Introduction to Cell Biology

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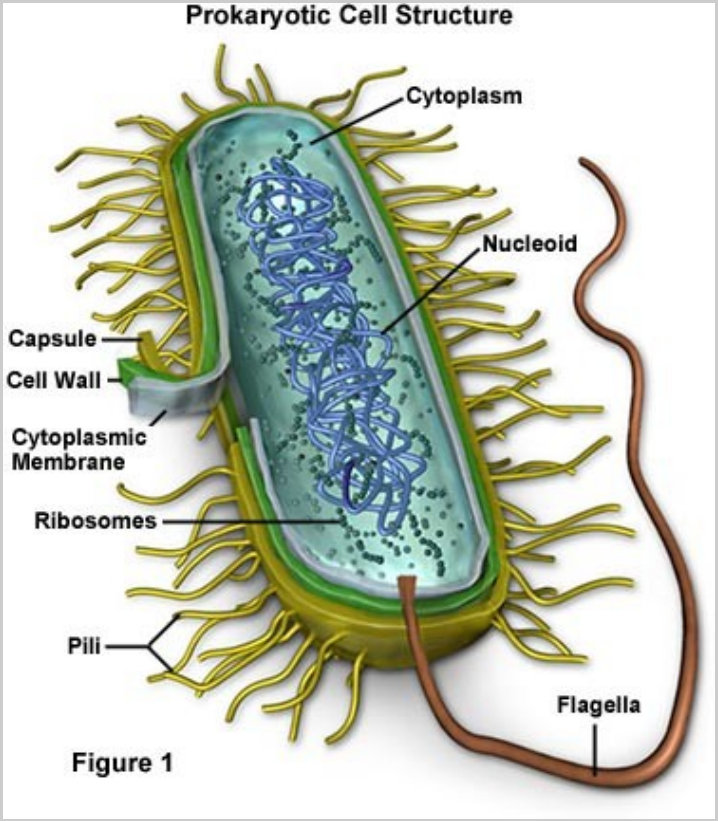
Biological Cell

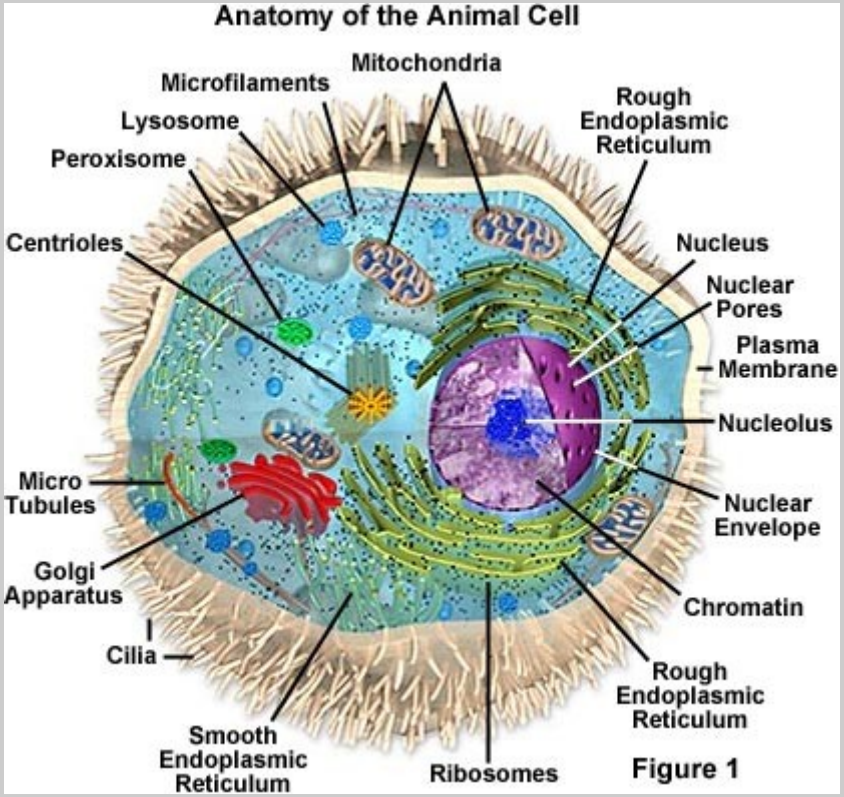
- Smallest unit of life.
- Smallest collection of matter that can live.
  - What is “life”? Hard to answer...
    - Order (entropy as a measure of order)
    - Reproduction (sexual/asexual)
    - Growth and development
    - Energy utilization (metabolism)
    - Response to environment
    - Homeostasis
    - Evolutionary adaptation

