

GENERAL BIOLOGY 1

Course code: BIO 101

Credit units: 2

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Office:	COAES Building, Room 36
Office hours:	8 am – 5 pm

Recommended text

- **Taylor, D.J., Green, N.P.O and Stout, G.W. (2010). *Biological Sciences*. Cambridge University Press, 10th Edition, South Africa.**
- **Jones, M., Fosbery, R., Gregory, J. and Taylor, D. (2014). *Cambridge International AS and A Level Biology*. Cambridge University Press, 4th Edition, United Kingdom**

Course Outline

❖ **Cell structure and organization**

❖ **Characteristics of living things**

❖ **Classification of living things**

Cell structure and organization

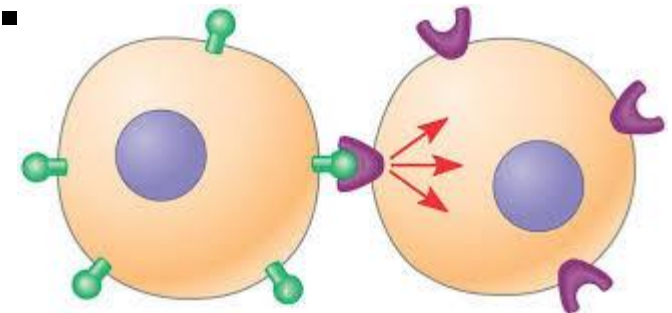
Learning Objectives

At the end of the class, the students should understand:

- ✓The biological cell,**
- ✓The cell theory**
- ✓Features of cells**
- ✓Cell organelles and their functions**

Introduction

- **All living things are made up of cells**
- **Cells are composed of:**
 - **genetic material,**
 - **cytoplasm,**
 - **ribosomes**
 - **cell membrane**
- **Cell communicates with one another.....**



Introduction

- **Robert Hooke (1665) examined thin slices of the bark of plant and he saw 'pore like' regular structures – 'cella'.**
- **The cell looks like an empty box surrounded by a wall.**



Robert Hooke's cells

The cell theory

- **Matthias Schleiden and Theodor Schwann found the cell theory (1838):**

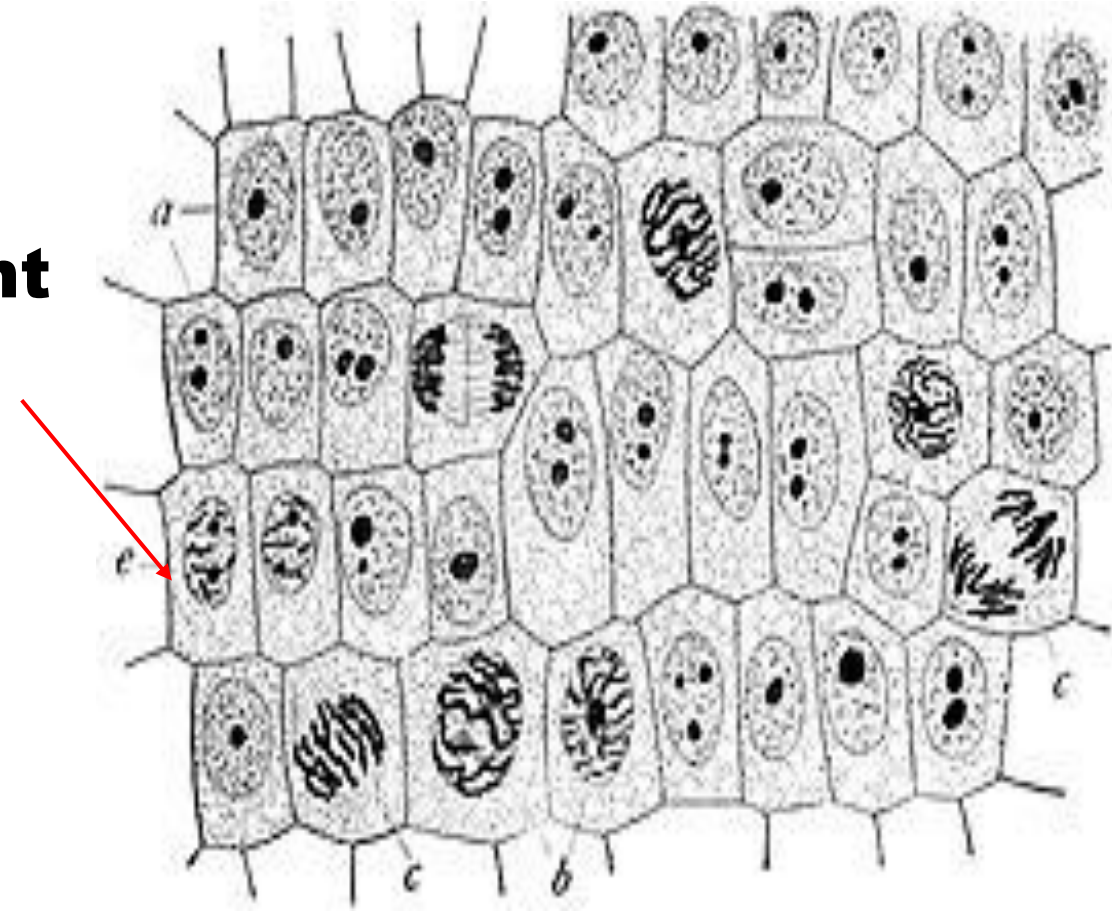
- 1. All organisms are made up of cell.**
- 2. Cell is the basic unit of structure and function of all living organisms.**

- **Rudolf Virchow (1855) proposed the third theory:**

- 3. All cells arise from pre-existing cells by cell division.**

What is a cell?

- A bag - the **chemistry** of life, **separated** from the outer environment by a **thin membrane**.



- It is the fundamental unit (i.e. building block) of all living organisms.
- A cell contains organelles which provide the necessary functions to sustain itself.

- **Two categories**
 - a) **Prokaryotes**
 - b) **Eukaryotes**

Differences – nuclear membrane, genetic material, organelles, ribosomes, and size.

Cytology - study of the structure and components of cell.

Cells can be study using microscope, such as the light and electron microscopes

Edouard Chatton (1937) first distinguished the two cell types:

- **The Prokaryotes – pro (before); karyote (nucleus)**

Single cell – mainly bacteria and archaea

- **The Eukaryote – eu (true); karyote (nucleus)**

The animal, plant, fungi and protists

Later adopted by Roger Stanier and Van Niel in 1962.

What are the common features between the prokaryotic and eukaryotic cells?

Prokaryotes

- 1. Do not have true nucleus
(chromosomes are not surrounded by a membrane)**
- 2. The organelles are not membrane bound**
- 3. The cells are usually smaller in size.**
- 4. Haploid chromosomes are present.**
- 5. Have 70S ribosome**
- 6. Many surrounded by cell wall.**
- 7. All genetic information is in a single thread of DNA**

Eukaryotes

Possess true nucleus (the chromosomes are surrounded with a membrane)

The organelles are bounded by membrane

Cells are usually larger and multicellular

Diploid chromosomes are present

Have 80 s ribosome

Plant cell and fungi has cell wall

Genetic materials are enclosed in the nucleus

Virus?

