Cell: Structure

Paper : V, Cell Biology/ B. Sc Part III

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Definition of a cell:

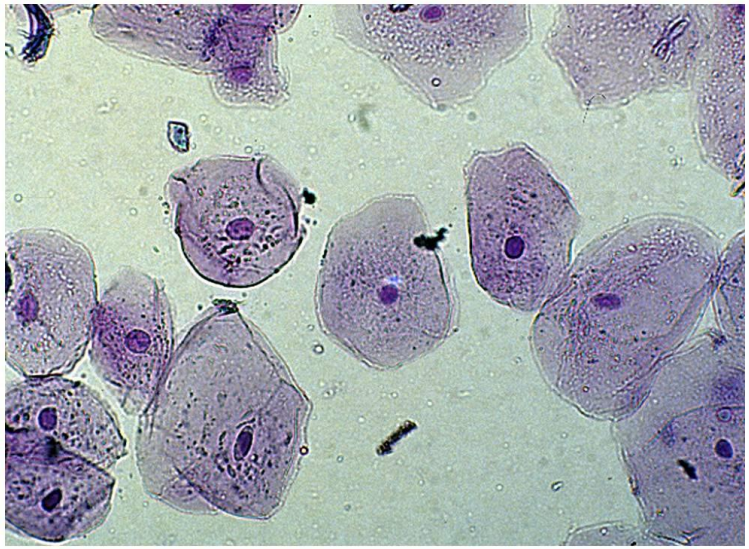
- basic structural and functional unit of life
- the smallest units that display the characteristics of life, i.e. reproduction, metabolism, response to stimuli.
- Living things are constructed of cells.
- ∵ Living things may be unicellular or multicellular.
- Cell structure is diverse but all cells share common characteristics.
- Cells are small so they can exchange materials with their surroundings.
  - - Surface area relative to the volume decreases as size of cell increases.
  - - This limits the size of cells

Discovery of Cells

- Robert Hooke (mid-1600s)
  - Observed sliver of cork
  - Saw “row of empty boxes”
  - Coined the term cell

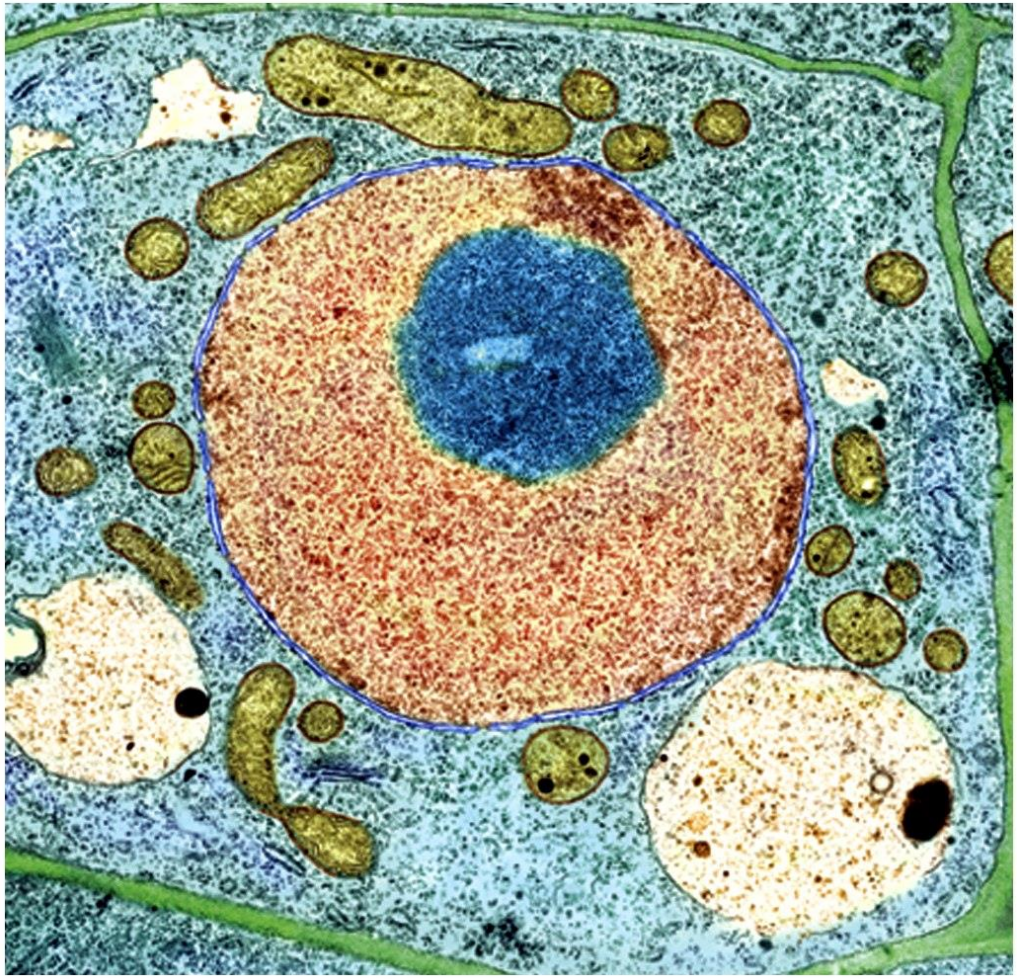
Characteristics of All Cells:

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



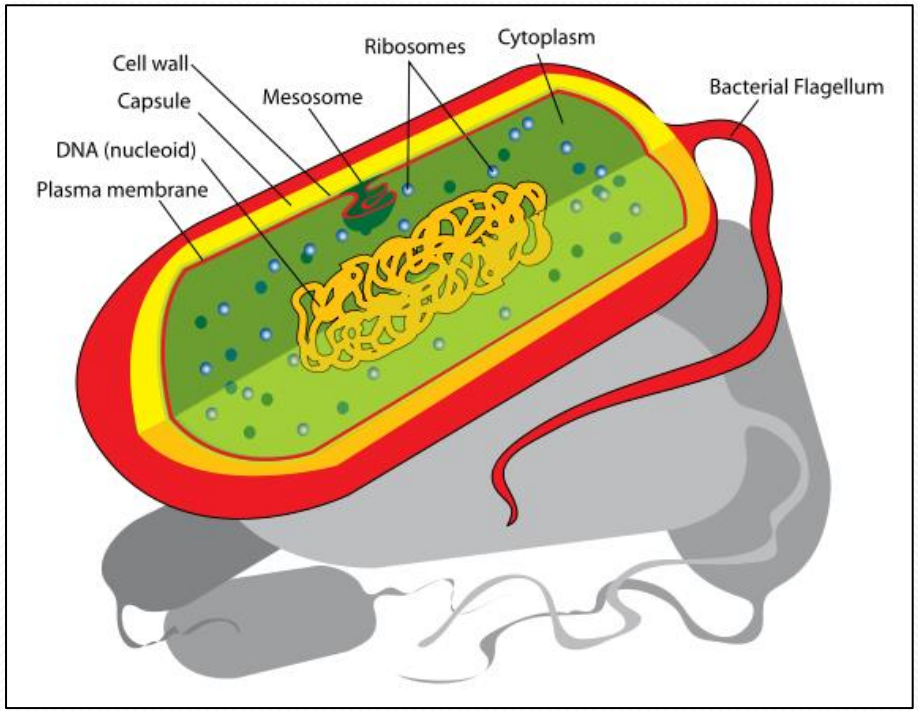
Cell Types

- Prokaryotic
- Eukaryotic

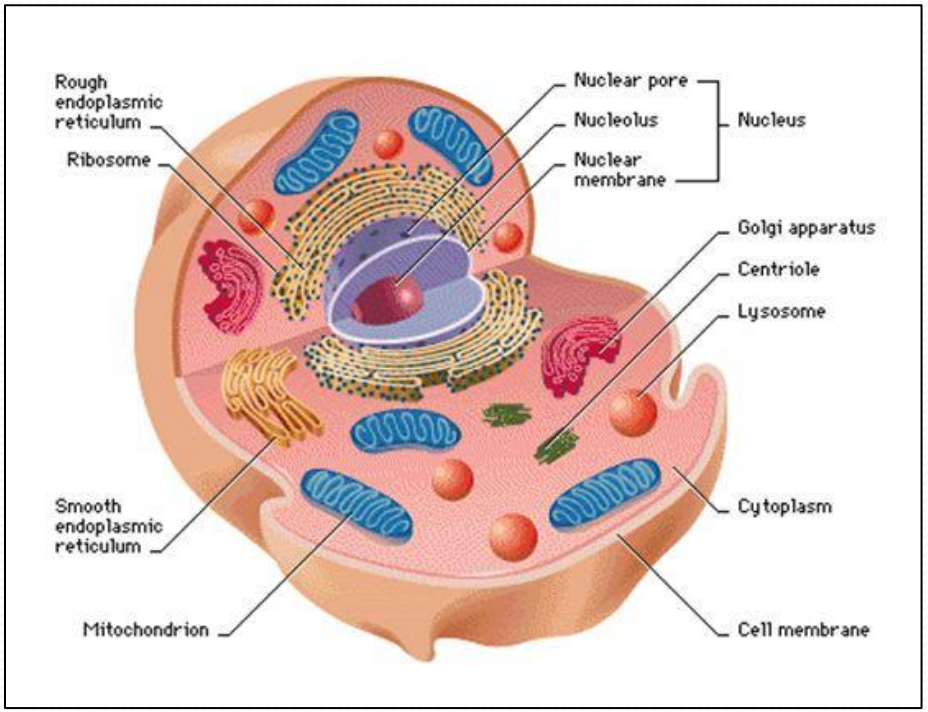


Similarities between Prokaryotic and Eukaryotic cells

Prokaryotes/Bacteria



Eukaryotes