Two Types of Cells

- Eukaryotic Cell
  - Higher organisms (Animals, Plants, Fungi, Protists)
    - *Human*
    - *Mouse*
    - *Drosophilia melanogaster (Fruit fly)*
    - *Caenorhabditis elegans (C. Elegans, earth worm)*
- Prokaryotic Cell (Bacteria and Archaea)
  - *Bacteria and Cyanobacteria (blue-green algae)*
    - *Escherichia Coli* (*E. Coli*)
    - *Pyrococcus Furious* (P. Furious)

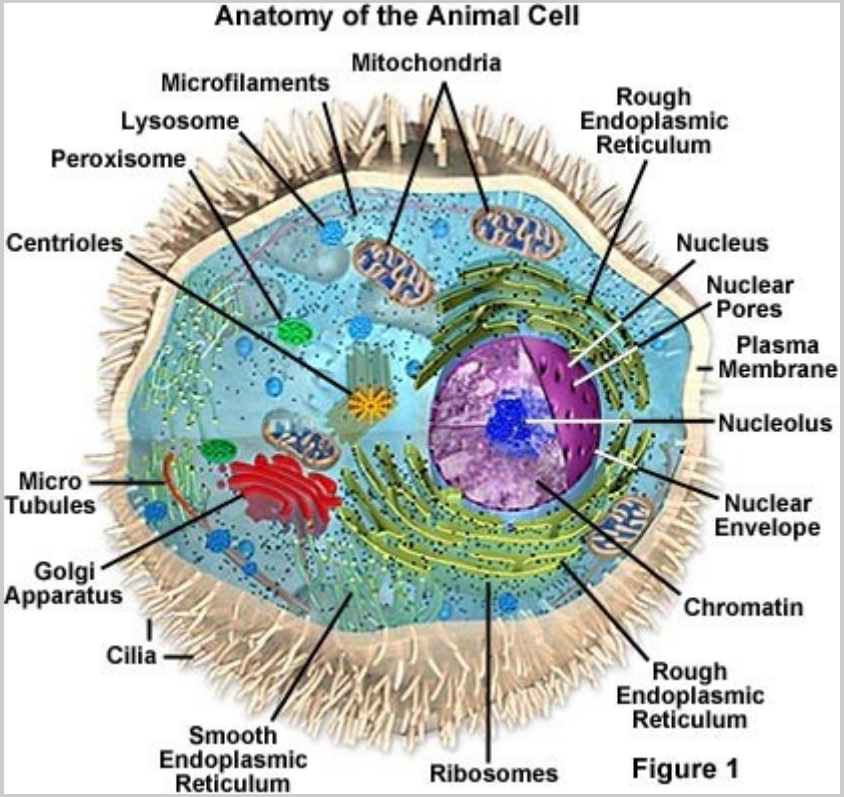
Anatomy of Cells





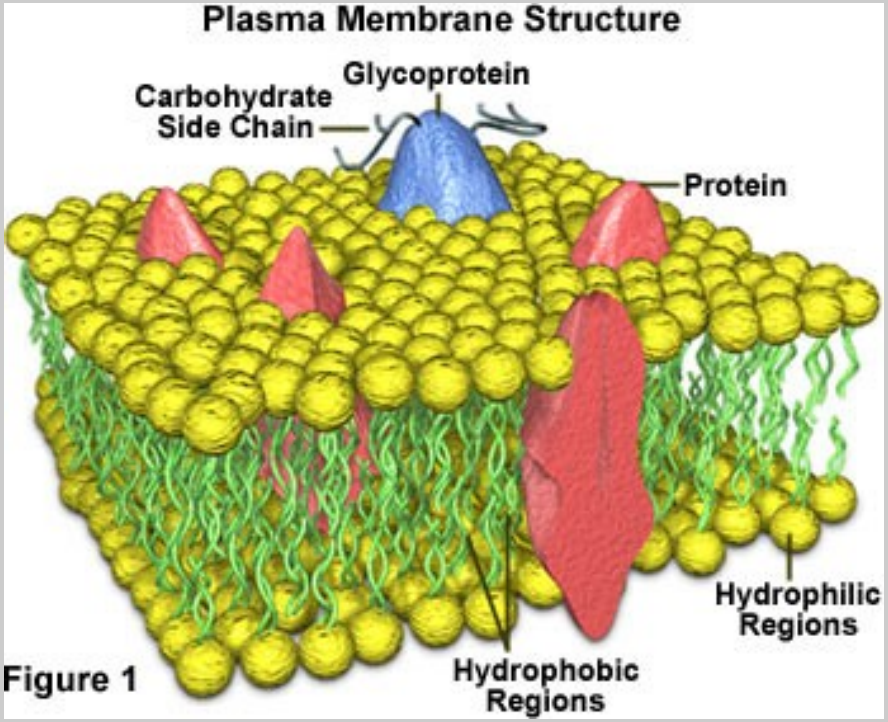
Anatomy of a Eukaryotic Cell

- Cell membrane (Plasma Membrane, Bilayer)
- Cytoplasm
- Organelle
- Nucleus
- Mitochondria
- Ribosome
- Endoplasmic reticulum
- Golgi apparatus



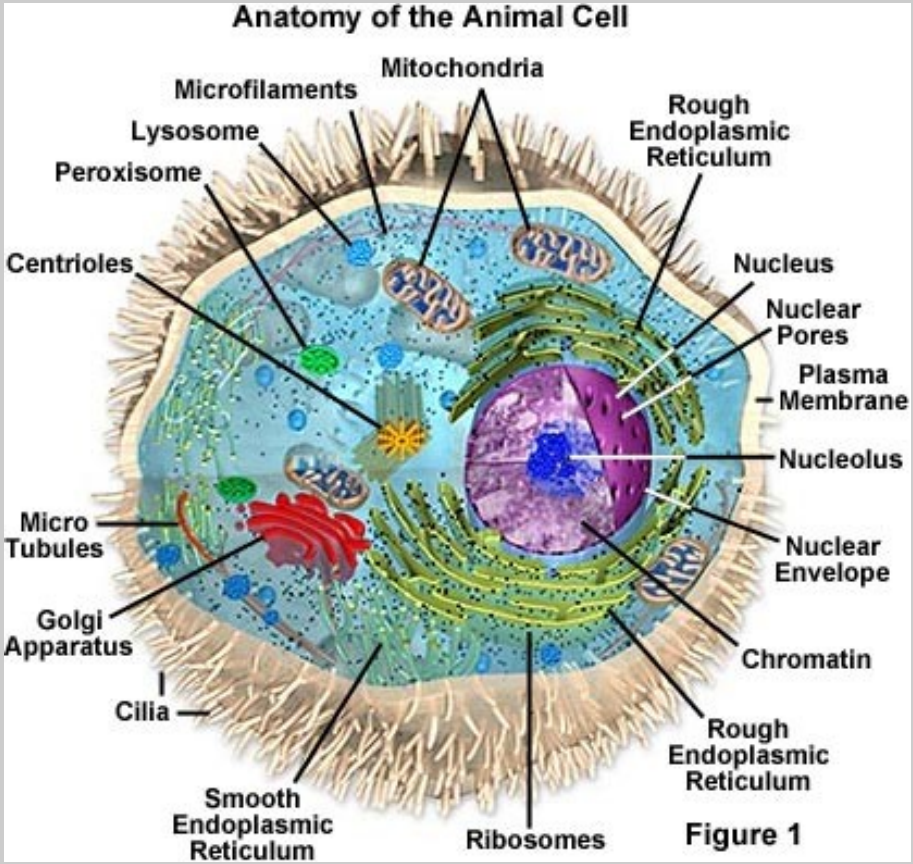
Cell Membrane (Bilayer)