- **No cell structure – no membrane containing cytoplasm with ribosomes.**
- **Many contain genetic material (DNA or RNA) and a protective coat of protein molecule (capsid).**
- **Viruses range in size (20-300 nm).**

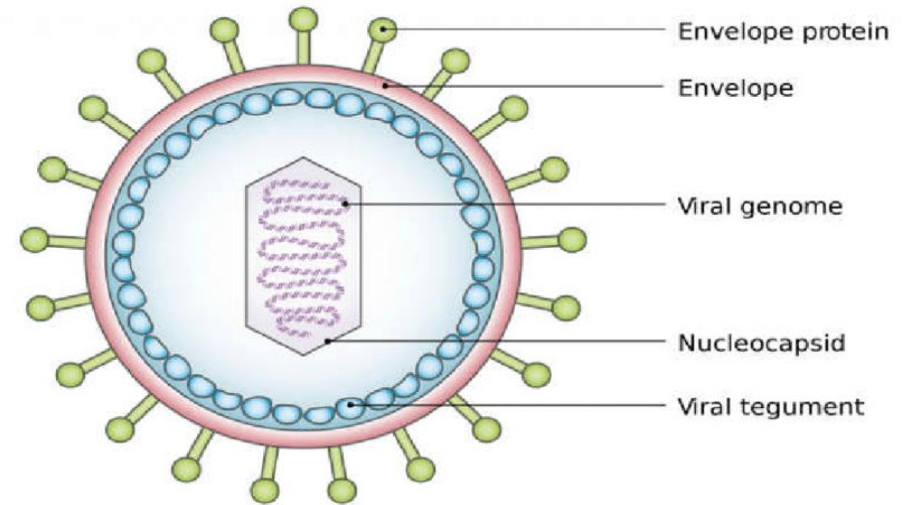
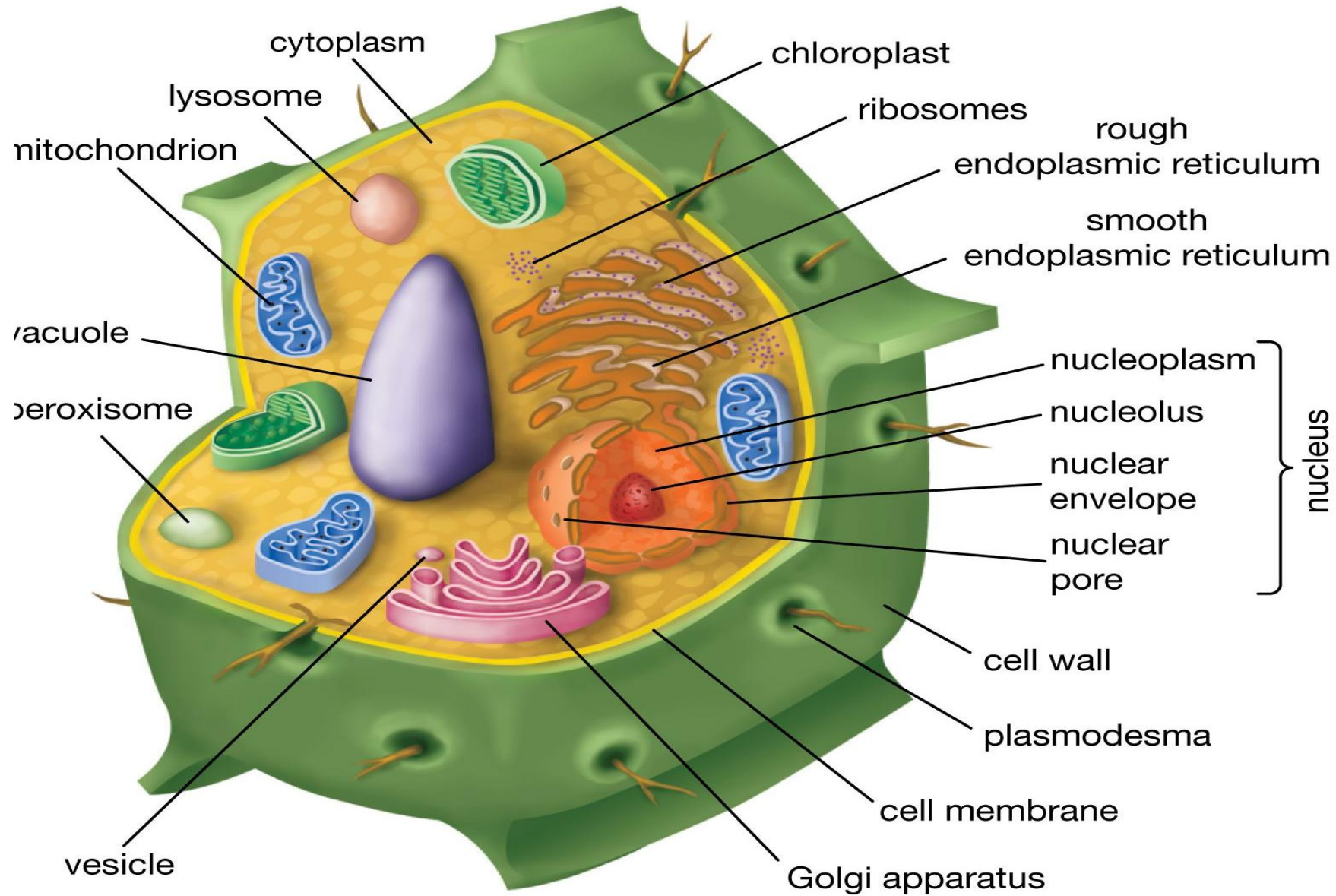


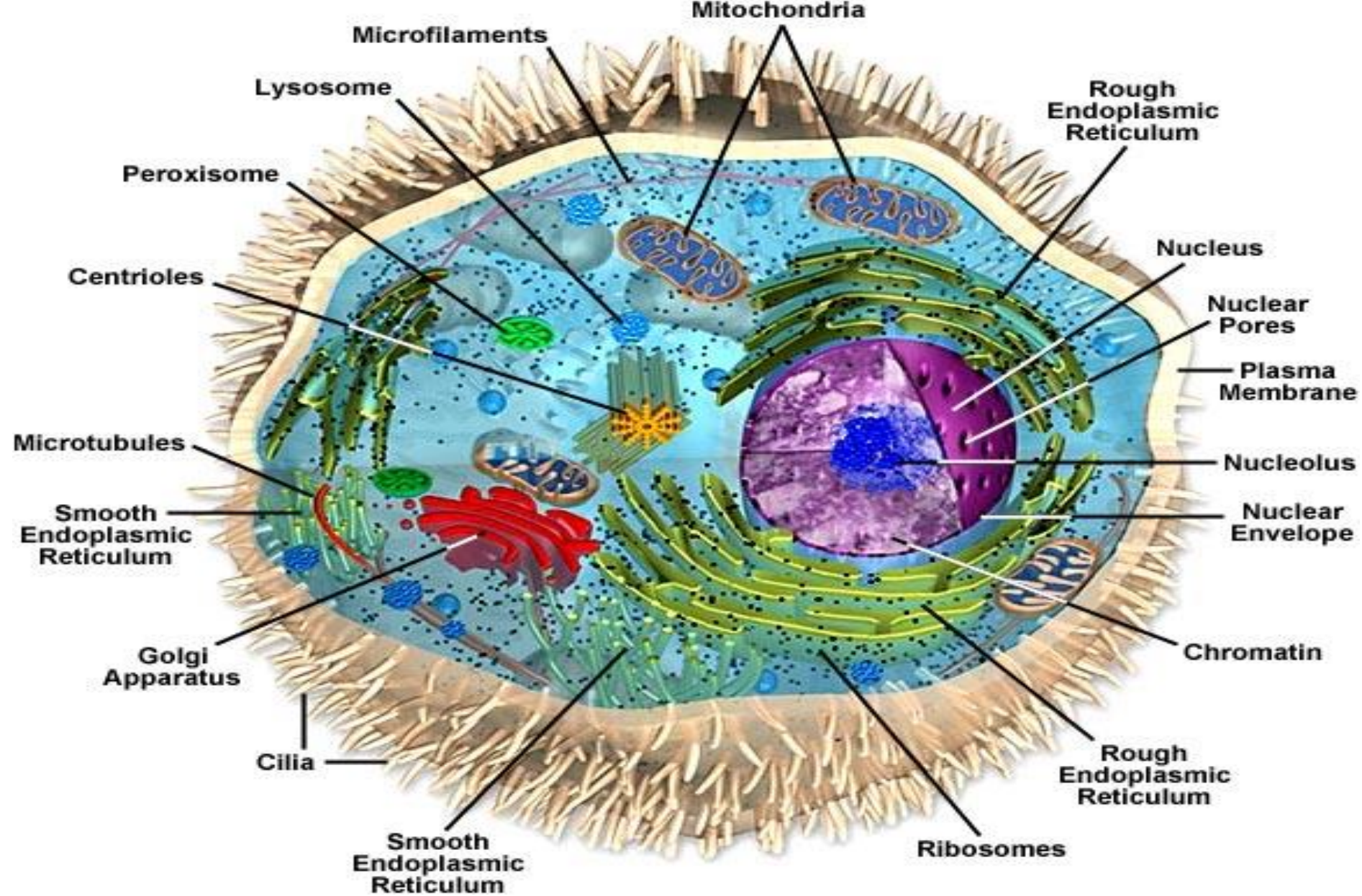
Image source: https://www.researchgate.net/figure/Basic-structure-of-a-virus-Taylor-2019_fig2_340249925

