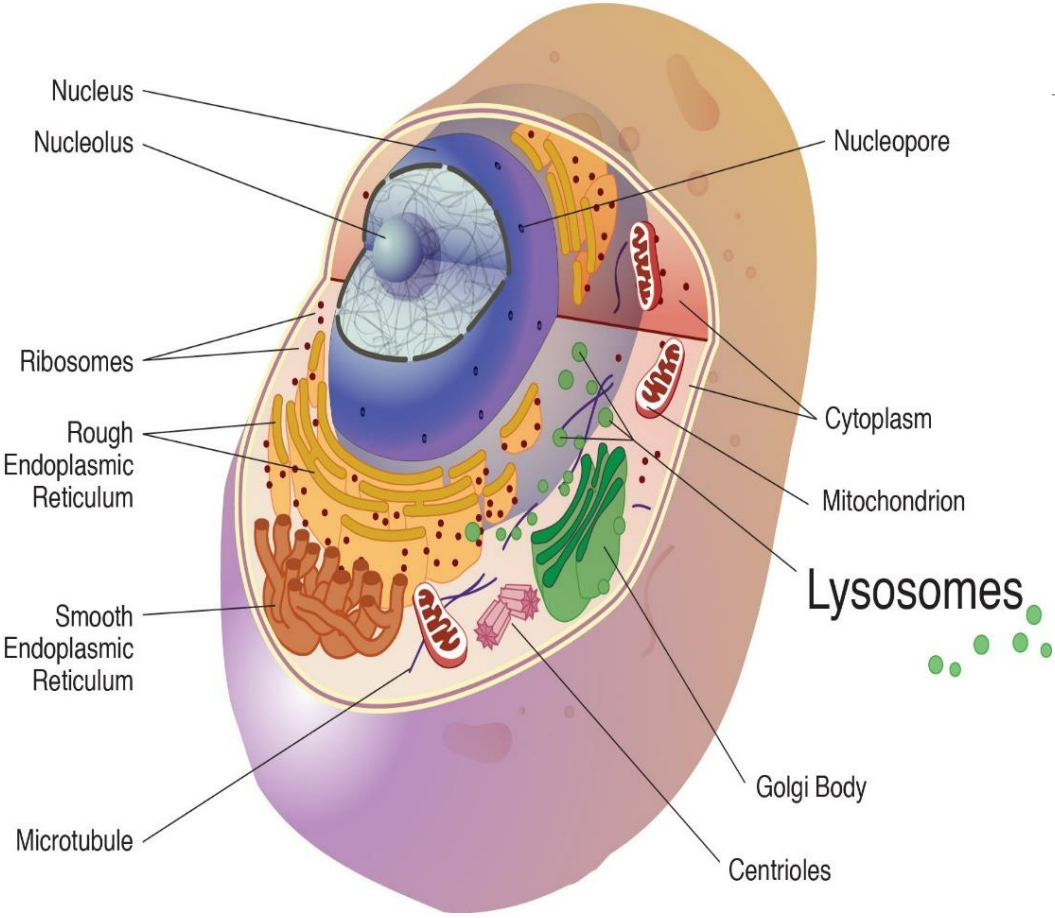


Eukaryotic Cell Structures

Other Organelles

- **Lysosomes** are membrane-enclosed compartments made from proteins and lipids transported from Golgi complex.
- **Function:** Receives proteins and lipid from the cytoplasmic membranes during the process of endocytosis and because it contains many digestive enzymes it is capable of breaking down various molecules.
- Hydrolyzing damaged cellular components and recycling these materials .