- Encapsulates all functional components of the cell and the Cytoplasm
- Insulates and isolates cell internals from external elements
- Composed of lipid bilayer
- Water insoluble
- Contains embedded trans-membrane proteins
- Surface Carbohydrates as markers



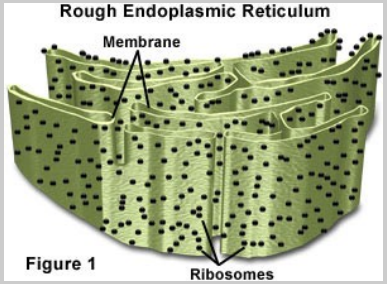
Cytoplasm

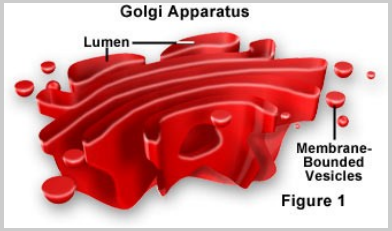
- The entire portion of the cell interior not occupied by the nucleus
- Very dynamic environment

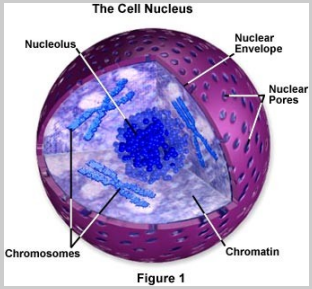


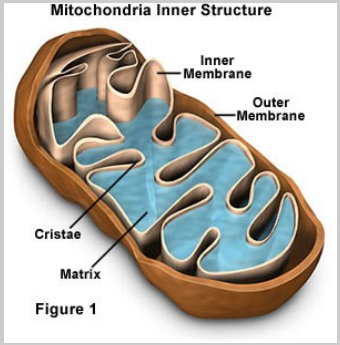
Organelle

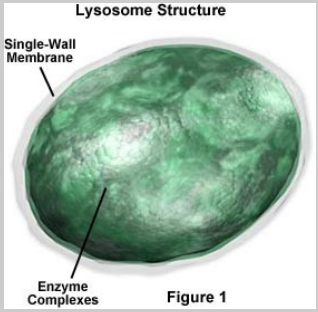
- Membrane-bound intracellular compartments
- Distinct and highly organized
- Contain specific chemicals to perform specific cellular function
- Suspended in the cytoplasm
- Only in Eukaryotic cells