- **All are parasitic because they can only reproduce by infecting and taking over living cells**



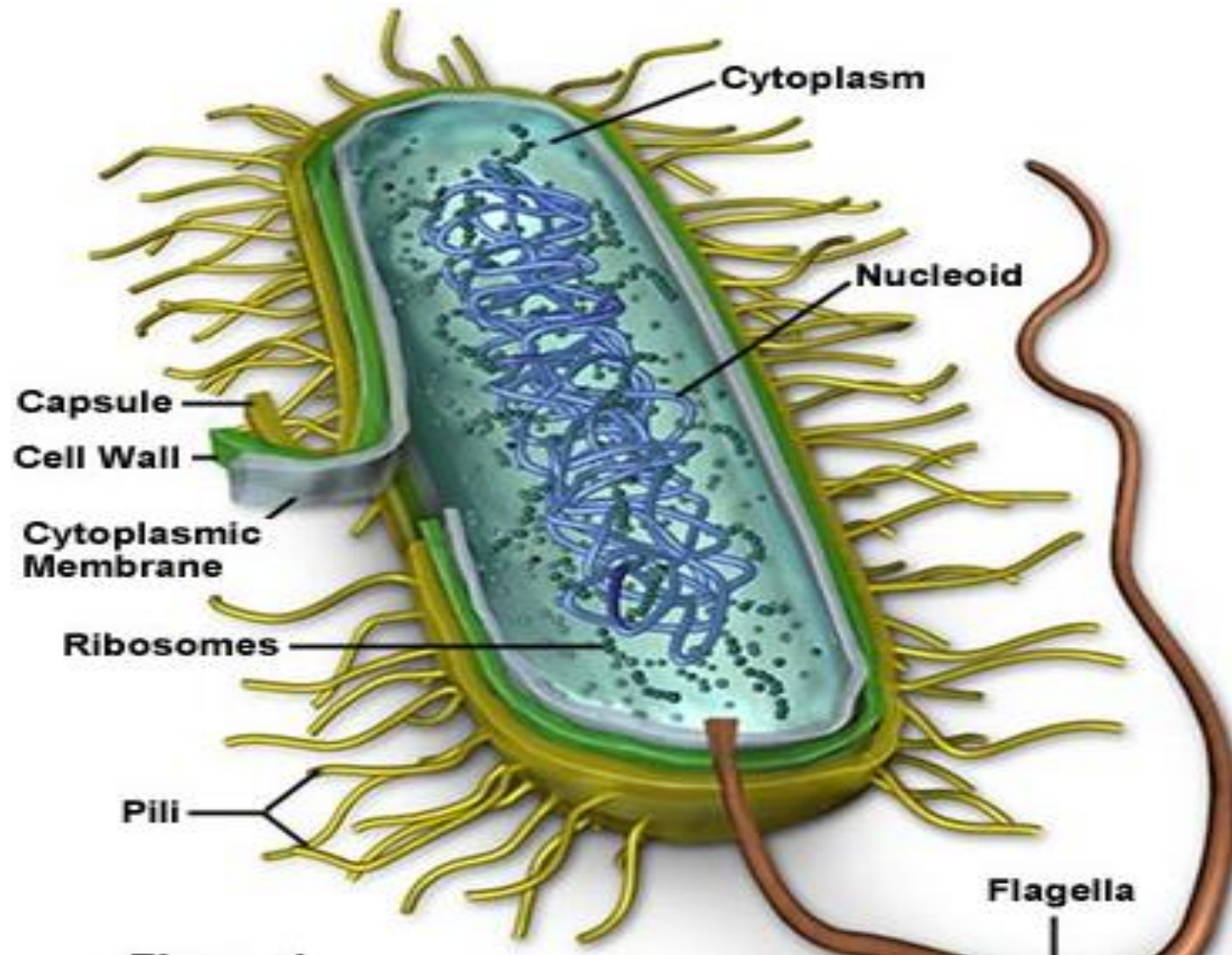
Plant cell

Image source: <https://www.britannica.com/science/plant-cell>



Animal cell

Image source: <https://micro.magnet.fsu.edu/cells/bacteriacell.html>



Bacteria cell

Common features in animal and plant cells

❖ Small structures within the cell - organelles:

- **Cell membrane**

- **Nucleus**

- **Golgi bodies**

- **Endoplasmic reticulum**

- **Cytoskeletons**

Cytoplasm

Mitochondria

Vacuole

Ribosomes

Differences - animal and plant cells

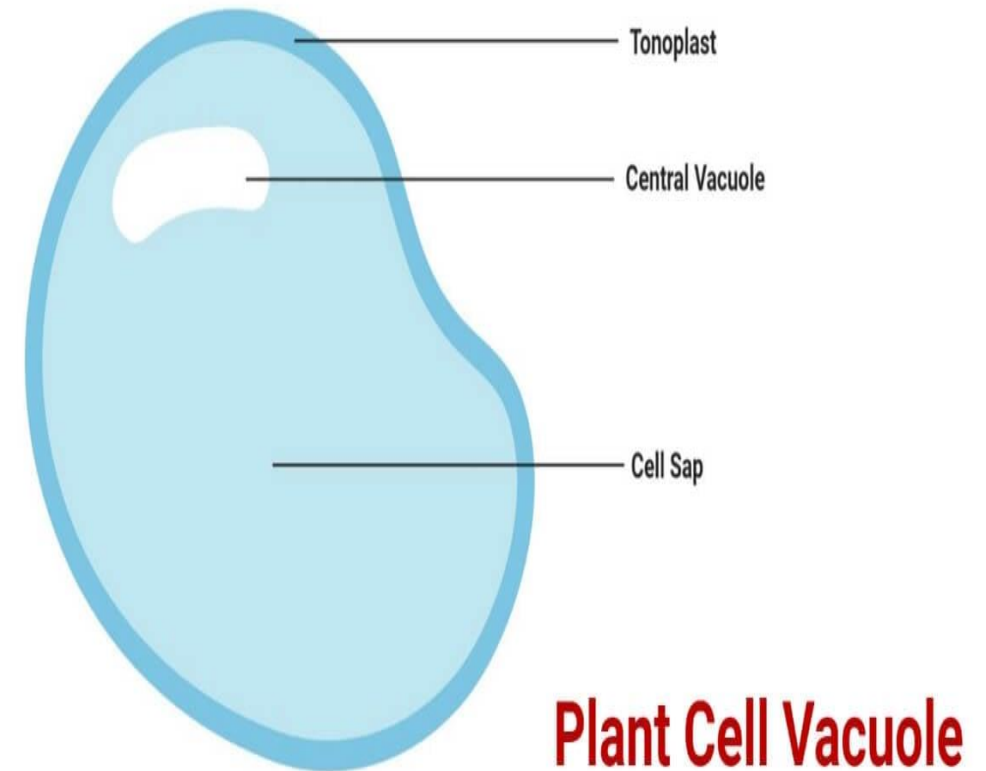
- Structures commonly found in animal cells but **ABSENT** in plant cells - **centriole, microvilli**.
- Plant cells possess **cell walls, large permanent vacuoles and chloroplasts**.

Cell wall and plasmodesmata

- Cell wall gives the definite shape.
- Prevents bursting during osmosis.
- Plant cells are linked to one another by **plasmodesmata** (singular: plasmodesma)

Vacuoles

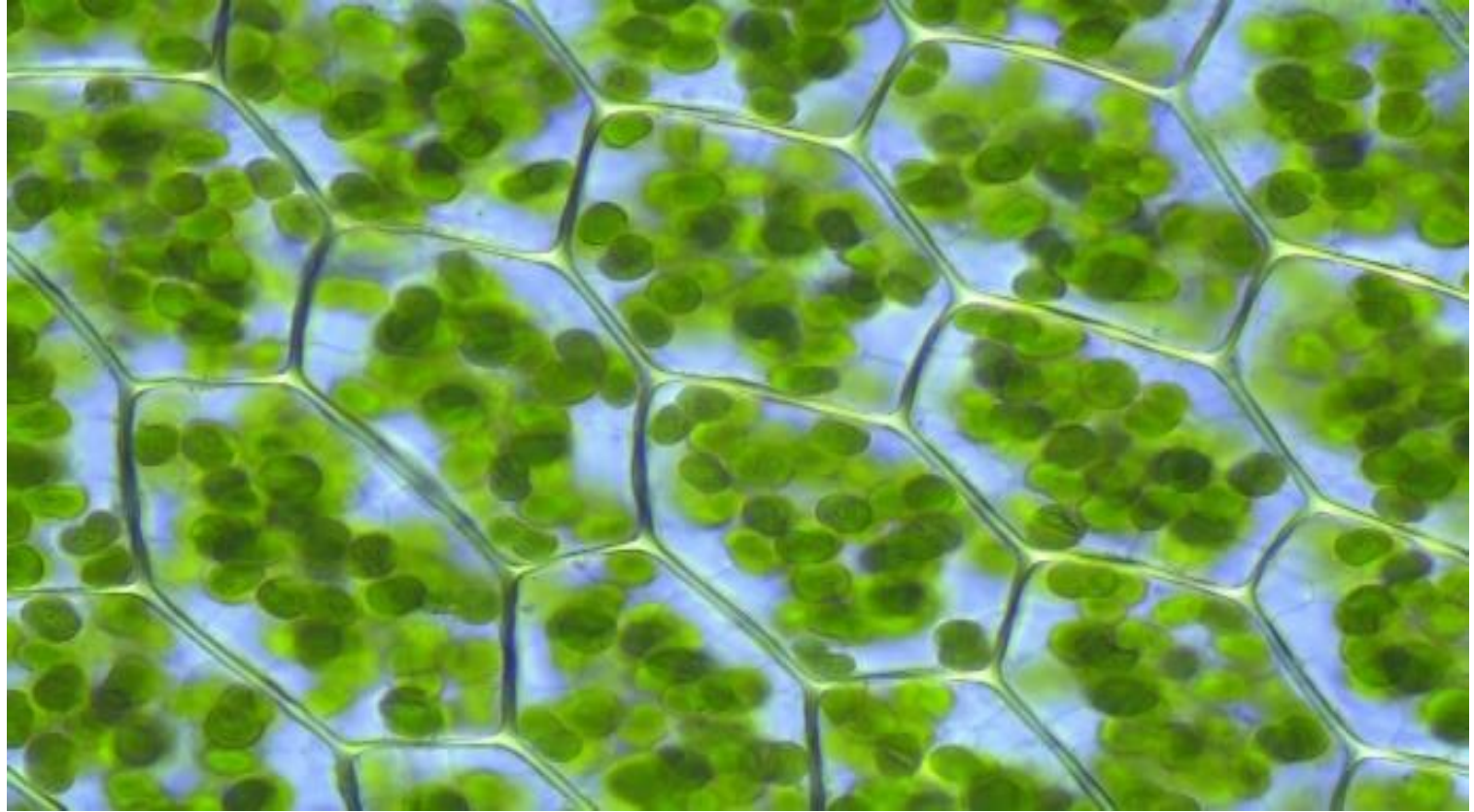
- **Plant cells often possess a large, central vacuole, surrounded by a tonoplast.**



- **The fluid in the vacuole contain pigments, enzymes, sugars, organic compounds, mineral salts, oxygen and carbon dioxide.**
- **Vacuoles - regulate the osmotic pressure within the cell.**

Chloroplasts

- **Found in the green parts of the plant.**
- **Contains the chlorophyll (green pigment which absorbs light during photosynthesis).**