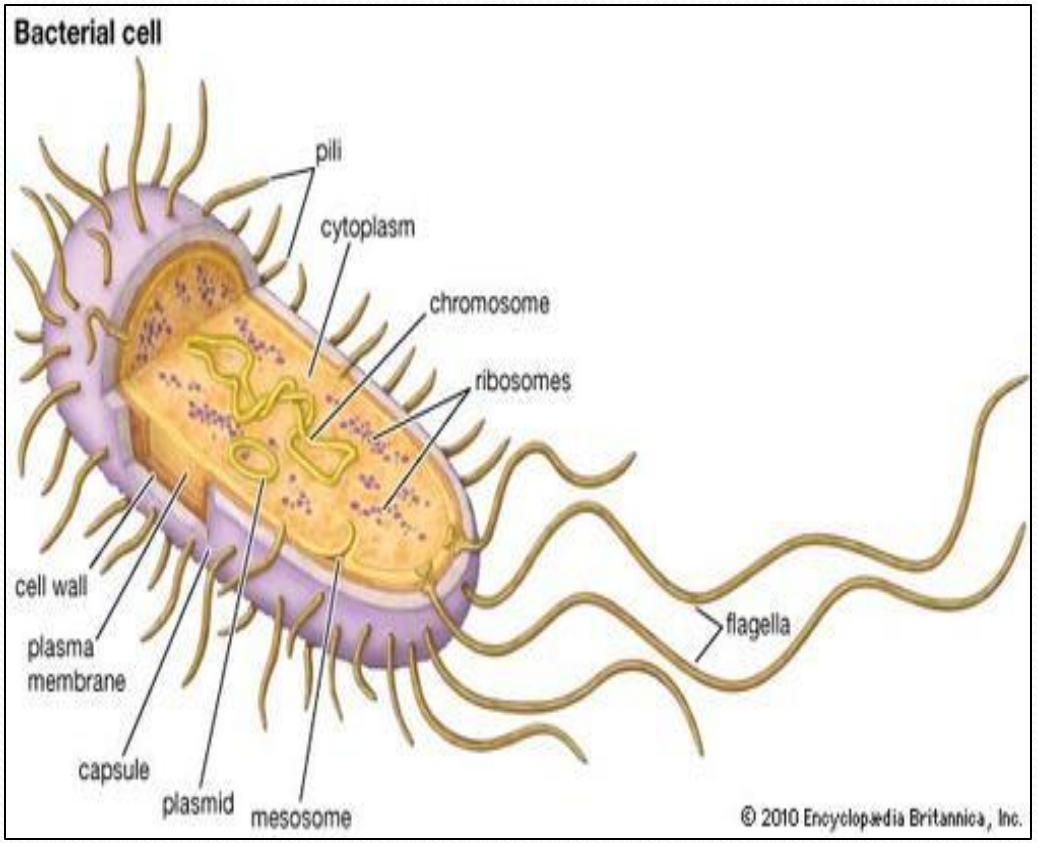


- **Plasma membrane** (phospholipid bilayer and regulates permeability)
- **Genetic material** – DNA
- **Cell Wall** – except animal cells
- **Ribosome** - catalyse protein synthesis
- **Cytoplasm/cytosol** – comprising of water, glucose, proteins and ions.