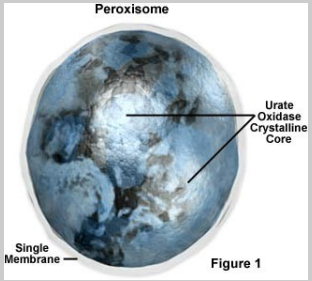






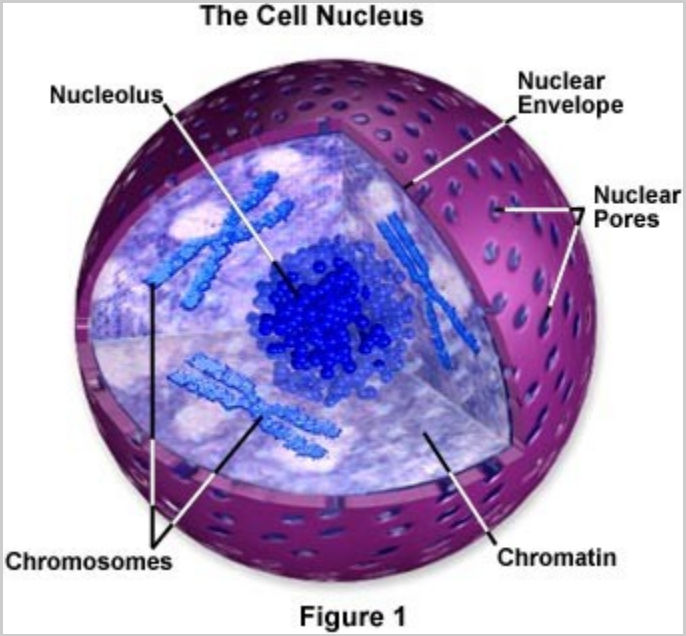






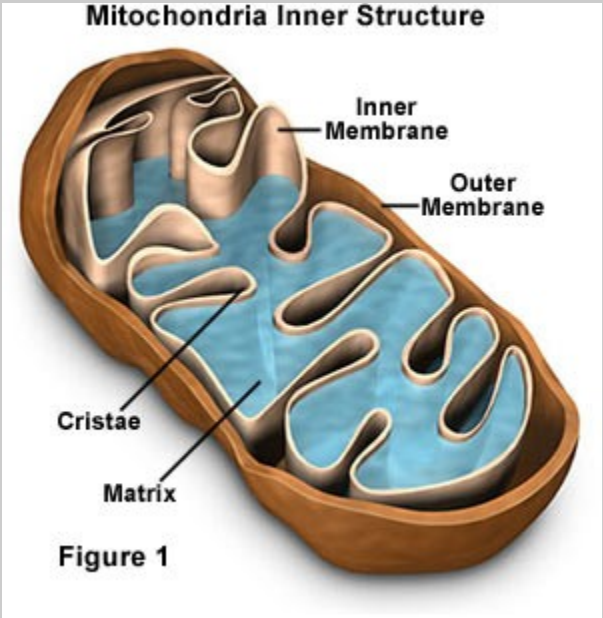
Nucleus

- Intracellular structure that contains the genetic material (DNA)
- Pseudo spherical in shape
- Usually near the center of the cell
- Protected by a porous bilayer membrane



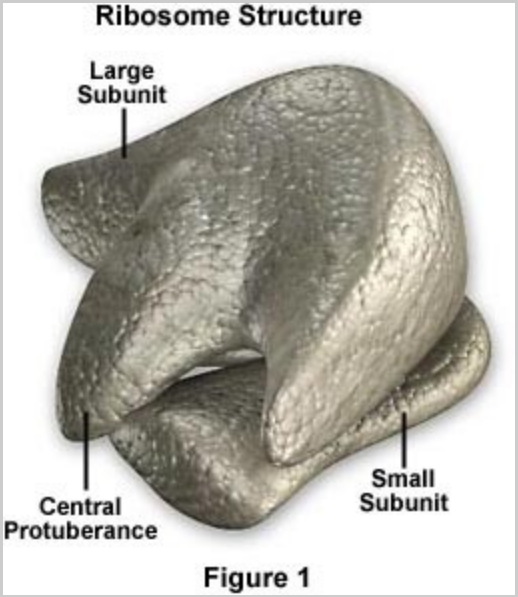
Mitochondria

- Cellular organelle responsible for energy production
- Contains enzymes for oxidative phosphorylation
- Site of Krebs cycle (conversion of sugar byproducts into units of energy)
- Produces energy in presence of O_2
- Most peculiar; made up of double bilayer membranes
- Evidence of evolution?