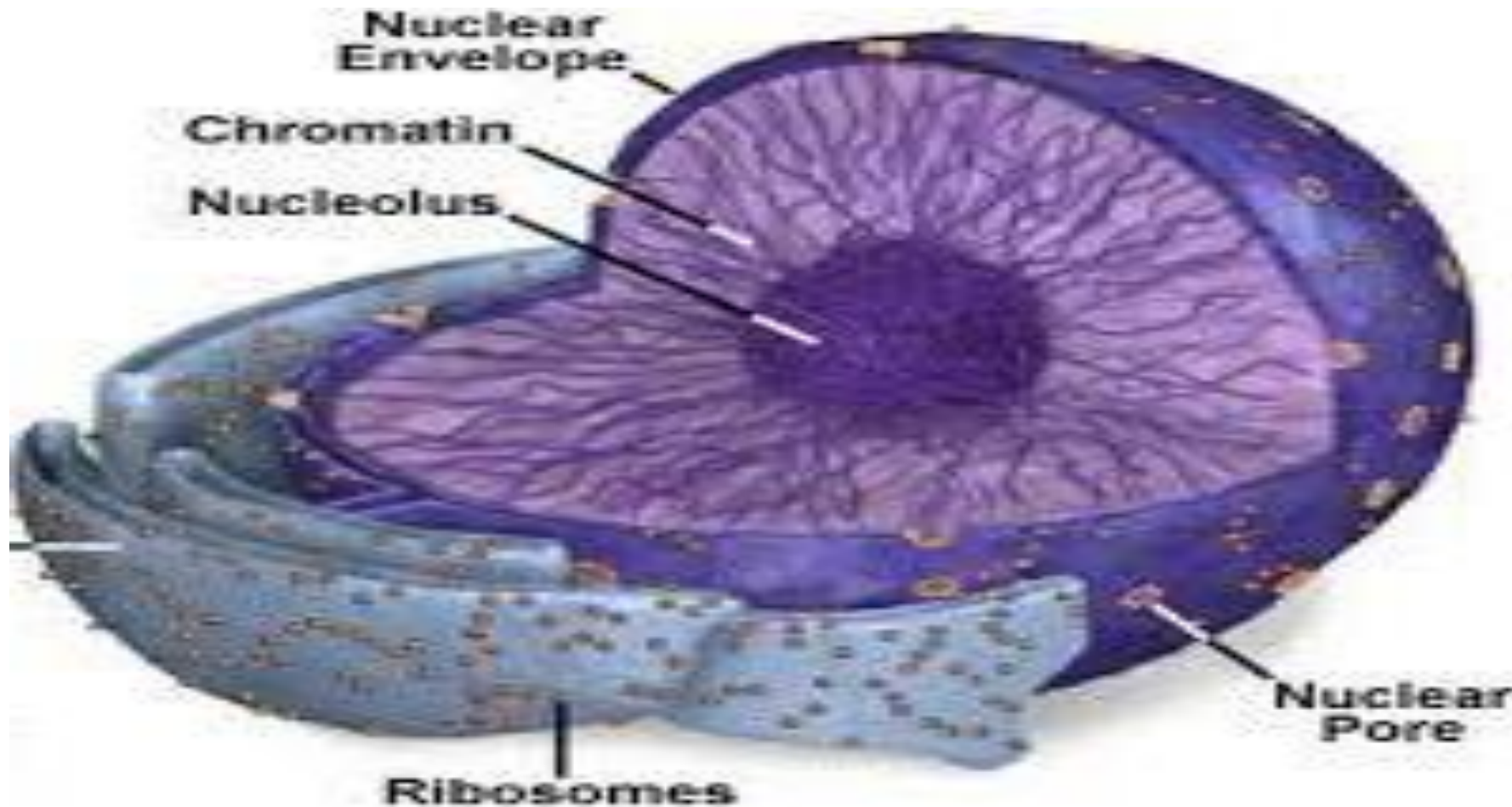


Structures and functions of organelles

Nucleus

- The largest cell organelle surrounded by two membranes (**nuclear envelope**).
- The outer membrane of the nuclear envelope is continuous with the **endoplasmic reticulum**.
- The nuclear envelope has many small pores called nuclear pores for exchange of materials between the nucleus and the cytoplasm (**mRNA, ribosomes, nucleotides, ATP, thyroid hormone T3**).
- Chromosomes are loosely coiled (chromatin) within the nucleus.
- Chromosomes contain DNA, which is organized into functional units called **genes**.
- Genes control the activities of the cell and inheritance -the nucleus controls all the activities in the cell.

- **The nucleus divide first prior cell division.**
- **The nucleolus use the information in its own DNA to make ribosomes.**