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

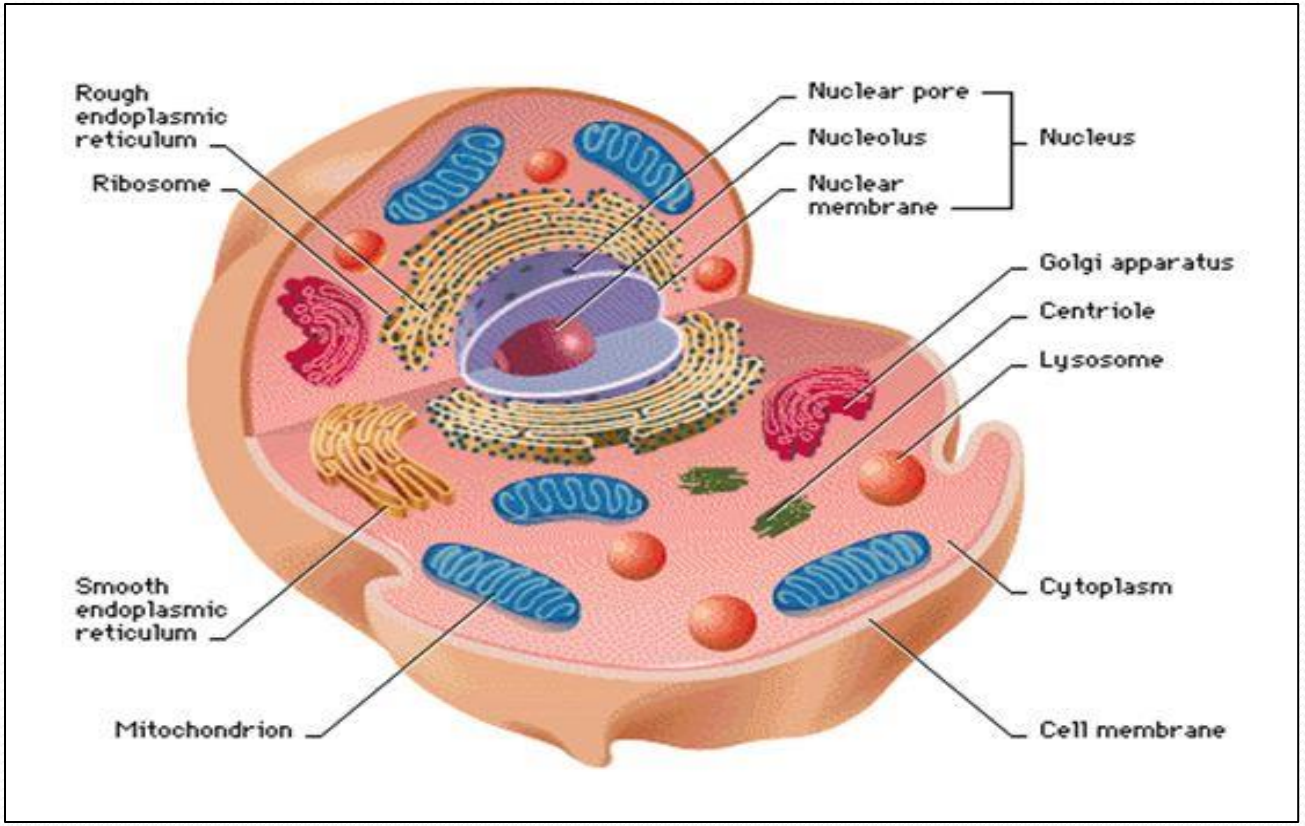


Prokaryotic cells

- **Capsule** – slime layer of mucilage and helps bacteria form colonies.
- **Cell Wall** – Rigid and made up of murein (polysaccharide cross-linked by peptide chains). Gram-positive thicker walls compared to Gram-negative. Protection from lysozymes and penicillin.
- **Flagellum** – Motility of many bacteria
- **Pilli** – protein rods for cell-cell attachment and DNA transfer.