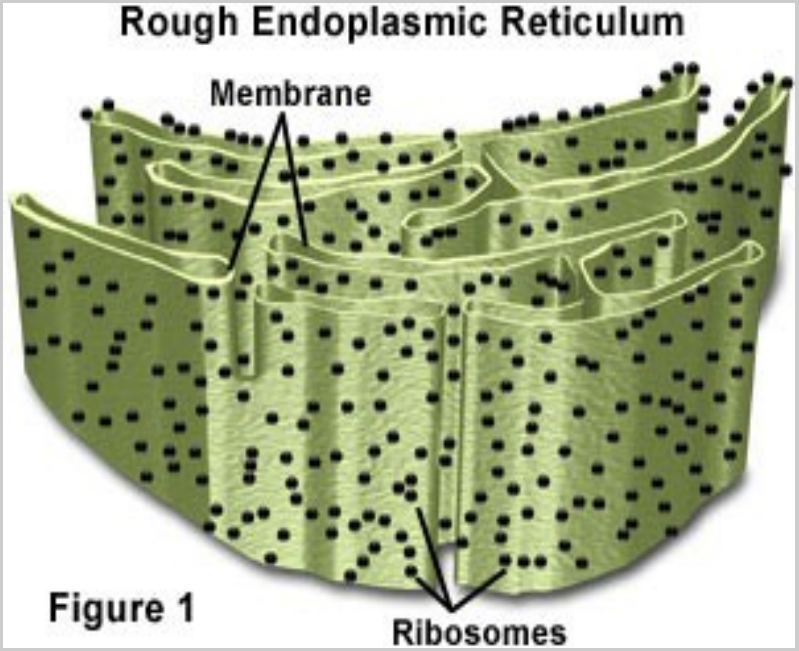
Ribosome

- Protein synthesis machinery.
- Free floating in cytoplasm.
- Bound to rough-Endoplasmic Reticulum (RER) in Eukaryotes.
- Consists of multiple subunits composed of RNA-protein complexes.



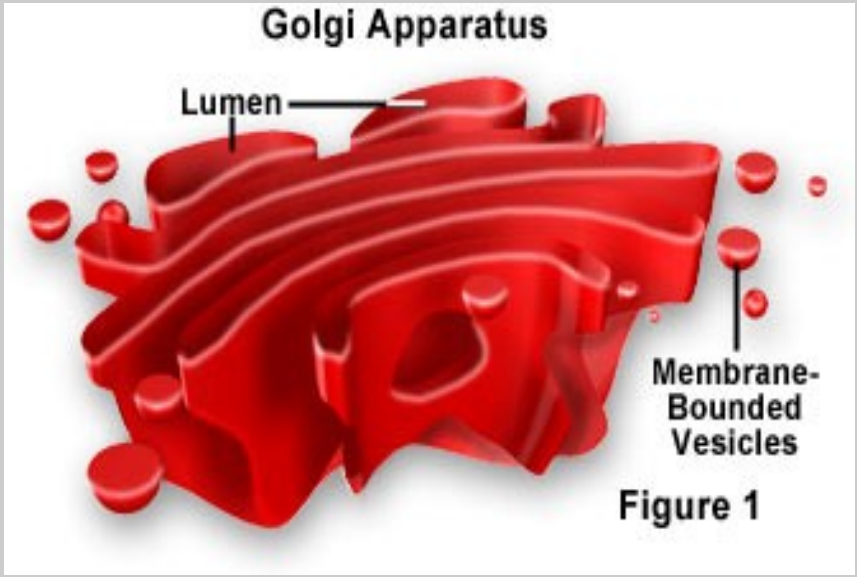
Endoplasmic Reticulum

- Organelle consisting of network of fluid-filled tubules and flattened sacs.
- Synthesis of proteins and lipids for formation of new cell membrane and other cellular components.
- Manufactures products of secretion.
- Rough or smooth types.