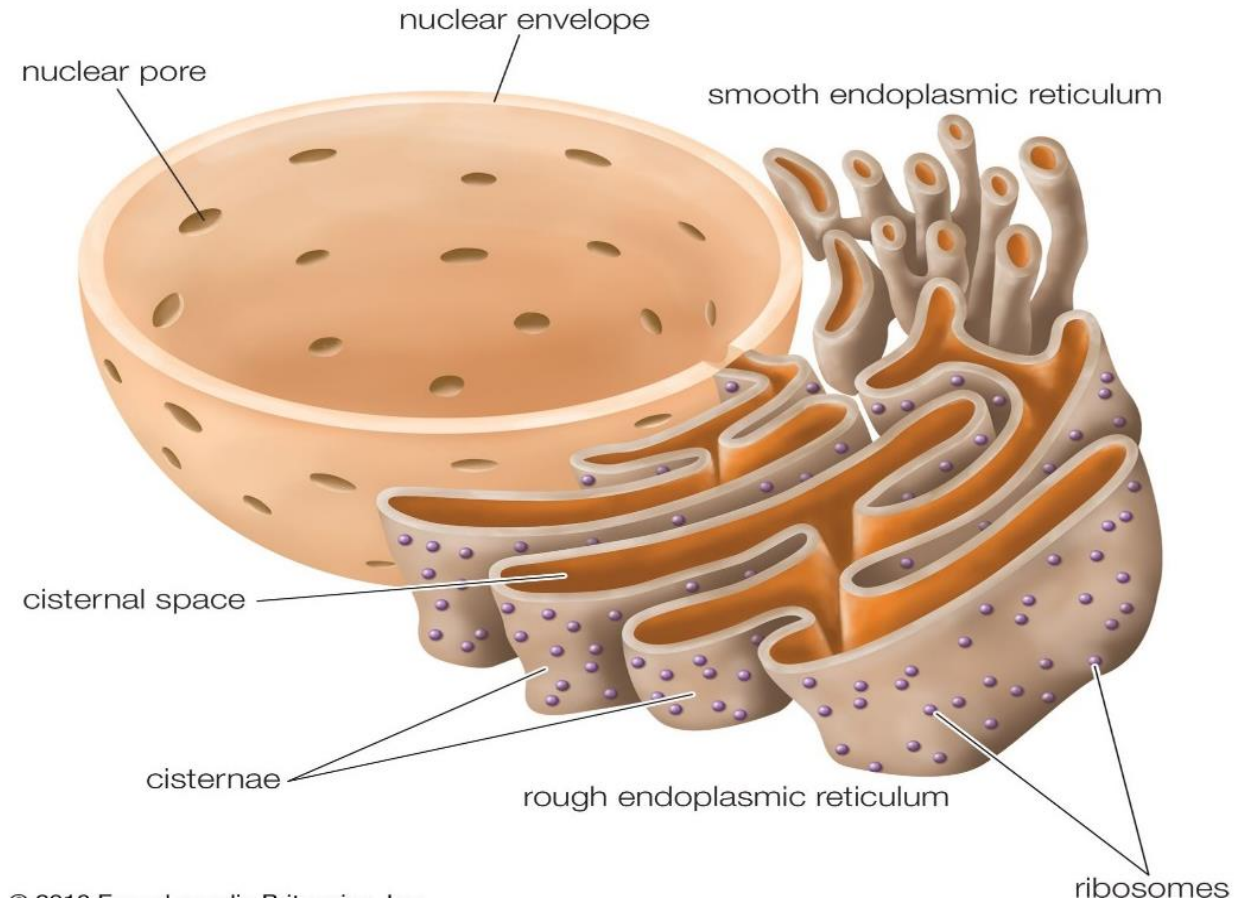


Nucleus

Image source: <https://micro.magnet.fsu.edu/cells/nucleus/nucleus.html>

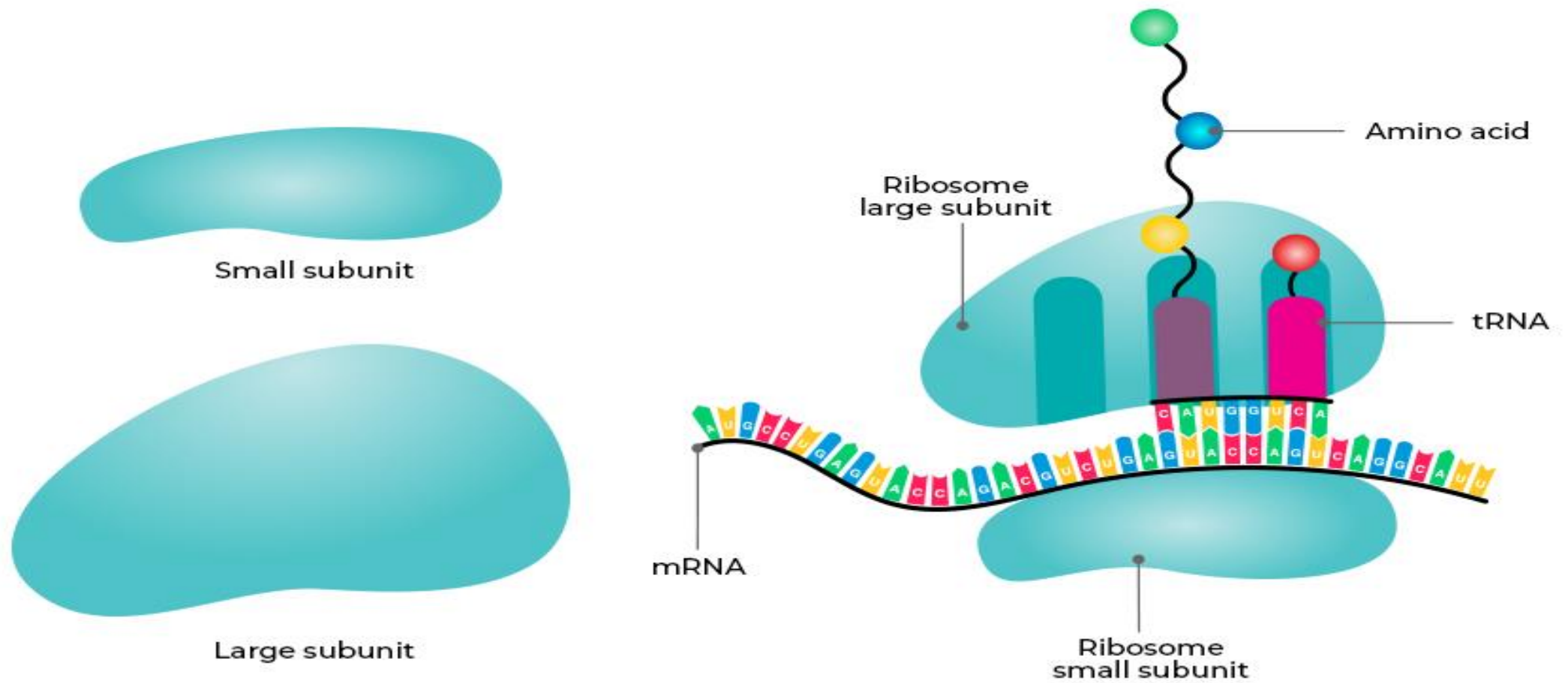
Endoplasmic reticulum and ribosomes

- **The endoplasmic reticulum (ER) is a tubular network of membranes that extends through the cytoplasm.**
- **Interconnected to form the reticulum.**
- **The ER is continuous with the outer membrane of the nuclear envelope.**



- **ER can be rough ER or smooth ER.**
- **Rough ER is covered with many tiny organelles called **ribosomes**.**
- **Ribosomes (about 25 nm) are the sites for protein synthesis.**
- **Ribosomes can be found freely in the cytoplasm and on the rough ER.**
- **Ribosomes on the ER gives rough appearance of the rough ER.**
- **Ribosomes are made of RNA (ribonucleic acid) and protein.**

- **Ribosomes – needed for protein synthesis (for growth, development and metabolism).**
- **Proteins are essential for all cellular functions.**
- **Translate messenger RNA (mRNA) into proteins by assembling amino acids in a sequence dictated by the mRNA's nucleotide sequence.**
- **Made up of two subunits: a small subunit and a large subunit.**
- **The small subunit binds to messenger RNA (mRNA), which contains the genetic code for the protein. The large subunit adds amino acids to the growing protein chain.**



Ribosome

Image source: <https://www.geeksforgeeks.org/interesting-facts-about-ribosomes/>

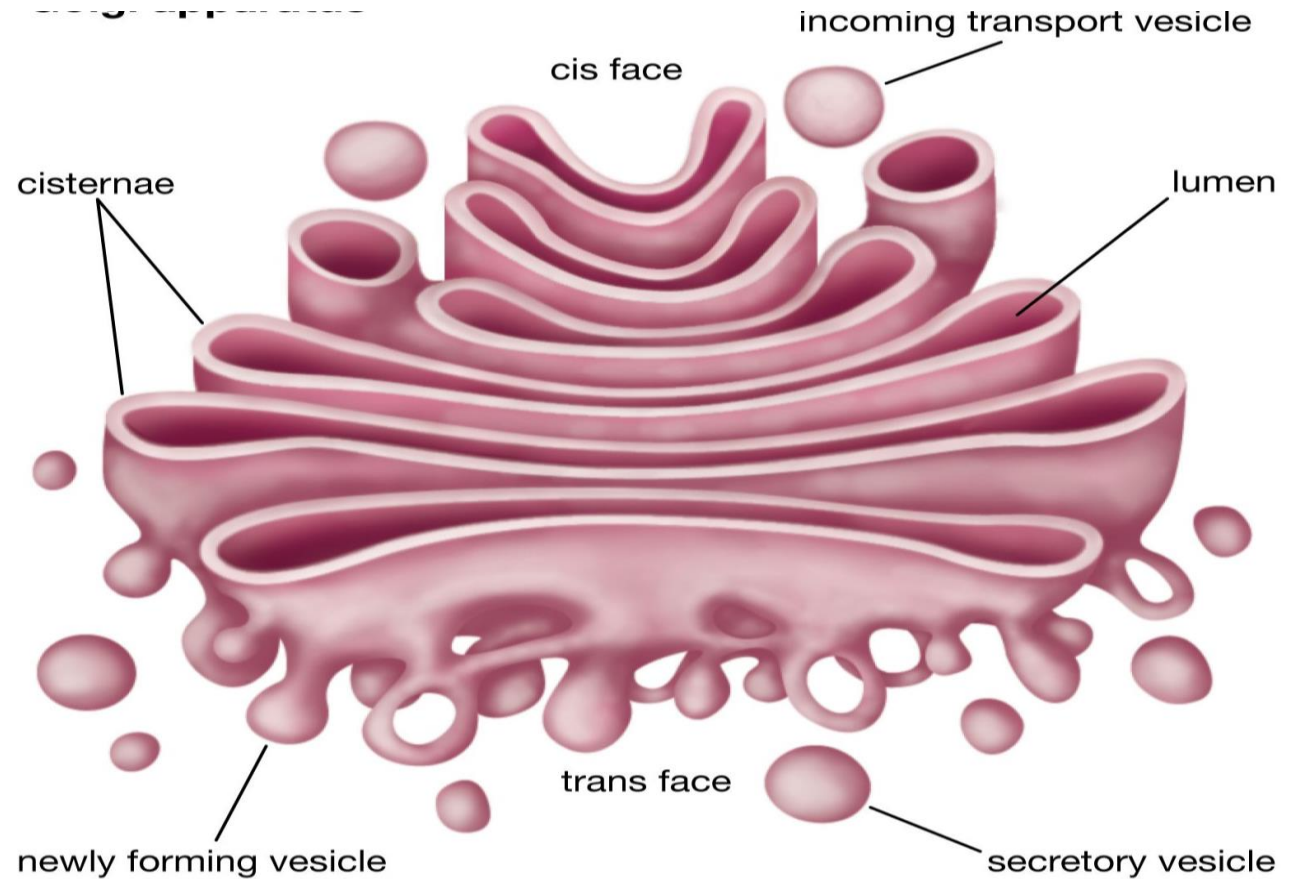
- **The human cell may have thousands to millions of ribosomes.**
- **Prokaryotic has 70S, while eukaryotic 80S ribosomes.**
- **It can disassemble and reassemble to regulate protein synthesis.**
- **Dysfunction/mutations in ribosomal proteins or rRNA are associated with some human diseases, certain cancers, and genetic disorders (ribosomopathies).**
- **Some antibiotics (e.g. tetracycline, erythromycin, and streptomycin) target bacterial ribosomes, inhibiting protein synthesis and thereby killing or inhibiting their growth**