- **Nucleoid** – composed of circular double-stranded DNA.
- **Plasmid DNA** – Short circular DNA and replicates independently of the cell genome.
- **Mesosome** – Folds of the plasma membrane with associated respiration enzymes. Instead of mitochondria.
- **Ribosomes** – Smaller, scattered throughout the cytoplasm

Eukaryotic Cells

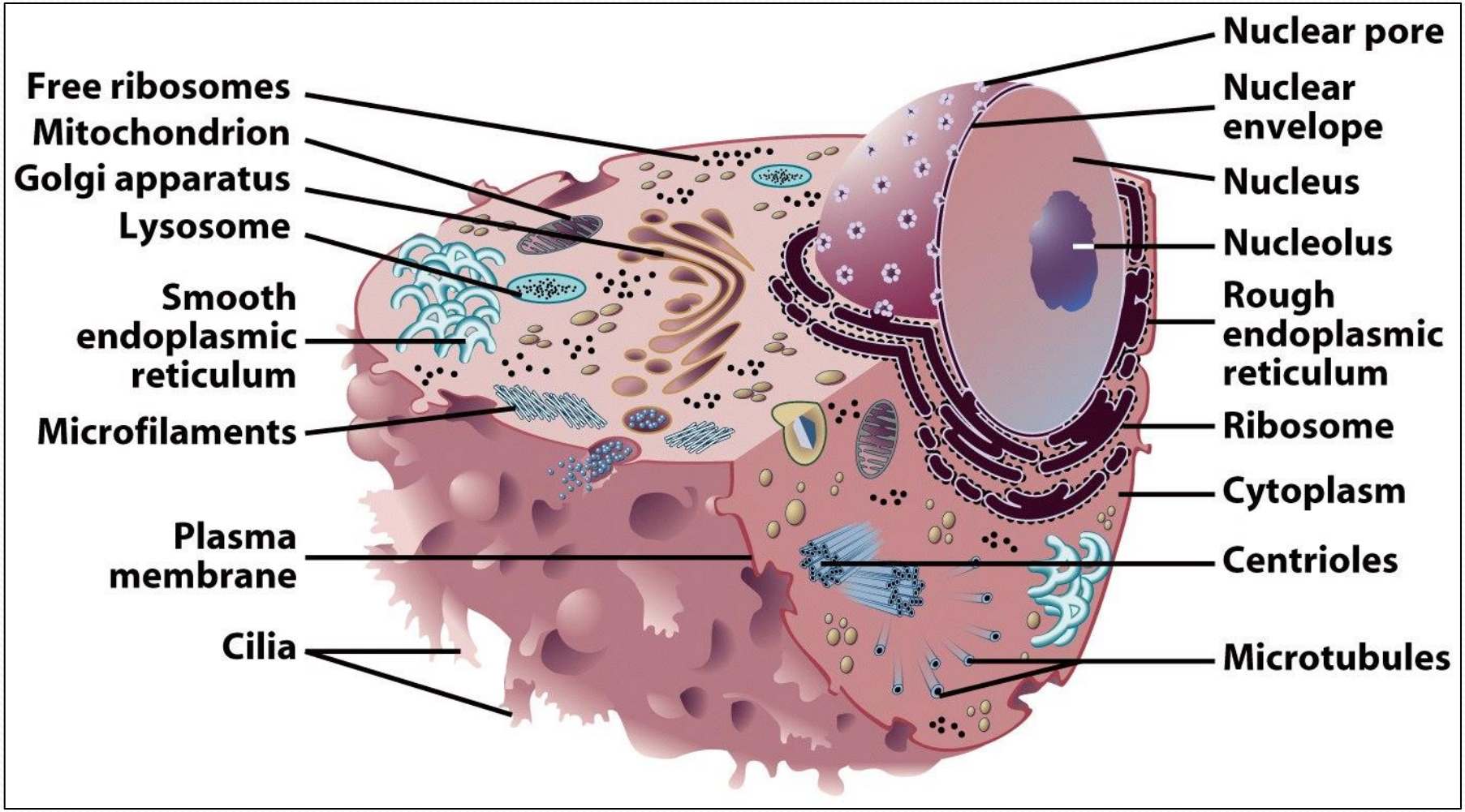
- Nucleus bound by membrane
- Include fungi, protists, plant, and animal cells
- Possess many organelles