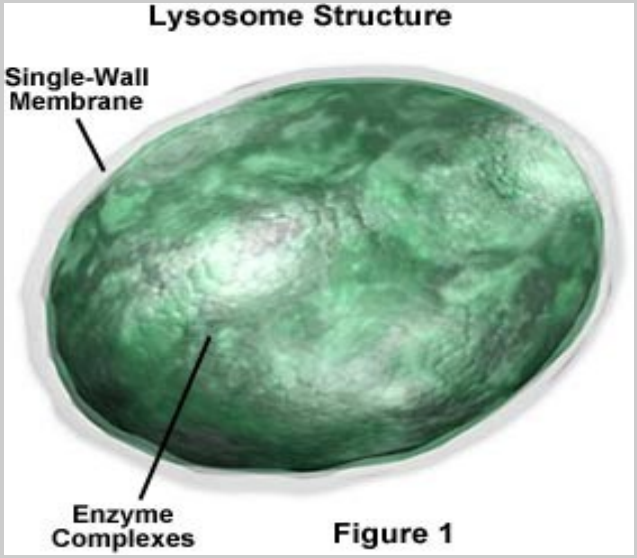
Golgi Apparatus (Golgi Complex)

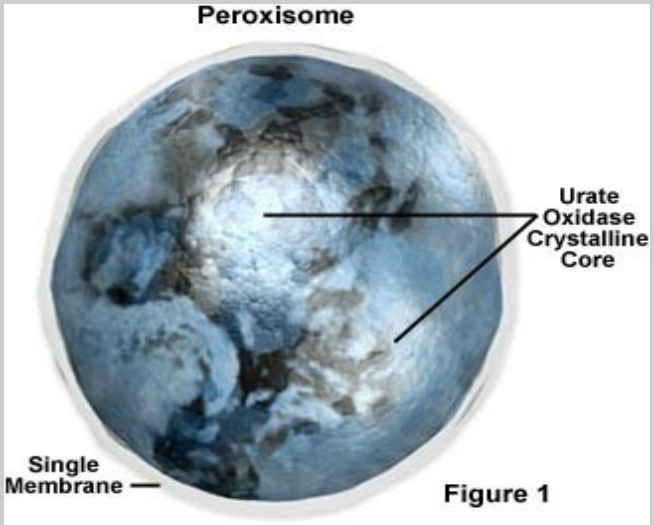
- Organelle consisting of network of fluid-filled tubules and flattened sacs.
- Processes raw material transported to if from the ER into finished material (Glycocylation, etc.)
- Sorts the finished products and directs them to their final destination.



Other Organells

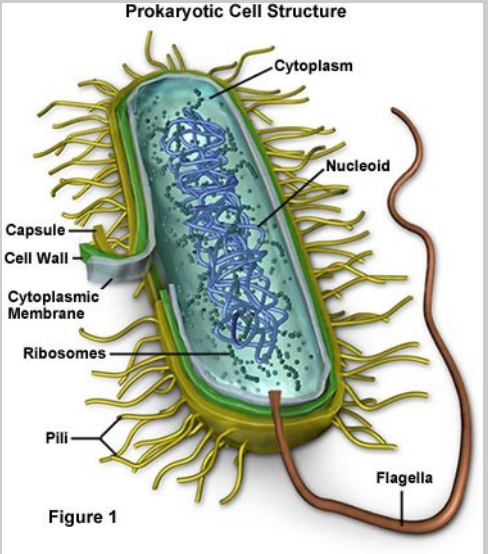
- Lysosome:
  - The main function of these microbodies is digestion. Lysosomes break down cellular waste products and debris from outside the cell into simple compounds, which are transferred to the cytoplasm as new cell-building materials.
- Peroxisomes:
  - Peroxisomes function to rid the cell of toxic substances, in particular, hydrogen peroxide





Eukaryotic versus Prokaryotic

- In general Prokaryotic cells are much simpler in anatomy than the Eukaryotes
- Prokaryotes do not have organelles
- Prokaryotes do not have nucleus (membrane bound DNA) Nucleoid region: region of the cell with high density of DNA (in Prokaryotes)
- Eukaryotes usually consist of more complex DNA (in number and coding, introns/exons later…)
- Prokaryotes have circular DNA called plasmid



Theory of Endosymbiosis

- Mitochondria and chloroplasts originated as separate prokaryotic organisms that were taken inside the cell as endosymbionts.
  1. Double bilayer
  2. Contains plasmids
  3. Size and shape of a bacterium
  4. In humans, it is only inherited from mother