- **Proteins on the rough ER enter the sacs and move through them.**
- **Small sacs called vesicles can break off from the ER and these can join together to form the Golgi body.**
- **Smooth ER do not have ribosomes attached to it.**
- **The ER serves for storage, synthesis of protein and metabolism of lipids.**

Golgi body (Golgi apparatus/complex)

- **The Golgi body is a stack of flattened sacs, may be more than one in a cell.**
- **The stack is formed at one end from vesicles which bud off from the ER.**
- **The stack of sacs together with the associated vesicles is referred to as the Golgi apparatus or Golgi complex.**
- **The Golgi body collects (e.g. protein) from the rough ER and transport it via the Golgi vesicles to other parts of the cell or out of the cell (secretion).**
 - For example, Golgi body add sugars to protein to make – glycoprotein; removes the amino acid methionine from newly formed proteins to make a functioning protein.

- In plants, enzymes in the Golgi body convert sugars into cell wall components.
- Golgi vesicles are also used to make lysosomes

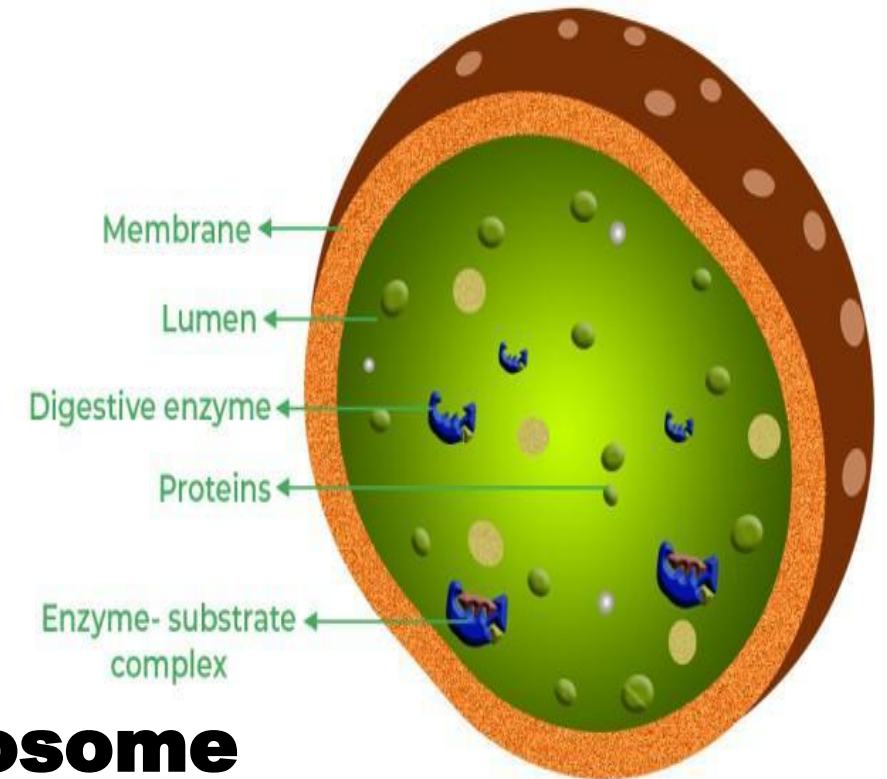


Golgi apparatus

Image source: <https://www.britannica.com/science/plant-cell>

Lysosomes

- **They are spherical sacs, surrounded by a membrane layer (about 0.1– 0.5 μm).**
- **Lysosomes breakdown (digestion) unwanted materials (e.g. old organelles).**
- **Forms phagolysosome in white blood cells to digest pathogens.**
- **Also, sperm cell contain acrosome (a kind of lysosome), for digesting a path to the ovum.**