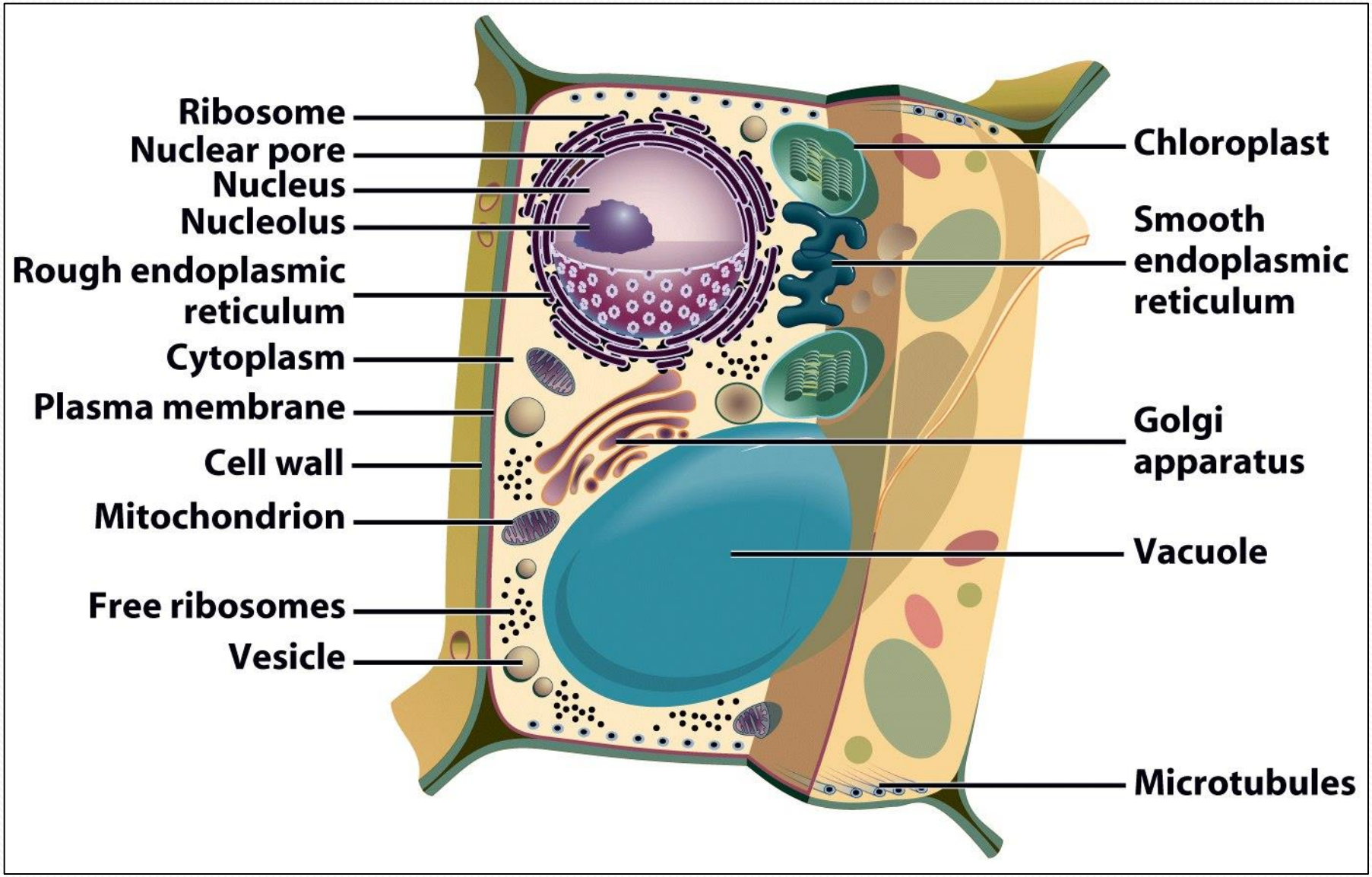
Eukaryotic cells

- **Nucleus** – Cellular DNA. Transcription & processing of RNA. Nuclear pores within the nuclear membrane.
- **Mitochondria** – Cellular respiration, the oxidation of nutrients to generate energy in the form of adenosine 5'-triphosphate (ATP). 1-2mm in diameter. 1000-2000 per cell. Smooth outer membrane & Inner folded membrane (cristae). Derived from prokaryotes and retain DNA (circular), RNA and protein machinery.
- **Endoplasmic Reticulum (ER)** – Cytoplasmic membrane system for lipid biosynthesis and xenobiotic metabolism. Smooth and Rough ER. Rough ER has ribosome attached for protein synthesis.
- **Golgi Apparatus** – Protein and lipids produced are packaged in the Golgi for final destination.
- **Lysosomes** – Small membrane-bound organelles & bud off from the Golgi. Consist of degradative enzymes for proteins, nucleic acid, lipids and carbohydrates (macromolecules).
- **Centrioles** – Regulator of the cell cycle and cytoskeletal organisation.

Animal Cell


Free ribosomes
Mitochondrion
Golgi apparatus
Lysosome
Smooth endoplasmic reticulum
Microfilaments
Plasma membrane
Cilia
Nuclear pore
Nuclear envelope