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Other Organelles and Eukaryotic Cell Structures

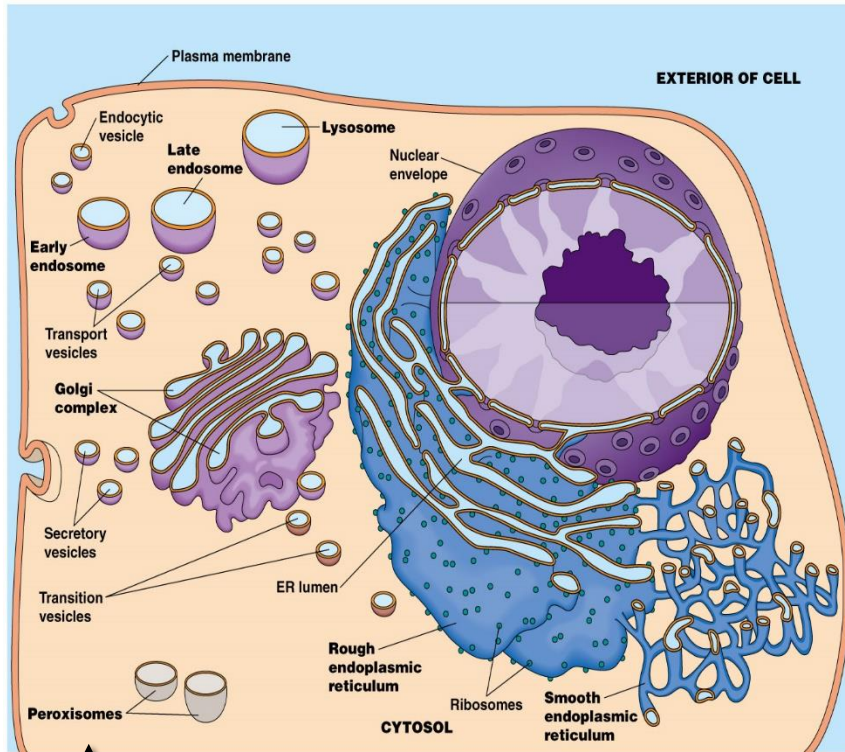
- **Peroxisomes** is similar to lysosomes structure but smaller.

Function: contain enzymes that can oxidize various organic substances .

- **Vacuoles** are space or cavity in cytoplasm of plant cells, derived from the Golgi complex

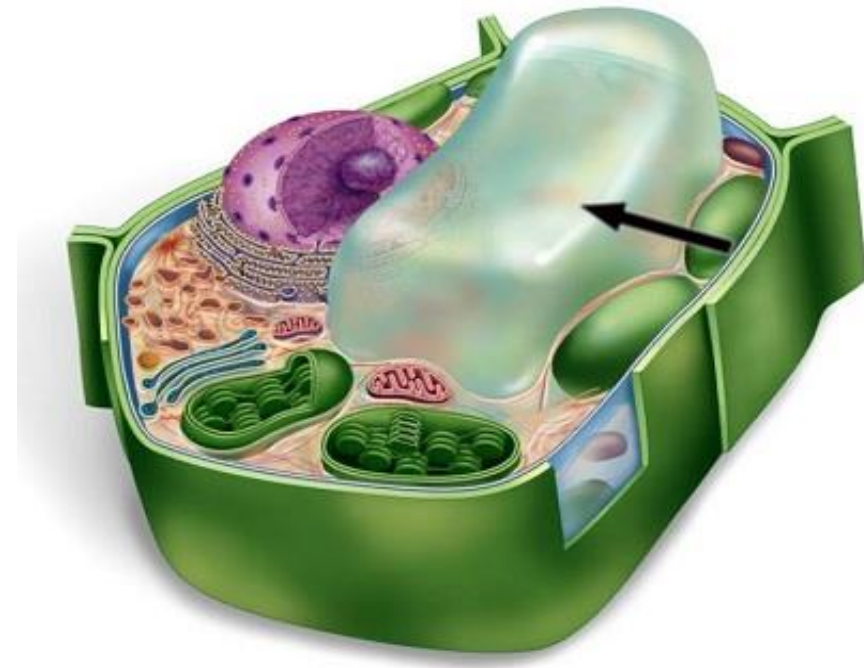
Function: serve as temporary storage organelles and help in endocytosis .

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Peroxisomes



Vacuoles

ANY
QUESTIONS

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