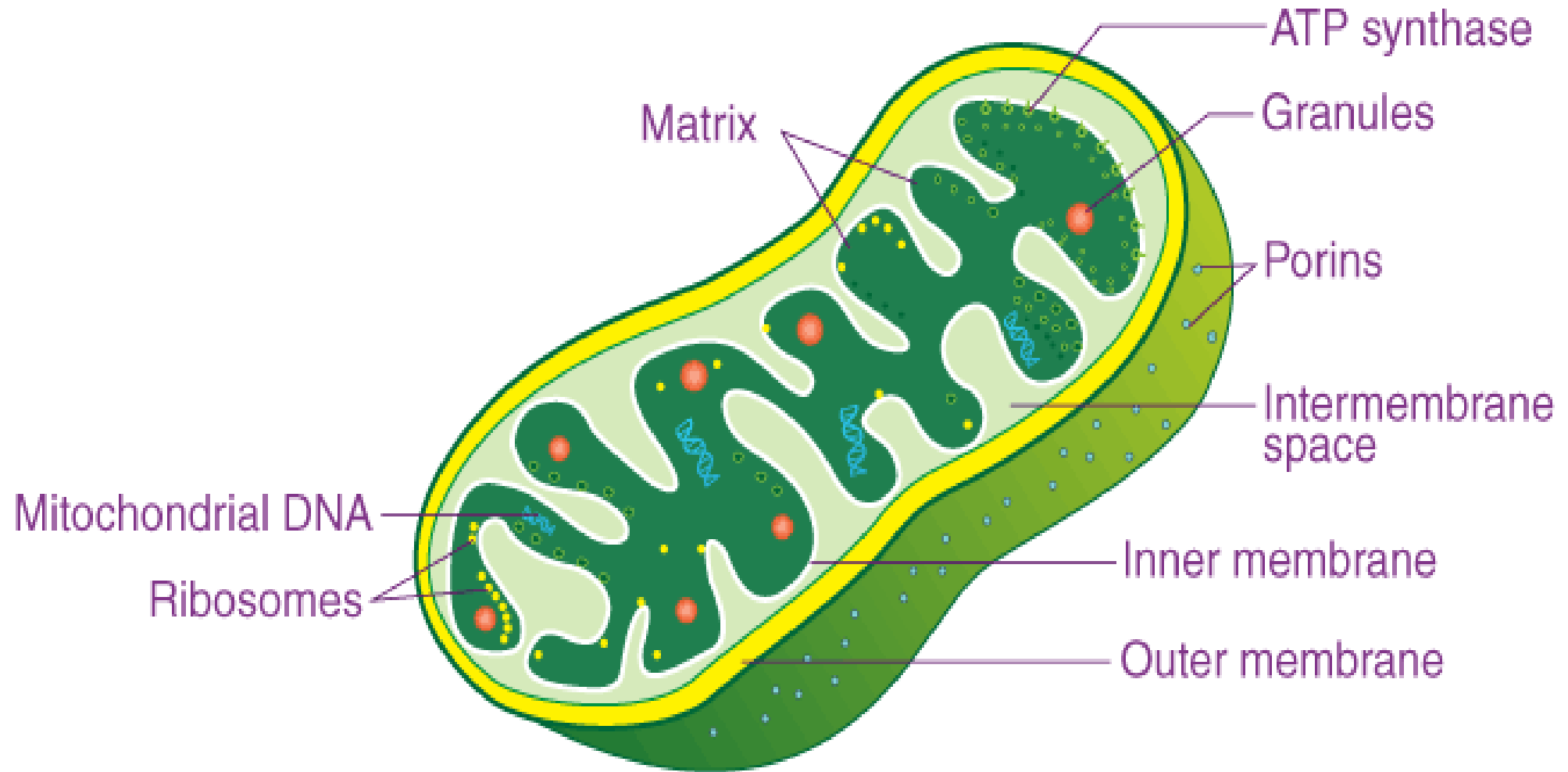


Lysosome

Mitochondria

- **The mitochondria (0.75 – 3 μm) often appear as oval-shaped, surrounded by two membranes.**
- **It is the power houses of the cell.**
- **It generate the energy currency of the cell (adenosine triphosphate); also in signaling between cells and cell death (apoptosis).**
- **The inner membrane is folded to form finger-like cristae and an interspace between the two membranes.**
- **The number of mitochondria in a cell is dependent on the energy demand (liver - >2,000; RBC - none).**

ATP is produced in the mitochondria (via Kreb's cycle).



Mitochondrion

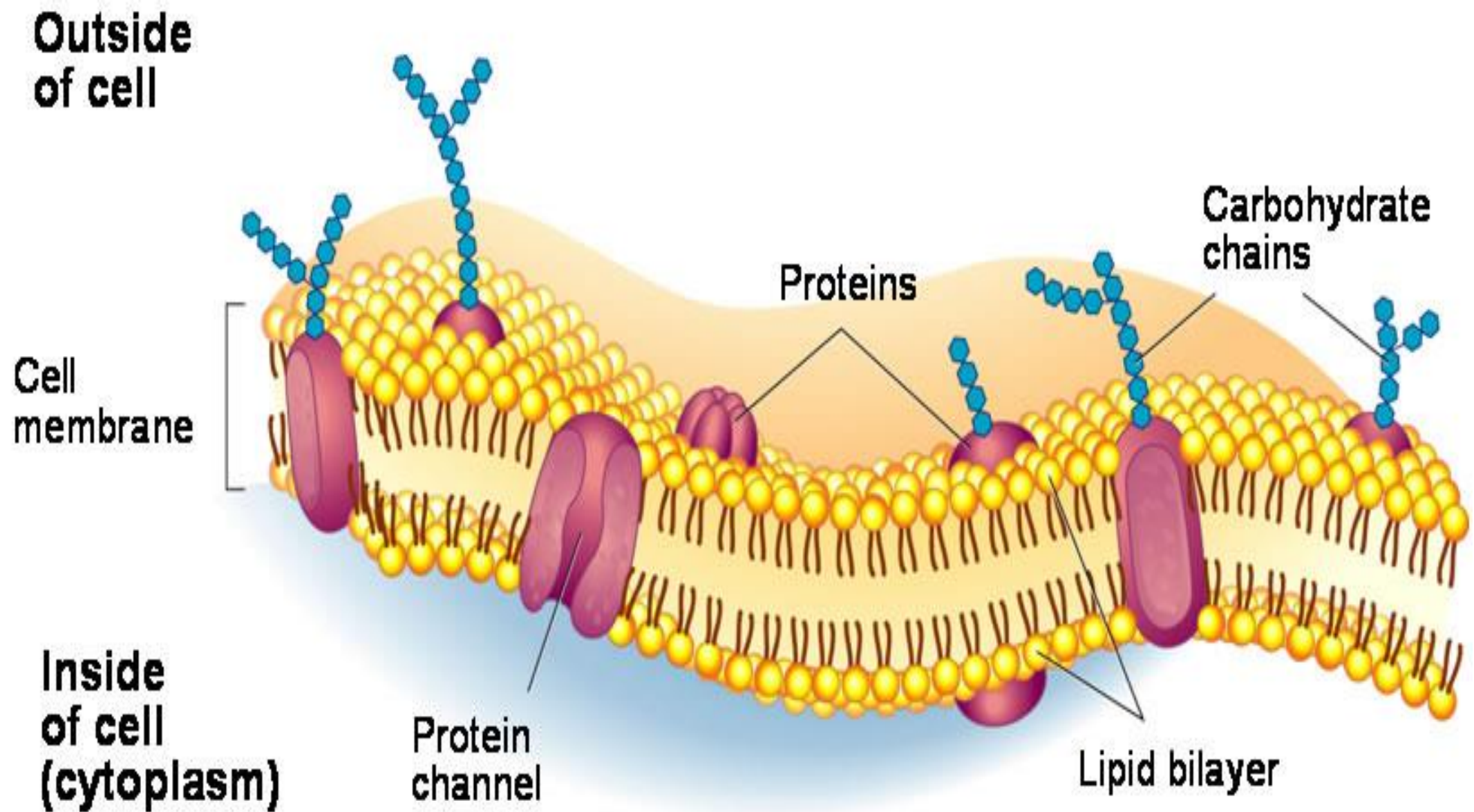
Image source: <https://byjus.com/biology/mitochondria/>

Cell membrane

A semi-permeable thin layer that surrounds the cytoplasm of a cell.

- **Functions of the cell membrane**

- **Mechanical barrier (protects the contents of the cell).**
- **Selectively permeable (controls the movement of substances).**
- **Transportation of materials (transportation of nutrients and waste products).**
- **Signaling and receptor site (cell to cell communication).**
- **Some metabolic activity (e.g. respiration, secretion, absorption).**



Fluid mosaic structure of the membrane

Microvilli (only in animal cell)

- **Microvilli (singular: microvillus) - finger-like extensions of the cell surface membrane.**
- **To increase the surface area of the cell surface membrane**
(absorption in the gut; reabsorption in the proximal convoluted tubules of the kidney).

Microtubules and microtubule organizing centres (MTOCs)

- **Microtubules - long, rigid, hollow tubes (25 nm).**
- **Microtubules are made of a protein called tubulin.**
- **Microtubules + actin filaments + intermediate filaments = cytoskeleton.**
- **The cytoskeleton determines the cell's shape.**
- **Membrane bound organelles are held in place by the cytoskeleton.**
- **The microtubules form part of the structure of centrioles.**
- **The MTOCs controls the assembly of microtubules from tubulin molecules**

Peroxisome

- **The peroxisome oxidizes and breakdown fatty acids and amino acids.**
- **Also help to detoxifies poisons in the cell.**