Nucleus
Nucleolus
Rough endoplasmic reticulum
Ribosome
Cytoplasm
Centrioles
Microtubules

Plant Cell


Ribosome
Nuclear pore
Nucleus
Nucleolus
Rough endoplasmic reticulum
Cytoplasm
Plasma membrane
Cell wall
Mitochondrion
Free ribosomes
Vesicle
Chloroplast
Smooth endoplasmic reticulum
Golgi apparatus
Vacuole
Microtubules

History of Cell Biology: Timeline

1595 – *Jansen:* developed the first light microscope
1655 – *Hooke:* described 'cells' in cork.
1833 – *Brown:* described the cell's nucleus from the orchid.
1839 – *Schleiden & Schwann:* proposed cell theory (all organisms are comprised of cells).
1858 – *Rudolf Virchow*: omnis cellula e cellula - cells develop only from pre-existing cells by a process called cell division
1894 – *Altmann:* first described mitochondria.
1874 – *Flemming:* described chromosome behaviour during mitosis.
1898 – *Golgi:* described the Golgi apparatus.
1925 – *Gorter & Grendel:* described the basic structure of the plasma membrane.
1945 – *Porter et al.* pioneers in this field of electron microscopy and were the first to identify the endoplasmic reticulum and many elements of the cytoskeleton.

Question : Name these organelles